ANTI-LOCK BRAKING SYSTEM

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1. Introduction

ABS is the active safety system that prevents the wheels from locking up during hard/emergency/panic braking. If ABS is not present in the vehicle means then it may lead to loss of traction between road and tyres and that leads to skidding of vehicle.

Working of ABS:

The ABS controller collects all(four) wheel sensor values and vehicle speed sensor values. Then it compares if any wheel speed is less compared to others. If yes then it continuously opens and closes the valve through which brake pressure flows. This happens now and then in a fraction of seconds and hence wheel gets stopped and vehicle does not skid, thereby coming to rescue of passe

2. MODEL

Below is the model of the ABS in the Simulink. Here modelling is done only for one wheel and can be extended to all wheels of the vehicle.

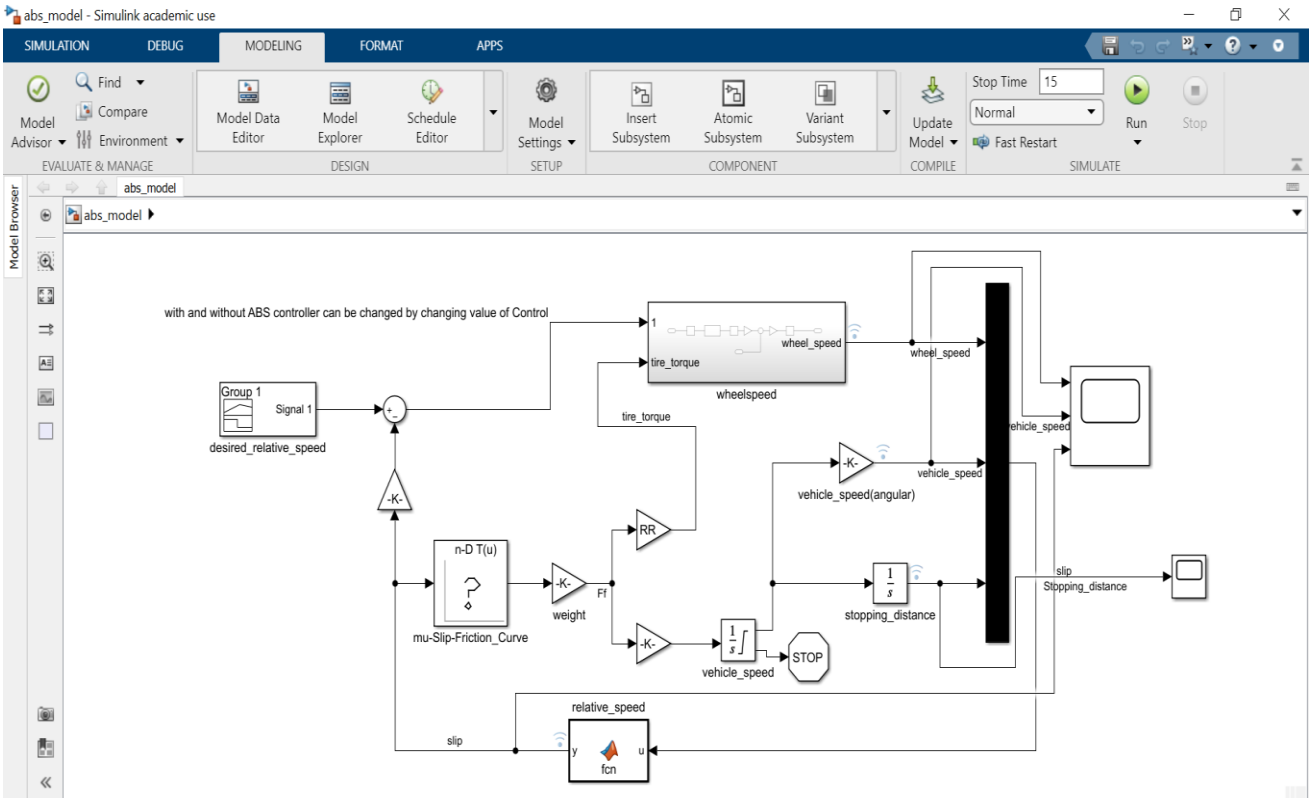

Fig1:Model of ABS

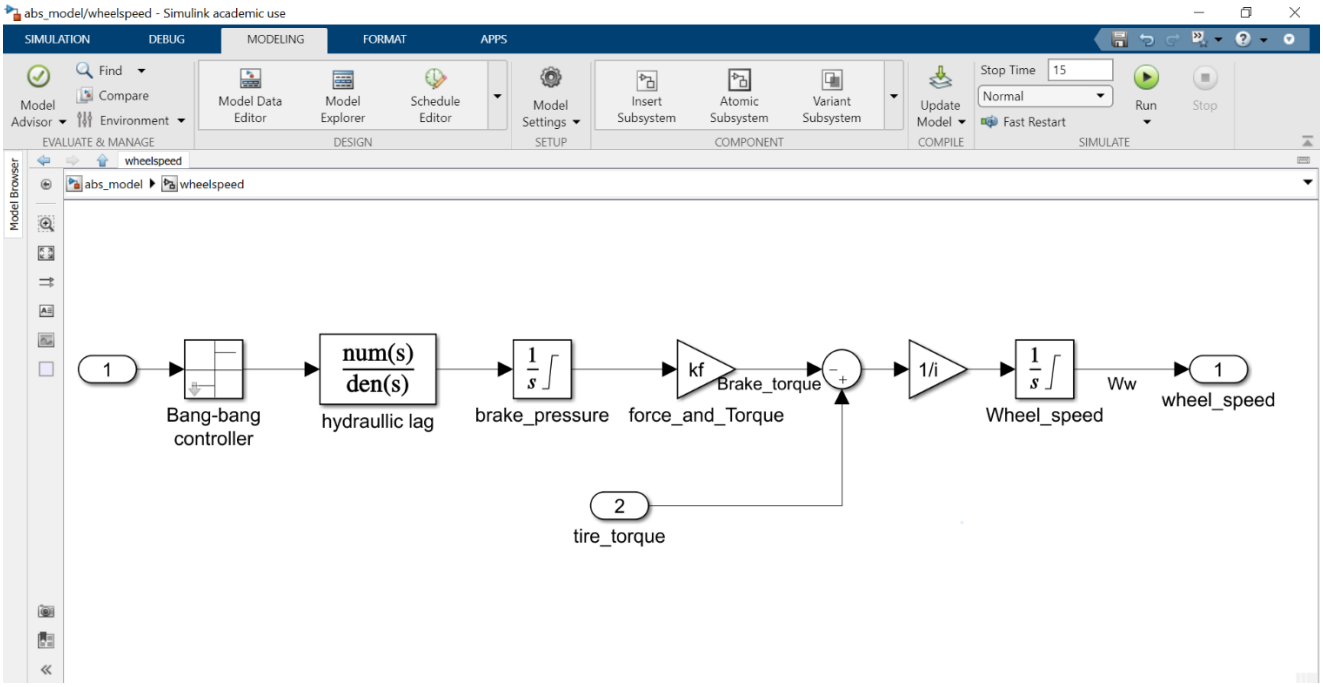

Fig2:Wheel speed subsystem

3. Features implemented

3.1 Callback

Callback is a function that gets executes in response to some predefined user action.

InitFcn (Initialization function) is a type of callback which is executed/evaluated at beginning of model compilation. It is used to initialize parameters(workspace) and environment settings which are used in the model.

