RESEARCH ARTICLE OPEN ACCESS

PV BASED CHOPPER FED DC DRIVE

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ABSTRACT
This paper presents the closed loop control of dc motor using one quadrant chopper supplied by Solar PV equivalent module with dc-dc boost converter in Matlab /Simulink. The aim of paper is to explain the design optimization with low cost implementation of controller circuit. For motor speed control the armature voltage is varied by the use of chopper circuit with varying chopping frequency as per requirement. Hysteresis controller gives fast speed response by means of its instantaneous action and limiting the starting current. When load torque is increased the armature current is increased to meet the load by increasing applied voltage to the converter.

Keywords— DC motor, solar power, chopper.

I. INTRODUCTION

Application of solar power drive is certainly growing as they offer clean source of energy and also there is need to conserve fossile fuels. At present solar drives are employed for space applications and water pumping particularly for agriculture applications and is seriously contender for use in room air conditioners. Standard DC motors are mostly used as constant speed or adjustable speed motors. The control schemes employed for the same are developing day by day. For reliable operation various sources of electrical energy are employed along with the drive. The power control scheme uses semiconductor devices such as MOSFET, IGBT, etc. with various switching techniques.The designers are forced to optimization of the performance of solar power DC motor drives. These drives have now dominated the area of variable speed because of their low cost reliability and simple control the various converter topologies are

a. Rectifier – Conversion of AC to DC
b. Cycloconverter – Providing variable AC , Conversion of AC to AC
c. Inverter – Conversion of DC to AC
d. Chopper – Conversion of DC to DC i.e. providing variable DC

The solar energy i.e. heat energy is converted to electrical energy (in DC voltage) using photo voltaic cell. In absence of solar energy, the power can also be supplied from batteries, rectifier or DC generator. The voltage needs to be step up using Boost Converter. Hence Boost converters are called as step up converter. The variable DC voltage can be achieved by using chopper. This variable DC voltage is required for the control of Drives with adjustable or varying speed control. The complete system of equivalent solar energy PV model feeding DC drives through control technique is as shown below. Some Application require the use of DC Drive, such as space application, water pumping, etc, Now, a day application of solar power is increasing as to conserve the energy.

II. PROJECT SCHEME:

In this project we are trying to make PV equivalent module in MATLAB, which will represents a solar PV Module. The output of this is then provided to dc-dc boost converter for boost up the voltage from solar PV module. This Boost voltage is given to the DC motor through one quadrant chopper circuit with current controller and speed controller.

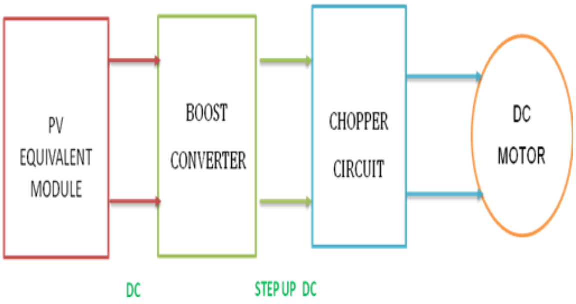

Figure.1:- Basic Block Diagram

Various stages of implementation:-

Stage 1:- Design of equivalent solar PV module using Matlab/simulink.

The equivalent solar PV module is developed in MATLAB with look up table and Controlled voltage source blocks. The design of this equivalent PV module is based on the reference taken from the characteristics of The **SOLAREX MSX60** PV module. Typical Electrical Characteristics of MSX-60 PV Module are –

