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CONTROL STRATEGY OF PHOTOVOLTAIC GENERATION INVERTER GRID-CONNECTED OPERATING AND HARMONIC ELIMINATION HYBRID SYSTEM

Mr. K. Harinath Reddy[1], Mr.M.Vishnuvardhan Reddy[2], Ms.V.Srilakshmi[3] , Mr.D.Venkatesh[4], Mr.N.Sai Krishna[5]

[1] *M. Tech, Asst-prof, dept of Electrical and Electronics Engineering , AITS(RJP),*

[2]*UG Student, dept of Electrical and Electronics Engineering, , AITS(RJP),*

[3]*UG Student ,dept of Electrical and Electronics Engineering , AITS(RJP),*

[4]*UG Student, dept of Electrical and Electronics Engineering, AITS(RJP),*

[5]*UG Student, dept of Electrical and Electronics Engineering, , AITS(RJP),*

harinathreddyks@gmail.com , mvishnuvardhanreddy69@gmail.com , yamunasrilakshmi@gmail.com , venkateshdasari9581@gmail.com , nsaikrishna418@gmail.com

Abstract- This paper proposes a three-phase three-wire photovoltaic generation inverter grid-connected operating and harmonic elimination hybrid system. The hybrid system mainly consists of photovoltaic array battery, photovoltaic output filter, three-phase voltage-type inverter, inverter output filter and passive filters. Based on working principle and working characteristics of the proposed hybrid system, the composite control strategy about active power, reactive power and harmonic suppression is proposed. The composite control strategy mainly consists of a single closed-loop control slip of active power and reactive power, double closed-loop control slip of harmonics. Simulation results show the correctly of this paper's contents, the hybrid system have an effective to improve power factor, supply active power for loads and suppress

Key words - Micro grid; harmonic restraint; active power control; reactive power control; photovoltaic generation.

1.INTRODUCTION

Energy is a vital natural resource for human survival. Electricity is the lifeblood of the national economy. since it is the most convenient kind of energy, Distributing, Generating technology can assist in making the most of the available resources.[1] [2] plentiful clean renewable energy to offer using green energy is an important part of achieving the objective of sustainability.

In our country, energy conservation is also a significant factor to address the issue of energy scarcity and environmental concerns pollutant levels [3–6]. Putting together a micro-grid based on distributed energy. It is not only possible to generate power with a huge power grid, but it is also possible assist in improving the microgrid's power quality, as well as contribute to the widespread adoption and application of the technology of micro-grid, but it also aids in the prevention of large-scale blackouts enhance the boost the electricity system's safety and dependability the electricity grid's ability to resist natural disasters It has a significant practical impact on national security and grid power [7][8].

Solar energy is an appropriate green energy for China's sustainable development strategy, considering several variables of micro-grid energy supply. Globalization is happening at the same time. Solar energy, according to experts, will become one of the most essential energy sources in the future Photovoltaic (PV) energy. In micro-grids, the generation system accounts for a significant amount. Micro-grid distribution system [9-10]. In the meantime, With the advancement of science and technology, the majority of the world's problems have been solved digital electrical devices and precision electronic instrumentation. In a microgrid and distribution system, equipment is used through the use of a micro-grid Higher demands are placed on the microgrid's power supply's reliability and power quality. In due to the micro-grid using photovoltaic power as a source to the presence of nonlinear intermittent loads, in particular a static converter that works in a mode of switching, and other electric arc furnaces, welding machines, and other nonlinear loads, Transformers, rotating motors, and other similar devices are used. Due to these nonlinear loads, a substantial quantity of reactive power is used, the power factor of the micro-grid is reduced, and the power factor of the micro-grid is reduced. The voltage and power losses have risen. Simultaneously in the microgrid, distinct frequency and amplitude harmonics are produced. It will wreak havoc on the spread equipment for power generation Harmonics pose a significant threat to the environment. Microgrid security, stability, and economic operation a distribution scheme for microgrids.

Currently, photovoltaic power generation is used to provide active electricity to the grid in micro-grids and power distribution systems with micro-grids system. That is, the PV array's DC power is converted to AC power.AC power with the same phase and frequency as the power grid as well as ensuring a high power factor. The unique in most cases, a capacitor is utilised to store the load's reactive power compensation. The active power filter and the passive power filter are two types of

filters. In a microgrid, it's frequently used to control harmonics. This will enhance power system investment such that the electrical grid's structure is intricate. In the meantime, the increasing load creates new power quality issues equipment.

