

# KOA Europe GmbH

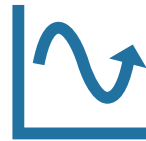
**Improving EV-Chargers  
by choosing  
Special Resistor Solutions**



25-01-2022



Introduction



Pulse Proof  
Resistors

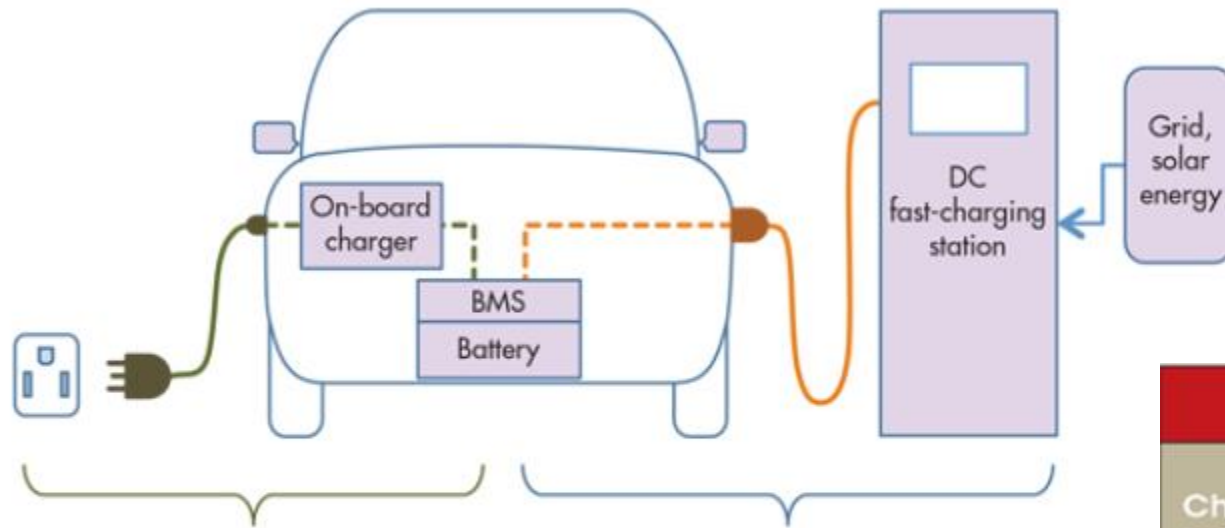


High Precision  
Resistors



Current Measurement  
Resistors

## AC or DC



### AC charging

- Every vehicle has an on-board charger.
- Limited power, slow charging.

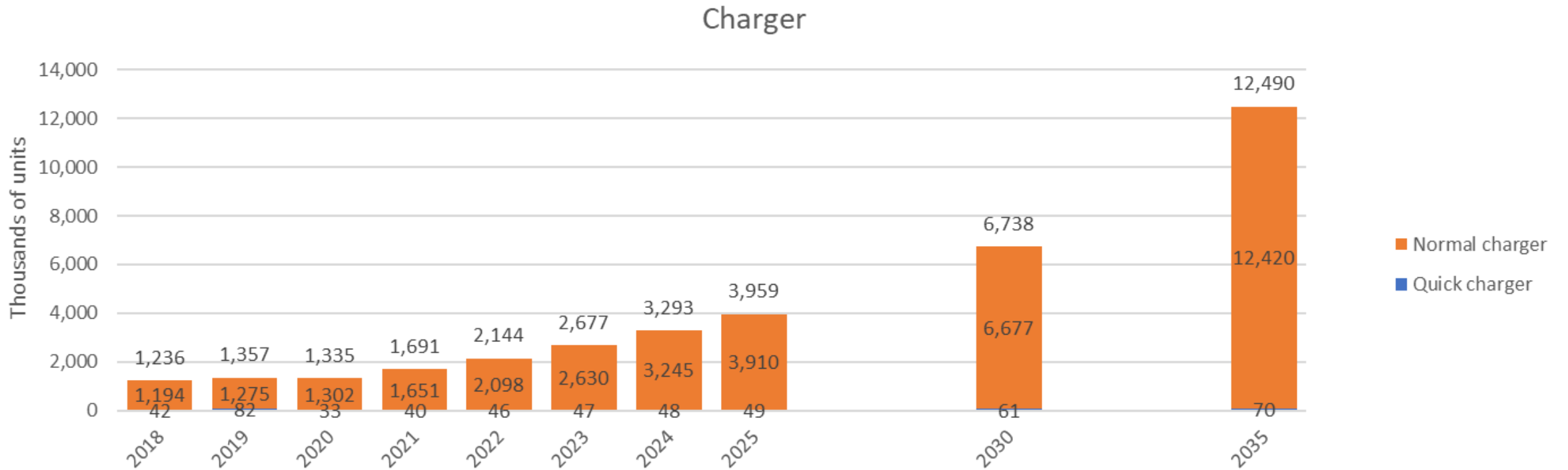
### DC charging

- Infrastructure investment is shared among hundreds of users.
- Large power rating, fast charging.
- Capable of integration with renewable resources.

