



VISHAY INTERTECHNOLOGY, INC.

# INTERACTIVE

## data book

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## SMD RESISTORS, ARRAYS AND NETWORKS

VISHAY

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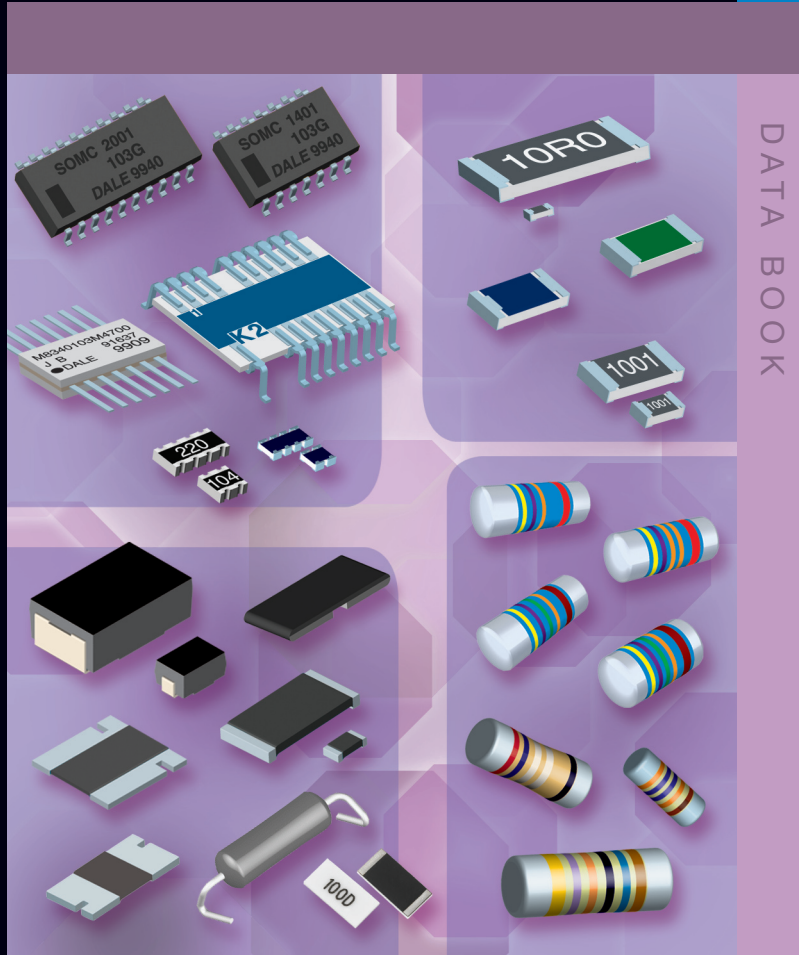
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One of the World's Largest Manufacturers of  
**Discrete Semiconductors and Passive Components**



VISHAY INTERTECHNOLOGY, INC.



DATA BOOK

## SMD RESISTORS, ARRAYS AND NETWORKS

MELF Resistors

Thick Film Chip Resistors

Thin Film Chip Resistors

Power Metal Strip® Resistors

Wirewound Resistors

Surface Mount Resistor Arrays and Networks

## SEMICONDUCTORS

### RECTIFIERS

- Schottky (single, dual)
- Standard, Fast, and Ultra-Fast Recovery (single, dual)
- Bridge
- Superrectifier®
- Sinterglass Avalanche Diodes

### SMALL-SIGNAL DIODES

- Schottky and Switching (single, dual)
- Tuner/Capacitance (single, dual)
- Bandswitching
- PIN

### ZENER AND SUPPRESSOR DIODES

- Zener (single, dual)
- TVS (TRANSZORB®, Automotive, ESD, Arrays)

### MOSFETs

- Power MOSFETs
- JFETs

### RF TRANSISTORS

- Bipolar Transistors (AF and RF)
- Dual Gate MOSFETs
- MOSMICs®

### OPTOELECTRONICS

- IR Emitters and Detectors, and IR Receiver Modules
- Optocouplers and Solid-State Relays
- Optical Sensors
- LEDs and 7-Segment Displays
- Infrared Data Transceiver Modules
- Custom Products

### ICs

- Power ICs
- Analog Switches
- DC/DC Converters
- RF Transceivers
- ICs for Optoelectronics

## PASSIVE COMPONENTS

### RESISTIVE PRODUCTS

- Foil Resistors
- Film Resistors
  - Metal Film Resistors
  - Thin Film Resistors
  - Thick Film Resistors
  - Metal Oxide Film Resistors
  - Carbon Film Resistors
- Wirewound Resistors
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- Chip Fuses
- Variable Resistors
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- Networks/Arrays
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- Transformers

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- Film Capacitors
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- Heavy-Current Capacitors
- Aluminum Capacitors
- Silicon RF Capacitors

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- PhotoStress®
- Strain Gages
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- Force Transducers
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- Weighing Systems
- Specialized Strain Gage Systems

# SMD Resistors, Arrays and Networks

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### Rated Resistance

Resistance value indicated upon the resistor

### Critical Resistance

Resistance value at which the rated voltage is equal to the limiting element voltage

### Resistance Tolerance

Permitted variation of the nominal resistance value expressed as a percentage of that value

### Nominal Dissipation

Maximum permitted load at a defined ambient temperature e.g.  $T_{@} = 70\text{ }^{\circ}\text{C}$ , which ensures that resistance stability limits in the relevant specification are not exceeded.

### Limiting Element Voltage

Maximum d.c. or a.c. effective voltage which can be applied continuously to the resistor

### Temperature Coefficient

The permissible change of the resistance value depending on temperature and can be described by the following equation:

$$\text{TCR} (10^{-6}/\text{K}) = (R_{\vartheta} - R_{T_{\text{REF}}}) / (R_{T_{\text{REF}}} * \Delta\vartheta) * 10^{-6}$$

$\Delta\vartheta$  is the difference between Reference Temperature ( $T_{\text{REF}}$ ) and the corresponding ambient temperature.

The maximum permissible increase of the resistance value by the TCR, in case of electric load can be determined by way of the maximum permissible film temperature. The change of resistance value is calculated by:

$$R_{\vartheta_{\text{max}}} = R_N [(1 + (\vartheta_{\text{smax}} - 20\text{ }^{\circ}\text{C}) * \text{TCR}_{\text{max}})]$$

Consequently the maximum permissible current for the voltage for  $P_{70}$  can be calculated by  $R_{\vartheta_{\text{max}}}$

### Insulation Voltage

Maximum peak voltage which may be applied under continuous operating conditions between the resistor terminations and any conducting mounting surface.

### Insulation Resistance

Electrical resistance value of the encapsulant measured between the terminations of the resistor and applied V-block according to IEC60115-1

### Derating

Boundary curve of maximum allowable dissipation at  $T_{@}$  between upper and lower category temperatures.

### Thermal Resistance

Under electrical load a film resistor generates heat which increases the film temperature. At the same time heat is dissipated to the environment, so that with constant electric load and constant convection a thermal balance appears between the heat, generated by the electrical load and the heat lost by convection.

These proportions are characterized by the thermal resistance. The thermal resistance is defined by the mechanical dimensions of a resistor, the heat dissipation by the wire leads as well as the convection, radiation and the mounting of the resistor.

The thermal resistance  $R_{\text{th}}$  is defined as follows:

$$R_{\text{th}} = (\vartheta_s - \vartheta_u) / P = \vartheta_{\bar{u}} / P$$

$\vartheta_s$  = film temperature in  $^{\circ}\text{C}$

$\vartheta_u$  = ambient temperature in  $^{\circ}\text{C}$

$\vartheta_{\bar{u}}$  = temperature rise

$P$  = load in Watts

The thermal resistance measurement is made under defined conditions according to DIN.

The maximum power rating can be calculated using the following equation:

$$P_{\text{max}} = (\vartheta_s - \vartheta_u) / R_{\text{th}}$$

Thus, the maximum permissible power rating  $P_{\text{max}}$  is dependant on the maximum permissible film temperature, the ambient temperature  $\vartheta_u$  and the thermal resistance.

### Current Noise

The current noise voltage expressed in  $\mu\text{V}$ , is that portion of noise voltage that arises from d.c. current in a resistor in addition to the thermal noise voltage. The relative noise voltage, expressed in  $\mu\text{V}/\text{V}$  is independent of the applied dc-voltage  $U_{\text{=}}$

### Non linearity $A_3$

The harmonic index and the voltage coefficient of resistors are a criteria for the non-linearity of the current voltage characteristic. The harmonic index is defined as the logarithm of the ratio of the fundamental  $U_1$  to the 3<sup>rd</sup> harmonic  $E_3$ . It is specified in dB:

$$A_3 = 20 \lg ( U_1 / E_3 ) \text{ in dB}$$

Measurements are according to IEC 60440

### Stability

The change of resistance values at certain loads and ambient temperatures can be obtained from the Stability Nomogram which consists of 4 diagrams; these can also be used independently. The stability nomogram for different products can be seen on the relevant data sheets. Additionally the limiting values stated in the data sheets such as maximum load, surface temperature etc., have to be observed. The following examples show how to use a nomogram:

#### Example 1:

Known: size D  
 $R = 1\text{ k}\Omega$ ,  $P = 0.5\text{ W}$ ,  $U_{LEV} = 350\text{ V}$ ,  $t = 5000\text{ h}$ ,  $\vartheta_u = 70\text{ }^\circ\text{C}$

Unknown:  $\Delta R/R$  after 5000 h  
 From Diagram A we see a temperature rise of  $\vartheta_u = 65\text{ }^\circ\text{C}$  for size D at  $P = 0.5\text{ W}$

From Diagram B a surface temperature of  $135\text{ }^\circ\text{C}$  can be obtained for  $\vartheta_u = 70\text{ }^\circ\text{C}$

From Diagram D a  $\Delta R/R$  after 5000 h of 0.4 % can be obtained for a surface temperature of  $135\text{ }^\circ\text{C}$  of a  $1\text{ k}\Omega$  resistor (see solid line in nomogram)

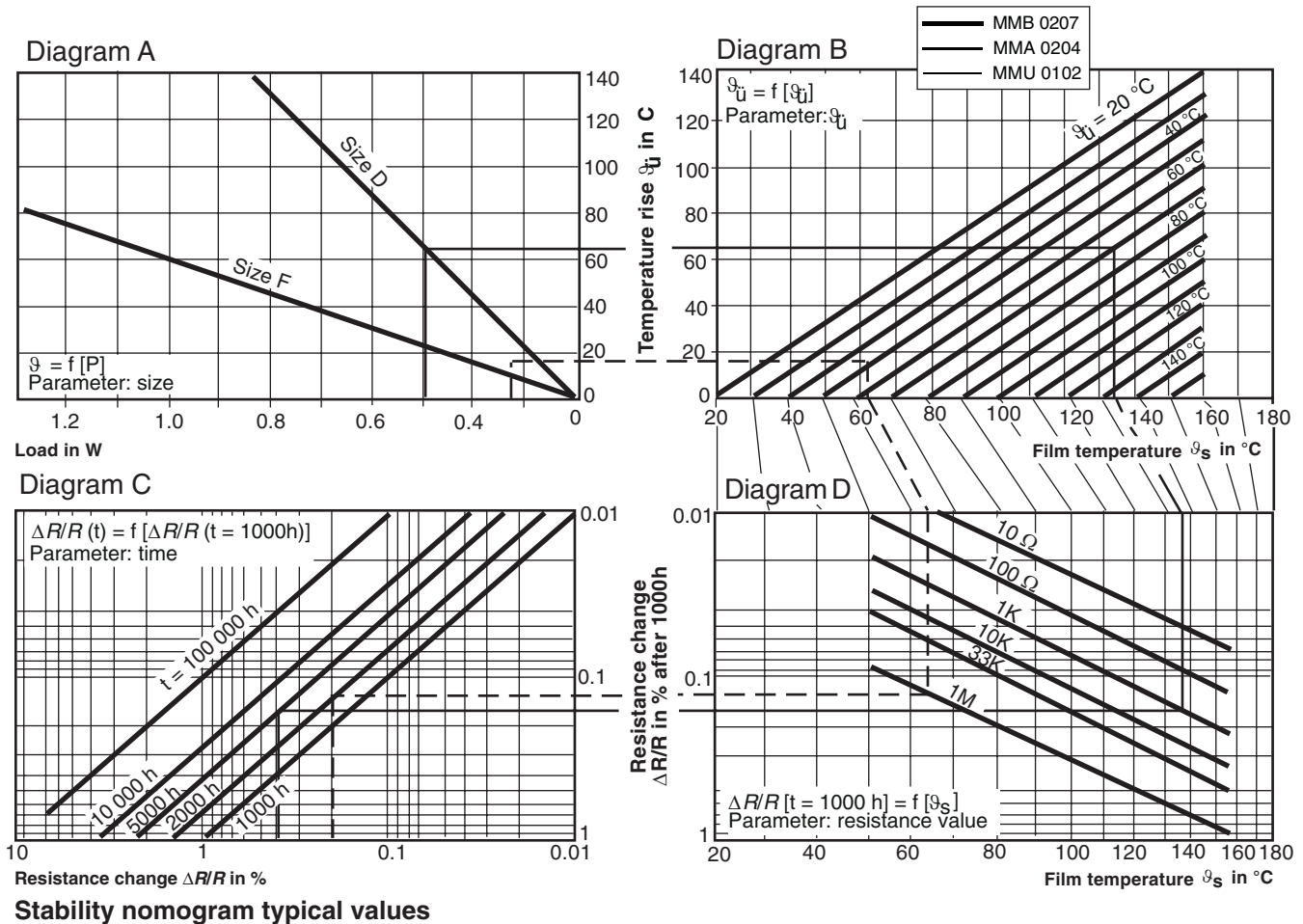
#### Example 2:

Known: size F  
 $R = 1\text{ M}\Omega$ ,  $P_{70} = 1.5\text{ W}$ ,  $U_{LEV} = 500\text{ V}$ ,  $t = 2000\text{ h}$  at  $\vartheta_u = 50\text{ }^\circ\text{C}$

Unknown:  $\Delta R/R$  after 2000 h

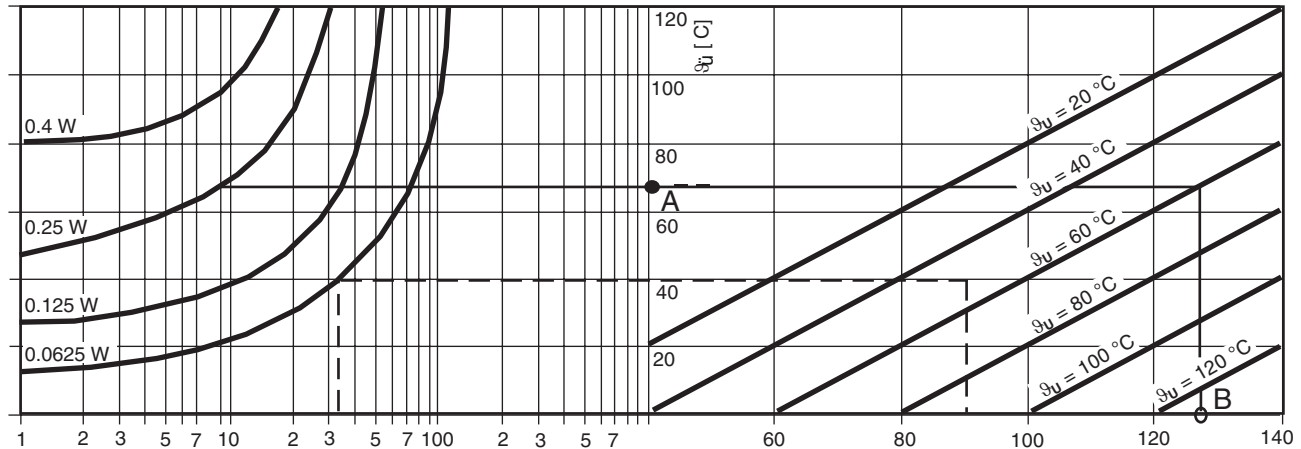
For  $R = 1\text{ M}\Omega$  the following equation applies:

$P = (U_{LEV}^2/R) = 0.25\text{ W}$  as  $U = \sqrt{P \times R} > U_{LEV}$  (see the dotted line in the nomogram).



## Packaging density

The temperature rise in respect of the surface temperature of the hottest SMD component on the board can be obtained from the nomogram below. It is necessary that the components are distributed uniformly over the whole circuit board.



### Example 1:

Known: 9 resistors each rated at 0.25 W

$\theta_u = 60\text{ }^\circ\text{C}$

Unknown: temp.rise  $\theta_u$ , surface temp.  $\theta_s$  of the hottest component

$\theta_u = 65\text{ }^\circ\text{C}$  (A),  $\theta_s = 125\text{ }^\circ\text{C}$  (B), see solid line

### Pulse Load

When a resistor is subjected to impulses the following points have to be observed:

1. The maximum pulse load permissible  $\hat{P}_{max}$  depends on the pulse duration  $t_i$

This also applies to the maximum permissible pulse voltage  $\hat{U}_{max}$

2. The average load  $P$  may not exceed the corresponding nominal load. For resistors with resistance values greater than the critical value the nominal value is determined by the critical value and the maximum operating voltage permissible.

Required

$$\bar{P} = \frac{1}{t_p \cdot R} \int_{t_1}^{t_2} U^2(t) dt P_g$$

Explanations:

R = nominal value

$t_p$  = period of time

U (t) = pulse voltage

PJ = nominal load of the resistor for the ambient temperature  $J t_2 - t_1$   
= pulse duration  $t_i$

### Example 2:

Load of each resistor = 0.0625 W,  $\theta_u = 50\text{ }^\circ\text{C}$  maximum admissible surface temperature  $90\text{ }^\circ\text{C}$

How many components may be mounted?

- 33 pcs, see dotted line

3. Differences arise when resistors are subject to single shot (switching-on processes) or repetitive pulses.

Approximate values for the load with rectangular pulses for each model are stated in the appropriate sections of the catalog.

All other pulses have to be converted to rectangular pulses which show the same energy content and the same pulse voltage.

Example: Exponential pulse

$$\tau U_s^2/2R = t_i U_s^2/R \text{ e.g. } t_i = \tau/2$$

Explanations:

$\tau$  = time constant of the exponential pulse

$t_i$  = pulse duration or the rectangular pulse

$\hat{U}_s$  = peak voltage

R = nominal value of the resistor

The maximum permissible pulse voltages  $\hat{U}_{max}$  are also stated. The permissible pulse loads have been fixed in such way that the changes which appear in resistance values are comparable to those stated for the electrical long time load according to IEC 60115-1.





# Metal Film Cylindrical

Thin Film Element



Power Dissipation up to 1 Watt



Excellent Stability



Tight Tolerances



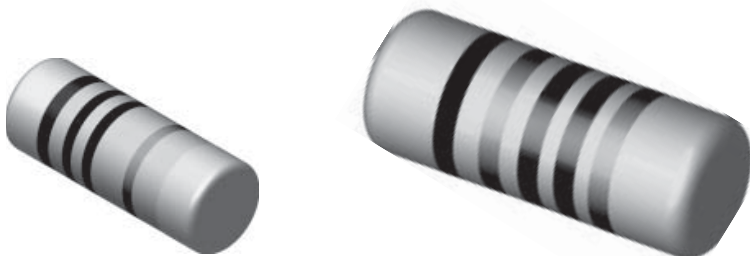
Temperature Coefficient to  $\pm 5$  ppm/ $^{\circ}$ C



Suitable for Reflow and Wave Soldering



Fusible Styles



## Model Numbers

MELF Resistors	
Laboratory Sample Kits .	10
MMU 0102, MMA 0204, MMB 0207 Professional	12
SMM0102 .....	24
SMM0204 .....	28
SMM0207 .....	34
MMU 0102, MMA 0204, MMB 0207 Precision .....	38
PMM0204 .....	48
PMM0207 .....	52
UMA 0204 .....	55
LCM0207SI .....	64
NMM0207SI .....	67
CMA 0204 .....	70
CMB 0207 .....	79
MMU 0102 HF, MMA 0204 HF, MMB 0207 HF .....	85
CMA 0204 HF .....	93
MMU 0102 VG03, MMA 0204 VG03, MMB 0207 VG03 .....	99

## MELF Resistors Laboratory Sample Kits

### MELF RESISTOR MMU 0102

Files contain lengths of blister tape, each holding 45 resistors of the most important values of the indicated IEC E-series. The blister tape pieces are ordered according to resistance value and arranged on well marked pages. Each single MICRO-MELF resistor can be picked up with tweezers.

The laboratory kit supplement LMU 96 includes every second value of the E96 series. It extends the value distribution of the laboratory kit LMU 48 to the E96 series.

	BASIC KIT	LAB. KIT	LAB. KIT SUPPLEMENT
Laboratory kit	<b>LMU 24</b>	<b>LMU 48</b>	<b>LMU 96</b>
Numeric ordering code (12NC)	2312 000 16001	2312 000 16002	2312 000 16003
Resistor type	<b>MMU 0102</b>	<b>MMU 0102</b>	<b>MMU 0102</b>
Temperature coefficient	<b>± 50 ppm/K</b>	<b>± 50 ppm/K</b>	<b>± 50 ppm/K</b>
Values in accordance with tolerance/IEC series	0.22 Ω to 0.82 Ω; 5 % E12 series  1 Ω to 8.2 Ω; 2 % E12 series  10 Ω to 2.2 MΩ; 1 % E24 series  jumper	0.22 Ω to 0.68 Ω; 5 % 1/2 E12 series  1 Ω to 8.2 Ω; 2 % 1/2 E24 series  10 Ω to 1 MΩ; 1 % 1/2 E96 series  1.1 MΩ to 2.15 MΩ; 1 % 1/2 E48 series  jumper	0.27 Ω to 0.82 Ω; 5 % E12 <sup>1)</sup> series  1.1 Ω to 9.1 Ω; 2 % E24 <sup>1)</sup> series  10.2 Ω to 976 kΩ; 1 % E96 <sup>1)</sup> series  1.05 MΩ to 2.21 MΩ; 1 % E48 <sup>1)</sup> series  jumper
Resistor type	<b>MMU 0102 HF</b>		
Temperature coefficient	<b>± 50 ppm/K</b>		
Values in accordance with tolerance/IEC series	6.8 Ω to 470 Ω; 2 % E6 <sup>2)</sup> series		
Number of resistance values	167	266	266
Resistors per value/total	45/7 515	45/11 970	45/11 970
Number of pages/files	10/1	15/1	15/1

#### Notes

1. Supplement to the laboratory kit LMU 48 to the complete declared E series.
2. Completed by some typical values for HF (RF) applications: 50 Ω, 60 Ω, 75 Ω, 120 Ω, 240 Ω.

For specification details of the MICRO-MELF resistor MMU 0102 please refer to the data sheet "MMU 0102, MMA 0204, MMB 0207 - Professional".

For specification details of the MICRO-MELF resistor MMU 0102 HF please refer to the data sheet "MMU 0102H F, MMA 0204 HF, MMB 0207 HF".

**MELF RESISTOR MMA 0204**

Files contain lengths of blister tape, each holding 45 resistors of the most important values of the indicated IEC E-series. The blister tape pieces are ordered according to resistance value and arranged on well marked pages. Each single MINI-MELF resistor can be picked up with tweezers.

the laboratory kit supplement LMA 96 includes every second value of the E96 series. It extends the value distribution of the laboratory kit LMA 48 to the E96 series.

	<b>BASIC KIT</b>	<b>LAB. KIT</b>	<b>LAB. KIT SUPPLEMENT</b>
Laboratory kit	<b>LMA 24</b>	<b>LMA 48</b>	<b>LMA 96</b>
Numeric ordering code (12NC)	2312 000 14001	2312 000 14002	2312 000 14003
Resistor type	<b>MMA 0204</b>	<b>MMA 0204</b>	<b>MMA 0204</b>
Temperature coefficient	<b>± 50 ppm/K</b>	<b>± 50 ppm/K</b>	<b>± 50 ppm/K</b>
Values in accordance with tolerance/IEC series	0.22 Ω to 0.82 Ω; 5 % E12 series  1 Ω to 8.2 Ω; 1 % E12 series  10 Ω to 10 MΩ; 1 % E24 series  jumper	0.22 Ω to 0.82 Ω; 5 % 1/2 E24 series  1 Ω to 9.09 Ω; 1 % 1/2 E48 series  10 Ω to 1 MΩ; 1 % 1/2 E96 series  1.1 MΩ to 10 MΩ; 1 % 1/2 E48 series  jumper	0.24 Ω to 0.91 Ω; 5 % E24 <sup>1)</sup> series  1.05 Ω to 9.53 Ω; 1 % E48 <sup>1)</sup> series  10.2 Ω to 976 kΩ; 1 % E96 <sup>1)</sup> series  1.05 M Ω to 9.53 MΩ; 1 % E48 <sup>1)</sup> series  jumper
Resistor type	<b>MMA 0102 HF</b>		
Temperature coefficient	<b>± 50 ppm/K</b>		
Values in accordance with tolerance/IEC series	4.7 Ω to 470 Ω; 2 % E6 <sup>2)</sup> series		
Number of resistance values	177	298	297
Resistors per value/total	45/7 965	45/13 410	45/13 365
Number of pages/files	10/1	17/1	17/1

**Notes**

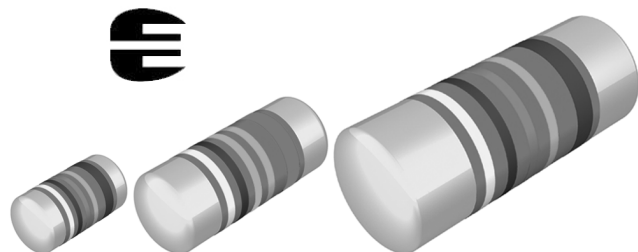
1. Supplement to the laboratory kit LMA 48 to the complete declared E series.
2. Completed by some typical values for HF (RF) applications: 50 Ω, 60 Ω, 75 Ω, 120 Ω, 240 Ω.

For specification details of the MINI-MELF resistor MMA 0204 please refer to the data sheet "MMU 0102, MMA 0204, MMB 0207 - Professional".

For specification details of the MINI-MELF resistor MMA 0204 HF please refer to the data sheet "MMU 0102 HF, MMA 0204 HF, MMB 0207 HF"



## Professional MELF Resistors



MMU 0102, MMA 0204 and MMB 0207 professional thin film MELF resistors are the perfect choice for most fields of modern professional electronics where reliability and stability is of major concern. The typical applications in the fields of automotive, telecommunication and medical equipment reflect the outstanding level of proven reliability.

### FEATURES

- Approved according to EN 140401-803
- Advanced thin film technology
- Excellent overall stability: exceeds Class 0.25
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

### METRIC SIZE

DIN:	0102	0204	0207
CECC:	RC 2211M	RC 3715M	RC 6123M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MMU 0102		MMA 0204		MMB 0207	
CECC size	RC 2211M		RC 3715M		RC 6123M	
Resistance range	0.22 Ω to 2.21 MΩ		0.22 Ω to 10 MΩ		0.1 Ω to 15 MΩ	
Resistance tolerance	± 5 %; ± 2 %; ± 1 %; ± 0.5 %		± 5 %; ± 1 %; ± 0.5 %		± 5 %; ± 2 %; ± 1 %; ± 0.5 %	
Temperature coefficient	± 50 ppm/K; ± 25 ppm/K				± 100 ppm/K; ± 50 ppm/K; ± 25 ppm/K	
Operation mode	standard	power	standard	power	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56	55/155/56
Rated dissipation, $P_{70}^{(1)}$	0.2 W	0.3 W	0.25 W	0.4 W	0.4 W	1.0 W <sup>(2)</sup>
Operating voltage, $U_{max}$ AC/DC	150 V		200 V		300 V	
Film temperature <sup>(3)</sup>	125 °C	155 °C	125 °C	155 °C	125 °C	155 °C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	0.22 Ω to 221 kΩ		0.22 Ω to 332 kΩ		0.22 Ω to 1 MΩ	
1000 h	≤ 0.15 %	≤ 0.25 %	≤ 0.15 %	≤ 0.25 %	≤ 0.15 %	≤ 0.25 %
8000 h	≤ 0.3 %	≤ 0.5 %	≤ 0.3 %	≤ 0.5 %	≤ 0.3 %	≤ 0.5 %
225 000 h	≤ 1 %	-	≤ 1 %	-	≤ 1 %	-
Permissible voltage against ambient (insulation):						
1 minute; $U_{ins}$	200 V		300 V		500 V	
continuous	75 V		75 V		75 V	
Failure rate	≤ 2 x 10 <sup>-9</sup> /h		≤ 0.7 x 10 <sup>-9</sup> /h		≤ 0.7 x 10 <sup>-9</sup> /h	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.
  2. Specified power rating requires dedicated heat-sink pads.
  3. Film temperatures above the specified range may be permissible, e.g. 175 °C. Please contact the factory for details.



### 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
0.1 Ω to 0.999 Ω	7
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5
10 MΩ to 99.9 MΩ	6

### 12NC Example

The 12NC of a MMU 0102 resistor, value 47 kΩ and TC 50 with ± 1 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 165 14703.

12NC - resistor type and packaging					
DESCRIPTION			ORDERING CODE 2312... ..		
			BLISTER TAPE ON REEL		BULK CASE
TYPE	TCR	TOL.	BL 3000 UNITS	B0 10 000 UNITS	M8 8000 UNITS
MMU 0102	± 50 ppm/K	± 5 %	165 3....	175 3....	060 3....
		± 2 %	165 2....	175 2....	060 2....
		<b>± 1 %</b>	<b>165 1....</b>	<b>175 1....</b>	<b>060 1....</b>
		± 0.5 %	165 5....	175 5....	060 5....
	± 25 ppm/K	± 1 %	166 1....	176 1....	061 1....
		<b>± 0.5 %</b>	<b>166 5....</b>	<b>176 5....</b>	<b>061 5....</b>
jumper			<b>165 90001</b>	<b>175 90001</b>	<b>060 90001</b>
TYPE	TCR	TOL.	BL 3000 UNITS	B0 10 000 UNITS	M3 3000 UNITS
MMA 0204	± 50 ppm/K	± 5 %	155 3....	145 3....	040 3....
		<b>± 1 %</b>	<b>155 1....</b>	<b>145 1....</b>	<b>040 1....</b>
		± 0.5 %	155 5....	145 5....	040 5....
	± 25 ppm/K	± 1 %	156 1....	146 1....	041 1....
		<b>± 0.5 %</b>	<b>156 5....</b>	<b>146 5....</b>	<b>041 5....</b>
	jumper			<b>155 90001</b>	<b>145 90001</b>
TYPE	TCR	TOL.	B2 2000 UNITS	B7 7000 UNITS	
MMB 0207	± 100 ppm/K	± 5 %	195 3....	185 3....	
	± 50 ppm/K	± 5 %	195 3....	185 3....	
		± 2 %	195 2....	185 2....	
		<b>± 1 %</b>	<b>195 1....</b>	<b>185 1....</b>	
	± 25 ppm/K	± 0.5 %	<b>196 5....</b>	<b>186 5....</b>	
	jumper			<b>195 90001</b>	<b>185 90001</b>

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

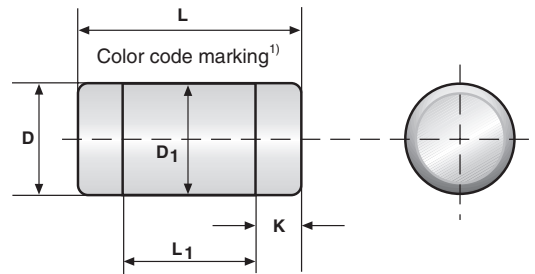
PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>						
PART NUMBER <sup>2)</sup> : MMB02070D5620DB200						
PART NUMBER <sup>2)</sup> : MMB02070Z0000ZB200						
M	M	B	0	2	0	7 0 D 5 6 2 0 D B 2 0 0
M	M	B	0	2	0	7 0 Z 0 0 0 0 Z B 2 0 0
MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
MMU0102 MMA0204 MMB0207	0 = neutral, acc. CECC E0	D = ± 25 ppm/K C = ± 50 ppm/K B = ± 100 ppm/K Z = Jumper	3 digit value 1 digit multiplier Multiplier 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup> 5 = *10 <sup>5</sup>	D = ± 0.5 % F = ± 1 % G = ± 2 % J = ± 5 % Z = Jumper	B3 B0 B2 B7 M3 M8	up to 2 digits 00 = standard
PRODUCT DESCRIPTION: MMB 0207 - 25 0.5 % B2 562R						
PRODUCT DESCRIPTION: MMB 0207 B2 0R0						
MMB	0207	- 25	0.5 %	B2	562R	
MMB	0207	-	-	B2	0R0	
MODEL	SIZE	TCR	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE	
MMU	0102	± 25 ppm/K	± 0.5 %	BL	562R = 562 Ω	
MMA	0204	± 50 ppm/K	± 1 %	B0	4M64 = 4.64 MΩ	
MMB	0207	± 100 ppm/K <sup>4)</sup>	± 2 %	B2	0R0 = Jumper	
			± 5 %	B7		
				M3		
				M8		

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.
4. A temperature coefficient 100 ppm/K is marked - 00.

PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
MMU 0102	180 mm/7"	3000	B3 = BL	8000	M8
	330 mm/13"	10 000	B0		
MMA 0204	180 mm/7"	3000	B3 = BL	3000	M3
	330 mm/13"	10 000	B0		
MMB 0207	180 mm/7"	2000	B2	-	-
	330 mm/13"	7000	B7		

### DIMENSIONS



<b>DIMENSIONS</b> - MELF resistor types, mass and relevant physical dimensions						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MMU 0102	2.2 + 0/- 0.1	1.1 + 0/- 0.1	1.2	D + 0/- 0.1	0.4 ± 0.05	7
MMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19
MMB 0207	5.8 + 0/- 0.2	2.2 + 0/- 0.2	2.8	D + 0/- 0.2	1.25 ± 0.15	79

#### Note

1. Color code marking is applied according to IEC 60062\* in four bands (E24 series) or five bands (E96 or E192 series). Each colour band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last colour band for tolerance is approximately 50 % wider than the other bands. An interrupted yellow band between the 4th and 5th full band indicates the temperature coefficient of 25 ppm/K.

<b>TEMPERATURE COEFFICIENT AND RESISTANCE RANGE</b>				
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>		
TCR	TOLERANCE	MMU 0102	MMA 0204	MMB 0207
± 100 ppm/K	± 5 %	-	-	0.1 Ω to 0.2 Ω
± 50 ppm/K	± 5 %	0.22 Ω to 0.91 Ω	0.22 Ω to 0.91 Ω	0.22 Ω to 0.91 Ω
	± 2 %	1 Ω to 9.1 Ω	-	0.2 Ω to 0.91 Ω
	± 1 %	<b>10 Ω to 2.21 MΩ</b>	<b>1 Ω to 10 MΩ</b>	<b>1 Ω to 15 MΩ</b>
	± 0.5 %	10 Ω to 221 kΩ	10 Ω to 2.21 MΩ	-
± 25 ppm/K	± 1 %	10 Ω to 221 kΩ	10 Ω to 511 kΩ	-
	± 0.5 %	<b>10 Ω to 221 kΩ</b>	<b>10 Ω to 511 kΩ</b>	<b>10 Ω to 1 MΩ</b>
Jumper		≤ 10 mΩ; I <sub>max</sub> = 2 A	≤ 10 mΩ; I <sub>max</sub> = 3 A	≤ 10 mΩ; I <sub>max</sub> = 5 A

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

#### Note

1. Resistance values to be selected for ± 5 % and ± 2 % tolerance from E24, for ± 1 % tolerance from E24 and E96 and for ± 0.5 % tolerance from E24 and E192.



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body (85 % Al<sub>2</sub>O<sub>3</sub>, for MICRO-MELF: 96 % Al<sub>2</sub>O<sub>3</sub>) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four or five colour code rings designate the resistance value and tolerance in accordance with **IEC 60062<sup>3)</sup>**.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3<sup>3)</sup>** or bulk case in accordance with **IEC 60286-6<sup>3)</sup>**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1<sup>3)</sup>**. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL<sup>1)</sup>** and the **CEFIC-EECA-EICTA<sup>2)</sup>** list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

## Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

The resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068<sup>3)</sup>** series. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

This product family of thin film MELF resistors is completed by **Zero Ohm Jumpers**.

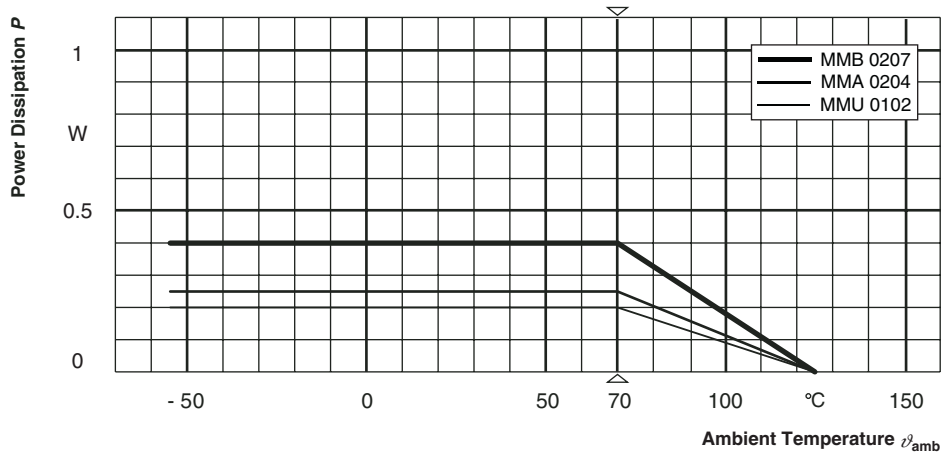
On request, resistors are available with established reliability in accordance with **EN 140401-803 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and ordering codes.

## Note

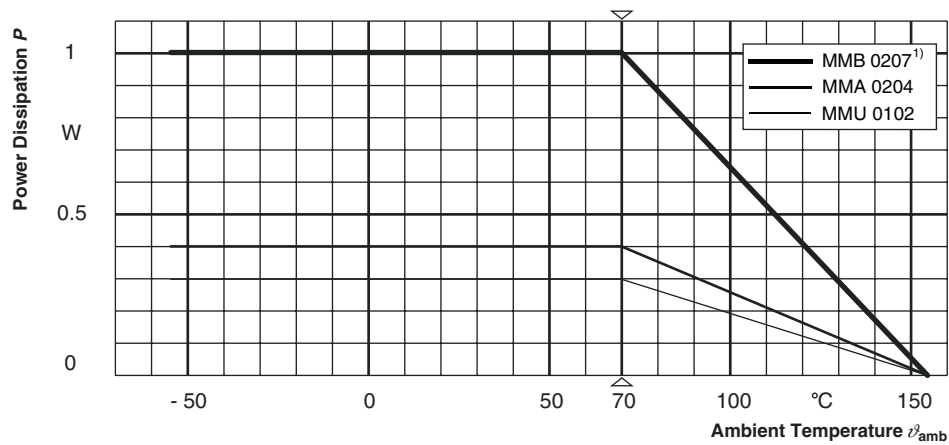
3. The quoted IEC standards are also released as EN standards with the same number and identical contents.



## FUNCTIONAL PERFORMANCE

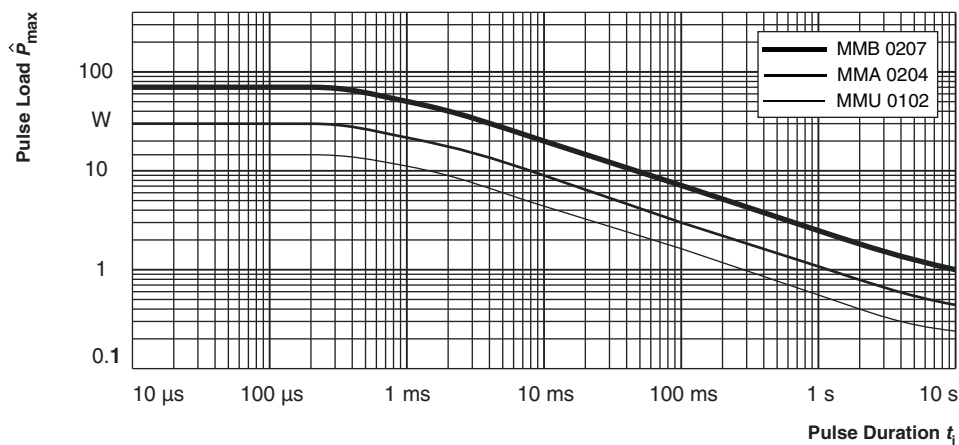


### Derating - Standard Operation



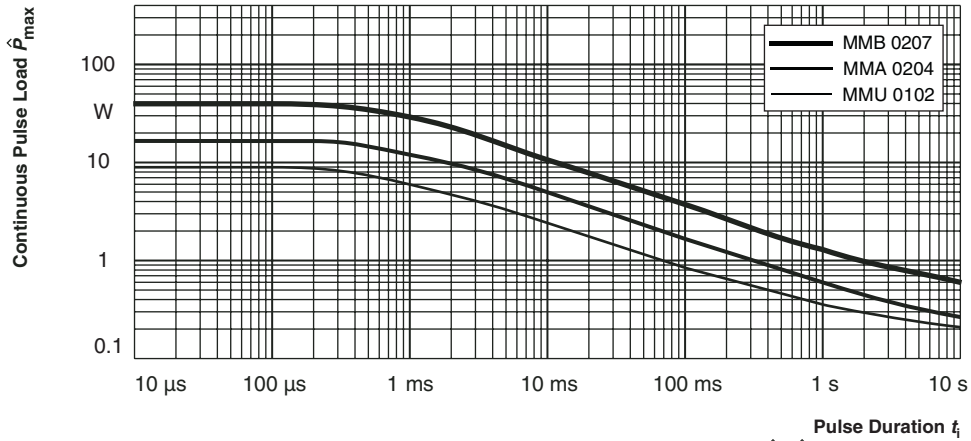
<sup>1)</sup> Specified power rating requires dedicated heat sink pads

### Derating - Power Operation



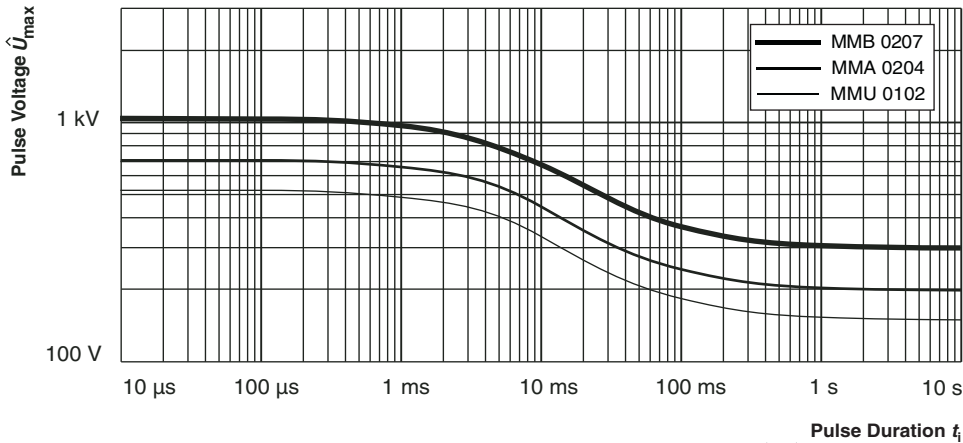
### Single Pulse

Maximum pulse load, single pulse; applicable if  $\bar{P} \rightarrow 0$  and  $n \leq 1000$  and  $\hat{U} \leq \hat{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation



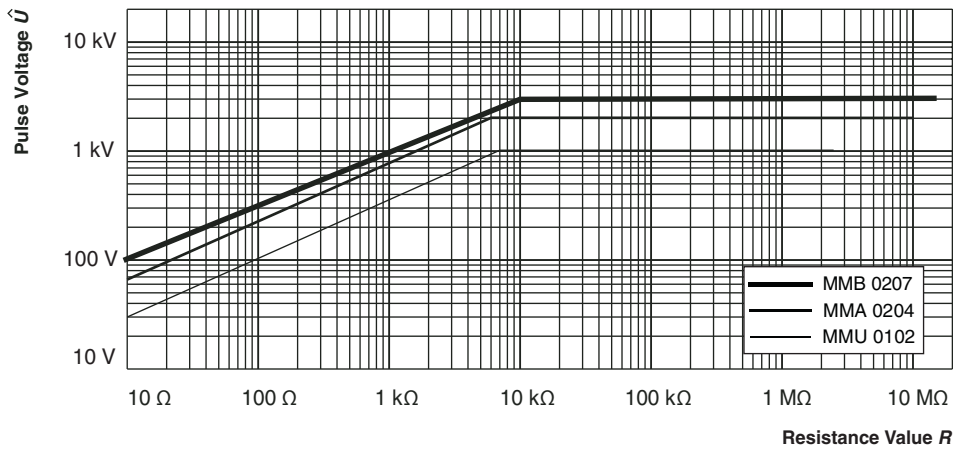
Maximum pulse load, continuous pulses; applicable if  $\bar{P} \leq P(\vartheta_{amb})$  and  $\hat{U} \leq \hat{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation

### Continuous Pulse



Maximum pulse voltage, single and continuous pulses; applicable if  $\hat{P} \leq \hat{P}_{max}$ ; for permissible resistance change equivalent to 8000 h operation

### Pulse Voltage



Pulse load rating in accordance with IEC 60 115-1, 4.27; 1.2  $\mu$ s/50  $\mu$ s; 5 pulses at 12 s intervals; for permissible resistance change 0.5 %

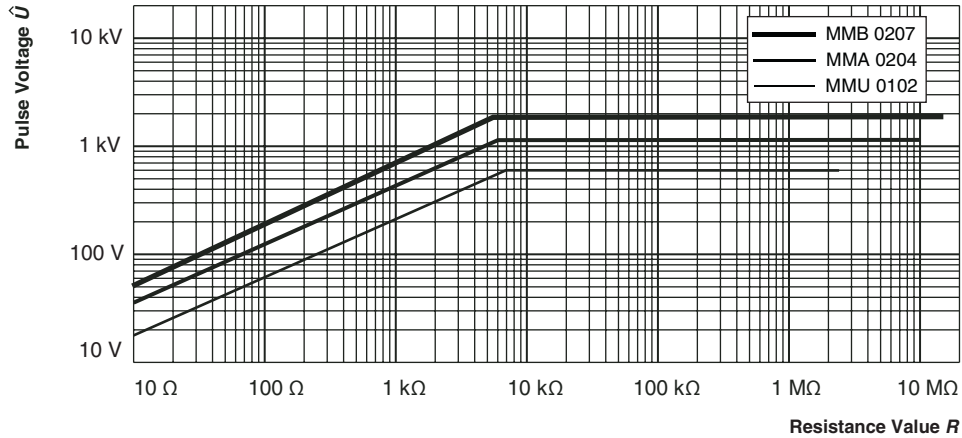
### 1.2/50 Pulse



# MMU 0102, MMA 0204, MMB 0207 - Professional

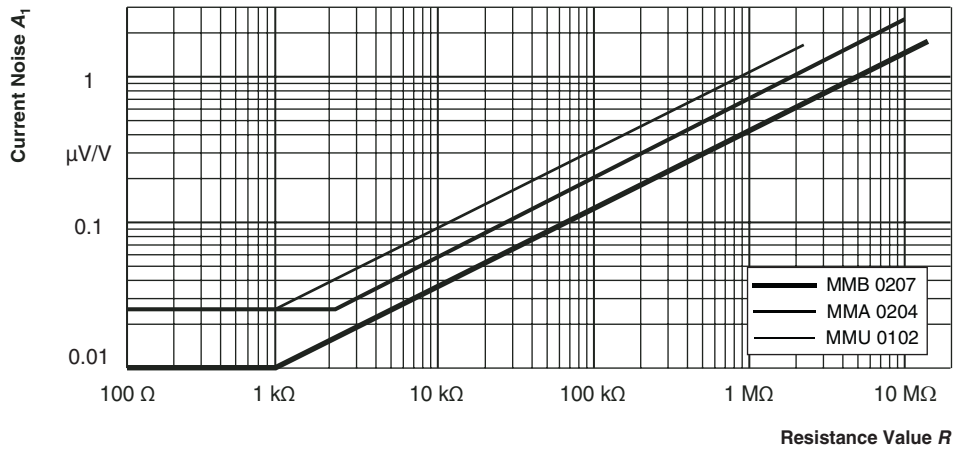
Professional MELF Resistors

Vishay Beyschlag



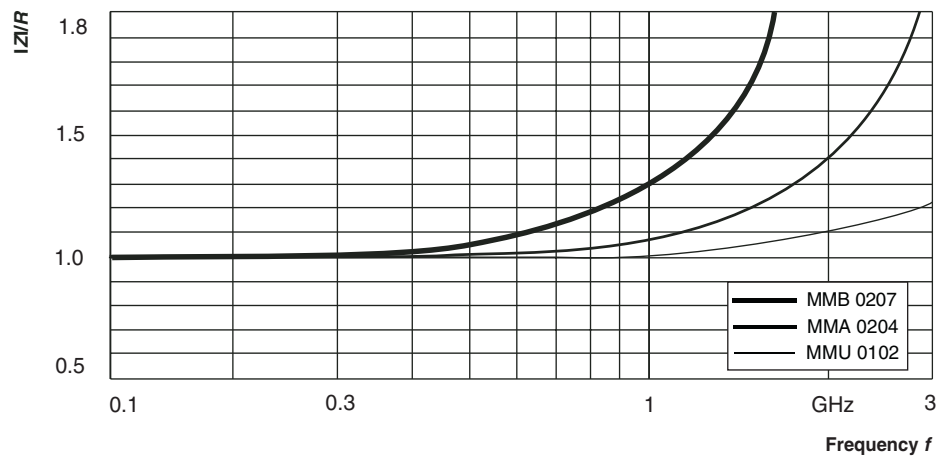
Pulse load rating in accordance with IEC 60 115-1, 4.27; 10  $\mu$ s/700  $\mu$ s; 10 pulses at 1 minute intervals; for permissible resistance change 0.5 %

## 10/700 Pulse



In accordance with IEC 60195

## Current Noise - $A_1$



$|Z|/R$  for 49.9 W MELF resistors

## RF - Behaviour





### TEST AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-803, detail specification

The components are approved in accordance with the IECQ-CECC-system, where applicable. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068\* and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3\*. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803. However, some additional tests and a number of improvements against those minimum requirements have been included. The stated requirements for long-term tests are typically fulfilled with a statistical safety of at least  $\bar{x} + 5 s$ .

TEST PROCEDURES AND REQUIREMENTS							
EN 60115-1 CLAUSE	IEC 60068-2 <sup>2)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )			
				STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			stability for product types:				
			MMU 0102	10 $\Omega$ to 221 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 221 k $\Omega$
			MMA 0204	10 $\Omega$ to 332 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 332 k $\Omega$
			MMB 0207	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 1 M $\Omega$
4.5	-	resistance	-	$\pm 1 \% R; \pm 0.5 \% R$	$\pm 2 \% R; \pm 1 \% R$	$\pm 5 \% R$	$\pm 1 \% R$
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 50 \text{ ppm/K}; \pm 25 \text{ ppm/K}$			
4.25.1	-	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R} \leq U_{\max};$ 1.5 h on; 0.5 h off; 70 °C; 1000 h		$\pm (0.15 \% R + 10 \text{ m}\Omega)$		$\pm (0.5 \% R + 10 \text{ m}\Omega)$
			70 °C; 8000 h		$\pm (0.3 \% R + 10 \text{ m}\Omega)$		$\pm (1 \% R + 10 \text{ m}\Omega)$
4.25.1	-	endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R} \leq U_{\max};$ 1.5 h on; 0.5 h off; 70 °C; 1000 h		$\pm (0.25 \% R + 10 \text{ m}\Omega)$		$\pm (0.5 \% R + 10 \text{ m}\Omega)$
			70 °C; 8000 h		$\pm (0.5 \% R + 10 \text{ m}\Omega)$		$\pm (1 \% R + 10 \text{ m}\Omega)$
4.25.3	-	endurance at upper category temperature	125 °C; 1000 h	$\pm (0.15 \% R + 5 \text{ m}\Omega)$	$\pm (0.25 \% R + 5 \text{ m}\Omega)$	$\pm (0.5 \% R + 5 \text{ m}\Omega)$	$+ (1 \% R + 5 \text{ m}\Omega)$
			155 °C; 1000 h	$\pm (0.3 \% R + 5 \text{ m}\Omega)$	$\pm (0.5 \% R + 5 \text{ m}\Omega)$	$\pm (1 \% R + 5 \text{ m}\Omega)$	$+ (2 \% R + 5 \text{ m}\Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.15 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 10 \text{ m}\Omega)$	$\pm (1 \% R + 10 \text{ m}\Omega)$	$\pm (1 \% R + 10 \text{ m}\Omega)$



TEST PROCEDURES AND REQUIREMENTS							
EN 60115-1 CLAUSE	IEC 60068-2 <sup>2)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )			
				STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			stability for product types:				
			<b>MMU 0102</b>	10 $\Omega$ to 221 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 221 k $\Omega$
			<b>MMA 0204</b>	10 $\Omega$ to 332 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 332 k $\Omega$
			<b>MMB 0207</b>	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 1 M $\Omega$
4.39	67 (Cy)	damp heat, steady state, accelerated	(85 $\pm$ 2) $^{\circ}$ C; (85 $\pm$ 5) % RH; $U = 0.1 \times \sqrt{P_{70} \times R} \leq 100$ V; 1000 h	$\pm (0.25 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 10 \text{ m}\Omega)$	$\pm (1 \% R + 10 \text{ m}\Omega)$	$\pm (2 \% R + 10 \text{ m}\Omega)$
4.23		climatic sequence:		$\pm (0.15 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 10 \text{ m}\Omega)$	$\pm (1 \% R + 10 \text{ m}\Omega)$	$\pm (1 \% R + 10 \text{ m}\Omega)$
4.23.2	2 (Ba)	dry heat	UCT; 16 h				
4.23.3	30 (Db)	damp heat, cyclic	55 $^{\circ}$ C; 24 h; $\geq 90$ % RH; 1 cycle				
4.23.4	1 (Aa)	cold	LCT; 2 h				
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) $^{\circ}$ C				
4.23.6	30 (Db)	damp heat, cyclic	55 $^{\circ}$ C; 24 h; $\geq 90$ % RH; 5 cycles				
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{\text{max}}$ ; 1 min. LCT = - 55 $^{\circ}$ C; UCT = 155 $^{\circ}$ C				
-	1 (Aa)	cold	- 55 $^{\circ}$ C; 2 h	$\pm (0.05 \% R + 5 \text{ m}\Omega)$			$\pm (0.1 \% R + 5 \text{ m}\Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT; 30 minutes at UCT; LCT = - 55 $^{\circ}$ C; UCT = 125 $^{\circ}$ C 5 cycles 1000 cycles LCT = - 55 $^{\circ}$ C; UCT = 155 $^{\circ}$ C 1000 cycles		$\pm (0.05 \% R + 10 \text{ m}\Omega)$ $\pm (0.15 \% R + 10 \text{ m}\Omega)$ $\pm (0.25 \% R + 10 \text{ m}\Omega)$		$\pm (0.1 \% R + 10 \text{ m}\Omega)$ $\pm (0.25 \% R + 10 \text{ m}\Omega)$ $\pm (0.5 \% R + 10 \text{ m}\Omega)$
4.13	-	short time overload: standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{\text{max}}$ ; 5 s	$\pm (0.03 \% R + 5 \text{ m}\Omega)$			$\pm (0.15 \% R + 5 \text{ m}\Omega)$
		short time overload: power operation mode		$\pm (0.05 \% R + 5 \text{ m}\Omega)$			$\pm (0.15 \% R + 5 \text{ m}\Omega)$
4.27	-	single pulse high voltage overload; standard operation mode	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R} \leq 2 \times U_{\text{max}}$ ; 10 pulses 10 $\mu$ s/700 $\mu$ s	$\pm (0.25 \% R + 5 \text{ m}\Omega)$			
		single pulse high voltage overload; power operation mode		$\pm (0.5 \% R + 5 \text{ m}\Omega)$			



TEST PROCEDURES AND REQUIREMENTS							
EN 60115-1 CLAUSE	IEC 60068-2 <sup>2)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )			
				STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			stability for product types:				
			MMU 0102	10 $\Omega$ to 221 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 221 k $\Omega$
			MMA 0204	10 $\Omega$ to 332 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 332 k $\Omega$
			MMB 0207	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 1 M $\Omega$
4.37	-	periodic electric overload; standard operation mode	$U = \sqrt{15 \times P_{70} \times R} \leq 2 \times U_{max}$ ; 0.1 s on; 2.5 s off; 1000 cycles	$\pm (0.5 \% R + 5 \text{ m}\Omega)$			
		periodic electric overload; power opera-		$\pm (1 \% R + 5 \text{ m}\Omega)$			
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq 1.5 \text{ mm}$ or $\leq 200 \text{ m/s}^2$ ; 6 h	$\pm (0.05 \% R + 5 \text{ m}\Omega)$			$\pm (0.1 \% R + 5 \text{ m}\Omega)$
4.40	-	electrostatic discharge (Human Body Model)	IEC 61340-3-1*; 3 pos. + 3 neg. discharges MMU 0102: 1.5 kV MMA 0204: 2 kV MMB 0207: 4 kV	$\pm (0.5 \% R + 50 \text{ m}\Omega)$			
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux; (215 $\pm$ 3) $^{\circ}\text{C}$ ; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage			
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux; (235 $\pm$ 3) $^{\circ}\text{C}$ ; (2 $\pm$ 0.2) s	good tinning ( $\geq 95 \%$ covered); no visible damage			
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$	$\pm (0.25 \% R + 10 \text{ m}\Omega)$	$\pm (0.25 \% R + 10 \text{ m}\Omega)$
			reflow method 2 (IR/forced gas convection); (260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s	$\pm (0.02 \% R + 10 \text{ m}\Omega)$	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$
4.29	45 (XA)	component solvent	isopropyl alcohol; 50 $^{\circ}\text{C}$ ; method 2	no visible damage			
4.30	45 (XA)	solvent resistance of marking	isopropyl alcohol; 50 $^{\circ}\text{C}$ ; method 1, toothbrush	marking legible; no visible damage			



TEST PROCEDURES AND REQUIREMENTS							
EN 60115-1 CLAUSE	IEC 60068-2 <sup>2)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )			
				STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			stability for product types:				
			<b>MMU 0102</b>	10 $\Omega$ to 221 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 221 k $\Omega$
			<b>MMA 0204</b>	10 $\Omega$ to 332 k $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 332 k $\Omega$
			<b>MMB 0207</b>	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to < 10 $\Omega$	< 1 $\Omega$	> 1 M $\Omega$
4.32	21 (Ue <sub>3</sub> )	shear	45 N	no visible damage			
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	no visible damage, no open circuit in bent position $\pm (0.05 \% R + 5 \text{ m}\Omega)^1$			
4.7	-	voltage proof	$U_{rms} = U_{ins}$ ; 60 s	no flashover or breakdown			
4.35	-	flammability	IEC 60 695-11-5 <sup>2)</sup> , needle flame test; 10 s	no burning after 30 s			

### Notes

1. Special requirements apply to MICRO-MELF, MMU 0102:

- $R < 100 \Omega$ :  $\pm (0.25 \% R + 10 \text{ m}\Omega)$
- $100 \Omega \leq R \leq 221 \text{ k}\Omega$ :  $\pm 0.1 \% R$
- $221 \text{ k}\Omega < R$ :  $\pm 0.25 \% R$

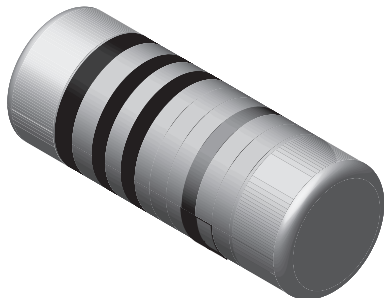
2. The quoted IEC standards are also released as EN standards with the same number and identical contents.

### REVISION HISTORY

Compared to the prior revision of this datasheet, 23-Feb-04, the following changes have been applied:

- Introduction of a standardized part numbering system
- Additional emphasis on the clean balance of materials and on the compliance with various EU directives
- Revision of the current noise diagram based on new test results
- Introduction of a test and requirements for electrostatic discharge (ESD)
- No other change of technical contents
- No product change

## Metal Film, Cylindrical Resistors



### FEATURES

- Stable metal film on high quality ceramic
- Low TCR and tight tolerances
- Excellent stability
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> $P_{70}$ W	LIMITING ELEMENT VOLTAGE <sup>2)</sup> DC or AC rms V	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
SMM0102	0.20	100	$\pm 15$	$\pm 0.1$	100R - 100K	24 - 96
SMM0102	0.20	100	$\pm 25$	$\pm 0.1$	100R - 100K	24 - 96
SMM0102	0.20	100	$\pm 50$	$\pm 1.0$	10R - 2M21	24 - 96

Zero-Ohm-Resistor: OMM0102       $R_{\max} = 10 \text{ m}\Omega$        $I_{\max} = 2 \text{ A}$

### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.

2. Rated voltage:  $\sqrt{P \times R}$ .

- Further values and tolerances on request
- Marking: According to IEC 60062; see also data sheet "surface mount resistor marking" (document number: 20020)

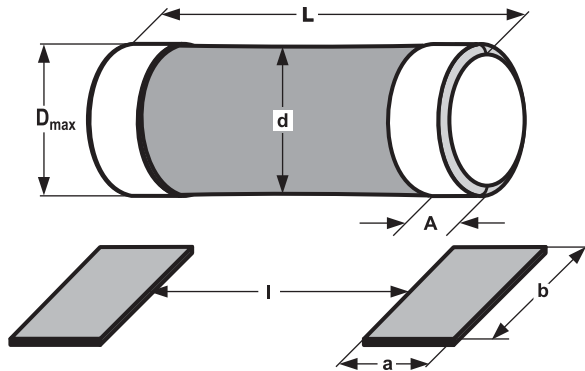
### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	SMM0102
Rated Dissipation at 70 °C	W	0.2
Limiting Element Voltage, DC or AC rms	V	100
Insulation Voltage (1 min), DC or AC peak	V	150
Thermal Resistance <sup>3)</sup>	K/W	$\leq 250$
Insulation Resistance	$\Omega$	$\geq 10^{10}$
Category Temperature Range	°C	- 55 to + 125
Failure Rate	$10^{-9}/\text{h}$	$< 2$
Weight/1000 pcs	g	7.8

### Note

3. Based on measurements on test board acc. to EN 140400.

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
SMM0102	1.1	D - 0.05	2.2 - 0.15	0.45	0.35

**Note**

1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW SOLDERING			WAVE SOLDERING		
	a	b	l	a	b	l
SMM0102	0.5	1.3	1.3	0.6	1.3	1.3

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

PART NUMBER<sup>2)</sup>: SMM01020D5620BB3

PART NUMBER<sup>2)</sup>: OMM01020000000B3

S	M	M	0	1	0	2	0	D	5	6	2	0	B	B	3	0	0
O	M	M	0	1	0	2	0	0	0	0	0	0	0	B	3	0	0

MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
SMM0102	0 = neutral	E = ± 15 ppm/K D = ± 25 ppm/K C = ± 50 ppm/K 0 = Jumper	3 digit value 1 digit multiplier 0000 = Jumper <b>Multiplier</b> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup>	B = ± 0.1 % F = ± 1 % 0 = Jumper	B1 B3 B0 M8	up to 2 digits 00 = standard
OMM0102						

PRODUCT DESCRIPTION: SMM0102 25 562R 0.1 % B3

PRODUCT DESCRIPTION: OMM0102 0R0 B3

SMM0102	25	562R	0.1 %	B3
OMM0102	-	0R0	-	B3
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>3)</sup>
SMM0102	± 15 ppm/K	100 = 100 Ω	± 0.1 %	B1
OMM0102	± 25 ppm/K	2M21 = 2.21 MΩ	± 1 %	B3
	± 50 ppm/K	0R0 = jumper		B0
				M8

**Notes**

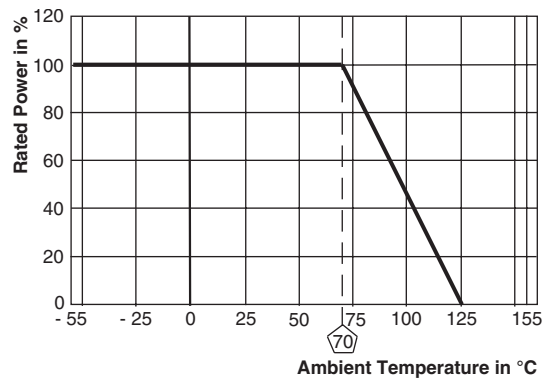
1. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, see below.



PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC IEC 60286-3			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
SMM0102	180 mm/7"	1000	B1 <sup>1)</sup>	8000	M8
OMM0102	180 mm/7"	3000	B3		
	330 mm/13"	10 000	B0		

**Note:** For further information about packing see also data sheet "surface mount resistor packing" (document number: 20014)

1. For TCR ≤ 25 ppm/K and Tolerance ≤ 0.25 % only



**Derating**



<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>REQUIREMENTS<sup>1)</sup></b>
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF" 8000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ 0.25 % ≤ 0.5 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 0.5 %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds at 6.25 x rated power	≤ 0.1 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 0.1 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 0.5 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 0.1 %

**Note**

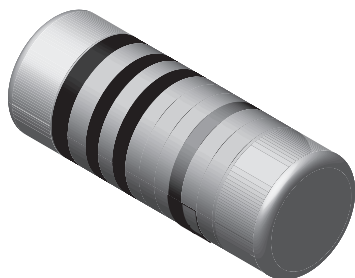
1. For a resistance range from 10 Ω to 221 kΩ.

**APPLICABLE SPECIFICATIONS**

- EN 140401-803
- EN 140400
- EN 60115-1



## Metal Film, Cylindrical Resistors



### FEATURES

- Stable metal film on high quality ceramic
- Low TCR and tight tolerances
- Excellent stability in different environmental conditions
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> $P_{70}$ W	LIMITING ELEMENT VOLTAGE <sup>2)</sup> DC or AC rms V	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
SMM0204	0.25	200	$\pm 15$	$\pm 0.1$ $\pm 0.25$ $\pm 0.5$	43R - 221K 22R - 221K 10R - 221K	24 - 192 24 - 192 24 - 192
SMM0204	0.25	200	$\pm 25$	$\pm 0.1$ $\pm 0.25$ $\pm 0.5$	43R - 511K 22R - 511K 10R - 1M0	24 - 192 24 - 192 24 - 192
SMM0204	0.25	200	$\pm 50$	$\pm 0.5$ $\pm 1$	10R - 1M0 R82 - 10M	24 - 192 24 - 96
SMM0204	0.25	200	$\pm 100$	$\pm 5$	R22 - 10M	24
Zero-Ohm-Resistor: OMM0204 $R_{max} = 10 \text{ m}\Omega$ $I_{max} = 2 \text{ A}$						

### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.
  2. Rated voltage:  $\sqrt{P \times R}$ .
- Further values and tolerances on request
  - Coating:  
Light green for TCR = 100 ppm/K, 50 ppm/K and 0  $\Omega$  resistor  
Pink TCR = 25 ppm/K  
Violet TCR = 15 ppm/K
  - Marking: According to IEC 60062; see also data sheet "surface mount resistor marking" (document number: 20020)
  - Zero ohm resistor has a black band only

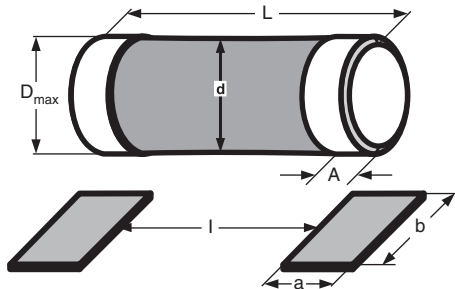
### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	SMM0204
Rated Dissipation at 70 °C	W	0.25
Limiting Element Voltage, DC or AC rms	V	200
Insulation Voltage (1 min), DC or AC peak	V	300
Thermal Resistance <sup>3)</sup>	K/W	$\leq 220$
Insulation Resistance	$\Omega$	$\geq 10^{10}$
Category Temperature Range	$^{\circ}\text{C}$	- 55 to + 125 (+ 155)
Failure Rate	$10^{-9}/\text{h}$	< 1
Weight/1000 pcs	g	18

### Note

3. Based on measurements on test board acc. to EN 140400.

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
SMM0204	1.4	D - 0.15	3.6 - 0.15	0.85	0.5

**Note**  
1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW SOLDERING			WAVE SOLDERING		
	a	b	l	a	b	l
SMM0204	1.0	1.6	2.2	1.2	1.6	2.2

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

PART NUMBER<sup>2)</sup>: SMM0204VC5620FB0  
 PART NUMBER<sup>2)</sup>: OMM0204000000B0

S	M	M	0	2	0	4	V	C	5	6	2	0	F	B	0	0	0
O	M	M	0	2	0	4	0	0	0	0	0	0	0	B	0	0	0

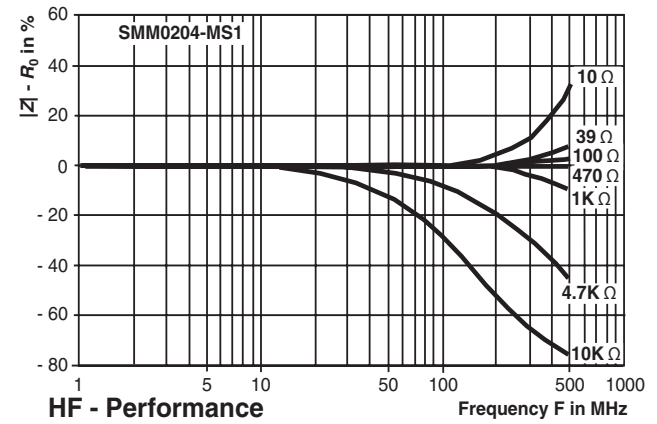
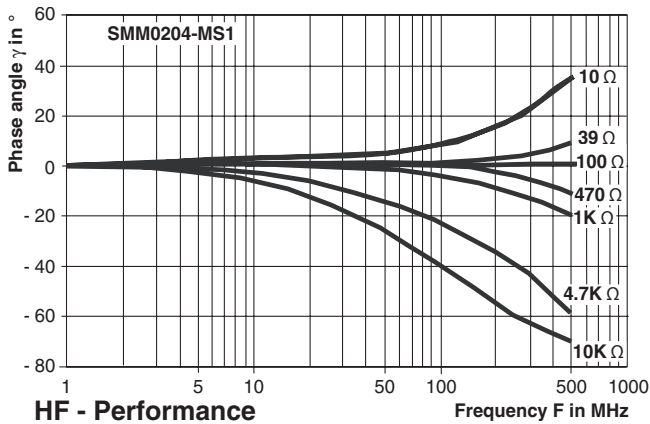
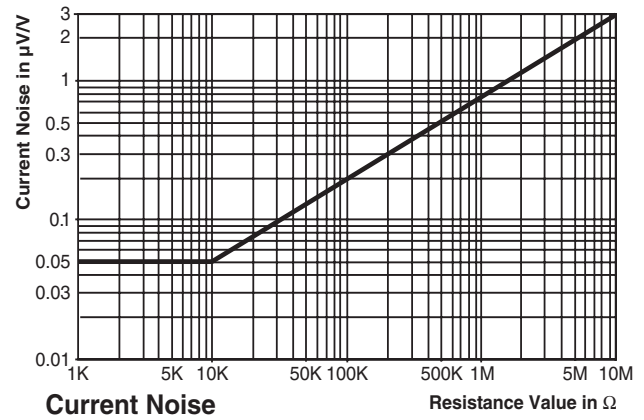
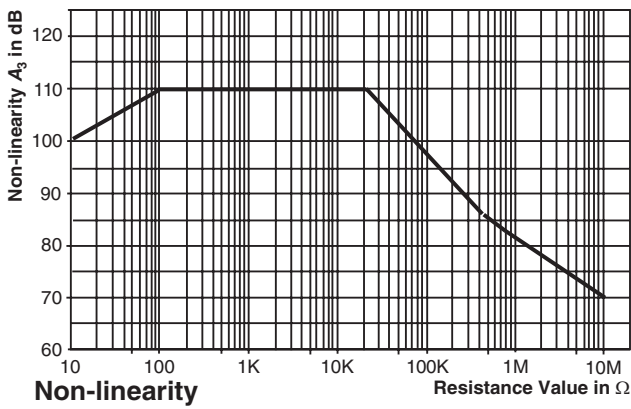
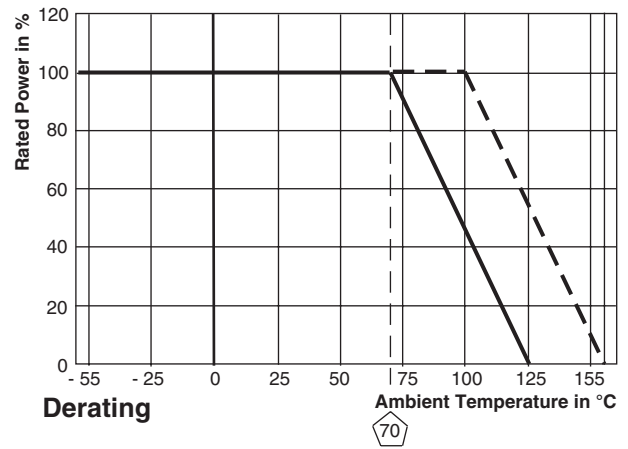
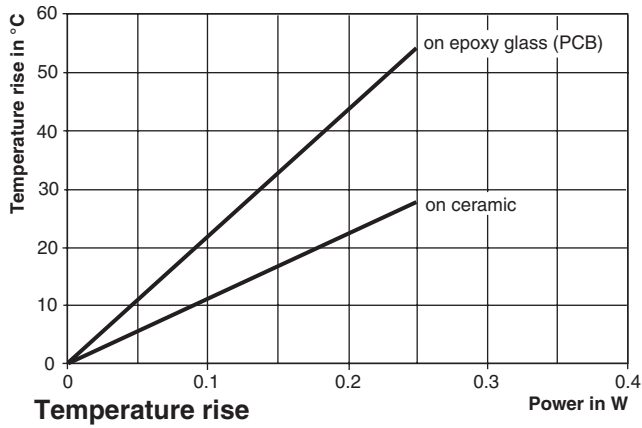
MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
SMM0204 OMM0204	0 = neutral V = CECC E0	E = ± 15 ppm/K D = ± 25 ppm/K C = ± 50 ppm/K B = ± 100 ppm/K 0 = Jumper	<b>3 digit value</b> <b>1 digit multiplier</b> 0000 = jumper MULTIPLIER 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup>	B = ± 0.1 % C = ± 0.25 % D = ± 0.5 % F = ± 1 % J = ± 5 % 0 = Jumper	B1 B3 B0 M3	up to 2 digits 00 = standard

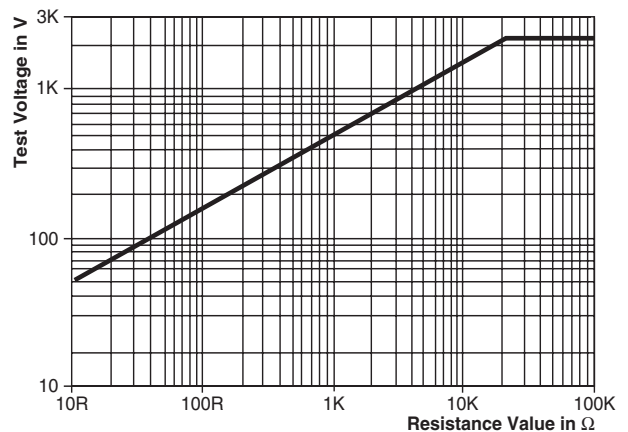
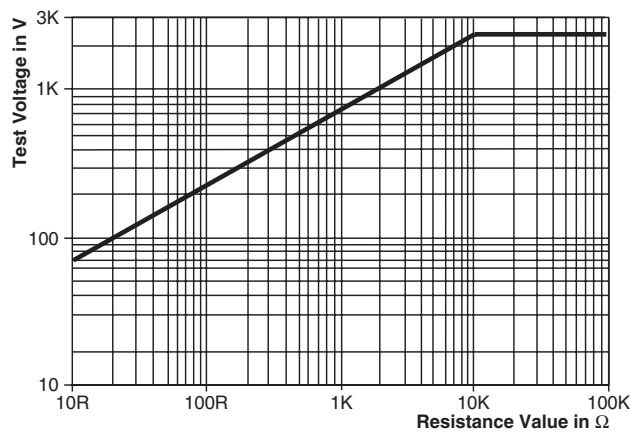
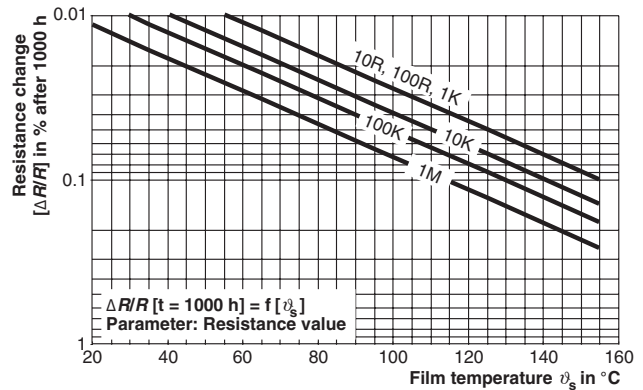
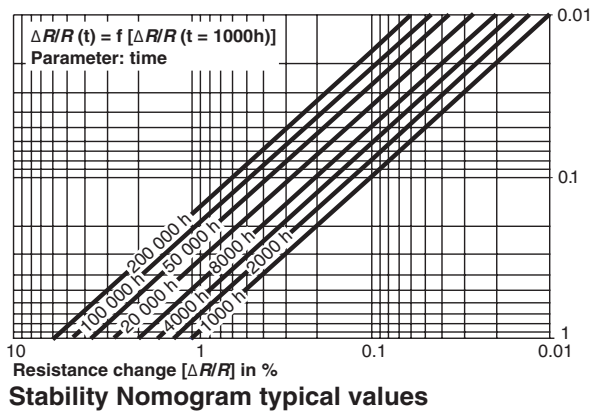
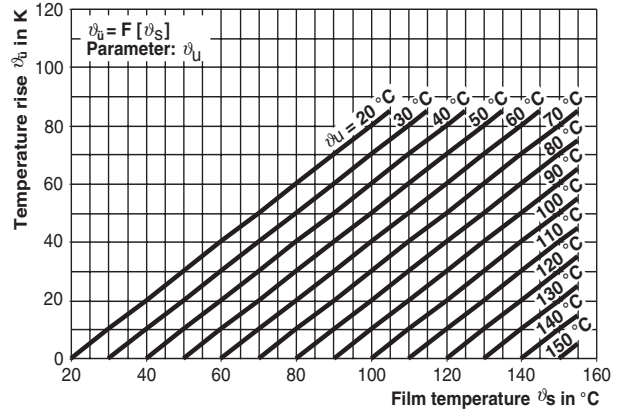
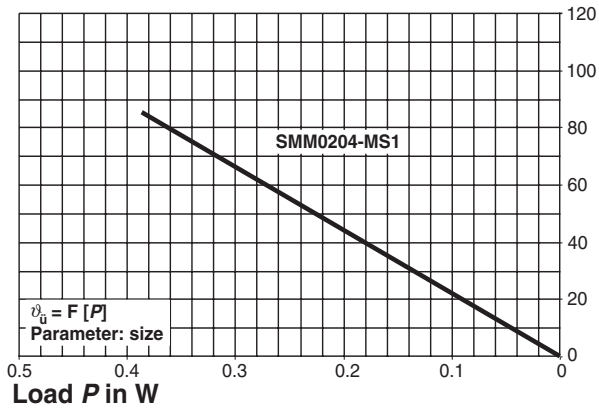
PRODUCT DESCRIPTION: SMM0204 50 562R 1 % B0 CECC 40401-803E0  
 PRODUCT DESCRIPTION: OMM0204 0R0 B0

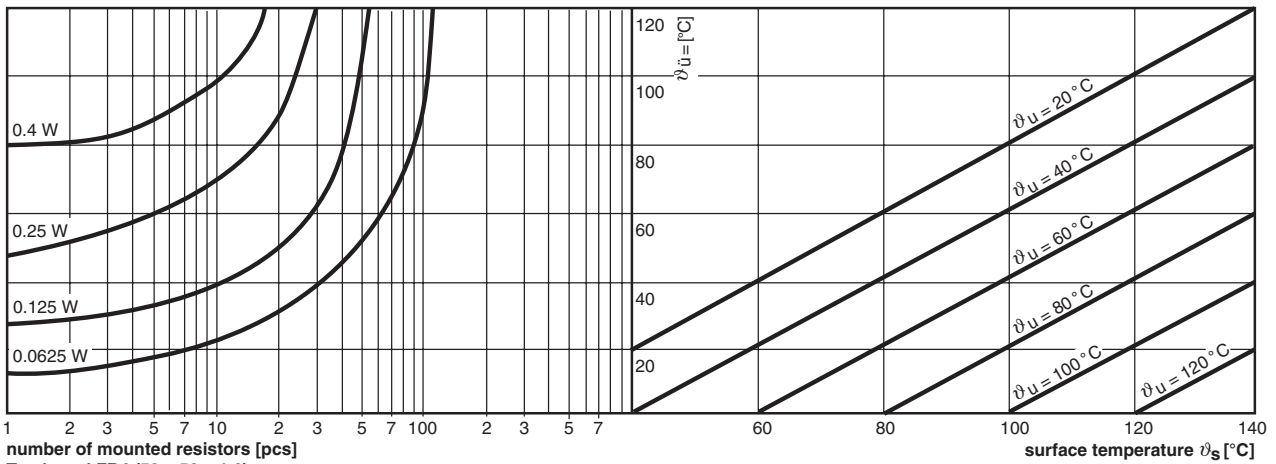
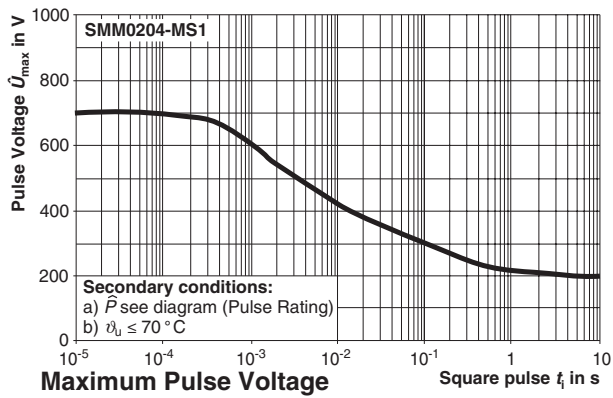
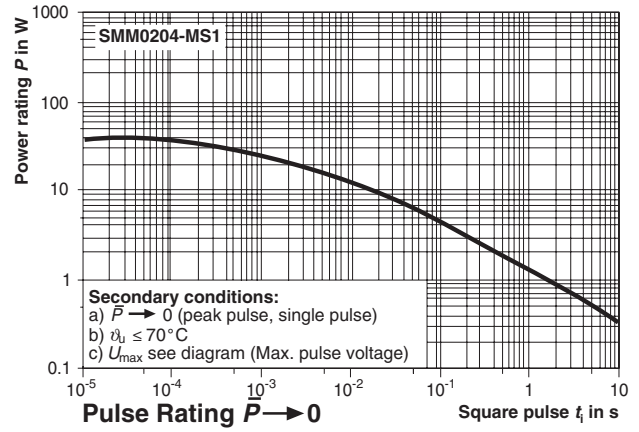
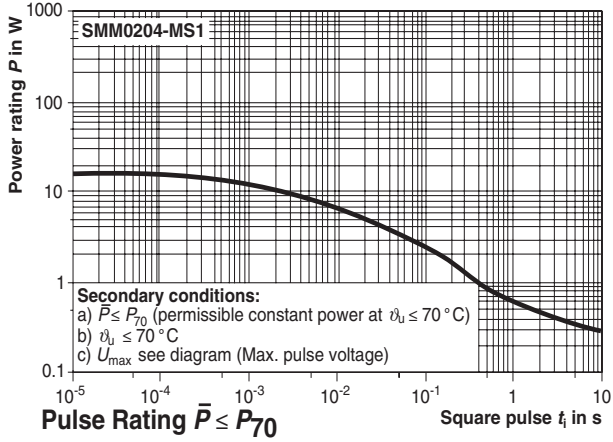
SMM0204	50	562R	1 %	B0	CECC 40401-803E0
OMM0204	-	0R0	-	B0	-
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
SMM0204 OMM0204	± 15 ppm/K ± 25 ppm/K ± 50 ppm/K ± 100 ppm/K	100R = 100 Ω 2M21 = 2.21 MΩ 0R0 = Jumper	± 0.1 % ± 0.25 % ± 0.5 % ± 1 % ± 5 %	B1 B3 B0 M3	CECC 40401-803E0

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, see below.







Power rating as a function of packaging density (guideline)



<b>PACKAGING</b>					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-6			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
SMM0204	180 mm/7"	1000	B1 <sup>1)</sup>	3000	M3
	180 mm/7"	3000	B3		
OMM0204	330 mm/13"	10 000	B0		

**Note**

1. For  $TCR \leq 25$  ppm/K and Tolerance  $\leq 0.25$  % only

<b>PERFORMANCE</b>		
TEST	CONDITIONS OF TEST	REQUIREMENTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C 1.5 hours "ON" 0.5 hours "OFF"	$\leq 0.25$ %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	$\leq 0.25$ %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds 2.5 x rated voltage or $\leq 2$ x limiting element voltage	$\leq 0.05$ %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	$\leq 0.05$ %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	$\leq 0.25$ %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	$\leq 0.05$ %

**Note**

1. For a resistance range from 10  $\Omega$  to 332 k $\Omega$ , limits for change of resistance at test acc. to EN 140401-803.

<b>APPLICABLE SPECIFICATIONS</b>
<ul style="list-style-type: none"><li>• EN140401-803</li><li>• EN140400</li><li>• EN 60115-1</li></ul>

## Metal Film, Cylindrical Resistors



### FEATURES

- Metal film resistor with high power rating
- Stable metal film on high quality ceramic
- Good thermal distribution
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> $P_{70}$ W	LIMITING ELEMENT VOLTAGE <sup>2)</sup> DC or AC rms V	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
SMM0207	1.0	350	$\pm 50$	$\pm 0.5$	1R0 - 2M21	24 - 96
SMM0207	1.0	350	$\pm 50$	$\pm 1$	1R0 - 10M	24 - 96
SMM0207	1.0	350	$\pm 100$	$\pm 5$	R16 - R91	24

Zero-Ohm-Resistor: OMM0207  $R_{max} = 10 \text{ m}\Omega$   $I_{max} = 5 \text{ A}$

### Notes

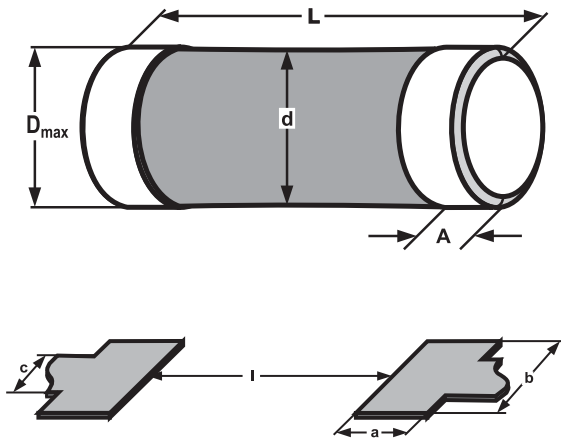
1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.
2. Rated voltage:  $\sqrt{P \times R}$ .

- Further values and tolerances on request
- Marking: According to IEC 60062; see also data sheet "surface mount resistor marking" (document number: 20020)
- Zero ohm resistor has one black band only

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	SMM0207
Rated Dissipation at 70 °C	W	1
Limiting Element Voltage, DC or AC rms	V	350
Insulation Voltage (1 min), DC or AC peak	V	500
Thermal Resistance	K/W	see table
Insulation Resistance	$\Omega$	$\geq 10^{11}$
Temperature Range	°C	- 55 to + 155
Failure Rate	$10^{-9}/\text{h}$	< 5
Weight/1000 pcs	g	77

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
SMM0207	2.2	D - 0.2	5.8 - 0.3	1.2	0.6

**Note**

1. d measured in the middle of the resistor

SOLDER PAD DIMENSIONS [in millimeters]					
a x b (mm)	LINE-WIDTH c (mm)	P <sub>70</sub> for 35 μ (W)	R <sub>th</sub> for 35 μ (K/W)	P <sub>70</sub> for 70 μ (W)	R <sub>th</sub> for 70 μ (K/W)
6 x 6	6	0.82	103	0.99	86
3 x 3	3	0.70	121	0.82	104
2 x 3	2	0.62	137	0.71	120
3 x 3	2	0.65	131	0.75	114
1 x 3	1	0.51	166	0.58	147
3 x 3	1	0.57	148	0.63	134
2.4 x 2	0.5	0.46	184	0.50	171
2.4 x 2	0.5	0.48	177	0.52	163

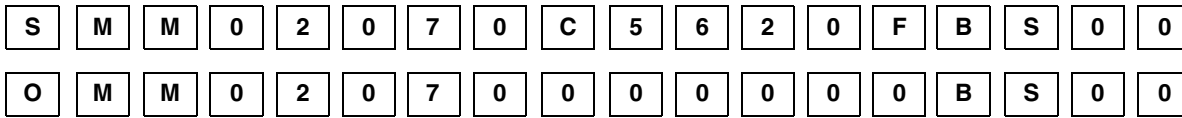
**Note**

Line length 30 mm min, l = 2.8 mm

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

PART NUMBER<sup>2)</sup>: SMM02070C5620FBS00

PART NUMBER<sup>2)</sup>: OMM0207000000BS



<b>MODEL/SIZE</b> SMM0207 OMM0207	<b>SPECIAL CHARACTER</b> 0 = neutral	<b>TCR</b> C = ± 50 ppm/K B = ± 100 ppm/K 0 = Jumper	<b>VALUE</b> 3 digit value 1 digit multiplier 0000 = jumper  <b>MULTIPLIER</b> 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup>	<b>TOLERANCE</b> D = ± 0.5 % F = ± 1 % J = ± 5 % 0 = Jumper	<b>PACKAGING<sup>3)</sup></b> BP BS	<b>SPECIAL</b> up to 2 digits 00 = standard
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PRODUCT DESCRIPTION: SMM0207 50 562R 1% BS

PRODUCT DESCRIPTION: OMM0207 0R0 BS

SMM0207	50	562R	1 %	BS
OMM0207	-	0R0	-	BS
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>3)</sup>
SMM0207 OMM0207	± 50 ppm/K ± 100 ppm/K	100R = 100 Ω 2M21 = 2.21 MΩ 0R0 = Jumper	± 0.5 % ± 1 % ± 5 %	BP BS

**Notes**

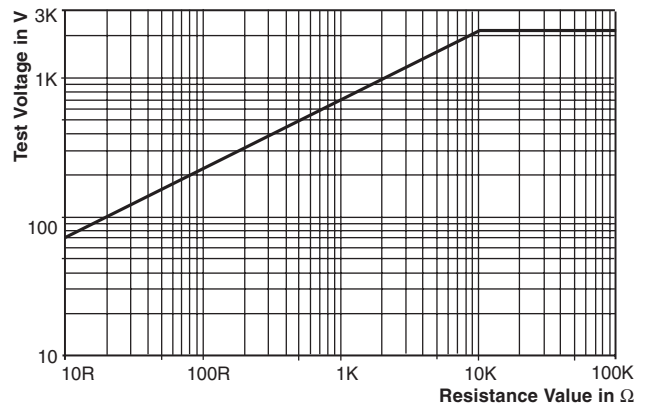
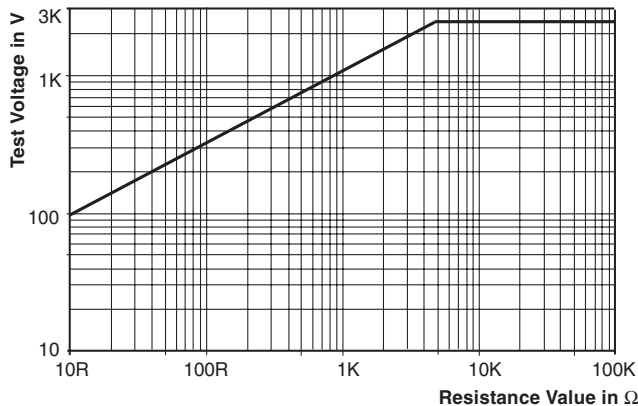
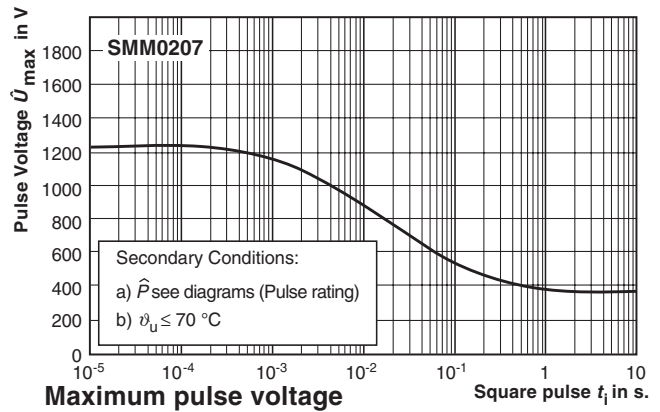
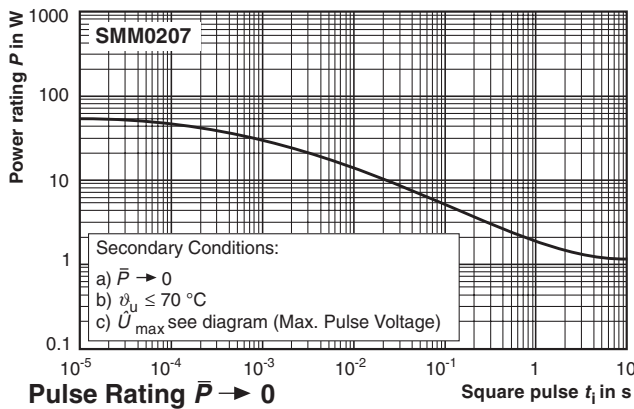
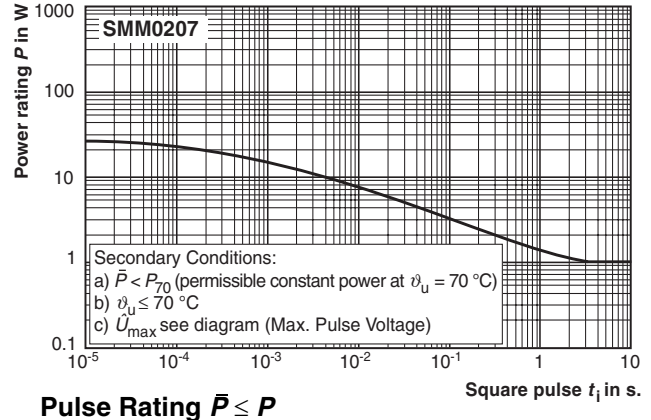
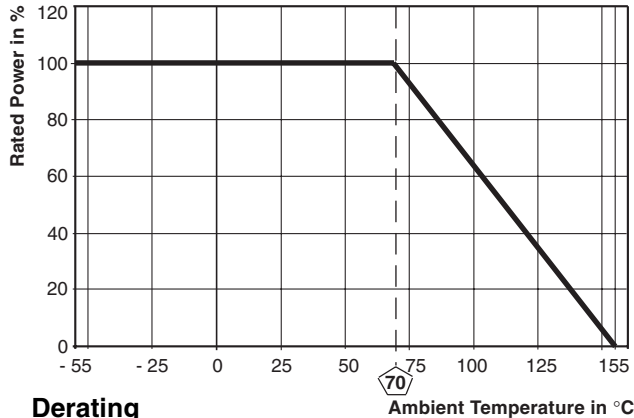
- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKAGING, see below.

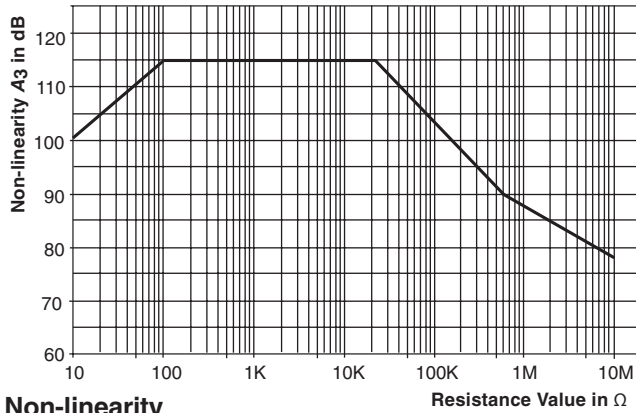


PACKAGING			
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
SMM0207	180 mm/7"	1500	BP
OMM0207	330 mm/13"	7500	BS

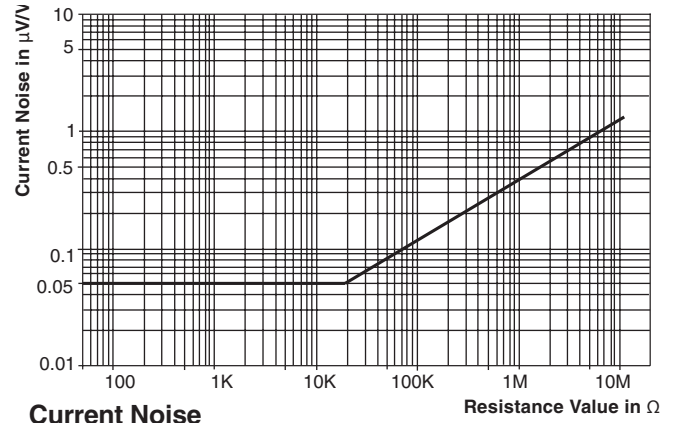
**Note**

Further information about packing see also data sheet "surface mount resistor packing" (document number: 20014)





Non-linearity



Current Noise

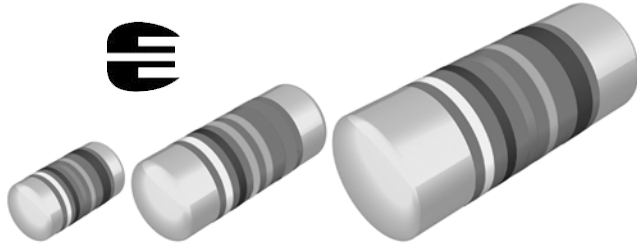
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST RESULTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C 1.5 hours "ON" 0.5 hours "OFF"	≤ 0.5 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 0.5 %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds 2.5 x rated voltage or ≤ 2 x limiting element voltage	≤ 0.5 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 0.1 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 0.5 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 0.25 %

**Note**

1. For a resistance range from 10 Ω to 1 MΩ.

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>• EN 140401-803</li> <li>• EN 140400</li> <li>• EN 60115-1</li> </ul>

## Precision MELF Resistors



MMU 0102, MMA 0204 and MMB 0207 precision thin film MELF resistors combine the proven reliability of the professional products with an advanced level of precision and stability. Therefore they are perfectly suited for applications in the fields of test and measuring equipment along with industrial and medical electronics.

### FEATURES

- Approved according to EN 140401-803
- Advanced thin film technology
- Superior stability: Class 0.05
- Wide precision range: 10 Ω to 1 MΩ
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Test and measuring equipment
- Industrial and medical electronics

### METRIC SIZE

<b>DIN:</b>	0102	0204	0207
<b>CECC:</b>	RC 2211M	RC 3715M	RC 6123M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MMU 0102		MMA 0204		MMB 0207	
Metric CECC size	RC 2211 M		RC 3715 M		RC 6123 M	
Resistance range	22 Ω to 332 kΩ		10 Ω to 511 kΩ		15 Ω to 1 MΩ	
Resistance tolerance	± 0.5 %; ± 0.25 %; ± 0.1 %				± 0.25 %; ± 0.1 %	
Temperature coefficient	± 25 ppm/K; ± 15 ppm/K					
Operation mode	precision	standard	precision	standard	precision	standard
Climatic category (LCT/UCT/days)	10/85/56	55/125/56	10/85/56	55/125/56	10/85/56	55/125/56
Rated dissipation, $P_{70}^{(1)}$	0.06 W	0.2 W	0.07 W	0.25 W	0.11 W	0.4 W
Operating voltage, $U_{max}$ AC/DC	150 V		200 V		300 V	
Film temperature	85 °C	125 °C	85 °C	125 °C	85 °C	125 °C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	22 Ω to 332 kΩ		10 Ω to 511 kΩ		15 Ω to 1 MΩ	
1000 h	≤ 0.05 %	≤ 0.1 %	≤ 0.05 %	≤ 0.1 %	≤ 0.05 %	≤ 0.1 %
8000 h	≤ 0.1 %	≤ 0.2 %	≤ 0.1 %	≤ 0.2 %	≤ 0.1 %	≤ 0.2 %
225 000 h	≤ 0.3 %	≤ 0.6 %	≤ 0.3 %	≤ 0.6 %	≤ 0.3 %	≤ 0.6 %
Permissible voltage against ambient (insulation): 1 minute, $U_{ins}$ continuous	200 V 75 V		300 V 75 V		500 V 75 V	
Failure rate	≤ $2.0 \times 10^{-9}$ /h		≤ $0.7 \times 10^{-9}$ /h		≤ $0.7 \times 10^{-9}$ /h	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



# MMU 0102, MMA 0204, MMB 0207 - Precision

Precision MELF Resistors

Vishay Beyschlag

## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5

### 12NC Example

The 12NC of a MMA 0204 resistor, value 47 kΩ and TC 25 with ± 0.1 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 156 74703.

12NC - resistor type and packaging						
DESCRIPTION			ORDERING CODE 2312 ... ..			
			BLISTER TAPE ON REEL			BULK CASE
TYPE	TCR	TOL.	B1 1000 units	BL 3000 units	B0 10 000 units	M8 8000 units
MMU 0102	± 25 ppm/K	± 0.25 %	171 6...	<b>166 6...</b>	176 6...	061 6...
		± 0.1 %	171 7...	<b>166 7...</b>	176 7...	061 7...
	± 15 ppm/K	± 0.5 %	172 5...	167 5...	177 5...	062 5...
		± 0.25 %	172 6...	167 6...	177 6...	062 6...
		± 0.1 %	172 7...	<b>167 7...</b>	177 7...	062 7...
TYPE	TCR	TOL.	B1 1000 units	BL 3000 units	B0 10 000 units	M3 3000 units
MMA 0204	± 25 ppm/K	± 0.25 %	141 6...	<b>156 6...</b>	146 6...	041 6...
		± 0.1 %	141 7...	<b>156 7...</b>	146 7...	041 7...
	± 15 ppm/K	± 0.5 %	142 5...	157 5...	147 5...	042 5...
		± 0.25 %	142 6...	157 6...	147 6...	042 6...
		± 0.1 %	142 7...	<b>157 7...</b>	147 7...	042 7...
TYPE	TCR	TOL.	B1 1000 units	B2 2000 units	B7 7000 units	
MMB 0207	± 25 ppm/K	± 0.25 %	181 6...	<b>196 6...</b>	186 6...	
		± 0.1 %	181 7...	<b>196 7...</b>	186 7...	
	± 15 ppm/K	± 0.1 %	182 7...	<b>197 7...</b>	187 7...	

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

# MMU 0102, MMA 0204, MMB 0207 - Precision

Vishay Beyschlag

Precision MELF Resistors



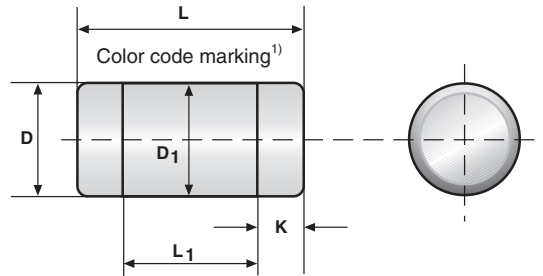
PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>																	
PART NUMBER <sup>2)</sup> : MMA02040D5620BBL00																	
M	M	A	0	2	0	4	0	D	5	6	2	0	B	B	L	0	0
MODEL/SIZE		SPECIAL CHARACTER			TCR		VALUE				TOLERANCE		PACKAGING <sup>3)</sup>		SPECIAL		
MMU0102 MMA0204 MMB0207		0 = neutral, acc. CECC E0			E = ± 15 ppm/K D = ± 25 ppm/K		3 digit value 1 digit multiplier <b>Multiplier</b> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup>				B = ± 0.1 % C = ± 0.25 % D = ± 0.5 %		B1 B3 B0 B2 B7 M3 M8		up to 2 digits 00 = standard		
PRODUCT DESCRIPTION: MMA 0204-25 0.1 % BL 562R																	
MMA		0204		-25		0.1 %		BL		562R							
MODEL		SIZE		TCR		TOLERANCE		PACKAGING <sup>3)</sup>		RESISTANCE VALUE							
MMU MMA MMB		0102 0204 0207		± 15 ppm/K ± 25 ppm/K		± 0.1 % ± 0.25 % ± 0.5 %		B1 BL B0 B2 B7 M3 M8		562R = 562 Ω 4K64 = 4.64 kΩ							

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.

PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
MMU 0102	180 mm/7"	1000	B1	8000	M8
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMA 0204	180 mm/7"	1000	B1	3000	M3
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMB 0207	180 mm/7"	1000	B1	-	-
	180 mm/7"	2000	B2		
	330 mm/13"	7000	B7		

### DIMENSIONS



DIMENSIONS - MELF resistor types, mass and relevant physical dimensions						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MMU 0102	2.2 + 0/- 0.1	1.1 + 0/- 0.1	1.2	D + 0/- 0.1	0.4 ± 0.05	7
MMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19
MMB 0207	5.8 + 0/- 0.2	2.2 + 0/- 0.2	2.8	D + 0/- 0.2	1.25 ± 0.15	79

#### Note

1. Color code marking is applied according to IEC 60062\* in five bands. Each color band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approx. 50 % wider than the other bands. An interrupted band between the 4rd and 5th full band identifies the temperature coefficient.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE <sup>2)</sup>		
TCR	TOLERANCE	MMU 0102	MMA 0204	MMB 0207
± 25 ppm/K	± 0.25 %	<b>47 Ω to 332 kΩ</b>	<b>22 Ω to 511 kΩ</b>	<b>15 Ω to 1 MΩ</b>
	± 0.1 %	<b>100 Ω to 221 kΩ</b>	<b>43 Ω to 511 kΩ</b>	<b>33 Ω to 1 MΩ</b>
± 15 ppm/K	± 0.5 %	22 Ω to 100 kΩ	10 Ω to 332 kΩ	-
	± 0.25 %	47 Ω to 100 kΩ	22 Ω to 332 kΩ	-
	± 0.1 %	<b>100 Ω to 100 kΩ</b>	<b>43 Ω to 332 kΩ</b>	<b>33 Ω to 1 MΩ</b>

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

#### Note

2. Resistance values to be selected from E24 and E192 series, for other values please contact the factory.



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body (85 % Al<sub>2</sub>O<sub>3</sub>, for MICRO-MELF: 96 % Al<sub>2</sub>O<sub>3</sub>) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilise the trimming result. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Five color code rings designate the resistance value and tolerance in accordance with **IEC 60062<sup>3)</sup>**.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60 286-3<sup>3)</sup>** or bulk case in accordance with **IEC 60286-6<sup>3)</sup>**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1<sup>3)</sup>**. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL<sup>1)</sup>** and the **CEFIC-EECA-EICTA<sup>2)</sup>** list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

## Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

The resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068<sup>3)</sup>** series. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

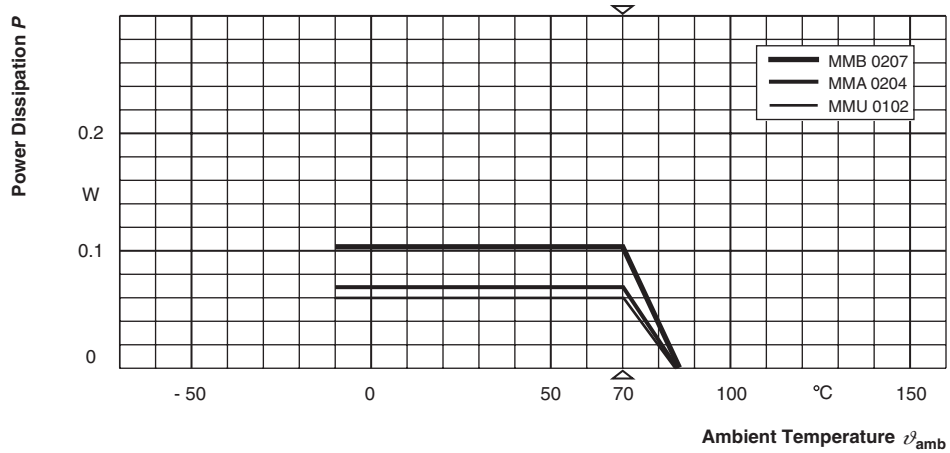
On request, resistors are available with established reliability in accordance with **EN 140401-803 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and ordering codes.

## Note

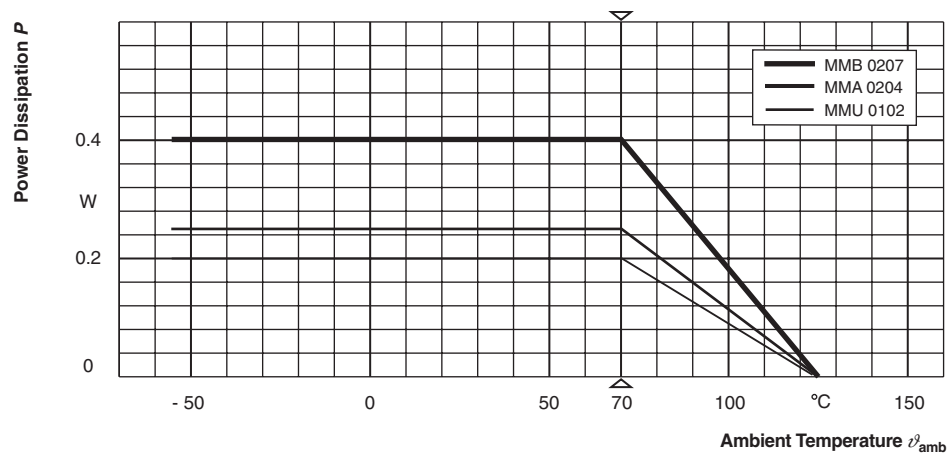
3. The quoted IEC standards are also released as EN standards with the same number and identical contents.



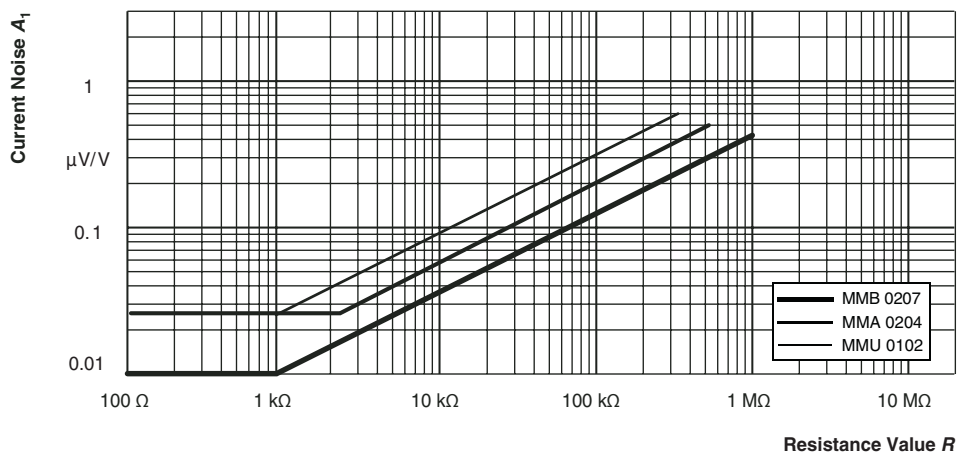
## FUNCTIONAL PERFORMANCE



### Derating - Precision Operation



### Derating - Standard Operation



### Current Noise - $A_1$

In accordance with IEC 60195



### TESTS AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-803, detail specification

The components are approved in accordance with the IECQ-CECC-system, where applicable. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068\* and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3\*. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated in Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803. However, some additional tests and a number of improvements against those minimum requirements have been included. The stated requirements for long-term tests are typically fulfilled with a statistical safety of at least  $\bar{x} + 5 s$ .

