



Power Electronics- A Key Technology for Rail Decarbonization

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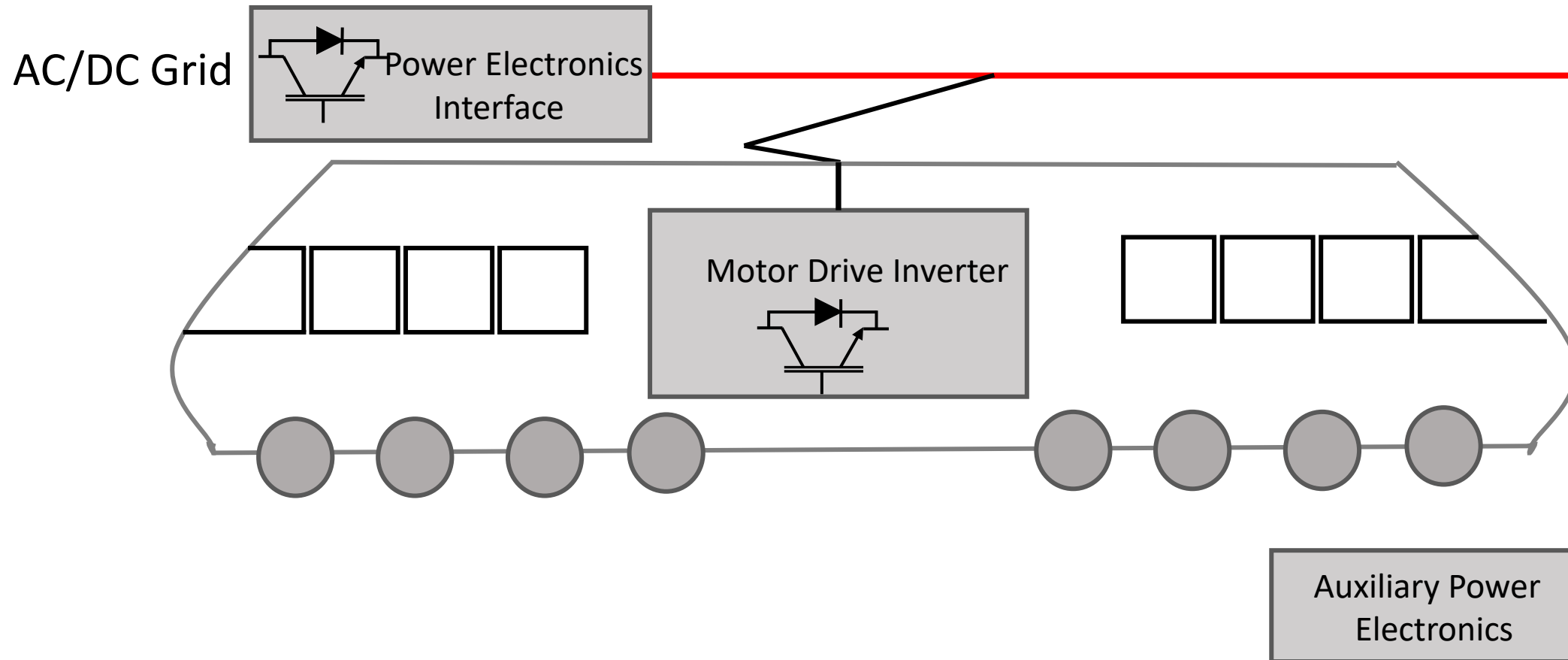
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Brief Overview:

- Scope of Power Electronics in Railway Electrification
- Projects at BCRRE:
 - Grid Unbalance Mitigation through Power Electronics Autotransformers (PEAT)
 - Grid forming EV charging infrastructure from Railway Reserve Capacity
- Other Potential Areas of Research

Scope of Power Electronics in Railway Electrification





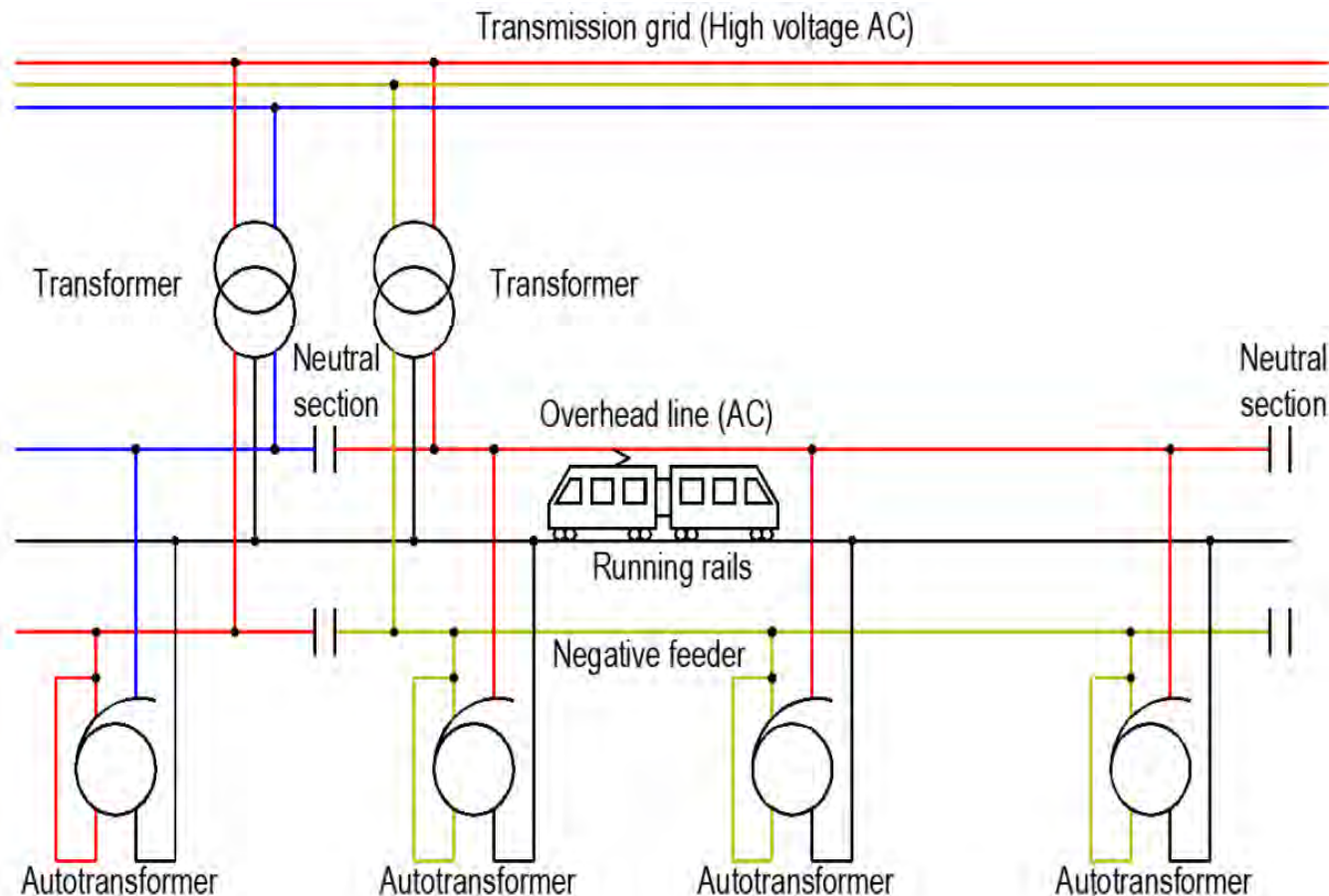
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Grid Unbalance Mitigation through Power Electronics Autotransformer (PEAT)

