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Control and Simulation of Smart Backup System for Photovoltaic System in MATLAB

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***Abstract*—Penetration of power electronics, environmental and location issues, power blackout and increasing power demand are the main concern for using this system. These factors provide an opportunity for new power generation systems and their integration with one another. This paper presents the smart battery backup system for Photo-Voltaic System (PVS) simulated using MATLAB. A new control strategy for charging and discharging controller(CDC) for battery, maximum power point tracker(MPPT) for PVS and a smart logic based control for connecting and disconnecting the batteries with PVS are developed for providing sustained load demands. The two batteries (B-1 and B-2) work in parallel with PVS to compensate varying natural conditions and to provide power continuously. A PI-controller is used for PWM three-phase voltage source inverter (VSI) to get regulated output power.**

***Keywords*— Photovoltaic System; Battery; Inverter; MPPT;**

I. INTRODUCTION

Today, approximately 87 percents of total energy comes from burning fossils fuels such as coal, natural gas, and oil which are being depleted rapidly [1]. The expanding power demands are the major challenges in front of us. The use of new and alternative energy sources with efficient configuration is one of the best solutions for these challenges. Nowadays, the most dominating technology is power electronics that provides life blood to alternative energy sources. It minimises conversion losses and gives high quality of power at minimal cost. The alternative energy sources are attracting more attention. New environmental regulations and advances in power generation technologies encourage a significant increase of these energy sources around the world[2].

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

Maximum power point Tracking(MPPT) of a photovoltaic(PV) array is an essential part of a PV system. Hill climbing [7] and perturb & observe (P&O) technique [8] have been used to design the MPPT.

The system under study in this paper is a stand-alone Battery backup PV system, which is constituted of one PVA and two GB system. A simulation software program known as MATLAB is used in dealing with 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.

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

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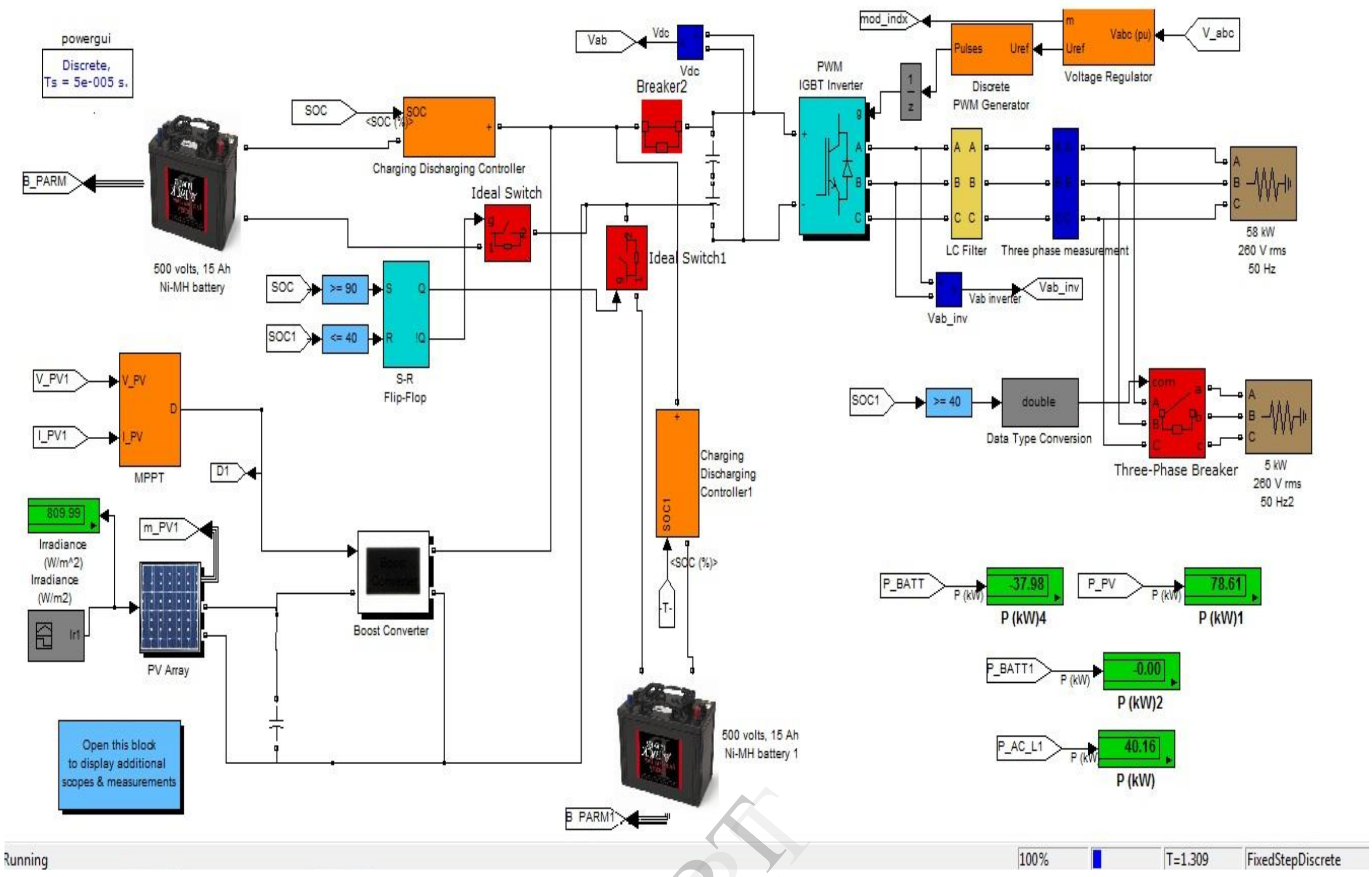