Equivalent PV Module Developed:-

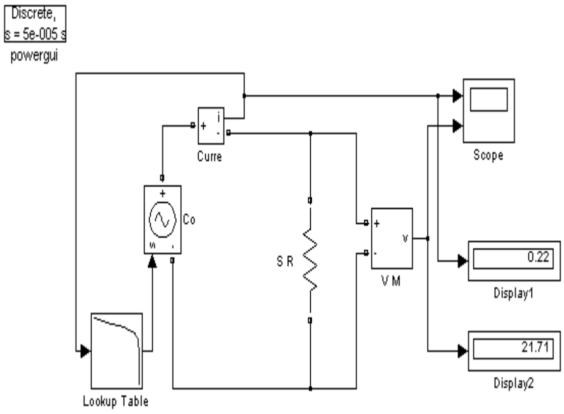

Figure. 2:-.Solar PV equivalent module using MATLAB /SIMULINK

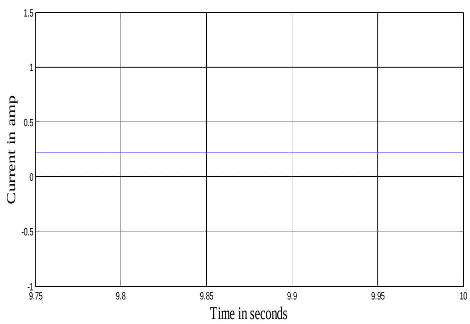

Figure.3:- Current output waveform of Solar PV Module

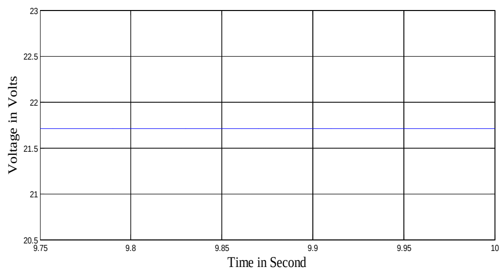

Figure.4.:-Voltage output waveform of Solar PV Module

Parameter obtained from designed module:-

Output voltage Vo = 21.71 volts
Output current Io = 0.22 amp

So, having the characteristics of from above module, it is clear that the results obtained from this equivalent PV module are almost same as that of reference module.

Motor Specifications of Separately Excited D.C. Motor:-

Table 1.1:- Motor Rating

KW Rating	0.75kw
HP Rating	1hp
Speed	1500rpm
Armature voltage	220Volts
Field Voltage	220 Volts
Armature Current	4Amp
Field Current	0.35Amp

Block parameter measured by using LCR meter of above moter in Electrical Drives Labortary For simlation in Matlab/Simulink as below :-

Table 1.2:- Measured Block Parameter of S.E.D.C. Motor

[Ra La]	[7 ohm 0.0913H]
[Rf Lf]	[621ohm 0.00064H]
[Laf]	[4.6H]
J	[0.0028Kg M sq.]

Figure.5.: Experimental arrangement for measurement of Ra and Lf of SEDC Motor

Stage 2:-Design of dc-dc converter (Boost converter) using Matlab/simulink

Table.1.3:-Parameter of the model developed.

PARAMETER	VARIABLE	VALUE
Input DC Voltage	Vdc	120 volts
Output DC Voltage	Vo	220 volts
Output current	Io	2.206 amp
Inductor	L	200 mH
Capacitor	C	10 F
Resistor	R	100 Ω
Duty Cycle	D	50 %

For getting smooth output of a dc-dc boost conveter, a LC filter is to be connected. Value of L and C of filter component are choose by trial and error method. This filter will work at load conditions only.

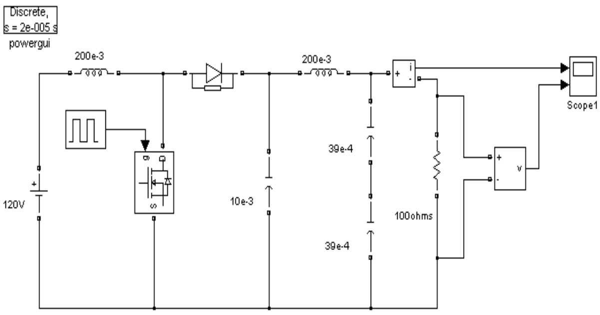

Figure 6:-. Dc-dc Boost Converter with LC filter in Matlab / Simulink

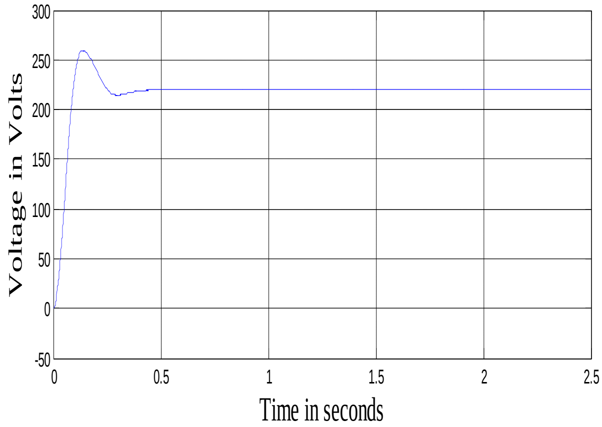

Figure.7. Voltage output(at load Condition) of dc-dc boost converter with LC filter

Stage 3:- Calculate required number of solar PV module and making modifications

[1] Calculating total no of solar PV module required for armature side.

