

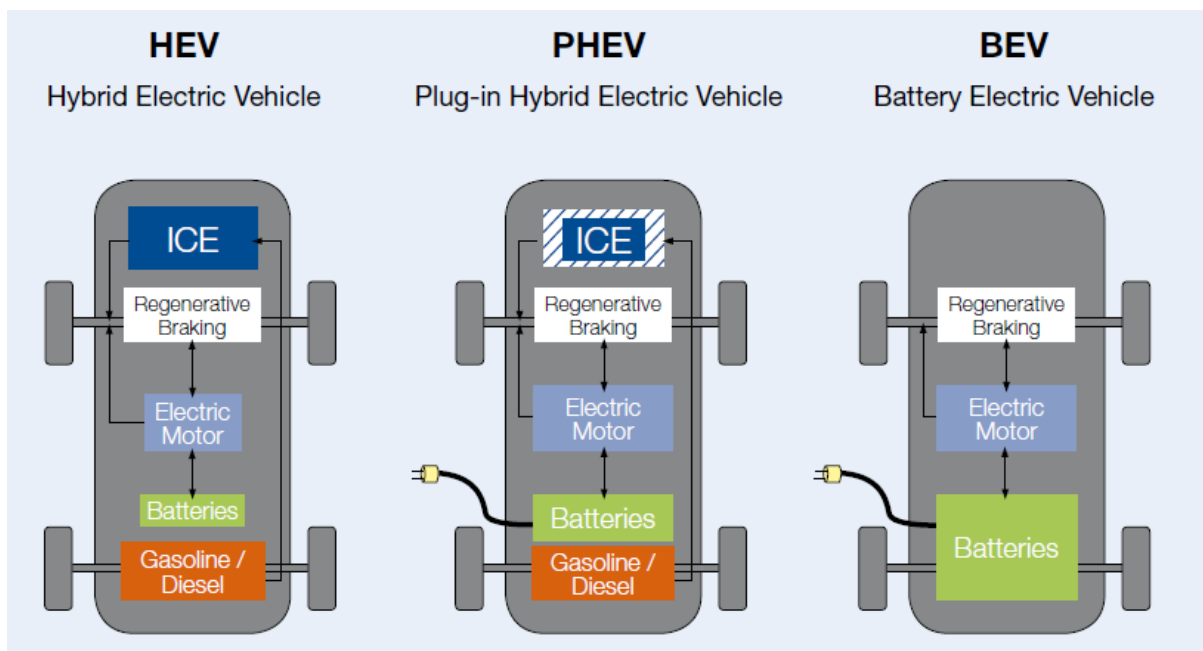
1.Title – Matlab model of electric car.

2.Objective –

- To Design and modelling of electric car subsystems, connect and perform simulation using Simulink.
- Analyse the plots.

3.Introduction –

Electric vehicles are vehicle that at least partially on electricity. Unlike conventional vehicles that use a gasoline or diesel powered engine. Electric vehicle can be categorized into three categories – HEVs, PHEVs, BEVs. Hybrid electric vehicles are powered by both petrol and electricity. Plug in hybrid vehicles are powered by conventional energy and electric energy, PHEVs can be externally charged at charging outlet. Battery electric vehicles are fully powered by electric energy. Main components of electric vehicle are – Battery, Inverter and converter, Master controller, Component controller, Motor and auxiliaries.

