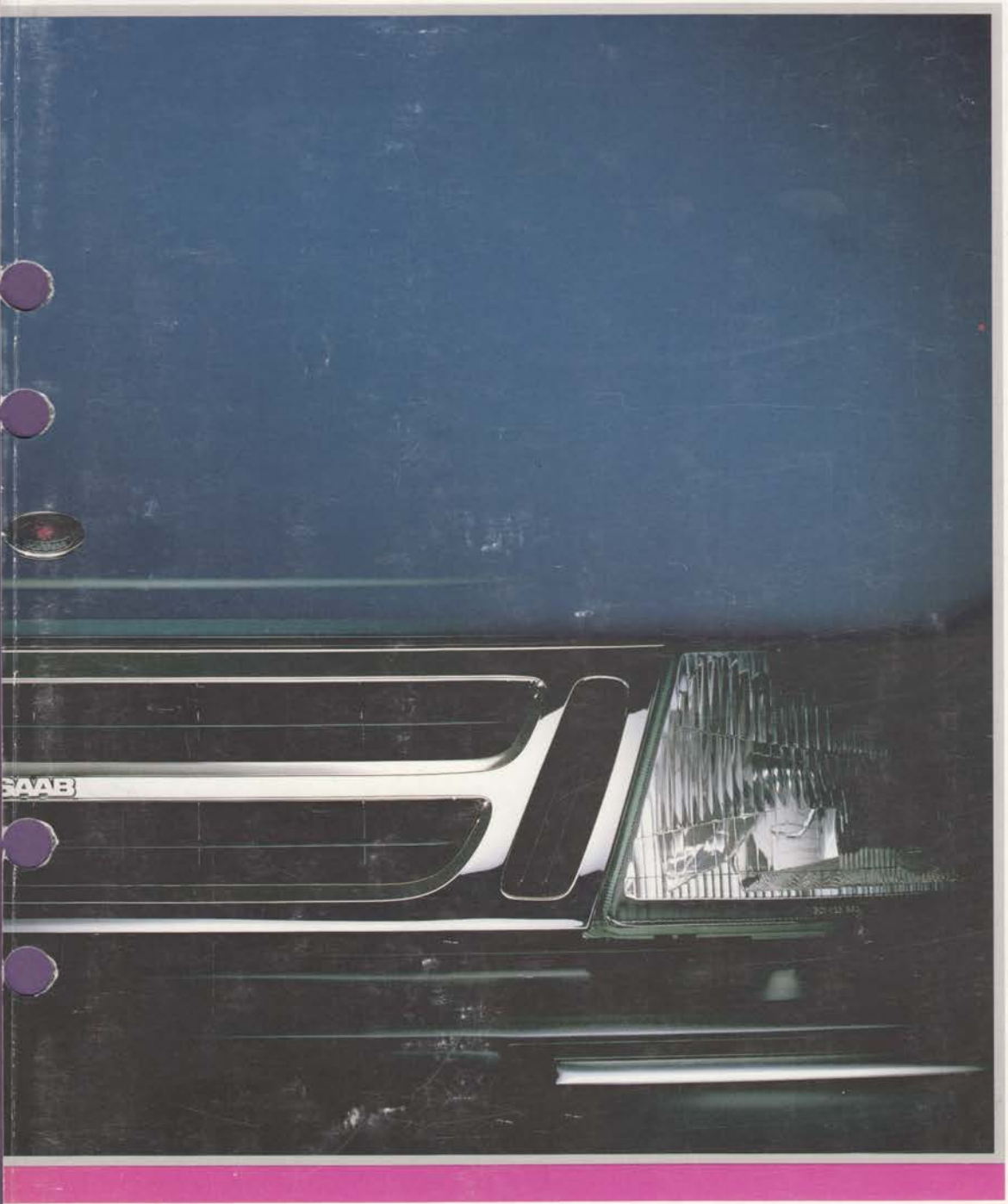
Saab 9000

SERVICE MANUAL



SAAB

2:7 TRIONIC Engine Managament System

M 1993

Saab 9000

SERVICE MANUAL

2:7 TRIONIC Engine Management System

M 1993

Units

The basic and derived units used throughout the Service Manual are in accordance with the SI system. (Systéme International d'Unités)

For users not familiar with the SI units, some non-Continental units are given in brackets after the respective SI unit.

The following symbols and abbreviations are used:

SI unit	Equivalent unit and symbol
Millimeter (mm)	inch (in)
Kilograme (kg)	pound (lb)
Newton (N)	pound-force (lbf)
Newtonmeter (Nm)	foot pound (ft lb)
Atmosphere (bar)	pound-force per square inch (lbf/in^2) (Also abbreviated: psi)
Liter (l)	US liquid quart (liq qt) (Also abbreviated: qts)
	US gallon (USgal)
°Celcius (°C)	°Fahrenheit (°F)

Conversion factors

1 in = 25.4 mm	1 mm = 0.039 in
1 lb = 0.45 kg	1 kg = 2.20 lb
1 lbf = 4.45 N	1 N = 0.23 lbf
1 lbf ft = 1.36 Nm	1 Nm = 0.74 lbf ft
1 psi = 0.07 bar	1 bar = 14.5 lbf/in^2
1 US liq qt = 0.83 UKqt	1 l = 1.05 liq qt
	1 USgal = 0.83 UKgal
°F = °C x 9/5 + 32	°C = (°F - 32) x 5/9

Market codes

The codes refer to market specifications

AT	Austria	GB	Great Britain
AU	Australia	GR	Greece
BE	Belgium	IS	Iceland
CA	Canada	IT	Italy
CH	Switzerland	JP	Japan
DE	Germany	ME	Middle East
DK	Denmark	NL	Netherlands
ES	Spain	NO	Norway
EU	Europe	SE	Sweden
FE	Far East	US	USA
FI	Finland	UC	US California
FR	France		

Production: Service Support, Saab Automobile AB, Trollhättan, Sweden

Information

A note concerning some of the terms used in this manual

This service Manual uses terminology for electrical and electronic components and systems which is somewhat different from that previously used by Saab. This new terminology conforms to the Society of Automotive Engineers Recommended Practice SAE J1930. The use of SAE J1930 terminology for emission-related systems and components is required by the California Air Resources Board (CARB) for new Service Manuals beginning with the 1993 model year. The U.S. Environmental Protection Agency has also proposed regulations requiring the use of J1930 terminology beginning in model year 1994.

While this change in terminology may be troublesome in the beginning for technicians accustomed to Saab component and system names, standardization within the automotive industry will in time reduce the confusion that can result from different terms for the same component. For example, the Saab term "Automatic Idle Control valve" or "AIC valve" is termed by other manufacturers as:"Electronic Air Control Valve solenoid", "Auxiliary Air Control valve", "Idle Stabilizer valve" and "Air Control Valve". This manual uses the SAE J1930 term "Idle Air Control Valve" (abbreviated as "IAC valve") which is the same term other automotive manufacturers will use for this component.

The SAE J1930 terms were not selected on the basis of what component names were the ones commonly used by most auto manufacturers. Instead the SAE used a logical method for describing components in which modifiers are added to a base word in order of decreasing signifiance. To use the example above: Idle Air Control Valve. The base word is "valve". What kind of valve is it? A "control" valve. What does it control? "Air". What kind of air? "Idle "air.

In order to assist technicians who are familiar with Saab terminology, there is a listing on the next page comparing previous Saab component and system terms with the equivalen SAE J1930 terms which are used in this book.

