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Design and Development of Hybrid microgrid to minimize the load on the powergrid.

Harshit Choubey

Prof. EE Department

SGSITS Indore

Dr Arun Parakh

Prof. EE Department

SGSITS Indore

Abstract - ***In this research work, the Simulink model presents an intricate yet efficient resolution for orchestrating power dissemination within the context of a hybrid microgrid paradigm. Through the harmonious amalgamation of a solar photovoltaic (PV) array, a DC backup source, an astute buck DC-DC converter, and a proficient inverter, the model establishes an unbroken conduit for furnishing consistent and dependable power provisioning to the interconnected loads. The strategic prioritization of solar energy as the pivotal source underscores the microgrid's proclivity towards sustainability and financial viability, thereby mitigating dependence on conventional energy reservoirs. The assimilation of the buck DC-DC converter not only amplifies the system's pliancy but also serves as an adept steward of voltage levels, ushering in fluid transitions between the solar PV array and the backup source. This intrinsic switching modality engenders an uninterrupted endowment of power to the loads, irrespective of the ebb and flow of solar luminosity. In its entirety, the proffered model proffers a prescient blueprint for microgrid architectural paradigms, encapsulating the essence of renewable energy exploitation, precision voltage regulation, and tenacious power administration.***

***Key Words*:** hybrid power system, simulations, solar, DC sources

1 INTRODUCTION

Due to the issue with fossil fuels, the fear of dependency on oil prompted research and development of alternative energy sources. Production of electricity is now using renewable energy sources including solar, wind, biomass, and micro-hydro systems. In an effort to promote the production of electricity utilising unconventional renewable energy sources, the national government continuously offers a variety of initiatives. As little as possible should be dependent on fossil fuels. As previously explained, it is important to use a sustainable energy source.

Alternative energy sources will be the basis of the power supply to various systems because of the limited availability of fuel resources and their detrimental impact on the environment [1]– [2]. The main advantages of alternative energy sources are their availability, accessibility, and lack of pollution with a fixed cost of usage. A different source is one that is not produced or used with nuclear energy or fossil fuels [3][4] or both [5].

The sun's beams are used by the solar system to generate electricity. Solar power output has significantly improved in recent years. Currently, the three most often used varieties of thin film solar panels are mono-crystalline, poly-crystalline, and amorphous. The most efficient solar panels are mono-crystalline ones [6]. Monocrystalline panels are more expensive per peak watt than amorphous and polycrystalline panels [6]. As the temperature climbs over 450 degrees, the effectiveness of all three types of panels begins to equalise. In hotter climates, amorphous solar panels are the ideal choice since they deliver the same power at a lower cost per peak watt [6].

By 2050, it is predicted that solar energy would supply 45% of the world's energy demands [7]. Chemical energy is converted to electrical energy in a fuel cell [8]. Hydrogen-based energy generation is becoming more and more practicable because to fast advancements in fuel cell technology [9]. Together, these two power sources can produce sustainable energy.

The greatest choice for meeting the world's energy needs is a hybrid power system [10]. Energy is obtained from two or more distinct types of energy sources in a hybrid power system. An efficient substitute for a hybrid power system is one that combines solar energy and fuel cells. Utilising MATLAB, many mathematical models of hybrid power systems have been created.

The development and performance assessment of a hybrid solar-fuel cell power system for the generation of energy is the main objective of the project.

The objectives are listed below.

1. Talk on the energy conundrum created by conventional energy sources. 2. Construct a Simulink model for a fuel cell and solar hybrid power system.

3. Development of a controller that can switch between sources based on the surrounding circumstances.

4. The hybrid power system's inverter concept and filtering operation integration

5. Improving the model's ability to access data online on a PC or mobile device by using Internet of Things technologies.

2 System Design

The hybrid power system model was made with Simulink in MATLAB. There are several libraries in the MATLAB tool Simulink. Every library has a function block that you may combine to build a bigger system [12].

A block diagram of the full model may be found below.

