BOURNS®

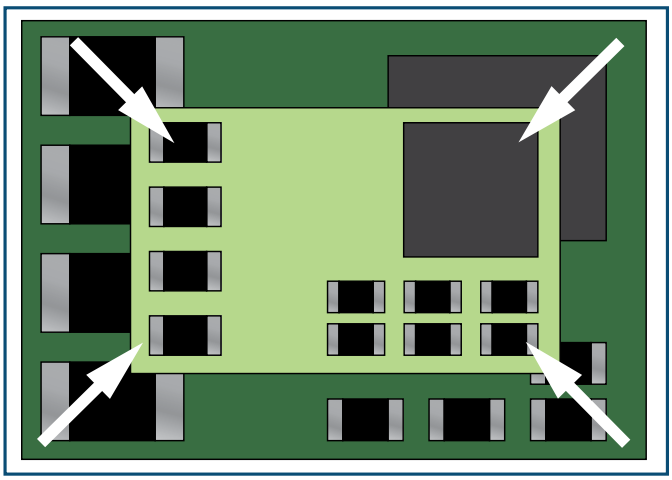
Using High Power Thick Film Resistors to Achieve Higher Component Density on Space-Constrained Printed Circuit Boards

APPLICATION NOTE

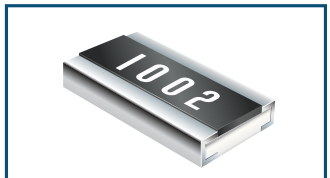
Introduction

The trend of making all types of electronic devices smaller and more integrated continues. Smartphones and other high performance mobile devices, shrinking automotive and telecommunication applications and compact home appliance designs all demand advanced component miniaturization solutions that will help designers meet ongoing space-constrained printed circuit board (PCB) requirements.

One way to support PCB high component density in more compact devices is with a new generation of smaller form factor thick film chip resistors. Working closely with customers to meet their miniaturization needs, Bourns has taken a leading role by introducing a new line of space-saving high power thick film resistor products. Bourns' latest products feature double and triple-rated power, providing an ultra-high power solution to meet next-generation application requirements in dense, complex designs.



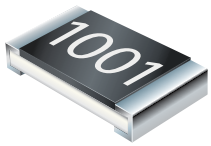
CRM(A) Series High Power Thick Film Resistor



CWM(Q) Series High Power Thick Film Resistor

CMP(A) Series High Pulse Power Resistor

CHP(A) Series Ultra-High Power Chip Resistors



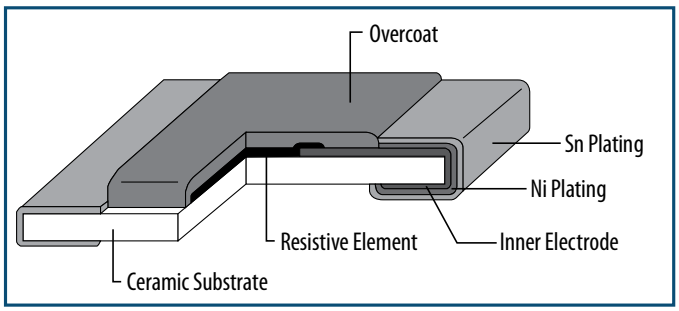
CRS(A) Series High Power Anti-Surge Resistor

High power, pulse-resistant chip resistors provide solutions for designers to follow the trend by replacing axial through-hole and Metal Electrode Leadless Face (MELF) resistors with compact chip resistors which have similar electrical characteristics but can be easily assembled.

Thick Film Chip Resistor Technology Basics

Optimized thick film chip resistors today are manufactured using a thick film element, screen-printed onto a high-grade ceramic substrate. This type of advanced ceramic substrate offers excellent heat dissipation. The resistive element is covered by an epoxy overcoat layer which isolates the resistive element electrically to protect it against mechanical damages and environmental effects such as humidity and gases. Termination of the resistor consists of an electroplated nickel barrier, offering additional protection as it helps prevent diffusion of the inner electrode material through the tin external layer. The termination's pure tin external layer provides the added advantage of supporting excellent solderability.