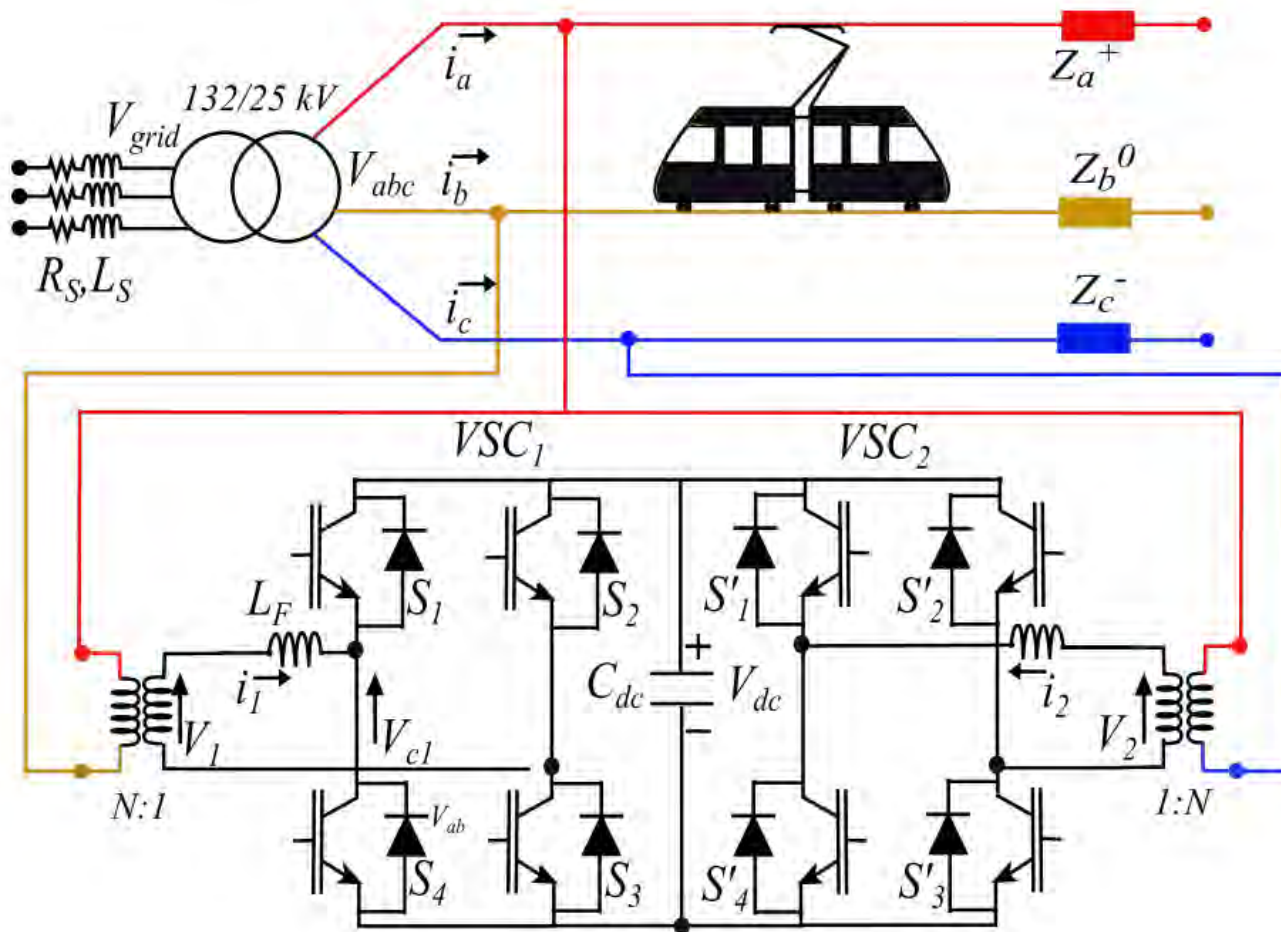
2×25 kV AC Railway Power Supply



Main Concerns:

- Grid current unbalance caused due to unequal loading of phases.
- Neutral sections hamper the speed profile.
- Auto-transformers cause reactive power loading.

