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# MPPT Algorithm for Effective Utilization of Solar Energy to Drive SPWM based VSI Fed IM

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***Abstract*— In this paper proposes to drive the induction motor using solar energy with MPPT algorithm .power electronic devices are essentials to interface the induction motor and solar energy. Power electronic devices are push-pull converter (dc-dc converter)and three phase VSI(dc-ac converter) is used. In VSI SPWM technique is used for switching operation ,because to obtain optimum motor performance. closed loop speed control technique is used to control the speed of IM to desired set points. In closed loop system speed is controlled by using PI and HYBRID fuzzy technique .MPPT (P and O)is used to track the maximum amount of voltage in solar PV panel. Simulation results are obtained by using MATLAB software.**

***Keywords—: Photovoltaic (PV), dc-dc push-pull converter, maximum power point tracking(MPPT), voltage source inverter(VSI),sinusoidal pulse width modulation(SPWM), induction motor(IM).***

## I. INTRODUCTION

PV power gives an eco-friendly source of electricity. In this fuel is sunshine. It is renewable energy. Now a day's pollution is increase towards the world because of using fossil fuels, emission of $co_2$ from vehicles and from power plants. Now a day's production of electricity by using solar energy is pollution free and also gives few watts to few megawatts. In order to run the three phases induction motor using solar energy power electronics devices are essential. In this paper we are using DC-DC push-pull converter, DC-AC three phase Voltage source inverter. By using these both converters transferring of power from the panel to machine is efficient. In push-pull converter MPPT is used to turn ON and OFF the Switches. MPPT has many types but here using Perturb &Observe technique Algorithm and it is ease to implement. Voltage source Inverter is used to convert DC to AC.SPWM technique is used to operate &control the VSI and also to run the motor effectively.Fig:1 shows the block diagram of proposed system.

By comparing actual motor speed and reference speed an error is produced. By nullifying these errors PI controller and HYBRID FUZZY technique is used. To Increase the motor efficiency, a closed loop speed control is implement. It is used to control both voltage magnitude and voltage frequency. The main objective of this project is to design &integrate the DC-DC push-pull converter& VSI, to run the Induction motor from solar panel with MPPT cost as possible.

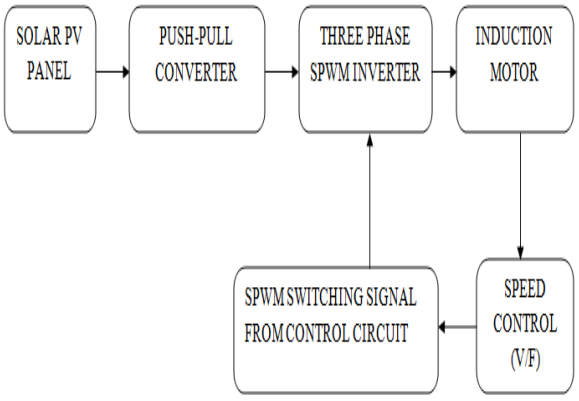


Fig 1 Block diagram of proposed system

## II. METHODOLOGY

### *A. Photovoltaic panel*

PV array means to conversion of sunlight into electrical energy using a p-n junction semiconductor. To produce electricity, solar energy must be exceeds the band gap energy then photons are observed. In PV array solar cells are connected series and parallel depends upon the solar irradiance, panel temperature.

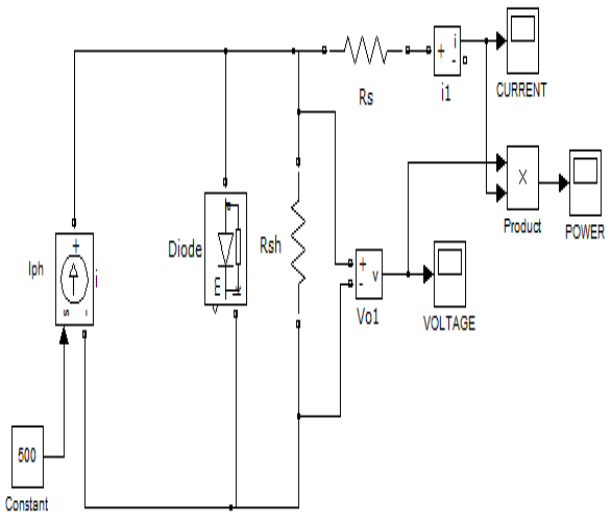


Fig 2 physical model of PV panel

$$P_{PV}=I_{PV}*V_{PV}$$
$$I_{PV}=I_{PH}-I_D-I_{SH}$$

Where $P_{PV}$ is PV power ,$V_{PV}$ is voltage at the terminals of the module,$I_{PV}$ s current supplied by the module, $I_{PH}$ is photo current (A),proportional to the solar irradiance, $I_D$ is diode current, $I_{SH}$ is shunt current.