A three-phase three-wire photovoltaic generation inverter grid-connected operation and harmonic elimination system was developed to address the shortages and challenges of active power, reactive power, and harmonic control technology in microgrids. This study proposes a hybrid system. The hybrid system consists of two parts. Basically consists of photovoltaic array battery, photovoltaic array battery, photovoltaic array battery, photovoltaic array battery, photovoltaic array battery inverter, output filter, three-phase voltage-type inverter. There are two types of filters: output filters and passive filters. The hybrid system that has been proposed is may control the system in real-time and dynamically in the micro-grid, harmonics, active and reactive power are all important considerations. Based on the theory of operation and the features of operation of the hybrid system under consideration, as well as the composite control strategy about active, reactive, and harmonic power. The idea of suppression has been proposed. The strategy for composite control. A single closed-loop control slip of active and reactive power, as well as a double closed-loop control slip of harmonics, make up the majority of the system. The simulation results confirm that this is correct. The hybrid system has an effective to the contents of the article boost the power factor, provide active power to loads, and suppress micro-grid harmonics.

2. SYSTEM STRUCTURE

The micro grid photovoltaic generation inverter Grid-Connected operation and harmonic elimination integrate device, as illustrated in Fig. 1, is primarily made from of photovoltaic array batteries, a photovoltaic output filter, and three photovoltaic array batteries phase voltage source inverter (VSI), output filter, and passive voltage source inverter (VSI) Filters of high power. Batteries for photovoltaic arrays are connected to through two diodes D1 and D2, the inverter DC Bus Capacitor is powered. The Lf and Cf DC side bus filter creates the DC side bus voltage is more consistent and smooth. Batteries for photovoltaic arrays the K1 can be connected to the DC side capacitor. The trio the power grid is connected to the phase voltage source inverter L4 and C4 combine to form a filter. C3 is a capacitor. The capacitor C2 and the inductor L3 are connected in series linked together to form Single-tuned passive power in the 5th and 7th octaves filter (PPF), and so on. These are the two types of PPFs between the nonlinear load and the micro grid coupled inverter.

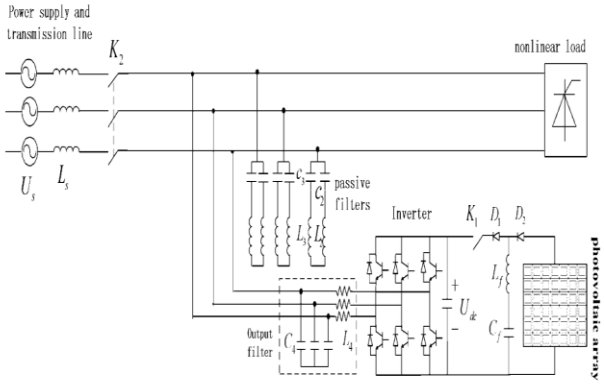


Figure 1. Structure of novel hybrid system.

The photovoltaic generation system can operate in island mode or in tandem with the public grid by adjusting K2. Photovoltaic generation decreases when K2 is turned off enters island mode, and the nonlinear load is reduced photovoltaic generation system provides power. Meanwhile when photovoltaic panels are linked to the micro grid. The active and reactive power are combined using a three-phase inverter can be adjusted, as well as the typical 5th and 7th PPFS can be used to suppress harmonics. When K2 and K1 are both present, Photovoltaic array batteries are both turned on during the day connected to the inverter's DC side capacitor. The public grid provides the majority of nonlinear load. A photovoltaic generation system is a device that converts sunlight into electricity. PPFs are used to protect the environment remove the 5th and 7th harmonics from the character. When K1 is turned off at night, the inverter is detached from the photovoltaic array batteries, and the load is exclusively supplied by the inverter through use of the public grid As a result, the three-phase VSI and PPFs are formed the active power filter hybrid (HAPF). The active hybrid the reactive power is dynamically compensated by the power filter. Harmonics are removed based on real-time detection the reactive power of the grid and the harmonic in the power grid of the load is nonlinear.

3. CONTROL STRATEGY OF THE PROPOSED HYBRID SYSTEM

In this control diagram, switch K_3 is turned to the left and switch K_4 is turned to the upside when the PV generation system is in island operation mode, as shown in Fig. 2. The current signal i_{pv} and the output voltage u_{pv} of the DC side voltage V_e of photovoltaic array batteries can be maximum power point tracking control was used to compute this. The **Ve** is then sent to the first regular PI via the MPPT procedure to obtain the current signal *i*d* of the d -axis.

