EMS & OBD

Engine Management System (EMS)

- It consists of ECU, various sensors and actuators in the engine. It uses the information acquired from sensors to control the fuel injection, ignition systems, air system (VGT, VVT), after-treatment and so on.
- This approach allows an engine's operation to be controlled in great detail, allowing greater fuel efficiency, better power and responsiveness, and much lower pollution levels than earlier generations of engines
- Because the EMS is dealing with actual measured engine performance from millisecond to millisecond, it can compensate for many variables that traditional systems cannot, such as ambient temperature, humidity, altitude (air density), fuel (octane rating), as well as the demands made on it by the driver.
- In addition, it is able to a large degree to compensate for the gradual wearing of the engine as it ages, which in practice allows it to extend engine life to two or three times that of engines of twenty years ago.

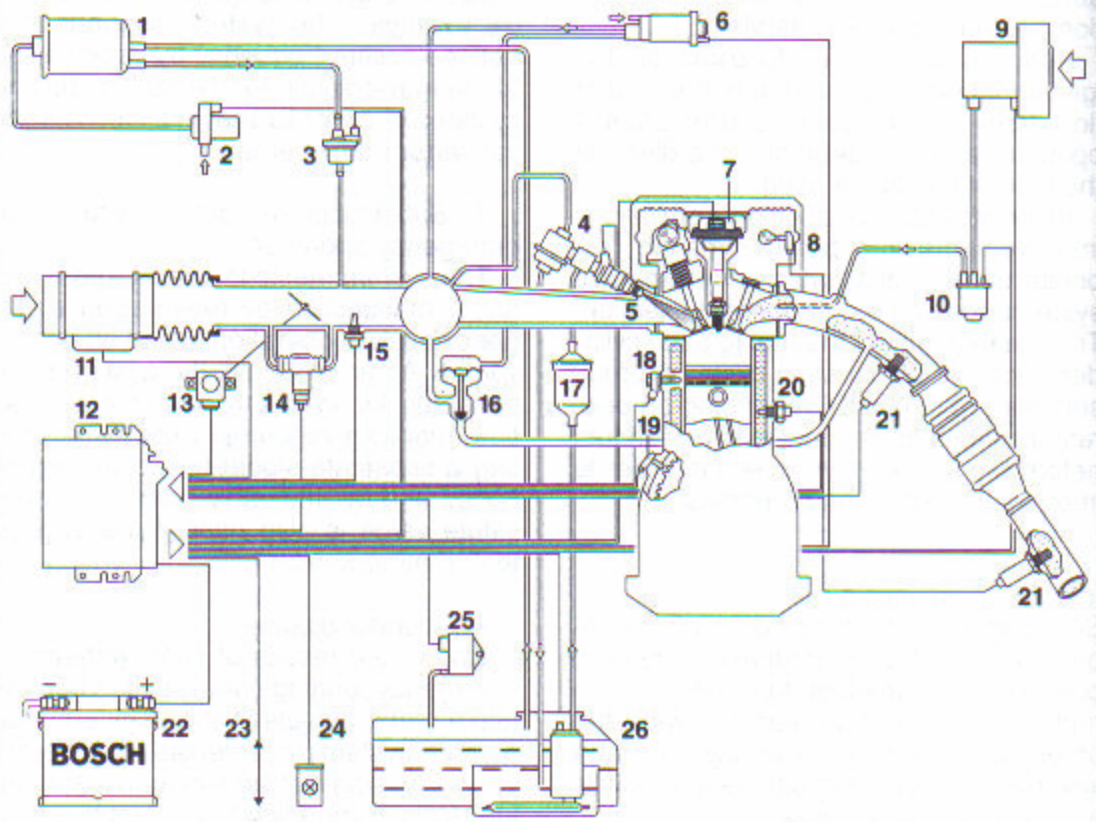
Why EMS?

- For fuel economy, emissions reduction, power performance and …
- With IT development
- With fuel injection system development
- With emissions reduction requirement
- With control and sensors technology development

