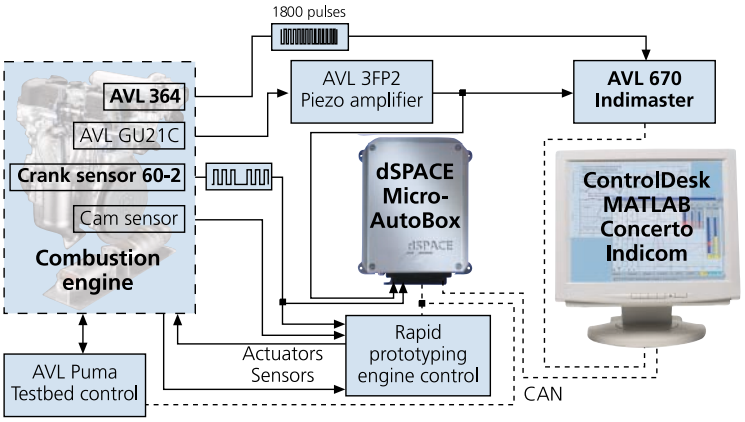
AVL Analyzes Cylinder Pressure with MicroAutoBox

CUSTOMERS

- Online cylinder pressure calculation
- Exact calculation with standard crankshaft signal
- MicroAutoBox as the proven in-vehicle solution

Today, engines have to meet the growing demands of rigid legislation in terms of exhaust emissions and fuel consumption (CO_2 emission). In order to achieve these objectives, it is necessary to optimize conventional combustion as well as to develop new combustion processes. AVL List GmbH, located in Austria, is working on a way to do this using advanced engine control algorithms that process additional combustion information provided by calculating in-cylinder based signals.



Integration of MicroAutoBox in engine test bed.

Real-Time Cylinder Pressure Processing

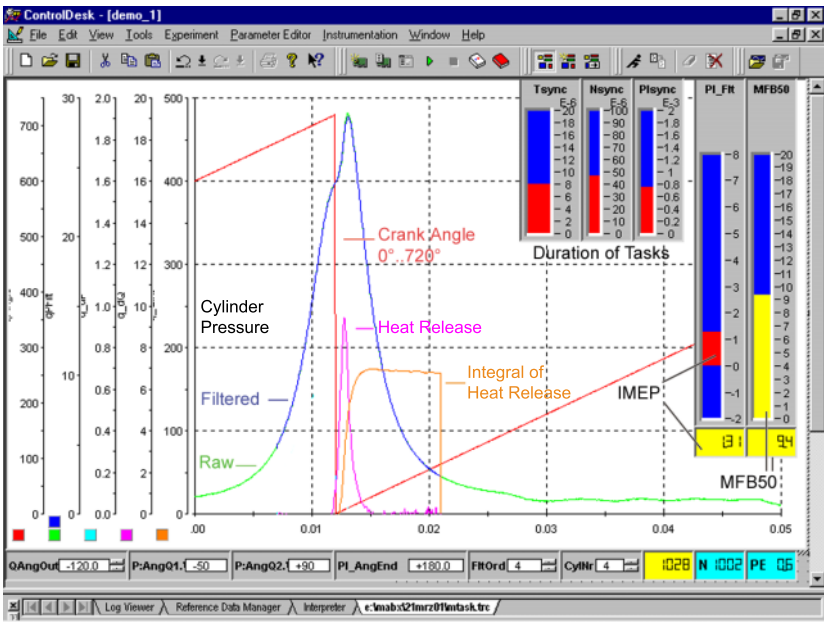
Algorithms were developed as graphical models in MATLAB/Simulink to process the combustion signals based on the cylinder pressure. At the same time a system had to be chosen that allows to test and optimize these algorithms, first on engine test beds and finally in the vehicle.

MicroAutoBox as In-Vehicle Solution

The demanding requirements for an in-vehicle solution, like compact size, stand-alone system with real-time hardware, automatic boot-up, and signal conditioning, were met by dSPACE's MicroAutoBox. For testing the algorithms AVL integrated MicroAutoBox into the engine test bed. With the help of dSPACE's Real-Time Interface, the code of the Simulink algorithms was implemented on MicroAutoBox with minimum effort.

