

What's the EMC problem at this PCB?

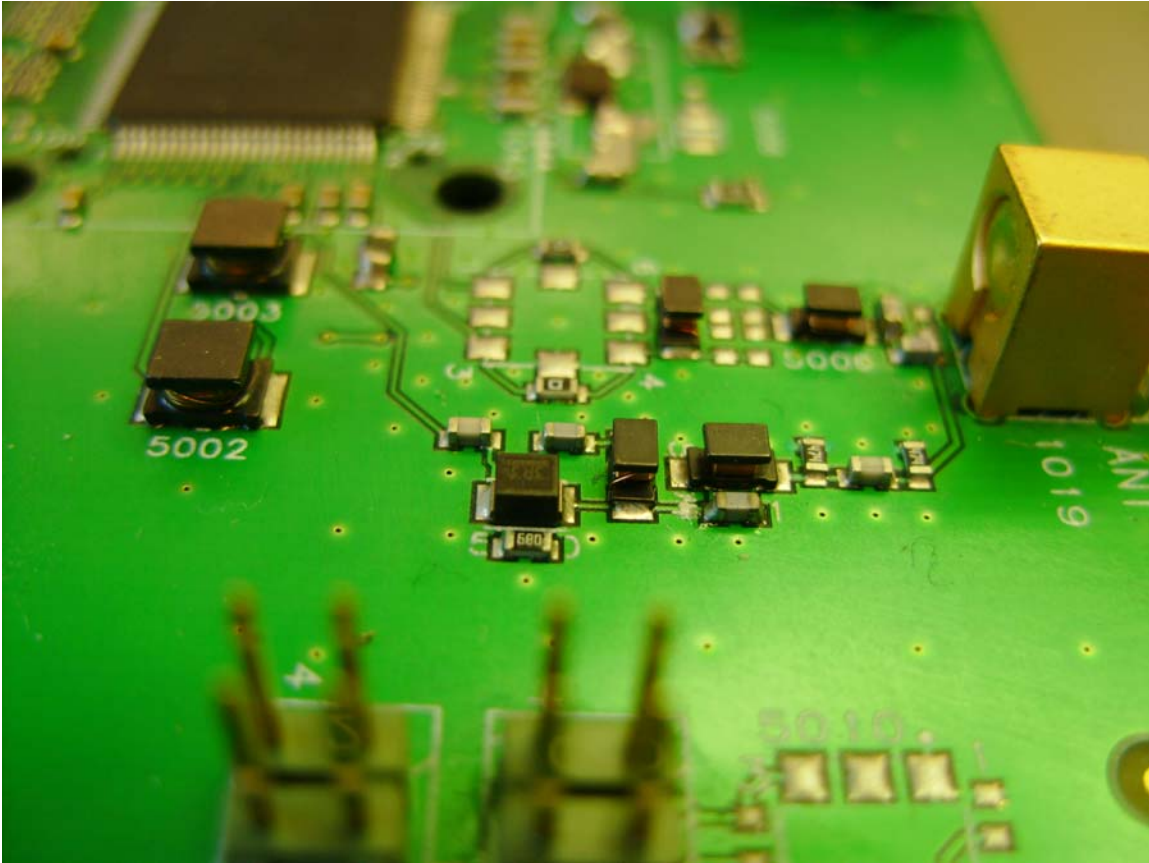


Photo 1. PCB with FM Band reject filter.

This PCB has a problem. During experiments, at some boards a bad FM band reject filter response has been measured with one weak notch. Other samples of the boards showed a response with two sharp deep notches.

The question is: Why?

Take a look at this photo. The two inductors at the right hand side, below, are mounted close together. This means that there is a mutual coupling between these inductors.

After calculations, it has been found that the estimated coupling factor k is approx. 5%. The frequency response of the band reject filter has been recalculated with a positive coupling of + 5% and with a negative coupling of - 5%.

It has been found that the positive coupling results in the weak notch and that the negative coupling results in the sharp and deep two notches. The distance between the notches depends of the value of the coupling factor.

See the next graphic as result of the calculation:

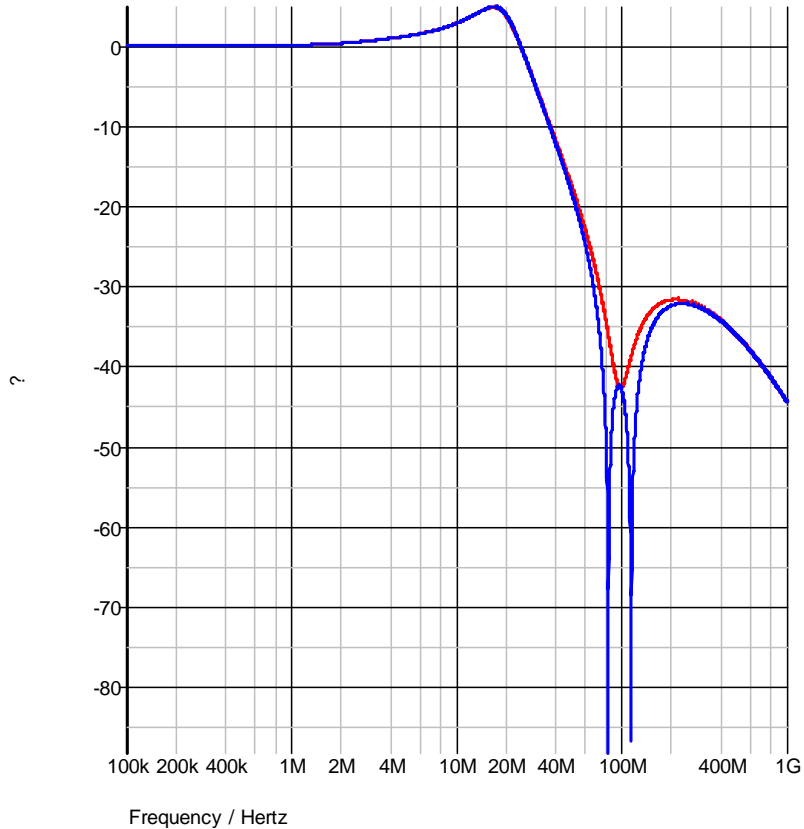


Fig. 1. Simulated results of the FM Band reject filter.

Blue: Coupling negative, approx. - 5 %.

Red: Coupling positive, approx. + 5 %.

Conclusion:

At the PCB, it has been found that the coupling between these inductors cannot be neglected. The estimated coupling between these inductors is approx. 5 %.

When the coupling is negative, two deep notches are found at the transfer function of the FM band reject filter. The distance between the notches depends of the coupling factor between these inductors.

When the coupling is positive, one weak notch is found. This occurs when one of the inductors is mounted in the reverse position.

Recommendations:

In a future lay-out, the physical distance between these two inductors must be increased. No further problems are expected when the coupling is reduced 10 times (k-factor below 0.5 %). The recommended physical distance between these inductors should be increased from 3 mm to at least 1 cm (assuming a quadratic decrease of the coupling factor as a function of the distance).

For the time being, as long as the PCB lay-out has not been changed, it is necessary to specify the orientation of these two inductors. Otherwise, there is a 50% chance to achieve the bad frequency response and a 50% chance to achieve the good response (when one of the inductors has been mounted in a reversed position). This is not practical for a production environment.

© 2009 ir. W.J. Vogel - www.mate.nl