*B. Maximum power point tracking (MPPT)*

In PV systems MPPT is used to increase the PV array output power by continuously tracking maximum power point. It is depends on solar irradiance and panel temperature. It is also reduce the solar array cost. It is device for getting maximum power point from the source and operating at that point.P&O MPPT is ease to implement and simple. If the operating voltage of PV array is changed in the given direction and if the power from pv array increases, it means that the operating point has moved toward the MPP. Therefore, the operating voltage must be further changed in the same direction. Otherwise, if the power drawn from the PV array decreases, the operating point has moved away from the MPP and, therefore, the direction of the operating voltage changes must be reversed.fig 3 shows the MPPT P&O algorithm.

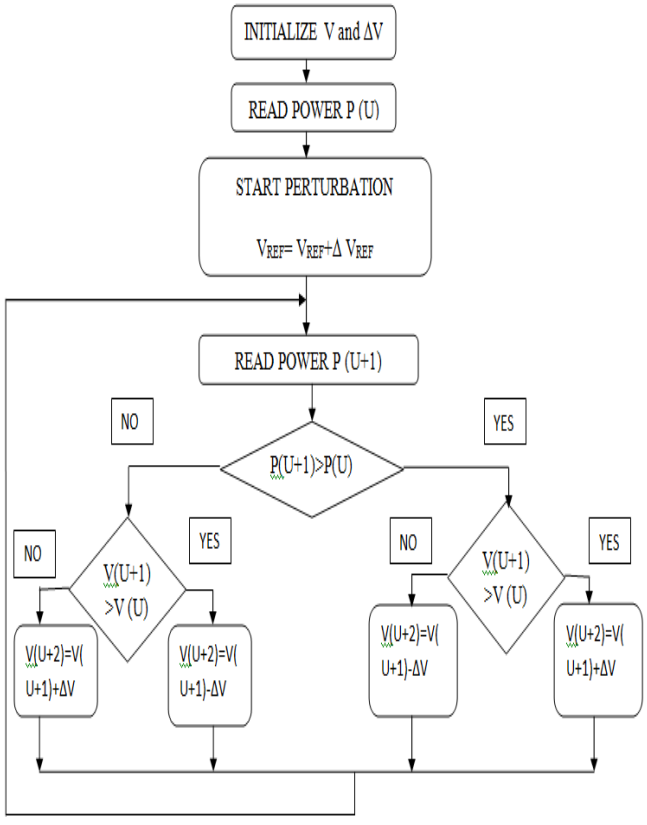


Fig 3 MPPT,P&O algorithm flow chart

Initialize the V and ΔV and then read the power p(u) afterwards voltage is changed .the power in time p(u+1) is read, if the power is incrementing we increment the duty ratio and the voltage. Now by comparing to power p(u+1) lower than the time of p(u). Then voltages must be added.

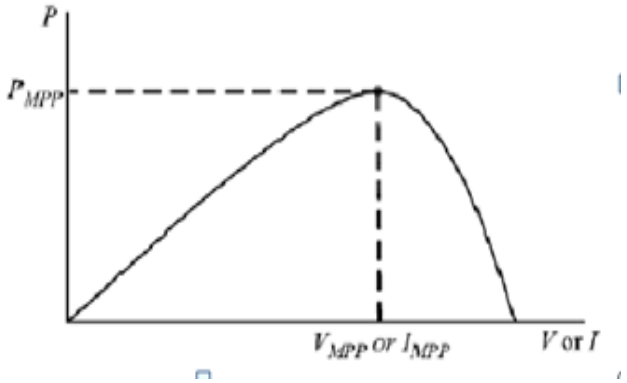


Fig 4 PMax vs voltage or current

*C.DC-DC push –pull converter*

To getting maximum power in the panel DC-DC push-pull converter is used. dc-dc converter is used to convert fixed dc to variable dc voltages. Push pull converter elements are mosfet, linear transformer, diodes, and capacitor. Whenever the supply is given to the circuit then one of the switch is to turn on and it is given to the transformer is given to load. The mosfet are alternately switched on and off, periodically reversing the current in the transformer. Therefore current is drawn from the line during both halves of the switching cycle.

