How to run the Simulation

Step 1: Download the Powertrain Blockset 2-motor BEV model. You will need MATLAB version R2023a or later and a license to the Powertrain Blockset. Below the Steps to generate the model:

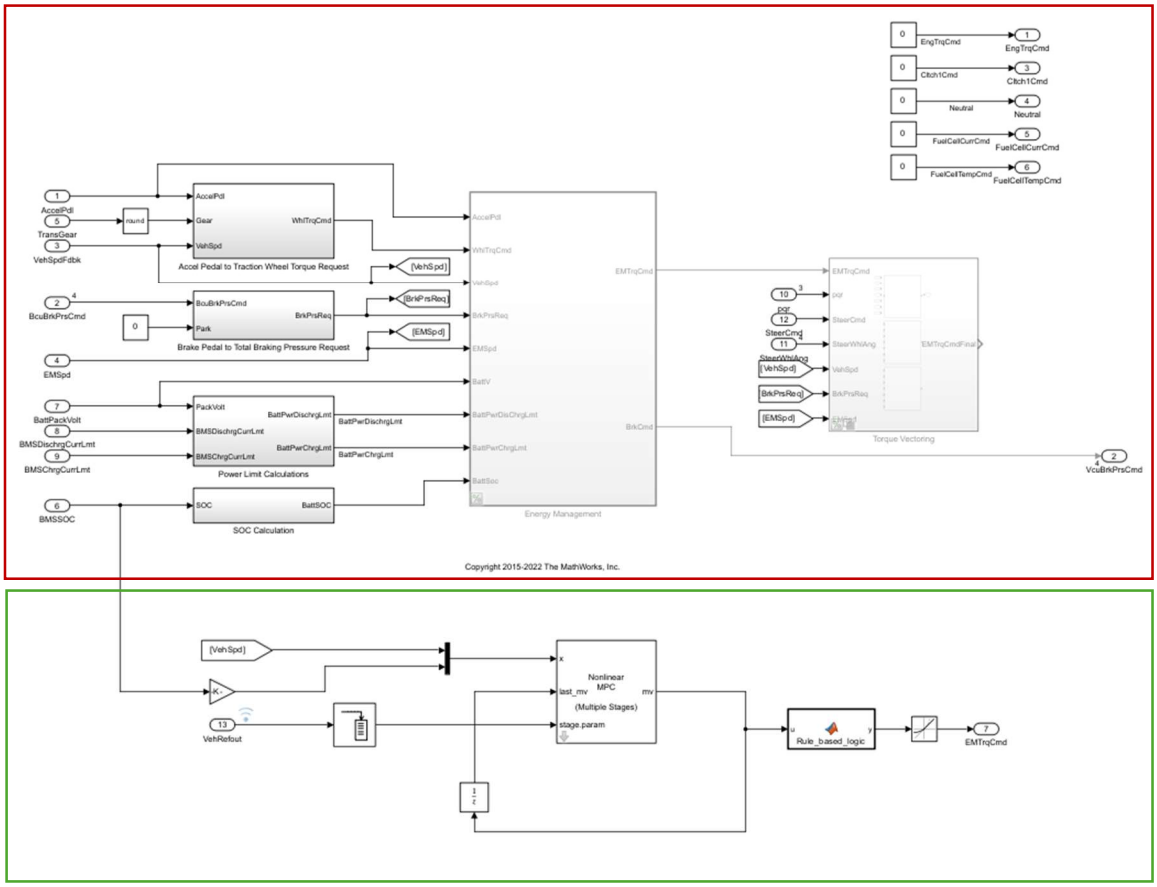
i. Open MATLAB and go to the Apps tab. Under Automotive, open the Virtual Vehicle Composer (VVC) App
ii. In the VVC app, select 'New'. Then select 'Electric Vehicle 2EM' for the powertrain architecture
iii. Select Simulink for the model template and longitudinal vehicle dynamics as shown. Then press the Configure button.
iv. In the Data and Calibration tab of the VVC app, the user has the option to parameterize the vehicle or use the default values.
v. Press the 'Virtual Vehicle' button in the VVC app menu to generate the 2 motor BEV model

Step 2: Run the model and review the output in the scope contained in the Visualization subsystem. Become familiar with the dynamic outputs of this closed-loop model as it simulates over a drive cycle.

Step 3: Add a goto block to Reference signal to extract the reference signal. Name it 'VehReference' and make it 'global'. Ensure you convert the units from mph to m/s.

Step 4: Insert a from block at the input terminal of the Vehicle control unit. Then update the model.

