State engine chip ENHANCES car performance

In the near future, one automotive manufacturer will offer cars with more power and less pollution—thanks to a silicon-chip state engine

THE EVOLUTION OF THE AUTOMOBILE owes part of its heritage to the cash register—at least indirectly. NCR had a division that made semiconductors for the auto industry. Former employee Rich Gauer, of NCR's Microelectronics Products Div., founded Automotive Integrated Electronics Corp (AIEC) of Phoenix, AZ.

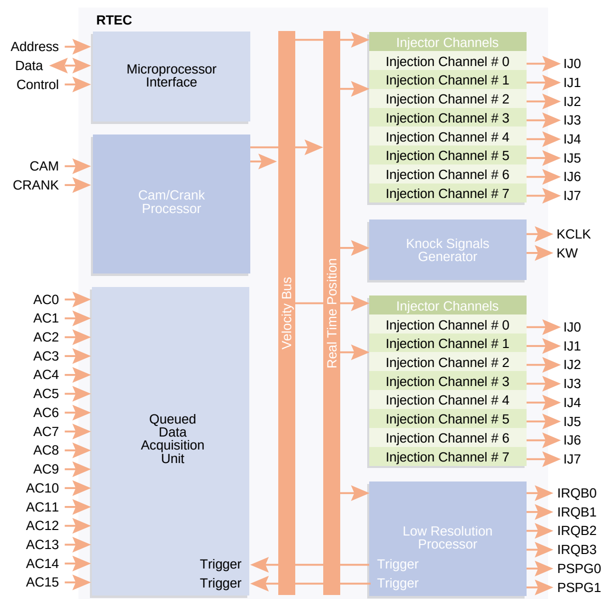
While AIEC originally intended to pick up where NCR left off taking care of existing customers, customer demand and regulations changed priorities. AIEC developed control chips to monitor and regulate gas engines. Its latest offering, the Real-Time Engine Controller (RTEC) chip, promises to boost performance while reducing emissions for cars in the 2002 model year.

A state-engine controller. "One of the 'Global Three' automakers will use the RTEC state-engine chip. A state engine," says Frank Emnett, VP engineering for AIEC, "works like a dedicated microprocessor or micro-controller. The automaker puts it on its engine controller printed circuit board.

"Because the RTEC's functions are built into silicon, it works faster than a software-programmed processor," he says. Used on the engine controller printed circuit board, it offloads operations which would otherwise have to be programmed into the main processor and take up a lot of processor cycles. The RTEC manipulates input data faster and eliminates the need for many real-time interrupts and latencies (time delays) on the main engine controller.

"The RTEC also takes care of many of the low-level functions such as conversion algorithms and servicing interrupts, and it provides I/O drivers," says Emnett. This enables automotive car designers to focus on refining higher-level functions to improve operating results and to not have to worry

Real-Time Engine Controller Block Diagram



AIEC's Real-Time Engine Controller builds ignition and injector controls into silicon. Delivering more precise operation and sensing results in more engine power with fewer emissions.

Alan J. Laduzinsky, Contributing Editor

VENDOR ADVERTORIAL

Production site achieves QS-9000 certification

Dyneon LLC, a 3M company, is one of the world's largest fluoropolymer producers, with operations or representatives in more than 50 countries on five continents. Engineers specify Dyneon fluoropolymers for automotive, aerospace, architectural, chemical processing, food processing, petroleum down-hole, pollution control, polymer processing, and wire and cable applications. Automotive applications include critical fuel system, powertrain, and drivetrain components.

All Dyneon production facilities are ISO 9001 certified. In June 2000, Dyneon's Decatur, AL, production site received the rigorous Quality Systems Requirements QS-9000 certification. QS-9000 is the common supplier quality standard for the Big Three U.S. automotive manufacturers: DaimlerChrysler Corp., Ford Motor Co., and General Motors Corp. In-creasingly, both automakers and Tier 1 and 2 suppliers are expecting their supplier partners to adopt this standard.

The QS-9000 certification applies to a broad range of automotive applications using fluoroelastomers and fluorothermoplastics. It covers personnel from the customer service, marketing communications, operations management, process, quality, and research departments that support the business groups.