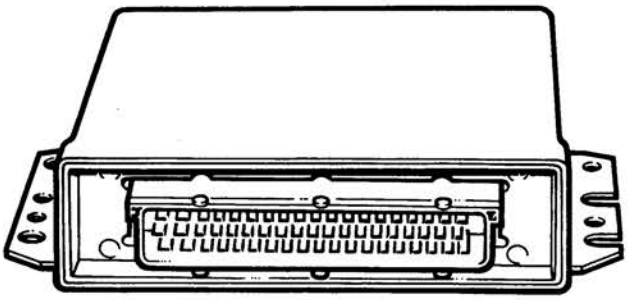
Saab-J1930 word list

Correct Abbreviation in ()

Previous Saab Term	J1930 Term
AC	Air conditioning (A/C)
Air Mass Meter	Mass Air Flow Sensor (MAF sensor)
APC Solenoid Valve	Boost Pressure Control Valve (BPC vlave)
Automatic Idle Control (AIC) valve	Idle Air Control valve (IAC valve)
Catalyst	Three Way Catalytic Converter (TWC)
Catalytic Converter	Three Way Catalytic Converter (TWC)
Charcoal Canister	Evaporative Emission Canister (EVAP canister)
Control Unit	Control Module
Crankshaft Sensor	Crankshaft Position Sensor (CKP sensor)
Direct Discharge Unit	Ignition Discharge Module (IDM)
Direct Ignition	Electronic Ignition (EI)
Earth	Ground
ELCD valve	Canister Purge valve (CP valve)
Electronic Control Unit	X Control Module (where X = ignition, engine, SRS, etc.)
Evaporative Emission Control System	Evaporative Emission System (EVAP system)
EZK ECU	Ignition Control Module (ICM)
EZK Electronic Ignition System	Distributor Ignition system (DI system)
Fault Code	Diagnostic Trouble Code (DTC)
Ignition Cassette	Ignition Discharge Module (IDM)
Ignition ECU	Ignition Control Module (ICM)
Injection valve	Injector
Inlet	Intake
Intercooler	Charge Air Cooler (CAC)
Knock Detector	Knock Sensor (KS)
LH ECU	Engine Control Module (ECM)
LH Fuel Injection system	LH Multiport Fuel Injection system (MFI system)
Pressure sensor	Manifold Absolute Pressure sensor (MAP sensor)
Saab DI/APC system	DI/APC Electronic Ignition system (EI)
Td signal	Engine Speed signal (RPM signal)
Temperature sensor	Intake Air Temperature sensor (IAT sensor) or Engine Coolant Temperature sensor (ECT sensor)
Test Socket	Data Link Connector (DLC)
Throttle Housing	Throttle Body (TB)
Throttle Potentiomenter	Throttle Position sensor (TP snesor)
Throttle Switch	Throttle Position Switch (TP switch)

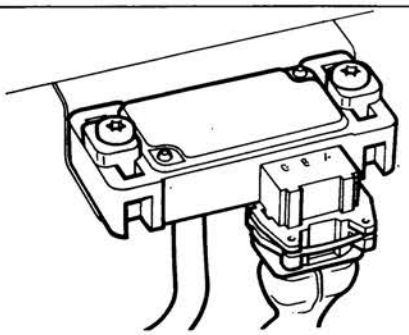
Technical data

Engine control module



Connecting pins	qty	70
+30 voltage supply	pin No.	1 and 48
Main ground	pin No.	24 and 25
Signal ground	pin No.	66 and 67
Reference ground	pin No.	47 and 66 (66 TCS cars only)

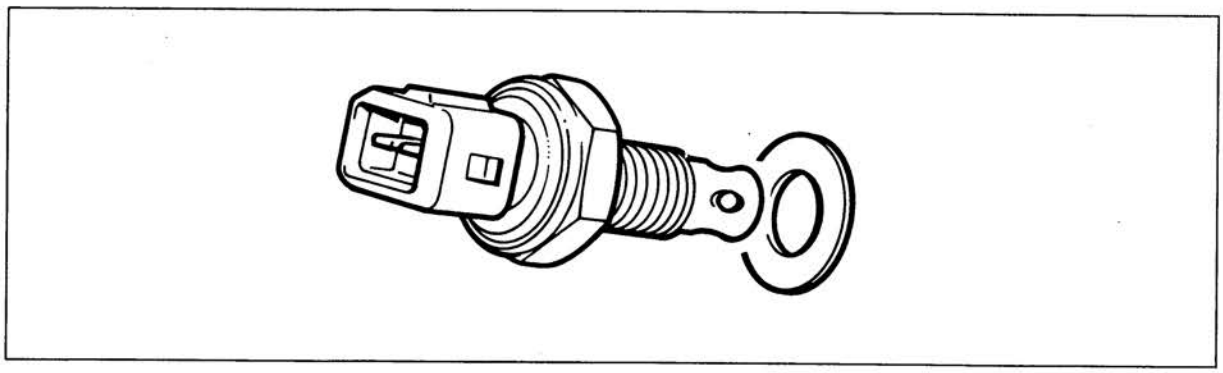
Manifold absolute pressure sensor



Approx. voltage at -0.75 bar (25 kPa*))	Volt	0.4
-0.50 bar (50 kPa*))	Volt	0.9
0 bar (100 kPa*))	Volt	1.8
0.25 bar (125 kPa*))	Volt	2.3
0.50 bar (150 kPa*))	Volt	2.8
0.75 bar (175 kPa*))	Volt	3.3

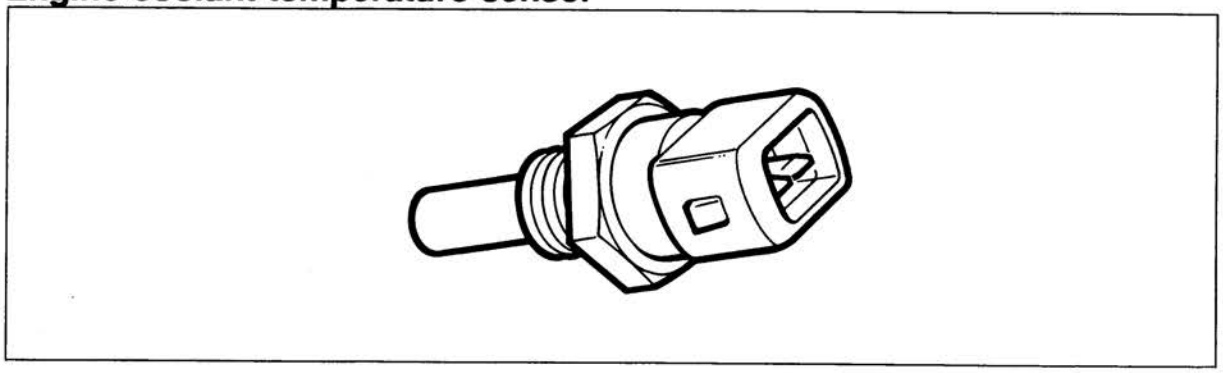
**) Referring to absolute pressure, i.e. 100 kPa corresponds to atmospheric pressure*

Intake air temperature sensor



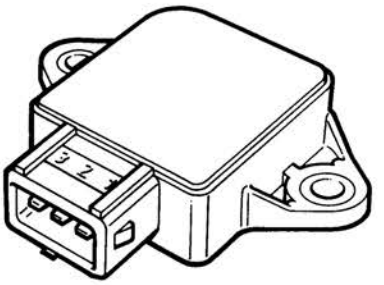
Resistance at -30°C	kohm	20-30 (approx. 4.5 V)
-10°C	kohm	8.3-10.6 (approx. 3.9 V)
20°C	kohm	2.3-2.7 (approx. 3.2 V)
40°C	kohm	1.0-1.3 (approx. 1.5 Volt)
60°C	Ohm	565-670 (approx. 0.9 V)
80°C	Ohm	295-365 (approx. 0.7 V)

