EMI Shielding Effectiveness for Package Simulation with Ansys HFSS

Fatemeh Hoveizavi

EDRMedeso

Introduction

In the modern world, the seamless operation of wireless technologies and RF systems, from mobile communication devices to satellite communication and radar systems, is essential. However, the proliferation of these technologies brings a complex challenge: electromagnetic interference (EMI). As RF packages become smaller and more densely packed with sensitive electronic components, the risk of EMI disrupting their operation grows. To ensure reliable RF system performance, signal integrity, and data transmission, a deep understanding of EMI shielding effectiveness is crucial.Ansys HFSS, a powerful electromagnetic simulation tool, has become indispensable for engineers and researchers in RF design and EMI mitigation. This paper explores EMI shielding effectiveness, providing an in-depth analysis within the context of RF packages and utilizing Ansys HFSS.

1.1 Purpose and Scope:

This paper's primary objective is to investigate the effectiveness of EMI shielding within RF packages and illustrate how Ansys HFSS can be used to simulate and evaluate shielding performance. Our research covers a wide spectrum, including simulations, field plots, emission test reports, and analyses of cavity resonance, providing a holistic view of EMI in RF applications.

2. Simulation Setup and Design Integration:

Before delving into the analysis of simulation results, it is crucial to outline the essential steps involved in setting up the EMI shielding study using Ansys HFSS and integrating the 3D structure of the RF package. This section provides insights into the design process and simulation setup.

2.1 Design Integration:

Our study began with the integration of the 3D structure of the RF package into Ansys HFSS. The process commenced with the creation of a new design or the import of an existing 3D model of the RF package into the HFSS environment, ensuring the integrity and precision of the 3D structure. Accurate geometrical representation is vital for simulation fidelity.Once the design was established, we meticulously defined the geometry, accurately representing the RF package with dimensions, material properties, and other relevant geometric aspects. This step was fundamental in capturing the complex physical properties of the RF package.

3. Simulation Setup: Analyzing Varied Scenarios:

The EMI shielding study in this paper encompasses three distinct simulation setups, each designed to address different scenarios and provide comprehensive insights into the behaviour of electromagnetic fields within and around the RF package.

3.1 Setup 1: Incident Planewave from Outside:

In the first setup, we introduced an incident planewave source from outside the RF package to simulate external electromagnetic sources. To create this scenario, the following steps were taken. Incident Planewave Configuration: the incident planewave have been configures as a source representing external electromagnetic fields. This configuration allowed us to model the behavior of electromagnetic waves arriving from a specific direction with defined parameters, including frequency and polarization. This approach is pivotal in various electromagnetic applications, including antenna analysis, signal transmission studies, and the assessment of how electromagnetic energy propagates through complex environments. the boundary condition have been defined, treating the surrounding environment as a vacuum box. This choice was made to simulate the package's interaction with external electromagnetic fields in a controlled manner. Field plots were generated at varying distances from the RF package, enabling us to analyse the behaviour of electromagnetic fields external to the package. These plots provided essential insights into how external incident planewaves interacted with the package's shielding mechanisms, including areas of attenuation and concentration of the electric field.Figure 1. shows the package while the IncWave excitation is located outside the package.

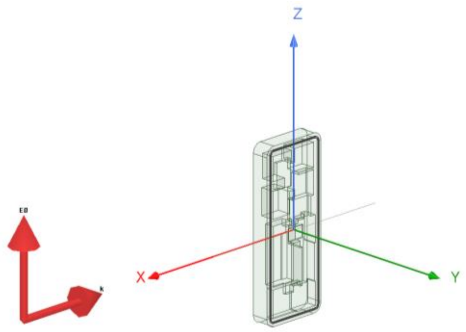

Figure 1. package and IncWave excitation

3.2 Setup 2: Incident Planewave from Inside:

In the second setup, we initiated incident planewave excitation from within the RF package, simulating the source of electromagnetic waves from an internal point. This scenario provided unique insights into the package's internal electromagnetic field behavior. Incident planewave excitation was introduced from within the RF package, simulating the source of electromagnetic waves from an internal point. The configuration of the incident planewave was tailored to mimic specific internal sources and their characteristics.To achieve this setup, a spherical port was utilized as the excitation point. The spherical port represented the internal source of electromagnetic waves. This approach allowed us to simulate the behavior of electromagnetic fields within the RF package from an internal perspective. The results obtained in this setup comprised calculations of |E| for different frequencies. These calculations offered intricate insights into the internal electromagnetic field behavior within the RF package. By analyzing these results, we could identify areas of concern and opportunities for further shielding improvements.