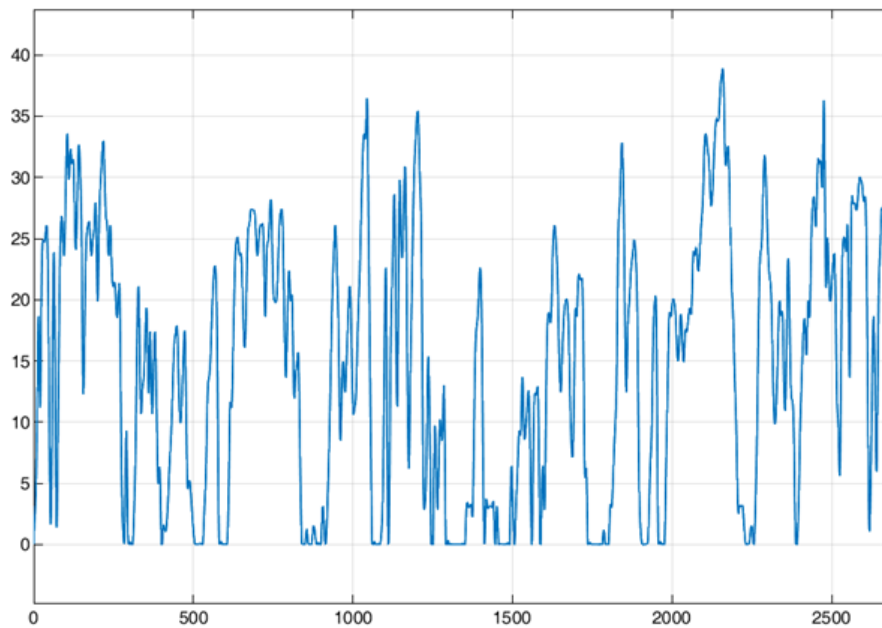
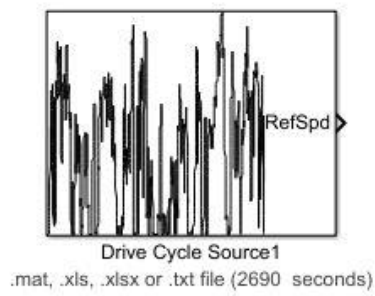


4.Description –

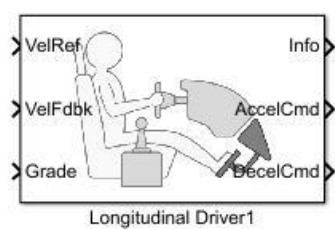
Modelling involves a representation of actual system. Consider a bike, it has hundreds of components. Each can be modelled separately and can be assembled together to make a subsystem in Simulink to perform simulation. Doing experiment on real bike would be very difficult but Simulink makes these experiment very easy to perform and analyse.

Blocks used –

Diving cycle Source – It specifies a standard driving cycle, files for driving cycle can be imported. We are using Indian urban driving cycle in this model.



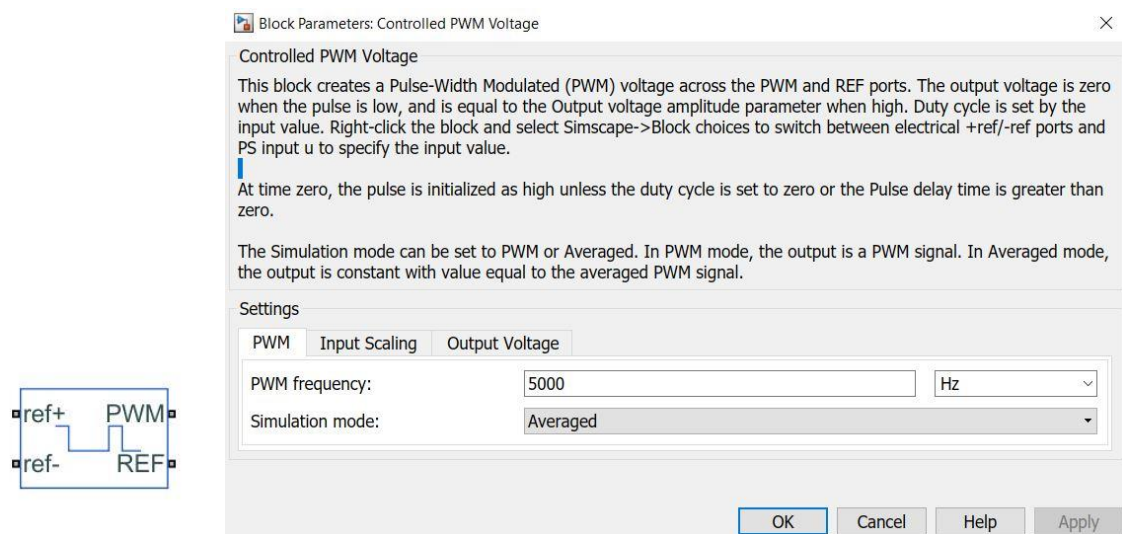
Longitudinal driver – This block tracks and controls longitudinal speed. It takes driving cycle or others signal as reference speed and vehicle speed (calculated by model) can be given as feedback. It gives acceleration and deceleration signal as output.



