Case Simulink

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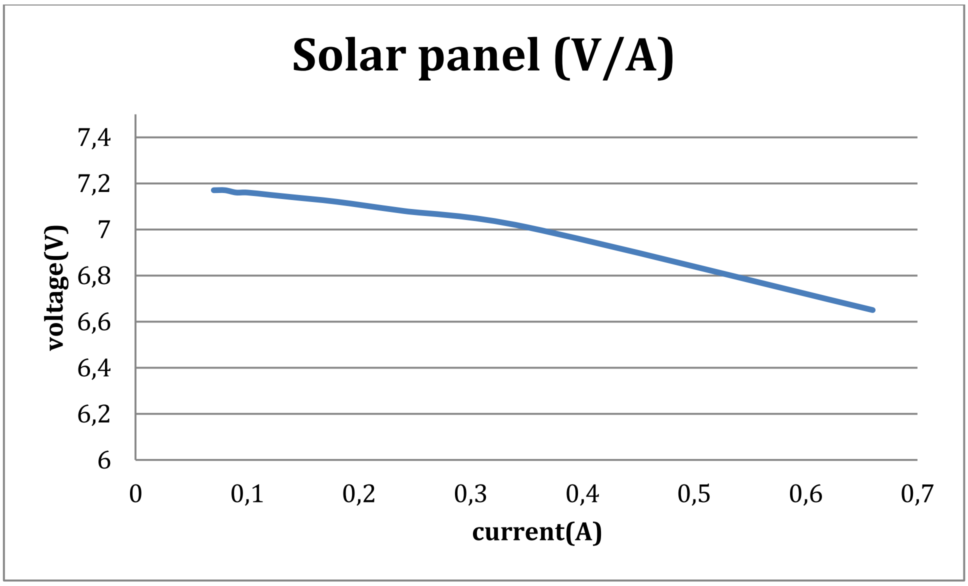
Circuit with resistance

The first simulation consists of attaching a resistor to the solar panel. Then we simulate all the values from 10 to 100 Ohms per 10. Below are the results.

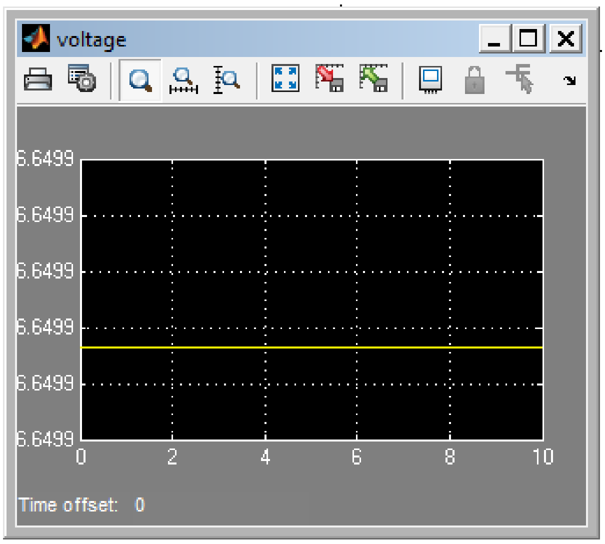
Table 1 - Measurements with Simulink

R	A	V	P
10	0,66	6,65	4,42
20	0,35	7,01	2,45
30	0,24	7,08	1,67
40	0,18	7,12	1,27
50	0,14	7,14	1,02
60	0,12	7,15	0,85
70	0,1	7,16	0,73
80	0,09	7,16	0,64
90	0,08	7,17	0,57
100	0,07	7,17	0,51