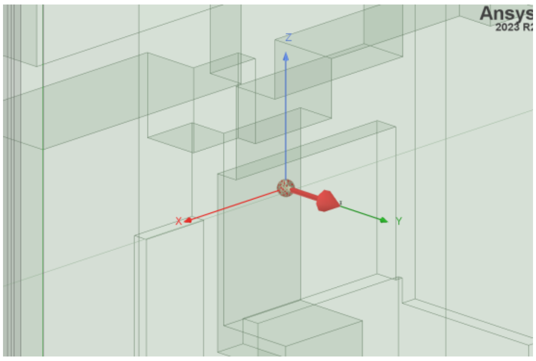

Figure 2. the IncWave excitation inside the package

3.3 Setup 3: Eigenmode Analysis for Cavity Resonance:

In the third setup, we conducted an eigenmode analysis to explore the phenomena of cavity resonance within the RF package. Eigenmode analysis have been used to uncover the resonance frequencies and modes within the RF package. Eigenmode analysis is a powerful technique in understanding the resonant behavior of electromagnetic structures, and it's particularly valuable in the realm of microwave and radio frequency (RF) engineering. It provides insights into natural modes of resonance within various structures, revealing essential information, including resonant frequencies, mode shapes, and the quality of resonance expressed as the Q-factor. This analysis is fundamental for characterizing cavity resonators, waveguides, antennas, and microwave components, offering deep insights into electromagnetic field distribution and resonance phenomena. The results of the eigenmode analysis were presented as resonance frequencies and mode shapes, as depicted in Figure 4. These findings were essential for understanding the internal electromagnetic behavior of the RF package, particularly in scenarios where resonance phenomena are critical. The resonance frequency data and mode shapes guided us in refining the RF package's design to mitigate potential resonance-related issues.

4. Result Analysis:

In this section, a comprehensive analysis of the results has been presented that obtained from EMI shielding study, considering the novel data and simulation setup. The analysis encompasses three distinct scenarios.

4.1 Incident Planewave from Outside:

In this scenario, the field strength in decibels (dB) has been analysed, as shown in Figure 1. The field plots provided critical insights into the effectiveness of EMI shielding. These plots demonstrated variations in electric field strength within the RF package and its immediate vicinity. Notably, the data reflected how external incident planewaves interacted with the package and its shielding mechanisms. We identified areas of attenuation and concentration of the electric field, offering crucial information for optimizing external EMI shielding. Figures 3. below shows the field plot with different distance from the package.

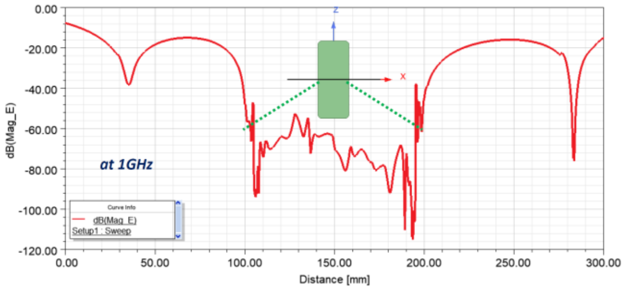

Figure 3. shows the field plot for excitation outside the package

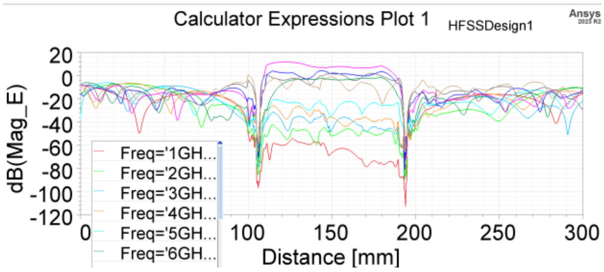

Figure 4. field plot with different distance

4.2 Incident Planewave from Inside:

With incident planewave excitation originating from within the RF package, our analysis focused on the internal electromagnetic field behavior. The novel data included calculations of |E| for different frequencies, as shown in Figure 3. This data provided an intricate view of how electromagnetic fields behaved within the package. The results helped identify areas of concern and opportunities for further shielding improvements.Figure below shows the E field for different frequency when the excitation is inside the package.

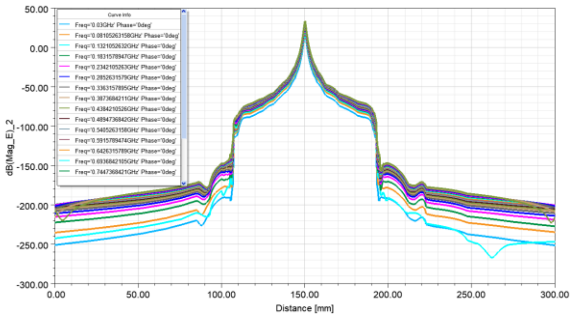

Figure 5. shows the field plot for different frequency while the IncWave excitation is inside the package

4.3 Eigenmode Analysis for Cavity Resonance:

In the context of cavity resonance, our eigenmode analysis unveiled resonance frequencies and modes within the RF package, as depicted in Figure 4. This data was essential for understanding the internal electromagnetic behavior in scenarios where resonance phenomena were critical. The results guided us in refining the RF package's design to mitigate potential resonance-related issues.

Figure below shows the E field plot inside the package with eigenmode analysis.

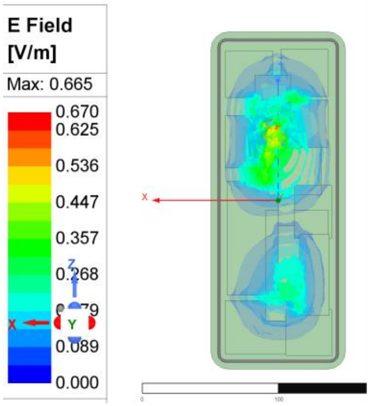

Figure 6. E field plot for eigenmode

4.4 Summary :

An overarching theme that emerged from our analysis was the necessity for a multi-faceted approach to EMI shielding. The varying scenarios—external incident planewaves, internal field behaviour, and cavity resonance—underscored the need for versatile shielding solutions that addressed both external and internal EMI challenges. Our results, as presented in the figures, provided valuable insights for future RF package designs, aiming to enhance EMI shielding and overall electromagnetic performance.