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POWER MANAGEMENT IN GRID CONNECTED PHOTOVOLTAIC SYSTEMS

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Abstract

Photovoltaic energy is a free clean and non pollutant renewable energy source. The costs of PV energy production have been reduced by more than 30% during the last decade and will continue decreasing in the future. On the other hand, prices for fossil energy sources increase dramatically. Therefore, Photovoltaic energy is promising source of energy for many of world countries.

Photovoltaic systems are a green power source, which can convert sunlight to electrical energy. Photovoltaic systems may be subjected to electrical change of operating condition due to change in insolation levels, ambient temperature and grid faults. Consequently most of photovoltaic systems operators want to protect their systems and guarantee continuous successful operation. Therefore, they adjust the systems to simply disconnect from the grid during any electrical disturbance. The design of the proposed photovoltaic system interconnected with electric utility has many difficulties if we take all economical and technical parameters into account. Therefore, designers define many techniques that do not allow photovoltaic systems to be disconnected from the electric grid for avoidable or less dangerous electrical disturbance.

The main objectives of this thesis are designing of a photovoltaic grid connected system with no battery storage and managing of active and reactive power of the proposed system. Therefore, the challenge in this research work is to introduce a possible circuit topology for the DC/DC converter controller and the grid-connected DC-AC power inverter controller.

The Matlab /Simulink simulation package version R2009a has been employed to design the proposed system, controller topologies and introduce the simulation results. Analyses of results are conducted.Conclusions and recommendations are extracted.

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Statement

This thesis is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering.

No Part of this thesis has been previously submitted for obtaining a degree or qualification before.

Name: Khaled Said Abdel Latif

Date:

Signature:

Contents

Q	Reactive power,Var.
^{o}C	Celsius.
T	Ambient temperature.
KB	Boltzman's constant.
^{o}K	Kelvin.
J	Joule.
C	Coulombs.
W	Watt.
VA	Volt ampere.
Ah	Ampere hour.
N_s	Number of cells per module.
N_m	Number of module per array.
A	Ideality factor for p-n junction.
q	Charge of the electron.
K_i	Integral gain.
K_p	Proportional gain.
kWh	Kilo watt hour.
A_c	Amplitude of the carrying wave.
A_r	Amplitude of the reference wave.
m_f	Frequency modulation index.
S	Apparent power.
m_a	Amplitude modulation index.
F_r	Frequency of the reference wave, Hertz.
F_c	Frequency of the carrying wave, Hertz.
ω	Angular frequency.
S	S-plane.
Z	Z-plane.

K	Gain.
T_S	Sample time, Second.
$\alpha\beta$	Two phases stationary reference frame.
abc	Three phases rotating frame.
dq	Two phases rotating reference frame.
P_{dq}	Active power in the dq frame.
q_{dq}	Reactive power in the dq frame.
V_d	Direct axis voltage, volt.
V_q	Quadrature axis voltage, volt.
I_d	Direct axis current, Ampere.
I_q	Quadrature axis current, Ampere.
(V_a,V_b,V_c)	Phase to neutral voltages, Volt.
θ	Transformation angle, Degree.
L_r	Coupling inductance, Henry.
R_r	Coupling resistance, Ohm.
V_{inv}	Inverter output voltage, Volt.
F	Fundamental frequency, Hertz.

Abbreviations

PVs	Photovoltaics.
PV	Photovoltaic.
SPV	Stand alone photovoltaic system.
MPPT	Maximum power point tracker.
DC	Direct current.
AC	Alternating current.
p-n	Positive - negative.
MPP	Maximum power point.
PWM	Pulse width modulation.
BJT	Bipolar junction transistor.
IGBT	Insulated gate bipolar transistor.
DCM	Discontinuous conduction mode.
CCM	Continuous conduction mode.
PCU	Power conditioning unit.
S	Switch.
D	Diode.
L	Inductor.
C	Capacitor.
R	Resistance.
LF	Low frequency.
HF	High frequency.
UG	Utility grid.
MPP	Maximum power point.
DSP	Digital signal processor.
PI	Proportional integral.
THD	Total harmonic distortion.

PLL	Phase locked loop.
BJT's	Bipolar junction transistors.
FPGA	Field programmable gate array.
DG	Distributed generation.
CSIs	Current source inverters.
VSIs	Voltage source inverters.
CCM	Continuous conduction mode.
DCM	Discontinuous conduction mode.
TF	Transfer function.
num	Numerator.
den	Denominator.
Mosfet	Metal oxide semiconductor field effect transistor.
CC	Current control.
VC	Voltage control.
SVM	Space vector modulation.
CB	Carrier based.
FET’s	Field effect transistors.
GTO’s	Gate turn off transistors.
KVL	Kirchhoff’s voltage law.
EMTP	Electro-magnetic transients Program.
VOC	Voltage oriented control.
PF	Power factor.

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