



CIRCUIT INTEGRATED DESIGN AND ANALYSIS TECHNOLOGY FOR PERFORMANCE AND RELIABILITY

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ABSTRACT

Integrated design and analysis technology for performance and reliability is a highlight issue in the field of reliability. A technical framework for the integration of performance and reliability of electronic products was built up. The framework integrates multiple performance analysis tools and reliability analysis tools and realizes the integrated design and analysis of performance and reliability, centering on performance simulation and on the basis of data-share. In order to realize the integrated capability, the flow and data relationship of integration of performance and reliability of electronic products were investigated, and then the integration platform was established. Finally, a case was analyzed to validate the function of the platform. It could take the circuit fault simulation, FMEA, reliability prediction, derating design, testability prediction etc. during the process of circuit performance design.

Keywords: *Integration, Reliability, Performance, Platform, Circuit*

1. INTRODUCTION

With the rapid progress of scientific technology and the ever-increasing complexity of modern products, the traditional product design idea in the past is not applicable to designing modern complicated products any more. The successively emerging methods like concurred design, collaborative design, multidisciplinary design optimization and integrated design have become research hot topics [1-3]. One field of integrated design is performance and reliability integration design. It's well known that, reliability design and performance design are two different technical systems and their separation severely restricts the improvement of product design. In recent years, performance and reliability integration technology is a method commonly used to improve the product design. The rapid progress of Electronic Design Automation (EDA) just forms an excellent basis for developing the integrated design of performance and reliability of electronic products. This technology is developed in two directions at present, one of which is set up a unified integrated design environment like ADEPT [4, 5]. This direction requires a complicated function modeling which is designed in need of building up a new model for the circuit; thus it is applicable to be operated by professional operators. The other direction of the

technology is centering on the existing EDA simulation tool by means of fault injection to realize analysis on fault/disturb like functional reliability simulation, fault simulation based on EDA [6, 7] and so on. By use of the existing simulation modeling without necessity to change the original design of circuit, this direction is able to obtain fault performance data of the circuit and then do relevant reliability analysis. Circuit designers can implement this technique effectively as long as there are necessary tools at hand. The breakthrough of basic level implementation techniques of performance and reliability integration technology, such as circuit fault modeling, fault injection and EDA tools interface technique [6] is making the core and independent integration design become realistic. However, problems still exists in implementing the integrated design in the whole process of electronic product design. Examples of such problems: 1) Due to the fact the overall electronic product design process includes circuit performance simulation, PCB design, reliability prediction, derating design and other performance and reliability design item, each item is operated separately without forming an optimized integral design process; 2) product information integration can not be realized because the data correlation between each design item is unclear and lack data exchange in the design process; 3) an effective integrated

environment/platform is unavailable which plays an important role in supporting the electronic product performance and reliability integration design.

Focusing on the overall electronic product design process, this paper analyzes elaborately the performance and reliability integration design process, studies the integration data model, and sets up electronic product performance and reliability integration platform so as to provide an effective instrument for integrated design.

2. TECHNICAL SCHEME OF INTEGRATED DESIGN AND ANALYSIS OF PERFORMANCE AND RELIABILITY OF ELECTRONIC PRODUCTS

Integration of performance and reliability of electronic products is to conduct reliability design and analysis on the basis of EDA design and full use of performance simulation model and data for well blending performance design with reliability design [8]. In respect of this, it's necessary to build up a platform for the cooperation and exchange between EDA tools and reliability CAD tools, blend performance design data with reliability data via relevant interface, further, integrate performance design process with reliability design process. Herein a technical scheme is shown in Figure 1.

