Application of power hardware-in-the-loop (PHIL) simulation methodology has been increasing steadily in recent years. As usage of PHIL techniques expands, PHIL methodology is being applied to several areas of power system technology. One of the main concerns in PHIL experiments is the tradeoff between accuracy, stability, and sensitivity of experiments, largely through the design of the PHIL interface. Recent work has included development of a general linear formulation for PHIL experiments, using the extended Lawrence architecture (ELA). Although in- depth analysis of the PHIL experiments in the context of the ELA framework have been provided, this has been limited to systems with one or more single phase or DC PHIL interfaces.

The work presented herein focuses on extension of this linear analysis framework to PHIL simulation experiments including multi-phase PHIL interfaces. Existing PHIL interface algorithms have been expressed using the ELA framework, as well as derivation of relevant transfer functions and metrics for assessment of performance. The analysis provided in this work can potentially be applied to systems with multi-phase interface algorithms implemented in different frames (e.g. abc, DQ0, sequence, etc.), but the focus herein has been primarily on systems employing interface algorithms implemented in the DQ0 frame. Performance is analyzed in terms of accuracy (compared to the ideal system) and stability and compared to systems employing rotating frame ’abc’ tppe inteface algorithm. It can be concluded from this work that the ELA framework can be extended to multiphase systems, and the linear analysis framework used to predict stability and accuracy of PHIL simulations is also applicable to multi-phase PHIL simulations.