The following is a discrete control expression

$$i_d^*(k) = i_d^*(k-1) + k_{p1}[V_e(k) - V_e(k-1)] + k_{i1}[V_e(k)] \quad (1)$$

The error i_d of the feedback current i_d and its reference current i^*_d is taken as the input signal of the third PI controller. The

output signal i_{d1} of the third PI controller is considered as the active power reference current signal which the inverter needs to produce. In the same way, the error i_q of feedback current i_q and its reference current i_q is regarded as the input signal of the fourth normal PI controller. And its output signal i_{q1} is as the reactive power compensation current. So there are only used PPFs to filter the 5th and 7th harmonics. When photovoltaic generation system is connected to public grid: In the day time, the switch K_3 is turned to left and the K_4 is turned to underside. The control mode of active and reactive power is the same as island operating mode. The harmonic double closed loop control branch is cascade connected to the reactive power control branch. Harmonic current of power grid i_{sh} and harmonic current outputted by inverter i_{dh} are respectively formed the outer control loop and inner control loop.The current error i_{sh} of i_{sh} and its reference harmonic current I_{sh}^* is took as the input of the first recursive integral controller. Its output signal i_{dh}^* is considered as the reference harmonic current signal of inner loop. The error i_{dh} is calculated by the signal i_{dh} and its reference signal i_{dh}^*.i_{ql} is the output of q-axis controller. The cascade result i_{ql} and i_{dh} is considered as the input signal of the second recursive integral controller. The output signal i_{nl} of the second recursive integral controller is regarded as the reference control signal of APF. The discrete control expression of the outer loop and inner loop are shown as follows:

$$i_{dh}^*(k) = i_{dh}^*(k-1) + k_{p10}[\Delta i_{sh}(k) - \Delta i_{sh}(k-N)] + k_{i10}[\Delta i_{sh}(k)] \quad (2)$$

$$i_{n1}(k) = i_{n1}(k-1) + k_{p12}[i_{q1}(k) + \Delta i_{dh}(k) - \Delta i_{dh}(k-N) - i_{q1}(k-N)] + k_{i12}[\Delta i_{dh}(k) + i_{q1}(k)] \quad (3)$$

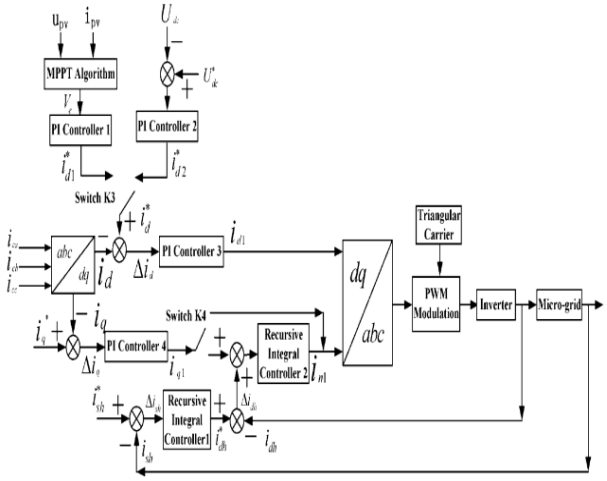


Figure 2. Control block diagram of the proposed hybrid system.

PPFs are being used to filter the 5th and 7th harmonics at this time, while active power filters are suppressing the remaining harmonics K3 is rotated to the right and K4 is turned to the left at night to the underside. The DC side capacitor's voltage error signal U_{dc} is sent to the second PI controller in usual mode I is the output signal i^*d. The reference current signal of the d-axis is taken from the controller. Its discrete control statement looks like this:

$$i_d^*(k) = i_d^*(k-1) + k_{p2}[\Delta U_{dc}(k) - \Delta U_{dc}(k-1)] + k_{i2}[\Delta U_{dc}(k)] \quad (4)$$

The reactive power and harmonic control branches are identical to those used in the Grid-Connected operating control method throughout the day.

