# Simulink Model For Voltage Controller In Microgrid

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*Abstract*—**Smart grid is a developing area for energy researchers. It provides technological improvements to have reliable, sustainable and more controllable power grids. Instead of using fossil fuels, many researchers use renewable energy sources like solar panels, wind turabines, etc. This paper is about the Matlab/Simulink model of microgrid and its controller, which can be used for smart grid simulations. Microgrids are the power generation units for local loads and microgrids are vulnerable to attacks. Two attacks named Man-In-The-Middle attack (MITM) and False Data Injection Attack (FDIA) are considered in the paper. A Matlab/Simulink model for controller to control the attacks in the microgrid is also introduced. The simulation results shows that a control can be done in the presence of attack.**

*Index Terms*—**Microgrid, Matlab/Simulink, power system simulation, Attacks.**

## I. INTRODUCTION

Microgrids are the power generation units for local loads. It will generate power and distribute it to the loads. Microgrids contain a Renewable Energy Sources (RES) and Energy Storage Systems (ESS). Renewable Energy Sources can be solar panels, wind turbains etc. The excess energy produced by RES can be stored in storage systems. The RES with the Energy Storage System provides power to loads when the RES is not generating any power. Microgrid can be off-grid and on-grid. The microgrid connected to the main grid is on-grid and when it is isolated from the main grid, it is called off-grid or islanded.

A microgrid may contain several Distribution Generation (DG) units. Each unit will produce an output voltage which should be controlled because if there is any attack in the link, we need to overcome its effect by controlling output voltage. If two DG units are connected each other, the power can be shared between these units. But if there is an attack in DG unit, then the output voltage of that unit will be varied.

Power generation by the RES depends on the condition of the weather like wind speed and temperature. The characteristics variation complicates RESs integration to the grid. Thus the designing and planning of RESs must contain new control method's design and best materials in accordance with the actual system and also the specification. To have a better result, we needs more time and money to do this experiments practically. So to do the experiments at low cost

and at reasonable period, the researchers requires computer aided design and several tools for simulation.

To execute virtual experiments and to design a new model , Matlab software is often used. It is adaptable to exchange data with electronic equipments and operating systems. It can be utilized for designing device, developing algorithms, scrutiny of data and arithmetic simulations. Simulink is the extension of Matlab software which can be used to model and simulate the systems. Simulink provides a graphical environment and allows active participation of the user. It is a block diagram model which contain blocks of several models.

Basic microgrid Simulink model is presented in [1]. Simulink model for microgrid is presented in the paper. Solar panel is taken as RES which is formed by connecting fourty parallel strings of ten series connected photo voltaic modules. This model can be used for controlling the output voltage of the microgrid by using a DC-DC voltage controller at the output of a microgrid along with a buck converter. The MITM attack in the link and FDIA attack in the controller of microgrid are introduced in the model affect the voltage and current of the microgrid. A controller model to control the voltage and current due to the attacks is also introduced which will make the microgrid work stable even in the presence of the attacks.

## II. MICROGRID MODEL

### A. Microgrid

Microgrid is a power generator that can supply power to nearby loads by utilizing a RES and a storage system to make it more efficient. Microgrid is modelled using Matlab/Simulink is shown in the figure 1 in which solar panels are used as a RES and a Lithium ion battery used as a ESS. A ten number of sixty cell solar panels used in this are connected in series to form a string and such fourty strings are connected in parallel to form a photo voltaic array. A lithium ion battery used here can store power from the solar panel which can be used when the customer needs. In this model solar panel is connected to a DC load and battery is connected to a AC load through a DC-AC converter as the battery outs a DC power. This model is connected to AC line by using a switch so that the model can work in both grid connected and islanded mode.
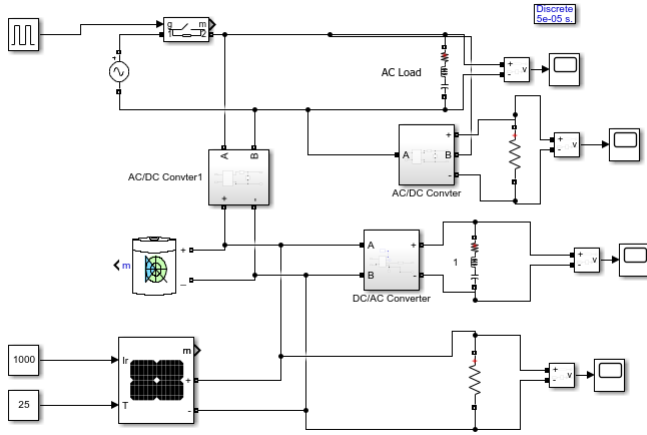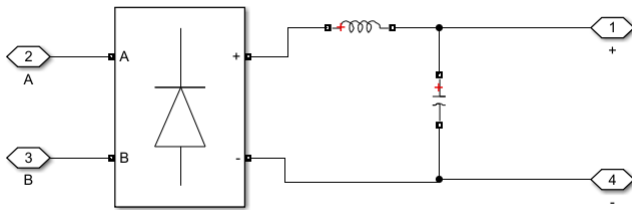
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Fig. 1.  Simulink model for microgrid