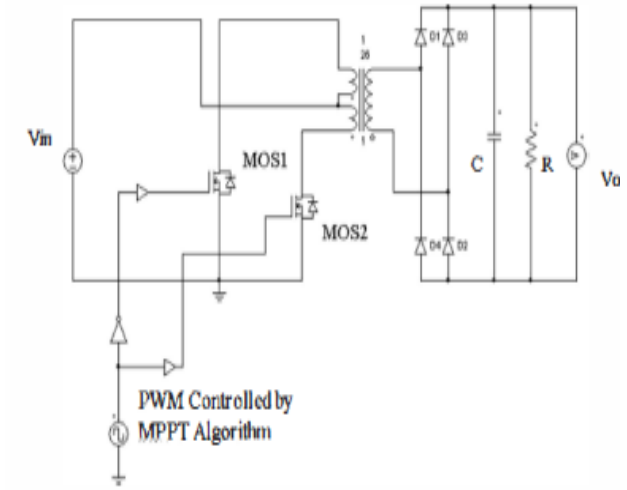


Fig 5 push-pull converter circuit

*D. Sinusoidal pulse width modulation (SPWM)*

Input of this voltage source inverter is fixed DC voltage, obtained output is controlled AC voltage by adjusting the turn on and turn off periods of the inverter components. The main disadvantage of PWM is SCRs are expensive as they must possess low turn-on and turn-off times. Switching control of SPWM is used to control three phase voltage source inverter. It has two signals one is triangular(carrier signal) and anotherone is sinusoidal signal(reference signal).in this three sinusoidal reference signal are delayed with $120^0$ with respect to each other having 50Hz frequency. Triangular signal has high

frequency. By comparing these two frequencies a gating pulses are generated.

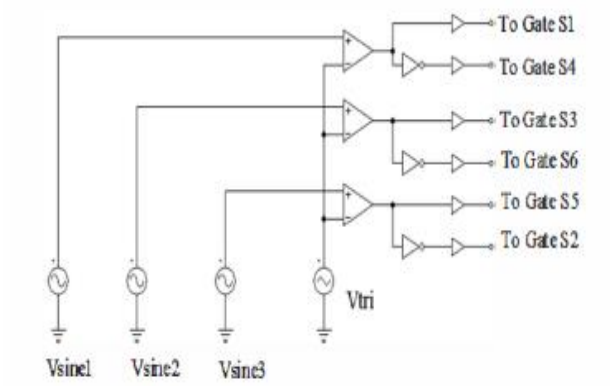


Fig 6 control circuit of SPWM technique.