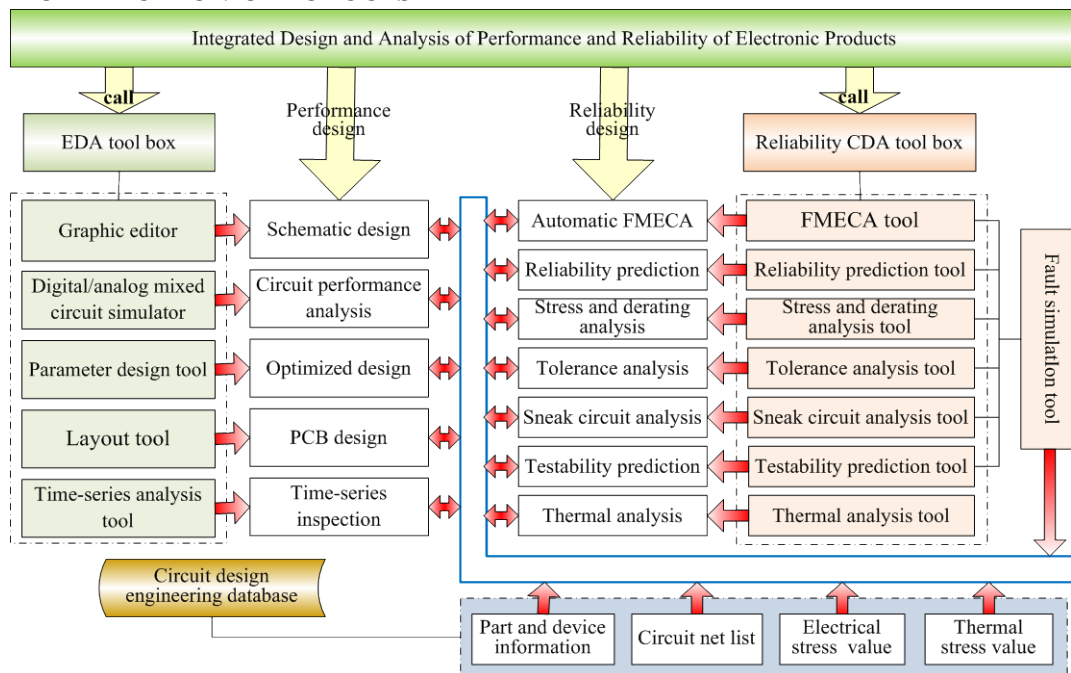


Figure 1. Technical Scheme Of Circuit Integrated Design And Analysis Of Performance And Reliability

Corresponding to circuit performance design process based on EDA tool, circuit reliability design and analysis and performance design collaborate with each other and are conducted synchronously, thereof, circuit performance design mainly uses EDA tools inclusive of schematic and HDL editor and digital/analog mixed circuit simulator etc., while reliability design mainly uses engineering reliability CAD tools inclusive of FMECA and reliability prediction etc. A common data interface is established between different tools and the platform to realize data sharing among different tools on the platform, and fault simulation tool is used for acquiring a lot of fault performance data needed by reliability analysis to lay a foundation for automatic FMECA, reliability prediction and testability prediction. Meanwhile, different tools are

used in different analysis phases through the platform's simulation logic control to effectively raise the automation level of circuit reliability analysis.

3. KEY TECHNIQUE OF INTEGRATED DESIGN AND ANALYSIS OF PERFORMANCE AND RELIABILITY OF ELECTRONIC PRODUCTS

As the electronic product design process contains various types of design items and also generates large amount of data, setting up an integral design idea, clarifying the relationships between each item and realizing data share & information integration are the key points of realizing integration design.

3.1. Integration Process Design

The common performance design of electronic product usually adopts serial design idea, in which the design is refined and data progresses step by step in normal order from the initial circuit schematic design to the following performance simulation and to the final PCB routing. Each step of reliability design needs to be developed synchronously with performance design, and data is in need of exchange or even reiteration in some procedures to trace conversely the data flow.

Therefore, we need to make a new product design process and realize the integrated design of performance and reliability in the research of integration design process by integrating serial design, concurred design and feedback design, reviewing in details the existing performance design items & reliability design items, and basing on the data flow direction and exchange relationship. After research, the flow of circuit integrated design and analysis of performance and reliability is set up as indicated in Figure 2.

