

Active Buffer-Based Energy Storage System with Enhanced Reliability for Solar PV Microinverter

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Research Motivation

Traditional solar photovoltaic (PV) inverters utilize electrolytic capacitors (ECs) for DC link voltage ripple mitigation. EC devices, however, detriment the overall power density and reliability of the inverter system. Therefore, an active buffer-based energy storage system alternate known as the pulsating power buffer (PPB) is investigated for a 20-60VDC/120VAC, 400W system.

Buck- and Boost-Derived PPB Continuous Conduction Modulation

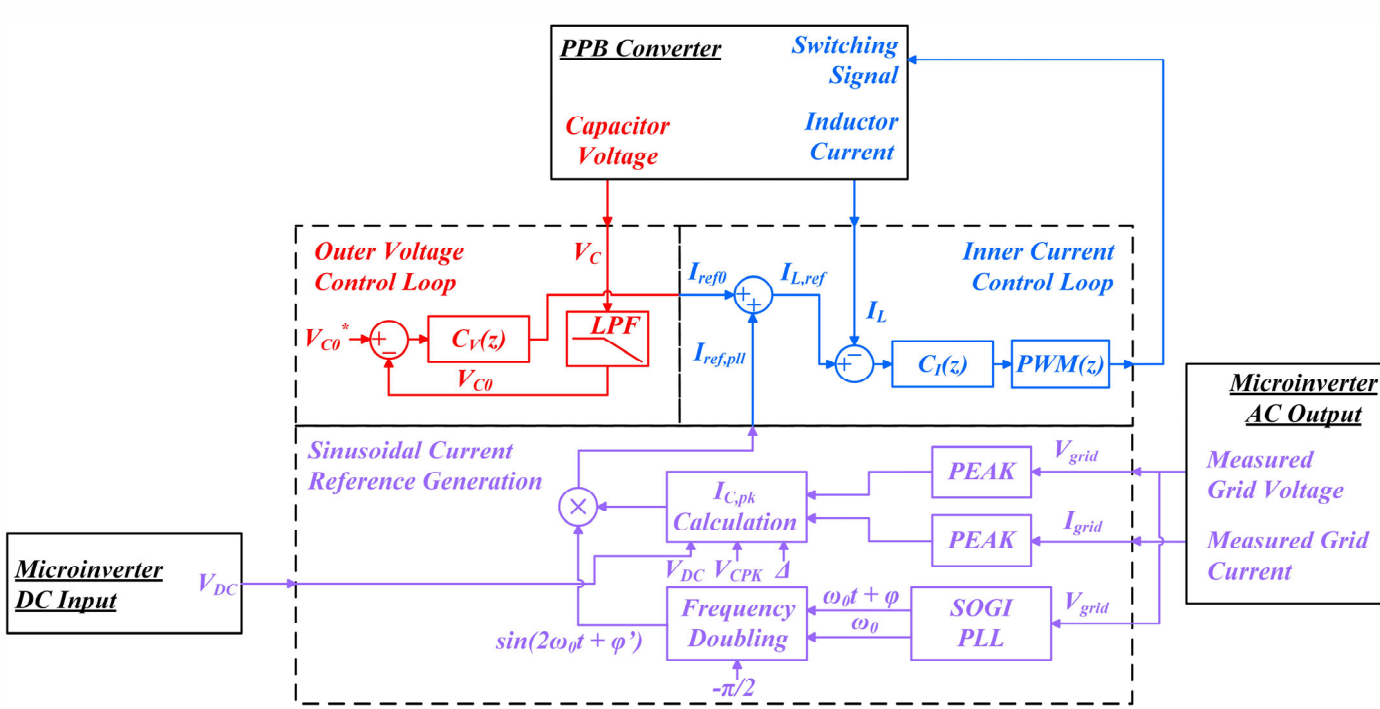


Fig. 1: Common CCM feedback control framework

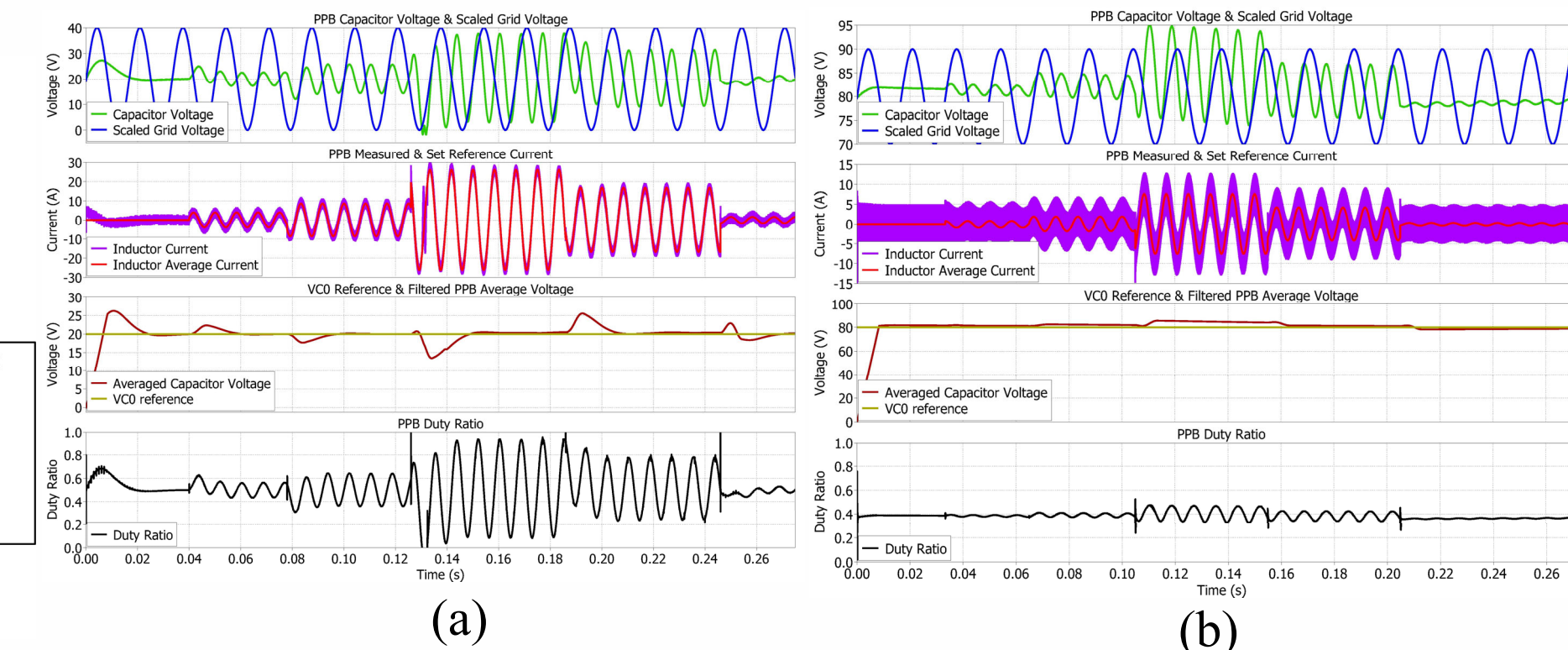


Fig. 2: Simulation results for (a) buck-PPB (b) boost-PPB 0VAr/50VAr/100VAr/400VAr/220VAr/50VAr load step

