

The Status Quo of HIL Simulation

In numerous companies, hardware-in-the-loop (HIL) simulation is an integral part of the electronics development process. Central HIL departments are often set up to run tests, though sometimes the engineering departments take care of their HIL systems themselves. In either case, teams solely dedicated to HIL are typical. Their fundamental tasks are to design the electrical aspects of the simulator (HIL hardware, connections for real loads and substitute loads, cable harnesses), to model the I/O and plant, and naturally to create and execute tests. The logical consequence of this is specialization, or task division, amongst the members of a HIL team. The resulting tasks need optimum support from powerful tools.

Flexibility is Key

HIL systems for network testing of the entire vehicle electronics are sometimes specified and built at a point in time when parts of the ECU specifications might still change. This makes tough demands on the flexibility and quick adaptability of the simulator. Flexibility is also essential when different ECU variants have to be tested singly or in a network. The same applies to testing new components for vehicle platforms that are already in production.

Maximum Scalability

In real-world testing, the ideal solution would be to use the same HIL system to test the ECU network and the individual components. This might be done to concentrate the error search on a single ECU on an isolated subsimulator, or it may be that after successful component tests, the single simulators are to be interconnected to make a network simulator at a later stage of development. All this places tough demands on the system's modularity, scalability, and extensibility.

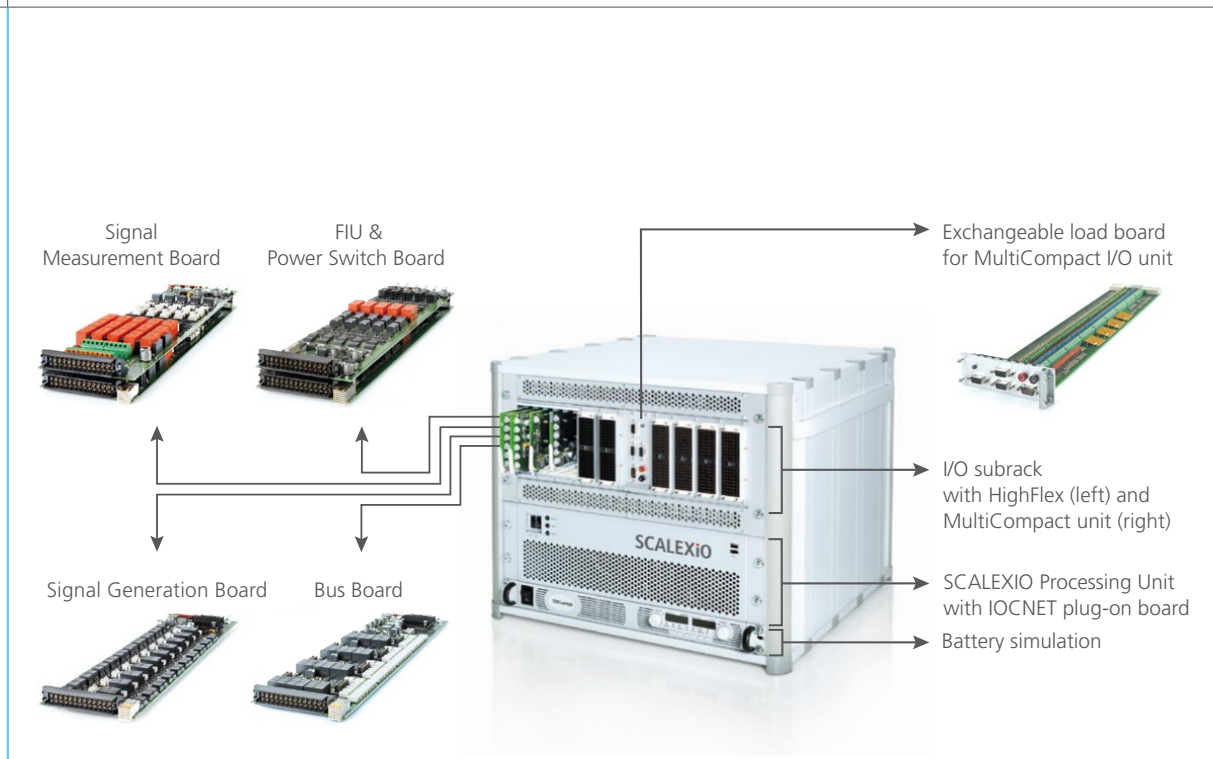


Flexible work processes with
new simulator technology



SCALEXIO

Hardware-in-the-loop technology for testing electronics has become an established industry method. Users' workflows have changed in many ways, and to ensure the greatest possible productivity in the development process, a new product concept is needed. The answer is SCALEXIO.



A SCALEXIO system configuration with the different I/O boards.

High Productivity

The time and cost spent on the first setup and on later adjustments and conversions must be kept as low as possible. Ideally, it would be best to produce new configurations at the push of a button. The testing and documentation of systems also plays an important role in this context, not least because the introduction of the ISO 26262 standard for the development of safety-critical systems will require precise documentation of the test systems.