Scope – It displays signal.



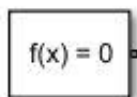
Controller PWM Voltage – it creates PWM voltage across PWM and reference port. Output voltage will be zero when pulse is low and equal to amplitude voltage when high. we are giving PWM frequency – 5000.



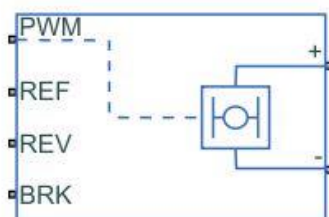
Controlled voltage source – it represents an ideal voltage source, which provides specified voltage regardless current. it is connected with controller voltage PWM voltage block.

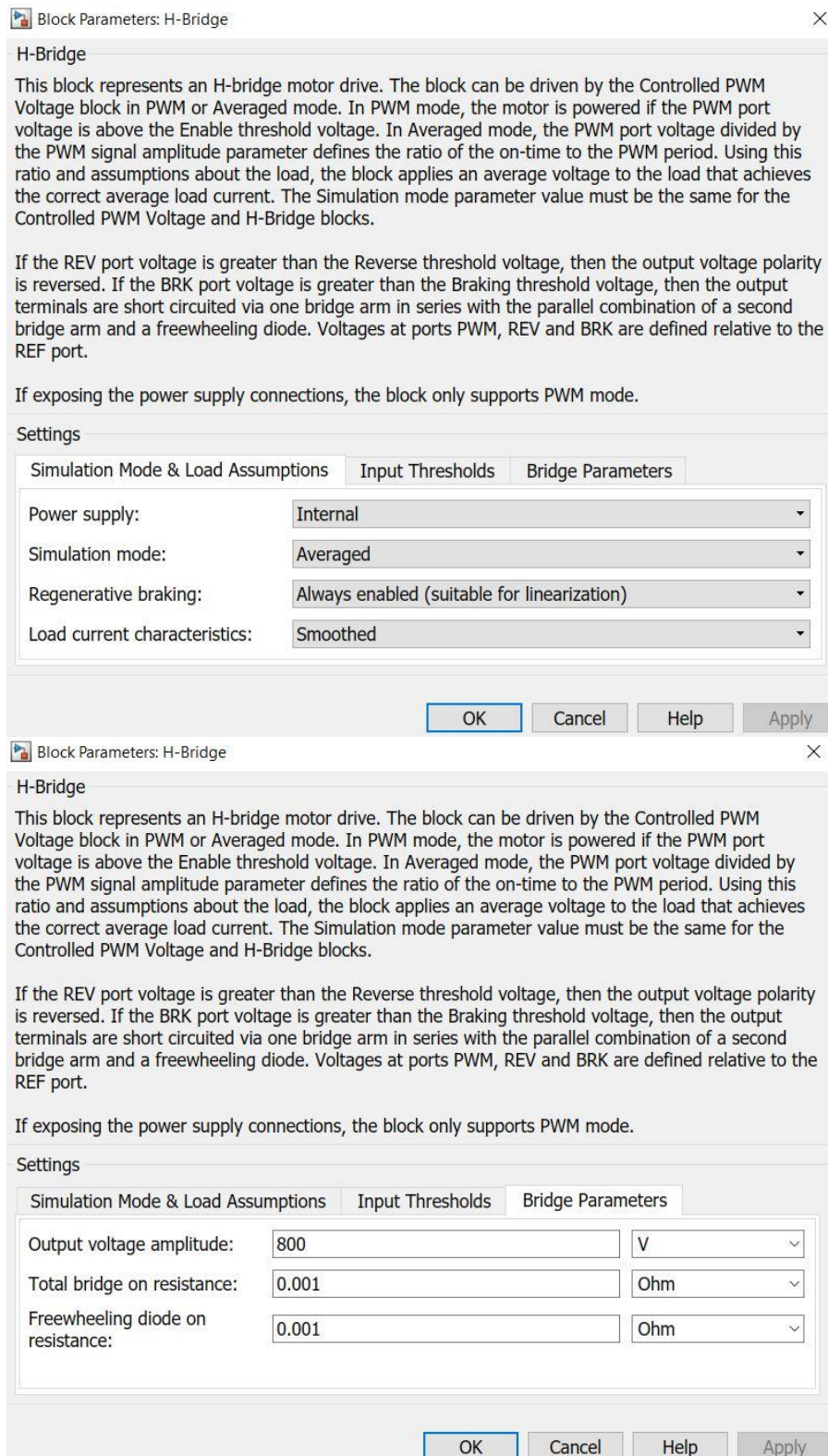


Solver configuration – it provides solver setting information to model.