Step 5: Insert the Multistage Nonlinear MPC block, a buffer and the MATLAB function block. Set up as shown in the image below. Make sure to uncomment the 'Energy Management block'. See the picture below for a description. The red portion marks the baseline controller while the green marks the MPC controller. Set the gain block to 296.382 (this converts the battery state of charge in fractions to the value in Amp-hour(Ah))



Step 6: After setting up. Ensure to run the '*multistagenlmpcobjecspecificationcodeRH.mlx*'. This will load the multistage nonlinear MPC object into the workspace. Set the buffer size p+1 where p is the prediction horizon. Then run the code.

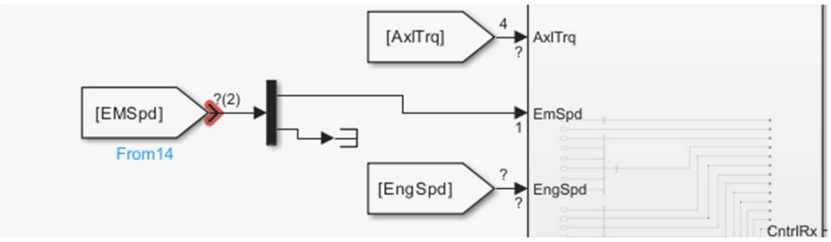
Step 7: Run the simulation.

Note: If you encounter the following errors, this is how to resolve them.

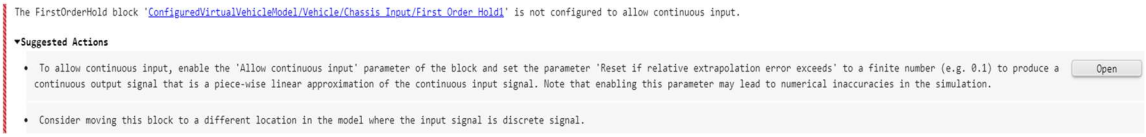
- Error 1

Error:Error in port widths or dimensions. 'Output Port 1' of 'ConfiguredVirtualVehicleModel/Vehicle/Plant Models/ConfiguredSimulinkPlantModel/From14' has 2 elements. This port does not accept the dimensions (or orientation) specified by the output signal.

How to resolve: Since due to the changes made, this block now expects a 1-dimensional signal, this error can be resolved by inserting a Demux. Link the first output of the Demux but terminate the other. See the image below for a description.



- Error 2

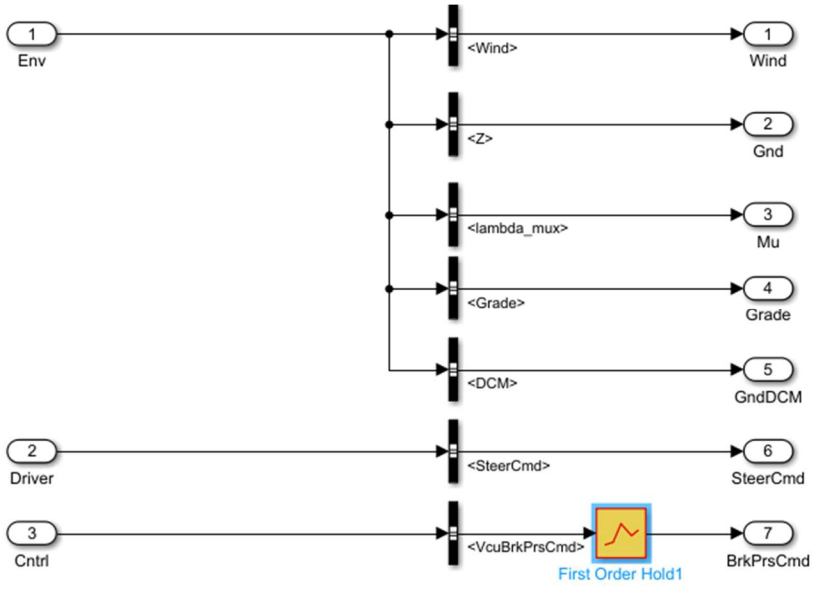


Error:The FirstOrderHold block 'ConfiguredVirtualVehicleModel/Vehicle/Chassis Input/First Order Hold1' is not configured to allow continuous input.

Suggested Actions:

To allow continuous input, enable the 'Allow continuous input' parameter of the block and set the parameter 'Reset if relative extrapolation error exceeds' to a finite number (0.1) to produce a continuous output signal that is a piece-wise linear approximation of the continuous input signal.

How to Resolve: Click on the first order hold 1 block shown in the image below. Allow continuous signal and set extrapolation error to 0.1.



Ensure to re-update the model after carrying out the changes before running the simulation.