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Design Guidelines for TCR® Thin Film Embedded Resistor Foil

Design Bulletin

Orientation of resistors

The sheet resistance of TCR® thin film embedded resistor is isotropic therefore the resistor patterns can be designed in any orientation required by the I/O or to optimize spacing.

Fixed resistor widths for minimizing etch variation

The final resistance tolerance is a function of the etch precision of the copper etch processes of the PCB fabricator. Precise etching will repeatedly produce resistors with good tolerance. The variation can be further minimized by choosing a fixed width for the resistor pattern or keeping the number of widths to a minimum and adjusting the resistor length to achieve the required finished resistor value.

Larger resistor dimensions reducing variability

Larger resistor dimension reduce the reliance on the etch capability of the copper etch processes for the final resistor tolerance. It is recommended to design resistor widths and lengths greater than 0.25 mm (0.010") unless the etch capability has been characterized and is known. Consult the TCR Resistor Calculator for determining recommended sizes based on tolerance and power dissipation.

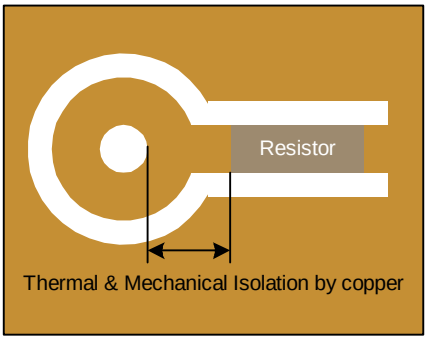
Thermal & mechanical spacing allowances at plated through and microvia holes

Several thermal excursion processes take place during the manufacturing and populating of printed circuit boards. The most severe of these is the component soldering process which can subject the PCB to temperatures greater than 200°C for more than 60 seconds.

Other processes, such as PTH drill can put mechanical stresses on the area directly around the innerlayer land and consequently between the copper and resistor alloy interface.

It is recommended to have a minimum of 0.25 mm (0.010") copper connection between the hole and the beginning of the resistor pattern. This ensures adequate isolation from the stresses caused by these processes.

Resistor in Ground Plane



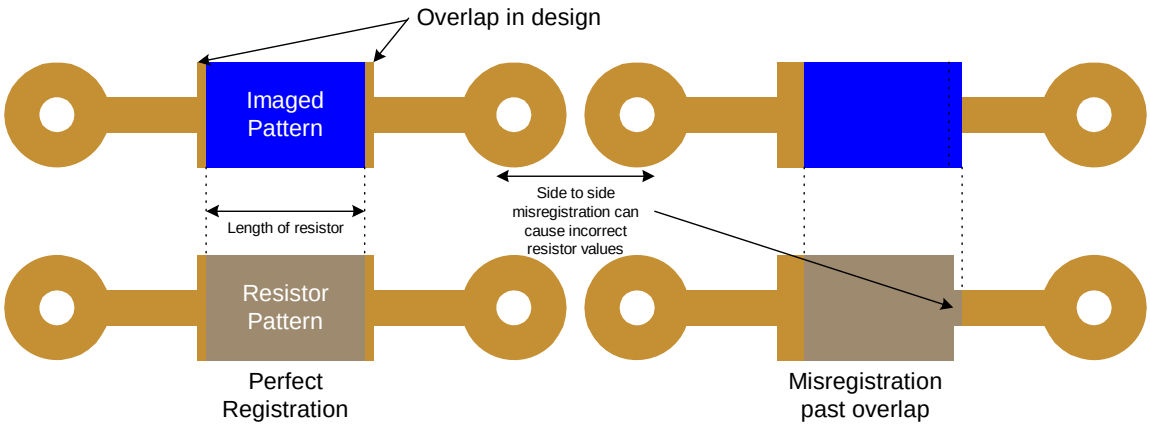
Signal Integrity

In most designs, placing the resistor as close to the pin/output ensures the best signal integrity in digital electronics.

