

Fault tolerant control of energy processes

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Abstract: This work deals with the control of energy systems subject to faults. The objective is to accommodate faults by the design of a control law that takes into account the existence of internal faults and dysfunctions caused by external environment. Energy systems are characterized by the dependence of their performance on energy efficiency, the total efficiency is the result of the operation of elementary energy processes to verify the final objective which is the production of energy in its final form. The supervision of these processes and tolerance to faults allow the improvement of individual performances and the achievement of global efficiency at a lower cost. In this context, renewable energy conversion processes are characterized by the aspect of their dependence on climatic conditions and direct exposure to outdoor environment, resulting in the occurrence of different types of faults and dysfunctions. Solar photovoltaic renewable energy generation systems are considered in this work as they dominate renewable electricity capacity expansion. The study of the effect of various abnormal events and degraded operating modes of solar photovoltaic systems is performed and a fault-tolerant control law is proposed to enhance the efficiency of these energy processes. A reconfiguration of controller is designed to switch between an improved current-based particle swarm optimization technique and the incremental conductance algorithm. Practical implementation of the proposed approach shows excellent performance in real operating conditions when compared to traditional maximum power point algorithms.

Keywords : fault-tolerant control, energy systems, renewable energy, Solar energy, Photovoltaic, Maximum Power Point Tracking, Particle Swarm Optimization