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Optimizing the Tapped Transformers Structure

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Abstract: *To have an efficient energy flow and accomplish voltage regulation, it is common to find taped transformers in the power system and in electronics. By optimizing their structure their thermal stability, energy losses and performance increase. Here, to achieve greater adaptability of loads, lower leakage inductance and better control of voltage, several modifications of design suggested in this article are investigated including optimum tap position, the type of core material and the winding schemes. A well-optimized tapped design of transformer has the promising capacity to enhance efficiency significantly and reduce operation-costs as revealed in simulation and laboratory investigation. The paper provides meaningful insights in the development of small, reliable and energy efficient transformers that could be used in smart grid and modern power electronic applications.*

Keywords: *Technological parameters, Tapped transformer, Geometrical parameters, High coupling coefficient, Quality factor*

I. Introduction

Taped transformers are vital components of modern electrical and electronic circuits because they are able to deliver variable voltages by means of the intermediate tap positions on the winding. These transformers are extensively used in applications such as multi-output power supply, impedance matching and voltage regulation. In changeable loading conditions however, traditional tapped transformer designs often suffer the problem of escalated copper loss, leakage inductance, unequal thermal loading and even reduced efficiency. To curb these limitations, optimisation of tapped transformer construction has become a major area of study and development in order to defeat costly constraints to construction of the transformers [3].

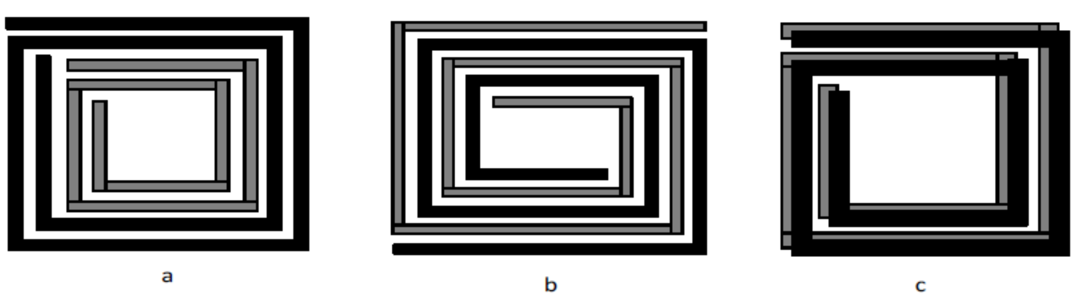

Fig 1: Types of Transformer structures (a) Tapped (b) Interleaved (c) Stacked

Many factors including tap position and number, winding configuration, core geometry and choice of core and conductor materials, to name but a few need to be considered in some detail during structural optimisation. The very advanced transformer design techniques and simulation models enable engineers to better model and analyses the magnetic and thermal behavior of transformers. The goals are to minimize power loss, enhance accuracy of voltage regulation, ensure a compact architecture that does not impair performance [1]. The primary study of the paper is the methods of enhancing the design of tapped transformers in order to make them have a good reliability, efficiency and heat dissipating ability. It provides a comprehensive model on designing third-gene tapped transformers that meet the needs of electronic applications with high performance, renewable energy systems, and self-intelligent grids through integrating the methods of computing and experiments [2-4].

II. Tapped Transformer

A tapped transformer has additional electrical connection (taps) along its windings in order to facilitate control of voltage or multiple voltages. It is commonly used in voltage stabilizers, distribution systems and power supply. Among the operations and considerations that should occur in optimizing the structure of a tapped transformer are the selection of best tap positions, winding structure and the selection of the core materials and core type [5-6]. These modifications improve thermal characteristics, reduce leakage inductance and reduce copper loss. Sophisticated simulation tools allow better-designed, smaller, and more precise products to be designed to analyze the magnetic fields and the efficiency in distributing heat. In the current electrical and electronic operations, an optimized tapped transformer ensures better performance in terms of efficiency, dependability and flexibility.

