Design And Implementation of Electric Vehicle Fast-Charging Station Combined PV Generator And Energy Storage

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Abstract- *The importance is given to the market integration of PHEV (Plug-in-Hybrid Electric Vehicle) and EV increasing the interest in the fast-charging technology of such car batteries. The paper reviews work recently conducted in this area and proposes a fast-charging station using flywheel energy storage and a super capacitor as energy storage devices. Design issues and simulation results for a typical Define Level III charger are presented. This paper explores the current and potential future use of fast-charging stations for electric passenger vehicles. The paper aims to analyze current charging patterns at fast-charging stations and the role of fast charging among different charging options. These patterns are explored along the lines of the technical capabilities of the vehicles and it is found that with increasing battery capacity the need for fast charging decreases. However, for those vehicles with large charging capacities, there are indications that fast charging is perceived as more convenient as these are used more often. Such results indicate a larger share for fast charging if charging capacities increase in the future. Results from a spatial analysis show that most fast charging is done at a considerable distance from home, suggesting mostly 'on the road' charging sessions. Some fast-charging sessions are relatively close to home, especially for those without private home charging access. This shows some future potential for fast charging in cities with many on-street parking facilities.*

Keywords- Battery, Microcontroller, Converter, PV, PWM Driver.

I. INTRODUCTION

In a power system network, the HVDC or DC transmission played a vital role because of huge power transmission and effective output maintenance. Here in the system, two conversion processes with several switches are used. Hence the losses and harmonics may increase. That's why in the past multilevel inverter concept is introduced and the accuracy and efficiency of the system are increased and the losses and harmonics were also reduced. Even with a huge number of advantages, it does also have some disadvantages like complex circuits, more voltage stress, and Low fault current tolerance. Because of this reason, the researchers have a look at the betterment of the multilevel converters. Among the research and researchers, the extended version of the multilevel inverter is MMC (Modular multilevel converter). MMC is nothing but a new topology for the voltage source inverter. Here in the converter, the multilevel inverters are separated as submodules with less number of switches. By using the switch the conventional switch drawbacks are limited. By using the methodology, the fault-tolerant strategy may be fulfilled, the fault strategy is nothing but identifying the fault and location of the fault then for the isolation and finally reconfigured as fast as possible.

II. LITERARY REVIEW

A. A. Elserougi, A. S. Abdel-Khalik, A. M. Massoud, S. Ahmed, "A New Protection Scheme for HVDC Converters Against DC-side Faults with Current Suppression Capability.Multilevel-Converter topologies are concerned with the need for series switching when it was progressed the power quality improvement and lower switchingloss.S. Cui, S. Sul, "A Comprehensive Dc Short-Circuit Fault Ride Through Strategy Of Hybrid Modular Multilevel Converters (Mmcs) For Overhead Transmission Line.In this paper, a comprehensive DC short circuit fault ride-through (FRT) strategy is proposed for a hybrid modular multilevel converter that combines half-bridge sub-modules and full-bridgesubmodules. By the proposed method, the hybrid MMC-based VSC-HVDC system can ride through a pole-to-pole short circuit fault supporting the AC grid as a Static Synchronous Compensator (STATCOM). Y. J. Jo, T. H. Nguyen, and D. C. Lee, "Condition monitoring of submodule capacitors in modular multilevel converters. The SM capacitors in the modular multilevel converters (MMC), which is based on the capacitance estimation using the information of the current and voltage ripples of the capacitors. O. Abushafa, S. Gadoue, M. Dahidah, and D. Atkinson, A new scheme for monitoring submodule capacitance in modular multilevel converter. Concept: This employs a Kalman filter (KF) algorithm to estimate the capacitance of submodule (SM) capacitors in modular multilevel converters (MMCs). The proposed method can be used in the health condition monitoring technique of the capacitors. This proposed scheme estimates the capacitance of each capacitor from data of arm current and the corresponding voltage across the targeted capacitor. The arm current is used to calculate the capacitor current from the upper state of the SMswitch and harmonics are also reduced. Even with a huge number of advantages, it does also have some disadvantages like complex circuits, more voltage stress, and Low fault current tolerance. Because of this reason, the researchers have a look at the betterment of the multilevel

