Micro Grid Operation Mode With Different MPPT Controller

Ihsan Mizher Baht [1], Farah Fahem Al Sarhan [2], Petre-Marian Nicolae [1], Nameer Bahat [3]

[1] *Department of Electrical Engineering-Craiova, Romania*
[2] *Department of mechanical engineering, University of Babylon, Iraq*
[3] *Department of computer science, Universities West of Timisoara, Romania*

Abstract **- The extent to which current is minimized helps in ensuring that the island to grid-connected mode transition is effectively controlled. This applies not only in the short-term but also in the long-term. This is also useful because it helps in maintaining the required level of flexibility as far as the framework of controlling island to grid-connected mode transition is concerned. The integration of interconnectors can also be useful with regard to control of island to grid-connected mode transition. This is because interconnectors can help in identification of shortcomings and existing gaps as far as the framework of island to grid-connected mode transition is concerned. A major reason why the use of interconnectors can help in controlling the island to grid-connected mode transition is that they facilitate continuous monitoring of the grid. This implies that the relevant changes can be identified and incorporated into the island to grid-connected mode transition, in this paper also comparative between two type of the algorithm control MPPT based on the fixed irradiance and temperature.**

***Keywords*— Micro grid, renewable energy, MPPT, MATLAB.**

1. Introduction

In any grid-connected to island mode transition, current regulation is an important control that helps in determining whether additions or deductions should be made. This is an important aspects that plays an integral role as far as the framework of controlling the grid-connected to island mode transition is concerned. A notable advantage associated with this strategy of controlling the grid-connected to island mode transition is that it helps in enhancement of stability in the grid system. Another strategy that can be used when it comes to controlling the grid-connected to island mode transition involves the reduction of voltage especially in grids that serve multiple systems.

2. Integrating Renewable Energy Resources

For a grid-connected mode, there are various strategies and approaches that can be used in control. One of the most important issues of consideration by which begins the process of controlling a grid-connected mode involves the analysis of topologies. This is because different aspects of topology can influence the framework of efficiency for the entire system within the context of a grid-connected mode. When the grid-connected mode is not adequately aligned to the required standard of topology, the required level of control cannot be achieved.

On the other hand, the maintenance of the required specifications as far as the framework of topology is concerned ensures that the level of control is sufficient for the entire grid-connected mode. Based on such an aspect, analysis of topology contributes extensively as far as controlling the grid-connected mode is concerned. This not only applies to the short-term but also in the long-term as far as the output of the grid-connected mode applies. Apart from the analysis of topology, another component that makes a major difference in controlling the grid-connected mode involves voltage. Depending on the level of voltage within the grid-connected mode, the equality of outcomes and level of control can be compromised or promoted. The required level of regulation has to maintained while determining how voltage is passed through the grid-connected mode so that a high level of control can be achieved. This is an aspect that is indicative of the multi-dimensional approaches that can be used in controlling the grid-connected mode.

DOI: 10.18421/TEM101-19
https://doi.org/10.18421/TEM101-19

Corresponding author: Ihsan Mizher Baht,
Department of Electrical Engineering-Craiova, Romania.
Email: imb121378@yahoo.com

Received: 10 October 2020.
Revised: 18 January 2021.
Accepted: 25 January 2021.
Published: 27 February 2021.

3. System Model

Assume the circuit model content multi inverter connected to point of couple connect (PCC) and load, the grid or generation connected to the load through transformer (DYn,ONAN,11/0.4Kv) as it is shown in the Fig. 1.

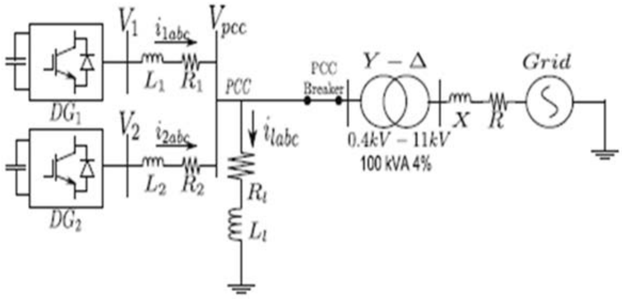


Figure 1. The power flow to the load.

