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Comparitive analysis of fuzzy and sliding mode control system for distributed hybrid power system

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ABSTRACT:

Hybrid system is the combination of PV cell & wind turbine. Two level control system (fuzzy & smc)

1. INTRODUCTION:

Nowadays hybrid renewable energy sources (HRES) or Distributed Energy Resources (DERs) plays an important role for generating electricity in world-wide economy. Distributed Generation (DG) also known as small-scale (typically 1KW-50 MW) electric power generators used to produce electricity nearer to the location of customers that are tied to a micro grid. Renewable energy resources such as solar photo voltaic, wind turbines and fuel cells are used for distributed generation. Distributed generation enhances the reliability of power supply. The capital cost of distributed generation system is usually low based on its size as explained. A micro grid is a part of distribution network that includes multiple loads and distributed energy resource converters that are operated in parallel with the boarder utility grid. It helps in integration of distributed energy resource converters to micro grid. Micro grid is a part of distributed generation system. It is a localized grouping of electricity generation, energy storage and loads that normally operate connected to a traditional centralized utility grid. The components of micro grid involve distributed generation resources such as photovoltaic panels, small wind turbines, fuel cells, etc. The storage devices are batteries, super capacitors, flywheel etc. along with local loads. Better efficiency, superior quality with high reliability of power supply having environmental as well as economic benefits can be achieved by using micro grid. A droop control is a control technique applied to distributed generation system for primary frequency control and as well as voltage control for load sharing between local loads to utility Grid. By controlling the frequency, as well as voltage, corresponding active power
(P) and reactive power (Q) can be controlled in distributed generation. Increase in active power output results in reduction of frequency and the corresponding increase in the reactive power results in decrease of voltage as explained.

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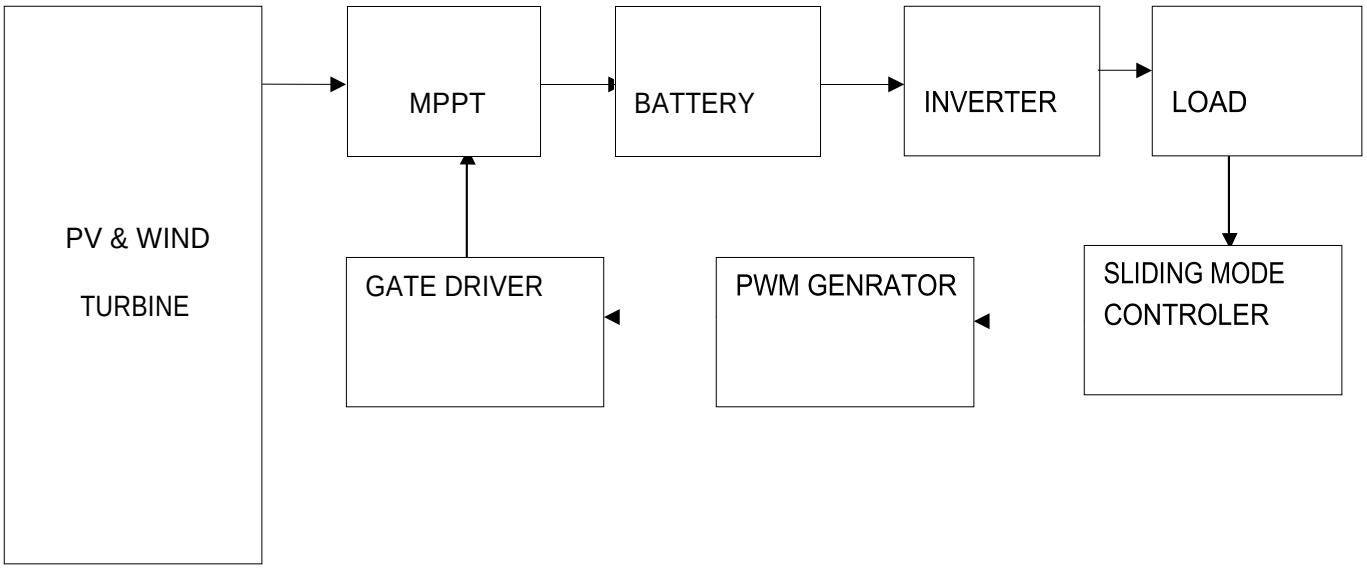
The concept of Phase Locked Loop (PLL) is used for the implementation of grid synchronization method. PLL is used for the estimation of grid voltage, phase angle and frequency. A PLL is a control system in which output signal is generated by relating its phase to the phase of an input signal. A PLL can track an input frequency or it can generate a frequency that is a multiple of the input frequency as explained.

