Design and implementation of a bidirectional AC-DC converter with power factor correction (PFC)

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➢ Abstract

In this thesis, two novel rectifiers with power factor correction were proposed which are used for electric vehicle (EV) batteries. The first converter is an off-board interleaved charger for EV that can be used in smart homes and buildings as rectifier converter. Working as rectifier to provide appropriate DC voltage for DC residential loads (G2H), providing DC output voltage and charging EV battery, simultaneously (G2VH), and returning stored energy in EV battery to DC load (V2H) are the operation modes of proposed charger. It can provide wide range of output voltage because of exclusive DC-DC stage structure. It has sinusoidal AC input current with low total harmonic distortion (THD). One of the prominent features of proposed topology is the battery bases grounded, so conducted noises cannot damage that. The second converter is a new on-board bidirectional switching-capacitor based buck-boost charger, which is capable to control active and reactive power in two modes (G2V and V2G). This on-board charger enables the EVs and PEVs to work as distributed generators (DGs), reactive power compensators, and voltage regulators. The proposed two-stage charger has the ability to work as buck-boost converter in both modes owing to its switching-capacitor base structure, which is the significant advantage of that. It has sinusoidal AC input current with low total harmonic distortion (THD). A suitable control method is introduced, which can control the active and reactive power in both modes depending on smart grid commands or customer requirements.

In order to verify system analysis, the proposed chargers are simulated in MATLAB/SIMULINK software and results confirm charger**s** capabilities. Two laboratory prototype of proposed chargers are built and experimental results confirm simulation ones.