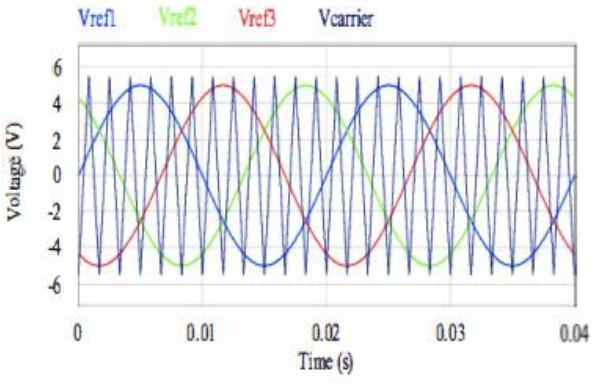


Fig 7 reference vs. carrier signal

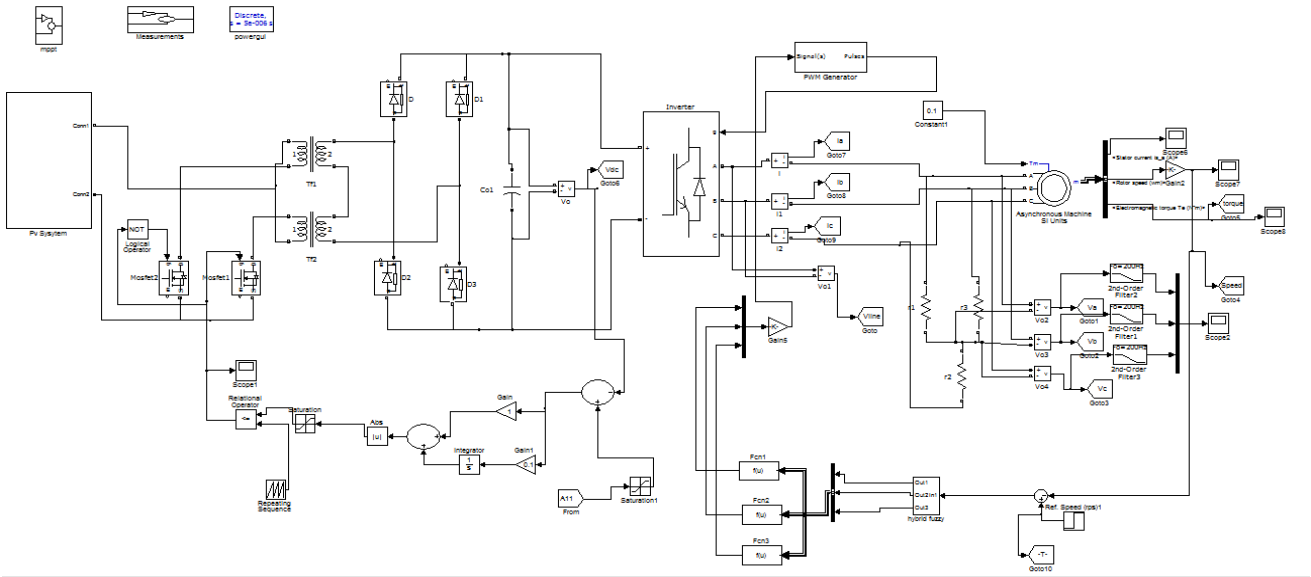

Fig 8 proposed simulation circuit diagram

*E.DC- AC three phase VSI*

Voltage source inverter is used to convert direct current to alternate current. It has six igbt/diode switches. First three switches are called upper switches and another three switches are called lower switches. If upper switches are turned on then lower switches must be turned off and vice versa. Gating signals are delayed by $120^0$ with respect to each other. Three phase VSI is operated with $180^0$ conduction. It has six modes of operation and each has $60^0$ duration. Output of the VSI is in the form of square waveform. By using filter it is converted into sine wave.

*F.Induction motor and its control strategy*

Induction motor consists of stator and rotor. This motor is used because of less cost and its features. An ac voltage is given to the stator of induction motor, an emf is induced.Due to this field current in the rotor is induced,it creates an another field and it tries to align with stator field.

$$Ns = 120*f/p$$

Where f is frequency of ac supply,Ns is the speed of the rotor,pis the no of poles per phase of the motor.by changing the frquency of control circuit through ac supply,the rotor speed will be change.To control this motor a volts/hertz control scheme is used.the amplitude and frequency of the reference signal will change according to the desired output. Ratio of voltage amplitude to voltage frequency must be kept constant to maintain flux as constant in the motor.PI controller is used to reduce the steadystate error.here we are using hybridfuzzy to reduce steadystate error and also to reduce the settling time.closed loop speed control is used to measure the actual speed,it is compared with reference speed an error signal is generated.

## III. RESULTS AND DISCUSSION

This design is proposed by matlab software. Our proposed design is solar panel followed by series of converters to control the speed of an induction motor.

Table1
System parameters of PV module

| parameter | value |
|---|---|
| Ipv | 8.46A |
| Vpv | 24.5V |
| Ppv | 206.8W |

Table 1 shows that values of the current, voltage, power of pv module at 500 solar irradiance value.

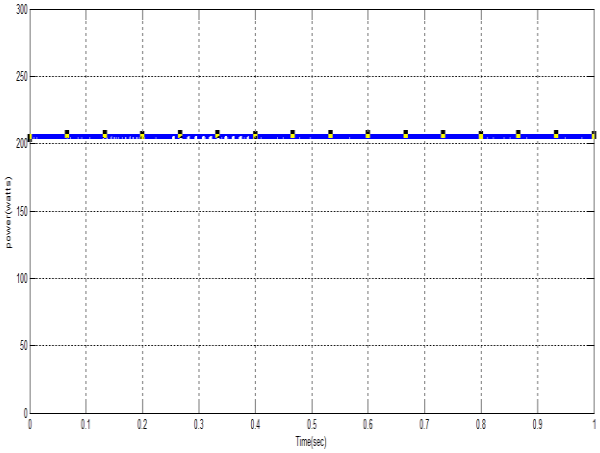


Fig 9 solar pv panel output power

Next, solar panel followed by push-pull converter which is successfully steps up 24.5V to 310V dc.