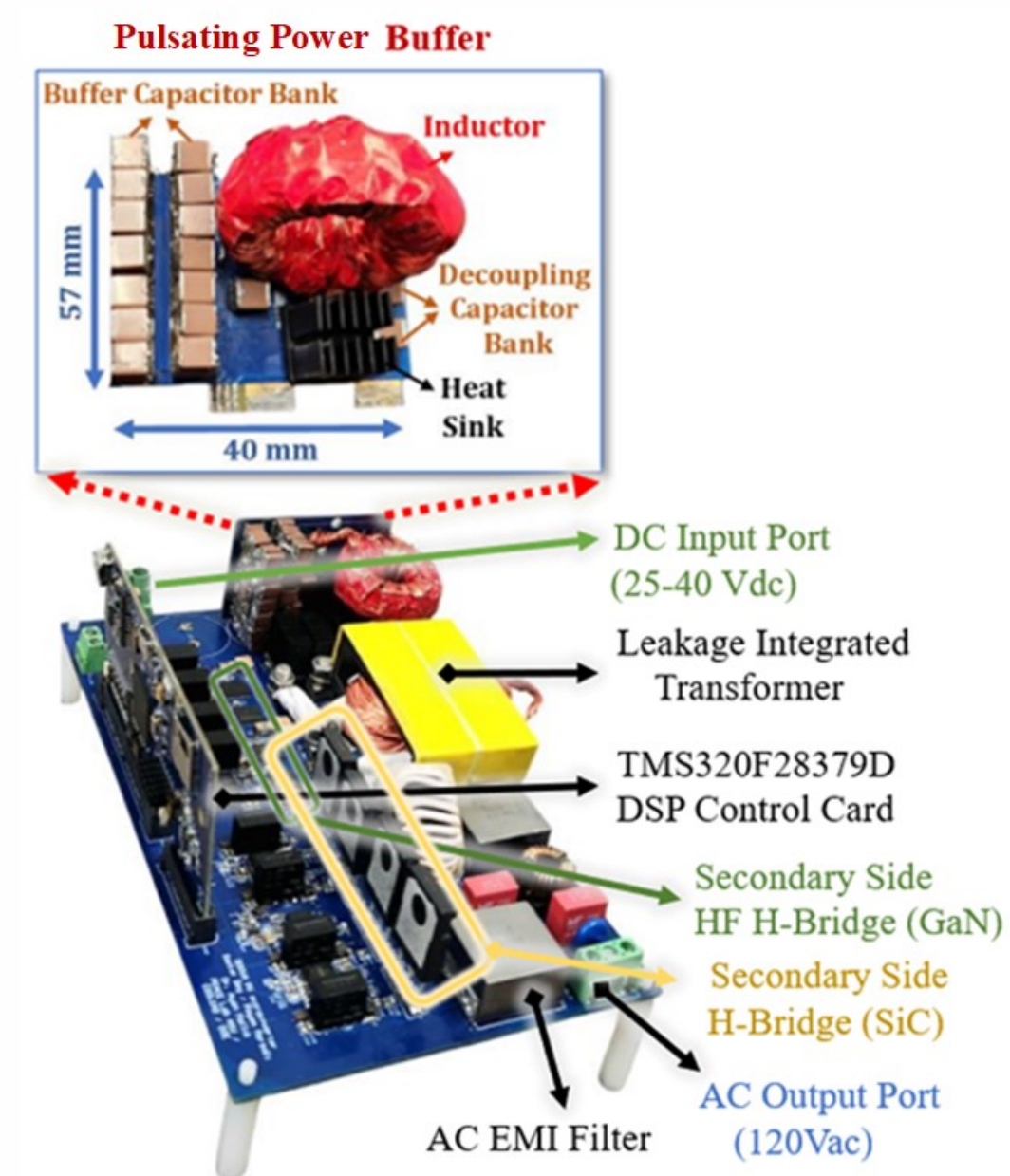


Fig. 3: PPB hardware experiment platform with PV microinverter

