A 3DFE- GA Procedure for the Optimum Placement of Magnetic Components on PCB Circuit Designs for Reduced EMI

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***Abstract*—This paper presents an optimization process to reduce the Electromagnetic Interference (EMI) of high frequency power converters through the optimum placement and orientation of magnetic components on the printed circuit board (PCB). Transducers and microcontrollers implemented in control circuits are sensitive to the effects of EMI. The developed technique is based on genetic algorithms (GA) that minimize the magnetic component in the sensitive locations of the PCB. The algorithm changes the physical position and orientation of the passive components in addition to the location of control devices to recalculate the EMI until a predetermined level is accomplished. The proposed technique was developed using coupled circuit/Finite Element (FE) analysis. The results demonstrate that EMI can be reduced significantly by identifying the optimum location, as well as orientation of the passive elements in the PCB. The proposed technique is validated through experimentation and the results will be presented in the full paper.**

***Index Terms*—EMI, PCB Design, Optimal Design**

I. PCB Problem and Design Methodology

High frequency converters are widely used in applications such as adjustable DC voltage controllers for various loads and systems. With increasing switching frequencies and smaller component sizes, issues resulting from the EMI increase [1] which is the problem that should be solved in the design stage. The placement and orientation of passive components on a PCB can be changed during this stage to study the EMI radiated between passive components. Changing the distance and orientation of the coupling effects between adjacent passive components can be used to cancel EMI at point of interest on the PCB (devices susceptible to EMI).

This paper presents a methodology for the optimum placement and orientation of components on the PCB using GA. The location of the device refers to its position on the PCB and the orientation of the device is its axial rotation relative to the center of the device. The proposed technique is based on 3 practical cases with different positions of the passive components as shown in Fig. 1. The positions of the coils should be as far as possible to the sensitive device (SD). In each case the relative orientation and distance between them are changed by GA as the cost function indicates in Fig. 2. Finally, the minimum among the cases indicates the optimum position for the SD. The proposed methodology was developed using Finite Element analysis (Infolytica). The program is called from the GA, programmed in Matlab.

II. Results and Analysis

Fig. 3a shows 54 generations of GA for optimization of the placement and orientation of the coils for the case 2. Fig. 3b shows the comparison between optimize case and non-optimum case of Magnetic field through the blue line from (90,0,5) to (90,100,5) that passes on the sensitive device. From the Fig. 3b it can be observed that after optimization the EMI is reduce considerably.

Fig. 1. 3DFE Mesh of the PCB showing 2 magnetic components and one sensitive element (a) case 1 (b) case 2 (c) case 3.

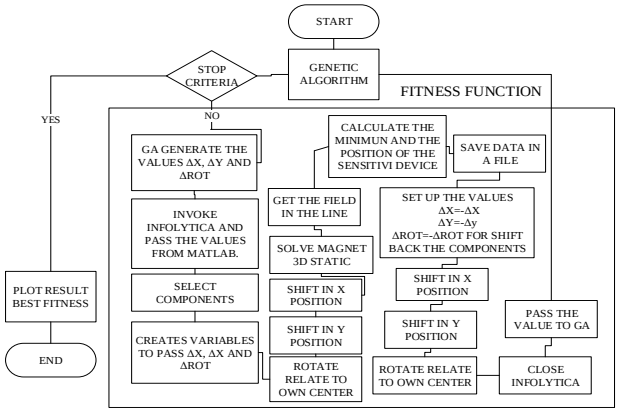

Fig. 2. Fitness Function for the Genetic Algorithm

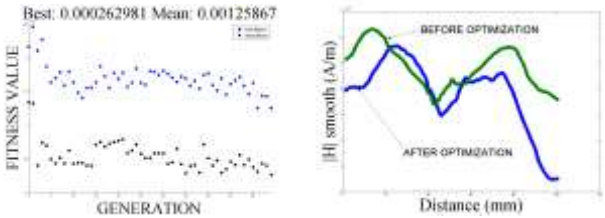

Fig. 3. (a) 54 Generations of GA optimization (b) Variation in magnitude of the magnetic field vs distance on the line from (90,0,5) mm to (90,100,5) mm.

Complete results for the optimization including experimental verification will also be presented in the full paper.

III. Conclusions

By observing the spectrum of the H-field versus distance, the EMI can be reduced considerably by changing the location and rotation of the passive components with respect to the sensitive devices on the PCB.

References

[1] B. Stube, B. Schroeder, E. Hoene, and A. Lissner, "A Novel Approach for EMI Design of Power Electronics," in *Design, Automation and Test in Europe, DATE '08*, 2008, pp. 170–175.