Electronic engine management: Key technology for intelligent engine control

The brain of a modern engine is the electronic control unit. It monitors and controls all the key functions of the engine and the exhaust aftertreatment system. The control unit also acts as the interface to the vehicle’s automation system. The optimum interplay of the entire drive system is the key to low pollutant emissions, low fuel consumption and high power output over the entire service life. MTU develops and manufactures this key technology in-house.

Engine control center
Legislators all over the world are specifying increasingly tougher emissions limits for diesel engines. To comply with the requirements, emissions from the drive system are constantly being reduced. As the engine’s brain, the engine management system (see Figure 1) controls key systems such as fuel injection, turbocharging and exhaust gas recirculation (EGR) that affect engine consumption and emission levels as well as performance. This means that the electronic engine management system is one of MTU’s key technologies for developing engines that comply with the increasingly tougher emissions stan-
MTU's own proprietary Engine Control Unit (ECU) controls engine functions extremely precisely so that the formation of harmful emissions is greatly reduced by internal engine modifications to the combustion process. For very stringent emission limits, MTU combines these measures with exhaust treatment systems that also remove emissions from the exhaust gas, such as the SCR system (Selective Catalytic Reduction) or the diesel particulate filter (DPF).

Electronics development and production at MTU

Around 300 staff in development, production and project planning at MTU work on tailor-made electronics solutions for engines and their automation systems. MTU develops the hardware and software for its engines in-house and also carries out production itself. By doing so, MTU can ensure a long-term product life-span of up to 30 years for electronic components. A particular challenge in this respect is the production lifecycle of bought in components such as microprocessors, which is generally much shorter than the production lifecycle of the engine control modules. As early as the ECU’s design concept stage, therefore, MTU chooses processor families that will continue to be able for a long period. If necessary, to ensure long-term availability, MTU also sets up a second supplier for electronic components. If components for control systems of older engines are no longer available, there is the possibility of adapting an ECU of the current generation to the engine concerned. In such cases, however, the engine management software has to be reconfigured for the drive system and the application.

MTU system modules

MTU’s engine controllers are designed as modular systems. That means that new functions can be quickly and flexibly integrated into the existing hardware and software platforms. The modular system also offers advantages for engine maintenance, since electronic engine diagnosis can be carried out quickly and efficiently for all MTU controller generations using just one service tool. In the development of engine management systems, MTU generally pursues the objective of producing as few hardware and software versions as possible. Five controllers in total cover all current MTU engine series — from the classic Series 396, 538, 956 and 1163 engines to the current Series 1600, 2000, 4000 and 8000 engines (see Figure 2). MTU launched its first electronic engine controller module to reduce engine fuel consumption and increase performance back in 1982. This was followed in the 1990s by the MDEC (MTU Diesel Engine Control), which controlled diesel engines with either unit-pump fuel injection or the common rail system, which was still quite new at the time. In 2004, there followed the ECU 7 for the Series 2000 and 4000 engines, which is designated ADEC (Advanced Diesel Engine Control). The universal controller is suitable for use with all cylinder configurations from V8 to V20 and for all drive applications. The ECU 8, a special version followed in 2008 for the Series 1600 engines.

From development to production, MTU electronic products come from a single source. The highly sophisticated electronic components are manufactured in the company’s in-house production section. Each control unit contains several thousand components.
The ECU is an electronic engine control unit that is responsible for the monitoring and control of all engine functions. MTU has named the current generation, the ECU 9, ADEC: Advanced Diesel Engine Control.
Automation solutions
Integration of the engine management system in the automation structure has been achieved using standardized MTU interface modules. This enables drive systems to be integrated even more easily into the automation system of a given application. Here, MTU offers a modular system that enables the engine control system to be extended by adding application-specific automation solutions. For marine applications, on the one hand MTU has developed standardized automation solutions. Standardized automation solutions are likewise available for marine applications. These include the ultra-compact Blue Vision New Generation automation system introduced in 2013. The system encompasses the complete Monitoring Control System (MCS) and Remote Control System (RCS) for the automation system of a vessel’s entire power train from the propeller to the control stands. On the other hand, with its ship auto-mation system “Callosum”, MTU has created a modern and highly efficient modular system which can be used for customer-specific project system solutions for all types of vessels.

For rail applications, MTU supplies automation solutions for drive systems in railcars as well as in locomotives. The modular automation system ‘Powerline’ which has been newly developed in conjunction with Series 4000 for locomotives, integrates all of the functions required for monitoring and control of the diesel drive plant (see Figure 3). The core electronic component of the new automation system is the Power Automation Unit (PAU Engine) which combines all of the functions in a compact unit as well as providing a secure link to the locomotive’s control systems via the CAN-Open interface.

Summary
As the brain of the engine, the ECU controls key engine systems that affect the engine’s consumption, emissions and performance, such as fuel injection, turbocharging and exhaust gas recirculation. Increasingly stringent emission standards are placing ever greater demands on the electronic engine management system. For particularly strict emission standards, MTU launched the new ECU 9 in 2011, which further reduces the production of harmful emissions inside the engine by providing even more precise control of the combustion process.

MTU unveiled its first electronic engine controller back in 1982. Since then, the company has continued to develop and produce the entire hardware and software in-house. This ensures that MTU is able to guarantee the long-term availability of spare parts, even for older engines. With the ECU 9, MTU is offering a separate, standardized automation system interface. In addition, customers can extend the engine management system by adding application-specific automation solutions from MTU for propulsion, on-board power generation and the complete ship in the marine sector, for example, as well as for rail applications.