The power flow to the load in case of grid connected mode should be constant, and the grid supports the voltage and frequency to keep the active and reactive power in the limit, Figure.2. Shows the control circuit of the inverter by using d-q axis current control, BusV1 connected with PLL to compeer between voltage produce from inverter with the voltage references [7].

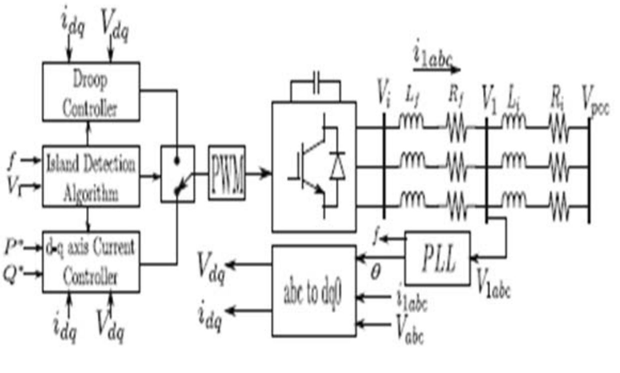


Figure 2. Control circuit of the of the inverter by using d-q axis current

$$(P) = 3/2(I_{d\ axis}\ V_{d\ axis} + I_{q\ axis}\ V_{q\ axis}) \ldots\ldots\ldots\ldots 1$$

$$(Q) = 3/2(-I_{q\ axis}\ V_{d\ axis} + I_{d\ axis}\ V_{q\ axis}) \ldots\ldots\ldots\ldots 2$$

Assume at the study state the voltage at q axis =0 than the power is:

$$(\text{Active Power}) = 3/2(I_{d\ axis}\ V_{d\ axis}) \ldots\ldots\ldots\ldots 3$$

$$(\text{Reactive Power}) = 3/2(-I_{q\ axis}\ V_{d\ axis}) \ldots\ldots\ldots\ldots 4$$

So the current control loop for both axes is:

$$Id_{\ axis} = 2/3(\text{active Power}/Vd_{\ axis}) \ldots\ldots\ldots\ldots 5$$

$$Iq_{\ axis} = 2/3\ (\text{reactive .Power}/V_{d\ axis}) \ldots\ldots\ldots\ldots 6$$

From control circuit (Fig. 2) [11] the load flow is showed by using node method.

$$Vd_{\ axis} = Lf\ di_{d\ axis}/dt + Rf\ id_{\ axis} \ldots\ldots\ldots\ldots 7$$

$$Vq_{\ axis} = Lf\ di_{q\ axis}/dt + Rf\ iq_{\ axis} \ldots\ldots\ldots\ldots 8$$

The control of the inverter is as shown in Fig.3. The transfer of the current from abc to dq serves to control the voltage output through PI control and PLL. In the Fig.3. three stages of the control circuit ,the Ki and Kp factor control are presented .

