Module 14: Electronic Fuel Injection Diagnosis and Repair

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Terms and Definitions

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- Active codes are codes describing a condition that is currently present to alert the driver or service technician of abnormal parameters.
- Actuator is a device that performs work in response to an electronic signal.
- Bypass circuit is a circuit, usually temporary, used to substitute for an existing circuit, typically for test purposes.
- Calibration is the adjustment of a sensor signal.
- Computer data link is a connection between two electronic devices for communication purposes and is used for programming and troubleshooting.
- Data is information in numerical form that can be digitally transmitted or processed.
- Diagnostic code is a digital readout that identifies a problem or event in an electronic system.
    Note: This may also be called a fault code or trouble code.
- Driver is a transistor in the output section of the ECM used to turn on or off various actuators in the system.
- Electronic control module (ECM) is a computerized device that monitors other electronic parts and acts as a governor in electronic fuel systems.
    Note: This is the "brains" or command center for the electronic system.
- Harness is a wiring bundle connecting all electronic components.
- Historical or inactive codes are codes stored in ECM memory.
- Microprocessor integrated circuit within a microcomputer controls information flow within the computer.
- On-demand test is a self-test that the technician initiates and is run from a program in the processor.
- Parameter is a programmable value that affects the characteristics or behavior of the engine and/or vehicle; some examples are high idle RPM, idle speed, and PTO speed.

- Personality module is an electronic module that stores individual vehicle parameters for the system being used.
    Note: This module allows for several vehicle features to be reset, such as road speed, cruise control set points, and speedometer calibrations.
- Potentiometer is an electromechanical device that senses the position of a mechanical component.
- Pulse width is the length of time an actuator, such as an injector, remains energized.
- Random access memory (RAM) is a type of memory used to store information and can be written to and read from.
- Read only memory (ROM) is a type of memory used to store information permanently, and it cannot be written over.
- Reference voltage is regulated voltage supplied by the electronic control module to a sensor and is used by a sensor to generate a signal voltage.
- Sensor is a device used to detect and convert a change in a measurement (such as pressure, temperature, or movement) into an electrical signal.
- Signal is a voltage or waveform used to transmit information, usually from a sensor to the electronic control module.
- Solenoid is an electronic device that controls the amount of fuel delivered by the injector.
- Thermistor is a sensor used to determine temperature.
- Threshold value is the value stored in the ROM portion of the ECM, which is used for comparison to a sensor's value.
    Note: If the value is not within the parameters of the threshold value, a service code is recorded.
- Transducer is a device that converts a mechanical signal to an electrical signal and is used to sense pressure.

Fuel Flow Through an Electronic Fuel System
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- Step 1: Fuel is drawn from the tank through a possible primary fuel filter (or strainer) and enters the fuel transfer pump.
- Step 2: Fuel then goes through a possible distribution block, priming pump, secondary fuel filter, cooler plate on the ECM, and to the cylinder head inlet passage.
- Step 3: Fuel is sent to the injectors.
- Step 4: The ECM senses the timing and sends a signal to the injector solenoid to energize it.
- Step 5: The energized solenoid opens the fuel flow through an injector body, which is pushed by a plunger operated by the cam lobe on the engine.
- Step 6: Fuel is pushed down to the injection nozzle and then sprayed into the combustion chamber under very high pressure.
- Step 7: The ECM deenergizes the solenoid, which shuts off the fuel.
- Step 8: The cam lobe rotates allowing the plunger to lift, ready for the next stroke.
- Step 9: Return fuel from the injector is routed back to the fuel tank.

Parts of an Electronic Unit Injector
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- Injector follower
- Injector follower spring
- Injector body
- Plunger
- O-ring
- Fuel outlet opening
- Injector nut
- Check valve
- Injector valve spring
- Needle valve
- Spray tip
- Spring cage
- Check valve cage
- Spacer
- Fuel inlet opening
- Fuel supply chamber
- Poppet control valve

Advantages of Electronic Fuel Injection
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- Improved engine governing, timing, and fuel/air ratios
- Improved engine performance
- Reduced fuel consumption
- Reduced emission levels
- Enhanced cold starting
- Improved diagnosis of engine malfunctions resulting in:
  - Reduced troubleshooting (down) time
  - Reduced labor costs
- Increased flexibility
  - Parameters can be changed electronically, instead of manually.
  - Parameters can be changed so the vehicle can operate at different loads, altitudes, and terrains.
- Improved engine protection
  - The engine can be programmed to shut down before dangerous limits are reached.
  - The system is more tamper resistant with multilevel security.
  - Engine warm-up can be programmed.