"We are particularly proud of our QS-9000 certification," Dyneon President Jim Gregory says. "This is another way of showing our commitment to service and our ability to meet or exceed the expectations of the automotive industry."

In fact, the Decatur plant, which has remote operations in Oakdale, MN, is the first Dyneon facility in the U.S. to achieve both QS-9000 and ISO 14001 certification. ISO 14001 provides a process to integrate environmental responsibility into everyday corporate management, thus ensuring compliance with environmental regulations.

"We are serious about managing our operations and resources in an environmentally responsible manner," says Gregory. "Our ISO 14001 certification demonstrates that we have world-class, structured management tools in place to control the effect of our operations and products on the environment." Circle 826

about the digital plumbing.

Common ground. "As AIEC worked with different automakers," says Gauer, AIEC president, "the company discovered that each used many of the same low-level conversion algorithms and I/O functions." With RTEC, engineers could spend more time focusing on the higher-level functions and developing more complex control algorithms to improve engine operating characteristics.

AIEC will start shipping product in the middle of 2001. With its silicon-based functionality, the RTEC can monitor the position of the cam/crank fly wheel on the crank shaft by sensing its teeth. It calculates the position of the cam shaft and the engine to 0.1 degree, as well as calculating the engine's velocity. This isn't new, but this previously required a heavy amount of interrupt processing and CPU intervention. Or, it required the use of a complex programmable timer unit, which is difficult to program and has limited data bandwidth.

Standard functions and speed. RTEC incorporates several engine characterization functions to control operation with microsecond precision. Independent ignition channels generate the spark for combustion with precise programmable dwell times, and ignition advance angle registers accommodate virtually all ignition strategies.

"The RTEC calculates an advance angle and a dwell time. It includes a dedicated circuit to generate the ignition pulses. Designers enter dwell time in one register and advance angle in another and forget about it," says Emnett. A similar function handles knock analysis. It connects to a knock sensor chip. Designers determine the proper firing angle. They set it up once. That's it.

"In a similar manner," says Emnett, "users can specify ignition start and stop angles for fueling. They can specify the amount of fuel as well as how it gets delivered in multiple fueling pulses. They might use two pulses of fuel injection to accommodate fluid dynamics requirements. One pulse evaporates, and then the cylinder gets another shot to complete fuel loading before combustion."

The benefits derived from the RTEC state engine result from its higher I/O processing speed and precision. "RTEC achieves spark control in the microsecond range. This, combined with its faster response time on engine positioning, delivers better fueling and ignition performance," says Emnett.

"RTEC monitors engine position to a tenth of a degree in production cars," he adds. It has higher resolution, but serves no purpose right now. It will even control engines at speeds up to 20,000 rpm. Some racing teams have expressed an interest in using the RTEC.

One area where RTEC might make a dramatic difference involves engine start up. Until the controller knows which cylinders are firing, it squirts raw fuel speculatively into all cylinders, causing the worst case scenario for emissions. RTEC determines the position of the engine in much less time to reduce these emissions.

Future refinements. AIEC also includes the ability to perform variable valve timing control with RTEC. Although today's automobiles still use cam shafts to control valve timing, the automotive industry has performed research on electronic valve lifters in an effort to eliminate another piece of engine hardware. The car makers want to ensure a high degree of reliability before introducing this technology to the public.

"The model for engine control is moving from an era of steady-state approximations to looking at actual operating parameters. This new strategy will address individual combustion events for each cylinder," says Emnett. "One day we may be able to adaptively control the contour of valve opening, fuel injection, and ignition of each cylinder with the RTEC state engine. The ability to independently control combustion in each cylinder and adapt it based on user needs and its operation will allows car makers to achieve even better engine performance."

With its silicon base, the RTEC chip will undergo a further transformation when its fabrication process moves from a 0.5-micron geometry to 0.18 microns. This will increase processor speed and increase chip complexity. The RTEC will also double its flash RAM memory to 8 Mbits. It needs the expanded memory to handle increased diagnostic requirements.

AIEC expects to incorporate the ARM Holding RISC processor in this next version of RTEC. This will result in a non-proprietary solution that is not tied to a single supplier, allowing customers more flexibility in suppliers.

AIEC is developing similar state engines for smart transmissions as well as anti-lock brake control. If these devices meet with success, AIEC will again hear the sound of cash registers, but in a different environment.