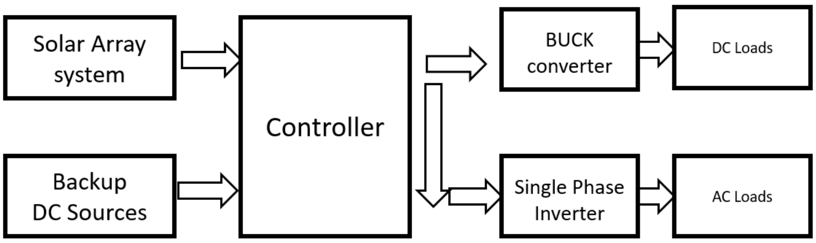

Figure 1 Block diagram of overall system

The solar cell and the backup DC sources make up the hybrid power system, as depicted in the block diagram above. The controller is wired to the DC sources and the solar PV array. Power flow from the source to the load is regulated by the controller. Single phase inverter model has been implemented to power the AC loads. Buck converter has been inserted in this microgrid to powerup the electronic gadgets and electric vehicles.

3 Modelling of Hybrid power system

In MATLAB Simulink, a model of the hybrid power system was created. There are numerous libraries included in the MATLAB tool Simulink. A function block is present in each library and can be coupled to others to create a larger system [12].

The components of the developed hybrid system's complete Simulink model are displayed below.

