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Smart Networks for Standalone Microgrid using Integrated Renewable Sources

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ABSTRACT: In this paper, the design and implementation of active power control (APC) with anti-windup PI controller (AWPI) and improved perturbation and observation (P&O) method with sliding mode control (SMC), are investigated to get high level of performance with reduced number of sensors for a stable operation of a wind-PV-battery based hybrid standalone power generation system (HSPGS). The SMC approach with boundary layer, is used to have an optimum trajectory of the system as sliding manifold of surfaces, under variable operating conditions of many power converters operated in simultaneously. Furthermore, detailed modeling and stability analysis to demonstrate the transversality, reachability and equivalent control, are presented. The effectiveness and robustness of HSPGS and their respective control strategies are validated by simulation and test results on a hardware prototype using DSPdSPACE real time controller.

I. INTRODUCTION

Severalremote areas in the world use only diesel generators (DGs) to support their electricity needs. This energy source (ES) is costly and pollutant. However, hybrid standalone power generation system (HSPGS) based on wind and solar energy supported by the battery energy storage system (BESS) is considered as a promising solution for remote areas to reduce diesel-fuel dependency, to minimize the greenhouse (GHS) emissions, to reduce power transmission, and to minimize the system losses. This new technology is effective however, it requires improvement especially in the design and control to become simple and easy to use. ESs are proposed in the literature . In the most of the proposed configurations , multi-stage converters are used to connect the distributed energy resources (DERs) to the point of common coupling (PCC), which leads to an increase of energy losses and the cost of installation. In, AC-DC microgrid configuration is proposed to connect the DERs to the PCC. The authors have succeeded to achieve their objectives; however, this proposition is not validated in realtime.

Generally, single or two-stage converters are used to connect the PCC and the solar photovoltaic array (SPVA) . In , a single stage system is proposed and obtained results show satisfactory performance According to and the comparative study realized in , two stage system showshigh level of performance especially in DC voltage stability and power quality. Regarding, the efficiency of SPVA and WT, many methods are developed in the literature to track the maximum power point (MPP) . Compared to the existing MPP tracking(MPPT) methods, perturbation and observation (P&O) is extensively applied as an easy method. Unfortunately, this method suffers from the continuous oscillation that occurs around the MPP. In addition, it loses the tracking direction during sudden change in weather conditions. These drawbacks are solved in by limiting the control using dynamic boundary conditions. This solution is effective however, it requires improvement especially in modeling and stability analysis. In an improved beta-P&O method is proposed to solve the drawbacks of the classical P&O method. Thissolution is complex and its dynamics is slow. Furthermore, it requires large run time because it uses two stages, 1) adaptive scaling factor beta to get high level of performance during transient response, and 2) zero oscillations P&O method for steady-state error. Similarly, the authors in , have presented improvement in the performance of classical P&Oby using delta-P&O, PI-P&O, as well as, ZA-P&O methods, however, with complicated control and hardware complexity.In the same context, hybrid analog-digital sliding mode around 25 years (as it is the lifetime of solar cells).

OBJECTIVE

The objective of this paper is to model a hybrid power system for buildings, which is technically feasible and economically optimal. With a view to promote renewable energy sources, photovoltaics and wind turbines are integrated with the grid connected building.

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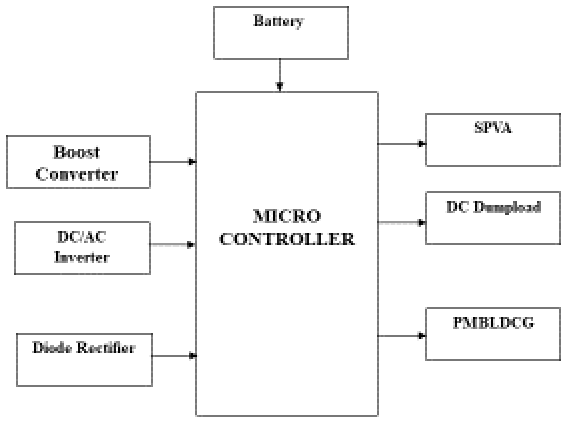
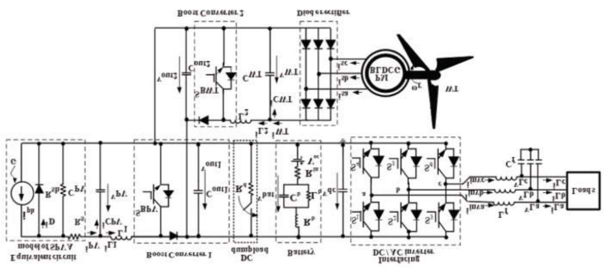
II. PROPOSED SYSTEM

The proposed model for Microgrid system. The inputs of the system are renewable energies such as solar energy, wind energy, hydro and fuel cell energy. After minimizing the losses and increase the efficiencies of the systems the energies can be combined standard are applied on the energy input and finally stored energy can be integrated into grid.

