Translated article „Messdatenmengen im Fahrzeug und am Prüfstand erfassen," ATZ extra 5/2016

Recording large volumes of measurement data in the vehicle and on the test bench

Together with interface and drive recorder modules, a newly developed ECU interface allows users to record large volumes of measurement data from ECUs and other sources. ETAS shows how these measurement data volumes can be captured and then used for complex analyses.

Combined measurement

In the past, standard procedure was to perform isolated measurements in the vehicle and on the test bench in order to answer specific questions. However, this approach is not sufficient for analyzing and predicting the behavior of complex systems such as modern high-tech IC engines [1], hybrid drives, and advanced braking and driver assistance systems. To accomplish this, it is highly beneficial to combine measurement tasks; in other words, to record as many signals as possible in just a few test runs. With this approach, users can correlate many different measurement variables and optimize interdependent functions. By systematically using the recorded data volumes, users can gain an understanding of complex processes and error patterns and analyze the causes of sporadic errors. In addition, the results of these measurements can be used for complete documentation, as required for OBD acceptance tests.

It also makes sense to use test vehicles and test benches as effectively as possible by combining as many measurement tasks as practical in a single test. In summary, what is needed is the end-to-end, time-synchronized recording of measurement signals from different sources [2].

Hardware modules

With the new ES800 product family and the FETK high-performance ECU interface, ETAS supports the calibration and validation of advanced in-vehicle electronic systems. The first products of the new series are now available: the two variants ES891 and ES892 of the new ES89x universal ECU and bus interface module and the ES820 drive recorder module.

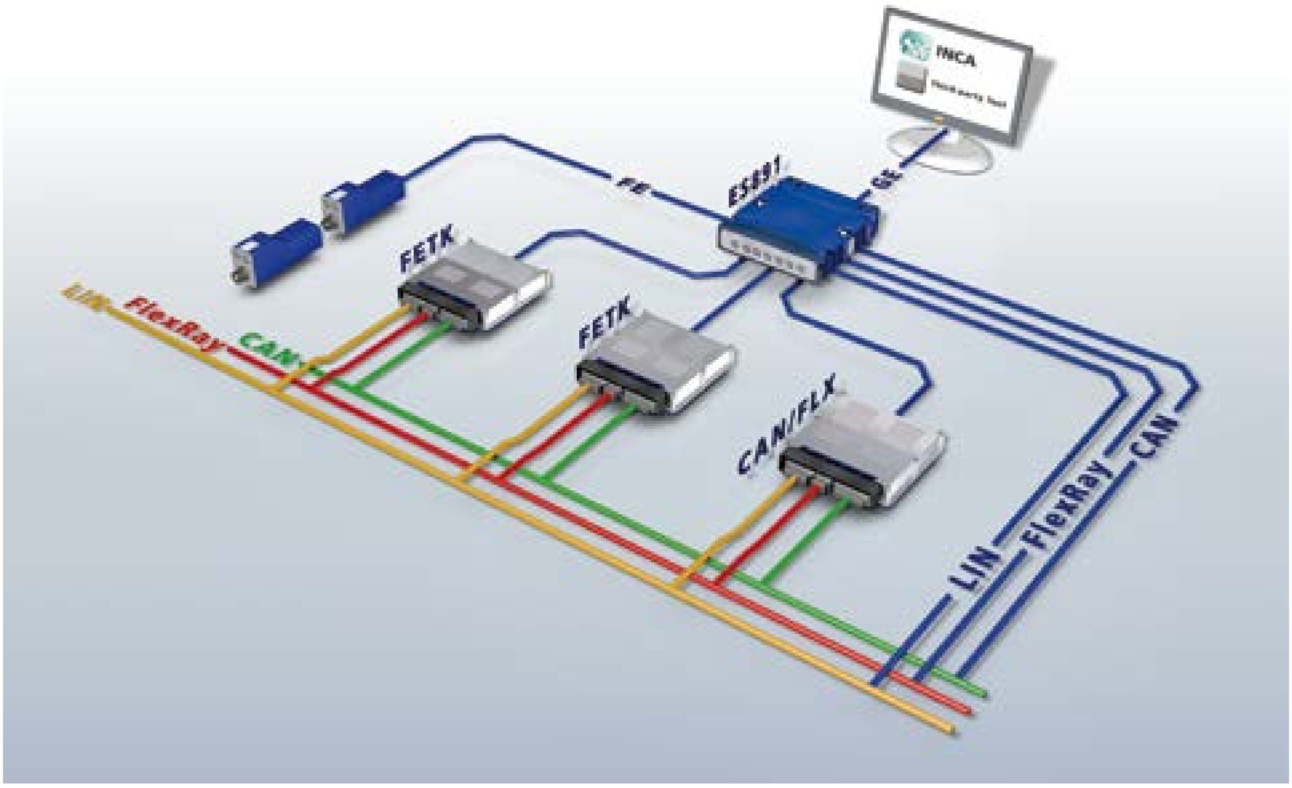
Thanks to a robust plug-in mechanism, the ES800 modules can be stacked (PICTURE 1). The modules are synchronized in compliance with the IEEE 1588 standard.

