PACCAR E-Truck Charging Subsystem Development

PACCAR Electric Truck Challenge

- The University of Washington E-Truck Registered Student Organization (RSO) is undertaking a four-year project to convert a a diesel truck into a battery electric vehicle (BEV) by 2027.
- Our team focused on high level implementation for charging and LV power distribution.

E-Truck

- This is a multi-year collaborations between the RSO, PACCAR, and multiple capstone teams

Figure 1 shows the provided Peterbilt 337 to convert to electric vehicle.

Figure 1. PACCAR E-Truck

Objective and Requirements

- Finalize high level concepts of the charging system
- Define charging strategy and implementation
- Simulate all charging strategies
- Define safety requirements for the system
  - Develop a living document for safety requirements
- Document work for future use by capstones and the RSO

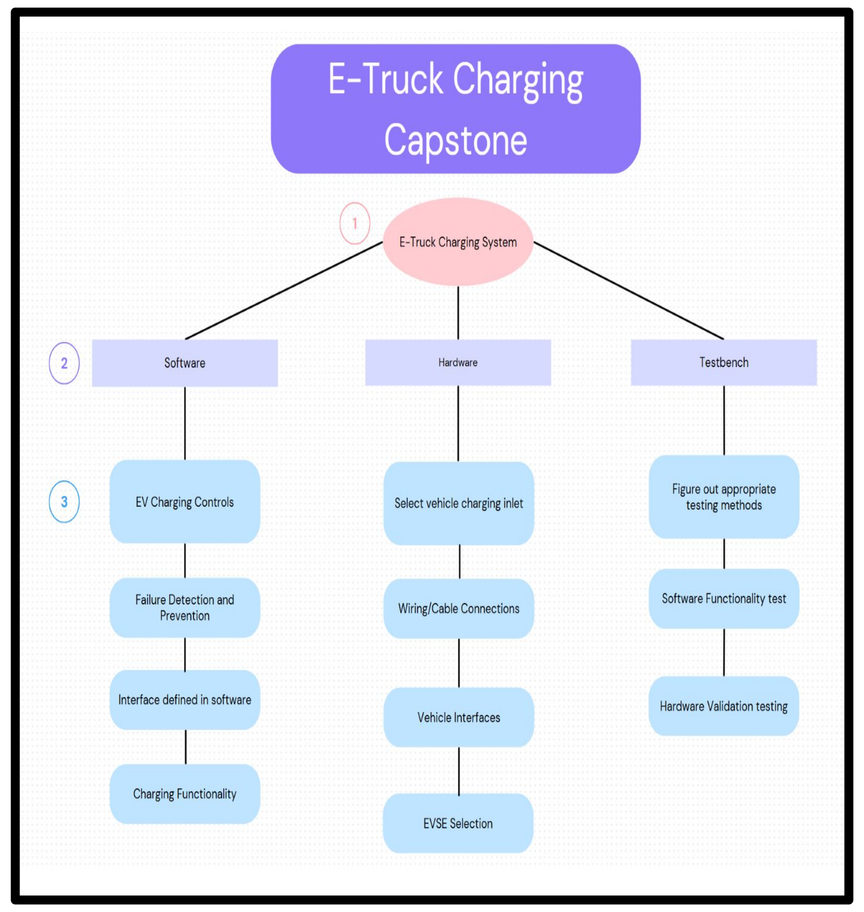

Figure 2. Initial Work Breakdown Structure

System Design Approach

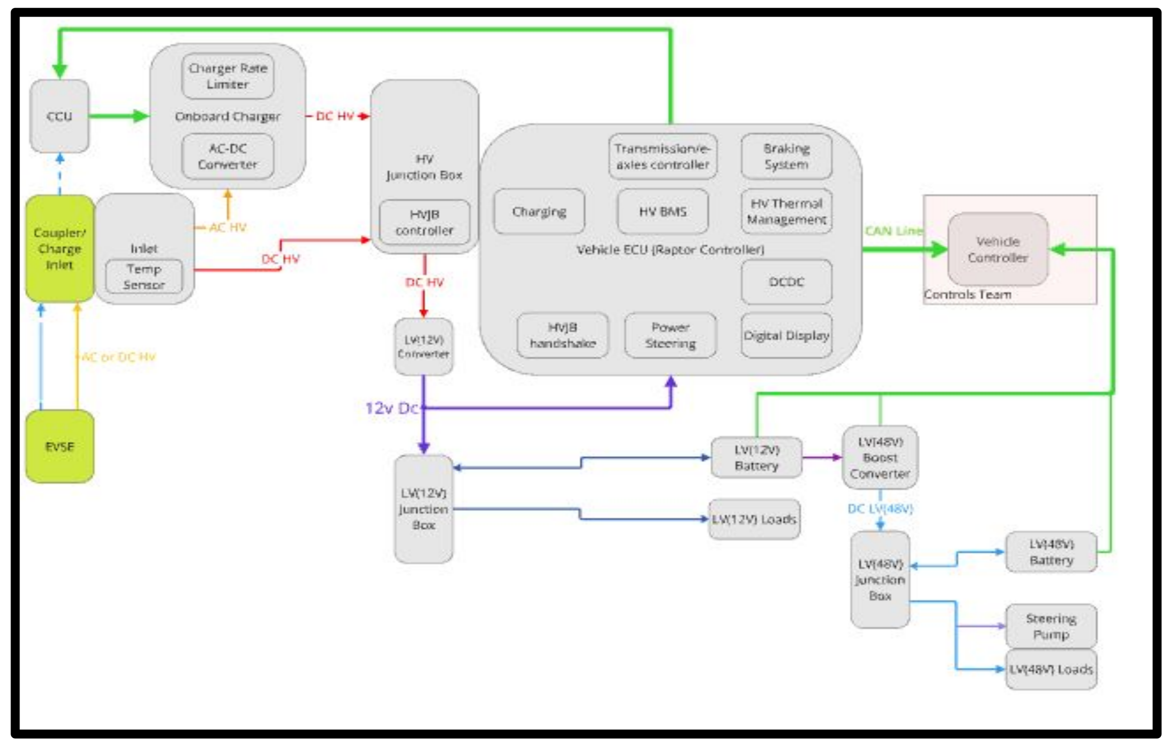

Figure 3. Charging Boundary Diagram

- Focused on the high-level design of the truck's charging system
- Created boundary diagrams to show the different subsystems
- Designed simulations for the high and low voltage systems