BLOCK DIAGRAM



CIRCUIT DIAGRAM



III. OPERATION

In future each home would have its own uninterruptible renewable energy system and has the capability to work in two main modes of operation such grid-connected mode and stand-alone mode. This system will be capable of producing a smooth, uninterrupted transition between these modes by using an advanced islanding detection and resynchronization algorithm. The both mode of transition power cycle . There are two modes of operations as shown in figure below, stand alone and grid connected.

When the power is shut off from the utility grid the system goes to the islanding mode and when the power is available from the utility grid the system will synchronize and connected to the utility grid. Output power from the fuel cell is available for Plug in hybrid electric vehicles (PHEV) system. Bidirectional Power Converter (BPC) controls two parameters active current and active/reactive power. In standalone mode BPC control two parameters AC frequency and voltage. The following paragraph will provide working principle of these modes. There are always changes in the condition of weather and speed of wind. Wind and solar system are condition dependents. These systems should be adoptable.

This means that these systems should change operating parameters according to the changes in weather conditions. These parameters are very unpredictable. These parameters cannot be predicted even the operators in the grid cannot predict the speed of wind and sun light conditions for solar cell farms accurately. The output of these systems still always varies and operator needs to be very careful in the grid. Still there are lots of issues not to solve.

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PIC MICROCONTROLLER

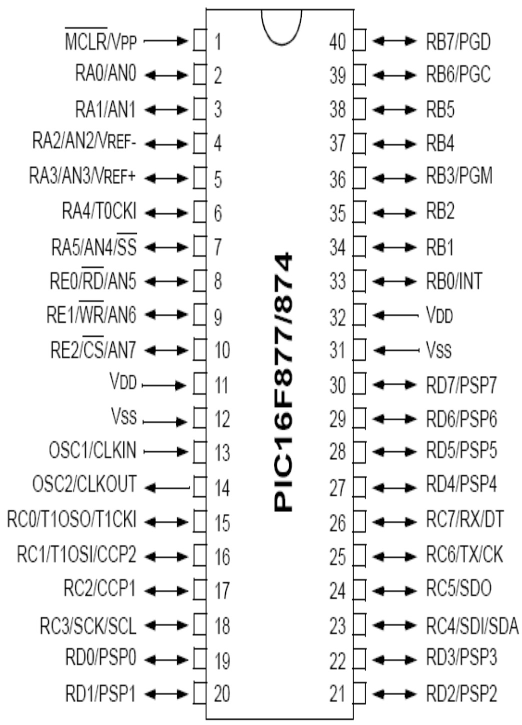
The PIC microcontroller has some advantages in many applications over the older chips such as the Intel 8048/8051/8052 and its derivatives, the Motorola MC6805/6hHC11, and many others. Its unusual architecture is ideally suited for embedded control. Nearly all instructions execute in the same number of clock cycles, which makes timing control much easier

It is the low cost, high available clock speeds, small size, and incredible ease of use of the tiny PIC. For timing-insensitive designs, the oscillator can consist of a cheap RC network. Clock speeds can range from low speed to 20MHz. Versions of the various PICmicro families are available that are equipped with various combinations ROM, EPROM, OTP (One-Time Programmable) EPROM, EEPROM, and FLASH program and data memory. In many cases, designing with a PICmicro is much simpler and more efficient than using an older, larger embedded microprocessor.

FEATURES OF PIC CONTROLLER:

- Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory, Up to 368 x 8 bytes of Data Memory (RAM) Up to 256 x 8 bytes of EEPROM Data Memory
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Low power, high speed CMOS FLASH/EEPROM technology
- Wide operating voltage range: 2.0V to 5.5V
- Low-power consumption:

PIN DIAGRAM OF 16F877A PIC CONTROLLER



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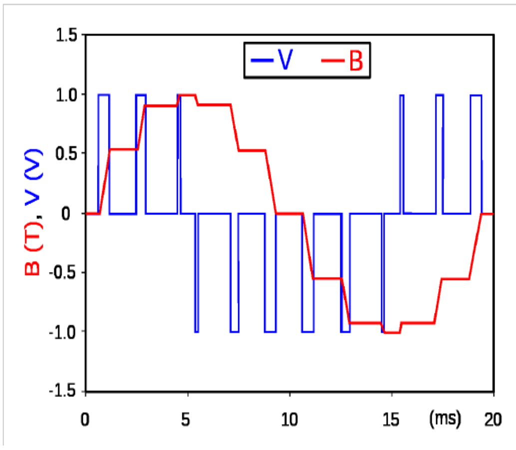
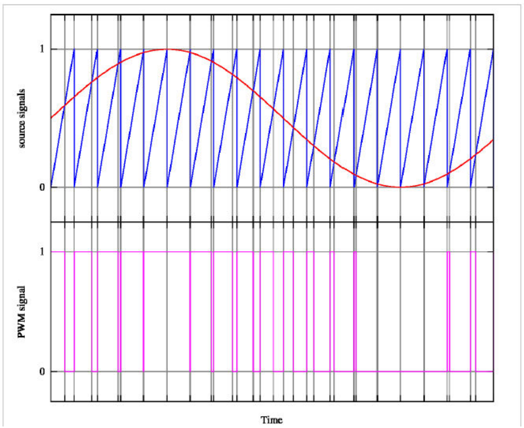
WORKING OF PWM AC MOTOR DRIVE WAVEFORM