Signal Processing

In order to verify the new algorithms on MicroAutoBox, signals were sent simultaneously to the indicating system AVL 670 Indimaster and to MicroAutoBox. A cylinder pressure signal was supplied to MicroAutoBox and the indicating system. A crankshaft signal generated by a conventional crankshaft sensor wheel (60-2) was then supplied to MicroAutoBox, whereas for comparison purposes the signal of an optical crank angle encoder (1800 pulses) generated a high-resolution signal for the indicating system. MicroAutoBox calculated the relevant combustion parameters, like the indicated mean effective pressure (IMEP) and the heat release, in real time



Combustion parameters calculated by dSPACE's MicroAutoBox.

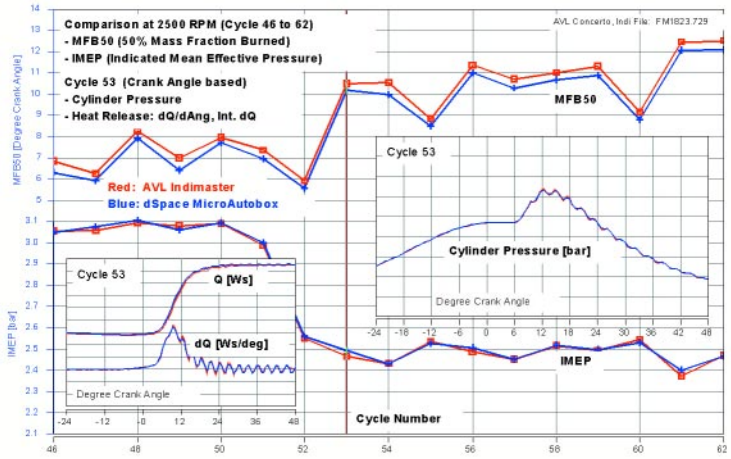
Papers

H. Hanselmann, F. Schütte: "Control System Prototyping, Productionizing and Testing with Modern Tools" (PCIM 2001)

English **04**

T. Michalsky, M. Büdenbender: "Testing Transmission ECUs with Integrated Sensors"

English **05**



Verifying the cylinder pressure analysis results of MicroAutoBox (blue) by comparison to that of the indicating system (red).

even with the low-resolution crank angle signal.
The combustion parameters were then supplied via CAN to the engine control in order to influence the fueling and charging for the next combustion cycle.

Experiment Visualization

The ControlDesk user interface was used for the visualization of signals like the cylinder pressure, the resulting combustion curve, and cycle based parameters like the IMEP, as well as for parameterization.

Verification

With the AVL software Indicom it was possible to access simultaneously the data of the indicating system (standard interface) and MicroAutoBox by using the IndiCom-MATLAB interface and MLIB/MTRACE, the MATLAB-dSPACE interface.
The online analysis of the cylinder pressure with the algorithms implemented in MicroAutoBox supplied combustion process information with a very small difference to that of the indicating system. Because of its high computing power and wide range of interfaces (CAN, analog and digital I/O), MicroAutoBox is a helpful tool for testing and optimizing the new algorithms later in the vehicle.

More MicroAutoBoxes Planned

MicroAutoBox was integrated into the AVL engine test bed and enabled us to conveniently analyze and use the new cylinder-pressure-based control algorithms. Both the positive test course and the support from dSPACE will enhance the use of further MicroAutoBoxes for engine optimization.

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Engine Control Based on Cylinder Pressure

Engine controls that use only standard sensors no longer allow major improvements in fuel economy and the reduction of vehicle emissions. Another challenge is to maintain emission compliance throughout the entire vehicle life.
New engine control concepts, with the cylinder pressure as the basic feedback variable, provide an excellent base for solving these tasks.
Cylinder pressure signals give much more detailed information about the combustion process. This facilitates improved engine management and the reduction of vehicle emissions. Gasoline engines with cylinder-pressure-based engine control feature an improved cold-start behavior, better warm-up of the catalytic converter, and enhanced control of ignition time, air-fuel ratio and exhaust-gas recirculation. These features all play a key role in reducing vehicle emissions, that is, particulates and NO_X. In addition, excellent knock signal detection, misfire and partial burn detection can be achieved. Cylinder-pressure-based controllers for diesel engines feature, above all, improved engine management and a much better idle speed control .
The likelihood of cylinder-pressure-based controls being present in high-volume cars is coupled, of course, with the availability of less expensive pressure sensors in the future.