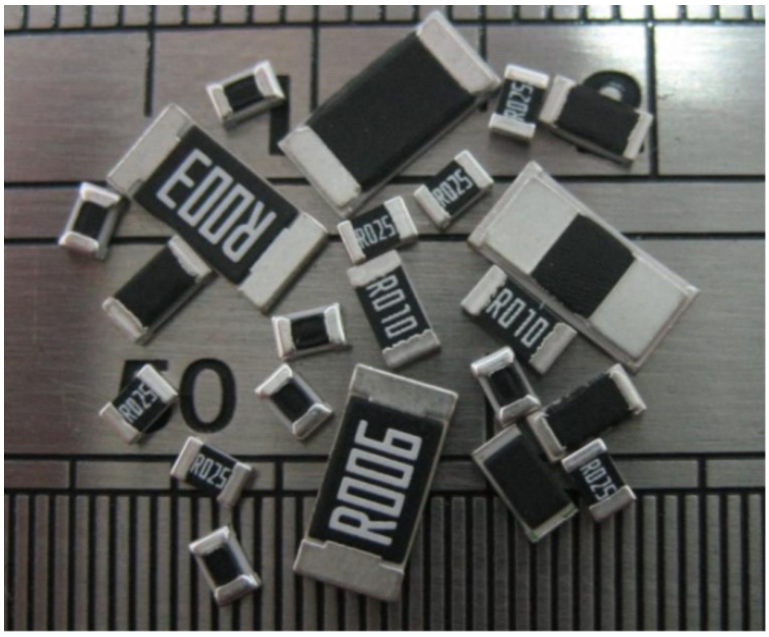
Foil On Ceramic Carrier Current Sense Chip Resistors Reshaping The Consumer Electronics Market

The explosion of consumer electronic devices has created a demand for higher efficiency current sense chip resistors in smaller sizes and lower resistance values. There are many technical challenges for resistor manufacturers to keep pace with these requirements. This article will discuss some of the consumer electronics driving these requirements, and why other sense resistor technologies have been unable to fully satisfy the needs. Additionally, the article will explain foil on ceramic technology and how it has become the technology of choice for these portable consumer electronics that require the efficiency, small footprint and performance from current sensing resistors.

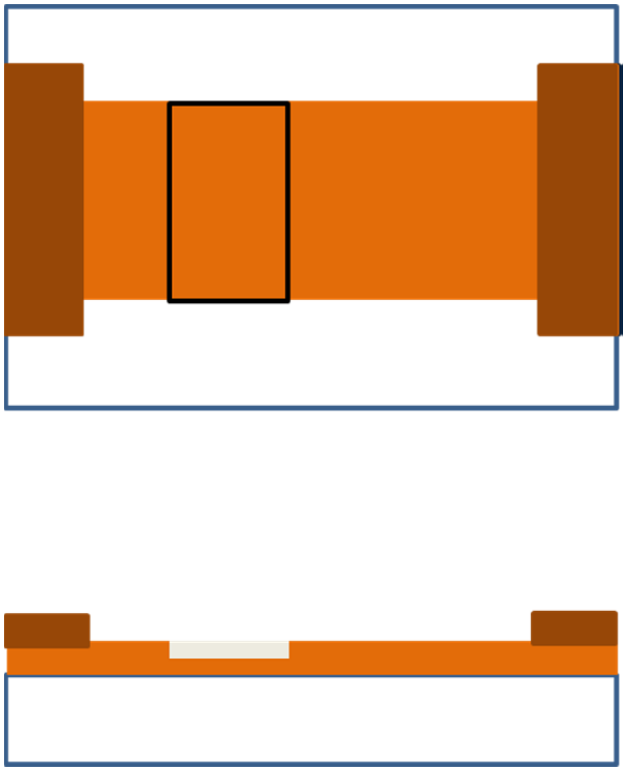
In the past, cell phones were used only for making phone calls. Now smart phones are be used for e-mail, music, navigation, internet browsing, movies, and hundreds of other things we could not have imagined ten years ago. Similarly, video game systems used to be nothing more than a box whose sole function was to accept the video game cartridge in order to play a game. Today, gaming systems have Blue Ray players and full internet browsing capability. They can stream online movies and content as well as providing a portal to allow people to play the same game with other players simultaneously around the world or simply connect with others with similar devices anywhere anytime. A completely new electronic device category, the tablet, has spawned from gradual improvements in cost and performance in touch screens. Tablets provide a huge amount of online content, e-mail, books, games, and other entertainment in a simple and intuitive interface.

Virtually all of these electronic devices have a power management scheme that requires a current sense resistor. There are other power management techniques that can be used such as Hall Effect Sensors, using the DCR or the output inductor, or simply using a power semiconductor that has the current sensing or power management function built in. However, these solutions are often difficult to calibrate, custom designed, expensive, and/or require a great deal of compensation to offset accuracy limitations. Current sense resistors are typically chosen because of their ease of use, wide availability, relative low cost, and accuracy.



Years ago, the current sense resistors available were manufactured using mainly thick film technology. These resistors were low cost and were available in small package sizes. The downside with thick film technology is that low resistance values are very difficult to manufacture, and the TCR for these low values is very high. In smaller case sizes such as 0402, values below 50 milliohm are difficult to find. Where they do exist, the TCR is typically greater than 1000ppm. This greatly affects the overall stability and limits the use of this type of part as a precision current sense resistor.

Metal element current sense resistors have dominated the precision current sensing market for many years because of their relatively low TCR, ability to achieve low resistance values, and overall stability. Because this type of part is typically punched from a larger sheet of resistive alloy, small sizes are very difficult to manufacture. It is extremely difficult to punch out metal element chip resistors in sizes of 0603 and smaller. Metal element current sense resistors in small chip sizes will have limited resistance value ranges and will be expensive to produce.



CSRF top and side view after laser trim calibration

Foil on ceramic carrier is a relatively new technology that makes it possible to provide low resistance values in small chip sizes with relatively low TCR characteristics. In the manufacturing process for a foil on ceramic carrier sense resistor, a metal alloy laminate is first applied to a ceramic substrate using a proprietary bonding process. The resistive element and the copper terminations are then formed using a photo lithography process. To achieve the required resistance value, the resistive element is laser trimmed to value. After that the parts are finished much like other chip resistors with coating, marking, and plating before final test and taping.

These processes are cost effective, scalable, and do not require significant manufacturing time. The foil on ceramic carrier CSRF series from Stackpole is available in case sizes down to 0402. The 0402 is available down to 10 mohm and has a relatively low TCR of 200ppm. The 0603 size is available down to 5 mohm. Case sizes of 0805 and larger case are also available with lower resistance values and lower TCR, though metal strip technology competes very well with foil on ceramic technology at these larger sizes.

It is the unique combination of low resistance values, precision, and small size that separates foil on ceramic technology from other current sensing resistor technologies, and their use will continue to grow in future generations of portable consumer electronic devices.