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A Review on analysis and modeling of grid connected PV system with three phase induction motor with different load condition

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Abstract - *A three-phase grid connected PV system with an induction motor running at different loads is presented here. The system employs the Perturb and Observe algorithm for Maximum Power Point Tracking (MPPT) to ensure precise and responsive performance. A D.C-D.C boost converter is employed to increase the low D.C voltage from the photovoltaic system. The Dq control strategy combined with the sinusoidal pulse width modulation strategy is utilized as a voltage control method. An inverter and photovoltaic array are linked via a bidirectional power flow. The inverter output uses a low pass filter to filter out high-frequency ripples. A Phase Locked Loop (PLL) feedback control method is employed for inverter voltage synchronization with the grid voltage, generating the necessary reference signal. Additionally, a simulation model is created to analyze the performance of a 3-phase induction motor, examining rotor and stator currents, rotor speed, and electromagnetic torque under various load conditions*

Key Words: PV System, MPPT, Grid, phase locked loop, bidirectional invertor.

1. LITERATURE SURVEY

K. Kumar et al. [1] (2021). A grid-connected PV system is described in this study. Sliding mode controllers are used to control solar systems that are connected to three-phase grids. To improve source side power while controlling harmonics at grid side current, a system must be designed. The converter is placed somewhere between the PV panels & the 3-phase RL load associated to the three-phase grid. The model consists of the photovoltaic array, boost converter, nonlinear load, and voltage source inverter. The system is made stable and resilient using the sliding mode control mechanism. To increase the generated voltage of the photovoltaic array, a converter is linked to the input of the voltage source inverter.

M.K. Mishra et al. [2] (2020). The echoic proportional D.C link with the current controller is proved in the accompanying paper. The 3-phase grid-connected photovoltaic system is approached by the MPPT. When grid voltage is disrupted, the given system to the Proportional-Resonant controller enables the supply grid current while minimizing overall harmonic deforming. This control approach uses a voltage controller based on a dq reference frame and a harmonic compensator for an MPR controller. When combined with MPR, the INC algorithm provides faster tracking of stable conditions and lower power fluctuations. Utilizing software, the projected plan for reducing current harmonics is verified. Through OPALRT, the proposed MPR current controller is demonstrated.

R.T. Poglaguntla et al. [1] (2020). As an unfolding type fly-back inverter is a cheap cost converter for the aforementioned application, it gives the research of differential fly-back based three-phase inverters running in continuous conduction mode (CCM) for solar grid linked applications. This paper discusses a proposed converter operating concept, a modulation technique for three-phase high- and low-frequency operating switches, the choice of power stage components, and the shaping of three-phase grid currents based on primary current control. In the MATLAB/SIMULINK environment, a model of the anticipated converter is created and put through a simulation

M. V. Kumar et al. [15] (2020). The need for electrical power is growing every day, and renewable energy sources can provide that need. Utilizing renewable energy is crucial for environmental protection and preserving fossil fuel stocks for future generations. Regarding the environment and accessibility, solar energy has numerous advantages. The amount of solar energy and operating temperature affect the voltage that is generated. There are more and more PV systems associated with the grid, which causes numerous issues with the quality of the voltage and the power and necessitates an increase. It displays mathematical modeling for photovoltaic cells, inverters, and D.C/D.C converters with MPPT controllers.

X. Zhou et al. [3] (2019). In the field of grid-connected photovoltaic power generation, the three-phase grid-connected current is susceptible to alteration due to the inverter circuit's relatively low output PWM carrier and numerous nonlinear switching semiconductor devices, which are essential for the system's dependable and safe operation. Although the control method may track quickly, PI current loop control is frequently exercised in the solar inverter circuit's control system. It suggests a harmonic

suppression method based on PI and proportional resonance management for photovoltaic grid-connected inverters to reduce harmonic current & provide good dynamic response (MPR). It is demonstrated using MATLAB that the configuration enhances the dynamic response performance.