Engine coolant temperature sensor



Resistance at -30°C	kohm	20-30 (approx. 4.5 V)
-10°C	kohm	8.3-10.6 (approx. 3.9 V)
20°C	kohm	2.3-2.7 (approx. 3.2 V)
40°C	kohm	1.0-1.3 (approx. 1.5 V)
60°C	Ohm	565-670 (approx. 0.9 V)
80°C	Ohm	295-365 (approx. 0.7 V)

Throttle position sensor (not TCS)

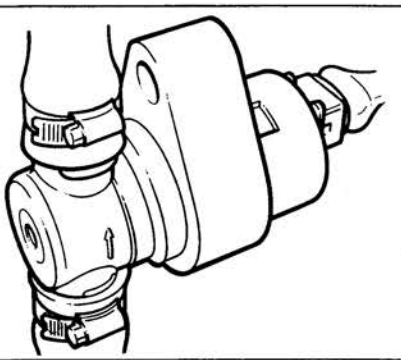


Resistance at idling speed (pins 1—3)	kohm	2.3-3.4
Resistance at wide open throttle (pins 1—3)	kohm	0.7-1.0

Injectors

Resistance	Ohm	15.5-16.3 (@20 ± 5°C)

Idle air control valve



Resistance	Ohm	6-10 (@20 ± 5°C)

Spark plugs

Manufacturer	NGK	BCPR 7ES
Electrode gap	mm	1.0 ± 0.1
Tightening torque	Nm (lbf ft)	25-29 (18.5-21.5)

Ignition voltage

Ignition voltage	V	40000
Ionization voltage	V	80
Capacitor voltage	V	400

Turbo boost pressure

Basic charging pressure, manual	bar	0.40 ± 0.03
Basic charging pressure, automatic	bar	0.40 ± 0.03
Maximum boost pressure, manual	bar	approx. 1.00 at 3000 rpm
Maximum boost pressure, automatic	bar	approx. 0.77 vid 2700 rpm

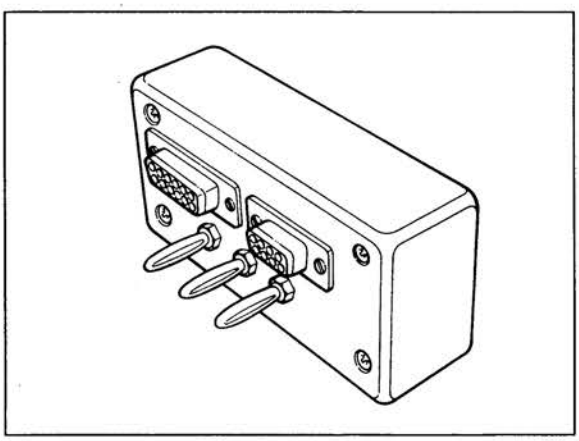
Boost pressure control valve

Frequency	Hz	70 - 90 depending on engine rpm
Resistance, coil	Ohm	3

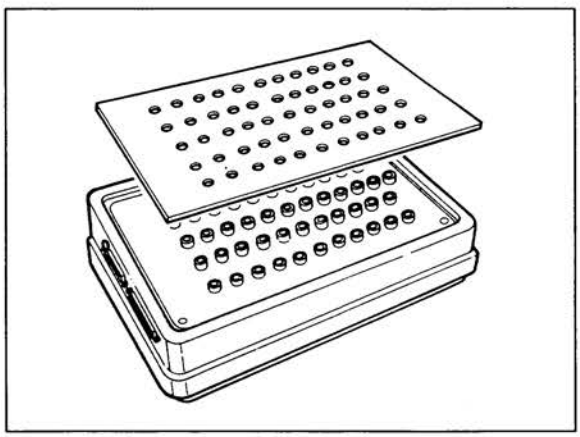
Special tools

86 11 188 Saab Diagnostic Adapter (SDA)

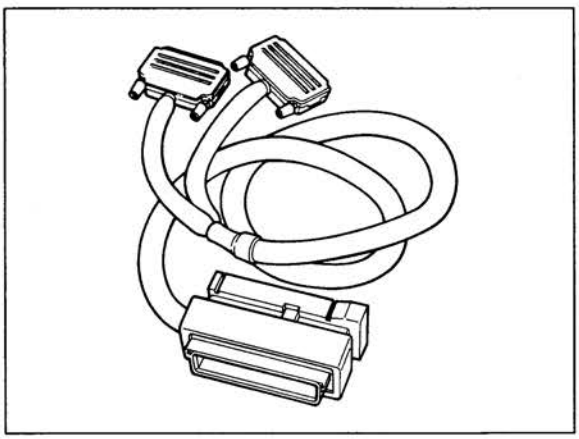
Adapter for connecting the SFI wiring to an ISAT scan tool. Applications will become more numerous in the future on subsequent Saab 9000 models.



86 11 204 Diagram showing ECM pin numbering on breakout box (BOB).

