About Stackpole Electronics, Inc. (SEI)

In 1906 Stackpole Battery Corporation was founded in St Mary's, Pennsylvania. In 1928, the Stackpole Corporation became one of the first resistor manufacturers in North America. Over the next several decades, Stackpole became one of the leading resistor manufacturers of carbon composition resistors in the world, with facilities in St. Mary's, Farmville Virginia and subsequently, Taiwan.

In 1979, Stackpole Components and Akahane Electronics (Japan) signed an agreement whereby Akahane Electronics would supply Stackpole with metal film resistors. In 1986, Stackpole Electronics Incorporated (SEI) was formed from the resistor division of the Stackpole Corporation. Shortly thereafter, Akahane Electronics became one of the major shareholders of SEI. In September 2004 SEI Electronics Inc. formally changed its name to Stackpole Electronics, Inc.

Still privately held by the Akahane family, Stackpole has become one of the leading global manufacturers of resistive products, and one of the few companies focusing primarily on resistive technologies. With manufacturing facilities in Taiwan, China, Japan and Mexico, and sales and distribution centers in the US, Taiwan, China and Japan, Stackpole has established a truly global footprint.

Today, Stackpole's customer base is comprised of companies from every major market including Consumer, Medical, Automotive, Computer, Telecom, Aerospace, Industrial Process Control and Instrumentation using a very broad line of resistive products.

Our 2006 Product Catalog

Stackpole is proud to present a comprehensive offering of thick film, thin film, wirewound, current sense, precision, high voltage, metal oxide and carbon composition resistors, resistor networks and arrays, and custom high power products - in both surface mount and through-hole options for your choosing.

Stackpole is committed to new product development and providing the broadest resistive offering in the industry. New products in our 2006 catalog include a new thick film surge handling chip, our high voltage divider networks and compliant-leaded surface mount metal oxides. We've also expanded our current sense offering, adding the BR series, which handles up to 5W and 70amps, and the very high current HLD series.

Need a Custom Solution?

Long recognized as a service leader in the commodity resistor market, SEI now offers the same service and responsiveness on custom resistive product solutions. With our engineering center in the US and our manufacturing facilities in Mexico and Asia, Stackpole is committed to new product development to meet the ever-changing needs of the resistor market. If you are exhausted with slow response times and exorbitant non-recoverable engineering fees from your current design partner, contact us today. When you think of ***Stackpole***, think ***Resistive Product Solutions!*** We're here to help.

Need Samples?

Stackpole is committed to providing engineering samples to prospective customers in order to assist them in completing their designs. Contact Stackpole toll free at 888-SEI-SEIS (888-734-7347), via email at marketing@seielect.com or via the web at www.seielect.com to place your sample order today.

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All information provided in this catalog is based on SEI's experience and testing programs and does not absolve customers from their responsibility to check the suitability of our products for their applications.

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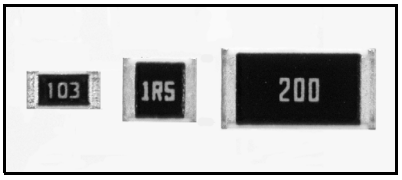
RMC Series — General Purpose Thick Film Chip Resistors

Features

- Nickel barrier terminations standard
- Power derating from 100% at 70°C to zero at +150°C
- Operating temp range from -65°C to +150°C
- Zero ohm available (max resistance 0.05Ω)
- RoHS compliant / lead-free available (RMCF)



Electrical Specifications

Type / Code	Package Size	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Max. Current	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
							1%	5%
RMC 1/20	0201	0.05W	25	50	1 Amp	±300 ppm/°C ±200 ppm/°C	10Ω – 97.6Ω 100Ω – 1M	10Ω – 91Ω 100Ω – 10M
RMC 1/16S	0402	0.063W	50	100	1 Amp	±200 ppm/°C	1Ω – 10M	1Ω – 10M
RMC 1/16	0603	0.1W	50	100	1 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	– 1Ω – 9.76Ω 10Ω – 1M 1.02M – 10M	1Ω – 9.1Ω 10Ω – 1M – 1.1M – 22M
RMC 1/10	0805	0.125W	150	300	2 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	– 0.1Ω – 0.976Ω 1.0Ω – 10M –	0.1Ω – 9.1Ω 10Ω – 1M – 1.1M – 22M
RMC 1/8	1206	0.25W	200	400	2 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	– 0.1Ω – 0.976Ω 1.0Ω – 10M –	0.1Ω – 9.1Ω 10Ω – 1M – 1.1M – 24M
RMC 1/4	1210	0.33W	200	400	3 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	– 0.1Ω – 0.97Ω 1.0Ω – 10M –	0.15Ω – 9.1Ω 10Ω – 1M – 1.1M – 22M
RMC 1/2	2010	0.75W	200	400	3 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	0.1Ω – 3.6Ω 3.9Ω – 9.76Ω 10Ω – 10M –	0.1Ω – 9.1Ω 10Ω – 1M – 1.1M – 22M
RMC 1	2512	1W	200	400	3 Amp	±350 ppm/°C ±200 ppm/°C ±100 ppm/°C ±350 ppm/°C	– 0.1Ω – 9.76Ω 10Ω – 1M –	0.1Ω – 9.1Ω 10Ω – 1M – 1.1M – 22M

* Lesser of √PR or maximum working voltage.

How to Order

RMC	1/16	4.7K	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

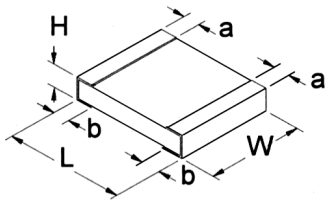
SEI Type	Description
RMC	Standard
RMCF	RoHS

Code	Wattage	Size
1/20	0.05W	0201
1/16S	0.063W	0402
1/16	0.1W	0603
1/10	0.125W	0805
1/8	0.25W	1206
1/4	0.33W	1210
1/2	0.75W	2010
1	1W	2512

Tolerance	Values
1%	E96,E24
5%	E24

Styles	Pkg Qty	Description	Code
1/16, 1/10, 1/8	1,000	Bulk	A
	10,000	10" reel - Paper	G
	5,000	7" reel - Paper	R
1/4, 1/2, 1	4,000	7" - Embossed	
1/20, 1/16S	10,000	10" reel - Paper	

RMC Series — General Purpose Thick Film Chip Resistors



Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RMC 1/20	0.024 ± 0.001 0.60 ± 0.03	0.011 ± 0.001 0.30 ± 0.03	0.009 ± 0.001 0.23 ± 0.03	0.004 ± 0.002 0.10 ± 0.05	0.006 ± 0.002 0.15 ± 0.05	inches mm
RMC 1/16S	0.039 ± 0.002 1.00 ± 0.05	0.020 ± 0.002 0.50 ± 0.05	0.014 ± 0.002 0.35 ± 0.05	0.008 ± 0.004 0.20 ± 0.10	0.010 +0.002, -0.004 0.25 +0.05, -0.10	inches mm
RMC 1/16	0.063 ± 0.004 1.60 ± 0.10	0.031 ± 0.004 0.80 ± 0.10	0.018 ± 0.004 0.45 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	inches mm
RMC 1/10	0.079 ± 0.008 2.00 ± 0.20	0.049 ± 0.004 1.25 ± 0.10	0.020 ± 0.006 0.50 ± 0.15	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RMC 1/8	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.006 1.60 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.010 0.50 ± 0.25	inches mm
RMC 1/4	0.126 ± 0.008 3.20 ± 0.20	0.098 ± 0.008 2.50 ± 0.20	0.021 ± 0.006 0.55 ± 0.15	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.010 0.50 ± 0.25	inches mm
RMC 1/2	0.197 ± 0.008 5.00 ± 0.20	0.098 ± 0.008 2.50 ± 0.20	0.021 ± 0.006 0.55 ± 0.15	0.024 ± 0.010 0.60 ± 0.25	0.024 ± 0.010 0.60 ± 0.25	inches mm
RMC 1	0.248 ± 0.008 6.30 ± 0.20	0.126 ± 0.008 3.20 ± 0.20	0.021 ± 0.006 0.55 ± 0.15	0.024 ± 0.010 0.70 ± 0.25	0.024 ± 0.010 0.70 ± 0.25	inches mm

*Lead free (RMCF) dimensions same as standard parts

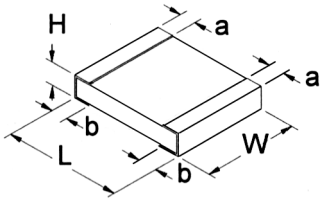
Performance Characteristics

Test	Test Conditions (JIS C 5202)	Test Results
Short Time Overload	2.5x rated voltage for 5 seconds	±(2% +0.1Ω)
Dielectric Withstanding Voltage	100VAC, 1 minute	±(1% +0.05Ω)
Resistance to Soldering Heat	260°C ±5°C, for 10 sec. ±0.5 sec. (Solder Bath)	±(1% +0.05Ω)
Solderability	235°C ±5°C, for 2 sec. ±0.5 sec. (Colophonium flux)	95% coverage, minimum
Temperature Cycle	-65°C: 30 min. 25°C: 2 to 3 min. 150°C: 30 min. 25°C: 2 to 3 min. (5 Cycles)	±(1% +0.05Ω) Jumper (<0.05Ω)
Endurance (Damp load)	40°C ± 2°C, 90% RH, Rated Load 90 min. On, 30 min. Off, (1,000 hrs. - 0 hrs. + 48 hrs.)	±(3% +0.1Ω) Jumper (<0.05Ω)
Endurance (Rated load)	70°C ± 2°C, Rated Load 90 min. On, 30 min. Off, (1,000 hrs. - 0 hrs. + 48 hrs.)	±(3% +0.1Ω) Jumper (<0.05Ω)
Voltage Coefficient	1/10 rated voltage for 3 sec. max, then rated voltage for 3 sec. max.	±100 (ppm/V)
Robustness of Termination	Bend of 3mm for 5 ± 1 sec.	±(1.0% + 0.05 Ohm)

HMC Series — General Purpose High Value Chip Resistors

Features

- R Value extension of RMC product
- Operating temperature range from -55°C to +150°C
- Power derating from 100% at 70°C to zero at 150°C
- Highly stable performance over time
- E12 values only
- Nickel barrier terminations
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Package Type	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
						10%	20%
HMC 1/16	0603	0.063W	50	100	±500 ppm/°C ±1,500 ppm/°C	47M – 1G 1.2G – 3.3G	47M – 1G 1.2G – 3.3G
HMC 1/10	0805	0.1W	75	150	±500 ppm/°C ±1,500 ppm/°C	47M – 1G 1.2G – 4.7G	47M – 1G 1.2G – 4.7G
HMC 1/8	1206	0.125W	150	300	±500 ppm/°C ±1,500 ppm/°C	47M – 1G 1.2G – 4.7G	47M – 1G 1.2G – 4.7G

* Lesser of √PR or maximum working voltage.

Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
HMC 1/16	0.063 ± 0.006 1.60 ± 0.15	0.031 ± 0.006 0.80 ± 0.15	0.018 ± 0.004 0.45 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	inches mm
HMC 1/10	0.079 ± 0.008 2.00 ± 0.20	0.049 ± 0.008 1.25 ± 0.20	0.020 ± 0.004 0.50 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
HMC 1/8	0.126 +0.002/-0.008 3.20 +0.05/-0.20	0.063 +0.002/-0.006 1.60 +0.05/-0.15	0.024 ± 0.004 0.60 ± 0.10	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.012 0.50 ± 0.30	inches mm

Performance Characteristics

Test	Test Conditions (JIS C 5202)	Test Results
Long Term Stability	Normal temperature & humidity for 1,000 hrs.	±0.5%
High Temperature Loading	$15V_{DC,}$ 1.5 hr. On, 0.5 hr. Off, 1,000 hrs. 70°C	±3%
Resistance to Solder Heat	260°C ± 5°C, 10 seconds +1/-0	±1%
Short Time Overload	5 seconds at maximum overload voltage	±2%
Voltage Coefficient of Resistance	Per JIS C 5202	±0.5%/V

How to Order

HMC	1/10	47M	10%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code	Wattage	Size
1/16	0.063W	0603
1/10	0.1W	0805
1/8	0.125W	1206

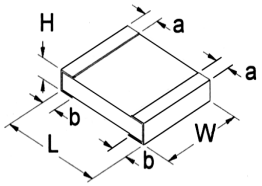
Tolerance	Values
10%	E12
20%	E12

Code	Description	Pkg Qty
R	7" - Paper	5,000

RGC Series — Semi-Precision Thick Film Chip Resistors

Features

- Precision performance
- Tolerances to ±0.5% and ±1%
- Operating temperature range from -55°C to +150°C
- Less sensitive to ESD discharges than comparable thin film devices
- RoHS compliant / lead-free
- Highly stable performance over time
- Power derating from 100% at 70°C to zero at 150°C
- Temperature coefficient of resistance of ±50ppm/°C and ±100ppm/°C



Electrical Specifications

Type / Code	Package Type	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage*	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
						0.5%	1%
RGC 1/16S	0402	0.063W	50	100	±50 ppm/°C ±100 ppm/°C	10Ω – 3.24M 10Ω – 3.24M	100Ω – 1M 10Ω – 3.24M
RGC 1/16	0603	0.10W	50	100	±50 ppm/°C ±100 ppm/°C	100Ω – 3.24M 100Ω – 3.24M	100Ω – 3.24M 100Ω – 3.24M
RGC 1/10	0805	0.125W	150	300	±50 ppm/°C ±100 ppm/°C	10Ω – 3.24M –	3.32Ω – 3.24M 3.32Ω – 3.24M
RGC 1/8	1206	0.25W	200	400	±50 ppm/°C ±100 ppm/°C	10Ω – 4.64M 10Ω – 4.64M	3.32Ω – 4.64M 3.32Ω – 4.64M

* Lesser of √PR or maximum working voltage.

Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RGC 1/16S	0.039 ± 0.002 1.00 ± 0.05	0.020 ± 0.002 0.50 ± 0.05	0.014 ± 0.002 0.35 ± 0.05	0.008 ± 0.004 0.20 ± 0.10	0.010 +0.002/-0.004 0.25 +0.05/-0.10	inches mm
RGC 1/16	0.063 ± 0.004 1.60 ± 0.10	0.031 +0.006/-0.002 0.80 +0.15/-0.05	0.018 ± 0.004 0.45 ± 0.10	0.010 ± 0.004 0.25 ± 0.10	0.012 ± 0.004 0.30 ± 0.10	inches mm
RGC 1/10	0.079 ± 0.004 2.00 ± 0.10	0.050 ± 0.004 1.25 ± 0.10	0.024 ± 0.004 0.60 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RGC 1/8	0.126 ± 0.006 3.20 ± 0.15	0.063 ± 0.006 1.60 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.10 0.50 ± 0.25	inches mm

Performance Characteristics

Test	Test Conditions	Test Results
Endurance @ 125°C	125°C, No load, 1,000 hrs.	±5%
Endurance @ 70°C	Rated Voltage, 1.5 hr. On, 0.5 hr. Off, 1,000 hrs. 70°C	±5%
Resistance to Soldering Heat	260°C ± 5°C, 5 seconds +1/-0	±1%
Short Time Overload	2 seconds at 2.5 times rated or limiting voltage	±1%
Voltage Proof	100 volts AC, 60 seconds	No breakdown or flashover R ≥ 1GΩ

How to Order

RGC	1/16	T1	4.75K	0.5%	R
SEI Type	Code	TCR	Nominal Resistance	Tolerance	Packaging

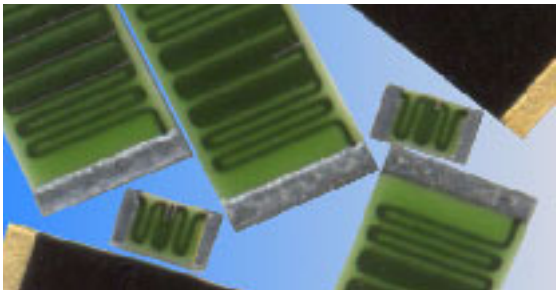
Code	Wattage	Size
1/16S	0.063W	0402
1/16	0.1W	0603
1/10	0.125W	0805
1/8	0.25W	1206

TCR
T1 = 100ppm
T2 = 50ppm

Tolerance	Values
0.5%	E96
1%	E96

Code	Description	Pkg Qty	Styles
R	Paper	10,000	1/16S
		5,000	1/16, 1/10, 1/8

HVC Series — High Voltage Chip Resistors



Features

- Voltage ratings to 40,000 volts
- Ohmic values to 10G; higher values possible
- Available with wire bondable terminations
- Tight tolerances to 0.1%
- Utilizes fine film resistor deposition technology
- Superior pulse handling capabilities
- Low TCR to 25 ppm/°C
- Low VCR to 1 ppm/volt
- Very low noise
- Ultra high stability
- Custom sizes available
- RoHS compliant / lead-free

Electrical Specifications

Type	Package Type	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Resistance Temperature Coefficient	Ohmic Range and Tolerance			
					0.25%	0.5%	1%	5%
HVC 0402	0402	0.04	100	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	–	100K – 1M 100K – 250M 10K – 250M 1K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 1G	100K – 1M 100K – 250M 10K – 250M 1K – 10G
HVC 0603	0603	0.06	400	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	–	100K – 1M 100K – 250M 10K – 250M 1K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 1G	100K – 1M 100K – 250M 10K – 250M 1K – 10G
HVC 0805	0805	0.20	750	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	100K – 1M 100K – 100M 100K – 250M 100K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 1G	100K – 1M 100K – 250M 10K – 250M 1K – 10G
HVC 1206	1206	0.33	1,000	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	100K – 1M 100K – 100M 100K – 250M 100K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 250M	100K – 1M 100K – 250M 10K – 250M 1K – 1G	100K – 1M 100K – 250M 10K – 250M 1K – 10G
HVC 2010	2010	1.00	1,700	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	100K – 1M 100K – 100M 100K – 250M 100K – 250M	100K – 1M 100K – 250M 10K – 250M 10K – 250M	100K – 1M 100K – 250M 10K – 250M 10K – 1G	100K – 1M 100K – 250M 10K – 250M 10K – 10G
HVC 2512	2512	2.00	2,500	±25 ppm/°C ±50 ppm/°C ±100 ppm/°C ±200 ppm/°C	100K – 1M 100K – 100M 100K – 250M 100K – 250M	100K – 1M 100K – 250M 10K – 250M 10K – 250M	100K – 1M 100K – 250M 10K – 250M 10K – 1G	100K – 1M 100K – 250M 10K – 250M 10K – 10G

*The continuous maximum voltage applied cannot exceed the maximum power rating and is ohmic value dependent.

Note: Other case sizes and tolerances are available.

How to Order

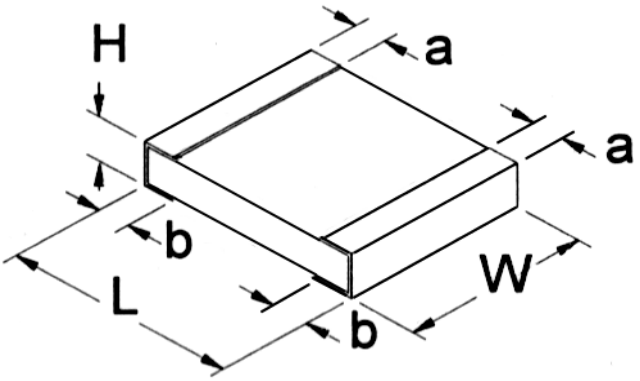
HVC	B	1206	T2	100M	5%	R
SEI Type	Termination	Size	TCR	Nominal Resistance	Tolerance	Packaging

Code	Termination
G	Wire bondable (gold)
S	Solderable single surface
U	Bondable wrap around
B	Solderable (solder coated with nickel barrier)

TCR
T0 = 200ppm
T1 = 100ppm
T2 = 50ppm
T9 = 25ppm

Code	Description	Pkg Qty
R	7" reel - paper	5,000
A	Bulk	1,000
I	7" reel - paper	1,000

HVC Series — High Voltage Chip Resistors



Mechanical Specifications						
Type	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
HVC 0402	0.040 ± 0.003 1.00 ± 0.13	0.020 ± 0.005 0.50 ± 0.13	0.015 0.38	0.010 ± 0.005 0.25 ± 0.13	0.010 ± 0.005 0.25 ± 0.13	inches mm
HVC 0603	0.063 + 0.01/-0.005 1.60 + 0.25/-0.13	0.031 ± 0.005 0.80 ± 0.13	0.020 0.50	0.010 + 0.01/-0.005 0.25 + 0.25/-0.13	0.010 + 0.01/-0.005 0.25 + 0.25/-0.13	inches mm
HVC 0805	0.079 + 0.01/-0.005 2.00 + 0.25/-0.13	0.050 ± 0.005 1.25 ± 0.13	0.025 0.64	0.010 + 0.01/-0.005 0.25 + 0.25/-0.13	0.010 + 0.01/-0.005 0.25 + 0.25/-0.13	inches mm
HVC 1206	0.126 + 0.01/-0.005 3.20 + 0.25/-0.13	0.063 ± 0.005 1.60 ± 0.13	0.030 0.76	0.015 + 0.01/-0.005 0.38 + 0.25/-0.13	0.015 + 0.01/-0.005 0.38 + 0.25/-0.13	inches mm
HVC 2010	0.200 + 0.01/-0.005 5.08 + 0.25/-0.13	0.100 ± 0.005 2.54 ± 0.13	0.030 0.76	0.020 + 0.01/-0.005 0.51 + 0.25/-0.13	0.020 + 0.01/-0.005 0.51 + 0.25/-0.13	inches mm
HVC 2512	0.250 + 0.01/-0.005 6.35 + 0.25/-0.13	0.125 ± 0.005 3.18 ± 0.13	0.030 0.76	0.020 + 0.01/-0.005 0.51 + 0.25/-0.13	0.020 + 0.01/-0.005 0.51 + 0.25/-0.13	inches mm

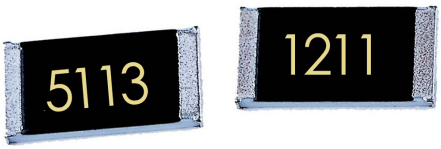
Note: 0202 and 0303 case sizes available only with wire bondable terminations.

Performance Characteristics		
Test	Test Method	Acceptable Parameter
Load Life	MIL-STD-202G Method 108A Test Condition D	$\Delta R = \pm 2\%$
Temperature Cycle (Thermal Shock)	MIL-STD-202G Method 107G Test Condition A	$\Delta R = \pm 0.02\%$
Resistance to Soldering Heat	IPC/EIA J-STD-002A Paragraph 4.2.4	IPC/EIA J-STD-002A Paragraph 4.2.4.4
Solderability	IPC/EIA J-STD-002A Paragraph 4.2.2	IPC/EIA J-STD-002A Paragraph 4.2.2.4.2
Short Time Overload	MIL-PRF-55342H Pg.32, Paragraph 4.8.6	MIL-PRF-55342H Pg.11, Paragraph 3.12

RVC Series — Medium Voltage Chip Resistors

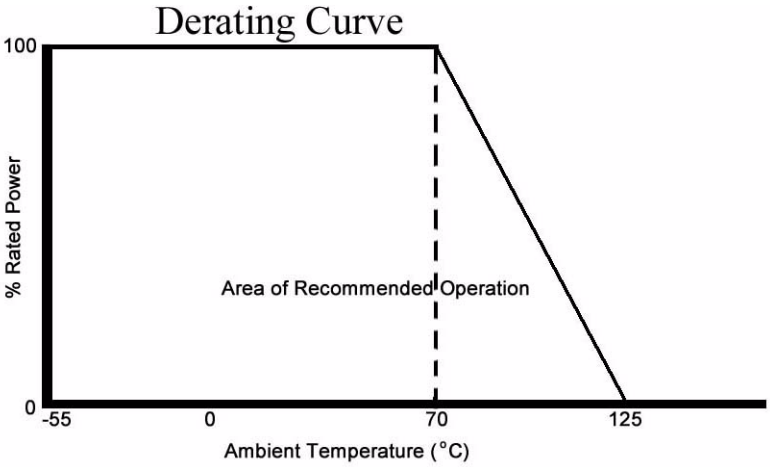
Features

- Voltage ratings 2x or more compared to standard chip resistors
- Values up to 51M
- Proportionally higher pulse power capability
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Limiting Element Voltage	Isolation Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance			
					1%	2%	5%	10%
RVC 0603	0.100	200V	200V	±200 ppm/°C ±100 ppm/°C	47Ω – 464Ω 470Ω – 10M	47Ω – 464Ω 470Ω – 10M	47Ω – 464Ω 470Ω – 10M	47Ω – 464Ω 470Ω – 10M
RVC 0805	0.125	300V	500V	±200 ppm/°C ±100 ppm/°C	47Ω – 97.6Ω 100Ω – 10M	47Ω – 97.6Ω 100Ω – 10M	47Ω – 97.6Ω 100Ω – 51M	47Ω – 97.6Ω 100Ω – 51M
RVC 1206	0.250	400V	500V	±200 ppm/°C ±100 ppm/°C	47Ω – 97.6Ω 100Ω – 10M	47Ω – 97.6Ω 100Ω – 10M	47Ω – 97.6Ω 100Ω – 51M	47Ω – 97.6Ω 100Ω – 51M
RVC 2010	0.500	500V	500V	±200 ppm/°C ±100 ppm/°C	47Ω – 464Ω 470Ω – 20M	47Ω – 464Ω 470Ω – 20M	47Ω – 464Ω 470Ω – 51M	47Ω – 464Ω 470Ω – 51M
RVC 2512	1.500	800V	800V	±500 ppm/°C ~ ±200 ppm/°C ±200 ppm/°C ±100 ppm/°C	47Ω – 97.6Ω 100Ω – 549Ω 560Ω – 20M	47Ω – 97.6Ω 100Ω – 549Ω 560Ω – 20M	47Ω – 97.6Ω 100Ω – 549Ω 560Ω – 51M	47Ω – 97.6Ω 100Ω – 549Ω 560Ω – 51M



How to Order

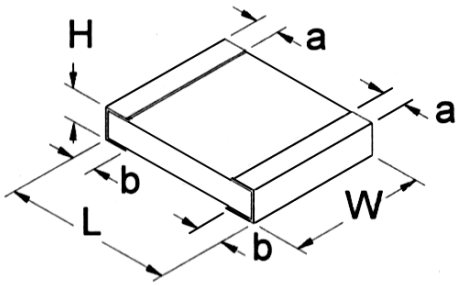
RVC	0805	10M	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
0603
0805
1206
2010
2512

Tolerance	Values
1%	E24, E96
2%	E24, E96
5%	E24
10%	E24

Code	Description	SEI Types	Pkg Qty
R	Tape	0603, 0805, 1206	5,000
		2010, 2512	4,000

RVC Series — Medium Voltage Chip Resistors



Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RVC 0603	0.063 ± 0.004 1.60 ± 0.10	0.031 + 0.006/ -0.002 0.80 + 0.15/ -0.05	0.018 ± 0.004 0.45 ± 0.10	0.012 ± 0.004 0.30 ± 0.10	0.012 ± 0.004 0.30 ± 0.10	inches mm
RVC 0805	0.079 ± 0.004 2.00 ± 0.10	0.049 ± 0.004 1.25 ± 0.10	0.021 ± 0.004 0.55 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RVC 1206	0.126 ± 0.006 3.20 ± 0.15	0.063 ± 0.006 1.60 ± 0.15	0.021 ± 0.004 0.55 ± 0.10	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.010 0.50 ± 0.25	inches mm
RVC 2010	0.197 ± 0.006 5.00 ± 0.15	0.098 ± 0.006 2.50 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.024 ± 0.008 0.60 ± 0.20	0.024 ± 0.008 0.60 ± 0.20	inches mm
RVC 2512	0.248 ± 0.006 6.30 ± 0.15	0.126 ± 0.006 3.20 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.024 ± 0.008 0.60 ± 0.20	0.024 ± 0.008 0.60 ± 0.20	inches mm

Climatic Category	
Lower Category Temperature	-55°C
Upper Category Temperature	+125°C
Duration of the Damp heat, Steady-State Test	56 days

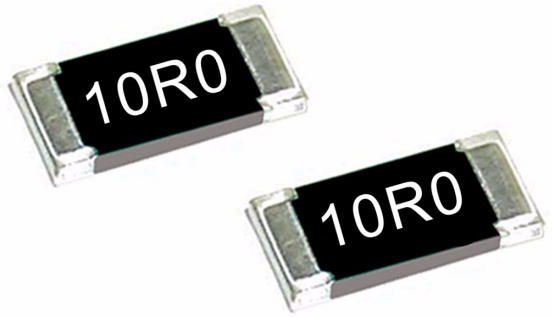
Performance Characteristics

Test	Test Results	Test Methods (JIS C 5201-1 : 1998)
Voltage Proof	No breakdown or flashover R ≥ 1G ohm	Clause 4.7 500Va.c.,60s : RVC 0805,RVC 1206, RVC 2010, RVC 2512 100Va.c.,60s : RVC 0603
Variation of Resistance with Temperature	See ratings table	Clause 4.8 Measuring temperature: +20°C/ -55°C/ +20°C/ +125°C/ +20°C
Overload	ΔR ≤ ± 1% + 0.05Ω No visible damage, legible markings	Clause 4.13 The applied voltage shall be 2.5 times of the rated voltage or twice of the limiting element voltage, whichever is the less severe, 2s.
Solderability	In accordance with Clause 4.17.4.5	Clause 4.17 235°C, 2s.
Resistance to Soldering Heat	ΔR ≤ ± 1% + 0.05Ω	Clause 4.18 After immersion into the flux, the immersion into solder shall be carried out in Solder bath at 260°C for 5s.
Rapid Change of Temperature	ΔR ≤ ± 1% + 0.05Ω No visible damage	Clause 4.19 5 Cycles between -55°C and + 125°C.
Climatic Sequence	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.23 Dry/Damp heat (12+12h cycle), first cycle./ Cold/Damp heat (12+12h cycle), remaining cycle./ D.C. Load
Damp Test, Steady State	ΔR ≤ ± 5% + 0.10Ω No visible damage, legible markings	Clause 4.24 40°C, 95% R.H., 56 days, test a) and b) of Clause 4.24.2.1
Endurance @ 70°C	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.25.1 Rated voltage, 1.5h "ON", 05.h "OFF", 70°C, 1,000h
Endurance at the Upper Category Temperature	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.25.3 125°C, no load, 1,000h
Adhesion	No visible damage	Clause 4.32 5N, 10s
Bend of Strength of the Face Plating	ΔR ≤ ± 1% + 0.05Ω	Clause 4.33 Amount of bend: 3mm RVC 0603 RVC 0805 RPC 1206 Amount of bend: 1mm RVC 2010 RVC 2512

FCR Series — Thick Film Trimmable Chip Resistors

Features

- YAG laser user-trimmable in circuit
- Available in a variety of pre-trim tolerance ranges
- TCR of ±200ppm/°C
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Package Type	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance				
						5%	10%	15%	0/-20%	0/-30%
FCR 1/16	0603	0.063W	50	100	±200 ppm/°C	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M
FCR 1/10	0805	0.1W	100	200	±200 ppm/°C	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M
FCR 1/8	1206	0.125W	200	400	±200 ppm/°C	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M
FCR 1/4	1210	0.25W	200	400	±200 ppm/°C	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M
FCR 1/2	2010	0.50W	200	400	±200 ppm/°C	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M	10Ω – 1M

* Lesser of √PR or maximum working voltage.

Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
FCR 1/16	0.063 ± 0.006 1.60 ± 0.15	0.031 ± 0.006 0.80 ± 0.15	0.018 ± 0.004 0.45 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	inches mm
FCR 1/10	0.079 ± 0.008 2.00 ± 0.20	0.050 ± 0.004 1.25 ± 0.10	0.020 ± 0.004 0.50 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
FCR 1/8	0.126 + 0.002/-0.008 3.20 + 0.05/-0.20	0.063 + 0.002/-0.006 1.60 + 0.05/-0.15	0.024 ± 0.004 0.60 ± 0.10	0.020 ± 0.010 0.50 ± 0.25	0.020 ± 0.012 0.50 ± 0.30	inches mm
FCR 1/4	0.126 ± 0.008 3.20 ± 0.20	0.098 + 0.008/-0.004 2.50 + 0.20/-0.10	0.024 ± 0.004 0.60 ± 0.10	0.020 ± 0.010 0.50 ± 0.25	0.0220 ± 0.008 0.50 ± 0.20	inches mm
FCR 1/2	0.197 ± 0.006 5.00 ± 0.15	0.098 ± 0.006 2.50 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.024 ± 0.010 0.60 ± 0.25	0.024 ± 0.010 0.60 ± 0.25	inches mm

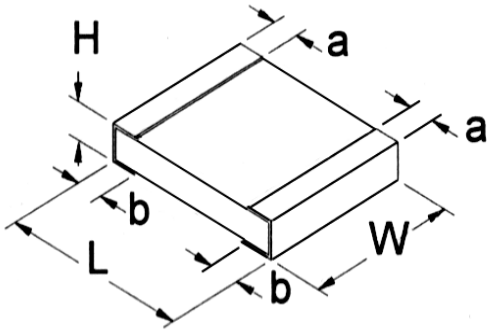
How to Order

FCR	1/10	47K	10%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code	Wattage	Size
1/16	0.063W	0603
1/10	0.1W	0805
1/8	0.125W	1206
1/4	0.25W	1210
1/2	0.50W	2010

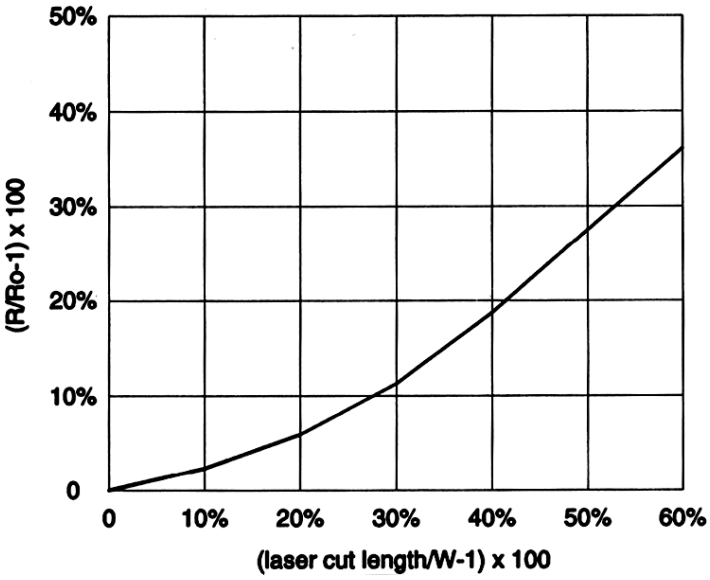
Tolerance	Values
10%	E24
20%	E24
0/-20%	E24
0/-30%	E24

Code	Description	Pkg Qty
R	7" - Paper	5,000
I	7" - Paper	1,000
A	Bulk	1,000



Performance Characteristics	
Test	**Test Results (JIS C 5202)**
Load Life in Moisture	±3%
Temperature Cycle	±1%
Load Life	±3%
Resistance to Solder Heat	±1%
Terminal Adhesion	±1%
Short Time Overload	±2%
Operating Range	-55°C to +125°C

Trimming Ratio Curve



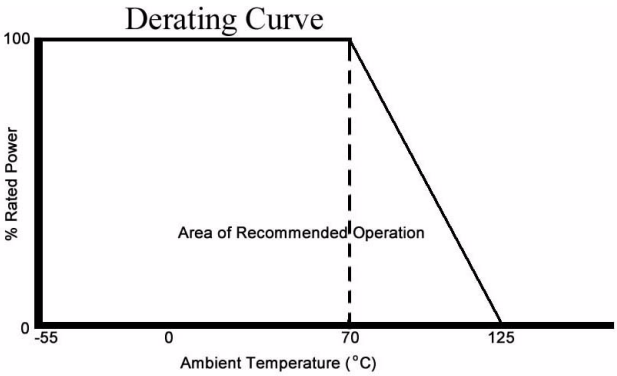
RPC Series — Resistor Pulse Chip

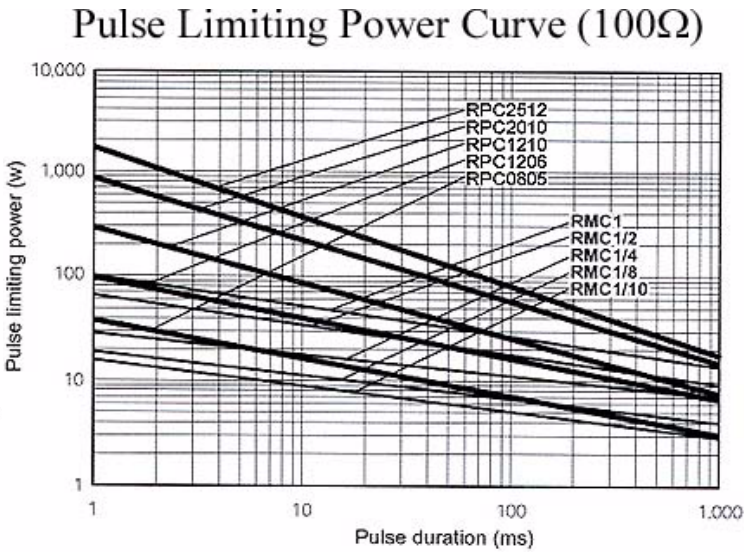
Features

- Excellent pulse withstanding performance
- Improved working voltage
- Higher anti-surge performance compared with RMC series
- Stability class: 5%
- Broad resistance range
- RoHS compliant / lead-free available

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage	Isolation Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					5%	10%
RPC 0805	0.100	150V	500V	±200 ppm/°C	0.27Ω – 22M	0.27Ω – 22M
RPC 1206	0.125	200V	500V	±200 ppm/°C	0.27Ω – 22M	0.27Ω – 22M
RPC 1210	0.250	200V	500V	±200 ppm/°C	0.27Ω – 22M	0.27Ω – 22M
RPC 2010	0.500	200V	500V	±200 ppm/°C	0.27Ω – 22M	0.27Ω – 22M
RPC 2512	1.000	200V	500V	±200 ppm/°C	0.27Ω – 22M	0.27Ω – 22M





How to Order

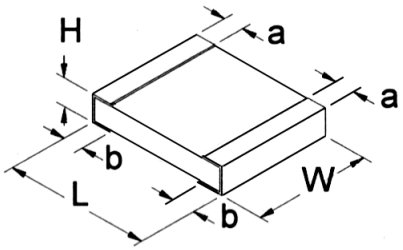
RPC	0805	10M	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
0805
1206
1210
2010
2512

Tolerance	Values
5%	E24
10%	E24
20%	E24

Code	Description	SEI Types	Pkg Qty
B	Bulk	All	1,000
R	Paper	RPC 0805, RPC 1206	5,000
R	Emboss	RPC 1210, RPC 2010, RPC 2512	4,000

RPC Series — Resistor Pulse Chip



Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RPC 0805	0.079 ± 0.004 2.00 ± 0.10	0.049 ± 0.004 1.25 ± 0.10	0.021 ± 0.004 0.55 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RPC 1206	0.126 ± 0.006 3.20 ± 0.15	0.063 ± 0.006 1.60 ± 0.15	0.021 ± 0.004 0.55 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.020 ± 0.010 0.50 ± 0.25	inches mm
RPC 1210	0.126 ± 0.006 3.20 ± 0.15	0.098 ± 0.006 2.50 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.012 ± 0.008 0.30 ± 0.20	0.020 ± 0.010 0.50 ± 0.25	inches mm
RPC 2010	0.197 ± 0.006 5.00 ± 0.15	0.098 ± 0.006 2.50 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.012 ± 0.008 0.30 ± 0.20	0.024 ± 0.008 0.60 ± 0.20	inches mm
RPC 2512	0.248 ± 0.006 6.30 ± 0.15	0.126 ± 0.006 3.20 ± 0.15	0.021 ± 0.006 0.55 ± 0.15	0.012 ± 0.008 0.30 ± 0.20	0.024 ± 0.008 0.60 ± 0.20	inches mm

Climatic Category

	RPC 2010 & RPC 2512	RPC 0805, RPC 1206, & RPC 1210
Lower Category Temperature	-55°C	-55°C
Upper Category Temperature	+125°C	+155°C
Duration of the Damp heat, Steady-State Test	56 days	56 days

Performance Characteristics

Test	Test Results	Test Methods (JIS C 520-1:1198)
Voltage Proof	No breakdown or flashover R ≥ 1G ohm	Clause 4.7 500Va.c.,60s
Variation of Resistance with Temperature	See ratings table	Clause 4.8 +20°C/ -55°C/ +20°C/ +125°C/ +20°C : RPC 2010 RPC 2512 +20°C/ -55°C/ +20°C/ +155°C/ +20°C : RPC 0805 RPC 1206 RPC 1210
Overload	ΔR ≤ ± 1% + 0.05Ω No visible damage, legible markings	Clause 4.13 The applied voltage shall be 2.5 times of the rated voltage or twice of the limiting element voltage, whichever is the less severe, 2s.
Solderability	In accordance with Clause 4.17.4.5	Clause 4.17 235°C, 2s.
Resistance to Soldering Heat	ΔR ≤ ± 1% + 0.05Ω	Clause 4.18 After immersion into the flux, the immersion into solder shall be carried out in Solder bath at 260°C for 5s.
Rapid Change of Temperature	ΔR ≤ ± 1% + 0.05Ω No visible damage	Clause 4.19 Cycle: -55°C/ + 125°C 5 times: RPC 2010 RPC 2512 Cycle: -55°C/ +155°C 5 times: RPC 0805 RPC 1206 RPC 1210
Climatic Sequence	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.23 Dry/Damp heat (12+12h cycle), first cycle./ Cold/Damp heat (12+12h cycle), remaining cycle./ D.C. Load
Damp Test, Steady State	ΔR ≤ ± 5% + 0.10Ω No visible damage, legible markings	Clause 4.24 40°C, 95% R.H., 56 days, test a) and b) of Clause 4.24.2.1
Endurance @ 70°C	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.25.1 Rated voltage, 1.5h "ON", 05.h "OFF", 70°C, 1,000h
Endurance at the Upper Category Temperature	ΔR ≤ ± 5% + 0.10Ω No visible damage	Clause 4.25.3 125°C, no load, 1,000h: RPC 2010 RPC 2512 155°C, no load, 1,000h: RPC 0805 RPC 1206 RPC 1210
Adhesion	No visible damage	Clause 4.32 5N, 10s
Bend of Strength of the Face Plating	ΔR ≤ ± 1% + 0.05Ω	Clause 4.33 Amount of bend: 3mm RPC 0805 RPC 1206 RPC 1210 Amount of bend: 1mm RPC 2010 RPC 2512

RNC Series — Precision Thin Film Chip Resistors

Features

- Precision tolerances to ±0.01%
- TCR down to ±10ppm/°C
- RoHS compliant / lead-free available (RNCF)
- Wide R-value range
- Consult factory for tighter tolerances
- 2010 and 2512 sizes now available

Electrical Specifications

Type / Code	Package Size	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance			
						0.01%, 0.05%	0.1%	0.5%	1%
RNC 05	0201	0.050	15	30	±100 ppm/°C ±25 ppm/°C	–	–	– 33Ω – 22K	10Ω – 30Ω –
RNC 10	0402	0.063	50	100	±25 ppm/°C ±10 ppm/°C	– 50Ω – 15K	10Ω – 100K 50Ω – 15K	10Ω – 100K –	–
RNC 16	0603	0.100	75	150	±50 ppm/°C ±25 ppm/°C ±10 ppm/°C	– – 50Ω – 50K	4.7Ω – 332K 4.7Ω – 332K 50Ω – 50K	4.7Ω – 332K 4.7Ω – 332K –	–
RNC 20	0805	0.125	100	200	±50 ppm/°C ±25 ppm/°C ±10 ppm/°C ±5 ppm/°C	– – 50Ω – 100K 100Ω – 22K	4.7Ω – 1M 4.7Ω – 1M 50Ω – 100K –	4.7Ω – 1M 4.7Ω – 1M – –	–
RNC 32	1206	0.250	150	300	±50 ppm/°C ±25 ppm/°C ±10 ppm/°C ±5 ppm/°C	– – 50Ω – 200K 100Ω – 30K	4.7Ω – 1M 4.7Ω – 1M 50Ω – 200K –	4.7Ω – 1M 4.7Ω – 1M – –	–
RNC 50	1210	0.250	200	400	±25 ppm/°C ±10 ppm/°C	–	51.1Ω – 2M 100Ω – 330K	–	–
RNC 57	2010	0.500	200	400	±50 ppm/°C ±25 ppm/°C	–	4.7Ω – 1M 4.7Ω – 1M	4.7Ω – 1M 4.7Ω – 1M	–
RNC 63	2512	1.000	200	400	±50 ppm/°C ±25 ppm/°C	–	4.7Ω – 1M 4.7Ω – 1M	4.7Ω – 1M 4.7Ω – 1M	–

* Lesser of √PR or maximum working voltage.

How to Order

RNC	20	T9	4.75K	0.5%	R
SEI Type	Code	TCR	Nominal Resistance	Tolerance	Packaging

SEI Type	Description
RNC	Standard
RNCF	RoHS

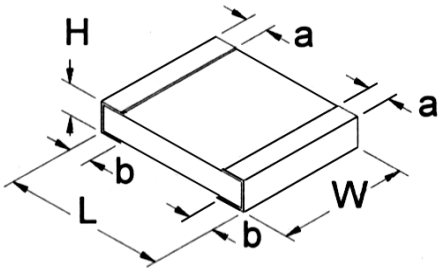
Code	Wattage	Size
05	.05W	0201
10	0.063W	0402
16	0.1W	0603
20	0.125W	0805
32	0.25W	1206
50	0.25W	1210
57	0.5W	2010
63	1.0W	2512

TCR
T1 = 100ppm
T2 = 50ppm
T9 = 25ppm
TB = 10ppm
TA = 5ppm

Tolerance	Values
0.01%	E96,E24
0.05%	E96,E24
0.1%	E96,E24
0.5%	E96,E24
1%	E96,E24

Code	Description	Pkg Qty
R	7" - Paper	5,000
R (0402 only)	7" - Paper	10,000
I*	7" - Paper	1,000

*Not available in all sizes



Mechanical Specifications						
Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RNC 05	0.024 ± 0.002 0.60 ± 0.05	0.012 ± 0.002 0.30 ± 0.05	0.009 ± 0.001 0.23 ± 0.030	0.005 ± 0.002 0.12 ± 0.05	0.005 ± 0.002 0.12 ± 0.05	inches mm
RNC 10	0.039 ± 0.002 1.00 ± 0.05	0.020 ± 0.002 0.50 ± 0.05	0.014 ± 0.002 0.35 ± 0.05	0.008 ± 0.004 0.20 ± 0.10	0.010 ± 0.002 0.25 ± 0.10	inches mm
RNC 16	0.063 ± 0.008 1.60 ± 0.20	0.032 ± 0.008 0.80 ± 0.20	0.016 ± 0.004 0.40 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	inches mm
RNC 20	0.079 ± 0.008 2.00 ± 0.20	0.049 ± 0.008 1.25 ± 0.20	0.016 ± 0.004 0.40 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RNC 32	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.008 1.60 ± 0.20	0.020 ± 0.004 0.50 ± 0.10	0.020 ± 0.012 0.50 ± 0.30	0.016 ± 0.008 0.40 ± 0.20	inches mm
RNC 50	0.126 ± 0.008 3.20 ± 0.20	0.100 ± 0.008 2.50 ± 0.20	0.024 ± 0.008 0.60 ± 0.20	0.020 ± 0.012 0.50 ± 0.30	0.016 ± 0.008 0.40 ± 0.20	inches mm
RNC 57	0.193 ± 0.006 4.90 ± 0.15	0.09 ± 0.006 2.40 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.024 ± 0.012 0.60 ± 0.30	0.020 ± 0.010 0.50 ± 0.25	inches mm
RNC 63	0.246 ± 0.006 6.30 ± 0.15	0.122 ± 0.006 3.10 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.024 ± 0.012 0.60 ± 0.30	0.020 ± 0.010 0.50 ± 0.25	inches mm

Performance Characteristics (JIS C 5202)		
Test	Specification	Typical
Moisture Resistance, Thermal Shock	±(0.25% +0.05Ω)	≤0.1%
Load Life	±(0.5% +0.05Ω)	≤0.2%
Load Life in Moisture	±(0.5% +0.05Ω)	≤0.25%
Resistance to Soldering Heat	±(0.25% +0.05Ω)	≤0.05%
Solderability	min 95% coverage	≥0.95%
Terminal Strength	±(0.2% +0.05Ω)	≤0.05%
Dielectric Withstanding Voltage	±(0.25% +0.05Ω)	≤0.05%
Short Time Overload	±(0.25% +0.05Ω)	≤0.05%
Insulation Resistance	1MΩ minimum	≥1MΩ

RNCS Series — Anti-Corrosive Precision Thin Film Chip Resistors

Features

- Special passivation for moisture sensitive applications
- Absolute TCR's to ±25 ppm/°C
- Available in industry standard sizes from 0201 to 2512
- Resistance range from 25Ω to 600KΩ
- Test proven immunity to humidity and moisture corrosion
- Absolute tolerances to 0.1%
- Ideal replacement for costly Tantalum Nitride resistors
- RoHS compliant / lead-free

The RNCS series employs a special manufacturing process to ensure high precision, ultra stable performance, and long life in the harshest environments. In moisture comparison testing the RNCS series outperformed Nichrome Chip Resistors and demonstrated the anti-corrosive claims characterized by Tantalum Nitride resistor products.

Electrical Specifications

Type / Code	Package Size	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Resistance Range	Resistance Tolerance
RNCS 10	0402	0.063W	25	50	±50 ppm/°C ±25 ppm/°C	25Ω – 25K	±0.10% ±0.25% ±0.50%
RNCS 16	0603	0.100W	50	100	±50 ppm/°C ±25 ppm/°C	25Ω – 200K	±0.10% ±0.25% ±0.50%
RNCS 20	0805	0.125W	100	200	±50 ppm/°C ±25 ppm/°C	25Ω – 400K	±0.10% ±0.25% ±0.50%
RNCS 32	1206	0.250W	150	300	±50 ppm/°C ±25 ppm/°C	25Ω – 500K	±0.10% ±0.25% ±0.50%
RNCS 57	2010	0.500W	150	300	±50 ppm/°C ±25 ppm/°C	25Ω – 600K	±0.10% ±0.25% ±0.50%
RNCS 63	2512	1.000W	150	300	±50 ppm/°C ±25 ppm/°C	25Ω – 600K	±0.10% ±0.25% ±0.50%

* Lesser of √PR or maximum working voltage.

How to Order

RNCS	20	T9	4.75K	0.5%	R
SEI Type	Code	TCR	Nominal Resistance	Tolerance	Packaging

Code	Wattage	Size
10	0.063	0402
16	0.100	0603
20	0.125	0805
32	0.250	1206
57	0.500	2010
63	1.000	2512

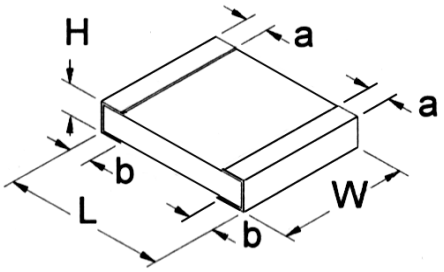
TCR
T2 = 50ppm
T9 = 25ppm

Tolerance	Values
±0.10%	E96,E24
±0.25%	E96,E24
±0.50%	E96,E24

Code	Description	Pkg Qty
R	7" - Paper	5,000
R (0402 only)	7" - Paper	10,000
I*	7" - Paper	1,000

*Not available in all sizes

RNCS Series — Anti-Corrosive Precision Thin Film Chip Resistors

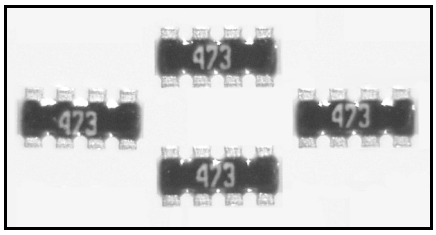


Mechanical Specifications						
Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
RNCS 10	0.039 ± 0.002 1.00 ± 0.05	0.020 ± 0.002 0.50 ± 0.05	0.014 ± 0.002 0.35 ± 0.05	0.008 ± 0.004 0.20 ± 0.10	0.010 ± 0.002 0.25 ± 0.10	inches mm
RNCS 16	0.063 ± 0.008 1.60 ± 0.20	0.032 ± 0.008 0.80 ± 0.20	0.016 ± 0.004 0.40 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	inches mm
RNCS 20	0.079 ± 0.008 2.00 ± 0.20	0.049 ± 0.008 1.25 ± 0.20	0.016 ± 0.004 0.40 ± 0.10	0.016 ± 0.008 0.40 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	inches mm
RNCS 32	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.008 1.60 ± 0.20	0.020 ± 0.004 0.50 ± 0.10	0.020 ± 0.012 0.50 ± 0.30	0.016 ± 0.008 0.40 ± 0.20	inches mm
RNCS 57	0.193 ± 0.006 4.90 ± 0.15	0.09 ± 0.006 2.40 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.024 ± 0.012 0.60 ± 0.30	0.020 ± 0.010 0.50 ± 0.25	inches mm
RNCS 63	0.246 ± 0.006 6.30 ± 0.15	0.122 ± 0.006 3.10 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.024 ± 0.012 0.60 ± 0.30	0.020 ± 0.010 0.50 ± 0.25	inches mm

Performance Characteristics			
Test	Test Conditions	Test Results	
		Size 0603 / 0805 / 1206 / 2012 / 2512	Size 0402
Short Time Overload	RCWV * 2.5 or Max Overloading Voltage, 2 seconds	≤±0.02%	≤±0.1%
Thermal Shock	**MIL - STD - 202F Method 107G** -55°C - 125°C, 100 Cycles	≤±0.02%	≤±0.1%
Load Life	**MIL - STD - 202F Method 108A** RCWV, 70°C, 1.5 hours ON, 0.5 hours OFF, total 1000 - 1048 hours	≤±0.05%	≤±0.25%
Humidity (Steady State)	**MIL - STD - 202F Method 103B** 40°C, 90-95% RH, RCWV 1.5 hours ON, 0.5 hours OFF, total 1000 -1048 hours	≤±0.05%	≤±0.5%
Resistance to Dry Heat	**JIS - C 5202 - 7.2** 1000 hours @ +125°C without load	≤±0.05%	≤±0.5%
Resistance to Soldering Heat	**MIL - STD - 202F Method 210E** 260 ± 5°C, 10 ± 1 second	≤±0.02%	≤±0.1%

*Storage Temperature: 25 ± 3°C; Humidity <80%RH

RAV / RAF Series — Chip Resistor Array Convex & Flat Terminations



Features

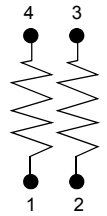
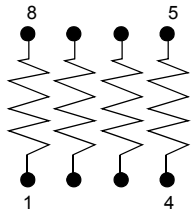
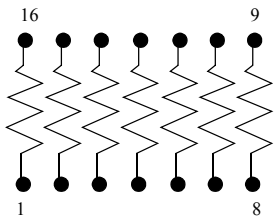
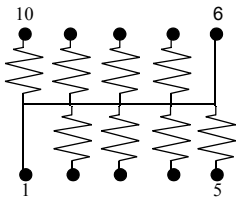
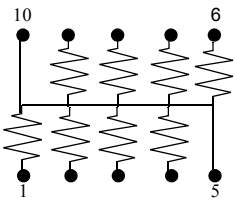
- Thick film resistor element
- Multiple circuit types available
- Flat termination for better solderability, reliability and lower cost
- Ideal SMD substitute for leaded networks
- RoHS compliant / lead-free available
- Auto-placement capability
- Square corner construction
- Available without square corner, contact factory
- Zero ohm jumper available

Electrical Specifications

Type / Code / # of Elements / Circuit Type	Power Rating (per element) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
RAF 102D	0.063W	25	50	±200 ppm/°C	10Ω – 1M	10Ω – 1M
RAF 104D	0.063W	25	50	±200 ppm/°C	10Ω – 1M	10Ω – 1M
RAF 06	0.031W	12.5		±200 ppm/°C	–	10Ω – 1M
RAV 102D	0.063W	25	50	±250 ppm/°C	22Ω – 1M	10Ω – 1M
RAV 104D	0.063W	25	50	±250 ppm/°C	22Ω – 10K	10Ω – 1M
RAV 162D	0.063W	50	100	±200 ppm/°C	10Ω – 1M	10Ω – 1M
RAV 164D	0.063W	50	100	±200 ppm/°C	10Ω – 1M	10Ω – 1M
RAV 168D	0.063W	25	50	±200 ppm/°C	10Ω – 1M	10Ω – 1M
RAV 324D	0.125W	200	400	±200 ppm/°C	22Ω – 1M	10Ω – 1M
RAV 328N	0.063W	25	50	±200 ppm/°C	–	22Ω – 1M
RAV 328R	0.063W	25	50	±200 ppm/°C	–	22Ω – 1M

*Lesser of √PR or maximum working voltage.

Schematics

Isolated Circuit - 2D	Isolated Circuit - 4D	Isolated Circuit - 8D	Bussed Circuit - N	Bussed Circuit - R
				

How to Order

RAV	16	4	D	10K	5%	R
SEI Type	Code	# of Elements	Circuit Type	Nominal Resistance	Tolerance	Packaging

SEI Type	Description
RAV	Concave
RAF	Flat
RAVF	Concave RoHS
RAFP	Flat RoHS

Code
10
16
32

Elements
2
4
8

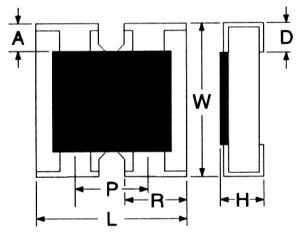
Circuit Type
D = Isolated
M = Bussed
N = Bussed
R = Bussed

Tolerance	Values
1%	E24
2%	E24
5%	E24

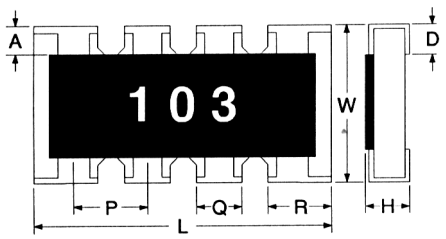
Code	Type	Description	Qty
R	10	Paper	10,000
R	16	Paper	5,000
R	32-4D	Emboss	4,000
R	32-8N and 32-8R	Emboss	5,000

RAV / RAF Series — Chip Resistor Array Convex & Flat

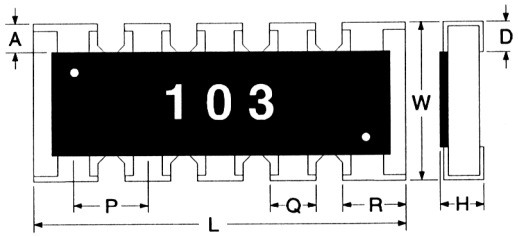
RAV - 2 Resistors / 4 Terminations (D)



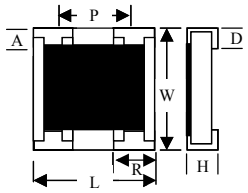
RAV - 4 Resistors / 8 Terminations (D)



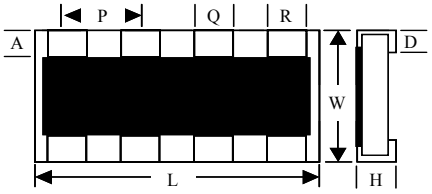
RAV - 8 Resistors / 10 Terminations (N/R)



RAF - 2 Resistors / 4 Terminations (D)



RAF - 4 Resistors / 8 Terminations (D)



Mechanical Specifications

inches
mm

Type/Code/ # of Elements/ Circuit Type	L Body Length	W Body Width	H Body Height	P Element Spacing	Q Termination Width	R Termination Width	D Bottom Termination	A Top Termination
RAF 102D	0.039 ± 0.002 1.0 ± 0.05	0.039 ± 0.004 1.0 ± 0.10	0.016 ± 0.004 0.4 ± 0.10	0.026 ± 0.002 0.65 ± 0.05	–	0.013 ± 0.004 0.33 ± 0.10	0.010 ± 0.004 0.25 ± 0.10	0.006 ± 0.004 0.15 ± 0.10
RAF 104D	0.079 ± 0.004 2.0 ± 0.10	0.039 ± 0.004 1.0 ± 0.10	0.016 ± 0.004 0.4 ± 0.10	0.020 ± 0.006 0.50 ± 0.15	0.012 ± 0.006 0.30 ± 0.15	0.012 ± 0.004 0.30 ± 0.10	0.014 ± 0.006 0.35 ± 0.15	0.009 ± 0.004 0.22 ± 0.10
RAF 06	0.055 ± 0.004 1.4 ± 0.10	0.024 ± 0.004 0.60 ± 0.10	0.014 ± 0.004 0.35 ± 0.10	0.016 0.40	0.008 ± 0.004 0.20 ± 0.10	0.008 ± 0.004 0.20 ± 0.10	0.006 ± 0.004 0.15 ± 0.10	0.004 ± 0.004 0.10 ± 0.10
RAV 102D	0.039 ± 0.004 1.00 ± 0.10	0.039 ± 0.004 1.0 ± 0.10	0.014 ± 0.002 0.35 ± 0.05	0.026 ± 0.002 0.65 ± 0.05	–	0.013 ± 0.002 0.33 ± 0.05	0.010 ± 0.002 0.25 ± 0.05	0.006 ± 0.004 0.15 ± 0.10
RAV 104D	0.079 ± 0.008 2.00 ± 0.20	0.039 ± 0.006 1.00 ± 0.15	0.014 ± 0.004 0.35 ± 0.10	0.020 ± 0.006 0.50 ± 0.15	0.012 ± 0.006 0.30 ± 0.15	0.016 ± 0.006 0.40 ± 0.15	0.010 ± 0.004 0.25 ± 0.10	0.006 ± 0.004 0.15 ± 0.10
RAV 162D	0.063 ± 0.006 1.60 ± 0.15	0.063 ± 0.006 1.60 ± 0.15	0.020 ± 0.006 0.50 ± 0.10	0.031 ± 0.002 0.80 ± 0.05	–	0.024 ± 0.006 0.60 ± 0.15	0.010 ± 0.004 0.25 ± 0.10	0.012 ± 0.008 0.30 ± 0.20
RAV 164D	0.126 ± 0.004 3.20 ± 0.10	0.063 ± 0.004 1.60 ± 0.10	0.020 ± 0.004 0.50 ± 0.10	0.031 ± 0.002 0.80 ± 0.05	0.016 ± 0.006 0.40 ± 0.15	0.024 ± 0.006 0.60 ± 0.15	0.010 ± 0.006 0.25 ± 0.15	0.012 ± 0.008 0.30 ± 0.20
RAV 168D	0.158 ± 0.008 4.0 ± 0.20	0.063 ± 0.006 1.60 ± 0.15	0.016 ± 0.004 0.4 ± 0.10	0.020 ± 0.006 0.50 ± 0.15	0.012 ± 0.004 0.30 ± 0.10	0.016 ± 0.004 0.40 ± 0.10	0.012 ± 0.008 0.30 ± 0.20	0.012 ± 0.008 0.30 ± 0.20
RAV 324D	0.200 ± 0.008 5.08 ± 0.20	0.122 ± 0.008 3.10 ± 0.20	0.022 ± 0.004 0.55 ± 0.10	0.050 ± 0.004 1.27 ± 0.10	0.031 ± 0.008 0.80 ± 0.20	–	0.012 ± 0.008 0.30 ± 0.20	0.020 ± 0.008 0.50 ± 0.20
RAV 328N	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.008 1.60 ± 0.20	0.020 ± 0.004 0.50 ± 0.10	0.025 ± 0.002 0.64 ± 0.05	0.013 ± 0.006 0.34 ± 0.15	0.019 ± 0.006 0.49 ± 0.15	0.010 ± 0.006 0.25 ± 0.15	0.012 ± 0.008 0.30 ± 0.20
RAV 328R	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.008 1.60 ± 0.20	0.020 ± 0.004 0.50 ± 0.10	0.025 ± 0.002 0.64 ± 0.05	0.013 ± 0.006 0.34 ± 0.15	0.019 ± 0.006 0.49 ± 0.15	0.010 ± 0.006 0.25 ± 0.15	0.012 ± 0.008 0.30 ± 0.20

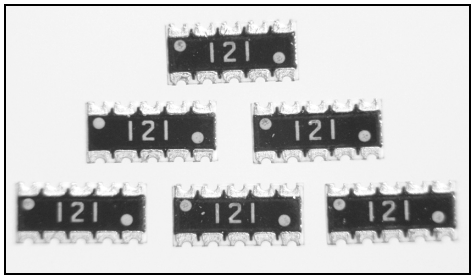
Performance Characteristics

Test	Test Results (JIS C 5202)
Load Life in Moisture	±3%
Temperature Cycle	±1%
Load Life	±3%
Resistance to Soldering Heat	±1%
Terminal Adhesion	±1%
Short Time Overload	±2%
Operating Range	-55°C to +150°C

RAC Series — Chip Resistor Array Concave Terminations

Features

- Thick film resistor element
- Zero ohm available
- Auto-placement capability
- Multiple circuit types available
- Ideal SMD substitute for leaded networks
- RoHS compliant / lead-free available (RACF)

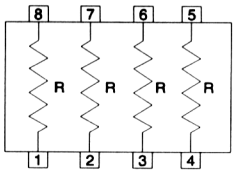
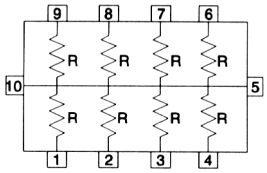
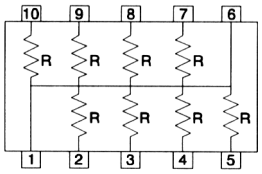
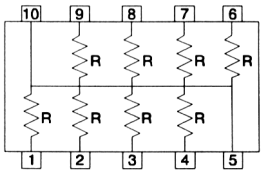


Electrical Specifications

Type/Code/ # of Elements/ Circuit Type	Power Rating (per element) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
RAC 16-4D	0.063W	50	100	±200 ppm/°C	22Ω – 1M	10Ω – 1M
RAC 32-4D	0.125W	75	150	±200 ppm/°C	22Ω – 1M	10Ω – 1M
RAC 40-8M	0.063W	25	50	±200 ppm/°C	–	22Ω – 1M
RAC 64-8N	0.063W	50	100	±200 ppm/°C	–	22Ω – 1M
RAC 64-8R	0.063W	50	100	±200 ppm/°C	–	22Ω – 1M

* Lesser of √PR or maximum working voltage.

