EE-580 ELECTRICAL MACHINE DRIVES SYSTEM

Term Paper

Standalone Photovoltaic Water Pumping System Using Induction Motor Drive With Reduced Sensors

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1 Objective:

Objective of this paper of make a standalone photovoltaic water pumping system using induction motor with reduced sensor . In this paper we are plotting following measurement

2. MTTP performance of PV array
1. Steady state performance of proposed system

2 Introduction

The rising energy crises throughout the world and pollution of natural habitats have attracted considerable attention from engineering and science fraternity since a couple of decades. The knowledge for manifestation of renewable energy sources into a useful form has been developing rapidly. The advent of fast switching power electronic devices and the development in semiconductor technology have contributed majorly to energy conversion methods Standalone Photovoltaic water pumping system comprises two stages of power conversion. The first stage extracts the maximum power from a solar PV array by controlling the duty ratio of a dc–dc boost converter. The dc bus voltage is maintained by the controlling the motor speed. This regulation helps in the reduction of motor losses by reducing motor currents at higher voltage for the same power injection. To control the duty ratio, an incremental conductance based maximum power point tracking (MPPT) control technique is utilized. In PV pumping systems, an induction motor drive (IMD) shows good performance compared to other commercial motors because of its rugged construction. A scalar-controlled voltage source inverter serves the purpose of operating an IMD. The stator frequency reference of IMD is generated by the proposed control scheme.

2.1 Proposed Design

The system configuration of the PV water pumping system is depicted in Fig. 1. It consists of a PV array followed by a boost converter. A VSI is used to provide pulsewidth modulated voltage input to the motor and pump assembly. The power from the PV array is regulated using the INC method to attain its maximum value with available radiation. The V/f control is used to give reference speed to IMD.

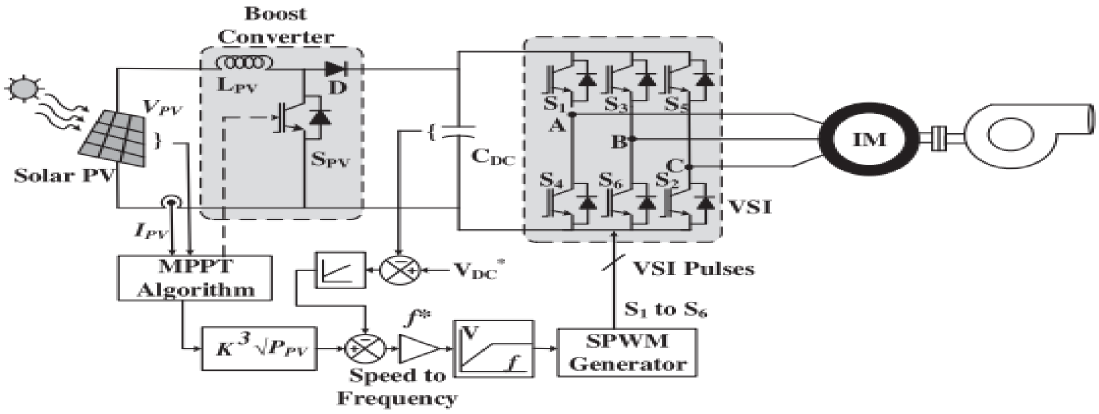

Fig. 1: Proposed system

2.2 PV array Design

An induction motor of 2.2 kW is selected for the proposed system. If losses of the motor and pump are neglected, the capacity of the PV array should be equivalent to the motor capacity. In this case, a 2.4-kW PV array is selected.Considering an open-circuit voltage of the panel to be near to a dc link voltage and the power drawn from the panel to be 2.4 kW, the number of modules in series and parallel are selected to be 11 and 1, respectively.The individual module and array specifications are provided in Table

Module Peak Voltage Of Single Module	225 W
Module open circuit voltage (v_oc)	41.79V
Module short circuit current (i_sc)	7.13 A
Module voltage at MPP (v_mp)	33.9 V
Module current at MPP(i_mp)	6.63 A
Array peak power(P_mp)	2.4 kW
Array open circuit voltage (V_oc)	459.69
Array short circuit current (I_sc)	7.13 A
Array voltage at MPP(V_mp)	372.9 V
Array current at MPP(I_mp)	6.63 A

