Speed Control of Solar Power FedInduction Motor Drive Simulation/Matlab

KRUNAL ZODAPE[1], MANDAR ISASARE[2], RUPALI WADKAR[3], HARSHAL SAKHARE[4], NITIN BADWAIK[5], MANGESH WANDHARE[6]

[1, 2, 3, 4, 5, 6] *Electrical Engineering, J D College of Engineering and Management, Nagpur, Maharashtra*

***Abstract*— Conventional energy sources are widely used to generate electricity, but they are harmful to the environment. Using renewable energy is an alternative solution to overcoming global warming. Solar energy has enormous potential for all renewable energy sources. Due to the low configurable efficiency of PV arrays, we can obtain maximum DC power by tracking the maximum power point using a boost converter. In this document, MPPT is used to track the maximum power point of the boost converter and feed its output to the inverter of a VFD (variable frequency drive) system. The model will be developed in MATLAB/SIMULINK.**

***Indexed Terms*— Solar panel, boost converter, 3-phase inverter, 3- phase induction motor, vector control.**

I. INTRODUCTION

The use of conventional energy sources such as coal, natural gas, gasoline, etc. to generate electricity can cause environmental problems, leading to global warming.

Therefore, the development of renewable energy sources, such as biogas, geothermal, solar, wind, etc., is a solution to reduce global greenhouse gas emissions. Among all renewable energy sources, solar energy has enormous potential. The main applications of solar energy are photovoltaics, solar heating, solar cookers, food processors, solar thermal, satellites, etc. Industrially, they are used in ASD dryers, refrigeration, electrification, electric ovens, power handling, water pumps, etc. The advantages of photovoltaics are low maintenance costs and the ability to provide low-cost electricity to remote areas.
In this paper the developed model has two stages as shown in figure 1 in the first stage providing DC supply to inverter was fed from the solar panel; the maximum power was tracked by Maximum Power Point Tracking(MPPT). Inthe second stage, the speed of the induction machine is controlled by the volts/hertz (V/f) control. The paper is organized as follows, section II present the MPPT based solar power module, section III discusses DC-DC Boost Converter, section IV discusses VFD control, section V discusses Speed control of the Induction motor, and finally conclude the solar power fed VFD system.

II. MPPT BASE SOLAR POWER MODULE

MPPT solar power module has three important elements namely PV array, controller (MPPT), and boost converter.

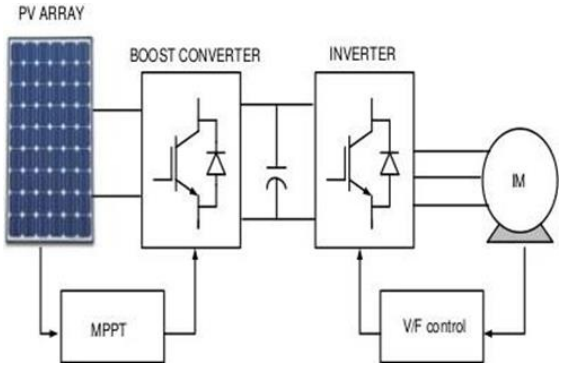


Fig.1. Block diagram of solar power fed VFD system

MPPT (MPPT referred to as a maximum power point tracking) is a system by adjusting the operation state of the electrical model electrical phenomenon panels will output a lot of power DC electrical system of the cell panel is emittedexpeditiously hold on in a very battery it will effectively solve the domestic and industrial electricity consumption in remote areas and traveler areas that can't be lined by typicalpower grids while not inflicting environmental pollution.

