



*GM Powertrain offers leading-edge technology in its industrial engines.*

## *Electronic Engine Management*

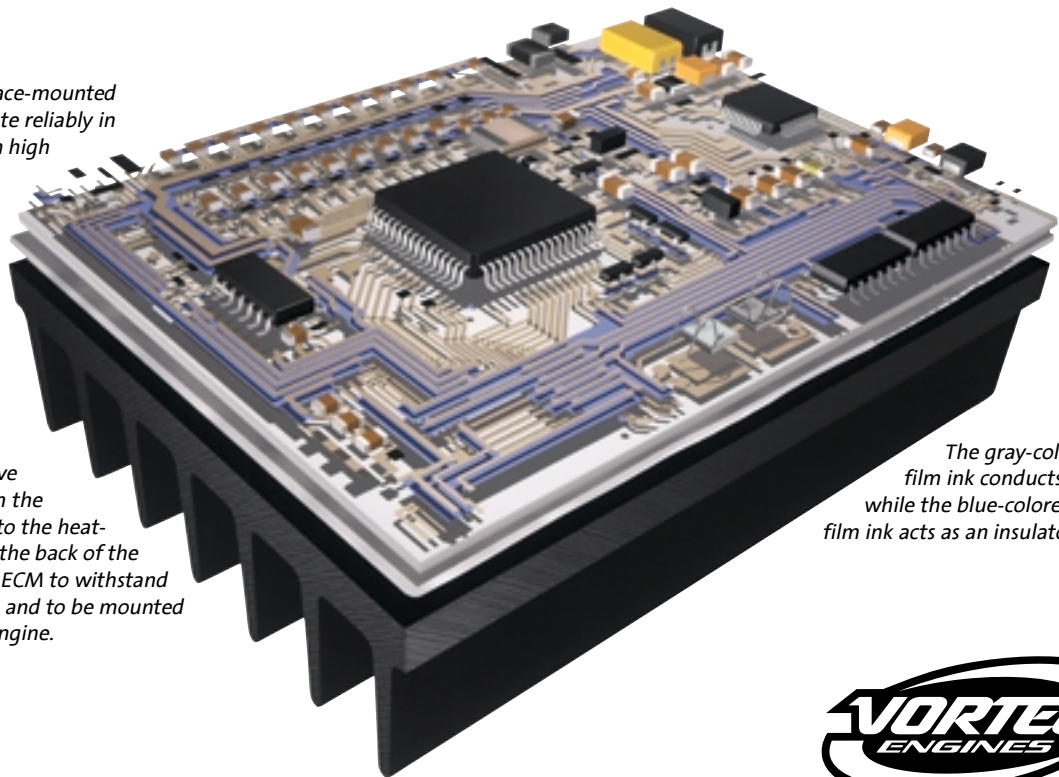
GM Powertrain has long been a pioneer in offering electronic engine management for industrial engines, adapting the technology that has transformed the automotive industry to the specific needs of the industrial environment.

The "brain" in every GM Powertrain engine management system is an Electronic Control Module (ECM) which was developed specifically for the industrial engine market. The ECM takes input from various sensors and then uses that data to continually optimize engine operation and performance. For example, if the engine knock sensor indicates there is detonation, the ECM instantly adjusts spark timing to eliminate the problem. In industrial applications, this can greatly increase the service life of the engine.

*Sophisticated surface-mounted components operate reliably in environments with high vibration.*

*A special heat-conducting adhesive transfers heat from the ceramic substrate to the heat-dissipating fins on the back of the ECM, enabling the ECM to withstand high temperatures and to be mounted directly onto the engine.*

For maximum reliability, GM Powertrain's commercial ECMs are manufactured using thick-film hybrid technology, a technology more advanced than what is used in much of the automotive industry. The circuits are formed by printing layers of conductive and nonconductive ink onto a ceramic substrate. The result is an extremely rugged and durable module that can handle very high temperatures and severe vibrations. This enables the OEM to mount the ECM directly onto the engine. It is one example of GM Powertrain's dedication to meeting the specific needs of the industrial engine market.



