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Proposed Battery Storage System Model Connected to the Grid

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***Abstract*— Batteries are highly sensitive to environmental conditions such as temperature and heat, due to energy exchanges through electrochemical reactions, and these factors will diminish their useful life. However, the increasing development of distributed products and using renewable energy to provide electrical energy leads to more usage of batteries in power systems. Battery cell structure cause that desired capacity, power and voltage of battery storage system to be achieved through connecting different number of battery cells. In this paper, battery storage system connected to the network is based on accurate modeling system, control consisting of flow control strategy and voltage control strategy. Flow control strategy has the duty of DC voltage regulation and power factor control. In addition, it is expected that current control strategy of battery storage system to have good control against external fault and increase system reliability. Sampling from distribution sensors has been specified to obtain a real-time delay between system controls that is stable according to the characteristics of analysis network.**

***keywords*— energy storage system , bidirectional dc–dc converter, battery system controller.**

I. INTRODUCTION

A new soft-switching bidirectional DC-DC converter which can be used as an interface circuit between super capacitors and batteries or fuel cells is used. All semiconductor devices are in the proposed converter of soft switching, while PWM control circuit is maintained. Due to the soft switching, energy convert via the proposed converter has high efficiency. Proposed converter has been analyzed and the experimental results have confirmed theoretical analysis. [8] Designing AC convert to DC has been suggested to enhance power quality and proper operation of the system during error and distortion that as a result reduces losses and costs, in DC drive systems with low voltage at which the speed control is intended, controlling speed of DC machines is obtained through changing the high voltage. [2] In this paper, centralized control of inverter parallel operation with distributed generation in micro-grid generators is referred. The control system integrates the Kalman filter and the harmonic spectrum extract of programmed load current. Distributed generation systems' inverter can compensate harmonic load currents [3]. Photovoltaic system and grid-connected battery generation system have been studied for converting solar energy with maximum power point of Photovoltaic array in order to generate maximum injected power into network. The battery can be charged or discharged to maintain the balance between Photovoltaic array demanding powers and thereby improved stability of the whole system can be seen [5]. Three-phase DC to DC converter is presented based on clamped neutral point of three phases that is considered for application programs that can be processed in an average DC voltage bus. [7]. A control system is proposed for distributed generation inverter system in connected to network micro-grid and in island operation. Proposed control has been considered for distributed generation inverter system in Maximum Power Control (MPC) developed algorithm for steady state based on transient mode to reduce overall computation time [4]. Many of the various converters' circuits have been studied that can be used for inverter application programs of photovoltaic systems. Application programs do not have now potential benefits to use common systems. While developing a sample system of power electronic system results in greater reliability and system flexibility. The current sample systems detect and limit currents' foreign error samples so that the remaining sample system can continue its work with minimal disruption [6].

II. SYSTEM CONFIGURATION

Based on need ,reverse chemical reaction causes the charge of electric from the battery to the grid .One of the important features of batteries is their quick response time; some of the batteries are able to respond to the changing load in less than 20 milliseconds. Battery efficiency is between 70% to 80% that depends on the type of battery and use of its cycle. Loss of battery's energy is low and yet they have high electrical energy storage density. Perhaps the main problem of batteries is their life time .Usually the battery's life is shorter than other energy storage systems ,and they must be replaced periodically. Power electronics technology plays an important role for the interface of battery storage system and grid.

A. The battery storage system structure and proposed circuit:

Simulation diagram of battery storage system connected to the grid is shown in figure. 1.

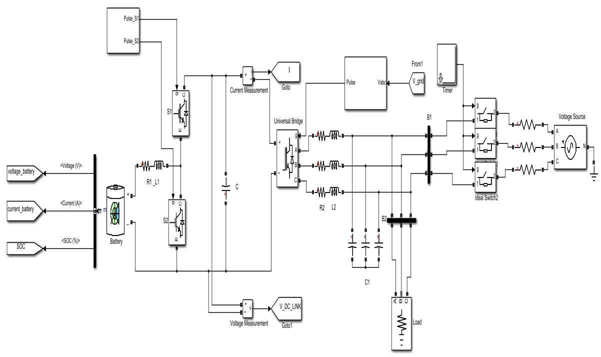

Figure 1 Schematic diagram of the simulated system examined

In examined system we used battery storage system that connected to the grid by DC/DC and DC/AC converter and the featured of examined system is shown in table 1.