Common Types of Electronic Fuel Injection Systems
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- In-line injection pump with an electronic governor
- Distributor-type injection pump with an electronic governor
- Electronic unit injectors
- Hydraulically operated and electronically controlled unit injectors (HEUI)

Basic Categories of Electronic Components
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- Input components include sensors and switches and send electrical signals to the ECM.
- The control component–the electronic control module (ECM)–contains the microcomputer, voltage reference regulator, input conditioners, and output drivers and receives input signals and sends output signals.
- Output components include electronic components that perform work, such as solenoids, and electrical warning devices, and receive electrical signals from the ECM.

Common Electronic Sensor
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- Atmospheric pressure sensor
- Boost pressure sensor (inlet manifold air pressure)
- Coolant level sensor
- Coolant temperature sensor
- Engine speed/timing sensor
- Fuel temperature sensor
- Intake manifold air temperature sensor
- Oil pressure sensor
- Oil temperature
- Synchronous reference
- Throttle position sensor
- Timing reference
- Vehicle speed sensor (rotation of gear teeth in the drive train)

Common Electronic Acronyms
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- CEL: "Check engine" light
- CELECT: Cummins electronically controlled fuel injection system
- DDEC–Detroit: Detroit diesel electronic control
- DDL: Diagnostic data link
- DDR: Diagnostic data reader
- ECAP: Electronic control analyzer and programmer (Caterpillar)
- ECM: Electronic control module
- ECUI: Electronically controlled unit injector
- EDU: Electronic distributor unit
- EEPROM: Electronically erasable programmable read only memory
- EUI: Electronic unit injector
- HEUI: Hydraulically actuated, electronically controlled, unit injectors
- ICM: Ignition control module
- IDM: Ignition driver module (distributor)
- IPR: Injection pressure regulator
- PROM: Programmable read only memory
- SEL: "Stop engine" light

Specialty Tools Used for Electronic Diagnosis
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- Adapter cables, breakout T cables, and probes are used with service tools in order to access the measurements of signals.
- A brass brush for electronic injection nozzle tips are used for cleaning nozzle tips.
- Diagnostic jumper wires are used for jumping terminals when troubleshooting.
- A digital multimeter (or DVOM) is used for checking voltages and resistance.
- An electronic service (scan) tool is a hand-held scanning device used to access diagnostic and programming information in order to locate problems in the electronic system.
- Injector tube installation/removal tools are used to replace defective injector tubes.
- An oscilloscope is used for visually checking the amount of voltage by observing visible wave forms on a fluorescent screen.
- A personal computer (PC) with diagnostic software is used to read diagnostic codes, change parameters, and obtain engine monitoring information.
- A PROM removal tool is used for removing defective memory chips or upgrading memory chips.
- A terminal crimping tool is used for pulling defective terminals.
- A testing harness is typically inserted between two ends of a connector to permit normal circuit operation while measuring voltages.

Basic Types of Diagnostic Codes

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- Cylinder faults
- Injector faults
- Temperature out of normal range
- Pressure out of normal range
- Speeds out of normal range
- Fluid levels below normal
- Voltage above or below normal or shorted
- Current above or below normal, open, or grounded

Electronic Identification Message Codes

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- SAE fault codes are standardized throughout the industry to identify electronic problems.
  - MID–Message identifier
    Note: This identifies the communication device sending the message. For example, MID 128 identifies the diesel engine as the communication device.
  - FMI–Failure mode identifier
  - SID–System (or subsystem) identifier

- PID–Parameter identifier
  Note: The FMI, SID, and PID narrow down the problem area to a specific sensor or other electronic output device. This will tell the service technician where to start.
- Flash codes are non-standardized numbering systems developed by different manufacturers to identify electronic problems. An example is a DDECIII flash code 66 that identifies an engine knock sensor input fault.