Modular Multilevel Converter Based Reconfigurable Ac Load Emulator

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Background & Motivation

- The recently emerging applications such as electrified transportation, smart utility grid and clean energy development have led to growing interests in power electronics converters with higher power, voltage and/or fundamental frequency.
- The lack of suitable loads/testing equipment with flexible and wide operation range at mega-watt level significantly increases the effort, cost and time for developing such power conversion systems.
- This research work aims at developing a flexible, scalar and universal testing platform for mega-watt level voltage source converters with ultra wide operation range of voltage, current and frequency.

Challenges

- Targeting at mega-watt level, 0-1360A current, 1-25 kV voltage and 60-3000Hz operation range, the design of the power conversion stage, control system and passives need to be highly modular.
- The design is based on modular multilevel converter consisting of 288 building blocks (submodules), which requires complicated control algorithm to monitor and manage the large quantities of submodules.
- In order to safely and accurately emulate any load characteristics in real applications, high speed control system, detailed load model and a strictly followed operation procedure need to be developed.
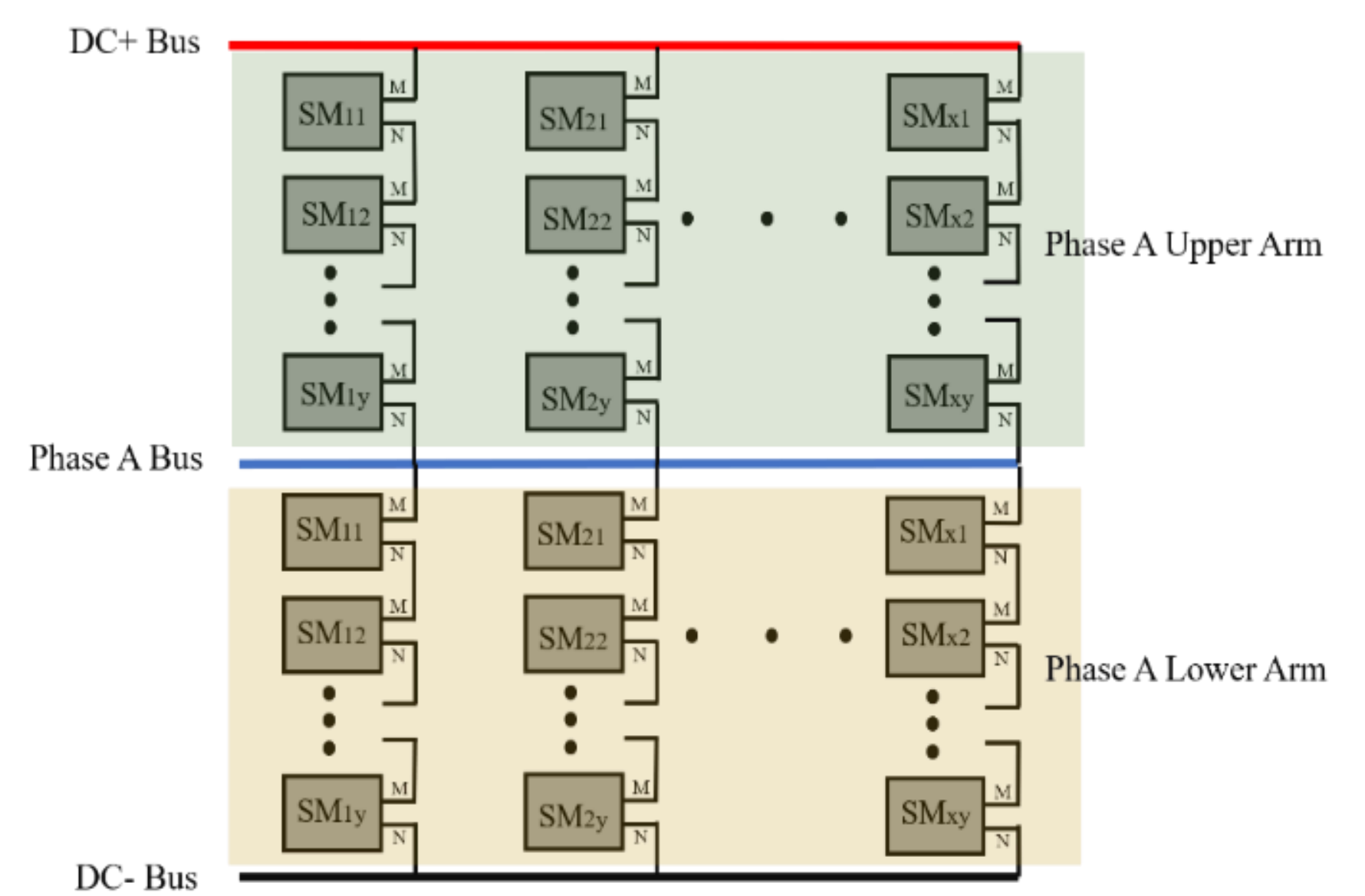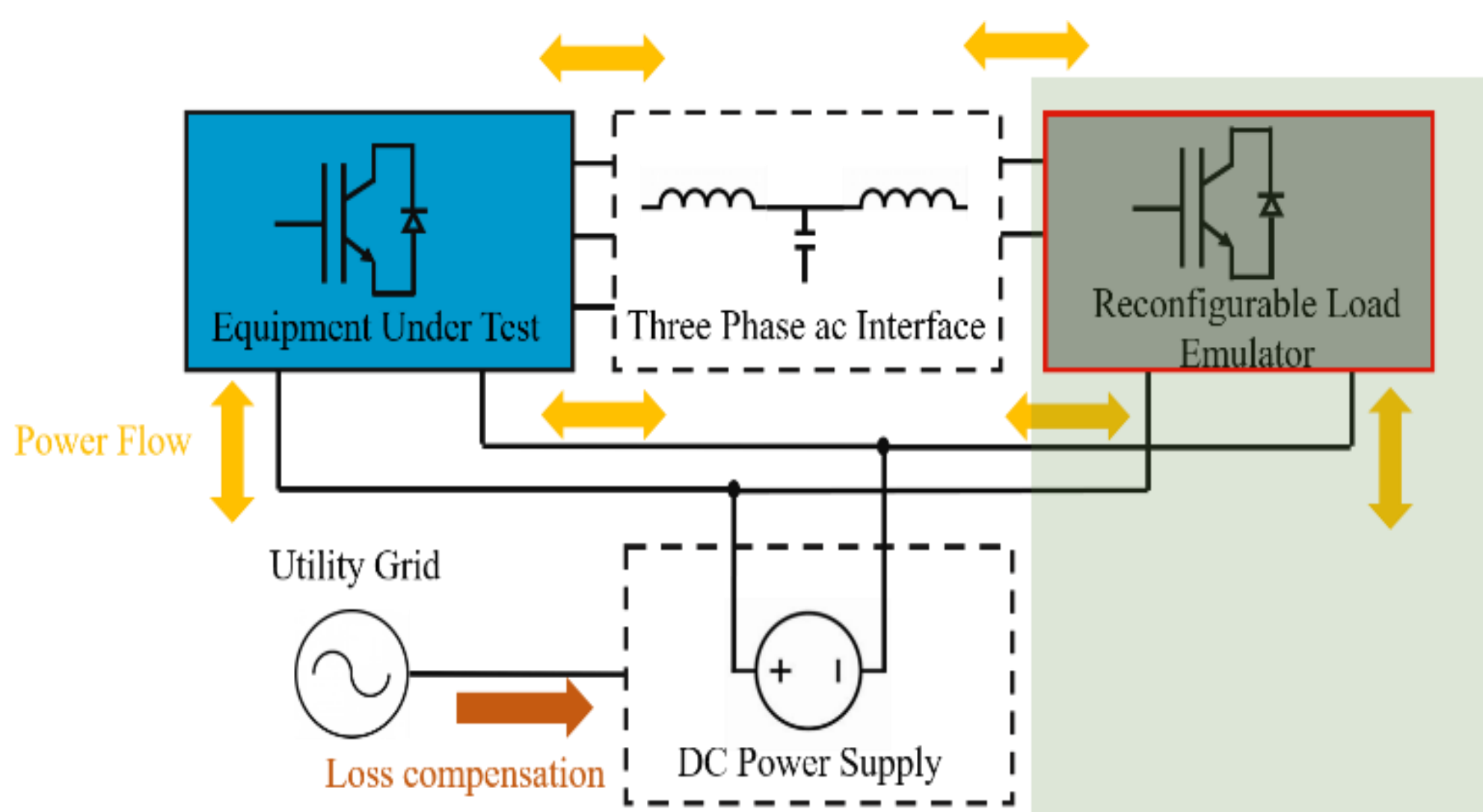
System Architecture

Fig.1 Overall testing set-up for dc/ac voltage source converters.