The MPPT controller will sight the voltage generated bythe solar array in a period of time and track the upmost voltage and current worth (VI) in the order that the system will charge the battery with the upmost

power output utilized in Star Electrical phenomenon systems to co- ordinate the work of star panels batteries and loads it's the brain of the electrical phenomenon system. [2]

III. DC-DC BOOST CONVERTER

A boost converter is used here as a step-up power converter because the output of this converter is always greater than the input. The input current of the boost power stage is continuous or non-pulsating because the output diodeconducts only during part of the switching cycle

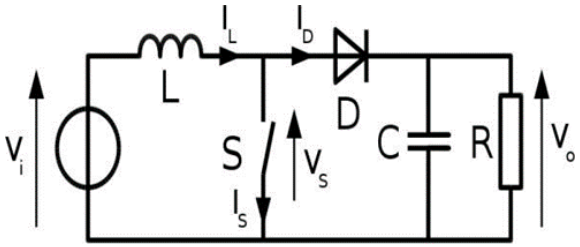


Fig.2. DC-DC Boost Converter

The output capacitor supplies all load current for the remainder of the switching cycle. The operation of the DC- DC boost converter depends on two modes, charge mode and discharge mode, which depend on the ON and OFF control of the switches, respectively. The DC-DC boostconverter consists of an inductor on the source side, a diode,and a capacitor on the load side as the main components of the circuit. The DC-DC boost converter is shown in Figure 2, and the waveform of the DC boost converter is shown in figure 3. [2]

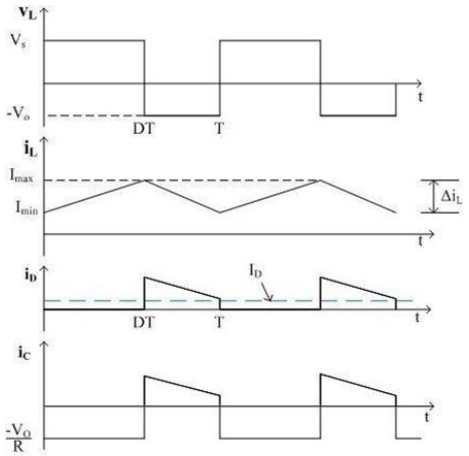


Fig.3. Waveform of DC-DC Boost Converter

How the DC-DC Boost converter used in project is shown in figure 4.

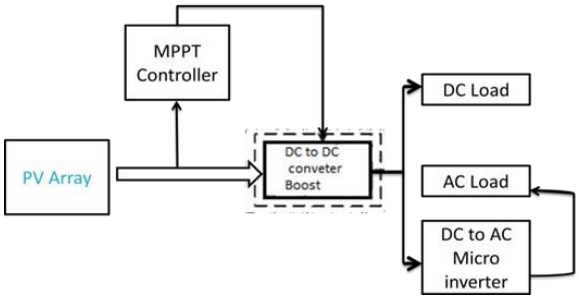


Fig.4. DC-DC Boost converter

IV. VFD CONTROL

A VFD controls the speed of an AC motor by changing the frequency feeding to the motor. The use ofVFD has been increased greatly in the field of HVAC applications. The VFDs are commonly used in air handlers, chillers, pumps, and tower fans. A better understanding of VFD give rise to development in the application and selection of both equipment and HVACsystem.

The VFD industry is enlarging speedily and it isnow more dominant than ever for technicians and maintenance personnel to keep VFD installations running quietly. Variable Frequency Drives (VFD) change the speed of the motor by changing the voltage and frequency of the power feeding to the motor. In order to maintain the proper power factor and reduce intemperate heating of the motor, the name plate volts/hertz rate must be maintained. This is the main function of Variable Frequency Drive. [6]

V. SPACE VECTOR PULSE WIDTH MODULATION

The (SVPWM) method considers this interactionof the phase and optimizes the harmonic content of the three phase isolated neutral load as shown in figure 5.

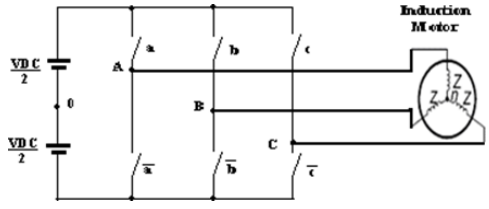


Fig 5. Voltage Source Inverter type 3 phase

The three phase sinusoidal and balance voltagegiven by the equation as follows:

$$V_{An} = V_m \cos \omega t \quad (1)$$

$$V_{Bn} = V_m \cos \{\omega t - 2\pi/3\} \quad (2)$$

$$V_{Cn} = V_m \cos \{\omega t + 2\pi/3\} \quad (3)$$

$$\bar{V} = 2\backslash 3 [\, V_{An} + aV_{Bn} + a^2 V_{Cn} \,] \quad (4)$$

Are applied to the three phase induction motor,using equation (4). A three phase bridge inverter. From figure 5, have 8 permissible switching states. Table 1 gives summery of switching states and corresponding phase to neutral voltage of isolated neutral machine.

