# Ford Electronic Engine Controls and On-Board Diagnostics II

Brookhaven College

## EEC Systems

- EEC I
  - 1978 - emission and timing control
- EEC II
  - 1979 - feedback carburetor
- EEC III
  - 1980 - central fuel injection
- EEC IV
  - 1983 - port fuel injection
- EEC V
  - 1994 - 3.8L Mustang and 4.6L 2V Cougar/Thunderbird
  - 1995 - Continental, Crown Victoria/Grand Marquis, Ranger and Windstar

## EEC I System

- Inputs
  - BARO
  - ECT
  - CKP
  - EVP
  - IAT
  - MAP
  - TP
- Electronic Control Assembly (ECA) and Calibration Assembly (CA)
- Outputs
  - EGRC
  - EGRV
  - Ignition Timing
  - TAB
- Operating Strategies
  - EGR Control
  - Thermactor Air Control
  - Ignition Timing

## EEC II System

- TWC and closed loop fuel control introduced
- Operating Strategies
  - A/C clutch cycling
  - EGR control
  - Fuel metering (cruise)
  - Idle speed control
  - Ignition timing
  - Secondary air control
  - Canister purge

# EEC II Inputs and Outputs

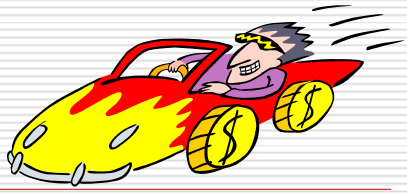
- Inputs
  - ACCS - air conditioning cycling switch
  - B/MAP - barometric/manifold absolute pressure
  - CKP - crankshaft position sensor
  - EVP - EGR valve position sensor
  - ECT - engine coolant sensor
  - EGO - exhaust gas oxygen sensor
  - TP - throttle position sensor
- Outputs
  - CANP - canister purge solenoid
  - EGRC - exhaust gas recirculation control solenoid
  - EGRV - exhaust gas recirculation vent solenoid
  - FBCA - feedback carburetor actuator
  - SPARK - ignition control
  - TAB - thermactor air bypass
  - TAD - thermactor air divert
  - TKS - throttle kicker solenoid
  - WAC - wide open throttle A/C clutch cutout

# EEC III

- Self test capability
  - two minute engine on test checked EGR, AIR and A/F ratio operation/control
  - EEC III tester hooked up similar to BOB and displayed two-digit codes
- Central fuel injection
- Closed loop fuel control at idle
- Fuel pump control and monitor
- Air charge Temperature sensor (ACT - IAT)

# EEC III Strategies

- AC clutch cycling for engine load
- Closed loop fuel control
- Fuel pump control and monitor
- EGR
- Fuel metering
  - feedback carburetor
  - central fuel injection (TBI)
- Idle speed control
- Ignition timing
- Secondary air injection
- Canister Purge



# EEC IV

- Port fuel injection
- TFI IV ignition
- DIS (1989) and EDIS (1990)
- KAM
- Adaptive strategy
- OBD I compliant
  - MIL illuminated for a monitored emission component failure

# OBDII Requirements

- All vehicles must use standardized DLC
- A generic scan tool must be able to access and interpret standardized DTCs
- MIL must inform the driver when any emission component or strategy causes NOx, HC or CO to exceed 1.5 times the applicable emission standard

# OBD II DTCs

- Alpha
  - P - Powertrain
  - B - Body
  - C - Chassis
  - U = Network
- Numeric
  - 0 - OBD II
  - 1 = Manufacturer
- Three Digit
  - 1XX - Fuel/Air mixture
  - 2XX - Ignition misfire
  - 3XX - Auxiliary emissions
  - 4XX - Vehicle speed and idle control
  - 5XX - computer and output circuits
  - 6XX - Computer an output circuits
  - 7XX - Transmission
  - 8XX - Non EEC powertrain codes