Tabel 1: SPECIFICATIONS OF THE SOLAR MODULE AND ARRAY

2.3 MPPT Algorithm

There have been many algorithms in the literature for tracking of maximum power point. Most basic of all is the perturb and observe algorithm, which involves step change in the reference voltage or duty ratio to the dc–dc converter and monitoring of the power output. It faces several issues when radiation changes. The INC method works much better in dynamic changes in solar insolation. This is due to a fact the mechanical time constant of the motor is much higher than the electrical time constant of the whole system. This work uses an INC algorithm, which is based on the monitoring of slope of the P_PV–V_PV curve.

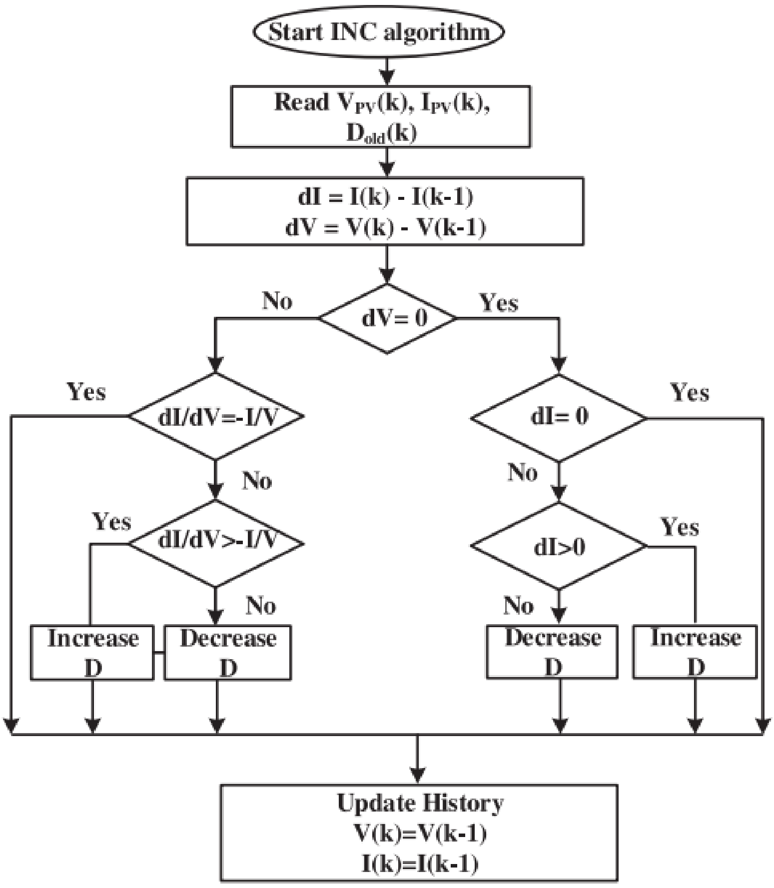

Fig. 2: INC algorithm of MPPT

2.4 Scalar (V/f) Control of Induction Motor

The scalar control of an induction motor is the most common and simplest control so far. Usually, induction motors are designed for 50-Hz input voltage. For operation at a lower speed, the voltage has to be reduced. The frequency control along with voltage magnitude control is also desired for constant flux operation. The voltage should be proportional to the frequency such that flux magnitude is maintained constant as s = V/. An IM is usually fed from a three-phase PWM VSI. Only an input parameter is the reference speed. Neglecting the small slip speed, the speed of the motor is approximately equal to the reference speed. The speed reference is integrated to generate , which is used to obtain three sinusoidal voltage references, which are compared with high-frequency triangular wave to generate the switching pulses for VSI. The speed reference is estimated from the control scheme