Schematics

Isolated Circuit - D	Bussed Circuit - M	Bussed Circuit - N	Bussed Circuit - R
			

How to Order

RAC	16	4	D	10K	5%	R
SEI Type	Code	# of Elements	Circuit Type	Nominal Resistance	Tolerance	Packaging

SEI Type	Description
RAC	Standard
RACF	RoHS

Code
16
32
40
64

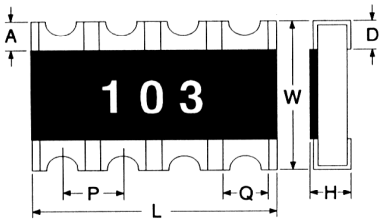
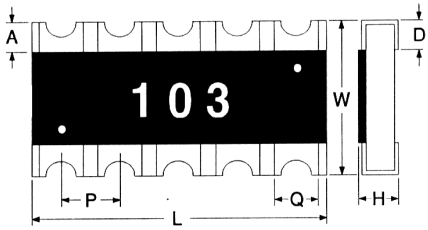
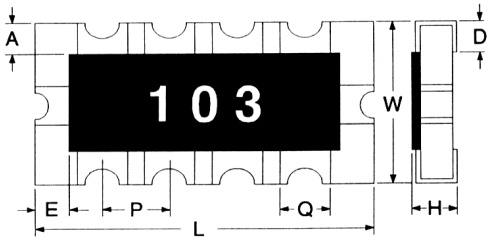
Elements
4
8

Circuit Type
D = Isolated
M = Bussed
N = Bussed
R = Bussed

Tolerance	Values
1%	E24
2%	E24
5%	E24

Code	Type	Description	Qty
R	16	Paper	5,000
R	32	Emboss	4,000
R	40	Emboss	4,000
R	64	Emboss	4,000

RAC Series — Chip Resistor Array Concave Terminations

4 Resistors / 8 Terminations (D)	8 Resistors / 10 Terminations (N/R)	8 Resistors / 10 Terminations (M)
		

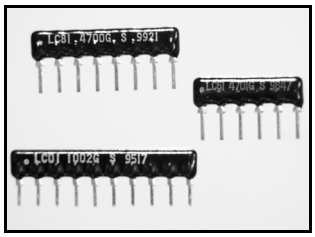
Mechanical Specifications inches mm								
Type/Code/ # of Elements/ Circuit Type	L Body Length	W Body Width	H Body Height	P Element Spacing	Q Termination Width	D Bottom Termination	A Top Termination	E End Termination
RAC 16-4D	0.126 ± 0.008 3.20 ± 0.20	0.063 ± 0.006 1.60 ± 0.15	0.024 ± 0.004 0.60 ± 0.10	0.031 0.80	0.016 ± 0.006 0.40 ± 0.15	0.016 ± 0.008 0.40 ± 0.20	0.012 ± 0.008 0.30 ± 0.20	–
RAC 32-4D	0.200 ± 0.008 5.08 ± 0.20	0.118 ± 0.008 3.00 ± 0.20	0.024 ± 0.004 0.60 ± 0.10	0.050 1.27	0.031 ± 0.004 0.80 ± 0.10	0.020 ± 0.008 0.50 ± 0.20	0.022 ± 0.008 0.55 ± 0.20	–
RAC 40-8M	0.157 ± 0.008 4.00 ± 0.20	0.083 ± 0.008 2.10 ± 0.20	0.024 ± 0.004 0.60 ± 0.10	0.031 0.80	0.020 ± 0.008 0.50 ± 0.20	0.016 ± 0.008 0.40 ± 0.20	0.010 ± 0.008 0.25 ± 0.20	0.012 ± 0.008 0.30 ± 0.20
RAC 64-8N	0.252 ± 0.008 6.40 ± 0.20	0.122 ± 0.008 3.10 ± 0.20	0.024 ± 0.004 0.60 ± 0.10	0.050 1.27	0.028 ± 0.008 0.70 ± 0.20	0.020 ± 0.008 0.50 ± 0.20	0.014 ± 0.006 0.35 ± 0.15	–
RAC 64-8R	0.252 ± 0.008 6.40 ± 0.20	0.122 ± 0.008 3.10 ± 0.20	0.024 ± 0.004 0.60 ± 0.10	0.050 1.27	0.028 ± 0.008 0.70 ± 0.20	0.020 ± 0.008 0.50 ± 0.20	0.014 ± 0.006 0.35 ± 0.15	–

Performance Characteristics	
Test	Test Results (JIS C 5202)
Load Life in Moisture	±3%
Temperature Cycle	±1%
Load Life	±3%
Resistance to Soldering Heat	±1%
Terminal Adhesion	±1%
Short Time Overload	±2%
Operating Range	-55°C to +150°C

LC Series — Thick Film Resistor Networks

Features

- Standard low profile
- 6, 8, or 10 pins standard
- 3, 4, 5, 7, 9, 11, 12 and 13 pins available
- Steel leads standard
- Conformally coated
- Absolute TCR typically better than 100ppm
- TCR tracking typically better than 50ppm

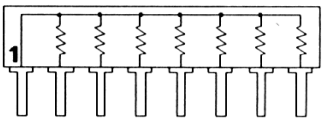
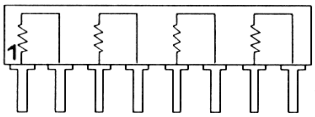


Electrical Specifications

Type	Power Rating (Watts) @ 70°C	Derated to 0 Load @	Max Working Voltage*	Resistance Temperature Coefficient	Ohmic Range and Tolerance
					2%
LC	0.125W Each resistor	125°C	200	±100 ppm/°C	22Ω – 1M

* Lesser of √PR or maximum working voltage

Standard Configurations – Low-Profile SIP Package

Single Common (Bussed) Pull-Up/Pull-Down	Discrete (Isolated) Terminator
	

How to Order

L	C	8	1	2.2K	2%	B
Profile	Coating	Pin Count	Circuit Type	Nominal Resistance	Tolerance	Packaging

L = Low profile

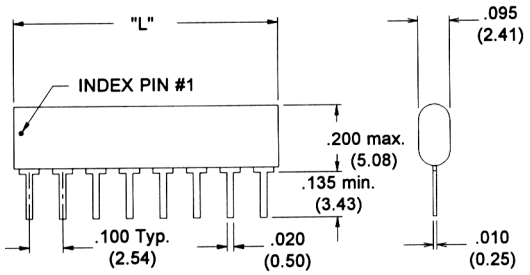
C = Conformal

Pin Count	
x = 3 pin	9 = 9 pin
4 = 4 pin	0 = 10 pin
5 = 5 pin	1 = 11 pin
6 = 6 pin	2 = 12 pin
7 = 7 pin	3 = 13 pin
8 = 8 pin	

Circuit Type
1 = Bussed
2 = Isolated

Tolerance	Value
2%	E24

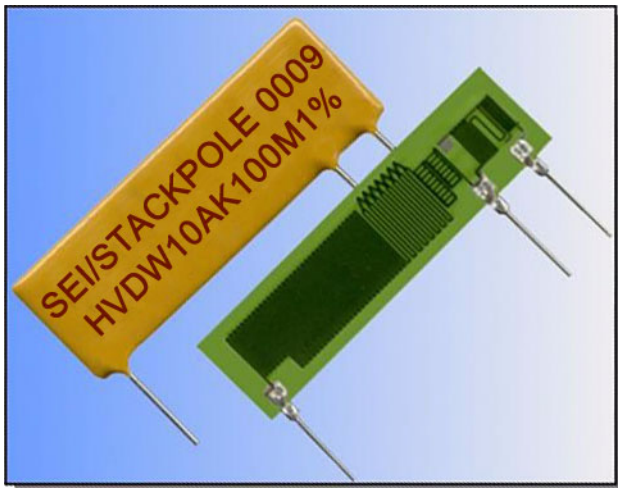
Code	Description	Qty
B	Bulk	1,000

Mechanical Specifications inches mm		
No. of Pins	**"L" Max.**	**Low Profile – LC Series**
4	0.390 9.91	
5	0.490 12.45	
6	0.590 14.99	
7	0.690 17.53	
8	0.790 20.07	
9	0.890 22.61	
10	0.990 25.15	
11	1.090 27.69	
12	1.190 30.23	

Performance Characteristics	
Test	**Test Results per MIL-R-S83401 (%ΔR max.)**
Thermal Shock	±0.5%
Low Temperature Operation	±0.5%
Short Time Overload	±0.5%
Moisture Resistance	±0.5%
Load Life @ 70°C - 1,000 Hours	±1%
Resistance to Soldering Heat	±0.25%
Terminal Strength	±0.25%
Shock (Specified Pulse)	±0.25%
Vibration (High Frequency)	±0.25%

HVD Series — High Voltage Leaded Resistors

Utilizing fine film resistor deposition technology SEI now offers a new level of stability and performance in leaded resistor dividers.



Competing product technologies have constraints due to their dependence on certain limiting composite materials. Traditional thick film products have restricted performance characteristics, while thin film offerings are confined within certain ohmic value ranges.

In addition to improving on these limitations the fine film deposition demonstrates new characteristics, such as a longer high-aspect ratio trace of lower resistivity film.

These fine film resistor dividers provide unique design efficiency, versatility, and linearity, through the combination of long line, high aspect ratio and higher conductivity film.

Features

- Ohmic values to 2,000G
- Voltage ratings to 40,000 volts
- Ultra high stability
- Tight tolerances to 0.1%
- Very low noise
- Low TCR to 10ppm/°C
- Low TCR tracking to 5ppm/°C
- Low VCR to 0.05ppm/volt
- Custom solutions available
- RoHS compliant / lead-free

Electrical Specifications

HVD Case Size	Power (watts) @ 25°C	Maximum Voltage Rating (kV)	Tolerance
04	0.5	4	0.1% – 1%
05	1	5	0.1% – 1%
10	1	10	0.25% – 1%
20	2	20	0.25% – 0.5%
30	3	30	0.5% – 5%
40	6	40	0.5% – 5%

How to Order

HVD	W	04	A	E	2005	B
SEI Type	Lead Style	Case Size	Ratio	Absolute TCR[1]	Total R Value[2]	Ratio Tolerance[3]

Lead Style	
S	Spade
W	Wire

Case Size
04
05
10
20
30
40

Ratio	
A	1,000:1
B	100:1
C	Other

Absolute TCR	
E	±25ppm/°C
H	±50ppm/°C
K	±100ppm/°C
L	±200ppm/°C

Ratio Tolerance	
B	±0.1%
C	±0.25%
D	±0.5%
F	±1%
G	±2%
J	±5%

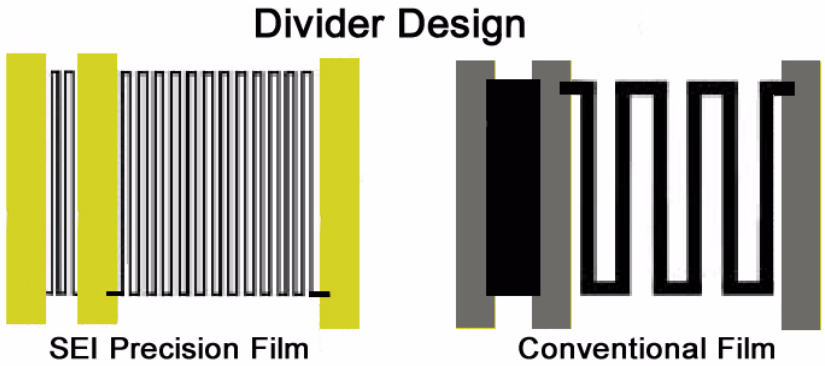
Note 1: TCR Tracking typically <25% of the Absolute TCR to a minimum of 10ppm/°C

Note 2: Express value as a four digit number, the first three numbers are the significant value and the forth number is the number of zeros

Note 3: The Absolute Tolerance is 5% unless otherwise specified

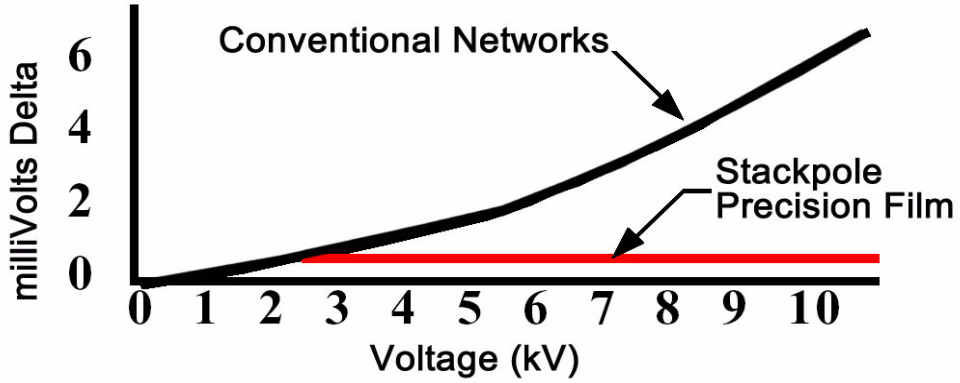
Design Flexibility

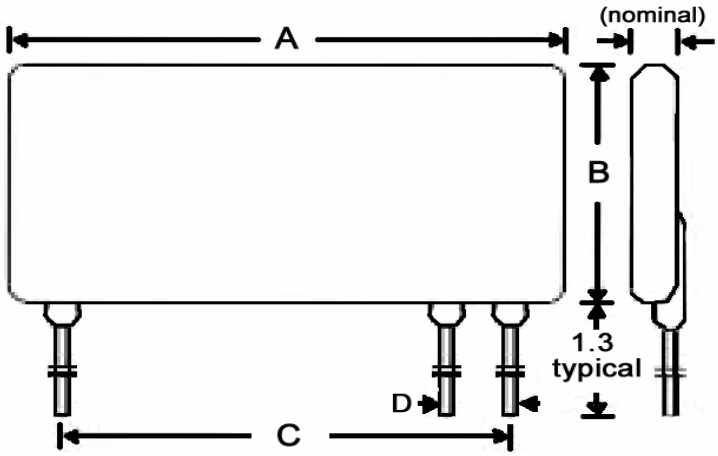
The HVD series can accomodate virtually any divider ratio due to the long serpentine pattern in the fine film manufacturing, combined with the utilization of low ohms/square thick film inks. Please contact SEI with custom design needs.



Excellent VCR Tracking

The VCR is virtually flat over a wide range of values.



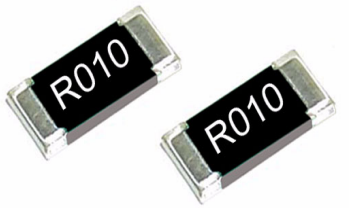


Mechanical Specifications					
HVD Case Size	A	B	C	D	Units
04	0.5 +0.08/-0.03 12.7 +2.032/-0.762	0.375 ± 0.03 9.525 ± 0.762	0.4 10.16	0.2 5.08	inches mm
05	1.0 +0.08/-0.03 25.4 +2.032/-0.762	0.375 ± 0.03 9.525 ± 0.762	0.9 22.86	0.2 5.08	inches mm
10	1.5 +0.08/-0.03 38.1 +2.032/-0.762	0.5 ± 0.03 12.7 ± 0.762	1.3 33.02	0.2 5.08	inches mm
20	2.0 +0.08/-0.03 50.8 +2.032/-0.762	0.75 ± 0.03 19.05 ± 0.762	1.9 48.26	0.2 5.08	inches mm
30	3.0 +0.08/-0.03 76.2 +2.032/-0.762	0.75 ± 0.03 19.05 ± 0.762	2.9 73.66	0.2 5.08	inches mm
40	4.0 +0.08/-0.03 101.6 +2.032/-0.762	0.75 ± 0.03 19.05 ± 0.762	3.9 99.06	0.2 5.08	inches mm

CSR / CSRN Series — Current Sensing Chip Resistors

Features

- 0402 to 2512 sizes available
- Power ratings to 3W
- Low inductance – less than 0.2nH typically
- RoHS compliant / lead-free
- Non-standard resistance values available
- 2010 and 2512 sizes available with narrow terminations (CSRN)



Electrical Specifications

Type / Code	Package Type	Power Rating (Watts) @ 70°C	Dielectric Withstanding Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
CSR 1/8S	0402	0.125	200	±200 ppm/°C	0.051Ω – 1.000Ω	0.051Ω – 1.000Ω
CSR 1/8	0603	0.125	200	±300 ppm/°C	0.021Ω – 1.000Ω	0.021Ω – 1.000Ω
CSR 1/4	0805	0.250	200	±200 ppm/°C	0.021Ω – 1.000Ω	0.021Ω – 1.000Ω
CSR 1/2	1206	0.500	200	±100 ppm/°C *	0.010Ω – 1.000Ω	0.010Ω – 1.000Ω
CSR 1	2010	1.000	200	±100 ppm/°C *	0.010Ω – 1.000Ω	0.010Ω – 1.000Ω
CSRN 1	2010	1.000	200	±250 ppm/°C	0.010Ω – 1.000Ω	0.010Ω – 1.000Ω
CSR 2	2512	2.000	200	±200 ppm/°C	0.010Ω – 1.000Ω	0.010Ω – 1.000Ω
CSRN 2	2512	2.000	200	±200 ppm/°C	0.010Ω – 1.000Ω	0.010Ω – 1.000Ω
CSR 3	1225	3.000	200	±200 ppm/°C	0.005Ω – 0.200Ω	0.005Ω – 0.200Ω

* Contact factory for TCR on values below 0.05Ω

Performance Characteristics

Test	Test Specification	Typical
Moisture Resistance	±0.5%	≤0.5%
Load Life	±0.5%	≤0.5%
Leach Resistance	90 seconds min	>90 seconds
Resistance to Soldering Heat	±0.5%	≤0.25%
Solderability	min 95% coverage	≥95%
Temperature Cycling	±0.5%	≤0.5%
Thermal Shock	±0.5%	≤0.5%
Short Time Overload	±0.5%	≤0.5%
Insulation Resistance	1MΩ minimum	≥1MΩ

How to Order

CSR	1/2	0.01	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
CSR	Standard
CSRN	Narrow Terminations

Code	Wattage	Size
1/8S	0.125	0402
1/8	0.125	0603
1/4	0.250	0805
1/2	0.500	1206
1	1.000	2010
2	2.000	2512
3	3.000	1225

Tolerance
1%
2%
5%

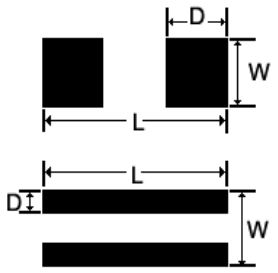
Code	Description	Pkg Qty
R	7" - Paper	5,000
R (0402 only)	7" - Paper	10,000
I	7" - Paper	1,000
A	Bulk	1,000

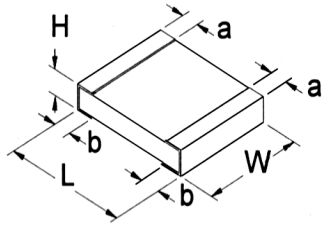
Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
CSR 1/8S	0.039 ± 0.004 1.0 ± 0.1	0.020 ± 0.004 0.5 ± 0.1	0.014 ± 0.004 0.35 ± 0.1	0.006 ± 0.004 0.15 ± 0.1	0.006 ± 0.004 0.15 ± 0.1	inches mm
CSR 1/8	0.063 ± 0.004 1.6 ± 0.1	0.032 ± 0.004 0.8 ± 0.1	0.018 ± 0.004 0.45 ± 0.1	0.012 ± 0.008 0.3 ± 0.2	0.012 ± 0.008 0.3 ± 0.2	inches mm
CSR 1/4	0.079 ± 0.008 2.0 ± 0.2	0.049 ± 0.008 1.25 ± 0.2	0.016 ± 0.004 0.4 ± 0.1	0.016 ± 0.008 0.4 ± 0.2	0.016 ± 0.008 0.4 ± 0.2	inches mm
CSR 1/2	0.126 ± 0.008 3.20 ± 0.2	0.063 ± 0.008 1.6 ± 0.2	0.020 ± 0.006 0.50 ± 0.15	0.039 ± 0.006 1.0 ± 0.15	0.039 ± 0.006 1.0 ± 0.15	inches mm
CSR 1	0.197 ± 0.008 5.0 ± 0.2	0.100 ± 0.008 2.5 ± 0.2	0.020 ± 0.006 0.5 ± 0.15	0.067 ± 0.006 1.7 ± 0.15	0.067 ± 0.006 1.7 ± 0.15	inches mm
CSRN 1	0.197 ± 0.006 5.0 ± 0.15	0.100 ± 0.006 2.5 ± 0.15	0.024 ± 0.004 0.6 ± 0.1	0.024 ± 0.012 0.6 ± 0.3	0.020 ± 0.010 0.5 ± 0.25	inches mm
CSR 2	0.252 ± 0.008 6.4 ± 0.2	0.126 ± 0.008 3.2 ± 0.2	0.020 ± 0.006 0.5 ± 0.15	0.075 ± 0.006 1.9 ± 0.15	0.075 ± 0.006 1.9 ± 0.15	inches mm
CSRN 2	0.246 ± 0.006 6.3 ± 0.15	0.121 ± .006 3.1 ± 0.15	0.023 ± .004 0.6 ± 0.10	0.023 ± .012 0.6 ± 0.3	0.020 ± .010 0.5 ± 0.25	inches mm
CSR 3	0.121 ± 0.006 3.10 ± 0.15	0.246 ± 0.006 6.30 ± 0.15	0.039 ± 0.004 1.00 ± 0.10	0.023 ± 0.012 0.060 ± 0.30	0.02 ± 0.010 0.50 ± 0.25	inches mm

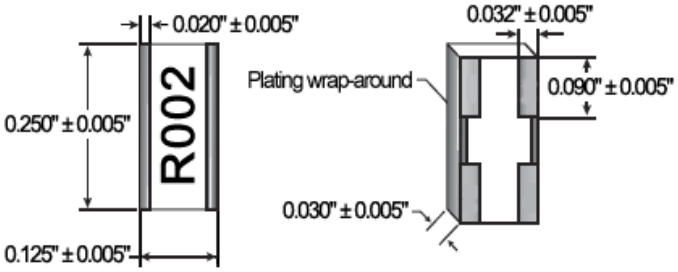
Solder Pad Dimensions

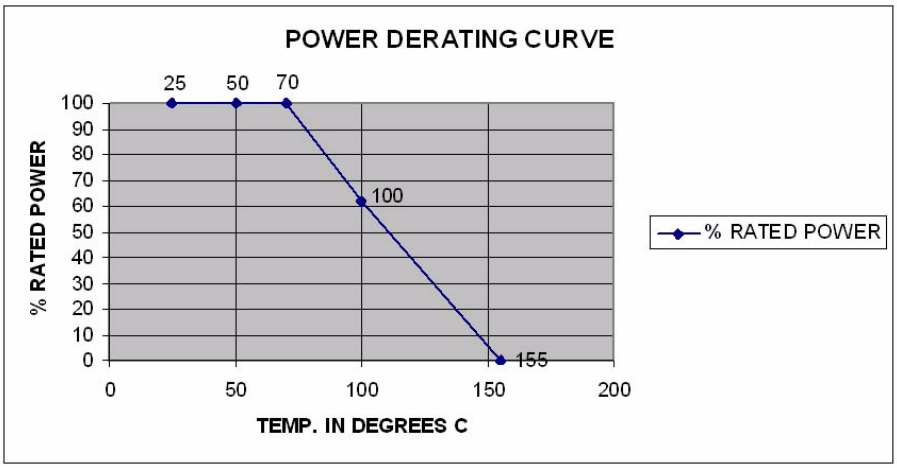
Type / Code	L Total Length	W Total Width	D Pad Depth	Units
CSR 1/8S	0.049 1.25	0.025 0.63	0.015 0.38	inches mm
CSR 1/8	0.060 1.50	0.035 0.90	0.020 0.50	inches mm
CSR 1/4	0.099 2.50	0.059 1.50	0.055 1.40	inches mm
CSR 1/2	0.158 4.00	0.079 2.00	0.071 1.80	inches mm
CSRN 1	0.250 6.35	0.145 3.68	0.055 1.40	inches mm
CSR 1	0.258 6.54	0.130 3.30	0.071 1.80	inches mm
CSR 2	0.315 8.00	0.158 4.00	0.079 2.00	inches mm
CSRN 2	0.315 8.00	0.158 4.00	0.055 1.40	inches mm
CSR 3	0.30 7.60	0.20 5.08	0.080 2.00	inches mm





CSR3 (1225) 4 Terminal Bottom

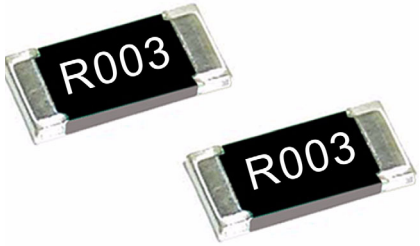




CSRL / CSNL Series — Metal Strip Current Sensing Chip Resistors

Features

- 2512 size
- 2W of power
- Low inductance – typically less than 0.1nH
- Resistances down to 0.0005 (1/2 milliΩ)
- TCR down to ±50 ppm/°C
- Current handling to 63 amps
- Non-standard resistance values available
- RoHS compliant / lead-free available



Electrical Specifications

Type / Code	Package Type	Power Rating (Watts) @ 70°C	Dielectric Withstanding Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
CSRL 2	2512	2	200	±50 ppm/°C	0.001Ω, 0.002Ω	0.001Ω, 0.002Ω
CSNL 2	2512	2	200	±50 ppm/°C	0.001Ω – 0.007Ω	0.001Ω – 0.007Ω

Performance Characteristics

Test	Test Specification	Typical
Moisture Resistance	±0.5%	≤0.5%
Load Life	±0.5%	≤0.5%
Leach Resistance	90 seconds min	>90 seconds
Resistance to Soldering Heat	±0.5%	≤0.25%
Solderability	min 95% coverage	≥95%
Temperature Cycling	±0.5%	≤0.5%
Thermal Shock	±0.5%	≤0.5%
Short Time Overload	±0.5%	≤0.5%
Insulation Resistance	1MΩ minimum	≥1MΩ

How to Order

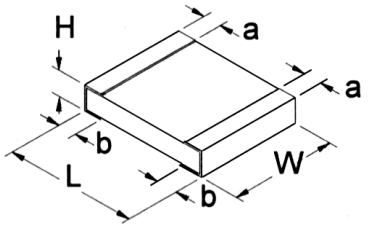
CSRL	2	0.01	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
CSRL	Standard
CSNL	Narrow Terminations

Code	Wattage	Size
2	2.000	2512

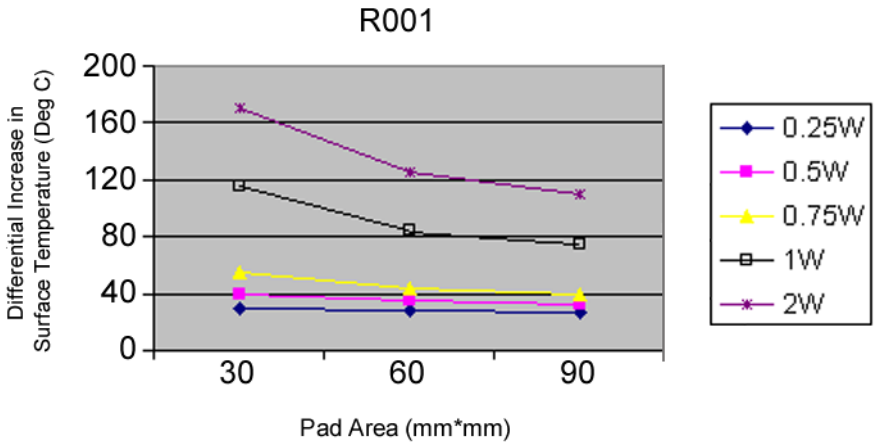
Tolerance
1%
5%

Code	Description	Pkg Qty
R	7" - Paper	4,000



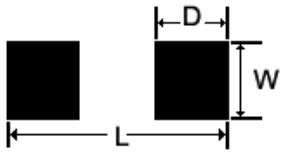
Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
CSRL 2 (2mΩ)	6.50 ± 0.33	3.20 ± 0..33	0.70 ± 0.15	1.90 ± 0.15	1.90 ± 0.15	mm
CSRL 2 (1mΩ)	6.50 ± 0.33	3.20 ± 0.33	0.80 ± 0.15	2.50 ± 2.50	2.50 ± 0.15	mm
CSNL 2 (0.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	1.40 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (0.75mΩ)	6.35 ± 0.25	3.18 ± 0.25	1.00 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (1mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.80 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (1.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.65 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (2mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.50 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (2.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	1.00 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (3mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.70 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (3.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.71 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (4mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.60 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (4.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.58 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.50 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (5.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.47 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (6mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.50 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (6.5mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.47 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (7mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.45 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm
CSNL 2 (10mΩ)	6.35 ± 0.25	3.18 ± 0.25	0.80 ± 0.20	1.30 ± 0.30	1.30 ± 0.30	mm



Solder Pad Dimensions

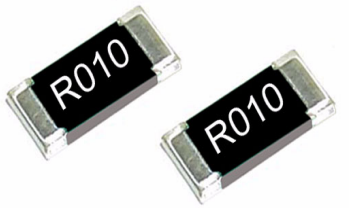
Type / Code	L Total Length	W Total Width	D Pad Depth	Units
CSRL 2	8.00	4.00	3.35	mm
CSNL 2	8.00	4.00	2.00	mm



CSRF Series — Foil on Ceramic Current Sensing Chip Resistors

Features

- 2512 size
- Power ratings to 2W
- Low inductance – typically less than 0.2nH
- Resistance range (0.003Ω - 0.50Ω)
- Non-standard resistance values available
- Current handling to 40 amps
- TCR down to ±50 ppm/°C
- RoHS compliant / lead-free available



Electrical Specifications

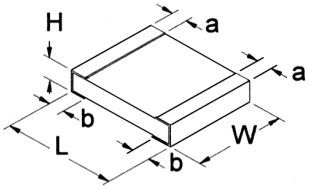
Type / Code	Package Type	Power Rating (Watts) @ 70°C	Dielectric Withstanding Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
CSRF 1/2	1206	0.5	200	±50 ppm/°C	0.005Ω – 0.009Ω	0.005Ω – 0.009Ω
CSRF 1	2010	1	200	±50 ppm/°C	0.001Ω – 0.500Ω	0.001Ω – 0.500Ω
CSRF 2	2512	2	200	±50 ppm/°C	0.003Ω – 0.500Ω	0.003Ω – 0.500Ω

Performance Characteristics

Test	Test Specification	Typical
Moisture Resistance	±0.5%	≤0.5%
Load Life	±0.5%	≤0.5%
Leach Resistance	90 seconds min	>90 seconds
Resistance to Soldering Heat	±0.5%	≤0.25%
Solderability	min 95% coverage	≥95%
Temperature Cycling	±0.5%	≤0.5%
Thermal Shock	±0.5%	≤0.5%
Short Time Overload	±0.5%	≤0.5%
Insulation Resistance	1MΩ minimum	≥1MΩ

Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	a Top Termination	b Bottom Termination	Units
CSRF 1/2	0.126 ± 0.008 3.200 ± 0.200	0.063 ± .008 1.600 ± 0.200	0.032 ± .006 0.800 ± 0.150	0.020 ± .006 0.500 ± 0.150	0.020 ± .006 0.500 ± 0.150	inches mm
CSRF 1	0.197 ± 0.008 5.000 ± 0.200	0.098 ± .008 2.500 ± 0.200	0.032 ± .006 0.800 ± 0.150	0.020 ± .006 0.500 ± 0.150	0.039 ± .006 1.000 ± 0.150	inches mm
CSRF 2 (3-50mΩ)	0.256 ± 0.013 6.500 ± 0.330	0.126 ± .008 3.200 ± 0.200	0.032 ± .006 0.800 ± 0.150	0.075 ± .006 1.900 ± 0.150	0.075 ± .006 1.900 ± 0.150	inches mm



How to Order

CSRF	2	0.01	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
CSRF	Foil / Ceramic

Code	Wattage	Size
1/2	0.5	1206
1	1.0	2010
2	2.0	2512

Tolerance
1%
5%

Code	Description	Pkg Qty
R	7" - Paper	4000

HLD Series — High Current Shunt / Sensing Resistor

Features

- Values from 0.001Ω to 0.1Ω
- Suitable for high current applications where standard current sense resistors will not survive
- Part size will vary according to value and wattage chosen
- Current handling to 100amps
- Various wire alloys and sizes allow for value, tolerance, and TC flexibility
- 1W to 5W of power

Electrical Information On Various Wire Types

Temperature Coefficient		Resistivity Ohms / CMF	Thermal EMF*
-55°C to 25°C	25°C to 125°C		
5 ± 10 **	5 ± 10	800	2.5
0 ± 20 **	0 ± 20	300	-45
80 ± 20	80 ± 20	650	6.0
140 ± 30	140 ± 30	675	2.0
180 ± 30	180 ± 30	180	-37
400 ± 40	380 ± 40	610	2.0
450 ± 50	450 ± 50	90	-26
700 ± 200	700 ± 200	60	-22
850 ± 80	850 ± 80	470	-3.0
1,000 ± 100	1,000 ± 100	420	-22
1,400 ± 300	1,400 ± 300	30	-14
1,500 ± 200	1,400 ± 200	500	9.0
2,600 ± 200	2,600 ± 200	420	-27
3,500 ± 300	3,500 ± 300	294	-35
3,700 ± 300	3,900 ± 300	10	Ref
3,700 ± 300	4,300 ± 300	120	-40
4,000 ± 500	5,000 ± 500	60	-22
5,000 ± 300	6,000 ± 300	42	-22

* Thermal EMF μV/°C referenced to copper at 0°C.
** Preferred Temperature Coefficient wire is readily available for most resistive ranges. The other alloys may require longer delivery times and higher minimum quantities, contact factory.

How to Order

HLD	4	0.1	5%	A
SEI Type	Watts	Value	Tolerance	Packaging

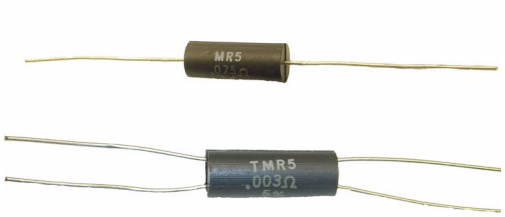
Tolerance
5%
10%

Code	Description	Pkg Qty
A	Bulk	100

MR / TMR Series — Low Resistance Value - Molded 2 and 4 Leads

Features

- Metal element resistors
- Excellent load life stability
- Inherently non-inductive
- Tinned copper leads - 10 lbs. pull
- Low temperature coefficient
- RoHS compliant / lead-free
- High power to size ratio
- Molded bodies
- Two or four terminal
- TMR - Kelvin Bridge Test
- Cut and formed product is available on select sizes; contact factory for details



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Short Time Overload	Dielectric Strength	Resistance Temperature Coefficient	Ohmic Range and Tolerance
					1%, 5%
MR 1	1W	5 sec. at 5x Rated Power	500 VAC	50 - 400 ppm/°C*	0.01Ω – 0.1Ω
MR 3	3W	5 sec. at 5x Rated Power	500 VAC	50 - 400 ppm/°C*	0.005Ω – 0.2Ω
MR 5	5W	5 sec. at 5x Rated Power	500 VAC	50 - 400 ppm/°C*	0.005Ω – 0.3Ω
MR 10	10W	5 sec. at 5x Rated Power	500 VAC	50 - 400 ppm/°C*	0.01Ω – 0.5Ω
TMR 3	3W	5 sec. at 5x Rated Power	500 VAC	40 ppm/°C	0.005Ω – 0.2Ω
TMR 5	5W	5 sec. at 5x Rated Power	500 VAC	40 ppm/°C	0.005Ω – 0.3Ω

*TCR is value dependent. Please contact factory for specific data

.

