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Designing, Controlling and Simulation for integrated Photovoltaic Array using Matlab

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***Abstract*: The recent reconstructing, Cutting-edge power electronics, expanding power demand and public environmental concerns, are providing the opportunity for photovoltaic generation technologies in the modern scenario. In order to fulfilment of sustained load demands during varying natural conditions, renewable energy sources are more beneficial and for that different energy sources need to be integrated with Photovoltaic power system. This paper presents the designing and control framework of smart battery backup system with PV array simulated in MATLAB/SIMULINK Environment. A control strategy for maximum power point tracker (MPPT), charging and discharging controller (CDC) for battery (GB), for photovoltaic array (PVA) and a smart logic based control for two batteries has been designed for supplying sustained power demands. The two batteries are connected in parallel with PVA to overcome changing natural conditions and supply power regularly. We also design a three-phase voltage source inverter (VSI) is also developed for the proposed system by considering the output voltage regulation.**

***Key words:* Maximum power point tracker, Charging and discharging controller, Photovoltaic array, Voltage source inverter**

I. INTRODUCTION

The natural fuel energy sources (conventional sources) such as coal, petroleum, and natural gas which meet most of the world's energy demand today are being depleted rapidly. Also, their combustion products are generating global problems such as the pollution and greenhouse effect which are dangerous for our environment and resulting for the entire life on our planet **[**2**].** The burning of fossils fuel continues to raise producing level of carbon dioxide, which climatologists believe is a major cause of global warming. The alternative energy sources are attracting more attention. Today, new advances in power generation technologies and new environmental regulations encourage a significant increase of non-conventional energy sources around the world [1].

A detailed approach to GB and PVA modelling based on a mathematical description of the equivalent electrical circuits are given in [3, 4, 5] and [6] respectively.

In this paper, we studied about the stand-alone Battery backup PV system, which is constituted of one PVA and two GB system. A simulation software program known as Matlab/ Simulink is used in dealing with designing, simulation, control and energy management of the system. The configuration of overall system is a hybrid system having integrated voltage source, a voltage source inverter (VSI) with a LC filter and two feedback controlled AC loads.

II. MAIN COMPONENTS OF THE PROPOSED SYSTEM

The basic components of the proposed system as shown in Fig. 1 are GB with CDC, PVA with MPPT, VSI with LC filter and two AC loads with feedback control.

Table I shows the parameter details of components in proposed Hybrid system.

Table I

Name of Components	Details about the Component
PVA	Power=100KW , V_o=273.5V at 1000 W/M^2 Irradiance
GB-1	Rated Capacity=15Ah,V_o=500V, Initial SOC =88.75%
GB-2	Rated Capacity=15Ah,V_o=500V, Initial SOC =40.50%
MPPT	Tracks Maximum Power Point and Varies duty cycle of Boost Converter

Boost Converter	Boost the V_{mpp} and fixed it to 500V
CDC	Control SOC in between 40% to 90%.
PWM IGBT VSI	Convert 500Volt(DC) to 280V(rms) (3-Phase AC)
PWM Generator	3 arm,6 pulse, carrier Frequency=2000KHz

Voltage Regulator	Regulates modulation Index to m=0.875 for PWM Generator
AC Load1	V_{rms}=260V, f=50Hz, Power=20KW, Critical load
AC Load2	V_{rms}=260V,f=50Hz,Power=20KW, Non-Critical load

