Final Project: Design of an Electric Vehicle

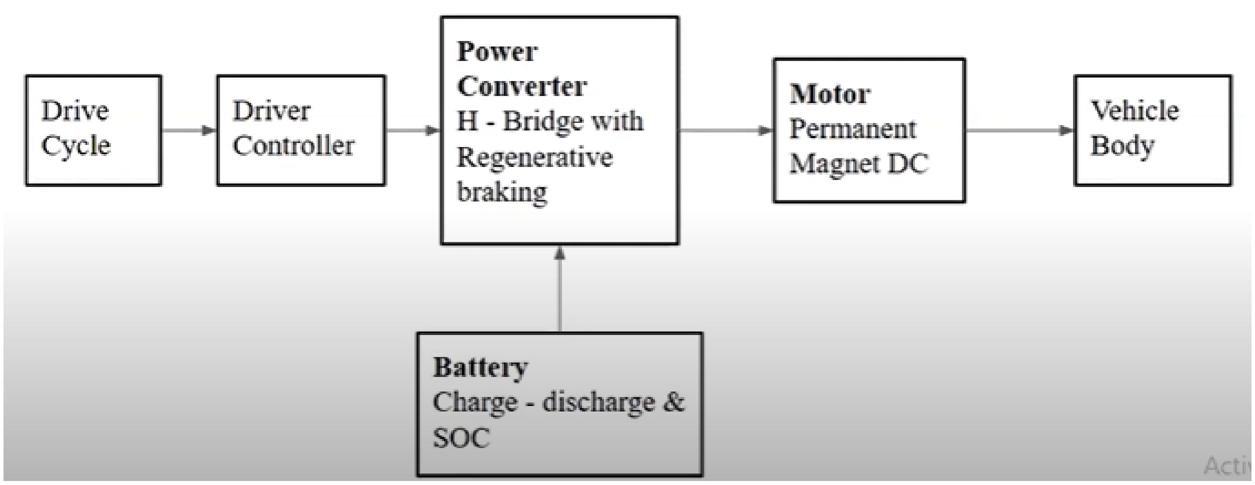
PURPOSE OF MATHEMATICAL MODEL & SIMULATION:

- Mathematical models are most suitable for initial experiments
- actual system realization is costly and time-consuming
- Testing before actual demonstration
- We know before to see limitations and failures and knowing errors of the model
- The mathematical model gives the performance of the vehicle
- Simulation is nothing but creates a virtual reality in a software environment by solving governing equations are solved from this equation mathematical model is developed

OBJECTIVES:

- To make a most simple and low run-time vehicle model using individual component blocks
- To run individual models of the vehicle model and integrate
- To checkout performance parameters like speed, state of charge of the battery, current
- Give inputs motor power and vehicle body
- To know MATLAB model and their configuration to match with actual vehicle

BLOCK DIAGRAM:



INTRODUCTION OF ELECTRIC VEHICLES:

- An electric vehicle (EV) is one that operates on an electric motor

- instead of an internal combustion engine that generates power by burning a mix of fuel and gases.
- Therefore, such a vehicle is seen as a possible replacement for current-generation automobiles
- In order to address the issue of rising pollution, global warming, depleting natural resources, etc.
- Though the concept of electric vehicles has been around for a long time,
- It has drawn a considerable amount of interest in the past decade amid a rising carbon footprint and other environmental impacts of fuel-based vehicles.

While some EVs used lead-acid or nickel-metal hydride batteries, the standard for modern battery electric vehicles is now considered to be lithium-ion batteries as they have greater longevity and are excellent at retaining energy, with a self-discharge rate of just 5% per month. Despite this improved efficiency, there are still challenges with these batteries as they can experience thermal runaway, which has, for example, caused fires or explosions in the Tesla Model S, although efforts have been made to improve the safety of these batteries.

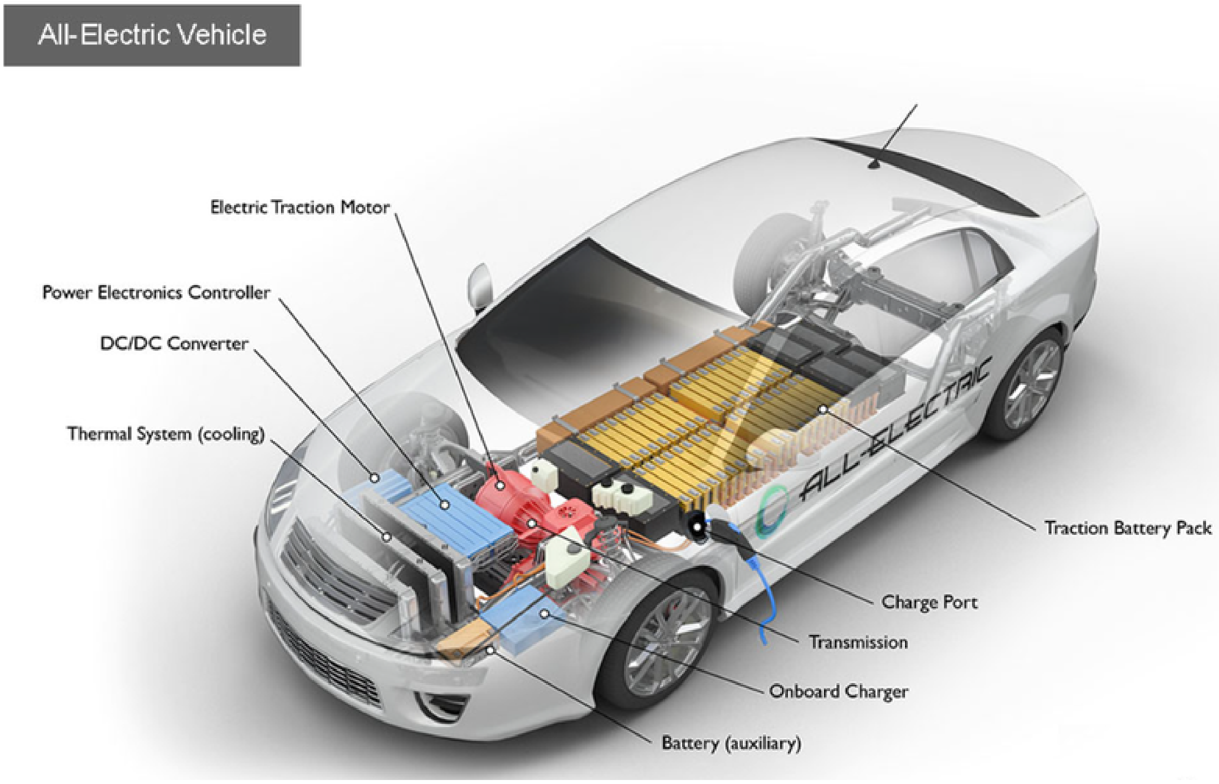
There are two main types of electric vehicles (EV); fully electric and plug-in hybrids:

fully electric:

- can be charged at home overnight, providing enough range for average journeys.
- However, long journeys or those that require a lot of hill climbs may mean that the fuel cells require charging before you reach your destination
- although regenerative braking or driving downhill can help mitigate against this by charging the battery packs.
- Charging ranges from 30 minutes and up to more than 12 hours. This all depends on the speed of the charging station and the size of the battery.

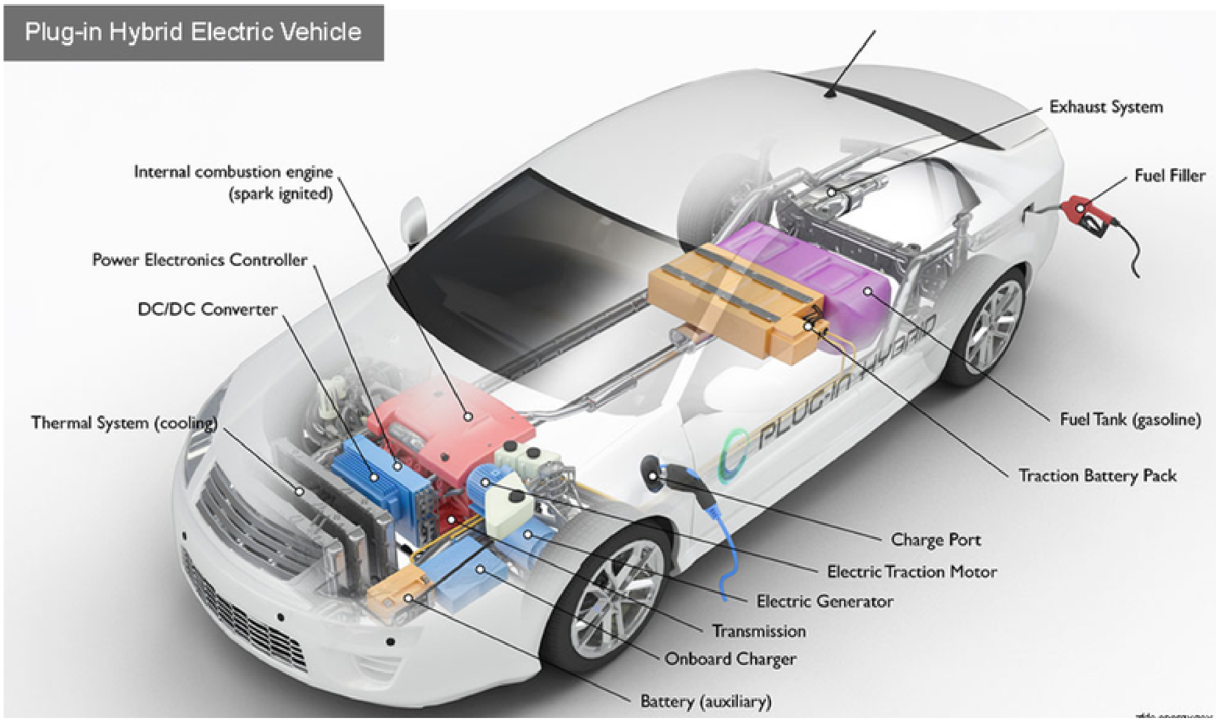
ADVANTAGES OF BATTERY ELECTRIC VEHICLES(BEV):

