Solar Power based Lifting System using DC Shunt Motor

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Abstract

Due to rapidly aging electric transmission power and distribution increased demand for energy, awareness of climate change and greenhouse gas pollution, and increased cost of fuel there is a need to produce and deliver energy more efficiently power. Solar energy is an important renewable resource which is abundant in nature and free of running cost though its installation cost is higher. The simulation study of the boost converter is presented in a standalone photovoltaic energy scheme. Moreover the simulation for a DC motor is presented in photovoltaic generator. Trapped solar energy is used to run motors for different applications. Motors used for applications are dc motors, induction motors or BLDC motors of which DC SHUNT motors are more advantageous and it is taken for analysis.

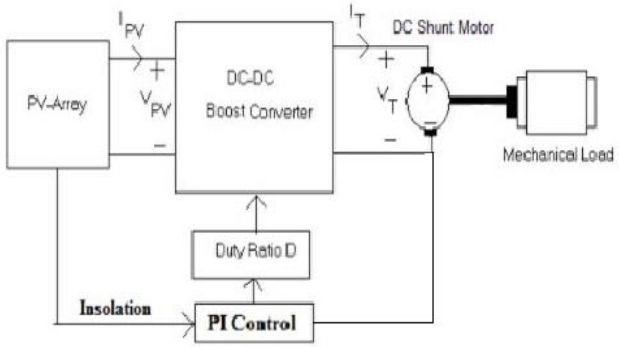
The complete system consists of an array of solar panels a boost converter with PIC controlled DC shunt motor. DC-DC converters are used to convert the unregulated DC input into a regulated DC output at desired voltage level. The duty cycle (D) of the converter is adjusted to obtain a constant level of voltage or a variable voltage Vout in case of voltage regulator or maximum power respectively.

Keyword—PV, Boost Converter, DC shunt motor, PIC Controller.

Introduction

Depletion and harmful effects of fossil fuels like carbon emission, global warming led to the utilization of renewable energies as they are a best alternative to the conventional energy resources. Renewable resources like solar energies and wind energies are receiving wide attention. India was the first country to include a separate ministry under government for renewable sources. The advantages like pollution free generation, no running cost and large abundance in nature made increasing attraction towards the installation of solar PV generating system. The tracked energy can be used for a wide range of applications like water pumping, ventilators etc. Irrigation in remote areas is economical with the use of solar PV water pumping system where transmission of conventionally generate dielectricity is either costly or not possible .Photovoltaic (PV) units are the most promising technologies for supplying load in remote and rural regions. PV system refers to any array of cells containing PV material that converts solar radiation into direct current electricity. PV systems work by converting light into electrical power. This is achieved using a thin layer of semiconducting material, most commonly silicon, enclosed in a glass or plastic
casing. When exposed to sunlight the semiconducting material causes electrons in the materials' atoms to be knocked loose. The electrons that are knocked loose then flow through the material to produce an electric current known as a DC.
In this study, PV array are designed to provide their maximum power at the rated conditions of the DC shunt motors when the PV array is fully illuminated. The average value of the output voltage of the DC-DC converter is controlled by its duty ratio with an aim of keeping fixed voltage across the terminals of the motors at all realistic loading conditions and solar illuminations.

BLOCK DIAGRAM



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II. PV MODULE

PV arrays are built up with series/parallel connected combinations of solar cells. PV cell equivalent circuit can be represented by a current source with a shunt diode D, shunt resistor Rsh and series resistor Rsas illustrated in Fig.2.

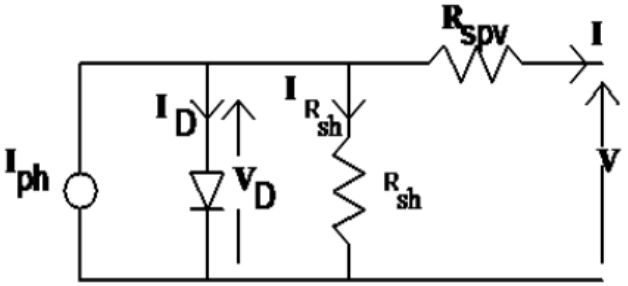

Fig 2: PV Cell Equivalent circuit

The MATLAB/Simulink block model of the PV panel has been used. PV panels are connected in series/parallel. In this study, we have the single array and 5 module and 40 panels.