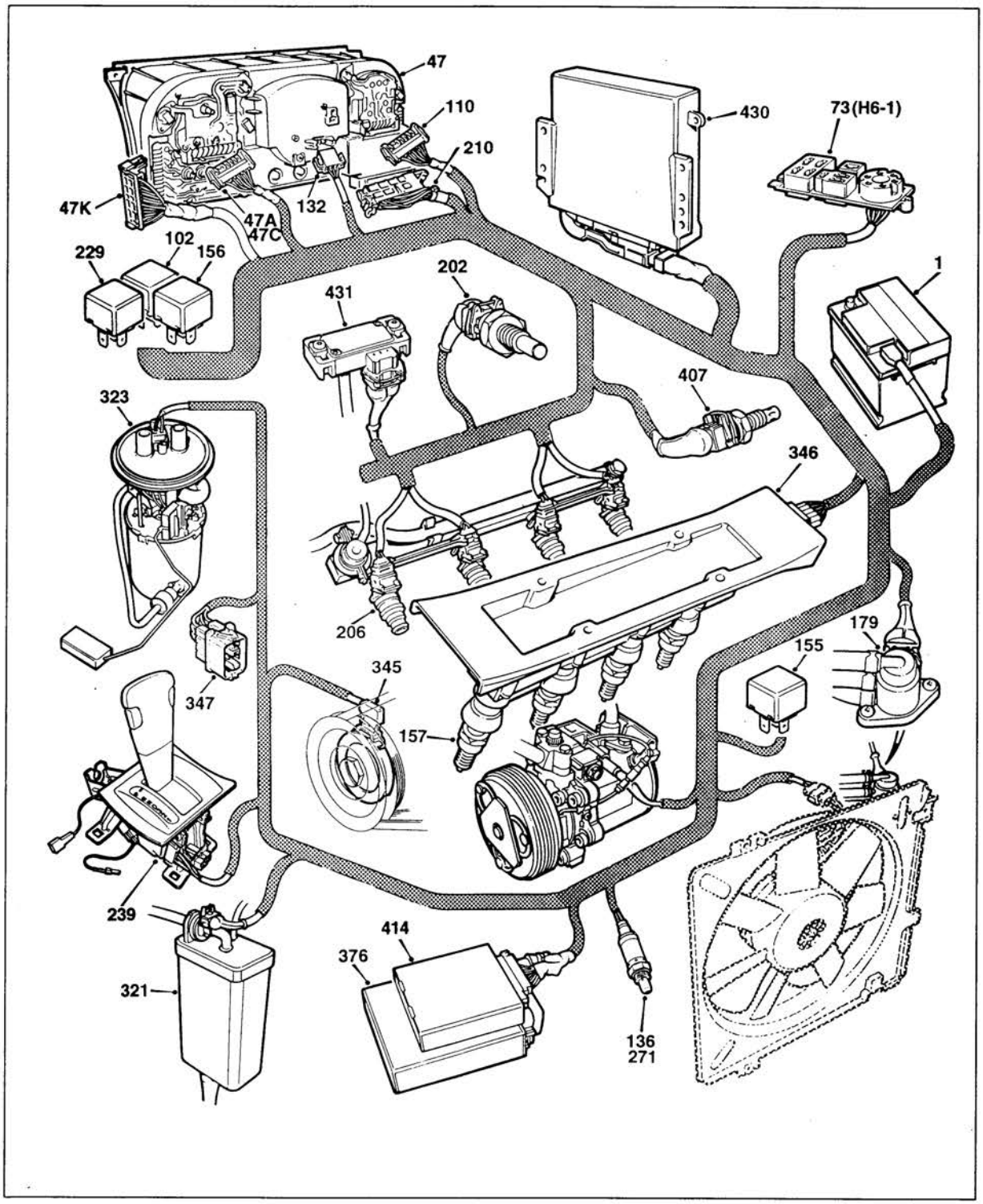


86 11 170 70-pin test cable for breakout box (BOB)

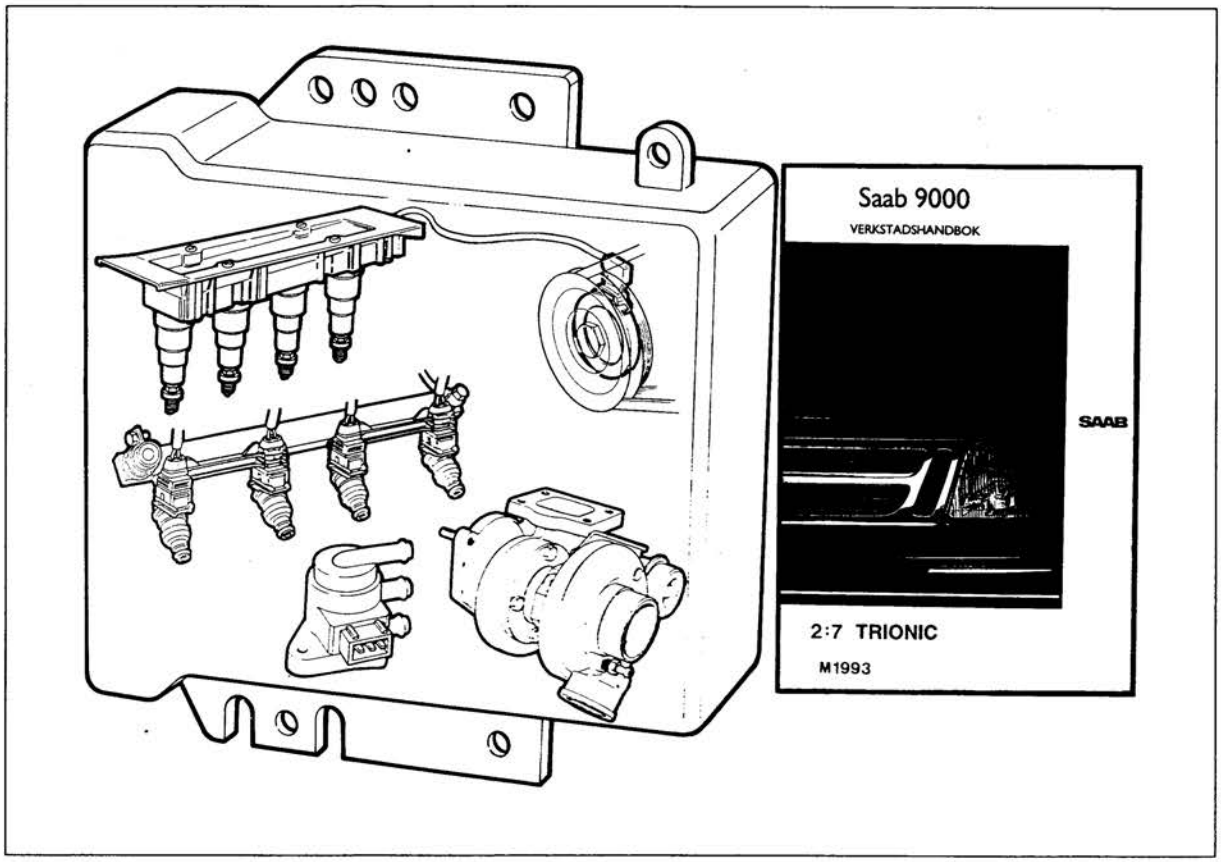


Technical description, Saab TRIONIC SFI system

Saab TRIONIC Sequential multiport fuel injection system (SFI)



Saab TRIONIC SFI system



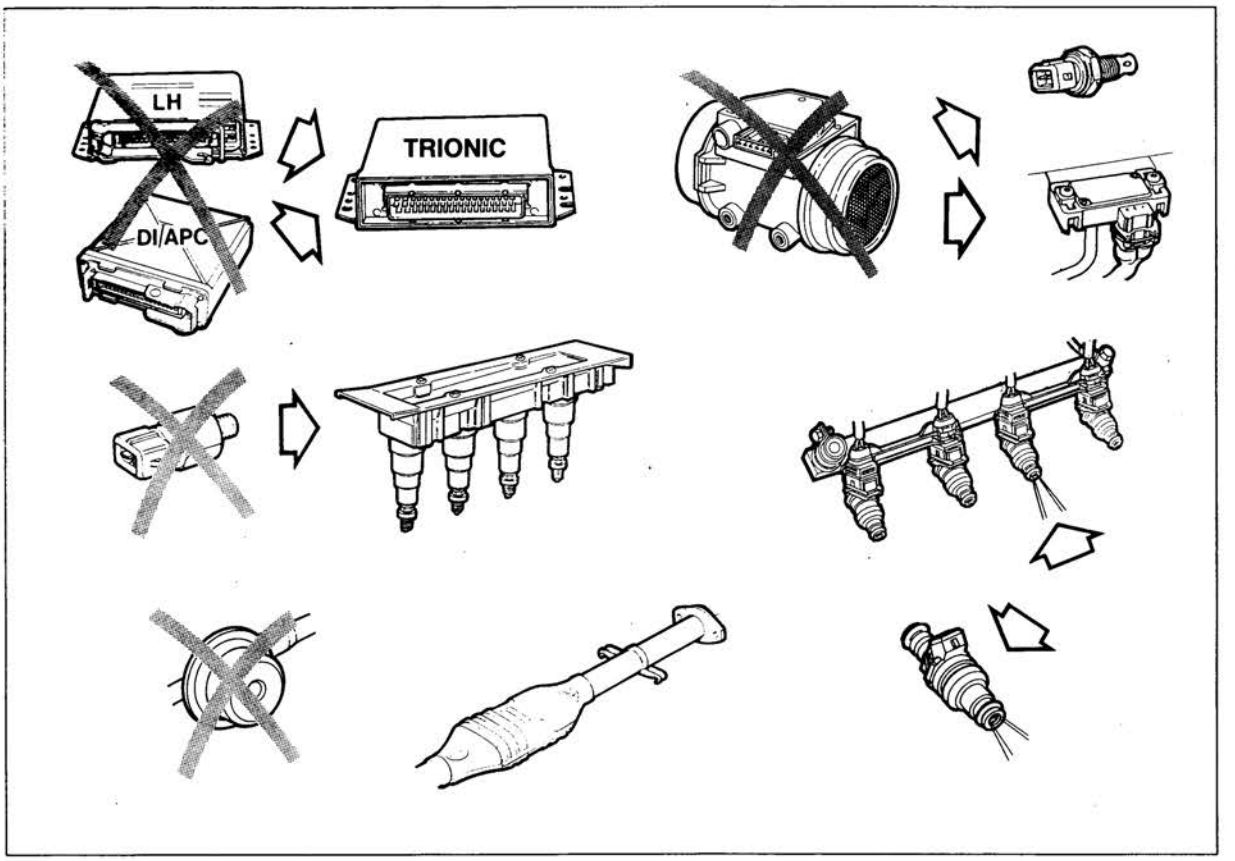
Three systems - one Engine Control Module

TRIONIC is a sequential multiport fuel injection (SFI) system designed by Saab in which fuel injection, ignition timing and charging pressure adjustment are integrated in a single system with one engine control module (ECM).