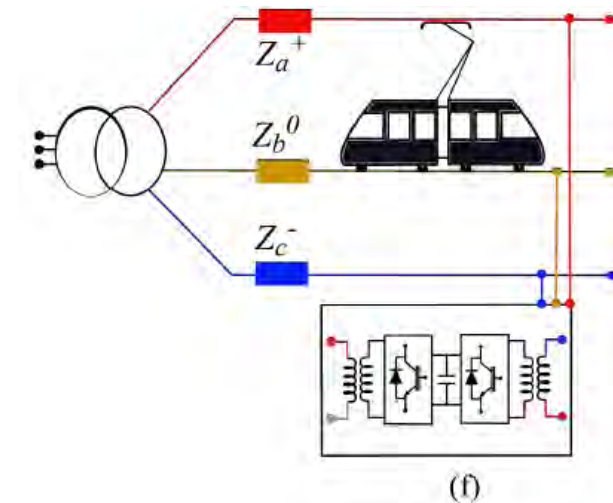
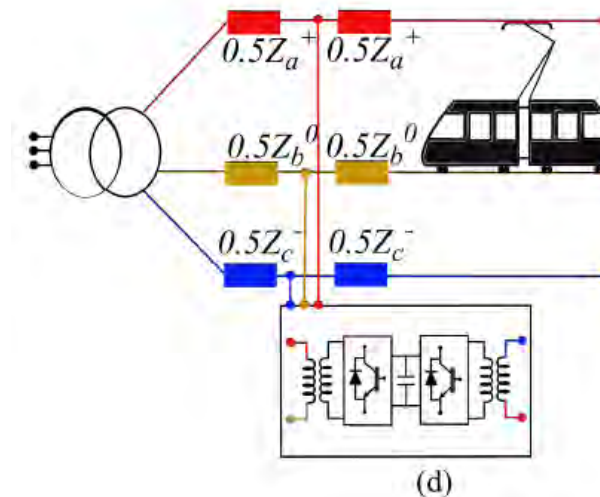
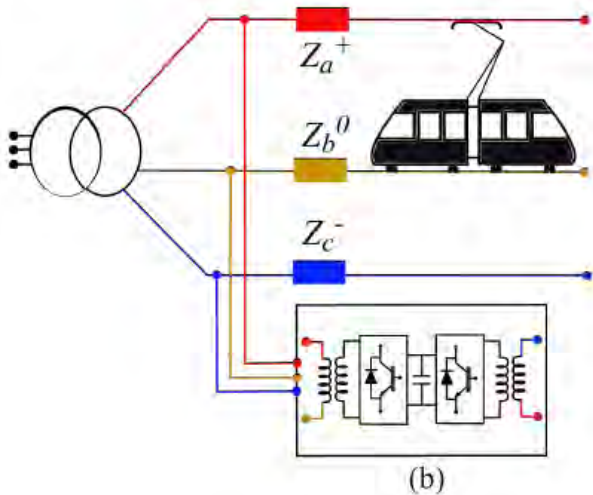
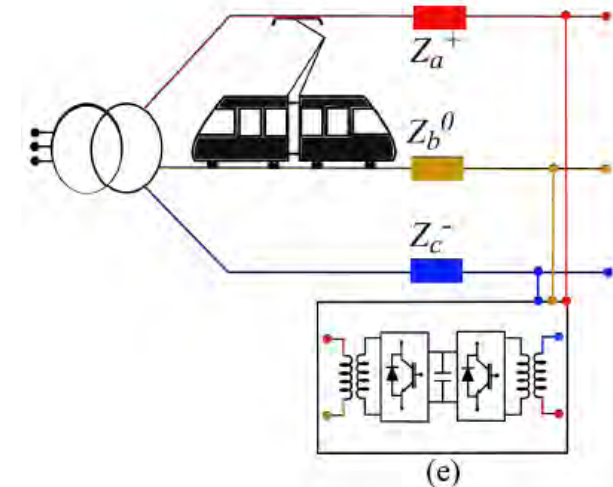
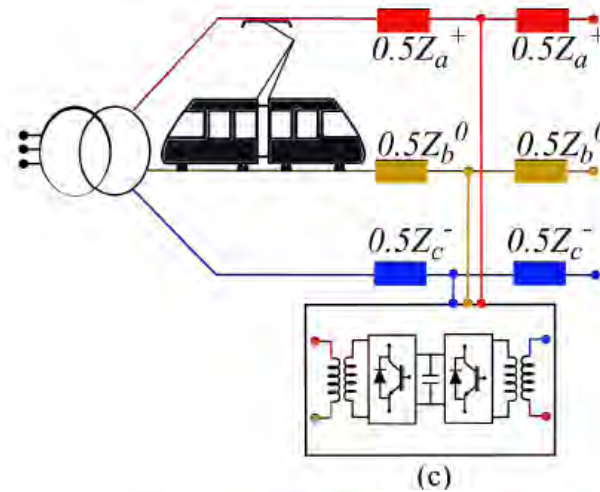
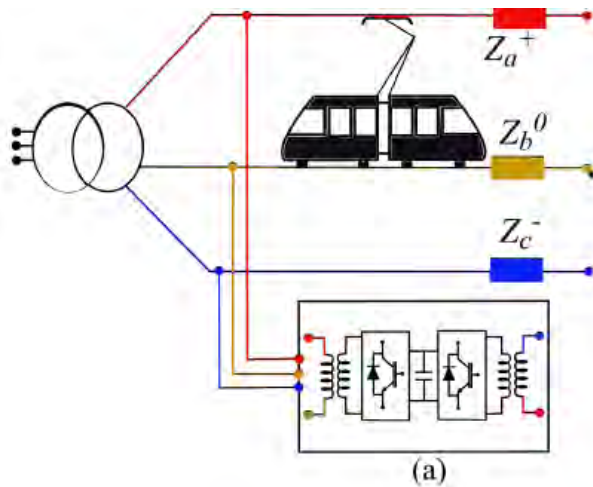
3×25 kV Railway Supply with Power Electronics Autotransformer (PEAT)



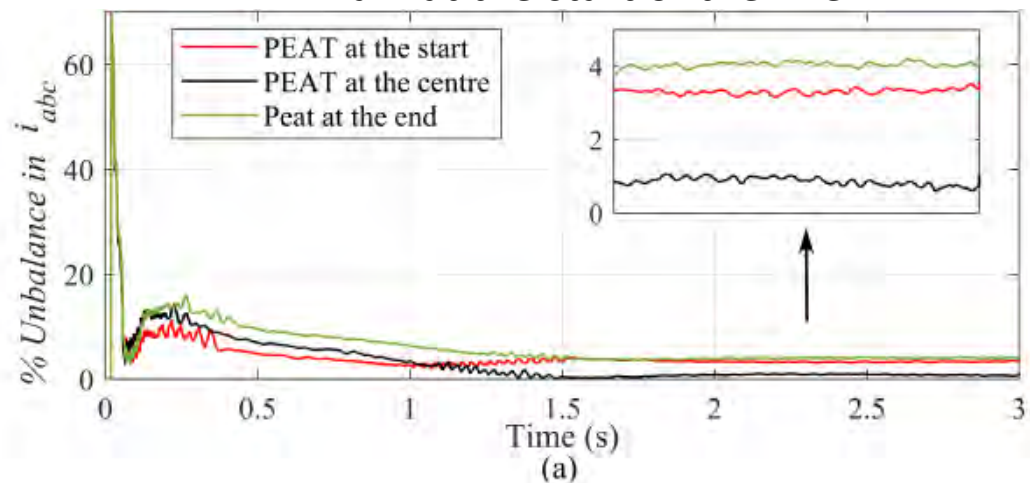
Key Features:

- Three-phase transformers instead of split phase/ Scott connections
- Back to back converters act as a compensator on the system and maintain three-phase grid current balance
- Neutral sections can be eliminated

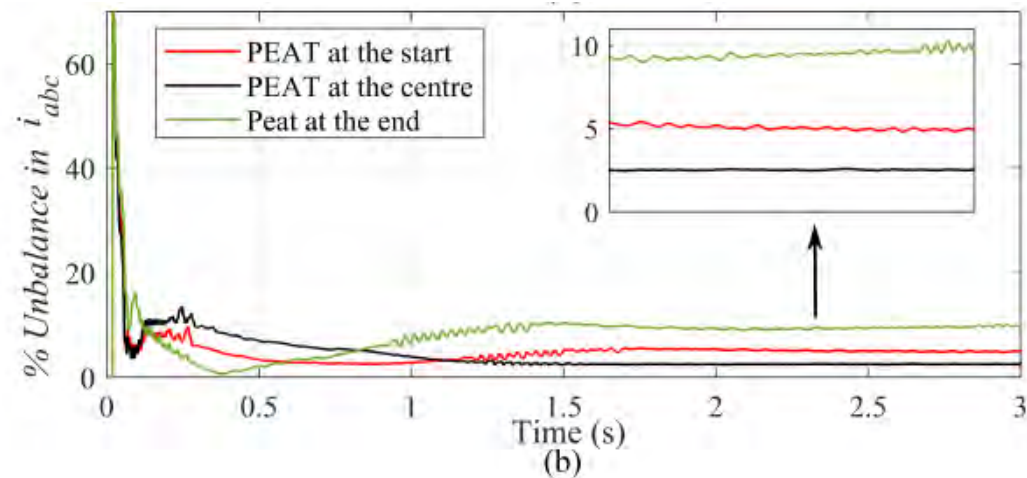
Optimal Positioning of Power Electronics Autotransformer (PEAT)