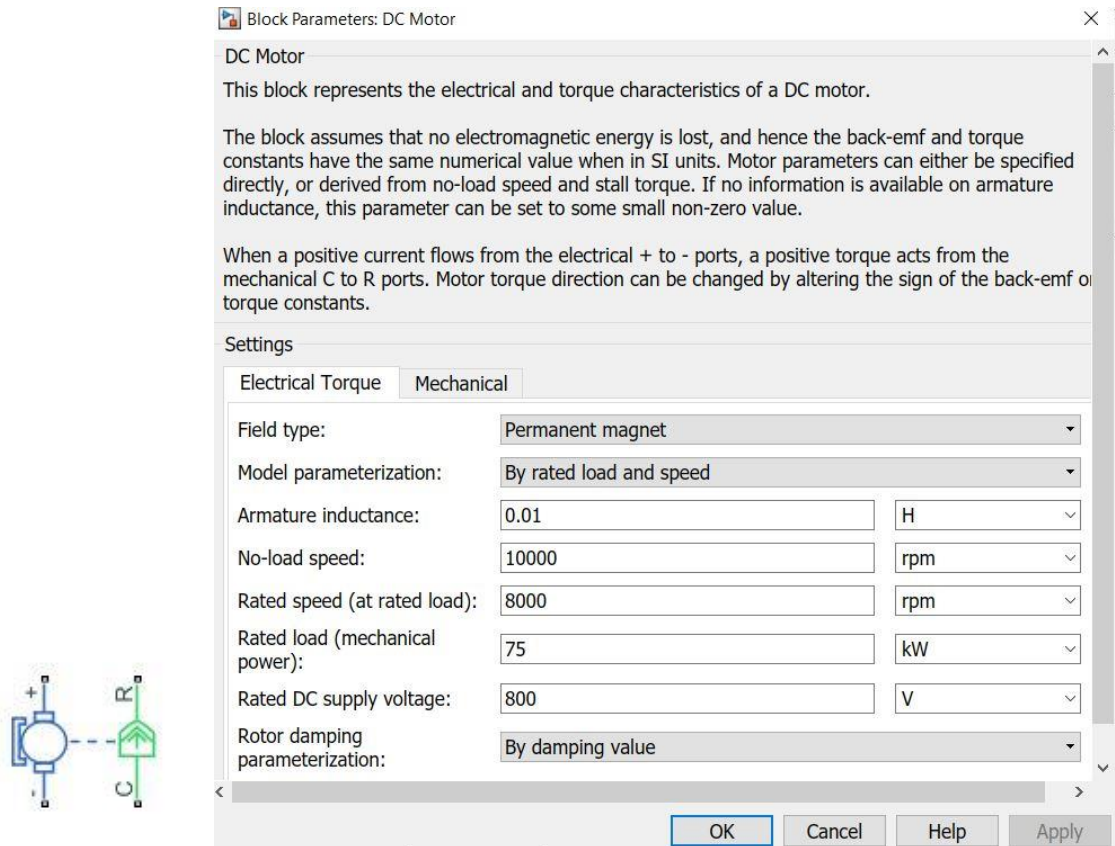


H- Bridge – it represents H-bridge motor driver. We run it in averaged mode and power supply mode is internal with voltage 800V. it takes PWM signal, reference voltage for reversing voltage, braking signal which short circuits output terminal as input. output port is connected to dc motor.

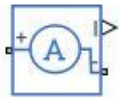




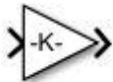
DC motor – this block represents a DC motor with specific torque and speed characteristic. Input port of this block takes voltage. It has mechanical rotational conserving port as output. We are using permanent magnet type DC motor in this model with 10000RPM speed at no load, 8000RPM rated speed, 75KW rated load.



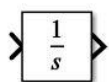
Ammeter – it measures current and it is connected with motor and h bridge in series. It is used to indicate state of charge.



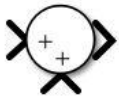
Gain – this block multiplies input with a constant value.



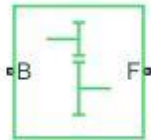
Integrator – it integrates input signal with respect to time.



Sum – it adds input values.



Simple gear -it represents a gear box that constrains the connected driveline axes of the base gear and follower gear, corotate with specified gear ratio. We are 4 as gear ratio.



Inertia – it represents mechanical rotational inertia. We are giving $0.01 \text{ kg}\cdot\text{m}^2$ as inertia.



Tire (magic formula) – it represents a tire longitudinal behaviour given by the magic formula, which is equation based on four coefficients.it takes normal force and value of coefficients as input and provide slip as an output. We are connecting axle and hub to vehicle body block.