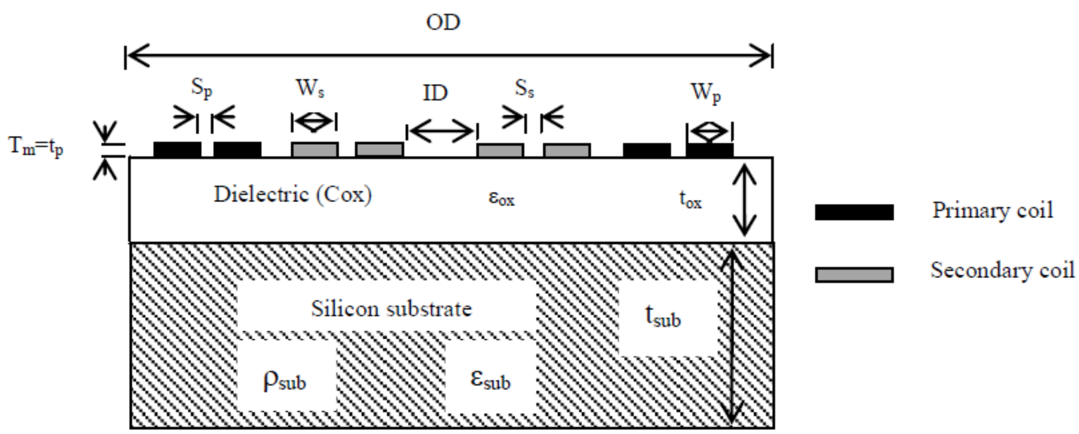

Fig 2: Tapped Transformer cross section view

III. Transformer Model

Equivalent electrical and magnetic models of core behavior, winding resistance, leakage inductance, tap ped connection all are present in a transformer model that is utilized to optimize the tapped transformer. The modelling of power losses, magnetic flux distribution and voltage regulation need accurate analysis. The model uses of tap positioning, winding type and core size variations to optimize to predict performance levels in a number of loading conditions. Simulation techniques including finite element analysis (FEA) are utilized in visualizing thermal and electromagnetic field effects [1-3]. Structural developments based on a well-founded model of the transformer are providing greater efficiency/smaller size and greater reliability in tapped transformer applications across the full range of power and electronics applications.