III. ARCHITECTURE OF MODULE AND MULTI-LEVEL CONVERTER

In a power system network, the HVDC or DC transmission played a vital role because of huge power transmission and effective output maintenance. Here in the system, two conversion processes with several switches are used. Hence the losses and harmonics may increase. The arm current is used to calculate the capacitor current from the upper state of the SM switch and harmonics are also reduced. That’s why in the past multilevel inverter concept is introduced and the accuracy and efficiency of the system are increased with the losses. Here in the proposed method, the MMC controller-based circuit is introduced. MMC is nothing but the Modular Multilevel Converter. It may divide the whole structure into sub-modules means the multilevel converter 6 switches are divided into the separate switch and it is excited by the common exciter. The input to the MMC converter is a 12v DC supply. 12-0-12v / 3A step-down transformer is used to provide the power unit to the whole circuit. Here the ac supply is converted into a dc supply by using a bridge rectifier. It may cause resulting deficiencies and finally separate the entire MMC framework. The arm current is used to calculate the capacitor current from the upper state of the SM switch and harmonics are also reduced. Even with a huge number of advantages, it does also have some disadvantages like complex circuits, more voltage stress, and Low fault current tolerance. Because of this reason, the researchers have a look at the betterment of the multilevel. Three different output voltages are generated through this prototype. In the conventional MMC framework, because of the prerequisite of capacitor voltage adjusting, the voltage sensor is required in each submodule which is straightforwardly parallel associated with the capacitor to acquire the capacitor voltage, as appeared in that an extra voltage sensor is applied to quantify the voltage of the upper control exchanging gadget, which may build the reaction speed of deficiency analysis for the power exchanging gadgets. The input of the circuit is ac, for a stable output the given ac supply is converted into DC by using a rectifier, the rectifier output is given to the MMC circuit. The MMC circuit output is connected with the controller, the controller may be the microcontroller or microprocessor, or some other control unit. The hardware prototype is developed for 60 watts. The sensors and converters have low power consumption and are small in size.The input to the MMC converter is a 12v DC supply. 12-0-12v / 3A step-down transformer is used to provide the power unit to the whole circuit. Here the ac supply is converted into a dc supply by using a bridge rectifier. Three different output voltages are generated through this prototype Not with standing, this will enormously expand the number of sensors where two voltage sensors are required in one submodule. Based on the figs, the voltage sensor senses the value from the arm and it’s associated with switches and the capacitor, and the switches are triggered by the switch. The voltage sensor is associated with a capacitor to retain the normal voltage if the fault current or voltage occurs, based upon the variation observed in the arm terminal voltage along with the value variation in the and its associated with capacitor voltage.The voltage sensor is associated with a capacitor to retain the normal voltage if the fault current or voltage occurs, based upon the variation observed in the arm terminal voltage along with the value variation in the and its associated with capacitor voltage.Even with a huge number of advantages, it does also have some disadvantages like complex circuits, more voltage stress, and Low fault current tolerance.

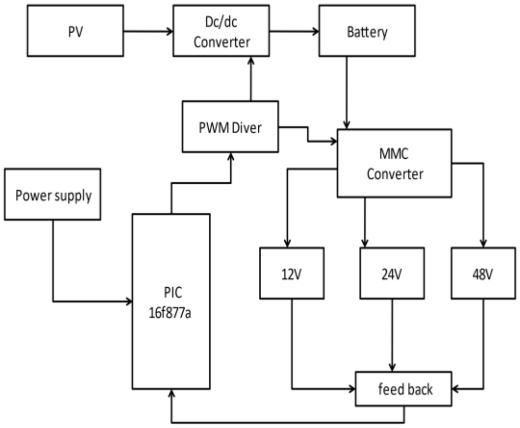


FIG.1 ARCHITECTURE OF MMC

IV. DETAILS OF COMPONENTS:

The components used in the hardware are explained clearly and their uses and advantages are listed below

A.UF5408:

The UF5408 is an ultra-fast recovery diode that comes with a quick recovery time. It is mainly used to rectify the sine waves. Upon rectifying the signal it converts the AC signal into a DC signal. This diode provides the DC signal to the electronic device since most electronic devices operate on the DC signal.

- The UF5408 is a recovery diode that carries a quick recovery time and is mainly used to convert the AC signal into a DC signal.
- Upon turning the AC signal to the DC signal diode requires a certain amount of time during which this rectification happens. This time is known as recovery time. And this diode exhibits an extremely good recovery time of 75ns.
- The average rectified current of UF5408 is 3A and the peak repetitive reverse voltage is 1000V. The maximum reverse current is recorded at 0.010mA and the maximum RMS reverse voltage is 700V.