$$Ki = L_{int}/\text{time const.} \ldots\ldots\ldots\ldots 9$$

$$Kp = R_{int}\ /\text{time cons.} \ldots\ldots\ldots\ldots 10$$

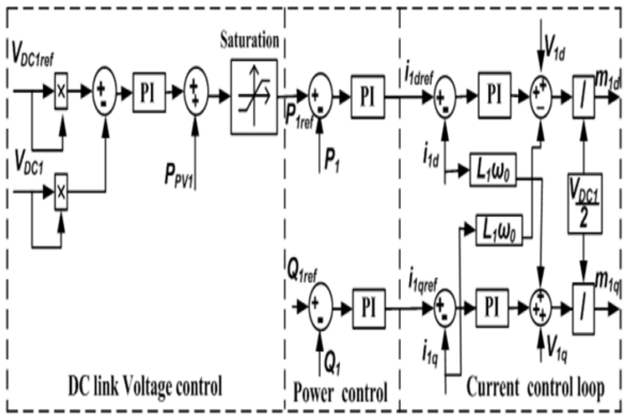


Figure 3. Control during island-connected mode

In order to achieve control during island connected mode, one of the most important strategies is characterization of weaknesses within the entire grid. This is an essential aspect because different systems are associated with different weaknesses. While some of the weaknesses can be negligible, others have far-reaching implications on the entire stability of the island connected mode. This accentuates the fact that it is important for specific weaknesses to be characterized and quantified so that they can be resolved. The strategies that can be used in controlling the island connected mode can also be evaluated in terms of power flow analysis.

The manner in which power flows in the grid can strengthen the control system of island connected mode or undermine it is explained by [1],[2]. Such an aspect is indicative of the important role played by the evaluation of how power is flowing in the grid so that determinations can be made on how control can be achieved as far as the island connected mode is concerned. Additionally, systematic alignment of the various components of the grid is essential in terms of ensuring that adequate information is gathered with regard to attainment of the required standards of control. Assume the C.B is open, and then the power flow from the grid or generator is OFF, the load observe the power from the inverter or PV cells only, and the two factors are controller by Droop Control Fig.4.

- Voltage.
- Frequency.

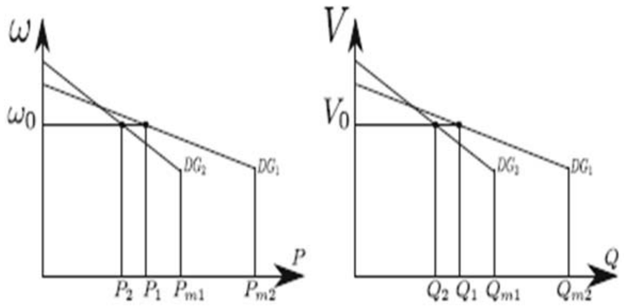


Figure 4. Factors Droop Control

$Freq. = Freq._{\cdot rate} - kp_{tf}\,(P_{calc\cdot} - P_{ref\cdot})$……………….11
$V = V_{rate} - ki_{t.f}\,(Q_{calc\cdot} - Q_{ref\cdot})$…………..………..12

From the equation 11, 12, the transfer function is:

$Kp = \text{Transfer fanction1} = \frac{Wmusret - W\ reated}{Pcal - Pref.}$..........13

$Ki = \text{Transfer fanction2} = \frac{Vmusret - V\ reated}{Pcal - Pref.}$...........14

4. Result and Disscuation

4.1. Control for Grid-Connected to Island Mode Transition

The framework of control for grid-connected to island mode transition can be analyzed in terms of the issue of current regulation. In any grid-connected to island mode transition, current regulation is an important control that helps in determining whether additions or deductions should be made. This is an important aspects that plays an integral role as far as the framework of controlling the grid-connected to island mode transition is concerned [3],[6]. A notable advantage associated with this strategy of controlling the grid-connected to island mode transition is that it helps in enhancement of stability in the grid system.

Another strategy that can be used when it comes to controlling the grid-connected to island mode transition involves the reduction of voltage especially in grids that serve multiple systems. Such an aspect is useful because it helps in attainment of flexibility in the entire system and therefore controlling the grid-connected to island mode transition not only in the short-term but also in the long-term. This is also an attribute that plays an integral role concerning the framework. The system content of two power supplies to the load through small transmutation line is shown in Fig. 5.CB1 opens the power flow to the load from the PV cells and the generators or grid is off, which is shown in Fig.6, as well as the waveform of the output (active and reactive power grid, voltage and current grid, voltage, current, active reactive power, frequency of the system respectively).