4. SIMULATION RESULTS

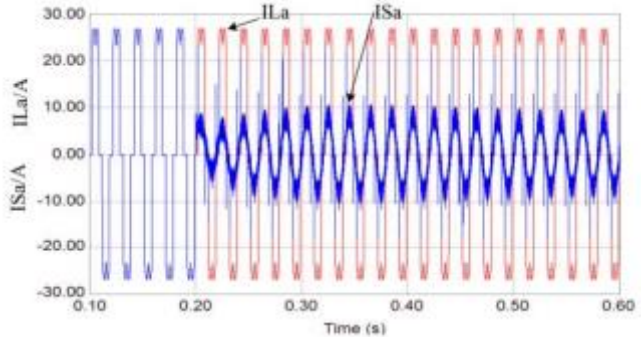
The proposed hybrid system and control approach are investigated in this research using PSIM6.0 to simulate the photovoltaic power generation system. The principle of simulation Figure 1 shows a schematic. The battery of a PV array is modelled because of its mathematical model The parameters of the simulation. The following is a list of the proposed hybrid system: The threephase power system's voltage is 380V. The three-phase frequency of the power system is 50 Hz. It's a three-phase nonlinear load rectifier with no control The nonlinear load's inductance is the nonlinear load resistance is 20 and the nonlinear load resistance is 1mH. The transmission line's inductance is 0.01mH. The worth of the DC side capacitor has a value of 10000F. a possible hybrid in 0.2 seconds, the system is connected to the grid. The duration of the simulation hybrid that has been proposed system in 0.8s.

A. Photovoltaic Array Battery is Connected to the Proposed Hybrid System

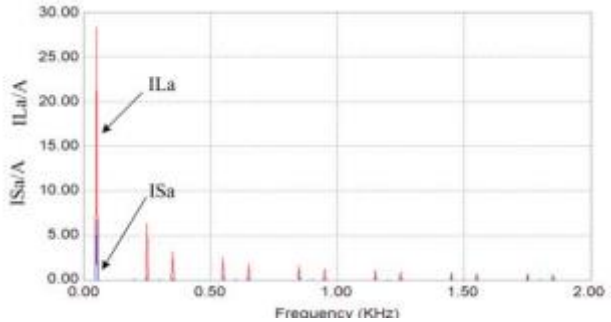
When the suggested battery is connected to the PV array battery,Figure 3 shows the simulation results for a hybrid system. ILa, The load current, grid side current, and load current (Isa, USa, Udc) are the load current, grid side current, and load current (Isa, USa, Udc) respectively. The inverter's DC side capacitor voltage, and the grid side voltage respectively. The harmonics have been considerably decreased after the suggested hybrid system, produced by nonlinear loads is connected to the electrical grid.

ISa is less than ILa because the active power of a solar power generation system is lower. When the micro source and the public grid are both active at the same time when it comes

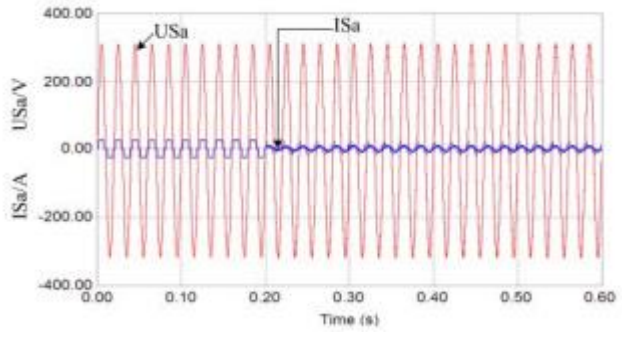
to supplying power to nonlinear loads, the micro source comes in handy. The micro source is the main power source because it is closed to the load source of nonlinear load supply The current and voltage of in Fig. 3, the electrical grid has the same phase (c). As can be seen in Fig. 3,(d), the PV system can keep the DC capacitor voltage stable without fluctuation, the inverter at 1000V.



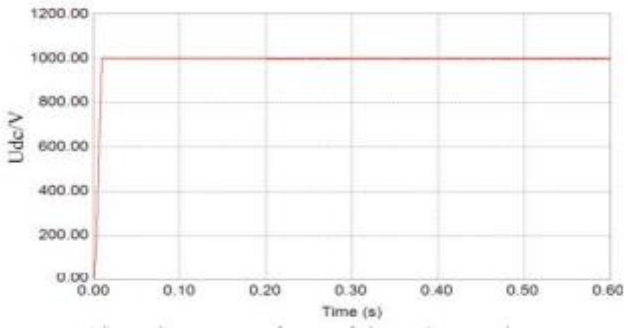
(a)Current dynamic waveform of load and grid side



(b) Current spectrum waveform of load and grid side

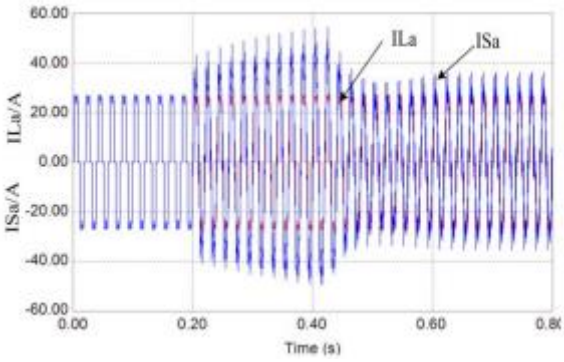


(c) Voltage and current dynamic waveform of grid side

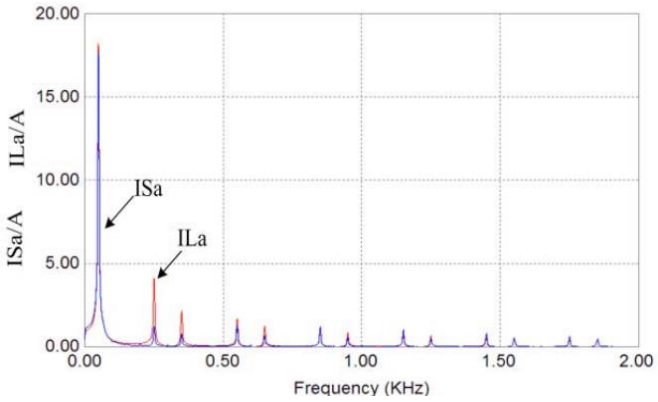


(d) Voltage waveform of the DC capacitor

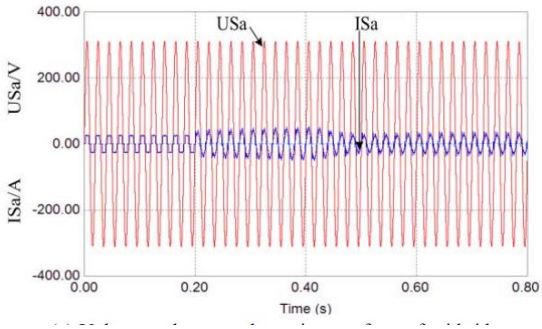
Figure 3. Simulation results when photovoltaic generation is connected.



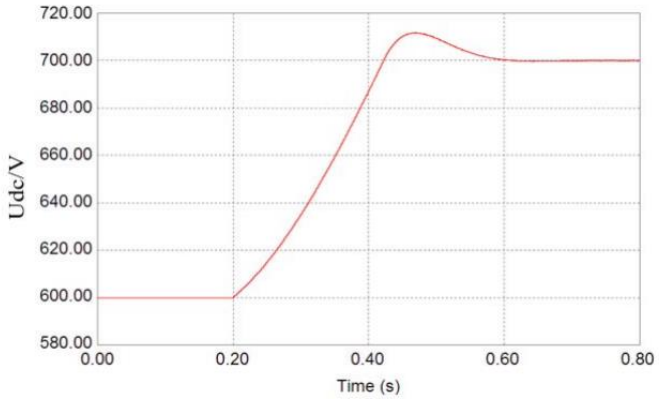
(a)Current dynamic waveform of load and grid side



(b) Current spectrum waveform of load and grid side



(c) Voltage and current dynamic waveform of grid side



(d) Voltage waveform of the DC capacitor

B. Photovoltaic Array Battery is not Connected to the Proposed Hybrid System

The simulation results are displayed in Fig. 4 when the PV array battery is not linked to the proposed hybrid system. The proposed hybrid system is currently equivalent. Active power filter, passive power filter, and pure shunt active power filter loads that are linked in parallel to the public power grid. It can be shown in Figures 4 (a) and 4 (c) that the harmonic current is considerably reduced, and the voltage and current are greatly lowered. The phase of the electricity grid is the same. The voltage of the DC capacitor. In Fig. 4, the inverter is 700V. (d). Currently, the DC side is in the lead from the grid to the capacitor through the IGBT diode rectifier as a result, the suggested hybrid system is slower than the current system to obtain energy when the capacitor on the DC side is charged.

5. CONCLUSION

A three-phase three-wire photovoltaic generation inverter grid-connected operation and harmonic elimination system was developed to address the shortages and challenges of active power, reactive power, and harmonic control technology in microgrids. This study proposes a hybrid system. The guiding principle and the proposed hybrid system's control strategy is investigated. The following conclusions were reached as a result of this paper's research: can be inferred:

1. The proposed hybrid system may achieve active and reactive power compensation as well as real-time dynamic management of harmonics.
2. The hybrid control approach of active power, reactive power, and harmonic suppression is based on the functioning concept of the proposed hybrid system at different times suggested. The proposed control technique is straightforward and straightforward to be implied in the field of engineering.
3. The simulation results demonstrate that the contents of this study are true, while the proposed control approach can also be applied to other similar systems in this paper.

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