Fuel Supply & ME-SFI Engine Management Electronic Controls (Part 8)
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ME Tasks

• Control individual injector opening time

• Mixture control
  • start, post-start, warm up
  • acceleration enrichment
  • decel shutoff

• Injector shutoff
  • inertia fuel shutoff
  • ignition faults

• Synchronizing injectors
Power Supply

K40/7 - Fuse & relay module
(215, 220) (Right SAM)

N16/1 - Base module
(129, 140)

F1 - Fuse & relay module
(163)

N10/1 - LF SAM
(203)

K40/4 - Fuse & relay module
(202, 208, 210 3/97)

K40 - Relay module
(170, 210 → 2/97)
ME-SFI Functions

- Fuel management
- Ignition control
- Electronic Accelerator /Cruise Control
- On Board Diagnosis
- Drive Authorization System
- Tip start
- Engine cooling fan
Fuel Management

Inputs:

• Coolant temperature sensor (B11)

• Intake air temperature sensor (B17 or IAT)

• Crankshaft position sensor (L5 or CKP)

• Camshaft position sensor (B6/… or CMP)

• Hot film mass air flow sensor (B2/… or MAF)

• Oxygen sensor (G3/… or O2S)
Coolant Temperature Sensor

B11/…

**Negative Temperature Coefficient**

Resistance decreases as the temperature rises.
NTC Sensors

20°C = 3.4V (3090 Ω)
30°C = 2.9V (2000 Ω)
40°C = 2.4V (1330 Ω)
60°C = 1.9V (900 Ω)
70°C = 1.5V (630 Ω)
80°C = 1.2V (440 Ω)
90°C = 0.9V (320 Ω)
100°C = 0.5V (170 Ω)
PO115

ME continuously checks the signal for limit values, if:

- $> 80 \, \text{k}\Omega$ (approx. $-39^\circ\text{C}$)
- $< 45 \, \Omega$ (approx. $+170^\circ\text{C}$)
- or the temperature change after start is not plausible

Then after two consecutive driving-cycles:

NOTE: IF a fault is present, a substitute value is used to operate the vehicle.
Intake Air Temperature Sensor

B17
Also a NTC type of sensor. Primarily affects ignition timing.

as of 1997
Crankshaft Position Sensor

CKP (L5)
Inductive sensor
Used to determine crankshaft position and speed.
CKP Pattern

Missing teeth used for crankshaft position recognition and irregular running.
Flywheel Adaptation

Flywheel needs to be adapted if:
• Replacing flywheel.
• Replacing ME-SFI control unit.
• Replacing flywheel sensor.
• Replacing engine.
• Disconnecting battery.
• Replacement of motor mounts
Adaptation

There are 6 RPM speed ranges, N1 to N6 and 3 load ranges L1 to L3.
Load range L2 and speed range 1 must be adapted first then ME-SFI will adapt the other segments automatically.
If the misfire occurred at L2 and speed range 2 be sure that Fly-Wheel is adapted to that point before returning vehicle to owner.
PO335

ME continuously checks the signal if:

- (60 - 2 teeth) - 1 tooth
- (60 - 2 teeth) +1 tooth
- for more then 5 seconds

Then after two consecutive driving-cycles:
Camshaft Position Sensor

CMP (B6)
Hall effect sensor
Used for recognition of cylinder # 1 compression stroke

Note: 5v on 112,113 engines
CMP Signal → 2001
111 & 137 Engines
Synchronizing

Cylinder 1 recognition

111, 137
PO341

ME continuously checks the signal if:

• No signal within 2 engine revolutions
  or
• More then 1 signal per engine revolution

Then after two consecutive driving-cycles:
Mass Air Flow Sensor
Air Mass Calculation

RL measures incoming air temperature.
RH is heated to 160°C above intake air.
RS monitors temperature of RH.

The voltage changes to RH are used to measure the air mass and calculate the fuel needs.
PO100

ME continuously checks the signal from B2/5 for limit values, if:

- Lower limit - Min. 16 kg/h, if throttle angle > 14°
- Upper limit - ~ 50-900 kg/h, rpm compared to throttle angle
- more then 5 seconds

Then after two consecutive driving-cycles:

NOTE: Will substitute values if fault is recognized.
O2 Sensor

Purpose:
To detect oxygen in the exhaust

1. Wiring to ME
2. Vented sensor housing
3. Protective tube

The number of sensors on a vehicle will vary with application.
O2 Sensor

4. Ceramic “thimble”
5. Inner electrode
6. Outer electrode
7. Ambient air
8. Heating element
   (Heating controlled by ME)
Planar Style O2 Sensor
(Starting 2001)

New construction technique, functions are the same as old style.

