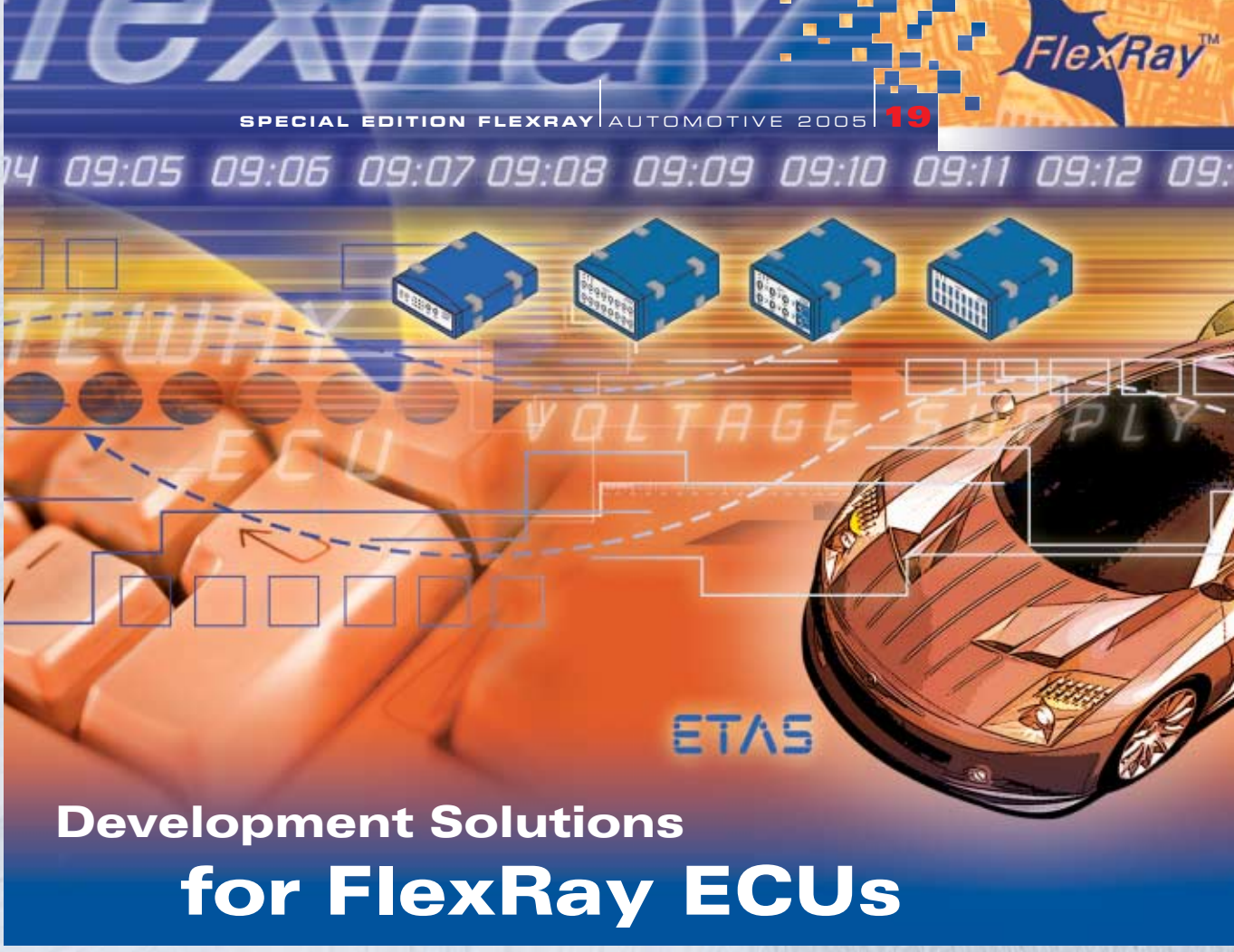

Development Solutions for FlexRay ECUs

FlexRay is on its way to becoming an established standard for time-division multiplexing in the automotive industry. The first FlexRay equipped cars will soon be on the road. To support developers with the execution of their FlexRay projects, ETAS integrates FlexRay in both its ECU development tools and basic software modules.

For over a decade, ETAS has provided software development tools for automotive ECUs in accordance with the V-Model (Development Process Model). As a member of the FlexRay Consortium, ETAS integrates FlexRay support in its development tools and production software modules. ETAS supports the development of FlexRay ECUs as components of a FlexRay cluster. The ETAS tools import the ASAM-specified FIBEX Field Bus Exchange format to align tools and ECUs with the communications scheme native to the FlexRay cluster. Together with an appropriate calibration protocol, FlexRay can be employed to implement an ECU's calibration interface. Laying the foundations for ECU calibration via FlexRay, ETAS heads the ASAM workgroup responsible for the specification of the FlexRay transport layer for the XCP Universal Measurement and Calibration Protocol.