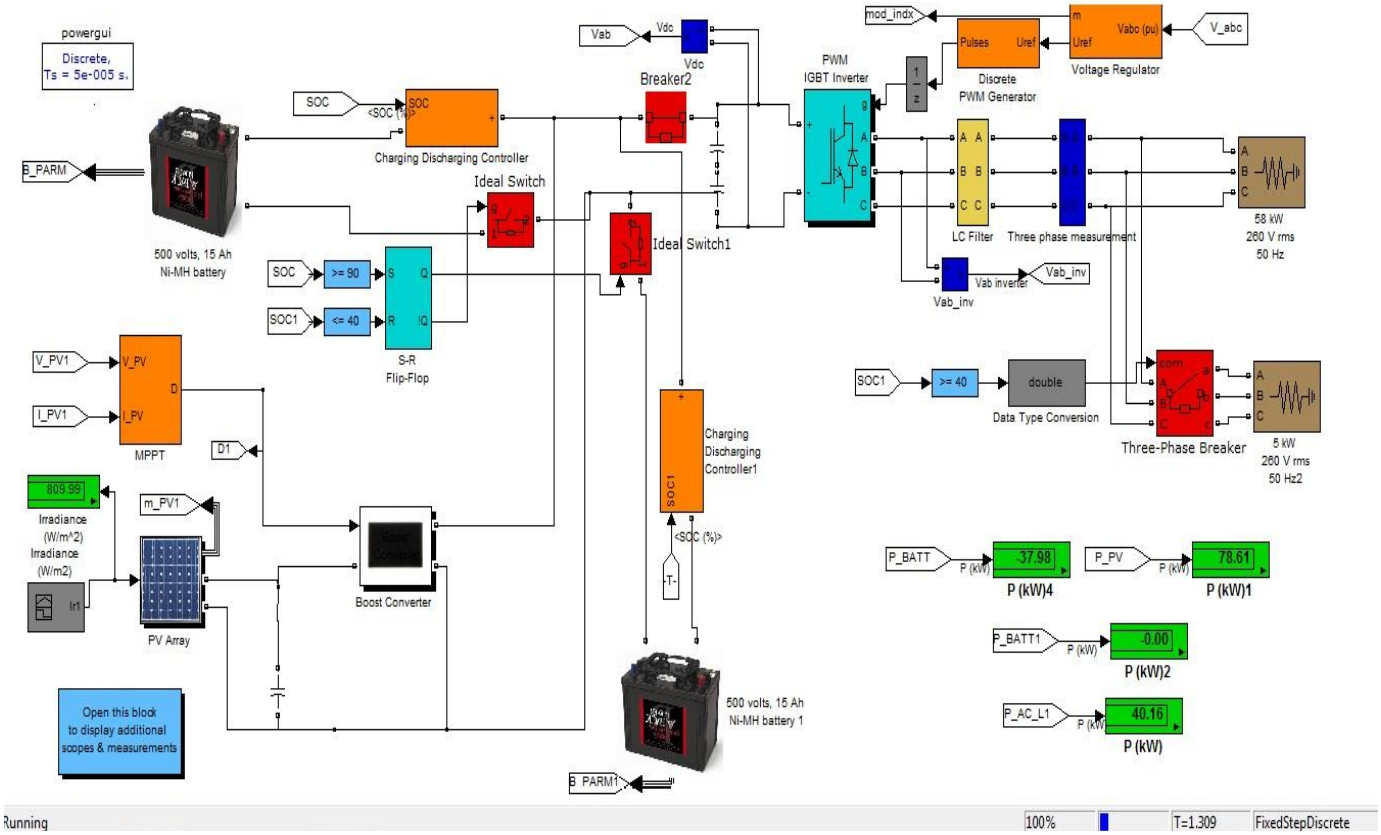

Fig. 1: The proposed system simulation model

III. IRRADIANCE INPUT FOR PVA

An irradiance signal has been built using Signal builder in Matlab. Fig.2 shows the irradiance power for 24s in which first 12s represents day time having natural disturbances from t=3s to t=5s and next 12s represents night time having zero solar power. This input is user dependent and can be

changed easily.

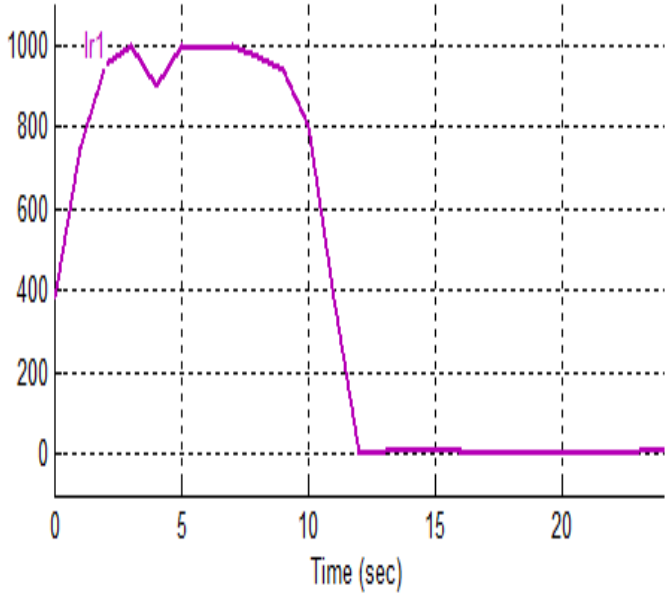

Fig.2: Irradiance (W/m^2) versus Time (t) signal

IV. SIMULATION RESULTS

The overall system has been simulated in Matlab/Simulink environment for 24s. At start, GB-1 and PVA starts working in parallel. At t=9s, GB-1 is fully charged and automatically disconnected for charging. Now GB-2 starts working in parallel. It is being charged as PVA power is greater than load power. At t=16s, it is fully discharged and disconnected. Again PVA establishes connection with GB-1. Since at this time, we have only back-up of GB-1, therefore one non-critical AC load is automatically disconnected to provide power continuously to critical load for long run. Fig.3 shows the power graph of PVA,GB-1,GB-2 and load by different colours.

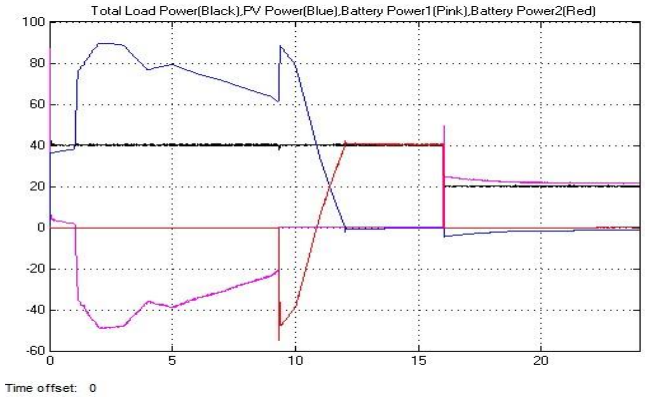

Fig.3: Power graph of PVA, GB-1, GB-2 and Load.