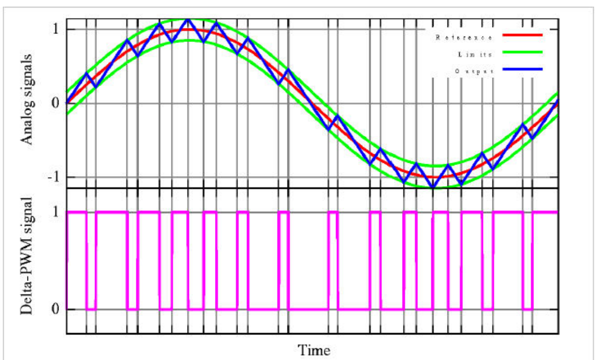


PWM SIGNAL GENERATION WAVEFORM



PWM PULSE CONVERTER

DELTA PWM WAVEFORM



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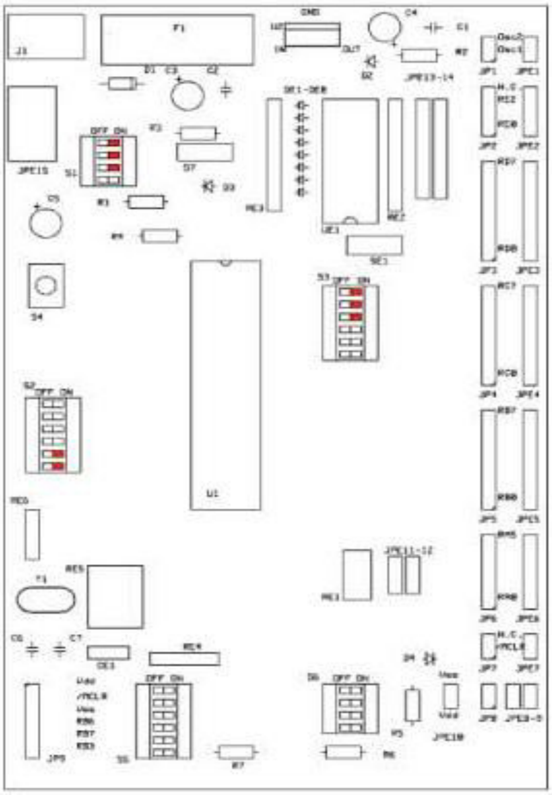
IV. PROCEDURE

Make a layout of the circuit.

Straighten and clean the component leads using blade or knife. Apply a little flux on the leads. Take a little solder on soldering iron and apply the molten solder on the leads.

Mount the components on the PCB by bending the leads of the components using nose-pliers.

Apply flux on the joints and solder the joints. Soldering must be done in minimum time to avoid dry soldering and heating up of components. Wash the residue using water and brush.



V. CONCLUSION

A wind-PV-battery based hybrid power generation system has been proposed for standalone application. Modeling, control design, and stability analysis have been presented in detail. Simulated performance of the system has been obtained with an improved P&O method for MPPT of SPVA and WT. For a multiple source power generation system, SMC with boundary layer is designed for improved performance under variable weather conditions. It has been demonstrated that the improved P&O based MPPT is more reliable and efficient during weather

ADVANTAGES

1. Reduce the manual power
2. Low cost and Reliable

VI. RESULTS

Experimental configuration used to validate in real time the HSPGS configuration and the developed control strategies. It consists of Lab-Volt WT emulator coupled with PMBLDCG and Lab-Volt PV emulator,

