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Controlling Microgrid System Using Renewable Energy Based Bidirectional PWM Technique with Wireless System and Administered By SCADA

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Abstract - *A microgrid is a local distribution system connecting local renewable energy sources and loads. A smart grid is a national electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation sources and loads, including the microgrids, to meet the varying electricity demands of end users. This paper deals with the control of microgrid system by using bidirectional PWM (Pulse Width Modulation) technique by utilizing renewable energy resources wirelessly through mobile phone using Bluetooth. All the wired and wireless devices of the system is controlled by a microcontroller, ARM 7 (LPC2148). The result of the designed converter is verified using the hardware. Assuming for an industrial control system, the design is simulated in the SCADA software and results are observed.*

Key Words: Microgrid, PWM, Wireless control, SCADA, Renewable energy,

1. INTRODUCTION

A grid remarkable in its intelligence and impressive in its scope which offers valuable technologies that can be developed within the very near future or are already developed today[1]. It simply means a "smarter" power grid.Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizingcosts and environmental impacts while maximizing system reliability, resilience and stability.

Smart grid establishes a two-way communication between the utilities and the customer and reduces the stress on the power system infrastructure. Smart grid integrates all sources of energy, mainly renewable energy.

2. MICROGRID

Microgrids are electricity distribution systems containing loads and distributed energy sources (such as distributed generators, storage devices or controllable loads) that can be operated in a controlled, coordinated way either as local islanded network or as connected to the main power network.

From a grid perspective, the microgrid concept is attractive because it recognizes the reality that the nation's distribution system is old, and will change only very slowly. The microgrid concept enables high penetration of **Distributed Generation** without requiring re-design or re-engineering of the national distribution system itself.

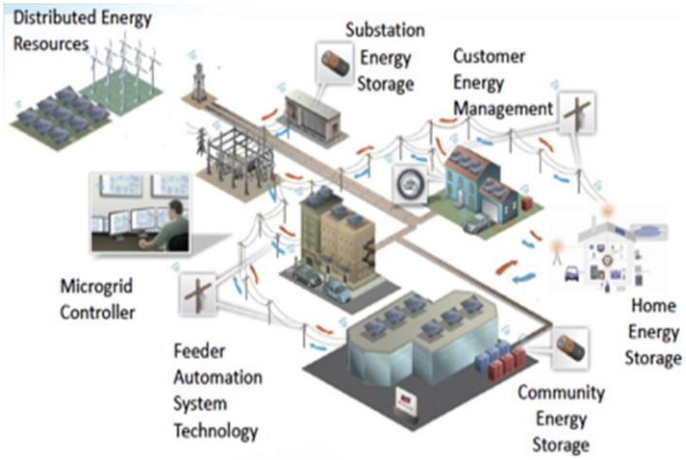

Fig -1: Microgrid

The benefits of using microgrids are improved energy efficiency, minimization of overall energy consumption, reduced environmental impact, and improvement of reliability of supply and network operational benefits such as loss reduction, congestion relief, voltage control and security of supply [2].

Solar energy is often heralded as a clean alternative to fossil energy, a way to save the planet from global warmingwhile still ensuring everyone's electrical needs are met. The technology is still progressing and people are finding new ways to make use of it. One idea is for communities to create their own Microgrids and here's whyMicrogrids are a great way for communities to generate their own solar electricity.

Single phase Bidirectional PWM converter is an important component in Microgrid system that connects ac and dc subsystem. It has to operate in Inverter mode as well as Rectifier mode by utilizing dc and ac renewable energy sources [3].

3. RENEWABLE ENERGY

Renewable energy is generally defined as energy that is collected from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.[4] Renewable energy often provides energy in four important areas: electricity generation, air and water heating/cooling, transportation, and rural (off-grid) energy services.

Solar energy is the ultimate source of energy from millions of years and it is a renewable energy. This energy consists of radiant light and heat energy from the sun. Out of all energy emitted by sun only a small fraction of energy is absorbed by the earth. Just this tiny fraction of the sun's energy that hits the earth is enough to meet all our power needs[5]. We can use solar energy by converting it to electrical energy. So we must use a device called solar panels which can convert the light energy into electrical energy. Solar panel is a group of solar cells. Solar cells works on the principle of photoelectric effect.