Low Voltage Simulation

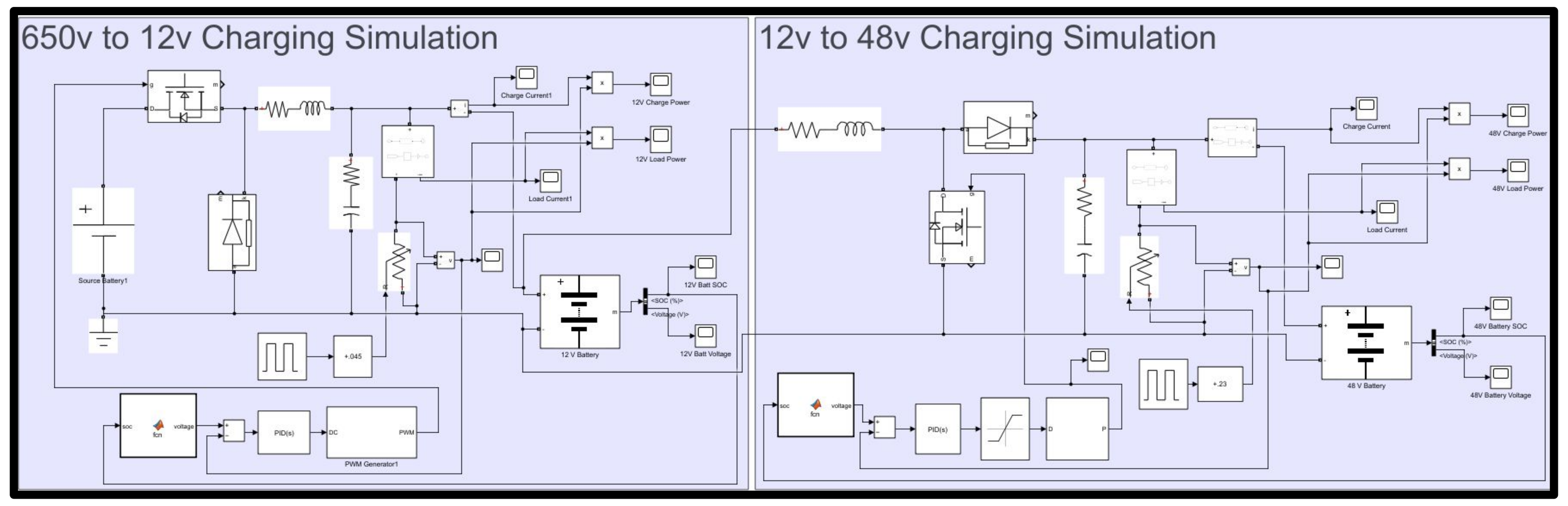

Figure 4. Full Low Voltage Charging Simulink Model

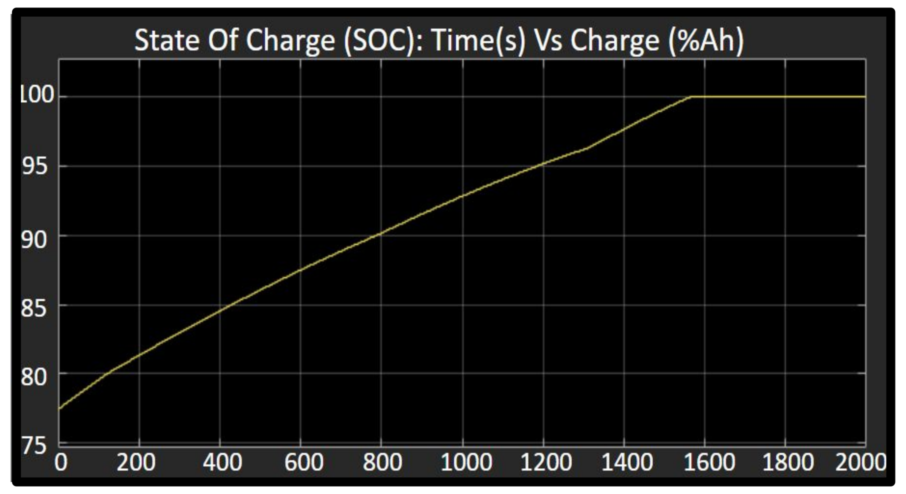

Figure 5. Low Voltage 12V battery SOC vs Time

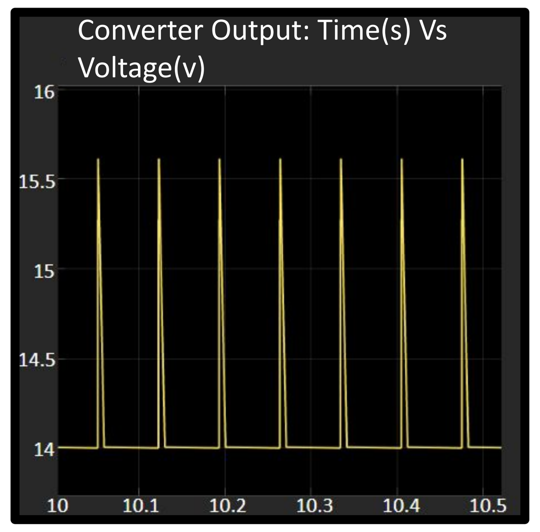

Figure 6. Buck Converter Output and Ripple Voltage

Figure 4 shows the full charging system of the 48V and 12V buses.
Figure 5 shows a 33 min charging simulation of the 12V battery.
Figure 6 shows a 0.5s segment of the 650V to 12V buck converter output/ripple voltage simulation.

