Flexible and Scalable

HIL simulation for body ECUs

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Testing powertrain ECUs for the drivetrain is a long-established standard part of the development process. The development of body ECUs is different, though, because budgets are much tighter here. The test systems have to be designed accordingly. Body ECUs have a much larger number of digital inputs and outputs than powertrain ECUs. They therefore place different demands on the test system: It has to provide reasonably priced digital I/O available but still offer all the options needed for performing functional and electrical tests.

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A door ECU gives the driver dedicated buttons for functionalities that control the power windows, exterior mirrors, door locks, etc. The same applies to electric seat adjustment and almost all the directly controllable functions in general, such as light, indicators, windshield wipers and climate control. ECUs do this by evaluating the signals coming from buttons or switches and by triggering relays or motors. The functionality can be implemented by a network of ECUs, which as a rule communicate via a bus. Test systems therefore have to be able to simulate a large number of switches and measure the resulting control signals for the motors, which are then usually connected to the test system so that the real currents also flow through it.

Flexible Test System

To fulfill these requirements, a test system must have a basic set of different I/O channels, and it must also be easy to extend it with numerous additional digital I/O channels. This requires suitable configuration software that gives the user a clear, intuitive view of the test system, provides convenient options for configuring and selecting the I/O functions, and enables clearly organized mapping to ECU pins. This interaction between hardware and software is provided by SCALEXIO and ConfigurationDesk®. In ConfigurationDesk, a user can easily assign one of the test system’s I/O functions to a pin in the ECU representation and connect it to the plant model in Simulink via the I/O function. The I/O function is then mapped to the SCALEXIO hardware. Requirements such as connecting real loads and handling the resulting currents are also taken into account. If a power window motor requires an ampacity of 14 A, which exceeds the capacity of a single channel, several channels are automatically run in parallel to meet the requirement. This flexibility means that a SCALEXIO test system can quickly be converted from one project to another. Basically, all that needs to be done is to replace the ECU and the externally connected real loads and download the new project. Because ConfigurationDesk performs the necessary hardware configuration, one test system can be used to validate various ECUs regardless of whether they are ECU variants or completely different ECUs.

Digital I/O Optimized for Body ECUs

dSPACE offers a tailor-made solution for setting up modular body HIL simulators: the SCALEXIO DS2690 Digital I/O Board. The board provides a total of 30 digital channels for simulating and measuring digital or pulse-width-modulated sensors and actuators. Three channel groups – 10 inputs, 10 outputs, and 10 channels that can be used for either input or output – make it possible to map any specific signal mix without having to leave some channels unused. All the channels can process voltages of up to 60 V DC and the inputs can process effective currents up to 6 A DC, and together with the board’s integrated connection to the SCALEXIO Failure Insertion Unit (FIU) and complete integration into ConfigurationDesk, this offers another major advantage: The board can run with a direct connection to the ECU without the cumbersome task of connecting additional hardware and assigning I/O channels. The board also provides a simple solution for power actuators up

Figure 1: Retrofitting a DS2690 Digital I/O Board to SCALEXIO.
to 48 A DC. The required current can be specified in ConfigurationDesk, so up to 10 channels can run in parallel without having to be dealt with at model level. Electrical failure simulation is naturally also available for such “doubled” channels, so that loose contacts and other electrical faults can be simulated with these too. In detail, ConfigurationDesk makes work easier with flexibly configurable channels. Each output can be configured as push, pull, or push/pull, and can output digital states or PWM signals; the reference voltage for the pull stage can be specified separately for each channel. All the inputs have a configurable switching threshold and can measure digital states or PWM signals. Substitute loads of up to 2 W can be mounted on the board internally, and (real) loads with higher dissipation can be conveniently wired to the plug connector.

**From a Single ECU to a Networked System**

When the ECUs have been tested individually, they have to be tested in the network. If the test scope only needs to expand from one ECU to two ECUs, the simulator’s I/O might be sufficient, or an I/O board can be retrofitted to the simulator. However, if a network of several ECUs needs to be tested, either this must be taken into account when the simulator is planned, so that there is enough I/O, or several test systems have to be coupled. SCALEXIO provides both these options. If several SCALEXIOs are used for function tests of single ECUs, they can easily be connected to one another to create a networked system.

All the SCALEXIOs are connected via the IOCNET system bus so that the individual models can exchange their model data. All this ensures convenient switching between different ECUs and also seamless extension for creating a networked system.

![Configuration of a PWM measurement in ConfigurationDesk, where the I/O function requires three channels to ensure the necessary ampacity.](image)

**Figure 2**

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