TEST PROCEDURES AND REQUIREMENTS						
EN 60115-1 CLAUSE	IEC 60068-2* TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
			stability for product types:	<b>STABILITY CLASS 0.05 OR BETTER</b>	<b>STABILITY CLASS 0.1 OR BETTER</b>	<b>STABILITY CLASS 0.25 OR BETTER</b>
			<b>MMU 0102</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 147 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
			<b>MMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	10 $\Omega$ to 511 k $\Omega$
			<b>MMB 0207</b>	100 $\Omega$ to 270 k $\Omega$	43 $\Omega$ to 510 k $\Omega$	15 $\Omega$ to 1 M $\Omega$
4.5	-	resistance	-	$\pm 0.5 \% R$ ; $\pm 0.25 \% R$ ; $\pm 0.1 \% R$		
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 25$ ppm/K, $\pm 15$ ppm/K		
4.25.1	-	endurance at 70 °C: precision operation mode	$U = \sqrt{P_{70}} \times R$ $\leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.05 \% R + 5 \text{ m}\Omega)$ $\pm (0.1 \% R + 5 \text{ m}\Omega)$		
		endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70}} \times R$ $\leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.1 \% R + 5 \text{ m}\Omega)$ $\pm (0.2 \% R + 5 \text{ m}\Omega)$		
4.25.3	-	endurance at upper category	85 °C; 1000 h	$\pm (0.02 \% R + 5 \text{ m}\Omega)$	$\pm (0.05 \% R + 5 \text{ m}\Omega)$	$\pm (0.1 \% R + 5 \text{ m}\Omega)$
			125 °C; 1000 h	$\pm (0.05 \% R + 5 \text{ m}\Omega)$	$\pm (0.1 \% R + 5 \text{ m}\Omega)$	$\pm (0.15 \% R + 5 \text{ m}\Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.05 \% R + 5 \text{ m}\Omega)$	$\pm (0.1 \% R + 5 \text{ m}\Omega)$	
4.39	67 (Cy)	damp heat, steady state, accelerated	(85 $\pm$ 2) °C; (85 $\pm$ 5) % RH; $U = 0.1 \times \sqrt{P_{70}} \times R$ $\leq 100$ V; 1000 h	$\pm (0.15 \% R + 5 \text{ m}\Omega)$	$\pm (0.25 \% R + 5 \text{ m}\Omega)$	



TEST PROCEDURES AND REQUIREMENTS						
EN 60115-1 CLAUSE	IEC 60068-2* TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
			stability for product types:	<b>STABILITY CLASS 0.05 OR BETTER</b>	<b>STABILITY CLASS 0.1 OR BETTER</b>	<b>STABILITY CLASS 0.25 OR BETTER</b>
			<b>MMU 0102</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 147 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
			<b>MMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	10 $\Omega$ to 511 k $\Omega$
			<b>MMB 0207</b>	100 $\Omega$ to 270 k $\Omega$	43 $\Omega$ to 510 k $\Omega$	15 $\Omega$ to 1 M $\Omega$
4.23		climatic				
4.23.2	2 (Ba)	dry heat	UCT; 16 h			
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90$ % RH; 1 cycle			
4.23.4	1 (Aa)	cold	LCT; 2 h			
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) °C			
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90$ % RH; 5 cycles	$\pm (0.05 \% R + 5 \text{ m}\Omega)$	$\pm (0.1 \% R + 5 \text{ m}\Omega)$	-
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{\text{max}}$ ; 1 min. LCT = - 10 °C; UCT = 85 °C			
			LCT = - 55 °C; UCT = 125 °C	-	-	$\pm (0.1 \% R + 5 \text{ m}\Omega)$
-	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.02 \% R + 5 \text{ m}\Omega)$		
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT; 30 minutes at UCT; LCT = - 10 °C; UCT = 85 °C			
			5 cycles	$\pm (0.01 \% R + 5 \text{ m}\Omega)$	$\pm (0.02 \% R + 5 \text{ m}\Omega)$	-
			1000 cycles	$\pm (0.1 \% R + 5 \text{ m}\Omega)$	$\pm (0.1 \% R + 5 \text{ m}\Omega)$	-
			LCT = - 55 °C; UCT = 125 °C			
			5 cycles	-	-	$\pm (0.025 \% R + 5 \text{ m}\Omega)$
			1000 cycles	-	-	$\pm (0.2 \% R + 5 \text{ m}\Omega)$
4.13	-	short time over- load; precision operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ $\leq 2 \times U_{\text{max}}$ ; 5 s	$\pm (0.01 \% R + 5 \text{ m}\Omega)$	$\pm (0.02 \% R + 5 \text{ m}\Omega)$	$\pm (0.03 \% R + 5 \text{ m}\Omega)$
		short time over- load; standard operation mode		$\pm (0.05 \% R + 5 \text{ m}\Omega)$		
4.27	-	single pulse high voltage overload; standard operation mode	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ $\leq 2 \times U_{\text{max}}$ ; 10 pulses 10 $\mu$ s/700 $\mu$ s	$\pm (0.25 \% R + 5 \text{ m}\Omega)^1$		
4.37	-	periodic electric overload; standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ $\leq 2 \times U_{\text{max}}$ ; 0.1 s on; 2.5 s off; 1000 cycles	$\pm (0.5 \% R + 5 \text{ m}\Omega)^1$		
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq 1.5$ mm or $\leq 200$ m/s <sup>2</sup> ; 6 h	$\pm (0.01 \% R + 5 \text{ m}\Omega)$	$\pm (0.02 \% R + 5 \text{ m}\Omega)$	$\pm (0.03 \% R + 5 \text{ m}\Omega)$



TEST PROCEDURES AND REQUIREMENTS						
EN 60115-1 CLAUSE	IEC 60068-2* TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
			stability for product types:	<b>STABILITY CLASS 0.05 OR BETTER</b>	<b>STABILITY CLASS 0.1 OR BETTER</b>	<b>STABILITY CLASS 0.25 OR BETTER</b>
			<b>MMU 0102</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 147 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
			<b>MMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	10 $\Omega$ to 511 k $\Omega$
			<b>MMB 0207</b>	100 $\Omega$ to 270 k $\Omega$	43 $\Omega$ to 510 k $\Omega$	15 $\Omega$ to 1 M $\Omega$
4.40	-	electrostatic discharge (Human Body Model)	IEC 61340-3-14 <sup>4</sup> ; 3 pos. + 3 neg. discharges MMU 0102: 1.5 kV MMA 0204: 2 kV MMB 0207: 4 kV	$\pm (0.5 \% R + 50 \text{ m}\Omega)^1$		
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux; (215 $\pm$ 3) $^{\circ}\text{C}$ ; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage		
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux; (235 $\pm$ 3) $^{\circ}\text{C}$ ; (2 $\pm$ 0.2) s	good tinning ( $\geq 95 \%$ covered); no visible damage		
4.18.2	58 (TD)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s	note 2		$\pm (0.05 \% R + 10 \text{ m}\Omega)$
			reflow method 2 (IR/forced gas convection); (260 $\pm$ 5) $^{\circ}\text{C}$ ; (10 $\pm$ 1) s	$\pm (0.01 \% R + 5 \text{ m}\Omega)$	$\pm (0.025 \% R + 5 \text{ m}\Omega)$	
4.29	45 (XA)	component solvent resistance	isopropyl alcohol; 50 $^{\circ}\text{C}$ ; method 2	no visible damage		
4.30	45 (XA)	solvent resistance of marking	isopropyl alcohol; 50 $^{\circ}\text{C}$ ; method 1, toothbrush	marking legible; no visible damage		
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	45 N	no visible damage		
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	no visible damage, no open circuit in bent position $\pm (0.02 \% R + 10 \text{ m}\Omega)^3$		$\pm (0.05 \% R + 10 \text{ m}\Omega)^3$
4.7	-	voltage proof	$U_{\text{rms}} = U_{\text{ins}}$ ; 60 s	no flashover or breakdown		
4.35	-	flammability	IEC 60 695-11-5*, needle flame test; 10 s	no burning after 30 s		

**Notes**

- The pulse load stability of professional MELF resistors applies for precision resistors also. However, severe pulse loads are likely to jeopardize precision stability requirements.
- Wave soldering is not recommended.
- Special requirements apply to MICRO-MELF, MMU 0102:
  - $R < 100 \Omega$ :  $\pm (0.15 \% R + 10 \text{ m}\Omega)$
  - $100 \Omega \leq R \leq 10 \text{ k}\Omega$ :  $\pm 0.1 \% R$
  - $R > 10 \text{ k}\Omega$ :  $\pm 0.05 \% R$
- The quoted IEC standards are also released as EN standards with the same number and identical contents.

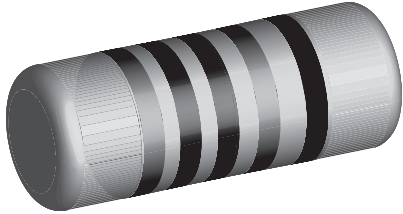


## REVISION HISTORY

Compared to the prior revision of this datasheet, 26-Feb-04, the following changes have been applied:

- Introduction of a standardized part numbering system
- Additional emphasis on the clean balance of materials and on the compliance with various EU directives.
- Revision of the current noise diagram based on new test results
- Introduction of a test and requirements for electrostatic discharge (ESD)
- No other change of technical contents
- No product change

## Metal Film, Cylindrical Resistors



### FEATURES

- Stable metal film on high quality ceramic
- Very low TCR and tight tolerances
- Excellent stability at different environmental conditions
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> $P_{70}$ W	LIMITING ELEMENT VOLTAGE <sup>2)</sup> DC or AC rms V	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
PMM0204	0.125	100	$\pm 5$	$\pm 0.1; \pm 0.25$	100R - 100K	96 - 192
PMM0204	0.125	100	$\pm 10$	$\pm 0.1; \pm 0.25$	100R - 221K	96 - 192
PMM0204	0.125	100	$\pm 15$	$\pm 0.1; \pm 0.25$	100R - 221K	96 - 192
PMM0204	0.125	100	$\pm 25$	$\pm 0.1; \pm 0.25$	100R - 221K	96 - 192
PMM0204	0.125	100	$\pm 50$	$\pm 0.1; \pm 0.25$	100R - 221K	96 - 192

#### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.
2. Rated voltage:  $\sqrt{P \times R}$ .

- TCR  $\leq 10$  ppm/°C: temperature range is - 10 °C to + 85 °C
- Without TCR-band, TCR marking on label only
- Marking: According to IEC 60062; see also datasheet "surface mount resistor marking" (document number: 20020)

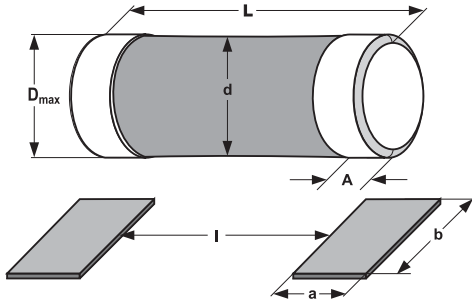
### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	PMM0204
Rated Dissipation at 70 °C	W	0.125
Limiting Element Voltage, DC or AC rms	V	100
Insulation Voltage (1 min), DC or AC peak	V	200
Thermal Resistance <sup>3)</sup>	K/W	$\leq 220$
Insulation Resistance	$\Omega$	$\geq 10^{10}$
Category Temperature Range	°C	- 10 to + 100
Failure Rate	$10^{-9}/h$	$< 1$
Weight/1000 pcs	g	18

#### Note

3. Based on measurements on test board acc. to EN 140400.

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
PMM0204	1.4	D - 0.15	3.6 - 0.15	0.85	0.5

**Note**  
1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW SOLDERING			WAVE SOLDERING		
	a	b	l	a	b	l
PMM0204	1.0	1.6	2.2	1.2	1.6	2.2

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

**PART NUMBER<sup>2)</sup>: PMM02040E5620CB0**

P	M	M	0	2	0	4	0	E	5	6	2	0	C	B	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

<b>MODEL/SIZE</b> PMM0204	<b>SPECIAL CHARACTER</b> 0 = neutral	<b>TCR</b> G = ± 5 ppm/K F = ± 10 ppm/K E = ± 15 ppm/K D = ± 25 ppm/K C = ± 50 ppm/K	<b>VALUE</b> 3 digit value 1 digit multiplier 0000 = Jumper <b>Multiplier</b> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>	<b>TOLERANCE</b> B = ± 0.1 % C = ± 0.25 %	<b>PACKAGING<sup>3)</sup></b> B1 B3 B0 M3	<b>SPECIAL</b> up to 2 digits 00 = standard
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**PRODUCT DESCRIPTION: PMM0204 15 562R 0.25 % B0**

<b>PMM0204</b>	<b>15</b>	<b>562R</b>	<b>0.25 %</b>	<b>B0</b>
<b>MODEL</b>	<b>TCR</b>	<b>RESISTANCE VALUE</b>	<b>TOLERANCE</b>	<b>PACKAGING<sup>3)</sup></b>
PMM0204	± 5 ppm/K ± 10 ppm/K ± 15 ppm/K ± 25 ppm/K ± 50 ppm/K	100R = 100 Ω 221K = 221 kΩ	± 0.1 % ± 0.25 %	B1 B3 B0 M3

**Notes**

- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKAGING, see below.

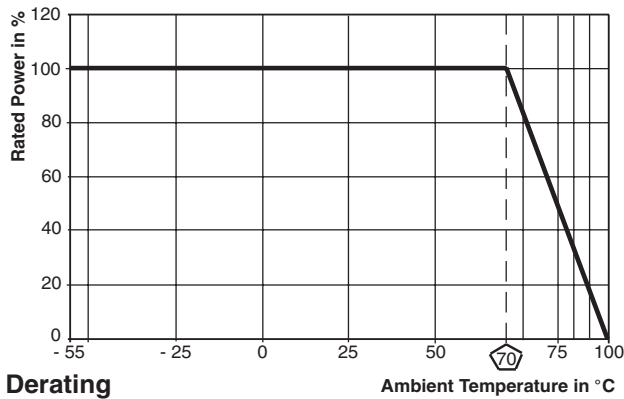


PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
PMM0204	180 mm/7"	1000	B1 <sup>1)</sup>	3000	M3
	180 mm/7"	3000	B3		
	330 mm/13"	10000	B0		

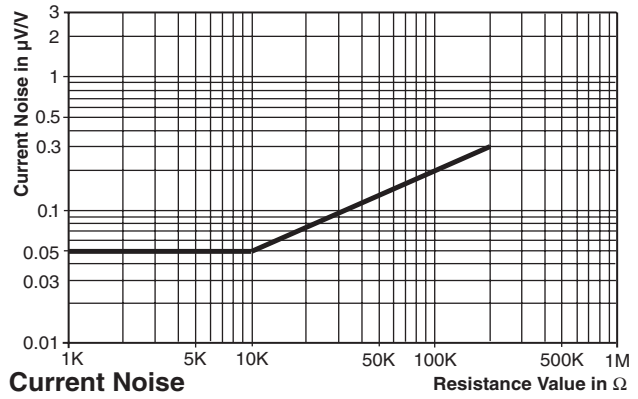
**Note**

1. For TCR ≤ 25 ppm/K and Tolerance ≤ 0.25 % only.

Further information about PACKAGING, see also datasheet "surface mount resistor packing" (document number: 20014)



Derating



Current Noise

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST RESULTS
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ 0.1 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 0.1 %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds 2.5 x rated voltage or ≤ 2 x limiting element voltage	≤ 0.02 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 0.02 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 0.2 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 0.05 %

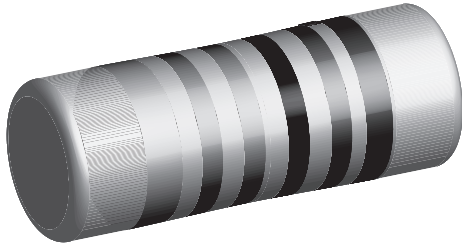


**APPLICABLE SPECIFICATIONS**

- EN 140401-803
- EN 140400
- EN 60115-1



## Metal Film, Cylindrical Resistors



### FEATURES

- Special stabilized metal film on high quality ceramic
- Very low TCR and tight tolerances
- Excellent long term stability
- Suitable for precision measuring techniques and precision controls
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> $P_{70}$ W	LIMITING ELEMENT VOLTAGE <sup>2)</sup> DC or AC rms V	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
PMM0207	0.4	250	$\pm 5$	$\pm 0.1; \pm 0.25$	100R - 100K	192
PMM0207	0.4	250	$\pm 10$	$\pm 0.1; \pm 0.25$	100R - 100K	192
PMM0207	0.4	250	$\pm 15$	$\pm 0.1; \pm 0.25$	100R - 511K	24 - 192
PMM0207	0.4	250	$\pm 25$	$\pm 0.25; \pm 0.5$	100R - 511K	24 - 192

### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.
2. Rated voltage:  $\sqrt{P \times R}$ .
- TCR  $\leq 10$  ppm/K: temperature range is - 10 °C to + 85 °C
- Marking: According to IEC 60062; see also datasheet "surface mount resistor marking" (document number: 20020)

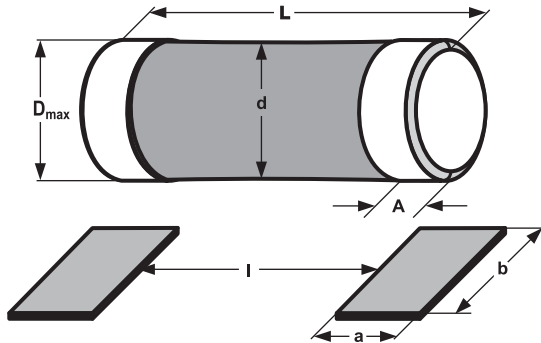
### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	PMM0207
Rated Dissipation at 70 °C	W	0.4
Limiting Element Voltage, DC or AC rms	V	250
Insulation Voltage (1 min), DC or AC peak	V	> 400
Thermal Resistance <sup>3)</sup>	K/W	$\leq 140$
Insulation Resistance	$\Omega$	$\geq 10^{10}$
Category Temperature Range	°C	- 55 to + 125
Failure Rate	$10^{-9}/h$	< 1
Weight/1000 pcs	g	77

### Note

3. Based on measurements on test board acc. to EN 140400.

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
PMM0207	2.2	D - 0.2	5.8 - 0.3	1.2	0.6

**Note**

1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW			WAVE SOLDERING		
	a	b	l	a	b	l
PMM0207	1.8	2.5	2.9	2.4	2.5	2.8

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

PART NUMBER<sup>2)</sup>: PMM02070E5620CBP00



MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
PMM0207	0 = neutral	G = ± 5 ppm/K F = ± 10 ppm/K E = ± 15 ppm/K D = ± 25 ppm/K	3 digit value 1 digit multiplier 0000 = Jumper <b>Multiplier</b> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>	B = ± 0.1 % C = ± 0.25 % D = ± 0.5 %	BP BS	up to 2 digits 00 = standard

PRODUCT DESCRIPTION: PMM0207 15 562R 0.25 % BP

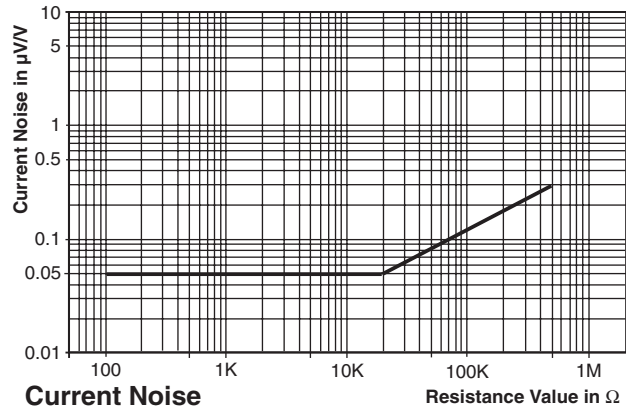
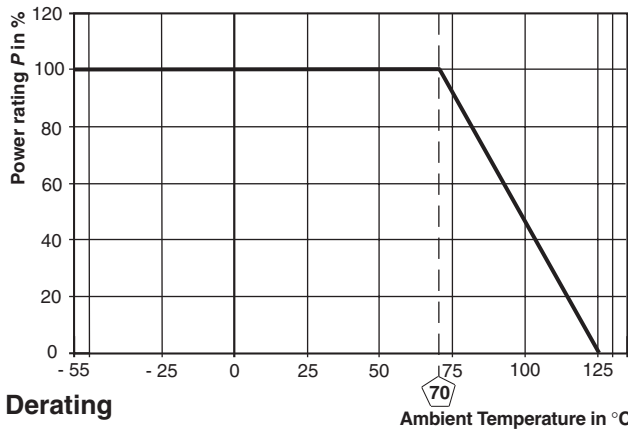
PMM0207	15	562R	0.25 %	BP
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>3)</sup>
PMM0207	± 5 ppm/K ± 10 ppm/K ± 15 ppm/K ± 25 ppm/K	100R = 100 Ω 221K = 221 kΩ	± 0.1 % ± 0.25 % ± 0.5 %	BP BS

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, see below.

**PACKAGING**

MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
PMM0207	180 mm/7"	1500	BP
	330 mm/13"	7500	BS

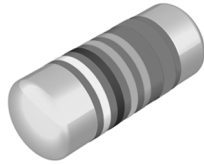


Further information about PACKAGING, see also datasheet "surface mount resistor packing" (document number: 20014).

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST RESULTS
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ 0.1 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 0.1 %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds 2.5 x rated voltage or ≤ 2 x limiting element voltage	≤ 0.02 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 0.02 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 0.2 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 0.05 %

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>• EN 140401-803</li> <li>• EN 140400</li> <li>• EN 60115-1</li> </ul>

## High Precision MELF Resistor



UMA 0204 high precision thin film MINI-MELF resistors combine the proven reliability of professional MELF products with a most advanced level of precision and stability first achieved with axial thin film high precision resistors. This unique combination makes the product perfectly suited for all applications with outstanding requirements towards reliable precision and stability.

### FEATURES

- Most advanced thin film technology
- TCR down to  $\pm 5$  ppm/K
- High precision tolerance down to 0.02 %
- Superior overall stability
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant
- Approved according to EN 140401-803



### APPLICATIONS

- Measuring and calibration equipment
- Industrial process control systems
- Space and aircraft electronics

### METRIC SIZE

<b>DIN:</b>	0204
<b>CECC:</b>	RC 3715M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	UMA 0204		
Metric CECC size	RC 3715M		
Resistance range	22 $\Omega$ to 332 k $\Omega$		
Resistance tolerance	$\pm 0.25$ %; $\pm 0.1$ %; $\pm 0.05$ %; $\pm 0.02$ %		
Temperature coefficient	$\pm 15$ ppm/K; $\pm 10$ ppm/K; $\pm 05$ ppm/K		
Operation mode	precision	standard	
Climatic category (LCT/UCT/days)	10/85/56	55/125/56	
Rated dissipation, $P_{70}^{1)}$	0.07 W	0.25 W	
Operating voltage, $U_{max}$ AC/DC	200 V		
Film temperature	85 $^{\circ}$ C	125 $^{\circ}$ C	
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	22 $\Omega$ to 332 k $\Omega$		
	1000 h	$\leq 0.02$ %	$\leq 0.05$ %
	8000 h	$\leq 0.05$ %	$\leq 0.1$ %
	225 000 h	$\leq 0.15$ %	$\leq 0.3$ %
Permissible voltage against ambient (insulation):	300 V		
	1 minute; $U_{ins}$	75 V	
Failure rate	$\leq 0.7 \times 10^{-9}$ /h		

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



**12NC INFORMATION**

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

RESISTANCE DECADE	LAST DIGIT
10 to 99.9 Ω	9
100 to 999 Ω	1
1 to 9.99 kΩ	2
10 to 99.9 kΩ	3
100 to 999 kΩ	4

**12NC Example**

The 12NC of an UMA 0204 resistor, value 4.75 kΩ and TC05 with ± 0.05 % tolerance, supplied in antistatic blister tape of 3000 units per reel is: 2312 113 44752.

<b>12NC - resistor type and packaging</b>						
DESCRIPTION			ORDERING CODE 2312 ... ..			
			ANTISTATIC BLISTER TAPE		ANTISTATIC BLISTER TAPE ON REEL	
TYPE	TCR	TOL.	AU 100 units	A1 1000 units	AL 3000 units	A0 10 000 units
UMA 0204	± 15 ppm/K	± 0.05 %	101 4....	106 4....	111 4....	116 4....
		note 1	101 91...	106 91...	111 91...	116 91...
	± 10 ppm/K	± 0.25 %	102 2....	107 2....	112 2....	117 2....
		± 0.1 %	102 3....	107 3....	112 3....	117 3....
		± 0.05 %	102 4....	107 4....	112 4....	117 4....
		note 1	102 91...	107 91...	112 91...	117 91...
		± 0.25 %	103 2....	108 2....	113 2....	118 2....
	± 5 ppm/K	± 0.1 %	103 3....	108 3....	113 3....	118 3....
		± 0.05 %	103 4....	108 4....	113 4....	118 4....
		± 0.02 %	103 6....	108 6....	113 6....	118 6....
		note 1	103 91...	108 91...	113 91...	118 91...

**Note**

1. Readable coding of resistance values is restricted to values with three significant digits. For resistance values with more than three significant digits, a non-readable sequential number will be issued by the factory for each requested combination of resistance value and tolerance.



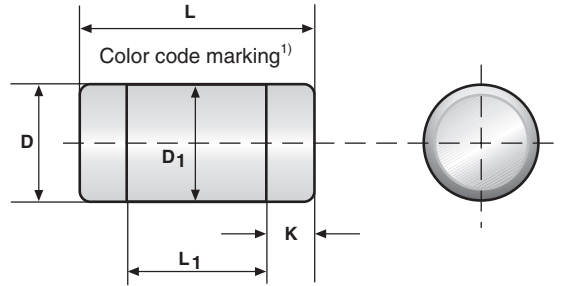
PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>																	
PART NUMBER <sup>2)</sup> : UMA02040G4641AA300																	
U	M	A	0	2	0	4	0	G	4	6	4	1	A	A	3	0	0
MODEL/SIZE <b>UMA0204</b>	SPECIAL CHARACTER 0 = neutral acc. CECC E0		TCR G = ± 5 ppm/K F = ± 10 ppm/K E = ± 15 ppm/K		VALUE 3 digit value 1 digit multiplier <b>Multiplier</b> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>			TOLERANCE H = ± 0.02 % A = ± 0.05 % B = ± 0.1 % C = ± 0.25 %		PACKAGING <sup>3)</sup> AU A1 A3 A0		SPECIAL up to 2 digits 00 = standard					
PRODUCT DESCRIPTION: UMA 0204 - 05 0.05 % AL 4K64																	
UMA	0204		- 05		0.05 %			AL		4K64							
MODEL	SIZE		TCR		TOLERANCE			PACKAGING <sup>3)</sup>		RESISTANCE VALUE							
UMA	0204		± 05 ppm/K ± 10 ppm/K ± 15 ppm/K		± 0.02 % ± 0.05 % ± 0.1 % ± 0.25 %			AU A1 AL A0		100R = 100 Ω 4K64 = 4.64 kΩ							

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.

PACKAGING					
MODEL	ANTISTATIC BLISTER TAPE ON REEL ACC. IEC 60286-3			ANTISTATIC BLISTER TAPE ACC. IEC 60286-3	
	DIAMETER	PIECES/REEL	CODE	PIECES	CODE
UMA 0204	180 mm/7"	1000	A1	100	AU
	180 mm/7"	3000	A3 = AL		
	330 mm/13"	10 000	A0		

**DIMENSIONS**



**DIMENSIONS - MELF resistor type, mass and relevant physical dimensions**

TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
UMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19

**Note**

1. Color code marking is applied according to IEC 60062\* in five bands. Each color band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approx. 50 % wider than the other bands. An interrupted band between the 4th and 5th full band indicates the temperature coefficient.

**TEMPERATURE COEFFICIENT AND RESISTANCE RANGE**

DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>
TCR <sup>2)</sup>	TOLERANCE	UMA 0204
15 ppm/K	0.05 %	47 Ω to 332 kΩ
10 ppm/K	0.25 %	22 Ω to 332 kΩ
	0.1 %	43 Ω to 332 kΩ
	0.05 %	75 Ω to 221 kΩ
05 ppm/K	0.25 %	33 Ω to 221 kΩ
	0.1 %	56 Ω to 221 kΩ
	0.05 %	75 Ω to 150 kΩ
	0.02 %	75 Ω to 100 kΩ

**Notes**

- Resistance values to be selected from E192 series, for other values please contact the factory.
- TC10 and TC05 is specified over the temperature range from - 10 °C to + 85 °C.

## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body (85 % Al<sub>2</sub>O<sub>3</sub>) and conditioned to achieve the desired temperature stability. Nickel plated steel terminations are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting in the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilise the trimming result. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Five colour rings designate the resistance value and tolerance in accordance with **IEC 60062<sup>3)</sup>**. Additional colour dots near the fourth ring are used to identify the temperature coefficient.

The result of the determined production is verified by an extensive testing procedure under strict temperature control, performed on 100 % of the individual resistors. Only accepted products are laid directly into the antistatic blister tape in accordance with **IEC 60286-3<sup>3)</sup>**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using reflow or vapour phase as shown in **IEC 61760-1<sup>3)</sup>**. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL<sup>1)</sup>** and the **CEFIC-EECA-EICTA<sup>2)</sup>** list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

The resistors are tested in accordance with **EN 140401-803** which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068<sup>3)</sup>** series. Approval of conformity is indicated by the **CECC** logo on the package label, where applicable.

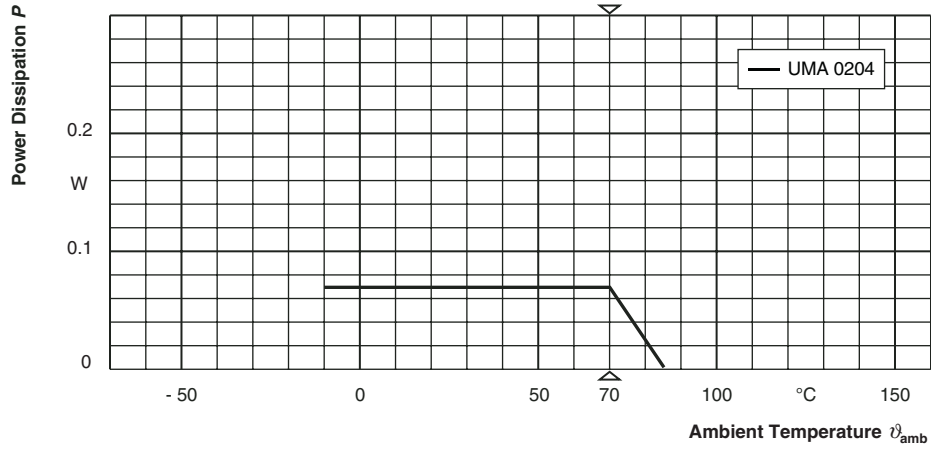
Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

### Note

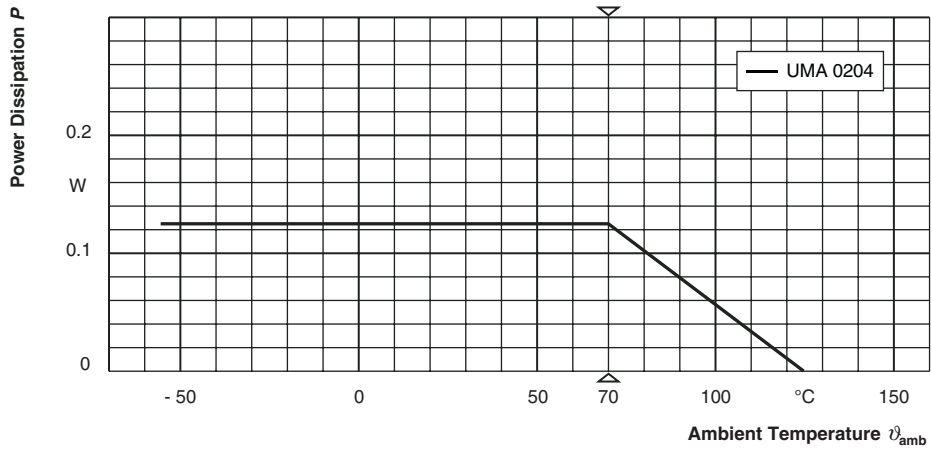
3. The quoted IEC standards are also released as EN standards with the same number and identical contents.



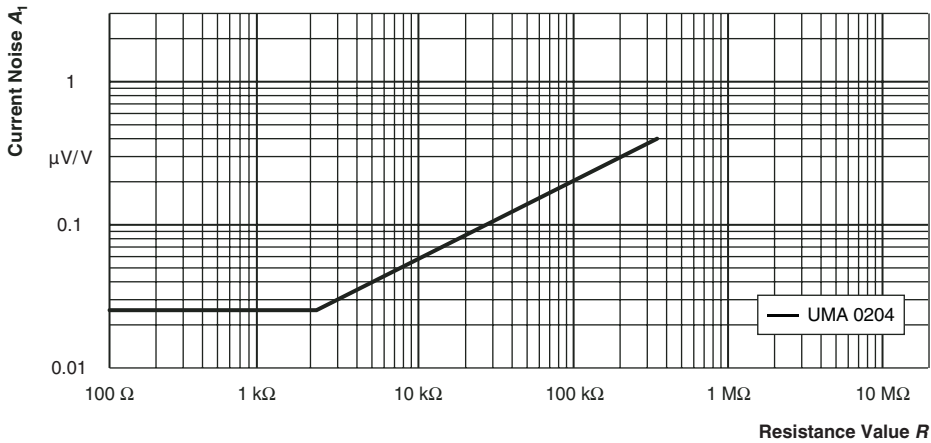
**FUNCTIONAL PERFORMANCE**



**Derating - Precision Operation**



**Derating - Standard Operation**



**Current Noise -  $A_1$**

In accordance with IEC 60195

**TESTS AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-803, detail specification

The components are approved in accordance with the IECQ-CECC-system, where applicable. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068\* and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3\*. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated below are based on the required tests and permitted limits of EN 140401-803. However, some additional tests and a number of improvements against those minimum requirements have been included. The stated requirements for long-term tests are typically fulfilled with a statistical safety of at least  $\bar{x} + 5 s$ .

<b>TEST PROCEDURES AND REQUIREMENTS</b>						
EN 60115-1 CLAUSE	IEC 60068-2 <sup>3)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
				STABILITY CLASS 0.05 OR BETTER	STABILITY CLASS 0.1 OR BETTER	STABILITY CLASS 0.25 OR BETTER
			stability for product types:  <b>UMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
4.5	-	resistance	-	$\pm 0.25 \% R$ ; $\pm 0.1 \% R$ ; $\pm 0.05 \% R$ ; $\pm 0.02 \% R$		
4.8.4.2	-	temperature coefficient	at 20/- 10/20 °C and 20/85/20 °C	$\pm 10$ ppm/K; $\pm 05$ ppm/K		
			at 20/- 55/20 °C and 20/125/20 °C	$\pm 15$ ppm/K		
4.25.1	-	endurance at 70 °C: precision operation mode	$U = \sqrt{P_{70} \times R} \leq U_{\max}$ ; 1.5 h on; 0.5 h off;  70 °C; 1000 h 70 °C; 8000 h	$\pm (0.02 \% R + 1 \text{ m}\Omega)$  $\pm (0.05 \% R + 1 \text{ m}\Omega)$		
		endurance at 70 °C: standard operating mode	$U = \sqrt{P_{70} \times R} \leq U_{\max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.05 \% R + 1 \text{ m}\Omega)$  $\pm (0.1 \% R + 1 \text{ m}\Omega)$		
4.25.3	-	endurance at upper category temperature	85 °C; 1000 h	$\pm (0.01 \% R + 1 \text{ m}\Omega)$	$\pm (0.05 \% R + 1 \text{ m}\Omega)$	$\pm (0.1 \% R + 1 \text{ m}\Omega)$
			125 °C; 1000 h	$\pm (0.05 \% R + 1 \text{ m}\Omega)$	$\pm (0.1 \% R + 1 \text{ m}\Omega)$	$\pm (0.15 \% R + 1 \text{ m}\Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.03 \% R + 1 \text{ m}\Omega)$	$\pm (0.05 \% R + 1 \text{ m}\Omega)$	$\pm (0.1 \% R + 1 \text{ m}\Omega)$
4.39	67 (Cy)	damp heat, steady state, accelerated	(85 $\pm$ 2) °C; (85 $\pm$ 5) % RH; $U = 0.1 \times \sqrt{P_{70} \times R} \leq 100 \text{ V}$ ; 1000 h	$\pm (0.1 \% R + 1 \text{ m}\Omega)$	$\pm (0.25 \% R + 1 \text{ m}\Omega)$	



TEST PROCEDURES AND REQUIREMENTS						
EN 60115-1 CLAUSE	IEC 60068-2 <sup>3)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
				STABILITY CLASS 0.05 OR BETTER	STABILITY CLASS 0.1 OR BETTER	STABILITY CLASS 0.25 OR BETTER
			stability for product types: <b>UMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
4.23		climatic sequence:				
4.23.2	2 (Ba)	dry heat	UCT; 16 h			
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90$ % RH; 1 cycle			
4.23.4	1 (Aa)	cold	LCT °C; 2 h			
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) °C			
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90$ % RH; 5 cycles			
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1 min. LCT = - 10 °C; UCT = 85 °C	$\pm (0.03 \% R + 1 \text{ m}\Omega)$	$\pm (0.05 \% R + 1 \text{ m}\Omega)$	-
			LCT = - 55 °C; UCT = 125 °C	-	-	$\pm (0.1 \% R + 1 \text{ m}\Omega)$
-	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.02 \% R + 1 \text{ m}\Omega)$		
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT; 30 minutes at UCT; LCT = - 10 °C; UCT = 85 °C 5 cycles 1000 cycles LCT = - 55 °C; UCT = 125 °C 5 cycles 1000 cycles	$\pm (0.01 \% R + 1 \text{ m}\Omega)$ $\pm (0.05 \% R + 1 \text{ m}\Omega)$	$\pm (0.02 \% R + 1 \text{ m}\Omega)$ $\pm (0.05 \% R + 1 \text{ m}\Omega)$	- - $\pm (0.025 \% R + 1 \text{ m}\Omega)$ $\pm (0.1 \% R + 1 \text{ m}\Omega)$
4.13	-	short time overload; precision operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}$ ; 5 s	$\pm (0.005 \% R + 1 \text{ m}\Omega)$	$\pm (0.01 \% R + 1 \text{ m}\Omega)$	
		short time overload; standard operation mode	$U = 2,5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}$ ; 5 s	$\pm (0.01 \% R + 1 \text{ m}\Omega)$		
4.27	-	single pulse high voltage overload; standard mode	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}$ ; 10 pulses 10 $\mu$ s/700 $\mu$ s	$\pm (0.25 \% R + 5 \text{ m}\Omega)^1$		
4.37	-	periodic electric overload; standard mode	$U = \sqrt{15 \times P_{70} \times R} \leq 2 \times U_{max}$ ; 0.1 s on; 2.5 s off; 1000 cycles	$\pm (0.5 \% R + 5 \text{ m}\Omega)^1$		
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq 1.5$ mm or $\leq 200$ m/s <sup>2</sup> ; 6 h	$\pm (0.01 \% R + 1 \text{ m}\Omega)$		
4.40	-	electrostatic discharge (Human Body Model)	IEC 61340-3-1*; 3 pos. + 3 neg. discharges UMA 0204: 2 kV	$\pm (0.5 \% R + 50 \text{ m}\Omega)^1$		

<b>TEST PROCEDURES AND REQUIREMENTS</b>						
EN 60115-1 CLAUSE	IEC 60068-2 <sup>3</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
				STABILITY CLASS 0.05 OR BETTER	STABILITY CLASS 0.1 OR BETTER	STABILITY CLASS 0.25 OR BETTER
			stability for product types:  <b>UMA 0204</b>	100 $\Omega$ to 100 k $\Omega$	43 $\Omega$ to 221 k $\Omega$	22 $\Omega$ to 332 k $\Omega$
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux; (215 $\pm$ 3) $^{\circ}$ C; (3 $\pm$ 0.3) s	good tinning ( $\geq$ 95 % covered); no visible damage		
			solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 $\pm$ 3) $^{\circ}$ C; (2 $\pm$ 0.2) s	good tinning ( $\geq$ 95 % covered); no visible damage		
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	note 2		$\pm$ (0.05 % $R$ + 10 m $\Omega$ )
			reflow method 2 (IR/forced gas convection) (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	$\pm$ (0.01 % $R$ + 1 m $\Omega$ )	$\pm$ (0.02 % $R$ + 1 m $\Omega$ )	
4.29	45 (XA)	component solvent resistance	isopropyl alcohol; 50 $^{\circ}$ C; method 2	no visible damage		
4.30	45 (XA)	solvent resistance of marking	isopropyl alcohol; 50 $^{\circ}$ C; method 1, toothbrush	marking legible; no visible damage		
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	45 N	no visible damage		
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	no visible damage, no open circuit in bent position		
				$\pm$ (0.02 % $R$ + 10 m $\Omega$ )	$\pm$ (0.05 % $R$ + 10 m $\Omega$ )	
4.7	-	voltage proof	$U_{rms} = U_{ins}$ ; 60 s	no flashover or breakdown		
4.35	-	flammability	IEC 60 695-11-5*, needle flame test; 10 s	no burning after 30 s		

**Notes**

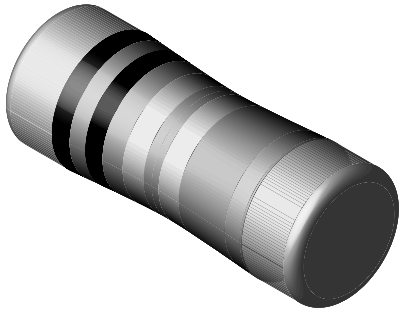
1. The pulse load stability of professional MELF resistors applies also to high precision resistors. However, severe pulse loads are likely to jeopardize high precision stability requirements.
2. Wave soldering is not recommended.
3. The quoted IEC standards are also released as EN standards with the same number and identical contents.

**REVISION HISTORY**

Compared to the prior revision of this datasheet, 25-Feb-04, the following changes have been applied:

- Change of title
- Introduction of a standardized part numbering system
- Additional emphasis on the clean balance of materials and on the compliance with various EU directives
- Revision of the current noise diagram based on new test results
- Introduction of a test and requirements for electrostatic discharge (ESD)
- No other change of technical contents
- No product change

## Carbon Film, Cylindrical, Fusible Resistors



### FEATURES

- Fusible resistor for constant voltage designed for overload protection
- Specially spiralled to provide the fusible function
- Flame retardant coating
- Used in battery chargers, TV-sets, cordless phones, PC/CPU-cooler
- Pure tin termination on nickel barrier, plated on press fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> P <sub>70</sub> W	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE Ω	E-SERIES
LCM0207SI	0.25	+ 300/- 250	± 5	R22 - 1K0	24

#### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.
- Marking: According to IEC 60062; see also datasheet "surface mount resistor marking" (document number: 20020)

### TECHNICAL SPECIFICATIONS

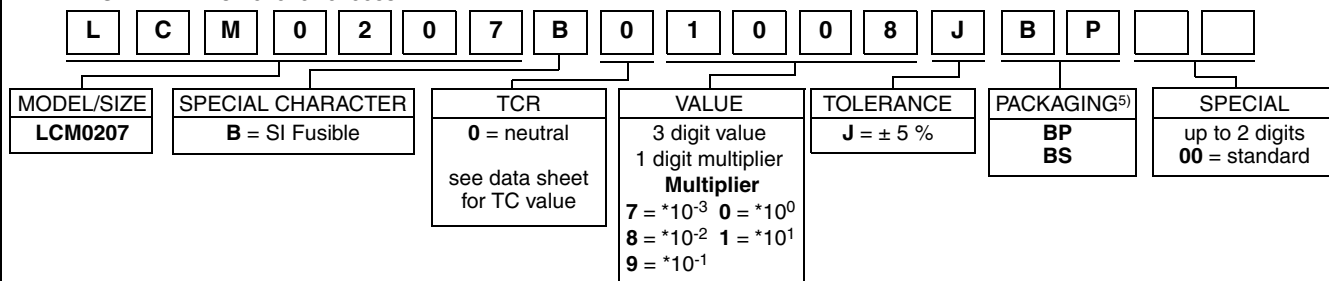
PARAMETER	UNIT	LCM0207SI
Rated Dissipation at 70 °C	W	0.25
Minimum Overload to Fuse	W	> 1R0 < 1R0
Time to Fuse (max)	s	15
Thermal Resistance <sup>2)</sup>	K/W	≤ 220
Voltage Coefficient	V <sup>-1</sup>	≥ 10 <sup>7</sup>
Category Temperature Range	°C	- 55 to + 125
Failure Rate	10 <sup>-9</sup> /h	< 30
Weight/1000 pcs	g	71

#### Note

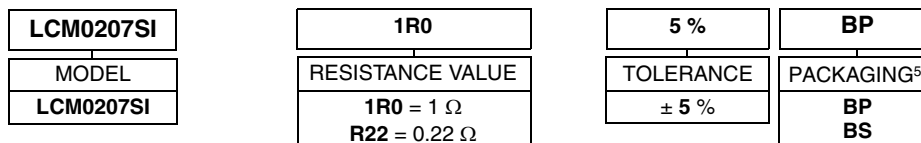
2. Based on measurements on test board acc. to EN 140400.

### PART NUMBER AND PRODUCT DESCRIPTION<sup>3)</sup>

#### PART NUMBER<sup>4)</sup>: LCM02070B01008JB



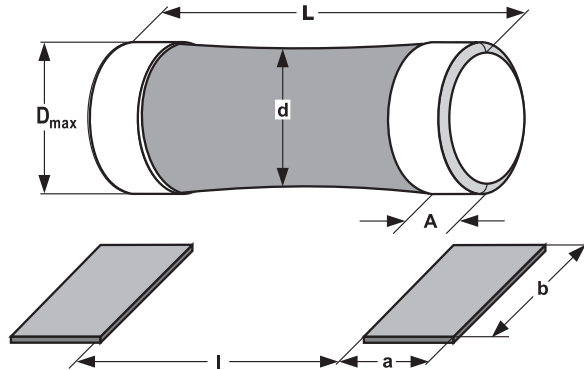
#### PRODUCT DESCRIPTION: LCM0207SI 1R0 5 % BP



#### Notes

3. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
4. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
5. Please refer to table PACKAGING, see below.

**DIMENSIONS**



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
LCM0207SI	2.2	D - 0.4	5.8- 0.3	1.2	0.6

**Note**

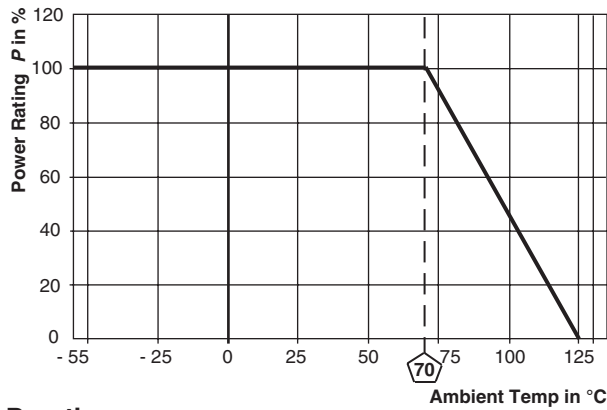
1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW SOLDERING			WAVE SOLDERING		
	a	b	l	a	b	l
LCM0207SI	1.8	2.5	2.9	2.4	2.5	2.8

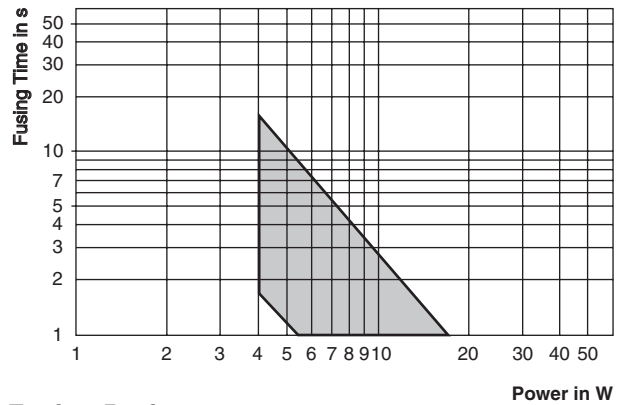
**PACKAGING**

MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
LCM0207SI	180 mm/7"	1500	BP
	330 mm/13"	7500	BS

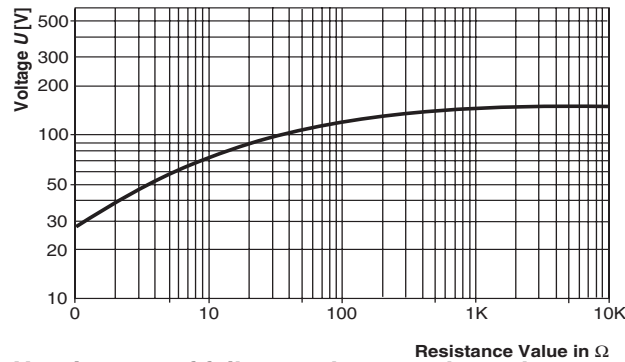
Further information about PACKAGING see also datasheet "surface mount resistor packing" (document number: 20014).



**Derating**



**Fusing Performance**



**U<sub>max</sub> in case of failure and max. pulse voltage**

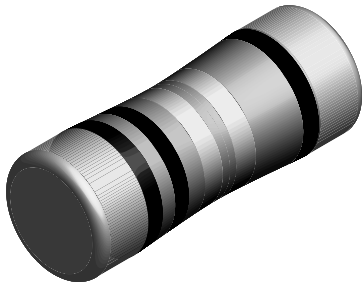


<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>REQUIREMENTS</b>
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ 2 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 2 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 0.5 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 2 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 0.25 %

<b>SOLDERING INFORMATION</b>
<ul style="list-style-type: none"> <li>• For reflow soldering only</li> <li>• Board has to be thoroughly cleaned after soldering. All flux materials must be completely removed</li> </ul>

<b>APPLICABLE SPECIFICATION</b>
<ul style="list-style-type: none"> <li>• EN 60115-1</li> </ul>

## Metal Film, Cylindrical, Fusible Resistors



### FEATURES

- Fusible resistor for constant current designed for overload protection
- High positive temperature coefficient
- Flame retardant coating
- Defined switch-off behaviour
- Pure tin termination on nickel barrier, plated on fress fit steel caps
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING <sup>1)</sup> P <sub>70</sub> W	TEMPERATURE COEFFICIENT	TOLERANCE %	RESISTANCE RANGE Ω	E-SERIES
NMM0207SI	0.35	+ 4500 (± 500)	± 5, ± 10, ± 20	1R0 - 47R	12 - 24
NMM0207SI	0.35	+ 4500 (± 500)	± 10, ± 20	R10 - R91	12

#### Notes

1. Permissible dissipation depends on the maximum temperature at the solder point, the component placement density and the substrate material.

• Marking: additional 5th band black; According to IEC 60062; see also datasheet "surface mount resistor marking" (document number: 20020)

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	NMM0207SI
Rated Dissipation at 70 °C	W	0.35
Minimum Overload to Fuse	W	1.5
Time to Fuse (max)	s	30
Max. applicable Voltage after Fusing	V	85
Thermal Resistance <sup>2)</sup>	K/W	≤ 220
Category Temperature Range	°C	- 55 to + 125
Failure Rate	10 <sup>-9</sup> /h	< 30
Weight/1000 pcs	g	71

#### Note

2. Based on measurements on test board acc. to EN 140400.

### PART NUMBER AND PRODUCT DESCRIPTION<sup>3)</sup>

PART NUMBER<sup>4)</sup>: NMM0207B01008JB P00

N M M 0 2 0 7 B 0 1 0 0 8 J B P 0 0

MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>5)</sup>	SPECIAL
NMM0207	B = SI Fusible	0 = neutral see data sheet for TC value	3 digit value 1 digit multiplier MULTIPLIER 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup>	J = ± 5 % K = ± 10 % M = ± 20 %	BP BS	up to 2 digits 00 = standard

PRODUCT DESCRIPTION: NMM0207SI 1R0 5 % BP

NMM0207SI	1R0	5 %	BP
MODEL	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>5)</sup>
NMM0207SI	1R0 = 1 Ω R22 = 0.22 Ω	± 5 % ± 10 % ± 20 %	BP BS

#### Notes

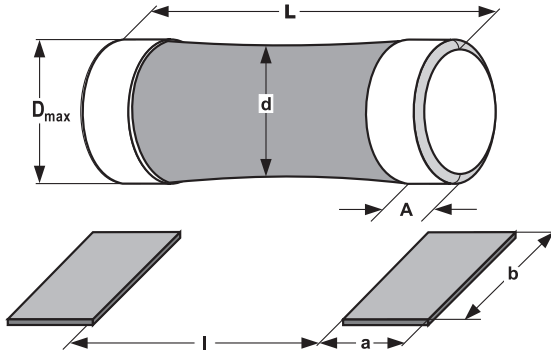
3. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.

4. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.

5. Please refer to table PACKAGING, see below.



## DIMENSIONS



MODEL	DIMENSIONS [in millimeters]				
	D <sub>max</sub>	d <sup>1)</sup>	L	A <sub>max</sub>	A <sub>min</sub>
NMM0207SI	2.2	D - 0.4	5.8- 0.3	1.2	0.6

**Note**

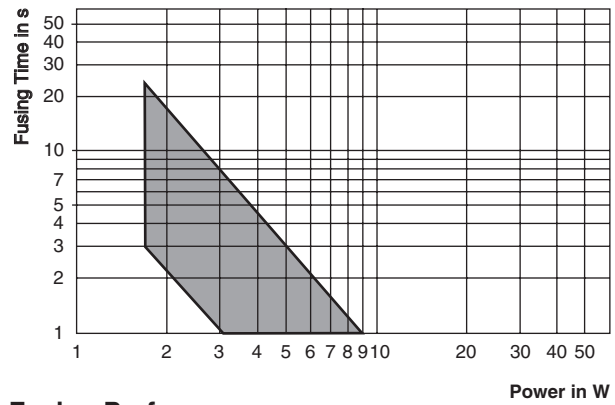
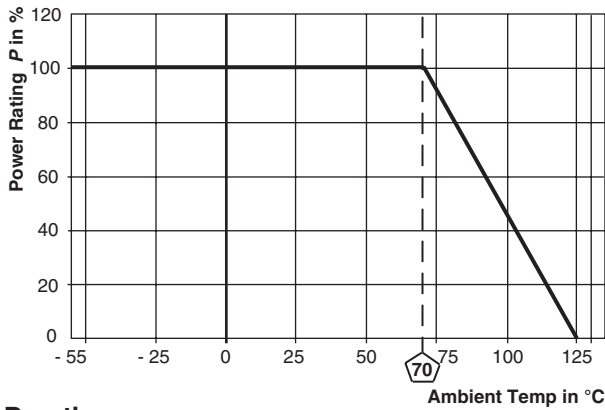
1. d measured in the middle of the resistor

MODEL	SOLDER PAD DIMENSIONS [in millimeters]					
	REFLOW SOLDERING			WAVE SOLDERING		
	a	b	l	a	b	l
NMM0207SI	1.8	2.5	2.9	2.4	2.5	2.8

## PACKAGING

MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
NMM0207SI	180 mm/7"	1500	BP
	330 mm/13"	7500	BS

Further information about PACKAGING, see also datasheet "surface mount resistor packing" (document number: 20014).



### Derating

### Fusing Performance

## PERFORMANCE

TEST	CONDITIONS OF TEST	REQUIREMENTS
Endurance Test at 70 °C IEC 60115-1, 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ 2 %
Endurance at UCT IEC 60115-1, 4.25.3	1000 hours at 125 °C without load	≤ 2 %
Overload Test IEC 60115-1, 4.13	Short time overload for 2 seconds	≤ 2 %
Thermal Shock IEC 60115-1, 4.19 and IEC 60068-2-14	Rapid change between upper and lower category temperature, 5 cycles	≤ 2 %
Damp Heat Steady State IEC 60115-1, 4.24 and IEC 60068-2-78	56 days at 40 °C and 93 % relative humidity	≤ 2 %
Resistance to Soldering Heat IEC 60115-1, 4.18 and IEC 60068-2-58	10 seconds at 260 °C solder bath temperature	≤ 1 %



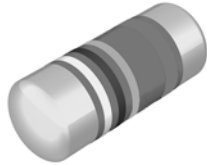
**SOLDERING INFORMATION**

- For reflow soldering only
- Board has to be thoroughly cleaned after soldering. All flux materials must be completely removed

**APPLICABLE SPECIFICATION**

- EN 60115-1

## High Pulse Load MELF Resistor



CMA 0204 specialty MELF resistors with advanced pulse load capability are the perfect choice for the protection of circuitry with signal or mains input lines from surge pulses. The resistors are also suitable for circuits exposed to high levels of electromagnetic interference or electrostatic discharge. The applications are in all fields of automotive, telecommunication, industrial and medical equipment.

### FEATURES

- Special carbon film technology
- Up to 4 kV single pulse capability
- Up to 70 W continuous pulse load
- ESD capability: 6 kV, Human Body Model
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

### METRIC SIZES

DIN:	0204
CECC:	RC 3715M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	CMA 0204	
Metric CECC size	RC 3715M	
Resistance range	10 $\Omega$ to 100 k $\Omega$	
Resistance tolerance	$\pm 2\%$	
Temperature coefficient	see TCR graph	
Operation mode	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56
Rated dissipation, $P_{70}^{1)}$	0.25 W	0.4 W
Operating voltage, $U_{max}$ AC/DC	200 V	
Film temperature <sup>2)</sup>	125 $^{\circ}$ C	155 $^{\circ}$ C
Max. resistance change at $P_{70}$ for resistance range,	10 $\Omega$ to 100 k $\Omega$	
$\Delta R/R$ after:		
1000 h	$\leq 1\%$	$\leq 2\%$
8000 h	$\leq 2\%$	$\leq 4\%$
Permissible voltage against ambient (insulation):		
1 minute; $U_{ins}$	300 V	
continuous	75 V	
Failure rate	$\leq 1 \times 10^{-9}/h$	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.
  2. Film temperatures above the specified range may be permissible, e.g. 175  $^{\circ}$ C. Please contact the factory for details.



**12NC INFORMATION**

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4

**12NC Example**

The 12NC of a CMA 0204 resistor, value 47 kΩ with ± 2 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 159 24703.

12NC - resistor type and packaging			
DESCRIPTION		ORDERING CODE 2312 ... ..	
		BLISTER TAPE ON REEL	
TYPE	TOL.	BL	B0
CMA 0204	± 2 %	159 2....	149 2....

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

**PART NUMBER<sup>2)</sup>: CMA02040X4701GB300**

C	M	A	0	2	0	4	0	X	4	7	0	1	G	B	3	0	0
MODEL/SIZE CMA0204	SPECIAL CHARACTER 0 = neutral		TCR X = no indication		VALUE 3 digit value 1 digit multiplier <b>Multiplier</b> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>			TOLERANCE G = ± 2 %	PACKAGING <sup>3)</sup> B3 B0		SPECIAL up to 2 digits 00 = standard						

**PRODUCT DESCRIPTION<sup>4)</sup>: CMA 0204 2 % BL 4K7**

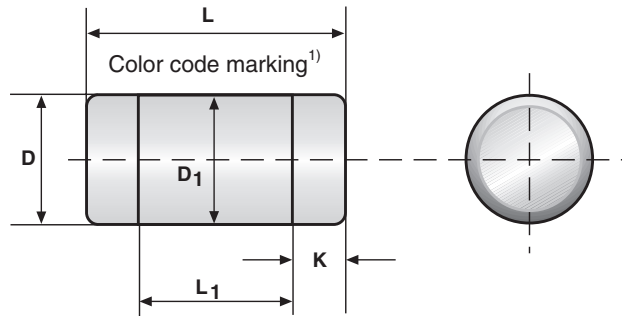
CMA	0204	2 %	BL	4K7
MODEL	SIZE	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
CMA	0204	± 2 %	BL B0	100R = 100 Ω 4K7 = 4.7 kΩ

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.
4. For CMA0204 the temperature coefficient is not identified in the PRODUCT DESCRIPTION.

<b>PACKAGING</b>			
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
CMA0204	180 mm/7"	3000	B3 = BL
	330 mm/13"	10 000	B0

**DIMENSIONS**



<b>DIMENSIONS</b> - MELF resistor types, mass and relevant physical dimensions						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
CMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19

Color code marking is applied according to IEC 60062\* in four bands (E24 series). Each color band appears as a single solid line, voids are permissible if at least 1/3 of the band is visible from each radial angle of view. The last color band for tolerance is approx, 50 % wider than the other bands. An interrupted band between the 2nd and 3rd full band identifies the special carbon film type.

<b>TOLERANCE AND RESISTANCE RANGE</b>	
TOLERANCE	RESISTANCE VALUE <sup>1)</sup>
	CMA 0204
± 2 %	10 Ω to 100 kΩ

**Note**

1. Resistance value to be selected from E24 series.

**DESCRIPTION**

Production of the CMA 0204 specialty MELF resistors with advanced pulse load capability is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous and dense carbon film is deposited on a high grade ceramic body (85 % Al<sub>2</sub>O<sub>3</sub>). Nickel plated steel termination caps are firmly pressed on the coated rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistors are covered by protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four color code rings designate the resistance value and tolerance in accordance with **IEC 60 062<sup>3)</sup>**.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60 286-3<sup>3)</sup>**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1<sup>3)</sup>**. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL<sup>1)</sup>** and the **CEFIC-EECA-EICTA<sup>2)</sup>** list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

**Notes**

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

**APPROVALS**

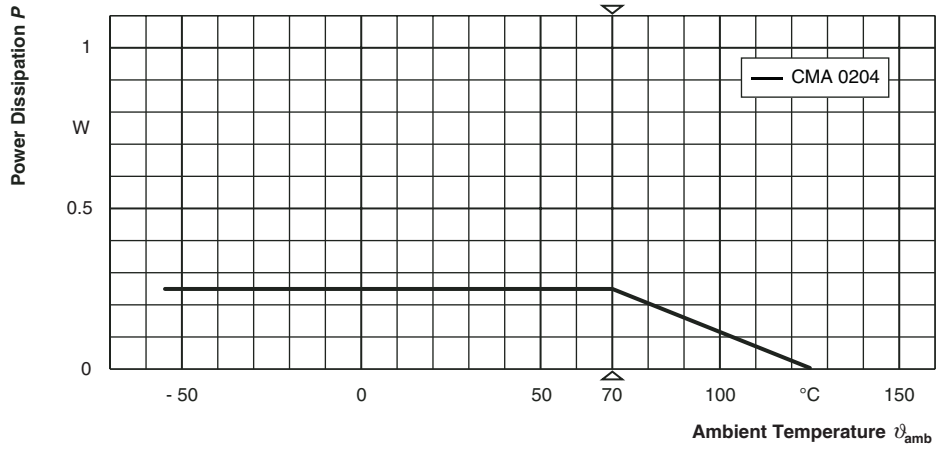
Where applicable the resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068<sup>3)</sup>** series.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

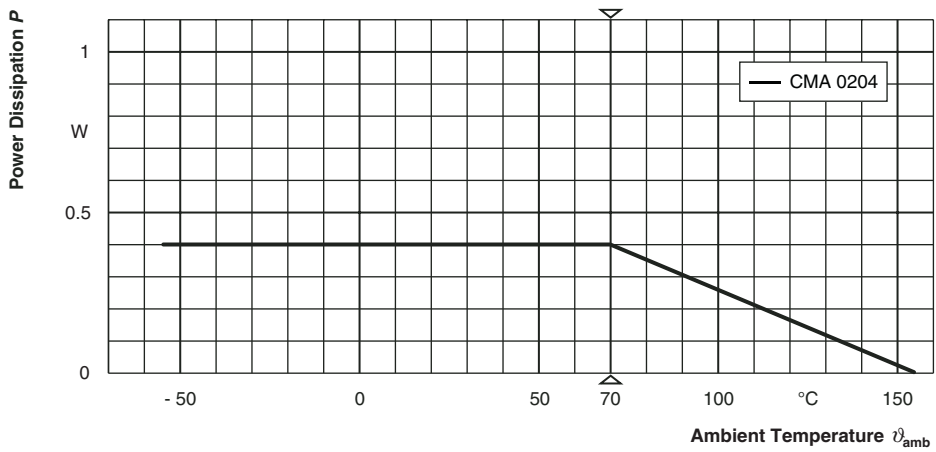
**Note**

3. The quoted IEC standards are also released as EN standards with the same number and identical contents.

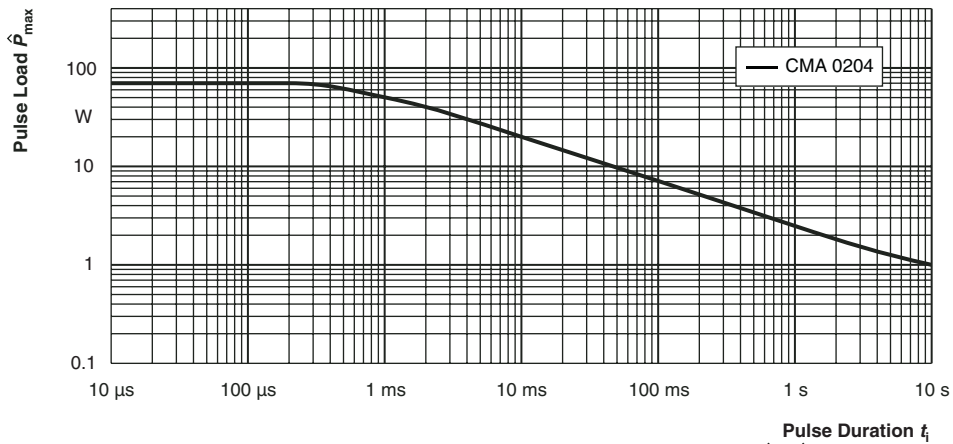
**FUNCTIONAL PERFORMANCE**



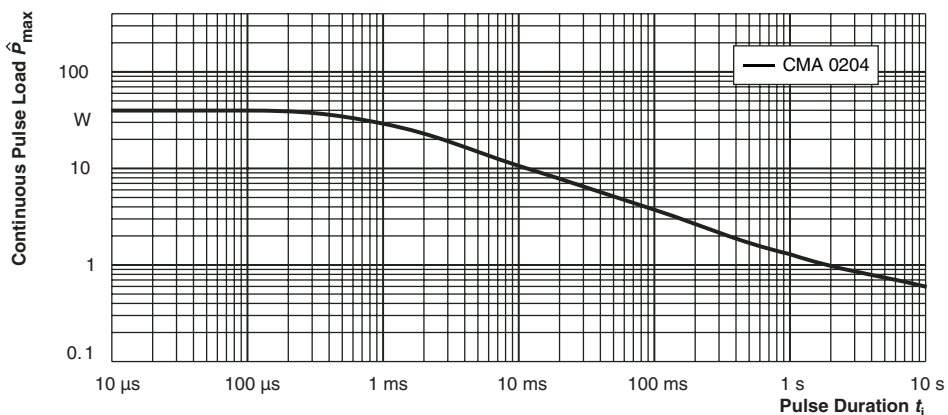
**Derating - Standard Operation**



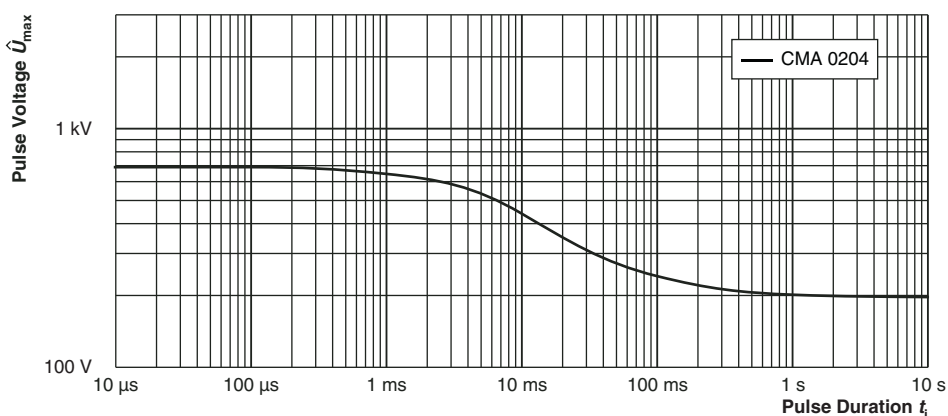
**Derating - Standard Operation**



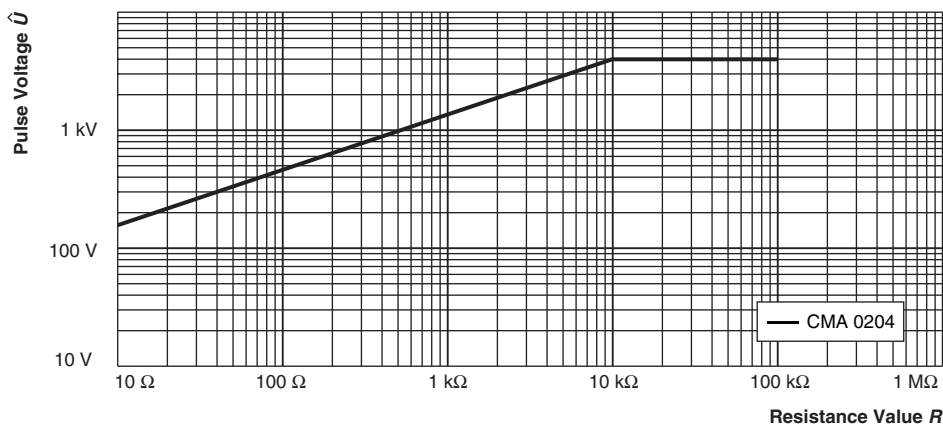
**Single Pulse**  
 Maximum pulse load, single pulse; applicable if  $\bar{P} \rightarrow 0$  and  $n \leq 1000$  and  $\hat{U} \leq \hat{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation



Maximum pulse load, continuous pulses; applicable if  $\bar{P} \leq P(\vartheta_{amb})$  and  $\hat{U} \leq \hat{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation

**Continuous Pulses**


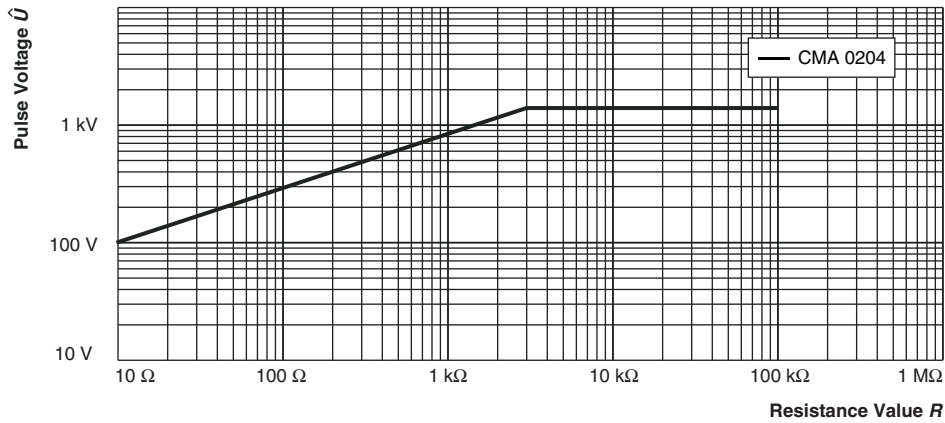
Maximum pulse voltage, single and continuous pulses; applicable if  $\hat{P} \leq \hat{P}_{max}$ ; for permissible resistance change equivalent to 8000 h operation

**Pulse Voltage**


Pulse load rating in accordance with IEC 60115-1, 4.27; 1,2  $\mu$ s/50  $\mu$ s; 5 pulses at 12 s intervals; for permissible resistance change 0.5 %

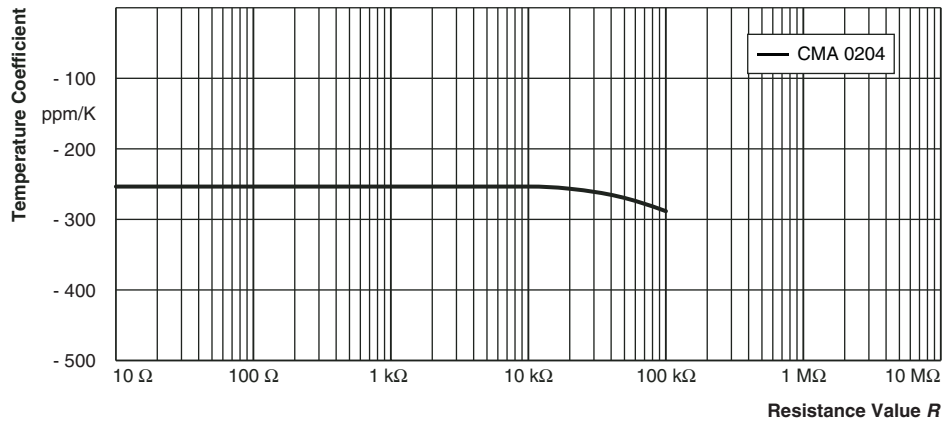
**1.2/50 Pulse**





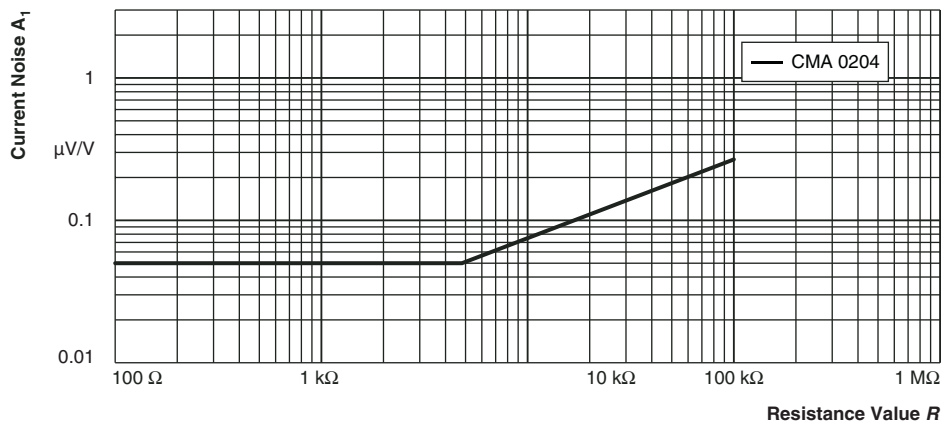
Resistance Value R  
 Pulse load rating in accordance with IEC 60115-1, 4.27; 10  $\mu$ s/700  $\mu$ s;  
 10 pulses at 1 minute intervals; for permissible resistance change 0.5 %

10/700 Pulse



Temperature coefficient of resistance

Temperature Coefficient (TCR)



In accordance with IEC 60 195

Current Noise -  $A_1$

**TESTS AND REQUIREMENTS**

Essentially all tests are carried out in accordance with the following specifications:

- EN 60115-1, generic specification
- EN 140400, sectional specification
- EN 140401-803, detail specification

The Test Procedures and Requirements table contains the applicable tests selected from the documents listed above.

The tests are carried out in accordance with IEC 60068<sup>1)</sup> and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3<sup>1)</sup>. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45 % to 75 %
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803.

<b>TEST PROCEDURES AND REQUIREMENTS</b>				
<b>EN 60115-1 CLAUSE</b>	<b>IEC 60068-2<sup>1)</sup> TEST METHOD</b>	<b>TEST</b>	<b>PROCEDURE</b>	<b>REQUIREMENTS PERMISSIBLE CHANGE (<math>\Delta R</math>)</b>
			stability for product types: <b>CMA 0204</b>	10 $\Omega$ to 100 k $\Omega$
4.5	-	resistance	-	$\pm 2 \% R$
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	see Temperature Coefficient graph
4.25.1	-	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (1 \% R + 0.05 \Omega)$ $\pm (2 \% R + 0.05 \Omega)$
4.25.1	-	endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (2 \% R + 0.05 \Omega)$ $\pm (4 \% R + 0.05 \Omega)$
4.25.3	-	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (2 \% R + 0.05 \Omega)$ $\pm (4 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (1 \% R + 0.1 \Omega)$
4.23		climatic sequence:		
4.23.2	2 (Ba)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90 \% RH$ ; 1 cycle	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90 \% RH$ ; 5 cycles	
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1 min. LCT = - 55 °C; UCT = 155 °C	$\pm (1 \% R + 0.1 \Omega)$
-	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.5 \% R + 0.1 \Omega)$



TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 <sup>1)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			stability for product types: <b>CMA 0204</b>	10 $\Omega$ to 100 k $\Omega$
4.19	14 (Na)	rapid change of temperature	30 minutes at - 55 °C; 30 minutes at + 125 °C; 5 cycles	$\pm (0.5 \% R + 0.1 \Omega)$
4.13	-	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}; 5 \text{ s}$	$\pm (0.25 \% R + 0.1 \Omega)$
		short time overload; power operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}; 5 \text{ s}$	$\pm (0.25 \% R + 0.1 \Omega)$
4.40	-	electrostatic discharge (Human body Model)	IEC 61340-3-1*; 3 pos. + 3 neg. discharges CMA 0204: 6 kV	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.29	45 (XA)	component solvent resistance	isopropyl alcohol; 50 °C; method 2	no visible damage
4.30	45 (XA)	solvent resistance of marking	isopropyl alcohol; 50 °C; method 1, toothbrush	marking legible; no visible damage
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq$ 95 % covered); no visible damage
			solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	good tinning ( $\geq$ 95 % covered); no visible damage
4.18.2	58 (Td)	resistance to soldering heat	solder bath method ; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.5 \% R + 0.1 \Omega)$
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	45 N	no visible damage
4.7	-	voltage proof	$U_{rms} = U_{ins}; 60 \text{ s}$	no flashover or breakdown
4.35	-	flammability	IEC 60 695-11-5*, needle flame test; 10	no burning after 30 s

**Note**

1. The quoted IEC standards are also released as EN standards with the same number and identical contents.

REVISION HISTORY
<p><b>Compared to the prior revision of this datasheet, 27-Feb-04, the following changes have been applied:</b></p> <ul style="list-style-type: none"> <li>• Introduction of a standardized part numbering system</li> <li>• Additional emphasis on the clean balance of materials and on the compliance with various EU directives</li> <li>• Revision of the current noise diagram based on new test results</li> <li>• Introduction of a test and requirements for electrostatic discharge (ESD)</li> <li>• No other change of technical contents</li> <li>• No product change</li> </ul>

## High Pulse Load MELF Resistor



CMB 0207 specialty MELF resistors with advanced pulse load capability are the perfect choice for the protection of circuitry with signal and mains input lines from surge pulses. The resistors are also suitable for circuits exposed to high levels of electromagnetic interference or electro-static discharge. The applications are in all fields of automotive, telecommunication, industrial and medical equipment.

### FEATURES

- Approved to the safety requirements of IEC 60065, 14.1.a\* (= VDE 0860, 14.1.a) VDE-REG.-Nr. B583
- Special carbon film technology
- Up to 10 kV or 17 kW single pulse capability
- Up to tbf. continuous pulse load capability
- ESD capability: 16 kV, Human Body Model
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

### METRIC SIZE

<b>DIN:</b>	0207
<b>CECC:</b>	RC 6123M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	CMB 0207	
CECC size	RC 6123M	
Resistance range	2.2 Ω to 1.5 MΩ	
Resistance tolerance	± 5 %; ± 2 %	
Temperature coefficient	see TCR graph	
Operation mode	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56
Rated dissipation, $P_{70}^{1)}$	0.4 W	1.0 W
Operating voltage, $U_{max}$ AC/DC	500 V	
Film temperature <sup>3)</sup>	125 °C	155 °C
Max. resistance change at $P_{70}$ for resistance range,	2.2 Ω to 10 kΩ	
$\Delta R/R$ after:		
1000 h	≤ 0.5 %	≤ 1 %
8000 h	≤ 1 %	≤ 2 %
225 000 h	t.b.f	-
Permissible voltage against ambient (insulation):		
1 minute; $U_{ins}$	750 V	
continuous	75 V	
Failure rate	≤ 1 × 10 <sup>-9</sup> /h	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.
  2. Specified power rating requires dedicated heat-sink pads.
  3. Film temperatures above the specified range may be permissible, e.g. 175 °C. Please contact the factory for details.



## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table

## Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5

## 12NC Example

The 12NC of a CMB 0207 resistor, value 47 kΩ with ± 2 % tolerance, supplied in blister tape of 2000 units per reel is: 2312 199 24703.

12NC - resistor type and packaging			
DESCRIPTION		ORDERING CODE 2312 ... ..	
		BLISTER TAPE ON REEL	
TYPE	TOL.	B2 2000 UNITS	B7 7000 UNITS
CMB 0207	± 5 %	... 199 3...	... 189 3....
	± 2 %	... 199 2....	... 189 2....

### PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>

**PART NUMBER<sup>2)</sup>: CMB02070X4701GB200**

C	M	B	0	2	0	7	0	X	4	7	0	1	G	B	2	0	0
MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE			TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL									
CMB0207	0 = neutral	X = no indication	3 digit value 1 digit multiplier <b>Multiplier</b> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup>			G = ± 2 % J = ± 5 %	B2 B7	up to 2 digits 00 = standard									

**PRODUCT DESCRIPTION<sup>4)</sup>: CMB 0207 2 % B2 4K7**

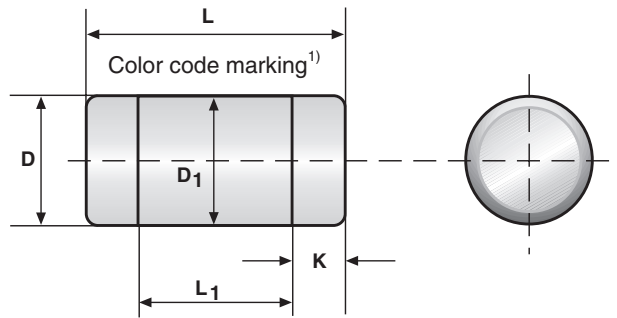
CMB	0207	2 %	B2	4K7
MODEL	SIZE	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
CMB	0207	± 2 % ± 5 %	B2 B7	100R = 100 Ω 4K7 = 4.7 kΩ

### Notes

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.
4. For CMB 0207 the temperature coefficient is not identified in the PRODUCT DESCRIPTION.

<b>PACKAGING</b>			
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
CMB0207	180 mm/7"	2000	B2
	330 mm/13"	7000	B7

**DIMENSIONS**



<b>DIMENSIONS - MELF resistor types, mass and relevant physical dimensions</b>						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
CMB 0207	5.8 + 0/- 0.15	2.2 + 0/- 0.2	3.2	D + 0/- 0.2	1.15 ± 0.1	79

**Note**

1. Color code marking is applied according to IEC 60062\* in four bands. Each color band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approximately, 50 % wider than the other bands. A brown interrupted band between the 2nd and 3rd full band indicates the special carbon film type.

<b>TOLERANCE AND RESISTANCE RANGE</b>	
DESCRIPTION	RESISTANCE VALUE <sup>2)</sup>
TOLERANCE	<b>CMB 0207</b>
± 5 %	2.2 Ω to 15 Ω
± 2 %	16 Ω to 1.5 MΩ

**Note**

2. Please select resistance values for ± 5 % and ± 2 % tolerance from the E24 series.

**DESCRIPTION**

Production of the CMB 0207 specialty MELF resistor is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous and dense carbon film is deposited on a high grade ceramic body (96 % Al<sub>2</sub>O<sub>3</sub>). Nickel plated steel termination caps are firmly pressed on the coated rods. Products with a resistance of 15 Ω or lower are made without trimming, whereas a special laser is used to achieve a target value of 16 Ω or above by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four color code rings designate the resistance value and tolerance in accordance with **IEC 60 062**<sup>3)</sup>.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60 286-3**<sup>3)</sup>.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**<sup>3)</sup>. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

**Notes**

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

**APPROVALS**

Where applicable the resistors are tested in accordance with **EN 140401-803** which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068**<sup>3)</sup> series.

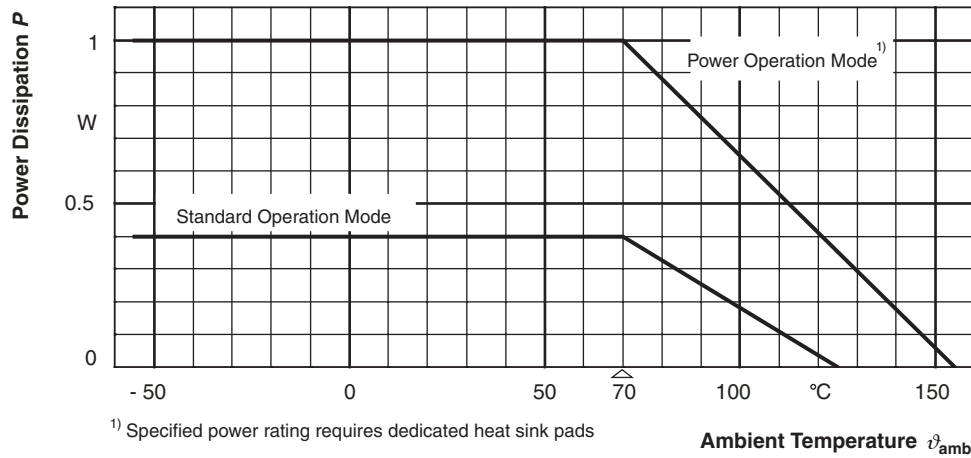
Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

**Note**

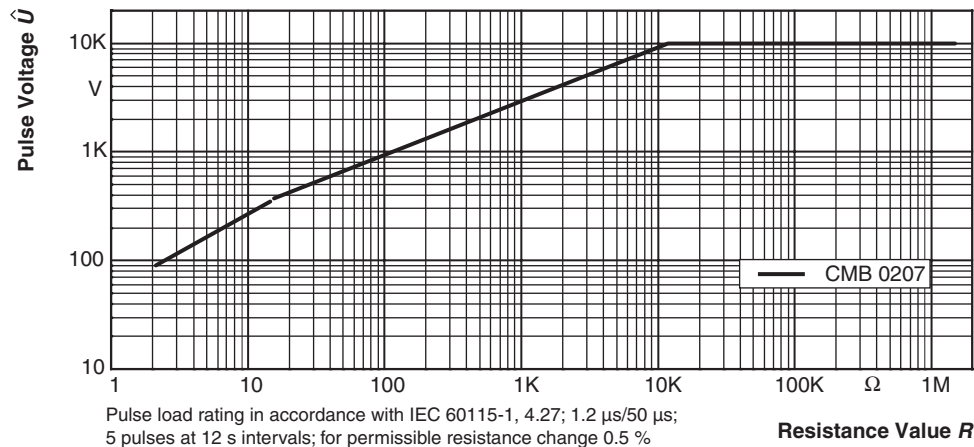
3. The quoted IEC standards are also released as EN standards with the same number and identical contents.



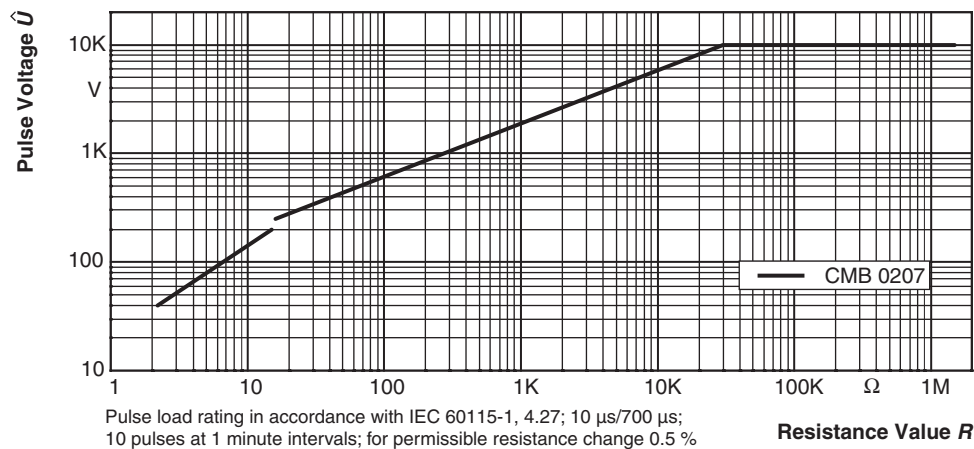
**FUNCTIONAL PERFORMANCE**



**Derating**

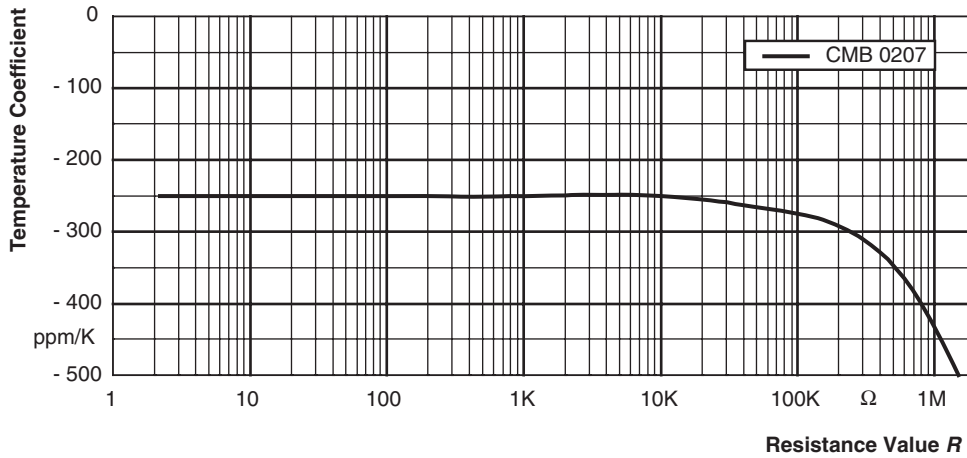


**1.2/50 Pulse**

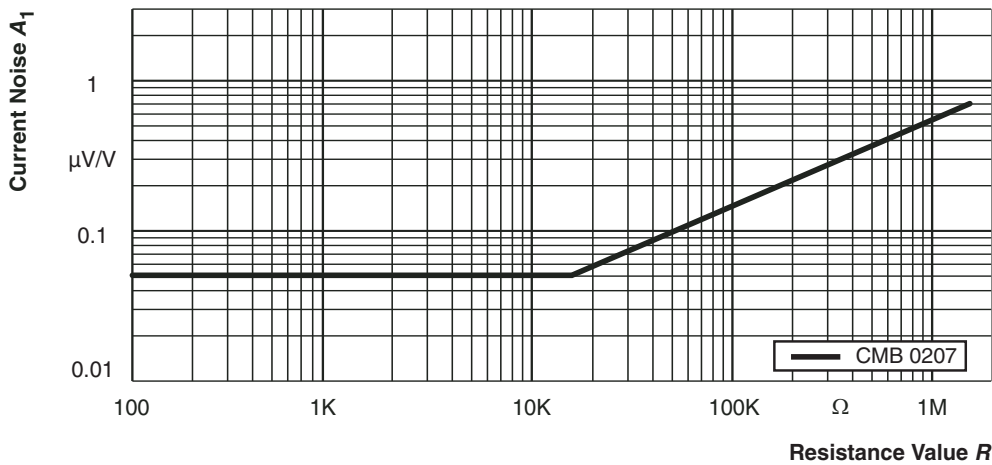


**10/700 Pulse**





**Temperature Coefficient (TCR)**



In accordance with IEC 60195

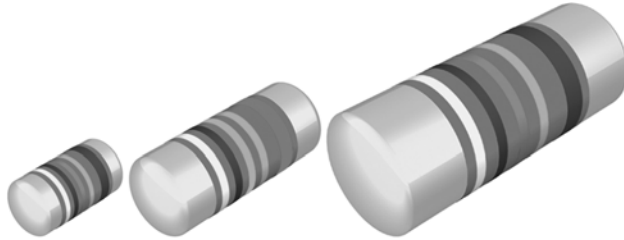
**Current Noise - A<sub>1</sub>**

**REVISION HISTORY**

Compared to the prior revision of this datasheet, short rev3, the following changes have been applied:

- Transfer into Vishay format for publication on the internet
- Introduction of a standardized part numbering system
- Additional emphasis on the clean balance of materials and on the compliance with various EU directives
- Revision of the 1.2/50 pulse load diagram
- Introduction of diagrams on 10/700 pulse load and on current noise
- Introduction of information on electrostatic discharge (ESD) capability
- No other change of technical contents
- No product change

## High Frequency MELF Resistors



MMU 0102 HF, MMA 0204 HF and MMB 0207 HF specialty thin film MELF resistors for RF applications are the perfect choice in high frequency circuit designs where the impedance change due to the parasitic inductance of regular and professional resistors can not be accepted. Typical applications are in the fields of telecommunication equipment and industrial electronics.

### FEATURES

- Specialty product for RF applications
- Low-inductance non-helical trimmed product
- Suitable for more than 10 GHz
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Telecommunication equipment
- Industrial electronics.

### METRIC SIZE

DIN:	0102	0204	0207
CECC:	RC 2211M	RC 3715M	RC 6123M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MMU 0102 HF		MMA 0204 HF		MMB 0207 HF	
	Metric CECC size	RC 2211M		RC 3715M		RC 6123M
Resistance range	6.8 Ω to 470 Ω		1.5 Ω to 475 Ω		6.8 Ω to 470 Ω	
Resistance tolerance	± 2 %		± 1 %		± 2 %	
Temperature coefficient	± 50 ppm/K					
Operation mode	standard	power	standard	power	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56	55/155/56
Rated dissipation, $P_{70}^{(1)}$	0.2 W	0.3 W	0.25 W	0.4 W	0.4 W	1.0 W <sup>(2)</sup>
Operating voltage, $U_{max}$ AC/DC	limited by $P_{70}$		limited by $P_{70}$		limited by $P_{70}$	
Film temperature	125 °C	155 °C	125 °C	155 °C	125 °C	155 °C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	6.8 Ω to 470 Ω		1.5 Ω to 475 Ω		6.8 Ω to 470 Ω	
4000 h	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %
8000 h	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %
225 000 h	≤ 1.5 %	-	≤ 1.5 %	-	≤ 1.5 %	-
Permissible voltage against ambient (insulation):						
1 minute; $U_{ins}$	150 V		300 V		500 V	
continuous	75 V		75 V		75 V	
Failure rate	≤ 2.0 × 10 <sup>-9</sup> /h		≤ 0.7 × 10 <sup>-9</sup> /h		≤ 0.7 × 10 <sup>-9</sup> /h	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.
  2. Specified power rating requires dedicated heat-sink pads.



## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1

### 12NC Example

The 12NC of a MMU 0102 HF resistor, value 50 Ω and TCR 50 with ± 2 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 168 0500 9.

12NC - RESISTOR TYPE AND PACKAGING									
DESCRIPTION			ORDERING CODE 2312 ... ..						
			BLISTER TAPE ON REEL				BULK CASE		
TYPE	TCR	TOL.	B1 1000 UNITS	B2 2000 UNITS	BL 3000 UNITS	B7 7000 UNITS	B0 10000 UNITS	M3 3000 UNITS	M8 8000 UNITS
MMU 0102 HF	± 50 ppm/K	± 2 %	173 0....	-	168 0....	-	178 0....	-	063 0....
MMA 0204 HF	± 50 ppm/K	± 1 %	143 0....	-	158 0....	-	148 0....	043 0....	-
MMB 0207 HF	± 50 ppm/K	± 2 %	183 0....	198 0....	-	188 0....	-	-	-

### PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>

**PART NUMBER<sup>2)</sup>: MMA0204AC5009FBL00**

M	M	A	0	2	0	4	A	C	5	0	0	9	F	B	L	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

<b>MODEL/SIZE</b> MMU0102 MMA0204 MMB0207	<b>SPECIAL CHARACTER</b> A = High Frequency	<b>TCR</b> C = ± 50 ppm/K	<b>VALUE</b> 3 digit value 1 digit multiplier <b>Multiplier</b> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup>	<b>TOLERANCE</b> F = ± 1 % G = ± 2 %	<b>PACKAGING<sup>3)</sup></b> B1 B3 B0 B2 B7 M3 M8	<b>SPECIAL</b> up to 2 digits 00 = standard
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**PRODUCT DESCRIPTION: MMA 0204-50 1 % HF BL 50R**

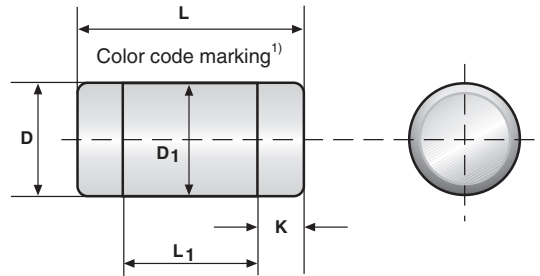
MMA	0204	- 50	1 %	HF	BL	50R
MODEL	SIZE	TCR	TOLERANCE	SUFFIX	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
MMU MMA MMB	0102 0204 0207	± 50 ppm/K	± 1 % ± 2 %	HF = High Frequency	B1 BL B0 B2 B7 M3 M8	50R = 50 Ω

### Notes

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.

PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286 -3			BULK CASE ACC. IEC 60286 -6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
MMU 0102 HF	180 mm/7"	1000	B1	8000	M8
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMA 0204 HF	180 mm/7"	1000	B1	3000	M3
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMB 0207 HF	180 mm/7"	1000	B1	-	-
	180 mm/7"	2000	B2		
	330 mm/13"	7000	B7		

### DIMENSIONS



DIMENSIONS - MELF resistor types, mass and relevant physical dimensions						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MMU 0102 HF	2.2 + 0/- 0.1	1.1 + 0/- 0.1	1.2	D + 0/- 0.1	0.4 ± 0.05	7
MMA 0204 HF	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19
MMB 0207 HF	5.8 + 0/- 0.2	2.2 + 0/- 0.2	2.8	D + 0/- 0.2	1.25 ± 0.15	79

#### Note

1. Color code marking is applied according to IEC 60062\* in four bands (E24 series) or five bands (E96 series). Each colour band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approx. 50 % wider than the other bands. An interrupted band between the 3rd and 4th full band identifies the special high frequency type.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE <sup>2)</sup>		
TCR	TOLERANCE	MMU 0102 HF	MMA 0204 HF	MMB 0207 HF
± 50 ppm/K	± 2 %	50 Ω, 6.8 Ω to 470 Ω	-	50 Ω, 6.8 Ω to 470 Ω
	± 1 %	-	50 Ω, 1.5 Ω to 475 Ω	-

#### Note

2. Resistance value to be selected from E24 series for ± 2 % tolerance and from E96 series for ± 1 % tolerance, for other values please contact the factory.



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade (85 % Al<sub>2</sub>O<sub>3</sub>, for MICRO-MELF: 96 % Al<sub>2</sub>O<sub>3</sub>) ceramic body and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting a non helical pattern with a resulting low inductivity in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four or five color code rings designate the resistance value and tolerance in accordance with **IEC 60062**<sup>3)</sup>. Additional black dots near the 3rd colour ring identify the special HF product.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3**<sup>3)</sup> or bulk case in accordance with **IEC 60286-6**<sup>3)</sup>.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**<sup>3)</sup>. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

## Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

Where applicable the resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068**<sup>3)</sup> series.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

## Note

3. The quoted IEC standards are also released as EN standards with the same number and identical contents.

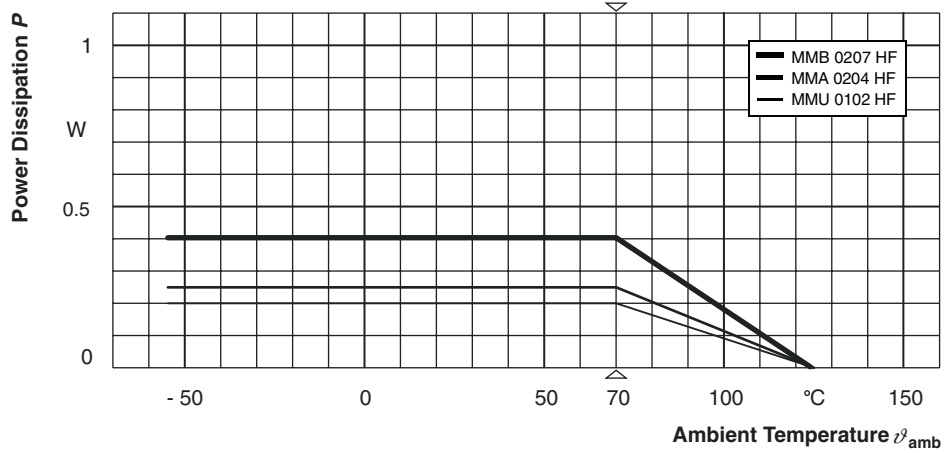


# MMU 0102 HF, MMA 0204 HF, MMB 0207 HF

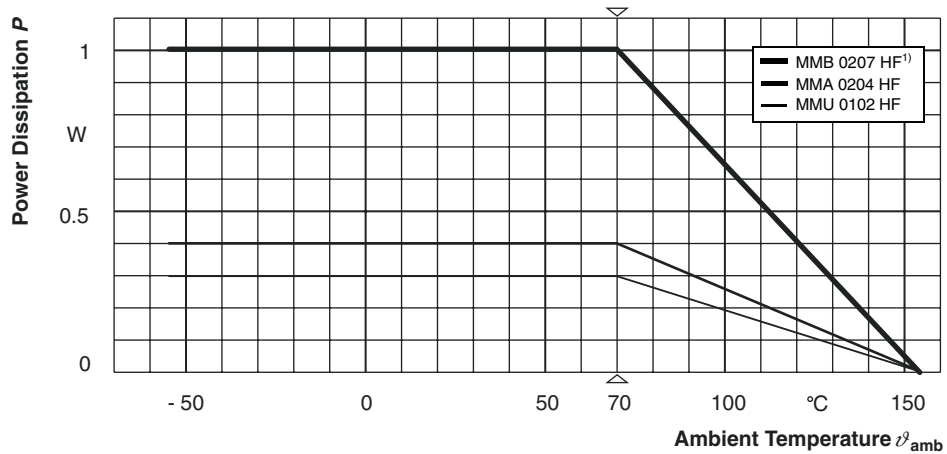
High Frequency MELF Resistors

Vishay Beyschlag

## FUNCTIONAL PERFORMANCE

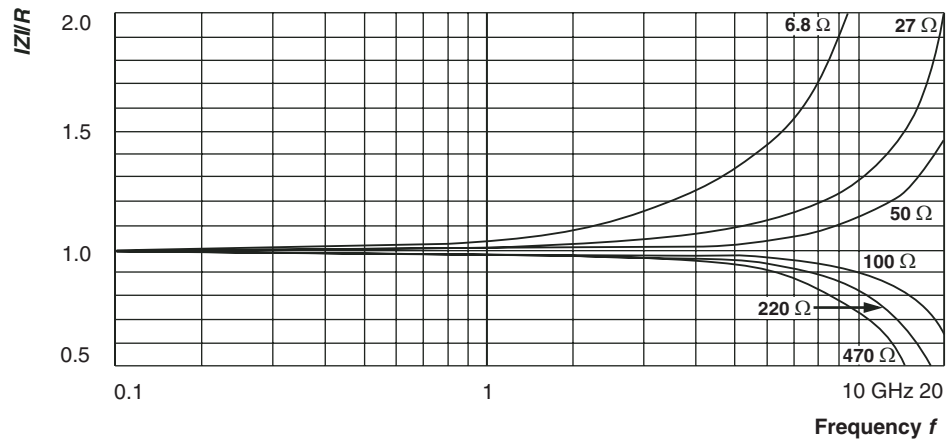


### Derating - Standard Operation



<sup>1)</sup> Specified power rating requires dedicated heat sink pads

### Derating - Power Operation



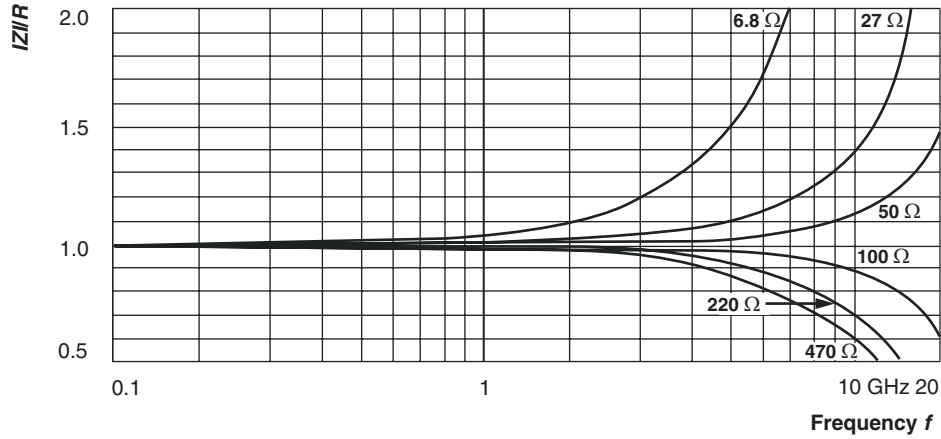
### RF - Behavior

IZ//R for MMU 0102 HF

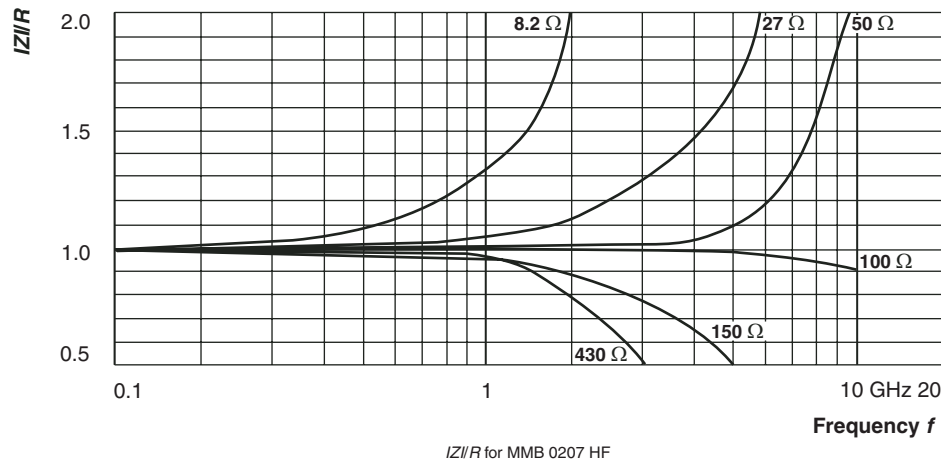
# MMU 0102 HF, MMA 0204 HF, MMB 0207 HF

Vishay Beyschlag

High Frequency MELF Resistors



## RF - Behavior



## RF - Behavior



### TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-803, detail specification

The Test Procedures and Requirements table contains the applicable tests selected from the documents listed above.

The tests are carried out in accordance with IEC 60068<sup>1)</sup> and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3.<sup>1)</sup> Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on printed-circuit boards in accordance with EN 140400, 2.3.3, unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803.

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 <sup>1)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			stability for product types:	
			<b>MMU 0102 HF</b>	6.8 $\Omega$ to 470 $\Omega$
			<b>MMA 0204 HF</b>	1.5 $\Omega$ to 475 $\Omega$
			<b>MMB 0207 HF</b>	6.8 $\Omega$ to 470 $\Omega$
4.5	-	resistance	MMU 0102 HF, MMB 0207 HF: MMA 0204 HF:	$\pm 2\% R$ $\pm 1\% R$
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 50$ ppm/K
4.25.1	-	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h; 70 °C; 8000 h	$\pm (0.25\% R + 0.05 \Omega)$ $\pm (0.5\% R + 0.05 \Omega)$
		endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.5\% R + 0.05 \Omega)$ $\pm (1\% R + 0.05 \Omega)$
4.25.3	-	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (0.5\% R + 0.05 \Omega)$ $\pm (1\% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5\% R + 0.05 \Omega)$
4.23		climatic sequence:		
4.23.2	2 (Ba)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90\%$ RH; 1 cycle	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 24 h; $\geq 90\%$ RH; 5 cycles	
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1 min. LCT = - 10 °C; UCT = 85 °C	$\pm (0.5\% R + 0.05 \Omega)$
-	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.1\% R + 0.01 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at - 55 °C; 30 minutes at 155 °C; 5 cycles	$\pm (0.25\% R + 0.05 \Omega)$





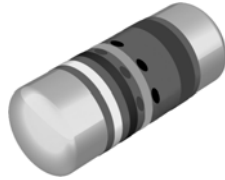
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 <sup>1)</sup> TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			stability for product types:	
			<b>MMU 0102 HF</b>	6.8 $\Omega$ to 470 $\Omega$
			<b>MMA 0204 HF</b>	1.5 $\Omega$ to 475 $\Omega$
			<b>MMB 0207 HF</b>	6.8 $\Omega$ to 470 $\Omega$
4.13	-	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$
		short time overload; power operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$
4.40	-	electrostatic discharge (Human Body Model)	IEC 61340-3-1 <sup>1)</sup> ; 3 pos. + 3 neg. discharges MMU 0102 HF: 800 V MMA 0204 HF: 1000 V MMB 0207 HF: 2000 V	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.29	45 (XA)	component solvent resistance	isopropyl alcohol; 50 °C; method 2	no visible damage
4.30	45 (XA)	solvent resistance of marking	isopropyl alcohol; 50 °C; method 1, toothbrush	marking legible; no visible damage
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq$ 95 % covered); no visible damage
			solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	good tinning ( $\geq$ 95 % covered); no visible damage
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.5 \% R + 0.05 \Omega)$
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	45 N	no visible damage
4.35	-	flammability	IEC 60 695-11-5 <sup>1)</sup> , needle flame test; 10 s	no burning after 30 s

**Note**

1. The quoted IEC standards are also released as EN standards with the same number and identical contents.

REVISION HISTORY
<p><b>Compared to the prior revision of this datasheet, 26-Feb-04, the following changes have been applied:</b></p> <ul style="list-style-type: none"> <li>• Introduction of a standardized part numbering system</li> <li>• Additional emphasis on the clean balance of materials and on the compliance with various EU directives</li> <li>• Introduction of a test and requirements for electrostatic discharge (ESD)</li> <li>• No other change of technical contents</li> <li>• No product change</li> </ul>

## Pulse Load MELF Resistors for High Frequency Applications



CMA 0204 HF specialty MELF resistors combine the advanced pulse load capability and the suitability for RF applications in a single component. They are the perfect choice in high frequency circuit designs where the parasitic inductance of regular, helical trimmed resistors can not be accepted, but where also pulse energies apply. Typical applications are in the fields of telecommunication equipment and industrial electronics.

### FEATURES

- Specialty product for RF applications
- Low-inductance non-helical trimmed product
- Special carbon film technology
- ESD capability: 3 kV, Human Body Model
- Suitable for more than 10 GHz
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Telecommunication equipment
- Industrial electronics

### METRIC SIZE

<b>DIN:</b>	0204
<b>CECC:</b>	RC 3715M

### TECHNICAL SPECIFICATION

DESCRIPTION	CMA 0204 HF	
CECC size	RC 3715M	
Resistance range	50 Ω; 47 Ω to 300 Ω	
Resistance tolerance	± 2 %	
Temperature coefficient	approx. - 250 ppm/K	
Operation mode	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56
Rated dissipation $P_{70}^{1)}$	0.25 W	0.4 W
Operating voltage, $U_{max}$ AC/DC	Limited by $P_{70}$	
Film temperature	125 °C	155 °C
Max. resistance change at $P_{70}$ for resistance range,	47 Ω to 300 Ω	
$\Delta R/R$ after:		
1000 h	≤ 1 %	≤ 2 %
8000 h	≤ 2 %	≤ 4 %
225 000 h	t.b.f.	-
Permissible voltage against ambient (insulation):		
1 minute; $U_{ins}$	300 V	
continuous	75 V	
Failure rate	≤ 1 × 10 <sup>-9</sup> /h	

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.



## 12NC INFORMATION

- The 12-digit numeric code starts with 2312
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

## Last digit of 12nc indicating resistance decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1

## 12NC Example

The 12NC of a CMA 0204 HF resistor, value 50 Ω with ± 1 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 158 25009.

12NC - resistor type and packaging		
DESCRIPTION		ORDERING CODE 2312 ... ..
		BLISTER TAPE ON REEL
TYPE	TOL.	BL 3000 UNITS 3000 units
CMA 0204 HF	± 2 %	... 158 2 ...

### PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>

**PART NUMBER<sup>2)</sup>: CMA0204AX1000GB300**

C	M	A	0	2	0	4	A	X	1	0	0	0	G	B	3	0	0
MODEL/SIZE <b>CMA0204</b>	SPECIAL CHARACTER <b>A = HF High Frequency</b>	TCR <b>X = no indication</b>	VALUE 3 digit value 1 digit multiplier <b>Multiplier</b> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup>				TOLERANCE <b>G = ± 2 %</b>	PACKAGING <sup>3)</sup> <b>B3</b>	SPECIAL up to 2 digits <b>00 = standard</b>								

**PRODUCT DESCRIPTION<sup>4)</sup>: CMA 0204 2 % HF BL 100R**

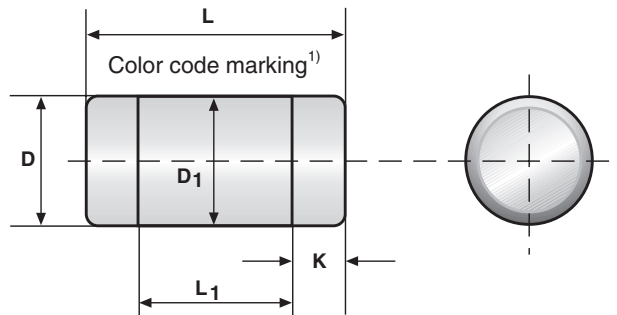
<b>CMA</b>	<b>0204</b>	<b>2 %</b>	<b>HF</b>	<b>BL</b>	<b>100R</b>
MODEL	SIZE	TOLERANCE	SUFFIX	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
<b>CMA</b>	<b>0204</b>	<b>± 2 %</b>	<b>HF = High Frequency</b>	<b>BL</b>	<b>100R = 100 Ω</b>

## Notes

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
2. The PART NUMBER is shown to facilitate the introduction of the unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.
4. For CMA0204 the temperature coefficient is not identified in the PRODUCT DESCRIPTION.

<b>PACKAGING</b>			
TYPE	BLISTER TAPE ON REEL ACC. IEC 60286-3		
	DIAMETER	PIECES/REEL	CODE
CMA 0204 HF	180 mm/7"	3000	B3 = BL

**DIMENSIONS**



<b>DIMENSIONS - MELF RESISTOR TYPES, MASS AND RELEVANT PHYSICAL DIMENSIONS</b>						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
CMA 0204 HF	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19

**Note**

1. Color code marking is applied according to IEC 60062\* in four bands. Each color band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approximately 50 % wider than the other bands. Interrupted bands left and right of the 3rd full band indicate the special carbon film high frequency type.

<b>TOLERANCE AND RESISTANCE RANGE</b>		
TYPE	TOLERANCE	RESISTANCE VALUE
CMA 0204 HF	± 2 %	50 Ω 47 Ω to 300 Ω <sup>2)</sup>

**Note**

2. Please select resistance values for ± 2 % tolerance from the E24 series.



### DESCRIPTION

Production of the CMA 0204 HF specialty MINI-MELF resistor is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous and dense carbon film is deposited on a high grade ceramic body (85 %  $\text{Al}_2\text{O}_3$ ). Nickel plated steel termination caps are firmly pressed on the coated rods. A special laser is used to achieve the target value by smoothly cutting a non helical pattern with a resulting low inductivity in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four color code rings designate the resistance value and tolerance in accordance with **IEC 60062**<sup>3)</sup>.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3**<sup>3)</sup>.

### ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**<sup>3)</sup>. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and the Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

#### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

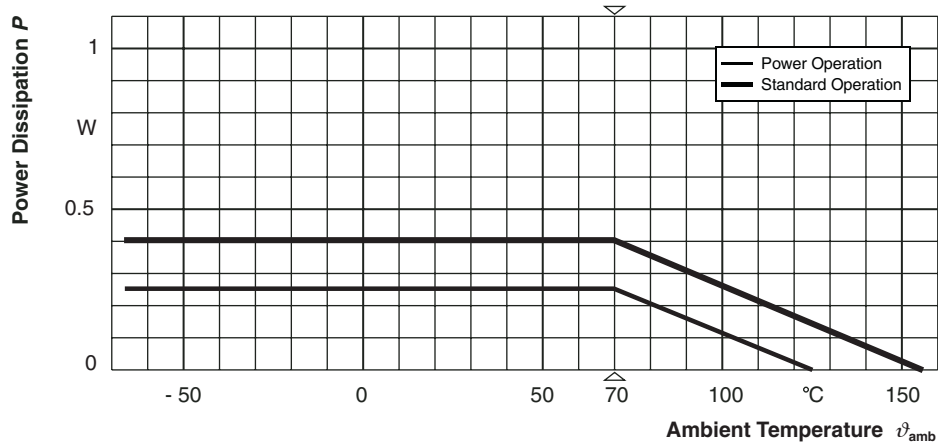
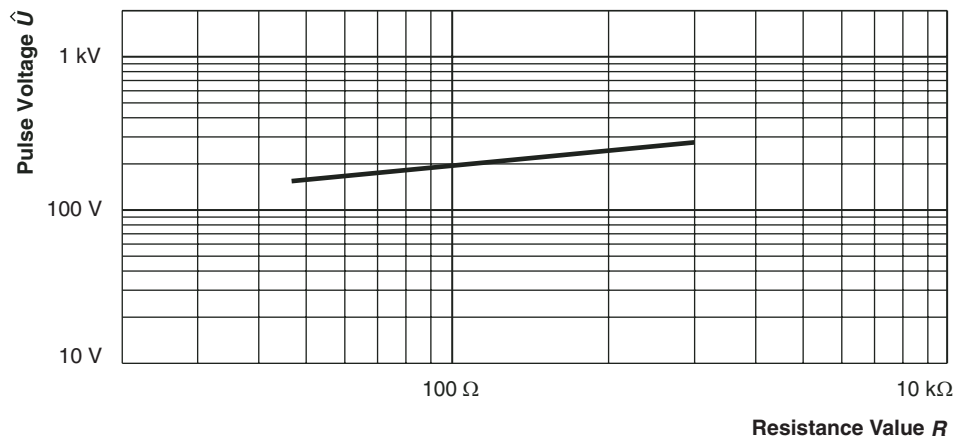
### APPROVALS

Where applicable the resistors are tested in accordance with **EN 140401-803** which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068**<sup>3)</sup> series.

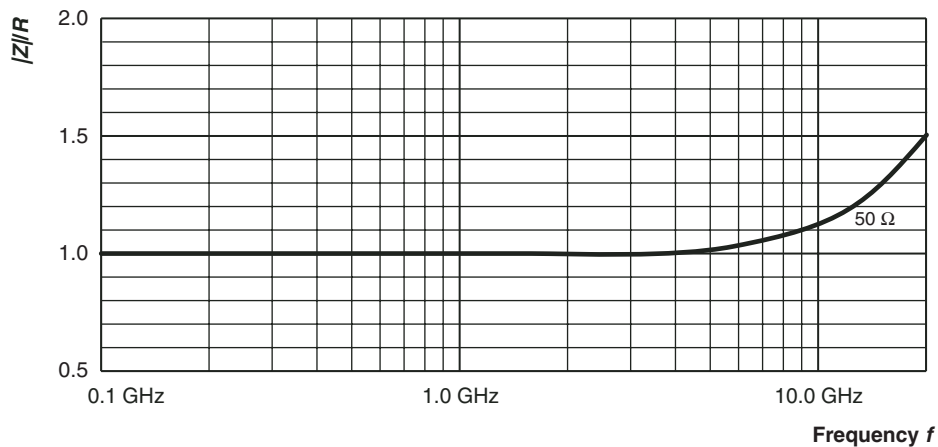
Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

#### Note

3. The quoted IEC standards are also released as EN standards with the same number and identical contents.

**FUNCTIONAL PERFORMANCE**

**Derating - Standard Operation**


1.2/50 Pulse Pulse load rating in accordance with IEC 60115-1, 4.27; 1,2 μs/50 μs; 5 pulses at 12 s intervals; for permissible resistance change 0.5 %


**RF - Behaviour**

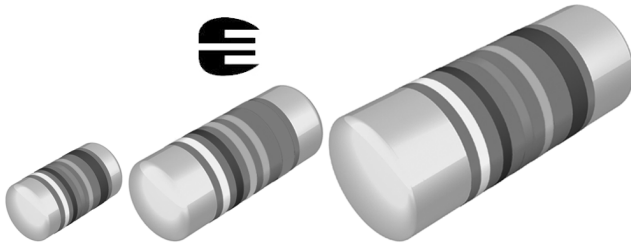


## REVISION HISTORY

Compared to the prior revision of this datasheet, CMA HF 030331, the following changes have been applied:

- Transfer into Vishay format for publication on the internet
- Introduction of a standardized part numbering system
- Emphasis on the clean balance of materials and on the compliance with various EU directives
- Introduction of information on electrostatic discharge (ESD) capability
- No other change of technical contents
- No product change

## MELF Resistors with Established Reliability



MMU 0102 VG03, MMA 0204 VG03 and MMB 0207 VG03 thin film MELF resistors with established reliability are the perfect choice for all high-reliability applications typically found in the fields of military, aircraft and spacecraft electronics. These versions supplement the families of professional and precision MELF resistors MMU 0102, MMA 0204 and MMB 0207.

### FEATURES

- Approved according to EN 140401-803, version E
- Established reliability, failure rate level E6
- Advanced thin film technology
- Excellent overall stability: Class 0.25
- Force fitted steel caps, tin plated on nickel barrier
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Military
- Avionics
- Space

### METRIC SIZE

DIN:	0102	0204	0207
CECC:	RC 2211M	RC 3715M	RC 6123M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MMU 0102	MMA 0204	MMB 0207
CECC size, style	RC 2211M	RC 3715M	RC 6123M
Resistance range	100 $\Omega$ to 2.21 M $\Omega$	1 $\Omega$ to 5.11 M $\Omega$	1 $\Omega$ to 10 M $\Omega$
Resistance tolerance	$\pm 1\%$ ; $\pm 0.1\%$		
Temperature coefficient	$\pm 50$ ppm/K; $\pm 15$ ppm/K		
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56
Rated dissipation, $P_{70}$	0.2 W	0.25 W	0.4 W
Operating voltage, $U_{max}$ AC/DC	150 V	200 V	300 V
Film temperature	125 $^{\circ}$ C	125 $^{\circ}$ C	125 $^{\circ}$ C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ after:	100 $\Omega$ to 221 k $\Omega$	1 $\Omega$ to 332 k $\Omega$	1 $\Omega$ to 1 M $\Omega$
1000 h	$\leq 0.15\%$		
8000 h	$\leq 0.3\%$		
225 000 h	$\leq 1\%$		
Permissible voltage against			
1 minute; $U_{ins}$	200 V	300 V	500 V
continuous	75 V	75 V	75 V
Assessed failure rate level	E6		
Failure rate	$\leq 2 \times 10^{-9}/h$	$\leq 0.7 \times 10^{-9}/h$	$\leq 0.7 \times 10^{-9}/h$

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.
- The failure rate level E6 corresponds to MIL Level P.





### 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC ordering code table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the Last Digit of 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5
10 MΩ	6

### 12NC Example

The 12NC of a MMU 0102 VG03 resistor, value 287K and TC 50 with ± 1 % tolerance, supplied in blister tape of 3000 units per reel is: 2312 165 02874.

12NC ORDERING CODE - resistor type and packaging						
DESCRIPTION			ORDERING CODE 2312 ... ..			
			BLISTER TAPE ON REEL			BULK CASE
TYPE	TCR	TOL.	B1 1000 UNITS	BL 3000 UNITS	B0 10 000 UNITS	M8 8000 UNITS
MMU 0102 VG03	± 50 ppm/K	± 1 %	170 0....	165 0....	175 0....	060 0....
	± 15 ppm/K	± 0.1 %	172 0....	167 0....	177 0....	062 0....
	jumper		172 90001	167 90001	177 90001	062 90001
TYPE	TCR	TOL.	B1 1000 UNITS	BL 3000 UNITS	B0 10 000 UNITS	M3 3000 UNITS
MMA 0204 VG03	± 50 ppm/K	± 1 %	140 0....	155 0....	145 0....	040 0....
	± 15 ppm/K	± 0.1 %	142 0....	157 0....	147 0....	042 0....
	jumper		142 90001	157 90001	147 90001	042 90001
TYPE	TCR	TOL.	B1 1000 UNITS	B2 2000 UNITS	B7 7000 UNITS	
MMB 0207 VG03	± 50 ppm/K	± 1 %	180 0....	195 0....	185 0....	
	± 15 ppm/K	± 0.1 %	182 0....	197 0....	187 0....	
	jumper		182 90001	197 90001	187 90001	



# MMU 0102 VG03, MMA 0204 VG03, MMB 0207 VG03

MELF Resistors with Established Reliability

Vishay Beyschlag

PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>																	
PART NUMBER <sup>2)</sup> : MMA02040WC4999FBL00																	
PART NUMBER <sup>2)</sup> : MMA02040WZ0000ZBL00																	
M	M	A	0	2	0	4	W	C	4	9	9	9	F	B	L	0	0
M	M	A	0	2	0	4	W	Z	0	0	0	0	Z	B	L	0	0
MODEL/SIZE	SPECIAL CHARACTER		TCR		VALUE			TOLERANCE	PACKAGING <sup>3)</sup>		SPECIAL						
MMU0102 MMA0204 MMB0207	W = VG03 CECC E6		E = ± 15 ppm/K C = ± 50 ppm/K Z = Jumper		3 digit value 1 digit multiplier 0000 = Jumper <b>Multiplier</b> 8 = *10 <sup>-2</sup> 2 = *10 <sup>2</sup> 9 = *10 <sup>-1</sup> 3 = *10 <sup>3</sup> 0 = *10 <sup>0</sup> 4 = *10 <sup>4</sup> 1 = *10 <sup>1</sup> 5 = *10 <sup>5</sup>			B = ± 0.1 % F = ± 1 % Z = Jumper	B1 B3 B0 B2 B7 M3 M8		up to 2 digits 00 = standard						
PRODUCT DESCRIPTION: MMA 0204 - 50 1 % VG03 BL 49R9																	
PRODUCT DESCRIPTION: MMA 0204 VG03 BL 0R0																	
MMA	0204	- 50	1 %	VG03	BL	49R9											
MMA	0204	-	-	VG03	BL	0R0											
MODEL	SIZE	TCR	TOLERANCE	ESTABLISHED RELIABILITY	PACKAGING <sup>3)</sup>	RESISTANCE VALUE											
MMU MMA MMB	0102 0204 0207	± 15 ppm/K ± 50 ppm/K	± 0.1 % ± 1 %	VG03 = CECC E6 <sup>4)</sup>	B1 BL B0 B2 B7 M3 M8	49R9 = 49.9 Ω 0R0 = Jumper											

### Notes

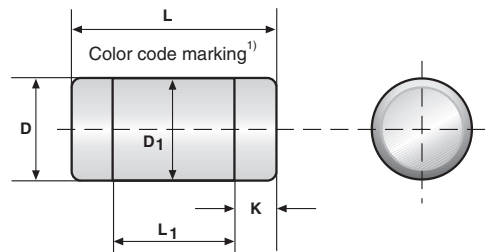
1. Products can be ordered using either the PRODUCT DESCRIPTION, the 12NC or the EN ordering information.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas and in Asia/Pacific only.
3. Please refer to table PACKAGING, see below.
4. Reference to EN140401-803 Version E.

EN 140401-803 ORDERING INFORMATION	
Example of the ordering information for a resistor: MMA 0204-50 1 % VG03 287K CECC40401-803EZRC3715MC287KFE6	
Example of the ordering information for jumpers: MMA 0204 VG03 0R0 CECC40401-803EZRC3715M-0R00-E6	
The elements used in this ordering information have the following meaning:	
CECC40401-803	CECC Detail specification number
EZ	Assessment level
RC3715M	Style (see table Technical Specification)
C	Temperature coefficient (C = ± 50 ppm/K; E = ± 15 ppm/K)
287K	Resistance value according to EN 60062, 4 characters
F	Tolerance on rated resistance (B = ± 0.1 %; F = ± 1 %)
E6	Failure rate level according to EN 60115-1, Table ZB.1



PACKAGING					
MODEL	BLISTER TAPE ON REEL ACC. IEC 60286-3			BULK CASE ACC. IEC 60286-6	
	DIAMETER	PIECES/REEL	CODE	PIECES/BULK CASE	CODE
MMU 0102 VG03	180 mm/7"	1000	B1	8000	M8
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMA 0204 VG03	180 mm/7"	1000	B1	3000	M3
	180 mm/7"	3000	B3 = BL		
	330 mm/13"	10 000	B0		
MMB 0207 VG03	180 mm/7"	1000	B1	-	-
	180 mm/7"	2000	B2		
	330 mm/13"	7000	B7		

## DIMENSIONS



DIMENSIONS - MELF resistor types, mass and relevant physical dimensions						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MMU 0102	2.2 + 0/- 0.1	1.1 + 0/- 0.1	1.2	D + 0/- 0.1	0.4 ± 0.05	7
MMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	19
MMB 0207	5.8 + 0/- 0.2	2.2 + 0/- 0.2	2.8	D + 0/- 0.2	1.25 ± 0.15	79

**Note:** Color code marking is applied according to EN 60062\* in four bands (E24 series) or five bands (E96 or E192 series). Each color band appears as a single solid line, voids are permissible if at least 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is approximately 50 % wider than the other bands. An interrupted blue band between the 1st and 2nd full band indicates the failure rate level E6. An interrupted orange band between the 4th and 5th full band indicates the temperature coefficient of 15 ppm/K.



### DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body (85 % Al<sub>2</sub>O<sub>3</sub>, for MICRO-MELF: 96 % Al<sub>2</sub>O<sub>3</sub>) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallised rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. Four or five color code rings designate the resistance value and tolerance in accordance with **IEC 60062<sup>3)</sup>**.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3<sup>3)</sup>** or bulk case in accordance with **IEC 60286-6<sup>3)</sup>**.

### ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1<sup>3)</sup>**. Excellent solderability is proven, even after extended storage in excess of 10 years. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL<sup>1)</sup>** and the **CEFIC-EECA-EICTA<sup>2)</sup>** list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issues -> environment policy -> chemicals -> chemicals for electronics

### APPROVALS

The resistors are tested in accordance with **EN 140401-803** (superseding **CECC 40401-803**) which refers to **EN 60115-1, EN 140400** and the variety of environmental test procedures of the **IEC 60068<sup>3)</sup>** series. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **IEC QC 001002-3, clause 2**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240 001** based on **IEC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

### SPECIALS

This product family of thin film MELF resistors with established reliability is complemented by **Zero Ohm Jumpers**.

### Note

3. The quoted IEC standards are also released as EN standards with the same number and identical contents.



## FUNCTIONAL PERFORMANCE

Further information on the performance of these products may be found in the following Data Sheets:

“Professional MELF Resistors”

Document No. 28713

“Precision MELF Resistors”

Document No. 28714

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE		
TCR	TOLERANCE	MMU 0102	MMA 0204	MMB 0207
± 50 ppm/K	± 1 %	100 Ω to 2.21 MΩ	1 Ω to 5.11 MΩ	1 Ω to 10 MΩ
± 15 ppm/K	± 0.1 %	100 Ω to 100 kΩ	75 Ω to 100 kΩ	75 Ω to 499 kΩ
Jumper		≤ 10 mΩ; $I_{max} = 2 A$	≤ 10 mΩ; $I_{max} = 3 A$	≤ 10 mΩ; $I_{max} = 5 A$

### Note

1. Resistance values to be selected for ± 1 % tolerance from E96 only and for ± 0.1 % tolerance from E192 only.

REVISION HISTORY
<p><b>Compared to the prior revision of this datasheet, 05-Aug-05, the following changes have been applied:</b></p> <ul style="list-style-type: none"> <li>• Introduction of a standardized part numbering system</li> <li>• No change of technical contents</li> <li>• No product change</li> </ul>



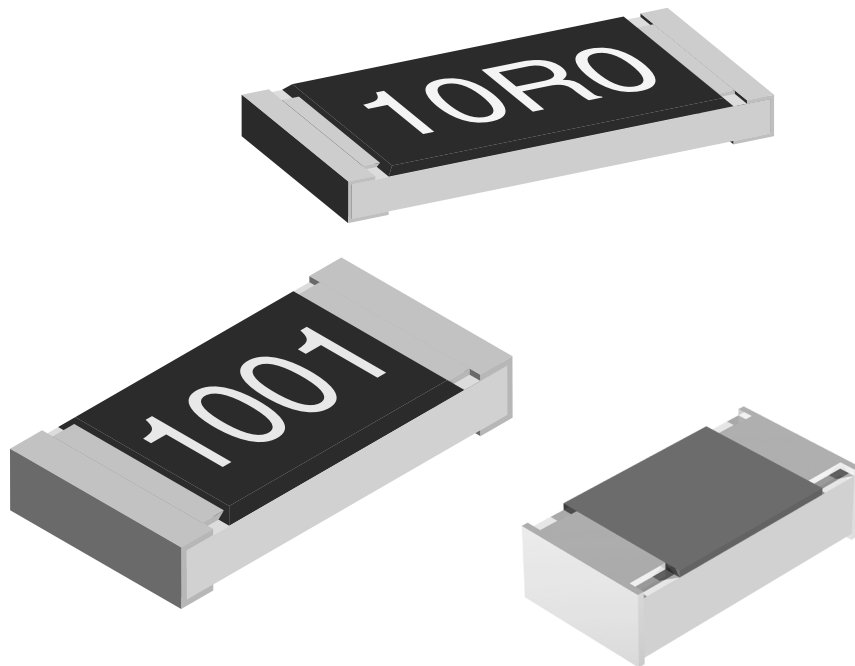
# Thick Film Rectangular

Broad Range of Sizes

Resistance Range 0.1  $\Omega$  to 470 M $\Omega$

Tolerance down to 0.25 %

Anti-Leaching Nickel Barrier Termination



## Model Numbers

Pick of the Chips .....	106
D - CRCW . . . . e3 .....	107
D - CRCW .....	114
RCA . . . . e3 .....	120
RCA .....	124
RCWP .....	128
RCWPM .....	130
D . . /CRCW-P . . . . e3 ..	132
D . . P/CRCW .....	136
D . . /CRCW-LR. . . . e3	140
D . . LR/CRCW .....	144
NCT 0603, NCU 0805 ...	148
D . . /CRCW-HR . . . . e3	156
D . . HR/CRCW .....	159
OCT 0603, OCU 0805 ...	163
D . . / CRCW . . . . -TR . . . . e3	169
D . . TR/CRCW . . TR ....	174
TCT 0603, TCU 0805, TCA 1206 .....	178
CRCC .....	186

## Thick Film Chip Resistors Engineering Design Kit, Surface Mount



Our popular D25/CRCW1206, D12/CRCW0805, D11/CRCW0603, D10/CRCW0402  $\pm 1\% \pm 100$  ppm/ $^{\circ}$ C and  $\pm 5\% \pm 200$  ppm/ $^{\circ}$ C, Thick Film Chip Resistors are now conveniently packaged in a choice of different engineering design kits.



You can choose a kit containing E24 or E48-series specified  $\pm 5\%$  or  $\pm 1\%$  tolerance values (see value tables).

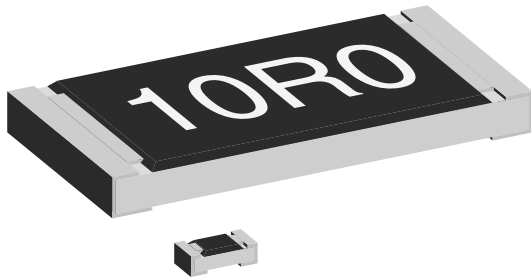
Each kit is packaged with components in bulk.

MINI-LABS, THICK FILM CHIP						
TYPE	PRODUCT	TEMPERATURE COEFFICIENT	VALUE RANGE	TOLERANCE %	SERIES	QUANTITY PIECES
LAE1F	D10/CRCW0402	200	10R - 1M0 + Jumper	5	24	122 x 50
LAE1G	D10/CRCW0402	100	10R - 1M0 + Jumper	1	48	242 x 50
LAE1B	D11/CRCW0603	200	10R - 1M0 + Jumper	5	24	122 x 50
LAE1E	D11/CRCW0603	100	10R - 1M0 + Jumper	1	48	242 x 50
LAE1A	D12/CRCW0805	200	10R - 1M0 + Jumper	5	24	122 x 50
LAE1D	D12/CRCW0805	100	10R - 1M0 + Jumper	1	48	242 x 50
LAE1K	D25/CRCW1206	200	10R - 1M0 + Jumper	5	24	122 x 50
LAE1C	D25/CRCW1206	100	10R - 1M0 + Jumper	1	48	242 x 50

MINI-LABS, METAL FILM MELF						
TYPE	PRODUCT	TEMPERATURE COEFFICIENT	VALUE RANGE	TOLERANCE %	SERIES	QUANTITY PIECES
LAB2	SMM0204/MS1	50	10R - 1M0	1	E24	122 x 50

MINI-LABS, THIN FILM CHIP						
TYPE	PRODUCT	TEMPERATURE COEFFICIENT	VALUE RANGE	TOLERANCE %	SERIES	QUANTITY PIECES
LAB3	M11	25	100R - 33K2	0.5	E48	122 x 50

## Lead (Pb)-free Thick Film, Rectangular Chip Resistors



### FEATURES

- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with “Restriction of the use of Hazardous Substances” (RoHS) directive 2002/95/EC (issue 2004)
- Excellent stability ( $\Delta R/R \leq 1\%$  for 1000 h at 70 °C)
- High volume product suitable for commercial and special applications



STANDARD ELECTRICAL SPECIFICATIONS								
MODEL	SIZE		POWER RATING $P_{70^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX V $\cong$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC						
CRCW0201	0201	0525	0.05	30	$\pm 200$	$\pm 1$ $\pm 5$	10R - 1M $\Omega$	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 50 \text{ m}\Omega$ , $I_{\text{max}} = 0.5 \text{ A}$					
D10/CRCW0402	0402	1005	0.063	50	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 1.0 \text{ A}$					
D11/CRCW0603	0603	1608	0.10	75	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 1.5 \text{ A}$					
D12/CRCW0805	0805	2012	0.125	150	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 2.0 \text{ A}$					
D25/CRCW1206	1206	3216	0.25	200	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 2.5 \text{ A}$					
CRCW1210	1210	3225	0.33	200	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 2.5 \text{ A}$					
CRCW1218	1218	3246	1.0	200	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 4.0 \text{ A}$					
CRCW2010	2010	5025	0.50	400	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 3.0 \text{ A}$					
CRCW2512	2512	6332	1.0	500	$\pm 100$ $\pm 200$	$\pm 1$ $\pm 5$	1R0 - 10M	24 + 96 24
			Zero-Ohm-Resistor: $R_{\text{max}} = 20 \text{ m}\Omega$ , $I_{\text{max}} = 4.0 \text{ A}$					

### Notes

- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime
- Marking and packaging: see appropriate catalog or web pages
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material



TECHNICAL SPECIFICATIONS										
PARAMETER	UNIT	CRCW0201	D10/ CRCW0402	D11/ CRCW0603	D12/ CRCW0805	D25/ CRCW1206	CRCW1210	CRCW1218	CRCW2010	CRCW2512
Rated Dissipation at 70 °C <sup>3)</sup>	W	0.05	0.063	0.10	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	V <sub>≅</sub>	30	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	V <sub>peak</sub>	50	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance <sup>1)</sup>	K/W		≤ 870	≤ 550	≤ 440	≤ 220	≤ 140	≤ 65	≤ 88	≤ 65
Insulation Resistance	Ω	> 10 <sup>9</sup>								
Category Temperature Range	°C	- 55/+ 125 (+ 155)								
Failure Rate	h <sup>-1</sup>	1.10 <sup>-9</sup>	0.3 • 10 <sup>-9</sup>							
Weight/1000 pcs	g	0.17	0.65	2	5.5	10	16	29.5	25.5	40.5

Notes

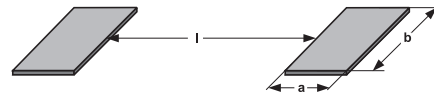
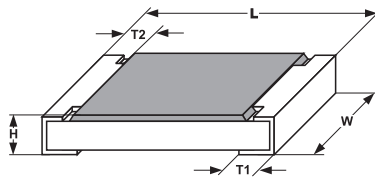
- For sizes 0402 until 1206 the measuring conditions are in acc. to EN 140401-802. For all other sizes the result depends on the solder pad dimensions.
- Rated voltage:  $\sqrt{P \times R}$
- The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heatflow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature of 155 °C is not exceeded.

PART NUMBER AND PRODUCT DESCRIPTION																	
PART NUMBER: CRCW0603562RFKEC																	
C	R	C	W	0	6	0	3	5	6	2	R	F	K	E	C		
MODEL		VALUE		TOLERANCE		TCR		PACKAGING <sup>2)</sup>		SPECIAL							
CRCW0201 CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW1218 CRCW2010 CRCW2512		R = Decimal K = Thousand M = Million 0000 = Jumper		F = ± 1.0 % J = ± 5.0 % Z = Jumper		K = ± 100 ppm/K N = ± 200 ppm/K O = Jumper S = Special		EA, EB, EC, ED, EE, EF, EG, EH, EI, EK, EL, EY		up to 2 digits							
PRODUCT DESCRIPTION: D11/CRCW0603 100 562R 1 % ET6 e3																	
D11/CRCW0603		100		562R		1 %		ET6		e3							
MODEL		TCR		RESISTANCE VALUE		TOLERANCE		PACKAGING <sup>2)</sup>		LEAD (Pb)-FREE							
CRCW0201 D10/CRCW0402 D11/CRCW0603 D12/CRCW0805 D25/CRCW1206 CRCW1210 CRCW1218 CRCW2010 CRCW2512		± 200 ppm/K ± 100 ppm/K		10R = 10 Ω 562R = 562 Ω 10K = 10.0 kΩ 1M = 1 MΩ 0R0 = Jumper		± 5 % ± 1 %		ET1, ET5 ET6, ET7 EF4, E02 E67, E82 EG1, ET9 E20, E27		e3 = Pure Tin Termination Finish							

Notes

- Preferred way for ordering products is by use of the PART NUMBER
- Please refer to table PACKAGING, see next page

PACKAGING											
MODEL	REEL								BULK		
	TAPE WIDTH	DIAMETER	PITCH	PIECES/ REEL	PACKING CODE				PIECES	PACKAGE CODE	
					PART NUMBER		PRODUCT DESC.			PART NUMBER	PRODUCT DESC.
					PAPER	BLISTER	PAPER	BLISTER			
CRCW0201	8 mm	180 mm/7"	2 mm	10 000	ED		ET7				
330 mm/13"		2 mm	50 000	EE		EF4					
D10/CRCW0402	8 mm	180 mm/7"	2 mm	10 000	ED		ET7		50 000	EY	E27
330 mm/13"		2 mm	50 000	EE		EF4					
D11/CRCW0603	8 mm	180 mm/7"	4 mm	5000	EA	EI	ET1	EG1	25 000	EY	E27
		285 mm/11.25"	4 mm	10 000	EB		ET5				
D12/CRCW0805	8 mm	180 mm/7"	4 mm	5000	EA	EI	ET1	EG1	10 000	EY	E27
		285 mm/11.25"	4 mm	10 000	EB		ET5				
D25/CRCW1206	8 mm	180 mm/7"	4 mm	5000	EA	EI	ET1	EG1			
		285 mm/11.25"	4 mm	10 000	EB		ET5				
CRCW1210	12 mm	180 mm/7"	4 mm	5000	EA		ET1				
		285 mm/11.25"	4 mm	10 000	EB		ET5				
CRCW1218	12 mm	180 mm/7"	4 mm	4000				ET9			
		330 mm/13"	4 mm	20 000	EC		ET6				
CRCW2010	12 mm	180 mm/7"	4 mm	4000		EK		E02			
CRCW2512	12 mm	180 mm/7"	8 mm	2000				E67			
		330 mm/13"	4 mm	4000		EH		E82			

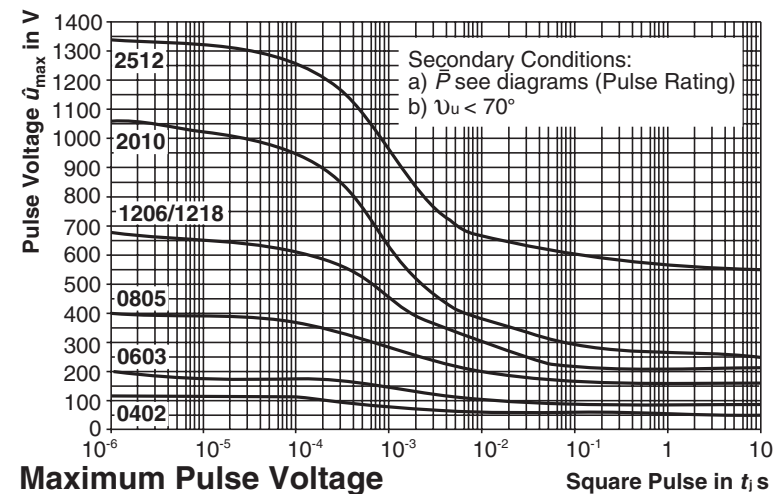
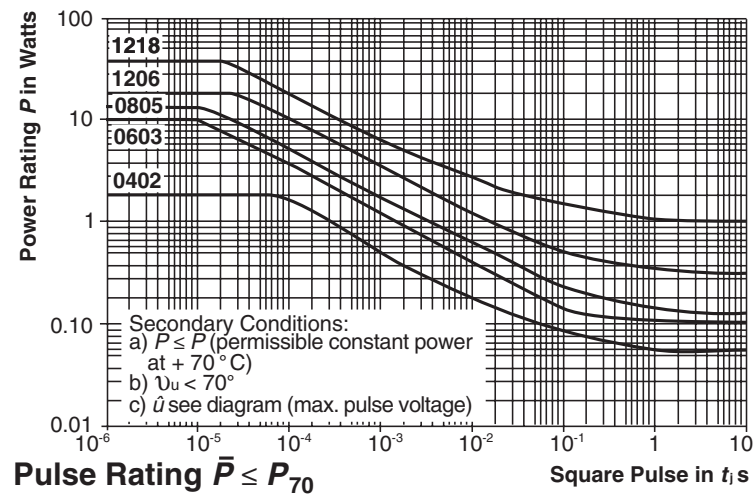
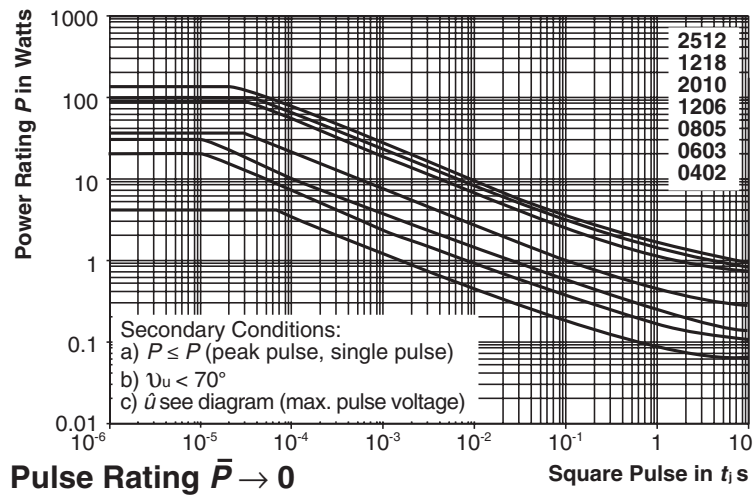
**DIMENSIONS**


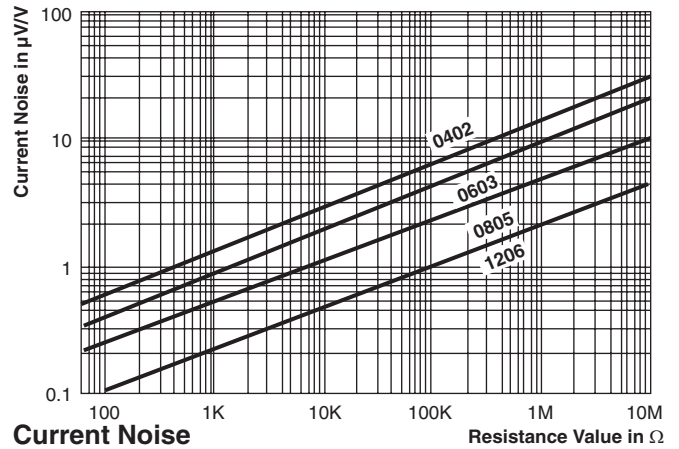
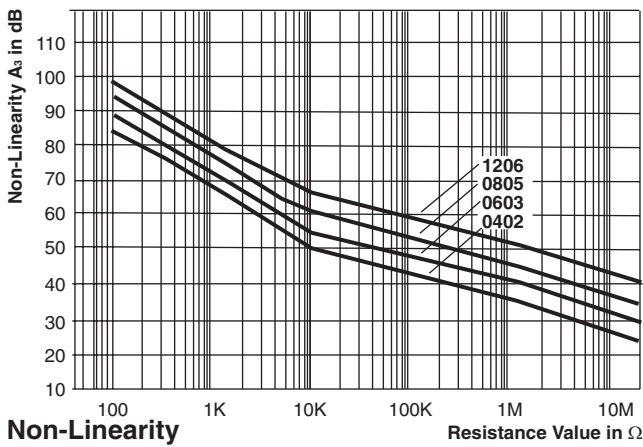
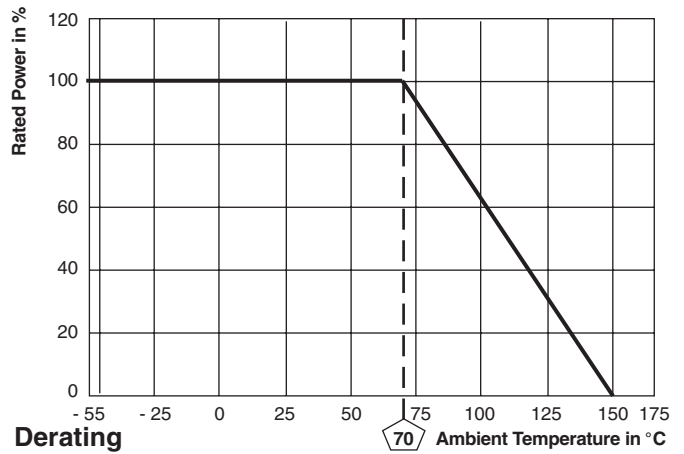
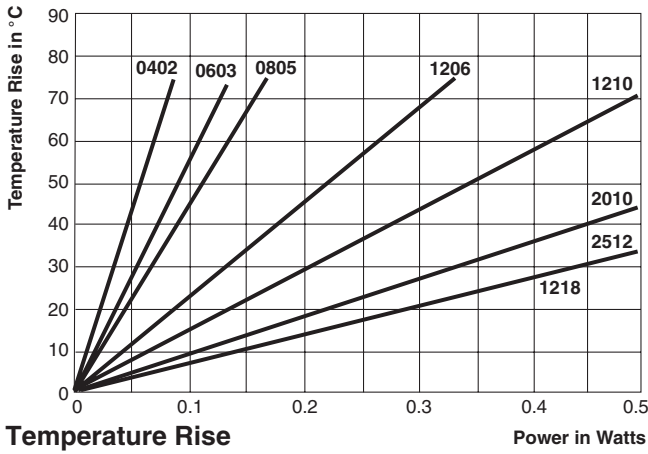
SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0201	0525	0.6 ± 0.05	0.3 ± 0.05	0.23 ± 0.05	0.15 ± 0.05	0.15 +0.05 -0.10
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 +0.10 -0.05	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 +0.20 -0.10	1.25 ± 0.15	0.45 ± 0.05	0.3 +0.20 -0.10	0.3 ± 0.2
1206	3216	3.2 +0.10 -0.20	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 +0.10 -0.20	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

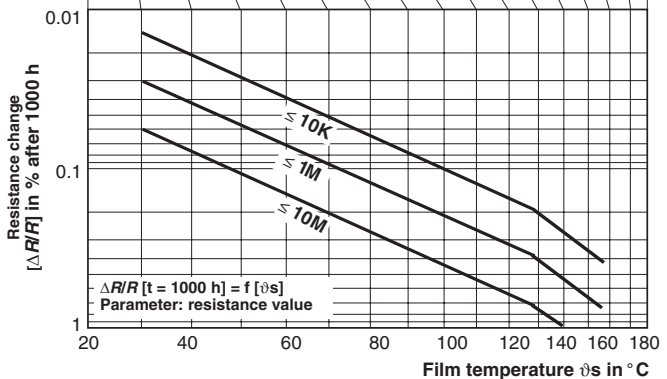
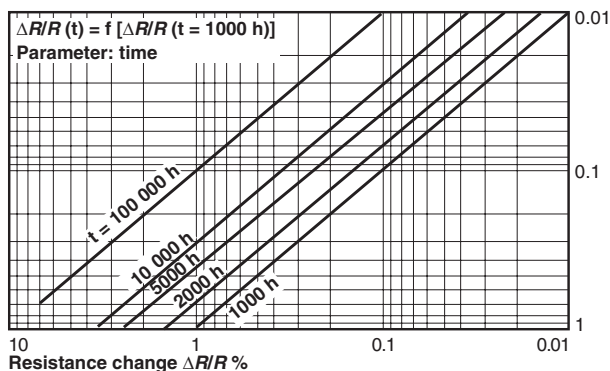
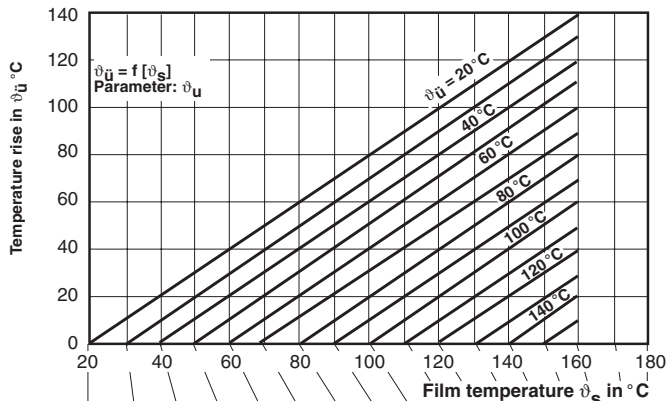
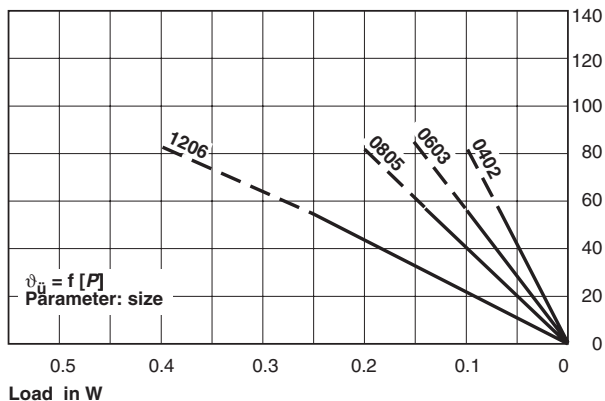
SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0201	0525	0.28	0.43	0.23			
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2



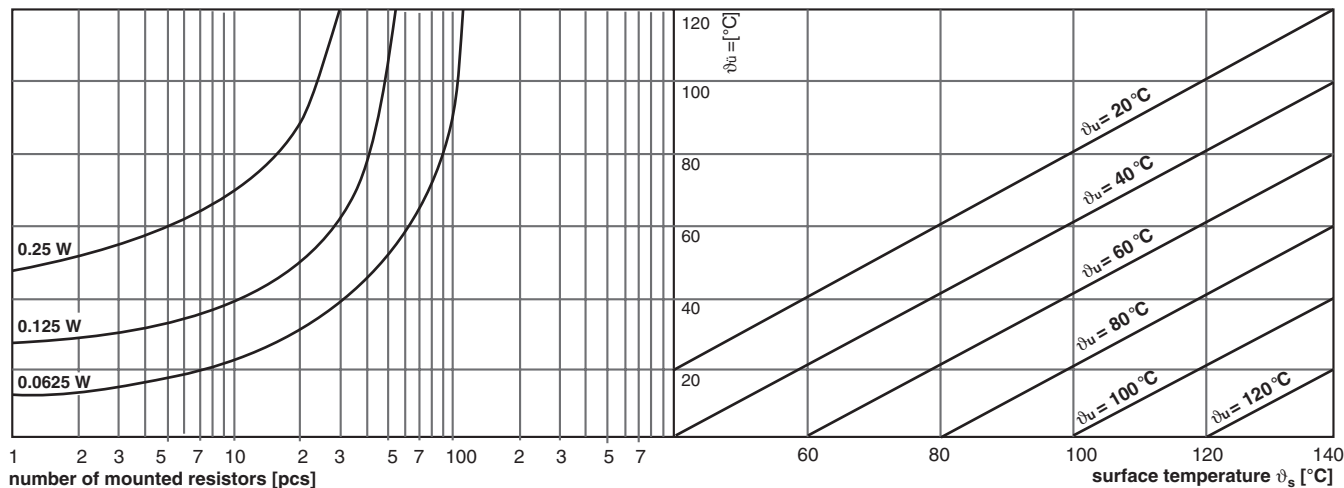
**FUNCTIONAL PERFORMANCE**







Stability nomogram typical values  
(for handling see general explanations)



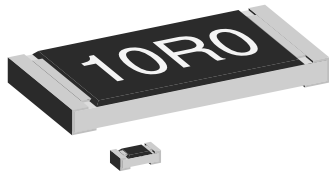
Power rating as a function of packaging density (guideline)



<b>TEST PROCEDURES AND REQUIREMENTS</b>				
EN 60115-1				SIZE 0201 ONLY
TEST (clause)	CONDITIONS OF TEST	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )		REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
		STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER	
	stability for product types:			
	<b>D../CRCW....e3</b>	1 $\Omega$ to 10 M $\Omega$	1 $\Omega$ to 10 M $\Omega$	10 $\Omega$ to 1 M $\Omega$
Resistance (4.5)	-	$\pm 1\%$	$\pm 1\%$	$\pm 1\%$ ; $\pm 5\%$
Temperature coefficient (4.8.4.2)	20/- 55/20 °C and 20/125/20 °C	$\pm 100$ ppm/K	$\pm 200$ ppm/K	$\pm 200$ ppm/K
Overload (4.13)	$U = 2.5 \times (P_{70} \times R)^{1/2}$ $\leq 2 \times U_{max}$ ; Duration: according the style	$\pm (0.25\% R + 0.05 \Omega)$	$\pm (0.5\% R + 0.05 \Omega)$	$\pm (1\% R + 0.05 \Omega)$
Solderability (4.17.5)	Aging 4 h at 155 °C, dryheat Solder bath method; 235 °C; 2 s Visual examination	Good tinning ( $\geq 95\%$ covered) no visible damage		
Resistance to soldering heat (4.18.2)	Solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.25\% R + 0.05 \Omega)$	$\pm (0.5\% R + 0.05 \Omega)$	$\pm (1\% R + 0.05 \Omega)$
Rapid change of temperature (4.19)	30 min. at LCT = - 55 °C; 30 min. at UCT = 125 °C; 5 cycles	$\pm (0.25\% R + 0.05 \Omega)$	$\pm (0.5\% R + 0.05 \Omega)$	$\pm (0.5\% R + 0.05 \Omega)$
Damp heat, steady state (4.24)	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (1\% R + 0.05 \Omega)$	$\pm (2\% R + 0.1 \Omega)$	$\pm (2\% R + 0.1 \Omega)$
Climatic sequence (4.23)	16 h at UCT = 125 °C; 1 cycle at 55 °C; 2 h at LCT = - 55 °C; 1 h/1 kPa at 15 °C to 35 °C; 5 cycles at 55 °C $U = (P_{70} \times R)^{1/2}$ $U = U_{max}$ ; whichever is less severe	$\pm (1\% R + 0.05 \Omega)$	$\pm (2\% R + 0.1 \Omega)$	$\pm (2\% R + 0.1 \Omega)$
Endurance at 70 °C (4.25.1)	$U = (P_{70} \times R)^{1/2}$ $U = U_{max}$ ; whichever is less severe 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\pm (1\% R + 0.05 \Omega)$	$\pm (2\% R + 0.1 \Omega)$	$\pm (3\% R + 0.1 \Omega)$
Extended endurance (4.25.1.8)	Duration extended to 8000 hours	$\pm (2\% R + 0.1 \Omega)$	$\pm (4\% R + 0.1 \Omega)$	$\pm (4\% R + 0.1 \Omega)$
Endurance at upper category temperature (4.25.3)	UCT = 125 °C; 1000 h	$\pm (1\% R + 0.05 \Omega)$	$\pm (2\% R + 0.1 \Omega)$	$\pm (2\% R + 0.1 \Omega)$

<b>APPLICABLE SPECIFICATIONS</b>	
• EN 60115-1	Generic Specification
• EN 140400	Sectional Specification
• EN 140401-802	Detail Specification
• IEC 60068-2-X	Variety of environmental test procedures
• IEC 60286-3	Packaging of SMD components

## Thick Film, Rectangular Chip Resistors



### FEATURES

- Metal glaze on high quality ceramic
- Protective overglaze
- Lead bearing (90 % Sn/10 % Pb) solder contacts
- Excellent stability ( $\Delta R/R \leq \pm 0.5\%$  for 1000 h at 70 °C) in different environmental conditions
- High volume product suitable for commercial and special applications

STANDARD ELECTRICAL SPECIFICATIONS								
MODEL	SIZE		POWER RATING $P_{70\text{ °C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D10 — — — CRCW0402	0402	1005	0.063	50	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 1\text{ A}$								
D11 — — — CRCW0603	0603	1608	0.10	75	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 1.5\text{ A}$								
D12 — — — CRCW0805	0805	2012	0.125	150	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 2\text{ A}$								
D25 — — — CRCW1206	1206	3216	0.25	200	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 2.5\text{ A}$								
CRCW1210	1210	3225	0.33	200	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 1M0 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 2.5\text{ A}$								
CRCW1218	1218	3246	1.0	200	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 2M2 1R0 - 2M2	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 4\text{ A}$								
CRCW2010	2010	5025	0.5	400	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 3\text{ A}$								
CRCW2512	2512	6332	1.0	500	$\pm 200^{1)}$ $\pm 100$ $\pm 200$	$\pm 1$ $\pm 1$ $\pm 5$	1R0 - 9R76 10R - 10M 1R0 - 10M	24 + 96 24 + 96 24
Zero-Ohm-Resistor: $R_{\max} = 20\text{ m}\Omega$ , $I_{\max} = 4\text{ A}$								

### Notes

1. 100 ppm/K on request
  - Ask about further value ranges
  - For low values see Thick Film rectangular low value resistors
  - For high values see Thick Film rectangular high values
  - Marking and packaging: see appropriate catalog or web pages
- For precision Thick Film CRCW see Thick Film rectangular Precision Resistors
  - Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
  - AgPd or Pd terminations for conductive adhesive attachment on request

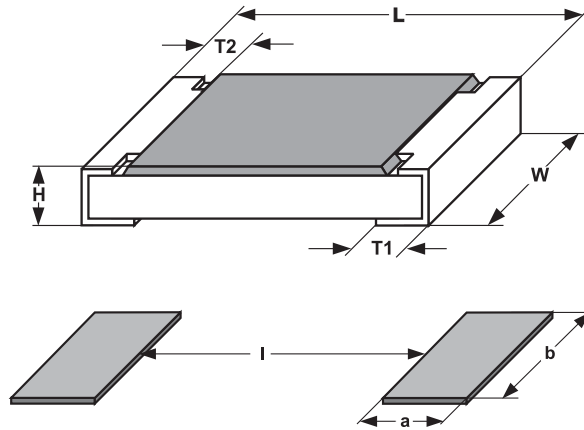
TECHNICAL SPECIFICATIONS									
PARAMETER	UNIT	D10 CRCW0402	D11 CRCW0603	D12 CRCW0805	D25 CRCW1206	CRCW1210	CRCW1218	CRCW2010	CRCW2512
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.10	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	$V_{\text{peak}}$	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	$\leq 870^{1)}$	$\leq 550^{1)}$	$\leq 440^{1)}$	$\leq 220^{1)}$	$\leq 140^{3)}$	$\leq 65^{3)}$	$\leq 88^{3)}$	$\leq 65^{3)}$
Insulation Resistance	$\Omega$								
Category Temperature	°C								
Failure Rate	$h^{-1}$	$0.3 \times 10^{-9}$							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

### Notes

1. Measuring conditions in acc. to CECC 4040
2. Rated voltage:  $\sqrt{P \times R}$
3. Depending on solder pad dimensions



**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
INCH	METRIC	REFLOW SOLDERING			WAVE SOLDERING		
		a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

PART NUMBER: D1208050B5620F P0



<b>MODEL/SIZE</b> D100402 D110603 D120805 D251206	<b>SPECIAL CHARACTER</b> 0 = neutral	<b>TCR</b> B = ± 100 ppm/K A = ± 200 ppm/K 0 = Jumper	<b>VALUE</b> 3 digit value 1 digit multiplier <b>MULTIPLIER</b> 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup> 0000 = Jumper	<b>TOLERANCE</b> F = ± 1 % J = ± 5 %	<b>PACKAGING<sup>2)</sup></b> P0 M0 P5 PZ PN B5 MZ BN MU	<b>SPECIAL</b> up to 2 digits
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PRODUCT DESCRIPTION: D12 100 562R 1% P5

<b>D12</b> MODEL D10 D11 D12 D25	<b>100</b> TCR ± 100 ppm/K ± 200 ppm/K	<b>562R</b> RESISTANCE VALUE 49K9 = 49.9 kΩ 5R1 = 5.1 Ω 0R0 = Jumper	<b>1 %</b> TOLERANCE ± 1 % ± 5 %	<b>P5</b> PACKAGING <sup>2)</sup> P0 M0 P5 PZ PN B5 MZ BN MU
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PART NUMBER: CRCW0805562RFKTA



<b>MODEL/SIZE</b> CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW2512 CRCW2010 CRCW2512	<b>VALUE</b> R = Decimal K = Thousand M = Million 0000 = Jumper	<b>TOLERANCE</b> F = ± 1 % J = ± 5 % Z = Zero Ohm Jumper	<b>TCR</b> K = ± 100 ppm/K N = ± 200 ppm/K S = Jumper or Special	<b>PACKAGING<sup>2)</sup></b> TA = RT1 TB = RT5 TC = RT6 TD = RT7 TF = R02 TG = R67 TH = R82 TK = RT9 BA = B27	<b>SPECIAL</b> up to 2 digits TR = Customer Trimmable
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PRODUCT DESCRIPTION: CRCW 0805 5620 F 100 RT1

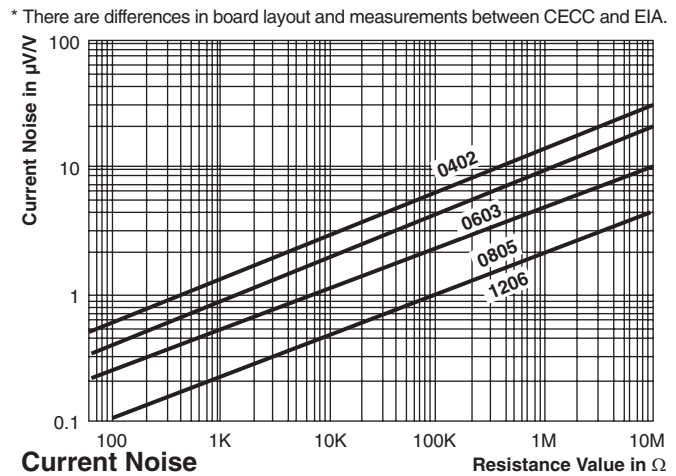
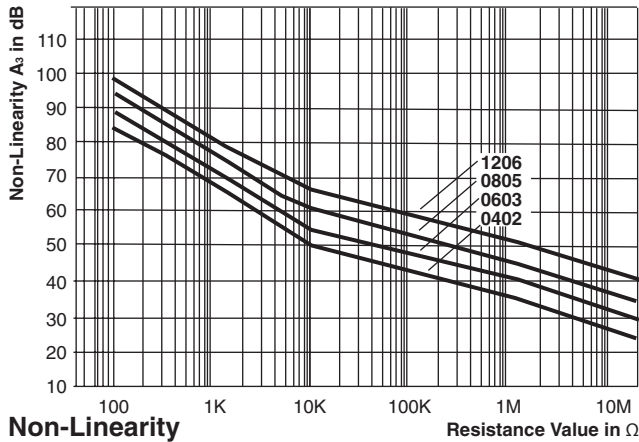
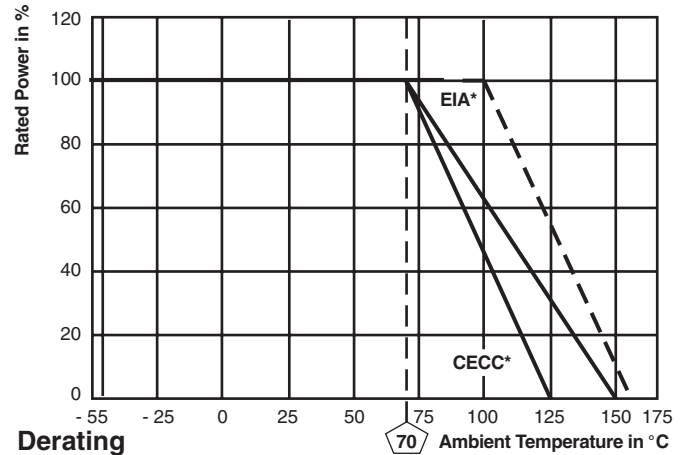
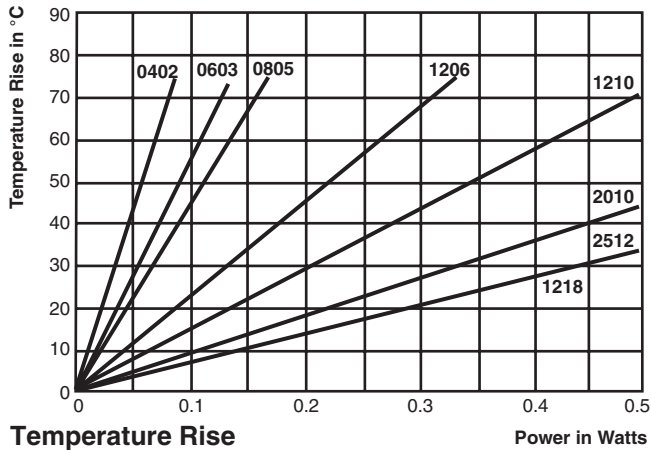
<b>CRCW</b> MODEL CRCW	<b>0805</b> SIZE 0402 1201 0603 1218 0805 2010 1206 2512	<b>5620</b> RESISTANCE VALUE 685 = 6.8 MΩ 224 = 220 kΩ	<b>F</b> TOLERANCE F = ± 1 % J = ± 5 % Z = Zero Ohm Jumper	<b>100</b> TCR ± 100 ppm/K ± 200 ppm/K	<b>RT1</b> PACKAGING <sup>2)</sup> RT1 R67 RT5 R82 RT6 RT9 RT7 B27 R02
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± 1 % = 3 sig.digits, plus multiplier  
± 5 % = 2 sig.digits, plus multiplier

**Notes**

1. Preferred way for ordering products is by use of the PART NUMBER.
2. Please refer to table PACKAGING, page 116.





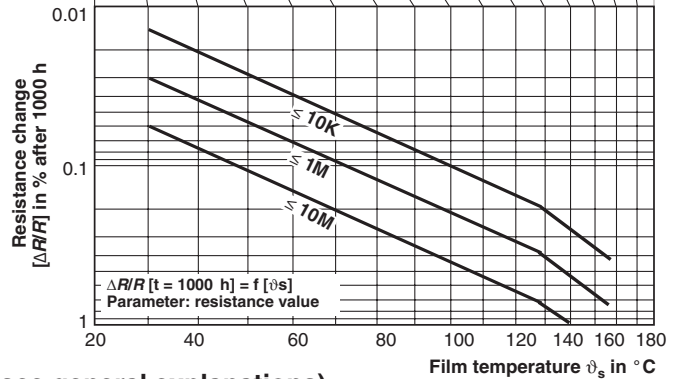
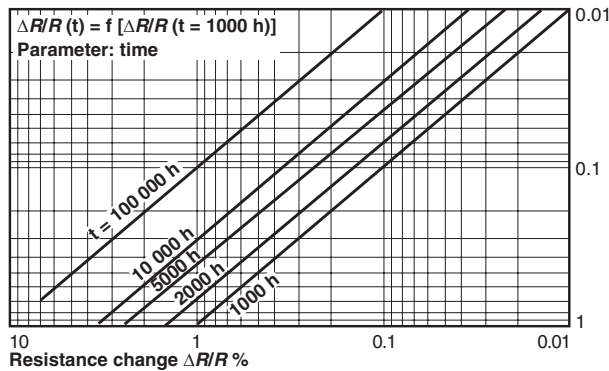
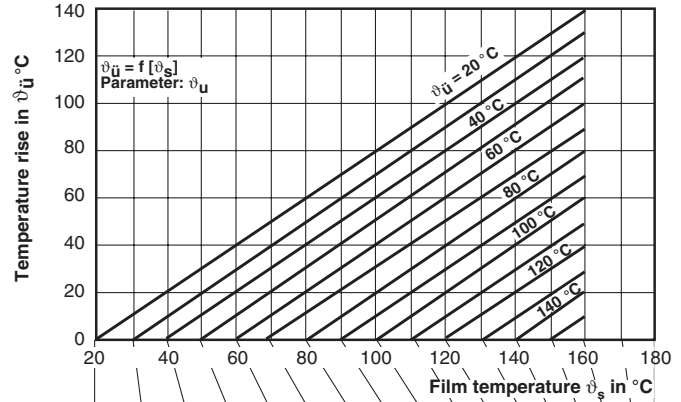
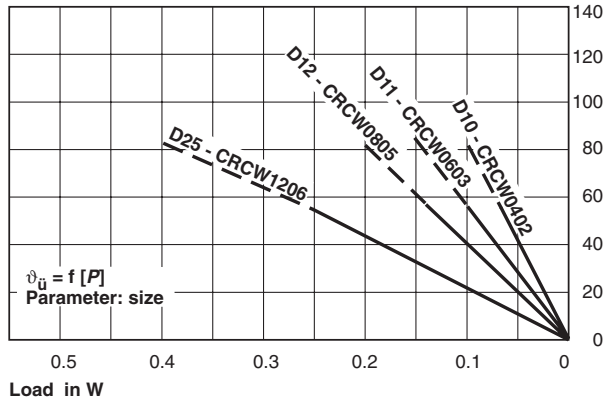
\* There are differences in board layout and measurements between CECC and EIA.

PACKAGING								
MODEL	REEL				BULK			
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PACKAGING CODE		BULK FEEDING MAGAZINE	
					PAPER <sup>1)</sup>	BLISTER <sup>2)</sup>	PIECES <sup>1)</sup>	CODE <sup>2)</sup>
D10 CRCW0402	8 mm	180 mm/7"	10 000	2 mm	P0/TD		50 000	MZ/BA
		330 mm/13"	50 000	2 mm	PZ/TE			
D11 CRCW0603	8 mm	180 mm/7"	5000	4 mm	P5/TA	B5/na	25 000	MU/BA
		255 mm/10"	10 000	4 mm	P0/TB	BN/na		
D12 CRCW0805	8 mm	180 mm/7"	5000	4 mm	P5/TA	B5/na	10 000	MO/BA
		255 mm/10"	10 000	4 mm	P0/TB	BN/na		
D25 CRCW1206	8 mm	180 mm/7"	5000	4 mm	P5/TA	B5/na		
		255 mm/10"	10 000	4 mm	P0/TB	BN/na		
CRCW1210	8 mm	180 mm/7"	5000	4 mm	P5/TA	B5/RG1		
		330 mm/13"	20 000	4 mm	PN/TC	BN/na		
CRCW1218	12 mm	180 mm/7"	4000	4 mm		TK		
CRCW2010	12 mm	180 mm/7"	4000	4 mm		TF		
CRCW2512	12 mm	180 mm/7"	2000	8 mm		B2/TG		
				4 mm		TH		

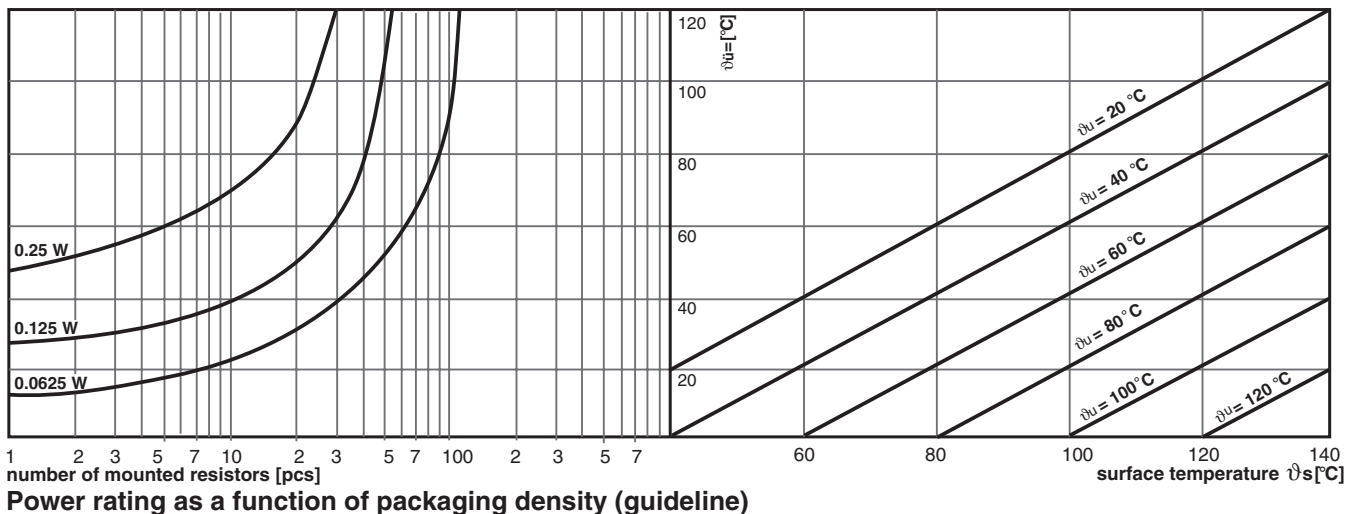
**Notes**

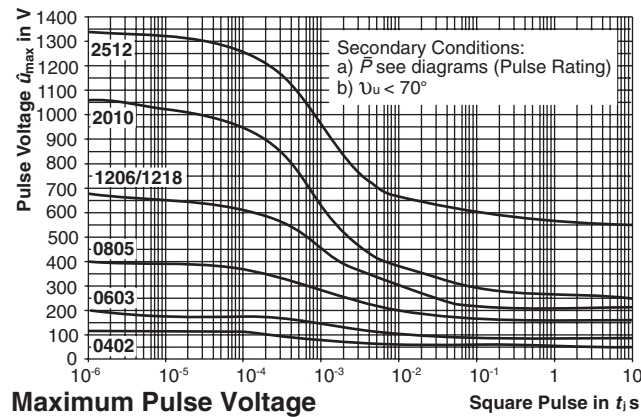
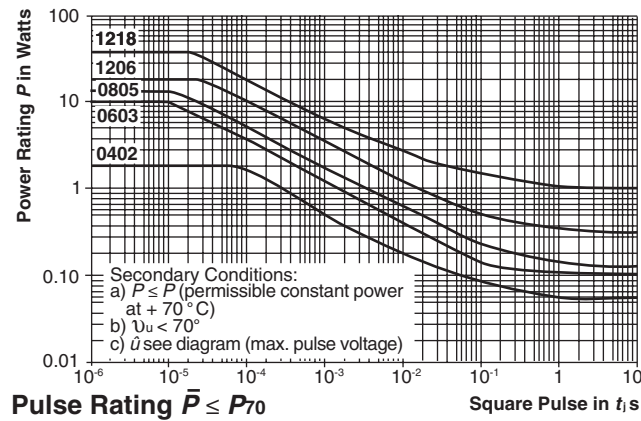
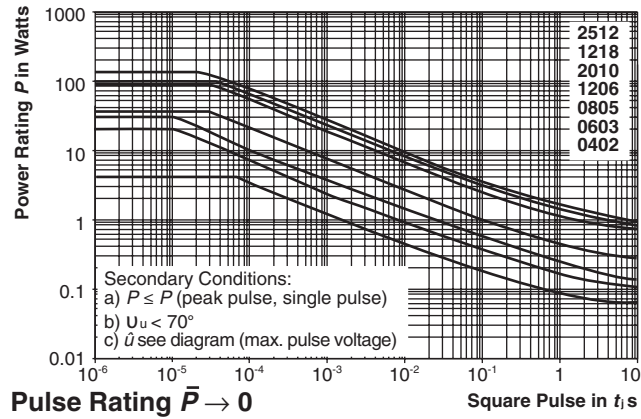
1. On request
2. European/N.American packaging codes: na = NOT AVAILABLE

- Further information about packaging: see appropriate catalog or web page.



Stability nomogram typical values (for handling see general explanations)







<b>PERFORMANCE</b>				
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>REQUIREMENTS IN %<sup>1)</sup></b>		
		<b>0402 0603</b>	<b>0805 1206 1210</b>	<b>1218 2010 2512</b>
Endurance Test at 70 °C IEC 60115-1 4.25.1; EIA-575	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13; EIA-575	Short time overload, 2.5 x rated voltage or 2 x limiting element voltage.	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14; EIA-575	Rapid change between upper and lower category temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20; EIA-575	10 seconds at 260 °C solder bath temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5

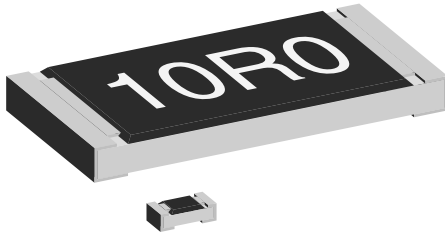
**Note**

1. Limits for change of resistance at test acc. to CECC

**APPLICABLE SPECIFICATIONS**

- CECC40000/40400/40401-004,-006,-007,-802
- EN140400/IEC 60115-1
- EIA-575

## Automotive Grade Lead (Pb)-free Thick Film, Rectangular Chip Resistors



### FEATURES

- Metal glaze on high quality ceramic with protective overglaze
- Sulfur resistant
- Superior resistance against H<sub>2</sub>S-atmosphere than standard Ag contacts
- Excellent stability ( $\Delta R/R \leq \pm 0.5\%$  for 1000 h at 70 °C) different environmental conditions
- High volume product suitable for commercial and special applications
- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Automotive Grade = sulfur resistant



STANDARD ELECTRICAL SPECIFICATIONS								
MODEL	SIZE		POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX V <sub>≡</sub>	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE Ω	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
RCA0402	0402	1005	0.063	50	± 50 ± 100 ± 100 ± 200 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 1 ± 5	100R - 1M0 10R - 1M0 10R - 5M6 1R0 - 9R76 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 40\text{ m}\Omega$ $I_{\text{max}} = 1\text{ A}$								
RCA0603	0603	1608	0.10	75	± 50 ± 100 ± 200 ± 200	± 0.5, ± 1 ± 0.5, ± 1 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 9R76 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 40\text{ m}\Omega$ $I_{\text{max}} = 1.5\text{ A}$								
RCA0805	0805	2012	0.125	150	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 40\text{ m}\Omega$ $I_{\text{max}} = 2\text{ A}$								
RCA1206	1206	3216	0.25	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 20\text{ m}\Omega$ $I_{\text{max}} = 2.5\text{ A}$								
RCA1210	1210	3225	0.33	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 1M0 100R - 1M0 1R0 - 1M0 1R0 - 1M0	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 20\text{ m}\Omega$ $I_{\text{max}} = 2.5\text{ A}$								
RCA1218	1218	3246	1.0	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 2M2 100R - 2M2 1R0 - 2M2 1R0 - 2M2	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 20\text{ m}\Omega$ $I_{\text{max}} = 4\text{ A}$								
RCA2010	2010	5025	0.50	400	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 20\text{ m}\Omega$ $I_{\text{max}} = 3\text{ A}$								
RCA2512	2512	6332	1.0	500	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96
								24 + 96
Zero-Ohm-Resistor: $R_{\text{max}} = 20\text{ m}\Omega$ $I_{\text{max}} = 4\text{ A}$								

**Notes**

- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web pages
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material



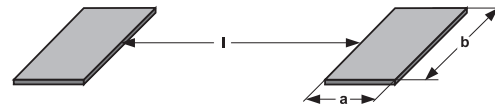
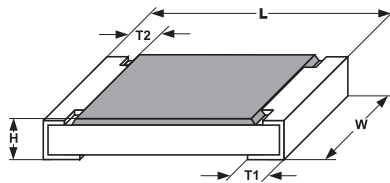
Automotive Grade  
Lead (Pb)-free Thick Film, Rectangular Chip Resistors

TECHNICAL SPECIFICATIONS									
PARAMETER	UNIT	RCA0402	RCA0603	RCA0805	RCA1206	RCA1210	RCA1218	RCA2010	RCA2512
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.10	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	V <sub>≡</sub>	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	V <sub>peak</sub>	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	≤ 870 <sup>1)</sup>	≤ 550 <sup>1)</sup>	≤ 440 <sup>1)</sup>	≤ 220 <sup>1)</sup>	≤ 140 <sup>3)</sup>	<sup>3)</sup>	≤ 88 <sup>3)</sup>	≤ 65 <sup>3)</sup>
Insulation Resistance	Ω	> 10 <sup>9</sup>							
Category Temperature Range	°C	- 55 to + 125 (+ 155)							
Failure Rate	h <sup>-1</sup>	0.3 × 10 <sup>-9</sup>							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

Notes

1. Measuring conditions in acc. to CECC 40401      2. Rated voltage:  $\sqrt{P \times R}$       3. Depending on solder pad dimensions

DIMENSIONS



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION RCA.... e3 - SERIES**

**PART NUMBERING: RCA080510K0FKEA**

R	C	A	0	8	0	5	1	0	K	0	F	K	E	A		
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	--	--

MODEL	SIZE	VALUE	TOLERANCE	TCR	PACKAGING	SPECIAL
RCA	0402 1210 0603 1218 0805 2010 1206 2512	R = decimal K = thousand M = million 1K32 = 1.32 kΩ 10R0 = 10 Ω 0000 = Jumper	D = ± 0.5 % F = ± 1.0 % J = ± 5.0 %	H = ± 50 ppm/K K = ± 100 ppm/K N = ± 200 ppm/K	EA = ET1 EG = E67 EB = ET5 EH = E82 EC = ET6 EK = ET9 ED = ET7 EY = E27 EE = EF4	up to 2 digits 00 = standard

**PRODUCT DESCRIPTION: RCA0805 10K 1% 100 ET1 e3**

<b>RCA0805</b>	<b>10K</b>	<b>1 %</b>	<b>100</b>	<b>ET1</b>	<b>e3</b>
MODEL	RESISTANCE VALUE	TOLERANCE	TCR	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE
RCA0402 RCA1210 RCA0603 RCA1218 RCA0805 RCA2010 RCA1206 RCA2512	49R9 = 49.9 Ω 3011 = 3.01 kΩ	± 0.5 % ± 1 % ± 5 %	± 50 ppm/K ± 100 ppm/K ± 200 ppm/K	ET1 E67 ET5 E82 ET6 ET9 ET7 E27 EF4	e3 = Pure Tin Termination Finish

± 1 % = 3 sig. digits, plus multiplier  
± 5 % = 2 sig. digits, plus multiplier

Notes

1. Please refer to table PACKAGING, on page 122.      • Preferred way for ordering products is by use of the PART NUMBER.

PACKAGING								
MODEL	REEL					BULK		
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PACKING CODE		BULK FEEDING MAGAZINE PIECES/MAGAZINE	
					PAPER	BLISTER	PIECES	CODE
RCA0402	8 mm	180 mm/7"	10 000	2 mm	ET7		50 000	E27
		330 mm/13"	50 000	2 mm	EF4			
RCA0603	8 mm	180 mm/7"	5000	4 mm	ET1		25 000	E27
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6			
RCA0805	8 mm	180 mm/7"	5000	4 mm	ET1		10 000	E27
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6			
RCA1206	8 mm	180 mm/7"	5000	4 mm	ET1			
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6			
RCA1210	8 mm	180 mm/7"	5000	4 mm	ET1			
		330 mm/13"	20 000	4 mm	ET6			
RCA1218	12 mm	180 mm/7"	4000	4 mm		ET9		
RCA2010	12 mm	180 mm/7"	4000	4 mm		E02		
RCA2512	12 mm	180 mm/7"	2000	8 mm		E67		
			4000	4 mm		E82		

Automotive Grade  
Lead (Pb)-free Thick Film, Rectangular Chip Resistors

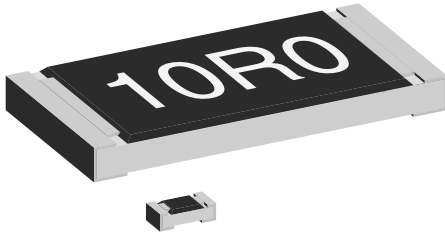
<b>PERFORMANCE</b>				
TEST	CONDITIONS OF TEST	TEST RESULTS %		
		0402 0603	0805 1206 1210	1218 2010 2512
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload 2.5 x rated voltage or ≤ 2 x limiting element voltage	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14	Rapid change between upper and lower category temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5

**Note**

1. For more details please refer to datasheet D../CRCW.



## Automotive Grade Thick Film, Rectangular Chip Resistors



### FEATURES

- Metal glaze on high quality ceramic with protective overglaze
- Sulfur resistant
- Superior resistance against H<sub>2</sub>S-atmosphere than standard Ag contacts
- Solder contacts on Ni barrier layer
- Excellent stability ( $\Delta R/R \leq \pm 0.5\%$  for 1000 h at 70 °C) different environmental conditions
- High volume product suitable for commercial and special applications
- Automotive Grade = sulfur resistant

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX V <sub>≡</sub>	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE Ω	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
RCA0402	0402	1005	0.063	50	± 50 ± 100 ± 100 ± 200 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 1 ± 5	100R - 1M0 10R - 1M0 10R - 5M6 1R0 - 9R76 1R0 - 10M	24 + 96 24 + 96 24 + 96 24 + 96 24
RCA0603	0603	1608	0.10	75	± 50 ± 100 ± 200 ± 200	± 0.5, ± 1 ± 0.5, ± 1 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 9R76 1R0 - 10M	24 + 96 24 + 96 24 + 96 24
RCA0805	0805	2012	0.125	150	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96 24 + 96 24 + 96 24
RCA1206	1206	3216	0.25	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96 24 + 96 24 + 96 24
RCA1210	1210	3225	0.33	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 1M0 100R - 1M0 1R0 - 1M0 1R0 - 1M0	24 + 96 24 + 96 24 + 96 24
RCA1218	1218	3246	1.0	200	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 2M2 100R - 2M2 1R0 - 2M2 1R0 - 2M2	24 + 96 24 + 96 24 + 96 24
RCA2010	2010	5025	0.50	400	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96 24 + 96 24 + 96 24
RCA2512	2512	6332	1.0	500	± 50 ± 100 ± 100 ± 200	± 0.5, ± 1 ± 0.5 ± 1 ± 5	100R - 10M 10R - 10M 1R0 - 10M 1R0 - 10M	24 + 96 24 + 96 24 + 96 24

#### Notes

- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web pages
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material

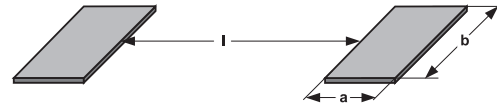
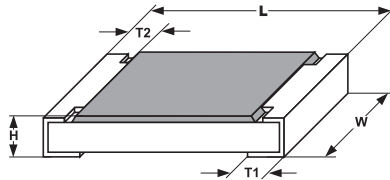
<b>TECHNICAL SPECIFICATIONS</b>									
PARAMETER	UNIT	RCA0402	RCA0603	RCA0805	RCA1206	RCA1210	RCA1218	RCA2010	RCA2512
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.10	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	V <sub>≡</sub>	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	V <sub>peak</sub>	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	≤ 870 <sup>1)</sup>	≤ 550 <sup>1)</sup>	≤ 440 <sup>1)</sup>	≤ 220 <sup>1)</sup>	≤ 140 <sup>3)</sup>	<sup>3)</sup>	≤ 88 <sup>3)</sup>	≤ 65 <sup>3)</sup>
Insulation Resistance	Ω	> 10 <sup>9</sup>							
Category Temperature Range	°C	- 55 to + 125 (+ 155)							
Failure Rate	h <sup>-1</sup>	0.3 × 10 <sup>-9</sup>							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

**Notes**

1. Measuring conditions in acc. to CECC 40401

 2. Rated voltage:  $\sqrt{P \times R}$ 

3. Depending on solder pad dimensions

**DIMENSIONS**


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ±	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ±	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION RCA - SERIES**
**PART NUMBERING: RCA080510K0FKTA00**

R	C	A	0	8	0	5	1	0	K	0	F	K	T	A	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

MODEL	SIZE	VALUE	TOLERANCE	TCR	PACKAGING	SPECIAL
RCA	0402 1210 0603 1218 0805 2010 1206 2512	R = decimal K = thousand M = million 1K32 = 1.32 kΩ 10R0 = 10 Ω 0000 = Jumper	D = ± 0.5 % F = ± 1.0 % J = ± 5.0 %	H = ± 50 ppm/K K = ± 100 ppm/K N = ± 200 ppm/K	TA = RT1 TG = R67 TB = RT5 TH = R82 TC = RT6 TK = RT9 TD = RT7 BA = B27 TF = R02	up to 2 digits 00 = standard

**PRODUCT DESCRIPTION: RCA0805 10K 1 % 100 RT1**

RCA0805	10K	1 %	100	RT1
MODEL	RESISTANCE VALUE	TOLERANCE	TCR	PACKAGING <sup>1)</sup>
RCA0402 RCA1210 RCA0603 RCA1218 RCA0805 RCA2010 RCA1206 RCA2512	49R9 = 49.9 Ω 3011 = 3.01 kΩ	± 0.5 % ± 1 % ± 5 %	± 50 ppm/K ± 100 ppm/K ± 200 ppm/K	RT1 R67 RT5 R82 RT6 RT9 RT7 B27 R02

**Notes**

- Please refer to table PACKAGING, on page 126.
- Products can be ordered either using the Product Description or the Part Number.



PACKAGING								
MODEL	REEL					BULK		
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PACKING CODE		BULK FEEDING MAGAZINE PIECES/MAGAZINE	
					PAPER	BLISTER	PIECES	CODE
RCA0402	8 mm	180 mm/7"	10 000	2 mm	RT7		50 000	B27
		330 mm/13"	50 000	2 mm	RF4			
RCA0603	8 mm	180 mm/7"	5000	4 mm	RT1		25 000	B27
		255 mm/10"	10 000	4 mm	RT5			
		330 mm/13"	20 000	4 mm	RT6			
RCA0805	8 mm	180 mm/7"	5000	4 mm	RT1		10 000	B27
		255 mm/10"	10 000	4 mm	RT5			
		330 mm/13"	20 000	4 mm	RT6			
RCA1206	8 mm	180 mm/7"	5000	4 mm	RT1			
		255 mm/10"	10 000	4 mm	RT5			
		330 mm/13"	20 000	4 mm	RT6			
RCA1210	8 mm	180 mm/7"	5000	4 mm	RT1			
		330 mm/13"	20 000	4 mm	RT6			
RCA1218	12 mm	180 mm/7"	4000	4 mm		RT9		
RCA2010	12 mm	180 mm/7"	4000	4 mm		R02		
RCA2512	12 mm	180 mm/7"	2000	8 mm		R67		
			4000	4 mm		R82		

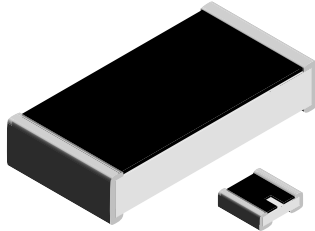


<b>PERFORMANCE</b>				
TEST	CONDITIONS OF TEST	TEST RESULTS %		
		0402 0603	0805 1206 1210	1218 2010 2512
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload 2.5 x rated voltage or ≤ 2 x limiting element voltage.	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5

**Note**

1. For more details please refer to datasheet D../CRCW.

## Thick Film Chip Resistors, Industrial



### FEATURES

- Operating temperature range: - 55 °C to + 150 °C
- Same materials and construction as MIL-PRF-55342 chip resistors
- Termination: Tin/Lead wraparound termination over nickel barrier. Also available with lead (Pb)-free wraparound terminations.
- Capability to develop specific reliability programs designed to customer requirements
- Size, value, packaging and materials can be customized for special customer requirements.



STANDARD ELECTRICAL SPECIFICATIONS						
GLOBAL MODEL	HISTORICAL MODEL	POWER RATING $P_{70^{\circ}\text{C}}$ (W <sup>1</sup> )	MAXIMUM OPERATING VOLTAGE	TEMPERATURE COEFFICIENT ppm/°C	TOLERANCE %	RESISTANCE RANGE Ω
RCWP0402	RCWP-0402	0.04	25	100, 300	± 1 to ± 10	1 - 22M
RCWP0603	RCWP-0603	0.07	50	100, 300	± 1 to ± 10	1 - 22M
RCWP0540	RCWP-540	0.08	40	100, 300	± 1 to ± 10	1 - 22M
RCWP0550	RCWP-550	0.10	50	100, 300	± 1 to ± 10	1 - 22M
RCWP0575	RCWP-575	0.15	70	100, 300	± 1 to ± 10	1 - 22M
RCWP5100	RCWP-5100	0.20	100	100, 300	± 1 to ± 10	1 - 22M
RCWP1206	RCWP-1206	0.25	100	100, 300	± 1 to ± 10	1 - 22M
RCWP5150	RCWP-5150	0.35	125	100, 300	± 1 to ± 10	1 - 22M
RCWP1100	RCWP-1100	0.50	100	100, 300	± 1 to ± 10	1 - 22M
RCWP7225	RCWP-7225	0.60	200	100, 300	± 1 to ± 10	1 - 22M
RCWP2010	RCWP-2010	0.80	200	100, 300	± 1 to ± 10	1 - 22M
RCWP2512	RCWP-2512	1.0	200	100, 300	± 1 to ± 10	1 - 22M

### Notes

1. Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material.
- Consult factory for extended resistance range.

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: RCWP510010K0GMWB (preferred part numbering format)

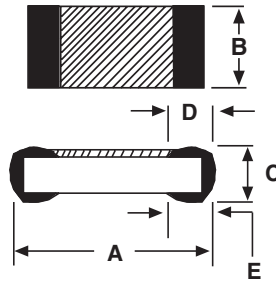
R	C	W	P	5	1	0	0	1	0	K	0	G	M	W	B		
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GLOBAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	TEMPERATURE COEFFICIENT	PACKAGING CODE	SPECIAL
(see Standard Electrical Specifications table)	R = Decimal K = Thousand M = Million 10R0 = 10 Ω 1K30 = 1.3 kΩ 1M00 = 1.0 MΩ 0000 = 0 Ω Jumper	F = ± 1 % G = ± 2 % J = ± 5 % K = ± 10 % Z = 0 Ω Jumper	K = 100 ppm M = 300 ppm S = Special, 0 Ω Jumper	TP = Tin/Lead, T/R (Full) S3 = Tin/Lead, T/R (1000 pcs) WB = Tin/Lead, Tray S2 = Tin/Lead, T/R (500 pcs) S6 = Tin/Lead, T/R (300 pcs)  EA = Lead (Pb)-free, T/R (Full) EB = Lead (Pb)-free, T/R (1000 pcs) ET = Lead (Pb)-free, Tray EC = Lead (Pb)-free, T/R (500 pcs) ED = Lead (Pb)-free, T/R (300 pcs)	Blank = Standard (Dash Number) (up to 2 digits) From 1 - 99 as applicable 99 = 0 Ω Jumper

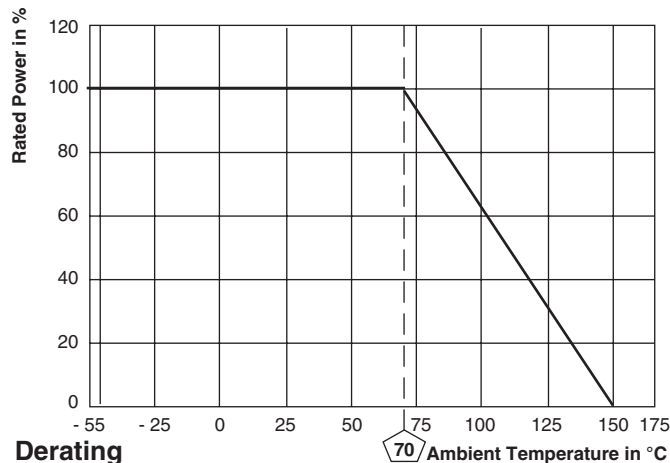
Historical Part Numbering: RCWP-5100103G (will continue to be accepted)

RCWP-5100	103	G	T03
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING CODE

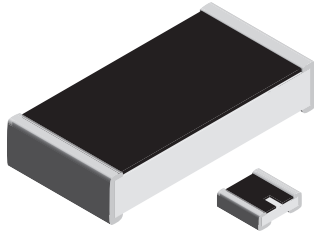
**DIMENSIONS**



DIMENSIONS in inches [millimeters]					
GLOBAL MODEL	A (Length)	B (Width)	C (Height)	D (Top Term)	E (Bottom Term)
RCWP0402	0.039 ± 0.003 [0.99 ± 0.08]	0.020 ± 0.003 [0.51 ± 0.08]	0.013 ± 0.003 [0.33 ± 0.08]	0.010 ± 0.005 [0.25 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]
RCWP0540	0.055 ± 0.005 [1.40 ± 0.13]	0.040 ± 0.005 [1.02 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]
RCWP0550	0.055 ± 0.005 [1.40 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP0575	0.080 ± 0.005 [2.03 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP0603	0.063 ± 0.005 [1.60 ± 0.13]	0.032 ± 0.005 [0.81 ± 0.13]	0.018 ± 0.005 [0.46 ± 0.13]	0.012 ± 0.005 [0.31 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP1100	0.105 ± 0.005 [2.67 ± 0.13]	0.100 ± 0.005 [2.54 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP1206	0.125 ± 0.005 [3.18 ± 0.13]	0.063 ± 0.005 [1.60 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP2010	0.197 ± 0.006 [5.00 ± 0.15]	0.098 ± 0.005 [2.49 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]
RCWP2512	0.250 ± 0.006 [6.35 ± 0.15]	0.124 ± 0.005 [3.15 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]
RCWP5100	0.105 ± 0.005 [2.67 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP5150	0.155 ± 0.005 [3.94 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWP7225	0.230 ± 0.005 [5.84 ± 0.13]	0.075 ± 0.005 [1.91 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]



## Thick Film Chip Resistors, Military/Established Reliability MIL-PRF-55342 Qualified, Type RM



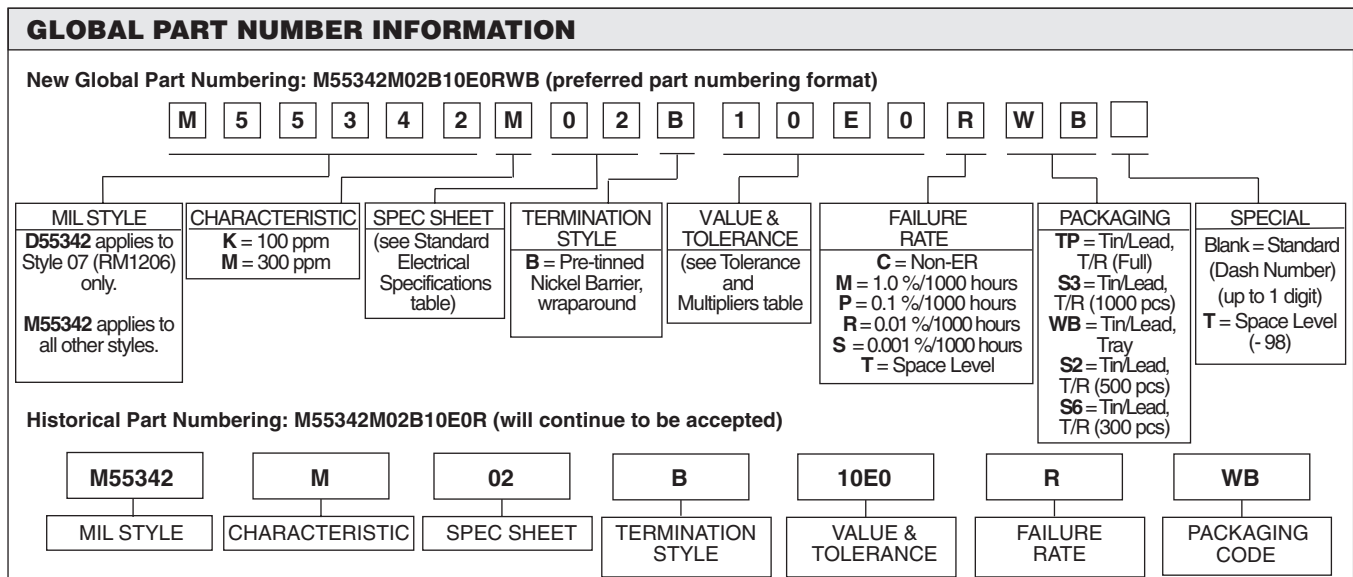
### FEATURES

- Fully conforms to the requirements of MIL-PRF-55342
- Established reliability - Verified failure rate; M, P, R, S & T levels
- Operating temperature range is - 55 °C to + 150 °C
- 100 % Group A screening per MIL-PRF-55342
- Termination Style B - Tin/Lead wraparound over nickel barrier

STANDARD ELECTRICAL SPECIFICATIONS								
VISHAY DALE MODEL	MIL-PRF-55342 STYLE	MIL SPEC. SHEET	TERM.	POWER RATING $P_{70^{\circ}\text{C}}$ W	MAXIMUM OPERATING VOLTAGE	CHAR.	TOLERANCE %	RESISTANCE RANGE $\Omega$
RCWPM-550	RM0505	02	B	0.055	40	K, M	± 1 to ± 10	1 - 22M
RCWPM-5100	RM1005	03	B	0.10	40	K, M	± 1 to ± 10	1 - 22M
RCWPM-5150	RM1505	04	B	0.15	40	K, M	± 1 to ± 10	1 - 22M
RCWPM-7225	RM2208	05	B	0.225	40	K, M	± 1 to ± 10	1 - 22M
RCWPM-575	RM0705	06	B	0.10	50	K, M	± 1 to ± 10	1 - 22M
RCWPM-1206	RM1206	07	B	0.25	100	K, M	± 1 to ± 10	1 - 22M
RCWPM-2010	RM2010	08	B	0.80 <sup>1)</sup>	150	K, M	± 1 to ± 10	1 - 22M
RCWPM-2512	RM2512	09	B	1.0 <sup>1)</sup>	200	K, M	± 1 to ± 10	1 - 22M
RCWPM-1100	RM1010	10	B	0.50 <sup>1)</sup>	75	K, M	± 1 to ± 10	1 - 22M
RCWPM-0402	RM0402	11	B	0.04	25	K, M	± 1 to ± 10	1 - 22M
RCWPM-0603	RM0603	12	B	0.07	50	K, M	± 1 to ± 10	1 - 22M

**Note**

1. Power rating based on a ceramic test board, see appropriate Mil Slash Sheet for power ratings based on a fiber test board.



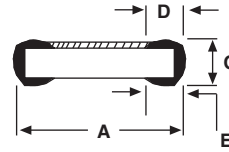


# RCWPM (Military M/D55342)

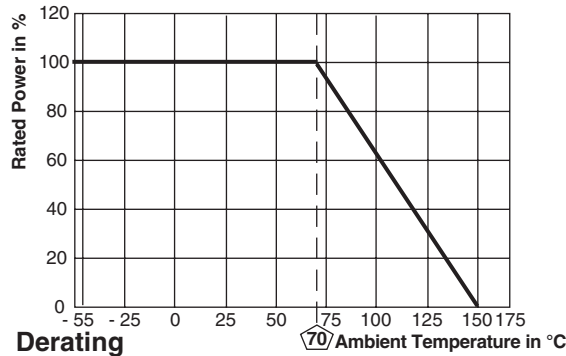
Thick Film Chip Resistors, Military/Established Reliability  
MIL-PRF-55342 Qualified, Type RM

Vishay Dale

## DIMENSIONS in inches [millimeters]



DIMENSIONS in inches [millimeters]							
VISHAY DALE MODEL	MIL-PRF-55342 STYLE	MIL. SPEC. SHEET	A (Length)	B (Width)	C (Height)	D (Top Term)	E (Bottom Term)
RCWPM-550	RM0505	02	0.055 ± 0.005 [1.40 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-5100	RM1005	03	0.105 ± 0.005 [2.67 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-5150	RM1505	04	0.155 ± 0.005 [3.94 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-7225	RM2208	05	0.230 ± 0.005 [5.84 ± 0.13]	0.075 ± 0.005 [1.91 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]
RCWPM-575	RM0705	06	0.080 ± 0.005 [2.03 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-1206	RM1206	07	0.125 ± 0.005 [3.18 ± 0.13]	0.063 ± 0.005 [1.60 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-2010	RM2010	08	0.197 ± 0.006 [5.00 ± 0.15]	0.098 ± 0.005 [2.49 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]
RCWPM-2512	RM2512	09	0.250 ± 0.006 [6.35 ± 0.15]	0.124 ± 0.005 [3.15 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]
RCWPM-1100	RM1010	10	0.105 ± 0.005 [2.67 ± 0.13]	0.100 ± 0.005 [2.54 ± 0.13]	0.020 ± 0.005 [0.51 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]
RCWPM-0402	RM0402	11	0.039 ± 0.003 [0.99 ± 0.08]	0.020 ± 0.003 [0.51 ± 0.08]	0.013 ± 0.003 [0.33 ± 0.08]	0.010 ± 0.005 [0.25 ± 0.13]	0.010 ± 0.005 [0.25 ± 0.13]
RCWPM-0603	RM0603	12	0.063 ± 0.005 [1.60 ± 0.13]	0.032 ± 0.005 [0.81 ± 0.13]	0.018 ± 0.005 [0.46 ± 0.13]	0.012 ± 0.005 [0.31 ± 0.13]	0.015 ± 0.005 [0.38 ± 0.13]



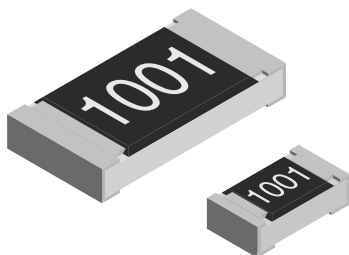
**CAGE CODE: 91637 and SH903**

## RESISTANCE TOLERANCE AND MULTIPLIERS

TOLERANCE				MULTIPLIER	VALUE RANGE (OHMS)
± 1 %	± 2 %	± 5 %	± 10 %		
D	G	J	M	1	1 - 9xx
E	H	K	N	1000	1K - 9xxK
F	T	L	P	1 000 000	1M - 22M
Examples:		11D3 = 11.3 Ω ± 1 %	15J0 = 15 Ω ± 5 %		
		10E0 = 10 kΩ ± 1 %	10K0 = 10 kΩ ± 5 %		
		332D = 332 Ω ± 1 %	560K = 560 kΩ ± 5 %		
		2F21 = 2.21 MΩ ± 1 %	8L20 = 8.2 MΩ ± 5 %		
		51G0 = 51 Ω ± 2 %	10M0 = 10 Ω ± 10 %		
		10H0 = 10 kΩ ± 2 %	10N0 = 10 kΩ ± 10 %		
		33H0 = 33 kΩ ± 2 %	2P70 = 2.7 MΩ ± 10 %		
		22T0 = 22 MΩ ± 2 %	8P20 = 8.2 MΩ ± 10 %		



## Lead (Pb)-free Thick Film, Rectangular, Precision Resistors



### FEATURES

- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Excellent stability ( $\Delta R/R \leq \pm 0.5\%$  for 1000 h at 70 °C) in different environmental conditions
- Low temperature coefficient (25 ppm/K) and tight tolerances ( $\pm 0.25\%$ )



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70\text{ }^\circ\text{C W}}$ CECC 40401-802/EIA-575	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC						
D10/CRCW0402-P	0402	1005	0.063	50	$\pm 100$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25; \pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 1M0 100R - 1M0 100R - 10K	96 96 96
D11/CRCW0603-P	0603	1608	0.1	75	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
D12/CRCW0805-P	0805	2012	0.125	150	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
D25/CRCW1206-P	1206	3216	0.25	200	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
CRCW1210-P	1210	3225	0.33	200	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5$	100R - 1M0 100R - 1M0	96 96
CRCW1218-P	1218	3246	1.0	200	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	100R - 2M2 100R - 2M2	96 96
CRCW2010-P	2010	5025	0.5	400	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	10R - 10M 100R - 10M	96 96
CRCW2512-P	2512	6332	1.0	500	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	10R - 10M 100R - 10M	96 96

### Notes

- Ask about further value ranges
- Special terminations for conductive adhesive attachment on request
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- Marking and packaging: see appropriate catalog or web pages

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	D10/ CRCW0402-P	D11/ CRCW0603-P	D12/ CRCW0805-P	D25/ CRCW1206-P	CRCW1210-P	CRCW1218-P	CRCW2010-P	CRCW2512-P
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.1	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	$V_{\text{peak}}$	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	$\leq 870^1)$	$\leq 550^1)$	$\leq 440^1)$	$\leq 220^1)$	$\leq 140^3)$	<sup>3)</sup>	$\leq 88^3)$	$\leq 65^3)$
Insulation Resistance	$\Omega$	> $10^9$							
Category Temperature Range	°C	- 55 to + 125							
Failure Rate	$\text{h}^{-1}$	$0.3 \cdot 10^{-9}$							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

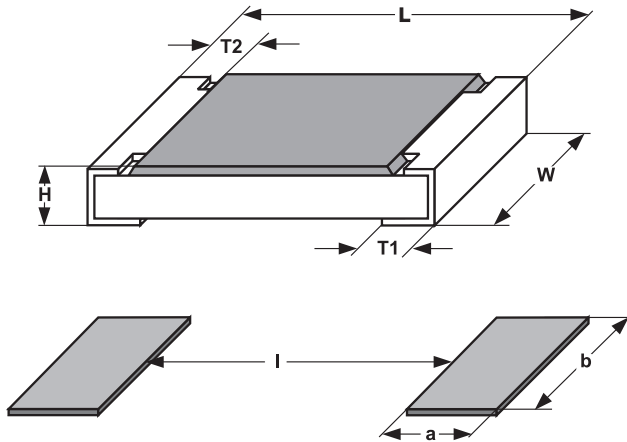
### Notes

1. Measuring conditions in acc. to CECC 40401-802
2. Rated voltage:  $\sqrt{P \times R}$
3. Depending on solder pad dimensions



Lead (Pb)-free Thick Film, Rectangular, Precision Resistors

**DIMENSIONS**

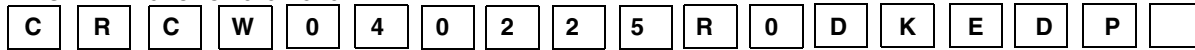


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 +0.10 -0.05	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 +0.20 -0.10	1.25 ± 0.15	0.45 ± 0.05	0.3 +0.20 -0.10	0.3 ± 0.2
1206	3216	3.2 +0.10 -0.20	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 +0.10 -0.20	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

Dimensions 1210 to 2512 and solder-pad dimensions: see standard chip resistors D../CRCW

**PART NUMBER AND PRODUCT DESCRIPTION D../CRCW....-P e3 SERIES**

PART NUMBERING: CRCW040225R0DKEDP



MODEL/SIZE	VALUE	TOLERANCE	TCR	PACKAGING	SPECIAL
CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW1218 CRCW2010 CRCW2512	R = Decimal K = Thousand M = Million	C = ± 0.25 % D = ± 0.5 % F = ± 1 %	E = ± 25 ppm/K H = ± 50 ppm/K K = ± 100 ppm/K	EA = ET1 EB = ET5 EC = ET6 ED = ET7 EE = EF4 EI = EG1 EL = E20 EK = ET9 EF = E02 EG = E67 EH = E82 EY = E27	up to 2 digits P = Precision

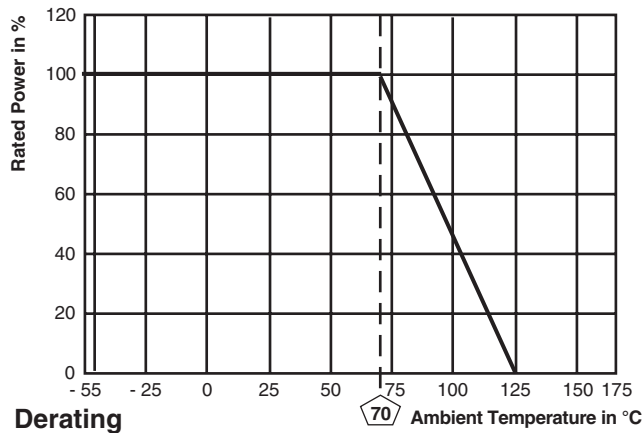
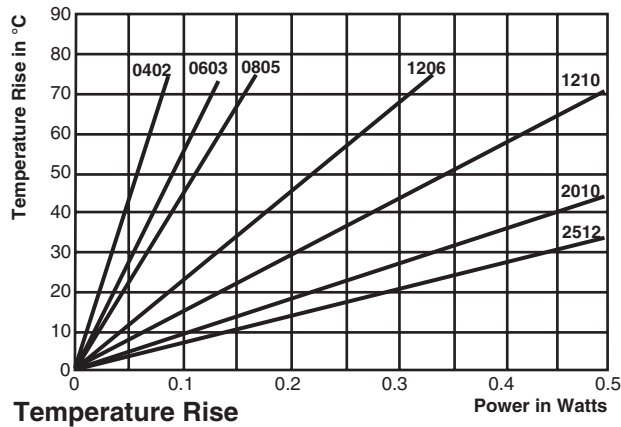
PRODUCT DESCRIPTION: D10/CRCW0402-P 100 25R 0.5 % ET7 e3

D10/CRCW0402-P	100	25R	0.5 %	ET7	e3
MODEL	TCR	RESISTANCE	TOLERANCE	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE
D10/CRCW0402-P D11/CRCW0603-P D12/CRCW0805-P D25/CRCW1206-P CRCW1210-P CRCW1218-P CRCW2010-P CRCW2512-P	± 25 ppm/K ± 50 ppm/K ± 100 ppm/K	49K9 = 49.9 kΩ 5R1 = 5.1 Ω	± 0.25 % ± 0.5 % ± 1 %	ET1 ET5 ET6 ET7 EF4 EG1 E20 ET9 E02 E67 E82 E27	e3 = Pure Tin Termination Finish

**Note**

1. Please refer to table PACKAGING, page 134.

PACKAGING								
MODEL	REEL					BULK		
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PACKING CODE		BULK FEEDING MAGAZINE	
					PAPER	BLISTER	PIECES	CODE
D10/CRCW0402-P	8 mm	180 mm/7"	10 000	2 mm	ET7		50 000	E27
		330 mm/13"	50 000	2 mm	EF4			
D11/CRCW0603-P	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	25 000	E27
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6	E20		
D12/CRCW0805-P	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	10 000	E27
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6	E20		
D25/CRCW1206-P	8 mm	180 mm/7"	5000	4 mm	ET1	EG1		
		255 mm/10"	10 000	4 mm	ET5			
		330 mm/13"	20 000	4 mm	ET6	E20		
CRCW1210-P	8 mm	180 mm/7"	5000	4 mm	ET1	EG1		
		330 mm/13"	20 000	4 mm	ET6	E20		
CRCW1218-P	12 mm	180 mm/7"	4000	4 mm		ET9		
CRCW2010-P	12 mm	180 mm/7"	4000	4 mm		E02		
CRCW2512-P	12 mm	180 mm/7"	2000	8 mm		E67		
			4000	4 mm		E82		





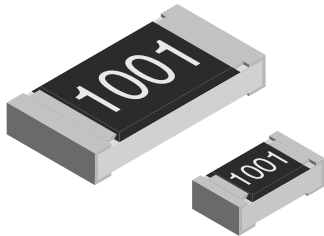
<b>PERFORMANCE</b>				
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>TEST RESULTS %</b>		
		<b>0402 0603</b>	<b>0805 1206 1210</b>	<b>1218 2010 2512</b>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 1.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload 2.5 x rated voltage or ≤ 2 x limiting element voltage.	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5

**CURRENT NOISE/NON-LINEARITY:**

See standard Chip series D...CRCW...