In simple terms, the system could be described as a combination of fuel injection, ignition, boost pressure control, diagnostic capability, emission control and combustion analysis with components which meet future legal and environmental requirements. At the same time, the new system is also a favourable economic alternative and with Saab's design solutions the requirement of development potential is also amply satisfied.

Starting with M93, the TRIONIC SFI will be featured on 9000 Turbo cars fitted with the B234 engine (except ME and LA).

Saab TRIONIC SFI system (contd.)



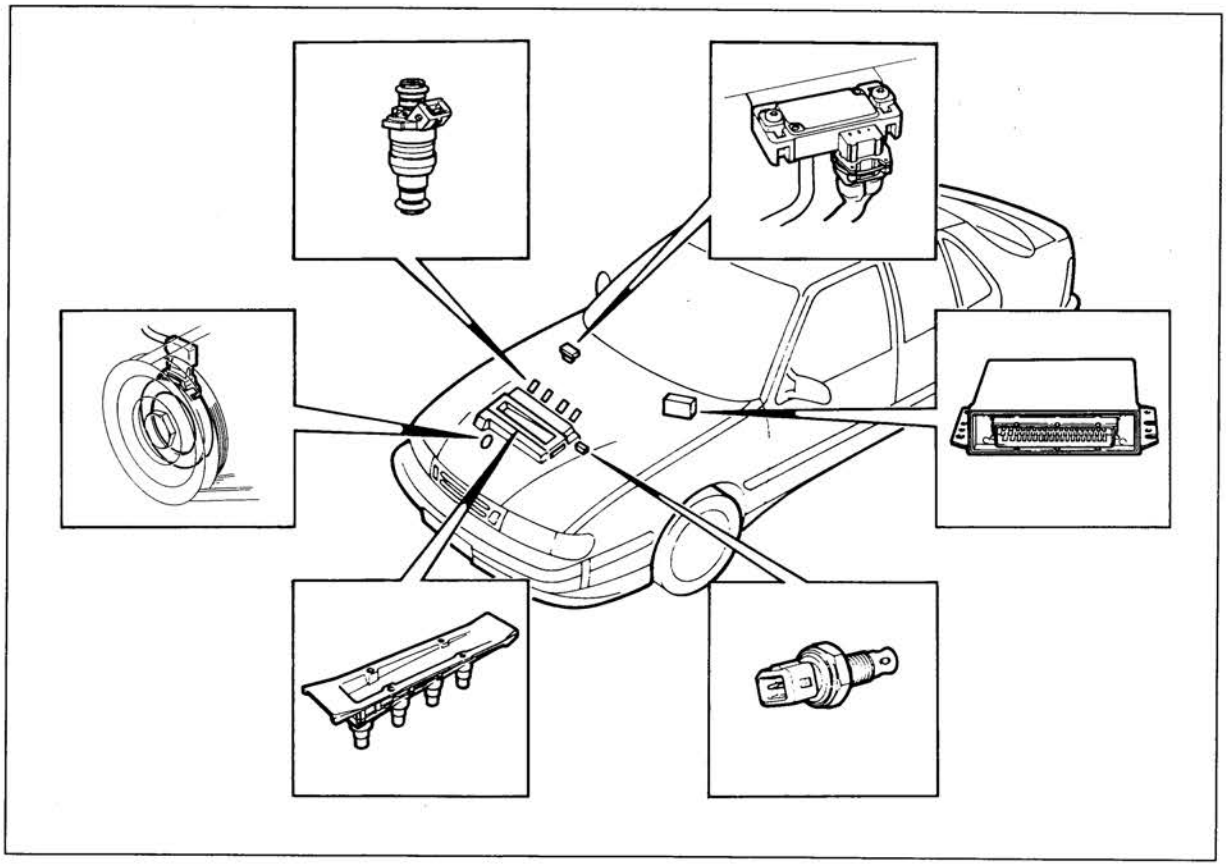
Comparison With TRIONIC SFI and LH - DI/APC

Briefly, the most important differences between the TRIONIC SFI system and the earlier LH multiport fuel injection and DI/APC electronic ignition/boost pressure control systems can be summarized as follows:

- two control modules are replaced by one only
- the mass air flow sensor is replaced by a manifold absolute pressure sensor for measuring the pressure in the intake manifold and an intake air temperature sensor for measuring the air temperature just ahead of the intake manifold.
- the separate external knock sensor is replaced by an integrated knock sensor function in the ignition discharge module (ignition cartridge)
- sequential (individual) control of each injector
- twin-jet injectors
- repositioned three way catalytic converter to reduce HC emissions and as a step towards meeting future OBD II requirements (USA, Scandinavia) *)
- the fuel rail pulsator is no longer fitted.

*)OBD II (On-Board Diagnostic II) is edition 2 of the applicable rules for inspecting, diagnosing and fault tracing emission-related functions and components with environmental requirements as the point of departure. See also page 69 for more information on OBD II.

Saab TRIONIC SFI system (contd.)