Connections

For connecting FETK ECU interfaces, the ES89x modules provide two Gigabit Ethernet ports, which can be used for network connection as well. Meanwhile, a fast Ethernet connection is available for connecting XETK ECUs, ECU and bus interface modules from the ES500 family or other ETAS measurement modules. For the connection of serial vehicle buses, the modules provide six channels to connect up to five CAN or CAN FD buses and one LIN bus. With the ES891 module variant, there is also the option of using two bus channels as FlexRay ports (PICTURE 2). The ES891 ECU and bus interface module communicates with the connected ECUs via FETK and serial bus interfaces. In addition, measurement data is recorded from bus communication via CAN, FlexRay, and LIN and from measurement modules. The ES89x modules capture the signals from the connected sources synchronously, bundle them, and transmit this bundle to the host application – for example, INCA.

For connection with the host computer, the modules provide a Gigabit Ethernet interface, which communicates with the ECU via XCP. To achieve maximum performance in data transmission, the logic of the XCP protocol and the TCP/IP protocols is implemented in the hardware in the ES89x module. This enables the recorded

PICTURE 1 ES800 system (© ETAS)



PICTURE 2 The ES891 module communicates with connected ECUs via FETK and serial bus interfaces (© ETAS)

data to be transmitted at high rates and with low latency. The combination of an FETK ECU interface and an ES89x ECU and bus interface module is therefore equally suitable for both measuring and prototyping applications. In the application, this has the advantage that prototypes of new control systems can be validated and calibrated together with existing ECUs in ETAS INCA using the same ECU instrumentation, which significantly reduces the amount of modification work required.

Data transmission

ES89x modules are able to transmit data at a rate of up to 120 MB/s – in other words, at the maximum line transmission rate via Gigabit Ethernet to an application on a PC or laptop. In combination with an FETK-T, approximately 50,000 two-byte values a second can be recorded simultaneously – effectively all measurement signals of a complex engine management system.

Alternatively, the data can be recorded independently by the ES820 module. The drive recorder module's memory capacity is sufficient to record this huge amount of measurement data without interruption for a period of twelve hours.

The ES800 hardware supports all use cases for the validation and calibration of ECU functions with a modular, central system. Measurement setups based on ES800 are scalable with respect to both the range of functions and the number of available interfaces.

ECU interface

Developed by ETAS engineers, the FETK is a new interface that connects the ECU and the host application through XCP via Gigabit Ethernet. FETKs are available in the versions T and S (PICTURE 3 and TABLE 1). Both variants are connected to the interface module using the same type of cable, through which they communicate over the efficient, latency-optimized FETK protocol. Via the ES89x module, applications can access the FETK ECU interface using the XCP protocol, which allows easy integration with customized solutions or third-party tools.