Figure 1: ES910 Rapid Prototyping Module providing CAN, LIN, and ETK ECU and bus interfaces, with inserted ES920 FlexRay Module.

Function Development for FlexRay ECUs

Rapid prototyping provides for the validation and verification of control and diagnostic functions onboard the vehicle during the early stages of the development process. The software part of automotive functions, either written in C code or specified in behavior modeling tools, is implemented in a real-time target system with high computing performance. To achieve smooth interaction with the environment, the rapid prototyping system is coupled with vehicle buses through dedicated interfaces, and with sensors and actuators via analog and digital I/O. ETAS provides the universal ETK ECU interface for direct access to the ECU – i.e., for measurement and calibration purposes or bypass applications. The entire rapid prototyping system, designed for quick deployment onboard a test vehicle, is operated from a host PC. With the release of the new compact ES910 Rapid Prototyping Module (**Figure 1**) scheduled for 2006, ETAS will provide a fully functional high-performance FlexRay node for rapid prototyping applications. The ES910 is capable of simultaneous real-time communications via FlexRay, CAN, LIN, and ETK interfaces. The related FlexRay hardware comes in the form of the ES920 FlexRay Module. Comprising an expansion of the ES910, the ES920 provides for extremely efficient coupling to the high-performance PowerPC onboard the ES910.

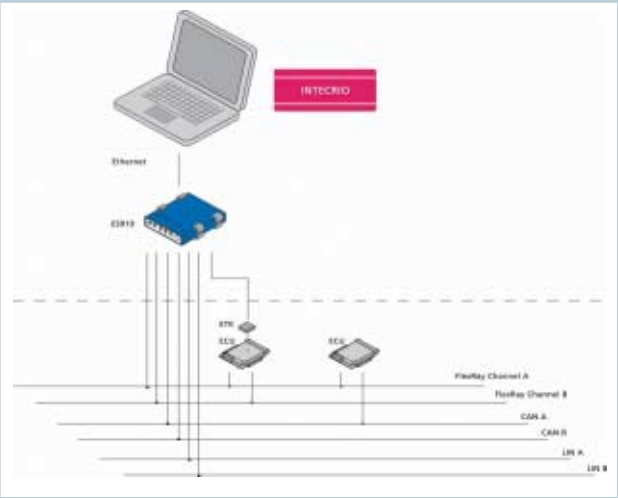

Figure 2: Function development for FlexRay ECUs using INTECRIO V2.0 and ES910 Rapid Prototyping Module.

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INTECRIO, the ETAS software integration platform for function development, is capable of integrating control and diagnostic algorithms either specified in MATLAB/Simulink and ASCET or written in C code. INTECRIO automatically translates the integrated code into an executable for the rapid prototyping system. Furthermore, INTECRIO provides for the connection of bypass signals to the various software components.

ETAS deploys a high-performance solution for the function development of FlexRay ECUs by integrating the new compact ES910 Rapid Prototyping Module with INTECRIO V2.0, which will be released in mid-2006 (**Figure 2**). INTECRIO V2.0 will import the FIBEX description format to configure the FlexRay node. It will provide an editor that assigns the signals of the control and diagnostic functions to FlexRay frames. INTECRIO V2.0, in conjunction with the ES910, will support both static and dynamic FlexRay segments.

Software Modules for FlexRay ECUs

The Real-Time AUTOSAR (RTA) product family from LiveDevices, member of the ETAS Group, provides a growing range of software modules and development tools to support the cost effective and standard-compliant design and production of automotive ECU software. The RTA basic software modules provide high-quality and efficient implementations of platform software modules used in today's ECUs. The RTA product family has a strong heritage in delivering proven production quality. Its products have been deployed in more than 200 million ECUs worldwide. In late 2006, to support the development and production of FlexRay ECUs, LiveDevices will release RTA-FLEXRAY, an implementation of the AUTOSAR FlexRay specification. It will include both driver and interface layers.

