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INTERCONNECTION OF A PHOTOVOLTAIC GENERATOR (PVG) TO A MAIN SUPPLY: A SIMULATION STUDY

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Abstract. *This paper presents a technique for interconnecting a photovoltaic generator (PVG) to a main supply of AC nature. The technique uses a single phase full wave bridge rectifier. Such bridge rectifier is operated in an inverter mode of operation. and that is to guaranty its contribution of real power to a main AC supply. The bridge rectifier is also operated in such a way that its control circuit (i.e triggering circuit) is self adjusted when extracting the maximum power from the PVG and injecting such power into to the main AC supply. The proposed technique has been formulated by a* MATLAB/SIMULINK *model. The simulation of the developed simulink model shows for a certain pre-defined AC load that up to 66.39 % of the power required by an AC load is obtained from the PVG source. The remaining 33.61 % of power required by the AC load is provided by the main AC supply. The Simulink model shows also that nearly 99.14 % of power can be extracted from the PVG source at a certain pretended solar radiation level (i.e insolation level).*

Key words: Integration of Renewable Energy Sources to Grid Systems, Photovoltaic Generation System, Maximum Power Point Tracker, AC/DC Converter Applications, MATLAB/SIMULINK Applications.

1. Introduction

It is well known that most (if not all) renewable energy resources suffer from the lack of providing constant power when the surrounding weather and environmental conditions change. Due to such non-constant power provision characteristic, storage batteries are traditionally employed in parallel with the renewable energy resources and that is to supply any deficiency or to absorb any excess in load energy requirements. Unfortunately, the storage batteries are characterized by an additional considerable cost to renewable energy resources cost. Moreover, the storage batteries have also a short life time when compared to the life time of the renewable energy resources. A wise solution to overcome the problem of relying totally on the power generated only by the renewable energy resources is to constitute a hybrid DC grid that should contain or connect all renewable energy resources plus storage units (storage batteries + fly wheels) in parallel and interconnecting such hybrid DC grid to the AC grid using power inverter [1] modules. A glance at the anticipated task from such proposed solution is that at any time of operation and for any prospective energy load demand the energy is guarantied from the DC grid as well as from the AC grid. One should note that it will be nice to use the AC grid whenever there is deficiency in energy from the hybrid DC grid. The ultimate goal of the proposed solution is to ease the constraint on relying totally on the storage batteries. The realization of the objective of the above proposed solution necessitates the development of advanced and smart power flow controllers. Such controllers may turn-out to be expensive and may not be flexible to certain modes of operation.

This paper continues the exploration of the author's idea reported in reference [2] which proposed a practical alternative to interconnect a PVG source to a main AC supply. Unfortunately, the author [2] had tried his work at a relatively low power ratings an more importantly he had not targeted the maximum extraction of power from the PVG source. That was due to the fact that he has operated his experimental setup on an open loop control way. This present contribution introduces a self-adjusted firing angle controller that can be attributed the term: maximum power point tracker and which is operated in closed loop format while targeting the maximum extraction of power the PVG source.

The work is done in the Matlab/Simulink environment and the simulation results prove the effectiveness of the tracker under a number of pretended insolation levels.

2- Study System

A general scheme of the study system is represented in figure 1. The desired powers flow is simplified in figure 1(a). Figure 1(b) consists of four main parts: An AC voltage source representing a 50 Hz main supply in series with a pretended equivalent source inductance, an AC load requiring a constant power and it is connected at a point refereed to usually in the literature by the term: point of common coupling (PCC), a bridge rectifier in series with a reactance representing the inductance of a power transformer, and a DC voltage source consisting of a PVG source in series with a reactor. The polarity of the PVG is reversed in the figure and that is to indicate that the PVG will be generating power rather than absorbing power. The bridge rectifier is controlled by a firing angle controller. The next subsections describe the PVG model and the contents of the important blocks of figure 1.