[2] Calculating total no of solar PV module required for field side.

[3] Analyzing the result from the same

a. Properly connecting them in series and parallel combination, gives the desired output. The next step is to analyze the model

Table no1.4:- Calculation of Total no. of PV Module

(For armature side)

Output power Required	1000watt
Single PV module o/p power	60watt
Single PV module o/p Voltage at max power	17.1Volts
o/p current at max power	3.5Amp
Parallel connected PV module	06 no
Parallel string connected in series	03 no
Total No. of PV module	18 no
Total o/p PV power	1080watt

Table no.1.5:- Calculation of Total no. of PV Module

(For field side)

Output Voltage Required	220Volts
Output Current Required	0.35Amps
Single PV module o/p Voltage	21.71Volts
Single PV module o/p Voltage at max power	17.1Volts
Output current at max power	3.5Amp
Series Connected PV module	10 no
Total No. of PV module	10 no

Combine model of equivalent PV model, Boost converter and one quadrant chopper controlled DC drive with motor are shown in figure 8. below.

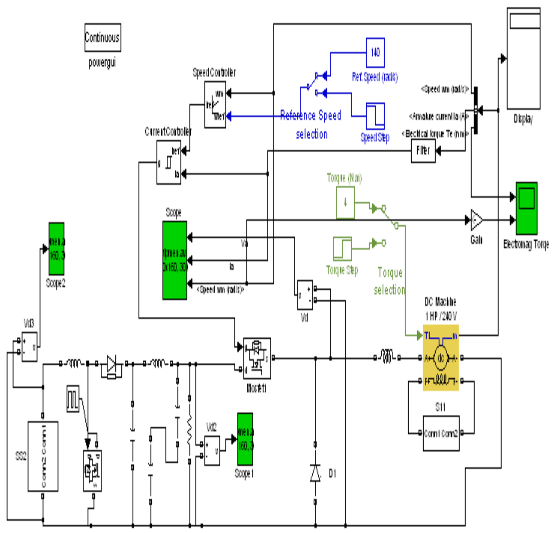

Figure. 8:- Solar power fed DC drive in Matlab / Simulink.

III.FINAL RESULTS AND ANALYSIS:

Output Results for Solar PV Module:-

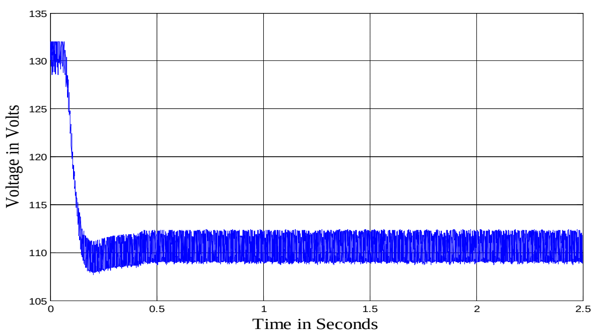

Figure. 9:- Solar PV module o/p Voltage (Arm Side)

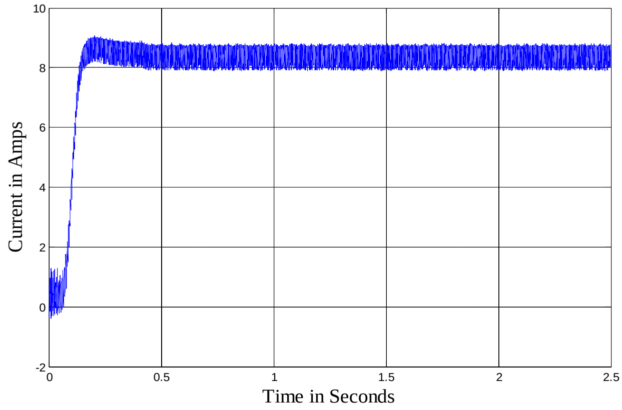

Figure.10 :- Solar PV module o/p current (Armature Side)

