Journal of Innovative Research in Engineering Technology and Management Science
Volume 01, Issue 01, May 2025
www.jiretms.com

Smart Home Energy System with Single Phase PV Grid Connected and Fault Condition Anticipation

Rama Krishna
Department of Energy Systems Engineering, ANNA University, Chennai
Corresponding Author: ramakrishnaesr@gmail.com

To Cite this Article
Rama Krishna, "Smart Home Energy System with Single Phase PV Grid Connected and Fault Condition Anticipation", Journal of Innovative Research in Engineering Technology and Management Science, Vol. 01, Issue 01, May 2025, pp:23-27.

Abstract*: To be able to predict power system grid fault conditions as such this study recommends an algorithm for smart home energy systems. The smart system that will regulate the electrical supply conditions to the load on the residential electrical system is a single-phase photovoltaic grid connected to a smart household energy system. Smart system consists of two voltage sources: photovoltaic as a backup supply and conventional power from the national electricity provider as the desirable source. Smart systems can predict faults being imposed on the load by controlling the proper voltage sources to feed it. Through detecting and identifying the voltage source's amplitude, phase angle, and frequency with reference to system reference, the state of smart system can be described in terms of power flow control to the load. The system operates by utilizing a static transfer switch having a phase-locked loop to determine source of voltage. The outcome from the voltage detection algorithm is used to ascertain the decision logic algorithm for switching conditions. The results show that, if a fault condition occurs, the voltage source selection in the decision logic can be utilized to determine the circumstances of the smart power system flow.*

Keywords*: Static transfer switch, Smart home system, Photovoltaic, Grid-connected inverter, Fault condition*

I. Introduction

Another electrical energy source is encouraged to be implemented as a substitute electrical energy supply in the grid because of Indonesia's limited power supply viability; which is managed by the national electricity provider as the most desirable source. Photovoltaics, or PV, utilizes solar radiation for the conversion of electrical energy is an alternative electrical energy source. Grid-connected systems, especially in case of residential applications, will improve the quality of power system when PV energy is used [1]. The failure condition should also be predicted for the system to become more dependable [5-7].

Faulty situations of the system may affect the power quality of the load. As a result of voltage faults such as voltage sag and voltage swell which cause power quality deterioration, electrical equipment may get damaged [2]. The one phase PV systems connected to the grid can use the smart home energy system. The PV grid-connected energy is utilized by the smart home energy system to regulate the power flow to the load. The amplitude, the phase angle, and the frequency of the preferred and alternative sources are detected and identified, so that the smart state is generated. The PLL method can also be used for voltage source jobs in a single-phase system.

The voltage source state can be used to predict the grid fault condition. Then, whose supply is connected to the load is determined by the state of both supplies [3]. In this study, a smart home energy system with the national electricity supplier as the primary source and photovoltaic (PV) as an alternate source is described. Static transfer switches (STS) are used in voltage source detection systems to build intelligent systems that anticipate grid fault conditions. It is anticipated that this technology will produce a system that can predict grid fault conditions and meet optimal conditions for power generation based on client needs [4].

II. Research Method

Generally, photovoltaic power systems functions are grouped depending on their component's configuration, needs of the functions and operations, and the way the equipment is linked up to other loads and power sources. PV stand- alone and grid-connected are the two major categories. PV generators, inverters, connection-interconnection

parts and other supplementary parts make up PV power systems [3]. PV generator is a kind of the PV module which is able to generate electricity from solar radiation. The DC power supply is converted into a DC power source with the help of inverter. To the load, electrical installations include application of the connection-interconnection components [1].

From figure 1, the condition of the PV grid-connected system is given. In the near situation, G_1 and G_2 are respectively for the state of PV grid-connected system where the grid and photovoltaics are cooperating to supply the load. The state of PV standalone that describes when the load will be supplied fully with photovoltaics is produced when G_1 is closed and G_2 is open.

While G_1 is open and G_2 is in close condition the whole load is fed by grid. Then, there is no current that flows to the load when G_1 and G_2 are open. PV utilizes a synchronization reference from the grid for the inverter to achieve a synchronous scenario for the PV and grid. This means that the conditions derived from the solar supply to the load is in pace with the grid.