Fig. 2.  AC to DC converter model



Fig. 3.  DC to AC converter model



Fig. 4.  Controller model with FDIA attack

### B. Components modelling

*1) AC-DC converter:* To connect the DC load with main grid which is an AC, it is necessary to convert the AC to DC. So, for that an AC-DC converter is used. In this AC-DC converter is modelled by using a rectifier along with an inductor and capacitor. The converter model is pesented in figure 2. The rectifier is modelled using diodes with snubber RC circuit.

*2) DC-AC converter:* The output of the battery and the solar panel are producing DC. So to provide power to a AC load from solar panel and battery source, the conversion of power from DC to AC is necessary. The DC to AC coverter's simulink model is shown in figure 3 in which a full bridge coverter is used. A Pulse Width Modulation (PWM) generator is used to gate the switching devices in the converter.

## III. CONTROLLER MODEL

A DC-DC voltage controller along with a buck converter is used to control or to stabilize the output voltage of the microgrid. If there is any attack like MITM attack or FDIA attack [2], it will affect the voltage and current of the microgrid, that will lead to the blackout condition of microgrid. So to avoid this situation, a control should be done to mitigate the effect of these attacks. The controller is Proportional-Integral (PI) DC-DC voltage controller which will take the
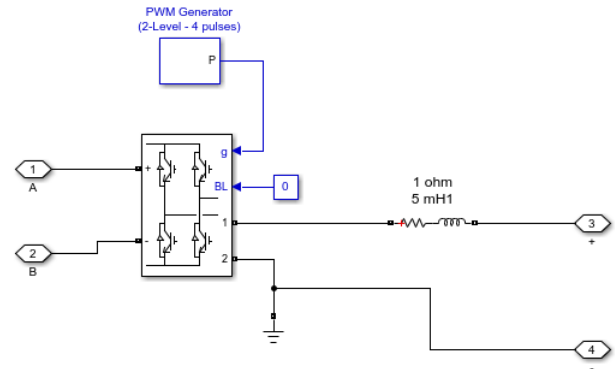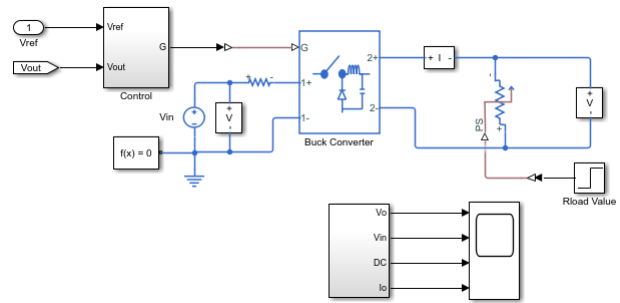
output voltage and reference voltage of the microgrid and produces an error signal. This signal is given to a DC PWM to provide a gating signal for the buck converter. Buck converter is a DC-DC converter whose output will be less than that of input voltage.the buck converter will maintain the output voltage within the reference voltage. If there is any false data is injected into the buck converter's output, this controller can overcome its effect on voltage and current by maintaining the output voltage at reference voltage. The parameters used for PI controller is shown in the table I. The parameters proportional gain and integral gain should be selected carefully.