High Voltage Simulation

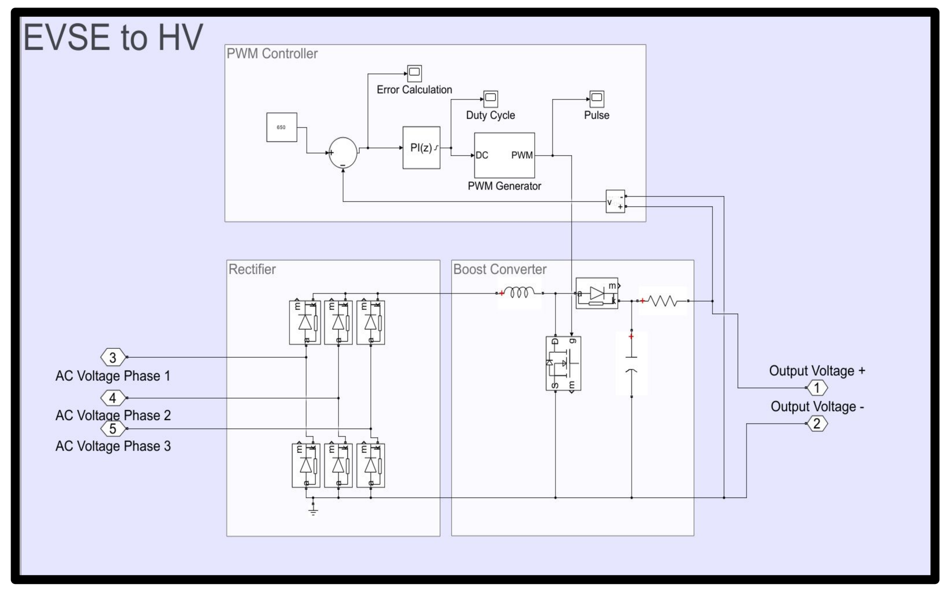

Figure 7. Onboard Charger with PWM Controller

Figure 7 shows the onboard charger circuit with the PWM controller, rectifier, and the board connector.

Figure 8 shows the controllers interface with the high voltage battery, controlling the start/stop signal and the AC/DC switching logic.