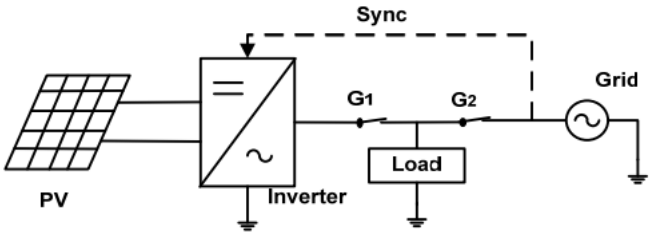

Fig 1: PV grid-connected system

III. Proposed Smart Household Energy System

The proposed system of smart homes energy with single-phase PV grid connected application is given in Figure 2. The system involves domestic appliances in AC load, STS, national energy grid system (main source) and a PV grid-connected system (alternate source). Virtual adjusting switching conditions G1 and G2 suggest the state of the smart home energy system. The choice of switching conditions made by STS control logic.

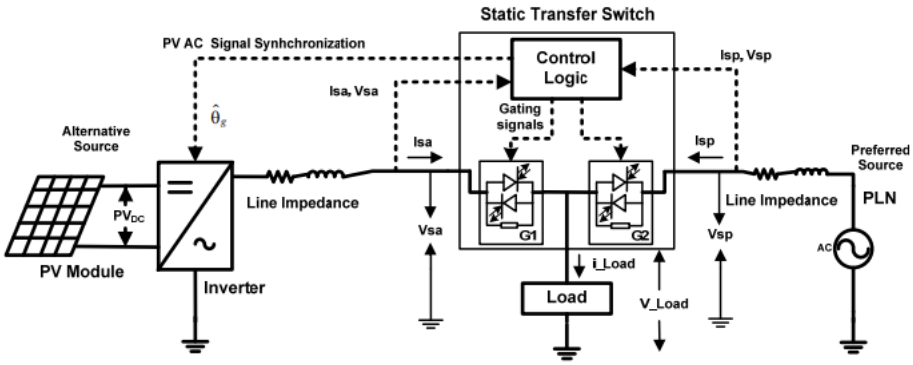

Fig 2: Proposed smart household energy system

IV. PV Grid Synchronization

To ensure synchronous behaviors on the power system network, the AC power output of the photovoltaic inverter should be synchronized with the grid [10-11]. There is a need for PV inverter to be taken up by a synchronous angle to help on maintaining the output for the PV inverter synchronous to the grid. In this system, a synchronization and protection method was developed. The PV inverter output will be synchronous to the grid using the standard PLL algorithm even if the grid power quality will be either in or above the acceptable bounds. This is due to a grid voltage being used as a reference to a phase angle in a conventional PLL algorithm. In this paper, an angel reference generator for a phase is developed [3].

The reference phase angel was obtained using the PLL algorithm. Nevertheless, a free running timer is used to provide the phase angel reference if the required power supply quality is not acceptable. Figure 3 presents diagram block of the proposed approach, and figure 4 is the flow chart that depicts phase angel reference selection algorithm.