III. MODELING SYSTEM

A. Battery storage system modeling

Battery model:
Change in current flowing from one battery causes the flow and battery voltage ,to have ac fluctuations besides the amount of dc .The response of a battery voltage to the change of its current flow is always delayed so this cause the internal impedance in modeling batteries accurately not considered to be resistant. Now in this study the most common model used in a battery containing a series ideal voltage source with a constant internal resistance is shown in figure 2.

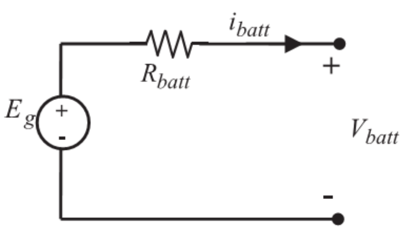

Figure 2: Equivalent circuit for the battery

That in this study is used Tonen (internal resistance model) [9] for modeling battery .In this method the battery is modeling by relations 1,2,3.

$$V_b = V_{boc} - r_b I_b \qquad (1)$$

$$E(t) = -\int (\beta V_{boc} I_b + w_{loss})dt, \beta = \begin{cases} \beta_1 & I_b > 0 \\ \beta_2 & I_b < 0 \end{cases} \qquad (2)$$

$$SoC(t) = E(t)/E_{max} \qquad (3)$$

V_{bc} is open circuit voltage of the battery ,r_b is internal resistance of battery ,E is storage energy in battery ,$ß_1$ is for Decharge ratio ,$ß_2$ charge ratio, W_{loss} is battery storage losses ,E_{MAX} is the maximum energy stored in battery and SoC is battery charge status. And also the circuit diagram of battery storage system is shown in figure 3.

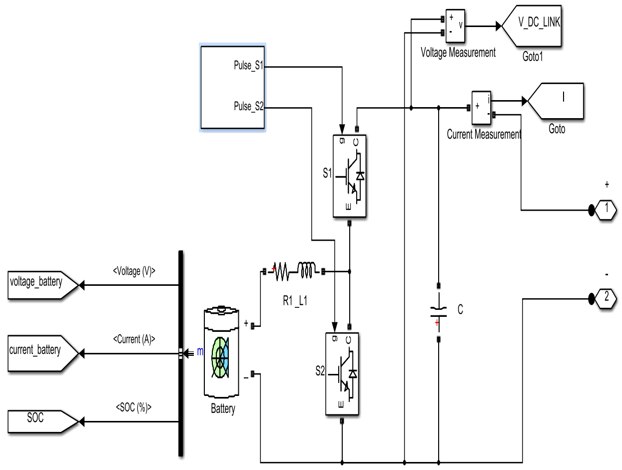

Figure 3. Battery Storage System

B. The control circuit of the battery storage system

Control system of battery storage system is to built based on the power control ,that by sampling the current ,voltage and using PID controller pulse control of storage system control the action of charge and Discharge. The control circuit of the battery storage system is shown in figure 4.

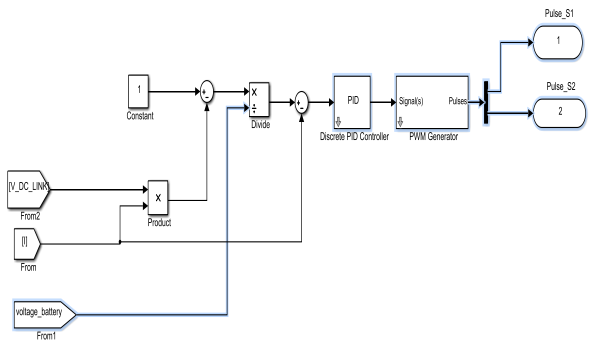

Figure 4. control circuit battery storage system

C. DC to AC circuit convertor

Control system of battery storage system is built based on voltage control ,that by sampling the voltage , current of grid , DC _link voltage ,lowpass filter ,PI controller and pulse with modulation ,make DC to AC control pulse convertor . Control circuit of DC to AC convertor is shown in figure 5.