3.1 Simulink model of hybrid power system

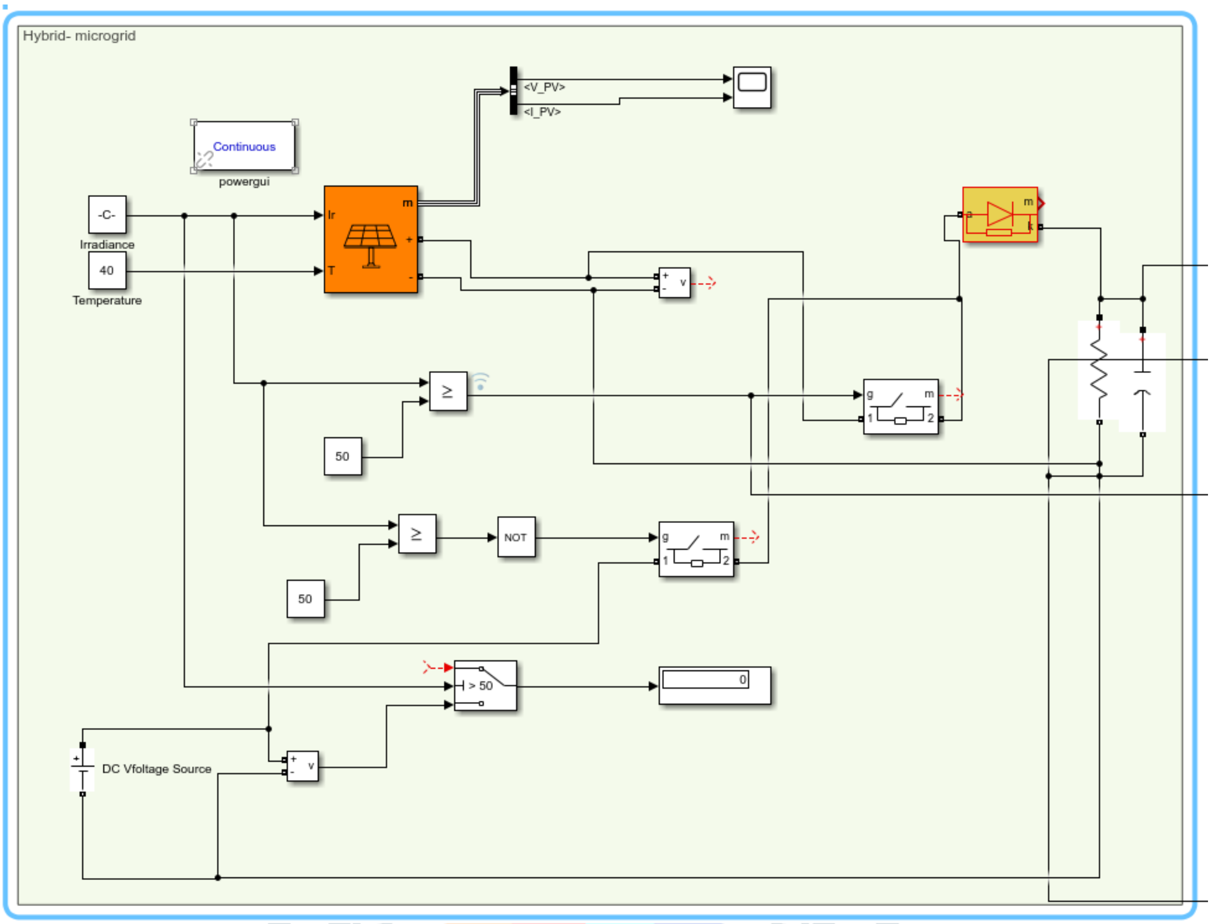

Figure 2 Simulink model of hybrid power system

In the aforementioned Simulink model, a knob is mapped to represent the PV array's irradiance. When the knob is rotated anticlockwise, the irradiance value decreases, and vice versa.

The type uses two bulbs in addition to a knob to indicate if the power source is giving electricity to the load. The electricity is provided by the backup DC sources, as seen in the image below. The hue green here stands in for the fuel cell.

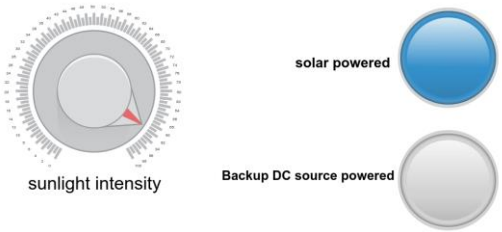

Figure 3 Indicators showing power is taken from Fuel Cell

3.2 \Simulink model of the Buck DC-DC Converter:

Buck DC-DC converters play a crucial role in microgrids by enabling efficient voltage regulation and power distribution. In a microgrid, which consists of distributed energy sources, energy storage systems, and loads, various components often operate at different voltage levels. The buck converter steps down the voltage from a higher level to a lower level, ensuring compatibility between sources and loads. This voltage regulation enhances the stability and reliability of the microgrid by preventing voltage fluctuations and optimizing power flow. Moreover, buck converters enhance energy efficiency by minimizing losses during the conversion process. By efficiently managing voltage levels and power distribution, buck DC-DC converters contribute significantly to the overall effectiveness and resilience of microgrid operations. Given below is the Buck converter implemented in the designed microgrid.