Performance Characteristics

Test	Test Results
Moisture Resistance	±5%
Thermal Shock	±2%
Load Life @ 70°C – 1,000 hrs.	±5%
Resistance to Soldering Heat	±2%
Short Time Overload	±2%
Dielectric Withstanding Voltage	±2%
Operating Temperature Range	-55ºC to +275°C

How to Order

MR	3	0.1	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

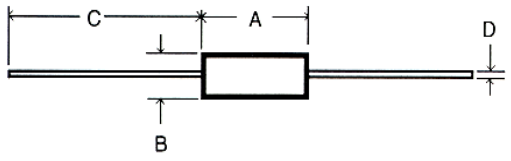
Type
MR
TMR

Code
1
3
5
10

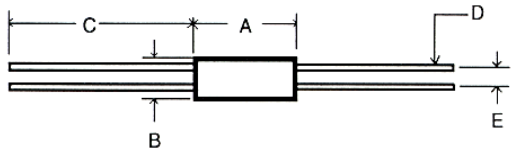
Tolerance
1%
5%

Code	Description	Pkg Qty
R	MR 1	2,500
R	MR 3	750
R	MR 5	500
R	MR 10	250
B	TMR 3	100
B	TMR 5	50

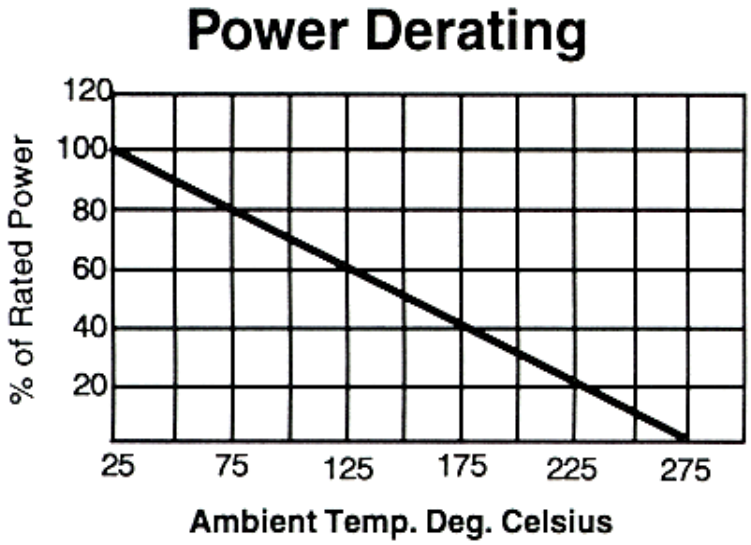
MR



TMR



Mechanical Specifications						
Type / Code	A Body Length	B Body Diameter	C Lead Length	D Lead Diameter	E Lead Spacing	Units
Tolerance	±0.015	±0.015	±0.125	±0.002	inches	inches
	±0.4	±0.4	±3.4	±0.05	mm	mm
MR 1	0.385 9.8	0.135 3.4	1.375 34.9	0.032 0.81	–	inches mm
MR 3	0.560 14.2	0.205 5.2	1.375 34.9	0.032 0.81	–	inches mm
MR 5	0.925 23.5	0.330 8.4	1.375 34.9	0.036 0.91	–	inches mm
MR 10	1.925 46.4	0.475 10.0	1.375 34.9	0.036 0.91	–	inches mm
TMR 3	0.625 15.9	0.205 5.2	1.375 34.9	0.032 0.81	0.125 3.2	inches mm
TMR 5	0.940 23.9	0.330 8.4	1.375 34.9	0.036 0.91	0.200 5.1	inches mm



RN / RNM Series — General Purpose Metal Film Resistors

Features

- Precision metal film
- Superior electrical, TCR performances
- Flame-retardant coatings are standard
- Panasert available (selected sizes; contact factory)
- RNM (mini) an ideal choice where size constraints apply
- RoHS compliant / lead-free available (RNF/RNMF)

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Max Working Voltage*	Max Pulse Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance				
					0.1%	0.25%	0.5%	1%	5%
RN 1/8	0.125W	200	400	±100 ppm/°C ±50 ppm/°C ±25 ppm/°C	100Ω – 100K 100Ω – 100K 100Ω – 100K	100Ω – 100K 100Ω – 100K 100Ω – 100K	10Ω – 1M 10Ω – 1M 30.1Ω – 499K	10Ω – 2.37M 10Ω – 1M 49.9Ω – 499K	1Ω – 2.2M – –
RN 1/4	0.25W	250	500	±100 ppm/°C ±50 ppm/°C ±25 ppm/°C	30.1Ω – 1M 30.1Ω – 1M 30.1Ω – 1M	30.1Ω – 1M 30.1Ω – 1M 30.1Ω – 1M	10Ω – 1M 10Ω – 1M 30.1Ω – 1M	1Ω – 10M 1Ω – 5.11M 30.1Ω – 1M	1Ω – 10M – –
RN 1/2	0.5W	350	700	±100 ppm/°C ±50 ppm/°C ±25 ppm/°C	100Ω – 100K 100Ω – 100K 100Ω – 100K	100Ω – 100K 100Ω – 100K 100Ω – 100K	10Ω – 1M 10Ω – 1M 49.9Ω – 499K	1Ω – 10M 1Ω – 4.99M 49.9Ω – 499K	1Ω – 10M – –
RN 1	1W	350	700	±100 ppm/°C ±50 ppm/°C	–	–	– 10Ω – 100K	10Ω – 1M 10Ω – 1M	–
RNM 1/4	0.25W	250	500	±100 ppm/°C ±50 ppm/°C ±25 ppm/°C	100Ω – 100K 100Ω – 100K 100Ω – 100K	100Ω – 100K 100Ω – 100K 100Ω – 100K	10Ω – 1M 10Ω – 1M 30.1Ω – 499K	10Ω – 4.99M 10Ω – 1M 30.1Ω – 499K	10Ω – 2M – –
RNM 1/2	0.5W	350	700	±100 ppm/°C ±50 ppm/°C ±25 ppm/°C	30.1Ω – 1M 30.1Ω – 1M 100Ω – 294K	30.1Ω – 1M 30.1Ω – 1M 100Ω – 294K	10Ω – 1M 10Ω – 1M 49.9Ω – 1M	10Ω – 10M 1Ω – 2.15M 49.9Ω – 1M	10Ω – 2M – –

* Lesser of √PR or maximum working voltage.

How to Order

RN	1/4	T1	4.75K	1%	R
SEI Type	Code	TCR	Nominal Resistance	Tolerance	Packaging

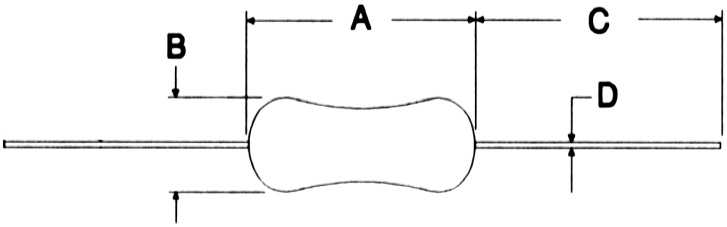
Type	Description
RN	EIA standard
RNM	Mini
RNF	Standard RoHS
RNMF	Mini RoHS

Code
1/8
1/4
1/2
1

TCR
T1 = 100ppm
T2 = 50ppm
T9 = 25ppm

Tolerance	Values
0.1%	E96
0.25%	E96
0.5%	E96
1%	E96,E24
5%	E24

Code	Description	Series	Pkg Qty
R	Tape	RN 1/8, RN 1/4	5,000
R	Tape	RNM 1/4, RNM 1/2	5,000
R	Tape	RN 1/2, RN 1	2,500
T	Ammo	All	5,000
A	Bulk	All	1,000



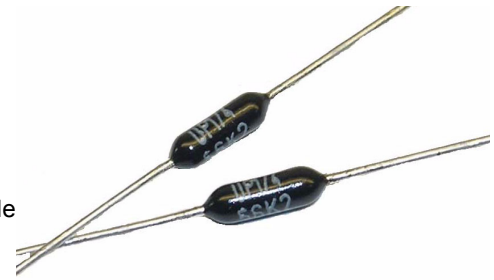
Mechanical Specifications					
Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
RN 1/8	0.13 ± 0.01/-0 3.2 ± 0.2/-0	0.073 ± 0.006 1.85 ± 0.20	1.10 ± 0.08 28.0 ± 2.0	0.018 ± 0.002 0.45 ± 0.05	inches mm
RN 1/4	0.24 ± 0.01 6.0 ± 0.3	0.09 ± 0.01 2.4 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.023 ± 0.002 0.60 ± 0.05	inches mm
RN 1/2	0.33 ± 0.02 8.5 ± 0.5	0.11 ± 0.01 2.8 ± 0.3	1.10 ± 0.08 28.0 ± 2.0	0.027 ± 0.002 0.70 ± 0.05	inches mm
RNM 1/4	0.13 ± 0.01/-0 3.2 ± 0.2/-0	0.073 ± 0.006 1.85 ± 0.20	1.10 ± 0.08 28.0 ± 2.0	0.018 ± 0.002 0.45 ± 0.05	inches mm
RNM 1/2	0.24 ± 0.01 6.0 ± 0.3	0.09 ± 0.01 2.4 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.023 ± 0.002 0.60 ± 0.05	inches mm
RN 1	0.433 ± 0.04 11.0 ± 1.0	0.177 ± 0.02 4.5 ± 0.5	1.18 ± 0.12 30 ± 3.0	0.032 ± 0.004 0.8 ± 0.1	inches mm

Performance Characteristics		
Test	Standard / Method	Requirement
Biased Humidity	MIL-STD 202, Method 103	± **1.5%**
Resistance to Solder Heat	MIL-STD 202, Method 210	± 0.5%
Insulation Resistance	JIS C 5202 5.6	± 0.5%
Load Life	MIL-STD 202, Method 208	± 1.0%
Terminal Strength	MIL-STD 202, Method 211	± 0.2%
Temperature Cycling	JESD22 Method JA-104	± 1.0%
Moisture Resistance	MIL-STD 202, Method 106	± 0.5%

UP Series — Ultra Precision Metal Film Resistors

Features

- Highest stability metal film available
- Higher power options available
- Tolerances to ±0.01% available
- 1W available, contact factory
- Cut and formed product is available on select sizes; contact factory for details
- TCRs as low as 5 ppm
- Matched sets available
- Low noise
- Non-standard resistance values available



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Pulse Voltage
UP 1/4	0.25W	350	500
UP 1/2	0.5W	350	500

* Lesser of √PR or maximum working voltage.

Tolerance / TCR Combinations

Electrical (Operating Temperature Range -20°C to +85°C)

TCR Code	TCR	UP 1/4				UP 1/2			
		0.01–0.02%	0.05%	0.1–0.25%	0.5–1%	0.01–0.02%	0.05%	0.1–0.25%	0.5–1%
TA	5	51.1Ω – 500K	10Ω – 1M	10Ω – 499K	1Ω – 4M	51.1Ω – 499K	10Ω – 499K	10Ω – 499K	10Ω – 499K
TB	10	51.1Ω – 500K	10Ω – 1M	10Ω – 4M	1Ω – 4M	51.1Ω – 499K	10Ω – 499K	10Ω – 1M	1Ω – 1M
TD	15	51.1Ω – 500K	10Ω – 1M	10Ω – 4M	1Ω – 4M	51.1Ω – 499K	10Ω – 499K	5.11Ω – 1M	1Ω – 1M
T9	25	51.1Ω – 294K	10Ω – 1M	5.11Ω – 2M	1Ω – 2M	51.1Ω – 499K	10Ω – 499K	5.11Ω – 2M	1Ω – 2M
T2	50	51.1Ω – 294K	10Ω – 1M	5.11Ω – 2M	1Ω – 3.92M	51.1Ω – 499K	10Ω – 499K	5.11Ω – 2M	1Ω – 3.92M

How to Order

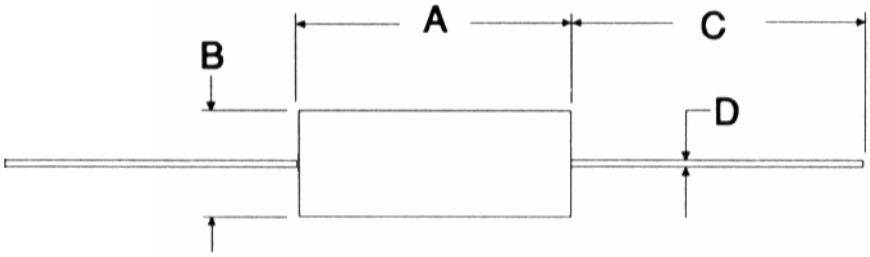
UP	1/4	T1	4.75K	1%	R
SEI Type	Code	TCR Code	Nominal Resistance	Tolerance	Packaging

Code
1/4
1/2

Code
T2 = 50ppm
T9 = 25ppm
TD = 15ppm
TB = 10ppm
TA = 5ppm

Tolerance	Values
0.01%	E192
0.02%	E192
0.05%	E192
0.1%	E192
0.25%	E192
0.5%	E192
1%	E192

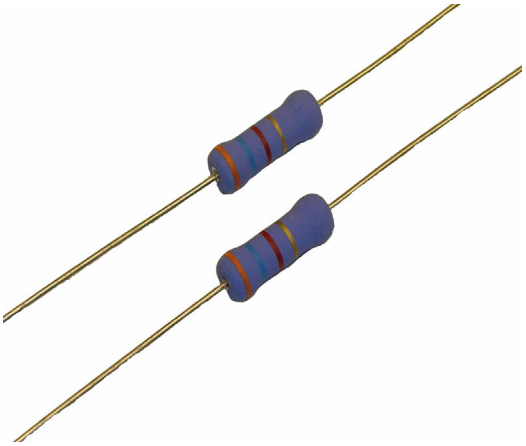
Code	Description	Pkg Qty
R	Paper	5,000
A	Bulk	1,000



Mechanical Specifications					
Type / Code	A Body Length	B Body Width	C Lead Length	D Lead Diameter	Units
UP 1/4	0.28 max 7.2 max	0.10 max 2.5 max	1.18 min 30.0 min	0.024 ± 0.002 0.61 ± 0.05	inches mm
UP 1/2	0.39 max 10.0 max	0.145 max 3.70 max	1.18 min 30.0 min	0.024 ± 0.002 0.61 ± 0.05	inches mm

Performance Characteristics			
Environmental		Maximum	Typical
Load at commercial rating: 1,000 hours at 70°C	ΔR%	0.30	0.10
Load at CECC rating: 1,000 hours at 70°C	ΔR%	0.30	0.05
Dry Heat: 1,000 hours at 155°C	ΔR%	1.00	0.15
Shelf Life: 12 months at room temperature	ΔR%	0.10	0.03
Short term overload	ΔR%	0.10	0.02
Climatic	ΔR%	0.30	0.10
Climatic category		55/155/56	
Long term damp heat	ΔR%	0.50	0.10
Temperature rapid change	ΔR%	0.20	0.05
Resistance to solder heat	ΔR%	0.06	0.03
Vibration and bump	ΔR%	0.06	0.02
Noise (in a decade of frequency)	μV/V	1.00	0.10

RS / RSM Series — Metal Oxide Resistors



Features

- Lower-cost alternative to Carbon Comps and Wirewounds
- Flameproof – meets overload test of UL #1412
- Meets solvent test of Mil Standard 202, Method 215
- Cut and formed product is available on select sizes; contact factory for details
- RSM style an ideal choice when size constraints apply
- Operating temperature range: -55°C to +155°C
- Temperature coefficient of resistance of ±200ppm
- Coating meets UL 94V-0
- Panasert lead form available; contact factory for details
- RoHS compliant / lead-free available (RSF, RSMF)

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Pulse Voltage	Dielectric Withstanding Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance		
						1%	2%	5%
RS 1/2	0.5W	250	400	400	±200 ppm/°C	0.1Ω – 75K	0.1Ω – 75K	0.1Ω – 1M
RS 1	1W	350	600	500	±200 ppm/°C	0.1Ω – 100K	0.1Ω – 100K	0.1Ω – 1M
RS 2	2W	350	600	500	±200 ppm/°C	0.1Ω – 120K	0.1Ω – 120K	0.1Ω – 1M
RS 3	3W	500	800	800	±200 ppm/°C	10Ω – 4.99K	1Ω – 150K	1Ω – 150K
RS 5	5W	750	1,000	800	±200 ppm/°C	–	10Ω – 10K	1Ω – 180K
RSM 1/2	0.5W	250	400	400	±200 ppm/°C	0.1Ω – 46.4K	0.1Ω – 47K	0.1Ω – 470K
RSM 1	1W	350	600	500	±200 ppm/°C	0.1Ω – 75K	0.1Ω – 75K	0.1Ω – 470K
RSM 2	2W	350	600	500	±200 ppm/°C	0.1Ω – 100K	0.1Ω – 100K	0.1Ω – 470K
RSM 3	3W	500	800	500	±200 ppm/°C	0.1Ω – 118K	0.1Ω – 120K	0.1Ω – 470K
RSM 5	5W	750	1,000	750	±200 ppm/°C	100Ω – 4.99K	10Ω – 20K	1Ω – 150K

* Lesser of √PR or maximum working voltage.

How to Order

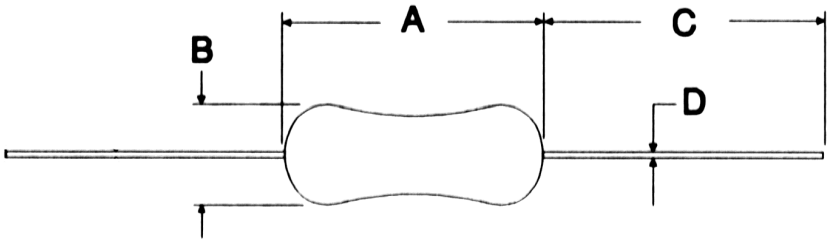
RS	1/2	0.47	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
RS	EIA Standard
RSM	Mini
RSF	Standard RoHS
RSMF	Mini RoHS

Code
1/2
1
2
3
5

Tolerance	Values
1%	E96
2%	E24
5%	E24

Code	Description	SEI Types	Pkg Qty
R	Tape	RSM 1/2	5,000
R	Tape	RS 1/2, RS 1, RSM 1, RSM 2	2,500
R	Tape	RS 2, RSM 3	1,000
R	Tape	RS 3, RSM 5	500
T	Ammo	RS 1/2, RSM 1	2,000
T	Ammo	RSM 1/2	5,000
T	Ammo	RS 1, RSM 2	1,000
T	Ammo	RS 2, RS 3, RSM 3, RSM 5	500
A	Bulk	All, except RS 5	1,000
A	Bulk	RS 5 (Bulk only)	250



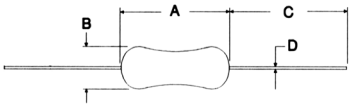
Mechanical Specifications					
Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
RS 1/2	0.35 ± 0.04 9.0 ± 1.0	0.12 ± 0.02 3.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.028 ± 0.002 0.70 ± 0.05	inches mm
RS 1	0.43 ± 0.04 11.0 ± 1.0	0.16 ± 0.02 4.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RS 2	0.59 ± 0.04 15.0 ± 1.0	0.22 ± 0.04 5.5 ± 1.0	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RS 3	0.98 ± 0.08 25 ± 2.0	0.34 ± 0.06 8.5 ± 1.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RS 5	1.61 ± 0.08 41.0 ± 2.0	0.34 ± 0.06 8.5 ± 1.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RSM 1/2	0.24 ± 0.02 6.0 ± 0.5	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.024 ± 0.002 0.60 ± 0.05	inches mm
RSM 1	0.35 ± 0.04 9.0 ± 1.0	0.12 ± 0.02 3.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.028 ± 0.002 0.70 ± 0.05	inches mm
RSM 2	0.43 ± 0.04 11.0 ± 1.0	0.16 ± 0.02 4.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RSM 3	0.59 ± 0.04 15.0 ± 1.0	0.22 ± 0.04 5.5 ± 1.0	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
RSM 5	0.98 ± 0.08 25.0 ± 2.0	0.34 ± 0.06 8.5 ± 1.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm

Performance Characteristics		
Test	Standard / Method	Requirement
Biased Humidity	MIL-STD 202, Method 103	± 1.5%
Resistance to Solder Heat	MIL-STD 202, Method 103	± 0.5%
Dielectric Withstanding Voltage	MIL-STD 202, Method 103	± 0.5%
Load Life	MIL-STD 202, Method 103	± 1.0%
Terminal Strength	MIL-STD 202, Method 103	± 0.2%
Temperature Cycling	JESD22 Method JA-104	± 1.0%
Moisture Resistance	MIL-STD 202, Method 103	± 0.5%
Vibration	MIL-STD 202, Method 103	± 0.5%
Low Temperature Operation	MIL-STD 202, Method 103	± 0.5%

ASR/ASRM Series — Anti-Surge Resistors

Features

- Extended value range from 100Ω to 33M
- Excellent anti-surge characteristics
- Stable characteristics through the resistance range
- Good alternative to carbon composition resistors
- RoHS compliant / lead-free
- Applications include power supplies, CRT's and anti-surge circuits
- Cut and formed product is available on select sizes, contact factory for details



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Surge Withstanding	Ohmic Range and Tolerance	
					5%	10%
ASR 1/4	0.25W	500V	1,000V	1KV	100Ω – 510KΩ	–
				3KV	560KΩ – 33MΩ	22MΩ – 33MΩ
ASRM 1/4	0.25W	500V	1,000V	2KV	100KΩ – 20MΩ	–
ASRM 1/2	0.50W	700V	1,000V	5KV	100Ω – 510KΩ	–
				10KV	560KΩ – 910KΩ	22MΩ – 33MΩ
					33MΩ – 20MΩ	
ASR 1	1.00W	1,000V	1,500V	5KV	100Ω – 510KΩ	–
				10KV	560KΩ – 910KΩ	22MΩ – 33MΩ
					13MΩ – 20MΩ	

* Lesser of √PR or maximum working voltage

Mechanical Specifications

Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
ASR 1/4	0.24 ± 0.01 6.0 ± 0.3	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.024 ± 0.002 0.6 ± 0.05	inches mm
ASRM 1/2	0.35 ± 0.03 9.0 ± 1.0	0.12 ± 0.02 3.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.027 ± 0.002 0.7 ± 0.05	inches mm
ASR 1	0.59 ± 0.04 15.0 ± 1.0	0.22 ± 0.02 5.5 ± 0.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.8 ± 0.05	inches mm

Performance Characteristics (JIS C 5202)

Test	Test Results
Moisture Resistance	±5%
Temperature Cycling	±1%
Load Life	±5%
Resistance to Soldering Heat	±1%
Short Time Overload	±1%
Operating Temperature Range	-55°C to +155°C
Discharge	±50%

How to Order

ASR	1/4	10K	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
ASR	EIA Standard
ASRM	Mini

Code
1/4
1/2
1

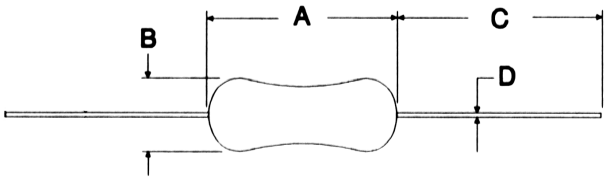
Tolerance
5%
10%

Code	Description	SEI Types	Pkg Qty
A	Bulk	All	1,000
T	Ammo	ASR 1/4, ASRM 1/4, ASR 1/2, ASRM 1/2	2,000
T	Ammo	ASR 1, ASRM 1	500

SPR / SPRM Series — Discharge Path Resistors

Features

- UL 1676 recognized
- Excellent anti-surge characteristics
- Stable characteristics through the resistance range
- Applications include power supplies, CRT's and anti-surge circuits
- Good alternative to Carbon Composition Resistors
- Cut and formed product is available on select sizes, contact factory for details
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Ohmic Range and Tolerance	
				5%	10%
SPRM 1/2	0.5W	700	2,000	1M – 12M	1M – 12M
SPR 1	1W	1,000	2,000	1M – 12M	1M – 12M

* Lesser of √PR or maximum working voltage.

Mechanical Specifications

Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
SPRM 1/2	0.35 ± 0.03 9.0 ± 1.0	0.12 ± 0.02 3.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.027 ± 0.002 0.7 ± 0.05	inches mm
SPR 1	0.59 ± 0.04 15.0 ± 1.0	0.30 ± 0.03 7.5 ± 1.0	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.8 ± 0.05	inches mm

Performance Characteristics (JIS C 5202)

Test	Test Results
Moisture Resistance	±5%
Temperature Cycling	±1%
Load Life	±5%
Resistance to Soldering Heat	±1%
Short Time Overload	±1%
Operating Temperature Range	-55°C~ +155°C
Discharge	±50%

How to Order

SPR	1	10M	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
SPR	EIA Standard
SPRM	Mini

Code
1/2
1

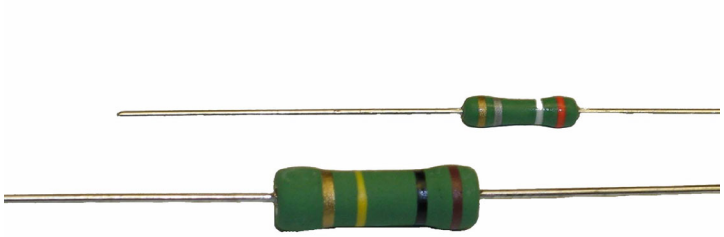
Tolerance	Values
5%	E24
10%	E12

Code	Description	SEI Types	Pkg Qty
A	Bulk	SPRM 1/2, SPR 1	2,500
T	Ammo	SPRM 1/2	2,000
T	Ammo	SPR 1	500

RSPF / RSPL Series — Flameproof Power Resistors

Features

- Flameproof design
- Compact size
- Useful in circuits where duty cycles require power resistors
- Tin-plated copper leads
- Swaged leads available
- Cut and formed product is available on select sizes, contact factory for details
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage	Maximum Pulse Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
					1%	5%
RSPF 1/2	0.5W	400	800	-200 ppm/°C ~ +350ppm/°C	10Ω – 100K	2.2Ω – 1M
RSPF 1	1W	500	1,000	-200 ppm/°C ~ +350ppm/°C	10Ω – 100K	2.2Ω – 1M
RSPF 2	2W	500	1,000	-200 ppm/°C ~ +350ppm/°C	10Ω – 100K	2.2Ω – 1M
RSPF 3	3W	500	1,000	-200 ppm/°C ~ +350ppm/°C	10Ω – 100K	2.2Ω – 1M
RSPL 1/2	0.5W	√PR	√PR x 2.5	-200 ppm/°C ~ +350ppm/°C	–	0.1Ω – 2Ω
RSPL 1	1W	√PR	√PR x 2.5	-200 ppm/°C ~ +350ppm/°C	–	0.1Ω – 2Ω
RSPL 2	2W	√PR	√PR x 2.5	-200 ppm/°C ~ +350ppm/°C	–	0.1Ω – 2Ω
RSPL 3	3W	√PR	√PR x 2.5	-200 ppm/°C ~ +350ppm/°C	–	0.1Ω – 2Ω

* Lesser of √PR or maximum working voltage

How to Order

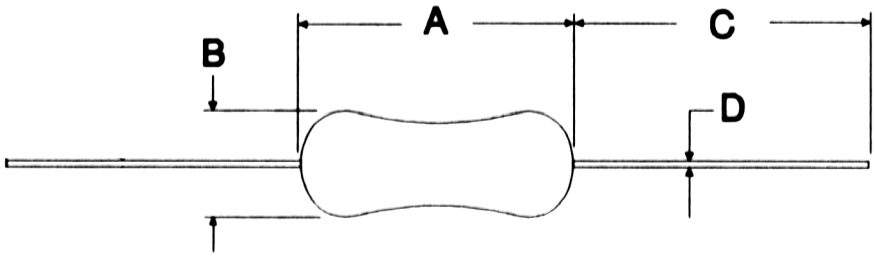
RSPF	1/2	10	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

SEI Type
RSPF
RSPL

Code
1/2
1
2
3

Tolerance	Values
1%	E24
5%	E12

Code	Description	SEI Types	Pkg Qty
A	Bulk	RSPF 1/2, RSPL 1/2	1,000
A	Bulk	RSPF 1, RSPF 2, RSPF 3 RSPL 1, RSPL 2, RSPL 3	500
T	Ammo	RSPF 1/2, RSPL 1/2 RSPF 1, RSPL 1	2,000
T	Ammo	RSPF 2, RSPL 2	1,000
T	Ammo	RSPF 3, RSPL 3	500



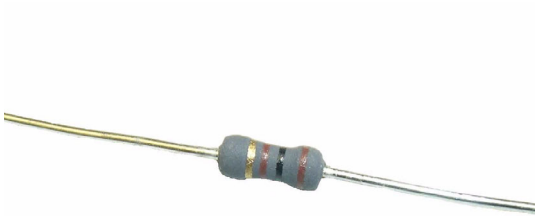
Mechanical Specifications					
Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
RSPF/ RSPL 1/2	0.24 ± 0.04 6.0 ± 0.3	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.024 ± 0.002 0.6 ± 0.05	inches mm
RSPF/ RSPL 1	0.35 ± 0.02 9.0 ± 0.5	0.12 ± 0.02 3.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.028 ± 0.002 0.7 ± 0.05	inches mm
RSPF/ RSPL 2	0.43 ± 0.02 11.0 ± 0.5	0.16 ± 0.02 4.0 ± 0.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.8 ± 0.05	inches mm
RSPF/ RSPL 3	0.59 ± 0.02 15.0 ± 0.5	0.22 ± 0.02 5.5 ± 0.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.8 ± 0.05	inches mm

Performance Characteristics (JIS C 5202)	
Test	Test Results
Operating Temperature Range	-55°C to +155°C
Short Time Overload	±(0.75% +0.05Ω)
Moisture Resistance	±(5% +0.05Ω)
Load Life @ 70°C – 1,000 hrs	±(5% +0.05Ω)
Dielectric Withstanding Voltage	±(5% +0.05Ω)
Resistance to Solvent	Permanent marking no physical damage or deterioration
Non-combustibility	Does not burn continuously for more than 5 seconds

FRN Series — Fusing Resistors

Features

- Coating meets UL 94V-0
- Flameproof – meets overload test of UL #1412
- Designed for constant current to provide overload protection
- Consistent performance and reliability
- Cut and formed product is available on select sizes, contact factory for details
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Overload Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance
					5%
FRN 1/4	0.25W	200	300	±350 ppm/°C	0.22Ω – 10K
FRN 1/2	0.5W	250	400	±350 ppm/°C	0.47Ω – 10K
FRN 1	1W	300	600	±350 ppm/°C	0.47Ω – 10K
FRN 2	2W	300	600	±350 ppm/°C	1Ω – 3K

*Lesser of √PR or maximum working voltage.

Fusing Characteristics
Magnification of Power Rating

Type / Code	X25	X15	X12	Fusing Time
FRN 1/4	0.22Ω – 0.91Ω	1Ω – 4.7KΩ 2.4KΩ – 10KΩ	5.1Ω – 2.2KΩ	30 Sec. Maximum
FRN 1/2	–	0.47Ω – 2Ω 1.1KΩ – 10KΩ	2.2Ω – 1KΩ	
FRN 1	–	0.47Ω – 2Ω 1.1KΩ – 10KΩ	2.2Ω – 1KΩ	
FRN 2	–	1Ω – 3.6Ω 1.1KΩ – 3KΩ	3.9Ω – 1KΩ	

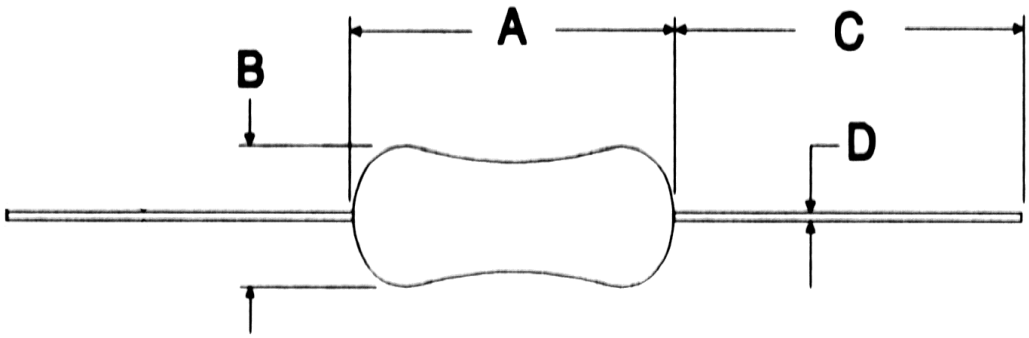
How to Order

FRN	1/2	4.7	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
1/4
1/2
1
2

Tolerance	Values
5%	E24

Code	Description	SEI Types	Pkg Qty
R	Tape	FRN 1/4	5,000
R	Tape	FRN 1/2, FRN 1	2,500
R	Tape	FRN 2	1,000
T	Ammo	All	2,500



Mechanical Specifications					
Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
FRN 1/4	0.24 ± 0.01 6.0 ± 0.2	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.022 ± 0.002 0.55 ± 0.05	inches mm
FRN 1/2	0.35 ± 0.02 9.0 ± 0.5	0.11 ± 0.02 2.8 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.028 ± 0.002 0.70 ± 0.05	inches mm
FRN 1	0.43 ± 0.02 11.0 ± 0.5	0.16 ± 0.02 4.0 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.028 + 0.002 0.70 ± 0.05	inches mm
FRN 2	0.59 ± 0.04 15.0 ± 1.0	0.22 ± 0.02 5.5 ± 0.5	1.38 ± 0.12 35.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm

Performance Characteristics	
Test	Test Results
Moisture Resistance	±5.0%
Thermal Shock	±1.0%
Load Life @ 70°C – 1,000hrs	±5.0%
Resistance to Soldering Heat	±1.0%
Short Time Overload	±2.0%
Operating Temperature Range	-40°C to +155°C

Dual Power Ratings For Resistors — Which One Is Correct?

This one definitely tops the FAQ list. Chip resistors and axial leaded resistors all seem to have various different wattage ratings depending on the manufacturer and even within the same manufacturer. This is completely illogical because intuition of the physics involved says that parts that are the same size, and are made of similar materials, will be able to handle the same power in a given application. So why all the confusion?

CHIP RESISTORS

First in the surface mount world, let's choose the 1206 size chip resistor as our example. For many years (and still today for EIA power ratings) this size resistor was considered an 1/8 watt part. These ratings were based on older design rules, and on a mindset influenced by the military. The military has traditionally been conservative in how they rate electrical components, and this case is no different. A 1206 used in an application where it will only need to handle 1/8 watt, will typically shift around .2% from its original value over the life of the part, per 1000 hours.

More recently, the CECC (a committee similar to EIA in Europe) has chosen to rate the 1206 size resistor at ¼ watt. Similarly the 0603 size rating was increased to 1/10 from 1/16, the 0805 increased to 1/8 from 1/10, and so on. These ratings were based on the fact that certain guidelines have been established in the circuit board industry, so that the worst-case scenario is now not nearly so bad. The same 1206 from our previous example, but now used in a ¼ watt application, will experience a typical shift of around .25 % per 1000 hours. This is clearly not much greater than the shift at the lower 1/8-watt power level, so the resistor industry has, for the most part, adopted the higher power rating as the standard.