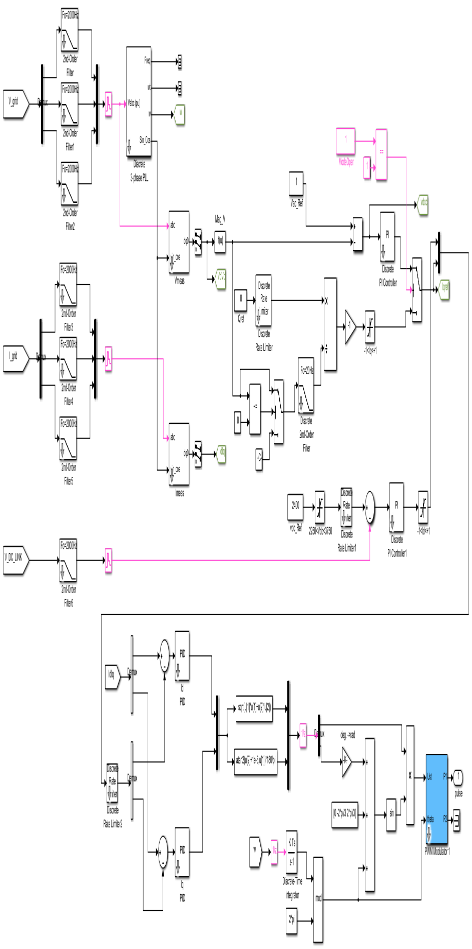

Figure 5.DC to AC converter control circuit

Table 1 shows the parameters of the system

Battery	
Battery type	*Lithium-Ion*
V_{nom}	*400v*
Rated Capacity (Ah)	*15Ah*
Initial State-Of-Charge (%)	*50%*
R1	*0.001Ω*
L1	*0.001mh*
C	*100uf*
Converter Buck-Boost	
Proportional gain (Kp)	*0.002*
Integral gain (Ki)	*50*
Carrier frequency	*11.1khz*
DC/AC converter	
Cut-off frequency	*20khz*
Damping factor Zeta	*0.707*
Carrier frequency	*1080Hz*
Modulation Index	*0.75*
Grid side	
Voltage	*400v*
Frequency	*60Hz*
R2	*0.001Ω*
L2	*1mh*

IV. CASE STUDY AND SIMULATION'S RESULTS

In order to verify the proposed control methods for battery storage system and grid integration ,system simulation is done by using Matlab/simulink . The result shown in figure 6_9. Figure 6 shown voltage current and SoC battery ,Figure 7 shows voltage and DC _link current ,Figure 8 shows Back_Boost convertor control pulse and figure 9 shows voltage and load bar .In examined system that showed in figure 1 stimulation time was considered 4 seconds that in second 0.5 battery isolated , fed from load grid and then again in second 1.5 connect to the grid and at the end in second 2 load disconnect from the grid.