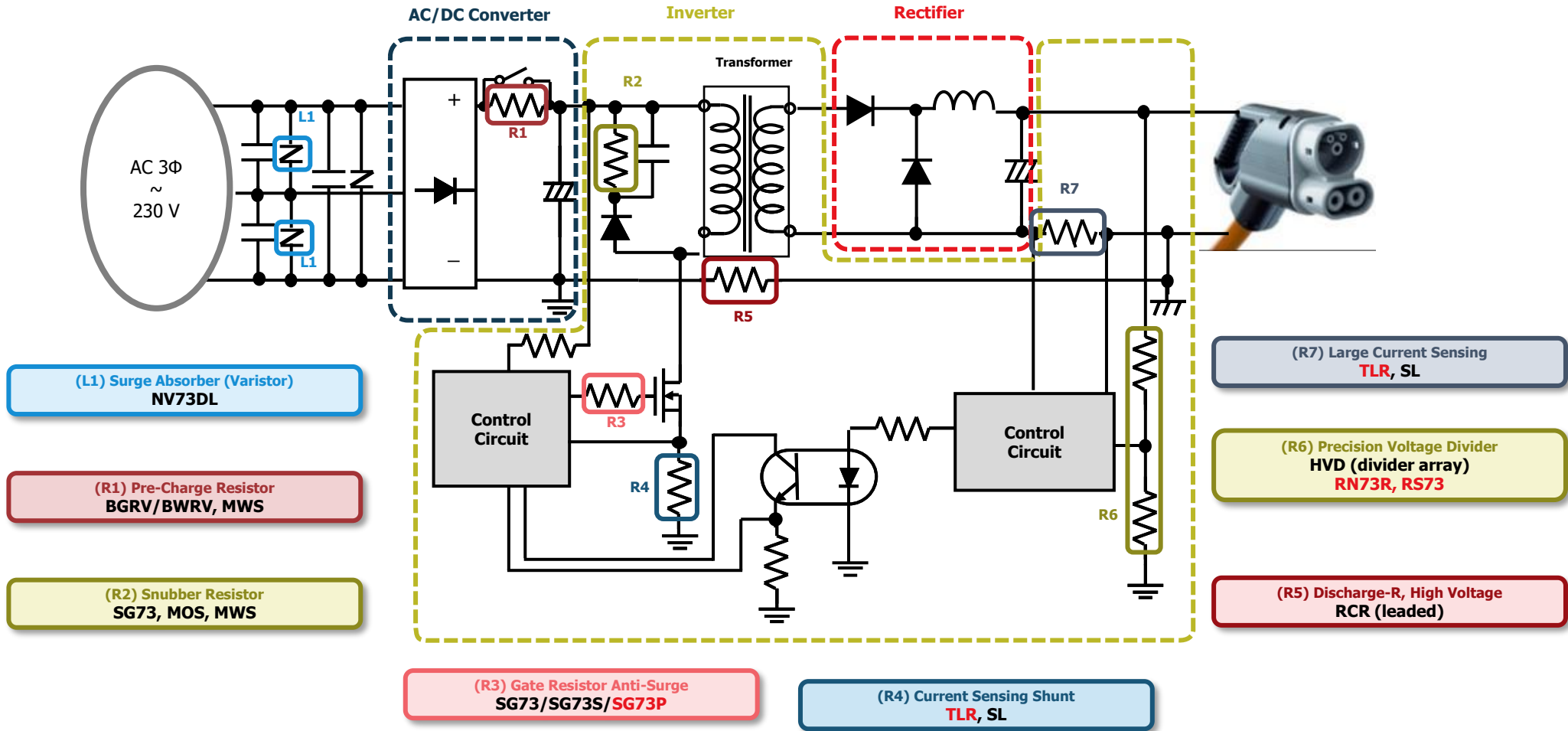
### AC/DC CHARGING ELECTRICAL RATINGS<sup>1,4</sup>

Charge method	Nominal supply voltage	Maximum continuous current (A)	Output power (kW)	Estimated charge time <sup>1</sup>
AC Level 1	120-V ac, 1-phase	12	1.4	17 hr. (OBC, SOC <sup>2</sup> —20% to full)
		16	1.9	
AC Level 2	208- to 240-V ac, 1-phase	80	Up to 19.2	SOC—20% to full: 7 hr. (3.3-kW off-board charger) 3.5 hr. (7-kW off-board charger) 1.2 hr. (20-kW off-board charger)
DC Level 1	200- to 500-V dc (EVSE output)	80	Up to 40	1.2 hr. (SOC—20% to 100%, 20-kW off-board charger)
DC Level 2	200- to 500-V dc (EVSE output)	200	Up to 100	20 min. (SOC—20% to 80%, 45-kW off-board charger)

## Charger Development

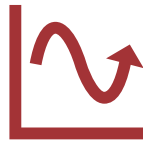


## Charging Station Circuit





Introduction



Pulse Proof  
Resistors

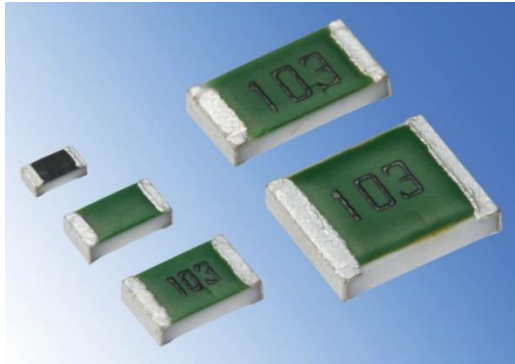


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## SG73P – Series



### Features

- Precision endured pulse power resistor:  $\pm 0.5\%$ ,  $\pm 1\%$ ,  $\pm 2\%$ ,  $\pm 5\%$
- Excellent pulse proof – almost the same as SG73 series
- Efficient for rectangular wave form (pulse-width modulation, MOSFET gate resistor) which has longer dwell times
- Higher power ratings compared to general F/C resistors
- AEC-Q200 tested

### Applications

ECU for automotive, motor control, power supply, industrial equipment, etc.

### Ratings

Operating Temperature Range:  $-55\text{ }^{\circ}\text{C} \sim +155\text{ }^{\circ}\text{C}$