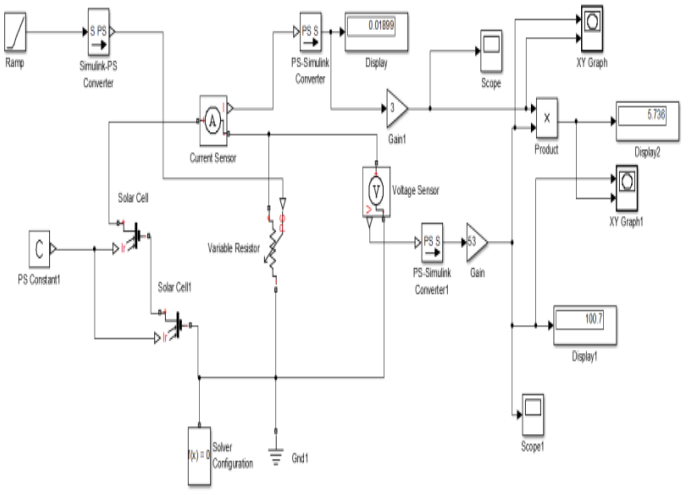

Fig 3: Simulation circuit of PV panel

Output curve of PV module.

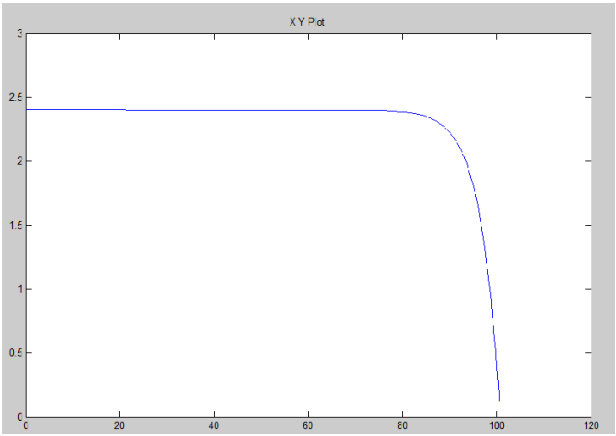

Fig 4: output of PV showing relation of voltage and current

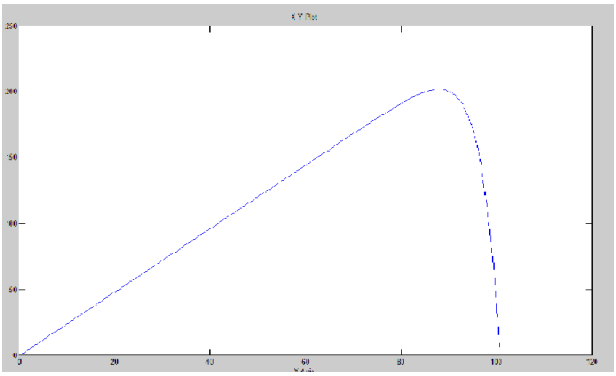

Fig 5: output of PV showing relation of voltage and power.

III.MODULATION OF THE SYSTEM

The system is consists of the PV array feeding a DC shunt motor via DC-DC boost converter. The motor are controlled by FLC in two loops (one for speed and other for current).

Fig.1 shows the PV array feeding a DC shunt motor via DCDCboost converter.

DC SHUNT MOTOR Shunt DC Motors operate on direct current. As such, the field windings and armature are connected in a parallel combination, and in electrical terminology a parallel combination is known as a shunt. This type of motor is a "shunt-wound" DC Motor and the type of winding is called a shunt winding In shunt motor, the field circuit is connected in parallel with the armature. Adjustable resistor Ris normally connected in series with the field circuit for speed control

BOOST CONVERTER

The boost converter is capable of providing an output voltage that is greater than the input voltage. It is also known as a step up converter and one switch is used. For which the continuous-time state space averaged representation Fig. 6 shows, the simulation blocks diagram of the boost converter analysis by MATLABSIMULINK. The Dynamic performance of boost converter with step change in PV isolation is shown in Fig. 7. The isolation changes from 0.6 to 1 at time 5 sec.