Furthermore, another advantage of newer thick film chip resistor designs is that many are RoHS compliant, making them suitable for most types of soldering processes used throughout the world, such as automatic, wave and reflow soldering within the shelf life of two years.



Of course, packaging dimensions are important and the ideal chip resistor packaging should conform to the EIA RS-481A standard. For ease and cost-efficient manufacturing, chip resistor packaging should be made available on paper or plastic tape placed on 7-inch plastic reels, which makes the product suitable for automatic SMD pick and place processes.

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High Power Thick Film Chip Resistor Advantages

Offering double and triple power, Bourns® Model CRM and CRS Series high power thick film chip resistors give designers power options to suit their application requirements.

Bourns® CRM and CRS series feature up to 2 watts, CMP up to 1.5 watts rated power at 70 °C. The CHP Series provides rated power up to 3 watts at 70 °C packaged in a small 2512 form factor. Ideal for current sensing in a wide range of consumer, industrial and telecommunication applications, the Bourns® CRM Series has very low resistance values down to 47 milliohms.

Bourns offers AEC-Q200 compliant versions of each of these series. Designed as sulfur resistant products, these series have been tested based on the ASTM B-809 standard at a temperature of +50 °C ±2 °C for 1,000 hours. The result of Bourns' testing showed these devices had significantly greater operating life than standard resistor components. Based on this test result, Bourns® resistors help increase system reliability by reducing field failures related to standard thick film chip resistor failure in sulfur-contaminated environments.

The Bourns® CHP Series provides ultra-high rated power at 0.33 watts packaged in a 0603 size form factor and 3 watts in a 2512 package at 70 °C. This series offers a wide resistance range from 0.1 ohms, high power rating and superior pulse load capabilities for an optimum current sensing solution. They are suitable for use in consumer electronics, industrial automation, power supplies, LED lighting applications and communication base stations.

Resistance values are available for all the high power thick chip resistor series based on the E96 and E24 code tables within the resistance range. Resistance value tolerances are 1 % or 5 %, and 0.5 % tolerance is available for the AEC-Q200 compliant versions, as well.

Table 1

	Standard Power	High Power				Ultra-High Power
Series	CR	CRM	CRS	CMP	CWM	CHP
Features	General Purpose	Current Sense	Surge-Resistant	Pulse-Resistant	Wide Terminal	Current Sense, Pulse-Resistant
Rated Power 70 °C, 2512 Size	1 W	2 W	2 W	1.5 W	1 - 2 W	3 W
AEC-Q200	CR-A, CR-A-AS	CRM-A	CRS-A	CMP-A	CWM-Q	CHP-A
Sulfur-Resistant	CR-A-AS	CRM-A	CRS-A	CMP-A	–	CHP-A
Available Sizes	01005 to 2512	0603 to 2512	0603 to 2512	0603 to 2512	0612, 1225	0603 to 2512
Tolerance	1 %, 5 %	0.5 %, 1 %, 5 %	1 %, 5 %	1 %, 5 %	1 %, 5 %	1 %, 5 %
Temperature Coefficient (PPM/°C)	±100 ±200 ±400 ±500	±100 ±150 ±200	±100 ±200	±100 ±200	±100 ±200	±100 ±150 ±200
Operating Temperature Range	-55 °C to + 155 °C					
RoHS3 Compliant*	Yes	Yes	Yes	Yes	Yes	Yes

*RoHS3 Directive 2011/65/EU, July 22, 2019

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High Power Thick Film Chip Resistors for Space-Savings on the Printed Circuit Board

