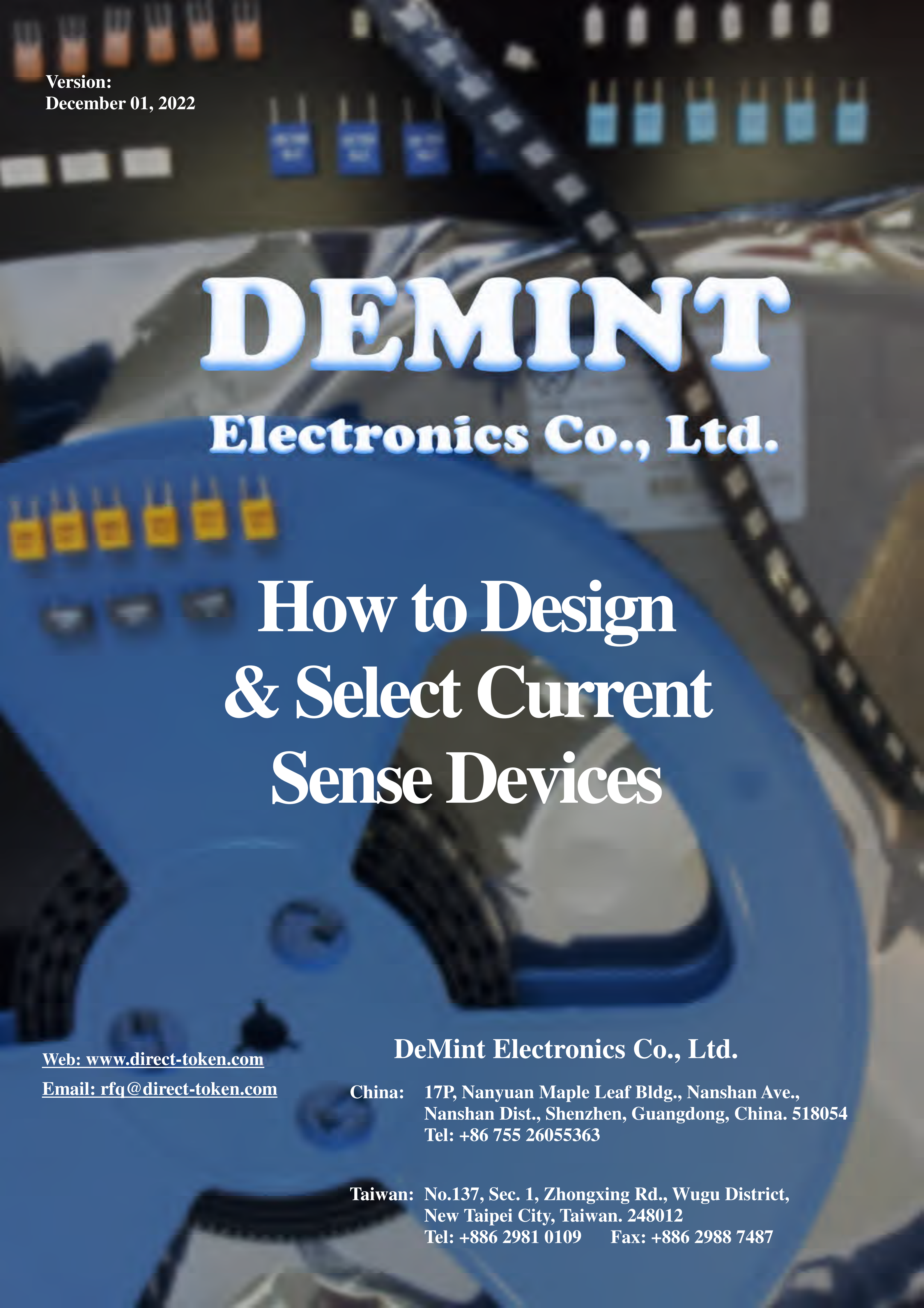

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DEMINT
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How to Design & Select Current Sense Devices

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Design & Selection

How to Design & Select Current Sense Devices

Generally, a resistor manufacturer will offer their most popular devices as standards creating a reference for Engineers to design from. Typically, and especially true in the Current Sensing category, a standard device is available for most common applications. However, for applications requiring parameters that are not currently considered industry standards, DeMint is uniquely equipped to offer design and development services at comparatively lower costs than our competitors. In this case, the following information is required to effectively design a current sensing resistor:

Power Rating

Calculate the power dissipation under operating conditions

Equation: $P_{avg} = I_{RMS}^2 \times R$; where Power (P), Current (I), Root Mean Square (RMS), Resistance (R).