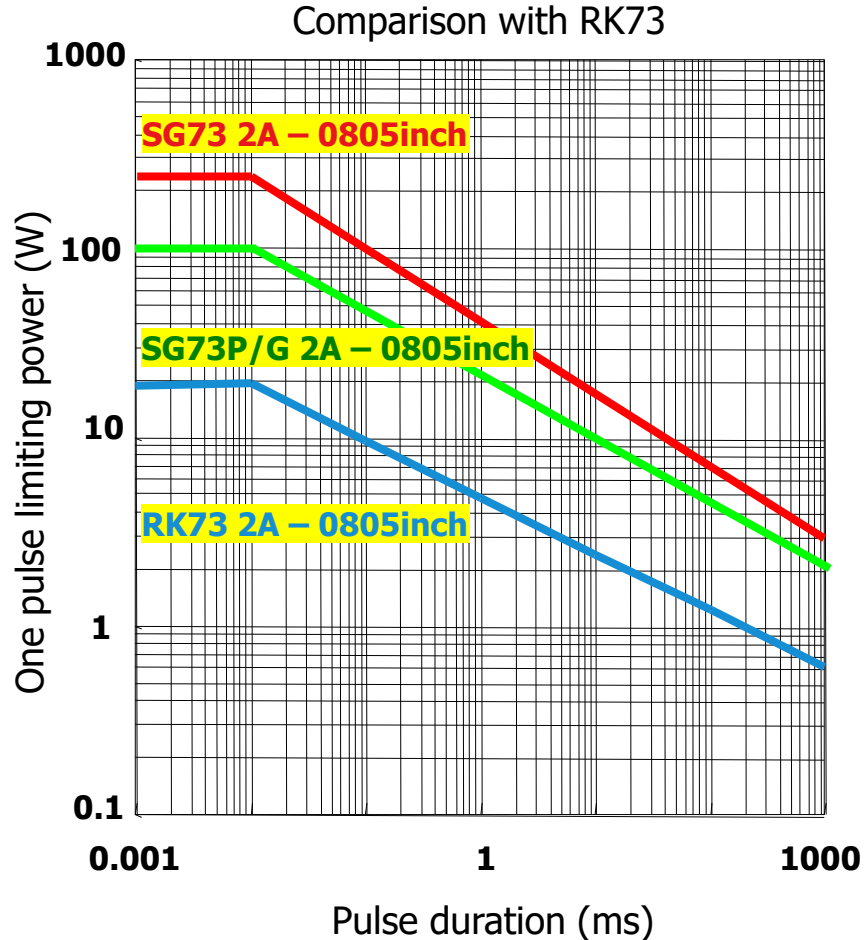
Type	Size (inch)	Power Rating *1	Rated Terminal Part Temperature	T.C.R. (ppm/K)	Max. Working Voltage	Resistance Range	Resistance Tolerance
SG73P 1E	0402	0.2 W	+105 °C	$\pm 200$	75 V	1 $\Omega$ ... 10 M $\Omega$	D: $\pm 0.5\%$ F: $\pm 1\%$ G: $\pm 2\%$ J: $\pm 5\%$
SG73P 1EW <b>NEW</b>		<b>0.25 W</b>	+125 °C	$\pm 100 / \pm 200^{*3}$			
SG73P 1J	0603	0.33 W	+125 °C	$\pm 100^{*2}$	150 V		
SG73P 2A	0805	0.5 W	+100 °C	$\pm 200$	400 V		
SG73P 2B	1206	0.75 W	+105 °C	$(\pm 100)^{*3}$	200 V		
SG73P 2E	1210	0.75 W	+110 °C	$\pm 200$			
SG73P 2E1	1210	1 W	+95 °C				

\*1 Rated power is guaranteed by keeping the max. termination temperature

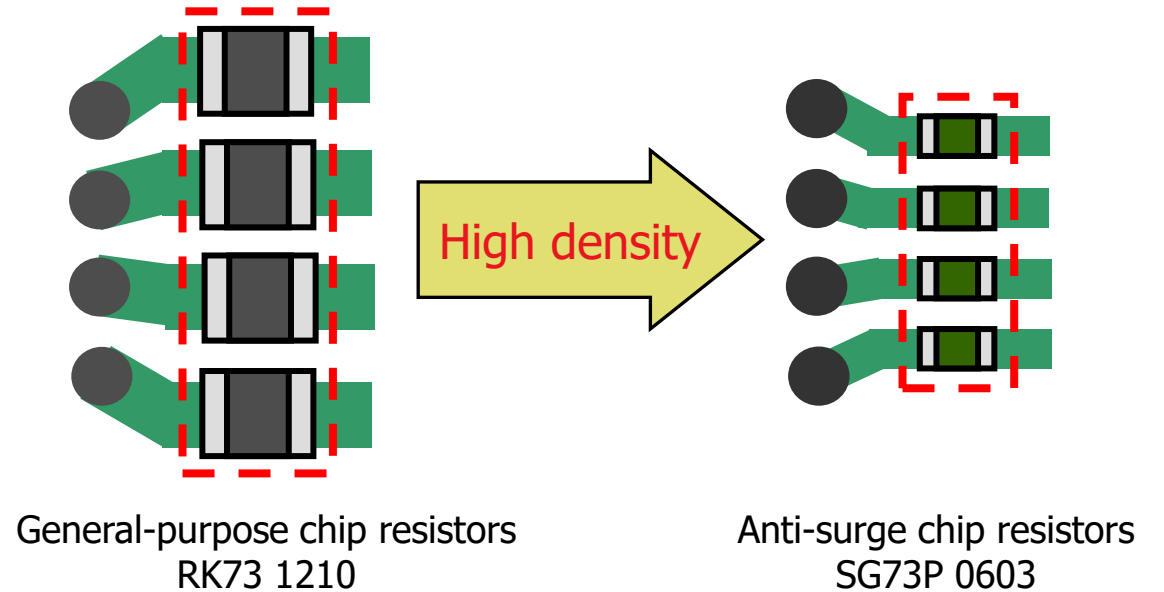
\*2 Cold T.C.R. ( $-55 \sim +25\text{ }^{\circ}\text{C}$ ) of SG73P1J is  $\pm 150\text{ ppm/K}$

\*3 T.C.R.  $\pm 100\text{ ppm/K}$  is specified for a limited resistance range. Please contact KOA.

## Comparison: SG73 vs SG73P vs RK73



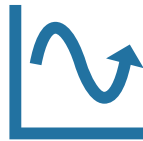
Size (inch)	One-pulse limiting electric power [W] Pulse duration: 10 $\mu$ s		
	General RK73	For Pulse SG73P/G	For Pulse SG73
0805	20	103	220
1206	40	268	500
1210	52	531	1300







Introduction



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Resistors

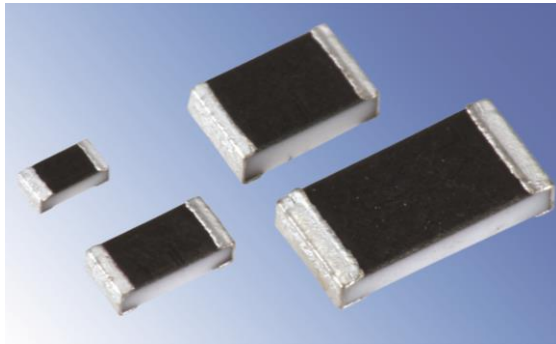


High Precision  
Resistors



Current Measurement  
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## RS73 – Ultra Precision & High Reliability Resistors



