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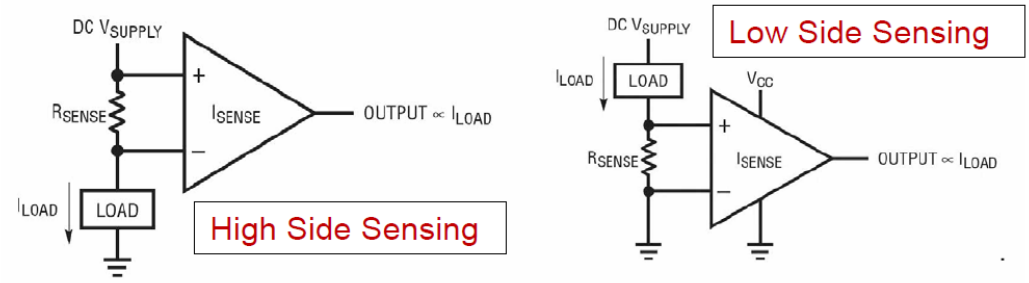
Stackpole Current Sensing Resistive Product Highlights

About Stackpole Electronics

Founded in 1928, Stackpole Electronics is a leading global manufacturer of resistive components including Thick and Thin Film Surface Mount resistors, Axial Leaded and Wirewound resistors, Current Sense resistors, Varistors, Inductors and various Power Resistors. Click the Spec Finder above to see a summary of our products.

SMD Current Sense Resistor Solutions

This product highlight will discuss Stackpole's SMD current sensing resistors and the recent significant additions we have made. Current sensing resistors are used for a wide variety of handheld electronic devices, and while the concept of current sensing itself is relatively simple, it is important to understand some of the details and tradeoffs of the different series that Stackpole offers. This product highlight will discuss each main series and give applications for each.



Current Sensing Using Resistors

Current sense resistors are put in series with a power source and an end device. All of the current delivered from the source must run through the resistor and is done typically using one of two methods. For high side current sensing, the current goes through the sense resistor before load. For low side sensing the resistor is placed after the load. A simple layout of each is shown above. The current through the resistor is monitored via reading the voltage across the resistor. This voltage reading is fed back to the power IC which normally utilizes a differential amplifier. This information is used by the power supply to regulate its output. Since power will be dissipated by this operation proportional to the resistance value, it is desirable that the value be as small as possible. This will reduce the amount of power dissipated by the current sensing function for a given level of current. However, as resistance values get smaller, the voltage changes across the resistor for a given current level also get smaller. If a resistance value is too low, the power source may not be able to distinguish the voltage difference between an acceptable level of current and an unacceptable level. For these reasons, current sense resistors are typically used for applications requiring only 50 amps or less; however, recent improvements have allowed the use of current sense resistors for currents beyond 100 amps. They can be and sometimes are used for higher current applications, but those current sense resistors need to be more precise and are more expensive, as will be the power supply and related circuitry.

CSR / CSRN Series

The CSR and CSRN series utilize a thick film resistive element. Their strengths are that they are relatively low cost and have a wide selection of sizes including 0402 which is among the industry's smallest current sense resistor chip. The largest size 1225 is capable of handling 3 watts of power and resistance values down to 3 milliohms. For the most part, the CSR / CSRN series is the product of choice for somewhat higher resistance values, which tend to have better TCR. The TCR ranges from 100 ppm to 600 ppm and varies with size and resistance value. In addition, the thick film resistive element is not as robust as metal foil current sense resistors so the CSR and CSRN won't handle the high pulse currents that those series will; but they are impervious to moisture. Finally, thick film resistors are typically printed onto a ceramic substrate. The difference in thermal expansion between ceramic and typical PCB materials such as FR4 may cause cracked or broken parts, solder joints, and solder lands; however this is typically only seen in 2010 sizes and larger and only if there is extreme thermal or mechanical stress in the application. In general, the CSR / CSRN series is the first product to consider when discussing new current sense applications where the details of the application are unknown or yet to be determined. Applications include handheld scanners and barcode readers, PDA's, cell phones, MP3 players, DC to DC converters, and voltage regulators.

CSRF Series

The newly expanded CSRF foil on ceramic series bridges the gap between the CSR / CSRN series general purpose thick film current sense resistors and the metal element CSNL, CSS, and CSSH. The CSRF can achieve lower values and better TCR compared to the CSR and CSRN. The CSRF can achieve smaller sizes than the CSNL, CSS, and CSSH and now offers on 0603 size at 5 milliohms and 0402 size at 10 milliohms which are among the lowest values currently available in these sizes. TCR is improved compared to the CSR / CSRN and ranges from 50 ppm to 200 ppm. The CSRF is less expensive than the CSNL, CSS, and CSSH series due to the reduced TCR and resistance tolerance capability. Applications for the CSRF would be the same as the CSR / CSRN but requiring better TCR or lower resistance values. Pricing for the CSRF is typically 20% to 40% higher than the CSR / CSRN.