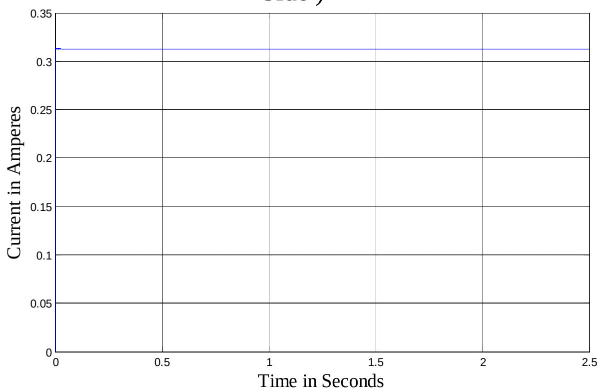

Figure.11:- Solar PV model Output field current

From the above Result Solar PV Module, it is seen that we are getting the constant output voltage 110 volts and constant current output is 8 amps. & from field current output is 0.3202 amps.

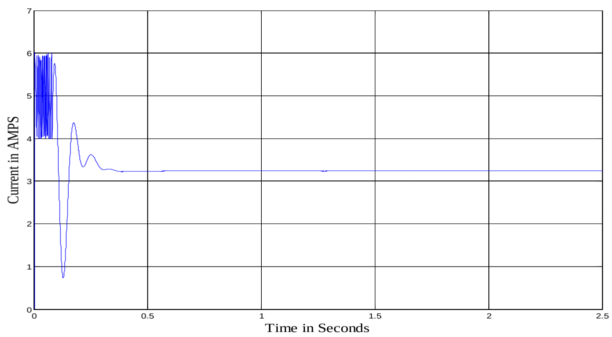

Figure.12:- Output current of D.C.Motor

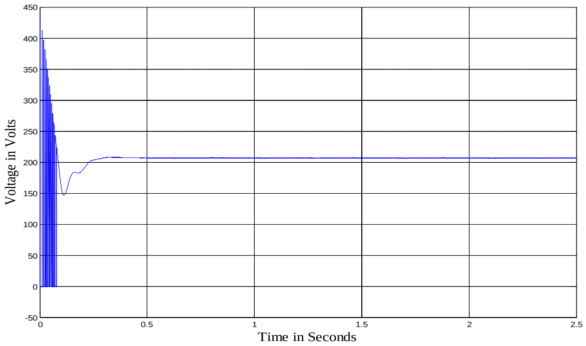

Figure.13:- Armature Voltage

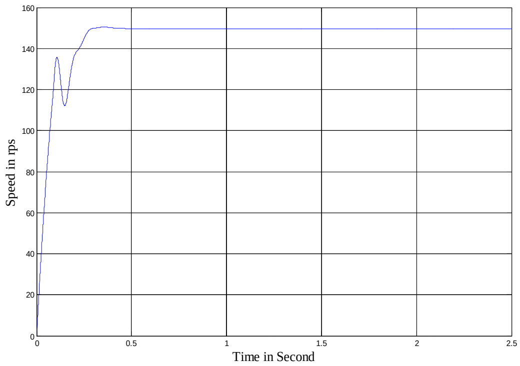

Figure.14:- Speed of D.C.Motor in rps

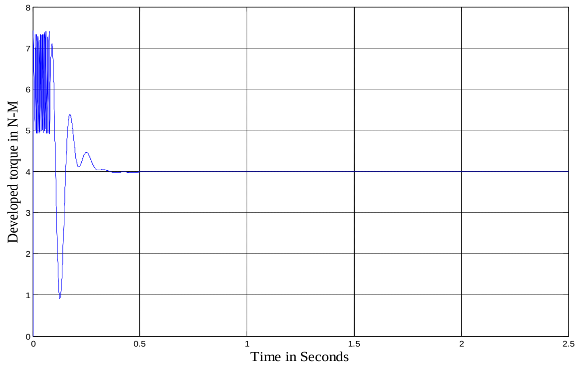

Figure.15:- Developed torque of D.C. Motor

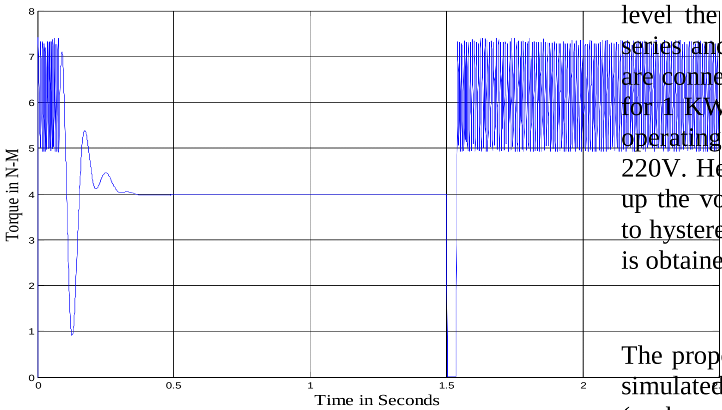

Figure.16:- Torque at different Step

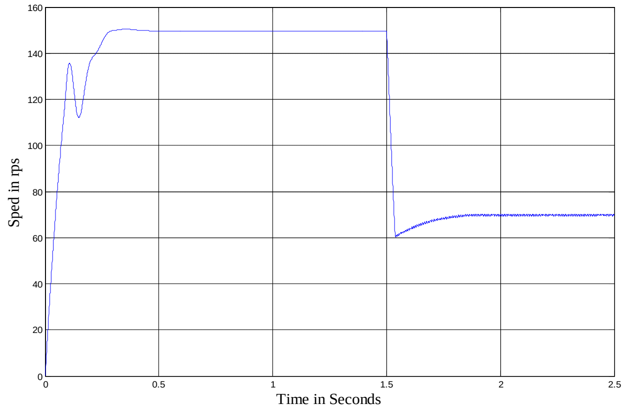

Figure.17:- Speed at different step

Table.1.6 Results for various parameters at different loading conditions

Motor load in %	Speed In rps	Developed Torque In N-M	Armature Current in Amps
0 %	150	3.435	2.786
20 %	149.8	3.9918	3.237
40%	149.4	5.038	4.086
60%	150.2	5.395	4.376
80%	149.8	6.346	5.147
100%	150.3	6.67	5.413

IV. CONCLUSION:-

The solar PV Module has been modeled with the use of MATLAB / SIMULIK. The solar PV array is developed from series- parallel combination of number of PV module to obtain the desired output power. Each Solarex MSX60 PV module has output power of 60 watt. In order to increase the voltage level the numbers of PV module are connected in series and to increase the current level, the modules are connected in parallel. Thus PV Array is designed for 1 KW and constant dc voltage of 110V. But the operating voltage (armature voltage) of motor is 220V. Hence a dc-dc boost converter is used to step up the voltage from 110V to 220V constant dc.Due to hysteresis current controller fast speed of response is obtained.