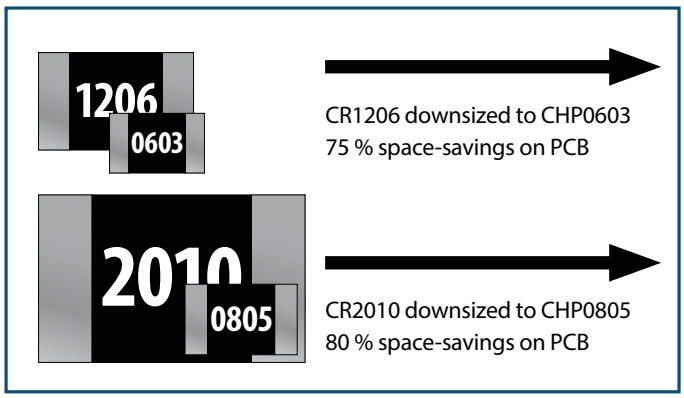
Offering double and triple power, Bourns® Model CRM and CRS Series high power thick film chip resistors give designers power options to suit their application requirements.

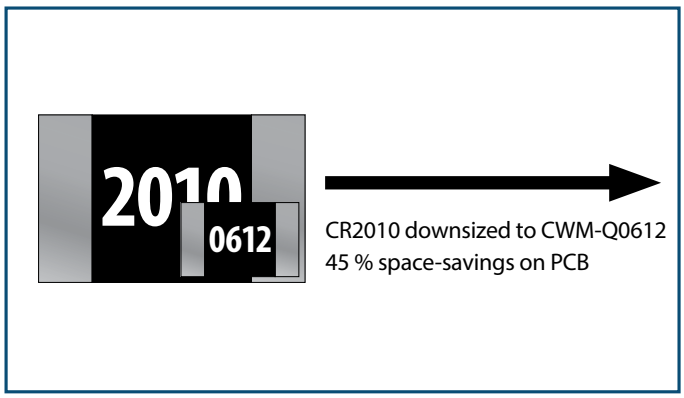
Table 2 below shows the rated power (in watts) for the different types and sizes of standard and high power Bourns® thick film chip resistors at 70 °C ambient temperature. The key feature enabling high component density is the size-to-power ratio, which is demonstrated in the features of Bourns® Model CHP Series. Based on its high-grade ceramic substrate and thick film resistive layer, the CHP Series has a very low size-to-power ratio. This feature lets designers use smaller resistors to achieve the same rated power while also helping OEMs reduce costs by saving space on the PCB.

For example, the Bourns® Model CHP0805 ultra-high power resistor is rated for 0.5 watts which is the same as the rated power of Model CRM/CRS1206 high power and Model CR2010 standard chip resistors.

Placing higher rated power resistors onto smaller component package form factors allows increased mounting density on the PCB. Important to note, however, is that if the electrical device works continuously close to its maximum rated power, designers need to take required heat dissipation into consideration and apply a thermal management solution such as larger solder pads under the termination, a thicker PCB substrate or metal substrate, or solder vias in order to manage the heat of the component.

Table 2	Rated Power (Watts)						
	2512	2010	1225	1206	0805	0612	0603
Standard (CR series)	1	0.5	–	0.25	0.125	–	0.1
High Power (CRM & CRS series)	2	1	–	0.5	0.25	–	0.125
High Pulse Power (CMP series)	1.5	1	–	0.75	0.5	–	0.25
Ultra-High Power (CHP series)	3	–	–	0.75	0.5	–	0.33
Wide Terminal (CWM series)	–	–	2	–	–	1	0.33





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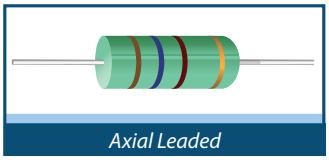
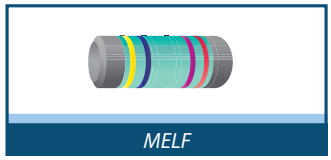
APPLICATION NOTE

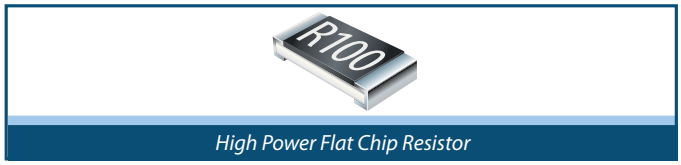
Replacing Cylindrical Axial and Melf Resistors