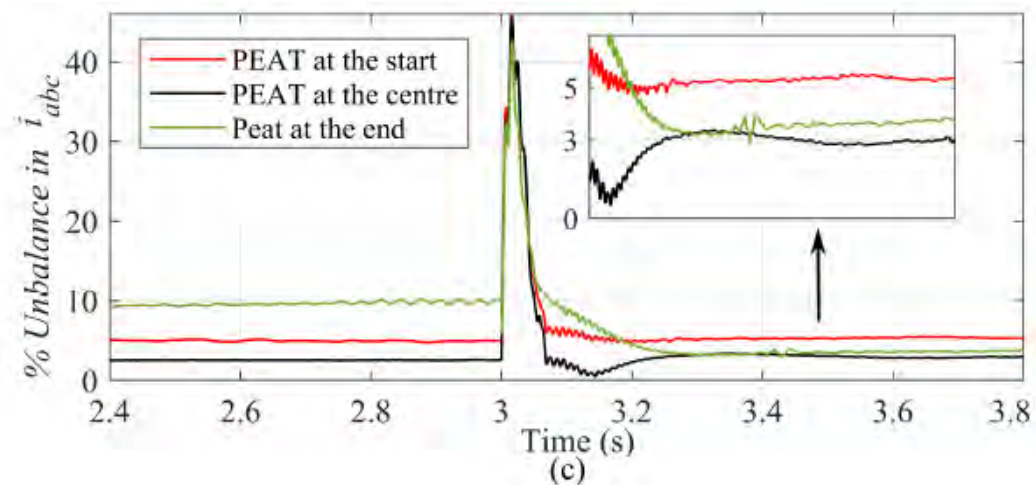
Train at the start of the line

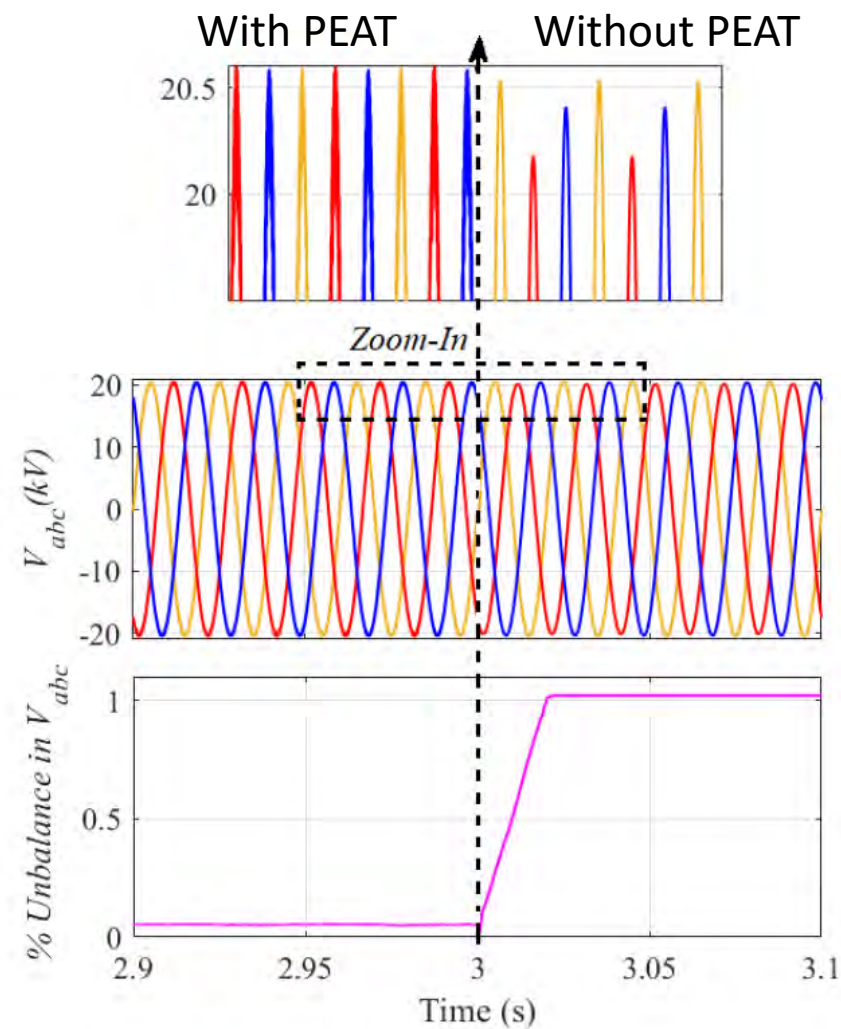
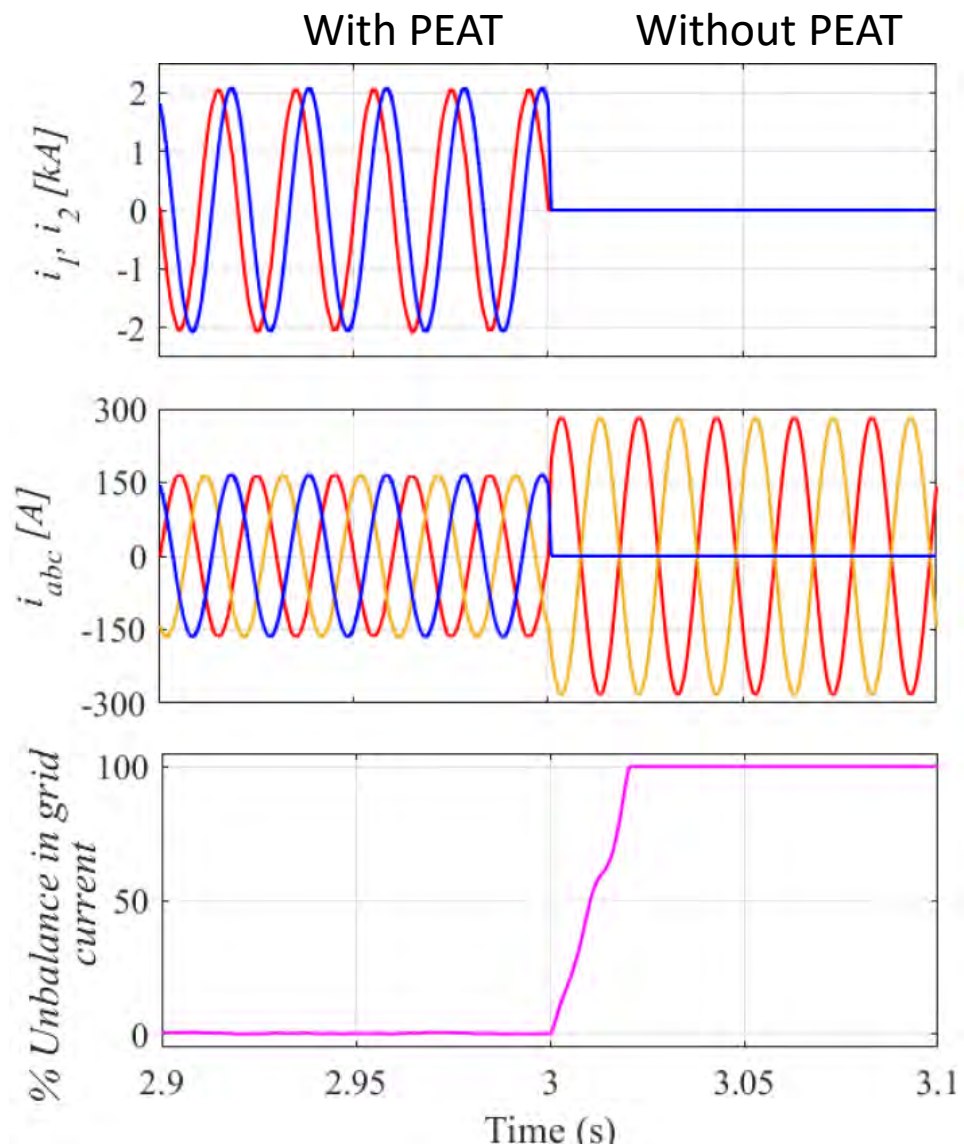