Allowing for transient or fault conditions and high ambient temperature if applicable, select the required power rating.
For many current sense resistors, only the maximum temperature of the solder joints limits the power rating.
Power rating is thus a function of the PCB layout design as well as of component selection
(sees point 4.).

Resistance Value

Determine the minimum suitable resistance value. This is the lowest value of peak sense voltage consistent with an acceptable signal to noise ratio, divided by the peak current to be measured.

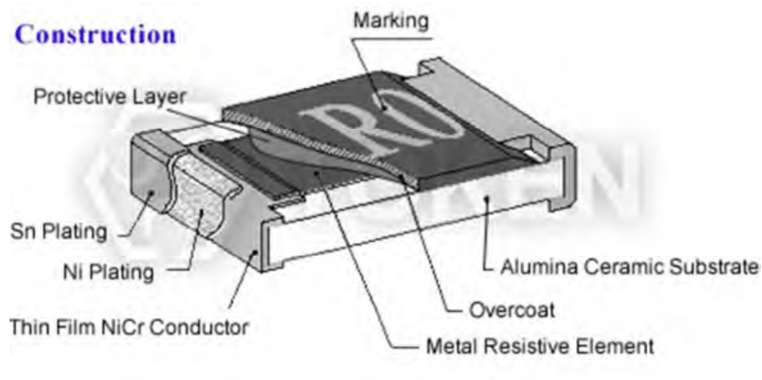
Temperature Coefficient of Resistance (TCR)

Establish the accuracy needed in terms of a tolerance on the value and of sensitivity to temperature. The latter factor is quoted as Temperature Coefficient of Resistance (TCR), defined as the value change in parts per million for a 1°C temperature rise. It is generally higher for low value resistors because the metallic leads or terminations, which have a very high TCR, make up a significant part of the total resistance value.

To achieve acceptable accuracy it is normally necessary to make four-terminal (Kelvin) connections to the resistor. This means connecting the current carrying tracks and the voltage sense tracks directly to the component pads. Even when this is done, there is still some pad area and solder in series with the resistor, which may compromise the actual tolerance and TCR of the soldered part. For very high accuracy or very low values, a four-terminal resistor type is the best choice.

Thick Film Current-Sensing Chips (CS)

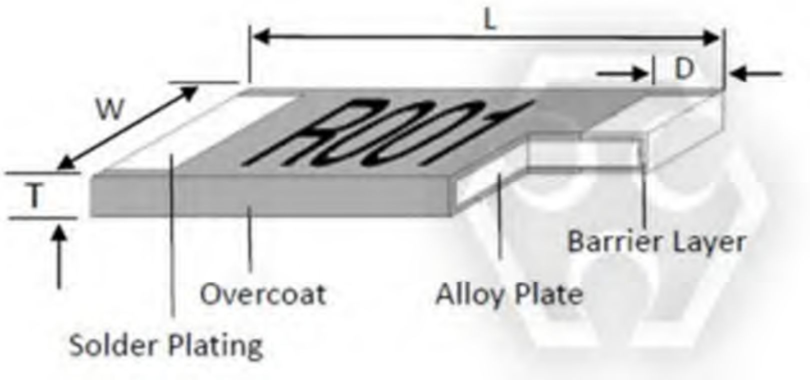
Based on thick film technology, the parasitic inductance of these chips is much lower than that of wire wound and leaded components. DeMint's thick film DeMint CS low ohmic current sense chip resistors are low cost, capable of providing low TCR down to ±100ppm/°C, resistance values as low as 1mΩ, and power consumption up to 3 watts.



Thick Film Current-Sensing Chips (CS Series)

Metal Plate Current-Sensing Chips (LRC, LRP, LRM, LRE, LREA)

A simple structure without multiple cuts, metal plate current sense resistors provide low TCR down to ±50ppm/°C, Up to 5W rated power, high frequency performance and low resistance down to 0.1mΩ.



Metal Plate Current-Sensing Chips (LRC, LRP, LRM, LRE, LREA)

PCB Layout

Care must be taken when laying out a PCB if the stated performance of a sense resistor is to be achieved. The current carrying tracks should be as wide as possible, using multiple layers connected by many vias near the component pad. This also improves the heat sinking of the joints.

The best way to make four-terminal connections to a two-terminal through-hole resistor is to use different sides of the PCB for the current and voltage connections. Failing this, current and voltage tracks should connect to opposite sides of the component pad.

