Impact on the grid of bridgeless interleaved boost PFC converter as the front-edge stage of an onboard charger

Tamara Ninković[1], Martin Ćalasan[2]
University of Montenegro, Faculty of Electrical Engineering, Podgorica, Montenegro
[1]tamara.ninkovic9@gmail.com , [2] martinc@ucg.ac.me

Introduction

- Increasing concerns about environment, along with development in battery technology, has resulted in expanding use of electric vehicles.
- Flexible use of electric vehicles requires development of EVSE (Electric Vehicle Supply Equipment) infrastructure.
- However, in order to minimize negative aspects of electric vehicles charging, proper design of battery chargers must be taken into account.
- This paper deals with the impact on the grid of bridgeless interleaved boost PFC converter as the front stage of an onboard charger.

Review of different front-end topologies

- EV's chargers are designed into two forms: onboard and off-board chargers.
- The front-end AC-DC converter represents a key component of a charger.
- AC-DC converter must meet regulatory standards of AC mains and must achieve high efficiency.
- Notable reduction of input current harmonics, and THD factor can be achieved by applying PFC (Power Factor Correction) convertors.
- Three popular topologies of these converters are:
    - conventional boost PFC converter;
    - interleaved boost PFC converter;
    - bridgeless interleaved boost PFC converter (BLIL).

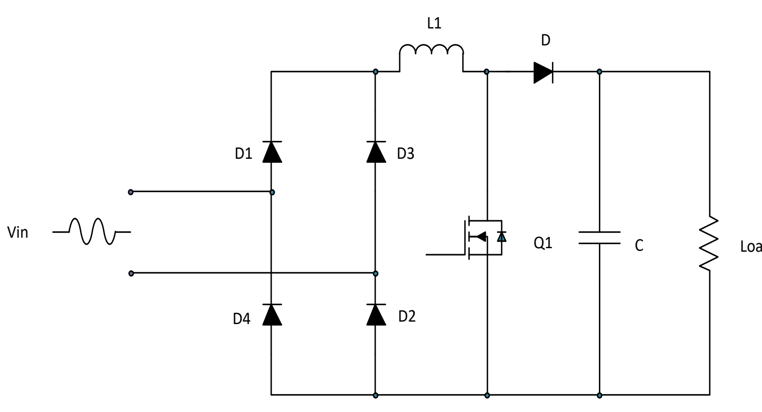

Figure 1. Conventional boost PFC converter

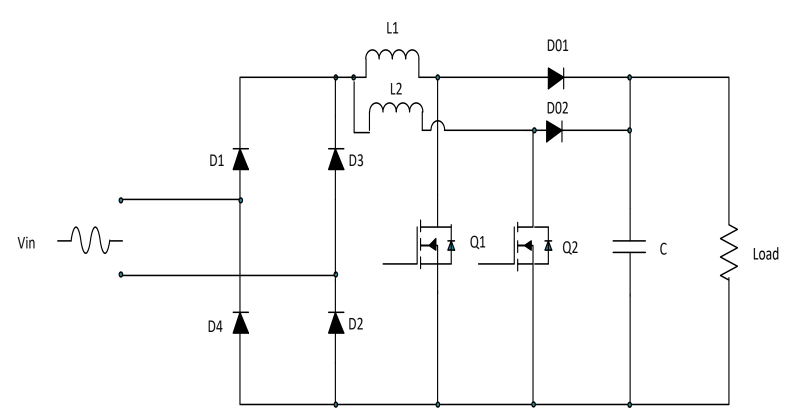

Figure 2. Interleaved boost PFC converter

- These convertors are designed and controlled to imitate resistive load and thus produce very low input current harmonics