- Creates very little noise
- No exhaust, spark plugs, clutch, or gears
- Doesn't burn fossil fuels, instead uses rechargeable batteries



plug-in hybrid Electric vehicles:

- hybrid electric vehicles offer a mixture of battery and petrol or diesel power.
- This makes them better for traveling long distances as you can switch to traditional fuels rather than having to find charge points to top up the battery.
- The same disadvantages that apply to combustion engine vehicles also apply to PHEVs
- Need for more maintenance, engine noise, emissions and the cost of petrol.

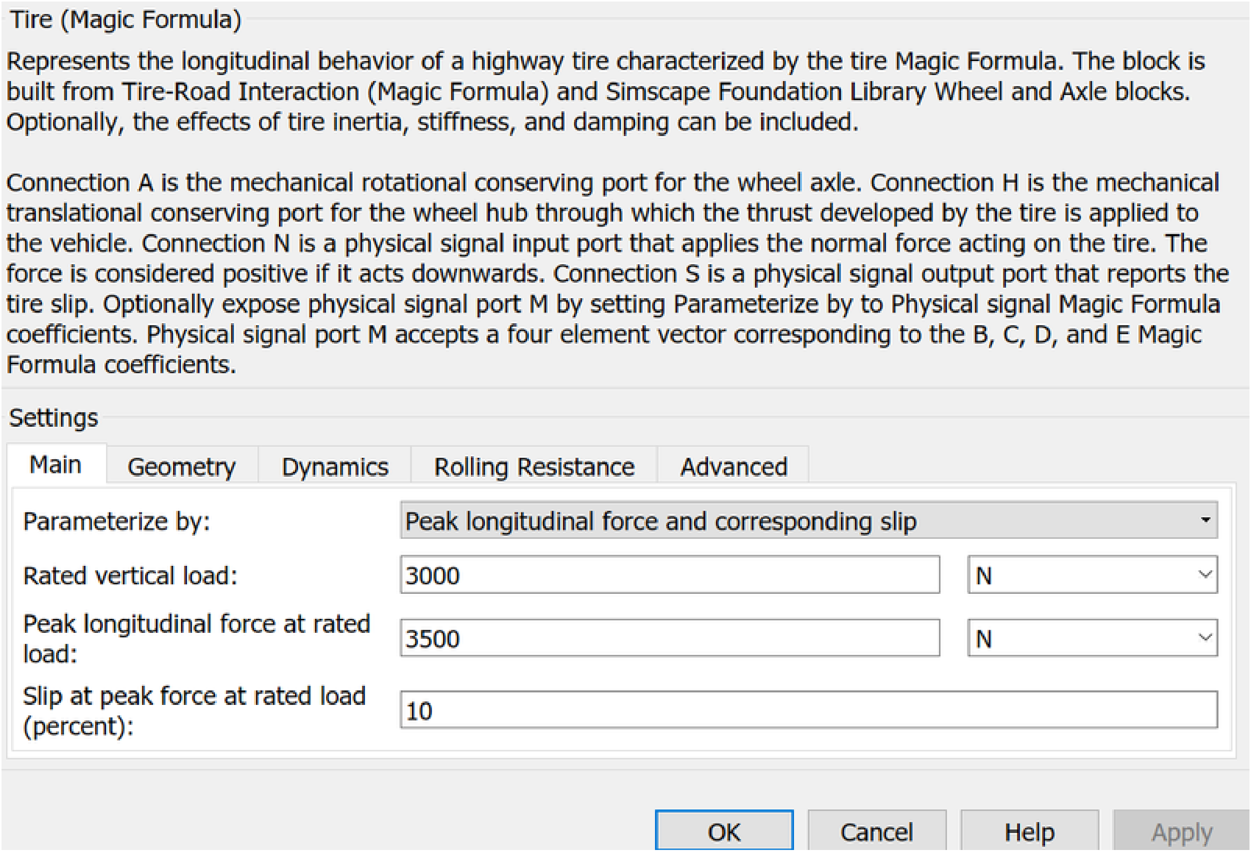


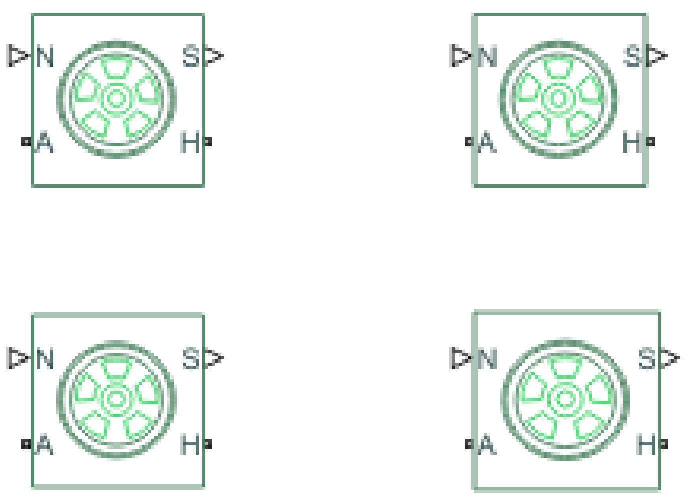
THE MAIN COMPONENTS OF THE ELECTRIC VEHICLE ARE:

- Wheels/tire
- Battery
- Motor/generator
- Motor controllers
- Power converters
- Transmission systems

Create a MATLAB model of an electric car:

Tires:

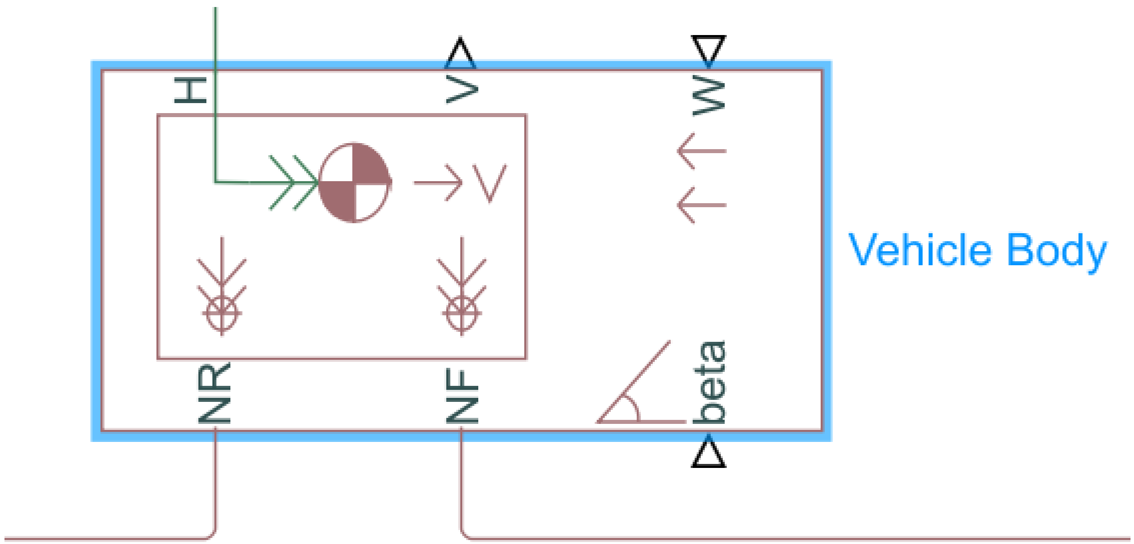




- N- WE need to apply a normal force
- A is nothing but an axle
- H is Nothing but a hub
- S stands for slip

- Total tire for a vehicle two of front and other two tires have the rare side of the vehicle connected with the vehicle body

VEHICLE BODY:



Vehicle Body

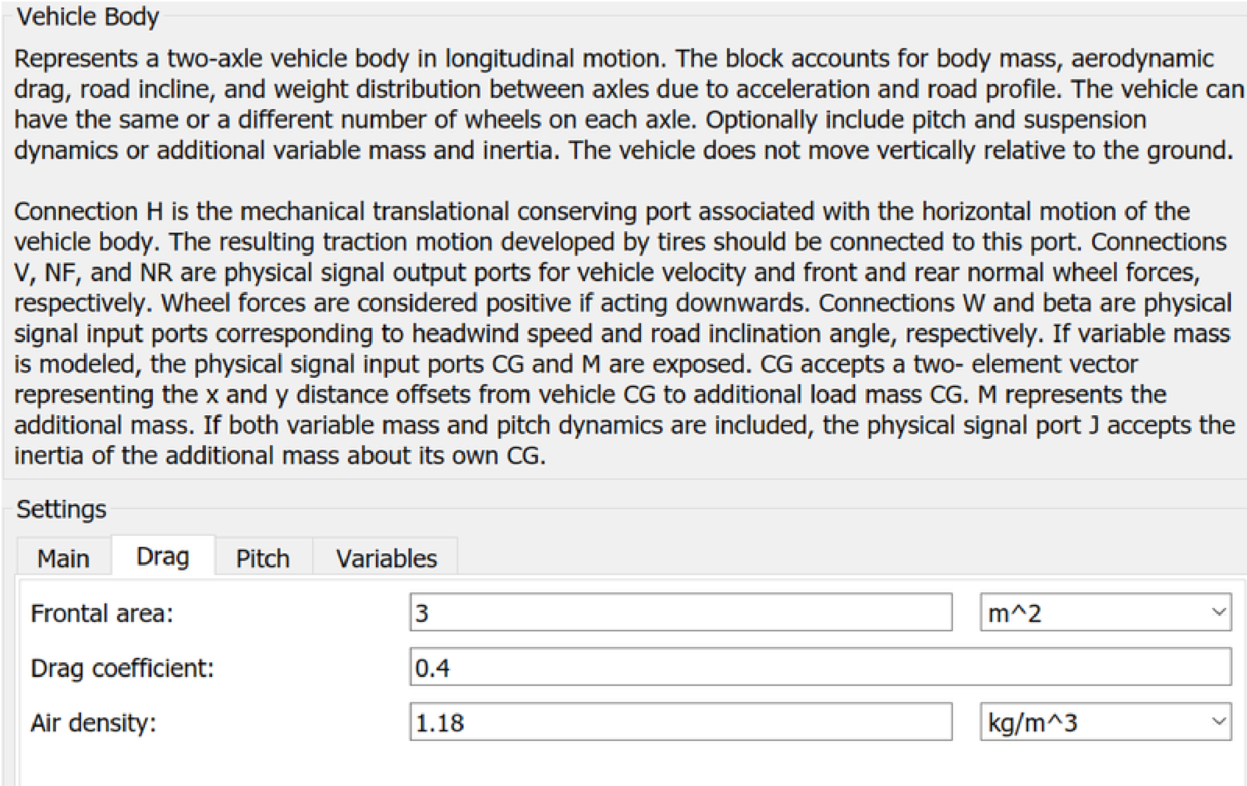
Represents a two-axle vehicle body in longitudinal motion. The block accounts for body mass, aerodynamic drag, road incline, and weight distribution between axles due to acceleration and road profile. The vehicle can have the same or a different number of wheels on each axle. Optionally include pitch and suspension dynamics or additional variable mass and inertia. The vehicle does not move vertically relative to the ground.

Connection H is the mechanical translational conserving port associated with the horizontal motion of the vehicle body. The resulting traction motion developed by tires should be connected to this port. Connections V, NF, and NR are physical signal output ports for vehicle velocity and front and rear normal wheel forces, respectively. Wheel forces are considered positive if acting downwards. Connections W and beta are physical signal input ports corresponding to headwind speed and road inclination angle, respectively. If variable mass is modeled, the physical signal input ports CG and M are exposed. CG accepts a two- element vector representing the x and y distance offsets from vehicle CG to additional load mass CG. M represents the additional mass. If both variable mass and pitch dynamics are included, the physical signal port J accepts the inertia of the additional mass about its own CG.

Settings

Main | Drag | Pitch | Variables

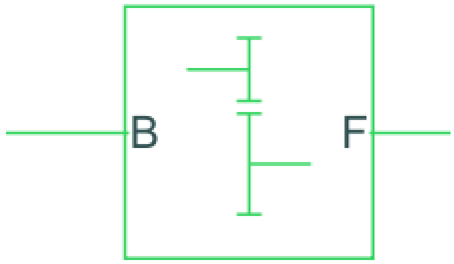
Mass:	950	kg
Number of wheels per axle:	2	
Horizontal distance from CG to front axle:	1.4	m
Horizontal distance from CG to rear axle:	1.6	m
CG height above ground:	0.5	m
Externally-defined additional mass:	Off	
Gravitational acceleration:	9.81	m/s^2
Negative normal force warning:	Off	

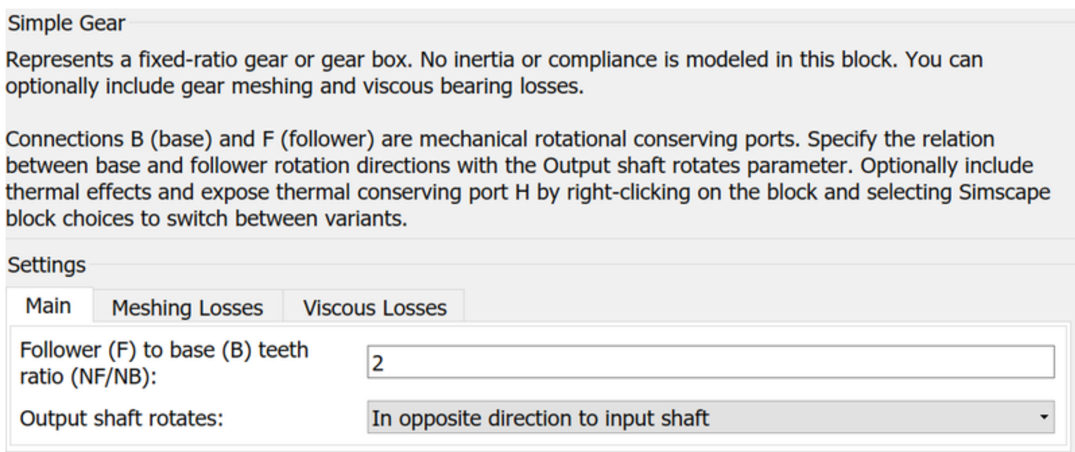


This block contains 6 ports that can be used in various aspects

- H- H Stand for hub it is used to connect the hub of wheels to the main body of the vehicle
- V- Physical signal output port of velocity is used the velocity output of the vehicle
- W- Physical input port used to wind velocity acts against the vehicle
- NR- Physical signal output port used to connect the rare wheels
- NS-Physical signal output port used to connect the front wheels
- Beta- physical signal input port which allows the vehicle to undergo an inclination of hill-climbing force

SIMPLE GEAR:

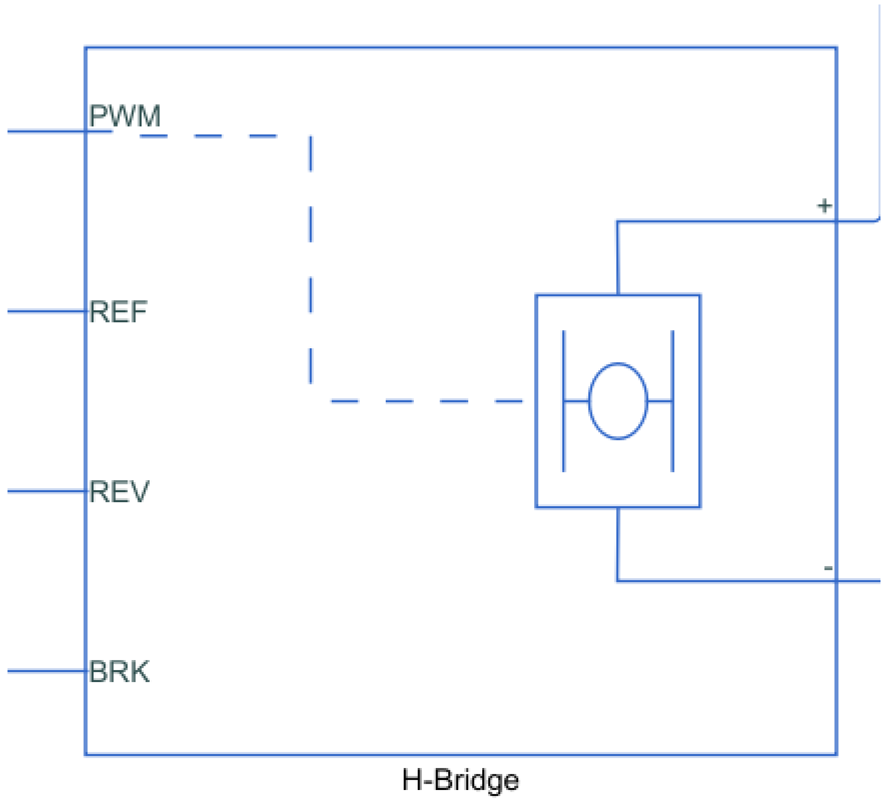




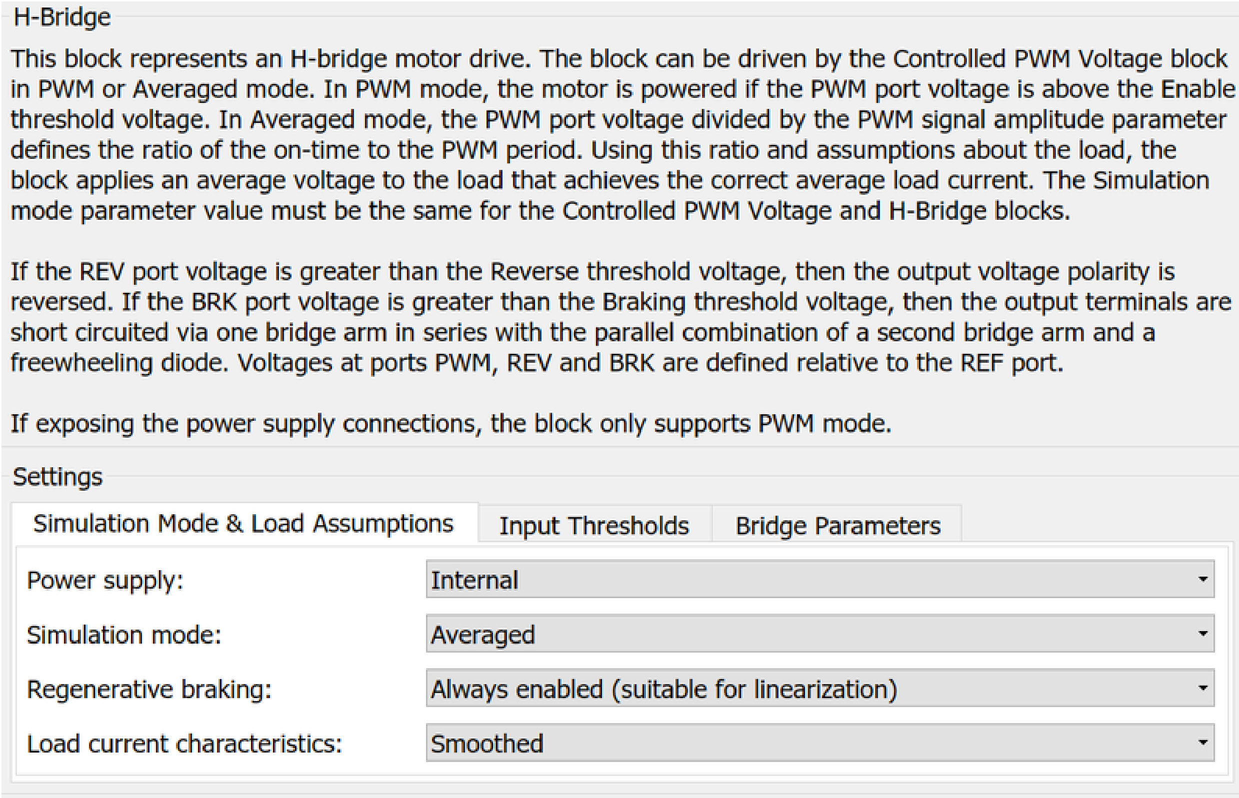
This block model a gear system with a fixed-gear ratio with non-inertial effects. However, we can modify the messing of the gear teeth here the follower to base teeth ratio has been set to 2 and the output shaft rotates in the same direction as the input shaft.

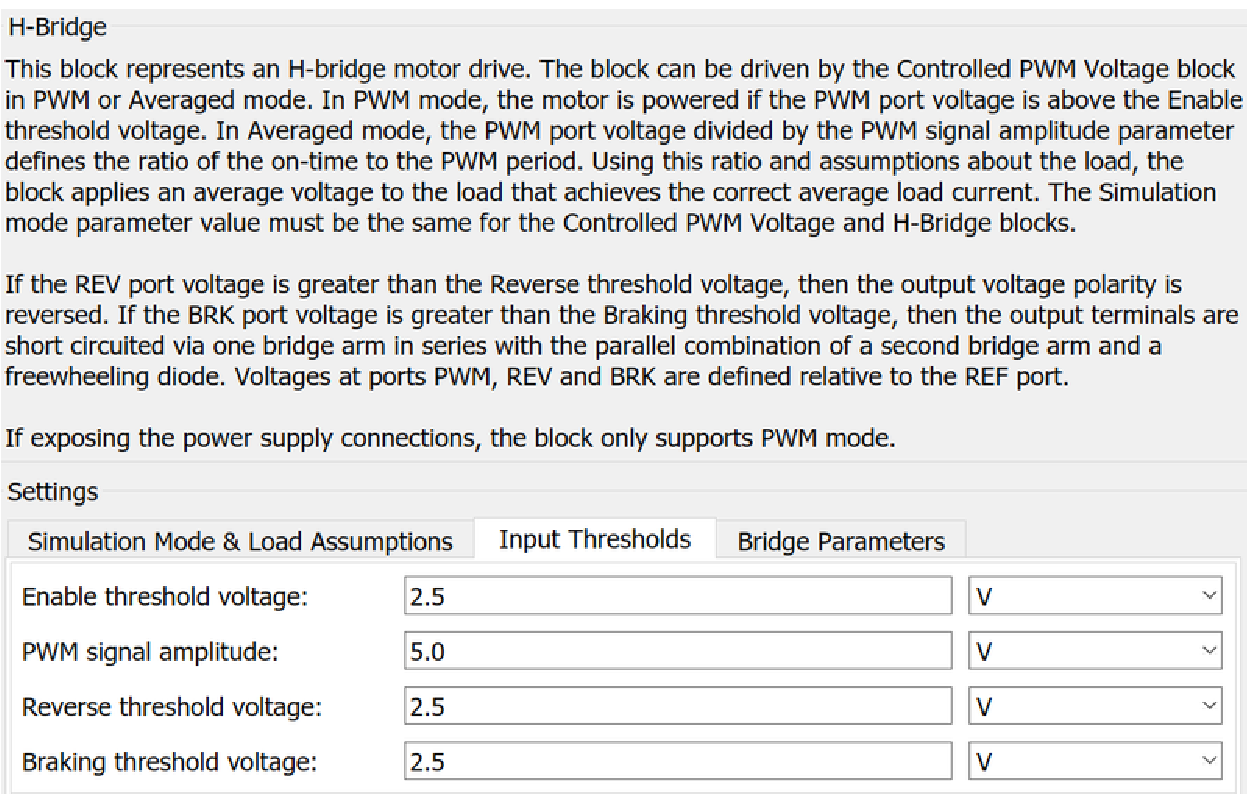
POWER BLOCKS:

H-BRIDGs :



- Create an H-bridge block and double click on it and change the simulation mode to averaged
- create current sensor block connect positive to positive and negative to negative of the dc motor port
- The REV and REF OF the H bridge are connected to the solver configuration.


H-Bridge
This block represents an H-bridge motor drive. The block can be driven by the Controlled PWM Voltage block in PWM or Averaged mode. In PWM mode, the motor is powered if the PWM port voltage is above the Enable threshold voltage. In Averaged mode, the PWM port voltage divided by the PWM signal amplitude parameter defines the ratio of the on-time to the PWM period. Using this ratio and assumptions about the load, the block applies an average voltage to the load that achieves the correct average load current. The Simulation mode parameter value must be the same for the Controlled PWM Voltage and H-Bridge blocks.
If the REV port voltage is greater than the Reverse threshold voltage, then the output voltage polarity is reversed. If the BRK port voltage is greater than the Braking threshold voltage, then the output terminals are short circuited via one bridge arm in series with the parallel combination of a second bridge arm and a freewheeling diode. Voltages at ports PWM, REV and BRK are defined relative to the REF port.
If exposing the power supply connections, the block only supports PWM mode.
Settings
Simulation Mode & Load Assumptions
Input Thresholds
Bridge Parameters
Power supply:
Internal
Simulation mode:
Averaged
Regenerative braking:
Always enabled (suitable for linearization)
Load current characteristics:
Smoothed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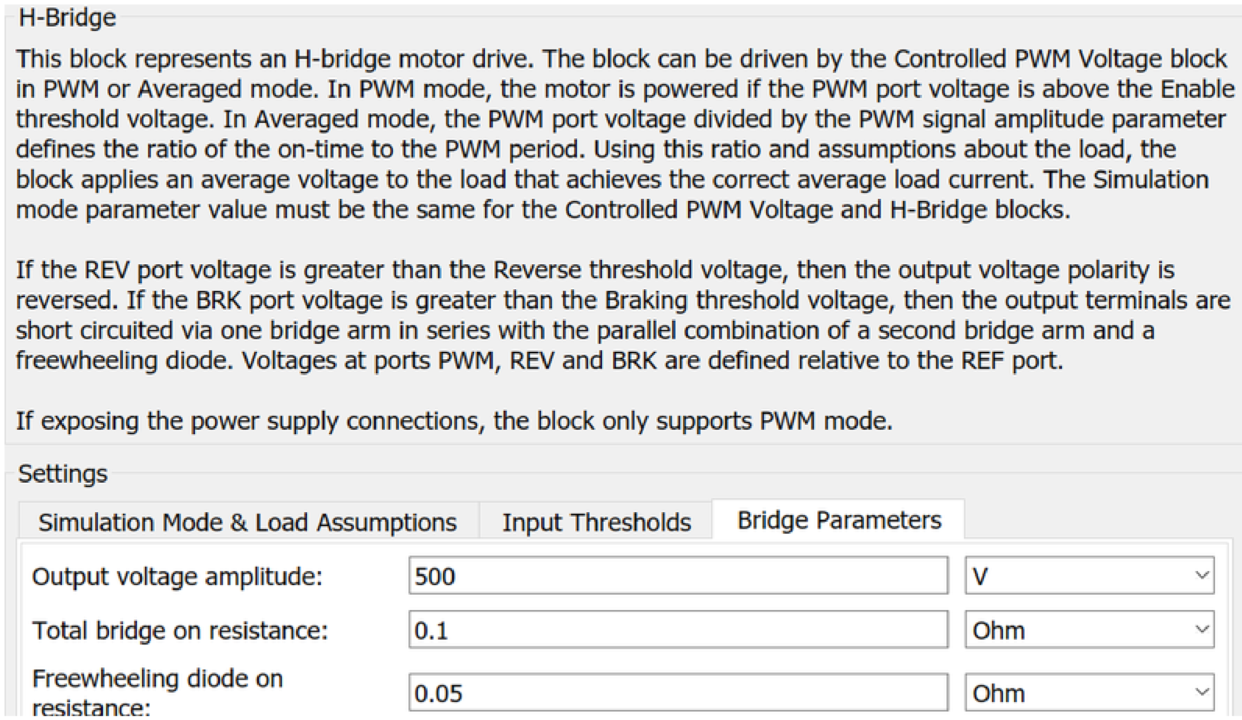
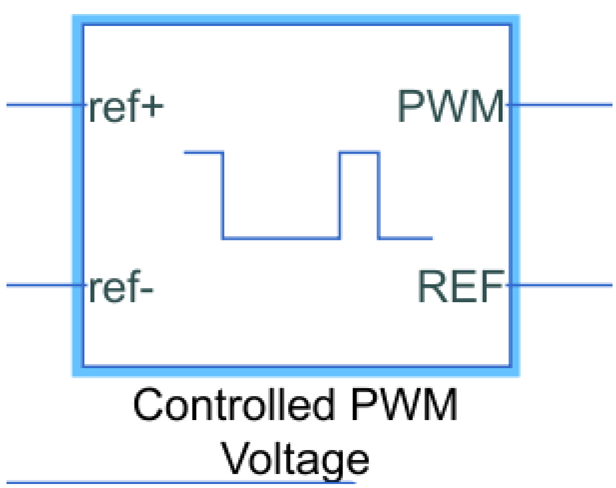
If exposing the power supply connections, the block only supports PWM mode.
Settings
Simulation Mode & Load Assumptions
Input Thresholds
Bridge Parameters
Enable threshold voltage:
2.5
V
PWM signal amplitude:
5.0
V
Reverse threshold voltage:
2.5
V
Braking threshold voltage:
2.5
V

