IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Nitte Conference on Advances in Electrical Engineering NCAEE-2016
NMAM Institute of Technology, Nitte
Vol. 4, Special Issue 2, April 2016

Design Of Single Ended Primary Inductance Converter For Photovoltaic Applications

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Abstract: In this paper, the design of Single Ended Primary Inductance Converter has been discussed for photovoltaic applications. This paper contains the modelling and simulation of solar cell using MATLAB/SIMULINK software. Maximum power point tracking has been discussed based on perturb and observe algorithm technique.

Keywords: Solar cell, SEPIC, MPPT, P & O.

I. INTRODUCTION

In present energy scenario, the renewable energy sources play a vital role due to its eco friendly characteristics. Among all the renewable energy sources photovoltaic technology has been predicted as the best alternative solution for the depleting fossil fuels. Solar energy is clean, inexhaustible and environment-friendly potential resource among renewable energy options. However, a successful integration of solar energy technologies into the existing energy structure depends also on a detailed knowledge of the solar resource.

II. PHOTOVOLTAIC TECHNOLOGY

Photovoltaic technology deals with the direct conversion of light energy in to electrical energy. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice. Photovoltaic offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. It is anticipated that photovoltaic systems will experience an enormous increase in the decades to come. When rays of sunlight hit the solar cell electrons are ejected from the atoms. Electrons are knocked loose from their atoms, which allow them to flow through the PN Junction to produce electricity. The output current and voltages are the function of light intensity falling on solar cell[1].

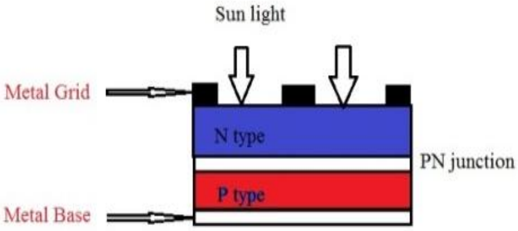

Fig 1 Photovoltaic Cell

III. MATHEMATICAL MODELLING OF SOLAR CELL

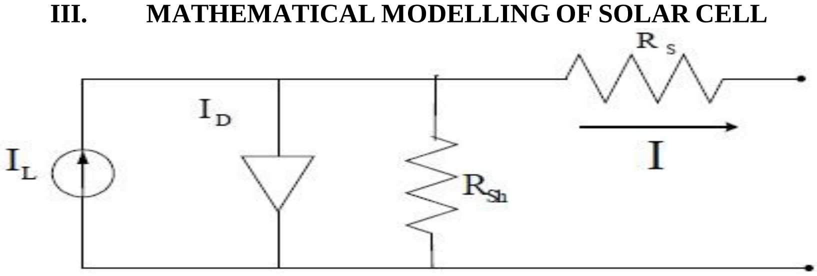

Fig 2 Equivalent Circuit Of Pv Cell

 DOI 10.17148/IJIREEICE/NCAEE.2016.19

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PV module modelled here is based on one diode topology. It is five parameter model.The voltage versus current characteristics of the solar cell is described by following equation[2],

$$I_L = I_P + I_{sh} + I \quad (1)$$

$$I_d = I_o * [e^{\left(\frac{q*(V+I*R_S)}{KTA}\right)} - 1] \quad (2)$$

Where
I = cell current (A)
I_p = photo current (A)
A = ideal factor which related to PV technology
above equation can be rewritten as

$$I = I_p - I_o * [e^{\left(\frac{q*(V+IR_S)}{KTA}\right)} - 1] \quad (3)$$

$$I = N_p * I_l - N_p * I_o * \left[e^{\frac{q*(VN_p+I*R_S*N_S)}{N_S N_p R_p}}\right] - [\frac{VN_p+IR_S N_S}{N_S N_p}] \quad (4)$$

$$I_p = [I_{sc} + K_i * (T - 298)] * \frac{\beta}{1000} \quad (5)$$

$$I_o = I_{rs} * \left[\frac{T}{298}\right]^3 * e^{\frac{[q*E_g*\left(\frac{1}{298}-\frac{1}{T}\right)]}{KA}} \quad (6)$$

IV. SIMULATION OF PV MODULE

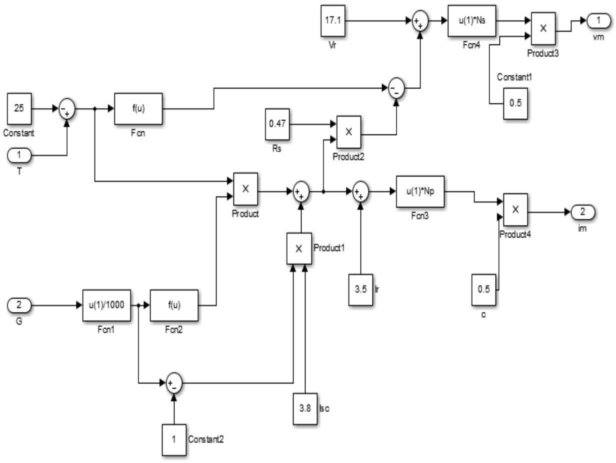

Fig 3 Simulink Model Of Pv[2]