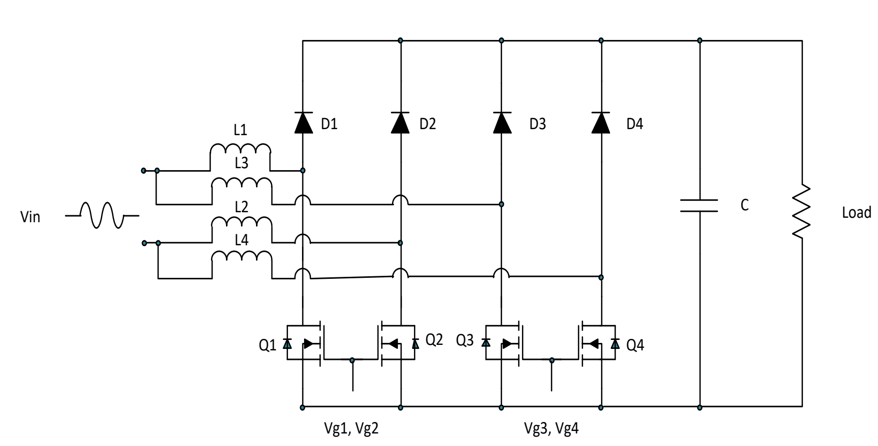

Figure 3. Bridgeless interleaved boost PFC converter

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Simulation results

- In order to compare performances of these three convertors, each topology is implemented in MATLAB Simulink.
- Obtained values of THD factor are respectively: 10.57 %; 8.33 % and 3.06 %.
- Waveforms of input current for all three converters are presented in Fig. 4-6.

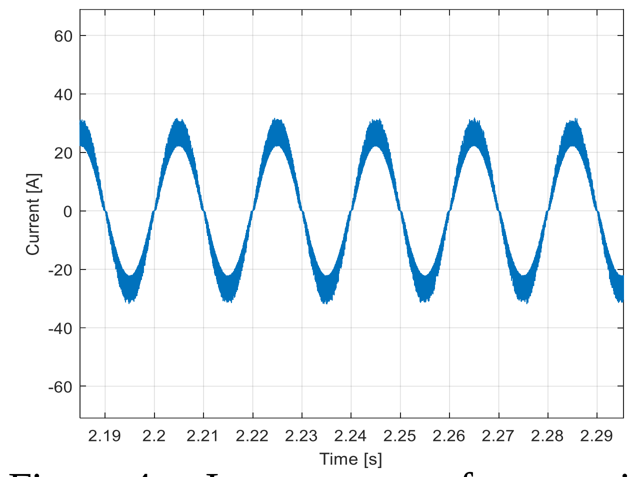

Figure 4. Input current of conventional boost PFC converter

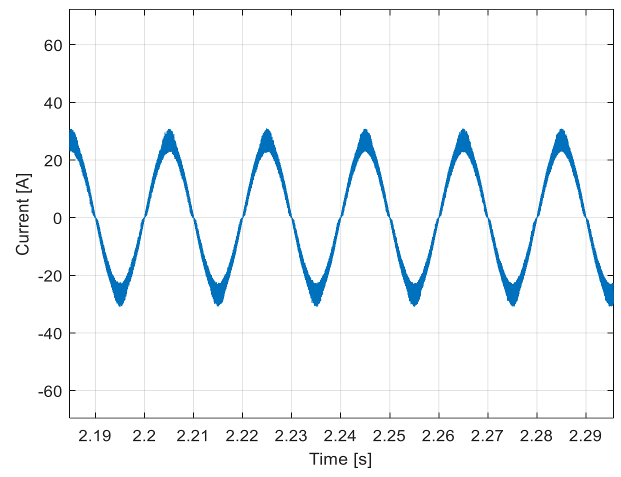

Figure 5. Input current of interleaved boost PFC converter

- Input current of BLIL has waveform closest to sinusoidal input voltage. Wave shape is slightly distorted near the curves, but not as much as in case of interleaved and conventional boost topology.