4. CONTROLLER

ARM-Advanced RISC Machine is a 32-bit RISC (Reduced Instruction Set Computer) processor architecture developed by ARM Holdings. ARM7 is most successful and widely used processor family in embedded system application. So we have decided to choose ARM7 TDMI based NXP controller LPC2148.

Also ARM is balance between classic microcontroller and new Cortex series. ARM7 is excellent to get start with in terms of resources available on internet and quality documentation provided by NXP. It suits perfectly for beginners to get in-depth idea about hardware and software implementation. LPC2148 is manufactured by NXP Semiconductor (Phillips) and it is preloaded with many in-build features and peripherals. The main advantages of using ARM7 LPC2148 is it is a 32 bit processor with High speed and Low power consumption and it has Internal ESD Protection

The PWM is based on the standard timer block and inherits all of its features, although only the PWM function is pinned out on the LPC2148. The timer is designed to count cycles of the peripheral clock (PCLK) and optionally generate interrupts or perform other actions when specified timer values occur, based on seven match registers. The PWM function is also based on match register events [13]. The ability to separately control rising and falling edge locations allow the PWM to be used for more applications.It can be used as a standard timer if the PWM mode is not enabled.

5. HARDWARE DESIGN

5.1 Block Diagram

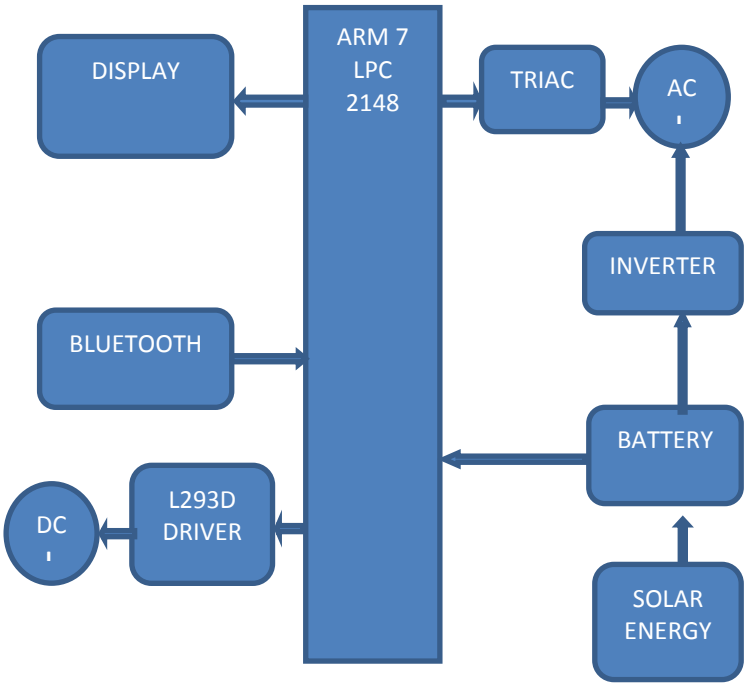

Fig -2: Basic Block Diagram

5.2 Schematic Diagram

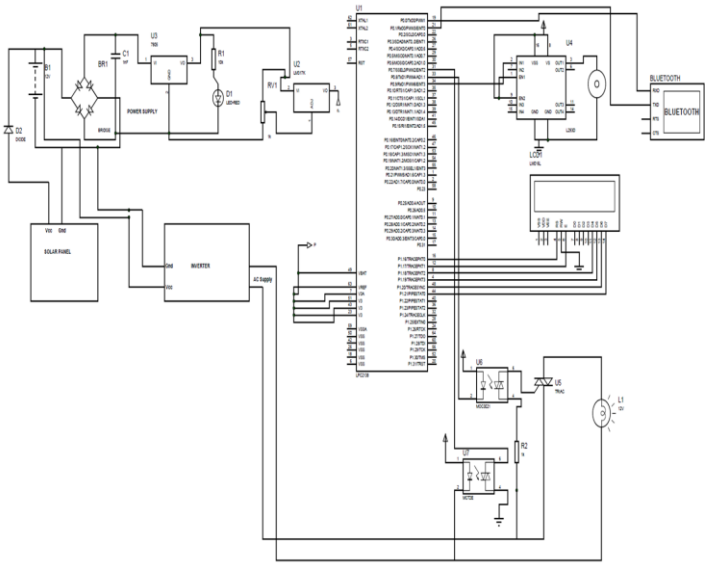

Fig -3: Schematic Diagram

5.3 Design

The bidirectional converter is designed using the optocoupler (MOC3021) and microcontroller LPC2148 is used to control the switches in the converter and driver L293D is used to drive the DC motor.Triac BT136 is used as a switch for AC bulb. Bluetooth HC05 is connected to the controller to control wirelessly. The power supply is taken from the solar panel. In order to avoid device failure and safety, the fabrication and the experiments were done as a scaled down voltage level