What is confusing is that there are many designs that have originated some years ago, and thus still use the lower power rating. This should not pose a problem, since a higher power rating than required is almost always acceptable. The key to surface mount resistors and their substitutions is to compare size vs. size as long as the rated power of the part utilized is greater than or equal to that required in the application. After all, it is the physical size of the part that determines whether it will retrofit into a particular board, not the power rating.

AXIAL LEADED RESISTORS

A similar argument can be made for axial leaded resistors. If physics says that parts of the same size, and relatively the same material should handle the same amount of power, then why are there ¼ watt and ½ watt parts with the same dimensions?

Our surface mount discussion still holds true here. An 1/8 watt part can usually handle more power, but it is at the expense of higher ambient and board temperatures, and a more extreme resistance shift over the life of the part. Again the rule of thumb should be to try to match parts of the same dimension rather than of the same wattage.

If the application can withstand a little more heat generated and a little more resistance shift over the life of the product, then there shouldn't be any issues with using the parts at their higher power rating.

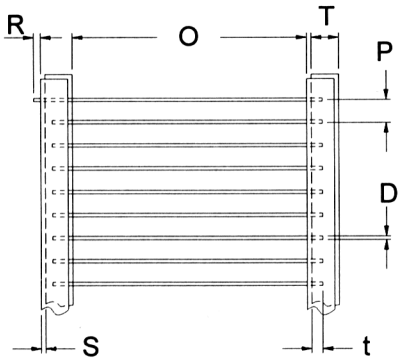
JW Series — Jumper Wire

Features

- Ideal for crossovers or jumpers on circuit boards
- High current rating
- Cut and formed product is available on select sizes, contact factory for details
- RoHS compliant / lead-free

Electrical & Mechanical Specifications

Part Number	Diameter inches mm	Gauge Reference	Maximum Current
JW 50 R	0.020 ± 0.001 0.50 ± 0.02	24	2 Amp.
JW 55 R	0.022 ± 0.001 0.55 ± 0.03	23	3 Amp.
JW 60 R	0.024 ± 0.001 0.60 ± 0.03	22	3 Amp.
JW 80 R	0.031 ± 0.001 0.80 ± 0.05	20	4 Amp.



*Bulk packaging available upon request.

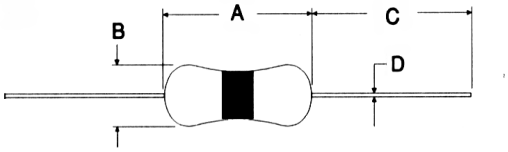
Packaging Specifications

O	P	T	R	D	t	S	Units
2.047 ± 0.039 52.00 ± 1.00	0.200 ± 0.016 5.00 ± 0.40	0.236 ± 0.039 6.00 ± 1.00	0	See TYPE above	0.118 min. 3.00 min.	0.020 max. 0.50 max.	inches mm

CD Series — Zero Ohm Resistors

Features

- Ideal for crossovers or jumpers on circuit boards with auto-insertion capability
- High current rating
- Cut and formed product is available on select sizes, contact factory for details
- RoHS compliant / lead-free



Electrical Specifications

Part Number	Current Rating (Amps) @ 70°C	Dielectric Withstanding Voltage	Marking	Resistance
CD 1/8 0 R	2A	300	Single black band	0.01Ω or less
CD 1/4 0 R	3A	500	Single black band	0.01Ω or less
CD 1/2 0 R	4A	600	Single black band	0.01Ω or less

Mechanical Specifications

Type	A - Body Length	B - Body Diameter	C - Lead Length (Bulk)	D - Lead Diameter	Units
CD 1/8	0.12 +0.01/-.00 3.2 +0.2/-0.0	0.07 ± 0.01 1.8 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.018 ± 0.001 0.45 ± 0.02	inches mm
CD 1/4	0.24 ± 0.01 6.0 ± 0.3	0.09 ± 0.001 2.3 ± 0.2	1.10 ± 0.08 28.0 ± 2.0	0.022 ± 0.001 0.55 ± 0.03	inches mm
CD 1/2	0.33 +0.02/-0.00 8.5 +0.5/-0.0	0.11 ± 0.02 2.7 ± 0.5	1.10 ± 0.08 28.0 ± 2.0	0.03 ± 0.001 0.7 ± 0.05	inches mm

RC Series — Carbon Composition Resistors

Features

- Non-inductive design
- Molded body for package uniformity
- Ideal for pulse-load handling characteristics
- Cut and formed product is available on select sizes; contact factory for details
- 1W now available
- RoHS compliant/ lead-free available

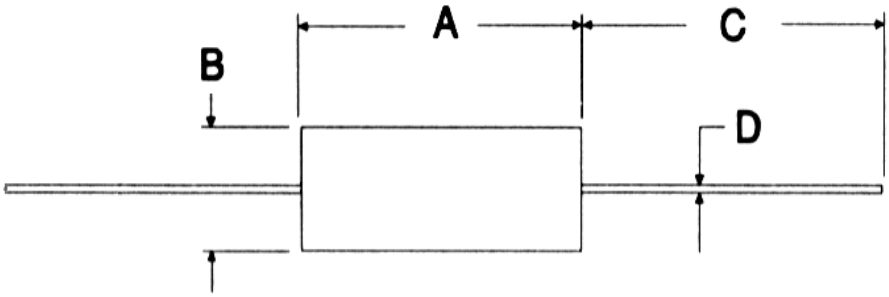
Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Continuous Working Voltage*	Maximum Pulse Voltage	Dielectric Withstanding Voltage	Ohmic Range and Tolerance	
					10%	5%
RC 1/4	0.25W	250	400	500	1Ω – 5.6M	1Ω – 5.6M
RC 1/2	0.5W	350	700	700	1Ω – 20M	1Ω – 20M
RC 1	1W	500	1,000	1,000	2.2Ω – 1.0M	–

* Lesser of √PR or maximum working voltage.

Mechanical Specifications

Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
RC 1/4	0.248 ± 0.028 6.30 ± 0.70	0.094 ± 0.004 2.40 ± 0.10	1.18 ± 0.12 30.0 ± 3.0	0.0236 ± 0.0020 0.60 ± 0.05	inches mm
RC 1/2	0.374 + 0.031/-0.028 9.50 + 0.8/-0.70	0.142 ± 0.008 3.60 ± 0.20	1.10 ± 0.12 28.0 ± 3.0	0.0275 + 0.0028/-0.0020 0.70 + 0.07/-0.05	inches mm
RC 1	0.56 ± 0.03 14.3 ± 0.70	0.22 ± 0.01 5.70 ± 0.30	1.02 ± 0.12 26.0 ± 3.0	0.04 ± 0.002 0.90 ± 0.05	inches mm



How to Order

RC	1/2	5.6M	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
1/4
1/2
1

Tolerance	Values
5%	E24
10%	E12

Code	Description	Pkg Qty
R	Tape	5,000
A	Bulk	1,000

Resistance Temperature Characteristics

	Resistance Range	-55°C	+105°C
Maximum % resistance change from room temperature (+25°C) value	under 1K 1K to 9.1K 10K to 91K 100K to 910K 1 Mg to 10 Mg	+2.0 to +5.0 +5.0 to +9.0 +8.0 to +11.0 +10.0 to +14.0 +13.0 to +20.0	-4.0 to -2.0 -5.0 to -3.0 -7.0 to -5.0 -9.0 to -7.0 -14.0 to -9.0

Performance Characteristics (JISC 5201 - 1:1998)

Test	Test Results	Test Method
Voltage Proof	No breakdown or flashover	V-block method RC 1/4 100 VAC, 60 seconds RC 1/2 500 VAC, 60 seconds
Overload	±2% +0.05Ω No visible damage, legible markings	2.5 times the rated voltage or twice the limiting element voltage, whichever is less. Severe, 5 seconds
Termination Strength	Tensile: ±2% +0.05Ω, No visible damage Bending: ±2% +0.05Ω, No visible damage Torsion: ±2% +0.05Ω, No visible damage	10N for 5 – 10 seconds 5N, twice 180°C, two rotations
Solderability	In accordance with Clause 4.17.4.5	235°C, 5 seconds
Resistance to Soldering Heat	±3% +0.05Ω No visible damage, legible markings	After immersion into flux, the immersion into solder shall be carried out 4mm from the body at 350°C for 3.5 seconds
Temperature Shock	±2% +0.05Ω No visible damage	5 cycles between -55°C to 125°C
Climatic Sequence	±10% +0.5Ω Insulation resistance: R ≥100M ohm. No visible damage	Dry/Damp heat: 12 +12 hour cycle, first cycle Cold/Damp heat: 12 +12 hour cycle, remaining cycle D.C. load
Damp Test, Steady State	±10% +0.5Ω Insulation resistance: R ≥100M ohm. No visible damage, legible marking	40°C 95% relative humidity for 56 days, test a, b, and c of Clause 4.24.2.1
Endurance @ 70°C	±10% +0.5Ω Insulation resistance: R ≥1G ohm. No visible damage	Rated voltage, 1.5 hours On, 0.5 hours Off at 70°C, 1,000 hours
Endurance @ 125°C	±10% +0.5Ω Insulation resistance: R ≥1G ohm. No visible damage	125°C, no load, 1,000 hours
Operating Temperature Range	-55°C to + 125°C	

Reliability Test - Load Life in Moisture

Criterion (%)		Load Ratio P/Pn (%)	Total Testing Time (Hrs)	Number of Fractures (pcs)	Failure Ratio		Average Lifetime (60% reliability level) (Hrs)
					λ	λ CL (60%)	
Δ R/R	±5	0	2.984×10^6	6	0.201	0.244	4.098×10^5
		20	2.990×10^6	4	0.134	0.176	5.682×10^5
		60	2.997×10^6	2	0.067	0.104	9.615×10^5
		100	2.992×10^6	3	0.100	0.139	7.194×10^5
		Total	1.196×10^7	15	0.125	0.138	7.209×10^5
	±10	Total	1.20×10^7	0	0.0055	0.0077	1.299×10^7

CF / CFM Series — Carbon Film Resistors

Features

- General purpose resistor ideal for commercial/industrial applications
- Flame retardant coatings standard, flameproof optional (contact factory)
- Panasert available on selected sizes (contact factory)
- Auto sequencing/insertion compatible
- CFM (mini) an ideal choice when size constraints apply
- Cut and formed product is available on select sizes; contact factory for details
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage*	Maximum Pulse Voltage	Dielectric Withstanding Voltage	Ohmic Range and Tolerance	
					2%	5%
CF 1/8	0.125W	250	500	300	10Ω – 4.7M	1Ω – 22M
CF 1/4	0.25W	350	600	500	1Ω – 4.7M	1Ω – 22M
CF 1/2	0.5W	350	700	700	10Ω – 4.7M	1Ω – 22M
CF 1	1W	500	1,000	1,000	1Ω – 10M	1Ω – 22M
CF 2	2W	500	1,000	1,000	10Ω – 1M	1Ω – 22M
CFM 1/4	0.25W	250	500	500	10Ω – 1M	1Ω – 22M
CFM 1/2	0.5W	250	500	500	10Ω – 4.7M	1Ω – 22M

* Lesser of √PR or maximum working voltage.

How to Order

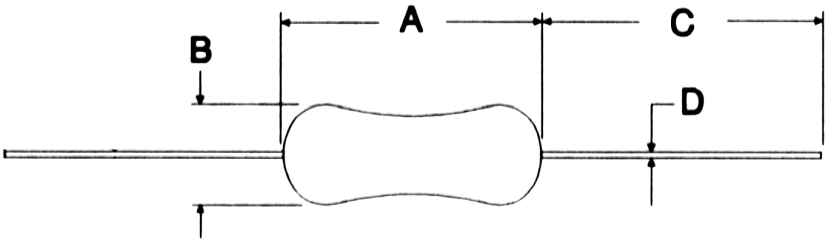
CF	1/2	4.7K	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
CF	EIA Standard
CFM	Mini
PCF	Panasert CF 1/4
PCFM	Panasert CFM 1/2

Code
1/8
1/4
1/2
1
2

Tolerance	Values
2%	E24
5%	E24

Code	Description	SEI Types	Qty
R	Tape	CF 1/8, CF 1/4, CF 1/2	5,000
R	Tape	CFM 1/4, CFM 1/2	5,000
R	Tape	CF 1	2,000
R	Tape	CF 2	1,000
T	Ammo	All	5,000
A	Bulk	All	1,000
P	Panasert	CF 1/4; CFM 1/2	5000
Q	Ammo	CF 1/4; CFM 1/2	2000



Mechanical Specifications					
Type / Code	A Body Length	B Body Diameter	C Lead Length (Bulk)	D Lead Diameter	Units
CF 1/8	0.13 + 0.01/-0 3.2 + 0.2/-0	0.07 ± 0.01 1.8 ± 0.2	1.10 ± 0.12 28.0 ± 3.0	0.018 ± 0.002 0.45 ± 0.05	inches mm
CF 1/4	0.26 ± 0.02 6.5 ± 0.5	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.12 28.0 ± 3.0	0.022 ± 0.002 0.56 ± 0.05	inches mm
CF 1/2	0.33 ± 0.02 8.5 ± 0.50	0.11 ± 0.02 2.7 ± 0.5	1.10 ± 0.12 28.0 ± 3.0	0.024 ± 0.002 0.60 ± 0.05	inches mm
CF 1	0.43 ± 0.04 11.0 ± 1.0	0.18 ± 0.02 4.5 ± 0.5	1.18 ± 0.12 30.0 ± 3.0	0.031 ± 0.004 0.80 ± 0.1	inches mm
CF 2	0.59 ± 0.04 15.0 ± 1.0	0.20 ± 0.02 5.0 ± 0.5	1.18 ± 0.12 30.0 ± 3.0	0.031 ± 0.004 0.80 ± 0.1	inches mm
CFM 1/4	0.13 + 0.01/-0 3.2 + 0.2/-0	0.07 ± 0.01 1.8 ± 0.2	1.10 ± 0.12 28.0 ± 3.0	0.018 ± 0.002 0.45 ± 0.05	inches mm
CFM 1/2	0.26 ± 0.02 6.5 ± 0.5	0.09 ± 0.01 2.3 ± 0.2	1.10 ± 0.12 28.0 ± 3.0	0.022 ± 0.002 0.56 ± 0.05	inches mm

Performance Characteristics		
Test	Standard / Method	Requirement
Short TIme Overload	EIA-RS-172-B 3.2.6	± 0.5%
Resistance to Solder Heat	MIL-STD 202, Method 210	± 0.5%
Dielectric Withstanding Voltage	JIS C 5202 5.6	± 0.5%
Load Life	MIL-STD 202, Method 108	± 1.0%
Terminal Strength	MIL-STD 202, Method 211	± 0.2%
Moisture Resistance	MIL-STD 202, Method 106	± 0.5%

SM / SMX Series — Surface Mount - Wirewound / Film

Features

SM - Wirewound Element

- High temperature molded encapsulation
- Flex termination for absorbing thermal expansion
- All welded construction
- Available in non-inductive styles

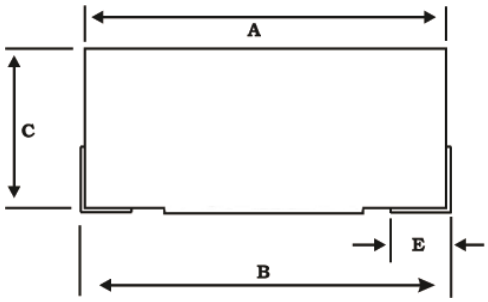
SMX - Metal Oxide Element

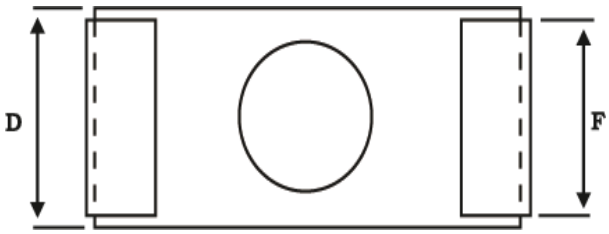
- SMX: economical SMT 2 and 3 watt
- SMX extends value range up to 470K
- Both are RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Maximum Working Voltage	Resistance Temperature Coefficient	Ohmic Range and Tolerance		
				0.1% & 0.5%	1%	5%
SM 1	1W	25	±100 ppm/°C ± 20 ppm/°C	0.01Ω – 10Ω* 10Ω – 1K	0.01Ω – 10Ω* 10Ω – 1K	0.01Ω – 10Ω* 10Ω – 1K
SM 2	2W	50	±100 ppm/°C ± 20 ppm/°C	0.01Ω – 10Ω* 10Ω – 2K	0.01Ω – 10Ω* 10Ω – 2K	0.01Ω – 10Ω* 10Ω – 2K
SMX 2	2W	350	±200 ppm/°C	–	2.0K – 100K	2.0K – 470K
SM 2A	2W	60	±100 ppm/°C	0.005Ω – 0.976Ω*	0.005Ω – 0.976Ω*	0.005Ω – 0.976Ω*
SM 3	3W	100	±100 ppm/°C ± 20 ppm/°C	0.01Ω – 10Ω* 10Ω – 3.01K	0.01Ω – 10Ω* 10Ω – 3.01K	0.01Ω – 10Ω* 10Ω – 3.01K
SMX 3	3W	500	±200 ppm/°C	–	3.01K – 118K	3.01K – 470K

* Zero ohm available on all sizes .





Mechanical Specifications

Type / Code	A Body Length	B Total Length	C Body Height	D Body Width	E Termination Width	F Termination Length	Units
Tolerance	±0.015 ±0.4	±0.032 ±0.81	±0.015 ±0.4	±0.015 ±0.4	±0.015 ±0.4	±0.015 ±0.4	
SM 1	0.260 6.6	0.280 7.1	0.140 3.6	0.150 3.8	0.090 2.3	0.100 2.5	inches mm
SM/ SMX 2	0.410 10.4	0.435 11.1	0.180 4.6	0.240 6.1	0.100 2.5	0.115 2.9	inches mm
SM 2A	0.475 12.1	0.500 12.7	0.140 3.6	0.305 7.8	0.110 2.8	0.115 2.9	inches mm
SM/ SMX 3	0.629 16.0	0.708 18.0	0.256 6.5	0.276 7.0	0.110 2.8	0.115 2.9	inches mm

How to Order

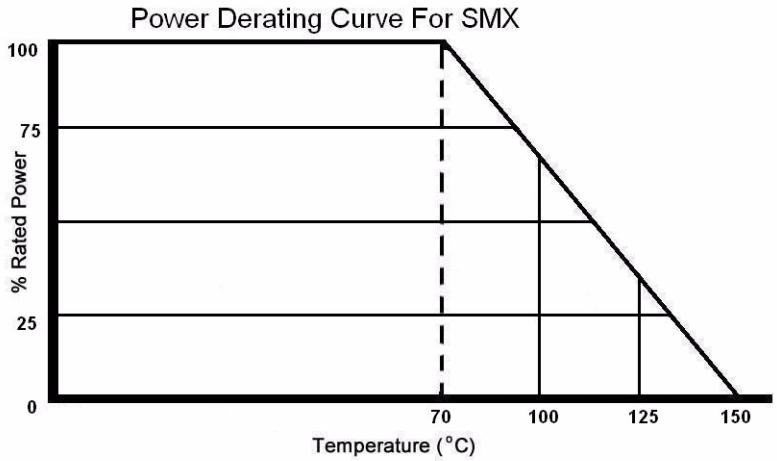
SM	2	1K	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

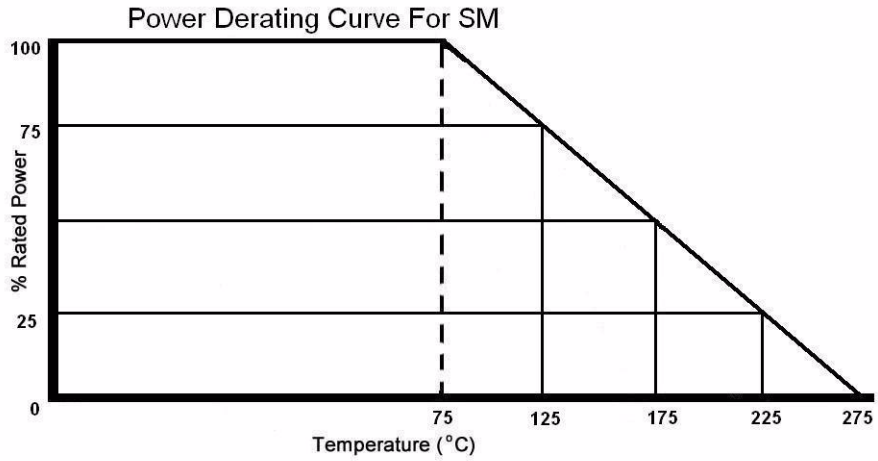
Type	Element
SM	Wirewound
SMX	Metal Oxide

Code	Size
1	2815
2	4424
2A	5031
3	7128

Tolerance
0.1%
0.5%
1%
5%

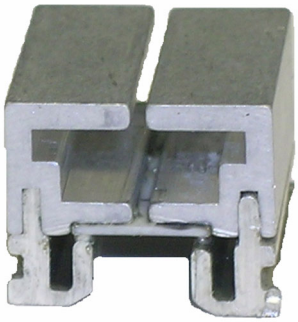
Series	Code	Description	Pkg Qty
SM 1	R	13" Reel	1,500
SM 2, SMX 2	R	13" Reel	800
SM 2A	R	13" Reel	1,200
SM 3, SMX 3	R	13" Reel	750





Performance Characteristics		
Test	**SM Test Results**	**SMX Test Results**
Moisture Resistance	±1.0%	±1.5%
Thermal Shock	± 0.5%	±1.0%
Load Life @70°C – 1,000 hrs.	±1.0%	±5.0%
Shock and Vibration	±1.0%	±1.0%
Resistance to Soldering Heat	±1.0	±1.0
Terminal Strength	±0.5%	±0.5%
Dielectric Withstanding Voltage	±0.001%/V	±0.001%/V
Short Time Overload	±0.5%	±0.75%
Low Temperature Operation	±0.5%	±0.5%
Operating Temperature Range	-55°C to +275°C	-55°C to +155°C

HPC Series — High Power Surface Mount Resistors



The HPC series represents a breakthrough in functional design, thermal management and end-user benefits. Borrowing from long-proven techniques used in power semiconductors, the HPC series provides up to eight times more useful power than SMD power resistors currently available.

The HPC series, through superior characterization, is intended to remove the mystery of managing board level power by combining established techniques in new ways. The result is superior technology in designs options, in a cost effective package.

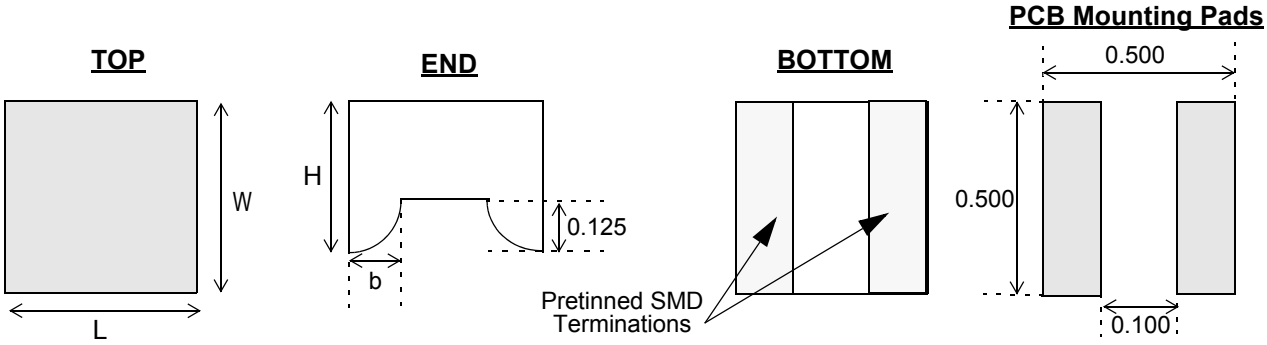
Features

- Up to 12W with no external heat sinks
- Compatible with conventional pick and place
- Only 0.5 x 0.5 PCB footprint
- Non inductive resistive element
- Up to 50W for short duration
- Patent pending
- Available in tolerances of 1%, 5%. and 10%
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 40°C w/400 LFM air flow	Power Rating (Watts) @ 40°C no air flow	Maximum Working Voltage	Max Overload Voltage	Dielectric Strength	Inductance	Resistance Temperature Coefficient	Ohmic Range and Tolerance
								5% & 10%
HPC 12	12W	5W	200	400	1,500	<2nH	±150 ppm/°C	0.025Ω – 250K

Dimensions
+/- 0.010



Mechanical Specifications

Type / Code	L Body Length	W Body Width	H Body Height	b Bottom Termination	Units
HPC 12	0.480 12.18	0.500 12.69	0.400 10.15	0.110 2.79	inches mm

How to Order

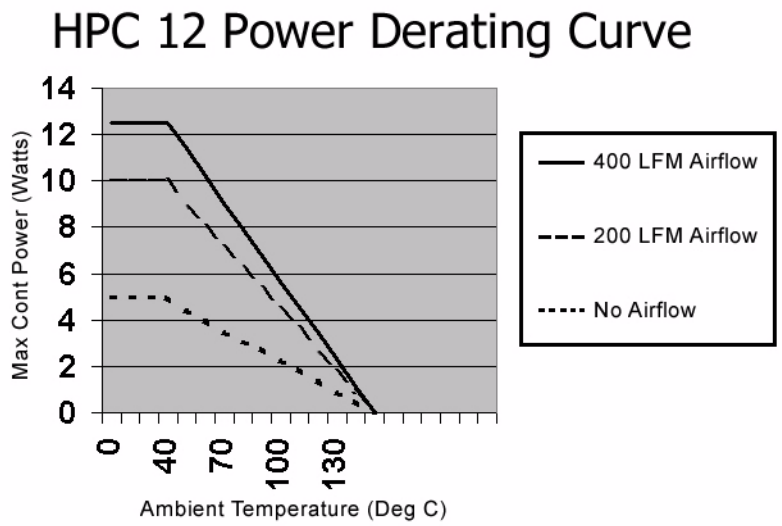
HPC	12	1K	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

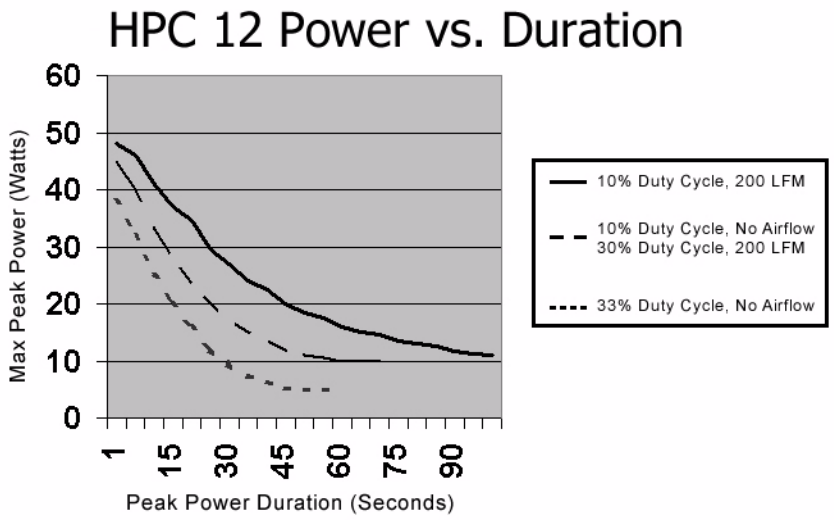
Code
12

Tolerance
1%
5%
10%

Code	Description	Pkg Qty
R	Standard Reel	xxx
A	Bulk	xxx

Performance Characteristics		
Test	**Test Conditions (JIS C 5202)**	**Test Results**
Short Time Overload	2.5x rated voltage for 5 seconds	±(2% +0.1Ω)
Dielectric Withstanding Voltage	100VAC, 1 minute	±(1% +0.05Ω)
Resistance to Soldering Heat	260°C ±5°C, for 10 sec. ±0.5 sec. (Solder Bath)	±(1% +0.05Ω)
Solderability	235°C ±5°C, for 2 sec. ±0.5 sec. (Colophonium flux)	95% coverage, minimum
Temperature Cycle	-65°C: 30 min. 25°C: 2 to 3 min. 150°C: 30 min. 25°C: 2 to 3 min. (5 Cycles)	±(1% +0.05Ω) Jumper (<0.05Ω)
Endurance (Damp load)	40°C ± 2°C, 90% to RH, Rated Load 90 min. On, 30 min. Off, (1,000 hrs. - 0 hrs. + 48 hrs.)	±(3% +0.1Ω) Jumper (<0.05Ω)
Endurance (Rated load)	70°C ± 2°C, 90% to RH, Rated Load 90 min. On, 30 min. Off, (1,000 hrs. - 0 hrs. + 48 hrs.)	±(3% +0.1Ω) Jumper (<0.05Ω)
Voltage Coefficient	1/10 rated voltage for 3 sec. max, then rated voltage for 3 sec. max.	±100 (ppm/V)
Robustness of Termination	Bend of 3mm for 5 ± 1 sec.	±(1.0% + 0.05 Ohm)





KAL Series — Aluminum Housed - General Purpose / Precision

Features

- Aluminum housing for maximum heat dissipation
- Complete welded construction
- Tinned copper terminals
- Centerless ground steatite or alumina cores
- Molded epoxy body for heat transfer
- Non-inductive winding available
- RoHS compliant / lead-free

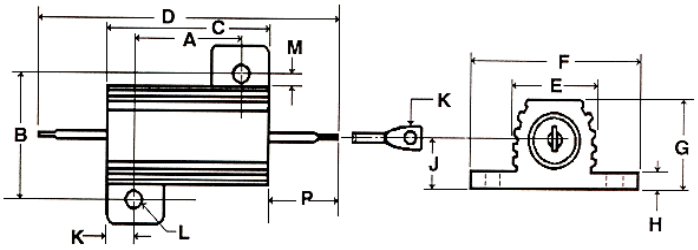
Electrical Specifications

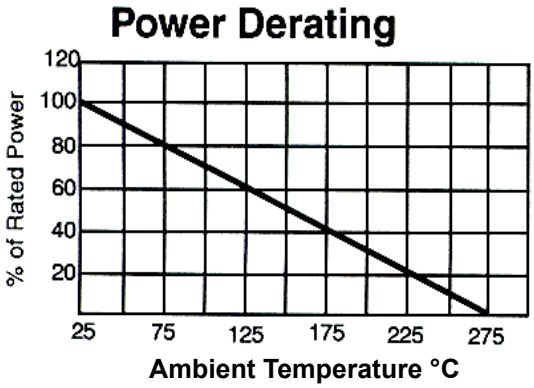
Type / Code	MIL-R-26 Ref.	Power Rating (Watts) @ 70°C		Dielectric Withstanding Voltage	Ohmic Range and Tolerance	
		Commercial	MIL		0.1% & 0.5%	1% & 5%
KAL 10	RE-65	12.5W	10W	1,000 VAC	1Ω – 1K	0.05Ω – 30K
KAL 25	RE-70	25W	20W	2,500 VAC	1Ω – 1K	0.05Ω – 50K
KAL 50	RE-75	50W	30W	2,500 VAC	1Ω – 1K	0.05Ω – 150K

Temperature Coefficient Standard: ±100ppm below 0.1Ω, ±50ppm from 0.1Ω - 9.9Ω, ±30ppm from 10Ω - 49Ω, & ±20ppm above 50Ω.

