Verification of the battery block with electric bus connectors

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Version of Model, Carnot, Matlab and Operation system

Battery_EB (Version 1.0), Carnot 7.0, Matlab R2018b, Windows 10

Complete path of the block in the Carnot Library

\branches\carnot_7_00_01\public\library_simulink\Storage\Electric\Battery_EB

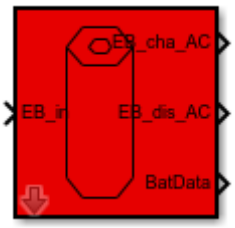
1 Data used for verifcation

The verification does not use real data. A power input is defined and the outputs are compared to calculated expected values.

2 Description of the model

2.1 Block

The model represents a simple battery, based on one integrator. Inputs and outputs are in the “Electric bus (power only)” format. It takes capacity, power limits, conversion efficiencies and stand-by power into account.



2.2 Model File

ModelVerification.slx: The model file containing all the input data.

MasterVerification.m: The master file running the model and plotting the results.

3 Results

The following parameters are used:

Parameters	
Capacity in kWh	5e6/3.6e6 = 1.388
Charging efficiency	0.9
Discharging efficiency	0.9
Initial charge condition (0…1)	1
Maximal SOC [-]	1
Minimal SOC [-]	0
Maximal input power	1000
Maximal output power	1000
Standby power consumption [W]	10

The following zero-order hold power inputs are fed to the battery model:

Time [s]	0	5e5	6e5	7e5	8e5	9e5
Power [W]	0	100	-100	10000	-10000	10000

From these values and the battery parameters, the following charging and discharging durations are calculated:

Stand-by discharge: $$\frac{5000000\ [J]}{\frac{10\ [W]}{0.9}} = 450000\ [s]$$

Charge with 100 W: $$\frac{5000000\ [J]}{(100\ [W] - 10\ [W]) * 0.9} = 61728.4\ [s]$$

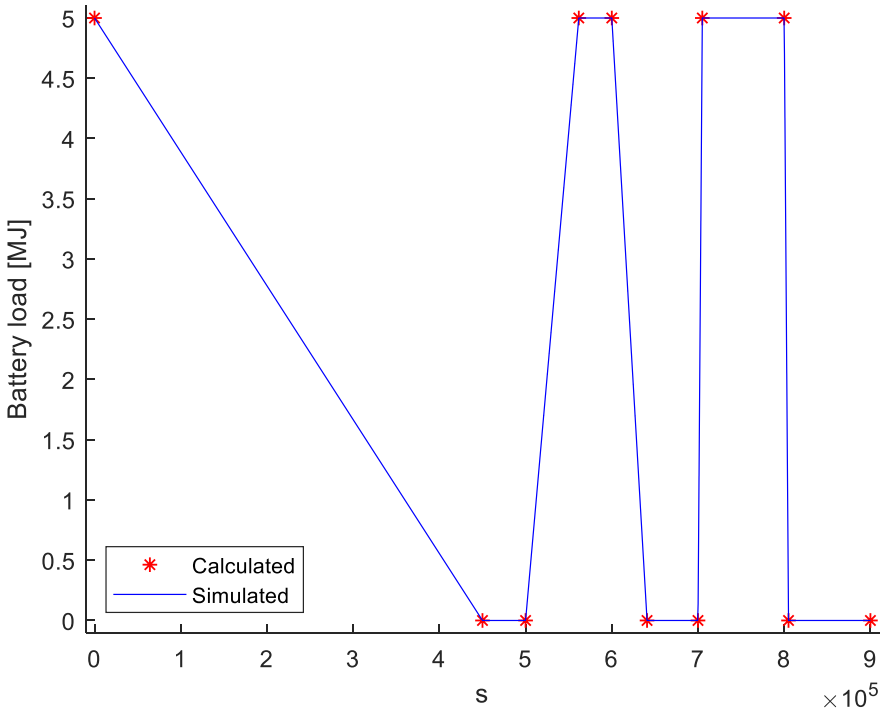
Discharge with 100 W: $$\frac{5000000\ [J]}{\frac{(100\ [W] + 10\ [W])}{0.9}} = 40909.1\ [s]$$

Charge and discharge with 10000 W (over the power limit): $$\frac{5000000\ [J]}{1000\ [W]} = 5000\ [s]$$

This results in the following energy levels should be reached at the specified times:

Time [s]	Energy [J]
0.0	5'000’000
450'000.0	0
500'000.0	0
561'728.4	5'000’000
600'000.0	5'000’000
640’909.1	0
700'000.0	0
705'000.0	5'000’000
800'000.0	5'000’000
805'000.0	0
900'000.0	0

As the plot generated by the MasterVerification.m file shows, calculated and simulated values match:



4 Literature