

Prognostic and lifetime modelling for reliable power converters

Prima Electro is a strategic EMS partner in high-tech sectors such as railway, energy and industrial automation. For over forty years, we have been converting ideas into full-custom embedded products, becoming the reference point for all those companies wishing to improve the features and performances of their systems with industrial-grade solutions. Always at the cutting edge of technology in power and control electronics design and production, Prima Electro offers support from the concept and preliminary analysis through the qualification and production stage, supervising the whole manufacturing process. Our business model can be summed up in the acronym DOTS (Dedicated Off The Shelf), because we are able to offer custom “end-to-end” turnkey solutions with a fast time-to-market and competitive costs.

Background:

Power electronics converters are used in a wide range of applications such as renewable energy generation, automotive, railway and industrial motor drives. In all these applications, the power electronics converters are regarded as one of the most unreliable parts of the system therefore the reliability analysis has become an important issue. Understanding the power converters lifetime limitations is critical to improve the life cycle cost, reduce components oversizing and predict the converter end-of-life. For each component inside a power converter, the failure mechanisms are investigated in order to find methods able to predict the components remaining useful life. For example, in a power converter the temperature is one of the major root causes of failure and the semiconductors and capacitors are the most vulnerable parts showing failure mechanism correlated to their average working temperature and thermal swing. Prognostics and health management (PHM) allows detecting signs of failures, providing warnings of failures in advance, and performing condition-based maintenance.

Type of work: Master Thesis

The goal of the thesis is to investigate the state-of-the-art prognostic techniques and to develop a robust prognostic model to detect anomalous behaviour and predict the lifetime of devices. The candidate will carry out the thesis in the Prima Electro R&D department.

Expected tasks:

- Literature survey of the failure mechanism and the end-of-life criteria for semiconductors and capacitors (10% of time)
- Literature survey of the state-of-the-art techniques for the converter health management able to predict the remaining useful life (30% of time)
- Simulation and hardware design (10% of time)
- Experimental testing on an industrial converter (40% of time)
- Documentation of all the activities (10% of time)

Requirements:

- Background on power electronics components as capacitors, diodes, SCRs and IGBTs
- Basic knowledge of power electronics converters principles and topologies
- Good knowledge of MATLAB and PLECS tools
- Basic knowledge of analog circuit design
- Analytical skills

Duration: 6-9 months

Contact:

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The master thesis project will be carried out at Prima Electro S.p.A.
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