Train at the end of the line



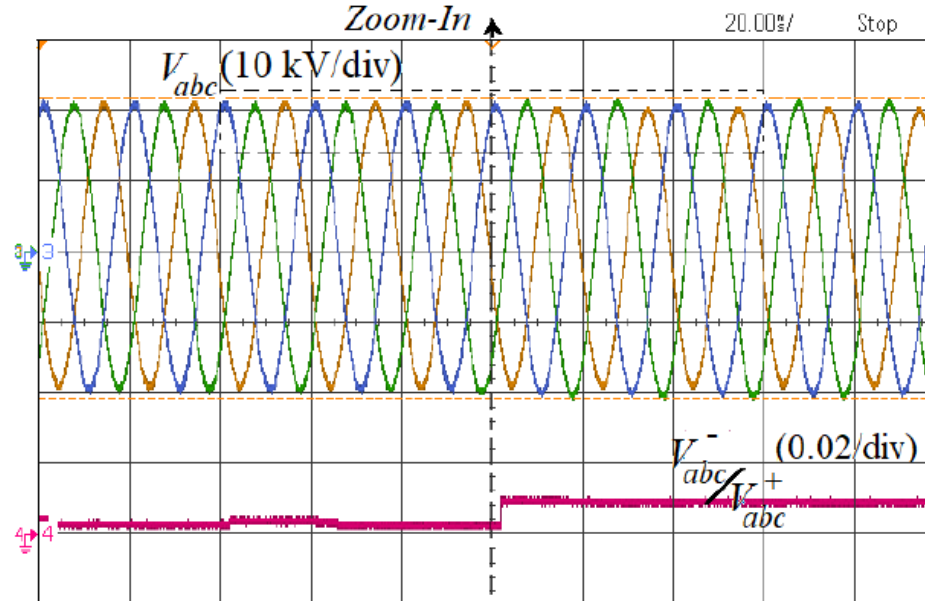
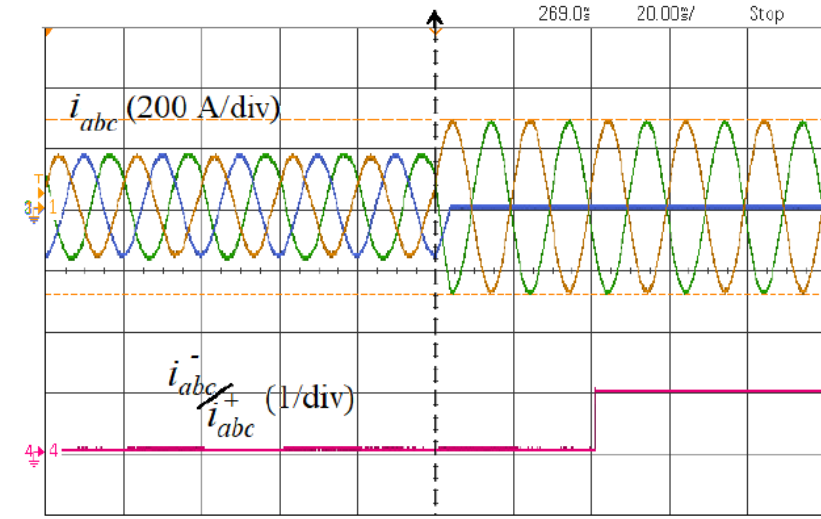
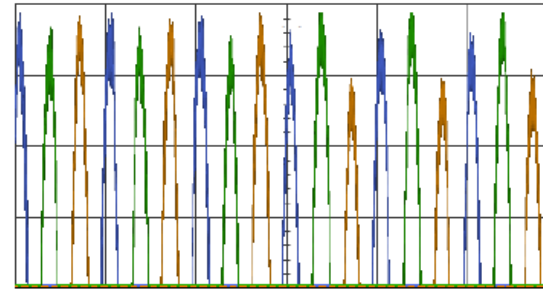
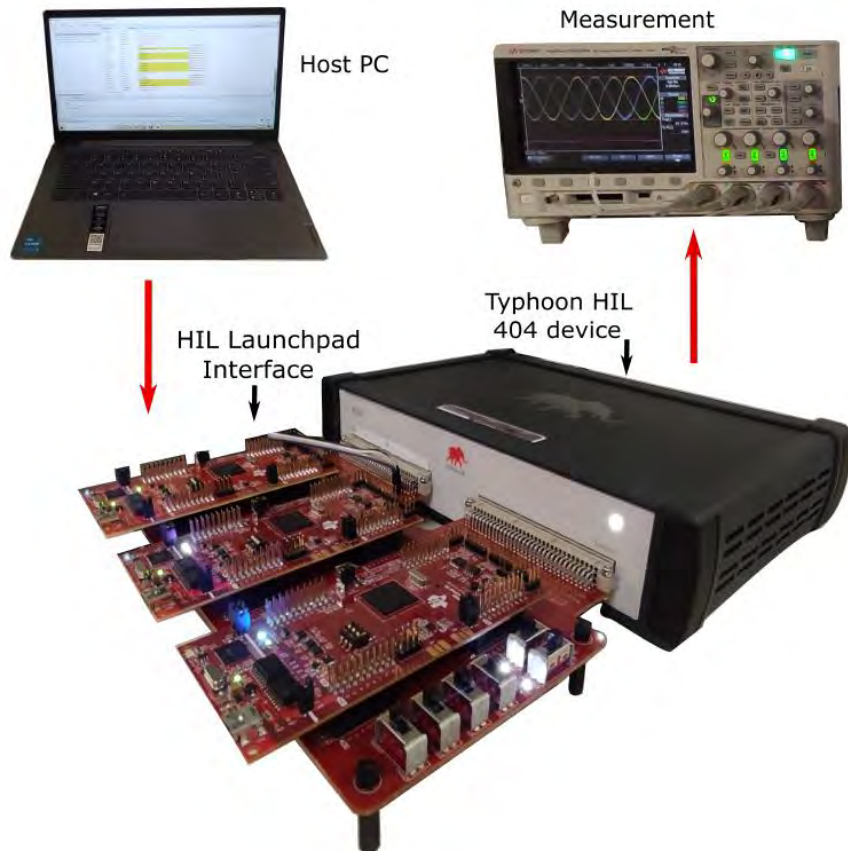
Dynamic train loading