3 MATLAB simulation

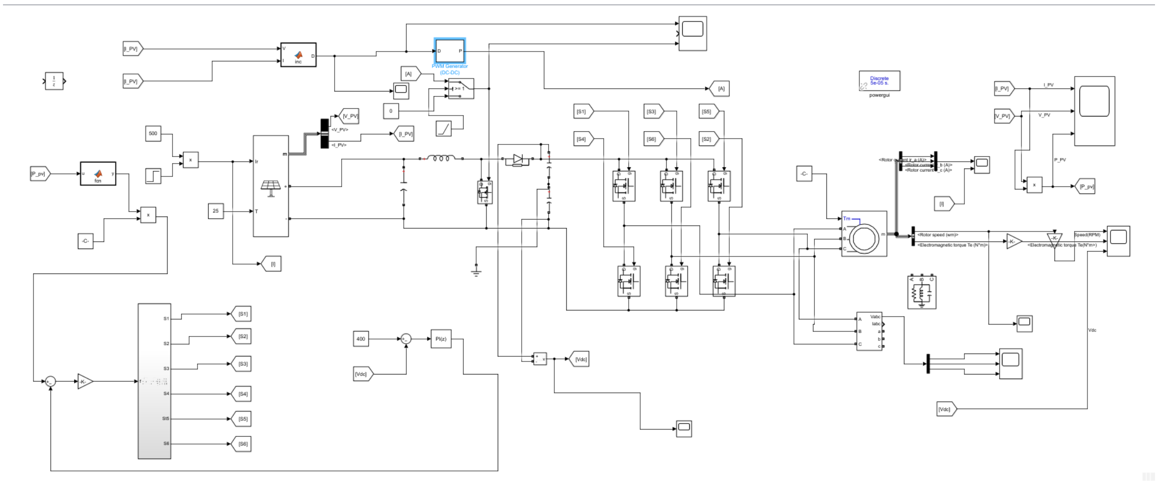

Fig. 3: Simulated Diagram

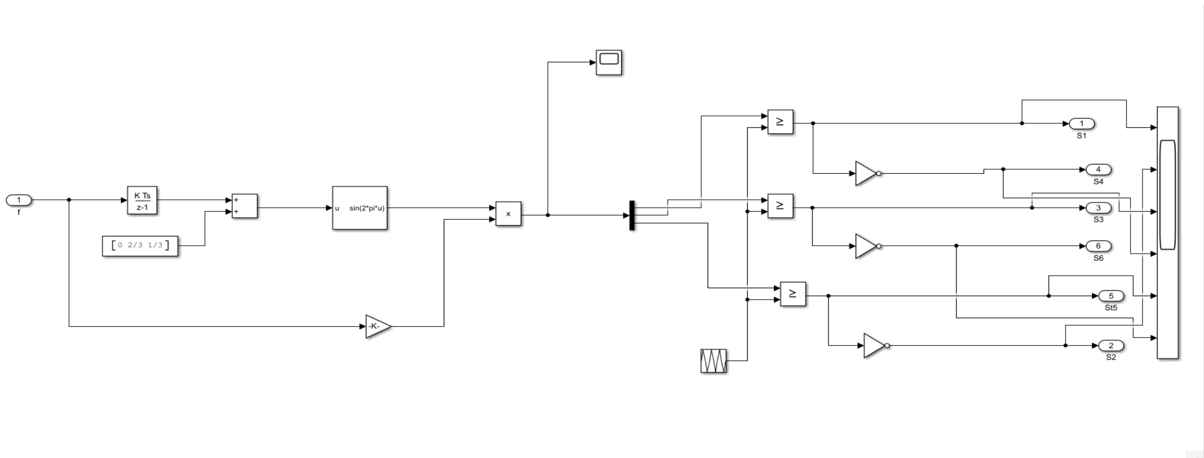

Fig. 4: Simulated Diagram

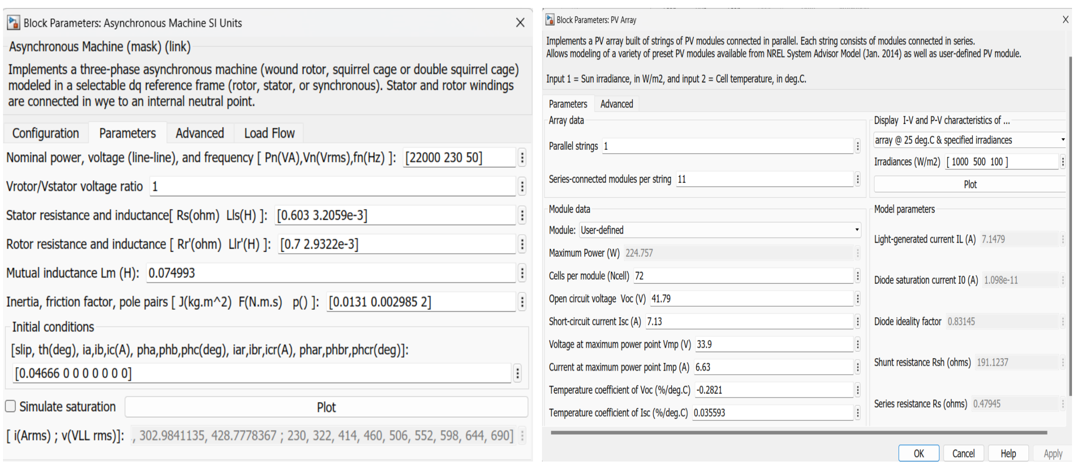

Fig. 5: (a) motor Parameter (b) PV array parameter

```
function D= inc(V,I)

Dinit=0.42;
Dmax=0.85;
Dmin=0;
deltaD =0.00005;


persistent Vold Iold Dold ;

datatype ='double';

if isempty(Vold)
    Vold =0;
    Iold=0;
    Dold=Dinit;
end

dV = V-Vold;
dI = I-Iold;

    if(dV == 0)
        if(dI == 0)
         D=Dold;
    elseif(dI>0)
            D=Dold - (deltaD);
        else
            D=Dold + (deltaD);
        end
    else
        if(dI/dV == (-I/V))
            D=Dold;
        elseif(dI/dV > (-I/V))
            D=Dold - (deltaD);
        else
            D=Dold + (deltaD);
        end
    end


if D >= Dmax | D <= Dmin
    D=Dold;
end

Dold=D;
Vold=V;
Iold=I;
```

