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AN IMPROVED FUZZY DRIVEN FAST DC-TYPE ELECTRIC VEHICLE CHARGER

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ABSTRACT

The main reason for the development of electric vehicles is the emission of toxic substances into the air by motor vehicles such as cars, buses, trucks, and so on, resulting in air pollution. A fast-charging electric vehicle's PI controller is always a closed-loop network that gets feedback. This feedback is used to make modifications to the output deviations. The capacitor bank is used to block the variable DC voltage, and the transformer voltage is used to step-up or step-down depending on the needs. Buffering loads are used in the radial distribution system to store electrical energy while there are no cars at the charging station. The battery serves as a rectifier, and the PI controller and buck-boost converter are used to manage the circuit with the FLC for rapid charging. The sophisticated regulating circuit includes a buck-boost converter, a PI controller, and an FLC. The electric cars that are linked to the grid are connected to the converter. The FLC is readily accessible in both household and industrial settings. When used in conjunction with a PI controller, fuzzy logic is simple to implement and adapts to system changes. This paper provides a low-switching-loss DC-type quick electric car battery charger based on fuzzy logic. In this example, a traditional three-phase two-level voltage source rectifier with limited capacitive energy storage uses a discontinuous PWM modulation in which each phase-leg pauses switching for 240o of the grid fundamental period, resulting in just a single phase-leg transition every 60o. In this instance, the DC-voltage link's controllability is lost, thus a fuzzy-based buck-type DC-DC converter is cascaded to provide the required voltage regulation and current limiting for the electric vehicle's charging process. When examining the charging of a 30 kWh battery, the provided circuit is compared to various options for a built 50 kW power capability battery charger.

INTRODUCTION

The market for electric vehicle (EV) charging is a fast-moving one. Companies and research institutions working in this field are focused to significantly reducing EV charging periods so that they are comparable to the time spent by consumers at petrol stations filling up their internal combustion engine cars (ICEVs). The fast charging standards "CCS - up to 80kW" and "CHAdeMO – approx. 50kW" allow most EVs to be charged at 50 kW and 400 V today. New EVs, on the other hand, are built to resist increased charging power. As a result of the use of power electronics building blocks (PEBB), output power scaling will be a fundamental aspect of the EV charging system, i.e. the total power can be scalable by paralleling circuits[1]. Because a single circuit building block design may fulfil a variety of business and charging criteria, this leads to production benefits. For EV chargers with power capacities of several hundred kW, connections to the medium-voltage (MV) level AC grid become more cost-effective than the current 380 V... 480 V grid. Local energy storage solutions, such as battery banks, may become increasingly common in regions where the high-power charger is deployed to alleviate power fluctuations and power quality concerns on the AC grid. Local renewable energy generating systems may also be utilised to minimise grid energy usage and buffer power demand. In reality, photovoltaic (PV) energy production has a lot of potential since the accessible surfaces on the roofs of the EV charging station and neighbouring buildings may be over 1000 m2. As suggested, both batteries and PV systems may be combined into the charger.

For a high-power DC-type EV charger connected to an MV grid through a 50/60 Hz transformer, an appropriate bidirectional PEBB circuit is demonstrated. The battery charger may be completely constructed using half-bridge power modules, which are available from a variety of manufacturers and come in a variety of current ratings and blocking voltages. A thorough examination of the circuit shown in Fig. 1 reveals a well-known two-stage power conversion system, consisting of a three-phase AC-DC converter and a DC-DC circuit. A three-channel PWM interleaved DC-DC buck-type converter serves as the back-end circuit. Hardparalleling of semiconductors results in improved loss distribution across semiconductors or better current sharing amongst parallel circuits. This improves the overall conduction and switching losses that may be achieved. Furthermore, the symmetric PWM interleaved operation cancels out high frequency harmonics proportionate to the number of parallel circuits utilised in both voltages and currents, decreasing the rms current across the DC capacitors Cf and Co[2]. This feature may be utilised to increase the current ripple across each phase-leg of the back-end circuit, allowing for Zero-Voltage-Switching turn-on of the active switches and reduced antiparallel diode reverse-recovery losses. A threephase three-wire two-level six-switch voltage source rectifier (2L-VSR) is used as the front-end converter, and it has a low complexity and cost. It's worth noting that with the right voltage conversion rate between the AC grid and the EV battery, the current stress over the front- and back-end circuits may be identical, which can save money in the long run. The front- and back-end circuits are purposely coupled in this study through a DC-link that uses capacitors with poor energy storage capacity, such as an electrolytic capacitor-less DC-link. As a result, the functioning of both circuits is closely linked. In Fig. 1, the DC-link or voltage between the terminals p and n (or upn) will follow the rectified envelop of the AC capacitors line-to-line voltages, similar to what a simple three-phase diode-bridge rectifier achieves.