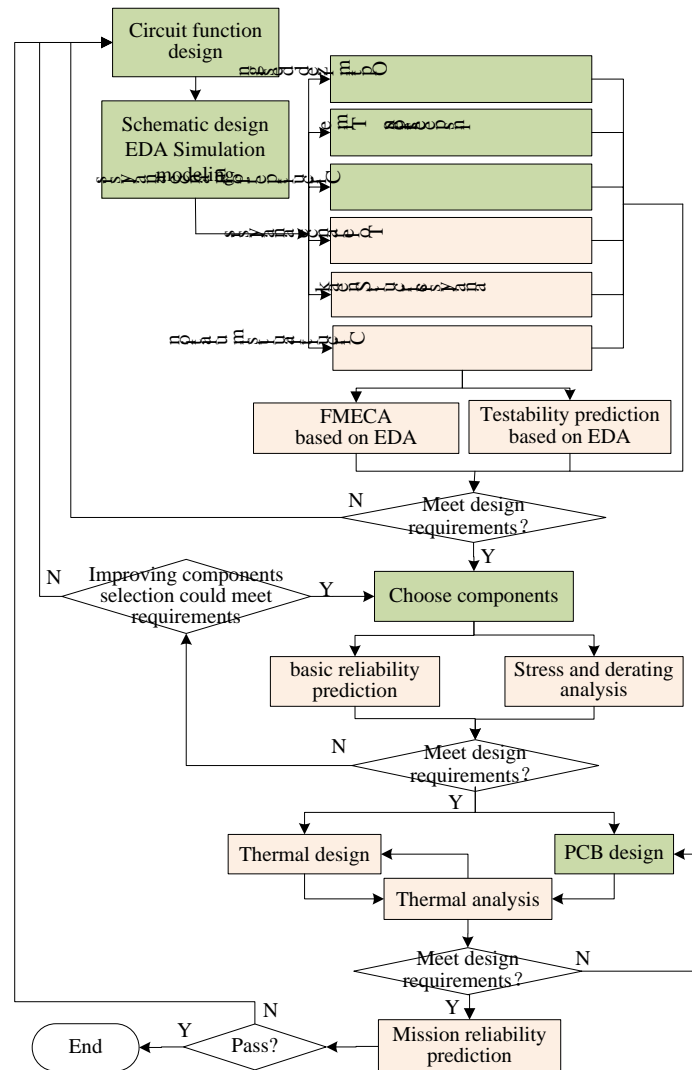


Figure 2. The Flow Of Circuit Integrated Design And Analysis Of Performance And Reliability

In this figure, the green part indicates performance design process, and the pink part indicates reliability design process. The two parts integrates and alternates so as to ensure the design outputs meet both performance requirements and

reliability requirements and to make the product design process more reasonable.

3.2. Integration Data Design

Data integration is the foundation of realizing performance and reliability integration design. In the integrated design process of performance and reliability indicated in figure 2, the latter design item in sequential progressed process are supported by relevant data generated in former item, and concurrently progressed design items need to exchange design information. So a close data coupling relationship exists in design items. Only with an integrated product design data flow

relationship set up, it is realistic to support the collaboration and data information exchange between each item in the integration design process. It's also effective in supporting data exchange and integration in performance design and reliability design. By analyzing the electronic product performance and reliability integration design projects and the relationship between input/output data, data relationship of performance & reliability integration design is set up as shown in Figure 3.

