AJ26 / AJ27
ENGINE MANAGEMENT SYSTEMS

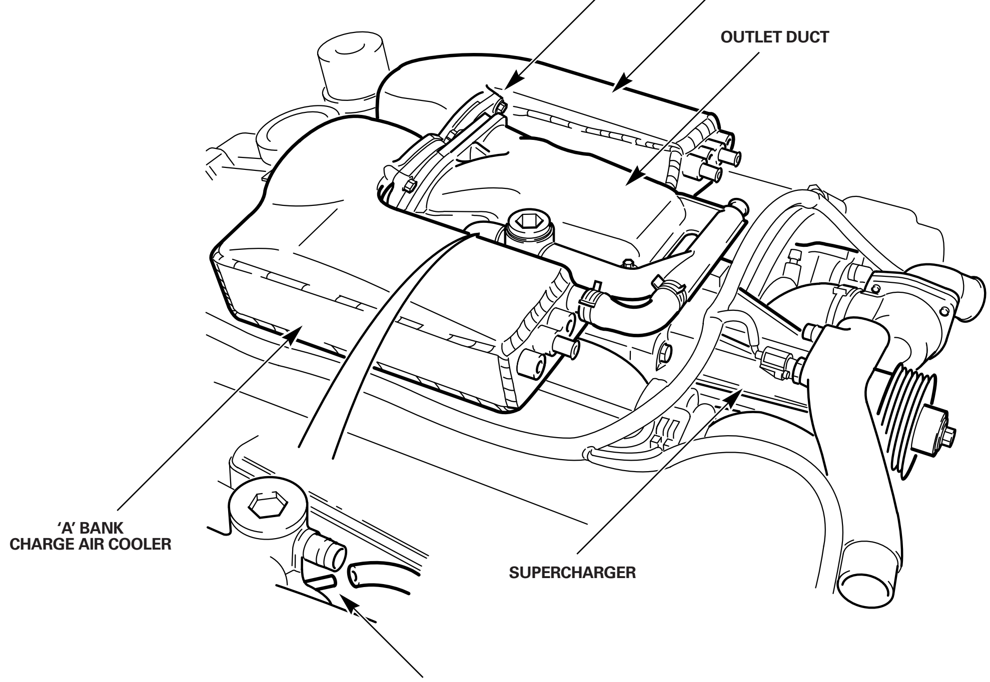
Service Training Course 881
DATE OF ISSUE: 9/2001

AJ26 / AJ27 SUPERCHARGED EMS

AJ V8 Supercharged Engine

The AJ V8 supercharged (SC) engine is essentially mechanically identical to the normally aspirated engine with the exception of the pistons, the cylinder head gaskets and the repositioning of components to allow installation of the supercharger system. The normally aspirated intake manifold and induction elbow are replaced with unique supercharged components.

SUPERCHARGER INSTALLATION

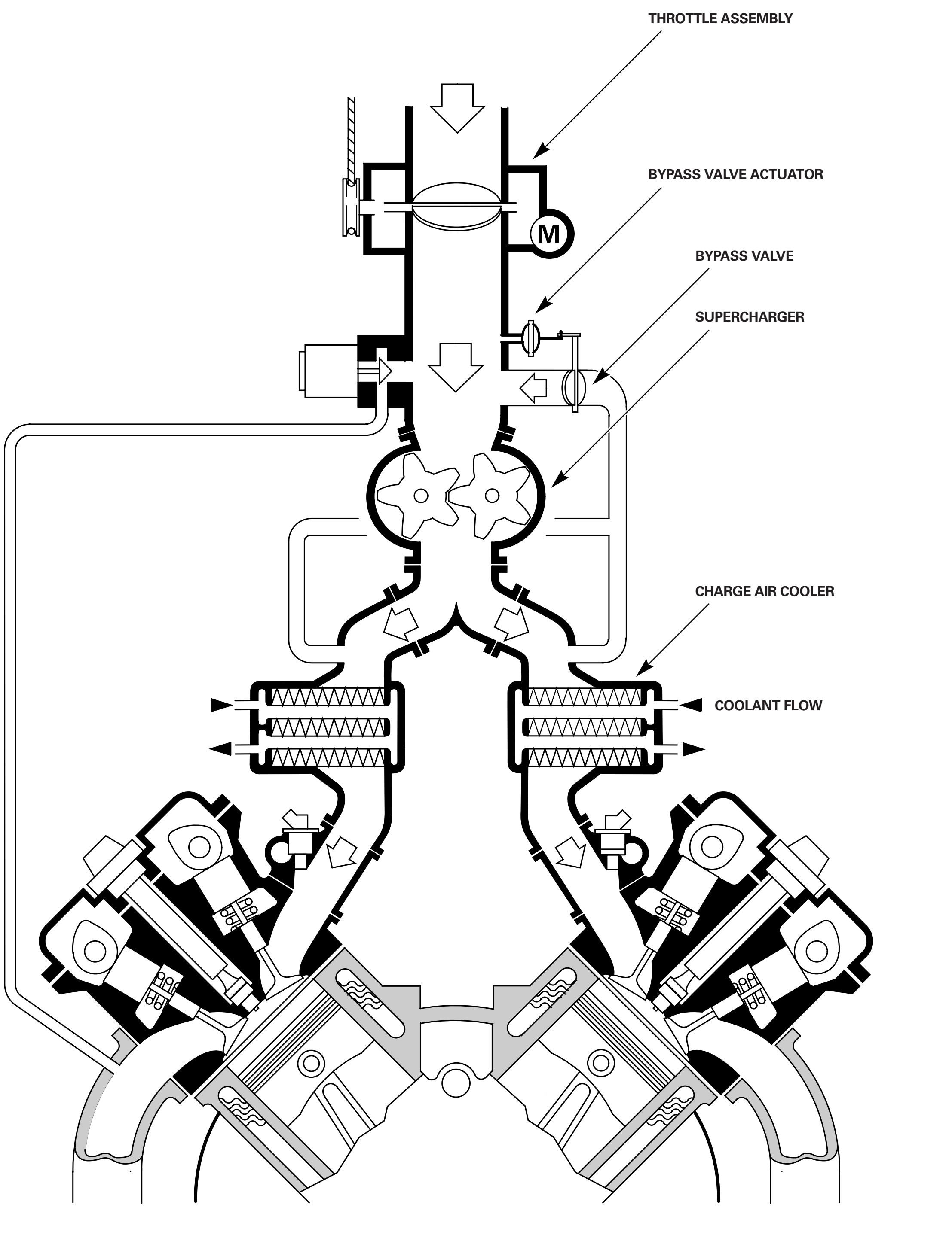


The supercharger is an Eaton M112 "Roots Type" unit mounted in the engine vee, driven by a separate poly v-belt from the crankshaft. Supercharger lubrication is "filled for life". If servicing of the lubricant is required, the supercharger must be removed from the engine. The maximum boost pressure is 0.8 bar (11.6 psi).

Intake air flows through a revised mass air flow sensor (MAFS), through the intake duct, the electronic throttle assembly and the induction elbow to the supercharger. The AJ26 SC throttle assembly is unchanged from the normally aspirated system with EGR. The AJ27 SC throttle deletes AAI and adds EGR. A bypass valve attaches to the induction elbow. From the supercharger, compressed intake air flows through the outlet duct to the individual A and B bank air-to-liquid charge air coolers, then through the A and B bank charge air cooler adapters to the cylinder heads.

NOTES

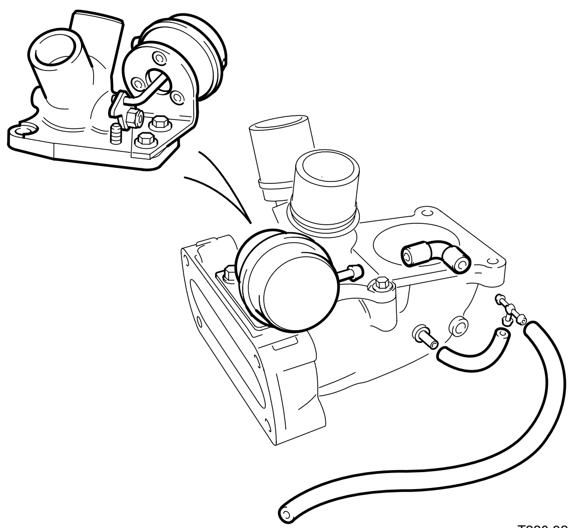
SUPERCHARGED INTAKE SYSTEM



AJ26 / AJ27 SUPERCHARGED EMS

Supercharger Mechanical Components

BYPASS VALVE AND ACTUATOR – AJ26



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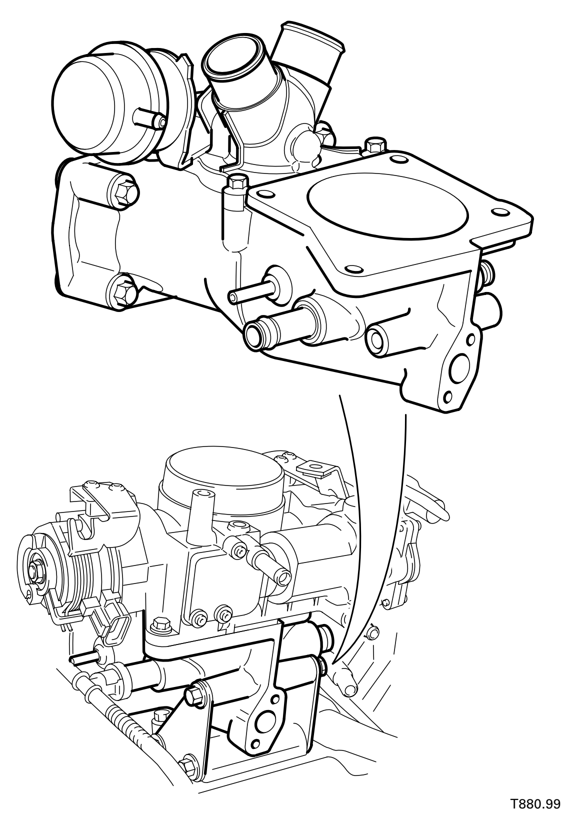
THROTTLE INDUCTION ELBOW – AJ27



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Bypass Valve and Actuator

The “butterfly” bypass valve is contained in a housing attached to the induction elbow. The valve is operated by a vacuum actuator. The valve controls bypass air flow from the charge air coolers to the induction elbow in order to regulate supercharger “boost pressure”. The valve is held closed by spring pressure.

With closed (idle) or partially open (cruise) throttle, intake vacuum (between the induction elbow and the supercharger) acts on the actuator diaphragm to hold the valve full open to provide maximum supercharger bypass and optimum fuel economy. As the throttle is opened, intake vacuum falls progressively and spring force moves the valve toward closed until the valve is fully closed at full throttle, providing maximum supercharger boost and power.

Outlet Duct

The supercharger outlet duct directs the charge air from the supercharger to the two charge air coolers. The fill point and connections for the charge air cooler coolant circuit are integrated into the outlet duct. Vacuum source is provided for the fuel pressure regulator and for cruise control. Rubber ducts secured by clamp plates connect the outlet duct to the two charge air coolers.

NOTES

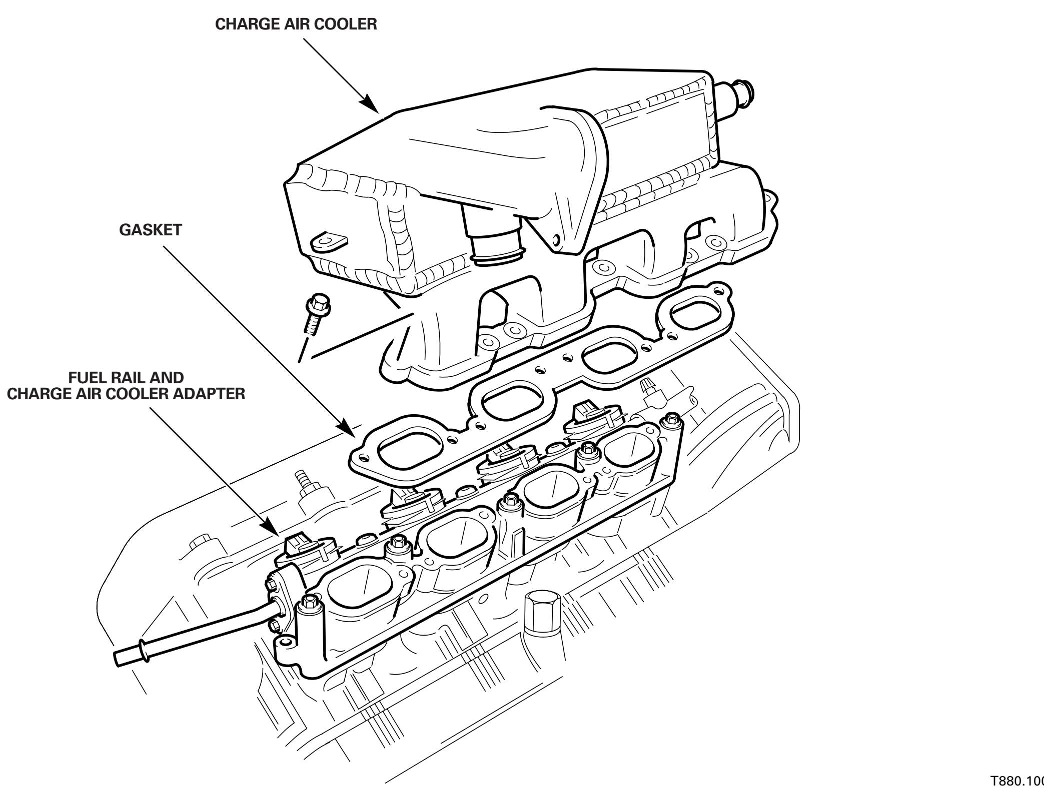
Charge Air Coolers

Each cylinder bank has a separate charge air cooler assembly. The charge air coolers are fabricated fin and tube air-to-liquid heat exchangers with individual "risers" to supply charge air to each cylinder. The charge air coolers cool the charge air leaving the supercharger to increase the mass of the air entering the engine. Coolant flow is provided by a separate cooling system with an electric pump under ECM control.

Charge air cooler adapters / fuel rails

The charge air cooler adapters provide the interface between the charge air coolers and the cylinder heads, and incorporate the fuel rails and fuel injector mountings. A crossover pipe connects the fuel rails.

SUPERCHARGER CHARGE AIR COOLER, ADAPTER AND FUEL RAIL



Fuel Injectors

The fuel injectors are high flow units designed for the supercharged engine. They are secured in the fuel rails by spring clips.

NOTES

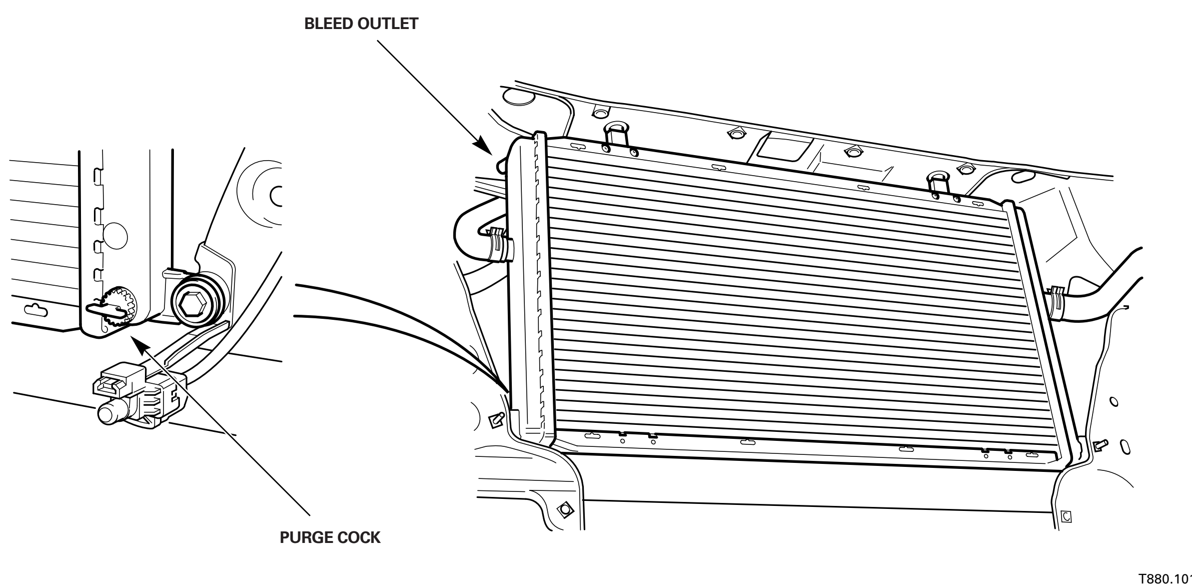
AJ26 / AJ27 SUPERCHARGED EMS

Supercharger Mechanical Components (continued)

Charge Air Cooler Radiator and Pump

The charge air cooler radiator is mounted ahead of the engine radiator and incorporates a bleed outlet and a purge cock.

CHARGE AIR COOLER RADIATOR



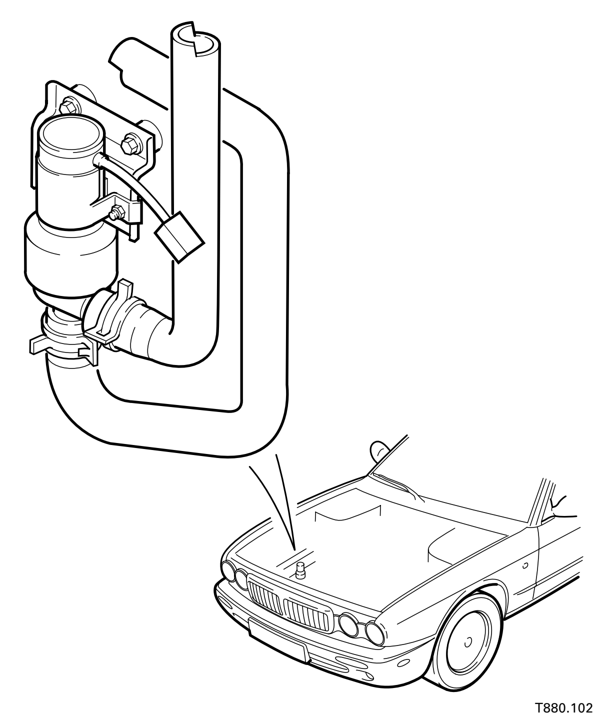
NOTES

Charge Air Cooler Coolant Pump

The charge air cooler coolant pump is activated via a relay under ECM control. During normal conditions, the ECM operates the pump continuously with the ignition switched ON.

NOTES

CHARGE AIR COOLER AND PUMP



AJ26 / AJ27 SUPERCHARGED EMS

The supercharged Engine Management System is essentially identical to the normally aspirated system with software revisions to accommodate the operating characteristics of the supercharged engine. Additional functions for operating two fuel pumps, the charge air cooler coolant pump, and EGR are included. Variable valve timing and air assisted fuel injection (AJ27) are deleted.

Components / Functions deleted for Supercharged Engine Management:

- Variable valve timing
- Air assisted fuel injection (AJ27)

Components / Functions added for Supercharged Engine Management

- Two fuel pumps
- Charge air cooler coolant pump
- Exhaust gas recirculation
- Second intake air temperature sensor (charge air temperature sensor)

Supercharged EMS Components

Fuel Pumps

Two fuel pumps are used to provide adequate fuel flow during high engine loads. Both pumps are operated by the ECM via relays. Operation of fuel pump 1 is identical to the normally aspirated single fuel pump. Diagnostic monitoring for the N/A single fuel pump remains unchanged. The other warnings and default action differs for the SC pump 1. Fuel pump 2 is switched by the ECM as determined by engine operating conditions. Refer to page 6.5 for fuel pump details.

NOTES

Intake Air Temperature Sensor 2 (IATS 2)

A separate intake air temperature sensor (IATS 2), located on the A bank charge air cooler outlet, provides the ECM with a “charge air” temperature signal.

As with previous air temperature sensors, the IATS 2 is a negative temperature coefficient (NTC) thermistor. Charge air temperature is determined by the ECM by a change in sensor resistance. The ECM applies 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.

The IATS located within the MAFS remains active in the system and is used for diagnostic purposes.

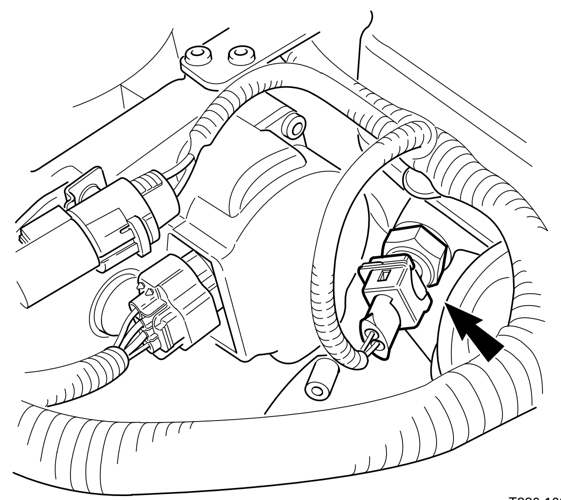
IATS air temperature / resistance / voltage

Temperature °C	Temperature °F	Resistance	Voltage
- 40	- 40	53.1kΩ	4.75
- 30	- 22	28.6kΩ	4.57
- 20	- 4	16.2kΩ	4.29
-10	14	9.6kΩ	3.90
0	32	5.9kΩ	3.43
10	50	3.7kΩ	2.89
20	68	2.4kΩ	2.38
30	86	1.7kΩ	1.93
40	104	1.1kΩ	1.45
50	122	810Ω	1.15
60	140	580Ω	0.88
70	158	430Ω	0.69
80	176	320Ω	0.53
90	194	240Ω	0.41
100	212	190Ω	0.33
110	230	150Ω	0.26
120	248	120Ω	0.21

Engine Coolant Temperature Sensor (ECTS)

On supercharged engines, the ECTS is relocated to accommodate the supercharger installation.

CHARGE AIR COOLER IATS 2



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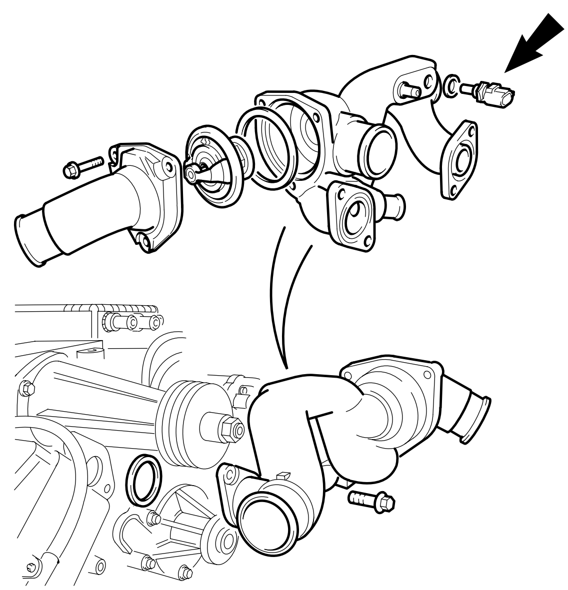
ECTS – AJ V8 SUPERCHARGED



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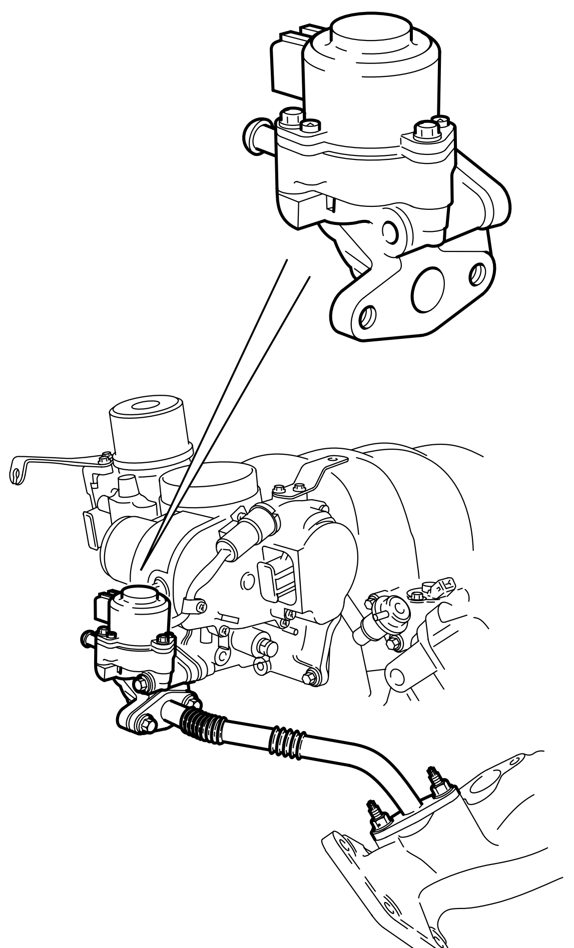
AJ26 / AJ27 SUPERCHARGED EMS

Exhaust Gas Recirculation – AJ26

EGR VALVE – AJ26



The AJ26 SC EMS uses the same EGR system as early production naturally aspirated engines.

Exhaust gas recirculation lowers combustion temperature, which in turn reduces NOx exhaust emission. EGR is controlled by the ECM from a map that factors engine operating conditions such as engine load and speed, throttle position, and coolant temperature.

The EGR valve is mounted directly to the intake air induction elbow and connects to the A bank exhaust manifold by a transfer pipe. The EGR valve contains a four-pole stepper motor (60 step), which is driven by the ECM. Engine coolant returning from the throttle assembly is channeled through the valve to provide cooling.

NOTES

Exhaust Gas Recirculation – AJ27

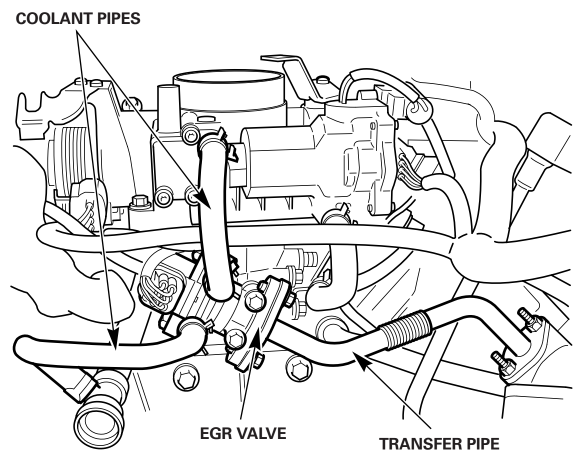
The AJ27 SC EGR system provides increased exhaust gas flow over the AJ26 SC system. ECM control is enhanced by an EGR flow monitoring feedback signal.

Manifold Absolute Pressure Sensor (MAPS)

AJ27 EGR systems include a MAP sensor, which enables the ECM to monitor EGR gas flow into the intake manifold. When the EGR valve opens to allow exhaust gas flow into the throttle elbow, the intake manifold absolute pressure will drop directly proportional to the amount the valve is open. The ECM applies 5 volts to the MAP sensor, which produces a linear output voltage signal to the ECM.

NOTES

EGR VALVE – AJ27



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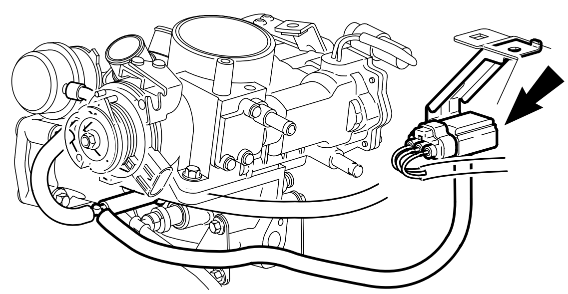
MAP SENSOR – AJ27



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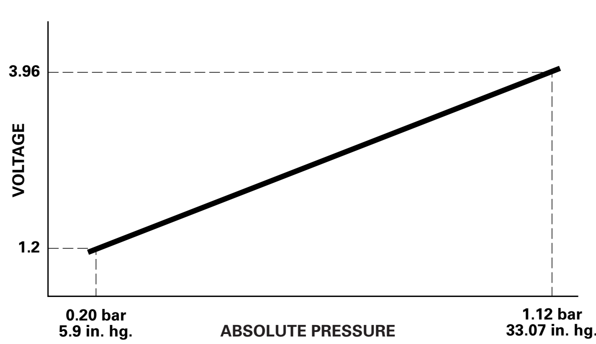
MAP SENSOR CHARACTERISTIC – AJ27



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AJ26 / AJ27 ENGINE MANAGEMENT SYSTEMS

AJ26/27 V8

JAGUAR

Service Training Course 881
DATE OF ISSUE: 9/2001

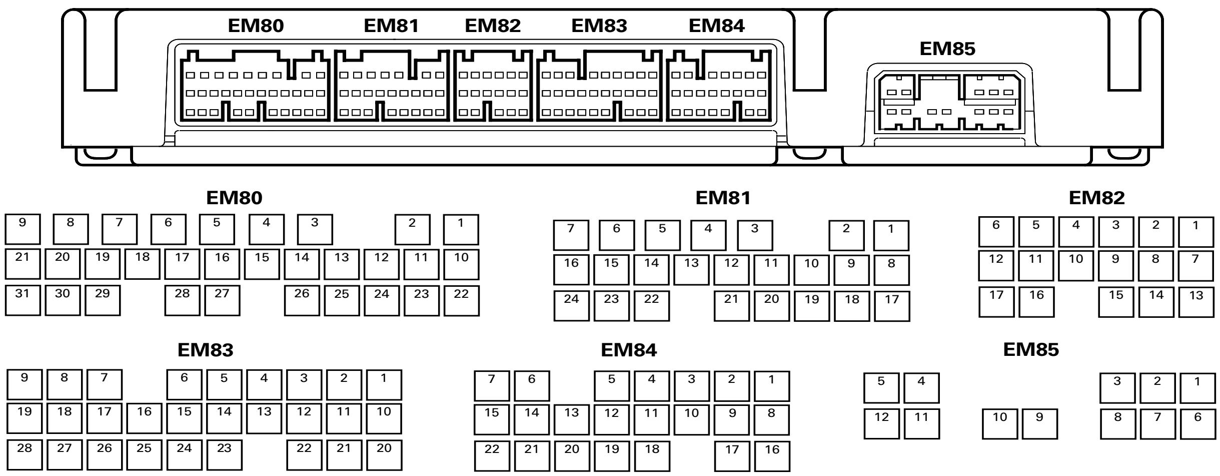
AJ27 - VVT System

Name:____________________ **Date:**__________ **Vehicle/VIN**________________

Perform procedure with parking brake on & exhaust extraction hoses connected.

1. Reference the correct Electrical Guide, identify and mark the pin numbers and wire colors for each VVT circuit per cylinder bank.

Bank B= ____________________________ Bank A = ____________________________



2. Using a DVOM capable of measuring frequency, set the meter to DC volts - Hz.

3. Back probe the red lead of the meter to one VVT control circuit at the ECM.

4. With the **key on engine off**, check and record the signal frequency: _______________.
   Is it a fixed frequency?: Yes [ ] No [ ]

5. Start engine and allow to idle. Switch the DVOM to duty cycle, what is the value?:________

6. Increase the engine speed to 2500 RPM. What is the value?: ____________

7. Switch the engine off, measure the resistance (Ω) of each solenoid: ______________

"continued"

AJ27 - VVT System (Page 2)

8. Reference the correct DTC Summary Guide. List the DTCs that identify VVT system malfunction.

9. When the identified DTCs are stored, what is the default action of the ECM for each DTC.

10. List the possible malfunctions associated with each DTC.

Instructor Check: ______________________________

AJ27 SC - Fuel Pressure Testing & SC Boost Demo

Name:____________________ **Date:**__________ **Vehicle/VIN**________________

Perform procedure with parking brake on & exhaust extraction hoses connected.

Tools needed: Fuel pressure gauge and Vacuum gauge

1. Depressurize Fuel Rail. Install a fuel pressure gauge to the fuel rail and check for leaks. Install a vacuum gauge with T fitting to the vacuum supply at the fuel pressure regulator.
2. Key on. What is the displayed fuel pressure: _____________bar (psi)
3. Start engine and idle. What is the displayed fuel pressure: ______________bar (psi).
4. Quickly step on the accelerator pedal and release.

- What is the max fuel pressure: ______bar (psi).
- What is the vacuum gauge positive pressure reading: ______________
- What causes the pressure increases:

____

____

____

____

5. With the engine running, disconnect the vacuum hose from fuel pressure regulator, What is the pressure value: ___________bar (psi)
6. Switch the ignition off. Observe the pressure gauge reading and describe what happens to the pressure value after 1 minute. _____________. Is this normal, [ ] Yes, [ ] No.

Instructor Check: ____________________

AJ27 - Air Assist Close Valve

Name:____________________ **Date:**__________ **Vehicle/VIN**________________

Perform procedure with parking brake on & exhaust extraction hoses connected.