Axial Leaded



MELF



High Power Flat Chip Resistor

Advances in resistive film technology combined with improved trimming techniques have made it possible to offer chip resistors with continuous power ratings and pulse resistances to match those of cylindrical resistors. Bourns® Model CRM, CRS and CHP Series resistors are designed to withstand high pulses, eliminating the requirement for a taller package or additional board real estate. These components have the same dimensions as standard chip resistors with the additional benefits of pulse capabilities, high power ratings, and optimized surge capabilities.

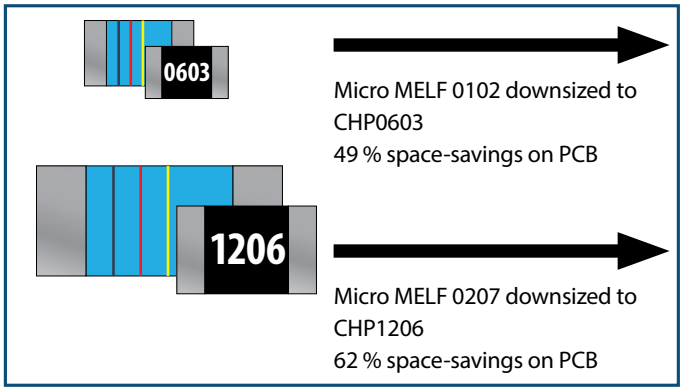
Comparing Bourns® Model CRS-A resistors with existing MELF resistors in Table 3 demonstrates that their sizes are very similar yet there is no difference in rated power. In addition, the pulse capability of the Model CRS-A Series is higher than the MELF type.

Comparing the one size smaller Bourns® Model CHP0603, for example, with the Micro MELF 0102, it's evident that they have different pulse capabilities but share similar electrical characteristics, enabling a significant space-saving achievement of 47 % on the PCB.

Further benefits of specifying a Bourns® high power thick film chip resistor include greater reliability and lower cost in assembly due to their construction. Axial leaded resistors require more space on the PCB which can result in higher assembly costs because of the through-hole technology. MELF resistors can have yield issues in assembly due to rolling during board mount. The advanced design of the Bourns® high power thick film resistor flat chip package eliminates this type of yield issue.

Table 3

Bourns® Replacement Resistors	Peak Pulse for 1 ms (watts)	Power (watts)	Length (mm)	Width (mm)
Micro MELF 0102	20	0.2	2.2	1.1
CRS0805A	**35**	**0.25**	**2**	**1.25**
CHP0603	**15**	**0.33**	**1.6**	**0.8**
Mini MELF 0204	40	0.4	3.5	1.4
CRS1206A	**70**	**0.5**	**3.1**	**1.6**
CHP0805	**30**	**0.5**	**2**	**1.25**
MELF 0207	100	1	5.9	2.2
CRS2010A	**150**	**1**	**5**	**2.5**
CHP1206	**50**	**0.75**	**3.1**	**1.6**



Summary

Bourns® high power thick film chip resistors deliver low size-to-power ratios so that designers can use smaller resistors to achieve the same rated power. This allows space-savings and increased mounting density on the PCB. It also enables designers to engineer increasingly compact electrical devices which is very important for high performance mobile devices and for telecommunication applications and home appliances.

Bourns® Models CRM-A, CRS-A, CMP-A and CHP-A products are high power resistor solutions rated up to 1.5, 2 and 3 watts of continuous power. They offer a wide resistance range for sensing current and limiting inrush current in applications such as stepper motor drives, snubber circuits, power supplies and power measurement electronics where high rated power, superior pulse load capability and reliability are required.

Bourns® high power thick film resistors are also ideal solutions for certain environments. For applications that must operate in more extreme conditions, these resistors are commonly used in parallel with Metal Oxide Varistors (MOVs) to provide high rated power and superior pulse capabilities for improved reliability in handling higher current pulses.