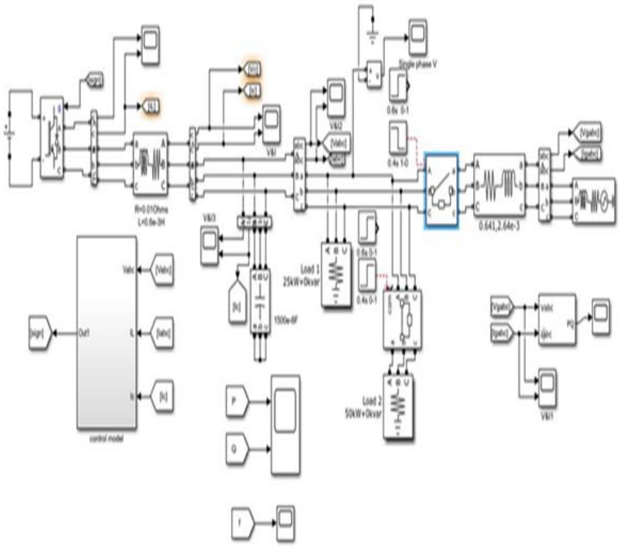
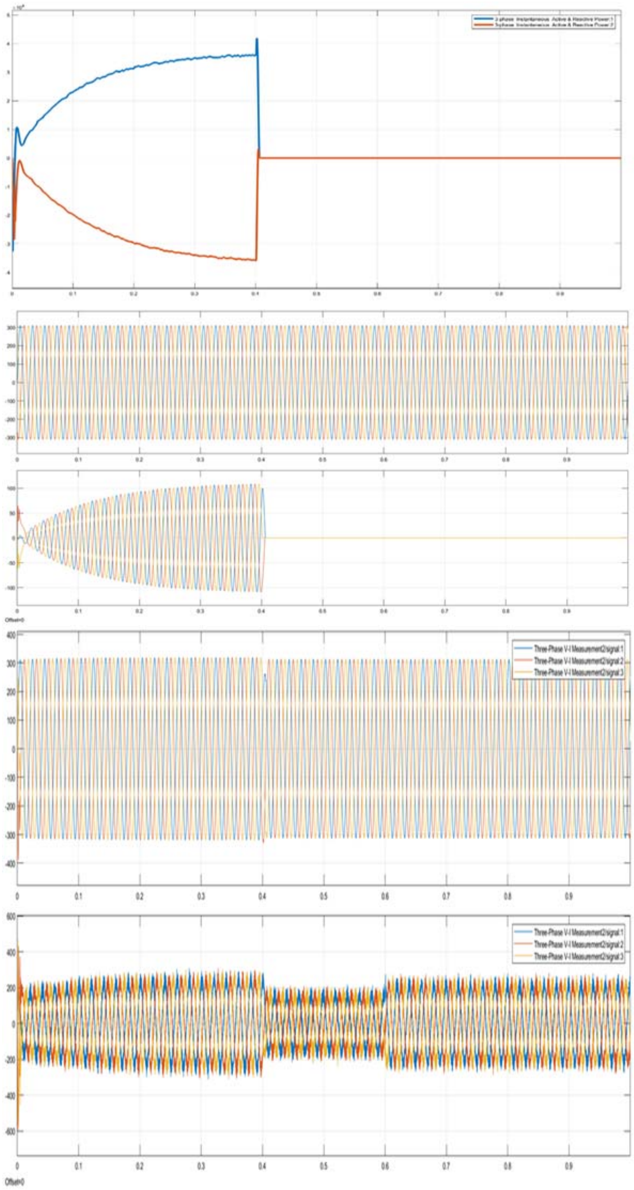


Figure 5. Comports of the system (CB1 OFF island mode)