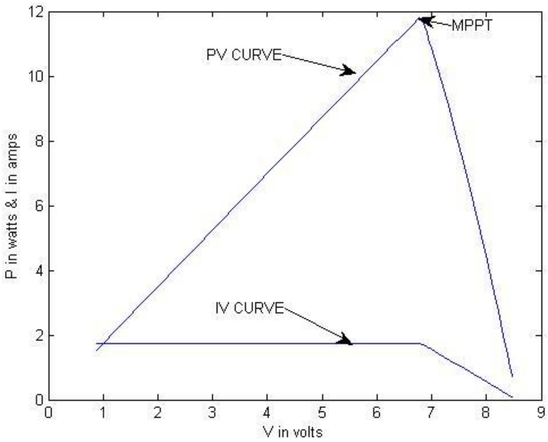

Fig 4 P-V And I-V Characteristics Of Pv

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V. MAXIMUM POWER POINT TRACKING

Maximum power transfer theorem states that, " Maximum power transfer between source and load occurs only when source resistance is equal to load resistance". Since the output characteristics of PV module is non- linear, it is necessary to track the power at maximum point in order to achieve maximum performance. To track maximum power, there are many algorithms and perturb and observe method is one of the simplest algorithm among all.[3]

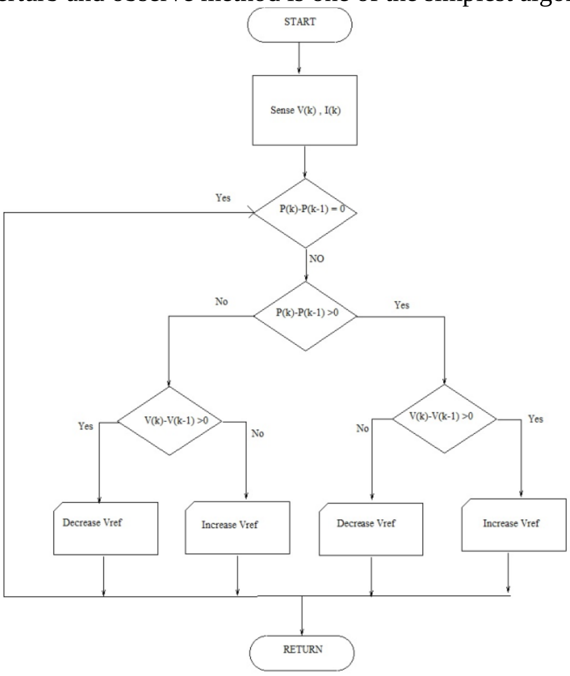

Fig 5 P & O Algorithm flow chart

VI. SINGLE ENDED PRIMARY INDUCTANCE CONVERTER

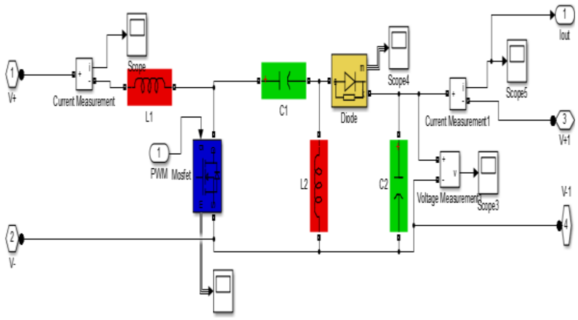

Fig 6 Single Ended Primary Inductance Converter

The circuit analysis can be made in two stages, In stage1 the inductor at the input side[L_1] stores energy when it is gated and current through in increases. In stage2 when the device is off the stored energy is delivered to the load. This paper involves continuous conduction mode[7].

$$\frac{V_O}{V_s} = \frac{D}{1 - D}$$

The circuit has been designed for following specifications :

Input voltage	3 to 8V
Output voltage	4V
Switching frequency	20kHZ
Δi_{L1}	10% of I_{L1}
Δi_{L2}	10% of I_{L2}
ΔV_{C1}	10% of V_S
ΔV_{C2}	10% of V_o

Duty cycle varies from 0.3333 to 0.57142

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VII. SIMULATION RESULTS

S.NO	PARAMETER	VALUE
01	I_{MP}(output current of converter at MPPT)	2.084 A
02	V_{MP}(output voltage of converter at MPPT)	4.188 V
03	P_{MP}(output power of converter at MPPT)	8.771 W
04	Converter efficiency	95.11%