<b>APPLICABLE SPECIFICATIONS</b>	
• EN 60115-1	Generic Specification
• EN 140400	Sectional Specification
• EN 140401-802	Detail Specification
• IEC 60068-2-X	Variety of environmental test procedures
• IEC 60286-3	Packaging of SMD components

## Thick Film, Rectangular, Precision Resistors



### FEATURES

- Metal glaze on high quality ceramic
- Protective overglaze
- Solder contacts on Ni barrier layer
- Excellent stability ( $\Delta R/R \leq \pm 0.5\%$  for 1000 h at 70 °C) in different environmental conditions
- Low temperature coefficient (25 ppm/K) and tight tolerances ( $\pm 0.25\%$ )

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D10P CRCW0402	0402	1005	0.063	50	$\pm 100$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25; \pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 1M0 100R - 1M0 100R - 10K	96 96 96
D11P CRCW0603	0603	1608	0.1	75	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
D12P CRCW0805	0805	2012	0.125	150	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
D25P CRCW1206	1206	3216	0.25	200	$\pm 100$ $\pm 50$ $\pm 50$ $\pm 25$	$\pm 0.5$ $\pm 0.25$ $\pm 0.5; \pm 1$ $\pm 0.25; \pm 0.5; \pm 1$	10R - 10M 100R - 1M0 100R - 10M 100R - 10K	96 96 96 96
CRCW1210	1210	3225	0.33	200	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5$	100R - 1M0 100R - 1M0	96 96
CRCW1218	1218	3246	1.0	200	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	100R - 2M2 100R - 2M2	96 96
CRCW2010	2010	5025	0.5	400	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	10R - 10M 100R - 10M	96 96
CRCW2512	2512	6332	1.0	500	$\pm 100$ $\pm 50$	$\pm 0.5$ $\pm 0.5; \pm 1$	10R - 10M 100R - 10M	96 96

#### Notes

- Ask about further value ranges
- Special terminations for conductive adhesive attachment on request
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- Marking and packaging: see appropriate catalog or web pages

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	D10P CRCW0402	D11P CRCW0603	D12P CRCW0805	D25P CRCW1206	CRCW1210	CRCW1218	CRCW2010	CRCW2512
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.1	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	50	75	150	200	200	200	400	500
Insulation Voltage (1 min)	$V_{\text{peak}}$	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	$\leq 870^1)$	$\leq 550^1)$	$\leq 440^1)$	$\leq 220^1)$	$\leq 140^3)$	<sup>3)</sup>	$\leq 88^3)$	$\leq 65^3)$
Insulation Resistance	$\Omega$	$> 10^9$							
Category Temperature Range	°C	- 55 to + 125							
Failure Rate	$\text{h}^{-1}$	$0.3 \cdot 10^{-9}$							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

#### Notes

1. Measuring conditions in acc. to CECC 40401-802
2. Rated voltage:  $\sqrt{P \times R}$
3. Depending on solder pad dimensions



PART NUMBER AND PRODUCT DESCRIPTION D-SERIES																	
PART NUMBERING: D120805FB5620DP0																	
D	1	2	0	8	0	5	F	B	5	6	2	0	D	P	0		
MODEL/SIZE	SPECIAL CHARACTER		TCR		VALUE		TOLERANCE		PACKAGING <sup>1)</sup>		SPECIAL						
D100402 D110603 D120805 D251206	F = P (Precision)		D = ± 25 ppm/K C = ± 50 ppm/K B = ± 100 ppm/K		3 digit value 1 digit multiplier  MULTIPLIER 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>-1</sup> 2 = *10 <sup>-2</sup> 3 = *10 <sup>-3</sup> 4 = *10 <sup>-4</sup> 5 = *10 <sup>-5</sup> 6 = *10 <sup>-6</sup>		C = ± 0.25 % D = ± 0.5 % F = ± 1 %		P0 P5 PN MZ MU M0 PZ B5 BN		up to 2 digits						
PRODUCT DESCRIPTION: D12P 100 562R 0.5 % P5																	
D12P		100		562R		0.5 %		P5									
MODEL		TCR		RESISTANCE VALUE		TOLERANCE		PACKAGING <sup>1)</sup>									
D10P D11P D12P D25P		± 25 ppm/K ± 50 ppm/K ± 100 ppm/K		49R9 = 49.9 Ω 5R1 = 5.1 Ω		± 0.25 % ± 0.5 % ± 1 %		P0 M0 P5 PZ PN B5 MZ BN MU BN									

Note

1. Please refer to table PACKAGING, page 138.

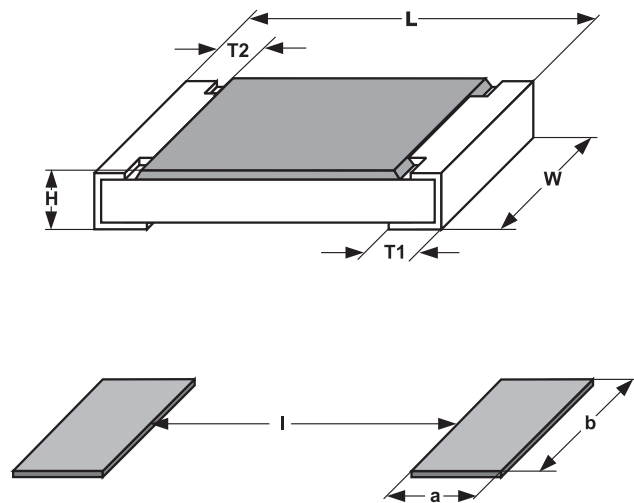
PART NUMBER AND PRODUCT DESCRIPTION CRCW-SERIES																	
PART NUMBERING: CRCW080525R0DKTAP																	
C	R	C	W	0	8	0	5	2	5	R	0	D	K	T	A	P	
MODEL/SIZE	VALUE		TOLERANCE		TCR		PACKAGING <sup>1)</sup>		SPECIAL								
CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW1218 CRCW2010 CRCW2512	R = Decimal K = Thousand M = Million		C = ± 0.25 % D = ± 0.5 % F = ± 1 %		E = ± 25 ppm/K H = ± 50 ppm/K K = ± 100 ppm/K		TA = RT1 TB = RT5 TC = RT6 TD = RT7 TF = R02 TG = R67 TH = R82 TK = RT9 BA = B27		up to 2 digits P = Precision								
PRODUCT DESCRIPTION: CRCW 0805 25R D 100 RT1																	
CRCW0805		25R		D		100		RT1									
MODEL		RESISTANCE VALUE		TOLERANCE		TCR		PACKAGING <sup>1)</sup>									
CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW1218 CRCW2010 CRCW2512		49R9 = 49.9 Ω 5R1 = 5.1 Ω		C = ± 0.25 % D = ± 0.5 % F = ± 1 %		± 25 ppm/K ± 50 ppm/K ± 100 ppm/K		RT1 RT5 RT6 RT7 R02 R67 R82 RT9 B27									

Note

1. Please refer to table PACKAGING, page 138.

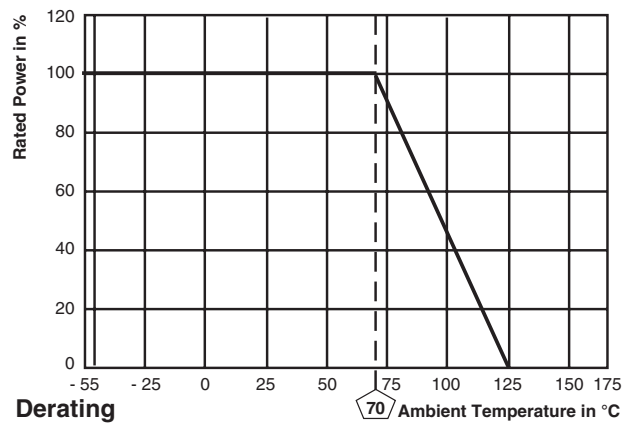
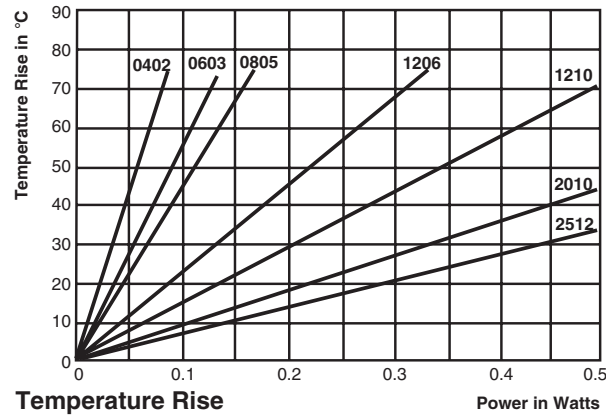
PACKAGING								
MODEL	REEL				PACKING CODE		BULK	
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PAPER	BLISTER	PIECES	CODE
D10P CRCW0402	8 mm	180 mm/7"	10 000	2 mm	P0/RT7		50 000	MZ/B27
		330 mm/13"	50 000	2 mm	PZ/RF4			
D11P CRCW0603	8 mm	180 mm/7"	5000	4 mm	P5/RT1	B5	25 000	MU/B27
		255 mm/10"	10 000	4 mm	P0/RT5			
		330 mm/13"	20 000	4 mm	PN/RT6	BN		
D12P CRCW0805	8 mm	180 mm/7"	5000	4 mm	P5/RT1	B5	10 000	MO/B27
		255 mm/10"	10 000	4 mm	P0/RT5			
		330 mm/13"	20 000	4 mm	PN/RT6	BN		
D25P CRCW1206	8 mm	180 mm/7"	5000	4 mm	P5/RT1	B5		
		255 mm/10"	10 000	4 mm	P0/RT5			
		330 mm/13"	20 000	4 mm	PN/RT6	BN		
CRCW1210	8 mm	180 mm/7"	5000	4 mm	P5/RT1	B5		
		330 mm/13"	20 000	4 mm	PN/RT6	BN		
CRCW1218	12 mm	180 mm/7"	4000	4 mm		B4/RT9		
CRCW2010	12 mm	180 mm/7"	4000	4 mm		B4/R02		
CRCW2512	12 mm	180 mm/7"	2000	8 mm		B2/R67		
			4000	4 mm		B4/R82		

**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.05	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

Dimensions 1210 to 2512 and solder-pad dimensions: see standard chip resistors D..CRCW

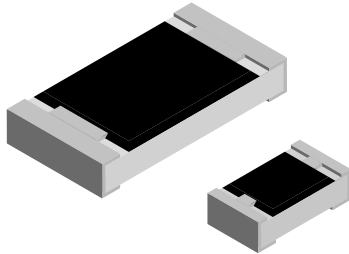


<b>PERFORMANCE</b>				
TEST	CONDITIONS OF TEST	TEST RESULTS %		
		0402 0603	0805 1206 1210	1218 2010 2512
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 1.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload 2.5 x rated voltage or ≤ 2 x limiting element voltage.	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.25	≤ ± 0.25	≤ ± 0.5

<b>APPLICABLE SPECIFICATIONS</b>
<ul style="list-style-type: none"> <li>• CECC40000/40400/40401-802</li> <li>• EN140400/IEC 60115 - 1</li> <li>• EIA 575</li> <li>• MIL-PRF-55342</li> </ul>



## Lead (Pb)-free Thick Film, Rectangular, Low Value Resistors ( $R \leq 1 \Omega$ )



### FEATURES

- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Extremely low resistance values ( $R \leq 1 \Omega$ )
- Suitable for current sensors and shunts



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D10/CRCW0402-LR	0402	1005	0.063	$\sqrt{P \times R}$	$\pm 400$ $\pm 600$	$\pm 5$ $\pm 5$	R47 - R91 R22 - R43	24 24
D11/CRCW0603-LR	0603	1608	0.1	$\sqrt{P \times R}$	$\pm 200$ $\pm 400$	$\pm 5$ $\pm 5$	R47 - R91 R10 - R43	24 24
D12/CRCW0805-LR	0805	2012	0.125	$\sqrt{P \times R}$	$\pm 200$ $\pm 300$	$\pm 5$ $\pm 5$	R47 - R91 R10 - R43	24 24
D25/CRCW1206-LR	1206	3216	0.25	$\sqrt{P \times R}$	$\pm 300$ $\pm 200$	$\pm 5$ $\pm 5$	R10 - R43 R47 - R91	24 24
CRCW1210-LR	1210	3225	0.33	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW1218-LR	1218	3246	1.0	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW2010-LR	2010	5025	0.5	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW2512-LR	2512	6332	1.0	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24

#### Notes

- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web page
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- 1 % tolerance on request

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	0402	0603	0805	1206	1210	1218	2010	2512
Rated Dissipation at 70 °C	W	0.063	0.1	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage	$V_{\equiv}$	$\sqrt{P \times R}$							
Insulation Voltage (1 min)	$V_{\text{peak}}$	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	$\leq 870^{1)}$	$\leq 550^{1)}$	$\leq 440^{1)}$	$\leq 220^{1)}$	$\leq 140^{2)}$	$^{2)}$	$\leq 88^{2)}$	$\leq 45^{2)}$
Insulation Resistance	$\Omega$	$> 10^9$							
Category Temperature Range	°C	- 55 to + 125 (+ 155)							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

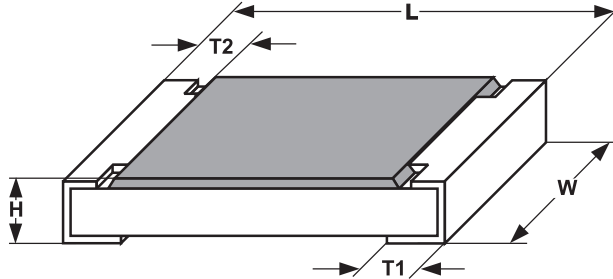
#### Notes

1. Measuring conditions in acc. to CECC 40401 - 802
2. Dependent on solder pad dimensions

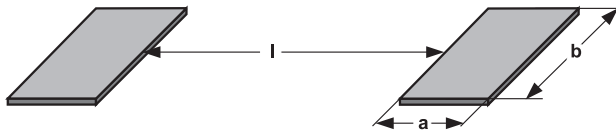


Lead (Pb)-free Thick Film, Rectangular,  
Low Value Resistors ( $R \leq 1 \Omega$ )

**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 <sup>+0.05</sup> / <sub>-0.10</sub>	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> / <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> / <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> / <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> / <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> / <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2



SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION D../CRCW...-LR e3 SERIES**

PART NUMBERING: CRCW0402R470JNEALR



MODEL/SIZE
CRCW0402
CRCW0603
CRCW0805
CRCW1206
CRCW1210
CRCW1218
CRCW2010
CRCW2512

VALUE
R = Decimal

TOLERANCE
J = ± 5 %

TCR
N = ± 200 ppm/K
M = ± 300 ppm/K
Q = ± 400 ppm/K
T = ± 600 ppm/K

PACKAGING
ED = ET7
EE = EF4
EA = ET1
EB = ET5
EC = ET6
EI = EG1
EL = E20
EK = ET9
EF = E02
EG = E67
EH = E82

SPECIAL
up to 2 digits
LR = Low Value

PRODUCT DESCRIPTION: D10/CRCW0402-LR 200 0R47 5 % ET1 e3

D10/CRCW0402-LR
MODEL
D10/CRCW0402-LR
D11/CRCW0603-LR
D12/CRCW0805-LR
D25/CRCW1206-LR
CRCW1210-LR
CRCW1218-LR
CRCW2010-LR
CRCW2512-LR

200
TCR
± 200 ppm/K
± 300 ppm/K
± 400 ppm/K
± 600 ppm/K

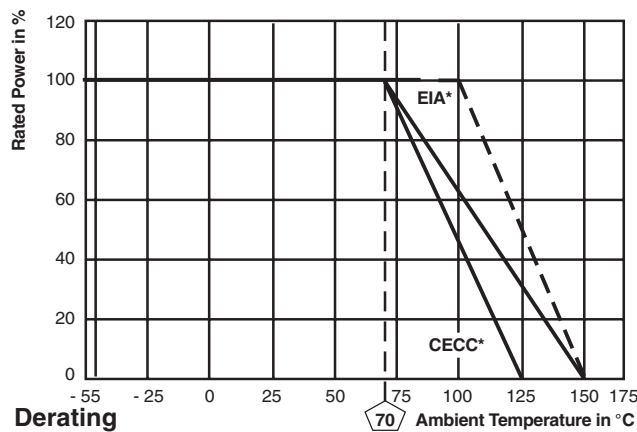
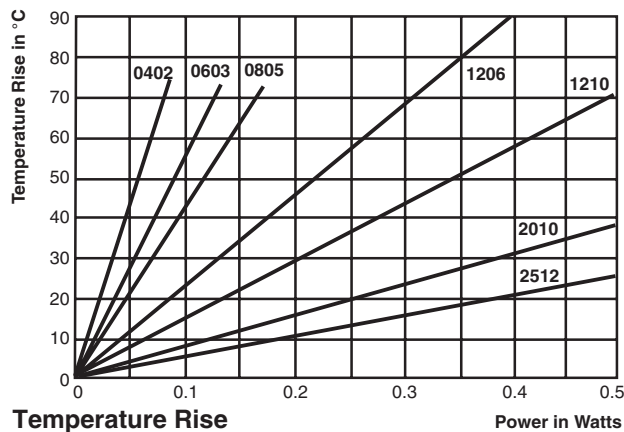
0R47
RESISTANCE VALUE
0R10 = 0.1 Ω
0R91 = 0.91 Ω

5 %
TOLERANCE
± 5 %

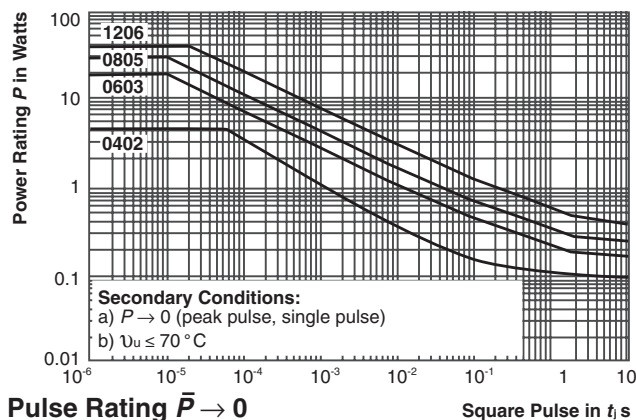
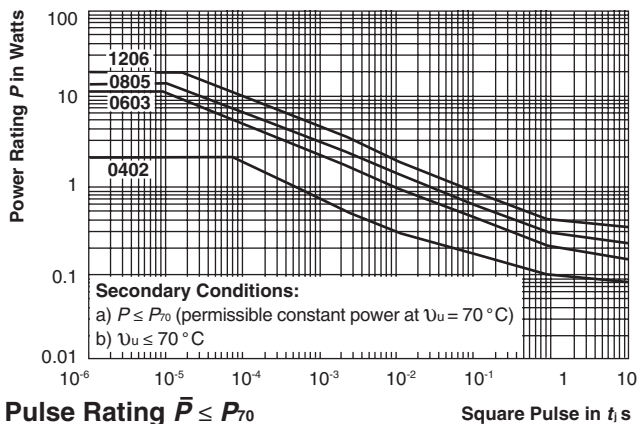
ET1
PACKAGING
ET7
EF4
ET1
ET5
ET6
EG1
E20
ET9
E02
E67
E82

e3
LEAD (Pb)-FREE
e3 = Pure Tin Termination Finish

PACKAGING						
MODEL	REEL				PACKING CODE	
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PAPER	BLISTER
D10/CRCW0402-LR	8 mm	180 mm/7" 330 mm/13"	10 000	2 mm	ET7	
			50 000	2 mm	EF4	
D11/CRCW0603-LR	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	4 mm	ET1	EG1
			10 000	4 mm	ET5	
			20 000	4 mm	ET6	E20
D12/CRCW0805-LR	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	4 mm	ET1	EG1
			10 000	4 mm	ET5	
			20 000	4 mm	ET6	E20
D25/CRCW1206-LR	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	4 mm	ET1	EG1
			10 000	4 mm	ET5	
			20 000	4 mm	ET6	E20
CRCW1210-LR	8 mm	180 mm/7" 330 mm/13"	5000	4 mm	ET1	EG1
			20 000	4 mm	ET6	E20
CRCW1218-LR	12 mm	180 mm/7"	4000	4 mm		ET9
CRCW2010-LR	12 mm	180 mm/7"	4000	4 mm		E02
CRCW2512-LR	12 mm	180 mm/7"	2000	8 mm		E67
			4000	4 mm		E82



\* There are differences in board layout and measurements between CECC and EIA.



**Lead (Pb)-free Thick Film, Rectangular,  
Low Value Resistors ( $R \leq 1 \Omega$ )**

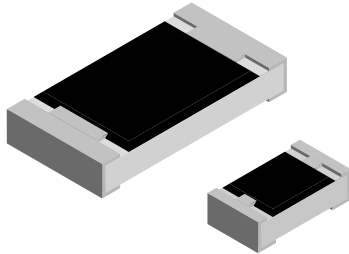
<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>REQUIREMENTS<sup>1)</sup></b>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	$\leq \pm 2 \%$
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	$\leq \pm 0.5 \%$
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds	$\leq \pm 1 \%$
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14	Rapid change between upper and lower category temperature	$\leq \pm 1 \%$
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	$\leq \pm 2 \%$
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	$\leq \pm 1 \%$

**Note**

1. Limits for change of resistance at test

<b>APPLICABLE SPECIFICATIONS</b>	
• EN 60115-1	Generic Specification
• EN 140400	Sectional Specification
• EN 140401-802	Detail Specification
• IEC 60068-2-X	Variety of environmental test procedures
• IEC 60286-3	Packaging of SMD components

## Thick Film, Rectangular, Low Value Resistors



### FEATURES

- Special metal glaze on high quality ceramic
- Protective overglaze
- Solder contacts on Ni barrier layer
- Extremely low resistance values (0.1  $\Omega$ )
- Suitable for current sensors and shunts

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\cong}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D10LR CRCW0402	0402	1005	0.063	$\sqrt{P \times R}$	$\pm 400$ $\pm 600$	$\pm 5$ $\pm 5$	R47 - R91 R22 - R43	24 24
D11LR CRCW0603	0603	1608	0.1	$\sqrt{P \times R}$	$\pm 200$ $\pm 400$	$\pm 5$ $\pm 5$	R47 - R91 R10 - R43	24 24
D12LR CRCW0805	0805	2012	0.125	$\sqrt{P \times R}$	$\pm 200$ $\pm 300$	$\pm 5$ $\pm 5$	R47 - R91 R10 - R43	24 24
D25LR CRCW1206	1206	3216	0.25	$\sqrt{P \times R}$	$\pm 300$ $\pm 200$	$\pm 5$ $\pm 5$	R10 - R43 R47 - R91	24 24
CRCW1210	1210	3225	0.33	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW1218	1218	3246	1.0	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW2010	2010	5025	0.5	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24
CRCW2512	2512	6332	1.0	$\sqrt{P \times R}$	$\pm 200$	$\pm 5$	R10 - R91	24

### Notes

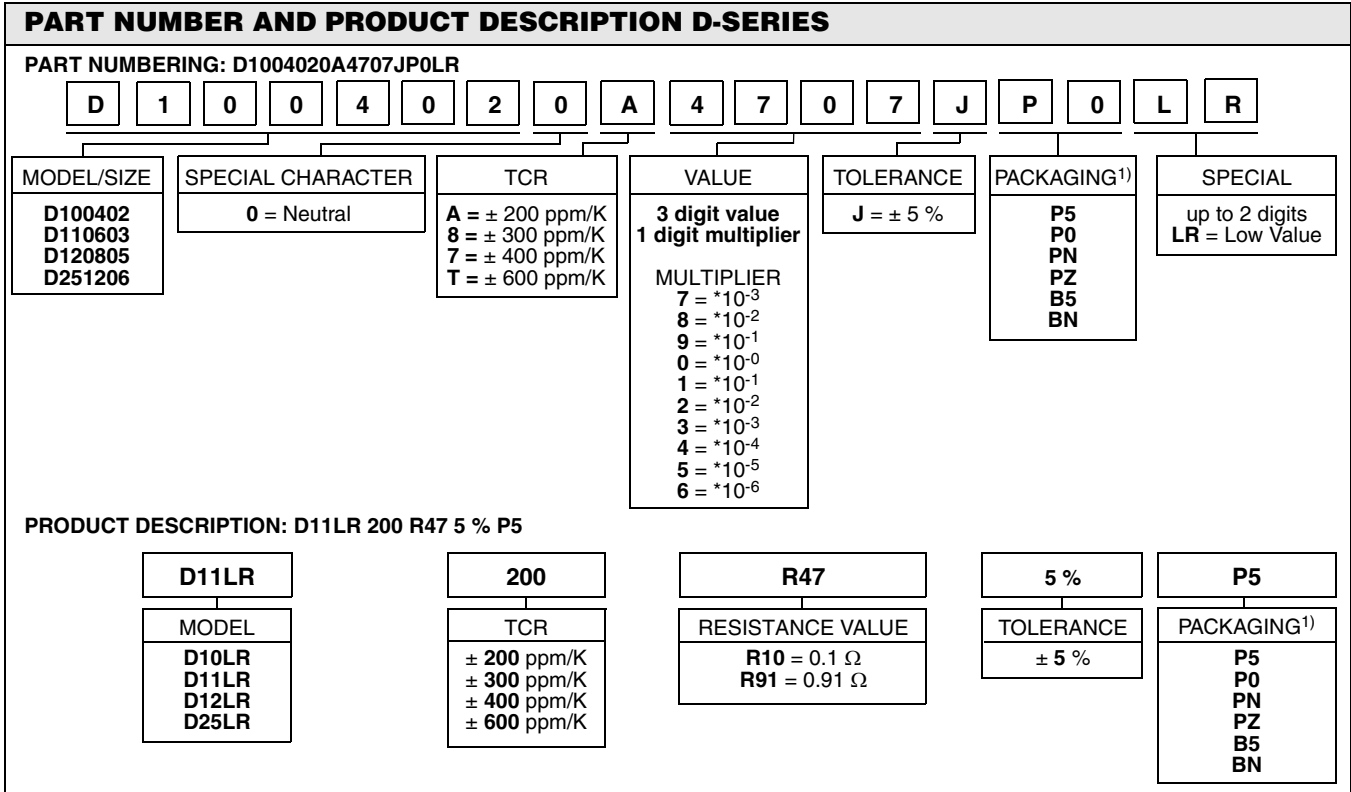
- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web page
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- 1 % tolerance on request

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	0402	0603	0805	1206	1210	1218	2010	2512
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.1	0.125	0.25	0.33	1.0	0.5	1.0
Limiting Element Voltage	$V_{\cong}$	$\sqrt{P \times R}$							
Insulation Voltage (1 min)	$V_{\text{peak}}$	> 75	> 100	> 200	> 300	> 300	> 300	> 300	> 300
Thermal Resistance	K/W	$\leq 870^{1)}$	$\leq 550^{1)}$	$\leq 440^{1)}$	$\leq 220^{1)}$	$\leq 140^{2)}$	$^{2)}$	$\leq 88^{2)}$	$\leq 45^{2)}$
Insulation Resistance	$\Omega$	$> 10^9$							
Category Temperature Range	°C	- 55 to + 125 (+ 155)							
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	25.5	40.5

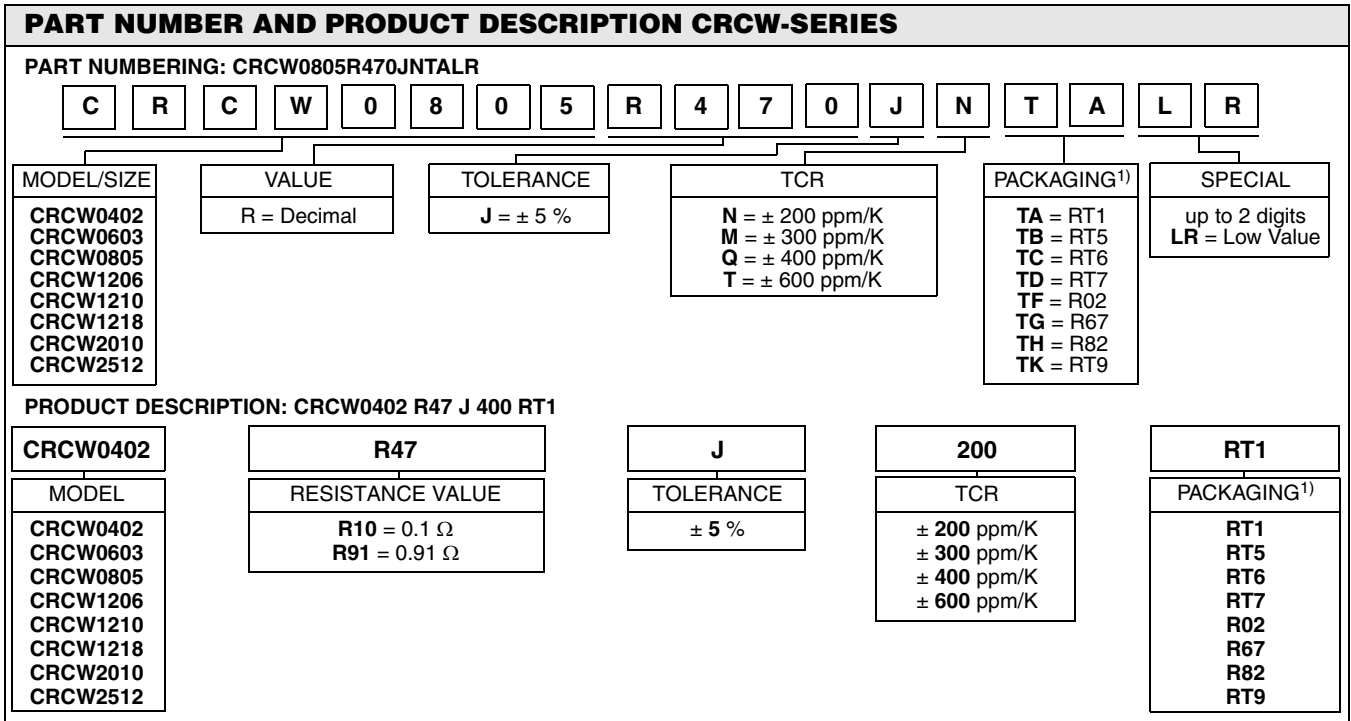
### Notes

1. Measuring conditions in acc. to CECC 40401-802
2. Dependent on solder pad dimensions



**Note**

1. Please refer to table PACKAGING, page 146.



**Note**

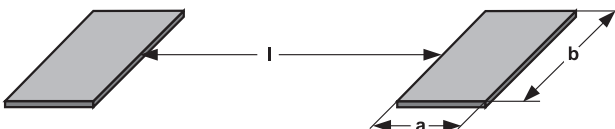
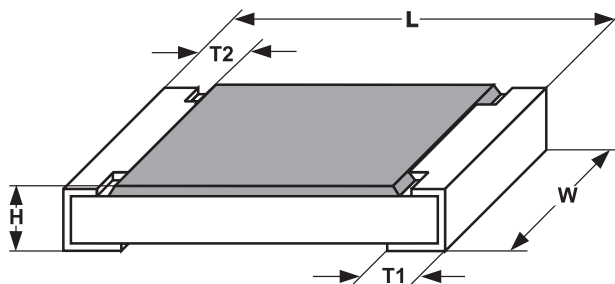
1. Please refer to table PACKAGING, page 146.

PACKAGING					
MODEL	REEL				
	TAPE WIDTH	DIAMETER	PIECES/REEL	PACKING CODE	
				PAPER <sup>1)</sup>	BLISTER <sup>1)</sup>
D10LR CRCW0402	8 mm	180 mm/7" 330 mm/13"	10 000	P0/RT7	
			50 000	PZ/RF4	
D11LR CRCW0603	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	P5/RT1	B5
			10 000	P0/RT5	
			20 000	PN/RT6	BN
D12LR CRCW0805	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	P5/RT1	B5
			10 000	P0/RT5	
			20 000	PN/RT6	BN
D25LR CRCW1206	8 mm	180 mm/7" 255 mm/10" 330 mm/13"	5000	P5/RT1	B5
			10 000	P0/RT5	
			20 000	PN/RT6	BN
CRCW1210	8 mm	180 mm/7" 330 mm/13"	5000 20 000	P5/RT1 PN/RT6	B5 BN
CRCW1218	12 mm	180 mm/7"	4000		RT9
CRCW2010	12 mm	180 mm/7"	4000		R02
CRCW2512	12 mm	180 mm/7"	2000		R67
			4000		R82

**Notes**

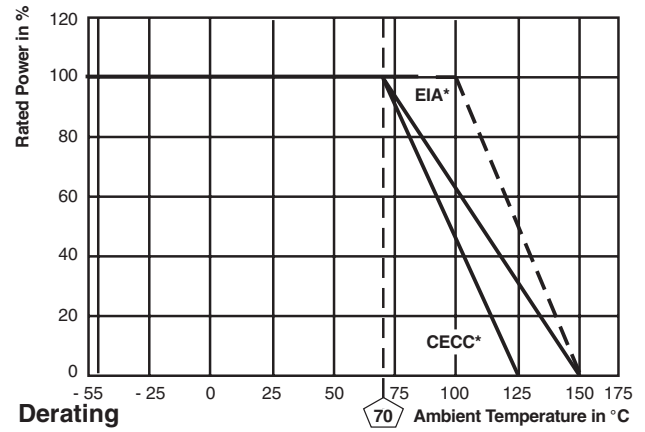
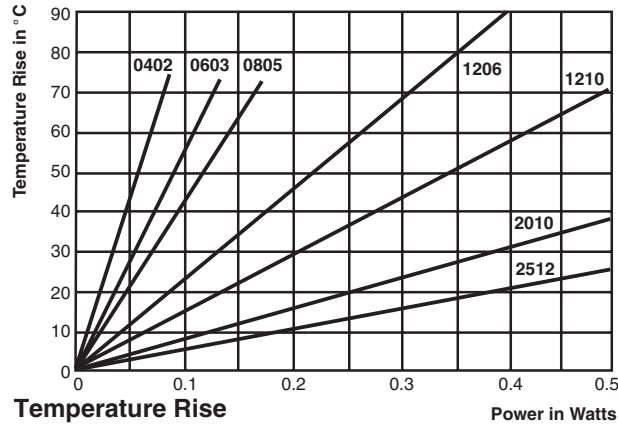
- 1. European/N. American packaging codes
- Further information about packaging: see appropriate catalog or web page

**DIMENSIONS**

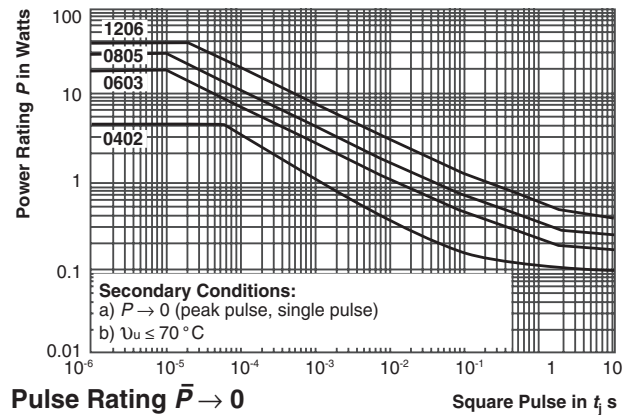
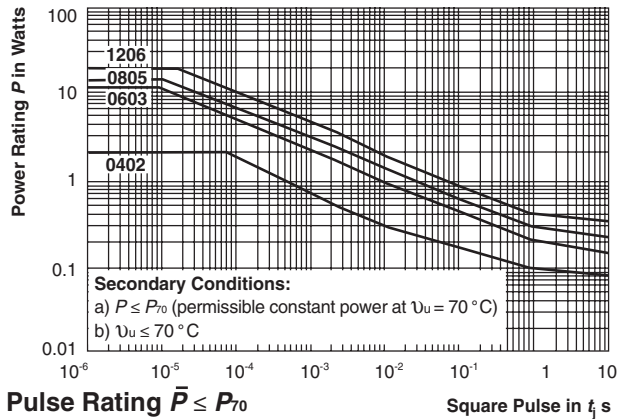


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 <sup>+0.05</sup> / <sub>-0.10</sub>	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> / <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> / <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> / <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> / <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1218	3246	3.2 <sup>+0.10</sup> / <sub>-0.20</sub>	4.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.2	0.6 ± 0.2

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
1218	3246	1.05	4.9	1.9	1.25	4.8	1.9
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2



\* There are differences in board layout and measurements between CECC and EIA.



PERFORMANCE		
TEST	CONDITIONS OF TEST	REQUIREMENTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	$\leq \pm 2\%$
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	$\leq \pm 0.5\%$
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds	$\leq \pm 1\%$
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	$\leq \pm 1\%$
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	$\leq \pm 2\%$
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	$\leq \pm 1\%$

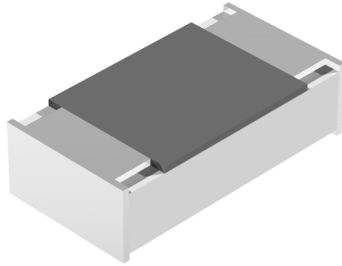
**Note**

1. Limits for change of resistance at test

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>• CECC40000/40400/40401-802</li> <li>• IEC 60115 - 1</li> <li>• EIA 575</li> </ul>



## Low Ohmic Flat Chip Resistors



NCS 0402, NCT 0603 and NCU 0805 low ohmic flat chip resistors are best suited where low resistance paired with high stability and high reliability is required. Typical applications include current sensors and shunts in power supplies and battery chargers. Other demands for low ohmic resistors come from the computer industry.

### FEATURES

- Unique low ohmic chip resistor
- Standard TCR:  $\pm 100$  ppm/K
- Excellent overall stability
- Wide low ohmic range:  $0.1 \Omega$  to  $< 1 \Omega$
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Power supplies
- Battery chargers
- Computer industry

### METRIC SIZE

INCH:	0402	0603	0805
METRIC:	RR 1005M	RR 1608M	RR 2012M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	NCS 0402		NCT 0603		NCU 0805		
Metric size	RR 1005M		RR 1608M		RR 2012M		
Resistance range	0.1 $\Omega$ to 0.91 $\Omega$		0.1 $\Omega$ to 0.91 $\Omega$		0.1 $\Omega$ to 0.91 $\Omega$		
Resistance tolerance	$\pm 5 \%$						
Temperature coefficient	$\pm 100$ ppm/K						
Operation mode	standard	power	standard	power	standard	power	
Climatic category (LCT/UCT/days)	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56	55/155/56	
Rated dissipation, $P_{70}^{1)}$	0.063 W	0.1 W	0.1 W	0.125 W	0.125 W	0.2 W	
Operating voltage, $U_{max}$ AC/DC	limited by $P_{70}$						
Film temperature	125 $^{\circ}$ C	155 $^{\circ}$ C	125 $^{\circ}$ C	155 $^{\circ}$ C	125 $^{\circ}$ C	155 $^{\circ}$ C	
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	0.1 $\Omega$ to 0.91 $\Omega$		0.1 $\Omega$ to 0.91 $\Omega$		0.1 $\Omega$ to 0.91 $\Omega$		
	1000 h	$\leq 1 \%$	$\leq 2 \%$	$\leq 1 \%$	$\leq 2 \%$	$\leq 1 \%$	$\leq 2 \%$
	8000 h	$\leq 2 \%$	$\leq 3 \%$	$\leq 2 \%$	$\leq 3 \%$	$\leq 2 \%$	$\leq 3 \%$
Specified lifetime	8000 h						
Insulation voltage:	75 V		100 V		200 V		
	1 minute; $U_{ins}$	75 V	75 V	75 V	75 V	75 V	
Failure rate	$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$		

### Note

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



**12NC INFORMATION**

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the last digit of 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

RESISTANCE DECADE	LAST DIGIT
0.1 Ω to 0.99 Ω	7

**12NC Example**

The 12 NC of a NCT 0603 resistor, value 0.22 Ω and TCR 100 with ± 5 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 219 32207.

12NC - RESISTOR TYPE AND PACKAGING					
DESCRIPTION			ORDERING CODE 2312 ... ..		
			CARDBOARD TAPE ON REEL		
TYPE	TCR	TOL.	P5 5000 UNITS	PW 20 000 UNITS	E0 10 000 UNITS
NCS 0402	± 100 ppm/K	± 5 %			279 3....
NCT 0603			219 3....	209 3....	
NCU 0805			259 3....	249 3....	

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

**PART NUMBER<sup>2)</sup>: NCT06030B2207JPW00**

N	C	T	0	6	0	3	0	B	2	2	0	7	J	P	W	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

<b>MODEL/SIZE</b> NCS0402 NCT0603 NCU0805	<b>SPECIAL CHARACTER</b> 0 = neutral	<b>TCR</b> B = ± 100 ppm/K	<b>VALUE</b> 3 digit value 1 digit multiplier Multiplier 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup>	<b>TOLERANCE</b> J = ± 5 %	<b>PACKAGING<sup>3)</sup></b> P5 PW E0	<b>SPECIAL</b> up to 2 digits 00 = standard
--	---	-------------------------------	--	-------------------------------	---	---

**PRODUCT DESCRIPTION: NCT 0603-100 5 % P5 R22**

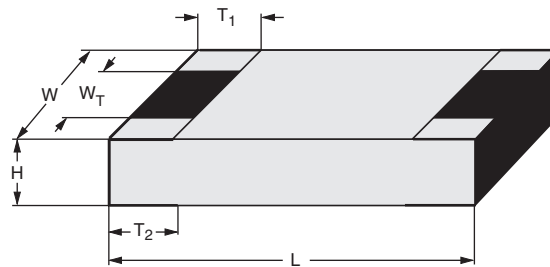
NCT	0603	- 100	5 %	P5	R22
MODEL	SIZE	TCR	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
NCS NCT NCU	0402 0603 0805	± 100 ppm/K	± 5 %	P5 PW E0	R56 = 0.56 Ω R1 = 0.1 Ω

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, page 150.

PACKAGING		
MODEL	REEL	
	PIECES/PAPER TAPE ON REEL	CODE
NCS0402	10 000	E0
NCT0603	5000	P5
	20 000	PW
NCU0805	5000	P5
	20 000	PW

## DIMENSIONS



DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
NCS 0402	0.32 ± 0.5	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
NCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
NCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>		
TCR	TOLERANCE	NCS 0402	NCT 0603	NCU 0805
± 100 ppm/K	± 5 %	0.1 Ω to 0.91 Ω	0.1 Ω to 0.91 Ω	0.1 Ω to 0.91 Ω

### Note

1. Resistance values to be selected from E24 series.

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A highly conductive film is built on a super high grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Optimised inner contacts are built on both sides of the substrate. A special laser is used to achieve the target value by smoothly cutting the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60 286-3**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

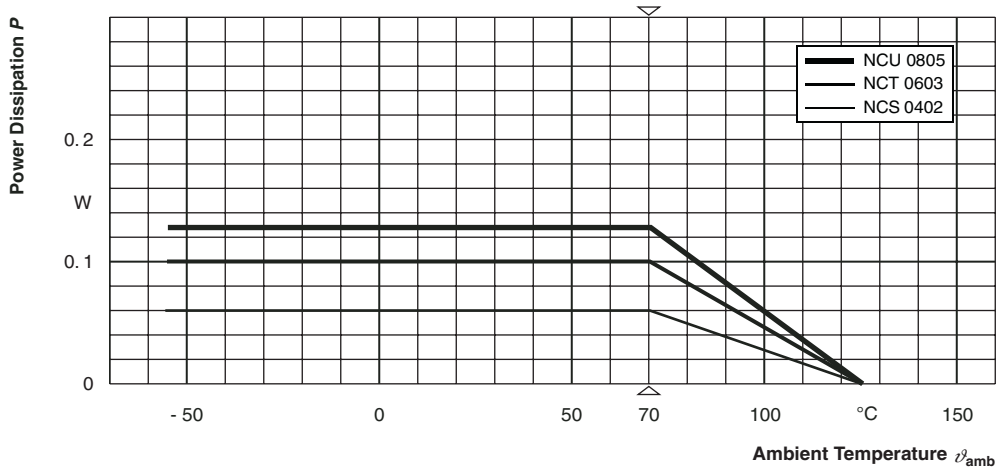
**APPROVALS**

The resistors are tested in accordance with **EN 140 401-802** (superseding **CECC 40 401-802**) which refers to **EN 60115-1** and **EN 140 400**.

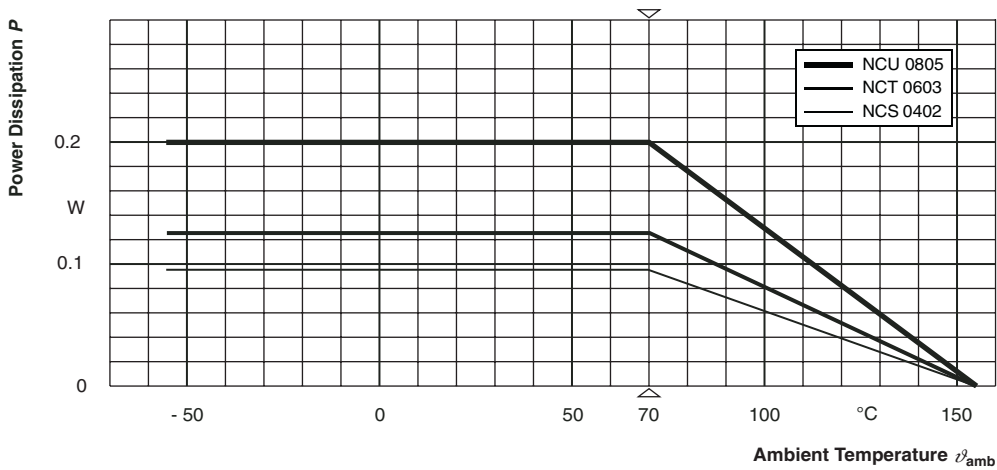
BCcomponents BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with EN 100 114-1.



**FUNCTIONAL PERFORMANCE**



**Derating - Standard Operation**



**Derating - Power Operation**



**TESTS AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

- EN 60115-1, Generic specification (includes tests)
- EN 140 400, Sectional specification (includes schedule for qualification approval)
- EN 140 401-802, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following tables contain only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45 % to 75 %
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-802. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			<b>NCS 0402</b>	0.1 $\Omega$ to 0.91 $\Omega$
			<b>NCT 0603</b>	0.1 $\Omega$ to 0.91 $\Omega$
			<b>NCU 0805</b>	0.1 $\Omega$ to 0.91 $\Omega$
4.5	–	resistance		$\pm 5 \%$
4.8.4.2	–	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 100$ ppm/K
4.25.1	–	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ ; 1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (1 \% R + 0.01 \Omega)$  $\pm (2 \% R + 0.01 \Omega)$
	–	endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R}$ 1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (2 \% R + 0.01 \Omega)$  $\pm (3 \% R + 0.01 \Omega)$

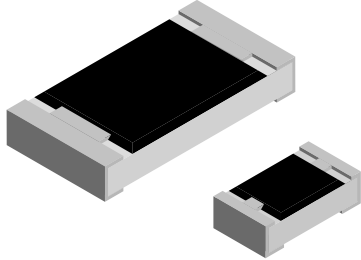
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			<b>NCS 0402</b>	0.1 $\Omega$ to 0.91 $\Omega$
			<b>NCT 0603</b>	0.1 $\Omega$ to 0.91 $\Omega$
			<b>NCU 0805</b>	0.1 $\Omega$ to 0.91 $\Omega$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (2 \% R + 0.01 \Omega)$ $\pm (3 \% R + 0.01 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (1 \% R + 0.01 \Omega)$
4.23		climatic sequence:		
4.23.2	2 (Ba)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; > 90 % RH; 1 cycle	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; 25 $\pm$ 10 °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	$\pm (1 \% R + 0.01 \Omega)$
–	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.5 \% R + 0.01 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles LCT = - 55 °C; UCT = 125 °C; 1000 cycles	$\pm (0.5 \% R + 0.01 \Omega)$ no visible damage  $\pm (1 \% R + 0.01 \Omega)$ no visible damage
4.13	–	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ ; 5 s	$\pm (0.5 \% R + 0.01 \Omega)$
		short time overload; power operation mode		$\pm (1 \% R + 0.01 \Omega)$
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq$ 1.5 mm or $\leq$ 200 m/s <sup>2</sup> ; 6 h	$\pm (0.5 \% R + 0.01 \Omega)$ no visible damage



TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			NCS 0402	0.1 $\Omega$ to 0.91 $\Omega$
			NCT 0603	0.1 $\Omega$ to 0.91 $\Omega$
			NCU 0805	0.1 $\Omega$ to 0.91 $\Omega$
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) $^{\circ}$ C; (3 $\pm$ 0.3) s	good tinning ( $\geq$ 95 % covered); no visible damage
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) $^{\circ}$ C; (2 $\pm$ 0.2) s	
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	$\pm$ (0.5 % $R$ + 0.05 $\Omega$ ) no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 $^{\circ}$ C; method 2	no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1005M and RR 1608M; 9N RR 2012M; 45N	no visible damage
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm$ (0.5 % $R$ + 0.01 $\Omega$ ) no visible damage, no open circuit in bent position
4.7	–	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s	no flashover or breakdown
4.35	–	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s



## Lead (Pb)-free Thick Film, Rectangular, High Value Resistors



### FEATURES



- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni Barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Suitable for voltage dividers and hybrids

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70^{\circ}\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D11/CRCW0603-HR	0603	1608	0.1	75	$\pm 500$	$\pm 5$	11M - 470M	24
D12/CRCW0805-HR	0805	2012	0.125	150	$\pm 500$	$\pm 5$	11M - 470M	24
D25/CRCW1206-HR	1206	3216	0.25	200	$\pm 500$	$\pm 5$	11M - 470M	24

#### Notes

- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web page

### TECHNICAL SPECIFICATIONS

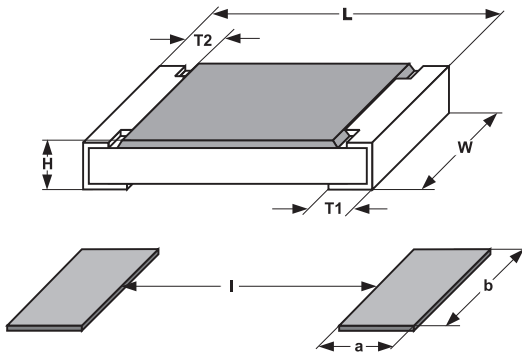
PARAMETER	UNIT	D11/CRCW0603-HR	D12/CRCW0805-HR	D25/CRCW1206-HR
Rated Dissipation at 70 °C	W	0.1	0.125	0.25
Limiting Element Voltage <sup>2)</sup>	$V_{\equiv}$	75	150	200
Voltage Coefficient	%/V	$< 100\text{M}: < 0.1/> 100\text{M}: < 0.3$		
Insulation Voltage (1 min)	$V_{\text{dc/ac peak}}$	$> 100$	$> 200$	$> 300$
Thermal Resistance	K/W	$\leq 550^{1)}$	$\leq 440^{1)}$	$\leq 220^{1)}$
Insulation Resistance	$\Omega$	$> 10^9$		
Category Temperature Range	$^{\circ}\text{C}$	$- 55 \text{ to } + 125 (+ 155)$		
Weight/1000 pcs	g	2	5.5	10

#### Notes

1. Measuring conditions in acc. to CECC 40401 - 802
2. Rated voltage:  $\sqrt{P \times R}$



**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2

**Note**  
For solder pad dimensions see D...CRCW...LR

**PART NUMBER AND PRODUCT DESCRIPTION D../CRCW....-HR e3 SERIES**

Part Numbering: CRCW060314M0JPEAHR

C	R	C	W	0	6	0	3	1	4	M	0	J	P	E	A	H	R
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

MODEL/SIZE CRCW0603 CRCW0805 CRCW1206	VALUE M = million	TOLERANCE J = ± 5 %	TCR P = ± 500 ppm/K	PACKAGING <sup>1)</sup> EA = ET1 EB = ET5 EC = ET6 EI = EG1 EL = E20	SPECIAL up to 2 digits HR = High Value
--	----------------------	------------------------	------------------------	---	--

Product Description: D11/CRCW0603-HR 500 14M 5 % ET1 e3

D11/CRCW0603-HR	500	14M	5 %	ET1	e3
MODEL D11/CRCW0603-HR D12/CRCW0805-HR D25/CRCW1206-HR	TCR ± 500 ppm/K	RESISTANCE VALUE 68M = 68 MΩ 227M = 227 MΩ	TOLERANCE ± 5 %	PACKAGING <sup>1)</sup> ET1 ET5 ET6 EG1 E20	LEAD (Pb)-FREE e3 = Pure Tin Termination Finish

**Note**  
1. Please refer to table PACKAGING, page 158.

PACKAGING						
MODEL	REEL					
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PACKAGING CODE	
					PAPER	BLISTER
D11/CRCW0603-HR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1
		255 mm/10"	10 000	4 mm	ET5	
		330 mm/13"	20 000	4 mm	ET6	E20
D12/CRCW0805-HR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1
		255 mm/10"	10 000	4 mm	ET5	
		330 mm/13"	20 000	4 mm	ET6	E20
D25/CRCW1206-HR	8 mm	180 mm/7"	5 000	4 mm	ET1	EG1
		255 mm/10"	10 000	4 mm	ET5	
		330 mm/13"	20 000	4 mm	ET6	E20

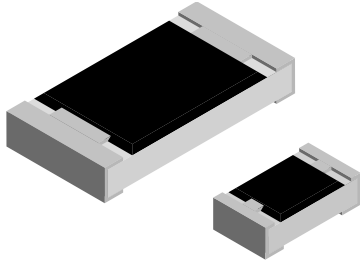
PERFORMANCE		
TEST	CONDITIONS OF TEST	REQUIREMENTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 2 %
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 2 %
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds	≤ ± 2 %
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 1 %
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 2 %
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 1 %

**Note**

1. Limits for change of resistance at test

APPLICABLE SPECIFICATIONS	
• EN 60115-1	Generic Specification
• EN 140400	Sectional Specification
• EN 140401-802	Detail Specification
• IEC 60068-2-X	Variety of environmental test procedures
• IEC 60286-3	Packaging of SMD components

## Thick Film, Rectangular, High Value Resistors



### FEATURES

- Thick film on high quality ceramic
- Protective over glaze passivation
- SnPb contacts on Ni barrier layer
- Silver palladium contacts for conductive adhesive attachment on request
- Suitable for voltage dividers and hybrids

STANDARD ELECTRICAL SPECIFICATIONS								
MODEL	SIZE		POWER RATING $P_{70\text{ }^{\circ}\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D11HR CRCW0603	0603	1608	0.1	75	$\pm 500$	$\pm 5$	11M - 470M	24
D12HR CRCW0805	0805	2012	0.125	150	$\pm 500$	$\pm 5$	11M - 470M	24
D25HR CRCW1206	1206	3216	0.25	200	$\pm 500$	$\pm 5$	11M - 470M	24

### Notes

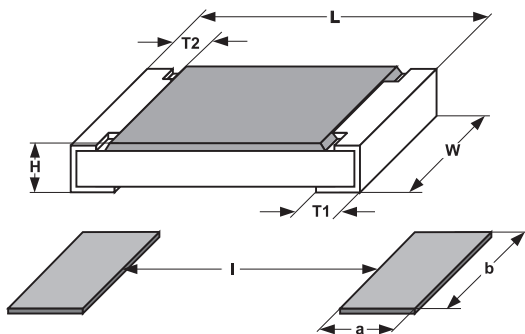
- Ask about further value ranges
- Marking and packaging: see appropriate catalog or web page

TECHNICAL SPECIFICATIONS				
PARAMETER	UNIT	D11 CRCW0603	D12 CRCW0805	D25 CRCW1206
Rated Dissipation at 70 °C	W	0.1	0.125	0.25
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	75	150	200
Voltage Coefficient	%/V	< 100M: < 0.1/> 100M: < 0.3		
Insulation Voltage (1 min)	$V_{dc/ac\ peak}$	> 100	> 200	> 300
Thermal Resistance	K/W	$\leq 550^{1)}$	$\leq 440^{1)}$	$\leq 220^{1)}$
Insulation Resistance	$\Omega$	> $10^9$		
Category Temperature Range	$^{\circ}\text{C}$	- 55 to + 125 (+ 155)		
Weight/1000 pcs	g	2	5.5	10

### Notes

1. Measuring conditions in acc. to CECC 40401-802
2. Rated voltage:  $\sqrt{P \times R}$

**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2

**Note**  
For solder pad dimensions see D...CRCW...LR

<b>PART NUMBER AND PRODUCT DESCRIPTION</b>																										
<b>PART NUMBER: D120805P1405JP0HR</b>																										
D	1	2	0	8	0	5																				
0	P	1	4	0	5	J																				
P	0	H	R																							
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>MODEL/SIZE</th></tr> <tr><td>D110603 D120805 D251206</td></tr> </table>	MODEL/SIZE	D110603 D120805 D251206	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>SPECIAL CHARACTER</th></tr> <tr><td>0 = neutral</td></tr> </table>	SPECIAL CHARACTER	0 = neutral	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>TCR</th></tr> <tr><td>P = ± 500 ppm/K</td></tr> </table>	TCR	P = ± 500 ppm/K	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>VALUE</th></tr> <tr><td>3 digit value 1 digit multiplier</td></tr> <tr><th>MULTIPLIER</th></tr> <tr><td>7 = *10<sup>-3</sup>    2 = *10<sup>2</sup></td></tr> <tr><td>8 = *10<sup>-2</sup>    3 = *10<sup>3</sup></td></tr> <tr><td>9 = *10<sup>-1</sup>    4 = *10<sup>4</sup></td></tr> <tr><td>0 = *10<sup>0</sup>    5 = *10<sup>5</sup></td></tr> <tr><td>1 = *10<sup>1</sup>    6 = *10<sup>6</sup></td></tr> </table>	VALUE	3 digit value 1 digit multiplier	MULTIPLIER	7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup>	8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup>	9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup>	0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup>	1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup>	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>TOLERANCE</th></tr> <tr><td>J = ± 5 %</td></tr> </table>	TOLERANCE	J = ± 5 %	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>PACKAGING<sup>1)</sup></th></tr> <tr><td>P5 P0 PN B5 BN</td></tr> </table>	PACKAGING <sup>1)</sup>	P5 P0 PN B5 BN	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>SPECIAL</th></tr> <tr><td>up to 2 digits HR = High Value</td></tr> </table>	SPECIAL	up to 2 digits HR = High Value
MODEL/SIZE																										
D110603 D120805 D251206																										
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0 = neutral																										
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PACKAGING <sup>1)</sup>																										
P5 P0 PN B5 BN																										
SPECIAL																										
up to 2 digits HR = High Value																										
<b>PRODUCT DESCRIPTION: D12HR 500 14M 5% P0</b>																										
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>D12HR</th></tr> <tr><td>MODEL</td></tr> <tr><td>D11HR D12HR D25HR</td></tr> </table>	D12HR	MODEL	D11HR D12HR D25HR	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>500</th></tr> <tr><td>TCR</td></tr> <tr><td>± 500 ppm/K</td></tr> </table>	500	TCR	± 500 ppm/K	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>14M</th></tr> <tr><td>RESISTANCE VALUE</td></tr> <tr><td>68M = 48 MΩ 220M = 220 MΩ</td></tr> </table>	14M	RESISTANCE VALUE	68M = 48 MΩ 220M = 220 MΩ	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>5 %</th></tr> <tr><td>TOLERANCE</td></tr> <tr><td>± 5 %</td></tr> </table>	5 %	TOLERANCE	± 5 %	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>P0</th></tr> <tr><td>PACKAGING<sup>1)</sup></td></tr> <tr><td>P5 P0 PN B5 BN</td></tr> </table>	P0	PACKAGING <sup>1)</sup>	P5 P0 PN B5 BN							
D12HR																										
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5 %																										
TOLERANCE																										
± 5 %																										
P0																										
PACKAGING <sup>1)</sup>																										
P5 P0 PN B5 BN																										
<b>PART NUMBER: CRCW060314M0JPTBHR</b>																										
C	R	C	W	0	6	0																				
3	1	4	M	0	J	P																				
T	B	H	R																							
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>MODEL/SIZE</th></tr> <tr><td>CRCW0603 CRCW0805 CRCW1206</td></tr> </table>	MODEL/SIZE	CRCW0603 CRCW0805 CRCW1206	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>VALUE</th></tr> <tr><td>M = million</td></tr> </table>	VALUE	M = million	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>TOLERANCE</th></tr> <tr><td>J = ± 5 %</td></tr> </table>	TOLERANCE	J = ± 5 %	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>TCR</th></tr> <tr><td>P = ± 500 ppm/K</td></tr> </table>	TCR	P = ± 500 ppm/K	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>PACKAGING<sup>1)</sup></th></tr> <tr><td>TA = RT1 TB = RT5 TC = RT6</td></tr> </table>	PACKAGING <sup>1)</sup>	TA = RT1 TB = RT5 TC = RT6	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>SPECIAL</th></tr> <tr><td>up to 2 digits HR = High Value</td></tr> </table>		SPECIAL	up to 2 digits HR = High Value								
MODEL/SIZE																										
CRCW0603 CRCW0805 CRCW1206																										
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<b>PRODUCT DESCRIPTION: CRCW0603 146 J 500 RT5</b>																										
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>CRCW0603</th></tr> <tr><td>MODEL</td></tr> <tr><td>CRCW0603 CRCW0805 CRCW1206</td></tr> </table>	CRCW0603	MODEL	CRCW0603 CRCW0805 CRCW1206	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>146</th></tr> <tr><td>RESISTANCE VALUE</td></tr> <tr><td>146 = 14 MΩ 686 = 68 MΩ 227 = 220 MΩ</td></tr> </table>	146	RESISTANCE VALUE	146 = 14 MΩ 686 = 68 MΩ 227 = 220 MΩ	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>J</th></tr> <tr><td>TOLERANCE</td></tr> <tr><td>± 5 %</td></tr> </table>	J	TOLERANCE	± 5 %	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>500</th></tr> <tr><td>TCR</td></tr> <tr><td>± 500 ppm/K</td></tr> </table>	500	TCR	± 500 ppm/K	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>RT5</th></tr> <tr><td>PACKAGING<sup>1)</sup></td></tr> <tr><td>RT1 RT5 RT6</td></tr> </table>	RT5	PACKAGING <sup>1)</sup>	RT1 RT5 RT6							
CRCW0603																										
MODEL																										
CRCW0603 CRCW0805 CRCW1206																										
146																										
RESISTANCE VALUE																										
146 = 14 MΩ 686 = 68 MΩ 227 = 220 MΩ																										
J																										
TOLERANCE																										
± 5 %																										
500																										
TCR																										
± 500 ppm/K																										
RT5																										
PACKAGING <sup>1)</sup>																										
RT1 RT5 RT6																										
± 5 % = 2 sig. digits, plus multiplier																										

**Note**

1. Please refer to table PACKAGING, page 161.



PACKAGING					
MODEL	REEL				
	TAPE WIDTH	DIAMETER	PIECES/REEL	PACKING CODE	
				PAPER <sup>1)</sup>	BLISTER
D11 _____ CRCW0603	8 mm	180 mm/7"	5000	P5/RT1	B5
		255 mm/10"	10 000	P0/RT5	
		330 mm/13"	20 000	PN/RT6	BN
D12 _____ CRCW0805	8 mm	180 mm/7"	5000	P5/RT1	B5
		255 mm/10"	10 000	P0/RT5	
		330 mm/13"	20 000	PN/RT6	BN
D25 _____ CRCW1206	8 mm	180 mm/7"	5000	P5/RT1	B5
		255 mm/10"	10 000	P0/RT5	
		330 mm/13"	20 000	PN/RT6	BN

**Note**

1. European/N. American packaging codes

PERFORMANCE		
TEST	CONDITIONS OF TEST	REQUIREMENTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 2 %
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 2 %
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds	≤ ± 2 %
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 1 %
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 2 %
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 1 %

**Note**

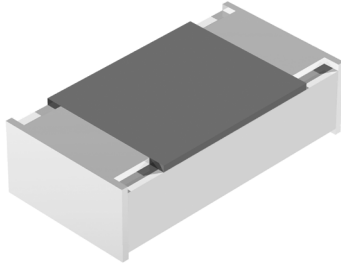
1. Limits for change of resistance at test



## APPLICABLE SPECIFICATIONS

- CECC40000/40400/40401-802
- EIA 575
- EN140400/IEC 60115 - 1

## High Ohmic Flat Chip Resistors



OCT 0603 and OCU 0805 high ohmic flat chip resistors are best suited where high resistance, high stability and high reliability are required. Typical applications include any kind of battery driven electronics, particularly low consumption CMOS circuitry.

### FEATURES

- Unique very high ohmic chip resistor product
- Standard TCR:  $\pm 100$  ppm/K
- Excellent overall stability
- Low voltage coefficient: 0.05 %/V
- Wide high ohmic range:  $> 10$  M $\Omega$  to 130 M $\Omega$
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Any kind of battery driven electronics
- Low consumption CMOS circuitry
- Small signal measurement

### METRIC SIZE

INCH:	0603	0805
METRIC:	RR 1608M	RR 2012M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	OCT 0603		OCU 0805		
Metric size	RR 1608M		RR 2012M		
Resistance range	11 M $\Omega$ to 130 M $\Omega$		11 M $\Omega$ to 130 M $\Omega$		
Resistance tolerance	$\pm 5$ %				
Temperature coefficient	$\pm 250$ ppm/K; $\pm 100$ ppm/K				
Operation mode	standard	power	standard	power	
Climatic category (LCT/UCT/days)	55/125/56	55/155/56	55/125/56	55/155/56	
Rated dissipation, $P_{70}^{(1)}$	limited by $U_{max}$				
Operating voltage, $U_{max}$ AC/DC	75 V	150 V	150 V	200 V	
Film temperature	125 °C	155 °C	125 °C	155 °C	
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	11 M $\Omega$ to 47 M $\Omega$		11 M $\Omega$ to 47 M $\Omega$		
	1000 h	$\leq 1$ %	$\leq 2$ %	$\leq 1$ %	$\leq 2$ %
	8000 h	$\leq 2$ %	$\leq 4$ %	$\leq 2$ %	$\leq 4$ %
Specified lifetime	8000 h				
Insulation voltage:	100 V		200 V		
	1 minute; $U_{ins}$	75 V	75 V	75 V	
Failure rate	$\leq 2 \times 10^{-9}$ /h		$\leq 2 \times 10^{-9}$ /h		

#### Note

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



**12NC INFORMATION**

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

RESISTANCE DECADE	LAST DIGIT
10 MΩ to 99.9 MΩ	6

**Last Two Digits Indicating Sequential Code Number**

RESISTANCE VALUE	LAST DIGITS
100 MΩ	01
110 MΩ	02
120 MΩ	03
130 MΩ	04

**12NC Example**

The 12 NC of a OCT 0603 resistor, value 51 MΩ and TC 250 with ± 5 % tolerance, supplied in cardboard tape of 20000 units per reel is: 2312 209 35106.

The 12 NC of a OCT 0603 resistor, value 130 MΩ and TC 250 with ± 5 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 219 90104.

12NC - resistor type and packaging					
DESCRIPTION				ORDERING CODE 2312 ... ..	
				CARDBOARD TAPE ON REEL	
TYPE	TCR	TOL.	RESISTANCE VALUE	P5 5000 UNITS	PW 20 000 UNITS
OCT 0603	± 250 ppm/K	± 5 %	51 MΩ to 91 MΩ ≥ 100 MΩ <sup>1)</sup>	219 3.... 219 901..	209 3.... 209 901..
	± 100 ppm/K	± 5 %	11 MΩ to 47 MΩ	<b>219 3....</b>	209 3....
OCU 0805	± 250 ppm/K	± 5 %	51 MΩ to 91 MΩ ≥ 100 MΩ <sup>1)</sup>	259 3.... 259 901..	249 3.... 249 901..
	± 100 ppm/K	± 5 %	11 MΩ to 47 MΩ	<b>259 3....</b>	249 3....

**Note**

1. Readable coding of resistance values is restricted to values below 100 MΩ. For resistance values from 100 MΩ onwards, refer to the pre-defined Table of non-readable sequential numbers above.

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

**PART NUMBER AND PRODUCT DESCRIPTION<sup>2)</sup>**

**PART NUMBER<sup>3)</sup>: OCT06030B5106JP500**

O	C	T	0	6	0	3	0	B	5	1	0	6	J	P	5	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>4)</sup>	SPECIAL
OCT0603 OCU0805	0 = neutral	B = ± 100 ppm/K W = ± 250 ppm/K	<b>For &gt; 99.9 MΩ</b> 2 digit fix number = 01 2 digit annex <b>Annex</b> 01 = 100 MΩ 02 = 110 MΩ 03 = 120 MΩ 04 = 130 MΩ <b>For 10 MΩ to 99.9 MΩ</b> 3 digit value 1 digit multiplier 6 = *10 <sup>5</sup>	J = ± 5 %	P5 PW	up to 2 digits 00 = standard

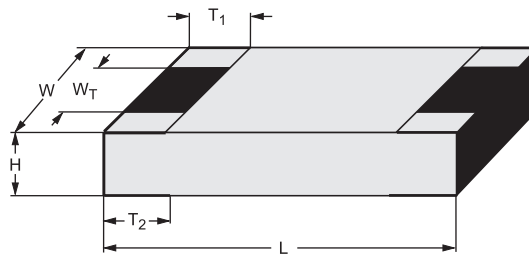
**PRODUCT DESCRIPTION: OCT 0603 -100 5% P5 51M**

OCT	0603	-100	5 %	P5	51M
MODEL	SIZE	TCR	TOLERANCE	PACKAGING <sup>4)</sup>	RESISTANCE VALUE
OCT OCU	0603 0805	± 100 ppm/K ± 250 ppm/K	± 5 %	P5 PW	47M = 47 MΩ 220M = 220 MΩ

**Notes**

2. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
3. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
4. Please refer to table PACKAGING, page 165.

PACKAGING		
MODEL	REEL	
	PIECES/ PAPER TAPE ON REEL	CODE
OCT0603	5000	P5
	20 000	PW
OCU0805	5000	P5
	20 000	PW

**DIMENSIONS**


DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
OCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
OCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE			
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>	
TCR	TOLERANCE	OCT 0603	OCU 0805
± 250 ppm/K	± 5 %	51 MΩ to 130 MΩ	51 MΩ to 130 MΩ
± 100 ppm/K	± 5 %	11 MΩ to 47 MΩ	11 MΩ to 47 MΩ

**Note**

1. Resistance values to be selected from E24 series.

**Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.**

**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A newly developed cermet layer is deposited on a super high grade ( $\text{Al}_2\text{O}_3$ ) ceramic substrate and conditioned to achieve the desired temperature coefficient. Inner contacts are built on both sides of the substrate. A special laser is used to achieve the target value by smoothly cutting the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

**APPROVALS**

The resistors are tested in accordance with **EN 140 401-802** (superseding **CECC 40 401-802**) which refers to **EN 60115-1** and **EN 140 400**.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**.



**TESTS AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-802, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated

temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

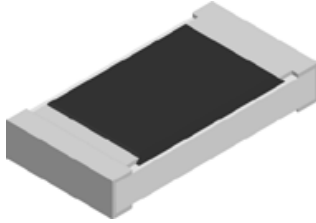
The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-802. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			<b>OCT 0603</b>	11 M $\Omega$ to 130 M $\Omega$
			<b>OCU 0805</b>	11 M $\Omega$ to 130 M $\Omega$
4.5	–	resistance	$U = 100 V$	$\pm 5 \%$
4.8.4.2	–	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 250 \text{ ppm/K}; \pm 100 \text{ ppm/K}$
4.25.1	–	endurance at 70 °C: standard operation mode	$U = U_{\text{max}};$ 1.5 h on; 0.5 h off 70 °C; 1000 h 70 °C; 8000 h	$\pm 1 \%$ $\pm 2 \%$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm 2 \%$ $\pm 3 \%$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm 1 \%$
4.23 4.23.2 4.23.3	2 (Ba) 30 (Db)	climatic sequence: dry heat damp heat, cyclic	UCT; 16 h 55 °C; 24 h; > 90 % RH; 1 cycle	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; 25 $\pm$ 10 °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	$\pm 1 \%$ no visible damage
–	1 (Aa)	cold	- 55 °C; 2 h	$\pm 0.5 \%$

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			<b>OCT 0603</b>	11 M $\Omega$ to 130 M $\Omega$
			<b>OCU 0805</b>	11 M $\Omega$ to 130 M $\Omega$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles LCT = - 55 °C; UCT = 125 °C; 1000 cycles	$\pm 0.5\%$ no visible damage $\pm 1\%$ no visible damage
4.13	–	short time overload	$U = 2 \times U_{max}$ ; 5 s	$\pm 0.5\%$
4.27	–	single pulse high voltage overload; standard operation mode	severity no. 4, $U = 2 \times U_{max}$ ; 10 pulses 10 $\mu$ s/700 $\mu$ s	$\pm 1\%$ no visible damage
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq 1.5$ mm or $\leq 200$ m/s <sup>2</sup> ; 6 h	$\pm 0.5\%$ no visible damage
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning (> 95 % covered); no visible damage
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm 0.5\%$ no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 °C; method 2	no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1608M; 9 N RR 2012M; 45 N	no visible damage
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm 0.5\%$ no visible damage, no open circuit in bent position
4.7	–	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s	no flashover or breakdown
4.35	–	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s

## Lead (Pb)-free Thick Film, Rectangular Trimmable, Resistor Chips


**FEATURES**

- Metal glaze on high quality ceramic
- Protective overglaze
- Lead (Pb)-free solder contacts on Ni Barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Can be trimmed to required value after insertion
- For applications in precision circuitry where relative tolerances can be compensated by trimming


**STANDARD ELECTRICAL SPECIFICATIONS**

MODEL	SIZE		POWER RATING $P_{70^{\circ}\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES	
	INCH	METRIC	CECC 40401-802/EIA-575						
D10/CRCW0402-TR	0402	1005	0.063	50		$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
						$\pm 200$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24
D11/CRCW0603-TR	0603	1608	0.1	75		$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
						$\pm 200$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24
D12/CRCW0805-TR	0805	2012	0.125	150		$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
						$\pm 200$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24
D25/CRCW1206-TR	1206	3216	0.25	200		$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M 10R - 20M	24
						$\pm 200$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M R47 - 20M	24
CRCW1210-TR	1210	3225	0.33	200		$\pm 200$	$\pm 15$	10R - 4M7	24
CRCW2010-TR	2010	5025	0.5	200		$\pm 200$	$\pm 15$	10R - 4M7	24
CRCW2512-TR	2512	6332	1.0	200		$\pm 200$	$\pm 15$	10R - 4M7	24

**Notes**

- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- Values from R10 to R43 with TC500 on request
- Marking: no marking on device, on label only
- Packaging: see appropriate catalog or web page
- Tolerance + 0 ... - 10 % and  $\pm 15$  % for D10 to D25 on request

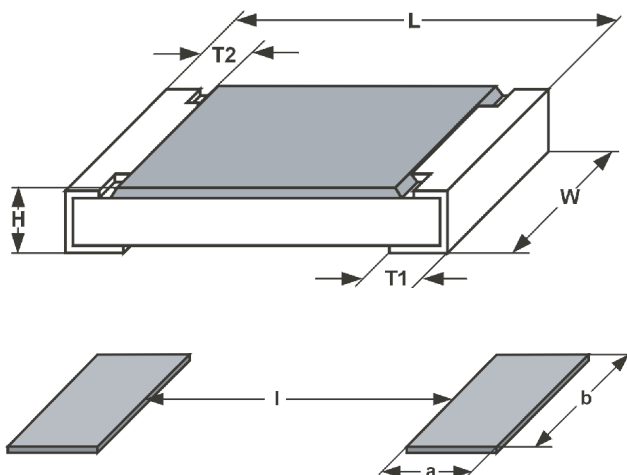
**TECHNICAL SPECIFICATIONS**

PARAMETER	UNIT	D10/ CRCW0402-TR	D11/ CRCW0603-TR	D12/ CRCW0805-TR	D25/ CRCW1206-TR	CRCW1210-TR	CRCW1210-TR	CRCW1210-TR
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.1	0.125	0.25	0.33	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	50	75	150	200	200	200	200
Insulation Voltage (1 min)	$V_{\text{peak}}$	75	100	200	300	300	300	300
Thermal Resistance <sup>1)</sup>	K/W	$\leq 870^1)$	$\leq 550^1)$	$\leq 440^1)$	$\leq 220^1)$	$\leq 140^3)$	$\leq 88^3)$	$\leq 65^3)$
Insulation Resistance	$\Omega$	$> 10^9$						
Category Temperature Range	°C	- 55 to + 125 (+ 155)						
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	40.5

**Notes**

1. Measuring conditions in acc. to CECC 40401-802
2. Rated voltage:  $\sqrt{P \times R}$
3. Depending on solder pad dimensions

**DIMENSIONS**

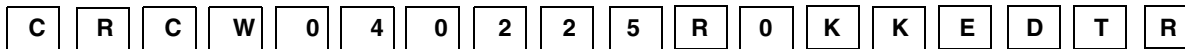


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 <sup>+0.05</sup> <sub>-0.10</sub>	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.25	0.6 ± 0.25
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.25	0.6 ± 0.25

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION D../CRCW....-TR e3 SERIES**

PART NUMBERING: CRCW040225R0KKEDTR



MODEL/SIZE	VALUE	TOLERANCE	TCR	PACKAGING <sup>1)</sup>	SPECIAL
CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW2010 CRCW2512	R = decimal K = thousand M = million	K = ± 10 % L = ± 15 % M = ± 20 % W = ± 0 %/- 30 %	K = ± 100 ppm/K N = ± 200 ppm/K	EA = ET1 EB = ET5 EC = ET6 ED = ET7 EE = EF4 EI = EG1 EL = E20 EF = E02 EG = E67 EH = E82	up to 2 digits TR = Customer Trimmable

PRODUCT DESCRIPTION: D10/CRCW0402-TR 100 25R 10 % ET7 e3

D10/CRCW0402-TR	100	25R	10 %	ET7	e3
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE
D10/CRCW0402-TR D11/CRCW0603-TR D12/CRCW0805-TR D25/CRCW1206-TR CRCW1210-TR CRCW2010-TR CRCW2512-TR	± 100 ppm/K ± 200 ppm/K	49K9 = 49.9 kΩ 5R1 = 5.1 Ω	± 10 % ± 15 % ± 20 % + 0 %/- 30 %	ET1 ET5 ET6 ET7 EF4 EG1 E20 E02 E67 E82	e3 = Pure Tin Termination Finish

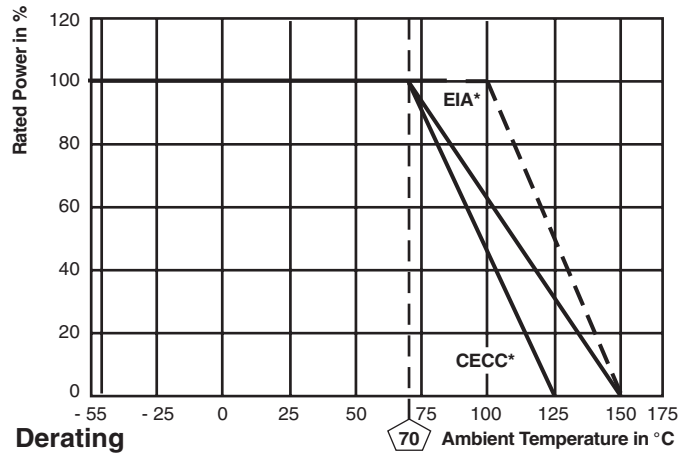
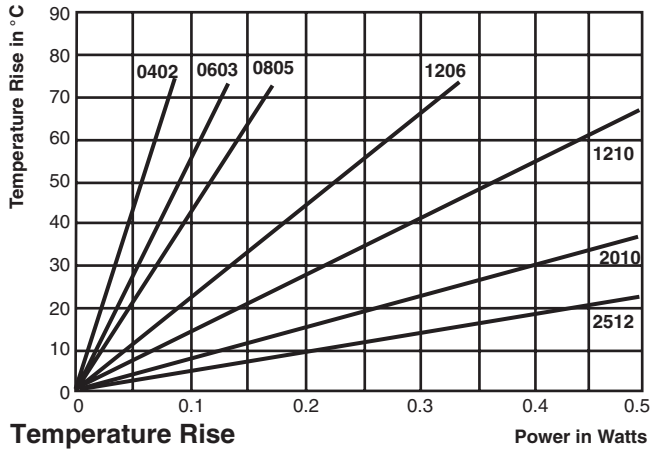
**Note**

1. Please refer to table PACKAGING, page 171.



Lead (Pb)-free Thick Film, Rectangular Trimmable, Resistor Chips

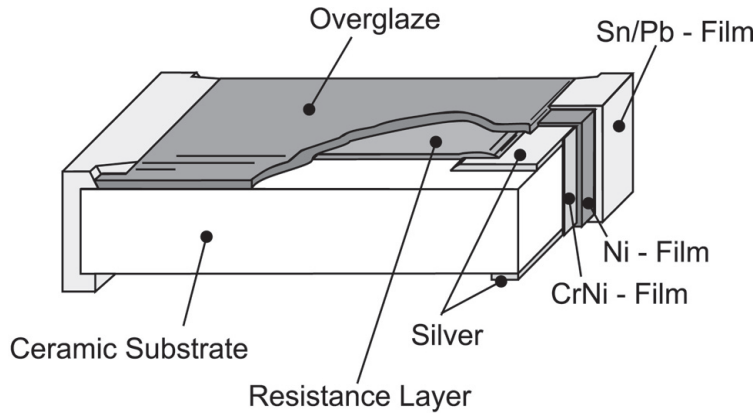
Vishay



\* There are differences in board layout and measurements between CECC and EIA.

PACKAGING							
MODEL	REEL					PACKING CODE	
	TAPE WIDTH	DIAMETER	PIECES/REEL	PITCH	PAPER	BLISTER	
D10/CRCW0402-TR	8 mm	180 mm/7"	10 000	2 mm	ET7		
		330 mm/13"	50 000	2 mm	EF4		
D11/CRCW0603-TR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	
		255 mm/10"	10 000	4 mm	ET5		
		330 mm/13"	20 000	4 mm	ET6	E20	
D12/CRCW0805-TR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	
		255 mm/10"	10 000	4 mm	ET5		
		330 mm/13"	20 000	4 mm	ET6	E20	
D25/CRCW1206-TR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	
		255 mm/10"	10 000	4 mm	ET5		
		330 mm/13"	20 000	4 mm	ET6	E20	
CRCW1210-TR	8 mm	180 mm/7"	5000	4 mm	ET1	EG1	
		330 mm/13"	20 000	4 mm	ET6	E20	
CRCW2010-TR	12 mm	180 mm/7"	4000	4 mm		E02	
CRCW2512-TR	12 mm	180 mm/7"	2000	8 mm		E67	
			4000	4 mm		E82	





**Trimming Instructions:**

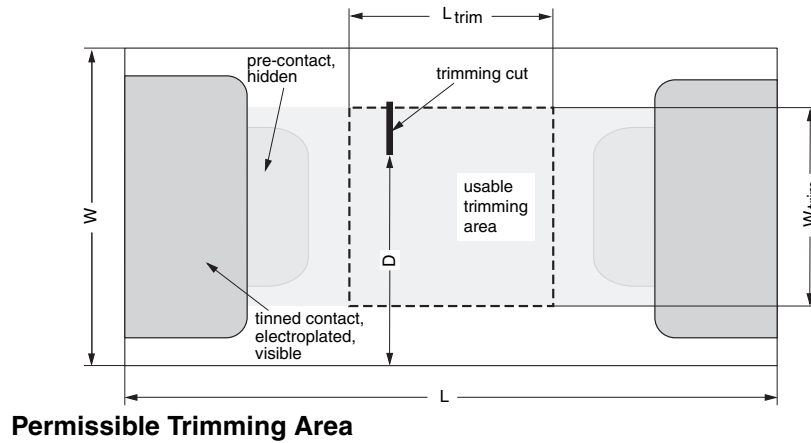
YAG-Laser:

Maximum trimming factor = 1.6 for an I-cut and 1.8 for a L-cut

Double cut: Distance between two cuts = 0.5 mm min

The laser-cut should be protected with epoxy resins

**FUNCTIONAL PERFORMANCE**



Permissible Trimming Area

DIMENSIONS OF THE PERMISSIBLE TRIMMING AREA in millimeters					
MODEL	L	W	$L_{trim}$	$W_{trim}$	D
D10/CRCW0402-TR <sup>1)</sup>	1.0	0.5	$\leq 0.25$	0.27	$\geq 0.25$
D11/CRCW0603-TR	1.55	0.85	$\leq 0.425$	0.5	$\geq 0.425$
D12/CRCW0805-TR	2.0	1.25	$\leq 0.625$	0.85	$\geq 0.625$
D25/CRCW1206-TR	3.2	1.6	$\leq 0.8$	1.0	$\geq 0.8$
CRCW1210-TR	3.2	2.5	$\leq 1.25$	1.6	$\geq 1.25$
CRCW2010-TR	5.0	2.5	$\leq 1.25$	1.9	$\geq 1.25$
CRCW2512-TR	6.3	3.15	$\leq 1.575$	2.4	$\geq 1.575$

**Note**

1. Single cut only



Lead (Pb)-free Thick Film, Rectangular  
Trimmable, Resistor Chips

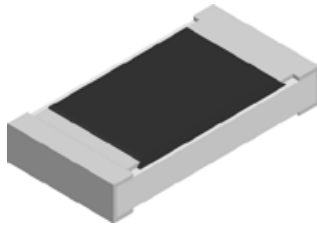
<b>PERFORMANCE</b>				
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>REQUIREMENTS IN %</b>		
		<b>0402 0603</b>	<b>0805 1206 1210</b>	<b>2010 2512</b>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14	Rapid change between upper and lower category temperature	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 0.25	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5

**Note**

1. Limits for change of resistance at test. Data is valid for the non trimmed resistors only. Depending on trimming process some properties can change.

<b>APPLICABLE SPECIFICATIONS</b>	
• EN 60115-1	Generic Specification
• EN 140400	Sectional Specification
• EN 140401-802	Detail Specification
• IEC 60068-2-X	Variety of environmental test procedures
• IEC 60286-3	Packaging of SMD components

## Thick Film, Rectangular, Trimmable, Resistor Chips



### FEATURES

- Thick film on high quality ceramic
- Solder contacts on Ni barrier layer
- Extremely low resistance values (0.1  $\Omega$ )
- Can be trimmed to required value after insertion
- For applications in precision circuitry where relative tolerances can be compensated by trimming

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE MAX $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	CECC 40401-802/EIA-575					
D10TR - - - - - CRCW0402TR	0402	1005	0.063	50	$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
$\pm 200$					$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24	
D11TR - - - - - CRCW0603TR	0603	1608	0.1	75	$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
$\pm 200$					$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24	
D12TR - - - - - CRCW0805TR	0805	2012	0.125	150	$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M	24
$\pm 200$					$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M	24	
D25TR - - - - - CRCW1206TR	1206	3216	0.25	200	$\pm 100$	$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	10R - 10M 10R - 20M	24
$\pm 200$					$\pm 10; \pm 15; \pm 20$ $+ 0/- 30$	R47 - 10M R47 - 20M	24	
CRCW1210TR	1210	3225	0.33	200	$\pm 200$	$\pm 15$	10R - 4M7	24
CRCW2010TR	2010	5025	0.5	200	$\pm 200$	$\pm 15$	10R - 4M7	24
CRCW2512TR	2512	6332	1.0	200	$\pm 200$	$\pm 15$	10R - 4M7	24

#### Notes

- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- Values from R10 to R43 with TC500 on request
- Marking: no marking on device, on label only
- Packaging: see appropriate catalog or web page
- Tolerance + 0 ... - 10 % and  $\pm 15$  % for D10 to D25 on request

### TECHNICAL SPECIFICATIONS

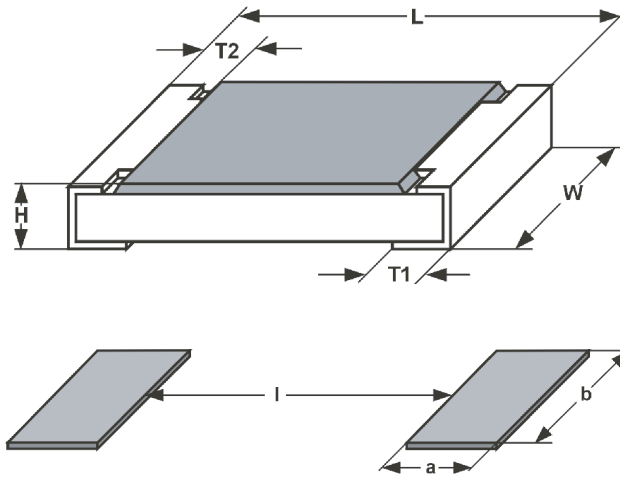
PARAMETER	UNIT	D10TR CRCW0402TR	D11TR CRCW0603TR	D12TR CRCW0805TR	D25TR CRCW1206TR	CRCW1210TR	CRCW2010TR	CRCW2512TR
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.063	0.1	0.125	0.25	0.33	0.5	1.0
Limiting Element Voltage <sup>2)</sup>	$V_{\Xi}$	50	75	150	200	200	200	200
Insulation Voltage (1 min)	$V_{\text{peak}}$	75	100	200	300	300	300	300
Thermal Resistance <sup>1)</sup>	K/W	$\leq 870^1)$	$\leq 550^1)$	$\leq 440^1)$	$\leq 220^1)$	$\leq 140^3)$	$\leq 88^3)$	$\leq 65^3)$
Insulation Resistance	$\Omega$	$> 10^9$						
Category Temperature Range	$^\circ\text{C}$	- 55 to + 125 (+ 155)						
Weight/1000 pcs	g	0.65	2	5.5	10	16	29.5	40.5

#### Notes

1. Measuring conditions in acc. to CECC 40401-802
2. Rated voltage:  $\sqrt{P \times R}$
3. Depending on solder pad dimensions



**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 <sup>+0.05</sup> / <sub>-0.10</sub>	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> / <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.3 <sup>+0.20</sup> / <sub>-0.10</sub>	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> / <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.3 <sup>+0.20</sup> / <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> / <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
1210	3225	3.2 ± 0.2	2.5 ± 0.2	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.6 ± 0.1	0.6 ± 0.25	0.6 ± 0.25
2512	6332	6.3 ± 0.2	3.15 ± 0.15	0.6 ± 0.1	0.6 ± 0.25	0.6 ± 0.25

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
INCH	METRIC	REFLOW SOLDERING			WAVE SOLDERING		
		a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.2
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

**PART NUMBER AND PRODUCT DESCRIPTION**

PART NUMBER: D120805IB2509KP0

D	1	2	0	8	0	5	I	B	2	5	0	9	K	P	0		
<b>MODEL/SIZE</b> D100402 D110603 D120805 D251206	<b>SPECIAL CHARACTER</b> I = Customer Trimmable	<b>TCR</b> B = ± 100 ppm/K A = ± 200 ppm/K	<b>VALUE</b> 3 digit value 1 digit multiplier <b>MULTIPLIER</b> 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup>	<b>TOLERANCE</b> K = ± 10 % L = ± 15 % M = ± 20 % W = 0 %/- 30 %	<b>PACKAGING<sup>1)</sup></b> P0 P5 PN B5 BN PZ	<b>SPECIAL</b> up to 2 digits											
<b>PRODUCT DESCRIPTION: D12TR 100 25R 10 % P5</b>																	
D12TR	100	25R	10 %	P5													
MODEL D10TR D11TR D12TR D25TR	TCR ± 100 ppm/K ± 200 ppm/K	RESISTANCE VALUE 25R = 25.0 Ω 49K9 = 49.9 kΩ 5R1 = 5.1 Ω	TOLERANCE ± 10 % ± 15 % ± 20 % + 0 %/- 30 %	PACKAGING <sup>1)</sup> P0 B5 P5 BN PN PZ													

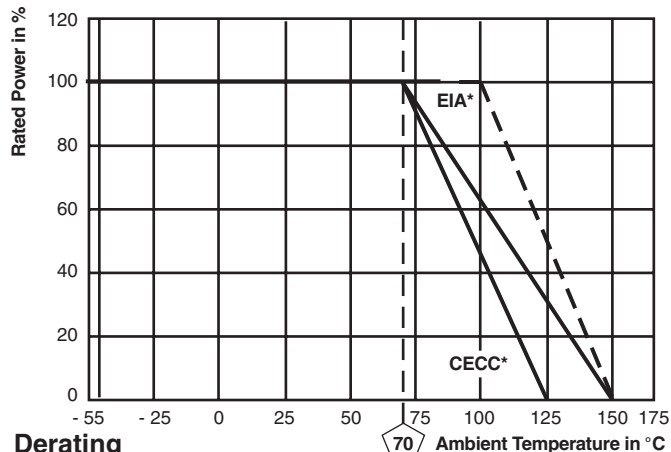
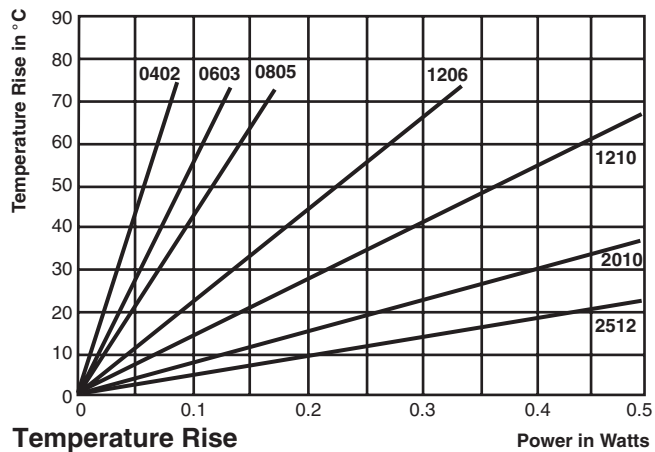
PART NUMBER: CRCW080525R0KKTATR

C	R	C	W	0	8	0	5	2	5	R	0	K	K	T	A	T	R
<b>MODEL/SIZE</b> CRCW0402 CRCW0603 CRCW0805 CRCW1206 CRCW1210 CRCW2010 CRCW2512	<b>VALUE</b> R = Decimal K = Thousand M = Million	<b>TOLERANCE</b> K = ± 10 % L = ± 15 % M = ± 20 % W = + 0 %,- 30 %	<b>TCR</b> K = ± 100 ppm/K N = ± 200 ppm/K	<b>PACKAGING<sup>1)</sup></b> TA = RT1 TB = RT5 TC = RT6 TD = RT7 TE = RF4 TF = R02 TG = R67 TH = R82	<b>SPECIAL</b> up to 2 digits TR = Customer Trimmable												
<b>PRODUCT DESCRIPTION: CRCWTR 0805 250 K 100 RT1</b>																	
CRCW0805TR	250	K	100	RT1													
MODEL CRCW0402TR CRCW0603TR CRCW0805TR CRCW1206TR CRCW1210TR CRCW2010TR CRCW2512TR	RESISTANCE VALUE 250 = 25R 392 = 3K9 105 = 1M0	TOLERANCE K = ± 10 % L = ± 15 % M = ± 20 % W = + 0 %,- 30 %	TCR ± 100 ppm/K ± 200 ppm/K	PACKAGING <sup>1)</sup> RT1 RF4 RT5 R02 RT6 R67 RT7 R82													

± 5 % = 2 sig.digits, plus multiplier

**Note**

1. Please refer to table PACKAGING, page 176.

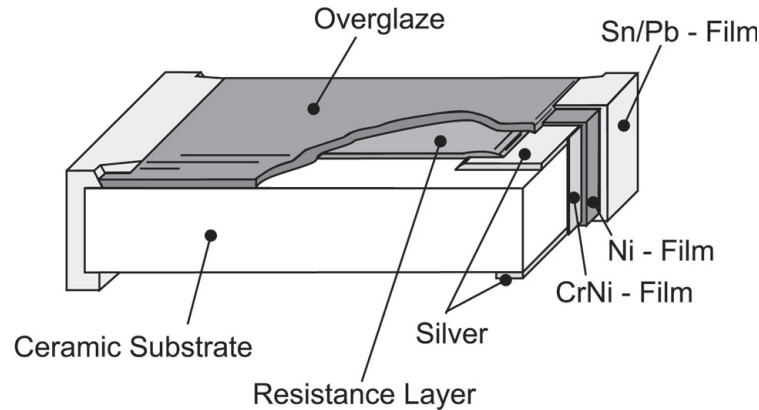


\* There are differences in board layout and measurements between CECC and EIA.

PACKAGING					
MODEL	REEL				
	TAPE WIDTH	DIAMETER	PIECES/REEL	PACKING CODE	
				PAPER <sup>1)</sup>	BLISTER <sup>1)</sup>
D10TR	8 mm	180 mm/7"	10 000	P0/RT7	
CRCW0402TR		330 mm/13"	50 000	PZ/RF4	
D11TR	8 mm	180 mm/7"	5000	P5/RT1	B5/na
CRCW0603TR		255 mm/10"	10 000	P0/RT5	BN/na
		330 mm/13"	20 000	PN/RT6	
D12TR	8 mm	180 mm/7"	5000	P5/RT1	B5/na
CRCW0805TR		255 mm/10"	10 000	P0/RT5	BN/na
		330 mm/13"	20 000	PN/RT6	
D25TR	8 mm	180 mm/7"	5000	P5/RT1	B5/na
CRCW1206TR		255 mm/10"	10 000	P0/RT5	BN/na
		330 mm/13"	20 000	PN/RT6	
CRCW1210TR	8 mm	180 mm/7"	5000	P5/RT1	B5/na
		330 mm/13"	20 000	PN/RT6	BN/na
CRCW2010TR	12 mm	180 mm/7"	4000		R02
CRCW2512TR	12 mm	180 mm/7"	2000		R67
			4000		R82

**Notes**

- 1. European/N. American packaging codes
- Further information about packaging: see appropriate catalog or web page


**Trimming Instructions:**

YAG-Laser:

The trimming length should not exceed 50 % of the dimension W (width)

Maximum trimming factor = 1.6

Distance between end termination and trimming cut = 0.2 mm min

Double cut: Distance between two cuts = 0.5 mm min

The laser-cut should be protected with epoxy resins

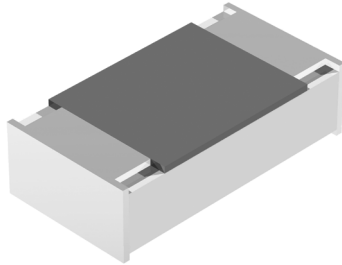
<b>PERFORMANCE</b>				
TEST	CONDITIONS OF TEST	REQUIREMENTS IN %		
		0402 0603	0805 1206 1210	2010 2512
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	≤ ± 1.0	≤ ± 0.5	≤ ± 1.0
Overload Test IEC 60115-1 4.13	Short time overload	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5
Thermal Shock IEC 60115-1 4.19; IEC 60068-2-14;	Rapid change between upper and lower category temperature	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5
Damp Heat Steady State IEC 60115-1 4.24; IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	≤ ± 0.25	≤ ± 0.5	≤ ± 1.0
Resistance to Soldering Heat IEC 60115-1 4.18; IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	≤ ± 0.5	≤ ± 0.25	≤ ± 0.5

**Note**

1. Limits for change of resistance at test. Data are valid for the non trimmed resistors only. Depending on trimming process some properties can change

<b>APPLICABLE SPECIFICATIONS</b>
<ul style="list-style-type: none"> <li>• CECC40000/40400/40401-802</li> <li>• EN140400/IEC 60115 - 1</li> <li>• EIA 575</li> <li>• MIL-PRF-55342</li> </ul>

## Trimmable Flat Chip Resistors



TCT 0603, TCU 0805 and TCA 1206 trimmable flat chip resistors are best suited whenever stable circuit adjustment is required and potentiometers will be either too expensive, too unstable or too large. The trimming is done directly on the printed-circuit board (PCB) using a state of the art laser trimming system e.g. with YAG or CO<sub>2</sub> laser source. Typical applications include any type of electronic sensors, oscillators or electronic circuits which have to be trimmed to certain functional parameters after PCB assembly.

### FEATURES

- Designed for state of the art laser trimming
- Enables economical functional circuit adjustment
- Low TCR  $\pm 50$  ppm/K available
- Excellent stability  $\leq \pm 0.25$  % (1000 h rated power at 70 °C)
- Wide ohmic range: 10  $\Omega$  to 1 M $\Omega$
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes



### APPLICATIONS

- Electronic sensors
- Oscillators
- Electronic circuits

### METRIC SIZE

	0603	0805	1206
INCH:			
METRIC:	RR 1608M	RR 2012M	RR 3216M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	TCT 0603		TCU 0805		TCA 1206
Metric size	RR 1608M		RR 2012M		RR 3216M
Resistance range	10 $\Omega$ to 1 M $\Omega$		10 $\Omega$ to 1 M $\Omega$		10 $\Omega$ to 1 M $\Omega$
Resistance tolerance	+ 0/- 30 %; + 0/- 20 %; + 0/- 10 %				+ 0/- 20 %
Temperature coefficient	$\pm 100$ ppm/K; $\pm 50$ ppm/K				$\pm 100$ ppm/K
Operation mode	standard	power	standard	power	standard
Climatic category	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56
Rated dissipation, $P_{70}^{1)}$	0.1 W	0.125 W	0.125 W	0.2 W	0.25 W
Operating voltage, $U_{max}$ AC/DC	75 V		150 V		200 V
Film temperature	125 °C	155 °C	125 °C	155 °C	125 °C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	10 $\Omega$ to 1 M $\Omega$		10 $\Omega$ to 1 M $\Omega$		10 $\Omega$ to 1 M $\Omega$
1000 h	$\leq 0.25$ %	$\leq 0.5$ %	$\leq 0.25$ %	$\leq 0.5$ %	$\leq 0.25$ %
8000 h	$\leq 0.5$ %	$\leq 1.0$ %	$\leq 0.5$ %	$\leq 1.0$ %	$\leq 0.5$ %
225 000 h	$\leq 1.5$ %	-	$\leq 1.5$ %	-	$\leq 1.5$ %
Insulation voltage:					
1 minute; $U_{ins}$	100 V		200 V		300 V
continuous	75 V		75 V		75 V
Failure rate	$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$

### Notes

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.
  2. All given figures are valid for the untrimmed resistor.
- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.



### 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade. in accordance with the 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5

### 12NC Example

The 12 NC of a TCT 0603 resistor, value 47 kΩ and TCR 50 with + 0/- 20 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 300 64703.

12NC - resistor type and packaging			ORDERING CODE 2312 ... ..	
DESCRIPTION			CARDBOARD TAPE ON REEL	
TYPE	TCR	TOL.	P5	PW
TCT 0603	± 100 ppm/K	+ 0/- 30 %	300 1....	305 1....
		+ 0/- 20 %	<b>300 2....</b>	<b>305 2....</b>
		+ 0/- 10 %	300 3....	305 3....
	± 50 ppm/K	+ 0/- 30 %	300 5....	305 5....
		+ 0/- 20 %	<b>300 6....</b>	<b>305 6....</b>
		+ 0/- 10 %	300 7....	305 7....
TCU 0805	± 100 ppm/K	+ 0/- 30 %	320 1....	325 1....
		+ 0/- 20 %	<b>320 2....</b>	<b>325 2....</b>
		+ 0/- 10 %	320 3....	325 3....
	± 50 ppm/K	+ 0/- 30 %	320 5....	325 5....
		+ 0/- 20 %	<b>320 6....</b>	<b>325 6....</b>
		+ 0/- 10 %	320 7....	325 7....
TCA 1206	± 100 ppm/K	+ 0/- 20 %	340 2....	345 2....

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

### PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>

**PART NUMBER<sup>2)</sup>: TCT06030C4702XP500**

T	C	T	0	6	0	3	0	C	4	7	0	2	X	P	5	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

MODEL/SIZE	SPECIAL CHARACTER	TCR	VALUE	TOLERANCE	PACKAGING <sup>3)</sup>	SPECIAL
TCT0603 TCU0805 TCA1206	0 = neutral	C = ± 50 ppm/K B = ± 100 ppm/K	3 digit value 1 digit multiplier Multiplier 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup> 5 = *10 <sup>5</sup>	W = + 0/- 30 % X = + 0/- 20 % Y = + 0/- 10 %	P5 PW	up to 2 digits 00 = standard

**PRODUCT DESCRIPTION: TCT 0603 - 50 - 20 % P5 47K**

TCT	0603	- 50	- 20 %	P5	47K
MODEL	SIZE	TCR <sup>4)</sup>	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE
TCT TCU TCA	0603 0805 1206	± 50 ppm/K ± 100 ppm/K	- 10 % = + 0/- 10 % - 20 % = + 0/- 20 % - 30 % = + 0/- 30 %	P5 PW	47K = 47 kΩ 1M = 1 MΩ

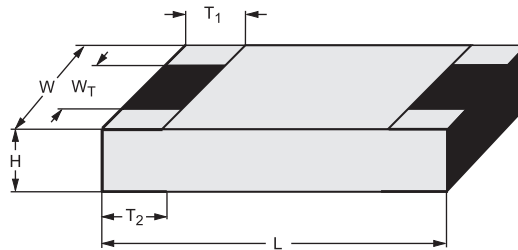
### Notes

- Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKAGING, page 180.
- A temperature coefficient ± 100 ppm/K is marked -00



PACKAGING		
MODEL	REEL	
	PIECES/PAPER TAPE ON REEL	CODE
OCT0603	5000	P5
	20 000	PW
OCU0805	5000	P5
	20 000	PW

## DIMENSIONS



DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
TCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
TCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6
TCA 1206	0.55 ± 0.1	3.2 + 0.1/- 0.2	1.6 ± 0.15	> 75 % of W	0.5 ± 0.25	0.5 ± 0.25	9.2

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>		
TCR	TOLERANCE	TCT 0603	TCU 0805	TCA 1206
± 100 ppm/K	+ 0/- 30 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	–
	+ 0/- 20 %	<b>10 Ω to 1 MΩ</b>	<b>10 Ω to 1 MΩ</b>	10 Ω to 1 MΩ
	+ 0/- 10 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	–
± 50 ppm/K	+ 0/- 30 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	–
	+ 0/- 20 %	<b>100 Ω to 1 MΩ</b>	<b>100 Ω to 1 MΩ</b>	–
	+ 0/- 10 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	–

**Note**

1. Resistance values to be selected from E12 (preferred) or E24 series.

**Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.**

**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A newly developed cermet layer is deposited onto a super-high-grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Pre-contacts are built on both sides of the substrate. The resistor elements are covered by glass for superior electrical, mechanical and climatic protection. The terminations receive a final pure tin-on-nickel plating.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

**Notes**

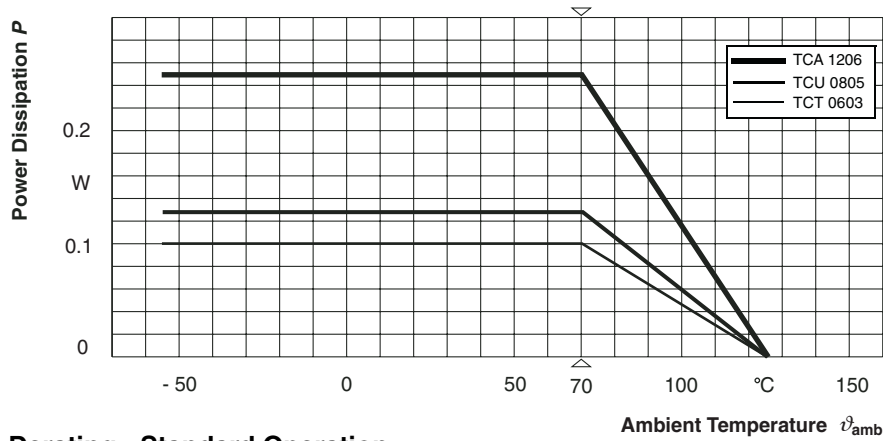
1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

**APPROVALS**

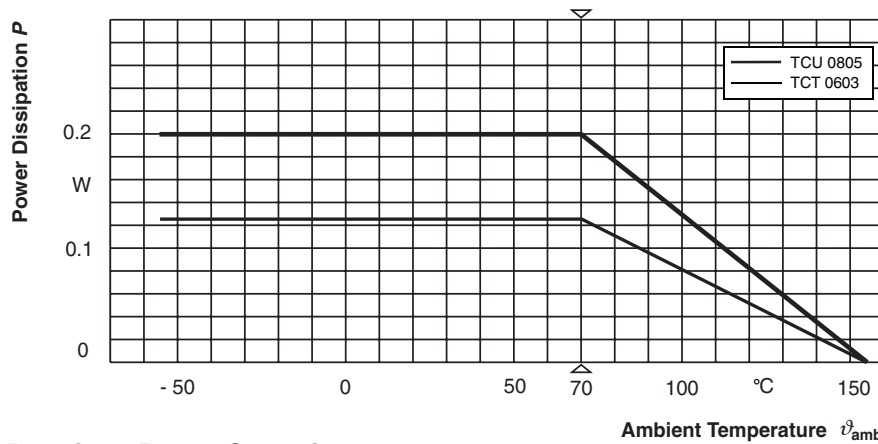
The resistors are tested in accordance with **EN 140 401-802** (superseding **CECC 40 401-802**) which refers to **EN 60115-1** and **EN 140 400**.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**.

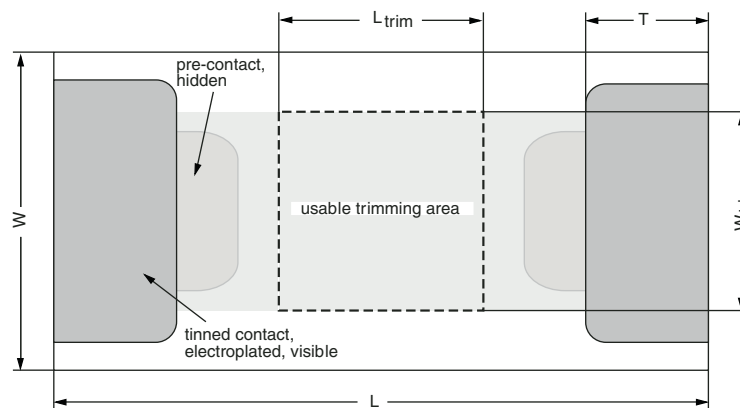
## FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Power Operation



Permissible Trimming Area

DIMENSIONS OF THE PERMISSIBLE TRIMMING AREA IN MILLIMETERS					
TYPE	L	W	T	L <sub>TRIM</sub>	W <sub>TRIM</sub>
TCT 0603	1.6	0.8	0.3	0.5	0.5
TCU 0805	2.0	1.2	0.3	0.8	0.8
TCA 1206	3.2	1.6	0.4	1.4	1.0



**TESTS AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-802, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper

Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-802. However, some additional tests and a number of improvements against those minimum requirements have been included.

<b>TEST PROCEDURES AND REQUIREMENTS<sup>1)</sup></b>				
<b>EN 60115-1 CLAUSE</b>	<b>IEC 60068-2 TEST METHOD</b>	<b>TEST</b>	<b>PROCEDURE</b>	<b>REQUIREMENTS PERMISSIBLE CHANGE (<math>\Delta R/R</math>)</b>
			stability for product types:	
			<b>TCT 0603</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCU 0805</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCA 1206</b>	10 $\Omega$ to 1 M $\Omega$
4.5	–	resistance		+ 0/- 30 %; + 0/- 20 %; + 0/- 10 %
4.8.4.2	–	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm$ 100 ppm/K; $\pm$ 50 ppm/K
4.25.1	–	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe 1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm$ (0.25 % $R$ + 0.05 $\Omega$ )  $\pm$ (0.5 % $R$ + 0.05 $\Omega$ )
	–	endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe 1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm$ (0.5 % $R$ + 0.05 $\Omega$ )  $\pm$ (1 % $R$ + 0.05 $\Omega$ )

<b>TEST PROCEDURES AND REQUIREMENTS<sup>1)</sup></b>				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:	
			<b>TCT 0603</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCU 0805</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCA 1206</b>	10 $\Omega$ to 1 M $\Omega$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$ $\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.25 \% R + 0.05 \Omega)$
4.23		climatic sequence:		
4.23.2	2 (Ba)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; > 90 % RH; 1 cycle	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; 25 $\pm$ 10 °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	$\pm (0.25 \% R + 0.05 \Omega)$
–	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles	$\pm (0.25 \% R + 0.05 \Omega)$ no visible damage
			LCT = - 55 °C; UCT = 125 °C; 1000 cycles	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage
4.13	–	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 5 s	$\pm (0.25 \% R + 0.05 \Omega)$
		short time overload; power operation mode		$\pm (0.5 \% R + 0.05 \Omega)$
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq$ 1.5 mm or $\leq$ 200 m/s <sup>2</sup> ; 6 h	$\pm (0.25 \% R + 0.05 \Omega)$ ; no visible damage
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq$ 95 % covered); no visible damage
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	

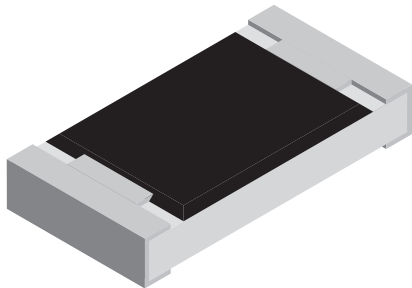


<b>TEST PROCEDURES AND REQUIREMENTS<sup>1)</sup></b>				
<b>EN 60115-1 CLAUSE</b>	<b>IEC 60068-2 TEST METHOD</b>	<b>TEST</b>	<b>PROCEDURE</b>	<b>REQUIREMENTS PERMISSIBLE CHANGE (<math>\Delta R/R</math>)</b>
			stability for product types:	
			<b>TCT 0603</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCU 0805</b>	10 $\Omega$ to 1 M $\Omega$
			<b>TCA 1206</b>	10 $\Omega$ to 1 M $\Omega$
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm$ (0.25 % $R$ + 0.05 $\Omega$ ); no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 °C; method 2	no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1608M; 9 N	no visible damage
			RR 2012M and RR 3216M; 45 N	
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm$ (0.25 % $R$ + 0.05 $\Omega$ ) no visible damage, no open circuit in bent position
4.7	–	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s	no flashover or breakdown
4.35	–	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s

**Note**

1. All given figures are valid for the untrimmed resistor.

## Thick Film, Rectangular, Resistor/Capacitor Chip



### FEATURES

- Single component reduces board space and component counts
- Choice of Dielectric Characteristics X7R or Y5U
- Wrap around termination
- Thick film Resistor/Capacitor element
- Inner electrode protection
- Flow & Reflow solderable
- Automatic placement capability, standard size
- Lead (Pb)-Free version is RoHS Compliant



RoHS\*  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS											
GLOBAL MODEL	SIZE		RESISTOR				CAPACITOR				
	INCH	METRIC	POWER RATING $P_{70^{\circ}\text{C}}$ W	TEMPERATURE COEFFICIENT ppm/°C	TOL %	VALUE RANGE Ω	DIELECTRIC	TEMPERATURE COEFFICIENT %	TOL. %	VOLTAGE RATING VDC	VALUE RANGE pF
CRCC1206	1206	3216	0.125	200	5	10R - 1M0	X7R	± 15	20	50	10 - 270
CRCC1206	1206	3216	0.125	200	5	10R - 1M0	Y5U	+ 22, - 56	20	50	270 - 1800

<b>RESISTOR</b> <ul style="list-style-type: none"> <li>• Operating Temperature Range: - 55 °C to + 125 °C</li> <li>• Technology: thick film</li> </ul>	<b>CAPACITOR</b> <ul style="list-style-type: none"> <li>• Operating Temperature Range: X7R - 55 °C to + 125 °C Y5U - 30 °C to + 85 °C</li> <li>• Maximum Dissipation Factor: 2.5 %</li> </ul>
--	---

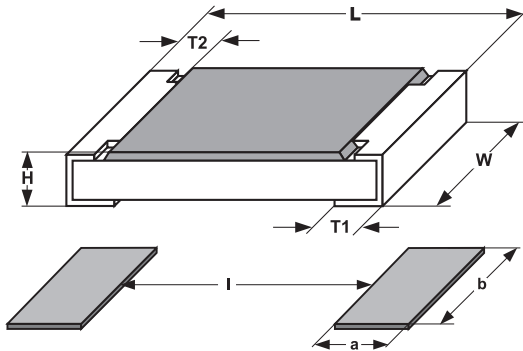
### Notes

- Packaging: see appropriate catalog or web page
- Power rating depends on the maximum temperature at the solder point, the component placement density and the substrate material

TECHNICAL SPECIFICATIONS				
PARAMETER	UNIT	RESISTOR	X7R CAPACITOR	Y5U CAPACITOR
Rated Dissipation at 70 °C	W	0.125	–	–
Capacitor Voltage Rating	V	–	50	50
Dielectric Withstanding Voltage (5 seconds, 50mA Charge)	V <sub>dc</sub>	–	125	125
Category Temperature Range	°C	- 55/+ 155	- 55/+ 125	- 30/+ 85
Insulation Resistance	Ω	> 10 <sup>10</sup>	> 10 <sup>10</sup>	> 10 <sup>10</sup>
Weight/1000 pieces	g	0.65	2	5.5

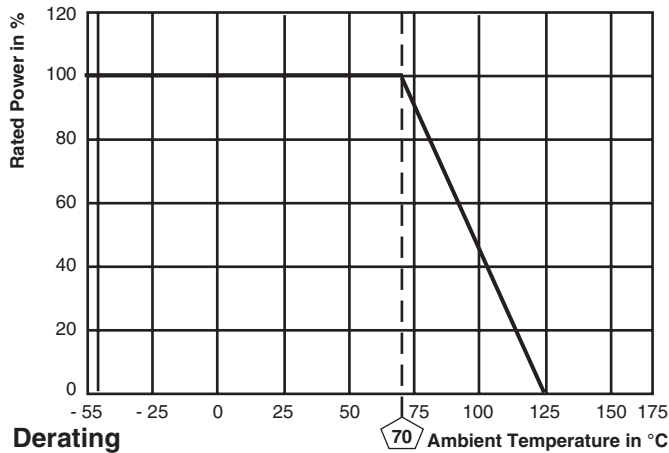
GLOBAL PART NUMBER INFORMATION																	
New Global Part Numbering: CRCC1206472J220MTF (preferred part numbering format)																	
C	R	C	C	1	2	0	6	4	7	2	J	2	2	0	M	T	F
GLOBAL MODEL CRCC1206	RESISTANCE VALUE 2 digit significant figure, followed by a multiplier 100 = 10 Ω 683 = 68 kΩ 105 = 1.0 MΩ		RES. TOLERANCE F = ± 1 % G = ± 2 % J = ± 5 %		CAPACITANCE VALUE (pF) 2 digit significant figure, followed by a multiplier 100 = 10 pF 271 = 270 pF 182 = 1800 pF		CAP. TOLERANCE K = ± 10 % M = ± 20 %		PACKAGING EA = Lead (Pb)-free, T/R (4000 pcs) TF = Tin/Lead, T/R (4000 pcs)								
Historical Part Number example: CRCC1206472J220MR02 (will continue to be accepted)																	
CRCC1206	472	J	220	M	R02												
MODEL	RESISTANCE VALUE	RES. TOLERANCE	CAPACITANCE VALUE	CAP. TOLERANCE	PACKAGING												

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
1206	3216	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.15	0.5 ± 0.25	0.5 ± 0.25

SIZE		SOLDER PAD DIMENSIONS [in millimeters]					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
1206	3216	0.9	1.7	2.0	1.1	1.7	2.2


**SCHEMATIC**


<b>PERFORMANCE</b>			
TEST	CONDITIONS OF TEST	TEST RESULTS	
		R	C
Endurance Test at 70 °C MIL-Std-202 Method 108	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (5 % + 2 Ω)	± 20 %
Dielectric Withstanding Voltage MIL-Std-202 Method 301	125 V <sub>dc</sub> , 5 seconds, 50 mA charge	no physical damage	
Thermal Shock MIL-Std-202 Method 107	100 cycles, - 55 to + 125 °C	± (5 % + 2 Ω)	± 20 %
Moisture MIL-Std-202 Method 106	Omit steps 7A and B	± (5 % + 2 Ω)	± 20 %
Resistance to Soldering Heat EIA 575	10 seconds at 260 °C solder bath temperature	± (5 % + 2 Ω)	± 20 %
High Temperature Exposure EIA 575	125 °C for 100 hours	± (5 % + 2 Ω)	± 20 %
Low Temperature Operation EIA 575	1 hour at - 55 °C then 45 minutes at 50 V	± (5 % + 2 Ω)	± 20 %
Solderability & Leaching EIA 575 3.12	Condition C	95 % Coverage	

<b>APPLICABLE SPECIFICATIONS</b>
<ul style="list-style-type: none"> <li>• IPC Standards</li> <li>• EIA 575</li> </ul>







# Thin Film Rectangular

Nickel Chrome Thin Film  
Resistor Element



TCR down to 25 ppm/°C



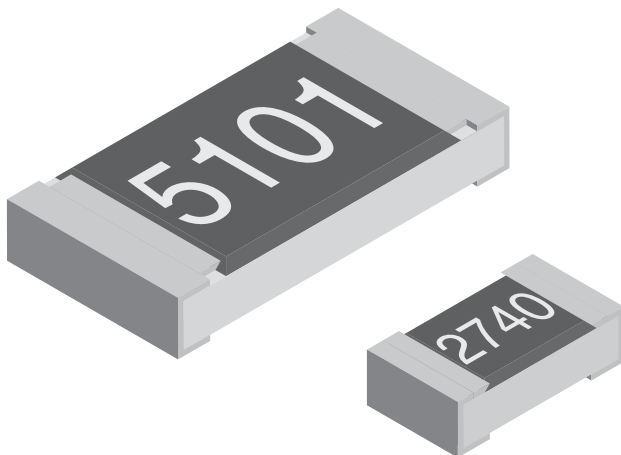
Tolerance down to 0.1 %



Low Current Noise



Excellent Overall Stability



## Model Numbers

Flat Chip Resistors	
Laboratory Sample Kits ..	190
MCS 0402, MCT0603, MCU 0805 - Professional	191
M10, M11, M12, M25 .....	202
MCS 0402, MCT0603, MCU 0805, MCA 1206 - Precision .....	208
TNPW . . . . e3 .....	217
TNPW .....	226
WSF .....	233
M25SI .....	235
MCT 0603 HF .....	237
MCS 0402 VG01, MCT 0603 VG01, MCU 0805 VG01 .....	243

## Flat Chip Resistors Laboratory Sample Kits

### FLAT CHIP RESISTORS MCT 0603

Files contain lengths of cardboard tape, each holding 45 resistors of the most important values of the IEC series. The cardboard tape pieces are ordered according to resistance value and arranged on well marked pages. Each single metal film flat chip can be picked up with tweezers.