SCALEXIO®, the New HIL Technology

Systematically implementing these identified requirements in a HIL test system will necessitate some a radical change of direction in existing hardware and software concepts. That is why SCALEXIO, the new HIL technology, is based on a completely new hardware and software architecture. Its outstanding features are high channel flexibility, granular extensibility and complete software configurability.

Real-Time Processor with Quad-Core Processor

At the heart of SCALEXIO is a real-time processor. This sets up a con-

nection to the host PC via Gigabit Ethernet. The connection is used to configure the entire simulator, load real-time applications, and finally monitor and control the HIL simulation itself. A SCALEXIO processor core is based on an industry PC with an Intel® Core™ i7 quad-core processor, a real-time operating system (RTOS), and a PCIe plug-on card

to a SCALEXIO system, all of which can be many meters apart. This makes it possible to implement widely distributed systems, addressing the requirements for modularity and flexibility. To guarantee dSPACE's accustomed real-time capability, the protocol was designed for real-time communication and highly precise time and angle synchronization.

■ SCALEXIO: More flexibility in HIL projects

developed by dSPACE for communication with the I/O and with further real-time processors. Using standard PC technology means that performance and technology innovations can be harnessed as soon as they come on the market.

Internal Communication

For internal communication between the real-time processor and the I/O boards, dSPACE developed a new communications protocol, IOCNET (I/O Carrier Network). IOCNET is based on Ethernet and allows more than 100 I/O devices to be connected

The transmission rate that can be achieved with IOCNET is around 10 times higher than with the previous technology.

Two I/O Board Types

The HIL signals can be roughly divided into four classes: signal generation (e.g., simulating sensor signals), signal measurement (e.g., measuring actuator signals), bus systems and supply signals. The SCALEXIO technology provides two different, software-configurable I/O board types for these four classes: the HighFlex I/O boards and the



SCALEXIO systems are extremely scalable.

MultiCompact I/O unit. What both types have in common is a local PowerPC processor for preprocessing signals and relieving the load on the real-time processor, an IOCNET interface, typical signal conditioning for automotive applications, converters, and parts of the electrical failure simulation. The two I/O board types can be combined in any way desired and used in small component testers and also in large network test systems. Integrating the signal conditioning and failure simulation reduces internal wiring and simplifies the technical setup, which makes reuse much easier.

HighFlex I/O Boards

The outstanding features of the HighFlex I/O boards are flexibility and performance. Each of the signal generation and measurement boards provides 10 separately galvanically isolated channels. The physical interface type of each channel is software-configurable, e.g. as a digital or analog interface, or as a resistance simulator. The bus board contains 4 galvanically isolated bus channels that can be software-configured as CAN, LIN, FlexRay or UART and that

■ SCALEXIO: Easily reused for further test tasks

provide the necessary transceivers and terminations. When a simulator is designed with HighFlex I/O boards, only the number of channels has to be taken into account and not their types. The physical interface that is actually used is configured via software and can be changed as often as required. This all adds up to a very high level of flexibility and reusability. All HighFlex I/O boards have the same connector concept. This ensures that they can be mounted in any slot, which makes it a great deal easier to build and adapt a SCALEXIO system.

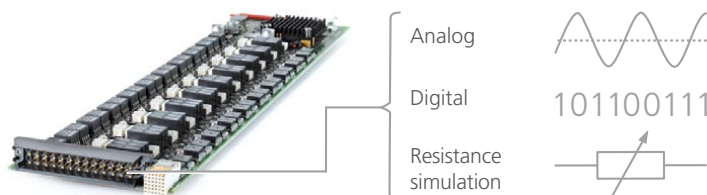
The channels of the HighFlex I/O signal generation board are physically configurable for analog and digital signals and for resistance simulation.

MultiCompact I/O Unit

The MultiCompact I/O unit currently available is tailor-made for powertrain and vehicle dynamics applications. It has a total of over 150 channels and is galvanically isolated as a unit. The channels are mainly dedicated rather than multifunctional to ensure compactness, a high channel density and a favorable price per channel.

Hardware Setup

Using as many off-the-shelf components as possible, plus simple, standardized 10-channel wiring, will dramatically reduce the work involved