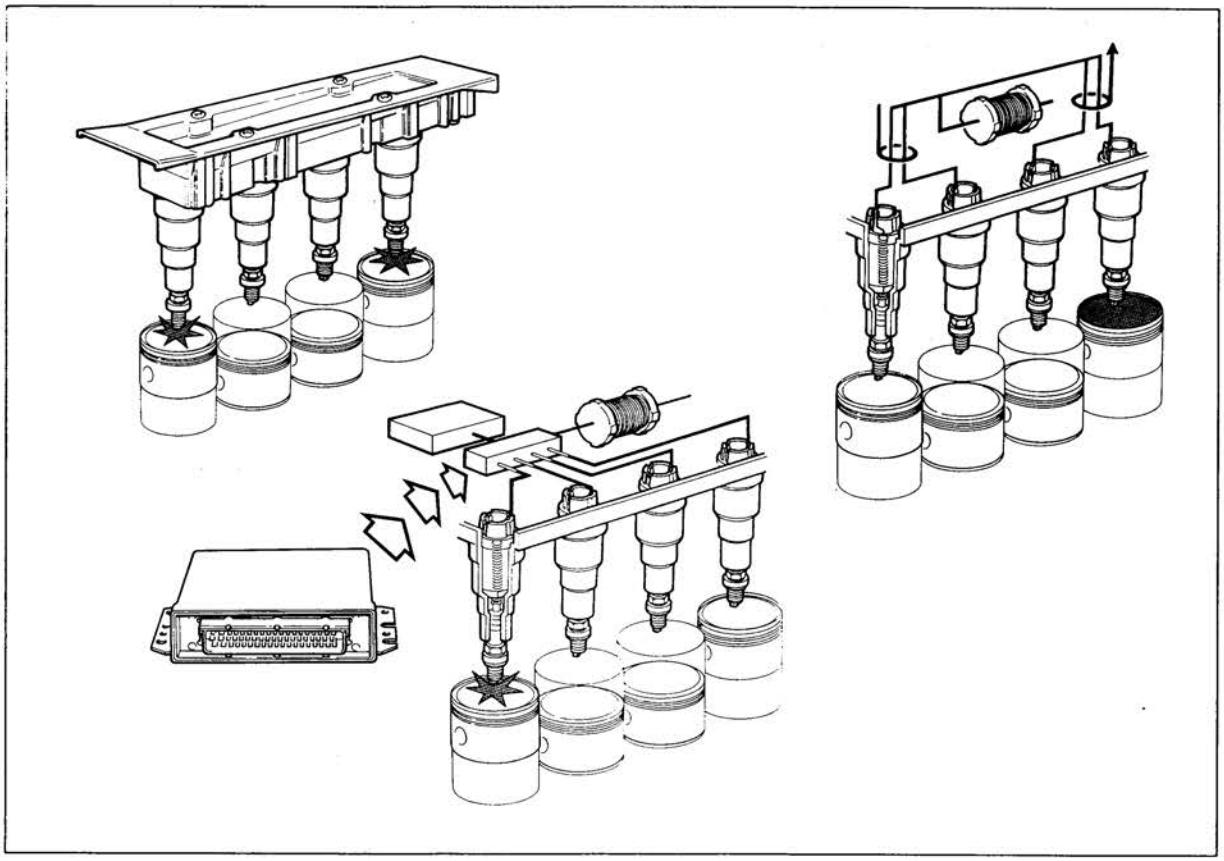
Principal components of the SFI system
The SFI system is an integrated engine system which controls the ignition and fuel injection systems and also regulates the turbo boost pressure from a common engine control module.

The system consists of the following main components:

- Engine control module (ECM)
- Ignition discharge module (IDM)
- Manifold absolute pressure (MAP) sensor
- Injectors
- Crankshaft position sensor
- Intake air temperature sensor

The 70-pin ECM, located in the bulkhead partition space on the left-hand side, has two ventilation holes at the bottom. To reduce radio interference, the casing is grounded to the car body by means of a separate braided ground strap.

Saab TRIONIC SFI system (contd.)



Ignition system

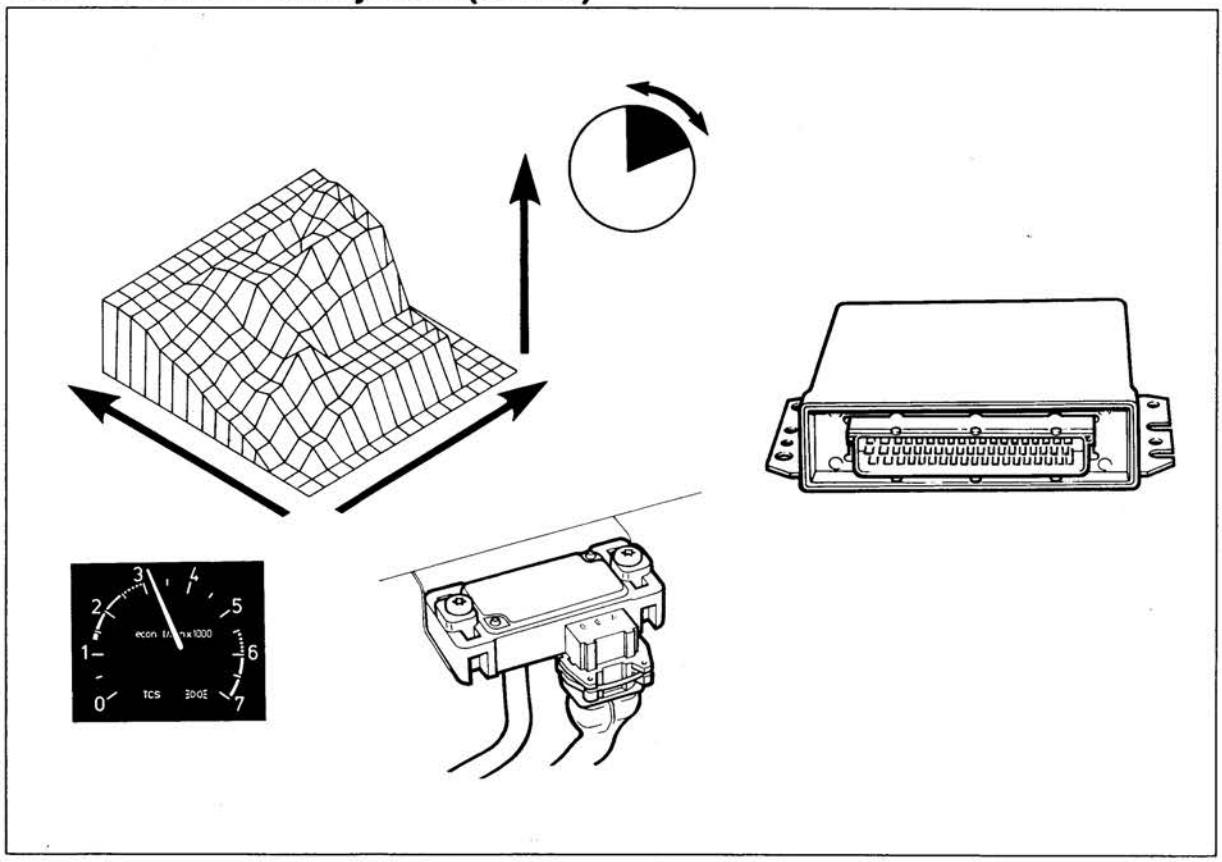
The SFI system is equipped with a capacitive ignition system consisting of four ignition coils and electronic circuitry built into an ignition discharge module mounted on the cylinder head of the engine. The ignition coils are controlled by electronic circuitry built into the discharge module which in its turn is regulated by low-level signals from the ECM.

When the engine is cranked, the system produces a spark in two cylinders simultaneously - 1 and 4 or 2 and 3 - for 10 consecutive complete combustion processes. Following this, on the basis of the ionization current flowing through the spark plugs and signals from the crankshaft position sensor, the system has sufficiently reliable information to synchronize spark generation and fuel injection so that optimum ignition timing is obtained.

To improve starting performance, the system always fires a large number of sparks in quick succession (multispark function) while the starter motor is engaged (10°BTDC - 60°ATDC) when engine coolant temperature is below 0°C.

The crankshaft position sensor consists of a Hall-effect sensor and a field rotor flange with three slots, two of the same size and one smaller.
The two larger slots show **that** a pair of pistons is at TDC and the smaller slot indicates **which** pair it is. The crankshaft position sensor works in the same way and provides the same information as in earlier DI/APC electronic ignition systems.

Saab TRIONIC SFI system (contd.)



