DC-DC Chargers for Efficient Utilization of Renewable Energy

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Abstract

Renewable energy resources have been widely adopted in the world due to environmental concerns, global energy shortage, and decreasing cost of system components. Among these renewable energy sources, solar energy generation has attracted significant interest worldwide due to its easy implementation, lower payback periods.

Lack of access to electricity is one of the biggest problems facing in rural area. For securing a reliable supply in rural areas, solar energy is the most practical and economical way of bringing power to poor and remote communities. Solar energy is especially good for residential buildings that are far from existing electrical grid.

All the utility systems worldwide are ac based. Internal circuitry rectifies and uses dc. This conversion of power causes about 25% loss of energy and also increase in size and weight of the equipment.

Mobile Phones and Radios are presently the most popular form of communication devices in the world. Mobile phones are used to do banking transactions, book travel tickets and shop online. Radio is the most popular form of information and entertainment device. This paper describes the design of a prototype which charges a battery by using photo voltaic panel. This battery can be used as an energy bank to charge the Mobile and power the Radio as per the user requirement.

Keywords:

Renewable energy, Solar Photo Voltaic Panel, Battery, Mobile, Radio.

1. Introduction

. According to the International Energy Agency, in 2011, 1.4 billion people around the world did not have the access of electricity. In many of the villages in India power is available only for 5 to 8 hours a day and that too is in middle of night and used primarily for irrigation. This leaves them with no scope to use any other form of utility using power supplied from grid.

Standard of living of any economy is indicated by its percapita energy consumption. In India it is 778 units (kwh) where as it is more than 8000 units (kwh) in developed nations. To improve the economy and supply better quality power, the only option is exploring the renewables. Solar Photo voltaic technology with its rapid improvements and decreasing costs is proving to be a better alternative

Portable electronic equipment require battery or storage device. One of the recent developments is to use a solar panel to recharge a cell phone. Experiments are conducted on solar cell efficiency under the indoor environment using a typical commercial solar panel with maximum power point tracking [1]. With the development of cellular phones many applications are introduced such as camera, music, movies, games integrated with mobiles. Because of these applications battery capacity and power consumption is increased. Worldwide the number of mobiles are over 86,78,00,000 The energy consumed by them is more than 21695 Mega units whose load can be taken by

distributed renewable at lower cost and higher efficiency. Efficient super capacitor storage and charging schemes were proposed [2]. Present chargers used are wall chargers with AC-DC converters which are lossy and utilize only 40% of useful energy and more than 55% is wasted by unnecessary plugging.[3]. Hence emphasis should be on increasing the functionality of user, increase the battery life and efficiency, increase the quality of interfacing system and decrease the size and weight.[4].

A charge protection between cell phone and battery is to limit the rate at which electric current is passing[5]. It prevents overcharging and also against overvoltage, which can reduce battery performance or lifespan. The current focus of PV based system is on lighting [6] though PV based water pump is also given importance. This paper aims to present other applications like mobile & radio battery charging through PV panels.

Most of the commercial Radio sets are designed with ac input (110/230) V and a standby 6V. These have usually 4 numbers of 1.5 V cells. Instead in the proposed prototype the radio was powered using a single rechargeable 4.5AH/ 10AH/75AH, 6V/12 V batteries powered by 75 watt solar PV panel.

DESCRIPTION: Generally, cell phone battery packs require 4.5Vdc and 400-1000mA current for charging. These usually contain three NiCad cells, each having 1.2V rating or Li-ion cells. Initially a 12V battery of 75 AH is charged by solar panel of 75W. The dc to dc cell phone charger circuit uses LM7805 as voltage regulator which maintains the constant output of 5V. Transistor BC548 and Zener Diode act as cut-off switch when battery is full. Diode IN4007 prevents reverse discharge of current from the battery and serves the purpose of safety in reverse polarity. Charging current for the battery is varied by load resistor. Output capacitor is placed to minimize the peak to peak output voltage ripple.

Simulation Results of Mobile charger:

Mobile charger circuit was simulated with multisim software and simulation results were observed. Output current was around= 484 mA. Output voltage was 4.84V.Input of 14.7 V is given to voltage regulator which provided 5V output, through a diode it was further reduced to 4.5V. Diode also serves to block the reverse flow of power.

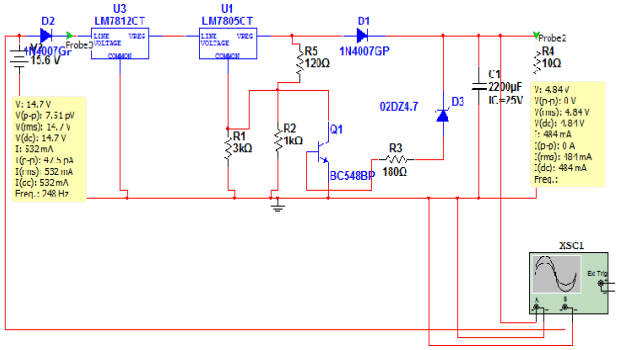

Fig 1: Multisim simulation circuit output.