Fig. 6: MPPT Code

4 Result

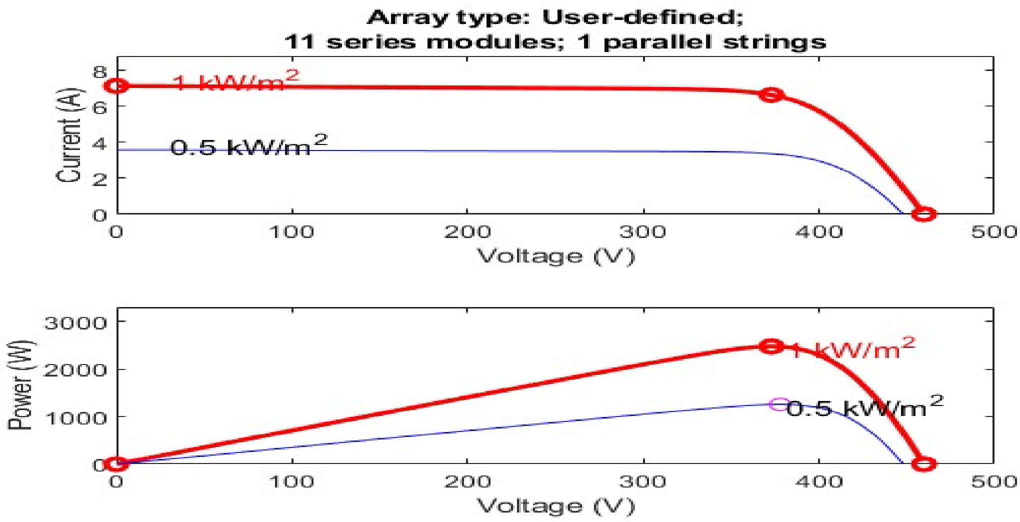

Fig. 7: PV Array Performance

4.1 At 500 w/m^2 Irrediance

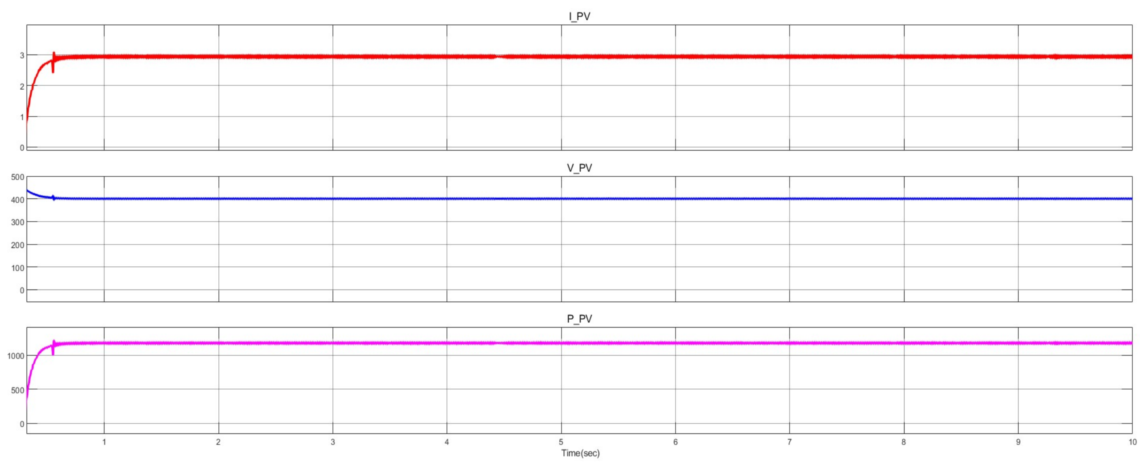

Fig. 8: (a) PV Array Current (b) PV Array Volatge (c)PV Array Power

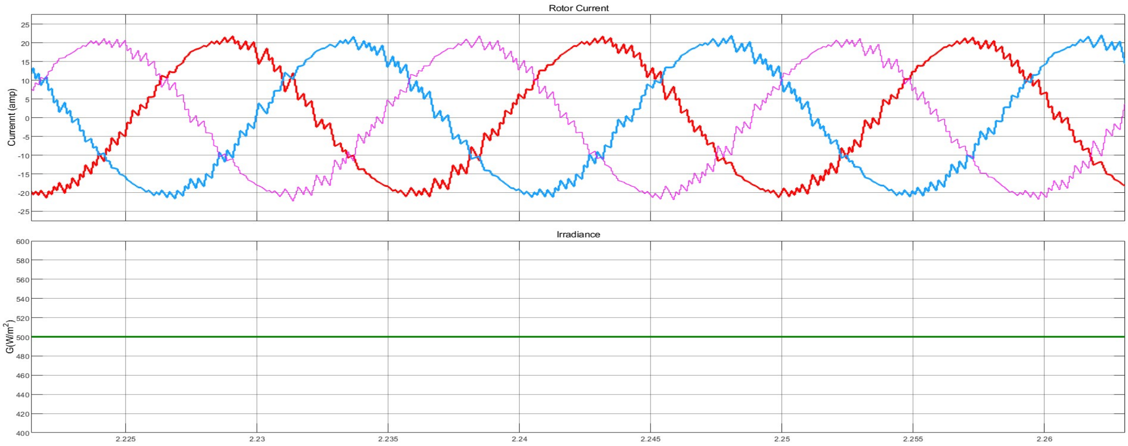

Fig. 9: (a) Rotor current (b) Solar irradiance

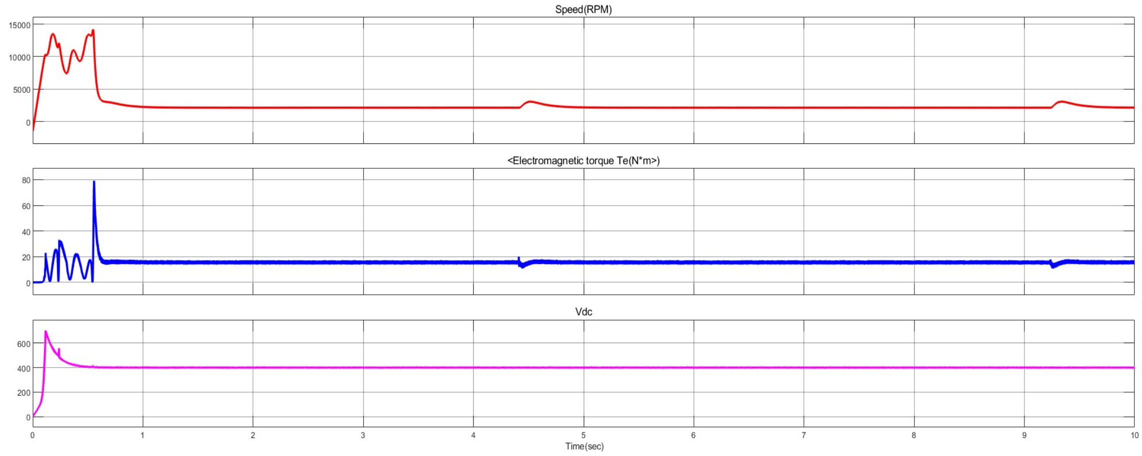