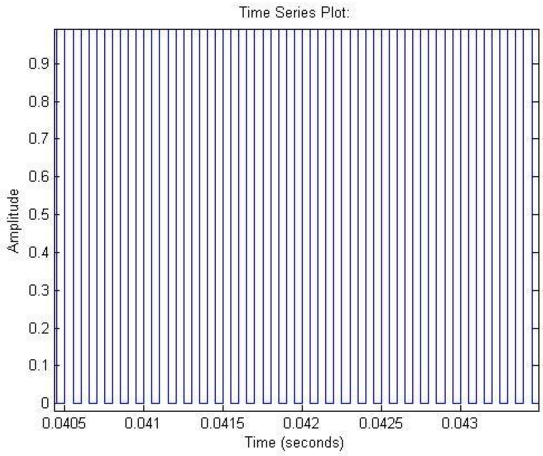
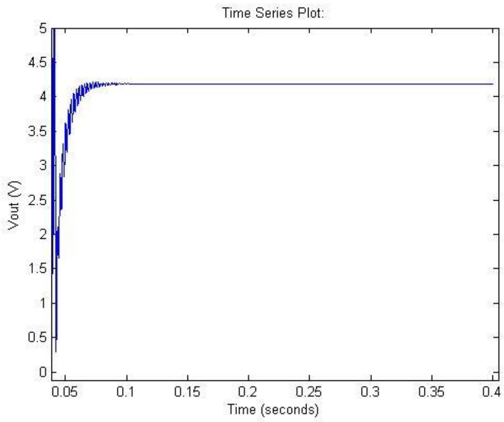
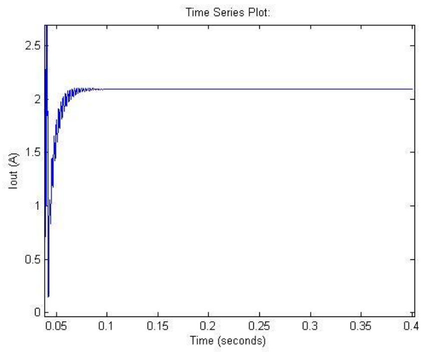


Fig 7 PWM(gate pulse) to the converter



(a)



(b)

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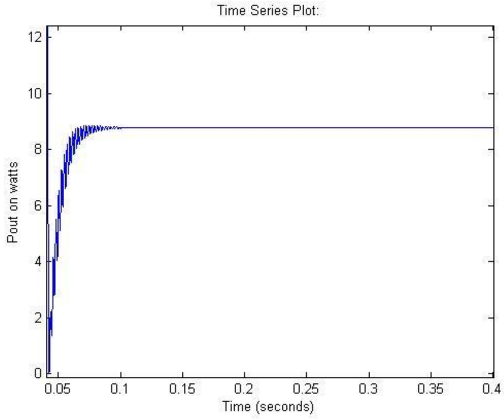

(c)

Fig 3 (a) Voltage (b)Current and (c)Power curves at MPPT.

VIII. CONCLUSION

The presented work is the Simulation of Single Ended Primary Inductance Converter for PV applications along with maximum power tracking using perturb and observe algorithm. Simulation is carried out using MATLAB/Simulink software. PV cell is drafted as per the fundamentals of semiconductor technology. The good converter efficiency is achieved for the specified parameters.

REFERENCES

[1]. Dr Nagana gouda,"Solar power Hand Book",NTCST,2015.
[2]. Cemal Keles, B. Baykant Alagoz, Murat Akcin, Asim Kaygusuz, Abdulkerim Karabiber" A Photovoltaic System Model For Matlab/Simulink Simulations".
[3]. DIB Djalel , Gasmi Moatazbillah, "Behavior Study of PVG via Designing of a Solar Simulator Software".The fifth International Renewable Energy Congress IREC 2014.
[4]. Hemalatha J N, Dr Hariprasad S A and Dr G S Anitha,"Performance Evaluation Of Single Ended Primary Inductance Converter For Photo Voltaic Applications", International Conference on Magnetics, Machines and Drives (AICERA-2014 iCMMD).
[5]. Ned Mohan,Tore M.Undeland,William P Robbins, power electronics converters, application and design, Newyork: John wiley and sons, 1995.
[6]. Ram Krishan,Yog Raj Sood and B.Uday Kumar,"The Simulation and Design for Analysis ofPhotovoltaic System Based on MATLAB",2013 IEEE.
[7]. Daniel W.Hart,"Power Electronics",Tata McGraw Hill Private Limited.

ACKNOWLEDGEMENT

I express my gratitude to Visvesvaraya Technological University, Belagavi for providing me an opportunity. I express my sincere thanks to our esteemed institution NMAM Institute of Technology, Nitte for supporting me in all the way possible.

BIOGRAPHIES

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