2 BLOCK DIAGRAM:



PV CELL :

Photovoltaic cells are connected electrically in series and/or parallel circuits to produce higher voltages, currents and power levels. Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate, and are the fundamental building blocks of PV systems.

WIND CELL

Ferrel **cell**, model of the mid-latitude segment of Earth's **wind** circulation, proposed by William Ferrel (1856). In the Ferrel **cell**, air flows poleward and eastward near the surface and equatorward and westward at higher altitudes; this movement is the reverse of the airflow in the Hadley **cell**.**Wind** circulates in each hemisphere in three distinct **cells** which help transport energy and heat from the equator to the poles. The **winds are** driven by the energy from the sun at the surface as warm air rises and colder air sinks. The circulation **cell** closest to the equator is called the Hadley **cell**.

C-- MAXIMUM POWER POINT TRACKING:

Maximum power point tracking (MPPT) or sometimes just power point tracking (PPT)) is a technique used commonly with wind turbines and photovoltaic (PV) solar systems to maximize power extraction under all conditions.

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DIFFERENT MPPT TECHNIQUES:

There are different techniques used to track the maximum power point. Few of the most popular

TECHNIQUES ARE:

1) Perturb and observe (hill climbing method)

2) Incremental Conductance method

3) Fractional short circuit current

4) Fractional open circuit voltage

5) Neural networks

6) Fuzzy logic

4.D BATTERY:

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to include devices composed of a single cell.

Some types of primary batteries used, for example, for telegraph circuits, were restored to operation by replacing the electrodes. Secondary batteries are not indefinitely rechargeable due to dissipation of the active materials, loss of electrolyte and internal corrosion.

4. G-- SLIDING MODE CONTROLLER:

In control systems, sliding mode control (SMC) is a nonlinear control method that alters the dynamics of a nonlinear system by application of a discontinuous control signal (or more rigorously, a set-valued control signal) that forces the system to "slide" along a cross-section of the system's normal behavior.

The state-feedback control law is not a continuous function of time. Instead, it can switch from one continuous structure to another based on the current position in the state space. Hence, sliding mode control is a variable structure control method.

The multiple control structures are designed so that trajectories always move toward an adjacent region with a different control structure, and so the ultimate trajectory will not exist entirely within one control structure. Instead, it will slide along the boundaries of the control structures. The motion of the system as

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it slides along these boundaries is called a sliding mode and the geometrical locus consisting of the boundaries is called the sliding (hyper)surface. In the context of modern control theory, any variable structure system, like a system under SMC, may be viewed as a special case of a hybrid dynamical system as the system both flows through a continuous state space but also moves through different discrete control modes.