### Features

- Ultra precise initial resistance tolerances
- Low T.C.R.:  $\pm 25$  ppm/K
- Precise long-term stability ( $\pm 0.2\% \sim$ )
- ESD stability of thick film resistors
- Ideal for applications where thin film is not suitable
- Can replace MINI-MELF resistors in several applications
- AEC-Q200 tested

### Applications

- High precision circuits for automotive and industrial
- A/D signal conversion
- High precision sensing
- Voltage detector

Anti-Sulfuration types are also available:

**RS73F\_RT**

**RS73G\_RT**

### Ratings

Operating Temperature Range:  $-55 \sim +155$  °C

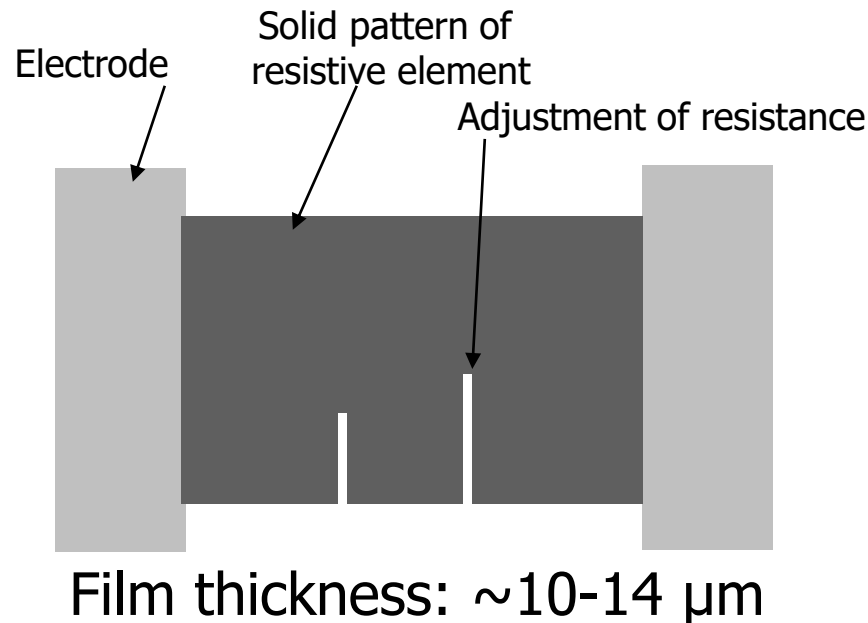
Type	Size (inch)	Power Rating	Rated Ambient Temperature	Rated Terminal Part Temperature	T.C.R. (ppm/K)	Resistance Range E24 • E96*			Long-Term Stability $\Delta R$
						B: $\pm 0.1\%$	C: $\pm 0.25\%$	D: $\pm 0.5\%$ F: $\pm 1\%$	
<b>RS73 (F/G) 1E</b> <span style="border: 1px solid red; padding: 2px;">NEW</span>	0402	0.125 W	<b>+85 °C</b>	+125 °C	F: $\pm 25$ G: $\pm 50$	300 $\Omega$ ~ 100 k $\Omega$	300 $\Omega$ ~ 1 M $\Omega$		<b><math>\pm 0.2\% \sim</math> <math>\pm 0.4\%</math></b>
<b>RS73 (F/G) 1J</b>	0603	<b>0.2 W</b>				10 $\Omega$ ~ 1 M $\Omega$			
<b>RS73 (F/G) 2A</b>	0805	0.25 W				10 $\Omega$ ~ 3 M $\Omega$	10 $\Omega$ ~ 6.8 M $\Omega$	10 $\Omega$ ~ 10 M $\Omega$	
<b>RS73 (F/G) 2B</b>	1206	0.33 W				10 $\Omega$ ~ 1 M $\Omega$			

\* Values from E192 series on request

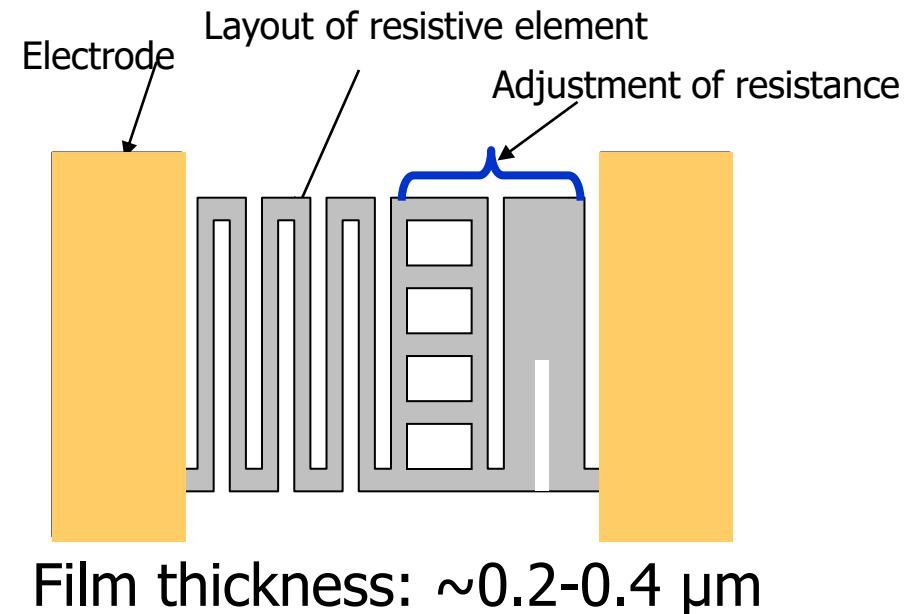
## What is the Structural Difference?

- The resistive element of a **metal glaze resistor** is formed by screen printing and the resistance value is finally adjusted by trimming.
- The resistive element of the **metal film resistors** is deposited by sputtering, the pattern is formed by photolithography technology and resistance value is finally adjusted by trimming.

