Portable Electric Vehicle Charger

Ms.Priti Kiran Garave.
ATS Sanjay Bhokare Group of Institute Miraj,
Faculty of Polytechnic

Abstract

This paper deals with design and development of a light electric vehicle (EV) charger. This EV charger operates in bulk charge as well as float charge mode with the battery deep discharge cutoff to enhance battery life. Its power converter is of 85W rating having operating voltages from 36V to 42V with 2A maximum current in bulk charge mode. Test results are presented for a 36V, 10Ah-20Ah battery, which is commercially used for electric cycle or equivalent EV application. The input voltage for this power converter is for universal input voltages (90VAC-265VAC/47Hz-63Hz). The AC-DC converter power switch operates in quasi-resonant mode for high efficiency in wide input voltage range. The converter size as well as thermal parameters are well within the limits as observed in test results.

Key Words - electric vehicle (EV), Solar energy, photovoltaic (PVs), Nickel metal hybrid (NiMH), Lithium-ion (Li-ion) batteries,
RF ID reader.

Introduction

With rising concerns about the pollution caused by gasoline vehicles and the impact of these vehicles on climate change, the transportation industry is experiencing a fast transition from gasoline vehicles to Electric Vehicles (EVs). The developments in the EV industry can significantly reduce carbon emissions and energy consumption

However, some challenges such as battery life, charging speed, accessibility to the charging stations, and duration of trips limit the viability of the EV industry. One of the major challenges to the widespread adoption of EVs is their limited range. In other words, the consumers fear running out of battery power on long trips where there are no charging stations available. To cope with this problem, charging stations have been installed in the cities and some remote areas. However, the number of these stations cannot support the large number of EVs. Moreover, in remote areas, these charging stations are few and far from each other. Furthermore, the installation of more charging stations in remote areas is not cost-effective. One alternative solution is to use the energy of another EV in an emergency situation. In this method, EVs can share 5–15% of the charge of the batteries to support each other in emergency mode. However, the technical specifications of batteries such as state of charge (SOC), voltage, current, capacity, and charging time are important for providing a safe and reliable charging process. i.e., the somatization of the charger and the charging process is inevitable. This feature can be achieved by a smart controller

Literature Survey

Solar energy conversion is one of the most addressed topics in the field of renewable energy. Solar radiation is usually converted into two forms of energy: thermal and electrical energy. The solar electricity has applications in many systems such as rural electricity, water pumping and satellite communications. In the past, solar power was usually used for large-scale grid connected system and small remote photovoltaic plants or stand-alone systems.

Recent technological development in thin-film photovoltaic (PVs) is leading to new generations of consumer portable solar panels. These new solar panels are light weight, durable, flexible, and have been reported to achieve power efficiencies of up to 10%.

The portable solar panels make solar power readily available for mobile power needs such as outdoor enthusiast, expeditions and campers. It also provides portable solar power for the military to extend the run time of military devices including satellite communications, two-way radios, laptop computers, thermal imaging cameras, GPS, and etc. Therefore, solar power is expanding beyond its traditional applications.

Solar power is harvested and stored by charging rechargeable batteries. Older solar battery chargers were mainly developed for stationary situations such as solar house and RVs. Lead acid batteries are usually used because light weight is not a major factor to consider. However, since the appearance of the foldable and light weight solar panels, the need to develop solar battery chargers for more portable batteries such as Nickel metal hybrid (NiMH) and Lithium-ion (Li-ion) batteries becomes essential. Previous work has been done to compare battery charging algorithms for standalone photovoltaic systems.

Peak power from the solar panels was tracked for photovoltaic systems using various methods. To increase conversion efficiency, maximum power point tracking techniques as well as optimal control were studied and implemented.

Presented in this paper is the development of a solar battery charger for Li-ion batteries. A senior design project team works on the solar battery charger under close guidance of faculty members. To charge the battery with a regulated voltage, a dc-dc converter is designed and implemented.