Block Parameters: Tire (Magic Formula) X

Tire (Magic Formula)

Represents the longitudinal behavior of a highway tire characterized by the tire Magic Formula. The block is built from Tire-Road Interaction (Magic Formula) and Simscape Foundation Library Wheel and Axle blocks. Optionally, the effects of tire inertia, stiffness, and damping can be included.

Connection A is the mechanical rotational conserving port for the wheel axle. Connection H is the mechanical translational conserving port for the wheel hub through which the thrust developed by the tire is applied to the vehicle. Connection N is a physical signal input port that applies the normal force acting on the tire. The force is considered positive if it acts downwards. Connection S is a physical signal output port that reports the tire slip. Optionally expose physical signal port M by setting Parameterize by to Physical signal Magic Formula coefficients. Physical signal port M accepts a four element vector corresponding to the B, C, D, and E Magic Formula coefficients.

Settings

Main Geometry Dynamics Rolling Resistance Advanced

Parameterize by: Constant Magic Formula coefficients

Magic Formula B coefficient: 10

Magic Formula C coefficient: 1.9

Magic Formula D coefficient: 1

Magic Formula E coefficient: 0.97

OK Cancel Help Apply

Block Parameters: Tire (Magic Formula) X

Tire (Magic Formula)

Represents the longitudinal behavior of a highway tire characterized by the tire Magic Formula. The block is built from Tire-Road Interaction (Magic Formula) and Simscape Foundation Library Wheel and Axle blocks. Optionally, the effects of tire inertia, stiffness, and damping can be included.