Fig.2 Topology of proposed load emulator (Phase A).
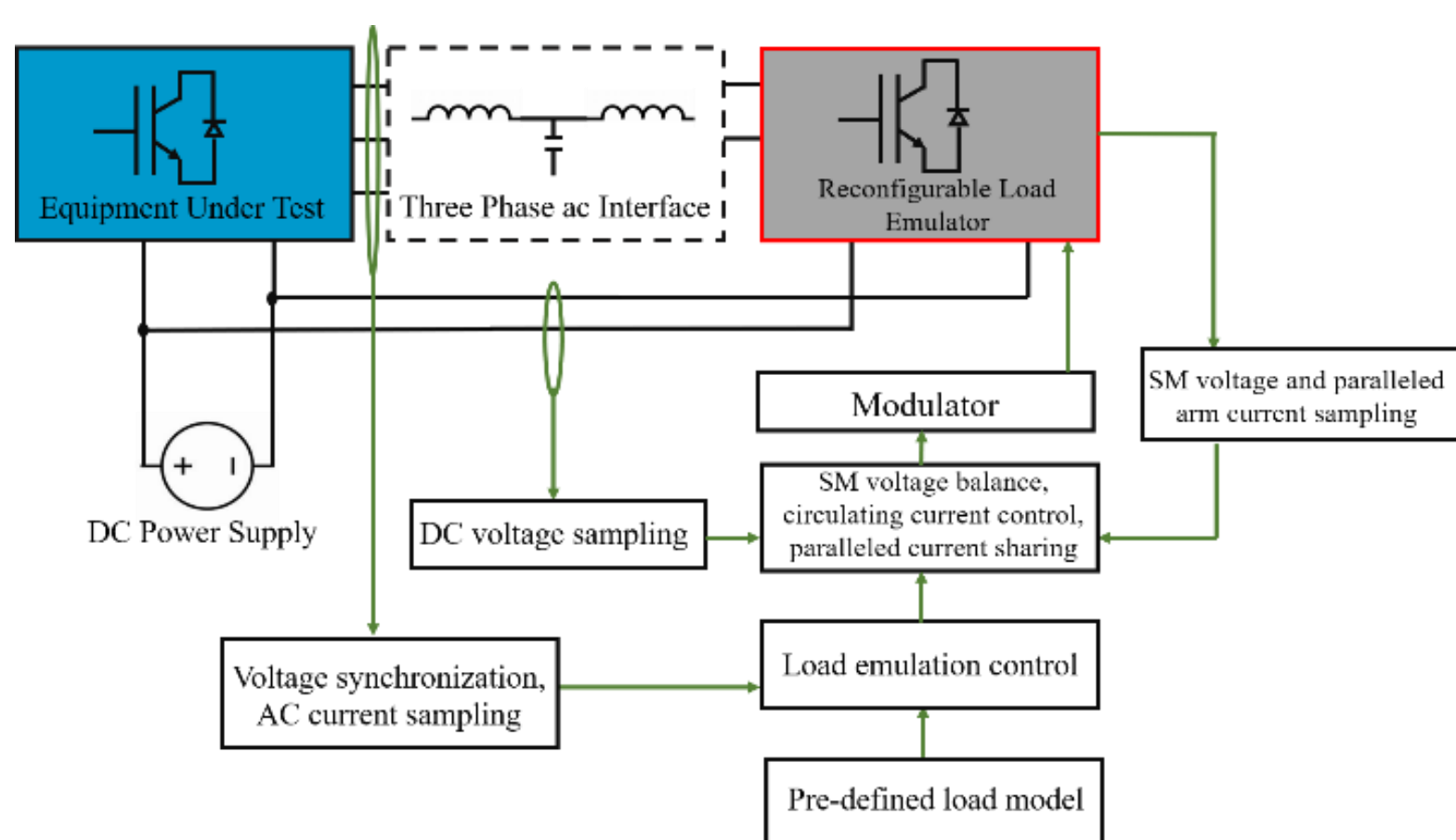
Control Diagram

Fig.3 Simplified control architecture.

Design and Integration of Modules

Fig.4 Full scale module and power cabinets.

Conclusion and Future Work

- This research work proposes a new concept to build a scalar and universal load emulator for testing high power, wide frequency and voltage range voltage source converters. Based on MMC and paralleled operation of power converters, the load emulator can be flexibly reconfigured to cover extremely wide voltage/current ratings of EUTs.
- Communication between different layer controllers implemented and tested.
- Control software designed, implemented, and real time control software testing platform built
- Control algorithm and power testing are ongoing.