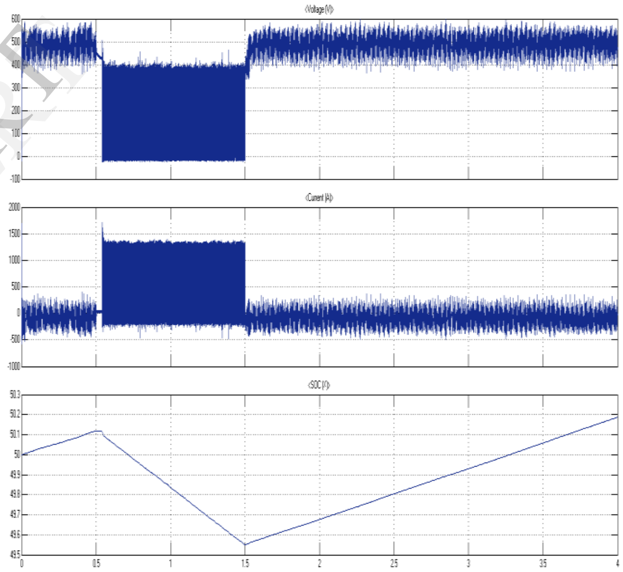

Figure 6. Voltage, current and SoC Battery

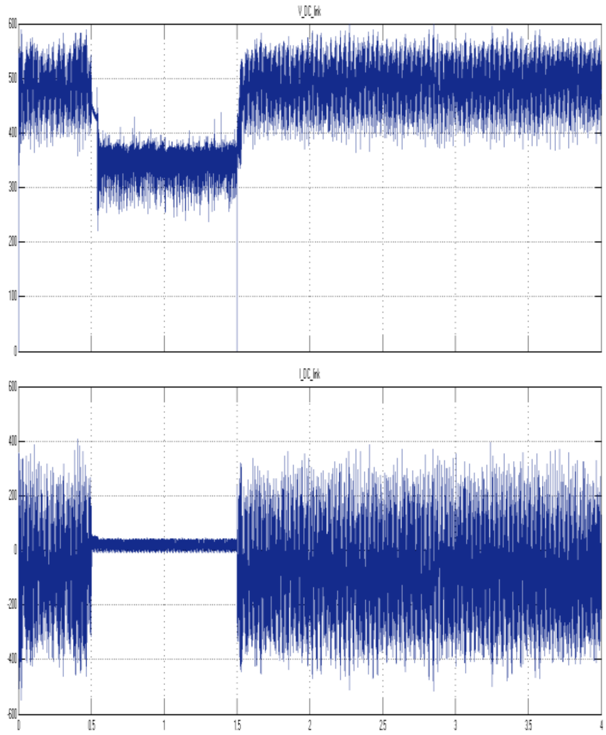

Figure 7. Voltage and current DC_link

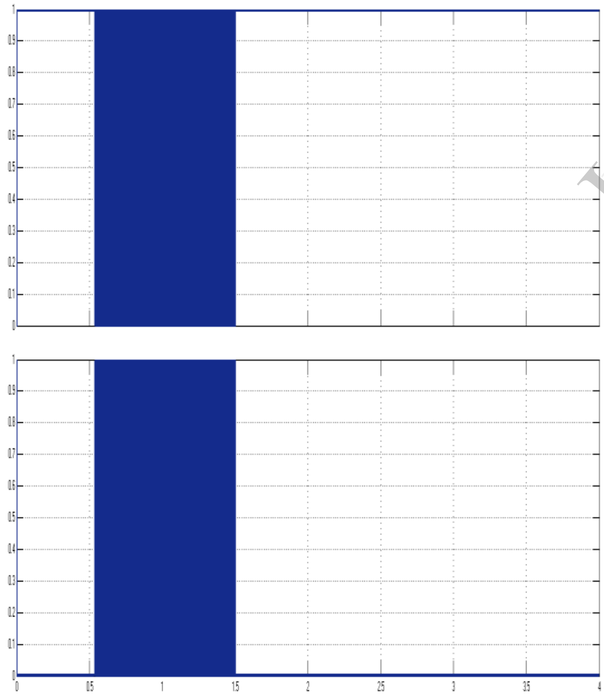

Figure 8. Pulse Controlled Buck-Boost Converter

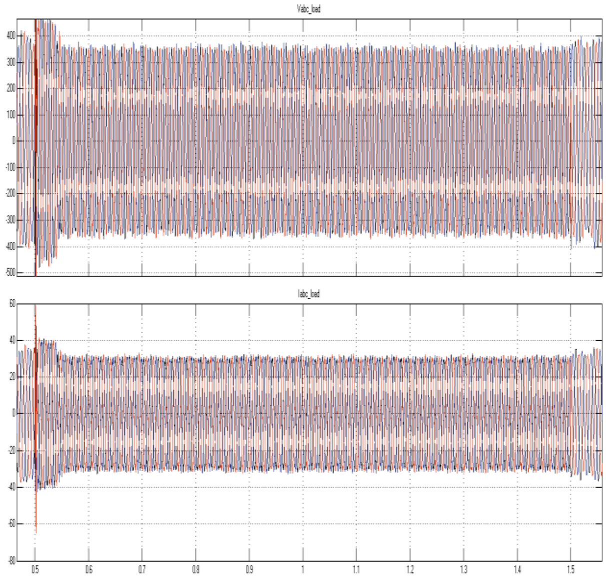

Figure 9. The voltage and current load

V. CONCLUSION

In this study control and battery storage system management is considered as connected to the grid and in the island mode. Proposed control provides maximum output of battery storage system during different operating condition with the minimal disturbance between grid and island mode. Controller is used as a system coordinator and battery storage used as a control input for switching model that it done on Matlab/Simulink environment.

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