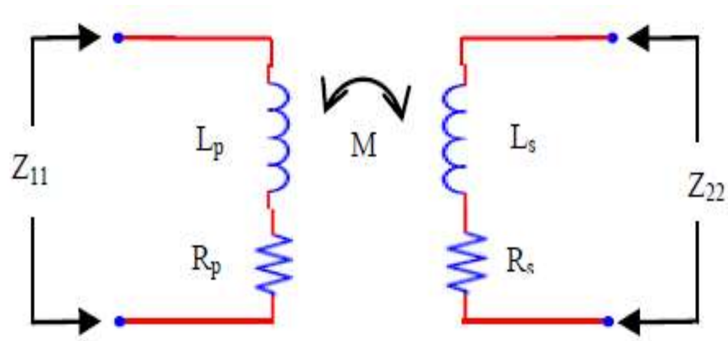

Fig 3: A Model of Transformer lossy

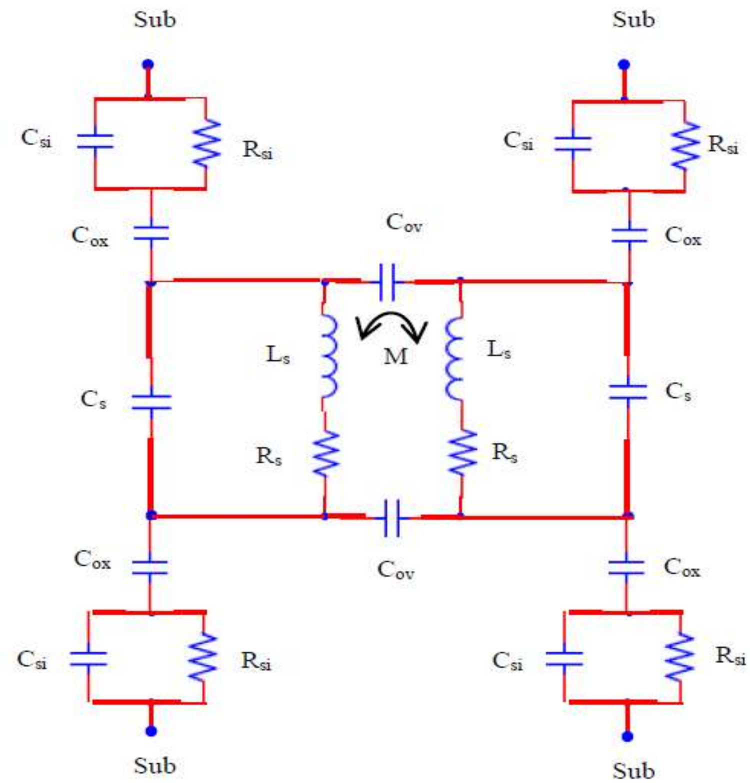

Fig 4: Equivalent Circuit of Model Parameters for Transformer

IV. Simulation and Results

To measure, as well as validate, the results of optimized tapped transformer designs, one requires simulation data. Even without evaluating the system aesthetically, computer simulations model temperature distributions, power regulation, and electromagnetic dynamics in different load conditions with such programs as ANSYS Maxwell or COMSOL Multiphysics. Optimisation of tap placements and winding topologies tend to result in the showing of significant increases in efficiency, the reduction of leakage inductance and the enhancement of voltage stability. Thermal analysis reveals better heat dissipation, reducing the chance of overheating and transformer life span. Modelling of magnetic flux confirms the presence of a uniformly distributed core thereby lowering core saturation and losses.