Fig. 1: The proposed system simulation model

II. 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.

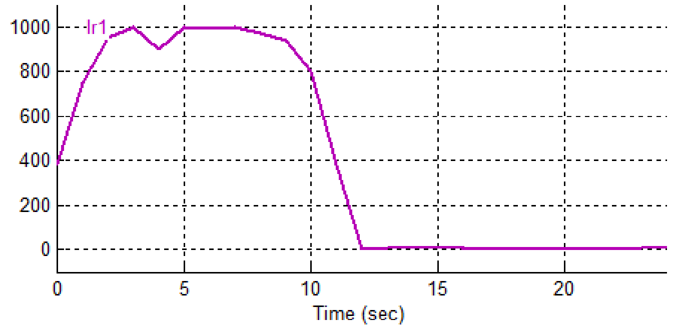

Fig.2: Irradiance(W/m^2) versus Time(t) signal

III. 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.

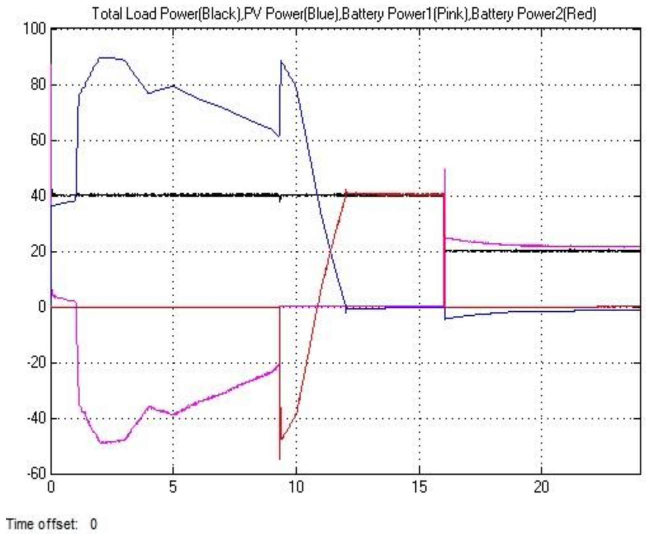

Fig.3: Power graph of PVA, GB-1,GB-2 and Load.

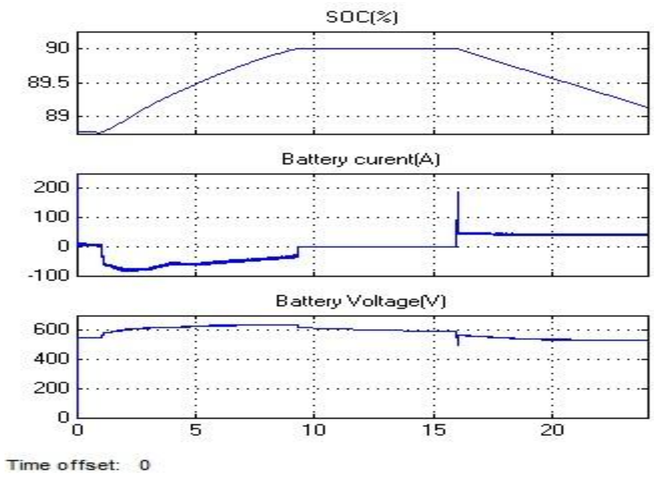

Fig. 4: GB-1 status.