Mechanical Specifications

Type / Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Units
Tolerance	± 0.005	± 0.005	± 0.031	±0.062	± 0.015	± 0.015	± 0.031	± 0.010	± 0.015	± 0.010	± 0.005	± 0.015	± 0.005	±0.062	inches
	±0.1	±0.1	±0.8	±1.6	±0.4	±0.4	±0.8	±0.3	±0.4	±0.3	±0.1	±0.4	±0.1	±1.6	mm
KAL 10	0.562 14.3	0.625 15.9	0.750 19.0	1.375 34.9	0.420 10.7	0.800 20.3	0.390 9.9	0.075 1.9	0.190 4.8	0.093 2.4	0.093 2.4	0.102 2.6	0.086 2.2	0.312 7.9	inches mm
KAL 25	0.719 18.3	0.781 19.8	1.062 27.0	1.938 49.2	0.550 14.0	1.080 27.4	0.546 13.9	0.088 2.2	0.260 6.6	0.172 4.4	0.125 3.2	0.115 2.9	0.086 2.2	0.438 11.1	inches mm
KAL 50	1.563 39.7	0.844 21.4	1.968 50.0	2.781 70.6	0.630 16.0	1.140 29.0	0.610 15.5	0.088 2.2	0.300 7.6	0.196 5.0	0.125 3.2	0.107 2.7	0.086 2.2	0.410 10.4	inches mm





How to Order

KAL	10	10K	1%	B
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type	Description
KAL	Standard
NKAL	Non-Inductive

Code
10
25
50

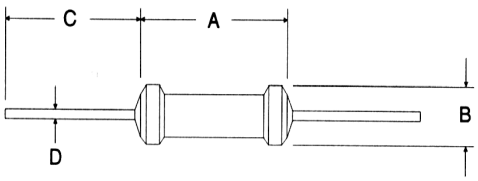
Tolerance
0.1%
0.5%
1%
5%

Code	Description	Pkg Qty
B	KAL 10	20
B	KAL 25	10
B	KAL 50	5

WRF Series — Consumer Grade - Conformal Coated Wirewound

Features

- Conformal coating
- Flameproof construction
- Temperature coefficient of resistance of ±100ppm/°C
- Cut and formed product is available on select sizes; contact factory for details
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 25°C	Maximum Working Voltage	Dielectric Withstanding Voltage (RMS)	Resistance Temperature Coefficient	Ohmic Range and Tolerance
					5%
WRF 1	1W	√PR	700	±200 ppm/°C	0.1Ω – 680Ω
WRF 2	2W	√PR	700	±200 ppm/°C	0.1Ω – 1.2K
WRF 3	3W	√PR	700	±200 ppm/°C	0.1Ω – 1.2K

Mechanical Specifications

Type / Code	A Body Length	B Body Width	C Lead Length (Bulk)	D Lead Diameter	Units
WRF 1	0.433 max 11.0 max	0.197 max 5.0 max	1.10 ± 0.08 28.0 ± 2.0	0.031 ± 0.002 0.78 ± 0.05	inches mm
WRF 2	0.630 max 16.0 max	0.197 max 5.0 max	1.10 ± 0.08 28.0 ± 2.0	0.031 ± 0.002 0.80 ± 0.05	inches mm
WRF 3	0.630 max 16.0 max	0.197 max 5.0 max	1.10 ± 0.12 28.0 ± 3.0	0.031 ± 0.002 0.80 ± 0.05	inches mm

Performance Characteristics

Test	Test Results
Moisture Resistance	±5% +0.05Ω
Thermal Shock	±2% +0.05Ω
Load Life @ 70°C – 1,000 hrs	±5% +0.05Ω
Shock and Vibration	±1% +0.05Ω
Resistance to Soldering Heat	±2% +0.05Ω
Short Time Overload	±3% +0.05Ω
Operating Temperature Range	-55ºC to +250°C

How to Order

WRF	2	1.1K	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
1
2
3

Tolerance	Values
5%	E24

Code	Description	Pkg Qty
A	Bulk	1,000
R	Tape	2,000

GP Series — Commercial Grade - Conformal Coated

Features

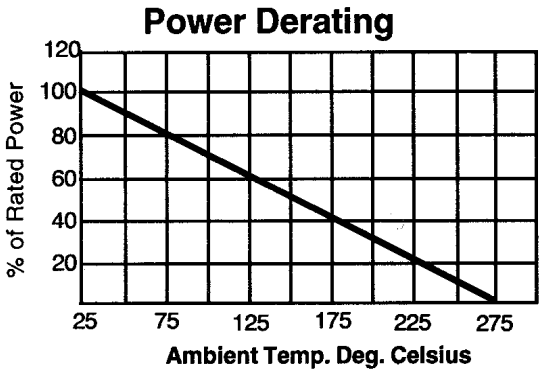
- Low cost power resistor
- All welded construction
- Cut and formed product is available on select sizes; contact factory for details
- Non-flammable conformal coating
- High temperature silicone coating
- Centerless ground ceramic cores
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Dielectric Withstanding Voltage	Ohmic Range and Tolerance
			2%, 5%, 10%
GP 1	1W	500 VAC	1Ω – 1K
GP 2	2.5W	500 VAC	1Ω – 2K
GP 3	3W	1,000 VAC	1Ω – 3K
GP 5	5W	1,000 VAC	1Ω – 10K
GP 7	7W	1,000 VAC	1Ω – 10K
GP 10	10W	1,000 VAC	1Ω – 20K

*Resistance Temperature Coefficient Standard: ±50ppm below 10Ω & ±30ppm above 10Ω

Please note: NOT Available in Non-Inductive / Fusible



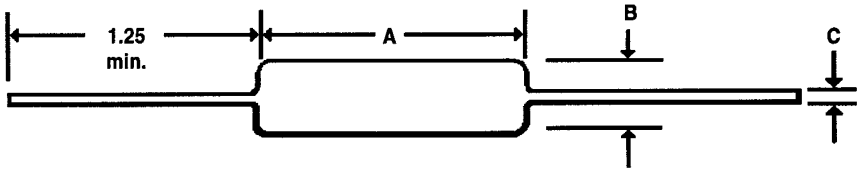
How to Order

GP	1	1K	2%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
1
2
3
5
7
10

Tolerance
2%
5%
10%

Code	Description	Pkg Qty
R	Reel	5,000



Mechanical Specifications				
Type / Code	A Body Length	B Body Diameter	C Lead Diameter	Units
Tolerance	±0.062	±0.031	±0.002	inches
	±1.6	±0.8	±0.05	mm
GP 1	0.370 9.4	0.156 4.0	0.032 0.81	inches mm
GP 2	0.550 14.0	0.156 4.0	0.032 0.81	inches mm
GP 3	0.560 14.2	0.187 4.8	0.032 0.81	inches mm
GP 5	0.875 22.2	0.312 7.9	0.036 0.91	inches mm
GP 7	1.125 28.6	0.312 7.9	0.036 0.91	inches mm
GP 10	1.780 45.2	0.375 9.5	0.040 1.0	inches mm

Performance Characteristics	
Test	Test Results
Moisture Resistance	±5%
Thermal Shock	±2%
Load Life @ 70°C – 1,000 hrs.	±5%
Resistance to Soldering Heat	±2%
Short Time Overload	±2%
Dielectric Withstanding Voltage	±2%
Operating Temperature Range	-55ºC to +275°C

WW / MWW Series — General Purpose/Precision

Features

- High performance for low cost
- Excellent stability in operation
- High power to size ratio
- MWW - Completely molded construction with welded terminations tested to MIL-R-39007
- Complete welded terminations
- Tinned copper leads
- Available in non-inductive styles
- High temperature silicone coating
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	MIL-R-26 Ref.	Dielectric Strength	Power Rating (Watts)		Std. Resistance Range* (ohms)
			@ 125°C (U)	@ 25°C (V)	0.1%, 0.5%, 1% & 5%
WW H	–	500	0.4W	0.6W	0.1Ω – 2K
WW 1	–	500	1.0W	1.2W	0.1Ω – 3K
WW 1A	RW-70	500	1.0W	1.5W	0.1Ω – 7K
WW 2	RW-69	1,000	1.5W	2.5W	0.1Ω – 10K
WW 2A	–	1,000	2.5W	3.0W	0.1Ω – 15K
WW 3	RW-79	1,000	3.0W	3.7W	0.1Ω – 22K
WW 3A	–	1,000	3.0W	4.0W	0.1Ω – 30K
WW 4	–	1,000	4.0W	5.0W	0.1Ω – 40K
WW 5	RW-67, RW-74	1,000	5.0W	6.0W	0.1Ω – 50K
WW 7	–	1,000	6.5W	8.5W	0.1Ω – 70K
WW 7B	–	1,000	7.0W	9.0W	0.1Ω – 100K
WW 10	RW-78	1,000	10W	13W	0.1Ω – 150K
MWW 1	RW-70	1,000	1.0W	1.5W	0.1Ω – 2K
MWW 3	RW-79	1,000	3.0W	3.75W	0.1Ω – 20K
MWW 5	RW-67, RW-74	1,000	5.0W	6.5W	0.1Ω – 40K
MWW 10	RW-68, RW-74	1,000	10.0W	13.0W	0.1Ω – 150K

*Standard TC as follows: ±90ppm below 1Ω, ±50ppm from 1 - 10Ω, & ±20ppm above 10Ω.

How to Order

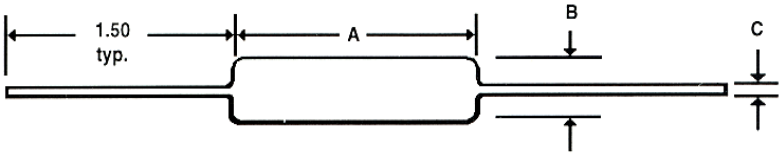
WW	1	10K	1%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Type
WW
MWW

Code
1
1A
2
2A
3
3A
4
5
7
7B
10
H

Tolerance
0.1%
0.5%
1%
5%

Code	Description	Pkg Qty 11" Flange
R	WW H, WW 1, WW 1A, MWW 1	2,500
R	WW 2, WW 2A, WW 3, MWW 3	2,000
R	WW 3A	750
R	WW 4, WW 5, WW 7, WW 7B, MWW 5	500
R	WW 10, MWW 10	250



Mechanical Specifications

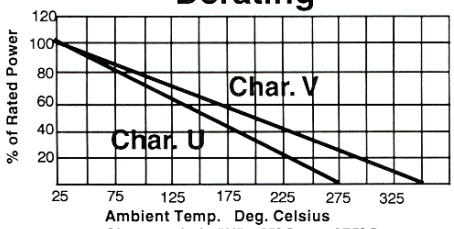
Type / Code	A	B	C	Units
Tolerance	± 0.062/±1.6	± 0.031/±0.8	± 0.002/±0.05	
WW H	0.312 7.9	0.110 2.8	0.0245 0.64	inches mm
WW 1	0.375 9.5	0.110 2.8	0.025 0.64	inches mm
WW 1A	0.420 10.7	0.110 2.8	0.025 0.64	inches mm
WW 2	0.370 9.4	0.156 4.0	0.032 0.81	inches mm
WW 2A	0.550 14.0	0.156 4.0	0.032 0.81	inches mm
WW 3	0.560 14.2	0.187 4.8	0.032 0.81	inches mm
WW 3A	0.500 12.7	0.218 5.5	0.032 0.81	inches mm
WW 4	0.700 17.8	0.270 6.9	0.036 0.91	inches mm
WW 5	0.875 22.2	0.312 7.9	0.036 0.91	inches mm
WW 7	1.000 25.4	0.312 7.9	0.036 0.91	inches mm
WW 7B	1.200 30.5	0.312 7.9	0.036 0.91	inches mm
WW 10	1.780 45.2	0.375 9.5	0.036* 0.91*	inches mm

* Available in 0.040

Mechanical Specifications

Type / Code	A	B	C	Units
Tolerance	± 0.015/±0.4	± 0.015/±0.4	± 0.002/±0.05	
MWW 1	0.385 9.8	0.135 3.4	0.032 0.81	inches mm
MWW 3	0.560 14.2	0.205 5.2	0.032 0.81	inches mm
MWW 5	0.925 23.5	0.330 8.4	0.036 0.91	inches mm
MWW 10	1.965 49.9	0.480 12.2	0.040 1.02	inches mm

Derating



Ambient Temp. Deg. Celsius
Characteristic "U" -55° C. to +275° C.
Characteristic "V" -55° C. to +350° C.

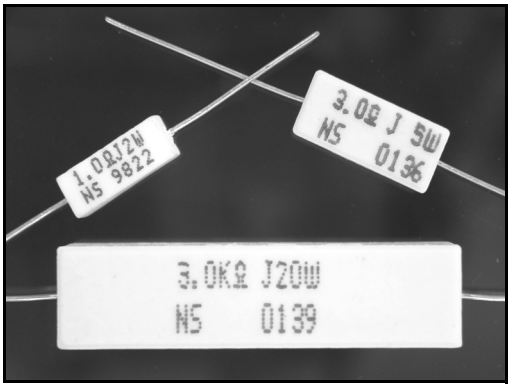
Performance Characteristics

Test	Results
Moisture Resistance	1% max.
Load Life	1%
Temperature Cycling	0.5%
Short Time Overload	1%

NSP Series — Ceramic Housed - Consumer Grade

Features

- Flameproof construction
- Temperature coefficient of resistance of ±200ppm/°C
- Low resistance values
- Power derating is linear from 100% at 25°C to zero at 250°C
- Also available with standoffs
- Other styles and configurations available; contact factory
- RoHS compliant / lead-free



Electrical Specifications

Type / Code	Power Rating (Watts) @ 25°C	Maximum Working Voltage*	Resistance Temperature Coefficient	Ohmic Range and Tolerance
				5%
NSP 2	2W	100	±200 ppm/°C	0.1Ω – 20K
NSP 3	3W	200	±200 ppm/°C	0.1Ω – 20K
NSP 5	5W	300	±200 ppm/°C	0.1Ω – 20K
NSP 7	7W	350	±200 ppm/°C	0.1Ω – 20K
NSP 10	10W	500	±200 ppm/°C	0.1Ω – 20K
NSP 15	15W	600	±200 ppm/°C	0.1Ω – 2K
NSP 20	20W	700	±200 ppm/°C	0.1Ω – 2K
NSP 25	25W	700	±200 ppm/°C	0.1Ω – 5.1K

* Lesser of √PR or maximum working voltage.

How to Order

NSP	7	1.2K	5%	A
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

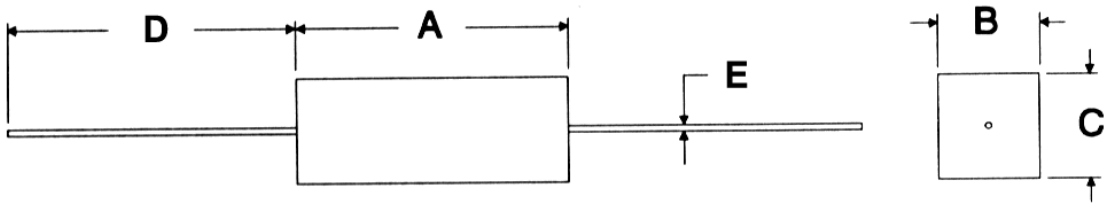
Code	Description
NSP	Standard
NSPP	With Standoff

Code
2
3
5
7
10
15
20
25

Tolerance	Values
5%	E24

Code	Description	Pkg Qty
A	Bulk	1,000

NSP Series — Ceramic Housed - Consumer Grade



Mechanical Specifications						
Type / Code	A Body Length	B Body Width	C Body Height	D Lead Length (Bulk)	E Lead Diameter	Units
NSP 2	0.71 ± 0.02 18.0 ± 0.5	0.28 ± 0.04 7.0 ± 1.0	0.28 ± 0.04 7.0 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.026 ± 0.002 0.65 ± 0.05	inches mm
NSP 3	0.87 ± 0.02 22.0 ± 0.5	0.32 ± 0.04 8.0 ± 1.0	0.32 ± 0.04 8.0 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 5	0.87 ± 0.02 22.0 ± 0.5	0.40 ± 0.04 10.0 ± 1.0	0.35 ± 0.04 10.0 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 7	1.38 ± 0.02 35.0 ± 0.5	0.40 ± 0.04 10.0 ± 1.0	0.35 ± 0.04 10.0 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 10	1.89 ± 0.02 48.0 ± 0.5	0.40 ± 0.04 10.0 ± 1.0	0.35 ± 0.04 10.0 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 15	1.89 ± 0.02 48.0 ± 0.5	0.49 ± 0.04 12.5 ± 1.0	0.49 ± 0.04 12.5 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 20	2.36 ± 0.04 60.0 ± 1.0	0.57 ± 0.04 14.5 ± 1.0	0.53 ± 0.04 13.5 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm
NSP 25	2.36 ± 0.04 60.0 ± 1.0	0.57 ± 0.04 14.5 ± 1.0	0.53 ± 0.04 13.5 ± 1.0	1.42 ± 0.12 36.0 ± 3.0	0.032 ± 0.002 0.80 ± 0.05	inches mm

*Contact factory for dimensions with standoffs.

Performance Characteristics	
Test	Test Results
Moisture Resistance	±5%
Thermal Shock	±2%
Load Life @ 70°C – 1,000 hrs.	±5%
Resistance to Soldering Heat	±2%
Short Time Overload	±2%
Dielectric Withstanding Voltage	±2%
Operating Temperature Range	-55ºC to +250°C

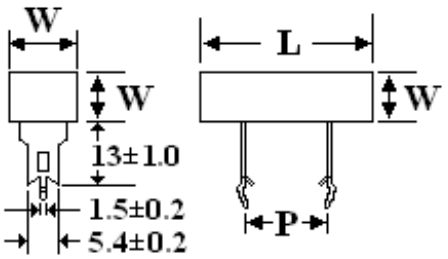
NSZ Series — Specialty Lead, Ceramic Housed - Consumer Grade

Features

- Special lead configurations
- RoHS compliant / lead-free

See NSP data sheet for electrical and environmental specifications

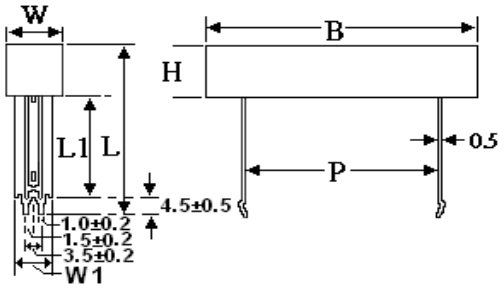
NSZ 1



NSZ 1 Specifications

Typd / Code	Power Rating (Watts) @ 25°C	Maximum Working Voltage	Resistance Range Wirewound	Resistance Range Metal Oxide	L ± 1.0	W ± 1.0	P ± 1.0	Units
NSZ 1	5W	300	1.0Ω – 680Ω	680Ω – 50K	1.06 27.0	0.39 10.0	0.59 15.0	inches mm
NSZ 1	7W	350	1.0Ω – 1.0K	1.0K – 50K	1.38 35.0	0.39 10.0	0.89 22.5	inches mm
NSZ 1	10W	500	1.0Ω – 1.0K	1.0K – 50K	1.89 48.0	0.39 10.0	1.38 35.0	inches mm

NSZ 2



NSZ 2 Specifications

Type / Code	Power Rating (Watts) @ 25°C	B ± 1.0	H ± 0.5	W ± 0.5	W1 ± 0.1	P ± 1.0	L ± 1.0	L1	Units
NSZ 2	3W	0.98 25.0	0.39 9.8	0.39 9.8	0.29 7.3	0.49 12.5	1.55 39.3	0.98+0.08/-0.04 25+2.0/-1.0	inches mm
NSZ 2	5W	1.10 28.0	0.39 9.8	0.39 9.8	0.29 7.3	0.59 15.0	1.55 39.3	0.98+0.08/-0.04 25+2.0/-1.0	inches mm
NSZ 2	7W	1.40 35.5	0.39 9.8	0.39 9.8	0.29 7.3	0.89 22.5	1.55 39.3	0.98+0.08/-0.04 25+2.0/-1.0	inches mm
NSZ 2	10W	1.89 48.0	0.39 9.8	0.39 9.8	0.29 7.3	1.38 35.0	1.55 39.3	0.98+0.08/-0.04 25+2.0/-1.0	inches mm
NSZ 2	15W	1.89 48.0	0.47 12.0	0.47 12.0	0.29 7.3	1.28 32.5	1.54 39.0	0.98+0.08/-0.04 25+2.0/-1.0	inches mm

How to Order

NSZ	1	7	1K	5%	A
Type	Code	Power Rating (Watts)	Nominal Resistance	Tolerance	Packaging

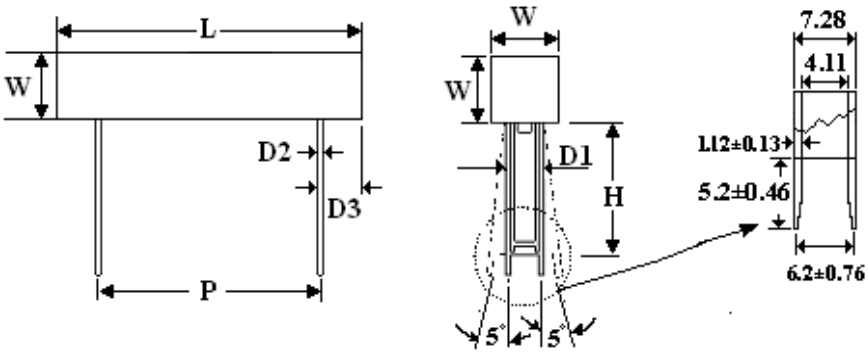
Code
1
2
3
4

3	3W
5	5W
7	7W
10	10W
15	15W
20	20W

Tolerance	Value
5%	E24

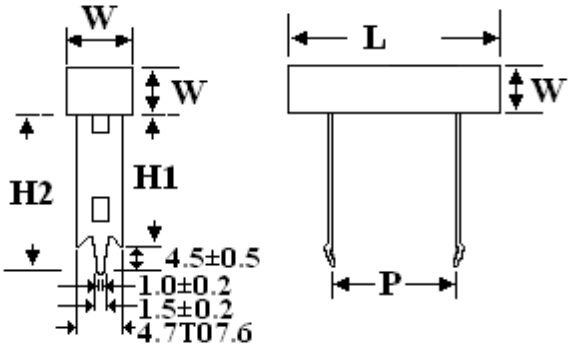
Code	Description	Pkg Qty
A	Bulk	1,000

NSZ 3



NSZ 3 Specifications									
Type / Code	Power Rating (Watts) @ 25°C	L +1.02/-2.03	W ±1.27	P ±1.52	H	D1 ±0.31	D2 ±0.1	D3 MIN	Units
NSZ 3	5W	1.06 27.0	0.39 10.0	0.59 15.0	0.39 10.0	0.29 7.3	0.02 0.46	0.24 6.2	inches mm
NSZ 3	7W	1.43 36.4	0.39 10.0	0.89 22.49	0.89 min 1.06 max 22.84 min 27.01 max	0.29 7.28	0.02 0.46	0.15 3.81	inches mm
NSZ 3	10W	1.89 47.97	0.39 9.82	1.38 35.03	0.89 min 1.06 max 22.84 min 27.01 max	0.29 7.28	0.02 0.46	0.15 3.81	inches mm
NSZ 3	15W	1.89 47.9	0.49 12.49	1.28 32.49	0.89 min 1.06 max 22.84 min 27.01 max	0.29 7.28	0.02 0.46	0.15 3.81	inches mm

NSZ 4



NSZ 4 Specifications										
Type / Code	Power Rating (Watts) @ 25°C	Maximum Working Voltage	Resistance Range Wirewound	Resistance Range Metal Oxide	H1 ± 1.0	H2 ± 1.0	L1 MAX	P ± 1.0	W MAX	Units
NSZ 4	5W	300	0.1Ω – 680Ω	680Ω – 50K	0.98 25.0	1.18 30.0	1.06 27.0	0.59 15.0	0.39 10.0	inches mm
NSZ 4	7W	350	0.1Ω – 1.0K	1.0K – 50K	0.98 25.0	1.26 32.0	1.38 35.0	0.94 24.0	0.39 10.0	inches mm
NSZ 4	10W	500	0.1Ω – 2.0K	2.0K – 50K	0.98 25.0	1.26 32.0	1.89 48.0	1.38 35.0	0.39 10.0	inches mm
NSZ 4	15W	600	0.1Ω – 2.0K	2.0K – 50K	0.98 25.0	1.26 32.0	1.89 48.0	1.26 32.0	0.47 12.0	inches mm
NSZ 4	20W	700	0.1Ω – 2.0K	2.0K – 50K	0.98 25.0	1.26 32.0	2.56 65.0	1.77 45.0	0.47 12.0	inches mm

CB Series — Ceramic Housed - General Purpose

Features

- Fireproof power wirewound
- High thermal conductivity
- Different element (resistor) available: precision / ceramic & metal oxide
- Non-inductive styles available
- Body standoffs available, add "F" after CB
- High temperature silicone coating
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Ohmic Range and Tolerance			
		0.5%	1%	5%	10%
CB 2	2W	–	–	0.2Ω – 125Ω	0.2Ω – 125Ω
CB 3	3W	–	–	0.1Ω – 350Ω	0.1Ω – 350Ω
CB 5	5W	–	–	0.1Ω – 500Ω	0.1Ω – 500Ω
CB 7	7W	–	–	0.15Ω – 750Ω	0.15Ω – 750Ω
CB 10	10W	–	–	0.2Ω – 1K	0.2Ω – 1K
CB 15	15W	–	–	0.2Ω – 1K	0.2Ω – 1K
CB 20	20W	–	–	0.3Ω – 1.25K	0.3Ω – 1.25K
CB 22	22W	–	–	0.3Ω – 1.25K	0.3Ω – 1.25K
CB 25	25W	–	–	0.3Ω – 1.25K	0.3Ω – 1.25K
CB 30	30W	–	–	0.3Ω – 1.25K	0.3Ω – 1.25K
WCB 2	2W	1Ω – 5K	1Ω – 5K	1Ω – 5K	–
WCB 3	3W	1Ω – 10K	1Ω – 10K	1Ω – 10K	–
WCB 5	5W	1Ω – 10K	1Ω – 10K	1Ω – 10K	–
WCB 7	7W	1Ω – 15K	1Ω – 15K	1Ω – 15K	–
WCB 10	10W	1Ω – 20K	1Ω – 20K	1Ω – 20K	–
WCB 15	15W	1Ω – 20K	1Ω – 20K	1Ω – 20K	–
MCB 3	3W	–	–	100Ω – 10K	–
MCB 5	5W	–	–	100Ω – 10K	–

Resistance Temperature Coefficient Standard:

CB series: ±800ppm below 1W & ±300ppm for 1W and above; WCB series: ±50ppm from 1W to 10W & ±20ppm above 10W; MCB series: ±200ppm

How to Order

CB	2	100	5%	B
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

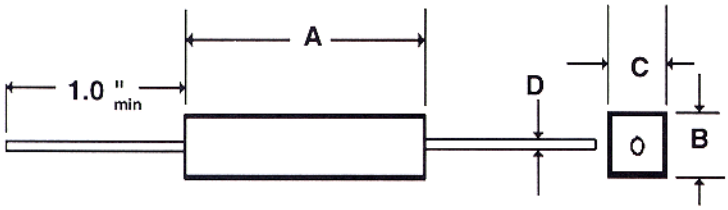
Type	Description
CB	Standard
WCB	
MCB	
CBF	With Standoff
WCBF	
MCBF	
NCB	Non Inductive
NWCB	
NCBF	Non Inductive With Standoff
NWCBF	

Code	
2	3
5	7
10	15
20	22
25	30

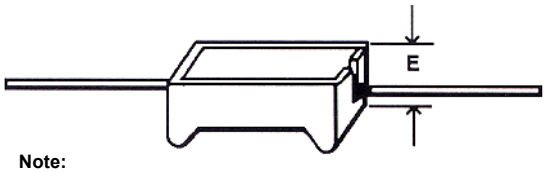
Tolerance
0.5%
1%
5%
10%

Code	Description	Pkg Qty
B	CB 2, CB 3, CB 5, WCB 2	750
B	WCB 3, WCB 5, MCB 3, MCB 5	750
B	CB 7, CB 10, CB 15, WCB 7, WCB 10, WCB 15	250
B	CB 20, CB 22, CB 25, CB 30	100

CB Series — Ceramic Housed - General Purpose



Body Standoff



Note:
CB - General Purpose Wirewound
WCB - Precision/Ceramic Wirewound
MCB - Metal Oxide Element

Mechanical Specifications

Type / Code	A	B	C	D	E	Units
Tolerance	±0.031	±0.031	±0.031	±0.002	±0.031	inches
	±0.8	±0.8	±0.8	±0.05	±0.8	mm
CB 2	0.700 17.8	0.245 6.2	0.255 6.5	0.032 0.81	0.300 7.6	inches mm
CB 3	0.875 22.2	0.312 7.9	0.312 7.9	0.036 0.91	0.375 9.5	inches mm
CB 5	0.875 22.2	0.375 9.5	0.375 9.5	0.036 0.91	0.437 11.1	inches mm
CB 7	1.400 35.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
CB 10	1.875 47.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
CB 15	1.875 47.6	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm
CB 20	2.500 63.5	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm
CB 22	2.500 63.5	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm
CB 25	2.500 63.5	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm
CB 30	2.500 63.5	0.625 15.9	0.625 15.9	0.036 0.91	–	inches mm
WCB 2	0.700 17.8	0.245 6.2	0.255 6.5	0.032 0.81	0.300 7.6	inches mm
WCB 3	0.875 22.2	0.312 7.9	0.312 7.9	0.032 0.81	0.375 9.5	inches mm
WCB 5	0.875 22.2	0.375 9.5	0.375 9.5	0.032 0.81	0.437 11.1	inches mm
WCB 7	1.400 35.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
WCB 10	1.875 47.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
WCB 15	1.875 47.6	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm
MCB 3	0.875 22.2	0.312 7.9	0.312 7.9	0.032 0.81	0.375 9.5	inches mm
MCB 5	0.875 22.2	0.375 9.5	0.375 9.5	0.032 0.81	0.437 11.1	inches mm

Performance Characteristics

Test	Test Results
Moisture Resistance	±5%
Thermal Shock	±2%
Load Life @ 70°C – 1,000 hrs.	±5%
Resistance to Soldering Heat	±2%
Short Time Overload	±2%
Dielectric Withstanding Voltage	±2%
Operating Temperature Range	-55ºC to +275°C

PCB Series — Ceramic Housed - Commercial Grade - PC Mount

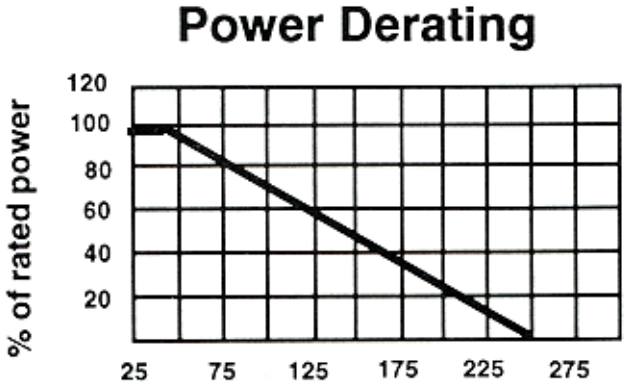
Features

- Flameproof construction
- Low resistance values available
- Labor saving circuit board mounting
- RoHS compliant / lead-free

Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Ohmic Range and Tolerance	
		5%	10%
PCB 3	3W	0.1Ω – 350Ω	0.1Ω – 350Ω
PCB 5	5W	0.1Ω – 500Ω	0.1Ω – 500Ω
PCB 7	7W	0.15Ω – 750Ω	0.15Ω – 750Ω
PCB 10	10W	0.2Ω – 1K	0.2Ω – 1K
PCB 15	15W	0.2Ω – 1K	0.2Ω – 1K
PCB 20	20W	0.3Ω – 1.25K	0.3Ω – 1.25K

Resistance Temperature Coefficient: ±300ppm/°C 1Ω and below & ±800ppm/°C above 1Ω



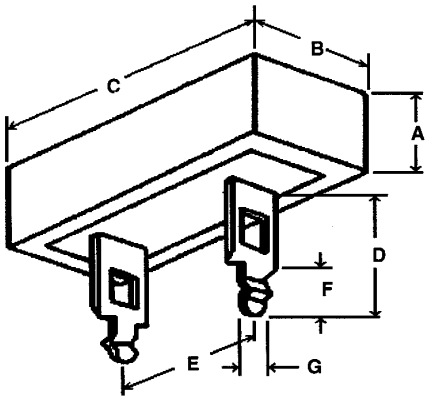
How to Order

PCB	3	10	5%	B
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
3
5
7
10
15
20

Tolerance
5%
10%

Code	Description	Pkg Qty
B	PCB 3, PCB 5	500
B	PCB 7	400
B	PCB 10	300
B	PCB 15	200
B	PCB 20	150



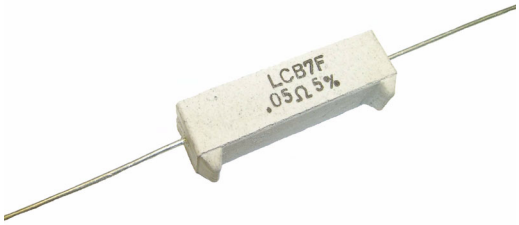
Terminal alignment ±5°

Mechanical Specifications								
Type / Code	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Units**
Tolerance	**±0.030**	**±0.030**	**±0.050**	**±0.062**	**±0.060**	**±0.010**	**±0.005**	**inches**
	±0.76	**±0.76**	**±1.3**	**±1.6**	**±1.5**	**±0.3**	**±0.12**	**mm**
PCB 3	0.375 9.5	0.375 9.5	0.900 22.9	0.590 15	0.500 12.7	0.180 4.6	0.059 1.5	inches mm
PCB 5	0.375 9.5	0.375 9.5	1.070 27.2	0.590 15	0.590 15	0.180 4.6	0.059 1.5	inches mm
PCB 7	0.375 9.5	0.375 9.5	1.400 35.6	0.590 15	0.886 22.5	0.180 4.6	0.059 1.5	inches mm
PCB 10	0.375 9.5	0.375 9.5	1.900 48.3	0.590 15	1.380 35.1	0.180 4.6	0.059 1.5	inches mm
PCB 15	0.500 12.7	0.500 12.7	1.900 48.3	0.590 15	1.280 32.5	0.180 4.6	0.059 1.5	inches mm
PCB 20	0.500 12.7	0.500 12.7	2.500 63.5	0.590 15	1.850 47	0.180 4.6	0.059 1.5	inches mm

LCB Series — Ceramic Housed - Current Sensing - 2 Leads

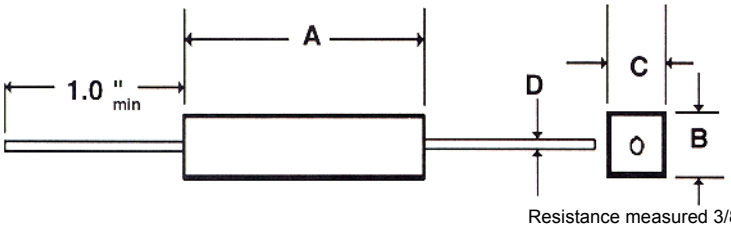
Features

- Fireproof construction
- Low temperature coefficient
- Low resistance value ceramic encased resistor
- All welded termination
- RoHS compliant / lead-free



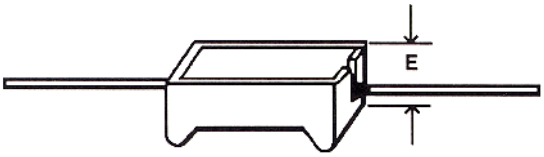
Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
			1%	5%
LCB 3	3W	±40 ppm/°C	0.005Ω – .1Ω	0.005Ω – .1Ω
LCB 5	5W	±40 ppm/°C	0.005Ω – .1Ω	0.005Ω – .1Ω
LCB 7	7W	±40 ppm/°C	0.010Ω – .15Ω	0.010Ω – .15Ω
LCB 10	10W	±40 ppm/°C	0.010Ω – .2Ω	0.010Ω – .2Ω
LCB 15	15W	±40 ppm/°C	0.010Ω – .2Ω	0.010Ω – .2Ω



Resistance measured 3/8" from the body

Alternate Configuration Series LCBF



Mechanical Specifications

Type	A	B	C	D	E	Units
Tolerance	±0.031	±0.031	±0.031	±0.031	±0.031	inches
	±0.8	±0.8	±0.8	±0.8	±0.8	mm
LCB 3	0.875 22.2	0.312 7.9	0.312 7.9	0.032 0.81	0.375 9.5	inches mm
LCB 5	0.875 22.2	0.375 9.5	0.375 9.5	0.032 0.81	0.437 11.1	inches mm
LCB 7	1.400 35.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
LCB 10	1.875 47.6	0.375 9.5	0.375 9.5	0.036 0.91	0.500 12.7	inches mm
LCB 15	1.875 47.6	0.500 12.7	0.500 12.7	0.036 0.91	0.625 15.9	inches mm

How to Order

LCB	3	0.1	5%	B
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code	Description
LCB	Standard
LCBF	With Standoff

