MICHIGAN CUSTOM MACHINES, INC.

Product Highlight:
PROGRAMMABLE FUEL INJECTOR MODULE

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The purpose of the Programmable Fuel Injector Module or “PFIM” is to provide the consumer with a means of firing a diesel fuel injector in a manner that duplicates the vehicle application.

Background
A typical modern electronic diesel injector requires much more power and control than a typical gasoline injector. Usually the current delivered to the injector must be delivered at a rate, held and then reduced once the injector actuator has moved. The reduction in current keeps the injector solenoid from burning up once the work from the solenoid has been done. During the holding phase, the current is dithered at a high frequency to minimize the hysteresis within the injector. This sequence is called a shot. To complicate matters, modern Diesel fuel injection systems require several “shots” within the combustion phase to achieve emission goals, quiet operation and improved performance in the engine. With the sophistication of the modern Diesel fuel injector, the timing of these waveforms is critical and directly affects the performance of the injector and engine. The combination of OEM accuracy and control for a variety of injectors has made the task of a common ECU a challenge for the testing industry, until now.

Module Features:

- Fully programmable waveform through serial port.
- Perfect OEM waveform duplication
- Able to synchronize with camshaft or fire asynchronously
- Operates on a single voltage
- Compact, self-contained design is not much larger than OEM controller.
- Open communication protocol allows easy interface to machine controls.
- Included software package allows configuration from PC or Laptop.
- Capabilities to fire up to 6 injectors in one unit using a specific firing order.
- Multiple units can be connected together as master and slave to fire up to 24 injectors.
- Open or Shorted Injector Connection Detection

Description
The PFIM can be used to fire a diesel injector or group of injectors with a precise waveform that is fully configurable by the end user. Synchronization with a cam or crank is possible with several input options such as encoder, once-per-rev or engine timing wheel with sensor. Communication is through a serial port using an open protocol. Drivers for Visual BASIC applications are available as well as a configuration tool that allows the real time editing of PFIM control variables. The module is designed to retain parameters in non-volatile memory for simpler applications that require infrequent configuration and no communication. Injector solenoid can be energized for extended periods of time for performing static seat leak tests.

The PFIM was designed for:

- OEM future product development, giving extended experimental range over the production ECU
- Test bench integration for endurance testing a complete Diesel fuel system
- Production test machine integration for in-line and end-of-line testing
- Lab bench or audit bench integration
- Expanded use with custom firmware
- Customers that test several injector types and brands on the same equipment

Using the PFIM for your application eliminates the need to address proprietary OEM communication protocols on a platform that has been designed and calibrated for precision, exceeding production hardware.

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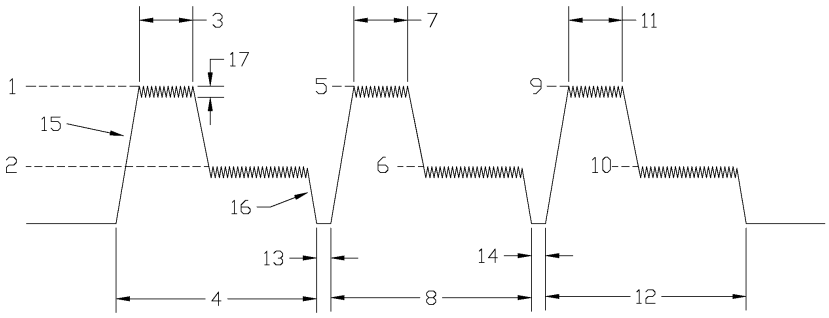
Flexibility

No matter what your requirements, the PFIM can deliver. The following waveform is an example of a waveform for a pilot, main and post injection for a diesel injection cycle. The various programmable features controlled by the PFIM are numerically labeled and described in the following table. Though this example shows two current levels and three splits, virtually anything else is possible.



Programmable Features

Controlled Feature	Name	Description	Range	Resolution
1 ,5, 9	Pull-In Current	Current driven to the solenoid to initially begin movement of the actuator. For split injections or different applications, this feature is individually controlled per split.	0-30A	100 mA
2, 6, 10	Hold-in Current	Current delivered to the solenoid once the actuator has moved. This current is only needed to maintain the solenoid engagement. For split injections or different applications, this feature is individually controlled per split.	0-30A	100 mA
3, 7, 11	Pull-In Duration	The time that the pull-in current is applied to the injector solenoid. For split injections or different applications, this feature is individually controlled per split.	0.2-100ms	1µsec
4, 8, 12	Pulse Width	The total “On” time of the injector. For split injections or different applications, this feature is individually controlled per split.	0.2 ms to 30 seconds[1]	1µsec
13	Main Delay	This is the delay time between the pilot and main shot. This parameter is only used for split injections	0.2-100 ms	1µsec
14	Post Delay	This is the delay time between the main and post shot. This parameter is only used for split injections	0.2-100 ms	1µsec
15	Rise Rate	This feature is a function of the characteristics of the solenoid on the injector[2]. The PFIM controls this by changing the applied voltage.	Supply voltage to 110V	1 Volt
16	Fall Rate	This is the rate at which the current is reduced at the injector, using our Patent pending technology. This feature is a function of the characteristics of the solenoid on the injector[3].	Supply voltage+10 to 110V	1 Volt
17	Chop Amplitude	This is the level of current regulation in the hold state of the waveform. For split injections or different applications, this feature is individually controlled per split.	100 mA-1A	10 mA
	Actuation Speed	When firing asynchronously, the PFIM dictates the firing rate	100-6000 RPM	1 RPM

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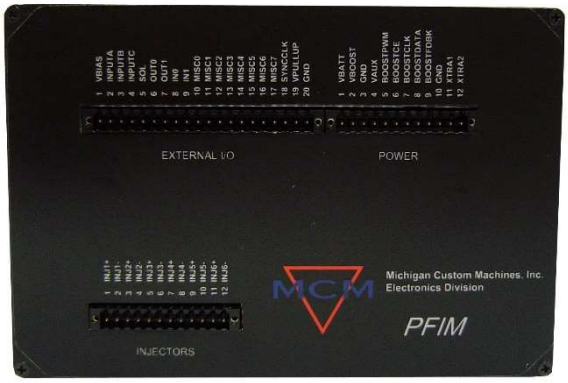
Specifications

- Operating Voltage: 12-24 VDC
- Maximum number of injectors per PFIM: 6
- Maximum Current per injector: 30A
- Maximum Voltage to injector: 110V
- Communication: Serial, RJ45 connector
- Protocol: SAE J1708 style messages
- Hall effect switch, Encoder, or TTL input for Synchronous Operation



[1] Note that improper parameters could result in solenoid damage
[2] Rise rate is defined as the applied voltage divided by the inductance of the injector solenoid (varies by type)
[3] Fall rate is defined as the control voltage divided by the inductance of the injector solenoid (varies by type)