Algorithm Development for Diesel Engines

Mechatronic Powertrain Systems
Confidence that pays
We can provide you with project solutions from the idea to the start of production using proven, specialized and efficient processes. From more than 20 years of experience in developing and calibrating engine control units, we have the confidence to fulfill your most challenging project assignments to production level. Doing so, you and we can draw on the largest pool of experts the market has to offer.

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Realizing innovations for implementation in mass production is supported or sometimes only made possible through new functionalities on the engine control unit in powertrain engineering.

This is where we see algorithm development as an integral part of powertrain development that works hand in hand with all of the engineering disciplines involved. This produces the following benefits:

- Processes can be handled on a modular basis and therefore more efficiently.
- Interfaces and interrelated sub-processes are mutually coordinated.
- You can choose whether to take advantage of the entire service spectrum or opt for the appropriate module.

Ensuring a high level of efficiency, IAV’s unique portfolio provides you with expertise in all areas of engine control.
Software Development Process
V-Model

Customer requirements

Requirements specification
• Compare with existing REQ
• Analyze patent situation

Function concept
• Define interfaces
• Approaches / evaluate
• Concept review / validate concept
• Issue tags (REQ_IAV_xxx)

Function specification
• Design function using Simulink®
• Document functions
• Prepare application information
• Review function

Software coding
• Generate target-specific code
• Integrate manual code

Application
• Basic application
• Generate dataset
• Conduct tests (GT / WT)
• Version application
• Master EEPROM

System validation
• Validate function in vehicle / HIL

Calibration and validation

Plan
Act
Check
Do
Algorithm and model testing
with target hardware and real-time simulation, e.g. THEMOS, TR Sim, Axisuite

Managing data, versioning, evaluating measurement data and providing documentation with standard software, e.g. IAV CalGuide, Borland StarTeam, IAV ADoS, in production-level calibration

Algorithm realization and calibration on the target system (single cylinder, multiple cylinder, vehicle) using standard calibration software, e.g. CANoe, INCA, CALDESK, IAV MiLDesk, CaliAV

Algorithm and model testing with target hardware and real-time simulation, e.g. THEMOS, TR Sim, Axisuite

Re-utilization of existing algorithm modules Modular principle for engine management in MATLAB®/SIMULINK®, ETAS ASCET

Model-based development of new algorithms using MATLAB®/SIMULINK®

Adapting models to the target system (engine, exhaust system, vehicle) independently of the system using scalable modules, e.g. IAV MPEC with EtherCat link, ETAS ES 910, ETAS ES1000, dSPACE MicroAutoBox

Automatic code generation and ASAM-MCD2 generation

“Advanced Rapid Controller Prototyping” methodology
IAV is a competent partner in developing algorithms from the initial idea to start of production. Our development activity covers algorithms for functions throughout the engine, for the exhaust path as well as all for stages from air-filter inlet to tailpipe. Alongside solutions tailored to specific customer requirements, examples of algorithms IAV has developed in-house are shown below. In addition to commercially available standard tools, IAV uses test environments it has developed to validate these advanced algorithms in the virtual (IAV Mil-Desk) or real world (IAV - MPEC).

- IAV Model-Based Controlled SCR – IAV SCR Control
- Model-Based Controlled Air Path – IAV MBCAP
- Hydraulic Wave Compensation Software – IAV HyWaCoS
- Modular Prototyping Engine Controller – IAV MPEC
- Advanced Closed-Loop Combustion Control Software – IAV AC3
- Virtual development environment – IAV MiL-Desk
IAV MPEC
His concept provides a start-to-finish Rapid Prototyping tool chain. It consists of an algorithm development environment for an engine control unit and the associated software. Using IAV’s FiPRE injection and ignition control unit, numerous degrees of freedom are provided for optimizing engine development.

IAV AC3
Is a cylinder-pressure-based engine management system combining control of the main center of energy release, the energy release rate, in-cylinder pressure as well as indicated torque. This system is the ideal tool for developing and calibrating alternative combustion processes.

IAV MBCAP
MBCAP is a model-based control concept for regulating and pre-controlling the air-path. For example, the high-pressure exhaust-gas turbocharger can be continuously activated and deactivated for a two-stage supercharged diesel engine without significant losses in boost pressure.

IAV HyWaCoS
HyWaCoS provides a correction function that reliably compensates for fluctuations in the injected fuel quantity in a CR injection system. Its model-based character makes it universally applicable while minimizing calibration work input.

IAV SCR-Control
Developed in-house by IAV, this software provides the capability of operating different SCR systems. Modular in structure, the software can be adapted to different SCR system types through its model-based character on the one hand and an open source code on the other. This permits the fast and efficient implementation and validation of new SCR metering strategies.

IAV MiL-Desk
IAV’s MiL-Desk tool chain combines real-time software modules with the benefits of modern calibration tools. Using a special Matlab / Simulink block set, IAV’s MiL-Desk tool chain provides access to measured and adjusted variables in real time. It takes a Simulink model as the basis for generating an executable autonomous file as well as the interface descriptions required by the calibration tool.

OBD
For many years, we have been a reliable partner to our customers in helping them to meet the many different demands (USA, Europe etc.) on OBD systems. We have been able to demonstrate our expertise worldwide and in all manner of vehicle concepts.

Figure: Algorithm development in general
Our Software Tools

IAV can adapt its tool chain to customer requirements quickly and efficiently. This applies to commercially available tools as well as customer-specific tools and ones developed in-house. Examples of commonly used tools are shown below.

- IAV – CalGuide
- IAV/ETAS – CalAV
- IAV – Themos, TR-Sim
- ATI – Vision, No-Hooks
- dSPACE – CalDesk, ControlDesk
- ETAS – INCA/ASCET/Intecrio
- Imagine LMS – AMESim
- MATLAB – Simulink, RT Workshop
- Vector – CANalyzer, CANoe, CANape
- Gamma Technologies – GT-Power
- HiL simulations: dSpace, IAV, customer
- IAV – MiL-Desk
- Exothermia – Axisuite
- IAV – ADoS
- Borland – StarTeam
- IBM – DOORS

Our Seals of Quality

- Certified under DIN EN ISO 9001
- Systems in conformity with AUTOSAR
- Programming in conformity with MAAB
- Software handling in line with SPICE
- Development in conformity with ISO 26262