For measurement purposes, users can achieve maximum data throughput with FETK-T. Measurement values can be recorded from the ECU at a raw data rate of up to 300 Mbit/s via the Trace/AURORA interface. This has almost no effects on the runtime behavior of the microcontroller in the ECU, because trace data is generated independently of the ECU program through automatic copying of the values of the relevant measurement signals, which write the µC cores to RAM cells. In FETK-T, the trace data, which comprises the time stamp, memory addresses, values, and trigger events, is written to a mirror RAM. There it is selected from the various measurement grids with respect to trigger time and thereby reduced. Transmission of the reduced data currently reaches speeds of 17 MB/s over the entire route from FETK to the INCA V7.2 application on the host computer. Thanks to the µC trace mechanism's high raw data rate, the FETK-T is also capable of

PICTURE 3 FETK-S (bottom left) and FETK-T (bottom right) (© ETAS)

recording signals from control processes with repetition frequencies of up to 200 kHz with great time precision. For prototyping and configuration purposes, both FETK-S and with FETK-T use the microcontroller's debug interface.

Through its µC connection via debug interface, FETK-S delivers a measurement performance that is sufficient for many calibration tasks. Its compact 46mm x 25mm housing makes this FETK model suitable for integration in production ECU housings, which reduces the costs of calibration projects.

FETKs support both research and calibration engineers as well as function developers in their work. With FETKs, users can record large volumes of measurement data from ECUs while they are running and simultaneously change characteristic values in the ECU. Furthermore, real-time-capable systems can be connected to it, such as the ES910 prototyping and interface module. ETAS is also developing a new ES800 family prototyping module that – like all ES800 family members – will utilize a PCI Express interface. This allows users to achieve very short measurement and calibration cycles on the test bench and calculate new functions synchronously with the control unit in short time frames with very low latency and without raster offset in the external bypass. In addition, via the FETK access, users can program ECU flash memories and connect software debuggers in parallel to a development tool.

Measurement data analysis

With MDA V8, ETAS provides an analysis tool that allows users to evaluate measurements with the high data volumes that can be generated with the FETK/ES89x system; this will help users with development, testing, and calibration tasks. MDA V8 has a high processing speed and enhanced operating concepts, such as the oscilloscope's scroll and zoom functions, allowing quick and intuitive excerption of very short time segments from very long measurement series.

Application

To optimize their use of resources, more and more OEMs and Tier 1 suppliers are looking to record and analyze as much data as possible in the smallest possible number of tests. With powerful methods from the world of big data and meta information that describe the test conditions, the measurement data from many different users can be employed for a wide variety of purposes, such as vehicle validation or the precalibration of simulations.

ETAS and Bosch's Diesel Gasoline Systems – Electronic Controls product division are currently working on a scalable data management system that is able to make very large measurement data volumes usable for rapid searches and complex analyses.

Feature	FETK-S	FETK-T
Microcontroller support (µC)	– Infineon AURIX µC – 32-bit automotive µC families NXP MPC560/MPC563xx and STMicroelectronics SPC560xx/SPC563xx	– Infineon AURIX µC
Data rate between µC and host application	– 2 MB/s (typical)	– 17 MB/s (currently with INCA V7.2)
Return time of a 128-byte signal between FETK and prototyping module (latency)	– Via Ethernet (ES910 module): 220 µs – Via PCI Express: under 100 µs	
Smallest measurement grid	– 50 µs	– 5 µs
Flash programming time	– 8 MB/s	

TABLE 1 Features of the two ECU interfaces FETK-S and FETK-T (© ETAS)

Summary

With the ES800 hardware product family and FETK ECU interface, users can record measurement data from ECUs and the system environment at high rates and with time synchronicity. This solution allows to implement modular systems that meet the high requirements for validating electronic systems in the next generations of vehicles. In conjunction with the new ETAS ASCMO and ETAS EHANDBOOK [3] software products, the FETK/ES800 solution makes it possible to significantly increase both the efficiency and quality of the calibration and validation of electronic systems in the vehicle and on the test bench.

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