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Clip-Attach EMI Shielding on Electronic IC Package

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Abstract— *Since the earliest days of radio and mobile communication, the need of managing the negative effect of electromagnetic interference (EMI) became necessary. The existence of EMI or radio-frequency interference inside the electronic system affects the performance of the device on its actual application, and on worst-case scenario it might stop the system from functioning. However, as the development and breakthrough in electronic integrated circuit (IC) packaging progress, different solution is offered in providing an advantageous approach for EMI shielding and protection. In this paper, an augmented and improved packaging technique for electronic IC is discussed in details providing the package design and the method of its fabrication.*

Keywords— *EMI; clip-attach process; EMI shield; metal clip; IC; electronic device.*

I. INTRODUCTION

Electromagnetic interference (EMI) is the disruption generated by an external source that affects the electrical circuitry or performance of an electronic integrated circuit (IC) product. As the electronic IC device becomes smaller and more compact, the effect of EMI or radio-frequency interference when in the radio frequency spectrum becomes more devastating and apparent on the actual application leading to an obvious failure in the package.

Through EMI mapping or visualization technique as illustrated in Fig. 1, the location and area inside the electronic IC device could be clearly studied and understood. The technique uses color scheme to aid the evaluator in terms of the intensity of disturbance inside the device.

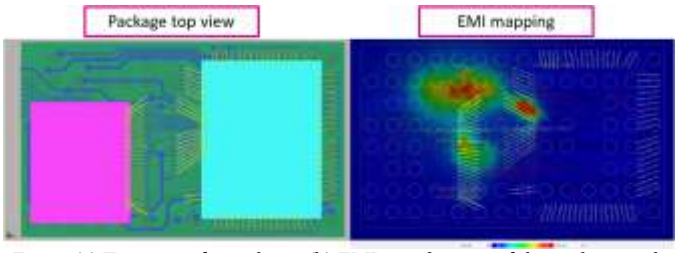

Fig. 1. (a) Top view of a package, (b) EMI visualization of the package with identified EMI-prone area.

A top view of the IC package is shown in Fig. 1a, wherein the device is designed to be a major component in the transmission of signals in a mobile system. Through EMI visualization highlighted in Fig. 1b, multiple locations that are very susceptible to EMI disturbances are identified. The color gradient located between the two silicon dies shows the intensity of potential EMI disturbances inside the package. The most affected zone which is identified by the red coloration is visible on the wiring location between the silicon die and substrate.

II. PACKAGE DESIGN SOLUTION

An improved package design solution through advanced packaging technique is presented in this study to evaluate the effectiveness of the design in terms of EMI shielding and protection.

A. Electronic Packaging Design

The improved design in reducing the EMI disturbance inside the electronic IC package includes integration of a metal cover or metal clip, covering the identified or EMI-prone areas inside the device. The metal cover or clip shown in Fig. 2 is electrically connected to the allotted grounding pads in the substrate layering where a conductive adhesive material is used to secure the electrical continuity between the grounding pads and the metal cover.

Fig. 2. 2D illustration of an IC with metal cover design.

The silicon die wirings and metal cover is isolated by a film-on-wire (FOW) material. This material is a non-conductive film that will conform to the wiring structure and adhere to the topside portion of the silicon die. The size and dimension including the design of the metal used depends of the area of EMI affected zone inside the package.

B. Method of Assembly and Discussion

The improved design of the electronic IC package could be realized when a clip-attach process is incorporated between wirebonding and plastic encapsulation processes. The assembly process flow is given in Fig. 3 with clip-attach process included.

Fig. 3. Assembly process flow.

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The clip-attach process is already an established process in semiconductor manufacturing industry which is primarily responsible for cutting and attaching of metal covers or known as metal clip, illustrated in Fig. 4. The metal clip is picked by the picker head from the metal reel part. The ejector underneath the metal clip cuts the tie bars of the metal clip and reel so that the picker can freely pick the unit.

