

2004

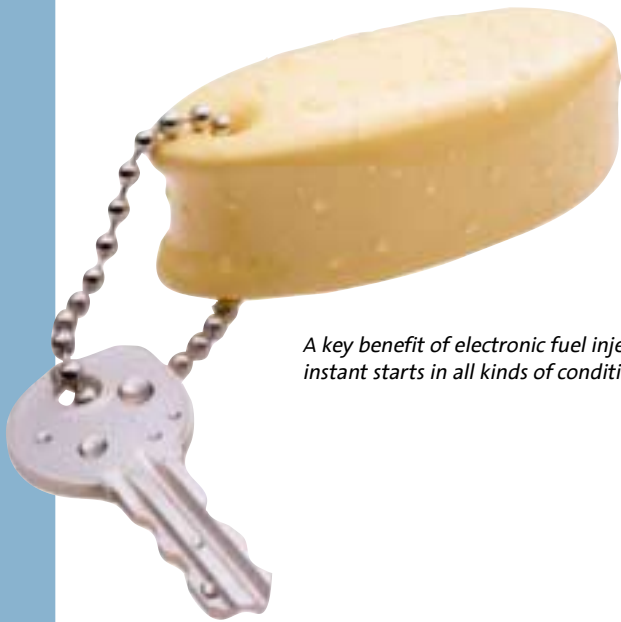


GM Powertrain continues to support the marine EFI revolution by offering leading-edge electronic fuel injection technology.

Marine EFI

Four Generations of EFI Innovation

A few years ago GM Powertrain's introduction of marine electronic fuel injection (EFI) revolutionized the boating industry. Now, an enhanced version of the General Motors electronic fuel injection technology that is well known for giving vehicle owners superb fuel economy, instant acceleration and turnkey starts is forever changing the marine industry. Boaters now know the joy of simply turning the key and having the engine start immediately, with no manipulating of the throttle and no stalling. Acceleration is powerful and instant. Idling is smooth, quiet and reliable. In addition, improved fuel economy and lower emissions help protect the environment.



A key benefit of electronic fuel injection is instant starts in all kinds of conditions.



Many boaters have found that EFI is the most important boating improvement of their lifetime.



A Fourth-Generation, State-of-the-Art Electronic Control Module

The "Brain" of the System Ties It All Together

A key factor in EFI's success was GM Powertrain's marine EFI Electronic Control Module (ECM), which was developed specifically for the marine industry. Its thick-film hybrid technology is more advanced than the circuit board technology used in much of the automotive industry.

The Benefits of Hybrid Technology

GM Powertrain's marine ECM is manufactured using a state-of-the-art, thick-film "hybrid" technology that forms the circuits by literally "printing" layers of conductive and nonconductive ink onto a ceramic substrate. The result is an extremely rugged and durable circuit board that can be mounted directly onto the engine, because it can handle very high temperatures and severe vibrations.

Small, Light Package

Extensive use of "flip chip" integrated circuit technology makes possible a smaller ECM. Flip chips require less space because they do not have the plastic covering of typical chips and are "flipped" over to fasten directly to the board,

An ECM with Exceptional Capabilities

GM Powertrain's fourth-generation ECM has several important capabilities and features.

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) protocol allows the controller to communicate with other electronic devices in the boat.

Integrated Knock Control

Incorporating the knock control module into the ECM eliminates the interface electronics module, which is located between the knock sensor and the ECM. The knock control module is software programmable, instead of hardwired, so parameters can be updated via software.

Optional Inputs and Outputs

OEMs are offered several optional inputs and outputs to use for adding more features and capabilities.



The new, fourth-generation EFI electronic control module has coil-near-plug and CAN interface capabilities.

EFI has Revolutionized the Boating Experience

Electronic fuel injection, combined with micro-processor-based engine management, has dramatically changed the entire boating experience.

What EFI means to the Boater and Family

- *More responsive and smoother acceleration* is the result of the EFI system's ability to instantly deliver an atomized flow of fuel for as long as needed.
- *Excellent turnkey starts in all weather conditions* are made possible because the ECM can sense whether the engine is cold from morning chill or hot from heavy use and then provide the right amount of fuel for instant starts.
- *Smooth, reliable idling* comes from the ECM's ability to provide the correct amount of air and fuel during idling. This results in reliable idling, whether the engine is hot or cold, and no stalling while moving in and out of gear.
- *Significantly reduced fuel consumption* is due to the precision of the electronic engine management system.
- *Improved control of emissions* is also due to the precision of EFI.
- *Engine knock control* is attained by detecting engine knock and then virtually eliminating it by automatically changing the spark timing and fuel delivery. This means a tank of less-than-perfect gasoline will not ruin a boating weekend.