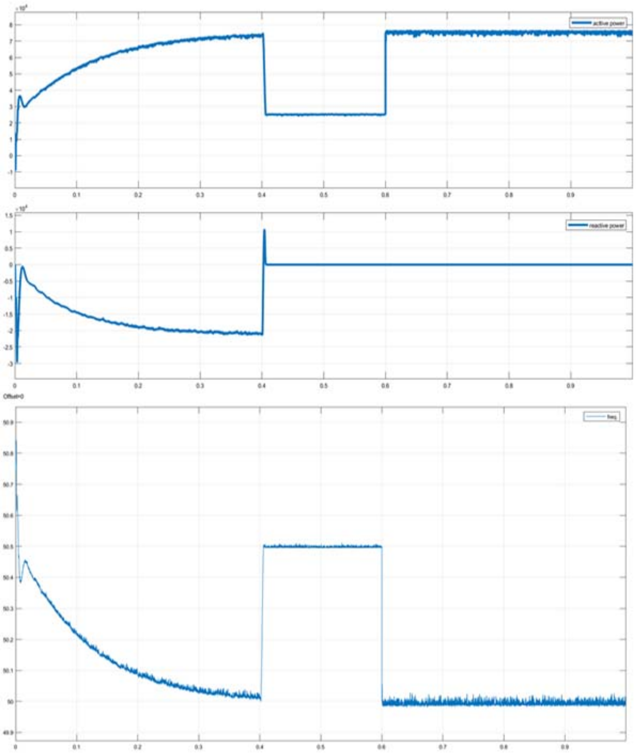


Figure 6. The waveform of the output (active and reactive power grid, voltage and current grid, voltage, current, active reactive power, frequency of the system respectively).

4.2. Control For Island To Grid -Connected Mode Transition

One of the most effective strategies that can be used to control island to grid-connected mode transition is the use of systematic topologies. Within the framework of controlling any grid, there is always the need to ensure coordination of the various components. Depending on the standard of coordination, the expected outcomes in terms of control can be achieved or not. This is why the use of systematic topologies can be useful either in the short-term power or in the long-term [10].

Another important issue consideration with regard to control of island to grid-connected mode transition is the minimization of current. The extent to which current is minimized helps in ensuring that the island to grid-connected mode transition is effectively controlled. This applies not only in the short-term but also in the long-term. This is also useful because it helps in maintaining the required level of flexibility as far as the framework of controlling island to grid-connected mode transition is concerned. The integration of interconnectors can also be useful with regard to control of island to grid-connected mode transition. This is because interconnectors can help in identification of shortcomings and existing gaps as far as the framework of island to grid-connected mode transition is concerned [5],[9]. A major reason why the use of interconnectors can help in controlling the island to grid-connected mode transition is that they facilitate continuous monitoring of the grid. This implies that the relevant changes can be identified and incorporated into the island to grid-connected mode transition. The use of interconnectors in controlling island to grid-connected mode transition also helps in minimization of risk regarding the reduction of output. It is therefore notable that there are many strategies that can be used controlling an island to grid-connected mode transition.

The system in which theCB1 close the power flow to the load from the PV cells and the generators or grid, is shown in Fig.7, and Fig.8.show the waveform of the output (active and reactive power grid, voltage and current grid, voltage, current, active reactive power, frequency of the system respectively).