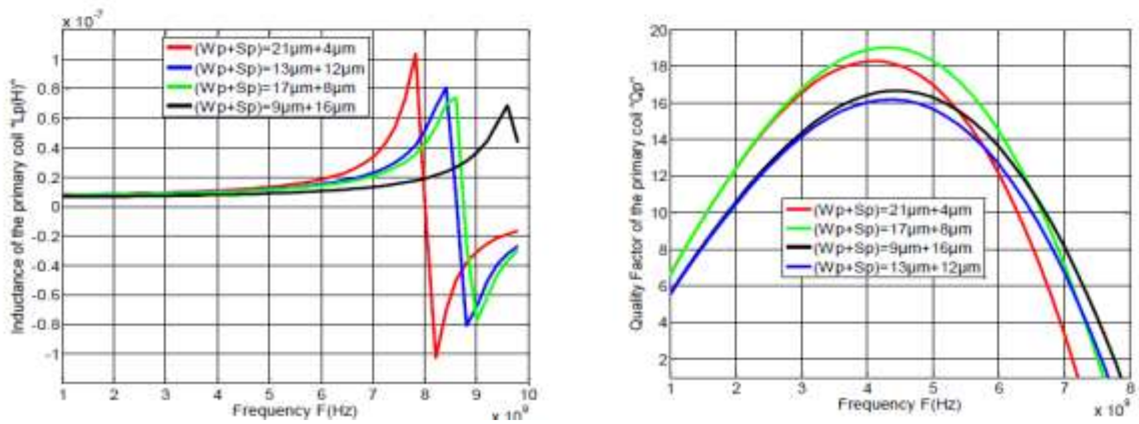

Fig 5: Primary Inductance *Lp* and Primary Quality Factor *Qp*

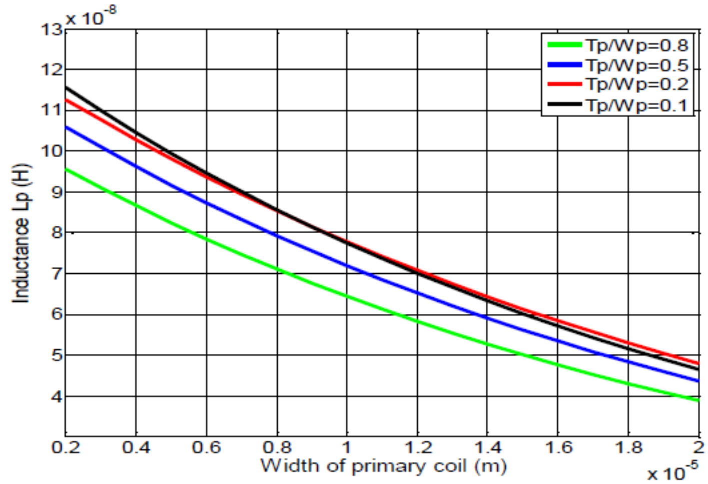

Fig 6: Tapped Transformer simulation

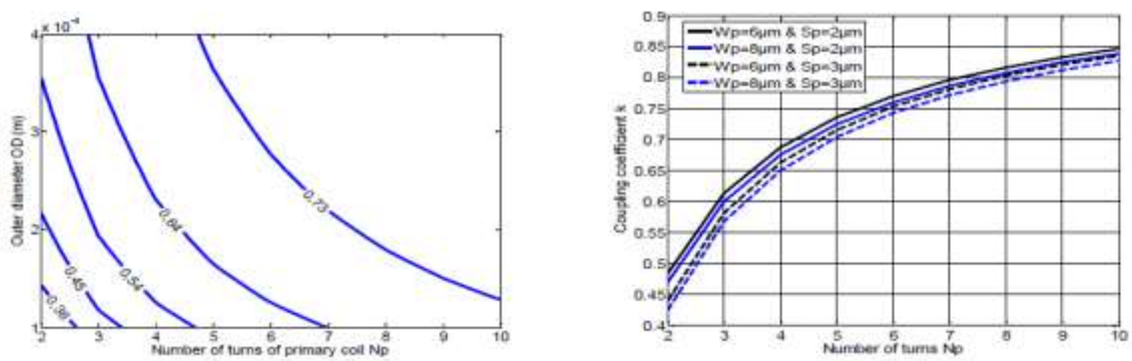

Fig 7: Primary coil turns vs outer diameter

It is also demonstrated by simulating that reduced winding paths and optimized conductor area cross-sections also lead to reduced coppers losses. The structural improvements proved their effectiveness as the voltage output in different tap places became more stable and precise. In these findings, tapped transformers have the potential to perform better and thus can be more fitted to more demanding applications in smart grid systems and power electronics due to scrutinized design and simulation.

