

Two stability theorems concerning power networks

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The stability of power networks is a highly relevant topic due to the penetration of distributed generators and the dramatic changes taking place or being planned for utility grids, such as the need for the autonomous operation of microgrids. We explain two recent mathematical stability results that are relevant for models of power systems. The first (due to V. Natarajan and G. Weiss, *Math. Control, Signals and Systems*, 2018) concerns a 4th order model of a synchronous generator with constant field current, connected to an infinite bus. The result is that under certain verifiable conditions on the parameters of the model, the system is almost globally asymptotically stable. We indicate how this result is useful in tuning the parameters of inverters working as virtual synchronous machines. The second result (first version due to F. Dörfler and F. Bullo, *SIAM J. Control and Optimization*, 2012) concerns a network of several synchronous generators modelled as second order systems, with a quasi-static model for the interconnection network. The result is that under certain conditions, the state trajectory of a power network is close to the trajectory of the corresponding Kuramoto model (that is obtained by setting the inertias of the generators to zero), if both start from the same initial angles. The Kuramoto model is exponentially stable, so that this gives us useful indications on the behavior of the power network. Based on our recent paper (to appear in *Systems and Control Letters* in 2020) we explain how the second result can be generalized and strengthened in several aspects, and we also point out some lack of precision in the original formulation of the result. We briefly indicate how this result can be useful for analyzing the stability of microgrids containing inverters.

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