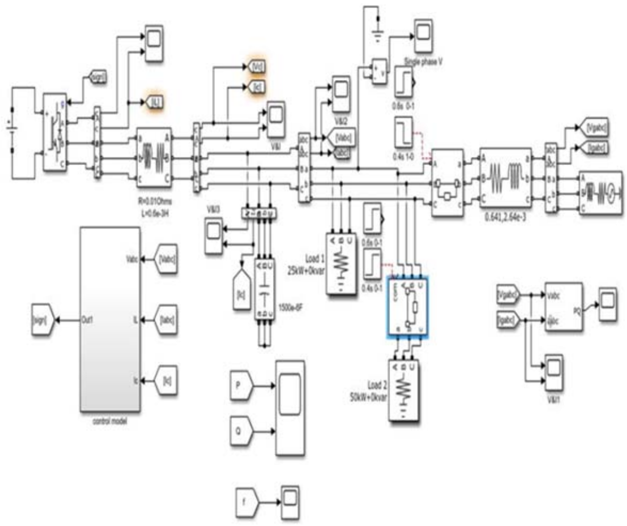
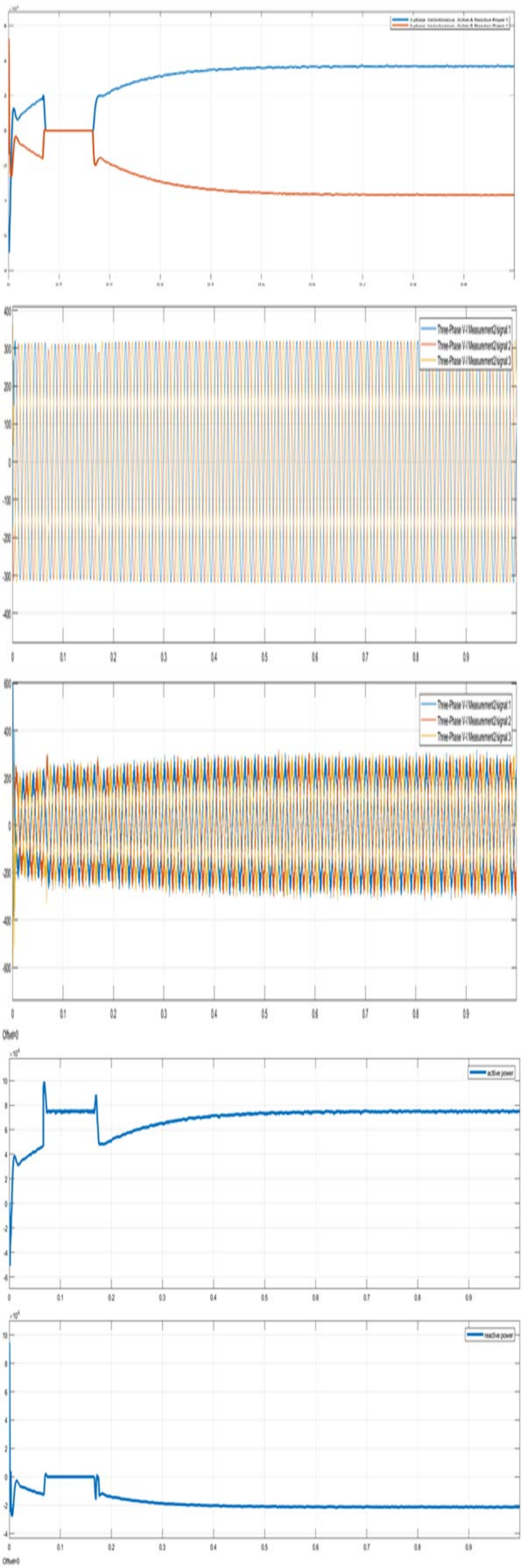


Figure 7. Components of the system (CB1 ON grid mode)



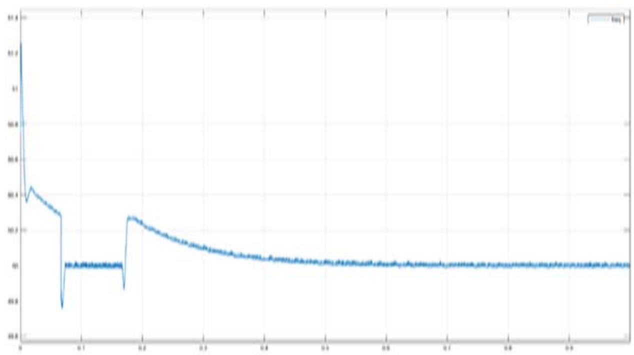


Figure 8. The waveform of the output (active and reactive power grid, voltage and current grid, voltage, current, active reactive power, frequency of the system respectively) grid mode.

5. Comparative MPPT Control Methods (P&Q, Incremental)

MPPT algorithm controls the output parameters of the PV cells and reduce the effect of the irradiance and temperature [4], MPPT algorithm uses two type of techniques (direct and indirect). To keep the PV cell operating at the MPPT, many control algorithms are obtained to maintain the output at the maximum point such as direct and indirect control [12]. The properties, such as physical materials of the PV cells and the position location effect the choice type of the MPPT control [11], [8].