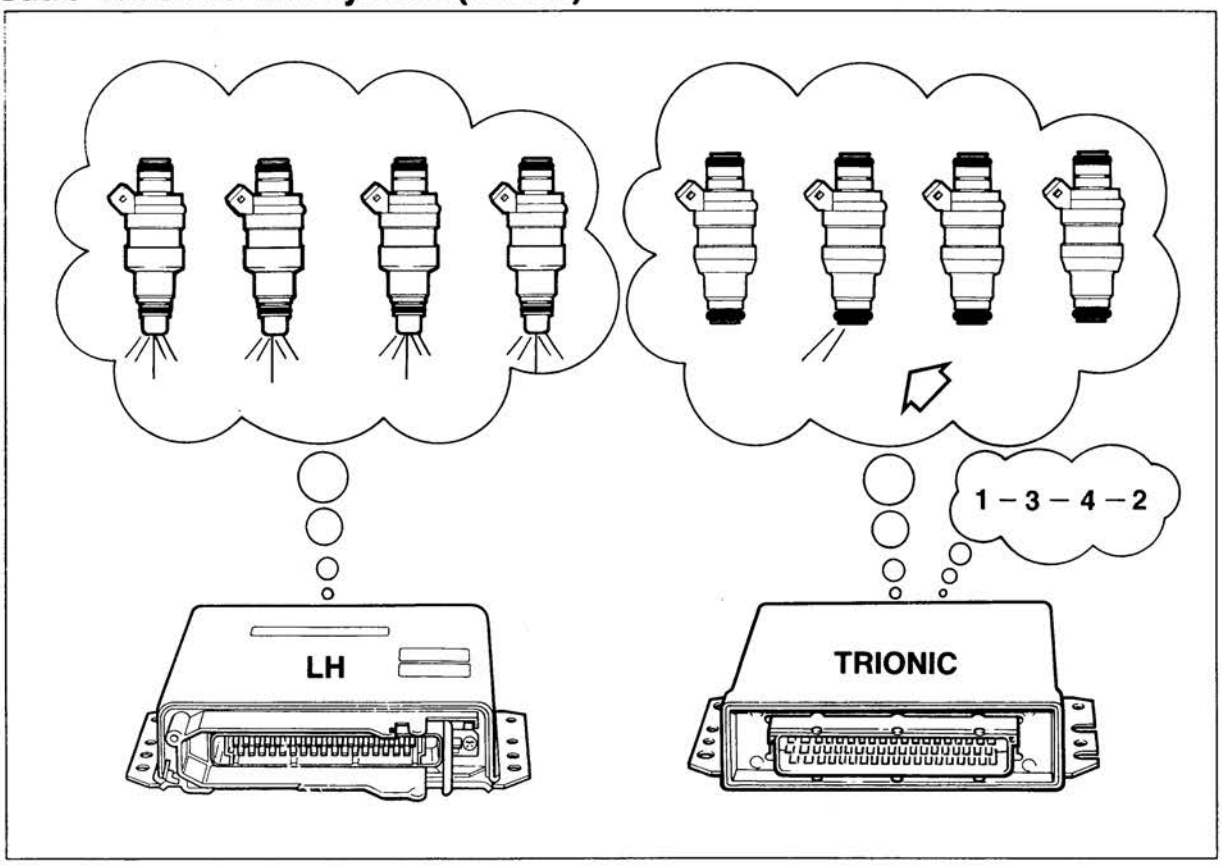
Ignition timing

Optimum ignition timing is calculated in the control module on the basis of the following information:

- engine load (Tq)
- engine speed

The throttle positon (at idle) also provides the basic ignition timing and, where appropriate, a knocking tendency in any of the cylinders will naturally also influence the control module's calculation of optimum ignition timing.

Saab TRIONIC SFI system (contd.)



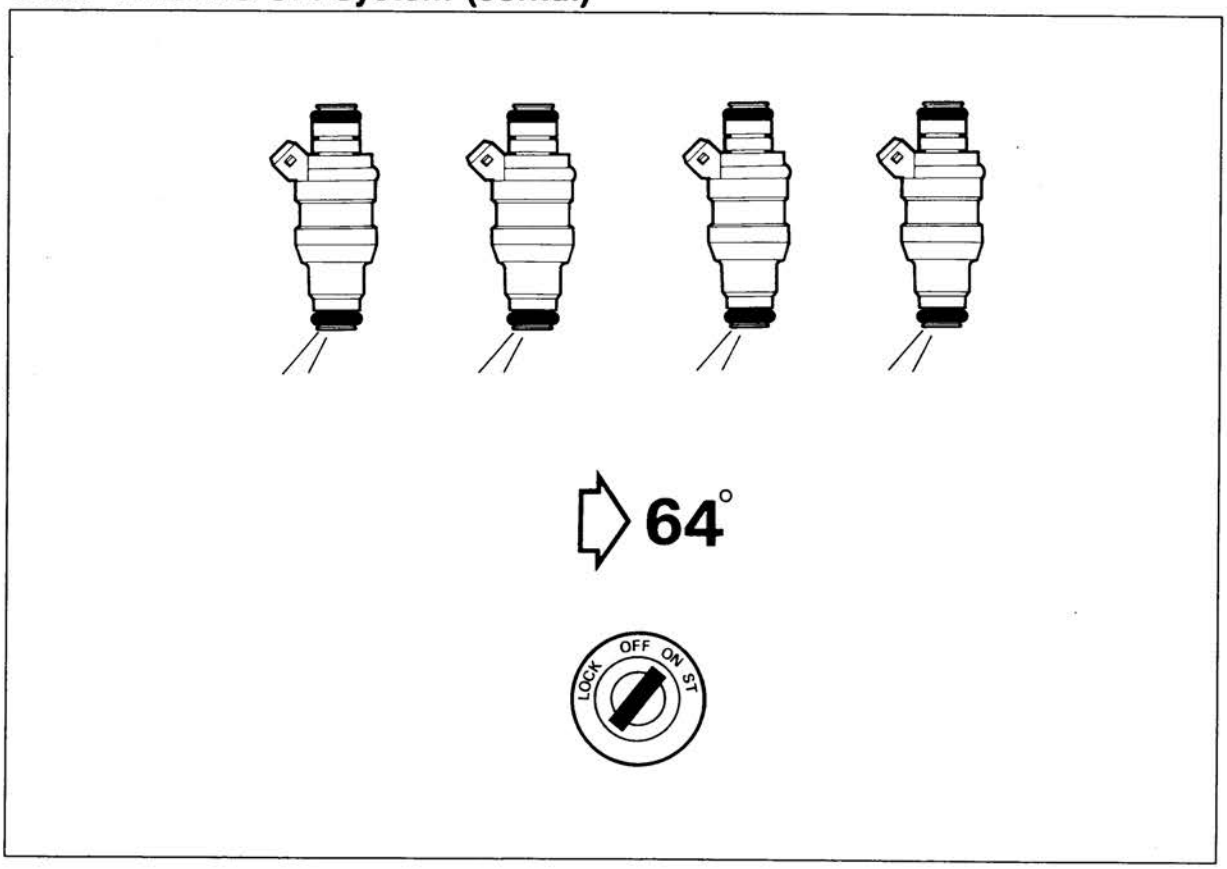
Sequential multiport fuel injection

Sequential fuel injector control is an important feature of the TRIONIC SFI system that permits each individual injector to be controlled and regulated individually by the engine control module.

This means that each cylinder can be supplied with precisely the right amount of fuel, depending on the air fed to it, the temperature, engine load and any knocking tendencies.

The amount of fuel, which is determined individually for each separate cylinder, is also dependent on the information received continuously by the ECM about the composition of the exhaust gases.

Saab TRIONIC SFI system (contd.)