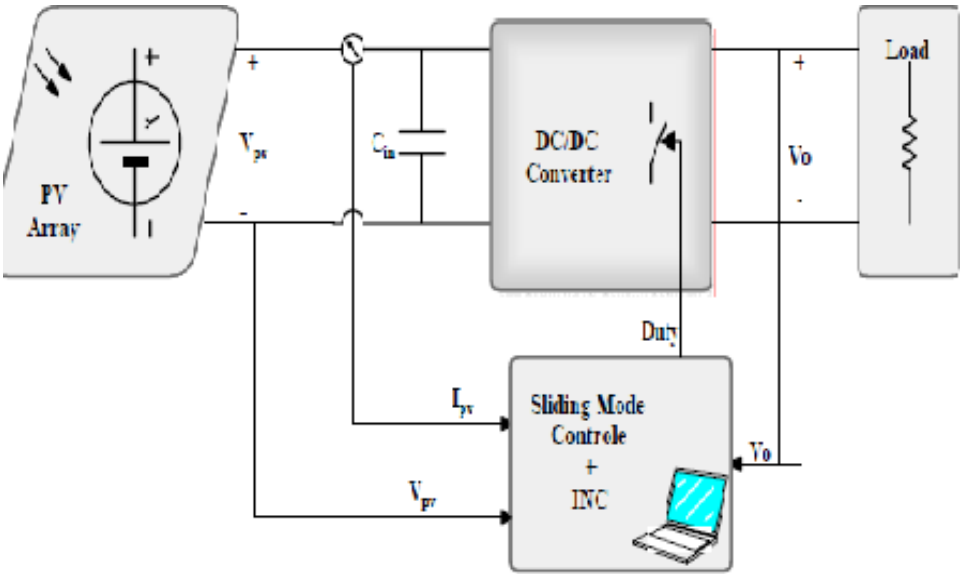

Figure4.4 sliding mode controller for hybrid energy system

FUZZY LOGIC CONTROL SYSTEM

Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage hat the solution to the problem can be cast in terms that human operators can understand, so that their experience can be use controller. This makes it easily.

PWM GENERATION

Pulse Width Modulation (PWM) controls analog circuits with a microprocessor's digital outputs. In this technique, Digital-to-Analog conversion is not necessary as the noise effects are minimized by keeping the signal digital. In PWM technique the energy is distributed through a series of pulses rather than a continuously varying (analog) signal. By increasing or decreasing pulse width, the energy flow to the

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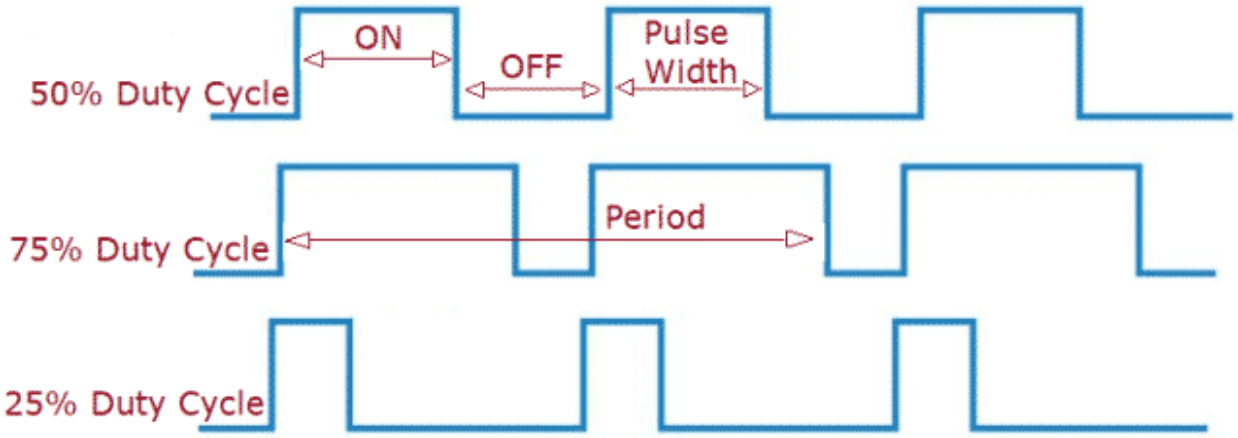
motor shaft can be control



GATE DRIVER

A **gate driver** is a power amplifier that accepts a low-power input from a controller IC and produces a high-current drive input for the gate of a high-power transistor such as an IGBT or power MOSFET. Gate drivers can be provided either on-chip or as a discrete module. In essence, a gate driver consists of a level shifter in combination with an amplifier. A gate driver IC serves as the interface between control signals (digital or analog controllers) and power switches (IGBTs, MOSFETs, SiC MOSFETs, and GaN HEMTs). An integrated gate-driver solution reduces design complexity, development time, bill of materials (BOM), and board space while improving reliability over discretely-implemented gate-drive solutions.

