

Siemens VDO accelerates validation of Engine Control Units with LMS Imagine.Lab

Tier 1 supplier applies 1D system simulation to optimize engine ECU strategies based on Hardware-in-the-Loop testing



Engine control systems have evolved into embedded intelligence units that play a critical role in delivering driving pleasure, optimal comfort, reduced emissions and minimal fuel consumption. The growing technical complexity of these control systems makes it ever more difficult to create and manage the appropriate engine control rules. The Siemens VDO Powertrain Engineering Group uses the LMS Imagine.Lab Engine Control solution to validate engine control unit (ECU) strategies based on Hardware-in-the-Loop (HiL) systems. This allows them to significantly reduce the costs and development time required to test and validate ECUs.

Challenges

- Reduce the required number of expensive prototypes, costing more than 1 million € each
- Develop ECU's with a very limited number of available prototypes
- Access a large range of reproducible measurements and test conditions
- Easily handle multi-domain issues
- Seamlessly manage real-time constraints

Solution

- LMS Imagine.Lab multi-domain platform
- LMS Imagine.Lab Engine Control Solution
- Matlab/Simulink interface
- Real-time interface with dSpace
- Project Assistance for delivery of cutting-edge engine models

Benefits

- Easily adapt engine models for real-time purpose
- Using the same engine model for all multi-domain aspects throughout the development cycle
- Eliminate the dependency on the timely availability of prototypes from customers
- Solve defaults and issues early in the development process
- Shorten development time and deliver higher quality
- Meet the remaining 13% customer requests that could not be met without simulation

The challenges of Engine Control Unit testing and validation

The reduced number of engine and vehicle prototypes has led to a reduced availability of prototypes for Engine Control Unit (ECU) suppliers. This initial disadvantage has turned into a benefit for the ECU supplier, since it has increased the usage of real-time simulations running on Hardware-in-the-Loop (HiL) test benches. These HiL tests are particularly useful in the validation phases of engine control algorithms.

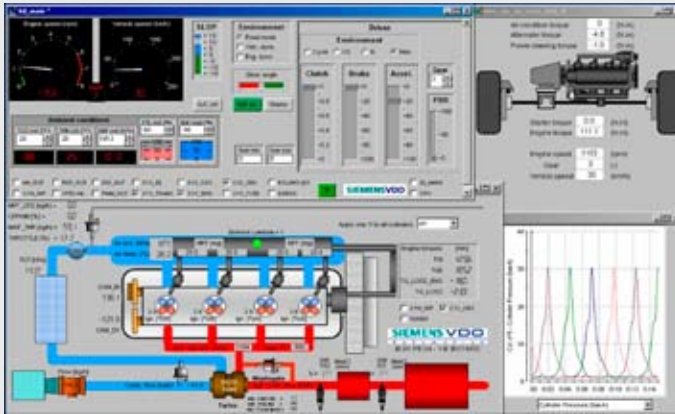
To fully leverage this evolution, Siemens VDO Powertrain required a system simulation software solution to support their design process and to create models for the HiL testing of engine control units in the validation phase. Moreover, Siemens VDO wanted to start these tests earlier in the development cycle, to eliminate weak spots and issues as quickly as possible.

The growing complexity of engines, driven by the global emission regulations, induces an important increase in the complexity of prototype building and control strategies development. To reduce costs and to become less dependent of the timely delivery of engine prototypes by OEM customers, Siemens VDO aimed at replacing physical prototype testing with a simulation based process.