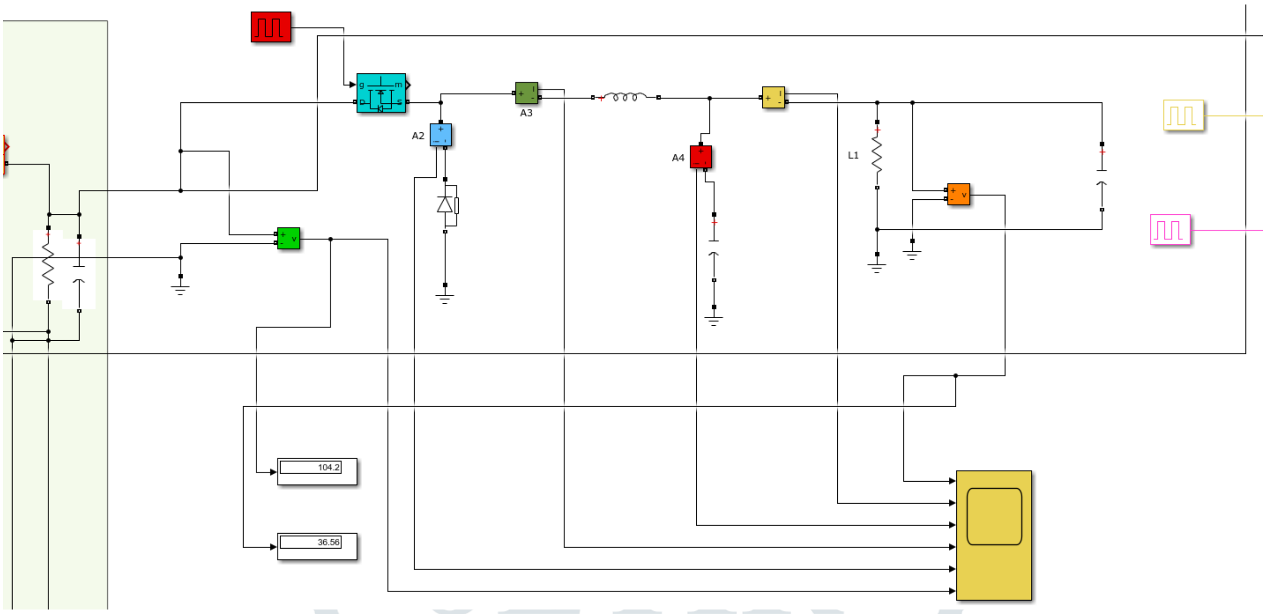

Figure 4 Simulink model of Buck converter in the microgrid

The electricity from the power source can be used to power either an AC or DC load. Our model generates a DC voltage. To run the AC loads from our model, an inverter had to be installed to the hybrid power system. The next image shows the inverter model.

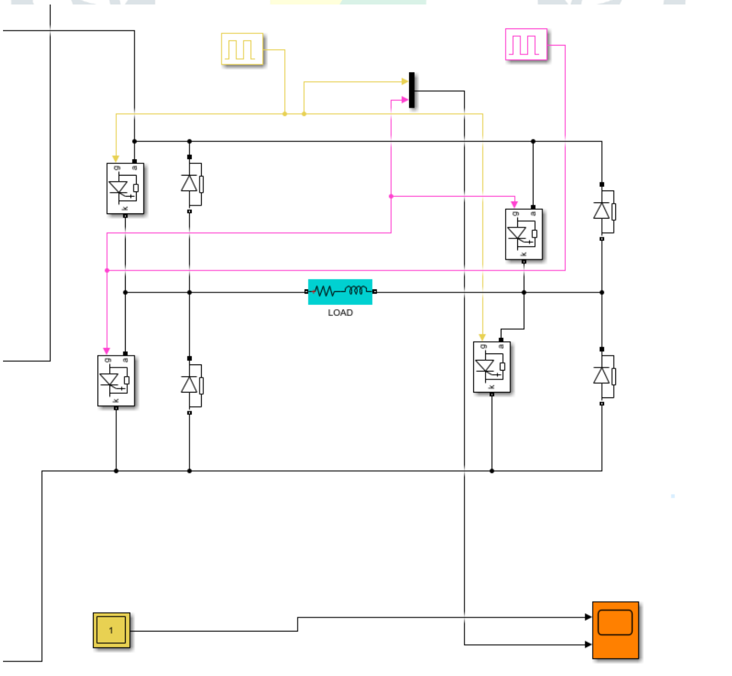

Figure 5 Simulink model of Inverter

3.3 Complete Simulink model of Hybrid power system

Every component has been discussed in detail. Below is a screenshot of the whole hybrid power system's Simulink model.