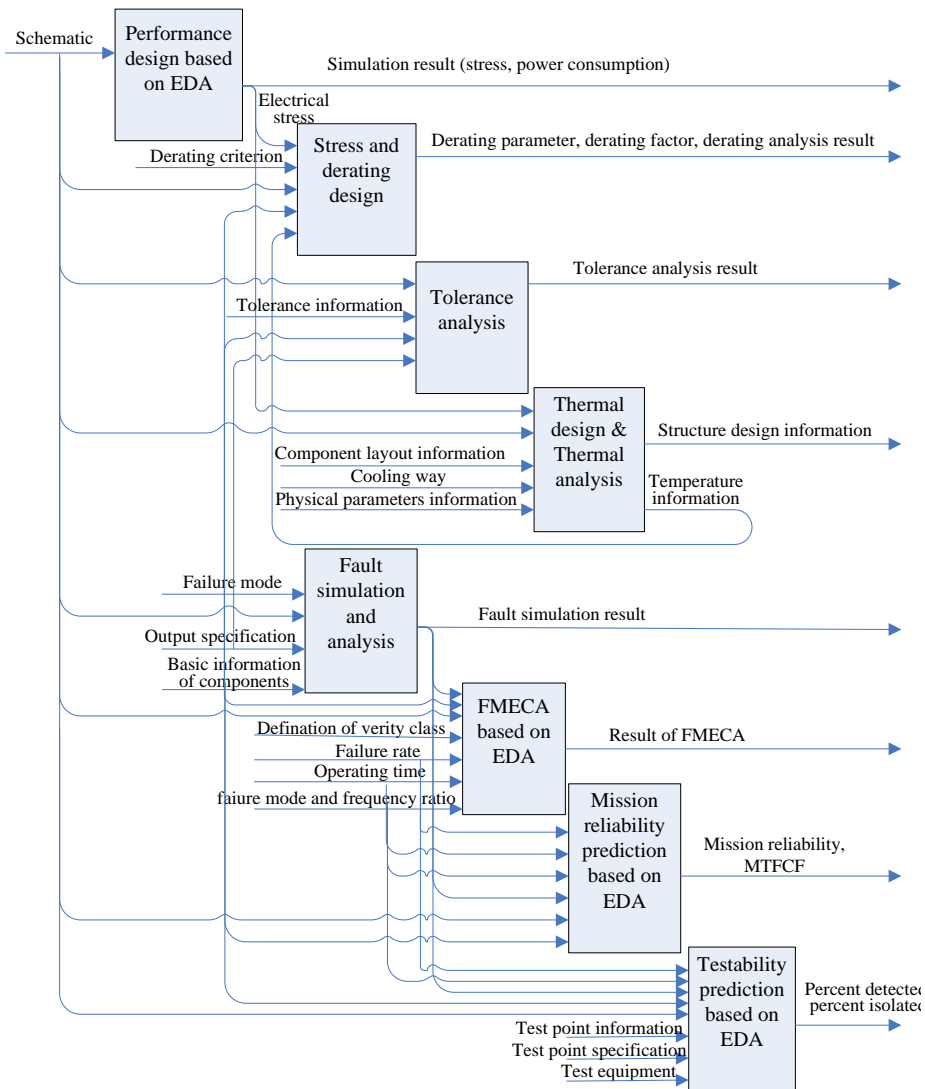


Figure 3. The Data Exchange Relationship Of Integrated Design

Circuit schematic diagram becomes initial input of all items, data of electrical stress and thermal stress generated from simulation will become input data for derating design and thermal design, and temperature information obtained from thermal design & thermal analysis will further become input

data of derating design. Realizing circuit fault simulation by injecting failure model can convert large amount of performance design data to fault information data, which can become input data for FMECA, mission reliability prediction, testability prediction, etc.

4. CIRCUIT INTEGRATED PLATFORM FOR PERFORMANCE AND RELIABILITY AND ITS APPLICATION

Practicing the electronic product performance & reliability integration design requires an integration design environment in capable of providing process control environment, necessary data share environment and core fault simulation means.

4.1. Integration Platform

In the thought of integrated design for performance and reliability, this paper establishes

an integrated platform for performance and reliability of electronic products to meet the need of collaboration. The integrated platform conducts circuit performance simulation in the view of performance designers of electronic products, integrates various reliability design and analysis tools in combination with the overall process of product design, controls product design flow, and uses shared data for the integrated design and analysis of performance and reliability of electronic products. Its structure is shown in Figure 4.