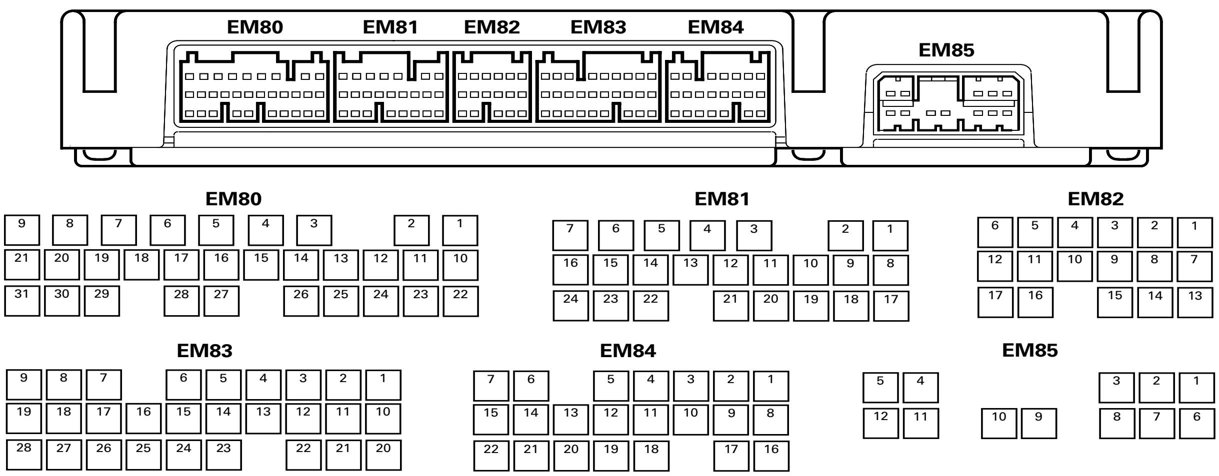
1. Locate and identify the AAIC valve on the engine. What is it's functional purpose:

   ____

   ____

2. Reference the correct Electrical Guide, identify and mark the pin numbers and wire colors for the AAIC valve.

   Power = ______________ Ground = _______________ Control = ______________



3. Using a DVOM capable of measuring frequency, set the meter to DC volts - Hz.

4. Connect the meter to the AAIC control circuit pin and to ground at the ECM.

5. With the **key on engine off,** check and record the signal frequency: ________________.
   Is it a fixed frequency: Yes [ ] No [ ]

6. **(Simulated Cold Engine)** Start the engine and monitor the engine temperature. Check and record the monitored frequency of the AAIC control signal ____________Hz.
   Is it a fixed frequency: Yes [ ] No [ ]

7. Start engine and allow to idle. What is the displayed duty cycle? _____________________

8. Increase the engine speed to 2500 RPM. What is the displayed duty cycle? ___________

9. Measure the voltage at the control circuit pin: _________________

"Continued on Back"

AJ27 - Air Assist Close Valve (Page 2)

10. **(Simulate Warm Engine)** Check and record the monitored frequency of the AAIC control signal ___________Hz. Is it a fixed frequency: Yes [ ] No [ ]

11. Increase the engine speed to 2500 RPM. What is the displayed duty cycle________

12. Measure the voltage at the control circuit pin: ________________________________

13. Switch engine off. What is the resistance value of the AAI _________

14 Reference the correct DTC Summary Guide. List the DTCs that identify AAI system malfunction.

____

____

____

____

15. When the identified DTCs are stored, what is the default action of the ECM for each DTC.

____

____

____

____

16. List the possible malfunctions associated with each DTC.

____

____

____

____

Instructor Check: ______________________________

AJ27 - DTC Summaries

Name:_____________________ **Date:**__________ **Vehicle/VIN**________________

1. What does P1000 and P1111 identify. ______________________________________

____

2. What is system readiness. ____.

3. How can system readiness information help you diagnose a vehicle that has an emission related DTC stored in memory.

____

____

4. Elaborate on DTC P1250.

- Is it an OBD II Fault: Yes [ ] No [ ]
- Will the Check Engine Light illuminate when this fault is stored: Yes [ ] No [ ]
- Does the ECM require two trips with the fault present to store this DTC: Yes [ ] No [ ]
- Will any messages be displayed in the Instrument Cluster with this DTC: Yes [ ] No [ ]
- If "Yes" please list the messages. ______________________________________

____

5. Referring to the correct Wiring Guide, list the pin numbers and wire colors for the following components/signals:

- CCV:____
- FTPS:____
- MAFS:____
- EOT:____
- ECT:____
- CKPS:____
- CMPS:____

Instructor Check:____

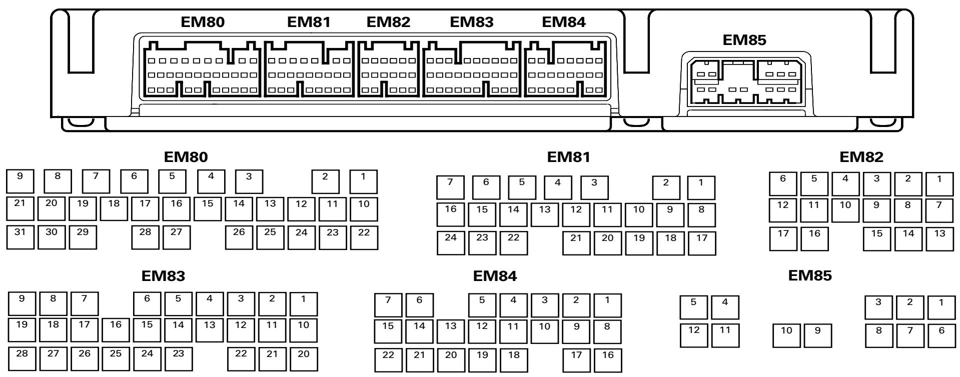
AJ27 - Component Monitoring

Name:______________________ Date:___________ Vehicle/VIN_________________

Perform procedure with parking brake on & exhaust extraction hoses connected.

1. Using the correct Wiring Guide, identify the component acronyms, their pin numbers and wire colors at the ECM for the components listed in the table below.

2. Use connector illustration to help locate the pins at the ECM when measuring signal.



3. Make sure meter is in appropriate setting (DC or AC). Using an approved probe adapter, back probe the correct pin to monitor the signal on the DVOM. Record the displayed values at the given engine speeds and note the signal voltage type (DC or AC).

Table 1:

Component	Reading @ Idle	Reading @ 2000 RPM	Reading @ 3000 RPM
MAFS =			
CMPS (A) =			
CMPS (B) =			
ECTS =			
EOTS =			
IATS =			
PPS1 =			
PPS2 =			
TPS1 =			
TPS2 =			

Instructor Check: ______________________

Evaporative System Leak Testing

Name:____________________ **Date:**__________ **Vehicle/VIN**________________

Refer to TSB 05.1.29 This bulletin was issued for the 1996/97 MY Sedan vehicles. The procedure is valid for all Jaguar vehicles including current production.

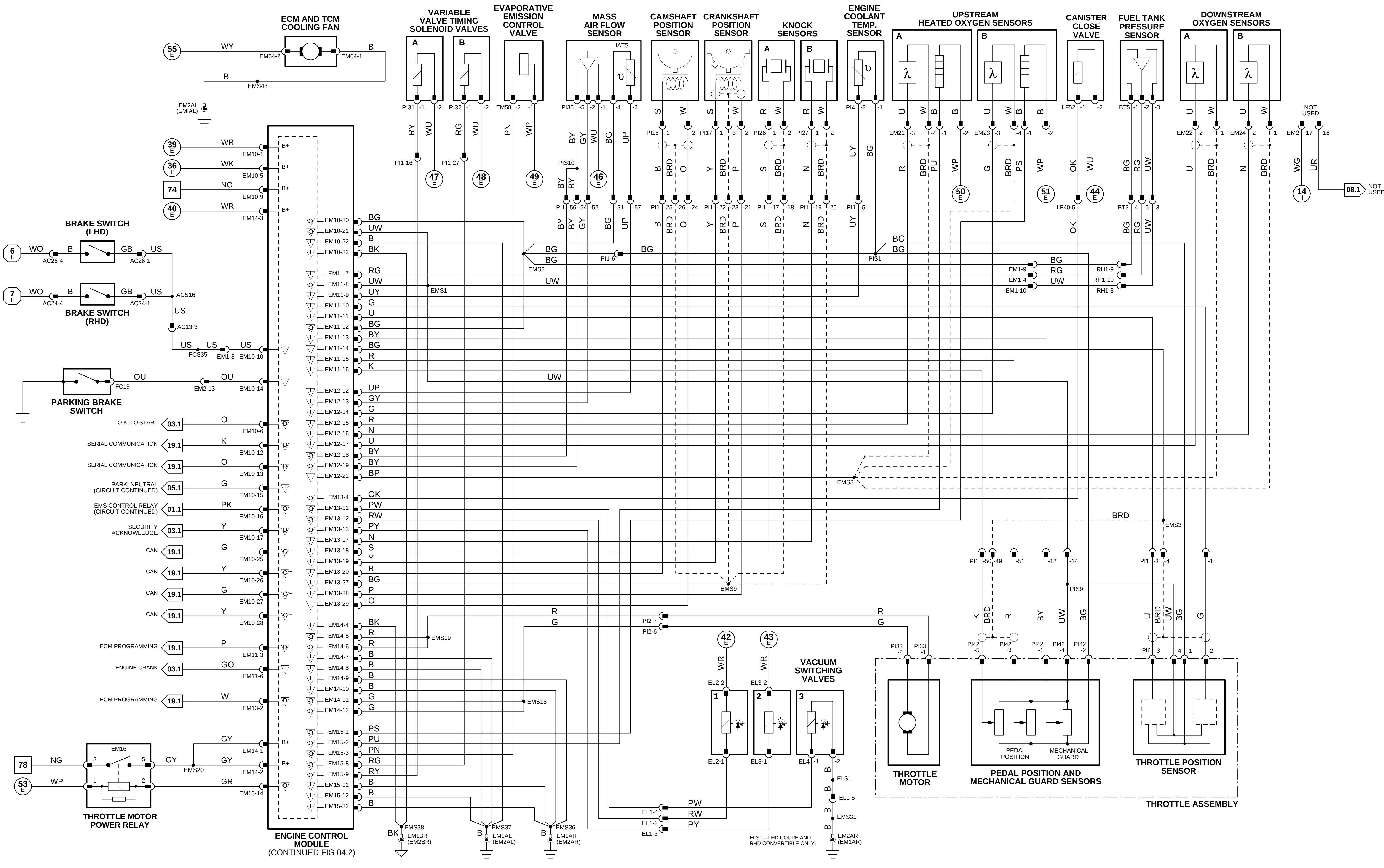
Note: The S-TYPE fuel cap is of a different design than all other Jaguar models and requires a unique filler cap adapter. (Ask your instructor for further information)

Customer Complaint = Check engine light on! Technician has connected connect PDU to vehicle and checked logged DTC(s). A DTC for a small evaporative system leak was logged.

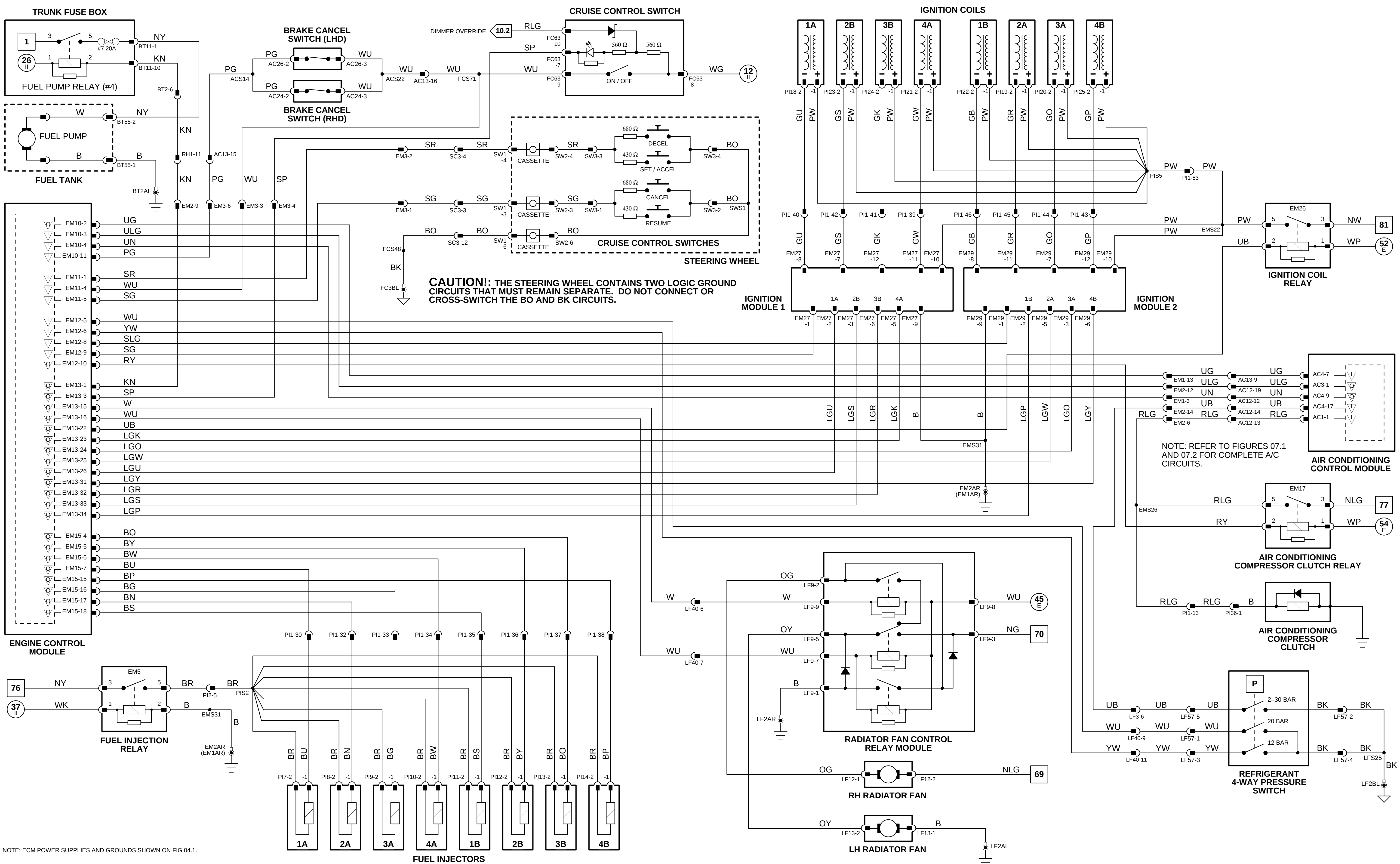
1. Reference the DTC summary guide. What is the specific DTC for the vehicle you are currently working on? ____________.
2. List the probable causes for this logged DTC. ________________________________

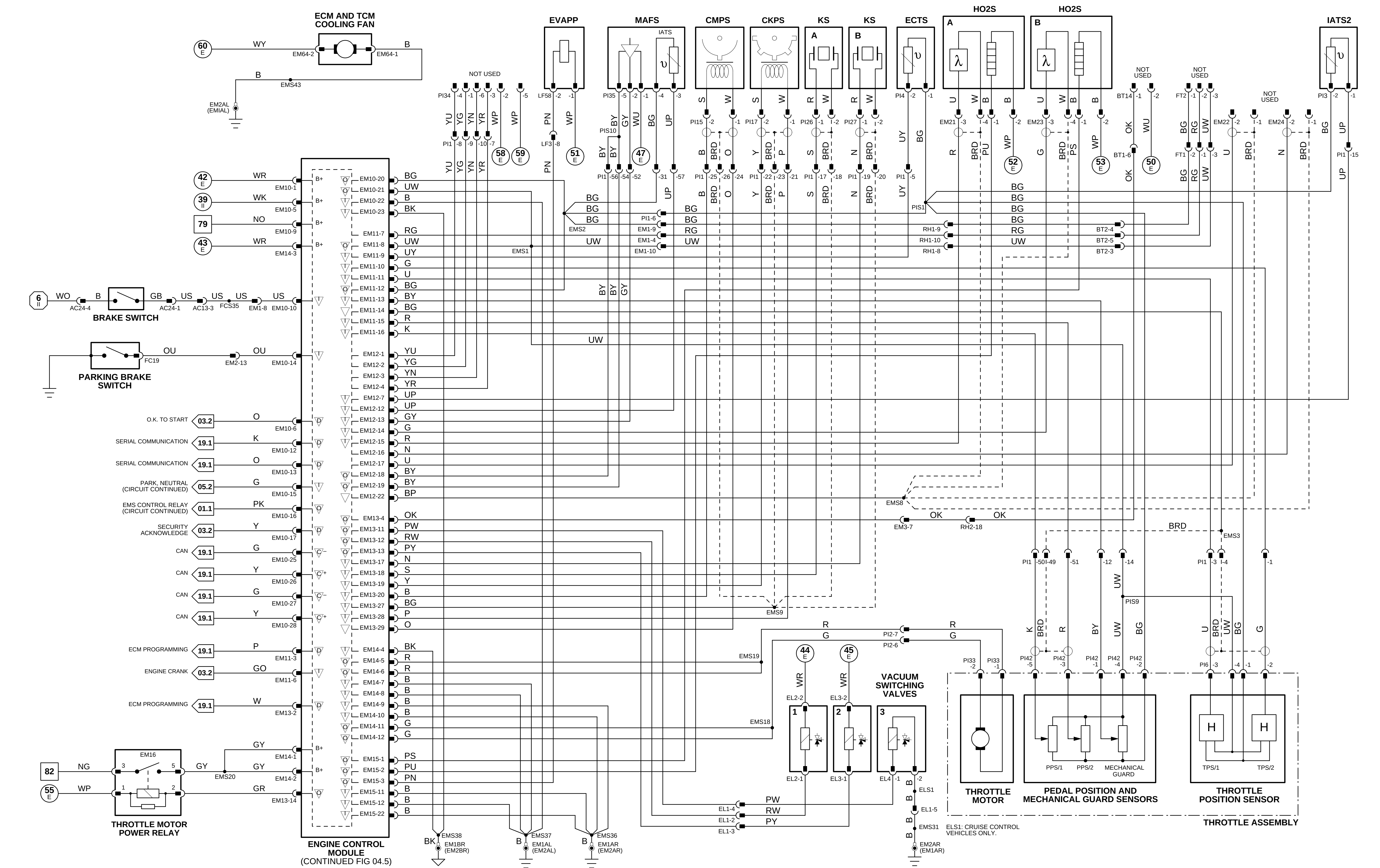
   ____
3. Follow the procedure as directed in TSB 05.1.29. Note progress and self recognized tips to help you perform this procedure easier at the dealership.

Instructor Check:____

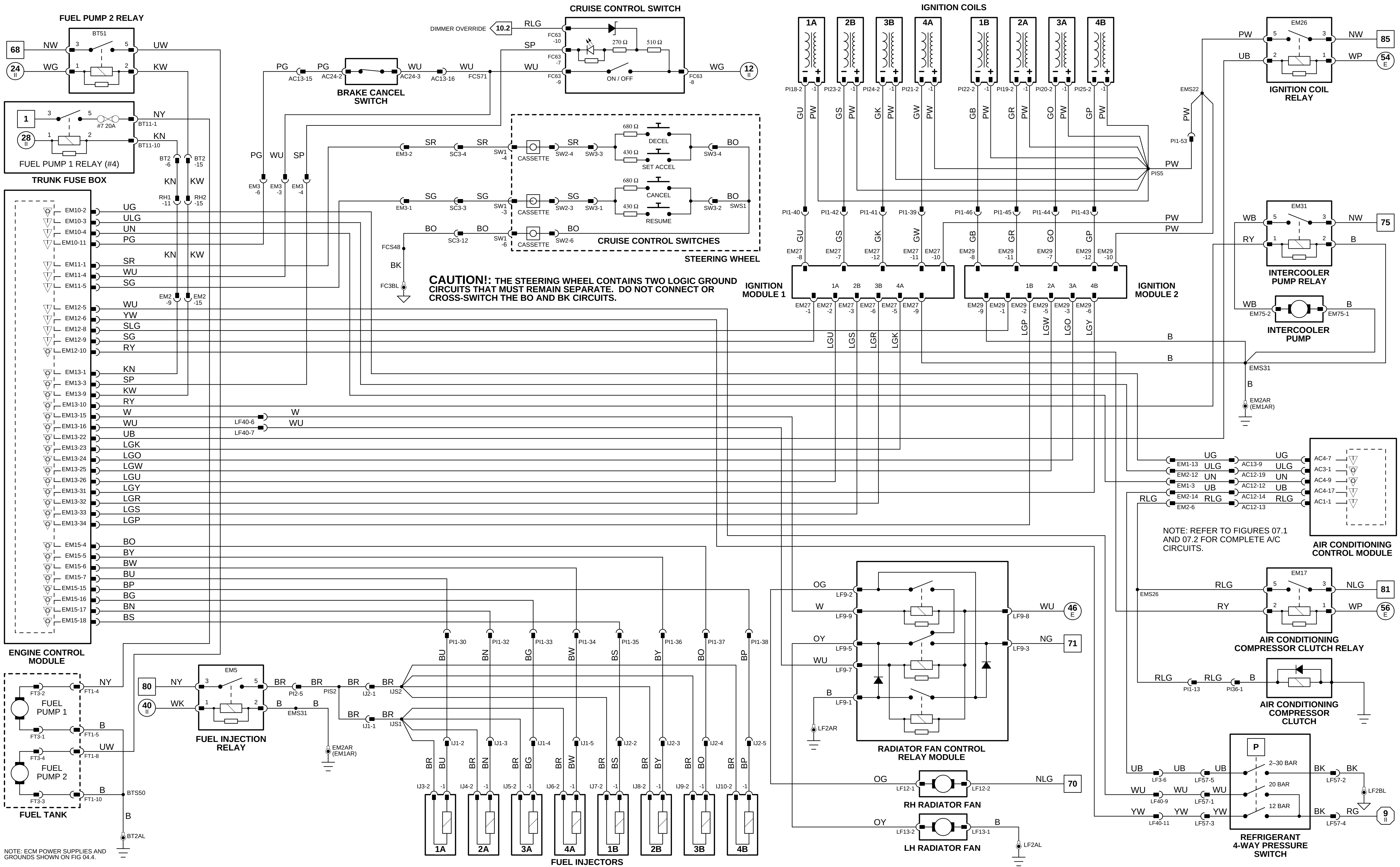

ECM AND TCM COOLING FAN
VARIABLE VALVE TIMING SOLENOID VALVES
EVAPORATIVE EMISSION CONTROL VALVE
MASS AIR FLOW SENSOR
IATS
CAMSHAFT POSITION SENSOR
CRANKSHAFT POSITION SENSOR
KNOCK SENSORS
ENGINE COOLANT TEMP. SENSOR
UPSTREAM HEATED OXYGEN SENSORS
CANISTER CLOSE VALVE
FUEL TANK PRESSURE SENSOR
DOWNSTREAM OXYGEN SENSORS
NOT USED
BRAKE SWITCH (LHD)
BRAKE SWITCH (RHD)
PARKING BRAKE SWITCH
O.K. TO START
SERIAL COMMUNICATION
PARK, NEUTRAL (CIRCUIT CONTINUED)
EMS CONTROL RELAY (CIRCUIT CONTINUED)
SECURITY ACKNOWLEDGE
CAN
ECM PROGRAMMING
ENGINE CRANK
THROTTLE MOTOR POWER RELAY
ENGINE CONTROL MODULE
(CONTINUED FIG 04.2)
VACUUM SWITCHING VALVES
ELS1 – LHD COUPE AND RHD CONVERTIBLE ONLY.
THROTTLE MOTOR
PEDAL POSITION
MECHANICAL GUARD
PEDAL POSITION AND MECHANICAL GUARD SENSORS
THROTTLE POSITION SENSOR
THROTTLE ASSEMBLY

AJ26 N/A ENGINE MANAGEMENT, PART 2 – 1998 MY XK8

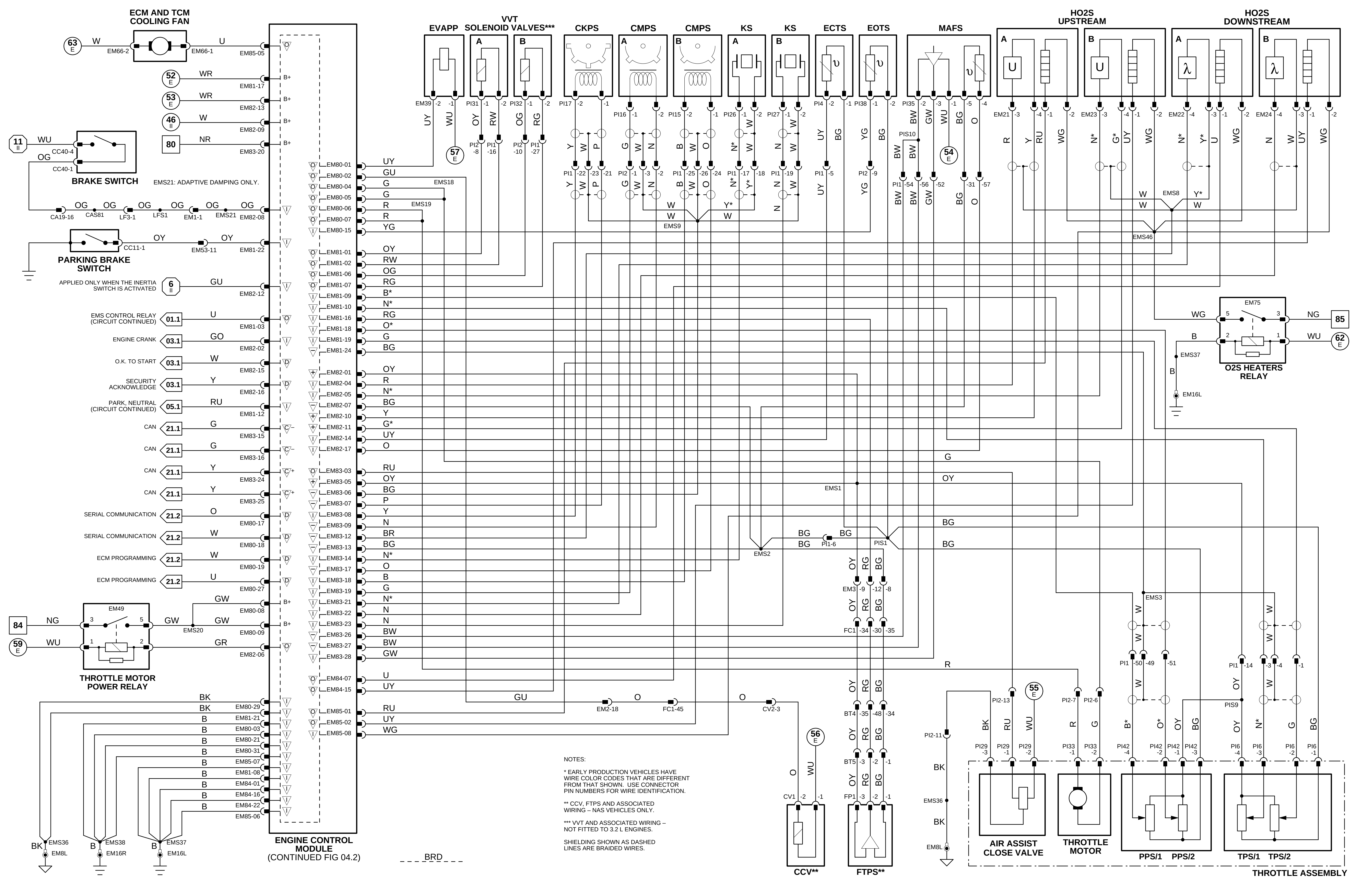


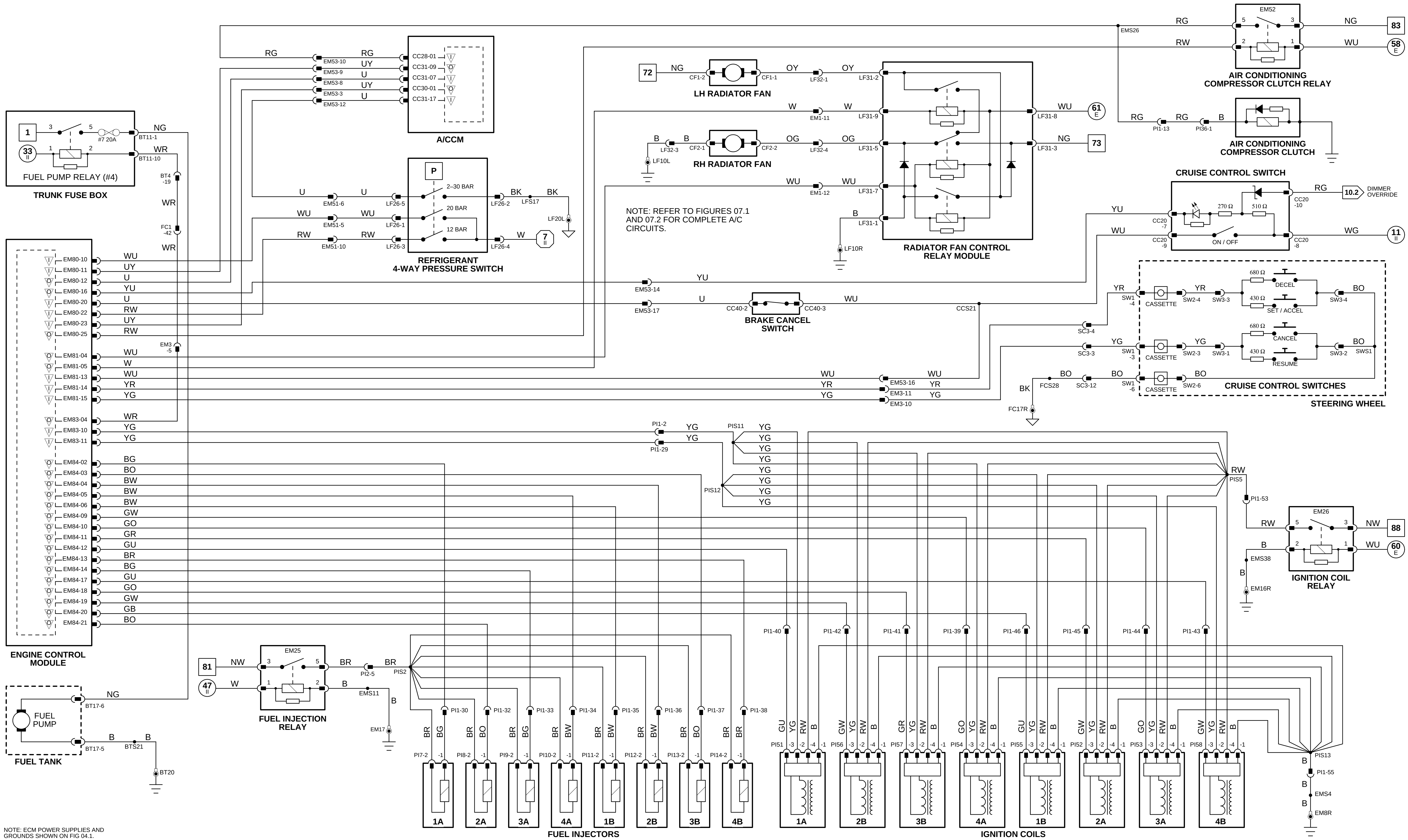

ECM AND TCM COOLING FAN
EVAPP
MAFS
IATS
CMPS
CKPS
KS
ECTS
HO2S
IATS2
NOT USED
BRAKE SWITCH
PARKING BRAKE SWITCH
O.K. TO START
SERIAL COMMUNICATION
PARK, NEUTRAL (CIRCUIT CONTINUED)
EMS CONTROL RELAY (CIRCUIT CONTINUED)
SECURITY ACKNOWLEDGE
CAN
ECM PROGRAMMING
ENGINE CRANK
THROTTLE MOTOR POWER RELAY
ENGINE CONTROL MODULE
(CONTINUED FIG 04.5)
VACUUM SWITCHING VALVES
THROTTLE MOTOR
PEDAL POSITION AND MECHANICAL GUARD SENSORS
THROTTLE POSITION SENSOR
THROTTLE ASSEMBLY
ELS1: CRUISE CONTROL VEHICLES ONLY.
PPS/1
PPS/2
MECHANICAL GUARD
TPS/1
TPS/2

AJ26 SC ENGINE MANAGEMENT, PART 2 – 1999 MY XKR



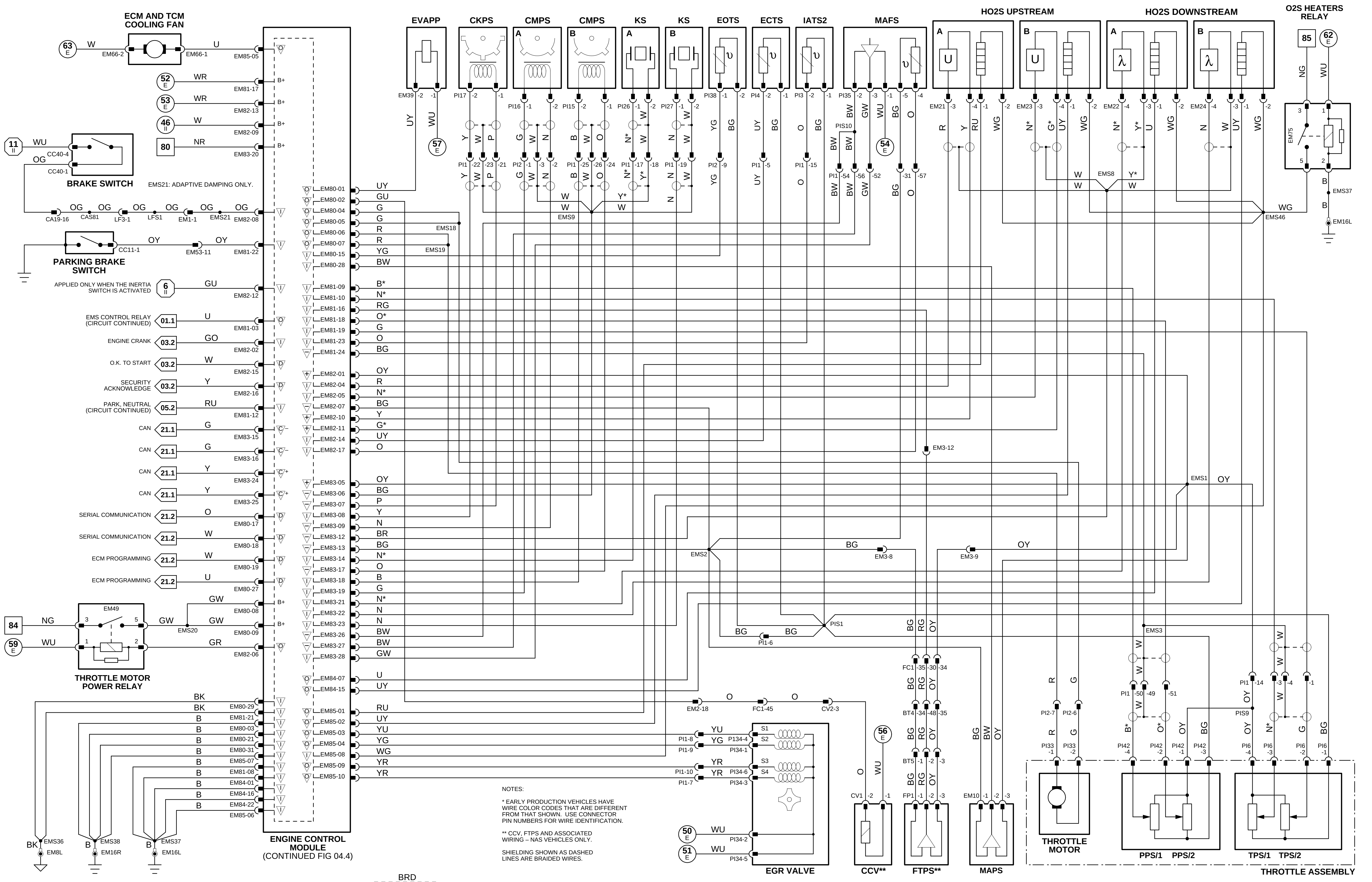
AJ27 N/A ENGINE MANAGEMENT, PART 1 – 2001 MY XJ8