The basic configuration of the control system, and the MPPT control process such as P&Q and its related control circuits depend on the system performance and comparison of results.

5.1. P&Q Algorithm

One of the most popular algorithm is control P and Q. The control circuit using the PI control for control and measured voltage to obtain the power required from the load. The main idea of the control circuit is in its control the voltage by measuring and sense the PV voltage which means decreasing or increasing the voltage to reach to the MMPT.The compound of the control circuit (PLL, DC current and PI control). is shown in Fig.9.

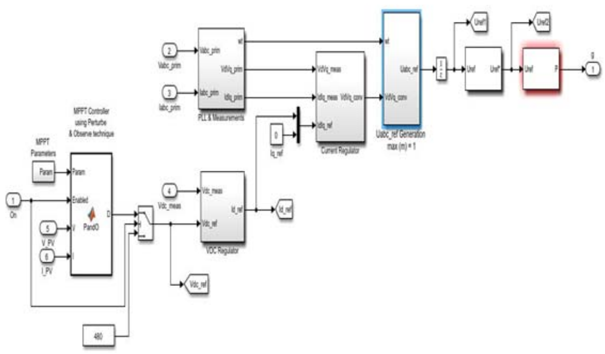


Figure 9. P&Q control circuit

5.2. Incremental Control

The mathematical model of the incremental control algorithm depends on two parameters current and voltage, comprising, the output at MPPT when the dI/dV= -I /The control diagram of the incremental circuit by using matalb Simulink is shown in Fig. 10.

The output of duty cycle. Shows the value of the both side if the equation is equal (Fig. 11), that means the PV system operation at maximum power.

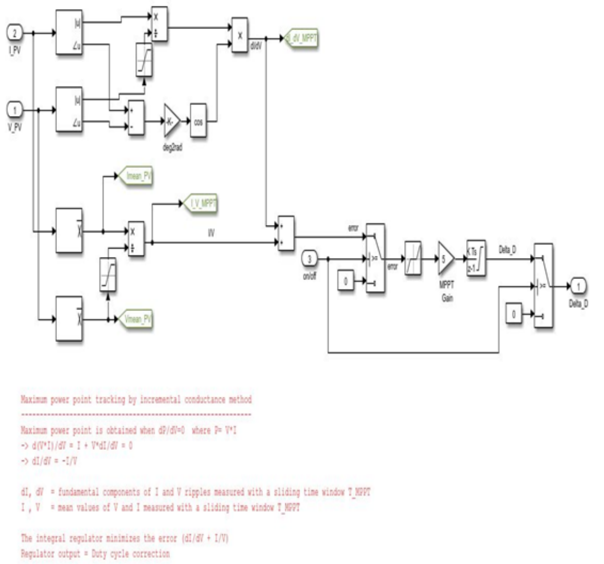


Figure 10. Control diagram of the incremental circuit

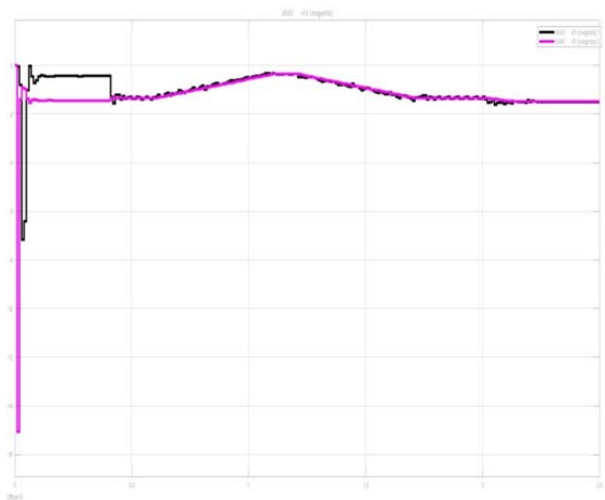


Figure 11. Duty cycle

Table 1. Results comparative

MPP	**I.OUT**	**V.OUT**	**P.OUT**	**T.RESP.**	**RELANILI.**
P&Q	357.14	280	100 kW	0.02 sec	LOW
Inc.	368	310	114 kW	0.135 sec	HIGH