CALCULATION

Input voltage=150 V

Output voltage =230 V

Duty ratio=34.78

Frequency =25 kHz

Output power =372.85W

Output current =9.18 A

Resistance =25 ohm

Vo = Vin/(1-D)

D = (1- Vin) / Vo

ΔI = 30 % of I0

ΔV = 5% of V0

ΔI = (D*Vin) / (FS * L) => L = (D*Vin) / (FS * ΔI)

ΔV = (D*I0) / (FS * C) => C = (D*I0) / (FS * ΔV)

By calculation the value of capacitance and inductance is.. C = 0.000195978 F

L = 0.429382716 H

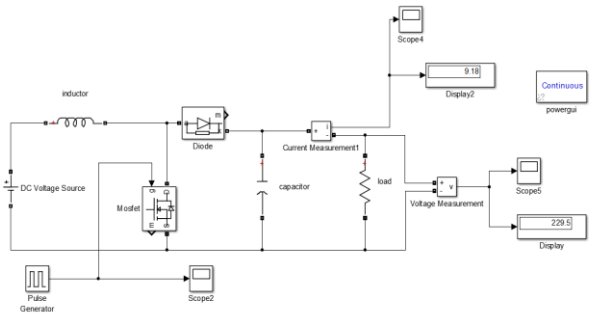

Fig 6: Simulation circuit of Boost converter

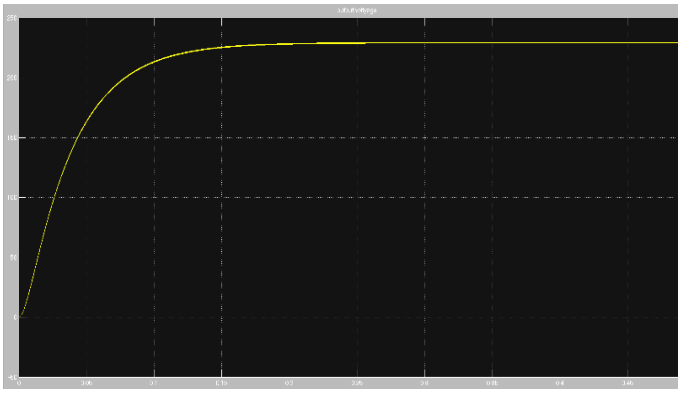

Fig 7 : simulation output of boost converter

PIC MICRO CONTROLLER

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and erasing are other features of PIC 16F877.

IV.RESULTS AND CONCLUSION

OVERALL BLOCK DIAGRAM

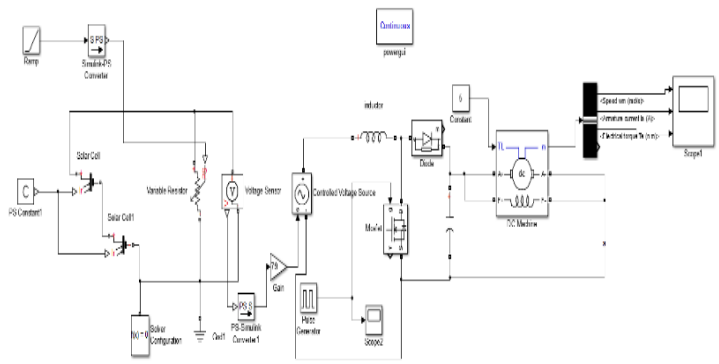

Fig 8: overall simulation circuit diagram

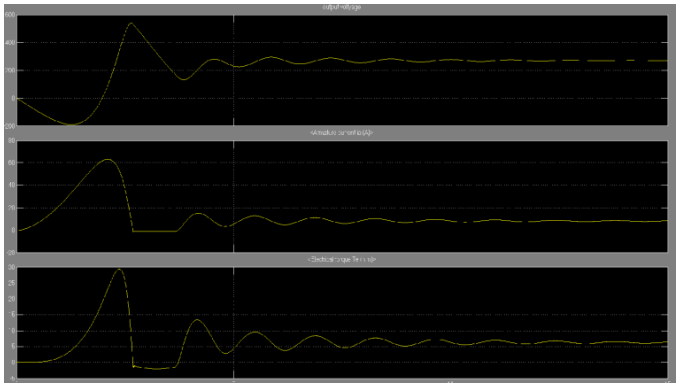

fig 9 : simulation output of overall circuit model

CONCLUSION

During this paper, we have focused on the development of a stand-alone autonomous PV system. Modeling and simulation of PV isolated system are presented. The system is simulated in the MATLAB/Simulink. The individual system performance of PV system is studied through simulation for solar insolation and temperature. The system is tested under different conditions at different level of insolation with change in load value. The proposed system performs well under different loading conditions. The duty cycle of this converter is decided by PI controller. This study presented speed control of DC Shunt motor fed directly through DC boost converter by PV generator. The control of speed and current are controlled by PIC. It was study voltage and current coupled with DC shunt motor at change in speed.

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