B. IRF540:

An advanced HEXFET power MOSFET like IRF540N is from an International rectifier that uses very complex processing methods to attain very low on-resistance for each ‘Si’ area. The main advantage is the quick switching speed, strong device design, and provides a very efficient, reliable device for the designer to use in different applications. The TO-220 package is commonly chosen for commercial-based industrial applications. The fewer packages cost and less thermal resistance of this package will give to its broad acceptance all over the industry. This IC is very flexible through its voltage and current switching capacities, so it is perfect for several electronic applications. The working principle of IRF540 MOSFET is very simple and it includes three terminals namely source, drain & gate. Once we apply the signal at the transistor’s Gate terminal, then both the terminals like drain & gate will be shorted. Whenever the Drain & the Gate gets shorted, then only we can get the preferred results, or else it will generate unnecessary outputs.

IRF540N MOSFET Pin Configuration

- **Pin1 (Source):** Current supplies out throughout the Source terminal
- **Pin2 (Gate):** This pin controls the MOSFET biasing
- **Pin3 (Drain):** Current supplies throughout the Drain terminal

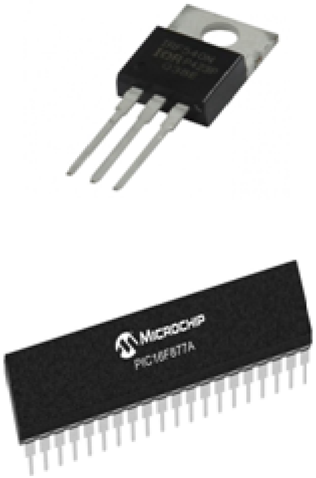


Fig.2 IRF540

C. SG3525

Importance is given to the market integration of PHEV (Plug-in-Hybrid Electric Vehicle) and EV increasing the interest in the fast-charging technology of such car batteries.PWM is used in all sorts of power control and converter circuits. Some common examples include motor control, DC-DC converters, DC-AC inverters, and lamp dimmers. The insulating layer between the plates of a capacitor is commonly called the Dielectric. Due to this insulating layer, DC can not flow through the capacitor as it blocks it allowing instead a voltage to be present across the plates in the form of an electrical charge. With proper understanding, you can soon start using SG3525 yourself in such applications or any other application really that demands PWM control. The conductive metal plates of a capacitor can be either square, circular or rectangular, or they can be of a cylindrical or spherical shape with the general shape, size, and construction of a parallel plate capacitor depending on its application and voltage rating. There are numerous PWM controllers available that make the use and application of PWM quite easy. One of the most popular such controllers is the versatile and ubiquitous SG3525 produced by multiple manufacturers – ST Microelectronics, Fairchild Semiconductors, On Semiconductors, to name a few. SG3525 is used extensively in DC-DC converters, DC-AC inverters, home UPS systems, solar inverters, power supplies, battery chargers, and numerous other applications. With proper understanding, you can soon start using SG3525 yourself in such applications or any other application really that demands PWM control. This chip we used to reduce complications of the circuits and make us simplified circuits as well. The Chip fig is shown below.

