Isobus testing with implement and remaining bus simulations

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The tractor is a multi-talented field machine due to its ability to interact with different implements. Modern automated agriculture solutions require support of such functions as variable spread quantities for seeds and documentation of the work performed on the field. It must be possible to connect any of a wide variety of implements to the tractor and have the tractor's electronics 'understand' it. The Isobus (a CAN-based protocol for agricultural machines defined in ISO 11783) was created so that tractors, implements and operator terminals could exchange data between each other. To ensure interoperability of devices from different manufacturers, extensive tests are required for tractor and implement producers.

Precision farming

Precision farming and the integration of intelligent technologies in machines and agricultural electronics represent a focal point at John Deere's ETIC. The goal of precision farming is to attain the highest yield and economy by optimal use of available resources such as machines, seed stock, fertilizers, fuel, time, etc. The farmer takes the parameters of the planned field operations on the farm computer and uploads them to the operator's terminal in the tractor by a memory card or USB stick, or in the future via WLAN. Telematics and satellite navigation also make important contributions in combination with steering and track guidance systems as well as section control. The result is a seamless application of seed stock and fertilizers. At the same time, the technology provides for minimal overlaps on wedge-shaped fields and saves raw materials at field borders. Implements with section control are subdivided into multiple sections, which can be activated or deactivated independently of one another. Since all activities are logged, movements of the tractor during which the implement either protrudes beyond field boundaries or overlaps already covered areas result in automatic deactivation of the relevant sections.

Task Controller

The Isobus operator terminal is a user control and display system as well as a minicomputer on which multiple applications run simultaneously. Such an application is the Task Controller, which is specified in ISO 11783-10. It serves as a documentation and control system with an interface to the Farm Management System via the TaskData.xml file. In the John Deere GreenStar 2630 display, the Task Controller represents an inter- ▷

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Agricultural specialist

John Deere is a company producing agricultural machines, construction machines, forestry machines and public utility equipment as well as machines for lawn, property and golf course maintenance. The company provides German subsidiaries in Zweibrücken, Mannheim and Bruchsal. In early 2010 the European Technology and Innovation Center (ETIC) in Kaiserslautern (Germany) was opened as well.

Introduction

The inter-system and inter-OEM compatibility of Isobus conformant devices lets farmers interconnect tractors and implements from different manufacturers in any desired combinations. As easy as this may seem from the user's perspective, the level of effort required in the device development side is high, especially in the testing phase. A look at John Deere shows that conventional industry methods for testing electronic components are now often running into their limits. An incomparably faster and more efficient means for attaining the desired goal is automatic test sequences with a simulated implement environment.

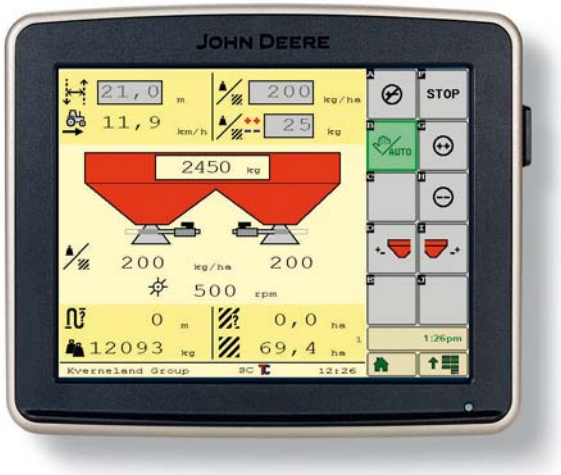

Figure 1: John Deere Isobus operator terminal with the Kverneland fertilizer spreader operating interface (John Deere)

face between the documentation system and an Isobus implement. The first time it is connected, the Task Controller loads a "Device Description File" from the implement's job computer. This file contains information necessary for the Task Controller, such as the implement's working width, type of mount to the tractor and number of switchable sections with associated element numbers, if it is an implement with section control. The implement may be operated via the tractor's operator terminal. The Task Controller has to master the entire bandwidth of possible implement device configurations to work properly with Isobus implements available on the market. Every work machine operates differently than another and uses a different combination of Task Controller functions. For test purposes, producers exchange special hardware boxes, in which the electronic functionality of their implement is represented. To the chagrin of test engineers, aside from the ECU hardware and software contained in the boxes, they very seldom include all of the components needed to conduct a comprehensive functional test of the device logic.

