

Hybrid Power Supply System Using Multifunctional Smart Controller

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ABSTRACT: The proposed system is called a “Hybrid Power Supply System Using Multifunctional Smart Controller”. This consists of a smart controller based design for cost effective operation of solar-grid tied system. In this system the load can be fed continuously according to the availability of power (i.e. solar or grid) thus increasing the reliability. In this system during the availability of solar energy load is fed from the energy stored in the battery. Unlike conventional system the load is not fed from the grid supply thus saving in energy and cost. The battery is charged on both the supplies according to their availability thus it can provide a backup during non-availability of supply. The proposed method is cheap, efficient, reliable and cost effective. The system has been tested for the 20 Watt solar panel with the battery backup storage and its effectiveness is observed.

KEYWORDS: Microcontroller, Sepic Converter, Relay, Regulating circuit.

I. INTRODUCTION

Among the non-conventional energy sources available solar energy is available mostly throughout the year. Solar energy has the greatest potential among all the sources of renewable energy. The sun gives us 1000 times more power than we need. The energy radiated by sun on a bright sunny day is approximately 1 KW/m². The energy available from sun can be used for household purposes. Today, Photovoltaic (PV) generation is becoming increasingly important as renewable source since it requires less maintenance, zero pollution.

Non-conventional sources of energy are one of the areas of emerging technologies which have higher priority with reference to national needs. Renewable energy sources include both ‘direct’ solar radiation intercepted by collectors and indirect energy such as wind, hydropower, ocean energy and biomass resources that can be managed in sustainable manner. Renewable energy is an indigenous resource available in considerable quantities to all developing nations. Several renewable options are financially and economically competitive for certain applications, such as in remote locations, where the costs of transmitting electrical power or transporting conventional fuels are high, or in those well-endowed with biomass, hydro or geothermal resources. They can be produced in large numbers and introduced quickly, unlike large power stations which have long lead times, often 10 years or more. The diversity of systems available also increases flexibility and security of supply.

This system consists of a micro-controller for smart switching of load on the basis of supply available. This system uses Sepic converter (Buck-Boost Converter) technique for charging of battery and for controlling solar power. It has single phase full wave inverter working on 180° mode to drive the load from battery. This system runs the load on solar system instead of main supply when solar energy is available thus saving cost and utilizing energy. The battery is charged through two supplies both solar and from mains according to the supply available thus increasing the reliability of the system. The proposed method is cheap, efficient, reliable and cost effective.

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II. RELATED WORK

While selecting the topic we found that the energy demand is increasing day by day. So to meet the energy demand and to conserve energy and conventional resources non-conventional energy sources can be used. We thought of using the solar energy available in abundant for Household purpose. The PV module installed at houses can meet total load demand which would result in saving of cost and energy. To build this prototype model we have gone through some reference books, reference papers and some online websites.

[1] In this project we are using electronic circuits for controlling and switching load between battery and mains so for this it is necessary to know about the electronic equipment's. Their construction, working, block diagram and their applications was essential to study.

[2] & [3] The energy from solar is varying continuously. To charge a battery with this continuously changing power is not possible. Battery is to be charged with a constant supply. So to charge a battery charge controller is required. In this project we are using Sepic converter for supplying constant voltage to battery from solar panel for charging. Therefore its practical application circuit is essential to understand.

[4] & [5] Single phase inverter is required to convert the DC energy stored in battery to AC. The idea of designing and implementation of single phase inverter and Microcontroller based PWM Inverter driving technique is most important in project.

III. AUTOMATIC SMART COTROLLER

A microcontroller (also microcontroller unit, MCU or μC) is a small computer on a single integrated circuit consisting of a relatively simple CPU combined with support functions such as a crystal oscillator, timers, watchdog, serial and analog I/O etc. Neither program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a, typically small, read/write memory. Microcontrollers are designed for small applications. Thus, in contrast to the microprocessors used in personal computers and other high-performance applications, simplicity is emphasized. Some microcontrollers may operate at clock frequencies as low as 32 kHz, as this is adequate for many typical applications, enabling low power consumption (mill watts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just Nano watts, making many of them well suited for long lasting battery applications.

PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

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IV. EXPERIMENTAL RESULTS

Figure 1 shows the working of hybrid power supply system and the results obtain is given below.