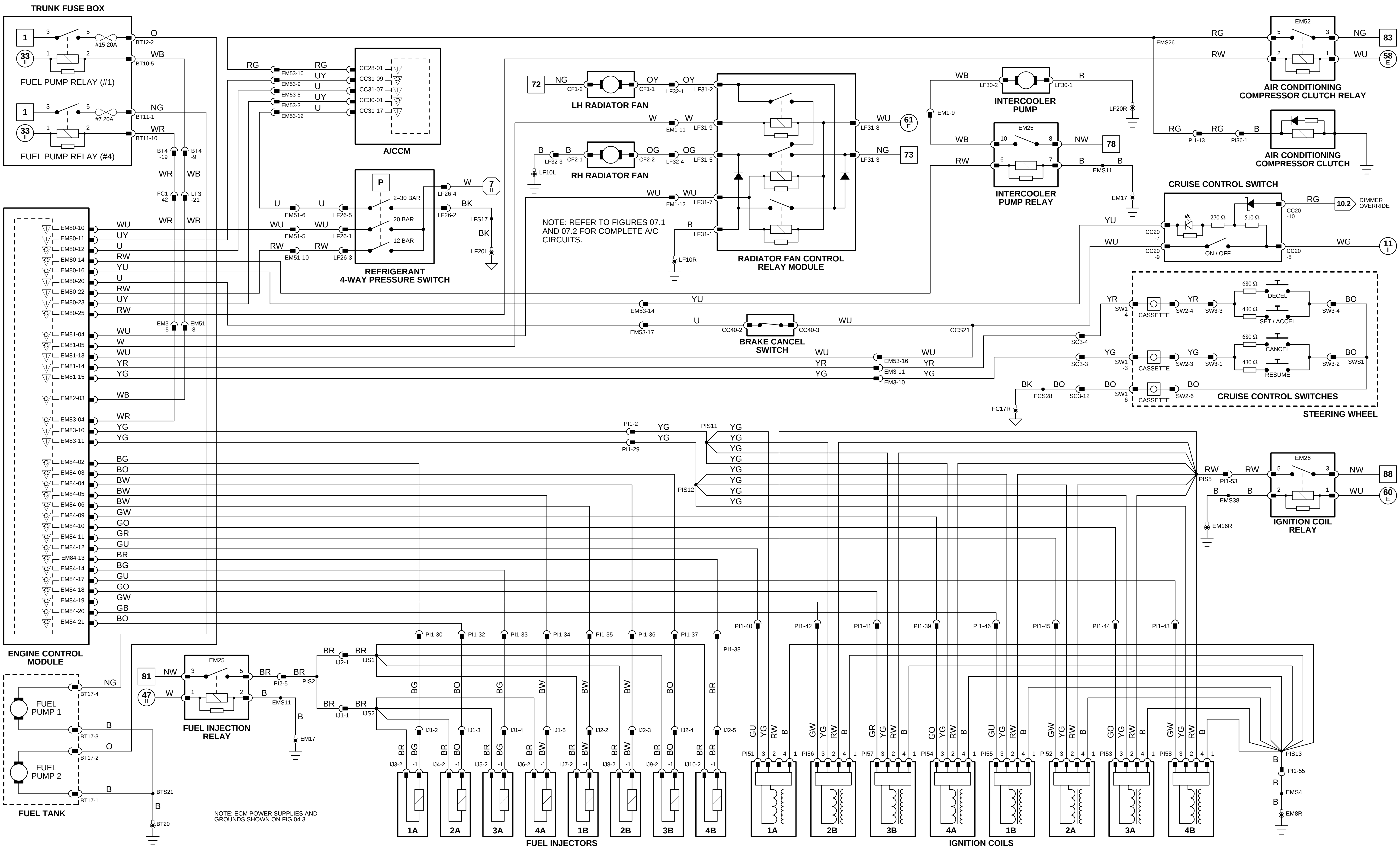


TRUNK FUSE BOX
FUEL PUMP RELAY (#4)
ENGINE CONTROL MODULE
FUEL TANK
FUEL PUMP
A/CCM
REFRIGERANT 4-WAY PRESSURE SWITCH
2–30 BAR
20 BAR
12 BAR
LH RADIATOR FAN
RH RADIATOR FAN
RADIATOR FAN CONTROL RELAY MODULE
NOTE: REFER TO FIGURES 07.1 AND 07.2 FOR COMPLETE A/C CIRCUITS.
AIR CONDITIONING COMPRESSOR CLUTCH RELAY
AIR CONDITIONING COMPRESSOR CLUTCH
CRUISE CONTROL SWITCH
DIMMER OVERRIDE
ON / OFF
BRAKE CANCEL SWITCH
CRUISE CONTROL SWITCHES
STEERING WHEEL
CASSETTE
DECEL
SET / ACCEL
CANCEL
RESUME
IGNITION COIL RELAY
FUEL INJECTION RELAY
FUEL INJECTORS
IGNITION COILS
1A
2A
3A
4A
1B
2B
3B
4B
NOTE: ECM POWER SUPPLIES AND GROUNDS SHOWN ON FIG 04.1.

AJ27 SC ENGINE MANAGEMENT, PART 1 – 2001 MY XJR



AJ27 SC ENGINE MANAGEMENT, PART 2 – 2001 MY XJR



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PTEC ENGINE MANAGEMENT SYSTEM

JAGUAR

Service Training Course 881
DATE OF ISSUE: 9/2001

Jaguar S-TYPE PTEC Acronyms and Abbreviations

AAI Valve	Air Assist Injection Valve
APP Sensor	Accelerator Pedal Position Sensor
B+	Battery Voltage
CHT Sensor	Cylinder Head Temperature Sensor
CKP Sensor	Crankshaft Position Sensor
CMP Sensor 1	Camshaft Position Sensor – RH Bank
CMP Sensor 2	Camshaft Position Sensor – LH Bank
DLC	Data Link Connector
DPFE Sensor	Differential Pressure Feedback EGR Sensor
ECT Sensor	Engine Coolant Temperature Sensor
EFT Sensor	Engine Fuel Temperature Sensor
EGR	Exhaust Gas Recirculation
EOT Sensor	Engine Oil Temperature Sensor
EVAP Canister Close Valve	Evaporative Emission Canister Close Valve
EVAP Canister Purge Valve	Evaporative Emission Canister Purge Valve
FTP Sensor	Fuel Tank Pressure Sensor
GECM	General Electronic Control Module
HO2 Sensor 1 / 1	Heated Oxygen Sensor – RH Bank / Upstream
HO2 Sensor 1 / 2	Heated Oxygen Sensor – RH Bank / Downstream
HO2 Sensor 2 / 1	Heated Oxygen Sensor – LH Bank / Upstream
HO2 Sensor 2 / 2	Heated Oxygen Sensor – LH Bank / Downstream
IAT Sensor	Intake Air Temperature Sensor
IMT Valve	Intake Manifold Tuning Valve
IP Sensor	Injection Pressure Sensor
KS 1	Knock Sensor – RH Bank
KS 2	Knock Sensor – LH Bank
MAF Sensor	Mass Air Flow Sensor
NAS	North America Specification
PCM	Powertrain Control Module
PSP Switch	Power Steering Pressure Switch
PTEC	Powertrain Electronic Control
RECM	Rear Electronic Control Module
ROW	Rest of World Specification
SCP	Standard Corporate Protocol Network
TACM	Throttle Actuator Control Module
TFT Sensor	Transmission Fluid Temperature Sensor
TP Sensor	Throttle Position Sensor
VVT Valve 1	Variable Valve Timing Valve – RH Bank
VVT Valve 2	Variable Valve Timing Valve – LH Bank

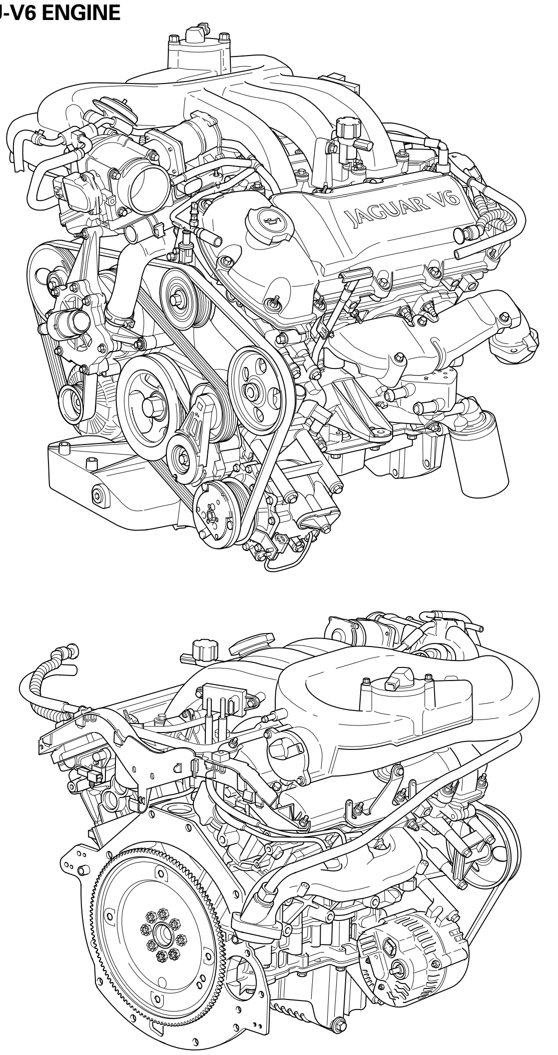
Note the following diagnostic PDU descriptions (refer to CMP Sensors, HO2 Sensors, KS and VVT Valves):

1	Right Hand engine bank (seated in the vehicle)
2	Left Hand engine bank (seated in the vehicle)
/ 1	Upstream
/ 2	Downstream

PTEC OVERVIEW

The PTEC (Powertrain Electronic Control) system is a comprehensive combined engine and transmission control system. The system is used on both the 3 liter AJ-V6 and the 4 liter AJ28 V8 engines installed in the Jaguar S-TYPE. There are detail sensor and control differences between V6 and V8, however the majority of the system is identical in its functions. PTEC complies with OBD II and is capable of achieving future LEV (Low Emission Vehicle) emission standards.

AJ-V6 ENGINE



PTEC.02

PTEC has several features that are unique from other Jaguar engine management systems:

Single control module

A single Powertrain Control Module (PCM) performs both engine and transmission control functions. This Student Guide covers only the engine management portion of the PTEC system.

SCP Network

PTEC communicates only on the vehicle SCP (Standard Corporate Protocol) multiplex network.

Returnless fuel system

The fuel delivery system is a supply only system with no provision for returning unused fuel from the fuel rail to the fuel tank.

Full authority throttle

PTEC employs a full authority electronic throttle assembly with no cable connection between the accelerator pedal and the throttle. The throttle assembly incorporates a separate control module with diagnostic capabilities.

Variable intake system (V6)

V6 engines are equipped with a variable length air intake manifold that optimizes engine torque across the entire speed/load range.

Fail safe cooling (V6)

V6 engines have a PCM "fail safe cooling" strategy that allows for limited engine operation with low or no coolant.

NOTES

PTEC CONTROL SUMMARY

The engine management systems for the 3.0 liter AJ-V6 engine and the 4.0 liter AJ28 V8 engine vehicles are virtually identical in function with differences in the control module parameters and the location of some components.

The major differences between the two systems are as follows:

AJ-V6

Two position VVT (variable valve timing)
Variable air intake system
EGR (exhaust gas recirculation) – 2000 MY only

AJ28 V8

Continuously variable VVT (variable valve timing)
AAI (air assisted injection)

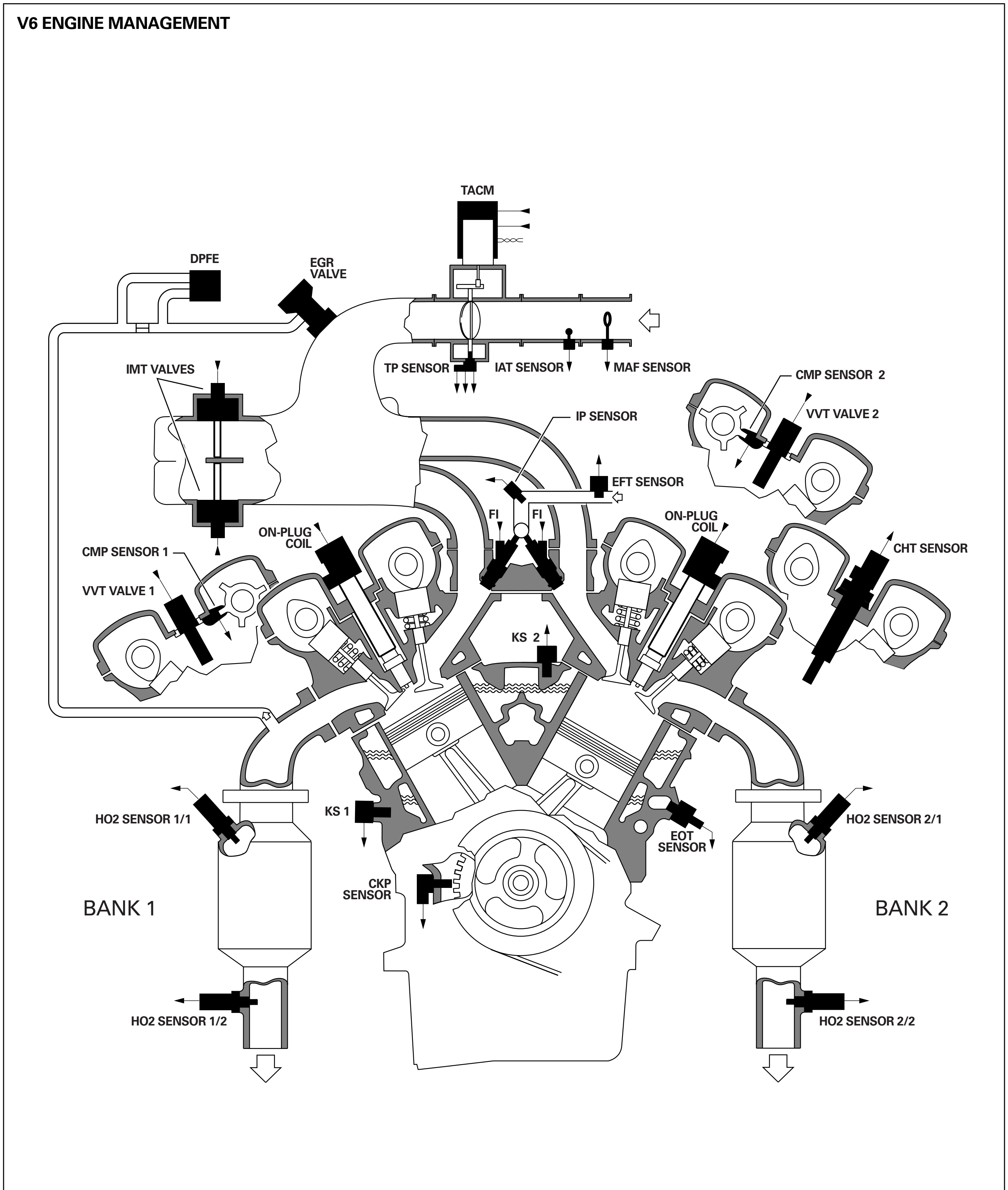
The PTEC powertrain control module (PCM) directly governs the following functions:

- Air assisted fuel injection (V8 only)
- Air conditioning compressor
- Automatic transmission
- Cooling system radiator fan
- Cruise control
- Default operating modes
- Engine power limiting
- Engine speed limiting
- Engine torque reduction control
- Evaporative emission control
- Exhaust emission control
- Exhaust gas recirculation (V6 only)
- Fail safe engine cooling
- Fuel delivery and injection (fuel pump via RECM)
- Fuel system leak check
- Full authority electronic throttle (via Throttle Actuator Control Module)
- Idle speed
- Ignition
- OBD II diagnostics
- Variable intake manifold tuning (V6 only)
- Variable intake valve timing
- Vehicle speed limiting

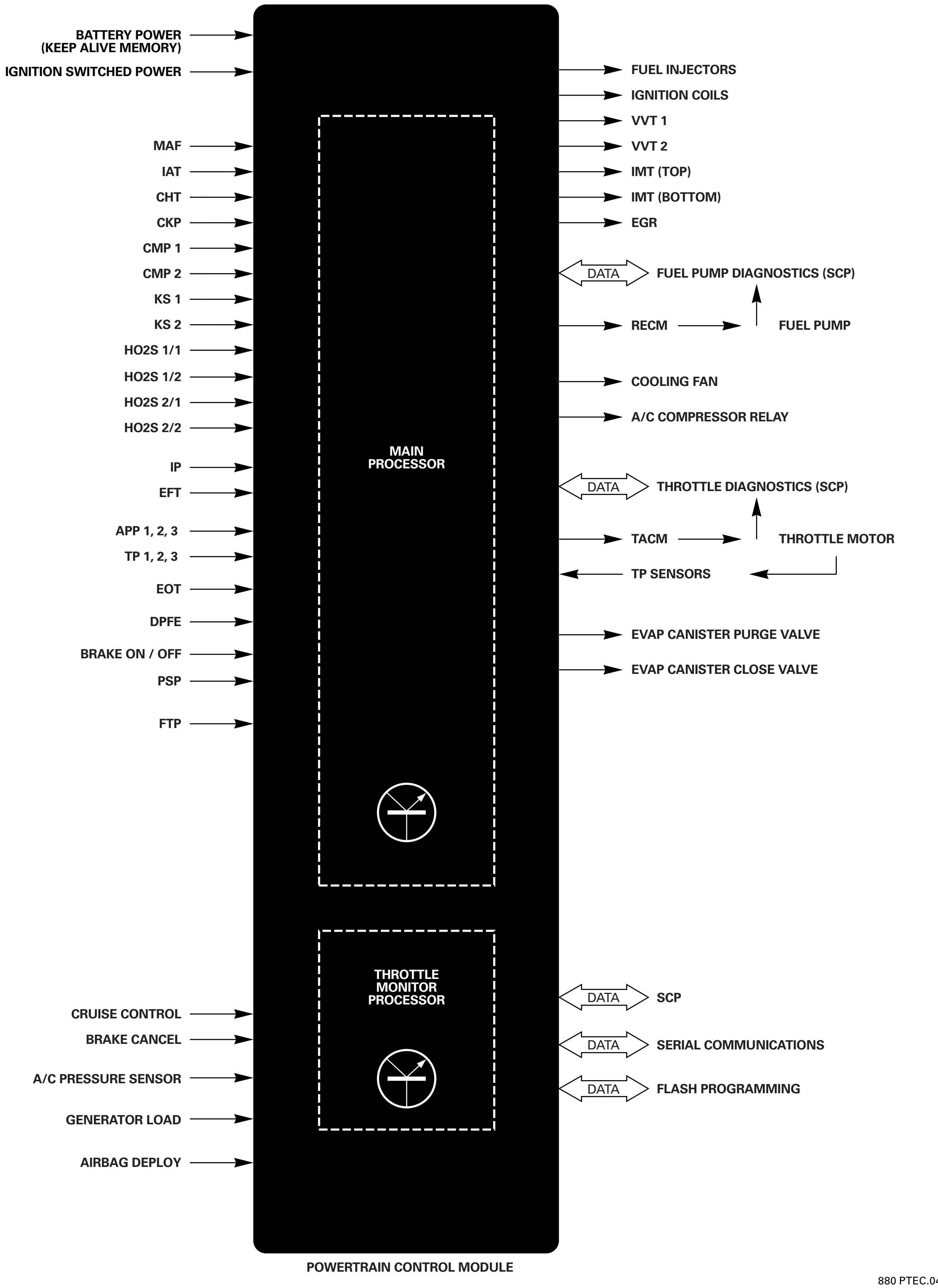
NOTES

PTEC CONTROL SUMMARY

System Logic – V6

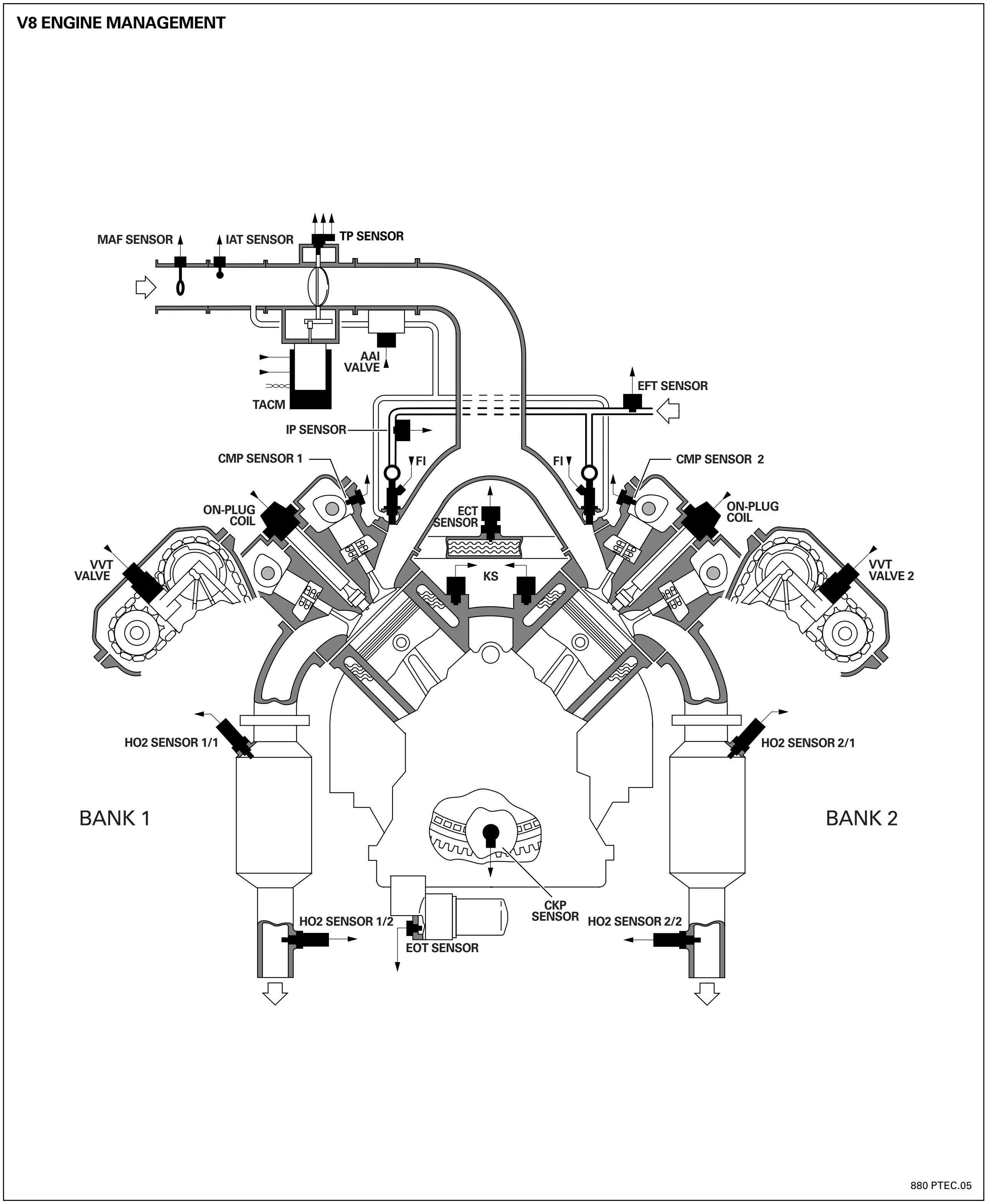


V6 PCM ENGINE MANAGEMENT INPUTS AND OUTPUTS

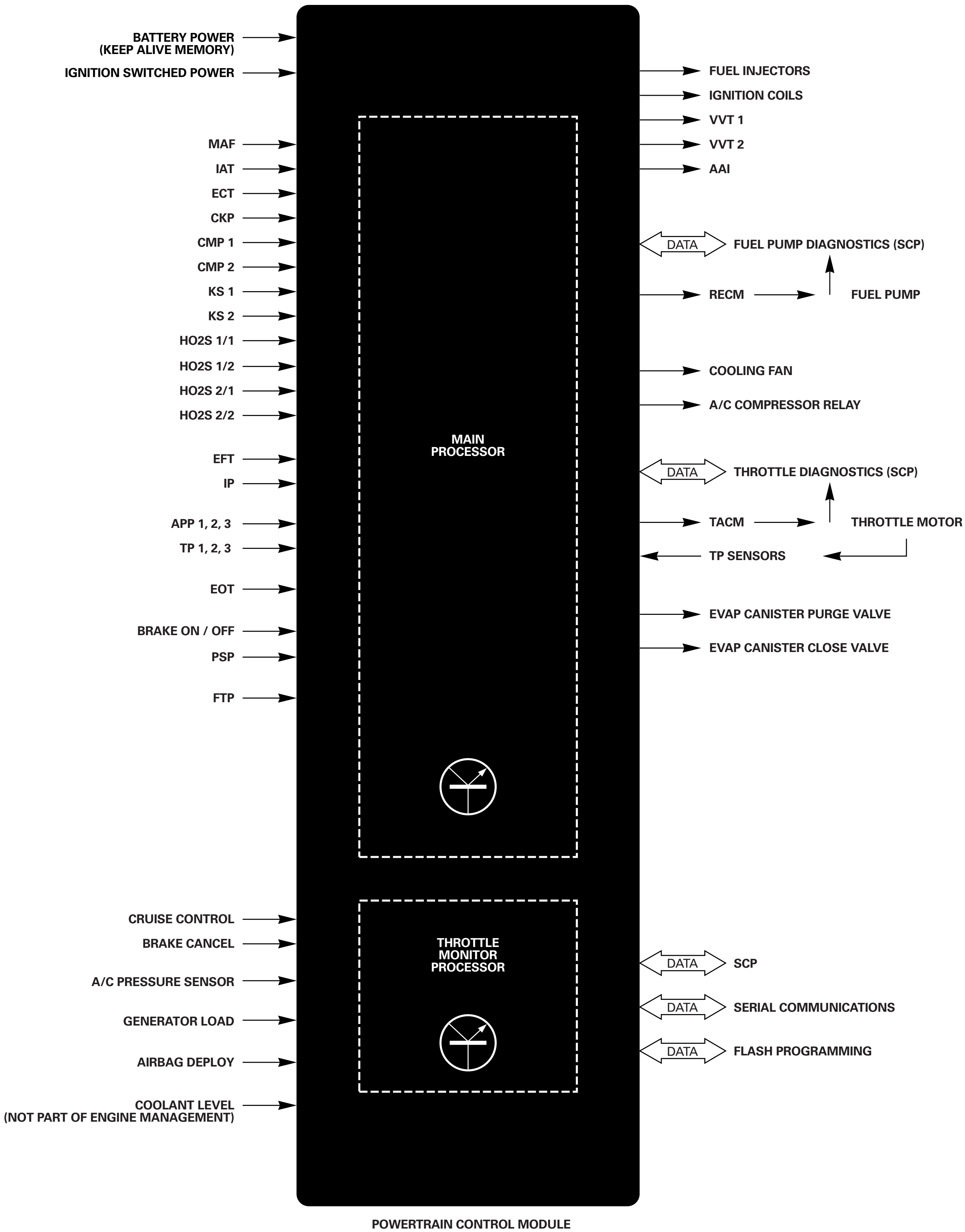


PTEC CONTROL SUMMARY

System Logic – V8



V8 PCM ENGINE MANAGEMENT INPUTS AND OUTPUTS



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PTEC ENGINE MANAGEMENT SYSTEM

V6 PTEC V8

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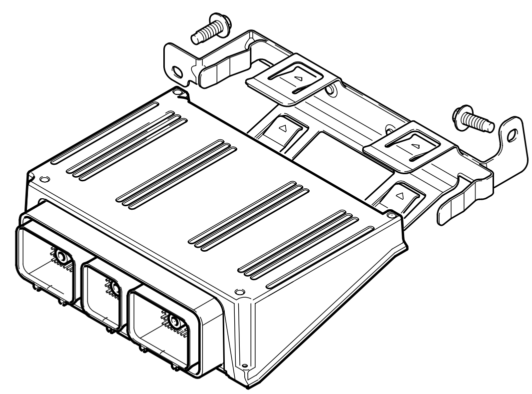
POWERTRAIN CONTROL MODULE (PCM)

- The PCMs for all S-TYPE Jaguars are almost identical but with unique programming for the characteristics of the various powertrain combinations. Also, some minor differences are required in the interface circuits to accommodate the sensors and actuators used on AJ-V6 or AJ28 engines.
- The vehicle powertrain configuration information and the vehicle identification number (VIN) are flash programmed into the PCM during vehicle production.
- Volatile memory Quiescent current from the vehicle battery is used to maintain OBD generated DTCs and adaptive values are maintained. If the vehicle battery is disconnected, stored DTCs and adaptive values will be lost. The ECM will "relearn" adaptive values during the next driving cycle.

POWERTRAIN CONTROL MODULE



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NOTE: If the PCM or Instrument Pack are replaced, PDU must be used to match the control modules before the vehicle is operated.

CAUTION: The PCM must not be switched from one vehicle to another; the VIN will be mismatched and the powertrain configuration information may be incorrect for the vehicle.

PCM Power Supplies

- The PCM power supplies flow through a 40 Amp fuse to powertrain control relay 1.
- Powertrain control relay 2 supplies power to the A/C compressor clutch, generator, HO2S heaters, and coil-on-plug ignition coils.
- Both relays are located in the front power distribution board and are powered by the same fuse. 5 Amp fused B+ voltage activates the relays directly from the ignition switch when it is in positions II (RUN) and III (START).
- The PCM is located on the passenger side of the cabin below the climate control blower unit.
- The 150-way three-pocket connector housing protrudes through the bulkhead to accept the matching connectors from the engine bay side harnesses.
- The 60-way socket connects to the engine harness (PI).
- The 32-way socket connects to the transmission harness (GB).
- The 58-way socket connects to the vehicle forward harness (FH).

PCM Configuration

NOTE: Once a PCM is configured to a vehicle, it cannot be re configured to another vehicle.

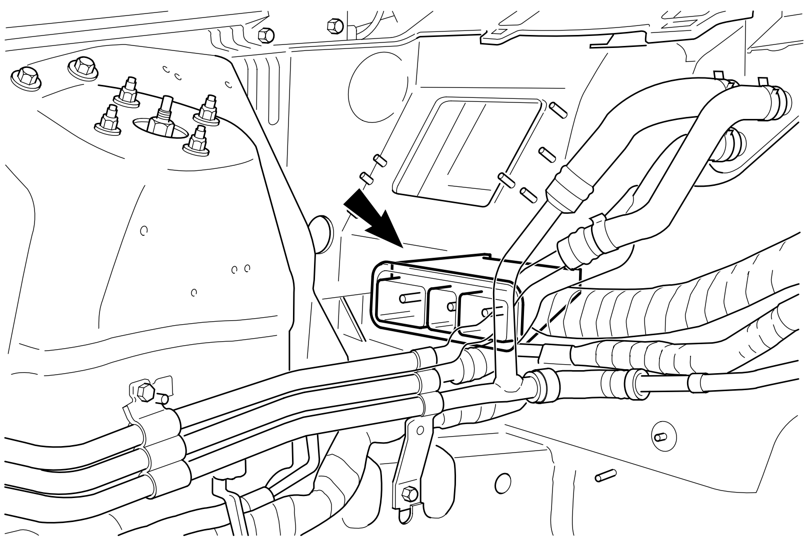
After a PCM is replaced and the battery reconnected, connect WDS. Select Guided Diagnostics from the Main Menu followed by Vehicle Set Up and Vehicle CM Set Up / Configuration. WDS will perform the configuration during which you will be prompted to enter the Vehicle Identification Number.

During configuration WDS writes vehicle identification information into a section of the PCM memory called the VID Block (Vehicle Identification Block). Once the VID Block space is occupied, it cannot be overwritten. The VID Block stores data pertaining to certain other vehicle control modules. For example, the instrument pack identification data.

The VID Block has no effect on vehicle operation and is accessible in the future via WDS. The intent of the VID Block is to give Jaguar technicians information on the programmed status of control modules, in the event of a problem.