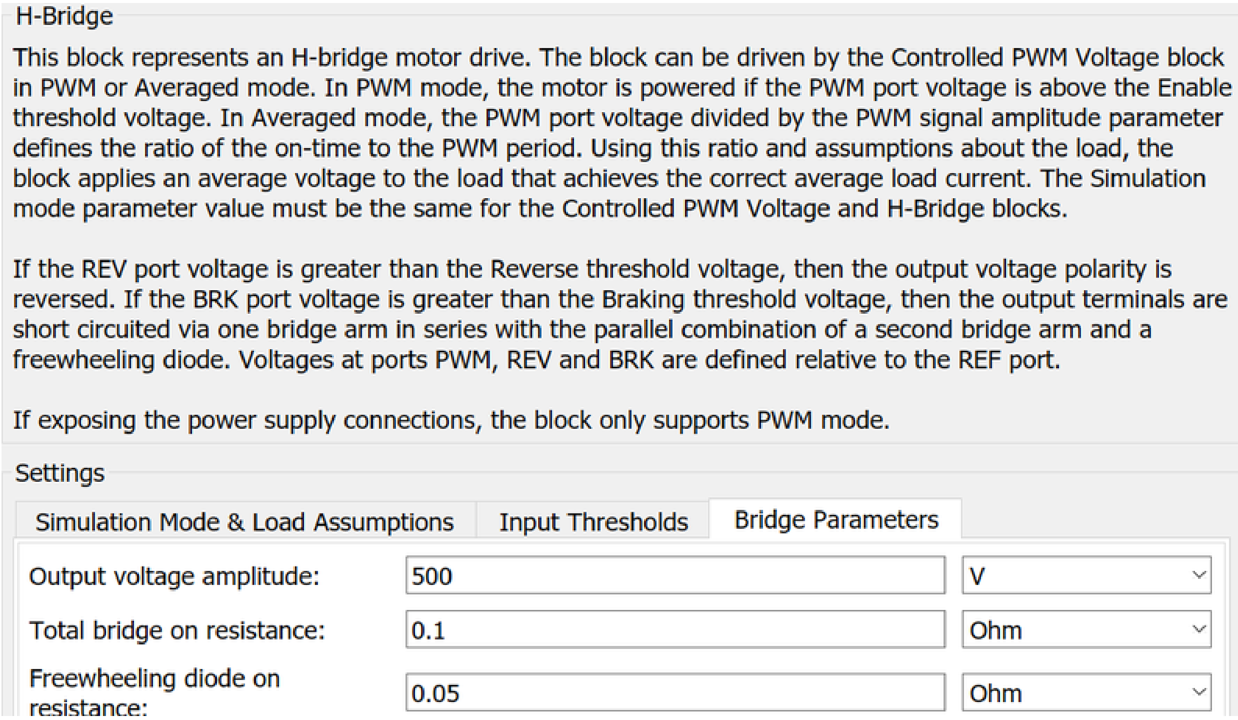


The H-Bridge block represents an H-bridge motor driver. The block has the following two Simulation mode options. If the input signal has a value greater than the Enable threshold voltage parameter value, the H-Bridge block output is on and has a value equal to the value of the Output voltage amplitude parameter.

The H-Bridge block drives the motor. In this example, all input ports of the H-Bridge block except the PWM port are connected to the ground. As a result, the H-Bridge block behaves as follows: When the motor is on, the H-Bridge block connects the motor terminals to the power supply.

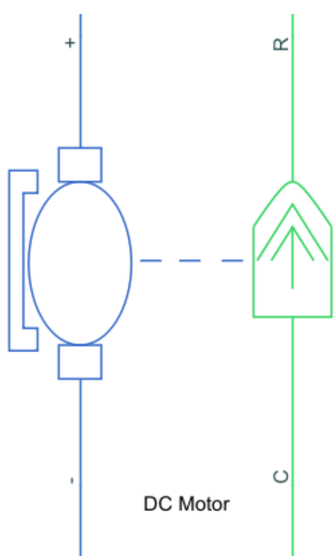
CONTROLLED PMW VOLTAGE:

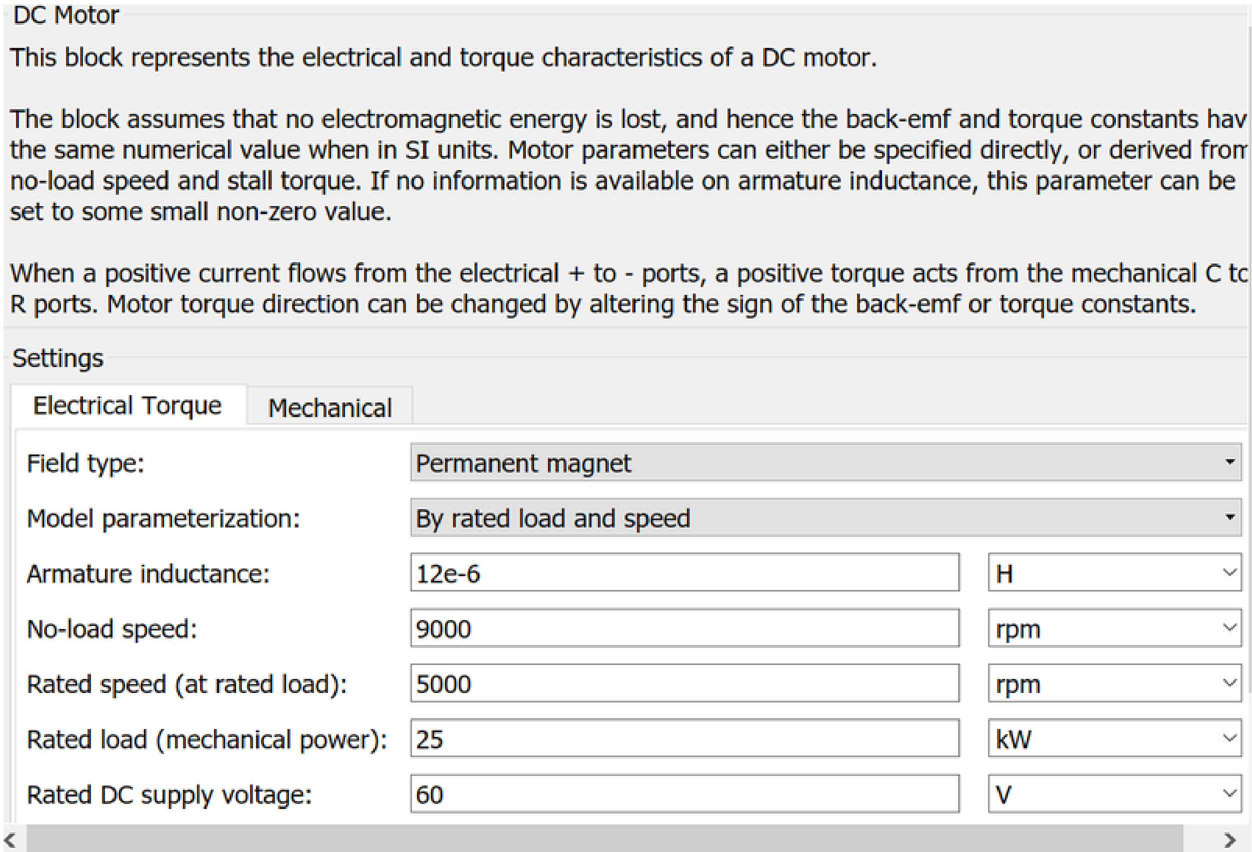


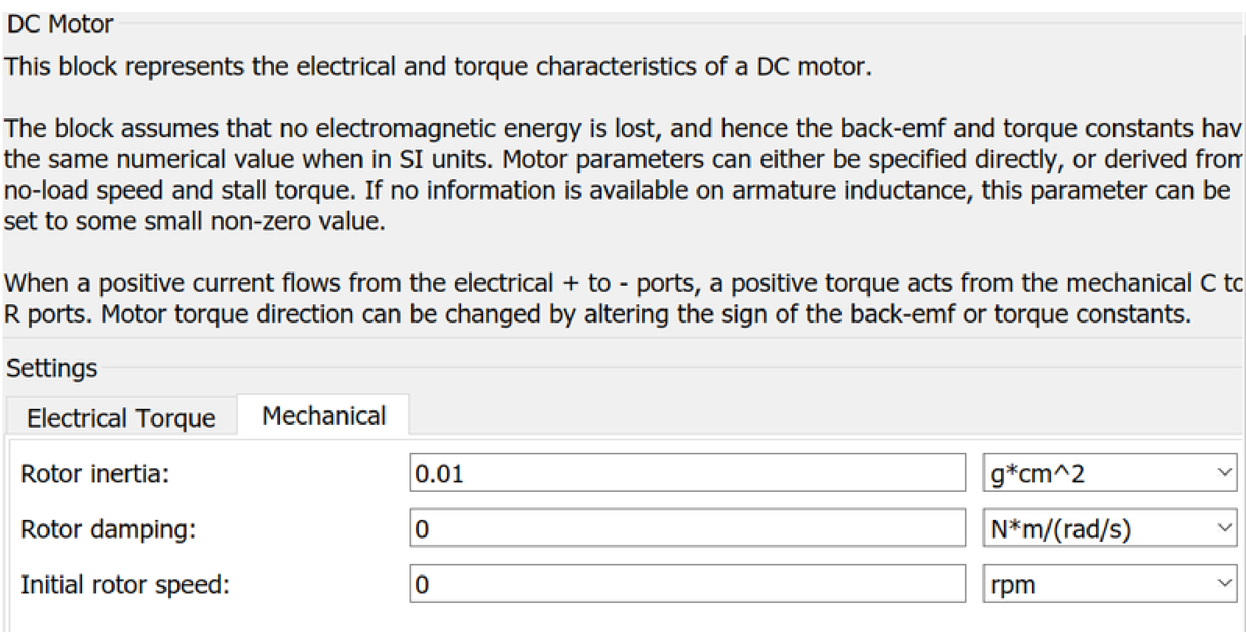


The H-Bridge block output is a controlled voltage that depends on the input signal at the PWM port. If the input signal has a value greater than the Enable threshold voltage parameter value, the H-Bridge block output is on and has a value equal to the value of the Output voltage amplitude parameter.

DC MOTOR:

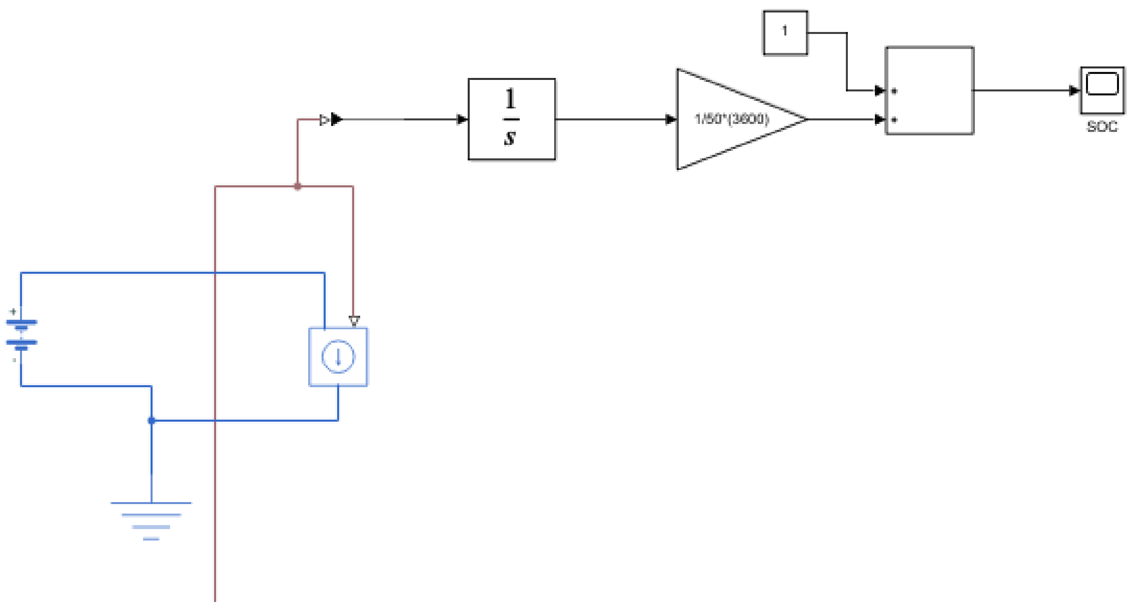




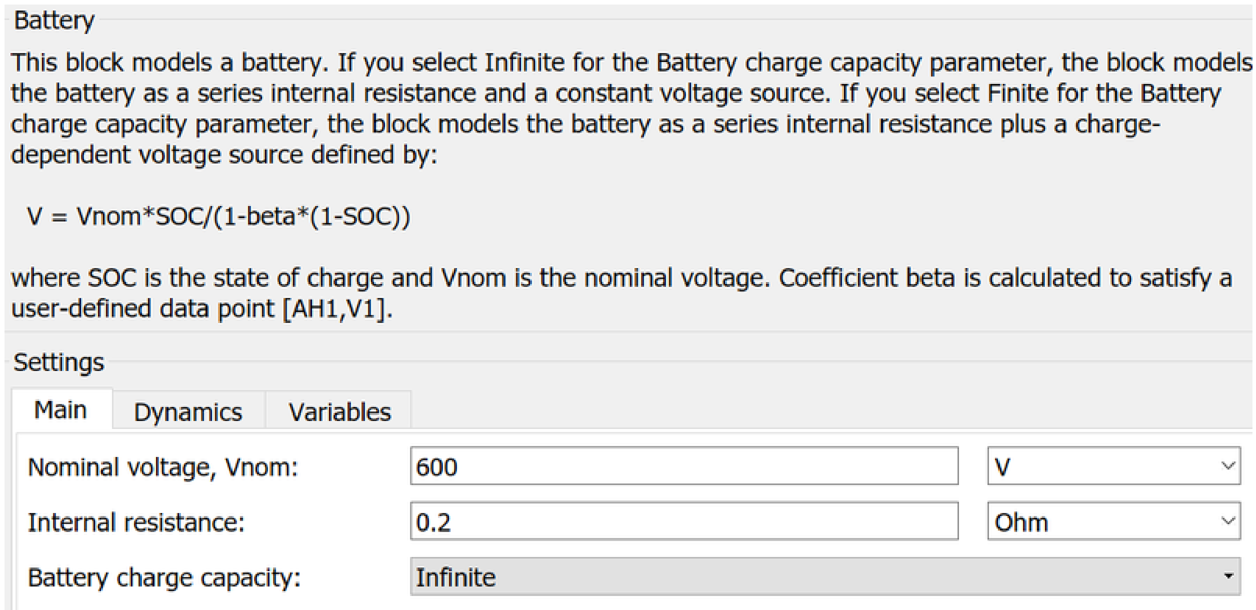


This block is used in the DC Motor Position: Simulink Modeling section. In order to simulate the response of this system, it is further necessary to add sensor blocks to the model to simulate the measurement of various physical parameters and a voltage source to provide excitation to the motor.