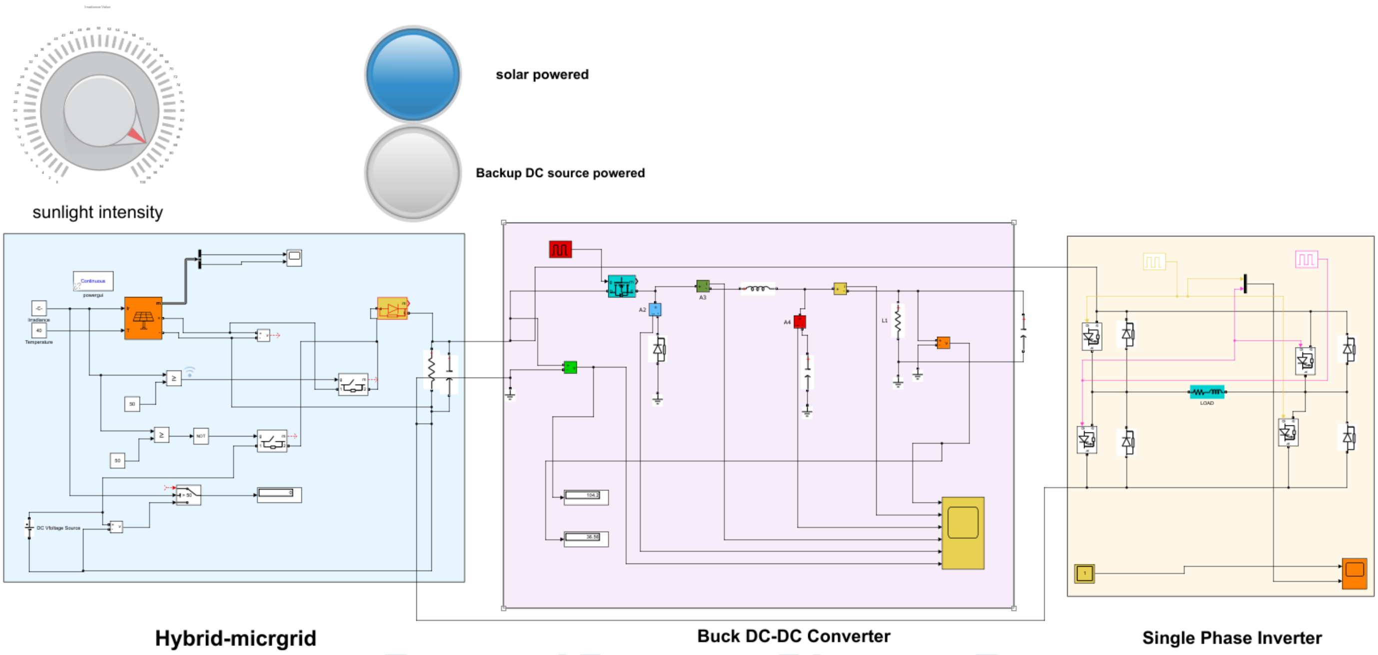

Figure 6 Complete Simulink model of Hybrid power system

4 Simulation Results

4.1 Simulation result of controller

The top ideal switch activates and connects the load and PV array whenever the irradiance value exceeds the reference irradiance value, which is how the entire model operates. The bottom ideal switch activates and connects the load and fuel cell (DC Voltage source) whenever the irradiance value is lower than the reference irradiance value.

The oscilloscope is fed the voltage across the load resistor, and the resultant waveform is seen below.