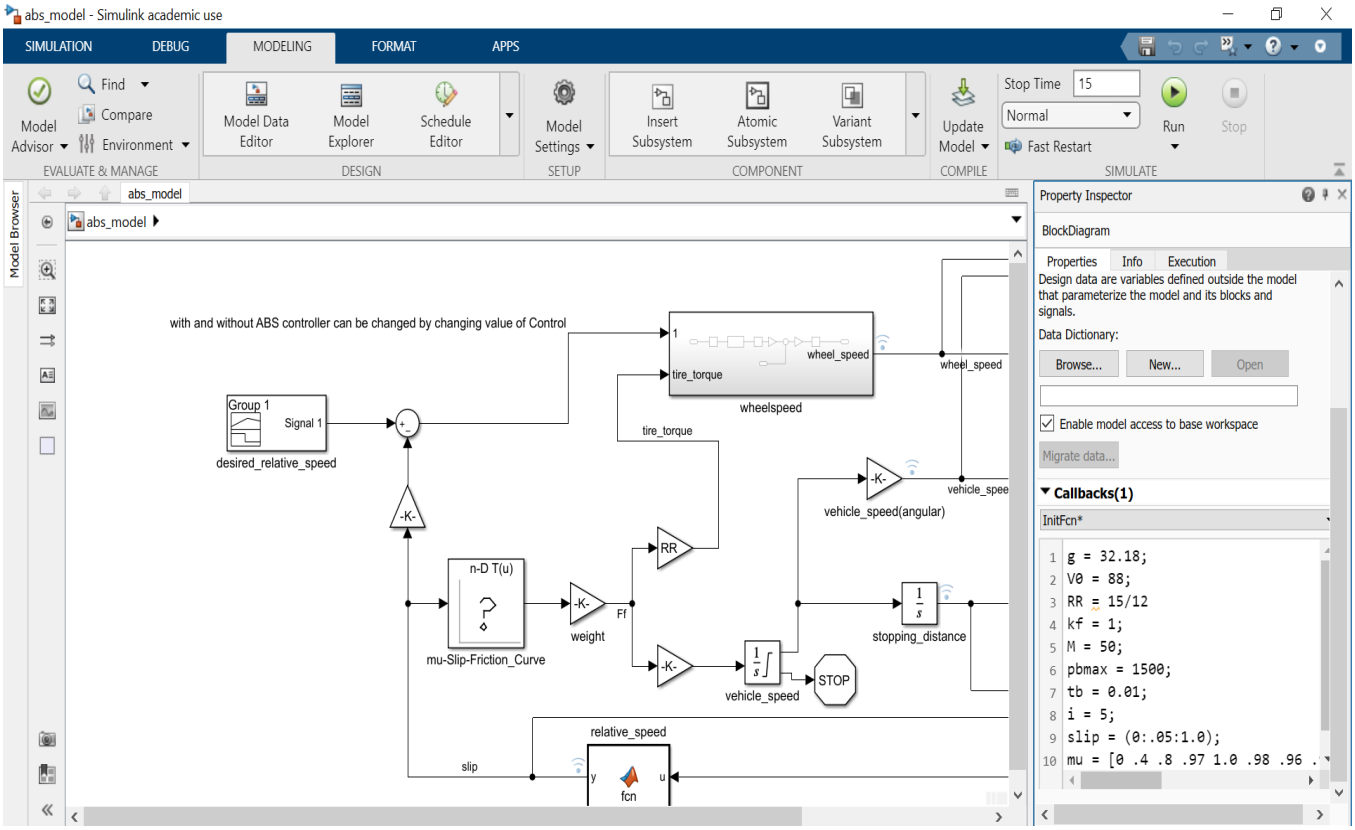

Fig3: Callback demonstration.

3.2 Data inspector

Simulation Data Inspector visualizes and compares multiple kinds of data. Through this we can log data, inspect and compare time series at various stages of the workflow design.
In the model below the logged signals are:

- Wheel speed
- Vehicle speed
- Stopping distance
- Slip

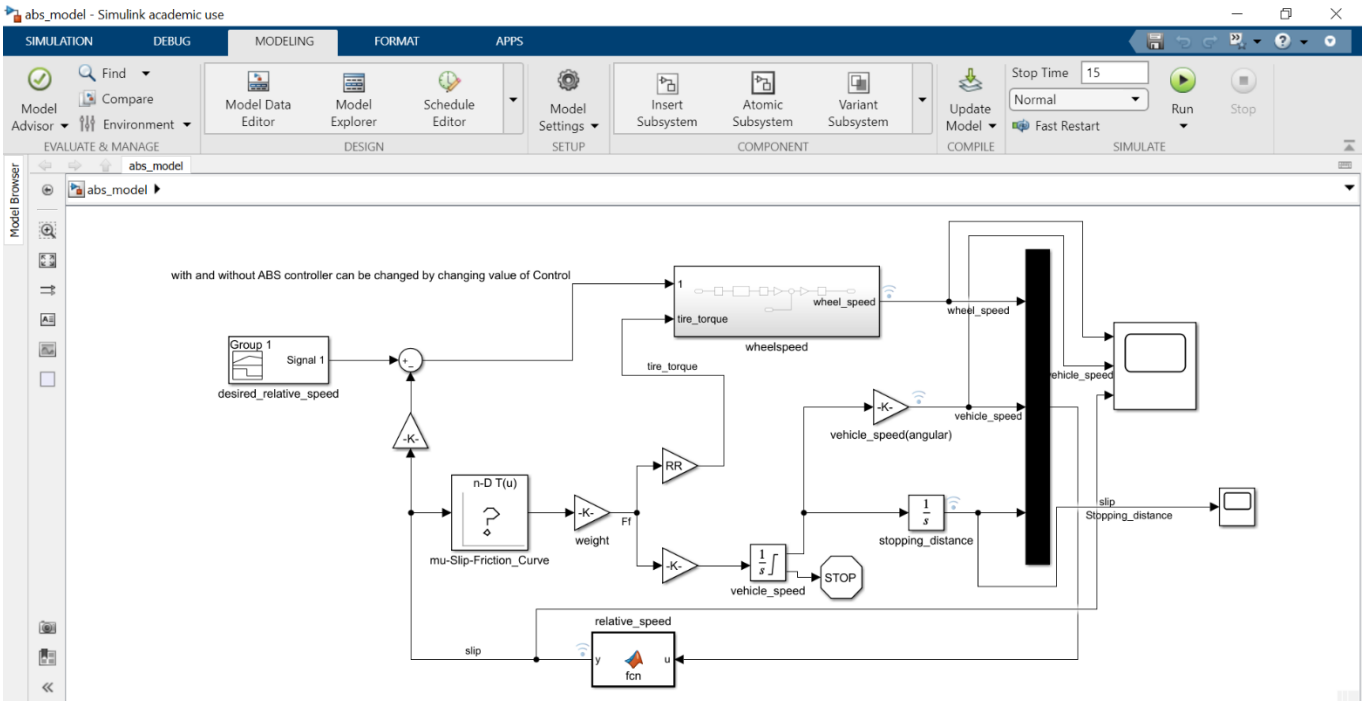

Fig4: Data logging demonstration.

Below is the image of data inspector with ABS controller.