The dc-dc converter is connected between the solar panel and the battery. The main components in the solar battery charger are standard Photovoltaic solar panels (PV), a deep cycle rechargeable battery, a Single-Ended Primary Inductance Converter (SEPIC) and a controller. Solar panels are made of many photovoltaic (PV) cells connected in series or parallel. The PV cell is a large area p-n diode with the junction positioned close to the top surface.

When the cell is illuminated, electron-hole pairs are generated by the interaction of the incident photons with the atoms of the cell. The electric field created by the cell junction auses the photon- generated electron-hole pairs to separate. The electrons drift into the n-region of the cell and the holes drift into the p-region.

To design portable EV batteries charging system with solar incorporated with 12v to 60v boost design with compact and lightweight design.

Necessity of Project

By 2030, the Government of India plans to have only EV in India. Fast charging of EVs and Charging Infrastructure is required to make EVs widely acceptable as the charging time is the key barrier standing in the way of widespread acceptance of EV. Thus, important enabler of the transformation will be – Smart Infrastructure for charging the EV. This will empower futuristic vision of the Nation. One of the important aspects of this transformation is having an approving charging infrastructure. The present power system could face huge instabilities with wide spread of EVs. This project named _Solar Powered Portable Electrical Vehicle charging station,, uses hybrid power system. The solar energy is converted to electrical and used to charge the lead acid battery, which in turn charges the battery of the EVs connected to this station. When the energy from solar panels is not sufficient to meet the demands, electricity from power grid is utilized. Electric Vehicle battery charger is a business of imminent potential. Currently its worth is of billions of dollars, and supports millions of vehicles worldwide and is expected to grow exponentially in coming years. In such a scenario, it is crucial to provide public charging service. In order to make this more user- friendly a set of facilities are attached along with this station like user authentication, LCD display, audio interaction, WIFI connectivity, cloud storage and thing speak platform. They could be installed at: Hotels, clubs, Retail stores, railway stations, and Shopping malls, Universities, Colleges, and Airports etc.

System Development

The proposed protype uses AC supply from grid. Transformer is used to step down the voltage from the distribution grid voltage level to EVs battery voltage levels. AC/DC converter transforms the ac power into dc power and forms a dc bus. EVs are connected to the DC bus for charging via DC-DC converters. The DC bus makes it possible to connect Renewable Energy Sources (RESs) generation systems directly through a simple DC-DC converter, that is DC supply from solar panel is passed via solar charge converter and DC-DC converter to be stored in Lead Acid (PbA) battery through a suitable battery charger. The prototype focuses on building an electric charging station which fills in the cavity that acts as obstruction in the penetration EVs globally. Thus, few user-friendly facilities are added and enabled with microcontroller unit to enhance the overall consumer experience. Few other facilities attached are, for example, the RF ID reader and card enables easy authentication of every user. LCD display shows the charging time selected and the amount of money deducted/ left. Voice recorded memory chip enables recorded audio instructions to the user. With help of WIFI mod all the data is stored in things peak platform, which can be analyzed and processed for further advancement.

Proposed System

The charging station prototype is implemented with a portable hybrid power bank to charge electric vehicles efficiently as system is portable and light weight it can be carried anywhere to charge any ev vehicle, keeping in mind the need to switch to renewable sources for energy supply. With the recent advancement of the sustainable transportation industry, this will be used to charge vehicles in an eco- friendly way. The proposed prototype can charge an electric scooter at the least. Since this is just a prototype, it may to be able to charge the e-scooter within desirable time.

In order to speed up the charging time necessary changes has to be made with respect to the battery capacity. Battery of higher ampere -hour specifications must be used. The current has few limitations, like it is not that efficient during cloudy and rainy days, there is loss of solar energy in the transfer of power, loss of solar energy in the transfer of power and the charging current is up to 3 amp @ 48vDC.