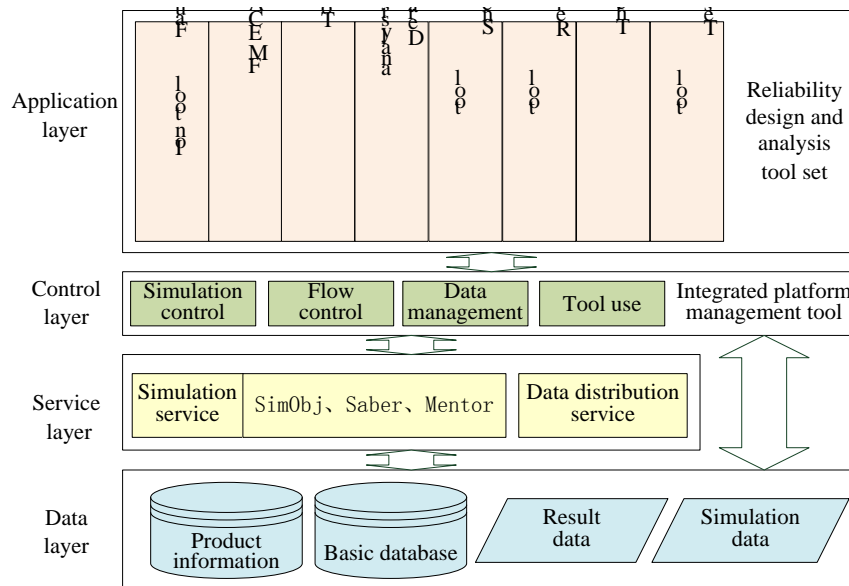


Figure 4. Platform System Structure

(1) Data layer mainly means the management of all data generated during the running of integrated platform, inclusive of product information, standard and criterion and other basic data, normal and faulty data generated by EDA simulation and analysis results, and is the basis of integration.

(2) Service layer is the inner core of the running of integrated platform and includes simulation service and data distribution service. Simulation service mainly means EDA tool simulation running service, e.g. SimObj, and all of EDA simulation, fault simulation, tolerance simulation and others need such service; data distribution service mainly means the distribution of simulation results.

(3) Control layer is system nerve center. It is realized by integrated platform management tool, and can activate various service and use different tools in accordance with simulation logic and design item to realize simulation control, flow control and

tool use, meanwhile, finish data management and data transfer between tools.

(4) Application layer is execution tool of integrated platform and achiever of platform function. It integrates total 8 reliability design and analysis tools, and realizes the interaction among tools via integrated platform management tool.

4.2. Case Study

Here is to take an example of main pass amplifier circuit of rudder loop in a UAV autopilot and have a reliability analysis to the circuit by use of integration platform.

When inputting the circuit EDA schematic diagram, the platform obtains the list of circuit components automatically. When users finish simple settings to the basic information and fault criterion of the components, the platform can automatically complete fault simulation for the

circuit by use of EDA simulator, share all performance simulation result data and fault result data at the same time, and perform analyses like reliability prediction, FMEA, testability prediction, etc. Some results are shown in Figure 5 - Figure 6.