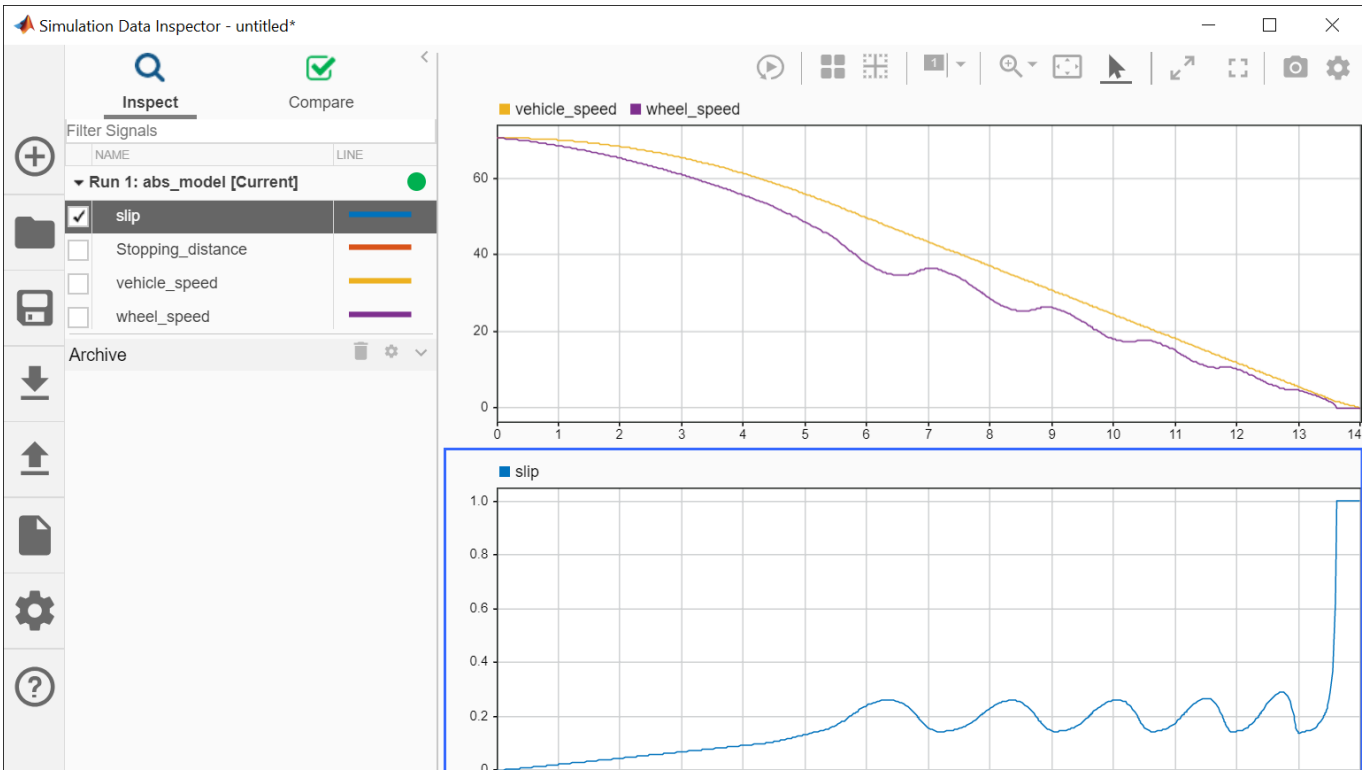

Fig5: Wheel speed, vehicle speed and slip demonstration in data inspector with ABS controller.

Below is the image of data inspector without ABS controller.

