HIGH EFFICIENCY SOLAR PHOTOVOLTAIC MICROINVERTERS WITH ISOLATED OUTPUT

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FEBRUARY 2015

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by

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submitted
in fulfillment of the requirements of the degree of
Doctor of Philosophy

to the

Indian Institute of Technology Delhi
February 2015

CERTIFICATE

This is to certify that the thesis entitled ***"High Efficiency Solar Photovoltaic Microinverters with Isolated Output"*** submitted by **Mr. Viranchi Chudamanibhai Pandya** for the award of the degree of the **Doctor of Philosophy** to the **Indian Institute of Technology Delhi** is a record of the bonafide research work he has carried out under my supervision. The results contained in this thesis have not been submitted to any other University or Institute for award of any degree or diploma.

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ACKNOWLEDGEMENTS

I gratefully express my sincere gratitude to my supervisor Shri A. K. Agarwala for his invaluable guidance, constant encouragement and support throughout this work. No amount of words can really be adequate in expressing my sincere thanks to him and without his unremitting support, this work would never been completed. His valuable suggestions and guidelines kept me focused in my research.

I am also grateful to my institute "A. D. Patel Institute of Technology, New Vallabh Vidyanagar" for putting trust on me and granting me study leave for this venture.

I am especially thankful to Dr. N. K. Jain, other faculty members and staff members of IDDC for providing immense encouragement and unsolicited support.

I am also thankful to Mr. V. K. Gandhi of NMR lab, IDDC for his sincere help in experimental work.

I would like to earnestly extend my thanks to my friends Sumer Singh, P. Packiam, Vashist Bist, Ashish Patel and Mayur Mistry for making my stay at IITD an intellectually stimulating environment.

Most importantly, I would like to express my heart-felt gratitude to my parents for their encouragement and blessings. I am greatly thankful to my wife, Drashti, and my son Swayam for their patience, cheerfulness and understanding during the course of my research. None of this would have been possible without the love and patience of my family.

I would finally like to thank all those directly and indirectly involved in making of this thesis and my research work a success.

Viranchi C. Pandya

Abstract

Because of the constantly increasing demand for electricity, and with the limited availability of conventional fossil fuels, research is now targeted towards sustainable energy generation.

The sun is a very powerful source of energy, and solar photovoltaic cells convert photon energy to electrical energy without any intermediate stage. A number of solar cells in series parallel combination can produce a significant amount of dc power. So, a power conversion system can be developed such that it will convert this dc power to ac power which can be used as a standalone power system or can also be connected with existing electrical grid system.

In any power conversion process, low power loss and hence high energy efficiency is very important. The other important considerations are the size, weight and cost of the power processor. Among the different types of power converters, switched mode power converters are now mostly used for the power conversion process. In such power converters, as the switching frequency increases, the size of inductors and capacitors decrease and hence the weight and size of overall converter also decreases.

Switched mode power converters can be of any type like dc-dc, dc-ac, ac-dc or ac-ac. Depending on need, one can design any such converter with high efficiency. In this work, an attempt is being made to develop a high efficiency solar micro-inverter with isolated output. A solar micro-inverter is a power converter module up to the range of 500W, which is integrated with a solar panel and can generate rated ac power with high efficiency. Such a device can be used as a solar power module unit which can be cascaded to construct micro-grids. A single stage modified time shifted sinusoidal pulse width modulation based bridge type photovoltaic micro-inverter is proposed here with isolated output for single phase configuration. The micro-inverter uses at input a full bridge topology using four power switches. A rectified sine wave at

50 Hz with 220 Vrms amplitude is generated by implementing time shifted sinusoidal pulse width modulation at 100 kHz. An unfolder bridge creates full sinusoidal voltage at the output.

A further simplified and lower cost single stage diagonal photovoltaic micro-inverter is also proposed for single phase configuration. This micro-inverter uses at input a forward converter in a diagonal topology using only two power switches. A low cost laboratory prototype is developed for diagonal micro-inverter for 300 W power rating. Major losses including switching loss, conduction loss, and magnetic component losses were evaluated via simulation and validated via extensive measurements. The proposed micro-inverter has advantages like small size, low power losses and simple architecture with estimated efficiency more than 95%. A boost stage is interfaced to extract maximum power from a PV module. The extensive control and calculation capabilities needed to implement the algorithms for switching at 100 kHz frequency, PWM modulation, phase lock and grid connection for 300 W laboratory prototype of diagonal micro-inverter were implemented on a high performance controller.

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