Futuristic approach or advancement could being able to charge a variety of EVs; use of solar tracking system for max output from solar panels; increase in the range of journey over one charge thus to establish the real time charging station.

Circuit Diagram

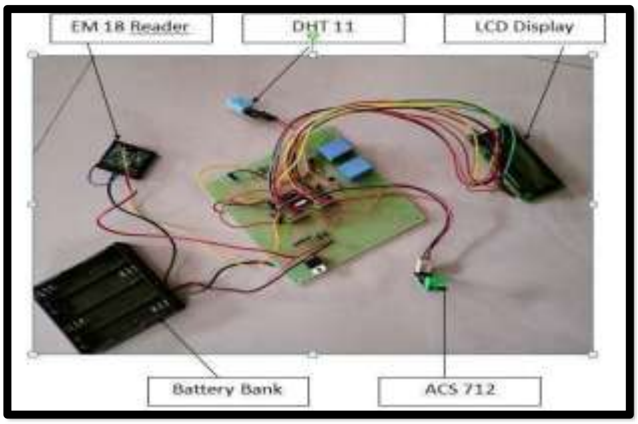

Fig- Circuit Diagram

General Description of the System

The charger implements several safety features. These include under voltage, overvoltage, short circuit and open circuit detection.

The typical voltage range where a Li-Ion battery can safely operate is between vmin=2.5v/cell and vmax=4.2v/cell. Operating outside this range is likely to cause permanent damage to the Li-Ion cells and may even result in a catastrophic failure such as an explosion or fire. The battery pack is additionally protected by a battery protection board (or Battery Management System aka BMS). The BMS measures the voltages of the individual battery cells as well as the charge/discharge current flowing through the battery. The BMS uses a solid-state switch to disconnect the battery as soon as the voltage or current values become outside of the specified limits. For the most part, the BMS is completely transparent and does not interfere with the charging process, except for the case where the BMS disconnects the depleted battery in order to prevent over-discharge.

In this case, the voltage of the depleted battery is still present across the BMS terminals through a high value resistor placed in series with the battery. This high value resistor causes a much lower voltage value to be measured at the charger terminals. Consequently, the charger must ignore the vmin lower limit and start charging at a much lower value of as low as vstart=0.5v/cell.

When presented with a depleted battery, the charger would start charging at a reduced safety current isafe=icharge/10 until the battery voltage reaches vsafe=2.8v/cell, afterwards it would apply the full charging current. Once the voltage reaches this threshold, it is no longer allowed to drop below the vmin. A voltage below vmin would raise an *"undervolt error"* which is may cause by either a short circuit or a battery open circuit.

Open circuit is also detected if the charging current stays equal to zero while the PWM duty cycle increases beyond a specific threshold. This condition would raise an *"open circuit error"*.

Overvoltage is detected whenever the battery pack voltage momentarily exceeds vsurge=2.25v/cell. Exceeding this value would raise an *"overvolt error"*.

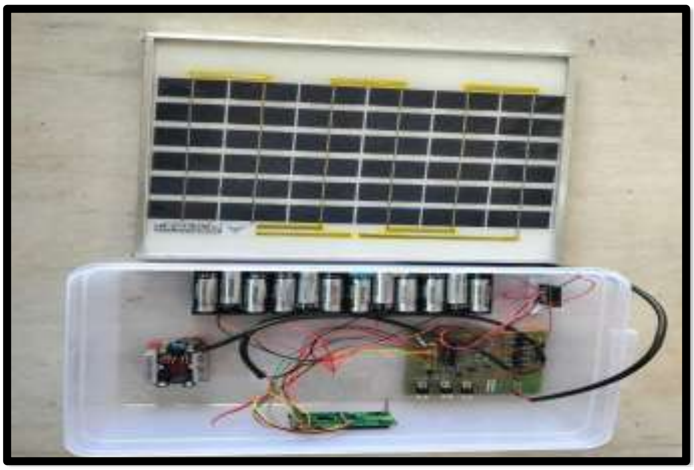

Fig - Final Hardware

Future Scope

It was proven that there was 3 times more necessary in a country than rebates and discounts on the sale of electric vehicles. From the market standpoint, public charging or home charging facilities are among the best promotions of EVs. Assessing electric vehicles is also a large supplier network of EVSE facilities. Adequate EV charging infrastructure relieves consumer pressure, and the technical advances that lead to shortened charging times improve user comfort. The main feature is the charging infrastructure that offers the "on-the-the-go," which can be truly the best innovation for EVs if it is generally accessible and practicable.