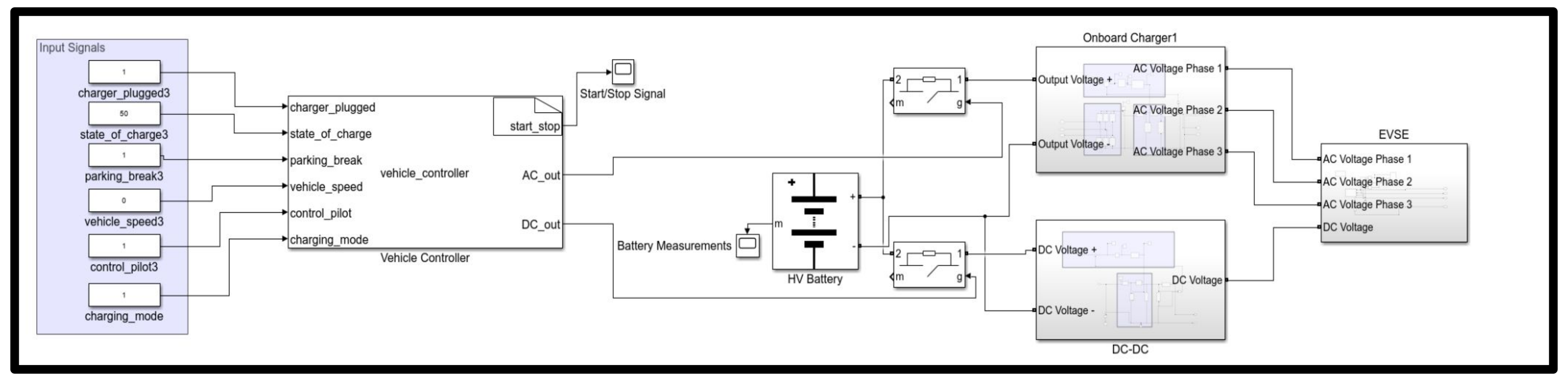

Figure 8. Controller Interface Simulation

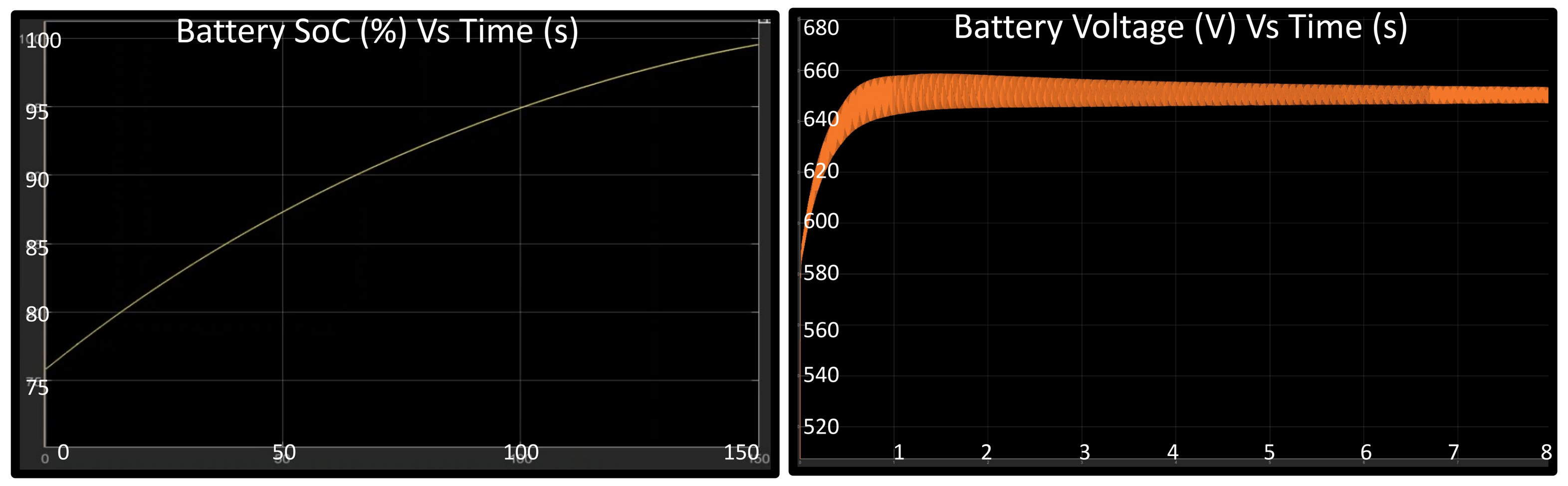

Figure 9. SoC [left] & Voltage [right] Simulation Result

Future Work, References, and Acknowledgments

Future Work

- Plan and make physical connections between the vehicle's charging inlet and the HV system
- Implement charging controls for both the HV and LV systems

Contributors

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References

[1] SAE J2931: *Digital Communications for Plug-in Electric Vehicles*
[2] ISO 15118: *Road vehicles – Vehicle to grid communication interface*
[3] IEC 61850: *Standard Based Integrated EV Charging Management in Smart Grids*

ELECTRICAL & COMPUTER ENGINEERING
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