



Solar Powered Inverter For Microgrid Using Fuzzy Logic MPPT

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Abstract: This research paper introduces a solar-powered inverter designed for a microgrid using fuzzy logic MPPT (Maximum Power Point Tracking). The inverter, utilizing the EGS002 module, takes in a 12V DC input from a solar power source and generates a 7V AC output. This output is then increased to 220V AC and 500W using different MOSFETs. MPPT plays a crucial role in stabilizing the solar source's output, which can fluctuate. Fuzzy logic is integrated into the MPPT algorithm to improve the efficiency and effectiveness of power conversion. The goal of the project is to tackle the challenges of varying solar power inputs in microgrid systems, presenting a sustainable and effective solution for power production and distribution.

Index Terms - Solar-powered inverter, Variable solar power input, Power conversion efficiency, Renewable energy systems, Maximum Power Point Tracking (MPPT)

I. INTRODUCTION

Advancements in technology and the decline of fossil fuels have led to a growing interest in renewable energy sources like solar and wind power. Solar power, in particular, has seen increased use due to improved solar cell efficiency and incentives for adoption. Microgrid inverters play a crucial role in this setup by converting the direct current (DC) output from solar panels into alternating current (AC).

The DC voltage from the solar panels is then adjusted using Fuzzy logic based MPPT to match the constant voltage of the microgrid and the constant output of solar powered source is fed to the microgrid inverter. This ensures a constant power level. The converter consists of components like inductors, capacitors, and switching devices such as IGBTs or MOSFETs.

The EGS002 module will be used to control the MOSFETs, which will switch the DC input from the solar power source into an AC waveform. The MOSFETs will be arranged in a bridge configuration to convert the DC input into an AC output. The EGS002 module will control the switching of the MOSFETs, generating a 7V AC output. To step up this output to 220V AC and 500 watts, a transformer can be used. The transformer will increase the voltage while maintaining the power level, resulting in a suitable output for powering a microgrid.

Fuzzy logic-based Maximum Power Point Tracking (MPPT) is essential for stabilizing the output of solar power sources in inverters. Solar panels have an optimal operating point called the Maximum Power Point (MPP), where they can generate the most power. However, this point changes due to factors such as temperature and sunlight intensity, resulting in power fluctuations.

By using fuzzy logic-based MPPT, the system can continuously track and adjust the operating point of the solar panels to maintain maximum efficiency despite these variations. Unlike traditional MPPT methods, which only consider current power output and voltage, fuzzy logic takes into account additional factors like power

and voltage changes over time. This allows for smoother and more stable adjustments, making fuzzy logic a more flexible and adaptive control strategy.

Fuzzy logic can handle the inherent uncertainties and imprecisions in the system, such as variations in sunlight intensity and panel degradation over time. This robustness helps in maintaining a more stable and consistent output from the solar power source, which is crucial for the reliable operation of the inverter and the microgrid.

II. LITERATURE REVIEW

1. Fuzzy-Logic-Based Solar Power MPPT Algorithm Connected to AC Grid. This paper presents a novel fuzzy logic controller for a 3-phase photovoltaic inverter connected to the grid, demonstrating improved control performance.
2. A Cascaded DC-AC-AC Grid-Tied Converter for PV Plants- This study investigates a cascaded multilevel converter based on medium-frequency AC-links, offering a promising alternative for grid-tied PV plants.
3. Design of MPPT Based Fuzzy Logic for Solar-Powered Unmanned Aerial Vehicle Application- This research proposes a fuzzy logic-based MPPT technique for solar- powered unmanned aerial vehicles, showcasing the adaptability of fuzzy logic in various applications.
4. Fuzzy Logic MPPT for Grid Tie Solar Inverter- This paper presents a smart method for MPPT based on fuzzy logic control, offering a more robust and efficient solution for grid-tie solar inverters.
5. Benefits of Fuzzy Logic on MPPT and PI Controllers in the Microgrid System- This study compares the performance of fuzzy logic and incremental conductance algorithms for MPPT, highlighting the advantages of fuzzy logic in microgrid systems.
6. Design and Analysis of Robust Fuzzy Logic Maximum Power Point Tracking Techniques for PV Systems- This research explores the use of fuzzy logic MPPT techniques based on an isolated push-pull boost converter, demonstrating robust power optimization for PV systems.

These papers collectively demonstrate the effectiveness and versatility of fuzzy logic-based MPPT in solar power systems, especially in microgrid inverters, showcasing its potential for improving efficiency and stability in renewable energy applications.

III. MARKET SURVEY

The global microgrid market is expected to experience significant growth in the coming years. It was valued at USD

7.76 billion in 2021 and is projected to reach USD 23.49 billion by 2029, with a notable compound annual growth rate (CAGR) of 15.2% during the forecast period from 2022 to 2029.

This upward trend can be attributed to the rising adoption of microgrids across various sectors such as healthcare and military, which is fueling the expansion of the market.