*The gray-colored thick-film ink conducts electricity while the blue-colored thick-film ink acts as an insulator.*

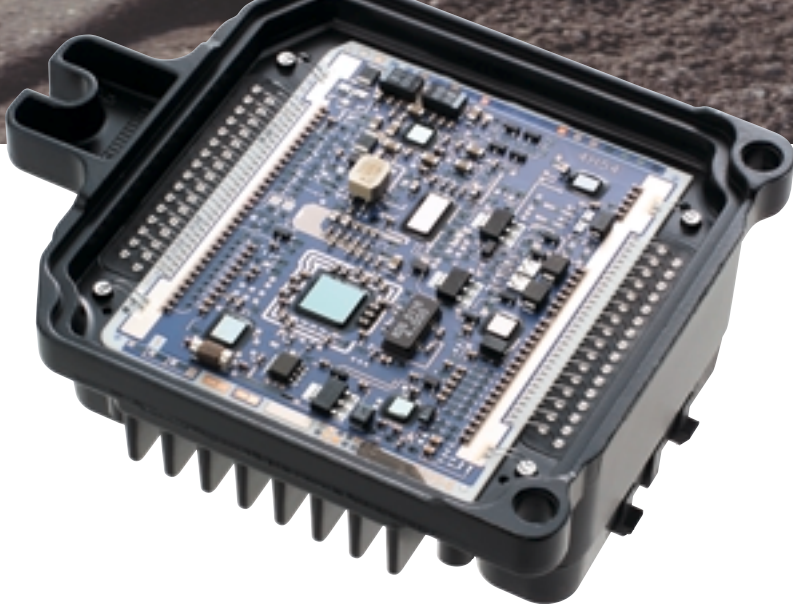


## A Choice of Engine Technologies: Commercial EFI or MSTS

OEMs have a choice of how much, if any, electronic engine management they want. GM Powertrain knows that industrial application OEMs have different needs. For example, many OEMs do not need the precise fuel control that comes with EFI, but they do want computer-controlled spark timing and engine diagnostics, which is why GM Powertrain offers a sophisticated microprocessor spark timing system (MSTS) for gasoline, natural gas or propane. For OEMs that require the absolute best in turnkey starts and want smooth, rock-steady idling, GM Powertrain's commercial EFI packages for gasoline models lead the industry.

Both the EFI and MSTs controllers use the rugged, thick-film hybrid technology that has proven itself in the demanding industrial environment. Both controllers help to protect the engine from engine knock and damage due to over-revving. Self-diagnostics allow service

*The compact MSTs controller uses the same rugged, thick-film hybrid technology used in GM Powertrain's commercial EFI controller.*



technicians to read diagnostic codes for quick and accurate system servicing. Altitude, engine load, and temperature compensation features adapt to changes in the environment for extraordinarily reliable and consistent performance.

## Benefits of EFI and Electronic Engine Management

Electronic fuel injection uses sophisticated microprocessor technology to precisely meter the optimum amount of fuel for every situation. So whether the engine is very hot or the ambient temperature is very cold, OEMs can expect reliable, turnkey starts. In addition, by replacing the carburetor with computer-controlled fuel injectors, the expensive, time-consuming task of continually adjusting the carburetor is entirely eliminated. OEMs have come to count on the instant starts, reduced maintenance, smooth idling and responsive performance made possible with GM Powertrain's commercial EFI.

## Announcing Enhanced EFI Software

OEMs can choose an improved version of the fourth-generation Commercial Electronic Fuel Injection software.

GM Powertrain has developed a new "B" version of the software used to control the industrial EFI system that offers several additional improvements:

### • *Controller Area Network (CAN) Bus Enhancements*

- Significant increase to the number of J1939 broadcast messages
- Option to interface EGR input to fuel level sensor to broadcast on CAN
- J1939/73 Diagnostics and Service Tool interface
- Support for CAN-based calibration tools

### • *Fuel Control Enhancements*

- Independent closed loop fuel calibrations for dual-fuel applications
- Improved fuel control algorithms

### • *Idle Control Enhancements*

- Improved idle control algorithm

### • *Idle Fuel Control (New feature)*

### • *ETC/Governor Control Enhancements*

### • *Knock Control and Octane Rating Enhancements*

### • *EGR Revisions to Allow for Alternate Uses of EGR Output*



## GM Powertrain Advantage

## MSTS



## EFI

**Idle Stabilization**

At low idle a microprocessor algorithm constantly adjusts spark timing for smooth idling.