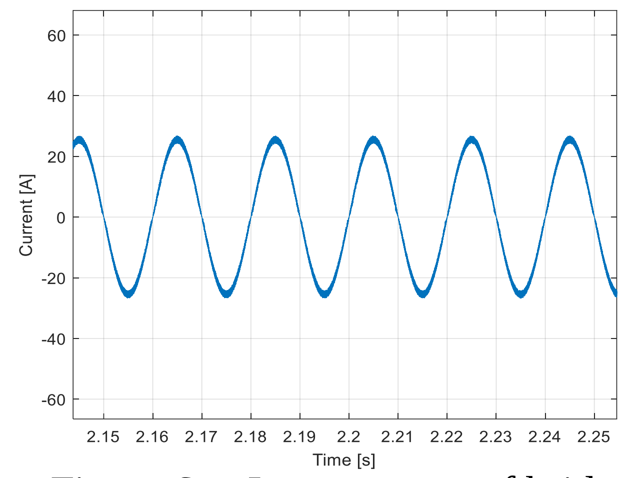

Figure 6. Input current of bridgeless interleaved boost PFC converter

- THD - voltage dependence is illustrated in Fig. 7. Decreasing function shows that by increasing output voltage, input current harmonics reduces.

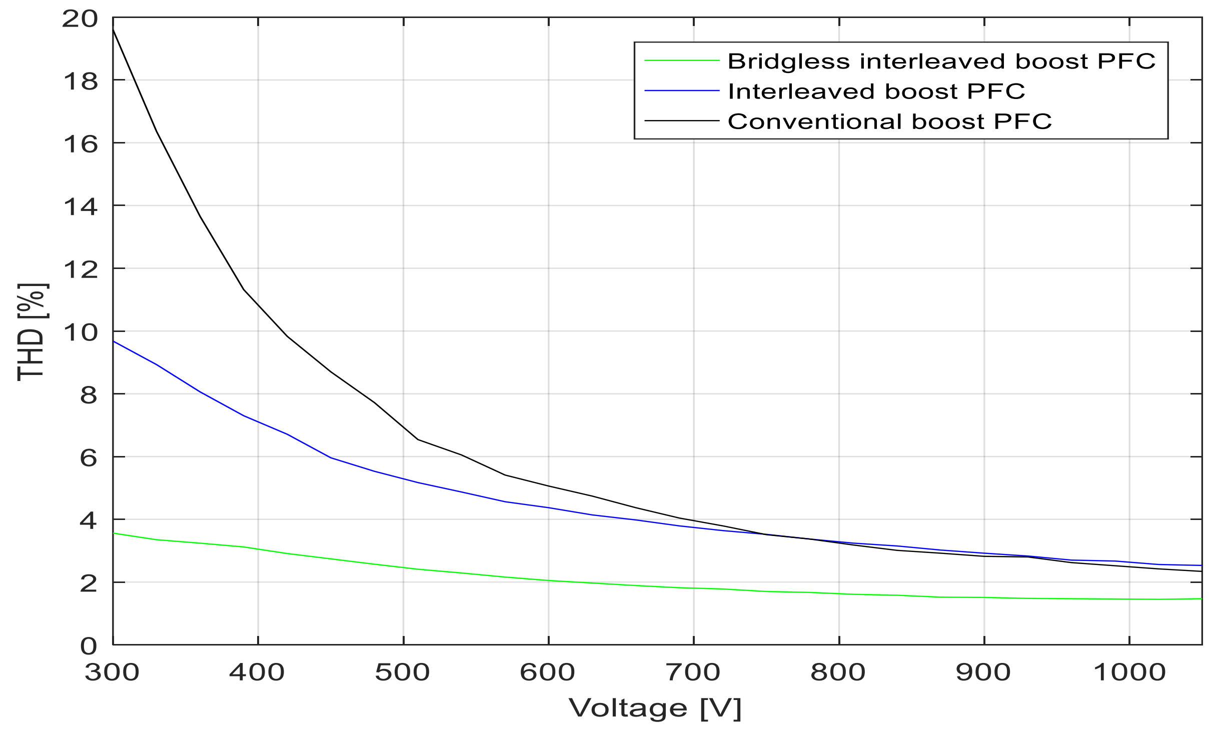

Figure 7. THD-Output voltage dependence

Conclusion

- Simulation results, ran for the same operation mode, confirm that the bridgeless interleaved boost PFC converter is the best solution for PFC stage of onboard charger.