CSM Series

The CSM series is a molded current sense resistor that also has a metal plate resistive element. The CSM series offers two different sizes, 2512 and 0603 with each filling a different niche. The CSM2512 extends our upper value range capability in a 2512 size part rated at 3 watts. The CSSH2512 is the product of choice for values below 10 milliohms and the CSM is the part for values above. The CSM0603 provides an inexpensive 10 milliohm current sense resistor. For higher resistance values the CSR0603 would be the product of choice. Applications for the CSM would be switching and linear power supplies, buck controllers for datacom and telecom equipment, LED drivers, motor control, electric power tools, and power amps. Pricing for the CSM is approximately 10% higher than the CSR / CSRN and is significantly lower than the CSNL, CSS, and CSSH.

SNL Series

The CSNL series is a metal foil SMD chip resistor. Metal based resistors are able to handle much higher surge currents, have better TCR capability, and typically will not have problems with thermal expansion differences with PCB's. The CSNL however is limited in resistance values and sizes and will be more expensive than the CSR / CSRN Series. The largest size CSNL2512 with the lowest resistance value of 0.5 milliohms can handle up to 63 amps. Pricing for the CSNL varies but will be typically 10% to 40% higher than a CSR / CSRN of similar size, resistance value, and tolerance. TCR is 50 ppm to 100 ppm depending on size and value. The CSNL series is a good choice as a next step when the CSR / CSRN doesn't have resistance values low enough or can't achieve the needed TCR. Applications would include switching and linear power supplies, buck controllers for datacom and telecom equipment, LED drivers, motor control, electric power tools, and power amps.

CSS / CSSH Series

The CSS / CSSH series is a precision current sensing chip resistor which also has a metal foil element. Like the CSNL it is capable of handling high surge currents, in this case up to 250 amps, and is not susceptible to failure due to thermal expansion differences with the PCB. In addition, the CSS / CSSH is capable of tolerances down to 0.5% and TCR's down to 15 ppm, both of which are the best that Stackpole has to offer and are among the best in the industry for SMD current sensing resistors. This series is capable of sustaining its full power at temperatures up to 100°C and can operate safely up to 225°C. It can also be used for environments up to 275°C with certain precautions. The CSS / CSSH series offers power ratings up to 4 watts where the previous two series only offer up to a 3 watt part. This series can achieve resistance values down to 0.25 milliohms, which is also among the industry's best. The price for this outstanding electrical performance is typically from 10% to 25% higher than the CSNL series of comparable size. The CSS / CSSH series is the series of choice when precision, high current handling and environmental stability are most important. Applications include switching and linear power supplies, LED drivers, instrumentation, precision motor control, portable test systems, datacom and telecom equipment, industrial and automotive motor control, and down-hole oil well controls.

HCS Series

The HCS series is a high current shunt resistor which utilizes a metal element which is elevated above the PCB to reduce board temperatures. For example the HCS2512 will experience hot spot temperatures that are 10 to 30 degrees C lower than comparable flat sense resistors of the same size. This is critical in handling higher currents safely and efficiently. The HCS is currently available in a 3W 2512 chip size and a 5W 3920 chip size. TCR ranges from 50 ppm to 150 ppm. The HCS is currently available in three resistance values: 0.3 milliohm, 0.5 milliohm, and 1 milliohm. Higher resistance values are under development and may be available for sampling. The HCS has pricing roughly 2X that of the CSS / CSSH series for comparable power ratings so the vastly improved thermal performance comes at a price. The applications using the HCS would be similar to the CSS / CSSH but requiring higher current handling or lower PCB temperatures. Among the applications would be power modules, frequency converters, power management for hybrid power sources and other types of motor and engine controls.

SM2A / SM3A

The SM2A and SM3A are molded current sense resistors with a metal plate element. This series has a compliant termination that is bent around the body of the part. This termination is very flexible so issues that result from board bending or thermal stress in ceramic chips are no problem. In addition, the SM2A and 3A are capable of tolerances down to 0.1% which is among the industry's best. The SM series can operate safely at temperatures up to 275°C making them good choice for applications with extremely high temperatures. They are larger in size compared to the 2 and 3 watt chips for the other series discussed. They are also the most expensive of all the options, being around 2X the price of a CSS / CSSH of equivalent power rating. The SM2A and 3A are typically chosen when the environment is very harsh, or unpredictable, and high temperatures can be encountered. Applications include controllers for DC to DC converters, voltage regulation for industrial grade computer equipment, industrial and automotive motor control and monitoring, gas and diesel powered engine controls, and down-hole electronics.

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