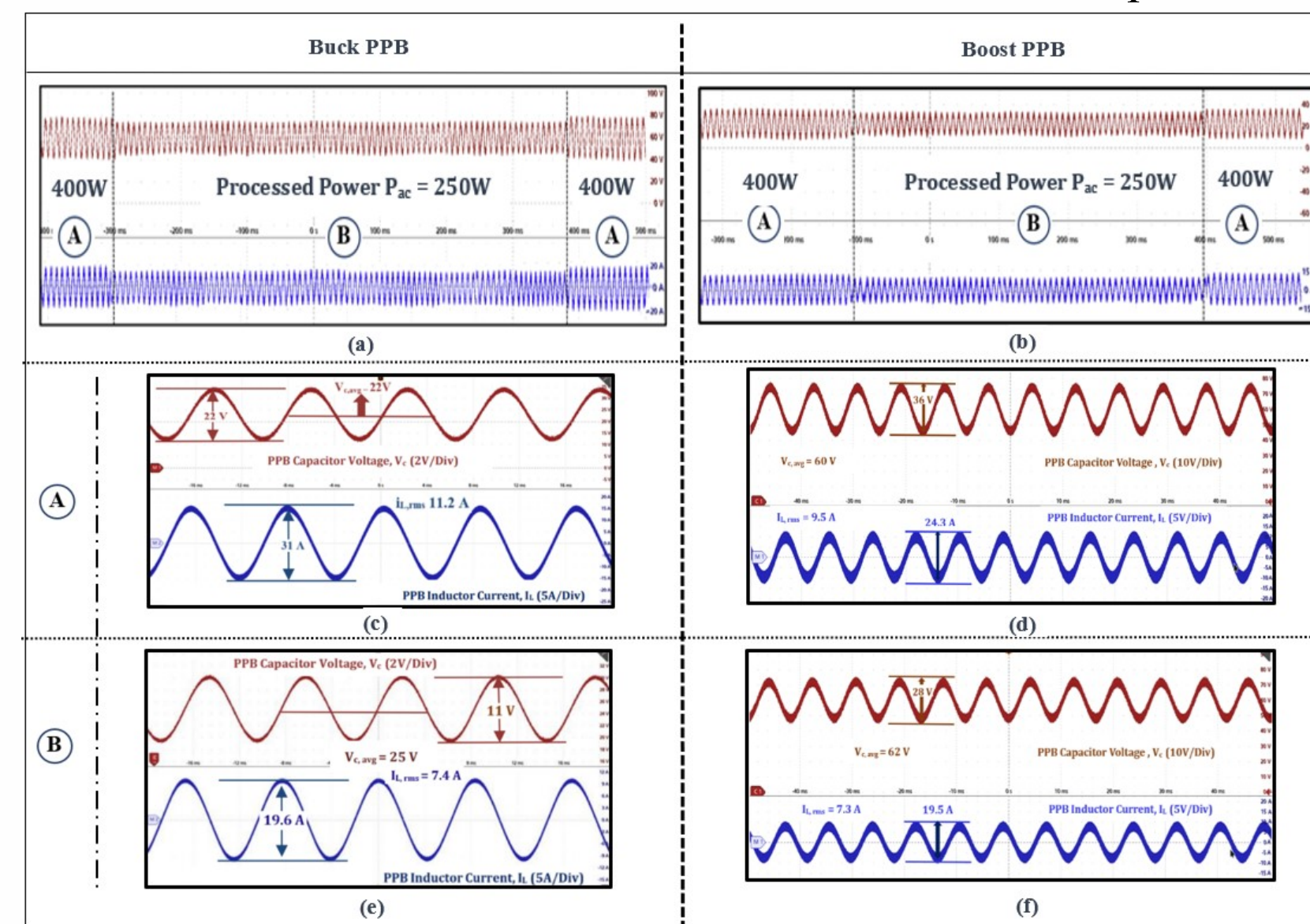


Fig. 4: Experimental results for (a) buck-PPB (b) boost-PPB 400VAr/200VAr/400VAr load step

