Abstract

It is critical to constrain and control characteristic impedance on high-speed printed circuit boards. However, in most cases, space constraints do not allow for impedance test coupons to be placed on the actual part. This creates the need for external coupons to be placed on the panel, resulting in the consumption of production panel real estate and increased cost.

Placing impedance coupons across the panel, and not on the part, presents the manufacturer’s engineer with a variety of coupon design challenges:

- A manual, time-consuming layout process that can take anything from minutes to hours to complete.
- An error-prone layout process, subject to design rule and signal integrity violations, (as engineers often try to make the design as compact as possible,) significantly increasing the challenge of manual layout.
- Requires expert work to make the coupons really efficient not only by packing more lines into the same impedance coupon, but by ensuring that they do not interfere with one another and do not add to the tooling cost.

This article describes a software solution that handles the above mentioned challenges to help front end departments in the PCB shop shorten the job editing cycle and optimize the quality of impedance coupon design.

Why is Impedance Coupon Layout so Complicated?

Impedance coupon layout would be a very simple task if there were just one impedance line per coupon. This, however, is a very costly approach that reduces the amount of deliverable parts on the production panel, thereby increasing the production cost per unit.
In order to create more compact coupon designs, where several impedance lines are placed on the same coupon, one needs to consider design rules and signal integrity factors so that product testing results in a clear signal.

There are many layout details to consider. Several of these are listed below:

- Not all impedance lines can be placed on the same coupon. Deciding which lines can share the same coupon is a complicated task that requires a true understanding of how signals work, and is therefore subject to frequent errors.
- Due to material properties and manufacturing issues, the line width required by the design is not exactly the same line width expected to be measured in production. However, this is the line that needs to be laid out on the coupon. The same complexity occurs with differential spacing that changes if differential line width is changed.
- A really compact design can be achieved by placing a few lines in a channel formed by each line of pads. And if coupon size is shorter than the required line length, the layout of the lines curves.
- Connectivity between layers is critical. Every line must be grounded through a drill to one of the adjacent ground layers. Manual coupon layout may require a very careful process to avoid connecting to the wrong ground layer or failing to connect some lines at all.
- Labelling: Placing text in the right location with the right information, text size and orientation is another challenge that if done manually, may be time-consuming and become a major source of errors.

**Proposed Solution - Automatic Impedance Coupon Generation Software**

Automatic Impedance Coupon Generation software should include the following major attributes in order to become a real solution to the challenges listed above:

- **Support a range of pad layouts** matching commonly used impedance-testing probes in the PCB industry.

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2 lines in the same row

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Readable text is a challenge

文字添加是一個挑戰

推薦的解決方案 阻抗條自動生成軟體

阻抗條自動生成軟體必須具備以下六大特徵才能成為應對上述難題的解決方案:

- 支援多種Pad排佈，適合PCB行業中常用的阻抗測試探針。
- **Automatically group impedance lines** to reduce the amount of coupons and minimize the coupon footprint on the panel.

- **Compact Layout** to minimize the coupon footprint on the panel while still maintaining all design, manufacturing and signal integrity rules. Coupon sizes may be determined by the remaining space on the panel, so that long impedance lines are packed into a relatively short coupon. The software should be able to handle these scenarios.

- **Automatic labelling** - To provide clear readings on the coupon during testing.

- **Sub-assembly testing** - To design impedance coupons that can be tested at earlier production stages in order to reduce the cost of malfunctioning boards as early as possible. This advanced capability requires an understanding of the PCB buildup as well as the sub-assembly structure of the board.

Impedance coupons should be automatically designed for high yield and cost-effective manufacturing. Coupons should **meet all design and manufacturing rules and should use the same tooling cycles and tooling sets already in use for manufacturing the deliverable part.**

- **Flexible shielding capabilities** - The software should allow users to configure a variety of shielding patterns in impedance coupon trace layers, including solid, dots and guard trace patterns.

- **Integration with the most popular stackup design, engineering and CAM systems.** This information is essential for determining the interconnectivity between coupon layers. Integration with CAM will enable the seamless transfer of impedance coupon data to the CAM system to ensure the coupons are successfully added to the production panel. Integration with engineering systems is also crucial, since in many cases, shop floor documentation requires

  - **自動對阻抗線進行分組，從而減少阻抗線的數量並使阻抗線在工作排板上佔用的空間最小。**
  - **緊密的佈線，使阻抗線在工作排板上佔用的空間最小，又不違反所有設計、製造和信號完整性規則。阻抗線的大小可由工作排板上的剩餘空間決定，因此較長的阻抗線可設計到到相對較短的阻抗線中。這軟體應能夠解決這些情況。**
  - **自動標記** - 可以提供阻抗測試時所需的清晰可讀的文字。
  - **多次焊接測試** - 設計在多次焊接生產階段測試的阻抗線，以便盡早發現有故障的電路板以降低製造成本。這先進的功能的測試必須充分瞭解 PCB 增層以及電路板的多次焊接原理。**

  ![Long Impedance lines packed into a relatively short coupon](image)

  **建構和子組裝列表**

自動設計阻抗線，以實現高良率和經濟有效的製造為目的。阻抗線應符合所有設計和製造規則，並使用目前已用於製造出貨單元的相同加工週期及設備。

- **靈活的護衛鋼功能** - 軟體應允許用戶在阻抗線路層中配置多種護衛鋼圖形，包括實線、點線和防護線圖案。

- **與最流行的堆疊設計、工程和 CAM 系統整合**。此資訊可確定阻抗線層之間的互連性至關重要。與 CAM 整合可以將阻抗資料無縫傳送 到 CAM
In the top class of engineering systems available today, there are also robust panel design tools that take impedance coupon sizes and quantities into consideration in their panel layout optimization program - thus ensuring better utilization of the panel area.

Conclusion

Impedance coupon design is a time-consuming preproduction challenge that requires expert understanding of impedance modelling, signal integrity and manufacturing processes.

Automatic, integrated Impedance Coupon Generation software may be considered as a solution to the challenges described above, and delivers the following benefits:

- Reduces CAM and Engineering cycle time.
- Generates coupons that meet all DRC, signal integrity and testability requirements.
- Designs coupons for impedance testing in the early production stages.
- Minimizes the coupon footprint on the panel leaving more space for sold footage.
- Transforms coupon design from an expert task to a standard operation.