**Engine Mountable**

Small size and rugged hybrid technology enable the OEM to mount the module directly onto the engine.

**Automatic Dwell Control**

If the battery or alternator are providing weak voltage, the system automatically compensates by charging the coil longer, which increases the voltage sent to the spark plug.

**Engine Load Compensation**

Sophisticated programming continually adjusts spark timing to compensate for changes in engine load.

**Temperature Compensation**

Continually adjusts spark timing to keep engine temperature within safe, efficient limits.

**Altitude Compensation**

Changes in altitude result in automatic adjustments to spark timing.

**Dual Fuel Spark Curves**

OEMs can connect a switch that will enable the operator to activate a different spark curve whenever fuel is changed to or from gasoline, natural gas or propane.

**Knock Control**

Refined spark control programming provides state-of-the-art knock control.

**Reprogrammable Calibration**

OEMs can quickly recalibrate the system in the field, using a laptop computer.

**RPM Limitation**

An intelligent rpm limiter protects the engine from damage caused by over-revving.

**Self-Diagnostics**

Service technicians can read diagnostic codes for quick and accurate system servicing.

**Adaptable to All GM Powertrain Spark-Ignited Industrial Engines**

OEMs can easily change to a 4-, 6-, or 8-cylinder engine by selecting a different calibration within the same controller.

**Electronic Fuel Injection Control Capability**

Electronic fuel injection uses sophisticated microprocessor technology to precisely meter the optimum amount of fuel for every situation. The result is smooth idling, responsive performance, reduced maintenance and instant starts.

**Coil-Near-Plug Capability**

Provides the OEM the opportunity to incorporate a coil-near-plug ignition system for more accurate ignition timing and better spark.

**CAN Interface Capability**

Controller Area Network (CAN) serial data interface protocol which allows the controller to communicate with other electronic devices in the application.

**Integrated Knock Control**

Incorporating the knock control module into the ECM eliminates the module between the knock sensor and the ECM. The knock control is software programmable, so parameters can be updated via software.

**Optional Inputs and Outputs**

OEMs are offered optional inputs and outputs to use for additional features and capabilities.

**Optimal Spark Control**

The spark timing algorithm calculates the peak performance spark advance and protects the engine from detonation damage. Based on rpm, engine load, and fuel source, the logic computes a spark angle. Then sophisticated correction factors, such as engine coolant temperature, manifold air temperature, altitude, boost, and exhaust gas recirculation (EGR) are applied. Up-integrated knock detection hardware provides state-of-the-art detonation control and allows the system to adapt to changes in the fuel octane level. In addition to providing the optimal timing, the controller provides the optimal coil charging time. Ignition voltage, engine speed, and temperature are considered when computing the dwell time that will allow the coil to provide the hottest spark possible.

**Multiple Governor Control Configurations**

The controller supports a host of options to make the governor very dynamic, including the capability of controlling maximum engine speed, engine acceleration rate, and vehicle speed to variable thresholds.