Heating function requires less amperage.

Not interchangeable.
O2 Sensor Function

Cold start:
- Rich mixture (no oxygen)
- Sensor inoperative

N3/…

Signal wires from ME

450mv (from ME)

Exhaust from engine
O2 Sensor Function

Operating temperature:
- Rich mixture (no O\(_2\))
- Large O\(_2\) difference
- High voltage output (~1v)
- ME drives mixture Lean

Exhaust from engine

Signal wires from ME

~1v
O2 Sensor Function

Operating temperature:
- Lean mixture (Lots of O₂)
- Small O₂ difference
- Low voltage output (~0v)
- ME drives mixture Rich

Signal wires from ME

~0mv

Exhaust from engine
Closed Loop

1 V

450mV

0 V
PO130, 136, 150, 156
(Code number indicates which sensor)

ME continuously checks the limit values and status, if:
• < -0.15V
• > 1.5V
• ~5 seconds
or
• With heater on, signal does not remain in range for 15 seconds
Then after two consecutive driving-cycles:
PO135, 141, 155, 161
(Code number indicates which sensor)

O2 Heater test (Calculated resistance of element)
ME continuously checks the signal for limit values, if:

• < 2.0 Ω (~6A at 12 V)
• > 10 Ω (~ 1.2A at 12V)

Then after two consecutive driving-cycles:
Fuel Adaptation

ME calculates from many sensor inputs the correct injection duration, one of the inputs is the MAF sensor.

Under normal conditions all the air entering the engine is measured by the MAF sensor.

For example:

20 kg/h

3.0 ms

3.8 BAR

Rich
Lean

ME
Fuel Adaptation (No Problem)

02 Sensor

0 Volt ← Lean ← Rich → 1.0 Volt

0.45 Volt

Lambda

0.750 ← Fuel % ← 1 ← + Fuel % ← 1.250

Mixture oscillates Rich/Lean around a Lambda value of “1”
Fuel Adaptation

In this example the intake system has a vacuum leak. The air entering the engine via the MAF sensor has reduced, but the engine is still getting the same volume of air.

The O2 sensor now measures more oxygen in the exhaust and ME responds by driving the mixture rich. This will **increase** the injection duration from a known “mapping” in the ME. This change will be stored as a correction value.
Fuel Adaptation (Vacuum Leak Before the Throttle)

**02 Sensor**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Fuel %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Volt</td>
<td>Lean</td>
</tr>
<tr>
<td>0.45 Volt</td>
<td></td>
</tr>
<tr>
<td>1.0 Volt</td>
<td>Rich</td>
</tr>
</tbody>
</table>

**Lambda**

-0.750  - Fuel %

1.250  + Fuel %

**Adaptation @ Idle**

-1.0  - Fuel %

0  + Fuel %

+1.0

ME will adapt by adding time to the injector opening base setting.
ME will adapt by multiplying the base setting of the injector opening time by a correction factor.
In this example the fuel pressure is too high (e.g. defective fuel pressure regulator).

The O2 sensor now measures less oxygen in the exhaust and ME responds by driving the mixture lean. This will **decrease** the injection **duration** from a known “mapping” in the ME. This change will be stored as a correction value.
Fuel Adaptation (High Fuel Pressure)

02 Sensor

0 Volt ← Lean → 1.0 Volt

0.45 Volt

Lambda

0.750 ← Fuel % → 1 + Fuel % → 1.250

Adaptation @ Idle

-1.0 ← Fuel % → 0 + Fuel % → +1.0

Adaptation @ P / T

0.680 ← Fuel % → 1 + Fuel % → 1.320
ME continuously checks the signal for limit values, if:

A. Limit value at idle ~± 1.0ms (~25% of injection time)
B. Limit value at part load  0.7 to 1.3 factor

Then after two consecutive driving-cycles:
ME Notes

• ME must be version coded when being replaced. Coding can be performed by;
  1. Downloading the information from old unit.
  2. Entering data manually.

• When battery is disconnected, the following must be adapted:
  • Throttle position
  • Flywheel
  • Mixture
Quick Quiz!

Q. If the engine has a vacuum leak, ME will do what to the mixture?
A. ________________________________

Q. If the air filter is restricted, ME will do what to the mixture?
A. ________________________________

Q. If the spark plugs in one cylinder are fouled (no ignition occurs), ME will do what to the mixture?
A. ________________________________
Acronyms

CKP - Crankshaft Position Sensor
CMP - Camshaft Position Sensor
IAT - Intake Air Temperature Sensor
MAF - Mass Air Flow Sensor
MAP - Manifold Absolute Pressure
NTC - Negative Temperature Coefficient
TDC - Top Dead Center