- *Overspeed protection* means that engine rpm is automatically limited if there is a danger of the engine overspeeding due to the propeller failing or coming out of the water.
- *Speed reduction* reduces engine speed and beeps a warning if one of the inputs to the ECM indicates an operating condition that is out of proper limits. Operating conditions that cause speed reduction could include engine overheating, low oil level, and low oil pressure.
- *Altitude compensation* is a welcome help for boaters who sometimes vacation in higher altitudes. The ECM system senses air density and modifies fuel and spark accordingly.
- *Self-diagnostic capabilities* make for faster, more accurate maintenance on those rare occasions when the EFI system needs servicing.
- *Reduced maintenance* results from replacing the complex carburetor with the simple EFI system.
- *Improved resale value* is due to all of the above features and the fact that GM Powertrain's EFI system is designed specifically to maintain superior performance year after year in the harsh marine environment.

Announcing Enhanced EFI Software

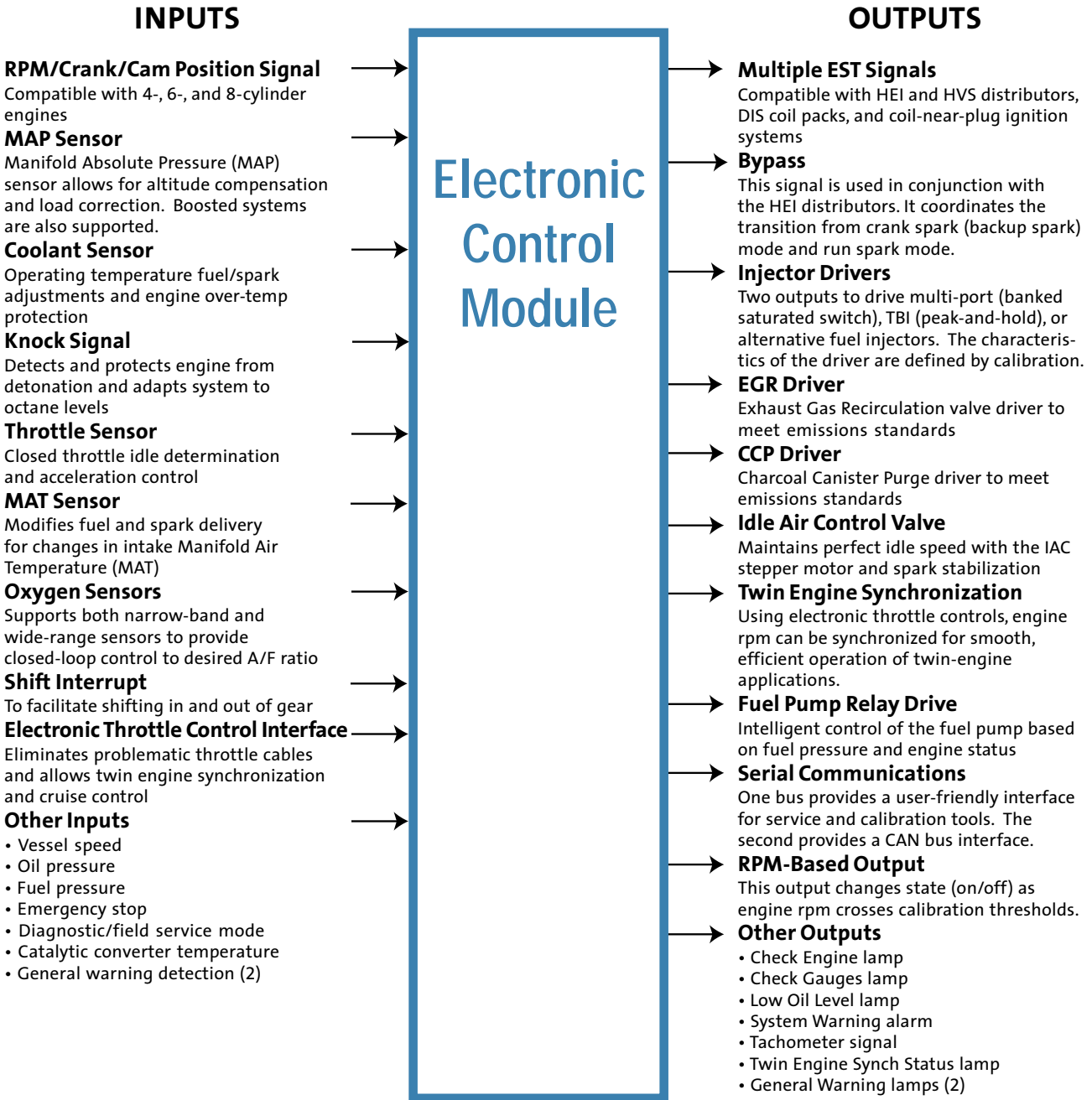
OEMs can choose an improved version of the fourth-generation Commercial Electronic Fuel Injection software.

GM Powertrain has developed a new "B" version of the software used to control the marine 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*

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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