➢ Chargers Topology

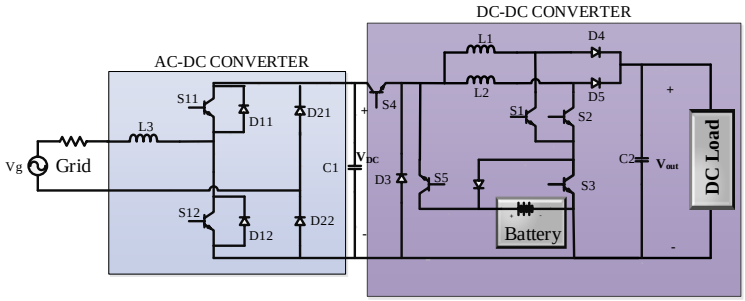

Fig.1 Charger#1

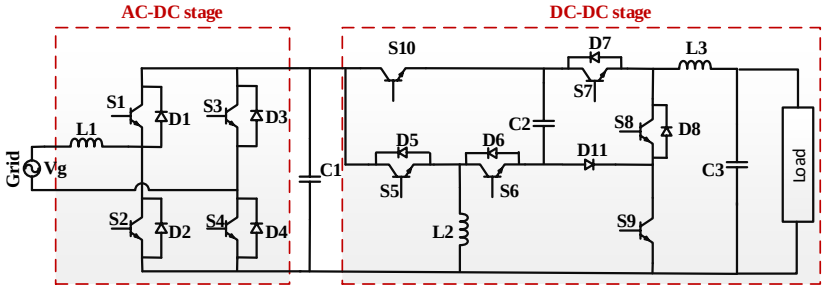

Fig.2 Charger#2

➢ Simulation Results

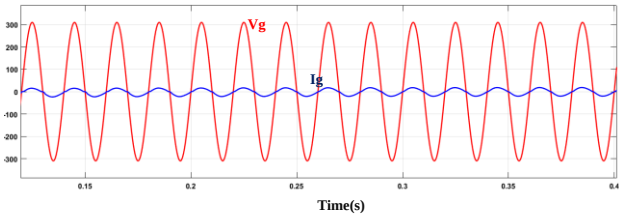

Fig.3 Grid Voltage and Input Current

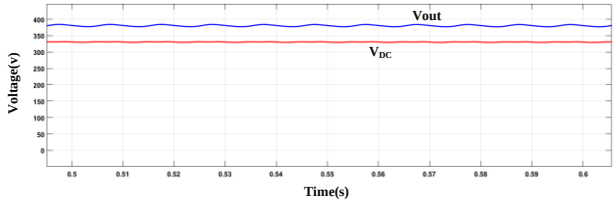

Fig.4 DC-Link Voltage and Output Voltage

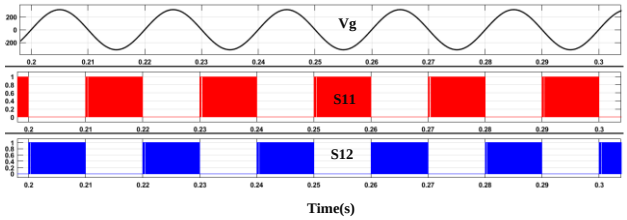

Fig.5 Gate Signals

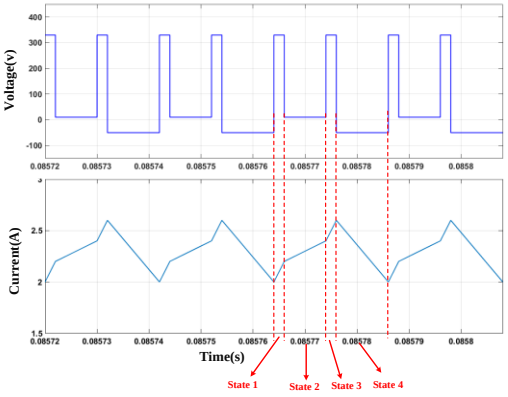

Fig.6 Inductor Current and Voltage

➢ Experimental Results

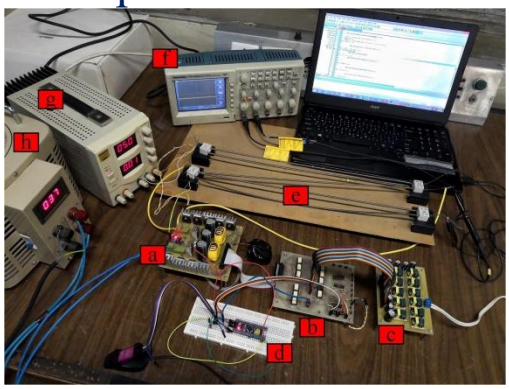

Fig.7 Setup

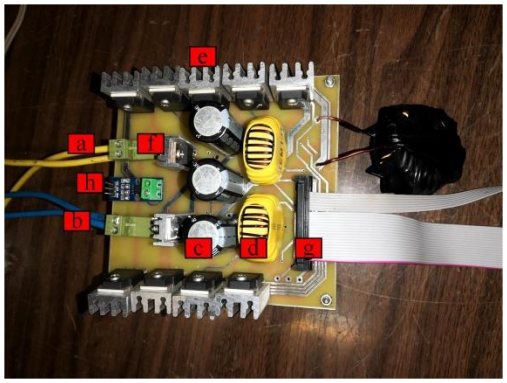

Fig.8 Prototype Circuit

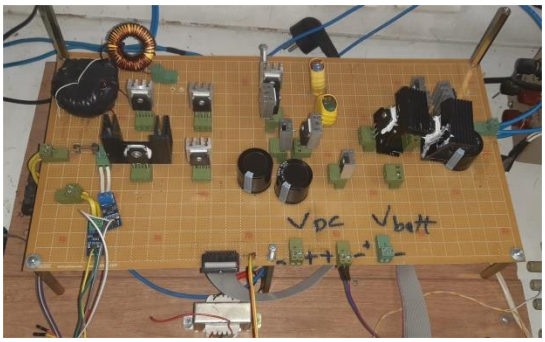

Fig.9 Prototype Circuit

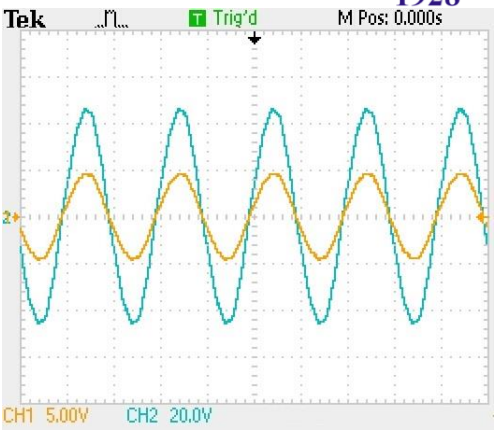

Fig.10 Input Current and Voltage

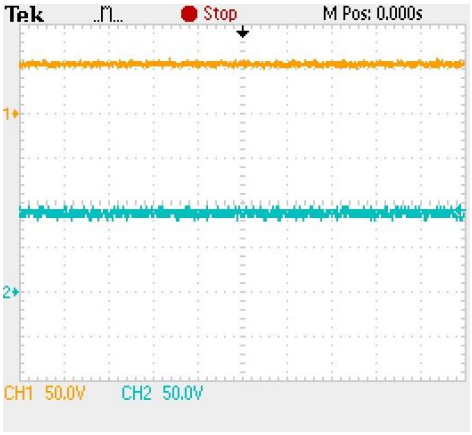

Fig.11 DC-Link and Output Voltage

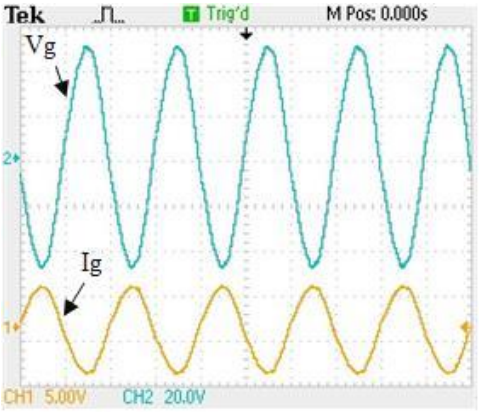

Fig.12 Input Current and Voltage


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