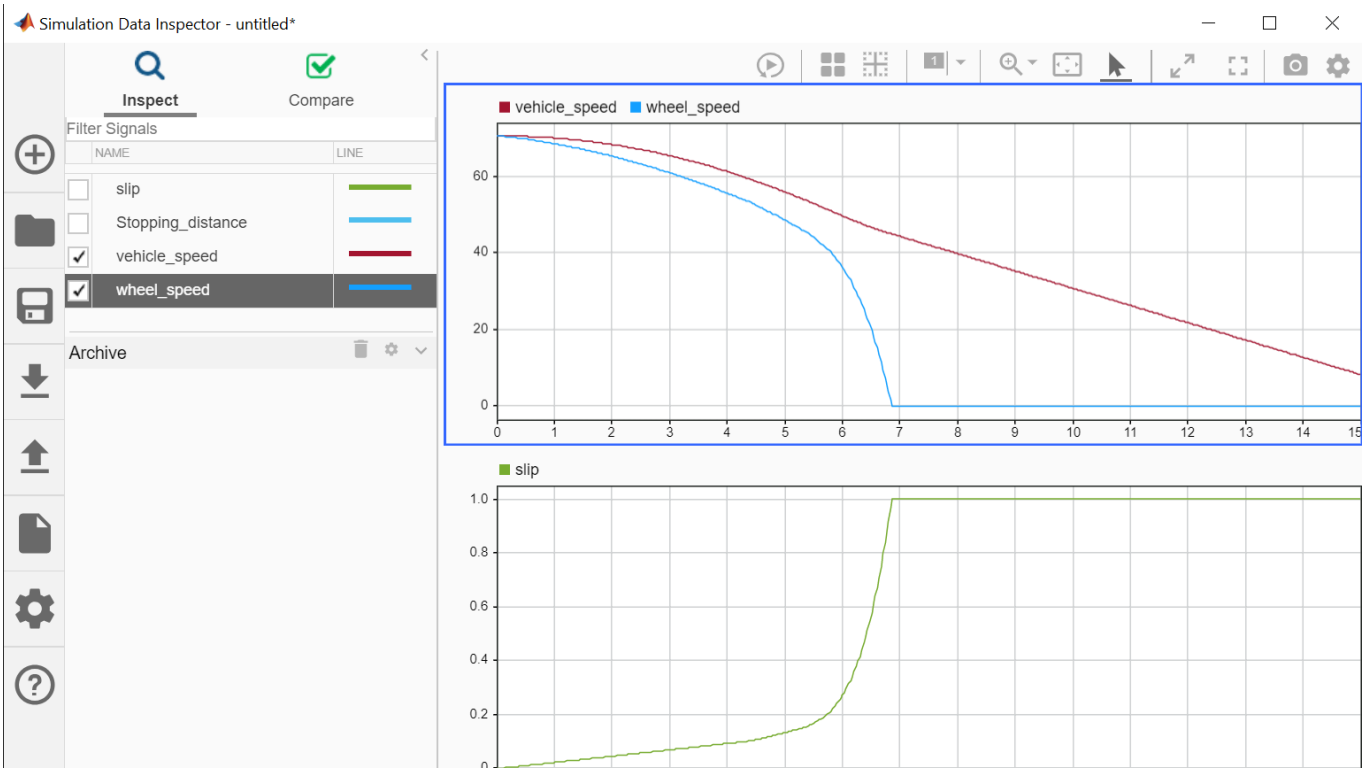

Fig6: Wheel speed, vehicle speed and slip demonstration in data inspector without ABS controller.

Below is the image of data inspector with and without ABS controller.

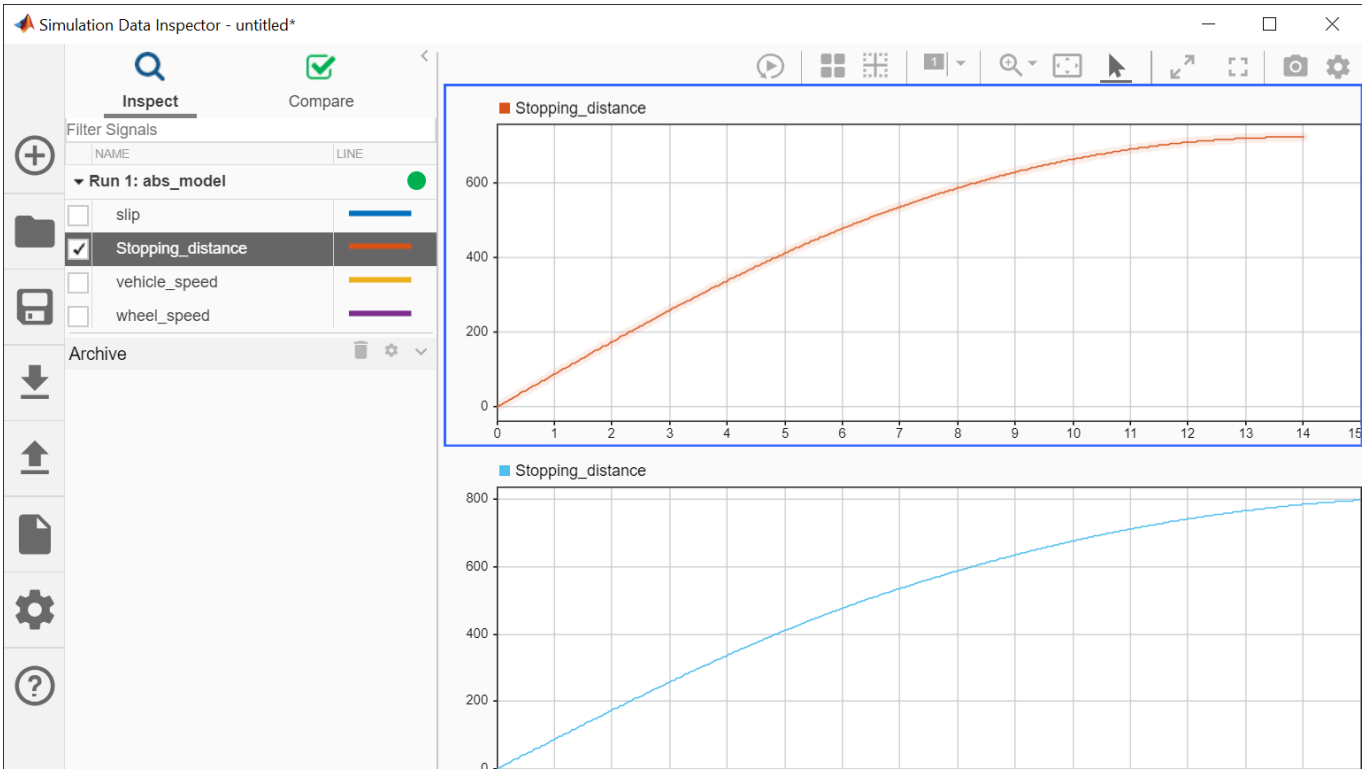

Fig7: Stopping distance demonstration in data inspector with and without ABS controller.