## OBDII Drive Cycles

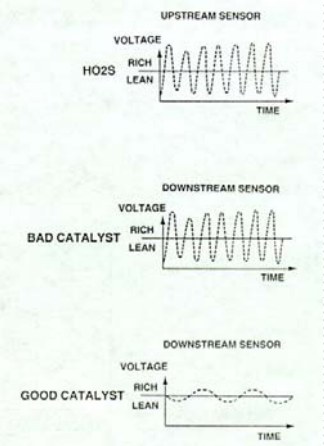
- Warm-up Cycle:
  - after an off cycle the engine temperature increases at least forty degrees Fahrenheit and reaches 160 degrees Fahrenheit
- OBDII Drive Cycle:
  - engine running, following an engine off period, during which the OBDII components are tested and the appropriate system monitors are completed (clears DTC P1000)

## Monitors

- Comprehensive component monitor - continuous
- Misfire monitor - continuous
- Fuel System monitor - continuous
- EGR monitor - a series of idles and accelerations required to complete
- HO2S monitor - 20 seconds at 20 to 45 MPH required to complete
- Secondary air monitor - closed loop idle
- Catalyst efficiency monitor - steady state monitor
- EVAP purge flow and vapor management monitor
- EVAP running loss system monitor

# Catalyst Efficiency Monitor

- The front and rear HO2S switches (rich/lean) are monitored under specified conditions for the purpose of calculating a rear-to-front HO2S switch ratio.
- After the switch ratio is calculated, it is compared against an emission threshold value. If the switch ratio is greater than the emission threshold, the catalyst has failed.
- In general, as catalyst efficiency decreases, the switch ratio increases.

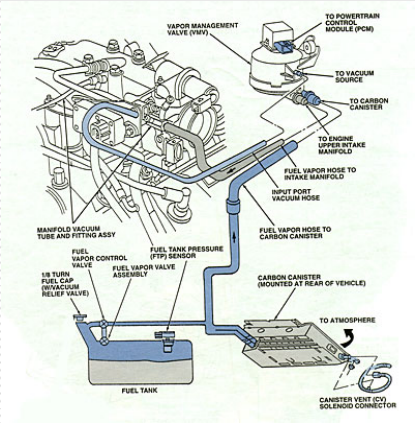



# Comprehensive Component Monitor

- An on-board strategy designed to monitor a failure in any electronic component or circuit that provides input or output signal to the PCM.
- Inputs and outputs are considered inoperative when a failure exists due to an open circuit, out-of-range value, or a failed rationality check.
- Some outputs are also monitored for proper function by observing the reaction of the control system to a given change in the output command. An example of this would be the IAC.
- A DTC is stored in continuous memory when a fault is detected, and the MIL is activated if the fault detected affects emissions. Most of the comprehensive component monitor tests are also performed during on demand self-test.

# OBDII EVAP System

- Monitors EVAP system operation
  - EVAP Purge Flow System Monitor
  - EVAP Vapor Management Flow System Monitor
- Checks the EVAP system for leaks
  - EVAP Running Loss System Monitor




# EVAP Purge Flow System Monitor

- The EVAP purge flow test will initiate when a 75% duty cycle is commanded on the EVAP canister purge valve during engine operation
- Purge Flow (PF) sensor will take a reading while fuel vapor is flowing to the engine
- The EVAP canister purge valve is then commanded closed (from 75% to 0% duty cycle)
- A second reading will be taken by the PF sensor after a calibrated time period of no fuel vapor flow to the engine
- If the difference between the two PF sensor readings taken (flow versus no flow) is not greater than a calibrated threshold, a DTC will be set.

# EVAP Vapor Management Flow System Monitor

- Before the flow test is performed, the PCM will calculate how much fuel vapor is present while purging under engine operation. If the amount of fuel vapor calculated is above a calibrated threshold, the idle speed portion of the EVAP vapor management flow test will be bypassed and the test will pass and complete.
- If the amount of fuel vapor calculated is below a calibrated threshold, the idle speed portion of the EVAP vapor management flow test must be executed to verify that the EVAP canister purge valve is functioning properly.
- The flow test will calculate the increase in the idle air requested by the PCM when the duty cycle on the EVAP canister purge valve is reduced from 75% to 0%.
- If the calculated increase in air flow exceeds a calibrated threshold, the PCM assumes the EVAP canister purge valve is functioning properly. If the calculated increase in air flow is negligible, the EVAP canister purge valve is not functioning properly and a DTC will be set.

