ABSTRACT

The ever increasing circuit density of Integrated Circuits (IC’s) with higher clock frequency generates heat in the electronics system/ chip. The lifetime of electronic components are shortened by the extended use of them at higher temperatures, hence the reliability of the electronic packages are reduced. By creating a suitable path to transfer the generated heat to ambient, the system will be saved from failures like catastrophic thermal failures, which is also called as the total loss of electronic function of a specific component. To improve the amount of heat transfer to the ambient, generally the chips are mounted on the flat plate heat sinks. These heat sinks transfers the generated heat into the ambient. As the power density of the chip are increasing multifold in recent years, the heat sinks are provided with fan to achieve higher rate of heat transfer by forced convection. Due to the proximity of the heat sink with the ICs, the Radio Frequency (RF) fields created in the IC’s gets coupled to the heat sinks. The fins of the heat sink effectively behave as monopoles at high frequencies. Hence the coupled RF current can cause electromagnetic radiated emission. This radiated noise from the device interferes with the functioning of the nearby electronic systems and poses a problem to the system compliance with respect to Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) regulations. Various techniques are practiced by the EMC engineers to suppress the radiated emission, but reducing the emission from the source point is mostly preferred. Since, the multiple performance characteristics of the flat plate heat sink are
dependent on its geometry, an optimal design of heat sink geometry is essential for better performance of the heat sink.

This research work focuses on optimization of multiple performance characteristics for the selection of flat plate heat sink using Grey Relational Analysis (GRA) based on Taguchi orthogonal array. The heat sink geometry factors considered for the design of L27 orthogonal array were length, width, fin height, number of fins, fin thickness and base height. The L27 orthogonal array (6 factors, 3 levels) was generated using Minitab software. The responses studied were thermal resistance, average heat transfer coefficient, pressure drop of processor fan, mass of the heat sink and emitted radiation. The multiple thermal performance characteristics like thermal resistance, average heat transfer coefficient, pressure drop were obtained through the Computational Fluid Dynamics (CFD) simulations using Flotherm 7.2 software and the emitted radiations were predicted using High Frequency Structure Simulator (HFSS) Ansoft version 12. The simulation results obtained were validated with the corresponding experimental investigations using Wilcoxon rank test and both were found to be in good agreement.

From the results of HFSS and CFD simulations, a multi objective optimization of the flat plate heat sink was performed using GRA and the optimal heat sink geometry parameters were obtained. Also, ANOVA test was carried out for finding out the contribution and impact of each heat sink design factor towards the multiple responses of the heat sink. From the results of Taguchi based GRA, it has been inferred that there is a remarkable improvement in the heat dissipation and reduction in emitted radiation of the heat sink.