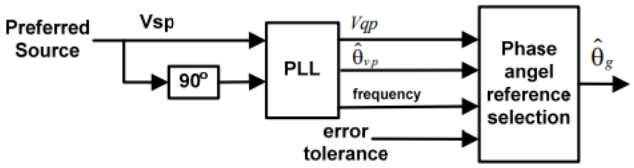

Fig 3: PLL from preferred source reference

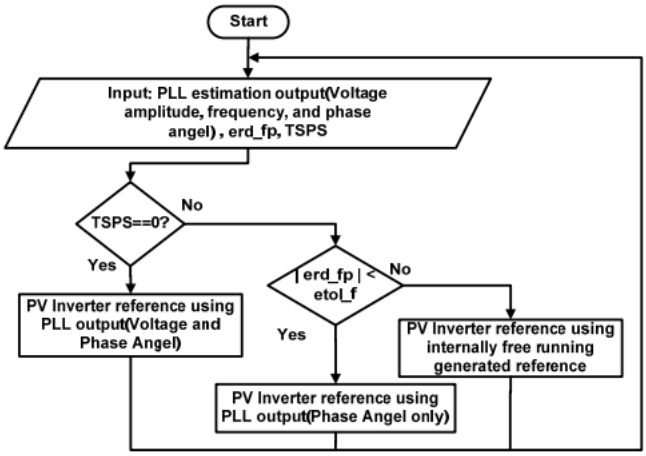

Fig 4: Flow Chart Flow chart algorithm PLL from preferred source reference

V. Results and Analysis

The system simulation is developed using the C programming language in MATLAB Simulink. Determination of how long it takes for the grid fault conditions to be detected is based on transfer signal circumstances, switching component gating logic and detection time. When in fault modes the system will switch on or off the switching device at the preferred source (G_2) and alternative source (G_1) by supplying the logic 1(closed)/0(open) to the gating logic. Voltage sag, swell, momentary interruption and frequency variation are the stated system fault conditions [1-3].

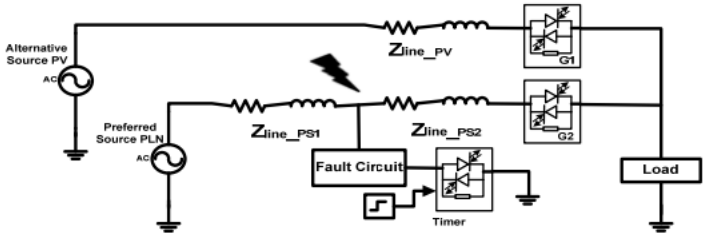

Fig 5: The schematic of fault conditions on preferred source

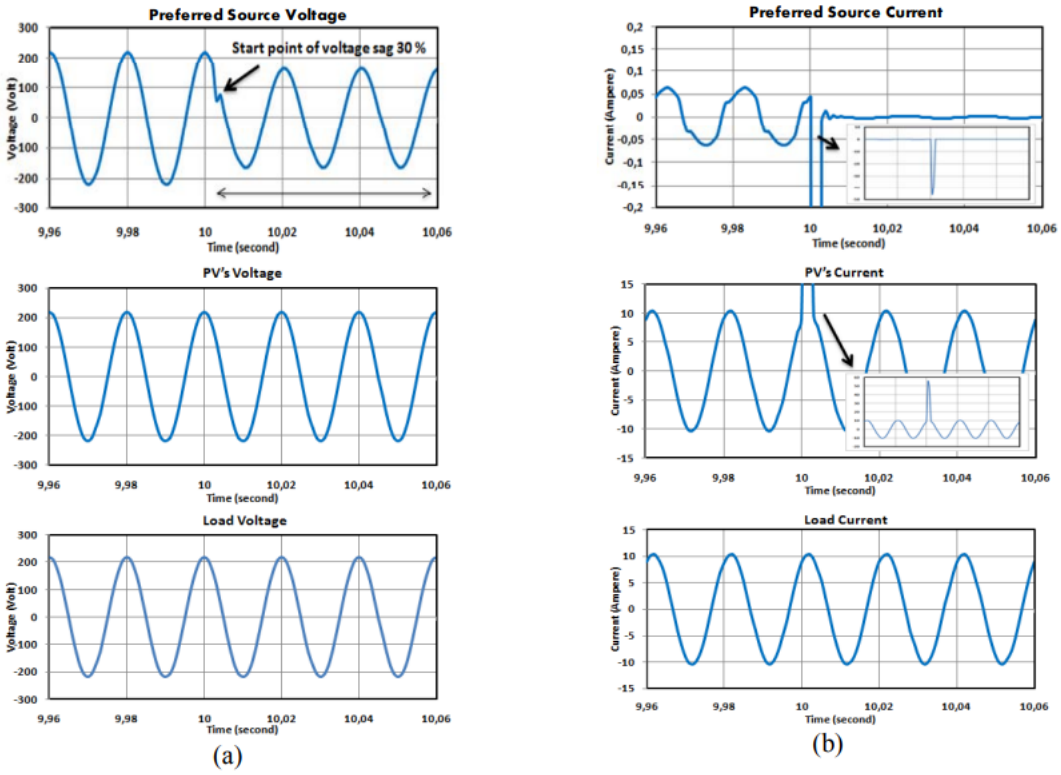

Fig 6: The conditions for voltage sag of 30% on preferred source (a) voltages system (b) currents system