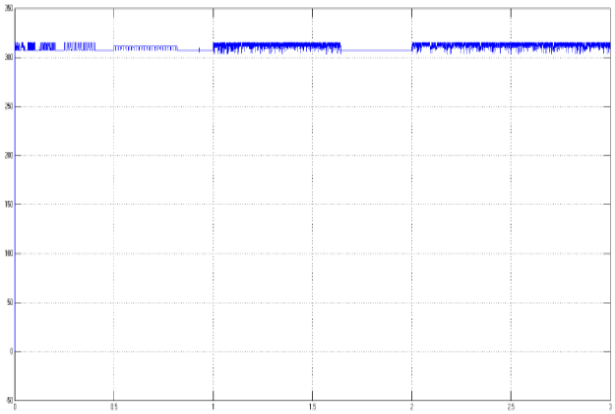

Fig 10 output voltage of push-pull converter voltage vs time

Three phase inverter is converter 310V dc to sinusoidal ac waveform. Three phase vsi is operated at 180 conduction mode. The output of vsi is in the square waveform. it is to be converted to sine wave by using LC filter.here,L=60.6mH, C=0.159mF.

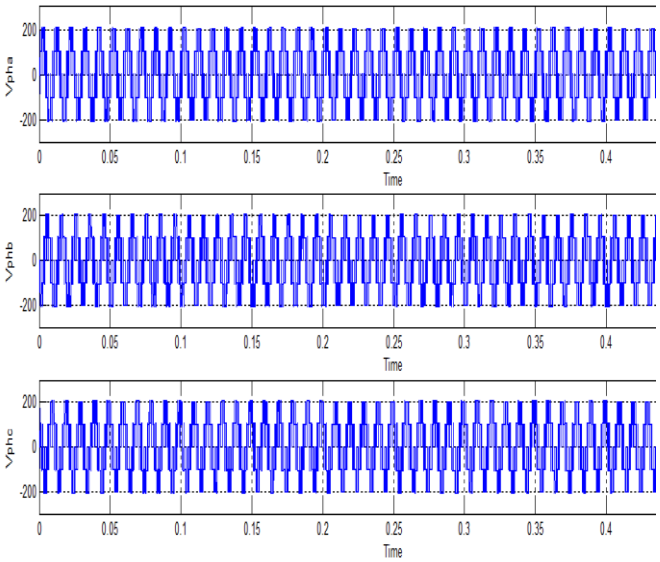


Fig 11 Three phase spwm output voltage without filtering

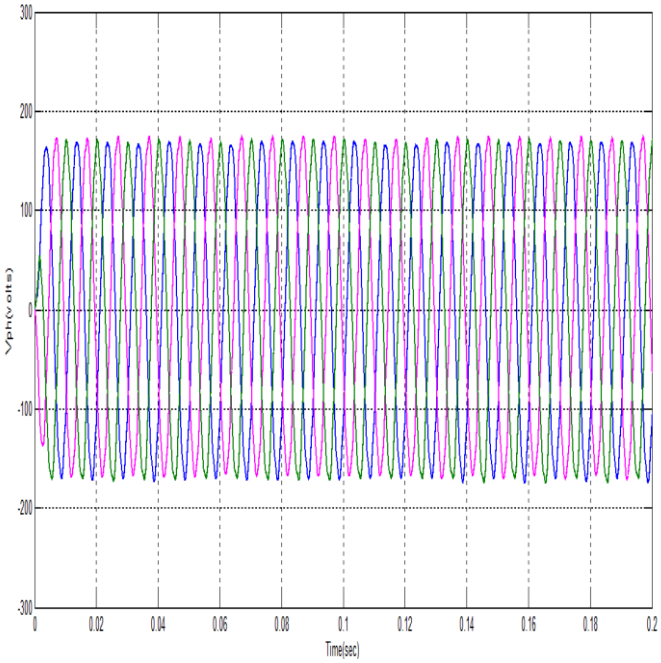


Fig 12 Three phase spwm output voltages with filtering

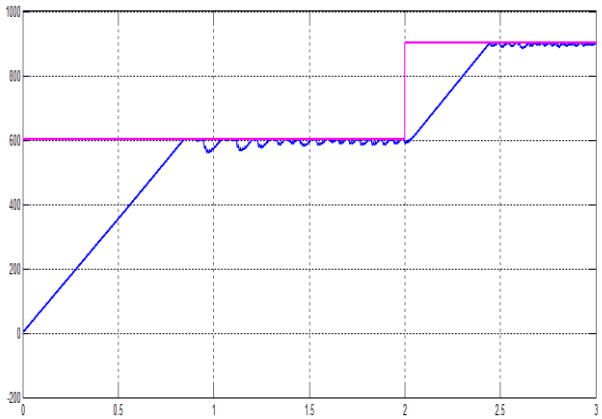

Fig 13 closed loop motor control speed vs time

Closed loop speed control is done by using hybrid fuzzy i.e., PI+fuzzy. It is used to reduce the steady state error and also reduce the settling time.

