Area of Application

Hardware-in-the-Loop (HiL) testing systems comprise an essential contribution to quality assurance during the early phases of ECU development. By simulating the model components known as Driver-Vehicle-Environment (DVE), they facilitate the testing of the functions or diagnostic behavior of ECUs in the laboratory. This makes it possible to run reproducible and comprehensive tests of virtually any driving situation with the added benefit of extensive test coverage through automation – entirely without hazard to driver and vehicle.

LABCAR is part of the standardized ETAS tool family, which covers all stages of the development cycle. Tests may therefore be run on a given model (Model-in-the-Loop, MiL), executed on existing software (Software-in-the-Loop, SiL), on the target hardware with ETK (Function-in-the-Loop, FiL), on a connected physical ECU (Hardware-in-the-Loop, HiL), or may involve additional measuring and calibration (M&C) steps affecting the data calibration onboard the ECU.

At a glance

- Compact real-time testing system for automotive Embedded Control Units (ECUs)
- Open, modular system architecture for simulation models, software, hardware, test automation, and time-synchronous ECU access
- PC-based simulation with extensive possibilities (Dual-Core, Quad-Core, etc.)
- FPGA hardware
- Excellent price/performance ratio.

All of the above cases provide the option of performing the tests in real time, either as closed-loop tests or, with additional external intervention, as open-loop tests.

LABCAR System Components

LABCAR’s main differentiator is its open, modular architecture, which allows the testing system to be easily adapted and functionally extended to suit future requirements. The strict separation of the system-specific hardware and the PC-based computing engine provides a high degree of investment protection. This facilitates the dedicated replacement or addition of individual hardware modules without the need for additional capital investment.
By way of illustration, the LABCAR architecture can be divided into five system components (see Figure 1).

**Simulation target**
The real-time PC (RTPC) is the heart of the LABCAR system. Adding the Linux-based LABCAR-RTPC software turns a standard industrial PC into a high-performance simulation target which calculates DVE models in real time with cycle times down to 10 µs. With FPGA models, this time could be reduced below 1 µs. With this, even highly dynamic physical plant models and control processes can be precisely simulated in real time. Communications of the hardware components are handled through standard interfaces such as PCIe, Ethernet, or VME.

The use of a PC facilitates easy hardware upgrades and economical increases in computing power. The sophisticated thermal management (common to industrial PCs) ensures that the system performance can be fully exploited, incidences of heavy computing loads notwithstanding.

**Hardware (signal I/O)**
Each ES4100 housing features 21 slots for VME modular cards. These allow for an exact adaptation to customer requirements while lending themselves to quick and economical system extensions. Also, adding the ES4440 Failure Simulation Module enables the integration of comprehensive electrical fault insertion. For the purpose of signal generation and measuring, numerous automotive-capable I/O cards are available (e.g., analog I/O, PWM, angle synchronous signal generation, and bus systems such as CAN, FlexRay, etc.).

The card connections at the backplane keep wiring tidy, both at system configuration and during experimentation.

**Models configuration prior to actual ECU testing**
Of particular interest in the long-term use of an HiL system is its openness to simulation models from different sources – containing the central know-how. LABCAR is open to the integration of numerous types and versions of modeling tools. In this way, it is possible to integrate, besides MATLAB®/Simulink®-based models (such as TESIS DYNAware), virtually any of the C code-based models supplied by third party vendors (e.g., SIMPACK, GT-Power, AMESim, CarSim). The execution of LABCAR experiments does not require a Simulink® license.

**Electrical operator interface for control during a test**
LABCAR comes with a breakout box, with 300 standardized jumpers and 50 additional jumpers for high-current signals. The breakout box also functions as a clearly structured interface for external measuring equipment, and physical real-world components, plus external access to experiments.

**Operating software**
The LABCAR-OPERATOR software serves as the user interface for LABCAR – not only for the pre-configuration procedures but also for experiment design and execution. LABCAR operating software is running on every Microsoft Windows® standard PC. LABCAR-OPERATOR has two separate user interfaces. One for configuring the HiL test bench setup and one for design and control of the experiment. The separation of Integration Platform and ETAS Experiment Environment provides clearly structured and customized operating concepts for both configuration tasks and user control.

![Figure 1: LABCAR system components](image-url)
Figure 2: Simple LABCAR system for CAN residual bus simulation

Figure 3: 2007 third generation MAN Lab Truck – HiL system for a powertrain ECU network

Figure 4: PT-LABCAR hardware components

Figure 5: Calculation time on a complex vehicle dynamics model
The LABCAR-AUTOMATION software provides for extensive test automation. It facilitates the economical and reproducible testing of safety-critical or time-intensive tests, such as OBD tests, e.g., in situations calling for the fulfillment of product liability requirements. The powerful hardware enables the accurate generation of spark failures and misfires.

**PT-LABCAR**

PT-LABCAR is specifically designed for powertrain applications. The basic configuration is designed for testing ECUs that control up to 8-cylinder gasoline engines or 12-cylinder diesel engines (car or truck). It is possible to upgrade the system up to 16-cylinder engines for all engine management units.

**CS-LABCAR**

CS-LABCAR is specifically designed for chassis applications, such as ABS and ESP. The basic configuration is designed to form four wheel speed sensors. Five different sensor types are available – from a passive, analog sensor to an active, digital sensor with current interface, three current levels, and additional information.

**Performance Features**

- Open, modular architecture – scalable for easy, project-specific functional adaptation
- Integrated signal conditioning for easy reuse of existing configurations across different projects
- PC-based system ensures continuous and cost effective upgrades of simulation performance
- High-performance multicore and multiprocessor support for high-end applications
- Real and modeled signals are easily combined
- Numerous hardware and software interfaces support all applicable automotive standards
- Easy integration of products from third party vendors (models and hardware)
- Extensive automation with LABCAR-AUTOMATION
- Enables time-synchronous measuring of internal ECU data, plus pre-calibration when coupled with INCA and ETK – the quasi-standard of data calibration
- 300 standardized jumpers and 50 additional jumpers for high-current signals from external measuring equipment, physical components, and external intervention in experiments
- Supports all current automotive sensors and actuators
- Deterministic real-time simulation of electrical faults with n x 80 channels, e.g., for the verification of OBD functionality
- Excellent signal precision and measuring accuracy
- Reliable and automotive-proven technology
- Compact and uncluttered physical design
- Global service and long-term support

Please refer also to the product flyers detailing individual LABCAR system components.

For additional information (e.g., ordering information, system configurations, licensing models, and service contracts), please contact your ETAS representative or go to [www.etas.com/labcar](http://www.etas.com/labcar).