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Effect of dielectric thickness on the bandwidth of planar transformers

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Abstract

This research has considered an idealistic non-interleaved planar transformer wherein only the electromagnetic parasitic capacitive and inductive elements arising out of the transformer geometry are taken into account, without considering material limitations. A suitable model for the planar transformer is used to analyse its frequency and power transfer characteristics; this model was validated by three dimensional electromagnetic simulations of various planar transformer structures in FEKO simulation software. The capacitive and inductive parasitics in this model have been found to be functions of the dielectric thickness.

The theoretical bandwidth for the planar transformer is defined in this research as a function of dielectric thickness. The effect of dielectric thickness of the transformer windings on the bandwidth of the transformer is analysed, based on the premise that the inherent parasitic capacitive and inductive elements would affect the transfer characteristics of the transformer. Upon conclusion of this analysis, it is found that the dielectric thickness of a planar transformer can be optimised such as to present an optimised bandwidth. A closed form analytic expression for the optimum dielectric thickness value is derived and presented in this research.

In a design example of a 4:1 50W transformer presented in this research, it has been shown that the bandwidth can be improved by 384%, along with a power density improvement of 45%, upon choosing of an optimum dielectric thickness of $0.156\mathrm{mm}$ to replace a standard $0.4\mathrm{mm}$ thick dielectric.

It should be noted that the results derived in this research are purely theoretical, justified by many idealisations and assumptions that are argued throughout the research. It is thus expected that practical results should at best approach the theoretical results, due to the known non-ideal nature of reality.