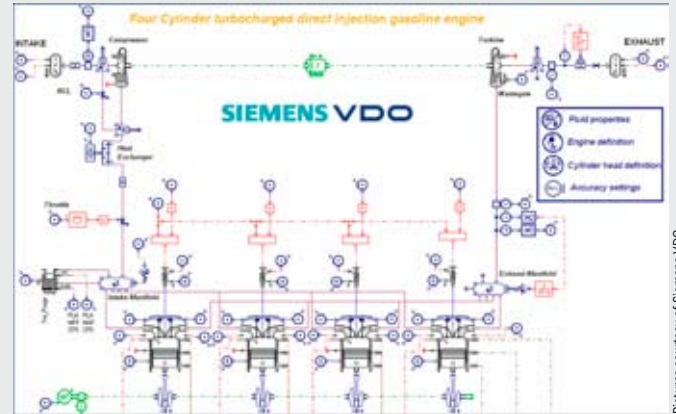
LMS Imagine.Lab simulates multi-physics engine behavior

Siemens VDO manufactures a comprehensive spectrum of products relating to drivetrain, engine management electronics and fuel injection. These systems all impact engine performance and reduced emissions. Siemens VDO Powertrain deployed the LMS Imagine.Lab Engine Control solution to support their engine control and ECU testing and validation process.





Siemens VDO built-in user interfaces for the HIL target



Typical sketch of Engine model integrated into a HIL bench

Pictures courtesy of Siemens VDO

The IFP-Engine Library components within LMS Imagine.Lab allows their development teams to model any kind of engine configuration (diesel, gasoline, turbocharged), and to handle high frequency as well as mean value models. Using the LMS Imagine.Lab Thermal, Pneumatic, Mechanical, IFP-Drive, and Hydraulics libraries, Siemens VDO develops accurate multi-domain engine models. The high frequency models require a phenomenological modeling of the combustion chamber, which involves thermal exchanges, thermodynamics variables, actuators, etc. The dedicated libraries enable them to seamlessly manage these multi-physics aspects and provide a straightforward representation of the steady-state and transient behavior of the engine.

Using the Matlab/Simulink interface, they can seamlessly manage the co-simulation between LMS Imagine.Lab and Simulink for the ECU design stage. The LMS Imagine.Lab Real-Time interface enabled Siemens VDO to avoid translation times and possible errors, and to directly export models on the real-time simulator. Siemens VDO relied on the engineering team of the LMS Imagine division to develop cutting-edge engines models that cover the full range of existing engine technologies.

Developing cutting-edge, high-quality engine control strategies

According to Thierry Bourdon at Siemens VDO, the LMS Imagine.Lab Engine Control solution plays an essential role in the process of designing and integrating the key functions within the ECU. It offers the capability to simulate the dynamic behavior of the engine and its actuators, using a crank angle time scale.

“The LMS Imagine.Lab approach perfectly applies to each stage of the ECU development cycle,” commented Thierry Bourdon. “It provides the capability to use the same engine model throughout the development cycle, from design and specification to real-time tests and validation. This allows our users to gradually extend model information and to capitalize their experience. They can easily evolve a high frequency model used for the engine design itself into a mean value model that fits the real-time computation constraints of the engine control strategy validation phase.”

The large set of tools and libraries in the LMS Imagine.Lab Engine Control solution enables the Siemens VDO team to flexibly apply changes and modifications in the models without additional cost.

“The use of the comprehensive LMS Imagine.Lab platform, from engine design to ECU validation, enabled us to solve issues early in the development process. This saves tremendous time in the late development stages, allows us to ensure better quality of the final vehicle and to avoid costly vehicle recalls.”

Thierry Bourdon - Powertrain Engineering Group - Siemens VDO

They can quickly set up a series of tests and easily repeat them to verify alternative parameter settings. The use of LMS Imagine.Lab also eliminated their dependency on the timely availability of prototypes from customers and allowed them to focus on additional issues for engine control tests like emission and consumption.

LMS Imagine.Lab Engine Control solution also enabled Siemens VDO to answer the remaining 13% of the requests that could not have been achieved without system simulation. The solution was particularly valuable in cases where no engine data were available. ■

About Siemens VDO

Siemens VDO is a leading international supplier of automotive electronics and mechatronics. As a development partner within the automobile industry, Siemens VDO manufactures a comprehensive spectrum of products. Some of them relate to drivetrain, engine management electronics and fuel injection that simultaneously improve engine performance and reduce emissions.