### Thick film(metal glaze) chip resistor (RK73)

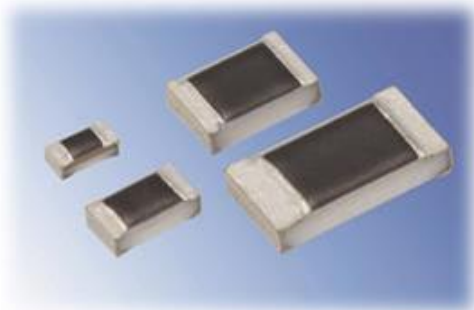


### Thin Film(metal film) chip resistor (RN73R)



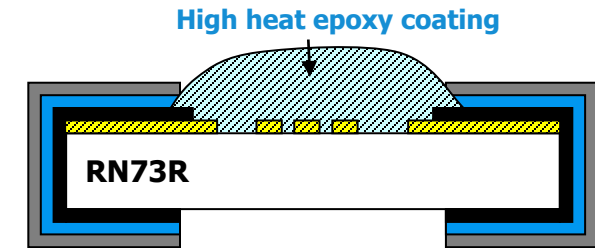
## RN73R & RN73H: Precision Metal Thin Film

### RN73R



#### Features

- Improved resistance to electric corrosion and stability compared to RN73
- Excellent heat resistance
  - ✓ Operating temperature range:  $-55\text{ °C} \sim +155\text{ °C}$
  - ✓ High power rating at rated ambient temperature  $+85\text{ °C}$
- Improved moisture resistance of 0.25 % ( $+85\text{ °C}$  ambient, 85 %, 1000 hrs)
- AEC-Q200 tested, Sulfur resistance verified according to ASTM B 809-95

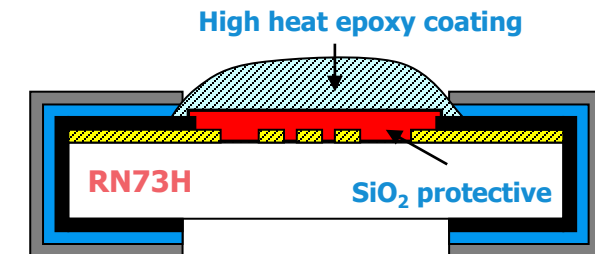


### RN73H



#### Features

- Recommended for automotive applications
- Excellent moisture resistance and high heat resistance by special resistive film and protective coating
- Additional inorganic passivation
- Improved moisture resistance of 0.1 % ( $+85\text{ °C}$  ambient, 85 %, 1000 hrs)
- Load life also specified and tested at  $+85\text{ °C}$  ambient, 3000 hrs
- AEC-Q200 tested, Sulfur resistance verified according to ASTM B 809-95



=> **Recommendation is RN73H for highest reliability**

## Precision Portfolio and Total Tolerance (worst case)

Product line-up list *1		Thick Film		Thin Film	
		RK73G (High Precision)	RS73F <b>NEW</b> (Ultra High Prec. & High Reliability)	RN73R <b>NEW</b> (Thin Film, High heat resistance)	RN73H (Thin Film, High heat resistance)
Product size (inch)		0201 ~ 1206	0402 ~ 1206	0402 ~ 1206	0402 ~ 1210
Resistance range ( $\Omega$ )		10 ~ 1M	10 ~ 10M	10 ~ 1.5M	10 ~ 1.5M
Resistance tolerance		C ( $\pm 0.25\%$ ) D ( $\pm 0.5\%$ ) F ( $\pm 1\%$ )	B ( $\pm 0.1\%$ ) C ( $\pm 0.25\%$ ) D ( $\pm 0.5\%$ ) F ( $\pm 1\%$ )	A ( $\pm 0.05\%$ ) B ( $\pm 0.1\%$ ) C ( $\pm 0.25\%$ ) D ( $\pm 0.5\%$ ) F ( $\pm 1\%$ )	A ( $\pm 0.05\%$ ) B ( $\pm 0.1\%$ ) C ( $\pm 0.25\%$ ) D ( $\pm 0.5\%$ ) F ( $\pm 1\%$ )
T.C.R. (ppm/K)		$\pm 50$	$\pm 25^{*2}$	$\pm 5^{*3} / \pm 25$	$\pm 5^{*3} / \pm 25$
Power rating (W)		0.05 ~ 0.2	0.125 ~ 0.33	0.063 ~ 0.25	0.063 ~ 0.25
Upper category ambient temperature		+155°C			
Reliability guaranteee (%)	Short time overload	$\pm 2.0$	$\pm 0.2$	$\pm 0.05$	$\pm 0.05$
	Solder dip resistance	$\pm 1.0$	$\pm 0.2$	$\pm 0.05$	$\pm 0.05$
	Rapid change of temp.	$\pm 0.5$	$\pm 0.2^{*4}$	$\pm 0.1$	$\pm 0.1$
	Moisture resistance load	$\pm 2.0$	$\pm 0.2^{*4}$	$\pm 0.25$	$\pm 0.1$
	Rated load	$\pm 2.0$	$\pm 0.2$	$\pm 0.1$	$\pm 0.1$
(%)	<b>Total tolerance (Initial + TCR + Solder heat + Rated load)</b>	$\pm 4.15$	$\pm 0.83$	$\pm 0.58$	$\pm 0.58$

\*1 Each product specification is extracted from the best guaranteed value of each item. Please refer to the catalog for detailed product specifications.

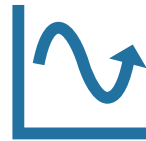
\*2 Hot: (+25°C/+125°C):  $\pm 25$ ppm/K ambient, Cold: (-55°C/+25°C): -50/~+25ppm/K ambient

\*3 Valid for +25°C/+125°C ambient

\*4 The resistance range of long-term stability  $\pm 0.2\%$  is 100  $\Omega$  ~ 200 k $\Omega$  (upper r-range is  $\pm 0.4\%$ )