Testing FlexRay ECUs

Hardware-in-the-Loop testing is an intrinsic part of modern development processes for automotive ECUs. The use of lab vehicles allows ECUs to be tested in a virtual test environment early along the development timeline. This makes it possible to carry out automated tests under reproducible lab conditions with a high degree of flexibility. Compared with bench or in-vehicle tests, the operating conditions can be set without restrictions, e.g., across the entire load speed range of a given ECU. Aging, wear, fault, and failure situations can be easily simulated, permitting the testing of ECU control and diagnostic functions. Application areas of the LABCAR product family include Hardware-in-the-Loop testing of single automotive ECUs as well as of ECU networks for engine (gasoline, diesel, hybrid, fuel cell) systems and those deployed in the transmission and chassis areas (ABS, ESP, ACC). The LABCAR product family comprises software, hardware, and driver-vehicle-environment (DVE) models suitable for integration into tailored test systems that fit perfectly into existing processes. Deployable from the earliest to the latest phase of development, the LABCAR product family provides efficient verification and validation of embedded systems and software.

ETAS, in a joint project with a pilot customer, has developed a high-performance solution for testing FlexRay ECUs with LABCAR. The LABCAR FlexRay solution comprises a communications interface to a DECOMSYS::NODE<PC> added to LABCAR-RTPC. To support closed-loop tests, the interface couples the DVE running on the LABCAR-RTPC in real-time with the FlexRay bus. Also, a plug-in for LABCAR-OPERATOR has been developed, enabling the entire test bench to be operated from within the LABCAR experiment environment.

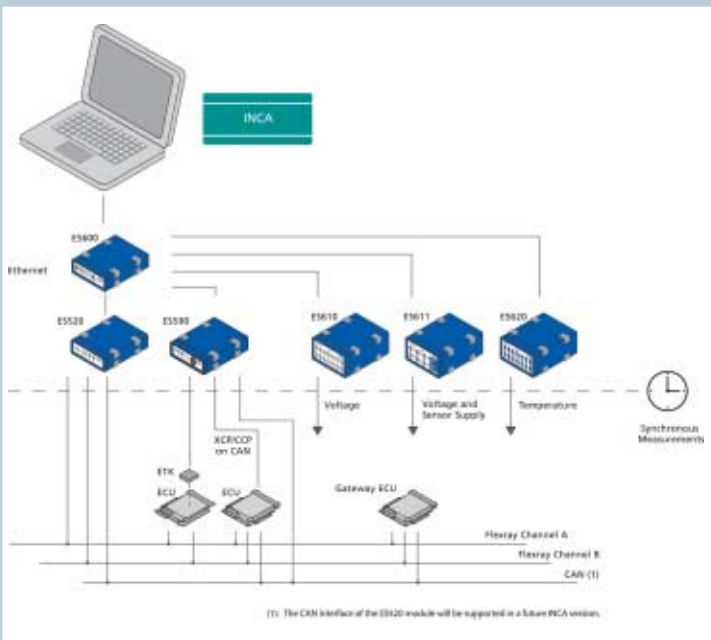

Figure 3: INCA measurement and calibration environment with integrated ES520 FlexRay and CAN Interface Module.

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Measuring and Calibrating FlexRay ECUs

A key application for FlexRay is the reliable and deterministic high-performance connection of ECUs to transfer large signal volumes. Together with the bus load, the number of internal ECU parameters and signals increases dramatically. By mid-2006, the INCA measurement and calibration tool will provide the ability to monitor signals on the FlexRay bus through the integration of the available ES520 FlexRay and CAN Interface Module. This module, which is connected to the host PC via Ethernet, is a member of the ETAS compact hardware series designed for in-vehicle applications.

FlexRay monitoring within INCA complements both measurement and calibration of ECUs, which is done via the high-performance ETK or a CAN, K-Line, or USB ECU interface. At the same time, not only messages on vehicle CAN buses, but also analog measurement signals from the vehicle environment can be acquired. To enable causal analysis as well as error tracking within an investigated system, the time stamps of the data samples are synchronized with all other data sources within INCA.

FlexRay monitoring facilitates the comparison of signals on the FlexRay channels with signals in the ECU and with signals on other communications systems such as CAN, plus external measurement signals. Monitoring the behavior of a CAN-to-FlexRay gateway, the validation of ECU drivers in terms of correct value transformation, or the comparison of digital measurements with independent analog signals, are examples of FlexRay measurement applications, all of which are addressed by INCA. All in all, FlexRay monitoring in INCA allows for expanded utilization of the existing measurement and calibration environment for vehicles equipped with a FlexRay bus (**Figure 3**). Complementing the measurement and calibration of FlexRay ECUs, the ES520 is supported by the DTS tools for diagnostic development from Softing AG, and by the MultibusAnalyser from IXXAT Automation

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