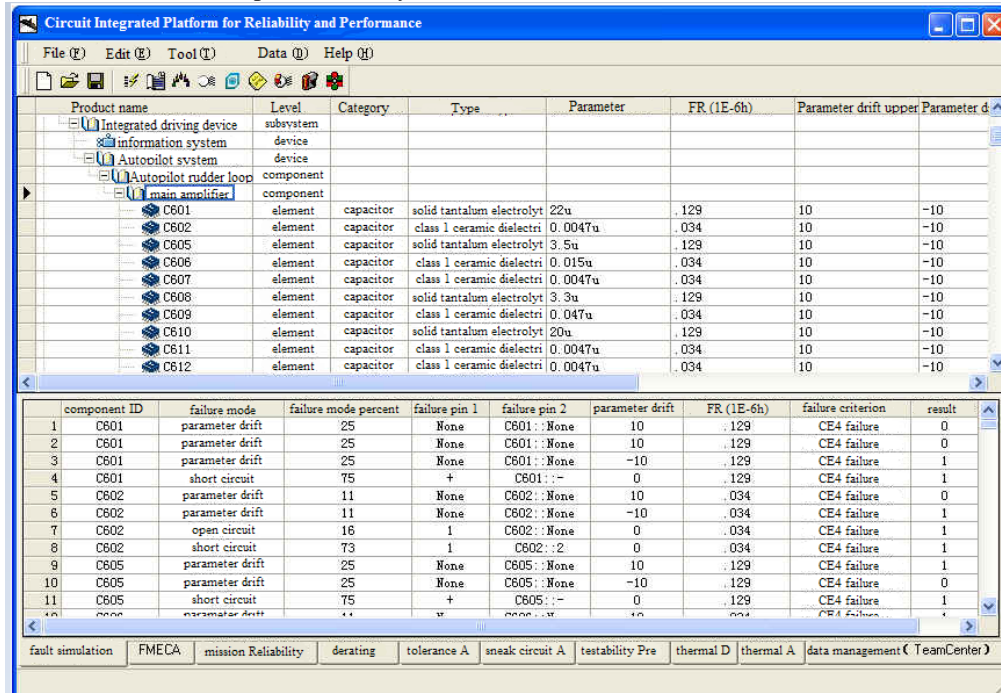


Figure 5. Integration Platform For Performance And Reliability

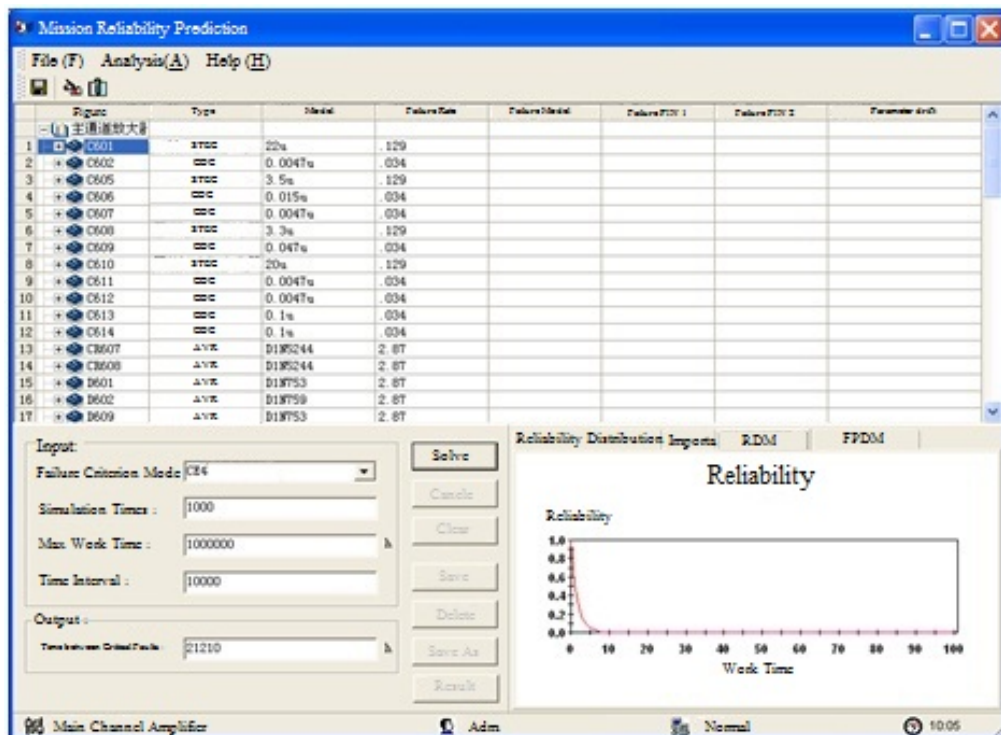


Figure 6. Result Of Mission Reliability Prediction



5. CONCLUSIONS

Integrated design and analysis technology for performance and reliability is a highlight issue in the field of reliability, and it provides an effective technical approach for improving overall performance and reliability of product. This paper, under the guidance of integration thought, studies integration process modeling and integration data modeling, establishes an integrated design and analysis platform for performance and reliability of electronic products. At present, this platform has been developed, and its functions have been verified through typical case analysis. The building and applying of electronic product performance and reliability integration platform is a breakthrough to the current status of separating product performance analysis and reliability analysis, an excellent tool to synchronize performance analysis and reliability analysis for electronic product performance designers and provide design improvement basis thanks to its automatic fault analysis, tolerance analysis and sneak circuit analysis synchronized in the circuit design process. Due to data sharing and process synchronization, the development cycle is effectively shortened, and working efficiency is improved; therefore, it has a significant role in project practice.

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