Magneti Marelli Introduces New ECU for MultiAir System

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ETAS supports ECU software development process

Engine cylinders are traditionally charged through the intake valves, with work cycles controlled by the rotating camshaft. The main drawbacks of this system are loss of energy as well as restricted options for adapting to changing driving conditions. “MultiAir”, patented by Fiat Powertrain Technologies (FPT), is the new technology of dynamic air and combustion control, independent for each cylinder as well as for each stroke, resulting in more power, reduced fuel consumption, and reduced emissions.

MultiAir defines a new, integrated air intake management system that uses electrohydraulic actuators. The lift of the mechanical intake valve is controlled by a high-pressure oil chamber. An electronic control unit (ECU) regulates the oil volume in the chamber by means of a solenoid valve. With this technology, the engine can be adapted very flexibly to changing requirements.

A real innovation

The solenoid valve loosely “connects” to the intake valve profile of the cam. Upon closing the solenoid valve, the intake valve follows the cam profile. When opening the solenoid valve completely, the oil flows out into a secondary chamber. The intake valve closes completely. In this way, an infinite number of valve diagram states may be realized independently for each cylinder, without pressure regulation in the intake system.

In the MultiAir engine, every single cylinder is regulated directly by the Variable Valve Actuator (VVA). Nevertheless, the intake pressure is controlled by the throttle body to manage some dedicated functions that require a defined pressure drop (i.e., through the canister purge valve). The main goal of the engine control strategy is to maximize efficiency, minimize pumping losses, and to provide a more efficient combustion. These objectives are achieved by taking advantage of different valve openings:

One, early control of valve closing with respect to the mechanical means provided by the cam profile. In this mode, the partial air flow into the cylinder minimizes the fluid-dynamic losses compared to an intake manifold with a throttle body, as in traditional engines. This mode is used at medium and low torques.

Two, late control of valve opening reduces the valve lift in order to produce a strong turbulence inside the cylinder to optimize the mixture of air and gasoline. This so-called “MultiLift” mode is used at engine startup for combustion control optimization.

Multiple advantages

The MultiAir technology facilitates charging each cylinder individually. The cam profiles can be designed without any compromises. The intake system of the engine can be maximized towards a power increase. The VVA allows the definition, by means of electronics, of different cam profiles with the appropriate valve opening management. In this way, it becomes possible to increase the torque at partial loads, namely by reducing the gas reflow from the intake valve, typically found in multi-valve engines. This produces a minimum of 10 percent more power, 15 percent more torque – especially at low engine speed – and a minimum of 10 percent reduction in fuel consumption.

ECU – new functionality for MultiAir

For the MultiAir system, Magneti Marelli Powertrain has designed and developed a new ECU based on a 32-bit Freescale microcontroller of the MPC5500 family. The ECU manages all engine functions and system components (including valves), resulting in optimized efficiency, power, and emissions. The ECU is equipped with several power drivers and customized components designed to Magneti Marelli technical specifications.

Magneti Marelli has developed and integrated a dedicated software architecture by partitioning the software into different layers (from HAL to application software). This makes the software components easy to integrate, test, and calibrate, while offering ready reusability.

Most segments of the software components have been implemented by means of model-based technology. The program code has been directly generated on the basis of MATLAB®/Simulink® models, resulting in dramatically reduced software development times, immediate adaptation of control strategies, and a robust code.

The ECUs used in development were based on the aforementioned Free-
## THE CHALLENGE

Engine cylinders are traditionally charged through the intake valves, with work cycles controlled by camshaft rotation.

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## THE SOLUTION

MultiAir is the designation for the new technology of dynamic air and combustion control. Magneti Marelli has developed a new ECU for the MultiAir system. ETAS supported the ECU software development process by providing its tools, e.g., ETK, ES1000, ES910, INCA, and INTECRIO, along with various measurement modules.

## THE BENEFIT

The use of the MultiAir system produces a minimum of 10 percent power increase, 15 percent more torque – especially at low engine speed – and a minimum of 10 percent reduction in fuel consumption.

ETAS China joins hands with Shanghai Jiao Tong University

In November 2009, ETAS China was awarded a million Yuan cooperation contract with Shanghai Jiao Tong University (SJTU). Under the agreement, ETAS will provide its entire product portfolio with a view to establishing a comprehensive tool chain that encompasses the entire Lifecycle Process Model (V-Model), including function development, software development, testing, validation, ECU calibration, and diagnostics.

Moreover, as part of the recently awarded State Engineering Laboratory of Automotive Electronics at SJTU, a joint laboratory for automotive control system engineering will be set up in the near future by both parties. ETAS is thus making another powerful contribution to the education and development of the automotive industry in China.

The National Engineering Laboratory for Automotive Electronic Control Technology is a key industrialisation project approved by the National Development and Reform Commission in September 2008. As a newly established scientific and technological innovation platform and high on the list of the long-term plan of the national science and technology innovation system, the National Engineering Laboratory for Automotive Electronic Control Technology is the only domestic laboratory for the automotive electronics industry with a new, 45 million Yuan Research & Development department and an area of 10,000 square meters. The lab will become the R&D and technology transfer center for China’s automotive electronics industry core technologies, general key technologies, and engineering applications, and an important base for personnel training and international exchanges.

The ETAS-SJTU Joint Automotive Control System Engineering Laboratory established by both parties is an organization dedicated to research work for projects of mutual interest. It also serves as a dedicated facility for conducting customer events related to automotive control systems. The joint lab will mainly focus on investigating and promoting advanced technologies related to automotive control system development, and will also serve as a facility for customer training seminars and workshops related to the same area of endeavor.

The facility features the ETAS automotive ECU development environment: Function development – using rapid prototyping, automatic target code generation, testing and validation – using high-performance real-time simulation of vehicle and environment; as well as calibration. Equipped with a complete set of ETAS function modules, the joint lab will be recognized as the most complete ECU software development environment in China.