Image design rule guidelines

Manufacturing embedded resistors with TCR foil involves 2 print/image and develop steps and 2 or 3 etch steps depending on the resistor alloy. It is important during the design of the resistor patterns to allow enough tolerance in the artwork patterns to compensate for misregistration during artwork alignment. Typical eye-aligned artwork will require 0.25 - 0.50 mm (0.010- 0.020") overlap. Automatic machine aligned artwork requires a minimum of 0.12 mm (0.005") and the laser direct imaging systems can align with 0.06 mm (0.0025") or better precision. Consult with fabricator on the artwork alignment system used and its precision prior to building resistor designs.

Resistor Length Defined



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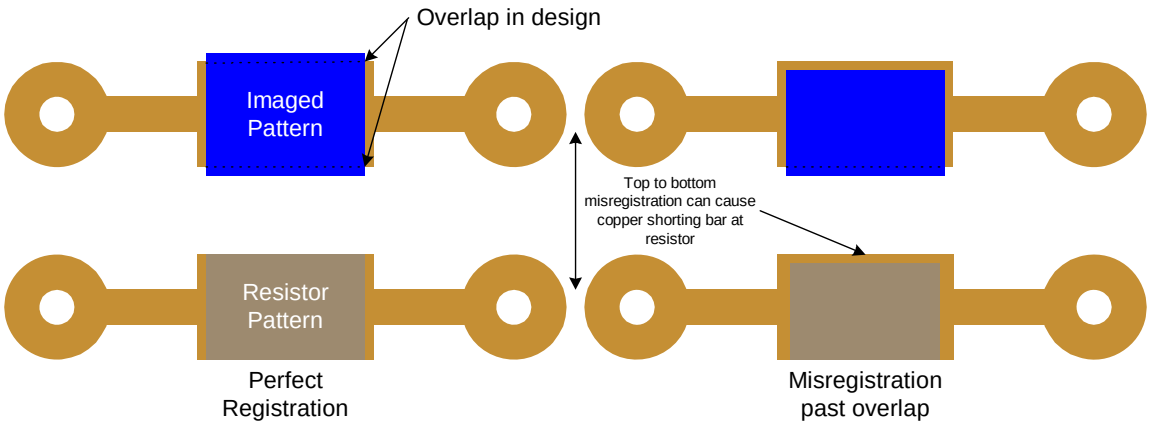
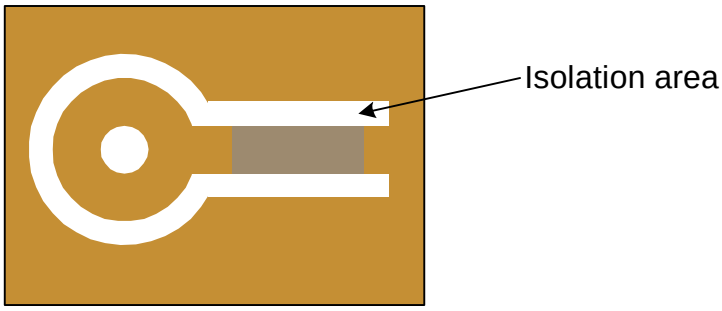
Resistor Defined



Resistors in ground planes require an isolation area between the ground plane and the resistor. Ensure the isolation area is wide enough to allow for misregistration as described above.

Resistor in Ground Plane



Design for Power and Thermal Dissipation Requirements

TCR's power dissipation ability is a function of the resistive alloy's power rating in (mW/mil^2) and the resistor area (mil^2). When higher power loading is required the resistor must be sized accordingly. Refer to the TCR Resistor Calculator for resistors sizes based on power dissipation requirements.

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In the finished PCB, the TCR resistive foil is an integrated part of the system and should not be considered as an isolated element when designing for thermal dissipation. Factors that effect thermal dissipation in the system are:

- Circuit configuration
- Circuit thickness and material type
- Thermal conductivity of the dielectric
- Proximity of power or ground planes to resistors
- Ambient temperature
- Additional system cooling or heat sinking
- Resistor size (total resistor area)

All aspects of the system's thermal dissipation must be considered in the PCB design. Critical thermal dissipation requirements may require thermal profile modeling or actual prototypes to ensure proper configuration is achieved.

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