The laboratory kit supplement LCT 96 includes every second value of the E96 series. It extends the value distribution of the laboratory kit LCT 48 to the E96 series.

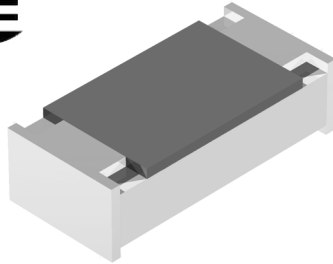
	BASIC KIT	LAB. KIT	LAB. KIT SUPPLEMENT
Laboratory kit	LCT 24	LCT 48	LCT 96
Numeric ordering code (12NC)	2312 000 20001	2312 000 20002	2312 000 20003
Resistor type	MCT 0603	MCT 0603	MCT 0603
Temperature coefficient	± 50 ppm/K	± 50 ppm/K	± 50 ppm/K
Values in accordance with tolerance/IEC series	10 Ω to 6.8 MΩ 1 % E24 8.2 MΩ to 10 MΩ 1 % E12 jumper	10 Ω to 1 MΩ 1 % 1/2 E96 1.1 MΩ to 10 MΩ 1 % 1/2 E48 jumper	10.2 Ω to 976 kΩ 1 % E96 <sup>1)</sup> 1.05 MΩ to 9.53 MΩ 1 % E48 <sup>1)</sup> jumper
Number of resistance values	144	266	265
Resistors per value/total	45/6480	45/11 970	45/11 925
Number of pages/files	8/1	15/1	15/1

#### Note

1. Supplement to the laboratory kit LCT48 to the complete declared E series.

For specification details of the flat chip resistor MCT 0603 please refer to the data sheet "Professional flat chip resistors MCS 0402; MCT 0603; MCU 0805".

## Professional Flat Chip Resistors



MCS 0402, MCT 0603 and MCU 0805 Professional Thin Film Flat Chip Resistors are the perfect choice for most fields of modern professional electronics where reliability and stability is of major concern. Typical applications include telecommunication, medical equipment and high-end computer and audio/video electronics.

### FEATURES

- Approved according to EN 140401-801
- Advanced thin film technology
- Advanced dissipation rating: 100 mW for 0603
- Excellent overall stability: Class 0.5
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



**RoHS**  
COMPLIANT

### APPLICATIONS

- Automotive
- Telecommunication
- Medical equipment
- Industrial equipment

### METRIC SIZE

INCH:	0402	0603	0805
METRIC:	RR 1005M	RR 1608M	RR 2012M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MCS 0402		MCT 0603		MCU 0805	
Metric size	RR 1005M		RR 1608M		RR 2012M	
Resistance range	10 Ω to 4.99 MΩ		1 Ω to 10 MΩ		10 Ω to 1.5 MΩ	
Resistance tolerance	± 1 %; ± 0.5 %				± 0.5 %	
Temperature coefficient	± 50 ppm/K; ± 25 ppm/K					
Operation mode	standard	power	standard	power	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56	55/155/56
Rated dissipation, $P_{70}^{(1)}$	0.063 W	0.1 W	0.1 W	0.125 W	0.125 W	0.2 W
Operating voltage, $U_{max}$ AC/DC	50 V		75 V		150 V	
Film temperature	125 °C	155 °C	125 °C	155 °C	125 °C	155 °C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	10 Ω to 4.99 MΩ		1 Ω to 10 MΩ		10 Ω to 1.5 MΩ	
1000 h	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %
8000 h	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %
225 000 h	≤ 1.5 %		≤ 1.5 %		≤ 1.5 %	
Insulation voltage:						
1 minute; $U_{ins}$	75 V		100 V		200 V	
continuous	75 V		75 V		75 V	
Failure rate	≤ 2 × 10 <sup>-9</sup> /h		≤ 2 × 10 <sup>-9</sup> /h		≤ 2 × 10 <sup>-9</sup> /h	

### Notes

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.
- These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.



## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packing; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the Last digit of 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5
10 MΩ to 99.9 MΩ	6

### 12NC example

The 12NC of a MCT 0603 resistor, value 47 kΩ and TCR 50 with ± 1 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 215 14703.

12NC - resistor type and packaging					
DESCRIPTION			ORDERING CODE 2312 ... ..		
			CARDBOARD TAPE ON REEL		
TYPE	TCR	TOL.	P5 (5000 UNITS)	E0 (10 000 UNITS)	PW (20 000 UNITS)
MCS 0402	± 50 ppm/K	± 1 %	-	<b>275 1....</b>	-
		± 0.5 %	-	275 5....	-
	± 25 ppm/K	± 0.5 %	-	<b>276 5....</b>	-
	jumper	-	-	<b>275 90001</b>	-
MCT 0603	± 50 ppm/K	± 1 %	<b>215 1....</b>	-	<b>205 1....</b>
		± 0.5 %	215 5....	-	205 5....
	± 25 ppm/K	± 0.5 %	<b>216 5....</b>	-	<b>206 5....</b>
	jumper	-	<b>215 90001</b>	-	<b>205 90001</b>
MCU 0805	± 50 ppm/K	± 0.5 %	255 5....	-	245 5....
	± 25 ppm/K	± 0.5 %	256 5....	-	246 5....
	jumper	-	255 90001	-	245 90001

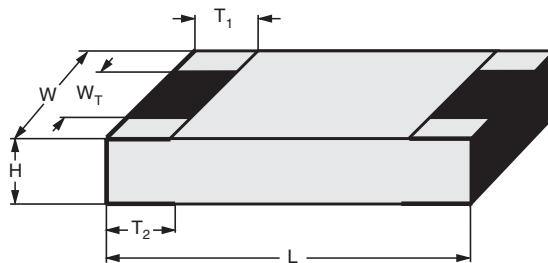
Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>																	
PART NUMBER <sup>2)</sup> : MCT06030D4641DPW00																	
M	C	T	0	6	0	3	0	D	4	6	4	1	D	P	W	0	0
MODEL/SIZE	SPECIAL CHARACTER		TCR		VALUE			TOLERANCE		PACKAGING <sup>3)</sup>		SPECIAL					
MCS0402 MCT0603 MCU0805	0 = neutral		D = ± 25 ppm/K C = ± 50 ppm/K Z = Jumper		3 digit value 1 digit multiplier			D = ± 0.5 % F = ± 1 % Z = Jumper		P5 PW E0		up to 2 digits 00 = standard					
MULTIPLIER																	
7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup> 4 = *10 <sup>4</sup> 5 = *10 <sup>5</sup> 6 = *10 <sup>6</sup> 0000 = Jumper																	
PRODUCT DESCRIPTION: MCT 0603 - 25 0.5 % PW 4K64																	
MCT	0603	- 25	0.5 %	PW	4K64												
MODEL	SIZE	TCR	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE												
MCS MCT MCU	0402 0603 0805	± 25 ppm/K ± 50 ppm/K	± 0.5 % ± 1 %	P5 PW E0	47K = 47 kΩ 50R1 = 50.1 Ω 0R0 = Jumper <sup>4)</sup>												

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, page 194.
4. Jumpers are ordered by the resistance value 0 Ω, e.g. MCT 0603 P5 0R0.

**DIMENSIONS**



DIMENSIONS - chip resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
MCS 0402	0.32 ± 0.05	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
MCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
MCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6



<b>TEMPERATURE COEFFICIENT AND RESISTANCE RANGE</b>				
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>		
TCR	TOLERANCE	MCS 0402	MCT 0603	MCU 0805
± 50 ppm/K	± 1 %	<b>10 Ω to 4.99 MΩ</b>	<b>1 Ω to 10 MΩ</b>	-
	± 0.5 %	100 Ω to 221 kΩ	39 Ω to 511 kΩ	10 Ω to 1.5 MΩ
± 25 ppm/K	± 0.5 %	<b>100 Ω to 221 kΩ</b>	<b>39 Ω to 511 kΩ</b>	10 Ω to 1.5 MΩ
Jumper	-	≤ 20 mΩ; <i>I</i> <sub>max</sub> = 0.63 A	≤ 20 mΩ; <i>I</i> <sub>max</sub> = 1 A	≤ 20 mΩ; <i>I</i> <sub>max</sub> = 1.5 A

**Note**

1. Resistance values to be selected for ± 1 % tolerance from E24 and E96; for ± 0.5 % tolerance from E24 and E192.

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

<b>PACKAGING</b>		
MODEL	REEL	
	PIECES/ PAPER TAPE ON REEL	CODE
MCS 0402	10 000	E0
MCT 0603	5000	P5
	20 000	PW
MCU 0805	5000	P5
	20 000	PW



### DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics. For the high ohmic range, optimized Cermet products provide comparable properties. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

### ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

### APPROVALS

The resistors are tested in accordance with **EN 140401-801** (superseding **CECC 40401-801**) which refers to **EN 60115-1** and **EN 140400**. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240 001** based on **EN 100114-6** is granted for the Vishay BEYSCHLAG manufacturing process.

### SPECIALS

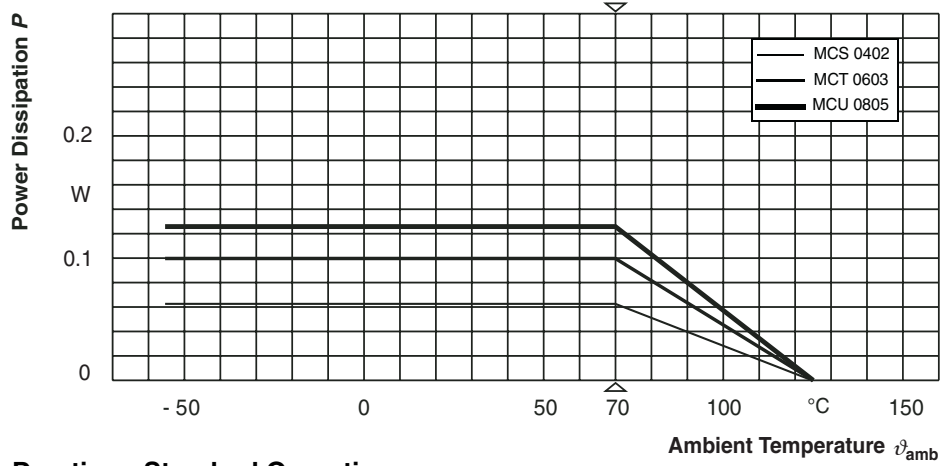
This product family of thin film flat chip resistors is completed by **Zero Ohm Jumpers**.

On request, resistors are available with established reliability in accordance with **EN 140401-801 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and order codes.

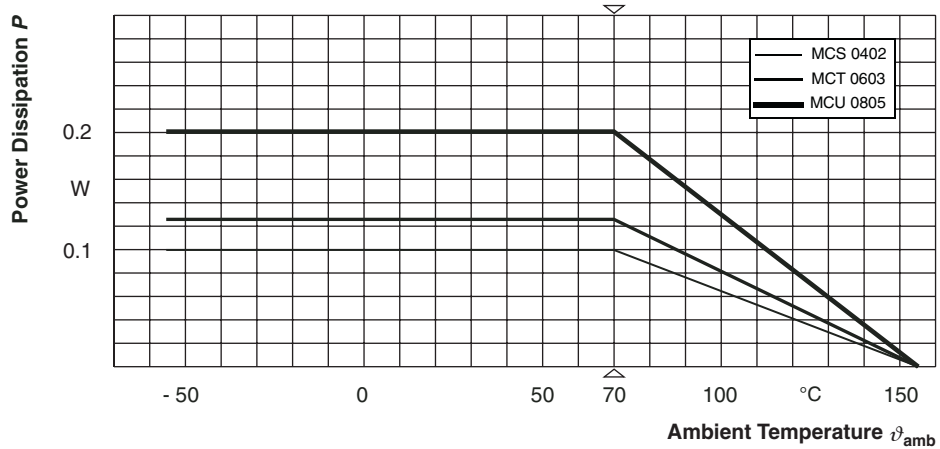




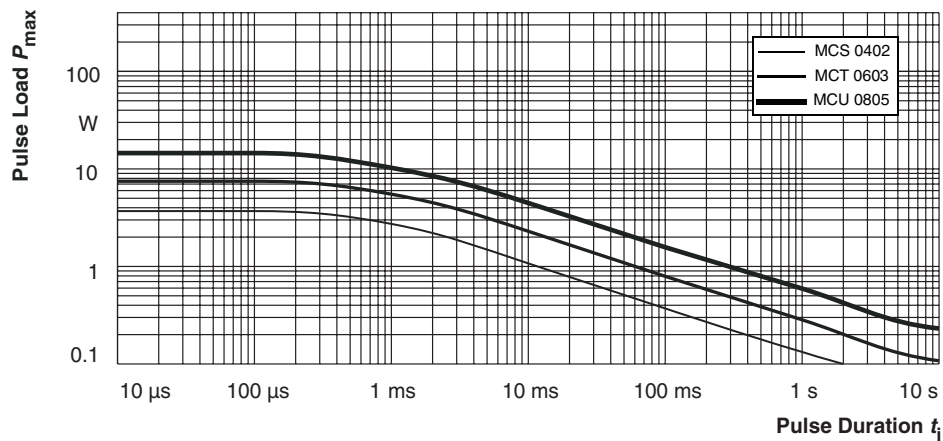
**FUNCTIONAL PERFORMANCE**



Derating - Standard Operation



Derating - Power Operation



Maximum pulse load, single pulse; for permissible resistance change equivalent to 8000 h operation

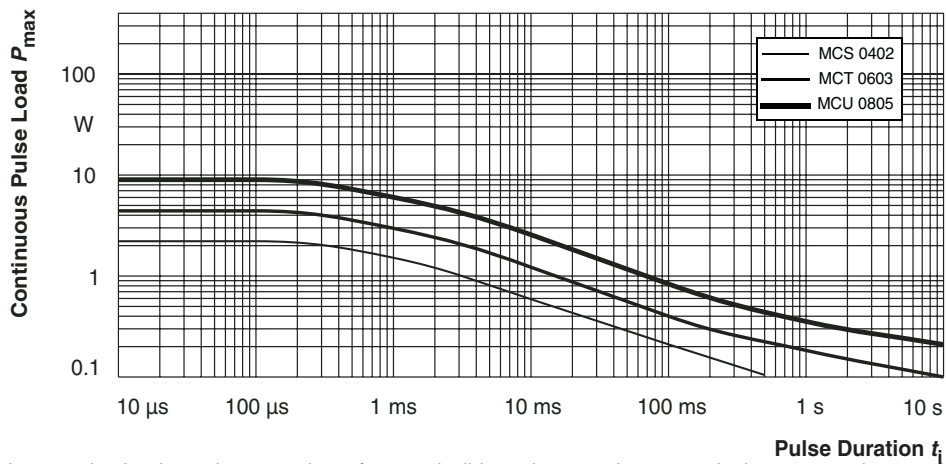
**Single Pulse**



# MCS 0402, MCT 0603, MCU 0805 - Professional

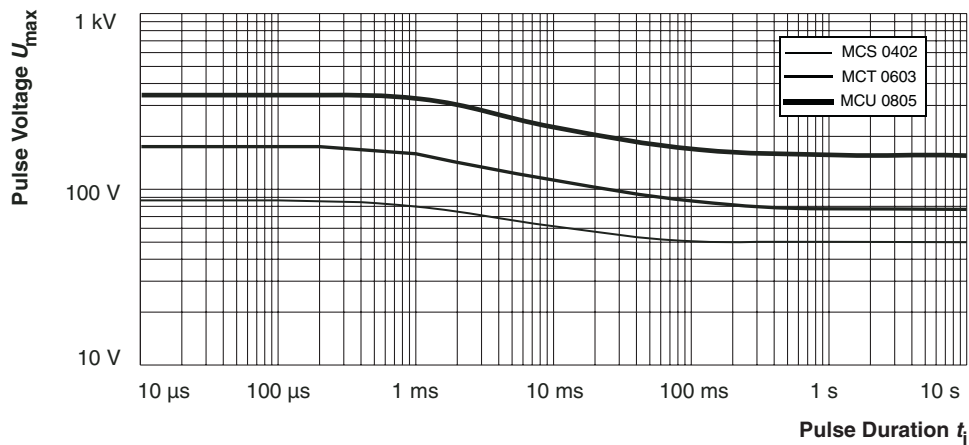
Professional Flat Chip Resistors

Vishay Beyschlag



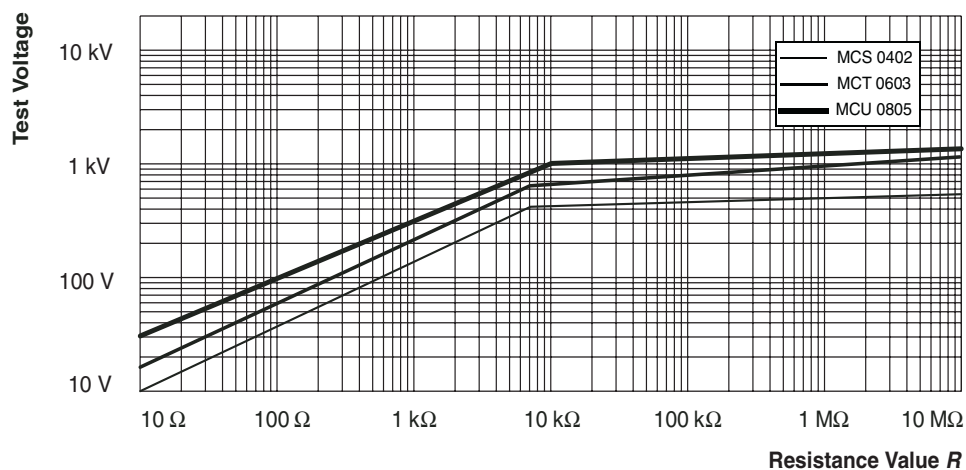
Maximum pulse load, continuous pulses; for permissible resistance change equivalent to 8000 h operation

## Continuous Pulse



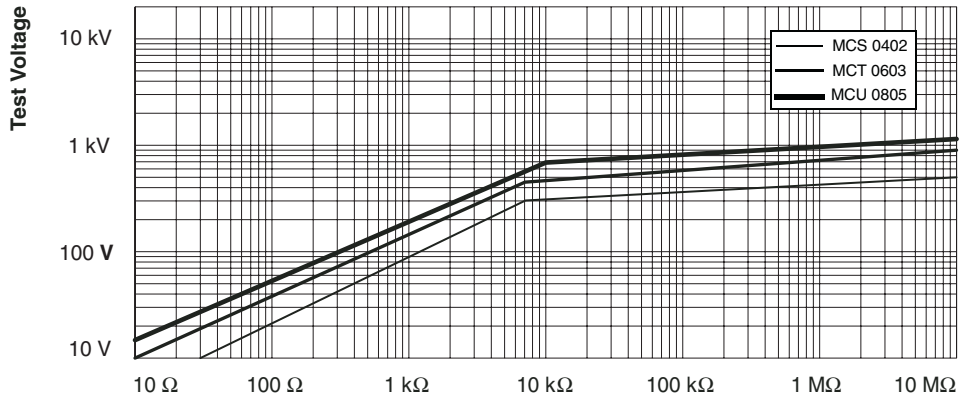
Maximum pulse voltage, single and continuous pulses; for permissible resistance change equivalent to 8000 h operation

## Pulse Voltage



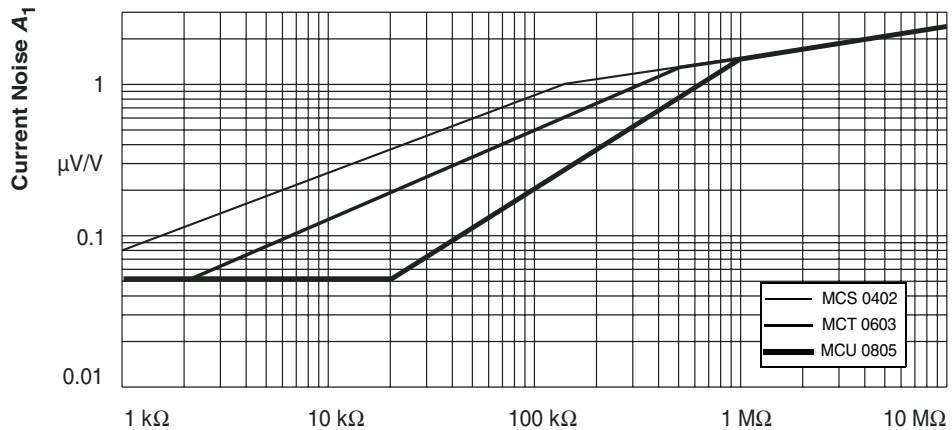
Pulse load rating in accordance with EN 60115-1 clause 4.27; 1.2  $\mu$ s/50  $\mu$ s; 5 pulses at 12 s interval; for permissible resistance change 0.5 %

## 1.2/50 Pulse



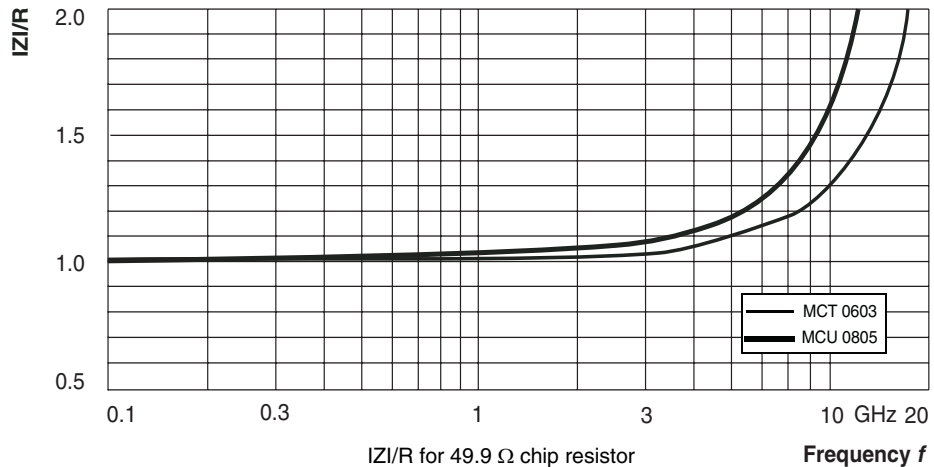
**Resistance Value R**  
 Pulse load rating in accordance with EN 60115-1 clause 4.27; 10 μs/700 μs;  
 10 pulses at 1 minute intervals; for permissible resistance change 0.5 %

**10/700 Pulse**



Current noise A<sub>1</sub> in accordance with IEC 60 195 **Resistance Value R**

**Current Noise**



**RF-Behaviour**

IZ/R for 49.9 Ω chip resistor



### TESTS AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper

Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )	
				STABILITY CLASS 0.5	STABILITY CLASS 1
			stability for product types:		
			<b>MCS 0402</b>	10 $\Omega$ to 33.2 k $\Omega$	> 33.2 k $\Omega$ to 4.99 M $\Omega$
			<b>MCT 0603</b>	10 $\Omega$ to 100 k $\Omega$	1 $\Omega$ to < 10 $\Omega$ ; > 100 k $\Omega$ to 10 M $\Omega$
			<b>MCU 0805</b>	10 $\Omega$ to 221 k $\Omega$	> 221 k $\Omega$ to 10 M $\Omega$
4.5	-	resistance		$\pm 1\%$ ; $\pm 0.5\%$	
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 50$ ppm/K; $\pm 25$ ppm/K	
4.25.1	-	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe;  1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (0.25\% R + 0.05 \Omega)$ $\pm (0.5\% R + 0.05 \Omega)$	
		endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe;  1.5 h on; 0.5 h off  1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (0.5\% R + 0.05 \Omega)$  $\pm (1\% R + 0.05 \Omega)$	

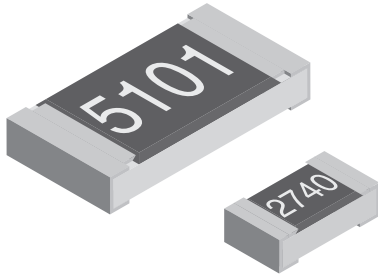


TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )	
				STABILITY CLASS 0.5	STABILITY CLASS 1
			stability for product types:		
			<b>MCS 0402</b>	10 $\Omega$ to 33.2 k $\Omega$	> 33.2 k $\Omega$ to 4.99 M $\Omega$
			<b>MCT 0603</b>	10 $\Omega$ to 100 k $\Omega$	1 $\Omega$ to < 10 $\Omega$ ; > 100 k $\Omega$ to 10 M $\Omega$
			<b>MCU 0805</b>	10 $\Omega$ to 221 k $\Omega$	> 221 k $\Omega$ to 10 M $\Omega$
4.25.3	-	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$ $\pm (0.5 \% R + 0.05 \Omega)$	$\pm (0.5 \% R + 0.05 \Omega)$ $\pm (1 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5 \% R + 0.05 \Omega)$	$\pm (1 \% R + 0.05 \Omega)$
4.23		climatic sequence:		$\pm (0.5 \% R + 0.05 \Omega)$	$\pm (1 \% R + 0.05 \Omega)$
4.23.2	2 (Ba)	dry heat	UCT; 16 h		
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; > 90 % RH; 1 cycle		
4.23.4	1 (Aa)	cold	LCT; 2 h		
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; 25 $\pm$ 10 °C		
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; > 90 % RH; 5 cycles		
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1 min LCT = - 55 °C UCT = 125 °C		
-	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.1 \% R + 0.01 \Omega)$	$\pm (0.25 \% R + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage	
			LCT = - 55 °C; UCT = 125 °C; 1000 cycles	$\pm (0.25 \% R + 0.05 \Omega)$ no visible damage	
4.13	-	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$	$\pm (0.25 \% R + 0.05 \Omega)$
		short time overload; power operation mode		$\pm (0.25 \% R + 0.05 \Omega)$	$\pm (0.5 \% R + 0.05 \Omega)$
4.27	-	single pulse high voltage overload; standard operation mode	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 10 pulses 10 $\mu$ s/700 $\mu$ s	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage	



TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )	
				STABILITY CLASS 0.5	STABILITY CLASS 1
			stability for product types:		
			<b>MCS 0402</b>	10 $\Omega$ to 33.2 k $\Omega$	> 33.2 k $\Omega$ to 4.99 M $\Omega$
			<b>MCT 0603</b>	10 $\Omega$ to 100 k $\Omega$	1 $\Omega$ to < 10 $\Omega$ ; > 100 k $\Omega$ to 10 M $\Omega$
			<b>MCU 0805</b>	10 $\Omega$ to 221 k $\Omega$	> 221 k $\Omega$ to 10 M $\Omega$
4.37	-	periodic electric overload; standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage	
		periodic electric overload; power operation		$\pm (1 \% R + 0.05 \Omega)$ no visible damage	
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq 1.5$ mm or $\leq 200$ m/s <sup>2</sup> ; 6 h	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage	
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) $^{\circ}$ C; (3 $\pm$ 0.3) s	good tinning ( $\geq 95$ % covered); no visible damage	
			solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 $\pm$ 3) $^{\circ}$ C; (2 $\pm$ 0.2) s	good tinning ( $\geq 95$ % covered); no visible damage	
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage	$\pm (0.25 \% R + 0.05 \Omega)$ no visible damage
4.29	45 (XA)	component solvent	isopropyl alcohol + 50 $^{\circ}$ C; method 2	no visible damage	
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1005M and RR 1608M; 9 N	no visible damage	
			RR 2012M; 45 N		
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage; no open circuit in bent position	
4.7	-	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s	no flashover or breakdown	
4.35	-	flammability	IEC 60695-11-5, needle flame test; 10 s	no burning after 30 s	

## Thin Film, Rectangular, Resistor Chips



### FEATURES

- Metal film layer on high quality ceramic
- Protective top coat
- Pure tin on nickel barrier layer
- Low temperature coefficient and tight tolerances ( $\pm 0.1\%$ ;  $\pm 10$  ppm/K)
- 56 days at 40 °C and 93 % relative humidity down to  $\leq \pm 0.2\%$



STANDARD ELECTRICAL SPECIFICATIONS									
MODEL	SIZE		POWER RATING $P_{70\text{ °C}}$		LIMITING ELEMENT VOLTAGE MAX $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
	INCH	METRIC	EN 140 401-801	EIA 575					
M10	0402	1005	0.063	0.063	25	$\pm 25; \pm 50$	$\pm 0.5; \pm 1$	10R - 20K <sup>(1)</sup>	24 - 96
M11	0603	1608	0.1	0.063	75	$\pm 25$	$\pm 0.1; \pm 0.25;$ $\pm 0.5; \pm 1$	10R - 56K <sup>(1)</sup>	24 - 96
						$\pm 50$	$\pm 0.1; \pm 0.25; \pm 0.5;$ $\pm 1$	10R - 56 <sup>(1)</sup> 1R0 - 100K <sup>(1)</sup>	
M12	0805	2012	0.125	0.1	150	$\pm 25$	$\pm 0.1; \pm 0.25;$ $\pm 0.5; \pm 1$	10R - 100K <sup>(1)</sup>	24 - 96
						$\pm 50$	$\pm 0.1; \pm 0.25; \pm 0.5;$ $\pm 1$	10R - 100K <sup>(1)</sup> 1R0 - 220K <sup>(1)</sup>	
M25	1206	3216	0.25	0.125	200	$\pm 25$	$\pm 0.1; \pm 0.25;$ $\pm 0.5; \pm 1$	10R - 220K <sup>(1)</sup>	24 - 96
						$\pm 50$	$\pm 0.1; \pm 0.25; \pm 0.5;$ $\pm 1$	10R - 220K <sup>(1)</sup> 1R0 - 330K <sup>(1)</sup>	

### Notes

1. Higher values on request, ask about extended value ranges
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
  - Marking: 4 digits, M10 - no marking

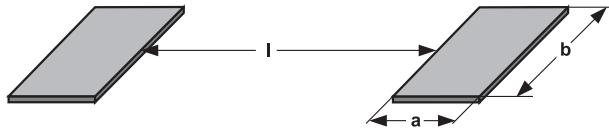
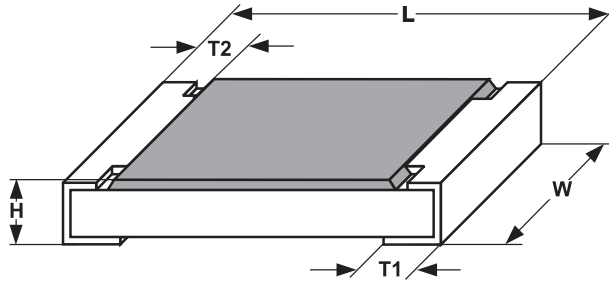
TECHNICAL SPECIFICATIONS									
PARAMETER	UNIT	M10		M11		M12		M25	
Rated Dissipation at 70 °C (EN 140 401-801  EIA 575)	W	0.063		0.1	0.063	0.125	0.1	0.25	0.125
Limiting Element Voltage <sup>(2)</sup>	$V_{\equiv}$	25		75		150		200	
Insulation Voltage (1 min)	$V_{dc/ac\ peak}$	> 50		> 100		> 200		> 300	
Thermal Resistance <sup>(1)</sup>	K/W	$\leq 870^{(1)}$	-	$\leq 550^{(1)}$	-	$\leq 440^{(1)}$	-	$\leq 220^{(1)}$	-
Insulation Resistance	$\Omega$	> $10^9$							
Category Temperature Range	°C	- 55 to + 125 (+ 155)							
Failure Rate	$h^{-1}$	$0.3 \cdot 10^{-9}$							
Weight/1000 pcs	g	0.65		2		5.5		10	

### Notes

1. Measuring conditions in acc. with EN 140 401-801
2. Rated voltage:  $\sqrt{P \times R}$



**DIMENSIONS**



SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.1	0.2 ± 0.1
0603	1608	1.55 <sup>+0.10</sup> <sub>-0.05</sub>	0.85 ± 0.1	0.45 ± 0.05	0.30 ± 0.2	0.3 ± 0.2
0805	2012	2.0 <sup>+0.20</sup> <sub>-0.10</sub>	1.25 ± 0.15	0.45 ± 0.05	0.30 <sup>+0.20</sup> <sub>-0.10</sub>	0.3 ± 0.2
1206	3216	3.2 <sup>+0.10</sup> <sub>-0.20</sub>	1.6 ± 0.15	0.55 ± 0.05	0.45 ± 0.2	0.4 ± 0.2

		SOLDER PAD DIMENSIONS [in millimeters]					
SIZE		REFLOW			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5			
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.4	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3

**PART NUMBER AND PRODUCT DESCRIPTION**

**PART NUMBERING: M1004020D5620DP000**

M	1	0	0	4	0	2	0	D	5	6	2	0	D	P	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

<b>MODEL/SIZE</b> M100402 M110603 M120805 M251206	<b>SPECIAL CHARACTER</b> 0 = Neutral	<b>TCR</b> D = ± 25 ppm/K C = ± 50 ppm/K	<b>VALUE</b> 3 digit value 1 digit multiplier  Multiplier 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *100 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>	<b>TOLERANCE</b> B = ± 0.1 % C = ± 0.25 % D = ± 0.5 % F = ± 1 %	<b>PACKAGING<sup>1)</sup></b> P0 P1 P5 PN PZ	<b>SPECIAL</b> up to 2 digits 00 = standard
---	---	--	---	---	---	---

**PRODUCT DESCRIPTION: M10 25 562R 0.5 % P0**

M10	25	562R	0.5 %	P0
MODEL	TCR	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>1)</sup>
M10 M11 M12 M25	± 25 ppm/K ± 50 ppm/K	49K9 = 49.9 kΩ 5R1 = 5.1 Ω	± 0.1 % ± 0.25 % ± 0.5 % ± 1 %	P0 P1 P5 PN PZ

**Notes**

1. Please refer to table PACKAGING, page 146.
2. Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.



# M10, M11, M12, M25

Vishay Draloric

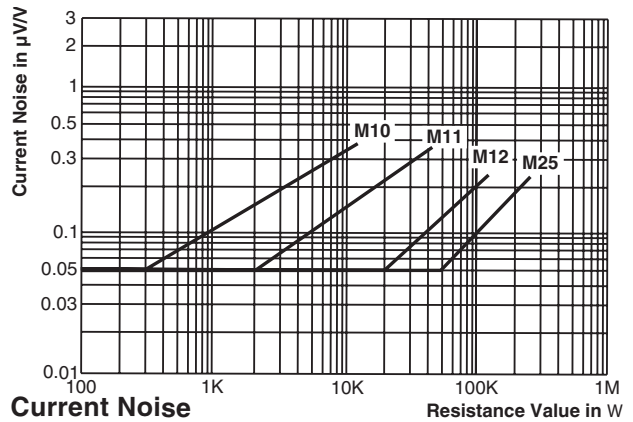
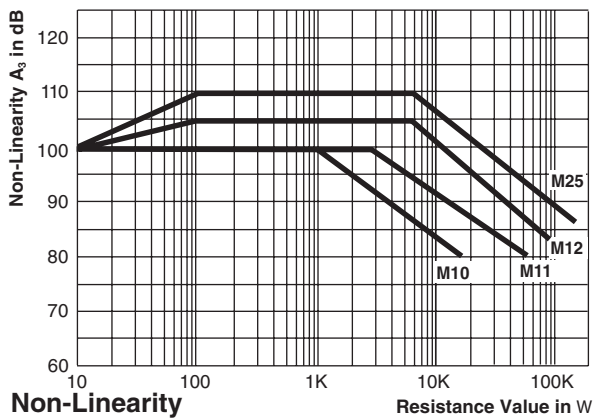
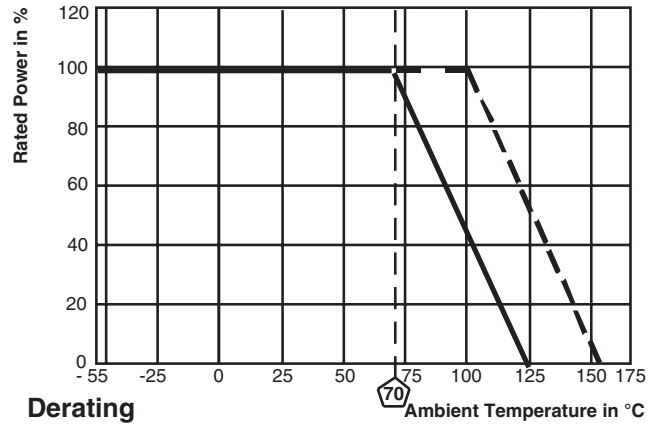
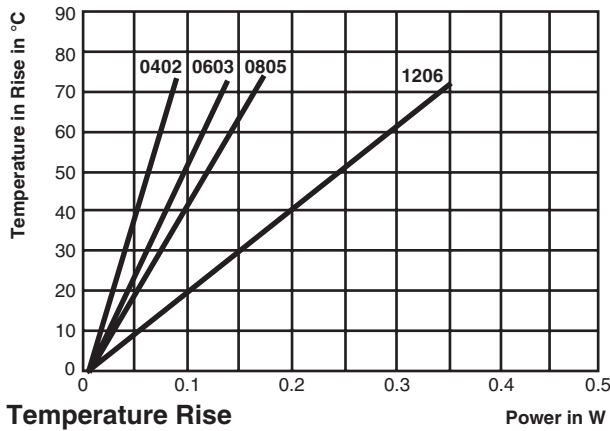
Thin Film, Rectangular, Resistor Chips

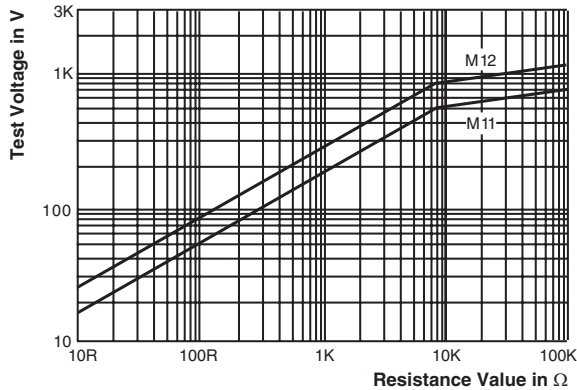
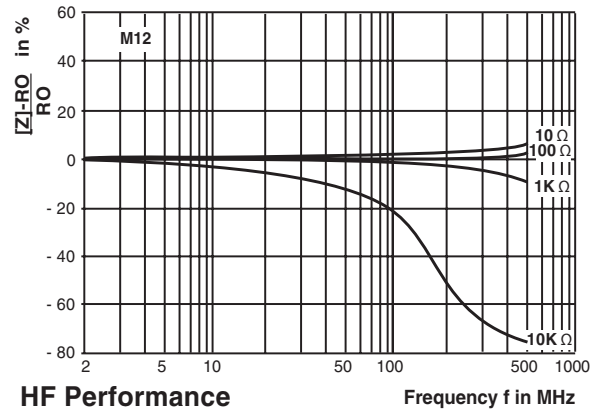
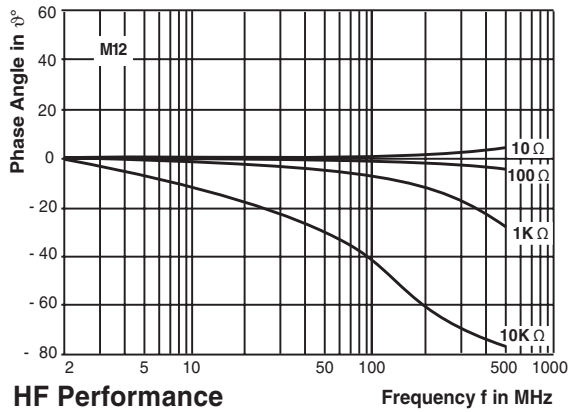
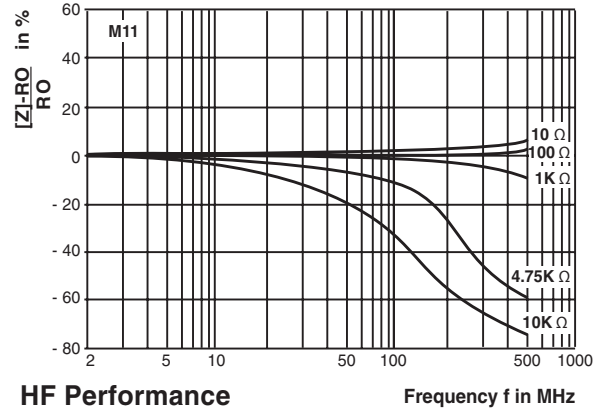
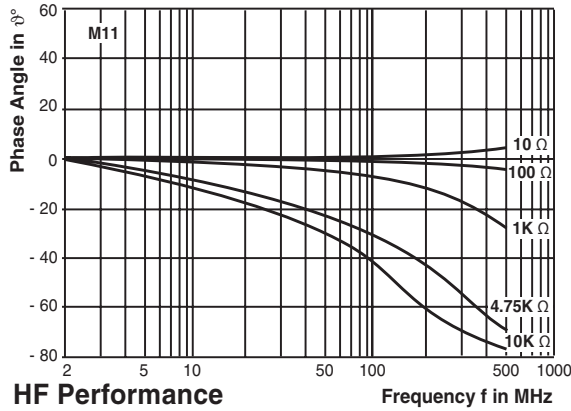


PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	PACKING CODE
				PAPER
M10	8 mm	180 mm/7" 330 mm/13"	10 000 50 000	P0 PZ
M11 M12 M25	8 mm	180 mm/7" 180 mm/7" 330 mm/13"	1000 <sup>1)</sup> 5000 20 000	P1 P5 PN

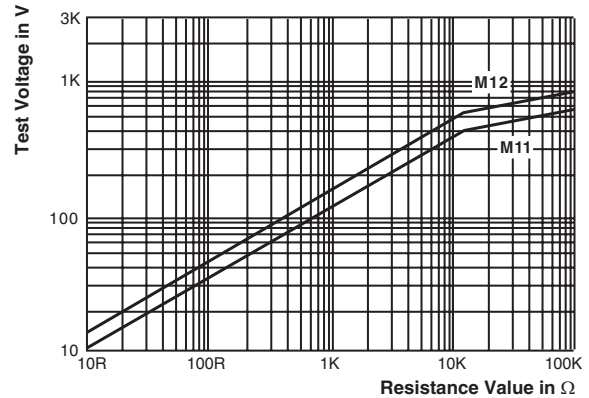
**Note**

1. For  $\leq$  TCR 25 ppm/K and Tolerance  $\leq$  0.1 % only.

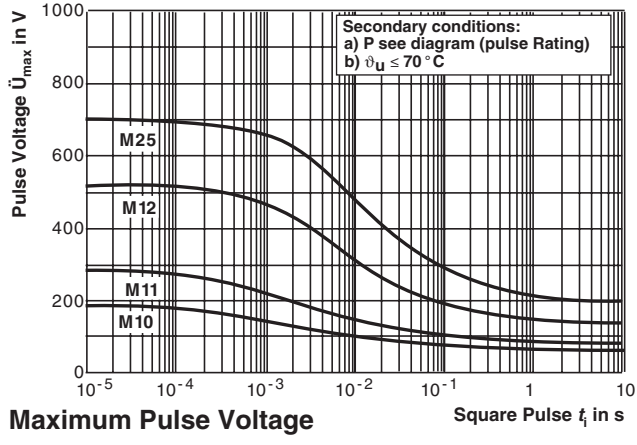
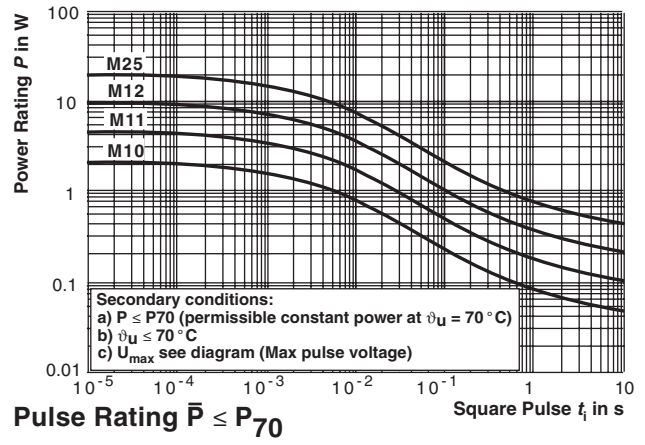
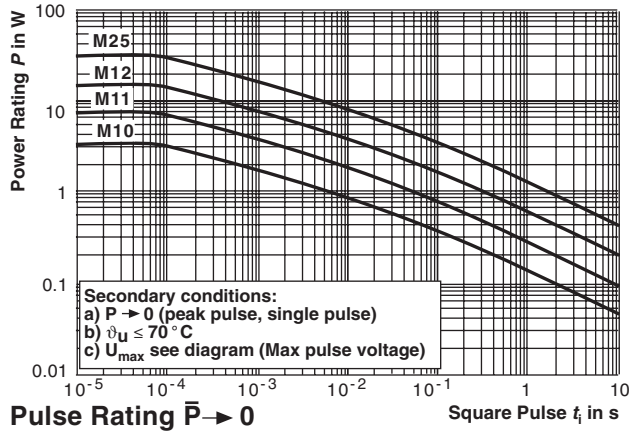




Single-Pulse High Voltage Overload Test  
1.2/50  $\mu$ s EN140000 4.27



Single-Pulse High Voltage Overload Test  
10/700  $\mu$ s EN140000 4.27



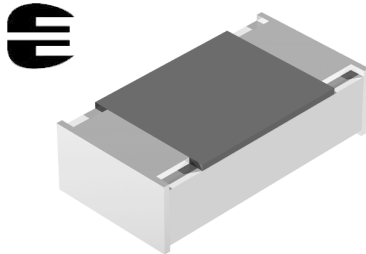
PERFORMANCE			
TEST	CONDITIONS OF TEST	TEST RESULTS	
		TOLERANCES	
		$\pm 0.1\% / \pm 0.25\%$	$\pm 0.5\% / \pm 1.0\%$
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	$\leq \pm 0.2\%$	$\leq \pm 0.5\%$
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	$\leq \pm 0.2\%$	$\leq \pm 0.5\%$
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds 2.5 x rated voltage or $\leq 2$ x limiting element voltage	$\leq \pm 0.05\%$	$\leq \pm 0.1\%$
Thermal Shock IEC 60115-1 4.19, IEC 60068-2-14	Rapid change between upper and lower category temperature	$\leq \pm 0.05\%$	$\leq \pm 0.1\%$
Damp Heat Steady State IEC 60115-1 4.24, IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	$\leq \pm 0.2\%$	$\leq \pm 0.5\%$
Resistance to Soldering Heat IEC 60115-1 4.18, IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	$\leq \pm 0.05\%$	$\leq \pm 0.2\%$



**APPLICABLE SPECIFICATIONS**

- CECC40000/40400/40401-801
- EN140400/IEC 60115 - 1/EN 140 401-801

## Precision Flat Chip Resistors



Thin Film Flat Chip Resistors combine the proven reliability of the professional products with an advanced level of precision and stability. Therefore they are perfectly suited for applications in the fields of test and measuring equipment together with industrial and medical electronics. The latest member of this product family size 0402 follows the ongoing trend of miniaturisation and enables precision applications in micro circuit designs.

### FEATURES

- Approved according to EN 140401-801
- Thin-film technology
- Low TCR:  $\pm 10$  to  $\pm 25$  ppm/K
- Precision tolerance of value:  $\pm 0.1$  and  $\pm 0.25$  %
- Superior overall stability: class 0.1 and 0.25
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Automotive
- Test and measuring equipment
- Medical equipment
- Industrial equipment

### METRIC SIZE

INCH:	0402	0603	0805	1206
METRIC:	RR 1005M	RR 1608M	RR 2012M	RR 3216M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MCS 0402		MCT 0603		MCU 0805		MCA 1206	
Metric size	RR 1005M		RR 1608M		RR 2012M		RR 3216M	
Resistance range	100 $\Omega$ to 221 k $\Omega$		39 $\Omega$ to 511 k $\Omega$		39 $\Omega$ to 1.5 M $\Omega$		39 $\Omega$ to 2 M $\Omega$	
Resistance tolerance	$\pm 0.25$ %; $\pm 0.1$ %							
Temperature coefficient	$\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K							
Operation mode	precision	standard	precision	standard	precision	standard	precision	standard
Climatic category (LCT/UCT/days)	10/85/56	55/125/56	10/85/56	55/125/56	10/85/56	55/125/56	10/85/56	55/125/56
Rated dissipation, $P_{70}^{1)}$	0.016 W	0.063 W	0.032 W	0.1 W	0.050 W	0.125 W	0.1 W	0.25 W
Operating voltage, $U_{max}$ AC/DC	12.5 V	50 V	25 V	75 V	35 V	150 V	50 V	200 V
Film temperature	85 $^{\circ}$ C	125 $^{\circ}$ C	85 $^{\circ}$ C	125 $^{\circ}$ C	85 $^{\circ}$ C	125 $^{\circ}$ C	85 $^{\circ}$ C	125 $^{\circ}$ C
Max. resistance change at $P_{70}$	100 $\Omega$ to 221 k $\Omega$		39 $\Omega$ to 511 k $\Omega$		39 $\Omega$ to 1.5 M $\Omega$		39 $\Omega$ to 2 M $\Omega$	
1000 h	$\leq 0.1$ %	$\leq 0.2$ %	$\leq 0.1$ %	$\leq 0.2$ %	$\leq 0.1$ %	$\leq 0.2$ %	$\leq 0.05$ %	$\leq 0.1$ %
8000 h	$\leq 0.2$ %	$\leq 0.4$ %	$\leq 0.2$ %	$\leq 0.4$ %	$\leq 0.2$ %	$\leq 0.4$ %	$\leq 0.1$ %	$\leq 0.25$ %
225 000 h	$\leq 0.5$ %	$\leq 1.0$ %	$\leq 0.5$ %	$\leq 1.0$ %	$\leq 0.5$ %	$\leq 1.0$ %	$\leq 0.25$ %	$\leq 0.5$ %
Specified lifetime	225 000 h		225 000 h		225 000 h		225 000 h	
Insulation voltage:								
1 minute; $U_{ins}$	75 V		100 V		200 V		300 V	
continuous	75 V		75 V		75 V		75 V	
Failure rate	$\leq 2 \times 10^{-9}$ /h		$\leq 2 \times 10^{-9}$ /h		$\leq 2 \times 10^{-9}$ /h		$\leq 2 \times 10^{-9}$ /h	

### Note

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



# MCS 0402, MCT 0603, MCU 0805, MCA 1206 - Precision

Precision Flat Chip Resistors

Vishay Beyschlag

## 12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

### Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5

### 12NC Example

The 12 NC of a MCT 0603 resistor, value 47 kΩ and TCR 25 with ± 0.1 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 216 74703.

12NC - resistors type and packaging							
DESCRIPTION			ORDERING CODE 2312... ..				
			CARDBOARD TAPE ON REEL				
TYPE	TCR	TOL.	P1 1000 UNITS	P5 5000 UNITS	PW 20 000 UNITS	E1 1000 UNITS	E0 10 000 UNITS
MCS 0402	± 25 ppm/K	± 0.25 %	-	-	-	261 6....	<b>276 6....</b>
		± 0.1 %	-	-	-	261 7....	<b>276 7....</b>
	± 15 ppm/K	± 0.25 %	-	-	-	262 6....	<b>277 6....</b>
		± 0.1 %	-	-	-	262 7....	<b>277 7....</b>
	± 10 ppm/K	± 0.25 %	-	-	-	263 6....	<b>278 6....</b>
		± 0.1 %	-	-	-	263 7....	<b>278 7....</b>
MCT 0603	± 25 ppm/K	± 0.25 %	201 6....	<b>216 6....</b>	206 6....	-	-
		± 0.1 %	201 7....	<b>216 7....</b>	206 7....	-	-
	± 15 ppm/K	± 0.25 %	202 6....	217 6....	207 6....	-	-
		± 0.1 %	202 7....	<b>217 7....</b>	207 7....	-	-
	± 10 ppm/K	± 0.25 %	203 6....	218 6....	208 6....	-	-
		± 0.1 %	203 7....	<b>218 7....</b>	208 7....	-	-
MCU 0805	± 25 ppm/K	± 0.25 %	241 6....	<b>256 6....</b>	246 6....	-	-
		± 0.1 %	241 7....	<b>256 7....</b>	246 7....	-	-
	± 15 ppm/K	± 0.25 %	242 6....	257 6....	247 6....	-	-
		± 0.1 %	242 7....	<b>257 7....</b>	247 7....	-	-
	± 10 ppm/K	± 0.25 %	243 6....	258 6....	248 6....	-	-
		± 0.1 %	243 7....	<b>258 7....</b>	248 7....	-	-
MCA 1206	± 25 ppm/K	± 0.25 %	381 6....	<b>396 6....</b>	386 6....	-	-
		± 0.1 %	381 7....	<b>396 7....</b>	386 7....	-	-
	± 15 ppm/K	± 0.25 %	382 6....	397 6....	387 6....	-	-
		± 0.1 %	382 7....	<b>397 7....</b>	387 7....	-	-
	± 10 ppm/K	± 0.25 %	383 6....	398 6....	388 6....	-	-
		± 0.1 %	383 7....	<b>398 7....</b>	388 7....	-	-

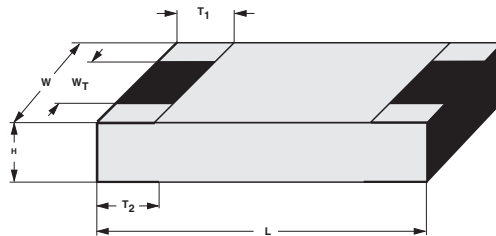
Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

PART NUMBER AND PRODUCT DESCRIPTION <sup>1)</sup>																	
PART NUMBER <sup>2)</sup> : MCT06030D4641BPW00																	
M	C	T	0	6	0	3	0	D	4	6	4	1	B	P	W	0	0
MODEL/SIZE	SPECIAL CHARACTER			TCR			VALUE			TOLERANCE		PACKAGING <sup>3)</sup>		SPECIAL			
MCS0402 MCT0603 MCU0805 MCA1206	0 = neutral			F = ± 10 ppm/K E = ± 15 ppm/K D = ± 25 ppm/K			3 digit value 1 digit multiplier  MULTIPLIER 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup> 6 = *10 <sup>6</sup>			B = ± 0.1 % C = ± 0.25 %		P1 P5 PW E1 E0		up to 2 digits 00 = standard			
PRODUCT DESCRIPTION: MCT 0603 - 25 0.1 % PW 4K64																	
MCT	0603	- 25	0.1 %	PW	4K64												
MODEL	SIZE	TCR	TOLERANCE	PACKAGING <sup>3)</sup>	RESISTANCE VALUE												
MCS MCT MCU MCA	0402 0603 0805 1206	± 10 ppm/K ± 15 ppm/K ± 25 ppm/K	± 0.1 % ± 0.25 %	P1 P5 PW E1 E0	47K = 47 kΩ 50R1 = 50.1 Ω												

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, page 211.

**DIMENSIONS**



DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	WT (mm)	T1 (mm)	T2 (mm)	MASS (mg)
MCS 0402	0.32 ± 0.05	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
MCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
MCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6
MCA 1206	0.55 ± 0.1	3.2 + 0.1/- 0.2	1.6 ± 0.15	> 75 % of W	0.5 ± 0.25	0.5 ± 0.25	9.2



# MCS 0402, MCT 0603, MCU 0805, MCA 1206 - Precision

Precision Flat Chip Resistors

Vishay Beyschlag

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE					
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>			
TCR	TOLERANCE	MCS 0402	MCT 0603	MCU 0805	MCA 1206
± 25 ppm/K	± 0.25 %	<b>100 Ω to 221 kΩ</b>	<b>39 Ω to 511 kΩ</b>	<b>39 Ω to 1.5 MΩ</b>	<b>39 Ω to 2 MΩ</b>
	± 0.1 %	<b>150 Ω to 221 kΩ</b>	<b>47 Ω to 511 kΩ</b>	<b>47 Ω to 1.5 MΩ</b>	<b>47 Ω to 2 MΩ</b>
± 15 ppm/K	± 0.25 %	100 Ω to 150 kΩ	39 Ω to 332 kΩ	39 Ω to 1 MΩ	39 Ω to 1.5 MΩ
	± 0.1 %	<b>150 Ω to 150 kΩ</b>	<b>47 Ω to 332 kΩ</b>	<b>47 Ω to 1 MΩ</b>	<b>47 Ω to 1.5 MΩ</b>
± 10 ppm/K <sup>(2)</sup>	± 0.25 %	100 Ω to 130 kΩ	39 Ω to 221 kΩ	39 Ω to 511 kΩ	39 Ω to 1 MΩ
	± 0.1 %	<b>150 Ω to 130 kΩ</b>	<b>47 Ω to 221 kΩ</b>	<b>47 Ω to 511 kΩ</b>	<b>47 Ω to 1 MΩ</b>

### Notes

- Resistance values to be selected from E96 and E192 series, other values are available on request.
- TCR 10 is specified over the temperature range from - 10 °C to 85 °C.

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

PACKAGING		
MODEL	REEL	
	PIECES/ PAPER TAPE ON REEL	CODE
MCS0402	1000	E1
	10 000	E0
MCT0603	1000	P1
	5000	P5
	20 000	PW
MCU0805	1000	P1
	5000	P5
	20 000	PW
MCA1206	1000	P1
	5000	P5
	20 000	PW





## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly fine trimming the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilize the trimming result. The resistor elements are covered by a blue protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems and for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

## APPROVALS

The resistors are tested in accordance with **EN 140401-801** (superseding **CECC 40401-801**) which refers to **EN 60115-1** and **EN 140400**. Approval of conformity is indicated by the CECC logo on the package label.

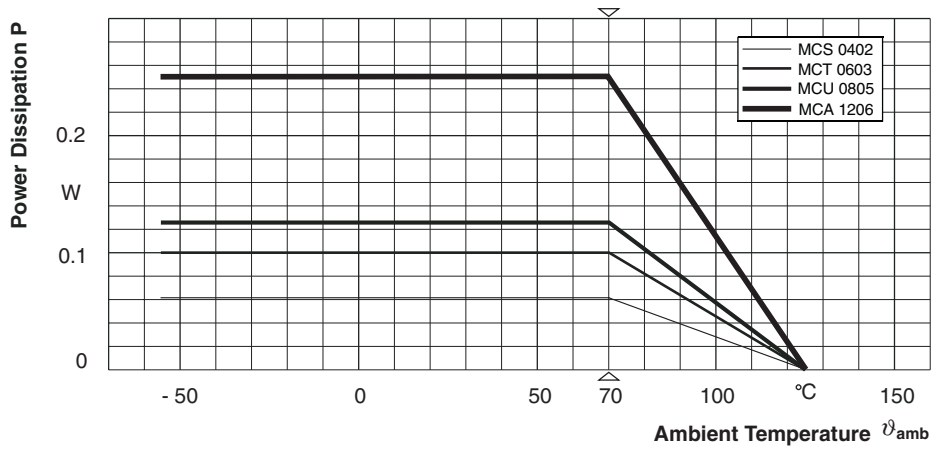
Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **EN 100114-6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

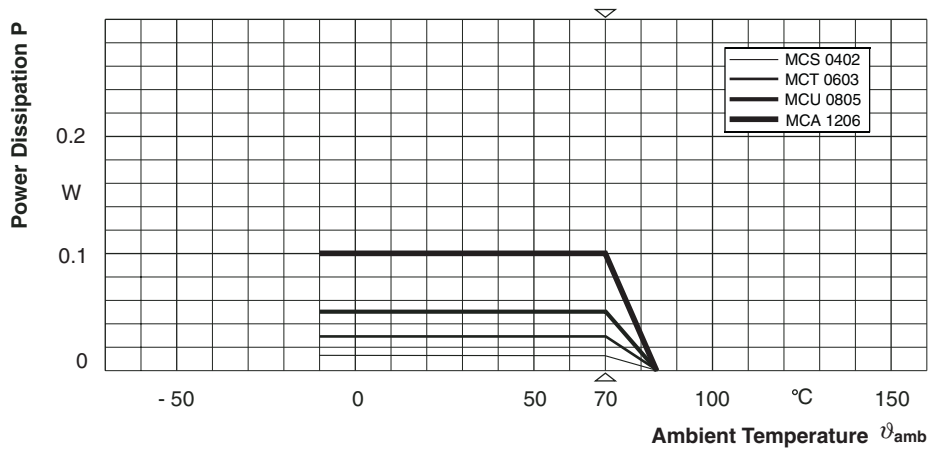
On request, resistors are available with established reliability in accordance with **EN 140 401-801 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and order codes.



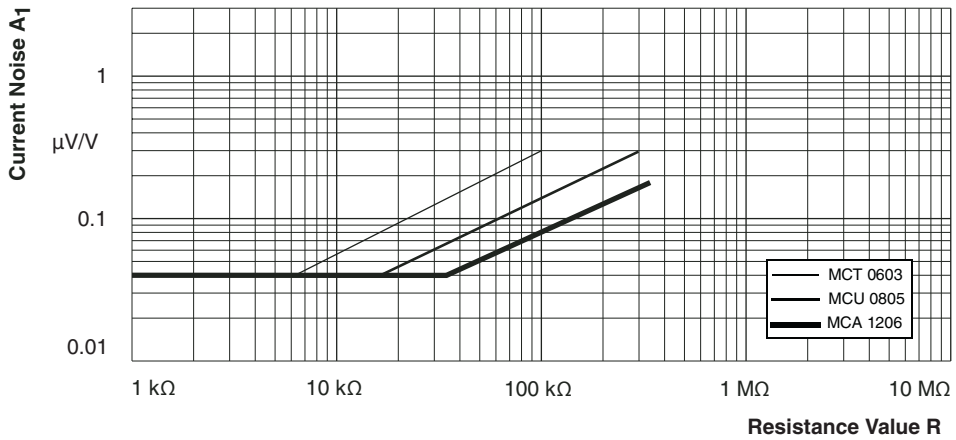
**FUNCTIONAL PERFORMANCE**



**Derating - Standard Operation**



**Derating - Precision Operation**



**Current Noise A<sub>1</sub>**

In accordance with IEC 60195



**TEST AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with

IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid. Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			<b>MCS 0402</b>	470 Ω to 10 kΩ	> 10 kΩ to 52.3 kΩ
			<b>MCT 0603</b>	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			<b>MCU 0805</b>	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			<b>MCA 1206</b>	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
4.5	-	resistance		± 0.1 %; ± 0.25 %	
4.8.4.2	-	temperature coefficient	at 20/- 10/20 °C and 20/85/20 °C	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K	
4.25.1	-	endurance at 70 °C: precision operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe;  1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (0.1 \% R + 0.02 \Omega)^1$ $\pm (0.2 \% R + 0.02 \Omega)^1$	
		endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe;  1.5 h on; 0.5 h off  70 °C; 1000 h  70 °C; 8000 h	$\pm (0.2 \% R + 0.02 \Omega)^1$ $\pm (0.4 \% R + 0.05 \Omega)^1$	



# MCS 0402, MCT 0603, MCU 0805, MCA 1206 - Precision

Precision Flat Chip Resistors

Vishay Beyschlag

TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			<b>MCS 0402</b>	470 Ω to 10 kΩ	> 10 kΩ to 52.3 kΩ
			<b>MCT 0603</b>	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			<b>MCU 0805</b>	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			<b>MCA 1206</b>	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
4.25.3	-	endurance at upper category temperature	85 °C; 1000 h 125 °C; 1000 h	± (0.1 % R + 0.02 Ω) ± (0.2 % R + 0.02 Ω)	± (0.2 % R + 0.02 Ω) ± (0.25 % R + 0.05 Ω)
4.24	78 (Cab)	damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.02 Ω)	± (0.25 % R + 0.05 Ω)
4.23 4.23.2 4.23.3 4.23.4 4.23.5 4.23.6	2 (Ba) 30 (Db) 1 (Aa) 13 (M) 30 (Db)	climatic sequence: dry heat damp heat, cyclic cold low air pressure damp heat, cyclic	UCT; 16 h 55 °C; 24 h; > 90 % RH; 1 cycle LCT; 2 h 8.5 kPa; 2 h; 25 ± 10 °C 55 °C; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	± (0.1 % R + 0.02 Ω)	± (0.25 % R + 0.05 Ω)
-	1 (Aa)	cold	- 55 °C; 2h	± (0.05 % R + 0.01 Ω)	
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 10 °C UCT = 85 °C; 5 cycles	± (0.05 % R + 0.01 Ω) no visible damage	
			LCT = - 55 °C; UCT = 125 °C; 1000 cycles	± (0.25 % R + 0.05 Ω) no visible damage	
4.13	-	short time overload; precision operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 5 s	± (0.05 % R + 0.01 Ω)	
		short time overload; standard operation mode		± (0.05 % R + 0.01 Ω)	
4.27	-	single pulse high voltage overload; standard operation mode	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 10 pulses 10 μs/700 μs	± (0.5 % R + 0.05 Ω) <sup>2</sup> no visible damage	
4.37	-	periodic electric overload; standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω) <sup>2</sup> no visible damage	

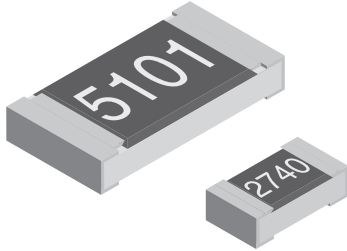


TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			MCS 0402	470 Ω to 10 kΩ	> 10 kΩ to 52.3 kΩ
			MCT 0603	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			MCU 0805	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			MCA 1206	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s <sup>2</sup> ; 6 h	± (0.05 % R + 0.01 Ω) no visible damage	
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 ± 3) °C; (3 ± 0.3) s	good tinning (≥ 95 % covered); no visible damage	
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 ± 3) °C; (2 ± 0.2) s		
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.05 % R + 0.01 Ω)	
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 °C; method 2	no visible damage	
4.32	21 (Ue <sub>3</sub> )	shear	RR 1005M and RR 1608M; 9 N RR 2012M and RR 3216M; 45 N	no visible damage	
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	± (0.05 % R + 0.01 Ω) no visible damage, no open circuit in bent position	
4.7	-	voltage proof	$U_{rms} = U_{ins}$ ; 60 ± 5 s	no flashover or breakdown	
4.35	-	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s	
Special requirements for type MCA 1206					
4.25.1	-	endurance at 70 °C: precision operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe 70 °C; 1000 h 70 °C; 8000 h	± (0.05 % R + 0.02 Ω) ± (0.1 % R + 0.02 Ω)	
	-	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe 70 °C; 1000 h 70 °C; 8000 h	± (0.1 % R + 0.02 Ω) ± (0.25 % R + 0.05 Ω)	

Notes

- See 4.25.1 (above): special requirements for type MCA 1206.
- The pulse load stability of professional MFC resistors applies for precision resistors also. However, severe pulse loads are likely to jeopardise precision stability requirements.

## High Stability Thin Film Flat Chip Resistor $\leq 0.05\%$ (1000 h rated power at 70 °C)



TNPW e3 Precision Thin Film Flat Chip Resistors are the perfect choice for most fields of modern electronics where highest reliability and stability is of major concern. Typical applications include automotive, telecommunication, industrial, medical equipment, precision test and measuring equipment.

**FEATURES**

- High Temperature Exposure: 200 °C; 1000 h
- Superior moisture resistivity  $\leq 0.25\%$  (85 °C; 56 days; 85 % RH)
- Lead (Pb)-free solder contacts, RoHS compliant
- Low temperature coefficient and tight tolerances ( $\pm 0.1\%$ ;  $\pm 10$  ppm/K)
- Waste gas resistant


**APPLICATIONS**

- Automotive
- Telecommunication
- Medical Equipment
- Industrial Equipment
- Instrumentation
- Test and Measuring Equipment

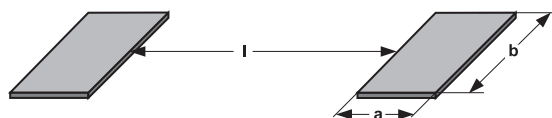
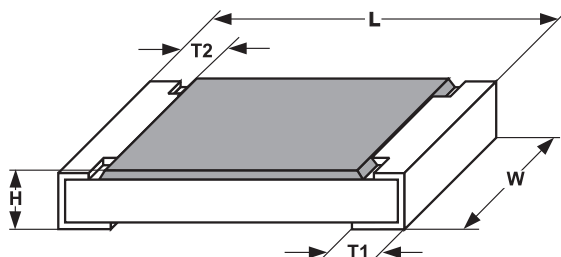
**STANDARD ELECTRICAL SPECIFICATIONS**

	TNPW0402	TNPW0603	TNPW0805	TNPW1206	TNPW1210 <sup>1)</sup>	TNPW2010	TNPW2512 <sup>1)</sup>
Metric Size	RR 1005M	RR 1608M	RR 2012M	RR 3216M	RR 3225M	RR 5025M	RR 6332M
Resistance range	10 $\Omega$ to 100 k $\Omega$	10 $\Omega$ to 332 k $\Omega$	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 2 M $\Omega$	10 $\Omega$ to 3.01 M $\Omega$	10 $\Omega$ to 4.99 M $\Omega$	10 $\Omega$ to 8.87 M $\Omega$
Resistance tolerance	$\pm 1\%$ ; $\pm 0.5\%$ ; $\pm 0.1\%$						
Temperature Coefficient	$\pm 50$ ppm/K; $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K					$\pm 50$ ppm/K; $\pm 25$ ppm/K	
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56
Rated dissipation, $P_{70}$ <sup>2)</sup>	0.063 W	0.1 W	0.125 W	0.25 W	0.33 W	0.4 W	0.5 W
Operating voltage, $U_{max}$ AC/DC	50 V	75 V	150 V	200 V	200 V	300 V	300 V
Maximum permissible film temperature	155 °C	155 °C	155 °C	155 °C	155 °C	155 °C	155 °C
Thermal resistance <sup>3)</sup>	870 K/W	550 K/W	440 K/W	220 K/W	170 K/W	140 K/W	110 K/W
Max. resistance change at $P_{70}$ ; $\Delta R/R$	10 $\Omega$ to 100 k $\Omega$	10 $\Omega$ to 332 k $\Omega$	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 2 M $\Omega$	10 $\Omega$ to 3.01 M $\Omega$	10 $\Omega$ to 4.99 M $\Omega$	10 $\Omega$ to 8.87 M $\Omega$
1000 h	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$
8000 h	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$
225 000 h	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$
Insulation voltage: $U_{ins}$ 1 min	75 V	100 V	200 V	300 V	300 V	300 V	300 V
continuous	75 V	75 V	75 V	75 V	75 V	75 V	75 V
Failure rate	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$
Weight/1000 pcs.	0.65 g	2 g	5.5 g	10 g	16 g	28 g	39 g

**Notes**

1. Size not specified in EN 140401-801
  2. Rated voltage  $\sqrt{P \times R}$ . The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded
  3. Measuring conditions in accordance with EN 140401-801
- TNPW 0402 without marking
  - Extended values, tighter tolerances and temperature coefficient available on request

**DIMENSIONS**



SIZE		DIMENSIONS in millimeters				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.2 ± 0.10	
0603	1608	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	
0805	2012	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	
1206	3216	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	
1210	3225	3.2 ± 0.15	2.45 ± 0.15	0.60 ± 0.15	0.5 ± 0.25	
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	
2512	6332	6.3 ± 0.20	3.1 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	

SOLDER PAD DIMENSIONS in millimeters							
SIZE		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5	-	-	-
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.3
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	TCR	TOLERANCE	RESISTANCE VALUE	E-SERIES
TNPW0402	± 50 ppm/K	± 1 %	10R - 100K	24 - 96
		± 0.5 %	10R - 100K	24 - 192
		± 0.1 %	47R - 100K	
	± 25 ppm/K	± 1 %	10R - 100K	24 - 96
		± 0.5 %	10R - 100K	24 - 192
		± 0.1 %	47R - 100K	
TNPW0603	± 50 ppm/K	± 1 %	10R - 332K	24 - 96
		± 0.5 %	10R - 332K	24 - 192
		± 0.1 %	10R - 332K	
	± 25 ppm/K	± 1 %	10R - 332K	24 - 96
		± 0.5 %	10R - 332K	24 - 192
		± 0.1 %	47R - 332K	
TNPW0805	± 50 ppm/K	± 1 %	10R - 1M0	24 - 96
		± 0.5 %	10R - 1M0	24 - 192
		± 0.1 %	10R - 1M0	
	± 25 ppm/K	± 1 %	10R - 1M0	24 - 96
		± 0.5 %	10R - 1M0	24 - 192
		± 0.1 %	47R - 1M0	
± 15 ppm/K	± 0.1 %			
	± 10 ppm/K	± 0.1 %		



High Stability Thin Film Flat Chip Resistor  
 $\leq 0.05\%$  (1000 h rated power at 70 °C)

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	TCR	TOLERANCE	RESISTANCE VALUE	E-SERIES
TNPW1206	$\pm 50$ ppm/K	$\pm 1\%$	10R - 2M0	24 - 96
		$\pm 0.5\%$	10R - 2M0	24 - 192
		$\pm 0.1\%$		
	$\pm 25$ ppm/K	$\pm 1\%$	10R - 2M0	24 - 96
		$\pm 0.5\%$	10R - 2M0	24 - 192
		$\pm 0.1\%$		
$\pm 15$ ppm/K	$\pm 0.1\%$	47R - 2M0	24 - 192	
$\pm 10$ ppm/K	$\pm 0.1\%$			
TNPW1210	$\pm 50$ ppm/K	$\pm 1\%$	10R - 3M01	24 - 96
		$\pm 0.5\%$	10R - 3M01	24 - 192
		$\pm 0.1\%$	47R - 2M13	
	$\pm 25$ ppm/K	$\pm 1\%$	10R - 3M01	24 - 96
		$\pm 0.5\%$	10R - 3M01	24 - 192
		$\pm 0.1\%$		
$\pm 15$ ppm/K	$\pm 0.1\%$	47R - 2M13	24 - 192	
$\pm 10$ ppm/K	$\pm 0.1\%$			
TNPW2010	$\pm 50$ ppm/K	$\pm 1\%$	10R - 4M99	24 - 96
		$\pm 0.5\%$	10R - 4M99	24 - 192
		$\pm 0.1\%$	47R - 1M0	
	$\pm 25$ ppm/K	$\pm 1\%$	10R - 4M99	24 - 96
		$\pm 0.5\%$	10R - 4M99	24 - 192
		$\pm 0.1\%$	47R - 1M0	
TNPW2512	$\pm 50$ ppm/K	$\pm 1\%$	10R - 8M87	24 - 96
		$\pm 0.5\%$	10R - 8M87	24 - 192
		$\pm 0.1\%$	47R - 1M0	
	$\pm 25$ ppm/K	$\pm 1\%$	10R - 8M87	24 - 96
		$\pm 0.5\%$	10R - 8M87	24 - 192
		$\pm 0.1\%$	47R - 1M0	

PART NUMBER AND PRODUCT DESCRIPTION																	
PART NUMBER: (LEAD (Pb)-FREE) TNPW12061K32DEEA																	
T	N	P	W	1	2	0	6	1	K	3	2	D	E	E	A		
MODEL		VALUE		TOLERANCE		TCR		PACKAGING <sup>1)</sup>		SPECIAL							
TNPW0402 TNPW0603 TNPW0805 TNPW1206 TNPW1210 TNPW2010 TNPW2512		R = Decimal K = Thousand M = Million (4 digits)		B = $\pm 0.1\%$ D = $\pm 0.5\%$ F = $\pm 1.0\%$		H = $\pm 50$ ppm/K E = $\pm 25$ ppm/K X = $\pm 15$ ppm/K Y = $\pm 10$ ppm/K		EA EC ED EF EG EN EY		up to 2 digits Blank = standard							
PRODUCT DESCRIPTION: TNPW1206 1K32 0.5% T-9 ET1 e3																	
TNPW1206	1K32	0.5%	T-9	ET1	e3												
MODEL	RESISTANCE VALUE	TOLERANCE	TCR	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE												
TNPW0402 TNPW0603 TNPW0805 TNPW1206 TNPW1210 TNPW2010 TNPW2512	Examples: 54R1 = 54.1 $\Omega$ 1K32 = 1320 $\Omega$	$\pm 0.1\%$ $\pm 0.5\%$ $\pm 1.0\%$	T-2 = $\pm 50$ ppm/K T-9 = $\pm 25$ ppm/K T-10 = $\pm 15$ ppm/K T-13 = $\pm 10$ ppm/K	ET1 ET6 ET7 E02 E67 E52 E75	e3 = Pure Tin Termination Finish												

Notes

- Please refer to PACKAGING table
- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
- For ordering TNPW with SnPb contacts please refer to latest edition of data sheet TNPW lead bearing.



PACKAGING							
MODEL	TAPE WIDTH [mm]	PITCH [mm]	REEL DIAMETER [mm/inch]	PIECES PER REEL	PACKING CODE FOR PRODUCT DESCRIPTION	PACKING CODE FOR PART NUMBER	TYPE OF CARRIER TAPE
TNPW 0402	8	2	180/7	10 000	ET7	ED	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	180/7	1000	E52 <sup>1</sup>	EN <sup>1</sup>	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	180/7	5000	ET1	EA	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	330/13	20 000	ET6	EC	Paper
TNPW 2010	12	4	180/7	1000	E75	EY	Blister
				4000	E02	EF	Blister
TNPW 2512	12	4	180/7	1000	E75	EY	Blister
				2000	E67	EG	Blister

**Note**

1. E52/EN only for precision resistors with tolerance ± 0.1 % and temperature coefficient ≤ ± 25 ppm/k

**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly fine trimming the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilize the trimming result. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating. The result of the determined production is verified by an extensive testing procedure on 100 % of the individual chip resistors. Only accepted products are laid directly into the tape in accordance with **EN 60286-3**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEPIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

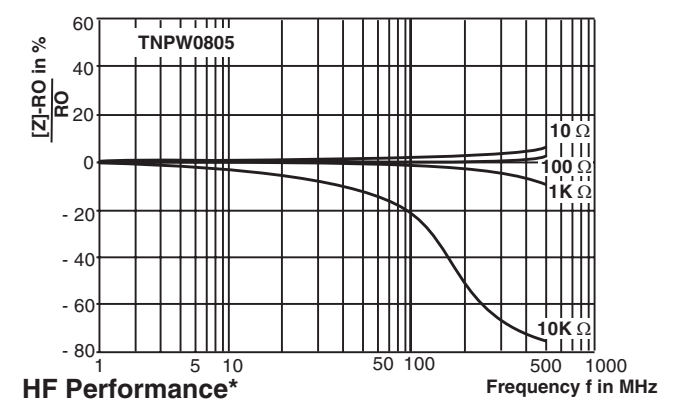
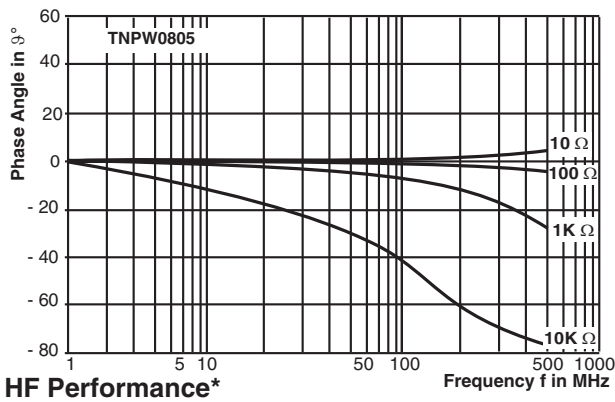
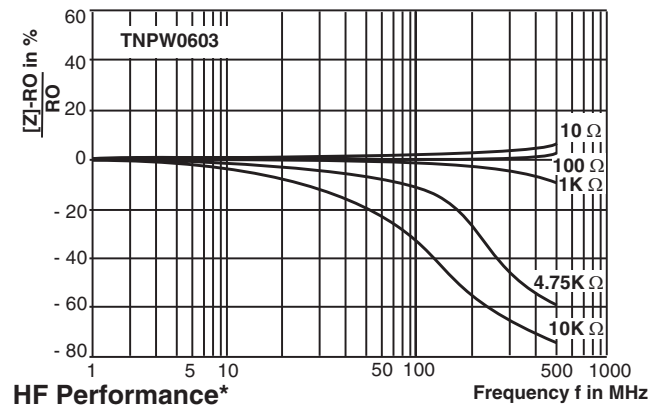
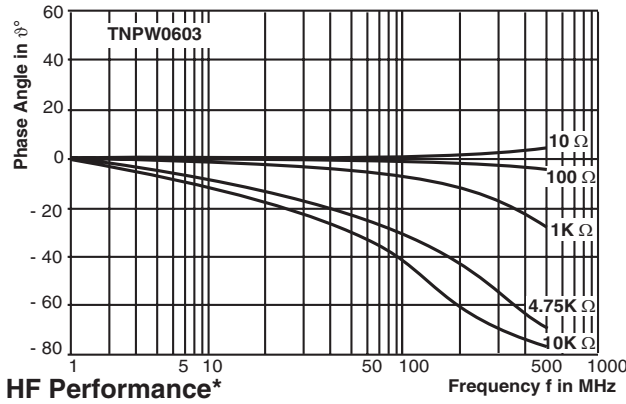
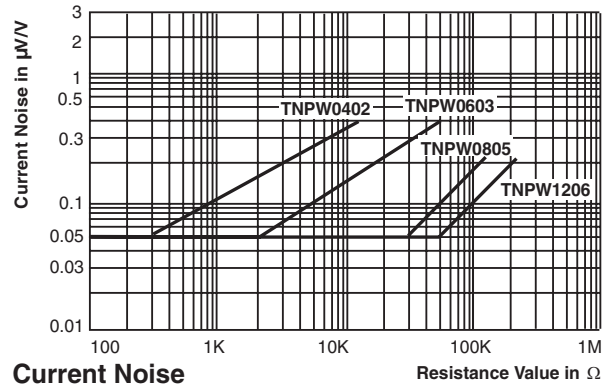
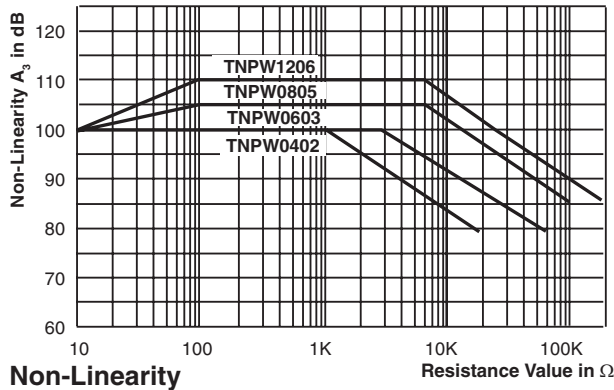
**Notes**

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEPIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

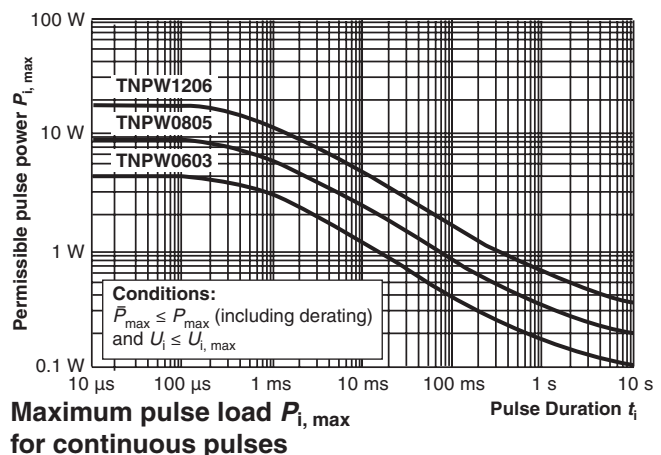
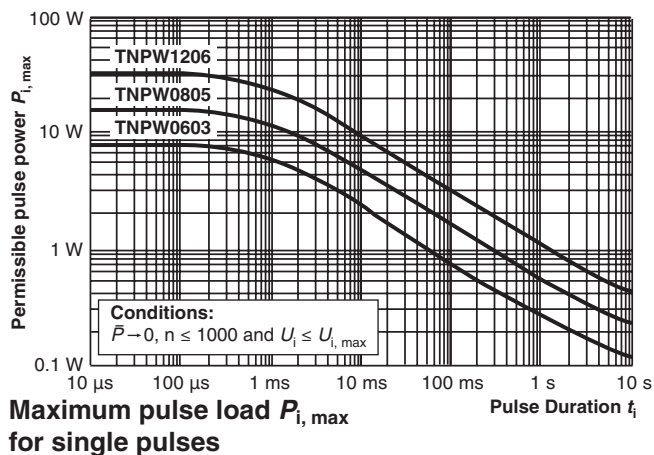
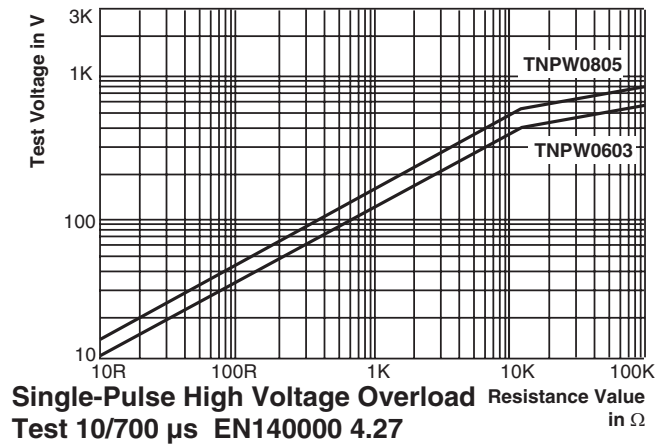
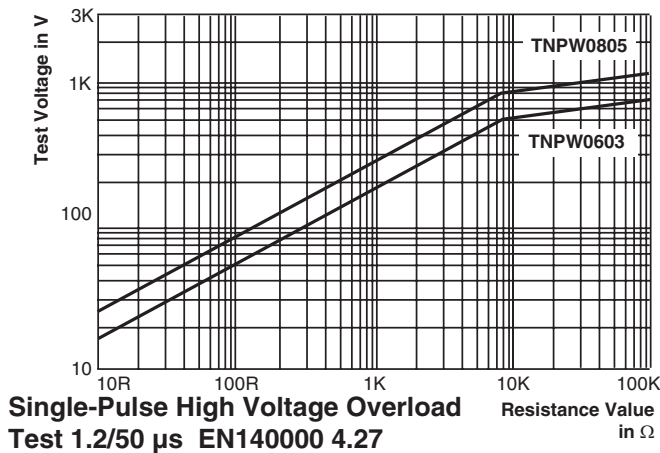
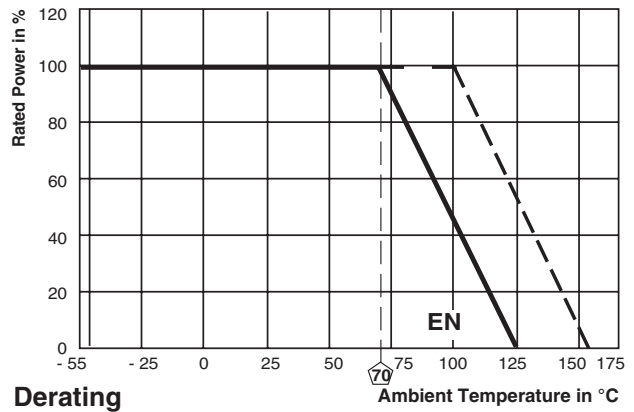
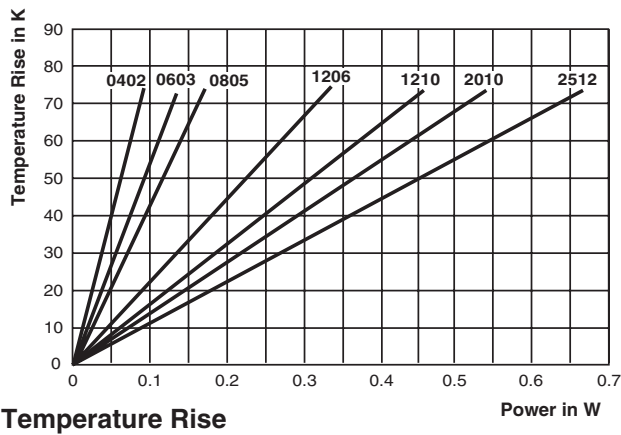


High Stability Thin Film Flat Chip Resistor  
 $\leq 0.05\%$  (1000 h rated power at 70 °C)

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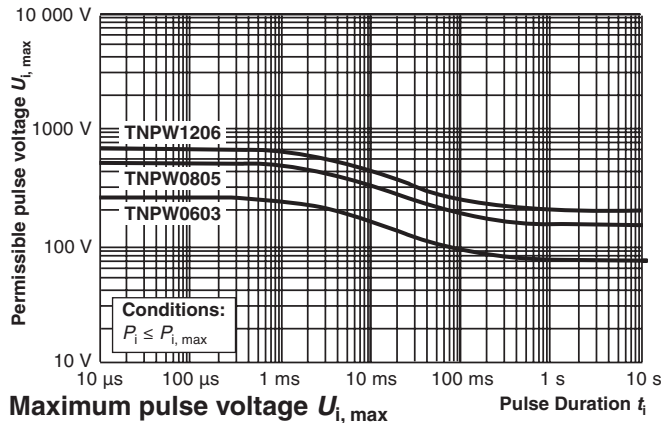


\* Typical figures. HF-characteristic also depends on termination and circuit design.





High Stability Thin Film Flat Chip Resistor  
 $\leq 0.05\%$  (1000 h rated power at 70 °C)



**TEST AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

- EN 60115-1, Generic specification (includes tests)
- EN 140 400, Sectional specification (includes schedule for qualification approval)
- EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202. The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower

Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid. Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 45 % to 75 %
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified. The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE
			<b>stability for product types:</b> TNPW0402 TNPW0603 TNPW0805 TNPW1206 TNPW1210 TNPW2010 TNPW2512	
4.5	-	resistance		$\pm 1\%$ ; $\pm 0.5\%$ ; $\pm 0.1\%$
4.8.4.2	-	temperature coefficient	at 20/- 55/20 °C $\pm$ and 20/125/20 °C	$\pm 50$ ppm/K; $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K
4.25.1	-	endurance at 70 °C	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.05\% R + 0.01 \Omega)$ $\pm (0.1\% R + 0.02 \Omega)$

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE
			stability for product types: TNPW0402 TNPW0603 TNPW0805 TNPW1206 TNPW1210 TNPW2010 TNPW2512	
4.25.3	-	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h 200 °C, 1000 h <sup>1)</sup>	± (0.05 % R + 0.01 Ω) ± (0.1 % R + 0.02 Ω) ± (0.25 % R + 0.05 Ω)
4.24	78 (Cab)	damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.01 Ω)
4.23		climatic sequence:		
4.23.2	2 (Ba)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp	55 °C; 24 h; > 90 % RH; 1	
4.23.4	1 (Aa)	cold	LCT; 2 h	
4.23.5	13 (M)	low air	8.5 kPa; 2 h; 25 ± 10 °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; > 95 to 100 % RH; 5 cycles	
4.23.7	-	d.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max}$ ; 1 min LCT = - 55 °C UCT = 125 °C	± (0.1 % R + 0.02 Ω)
-	1 (Aa)	cold	- 55 °C; 2 h	± (0.05 % R + 0.01 Ω)
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 1000 cycles	± (0.1 % R + 0.01 Ω)
4.13	-	short time overload	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 5 s	± (0.05 % R + 0.01 Ω)
4.27	-	single pulse high voltage overload	severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 10 pulses 10 μs/700 μs	± (0.5 % R + 0.05 Ω) no visible damage
4.37	-	periodic electric overload	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max}$ ; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω) no visible damage
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s <sup>2</sup> ; 6 h	± (0.05 % R + 0.01 Ω) no visible damage

**Note**

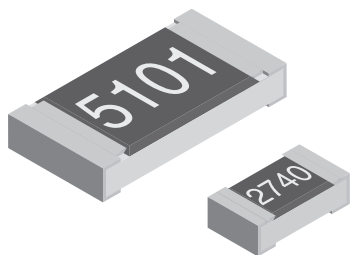
1. Using advanced temperature level may require special considerations towards the choice of circuit board and solder material



TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE
			<b>stability for product types:</b> TNPW0402 TNPW0603 TNPW0805 TNPW1206 TNPW1210 TNPW2010 TNPW2512	
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 ± 3) °C; (3 ± 0.3) s  solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 ± 3) °C; (2 ± 0.2) s	good tinning ( $\geq 95\%$ covered); no visible damage
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 ± 5) °C; (10 ± 1) s	$\pm (0.02\% R + 0.01 \Omega)$
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 °C; method 2	no visible damage
4.32	21 (Ue <sub>3</sub> )	shear	RR 1005M and RR 1608M; RR 2012M and RR 3216M;	no visible damage
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm (0.05\% R + 0.01 \Omega)$ no visible damage, no open circuit in bent position
4.7	-	voltage proof	$U_{rms} = U_{ins}$ ; 60 ± 5 s	no flashover or breakdown
4.35	-	flammability	IEC 60695-11-5, needle flame test; 10 s	no burning after 30 s
	-	damp heat	(85 ± 5) °C; 56 days (85 ± 5) % RH	$\pm (0.25 R + 0.05 \Omega)$

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>• CECC40000/40400</li> <li>• EN140400</li> <li>• EN 140401-801</li> <li>• EN 60115-1</li> <li>• IEC 60286-3</li> </ul>

## High Stability Thin Film Chip Resistor $\leq 0.05\%$ (1000 h rated power at 70 °C)



TNPW Precision Thin Film Flat Chip Resistors are the perfect choice for most fields of modern electronics where reliability and stability is of major concern. Typical applications include telecommunication, industrial, medical equipment, high-end computer and audio/video electronics.

### FEATURES

- Metal film layer on high quality ceramic
- Protective top coat
- Tin/lead (Pb) solder contacts
- Excellent overall stability at different environmental conditions  $\leq 0.05\%$  (1000 h rated power at + 70 °C)
- Low temperature coefficient and tight tolerances ( $\pm 0.1\%$ ;  $\pm 10$  ppm/K)

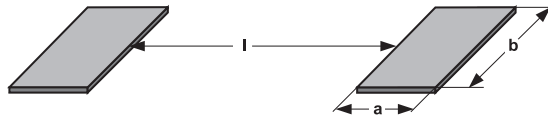
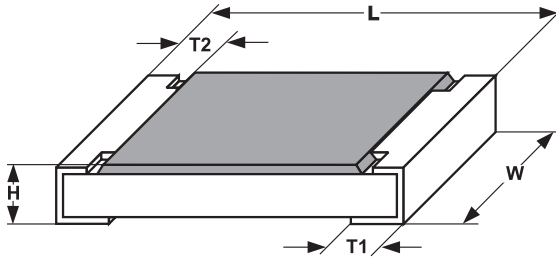
### APPLICATIONS

- Automotive
- Telecommunication
- Medical Equipment
- Industrial Equipment

STANDARD ELECTRICAL SPECIFICATIONS							
	TNPW0402	TNPW0603	TNPW0805	TNPW1206	TNPW1210 <sup>1)</sup>	TNPW2010	TNPW2512 <sup>1)</sup>
Metric Size	RR 1005M	RR 1608M	RR 2012M	RR 3216M	RR 3225M	RR 5025M	RR 6332M
Resistance range	10 $\Omega$ to 100 k $\Omega$	10 $\Omega$ to 332 k $\Omega$	10 $\Omega$ to 1 M $\Omega$	10 $\Omega$ to 2 M $\Omega$	10 $\Omega$ to 3.01 M $\Omega$	10 $\Omega$ to 4.99 M $\Omega$	10 $\Omega$ to 8.87 M $\Omega$
Resistance tolerance	$\pm 1\%$ ; $\pm 0.5\%$ ; $\pm 0.1\%$						
Temperature Coefficient	$\pm 50$ ppm/K; $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K					$\pm 50$ ppm/K; $\pm 25$ ppm/K	
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56
Rated dissipation, $P_{70}$ <sup>2)</sup>	0.063 W	0.1 W	0.125 W	0.25 W	0.33 W	0.4 W	0.5 W
Operating voltage, $U_{max}$ AC/DC	50 V	75 V	150 V	200 V	200 V	300 V	300 V
Maximum permissible film temperature	155 °C	155 °C	155 °C	155 °C	155 °C	155 °C	155 °C
Thermal resistance <sup>3)</sup>	870 K/W	550 K/W	440 K/W	220 K/W	170 K/W	140 K/W	110 K/W
Insulation voltage:							
$U_{ins}$ 1 min	75 V	100 V	200 V	300 V	300 V	300 V	300 V
continuous	75 V	75 V	75 V	75 V	75 V	75 V	75 V
Failure rate	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$	$\leq 0.3 \times 10^{-9}/h$
Weight/1000 pcs.	0.65 g	2 g	5.5 g	10 g	16 g	28 g	39 g

### Notes

1. Size not specified in EN 140401-801
  2. Rated voltage  $\sqrt{P \times R}$ . The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded
  3. Measuring conditions in accordance with EN 140401-801
- TNPW 0402 without marking
  - Extended values, tighter tolerances and temperature coefficient available on request

**DIMENSIONS**


SIZE		DIMENSIONS millimeters				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.2 ± 0.10	
0603	1608	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	
0805	2012	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	
1206	3216	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	
1210	3225	3.2 ± 0.15	2.45 ± 0.15	0.60 ± 0.15	0.5 ± 0.25	
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	
2512	6332	6.3 ± 0.20	3.1 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	

SOLDER PAD DIMENSIONS millimeters							
SIZE		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5	-	-	-
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.3
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	TCR	TOLERANCE	RESISTANCE VALUE	E-SERIES
TNPW0402	± 50 ppm/K	± 1 %	10R - 100K	24 -96
		± 0.5 %	10R - 100K	24-192
		± 0.1 %	47R - 100K	
	± 25 ppm/K	± 1 %	10R - 100K	24 -96
		± 0.5 %	10R - 100K	24-192
		± 0.1 %	47R - 100K	
		± 0.1 %		
TNPW0603	± 50 ppm/K	± 1 %	10R - 332K	24 -96
		± 0.5 %	10R - 332K	24-192
		± 0.1 %	10R - 332K	
	± 25 ppm/K	± 1 %		24 -96
	± 0.5 %	24-192		
	± 0.1 %			
	± 15 ppm/K	± 0.1 %	47R - 332K	
± 10 ppm/K	± 0.1 %			
TNPW0805	± 50 ppm/K	± 1 %	10R - 1M0	24 -96
		± 0.5 %	10R - 1M0	24-192
		± 0.1 %	10R - 1M0	
	± 25 ppm/K	± 1 %		24 -96
	± 0.5 %	24-192		
	± 0.1 %			
	± 15 ppm/K	± 0.1 %	47R - 1M0	
	± 10 ppm/K	± 0.1 %		



TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	TCR	TOLERANCE	RESISTANCE VALUE	E-SERIES
TNPW1206	± 50 ppm/K	± 1 %	10R - 2M0	24 -96
		± 0.5 %	10R - 2M0	24-192
		± 0.1 %		
		± 25 ppm/K	± 1 %	10R - 2M0
	± 0.5 %		10R - 2M0	24-192
	± 0.1 %			
	± 15 ppm/K		± 0.1 %	47R - 2M0
	± 10 ppm/K	± 0.1 %		
TNPW1210	± 50 ppm/K	± 1 %	10R - 3M01	24 -96
		± 0.5 %	10R - 3M01	24-192
		± 0.1 %	47R - 2M13	
		± 25 ppm/K	± 1 %	10R - 3M01
	± 0.5 %		10R - 3M01	24-192
	± 0.1 %			
	± 15 ppm/K		± 0.1 %	47R - 2M13
	± 10 ppm/K	± 0.1 %		
TNPW2010	± 50 ppm/K	± 1 %	10R - 4M99	24 -96
		± 0.5 %	10R - 4M99	24-192
		± 0.1 %	47R - 1M0	
	± 25 ppm/K	± 1 %	10R - 4M99	24 -96
		± 0.5 %	10R - 4M99	24-192
		± 0.1 %	47R - 1M0	
TNPW2512	± 50 ppm/K	± 1 %	10R - 8M87	24 -96
		± 0.5 %	10R - 8M87	24-192
		± 0.1 %	47R - 1M0	
	± 25 ppm/K	± 1 %	10R - 8M87	24 -96
		± 0.5 %	10R - 8M87	24-192
		± 0.1 %	47R - 1M0	

PART NUMBER AND PRODUCT DESCRIPTION																	
Part Number: (TIN LEAD) TNPW12061K32DETA																	
T	N	P	W	1	2	0	6	1	K	3	2	D	E	T	A		
MODEL		VALUE		TOLERANCE		TCR		PACKAGING <sup>1)</sup>		SPECIAL							
TNPW 0402 TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210 TNPW 2010 TNPW 2512		R = Decimal K = Thousand M = Million (4 digits)		B = ± 0.1 % D = ± 0.5 % F = ± 1.0 %		H = ± 50 ppm/K E = ± 25 ppm/K X = ± 15 ppm/K Y = ± 10 ppm/K		TA TC TD TF TG CN TY		up to 2 digits Blank = standard							
Historical Part Number: TNPW-1206 1.32K 0.5 % T-9 RT1(will continue to be accepted)																	
TNPW-1206		1.32K		0.5 %		T-9		RT1									
MODEL		RESISTANCE VALUE Ω		TOLERANCE		TCR		PACKAGING <sup>1)</sup>									
TNPW-0402 TNPW-0603 TNPW-0805 TNPW-1206 TNPW-1210 TNPW-2010 TNPW-2512		Examples: 1K32 = 1320 Ω 99.68K = 99 680 Ω 360 = 360 Ω		± 0.1 % ± 0.5 % ± 1.0 %		T-2 = ± 50 ppm/K T-9 = ± 25 ppm/K T-10 = ± 15 ppm/K T-13 = ± 10 ppm/K		RT1 RT6 RT7 R02 R67 R52 R75									

**Notes**

- Please refer to PACKAGING table
- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
  - For ordering TNPW with SnPb contacts please refer to latest edition of data sheet TNPW lead bearing.



PACKAGING							
MODEL	TAPE WIDTH [mm]	PITCH [mm]	REEL DIAMETER [mm/inch]	PIECES PER REEL	PACKAGING CODE FOR PRODUCT DESCRIPTION	PACKAGING CODE FOR PART NUMBER	TYPE OF CARRIER TAPE
TNPW 0402	8	2	180/7	10 000	RT7	TD	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	180/7	1000	R52 <sup>1</sup>	CN <sup>1</sup>	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	180/7	5000	RT1	TA	Paper
TNPW 0603 TNPW 0805 TNPW 1206 TNPW 1210	8	4	330/13	20 000	RT6	TC	Paper
TNPW 2010	12	4	180/7	1000	R75	TY	Blister
				4000	R02	TF	Blister
TNPW 2512	12	4	180/7	1000	R75	TY	Blister
				2000	R67	TG	Blister

**Note**

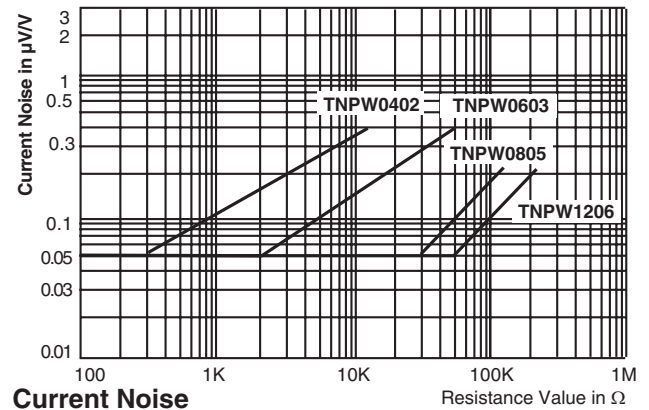
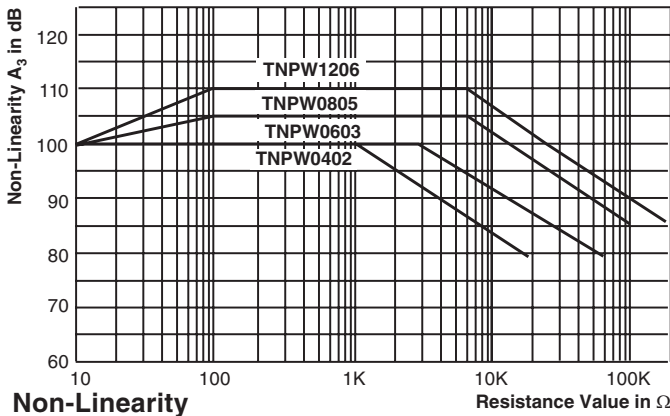
1. R52/CN only for precision resistors with tolerance  $\pm 0.1\%$  and temperature coefficient  $\leq \pm 25$  ppm/k

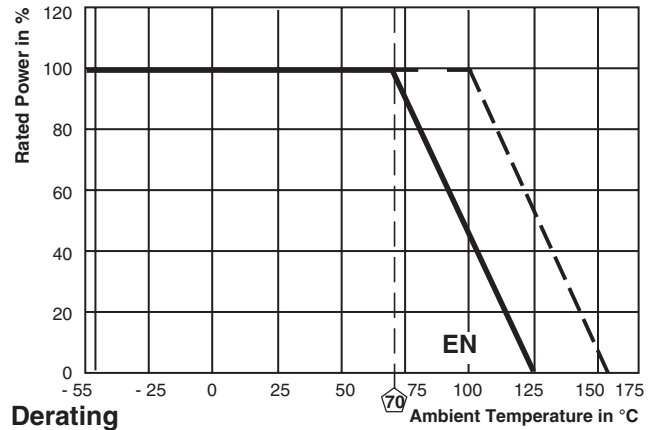
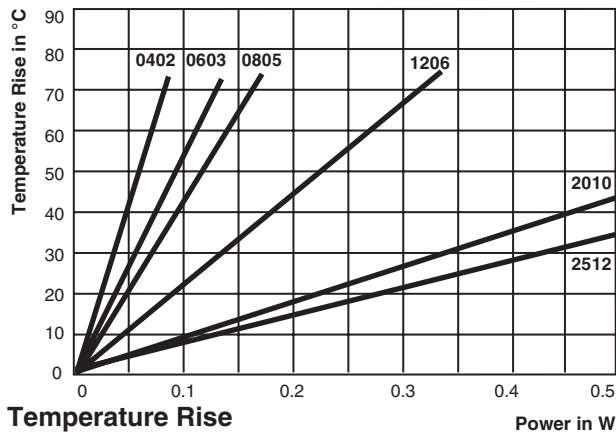
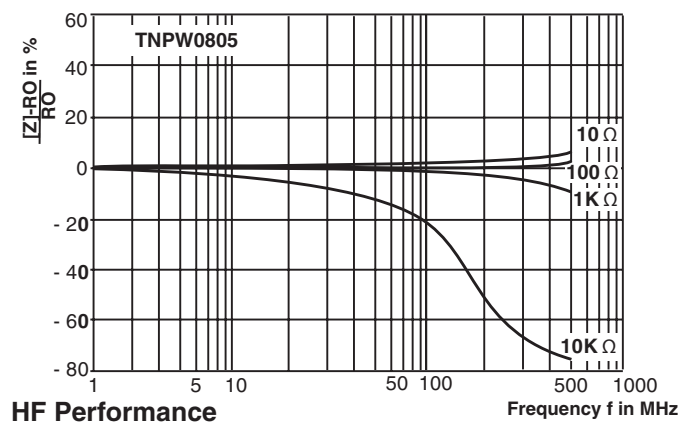
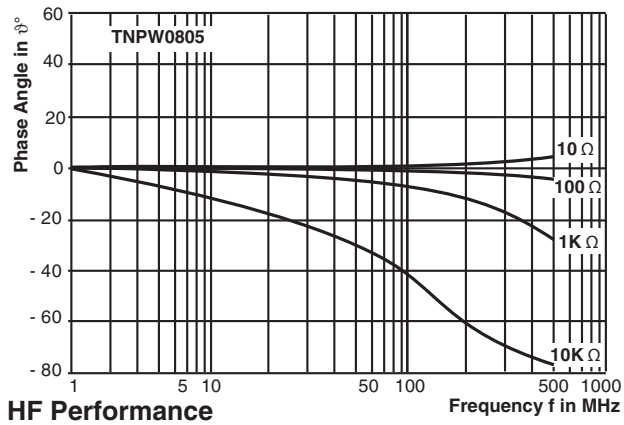
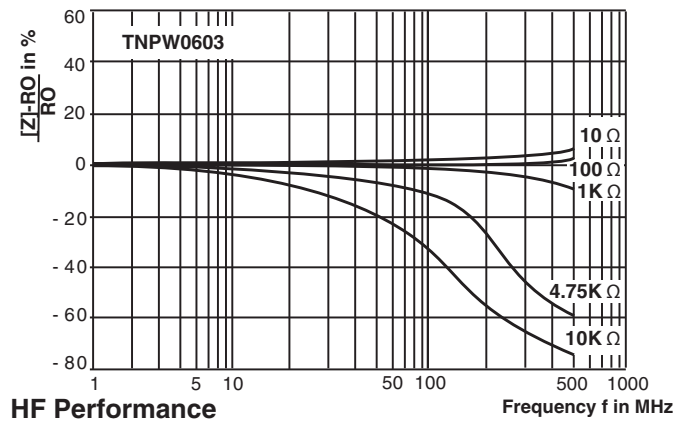
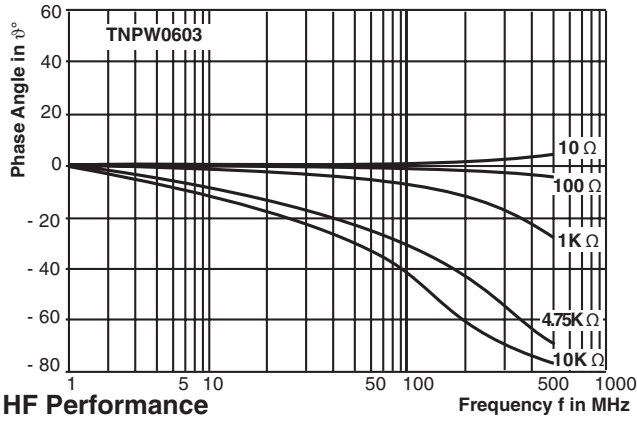
**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade ceramic substrate and conditioned to achieve the desired temperature coefficient. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics.