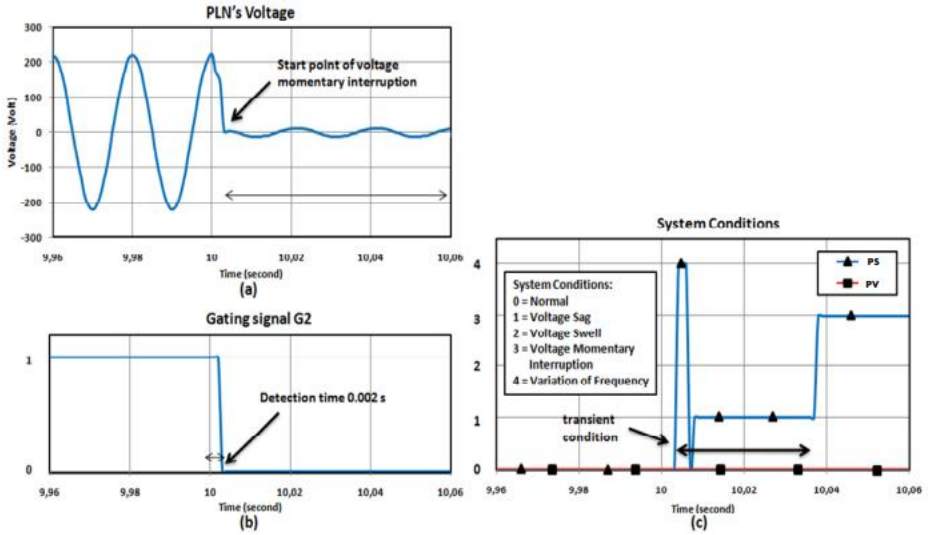

Fig 7: The Conditions for voltage momentary interruption on preferred source

VI. Conclusion

This research suggests an algorithm for energy systems of a smart home for predicting power system grid failure conditions. With the selection of appropriate voltage sources, supply to the load, fault conditions can be predicted. Through the design of detecting and identifying the amplitude and phase angle of the voltage source of the voltage source, relative to the system reference and the identification of the frequency associated with the smart

system's state, the state of the system is described in terms of management of power flow to the load. The findings illustrate that in a fault condition. It is possible to use the voltage source selection in the decision logic to determine the smart power system flow circumstances.

References

[1] Chie Lee and Yadav Kumar. "An Matrix Converter using Array System in Power Electronics in Communication Systems". Springer Conference in Hindustan University, Chennai, VOL. 2, NO. 3, March 2009

[2] Saritha, Srikanth, Subhakar and Sunitha, "A Process control system in Industrial Applications using Thyristors in power electronics for PMSG",". Elsevier 2011. China, 7 – 9, January 2012.

[3] Niharika, Lakshman Reddy and Shanchie, "A Novel of MIMO concepts in wireless relay networks in Space Time and Space Frequency in achieve diversity", " IEEE Conference Proceedings on Innovative Research in Communication Systems (IRCS), International Conference. vol. 2, pp. 67 – 75, January. 2010

[4] John Diesel, Shang Chee and Cooper Lee, "Standalone Grid system for On and OFF modes Using Renewable energy sources using PMMC Technology', "Springer Proceedings on Green Energy on World environmental Day", IEEE conference proceedings held at Madras University, on the 20tt Century. pp.10-19, 2020

[5] Saritha, Srikanth, Subhakar and Sunitha, "A Process control system in Industrial Applications using Thyristors in power electronics for PMSG",". Elsevier 2011. China, 7 – 9, January 2012.

[6] A Muetze and A Binder. "Calculation of circulating bearing currents in machines of inverter-based drive systems". IEEE Trans. Ind. Electron. 2007; 54(2) 932–938.

[7] A Purna Chandra Rao, YP Obulesh and Ch Sai Babu. "High performance Cascaded multilevel inverter fed brushless dc motor drive". International Journal of Engineering Sciences & Emerging Technologies. 2013; 5(2): 88-96.