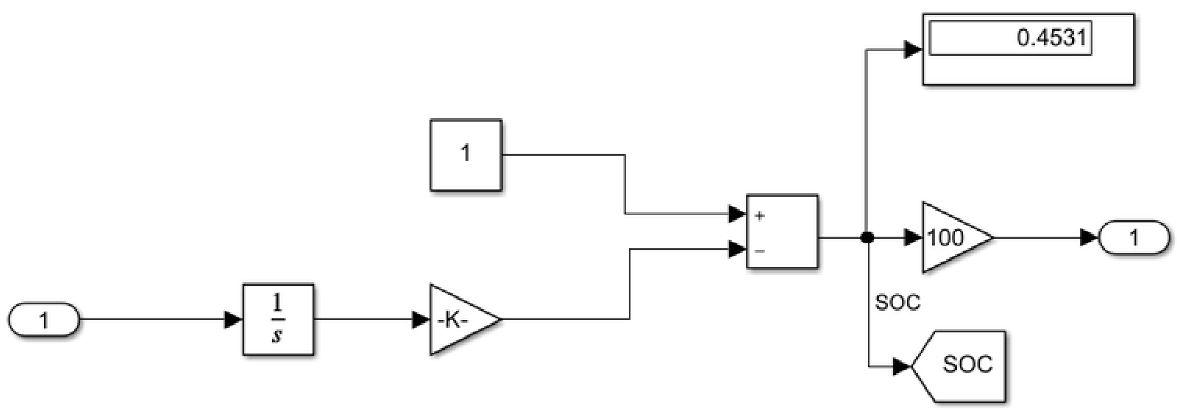
BATTERY:



- The positive terminal of the battery is connected to the positive port of the controlled current source and the negative terminal is connected to the negative port of the controlled current source
- The physical signal of the controlled current source is connected to a PS-Simulink converter to connect to go block
- connect integrator to the gain block such that ampere-hour is converted to ampere sec
- and connect it sum block with constant 1
- Create Go block name it as SOC.



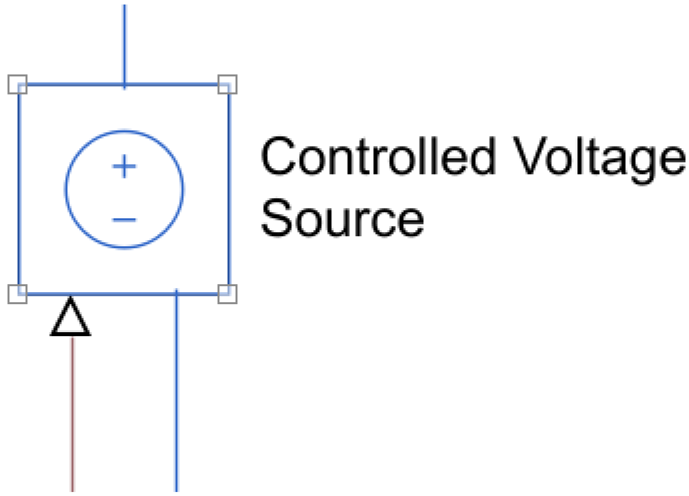
STATE OF CHARGE(state of charge):



To measure the state charge of the battery. the integrator block is used to handle data transfer and integrate the value of the current signal with respect to time then gain block is used in order to multiply divide the signal coming from the integrating block. this block will divide a current signal with the ampere rating battery which is 160(ah)*3600(sec). Assuming the battery is always fully charged i have added a constant block with a value of 1 representing 100%.

TOOLS:

CONTROLLED VOLTAGE SOURCE:

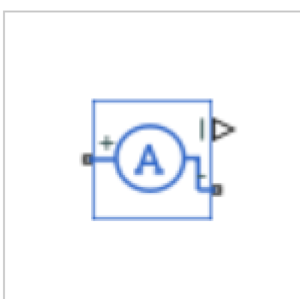


The Controlled Voltage Source block converts a Simulink input signal into an equivalent voltage source. The generated voltage is driven by the input signal of the block.

CONTROLLED CURRENT SOURCE:

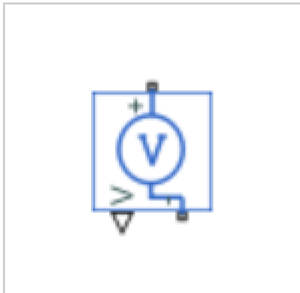
The Controlled Current Source block provides a current source controlled by a Simulink signal. The positive current direction is as shown by the arrow in the block icon.

CURRENT SENSOR:



The Current Sensor block represents an ideal current sensor, that is, a device that converts current measured in any electrical branch into a physical signal proportional to the current.

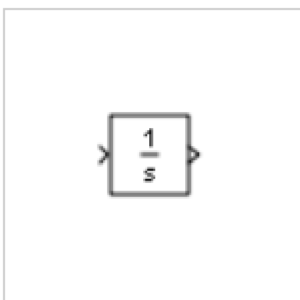
VOLTAGE SENSOR:



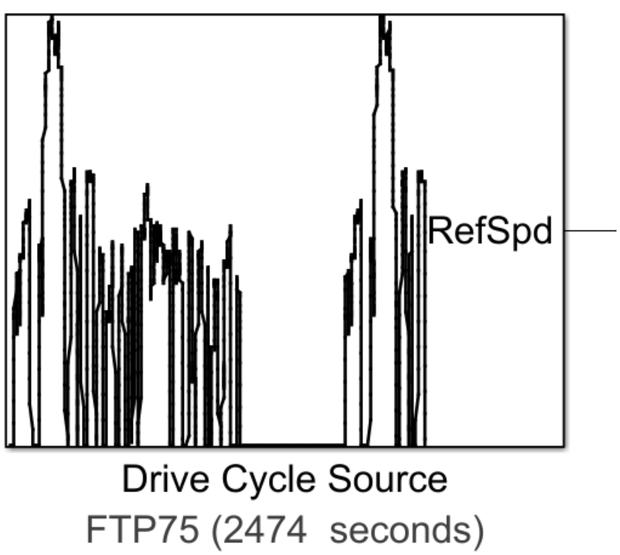
The Voltage Sensor block represents an ideal voltage sensor, that is, a device that converts voltage measured between two points of an electrical circuit into a physical signal proportional to the voltage.

INTEGRATOR:

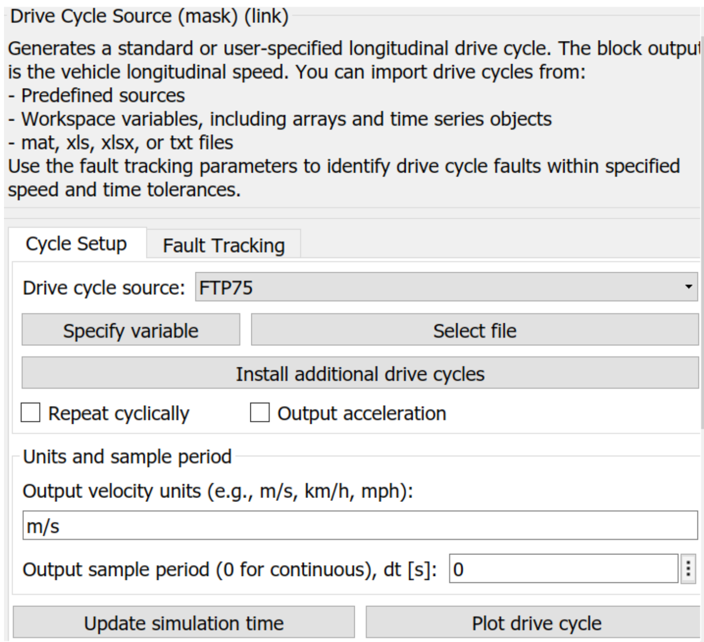
The Integrator block outputs the value of the integral of its input signal with respect to time.



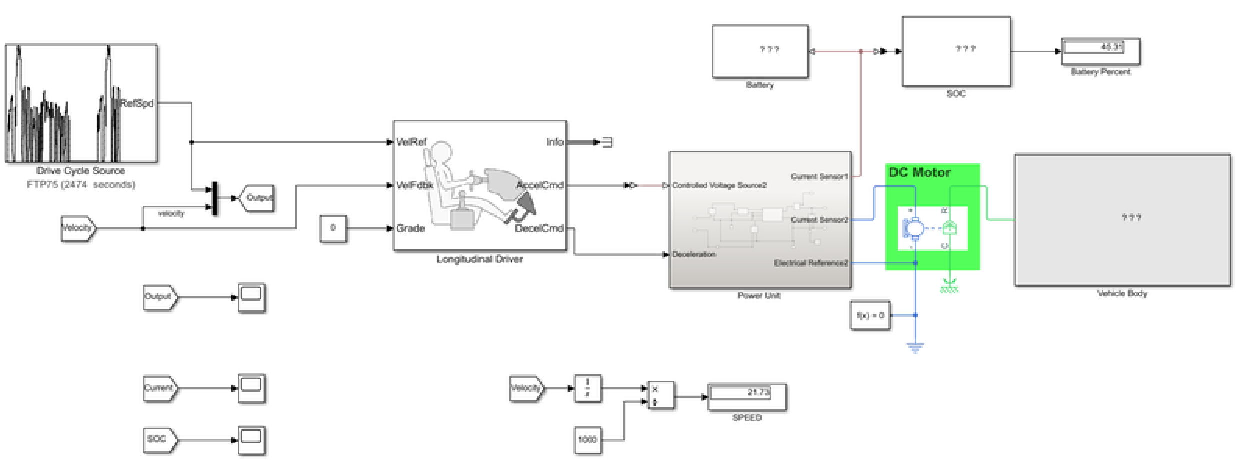
GIVING THE DRIVE CYCLE:



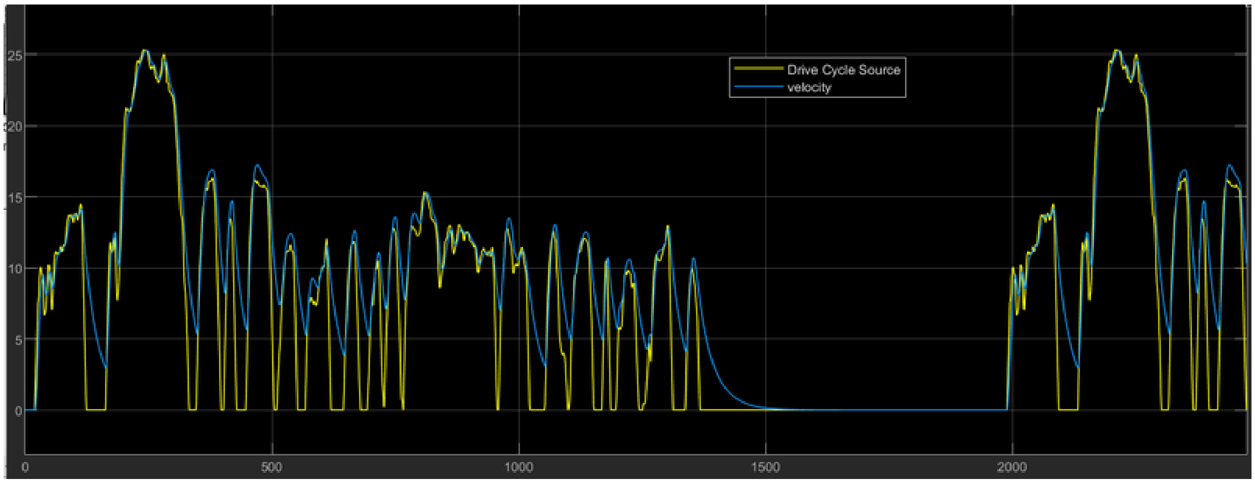
It generates a standard or user-specified longitudinal drive cycle. the block output is the vehicle's longitudinal speed. use the fault tracking parameters to identify drive cycle faults within the specified speed and time tolerances.



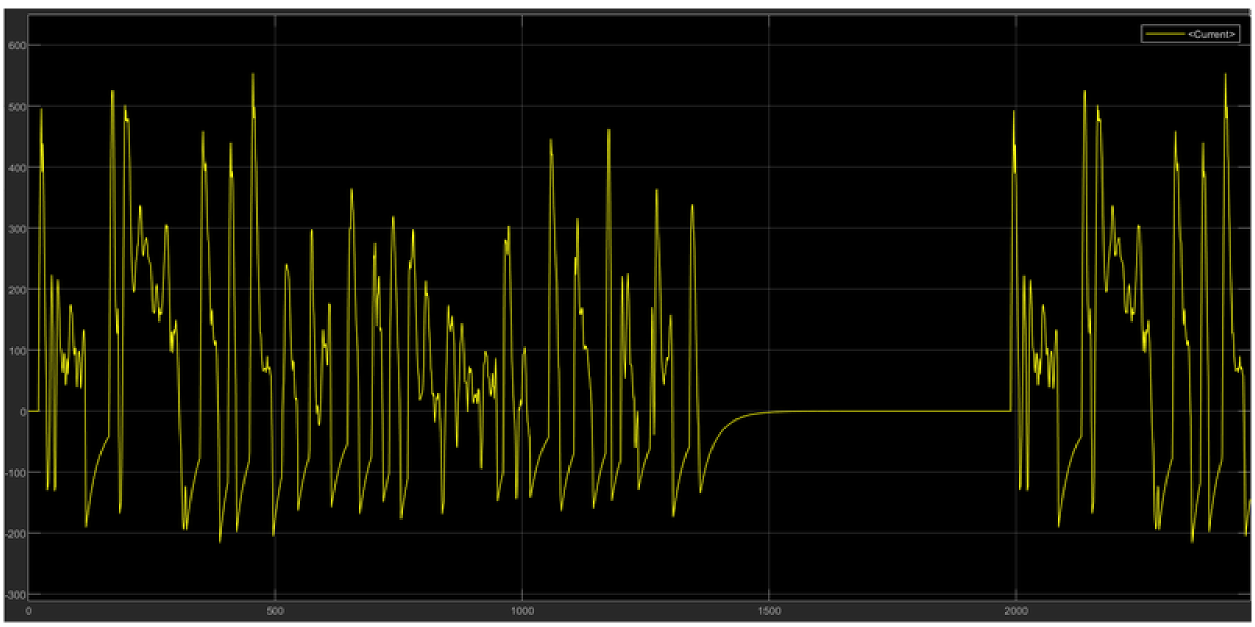
- Open the drive cycle source and select the drive cycle as FTP75 AND CLICK OK
- Connect the Refspd to the Velref of the longitudinal drive block
- Create from the block and connect it to the Velfdbk.
- Connect the velocity block to the MUX along with the drive cycle and the go-to block is created and connected to the output of the MUX.



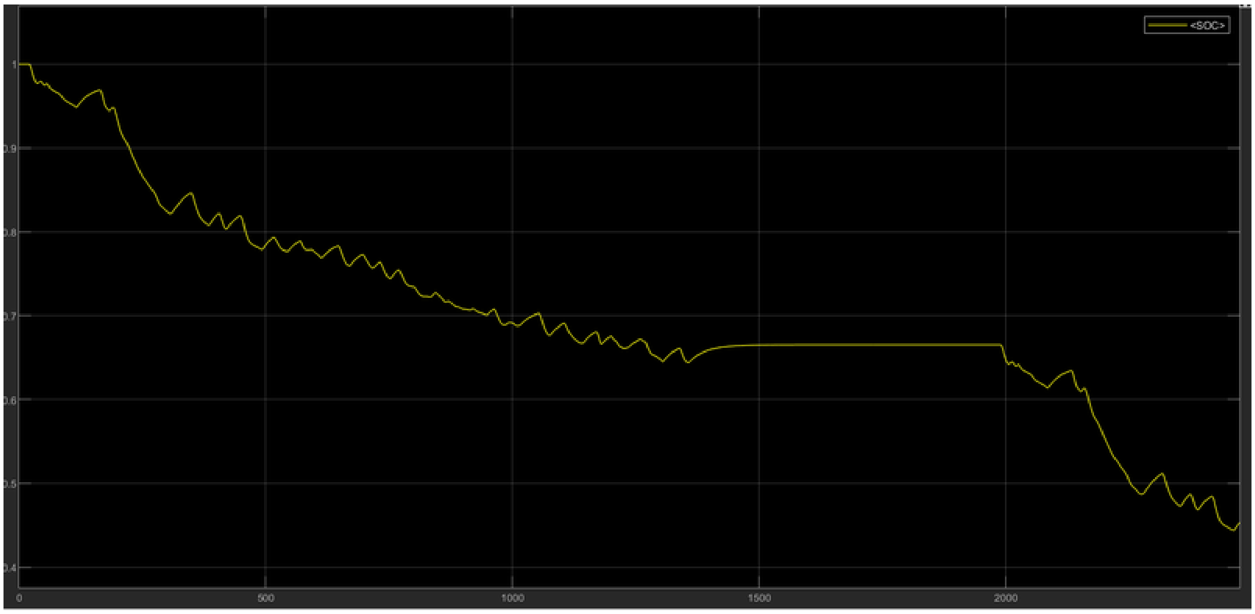
RESULT:



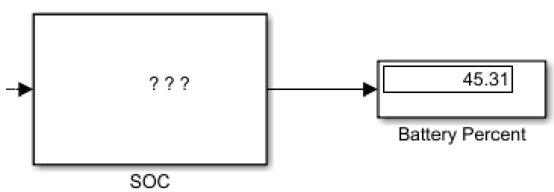
- The output of the drive cycle and velocity graph can be seen and observed that the velocity depends on the drive cycle input.

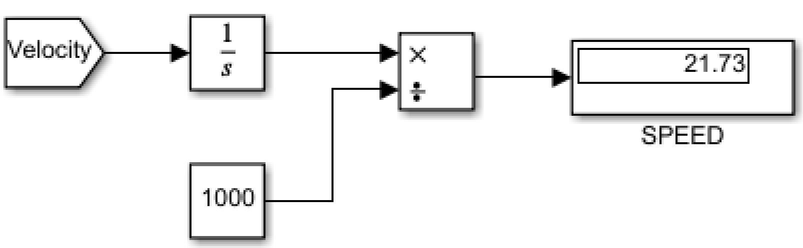


- The current output is plotted and observed that the current is fluctuating with respect to time



- In this graph state of charge of the battery decreases with time
- in the SOC graph, the speed spikes show regenerative braking is considered
- The state of charge is presented as 45.31% at a distance of 21.73kmph
- The vehicle traveled 21.73kmph in 2474 sec with 45.31% SOC





CONCLUSION:

The Ev model has been created with Simulink. and the model simulated with Drive cycle source (FTP575(2474sec)) the simulation has produced the results of vehicle velocity with respect to acceleration and the current flowing state of charge as well as the distance traveled in simulation time The vehicle traveled 21.73kmph in 2474 sec with 45.31% SOC