Conclusion

The designed EV charger has been developed and tested with shown with the battery. The charger operates in different charging modes reliably. The power charger is good to charge the battery having capacity of 10Ah to 20Ah with 36V nominal voltage. The measured input harmonics current of charger is under the IEC61000-3-2 limit. It is mandatory for single phase charger with less than 16A current drawing capability. The charging current regulation is also less than 1% for universal input voltage. The protection features from battery as well as well as source side are implemented for this charger. An Emergency EV-to-EV Portable Battery Charger was developed for charging EVs in emergency mode on-the-road. The proposed smart charger can share up to 15% of the stored energy while taking into consideration the state of charge , capacity, and important technical specifications of the EV"s battery. By using a bidirectional dual active bridge dc-dc converter, the proposed EPBC can regulate the output voltage and the injected current to the EV simultaneously. To achieve smart charging presses with the proposed EPBC, a model free nonlinear integral backstopping control was implemented to regulate the output voltage of the EPBC. Moreover, in order to adjust the MF-NIBC controller, a deep deterministic policy gradient was employed by utilizing the actor and critic networks. Real-time results based on the OPAL-RT setup were carried out to validate the feasibility and performance of the proposed EPBC.

References

1. M. S. Rahman and M. A. Hossain, "Design and Implementation of a Portable EV Charger for Electric Vehicles," 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Genoa, Italy, 2019, pp. 1-5.
2. M. Siddique, A. W. Reza, and R. Choudhury, "Development of a Portable EV Charger with Renewable Energy Integration," 2020 IEEE Region 10 Symposium (TENSYMP), Dhaka, Bangladesh, 2020, pp. 455-460.
3. S. N. Mekala and M. Srinivasan, "Portable Electric Vehicle Charger for Sustainable Mobility," 2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Chennai, India, 2018, pp. 1-6
4. J. Prasanth, N. Shabbir, and S. Gupta, "Design and Development of a Portable EV Charger for Indian Road Conditions," 2020 IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), Harbin, China, 2020, pp. 1-6.
5. L. Xie et al., "Design and Implementation of a Portable EV Charger Based on Vehicle-to-Home (V2H) Technology," 2019 IEEE International Power Electronics and Application Conference and Exposition (PEAC), Shenzhen, China, 2019, pp. 202-207.
6. S. A. Cheema, K. M. Islam, and M. I. Hossain, "Design and Implementation of a Portable EV Charger Using Solar Energy," 2020 IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), Harbin, China, 2020, pp. 1-6
7. N. Ondari, T. Eltohamy, and M. Abdel-Akher, "Design and Development of a Portable EV Charger

for Rural Areas," 2021 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT), Amman, Jordan, 2021, pp. 48-52.

8. H. Lin, "Design of Portable EV Charger Based on DC/DC Converter," 2020 International Conference on Electrical, Automation and Mechanical Engineering (AME 2020), Chengdu, China, 2020, pp. 26-30.

9. S. Sharma, S. H. Patel, and N. Gupta, "Design and Development of a Portable EV Charger for Indian Conditions," 2020 IEEE Power Electronics, Drives and Energy Systems (PEDES), Chennai, India, 2020, pp. 1-6.

10. M. R. Ali et al., "Design and Implementation of a Portable EV Charger for Emergency Situations," 2021 IEEE International Conference on Industrial Engineering and Engineering Management