## IV. CONCLUSION

In this paper we present method to drive the induction motor by using solar pv panel. Based on results induction motor can be effectively driven by using pv panel with MPPT P&O algorithm with push –pull converter. Three phase inverter is effectively convert dc to ac voltage with $180^0$ conduction. Speed control of induction motor is to be controlled by using hybrid fuzzy controller with v/f ratio to maintain magnetic flux to be constant.

## REFERENCES

[1] M. Abdur Razzak , Ahmed Sony Kamal Chowdhury, K. M. A. Salam, "Induction Motor Drive System Using Push-Pull Converter and Three-Phase SPWM Inverter Fed from Solar Photovoltaic Panel," 2014 Power and Energy Systems: Towards Sustainable Energy (PESTSE 2014)..pp.1-6.

[2] Xiao, F. F. Edwin, G. Spagnuolo, J. Jatsvevich, "Efficient approach for modelling and simulating photovoltaic power system " IEEE Journal of photovoltaics .. vol. 3, no. I, pp. 500-508, Jan. 2013.

[3] N. Femia, G. Petrone, G. Spagnuolo, and M. Vitelli,"Optimization of per-turb and observe maximum power point tracking method," IEEE Trans. Power Electron., vol. 20, no. 4, pp. 963-973, Jul. 2005.

[4] E.I Ortiz-Rivera, "Maximum power point tracking using the optimal duty ratio for DC-DC converters and load matching in photovoltaic application," in Proc. IEEE Applied Power Electronics Conference and Exposition (APEC)., Feb 2008.

[5] S.AbeetaI.,"Operation Characteristics of push-pull type series resonant DC-DC converter with synchronous rectifier,"inProc.IEEE341h international Telecommunication Energy Conference (INTELEC), PP. 1-6, Sept.30/0ct.4 2012.

[6] D. Holmes, P. Atmur, C. Beckett, M.Bull,W.Luo,D.Ng,N.Sachchithananthan, P. Su, D. Ware, and P. Wrzos, " An innovative efficient current-fed push-pull grid connectable inverter for distributed generation systems," in Proc. IEEE PESC, 2006, pp. 1-7.

[7] M. H. Rashid, Power Electronics, Circuits, Devices, and Applications, 3rd ed. New Delhi: Prentice-Hall of India Private Limited, 2007 pp.253-256.

[8] N. Mohan, T. M. Undeland, & W. Robbins, Power Electronics, 3rd Ed.,Denvers, MA: John Wiley & Sons, Inc., 2006, pp. 211-350.

[9] N. Mendez-Gomez, O. Bousono, R Castaneyra, and E.!. Ortiz-Rivera, " Development of a low cost induction motor drive system using a PVM, boost converter and three-phase inverter," Proc. IEEE Photovoltaic Specialist Conference (PVSC), pp. 1348-1351, 2012.

[10] E. Ortiz-Perez, R. Maldonado, H. O'Neill, and E.1. Ortiz-Rivera, "Proposed system model and simulation for three-phase induction motor operation with single PV panel," Proc. IEEE Power and Energy Society (PES) General Meeting, pp. 2011.

[11] 1. A Santiago-Gonzalez, 1. Cruz-Colon, R. otero-De-Ieon, V. lopez-Santiago, E.1. Ortiz-Rivera, " Three phase induction motor drive using flyback converter and PWM inverter fed from a single photovoltaic panel," Proc. IEEE PES General Meeting, pp. 1-6,2011.

[12] M. A Vitorino et aI., "An efficient induction motor control for photovoltaic pumping," IEEE Trans. Industrial Electron., vol. 54, no.4, pp. 1162-1170, April. 2011 .

[13] ADiaz, R. Saltares, C. Rodriguez, R. F. Nunez, E.!. Ortiz-Rivera, and 1.Gonzalez-Llorente, "Induction motor equivalent circuit for dynamic simulation," Proc. IEEE Electric Machines and Drive Conference, (IEMDC ), May 2009.