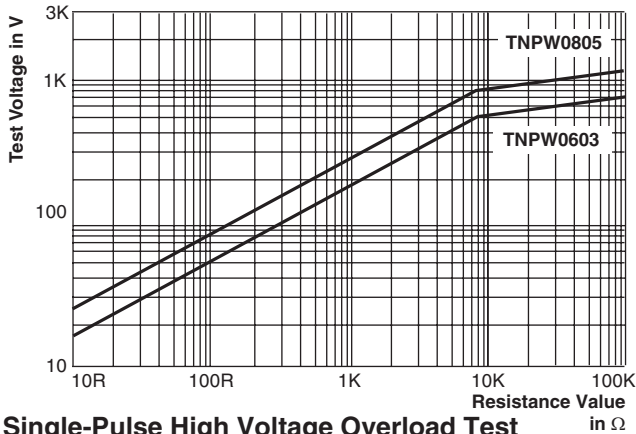
**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems.

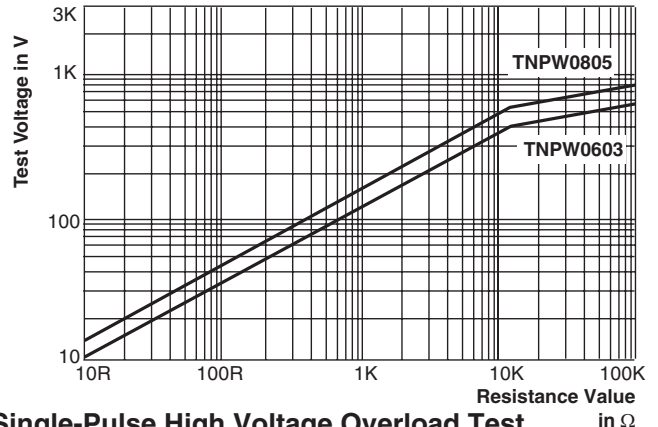




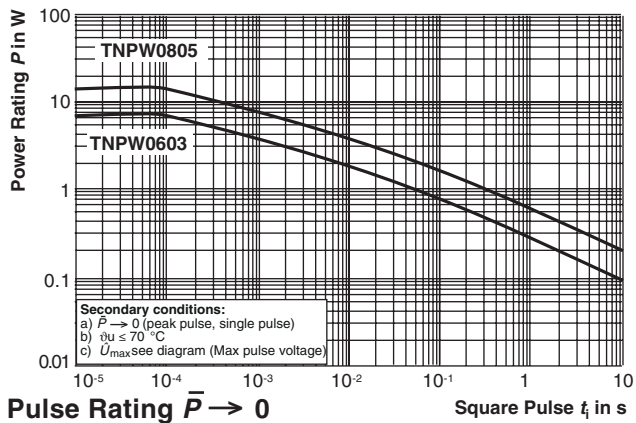
High Stability Thin Film Chip Resistor  
 $\leq 0.05\%$  (1000 h rated power at 70 °C)



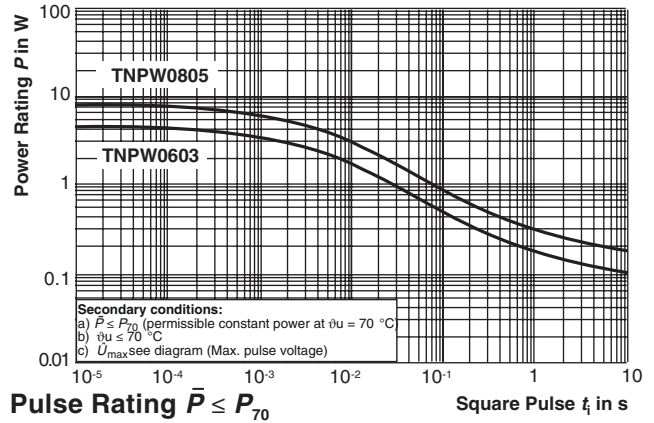
**Single-Pulse High Voltage Overload Test**  
 1.2/50  $\mu$ s EN140000 4.27



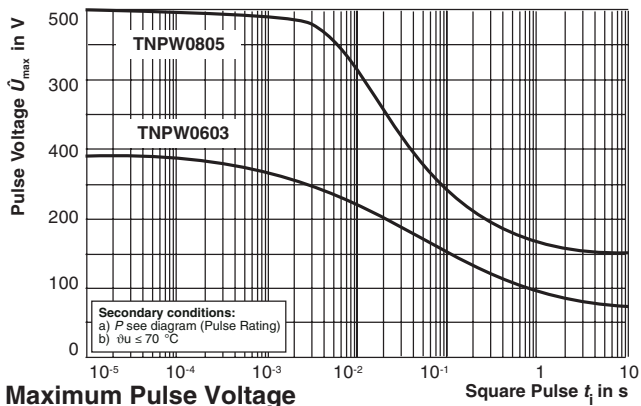
**Single-Pulse High Voltage Overload Test**  
 10/700  $\mu$ s EN140000 4.27



**Pulse Rating  $\bar{P} \rightarrow 0$**



**Pulse Rating  $\bar{P} \leq P_{70}$**



**Maximum Pulse Voltage**

**TEST AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

- EN 60115-1, Generic specification (includes tests)
- EN 140 400, Sectional specification (includes schedule for qualification approval)
- EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202. The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower

Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid. Unless otherwise specified the following values apply:

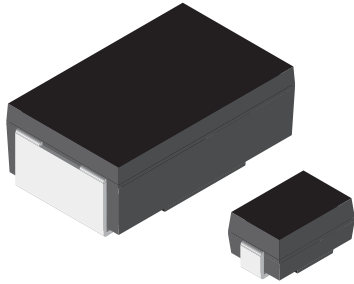
- Temperature: 15 °C to 35 °C
- Relative humidity: 45 % to 75 %
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified. The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS				
TEST	CONDITIONS OF TEST	TEST RESULTS		
		TNPW0402 TO TNPW2512		
		TOLERANCES		
		$\pm 0.1\%$ ; $\pm 0.25\%$		$\pm 0.5\%$ ; $\pm 1.0\%$
< 100R	$\geq 100R$			
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	$\leq \pm 0.1\%$	$\leq \pm 0.05\%$	$\leq \pm 0.25\%$
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	$\leq \pm 0.1\%$	$\leq \pm 0.05\%$	$\leq \pm 0.5\%$
Overload Test IEC 60115-1 4.13	Short time overload for 2 seconds 2.5 x rated voltage or $\leq 2$ x limiting element voltage	$\leq \pm 0.05\%$	$\leq \pm 0.02\%$	$\leq \pm 0.1\%$
Thermal Shock IEC 60115-1 4.19, IEC 60068-2-14	Rapid change between upper and lower category temperature	$\leq \pm 0.05\%$	$\leq \pm 0.02\%$	$\leq \pm 0.1\%$
Damp Heat Steady State IEC 60115-1 4.24, IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	$\leq \pm 0.1\%$	$\leq \pm 0.05\%$	$\leq \pm 0.5\%$
Resistance to Soldering Heat IEC 60115-1 4.18, IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	$\leq \pm 0.05\%$	$\leq \pm 0.02\%$	$\leq \pm 0.1\%$

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>• CECC40000/40400</li> <li>• EN140400</li> <li>• EIA 575</li> <li>• EN 140401-801</li> <li>• EN 60115-1</li> <li>• IEC 60286-3</li> </ul>

## Metal Film Resistors, Power, Surface Mount



### FEATURES

- Molded encapsulation
- Wrap-Around Compliant Terminations eliminate risk of solder fillet cracking
- Solderable terminations
- Excellent stability at different environmental conditions
- High power ratings


**RoHS\***  
COMPLIANT

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	SIZE INCH	POWER RATING $P_{70^\circ\text{C}}$ W	TOLERANCE $\pm \%$	RESISTANCE RANGE $\Omega$	ENCAPSULATION
WSF2012	2012	0.5	0.5, 1, 5	5.0 - 1.43K <sup>1)</sup>	Epoxy
WSF2515	2515	1.0	0.5, 1, 5	26.5 - 10K	Thermoplastic
WSF4527	4527	2.0 <sup>2)</sup>	0.5, 1, 5	10 - 100K	Thermoplastic

#### Notes

1. E96 values only
  2. Resistance values above 31 250  $\Omega$  are limited to 250 maximum working voltage
- Part Marking: 1/2 W - DALE, Value; 1 W - Model, Value, Tolerance, Date Code; 2 W - DALE, Model, Value, Tolerance, Date Code.

### TECHNICAL SPECIFICATIONS

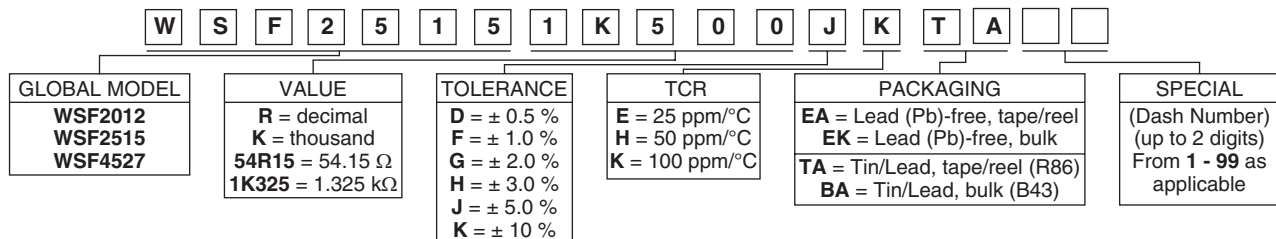
PARAMETER	UNIT	WSF2012	WSF2515	WSF4527
Temperature Coefficient	ppm/ $^\circ\text{C}$	$\pm 100^3)$	$\pm 100^3)$	$\pm 100^3)$
Dielectric Withstanding Voltage	$V_{AC}$	> 500	> 500	> 500
Insulation Resistance	$\Omega$	> 10 <sup>9</sup>		
Operating Temperature Range	$^\circ\text{C}$	- 65/+ 175	- 65/+ 175	- 65/+ 150
Maximum Working Voltage	V	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$	$(P \times R)^{1/2 4)}$
Weight/1000 pieces (typical)	g	90	165	760

#### Notes

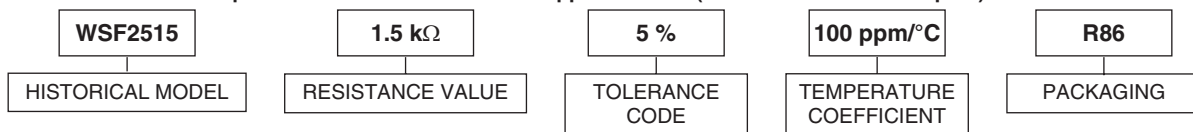
3.  $\pm 50$  ppm/ $^\circ\text{C}$  and  $\pm 25$  ppm/ $^\circ\text{C}$  available
4. Resistance values above 31 250  $\Omega$  are limited to 250 V maximum working voltage

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: WSF2515K500JKTA (preferred part numbering format)

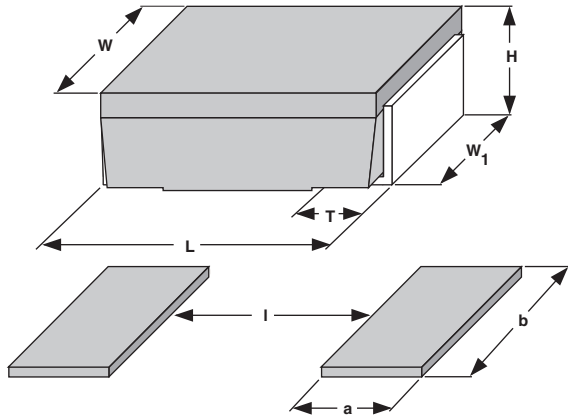


Historical Part Number example: WSF2515 1.5 k $\Omega$  5% 100 ppm/ $^\circ\text{C}$  R86 (will continue to be accepted)



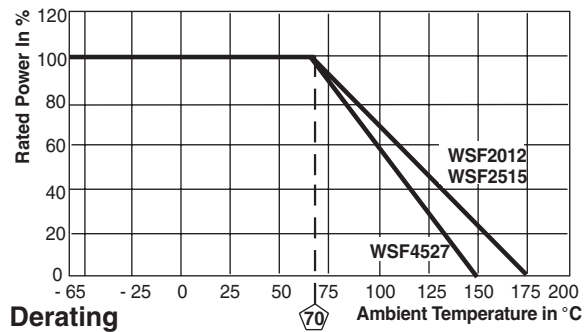
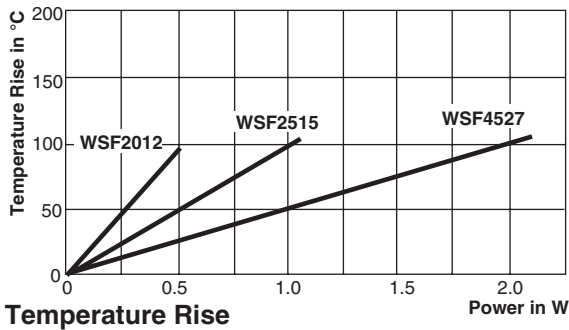
\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	L	H	T	W	W <sub>1</sub>
WSF2012	0.200 ± 0.020 [5.08 ± 0.508]	0.096 ± 0.015 [2.44 ± 0.381]	0.040 ± 0.010 [1.02 ± 0.254]	0.125 ± 0.005 [3.18 ± 0.127]	0.050 ± 0.005 [1.27 ± 0.127]
WSF2515	0.250 ± 0.020 [6.35 ± 0.508]	0.110 ± 0.015 [2.79 ± 0.381]	0.045 ± 0.010 [1.14 ± 0.254]	0.150 ± 0.005 [3.81 ± 0.127]	0.098 ± 0.005 [2.49 ± 0.127]
WSF4527	0.455 ± 0.020 [11.56 ± 0.508]	0.167 ± 0.010 [4.24 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.275 ± 0.005 [6.98 ± 0.127]	0.215 ± 0.005 [5.46 ± 0.127]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSF2012	0.085 [2.16]	0.070 [1.78]	0.080 [2.03]
WSF2515	0.090 [2.29]	0.115 [2.92]	0.120 [3.05]
WSF4527	0.155 [3.94]	0.230 [5.94]	0.205 [5.21]

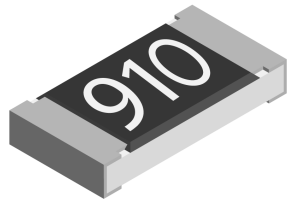


PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (1.0 % + 0.05 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.5 % + 0.05 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.5 % + 0.05 Ω) ΔR
High Temperature Exposure	1000 hours at + 175 °C (150 °C for WSF4527)	± (1.0 % + 0.05 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.05 Ω) ΔR
Moisture Resistance	MIL-STD-202 Method 106, 0 % Power, 7a and 7b not required	± (0.5 % + 0.05 Ω) ΔR
Mechanical Shock	100 g's for 11 milliseconds, 5 pulses	± (0.5 % + 0.05 Ω) ΔR
Vibration	Frequency varied 10 to 500 Hz in one minute, 3 directions, 9 hours	± (0.5 % + 0.05 Ω) ΔR
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.05 Ω) ΔR
Resistance to Solder heat	+ 260 °C solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.05 Ω) ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSF2012	12 mm/Embossed Plastic	330 mm/13"	2000	EA/TA
WSF2515	16 mm/Embossed Plastic	330 mm/13"	2000	EA/TA
WSF4527	24 mm/Embossed Plastic	330 mm/13"	1200	EA/TA

Embossed Carrier Tape per EIA 481-1, 2.

## Thin Film, Rectangular, Fusible, Resistor Chips



### FEATURES

- Metal film on high quality ceramic
- Special protective top coat
- Flame retardant
- Sn solder contacts on Ni barrier layer
- Fusible resistor for constant voltage
- Automatic placement compatibility

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE		POWER RATING W <sub>70°C</sub>	LIMITING ELEMENT VOLTAGE V <sub>≅</sub> MAX	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE Ω	E-SERIES
	INCH	METRIC						
M25SI	1206	3216	0.25	$\sqrt{P \times R}$	100	5	1R - 3K9	24

#### Notes

- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material.
- Marking: 3 digits.
- Ask about extended value ranges.
- TCR 50 ppm/°C, Tolerance 1 % on special request.
- Top coat: beige, transparent.

### TECHNICAL SPECIFICATIONS

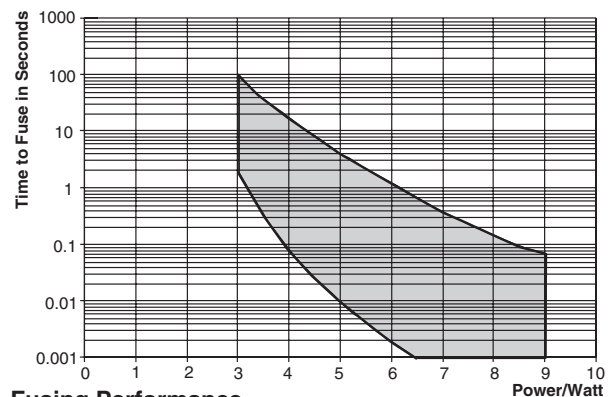
PARAMETER	UNIT	M25SI
Rated Dissipation at 70 °C	W	0.25
Insulation Voltage (1 min)	V <sub>dc/ac peak</sub>	> 300
Thermal Resistance <sup>1)</sup>	K/W	≤ 220 <sup>1)</sup>
Insulation Resistance	Ω	> 10 <sup>9</sup>
Category Temperature Range	°C	- 55/+ 125
Failure Rate	h <sup>-1</sup>	1 • 10 <sup>-9</sup>
Weight/1000 pcs	g	10

#### Note

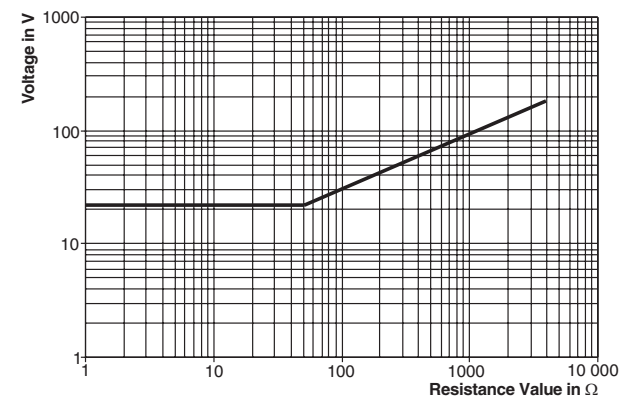
1. Measuring conditions in acc. with CECC 40401

### PULSE TEST DATA

Pulse Power (Square Pulse)	0.9 W	0.3 W
Pulse Duration t <sub>i</sub>	100 μs	100 ms
Pulse Pause t <sub>p</sub>	100 ms	1 s
Number of pulses	10 <sup>5</sup>	10 <sup>5</sup>
Drift after pulse test	< 0.1 %	< 0.1 %



Fusing Performance



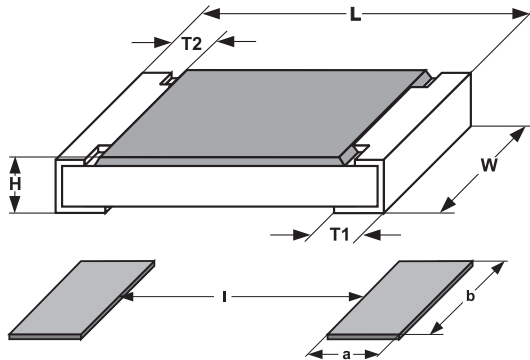
Maximum Applicable Voltage after Fusing

### ORDERING INFORMATION

M25SI	100	91R	5 %	P5
MODEL	TCR ppm/K	RESISTANCE VALUE Ω	TOLERANCE ± %	PACKAGING P5-Papertape 5000 pcs



## DIMENSIONS

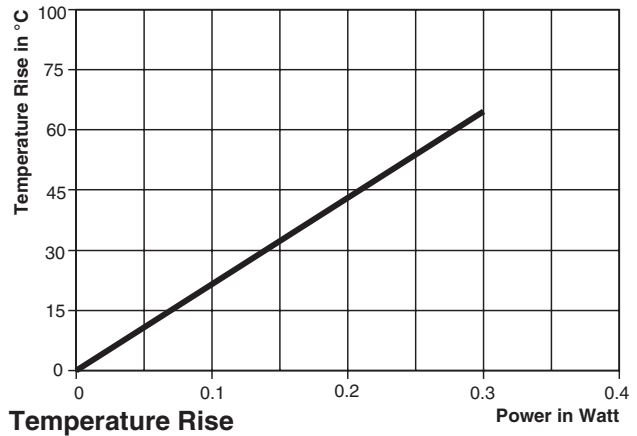
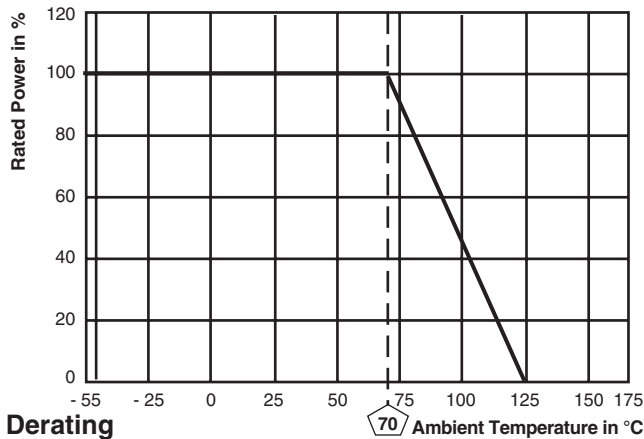


SIZE		DIMENSIONS [in millimeters]				
INCH	METRIC	L	W	H	T1	T2
1206	3216	$3.2^{+0.10}_{-0.20}$	$1.6 \pm 0.15$	$0.55 \pm 0.05$	$0.45 \pm 0.2$	$0.4 \pm 0.2$

SIZE		SOLDER PAD DIMENSIONS in millimeters <sup>1)</sup>					
INCH	METRIC	a	b	l	a	b	l
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3

**Note**

1. Pads: recommendations only



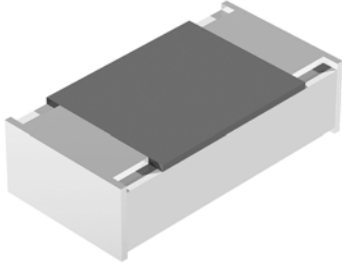
PERFORMANCE		
TEST	CONDITIONS OF TEST	REQUIREMENTS <sup>1)</sup>
Endurance Test at 70 °C IEC 60115-1 4.25.1	1000 hours at 70 °C 1.5 hours "ON", 0.5 hours "OFF"	$\leq \pm 1 \%$
Endurance at UCT IEC 60115-1 4.25.3	1000 hours at 125 °C without load	$\leq \pm 1 \%$
Thermal Shock IEC 60115-1 4.19, IEC 60068-2-14	Rapid change between upper and lower category temperature	$\leq \pm 0.2 \%$
Damp Heat Steady State IEC 60115-1 4.24, IEC 60068-2-3	56 days at 40 °C and 93 % relative humidity	$\leq \pm 0.5 \%$
Resistance to Soldering Heat IEC 60115-1 4.18, IEC 60068-2-20	10 seconds at 260 °C solder bath temperature	$\leq \pm 0.2 \%$

**Note**

1. Limits for change of resistance at test

APPLICABLE SPECIFICATIONS
<ul style="list-style-type: none"> <li>CECC40000/40400</li> <li>EN140400/IEC 60115 - 1</li> </ul>

## High Frequency Flat Chip Resistors



MCT 0603 HF specialty thin film flat chip resistors for RF applications is the perfect choice in high frequency circuit designs where the impedance change due to the parasitic inductance of regular and professional resistors can not be accepted. Typical applications are in the fields of telecommunication equipment and industrial electronics.

### FEATURES

- Specialty product for RF applications
- Low-inductance trimmed product
- Suitable for more than 10 GHz
- Resistance range: 6.8  $\Omega$  to 470  $\Omega$
- Green product, supports lead-free soldering

### APPLICATIONS

- Telecommunication equipment
- Industrial electronics

METRIC SIZE	
INCH:	0603
METRIC:	RR 1608M

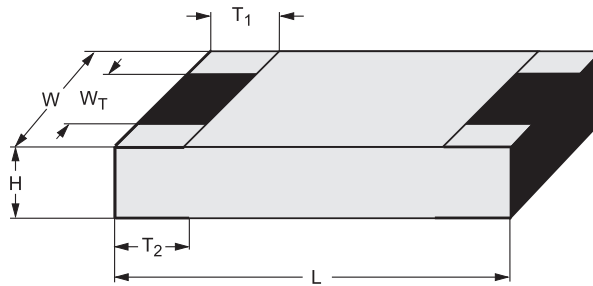
TECHNICAL SPECIFICATIONS		
DESCRIPTION	MCT 0603 HF	
Metric size	RR 1608M	
Resistance range	6.8 $\Omega$ to 470 $\Omega$ ; 50 $\Omega$	
Resistance tolerance	$\pm 2\%$	
Temperature coefficient	$\pm 50$ ppm/K	
Operation mode	standard	power
Climatic category (LCT/UCT/days)	55/125/56	55/155/56
Rated dissipation, $P_{70}^{(1)}$	0.1 W	0.125 W
Operating voltage, $U_{max}$ AC/DC	limited by $P_{70}$	
Film temperature	125 $^{\circ}$ C	155 $^{\circ}$ C
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after:	6.8 $\Omega$ to 470 $\Omega$	
	$\leq 0.5\%$	$\leq 1.0\%$
1000 h	$\leq 1.0\%$	$\leq 2.0\%$
8000 h	$\leq 3.0\%$	–
225 000 h		
Specified lifetime	225 000 h	8000 h
Insulation voltage:		
1 minute; $U_{ins}$	100 V	
continuous	75 V	
Failure rate	$\leq 2.0 \times 10^{-9}/h$	

### Note

1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.

ORDERING INFORMATION - type description and ordering code								
M	C	T	0603	- 50	2 %	HF	P5	50 R
FILM TYPE	PRODUCT CODE	SIZE CODE	IMPERIAL SIZE	TEMPERATURE COEFFICIENT	TOLERANCE	SUFFIX	PACKAGING	RESISTANCE VALUE
M = metal	C = flat chip	T = 0603	0603	± 50 ppm/K	± 2 %	HF = High frequency	P1 = 1000 units P5 = 5000 units PW = 20 000 units	See Temperature Coefficient and Resistance Range Table.

## DIMENSIONS



DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
MCT 0603 HF	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE		
DESCRIPTION		RESISTANCE VALUE <sup>1)</sup>
TCR	TOLERANCE	MCT 0603 HF
± 50 ppm/K	± 2 %	6.8 Ω to 470 Ω; 50 Ω

### Note

1. Resistance values to be selected from E24 series.

**DESCRIPTION**

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade (96 %  $\text{Al}_2\text{O}_3$ ) ceramic body and conditioned to achieve the desired temperature coefficient. Specially designed pre-contacts are deposited on both sides using the same thin film technology. A special laser is used to achieve the target value by smoothly cutting a groove - with a resulting low inductivity - in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **IEC 60286-3**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

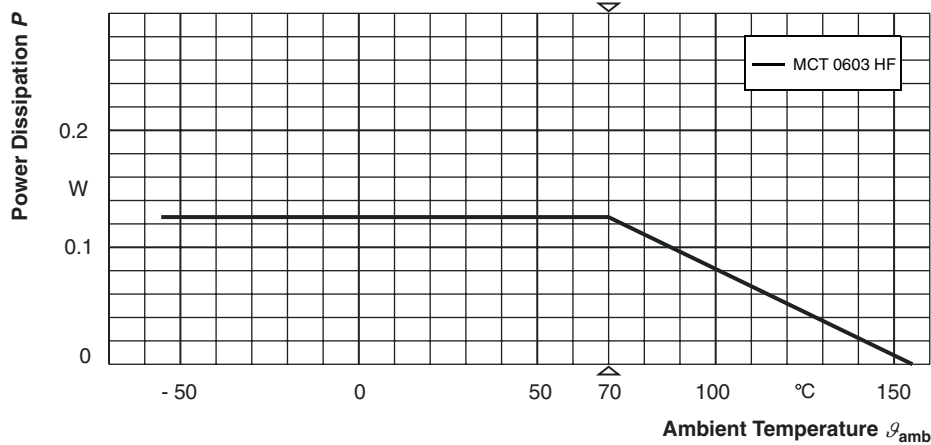
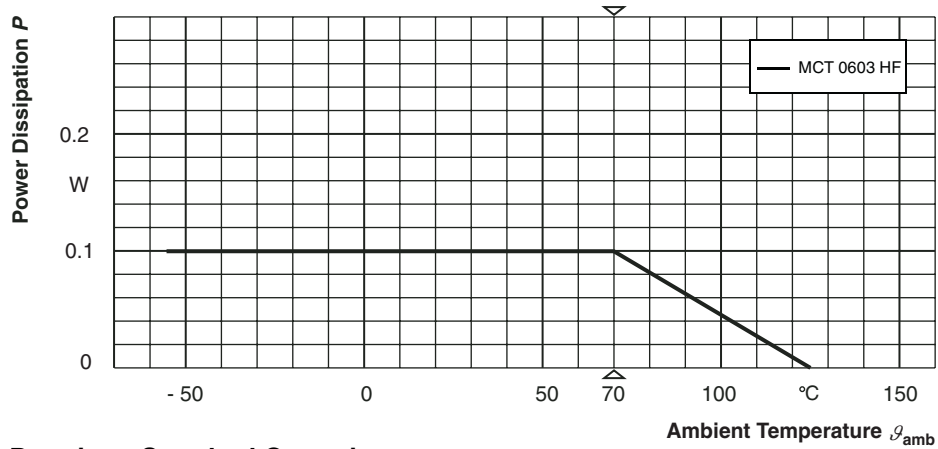
**APPROVALS**

The resistors are tested in accordance with **EN 140 401-801** (superseding **CECC 40 401-801**) which refers to **EN 60115-1** and **EN 140 400**.

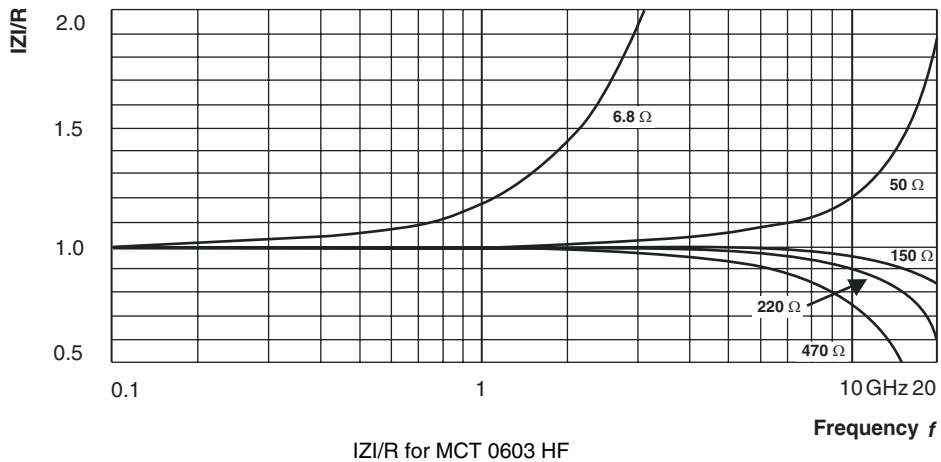
Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**.



## FUNCTIONAL PERFORMANCE



## RF-Behaviour



**TESTS AND REQUIREMENTS**

All tests are carried out in accordance with the following specifications:

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated

temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table below are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

<b>TEST PROCEDURES AND REQUIREMENTS</b>				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types: <b>MCT 0603 HF</b>	6.8 $\Omega$ to 470 $\Omega$
4.5	–	resistance		$\pm 2 \%$
4.8.4.2	–	temperature coefficient	at 20/- 55/20 °C and 20/125/20 °C	$\pm 50$ ppm/K
4.25.1	–	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ 1.5 h on; 0.5 h off 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.5 \% R + 0.05 \Omega)$ $\pm (1 \% R + 0.05 \Omega)$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h	$\pm (1 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (1 \% R + 0.05 \Omega)$
4.23 4.23.2 4.23.3 4.23.4 4.23.5 4.23.6	2 (Ba) 30 (Db) 1 (Aa) 13 (M) 30 (Db)	climatic sequence: dry heat damp heat, cyclic cold low air pressure damp heat, cyclic	UCT; 16 h 55 °C; 24 h; > 90 % RH; 1 cycle LCT; 2 h 8.5 kPa; 2 h; 25 $\pm$ 10 °C 55 °C; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	$\pm (1 \% R + 0.05 \Omega)$
–	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.5 \% R + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage
4.13	–	short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$	$\pm (0.5 \% R + 0.05 \Omega)$
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude $\leq$ 1.5 mm or $\leq 200$ m/s <sup>2</sup> ; 6 h	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage



TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types: <b>MCT 0603 HF</b>	6.8 $\Omega$ to 470 $\Omega$
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) $^{\circ}$ C; (3 $\pm$ 0.3) s  solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) $^{\circ}$ C; (2 $\pm$ 0.2) s	good tinning ( $\geq$ 95 % covered); no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 $^{\circ}$ C; method 2	no visible damage
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	$\pm$ (1 % R + 0.05 $\Omega$ ) no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1608M; 9 N	no visible damage
4.33	21 (Ue <sub>1</sub> )	substrate bending	depth 2 mm, 3 times	$\pm$ (0.5 % R + 0.05 $\Omega$ ) no visible damage, no open circuit in bent position
4.7	–	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s	no flashover or breakdown
4.35	–	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s

**ORDERING INFORMATION**

Components may be ordered by using either a simple clear text ordering code, see “Type description and ordering code” or Vishay BCcomponents’ unique 12NC.

**Numeric Ordering code (12NC)**

- The resistors have a 12-digit ordering code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC Ordering Code table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the Last digit of 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

RESISTANCE DECADE	LAST DIGIT
1 $\Omega$ to 9.99 $\Omega$	8
10 $\Omega$ to 99.9 $\Omega$	9
100 $\Omega$ to 999 $\Omega$	1

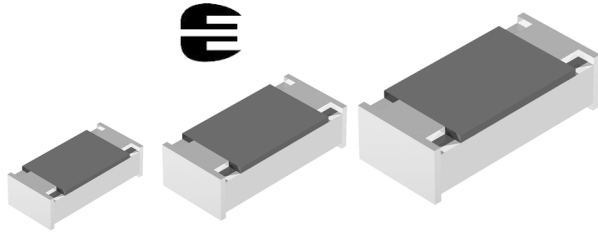
**Ordering example**

The ordering code of a MCT 0603 HF resistor, value 50  $\Omega$  and TCR 50 with  $\pm$  2 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 218 05009.

12NC ORDERING CODE - resistor type and packaging					
DESCRIPTION			ORDERING CODE 2312 ... ..		
			CARDBOARD TAPE ON REEL		
TYPE	TCR	TOL.	P1 1000 UNITS	P5 5000 UNITS	PW 20 000 UNITS
MCT 0603 HF	$\pm$ 50 ppm/K	$\pm$ 2 %	203 0....	218 0....	208 0....

Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.

## Flat Chip Resistors with Established Reliability



MCS 0402 VG01, MCT 0603 VG01 and MCU 0805 VG01 thin film flat chip resistors with established reliability are the perfect choice for all high-reliability applications typically found in the fields of military, aircraft and spacecraft electronics. These versions supplement the families of professional and precision thin film flat chip resistors MCS 0204, MCT 0603 and MCU 0805.

### FEATURES

- Approved according to EN 140401-801, version E
- Established reliability, failure rate level E6
- Advanced thin film technology
- Advanced dissipation rating: 100 mW
- Excellent overall stability: Class 0.5
- Green product, supports lead (Pb)-free soldering



**RoHS**  
COMPLIANT

### APPLICATIONS

- Military
- Avionics
- Space

### METRIC SIZE

METRIC SIZE			
<b>INCH:</b>	0402	0603	0805
<b>METRIC:</b>	RR 1005M	RR 1608M	RR 2012M

### TECHNICAL SPECIFICATIONS

DESCRIPTION	MCS 0402	MCT 0603	MCU 0805	
CECC size, style	RR 1005M	RR 1608M	RR 2012M	
Resistance range	100 $\Omega$ to 100 k $\Omega$	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to 1 M $\Omega$	
Resistance tolerance	$\pm 1\%$ ; $\pm 0.1\%$			
Temperature coefficient	$\pm 50$ ppm/K; $\pm 15$ ppm/K			
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56	
Rated dissipation, $P_{70}$	0.063 W	0.1 W	0.125 W	
Operating voltage, $U_{max}$ AC/DC	50 V	75 V	150 V	
Film temperature	125 $^{\circ}$ C	125 $^{\circ}$ C	125 $^{\circ}$ C	
Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ after:	100 $\Omega$ to 100 k $\Omega$	10 $\Omega$ to 1 M $\Omega$	1 $\Omega$ to 1 M $\Omega$	
	1000 h	$\leq 0.25\%$		
	8000 h	$\leq 0.5\%$		
	225 000 h	$\leq 1.5\%$		
Permissible voltage against ambient (insulation):				
	1 minute; $U_{ins}$	75 V	100 V	200 V
	continuous	75 V	75 V	75 V
Failure rate level	E6			
Failure rate	$\leq 2 \times 10^{-9}/h$	$\leq 2 \times 10^{-9}/h$	$\leq 2 \times 10^{-9}/h$	

### Notes

1. The failure rate level E6 corresponds to MIL Level P.
2. These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime.





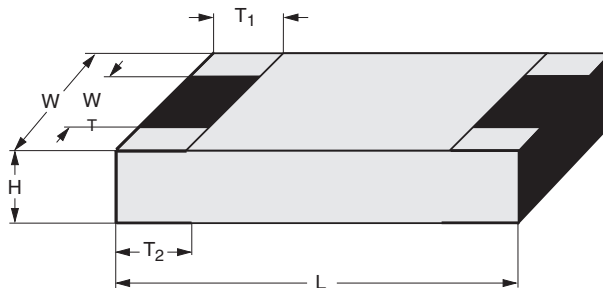
PRODUCT DESCRIPTION								
M	C	T	0603	- 50	1 %	VG01	P5	287 K
FILM TYPE	PRODUCT CODE	SIZE CODE	IMPERIAL SIZE	TEMPERATURE COEFFICIENT	TOLERANCE	ESTABLISHED RELIABILITY	PACKAGING <sup>1)</sup>	RESISTANCE VALUE
M = Metal	C = Flat Chip	S = 0402 T = 0603 U = 0805	0402 0603 0805	± 15 ppm/K ± 50 ppm/K	± 0.1 % ± 1 %	Reference to EN 140401-8Q1 Version E	P1 = 1000 units P5 = 5000 units E1 = 1000 units E0 = 10 000 units PW = 20 000 units	See Temperature coefficient and resistance range table

**Notes**

- We recommend that the clear text ordering code is used to minimize the possibility of errors in order handling.
- Availability in accordance to the table Part Numbers at the end of this datasheet.
  - Jumpers are ordered by the resistance value 0 Ω, e.g. MCT 0603 VG01 P5 0R0.

EN 140401-801 ORDERING INFORMATION	
Example of the ordering information for a resistor: MCT 0603-50 1 % VG01 287K CECC40401-801EZRR1608MC287KFE6	
Example of the ordering information for jumpers: MCT 0603 VG01 0R0 CECC40401-801EZRR1608M-0R00-E6	
The elements used in this ordering information have the following meaning:	
CECC40401-801	CECC Detail specification number
EZ	Assessment level
RR1608M	Style (see table Technical Specification)
C	Temperature coefficient (C = ± 50 ppm/K; E = ± 15 ppm/K)
287K	Resistance value according to EN 60062, 4 characters
F	Tolerance on rated resistance (B = ± 0.1 %; F = ± 1 %)
E6	Failure rate level according to EN 60115-1, Table ZB.1

**DIMENSIONS**



DIMENSIONS - chip resistor types, mass and relevant physical dimensions							
TYPE	H (mm)	L (mm)	W (mm)	W <sub>T</sub> (mm)	T <sub>1</sub> (mm)	T <sub>2</sub> (mm)	MASS (mg)
MCS 0402	0.32 ± 0.05	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
MCT 0603	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
MCU 0805	0.45 + 0.1/- 0.05	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub>O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics. For the high ohmic range, optimized Cermet products provide comparable properties. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

## Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

The resistors are tested in accordance with **EN 140401-801** (superseding **CECC 40401-801**) which refers to **EN 60115-1** and **EN 140400**. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240 001** based on **EN 100114-6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

This product family of thin film flat chip resistors with established reliability is complemented by **Zero Ohm Jumpers**.

## FUNCTIONAL PERFORMANCE

Further information on the performance of these products may be found in the following Data Sheets:

- "Professional Chip resistors"  
Document No. 28705
- "Precision Chip resistors"  
Document No. 28700



TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE		
TCR	TOLERANCE	MCS 0402	MCT 0603	MCU 0805
± 50 ppm/K	± 1 %	100 Ω to 100 kΩ	10 Ω to 1 MΩ	1 Ω to 1 MΩ
± 15 ppm/K	± 0.1 %	100 Ω to 33 kΩ	100 Ω to 47.5 kΩ	100 Ω to 100 kΩ
Jumper	-	≤ 20 mΩ; $I_{max} = 0.63$ A	≤ 20 mΩ; $I_{max} = 1$ A	≤ 20 mΩ; $I_{max} = 1.5$ A

**Note**

- Resistance values to be selected for ± 1 % tolerance from E96 only and for ± 0.1 % tolerance from E192 only.

## ORDERING INFORMATION

Components may be ordered by using either the Product Description, the EN 140401-801 Ordering Information or the Part Number.

### Part Number

- The resistors have a 12-digit ordering code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the Part Number table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the Resistance Decade table.

### Resistance Decade

RESISTANCE DECADE	LAST DIGIT
1 Ω to 9.99 Ω	8
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ	5

### Ordering example

The Part Number of a MCT 0603 VG01 resistor, value 287K and TCR 50 with ± 1 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 215 02874.

PART NUMBER - RESISTOR TYPE AND PACKAGING					
DESCRIPTION			ORDERING CODE 2312 ... ..		
			CARDBOARD TAPE ON REEL		
TYPE	TCR	TOL.	E1 1000 UNITS	E0 10 000 UNITS	
MCS 0402	± 50 ppm/K	± 1 %	260 0...	275 0...	
	± 15 ppm/K	± 0.1 %	262 0...	277 0...	
	jumper	-	262 90001	277 90001	
TYPE	TCR	TOL.	P1 1000 UNITS	P5 5000 UNITS	PW 20 000 UNITS
MCT 0603	± 50 ppm/K	± 1 %	200 0...	215 0...	205 0...
	± 15 ppm/K	± 0.1 %	202 0...	217 0...	-
	jumper	-	202 90001	217 90001	207 90001
MCU 0805	± 50 ppm/K	± 1 %	240 0...	255 0...	245 0...
	± 15 ppm/K	± 0.1 %	242 0...	257 0...	-
	jumper	-	242 90001	257 90001	247 90001



# Resistor Arrays

Resistor or Resistor/Capacitor  
Configurations



Several Devices in one Package



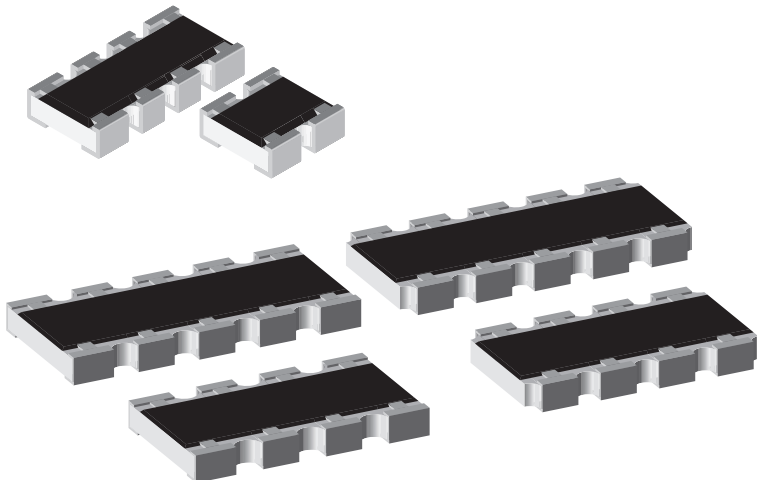
Commoned, Isolated and Line  
Terminator Schematics



Design Flexibility



High Packaging Density

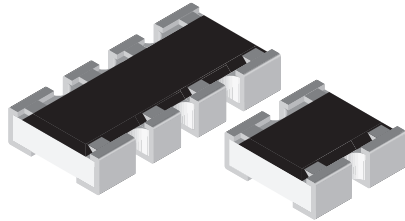


## Model Numbers

CRA04S .....	248
CRA06E & S .....	252
CRA06P .....	256
CRA12E & S .....	260
ACAC 0612 - Professional .....	264
ACAS 0612 - Professional .....	268
ACAC 0612 - Precision .....	272
ACAS 0612 - Precision .....	276
CRCA .....	280
CZA .....	282

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## Thick Film Resistor Array



The CRA04S thick film resistor array is constructed on a high grade ceramic body with convex terminations. A small package enables the design of high density circuits. The single component reduces board space, component counts, and assembly costs.

### FEATURES

- Convex terminal array with square corners
- Wide ohmic range: 1R0 to 1M0
- 4 or 8 terminal package with isolated resistors
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Operating temperature range of - 55 °C to + 150 °C



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	CIRCUIT	LIMITING ELEMENT VOLTAGE MAX. $V_{\Xi}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
CRA04S	0.063	03	50	$\pm 200$	$\pm 5$	1R0 - 1M0	24
				$\pm 100$	$\pm 1; \pm 2$	10R - 1M0	24

Jumper: Zero-Ohm-Resistor available;  $R \leq 50 \text{ m}\Omega$

### TECHNICAL SPECIFICATIONS

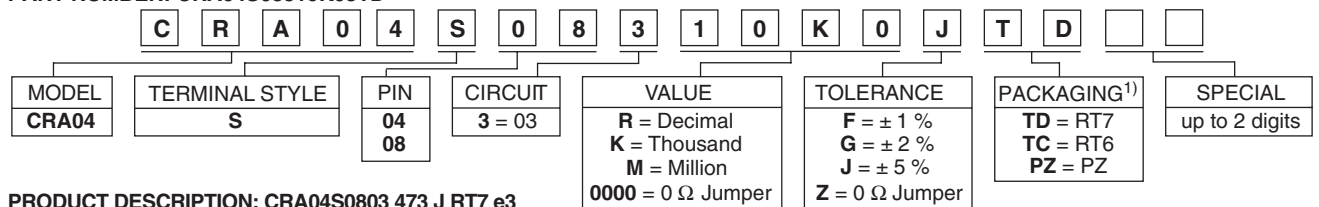
PARAMETER	UNIT	CRA06P 03 CIRCUIT
Rated Dissipation at 70 °C	W	0.063
Limiting Element Voltage <sup>1)</sup>	$V_{\Xi}$	50
Insulation Voltage (1 min)	$V_{\text{dc/ac peak}}$	100
Category Temperature Range	°C	- 55 to + 150
Insulation Resistance	$\Omega$	$> 10^9$

**Note**

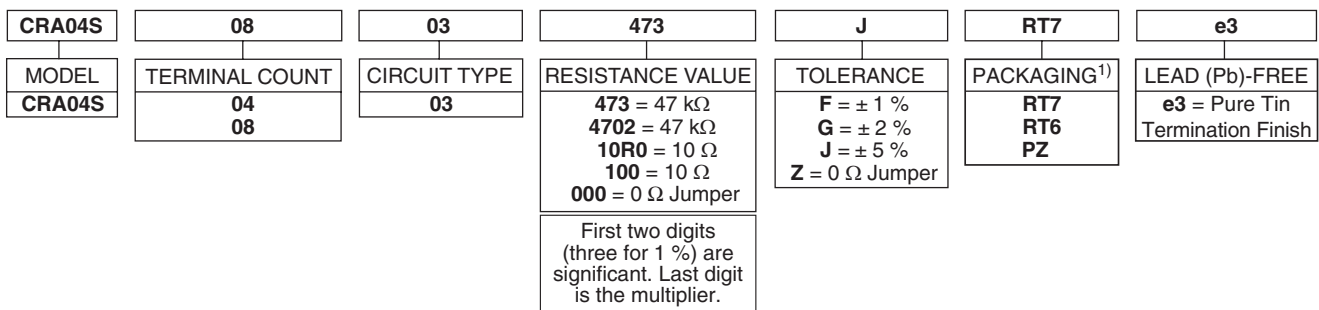
1. Rated voltage:  $\sqrt{P \times R}$

### PART NUMBER AND PRODUCT DESCRIPTION

PART NUMBER: CRA04S08310K0JTD



PRODUCT DESCRIPTION: CRA04S0803 473 J RT7 e3

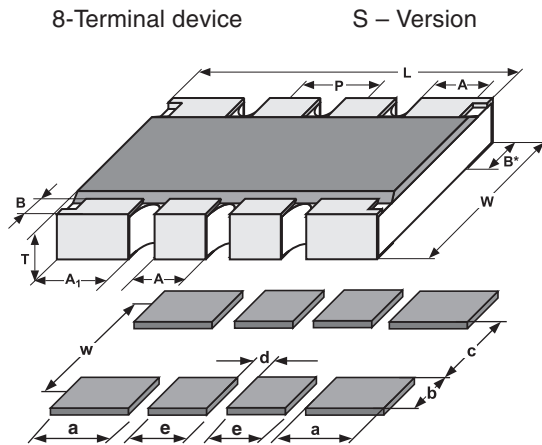


**Notes**

1. Please refer to table PACKAGING, on page 250

- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER

**DIMENSIONS**



SOLDER PAD DIMENSIONS [in millimeters]						
	c	w	d	a	b	c
<b>WAVE</b>	0.45	1.0	0.2	0.4	0.5	0.3

The dimensions shown are for a 8 pin part. For parts with different pin numbers use the same pitch and add or subtract pads as required.

PIN NO#	DIMENSIONS [in millimeters]							
	L	A	A <sub>1</sub>	B	B*	P <sub>NOM</sub>	T	W
<b>4</b>	1.0 ± 0.1	-	0.33	0.15	0.25	0.65	0.35	1.0
<b>8</b>	2.0 ± 0.2	0.30	0.4	0.15	0.25	0.50	0.45	1.0
<b>TOL.</b>	-	± 0.15	± 0.15	± 0.10	± 0.1	-	± 0.1	± 0.15

**DESCRIPTION**

Production is strictly controlled and follows a set of instructions established for reproducibility. A thick film layer is deposited on a high grade ceramic substrate. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The wrap around terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure. Only accepted products are laid directly into the paper tape in accordance with **EIA 481**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave and solder paste reflow. Due to the design, arrays have automatic placement capability. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

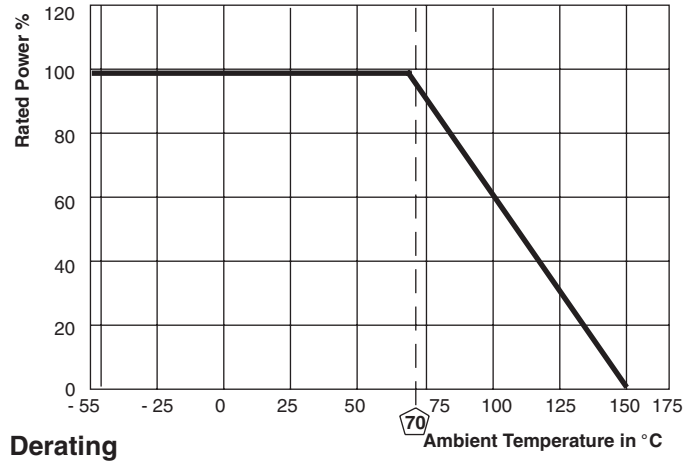
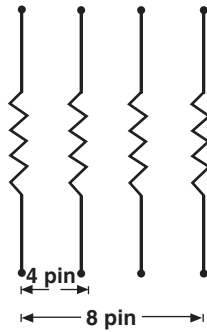
This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle Life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

**CIRCUIT**

03 Circuit



PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKING CODE
					PAPER TAPE
CRA04	8 mm	180 mm/7"	10 000	2 mm	RT7
	8 mm	330 mm/13"	20 000	2 mm	RT6
	8 mm	330 mm/13"	50 000	2 mm	PZ

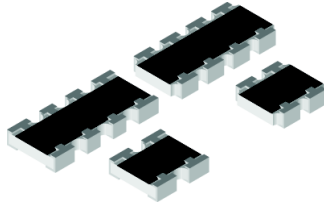
Packaging: according to EIA 481



<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>TEST RESULTS</b>
Endurance Test at 70 °C per EIA 575-3.14	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 1.5 %
Overload per EIA 575-3.6	Short time overload	± 0.5 %
Thermal Shock	per EIA 575-3.5	± 0.5 %
Moisture Resistance	per EIA 575-3.10	± 1.0 %
Resistance to Soldering Heat EIA 575 3.8	10 seconds at 260 °C solder bath temperature	± 2.0 %
High Temperature Exposure	per EIA 575-3.7	± 1.0 %
Low Temperature Operations	per EIA 575-3.6	± 0.5 %
Solderability & Leaching	EIA 575-3.12	95 % Coverage



## Thick Film Resistor Array



CRA06E and CRA06S Thick Film resistor arrays are constructed on a high grade ceramic body with convex terminations. A small package enables the design of high density circuits. The single component reduces board space, component counts and assembly costs.

### FEATURES

- Convex terminal array available with either scalloped corners (E version) or square corners (S version)
- Wide ohmic range: 10R to 1MΩ
- 4 or 8 terminal package with isolated resistors
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with Lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Operating temperature range of - 55 °C to + 150 °C



STANDARD ELECTRICAL SPECIFICATIONS							
MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	CIRCUIT	LIMITING ELEMENT VOLTAGE MAX. $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
CRA06E CRA06S	0.063	03	50	100	$\pm 1$	10R - 1MΩ	24 - 96
				200	$\pm 2; \pm 5$	10R - 1MΩ	24

Jumper: Zero-Ohm-Resistor available;  $R \leq 50 \text{ m}\Omega$

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	CRA06E & S 03 CIRCUIT
Rated Dissipation at 70 °C	W	0.063
Limiting Element Voltage <sup>1)</sup>	$V_{\equiv}$	50
Insulation Voltage (1 min)	$V_{\text{dc/ac peak}}$	100
Category Temperature Range	°C	- 55 to + 150
Insulation Resistance	$\Omega$	$> 10^{10}$

**Note**

1. Rated voltage:  $\sqrt{P \times R}$

### PART NUMBER AND PRODUCT DESCRIPTION

**PART NUMBER: CRA06S08310K0JTA**

C	R	A	0	6	S	0	8	3	1	0	K	0	J	T	A		
MODEL	TERMINAL STYLE	PIN	CIRCUIT	VALUE	TOLERANCE	PACKAGING <sup>1)</sup>	SPECIAL										
CRA06	S E	04 08	3 = 03	R = Decimal K = Thousand M = Million 0000 = 0 $\Omega$ Jumper	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$ Z = 0 $\Omega$ Jumper	TA = RT1 TC = RT6	up to 2 digits										

**PRODUCT DESCRIPTION: CRA06S 08 03 473 J RT1 e3**

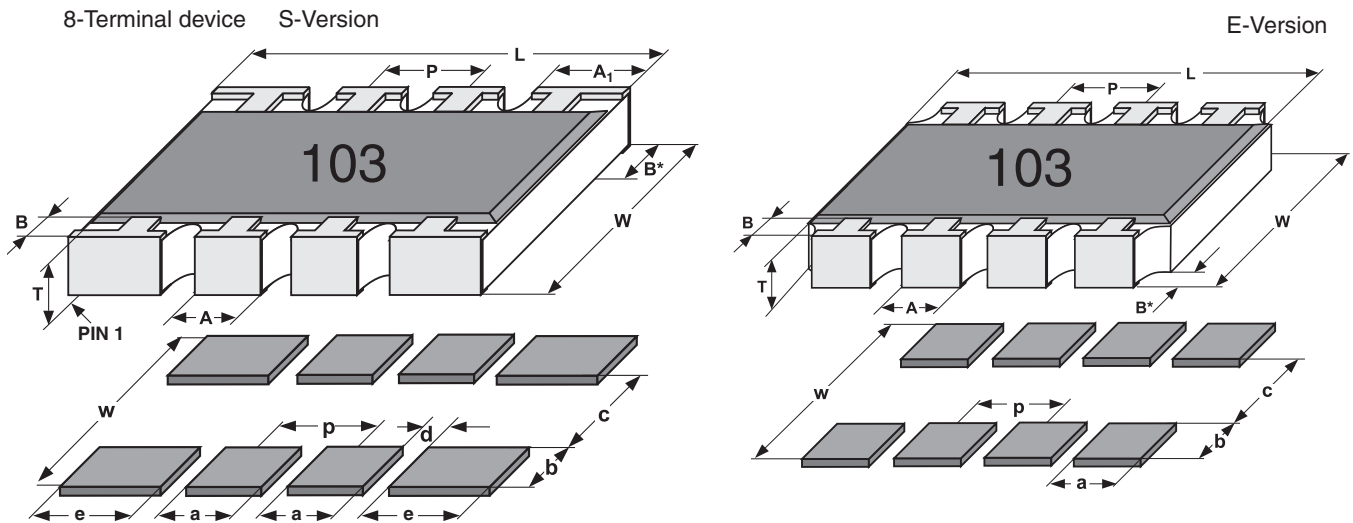
CRA06S	08	03	473	J	RT1	e3											
MODEL	TERMINAL COUNT	CIRCUIT TYPE	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE											
CRA06S CRA06E	04 08	03	473 = 47 k $\Omega$ 4702 = 47 k $\Omega$ 10R0 = 10 $\Omega$ 100 = 10 $\Omega$ 000 = 0 $\Omega$ Jumper	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$ Z = 0 $\Omega$ Jumper	RT1 RT6	e3 = Pure Tin Termination Finish											

First two digits (three for 1 %) are significant. Last digit is the multiplier

**Notes**

1. Please refer to table PACKAGING, page 254.
- Products can be ordered using either the PRODUCT DECIPTION or the PART NUMBER

**DIMENSIONS**



MODEL	PIN NO#	DIMENSIONS [in millimeters]							
		L	A	A <sub>1</sub>	B	B*	P	T	W
CRA06S	4	1.6	0.38	0.61	0.3	0.3	0.8	0.5	1.5
CRA06E	8	3.2	0.38	-	0.3	0.3	0.8	0.5	1.5
CRA06S	8	3.2	0.38	0.61	0.3	0.3	0.8	0.5	1.5
	Tol	± 0.15	± 0.15	± 0.15	± 0.15	± 0.15	± 0.1	± 0.1	± 0.15

SOLDER PAD DIMENSIONS [in millimeters]								
MODEL	PINS	c	w	d	p	a	b	e
CRA06S	4	0.8	3.1	0.36		0.44	1.15	
CRA06E CRA06S	8	0.8	3.1	0.36	0.8	0.44	1.15	0.63

AVAILABLE TYPES AND RANGES				
MODEL	TERMINAL COUNT	CIRCUIT	TEMPERATURE COEFFICIENT	TOLERANCE
CRA06S	04	03	± 100 ppm/K	± 1 %
			± 200 ppm/K	± 5 %; ± 2 %
	08	03	± 100 ppm/K	± 1 %
			± 200 ppm/K	± 5 %; ± 2 %
CRA06E	08	03	± 100 ppm/K	± 1 %
			± 200 ppm/K	± 5 %; ± 2 %

**DESCRIPTION**

Production is strictly controlled and follows a set of instructions established for reproducibility. A thick film layer is deposited on a high grade ceramic substrate. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The wrap around terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure. Only accepted products are laid directly into the paper tape in accordance with **EIA 481**.

**ASSEMBLY**

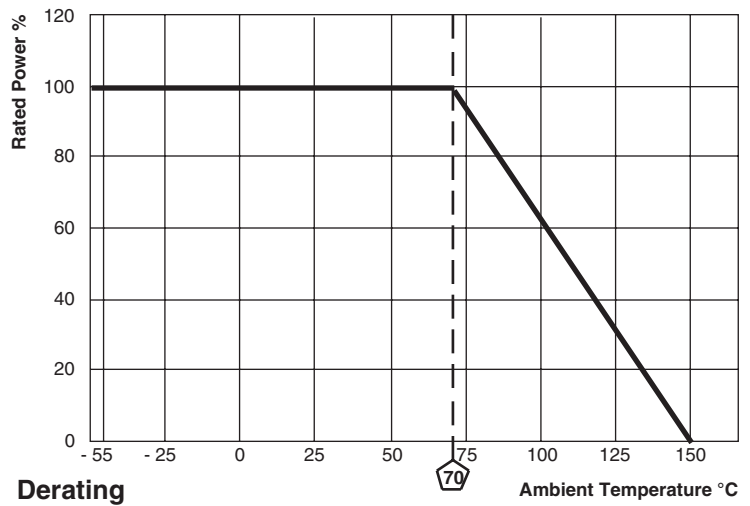
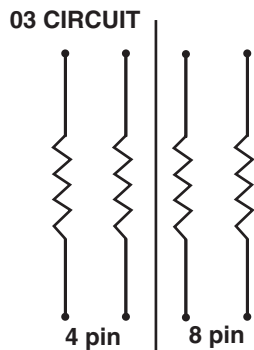
The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave and solder paste reflow. Due to the design, arrays have automatic placement capability. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle Life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

**CIRCUIT**

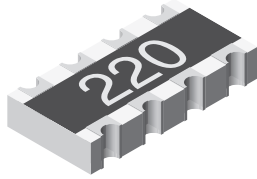


PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER
CRA06	8 mm	180 mm/7"	5000	4 mm	RT1
	8 mm	330 mm/13"	20 000	4 mm	RT6



<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>TEST RESULTS</b>
Endurance Test at 70 °C per EIA 575	1000 hour at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 1.0 %
Overload per EIA 575	Short time overload 2.5 x rated continuous working voltage for 5 seconds. Not to exceed 2 x max operating voltage	± 0.5 %
Thermal Shock	per EIA 575-3.5	± 0.5 %
Moisture Resistance	per EIA 575-3.10	± 1.0 %
Resistance to Soldering Heat EIA 575	10 seconds at 260 °C solder bath temperature	± 2.0 %
High Temperature Exposure	per EIA 575-3.7	± 1.0 %
Low Temperature Operations	per EIA-575-3.6	± 0.5 %
Solderability & Leaching	EIA 575-3.12	95 % Coverage

## Thick Film Resistor Array



CRA06P Thick Film resistor array is constructed on a high grade ceramic body with concave terminations. A small package enables the design of high density circuits. The single component reduces board space, component counts and assembly costs.

### FEATURES

- Concave terminal array with square corners
- 8 terminal package with isolated resistors
- Wide ohmic range: 10R to 1M $\Omega$
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with Lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)
- Operating temperature range of - 55 °C to + 150 °C



### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	CIRCUIT	LIMITING ELEMENT VOLTAGE MAX. $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
CRA06P	0.0625	03	50	200	$\pm 2; \pm 5$	10R - 1M $\Omega$	24
				100	$\pm 1$	10R - 1M $\Omega$	24 - 96

Jumper: Zero-Ohm-Resistor available;  $R \leq 50\text{ m}\Omega$

### TECHNICAL SPECIFICATIONS

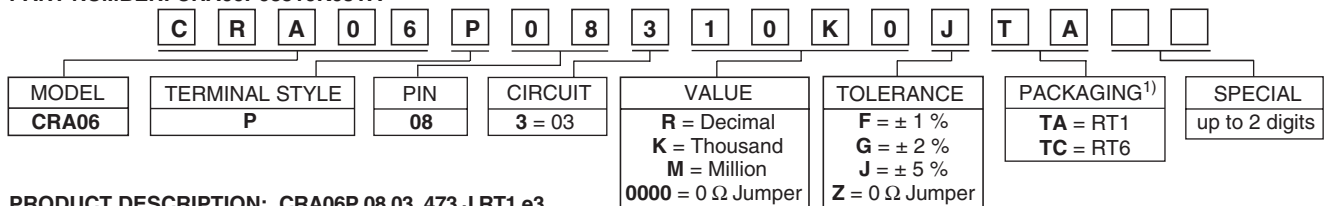
PARAMETER	UNIT	CRA06P 03 CIRCUIT
Rated Dissipation at 70 °C	W	0.0625
Limiting Element Voltage <sup>1)</sup>	$V_{\equiv}$	50
Insulation Voltage (1 min)	$V_{dc/ac\ peak}$	100
Category Temperature Range	°C	- 55 to + 150
Insulation Resistance	$\Omega$	$> 10^{10}$

**Note**

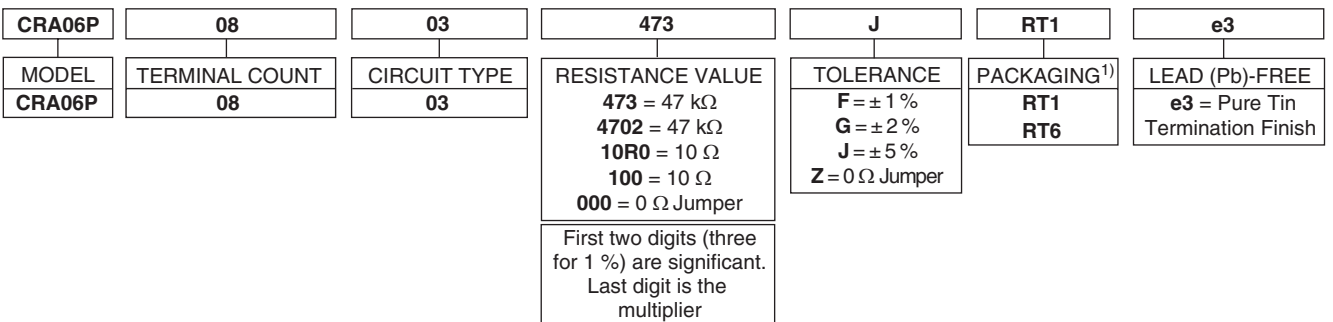
1. Rated voltage:  $\sqrt{P \times R}$

### PART NUMBER AND PRODUCT DESCRIPTION

PART NUMBER: CRA06P08310K0JTA



PRODUCT DESCRIPTION: CRA06P 08 03 473 J RT1 e3

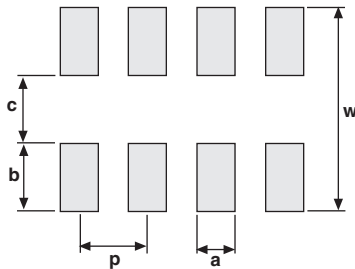
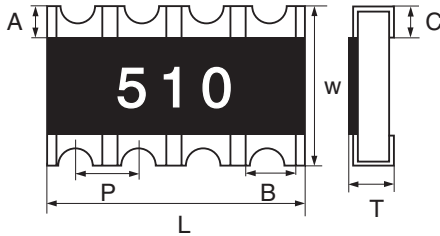


**Notes**

1. Please refer to table PACKAGING, page 258.
- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.

**DIMENSIONS**

4-Resistor Device



PIN NO#	DIMENSIONS [in millimeters]						
	L	A	B	C	P	T	W
8	3.20	0.30	0.40	0.40	0.80	0.60	1.6
Tol	± 0.20	± 0.20	± 0.15	± 0.20	-	± 0.10	± 0.15

SOLDER PAD DIMENSIONS [in millimeters]					
	c	w	p	a	b
WAVE	0.8	2.6	0.8	0.4	0.9

**DESCRIPTION**

Production is strictly controlled and follows a set of instructions established for reproducibility. A thick film layer is deposited on a high grade ceramic substrate. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The wrap around terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure. Only accepted products are laid directly into the paper tape in accordance with **EIA 481**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave and solder paste reflow. Due to the design, arrays have automatic placement capability. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and Lead-containing soldering processes. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

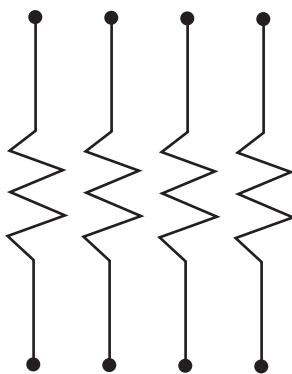
This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle Life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

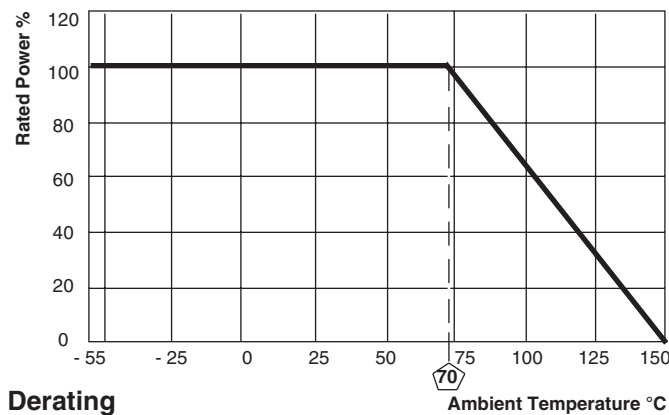
Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

**CIRCUIT**

03 Circuit



8-pin



Derating

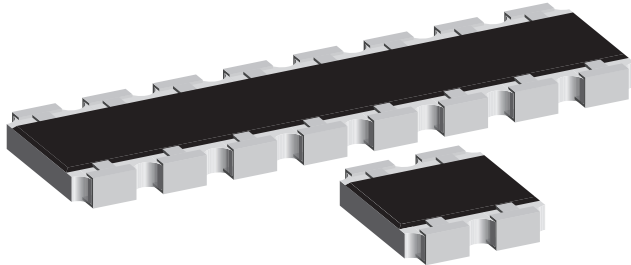
PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER
CRA06P	8 mm	180 mm/7"	5000	4 mm	RT1
	8 mm	330 mm/13"	20 000	4 mm	RT6



<b>PERFORMANCE</b>		
<b>TEST</b>	<b>CONDITIONS OF TEST</b>	<b>TEST RESULTS</b>
Endurance Test at 70 °C per EIA 575-3.14	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 1.0 %
Overload per EIA 575-3.6	Short time overload	± 0.5 %
Thermal Shock	per EIA 575-3.5	± 0.5 %
Moisture Resistance	per EIA 575-3.10	± 1.0 %
Resistance to Soldering Heat EIA 575 3.8	10 seconds at 260 °C solder bath temperature	± 1.0 %
High Temperature Exposure	per EIA 575-3.7	± 1.0 %
Low Temperature Operation	per EIA-/ IS-30A-3.6	± 0.5 %
Solderability & Leaching	EIA 575-3.12	95 % Coverage



## Thick Film Resistor Array



### FEATURES

- Convex terminal array available with either scalloped corners (E version) or square corners (S version)
- Lead (Pb)-free solder contacts on Ni barrier layer
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Operating temperature range of - 55 °C to + 150 °C
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)



STANDARD ELECTRICAL SPECIFICATIONS							
MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	CIRCUIT	LIMITING ELEMENT VOLTAGE MAX. $V_{\equiv}$	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE $\Omega$	E-SERIES
CRA12E	0.100	01; 02; 20	50	200	$\pm 2; \pm 5$	10R - 1M $\Omega$	24
CRA12S	0.125	03		100	$\pm 1$	10R - 1M $\Omega$	24 - 96

Jumper: Zero-Ohm-Resistor available;  $R \leq 50\text{ m}\Omega$

For available types please refer to "TECHNICAL SPECIFICATIONS" table, page 261.

TECHNICAL SPECIFICATIONS			
PARAMETER	UNIT	CRA12E & S 01/02/20 CIRCUIT	CRA12E & S 03 CIRCUIT
Rated Dissipation at 70 °C	W	0.1	0.125
Limiting Element Voltage <sup>1)</sup>	$V_{\equiv}$	50	
Insulation Voltage (1 min)	$V_{dc/ac\text{ peak}}$	100	
Category Temperature Range	°C	- 55 to + 150	
Insulation Resistance	$\Omega$	$> 10^9$	

**Note**

1. Rated voltage:  $\sqrt{P \times R}$

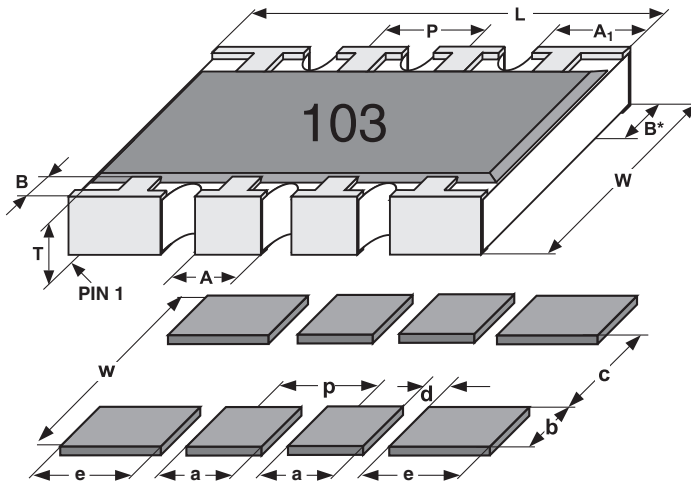
PART NUMBER AND PRODUCT DESCRIPTION							
PART NUMBER: CRA12E08310K0JTR							
C	R	A	1	2	E	0	8
			3	1	0	K	0
						J	T
							R
MODEL	TERMINAL STYLE	PIN	CIRCUIT	VALUE	TOLERANCE	PACKAGING <sup>1)</sup>	SPECIAL
CRA12	S E	04 08 10 16	1 = 01 2 = 02 3 = 03 8 = 20	R = Decimal K = Thousand M = Million 0000 = 0 $\Omega$ Jumper	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$ Z = 0 $\Omega$ Jumper	TR = RB8 TL = RD7	up to 2 digits
PRODUCT DESCRIPTION: CRA12S 08 03 473 J RB8 e3							
CRA12S	08	03	473	J	RB8	e3	
MODEL	TERMINAL COUNT	CIRCUIT TYPE	RESISTANCE VALUE	TOLERANCE	PACKAGING <sup>1)</sup>	LEAD (Pb)-FREE	
CRA12E CRA12S	04 08 10 16	01 02 03 20	473 = 47 k $\Omega$ 4702 = 47 k $\Omega$ 10R0 = 10 $\Omega$ 100 = 10 $\Omega$ 000 = 0 $\Omega$ Jumper	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$ Z = 0 $\Omega$ Jumper	RB8 RD7	e3 = Pure Tin Termination Finish	
First two digits (three for 1 %) are significant. Last digit is the multiplier							

**Notes**

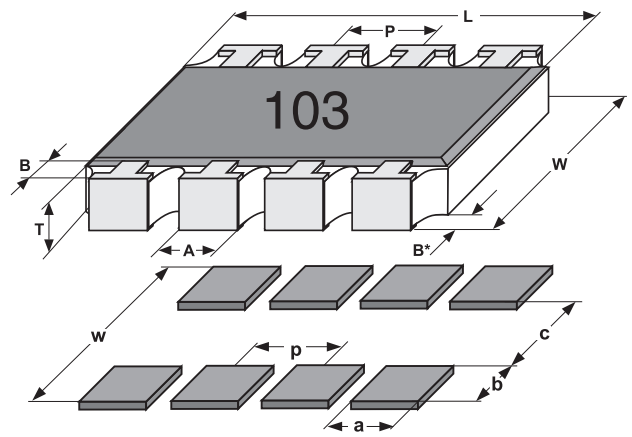
1. Please refer to table PACKAGING, page 263
- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
- For available types please refer to "TECHNICAL SPECIFICATIONS" table, page 261.

**DIMENSIONS**

8-Terminal device S-Version



E-Version



MODEL	PIN NO#	DIMENSIONS [in millimeters]							
		L	A	A*	B	B*	P	T	W
CRA12E	4	2.54	0.79	-	0.51	0.38	1.27	0.53	3.05
CRA12E	8	5.08	0.79	-	0.51	0.38	1.27	0.53	3.05
CRA12S	8	5.08	0.79	0.89	0.51	0.38	1.27	0.53	3.05
CRA12E	10	6.40	0.79	-	0.51	0.38	1.27	0.53	3.05
CRA12S	10	6.40	0.79	0.89	0.51	0.38	1.27	0.53	3.05
CRA12E	16	10.30	0.79	-	0.51	0.38	1.27	0.53	3.05
	<b>Tol</b>	-0.15	-0.15	-0.15	-0.25	-0.2	-0.1	-0.1	-0.15

SOLDER PAD DIMENSIONS [in millimeters]							
	c	w	d	p	a	b	e
<b>WAVE</b>	2.2	4.3	0.57	1.27	0.71	1.05	1.09
<b>REFLOW</b>	2.2	3.9	0.57	1.27	0.71	0.86	1.09

The dimensions shown are for 8 pin part. For parts with different pin numbers use the same pitch and add or subtract pads as required.

TECHNICAL SPECIFICATIONS				
MODEL	TERMINAL COUNT	CIRCUIT	TEMPERATURE COEFFICIENT	TOLERANCE
CRA12 S	08	03	± 100 ppm/K	± 1 %
		01	± 200 ppm/K	± 5 %; ± 2 %
	10	02		
		20		
CRA12 E	04	03	± 100 ppm/K	± 1 %
		03	± 100 ppm/K	± 1 %
	08	01	± 200 ppm/K	± 5 %; ± 2 %
		02		
		03	± 100 ppm/K	± 1 %
	10	01	± 200 ppm/K	± 5 %; ± 2 %
		02		
		20	± 100 ppm/K	± 1 %
		03		
	16	01	± 200 ppm/K	± 5 %; ± 2 %
		02		
		20	± 100 ppm/K	± 1 %
03				

**DESCRIPTION**

Production is strictly controlled and follows a set of instructions established for reproducibility. A thick film layer is deposited on a high grade ceramic substrate. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The wrap around terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure. Only accepted products are laid directly into the paper tape in accordance with **EIA 481**.

**ASSEMBLY**

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave and solder paste reflow. Due to the design, arrays have automatic placement capability. The resistors are Lead (Pb)-free, the pure tin plating provides compatibility with Lead (Pb)-free and Lead-containing soldering processes. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compatibility with the following directives:

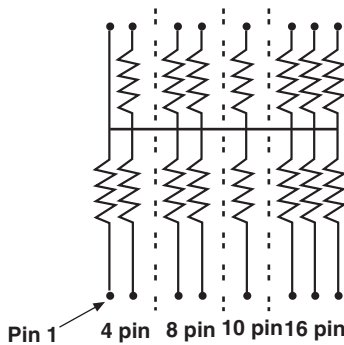
- 2000/53/EC End of Vehicle Life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification.

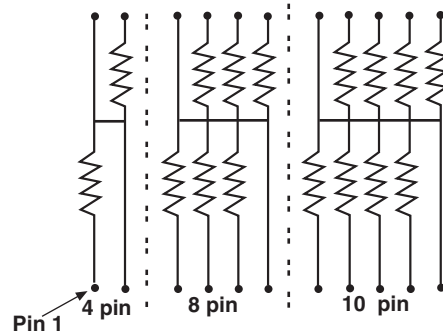
The permitted storage time is 20 years.

**CIRCUIT**

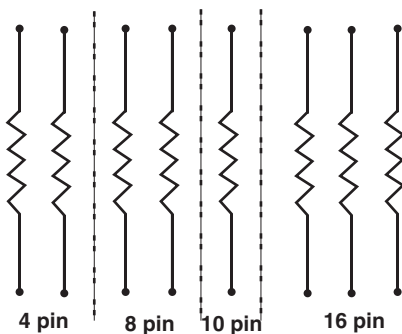
01 Circuit



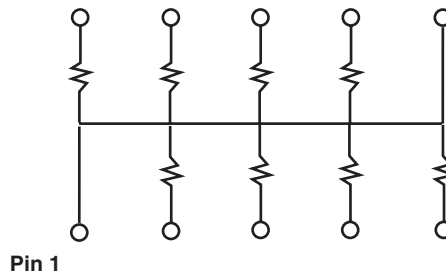
02 Circuit

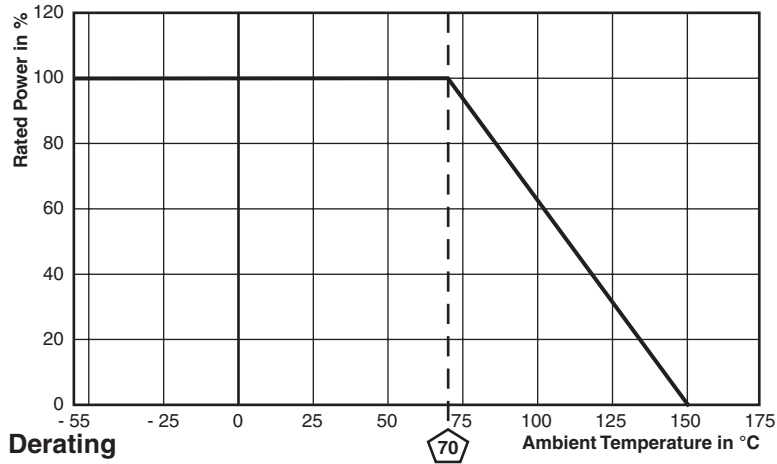


03 Circuit



20 Circuit

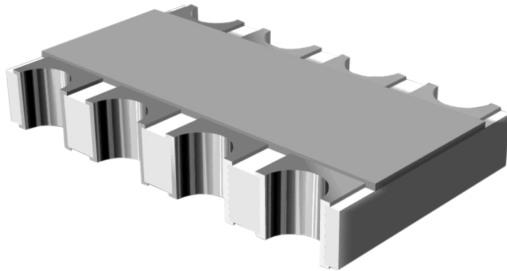




PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER
CRA12 E 04	8 mm	180 mm/7"	2000	4 mm	RB8
CRA12 E 08 CRA12 S 08	12 mm	180 mm/7"	2000	8 mm	RB8
CRA12 E 10 CRA12 S 10	12 mm	330 mm/13"	5000	8 mm	RD7
CRA12 E 16	24 mm	330 mm/13"	2000	8 mm	RB8
CRA12 E 16			5000	8 mm	RD7

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST RESULTS
Endurance Test at 70 °C per EIA 575-3.14	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 1.0 %
Overload per EIA 575-3.6	Short time overload 2.5 x rated continuous working voltage for 5 seconds. Not to exceed 2 x max operating voltage	± 0.5 %
Thermal Shock	per EIA 575-3.5	± 0.5 %
Moisture Resistance	per EIA 575-3.10	± 1.0 %
Resistance to Soldering Heat EIA 575-3.8	10 seconds at 260 °C solder bath temperature	± 2.0 %
High Temperature Exposure	per EIA 575-3.7	± 1.0 %
Low Temperature Operations	per EIA 575-3.6	± 0.5 %
Solderability & Leaching	EIA 575-3.12	95 % Coverage

## Professional Flat Chip Resistor Array



ACAC 0612 flat chip resistor array combines the proven reliability of professional MFC products with the advantages of a chip array. A small package enables the design of high density circuits in combination with reduction of assembly costs. Different resistance values can be realized on one substrate.

### FEATURES

- Advanced thin film technology
- Superior overall stability
- Four resistors on one substrate
- Tight TCR of  $\pm 50$  ppm/K
- Tolerance of  $\pm 1$  %
- Different resistance values are possible
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Bus terminations
- Voltage divider
- Feedback circuits
- Signal conditioning

### TECHNICAL SPECIFICATIONS

DESCRIPTION	ACAC 0612
EIA size	0612
Metric size	RR 1632M
Configuration, isolated	4 x 0603
Design:	
all equal	AE
two pairs	TP
different values	DF
Resistance values	100 $\Omega$ to 221 k $\Omega$ <sup>1)</sup>
Tolerance:	
absolute	$\pm 1$ %
Temperature coefficient:	
absolute	$\pm 50$ ppm/K ( $\pm 25$ ppm/K on request)
Max. resistance ratio $R_{min}/R_{max}$	1:10 <sup>2)</sup>
Climatic category (LCT/UCT/days)	55/125/56
Rated dissipation: $P_{70}$ <sup>3)</sup>	
element	0.1 W
package	0.3 W
Operating voltage	75 V
Film temperature	125 °C
Insulation voltage ( $U_{ins}$ ) against ambient and between isolated resistors, continuous	75 V

#### Notes

1. Resistance values to be selected from E24 and E96.
2. Higher ratio on request.
3. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.

### 12NC INFORMATION

- The arrays have a 12-digit numeric code starting with 2312.
- The subsequent 3 digits indicate the array packing and body size; see the 12NC table.
- The last 5 digits indicate the termination and individual array design number (last 4 digits).

12NC - resistor array type and packaging						
DESCRIPTION					ORDERING CODE 2312 ... ..	
					AE (ALL EQUAL)	TP (TWO PAIRS)
TYPE	TCR	TOL.	R1; R4	R2; R3	P5 5000 UNITS	P5 5000 UNITS
ACAC 0612	± 50 ppm/K	± 1 %	1 kΩ	1 kΩ	441 09011	–
			10 kΩ	10 kΩ	441 09012	–
			100 kΩ	100 kΩ	441 09013	–
			1 kΩ	2 kΩ	–	441 19014
			10 kΩ	20 kΩ	–	441 19015
			1 kΩ	3 kΩ	–	441 19016
			10 kΩ	30 kΩ	–	441 19017

#### Note

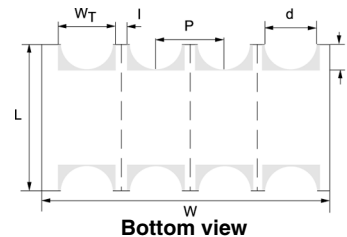
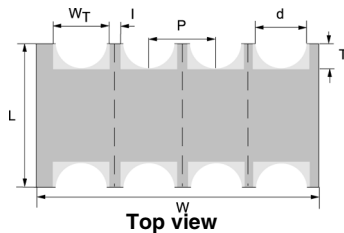
1. 12NC indicating resistor array type and packing table shows standard array types with a resistance divider ratio up to 1:3. Please consult Vishay Beyschlag for specific divider ratio, temperature coefficient, tolerance and ohmic values.

PART NUMBER AND PRODUCT DESCRIPTION <sup>2)</sup>																	
PART NUMBER <sup>3)</sup> : ACAC06P0839011P500																	
A	C	A	C	0	6	P	0	8	3	9	0	1	1	P	5	0	0
MODEL	SIZE	TERMINAL	PIN		SCHEMATIC	DESIGN NUMBER		PACKAGING <sup>4)</sup>		SPECIAL							
ACAC	06	P = concave	08 = 8 Pins		3 = 03	Design number is available on request		P1 P5 PW		00 = standard							
PRODUCT DESCRIPTION: ACAC 9011 TP P5																	
A	C	A	C		9011		TP		P5								
MODEL	PRODUCT	SIZE	TERMINATION		DESIGN NUMBER		DESIGN		PACKAGING <sup>4)</sup>								
A = Array	C = Flat chip	A = 0612	C = Concave		Design number is available on request		AE = All Equal TP = Two Pairs DF = Different Values		P1 P5 PW								

#### Notes

- Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKAGING, page 266.

### DIMENSIONS

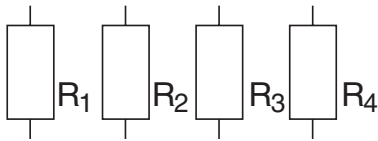


DIMENSIONS - CHIP resistor array top view, mass and relevant physical dimensions									
TYPE	L (mm)	W (mm)	H (mm)	P (mm)	W <sub>T</sub> (mm)	T (mm)	D (mm)	I (mm)	MASS (mg)
ACAC 0612	1.6 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.3 ± 0.15	0.3 ± 0.1	min. 0.15	9.41

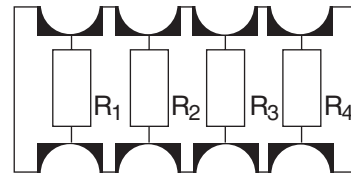
DIMENSIONS - CHIP resistor array bottom view, mass and relevant physical dimensions									
TYPE	L (mm)	W (mm)	H (mm)	P (mm)	W <sub>T</sub> (mm)	T (mm)	D (mm)	I (mm)	MASS (mg)
ACAC 0612	1.6 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.3 ± 0.1	min. 0.25	9.41

PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER TAPE
ACAC	8 mm	180 mm/7"	1000	4 mm	P1
	8 mm	180 mm/7"	5000	4 mm	P5
	8 mm	330 mm/13"	10 000	4 mm	PW

## APPLICATION INFORMATION



Equivalent circuit  
(SCHEMATIC 03)



Array configuration

## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub> O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics.

The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60 286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems and for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

## APPROVALS

Where applicable, the resistors are tested in accordance with **EN 140 401-801** (superseding **CECC 40401-801**) which refers to **EN 140 000 (EN 60 115-1)** and **EN 140 400 (IEC 60 115-8)**.



**TESTS AND REQUIREMENTS**

Essentially all tests are carried out in accordance with the following specifications:

EN 140 000/EN 60 115-1, Generic specification (includes tests)

EN 140 400/EN 60 115-1, Sectional specification (includes schedule for qualification approval)

The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60 068 and under standard atmospheric conditions according to IEC 60 068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60 115-1, 4.31 unless otherwise specified.

In the Test Procedures and Requirements table below, only the tests and requirements are listed with reference to the relevant clauses of EN 60 115-1 and IEC 60 068-2; a short description of the test procedure is also given.

<b>TEST PROCEDURES AND REQUIREMENTS</b>				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS <sup>1)</sup> PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types:  <b>ACAC 0612</b>	100 $\Omega$ to 221 k $\Omega$
4.5	–	resistance	–	$\pm 1 \%$
4.8.4.2	–	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 50$ ppm/K
4.25.1	–	endurance	$U = \sqrt{P_{70} \times R}$ or $U = U_{max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h	$\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5 \% R + 0.05 \Omega)$
4.13	–	short time overload <sup>2)</sup>	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.19	14 (Na)	rapid change of temperature	30 min. at LCT and 30 min. at UCT; 5 cycles	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.18.2	58 (Tb)	resistance to soldering heat	(260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.25 \% R + 0.01 \Omega)$ no visible damage
4.17.2	58 (Ta)	solderability	solder bath method; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1632 M; 45 N	no visible damage
4.7	–	voltage proof	$U_{rms} = U_{ins}$ ; 60 $\pm$ 5 s; against ambient, between adjacent resistors	no flashover or breakdown

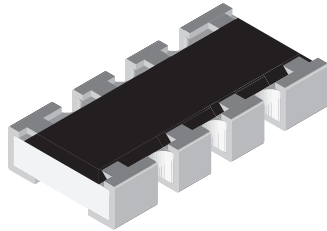
**Notes**

1. Figures are given for equal values.

2. For a single element.



## Flat Chip Resistor Array



ACAS 0612 flat chip resistor arrays combine the proven reliability of professional MFC products with the advantages of chip arrays. A small package enables the design of high density circuits in combination with reduction of assembly costs. Different resistance values can be realized on one substrate.

### FEATURES

- Advanced thin film technology
- Four resistors on one substrate
- Tight TCR of  $\pm 50$  ppm/K
- Tolerance of  $\pm 1$  %
- Different resistance values are possible
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes



### APPLICATIONS

- Voltage divider
- Feedback circuits
- Signal conditioning
- Bus terminations

TECHNICAL SPECIFICATIONS	
DESCRIPTION	ACAS 0612
EIA size	0612
Metric size	RR 1632M
Configuration, isolated	4 × 0603
Design:	
all equal	AE
two pairs	TP
different values	DF
Resistance values	100 $\Omega$ to 221 k $\Omega$ <sup>1)</sup>
Tolerance:	
absolute	$\pm 1$ %
Temperature coefficient:	
absolute	$\pm 50$ ppm/K
Max. resistance ratio $R_{min}/R_{max}$	1:10 <sup>2)</sup>
Climatic category (LCT/UCT/days)	55/155/56
Rated dissipation: $P_{70}$ <sup>2)</sup>	
element	0.1 W
package, 4 x 0603	0.3 W
Operating voltage	75 V
Film temperature	155 °C
Insulation voltage ( $U_{ins}$ ) against ambient and between isolated resistors, continuous	75 V

### Notes

1. Resistance values to be selected from E24 and E96.
2. Higher ratio and different tolerance on request.
3. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



### 12NC INFORMATION

- The arrays have a 12-digit numeric code starting with 2312.
- The subsequent 3 digits indicate the array and body size.
- The last 5 digits indicate the circuit style and individual array design number (last 4 digits).

12NC - resistor type and packaging			
DESCRIPTION	ORDERING CODE 2312... ..		
	CARDBOARD TAPE ON REEL		
TYPE	DESIGN	P1	P5
ACAS	AE	440 3....	441 3....
	TP	440 4....	441 4....
	DF	440 5....	441 5....

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

**PART NUMBER<sup>2)</sup>: ACAS06S0839011P500**

A	C	A	S	0	6	S	0	8	3	9	0	1	1	P	5	0	0
MODEL ACAC	SIZE 06	TERMINAL S = convex square	PIN 08 = 8 Pins	SCHEMATIC 3 = 03	DESIGN NUMBER Design number is available on request	PACKAGING <sup>3)</sup> P1 P5 PW	SPECIAL 00 = standard										

**PRODUCT DESCRIPTION: ACAS 9011 TP P5**

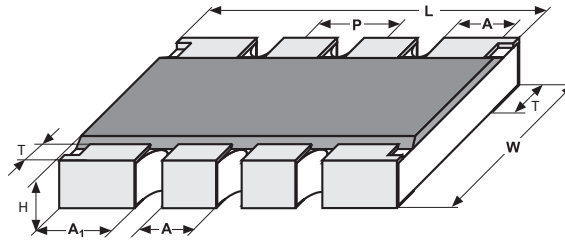
A	C	A	S	9011	TP	P5
MODEL A = Array	PRODUCT C = Flat chip	SIZE A = 0612	TERMINATION S = Convex	DESIGN NUMBER Design number is available on request	DESIGN AE = All Equal TP = Two Pairs DF = Different Values	PACKAGING <sup>3)</sup> P1 P5 PW

#### Notes

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, below.

PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER TAPE
ACAS	8 mm	180 mm/7"	1000	4 mm	P1
	8 mm	180 mm/7"	5000	4 mm	P5
	8 mm	330 mm/13"	10 000	4 mm	PW

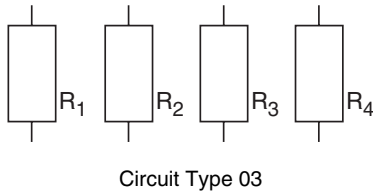
## DIMENSIONS



DIMENSIONS - chip resistor array top view, mass and relevant physical dimensions								
TYPE	W (mm)	L (mm)	H (mm)	P (mm)	A <sub>1</sub> (mm)	A (mm)	T (mm)	MASS (mg)
ACAS 0612	1.5 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.3 ± 0.15	9.41

DIMENSIONS - chip resistor array bottom view, mass and relevant physical dimensions								
TYPE	W (mm)	L (mm)	H (mm)	P (mm)	A <sub>1</sub> (mm)	A (mm)	T (mm)	MASS (mg)
ACAS 0612	1.5 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.4 ± 0.15	9.41

## APPLICATION INFORMATION



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub> O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics.

The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60 286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning

solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

Where applicable, the resistors are tested in accordance with **EN 140 401-801** (superseding **CECC 40401-801**) which refers to **EN 140 000 (EN 60 115-1)** and **EN 140 400 (IEC 60 115-8)**.

### TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the following specifications:

EN 140 000/EN 60 115-1, Generic specification (includes tests)

EN 140 400/EN 60 115-1, Sectional specification (includes schedule for qualification approval)

The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60 068 and under standard atmospheric conditions according to IEC 60 068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60 115-1, 4.31 unless otherwise specified.

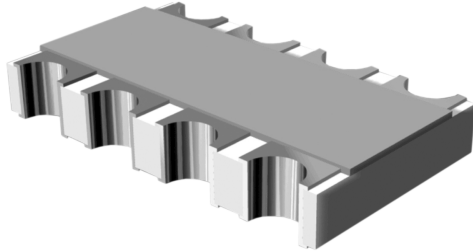
In the following table only the tests and requirements are listed with reference to the relevant clauses of EN 60 115-1 and IEC 60 068-2; a short description of the test procedure is also given.

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS <sup>1)</sup> PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types: <b>ACAS 0612</b>	100 $\Omega$ to 221 k $\Omega$
4.5	–	resistance	–	$\pm 1 \%$
4.8.4.2	–	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 50$ ppm/K
4.25.1	–	endurance	$U = \sqrt{P_{70} \times R}$ or $U = U_{\max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.25.3	–	endurance at upper category temperature	155 °C; 1000 h	$\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5 \% R + 0.05 \Omega)$
4.13	–	short time overload <sup>2)</sup>	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{\max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 min. at LCT and 30 min. at UCT; 5 cycles	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.18.2	58 (Tb)	resistance to soldering heat	reflow method 2 (IR/forced gas convention); (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.25 \% R + 0.01 \Omega)$ no visible damage
4.17.2	58 (Ta)	solderability	solder bath method; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1632M; 45 N	no visible damage
4.7	–	voltage proof	$U_{\text{rms}} = U_{\text{ins}}$ ; 60 $\pm$ 5 s; against ambient, between adjacent resistors	no flashover or breakdown

#### Notes

- Figures are given for equal values.
- For a single element.

## Flat Chip Resistor Array



ACAC 0612 flat chip resistor array combines the proven reliability of precision MFC products with the advantages of a chip array. The possibility of tolerance matching and TCR tracking makes this product perfectly suited for applications with outstanding requirements towards stable fixed resistor ratios. A small package enables the design of high density circuits in combination with reduction of assembly costs. Different resistance values can be realized on one substrate.

### FEATURES

- Advanced thin film technology
- Superior overall stability
- Four resistors on one substrate
- Tight TCR of  $\pm 25$  ppm/K and TCR tracking of 15 ppm/K, (10 ppm/K on request)
- Tolerance of  $\pm 0.25$  % and matched tolerance of 0.1 %
- Different resistance values are possible
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



### APPLICATIONS

- Precision analogue circuits
- Voltage divider
- Feedback circuits
- Signal conditioning

TECHNICAL SPECIFICATIONS	
DESCRIPTION	ACAC 0612
EIA size	0612
Metric size	RR 1632M
Configuration, isolated	4 × 0603
Design: all equal two pairs different values	AE TP DF
Resistance values	100 $\Omega$ to 221 k $\Omega$ <sup>1)</sup>
Tolerance: absolute matching	$\pm 0.25$ % 0.1 %
Temperature coefficient: absolute tracking	$\pm 25$ ppm/K 15 ppm/K
Max. resistance ratio $R_{min}/R_{max}$	1:5
Climatic category (LCT/UCT/days)	55/125/56
Rated dissipation: $P_{70}^{(2)}$ element package	0.1 W 0.3 W
Operating voltage	75 V
Film temperature	125 °C
Insulation voltage ( $U_{ins}$ ) against ambient and between isolated resistors, continuous	75 V

### Notes

1. Resistance values to be selected from E24 and E96.
2. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.

### 12NC INFORMATION

- The arrays have a 12-digit numeric code starting with 2312.
- The subsequent 3 digits indicate the array packing and body size; see the 12NC table.
- The last 5 digits indicate the termination and individual array design number (last 4 digits).

12NC - resistor array type and packaging					ORDERING CODE 2312 ... ..	
DESCRIPTION					AE (ALL EQUAL)	TP (TWO PAIRS)
TYPE	TCR	TOL.	R1; R4	R2; R3	P5 5000 UNITS	P5 5000 UNITS
ACAC 0612	15 ppm/K	0.1 %	1 kΩ	1 kΩ	441 09001	–
			10 kΩ	10 kΩ	441 09002	–
			100 kΩ	100 kΩ	441 09003	–
			1 kΩ	2 kΩ	–	441 19004
			10 kΩ	20 kΩ	–	441 19005
			1 kΩ	3 kΩ	–	441 19006
			10 kΩ	30 kΩ	–	441 19007

#### Note

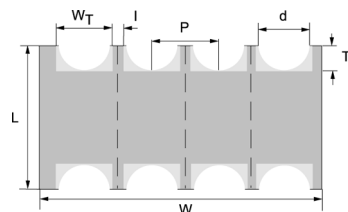
- 12NC indicating resistor array type and packing table shows standard array types with a resistance divider ratio up to 1:3. Please consult Vishay BEYSCHLAG for specific divider ratio, temperature coefficient, tolerance and ohmic values.

PART NUMBER AND PRODUCT DESCRIPTION <sup>2)</sup>							
PART NUMBER <sup>3)</sup> : ACAC06P0839001P500							
A	C	A	C	0	6	P	0839001P500
MODEL	SIZE	TERMINAL	PIN	SCHEMATIC	DESIGN NUMBER	PACKAGING <sup>4)</sup>	SPECIAL
ACAC	06	P = Concave	08 = 8 Pins	3 = 03	Design number is available on request	P1 P5 PW	00 = standard
PRODUCT DESCRIPTION: ACAC 9001 TP P5							
A	C	A	C	9001	TP	P5	
MODEL	PRODUCT	SIZE	TERMINATION	DESIGN NUMBER	DESIGN	PACKAGING <sup>4)</sup>	
A = Array	C = Flat chip	A = 0612	C = Concave	Design number is available on request	AE = All Equal TP = Two Pairs DF = Different Values	P1 P5 PW	

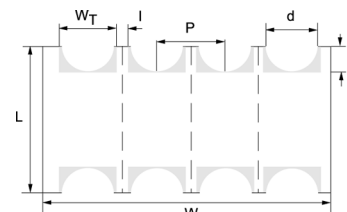
#### Notes

- Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKAGING, page 274.

### DIMENSIONS



Top view



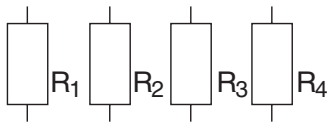
Bottom view

DIMENSIONS - CHIP resistor array top view, mass and relevant physical dimensions									
TYPE	L (mm)	W (mm)	H (mm)	P (mm)	W <sub>T</sub> (mm)	T (mm)	d (mm)	I (mm)	mass (mg)
ACAC 0612	1.6 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.3 ± 0.15	0.3 ± 0.1	min. 0.15	9.41

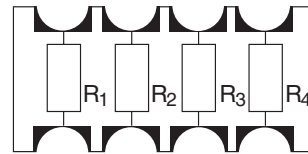
DIMENSIONS - CHIP resistor array bottom view, mass and relevant physical dimensions									
TYPE	L (mm)	W (mm)	H (mm)	P (mm)	W <sub>T</sub> (mm)	T (mm)	d (mm)	I (mm)	mass (mg)
ACAC 0612	1.6 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.3 ± 0.1	min. 0.25	9.41

PACKAGING					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER TAPE
ACAC	8 mm	180 mm/7"	1000	4 mm	P1
	8 mm	180 mm/7"	5000	4 mm	P5
	8 mm	330 mm/13"	10 000	4 mm	PW

## APPLICATION INFORMATION



Equivalent circuit  
(SCHEMATIC 03)



Array configuration

## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub> O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics.

The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60 286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems and for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances:

This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

## APPROVALS

Where applicable, the resistors are tested in accordance with **EN 140 401-801** (superseding **CECC 40401-801**) which refers to **EN 140 000 (EN 60 115-1)** and **EN 140 400 (IEC 60 115-8)**.

**TESTS AND REQUIREMENTS**

Essentially all tests are carried out in accordance with the following specifications:

EN 140 000/EN 60 115-1, Generic specification (includes tests)

EN 140 400/EN 60 115-1, Sectional specification (includes schedule for qualification approval)

The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60 068 and under standard atmospheric conditions according to IEC 60 068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60 115-1, 4.31 unless otherwise specified.

In the following table only the tests and requirements are listed with reference to the relevant clauses of EN 60 115-1 and IEC 60 068-2; a short description of the test procedure is also given.

<b>TEST PROCEDURES AND REQUIREMENTS</b>				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS <sup>1)</sup> PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types: <b>ACAC 0612</b>	100 $\Omega$ to 221 k $\Omega$
4.5	–	resistance	–	$\pm 0.25 \%$
4.8.4.2	–	temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C	$\pm 25$ ppm/K
4.25.1	–	endurance	$U = \sqrt{P_{70} \times R}$ or $U = U_{\max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h	$\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5 \% R + 0.05 \Omega)$
4.13	–	short time overload <sup>2)</sup>	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{\max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.19	14 (Na)	rapid change of temperature	30 min. at LCT and 30 min. at UCT; 5 cycles	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.18.2	58 (Tb)	resistance to soldering heat	reflow method 2 (IR/forced gas convention); (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.17.2	58 (Ta)	solderability	solder bath method; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1632M; 45 N	no visible damage
4.7	–	voltage proof	$U_{\text{rms}} = U_{\text{ins}}$ ; 60 $\pm$ 5 s; against ambient, between adjacent resistors	no flashover or breakdown

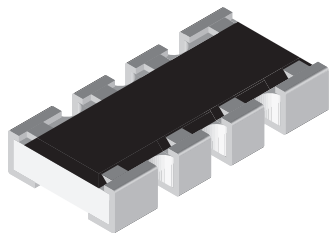
**Notes**

1. Figures are given for equal values.

2. For a single element.



## Flat Chip Resistor Array



ACAS 0612 flat chip resistor arrays combine the proven reliability of precision MFC products with the advantages of chip arrays. The possibility of tolerance matching and TCR tracking makes this product perfectly suited for applications with outstanding requirements towards stable fixed resistor ratios. A small package enables the design of high density circuits in combination with reduction of assembly costs. Different resistance values can be realized on one substrate.

### FEATURES

- Advanced thin film technology
- Four resistors on one substrate
- Tight TCR of  $\pm 25$  ppm/K and TCR tracking of 15 ppm/K, (10 ppm/K on request)
- Tolerance of  $\pm 0.25$  % and matched tolerance of 0.1 %
- Different resistance values are possible
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes



**RoHS**  
COMPLIANT

### APPLICATIONS

- Precision analogue circuits
- Voltage divider
- Feedback circuits
- Signal conditioning

TECHNICAL SPECIFICATIONS	
DESCRIPTION	ACAS 0612
EIA size	0612
Metric size	RR 1632M
Configuration, isolated	4 × 0603
Design:	
all equal	AE
two pairs	TP
different values	DF
Resistance values	100 $\Omega$ to 221 k $\Omega$ <sup>1)</sup>
Tolerance:	
absolute	$\pm 0.25$ %
matching	0.1 %
Temperature coefficient:	
absolute	$\pm 25$ ppm/K
tracking	15 ppm/K
Max. resistance ratio $R_{min}/R_{max}$	1:5
Climatic category (LCT/UCT/days)	55/125/56
Rated dissipation: $P_{70}^{(2)}$	
element	0.1 W
package, 4 x 0603	0.3 W
Operating voltage	75 V
Film temperature	125 °C
Insulation voltage ( $U_{ins}$ ) against ambient and between isolated resistors, continuous	75 V

### Notes

1. Resistance values to be selected from E24 and E96.
2. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.



**12NC INFORMATION**

- The arrays have a 12-digit numeric code starting with 2312.
- The subsequent 3 digits indicate the array packing and body size.
- The last 5 digits indicate the circuit style and individual array design number (last 4 digits).

<b>12NC - resistors type and packaging</b>			
DESCRIPTION	ORDERING CODE 2312... ..		
	CARDBOARD TAPE ON REEL		
TYPE	DESIGN	P1	P5
ACAS	AE	440 3....	441 3....
	TP	440 4....	441 4....
	DF	440 5....	441 5....

**PART NUMBER AND PRODUCT DESCRIPTION<sup>1)</sup>**

**PART NUMBER<sup>2)</sup>: ACAS06S0839001P500**

A	C	A	S	0	6	S	0	8	3	9	0	0	1	P	5	0	0
MODEL	SIZE	TERMINAL	PIN	SCHEMATIC	DESIGN NUMBER	PACKAGING <sup>3)</sup>	SPECIAL										
ACAC	06	S = Convex square	08 = 8 Pins	3 = 03	Design number is available on request	P1 P5 PW	00 = Standard										

**PRODUCT DESCRIPTION: ACAS 9001 TP P5**

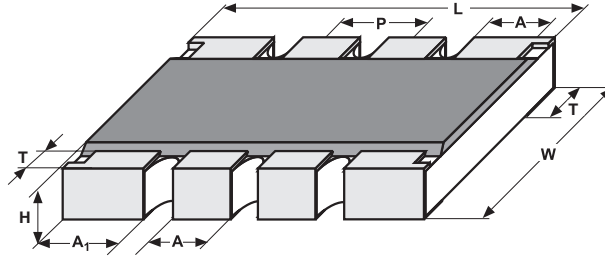
A	C	A	S	9001	TP	P5							
MODEL	PRODUCT	SIZE	TERMINATION	DESIGN NUMBER	DESIGN	PACKAGING <sup>3)</sup>							
A = ARRAY	C = Flat chip	A = 0612	S = Convex	Design number is available on request	AE = All Equal TP = Two Pairs DF = Different Values	P1 P5 PW							

**Notes**

1. Products can be ordered using either the PRODUCT DESCRIPTION or the 12 NC.
2. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
3. Please refer to table PACKAGING, see below.

