Adaptive DC-Link Control of a Seven-Level Solid-State Transformer for Islanded Operation of EV Fast-Charging Stations

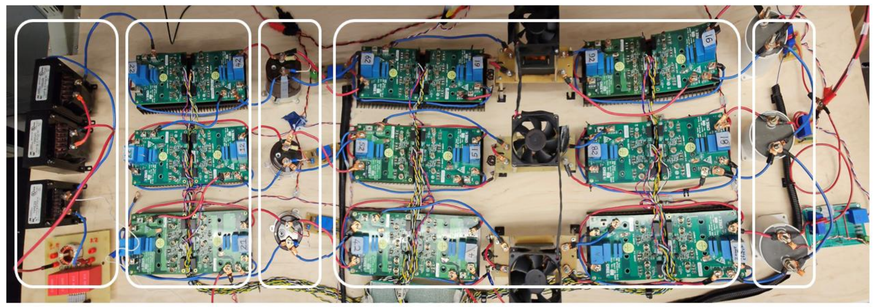
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❖ Introduction and Research Objective

During a grid outage, an EV fast-charging station could use energy stored in a stationary battery or a connected vehicle to power nearby loads. Once the station is isolated from the utility grid, its converter must establish a 60 Hz AC supply and maintain the output voltage as demand changes. This research investigates adaptive DC-link control for a seven-level solid-state transformer. The dual-active-bridge converters adjust the internal DC-link voltages according to load demand, while the cascaded H-bridge adjusts its modulation to maintain the required AC voltage. The goal is to determine how this coordinated control affects voltage regulation and efficiency during islanded operation.

❖ Seven-Level SST Architecture



❖ Controlling Equations

Power Flow in Dual Active Bridge

$$P_{DAB} = \frac{n_{tr} V_{CHB} V_{DAB}}{2 f_s L_{DAB}} D_{DAB}(1 - D_{DAB})$$

Power Flow in Dual Active Bridge

$$\theta^{ref}(t) = \int 2\pi f^{ref}\, dt, \;\; f^{ref} = 60Hz$$

Dc Link Voltage Mapping

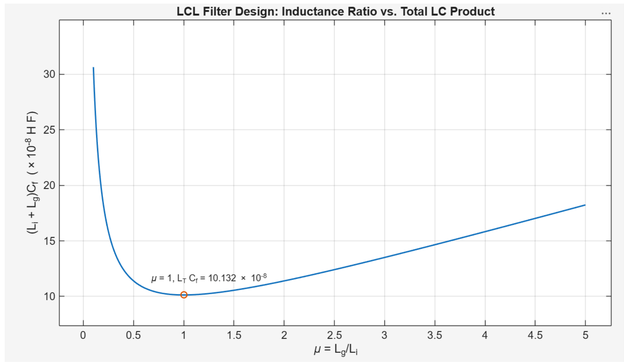
$$V_{DC}^{ref} = f(P_{AC})$$

LCL Filter calculations:

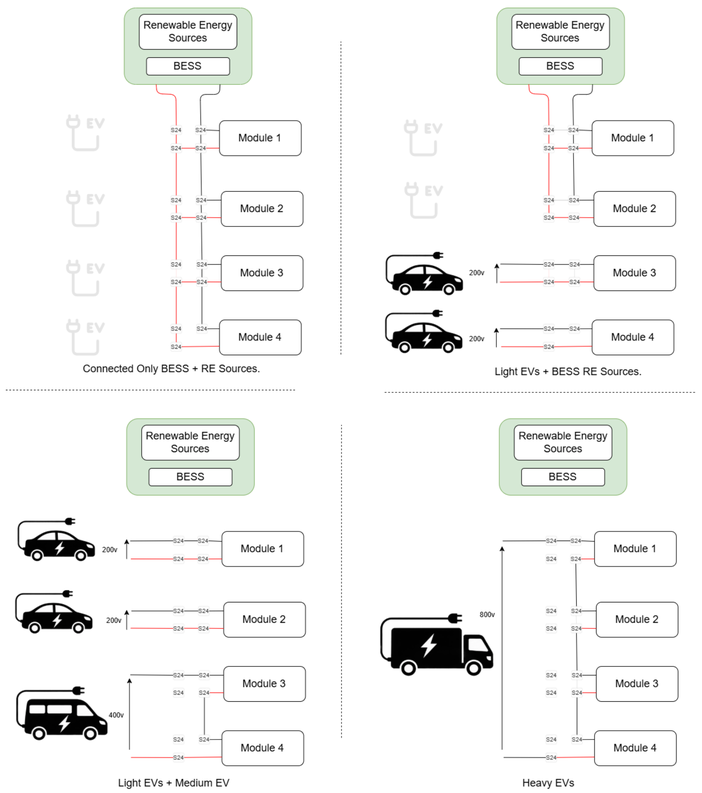
$$f_{res} = \frac{1}{2\pi}\sqrt{\frac{L_i + L_g}{L_i L_g C_f}}$$

❖ Design Stages

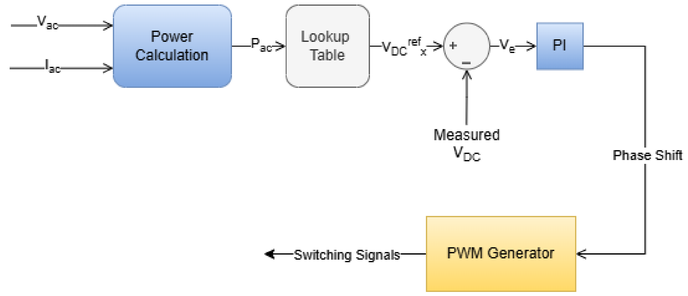
LCL Filter Design



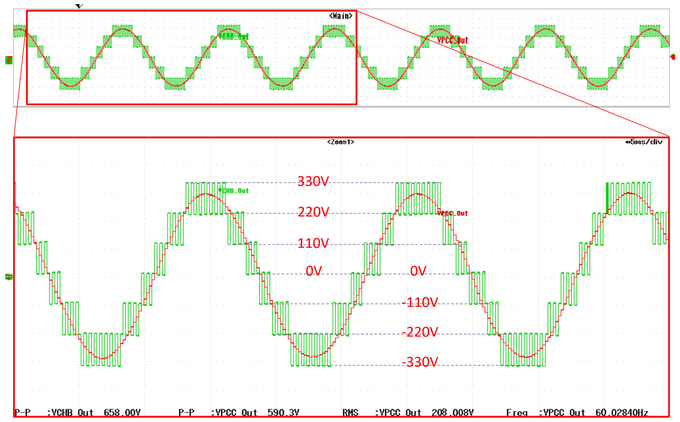
❖ EV Charging Station – Possible Configurations



❖ Controller for Adaptive DC-Link



❖ Simulation Results



❖ Conclusions

- The single-phase seven-level solid-state transformer prototype supplied **208 V AC and 453 W** to a **96 Ω resistive load** at **92.0% measured efficiency**. This steady-state result provides a baseline for evaluating how adaptive DC-link control affects voltage regulation and efficiency as load demand changes.

❖ Next Steps

Test voltage regulation. Apply identical load increases and decreases under fixed and adaptive DC-link control. Compare the AC voltage deviation and recovery time.

Evaluate performance across loads. Measure efficiency, output-voltage harmonic distortion, and voltage balance across the three DC links.

Extend to three-phase operation. Use simulation to evaluate the control strategy for a three-phase EV fast-charging station supplying local loads during a grid outage.