Code
3
5
7
10
15

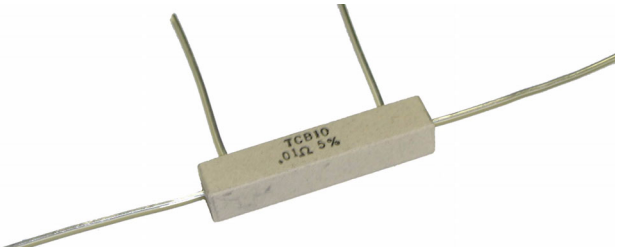
Tolerance
1%
5%
10%

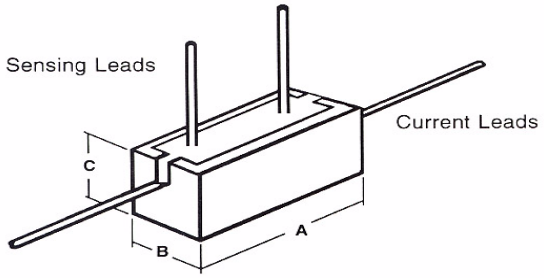
Code	Description	Pkg Qty
B	LCB 3, LCB 5	750
B	LCB 7, LCB 10, LCB 15	250

TCB Series — Ceramic Housed - Current Sensing - 4 Leads

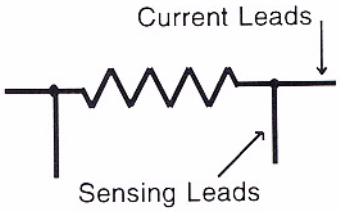
Features

- Four terminal construction
- Low inductance
- Low temperature coefficient
- RoHS compliant / lead-free
- Fireproof construction
- All welded termination
- Low resistance value ceramic encased resistor





Lead Diameter .036 Length 1" minimum



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Resistance Temperature Coefficient	Ohmic Range and Tolerance	
			1%	5%
TCB 3	3W	±40 ppm/°C	0.005Ω – 0.1Ω	0.005Ω – 0.1Ω
TCB 5	5W	±40 ppm/°C	0.005Ω – 0.1Ω	0.005Ω – 0.1Ω
TCB 7	7W	±40 ppm/°C	0.01Ω – 0.15Ω	0.01Ω – 0.15Ω
TCB 10	10W	±40 ppm/°C	0.01Ω – 0.2Ω	0.01Ω – 0.2Ω
TCB 15	15W	±40 ppm/°C	0.01Ω – 0.2Ω	0.01Ω – 0.2Ω

Mechanical Specifications

Type / Code	A Body Length (max)	B Body Width	C Body Height (Bulk)	Sensing Lead Spacing	Units
Tolerance	±0.031	±0.031	±0.031	±0.062	inches
	±0.8	±0.8	±0.8	±1.6	mm
TCB 3	0.875 22.2	0.312 7.9	0.312 7.9	0.563 14.3	inches mm
TCB 5	0.875 22.2	0.375 9.5	0.375 9.5	0.563 14.3	inches mm
TCB 7	1.400 35.6	0.375 9.5	0.375 9.5	1.000 25.4	inches mm
TCB 10	1.875 47.6	0.375 9.5	0.375 9.5	1.375 34.9	inches mm
TCB 15	1.875 47.6	0.500 12.7	0.500 12.7	1.375 34.9	inches mm

How to Order

TCB	3	0.1	5%	B
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

Code
3
5
7
10
15

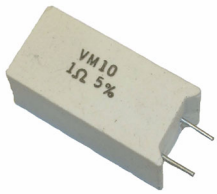
Tolerance
1%
5%

Code	Description	Pkg Qty
B	Bulk	50

VM / MVM / LVM / WVM Series — Ceramic Housed Vertical Mount

Features

- Flameproof inorganic construction
- High temperature potting compound
- VM - Wirewound on fiberglass element
- RoHS compliant / lead-free
- MVM - Metal oxide element for higher values
- LVM - Low resistance wire or ribbon element
- WVM - Precision wirewound element



Electrical Specifications

Type / Code	Power Rating (Watts) @ 70°C	Ohmic Range and Tolerance			
		0.5%	1%	5%	10%
VM 2	2W	–	–	0.1Ω – 100Ω	0.1Ω – 100Ω
VM 3	3W	–	–	0.1Ω – 125Ω	0.1Ω – 125Ω
VM 5	5W	–	–	0.1Ω – 150Ω	0.1Ω – 150Ω
VM 7	7W	–	–	0.2Ω – 300Ω	0.2Ω – 300Ω
VM 10	10W	–	–	0.2Ω – 300Ω	0.2Ω – 300Ω
MVM 3	3W	–	–	100Ω – 1K	100Ω – 100K
MVM 5	5W	–	–	100Ω – 1K	100Ω – 100K
LVM 2	2W	–	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω
LVM 3	3W	–	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω
LVM 5	5W	–	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω	0.01Ω – 0.1Ω
LVM 7	7W	–	0.02Ω – 0.15Ω	0.02Ω – 0.15Ω	0.02Ω – 0.15Ω
LVM 10	10W	–	0.02Ω – 0.15Ω	0.02Ω – 0.15Ω	0.02Ω – 0.15Ω
WVM 2	2W	0.1Ω – 2K	0.1Ω – 2K	0.1Ω – 2K	–
WVM 3	3W	0.1Ω – 5K	0.1Ω – 5K	0.1Ω – 5K	–
WVM 5	5W	0.1Ω – 5K	0.1Ω – 5K	0.1Ω – 5K	–
WVM 7	7W	0.1Ω – 8K	0.1Ω – 8K	0.1Ω – 8K	–
WVM 10	10W	0.1Ω – 8K	0.1Ω – 8K	0.1Ω – 8K	–

Resistance Temperature Coefficient Standard:

VM series: ±800ppm below 1Ω & ±400ppm at 1Ω and above

MVM series: ±200ppm

LVM series: ±50 to 400ppm depending on value

WVM series: ±90ppm below 1Ω, ±50ppm from 1Ω to 10Ω & ±20ppm above 10Ω.

How to Order

VM	3	2.2	5%	B
SEI Type	Code	Nominal Value	Tolerance	Packaging

Type
VM
MVM
LVM
WVM

Code
2
3
5
7
10

Tolerance
0.5%
1%
5%
10%

Code	Description	Pkg Qty
B	VM, MVM, LVM, WVM	750

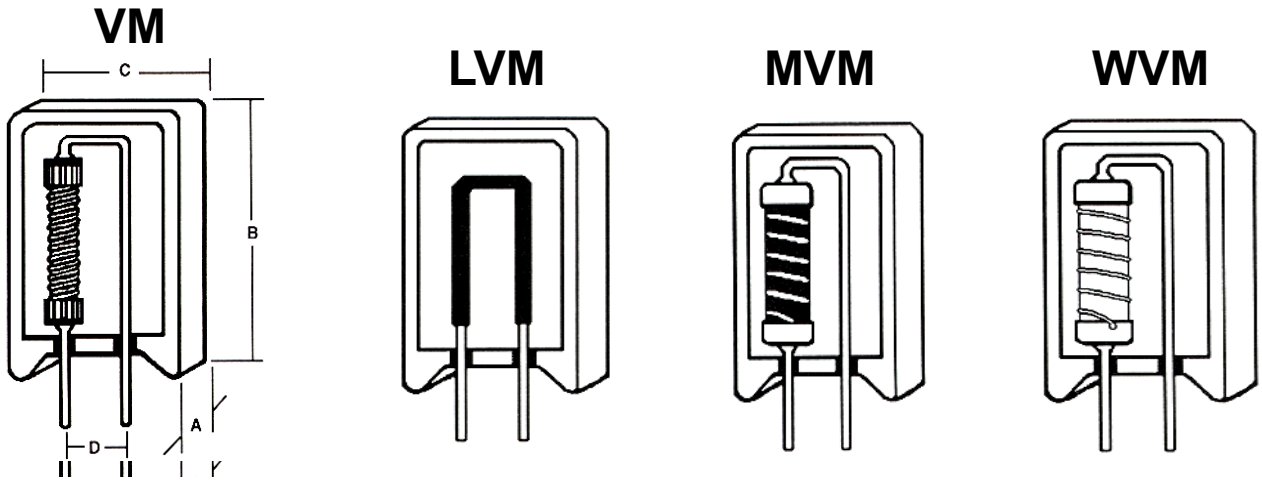
Mechanical Specifications					
Type / Code	A	B	C	D	Units
Tolerance	±0.039	±0.059	±0.039	±0.059	inches
	±1.0	±1.5	±1.0	±1.5	mm
VM 2	0.280 7.1	0.820 20.8	0.435 11.0	0.200 5.1	inches mm
VM 3	0.380 9.7	0.975 24.8	0.475 12.1	0.200 5.1	inches mm
VM 5	0.380 9.7	0.990 25.1	0.520 13.2	0.200 5.1	inches mm
VM 7	0.380 9.7	1.520 38.6	0.520 13.2	0.200 5.1	inches mm
VM 10	0.480 12.2	1.375 34.9	0.635 16.1	0.300 7.6	inches mm

*VM lead length 0.175 ± 0.032 and lead diameter 0.032

*MVM lead length 0.175 ± 0.032 and lead diameter 0.032

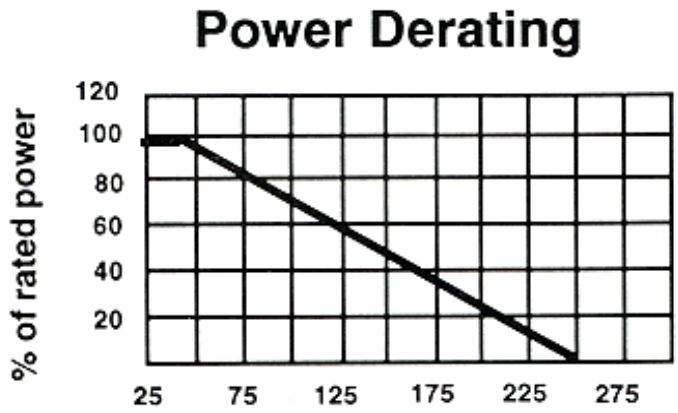
*LVM lead length 0.175 ± 0.032 and LVM 2 to LVM 5 lead diameter 0.032 & LVM 7 to LVM 10 lead diameter 0.036

*WVM lead length 0.175 ± 0.032 and WVM 2 to WVM 5 lead diameter 0.032 & WVM 7 to WVM 10 lead diameter 0.036



*VM 2 lead diameter is 0.032 and MVM, LVM & WVM lead diameter is 0.036

**Series VM, MVM, LVM, & WVM have the same dimensions.



EL / CEL Series — Commercial Power Resistors

Features

- Low cost, high performance
- Resistance range from 0.2 to 600 ohms
- Power rating: EL series = 4 watts per inch
- Power rating: CEL series = 5 watts per inch
- CEL series has a special flame retardant conformal coating
- RoHS compliant / lead-free

Applications

- Kitchen appliances
- Automotive devices
- Televisions and radios
- Computers
- Power supplies

Electrical Specifications

Type / Code	Power Rating (Watts)	Resistance Temperature Coefficient EL and CEL	Ohmic Range and Tolerance	
			5%	10%
EL 4050 CEL 4050	2.0W 2.5W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.2Ω – 100Ω	0.2Ω – 100Ω
EL 4055 CEL 4055	2.20W 2.75W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.2Ω – 130Ω	0.2Ω – 130Ω
EL 4060 CEL 4060	2.4W 3.0W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.22Ω – 180Ω	0.22Ω – 180Ω
EL 4070 CEL 4070	2.8W 3.5W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.26Ω – 215Ω	0.26Ω – 215Ω
EL 4080 CEL 4080	3.2W 4.0W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.32Ω – 255Ω	0.32Ω – 255Ω
EL 4090 CEL 4090	3.6W 4.5W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.36Ω – 270Ω	0.36Ω – 270Ω
EL 4100 CEL 4100	4.0W 5.0W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.4Ω – 300Ω	0.4Ω – 300Ω
EL 4150 CEL 4150	6.0W 7.5W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.66Ω – 400Ω	0.66Ω – 400Ω
EL 4200 CEL 4200	8.0W 10.0W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	0.9Ω – 500Ω	0.9Ω – 500Ω
EL 4220 CEL 4220	8.8W 11.0W	±800 ppm/°C below 1Ω ±400 ppm/°C above 1Ω	1Ω – 600Ω	1Ω – 600Ω

How to Order

EL	4100	1	5%	R
SEI Type	Code	Nominal Resistance	Tolerance	Packaging

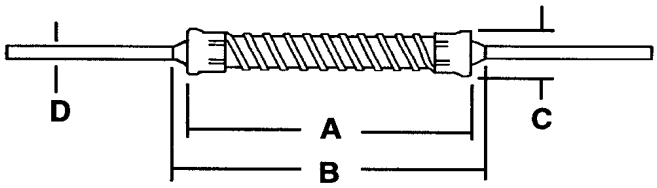
Type	Description
EL	Uncoated
CEL	Coated

Code	Wattage
4050	2.0/2.5
4055	2.2/2.75
4060	2.4/3.0
4070	2.8/3.5
4080	3.2/4.0
4090	3.6/4.5
4100	4.0/5.0
4150	6.0/7.5
4200	8.0/10.0
4220	8.8/11.0

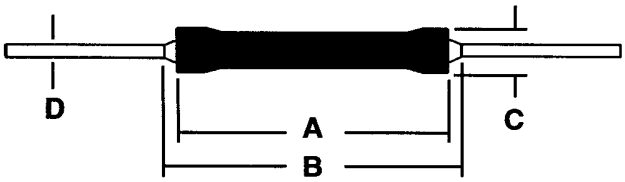
Tolerance
5%
10%

Code	Description
R	Standard Packaging

25k piece order minimum



EL Series



CEL Series

Mechanical Specifications				
Dimensions				
Type / Code	A	B	C	D
	(± 0.031)	(± 0.031)	(± 0.031)	(± 0.002)
EL 4050	0.500	0.562	0.140	0.036
EL 4055	0.550	0.612	0.140	0.036
EL 4060	0.600	0.662	0.140	0.036
EL 4070	0.700	0.762	0.140	0.036
EL 4080	0.800	0.862	0.140	0.036
EL 4090	0.900	0.962	0.140	0.036
EL 4100	1.000	1.062	0.140	0.036
EL 4150	1.500	1.562	0.140	0.036
EL 4200	2.000	2.062	0.140	0.036
EL 4220	2.200	2.262	0.140	0.036
CEL 4050	0.500	0.593	0.160	0.036
CEL 4055	0.550	0.643	0.160	0.036
CEL 4060	0.600	0.693	0.160	0.036
CEL 4070	0.700	0.793	0.160	0.036
CEL 4080	0.800	0.893	0.160	0.036
CEL 4090	0.900	0.993	0.160	0.036
CEL 4100	1.000	1.093	0.160	0.036
CEL 4150	1.500	1.593	0.160	0.036
CEL 4200	2.000	2.093	0.160	0.036
CEL 4220	2.500	2.293	0.160	0.036

SHP Series — Thick Film on Metal Technology

The SHP series of resistors is a thick film on steel technology uniquely suited for wide-scale usage in resistor and heating applications where high power density, surge handling, and low inductance are required in a defined space.

The SHP series differentiates itself from other thick film on metal products through the manner in which the resistive film is deposited. Other manufacturers utilize crude screenprinting processes, while the SHP series employs a precision fine film dispensing system, capable of writing quality resistive traces on a non corrosive 300 or 400 series stainless steel substrate.

Features

- Superior thermal transfer
- Superior shock and vibration strength
- Integrated fusing for failsafe circuit protection
- Available in flat and tubular geometries
- Reduced size compared to power wirewounds
- Flameproof package
- Current and temperature sense options available
- Custom mounting and lead attachment
- RoHS compliant / lead-free

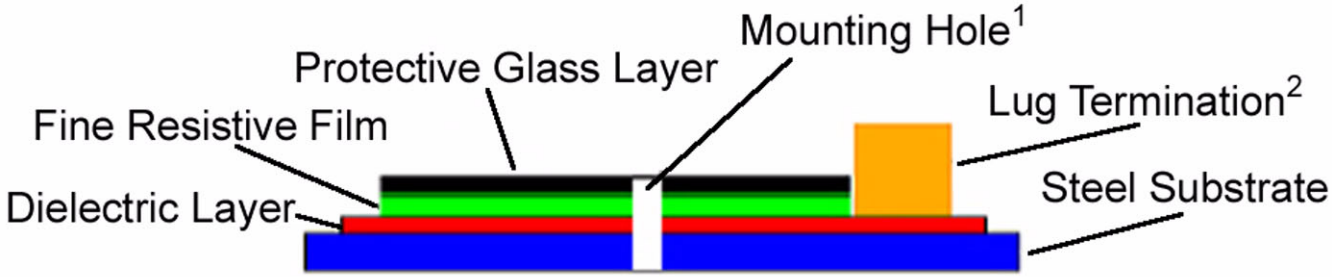
Electrical Specifications

Type / Code	Size to Power Dissipation Ratio	Resistance Values	Tolerance	Temperature Operation	Voltage Handling	Resistance Temperature Coefficient
SHP 1	+50 W/cm^2	0.1Ω – 1GΩ	From 10%	to 400°C	to 3,000 Vdc	±150 to ±2,000 ppm/°C
SHP 2	+50 W/cm^2	0.1Ω – 1GΩ	From 10%	to 400°C	to 3,000 Vdc	±150 to ±2,000 ppm/°C

Construction of SHP series

The SHP series is a ceramic encapsulated resistor constructed on a non-corrosive 300 or 400 series stainless steel substrate. Ceramic dielectric layers insulate the substrate with a matching thermal expansion coefficient to the stainless steel. A layer of a conductor and resistor are added and finally coated with an insulating layer of glass.

Cross Sectional Perspective



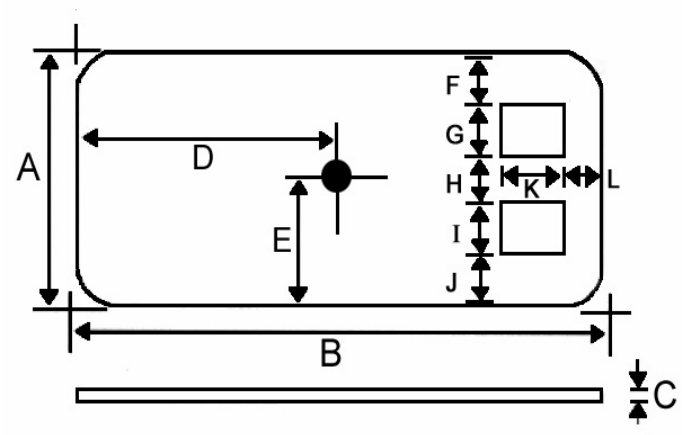
1. A heat sink can be mounted to the resistor to increase size to power dissipation ratio.
2. Wires or terminals are constructed to the requirements of the application.
Contact SEI for more information on termination considerations.

How to Order

SHP 1	300	18	10%
SEI Type	Power Rating	Nominal Resistance	Tolerance

SHP Series — Thick Film on Metal Technology

While the SHP series is offered in only one size, SEI's manufacturing process can accommodate various geometries as well as steel tubing. Custom features including mounting holes and lead attachment options are available to meet the design needs.



Mechanical Specifications													
Type / Code	A	B	C	D	E	F	G	H	I	J	K	L	Units
SHP 1	1.65 41.91	3.50 88.90	0.0625 1.59	1.75 44.45	0.825 20.64	0.375 9.53	0.3125 7.94	0.125 3.18	0.3125 7.94	0.375 9.53	0.3125 7.94	0.1875 4.76	inches mm
SHP 2	4.50 114.30	4.50 114.30	–	2.25 57.15	4.2375 107.6325	0.2625 6.6675	–	–	–	–	–	–	inches mm

Where this technology can be applied:

Applications currently using bulky power wirewounds (+100W)

- Elevator load banks
- Defibrillators
- Industrial welding equipment
- Power supplies
- Hi voltage transformers
- Various load resistor circuits

Motor Control/ Dynamic Braking

- Motor drives
- Industrial tools

Heaters

- Instantaneous hot water
- White goods
- Spa heating
- Glue guns
- Fluid heating

SEI Custom Lead Forming Capabilities

Developing custom solutions for your resistive product requirements is one of SEI's core competencies. Flexibility is a key design feature of SEI resistors and our manufacturing processes are designed to support this concept. The resistor is often the last component designed into a circuit and frequently the design engineer faces some interesting challenges when fitting a resistor into a space that it was not meant to go. That's where SEI's flexibility and custom lead forming capabilities allow us to provide creative solutions.

Many customers who have already designed in a non-standard resistor choose to do the lead forming themselves. This can be costly and time consuming for customers not properly equipped to perform these processes quickly and accurately. Whether it's a panasert lead configuration, 90° bends, board standoffs, lead extensions, or some other custom lead requirement, SEI is the resistive product solutions provider.

Features

- Hairpin (Panasert) cut and form for a variety of resistors sizes. Some available in bulk packaging only.
- Lead extensions on one or both sides.
- 90° bends on one or both sides. Also capable of lead crimping to hold the resistor off of the board.
- Series and parallel connection of two or more resistors

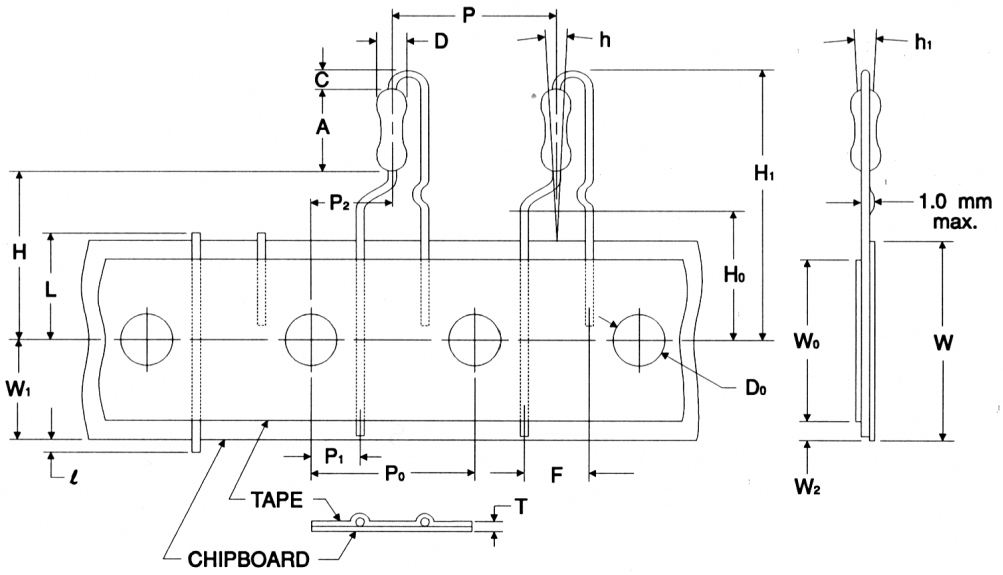
90° bends with Standoff

Panasert

Custom Lead Forming

Panasert Capabilities			
Product	**Tape and Reel**	**Tape and Ammo**	**Bulk**
CF 1/4, CFM 1/2	Yes	Yes	Yes
CF 1	No	Yes	Yes
RN 1/4, RMN 1/2	Yes	Yes	Yes
RSM 1/2	Yes	Yes	Yes
RSM 1	No	Yes	Yes
RS 1, RSM 2	No	Yes	Yes
RS 2	No	Yes	Yes

Radial Lead Taping Specification — Pana-Sert
Carbon Film & Metal Film Resistors (1/4W Body Size)



Description	Symbol	PANA-SERT Inches mm
Resistor body diameter	D	0.090 ± 0.008 2.3 ± 0.2
Resistor body length	A	0.256 ± 0.020 6.5 ± 0.5
Resistor pitch[1]	P	0.500 ± 0.039 12.7 ± 1.0
Sprocket-hole pitch[1]	P_0	0.500 ± 0.012 12.7 ± 0.3
Sprocket-hole center to lead center	P_1	0.152 ± 0.028 3.85 ± 0.7
Sprocket-hole center to resistor center[1]	P_2	0.250 ± 0.051 6.35 ± 1.3
Resistor lead spacing	F	0.197 ± 0.039 5.0 ± 1.0
Resistor alignment	h	0.0 ± 0.079 [0 ± 5°] 0 ± 2.0 [0 ± 5°]
Chipboard width[1]	W	0.709 ± 0.039/-0.020 18.0 ± 1.0/-0.5
Hold-down tape width	W_0	0.492 12.5 min.
Sprocket-hole position	W_1	0.354 ± 0.030/-0.020 0.9 ± 0.75/-0.5

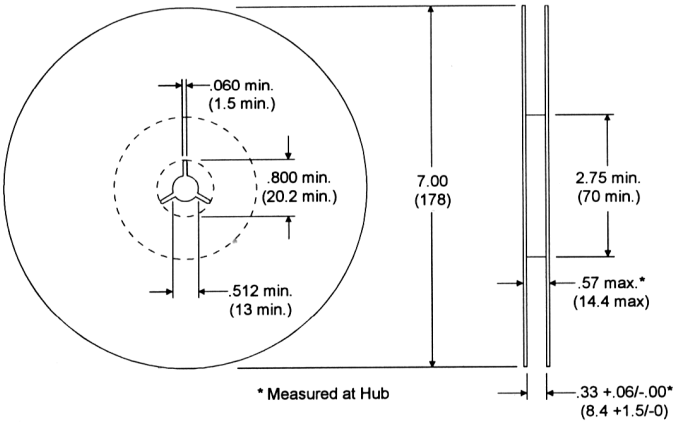
Description	Symbol	PANA-SERT Inches mm
Hold-down tape position	W_2	0.118 3.0 max.
Height to bottom of resistor	H	0.748 ± 0.039 19.0 ± 0.21.0
Height to lead clinch	H_0	0.630 ± 0.020 16.0 ± 0.5
Lead protrusion	I	0.079 2.0 max.
Sprocket-hole diameter	D_0	0.157 ± 0.012 4.0 ± 0.3
Thickness (chipboard and tape)	T	0.028 ± 0.008 0.7 ± 0.2
Cutout length[1]	L	0.433 11.0 max.
Height of resistor	H_1	1.122 28.5 max.
Height of bending	C	0.098 ± 0.020 2.5 ± 0.5
Resistor alignment	h_1	0.0 ± 0.079 [0 ± 5°] 0 ± 2.0 [0 ± 5°]

Note 1. Cumulative pitch tolerances not to exceed ±0.039 (±1.0) over 20 consecutive pitches. 2,500 pieces per reel.

Note 2. Product only available from 10Ω to 1 Mg in 5% or 1% tolerances.

Chip Resistor Reel

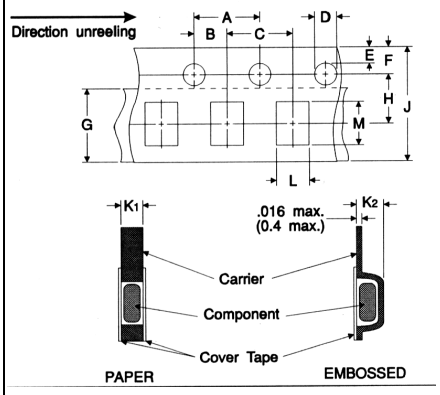
Nominal Dimensions
Inches (mm)



Packaging: Chips Per EIA Standard RS-481

inches
mm

A	B	C	D	E	F	G	H	J[1]
0.16 ± 0.01 4.0 ± 0.1	0.08 ± 0.01 2.0 ± 0.1	0.16 ± 0.01 4.0 ± 0.1	0.06 + 0.01/-0 1.5 + 0.1/-0	0.04 1.0	0.069 1.75	0.20 5.0	0.138 ± 0.002 3.50 ± 0.05	0.32 ± 0.01 8.0 ± 0.1



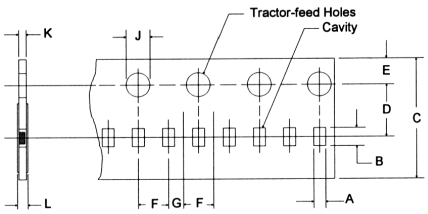
	K1	K2	L	M
RGC 1/16, RMC 1/16, RNC 16, TTF 16, CSR 1/8	0.04 max 1.1 max	-	0.04 ± 0.01 1.1 ± 0.2	0.08 ± 0.01 1.9 ± 0.2
RGC 1/10, RMC 1/10, HMC 1/10, FCR 1/10, TTF 20, RNC 20, CSR 1/4	0.04 max 1.1 max	-	0.65 ± 0.008 1.65 ± 0.20	0.09 ± 0.01 2.4 ± 0.2
RGC 1/8, RMC 1/8, HMC 1/8, FCR 1/8, TTF 32, RNC 32, CSR 1/2	0.04 max 1.1 max	0.09 max 2.4 max	0.08 ± 0.01 2.0 ± 0.1	0.138 ± 0.002 3.50 ± 0.05
RMC 1/4, FCR 1/4	-	0.09 max 2.4 max	0.11 ± 0.01 2.8 ± 0.2	0.14 ± 0.01 3.6 ± 0.2
RMC 1/2, CSR 1	-	0.09 max 2.4 max	0.11 ± 0.01 2.8 ± 0.2	0.21 ± 0.01 5.3 ± 0.2
RMC 1, CSR 2	-	0.09 max 2.4 max	0.15 ± 0.01 3.8 ± 0.2	0.26 ± 0.01 6.6 ± 0.2

Notes:

1. Dimensions are 0.47 ± 0.01 (12.0 ± 0.1) for 1/2 and 1 Watt.
2. 5,000 per (7") reel — 1/16, 1/10, & 1/8 Watt. 4,000 per (7") reel — 1/4, 1/2 & 1 Watt. Available Options — 10,000 piece (13") reels.
3. Embossed taping standard 4,000 per (7") reel on 1/4, 1/2 & 1 Watt.
4. Paper taping available 4,000 per (7") reel on RMC 1/4 Watt.