# EVAP Running Loss System Monitor

- The canister vent (CV) solenoid is closed and the EVAP canister purge valve is operated at a minimum duty cycle of 75%. The fuel tank pressure (FTP) sensor monitors system pressure
- If the target vacuum cannot be reached, a DTC will be set and the test will not be performed.
- After the target vacuum is reached, the purge valve is closed and the FTP monitors the EVAP system vacuum over time.
- If the allowable leakage is exceeded after three tests, a vapor generation check must be performed.

## EVAP Running Loss System Monitor (cont.)

- A vapor generation test is performed by closing the EVAP canister purge valve and opening the CV solenoid until atmospheric pressure is reached. The CV solenoid is then closed to seal the EVAP system.
- Fuel tank pressure build-up is monitored over a period of time to check for pressure build-up due to vapor generation. If the pressure build-up exceeds a specific value, the leak test results are invalid due to vapor generation and the system passes.
- If the fuel tank pressure build-up does not exceed the threshold, the leak test results are valid and a DTC will be set.

## EGR System Monitor

- The differential pressure feedback EGR (DPFE) sensor and circuit are continuously tested for opens and shorts.
- The EGR vacuum regulator solenoid is continuously tested for opens and shorts.
- The test for a stuck open EGR valve or EGR flow at idle is continuously performed whenever at idle. The monitor compares the DPFE circuit voltage at idle to the DPFE circuit voltage stored during KOEO.
- The DPFE sensor upstream hose is tested once per drive cycle for disconnect and plugging. The PCM will momentarily command the EGR valve closed during acceleration. The monitor looks for the DPFE sensor voltage to be inconsistent for a no flow voltage.
- The EGR flow rate test is performed when engine speed and load are moderate and EGR vacuum regulator duty cycle is high. The monitor compares the actual DPFE circuit voltage to a desired EGR flow voltage.

# Fuel System Monitor

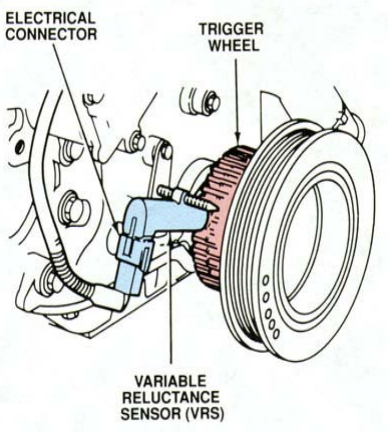
- The HO2S detects the presence of oxygen in the exhaust and provides the PCM with feedback indicating air/fuel ratio.
- A correction factor is added to the fuel injector pulse-width calculation according to the Long and Short Term Fuel Trims as needed to compensate for variations in the fuel system.
- When the compensation exceeds a calibrated limit and the fuel trim table has clipped, the Fuel System Monitor sets a DTC.

# HO2S Monitor

- A fixed frequency closed loop fuel control routine is executed and the upstream HO2S voltage amplitude and output response frequency are observed.
- A HO2S heater circuit fault is determined by turning the heater on and off and looking for a corresponding change in the Output State Monitor and by measuring the current going through the heater circuit.

# Misfire Monitor

- The CKP input signal is used to monitor crankshaft rotational velocity and acceleration. By comparing the accelerations of each power stroke, the power loss of each cylinder is determined.
- When the power loss of a particular cylinder is sufficiently less than a calibrated value the suspect cylinder is determined to have misfired.
- The Misfire Detection Monitor is also performed during on demand self-test.




# Misfire Types

- The PIP signal is monitored and misfire rates are evaluated over 200 and 1000 revolution periods.
- **Type A** - a fault occurs if the misfire rate exceed 2% to 20% during a 200 revolution period.
  - The misfire could cause catalyst temperatures to exceed 1600 degrees Fahrenheit.
  - The MIL will blink once per second during the actual misfire, and a DTC will be stored.
  - Fuel may be turned off to up to two affected cylinders at a time to prevent catalyst damage.
- **Type B/C** - a fault occurs if the misfire rate exceed 2% to 4% during a 1000 revolution period.
  - Vehicle emissions will exceed limits.
  - The MIL will illuminate and a DTC will be stored.

# Secondary Air Monitor

- A functional air flow test is performed during idle, once per engine start-up, after all HO2S Monitor tests have been successfully performed.
- Fuel control commands the air/fuel ratio rich.
- The secondary air pump is commanded on.
- The HO2S voltage should indicate a lean condition.