Stability Improvement and Control Optimization of Isolated Two-Stage AC-DC-DC Converter Systems

Abstract

As the renewable integration trend continues, more and more power electronic converters are required as the interfaces between different networks in the power systems. However, the direct interaction of the converters introduces uncertainties to the power systems, especially for the stability and reliability.

This thesis focuses on the instability issues of the dual active bridge (DAB) converter-based two-stage DC-DC-AC systems and addresses their concerns. Specifically, the full-order impedance model of the DAB converter is presented for the first time to facilitate the stability analysis. Based on the impedance model, the effects of different DAB modulation schemes on the stability have been analyzed and the optimal modulation method is investigated from the point of view of stability. The proposed feedback controller optimization method is effective to improve the stability of the two-stage system. Moreover, a family of impedance shaping regulators is proposed to suppress the dc-bus voltage ripples.

List of Publications

[1] **Feng F**., Wu F., & Gooi H. B. Impedance shaping of isolated two-stage converter for dc-link voltage stabilization. *IEEE Access*, vol. 7, pp. 18601-18610, Feb. 2019.

[2] **Feng F**., Zhang X., Lin F., & Gooi H. B. Impedance modeling and stability analysis of dual active bridge converter with LC input filter. *CES Transactions on Electrical Machines and Systems*, 2(3), 289-295, Sep. 2018.

[3] **Feng F.**, Zhang X., Gooi H. B. Stability Enhancement via Controller Optimization and Impedance Shaping for Dual Active Bridge Converters-Based Energy Storage System. *IEEE Transactions on Power Electronics*, (conditional acceptance).

[4] **Feng F.**, Zhang X., Gooi H. B. Comparison of SPS, DPS and CTPS modulation with fully consideration of stability of DAB with its LC filter. *IEEE Transactions on Power Electronics*, (under revision).

[5] **Feng F**. Zhang X., Gao P., Lin F., Gooi H. B. Impedance modeling and stability analysis of triple-phase-shift-based dual active bridge converter with LC filter. *10th International Conference on Power Electronics – ECCE Asia* (ICPE 2019-ECCE Asia), May 2019.

[6] **Feng F.,** Zhang X., Lin F., Gooi H. B. Stability Analysis and Optimization of Dual Active Bridge Converter with LC Input Filter. *2019 IEEE International Conference on Industrial Technology* (ICIT), Feb. 2019.

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