Initially only LM7805 was used for charging considering that maximum input voltage for the IC was 12 V. But the 75 AH battery charged by the panel showed an increase in its output voltage to 14.5 V. This made us to redesign the existing circuit with addition of 7812 which can supply constant output of 12 V, Irrespective of solar panel charged battery output rising to 15V.

Hardware Results of mobile charger:

Fig2: Output voltage of prototype charger

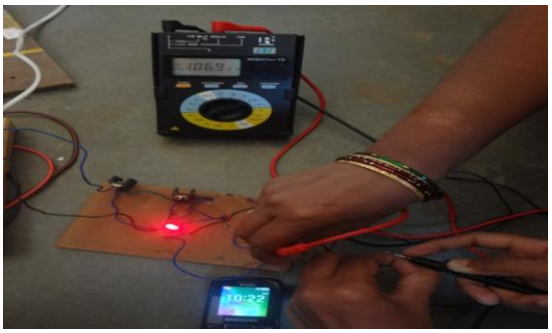

Fig3: Mobile charged from 75AH battery with charging current of 106.9 mA.

Charging current can be increased and time reduced by reducing the load resistance from 10 ohm currently used to 4.7 ohm.

Extending the application of direct utilization of DC thereby reducing the number of stages of conversion of power to single dc-dc rather than dc-ac – step-up, step-down and rectify, thereby limiting losses, complexity, weight and cost to Radio, the radio battery charger circuit was simulated using multisim software. Maximum allowable voltage for 6V battery is 7.5V and current rating of 1.3A. The proposed charger circuit satisfied the requirement.

Simulation results of Radio battery of 4.5 AH and 6V.

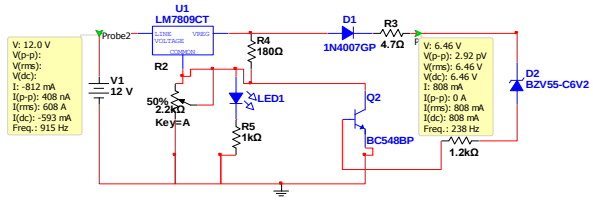

Fig 4: Radio battery charger circuit with output of 6.46V and 808mA.

Fig 5: Battery of 6V, 4.5AH charged by 12V, 75AH battery.

Fig 6: Radio cum tape recorder powered by 4.5AH battery charged from 12V, 75AH battery.

This battery was able to power the radio for more than 12 hours.

Fig 7: Trial with 12V,10AH battery

Trials were extended to direct connection of radio battery charger circuit to radio instead of 6V battery. The radio was working with no noise.

Fig 8: Trial with 12V,75AH battery

Trials were extended with radio powered directly from 75AH battery charged by solar PV panel. This trial also worked satisfactorily. Using a inverter circuit, radio was run from 10AH battery. But noise interference with music was observed which was disturbing. This could have occurred because of square wave of inverter with harmonics instead of pure ac.

Fig 9: Radio running with inverted square wave ac output.

CONCLUSION:

To serve communication needs a dc-dc charger is designed and simulated using multisim software. The performance of mobile and radio was tested for over 6 months and were found to be satisfactory.

FUTURE SCOPE:

1. Mobile charger circuit can be modified to provide multiple charging facility from single circuit.

2. Direct connection from solar panel to mobile phone / Radio can be developed by designing small PV panel which reduces the overall cost and eliminates the cost of storage devices.

3. Instead of voltage regulator IC's which dissipate power in the form of heat, alternate technology in the form of buck/ boost converters could be developed.

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References:

1.Chung I.Y.W, Liang YC **"**A low-cost photovoltaic energy harvesting circuit for portable devices "Power Electronics and Drive Systems (PEDS), IEEE Ninth International Conference", Singapore, Dec. 2011,PP334-339

2. Monteiro J.Garrido N. Fonseca R." Efficient supercapacitor energy usage in mobile phones.", Consumer Electronics - IEEE International Conference, Berlin (ICCE-Berlin), Sept. 2011,PP 318-321.

3. Heikkinen, M.V.J.,Nurminen, J.K. "Measuring and modeling mobile phone charger energy consumption and environmental impact ",Wireless Communications and Networking Conference (WCNC), IEEE, April 2012. PP 3194 – 3198.

4. Efland, T.R. "The Earth is mobile-power", Power Semiconductor Devices and ICs, 2003. Proceedings. ISPSD '03,IEEE 15th International Symposium. April 2003 PP 2 - 9

5. Compendium, M. Prajapati et al: "Design and testing of prediction based battery charging technique for solar home system".

6. Lalitha Darbha, Sneha K, Shradha M "Integrated multi utility hybrid module for isolated households in remote villages", International Journal Of Advance Research In Science And Engineering IJARSE, Vol. No.2, Issue No.10, October 2013.

Textbooks

1a. Chetan Singh Solanki, "*Renewable Energy and Technologies*", PHI learning Pvt. Ltd.
2a. Muhammed H. Rashid, "*Power Electronics Circuits, Devices, and Applications,"* Pearson Education, 2004, Third edition.