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THE XL-CONNECT PROJECT: QUANTITATIVE PARAMETRIC MODELS FOR ASSESSING THE INFLUENCE OF V2X ON BATTERY DEGRADATION IN ELECTRIC VEHICLES

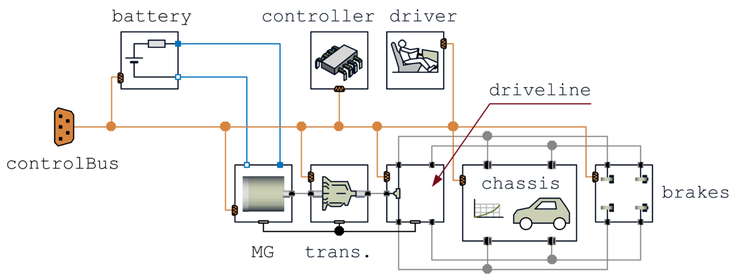
Overview

For degradation mechanisms caused by V2X operations, a deeper understanding is needed because the lifespan and performance of EV batteries are affected by various factors such as high-power cycles, frequency of charge/discharge cycles, and operating temperatures.

The XL-Connect project deals with the development and implementation of quantitative parametric models for assessing the influence of V2X on battery degradation in EVs.

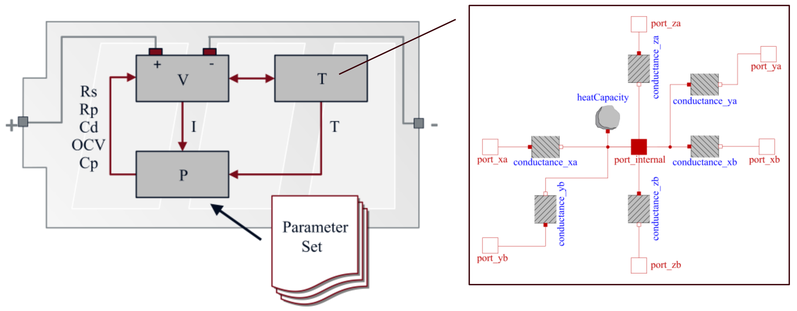
The investigation of various smart charging and V2X scenarios is made possible by setting up a comprehensive, physics-orientated EV model consisting of several subcomponent models to simulate the EV behavior and the occurring effects on the EV battery during operation and smart charging.

The physics orientated EV model developed in Modelica includes a parametric electro-thermal battery model and considers beside the HVAC system (as main auxiliary component of the EV) all driving resistances of the vehicle.



Parametric electro-thermal battery model

The parametric electro-thermal battery model can be structured in an electric part (V), in a thermal part (T) and in a parameter adaption part (P). The electric model (V) is used to map the dynamic material characteristics from the battery to an electric equivalent circuit. The thermal model (T) is used to consider thermal aspects during operation whereas the parameter adaption block (P) calculates the electric, thermal and aging dependencies based on the internal battery parameters.



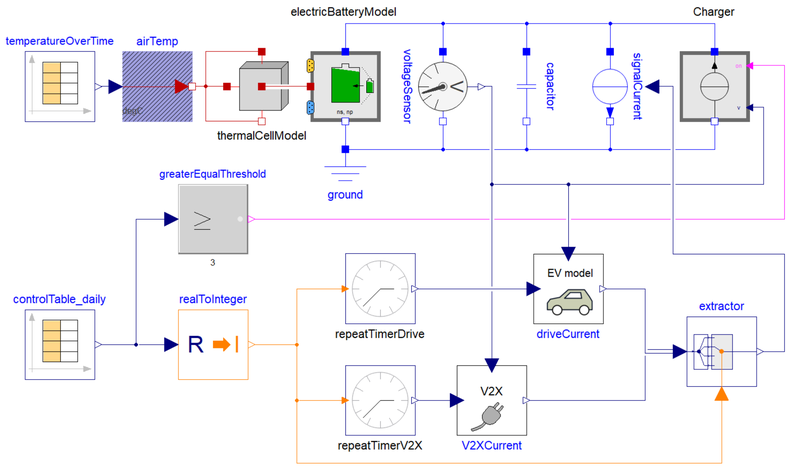
Application example for V2X use case

With the implementation of these quantitative parametric models the influence of V2X on the aging rate of a battery system in an EV can be investigated.

The battery stack is attached to a cell thermal model fed with variable outside temperatures (e.g., temperature cycle over time).

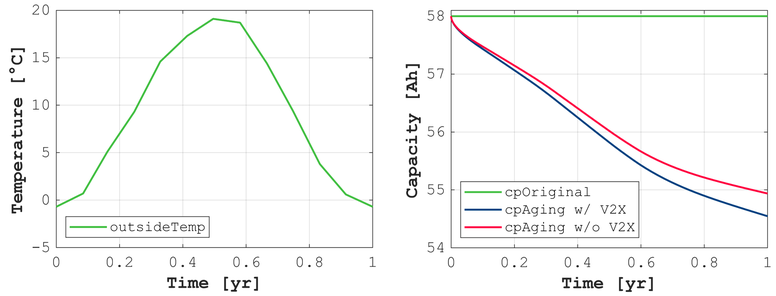
Either the driving current of the EV or the current from a V2X application is withdrawn from the battery, or the battery is charged (advanced V2X bidirectional charging).

The V2X functionality can be optionally disabled to demonstrate the influence of V2X on the aging rate of the battery.



Outlook and results

V2X technologies as vehicle-to-home or vehicle-to-grid lead to an increased number of charging and discharging procedures and, therefore, a higher number of battery cycles. Thus, the influence of V2X on battery degradation in EVs will be investigated.



Parameterization of the electro-thermal battery model

For the parameterization of the electro-thermal battery model, aging characterization tests for two different cell chemistries (NMC and LFP) are currently performed within XL-Connect. The test runs for 56 weeks at the testing laboratories of AIT. The aging characterization covers calendar aging and cycle aging procedures.

Discussion

The cycle-aging has an individual impact on the battery, i.e., the battery capacity decreases, and the internal resistance increases correspondingly.

The influence of V2X on the aging rate of a battery system can be investigated and can be analyzed for different scenarios considering variable outside temperatures.

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