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Settings

Main Geometry Dynamics Rolling Resistance Advanced

Rolling resistance: On

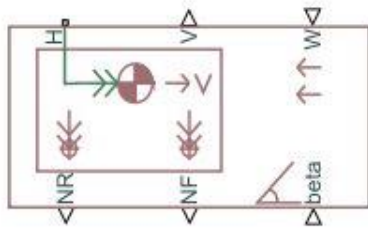
Resistance model: Constant coefficient

Constant coefficient: 0.015

Velocity threshold: 0.001 m/s

OK Cancel Help Apply

Vehicle body – the vehicle body block represents two axle vehicle body. It takes wind speed, grade angle as input and provides longitudinal velocity, normal force as output. Tire are connected to hub port of this block.



Block Parameters: 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

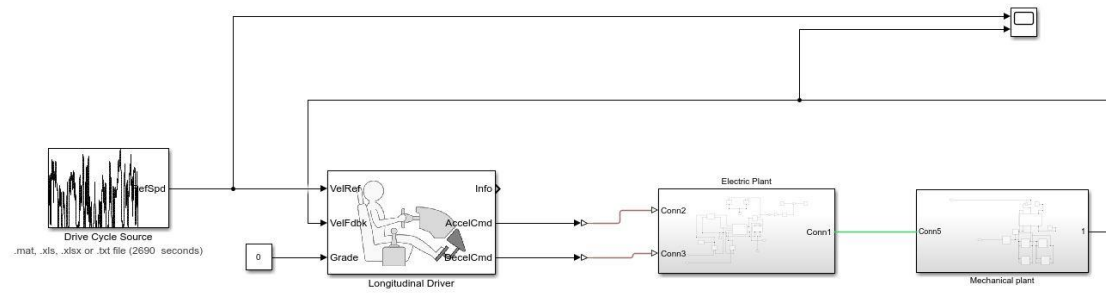
Main	Drag	Pitch	Variables
Mass:	500	kg	
Number of wheels per axle:	2		
Horizontal distance from CG to front axle:	1.4	m	
Horizontal distance from CG to rear axle:	1.6	m	
CG height above ground:	0.5	m	
Externally-defined additional mass:	Off		
Gravitational acceleration:	9.81	m/s^2	
Negative normal force warning:	Off		

OK Cancel Help Apply

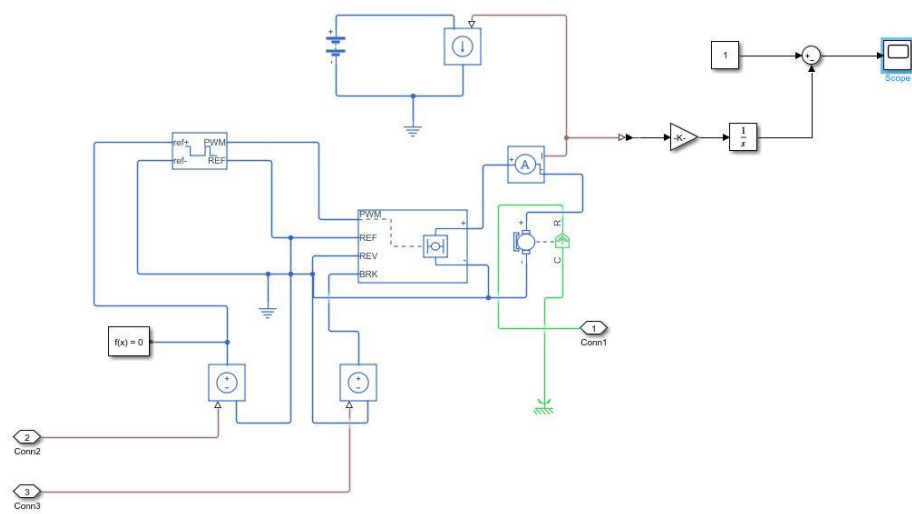
Constant – this block provides constant, it could be for Simulink system or physical system.