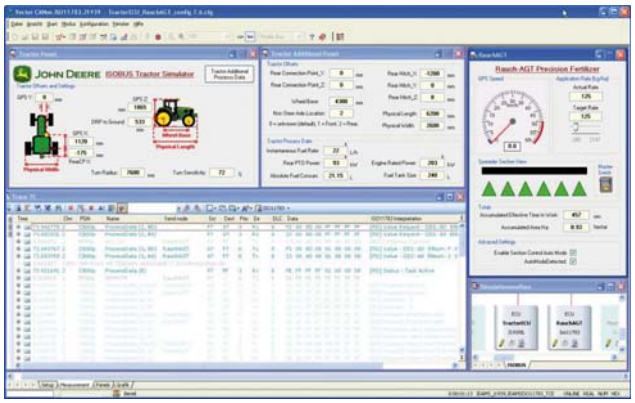

Figure 2: Simulation of tractor and fertilizer spreader (John Deere)

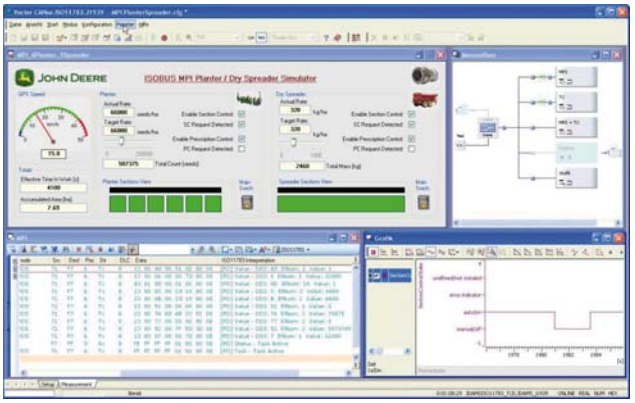

Figure 3: Support of an Isobus Multiple Product Implement by the Task Controller via a simulation (John Deere)

More efficient test method

The ETIC employees were former also using test boxes and real devices of various implement producers to test the functionality and compatibility of their Task Controller. The test boxes are not standardized with regard to their layout or handling. Each company follows a different operating philosophy, and some boxes are pure simulations, while others largely match the real electronics. Before test personnel can perform their work, they must first study many different user manuals to gain familiarity with the virtual control elements and functions.

This approach motivated the engineers to seek a more efficient test method. They found the solution in CANoe.ISO11783. It is a development, test and simulation tool from Vector with Isobus conformity from the product development to the test phase and maintenance. The Isobus communication structures may be analyzed, visualized and prepared. The "Virtual Terminal" function may be used to simulate different display types, resolutions or black/white settings. The "Interactive Task Controller" function lets users load a device description from any real Isobus machine, or may be used to verify simulators before they are used for testing.

Test engineers made use of the tool's simulation ▷

capabilities in order to be independent from implement producers. The tool may simulate individual ECUs as well as entire networks (remaining bus simulation). For defining automated and recurring tests the CANoe's integrated "Test Feature Set" is a useful feature. The system may act as either the Test Master or be inserted into existing test environments. Interfaces such as COM or .NET are available for control and communication with other tools.

For section control simulations it was possible to vary the type and sizes of working machines e.g. to check whether the Task Controller could handle 16 instead of 8 sections. Implements may also be defined whose sections are not strictly adjacent. Since the tool completely represents the Isobus standard, a higher level of test coverage in a shorter amount of time was attained. This was helpful in application situations with unsupported or just partially supported functionality by the hardware boxes. Such situations include tests of driving speed control, checking for correct handshakes or simulation of errors, e.g. when an implement does not signal its readiness for section control.

The tool is also used for the in-house development of ECUs. For testing, the real tractor hardware may be used or simulated. Users may toggle between different variants if multiple versions of a Task Controller need to be tested. The simulation configurations may be exchanged between company's departments via the intranet or by e-mail.

Covering future requirements

Tool's multi-bus capability enables displaying and interpretation of Isobus and J1939 messages in a Trace Window. It covers the Isobus functionality at the latest revision level. Using the tool, John Deere has the ability to test extended Task Controller functions and also to simulate the counterpart device. Interesting in this context is the Isobus multiple-product implement simulator. A multiple-product implement might be a corn sowing machine with under-root fertilization. It enables simultaneous sowing and spreading of solid fertilizer. One of the benefits, besides time-savings, is reduced soil erosion, because the tractor only drives across the field once instead of multiple times. At the time of testing in early 2011, there was still no implement producer that offered such Isobus machines on the market. Therefore, it was only possible to have the Task Controller support for such machines in a simulation. From the perspective of John Deere employees, it would be desirable if manufacturers would exchange their CANoe simulations instead of the black boxes. The fear that this would somehow reveal internal know-how is unfounded, since it is possible to share the compiled simulations without the source, thereby preserving internal know-how. ◀