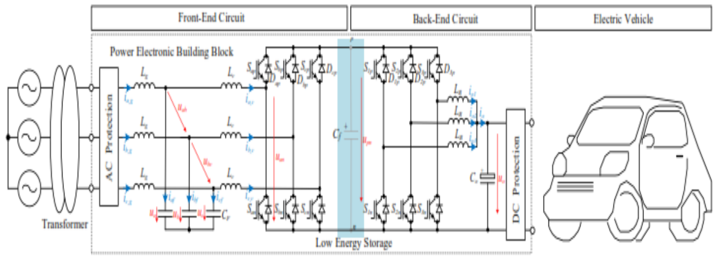

Fig.1 EV charger design using a PWM interleaved Buck-converter

Fig 1.EV charger design using a PWM interleaved Buck-converter as the back-end power converter and a two-level bidirectional six-switch voltage source rectifier as the front-end circuit driver. System interconnection is accomplished through a low energy-storage direct current.

Because of this, the rectifier phase-legs may function with a unique discontinuous PWM modulation (DPWM) in which they can cease switching for two-thirds of the grid period, or 240o, when the AC currents are at their greatest levels, i.e., just one phase-leg switch every 60o. The best switching loss reduction in any known DPWM technique, e.g. the ones outlined, may be achieved with this operation, but the voltage controllability of [3]upn is sacrificed in the process. The EV battery charging process necessitates the use of a back-end circuit for voltage management and current limiting. The back-end converter must maintain continuous power operation in order to achieve high power factor operation. Front-end circuits of the VIENNA type and the DELTA-SWITCH type have also been suggested, both of which operate similarly. It is the purpose of this research to examine the advantages of using an electric vehicle battery charger with an output voltage of 240 volts to implement the DPWN in the commonly used 2L-VSR. The following is the structure of this document. Sections II and III explain the DC-type EV charger's structural properties, a modulation approach with reduced switching losses, and a feedback control mechanism that ensures high power factor functioning. Calculations for determining stresses on power semiconductors and passive components based on current amplitude and converter voltage transfer ratio are provided in Section IV. Fig. 1's circuit is tested in Section V against alternative 50 kW PEBB system options for the efficiency that can be achieved when a 30 kWh Nissan Leaf car is rapidly charged from the state of charging (SoC) 0% to 90%.

PROBLEM IDENTIFICATION

This is the slowest charging method and is suitable for people who travel less than 60 kilo meters per day and have all night to charge. At home or at a public station, a specialized Electric Vehicle Supply Equipment (EVSE) provides power at 220 V or 240 V and up to 30 A. DC rapid charging is another name for level 3 charging. DC fast charging stations provide up to 90 kW of charging power at 200/450 V, cutting charging time in half to 20-30 minutes. Due to the rapid power transfer needed when EVs are used for energy storage, DC fast charging is recommended for establishing a Vehicle to Grid architecture in a micro grid. The dc bus may also be utilized to include renewable energy into the system.

