

HIGH FREQUENCY PLANAR TRANSFORMER WITH HELICAL WINDING STRUCTURE

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Abstract — A high frequency planar transformer with helical windings is proposed in this paper. This transformer combines the advantages of the planar magnetic core transformer and air core transformer. The input impedance and the voltage ratio of this new transformer are much higher than its air core counterpart. The numerical result shows that the flux is evenly distributed and totally enclosed inside the planar ferrite. The electromagnetic interference (EMI), generated from the windings of transformer, is significantly reduced by using magnetic ferrite cores.

1. Introduction

Various winding and magnetic core structures have been developed for high frequency transformers. Among them, the planar air core transformers and the planar magnetic core transformers are targeted by switching mode power supply designers recently. Both of them have their advantages and disadvantages for high frequency applications. The typical advantages for air core transformers are no core loss and low manufacturing cost. However drawbacks still exist for air core transformers due to the problems of EMI, low magnetic coupling coefficient and low input impedance. The planar magnetic core transformers using meander or spiral windings have problems of proximity effect and unbalance magnetic flux distribution. The proposed planar magnetic transformer with helical windings can significantly overcome some of these disadvantages while keeping their advantages.

2. Structure of Planar Transformer

The transformer consists of two pieces of planar magnetic ferrite and one double side printed circuit board (PCB), as shown in fig. 1(a). The double side PCB forms an air core transformer with vertical helical windings. The primary winding and secondary winding are going around the upper layer and bottom layer of the PCB vertically, as shown in fig. 1(b).

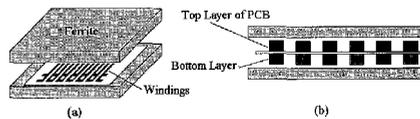


Figure 1 (a) Overall structure of the planar transformer and (b) part of the cross section of helical windings.

Two pieces of planar magnetic ferrite increase the magnetizing inductance and greatly reduce the EMI generated by the helical windings. All the flux generated by the coils is enclosed inside the ferrite. The primary winding and the secondary winding are separated from each other to minimize the proximity effect [1, 2].

3. Flux Distribution

Operating at a frequency of 1MHz, the flux distribution of the transformer shows that the magnetic flux is evenly distributed around each primary winding and induces the emf in the secondary winding. Two pieces of ferrite enclose all the flux inside the transformer, which increases magnetic coupling and input impedance, and reduces EMI as produced by an air core transformer.

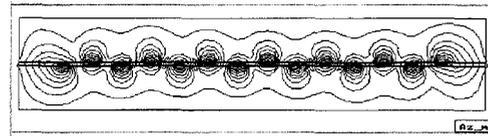


Figure 2 The flux distribution in HF transformer.

4. Voltage Ratio and Input Impedance

The voltage ratio of the transformer has been measured and plotted for the frequency range between 500kHz to 2MHz as shown in figure 3 (a). The input impedance normalized with its air core counterpart is shown in figure 3 (b).

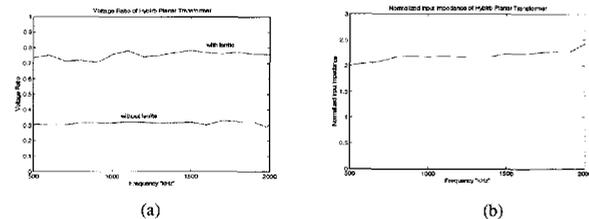


Figure 3 (a) The voltage ratio, (b) the normalized input impedance.

References

- [1] P.L. Dowell, "Effect of Eddy Currents in Transformer Windings". Proc. IEE, vol. 113, No. 8, pp.1387-1394, Aug.1966.
- [2] Fu Wong, J.W. Lu and etc, "Applications of High Frequency Magnetic Components for Switching Resonant Mode Power Supply", Proc. IEEE-ICIT'96.