Packaging: RMC 1/16S, RGC 1/16S, RNC 10, and RMC 1/20 Chips (2mm Pitch)

inches
mm



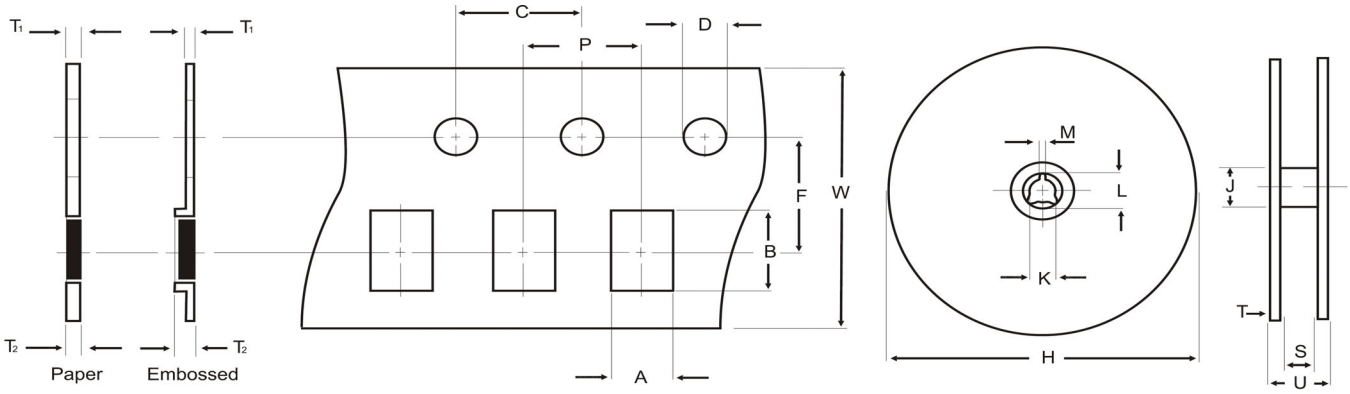
A	B	C	D	E
0.026 + 0.004/-.002 0.65+0.10/-0.05	0.045 + 0.004/-002 1.15+0.10/-0.05	0.315 ± 0.008 8.00 ± 0.20	0.138 ± 0.002 3.50 ± 0.05	0.69 ± 0.004 1.75 ± 0.10
F	**G**	**J**	**K**	**L**
0.079 ± 0.002 2.00 ± 0.05	0.039 ± 0.002 1.00 ± 0.05	0.059 + 0.004/-.000 1.50 + 0.10/-0.00	0.016 + 0.002/-.000 0.40 + 0.05/0.00	0.020 max 0.50 max

Standard Tape Packaging
2 mm Pitch – 10,000 per reel Reel diameter – 7.0 (178) Reel width – 0.315 (8.0)

Packaging — Chip Resistors

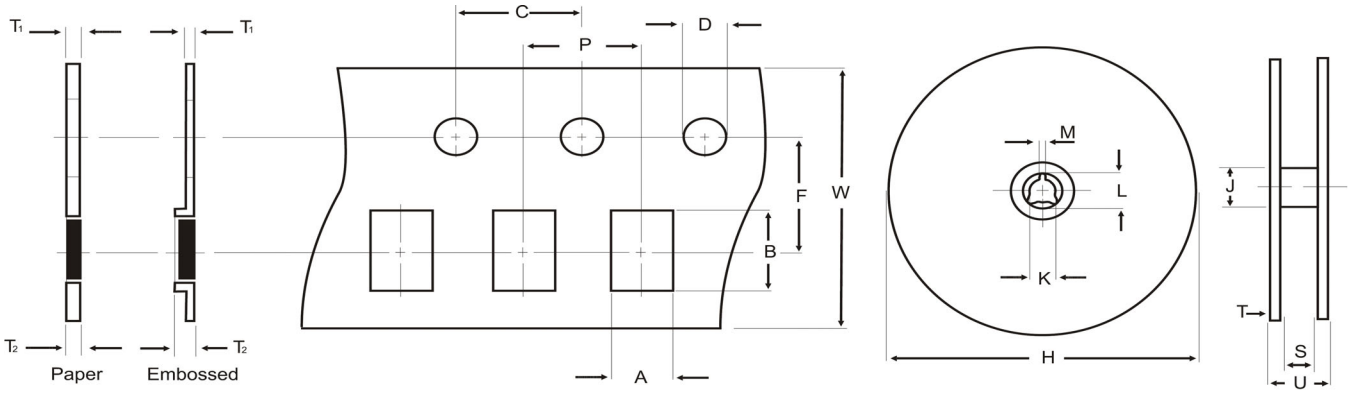
Packaging for Chip Resistors			
Chip Resistors	**Options**	**Description**	**Package Quantity**
RMC 1/20, RMCF 1/20, RMC 1/16S, RMCF 1/16S, RGC 1/16S, RNC 10, RNCF 10, CSR 1/8S, CSF 1/8S, HVC 0402	R	7" reel - paper taping	10,000
RMC 1/16, RMCF 1/16, RMC 1/10, RMCF 1/10, RMC 1/8, RMCF 1/8 RPC 0805, RPC 1206, HVC 0603,HVC 0805, HVC 1206	R G A	7" reel - paper taping 10" reel - paper taping Bulk	5,000 10,000 1,000
HMC 1/16, HMC 1/10, HMC 1/8, RGC 1/16, RGC 1/10, RGC 1/8, CSR 1/4	R	7" reel - paper taping	5,000
RNC 16, RNCF 16, RNC 20, RNCF 20, RNC 32 RNCF 32, TTF 16, TTF 20, TTF 32, FCR 1/16, FCR 1/10, FCR 1/8, CSR 1/2, CSF 1/2	R I	7" reel - paper taping 7" reel - paper taping	5,000 1,000
RMC 1/4, RMC 1/2, RMC 1, RMCF 1, FCR 1/4, RPC 1210, RPC 2010, RPC 2512, HVC 1210, HVC 2010, HVC 2512	R	7" reel - emboss taping	4,000
CSR 1, CSRF 1, CSRN 1, CSFN 1, CSR 2, CSRF 2, CSRL 2, CSFL 2, CSRN 2, CSFN 2	R I	7" reel - emboss taping 7" reel - emboss taping	4,000 1,000
CSRF 2, CSFF 2	R	7" reel - emboss taping	2,000
Chip Arrays	**Options**	**Description**	**Package Quantity**
RAV 10-2D, RAVF 10-2D, RAF 10-2D, RAV 10-4D, RAVF 10-4D, RAF 10-4D	R	7" reel - paper taping	10,000
RAV 16-2D, RAVF 16-2D, RAV 16-4D, RAVF 16-4D, RAC 16-4D, RACF 16-4D, RAV 32-8R, RAVF 32-8R, RAV 32-8N, RAVF 32-8N	R	7" reel - paper taping	5,000
RAV 32-4D, RAVF 32-4D, RAV 64-8N, RAVF 64-8N, RAV 64-8R, RAVF 64-8R, RAC 32-4D, RACF 32-4D, RAC 40-8M, RACF 40-8M, RAC 64-8N, RACF 64-8N, RAC 64-8R, RACF 64-8R, RAV 16-8D, RAVF 16-8D	R	7" reel - emboss taping	4,000
Surface Mount Wirewounds	**Options**	**Description**	**Package Quantity**
SM 1	R B	13" reel - paper taping Bulk	1,500 500
SM 2, SMX 2	R B	13" reel - paper taping Bulk	800 250
SM 2A	R B	13" reel - paper taping Bulk	1,200 250
SM 3 SMX 3	R B	13" reel - paper taping Bulk	750 100

PACKING SPECIFICATIONS: Inch (mm)



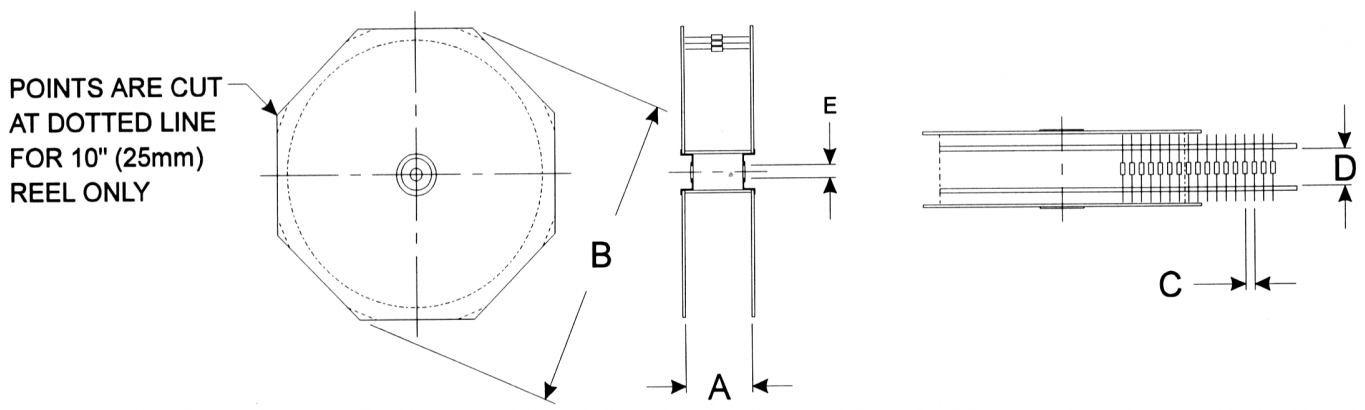
FEATURES	RAV/ RAF 10-2D	RAV/ RAF 10-4D	RAV 16-2D	RAV 16-4D & 32-8	RAV 32-4D
A - Pocket Width	.046±.004 (1.17±0.10)	.051±.008 (1.30±0.20)	.071±.004 (1.80±0.10)	.079±.008 (2.00±0.20)	.134±.004 (3.40±0.10)
B - Pocket Length	.046±.004 (1.17±0.10)	.091 ±.008 (2.30±0.20)	.071±.004 (1.80±0.10)	.142±.008 (3.60±0.20)	.220±.004 (5.60±0.10)
P - Pocket Spacing	.079±.002 (2.00±0.05)	.079±.002 (2.00±0.05)	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)
C - Pin Spacing	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)	.157±.004 (4.00±0.10)
D - Pin Diameter	.06+.004/-0 (1.5+0.1/-0)	.06+.004/-0 (1.5+0.1/-0)	.06+.004/-0 (1.5+0.1/-0)	.06+.004/-0 (1.5+0.1/-0)	.06+.004/-0 (1.+±0.1/-0)
F - Pin-Pocket C/L	.138±.002 (3.50±0.05)	.138±.002 (3.50±0.05)	.138±.002 (3.50±0.05)	.138±.002 (3.50±0.05)	.217±.002 (5.50±0.05)
W - Strip Width	.315±.008 (8.00±0.20)	.315±.008 (8.00±0.20)	.315±.008 (8.00±0.20)	.315±.008 (8.00±0.20)	.472±.008 (12.00±0.20)
T1 - Strip Thickness	.04 max. (1.0 max.)	.04 max. (1.0 max.)	.02 max. (0.5 max.)	.04 max. (1.0 max.)	.010±.002 (0.25±0.05)
T2 - Total Thickness	.06 max. (1.4 max.)	.06 max. (1.4 max.)	.04 max. (1.0 max.)	.06 max. (1.4 max.)	.043 max. (1.10 max.)
Material Pieces/Reel	Paper 10,000	Paper 10,000	Paper 5,000	Paper 5,000	Embossed 4,000
H - Reel Diameter	7.00±.08 (178.0±2.0)	7.00±.08 (178.0±2.0)	7.00±.08 (178.0±2.0)	7.00+.08 (178.0+2.0)	7.1+0/-.12 (180+0/-3.0)
J - Hub Diameter	2.0 (50) approx.	2.0 (50) approx.	2.0 (50) approx.	2.0 (50) approx.	2.4±.04/-0 (60±1.0/-0)
K - Hole Diameter	.51±.04 (13.0±1.0)	.51±.04 (13.0±1.0)	.51±.04 (13.0±1.0)	.51±.04 (13.0±1.0)	.51±.01 (13.0±0.2)
L - Key Diameter	.83±.04 (21.0±1.0)	.83±.04 (21.0±1.0)	.83±.04 (21.0±1.0)	.83±.04 (21.0±1.0)	.83±.03 (21.0±0.8)
M - Key Width	.08±.04 (2.0±1.0)	.08±.04 (2.0±1.0)	.08±.04 (2.0±1.0)	.08±.04 (2.0±1.0)	.08±.02 (2.0±0.5)
S - Reel Inside Width	.53±.08 (13.5±2.0)	.53±.08 (13.5±2.0)	.53±.08 (13.5±2.0)	.53±.08 (13.5±2.0)	.35±.01 (9.0±0.3)
T - Side Thickness	.03±.01 (0.8±0.2)	.03±.01 (0.8±0.2)	.03±.01 (0.8±0.2)	.03±.01 (0.8±0.2)	-
U - Reel Outside Width	-	-	-	-	.45±.04 (11.4±1.0)

PACKING SPECIFICATIONS: Inch (mm)



FEATURES	RAC 16-4D	RAC 32-4D	RAC 40-8M	RAC 64-8N/R
A - Pocket Width	0.079±0.008 (2.00±0.20)	0.138±0.004 (3.50±0.10)	0.098±0.004 (2.50±0.10)	0.138±0.004 (3.50±0.10)
B - Pocket Length	0.142±0.008 (3.60±0.20)	0.224±0.004 (5.70±0.10)	0.173±0.004 (4.40±0.10)	0.266±0.004 (6.75±0.10)
P - Pocket Spacing	0.157±0.004 (4.00±0.010)	0.157±0.004 (4.00±0.10)	0.157±0.004 (4.00±0.10)	0.157±0.004 (4.00±0.10)
C - Pin Spacing	0.157±0.004 (4.00±0.10)	0.157±0.004 (4.00±0.10)	0.157±0.004 (4.00±0.10)	0.157±0.004 (4.00±0.10)
D - Pin Diameter	0.06+0.004/-0 (1.5+0.1/-0)	0.06+0.004/-0 (1.+0.1/-0)	0.06+0.004/-0 (1.5+0.1/-0)	0.06+0.004/-0 (1.5+0.1/-0)
F - Pin-to-Pocket Center	0.138±0.002 (3.50±0.05)	0.217±0.002 (5.50±0.05)	0.217±0.002 (5.50±0.05)	0.217±0.002 (5.50±0.05)
W - Strip Width	0.315±0.008 (8.00±0.20)	0.472±0.008 (12.00±0.20)	0.472±0.008 (12.00±0.20)	0.472±0.008 (12.00±0.20)
T1 - Strip Thickness	0.02 max. (0.5 max.)	0.010±0.002 (0.25±0.05)	0.010±0.002 (0.25±0.05)	0.010±0.002 (0.25±0.05)
T2 - Total Thickness	0.04 max. (1.0 max.)	0.043 max. (1.10 max.)	0.043 max. (1.10 max.)	0.043 max. (1.10 max.)
Material Pieces/Reel	Paper 5,000	Embossed 4,000	Embossed 4,000	Embossed 4,000
H - Reel Diameter	7.00±0.08 (178.0±2.0)	7.09+0/-0.12 (180.0+0/-3.0)	7.09+0/-0.12 (180.0+0/-3.0)	7.09+0/-0.12 (180.0+0/-3.0)
J - Hub Diameter	2.0 (50) approx.	2.4+0.04/-0 (60+1.0/-0)	2.4+0.04/-0 (60+1.0/-0)	2.4+0.04/-0 (60+1.0/-0)
K - Hole Diameter	0.51±0.04 (13.0±1.0)	0.51±0.01 (13.0±0.2)	0.51±0.01 (13.0±0.2)	0.51±0.01 (13.0±0.2)
L - Key Diameter	0.83±0.04 (21.0±1.0)	0.83±0.03 (21.0±0.8)	0.83±0.03 (21.0±0.8)	0.83±0.03 (21.0±0.8)
M - Key Width	0.08±0.04 (2.0±1.0)	0.08±0.02 (2.0±0.5)	0.08±0.02 (2.0±0.5)	0.08±0.02 (2.0±0.5)
S - Reel Inside Width	0.53±0.08 (13.5±2.0)	0.35±0.01 (9.0±0.3)	0.35±0.01 (9.0±0.3)	0.35±0.01 (9.0±0.3)
T - Reel Side Thickness	0.03±0.01 (0.8±0.2)	-	-	-
U - Reel Outside Width	-	0.45±0.04 (11.4±1.0)	0.45±0.04 (11.4±1.0)	0.45±0.04 (11.4±1.0)

Packaging & Identification Variations



Lead Tape Specifications: Reeled in accordance with RS-296-E							inches mm
Dimensions	**A max.**	**B max.**	**C**	**D**	**E**	**Tape**	**Products**
Class I	See Note 1	13 1/2 343	See Note 2	2 1/16 52.4	9/16 14.3	1/4 6.35	All except below
Class II	See Note1	13 1/2 343	See Note 2	2 1/2 63.5	9/16 14.3	1/4 6.35	RS 2, RS 3, RSM 3, RSM 5, FRN 2, WRF 2, WRF 3
Class III	See Note 1	13 1/2 343	See Note 2	2 7/8 73	9/16 14.3	1/4 6.35	RS 2 and RSM 5 capable

Note 1. The A dimension shall be governed by the overall length of the taped component. The distance between flanges shall be 0.059 inches (1.50 mm) to 0.315inches (8.00 mm) greater than the overall component.

Note 2.

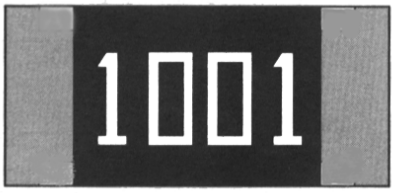
Component Diameter	Component Pitch
0.0 to 0.197 0 to 5.0	0.200 ± 0.020 5.0 ± 0.5
0.197 to 0.394 5.0 to 10.0	0.400 ± 0.020 10.0 ± 0.5

Note 3. RS 5, TMR, KAL, CB, VM, VER, NSP, available bulk only

Packaging — Axial Leaded Resistors

Packaging for Axial Leaded Resistors			
Leaded Resistors	**Code**	**Description**	**Package Quantity**
RN 1/8, RNM 1/4, RN 1/4, RN 1/2, RNM 1/2, CF 1/8, CFM 1/4, CF 1/4, CFM 1/2, CF 1/2	R T A	Reel Ammo Bulk	5,000 5,000 1,000
UP 1/4, UP 1/2, RC 1/4, RC 1/2, CD 1/8, CD 1/4, CD 1/2	R A	Reel Bulk	5,000 1,000
RSM 1/2	R T A	Reel Ammo Bulk	5,000 2,000 1,000
RS 1/2, RSM 1, RSPF 1/2, RSPL 1/2, RSPF 1, RSPL 1	R T A	Reel Ammo Bulk	2,500 2,000 1,000
RS 1, RSM 2, CF 1	R T A	Reel Ammo Bulk	2,000 1,000 1,000
RS 2, RSM 3, RSPF 2, RSPL 2, CF 2	R T A	Reel Ammo Bulk	1,000 1,000 1,000
RS 3, RSM 5, RSPF 3, RSPL 3	R T A	Reel Ammo Bulk	500 500 1,000
RS 5	A	Bulk	1,000
NSP (all), NSZ (all), LC (all), BR (all), HVD (all)	A	Bulk	1,000
WRF (all)	R A	Reel Bulk	2,000 1,000
JW 50, JW 55, JW 60	R T	Reel Ammo	10,000 10,000
JW 80	R T	Reel Ammo	10,000 10,000
FRN 1/4, ASR 1/4, ASRM 1/2, SPRM 1/2	R T A	Reel Ammo Bulk	5,000 2,000 1,000
FRN 1/2, FRN 1	R T A	Reel Ammo Bulk	2,500 1,000 1,000
ASR 1, SPR 1	R T A	Reel Ammo Bulk	1,000 500 1,000
FRN 2	R T A	Reel Ammo Bulk	1,000 2,500 1,000

Part Marking Instructions — Chip Resistors



1% Marking

The nominal resistance is marked on the surface of the overcoating with the use of 4 digit markings. 0201 and 0402 are not marked

5% Marking

The nominal resistance is marked on the surface of the overcoating with the use of 3 digit markings. 0201 and 0402 are not marked

For shared E24/ E96 values, 1% tolerance product may be marked with three digit marking instead of the standard four digit marking for all other E96 values. All E24 values available in 1% tolerance are also marked with three digit marking.

Marking Instructions for 0603 1% Chip Resistors (Per EIA-J)

A two-digit number is assigned to each standard R-Value (E96) as shown in the chart below

This is followed by one alpha character which is used as a multiplier. Each letter from "Y" – "F" represents a specific multiplier as follows:

Y = 0.1	**B = 100**	**E = 100,000**
X = 1	**C = 1,000**	**F = 1,000,000**
A = 10	**D = 10,000**	

EXAMPLE:

Chip Marking	Explanation	Value
01B	**01 means 10.0 and B = 100**	**10.0 x 100 = 1 K ohm**
25C	**25 means 17.8 and C = 1,000**	**17.8 x 1,000 = 17.8 K ohm**
93D	**93 means 90.9 and D = 10,000**	**90.9 x 10,000 = 909 K ohm**

E96											
1%	#	1%	#	1%	#	1%	#	1%	#	1%	#
10.0	01	14.7	17	21.5	33	31.6	49	46.4	65	68.1	81
10.2	02	15.0	18	22.1	34	32.4	50	47.5	66	69.8	82
10.5	03	15.4	19	22.6	35	33.2	51	48.7	67	71.5	83
10.7	04	15.8	20	23.2	36	34.0	52	49.9	68	73.2	84
11.0	05	16.2	21	23.7	37	34.8	53	51.1	69	75.0	85
11.3	06	16.5	22	24.3	38	35.7	54	52.3	70	76.8	86
11.5	07	16.9	23	24.9	39	36.5	55	53.6	71	78.7	87
11.8	08	17.4	24	25.5	40	37.4	56	54.9	72	80.6	88
12.1	09	17.8	25	26.1	41	38.3	57	56.2	73	82.5	89
12.4	10	18.2	26	26.7	42	39.2	58	57.6	74	84.5	90
12.7	11	18.7	27	27.4	43	40.2	59	59.0	75	86.6	91
13.0	12	19.1	28	28.0	44	41.2	60	60.4	76	88.7	92
13.3	13	19.6	29	28.7	45	42.2	61	61.9	77	90.9	93
13.7	14	20.0	30	29.4	46	43.2	62	63.4	78	93.1	94
14.0	15	20.5	31	30.1	47	44.2	63	64.9	79	95.3	95
14.3	16	21.0	32	30.9	48	45.3	64	66.5	80	97.6	96

Temperature Coefficient Codes

SEI TC Code	MIL TC Code	Industry Std TC Code	Temperature Coefficient	Temperature Span
T0	N/A	T0	±200ppm/°C	-55°C to + 150°C
T1	D	T1	±100ppm/°C	-55°C to + 165°C
T2	C	T2	±50ppm/°C	-55°C to + 175°C
T9	E	T9	±25ppm/°C	-55°C to + 175°C
TD	N/A	T10	±15ppm/°C	-55°C to + 150°C
TB	N/A	T13	±10ppm/°C	-55°C to + 150°C
TA	N/A	T16	±5ppm/°C	-55°C to + 150°C

Tolerance Codes

SEI/MIL Reference	Tolerance
K	±10%
J	±5%
G	±2%
F	±1%
D	±0.5%
C	±0.25%
B	±0.1%

Resistance Values

SEI Standard for Nominal Values & Tolerances	
Series	Tolerance
E12	±10%
E24	±5%, ±2%
E96	±1%
E192	±0.5%, ±0.25%, ±0.1%

Note: Non-standard R values are available. Consult factory for minimum order quantities.

Component Flammability

SEI Electronics Product Type	Polymer Type	IEC 695-2-2	UL94V Rating	Total Polymer Mass	Oxygen Index
Carbon Films					
CF 1/8 (CFM 1/4)	Epoxy	*	N/A	3 mg	N/A
CF 1/4 (CFM 1/2)	Epoxy	*	N/A	15 mg	N/A
CF 1/2	Epoxy	*	N/A	30 mg	N/A
Metal Films					
RN 1/8 (RNM 1/4)	Epoxy	*	N/A	3 mg	N/A
RN 1/4 (RNM 1/2)	Epoxy	*	N/A	15 mg	N/A
RN 1/2	Epoxy	*	N/A	30 mg	N/A
Metal Oxides					
RSM 1/2	Silicone	*	94V-0	20 mg	46 – 48%
RSM 1 (RS 1/2)	Silicone	*	94V-0	30 mg	46 – 48%
RSM 2 (RS 1)	Silicone	*	94V-0	50 mg	46 – 48%
RSM 3 (RS 2)	Silicone	*	94V-0	130 mg	46 – 48%
RSM 5 (RS 3)	Silicone	*	94V-0	500 mg	46 – 48%
RS 5	Silicone		94V-0	400 mg	46 – 48%
Chip Resistors					
RMC Series	Boro-Silicated Acid Lead Glass	*	94V-0	N/A	N/A
Resistor Networks					
LC5X	Epoxy	*	94V-0	70 mg	N/A
LC6X	Epoxy	*	94V-0	80 mg	N/A
LC7X	Epoxy	*	94V-0	90 mg	N/A
LC8X	Epoxy	*	94V-0	110 mg	N/A
LC9X	Epoxy	*	94V-0	120 mg	N/A
LC0X	Epoxy	*	94V-0	140 mg	N/A
Chip Networks					
RAC Series	Boro-Silicated Acid Lead Glass	*	94V-0	N/A	N/A
RAV Series	Boro-Silicated Acid Lead Glass	*	94V-0	N/A	N/A

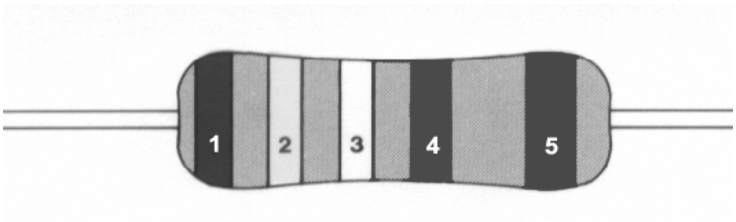
* Meets specification

Resistor Glossary	
Term	**Definition**
Ambient temperature	The ambient temperature is the temperature in the immediate environment of the resistor.
Carbon-composition	Resistor with the resistance element formed by molding a body of carbon powder mixed with a phenolic binder.
Carbon-film	Resistor whose resistance element is carbon film deposited on a ceramic core.
Climate category	Indicates the lowest and the highest ambient temperature at which the resistors may be operated continuously.
Color-band or color code	Method of indicating value and tolerance on axial leaded resistors whose body is too small for legible alphanumerical marking.
Critical resistance	The critical resistance (Rcrit) is the resistance that can be calculated from the rated dissipation Pv occurring under operating voltage Vmax. A resistor of critical resistance will exhibit the largest drift in a style, because it is the highest value that may carry the full rated power load.
Current noise	Random low frequency electrostatic noise arising from current fluctuations in parallel with the resistor.
Current sensor	A resistive device employed to sense levels of changes in current.
Derating	The power load capability of a resistor is limited by its permissible element temperature. Since the rated power dissipation is referenced to a specific ambient temperature, higher ambient temperatures require a reduced permissible load, i.e., a derating. The derating curve indicates the permissible power load as a function of the ambient temperature.
Dielectric strength (dielectric withstanding voltage)	The ultimate breakdown voltage of the dielectric or insulation of the resistor when the voltage is applied between the case and all terminals tied together. Dielectric strength is usually specified at sea level and simulated at high altitude air pressures.
DIP	Dual-in-line package resistor network.
Drift	The change of a resistance value from its initial value during a specified period of time under specified operating conditions.
E-series	Method of deriving nominal resistance values required for each tolerance level. The series E24 is comprised of 24 values per decade and applies to 2% and 5% tolerances. The series E96 applies to 1% tolerance and E192 applies to .1%, .25%, and .5%.
Failure rate	The failure rate indicates the statistically established maximum rate of failures at a level of confidence of 60%. The figures are derived from certified results of standard endurance tests after 1000 hours duration at the rated dissipation.
Film temperature	The temperature of the resistive film is considered in discussions about power rating and pulse load capability. The film temperature determines the drift and stability of the resistor. For resistors that feature hot spots in the resistive film, the higher temperature of the hot spot is to be considered. Since most resistors are covered with lacquer or protective coating, only the surface temperature can be measured on the outside. However, the surface temperature is almost as high as the film temperature.
Fixed resistors	Resistors whose value is set in the manufacturing process.
Insulation resistance	The DC resistance measured between all terminals connected together and the case, exterior insulation, or external hardware.
Kelvin connection	Four-terminal connection required in low-resistance measurements to eliminate the effects of contact resistance and lead resistance, as well as the effects of lead temperature, providing accurate measurements. Invented by Lord Kelvin in the 19th Century.

Resistor Glossary

Resistor Glossary	
Term	**Definition**
Maximum working voltage	The maximum voltage stress (DC or rms) that may be applied to the resistor (resistance element). A function of the materials used, the required performance, and the physical dimensions.
Metal oxide	Resistor whose resistance element is a thick film ruthenium oxide paste deposited on a cylindrical ceramic core by means of dipping or spiral-coating.
Operating voltage	The limiting element voltage Vmax is the maximum voltage that may be applied continuously to the resistor, provided its resistance value is equal to or higher than the critical resistance. The limit applies to DC voltages and to AC rms voltage of undistorted sinusoidal shape.
Power rating	Maximum power in still air that will limit the resistor internal hot-spot temperature to a satisfactory level. Power ratings must be reduced as the temperature rises, so derating curves or charts are published. These parameters are application-dependent.
Pulse load capability	The pulse load capability of a resistor is its ability to withstand transient loads that considerably exceed the rated dissipation with its peak value.
Resistance temperature characteristic (coefficient)	The magnitude of change in resistance due to temperature, expressed in percent or degree centigrade or parts-per-million per degree centigrade (PPM/C). If the resistance changes are linear over the specified temperature range, the parameter is known as the temperature "coefficient." This assumption of linearity is usually made in order to ease calculations.
Resistance tolerance	The permissible deviation of the manufactured resistance value (express in percent) from the specified nominal resistance value at standard or stated environmental conditions.
Resistor	A device that converts electrical energy to thermal energy according to Ohm's Law.
Shunt	A resistive device employed to divert most of the current in an electric circuit.
SIP	Single-in-line package resistor network.
SMD	Surface mount devices. Chips and chip arrays are examples.
Solderability	Property of the termination to accept new solder in a soldering process.
Stability	Ability of a resistor to maintain its initial resistance value of extended periods of time when subjected to any combination of electrical stresses and environmental conditions.
Temperature rise	Thermal resistance that impedes the dissipation of heat from the resistor.
Thick-film	Resistor whose resistance element consists of a ruthenium oxide (also called cermet) screen printed onto a ceramic substrate and fired at a high temperature.
Thin-film	Resistor whose resistance element (typically nickel-chromium on a ceramic core or substrate) is created typically by vacuum deposition or sputtering.
Variable resistors	Resistors whose value can be adjusted (trimmed) by the user, typically by means of a dial.
Voltage coefficient	A resistor has a voltage coefficient if measurements of resistance with different voltages yield different results. The voltage coefficient is the quotient of the relative difference in resistance and the difference of measuring voltage.
Wirewound	Resistor whose resistance element consists of a wire (nickel-chromium, copper-nickel, or gold-platinum) wound around a bobbin or core.
Zero-ohm resistors	Jumpers that are manufactured into resistor bodies for ease of insertion by the user.

Standard Color Codes



Standard Color Code			
Band Color	**Nominal**	**Multiplier**	**Tolerance (%)**
Black	0	1	—
Brown	1	10	1
Red	2	100	2
Orange	3	1K	—
Yellow	4	10K	—
Green	5	100K	0.5
Blue	6	1,000K	0.25
Violet	7	—	—
Gray	8	—	—
White	9	0.001	—
Silver	—	0.01	10
Gold	—	0.1	5

Color Band Description		
Band	**Precision**	**General Purpose**
	Have three significant-figure bands, a multiplier band and a tolerance band. Tolerances 1% or less	Have two significant-figure bands, a multiplier band and a tolerance band. Tolerances 2% or greater
1st Band	Nominal	Nominal
2nd Band	Nominal	Nominal
3rd Band	Nominal	Multiplier
4th Band	Multiplier	Tolerance
5th Band	Tolerance	

Standard Resistance Values for the 10 to 100 Decade

(also usable in decade multiples or sub-multiples)

Resistance Tolerance (%)																								
E192	E96	E24	E12	E6	E192	E96	E24	E12	E6	E192	E96	E24	E12	E6	E192	E96	E24	E12	E6	E192	E96	E24	E12	E6
0.1%					0.1%					0.1%					0.1%					0.1%				
0.25%	1%	2%	10%	20%	0.25%	1%	2%	10%	20%	0.25%	1%	2%	10%	20%	0.25%	1%	2%	10%	20%	0.25%	1%	2%	10%	20%
0.5%		5%			0.5%		5%			0.5%		5%			0.5%		5%			0.5%		5%		
10.0	10.0	10	10	10	15.8	15.8	—	—	—	24.9	24.9	—	—	—	39.2	39.2	39	39	—	62.6	—	—	—	—
10.1	—	—	—	—	16.0	—	16	—	—	25.2	—	—	—	—	39.7	—	—	—	—	63.4	63.4	—	—	—
10.2	10.2	—	—	—	16.2	16.2	—	—	—	25.5	25.5	—	—	—	40.2	40.2	—	—	—	64.2	—	—	—	—
10.4	—	—	—	—	16.4	—	—	—	—	25.8	—	—	—	—	40.7	—	—	—	—	64.9	64.9	—	—	—
10.5	10.5	—	—	—	16.5	16.5	—	—	—	26.1	26.1	—	—	—	41.2	41.2	—	—	—	65.7	—	—	—	—
10.6	—	—	—	—	16.7	—	—	—	—	26.4	—	—	—	—	41.7	—	—	—	—	66.5	66.5	—	—	—
10.7	10.7	—	—	—	16.9	16.9	—	—	—	26.7	26.7	—	—	—	42.2	42.2	—	—	—	67.3	—	—	—	—
10.9	—	—	—	—	17.2	—	—	—	—	27.1	—	27	27	—	42.7	—	—	—	—	68.1	68.1	68	68	68
11.0	11.0	11	—	—	17.4	17.4	—	—	—	27.4	27.4	—	—	—	43.2	43.2	43	—	—	69.0	—	—	—	—
11.1	—	—	—	—	17.6	—	—	—	—	27.7	—	—	—	—	43.7	—	—	—	—	69.8	69.8	—	—	—
11.3	11.3	—	—	—	17.8	17.8	—	—	—	28.0	28.0	—	—	—	44.2	44.2	—	—	—	70.6	—	—	—	—
11.4	—	—	—	—	18.0	—	18	18	—	28.4	—	—	—	—	44.8	—	—	—	—	71.5	71.5	—	—	—
11.5	11.5	—	—	—	18.2	18.2	—	—	—	28.7	28.7	—	—	—	45.3	45.3	—	—	—	72.3	—	—	—	—
11.7	—	—	—	—	18.4	—	—	—	—	29.1	—	—	—	—	45.9	—	—	—	—	73.2	73.2	—	—	—
11.8	11.8	—	—	—	18.7	18.7	—	—	—	29.4	29.4	—	—	—	46.4	46.4	—	—	—	74.1	—	—	—	—
12.0	—	12	12	—	18.9	—	—	—	—	29.8	—	—	—	—	47.0	—	47	47	47	75.0	75.0	75	—	—
12.1	12.1	—	—	—	19.1	19.1	—	—	—	30.1	30.1	30	—	—	47.5	47.5	—	—	—	75.9	—	—	—	—
12.3	—	—	—	—	19.3	—	—	—	—	30.5	—	—	—	—	48.1	—	—	—	—	76.8	76.8	—	—	—
12.4	12.4	—	—	—	19.6	19.6	—	—	—	30.9	30.9	—	—	—	48.7	48.7	—	—	—	77.7	—	—	—	—
12.6	—	—	—	—	19.8	—	—	—	—	31.2	—	—	—	—	49.3	—	—	—	—	78.7	78.7	—	—	—
12.7	12.7	—	—	—	20.0	20.0	20	—	—	31.6	31.6	—	—	—	49.9	49.9	—	—	—	79.6	—	—	—	—
12.9	—	—	—	—	20.3	—	—	—	—	32.0	—	—	—	—	50.5	—	—	—	—	80.6	80.6	—	—	—
13.0	13.0	13	—	—	20.5	20.5	20	—	—	32.4	32.4	—	—	—	51.1	51.1	51	—	—	81.6	—	—	—	—
13.2	—	—	—	—	20.8	—	—	—	—	32.8	—	—	—	—	51.7	—	—	—	—	82.5	82.5	82	82	—
13.3	13.3	—	—	—	21.0	21.0	—	—	—	33.2	33.2	33	33	33	52.3	52.3	—	—	—	83.5	—	—	—	—
13.5	—	—	—	—	21.3	—	—	—	—	33.6	—	—	—	—	53.0	—	—	—	—	84.5	84.5	—	—	—
13.7	13.7	—	—	—	21.5	21.5	—	—	—	34.0	34.0	—	—	—	53.6	53.6	—	—	—	85.6	—	—	—	—
13.8	—	—	—	—	21.8	—	—	—	—	34.4	—	—	—	—	54.2	—	—	—	—	86.6	86.6	—	—	—
14.0	14.0	—	—	—	22.1	22.1	22	22	22	34.8	34.8	—	—	—	54.9	54.9	—	—	—	87.6	—	—	—	—
14.2	—	—	—	—	22.3	—	—	—	—	35.2	—	—	—	—	55.6	—	—	—	—	88.7	88.7	—	—	—
14.3	14.3	—	—	—	22.6	22.6	—	—	—	35.7	35.7	—	—	—	56.2	56.2	56	56	—	89.8	—	—	—	—
14.5	—	—	—	—	22.9	—	—	—	—	36.1	—	36	—	—	56.9	—	—	—	—	90.9	90.9	91	—	—
14.7	14.7	—	—	—	23.2	23.2	—	—	—	36.5	36.5	—	—	—	57.6	57.6	—	—	—	92.0	—	—	—	—
14.9	—	—	—	—	23.4	—	—	—	—	37.0	—	—	—	—	58.3	—	—	—	—	93.1	93.1	—	—	—
15.0	15.0	15	15	15	23.7	23.7	—	—	—	37.4	37.4	—	—	—	59.0	59.0	—	—	—	94.2	—	—	—	—
15.2	—	—	—	—	24.0	—	24	—	—	37.9	—	—	—	—	59.7	—	—	—	—	95.3	95.3	—	—	—
15.4	15.4	—	—	—	24.3	24.3	—	—	—	38.3	38.3	—	—	—	60.4	60.4	—	—	—	96.5	—	—	—	—
15.6	—	—	—	—	24.6	—	—	—	—	38.8	—	—	—	—	61.2	—	—	—	—	97.6	97.6	—	—	—
															61.9	61.9	62	—	—	98.8	—	—	—	—