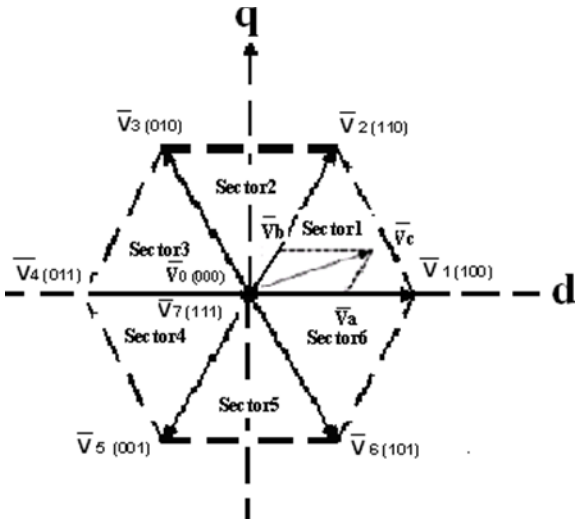


Fig. 6 Space Vector of Voltage

Name	A	B	C	VAn	VBn	VCn
V0	0	0	0	0	0	0
V1	1	0	0	2VDc/3	-VDc/3	-VDc/3
V2	1	1	0	VDc/3	VDc/3	-2VDc/3
V3	0	1	0	-VDc/3	2VDc/3	-VDc/3
V4	0	1	1	-2VDc/3	VDc/3	VDc/3
V5	0	0	1	-VDc/3	-VDc/3	2VDc/3
V6	1	0	1	VDc/3	-2VDc/3	VDc/3

SIMULATION RESULT

The implementation of the proposed algorithm is done over MATLAB (R2019). The signal processing toolbox helps us to use the functions available in MATLAB Library for various methods like Windows, shifting, scaling etc.

Parameter	Value
Temperature of PV	25°
Irradiation (maximum)	1000 w/m2
Irradiation (minimum)	500 w/m2
DC link capacitor	2500μf
Rating of induction motor (power)	50 hp 460 v

Table: Parameters used in simulation

PVA fed Sensor less speed control of induction motor using vector control technique. The proposed model is shown in fig.7. The proposed model is consisting of sevenmajor component .such as photo voltaic array, dc link capacitor connected with voltage source inverter, boost converter, 3 phase inverter, 3 phase induction motor, vector control techniques.

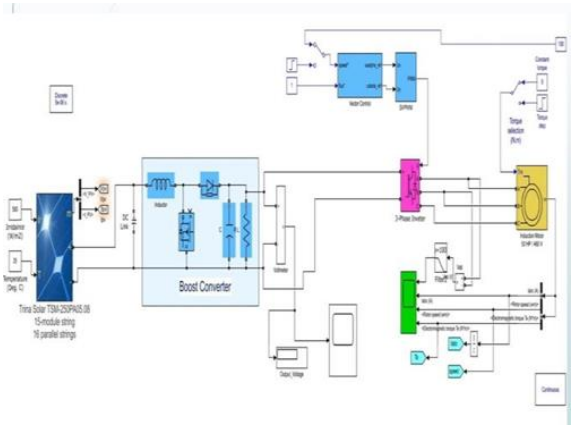
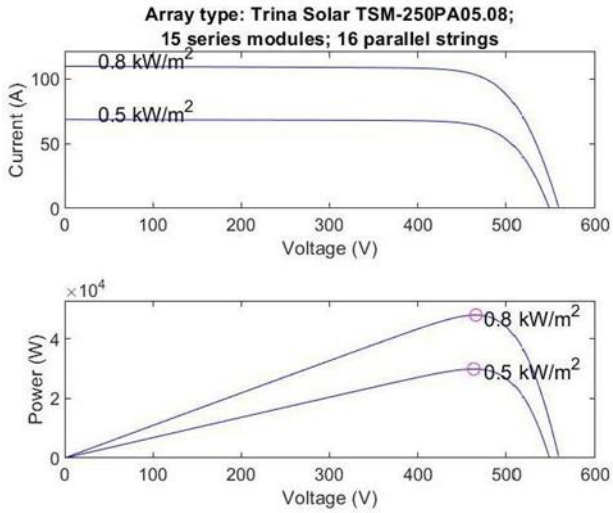


