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**

**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**

- 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**

- 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**

- 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

- **Input components** include sensors and switches and send electrical signals to the ECM.
- **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

- 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

### Common Electronic Acronyms

- 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
- IDM: Ignition driver module (distributor)
- ICM: Ignition control module
- IPR: Injection pressure regulator
- PROM: Programmable read only memory
- SEL: “Stop engine” light

### Specialty Tools Used for Electronic Diagnosis

- 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 DVM) 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

- 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

- 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

- 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.

- 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.