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Electric Vehicles Charger And Impact On Grid

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Abstract *This paper briefly covers the challenges of EV proliferation, its impact on grid and glimpses of Singapore, Amsterdam policy for EV. This work presents the design process of a universal EV charger, The proposed charger is able of providing a controllable and constant charging voltage for a various EVs, which is composed of three levels of charging, 650 V/100 A DC for bus or lorry The input current of an EV charger with a high total harmonic distortion (THD) and a high ripple distortion of the output voltage can impact battery life and battery charging time. Furthermore, the high cost and large size of the chargers are considered other issues in EV development. This work presents the complete design process of a ANN controlled universal EV charger with a special focus on its control algorithms. In this regard, a C and the sinusoidal pulse-width modulation (SPWM) technique is proposed to ensure effective Levels 3 battery charging. A simulation of the universal EV charger was conducted and assessed in MATLAB–Simulink.*

Keywords: **EV, VOC, THD, SOC, ANN, EV battery**

1. INTRODUCTION

Since the start of the twenty-first century, the number of electric cars (EVs) has been gradually increasing [1]. However, the technology's use is hampered by the battery's charging constraints [2] and its lack of control [3]. The immediate impact is that power cords and charges are a part of daily life, which tends to limit the amount of mobility that vehicles can provide. [4]. There has been a lot of study put into finding solutions to these issues, additionally, EV wireless power transfer (WPT) has emerged as a viable option [5]WPT devices with high strength, time-varying electromagnetic fields were first introduced many years ago. However, the WPT was not particularly necessary at that time as a result of cable electricity delivery networks were usually more economical and efficient for power equipment. Industrial goods are increasingly using electromagnetic induction-based wireless short-range power transmission devices for contactless charging today [6]. However, due to the limitation on the energy transmission distance, this technology cannot charge EVs to cover distances of more than one-fifth (1/5) the dimension of the power transmitter [7]. The transmission distance could be increased to more than 2 or 3 times the size of the emitter or recipient using an enhanced resonant coupling technique [8].

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2. LITERATURE REVIEW

A predictive current control method to minimize the THD by using a switching frequency of 8 kHz with a voltage source inverter. In [14], the researchers implemented a four-leg converter by applying a model predictive current control algorithm, where the THD and switching frequency were observed at low values of the filter parameter. A comparative study between a finite-control-set MPC (FCS-MPC) and synchronous proportional integral (PI) controller with space vector modulation (PI-SVP) was presented in [15]; it was observed that the FCS-MPC is able to generate waveforms with fewer low-order harmonics than the PI-SVM. The MPC method is able to operate with different voltage/frequency values while maintaining a lower THD value [16]. However, MPC requires complex implementation as compared to linear controllers. Meanwhile, in the single-phase on-board bidirectional charger proposed by [17], PI controllers were employed in AC/DC converters and DC/DC converters to provide constant voltage and constant current charging, as well as reactive power compensation. Road EVs include a large range of vehicles from electric two-wheelers, three-wheelers (rickshaws), cars and electric buses. In addition, plug-in electric vehicles can be classified into two types: battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs). BEVs have an electric motor in place of combustion engine and use electricity from the grid stored in batteries. Plug-in hybrid electric vehicles (PHEV) use batteries to power an electric motor and liquid fuel such as gasoline or diesel to power an internal combustion engine or other propulsion source. EVs can go beyond the above mentioned technology based classification, and can be classified on the basis of their attributes such as i) charging time, ii) driving range, and iii) the maximum load it can carry. Of these attributes, the two most important characteristics of an electric vehicle of concern to the consumer are:- 1. Driving range (i.e. the maximum distance an EV can run when fully charged) 2. Charging time of batteries (i.e. the time required to fully charge the battery) and Charging time depends on the input power characteristics (i.e. input voltage and current), battery type, and battery capacity.

Battery in EV: The choice of batteries depends on the energy density, weight and costs. Electric cycles and low range mopeds have simple battery units while electric cars deploy a large number of batteries. Traditionally, most electric vehicles have used lead-acid batteries due to their mature technology, easy availability, and low cost. However, since the 1990s battery technologies have evolved significantly and several new types of batteries have been developed. More recently, batteries using combinations of lithium ion and its variations are gaining widespread acceptance due to better efficiency, reduced weight, lower charging time, better power output, longer lifetime, and reduced environmental implications from battery disposal. The following four types of batteries are commonly used today in EVs: 1) Lead Acid, 2) Nickel Cadmium (NiCd), 3) Nickel Metal Hydride (NiMH), and 4) Lithium-ion (Li-ion). Lithium-ion batteries have higher specific energy relative to the other battery types. In the future, technology innovations with Li-ion and other battery technologies are expected to result in batteries with much higher specific energy and lower costs.