<b>PACKAGING</b>					
MODEL	TAPE WIDTH	DIAMETER	PIECES	PITCH	PACKAGING CODE
					PAPER TAPE
ACAS	8 mm	180 mm/7"	1000	4 mm	P1
	8 mm	180 mm/7"	5000	4 mm	P5
	8 mm	330 mm/13"	10 000	4 mm	PW

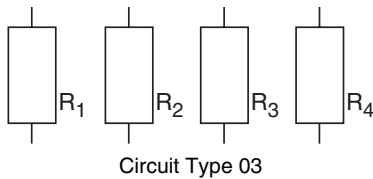
## DIMENSIONS



DIMENSIONS - chip resistor array top view, mass and relevant physical dimensions								
TYPE	W (mm)	L (mm)	H (mm)	P (mm)	A <sub>1</sub> (mm)	A (mm)	T (mm)	MASS (mg)
ACAS 0612	1.5 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.3 ± 0.15	9.41

DIMENSIONS - chip resistor array bottom view, mass and relevant physical dimensions								
TYPE	W (mm)	L (mm)	H (mm)	P (mm)	A <sub>1</sub> (mm)	A (mm)	T (mm)	MASS (mg)
ACAS 0612	1.5 ± 0.15	3.2 ± 0.15	0.55 ± 0.1	0.8 ± 0.1	0.6 ± 0.15	0.4 ± 0.15	0.4 ± 0.15	9.41

## APPLICATION INFORMATION



## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a super high grade (96 % Al<sub>2</sub> O<sub>3</sub>) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics.

The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. Only accepted products are laid directly into the paper tape in accordance with **EN 60 286-3**.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1**. The encapsulation is resistant to all cleaning

solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are RoHS compliant, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL**<sup>1)</sup> and the **CEFIC-EECA-EICTA**<sup>2)</sup> list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

### Notes

1. Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org)
2. CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see [www.eicta.org](http://www.eicta.org) -> issue -> environment policy -> chemicals -> chemicals for electronics

## APPROVALS

Where applicable, the resistors are tested in accordance with **EN 140 401-801** (superseding **CECC 40401-801**) which refers to **EN 140 000 (EN 60 115-1)** and **EN 140 400 (IEC 60 115-8)**.

**TESTS AND REQUIREMENTS**

Essentially all tests are carried out in accordance with the following specifications:

EN 140 000/EN 60 115-1, Generic specification (includes tests)

EN 140 400/EN 60 115-1, Sectional specification (includes schedule for qualification approval)

The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60 068 and under standard atmospheric conditions according to IEC 60 068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60 115-1, 4.31 unless otherwise specified.

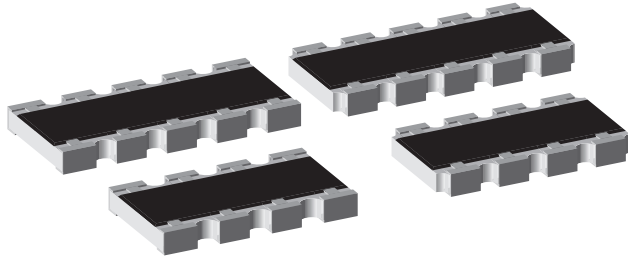
In the following table only the tests and requirements are listed with reference to the relevant clauses of EN 60 115-1 and IEC 60 068-2; a short description of the test procedure is also given.

<b>TEST PROCEDURES AND REQUIREMENTS</b>				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS <sup>1)</sup> PERMISSIBLE CHANGE ( $\Delta R/R$ )
			stability for product types: <b>ACAS 0612</b>	100 $\Omega$ to 221 k $\Omega$
4.5	–	resistance	–	$\pm 0.25 \%$
4.8.4.2	–	temperature coefficient	at 20/LCT/ 20 °C and 20/UCT/20 °C	$\pm 25$ ppm/K
4.25.1	–	endurance	$U = \sqrt{P_{70} \times R}$ or $U = U_{\max}$ ; 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h	$\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.5 \% R + 0.05 \Omega)$
4.13	–	short time overload <sup>2)</sup>	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{\max}$ ; 5 s	$\pm (0.1 \% R + 0.01 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 min. at LCT and 30 min. at UCT; 5 cycles	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.18.2	58 (Tb)	resistance to soldering heat	reflow method 2 (IR/forced gas convention); (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.1 \% R + 0.01 \Omega)$ no visible damage
4.17.2	58 (Ta)	solderability	solder bath method; (215 $\pm$ 3) °C; (3 $\pm$ 0.3) s	good tinning ( $\geq 95 \%$ covered); no visible damage
4.32	21 (Ue <sub>3</sub> )	shear (adhesion)	RR 1632M; 45 N	no visible damage
4.7	–	voltage proof	$U_{\text{rms}} = U_{\text{ins}}$ ; 60 $\pm$ 5 s; against ambient, between adjacent resistors	no flashover or breakdown

**Notes**

- Figures are given for equal values.
- For a single element.

## Thick Film Array, Resistor/Capacitor



### FEATURES

- Single component reduces board space and component counts
- Choice of dielectric characteristics X7R or Y5U
- Wrap around termination
- Thick film R/C element
- Inner electrode protection
- Flow & Reflow solderable
- Automatic placement capability, standard size
- 8 or 10 pin configurations
- Lead (Pb)-free version is RoHS compliant



Available



RoHS\*  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS									
GLOBAL MODEL	RESISTOR				CAPACITOR				
	POWER RATING P <sub>70 °C</sub> W	TEMPERATURE COEFFICIENT ppm/°C	TOLERANCE %	VALUE RANGE Ω	DIELECTRIC	TEMPERATURE COEFFICIENT %	TOLERANCE %	VOLTAGE RATING VDC	VALUE RANGE pF
CRCA12E CRCA12S	0.125	200	5	10R - 1M0	X7R	± 15	20	50	10 - 270
CRCA12E CRCA12S	0.125	200	5	10R - 1M0	Y5U	+ 20, - 56	20	50	270 - 1800
<b>RESISTOR</b>					<b>CAPACITOR</b>				
<ul style="list-style-type: none"> <li>• Operating Temperature Range: X7R - 55 °C to + 125 °C</li> <li>• Technology: Thick Film</li> </ul>					<ul style="list-style-type: none"> <li>• Operating Temperature Range: X7R - 55 °C to + 125 °C Y5U - 30 °C to + 85 °C</li> <li>• Maximum Dissipation Factor: 2.5 %</li> <li>• Dielectric Withstanding Voltage: 125 V<sub>dc</sub>, 5 sec, 50 mA Charge</li> </ul>				

### Notes

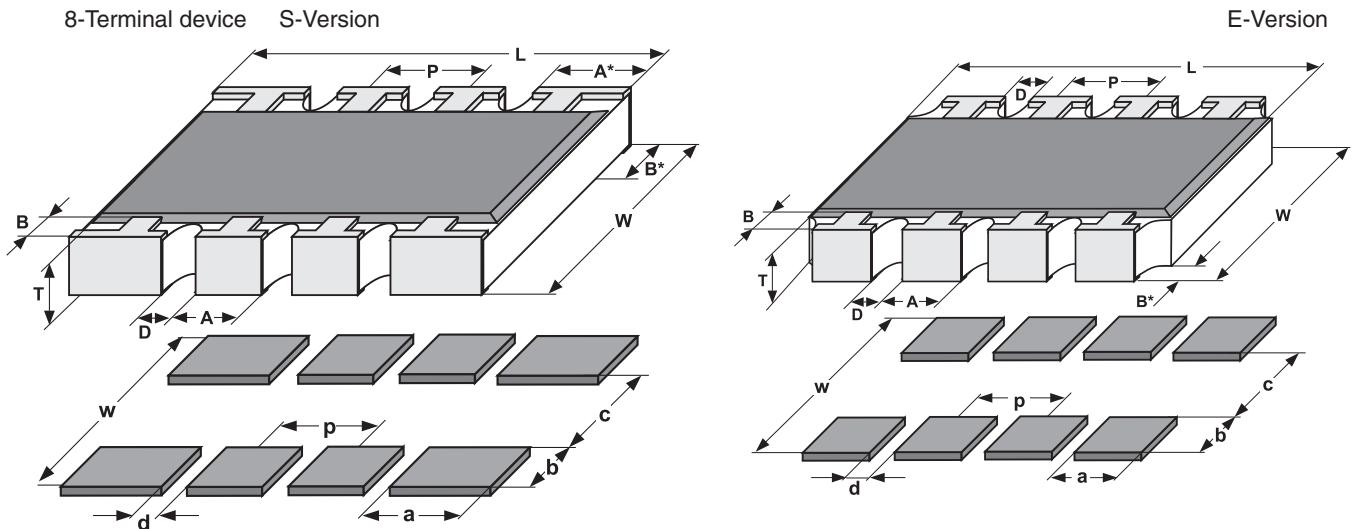
- Ask about extended value rangess
- Packaging: according to EIA 481
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material

TECHNICAL SPECIFICATIONS				
PARAMETER	UNIT	RESISTOR	X7R CAPACITOR	Y5U CAPACITOR
Rated Dissipation at 70 °C (CECC 40401   EIA 575)	W	0.125	-	-
Capacitor Voltage Rating	V	-	50	50
Dielectric Withstanding Voltage (5 sec, 50 mA Charge)	V <sub>dc</sub>	-	125	125
Category Temperature Range	°C	- 55/+ 155	- 55/+ 125	- 30/+ 85
Insulation Resistance	Ω	> 10 <sup>10</sup>		

GLOBAL PART NUMBER INFORMATION							
New Global Part Numbering: CRCA12E081472220R (preferred part numbering format)							
<div style="display: flex; justify-content: space-around; font-weight: bold; font-size: 1.2em;"> <span>C</span> <span>R</span> <span>C</span> <span>A</span> <span>1</span> <span>2</span> <span>E</span> <span>0</span> <span>8</span> <span>1</span> <span>4</span> <span>7</span> <span>2</span> <span>2</span> <span>2</span> <span>0</span> <span>R</span> <span> </span> </div>							
MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	CAPACITANCE VALUE	PACKAGING		SPECIAL
CRCA12E CRCA12S	08 = 8 Pin 10 = 10 Pin	1 = 01 2 = 02 3 = 03 0 = Special	2 digit significant figures, followed by a multiplier 100 = 10 Ω 683 = 68 kΩ 105 = 1.0 MΩ (Tolerance = ± 5 %)	2 digit significant figures, followed by multiplier 100 = 10 pF 271 = 270 pF 182 = 1800 pF (Tolerance = ± 20 %)	E = Lead (Pb)-free, T/R (2000 pcs) R = Tin/Lead, T/R (2000 pcs)		(Dash Number) (up to 1 digit) Blank = Standard
Historical Part Number example: CRCA12E0801472J220MRB8 (will continue to be accepted)							
CRCA12E	08	01	472	J	220	M	RB8
MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE	CAPACITANCE VALUE	TOLERANCE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**



GLOBAL MODEL	PIN NO#	SIZE		DIMENSIONS [in millimeters]								
		INCH	METRIC	L	W	T	B	B*	A	A*	D <sub>NOM</sub>	P <sub>NOM</sub>
CRCA12E	8	2012	5032	5.1 ± 0.15	3.05 ± 0.15	0.61 ± 0.10	0.51 ± 0.25	0.38 ± 0.2	0.79 ± 0.15	-	0.25	1.27
CRCA12S	8	2012	5032	5.1 ± 0.15	3.05 ± 0.15	0.61 ± 0.10	0.51 ± 0.25	0.38 ± 0.2	0.79 ± 0.15	0.89 ± 0.15	0.25	1.27
CRCA12E	10	2512	6432	6.4 ± 0.15	3.05 ± 0.15	0.61 ± 0.10	0.51 ± 0.25	0.38 ± 0.2	0.79 ± 0.15	-	0.25	1.27
CRCA12S	10	2512	6432	6.4 ± 0.15	3.05 ± 0.15	0.61 ± 0.10	0.51 ± 0.25	0.38 ± 0.2	0.79 ± 0.15	0.89 ± 0.15	0.25	1.27

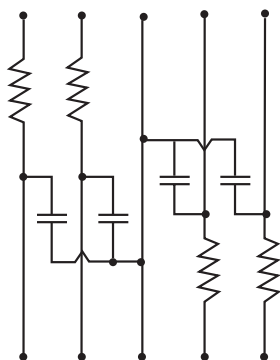
SOLDER PAD DIMENSIONS [in millimeters]											
WAVE SOLDERING						REFLOW SOLDERING					
c	w	d	p	a	b <sup>1)</sup>	c	w	d	p	a	b <sup>1)</sup>
2.2	4.3	0.57	1.27	0.71	1.05	2.2	3.9	0.57	1.27	0.71	0.86

**Note**

1. For layouts to accept both the edge type and pull through type terminations add 0.25 mm to the b-dimension and c = 1.7 mm

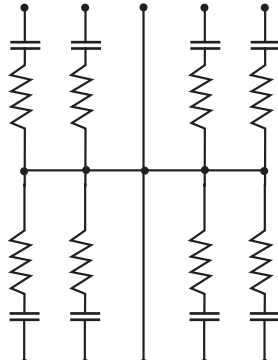
**PERFORMANCE:** see CRCC1206

01 Circuit CRCA12E & S



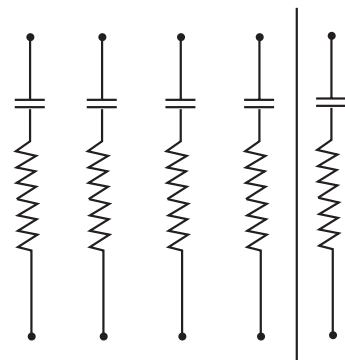
10 Pin only

02 Circuit CRCA12E & S



10 Pin only

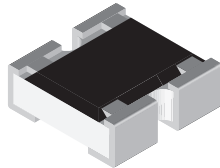
03 Circuit CRCA12E & S



8 Pin

10 Pin

## Surface Mount Chip Resistor Attenuator



### FEATURES

- Single component reduces board space and component counts - replaces 3 or more components
- Tolerance matching and temperature tracking superior to individual components
- Maximum power dissipation: 0.075 Watts for CZA06S; 0.040 Watts for CZA04S
- Consult factory for extended values, non-standard tolerances, impedance matching and other attenuation values
- Frequency range: DC to 3 GHz
- Lead (Pb)-free version is RoHS compliant



RoHS\*  
COMPLIANT

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	POWER RATING P <sub>70 °C</sub> W	IMPEDANCE Ω	ATTENUATION RANGE AND TOLERANCE	
			± 0.3 dB (L)	± 0.5 dB (H)
CZA04S	0.040	50	1 - 5 dB	6 - 20 dB
CZA06S	0.075	50/75/100/300/600	1 - 5 dB	6 - 20 dB

**Note**

- Power rating depends on the maximum temperature at the solder point, the component placement density and the substrate material

IMPEDANCE	50 Ω	75 Ω	100 Ω	300 Ω	600 Ω
1	1	1	1	1	1
1.5	1.5	1.5	1.5	1.5	1.5
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
10	10	10	10	10	10
11	11	11	11	11	11
12	12	12	12	12	12
13	13	13	13	13	13
14	14	14	14	14	14
15	15	15	15	15	15
16	16	16	16	16	16
17	17	17	17	17	17
18	18	18	18	18	18
19	19	19	19	19	19
20	20	20	20	20	20

Attenuation in dB

#### 4-PIN CIRCUIT

CZA04S:  
(Marking)

Unbalanced π Type

CZA06S:  
(Marking)

Unbalanced π Type

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	CZA04S	CZA06S
Rated Dissipation at 70 °C	W	0.040	0.075
VSWR		1.2 max.	1.2 max.
Category Temperature Range	°C	- 55/+ 125	- 55/+ 150
Frequency Range		DC to 3 GHz	DC to 3 GHz

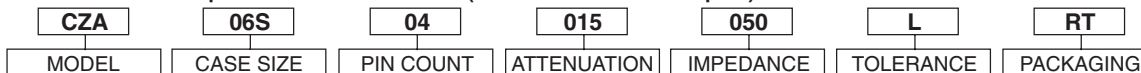
### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: CZA06S04015050LRT (preferred part numbering format)

C Z A 0 6 S 0 4 0 1 5 0 5 0 L R T

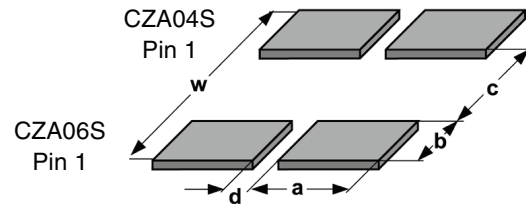
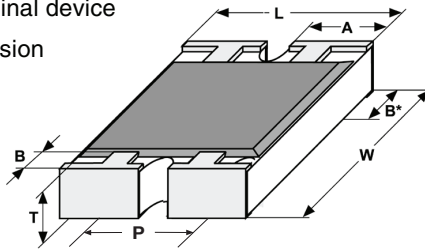
MODEL	PIN COUNT	ATTENUATION	IMPEDANCE	TOLERANCE	PACKAGING	SPECIAL
CZA04S CZA06S	04 = 4 Pin	010 = 1.0 dB 015 = 1.5 dB 020 = 2.0 dB 150 = 15.0 dB 000 = 0 Ω Jumper	050 = 50 Ω 075 = 75 Ω 100 = 100 Ω 000 = 0 Ω Jumper	H = ± 0.5 dB L = ± 0.3 dB Z = 0 Ω Jumper	EA = Lead (Pb)-free, T/R (All) TD = Tin/Lead, T/R (04 only) RT = Tin/Lead, T/R (06 only)	(Dash Number) (up to 1 digit) Blank = Standard

Historical Part Number example: CZA06S04015050LRT (will continue to be accepted)



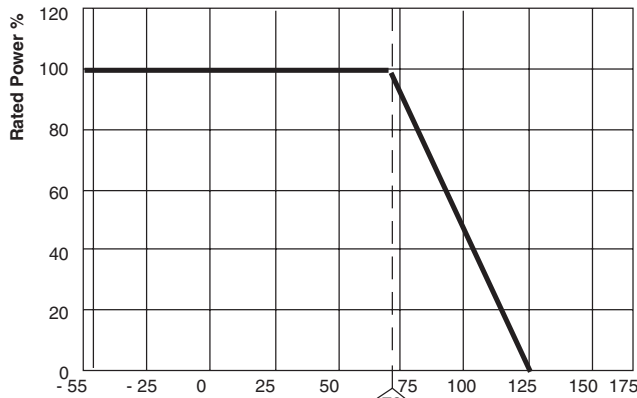
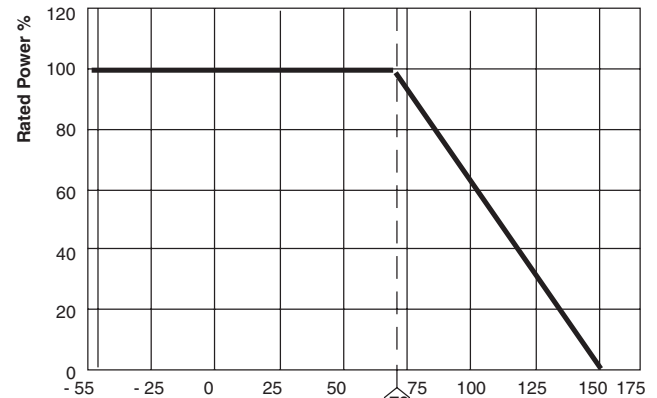
\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**

 4-Terminal device  
 S - Version


GLOBAL MODEL	DIMENSIONS in inches (millimeters)						
	L	W	T	A	P	B	B*
CZA04S	0.039 ± 0.004 [1.00 ± 0.10]	0.039 ± 0.006 [1.00 ± 1.15]	0.014 ± 0.004 [0.36 ± 0.10]	0.13 ± 0.006 [0.33 ± 0.15]	0.026 [0.65]	0.006 ± 0.004 [0.15 ± 0.10]	0.010 ± 0.004 [0.25 ± 0.10]
CZA06S	0.063 ± 0.006 [1.60 ± 0.15]	0.059 ± 0.006 [1.50 ± 1.15]	0.020 ± 0.004 [0.51 ± 0.10]	0.024 ± 0.006 [0.61 ± 0.15]	0.031 [0.80]	0.012 ± 0.006 [0.30 ± 0.15]	0.012 ± 0.006 [0.30 ± 0.15]

SOLDER PAD DIMENSIONS in inches (millimeters)					
	c	w	d	a	b
CZA04S	0.018 [0.45]	0.083 [2.10]	0.083 [0.20]	0.018 [0.45]	0.032 [0.82]
CZA06S	0.031 [0.80]	0.122 [3.10]	0.014 [0.36]	0.024 [0.63]	0.045 [1.15]


**Derating CZA04S**

**Derating CZA06S**

PERFORMANCE			
TEST	CONDITIONS OF TEST	TEST RESULTS	
		0.5 dB to 5 dB	6 dB to 20 dB
Endurance Test at 70 °C per EIA 575-3.14	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 0.2 dB	± 0.3 dB
Overload per EIA 575-3.6	Short time overload	± 0.2 dB	± 0.3 dB
Thermal Shock	per EIA 575-3.5	± 0.2 dB	± 0.3 dB
Moisture Resistance	per EIA 575-3.10	± 0.2 dB	± 0.3 dB
Resistance to Soldering Heat	10 seconds at 260 °C solder bath temperature EIA 575 3.8	± 0.2 dB	± 0.3 dB
High Temperature Exposure	per EIA 575-3.7	± 0.2 dB	± 0.3 dB
Low Temperature Operations	per EIA-575-3.6	± 0.2 dB	± 0.3 dB
Solderability & Leaching	EIA 575-3.12	95 % Coverage	







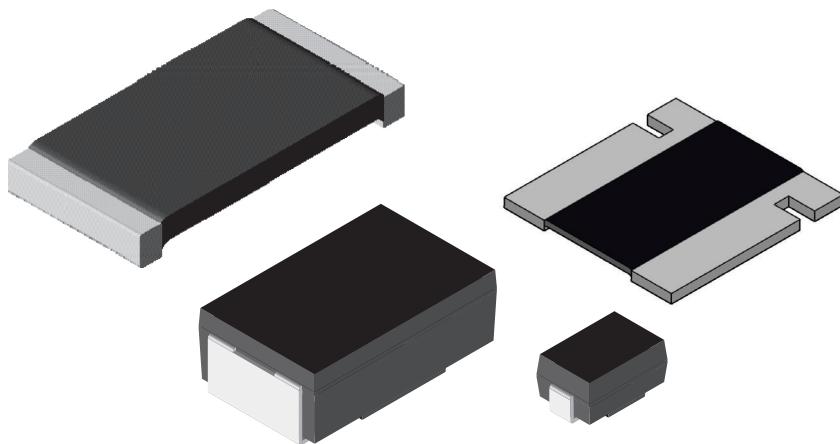
# Wirewound and Power Metal Strip<sup>®</sup> Resistors

High Power Dissipation

•  
Ohmic Values from 0.0002  $\Omega$  to 15 k $\Omega$

•  
Standard and Custom Package Sizes

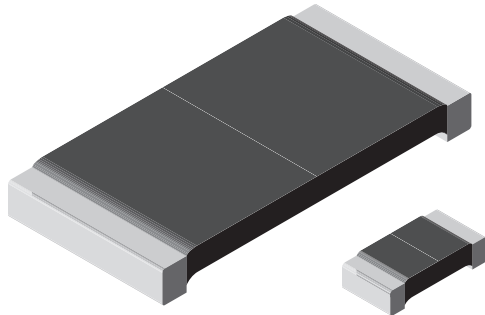
•  
High Temperature Coated or  
Molded Encapsulation



## Model Numbers

WSL .....	286
WSL High Power .....	288
WSLP1206 .....	290
WSLT2512 .....	292
WSL3637 .....	294
WSL3921 and WSL5931 .....	296
WSH2818 .....	298
WSE .....	300
WSL . . . E .....	302
WSK .....	304
WSR .....	306
WSR High Power .....	308
WSC, WSN .....	310
WSZ .....	312
CP002M .....	314
CPSM .....	316

# Power Metal Strip® Resistors, Low Value, Surface Mount



## FEATURES

- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-chrome or Manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Solderable terminations
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response
- Low thermal EMF
- Lead (Pb)-free version is RoHS compliant



RoHS\*  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS				
GLOBAL MODEL	POWER RATING $P_{70^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$		WEIGHT (typical) g/1000 pcs
		$\pm 0.5\%$	$\pm 1.0\%$	
WSL0603	0.1	0.015 - 0.1	0.015 - 0.1	1.9
WSL0805	0.125	0.01 - 0.2	0.01 - 0.2	4.8
WSL1206	0.25	0.01 - 0.2	0.002 - 0.2	16.2
WSL2010	0.5	0.01 - 0.5	0.001 - 0.5	38.9
WSL2512	1.0 <sup>1)</sup>	0.01 - 0.5	0.001 - 0.5	63.6
WSL2816	2.0	0.01 - 0.10	0.01 - 0.10	118

### Notes

1. For values above 0.1  $\Omega$  derate linearly to 80 % rated power at 0.5  $\Omega$
- Part Marking: DALE, Value, Tolerance: due to resistor size limitations some resistors will be marked with only the resistance value

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSL RESISTOR CHARACTERISTICS
Temperature Coefficient	ppm/°C	$\pm 275$ for 1 m $\Omega$ to 2.9 m $\Omega$ , $\pm 150$ for 3 m $\Omega$ to 4.9 m $\Omega$ $\pm 110$ for 5 m $\Omega$ to 6.9 m $\Omega$ , $\pm 75$ for 7 m $\Omega$ to 0.5 $\Omega$
Operating Temperature Range	°C	- 65/+ 170
Maximum Working Voltage	V	$(P \times R)^{1/2}$

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: WSL25124L000FEA (preferred part numbering format)

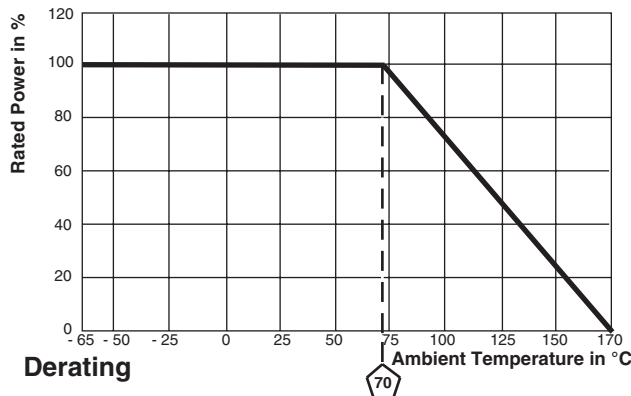
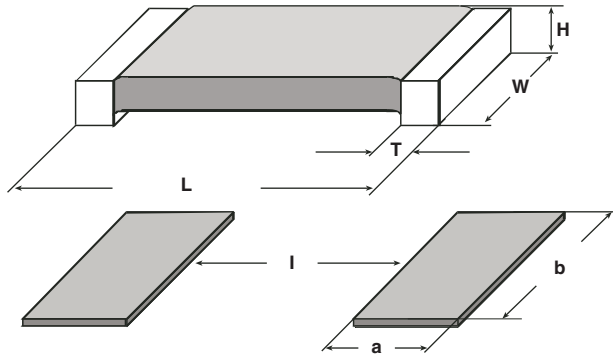
W	S	L	2	5	1	2	4	L	0	0	0	F	E	A		
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GLOBAL MODE	VALUE	TOLERANCE CODE	PACKAGING	SPECIAL
(See Standard Electrical Specifications, Global Model, for more options)	L = Milliohm* R = Decimal 4L000 = 0.004 $\Omega$ R0100 = 0.01 $\Omega$ * use "L" for resistance values < 0.01 $\Omega$	D = $\pm 0.5\%$ F = $\pm 1.0\%$ J = $\pm 5.0\%$	EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk TA = Tin/Lead, Tape/Reel (R86) TG = Tin/Lead, Tape/Reel (RT1) BA = Tin/Lead, Bulk (B43)	(Dash Number) (up to 2 digits) From 1-99 as applicable

Historical Part Number example: WSL2512 0.004  $\Omega$  1% EA (will continue to be accepted)

WSL2512	0.004 $\Omega$	1%	EA
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**


MODEL	DIMENSIONS in inches [millimeters]				
	RESISTANCE RANGE Ω	L	W	H	T
WSL0603	0.015 - 0.1	0.060 ± 0.010 [1.52 ± 0.254]	0.030 ± 0.010 [0.76 ± 0.254]	0.013 ± 0.005 [0.330 ± 0.127]	0.015 ± 0.010 [0.381 ± 0.254]
WSL0805	0.01 - 0.2	0.080 ± 0.010 [2.03 ± 0.254]	0.050 ± 0.010 [1.27 ± 0.254]	0.013 ± 0.005 [0.330 ± 0.127]	0.015 ± 0.010 [0.381 ± 0.254]
WSL1206	0.002 - 0.2	0.126 ± 0.010 [3.20 ± 0.254]	0.063 ± 0.010 [1.60 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.020 ± 0.010 [0.508 ± 0.254]
WSL2010	0.001 - 0.0069	0.200 ± 0.010 [5.08 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.058 ± 0.010 [1.47 ± 0.254]
	0.007 - 0.5	0.200 ± 0.010 [5.08 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.020 ± 0.010 [0.508 ± 0.254]
WSL2512	0.001 - 0.0049	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.087 ± 0.010 [2.21 ± 0.254]
	0.005 - 0.0069	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.047 ± 0.010 [1.19 ± 0.254]
	0.007 - 0.5	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.030 ± 0.010 [0.762 ± 0.254]
WSL2816	0.01 - 0.1	0.280 ± 0.010 [7.1 ± 0.254]	0.165 ± 0.010 [4.2 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.062 ± 0.010 [1.57 ± 0.254]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]			
	RESISTANCE RANGE Ω	a	b	l
WSL0603	0.015 - 0.1	0.040 [1.01]	0.040 [1.01]	0.020 [0.50]
WSL0805	0.01 - 0.2	0.040 [1.02]	0.050 [1.27]	0.020 [0.50]
WSL1206	0.002 - 0.2	0.050 [1.27]	0.070 [1.78]	0.055 [1.40]
WSL2010	0.001 - 0.0069	0.093 [2.36]	0.120 [3.05]	0.055 [1.40]
	0.007 - 0.5	0.055 [1.40]	0.120 [3.05]	0.130 [3.30]
WSL2512	0.001 - 0.0049	0.120 [3.05]	0.145 [3.68]	0.050 [1.27]
	0.005 - 0.0069	0.083 [2.11]	0.145 [3.68]	0.125 [3.18]
	0.007 - 0.5	0.065 [1.65]	0.145 [3.68]	0.160 [4.06]
WSL2816	0.01 - 0.1	0.130 [3.3]	0.190 [4.8]	0.040 [1.00]

**PERFORMANCE**

TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.5 % + 0.0005 Ω) ΔR
Low Temperature Operation	- 65 °C for 24 hours	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 170 °C	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 Ω) ΔR

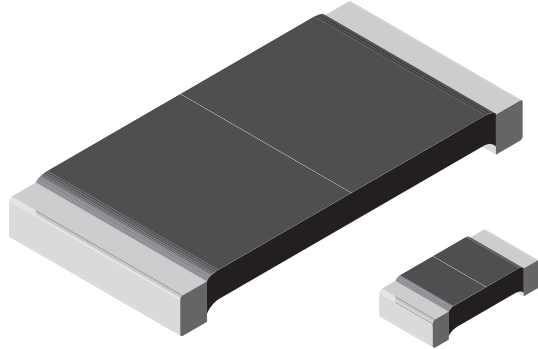
**PACKAGING**

MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSL0603	8 mm/Punched Paper	178 mm/7"	5000	EA
WSL0805	8 mm/Punched Paper	178 mm/7"	5000	EA
WSL1206	8 mm/Embossed Plastic	178 mm/7"	4000	EA
WSL2010	12 mm/Embossed Plastic	178 mm/7"	4000	EA
WSL2512	12 mm/Embossed Plastic	178 mm/7"	2000	EA
WSL2816	16 mm/Embossed Plastic	330 mm/13"	5000	EA

**Note**

- Embossed carrier tape per EIA-481-1A

## Power Metal Strip® Resistors, High Power, Low Value, Surface Mount



### FEATURES

- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- Specially selected and stabilized materials allow for high power rating
- All welded construction
- Solid metal Nickel-chrome or Manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Solderable terminations
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response
- Low thermal EMF
- Lead (Pb)-free version is RoHS compliant



RoHS\* COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS					
GLOBAL MODEL	HISTORICAL MODEL	POWER RATING $P_{70^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$		WEIGHT (typical) g/1000 pcs
			$\pm 0.5\%$	$\pm 1.0\%$	
WSL0805...18	WSL0805-18	0.25	0.01 - 0.2	0.01 - 0.2	4.8
WSL1206...18	WSL1206-18	0.5	0.01 - 0.2	0.002 - 0.2	16.2
WSL2010...18	WSL2010-18	1.0	0.01 - 0.5	0.001 - 0.5	38.9
WSL2512...18	WSL2512-18	2.0	0.01	0.001 - 0.01	63.6

**Note**

- Part Marking: DALE, Value, Tolerance: due to resistor size limitations some resistors will be marked with only the resistance value

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSL RESISTOR CHARACTERISTICS
Temperature Coefficient	ppm/°C	$\pm 275$ for 1 m $\Omega$ to 2.9 m $\Omega$ , $\pm 150$ for 3 m $\Omega$ to 4.9 m $\Omega$ $\pm 110$ for 5 m $\Omega$ to 6.9 m $\Omega$ , $\pm 75$ for 7 m $\Omega$ to 0.5 $\Omega$
Operating Temperature Range	°C	- 65/+ 170
Maximum Working Voltage	V	$(P \times R)^{1/2}$

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: WSL25124L000FEA18 (preferred part numbering format)

W	S	L	2	5	1	2	4	L	0	0	0	F	E	A	1	8
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<b>GLOBAL MODEL</b> (See Standard Electrical Specifications, Global Model, for options).	<b>VALUE</b> L = Miliohm* R = Decimal 4L000 = 0.004 $\Omega$ R0100 = 0.01 $\Omega$ * use "L" for resistance values < 0.01 $\Omega$	<b>TOLERANCE CODE</b> D = $\pm 0.5\%$ F = $\pm 1.0\%$ J = $\pm 5.0\%$	<b>PACKAGING</b> EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk TA = Tin/Lead, Tape/Reel (R86) TG = Tin/Lead, Tape/Reel (RT1) BA = Tin/Lead, Bulk (B43)	<b>SPECIAL</b> 18 = "High Power" option
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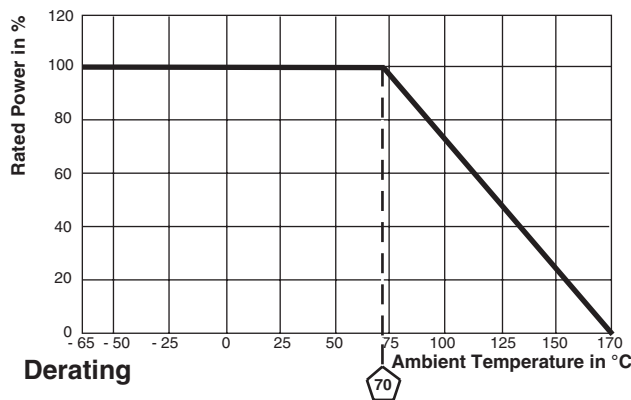
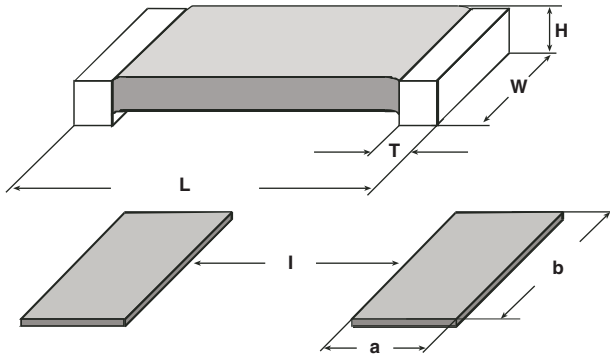
Historical Part Number example: WSL2512-18 0.004  $\Omega$  1% EA (will continue to be accepted)

WSL2512-18	0.004 $\Omega$	1%	EA
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply



**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	RESISTANCE RANGE Ω	L	W	H	T
WSL0805-18	0.01 - 0.2	0.080 ± 0.010 [2.03 ± 0.254]	0.050 ± 0.010 [1.27 ± 0.254]	0.013 ± 0.005 [0.330 ± 0.127]	0.015 ± 0.010 [0.381 ± 0.254]
	0.002 - 0.2	0.126 ± 0.010 [3.20 ± 0.254]	0.063 ± 0.010 [1.60 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.020 ± 0.010 [0.508 ± 0.254]
WSL2010-18	0.001 - 0.0069	0.200 ± 0.010 [5.08 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.058 ± 0.010 [1.47 ± 0.254]
	0.007 - 0.5	0.200 ± 0.010 [5.08 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.020 ± 0.010 [0.508 ± 0.254]
WSL2512-18	0.001 - 0.0049	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.087 ± 0.010 [2.21 ± 0.254]
	0.005 - 0.0069	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.047 ± 0.010 [1.19 ± 0.254]
	0.007 - 0.01	0.250 ± 0.010 [6.35 ± 0.254]	0.125 ± 0.010 [3.18 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.030 ± 0.010 [0.762 ± 0.254]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]			
	RESISTANCE RANGE Ω	a	b	l
WSL0805-18	0.01 - 0.2	0.040 [1.02]	0.050 [1.27]	0.020 [0.50]
WSL1206-18	0.002 - 0.2	0.050 [1.27]	0.070 [1.78]	0.055 [1.40]
WSL2010-18	0.001 - 0.0069	0.093 [2.36]	0.120 [3.05]	0.055 [1.40]
	0.007 - 0.5	0.055 [1.40]	0.120 [3.05]	0.130 [3.30]
WSL2512-18	0.001 - 0.0049	0.120 [3.05]	0.145 [3.68]	0.050 [1.27]
	0.005 - 0.0069	0.083 [2.11]	0.145 [3.68]	0.125 [3.18]
	0.007 - 0.01	0.065 [1.65]	0.145 [3.68]	0.160 [4.06]

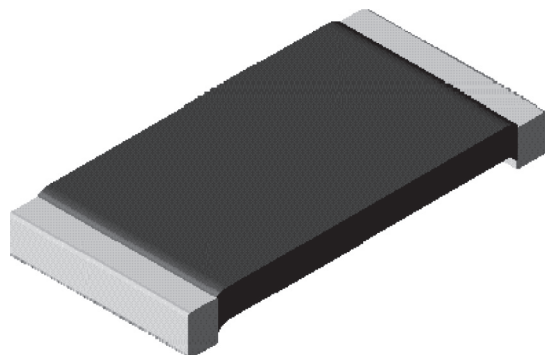
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.5 % + 0.0005 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 170 °C	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 Ω) ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSL0805-18	8 mm/Punched Paper	178 mm/7"	5000	EA
WSL1206-18	8 mm/Embossed Plastic	178 mm/7"	4000	EA
WSL2010-18	12 mm/Embossed Plastic	178 mm/7"	4000	EA
WSL2512-18	12 mm/Embossed Plastic	178 mm/7"	2000	EA

**Note**

- Embossed carrier tape per EIA-481-1A

## Power Metal Strip® Resistors, Very High Power (1 W) Low Value (down to 0.001 Ω), Surface Mount



### FEATURES

- Very high power to foot print size ratio (1 W in 1206 package)
- Ideal for all types of current sensing and pulse applications including switching and linear power supplies, instruments, power amplifiers and shunts
- Proprietary processing technique produces extremely low resistance values (down to 0.001 Ω)
- All welded construction
- Solid metal Nickel-chrome or Manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response to 50 MHz
- Low thermal EMF (< 3 μV/°C)



**RoHS**  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS				
GLOBAL MODEL	POWER RATING $P_{70^{\circ}\text{C}}$ W	RESISTANCE RANGE Ω		WEIGHT (typical) g/1000 pcs
		± 0.5 %	± 1.0 %	
WSLP1206	1.0	0.01 - 0.05	0.002 - 0.05	16.2

**Note**

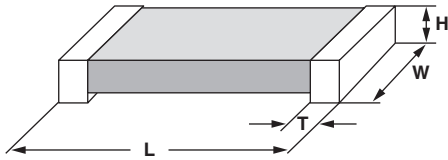
- Part Marking: Value

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSLP1206
Temperature Coefficient	ppm/°C	± 75
Operating temperature range	°C	- 65/+ 170
Maximum Working Voltage	V	$(P \times R)^{1/2}$

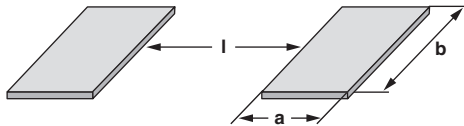
GLOBAL PART NUMBER INFORMATION																	
New Global Part Numbering: WSLP1206R0100FEA																	
W	S	L	P	1	2	0	6	R	0	1	0	0	F	E	A		
GLOBAL MODEL		RESISTANCE VALUE				TOLERANCE CODE		PACKAGING CODE				SPECIAL					
WSLP1206		L = Milliohm* R = Decimal 4L000 = 0.004 Ω R0100 = 0.01 Ω  * use "L" for resistance values < 0.01 Ω				D = ± 0.5 % F = ± 1.0 %		EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk				Reserved for future specials					



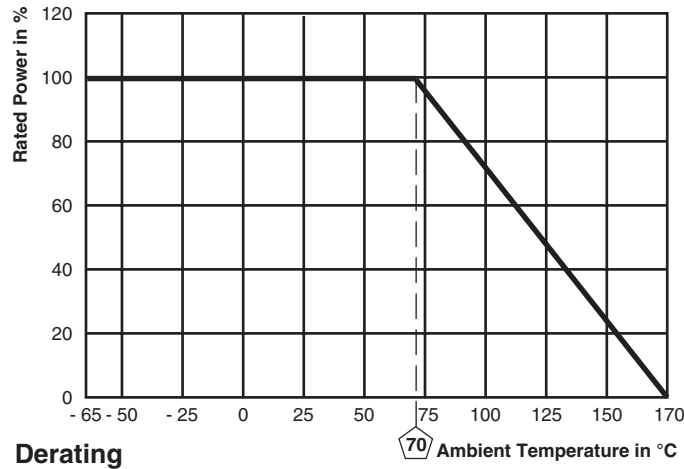
**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]			
	L	W	H	T
WSLP1206	0126 ± 0.010	0.063 ± 0.010	0.025 ± 0.010	0.020 ± 0.010
	[3.20 ± 0.254]	[1.60 ± 0.254]	[0.635 ± 0.254]	[0.508 ± 0.254]



MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSLP1206	0.062	0.070	0.030
	[1.57]	[1.78]	[0.76]



PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 Ω) ΔR
Low Temperature Operation	- 65 °C for 45 minutes	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 170 °C	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at 70 °C, 1.5 hrs "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7b not required	± (0.5 % + 0.0005 Ω) ΔR

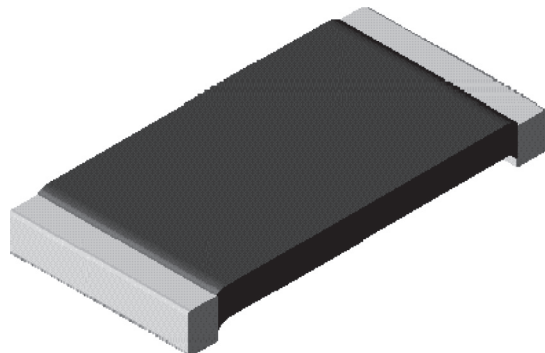
PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSLP1206	8 mm/Embossed Plastic	178 mm/7"	4000	EA

**Note**

- Embossed Carrier Tape per EIA-481-2



## Power Metal Strip<sup>®</sup> Resistors, High Temperature (275 °C) Low Value (down to 0.01 Ω), Surface Mount



### FEATURES

- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments and power amplifiers
- Proprietary processing technique produces extremely low resistance values
- Specially selected and stabilized materials allow for high temperature derating (to + 275 °C)
- All welded construction
- Solid metal Nickel-Chrome alloy resistive element with low TCR (< 20 ppm/°C)
- Very low inductance (< 5 nH)
- Excellent frequency response to 50 MHz
- Low thermal EMF (< 3 μV/°C)



**RoHS**  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS				
GLOBAL MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$		WEIGHT (Typical) g/1000 pcs
		$\pm 0.5\%$	$\pm 1.0\%$	
WSLT2512	1.0	0.01 - 0.50	0.01 - 0.50	63.6

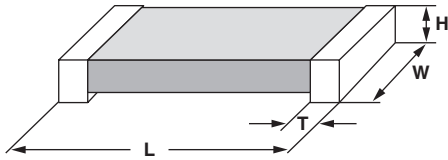
• Part Marking: DALE, Value, Tolerance Code

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSLT2512
Temperature Coefficient	ppm/°C	$\pm 75$
Inductance	nH	< 5
Operating temperature range	°C	- 65/+ 275
Max. Continuous Current	A	$(P/R)^{1/2}$

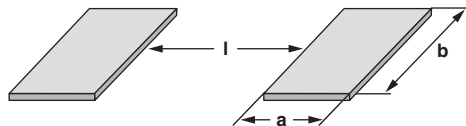
GLOBAL PART NUMBER INFORMATION																	
New Global Part Numbering: WSLT2512R0100FEA																	
W	S	L	T	2	5	1	2	R	0	1	0	0	F	E	A		
GLOBAL MODEL		RESISTANCE VALUE				TOLERANCE CODE		PACKAGING CODE				SPECIAL					
WSLT2512		L = Milliohm* R = Decimal 4L000 = 0.004 Ω R0100 = 0.01 Ω  * use "L" for resistance values < 0.01 Ω				D = $\pm 0.5\%$ F = $\pm 1.0\%$		EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk				Reserved for future specials					



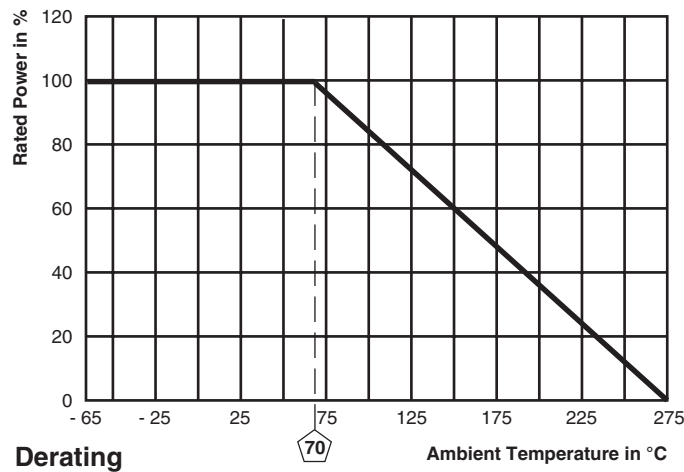
**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]			
	L	W	H	T
WSLT2512	0.250 ± 0.010	0.125 ± 0.010	0.025 ± 0.010	0.030 ± 0.010
	[6.35 ± 0.254]	[3.18 ± 0.254]	[0.635 ± 0.254]	[0.762 ± 0.254]



MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSLT2512	0.083	0.145	0.160
	[1.65]	[3.68]	[4.06]



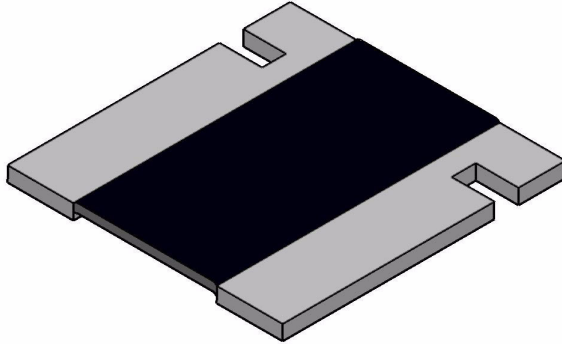
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± 0.5 % ΔR
Short Time Overload	5 × rated power for 5 seconds	± 0.5 % ΔR
Low Temperature Operation	- 65 °C for 45 minutes	± 0.5 % ΔR
High Temperature Exposure	1000 hours at + 275 °C	± 1.0 % ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± 0.5 % ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± 0.5 % ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± 0.5 % ΔR
Load Life at 70 °C	1000 hours, 1.5 hrs "ON", 0.5 hours "OFF"	± 1.0 % ΔR
Load Life at 150 °C	1000 hours, 1.5 hrs "ON", 0.5 hours "OFF"	± 1.0 % ΔR
Resistance to Solder Heat	260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± 0.5 % ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7b not required	± 1.0 % ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSLT2512	12 mm/Embossed Plastic	178 mm/7"	2000	EA

**Note**

- Embossed Carrier Tape per EIA-481-2

## Power Metal Strip® Resistors, Low Value, Surface Mount, 4-Terminal



### FEATURES

- 4-Terminal design allows for 0.5 % resistance tolerance down to 0.003 Ω
- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments and power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-chrome alloy resistive element
- Solderable terminations
- Encapsulated with a high temperature coating
- Very low inductance, 0.5 nH to 5 nH
- Excellent frequency response
- Lead (Pb)-free version is RoHS compliant



RoHS\* COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS			
GLOBAL MODEL	POWER RATING $P_{70} \text{ } ^\circ\text{C}$ W	TOLERANCE %	RESISTANCE RANGE Ω
WSL3637	3.0	0.5 & 1.0	0.001 - 0.01

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSL3637
Temperature Coefficient	ppm/°C	0.001 Ω - 0.0299 Ω = ± 75 0.003 Ω - 0.010 Ω = ± 50
Operating Temperature Range	°C	- 65/+ 170
Maximum Working Voltage	V	$(P \times R)^{1/2}$
Weight/1000 pcs	g	274.3

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: WSL36375L000FEA (preferred part numbering format)

W	S	L	3	6	3	7	5	L	0	0	0	F	E	A		
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<b>GLOBAL MODEL</b> WSL3637	<b>VALUE</b> L = Miliohm R = Decimal 5L000 = 0.005 Ω R0100 = 0.01 Ω	<b>TOLERANCE</b> D = ± 0.5 % F = ± 1.0 %	<b>PACKAGING</b> EA = Lead (Pb)-free, tape/reel EK = Lead (Pb)-free, Bulk TA = Tin/Lead, tape/reel (R86) BA = Tin/Lead, bulk (B43)	<b>SPECIAL</b> (Dash Number) (up to 2 digits) From 1-99 as applicable
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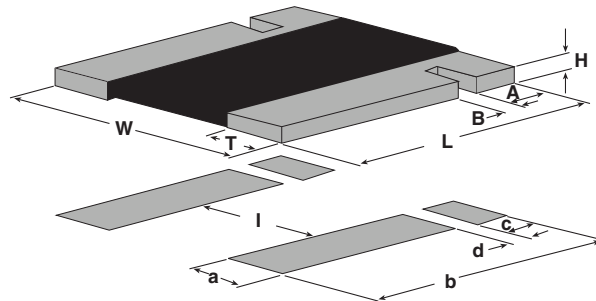
Historical Part Number example: WSL3637 0.005 Ω 1 % EA (will continue to be accepted)

WSL3637	0.005 Ω	1 %	EA
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

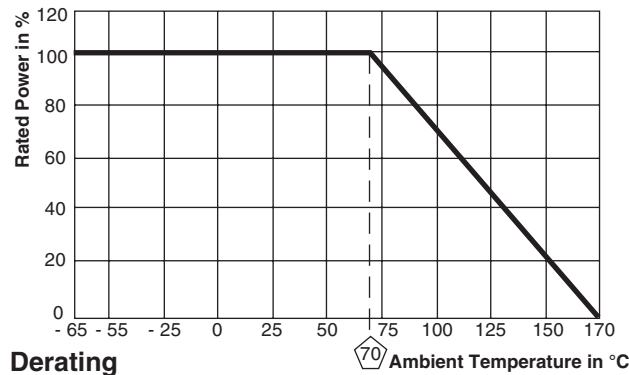
\* Pb containing terminations are not RoHS compliant, exemptions may apply

**Power Metal Strip® Resistors, Low Value,  
Surface Mount, 4-Terminal**

Vishay Dale

**DIMENSIONS**


MODEL	DIMENSIONS in inches [millimeters]						
	RESISTANCE RANGE $\Omega$	L	W	H	T	A	B
WSL3637	0.002 - 0.01	0.370 ± 0.010 [9.40 ± 0.254]	0.360 ± 0.010 [9.14 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.086 ± 0.010 [2.18 ± 0.254]	0.061 ± 0.010 [1.55 ± 0.254]	0.032 ± 0.010 [0.813 ± 0.254]
	0.001 - 0.0019	0.370 ± 0.010 [9.40 ± 0.254]	0.360 ± 0.010 [9.14 ± 0.254]	0.025 ± 0.010 [0.635 ± 0.254]	0.138 ± 0.010 [3.51 ± 0.254]	0.061 ± 0.010 [1.55 ± 0.254]	0.032 ± 0.010 [0.813 ± 0.254]



MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]					
	RESISTANCE RANGE $\Omega$	a	b	c	d	l
WSL3637	0.002 - 0.01	0.116 [2.95]	0.366 [9.30]	0.066 [1.68]	0.024 [0.610]	0.178 [4.52]
	0.001 - 0.0019	0.168 [4.27]	0.366 [9.30]	0.066 [1.66]	0.024 [0.610]	0.074 [1.88]

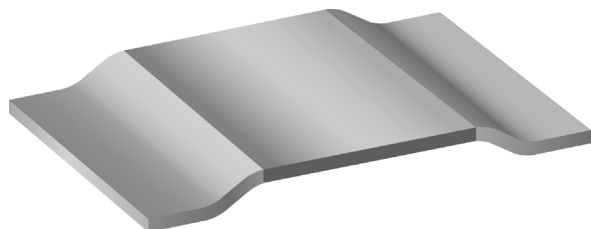
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Short Time Overload	5 x Rated Power for 5 seconds	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Low Temperature Storage	- 65 °C for 24 hours	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
High Temperature Exposure	1000 hours at + 170 °C	± (1.0 % + 0.0005 $\Omega$ ) $\Delta R$
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Vibration	Frequency varied 10 to 2000 Hz in 1 minute, 3 directions, 12 hours	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 $\Omega$ ) $\Delta R$
Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 $\Omega$ ) $\Delta R$

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSL3637	16 mm/Embossed Plastic	330 mm/13"	4000	EA

**Note**

- Embossed carrier tape per EIA-481-2

## Power Metal Strip® Resistors, Low Value (down to 0.0002 Ω), Surface Mount



### FEATURES

- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values, down to 0.0002 Ω
- All welded construction
- Solid metal Iron-chrome or Manganese-copper alloy resistive element
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response to 50 MHz
- Low thermal EMF (< 3 μV/°C)
- 100 % lead (Pb)-free and RoHS compliant



**RoHS**  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS				
GLOBAL MODEL	POWER RATING <i>P</i> <sub>70 °C</sub> W	TOLERANCE %	RESISTANCE VALUES AVAILABLE mΩ	WEIGHT (typical) g/1000 pcs
WSL3921	3.0	1.0 & 5.0	0.3, 0.5, 1, 2, 3, 4	281
WSL5931	5.0	1.0 & 5.0	0.2, 0.3, 0.5, 1, 2, 3	398

**Note**

- Part Marking: no part marking on these parts

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSL RESISTOR CHARACTERISTICS
Temperature Coefficient	ppm/°C	± 225 for 0.2 mΩ, ± 175 for 0.3 mΩ and 0.5 mΩ, ± 75 for 1 mΩ to 4 mΩ
Operating Temperature Range	°C	- 65/+ 170
Maximum Working Voltage	V	( <i>P</i> × <i>R</i> ) <sup>1/2</sup>

GLOBAL PART NUMBER INFORMATION																
Global Part Numbering: WSL3921L5000FEA																
W	S	L	3	9	2	1	L	5	0	0	0	F	E	A		
GLOBAL MODEL WSL3921 WSL5931		RESISTANCE VALUE L = Milliohm L5000 = 0.0005 Ω			TOLERANCE CODE F = ± 1.0 % J = ± 5.0 %			PACKAGING CODE EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk				SPECIAL (Dash Number) (up to 2 digits) From 1-99 as applicable				

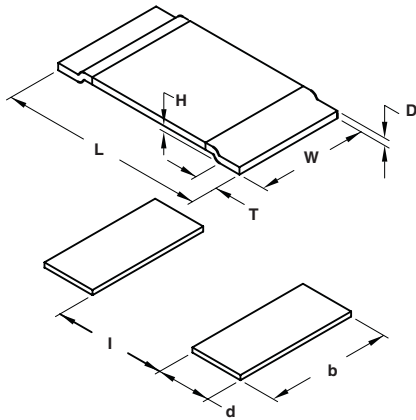


# WSL3921 and WSL5931

Power Metal Strip® Resistors,  
Low Value (down to 0.0002 Ω), Surface Mount

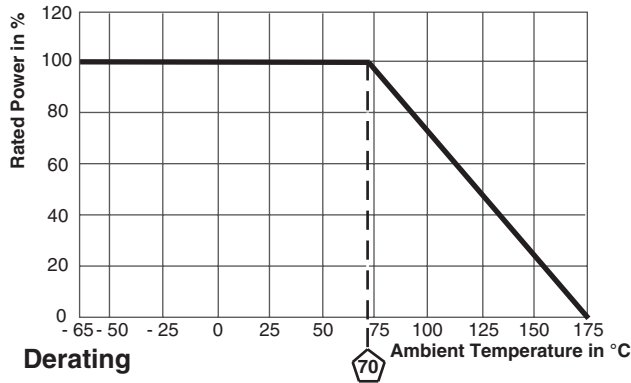
Vishay Dale

## DIMENSIONS



MODEL	DIMENSIONS in inches [millimeters]			
	L	W	H	T
WSL3921	0.394 ± 0.010 [10.0 ± 0.254]	0.205 ± 0.010 [5.20 ± 0.254]	0.020 [0.5]	0.080 ± 0.010 [2.00 ± 0.254]
WSL5931	0.591 ± 0.010 [15.0 ± 0.254]	0.305 ± 0.010 [7.75 ± 0.254]	0.020 [0.5]	0.157 ± 0.010 [4.00 ± 0.254]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	d	b	l
WSL3921	0.106 ± 0.010 [2.70 ± 0.254]	0.244 ± 0.010 [6.20 ± 0.254]	0.220 ± 0.005 [5.60 ± 0.13]
WSL5931	0.205 ± 0.010 [5.20 ± 0.254]	0.344 ± 0.010 [8.75 ± 0.254]	0.220 ± 0.005 [5.60 ± 0.13]



GLOBAL MODEL	RESISTANCE VALUE mΩ	"D" THICKNESS	ELEMENT MATERIAL
WSL3921	0.3	0.0510	Mn-Cu
WSL3921	0.5	0.0300	Mn-Cu
WSL3921	1.0	0.0150	Mn-Cu
WSL3921	2.0	0.0270	Fe-Cr
WSL3921	3.0	0.0170	Fe-Cr
WSL3921	4.0	0.0130	Fe-Cr
WSL5931	0.2	0.0485	Mn-Cu
WSL5931	0.3	0.0300	Mn-Cu
WSL5931	0.5	0.0180	Mn-Cu
WSL5931	1.0	0.0330	Fe-Cr
WSL5931	2.0	0.0155	Fe-Cr
WSL5931	3.0	0.0105	Fe-Cr

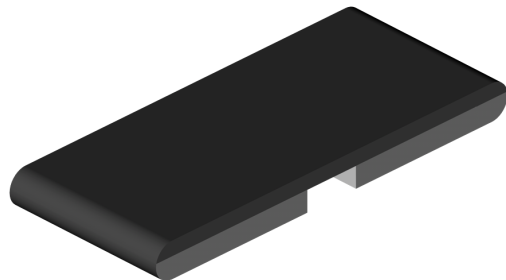
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (1.0 % + 0.0005 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.5 % + 0.0005 Ω) ΔR
Low Temperature Storage	- 65 °C for 45 Min.	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 175 °C	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 Ω) ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSL3921	16 mm/Embossed Plastic	330 mm/13"	3000	EA
WSL5931	16 mm/Embossed Plastic	330 mm/13"	1500	EA

### Note

- Embossed carrier tape per EIA-481-1A

## Power Metal Strip<sup>®</sup> Resistors, High Power (5 watt) Low Value (down to 0.001 Ω), Surface Mount



### FEATURES

- Improved thermal management incorporated into design
- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-chrome or Manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Lead (Pb)-free construction
- Very low inductance (< 5 nH)
- Excellent frequency response to 50 MHz
- Low thermal EMF (< 3 μV/°C)



**RoHS**  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS			
GLOBAL MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	TOLERANCE %	RESISTANCE RANGE Ω
WSH2818	5 <sup>1)</sup>	1.0	0.001 - 0.1

**Note**

1. The WSH2818 is rated at 5 watts with maximum surface temperature of 200 °C

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSH2818
Temperature Coefficient	ppm/°C	± 200 for 1 mΩ to 5.99 mΩ ± 75 for 6 mΩ to 100 mΩ
Inductance	ηH	< 5
Operating Temperature Range	°C	- 65/+ 170
Maximum Continuous Current	A	$(P/R)^{1/2}$
Weight/1000 pieces	g	126

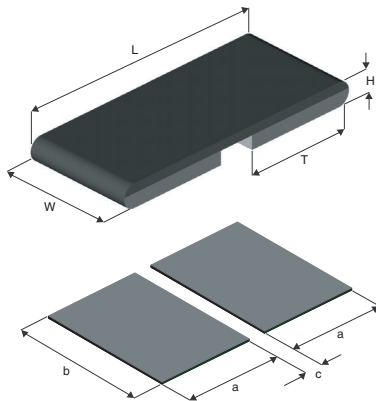
GLOBAL PART NUMBER INFORMATION																
Global Part Numbering: WSH2818R1000FEA																
W	S	H	2	8	1	8	R	1	0	0	0	F	E	A		
GLOBAL MODEL			RESISTANCE VALUE			TOLERANCE CODE		PACKAGING CODE			SPECIAL					
WSH2818			L = Milliohm* R = Decimal 4L000 = 0.004 Ω R0100 = 0.01 Ω  * use "L" for resistance values < 0.01 Ω			F = ± 1.0 % J = ± 5.0 %		EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk			(Dash number up to 2 digits) From 1 - 99 as applicable					



**Power Metal Strip® Resistors, High Power (5 watt)  
Low Value (down to 0.001 Ω), Surface Mount**

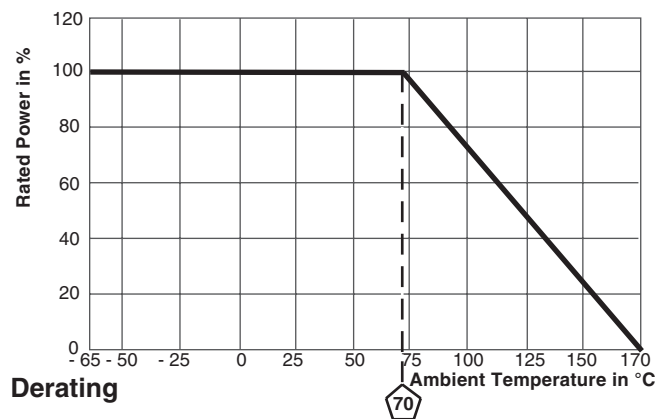
Vishay Dale

**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	RESISTANCE RANGE Ω	L	W	H	T
WSH2818	0.006 - 0.1	0.280 ± 0.010 [7.1 ± 0.25]	0.180 ± 0.010 [4.6 ± 0.25]	0.032 ± 0.010 [0.813 ± 0.25]	0.125 ± 0.010 [3.18 ± 0.25]
	0.001 - 0.0059	0.280 ± 0.010 [7.1 ± 0.25]	0.180 ± 0.010 [4.6 ± 0.25]	0.045 ± 0.010 [1.143 ± 0.25]	0.125 ± 0.010 [3.18 ± 0.25]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	c
WSH2818	0.138 [3.5]	0.200 [5.1]	0.024 [0.61]



PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± 0.5 % ΔR
Short Time Overload	4 x rated power for 5 seconds	± 1.0 % ΔR
Low Temperature Operation	- 65 °C for 45 minutes	± 0.5 % ΔR
High Temperature Exposure	1000 hours at + 170 °C	± 1.0 % ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± 0.5 % ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± 0.5 % ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± 0.5 % ΔR
Load Life	1000 hours at + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 1.0 % ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± 0.5 % ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7b not required	± 0.5 % ΔR

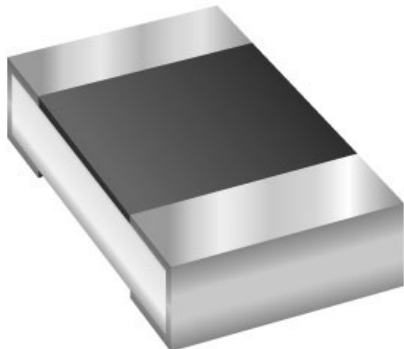
PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSH2818	16 mm/Embossed Plastic	330 mm/13"	3500	EA

**Note**

- Embossed carrier tape per EIA-481-2



## Power Metal Strip® Resistors (Extended Range) Surface Mount



### FEATURES

- 0805 size resistors with 0.25 watt power rating
- Smaller footprint than a 1206 resistor (uses 40 % less board space)
- Superior overload and pulse handling capability
- SMD alternative for low power leaded wirewound resistors
- Low TCR 15 ppm/°C
- Low noise: < - 40 dB
- Voltage Coefficient: < 0.00001 %/volt (< 0.1 ppm/V)
- Very low inductance: < 0.08 μH

### STANDARD ELECTRICAL SPECIFICATIONS

MODEL	SIZE	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	LIMITING ELEMENT VOLTAGE V	TEMPERATURE COEFFICIENT ppm/°K	RESISTANCE RANGE	E-SERIES
					Ω	
WSE0805	0805	0.25	$(P \times R)^{1/2}$	15, 25	± 0.1 %, ± 0.25 %, ± 0.5 %, ± 1 %	96

### TECHNICAL SPECIFICATIONS

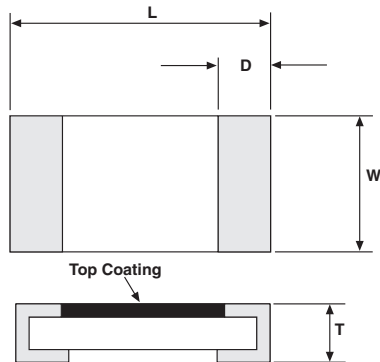
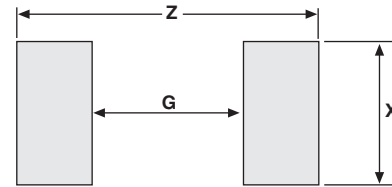
PARAMETER	UNIT	WSE0805
Dielectric Withstanding Voltage	$V_{AC}$	200
Insulation Resistance	Ω	> 10 <sup>9</sup>
Operating Temperature Range	°C	- 65/+ 150
Weight/1000 pcs	G	5.5

### GLOBAL PART NUMBER INFORMATION

GLOBAL PART NUMBERING: WSE08051K500FXEA

W S E 0 8 0 5 1 K 5 0 0 F X E A

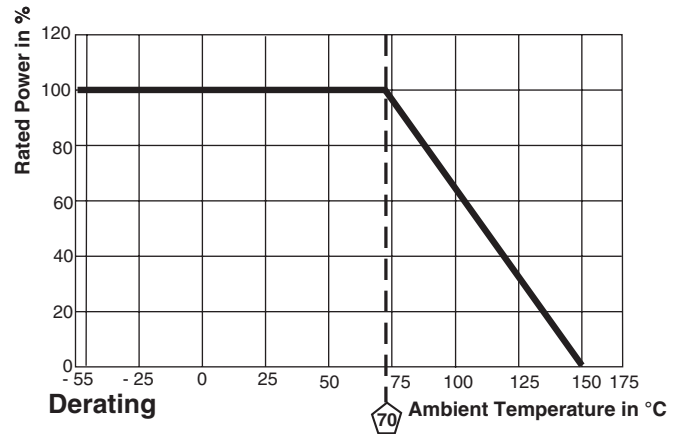
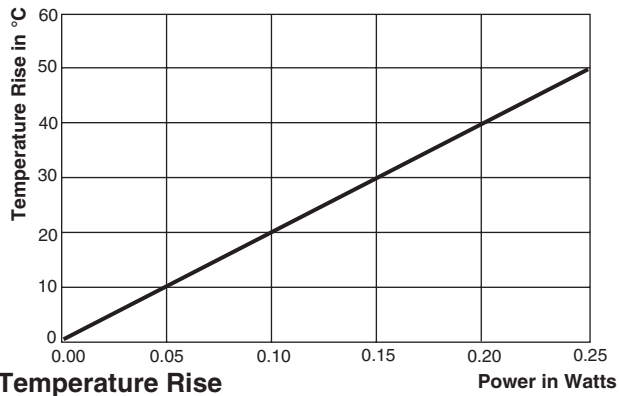
GLOBAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	TCR CODE	PACKAGING CODE	SPECIAL
WSE0805	R = Decimal K = Thousand 100R0 = 100 Ω 4K000 = 4 kΩ	B = ± 0.1 % C = ± 0.25 % D = ± 0.5 % F = ± 1.0 %	X = ± 15 ppm/°C E = ± 25 ppm/°C	EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk  TG = Tin/Lead, Tape/Reel (RT1) BA = Tin/Lead, Bulk (B43)	(Dash Number) (up to 2 digits) from 1 - 99 as applicable

**DIMENSIONS**

**RECOMMENDED LAND PATTERN**


MODEL	DIMENSIONS in inches [millimeters]						
	D	L	W	T	G <sup>1)</sup>	X <sup>1)</sup>	Z <sup>1)</sup>
WSE0805	0.015 ± 0.005 [0.38 ± 0.13]	0.080 ± 0.005 [2.30 ± 0.13]	0.050 ± 0.005 [1.27 ± 0.13]	0.025 max [0.64 max]	0.028 ± 0.004 [0.70 ± 0.10]	0.050 ± 0.004 [1.27 ± 0.10]	0.122 ± 0.004 [3.103 ± 0.10]

**Note**

1. Land pattern dimensions (G, X, Z) are per IPC-782A



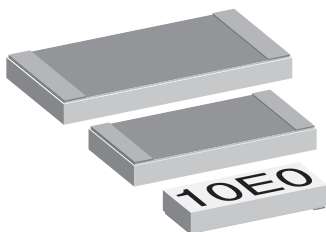
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 65 °C to + 150 °C, 100 cycles, 15 minutes at each extreme	± 0.10 % ΔR
Short Time Overload	5 x rated power for 5 seconds	± 0.10 % ΔR
Low Temperature Operation	- 65 °C, 0.25 W for 45 minutes	± 0.05 % ΔR
High Temperature Exposure	100 hours at + 150 °C	± 0.10 % ΔR
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7b not required	± 0.10 % ΔR
Load Life	1000 hours at 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 0.05 % ΔR
Resistance to Bonding Exposure	260 °C for 10 seconds	± 0.10 % ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSE0805	8 mm/Punched Paper	178 mm/7"	5000	EA

**Note**

- Embossed Carrier Tape per EIA-481-1A

## Power Metal Strip® Flip Chip (Extended Range) Patents Pending



### FEATURES

- SMD alternative for low power leaded wirewound resistors
- Excellent stability in different environmental conditions (< 0.5 % change in resistance)
- Superior overload and pulse handling capability as compared to thin film (as much as 2 x better)
- Low TCR, down to ± 15 ppm/K
- Low noise: < 0.01 µV(rms)/Volt
- Voltage coefficient: < 0.00001 %/Volt (< 0.1 ppm/V)
- Very low inductance: < 0.08 µH

STANDARD ELECTRICAL SPECIFICATIONS							
GLOBAL MODEL	SIZE INCH	POWER RATING P <sub>70 °C</sub>	LIMITING ELEMENT VOLTAGE <sup>1)</sup> MAX V <sub>≡</sub>	TEMPERATURE COEFFICIENT ppm/K	TOLERANCE %	RESISTANCE RANGE <sup>2)</sup> Ω	E-SERIES
WSL1506E	1506	0.25	63	15, 25	0.5, 1	0R5 - 10K	96
WSL2010E	2010	0.5	100	15, 25	0.5, 1	0R5 - 10K	96
WSL2512E	2512	1.0	100	15, 25	0.5, 1	0R5 - 10K	96

**Notes**

- Ask about further value ranges, tighter tolerances and TCR's
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
- 4-Digit Marking, according to MIL-PRF-55342 (except as noted in Ordering Information table), on top side

1. Rated voltage:  $\sqrt{P \times R}$
2. Contact factory using e-mail address at bottom of this page for resistance values available between 0R5 - 10R for 1506 and 0R5 - 100R for 2010 and 2512

TECHNICAL SPECIFICATIONS				
PARAMETER	UNIT	WSL1506E	WSL2010E	WSL2512E
Rated Dissipation at 70 °C	W	0.25	0.5	1.0
Limiting Element Voltage <sup>1)</sup>	V <sub>≡</sub>	63	100	100
Insulation Voltage (1 min)	Vdc/ac peak	200	200	200
Thermal Resistance	K/W	≤ 220 <sup>2)</sup>	≤ 88 <sup>2)</sup>	≤ 65 <sup>2)</sup>
Insulation Resistance	MΩ	> 10 <sup>6</sup>		
Category Temperature Range	°C	- 55/+ 150		
Weight/1000 pcs	g	12	25	35

**Notes**

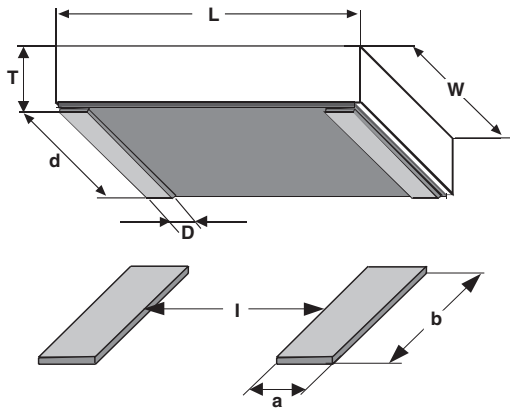
1. Rated voltage:  $\sqrt{P \times R}$
2. Depending on solder pad dimensions

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSL1506E	12 mm/Embossed Plastic	180 mm/7"	4000	EA
WSL2010E	12 mm/Embossed Plastic	180 mm/7"	4000	EA
WSL2512E	12 mm/Embossed Plastic	180 mm/7"	2000	EA

**Note**

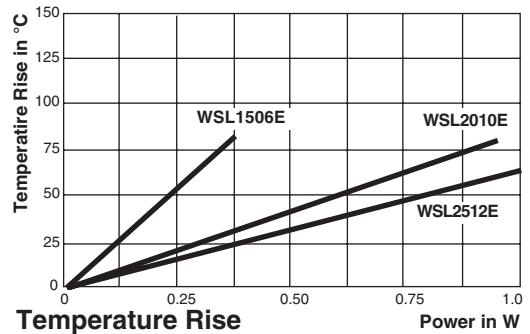
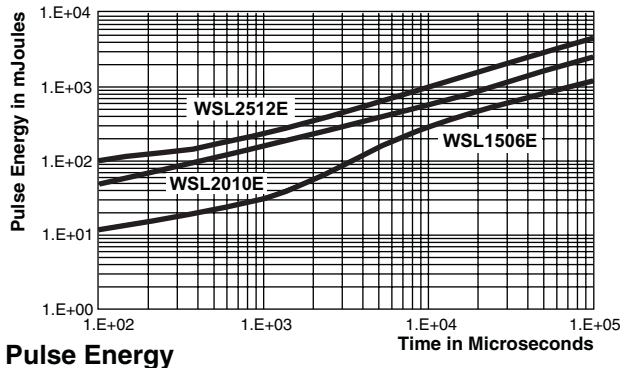
- Embossed Carrier Tape per EIA-481-1.2

GLOBAL PART NUMBER INFORMATION				
New Global Part Numbering: WSL1506E10E0XE A				
W	S	L	1 5 0 6	E 1 0 E 0 X E A
<b>GLOBAL MODEL</b> WSL1506E	<b>RESISTANCE VALUE &amp; TOLERANCE</b> Resistance Multiplier Symbol Tolerance (±)		<b>TOLERANCE CODE</b> E = ± 25 ppm/K X = ± 15 ppm/K	<b>PACKAGING</b> EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk  TA = Tape/Reel (R86) BA = Bulk (B43)
	0.5	X1	W	<b>SPECIAL</b> (Dash Number) (up to 2 digits) From 1-99 as applicable
	0.5	X1000	X	
	0.5	X1 000 000	Y	
	1.0	X1	D	
	1.0	X1000	E	
	1.0	X1 000 000	F	

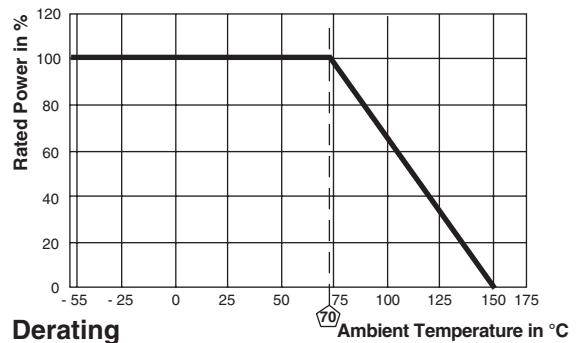
**DIMENSIONS**


SIZE INCH	DIMENSIONS in inches [millimeters]				
	L	W	T <sub>max</sub>	D	d
1506	0.15 ± 0.005 [3.81 ± 0.13]	0.062 ± 0.003 [1.57 ± 0.08]	0.025 [0.64]	0.012 ± 0.003 [0.30 ± 0.08]	0.059 ± 0.003 [1.50 ± 0.08]
2010	0.200 ± 0.005 [5.08 ± 0.13]	0.100 ± 0.003 [2.54 ± 0.08]	0.025 [0.64]	0.020 ± 0.003 [0.51 ± 0.08]	0.097 ± 0.003 [2.46 ± 0.08]
2512	0.250 ± 0.005 [6.35 ± 0.13]	0.126 ± 0.003 [3.20 ± 0.08]	0.025 [0.64]	0.024 ± 0.003 [0.61 ± 0.08]	0.123 ± 0.003 [3.12 ± 0.08]

SIZE INCH	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
1506	0.015 [0.38]	0.062 [1.57]	0.118 [3.00]
2010	0.023 [0.58]	0.100 [2.54]	0.153 [3.89]
2512	0.027 [0.69]	0.126 [3.20]	0.196 [4.98]

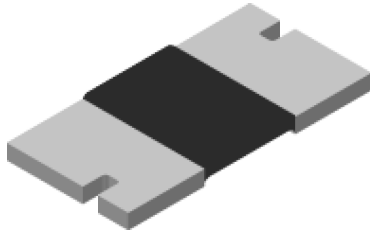

**Pulse Energy Plot:**

This represents the energy in each of 50 pulses, with a 1 second rest between pulses, that it takes to shift the WSL....E resistance ± (0.50 % + 0.01 Ω).


**PERFORMANCE**

TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 100 cycles, 15 minutes at each extreme	± (0.20 % + 0.01 Ω)
Short Time Overload	5 x rated power for 5 seconds	± (0.20 % + 0.01 Ω)
Low Temperature Storage	- 65 °C for 24 hours	± (0.20 % + 0.01 Ω)
High Temperature Exposure	1000 hours at + 150 °C	± (0.50 % + 0.01 Ω)
Moisture Resistance	MIL-STD-202, Method 106, 0 % power, 7a and 7b not required	± (0.50 % + 0.01 Ω)
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (0.50 % + 0.01 Ω)
Vibration	MIL-STD-202, Method 204D	± (0.10 % + 0.01 Ω)
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.10 % + 0.01 Ω)
Resistance to Soldering Heat	+ 260 °C solder, 10 - 12 seconds dwell, 25 mm/second emergence	± (0.50 % + 0.01 Ω)

## Power Metal Strip® Resistors, Low Value, Surface Mount, 4 - Terminal



### FEATURES

- 4-Terminal design allows for 1 % tolerance down to 0.001 Ω and 0.5 % tolerance down to 0.003 Ω
- Ideal for all types of precision current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-Chrome or Manganese-Copper alloy resistive element with low TCR (< 20 ppm/°C)
- Solderable terminations
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response
- Lead (Pb)-free version is RoHS compliant



RoHS\* COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS			
GLOBAL MODEL	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE Ω	
		± 0.5 %	± 1.0 %
WSK2512	1.0	0.003 - 0.025	0.001 - 0.025

**Note**

- Part Marking: DALE, Value, Tolerance; due to resistor size limitations some resistance values will be marked with only the resistance value

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSK2512
Temperature Coefficient	ppm/°C	0.001 Ω - 0.0029 Ω = ± 250 0.003 Ω - 0.0049 Ω = ± 75 0.005 Ω - 0.025 Ω = ± 35
Operating temperature range	°C	- 65/+ 170
Maximum Working Voltage	V	$(P \times R)^{1/2}$
Weight/1000 pieces	g	63.6

### PART NUMBER

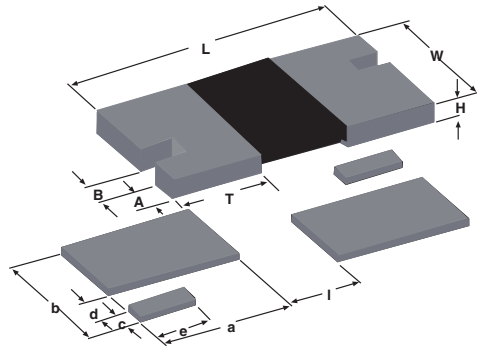
New Global Part Numbering: WSK25125L000FEA (preferred part numbering format)

W	S	K	2	5	1	2	5	L	0	0	0	F	E	A		
GLOBAL MODEL <b>WSK2512</b>			RESISTANCE VALUE L = Milliohm R = Decimal <b>5L000 = 0.005 Ω</b> <b>R0100 = 0.01 Ω</b>			TOLERANCE CODE <b>D = ± 0.5 %</b> <b>F = ± 1.0 %</b>			PACKAGING CODE <b>EA = Lead (Pb)-free, Tape/Reel</b> <b>EK = Lead (Pb)-free, Bulk</b> <b>TA = Tin/Lead, Tape/Reel (R86)</b> <b>BA = Tin/Lead, Bulk (B43)</b>				SPECIAL (Dash Number) (up to 2 digits) <b>From 1-99 as applicable</b>			

Historical Part Numbering: WSK2512 0.005 Ω 1 % EA (will continue to be accepted)

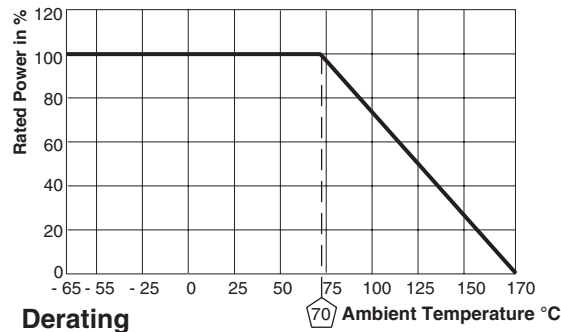
WSK2512	0.005 Ω	1 %	EA
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**


MODEL	DIMENSIONS in inches [millimeters]						
	RESISTANCE RANGE $\Omega$	L	W	H	T	A	B
WSK2512	0.001 - 0.0049	0.250 $\pm$ 0.010 [6.35 $\pm$ 0.254]	0.125 $\pm$ 0.010 [3.18 $\pm$ 0.254]	0.025 $\pm$ 0.010 [0.635 $\pm$ 0.254]	0.087 $\pm$ 0.010 [2.21 $\pm$ 0.254]	0.030 $\pm$ 0.010 [0.762 $\pm$ 0.254]	0.020 $\pm$ 0.010 [0.508 $\pm$ 0.254]
	0.005 - 0.025	0.250 $\pm$ 0.010 [6.35 $\pm$ 0.254]	0.125 $\pm$ 0.010 [3.18 $\pm$ 0.254]	0.025 $\pm$ 0.010 [0.635 $\pm$ 0.254]	0.047 $\pm$ 0.010 [1.19 $\pm$ 0.254]	0.030 $\pm$ 0.010 [0.762 $\pm$ 0.254]	0.020 $\pm$ 0.010 [0.508 $\pm$ 0.254]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]					
	a	b	c	d	e	l
WSK2512	0.125 [3.18]	0.130 [3.30]	0.030 [0.76]	0.020 [0.51]	0.055 [1.40]	0.065 [1.65]



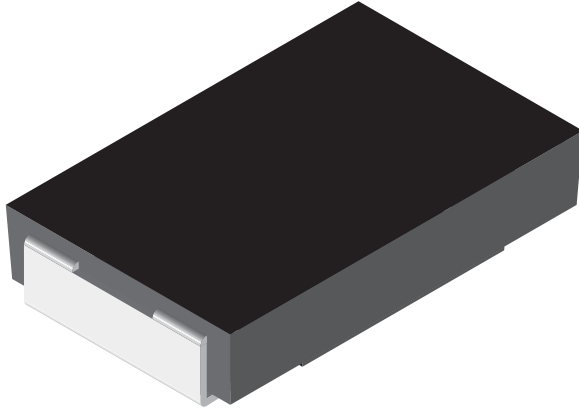
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Short Time Overload	5 x power for 5 seconds	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Low Temperature Storage	- 65 °C for 24 hours	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
High Temperature Exposure	1000 hours at + 170 °C	$\pm$ (1.0 % + 0.0005 $\Omega$ ) $\Delta R$
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	$\pm$ (1.0 % + 0.0005 $\Omega$ ) $\Delta R$
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$
Moisture Resistance	MIL-STD-202 Method 106, 0 % power, 7a and 7b not required	$\pm$ (0.5 % + 0.0005 $\Omega$ ) $\Delta R$

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSK2512	12 mm/Embossed Plastic	178 mm/7"	2000	R86

**Note**

- Embossed carrier tape per EIA-481-1A

## Power Metal Strip® Resistors, Low Value, Surface Mount



### FEATURES

- Molded high temperature encapsulation
- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instruments, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-chrome or Manganese-copper alloy resistive element with low TCR (< 20 ppm/°C)
- Solderable terminations
- Very low inductance 0.5 nH to 5 nH
- Excellent frequency response
- Low thermal EMF
- Lead (Pb)-free version is RoHS compliant



RoHS\*  
COMPLIANT

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	SIZE	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$	
			$\pm 0.5\%$	$\pm 1.0\%$
WSR2	4527	2.0	0.01 - 1.0	0.001 - 1.0
WSR3	4527	3.0 <sup>1)</sup>	0.01 - 0.2	0.001 - 0.2

**Note**

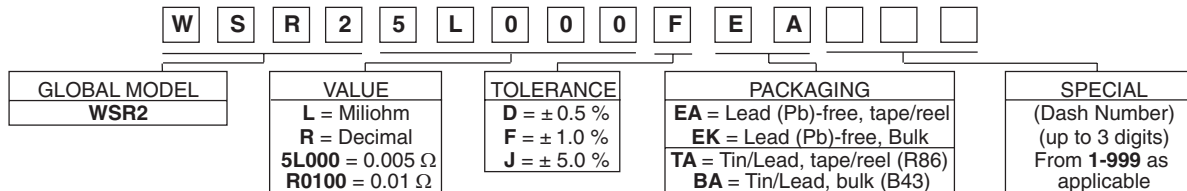
1. The WSR3 requires a minimum of 1050 sq. mil. circuit traces connecting to the recommended solder pad
- Part Marking: DALE, Model, Value, Tolerance, Date Code

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	WSR2 & WSR3
Temperature Coefficient	ppm/°C	0.005 $\Omega$ - 0.0099 $\Omega$ $\pm$ 110 0.010 $\Omega$ - 1.0 $\Omega$ $\pm$ 75
Dielectric Withstanding Voltage	$V_{AC}$	> 500
Insulation Resistance	$\Omega$	> 10 <sup>9</sup>
Operating Temperature Range	°C	- 65/+ 275
Maximum Working Voltage	V	( $P \times R$ ) <sup>1/2</sup>
Weight/1000 pieces (typical)	g	440

### GLOBAL PART NUMBER INFORMATION

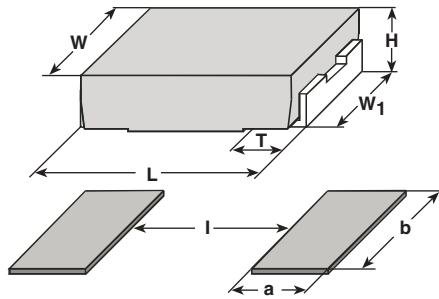
New Global Part Numbering: WSR25L000FEA (preferred part numbering format)



Historical Part Number example: WSR2 0.005  $\Omega$  1% EA (will continue to be accepted)

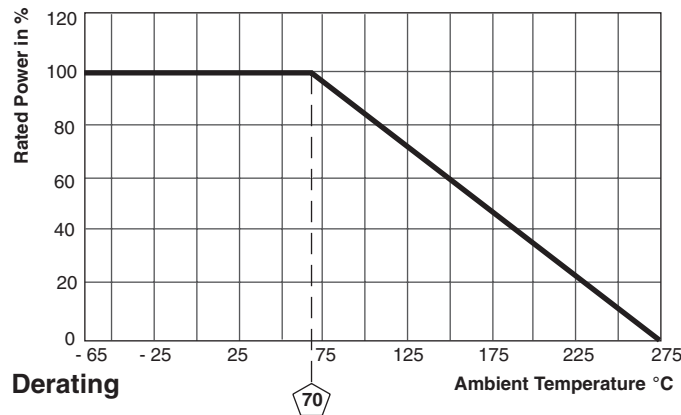


\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**


MODEL	DIMENSIONS in inches [millimeters]				
	L	H	T	W	W <sub>1</sub>
WSR2	0.455 ± 0.032	0.095 ± 0.005	0.100 ± 0.010	0.275 ± 0.005	0.215 ± 0.005
WSR3	[11.56 ± 0.813]	[2.41 ± 0.127]	[2.54 ± 0.254]	[6.98 ± 0.127]	[5.46 ± 0.127]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSR2	0.155	0.230	0.205
WSR3	[3.94]	[5.84]	[5.21]



PERFORMANCE			
TEST	CONDITIONS OF TEST	TEST LIMITS	
		WSR2	WSR3
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
Short Time Overload	WSR2: 5 x rated power for 5 sec. WSR3: 4 x rated power for 5 sec.	± (0.5 % + 0.0005 Ω) ΔR	± (2.0 % + 0.0005 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 275 °C	± (1.0 % + 0.0005 Ω) ΔR	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.0005 Ω) ΔR	± (2.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202 Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 Ω) ΔR	± (0.5 % + 0.0005 Ω) ΔR

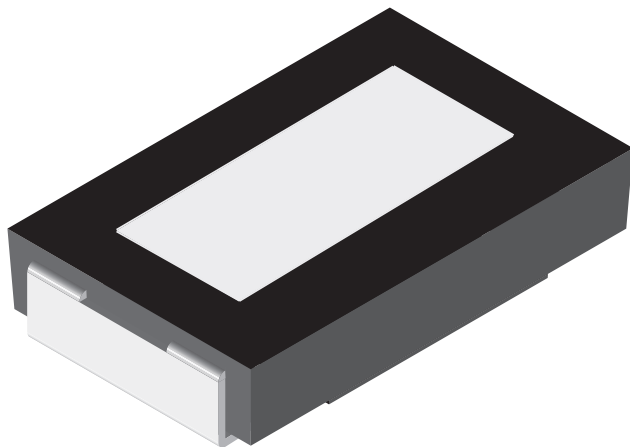
PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSR2 & WSR3	24 mm/Embossed Plastic	330 mm/13"	1500	EA

**Note**

- Embossed Carrier Tape per EIA-481-2



## Power Metal Strip® Resistors, High Power, Low Value, Surface Mount



### FEATURES

- Molded high temperature encapsulation
- Improved thermal management incorporated into design
- Ideal for all types of current sensing, voltage division and pulse applications including switching and linear power supplies, instrumentation, power amplifiers
- Proprietary processing technique produces extremely low resistance values
- All welded construction
- Solid metal Nickel-chrome alloy resistive element
- Solderable terminations
- Very low inductance 0.5 nH to 5 nH
- Low thermal EMF
- Lead (Pb)-free version is RoHS compliant



RoHS\*  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS				
GLOBAL MODEL	SIZE	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE	
			$\Omega$	
			$\pm 0.5\%$	$\pm 1\%$
WSR5	4527	5.0 <sup>1)</sup>	0.01 - 0.3	0.0075 - 0.3

#### Note

1. The WSR5 is rated at 5 watts with terminal temperature maintained  $\leq 120\text{ }^\circ\text{C}$

- Part Marking: DALE, Model, Value, Tolerance, Date Code

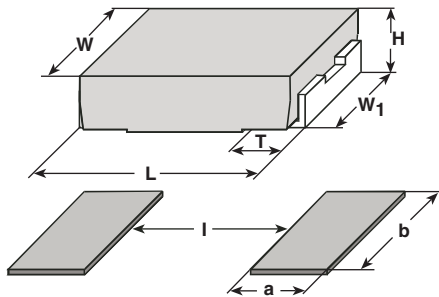
TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	WSR5
Temperature Coefficient	ppm/ $^\circ\text{C}$	0.0075 $\Omega$ to 0.0099 $\Omega$ = $\pm 110$ 0.01 $\Omega$ to 0.3 $\Omega$ = $\pm 75$
Dielectric Withstanding Voltage	$V_{AC}$	> 500
Insulation Resistance	$\Omega$	> $10^9$
Operating Temperature Range	$^\circ\text{C}$	- 65/+ 275
Maximum Working Voltage	V	$(P \times R)^{1/2}$
Weight/1000 pcs	g	476

GLOBAL PART NUMBER INFORMATION				
New Global Part Numbering: WSR5R0100FEA (preferred part numbering format)				
W	S	R	5	R
0	1	0	0	F
E	A			
GLOBAL MODEL WSR5	VALUE L = Milliohm R = Decimal 7L500 = 0.0075 $\Omega$ R0100 = 0.01 $\Omega$	TOLERANCE D = $\pm 0.5\%$ F = $\pm 1.0\%$ J = $\pm 5.0\%$	PACKAGING EA = Lead (Pb)-free, tape/reel EK = Lead (Pb)-free, Bulk TA = Tin/Lead, tape/reel (R86) BA = Tin/Lead, bulk (B43)	SPECIAL (Dash Number) (up to 3 digits) From 1-999 as applicable
Historical Part Number example: WSR5 0.01 $\Omega$ 1% EA (will continue to be accepted)				
WSR5	0.01 $\Omega$	1%	EA	
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING	

\* Pb containing terminations are not RoHS compliant, exemptions may apply

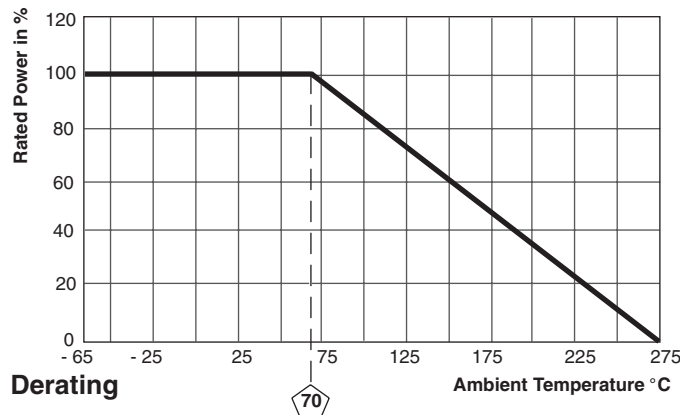


**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	L	H	T	W	W <sub>1</sub>
WSR5	0.455 ± 0.032 [11.56 ± 0.813]	0.095 ± 0.005 [2.41 ± 0.127]	0.100 ± 0.010 [2.54 ± 0.254]	0.275 ± 0.005 [6.98 ± 0.127]	0.215 ± 0.005 [5.46 ± 0.127]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSR5	0.155 [3.94]	0.230 [5.84]	0.205 [5.21]



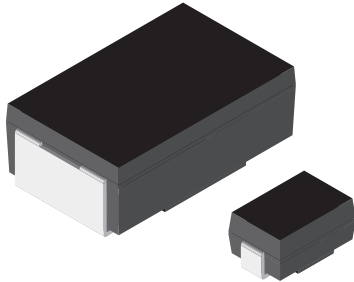
PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.0005 Ω) ΔR
Short Time Overload	3 x rated power for 5 sec.	± (2.0 % + 0.0005 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.5 % + 0.0005 Ω) ΔR
High Temperature Exposure	1000 hours at + 275 °C	± (1.0 % + 0.0005 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % bias, 1000 hours	± (0.5 % + 0.0005 Ω) ΔR
Mechanical Shock	100 g's for 6 milliseconds, 5 pulses	± (0.5 % + 0.0005 Ω) ΔR
Vibration	Frequency varied 10 to 2000 Hz in one minute, 3 directions, 12 hours	± (0.5 % + 0.0005 Ω) ΔR
Load Life	1000 hours at 70 °C	± (2.0 % + 0.0005 Ω) ΔR
Resistance to Solder Heat	260 ± 3 °C 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.0005 Ω) ΔR
Moisture Resistance	MIL-STD-202 Method 106, 0 % power, 7a and 7b not required	± (0.5 % + 0.0005 Ω) ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSR5	24 mm/Embossed Plastic	330 mm/13"	1500	EA

**Note**

- Embossed Carrier Tape per EIA-481-2

## Wirewound Resistors, Precision Power, Surface Mount



### FEATURES

- All welded construction
- Molded encapsulation
- Wrap around terminations
- Solderable termination
- Excellent stability at different environmental conditions
- High power ratings
- Superior surge capability
- Available in non-inductive styles with Aryton-Perry winding (WSN in lieu of WSC, maximum resistance is one-half WSC range)
- Lead (Pb)-free version is RoHS compliant



**RoHS\***  
COMPLIANT

STANDARD ELECTRICAL SPECIFICATIONS						
GLOBAL MODEL	HISTORICAL MODEL	SIZE INCH	POWER RATING $P_{70\text{ }^\circ\text{C}}$ W	TOLERANCE $\pm\%$	RESISTANCE RANGE $\Omega$	ENCAPSULATION
WSC01/2	WSC-1/2	2012	0.5	0.5, 1, 5	0.1 - 4.99	Epoxy
WSC0001	WSC-1	2515	1.0	0.5, 1, 5	0.1 - 2.77K	Epoxy
WSC2515	WSC2515	2515	1.0	0.5, 1, 5	0.1 - 2.77K	Thermoplastic
WSC0002	WSC-2	4527	2.0	0.5, 1, 5	0.1 - 4.92K	Epoxy
WSC4527	WSC4527	4527	2.0	0.5, 1, 5	0.1 - 4.92K	Thermoplastic
WSC6927	WSC6927	6927	3.0	0.5, 1, 5	0.1 - 8K	Thermoplastic

**Note**

- Part Marking: 1/2 W - DALE, Value; 1 W - Model, Value, Tolerance, Date Code; 2 W & 3 W - DALE, Model, Value, Tolerance, Date Code

TECHNICAL SPECIFICATIONS						
PARAMETER	UNIT	WSC01/2	WSC0001	WSC2515	WSC0002	WSC4527/WSC6927
Temperature Coefficient	ppm/ $^\circ\text{C}$	0.1 $\Omega$ - 0.99 $\Omega$ = $\pm 90$ 1.0 $\Omega$ - 4.99 $\Omega$ = $\pm 50$	0.1 $\Omega$ - 0.99 $\Omega$ = $\pm 90$ 1.0 $\Omega$ - 26.5 $\Omega$ = $\pm 50$ 26.51 $\Omega$ and above = $\pm 20$	0.1 $\Omega$ - 0.99 $\Omega$ = $\pm 90$ 1.0 $\Omega$ - 26.5 $\Omega$ = $\pm 50$ 26.51 $\Omega$ and above = $\pm 20$	0.1 $\Omega$ - 0.99 $\Omega$ = $\pm 90$ 1.0 $\Omega$ - 9.9 $\Omega$ = $\pm 50$ 10.0 $\Omega$ and above = $\pm 20$	0.1 $\Omega$ - 0.3 $\Omega$ = $\pm 150$ 0.31 $\Omega$ - 0.99 $\Omega$ = $\pm 90$ 1.0 $\Omega$ - 9.9 $\Omega$ = $\pm 50$ 10 $\Omega$ and above = $\pm 20$
Dielectric Withstanding Voltage	$V_{AC}$	> 500	> 500	> 500	> 500	> 500
Insulation Resistance	$\Omega$	> $10^9$	> $10^9$	> $10^9$	> $10^9$	> $10^9$
Operating Temperature Range	$^\circ\text{C}$	- 65/+ 175	- 65/+ 175	- 65/+ 275	- 65/+ 175	- 65/+ 275
Maximum Working Voltage	V	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$
Weight/1000 pieces (typical)	g	90	165	165	760	760/1675

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: WSC2515R7000FTA (preferred part numbering format)

W	S	C	2	5	1	5	R	7	0	0	0	F	T	A		
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GLOBAL MODEL

WSC  
WSN

SIZE

01/2  
0001  
2515  
0002  
4527  
6927

VALUE

R = decimal  
K = thousand  
54R15 = 54.15  $\Omega$   
1K500 = 1.5 k $\Omega$

TOLERANCE

D =  $\pm 0.5\%$   
F =  $\pm 1.0\%$   
G =  $\pm 2.0\%$   
H =  $\pm 3.0\%$   
J =  $\pm 5.0\%$   
K =  $\pm 10\%$

PACKAGING

EA = Lead (Pb)-free, tape/reel  
EK = Lead (Pb)-free, bulk  
TA = Tin/Lead, Tape/reel (R86)  
BA = Tin/Lead, bulk (B43)

SPECIAL

(Dash Number)  
(up to 2 digits)  
From 1-99 as applicable

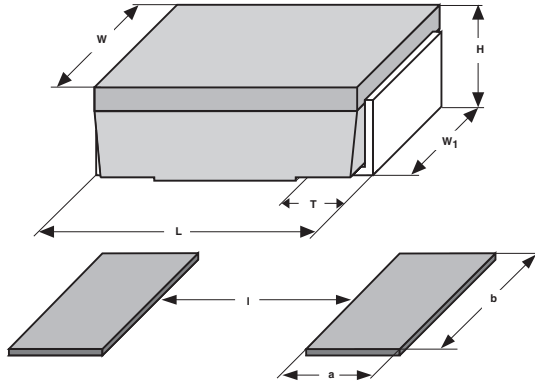
Historical Part Number example: WSC2515 0.7  $\Omega$  1% R86 (will continue to be accepted)

WSC2515	0.7 $\Omega$	1%	R86
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply

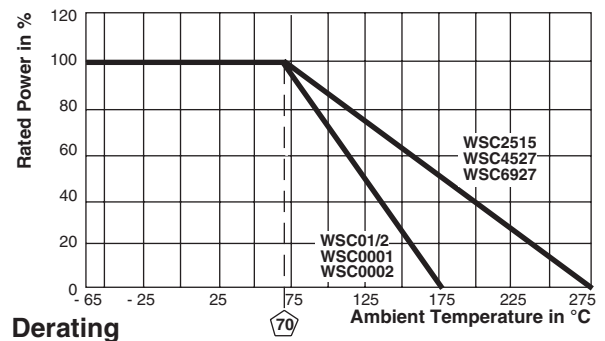
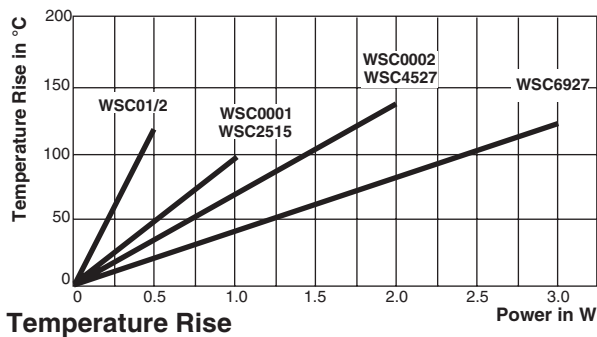


**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	L	H	T	W	W <sub>1</sub>
WSC01/2	0.200 ± 0.020 [5.08 ± 0.508]	0.096 ± 0.015 [2.44 ± 0.381]	0.040 ± 0.010 [1.02 ± 0.254]	0.125 ± 0.005 [3.18 ± 0.127]	0.050 ± 0.010 [1.27 ± 0.254]
WSC0001	0.250 ± 0.020 [6.35 ± 0.508]	0.110 ± 0.015 [2.79 ± 0.381]	0.045 ± 0.010 [1.14 ± 0.254]	0.150 ± 0.005 [3.81 ± 0.127]	0.098 ± 0.005 [2.49 ± 0.127]
WSC2515	0.250 ± 0.020 [6.35 ± 0.508]	0.110 ± 0.015 [2.79 ± 0.381]	0.045 ± 0.010 [1.14 ± 0.254]	0.150 ± 0.005 [3.81 ± 0.127]	0.098 ± 0.005 [2.49 ± 0.127]
WSC0002	0.445 ± 0.032 [11.30 ± 0.813]	0.162 ± 0.015 [4.11 ± 0.381]	0.100 ± 0.010 [2.54 ± 0.254]	0.275 ± 0.005 [6.98 ± 0.127]	0.215 ± 0.005 [5.46 ± 0.127]
WSC4527	0.455 ± 0.020 [11.56 ± 0.508]	0.167 ± 0.010 [4.24 ± 0.254]	0.100 ± 0.010 [2.54 ± 0.254]	0.275 ± 0.005 [6.98 ± 0.127]	0.215 ± 0.005 [5.46 ± 0.127]
WSC6927	0.690 ± 0.032 [17.53 ± 0.813]	0.280 ± 0.015 [7.11 ± 0.381]	0.100 ± 0.010 [2.54 ± 0.254]	0.275 ± 0.005 [6.98 ± 0.127]	0.215 ± 0.015 [5.46 ± 0.381]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
WSC01/2	0.085 [2.16]	0.070 [1.78]	0.080 [2.03]
WSC0001	0.090 [2.29]	0.115 [2.92]	0.120 [3.05]
WSC2515	0.090 [2.29]	0.115 [2.92]	0.120 [3.05]
WSC0002	0.155 [3.94]	0.230 [5.84]	0.205 [5.21]
WSC4527	0.155 [3.94]	0.230 [5.84]	0.205 [5.21]
WSC6927	0.155 [3.94]	0.235 [5.97]	0.470 [11.94]

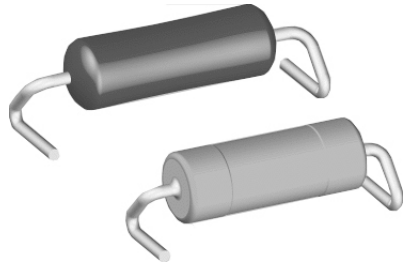


PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 1000 cycles, 15 minutes at each extreme	± (0.5 % + 0.05 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.2 % + 0.05 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.2 % + 0.05 Ω) ΔR
High Temperature Exposure	1000 hours at + 275 °C (+ 175 °C for WSC01/2, WSC0001 and WSC0002)	± (0.5 % + 0.05 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % Bias, 1000 hours	± (0.2 % + 0.05 Ω) ΔR
Mechanical Shock	100 g's for 11 milliseconds, 5 pulses	± (0.1 % + 0.05 Ω) ΔR
Vibration	Frequency varied 10 to 500 Hz in one minute, 3 directions, 9 hours	± (0.1 % + 0.05 Ω) ΔR
Load Life	1000 hours at rated power, + 70 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.05 Ω) ΔR
Resistance to Solder Heat	+ 260 °C Solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.05 Ω) ΔR

PACKAGING				
MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSC01/2	12 mm/Embossed Plastic	330 mm/13"	2000	EA/TA
WSC0001/WSC2515	16 mm/Embossed Plastic	330 mm/13"	2000	EA/TA
WSC0002/WSC4527	24 mm/Embossed Plastic	330 mm/13"	1200	EA/TA
WSC6927	32 mm/Embossed Plastic	330 mm/13"	725	EA/TA

**Note**  
• Embossed Carrier Tape per EIA-481-1, 2, 3

## Wirewound Resistors, Surface Mount, Silicone or Cement Coated, High Power



### FEATURES

- Low cost, high power (up to 4 W)
- All welded construction
- Ideal for pulsing application
- Ceramic core
- Available on tape and reel
- Lead (Pb)-free version is RoHS compliant



**RoHS\***  
COMPLIANT

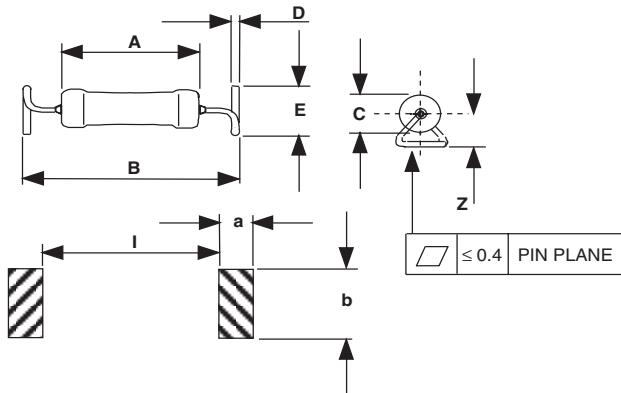
STANDARD ELECTRICAL SPECIFICATIONS							
MODEL	POWER RATING P <sub>25 °C</sub> <sup>3</sup> W	TOLERANCE ± %	RESISTANCE RANGE E12/E24 <sup>1</sup> Ω		RESISTANCE RANGE Ω		ENCAPSULATION
			TCR - 10 ... - 80 ppm/K <sup>2</sup> (CLASS 1)	TCR 100 ... 180 ppm/K (CLASS 3)	TCR ± 50 ppm/°C	TCR ± 30 ppm/°C	
WSZ6720	1.8	1 2 5 10	1R0 - 510R R22 - 510R R10 - 510R R10 - 510R	- - 24R - 3K3 1R8 - 3K3	- - - -	- - - -	Cement
WSZ7532	3.75	1, 3 5, 10	- -	- -	1R0 - 9R99	10R0 - 15K 10R0 - 15K	Silicone
WSZ8027	4	1 2 5 10	1R0 - 1K0 R10 - 1K0 R10 - 1K0 R10 - 1K0	- - 12R - 3K9 1R8 - 3K9	- - - -	- - - -	Cement

**Notes**

1. Lower TCR or other power range on request
2.  $1 \Omega \leq 400 \text{ ppm/K}$
3. Power rating depends on the maximum temperature at the solder point, solder pad dimensions, the component placement density and the substrate material

GLOBAL PART NUMBER INFORMATION																	
New Global Part Numbering: <b>WSZ672011509KBM000</b> (preferred part numbering format)																	
W	S	Z	6	7	2	0	1	1	5	0	9	K	B	M	0	0	0
GLOBAL MODEL <b>WSZ6720</b> <b>WSZ8027</b>	TC/MATERIAL 1 = -10...- 80 ppm/K WM50 Class 1 3 = 100...180 ppm/K WM110 Class 3	VALUE 3 digit value 1 digit multiplier Multiplier: 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup> 3 = *10 <sup>3</sup>	TOLERANCE CODE F = ± 1.0 % G = ± 2.0 % J = ± 5.0 % K = ± 10.0 %	PACKAGING BM = Lead (Pb)-free, Tape/Reel LX = Lead (Pb)-free, Bulk	SPECIAL 3 digits 000 = Standard												
Historical Part Number example: <b>WSZ6720WM50 15 Ω 10 % BM</b> (will continue to be accepted)																	
W	S	Z	6	7	2	0	1	1	5	0	9	K	B	M	0	0	0
HISTORICAL MODEL <b>WSZ6720</b>	TCR/MATERIAL <b>WM50</b>	VALUE <b>15 Ω</b>	TOLERANCE CODE <b>10 %</b>	PACKAGING <b>BM</b>													
New Global Part Numbering: <b>WSZ75321K000JBA1</b> (preferred part numbering format)																	
W	S	Z	7	5	3	2	1	K	0	0	0	J	B	A	1		
GLOBAL MODEL <b>WSZ7532</b>	VALUE R = Decimal K = Thousand 54R15 = 54.15 Ω 1K325 = 1325 Ω	TOLERANCE CODE F = ± 1.0 % G = ± 2.0 % H = ± 3.0 % J = ± 5.0 % K = ± 10 %	PACKAGING EA = Lead (Pb)-free, Tape/Reel EK = Lead (Pb)-free, Bulk TA = Tin/Lead, Tape/Reel BA = Tin/Lead, Bulk	SPECIAL (Dash Number) (up to 3 digits) From 1 to 999 as applicable													
Historical Part Number example: <b>WSZ7532-1 1 kΩ 5 % B43</b> (will continue to be accepted)																	
W	S	Z	7	5	3	2	1	K	0	0	0	J	B	A	1		
HISTORICAL MODE <b>WSZ7532-1</b>	VALUE <b>1 kΩ</b>	TOLERANCE CODE <b>5 %</b>	PACKAGING <b>B43</b>														