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Resistors

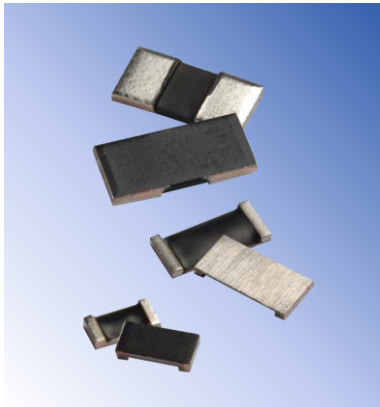


High Precision  
Resistors



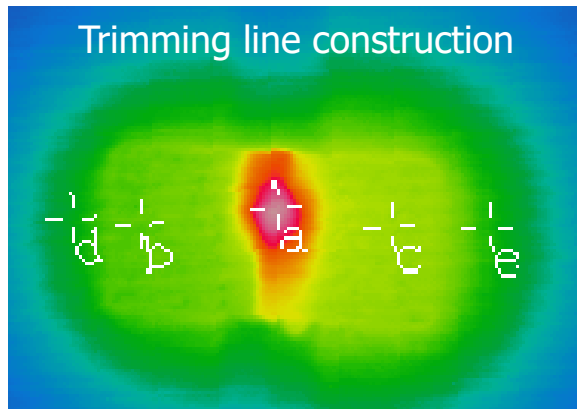
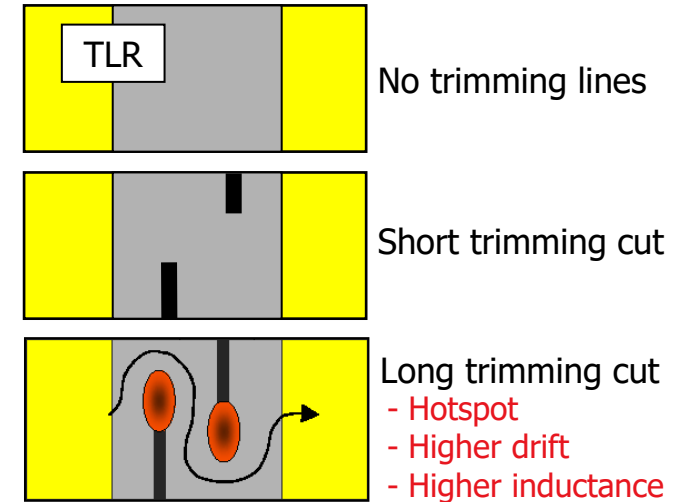
Current Measurement  
Resistors

## TLR – Series Advantages of Special Trimming

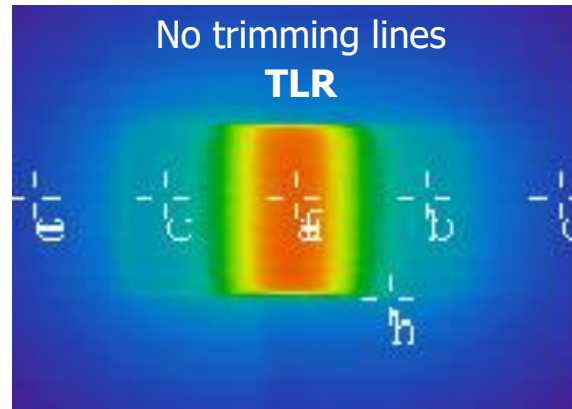


### Special trimming of shunts

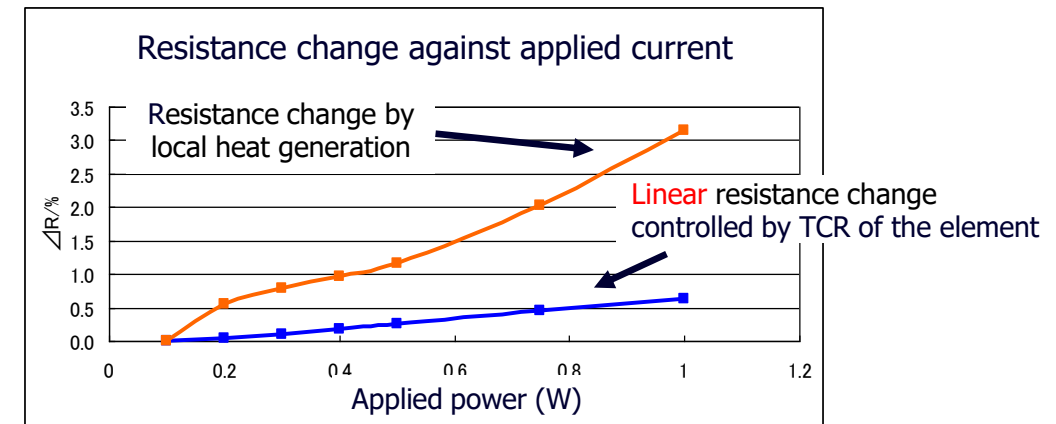
- Extremely low resistance values  $0.2 \text{ m}\Omega \sim 20 \text{ m}\Omega$
- Tolerance  $\pm 1 \%$  is standard
- Special trimming for **uniform temperature distribution and enhanced reliability**
- **Ultra low inductance** - suitable for high frequencies
- Excellent heat radiation due to wide electrode



Hot spot is created in the middle, close to the trimming cut.

