



The new AST-2P/X high-speed aircraft tow tractor by Goldhofer utilizes a diesel-hydraulic drive system with a driveline controller supplied by Sensor-Technik Wiedemann.

## SAFETY ON THE RUNWAY

Driveline controller for airplane tow tractor provides optimum traction and a fuel-saving option

German manufacturer Goldhofer recently introduced its new generation AST-2P/X high-speed aircraft tow tractor, which is designed to move a broad range of aircraft — everything from an Embraer 170 up to the Boeing B777-300ER and Airbus A340.

The AST 2 tractor is in its fourth generation and is characterized by a new, compact and modular vehicle concept with a hydrostatically driven steering axle designed to deliver optimum traction, even in the case of low superimposed load. The tractor is available in two engine versions, with Cummins QSL9 diesel engines delivering 228 or 283 kW and complying with EU 3a and U.S. Tier 4 final emissions regulations. A three-circuit braking system is also used, which distributes the braking force for maximum stability and safety, the company said.

The airplane power supply during towing operation is ensured via a ground power unit (GPU), which can be retrofitted into each of these vehicles.

Since towing operations in airports entail a lot of waiting periods, an automatic start-stop function has been installed to achieve maximum fuel savings. This function helps with

reducing diesel consumption as well as tractor maintenance costs since operating hours are reduced.

A central component of the system is the diesel-hydraulic drive system. It is composed of a pump and two hydraulic motors which operate a differential steering axle through a summation gearbox. The pump and motors are controlled through electrical proportional adjustment.

The drive system is overseen by a driveline controller (DLC), which is responsible for the entire drive system management and the airplane type-dependent tensile force limitation. During the towing process, only a limited tensile force may be applied to the aircraft's nose wheel. The tensile force limitation in the DLC is realized through a dynamic, airplane type dependent, high-pressure regulation. In addition, the DLC is responsible for the automatic start-stop function.

For the selection of the drive controller, Goldhofer was looking for a flexible and high-power control unit that would be in a position to reliably execute the safety-relevant functionalities. The control unit needed to be adaptable to other aircraft tractor types and provide the required performance to safely cover current and future requirements.

The solution was found with the ESX-3XL safety control unit from Germany-based Sensor-Technik Wiedemann (STW). The control is built on a 32-bit TriCore controller with a 150 MHz core, 4 MB RAM, 6 MB Flash and 32 KB EEPROM.

“In addition to the flexible adaptation possibilities in the basic version, so that all inputs can be configured via the initial functions as current/voltage/digital or rpm inputs, one other outstanding feature of the ESX-3XL is the possibility to extend the device via expansion boards,” said Rudolf Filser, head of the System Support Team at STW. “Because the control unit can be configured with up to six of these boards, it simply grows flexibly with the project.”

At the moment, 14 expansion board versions are available featuring different inputs and outputs, additional RS232/RS485/CAN interfaces and a programmable Linux system including Ethernet and USB.

Generally, development environments for programming in “C,” Matlab and Codesys are available, the company said. For the development of the DLC, the development environment Codesys in version Codesys Safety SIL2 was chosen. The control unit is certified according to standards such as DIN IEC 61508: SIL 2 and DIN EN ISO 13849: PL d.

“Since safety-orientated development represents a substantial cost factor during product development and during maintenance of the subsequent product, STW paid particular attention during drafting of the technical safety concept to a clear and unambiguous definition of the safety functions and their assignment to the appropriate software components,” Filser said.

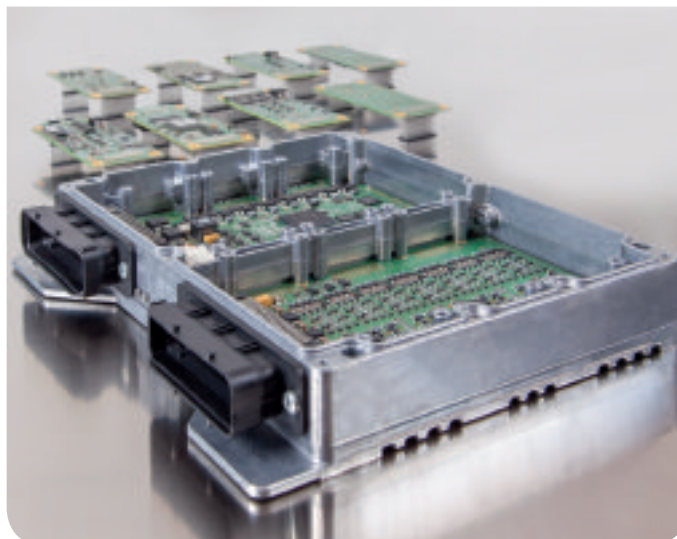
“The focus was placed on keeping safety-relevant parts as simple as possible and creating clear interfaces between safety-relevant and nonsafety-relevant software parts. In the software architecture, this is presented in appropriate safety-relevant and nonsafety-relevant modules.”

According to Filser, a clear assignment of functionalities and the precise definition of the interface between the two software worlds are always meaningful. But it only leads to cost reductions for development and maintenance if the separation of different software components is supported by the hardware.

According to the IEC 61508 standard for the functional safety of electrical/electronic/programmable electronic safety-related system (IEC 61508-3, 7.4.2.9), software parts with different safety classifications are to be developed on a control unit in accordance with the highest safety level unless they are suitably independent through temporal and spatial separations.

The ESX-3XL control unit supports temporal and spatial independence of application parts by providing appropriate memory protection and watchdog functionalities. This opens up the possibility for the development team to develop nonsafety-relevant parts of the application in accordance with a simplified development and verification process.

“STW’s objective was to guarantee a standard-compliant



The ESX-3XL freely programmable control unit by Sensor-Technik Wiedemann is designed with clear interfaces between safety-relevant and nonsafety-relevant software parts. The safety-relevant parts have been kept as simple as possible, the company said.

parameterization of the DLC,” Filser said. “In addition, it was necessary to verify that parameter changes to nonsafety-relevant application parts would not have any effects on the safety-relevant application parts. This will keep the required validation and verification expenses as low as possible, too.

“Basically, every additional parameterization provides additional complexity, additional error sources and therefore increased validation and verification expenses. Accordingly, attention was paid in the specifications and design of the safety-relevant modules to limit the number of parameters to a minimum.”

With the clear delineation between safety-relevant and nonsafety-relevant application parts, the basis was provided for division of the parameterization into a safety-relevant and nonsafety-relevant part.

The process of safe parameterization is supported via the ESX-Kefex toolchain. This toolchain is part of the ESX-3XL development environments and comes with a detailed user and safety manual. The Kefex toolchain has been certified for use in projects with safety requirements in accordance with DIN IEC 61508: SIL 2 and DIN EN ISO 13849: PL d.

In the case of the AST-2P/X tow tractor, the entire development process — risk analysis, hardware assignment, preparation of safety concept, software architecture, implementation and verification — has been realized in close coordination between STW and Goldhofer. [dpi](#)

FOR MORE INFORMATION  
[www.sensor-technik.de](http://www.sensor-technik.de)