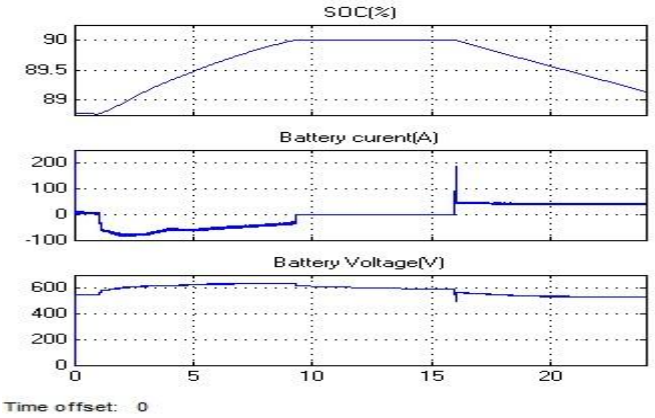

Fig. 4: GB-1 status.

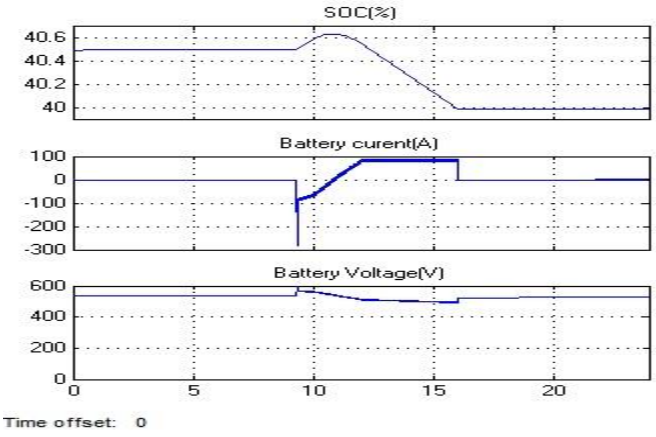

Fig. 5: GB-2 status.

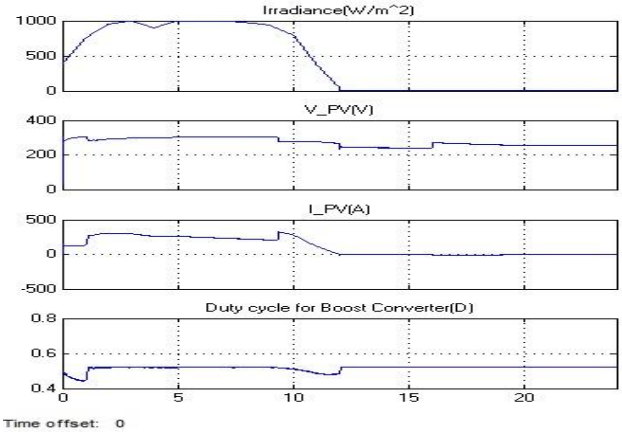

Fig.6: PVA status

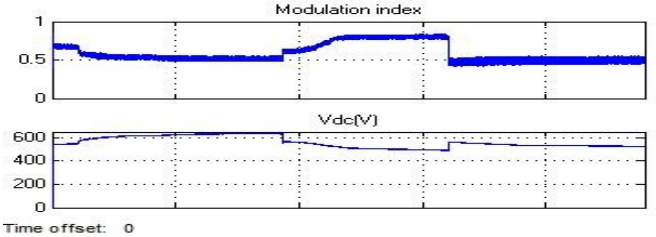

Fig.7: Modulation index of PWM generator and V_{dc} of VSI.

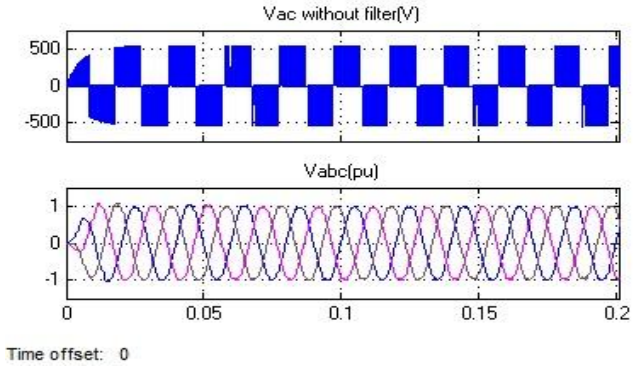

Fig.8: VSI output without and with filter.

V. CONCLUSIONS

The paper describes a Simulink on Matlab for hybrid simulation model of smart battery back-up for PV array. The simulation model is capable of handling varying natural prospects and to provide power regularly. The simulation results give encouraging output on the performance of the proposed system. It can be believed that the proposed system will have more accurate results if the mentioned system is considered and improved in the future research. In order to meet sustained load demand additional concerns such as utility grid connection must be planned.

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