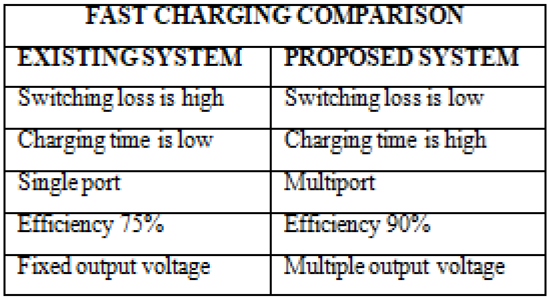
Fig.3 SG3525

E. CAPACITOR:

The capacitor is a component that has the ability or “capacity” to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery. There are many different kinds of capacitors available from very small capacitor beads used in resonance circuits to large power factor correction capacitors, but they all do the same thing, they store charge.In its basic form, a capacitor consists of two or more parallel conductive (metal) plates that are not connected or touching each other but are electrically separated either by air or by some form of a good insulating material such as waxed paper, mica, ceramic, plastic or some form of a liquid gel as used in electrolytic capacitors. The insulating layer between the plates of a capacitor is commonly called the Dielectric. Due to this insulating layer, DC can not flow through the capacitor as it blocks it allowing instead a voltage to be present across the plates in the form of an electrical charge.The conductive metal plates of a capacitor can be either square, circular or rectangular, or they can be of a cylindrical or spherical shape with the general shape, size, and construction of a parallel plate capacitor depending on its application and voltage rating.When used in a direct current or DC circuit, a capacitor charges up to its supply voltage but blocks the flow of current through it because the dielectric of a capacitor is non-conductive and an insulator. However, when a capacitor is connected to an alternating current or AC circuit, the flow of the current appears to pass straight through the capacitor with little or no resistance.There are two types of electrical charge, the positive charge in the form of Protons and the negative charge in the form of Electrons. When a DC voltage is placed across a capacitor, the positive (+ve) charge quickly accumulates on one plate while a corresponding and opposite negative (-ve) charge accumulate on the other plate. For every particle of +ve charge that arrives at one plate a charge of the same sign will depart from the -ve plate.Then the plates remain charge neutral and a potential difference due to this charge is established between the two plates. Once the capacitor reaches its steady-state condition an electrical current is unable to flow through the capacitor itself and around the circuit due to the insulating properties of the dielectric used to separate the plates. The flow of electrons onto the plates is known as the capacitor Charging Current which continues to flow until the voltage across both plates (and hence the capacitor) is equal to the applied voltage Vc. At this point, the capacitor is said to be “fully charged” with electrons.

Fig.4 CAPACITOR

V. RESULT COMPARISON:



FAST CHARGING COMPARISON	
EXISTING SYSTEM	**PROPOSED SYSTEM**
Switching loss is high	Switching loss is low
Charging time is low	Charging time is high
Single port	Multiport
Efficiency 75%	Efficiency 90%
Fixed output voltage	Multiple output voltage

VI. CONCLUSION

This research paper has highlighted the most important aspects of fast charging for the use of passenger electric vehicles. An overview of the literature and the data analysis presented has shown that fast charging mainly plays a role in long-distance travel, or at least in the case when the battery runs empty on the road. This paper has explored the potential of fast charging in the future given technological developments and the charging behavior of the EV driver.Data have shown that fast charging has distinctly different patterns in terms of energy delivered and the timing of the charging session compared to other charging modes. The analysis suggests a relatively small role for fast charging across the day and is especially relevant for those drivers who own a fully electric vehicle with a smaller battery pack (<30 kWh). These drivers tend to drive and therefore charge less than those drivers with larger battery packs, meaning that their absolute contribution to the energy charged at fast-charging stations is rather similar. Given the developments in battery technology and the shift towards more long-range EVs, it can be questioned whether the role of fast charging continues to grow in the future. There are indications that for those with large battery packs and higher charging capacities there is a convenience in fast charging which could continue to grow with further technological improvements. However, such observations are only preliminary and should also be interpreted in the light that those with higher batteries also tend to drive more generally. The turning point for more charging convenience could be at higher charging speeds than 150 kW as this would limit the charging speed. Better availability of fast-charging stations could then be considered more attractive instead of cruising for level 2 charging stations in the city. Further research could look into the motivations of EV drivers for choosing fast charging and which factors play a crucial role. Such research could confirm the possibility that at faster charging speeds EV drivers are more inclined to use fast-charging stations regularly. An analysis of the distances of fast charging sessions to the home locations shows that most charging is done ‘on the road’. There is some room for close-to-home ‘fast charging’ in the future, although currently this is mostly done by vehicles with a shorter range, which could indicate that fast-charging station operators could potentially expand to inner-city locations. Demand for fast charging could also be induced simply by its mere presence. The data that were analyzed were mostly from highway locations because fast-charging stations can be found there. Generally, fast-charging stations have a mixed future perspective. Given the trend in battery capacities in vehicles, there is a decreasing demand for ‘necessity’ charging sessions. The convenience of higher charging speeds might counter this decreasing need for necessary charging. This would open up pathways to fast charging at new locations such as in the city. The path towards this will be crucial, and currently, the slower charging modes are dominant, both in the number of charging stations and sessions. Fast charging stations will have to cover significant ground to become obtain a significant share of the charging mix.

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