This converter has low voltage ripples, current ripples and less EMI. Also, this converter has high reliability, high efficiency and bidirectional. Some arguments were raised like instead of using DC-DC converters, it is better to step up the AC voltage. However, DC-DC converters have several merits like low ripples, less EMI effect and high reliability. Moreover, HV batteries have some merits compared to DC-DC converters like less complexity and ease of designing the effective Battery Management System (BMS). To increase the usage of Electric Vehicles, charging infrastructure should be greatly enhanced and charging periods should be made low. The different types of chargers used are: Type I charger are the standard chargers with power rating 120V AC and 230V AC. Type II charger is specified with 400V AC, whereas Type III charges are fast chargers which have power transferring capacity with power rating of 480V DC and also known as Fast Chargers (FCHARs)[8]. This type of chargers is mainly used for commercial purposes for fast charging applications, Vienna rectifier is the efficient converter for better voltage strategy and high-power transfer. The control technique and circuit topology are analyzed with respect to traditional converters. This paper gives the merits of interleaved DC-DC converter over the other converters. The objective of project is to supply the power from grid to vehicle utilizing level 3 rapid charging electric vehicles. A micro grid test system with a DC rapid charging station for connecting EVs. Rapid charging stations decrease the charging time with less heat dissipation and without effecting the life cycle of Battery. Parallel connections are possible through smart grids so that multiport charging systems can be developed without the effect of harmonics on the vehicle when it is connected to grid.

PROPOSED MODEL

The control system only has one degree of freedom since thyristors can only be switched on (not off) by control action, and because they depend on an external AC system to accomplish the turn-off procedure, the control system only has one degree of freedom. This limits the utility of high-voltage direct current (HVDC) in some situations because it means that the alternating current system to which the HVDC adapter is connected also must contain synchronous mechanisms in order to provide the reactance voltage – the HVDC converter could indeed feed power into an inactive system. The turn-on and turn-off of certain other kinds of semiconductor devices, such as the insulated-gate bipolar transistor (IGBT), may be regulated independently, providing the device an additional degree of freedom. A consequence of this is that IGBTs may be utilized to construct self-commutated converters[9]. Such converters have the advantage that the polarity of the DC voltage is typically set, and the DC voltage, which has been smoothed by a high capacitor, may be regarded constant. As a result, a high-voltage direct current converter based on IGBTs is often referred to as a voltage-source converter (or voltage-sourced converter). The increased controllability provides a number of benefits, including the ability to switch the IGBTs on and off multiple times per cycle in attempt to optimize the harmonic efficiency, as well as the fact that the converter is no longer reliant on synchronous machines in the alternating current system for its operation. As a result, a voltage-sourced converter can provide power to an alternating current network consisting only of passive loads, something that is not feasible with LCC high-voltage direct current. Aside from being much more compact than line-commutated converters (mostly due to the fact that less harmonic filtering is required), voltage-source converters are preferred over line-commutated converters in places where space is at a premium, such as offshore platforms.

When compared to line-commutated high-voltage direct-current converters, voltage-source converters preserve the constant polarity of the DC voltage, and power reversal is accomplished by reversing the direction of the current instead of the voltage. This makes it considerably simpler to connect voltage-source converters to a multi-terminal high-voltage direct current system, often known as a "DC Grid." Due to the fact that voltage-source converters generate much less harmonic distortion than similar LCCs, the six-pulse connection is often used in high-voltage direct current systems[10]. The twelve-pulse connection is not required in these systems. The building of the converter transformer is made easier as a result. However, there are a variety of voltage-source converter combinations available, and research into novel options is still ongoing at this time.