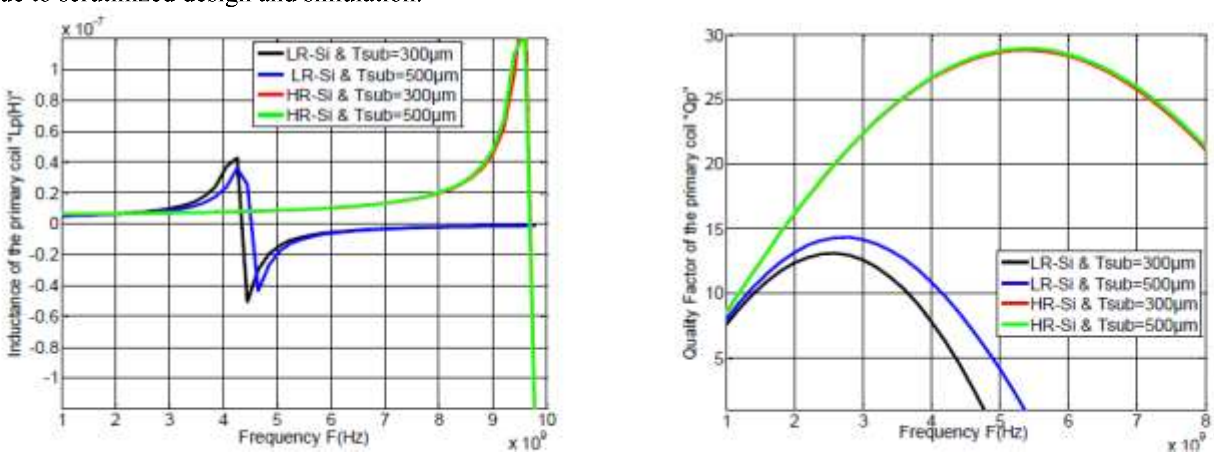

Fig 8: Primary coil frequency vs inductance of the coil

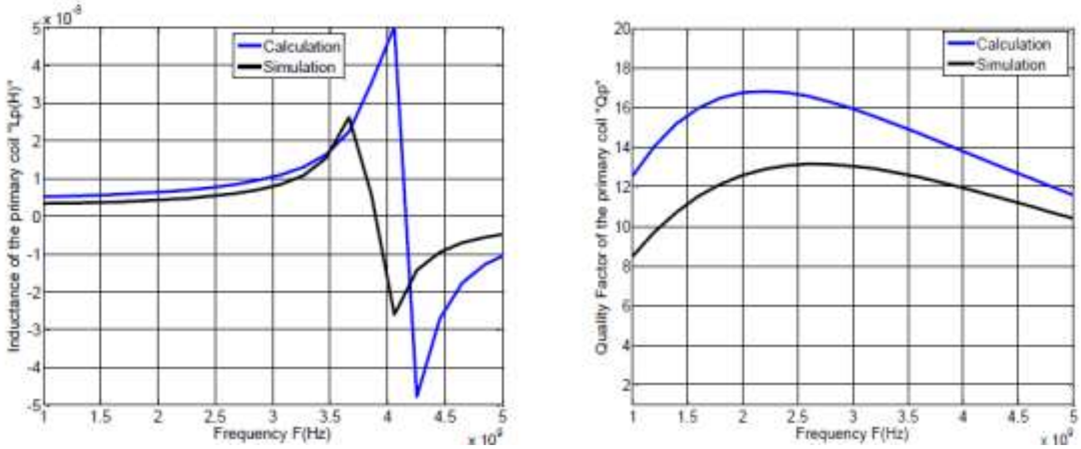

Fig 9: Primary coil distribution ratio

V. Conclusion

In this paper, the tapped transformer is analysed with an equivalent circuit model. This model is applicable to get rid of the technological and geometric aspects and offers an excellent physical depiction of the tapped transformer. The accuracy of the model will be determined by comparing the result of the circuit model and the outcome of the MATLAB simulation. The physical structure of the tapped transformer is also optimized with the aim of enhancing performance. By optimising the outer and inner diameters, width, space, substrate thickness and substrate resistivity a maximum quality factor is realized in the tapped transformer by comparing the MATLAB simulation results of these different structures. The selected tapped transformer requirements chosen by the designer without dismissing the process parameter are transmuted into the suitable geometrical parameter.

References

[1] K S Srikanth, Hima bindu and Sai sri Lakshmi, "Using neural network algorithm for physical structure transformers,"*Journal of Electrical and Electronics and management Engineering*, vol/issue: 1(4), pp. 44-58, 2012.

[2] Md Shaik, R Ravi Sankar and Sasidhar, "Using design analysis for Transformers of Silicon for RF IC Design," *Springer Vacuum,,* vol. 66, pp. 342-356, 2010.

[3] S. I. Hong, *et al.*, "Robust Digital Predistortion in Saturation Region of Power Amplifiers," *International Journal of Electrical and Computer Engineering (IJECE)*, vol/issue: 6(1), pp. 99-105, 2016.

[4] B. Razzaghzadeh and M. Salimi, "Analysis of a Bidirectional DC-DC Converter with High Voltage Gain," *Bulletin of Electrical Engineering and Informatics,* vol/issue: 4(4), pp. 280-288, 2015.

[5] Pan S. J, *et al.*, "Comparative Investigation on Various On-Chip Center-Tapped Interleaved Transformers," *International Journal RF and Microwave CAE*, vol. 14, pp. 424-432, 2004.

[6] Sasikumar M and Chenthur Pandian S. "Characteristics Study of ZSI For PMSG Based Wind Energy Conversion Systems". Journal of Electrical Engineering (JEE). ISSN: 1582-4594.