**Engine Protection**

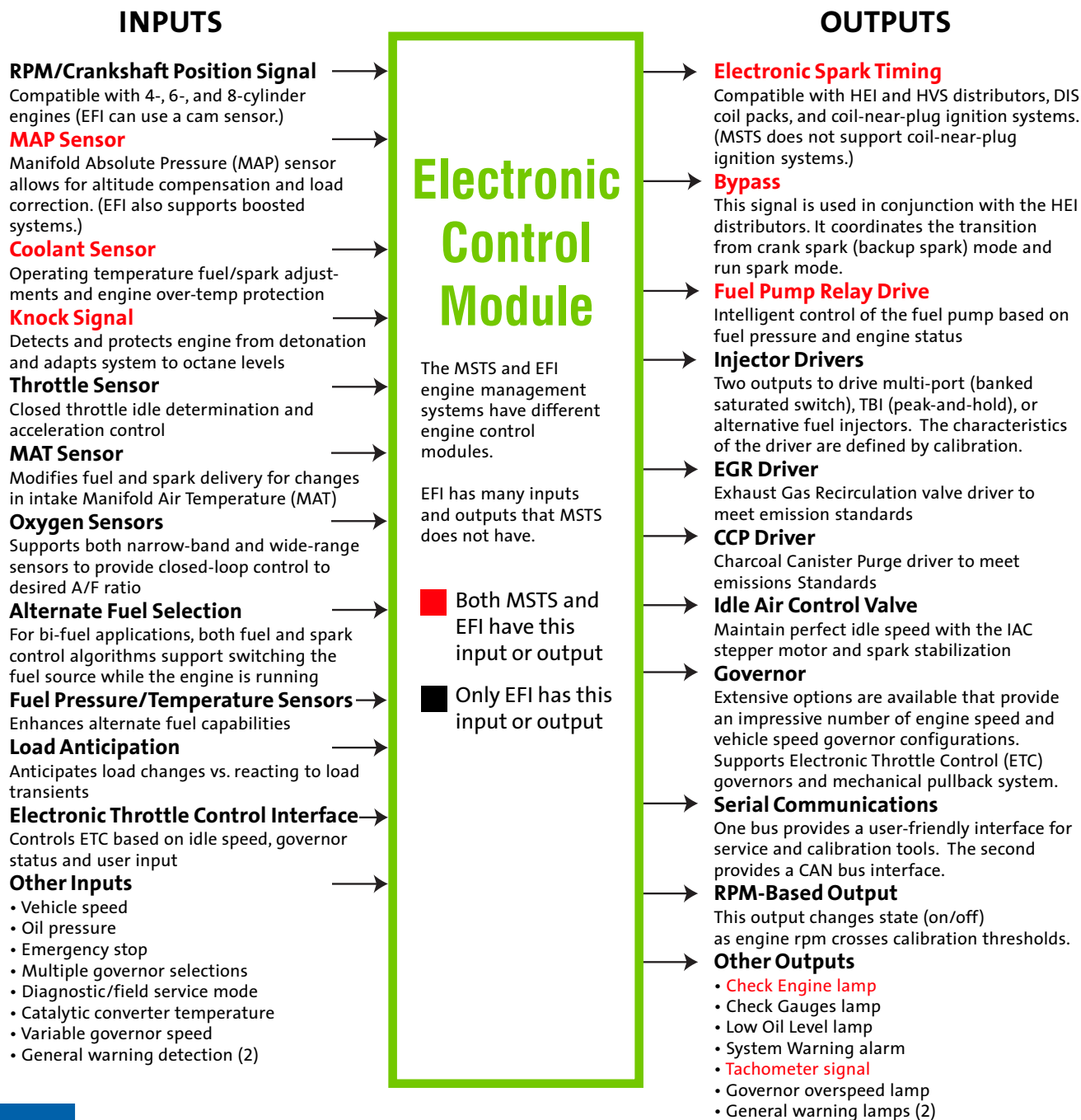
The EFI controller continuously monitors the system for warning conditions that may lead to engine damage. The actions taken by the ECM when a warning condition is detected include combinations of warning lamps, warning alarms, reduced speed, stop engine, and preventing the engine from restarting until serviced.

**Expanded Emission Control Interfaces**

The controller provides interfaces for two oxygen sensors, an exhaust gas recirculation (EGR) valve, and a charcoal canister purge (CCP) valve. Alternative fuel interfaces include a fuel pressure sensor and fuel temperature sensor inputs.

## Electronic Engine Management System

The technology behind electronic engine management is very sophisticated, but the basic concepts are easy to understand. The diagram below shows the major inputs that the ECM continuously monitors and the major outputs that it precisely controls for both an MSTs and EFI system.



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