Hardware in Loop (HIL) Implementation



V_{abc}^- / V_{abc}^+ (0.02/div)

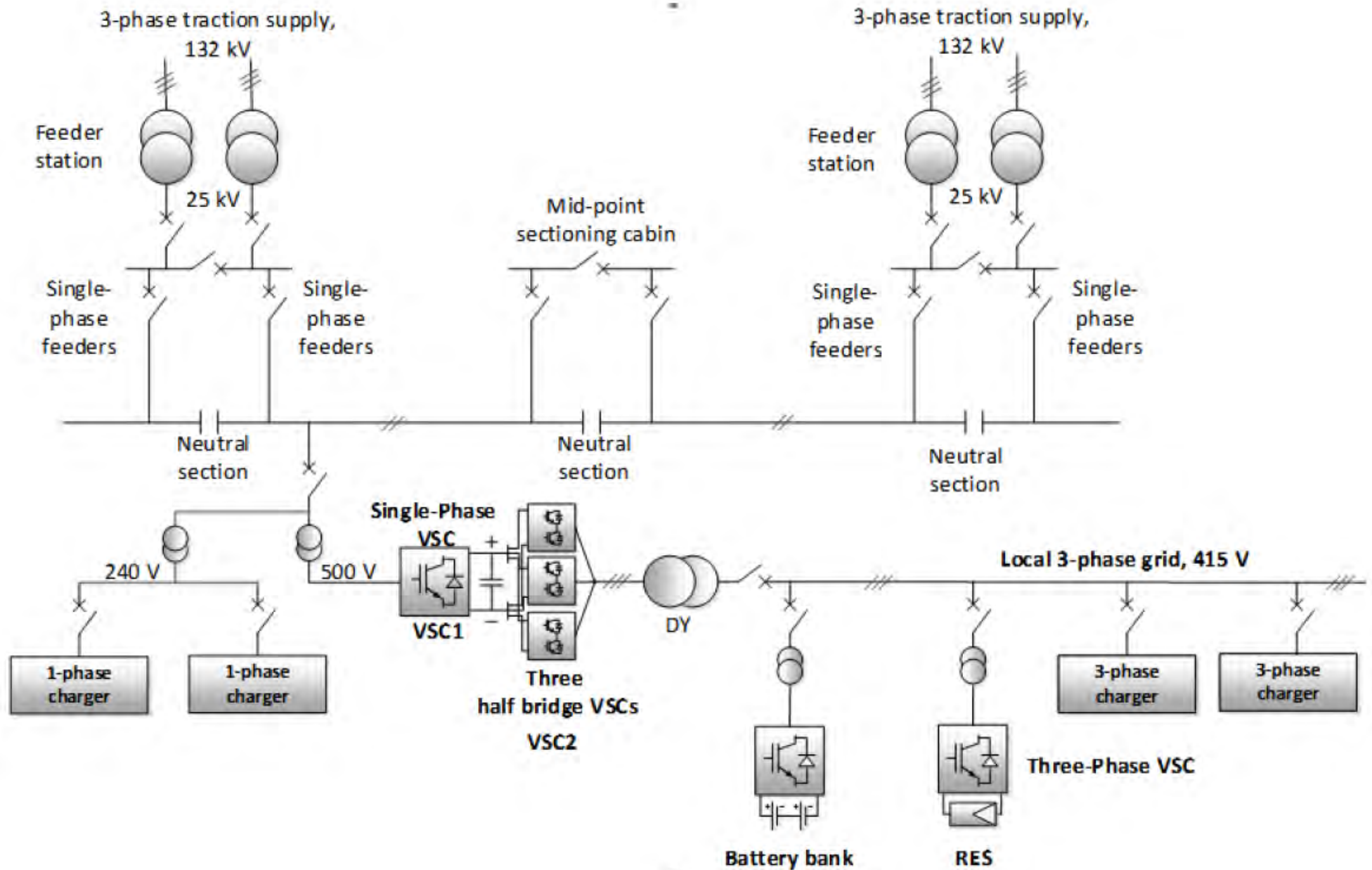


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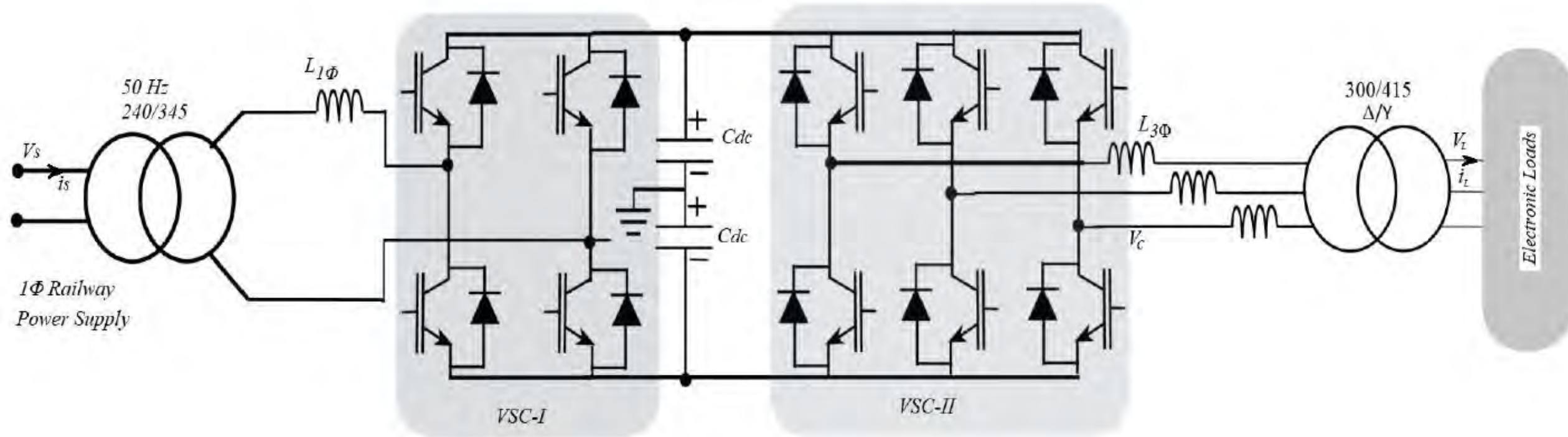