6. Conclusion

From the results above shown in Table 1, one can conclude that at the same weather condition the efficiency of the incremental control is better than P&Q because the incremental uses two sensors of control (current, voltage), while P&Q use only voltage sensor for control. The reliability of the system in case of incremental algorithm control is higher than P&Q when the sudden environmental change happens (irradiance, temperature).

Component that makes a major difference in controlling the grid-connected mode involves voltage. Depending on the level of voltage within the grid-connected mode, the equality of outcomes and level of control can be compromised or promoted. The required level of regulation has to be maintained while determining how voltage is passed through the grid-connected mode so that a high level of control can be achieved. This is an aspect that is indicative for the multi-dimensional approaches that can be used in controlling the grid-connected mode.

References

[1]. Abbasi, A., Abbasi, S., Ansari, J., & Rahmani, E. (2015). Effect of plug-in electric vehicles demand on the renewable micro-grids. *Journal of Intelligent & Fuzzy Systems*, *29*(5), 1957-1966.

[2]. Adam, R., & Wintersteller, W. (2008). European Smart Grid Faces Different Hurdles From United States. *Natural Gas & Electricity*, *25*(3), 13-18.

[3]. Basu, A. K., Chowdhury, S., & Chowdhury, S. P. (2010). Value-based operational strategy at the planning of CHP-based micro-grid. *Int J Energy Environ*, *1*(5), 871-882.

[4]. Fei, J., & Zhu, Y. (2017). Adaptive fuzzy sliding control of single-phase PV grid-connected inverter. *PLOS ONE*, *12*(8), 1-15.

[5]. Gourdain, N., Singh, D., Jardin, T., & Prothin, S. (2017). Analysis of the turbulent wake generated by a micro air vehicle hovering near the ground with a lattice boltzmann method. *Journal of the American Helicopter Society*, *62*(4), 1-12.

[6]. Hao, X., Wang, H., Peng, B., Yao, Z., Wang, Y., & Gu, M. (2018). Research on the virtual synchronous generator control strategy of grid-connected permanent-magnet direct-driven wind power system. *Thermal Science*, *22*(Suppl. 2), 401-408.

[7]. HairulNissah Zainudin, Saad Mekhilef,(2010) "Comparison Study of Maximum Power Point Tracker Techniques for PV Systems," Proc. 14th International Middle East Power Systems Conference (MEPCON"10), Cairo University, Egypt, 750-755.

[8]. Pan, J. F., Hou, Z. Y., Liu, Y. X., Tang, A. K., Zhou, J., Shao, X., ... & Wang, Q. (2015). Design and working performance study of a novel micro parallel plate combustor with two nozzles for micro thermophotovotaic system. *Thermal Science*, *19*(6), 2185-2194.

[9]. Joyce, G., & Soliman, H. M. (2009). Analysis of the transient single-phase thermal performance of micro-channel heat sinks. *Heat Transfer Engineering*, *30*(13), 1058-1067.

[10]. Pongratananukul, N., & Kasparis, T. (2004, August). Tool for automated simulation of solar arrays using general-purpose simulators. In *2004 IEEE Workshop on Computers in Power Electronics, 2004. Proceedings.* (pp. 10-14). IEEE.

[11]. Esram, T., & Chapman, P. L. (2007). Comparison of photovoltaic array maximum power point tracking techniques. *IEEE Transactions on energy conversion*, *22*(2), 439-449.

[12]. Zare, J., & Zare, A. (2015). An intelligent stochastic method based on fuzzy cloud theory for modeling uncertainty effects in the renewable micro-grids. *Journal of Intelligent & Fuzzy Systems*, *28*(1), 421-431.