PhD THESIS ABSTRACT

" Electromagnetic comaptibility study concerning low power consumption devices"

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The thesis presents the principles, results, and contributions related to two essential research challenges in the field of Electromagnetic Compatibility (EMC). First, it addresses the assessment of risks posed by electromagnetic interference (EMI) on low-power electronic equipment, and second, it proposes technical methods and solutions to mitigate these interferences, thereby ensuring the correct and compliant operation of devices within modern electronic ecosystems, including IoT and 5G applications.

This PhD thesis examines the issue of electromagnetic compatibility (EMC) in the context of low-power electronic devices, focusing on the analysis and evaluation of electromagnetic interference at the level of printed circuit boards (PCBs). Both theoretical aspects and practical and experimental applications are covered in this research work.

The study introduces fundamental notions regarding EMC, including general definitions and concepts. It provides a detailed analysis of electromagnetic coupling mechanisms in electronic circuits, such as common-mode and differential-mode disturbances, and capacitive, inductive, radiative, and conductive couplings. I highlighted best practices in PCB design to reduce intra- and inter-system interference, such as separating power and signal circuits, using ground planes, and avoiding ground loops

The thesis includes an analysis of the technologies and interfaces used in low-power devices. It presents a classification of electronic systems based on applications, communication protocols, and energy consumption characteristics, evaluating them from the EMC perspective. Signals and sources of electromagnetic interference at the PCB level in such devices are identified, and techniques and methods for reducing them are proposed. A case study illustrates the selection of a sensor node for an IoT ecosystem, introducing a methodology for assessing EMI risks in the project's conceptual phase.

The thesis explores the use of specialized software applications for analyzing and addressing EMC issues at the PCB level. Theoretical aspects of numerical methods in electromagnetism are presented, including the finite element method (FEM), method of moments (MoM), finite-difference time-domain (FDTD) method, among others. Numerical modeling and simulation applications, such as Ansys HFSS and Matlab, are used to study electromagnetic coupling phenomena and propose solutions for reducing interferences.

System-level analysis focuses on using software applications for analyzing and addressing EMC issues at the system level, concluding the investigative session utilizing specialized software applications for EMC evaluation of low-power equipment. This includes Matlab simulations to analyze the spectrum of the signals investigated, signal-to-noise ratio (SNR), and EMI resilience of these systems.

The study also presents measurement techniques and methods for analyzing and addressing electromagnetic compatibility issues. I detailed the development stages and EMC evaluation instruments, along with methods for measuring electromagnetic emissions and immunity, and procedures for EMC compliance testing

The experimental activities carried out as part of the research program consist of experimental measurements to evaluate EMC issues in low-power electronic systems. I analyzed and interpreted the near-field and far-field measurement results of the tested equipment to assess compliance with specific EMC requirements

This work contributes to deepening the understanding of electromagnetic interference phenomena in low-power devices and proposes efficient methods for analyzing and mitigating these issues. By combining theoretical aspects with numerical simulations and experimental measurements, the study offers practical solutions for improving electromagnetic compatibility at the PCB and system levels, with significant implications for the electronics and telecommunications industries.