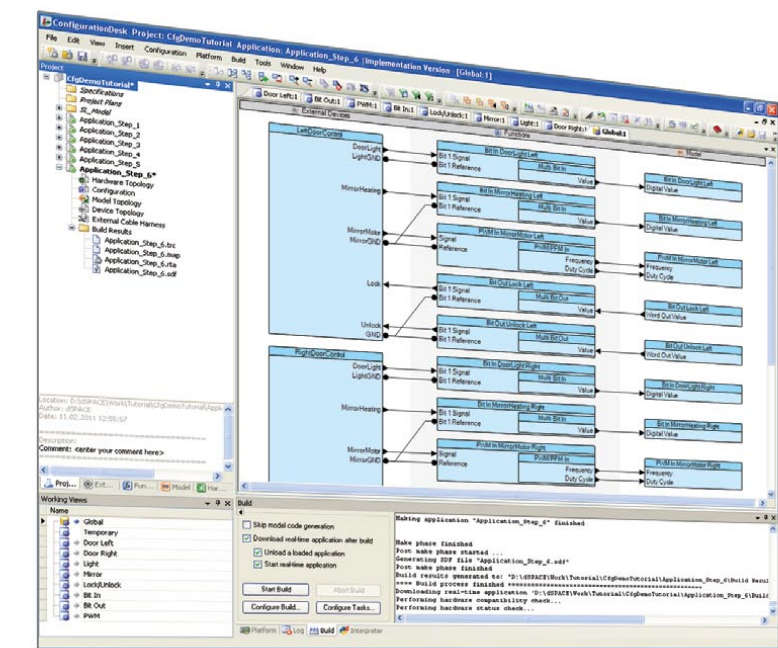


Summary and Outlook

SCALEXIO fulfills all the new requirements that hardware-in-the-loop (HIL) users have encountered over the years. Its cutting-edge hardware and software architectures are a complete response to the changes and new challenges in today's HIL projects. The potential of the SCALEXIO technology was already thoroughly tested and confirmed in customers' evaluation projects and concrete pilot projects. The first version of the SCALEXIO system is ideal for projects in the areas of power-trains and vehicle dynamics. Later versions will see the addition of further MultiCompact I/O units tailored to other application areas such as body applications, which typically require a lot of digital I/O.

in configuring, setting up, testing and documenting a simulator. All the system components, such as the real-time processor, HighFlex I/O component carrier, MultiCompact I/O unit and battery simulation power unit are installed in standard 19" cabinets. The combination of software configurability, multifunctionality and preinstalled signal conditioning, plus failure simulation on the I/O boards, means that a simulator can often be adapted simply by replacing the external cable harness. SCALEXIO's component design also considerably increases efficiency.

Simple Configuration via Software
Users can easily access the SCALEXIO



ConfigurationDesk provides a convenient user interface for quick I/O configuration.

SCALEXIO: Lower costs and faster progress

hardware's versatile configuration options from the new ConfigurationDesk® tool. The I/O functions are configured at an abstract, logical level, and not on any specific hardware channel. This means, for example, that functionality can be reassigned to another I/O board, and it is even possible to use several physical channels with one I/O-function if the current/voltage limit of a signal has to be increased. This abstract configuration level also allows virtual project planning while the HIL hardware setup is still evolving, so that configuration work can begin very early in a project. The (incremental) build process is also run from within ConfigurationDesk, resulting in an executable real-time application

that can be loaded straight to the HIL simulator.

Coexistence of I/O and Plant Models

Separating the I/O configuration from the plant model enables modular, reusable configurations. This gives better support to new workflows and to parallel work on different tasks. This in turn saves time, because when modifications are made to the I/O, only new I/O code is needed, and there is no need to touch the code for the plant model.

Convenient Configuration Process

The configuration process is roughly divided into three tasks: describing the externally connected devices

(e.g., ECUs, real loads), selecting the I/O functions for each signal, and linking the I/O functions to the plant model. Configuration can be performed in any order in a clearly organized 3-column display.

Other Software

In addition to ConfigurationDesk, other familiar dSPACE software is also available for SCALEXIO:

- ControlDesk® Next Generation for instrumentation
- AutomationDesk® for test creation and automation
- Real-Time Testing for clock-synchronous execution of real-time test scripts and the simulation model
- MotionDesk for visualization
- ModelDesk for graphical model parameterization
- Automotive Simulation Models for real-time simulation models
- CAN and LIN MultiMessage Blocksets and the FlexRay Configuration Package for restbus simulation

These are the ideal basis for a HIL testing. ■

Interview

with Susanne Köhl,
Lead Product Manager
for Hardware-in-the-Loop
Simulators



Ms. Köhl, why did dSPACE develop a new technology for HIL simulation?

The new technology is needed to provide optimum solutions for the changing requirements our customers are encountering in their HIL projects.

What is really new about SCALEXIO?

Everything in SCALEXIO is brand-new technology: from the processor board, the internal bus for communication with the I/O, and the I/O boards tailor-made for HIL applications, to the hardware setup, and the software support for hardware configuration.

How do users benefit?

SCALEXIO provides targeted support for customers' individual workflows, such as the separate roles of plant modelers and hardware specialists. SCALEXIO gives projects more flexibility: SCALEXIO systems can be planned and modified quickly and easily. Different ECU variants and types can be tested on one system, and it is easy to implement system extensions at a later date.

Using the same components for large network testers and small component testers ensures seamless transitions between different test tasks.

And last but not least, time and costs are saved by simplified system assembly and modification, and because software-based configuration means automatic system documentation.

Can existing HIL systems still be used?

Yes, of course. And SCALEXIO can also be connected to existing HIL systems via processor-to-processor coupling. With ControlDesk Next Generation, the two systems can even be handled from within one layout. The host PC performs measurement synchronization.

Will SCALEXIO replace the PHS-bus-based systems?

Yes, in the long term, we'll continue expanding SCALEXIO so that it can replace the PHS-bus-based systems. But we feel that both systems will exist side by side for a very long time, so everyone has a completely free choice of system.

Ms. Köhl, thank you for talking to us.