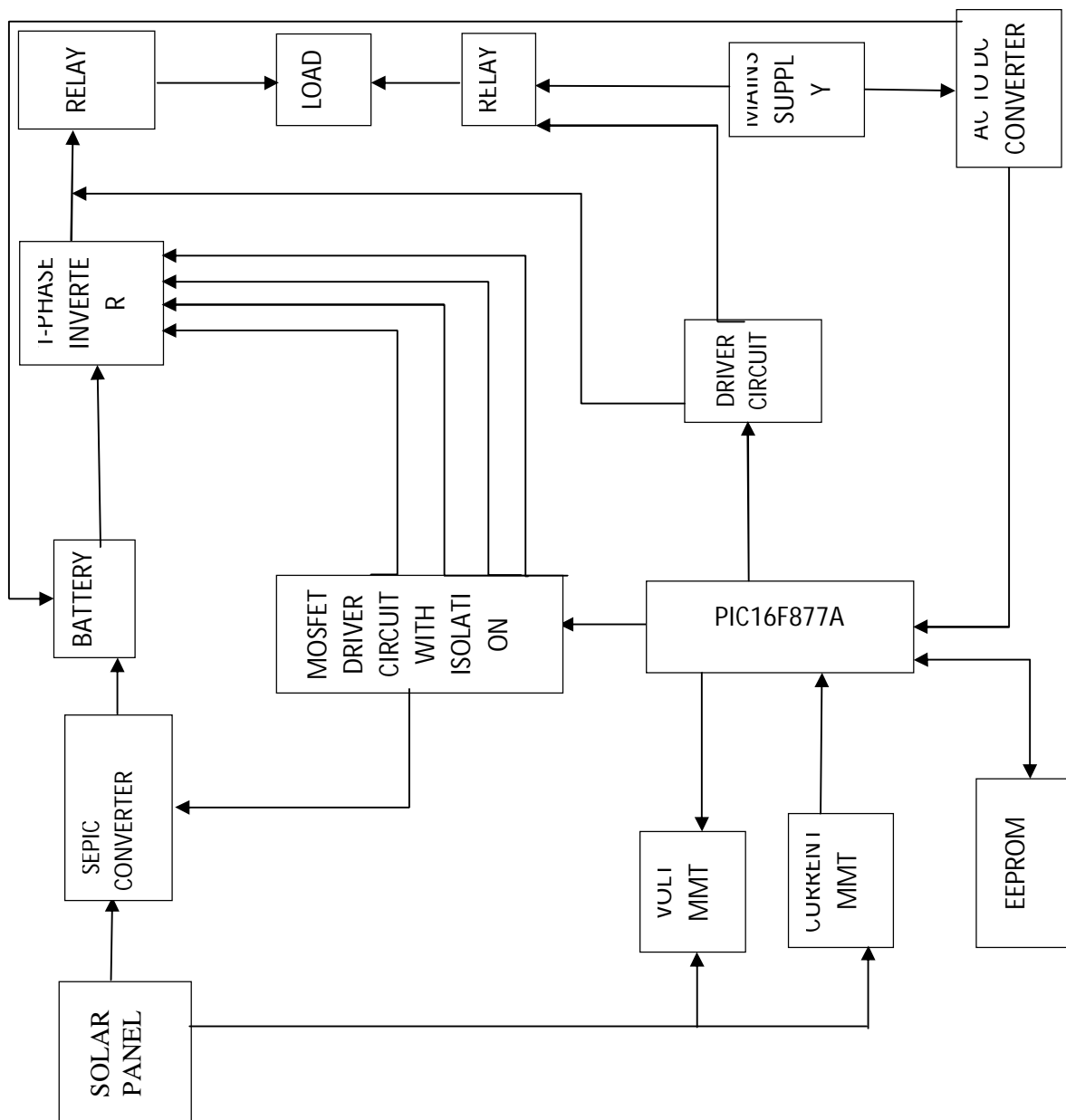


Figure 1: Block Diagram“Hybrid Power Supply System Using Multifunctional Smart Controller”

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Initially the solar panel output is given to the battery. The output of the solar panel is DC hence this DC output will charge the battery as the battery can accept only DC input and provides DC output. The solar panel used in the circuit is of 12V and also the battery used is of 12V. As the output of solar panel is not stable throughout the day, so we connected sepic converter between solar panel and battery which maintains solar output at 12V. Now this DC output from the battery is given to the inverter circuit which converts the DC signal to AC. Now the converted AC output is given to the relay which acts as an automatic switch. The output load is connected to the relay, so whenever the relay gets ON signal from the inverter circuit, it will turn ON the output load and whenever the input to the relay is OFF, it will turn OFF the output load.

The other part of the project is to turn ON and OFF the load through the AC mains. For this purpose we take the input from the AC mains and provide this input to the relay to which the output load is connected. So whenever the AC main is ON the load will be ON and vice versa.

a) Solar Panel Payback

- 1) Payback Period = System Cost / (Annual Energy Delivered * Cost of Electricity) [Note; this is “simple” payback and doesn’t include the time value of money]
- 2) Savings-to-Investment Ratio = (Annual Energy Delivered * Cost of Electricity * Present Worth Factor) / System Cost
- 3) Electricity Rate to achieve Savings-to-Investment Ratio of 1 = System Cost / (Annual Energy Delivered * Present worth Factor)

b) Solar Maintenance

The 20W solar panel requires no special maintenance. Occasional cleaning with a mild solution of soap and water is recommended. Do not use hard abrasive cleaners, pads or solvents. Any cracks or minor breaks in the glass surface should be repaired immediately using transparent silicon caulking material. This is a temporary solution. Water or moisture leakage must be stopped or damage to your solar panel may occur. Check all connections regularly for corrosion or poor contact points. Clean or grease as needed.

c) Solar Energy Calculation

One single solar panel from type standard 20 Watt / 12 volts can deliver a power of 20 Watt per hour, considering full sunshine. Knowing that the sun shine vary during the day, the effective sun power of one day is equal from 4 to 6 hours of a maximum measured at midday.

Since this maximum at midday is not the same every day, it should be taken in consideration, that more or less heavy cloud reduces the possible power.

Example:

One solar panel of 20W/12V produce between

$$20W \times 4h = 80 \text{ Wh.}$$

And

$$20W \times 6h = 120 \text{ Wh.}$$

One battery of 12V/7.6Ah has a capacity of $12V \times 7.6Ah = 91.2 \text{ Wh.}$

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For technical reasons, it is not recommended to empty a battery more than 70%. The usable capacity of this type of battery is around 63.84 Wh., what match to the produced electrical energy of 80Wh to 120Wh.

We are using 12V-systems, using 1 batteries with 12V/7.6Ah. Using an inverter 12V to 230V connected to the batteries, it is possible to get a power source of 230V, driving different types of electrical appliances like a fan, energy saving lamps. We recommend the usage of two solar panels to get a buffer capacity in case of less sun.

Analysis of Payback Period:

3000 W load for 6 Hrs in a Day:

- Energy needed $= 3000 \text{ w} * 6 \text{ h} = 18000 \text{ Wh}$
- Size of solar panel (sunlight for 6hr) $= 18000/6 = 3000 \text{ W}$
- Size of battery required $= 18000/12 = 1500 \text{ Ah}$
- Size of solar charge controller $= 3000/12 = 260 \text{ A}$
- Rating of inverter $= 3000 \text{ W}$

Monthly consumption $= 18000 * 30$
 $= 540000 \text{ Wh}$

Monthly bill saving (Rs) = Fixed charge + (Energy charged KW/hr)*(Energy consumed)
 $= 220 + (13.01 * 540000)$
 $= \text{Rs } 7300 \text{ /-}$

Yearly bill saving (Rs) $= \text{Rs } 87,600 \text{ /-}$

Approximate cost of installation:

- Solar panel $= 3000 * 60 = \text{Rs } 180000$
- Battery $= \text{Rs } 150000$
- Solar charge controller $= \text{Rs } 50000$
- Inverter $= \text{Rs } 25000$
- Installing cost $= \text{Rs } 3000$

Total cost $= \text{Rs } 408000$

Payback period in months $= (408000/87600) * 12$
 $= 56 \text{ Month.}$

Payback period in years $= 56/12 = 4.66$
 $= 5 \text{ Year}$

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V. CONCLUSION

From the results acquired during experiments, it was confirmed that, with a well-designed system including a proper converter and selecting an efficient and proven algorithm, the implementation of “Hybrid Power Supply System Using Multifunctional Smart Controller” is simple and can be easily constructed to achieve an acceptable efficiency level of the PV modules.

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