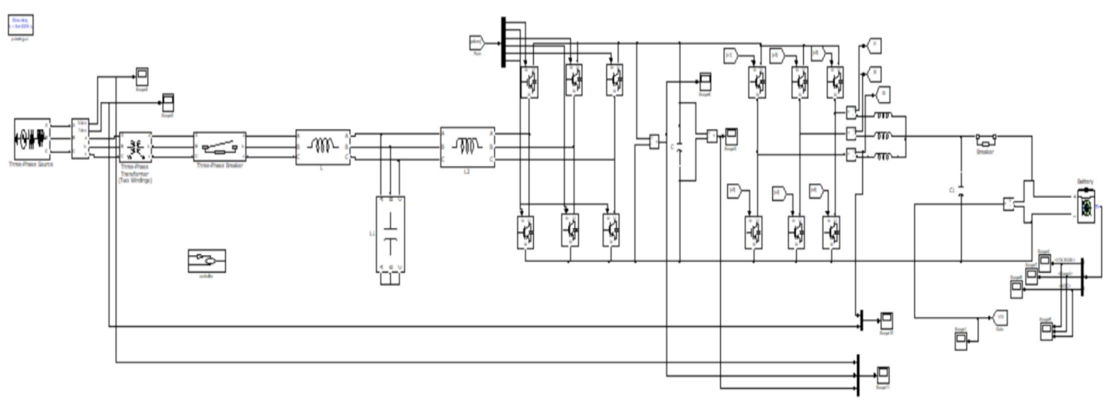

Fig.2 Proposed System Circuit Configuration

In Fig.2 shows the proposed system circuit configuration Fuzzy Logic Toolbox provides matlab functions, apps, and a Simulink block for analyzing, designing, and simulating systems based on fuzzy logic. The product guides you through the steps of designing fuzzy inference systems. Functions are provided for many common methods, including fuzzy clustering and adaptive neurofuzzy learning.The toolbox lets you model complex system behaviors using simple logic rules, and then implement these rules in a fuzzy inference system. You can use it as a stand-alone fuzzy inference engine. Alternatively, you can use fuzzy inference blocks in Simulink and simulate the fuzzy systems within a comprehensive model of the entire dynamic system.

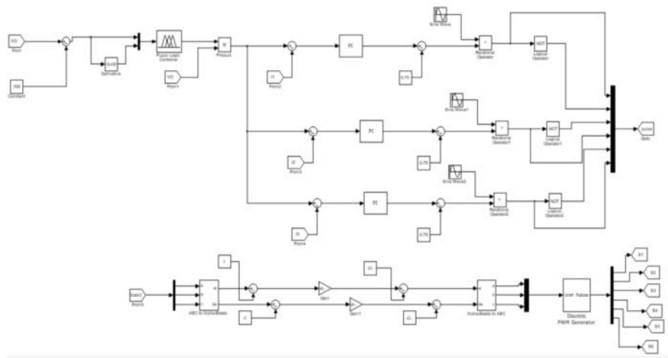

Fig.3 FLC Circuit Configuration

In Fig.3 shows the To add the fuzzy logic controller to this module, we open the Simulink library browser. And in the fuzzy logic tool box library, select Fuzzy Logic Controller in this rule viewer block. We add this block into our model and connect it to the rest of the model. As you can see, the final logic controller has two inputs.

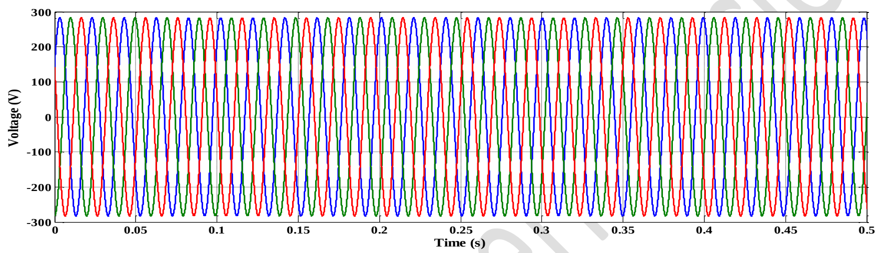

Fig.4 Input Voltage for FLC System

In Fig. 4 shows the Input voltage for proposed system which we have used for fuzzy logic controller, If the input signals are within the selected range, the output signals will also be within the selected range. Input signals above or below the selected range can produce very large output voltages.

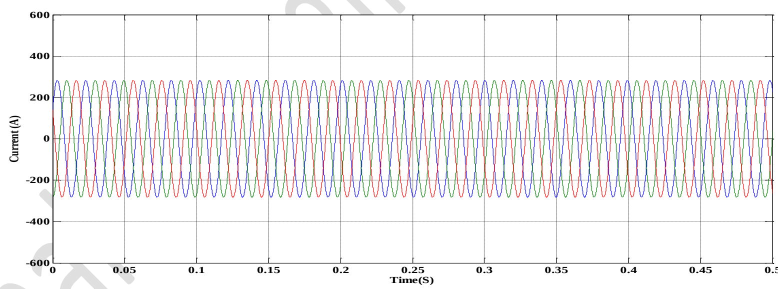

Fig.5 Input Current for FLC System

In Fig. 5 shows the Input current for proposed system a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0 (true or false), respectively.