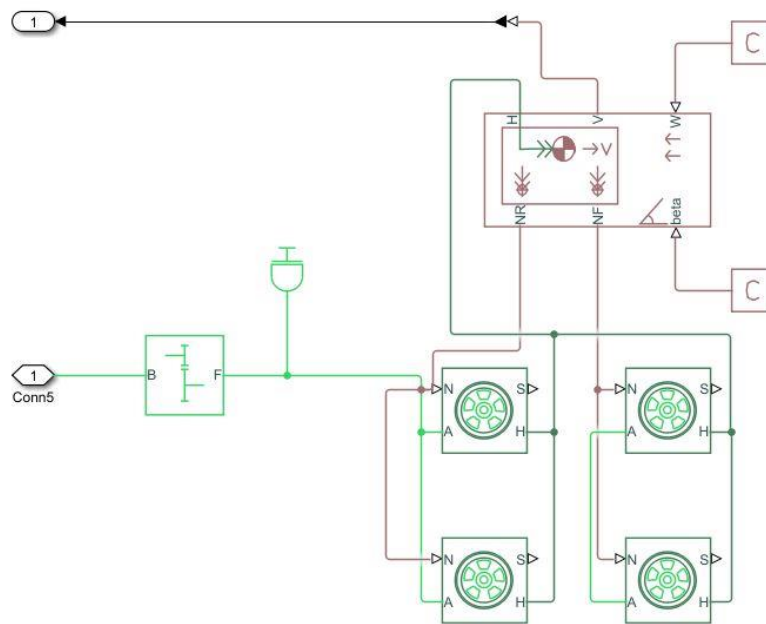
Electric vehicle model –



Electric plant

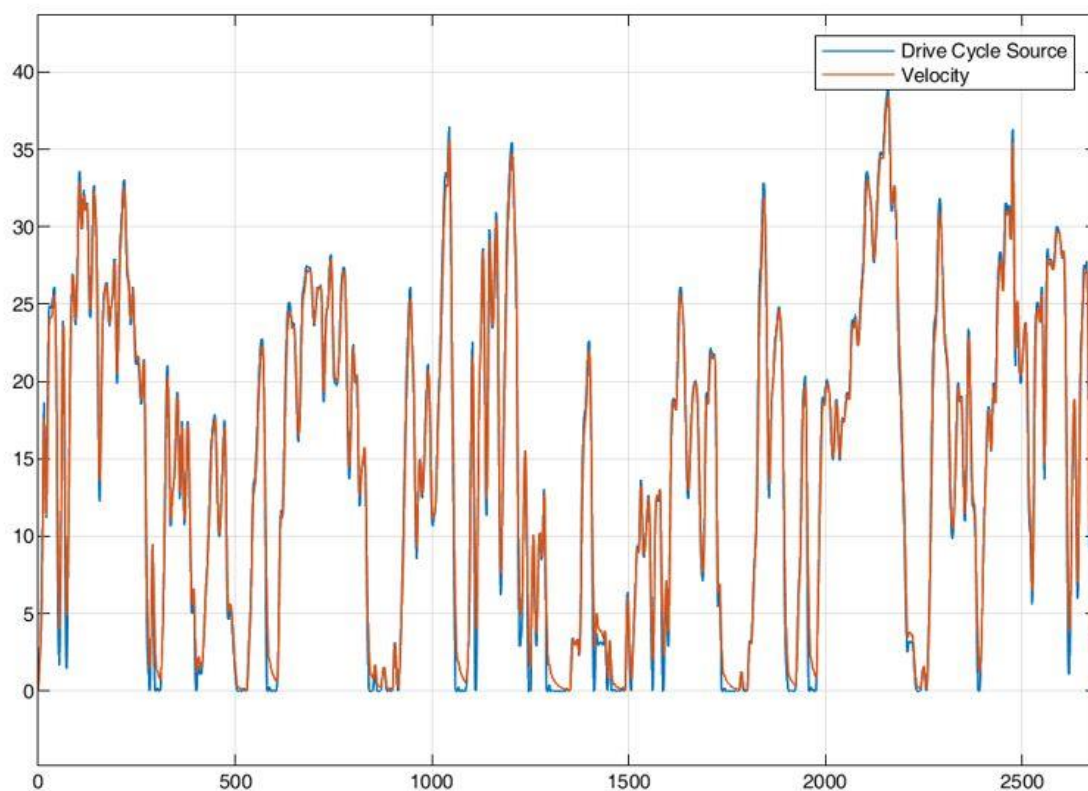


Drivetrain

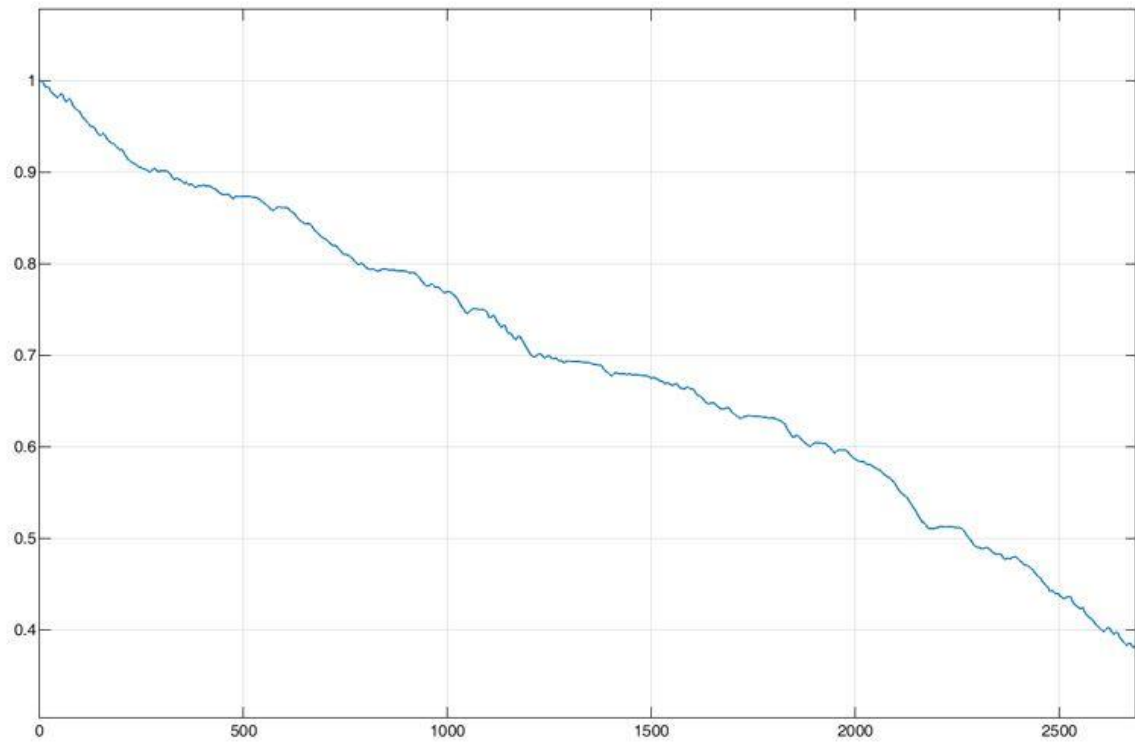


Results –

We can in plot that vehicle speed is imitating driving cycle, so we can say our model is working fine.



State of charge was 100% at the beginning of simulation and after simulation SOC is only 38%



5.Conclusion –

We used Simulink blocks to model electric vehicle. We used driving cycle as a reference speed and vehicle speed we got mimics it, So we can say our model is performing well. There are others plots which can give us valuable information about like state of charge, rotor speed etc.