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**


MODEL	DIMENSIONS in millimeters [inches]					
	A <sub>max</sub>	B	C <sub>max</sub>	D <sub>nom</sub>	E	Z
WSZ6720	13.2 [0.512]	17 ± 0.5 [0.670]	4.8 [0.189]	0.8 [0.031]	5 ± 0.5 [0.20 ± 0.02]	3.6 ± 0.5 [0.142 ± 0.02]
WSZ7532	14.27 [0.562]	19.86 [0.782]	4.78 [0.188]	0.813 [0.032]	8.18 [0.322]	6.5 [0.256]
WSZ8027	15.8 [0.622]	20.5 [0.807]	5.5 [0.217]	0.8 [0.031]	7.0 ± 0.5 [0.276 ± 0.02]	5.0 ± 0.5 [0.197 ± 0.02]

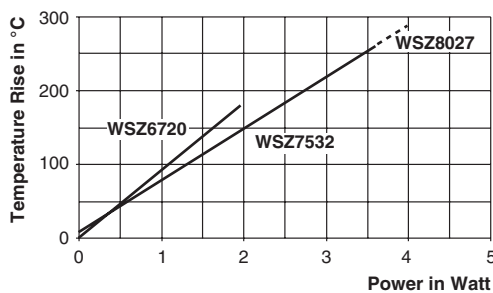
MODEL	SOLDER PAD DIMENSIONS in millimeters [inches]		
	a	b	l
WSZ6720	10 [0.394]	10 [0.394]	14.5 [0.57]
WSZ7532	4.0 [0.157]	9.50 [0.374]	15.05 [0.593]
WSZ8027	t.b.f.	t.b.f.	18 [0.709]

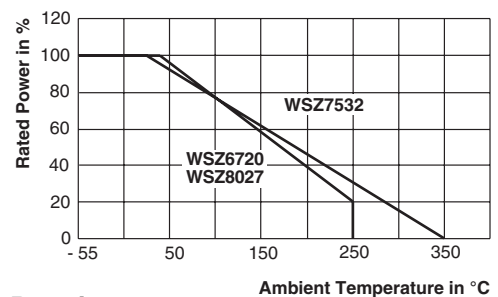
**TECHNICAL SPECIFICATIONS**

PARAMETER	UNIT	WSZ6720	WSZ7532	WSZ8027
Operating Temperature Range	°C	- 55/+ 250	- 65/+ 350	- 55/+ 250
Maximum Working Voltage	V	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$	$(P \times R)^{1/2}$
Weight (Typical)	g	0.6	0.7	0.9
Terminal Strength	lb	10 minimum	10 minimum	10 minimum

**PERFORMANCE**

TEST	CONDITIONS OF TEST	TEST LIMITS	
		WSZ6720	WSZ7532
Temperature Cycling	- 55 °C to + 125 °C, 5 cycles, 15 minutes at each extreme	± 3 % $\Delta R$	± (2 % + 0.05 $\Omega$ ) $\Delta R$
High Temperature Exposure	1000 hours at + 250 °C	± 3 % $\Delta R$	± (2 % + 0.05 $\Omega$ ) $\Delta R$
Short Time Overload	5 x rated power for 5 seconds	± 1 % $\Delta R$	± (2 % + 0.05 $\Omega$ ) $\Delta R$
Shock, Specified Pulse	100 g's for 6 milliseconds, 10 shocks	± 1 % $\Delta R$	± (0.2 % + 0.05 $\Omega$ ) $\Delta R$
Vibration, High Frequency	Frequency varied 10 to 2000 Hz, 20 g peak, 2 directions 6 hours each	± 1 % $\Delta R$	± (0.2 % + 0.05 $\Omega$ ) $\Delta R$
Load Life	2000 hours at rated power, + 25 °C, 1.5 hours "ON", 0.5 hours "OFF"	± 3 % $\Delta R$	± (3 % + 0.05 $\Omega$ ) $\Delta R$
Resistance to Soldering Heat	+ 260 °C solder, 10 - 12 second dwell, 25 mm/second emergence	± 1 % $\Delta R$	± (0.5 % + 0.05 $\Omega$ ) $\Delta R$


**Temperature Rise**

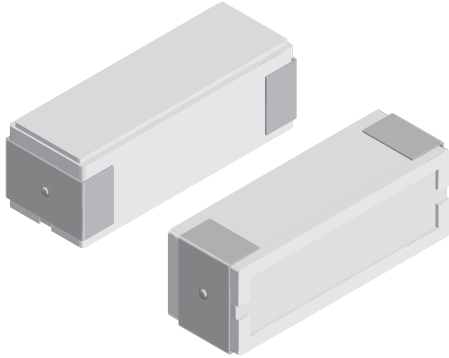
 Measurement based on recommended solder pads  
 WSZ 8027 Temperature Rise to 280 °C at 4 W

**Derating**
**PACKAGING**

MODEL	REEL			
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE
WSZ6720	24 mm	330 mm	1250	BM
WSZ7532 <sup>1)</sup>	32 mm/Embossed Plastic	330 mm/13"	350	EA/TA
WSZ8027	on request			

**Note**

1. Embossed Carrier Tape per latest revision of EIA-481-3

## Wirewound Resistors, Commercial Power, Surface Mount



### FEATURES

- High wattage in a SMD package
- Meets or performs better than EIA-RS-344 requirements
- Special inorganic potting compound and ceramic case provide high thermal conductivity in a fireproof package
- Superior surge capability
- Direct mounting on printed circuit board

STANDARD ELECTRICAL SPECIFICATIONS			
GLOBAL MODEL	HISTORICAL MODEL	POWER RATING $P_{40\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$ $\pm 5\%$ Standard; $\pm 1\%$ and $\pm 3\%$ Available
CP002M	CP-2M	4	0.1 - 2.74 k

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	CP002M RESISTOR CHARACTERISTICS
Temperature Coefficient	ppm/ $^\circ\text{C}$	$\pm 90$ below 1.0 $\Omega$ , $\pm 50$ 1.0 $\Omega$ and above
Short Time Overload	-	5 x rated power for 5 seconds
Operating Temperature Range	$^\circ\text{C}$	- 65/+ 175
Dielectric Withstanding Voltage	$V_{AC}$	1000
Maximum Working Voltage	V	$(P \times R)^{1/2}$
Weight (typical)	g	1.6

### GLOBAL PART NUMBER INFORMATION

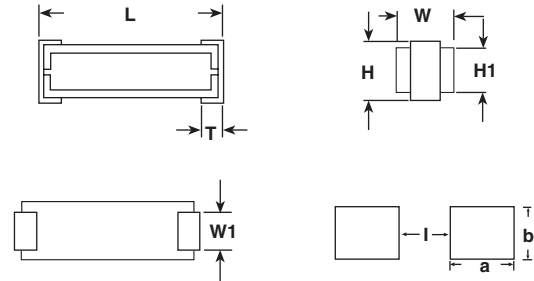
New Global Part Numbering: CP002M15R00JB37 (preferred part numbering format)

C	P	0	0	2	M	1	5	R	0	0	J	B	3	7			
GLOBAL MODEL CP002M					VALUE R = decimal K = thousand R1500 = 0.15 k $\Omega$ 1K500 = 1.5 k $\Omega$			TOLERANCE F = $\pm 1.0\%$ H = $\pm 3.0\%$ J = $\pm 5.0\%$ K = $\pm 10\%$			PACKAGING B37 = Tin/Lead, bulk P07 = Tin/Lead, tube		SPECIAL (Dash Number) (up to 3 digits) From 1-999 as applicable				

Historical Part Number example: CP-2M 15  $\Omega$  5% B37 (will continue to be accepted)

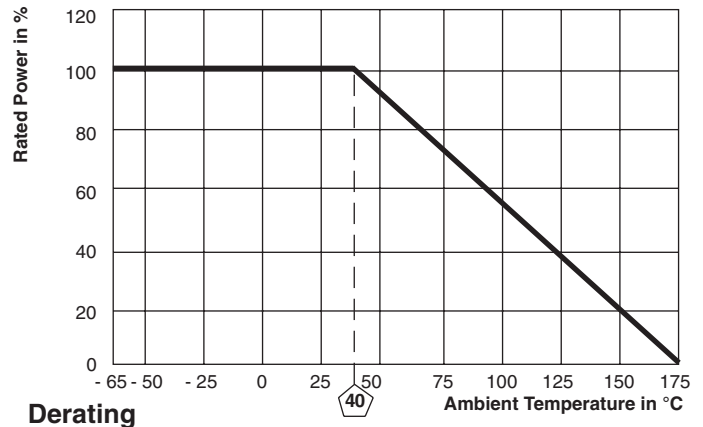
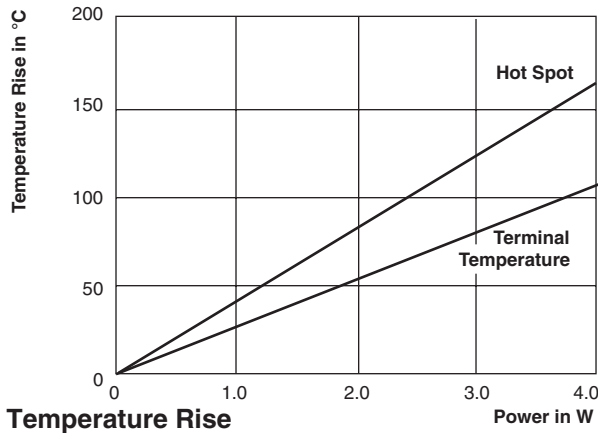
CP-2M	15 $\Omega$	5%	B37
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]					
	L ± 0.032 [0.813]	W ± 0.032 [0.813]	H ± 0.032 [0.813]	W <sub>1</sub> ± 0.010 [0.254]	H <sub>1</sub> ± 0.032 [0.813]	T ± 0.010 [0.254]
CP002M	0.712 [18.08]	0.250 [6.35]	0.262 [6.65]	0.170 [4.32]	0.250 [6.35]	0.100 [2.54]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
CP002M	0.280 [7.11]	0.200 [5.08]	0.460 [11.68]

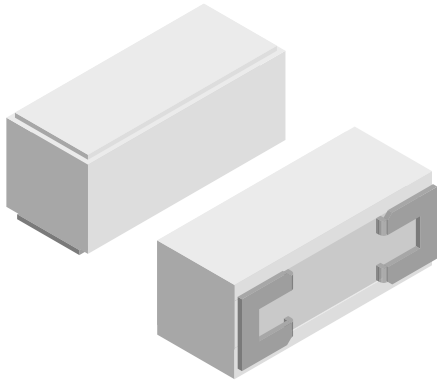


MATERIAL SPECIFICATIONS	
Element	Copper-nickel alloy or nickel-chrome alloy depending on resistance value
Core	Alumina ceramic
Body	Steatite ceramic case with inorganic potting compound
Terminals	High temperature solder dipped copper
Part Marking	DALE, Model, Wattage, Value, Tolerance, Date Code

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS
Thermal Shock	- 55 °C to + 150 °C, 5 cycles, 15 minutes at each extreme	± (0.2 % + 0.05 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (0.5 % + 0.05 Ω) ΔR
Low Temperature Storage	- 65 °C for 24 hours	± (0.2 % + 0.05 Ω) ΔR
High Temperature Condition	1000 hours at + 175 °C	± (0.5 % + 0.05 Ω) ΔR
Insulation Resistance	MIL-STD-202 Method 302, 100 volts	1000 MΩ minimum
Mechanical Shock	100 g's for 11 milliseconds, 5 pulses	± (0.1 % + 0.05 Ω) ΔR
Vibration	Frequency varied 10 to 500 Hz in one minute, 3 directions, 9 hours	± (0.1 % + 0.05 Ω) ΔR
Load Life	1000 hours at rated power, + 40 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (1.0 % + 0.05 Ω) ΔR
Resistance to Solder Heat	+ 260 °C solder, 10 - 12 second dwell, 25 mm/second emergence	± (0.5 % + 0.05 Ω) ΔR
Bias Humidity	+ 85 °C, 85 % RH, 10 % bias, 1000 hours	± (1.0 % + 0.05 Ω) ΔR



## Wirewound Resistors, Commercial Power, Surface Mount



### FEATURES

- Direct mounting on printed circuit board
- High wattage capabilities, low board temperatures
- Meets or exceeds EIA-RS-344 requirements
- Special inorganic potting compound and ceramic case provide high thermal conductivity in a fireproof package
- Superior surge capability

STANDARD ELECTRICAL SPECIFICATIONS			
GLOBAL MODEL	HISTORICAL MODEL	POWER RATING $P_{40\text{ }^\circ\text{C}}$ W	RESISTANCE RANGE $\Omega$ $\pm 5\%, \pm 10\%$
CPSM03	CPSM-3	3	0.1 - 1K
CPSM05	CPSM-5	5	0.1 - 1K

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	CPSM RESISTOR CHARACTERISTICS
Temperature Coefficient	ppm/ $^\circ\text{C}$	$\pm 600$ below 1.0 $\Omega$ , $\pm 300$ 1.0 $\Omega$ and above
Short Time Overload	-	5 x rated power for 5 seconds
Operating Temperature	$^\circ\text{C}$	- 65/+ 275
Dielectric Withstanding Voltage	$V_{AC}$	1000
Maximum Working Voltage	V	$(P \times R)^{1/2}$
Weight (typical)	g	CPSM03 = 5.5; CPSM05 = 6.5

### GLOBAL PART NUMBER INFORMATION

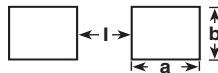
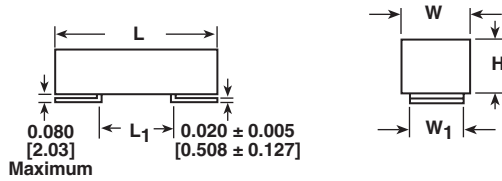
New Global Part Numbering: CPSM0315R00JB31 (preferred part numbering format)

C	P	S	M	0	3	1	5	R	0	0	J	B	3	1			
GLOBAL MODEL CPSM03 CPSM05			VALUE R = decimal K = thousand R1500 = 0.15 $\Omega$ 100R0 = 100 $\Omega$ 1K000 = 1 k $\Omega$				TOLERANCE H = $\pm 3.0\%$ J = $\pm 5.0\%$ K = $\pm 10\%$			PACKAGING E31* = Lead (Pb)-free, 4 layer bulk B31 = Tin/Lead, 4 layer bulk <small>* Lead (Pb)-free will not be available until Q2 2006</small>			SPECIAL (Dash Number) (up to 3 digits) From 1-999 as applicable				

Historical Part Number example: CPSM-3 15  $\Omega$  5% B31 (will continue to be accepted)

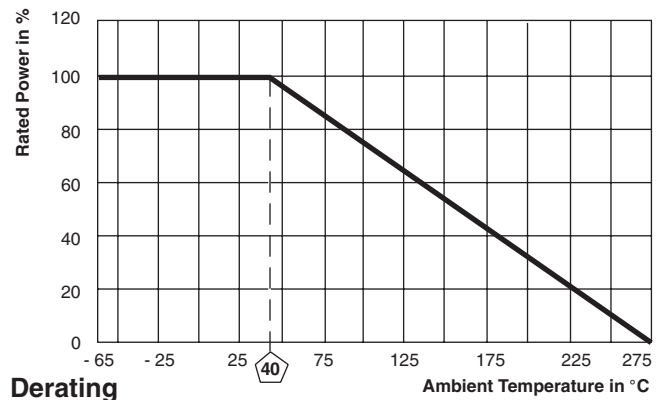
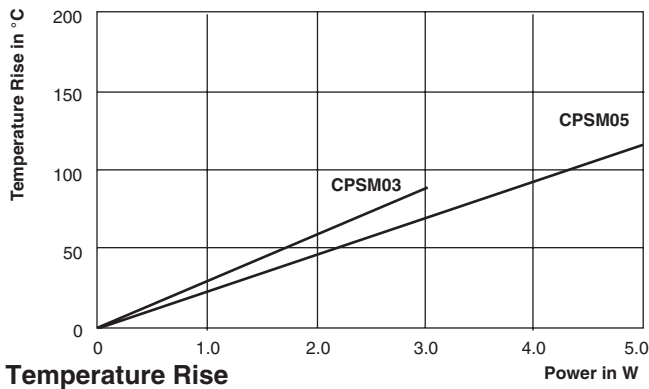
CPSM-3	15 $\Omega$	5%	B31
HISTORICAL MODEL	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

**DIMENSIONS**



MODEL	DIMENSIONS in inches [millimeters]				
	L ± 0.032 [0.813]	W ± 0.031 [0.787]	L <sub>1</sub> ± 0.062 [1.57]	W <sub>1</sub> + 0.032 [0.813] - 0.012 [0.305]	H ± 0.031 [0.787]
CPSM03	0.906 [23.01]	0.374 [9.50]	0.480 [12.19]	0.287 [7.29]	0.374 [9.50]
CPSM05	1.060 [26.92]	0.374 [9.50]	0.590 [14.99]	0.287 [7.29]	0.374 [9.50]

MODEL	SOLDER PAD DIMENSIONS in inches [millimeters]		
	a	b	l
CPSM03	0.420 [10.67]	0.340 [8.64]	0.380 [9.65]
CPSM05	0.440 [11.18]	0.340 [8.64]	0.490 [12.45]



MATERIAL SPECIFICATIONS	
Element	Copper-nickel alloy or nickel-chrome alloy, depending on resistance value
Core	Woven fiberglass
Body	Steatite ceramic case with inorganic potting compound
Terminals	Tin/lead plated steel (Lead (Pb)-free version will be 100 % tin)
Part Marking	DALE, Model, Wattage, Value, Tolerance, Date Code

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST LIMITS (EIA RS-344)
Thermal Shock	- 55 °C to + 165 °C, 5 cycles, 30 minute dwell time	± (5.0 % + 0.05 Ω) ΔR
Short Time Overload	5 x rated power for 5 seconds	± (4.0 % + 0.05 Ω) ΔR
Dielectric Withstanding Voltage	1000 V <sub>rms</sub> for one minute	± (2.0 % + 0.05 Ω) ΔR
Low Temperature Operation	- 65 °C, full rated working voltage for 45 minutes	± (3.0 % + 0.05 Ω) ΔR
Humidity	75 °C, 90 % - 100 % RH, 240 hours	± (5.0 % + 0.05 Ω) ΔR
Load Life	1000 hours at rated power, + 40 °C, 1.5 hours "ON", 0.5 hours "OFF"	± (10.0 % + 0.05 Ω) ΔR
Resistance to Solder Heat	+ 260 °C solder, 10 - 12 second dwell, 25 mm/second emergence	± (4.0 % + 0.05 Ω) ΔR





# SMD Resistor Networks

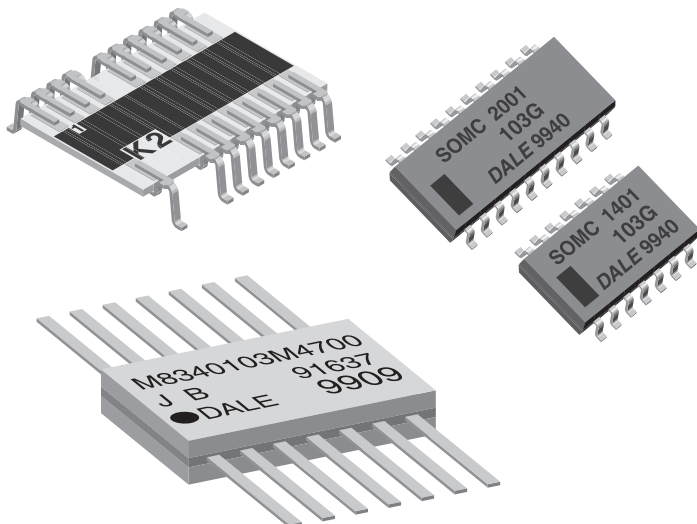
## Model Numbers

SOGC-01, -03, -05.....	320
SOGC-45, -46 .....	324
SOMC .....	326
DFP .....	328
DFM .....	330

SIL, DIL or Custom Configurations

- Isolated, Bussed or TTL-Terminator Circuits

- High Packaging Density



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## Thick Film Resistor Networks, Dual-In-Line Small Outline Molded Dip, 01, 03, 05 Schematics



**FEATURES**

- 0.110" [2.79 mm] maximum seated height
- Rugged, molded case construction
- 0.050" [1.27 mm] lead spacing
- Reduces total assembly costs
- Compatible with automatic surface mounting equipment
- Uniform performance characteristics
- Meets EIA PDP 100, SOGN-0003 outline dimensions
- Available in tube pack or tape and reel pack
- Lead (Pb)-free version is RoHS compliant



STANDARD ELECTRICAL SPECIFICATIONS							
GLOBAL MODEL	SCHEMATIC	RESISTOR CIRCUIT W at 70 °C	PACKAGE POWER W at 70 °C	TOLERANCE ± %	RESISTANCE RANGE Ω	OPERATING VOLTAGE VDC	TEMPERATURE COEFFICIENT ppm/°C
SOGC16	01	0.1	1.6	2 (1, 5 <sup>1</sup> )	10-1M0	50 max	100
	03	0.19	1.6	2 (1, 5 <sup>1</sup> )	10-1M0	50 max	100
	05	0.1	1.6	2 (5 <sup>1</sup> )	10-1M0	50 max	100
SOGC20	01	0.1	2.0	2 (1, 5 <sup>1</sup> )	10-1M0	50 max	100
	03	0.19	2.0	2 (1, 5 <sup>1</sup> )	10-1M0	50 max	100
	05	0.1	2.0	2 (5 <sup>1</sup> )	10-1M0	50 max	100

**Notes**

1. Tolerances in brackets available upon request      • 100 mΩ maximum on 0 Ω jumper

### GLOBAL PART NUMBER INFORMATION

**New Global Part Numbering: SOGC200310K0GDC (preferred part numbering format)**

S	O	G	C	2	0	0	3	1	0	K	0	G	D	C			
GLOBAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING			SPECIAL									
SOGC	16 20	01 = Bussed 03 = Isolated 00 = Special	R = Decimal K = Thousand M = Million 10R0 = 10 Ω 680K = 680 kΩ 1M00 = 1.0 MΩ	F = ± 1 % G = ± 2 % J = ± 5 % S = Special Z = 0 Ω Jumper	EJ = Lead (Pb)-free, Tube EA = Lead (Pb)-free, Tape & Reel DC = Tin/Lead, Tube RZ = Tin/Lead, Tape & Reel			Blank = Standard (Dash Number) (up to 3 digits) From 1-999 as applicable									

**Historical Part Number example: SOGC2003103G (will continue to be accepted)**

SOGC	20	03	103	G	D02
HISTORICAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

**New Global Part Numbering: SOGC1605131AGRZ (preferred part numbering format)**

S	O	G	C	1	6	0	5	1	3	1	A	G	R	Z			
GLOBAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING			SPECIAL									
SOGC	16 20	05 = Dual Terminator	3 digit Impedance code, followed by Alpha modifier (see Impedance Codes table)	F = ± 1 % G = ± 2 % J = ± 5 %	EJ = Lead (Pb)-free, Tube EA = Lead (Pb)-free, Tape & Reel DC = Tin/Lead, Tube RZ = Tin/Lead, Tape & Reel			Blank = Standard (Dash Number) (up to 3 digits) From 1-999 as applicable									

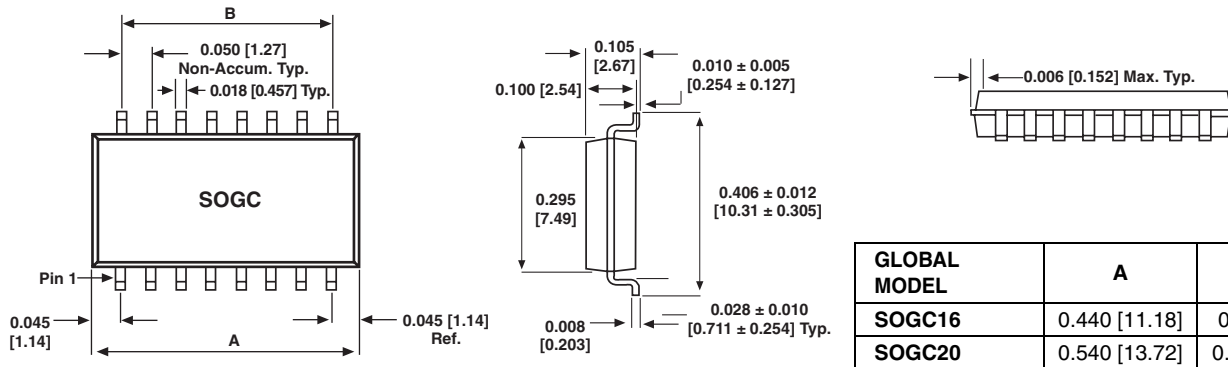
**Historical Part Number example: SOGC1605221331G (will continue to be accepted)**

SOGC	16	05	221	331	G	R61
HISTORICAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE 1	RESISTANCE VALUE 2	TOLERANCE CODE	PACKAGING

\* Pb containing terminations are not RoHS compliant, exemptions may apply



**DIMENSIONS** in inches [millimeters]

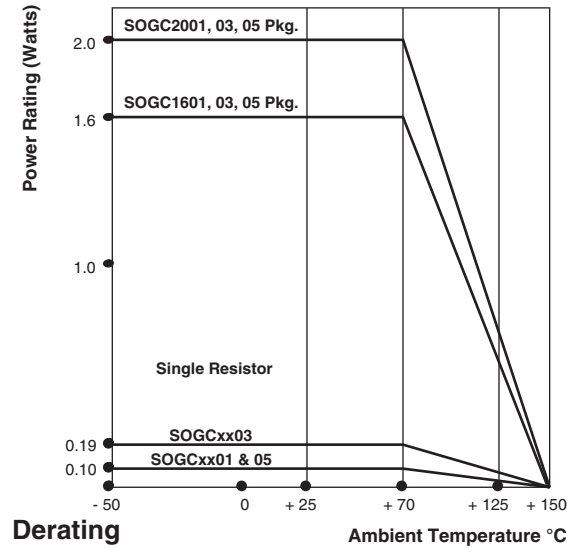


TECHNICAL SPECIFICATIONS			
PARAMETER	UNIT	SOGC16	SOGC20
Package Power Rating (max. at + 70 °C)	W	1.6	2.0
TCR Tracking (- 55 °C to + 125 °C)	ppm/°C	± 50	
Voltage Coefficient of Resistance	ppm/V	< 50 typical	
Maximum Operating Voltage	VDC	50	
Operating Temperature Range	°C	- 55 to + 125	
Storage Temperature Range	°C	- 55 to + 150	

MECHANICAL SPECIFICATIONS	
Marking	Model number, schematic number, value tolerance, pin 1 indicator, date code
Marking Resistance to Solvents	Permanency testing per MIL-STD-202, Method 215
Maximum Solder Reflow Temperature	+ 255 °C
Solderability	Per MIL-STD-202, Method 208E
Terminals	Copper alloy. Solder dipped terminal
Body	Molded epoxy

IMPEDANCE CODES					
CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)	CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)
500B	82	130	141A	270	270
750B	120	200	181A	330	390
800C	130	210	191A	330	470
990A	160	260	221B	330	680
101C	180	240	281B	560	560
111C	180	270	381B	560	1.2K
121B	180	390	501C	620	2.7K
121C	220	270	102A	1.5K	3.3K
131A	220	330	202B	3K	6.2K

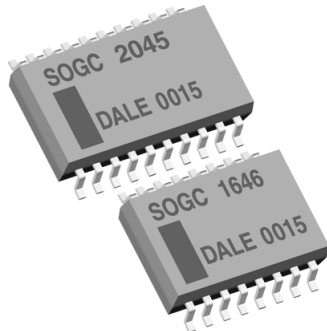
CIRCUIT APPLICATIONS	
<p><b>01 Schematic</b></p>	<p>15 or 19 resistors with one pin common</p> <p>The SOGCxx01 circuit provides a choice of 15 or 19 nominally equal resistors, each connected between a common lead (16 or 20) and a discrete PC board pin. Commonly used in the following applications:</p> <ul style="list-style-type: none"> <li>• MOS/ROM Pull-up/Pull-down</li> <li>• Open Collector Pull-up</li> <li>• "Wired OR" Pull-up</li> <li>• Power Driven Pull-up</li> <li>• TTL Input Pull-down</li> <li>• Digital Pulse Squaring</li> <li>• TTL Unused Gate Pull-up</li> <li>• High Speed Parallels Pull-up</li> </ul>
<p><b>03 Schematic</b></p>	<p>8 or 10 isolated resistors</p> <p>The SOGCxx03 circuit provides a choice of 8 or 10 nominally equal resistors with each resistor isolated from all others and wired directly across. Commonly used in the following applications:</p> <ul style="list-style-type: none"> <li>• "Wired OR" Pull-up</li> <li>• Power Driven Pull-up</li> <li>• Powergate Pull-up</li> <li>• Line Termination</li> <li>• Long-line Impedance Balancing</li> <li>• LED Current Limiting</li> <li>• ECL Output Pull-down</li> <li>• TTL Input Pull-down</li> </ul>
<p><b>05 Schematic</b></p>	<p>TTL dual-line terminator; pulse squaring, 14 or 18 pairs of resistors (R<sub>1</sub> Resistors are common to leads 16 or 20) (R<sub>2</sub> Resistors are common to leads 8 or 10)</p> <p>The SOGCxx05 circuit contains 14 or 18 pairs of resistors. Each pair is connected between ground and a common line. The junctions of these resistor pairs are connected to the input leads.</p> <p>The 05 circuits are designed for TTL dual-line termination and pulse squaring.</p>



<b>PERFORMANCE</b>	
<b>TEST</b>	<b>MAX. <math>\Delta R</math> (TYPICAL TEST LOTS)</b>
Power Conditioning	$\pm 0.50\% \Delta R$
Thermal Shock	$\pm 0.50\% \Delta R$
Short Time Overload	$\pm 0.25\% \Delta R$
Low Temperature Operation	$\pm 0.25\% \Delta R$
Moisture Resistance	$\pm 0.50\% \Delta R$
Resistance to Soldering Heat	$\pm 0.25\% \Delta R$
Shock	$\pm 0.25\% \Delta R$
Vibration	$\pm 0.25\% \Delta R$
Load Life	$\pm 0.50\% \Delta R$
Terminal Strength	$\pm 0.25\% \Delta R$
Insulation Resistance	10 000 M $\Omega$ (minimum)
Dielectric Withstanding Voltage	No evidence of arcing or damage (200 V RMS for 1 minute)



## Thick Film Resistor Networks, Dual-In-Line Small Outline Molded Dip 45 & 46 Schematics



### FEATURES

- 0.110" [2.79] maximum seated height
- Rugged, molded case construction
- 0.050" [1.27] lead spacing
- Reduces total assembly costs
- Compatible with automatic surface mounting equipment
- Uniform performance characteristics
- Meets EIA PDP 100, SOGN-0003 outline dimensions
- Available in tube pack or tape and reel pack
- Lead (Pb)-free version is RoHS compliant



Available



**RoHS\***  
COMPLIANT

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	CIRCUIT SCHEMATIC	RESISTOR CIRCUIT W at 70 °C	PACKAGE POWER W at 70 °C	TOLERANCE ± %	RESISTANCE VALUES Ω	OPERATING VOLTAGE VDC	TEMPERATURE COEFFICIENT ± ppm/°C
SOGC16	45	0.1	1.6	2	180, 270, 820	50 max	100
	46	0.1	1.6	2	330, 150, 330	50 max	100
SOGC20	45	0.1	2.0	2	180, 270, 820	50 max	100
	46	0.1	2.0	2	330, 150, 330	50 max	100

### TECHNICAL SPECIFICATIONS

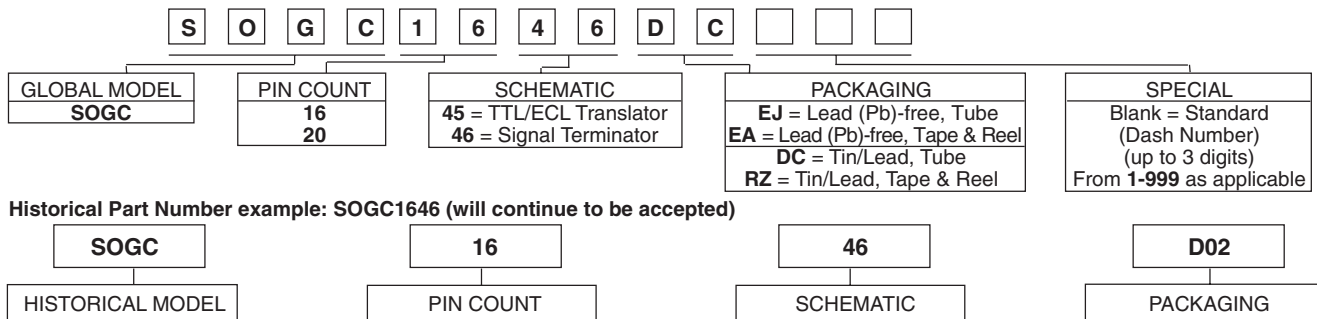
PARAMETER	UNIT	SOGC16	SOGC20
Package Power Rating (Maximum at + 70 °C)	W	1.6	2.0
TCR Tracking (- 55 °C to + 125 °C)	ppm/°C	± 50	
Voltage Coefficient of Resistance	ppm/V	< 50 typical	
Maximum Operating Voltage	VDC	50	
Operating Temperature Range	°C	- 55 to + 125	
Storage Temperature Range	°C	- 55 to + 150	

### MECHANICAL SPECIFICATIONS

Marking	Model number, schematic number, value, tolerance, pin 1 indicator, date code
Marking Resistance to Solvents	Permanency testing per MIL-STD-202, Method 215
Maximum Solder Reflow Temperature	+ 255 °C
Solderability	Per MIL-STD-202, Method 208E
Terminals	Copper alloy. Solder dipped terminal
Body	Molded epoxy

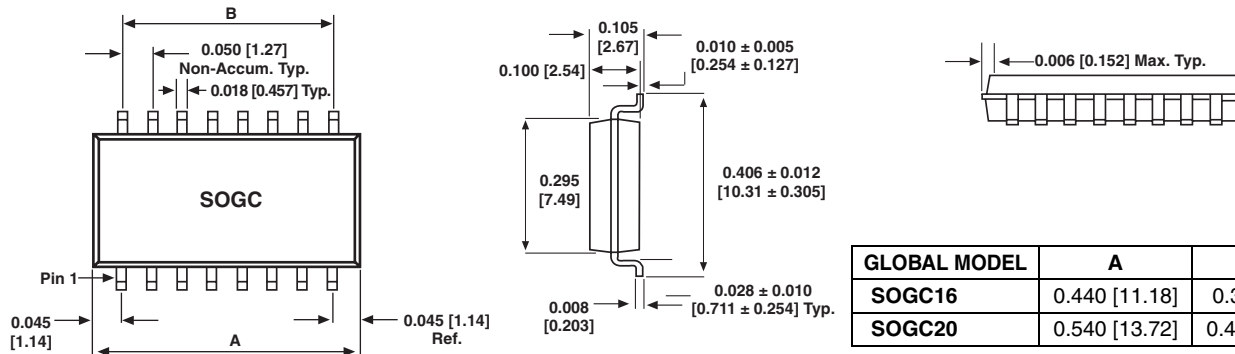
### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: SOGC1646DC (preferred part numbering format)



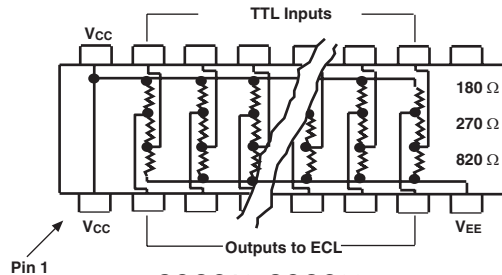
\* Pb containing terminations are not RoHS compliant, exemptions may apply

### DIMENSIONS in inches [millimeters]



### CIRCUIT APPLICATIONS

#### 45 Schematic

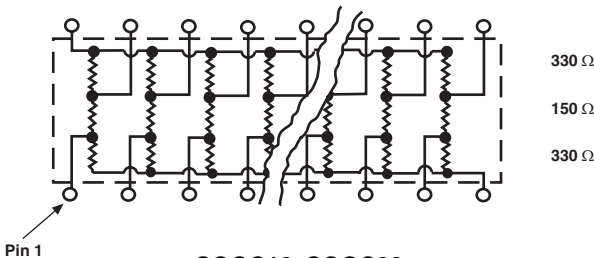


SOGC16, SOGC20

#### TTL to ECL translator

The SOGCxx45 network consists of resistors of 3 different values, internally divided into 6 or 8 identical three (3) resistor sections for TTL to ECL translation.

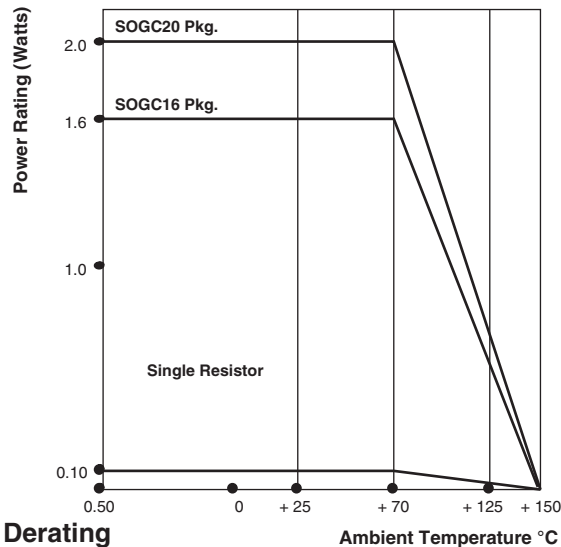
#### 46 Schematic



SOGC16, SOGC20

#### SCSI-BUS signal terminator

The SOGCxx46 network consists of resistors of 2 different values, internally divided into 7 or 9 identical three (3) resistor sections for SCSI-BUS terminator applications.



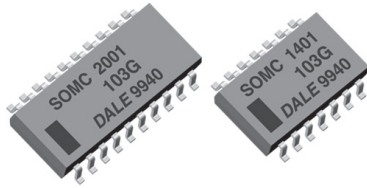
Derating

### PERFORMANCE

TEST	MAX. ΔR (TYPICAL TEST LOTS)
Power Conditioning	± 0.50 % ΔR
Thermal Shock	± 0.50 % ΔR
Short Time Overload	± 0.25 % ΔR
Low Temperature Operation	± 0.25 % ΔR
Moisture Resistance	± 0.50 % ΔR
Resistance to Soldering Heat	± 0.25 % ΔR
Shock	± 0.25 % ΔR
Vibration	± 0.25 % ΔR
Load Life	± 0.50 % ΔR
Terminal Strength	± 0.25 % ΔR
Insulation Resistance	10 000 MΩ (minimum)
Dielectric Withstanding Voltage	No evidence of arcing or damage (200 V RMS for 1 minute)

• Test methods per MIL-STD-202

## Thick Film, Dual-in-Line Resistor Networks



### FEATURES

- 14, 16 or 20 terminal package
- Isolated, bussed or TTL-terminator circuits
- Molded case construction
- Thick film resistive elements
- Reflow solderable
- Compatible with automatic surface mounting equipment
- Reduces total assembly costs
- For wave flow soldering contact factory
- Lead (Pb)-free version is RoHS compliant



RoHS\*  
COMPLIANT

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	ELEMENT $P_{70^\circ\text{C}}$ W	PACKAGE POWER RATING $P_{70^\circ\text{C}}$ W			CIRCUIT	LIMITING ELEMENT VOLTAGE MAX. $V_{\equiv}$	TEMPERATURE COEFFICIENT <sup>1)</sup> ppm/°C	TOL. %	RESISTANCE RANGE $\Omega$	E-SERIES
		14	16	20						
SOMC	0.08 0.16 0.08	1.05 1.125 1.05	1.20 1.28 1.20	1.52 1.60 1.52	01 03 05	50	100	1, 2, 5 1, 2, 5 1, 2, 5	10R - 1M	24

#### Notes

1. Temperature Range: - 55 °C to + 125 °C
- Power rating depends on the max. temperature at the solder point, the component placement density and the substrate material
  - Jumper: Zero-Ohm-Resistor on request (100 m $\Omega$ )
  - Packaging: according to EIA; see appropriate catalog or web page

### TECHNICAL SPECIFICATIONS

PARAMETER	UNIT	01 CIRCUIT	03 CIRCUIT	05 CIRCUIT
Rated Dissipation at 70 °C per Element	W	0.08	0.16	0.08
Limiting Element Voltage <sup>1)</sup>	$V_{\equiv}$	50		
Voltage Coefficient	ppm/V		< 50	
Insulation Voltage (1 min)	$V_{dc/ac}$ peak		200	
Category Temperature Range	°C		- 55/+ 150	
Insulation Resistance	$\Omega$		> 10 <sup>10</sup>	
TC Tracking (- 55 °C to + 125 °C)	ppm/°C		50	

Note: 1. Rated voltage:  $\sqrt{P \times R}$

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: SOMC16011K00GDC (preferred part numbering format)

S O M C 1 6 0 1 1 K 0 0 G D C

GLOBAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING	SPECIAL
SOMC	14 16 20	01 = Bussed 03 = Isolated 00 = Special	R = Decimal K = Thousand M = Million 10R0 = 10 $\Omega$ 680K = 680 k $\Omega$ 1M00 = 1.0 M $\Omega$	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$ S = Special	EJ = Lead (Pb)-free, Tube EA = Lead (Pb)-free, Tape & Reel DC = Tin/Lead, Tube RZ = Tin/Lead, Tape & Reel	Blank = Standard (Dash Number) (up to 3 digits) From 1-999 as applicable

Historical Part Number example: SOMC1601102G (will continue to be accepted)

SOMC 16 01 102 G D02

New Global Part Numbering: SOMC2005500BGRZ (preferred part numbering format)

S O M C 2 0 0 5 5 0 0 B G R Z

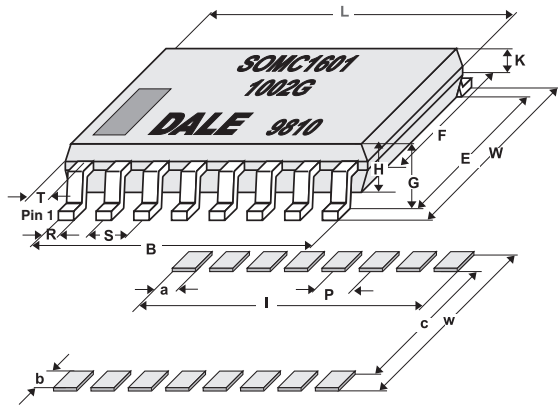
GLOBAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING	SPECIAL
SOMC	14 16 20	05 = Dual Terminator	3 digit Impedance code, followed by Alpha modifier (see Impedance table)	F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$	EJ = Lead (Pb)-free, Tube EA = Lead (Pb)-free, Tape & Reel DC = Tin/Lead, Tube RZ = Tin/Lead, Tape & Reel	Blank = Standard (Dash Number) (up to 3 digits) From 1-999 as applicable

Historical Part Number example: SOMC2005820131G (will continue to be accepted)

SOMC 20 05 810 131 G R61

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**DIMENSIONS**



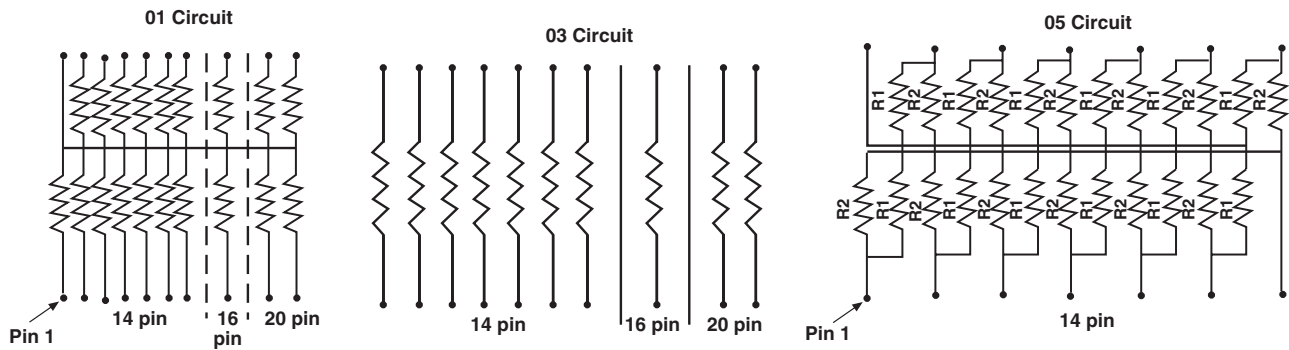
SOLDER PAD DIMENSIONS in inches [millimeters]						
	a	b	c	l	p	w
WAVE	0.64	1.91	5.34	9.53	1.27	9.15
REFLOW	0.64	1.91	5.34	9.53	1.27	9.15

The dimension shown are for a 16 pin part. For parts with different pin numbers use the same pitch and add or subtract pads as required.

**Note:** Maximum solder reflow temperature + 255 °C

DIMENSIONS [in millimeters]											
PIN NO#	L	W	B	E	F	G	H	K	R	S	T
14	9.91	7.62	7.62	6.20	5.59	2.16	2.03	0.914	0.457	1.27	1.14
16	11.18	7.62	8.89	6.20	5.59	2.16	2.03	0.914	0.457	1.27	1.14
20	13.72	7.62	11.43	6.20	5.59	2.16	2.03	0.914	0.457	1.27	1.14
Tol	±0.254	±0.381	±0.254	±0.381	±0.127	±0.127	±0.127				±0.254

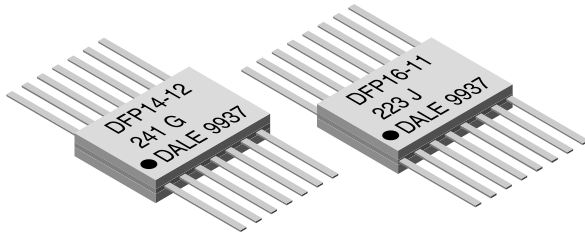
**CIRCUIT SCHEMATICS**



IMPEDANCE CODES					
CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)	CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)
500B	82	130	141A	270	270
750B	120	200	181A	330	390
800C	130	210	191A	330	470
990A	160	260	221B	330	680
101C	180	240	281B	560	560
111C	180	270	381B	560	1.2K
121B	180	390	501C	620	2.7K
121C	220	270	102A	1.5K	3.3K
131A	220	330	202B	3K	6.2K

PERFORMANCE		
TEST	CONDITIONS OF TEST	TEST RESULTS
Power Conditioning	MIL STD-202	± 0.5 %
Load Life at 70 °C	MIL STD-202	± 0.5 %
Short Time Overload	MIL STD-202	± 0.25 %
Thermal Shock	MIL STD-202	± 0.5 %
Moisure Resistance	MIL STD-202	± 0.5 %
Resistance to Soldering Heat	MIL STD-202	± 0.25 %
Low Temperature Operation	MIL STD-202	± 0.25 %
Vibration	MIL STD-202	± 0.25 %
Shock	MIL STD-202	± 0.25 %
Terminal Strength	MIL STD-202	± 0.25 %

## Thick Film Resistor Networks Flat Pack, 11, 12 Schematics



### FEATURES

- 11 and 12 Schematics
- 0.065" [1.65 mm] height for high density packaging
- Low temperature coefficient (- 55 °C to + 125 °C) ± 100 ppm/°C
- Hot solder dipped leads
- Highly stable thick film
- Wide resistance range
- All devices are capable of passing the MIL-STD-202, Method 210, Condition C "Resistance to Soldering Heat" test

### STANDARD ELECTRICAL SPECIFICATIONS

GLOBAL MODEL	POWER RATING		CIRCUIT SCHEMATIC	LIMITING ELEMENT VOLTAGE MAX. V <sub>≡</sub>	TEMPERATURE <sup>1)</sup> COEFFICIENT ppm/°C	STANDARD <sup>2)</sup> TOLERANCE %	RESISTANCE RANGE Ω	TEMPERATURE COEFFICIENT TRACKING ppm/°C
	P <sub>25 °C</sub> ELEMENT W	P <sub>25 °C</sub> PACKAGE W						
DFP	0.25	0.65	11	75	± 100	2	10 - 1M	50
	0.15	0.65	12	75	± 100	2	10 - 1M	50

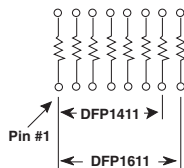
**Notes**

1. Temperature Range: - 55 °C to + 125 °C
2. ± 1 % and ± 5 % tolerance available

- Consult factory for stocked values

### TECHNICAL SPECIFICATIONS

**11 Schematic**

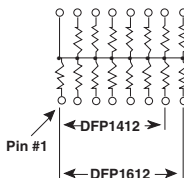


7 or 8 isolated resistors

The DFPxx11 provides the user with 7 or 8 nominally equal resistors with each resistor isolated from all others. Commonly used in the following applications:

- "Wired OR" Pull-up
- Power Driven Pull-up
- Power Gate Pull-up
- Line Termination
- Long-line Impedance Balancing
- LED Current Limiting
- ECL Output Pull-down
- TTL Input Pull-down

**12 Schematic**



13 or 15 resistors with one pin common

The DFPxx12 provides the user with a choice of 13 or 15 nominally equal resistors, each connected to a common pin (14 or 16). Commonly used in the following applications:

- MOS/ROM Pull-up/Pull-down
- Open Collector Pull-up
- "Wired OR" Pull-up
- Power Driven Pull-up
- TTL Input Pull-down
- Digital Pulse Squaring
- TTL Unused Gate Pull-up
- High Speed Parallel Pull-up

### GLOBAL PART NUMBER INFORMATION

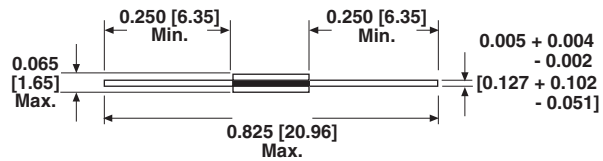
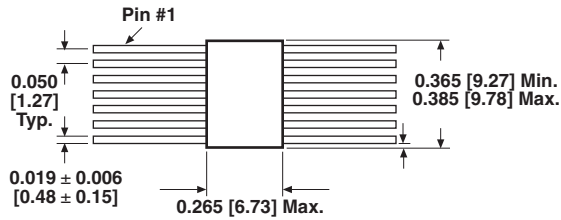
New Global Part Numbering: DFP14121K00GD05 (preferred part numbering format)



GLOBAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING	SPECIAL
DFP	14 16	11 = Isolated 12 = Bussed	R = Decimal K = Thousand M = Million 10R0 = 10 Ω 680K = 680 kΩ 1M00 = 1.0 MΩ	F = ± 1 % G = ± 2 % J = ± 5 %	E05 = Lead (Pb)-free, Tube D05 = Tin/Lead, Tube	Blank = Standard (Dash Number) (up to 3 digits) From 1-999 as applicable

Historical Part Number example: DFP1412102G (will continue to be accepted)

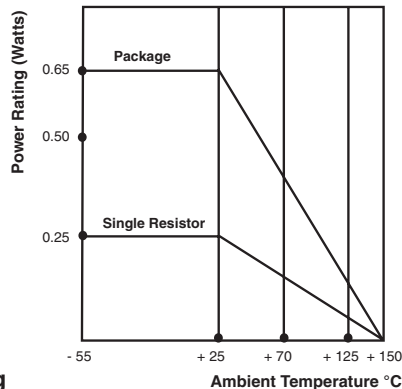
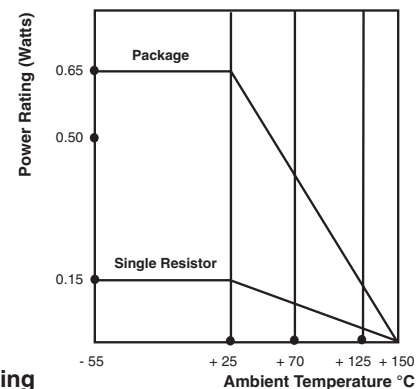
DFP	14	12	102	G	D05
HISTORICAL MODEL	PIN COUNT	SCHEMATIC	RESISTANCE VALUE	TOLERANCE CODE	PACKAGING

**DIMENSIONS** in inches [millimeters]


GLOBAL MODEL	DIMENSION A
DFP14	0.037 ± 0.010 [0.94 ± 0.25]
DFP16	0.012 ± 0.010 [0.30 ± 0.25]

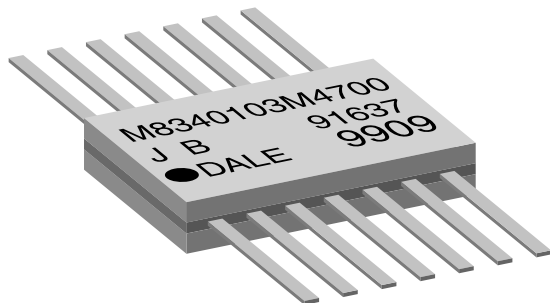
TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	DFP14/16
Isolation Resistance 11 Schematic	MΩ	> 100
Voltage Coefficient of Resistance	ppm/V	< 50 typical
Maximum Operating Voltage	VDC	75
Operating Temperature Range	°C	- 55 to + 125
Storage Temperature Range	°C	- 55 to + 150

MECHANICAL SPECIFICATIONS	
Marking	Model number, schematic number, value tolerance, pin 1 indicator, date code.
Marking Resistance to Solvents	Permanency testing per MIL-STD-202 Method 215.
Solderability	Per MIL-STD-202, Method 208E.
Terminals	Per MIL-STD-1276 DFPxx11, DFPxx12 = Type G (hot solder dipped). Hot solder dipped leads supplied as standard finish.
Body	Epoxy filled ceramic sandwich

**11 Schematic**

**Derating**
**12 Schematic**

**Derating**

PERFORMANCE		
TEST	CONDITIONS	MAX. ΔR (Typical Test Lots)
Power Conditioning	1.5 x rated power, applied 1.5 hours "ON" and 0.5 hour "OFF" for 100 hours ± 4 hours at + 25 °C ambient temperature	± 0.50 % ΔR
Thermal Shock	5 cycles between - 65 °C and + 125 °C	± 0.50 % ΔR
Short Time Overload	2.5 x rated working voltage, 5 seconds	± 0.25 % ΔR
Low Temperature Operation	45 minutes at full rated working voltage at - 65 °C	± 0.25 % ΔR
Moisture Resistance	240 hours with humidity ranging from 80 % RH to 98 % RH	± 0.50 % ΔR
Resistance to Soldering Heat	Leads immersed in + 260 ° ΔC solder to within 1/16" of body for 10 seconds	± 0.25 % ΔR
Shock	Total of 18 shocks at 100 g's	± 0.25 % ΔR
Vibration	12 hours at maximum of 20 g's between 10 and 2000 Hz	± 0.25 % ΔR
Load Life	1000 hours at + 70 °C, rated power applied 1.5 hours "ON", 0.5 hour "OFF" for full 1000 hour period. Derated according to the curve.	± 0.50 % ΔR
Terminal Strength	1.5 pound pull for 30 seconds	± 0.25 % ΔR
Insulation Resistance	10 000 Megohm (minimum)	-
Dielectric Withstanding Voltage	No evidence of arcing or damage (200 V RMS for 1 minute)	-

## Thick Film Resistor Networks, Military, MIL-PRF-83401 Qualified, Type RZ030, Schematics A (11), B (12), J (15)



### FEATURES

- 11, 12, 15 Schematics; hot-solder dipped
- MIL-PRF-83401 qualified
- Thick film resistive elements
- TCR available in "K" ( $\pm 100$  ppm/ $^{\circ}$ C) or "M" ( $\pm 300$  ppm/ $^{\circ}$ C) characteristic
- 100 % screen tested per Group A, Subgroup 1 of MIL-PRF-83401
- 0.065" [1.65 mm] height for high density packaging

### STANDARD ELECTRICAL SPECIFICATIONS

VISHAY DALE MODEL	POWER RATING		CIRCUIT SCHEMATIC	LIMITING ELEMENT VOLTAGE MAX. V $\equiv$	TEMPERATURE COEFFICIENT <sup>1)</sup> (- 55 $^{\circ}$ C to + 125 $^{\circ}$ C)	STANDARD <sup>2)</sup> TOLERANCE %	RESISTANCE RANGE $\Omega$
	P <sub>70</sub> $^{\circ}$ C ELEMENT W	P <sub>70</sub> $^{\circ}$ C PACKAGE W					
DFM	0.050	0.350	11	50	K, M	2	10R0 - 1M0
	0.025	0.325	12	50	K, M	2	10R0 - 1M0
	0.015	0.350	15	50	K, M	2	see table

**Notes**

1. K =  $\pm 100$  ppm/ $^{\circ}$ C; M =  $\pm 300$  ppm/ $^{\circ}$ C
2.  $\pm 1$  % and  $\pm 5$  % tolerance available

- Consult factory for stocked values

### GLOBAL PART NUMBER INFORMATION

New Global Part Numbering: M8340103M6801GAD05 (preferred part numbering format)

M 8 3 4 0 1 0 3 M 6 8 0 1 G A D 0 5

MIL STYLE	SPEC SHEET	CHARACTERISTIC	RESISTANCE VALUE	TOLERANCE	SCHEMATIC	PACKAGING
M83401	03	K = 100 ppm M = 300 ppm	3 digit significant figure, followed by a multiplier 10R0 = 10 $\Omega$ 3302 = 33 k $\Omega$ 1004 = 1 M $\Omega$	F = $\pm 1$ % G = $\pm 2$ % J = $\pm 5$ %	A = Isolated B = Bussed	D05 = Tin/Lead, Tube

Historical Part Number example: M8340103M6801GA (will continue to be accepted)

M83401 03 M 6801 G A D05

MIL STYLE	SPEC SHEET	CHARACTERISTIC	RESISTANCE VALUE	TOLERANCE	SCHEMATIC	PACKAGING
M83401	03	M	6801	G	A	D05

New Global Part Numbering: M8340103KA001GJD05 (preferred part numbering format)

M 8 3 4 0 1 0 3 K A 0 0 1 G J D 0 5

MIL STYLE	SPEC SHEET	CHARACTERISTIC	RESISTANCE VALUE	TOLERANCE	SCHEMATIC	PACKAGING
M83401	03	K = 100 ppm M = 300 ppm	Per Std. MIL. Spec (see Impedance Codes table)	F = $\pm 1$ % G = $\pm 2$ % J = $\pm 5$ %	J = Dual Terminator	D05 = Tin/Lead, Tube

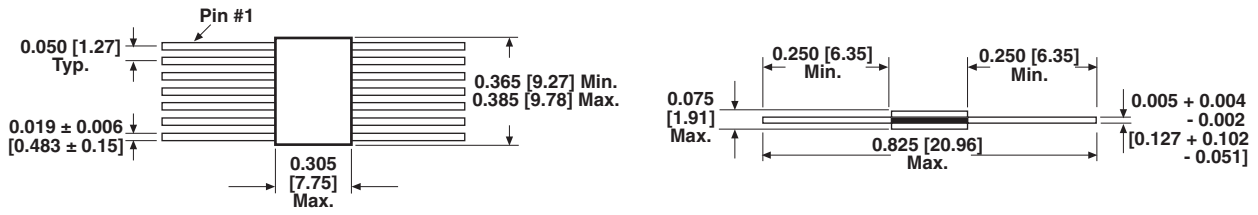
Historical Part Number example: M8340103KA001GJ (will continue to be accepted)

M83401 03 K A001 G J D05

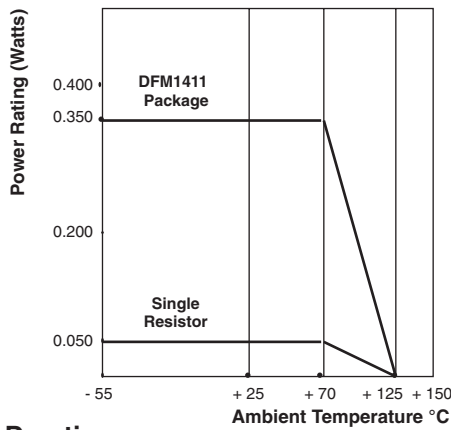
MIL STYLE	SPEC SHEET	CHARACTERISTIC	RESISTANCE VALUE	TOLERANCE	SCHEMATIC	PACKAGING
M83401	03	K	A001	G	J	D05



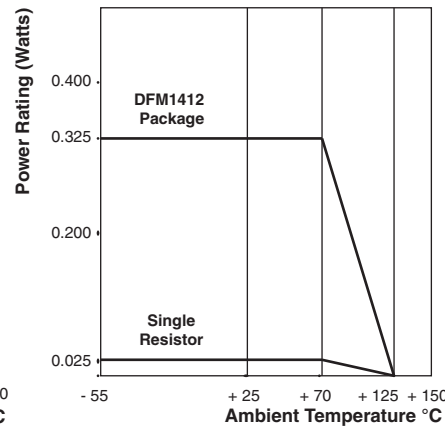
**DIMENSIONS** in inches [millimeters]



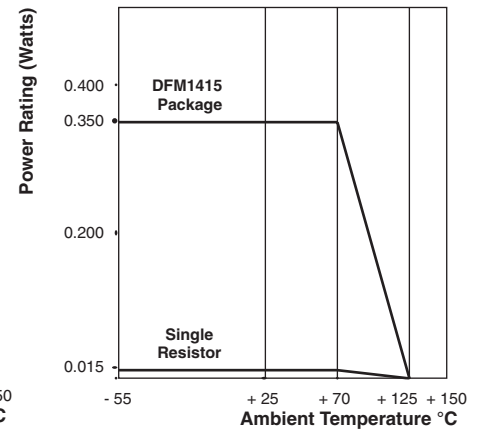
**11 Schematic**



**12 Schematic**



**15 Schematic**



**Derating**

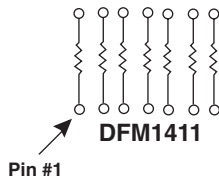
<b>MECHANICAL SPECIFICATIONS</b>	
Marking Resistance to Solvents	Permanency testing per MIL-PRF-83401
Solderability	Per MIL-PRF-83401
Terminals	Per MIL-STD-1276 DFM1411, DFM1412 and DFM1415 = Type G (hot solder dipped) Hot solder dipped leads supplied as standard finish.
Body	Epoxy filled ceramic sandwich

<b>IMPEDANCE CODES</b>					
CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)	CODE	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)
A001	82	130	A010	330	470
A002	120	200	A011	330	680
A003	130	210	A012	1.5K	3.3K
A004	160	260	A013	3K	6.2K
A005	180	240	A014	180	270
A006	180	390	A015	270	270
A007	220	270	A016	560	560
A008	220	330	A017	560	1.2K
A009	330	390	A018	620	2.7K



## CIRCUIT APPLICATIONS

### 11 Schematic



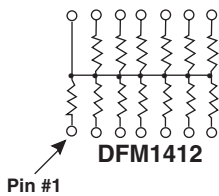
#### DFM1411 (M8340103xxxxxA)

7 isolated resistors

The DFM1411 provides the user with 7 nominally equal resistors with each resistor isolated from all others. Commonly used in the following applications:

- "Wired OR" Pull-up
- Line Termination
- LED Current Limiting
- Power Driven Pull-up
- ECL Output Pull-down
- Power Gate Pull-up
- TTL Input Pull-down
- Long-line Impedance balancing

### 12 Schematic



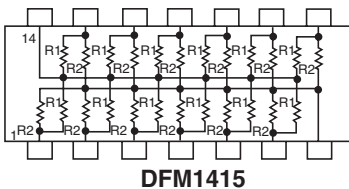
#### DFM1412 (M8340103xxxxxB)

13 resistors with one pin common

The DFM1412 provides the user with a choice of 13 nominally equal resistors, each connected to a common pin. Commonly used in the following applications:

- MOS/ROM Pull-up/
- "Wired OR" Pull-up
- Digital Pulse Squaring
- Pull-down
- Power Driven Pull-up
- TTL Input Pull-down
- Open Collector Pull-up
- TTL Unused Gate Pull-up
- High Speed Parallel Pull-up

### 15 Schematic



#### DFM1415 (M8340103xxxxxJ)

12 pairs of resistors

The DFM1415 provides the user with a choice of 12 pairs of R1/R2 resistor values for pulse squaring and TTL dual-line terminating requirements.

**CAGE CODE: 91637**



## DFM (Military M83401)

Thick Film Resistor Networks, Military, MIL-PRF-83401  
Qualified, Type RZ030, Schematics A (11), B (12), J (15)

Vishay Dale

PERFORMANCE		
TEST	CONDITIONS	MAX. $\Delta R$ (Typical Test Lots)
Power Conditioning	1.5 x rated power, applied 1.5 hours "ON" and 0.5 hours "OFF" for 100 hours $\pm$ 4 hours at + 25 °C ambient temperature	$\pm$ 0.50 % $\Delta R$
Thermal Shock	5 cycles between - 65 °C and + 125 °C	$\pm$ 0.50 % $\Delta R$
Short Time Overload	2.5 x rated working voltage, 5 seconds	$\pm$ 0.25 % $\Delta R$ (Char. K) $\pm$ 0.50 % $\Delta R$ (Char. M)
Low Temperature Operation	45 minutes at full rated working voltage at - 65 °C	$\pm$ 0.25 % $\Delta R$ (Char. K) $\pm$ 0.50 % $\Delta R$ (Char. M)
Moisture Resistance	240 hours with humidity ranging from 80 % RH to 98 % RH	$\pm$ 0.50 % $\Delta R$
Resistance to Soldering Heat	Leads immersed in + 260 °C solder to within 1/16" of body for 10 seconds	$\pm$ 0.25 % $\Delta R$
Shock	Total of 18 shocks at 100 g's	$\pm$ 0.25 % $\Delta R$
Vibration	12 hours at maximum of 20 g's between 10 and 2000 Hz	$\pm$ 0.25 % $\Delta R$
Load Life	1000 hours at + 70 °C, rated power applied 1.5 hours "ON", 0.5 hour "OFF" for full 1000 hour period	$\pm$ 0.50 % $\Delta R$ (Char. K) $\pm$ 2.0 % $\Delta R$ (Char. M)
Terminal Strength	1.5 pound pull for 30 seconds	$\pm$ 0.25 % $\Delta R$
Insulation Resistance	10 000 M $\Omega$ (minimum)	-
Dielectric Withstanding Voltage	No evidence of arcing or damage (200 V RMS for 1 minute)	-

## Resistor Marking

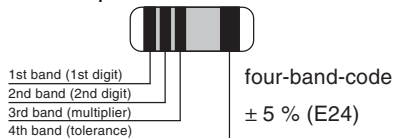
MARKING OF CHIP RESISTOR STYLE 0603 - 2512											
2 % (E24), 5 %, 10 %		≤ 1 %, 2 % (E48/E96)									
NOMINAL VALUE		MARKING		NOMINAL VALUE		MARKING					
0.1 Ω	to	0.91 Ω	R10	to	R91	0.1 Ω	to	0.976 Ω	R100	to	R976
1 Ω	to	9.1 Ω	1R0	to	9R1	1 Ω	to	9.76 Ω	1R00	to	9R76
10 Ω	to	91 Ω	100	to	910	10 Ω	to	97.6 Ω	10R0	to	97R6
100 Ω	to	910 Ω	101	to	911	100 Ω	to	976 Ω	1000	to	9760
1 kΩ	to	9.1 kΩ	102	to	912	1 kΩ	to	9.76 kΩ	1001	to	9761
10 kΩ	to	91 kΩ	103	to	913	10 kΩ	to	97.6 kΩ	1002	to	9762
100 kΩ	to	910 kΩ	104	to	914	100 kΩ	to	976 kΩ	1003	to	9763
1 MΩ	to	9.1 MΩ	105	to	915	1 MΩ	to	97.6 MΩ	1004	to	9764
10 MΩ	to	91 MΩ	106	to	916	10 MΩ	to	97.6 MΩ	1005	to	9765
100 MΩ	to	910 MΩ	107	to	917	100 MΩ	to	976 MΩ	1006	to	9766

### MARKING OF MELF-RESISTOR STYLES 0102, 0204, 0207

Color code acc. to IEC-publ. 62

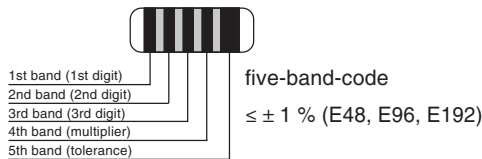
Type:

SMM0204 MS1



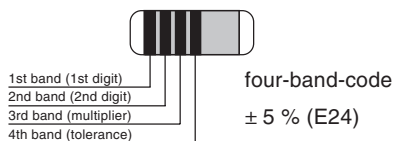
Type:

SMM0102  
SMM0204 MS1  
PMM0204<sup>1)</sup>



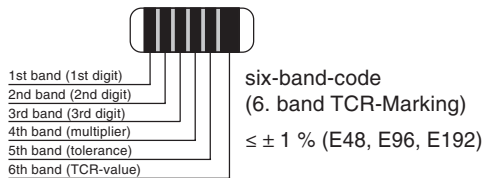
Type:

SMM0207



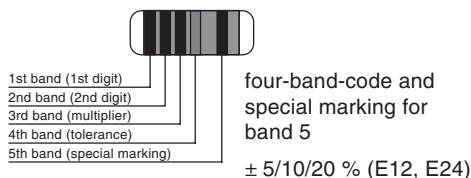
Type:

SMM0207  
PMM0207



Type:

LCM0207SI  
NMM0207SI



### COLOR CODE

COLOR	DIGIT	MULTIPLIER	TOLERANCE
None			± 20 %
silver		10 <sup>-2</sup>	± 10 %
gold		10 <sup>-1</sup>	± 5 %
black	0	10 <sup>0</sup>	
brown	1	10 <sup>1</sup>	± 1 %
red	2	10 <sup>2</sup>	± 2 %
orange	3	10 <sup>3</sup>	
yellow	4	10 <sup>4</sup>	
green	5	10 <sup>5</sup>	± 0.5 %
blue	6	10 <sup>6</sup>	± 0.25 %
violet	7	10 <sup>7</sup>	± 0.1 %
grey	8	10 <sup>8</sup>	
white	9	10 <sup>9</sup>	

### TEMPERATURE COEFFICIENT MARKING

TCR ppm/K	COLOR CODE 6 <sup>TH</sup> BAND
± 100	brown
± 50	red
± 25	yellow
± 15	orange
± 10	blue
± 5	violet

**Note**

1. PMM0204: TCR-Marking on label only



## Standard Electronic Decade Value Tables

### STANDARD DECADE RESISTANCE VALUES

The following table lists four established number series which are used as preferred values in electronic design. Each series is shown under an associated value of tolerance %. The number series under the  $\pm 10\%$  column is known as the E12 Series because there are 12 standard values within a decade range.  $\pm 2\%$  and  $\pm 5\%$  utilize the E24 Series,  $\pm 1\%$  uses E96 and  $\pm 0.1\%$ ,  $\pm 0.25\%$  and  $\pm 0.5\%$  use E192. Successive values within a decade series are related (approximately) by a factor of  $\sqrt[12]{10}$  for the E12 Series,  $\sqrt[24]{10}$  for the E24 Series,  $\sqrt[96]{10}$  for the E96 Series and  $\sqrt[192]{10}$  for the E192 Series.

Use of standard values is encouraged because stocking programs are designed around them. However, intermediate values can be special ordered where permitted. Consult factory.

$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 0.1\%$ $\pm 0.25\%$ $\pm 0.5\%$ $\pm 1\%$		$\pm 2\%$ $\pm 5\%$ $\pm 10\%$	
10.0	10.0	14.7	14.7	21.5	21.5	31.6	31.6	46.4	46.4	68.1	68.1	10	10
10.1		14.9		21.8		32.0		47.0		69.0		11	-
10.2	10.2	15.0	15.0	22.1	22.1	32.4	32.4	47.5	47.5	69.8	69.8	12	12
10.4		15.2		22.3		32.8		48.1		70.6		13	-
10.5	10.5	15.4	15.4	22.6	22.6	33.2	33.2	48.7	48.7	71.5	71.5	15	15
10.6		15.6		22.9		33.6		49.3		72.3		16	-
10.7	10.7	15.8	15.8	23.2	23.2	34.0	34.0	49.9	49.9	73.2	73.2	18	18
10.9		16.0		23.4		34.4		50.5		74.1		20	-
11.0	11.0	16.2	16.2	23.7	23.7	34.8	34.8	51.1	51.1	75.0	75.0	22	22
11.1		16.4		24.0		35.2		51.7		75.9		24	-
11.3	11.3	16.5	16.5	24.3	24.3	35.7	35.7	52.3	52.3	76.8	76.8	27	27
11.4		16.7		24.6		36.1		53.0		77.7		30	-
11.5	11.5	16.9	16.9	24.9	24.9	36.5	36.5	53.6	53.6	78.7	78.7	33	33
11.7		17.2		25.2		37.0		54.2		79.6		36	-
11.8	11.8	17.4	17.4	25.5	25.5	37.4	37.4	54.9	54.9	80.6	80.6	39	39
12.0		17.6		25.8		37.9		55.6		81.6		43	-
12.1	12.1	17.8	17.8	26.1	26.1	38.3	38.3	56.2	56.2	82.5	82.5	47	47
12.3		18.0		26.4		38.8		56.9		83.5		51	-
12.4	12.4	18.2	18.2	26.7	26.7	39.2	39.2	57.6	57.6	84.5	84.5	56	56
12.6		18.4		27.1		39.7		58.3		85.6		62	-
12.7	12.7	18.7	18.7	27.4	27.4	40.2	40.2	59.0	59.0	86.6	86.6	68	68
12.9		18.9		27.7		40.7		59.7		87.6		75	-
13.0	13.0	19.1	19.1	28.0	28.0	41.2	41.2	60.4	60.4	88.7	88.7	82	82
13.2		19.3		28.4		41.7		61.2		89.8		91	-
13.3	13.3	19.6	19.6	28.7	28.7	42.2	42.2	61.9	61.9	90.9	90.9		
13.5		19.8		29.1		42.7		62.6		92.0			
13.7	13.7	20.0	20.0	29.4	29.4	43.2	43.2	63.4	63.4	93.1	93.1		
13.8		20.3		29.8		43.7		64.2		94.2			
14.0	14.0	20.5	20.5	30.1	30.1	44.2	44.2	64.9	64.9	95.3	95.3		
14.2		20.8		30.5		44.8		65.7		96.5			
14.3	14.3	21.0	21.0	30.9	30.9	45.3	45.3	66.5	66.5	97.6	97.6		
14.5		21.3		31.2		45.9		67.3		98.8			

Standard resistance values are obtained from the decade table by multiplying by powers of 10. As an example, 13.3 can represent  $\Omega$ , 133  $\Omega$ , 1.33 k $\Omega$ , 13.3 k $\Omega$ , 133 k $\Omega$ , 1.33 M $\Omega$ .



## WSL Type Resistors

STANDARD RESISTANCE DECADE VALUES								
10	20	30	40	50	60	70	80	90
11	21	31	41	51	61	71	81	91
12	22	32	42	52	62	72	82	92
13	23	33	43	53	63	73	83	93
14	24	34	44	54	64	74	84	94
15	25	35	45	55	65	75	85	95
16	26	36	46	56	66	76	86	96
17	27	37	47	57	67	77	87	97
18	28	38	48	58	68	78	88	98
19	29	39	49	59	69	79	89	99

(Resistance values must be within the resistance range listed on the most current data sheet.)

**Example of decade value:** 0.99  $\Omega$ , 0.099  $\Omega$ , 0.0099  $\Omega$ , or 0.23  $\Omega$ , 0.023  $\Omega$ , 0.0023  $\Omega$

**Note:** Other resistance values may be available, contact factory



## Resistor Packaging

<b>FILM CHIP PACKAGING</b>							
SIZE	BLISTER TAPE ON REEL ACC. IEC 60286-3					BULK FEEDING MAGAZINE ACC. IEC 60286-6	
	TAPE WIDTH	DIAMETER	PIECES/ REEL	PACKING CODE		PIECES/ MAGAZINE	CODE <sup>2)</sup>
				PAPER <sup>2)</sup>	BLISTER <sup>2)</sup>		
0201	8 mm	180 mm/7"	10 000	P0/RT7			
	Papertape	330 mm/13"	50 000	PZ/RF4			
0402	8 mm	180 mm/7"	10 000	P0/RT7		50 000 <sup>1)</sup>	MZ/B27
	Papertape	330 mm/13"	50 000	PZ/RF4			
0603	8 mm Paper-/Blisertape	180 mm/7"	5000	P5/RT1	B5/Na	25 000	MU/B27
		255 mm/10"	10 000	P0/RT5			
		330 mm/13"	20 000	PN/RT6	BN/Na		
0805	8 mm Paper-/Blisertape	180 mm/7"	5000	P5/RT1	B5/Na	10 000	MO/B27
		255 mm/10"	10 000	P0/RT5			
		330 mm/13"	20 000	PN/RT6	BN/Na		
1206	8 mm Paper-/Blisertape	180 mm/7"	5000	P5/RT1	B5/Na		
		255 mm/10"	10 000	P0/RT5			
		330 mm/13"	20 000	PN/RT6	BN/Na		
1210	8 mm Paper-/Blisertape	180 mm/7"	5000	P5/RT1	B5/Na		
		255 mm/10"	10 000	P0/RT5			
		330 mm/13"	20 000	PN/RT6	BN/Na		
1218	12 mm Blisertape	180 mm/7"	4000		B4/RT9		
2010	12 mm Blisertape	180 mm/7"	4000		B4/RO2		
2512	12 mm Blisertape	180 mm/7"	2000		B2/R67		
			4000		B4/R82		

**Notes**

1. On request
  2. European/N.American packing codes, Na = Not available
- Further information about packing, see appropriate catalog or web page

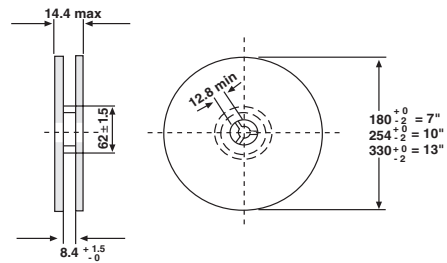
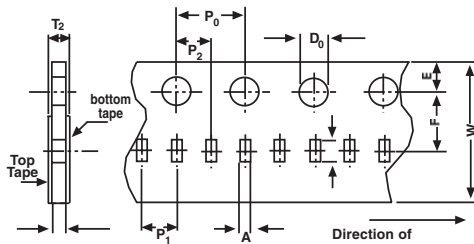
<b>MELF PACKAGING</b>						
SIZE	BLISTER TAPE ON REEL ACC. IEC 60286-3				BULK FEEDING MAGAZINE ACC. IEC 60286-6	
	TAPE WIDTH	DIAMETER	PIECES/REEL	CODE	PIECES/ MAGAZINE	CODE
0102	8 mm Blisertape	180 mm	1000	B1 <sup>1)</sup>	8000	M8
		180 mm	3000	B3		
		330 mm	10 000	B0		
0204	8 mm Blisertape	180 mm	1000	B1 <sup>1)</sup>	3000	M3
		180 mm	3000	B3		
		330 mm	10 000	B0		
0207	12 mm Blisertape	180 mm	1500	BP		
		330 mm	7500	BS		

**Note**

1. For TCR ≤ 25 ppm/K and Tolerance ≤ 0.25 % only

WIREWOUND PACKAGING (WSC, WSF, WSK, WSL, WSN, WSR, WSZ)							
SIZE	REEL			PACKAGING CODE		BULK	
	TAPE WIDTH	DIAMETER	MAXIMUM PIECES/REEL	PAPER TAPE	BLISTER TAPE	MAXIMUM PIECES/BAG	LOOSE IN PLASTIC BAG
							CODE
0805	8 mm	180 mm/7"	5000	RT1		5000	B43
1206	8 mm	180 mm/7"	4000		R86	4000	B43
1506	12 mm	180 mm/7"	4000		R86	2500	B43
2010	12 mm	180 mm/7"	4000		R86	2500	B43
2012	12 mm	330 mm/13"	2000		R86	1000	B43
2512	12 mm	180 mm/7"	2000		R86	2000	B43
2515	16 mm	330 mm/13"	2000		R86	1000	B43
3637	16 mm	330 mm/13"	4000		R86	250	B43
4527	24 mm	330 mm/13"	1200		R86	1000	B43
6927	32 mm	330 mm/13"	725		R86	300	B43
7532	32 mm	330 mm/13"	350		R86	300	B43
WSR2 & 3	24 mm	330 mm/13"	1500		R86	1000	B43

## 8 mm PAPER TAPE: 2 mm PITCH, CHIP STYLES

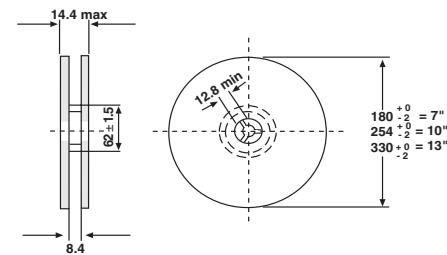
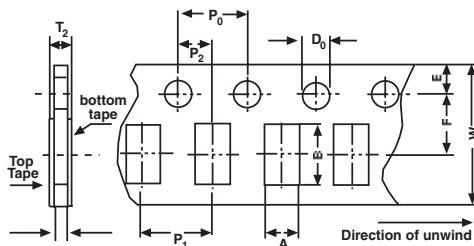


SIZE	A <sub>0</sub> ± 0.05	B <sub>0</sub> ± 0.05	D <sub>0</sub> + 0.1	P <sub>0</sub> ± 0.1	P <sub>1</sub> ± 0.05	P <sub>2</sub> ± 0.05	E ± 0.1	F ± 0.05	W ± 0.2	T <sub>2</sub> max.	T ± 0.05
0201 <sup>1)</sup>	0.38	0.68	1.5	4.0	2.0	2.0	1.75	3.5	8.0	0.39	0.27
0402	0.65	1.15	1.5	4.0	2.0	2.0	1.75	3.5	8.0	0.5	0.4

### Notes

- Punched tape
- For further information regarding taping, see IEC 60286-3 and EIA 481-1, -2

## 8 mm PAPER TAPE, CHIP STYLES

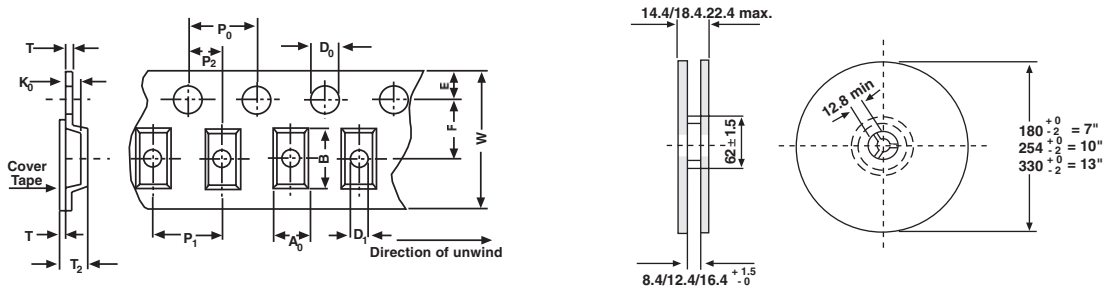


SIZE	A <sub>0</sub> ± 0.05	B <sub>0</sub> ± 0.05	D <sub>0</sub> + 0.1	P <sub>0</sub> ± 0.1	P <sub>1</sub> ± 0.05	P <sub>2</sub> ± 0.05	E ± 0.1	F ± 0.05	W ± 0.2	T <sub>2</sub> max.	T ± 0.05
0603	1.15	1.85	1.5	4.0	4.0	2.0	1.75	3.5	8.0	0.8	0.6
0805	1.65	2.4	1.5	4.0	4.0	2.0	1.75	3.5	8.0	0.85	0.6
WSL0805	1.65	2.4	1.5	4.0	4.0	2.0	1.75	3.5	8.0	0.85	0.6
1206	2.0	3.5	1.5	4.0	4.0	2.0	1.75	3.5	8.0	1.0	0.75
1210	2.8	3.6	1.5	4.0	4.0	2.0	1.75	3.5	8.0	1.0	0.75

### Note

- For further information regarding taping see IEC 60286-3 and EIA 481-1, -2

### 8 mm/12 mm/16 mm BLISTER CARRIER TAPE: CHIP STYLES

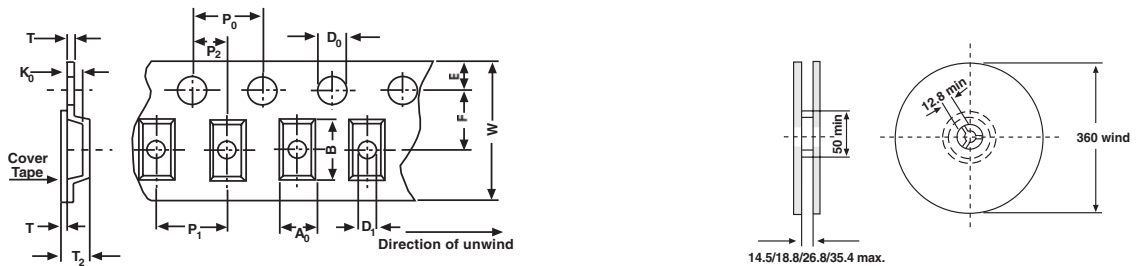


SIZE	A <sub>0</sub> + 0.1/- 0.05	B <sub>0</sub> + 0.01/- 0.05	D <sub>0</sub> + 0.1	D <sub>1</sub> max.	P <sub>0</sub> ± 0.1	P <sub>1</sub> ± 0.1	P <sub>2</sub> ± 0.05	E ± 0.05	F ± 0.05	W + 0.2	K <sub>0</sub> max.	T <sub>1</sub> max.	T <sub>2</sub> max.	T max.
0603	1.1	1.85	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	0.65	0.1	0.9	0.25
0805	1.5	2.25	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	0.7	0.1	0.95	0.25
1206	1.9	3.5	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	0.85	0.1	1.1	0.25
WSL1206	1.91	3.51	1.5	1.0	4.0	4.0	2.0	1.75	3.51	8.0	0.69	0.1	1.09	0.3
WSL1506E	2.134	4.343	1.5	1.5	4.0	4.0	2.0	1.75	5.5	12.0	0.69	0.1	1.1	0.3
1210	2.8	3.6	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	0.95	0.1	1.25	0.3
1218	3.45	4.9	1.5	1.5	4.0	4.0	2.0	1.75	5.5	12.0	0.9	0.1	1.15	0.25
2010	2.8	5.6	1.5	1.5	4.0	4.0	2.0	1.75	5.5	12.0	0.9	0.1	1.2	0.3
WSL2010	2.79	5.38	1.5	1.5	4.0	4.0	2.0	1.75	5.51	12.0	0.69	0.1	1.09	0.3
WSL2010E	2.8	5.6	1.5	1.5	4.0	4.0	2.0	1.75	5.5	12.0	0.9	0.1	1.2	0.3
2512	3.55	6.85	1.5	1.5	4.0	4.0/8.0	2.0/4.0	1.75	5.5	12.0	0.9/0.8	0.1	1.2/1.1	0.3
WSL2512/ WSK2512	3.42	6.63	1.5	1.5	4.0	4.0/8.0	2.0/4.0	1.75	5.51	12.0	0.69	0.1	1.09	0.3
WSL2512E	3.55	6.85	1.5	1.5	4.0	4.0/8.0	2.0/4.0	1.75	5.5	12.0	0.9 0.8	0.1	1.2 1.1	0.3
WSL3637	9.6	9.9	1.5	1.5	4.0	12.0	2.0	1.75	7.5	16.0	0.9	0.1	1.4	0.4

**Note**

- For further information regarding taping, see EIA 481-1, -2

### 12 mm/16 mm/24 mm/32 mm BLISTER CARRIER TAPE: WSC/WSF/WSN/WSR/WSZ



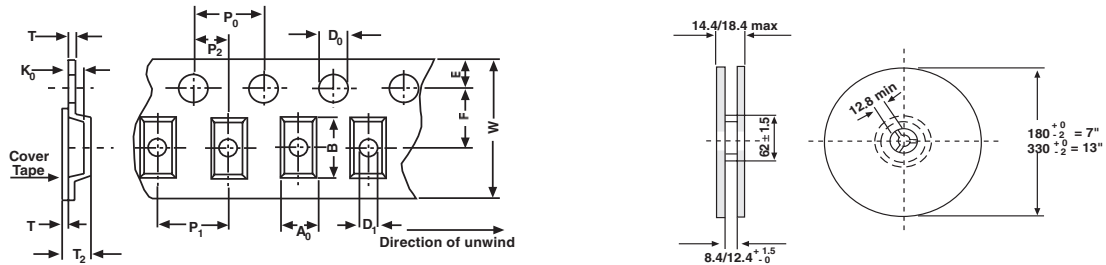
SIZE	A <sub>0</sub> ± 0.15	B <sub>0</sub> ± 0.15	D <sub>0</sub> ± 0.1	D <sub>1</sub> MAX.	P <sub>0</sub> ± 0.1	P <sub>1</sub> ± 0.1	P <sub>2</sub> ± 0.1	E ± 0.1	F ± 0.1	W + 0.3	K <sub>0</sub> max.	T <sub>1</sub> max.	T <sub>2</sub> max.	T max.
2012	3.5	5.6	1.5	1.5	4.0	8.0	2.0	1.75	5.5	12.0	2.9	0.1	3.4	0.4
2515	4.3	7.1	1.5	1.5	4.0	8.0	2.0	1.75	7.5	16.0	3.4	0.1	3.9	0.4
4527	7.3	12.0	1.5	1.5	4.0	12.0	2.0	1.75	11.5	24.0	4.7	0.1	5.2	0.4
<sup>1)</sup> 6927	7.5	18.3	1.5	2.0	4.0	12.0	2.0	1.75	14.2	32.0	7.6	0.1	8.1	0.4
<sup>1)</sup> WSZ753	9.2	20.9	1.5	N/A	4.0	16.0	2.0	1.75	14.2	32.0	10.4	0.1	10.9	0.4
WSR2 & 3	7.4	12.1	1.5	1.5	4.0	12.0	2.0	1.75	11.5	24.0	2.9	0.1	3.4	0.4

**Notes**

- For further information regarding taping, see EIA 481-1, -2, -3
- 1. 6927 and WSZ7532 pocket shapes are slightly different than shown; however, dimensions that are given are correct



## 8 mm/12 mm BLISTER CARRIER TAPE: MELF STYLES

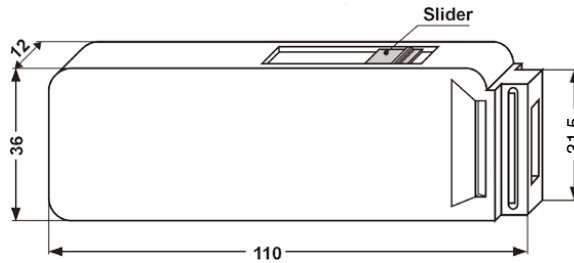


SIZE TOLERANCE	A <sub>0</sub> + 0.1/- 0.05	B <sub>0</sub> + 0.1/- 0.05	D <sub>0</sub> + 0.1	D <sub>1</sub> max.	P <sub>0</sub> ± 0.1	P <sub>1</sub> ± 0.1	P <sub>2</sub> ± 0.05	E ± 0.05	F ± 0.05	W + 0.2	K <sub>0</sub> + 0.1	T <sub>1</sub> max.	T <sub>2</sub> max.	T max.
0102	1.3	2.45	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	1.2	0.1	1.55	0.25
0204	2.0	3.65	1.5	1.0	4.0	4.0	2.0	1.75	3.5	8.0	1.5	0.1	1.85	0.25
0207	2.6	5.9	1.5	1.5	4.0	4.0	2.0	1.75	5.5	12.0	2.3	0.1	2.65	0.25

### Note

- For further information regarding taping see IEC 60286-3 and EIA 481-1, -2

## BULK CASE FOR CHIP AND MELF STYLES



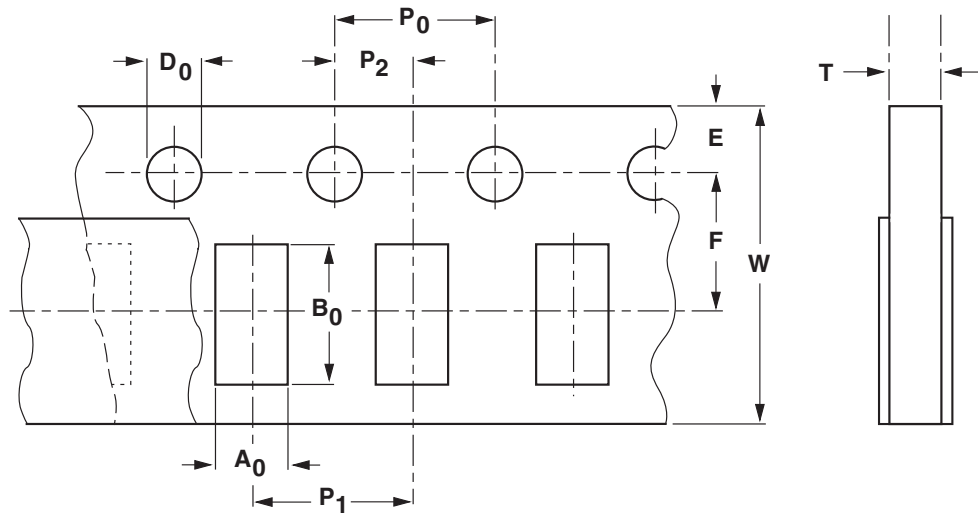
CHIP SIZE	PIECES/MAGAZINE	MELF - SIZE	PIECES/MAGAZINE
0402	50 000	0102	8000
0603	25 000	0204	3000
0805	10 000	0207	N. A.

## SMD Chip and MELF Resistors

### TAPE AND REEL

#### CARDBOARD TAPE

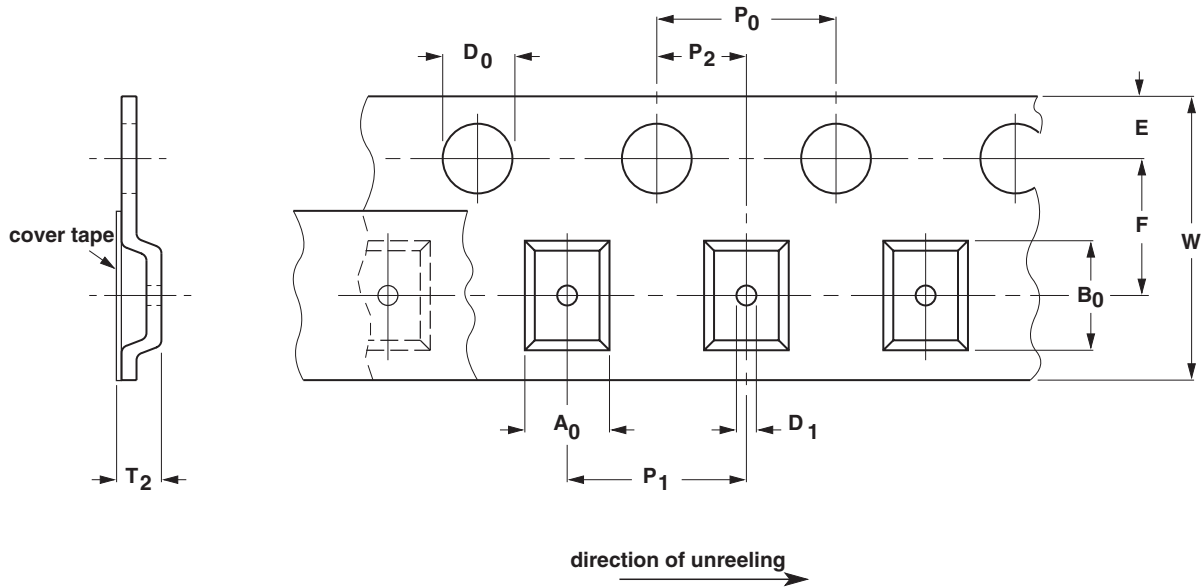
According to IEC 60286-3, Type I



<b>DIMENSIONS</b> in millimeters				
SYMBOL	FLAT CHIP PRODUCT SIZE			
	0402	0603	0805	1206, 0612
A <sub>0</sub>	0.7 - 0.05	1.1 - 0.05	1.65 - 0.05	2.0 ± 0.1
B <sub>0</sub>	1.2 - 0.05	1.9 - 0.05	2.4 - 0.05	3.5 ± 0.1
P <sub>1</sub>	2.0 ± 0.05	4.0 ± 0.1		
P <sub>2</sub>	2.0 ± 0.05			
P <sub>0</sub>	4.0 ± 0.1			
D <sub>0</sub>	1.5 <sup>+0.1</sup>			
E	1.75 ± 0.1			
F	3.5 ± 0.05			
W	8.0 <sup>+0.3</sup> -0.2			
T	0.43 ± 0.05	0.6 ± 0.05		0.75 ± 0.05

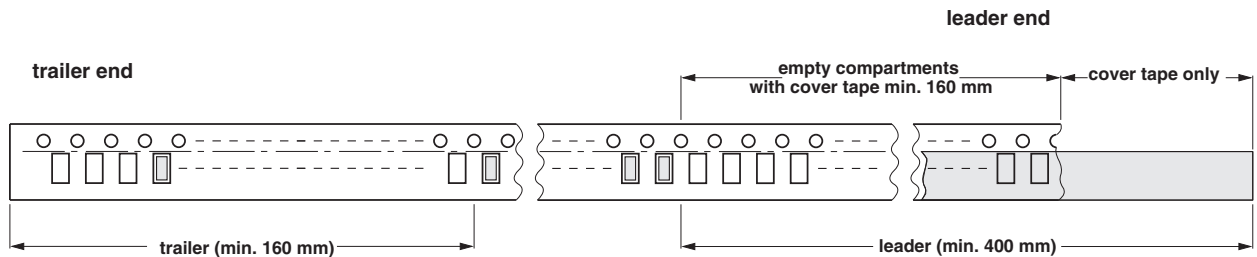
## BLISTER TAPE

According to IEC 60286-3, Type II



DIMENSIONS in millimeters			
SYMBOL	MELF PRODUCT SIZE		
	0102	0204	0207
$A_0$	$1.3 \pm 0.1$	$1.55 \pm 0.1$	$2.4 \pm 0.1$
$B_0$	$2.47 \pm 0.1$	$3.7 \pm 0.1$	$6.0 \pm 0.1$
$P_1$	$4.0 \pm 0.1$		
$P_2$	$2.0 \pm 0.05$		
$P_0$	$4.0 \pm 0.1$		
$D_0$	$1.5 \pm 0.1$		
$E$	$1.75 \pm 0.1$		
$F$	$3.5 \pm 0.05$		$5.5 \pm 0.05$
$W$	$8.0 \begin{smallmatrix} +0.3 \\ -0.1 \end{smallmatrix}$		$12 \pm 0.3$
$T_2$	$\leq 1.65$	$\leq 1.80$	$\leq 2.7$

## LEADER AND TRAILER TAPE



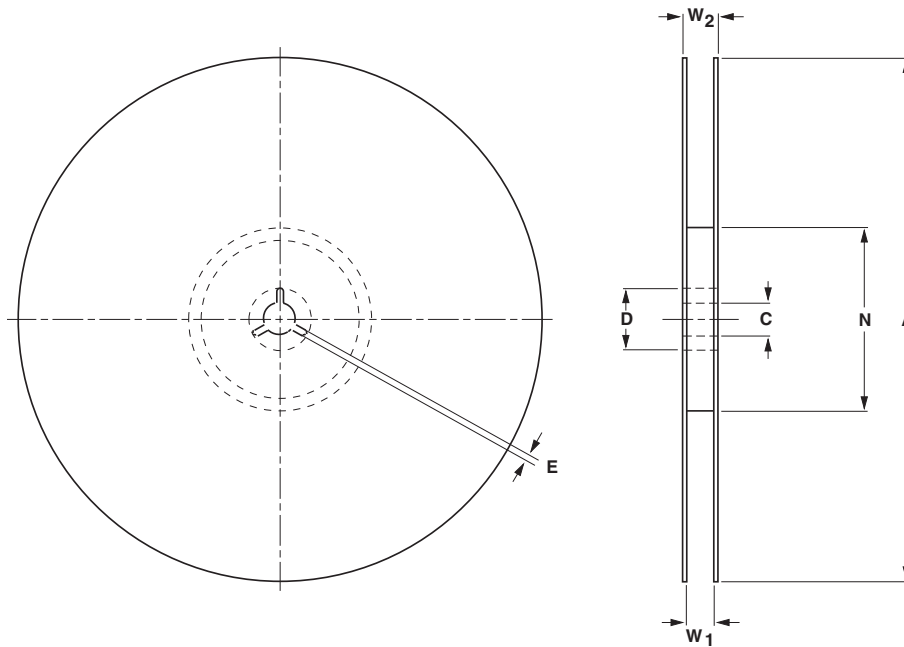
The minimum length of the leader is 400 mm, which includes a minimum 160 mm of carrier tape with empty compartments and sealed by the cover tape.

The minimum length of the trailer is 160 mm carrier tape with empty compartments and sealed by the cover tape.

**PEEL-OFF FORCE**

Peel-off forces are 0.1 N to 1.0 N for 8 mm tape and 0.1 N to 1.3 N for 12 mm tape at a peel-off speed of  $300 \pm 10$  mm/minute. The peel-off angle should be between  $165^\circ$  and  $180^\circ$ .

**REEL**



<b>DIMENSIONS</b> in millimeters - packaging codes, quantities and reel									
DESCRIPTION	VALUE								
Packaging code	P1 <sup>1)</sup>	B1 <sup>1)</sup>	BL	P5	E0	B0	PW	B2	B7
Units per reel	1000	1000	3000	5000	10 000	10 000	20 000	2000	7000
A	180					330		180	330
W <sub>1</sub>	8.4 + 1.5/0							12.4 + 1.5/0	
W <sub>2max</sub>	14.4							18.4	
E	2.5 ± 0.5								
D	22.5 ± 2.0								
C	13.0 + 0.5/- 0.25								
N	62								

**Note**

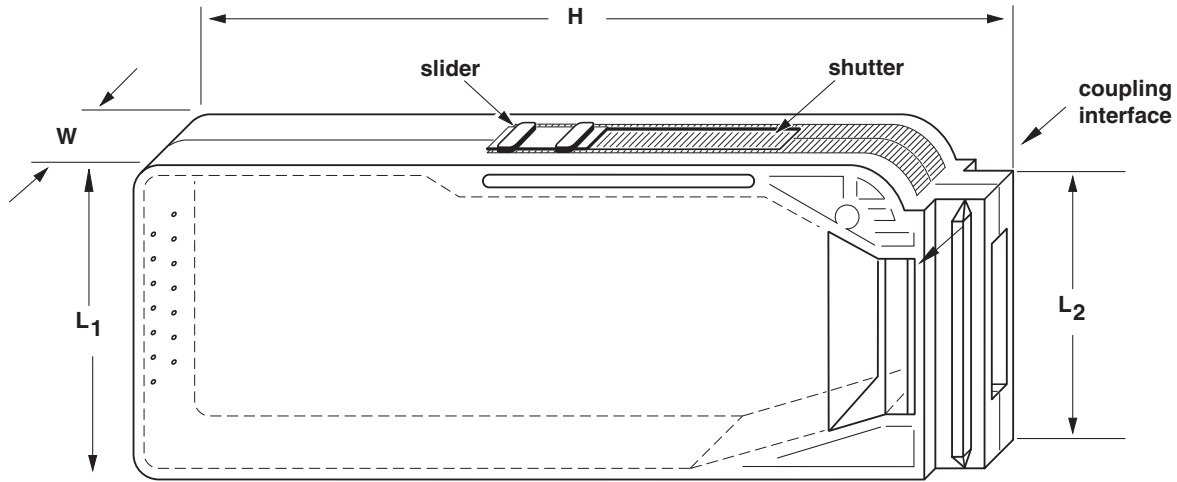
1. Only for precision products (P1 chip resistors; B1 MELF resistors)

**ENVIRONMENTAL CONSIDERATIONS**

- Cover tape, carrier tape and reel do not contain environmentally-harmful PVC materials
- Because the carrier tape is made of either paper (paper tape) or polystyrene (blister tape) and the reel is polystyrene, they are ideally suited for recycling

## BULK CASE

According to IEC 60286-6



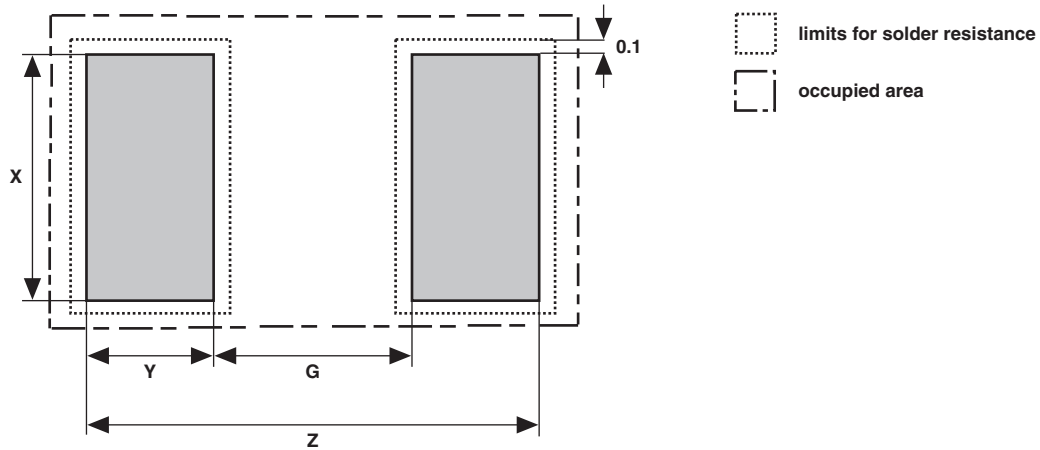
DIMENSIONS in millimeters - packaging codes, quantities and bulk case		
DESCRIPTION	VALUE	
Packaging code	<b>M3</b>	<b>M8</b>
Units per bulk case	<b>3000</b>	<b>8000</b>
L <sub>1</sub>	36	
L <sub>2</sub>	31.5	
W	12	
H	110	

## ENVIRONMENTAL CONSIDERATIONS

- Bulk cases are designed for re-use
- The construction materials are ideally suited for recycling after the case's end life

## Surface Mount Resistors

### PATTERN STYLES FOR SMD RESISTORS



Dimensions in mm

RECOMMENDED SOLDER PAD DIMENSIONS FOR FIXED LINEAR SMD RESISTORS								
TYPE	WAVE SOLDERING				REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)	G (mm)	Y (mm)	X (mm)	Z (mm)
MCS 0402	-	-	-	-	0.25	0.6	0.55	1.45
MCT 0603	0.5	1.2	1.1	2.9	0.5	0.95	0.95	2.4
MCU 0805	0.65	1.4	1.5	3.45	0.65	1.1	1.4	2.85
MCA 1206	1.5	1.6	1.9	4.7	1.5	1.25	1.75	4.0
MMU 0102	0.65	1.4	1.5	3.45	0.65	1.1	1.4	2.85
MMA 0204	1.5	1.6	1.9	4.7	1.5	1.25	1.75	4.0
MMB 0207	2.8	2.3	2.5	7.4	2.8	2.2	2.2	7.2

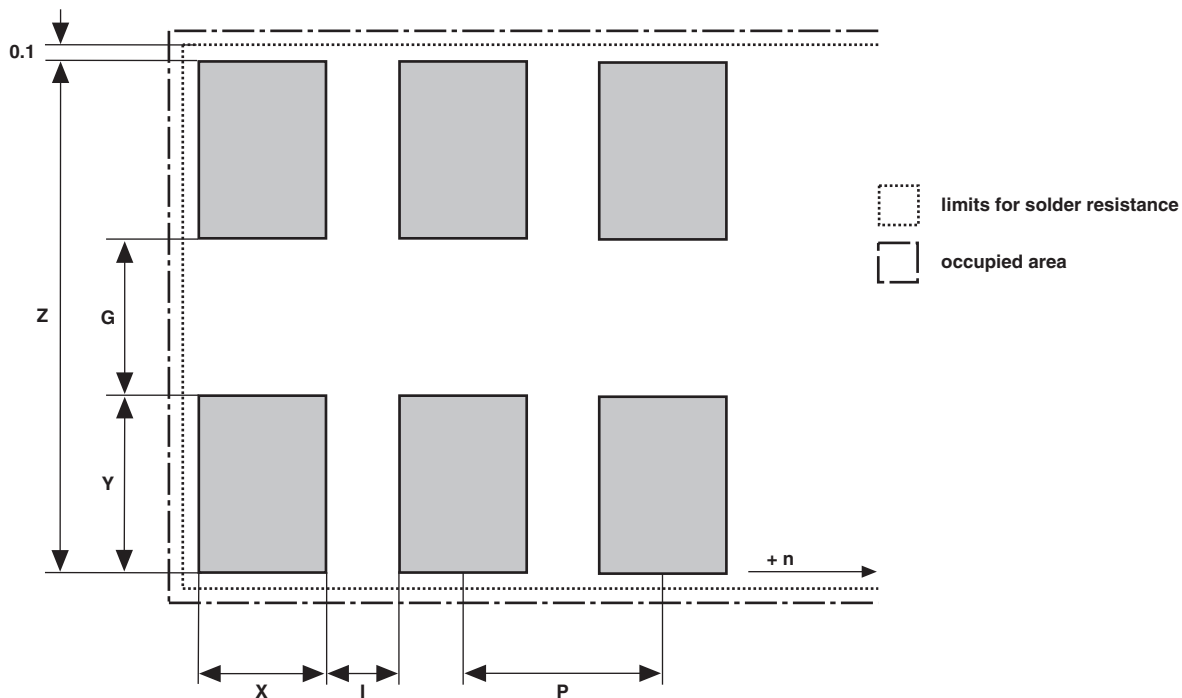
# Recommended Solder Pad Dimensions

Vishay Beyschlag

Surface Mount Resistors



## PATTERN STYLES FOR THIN FILM FLAT CHIP RESISTOR ARRAYS

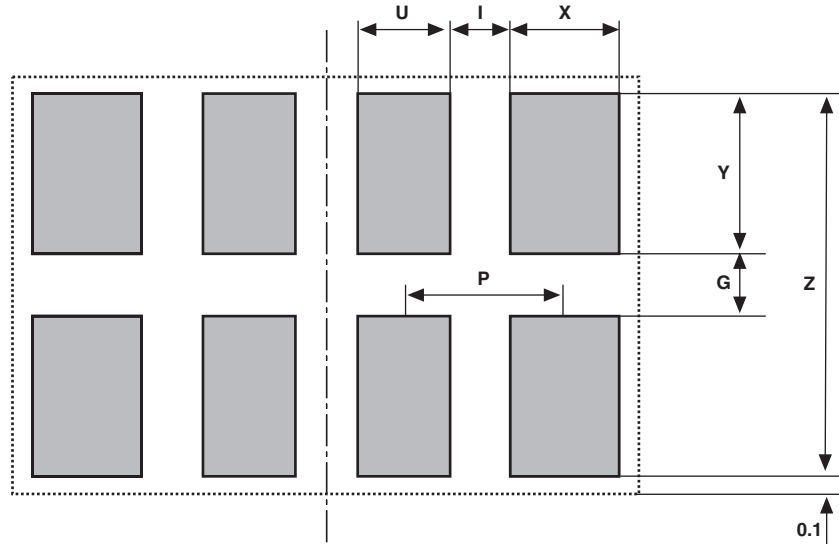


Dimensions in mm

### RECOMMENDED SOLDER PAD DIMENSIONS FOR FIXED LINEAR THIN FILM FLAT CHIP RESISTOR ARRAYS (ACAC) AND APPLICATION SPECIFIC RESISTOR ARRAYS (ASRA)

TYPE	G (mm)	Y (mm)	X (mm)	Z (mm)	I (mm)	P (mm)
ACAC	0.7	0.7	0.5	2.1	0.3	0.8
ASRA	7.8	1.8	0.6	11.4	-	1.27

## PATTERN STYLES FOR THIN FILM FLAT CHIP RESISTOR ARRAYS



 limits for solder resistance

Dimensions in mm

<b>RECOMMENDED SOLDER PAD DIMENSIONS FOR FIXED LINEAR THIN FILM FLAT CHIP RESISTOR ARRAYS (ACAS)</b>							
TYPE	G (mm)	Y (mm)	X (mm)	U (mm)	Z (mm)	I (mm)	P (mm)
ACAS	0.8	1.15	0.63	0.44	3.1	0.36	0.8









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SMD RESISTORS, ARRAYS AND NETWORKS

DATA BOOK

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