### TABLE I
### CONTROLLER PARAMETERS

| Parameter | Value |
|---|---|
| Proportional gain $K_p$ | 0.22 |
| Integral gain $K_i$ | 46 |
| Sample time $T_s$ | $5e^{-6}$ |
| Reference voltage $V_ref$ | 6 V |

## IV. SIMULATION RESULTS

Microgrid model is simulated using Matlab/Simulink and result is noted. For DC load and AC load microgrid provides power as shown in the figure 5 and figure 6 . For DC load power is directly provided by solar panels and battery provides power to the AC load through a DC-AC converter.

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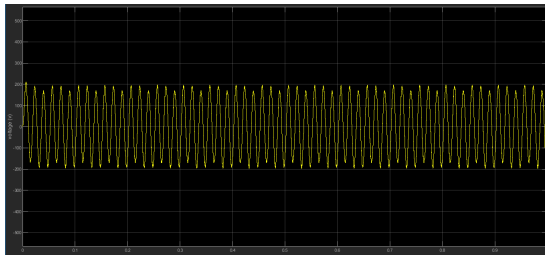ISSN: 2395-3470
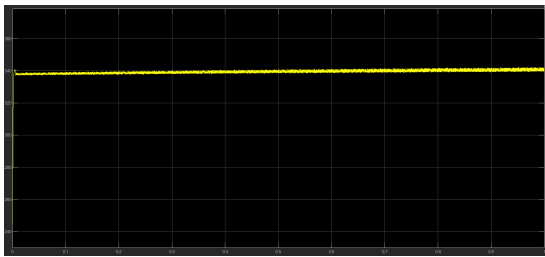www.ijseas.com



Fig. 5.  AC load voltage



Fig. 6.  DC load voltage

When attack named FDIA and MITM were introduced in the controller section and transmission link, it will affect the current and voltage of that microgrid, so we need to control it. The MITM attack is introduced when time equal to one second, as a result the voltage decreases from 5.96 volts to 5.84 volts as shown in figure 7 and also there is a change in current shown in figure 8.

Figure 9 shows the controlled outputs of the controller with buck converter. The input voltage is chosen as 12 volts for buck converter and it will maintain the output voltage at about 6 volts. When FDIA attack is introduced at time t=0.5 s, the voltage suddenly increases which is shown as a glitch in figure 9. The controller will reduce the voltage to maintain it at about 6 volts.The effect on current and its control also show in figure 9. And at t=1s, the effect of MITM attack on voltage also controlled by controller which is shown as a small fluctuation after 1second.
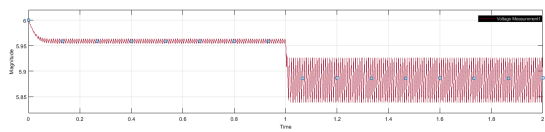


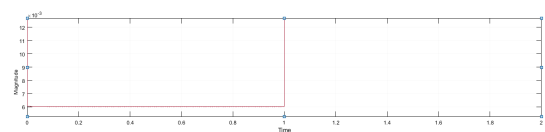Fig. 7.  MITM effect on voltage
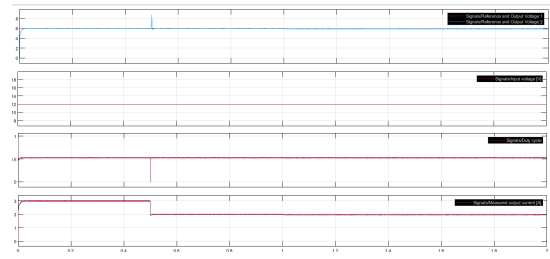


Fig. 8.  MITM effect on current



Fig. 9.  Controlled output

## CONCLUSION

The paper presented a Matlab/Simulink model for microgrid which can be useful for researchers of smartgrid. The paper also presents a controller model for microgrid. There are so many attacks that make microgrid unstable, so we need to work microgrid normally even in the presence of these attacks. The paper considers only two attacks named FDIA and MITM attack. These attacks are introduce in the microgrid's transmission link and controller section, and succesfully controlled the output voltage of the microgrid by using a PI controller along with a buck converter. This model can be used to detect and mitigate the FDIA and MITM attacks in two or more distribution generation units. The microgrid model can use to detect other attacks such as Denial-of-Service (DoS) attack [3], hijacking attacks etc. The microgrid model and its controller model is simulated using Matlab/Simulink.

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