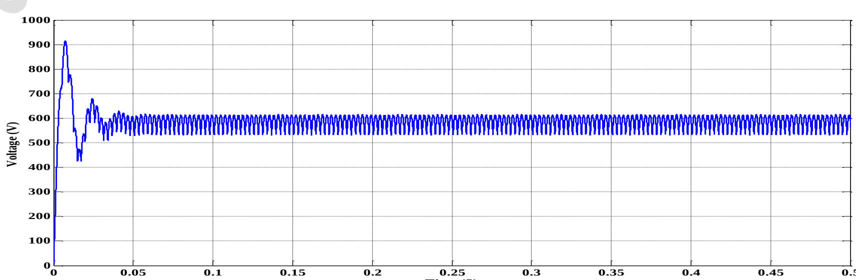

Fig.6 DC-link Voltage for FLC System

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In the Fig.6 shows the Dc-link voltage for proposed system, the DC link capacitor is used as a load-balancing energy storage device. The capacitor is placed parallel to the battery, which maintains a solid voltage across the inverter. The device helps protect the inverter network from momentary voltage spikes, surges.

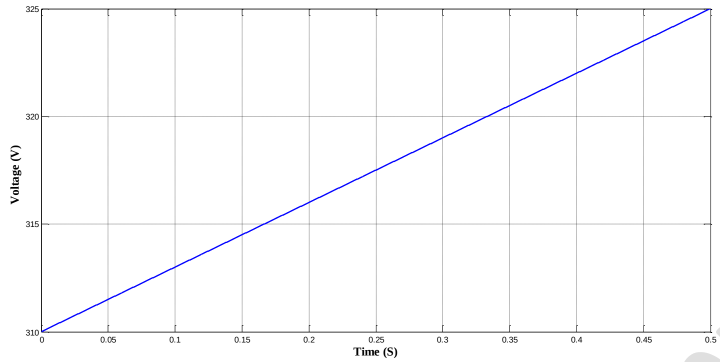

Fig.7 Battery Voltage for FLC System

In fig 7 shows battery voltage for proposed system the voltage of a battery is a fundamental characteristic of a battery, which is determined by the chemical reactions in the battery, the concentrations of the battery components, and the polarization of the battery. The voltage calculated from equilibrium conditions is typically known as the nominal battery voltage. In practice, the nominal battery voltage cannot be readily measured, but for practical battery systems the open circuit voltage is a good approximation to the nominal battery voltage.

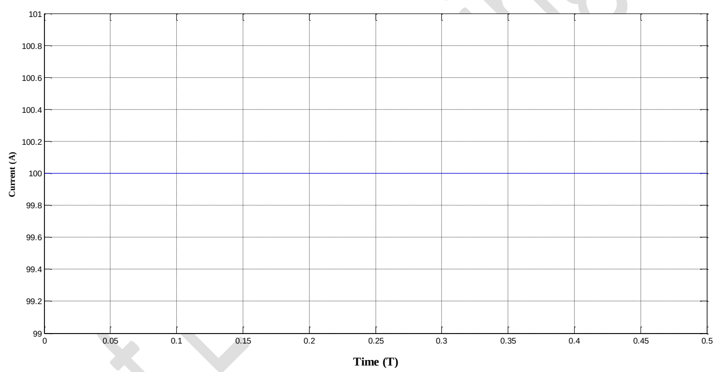

Fig.8 Battery Current for FLC System

In the Fig.8 shows the The voltage of a battery is also known as the emf, the electromotive force. This emf can be thought of as the pressure that causes charges to flow through a circuit the battery is part of. This flow of charge is very similar to the flow of other things, such as heat or water. A flow of charge is known as a current.