6. EXPERIMENTAL RESULTS

Serial controller application from the Google play store is installed our android mobile phone. The required buttons are set, for e.g. AC LOW, DC MID and so on. The phone is now paired to the setup using Bluetooth.The output on the hardware in controlled wirelessly through the mobile phone and it is tabulated.

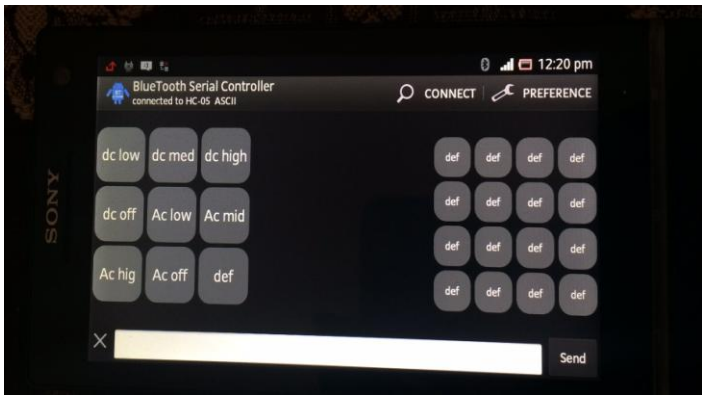

Fig -4: Bluetooth serial controller

Table -1

Input on the phone	CD motor	AC Bulb
AC low		Intensity is low
AC high		Intensity is high
AC Off		OFF
DC high	Motor in max speed	
DC low	Speed is decreased	
DC off	OFF	

7. SIMULATION ON SCADA

SCADA (**Supervisory Control and Data Acquisition**) is a system for remote monitoring and control that operates with coded signals over communication channels (using typically one communication channel per remote station). The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions.It is a type of industrial control system (ICS). Industrial control systems are computer-based systems that monitor and control industrial processes that exist in the physical world. Most control actions are performed by PLC because they are more economical, versatile, flexible and configurable [19]. Hence PLC is to control the process and SCADA allow the operator to change the set points for

the process and the process can be displayed and recorded.

The main advantages of using SCADA are, it minimizes the fault response time and reduce failure or unplanned downtimes.

For an industrial control system, the design is designed using SCADA software and the simulations are observed. The software used for PLC is CODESYS which is a software platform especially designed to fulfill the different requirement of modern industrial automation projects. The software used for SCADA is Intouch from wonderware by Schneider Electric.