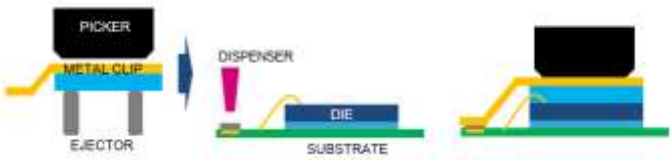

Fig. 4. Clip-attach process.

The dispenser module dispenses the conductive glue according to the designated grounding pads. The metal clip from the picker is then placed on top of the silicon die. A curing process afterwards is necessary to promote the thermo-settlement of both the conductive glue and the non-conductive FOW material.

III. Experimentation

Two versions of the electronic IC package shown in Fig. 5 are designed and tested in parallel to determine the significance of the improved design for EMI protection.

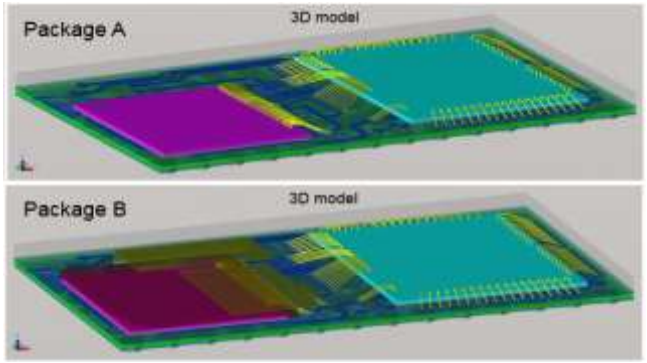

Fig. 5. 3D model of a package with and without metal cover.

Package A is designed with normal or conventional IC packaging technique while Package B is integrated with the metal clip design. The focus of the experiment is to study only the EMI reduction on the left silicon die thus the right silicon die is left with no change in the design. An EMI visualization and simulation tool is used on both package designs to compared the performance on the EMI protection.

IV. Results and Discussion

Comparing the results of Package A and Package B after the EMI mapping and visualization analysis in Fig. 6 clearly shows the difference and reduction of EMI disturbances inside the device. For Package A, the color gradient in the wiring portion visibly identifies that EMI disturbance is evident in the design. The coloration of red in the color gradient also identifies that there is a strong potential EMI disturbance in the left silicon die portion.

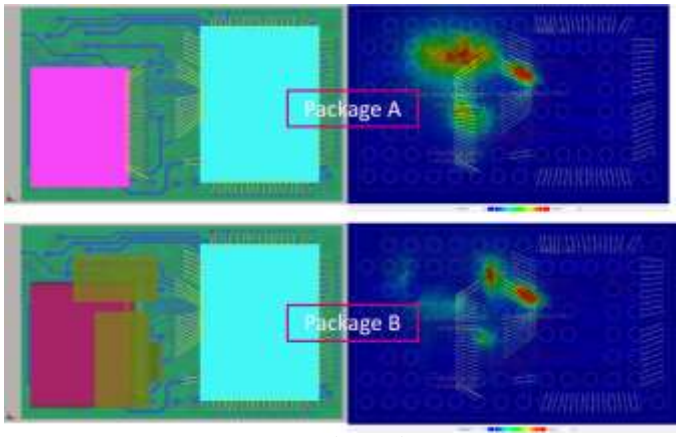

Fig. 6. Comparison of result for both design.

For Package B with a metal clips incorporated in the design, it shows improvement in the EMI protection. The EMI mapping or visualization shows acceptable coloration in the left silicon die wiring area.

The coloration on the right silicon die is disregarded in the analysis since from the start of the evaluation it is determined without any modification.

V. Summary

The study evidently proves the improvement of EMI shielding and protection through incorporating a grounded metal cover for the area in the device with identified EMI-prone portion. The application of the improved package design significantly reduced the effect of disturbances evident on the electronic IC devices intended for mobile applications.