In order to avoid interference from stray magnetic fields, the loop area contained by the sense resistor, the voltage sense tracks and the sense circuit input should be minimized. This means keeping the sense circuitry as close as possible to the sense resistor and running the voltage sense tracks close to each other.

High Frequency Applications

Where transient or AC currents involving high frequencies are to be sensed, the self-inductance of the resistor must be minimised. Wirewound or spiralled film parts should be avoided, in favour of bulk metal or low value chips.

High Heat Dissipation

When using a metallic element shunt with high heat dissipation and low sense voltage, consideration may need to be given to thermoelectric voltages. The junction between a metallic resistance element and metal terminations acts as a thermocouple, generating a voltage proportional to the temperature difference across it.

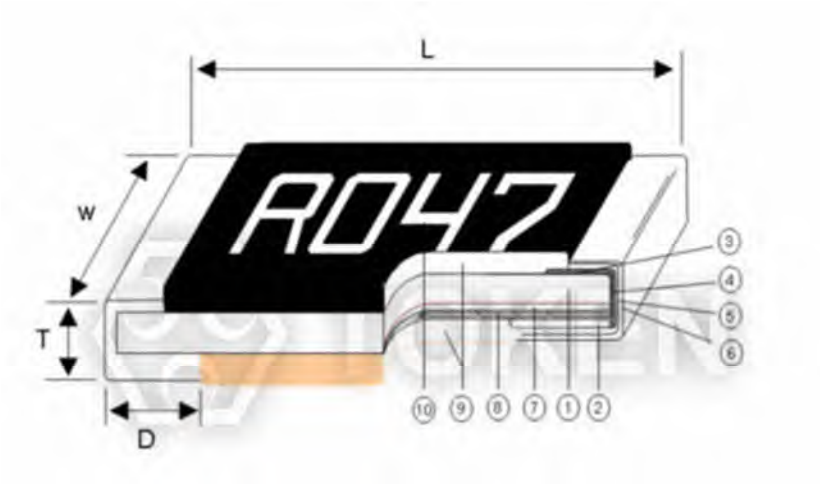
A leaded metallic element sense resistor is therefore like two thermocouples back to back. This means that, if the temperature differences across both junctions are equal, the error voltage is cancelled out. This is achieved by making the design thermally symmetrical, namely, by presenting both terminals with similar heatsinking and by keeping any other heat sources thermally distant.

Wide Terminal Current-Sensing Chips (CSM)

Using a wider side as the connection in the mounting plate, the wide terminal current sense chip reinforces the solder joint and is reliably held to achieve higher power ratings. The wide-terminal current sensor saves space and reduces the amount of resistors in high-density board designs due to its ideal structure to suppress heat generation

Metal Foil Current-Sensing Chips (CSM)

Metal foil current sense resistors made of manganese-copper alloy were developed with the substrate to provide better heat dissipation and a wider resistance range of up to 700mΩ. Metal foil The CSM series has a lower EMF under temperature variations. µ0.03µV/°C is more likely to withstand harsh conditions. In the metal foil type, the TCR ranges from 50 to 100 ppm, the power is up to 5W, and the resistance is as low as 1mΩ.

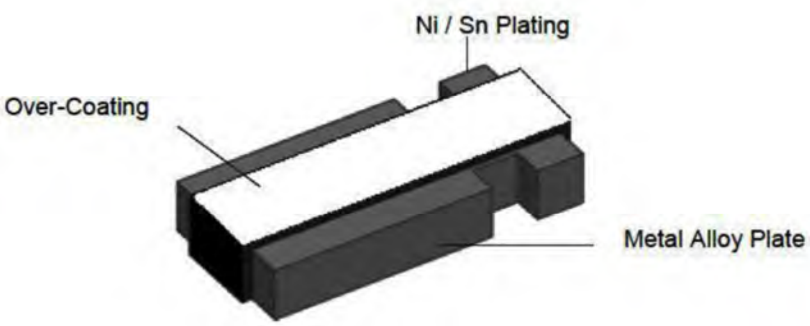


Metal Foil Current-Sensing Chips (CSM)

Four-Terminal Current-Sensing Chips (LRF)

For accurate measurement of circuit design, lower power consumption, higher accuracy and smaller space requirements are important features of electronic control units. In order to minimize power consumption, it is necessary to measure the large current across the (Rsense) resistor, and the high-side current sense amplifier IC must accurately monitor the current.

A four-terminal current-sense resistor that separates the current transfer from the voltage-sensing terminal, from the ideal Kelvin configuration, improves voltage and current measurement accuracy. They also improve interference and thermoelectric effects in higher power applications.



Four-Terminal Current-Sensing Chips (LRF)