Graph 1 - U/I graph of the solar panel

Here we can clearly see that, between these values, a resistance of about 10 ohms is ideal considering we achieve the highest power with this resistance.
Below, you can also see the scoped values for 10 Ohms in Simulink and the used circuit: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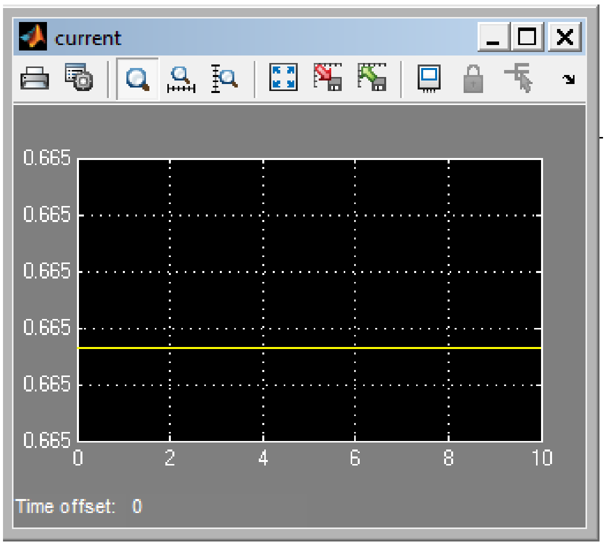
6.6499
6.6499
6.6499
6.6499
0
2
4
6
8
10
Time offset: 0


current
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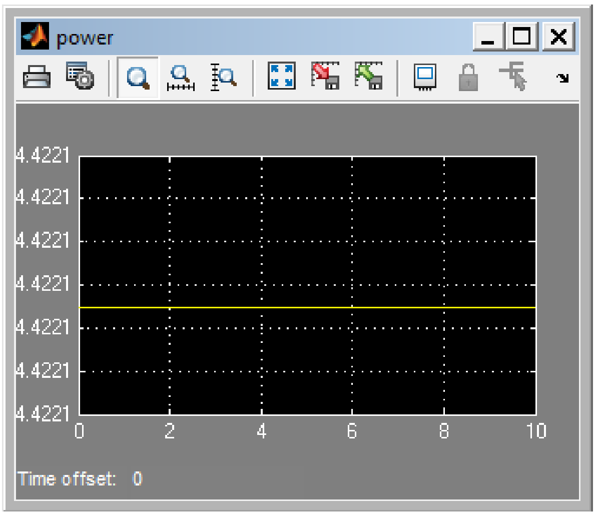
0.665
0.665
0.665
0.665
0.665
0
2
4
6
8
10
Time offset: 0


power
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4.4221
4.4221
4.4221
4.4221
4.4221
4.4221
0
2
4
6
8
10
Time offset: 0