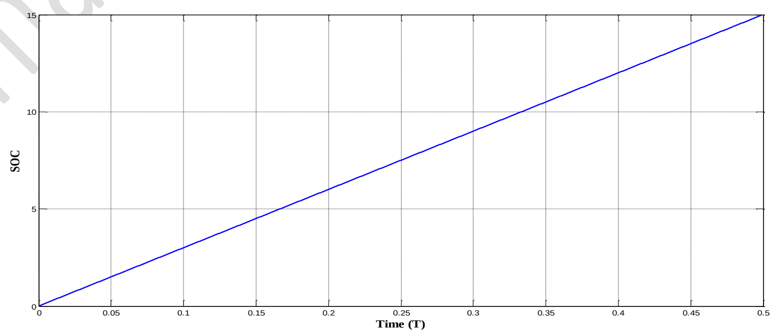

Fig.9 SOC for FLC System

In the Fig.9 shows the The state of charge of a battery it is important to measure the state of charge (SOC) of the cells, which is defined as the available capacity (in Ah) and expressed as a percentage of its rated capacity. The SOC parameter can be viewed as a thermodynamic quantity enabling one to assess the potential energy of a battery.

	BATTERY

VOLTAGE	325V
CURRENT	100A
SOC	15

CONCLUSION

A three-phase DC-type electric vehicle battery concept has been investigated, with a back-end power conversion based on a PWM interleaved Buck-converter and a front-end circuit based on a two-level bidirectional six-switch voltage source rectifier. It was explained how to implement a one-of-a-kind DPWM modulation. This assures high power-factor operation while allowing the phase-leg to switch off for two-thirds of the grid period, or 240, decreasing semiconductor switching losses significantly. The project describes the theory of operation, the key designing expressions, a suitable modulation scheme, and PWM control, as well as a comparison of the current and suggested controllers.

REFERENCES

[1] Dale Hall and Nic Lutsey, "Emerging best practices for electric vehicle charging infrastructure," in Proc. of the international council on clean transportation (ICCT), Oct. 2017.

[2] IEA, "Global ev outlook 2017- two million and counting," 2017.

[3] NEA, "Electric transport in the Netherlands – 2016 highlights," 2017.

[4] Ministry of Economic Affairs, "Vision on the charging infrastructure for electric transport – policy agenda looking ahead to 2020 for smart and clean transport," 2017.

[5] J. C. Spoelstra and J. Helmus, "Public charging infrastructure use in the Netherlands: a rollout-strategy assessment," in Proc. of European Battery, Hybrid and Fuel Cell Electric Vehicle Congress, Dec. 2016.

[6] A. Kuperman, U. Levy, J. Goren, A. Zafransky and A. Savernin "Battery charger for electic vehicle traction battery switch station," IEEE Trans. Ind. Electr., 2013.

[7] G. R. Chandra Mouli, M. Kefayati, R. Baldick, and P. Bauer, "Integrated pv charging of ev fleet based on dynamic prices, v2g and offer of reserves," IEEE Trans. Smart Grids, 2018.

[8] M. Kesler, M. C. Kisacikoglu, and L. M. Tolbert, "Vehicle-to-grid reactive power operation using plug-in electric vehicle bidirectional offboard charger," IEEE Trans. Ind. Electr., 2014.

[9] J. C. Gomez and M. M. Morcos, "Impact of ev battery chargers on the power quality of distribution systems," IEEE Power Delivery, 2003.

[10] S. Rahman and G. B. Shrestha, "An investigation into the impact of electric vehicle load on the electric utility distribution system," IEEE Trans. Power Delivery, 1993.

[11] E. Sortomme and M. A. El-Sharkawi, "Optimal combined bidding of vehicle-to-grid ancillary services," IEEE Trans. Smart Grid, 2012.

[12] C. C. Chan and K. T. Chau, "An overview of power electronics in electric vehicles," IEEE Trans. Ind. Electr., 1997.

[13] J. Sallan, J. L. Villa, A. Llombart and J. F. Sanz, "Optimal design of icpt systems applied to electric vehicle battery charge," IEEE Trans. Ind. Electr., 2009.

[14] M. Vasiladiotis and A. Rufer, "A modular multiport power electronic transformer with integrated split battery energy storage for versatile ultrafast ev charging stations," IEEE Trans. Ind. Electr., 2015.

[15] S. Bai and S. M. Lukic, "Unified active filter and energy storage system for an mv electric vehicle charging station," IEEE Trans. Power Electr., 2013.

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