Kimball et al. [4] (2018). This study proposes a model of a 3-phase grid-connected PV inverter in a scenario of grid failure. The DSOGI (Dual Second Order Generalized Integrator) technique is utilized by the system in difficulty. The recording of simulation outcomes demonstrates that the voltage dip is worse for the system with higher line inductance.is presented in the given paper. The author proposed an LVRT (Low Voltage Ride Through) method is proposed

Heydari et al. [16] (2018). Photovoltaic systems that are connected to the grid have become very important recently. Both stage and two stage power conversion systems are used. Efficiency and cost are increased in single-stage systems due to the absence of the D.C-D.C converter. In this system's inverter, maximum Power Point Tracking and D.C/A.C conversion should be accomplished. Application of the proper control method is crucial. In order to improve the dynamic response of the suggested control system, this research suggests a modified MPPT algorithm based on power perturbation rather than voltage or current perturbation. An enhanced direct power control method based on sliding mode control has been developed because it has various advantages for controlling non-linear systems.

Abderrahi, M., et al. [18] (2017). For research purposes, the operation as well as energy conservation of a grid-connected PV system were examined. In this setup, a double-stage conversion consisting of two D.C to D.C converters and a three-phase, PV system serves as the primary energy source and is transported in three stages to the distribution grid (DCI) via a clamped diode inverter and battery storage. To keep the system's power balance, an effective power management technique controls the power flow among the load and converter. The resultant power system may guarantee reactive power compensation and obtain sinusoidal grid currents, it can also draw the greatest amount of power possible at the generator photovoltaic system

Banu et al. [5] (2014). The study of three phase solar photovoltaic system under the stimulated grid fault in the given paper for the stimulation of the given model. At the end of the operation, we get the result that symmetrical fault has higher impact on the performance of the PV system than the asymmetrical fault.

S.R. Nandurkar et al. [6] (2012). In this investigation, a PV system instantaneously transmits electricity to the electrical network while a conventional source is still operating in parallel. It deals with the design and simulation of a three-phase inverter in MATLAB, which is a part of solar systems that are connected to the grid. Here, a voltage source inverter (VSI) converter that delivers a controlled current into the grid is run using synchronous dq reference frame. PLL is used to lock the grid's frequency and phase. The low pass filter is created to remove a significant frequency ripple at the inverter output.

L.M. Phuong et al. [7] (2012). The three-phase grid linked photovoltaic generation system with reactive power management is discussed in this study. A difficult control strategy with two PI controllers and MPPT is suggested in this study to maintain D.C voltage. The phase locked loop synchronizes the 3phase grid linked (VSI) to the grid (PLL). Results demonstrate this 3-phase grid connected Photovoltaic system's great stability and efficiency.

R. Marouani et al. [17] (2012). In this paper an alternative design and control for three-phase grid connected photovoltaic systems is presented. Here the PV generation source is connected to the main electric grid. The first stage contains on a buck-boost D.C-D.C converter which is controlled by the sliding mode control SMC. The second stage is made up of a D.C-bus and a three-phase voltage inverter. The inverter is controlled by the Direct Power Control which is used to supply the power into the main grid with a high-quality power factor. Sliding mode control permits to D.C-D.C controller the tracking of the situation direct voltage requirement by the grid.

F. He et al. [13] (2010). For grid-connected inverters, a D.C voltage control is crucial since it helps to reduce D.C capacitance, enhance system dependability, and boost MPPT performance. An analysis of the energy balance connection throughout the length of one control period is used to suggest an analytical control approach for D.C. “voltage for single-stage, 3-phase grid-connected PV inverters”; predictive control is also employed to regulate A.C. current. The suggested method delivers a good steady state and dynamic performance. In particular, the dynamic reaction has improved. The D.C voltage is tuned with a small amount of overshoot as quickly as feasible.

H. Wu et al. [19] (2009). This project simulates grid grid-connected Solar Photovoltaic 3 phase system. MPPT is the technique utilized, as well as voltage control function is suggested. In this instance, it produced the most electricity possible given the weather.

W. Libo et al. [20] (2007). A single-stage, 3-phase grid-coupled photovoltaic system is simulated by this model. They applied the Revised MPPT approach in this model. By increasing the system stability during insolation, the system's performance is enhanced.

2. Proposed methodology:

Matlab software is used to stimulate grid grid-connected PV systems with three three-phase induction motors. To make up the system photovoltaic array, filter, bidirectional inverter, boost converter, MPPT controller, inverter controller, grid, and induction motor are used here PV grid-connected system using VSI (Voltage Source Inverter) with a sinusoidal pulse width modulation technique has been developed. To get accurate and fast response MPPT algorithm and Perturb and Observe algorithm are used in this PV system. No batteries are employed here so energy losses across the battery are zero boost converter is utilized here to Step up the voltage of photovoltaic generated voltage as well as fed on a bidirectional inverter here dc voltage is converted into ac voltage by using an inverter controller after conversion of dc to ac ripple are there that are removed by using filter circuit here three phase induction motor are connected.

