CESARE'17
International Conference Coordinating Engineering for Sustainability and Resilience
Dead Sea, 3-8 May 2017

Switching charastristcs of IGBT as the initial failure indicator of the wind turbine converters

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Keywords: Relability, Insulated Gate BipolarTransistor (IGBT), Wind Turbine, Failure Mechanism

ABSTRACT

High power insulated gate bipolar transistor (IGBT) modules are widely used in the power electronics converter of wind turbines. However, it is difficult to estimate correctly their reliability, as it is dependent on variable operating conditions that cause mismatch between the thermal expansions of the different layers of the device, especially between the silicon semiconductor chip module of aluminum bond wire[1]. Bond wire lift-off and solder fatigue are the most common degradation causes of IGBT modules for wind turbine applications[2]. These degradations may significantly affect the temperature distribution within the IGBT modules and lead to early failures of the modules. Temperature response is fairly slow and, hence, temperature monitoring is not recommended in monitoring the state of health of IGBT modules for variable and unpredictable loads like those of wind turbines. The perpose of this paper is to study the influence of bond-wire lift off and solder fatigue on the switching charastristics of IGBT modules, in particular the turn-on and turn-off delay times, the turn-on and turn-off times for different values of the dc-bus voltages and different load currents. Bond wire lift-off is manually imposed to the module by physically lifting off some of the bond wires. On the other hand, solder fatigue is modeled by changing the heat sink of module, as solder fatigue affects the thermal coupling between the die and the contact pad, introducing voids between the layers and reducesthe effectiveness of the power transfer from the die to the heatsink. The effects of these faults on the switching

charastristics of the IGBT module are discussed in details by comparing the experimental results of healthy and damaged modules.

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