3. PROPOSED METHODOLOGY

The proposed universal charger shown in Figure 1 is composed of a three-stage converter that is controlled by the VOC algorithm. The first stage consists of a three-phase AC source, a three-phase rectifier controlled by the VOC technique (named the VOC rectifier), and a DC-link capacitor. For closed-loop operation, the voltage and current controllers are used to obtain feedback voltage from the load-side battery of the EV. This is the most important control stage and consists of two main functions: (1) Regulating the output DC voltage to a pre-determined value, and (2) controlling the input AC phase currents to have a nearly sinusoidal wave shape and also to work in phase with the AC phase voltage.

4. ESTIMATIONS AND RESULTS

Simulink is a software package for modeling, simulating, and analyzing dynamical systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams, using click-and-drag mouse operations. Models are hierarchical, so we can build models using both top-down and bottom-up approaches.

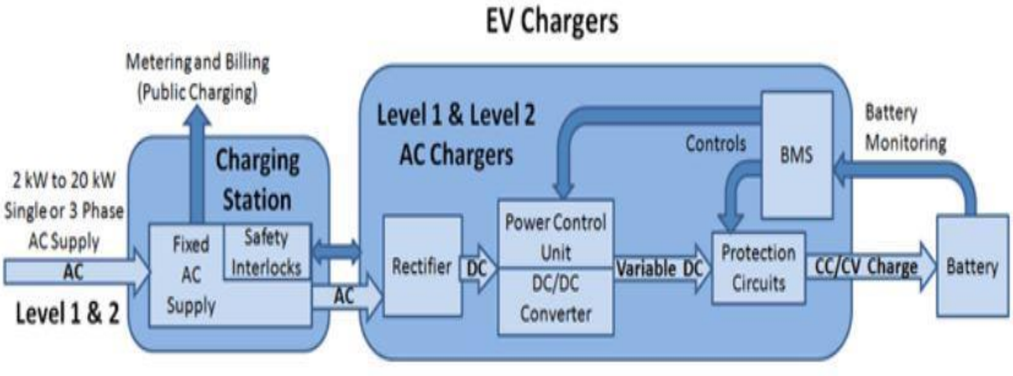

Fig 1 Proposed system simulation

Table 1: For level 3 component values

Parameter	Symbol	Unit	Value
Resistance load	R_{load}	Ω	20
Input inductance	L_f	mH	5
DC-link capacitor	C_f	µF	6
Grid voltage frequency	f	Hz	50
Switching frequency	f_s	KHz	12
Input resistance	R_f	Ω	5
Input voltage	V_{in}	volts	120

5. CONCLUSION

The proposed charger is able to provide a controllable and constant charging voltage for various EVs and is composed of three level of charging. The three-phase PMW converter, based on the VOC of conversion theory and appropriate for Level 3 of charging, was proposed. A new control algorithm based on the integration of the VOC and SPWM techniques for the effective operation of three battery charging level circuits was presented. It is clear that the control algorithm accurately regulates the output DC voltage. At the same time, it ensures a sinusoidal input current with minimum switching ripples and distortions. The power factor of the system is almost unity, and the total harmonic distortion (THD) for the input current is less than 0.39%. However, due to limitations in terms of available facilities and resources, the ability of the proposed charging strategy in performing Level 1 and Level 2 charging have not been practically verified in this work, in which only the simulation findings have presented for this aspect.

Overall, as reported by the simulation results, the design concept of the proposed universal EV charger itself and, subsequently, the operation of the VOC and SPWM algorithms in a control system, can be confirmed to be valid. The proposed universal EV charger is designed to perform three types of charging: Single-phase AC charging (Level 1), three-phase AC charging (Level 2), and DC charging (Level 3). Furthermore, the proposed VOC and SPWM control techniques are applied to minimize the harmonic distortion in the grid. As can be seen from the simulation work, the THD value is well below 5%. In other words, the proposed charging strategy does not cause significant harmonic distortions to the grid while charging.

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