V. FUTURE SCOPE:-

The proposed Solar Power Fed D.C. Drive has been simulated for low power applications up to 1 kW (such as agriculture pump, home appliances). The scheme could be extended for high power applications for industries. This would require more PV module to be connected in series–parallel combinations. For desired output power, variation in design parameters of converter, chopper and controller.

REFERENCES:-

[1] Athimulam Kalirasu1, Subharensu Sekar Dash2 "Simulation of Closed Loop Controlled Boost Converter for Solar Installation" Serbian Journal of Electrical Engineering. Vol. 7, No. 1, May 2010, pp. 121-130.

[2] Mehrnet Akbaba,Optimization at the Performance of solar power PM DC motor Drives", International Conference on Electrical Machines and Power Electronics Issue Date: 10-12 Sept. 2007 On page(s): 725 – 729 S.M. IEEE 2007.

[3] Moleykutty George, Speed Control of Separately Excited DC Motor, American Journal of Applied Sciences, pp. 227-233, 2008.

[4] Roger Gules, Juliano De Pellegrin Pacheco, Helio Leaes Hey, "A Maximum Power Point Tracking System With Parallel Connection for PV Stand-Alone Applications" IEEE Transactions on Industrial Electronics, Vol. 55, Issue No. 7, July 2008

[5] S.M.Alghuwainem, "Speed Control of PV Power DC Motor Driving A Self-Excited 3 Phase Induction Generator for Maximum Utilization Efficiency", Energy Conversion, Vol. 11, No. 4, December 1996 IEEE.

[6] G. K. Dubey, "Fundamental of Electrical Drives" second edition Narosa publishing house, 2001.

[7] Mohan, Ned, Electrical Drives-An Integrated Approach. Minneapolis, MNPERE, 2003