3.3 Solver selection

In the ABS model

- solver – ode45(Dormand-Prince)
- Type – Variable-sep
- Problem type- Non-stiff
- Accuracy – Medium
- This solver computes the model's state at the next time step using explicit Runge-Kutte (4,5 order) formula for numerical integration.
- Explicit takes care of absolute/relative tolerances and finishes computations faster.
- The reason for choosing ode45 is– it has more accuracy than ode23 and ode113.
- Ode45 does more work per step

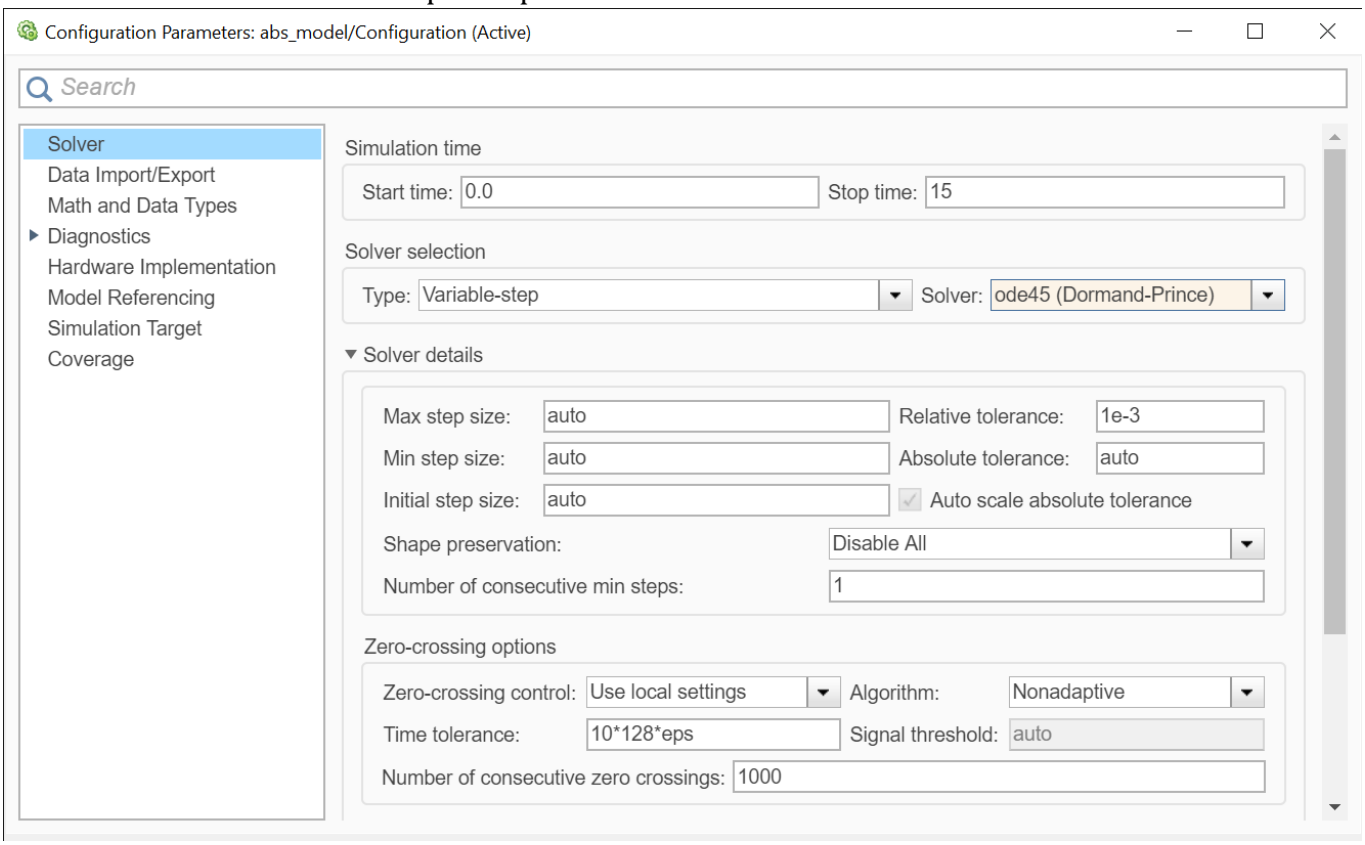

Fig8: Solver configuration parameters settings.

3.4 Matlab function block

Matlab function blocks enable us to define custom functionality in Simulink by using MATLAB language.

Here It is the function block is used to calculate relative slip. It takes input as bus selector which comprises of wheel speed, vehicle speed and stopping distance and gives output as slip.