Fig.7 Proposed system with PVA feed to induction motor

We are taking an input as a solar power which graph 1 is shown below.



Graph 1

In a Fig. 7 is the three phase induction motor connected to boost converter fed by PVA with variable solarirradiation. The converter is controlled by vector control with speed and torque individual controllers. The below are the speed regulator and torque controller with PI controller. The internal sub system of speed regulator of pi controller isshown in figure fig. 8 and fig.9.

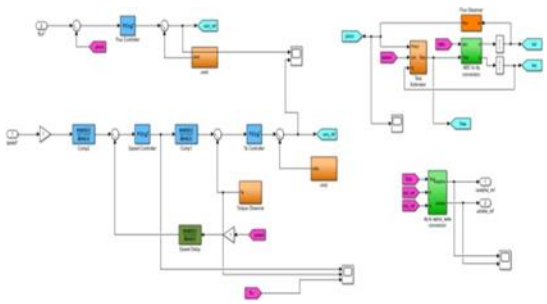


Fig.8 Speed regulator with vector control

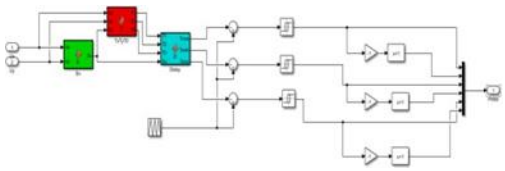
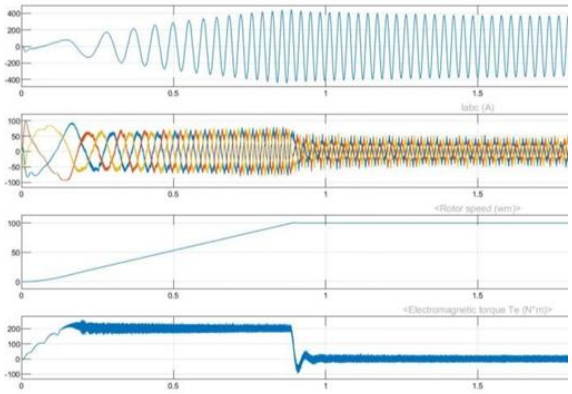


Fig.9 The internal sub system of SPVWM

We take input as a PVA with maximum power of250w we run the induction motor by converting input DC power to AC power using boost converter and feeding thispower to induction motor via three-phase inverter.

Using vector control method we control the speedof induction motor which result is shown in below graph 2.



Graph 2

VI. CONCLUSION AND FUTURE SCOPE

- Conclusion

With the above results it can be concluded that the speed of the induction motor is more stable with less peak value generation and less settling time. The torque and stator flux, have been controlled independently. The motor is started smoothly. The reference speed is generated by DC link voltage controller controlling the voltage at DC link along with the speed estimated by the feed forward term incorporating the pump affinity law. The power of PV array is maintained at maximum power point at the time of changein irradiance. This is achieved by using incremental conductance based MPPT algorithm. The model is run by Simulink modeling generating graphs with respect to time.

- Future Scope

The input source PVA can be replaced with fuel cell or wind farm (connected to controlled rectifier) for multiple renewable source feeding the converter. The speed regulator can be updated with neuro fuzzy controller for faster response of speed with reduced settling speed and ripple in the value.

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