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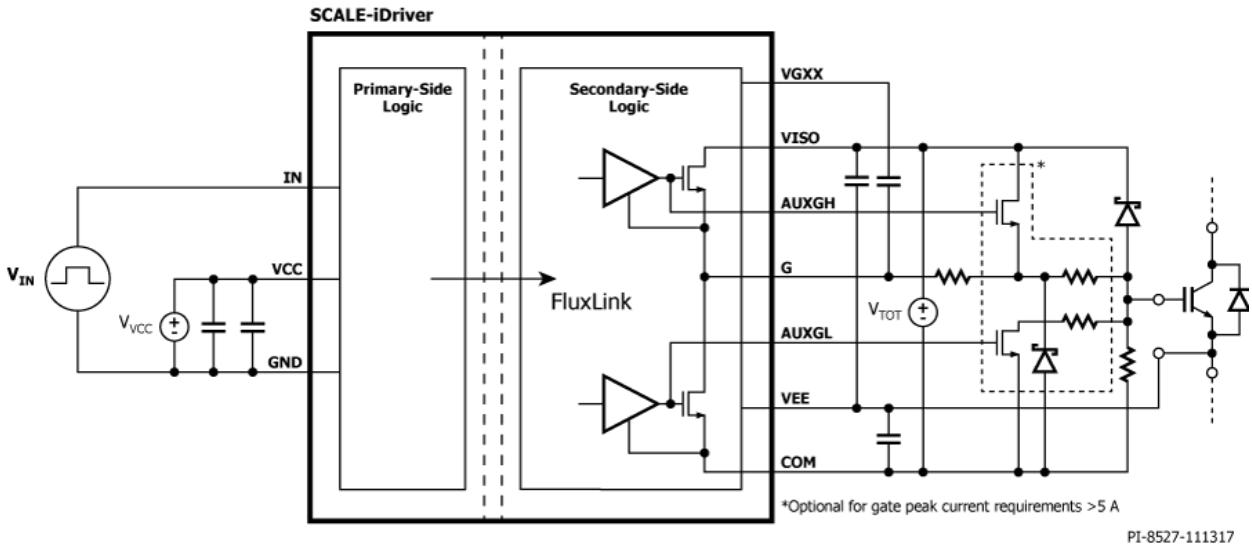
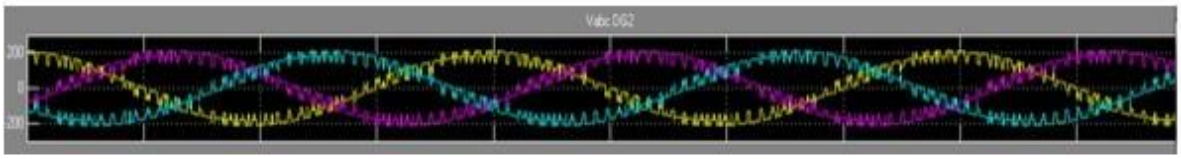
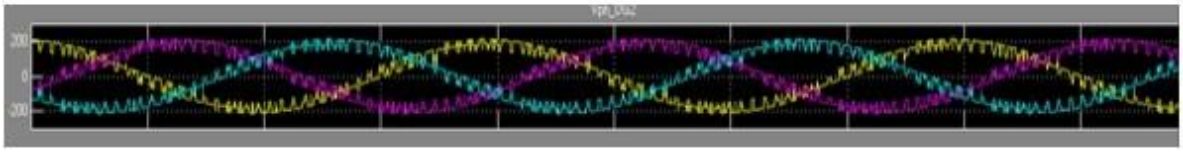
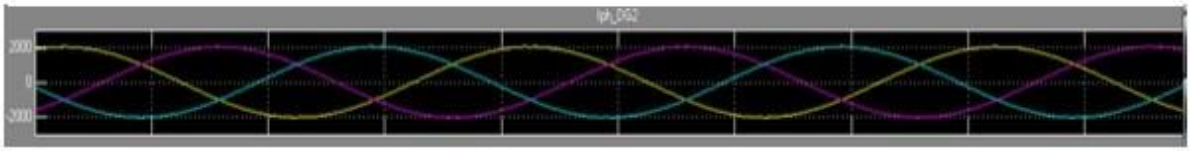