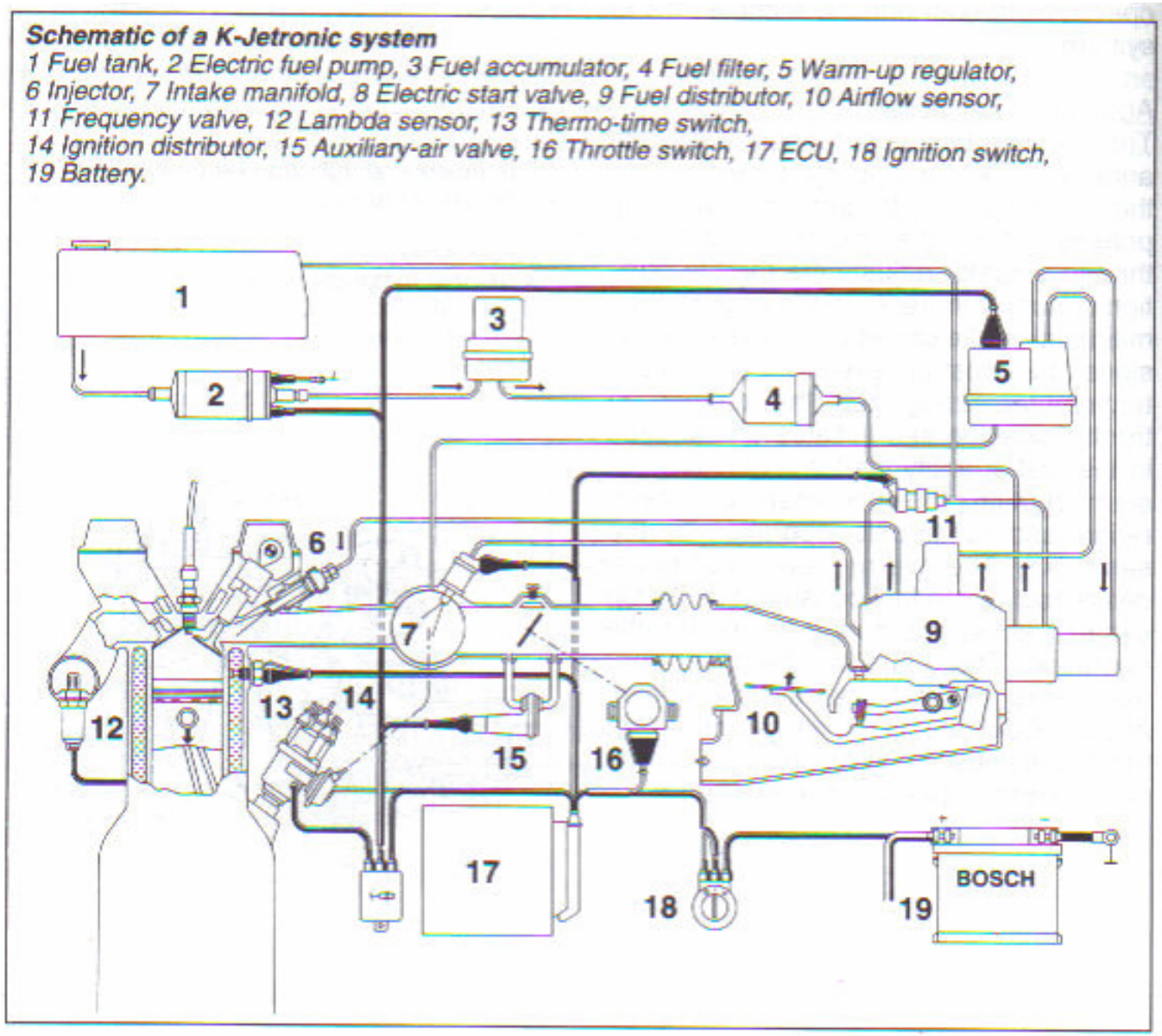
EMS of Gasoline Engines

Motronic engine-management system

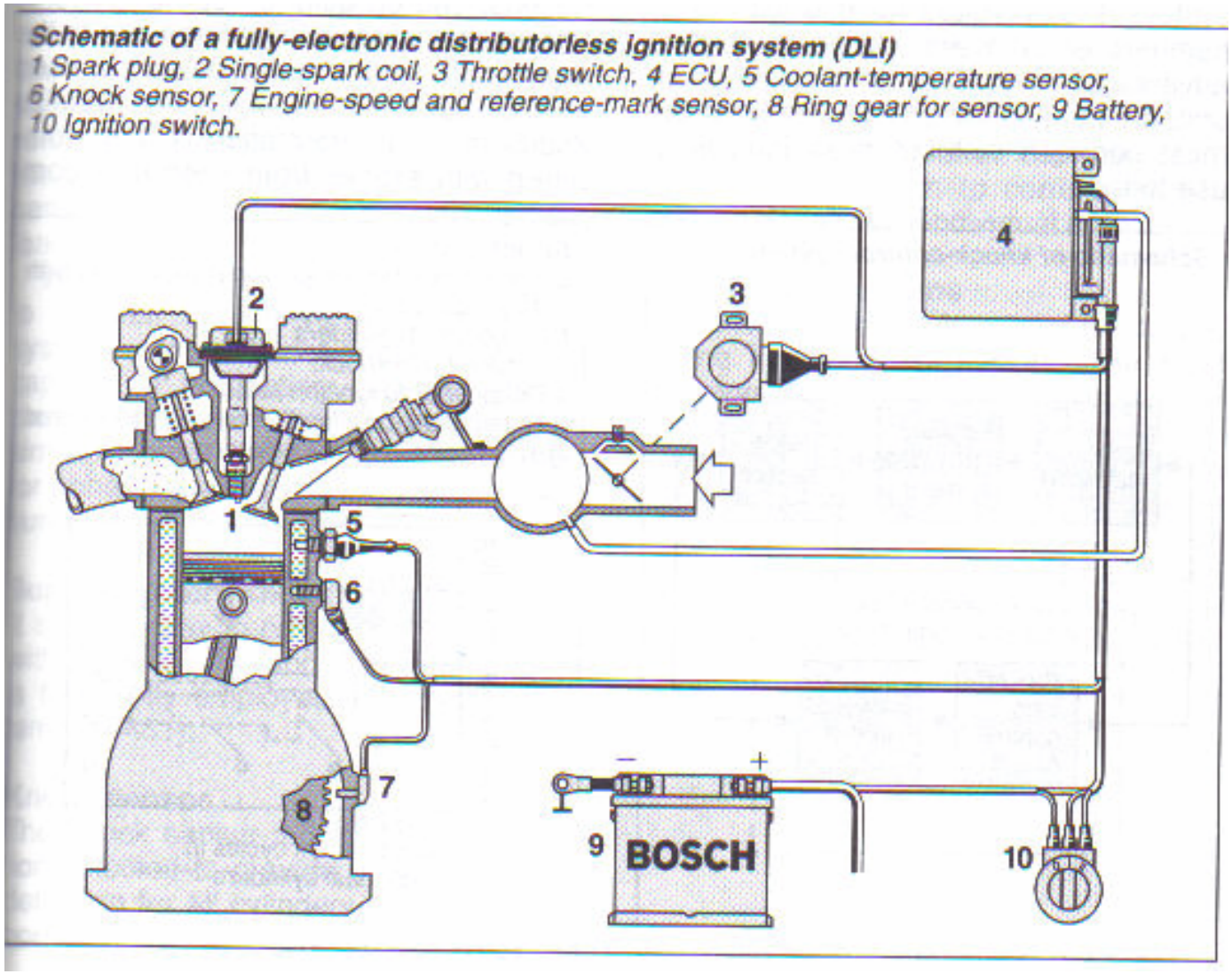
1 Charcoal canister, 2 Air intake valve, 3 Canister-purge valve, 4 Fuel-pressure regulator, 5 Injector, 6 Pressure controller, 7 Ignition coil, 8 Phase sensor, 9 Secondary air-injection pump 10 Secondary air valve, 11 Air-mass flow sensor, 12 ECU, 13 Throttle-valve sensor 14 Idle-actuator, 15 Air-temperature sensor, 16 EGR valve, 17 Fuel filter, 18 Knock sensor, 19 RPM sensor, 20 Engine-temperature sensor, 21 Lambda O_2 sensor, 22 Battery, 23 Diagnosis interface, 24 Diagnosis lamp, 25 Differential pressure sensor, 26 Electric fuel pump.



Management of Fuel System

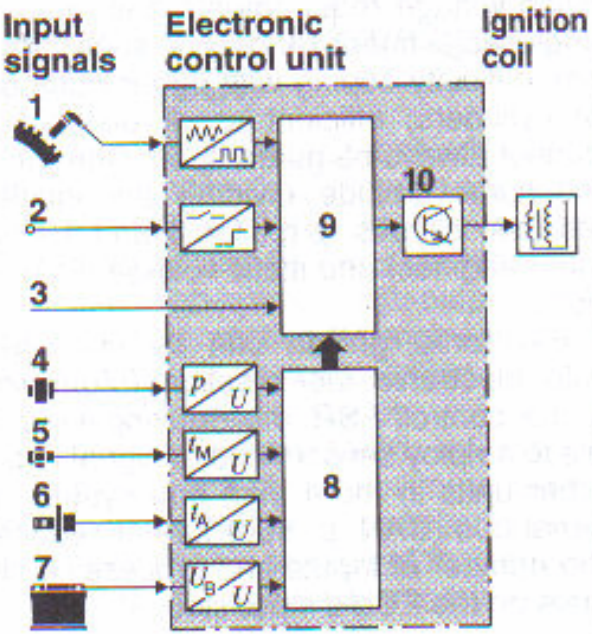


Management of Ignition System

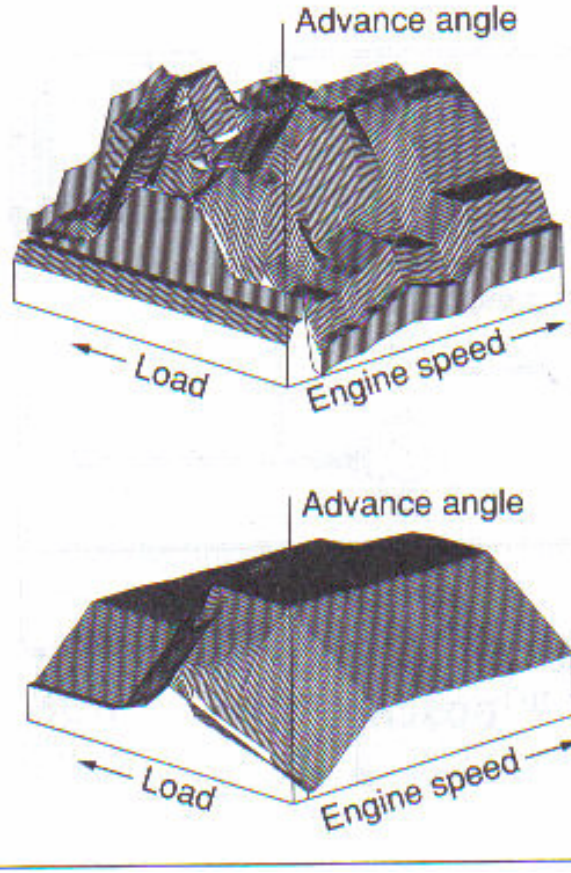


Ignition Control

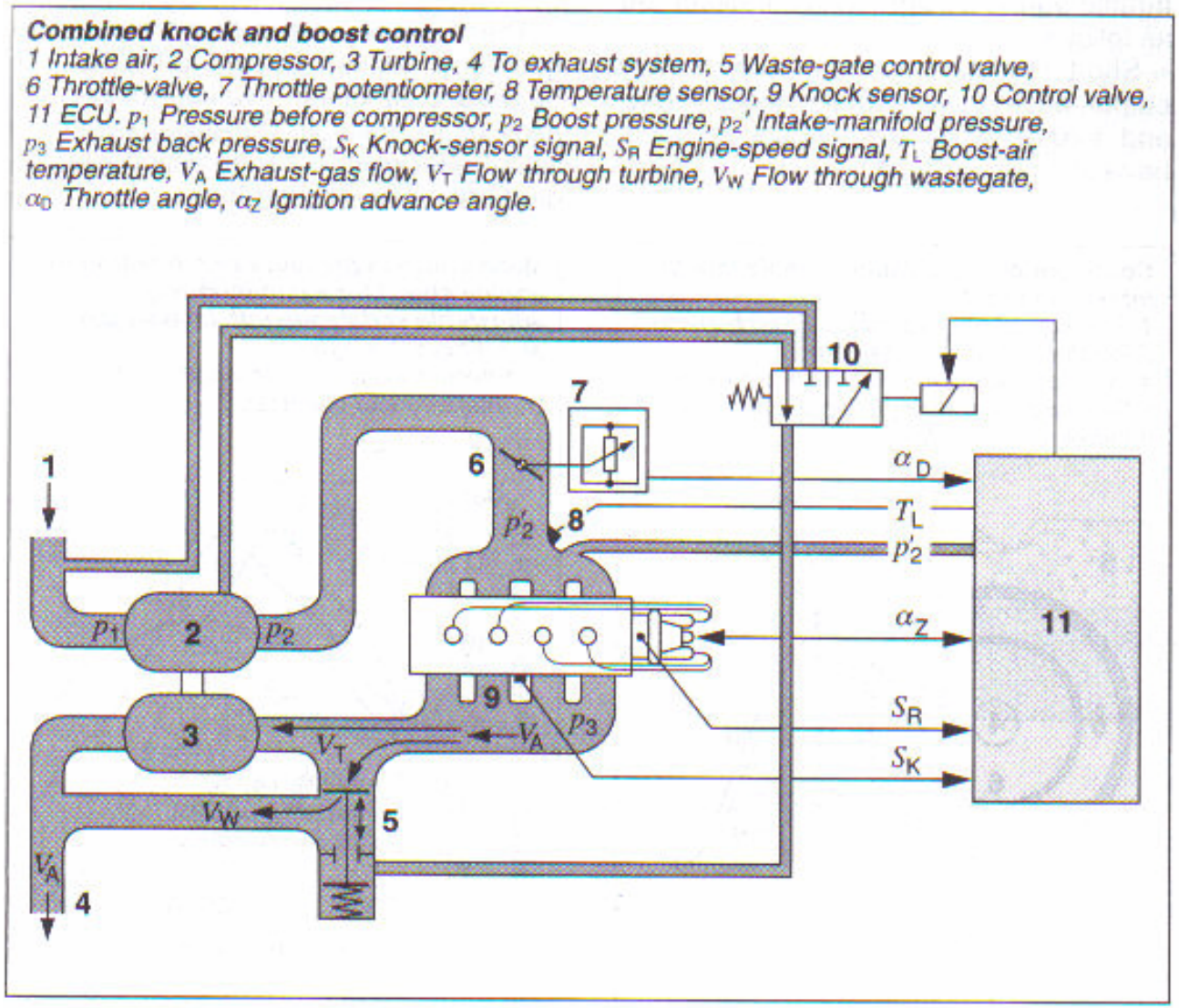
Electronic ignition, signal processing
1 Engine speed, 2 Switch signals, 3 CAN (serial bus), 4 Intake-manifold pressure, 5 Engine temperature, 6 Intake-air temperature, 7 Battery voltage, 8 Microprocessor, 9 Analog/digital converter, 10 Driver stage.



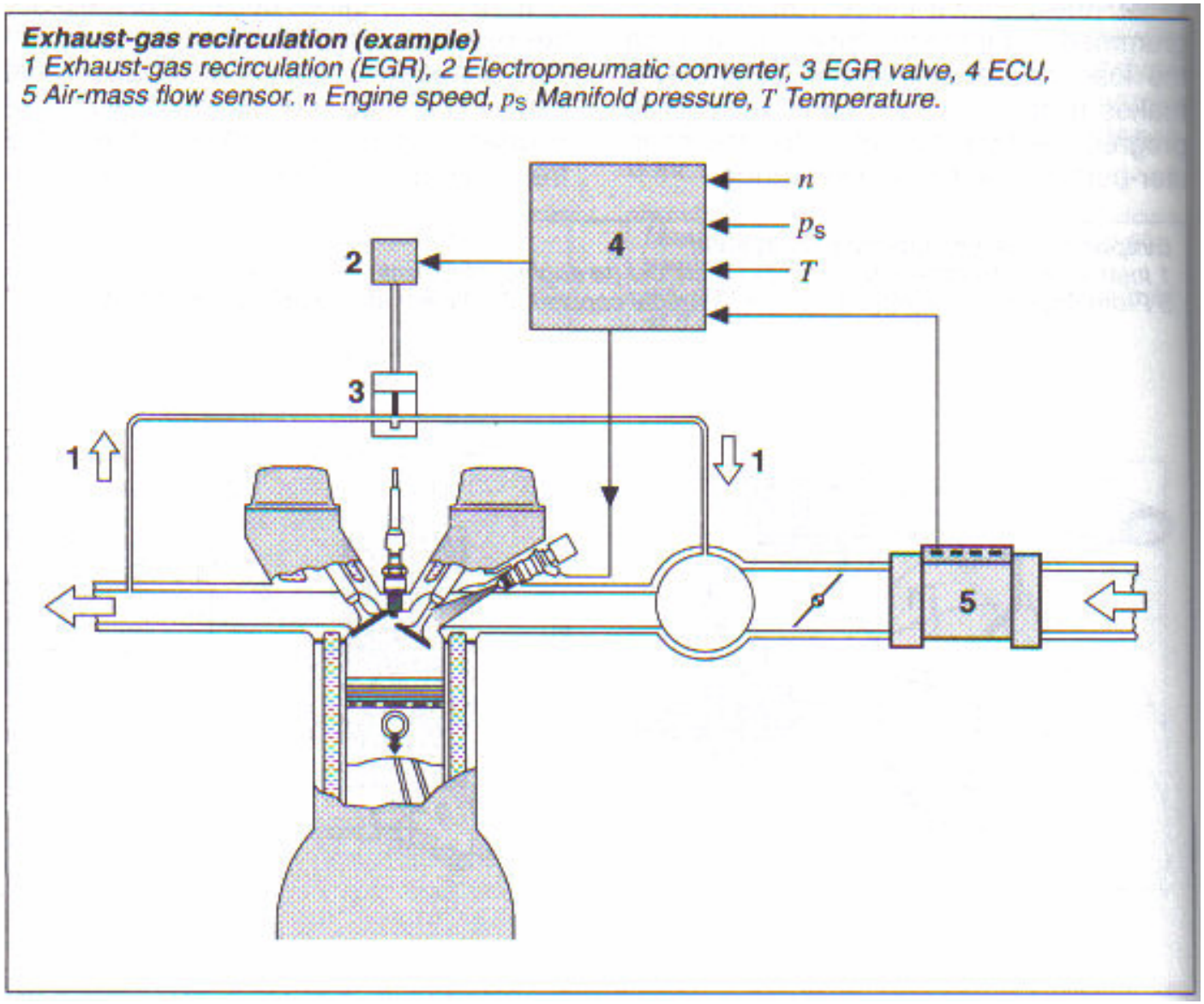
Ignition maps
Above: electronically optimized
Below: mechanical advance system.



Boost Control to Avoid Knock



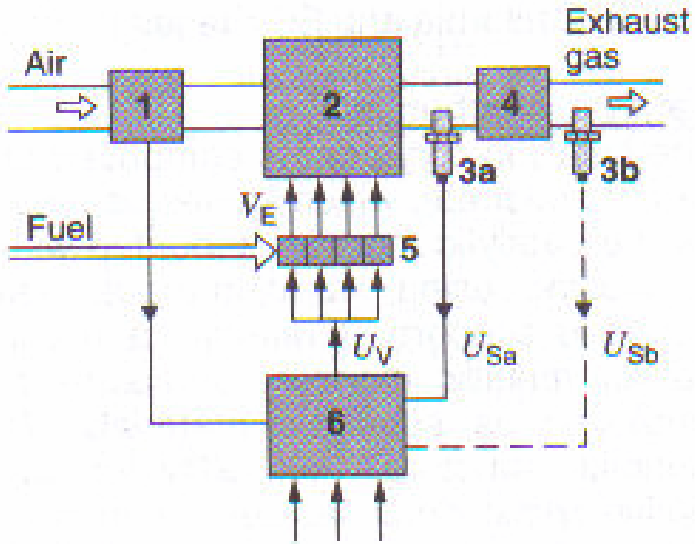
EGR Control


Exhaust-gas recirculation (example)
1 Exhaust-gas recirculation (EGR), 2 Electropneumatic converter, 3 EGR valve, 4 ECU,
5 Air-mass flow sensor. n Engine speed, p_S Manifold pressure, T Temperature.
n
p_S
T
4
2
3
1
1
5

Lambda Control

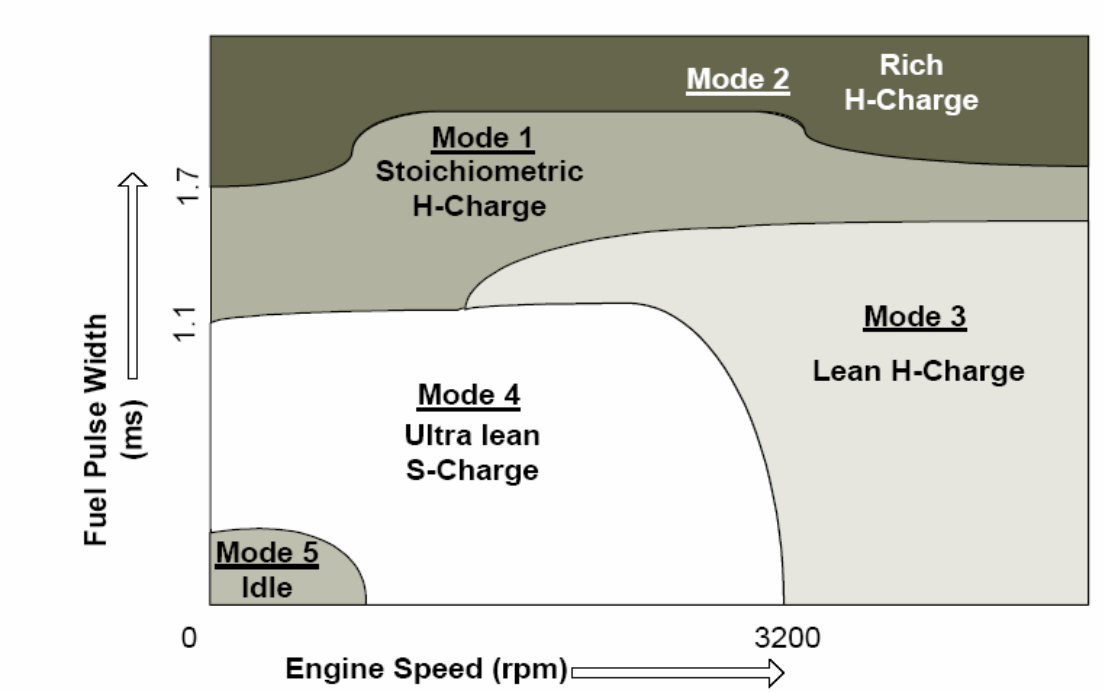
Functional schematic of the Lambda closed-loop control

1 Air-mass meter, 2 Engine,
3a Lambda oxygen sensor 1,
3b Lambda oxygen 2 (only if required),
4 Catalyic converter,
5 Fuel injectors, 6 ECU.
U_S Sensor voltage,
U_V Injector triggering voltage,
V_E Injected fuel quantity.



EMS for GDI

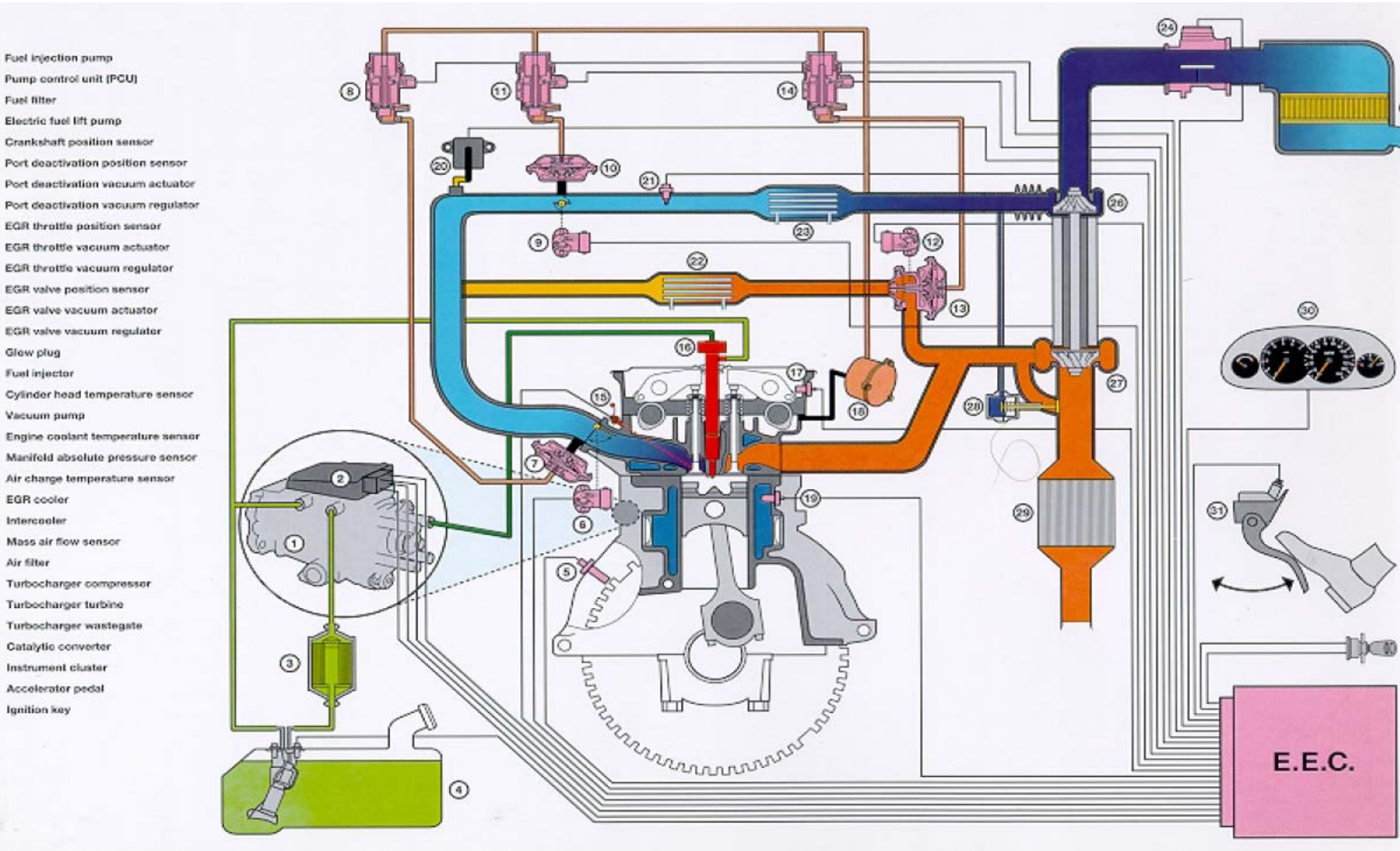
- Most similar with conventional gasoline engine's EMS
- Aftertreatment, NOx trap regeneration



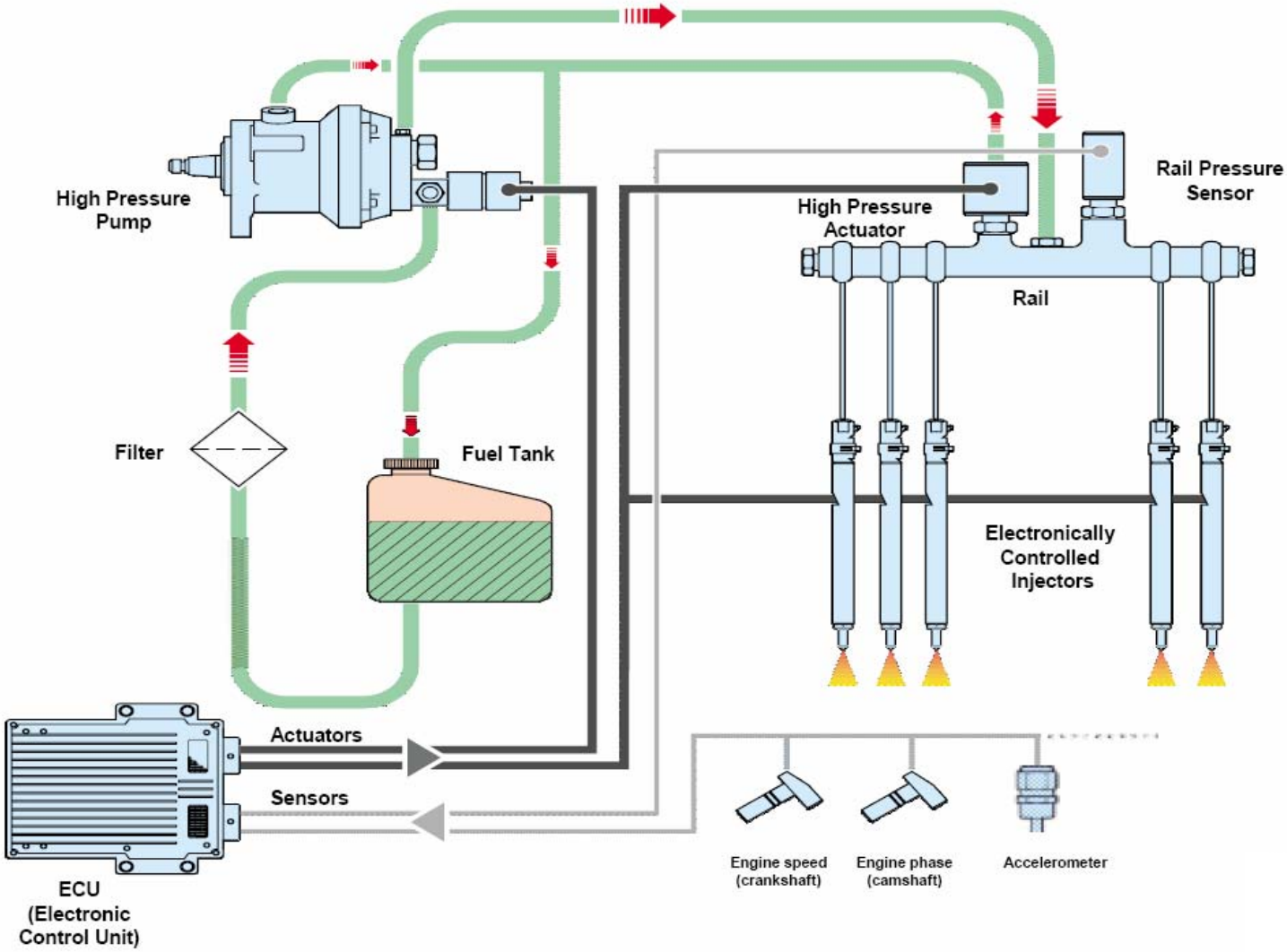
EMS for Diesel Engines

- Fuel Injection
- Aftertreatment

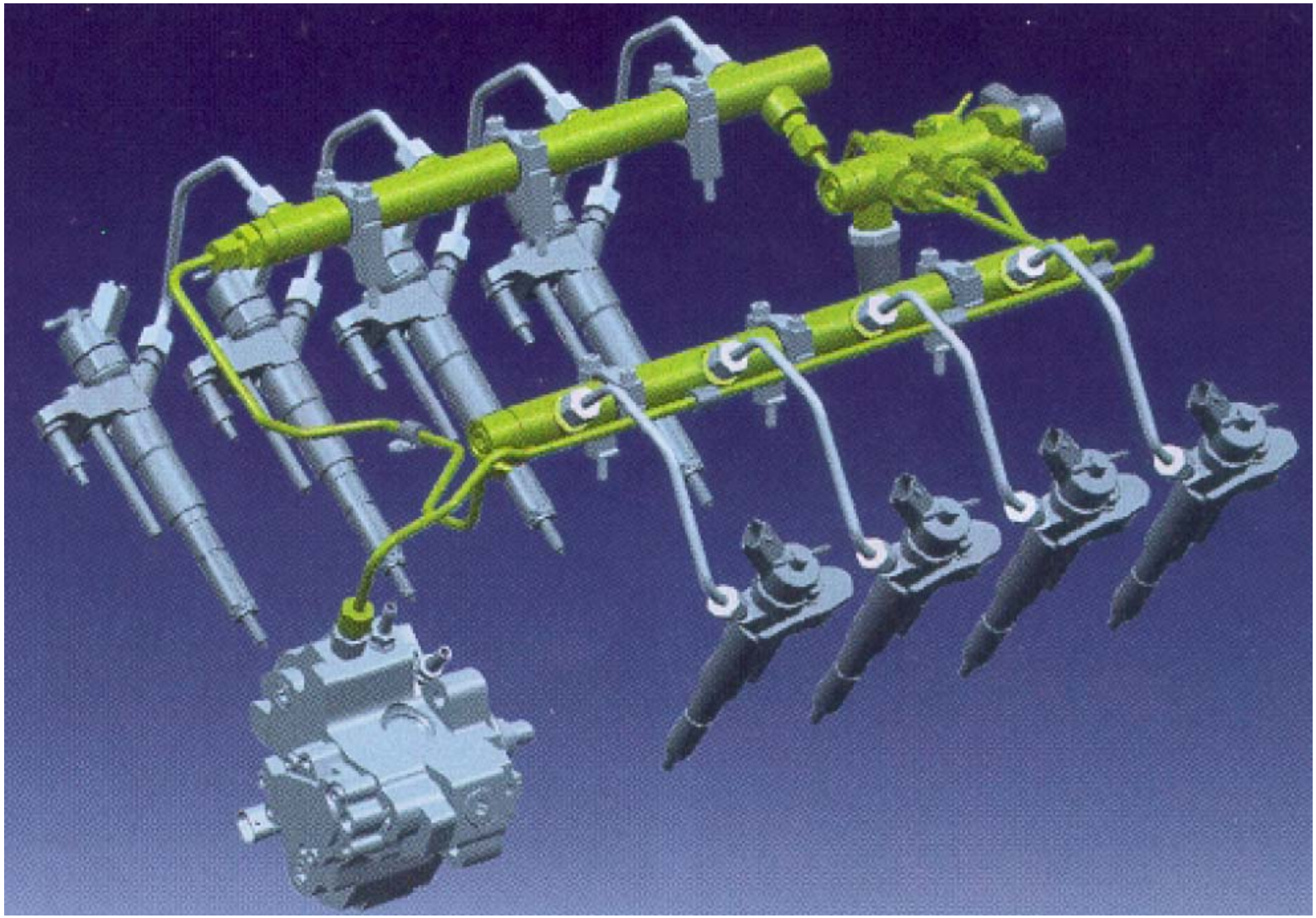
EMS of a Diesel Engine



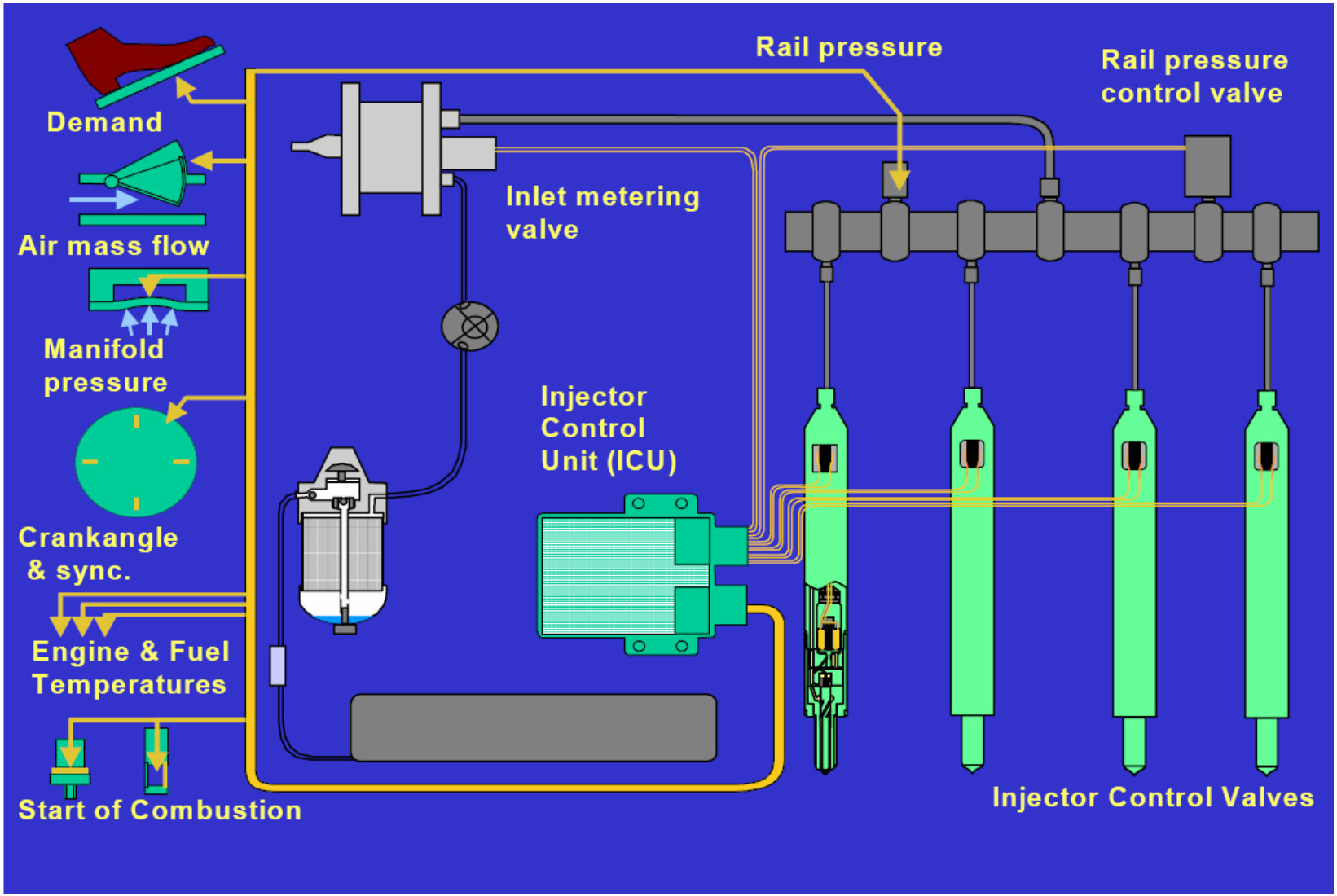
Fuel Injection Management



Fuel Injection Hardware

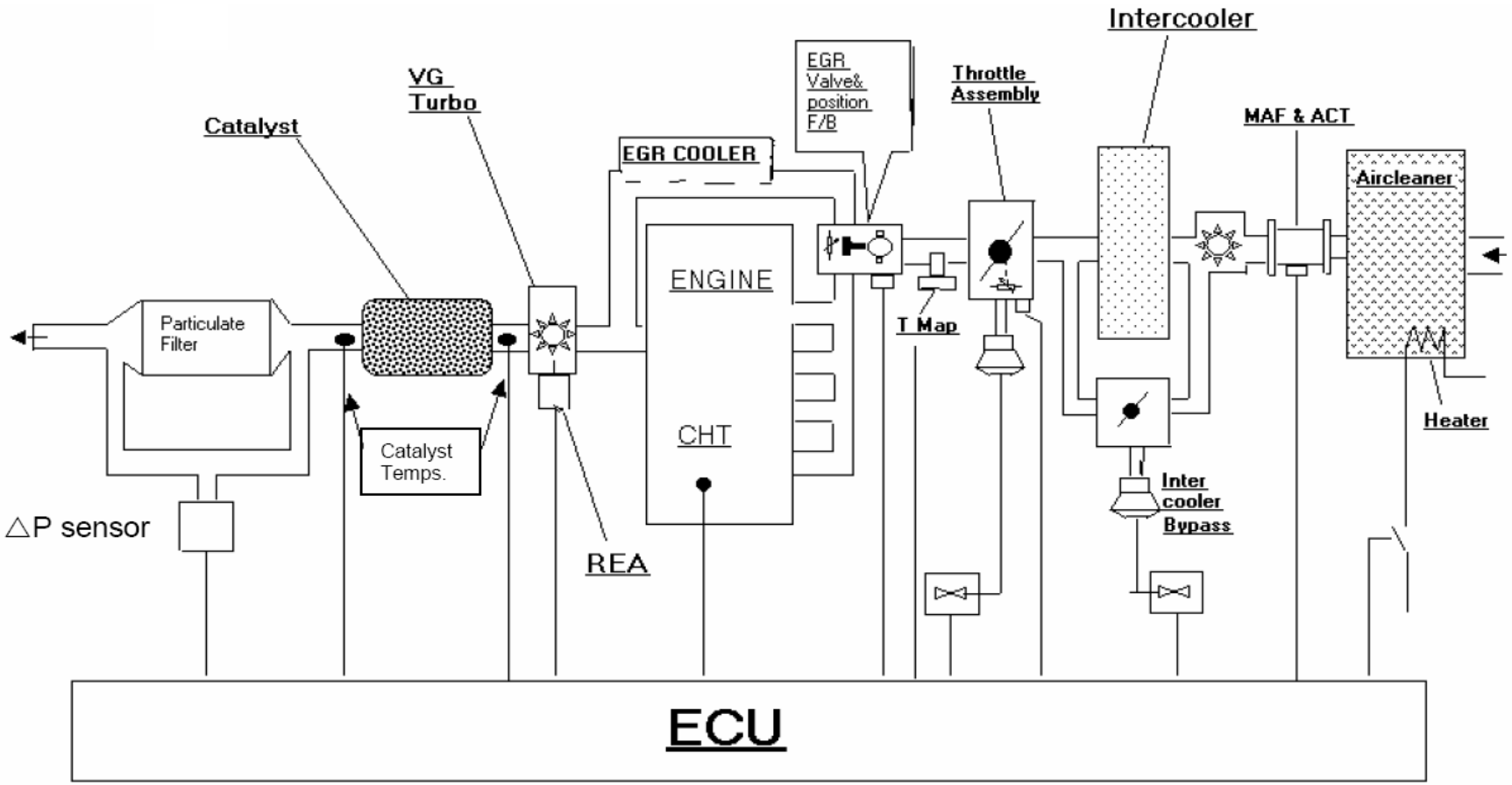


Fuel Injection Management

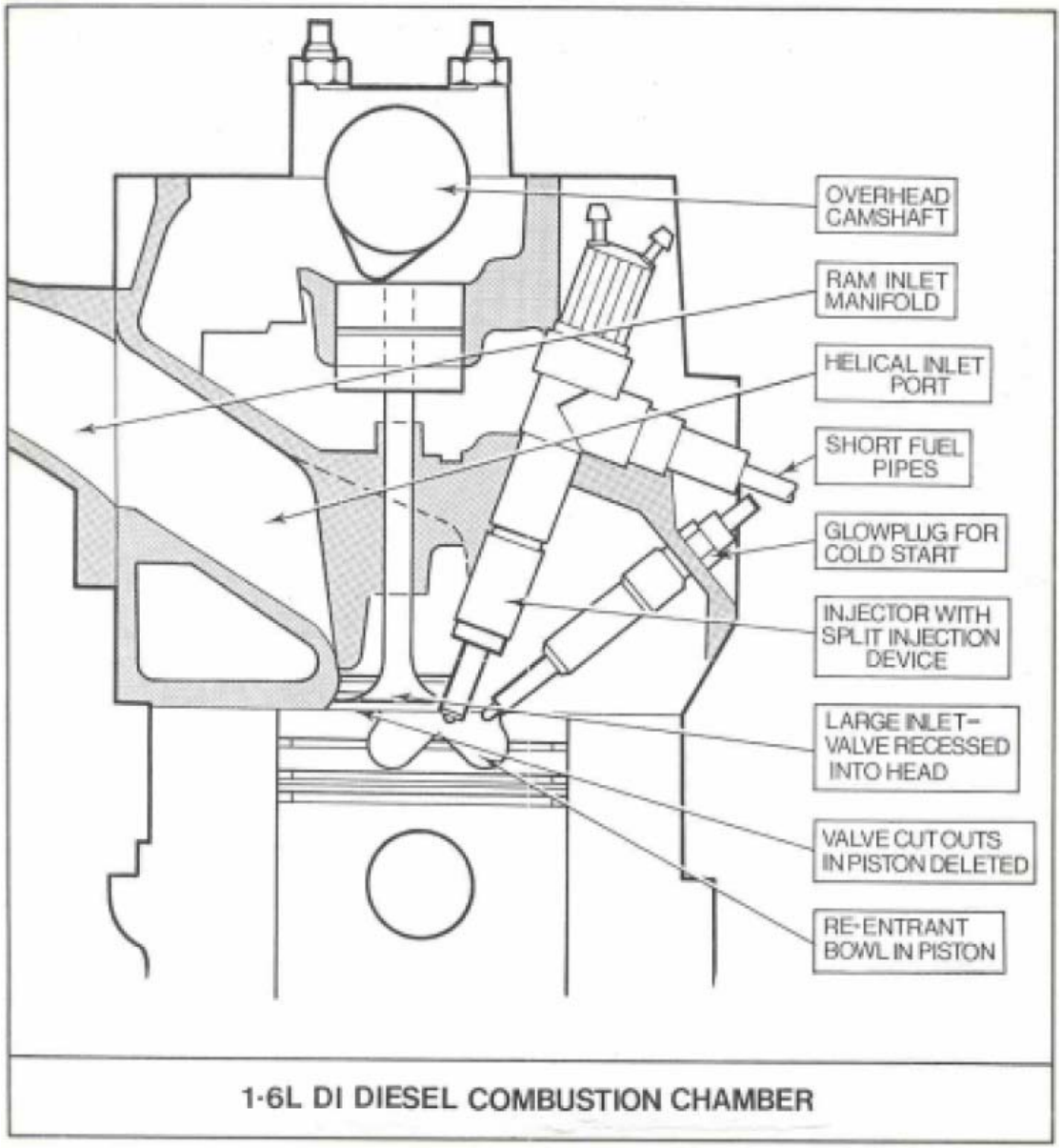


Control for Aftertreatment

Outlined in the picture below are the additional features required on the engine to facilitate the Regeneration of the Diesel Particulate Filter (DPF), these are:
air cleaner, air heater, intercooler bypass, inlet throttle, differential pressure sensor, exhaust Temperature sensors and the DPF itself, additionally a metering system for additives into the fuel has to be engineered.



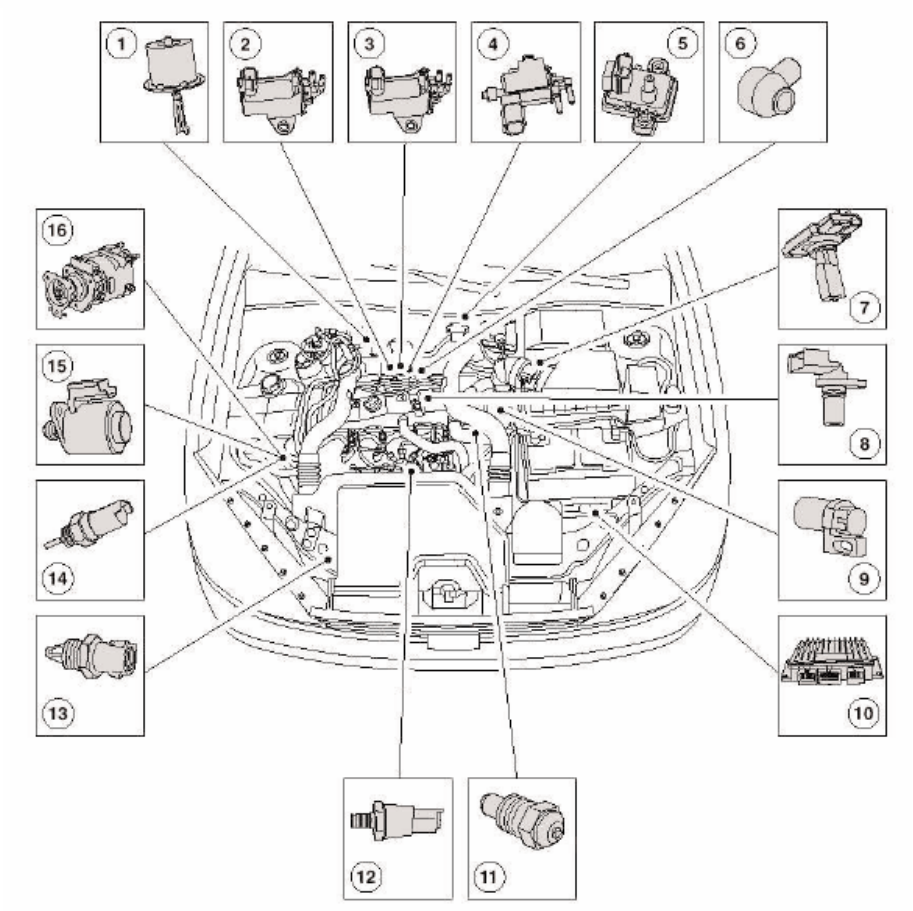
Cold Start



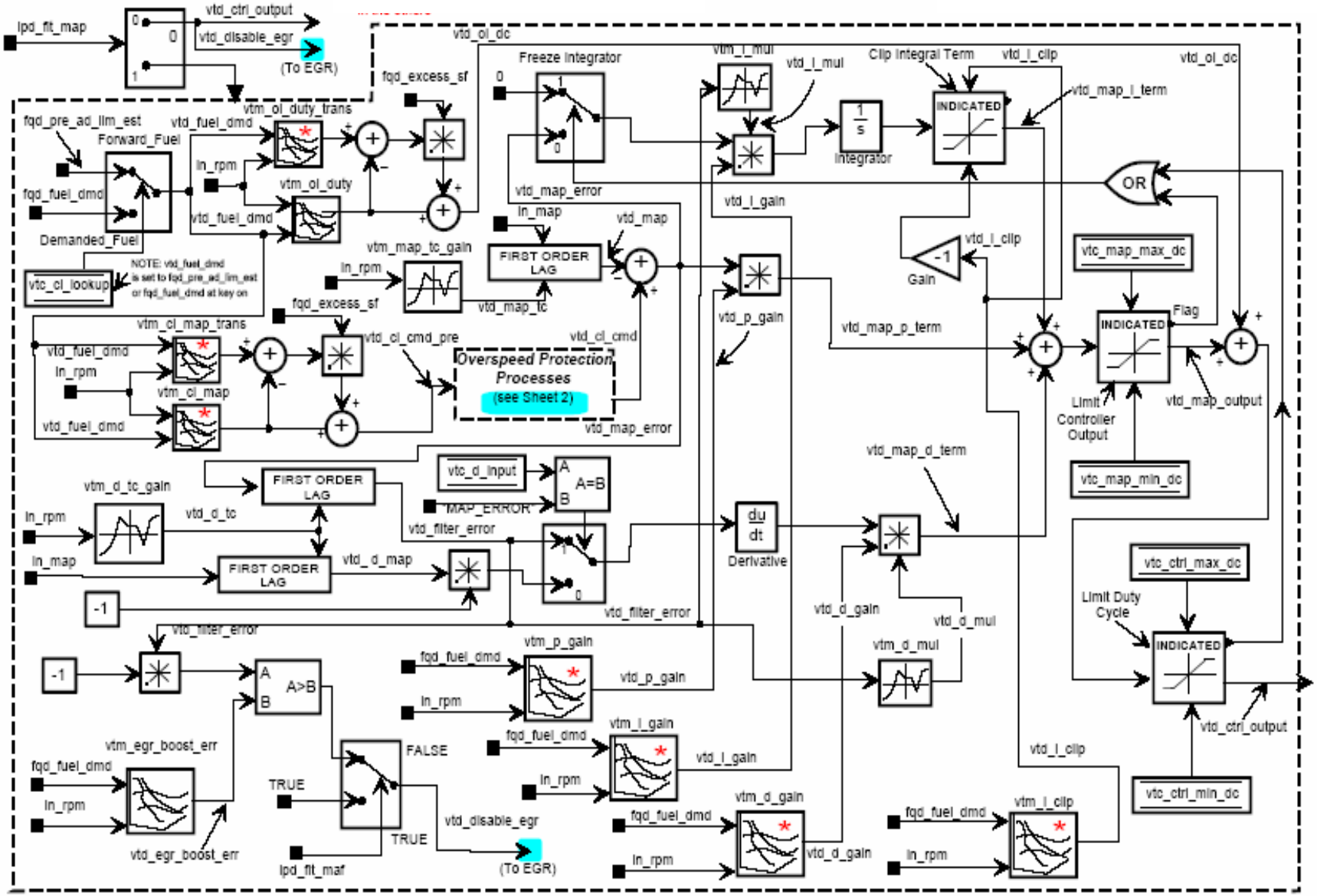
1·6L DI DIESEL COMBUSTION CHAMBER

Sensors Position in a CAR

Item	Component	Item.	Component
1	Air shut off throttle vacuum diaphragm unit	9	Crankshaft Position sensor (CKP)
2	EGR solenoid valve	10	Injector Control Unit (ICU)
3	Boost pressure solenoid valve	11	Cylinder Head Temperature sensor (CHT)
4	Air shut off throttle solenoid valve	12	Rail Pressure Sensor (RPS)
5	Manifold Absolute Pressure sensor (MAP)	13	Intake Air Temparature sensor (IAT)
6	Combustion Noise Sensor (CNS)	14	Fuel Temperature sensor
7	Mass Air Flow sensor (MAF)	15	Inlet Metering Valve (IMV)
8	Camshaft Position sensor (CMP)	16	High Pressure pump



A Control Sample



EMS for HCCI Engines

- Feedback from in-cylinder P analysis for right auto-ignition timing
- VVT, VVA, VCR or dual fuel control
- Intake T, exhaust T
- Exchange between HCCI and traditional combustion

On-Board Diagnostics (OBD)

- A system in the engine's on-board computer that monitors the performance of emission-related components for malfunctions
- Uses information from sensors
- Mostly software that runs diagnostics in the background
- Uses information from sensors to judge the performance of the emission controls
- These sensors do not directly measure emissions

Benefits of OBD

- Encourages design of durable emission control systems
- Aids diagnosis and repair of complex electronic engine controls
- Helps keep emissions low by identifying emission controls in need of repair
- Works for life of the vehicle

What vehicles have OBD today?

- All passenger cars, SUVs, and small trucks
- Started in 1996 for gasoline and 1997 for diesel
- Over 120 million OBD II-equipped vehicles operating in the United States today

How OBD works

- Fuel system pressure control
- Fuel pressure sensor measures how well pressure is controlled
- Manufacturer correlates pressure control error to corresponding emission increase
- OBD system is calibrated to turn on MIL when pressure is outside limits

Malfunction Indicator Light (MIL)

- Should a malfunction be detected, a warning light will appear on the vehicle's instrument panel to alert the driver
- When a malfunction is detected, information about the malfunctioning component is stored
- Technicians can download the information with a “scan tool”
- Information is communicated in a standardized format so one tool works with all vehicles