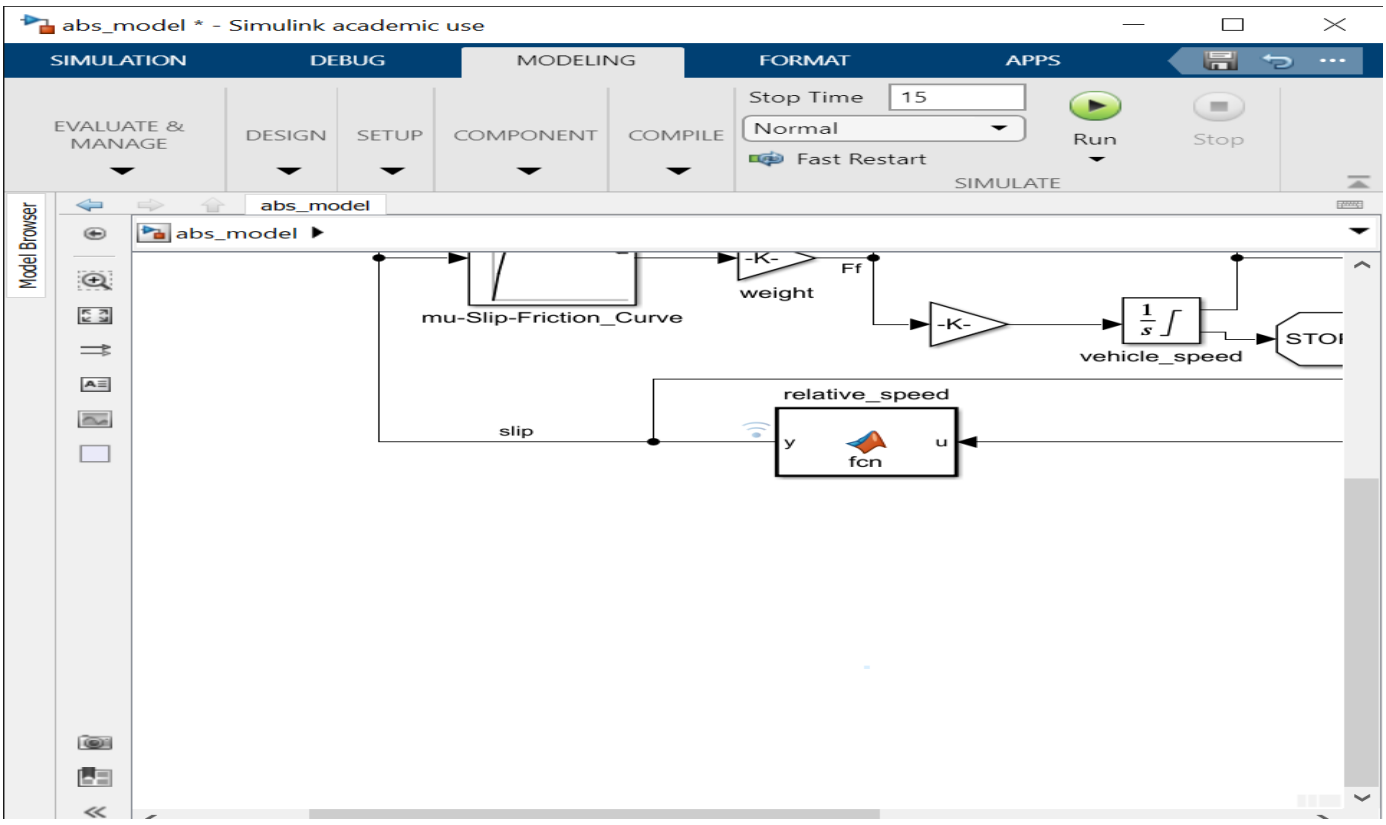

Fig9: MATLAB function block demonstration.

3.5 Look-up table

Lookup tables are used to model nonlinearity. It uses array of data to map input values to output values, approximating mathematical functions.
In the ABS model lookup table is designed for generating mu friction slip curve.
Here the values for lookup table are given through init callback function.