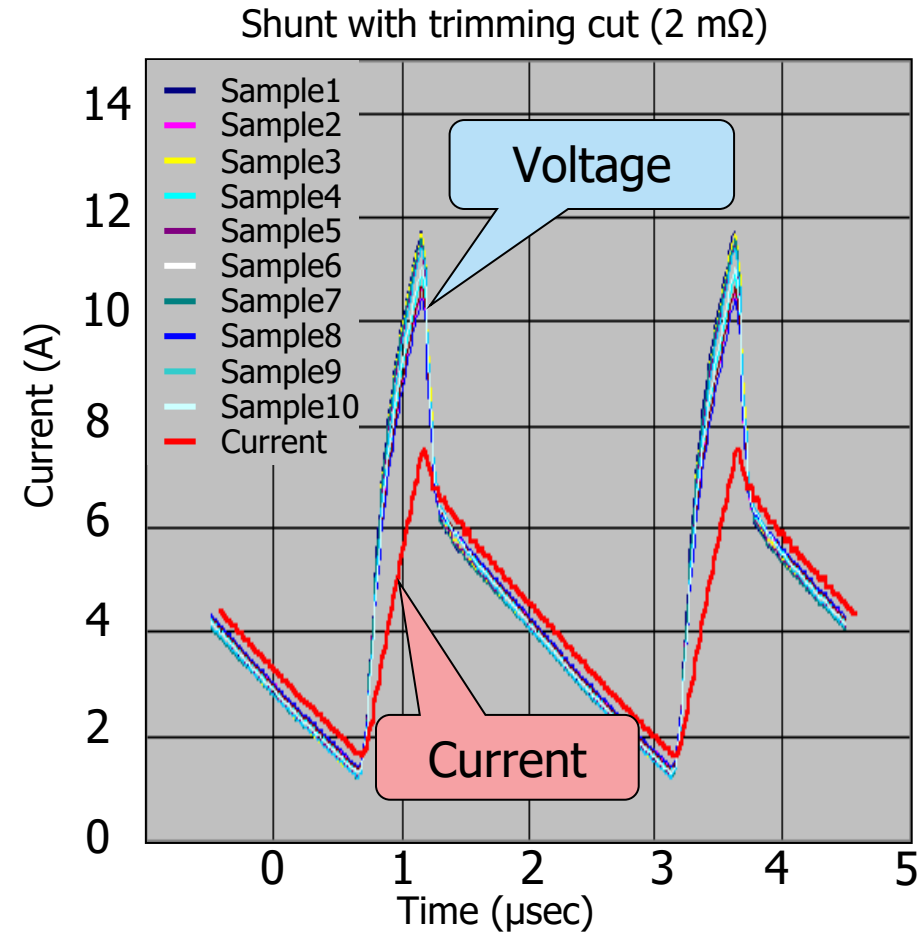
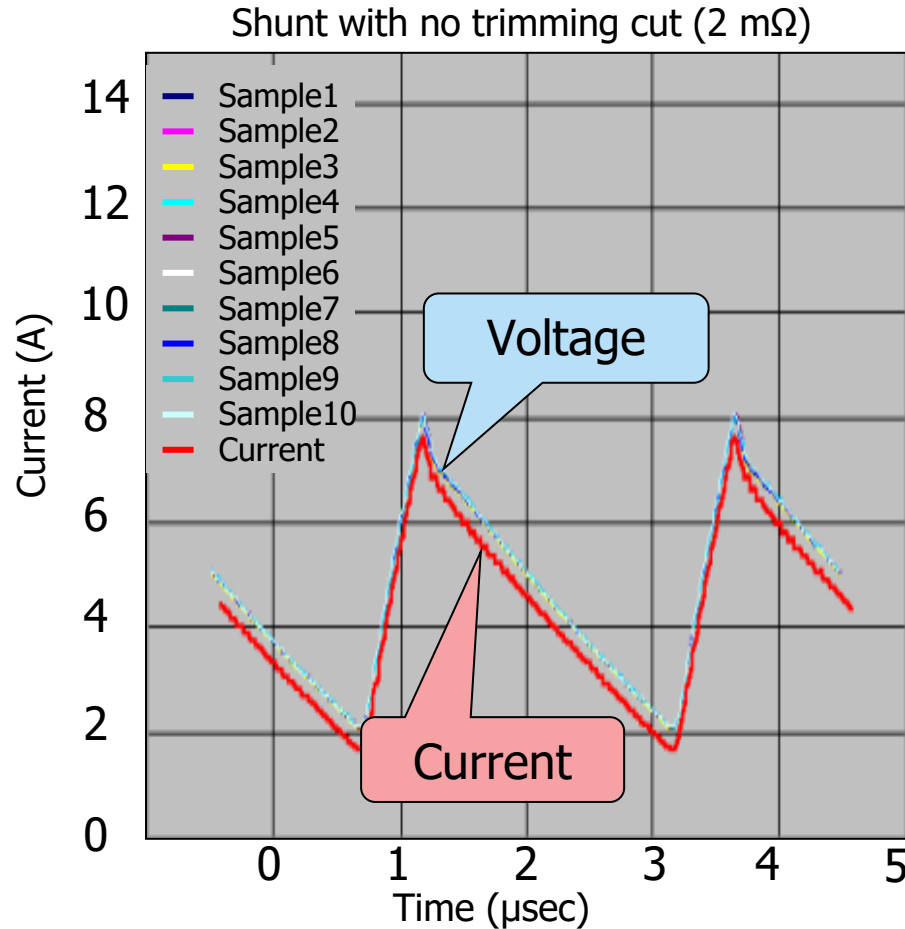


Hot spot is created symmetrically to the central axis.  
=> Better heat distribution for resistance stability.



## Advantage of Non-Trimming Structure

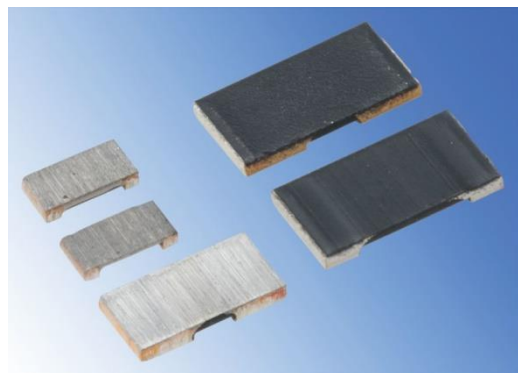
Parasitic inductance has an influence on the current detection accuracy



High frequency and large slope (rising fast) are affected by inductance.

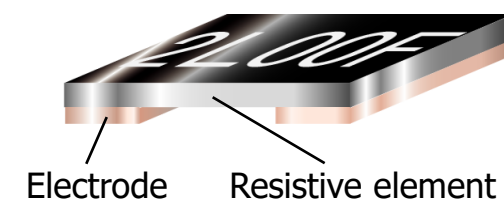


## TLR – Series Metal Plate Chip Type Resistor – High Power



### Features

- High power in small package
- Low resistances available: 0.5 mΩ ~ 20 mΩ
- Ultra low profile: 0.6 mm ~ 0.7 mm height
- No laser trimming cut - excellent pulse resistance - low inductance
- Metal alloy: superior corrosion and heat resistance
- Soldering area is mainly the bottom electrode
- AEC-Q200 tested



### Applications

Automotive electronics, power steering (EPS), motor control units, power supplies, AC / DC-DC converter, metering, CPU current sensing, mobile devices charge controller, etc.