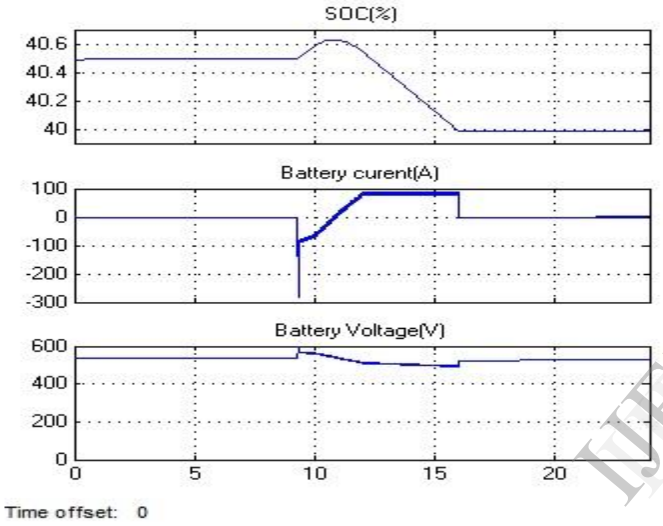

Fig. 5: GB-2 status.

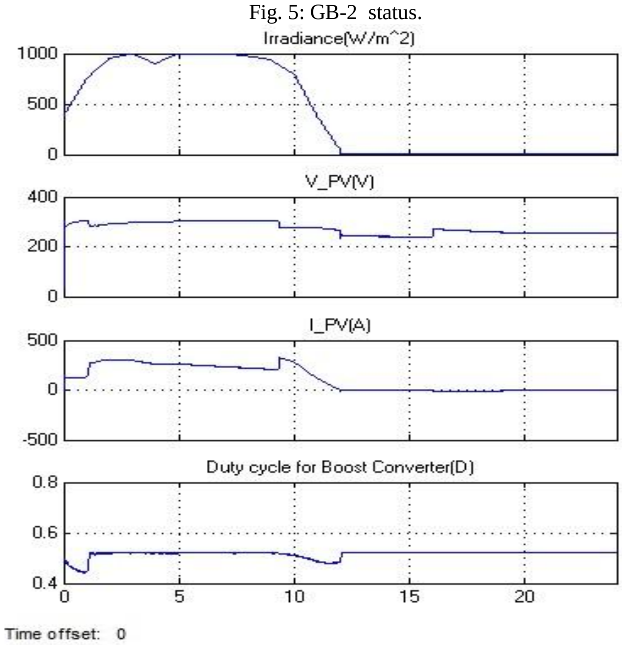

Fig.6: PVA status.

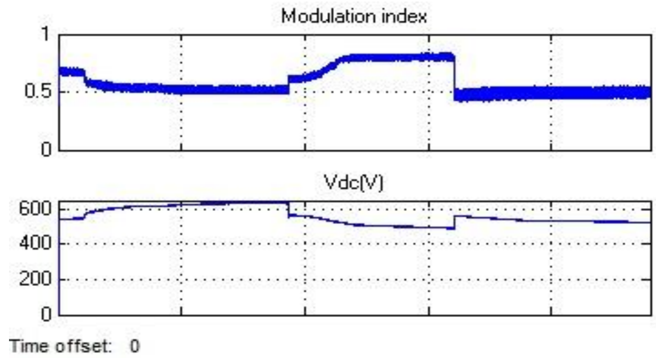

Fig.7: Modulation index of PWM generator and V_{dc} of VSI.

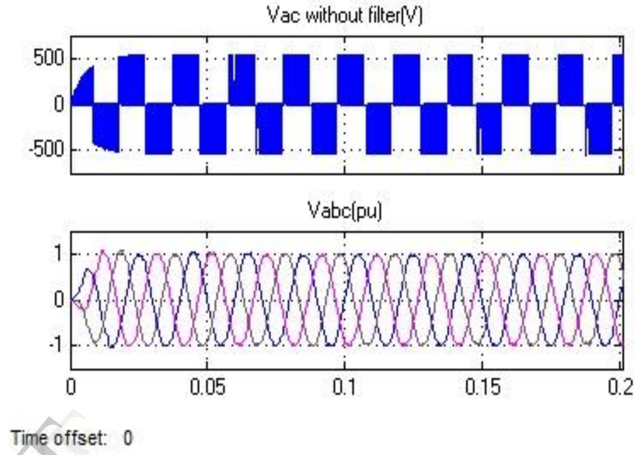

Fig.8: VSI output without and with filter.

IV. CONCLUSIONS

The paper presents a Matlab/Simulink hybrid simulation model of smart battery back-up for PV array. The simulation model is capable of handling varying natural conditions and to provide power continuously. 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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