Fig. 10: (a) Motor Speed (b) Electromagnec Torque (c) Dc Link Capacitor Voltage

4.2 At 1000 w/m^2 Irrediance

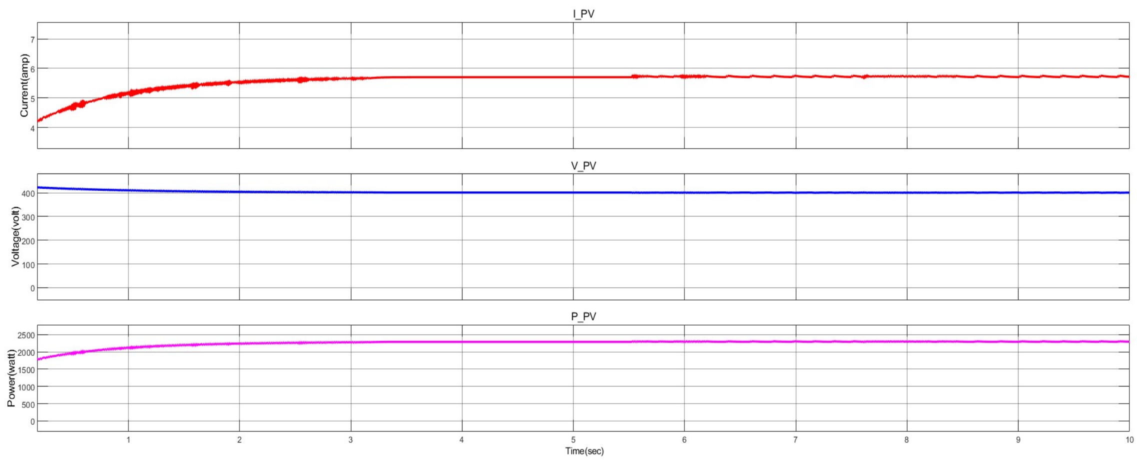

Fig. 11: (a) Pv Array Current (b) Pv Array Volatge (c)Pv Array Power

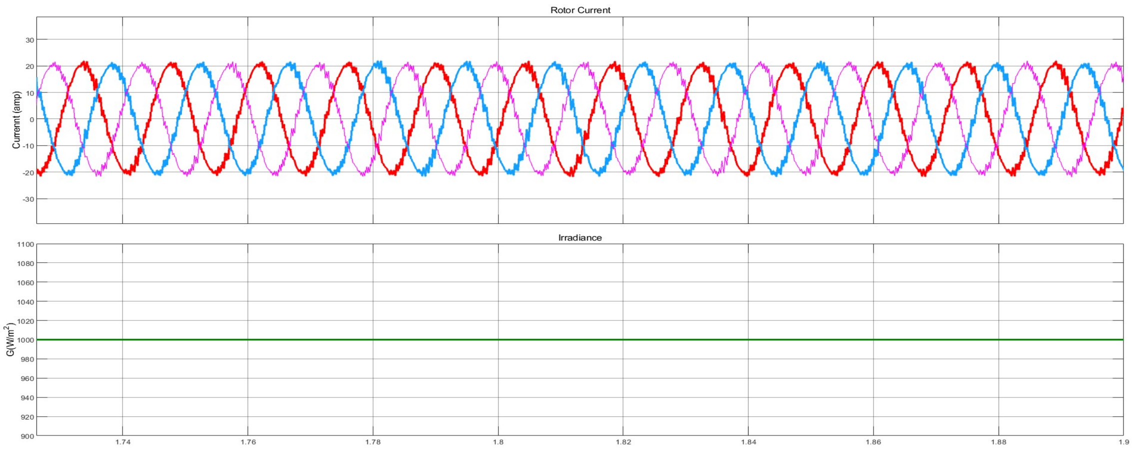

Fig. 12: Frequency at PCC

Fig. 13: (a) Rotor current (b) Solar irradiance