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Grid forming EV charging infrastructure from Railway Reserve Capacity

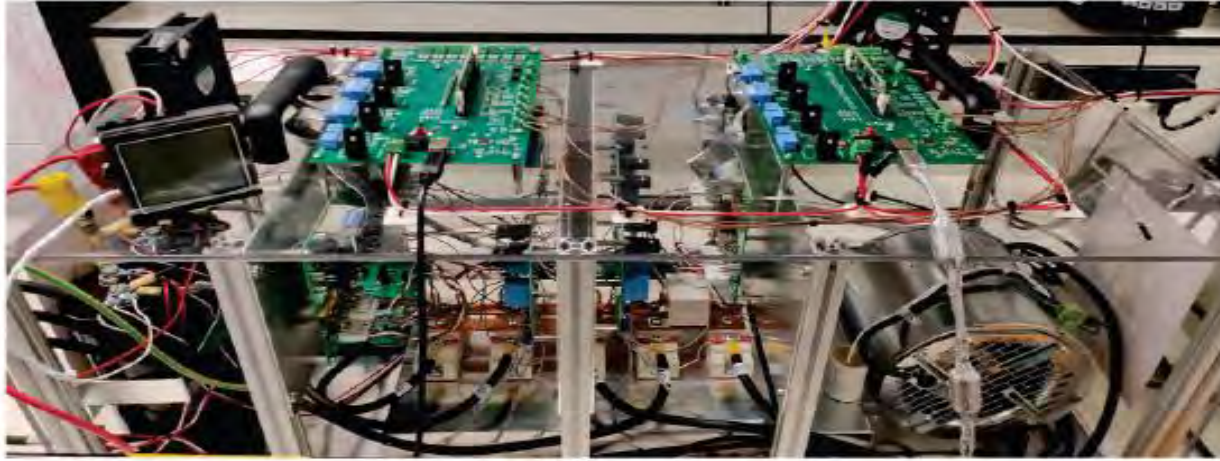


1-phase to 3-phase grid forming power converters



Laboratory prototype at BCRRE, UoB

VSCs with Control Units



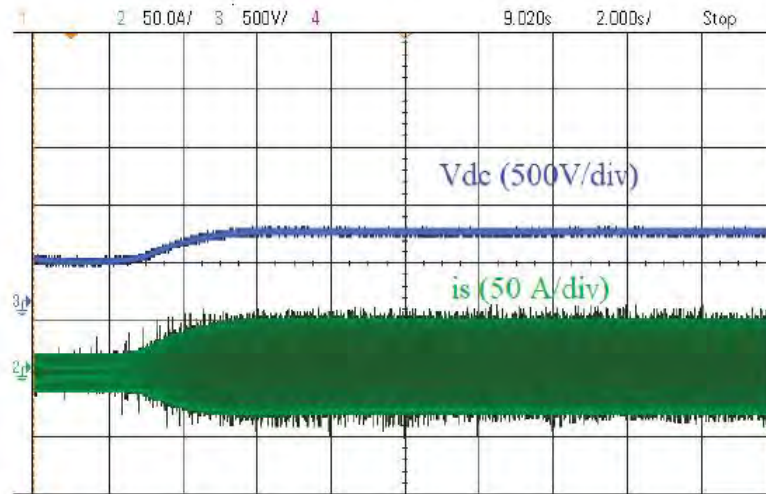
*Interfacing Inductors
and Transformers*



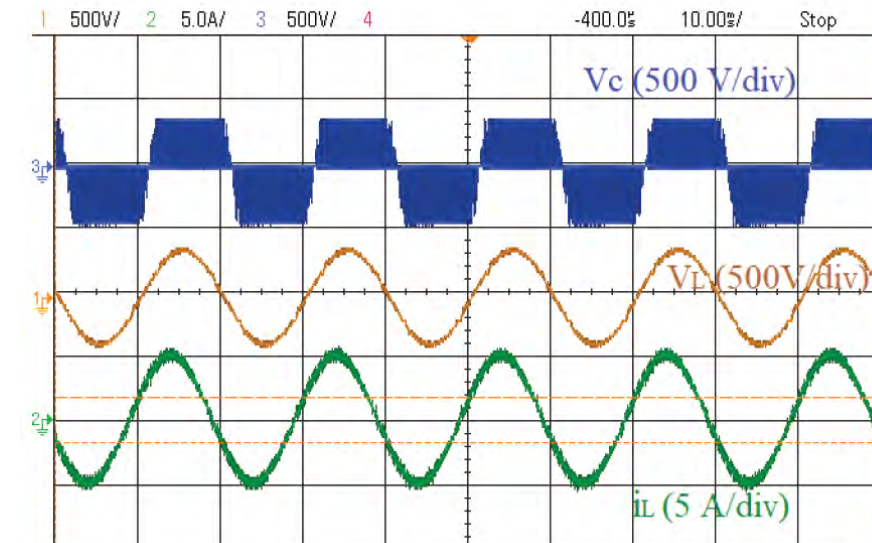
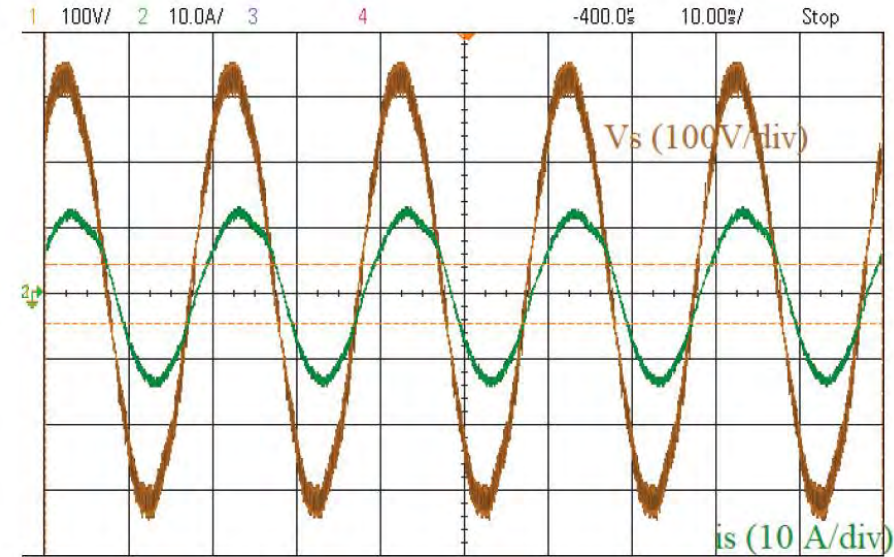
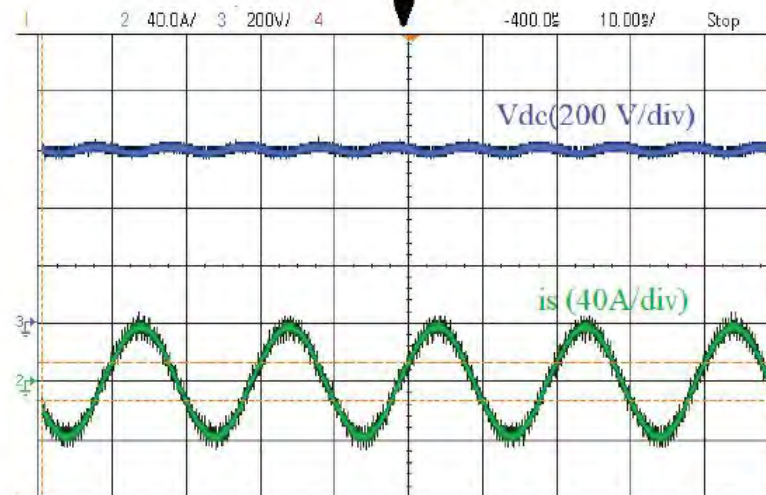
*Alfen Electric Vehicle
Supply Equipment*