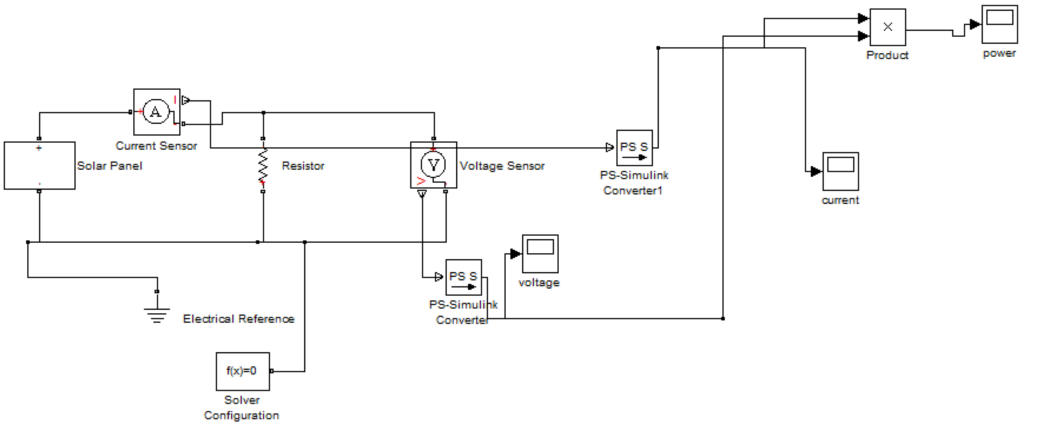
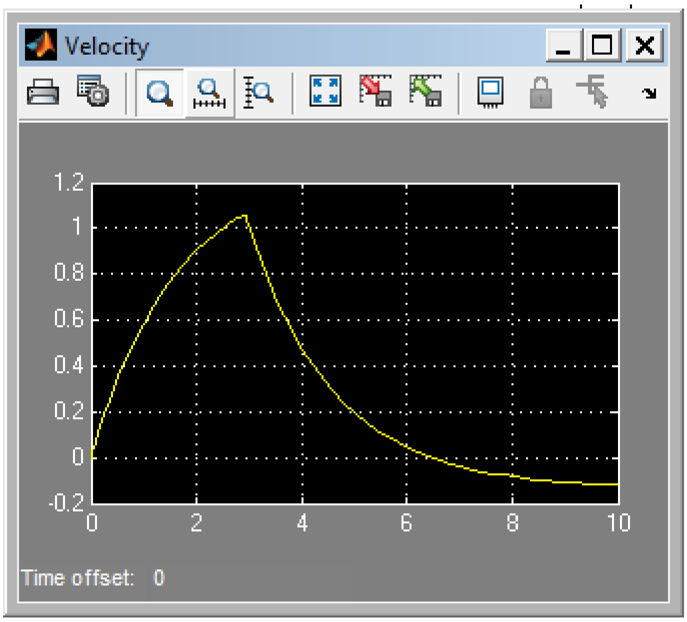
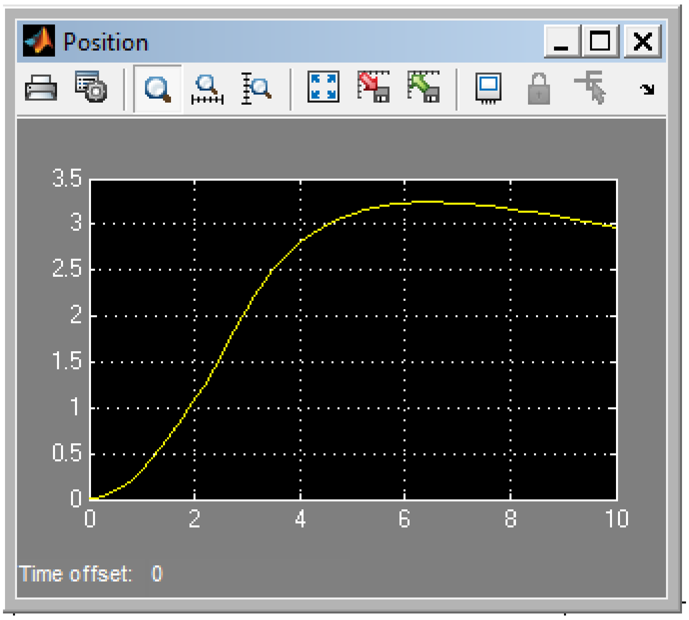


Diagram 1 - Measuring the U and I values

SSV rolling down the hill

In this next simulation we are not using any power source, but we let the SSV model run off of a slight slope and we take a look at the effects of the rolling resistance on our SSV:





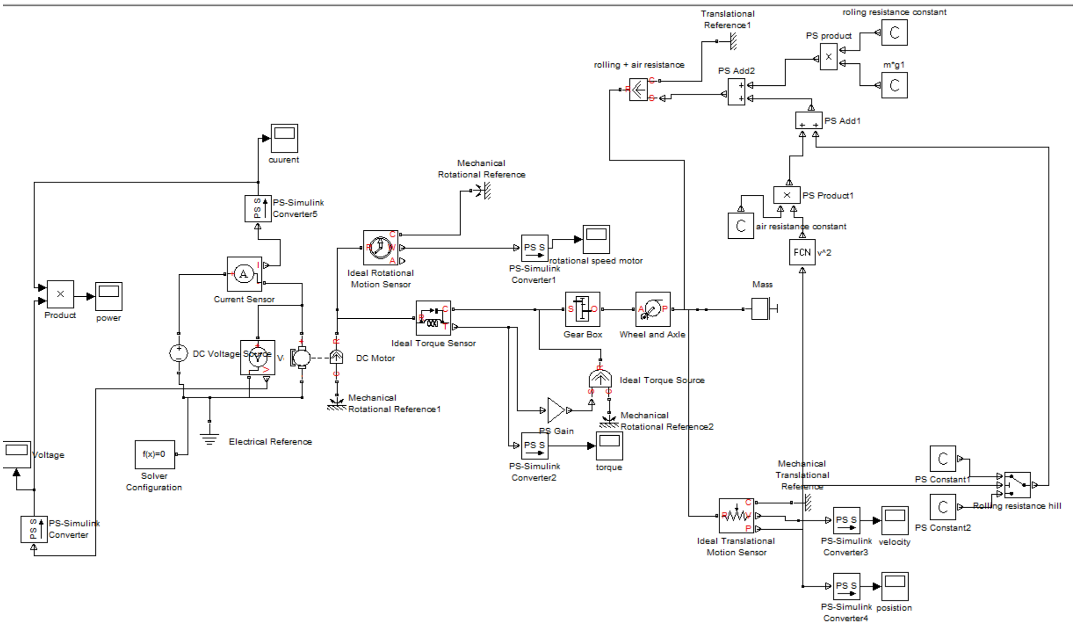


Diagram 2 – Measuring resistances of the rolling SSV

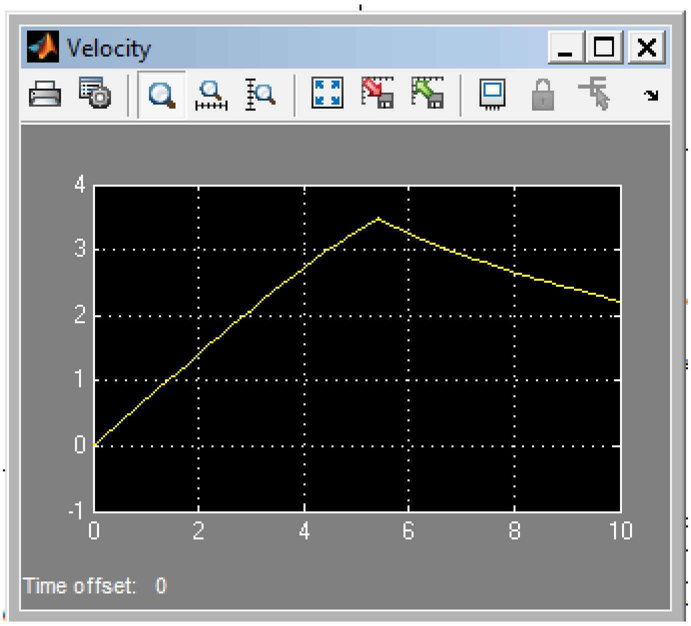
As visible in these graphs, the SSV will increase in speed until slightly after the end of the downwards slope. Then the effect of the rolling resistance becomes greater than the inertia of the vehicle and the SSV starts to slow down rapidly. In the graph of the velocity it seems that the rolling resistance eventually makes the SSV go backwards. This of course is not true, this effect is due to the fact that we assumed the rolling resistance as a constant. If simulated as a factor multiplied with the velocity the SSV in the simulation would simply come to a stop.