NOTE: The PCM must be configured to the instrument pack as part of the security system set up. If this is not carried out, the engine will not start.

POWERTRAIN CONTROL MODULE LOCATION (LHD SHOWN)



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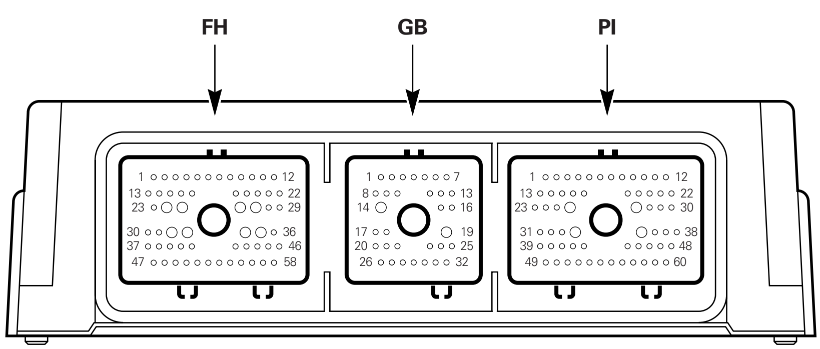
POWERTRAIN CONTROL MODULE FACE



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POWERTRAIN CONTROL MODULE (PCM)

Barometric Pressure

The PCM does not incorporate a barometric pressure sensor. Instead, it calculates barometric pressure based on input signals received from the mass air flow sensor and the throttle position sensor. If the PCM cannot calculate barometric pressure (failure mode), it defaults to an atmospheric pressure of 27 in. Hg. (902 mBar).

PCM Multiplex and Serial Data Communications

The PCM is part of the SCP vehicle multiplex data network that operates at 41.6 kb per second. In addition to the SCP network, the PCM is connected to the Serial Data Link, and has a dedicated flash programming circuit. All three circuits are accessed at the Data Link Connector (DLC) for DTC retrieval, system diagnostics and monitoring, and PCM EPROM flash programming.

Idle Speed Adaptions

If the vehicle battery is disconnected, idle speed adaptions will be lost. After battery reconnection, operate the vehicle as follows to restore the idle speed adaptions:

- Start the engine and warm to >82 °C (180 °F)
- Switch off the engine; restart the engine
- Idle in Neutral for two (2) minutes
- Depress and hold brake pedal; select Drive; idle for two (2) minutes

System Diagnostics – Faults / Default Action

The PCM continuously performs diagnostic monitoring for OBD II and non-OBD II functions. Diagnostics include: self-test routines, engine and transmission function monitoring, individual sensor circuit, signal, function and integrity monitoring, and critical sensors input signal validation. Detected faults are logged in the PCM memory as DTCs.

In most instances of detected sensor and/or component failure, the PCM takes default action. Specific default actions, messages and warnings are contained in the Jaguar Quick Reference Diagnostic Guide: S-TYPE POWERTRAIN DTC Summaries.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

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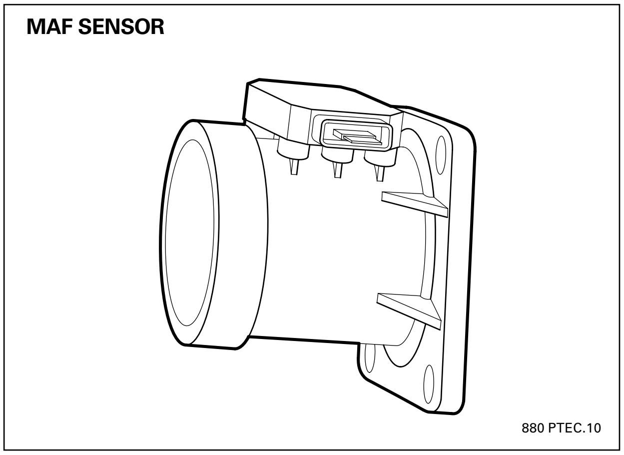
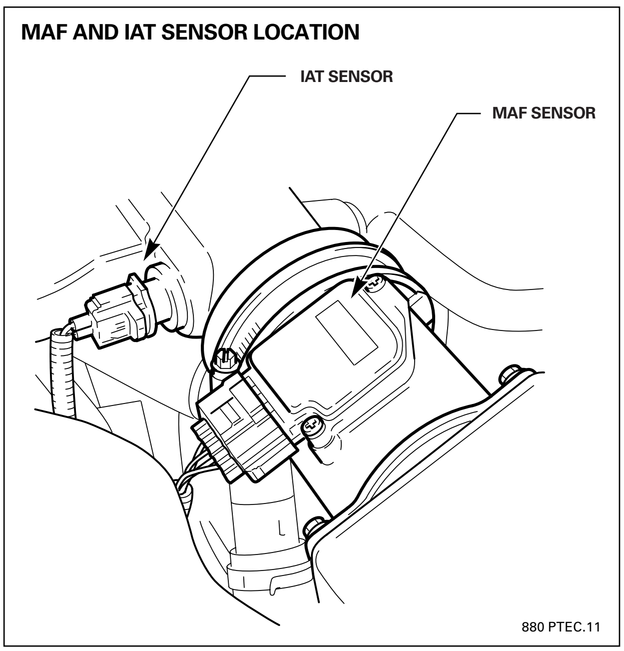
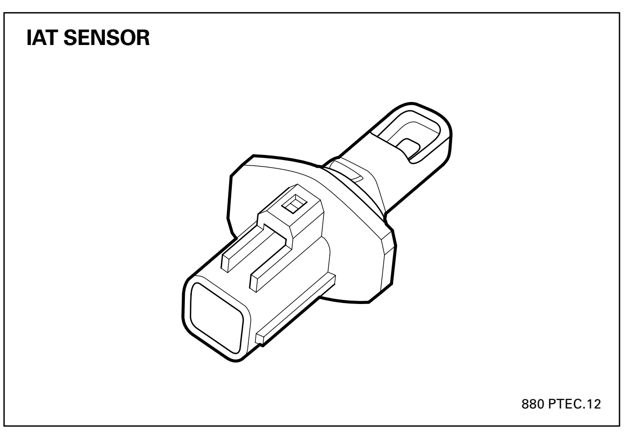
PCM SENSING COMPONENTS – ENGINE







Mass Air Flow (MAF) Sensor

- The MAF sensor measures the mass of air entering the intake system, the measurement being based on the constant temperature hot wire principle.
- A hot wire probe and an air temperature probe are Suspended in the air intake tract.
- The PCM ensures that the hot wire probe is always 200 °C hotter that the air temperature probe.
- The hot wire probe is cooled by the air flowing through the intake system and the PCM varies the heating current to maintain the 200 °C temperature difference.
- The change in heating current is measured as a voltage drop across a precision resistor and is assigned to a corresponding mass air flow calculation by the PCM.

Intake Air Temperature (IAT) Sensor

- The IAT sensor, located in the air induction duct, is a thermistor which has a negative temperature coefficient (NTC).
- Intake air temperature is determined by the PCM by the change in the sensor resistance.
- The PCM applies stable 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.
- The PCM uses the IAT signal to adjust ignition timing to match intake air temperature.

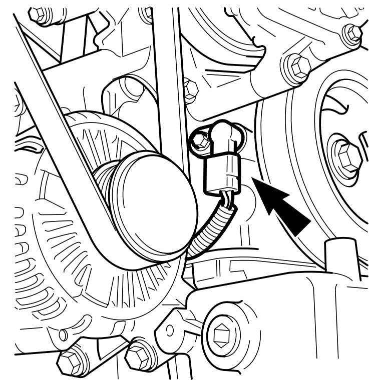
NOTES

Crankshaft Position (CKP) Sensor

- The CKP sensor is an inductive pulse generator, which provides the PCM with an engine speed and position alternating voltage signal.
- The PCM uses the CKP signal to determine both engine speed and crankshaft position.
- The 36-tooth (minus one tooth) reluctor is located on the crankshaft at different locations in the V6 and V8.
  – V6 sensor is located on the front of the crankshaft, in the front timing cover.
  – V8 sensor is located on the transmission drive plate as in previous V8 engines.
- The missing tooth gap provides a PCM reference for crankshaft position.
  – V6 gap is located at 60° BTDC cylinder 1/1.
  – V8 gap is located at 50° BTDC cylinder 1/1.
- The PCM requires the input signal from the camshaft position sensor to determine the engine stroke.

NOTES

CKP SENSOR – V6



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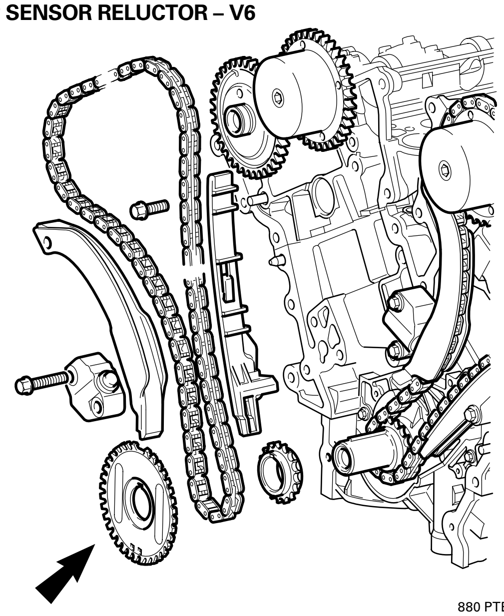
CKP SENSOR RELUCTOR – V6



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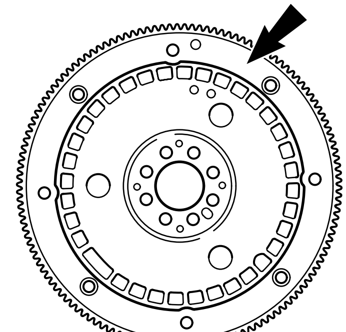
CKP SENSOR RELUCTOR – V8



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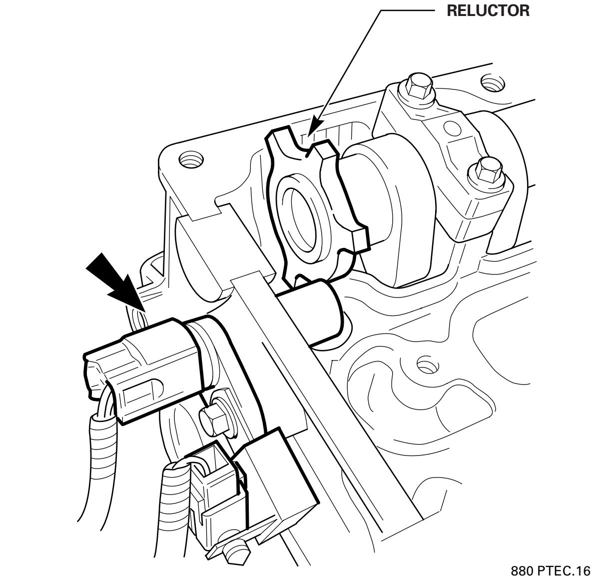
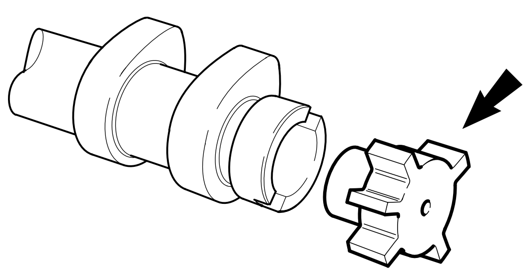
PCM SENSING COMPONENTS – ENGINE

CMP SENSOR AND RELUCTOR – V6



CMP SENSOR RELUCTOR – V8



Camshaft Position (CMP) Sensors

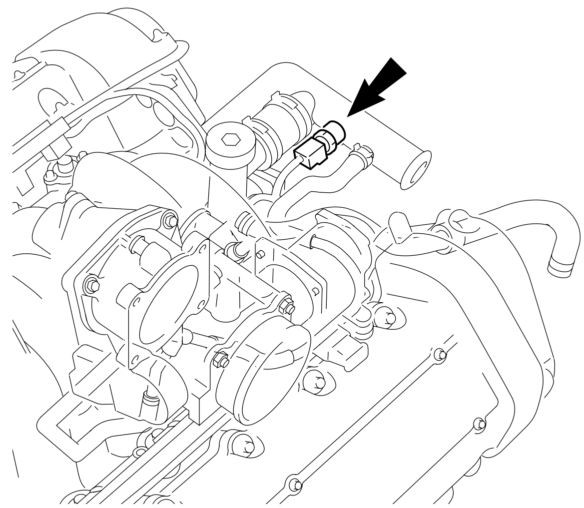
- The CMP sensors are inductive pulse generators which provide the PCM with a cylinder identification alternating voltage signal.
- The PCM uses the CMP signals (one for each cylinder bank) for:
  - cylinder identification to control starting, fuel injection sequential operation
  - ignition timing
  - variable valve timing operation and diagnostics.
- The CMP reluctors are located on the inlet camshafts at the rear of the cylinder heads.
  - V6 reluctors have four teeth (three are equally spaced)
  - V8 reluctors have five teeth (four are equally spaced).
- The multi-tooth cam sensor rings increase the cam position feedback frequency, providing the enhanced control required by the VVT system.
- The use of multi-tooth sensor rings also improves starting by providing additional reference points for the PCM to determine camshaft position.

NOTES

Engine Coolant Temperature (ECT) Sensor (V8)

- The V8 ECT sensor, located on the coolant outlet elbow between the cylinder banks, is a thermistor which has a negative temperature coefficient (NTC).
- Engine coolant temperature is determined by the PCM by the change in the sensor resistance.
- The PCM applies 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.

ECT SENSOR (V8)



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PTEC Temperature Sensors

The following Temperature / Resistance / Voltage chart applies to all of the PTEC Temperature Sensors except for the Cylinder Head Temperature (CHT) Sensor:

- Engine Coolant Temperature (ECT) Sensor
- Engine Fuel Temperature (EFT) Sensor
- Engine Oil Temperature (EOT) Sensor
- Intake Air Temperature (IAT) Sensor
- Transmission Fluid Temperature (TFT) Sensor

Temperature °C	Temperature °F	Nominal Resistance	Nominal Voltage at PCM
0	32	95.851 kΩ	3.88 v
10	50	59.016 kΩ	3.52 v
20	68	37.352 kΩ	3.09 v
30	86	24.239 kΩ	2.62 v
40	104	16.092 kΩ	2.15 v
50	122	10.908 kΩ	1.72 v
60	140	7.556 kΩ	1.34 v
70	158	5.337 kΩ	1.04 v
80	176	3.837 kΩ	0.79 v
90	194	2.840 kΩ	0.61 v
100	212	2.080 kΩ	0.47 v
110	230	1.564 kΩ	0.36 v
120	248	1.191 kΩ	0.28 v
130	266	0.918 kΩ	0.22 v
140	284	0.715 kΩ	0.17 v
150	302	0.563 kΩ	0.14 v

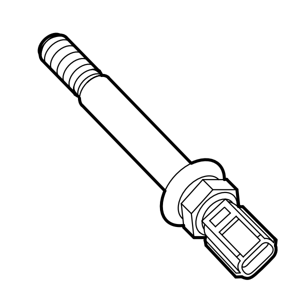
NOTES

PCM SENSING COMPONENTS – ENGINE

Cylinder Head Temperature (CHT) Sensor (V6)

- The CHT sensor, located between the two rear coil-on-plug units in the bank 2 cylinder head, is a thermistor which has a negative temperature coefficient (NTC).
- The sensor directly monitors the metal temperature of the cylinder head. This method of engine heat sensing is used in place of an engine coolant temperature sensor to enable the V6 fail safe cooling strategy to operate. Refer to page 10.4. The use of a metal temperature sensor allows cylinder head temperature to be measured even if coolant has been lost.
- Cylinder head temperature is determined by the PCM by the change in the sensor resistance. The PCM applies 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.

CHT SENSOR (V6)



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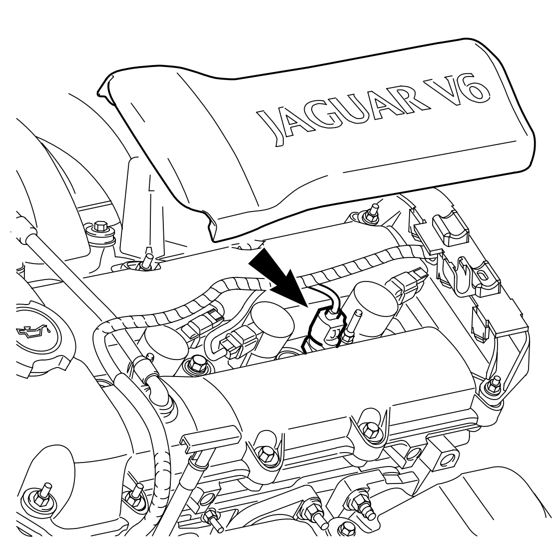
CHT SENSOR LOCATION (V6)



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V6 Cylinder Head Temperature Sensor

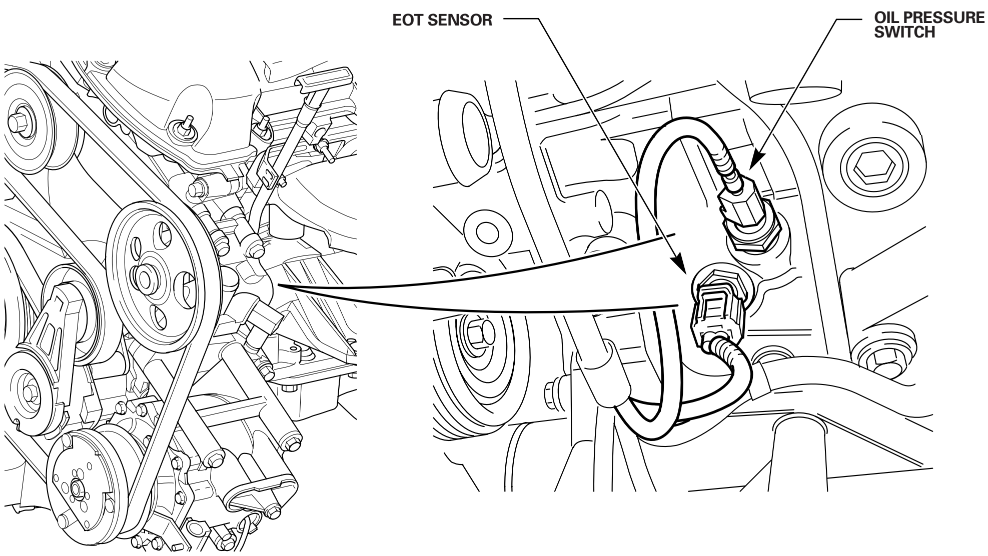
Temperature °C	°F	Nominal Resistance	Nominal Voltage at PCM
0	32	96.248 kΩ	4.140 v
10	50	59.173 kΩ	3.737 v
20	68	37.387 kΩ	3.257 v
30	86	24.216 kΩ	2.738 v
40	104	16.043 kΩ	2.226 v
50	122	10.851 kΩ	1.759 v
60	140	7.487 kΩ	1.362 v
70	158	5.269 kΩ	1.043 v
80	176	3.775 kΩ	0.794 v
90	194	2.750 kΩ	0.604 v
100	212	2.038 kΩ	0.462 v
110	230	1.523 kΩ	0.354 v
120	248	1.155 kΩ	0.273 v
130	266	0.887 kΩ	0.212 v
140	284	0.689 kΩ	0.167 v
150	302	0.542 kΩ	0.132 v
160	320	0.430 kΩ	0.105 v
170	338	0.345 kΩ	0.085 v

NOTES

Engine Oil Temperature (EOT) Sensor

- The PCM uses the EOT signal for variable valve timing control.
- The EOT sensor is a thermistor which has a negative temperature coefficient (NTC).
- The PCM applies 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.
- Engine oil temperature is determined by the PCM by the change in the sensor resistance.
- The V6 and V8 sensors are fitted to the engine lubrication system in different locations:
  - V6 EOT sensor is located on the left hand side of the cylinder block in the oil return channel from the oil cooler
  - V8 EOT sensor is located on the oil cooler / filter adapter.

EOT SENSOR – V6



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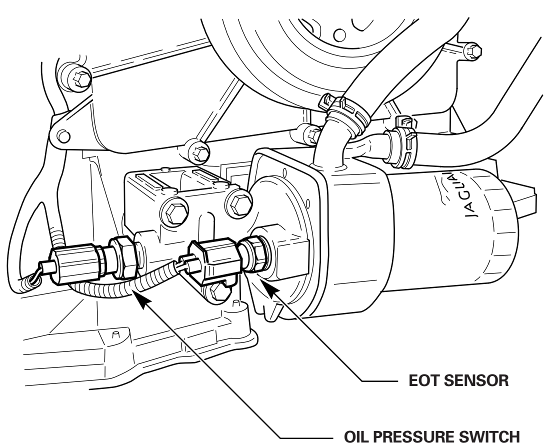
NOTES

EOT SENSOR – V8



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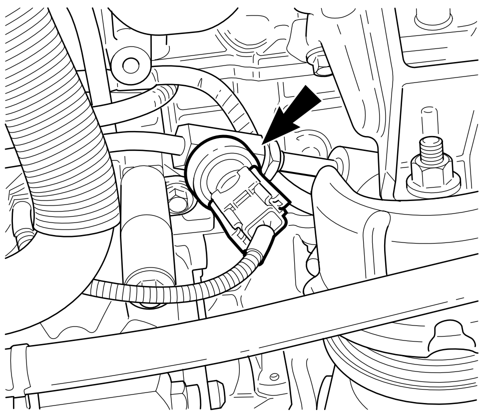
PCM SENSING COMPONENTS – ENGINE

PSP SWITCH – V6 SHOWN



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Power Steering Pressure (PSP) Switch

- The PCM uses the input from the PSP switch to compensate for the additional accessory drive load on the engine by adjusting the engine idle speed and preventing engine stall during parking maneuvers.
- The PSP switch, located on the PAS pump outlet pipe, monitors the hydraulic pressure on the high pressure side of the power steering system.
- The switch is a normally open switch that closes when the hydraulic pressure reaches 24.13 ± 3.45 Bar (350 ± 50 psi).

Brake Switches

The PCM receives input signals from two brake pedal position switches:

- Brake switch (B+ voltage / normally open)
- Brake cancel switch

Two switches provide signal plausibility.

- The switch inputs to the PCM are used for cruise control cancel and multiple vehicle functions (via SCP).
  - On DSC equipped vehicles, the brake switch is hard wired to the DSC control module.

The DSC system uses an active brake booster, which when activated by the DSCCM, will cause the brake pedal to drop with the subsequent activation of the brake switches. During the DSC self test when the vehicle first moves off, the booster is momentarily activated by the DSCCM causing the brake pedal to drop.

When the DSCCM is performing the self test, it does not broadcast an SCP BRAKES APPLIED message, which prevents erroneous brake light activation.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

V6 PTEC V8

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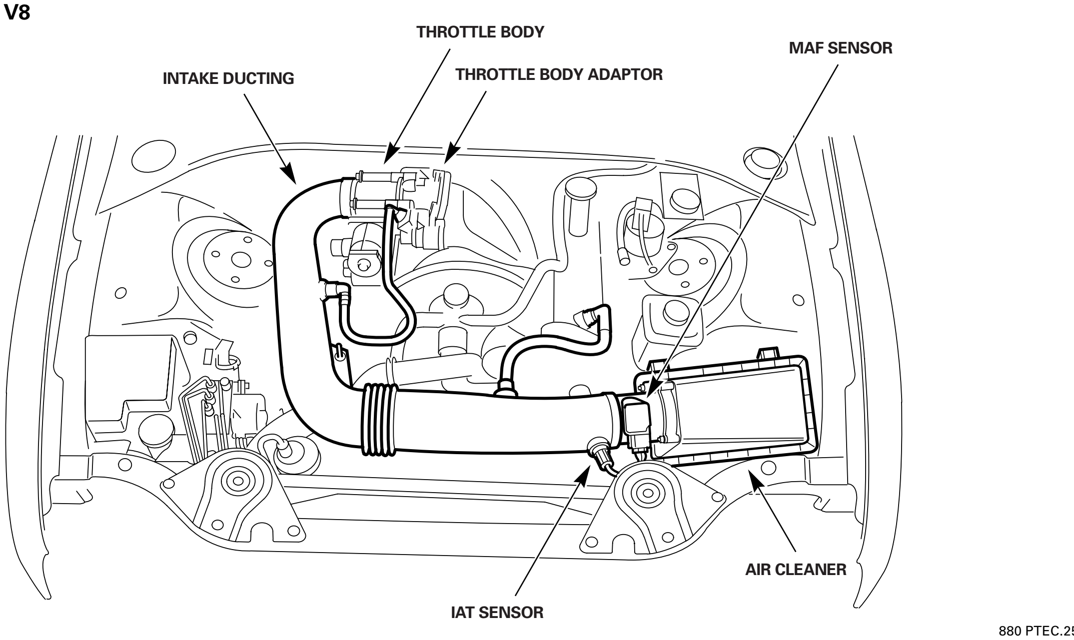
INDUCTION AIR AND THROTTLE CONTROL

Air Induction Systems

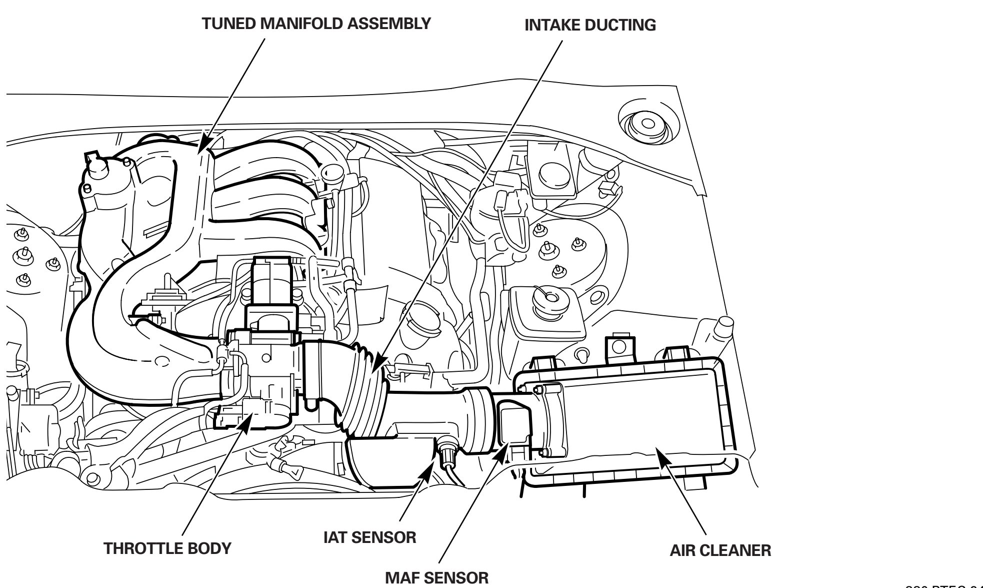
The V6 and V8 engines have air induction systems that are similar from the air cleaner inlet through the throttle body. The systems consist of the normal components with the MAF sensor located in the air cleaner outlet and the IAT sensor located in the air intake duct just downstream of the MAF sensor. Resonator chambers are fitted to the intake ducting to control intake air reverberation at certain throttle openings.

After exiting the throttle body, the V6 and V8 induction air systems differ greatly.

AIR INDUCTION: V8



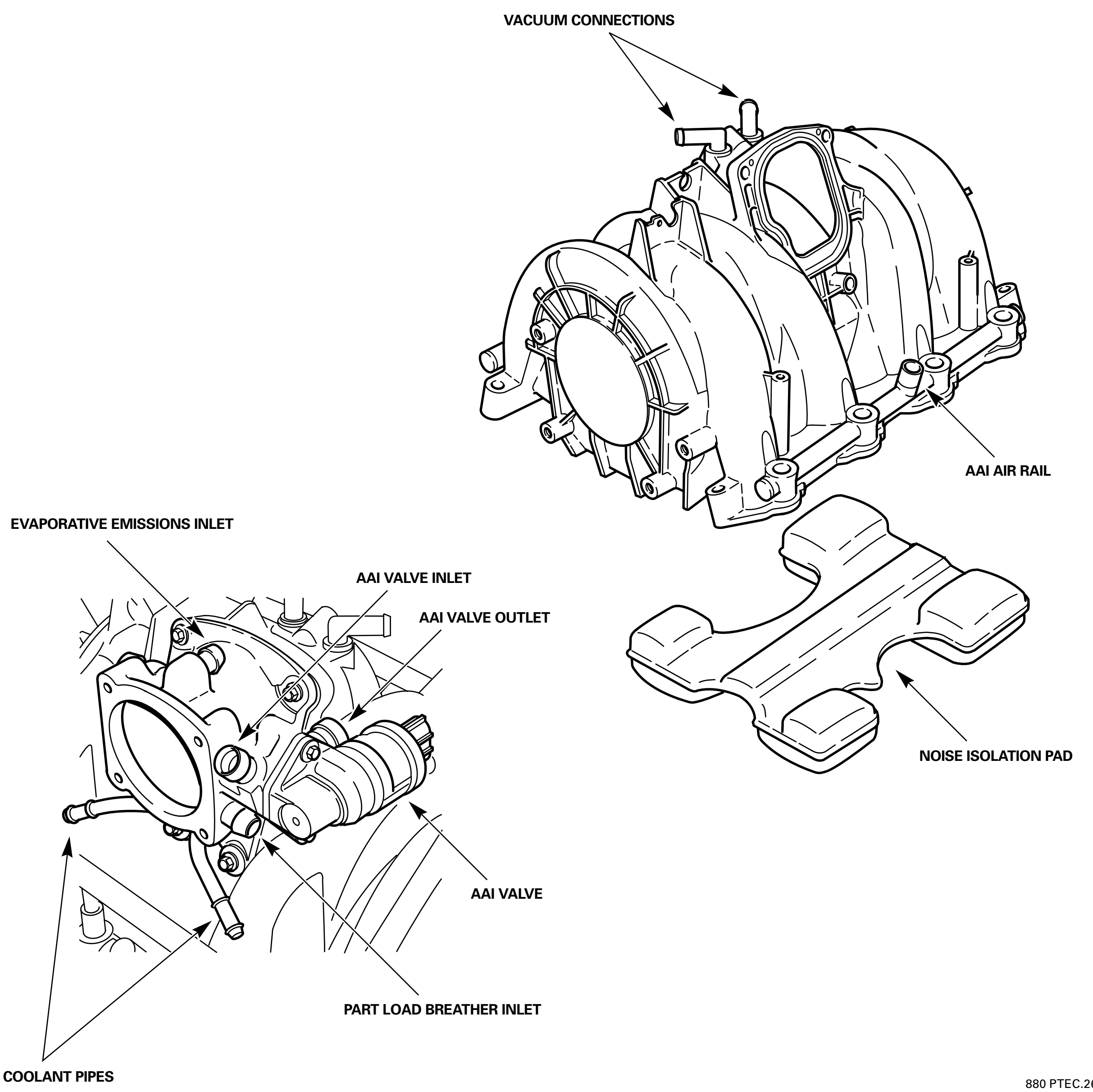
AIR INDUCTION: V6



Air Intake – V8

Induction air flows into the manifold through a centrally located inlet. The manifold incorporates the air rails for air assisted fuel injection. The heated (engine coolant) throttle adapter connects the throttle body to the manifold and provides EVAP, and vacuum source connections. The air assist injection valve is located on the throttle adapter. A noise isolation pad locates between the induction manifold and the engine vee.

INTAKE MANIFOLD, THROTTLE ADAPTOR AND ISOLATION PAD – V8



INDUCTION AIR AND THROTTLE CONTROL

Full Authority Throttle Control

The electronic throttle control system used in the PTEC engine management systems is designed with no mechanical connection between the vehicle accelerator pedal and the throttle valve. The PCM has full authority over throttle valve movement.

Accelerator pedal position is monitored by APP (accelerator pedal position) sensors that are hard wired to the PCM. The PCM calculates a throttle plate opening appropriate for the vehicle operating conditions using:

- pedal position
- engine speed
- vehicle speed
- cruise control status
- power reduction requirements for traction control, transmission torque input limits, and torque modulation required during transmission shifting.

The PCM issues redundant PWM throttle position command signals via hard wired connections to the throttle actuator control module (TACM), which is located on the throttle body assembly. The TACM drives the throttle valve to the desired position via the throttle drive motor.

Throttle position sensors communicate actual throttle angle feedback to the PCM via hard wires to provide closed loop control. The TACM communicates calculated throttle position to the PCM via hard wire connection as a cross-check.

The throttle control system uses multiple accelerator pedal position sensors, throttle position sensors, and multiple hard wired signals that allow the PCM to monitor individual signal validity. Two separate, dedicated, twisted pair (B+ around ground) provide supply power and ground to the TACM.

A dedicated electronic throttle monitor microprocessor, within the PCM, constantly monitors overall operation of the throttle control system. The throttle monitor microprocessor interfaces internally with the PCM main microprocessor logic and software.

In the event of a software or component failure, the system alerts the driver and, depending on the failure, adopts a default action to ensure driver safety. Refer to the Jaguar Quick Reference Diagnostic Guide: S-TYPE POWERTRAIN DTC Summaries.

Operation of the system is designed to be totally transparent to the driver with a total delay of less than 70 ms between pedal actuation and throttle movement.