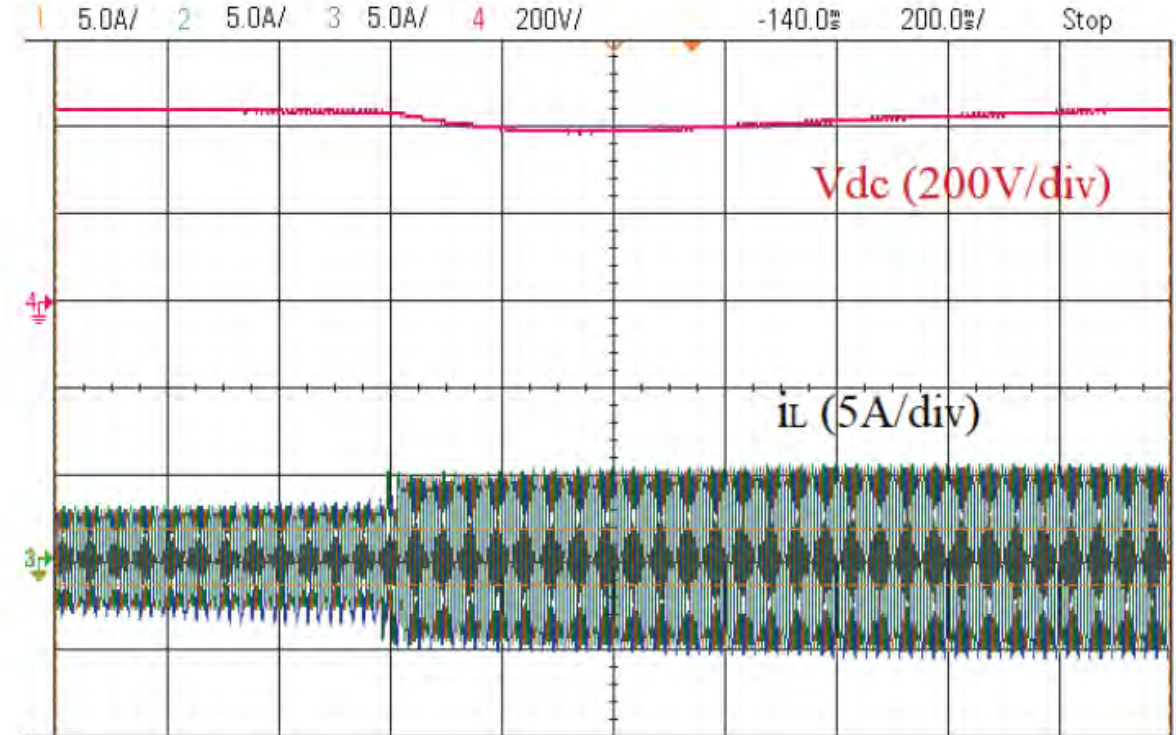
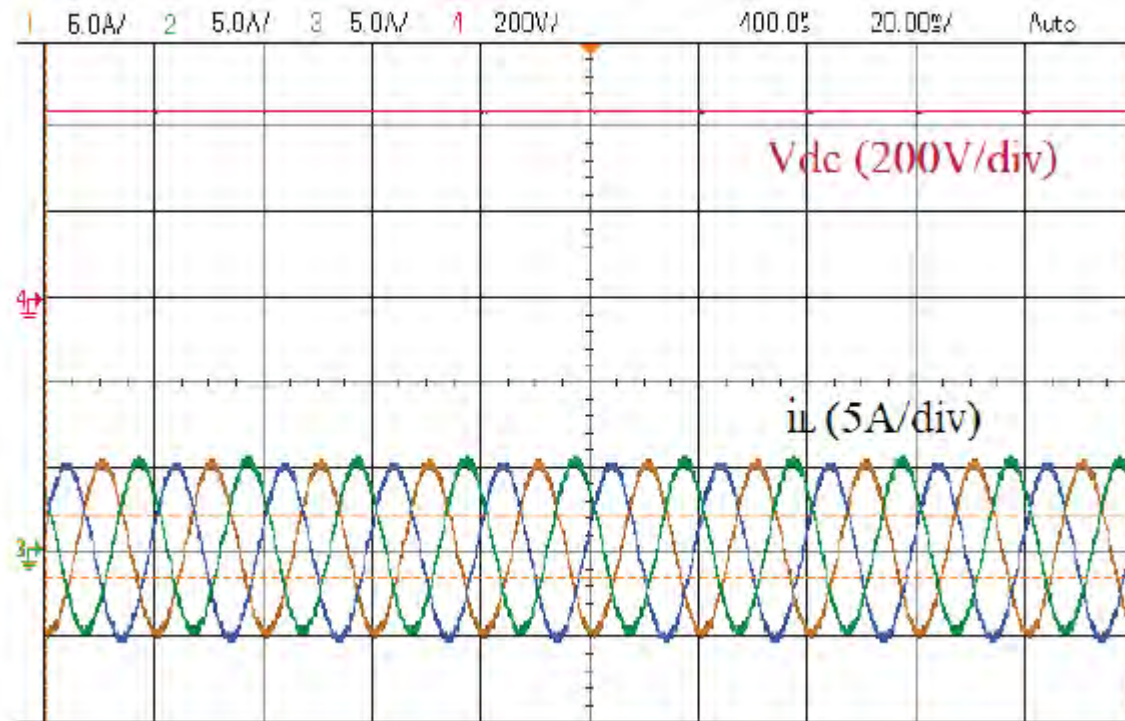


Programmable Electronic Loads



Zoom In







Other Potential Areas of Research

- Utilization of braking energy in decelerating trains to support weak local grids
- Multi-phase drive systems for traction motor control
- Energy efficiency of power electronics in traction systems



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Thank You!