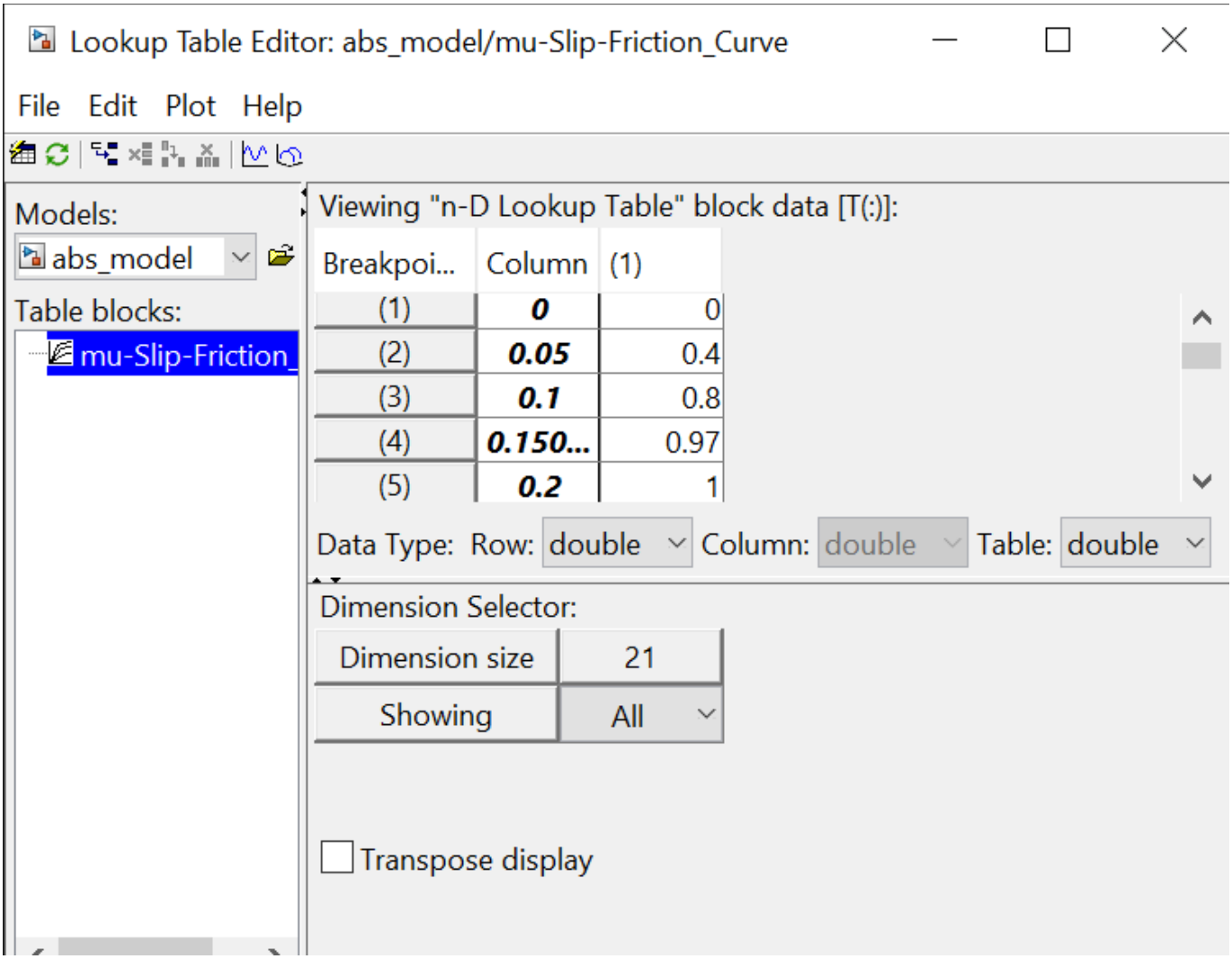

Fig10:Lookup table edit table and breakpoints demonstration.

3.6 Signal builder

The signal builder allows us to create interchangeable groups of piecewise linear signal sources and use them in our model.
In the ABS model it is used to generate the contant input signal i.e. desired relative speed which is 0.2. Similarly the signal can be generated for various input range ranging from 0 to 1.

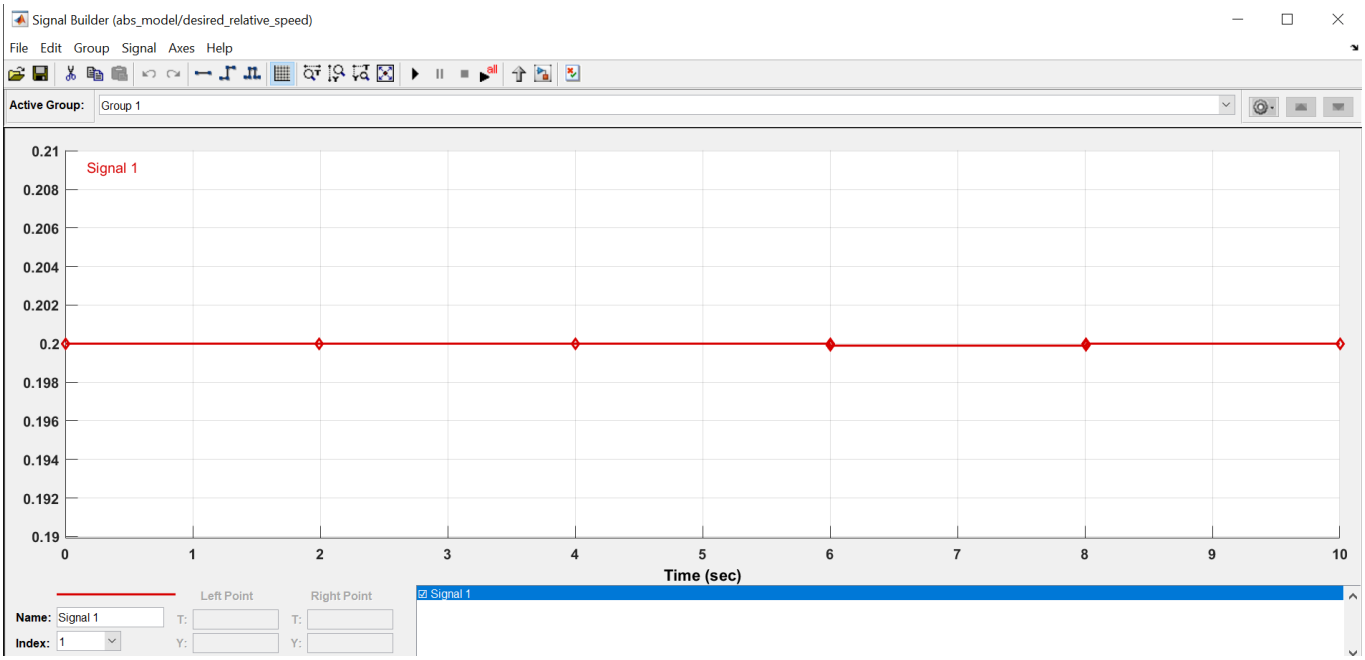

Fig11: Signal builder demonstration.

References:

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https://www.confused.com/on-the-road/gadgets-tech/what-is-abs

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