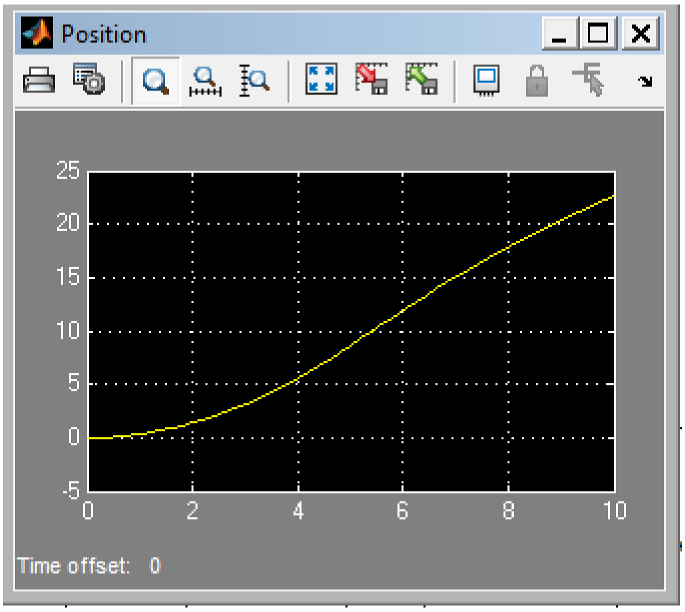
This simulation clearly shows the importance of the rolling resistance factor. And it shows we need to keep this to a minimum.

Race simulation

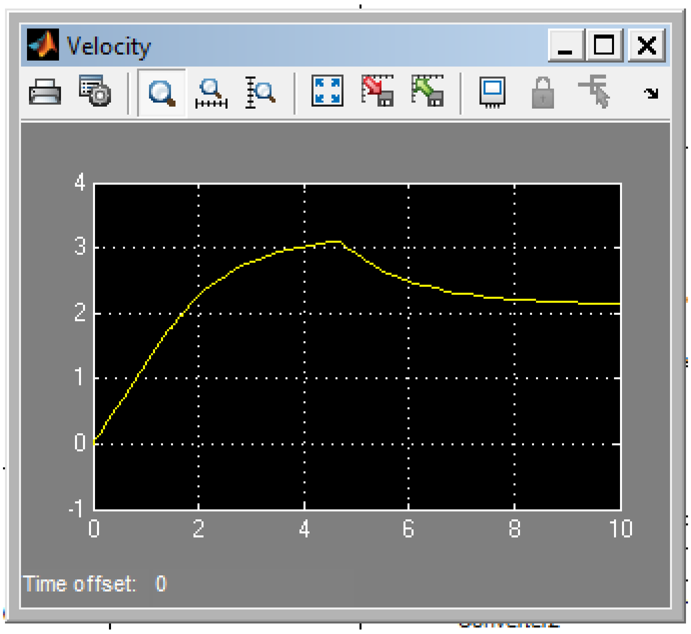
The last simulation is the full simulation of the race. Our SSV has the solar panel as power source and travels a distance of 14 meters of which the last 4 our slightly uphill.
Below are the graphs and the used circuit:

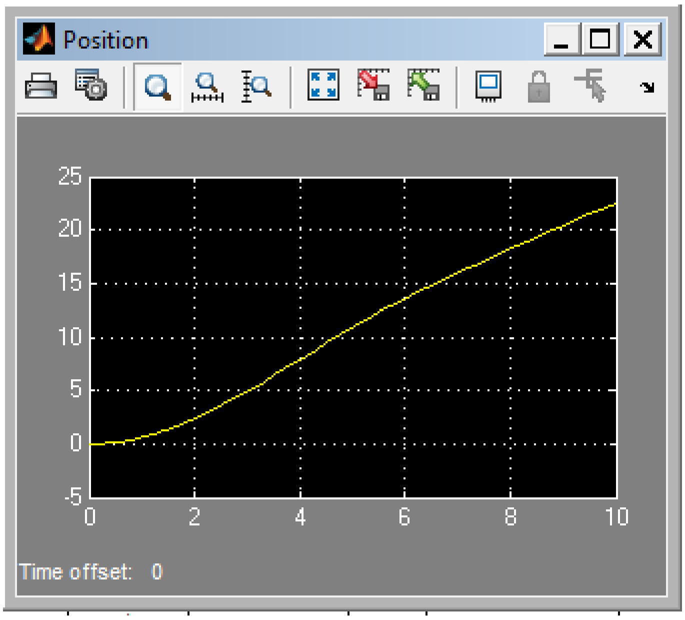
Gear ratio 6:





Gear ratio 10:





Circuit:

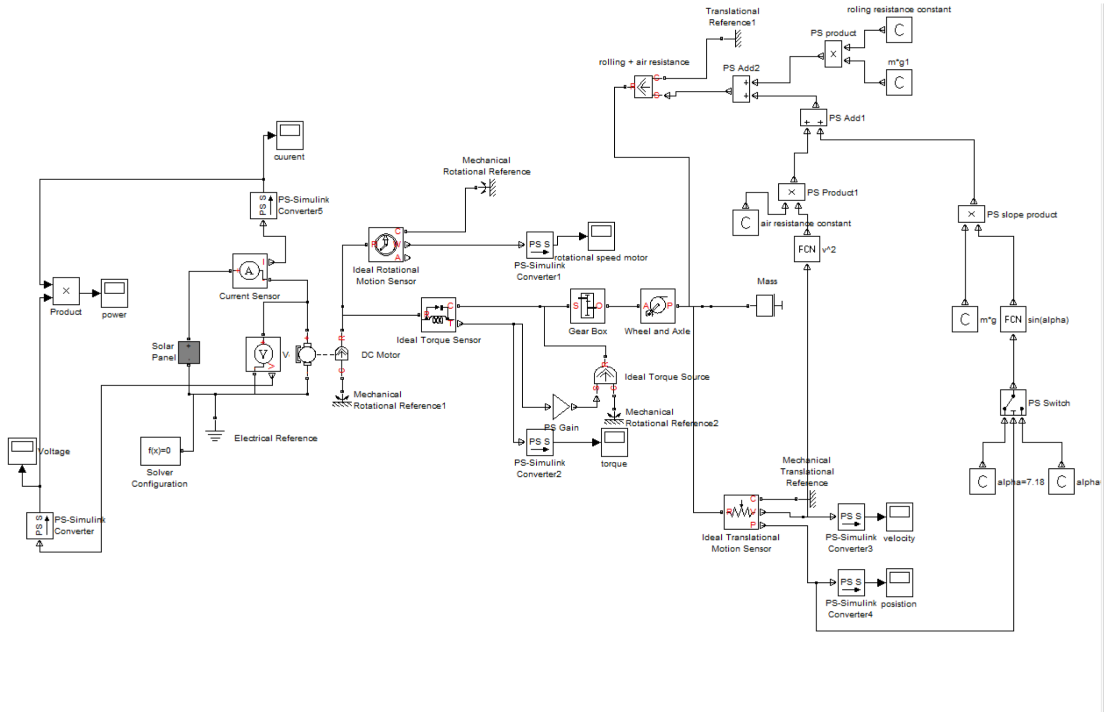


Diagram 3 - Complete SSV simulation

As stated in the MatLab simulation, we will be using 2 gear ratios and will make a switch during the race. Due to problems with the creation of the circuit, it didn't seem possible to introduce 2 gear ratios in this simulation. But we still came to the same conclusion as with the MatLab simulation. Namely we will use gear ratios of 10 and 6. These still seemed to be the most ideal ratios to use in combination. When using just one gear ratio, the ideal ratio to use is somewhere between 8 and 9. So using a gear ratio of 10 will offer a quicker starting acceleration, but lower top speed. Making a switch to a ratio of 6 after this quick acceleration will result in a higher top speed, which we should achieve in a quick manner.

Reasons for doing these simulations.

The first simulation is used to determine how the solar panel should be connected. Namely, the resistance of our DC motor should be comparable to a resistor of 10 ohms if we wish to achieve the maximum power transfer.

The second simulation shows us the importance of the rolling resistance factor and also shows us that the air resistance factor doesn't have a big influence on our SSV because we do not achieve a high enough velocity for its value to become noticeable.

As for the third simulation, it's very clear how important this is. With this simulation, the ideal combination of gear ratios can be determined. This is by far the most important factor for the project.