JOURNAL OF SOUTHERN COMMUNICATION ENGINEERING
ISLAMIC AZAD UNIVERSITY BUSHEHR BRANCH
E-ISSN: 2980-9231
https://jce.bushehr.iau.ir
https://doi.org/...

Vol. x/ No. x/xxx

Research Article

Design and Simulation of a Fuel Cell Power Conditioning System Connected to a Weak Grid to Enhance Current Quality

Majid Hosseinpour [1] | Hadi Khorramdel[2] | Mahdi Shahparasti [3]

[1]Department of Electrical Engineering, University of Mohaghegh Ardabili, Ardabil, Iran, hoseinpour.majid@uma.ac.ir

[2]Department of Electrical Engineering, University of Mohaghegh Ardabili, Ardabil, Iran, rasoul.akbari@uma.ac.ir

[3]School of Technology and Innovations, University of Vaasa, Vaasa, Finland, mahdi.shahparasti@univaasa.fi

Correspondence
Majid Hosseinpour, Associate Professor of Electrical Engineering, University of Mohaghegh Ardabili, Ardabil, Iran,
Email: hoseinpour.majid@uma.ac.ir

Received: 3 November 2024
Revised: 1 December 2024
Accepted: 11 December 2024

Abstract

Injecting good-quality power into the grid through grid-connected inverters is an important industry issue besides some challenges. One of these challenges is the presence of harmonics at the point of common coupling (PCC) to the grid. Various methods have been presented to overcome PCC voltage harmonics. One of these methods is PCC voltage feedforward based impedance reshaping. This paper investigates a fuel cell-based grid-connected inverter in the presence of a third-order filter to inject current and power with the desired quality into the grid. However, the presence of PCC voltage harmonics prevents the injection of desired quality power into the grid. To overcome this challenge, in this study, an innovative approach for shaping virtual impedance based on frequency apportionment is proposed. In the proposed method, the output impedance of the fuel cell-based grid-connected system is shaped in various frequency bands with various coefficients. The investigation, analysis, design, and application of the system under study have been examined. The system studied with the proposed method can simultaneously adapt to weak network impedance and eliminate PCC voltage harmonics. To verify the performance and validate the proposed method, fuel cell-based grid-connected inverter has been simulated in the Simulink/MATLAB environment. The results of theoretical analysis and simulation indicate the injection of fuel cell power with desirable quality into the grid, which is also compatible with a weak grid.

Keywords: Grid-connected inverter, Photovoltaic array, LCL filter, Virtual impedance.

Highlights

- Current quality improvement of the LCL-based grid-connected fuel cell power conditioning system.
- Stable and passive performance of the grid-tied inverter using an improved virtual impedance shaping method.
- Virtual impedance shaping in different frequency bands based on frequency division with different coefficients.
- Simultaneous capability to eliminate PCC voltage harmonics and strong compatibility with a wide range of weak grid impedance.

Citation: [in Persian].