Snow Cat on a Hook

- PistenBully 600 W from Kässbohrer
- Ski run preparation vehicle for steep slopes
- Traction control developed with MicroAutoBox

Kässbohrer Geländefahrzeug AG has developed new winch electronics for its PistenBully 600 W. The winch enables the vehicle to rope itself down steep slopes and climb back up again. The existing electronics were mapped to a dSPACE system, where their functions were extended and improved. Traction control functions were developed very efficiently and quickly with MicroAutoBox from dSPACE. The MicroAutoBox was also used to verify the production electronic control unit (ECU).

New Winch Electronics

Kässbohrer's snow slope preparation vehicle, the PistenBully 600 W, is used to maintain and smooth ski runs. The vehicle is about 10 meters long, with a plow blade in front to push the snow aside and a tiller at the rear to break up clumps of ice and snow. The 1.50 meter long tracks distribute the vehicle's weight of 9 tonnes so widely that the vehicle exerts less pressure on the ground than a person walking. To work on steep mountain slopes, the vehicle is equipped with a cable winch, using a 1000-meter-long and 11-millimeter-thin steel cable to slide down slopes of up to 45° and pull itself back up again.

Up to now, we always used third-party control electronics for the traction control. However, with modern vehicle networking, various function nodes are connected via a CAN bus, so we had to replace the existing winch electronics.

Since the functions of the replacement electronics also needed improving and extending, we decided to replicate them in-house. This meant we could respond to customers' wishes better and at the same time develop replacement electronics that were 1:1 compatible with the winch electronics in older vehicles.

▲ *The 11-millimeter-thin steel cable allows work on slopes of 45°.*

Traction Control with MicroAutoBox

We studied the existing winch electronics, taking measurements to identify their basic functions and then replicate and modify them. The first step was to model and validate the electronics as a function map in MATLAB®/Simulink®. The model was then implemented on the MicroAutoBox by means of the Real-Time Interface, both from dSPACE. The MicroAutoBox acted as a bypass system, replacing the functions that needed modifying with the new ones so we could test them on the actual cable winch. Thus at a very early stage, were able to test whether new functions worked correctly in the envisaged constellation. The original ECU reads all the sensors and signals and controls the winch's actuators and sensors as before. It sends the signals that it reads to the MicroAutoBox via CAN.

The MicroAutoBox is the control unit that calculates the required traction along with other control variables and returns the results to the ECU via CAN. We programmed the CAN connection of the ECU graphically using the CAN MultiMessage Blockset from dSPACE. This gave us complete access to variables such as actual and desired cable traction and the function states of the winch and vehicle.

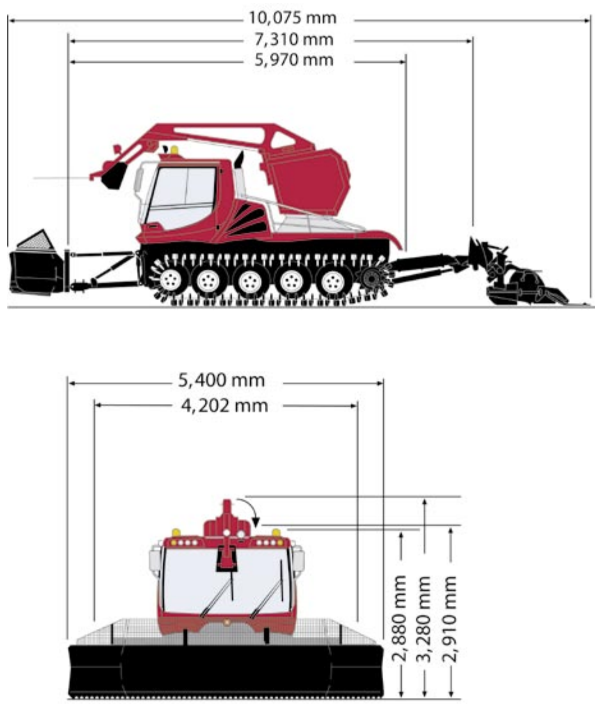
Access via ControlDesk

We access the controller's internal variables with the ControlDesk experiment software from dSPACE. The variables include various dynamic components in the controller such as integrative parts, limiting actuators and controller output.

We can therefore analyze the functions quickly and adapt them online. To ensure that the controller algorithms always have current values, it was important

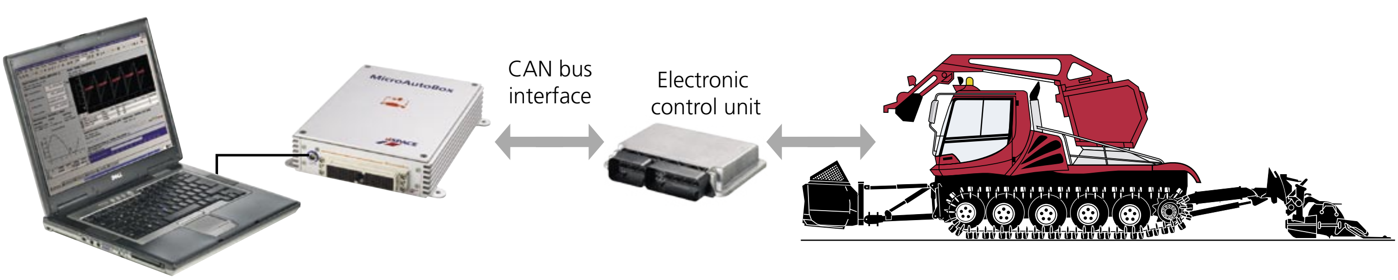
> *"Using dSPACE tools, development was 50% faster than with conventional methods."*
> ***Dr. Alexander Bulach, Kässbohrer Geländefahrzeug AG***

to synchronize the data exchange between the ECU and the MicroAutoBox, which was no problem at all. At the same time, we used bypassing to verify the production ECU used in older versions of the winch electronics. We performed the necessary optimizations of control functions on the vehicle itself. These modifications were then fed back into the model to improve it.



▲ *The side and front dimensions of the PistenBully 600 W.*

With the tool chain it took only a short time to model the functionality of the winch electronics. Compared with conventional programming, using dSPACE tools for function development gave us a time-saving potential of approx. 50%.



▲ *Function modifications are transferred to the ECU via the MicroAutoBox.*

Field Trials

We coded the modified traction control functions, tested them thoroughly in the field, and optimized them within the overall system. The dynamic cable traction behavior had to be tested for this, as there are two overlapping control loops. So far, we have implemented and tested the basic functions. New functions have been partially tested and are still in the prototype stage. It took approximately one week to test basic functionality on the vehicle.

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