According to Fortune Business Insights, key factors driving this growth include:

- Increasing adoption of microgrids in industries like healthcare and military
- Technological advancements in microgrid systems
- Growing focus on renewable energy sources
- Need for reliable and resilient power supply

Several companies are playing a crucial role in shaping the microgrid market. These key players are driving innovation in microgrid technology and expanding its presence worldwide:

1. ABB (Switzerland)
2. Eaton Corp (Ireland)
3. Honeywell (U.S.)
4. Schneider Electric (France)
5. Siemens (Germany)
6. Spirae, LLC (Colorado)
7. Power Analytics Corporation (U.S.)
8. Toshiba Corporation (Japan)
9. GE (U.S.)
10. HOMER Energy (Colorado)
11. S&C Electric (Chicago)
12. Caterpillar (U.S.)

These companies are continuously investing in research and development to enhance microgrid solutions and meet the growing demand from various industries

IV. METHODOLOGY

1. **System Design and Component Selection:** Design the microgrid inverter system layout, including the DC-DC boost converter, MOSFETs, and control module (EGS002).
2. **Fuzzy Logic MPPT Algorithm Development:** Develop a fuzzy logic-based MPPT algorithm using MATLAB or other simulation tools. Incorporating fuzzy logic rules to adjust the operating point of the solar panels based on inputs such as sunlight intensity and panel temperature.
3. **Simulation and Testing:** Simulate the designed system using software like Simulink to validate its performance. Conduct tests to evaluate the efficiency and stability of the fuzzy logic-based MPPT algorithm under varying environmental conditions.
4. **Prototype Development:** Build a prototype of the microgrid inverter system based on the designed specifications. Implementing the fuzzy logic-based MPPT algorithm on the control module (EGS002) for real-time operation.
5. **Performance Evaluation:** Evaluate the performance of the prototype system in terms of efficiency, stability, and ability to maintain a constant power level. Comparing the performance of the fuzzy logic-based MPPT algorithm with traditional MPPT methods.
6. **Data Analysis and Results Presentation:** Analyze the data collected from simulations and prototype testing.

V. MAJOR PARTS OF METHODOLOGY

EGS002 Module: The EGS002 is a popular IC (Integrated Circuit) used in the design of solar-based inverters for microgrids. It is specifically designed for controlling the speed of AC motors, making it suitable for applications where precise control of AC voltage and frequency is required, such as in solar inverters.

In a solar-based inverter for a microgrid, the EGS002 can be used to control the output voltage and frequency of the inverter, ensuring that it matches the requirements of the microgrid. This is important for ensuring that the power generated by the solar panels can be efficiently distributed and used within the microgrid.

Microgrid Inverter: The inverter is an essential component of a microgrid. It converts DC power from solar panels or other renewable sources into AC power, which can then be used by the loads connected to the microgrid.

Here's why the inverter is so important:

1. **Power Conversion:** The inverter's main function is to convert the power from DC to AC. This is necessary because most electrical appliances and devices operate on AC power.
2. **Voltage and Frequency Regulation:** Another crucial role of the inverter is to regulate the voltage and frequency of the AC power. Voltage refers to the electrical pressure, while frequency refers to the

number of times the current alternates direction per second. Both voltage and frequency need to be maintained within specific limits for the microgrid to function properly.

By performing these functions, the inverter ensures that the power generated by the solar panels or other renewable sources is compatible with the existing AC infrastructure in the microgrid.

MPPT for solar input: MPPT is crucial in solar-based inverters for microgrids as it helps to maximize the power output from the solar panels, increasing the overall efficiency of the system. By continuously tracking the maximum power point, MPPT ensures that the solar panels operate at their peak performance, even under changing environmental conditions. This is particularly important in microgrid systems where the availability of power from the grid may be limited, making it necessary to maximize the power output from renewable sources like solar panels.

The type of MPPT used in the project is Perturb and Observe (P&O). This is one of the simplest MPPT algorithms. It works by changing the operating point of the solar panels (perturbing) and then observing the change in power output. Based on this observation, the algorithm adjusts the operating point to move towards the maximum power point.

Fuzzy Logic for solar Inverter: This project will use fuzzy logic to create a control system that constantly monitors the power of solar panels and adjusts their operating position to maximize power output. The fuzzy logic controller will accept inputs such as solar panel voltage and current, temperature and irradiance, and use fuzzy rules to determine the optimal operating position. Uncertainty and uncertainty in solar energy production potential. Solar panels can be affected by many factors such as temperature, shading and weather conditions, causing maximum power to vary. Fuzzy logic can capture this uncertainty and adjust the panel's performance accordingly.

VI. FUTURE SCOPE

A microgrid system is an electrical grid that carries renewable energy, storage equipment, and load equipment at medium and low voltages. Its purpose is to use clean energy sources and reduce reliance on fossil fuels, thereby lowering greenhouse gas emissions.

Here are some key points about microgrid systems:

1. They can operate in two modes: connected to the main power grid or independently as an island system.
2. In remote areas where electricity is scarce and fuel transportation is costly, microgrids offer a viable solution for accessing electricity.
3. Microgrids are designed to be flexible and adaptable, allowing for future expansion of the grid if needed.
4. The primary energy sources used in microgrids are renewable sources like wind energy, solar energy, and biomass energy.
5. Among these renewable sources, solar energy has gained significant popularity due to its improved performance, lower costs, and ease of maintenance. It is projected that solar energy will account for a substantial portion of global electricity generation by 2050.

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