Output for sliding mode controller:







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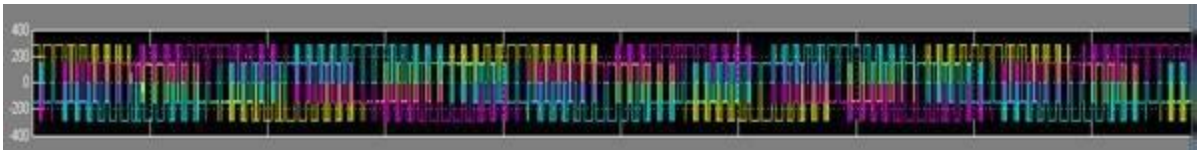
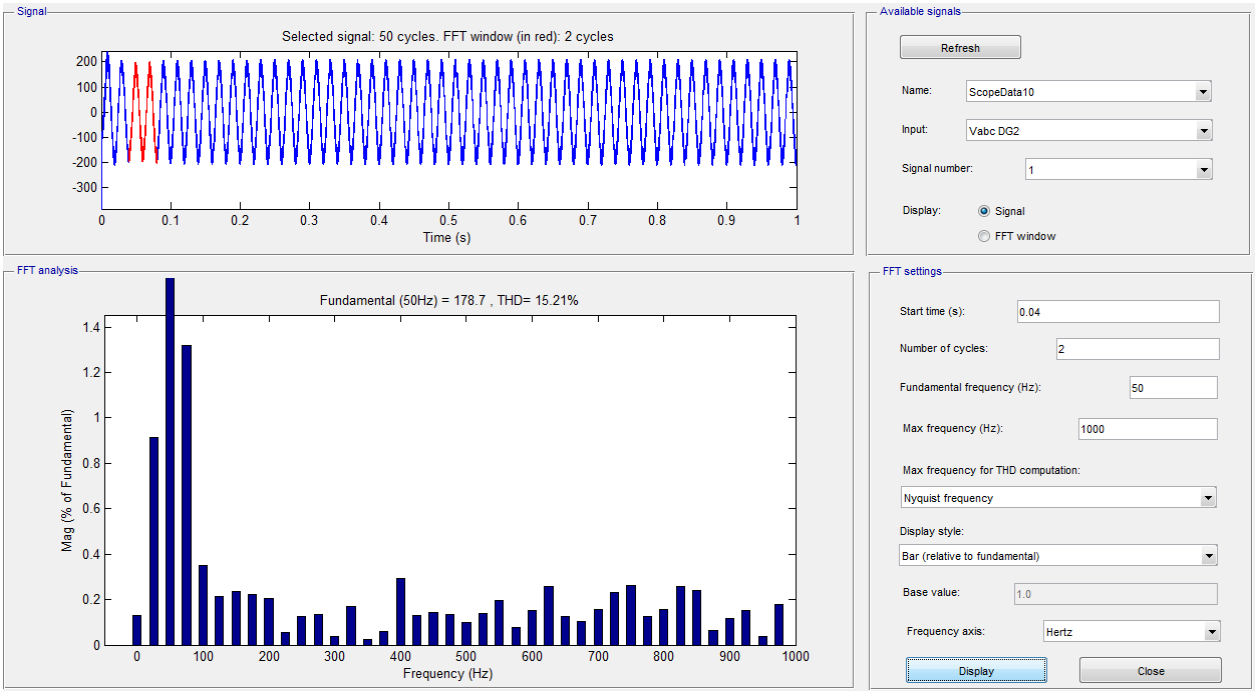
Response of pulse width Modulation



FFT analysis for sliding mode control



FFT analysis for sliding mode control

CONCLUSION

A sliding mode based secondary controller is used for achieving the grid synchronization by integrating the distributed energy resource converters to micro grid. The simulation results with sliding mode controller helps in obtaining the response, low steady state error and reduces the harmonics with low ripple content. The power factor is also improved near PCC and power quality has been increased by the influence of multiple types of DG sources in distribution generation system. Hence, the proposed sliding mode controller system has better performance for achieving grid synchronization than existed conventional PI controller.

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