Buck-Derived PPB Critical Conduction Modulation

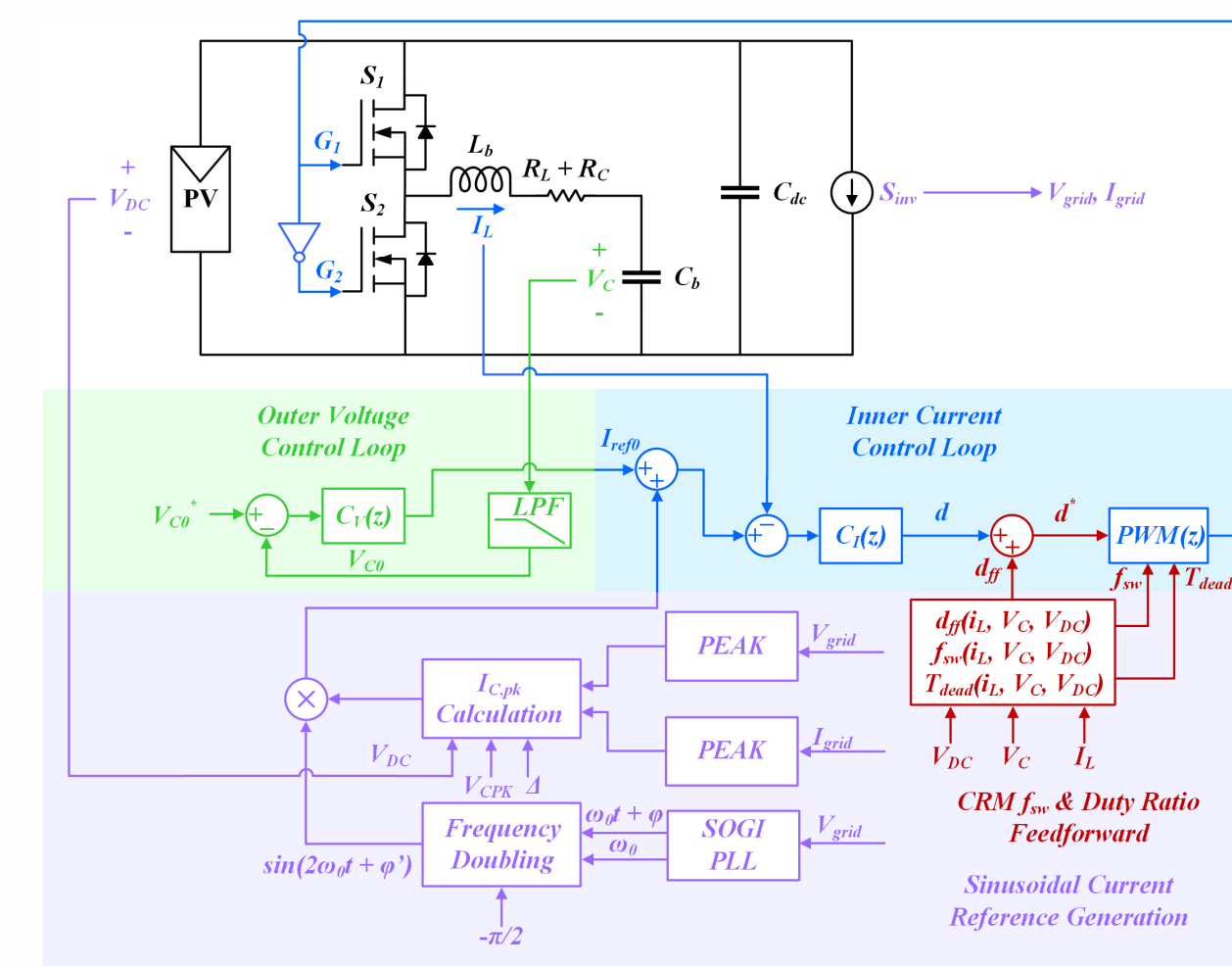


Fig. 5: Buck-PPB CRM feedback control framework

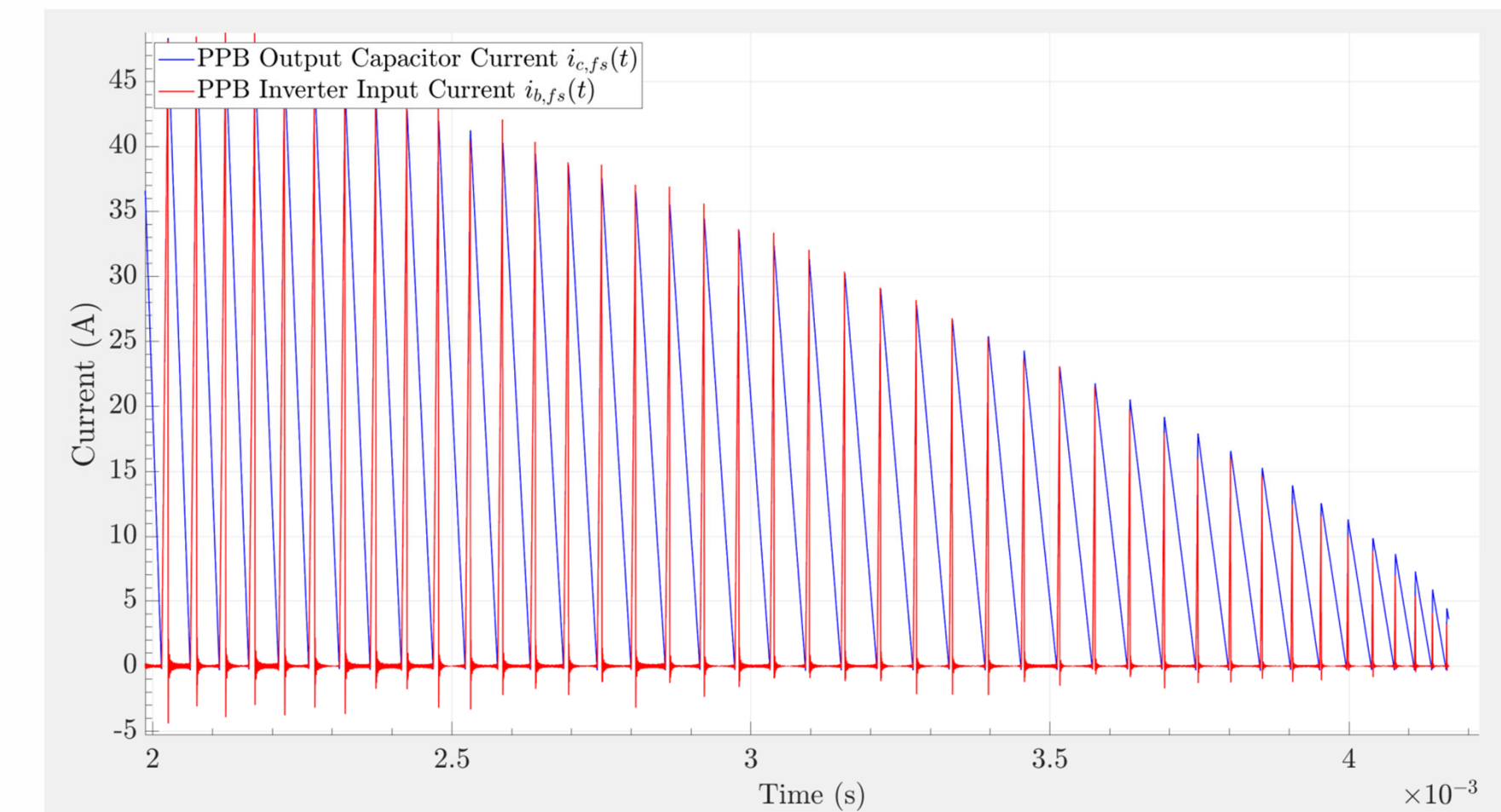


Fig. 6: Modeled/derived CRM current waveform, 20μH inductance, 60VDC/400VAr power compensation

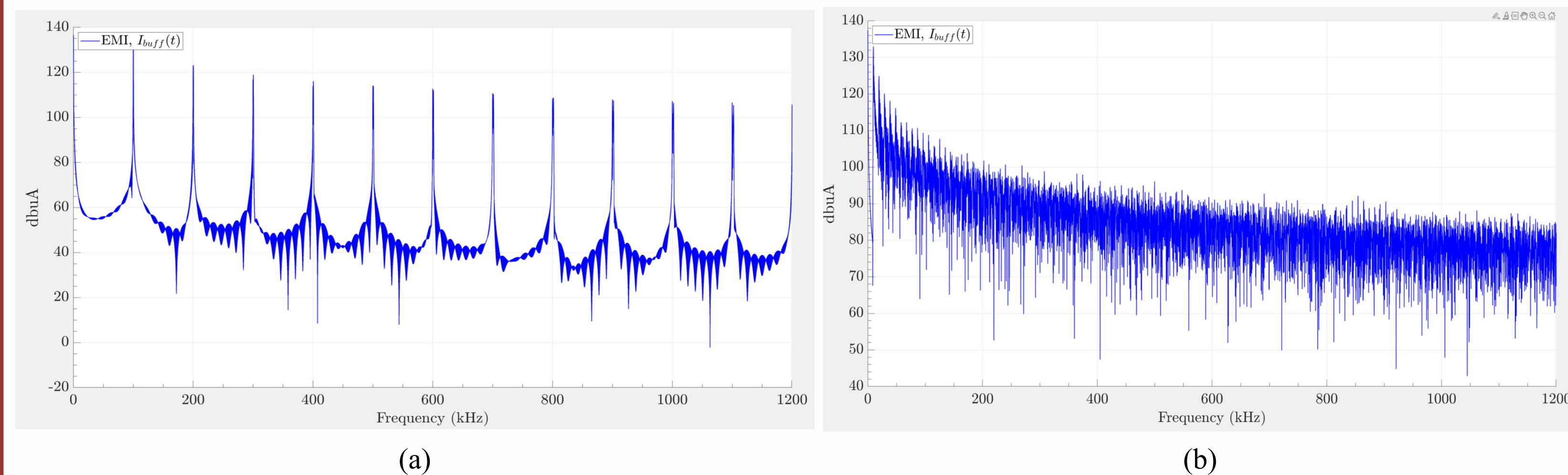


Fig. 7: Modeled differential-mode noise of buck PPB current waveform for 40VDC/400VAr power compensation, 20μH inductance (a) CCM (b) CRM

Key Contributions

Comprehensive circuit modeling of buck- and boost-derived PPB for operational waveforms, energy and reactive power compensation, thermal and power dissipation, and differential-mode current conducted emission noise under CCM and CRM feedback control. Experimental validation of common CCM reactive power compensation control framework, and defined CRM control