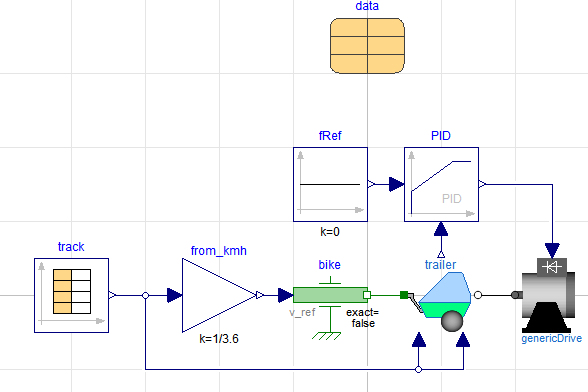
A single-axis bike trailer with two wheel hub motors shall be investigated.  
In the drawbar, a traction force sensor is integrated.

For the beginning, only straight-line driving should be considered. For turns, the torque must be distributed to the two wheel hub motors in such a way that neither oversteer nor understeer occurs. Additional sensors are required to achieve this goal.



The bicycle is modeled in a simplified way using a specified riding speed. Speed, gradient and wind speed are specified by a time-dependent table:  
Modelica.Mechanics.Translational.Sources.Speed  
Modelica.Blocks.Sources.CombiTimeTable

The trailer is implemented as a separate model:

* Modelica.Mechanics.Translational.Components.Vehicle describing:
  + Mass of trailer
  + Wheels
  + Moment of inertia of wheels
  + Resistances (can be specified constant or by an input):
    - Air drag resistance
    - Rolling resistance
    - Inclination resistance  
      Note: Inclination is the tangent of .
* Translational multi-sensor, providing traction force, speed and power

The drives are summarized in one external generic drive model:

* Limiter for maximum and minimum achievable torque  
  Modelica.Blocks.Nonlinear.Limiter
* Second-Order (Reference transfer function for an optimal designed current controller)   
  Modelica.Blocks.Continuous.TransferFunction
* Gesteuertes Drehmoment  
  Modelica.Mechanics.Rotational.Sources.Torque

**Control** oft the two wheel hub drives to achieve zero traction force at the drawbar.

Proportional gain can be calculated from the relationship between force and torque:

The reference transfer function for an optimal designed current controller can be written as:

is the substitute time constant. is the sum of small time constants on the current control loop (dead time respectively delay of the power converter as well as current measurement).

A PID-controller with ideal differential part cannot be achieved. Therefore a PIDT1-controller is choosen:

determines how near the behaviour of the DT1-term approximates the ideal differentiator,

The transfer function of the open loop can be written as:

Compensation of the denominator of the plant using the numerator of the controller delivers:

Therefor we can derive the parameterization oft he controller:

To get only real solutions, is limited:

Thus we get the transfer function of the open loop:

The reference transfer function shows second order behaviour:

Compariosn of coefficients reveals:

The aperiodic borderline case is achieved for damping :

For all solutions of quadratic equations the positive sign of the root is taken.

Comparison of PID – controller Modelica – Simulink (ideal)

Conversion of the parameters: