Design for reliability of power electronic systems

Should reliability be included in the design phase of power electronic systems?
The conventional design of power electronic systems focuses on power density and efficiency. However,the power electronic system is also one of the most life-limiting parts,and thus,the reliability should be included in the design phase,being the design for reliability (DfR) approach,as demonstrated in this chapter.

How to determine reliability of a power electronic system?
A power electronic system usually has many power devices,and each power electronic device has its own unreliability function F (x). In order to perform the system-level reliability assessment,the reliability block diagramof the entire system should be constructed [16].

What is a design for reliability?
For reliability, more challenging issues should be addressed , , , , , , , , . Prediction on the lifetime of the power electronics is the first task so that reliability can be considered in the design phase, which is also referred to as the design for reliability (DfR) , , .

How to design a power electronic system with a specific reliability target?
To design a power electronic system with a specific reliability target,a top-down reliability allocationto the component level is necessary. Fig. 45.13 shows a typical architecture to illustrate this concept. The failure causes of a power electronic system could be hardware,software,and human errors.

How does a power electronics system perform a system-level reliability assessment?
A power electronics system usually has many power devices,and each power electronics device has its own unreliability function F (x). To perform the system-level reliability assessment,the reliability block diagramof the entire system needs to be constructed .

How to improve reliability prediction in power electronic systems?
To improve the reliability prediction,more failure mechanisms as well as possible coupling effects should be taken into account. It in return may make the analysis become more complicated. Nevertheless,the above demonstrates a way to lifetime prediction,and thus enables the DfR in power electronic systems. 45.5. Summary

power systems, and reliability physics degradation models for ... These models can be embedded in digital twins created specifically to replicate the design of current and new inverters. The output of these digital twins reflects the effects of aging and ... transferable to multiple power electronic systems and platforms. Keywords: AI, Digital ...

This article aims to provide an update of the reliability aspects of research on power electronic components and hardware systems. It introduces the latest advances in the understanding of failure mechanisms, testing methods, accumulated damage modeling, and mission-profile-based reliability prediction. Component-level examples (e.g., Si IGBT modules, ...

To be cost effective and safe, reliability design, test and health monitoring and management are a necessary part of power electronics implementation and its integration into energy systems. Being able to design power electronics to meet a required lifetime for a given load profile with a certain probability becomes acheiveable as we understand the physics of failure in power electronic ...

Hence, it calls for highly reliable power electronic systems, where reliability together with various common design parameters should be considered in the design phase. Clearly, it is a prerequisite to know the main life-limiting factors so as to predict the lifetime.

Then, the design for reliability (DfR) can be performed. In this chapter, the technological challenges in the DfR of power electronic systems are addressed and how the power electronics is loaded considering mission profiles is demonstrated. Further, the DfR approach is systematically exemplified in grid-connected photovoltaic power electronic ...

Power electronics systems are used increasingly in a wide range of application fields, such as variable-speed drives, electric vehicles, and renewable energy systems. These elements have become crucial constituents in the further development of such emerging application fields as lighting, more-electric aircraft, and medical systems [1]. Reliable operation ...

This chapter aimed to provide insights about the reliability of power electronic systems. We introduced the basics and metrics of reliability, new modern approaches such as Physics of Failure and Design for Reliability, and also detailed the step-by-step procedure to calculate the lifetime of power semiconductors and capacitors.

High Reliability Power Electronic Systems Supported by: IEEE IES Technical Committee on Power Electronics E lectrification is a megatrend in the modern economy, urged by the need for a more ecological and sustainable impact of new ... Data ...

the power electronic systems with low failure rates during a service life of 20 years or even more. To achieve so, it is vital to know the main life-limiting factors of power electronic systems as well as to design for high reliability at an early stage. Knowhow of the loading in ...

Power electronics is the enabling technology for optimizing energy harvesting from renewable systems like Photovoltaic (PV) and wind power systems, and also for interfacing grid-friendly energy systems. Advancements in the power semiconductor technology (e.g., wide band-gap devices) have pushed the conversion efficiency of power electronics to above 98%, where ...

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The design methodology and utilized techniques for reducing stray inductances and EMI radiation on the printed circuit board, as well as the way to calculate and select the main electronic components, demonstrated the excellent performance, reliability, and high efficiency of the developed half-bridge power cell for modular VSIs.

So far, system-level design for reliability and mainte-nance planning in Power Electronic-based Power Systems (PEPSs) have not been explored. However, they have con-siderable impact on the reliability worth in design and planning of PEPS. On the other hand, design and mainte-nance activities in conventional power systems are per-

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Then, the advances in power electronic components to address the reliability challenges are introduced as they individually contribute to the overall system reliability. The reliability-oriented design methodology is also discussed, including two examples: an EV onboard charger and the drive train inverter.

The need for an integrated design tool for power electronics engineers has been highlighted. Such a tool must consider design variable variations and uncertainties and their impact of reliability distributions. ... (FS/05/01) and the project "A Prognostic and Diagnostic Environment for High Reliability Electronic Systems" (SP/06/03). We ...

Design for Reliability in Power Electronic Systems. Online ... PV systems, reliability, harmonics and adjustable speed drives. He has published more than 300 journal papers in the fields of power electronics and its applications. He has received 17 IEEE Prize Paper Awards, the IEEE PELS Distinguished Service Award in 2009, the EPE-PEMC Council ...

Advances in power electronics enable efficient and flexible interconnection of renewable sources, loads and electric grids. While targets concerning efficiency of power converters are within reach, recent research endeavors to predict and improve their reliability to ensure high availability, low maintenance costs, and therefore, low Levelized-Cost-of-Energy (LCOE) of renewable energy ...

Power electronic systems have their own challenges and new opportunities in enhancing the reliability, which is worthwhile to be investigated. Moreover, design tools, except for the reliability prediction, are rarely applied in state-of-the-art ...

Figure 3. State-of-the-art reliability design procedure for power electronics. 2) Load-strength analysis A component fails when the applied load L exceeds the design strength S.Load L here refers to a kind of stress

(e.g. voltage, cyclic load, temperature, etc.) and strength S refers to any resisting physical property (e.g. harness, melting point,

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