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CONTROL OF ACTIVE AND REACTIVE POWER FOR GRID GONNECTED PV INVERTER

A Thesis
Submitted in partial fulfillment for the requirement of the Degree of Master of Science in Electrical Engineering

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Keywords:

Renewable Energy, Photovoltaic, Distributed Generator, Maximum Power Point Tracking, Grid Connected inverters, Phase Locked Loop, Low Voltage Ride Through.

Abstract

PV grid-connected systems become one of the most important and promising applications for solar energy. The interfacing of solar PV systems to the grid requires efficient control strategies for operation, control and Power Quality (PQ) improvement. In order to facilitate increasing the penetration levels of PV systems into the grid, Egypt has approved the Feed in Tariff systems (FIT),which aims to generate 2300 MW of PV system , also with the advancement of the technology and reduction in the cost of the power electronic devices, PV prices are rapidly decreasing. Due to these incentives, grid connected PV solar systems are growing rapidly and many new investments in this field are published, recently the Egyptian Ministry of Electricity and Renewable Energy have added 40 KW PV system connected to the grid over its building which will be the core of this thesis.

For grid-connected PV applications, two different topologies have been mostly studied worldwide, known as one-stage and two-stage PV systems. This thesis presents a comparative study with the basic characteristics for two types of topologies of a grid-tie PV system to show the overall system performance aspects including energy conversion efficiency, power quality, and maximum power point tracking "MPPT" accuracy.

In addition, the thesis presents the maximum real and reactive power control algorithm for 40 kW three-phase single-stage PV system using a fast approximation interpolation algorithm of MPPT. For synchronization with the grid, the phase locked loop technique (PLL) is used, which controls the system using dq0 transformation by converting the three-phase voltages into the d-q axes. This technique utilizes the filtered grid voltages and gives an improved results.

The operational objectives of PV system are fulfilled by many control schemes, MPPT control mode, a certain amount of real power control mode and the switching between them. During sunlight, the system sends active power to the grid and at the same time compensates some of the load reactive power. In case of lower isolation level, the inverter compensates some of the load reactive power. The advantage of this strategy is to get use of the inverter total capacity all day long.

According to the grid code requirements to remain photovoltaic inverters connected to the grid to ride-through the faults and support the grid voltages, the control of a single-stage grid-connected photovoltaic power plant must fulfill the low-voltage ride through (LVRT) requirements. The control of the inverter has to incorporate reactive power support in the case of voltage sags. For this purpose, some modifications need to be applied to make the inverter ride-through compatible with any type of faults according to the grid codes.

These modifications include developing a control strategy using a droop control algorithm is activated to address the LVRT capability in order to remain the output currents and voltages sinusoidal. Selected simulation results are reported using error techniques (error, absolute error, performance index error) to validate the effectiveness of the proposed control algorithm. The control algorithm suggested making the photovoltaic system generates the maximum power available from the solar source and, at the same time, capable of contributing with the voltage regulation of the grid.

ACKNOWLEDGEMENT

I have the great honor to express my deepest gratitude and sincere thanks to **Prof. Dr. Mohamed Abd-El-Latif Badr** at Electrical power & Machines Department, Faculty of Engineering, Ain Shams University, for his kind supervision, guidance and continuous encouragement and for his helpful and fruitful discussions in the preparation of this thesis.

I wish to express my deepest gratitude and sincere appreciation to **Prof. Dr. Ahmed Mohamed Atallah** at Electrical power & Machines Department, Faculty of Engineering, Ain Shams University, for every good help and guidance during carrying this thesis.

Finally, but most importantly, I would like to thank **my beloved family** who always give me strong inspirations, moral supports, and helpful suggestions. Without them, my study career would never have begun.

Mostafa Hasaneen

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NOMENCLATURE:

AC	Alternating current
ABH	Adaptive Band Hysteresis
DC	Direct current
G	Solar radiation
Gref	Nominal solar radiation
Id_1	Main current of the first diode
Id_2	Main current of the second diode
id ref	The reference current of real power
Ipv	Output current of PV cells
Iph	The photo current of PV cell.
Is_1	Saturation current of the first diode
Is_2	Saturation current of the second diode
Ish	Shunt current
Isc	Short circuit current
K	Boltzmann constant
m_1	Ideality factor of the first diode
m_2	Ideality factor of the second diode
MPPT	Maximum Power Point Tracking
PCC	Point of common coupling
PV	Photovoltaic
Ppv	Output power of PV cells
PI	Proportional integral
PLL	Phase locked loop
Q	The electron charge
Rs	Series resistance
Rsh	Shunt resistance
T	Temperature of PV cell.
THD	Total Harmonic Distortion
Vdc ref	Reference DC voltage determined by MPPT scheme
Vpv	Output voltage of PV cells
VSC	Voltage source converter
VSI	Voltage source inverter
VT	Thermal voltage