### Ratings

Type	Inch Size	Power Rating	Rated Terminal Part Temperature	T.C.R. (ppm/K)	Resistance Range F: ±1%
TLR2A	0805	1 W	+105 °C	±100	2 mΩ ~ 10 mΩ
TLR2BP	1206	1.5 ~ 3 W	+100 °C / +110 °C	±50 / ±75	0.5 mΩ ~ 20 mΩ
TLR2HW	2010	2 W	+120 °C		0.5 mΩ ~ 10 mΩ
TLR3AP	2512	3 ~ 5 W	+90 °C / +110 °C		

**TLRH:** Higher resistance range of TLR

- 10mΩ ... 270mΩ, 0.25W ~ 5W, 0805 and 2512

**TLRZ:** Metal plate chip jumper

- 10A ... 50A, 0402/0603/0805/1206

Operating Temp. Range:  
-65 ~ +155 °C (2A size)  
-65 ~ +170 °C (2B,2H,3A)

## Wide Terminal Chip Resistors

AEC-Q200 qualified

### Wide Terminal Chip Resistors

**WK73/WU73 Series**

High reliability and enhanced terminal strength are essential in all power applications. KOA's wide terminal resistors offer several advantages compared to standard footprints. The 0612 chip size allows 6 x power rating and is standard 1206 parts. This saves board space and possible due to the improved heat dissipation via the large terminals also enhance terminal strength and the smaller distance between the terminals reduces expansion stress. Finally, the inner resistive pattern is designed to minimize solder joints. The large terminals also enhance terminal strength and the smaller distance between the terminals reduces expansion stress. Finally, the inner resistive pattern is designed to minimize solder joints. The large terminals also enhance terminal strength and the smaller distance between the terminals reduces expansion stress. Finally, the inner resistive pattern is designed to minimize solder joints.

KOA offers the **WK73S** & the **WU73** series which are suitable for **current sensing (10 mΩ to 9.1 Ω)** and the **WK73R** series for the standard resistance range (10 Ω to 1 MΩ) in 7 different sizes.

**Smaller sizes:** WK73\_1E (0204), WK73\_1J (0306), WK73\_2A (0508)

**NEW**

Rated Power of a resistor strongly depends on the maximum available heat transport capability, which mainly relies on heat conduction through air, convection and radiation can be neglected. Knowing this, KOA offers the WK73 resistors with inverse geometry. The long sides of the flat chip resistors are used for better heat dissipation through the solder junction.

**Size 1206**

- power rating 0.25 W
- longer distance between the terminals
- absolute stress at solder fillet is high
- higher thermal expansion influence

**Application Examples**

- Automotive, including "under the hood" applications
- Power supplies
- Motor control units
- Industrial power control
- Battery packs
- Consumer electronics

**Product Features**

- Excellent heat dissipation
- Superior temperature stress
- Low thermal expansion stress
- Higher rated power - less board space than standard chips
- Standard sizes 0204, 0306, 0508, 0612, 1020, 1218 and 1225
- Resistance range 10 mΩ ... 1 MΩ
- EU-RoHS compliant, AEC-Q200 qualified
- Lab Kits are available
- Anti-Sulfuration types also available (WK73S/R\_RT)

For more information, please contact:  
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## Current Sensing Resistors

### Metal Plate Technology

### SL Series

**High Temperature - Molded**

High reliability of the terminal connection in case of heat cycle stress is essential in several circuit designs and applications. With the SL-series, KOA offers excellent terminal strength and solderability due to its molded design with metal electrodes which easily absorb thermal expansion and shrinkage stress.

**NEW** SLN5: 4527, 7 W, 3 mΩ to 200 mΩ  
SLZ1: 2512, Jumper, 44 A

### Heat Stress & Mechanical Stress

The stress of solder junction is reduced

**Standard Flat Chip Style** vs **KOA SL-types**

Mechanical stress can cause cracks due to the different thermal expansion coefficient of the ceramic substrate and the PCB. The special electrode construction of the SL-series gives the ability to absorb this stress.

**Features**

- Low risk of solder cracks - electrodes absorb heat & mechanical stress
- High component and equipment reliability
- Flame retardant resin molding (UL94 V-0)
- Low resistance 3 mΩ~ and high precision ±0.5 %
- T.C.R. ±50 ppm/K is possible
- Available in sizes 2010, 2512 and 4528 inch
- Operating temperatures up to +180 °C
- EU-RoHS compliant, AEC-Q200 qualified
- Lab Kits are available

**Application Examples**

- Current detection in automotive (e.g. ECU)
- Power supplies, battery packs
- D-C converter
- AC adapters
- Inverter circuits
- Current sensing for CPU
- Power conditioner/inverter
- Industrial equipment
- Notebook PC's

Type	Power Rating	Resistance Range (Ω) <sup>1)</sup>			T.C.R. (ppm/K)	Rated Terminal Part Temp.	Operating Temp. Range
		D ±0.5% E24-E96	F ±1% E24-E96	J ±5% E24			
2010	SLW07 1W	—	5m~100m <sup>2)</sup>	—	0~300 R±10mΩ 0~150 R±11mΩ ±180 R±15mΩ ±100 R±15mΩ ±750 R±15mΩ ±50~34 (8mΩ R±100mΩ)	125°C	—55°C~+180°C
2512	SLW1 1.5W	10m~100m	5m~100m	—	±110 R<10mΩ ±275 R±10mΩ	105°C	—65°C~+110°C
4527	SLN3 3W	—	5m~110m	—	—	70°C	—65°C~+110°C
	SLN5 7W	—	3m~200m <sup>2)</sup>	—	—	120°C <sup>3)</sup>	—65°C~+110°C

<sup>1)</sup> 5m, 6m, 7m, 8m, 9mΩ are also available in each resistance range <sup>2)</sup> 3mΩ ~ 4.7mΩ only in E24 series <sup>3)</sup> 5W in case of rated terminal temperature below 70°C

For more information, please contact:  
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Phone: +49 (0)4521 99990, E-Mail: [sales@koaeurope.de](mailto:sales@koaeurope.de), Internet: [www.koaeurope.de](http://www.koaeurope.de)  
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## VIA ELECTRONIC Low Temperature Co-fired Multilayer Ceramic Substrates

### Multilayer ceramics and cavity packages enable complex module creation

Highly controlled dimensions, flatness  
Low thermal expansion enhances bare IC's use  
Ceramics with low dielectric constant & loss  
Low ohm silver conductor

**Optimal for bare chip module**

**High frequency performance**

**Miniaturation & Integration**

**Environmental & reliability**

High heat/moisture resistance (zero water absorption)  
Outgas/dust free, impermeability

**Application Examples**

- Interposer
- Semiconductor package
- Multi-chip module
- Multi-cavity
- Customized shape
- High frequency module

For more information, please contact:  
KOA Europe GmbH, Kaddembusch 6, D-25778 Dägeling-Itzehoe, Germany  
Phone: +49 (0)4521 99990, E-Mail: [sales@koaeurope.de](mailto:sales@koaeurope.de), Internet: [www.koaeurope.de](http://www.koaeurope.de)  
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18. Nov. 2020



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