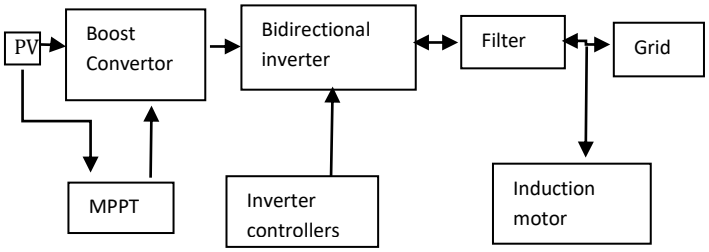

Figure. Grid block schematic for the linked photovoltaic system

Solar technology with semiconductor, PV technology transforms sunlight and sunrays into direct current or electricity in this solar cell's utilize sun rays and make electrons more mobile. PV cells are mounted on frame known as frame as module and wired to one another a large number of module are combined to create array the number of module depends upon voltage and current requirement

Different material are used to make PV cell but more popular material is silicon here boost converter are used which contributes to a greater overall effectiveness of system . the output pulse signal from the MPPPT controller control the switch. MPPT use perturbation and observation algorithm this algorithm perturb the operating voltage to ensure maximum power.

- P & O algorithm is used in the model. The P & O algorithm scans the Power Vs Voltage curve of the PV module in order to find the maximum power point by changing the operating point. This step is known as the perturbation step.
- And in the next step the change in the power is measured which is known as the observation step.
- When the ratio of the change in power to the change in voltage is more than 0 than the perturbation of voltage should be increased and is moved towards right and when the ratio of change in power to change in voltage is less than 0 than the perturbation of voltage should be decreased to move towards MPPT.
- At the steady state condition, the ratio of the change in power to change in voltage is close to 0 in any direction and the P & O kept searching until it has found this operating point.

In this controller, a control loop feedback device is used to regulate all the process variables. This type of control is used to drive a system in the direction of an objective location otherwise level.

In this controller, a control loop feedback device is used to regulate all the process variables. This type of control is used to drive a system in the direction of an objective location otherwise level. PID controller modifies the output based on proportional gain (K_p), integral gain (K_I) and derivative gain (K_a). PID controller makes the system stable and more accurate as it reduces the oscillation present in the system.

Here the Three-phase inverter which converts the D.C voltage to three phase A.C supply is used. A Three-phase inverteris made up of three single-phase inverter switches. Three phase sinusoidal voltages and currents are generated by inverter. The external control loop of the D.C voltage is essential to sustain the D.C- bus voltage constant to assurance the correct function of the MPPT. An internal control loop of the current is calculated to control the power inserted into the grid. This permits the output current control in instantaneous values. The current generated by the grid connected inverter contains lot of harmonics without the filter, when this current is flowed through the grid it causes power quality issues by the grid voltage. Hence the filters are used. The PWM square wave cannot be fed to the grid therefore low pass filter is used to convert this square wave to pure sine wave.

PLL plays an important role in grid synchronization in grid connected system. PLL is based on the principle that it will generate an output signal from its own internal voltage control oscillator by taking a signal to which it locks. It monitors the frequency and generates a signal (wt) that is locked on the variable frequency system voltage. It is used to extract the phase of the grid voltage vector with respect to inverters. Here 3 phase induction motor are used

. A 3-phase induction motor consists of a stator and a rotor. The stator carries a 3-phase stator winding while the rotor carries a short- circuited winding called rotor winding. The stator winding is supplied from a 3-phase supply. The rotor winding drives its voltage and power from the stator winding through electromagnetic induction. An induction motor (also known as an

asynchronous motor) is a commonly used A.C electric motor. In an induction motor, the electric current in the rotor needed to produce torque is obtained via electromagnetic induction from the rotating magnetic field of the stator winding.

3. CONCLUSIONS

A 3-phase induction motor PV system linked to the grid along with operating under various load conditions is proposed. This model type includes a 3-phase induction motor, a boost converter, and a bidirectional inverter. It does not produce any carbon footprint that can reduce global warming. Conventional energy sources have limited so this nonconventional source based three phase induction motor at different loads is useful for future aspect.

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