Automated Fast Frequency Response From Inverter-Based Motor Loads

Zarka Mirza[1], Himanshu Jain[1]

[1]Indian Institute of Technology (IIT) Roorkee

The increasing integration of inverter-based renewable generation presents challenges for the frequency stability of power systems, primarily due to reduced system inertia and governor response—collectively known as Fast Frequency Response (FFR). Obtaining FFR from inverter-based generation requires reserving operational headroom, resulting in a lost opportunity to generate more renewable energy. Recently, inverter-based loads have been proposed as potential sources of FFR; however, critical gaps remain in the control algorithms needed to transform these loads into grid-supportive loads (GSLs) capable of delivering FFR. To address this gap, this paper introduces a novel algorithm that enables automatic, communication-free, grid-supportive behavior in inverter-based motor loads. The algorithm's efficacy is demonstrated through comprehensive simulations and hardware experiments. Experimental results demonstrate that GSLs equipped with the proposed controller can provide FFR by adjusting power consumption, reducing it by up to 32% for a 1.8% drop in grid frequency and increasing it by 10.65% for a 0.4% rise, within 1.5 seconds in response to frequency events. By retrofitting existing, or designing new inverter-based motor loads with this controller, end-use devices can automatically deliver aggregated FFR without communication infrastructure, enhancing frequency stability in grids with high levels of variable renewable energy.

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