Steer-by-Wire Test Bench

ETAS supports Stuttgart University

At the Chair of Automotive Mechatronics of the Institute for Combustion Engines and Automotive Technology (IVK), engineering students gained detailed insights into modern vehicle mechatronics by taking part in lab internships. One of the internship exercises consists of comparing the CAN (Controller Area Network) fieldbus with the better-performing FlexRay vehicle bus.

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ETAS made it possible to put the steer-by-wire test bench into practice for FlexRay testing (shown schematically in the figure) by providing the ES520 and ES910/ES920 hardware modules, along with the ASCET and INTECRIO software tools.

Working principle

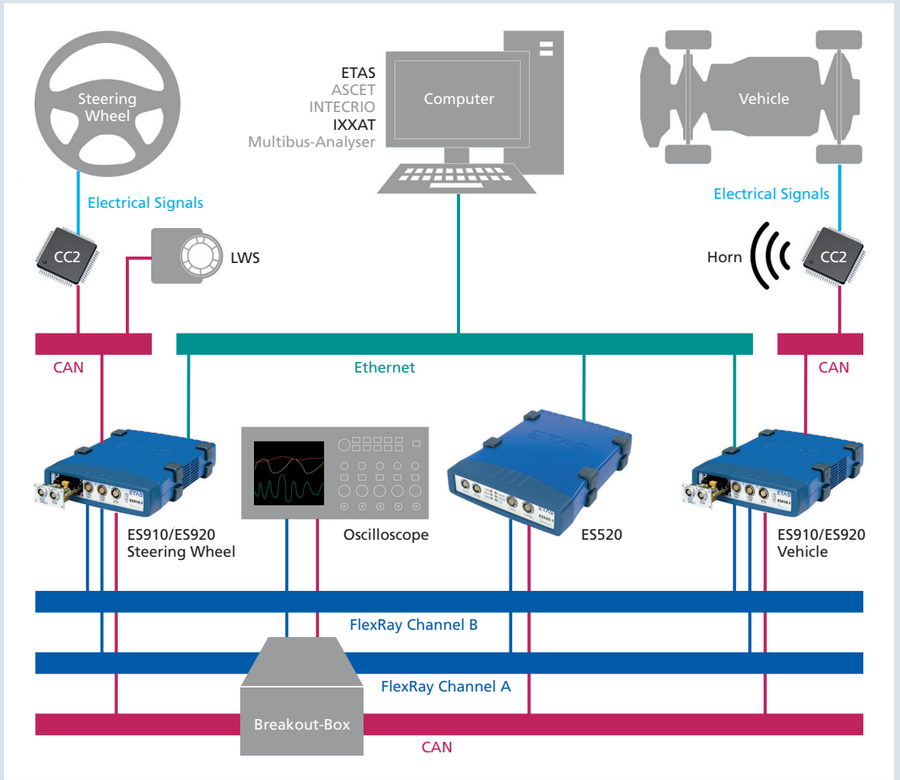
The series of experiments centered on the "steering", "blinking", and "honking" functions. Due to system constraints, exclusive communication of the sensor and control signals via FlexRay is not possible. That is why trigger signals from the steering wheel levers are first packaged in CAN messages through the C-Control II (CC2) microcontroller from Conrad Electronic. A "send" option for CAN messages is already integrated into the Takata Petri steering angle sensor (LWS). CAN messages from both sensors can be converted into FlexRay messages with the help of the ETAS ES910/ES920 Prototyping and Interface Module "Steering Wheel". A second ES910/ES920 module called "Vehicle" establishes a CAN and FlexRay network. Using the left steering column lever, the test bench operator can select whether the CAN or FlexRay messages should be further processed by the ES910/ES920 "Vehicle" module. The ETAS ES520 FlexRay and CAN Module is integrated into the bus as an additional node to perform measurements at the bus or to put additional messages on the bus with the help of IXXAT's Multibus-Analyser software. Programming of the ES910/ES920 module is done using the ASCET and INTECRIO tools on a Windows PC. From the "Vehicle" module, the information is then sent via CAN to a further CC2 controller and integrated in a vehicle model, which activates a piezo buzzer which sounds an alert. What's more, a pulse width modulated signal actuates yellow LEDs as direction indicators and a servomotor for steering.

A specially designed breakout-box makes it possible to electrically access the signal lines of both communication buses. For example, this allows voltage differences to be detected with an oscilloscope, disruptions caused by short-circuits or excessive contact resistances to be simulated.

Lab internship

At the outset of the internship experiment, the hardware modules must be connected and the correct terminating resistors selected. Although communication via FlexRay can also function without terminating resistors, this disrupts communication via CAN due to line reflections – which can lead to steering failure. An ETAS ES520 FlexRay and CAN Module is additionally integrated into the network to analyze the bus signals with Multibus-Analyser. In addition to reading out individual message details – including identifier, data length, payload data, transmission intervals, etc. – this makes it possible to specifically influence the CAN bus. The ES520 module is configured as sending node for this purpose. The continuous sending of high-priority "ID0" and "ID1" messages can drastically increase bus load and cause major delays in signal transmission.

With the INTECRIO prototyping environment it is possible to reprogram the ES910/ES920 module during online operation and demonstrate the merits of steer-by-wire:



Schematic layout of the test bench

assisted by ASCET-MD, steering ratio modulation can be applied with preamplification, thus allowing for easy influencing as desired via software. Negative transmission ratios can be likewise selected, clearly illustrating how rear axle steering can be accomplished with steer-by-wire.

Outlook

Susceptibility to errors and fail-safe operation are key issues in the automotive industry. Consequently, at this time the implementation of a "babbling idiot" – i.e., a node which continually sends erroneous messages – is being pursued in order to visually represent the error response of bus systems. The further increase in bus load resulting from the addition of nodes in the residual bus simulation represents another application scenario that is to be examined in the future within the scope of the lab internship.

Summary

The IVK's steer-by-wire test bench provides students at Stuttgart University with a "hands-on" opportunity to explore the CAN and FlexRay bus systems. There they can gather initial experience with the hardware and software that is prevalent in the engineering departments of the automotive industry. Some 50 students per semester take part in the FlexRay lab internship. The "FlexRay" experiment series is offered in conjunction with the lecture "Embedded Controllers and Data Networks in Vehicles." The lecture is an element of the "Automotive Mechatronics" major of the Chair of (Engineering) Professor Dr. H.C. Reuss, offered within Stuttgart University's "Automotive and Engine Technology" Master of Science academic program.