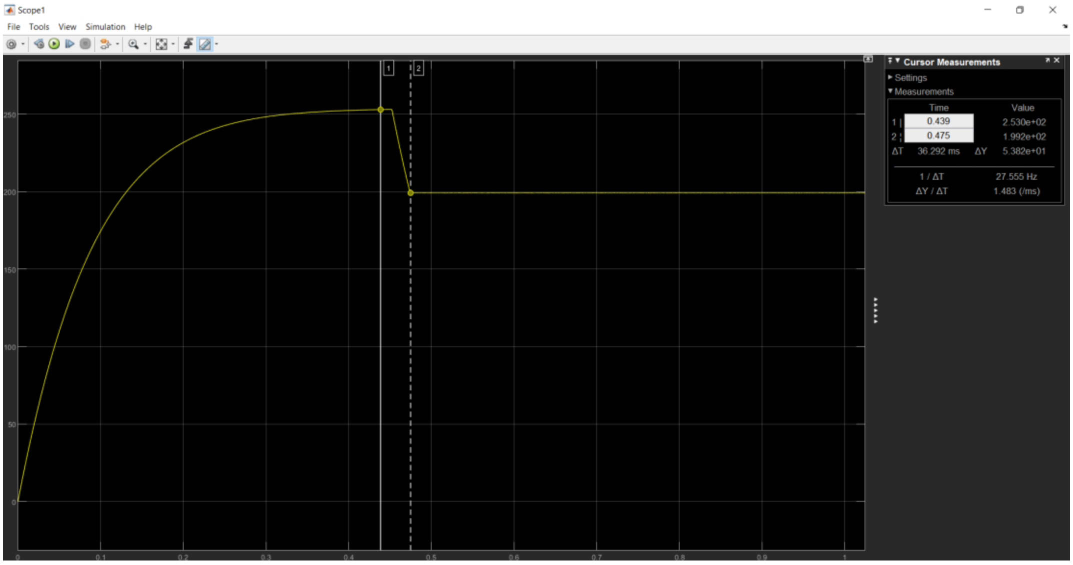

Figure 7 The voltage across the load resistor

4.2 Simulation result of BUCK Dc-DC converter

The Buck converter is reducing the voltage of the input DC signal so that it can power low voltage electronic devices, given below is the input and output waveform.

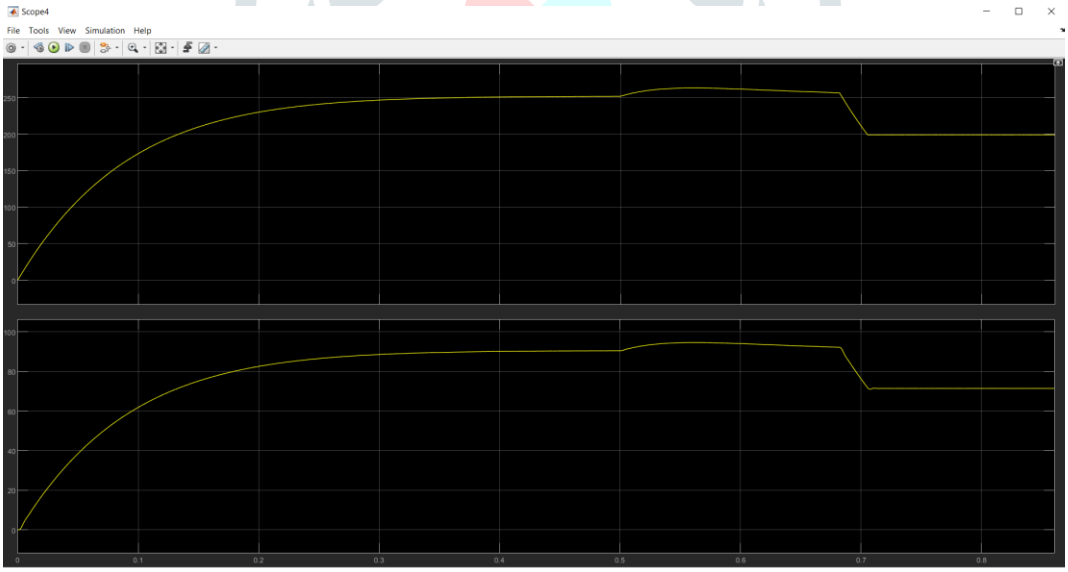

Figure 8 Simulation result of noise filtering model

4.3 Simulation result of the single phase inverter model

The oscilloscope in the Simulink model is given the pulse and the current flowing through the RL load, and the resultant waveform is seen below.

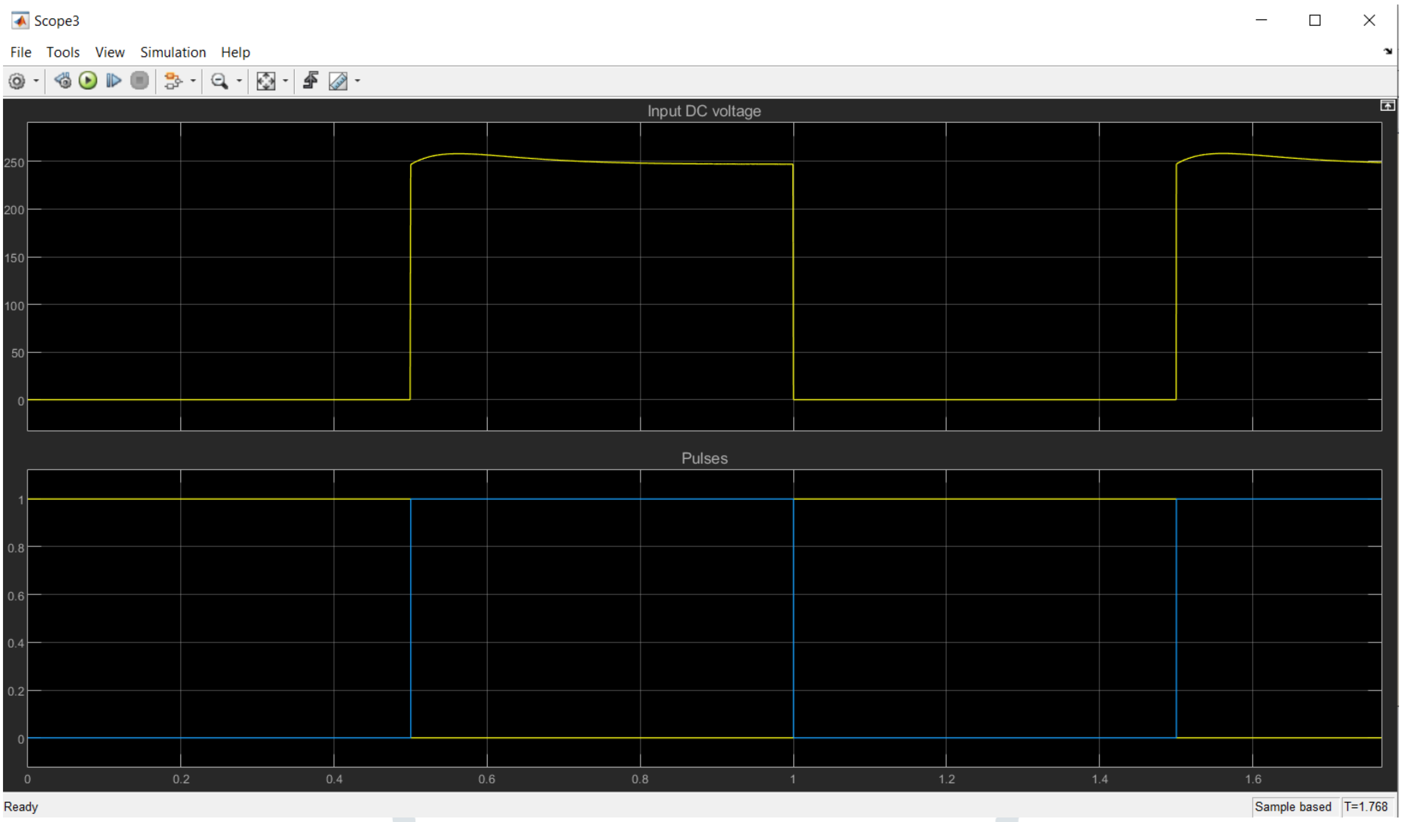

Figure 9 DC voltage and the thryristor gate pulses shown on oscilloscope

5 Conclusion

In conclusion, the designed Simulink model presents a comprehensive and efficient solution for managing power distribution in a hybrid microgrid scenario. By seamlessly integrating a solar PV array, a DC backup source, a buck DC-DC converter, and an inverter, the model ensures continuous and reliable power supply to the connected loads. The utilization of solar energy as the primary source optimizes the microgrid's sustainability and cost-effectiveness, reducing dependency on conventional energy sources. The integration of the buck DC-DC converter further enhances the system's flexibility by efficiently regulating voltage levels and facilitating seamless transitions between the solar PV array and the backup source. This dynamic switching mechanism guarantees uninterrupted power supply to the loads, regardless of sunlight availability. Overall, the presented model showcases a forward-looking approach to microgrid design, embodying the principles of renewable energy utilization, effective voltage regulation, and robust power management.

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