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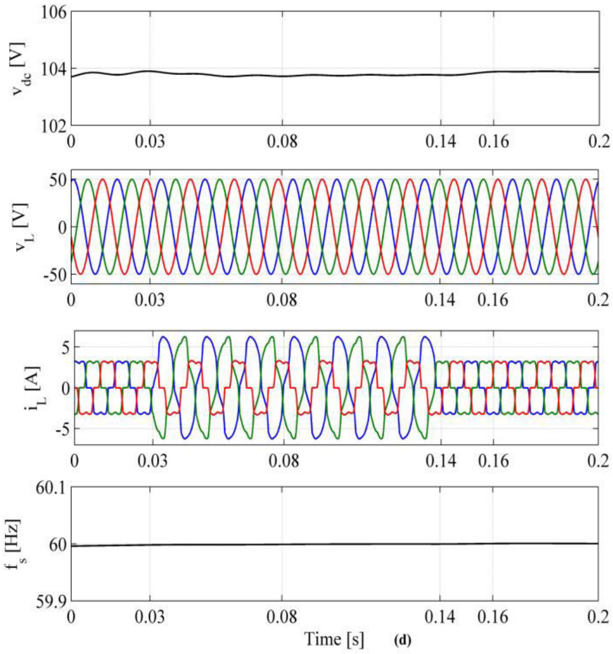

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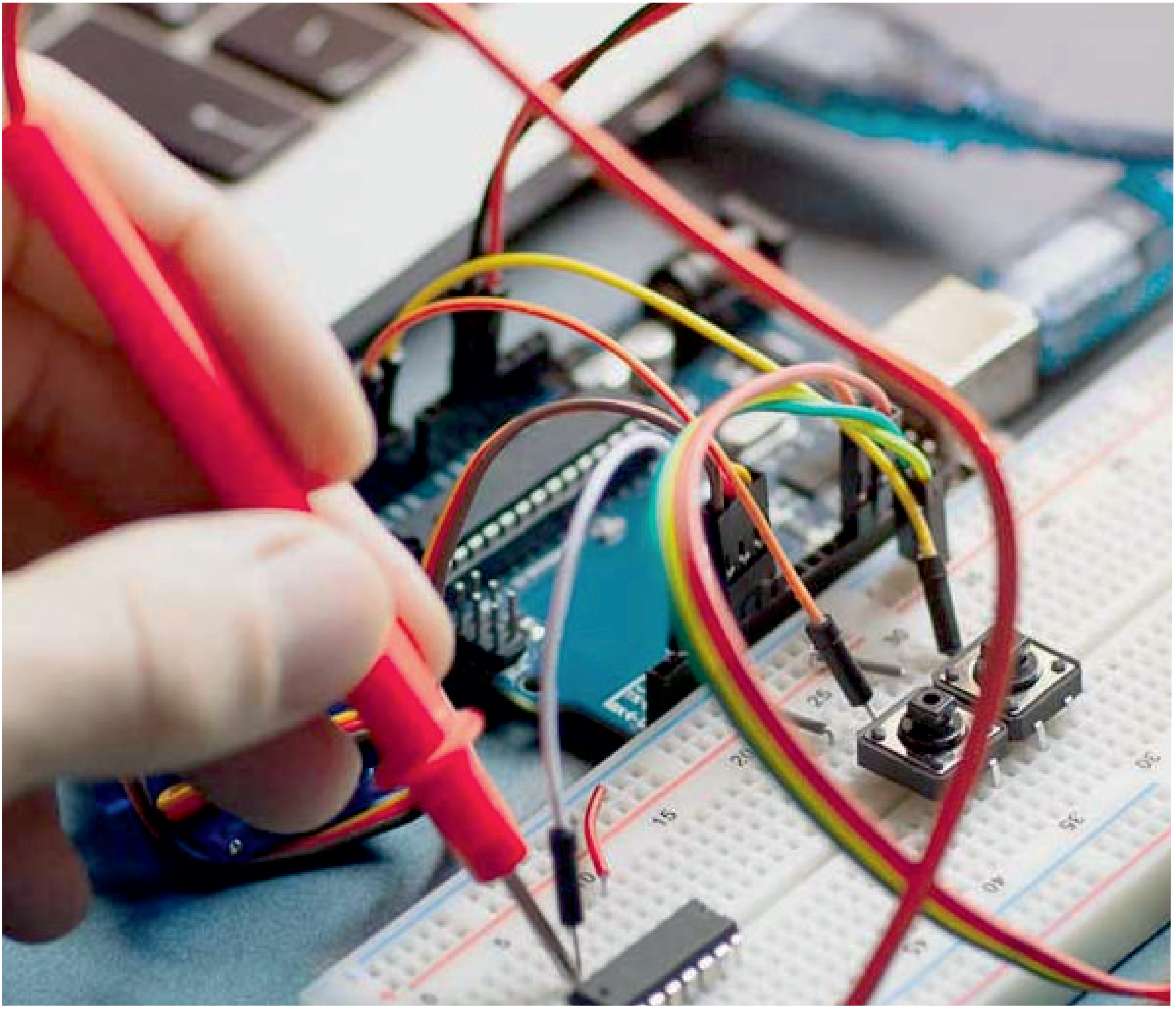

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