World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:12, No:11, 2018

Design, Control and Implementation of 300Wp Single Phase Photovoltaic Micro Inverter for Village Nano Grid Application

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Abstract : Micro Inverters provide Module Embedded Solution for harvesting energy from small-scale solar photovoltaic (PV) panels. In addition to higher modularity & reliability (25 years of life), the MicroInverter has inherent advantages such as avoidance of long DC cables, eliminates module mismatch losses, minimizes partial shading effect, improves safety and flexibility in installations etc. Due to the above-stated benefits, the renewable energy technology with Solar Photovoltaic (PV) Micro Inverter becomes more widespread in Village Nano Grid application ensuring grid independence for rural communities and areas without access to electricity. While the primary objective of this paper is to discuss the problems related to rural electrification, this concept can also be extended to urban installation with grid connectivity. This work presents a comprehensive analysis of the power circuit design, control methodologies and prototyping of $300W_P$ Single Phase PV Micro Inverter. This paper investigates two different topologies for PV Micro Inverters, based on the first hand on Single Stage Flyback/ Forward PV Micro-Inverter configuration and the other hand on the Double stage configuration including DC-DC converter, H bridge DC-AC Inverter. This work covers Power Decoupling techniques to reduce the input filter capacitor size to buffer double line (100 Hz) ripple energy and eliminates the use of electrolytic capacitors. The propagation of the double line oscillation reflected back to PV module will affect the Maximum Power Point Tracking (MPPT) performance. Also, the grid current will be distorted. To mitigate this issue, an independent MPPT control algorithm is developed in this work to reject the propagation of this double line ripple oscillation to PV side to improve the MPPT performance and grid side to improve current quality. Here, the power hardware topology accepts wide input voltage variation and consists of suitably rated MOSFET switches, Galvanically Isolated gate drivers, high-frequency magnetics and Film capacitors with a long lifespan. The digital controller hardware platform inbuilt with the external peripheral interface is developed using floating point microcontroller TMS320F2806x from Texas Instruments. The firmware governing the operation of the PV Micro Inverter is written in C language and was developed using code composer studio Integrated Development Environment (IDE). In this work, the prototype hardware for the Single Phase Photovoltaic Micro Inverter with Double stage configuration was developed and the comparative analysis between the above mentioned configurations with experimental results will be presented.

Keywords : double line oscillation, micro inverter, MPPT, nano grid, power decoupling
Conference Title : ICPEPE 2018 : International Conference on Power Electronics and Power Engineering
Conference Location : Venice, Italy
Conference Dates : November 14-15, 2018