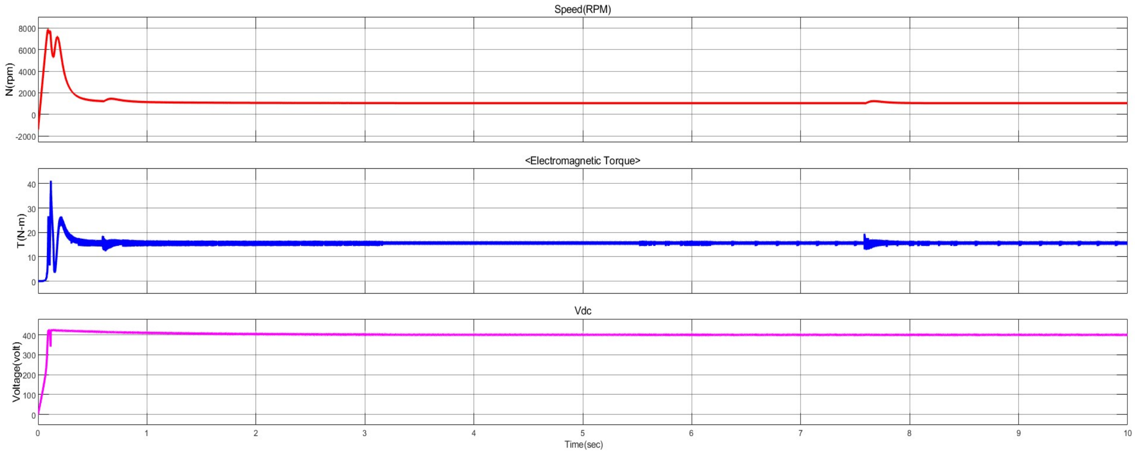

Fig. 14: (a) Motor Speed (b) Electromagnec Torque (c) Dc Link Capacitor Voltage

4.3 Changing Irrediance in a step from 1000 w/m^2 to 500 w/m^2

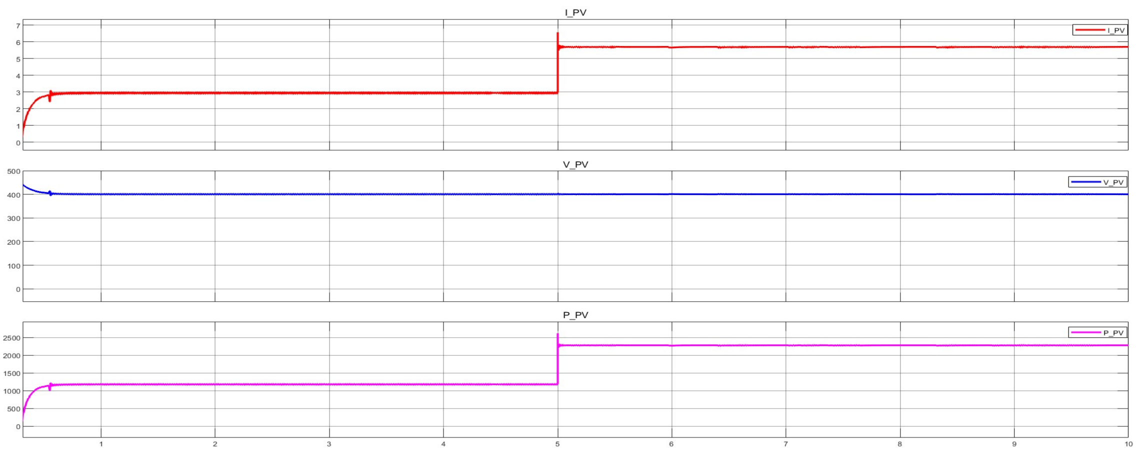

Fig. 15: (a) Pv Array Current (b) Pv Array Volatge (c)Pv Array Power

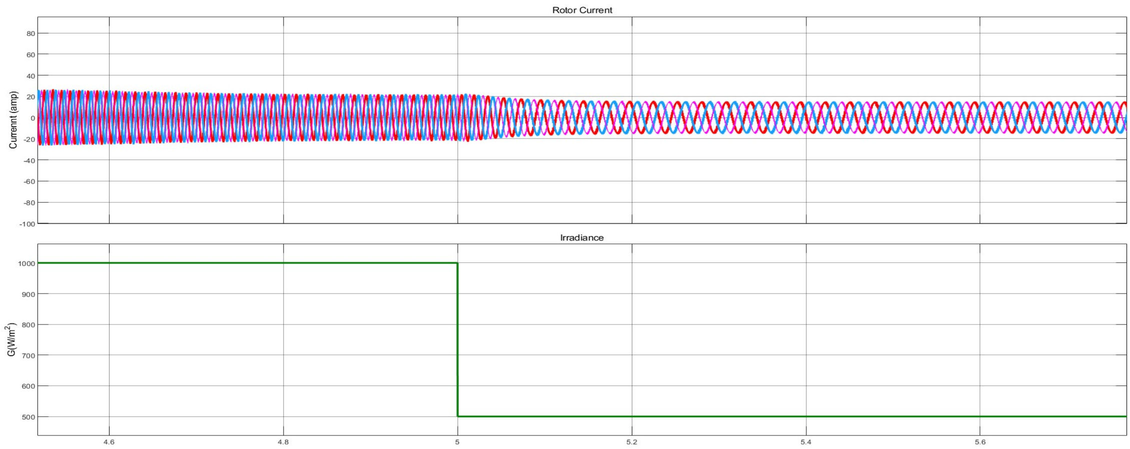

Fig. 16: (a) Rotor current (b) Solar irradiance

