Leakage field modeling of spiral winding transformer for contactless power converters

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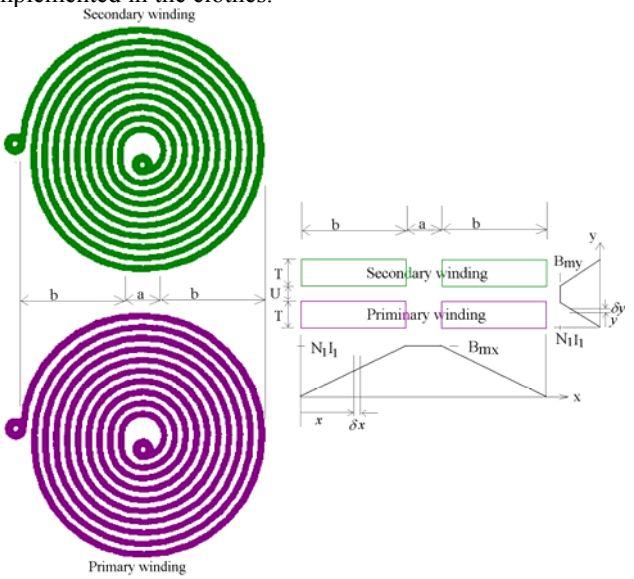
Abstract— The leakage inductance of the spiral winding transformer is examined. Two dimensional leakage field is modeled and leakage field linkage is then obtained to calculate the leakage inductance. The transformer is an air core based with a separation between the primary and secondary. The application is for contactless power conversion.

I. INTRODUCTION

Contactless power conversion is special application for power conversion[1]. Its applications includes the contactless charger, contactless power converter and can be used in intelligent clothing such that the power can be transferred without using conductor and it gives a flexibility of fashion design and hence some electronics or entertainment can be implemented in the clothes.



(a) (b)

Fig. 1 (a)Two spiral winding of the contactless transformer (b) The mmf diagram

II. MODELING OF THE SPIRAL WININGS

Fig 1a shows two spiral windings that forms the transformer. They are air-core so that no magnetic core is used. This is important for contact arrangement such that the size of the thickness of the transformer can be minimized. Two dimensional fields are considered and they are x and y directive as shown in Fig 1b. It is assumed that N_1 and N_2 are the number of turns and I_1 and I_2 be the current in the primary and secondary windings respectively. It also is assumed there are M_1 and M_2 layers in the primary and secondary windings. It can be seen that using mmf diagrams in both x and y directions the leakage field can be computed by considering the leakage field at *x* or *y*. The maximum Magnetic field at *x* and *y* are B_{mx} and B_{my}. The flux linkage is:

$$\delta\varphi_x = B_{mx} N_1 \frac{x}{b}(1-\frac{x}{b})C\delta x, \qquad (1)$$

$$\delta\varphi_y = B_{my} N_1 \frac{y}{T}(1-\frac{y}{T})b\delta y \qquad (2)$$

where C is the mean turn length.

III. COMPUTED RESULTS

The leakage inductance is computed the Fig 2 shows the computed leakage inductance L_k versus the ration of separation U to radial copper width b. .It is found that the leakage inductance increases quite linear with the separation.

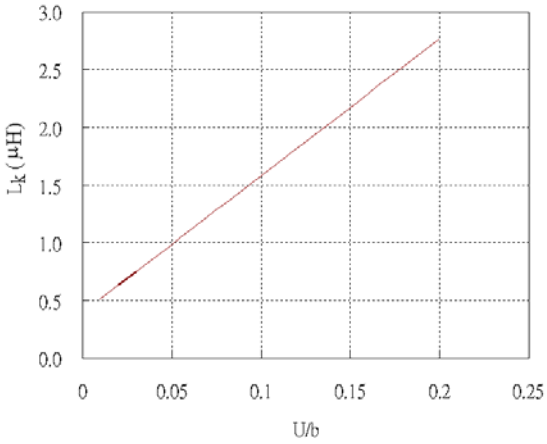


Fig. 3 The y-directive leakage inductance against the separation of the primary and secondary windings

IV. CONCLUSION AND ANALYSIS

A two dimensional field modeling is developed for spiral windings of contactless windings. The results have been compared with the experimental results and good agreement has been found.

V. REFERENCES

[1] Miura, H.; Arai, S.; Sato, F.; Matsuki, H.; Sato, T.; "A synchronous rectification using a digital PLL technique for contactless power supplies", IEEE Trans. Magnetics, Vol 41(10), pp.3997 – 3999

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