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A Matrix Converter Based Bidirectional Contactless Grid Interface

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ABSTRACT

Inductively coupled, bidirectional grid interfaces are gaining popularity as an attractive solution for vehicle-to-grid (v2g) and grid-to-vehicle (g2v) systems. However, such systems conventionally use a large, electrolytic dc-link capacitor as well as a large input inductor, leading to expensive, bulky, and less reliable systems. Fuzzy based grid contact less system for matrix converter are gaining popularity as an efficient and reliable technique.

Moreover MCs are invariably rich in harmonics and thus affect both power quality and power factor on the grid side. Although fuzzy based grid contact less system for matrix converter are proposed as an alternative, the matrix converter is an ac–ac power converter topology, mainly based on semiconductor switches with minimal requirements for passive components. Performance of such converter has been analyzed when driving linear load current fuzzy logic controllers.

The matrix converter system that allows bidirectional power flow and it converts a voltage with a variable amplitude and frequency from a constant voltage of magnitude and frequency. Thus the proposed system employs a simpler switching strategy with a lower switching frequency and reduces the total harmonics.

INTRODUCTION

The demand for electric vehicles (EVs) has raised significantly due to several reasons, such as improvement in EV technologies, high fuel costs associated with conventional vehicles and increased awareness on reducing greenhouse gas emissions. Moreover, with the emergence of vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technologies, EVs have been proposed as energy storage devices for storage and retrieval of energy for dynamic demand management. Presently, hard-wired bi-directional grid interfaces are employed for grid integration of EVs. Although hard-wired interfaces between EVs and the utility grid are simple, they must be suitably isolated to avoid the risk of shock hazards. However, they still increase the risk of electrocution, particularly under wet environments and harsh weather conditions, such as snow and ice, making safe use of hard-wired interfaces practically difficult.

Since these particular grid interfaces are equipped with long cables, they can also be inconvenient and inflexible. In recent years, inductive power transfer (IPT) has emerged as a favored technique for supplying contactless power for a wide range of applications. In contrast to hardwired interfaces, contactless grid interfaces based on bi-directional inductive power transfer (BD-IPT) technology have shown substantial promise as an attractive solution for V2G and G2V applications due to their higher galvanic isolation, flexibility and efficiencies comparable to hard-wired systems. Nevertheless, the operating frequencies of BDIPT systems are typically much higher than the utility grid frequency. Therefore, contactless grid integration of EVs for V2G or G2V applications involves a single or multi-stage frequency conversion, using one or more bi-directional power electronic converters.

By doing so, it converts the utility grid AC voltage to a DC voltage and maintains the converted DC voltage at a relatively constant value. The converter on the back end, known as the inductive power transfer (IPT) primary converter, then converts the constant DC voltage at the intermediate DC-link to an AC voltage at the resonant frequency, in order to drive the resonant network. Hence, this system necessitates a large electrolytic DC-link capacitor and an input inductor for minimizing voltage ripple at the intermediate DC link and reducing input current ripples, respectively. Inclusion of these two energy storage elements makes the system bulky and more expensive. In addition, numerous external factors such as, type of dielectric material used, operating and storage temperatures, contribute to determining the life time of the DC-link capacitor.

EXISTING SYSTEM

This paper proposes a matrix converter (MC) that directly produces voltages at high frequency from the utility grid to drive resonant networks of the bidirectional contactless interface. A comprehensive mathematical model that predicts the steady-state voltages and currents as well as the power drawn by the system is proposed to gain an insight into the operation of the proposed MC topology. Utilizing the mathematical model, a modulation strategy is also proposed to attenuate the undesirable harmonics in the grid current.

PROPOSED SYSTEM

A novel matrix converter based IPT interface that requires only a single-stage power conversion process to facilitate bi-directional and contactless power transfer between EVs and the grid. A mathematical model, which predicts the behavior of the proposed system, is presented to show that both power flow and direction can be controlled through either relative phase angle or magnitude modulation of voltages produced by converters.

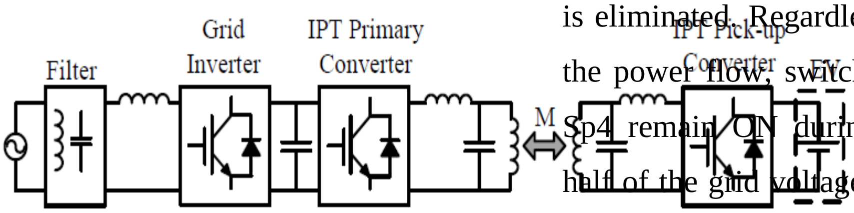

Fig:3.1 Grid inverter based system

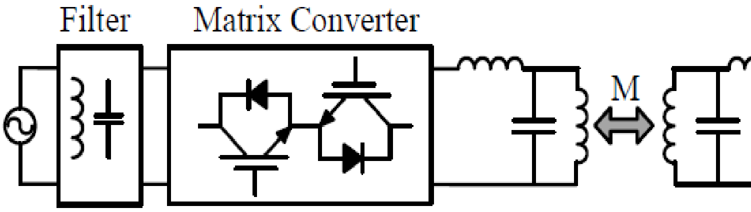

Fig 3.2: matrix converter based system

A schematic of the proposed grid integrated BD-IPT system. The primary side of the system consists of two converters that are connected in a back-to-back configuration. The front end converter, which is referred to as the grid converter, is directly interfaced with the utility grid. Due to current source nature of the tuned inductor-capacitor-capacitor-inductor (LCCL) resonant network, an input inductor is not required for controlling the grid current. Therefore, the large input inductor is eliminated. Regardless of the direction of the power flow, switching devices Sp1 and Sp4 remain ON during the entire positive half of the grid voltage, whereas, during the negative half cycle of the grid voltage Sp2 and Sp3 remain ON.

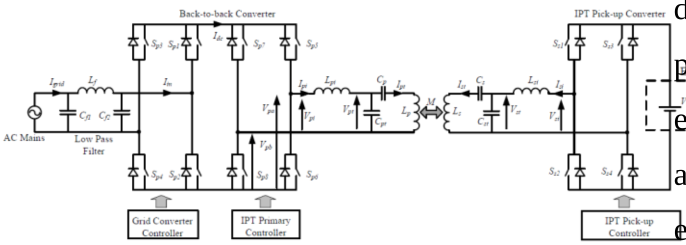

Fig 3.3 : Proposed converter topology for grid integration of BD-IPT systems.

Thus, the utility grid supply is completely disconnected from the BDIPT system, during the dead-band. When the grid voltage, Vgrid>4V + and Vgrid<4V, the grid converter is said to be in normal operation. Due to the switching of Sp1 and Sp4, a DC voltage with a ripple of Vin is formed in the DC-link where, Vin is the peak of the utility grid voltage. Thus, the grid converter functions as a rectifier at utility grid frequency when the power flows from the grid to the EV, while, it operates as an inverter when the power flow is in reverse direction.

CONCLUSION

The proposed system wirelessly transfers power through loose magnetic coupling, and a mathematical analysis together with simulation results have been presented to show that the proposed technique is viable and requires a simple control strategy to effectively control both direction and amount of power flow. The proposed IPT power interface is reliable, efficient and low in cost without an additional power conversion stage, and expected to be attractive for applications, which require wireless power.

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