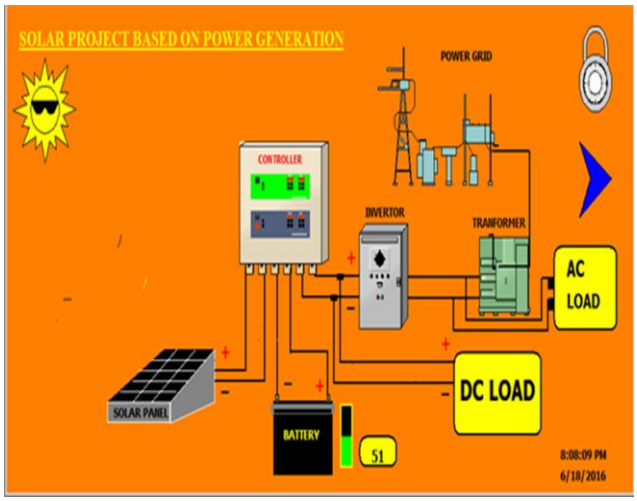

Fig -5: On SCADA

8. SIMULATION OBSERVATION

Fig -6-8 shows the control panel of the SCADA simulation. ON and OFF button for AC load and DC load is used. Regulator is used to control the AC and DC load. The graph shows the performance of the load. Green line in the graph shows the speed of the DC load which is assumed to be the fan and the red line indicates the intensity of the AC load whichis assumed to be a bulb.

The simulation results are observed as, when speed of the Ac load is increased, the frequency changes and when intensity on the bulb is increased the amplitude is increased.

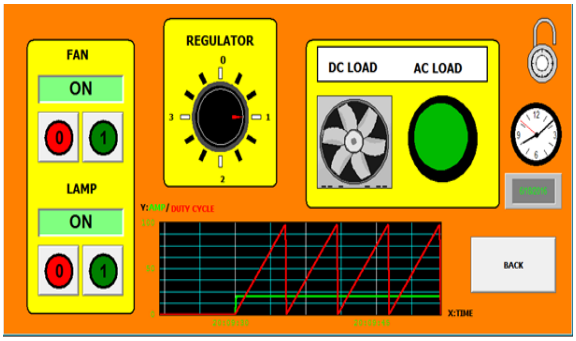

Fig -6: LOW

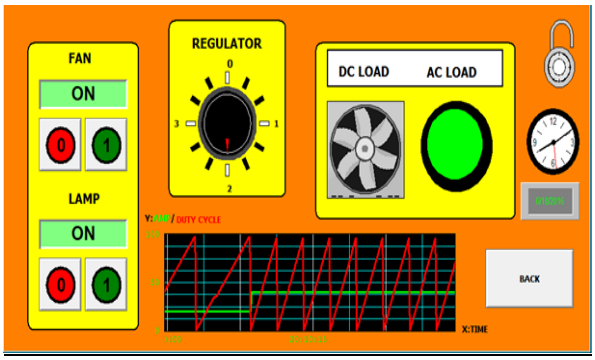

Fig -7: MEDIUM

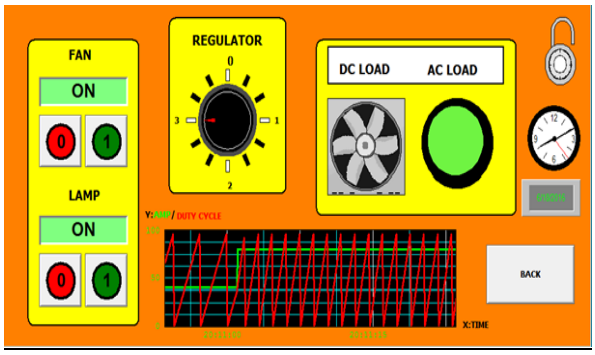

Fig -8: HIGH

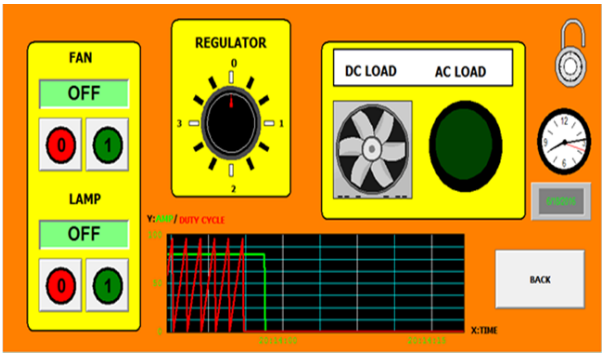

Fig -9: OFF

9. CONCLUSION

With world's enhanced focus on renewable energy resources the growth of microgrids is imminent for the efficient distribution of electricity. The success of microgrids depends on their seamless two-way integration with national smart grids. This paper shows how bidirectional PWM (Pulse Width Modulation) technique and SCADA system can be used to achieve this integration.

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