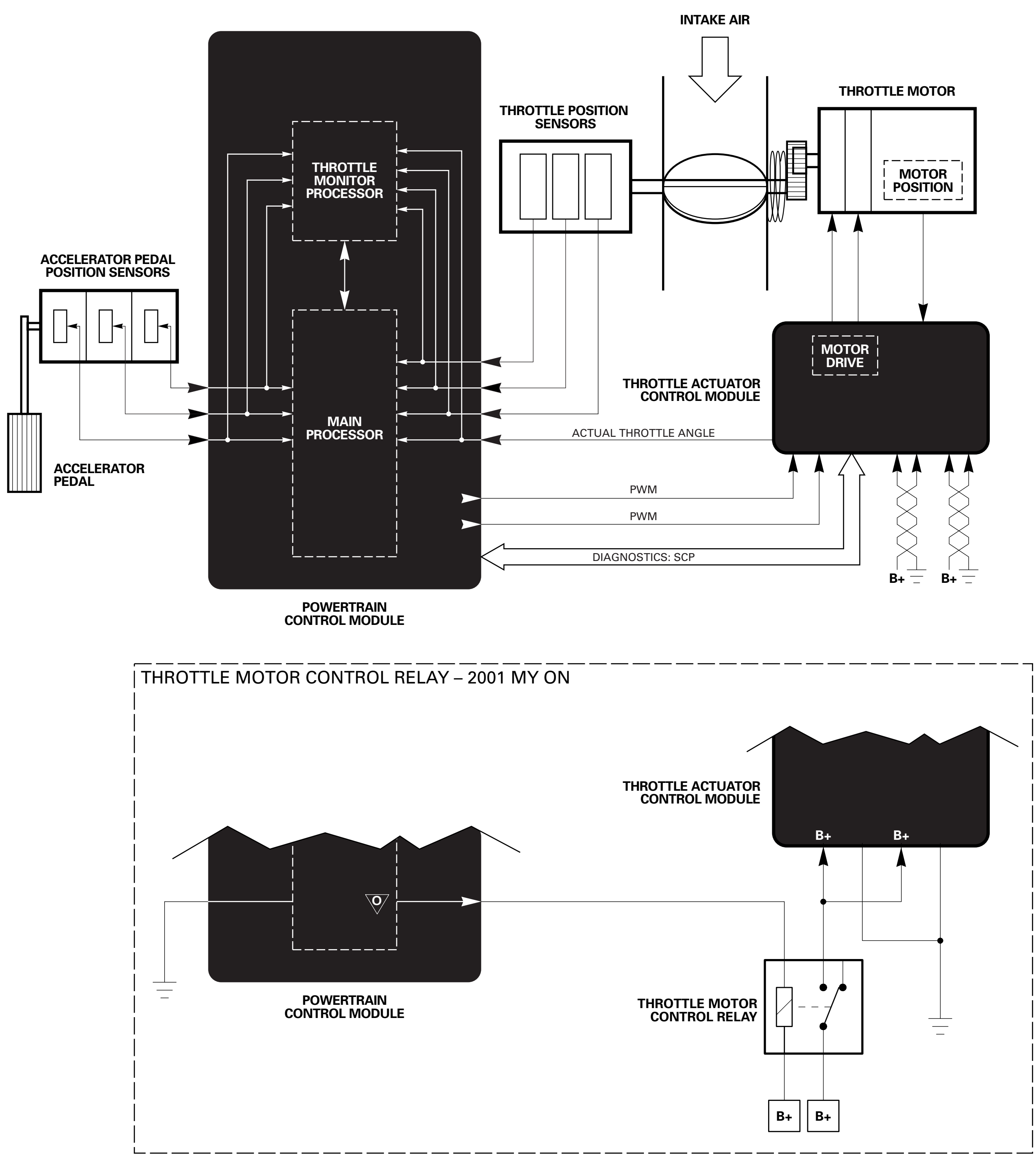
Throttle Data Recorder

The PCM throttle monitor processor incorporates a throttle data recorder. If the throttle data recorder is stopped by an airbag deployed input, the current throttle data is retained in memory and the PCM main processor flags DTC P1582. The throttle data recorder will not function again until 100 ignition key cycles have been completed. The logged DTC P1582 will require an additional 40 key cycles to clear, or the DTC can be cleared using PDU.

Throttle Motor Control Relay, 2001 Model Year ON

2001 Model Year ON PTEC systems have a PCM internal timer circuit to control a throttle motor control relay. This circuit allows the PCM to open the throttle, via the relay, after engine OFF to prevent exhaust gas from building-up in the intake manifold and creating difficult hot start conditions.

THROTTLE CONTROL LOGIC



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INDUCTION AIR AND THROTTLE CONTROL

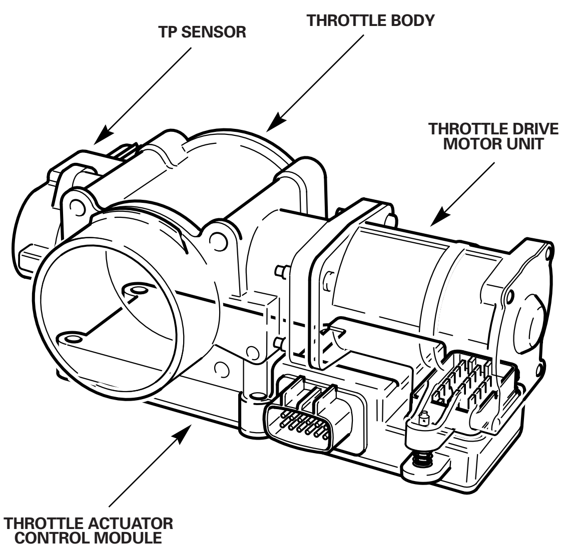
Throttle Body Assembly

The throttle body assembly consists of the following sub components:

- Throttle body with valve and shaft
- Throttle actuator control module (TACM)
- Drive motor unit
- Throttle position (TP) sensor assembly

Because each throttle assembly is calibrated during assembly, no adjustments to the assembly or its components are required or permitted. The throttle body must not be disassembled. The only serviceable component is the TP sensor assembly.

THROTTLE BODY ASSEMBLY



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Throttle body

The throttle body is an aluminum casting with a 70 mm (2.75 in.) intake bore. The throttle valve and shaft rotate on ball bearings with an internal tooth quadrant gear and two throttle return springs on the drive end of the shaft. Factory adjusted and sealed stop screws set the throttle closed and full open positions.

Throttle drive motor unit

The throttle drive motor unit consists of the motor and an integral position encoder. If the motor fails, the throttle return springs return the throttle valve to the closed position.

WARNING: DO NOT PUT YOUR FINGERS IN THE THROTTLE BODY BORE. THEY COULD BE INJURED IF TRAPPED BY THE THROTTLE PLATE.

CAUTION: Do not attempt to clean the throttle housing or remove any sealant from the assembly. Any air leakage will disturb the idle speed calibration.

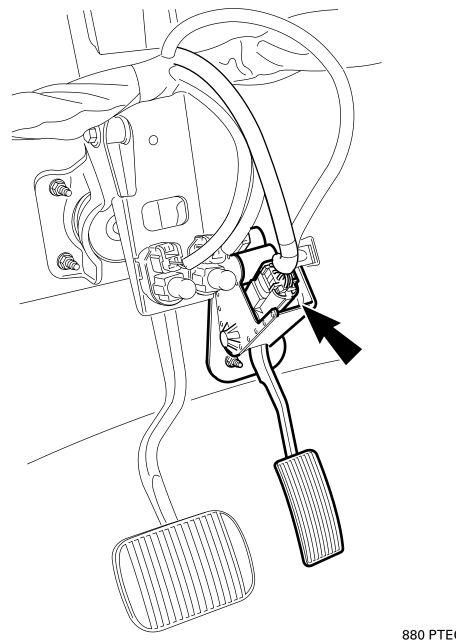
NOTES

Accelerator Pedal Position (APP) Sensor Assembly

- Three individual rotary potentiometers comprise the APP sensor assembly located at the top of the accelerator pedal.
- The potentiometers are driven by the accelerator pedal pivot shaft and provide separate analog voltage signals to the PCM proportional to accelerator pedal movement and position.
- The accelerator pedal uses two return springs to provide a positive return if one should fail, and to simulate the feel of a conventional accelerator pedal.

Each potentiometer has separate reference voltage and reference ground circuits hard-wired to the PCM; each provides its unique pedal position signal (via hard-wire connection) directly to the PCM. The PCM detects faults by comparing each pedal position signal to expected values as shown in the chart below.

APP SENSOR



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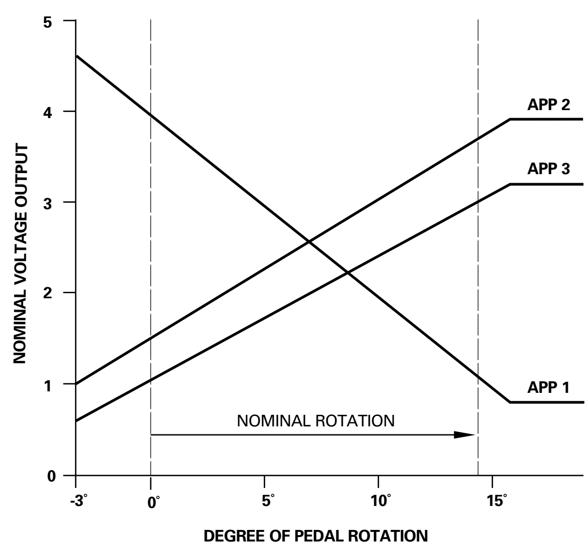
PCM throttle control

The PCM calculates a required throttle position from the APP input signals and applies engine speed, cruise control status, engine torque reduction requirements, and other applicable data to generate duplicate 256 Hz PWM throttle command signals.

The command signal duty cycle is increased as more throttle opening is required. Duplicate throttle command signals are transmitted to the throttle actuator control module (TACM) over separate wires.

APP SENSOR CHARACTERISTIC



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NOTES

INDUCTION AIR AND THROTTLE CONTROL

Throttle Actuator Control Module (TACM)

The TACM has two connectors and mounts to the throttle body and motor assembly. One connector plugs directly into the throttle motor. The second connector is the main interface with the PCM and also carries the twisted pair B+ voltage and ground supplies for TACM and throttle motor drive power. The two separate B+ voltage supplies from the front power distribution boxes are switched by powertrain relay 1 and the two separate ground supplies share the main ground stud used by the PCM.

The TACM processes the two throttle command PWM signals from the PCM and drives the throttle motor to the required position. The motor's position feedback to the TACM provides closed loop control and enables the TACM to maintain the desired throttle valve position. The PCM monitors actual throttle valve angle via the three-element TP sensor signals.

The TACM is on the SCP multiplex network and communicates with the PCM only for diagnostic purposes.

In addition to motor drive and positioning, the TACM also performs the following functions:

- Self diagnostics
- PCM throttle command signals validity comparison
- Requested throttle angle to actual throttle angle comparison
- Drive motor circuit operational comparison
- Failed throttle return spring detection
- Drive motor internal circuit continuity monitoring
- Inductive position encoder failure and out of range signals monitoring
- SCP transmission of diagnostic data to the PCM

NOTES

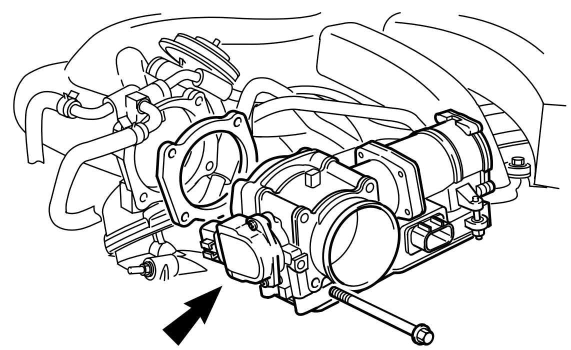
Throttle Position Sensor (TPS) Assembly

The throttle position sensor assembly consists of three Hall effect sensing elements with conditioning circuits that are directly driven by the throttle valve shaft.

Each sensing element has separate reference voltage and reference ground circuits hard-wired to the PCM; each provides its unique throttle position signal (via hard-wire connection) directly to the PCM. The unique characteristics of each signal are used for identification, similar to the APP Sensor signals.

NOTES

TP SENSOR



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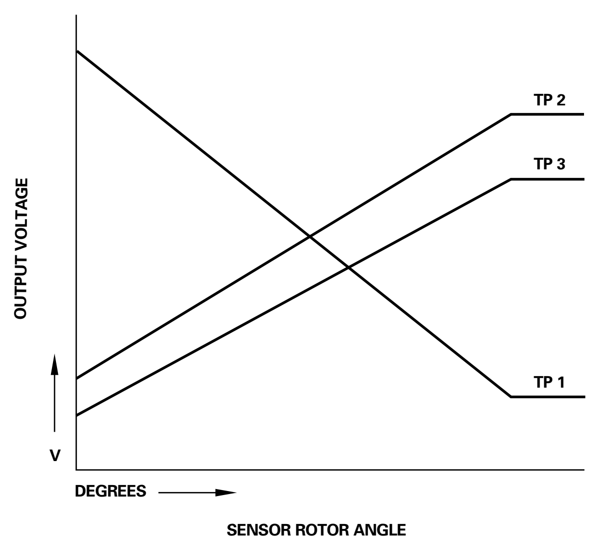
TP SENSORS GENERAL CHARACTERISTICS



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INDUCTION AIR AND THROTTLE CONTROL

Cruise Control

The cruise control system is fully integrated within PTEC. The PCM maintains the driver selected vehicle speed to within ±1 mph (1.5 km/h) via the normal throttle control and other engine and transmission control functions. The system uses inputs from illuminated steering wheel mounted ON / OFF, SET / ACCEL, COAST, CANCEL, and RESUME switches, the two brake pedal switches (normally open Brake Switch, normally closed Brake Cancel Switch), and vehicle speed. Cruise control is operational between 25 – 130 mph (40 – 209 km/h).

The cruise control strategy within the PCM uses engine control to provide smooth acceleration and deceleration. In cases such as driving downhill, where the vehicle tends to exceed the cruise control set speed, the PCM uses an engine braking strategy and transmission downshifts to help maintain the desired speed.

Cruise control switch functions

ON / OFF

When the system is switched ON or OFF, the PCM broadcasts an SCP VEHICLE SPEED CONTROL ON/OFF message. A SPEED CONTROL ON or OFF message is displayed in the message center for 4 seconds accompanied by a single audible chime. The PCM also broadcasts an SCP VEHICLE SPEED CONTROL SET SPEED ENABLE/DISABLE message whenever the Speed Control Set lamp in the instrument pack should be switched ON or OFF.

SET / ACCEL

Touching the SET / ACCEL switch with the cruise control switched ON and vehicle speed in the operating range puts the system into SET mode. The current vehicle speed is memorized and maintained. If the switch is held in the active position the vehicle will accelerate smoothly until it the switch is released. If the switch is touched momentarily (less than 640 ms), the vehicle speed increases by 1 mph. Pressing the accelerator pedal will accelerate the vehicle higher than the memorized speed without disengaging cruise control. When the pedal is released, the vehicle smoothly decelerates to the memorized speed.

COAST

Touching the COAST switch momentarily (less than 640 ms) decelerates the vehicle 1 mph. Holding the switch allows the vehicle to decelerate until the switch is released. When the switch is released, the vehicle will maintain the current speed.

CANCEL

Touching the CANCEL switch or applying the brakes puts the system into STANDBY mode and allows the vehicle to decelerate until either the SET / ACCEL or the RESUME switch is activated.

RESUME

When the system is STANDBY mode, touching the RESUME switch accelerates the vehicle to the memorized set speed. Resume will not function if the system has been switched OFF, the ignition has been switched OFF, or the vehicle is below the minimum operational speed.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

JAGUAR

Service Training Course 881
DATE OF ISSUE: 9/2001

FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Electronic Returnless Fuel System

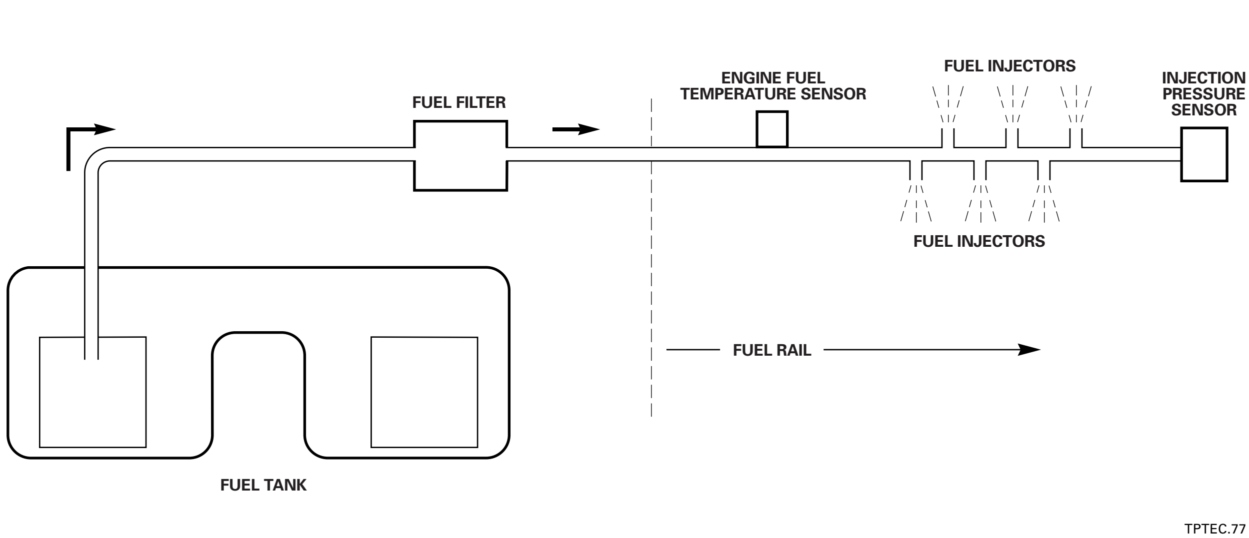
The electronic returnless fuel system used with the PTEC engine management system provides pressurized fuel at the fuel injectors and does not require a return line with its associated hardware. Additional benefits of the system include:

- Precise fuel pressure control
- Reduced fuel temperature and fuel tank vapor caused by constant fuel recirculation
- Reduced electrical system load
- Fuel pressure boost to prevent fuel vapor lock
- Reduce hot start cranking time

Fuel delivery volume and pressure from the single in-tank fuel pump are controlled by the PCM in a closed loop. The actual fuel pump “drive” is supplied and controlled by the Rear Electronic Control Module (RECM), which receives fuel pump control input from the PCM. The PCM / RECM fuel pump control circuit is hard wired.

The system delivers the correct amount of fuel to the engine under all conditions and at a constant pressure differential with respect to manifold absolute pressure, without the need for a return line to the tank or a fuel rail pressure regulator.

ELECTRONIC RETURNLESS FUEL SYSTEM

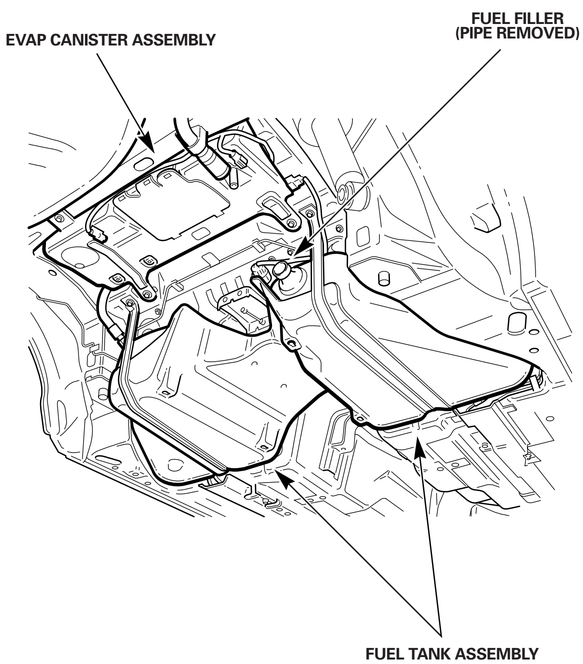


NOTES

FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Electronic Returnless Fuel System (continued)

JAGUAR S-TYPE FUEL TANK AND EVAP CANISTERS (UNDERFLOOR)



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Fuel tank (Jaguar S-TYPE)

The plastic blow-molded fuel tank is a saddle shape tank with LH and RH fuel compartments. The tank is located below the rear passenger seat with the drive shaft and exhaust running through the arch of the tank. The underside of the tank is protected by a heat shield. The tank assembly is retained by two metal straps which are fixed to the underbody at the front by removable hinge pins and at the rear by bolts.

Refueling is via a separate filler pipe and connecting hose to a stub pipe on the RH fuel compartment.

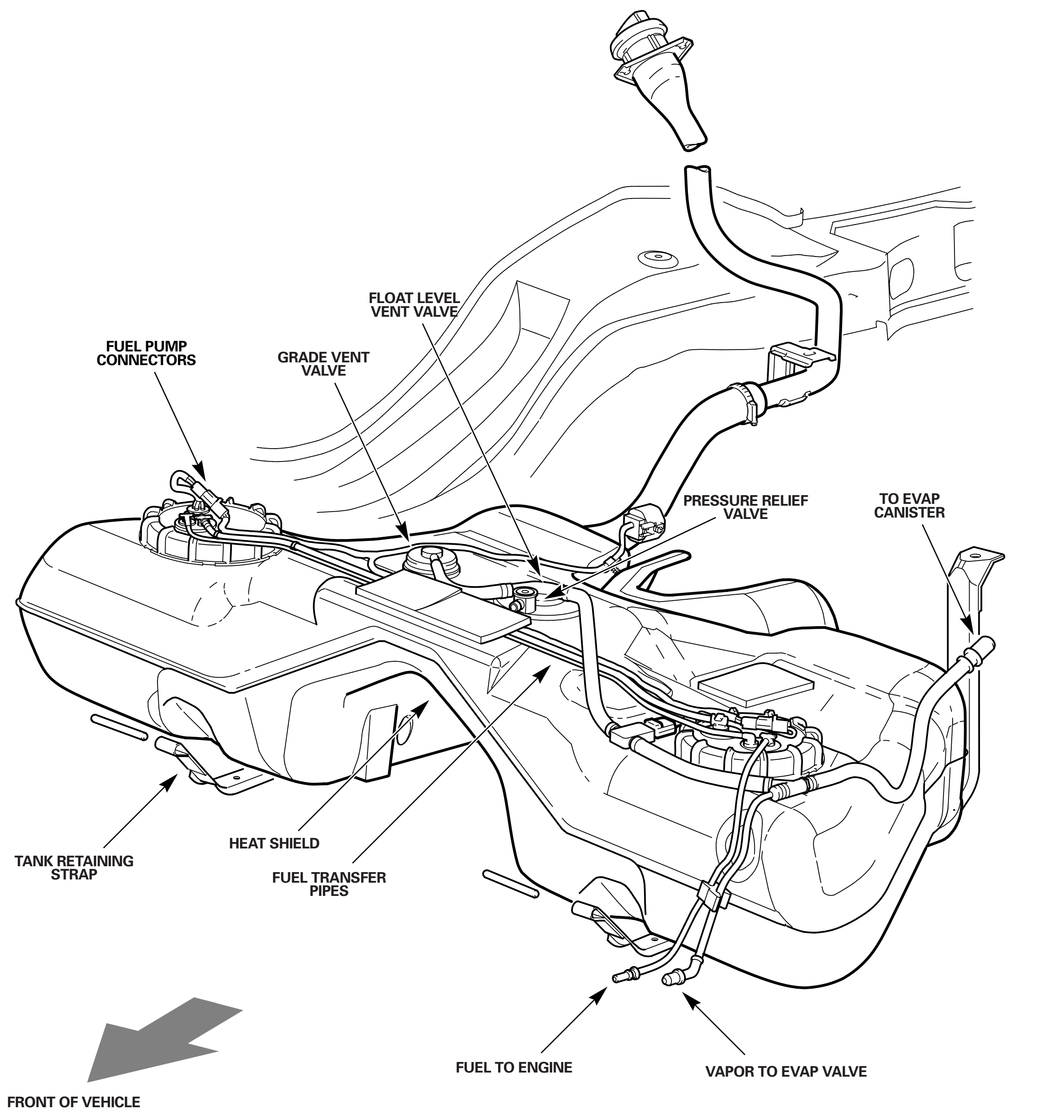
A variable speed fuel pump is located in the RH compartment. Jet pumps are located in both compartments with external crossover pipes for fuel transfer between the compartments. The crossover pipes and electrical connectors exit the fuel tank through top plates which are secured in the tank using screw-on closure rings. The components on the top of the fuel tank are accessible from inside the vehicle via two access holes in the floor panel, below the rear seat.

Fuel filter

The replaceable in-line fuel filter is located in the back of the left wheel well. All fuel supply lines use quick-fit connections that require a Jaguar service tool.

NOTES

JAGUAR S-TYPE FUEL TANK ASSEMBLY



FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Electronic Returnless Fuel System (continued)

Fuel flow

- The variable speed fuel pump is contained in a fuel reservoir in the RH compartment.
- Fuel is pumped from the reservoir through an external crossover pipe to the LH compartment where it flows via a 'T' junction to the parallel pressure relief valve and then out to the engine fuel rail.
- The reservoir fuel level is maintained by the continual flow of fuel supplied by jet pumps in the LH and RH compartments.

Fuel from the LH compartment is pumped through an external crossover pipe to the reservoir. The RH compartment jet pump is located in the base of the reservoir.

Parallel pressure relief valve

The parallel pressure relief valve assembly contains two spring-loaded valves, which operate in opposite directions:

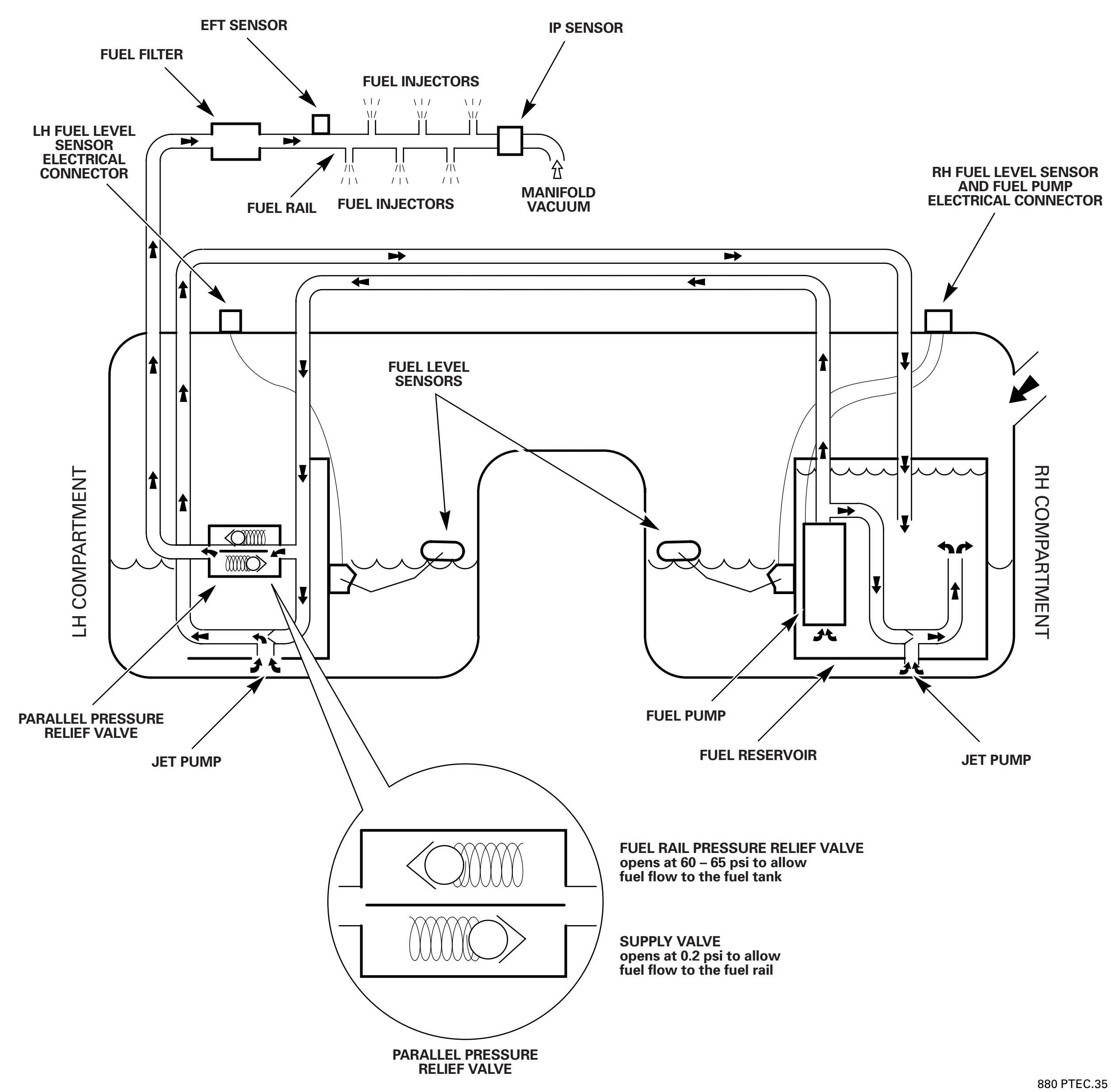
- The supply valve opens to allow fuel flow at approximately 0.014 Bar (0.2 psi) during normal operation.
- The fuel rail pressure relief valve opens at approximately 4.14 – 4.48 Bar (60 – 65 psi) to relieve excessive fuel rail pressure.

The main functions of the parallel pressure relief valve assembly are:

- To ensure fast engine starting by "checking" fuel in the supply lines and rail.
- To limit rail pressure due to temporary vapor increase during hot soak conditions (temperature and thus pressure drop after approximately 20 minutes.)
- To limit rail pressure caused by sudden load changes such as a full to closed throttle transition.
- To prevent siphoning from the tank in the even of the fuel line being severed with the pump inactive.

NOTES

FUEL FLOW



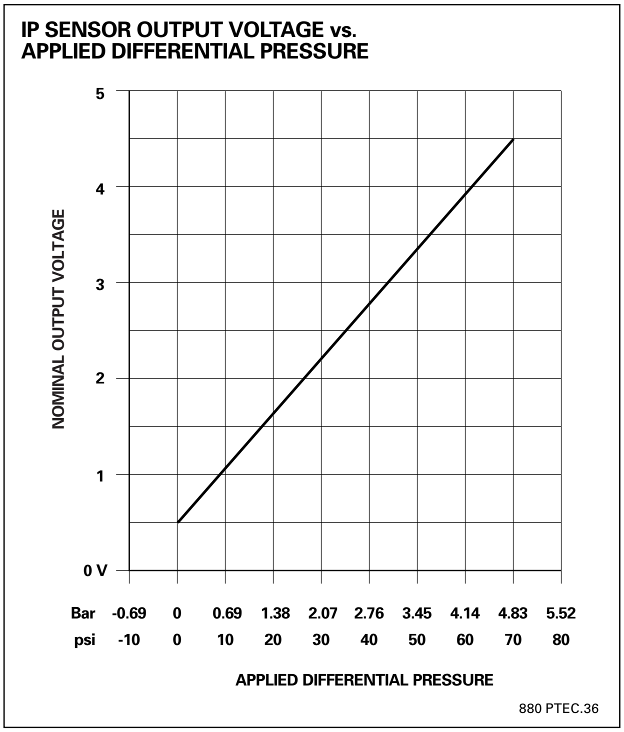
NOTES

FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Electronic Returnless Fuel System (continued)

Fuel System Sensors

The fuel pump delivers fuel through a single fuel supply line to the closed-ended fuel rail. Two sensors feedback rail fuel pressure and temperature to the PCM. The IP (injector pressure) sensor is located at the end of the fuel rail, the EFT (engine fuel temperature) sensor is located at the supply end of the fuel rail.



Fuel injection pressure (IP) sensor

- The IP sensor, located on the fuel rail, is a pressure transducer device with a diaphragm separating the pressure transducer from direct contact with the fuel.
- A pipe connects the sensor to the intake manifold for sensing manifold depression (manifold vacuum).
- The voltage signal from the transducer is "conditioned" within the sensor.
- The PCM receives the conditioned voltage signal, which is proportional to differential fuel pressure in the rail.

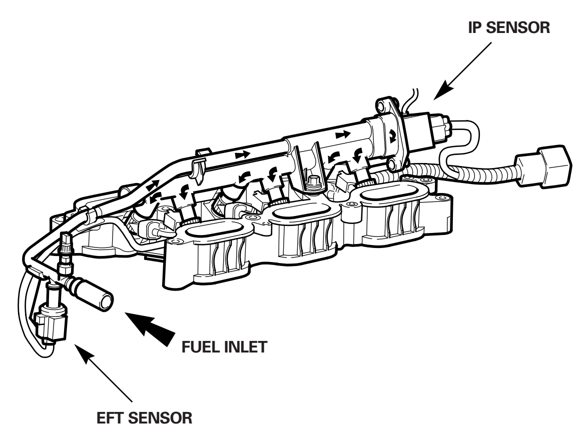
NOTES

Engine fuel temperature (EFT) sensor

- The EFT sensor, located on the fuel rail, is a thermistor which has a negative temperature coefficient (NTC).
- Fuel temperature is determined by the PCM by the change in the sensor resistance.
- The PCM applies a 5 volts to the sensor and monitors the voltage across the pins to detect the varying resistance.
- The PCM uses the EFT signal to adjust fuel pump pressure to prevent fuel vaporization and ensure adequate fuel supply to the injectors.

NOTES

FUEL RAIL – V6



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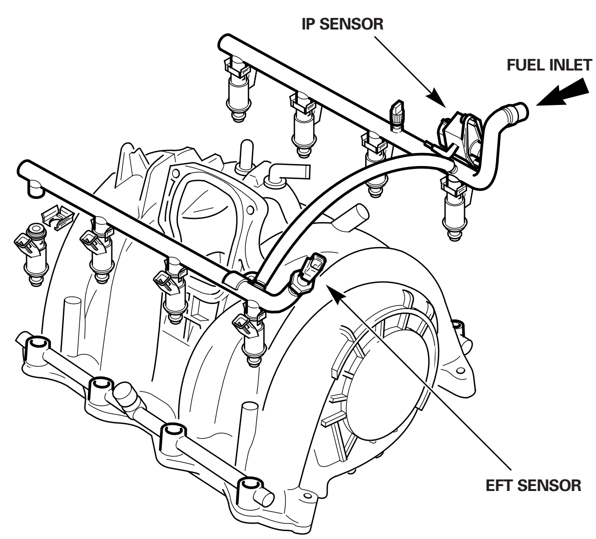
FUEL RAIL – V8



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FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Electronic Returnless Fuel System (continued)

Fuel pump control and operation

The fuel pump relay, located in the rear power distribution box, supplies power to the RECM to operate the fuel pump. The relay is activated by ignition switched B+ voltage via the inertia switch.

The PCM calculates engine fuel requirements using:

- engine load
- speed
- air flow
- engine temperatures:
  - cylinder head (V6)
  - engine coolant (V8)
  - intake air
- current fuel rail environment from the IP and EFT sensors.

The PCM communicates the fuel flow demand to the RECM as a pulse width modulated (PWM) signal over a single line at a frequency of approximately 256 Hz and a duty cycle of 0-50%.

The RECM amplifies this signal by increasing the frequency by 64 and doubling the duty cycle, thus providing the variable high current drive for the fuel pump.

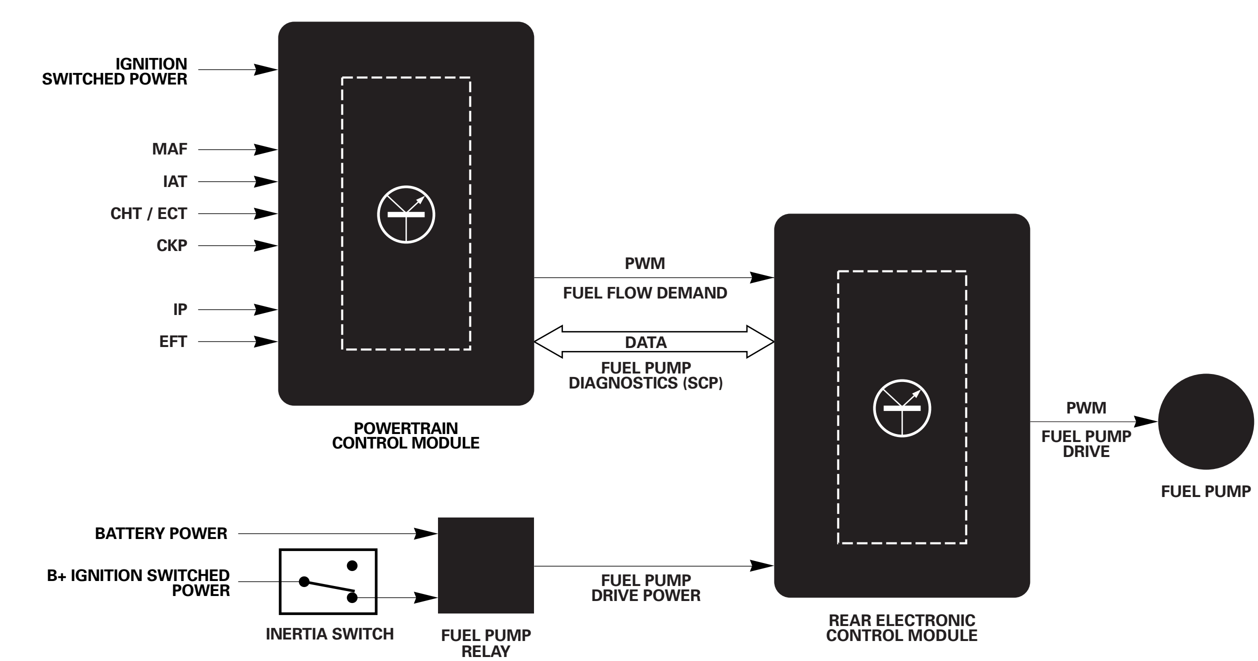
When the ignition switch is turned from OFF to RUN or START, the PCM primes the system by running the pump for 1 second. After prime, the pump is switched ON when the CKP signal is received. The pump is switched OFF 1 second after the engine is stopped. During all hot fuel conditions, fuel pressure is increased to prevent vapor lock.

Fuel pump drive status is monitored by the RECM and communicated to the PCM via the SCP network.

In the event of a vehicle impact, the inertia switch switches open deactivating the fuel pump relay and causing the RECM to cancel fuel pump drive.

NOTES

FUEL PUMP CONTROL



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Fuel level sensors

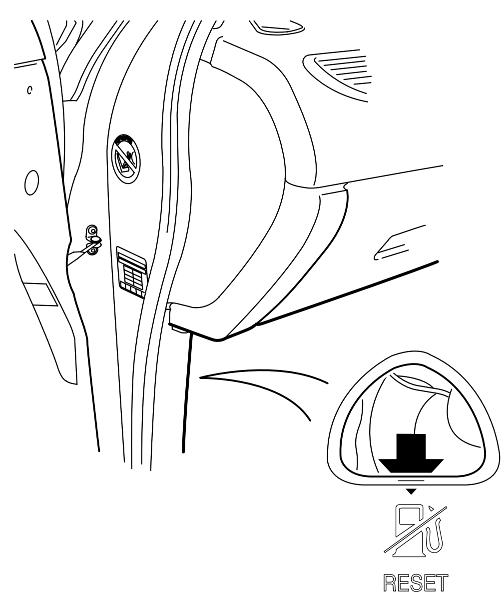
Outputs from the fuel level sensors are connected by independent wires to the RECM, which communicates the LH and RH sensor data independently to the instrument pack and the PCM via the SCP network.

Inertia switch

The inertia switch is located behind the trim on the left side of the vehicle, forward of the front door post and below the fascia. A finger access hole in the trim allows the switch to be reset.

If the inertia switch is tripped, it interrupts the ignition switched B+ voltage supply circuit to the fuel pump relay coil. The direct B+ voltage fuel pump supply to the RECM is interrupted and the pump immediately stops.

INERTIA SWITCH



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NOTES

FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Evaporative Emission Control System

EVAP fuel tank components

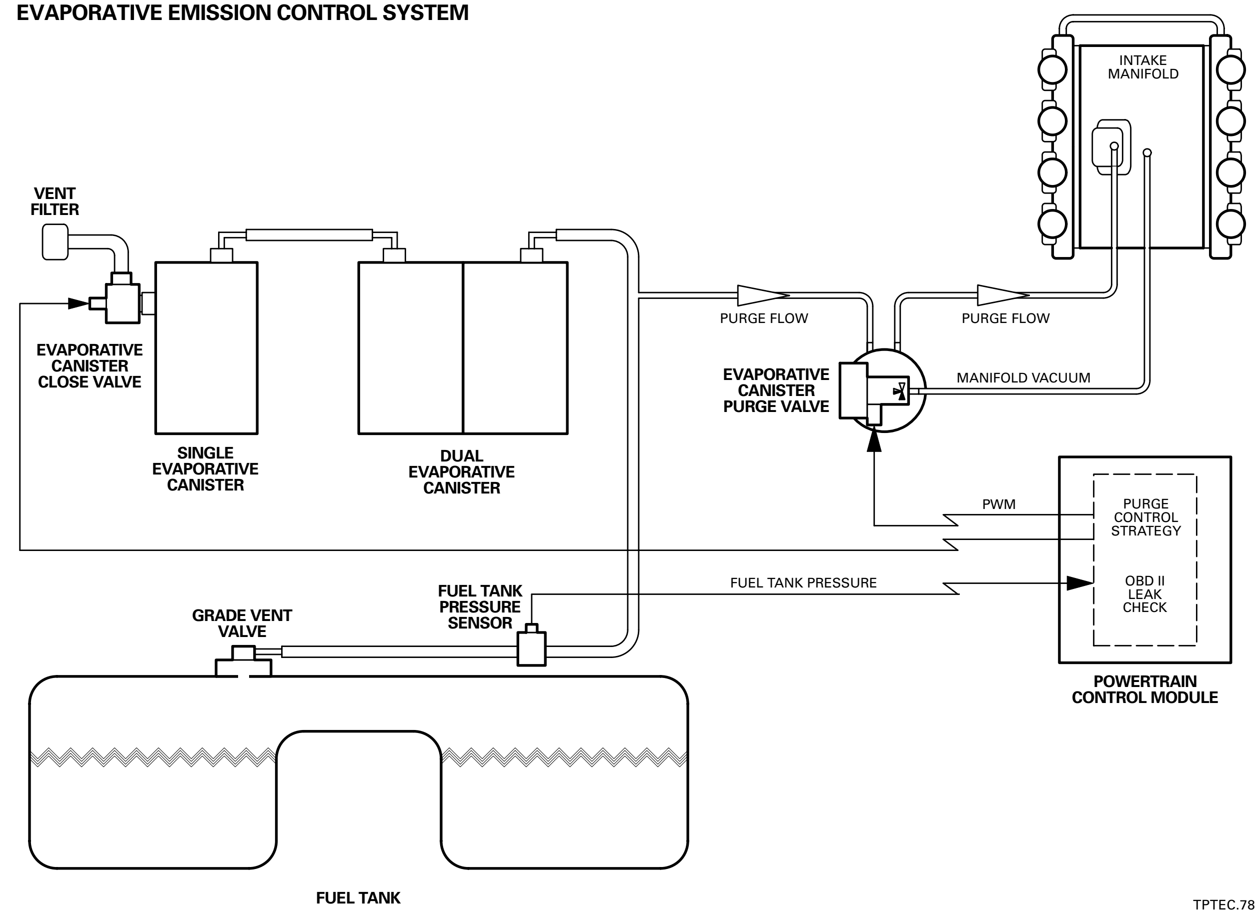
To meet ORVR evaporative emission requirements, the tank and associated components are designed to minimize vapor losses. During refueling, the narrowed fuel filler tube below the nozzle region provides a liquid seal against the escape of vapor and a check valve in the tank inlet pipe opens to incoming fuel only to prevent splashback. As the tank fills, vapor escapes through the fuel level float valve, at the top of the tank, and passes through the adsorption canisters to atmosphere. When the rising fuel level closes the float valve, the resulting back pressure causes refueling cutoff. While the float valve is closed, any further rise in vapor pressure is relieved by the grade vent valve which connects to the canisters via the outlet of the float valve. At less than full tank level, the float valve is always open, providing an unrestricted vapor outlet to the canisters.

If the tank is over filled (e.g. a fault in the delivery system) an integral pressure relief valve in the float valve assembly opens to provide a direct vent to atmosphere.

The float level vent valve/pressure relief valve assembly and the grade valve are welded to the tank top and are non-serviceable. Note that both valve assemblies incorporate roll-over protection.

The fuel filler cap uses a 1/8 turn action and is tethered to the body. The filler cap assembly incorporates both pressure relief and vacuum relief valves (the latter is a new feature to Jaguar).

EVAPORATIVE EMISSION CONTROL SYSTEM

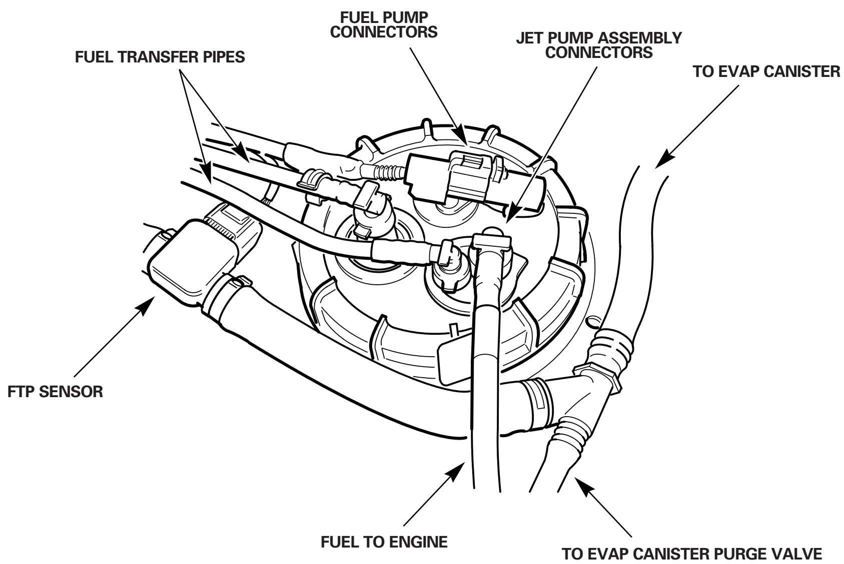


EVAP canister assembly

Three series connected EVAP carbon canisters (one single, one dual) are used for vapor storage and are mounted on a plastic bracket fixed to the underbody above the rear axle.

The EVAP canister close valve and fuel tank pressure sensor are components used by the PCM for leak check monitoring. The EVAP canister close valve is mounted on the canister bracket. The fuel tank pressure sensor is fitted to the vapor pipe.

JAGUAR S-TYPE EVAP FUEL TANK COMPONENTS



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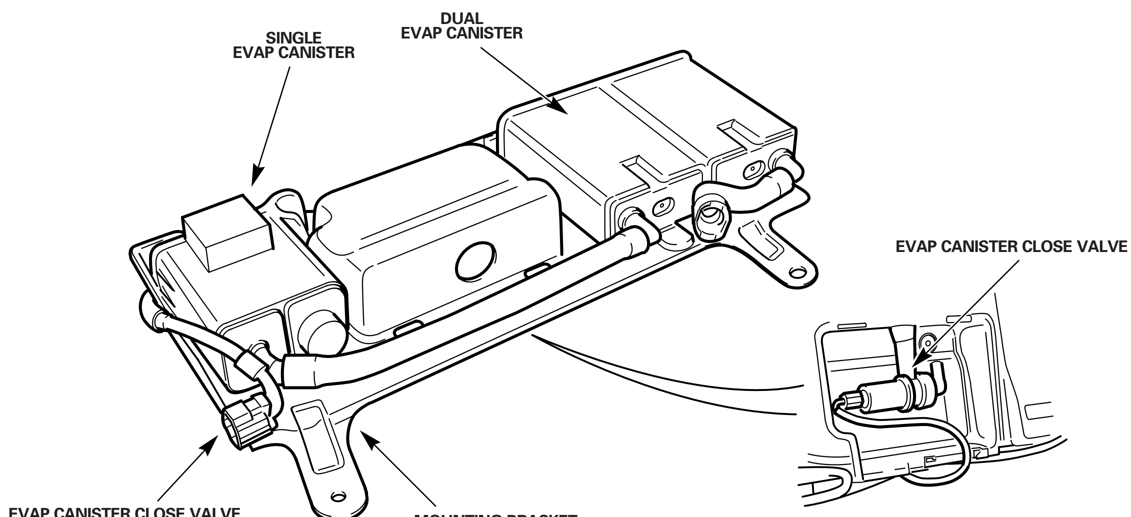
JAGUAR S-TYPE EVAP CANISTER ASSEMBLY



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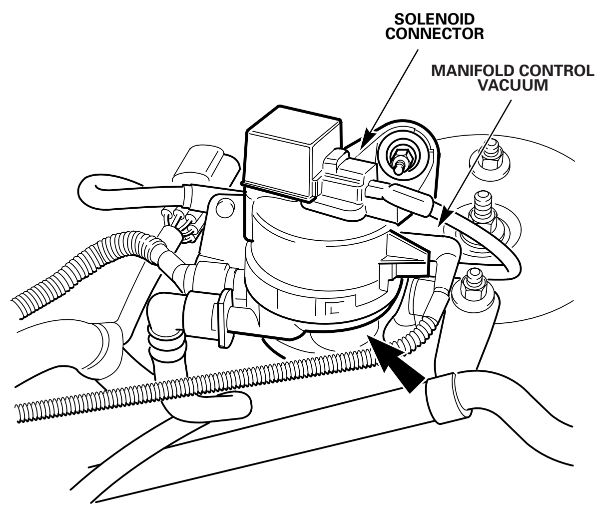
FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

Evaporative Emission Control System (continued)

EVAP CANISTER PURGE VALVE



EVAP canister close valve

The EVAP canister close valve is a solenoid valve that closes the canister vent outlet when driven by the PCM. By closing the vent, the system can be monitored for leaks.

Fuel tank pressure (FTP) sensor

The FTP sensor is a pressure transducer device. The voltage signal from the transducer is “conditioned” within the sensor. The PCM receives the conditioned voltage signal, which is proportional to the vapor pressure in the fuel tank.

EVAP canister purge valve

The EVAP canister purge valve is mounted on the rear left hand side of the engine bay. The valve is controlled by the PCM with a PWM signal driving a solenoid valve, which in turn applies manifold vacuum to actuate the valve.

NOTES

Crankcase Ventilation System: V6

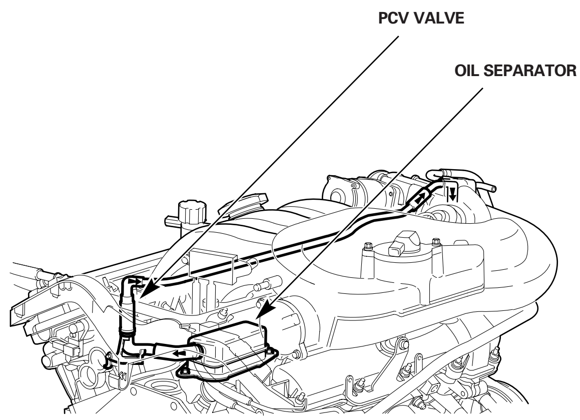
The closed and part throttle crankcase ventilation system consists of an oil separator, externally mounted to the cylinder block between the cylinder banks, a spring-loaded in-line positive crankcase ventilation (PCV) valve, and a hose to the intake manifold. The intake manifold hose connection is downstream of the throttle valve and is warmed by engine coolant to prevent icing.

During closed and part throttle conditions, high manifold vacuum opens the spring loaded PCV valve allowing crankcase vapors to be drawn through the oil separator to the intake manifold. Any oil in the vapors is trapped by the separator and returns to the crankcase. As throttle opening increases, intake manifold vacuum decreases and the PCV valve closes in proportion to the manifold vacuum decrease.

The full load crankcase ventilation system consists of breather outlets on each camshaft cover connected to the intake duct via hoses and a tee connection. At full and near full load engine operation, intake duct pressure decreases drawing crankcase vapor to the intake via the hoses and tee connection.

NOTES

POSITIVE CRANKCASE VENTILATION: V6



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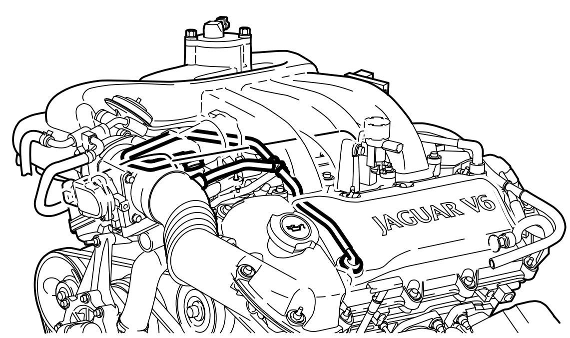
FULL LOAD VENTILATION: V6



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FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL

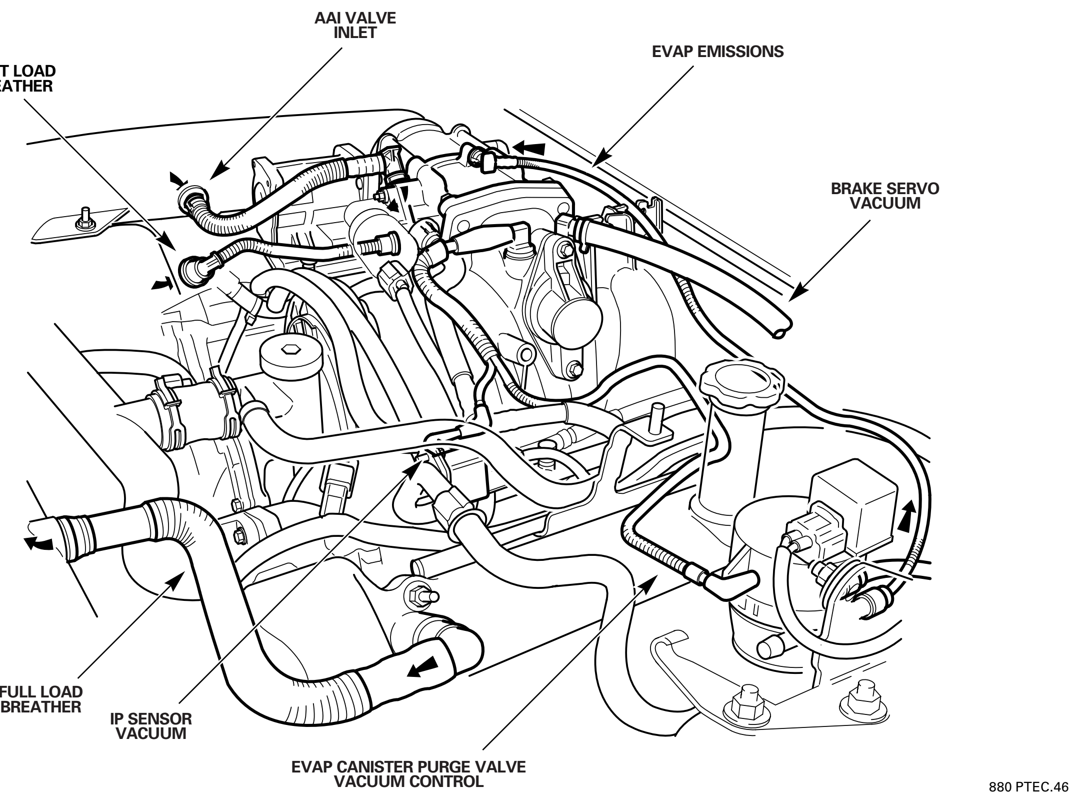
Crankcase Ventilation System: V8

The V8 full load and part load breather pipes are reconfigured in the Jaguar S-TYPE to accommodate the induction manifold, camshaft covers and the engine installation.

During idle and part load operation, crankcase vapors are drawn through the bank 1 camshaft cover oil separator to the heated intake manifold connection downstream of the throttle valve. During full load operation the vapors flow through the bank 2 camshaft cover oil separator to the intake duct.

Vacuum connections for the EVAP system and the IP Sensor are also shown in the illustration.

JAGUAR S-TYPE CRANCKCASE VENTILATION AND VACUUM CONNECTIONS: V8



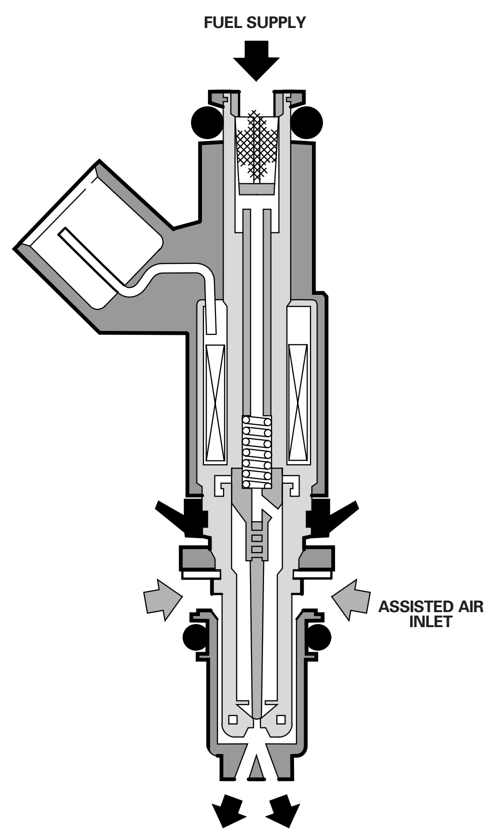
NOTES

PTEC ENGINE MANAGEMENT SYSTEM

JAGUAR

Service Training Course 881
DATE OF ISSUE: 9/2001

FUEL INJECTION



PTEC fuel injection strategy follows the current standard practice of sequential operation with PCM control to suit the prevailing engine and vehicle operating modes and conditions.

The fuel injectors for the S-TYPE V6 and V8 are of the twin-spray pintle-type design. The injectors for each engine have unique flow rates. The V8 injectors are constructed with a shroud to accommodate the air assisted injection (AAI) system.

Fuel injectors are identified by engine bank and cylinder position (bank/position) as follows:

	V6			V8			
Right hand bank	1 / 1	1 / 2	1 / 3	1 / 1	1 / 2	1 / 3	1 / 4
Left hand bank	2 / 1	2 / 2	2 / 3	2 / 1	2 / 2	2 / 3	2 / 4

Fuel injector resistance

V8 (Siemens)	12 Ohms
V6 (Bosch / Ford)	14 Ohms

NOTES

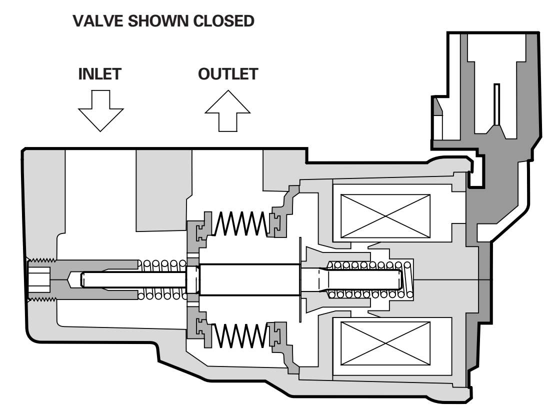
Air Assisted Fuel Injection (V8)

- Air assisted injection decreases the formation of hydrocarbons and improves combustion stability during cold engine starts by admitting a metered amount of air to the base of each fuel injector to help atomize the fuel.
- The amount of air admitted reduces progressively as engine temperature increases.

- The PCM controlled AAI valve is attached to the throttle body adapter.
- The valve controls the air flow volume through the hoses to the air rails and fuel injectors.
- The air rails are part of each bank of the intake manifold.
- The difference between intake manifold pressure and atmospheric pressure causes the air to flow through the valve.

NOTES

AAI VALVE (V8)



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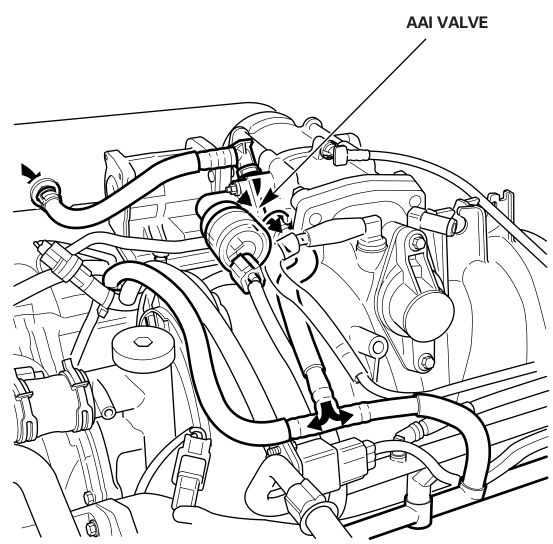
AAI VALVE AND AIR DISTRIBUTION



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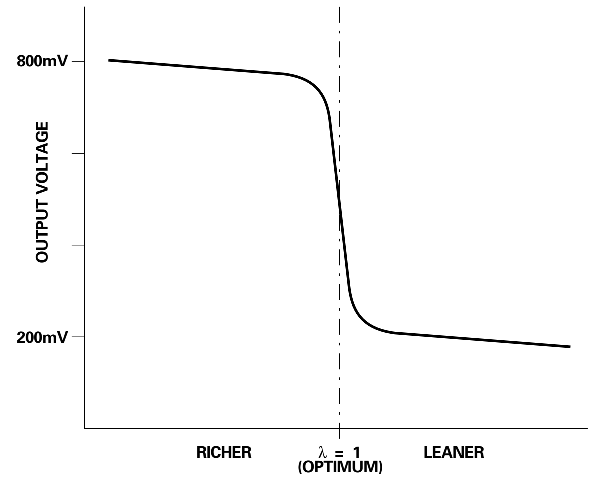
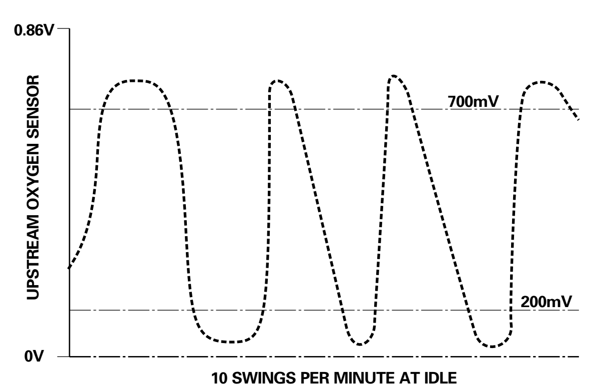
FUEL INJECTION

Heated Oxygen (HO2) Sensors



TPTEC.50



TPTEC.51

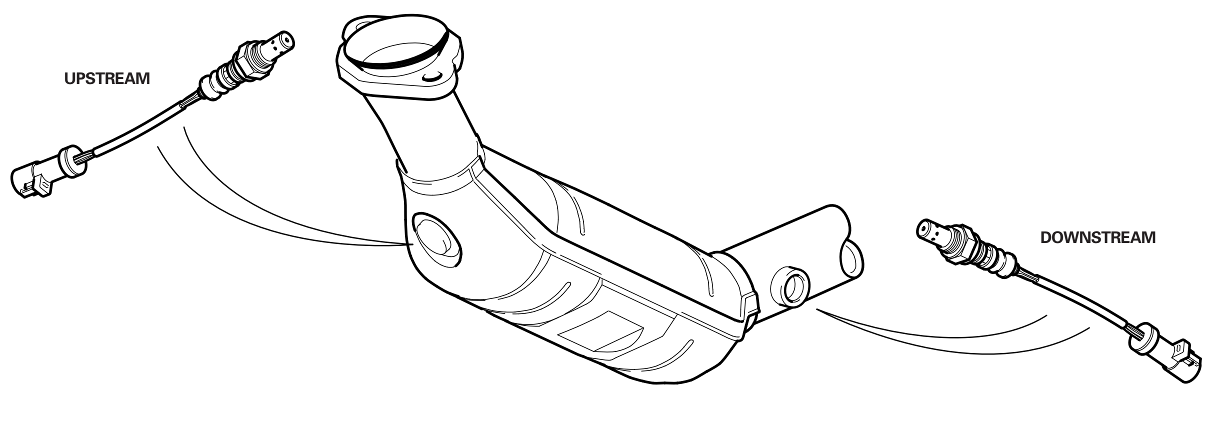
- Both the V6 and V8 engines use two conventional zirconium dioxide heated oxygen sensors for each cylinder bank.
- The oxygen sensors produce a voltage by conducting oxygen ions at temperatures above 300 °C (572 °F).
- The tip portion of the sensor's ceramic element is in contact with the exhaust gas.
- The remaining portion of the ceramic element is in contact with ambient air via a filter through the sensor body.

- Sensor output voltage switches between approximately 800 millivolts and 200 millivolts, depending on the oxygen content of the exhaust gas:
  - when the air : fuel ratio is richer than optimum, the oxygen content of the exhaust gas is low and the voltage output is high
  - when the air : fuel ratio is leaner than optimum, the oxygen in the exhaust is high and the output voltage is low.
- Only a very small change in air : fuel ratio is required to swing the oxygen sensor voltage from one extreme to the other, thus enabling precise fuel metering control.

NOTES

One sensor is located upstream and one is located downstream of each catalytic converter. The upstream sensors are used by the ECM for closed loop fuel metering correction. The downstream sensors are used to monitor catalyst efficiency.

HO2 SENSORS



HO2 sensors are identified by engine bank and exhaust position (bank/position) as follows:

	Upstream	Downstream
Right hand bank	HO2 sensor 1 / 1	HO2 sensor 1 / 2
Left hand bank	HO2 sensor 2 / 1	HO2 sensor 2 / 2

The HO2 sensor internal electric heaters reduce the time needed to bring the sensors up to operating temperature and maintain sensor temperature when the exhaust gasses are cool. B+ voltage is supplied to all four heaters from powertrain relay 2. Each heater has a separate ground circuit to the PCM for control and diagnostics.

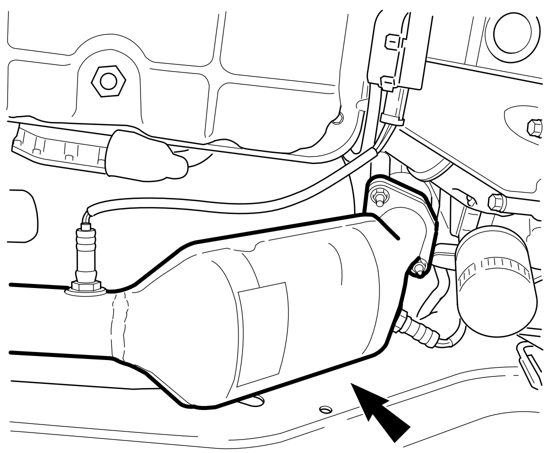
Upstream HO2 Sensor heater resistance	3.3 Ω
Downstream HO2 Sensor heater resistance	5.0 Ω

The PCM switches the upstream heaters ON at 100% for about 10 seconds during engine cranking, then controls the voltage to maintain sensor temperature above 350 °C (662 °F). This action provides fast "light off". The downstream HO2 sensors operate in the cooler exhaust gas exiting from the catalytic converter and are always ON while the engine is running.

NOTE: The upstream sensors connect to the engine (PI) harness and the downstream sensors connect to the transmission (GB) harness. THE UPSTREAM AND DOWNSTREAM SENSORS ARE NOT INTERCHANGEABLE.

FUEL INJECTION

CATALYTIC CONVERTER



TPTEC.53

Catalytic Converters

Each two-element catalytic converter is attached to its exhaust manifold with a two bolt self sealing flange. The resonator and muffler assemblies connect to the converter outlets with Torca clamps. The entire exhaust system can be serviced from under the vehicle.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

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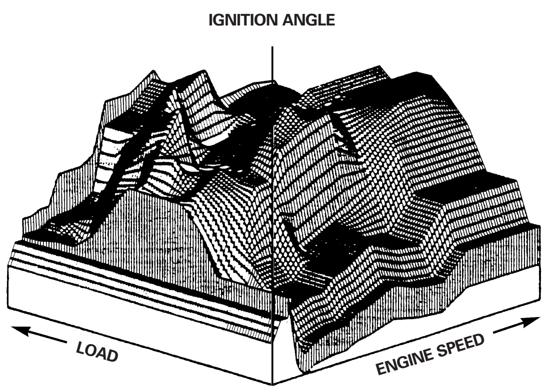
IGNITION

BASE IGNITION MAP (TYPICAL)



880 PTEC.54

PTEC ignition strategy follows the current standard practice of PCM control from a base ignition map, which is then corrected for the specific engine operating conditions. Ignition is synchronized by the PCM using the input signals from the CKP and CMP sensors.

Ignition coils are identified by engine bank and cylinder position (bank/position) as follows:

	V6	V8
Right hand bank	1/1 1/2 1/3	1/1 1/2 1/3 1/4
Left hand bank	2/1 2/2 2/3	2/1 2/2 2/3 2/4

Engine firing order

V6 1/1 . . . . 2/1 . . . . 1/2 . . . . 2/2 . . . . 1/3 . . . . 2/3

V8 1/1 . . . . 2/1 . . . . 1/4 . . . . 1/2 . . . . 2/2 . . . . 1/3 . . . . 2/3 . . . . 2/4

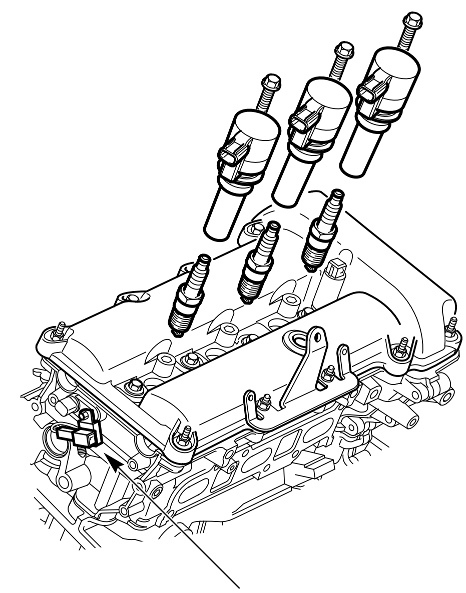
NOTES

- The spark plug for each cylinder is fired by an on-plug ignition coil.
- The primary current side of each coil is supplied with ignition switched B+ power.
- The ground side of each coil is switched directly by the PCM with no additional ignition amplifiers required.
- The primary coil switching duration is limited by the PCM to manage the voltage at 9.0v through the coils.
- Damage to the coils will result if the PCM switched circuit is short circuited to ground.
- The ignition suppression capacitors in the B+ supply circuit, fitted to the rear of each cylinder head, prevent radio interference.

CAUTION: The ignition coils are rated at approximately 9 volts. Testing a coil by applying B+ voltage will cause permanent damage and may destroy the unit.

NOTES

ON-PLUG IGNITION COILS – V6



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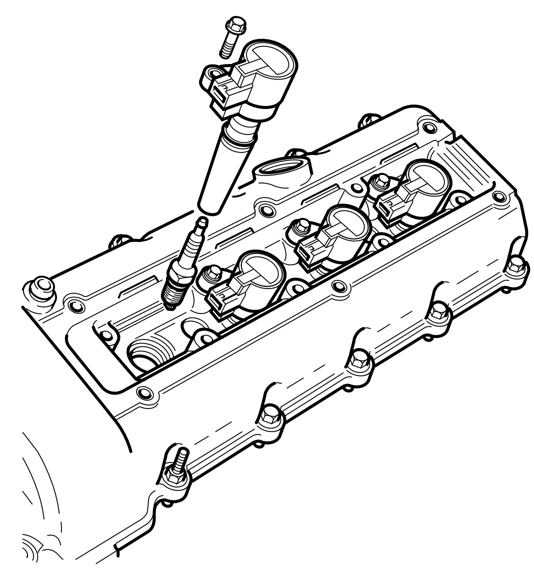
ON-PLUG IGNITION COILS – V8



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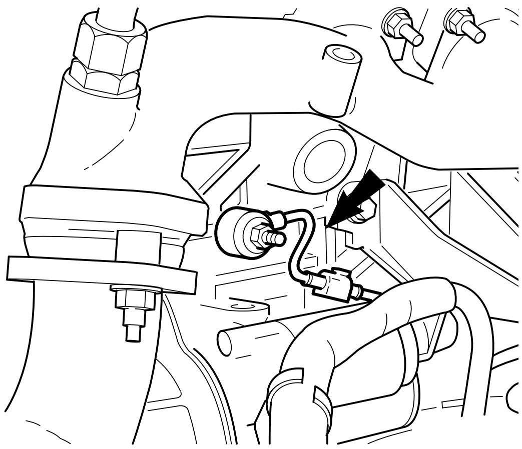
IGNITION

BANK 1 KNOCK SENSOR – V6



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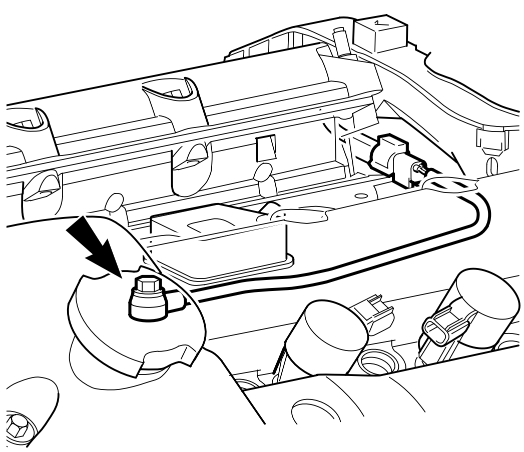
BANK 2 KNOCK SENSOR: – V6



880 PTEC.58

Ignition Knock (detonation) Control

- The ECM retards ignition timing to individual cylinders to control ignition knock (detonation) and optimize engine power.
- Two knock sensors (KS) are positioned on the cylinder block to sense engine detonation. One KS is positioned on bank 1 and the other on bank 2.
- V6 knock sensors are attached to the engine bank in different locations.
  – the bank 1 sensor, with the short flying lead, is located on the right side of the engine block above the starter motor
  – the bank 2 sensor, with the long flying lead, is located near the oil separator on the top of the cylinder block.
- V8 knock sensors are unchanged from previous Jaguar V8 engines.
- Each knock sensor has a piezo electric sensing element to detect broad band (2 – 20 kHz) engine accelerations.

- If detonation is detected, the PCM determines which cylinder is firing, and retards the ignition timing for that cylinder only.
- If, on the next firing of that cylinder, the detonation reoccurs, the PCM will further retard the ignition timing
- If the detonation does not reoccur on the next firing, the PCM will advance the ignition timing incrementally with each firing.
- The knock sensing ignition retard / advance process can continue for a particular cylinder up to a specified maximum retard measured in degrees of crankshaft rotation.

- During acceleration at critical engine speeds, the PCM retards the ignition timing to prevent the onset of detonation. This action occurs independent of input from the knock sensors

NOTES

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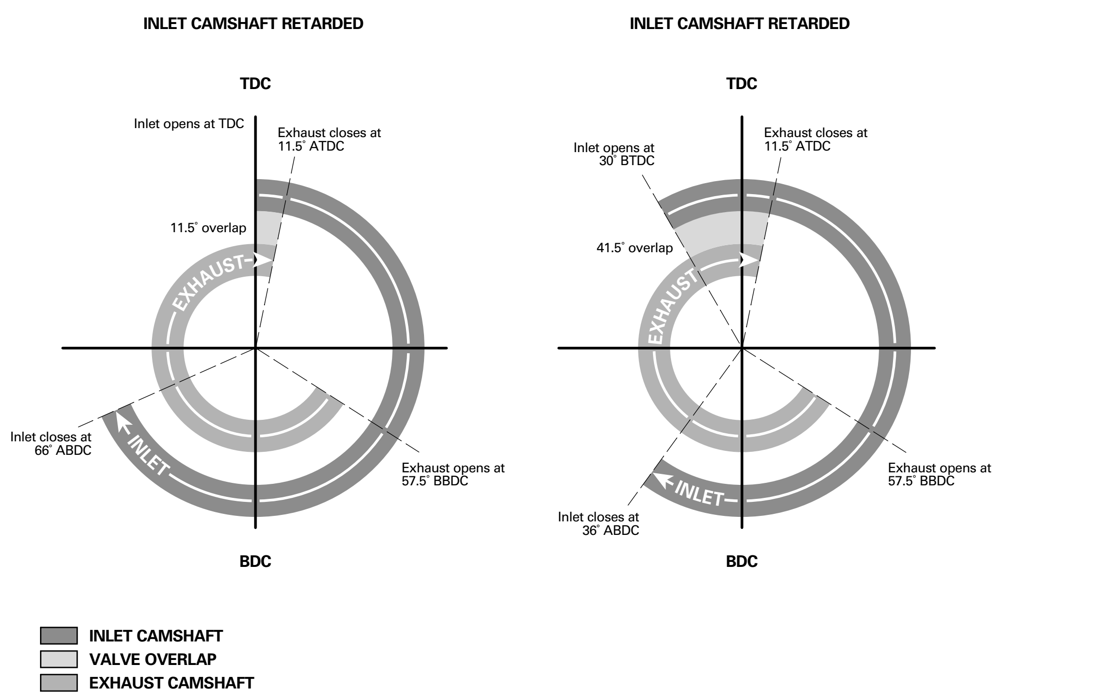
VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Valve Timing (VVT) – V6

A VVT system is used to allow the phasing of the inlet valve opening to be changed relative to the fixed timing of the exhaust valves. Two positions are used, 30˚ apart, with the advanced position occurring at 30˚ BTDC and overlapping with the exhaust opening.

The operating strategy is controlled by the engine management system in conjunction with the variable geometry induction system so as to optimize torque characteristics over the engine speed/load range. The VVT system also provides increased amounts of 'internal' EGR under certain speed/load operating conditions.

TWO-STAGE VVT TIMING – V6



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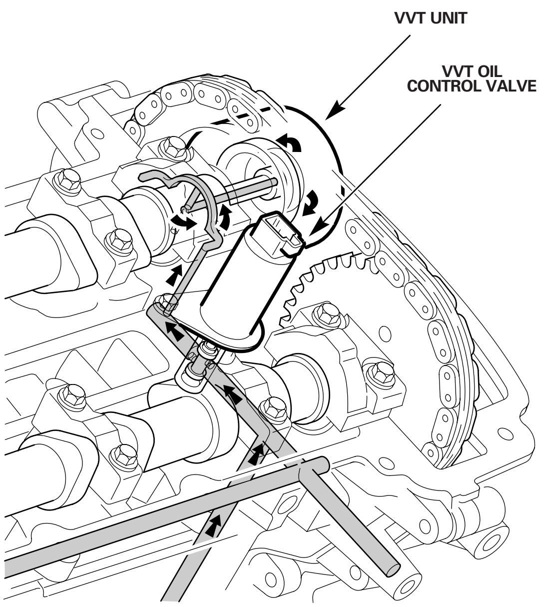
NOTES

VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Valve Timing (VVT) – V6 (continued)

VVT OIL FEED – V6



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V6 VVT Oil Feed

- The VVT/sprocket unit is fixed on the nose of each inlet camshaft via a locating pin and hollow bolt and is driven directly by the timing chain.
- The oil feed to each VVT unit is supplied via fixed oilways in the cylinder heads
- The oil feed is controlled by the VVT solenoid operated oil control valves, which are bolted directly to each cylinder head.

NOTES

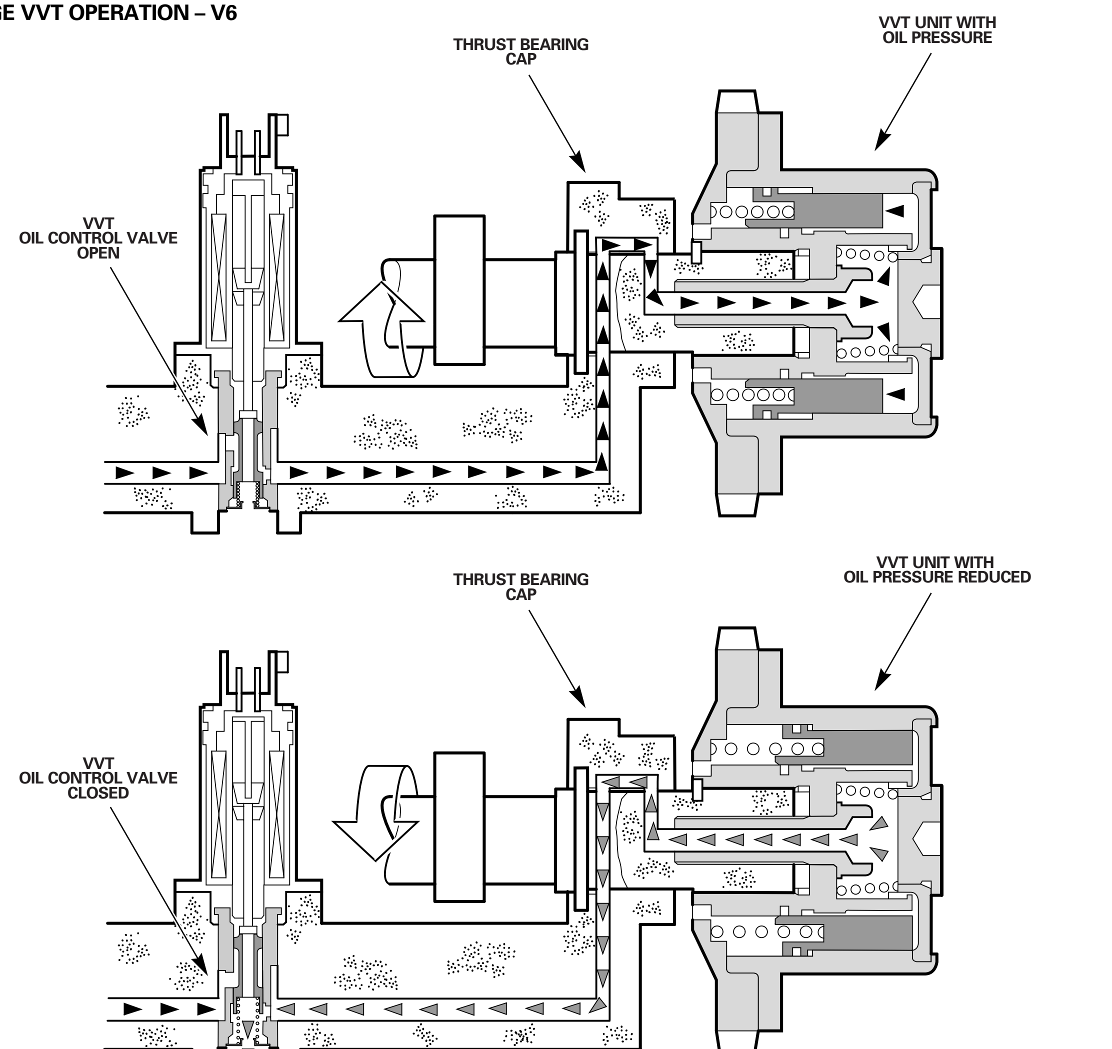
V6 VVT Operation

From the oil control valve, the flow is via the thrust bearing cap, through drillings in the camshaft and then through the hollow fixing bolt which secures the VVT unit. Drain holes are provided at the rear (camside) face of the VVT unit for any residual oil which has seeped past the piston.

With the oil control valve open, oil pressure on the helical drive piston is increased, rotating the cams to the advanced position. When the valve closes, oil pressure reduces and the return spring pushes the piston back to the fully retarded position.

The oil control valve is controlled by a 300Hz PWM signal from the PCM which sets it to either the fully open or fully closed position.

TW0-STAGE VVT OPERATION – V6



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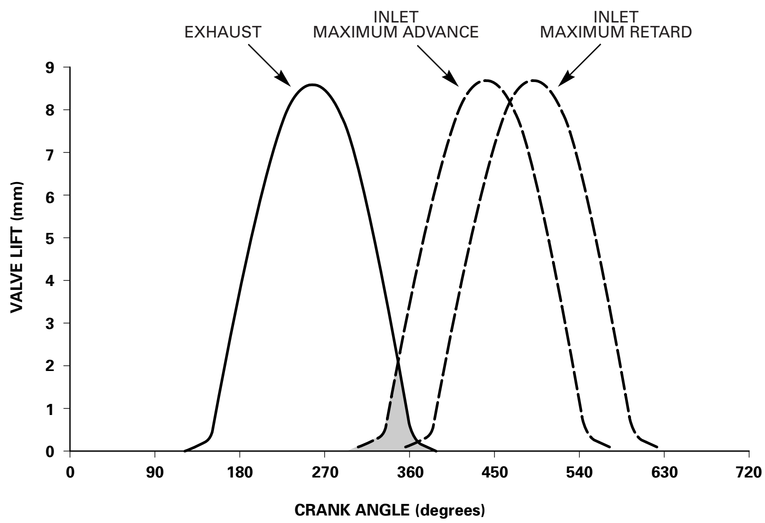
VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Valve Timing – V8

The V8 variable valve timing (VVT) system is the same as the linear VVT system used on AJ27 V8 engines. The system provides continuously variable inlet valve timing over a crankshaft range of 48° ±2°. Depending on driver demand, engine speed/load conditions and Powertrain Control requirements, the inlet valve timing is advanced or retarded to the optimum angle within this range. Compared to the two position system, inlet valve opening is advanced by an extra 8°, providing greater overlap and increasing the internal EGR effect (exhaust gases mixing with air in the inlet port).

LINEAR VVT TIMING – V8



880 PTEC.62

The linear VVT system provides a number of advantages:

- Improves internal EGR, further reducing NOx emissions and eliminating the need for an external EGR system
- Optimizes torque over the engine speed range without the compromise of the two position system: note that specified torque and power figures are unchanged
- Improves idle quality: the inlet valve opens 10° later, reducing valve overlap and thus the internal EGR effect (undesirable at idle speed)
- Faster VVT response time
- VVT operates at lower oil pressure

NOTES

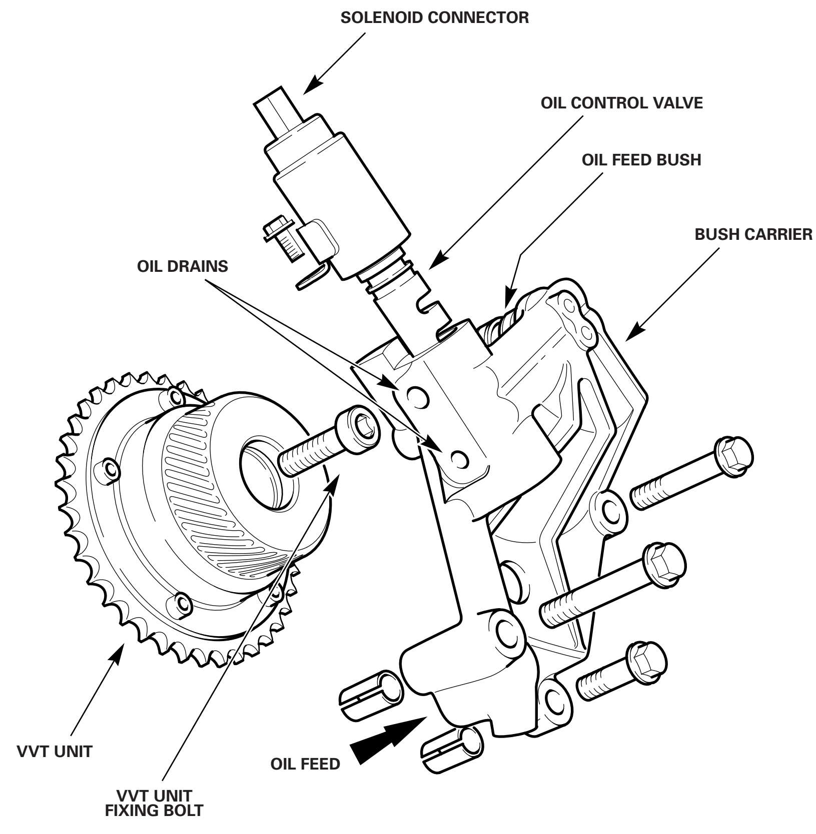
V8 Linear VVT Components

Each cylinder bank has a VVT unit, bush carrier and solenoid operated oil control valve. The VVT unit consists of an integral control mechanism with bolted on drive sprockets, the complete assembly being non-serviceable. The unit is fixed to the front end of the inlet camshaft via a hollow bolt and rotates about the oil feed bush on the bush carrier casting. The bush carrier is aligned to the cylinder head by two hollow spring dowels and secured by three bolts.

The oil control valve fits into the bush carrier to which it is secured by a single screw. The solenoid connector at the top of the valve protrudes through a hole in the camshaft cover but the cover must first be removed to take out the valve.

Note that only the bush carriers are left and right handed.

LINEAR VVT COMPONENTS – V8



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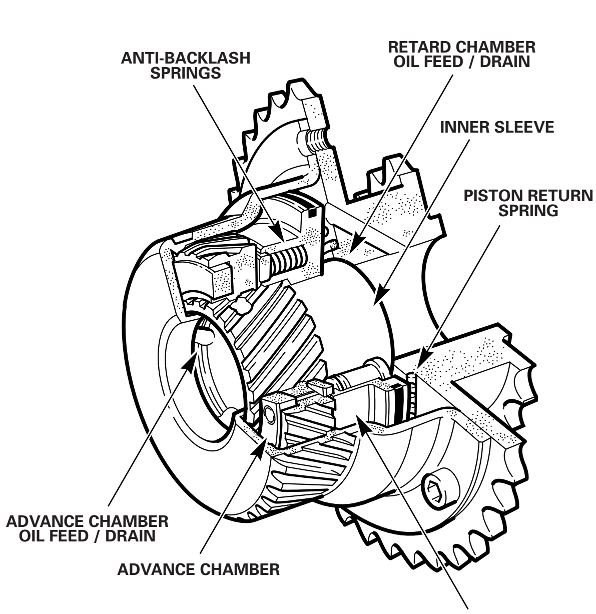
NOTES

VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Valve Timing: – V8 (continued)

LINEAR VVT UNIT – V8



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V8 Linear VVT unit

The VVT unit drives the secondary chain to the exhaust camshaft. The inlet camshaft is driven from the body of the unit via internal helical splines. When commanded from the PCM, this mechanism rotates the inlet camshaft relative to the body/sprocket assembly to advance or retard the valve timing.

The VVT unit has three main parts:

- the body/sprocket assembly
- an inner sleeve bolted axially to the nose of the camshaft
- a drive ring/piston assembly located between the body and inner sleeve and coupled to both via helical splines.

Oil pressure applied in the advance chamber forces the drive ring/piston assembly to move inwards along its axis while rotating clockwise on the helical body splines. Since the drive ring is also helically geared to the inner sleeve but with opposite angled splines, the inner sleeve is made to rotate in the same direction, turning the camshaft.

To move back to a retard position, oil pressure is switched to the retard chamber and the piston and rotational movements are reversed. A light pressure spring is fitted in the retard chamber to assist the piston assembly to revert to the fully retarded position with the engine stopped.

NOTES

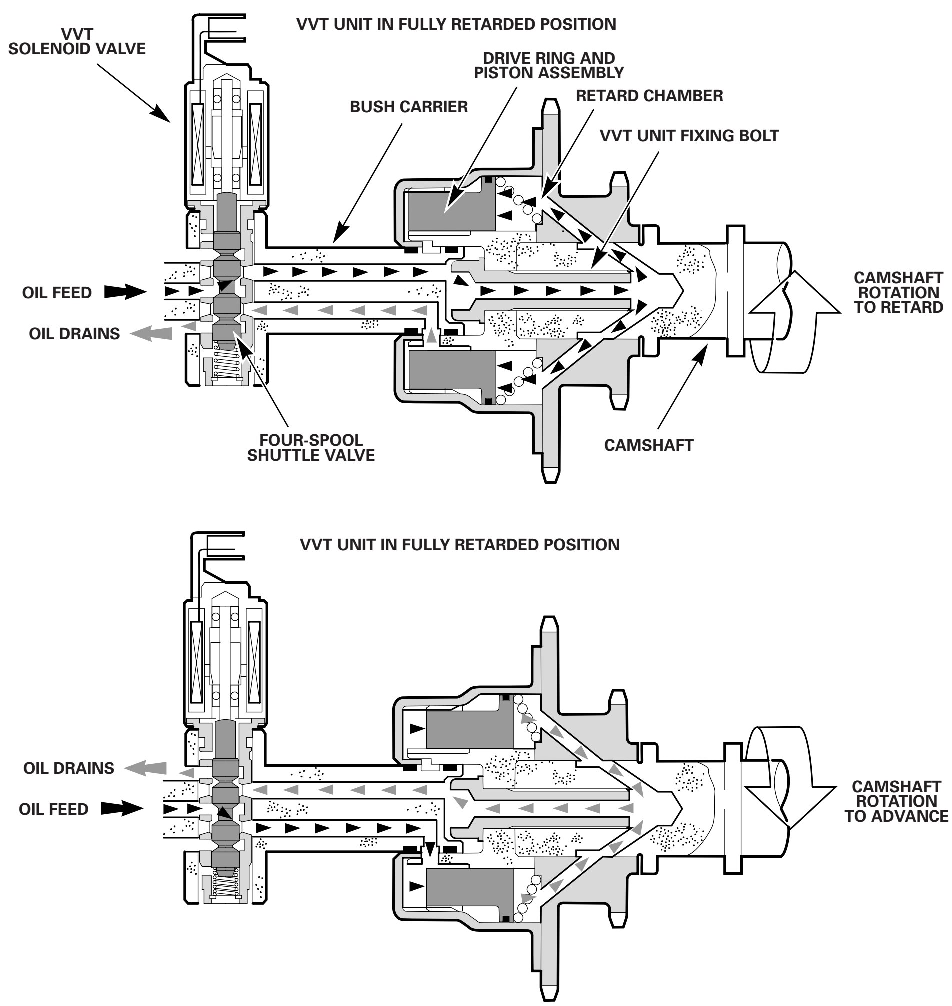
Linear VVT Oil Control

Engine oil is supplied to the VVT unit via the bush carrier and is switched to either the advance or retard side of the moving piston assembly by the oil control valve. The oil control valve consists of a four spool shuttle valve directly operated by a solenoid plunger and fitted with a return spring. It is a non-serviceable component.

To fully advance the cams, the solenoid is energized pushing the shuttle valve down. This action causes the incoming oil feed to be directed through the lower oilway in the bush carrier and into the advance oil chamber where it pushes on the piston/drive ring assembly. As the piston moves in the advance direction (towards the camshaft), oil is forced out of the retard chamber through oilways in the sprocket unit, camshaft, hollow fixing bolt, bush carrier and the shuttle valve from which it drains into the engine.

To move to the fully retarded position, the solenoid is de-energized, the return spring holds the shuttle valve in its upper position and the oil flow is directed through the bush carrier upper oilway into the VVT unit. Oil is channelled through the hollow VVT fixing bolt and via oilways in the camshaft and sprocket unit to the retard chamber where it acts on the moveable piston/drive ring assembly. As the piston moves, oil is forced from the advance chamber back through the shuttle valve to the engine.

LINEAR VVT OIL CONTROL – V8



VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Valve Timing – V8 (continued)

Linear VVT-PCM Control System

Closed loop control
Normally, continuously variable timing requires the VVT piston to be set to the optimal position between full advance and retard for a particular engine speed and load. The PCM positions the shuttle valve using a PWM control signal operating at a frequency of 300 Hz. The shuttle valve assumes a position between the limits of travel proportional to the "duty cycle" of the signal. An increasing duty cycle causes an increase in timing advance.

The actual position of the camshaft is monitored by the PCM from the CMP sensor signal. If a difference is sensed between the actual and demanded positions, the PCM will attempt to correct it.

Engine oil temperature
Engine oil properties and temperature can affect the ability of the VVT mechanism to follow demand changes to the cam phase angle. At very low oil temperatures, movement of the VVT mechanism is sluggish due to increased viscosity and at high temperatures the reduced viscosity may impair operation if the oil pressure is too low.

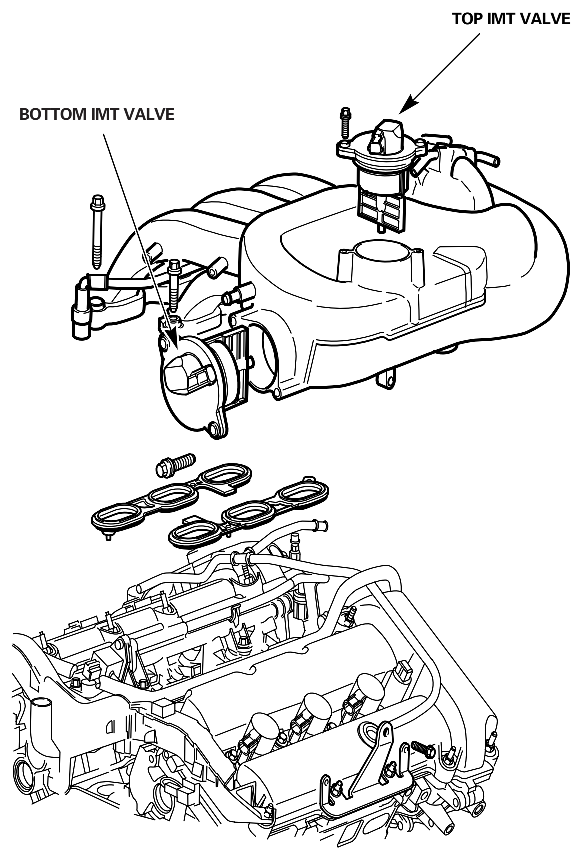
The VVT system is normally under closed loop control except in extreme temperature conditions such as cold starts below 0 °C (32 °F). At extremely high oil temperatures, the PCM may limit the amount of VVT advance to prevent the engine stalling when returning to idle speed. This could occur because of the slow response of the VVT unit to follow a rapid demand for speed reduction. Excessive cam advance at very light loads produces high levels of internal EGR which may result in unstable combustion or misfires.

NOTES

Variable Intake System (V6)

V6 engines use a variable intake system designed to optimize engine torque across the engine speed / load range. Variable intake combined with variable valve timing provides an optimized engine torque curve throughout the engine operating range.

VARIABLE INTAKE SYSTEM MANIFOLD (V6)



Variable Intake Components

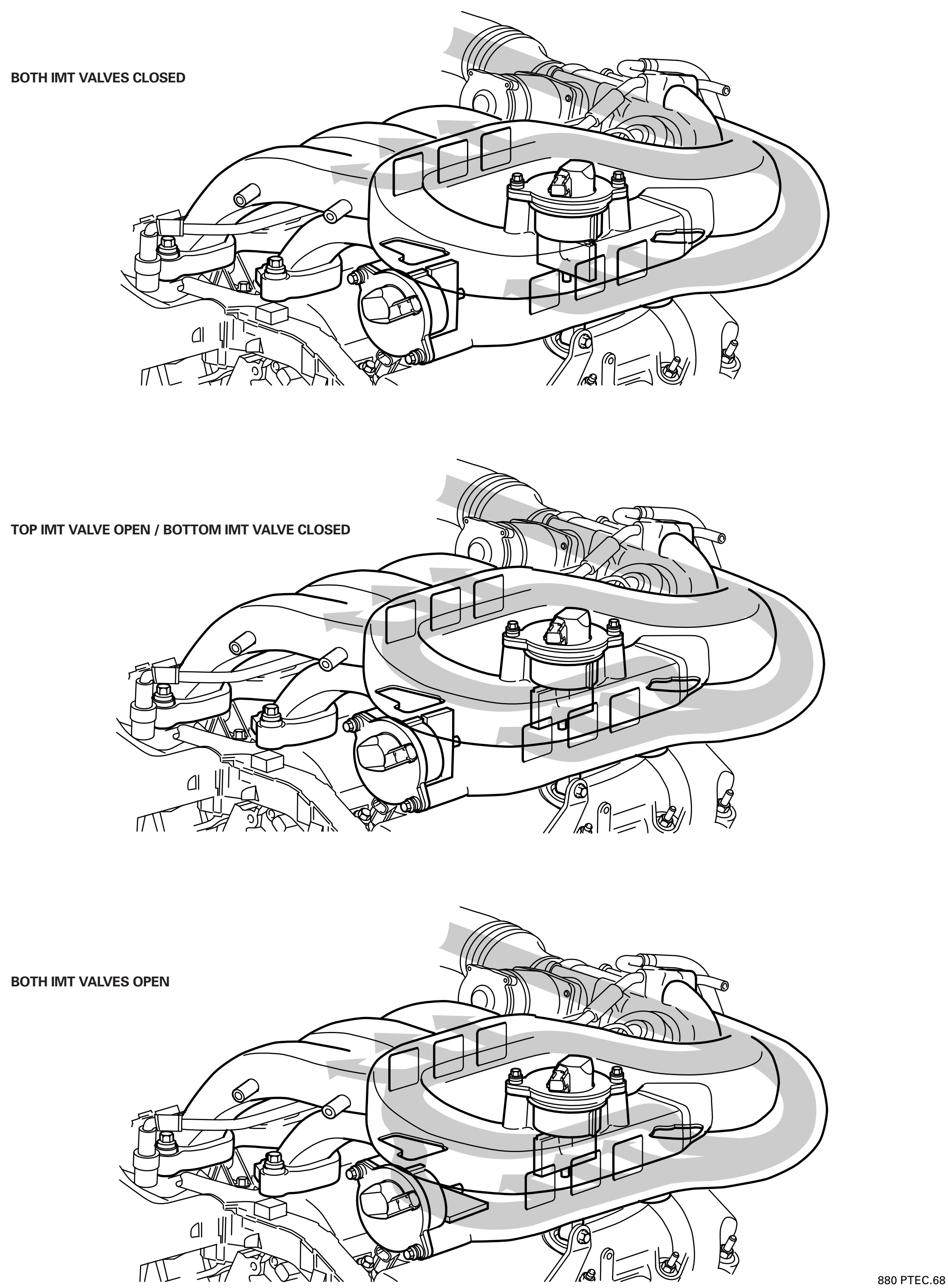
- The throttle body connects directly to the induction manifold assembly, which is constructed of aluminum alloy.
- The manifold mounts to the cylinder heads with the lower intake manifold assembly "sandwiched" between.
- The manifold plenum chamber is split into upper and lower compartments with two interconnecting holes.
- Two identical Intake Manifold Tuning (IMT) Valves are located at the interconnecting holes.
- The IMT valves are solenoid operated gate valves, which rotate 90° for open / close.
- B+ voltage is separately supplied to each IMT valve via powertrain control relay 1 in the front power distribution box.
- The PCM switches the ground side of the valves via separate hard wires to activate the solenoids.
- The plenum chamber volume and the length of the intake air path are tuned by the positions of the IMT valve gates to assure that the natural charge air pressure waves or pulses are maximized for the ever-changing engine speed and load conditions.
- The plenum chamber volume and manifold geometry can be set to three different configurations based on the specific engine speed / load range:
  - short pipe
  - medium-length pipe
  - long pipe
- The two IMT valves, controlled by the PCM are set in combination to provide the three manifold configurations.

NOTES

VARIABLE VALVE TIMING / VARIABLE INTAKE

Variable Intake System (V6) (continued)

VARIABLE INTAKE SYSTEM OPERATION (V6)



The PCM calculates the required valve positions using the following data:

- Engine speed from CKP sensor
- Throttle position from TP sensors
- Engine temperature from CHT sensor
- Charge air temperature from IAT sensor

Both valves closed

Both IMT valves closed provides the minimum plenum volume and the shortest intake air path to the cylinders.

Top valve open / bottom valve closed

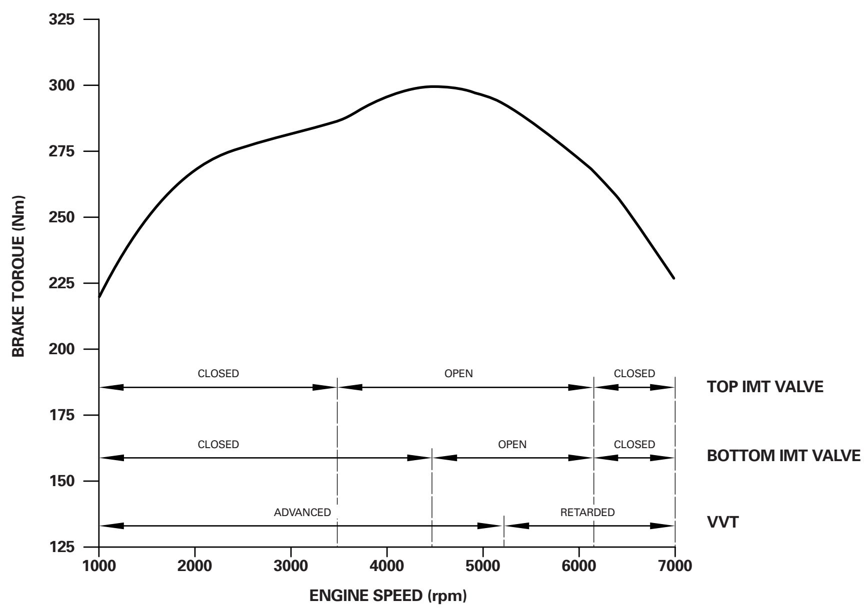
With the top valve open and the bottom valve closed, plenum volume and the effective length of the intake air path are both increased.

Both valves open

With both valves open, the plenum volume and the air intake path effective length are at their maximum.

The graph shows the how the PCM control of variable intake system optimizes the engine torque curve.

ENGINE TORQUE CHARACTERISTICS



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NOTES

PTEC ENGINE MANAGEMENT SYSTEM

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EXHAUST GAS RECIRCULATION (EGR): V6 ONLY

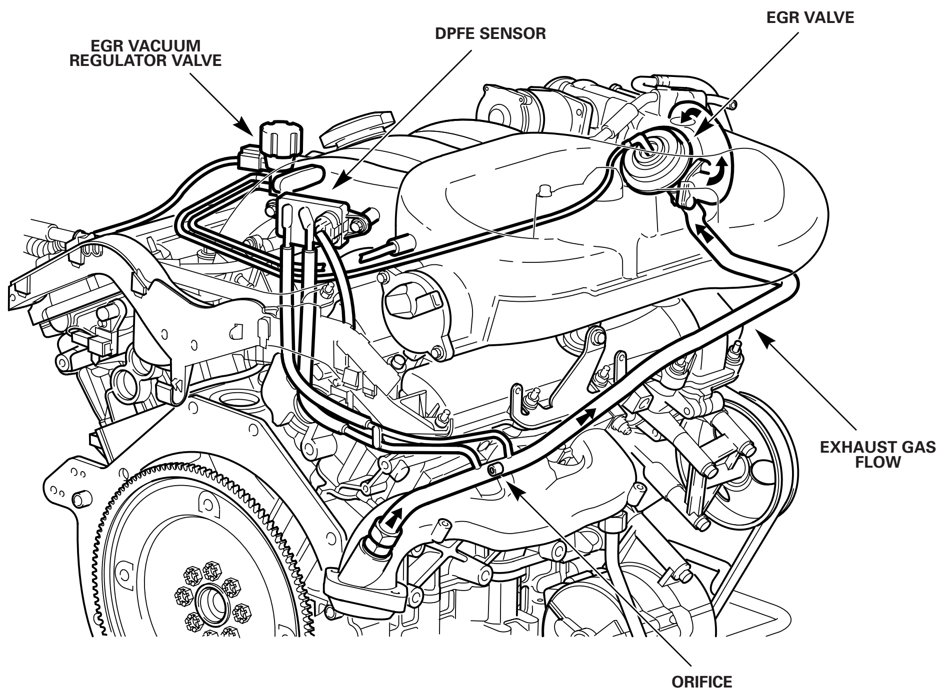
The EGR system is only fitted to V6 engines and comprises the following components:

- EGR vacuum regulator valve
- EGR valve
- Differential pressure feedback EGR sensor
- Exhaust gas feedback pipe with internal orifice

Exhaust gas is recirculated back to the engine intake in proportion to a measured pressure differential in the feedback pipe. The amount of gas recirculated varies primarily with engine speed and load but is also modified by the PCM to allow for other factors, e.g. coolant temperature, and also to achieve optimum emissions and fuel economy.

The recirculated exhaust gas is taken from the bank 1 exhaust manifold and fed into the engine via the EGR valve. The feedback pipe contains an internal tube with a small diameter orifice that creates a pressure differential in the feedback pipe. Two small pipes, connected to the feedback pipe each side of the orifice, transmit the pressure differential to the differential pressure feedback EGR sensor.

EGR SYSTEM (V6)



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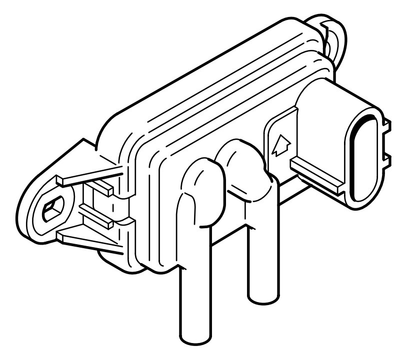
NOTES

Differential pressure feedback EGR (DPFE) sensor

The PCM receives an EGR feedback signal from the DPFE sensor. The sensor consists of a vacuum operated variable capacitor and a processing circuit, which convert the input pressure / vacuum value to a corresponding analogue voltage signal. The DPFE sensor has a linear response and the variations in exhaust pressure produce a signal voltage in the range of 1V – 3.5V dc.

- The EGR vacuum regulator valve and the EGR valve comprise the actuating components of the control loop.
- The EGR vacuum regulator valve has a vacuum input from the manifold distribution pipes, a vacuum output to the EGR valve, and receives a pulse width modulated (PWM) signal from the PCM.
- The PWM signal switches the vacuum control output to the EGR valve according to input demand from the differential pressure feedback EGR sensor or in response to override conditions determined by the engine management system.
- The EGR valve is a vacuum operated diaphragm valve with no electrical connections, which opens the EGR feed pipe to the induction manifold under the EGR vacuum regulator control.

DPFE SENSOR (V6)



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EGR Control Conditions

EGR operates over most of the engine speed/load range but is disabled by the engine management system under certain conditions:

- During engine cranking
- Until normal operating temperature is reached
- When the diagnostic system registers a failure which affects the EGR system (e.g. a faulty sensor)
- During idling to avoid unstable or erratic running
- During wide open throttle operation
- When traction control is operative.

While the main control loop is based on feedback from the differential pressure feedback EGR sensor, the EGR rate is also modified by other engine conditions; coolant, ambient and charge air temperatures, barometric pressure, VVT cam position and charge air mass. Note also that the EGR rate increases gradually after it is enabled during each driving period.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

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OTHER PCM ENGINE CONTROL AND INTERFACE FUNCTIONS

Radiator Cooling Fan and Air Conditioning Compressor Control

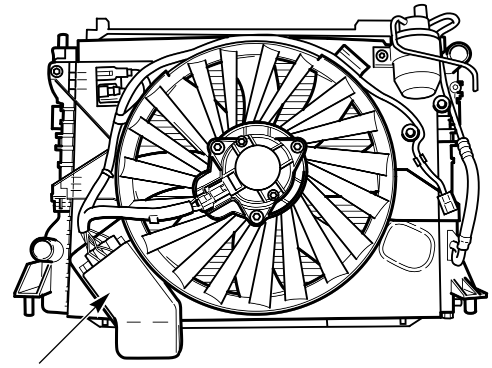
The Jaguar S-TYPE radiator cooling fan is driven by a variable speed 500W electric motor. An electronic cooling fan module, located under the radiator cooling pack, drives the fan motor.

The cooling fan module is supplied with:

- ignition switched 20 Amp fused B+ power supply from powertrain relay 1 for the control circuit
- battery direct B+ power supply via the 80 Amp fuse adjacent to the front power distribution box for fan motor drive.

When the engine is running, the cooling fan module receives a PWM control signal proportional to the engine cooling requirements from the PCM. In response to the PCM control signal, the cooling fan module switches the fan motor ON and OFF and varies fan speed between 300 rpm to 2900 rpm using PWM drive voltage.

JAGUAR S-TYPE RADIATOR COOLING FAN ASSEMBLY



As the engine is switched off, the A/CCM notes the engine coolant (V8) or cylinder head (V6) temperature (SCP MESSAGE) and provides a control signal to the cooling fan control module for a fixed period of time to operate the fan motor. The engine off fan operational time period is determined by the A/CCM based on the SCP temperature message.

In addition to radiator cooling fan control, the PCM controls the operation of the air conditioning compressor clutch. The PCM receives the air conditioning compressor operation request from the A/CCM via the SCP network.

The PCM calculates the engine cooling requirement from signal inputs received from the following sources:

- ECT sensor (V8)
- CHT sensor (V6)
- Air conditioning pressure sensor
- Air conditioning compressor status
- Transmission fluid temperature

NOTES

OTHER PCM ENGINE CONTROL AND INTERFACE FUNCTIONS

Radiator Cooling Fan and Air Conditioning Compressor Control (continued)

Air Conditioning Pressure Sensor

The air conditioning pressure sensor, located in the A/C "high side" is a pressure transducer sensing refrigerant system high side pressure. The feedback voltage from the transducer supplies the PCM with a signal proportional to refrigerant pressure. The PCM uses the refrigerant pressure signal for coolant fan requirement and compressor clutch control.

Fail Safe Engine Cooling (V6)

V6 PCMs are programmed with a function that monitors engine temperature and performs actions that prolong safe engine operation by controlling engine temperature. This "fail safe engine cooling" strategy is fully controlled by the PCM. Fail safe engine cooling strategy on V6 engines is made possible by monitoring the engine temperature with a cylinder head temperature (CHT) sensor (metal contact) instead of a ECT sensor (coolant).

If the PCM detects excessively high engine temperature, it switches off the fuel injector(s) of one or more cylinders. With no fuel being injected, ambient air is pumped through the cylinder cooling the engine. By switching individual injectors off for a period of time and in a sequence determined by the PCM, engine temperature can be controlled to allow the vehicle to be driven for a short distance.

The overall engine cooling strategy can be divided into five stages. The fail safe engine cooling (FSC) strategy operates in the three top stages as explained in the following chart.

Engine cooling strategy

Stage	Temperature	Warnings	Action
Normal	82 °C (180 °F) – 118 °C (245 °F)	Coolant temp gauge	Normal cooling fan control
Above normal	> 118 °C (245 °F) – <121 °C (250 °F)	Coolant temp gauge in RED zone ENGINE OVERTEMP warning light CHECK ENGINE TEMP message Single chime	Cooling fan maximum
FSC Stage 1 Reduced power	> 121 °C (250 °F) – < 149 °C (300 °F)	Coolant temp gauge in RED zone ENGINE OVERTEMP warning light REDUCED ENGINE POWER message CHECK ENGINE MIL Three chimes	Cooling fan maximum PCM begins selectively and alternately shutting off the fuel injectors Engine speed limited
FSC Stage 2 Stop engine safely	> 149 °C (300 °F) – < 166 °C (330 °F)	Coolant temp gauge in RED zone Flashing ENGINE OVERTEMP warning light STOP ENGINE SAFELY message CHECK ENGINE MIL Five chimes	Cooling fan maximum PCM continues selectively and alternately shutting off the fuel injectors Engine speed limited
FSC Stage 3 Engine shut down	166 °C (330 °F)	Coolant temp gauge in RED zone ENGINE OVERTEMP warning light CHECK ENGINE MIL	Cooling fan maximum PCM shuts down engine

All temperatures shown are approximate.

Generator

The PCM is responsible for issuing SCP commands directing the instrument pack to switch the generator warning light OFF or ON. Each time the ignition is switched ON to position II, the instrument pack initiates its bulb check cycle. The generator warning light will remain active until the instrument pack receives an SCP LOW VOLTAGE TELLTALE (OFF) message from the PCM.

The PCM receives generator charging voltage information via a hard wire from generator pin marked ALTLMP on the generator. If the charging system is functioning correctly, the PCM transmits the SCP LOW VOLTAGE TELLTALE (OFF) message. If the PCM detects an out of range voltage (high or low) during normal operation, it transmits an SCP LOW VOLTAGE TELLTALE (ON) message signaling the instrument pack to activate the generator warning light. If the generator detects an internal fault it holds the ALTLMP signal at zero volts. After 15 seconds at zero volts the PCM transmits the SCP LOW VOLTAGE TELLTALE (ON) message and triggers a non OBD II DTC.

The PCM receives generator load information via a hard wire from the generator pin marked FRI. This circuit communicates a PWM signal proportional to generator field load. When the vehicle battery is fully charged and electrical demands are low, generator output can drop to zero resulting in a B+ voltage signal. As generator output increases to supply increased electrical demands the PWM duty cycle increases. At full generator output the duty cycle is 100% resulting in a continuous zero voltage signal. The PCM increases throttle valve opening at idle to compensate for the increased generator load.

NOTES

PTEC ENGINE MANAGEMENT SYSTEM

JAGUAR

Service Training Course 881
DATE OF ISSUE: 9/2001

S-TYPE - DTC Summaries

Name:____________________ **Date:**__________ **Vehicle/VIN**________________

1. What is KOEO self test? ____

   ____

2. What is KOER self test? ____

   ____

3. What does DTC P1001 provide as a fault description? ______________________

   ____

4. If DTC P0102 is logged what self test should you perform? KOEO [ ], KOER [ ], Why?

   ____

5. Elaborate on DTC P1299.

   - Can it be logged on an AJ V8 PTEC system: Yes [ ] No [ ]
   - How many trips does it require to log? 1 Trip [ ], 2 Trips [ ]
   - What is the PCM's default action if this fault is logged? ____________________

   ____

   - Will any messages be displayed in the Instrument Cluster with this DTC: Yes [ ] No [ ]
   - If "Yes" please list the messages. __________________________________

   ____

6. Is the drive cycle for comprehensive component monitoring longer for the AJV8 compared to the AJV6? Yes [ ] No [ ]. If yes, why? _______________________

   ____

Instructor Check:____

S-TYPE - PTEC Overview

Name:______________________ **Date:**___________ **Vehicle/VIN**_________________

1. Review the correct Electrical Guide and list the power distribution paths for the PCM.

   ____

   ____

   ____

2. How does the PCM control power to operate high amperage consumers (i.e.:, AC compressor).

   ____

3. Why is communication occurring between the PCM and the Throttle Motor Actuator.

   ____

   ____

4. What signal does the PCM receive when the PSP switch closes? ____________________

5. Where does APP2 receive it's operating voltage from? ______________________,
   Why? ____

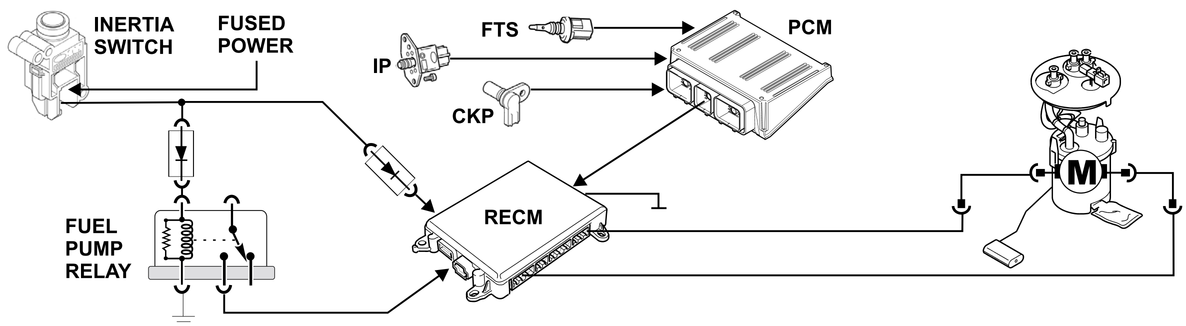
Instructor Check: _______________________________

S-TYPE - PTEC Fuel Pump Control

1. The illustration below Identifies the components and signals used to operate the fuel pump. What is the purpose of the IP sensor? ____________________________

   ____

   ____



2. What is the purpose of the FTS? ____

   ____

   ____

Use the appropriate Electrical Guide to identify the wire colors and pin numbers at the RECM.

3. What type of signal is provided to the RECM by the PCM requesting for fuel pump operation. ______________, What is the wire color and pin number________________

4. Signal frequency?_______________. Is it fixed [ ] Yes, [ ] No

5. Signal duty cycle at idle = _____________, under load (2500 RPM) _____________

6. What type of signal is provided from the RECM to drive the fuel pump? ____________, What is the wire color and pin number. ____________________________________

7. Signal frequency ? ______________. Is it fixed [ ] Yes, [ ] No

8. Signal duty cycle at idle = _____________, under load (2500 RPM) _____________

9. Load PDU multimeter, load amp clamp. Connect the fuel pump control circuit and measure value. Record reading at the idle and under load.

   Idle = __________ Under load = ___________

Instructor Check: __________________________

S-TYPE - PCM Datalogger

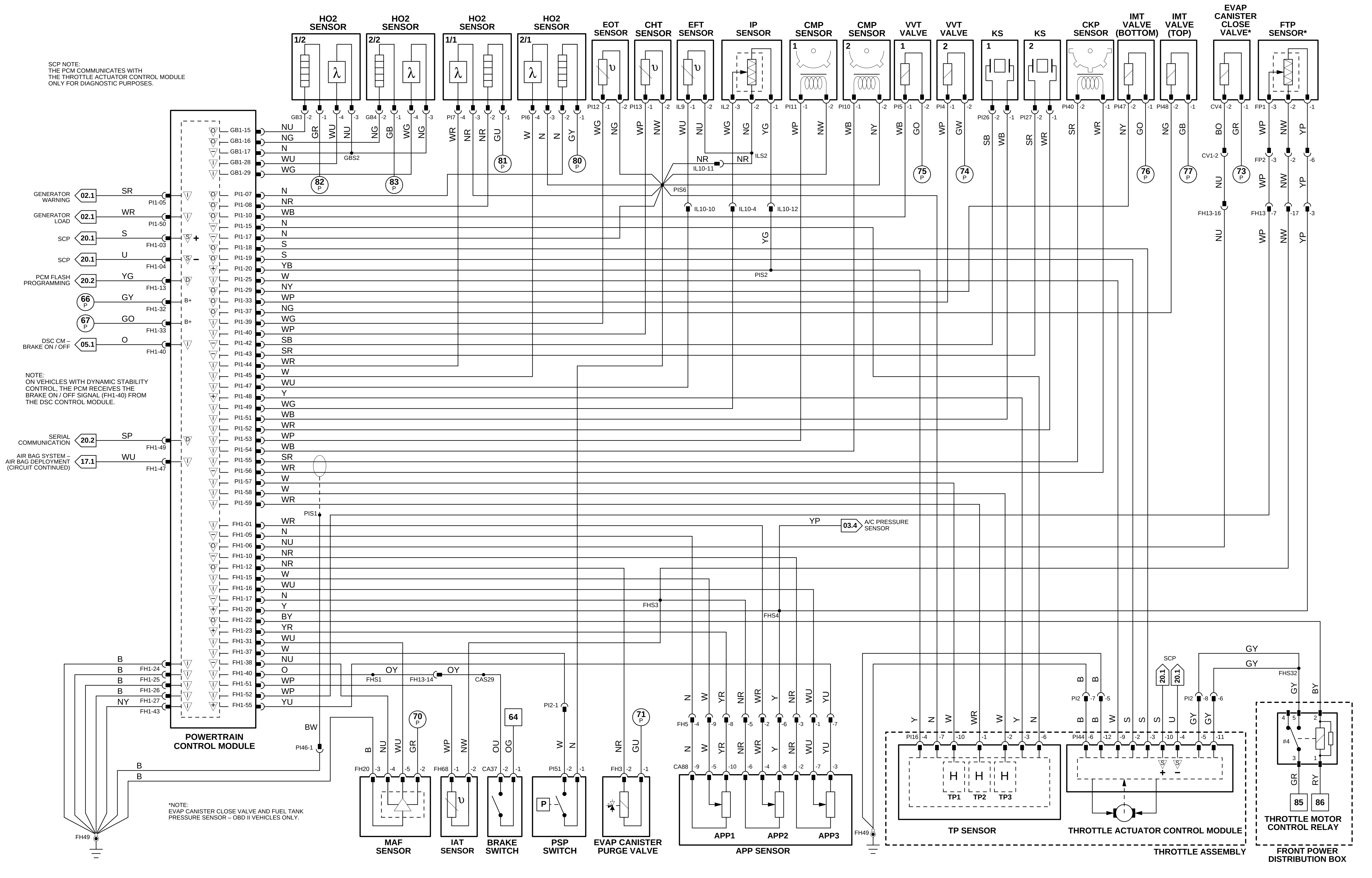
Name:____________________, **Date:**___________, **Vehicle/VIN**________________

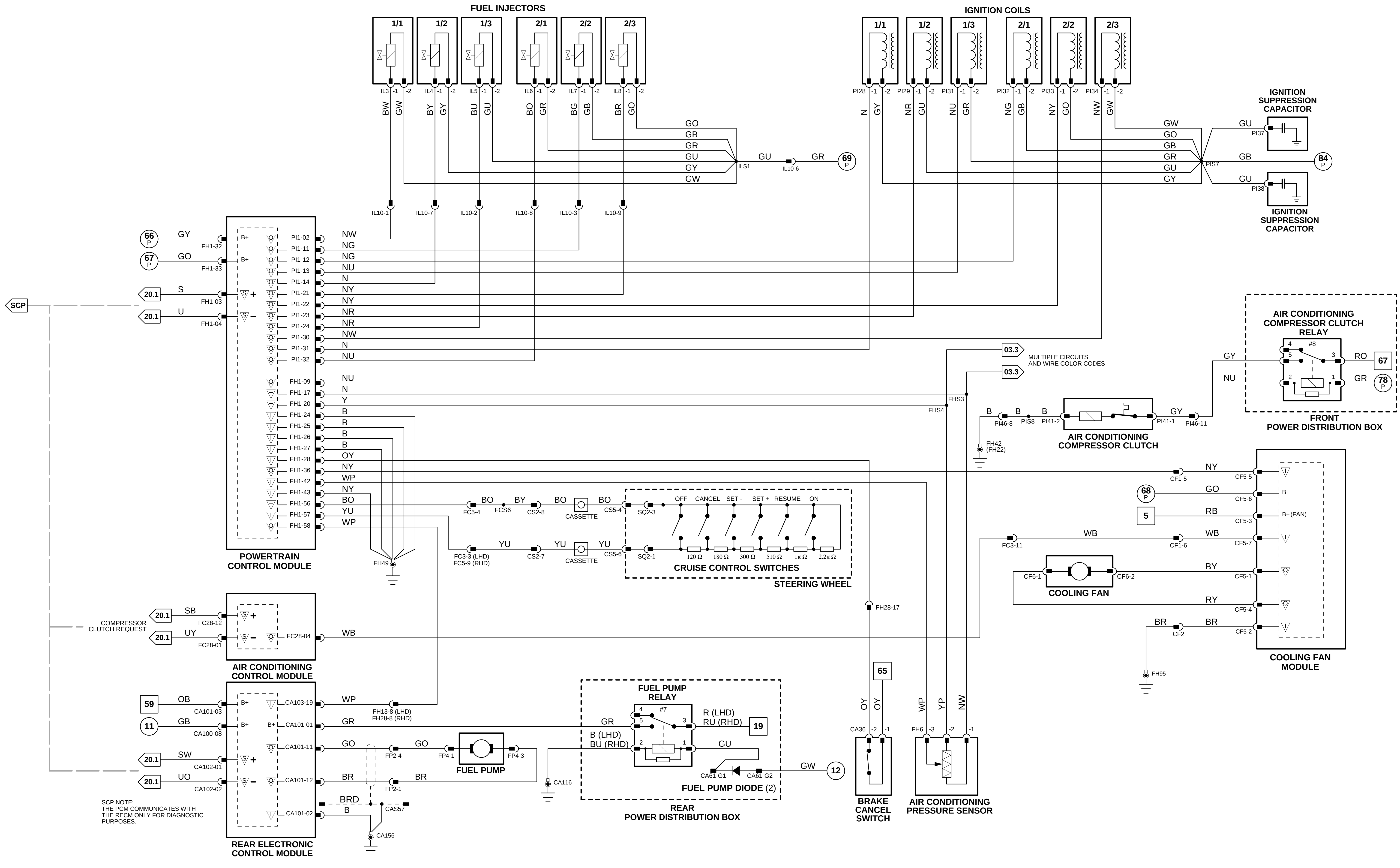
Connect the PTU to the vehicle and enter the datalogger program.

1. With the engine running, highlight the information button on each signal. Observe and record the following signals.
   - AIRI = Air Assist Injection ____________________
   - CHT = Cylinder Head Temperature sensor (AJV6) ____________________
   - DPFE V6 =Differential Pressure Sensor ____________________
   - EFPT = Fuel Rail Pressure Transducer ____________________
   - EFT = Fuel Rail Temperature Sensor ____________________
   - FPDC = Fuel Pump Duty Cycle. ____________________
   - EGRDC = EGR Duty Cycle ____________________
   - H02SIU = Upstream 02 Sensor Signal ____________________
   - H02SID = Downstream 02 Sensor Signal ____________________
   - MAF= Mass Air Flow ____________________
   - PURGEDC = Purge Valve Duty Cycle ____________________
2. Monitor and record the following signals with engine at idle and then at 1500 RPM.
   - APP1 = ____________________
   - APP2 = ____________________
   - APP3 = ____________________
   - TPS1 = ____________________
   - TPS2 = ____________________
   - TPS3 = ____________________

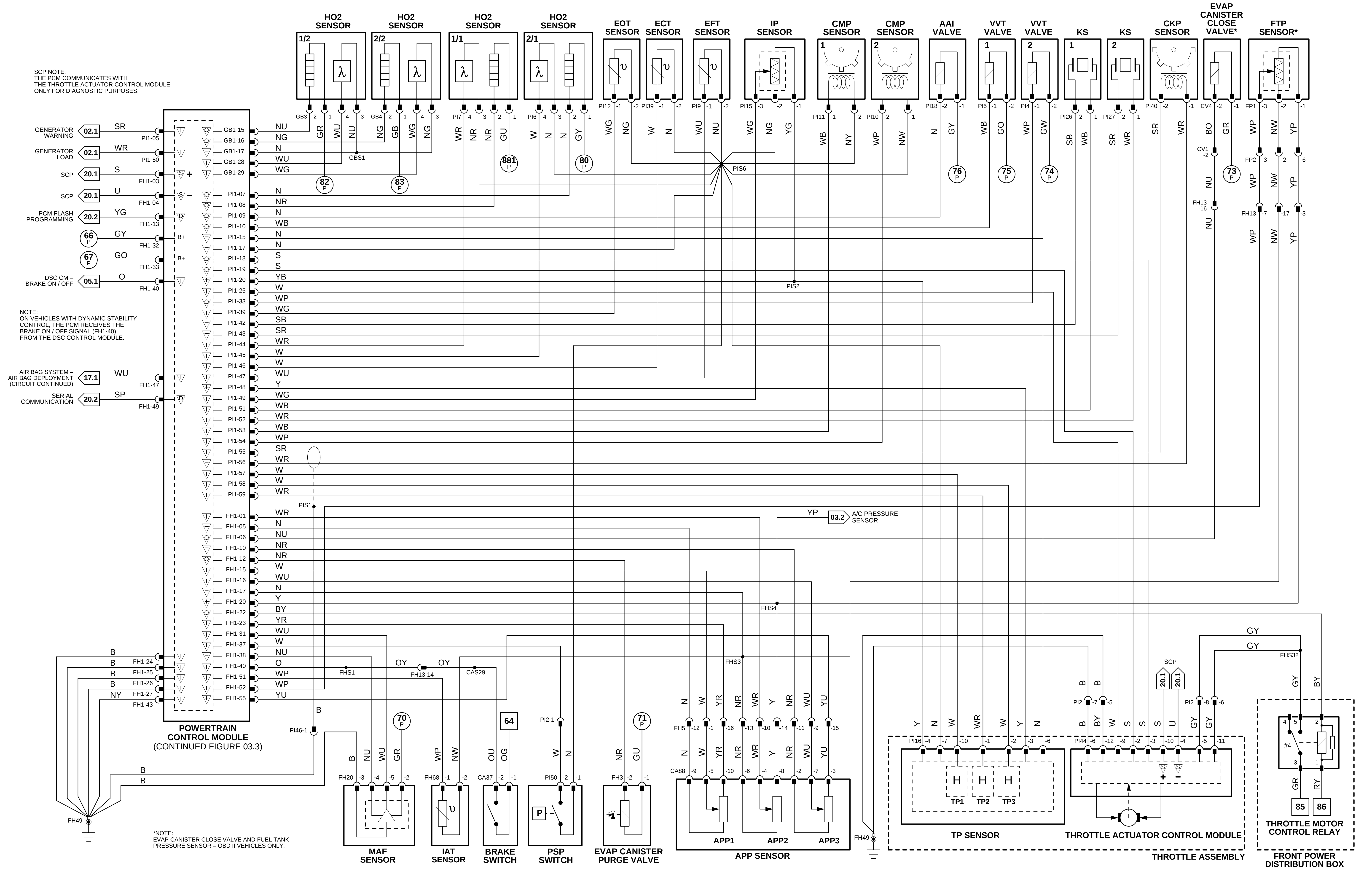
Instructor Check:____________________

PTEC V8 ENGINE MANAGEMENT, PART 1 – 2001 MY S-TYPE




FUEL INJECTORS
IGNITION COILS
IGNITION SUPPRESSION CAPACITOR
IGNITION SUPPRESSION CAPACITOR
POWERTRAIN CONTROL MODULE
AIR CONDITIONING COMPRESSOR CLUTCH RELAY
FRONT POWER DISTRIBUTION BOX
AIR CONDITIONING COMPRESSOR CLUTCH
MULTIPLE CIRCUITS AND WIRE COLOR CODES
CRUISE CONTROL SWITCHES
OFF
CANCEL
SET -
SET +
RESUME
ON
STEERING WHEEL
CASSETTE
COOLING FAN
COOLING FAN MODULE
COMPRESSOR CLUTCH REQUEST
AIR CONDITIONING CONTROL MODULE
REAR ELECTRONIC CONTROL MODULE
FUEL PUMP
FUEL PUMP RELAY
FUEL PUMP DIODE (2)
REAR POWER DISTRIBUTION BOX
BRAKE CANCEL SWITCH
AIR CONDITIONING PRESSURE SENSOR
SCP
SCP NOTE: THE PCM COMMUNICATES WITH THE RECM ONLY FOR DIAGNOSTIC PURPOSES.

PTEC V6 ENGINE MANAGEMENT, PART 1 – 2001 MY S-TYPE



PTEC V6 ENGINE MANAGEMENT, PART 2 – 2001 MY S-TYPE