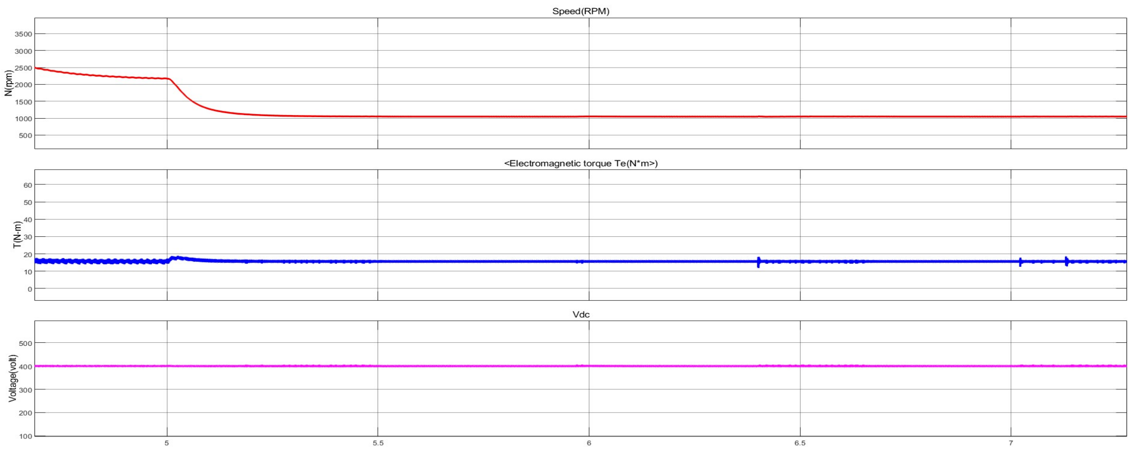

Fig. 17: (a) Motor Speed (b) Electromagnec Torque (c) Dc Link Capacitor Voltage

5 Colclusion

A standalone PV water pumping system with a reduced sensor has been proposed. The reference speed generation for the V/f control scheme has been proposed based on the available power by regulating the active power at dc bus. The PWM frequency and pump affinity law have been used to control the speed of an induction motor drive. Various performance conditions such as starting, variation in radiation, and steady state have been experimentally verified and found to be satisfactory. The system tracks the MPP with acceptable tolerance even at varying radiations.