Title: **An Extended Acausal Li-Ion Battery Model for EV Applications**

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Abstract:
This paper presents an extended acausal Lithium-ion (Li-ion) battery model for simulating a cell balancing method in electric vehicle (EV) applications. The simulation study performed with an acausal battery model is extended to develop an electro-thermal-cycle life (ETCL) model in **Dymola**. The model improvement consists of development of the following; (1) a one-dimensional (1-D) discrete radial thermal model, (2) a nonlinear estimation method for the models parameterisation, and (3) a simple cycle life model for the state-of-health (SOH) estimation. The electrical model is parameterised with capacity, open circuit voltage (OCV) charge/discharge pulses and hybrid pulse power characterisation (HPPC) tests data collected from cylindrical Li-ion cells at three different temperatures, namely 0, 25, 45°C; the thermal model is parameterised using data collected from US06 drive cycle for a full charge/discharge cycle. The new electro-thermal (ET) battery cell model is then validated against US06 drive cycle data collected at 15°C. For addressing the effectiveness of acausal modelling technique on cell balancing study, the newly developed parameterised electro-thermal model is further extended to include a cycle life model. Finally, the further extended version of model is instantiated and integrated with a simple battery management system (BMS) for illustrating an active cell balancing method using a proposed battery module.

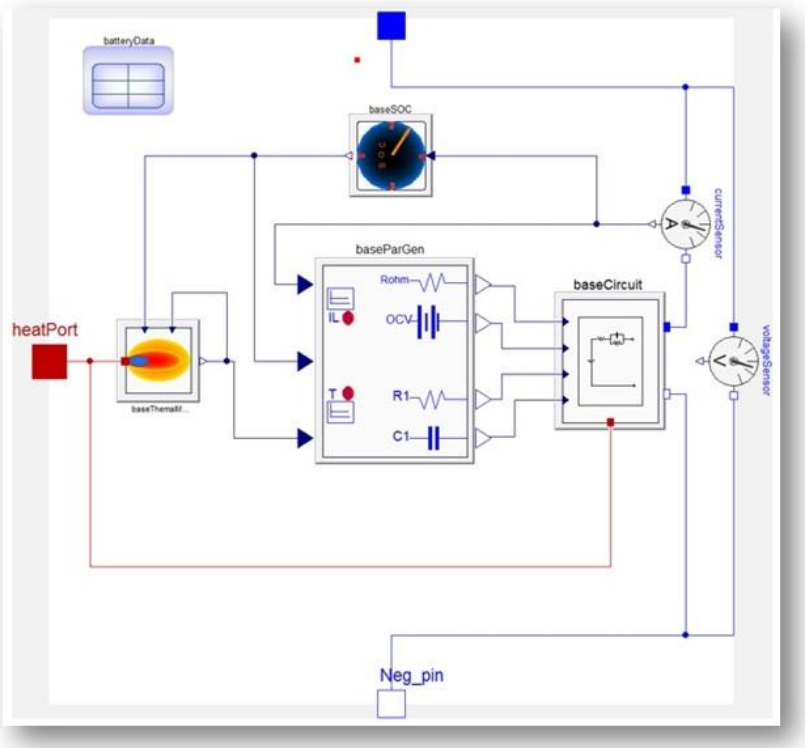

Figure: Structure of an acausal electrical-thermal-cycle life (ETCL) cell model