Before-start function

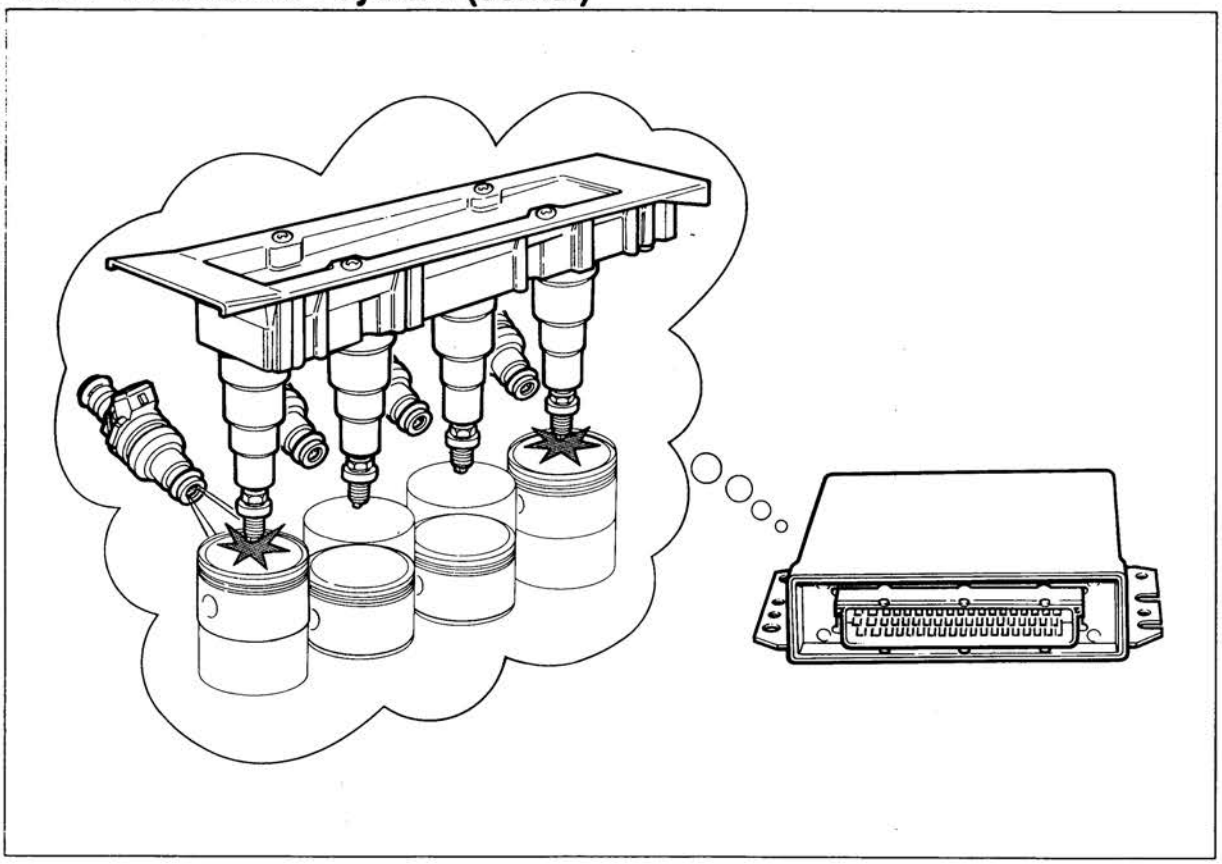
To achieve short starting times the ECM is programmed with a "Before-start" function, which means that a temperature-dependent amount of fuel is injected into all the cylinders when the ignition switch is turned to the Drive position.

When the ignition switch is turned at the next moment to the Start position, fuel is already present at all inlet valves. Together with the double spark (or multispark) function of the ignition discharge module, this ensures extremely short starting times.

The "Before-start" function is utilized by the ECM at engine coolant temperatures up to 64°C.

When the ignition is turned off, certain functions in the ECM stay "live" for another 15 minutes. One example is that the ECM inhibits the "Before-start" function from repeating for 15 minutes.

Saab TRIONIC SFI system (contd.)

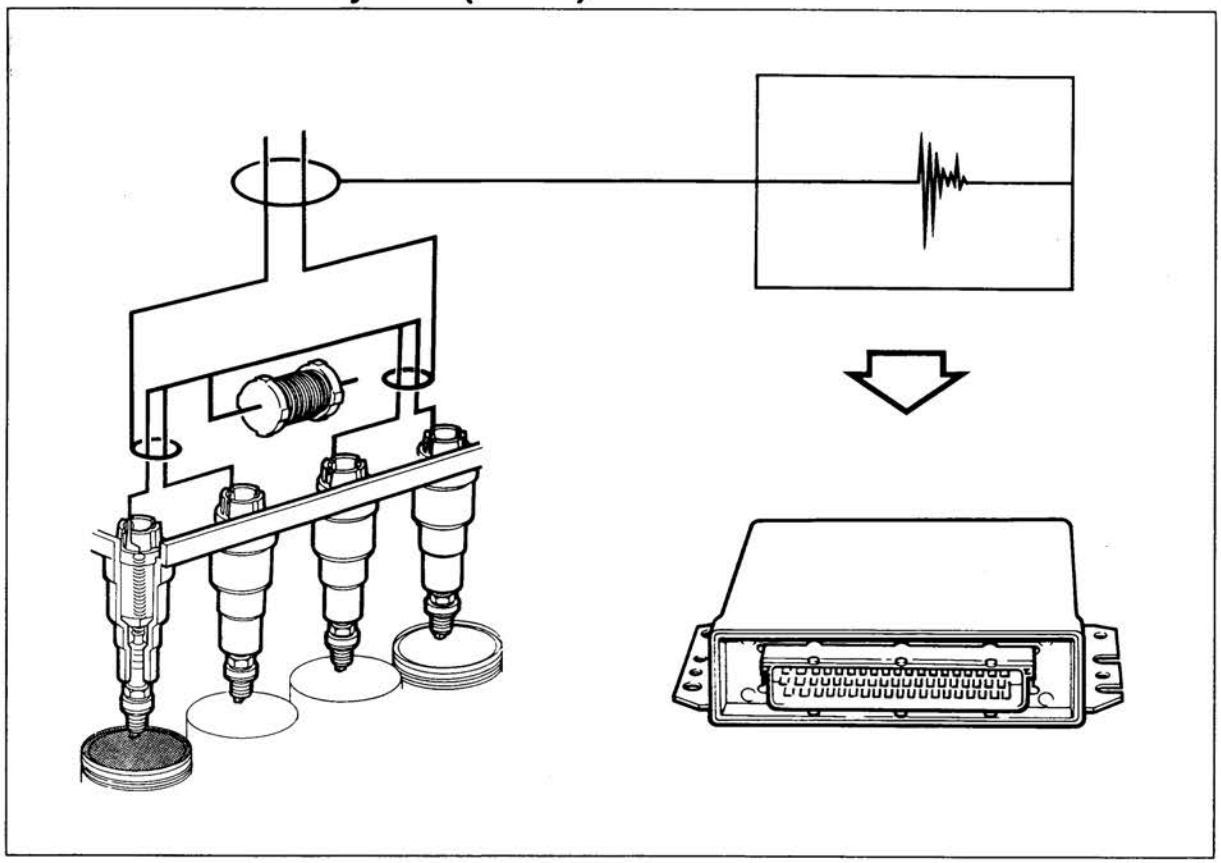


Starter motor cranking

When fuel is first injected after the starter motor has been engaged and begins to crank the engine, the ECM selects on the basis of certain parameters the cylinder (of the two pairs 1 and 4 or 2 and 3 where a spark is produced) in which fuel should be injected.

For the first combustion processes the system generates an ignition spark in two cylinders but controls the supply of fuel right from the outset to only one of them. Not until then will both spark and fuel injection be synchronized so that the correct ignition timing is obtained.

Saab TRIONIC SFI system (contd.)



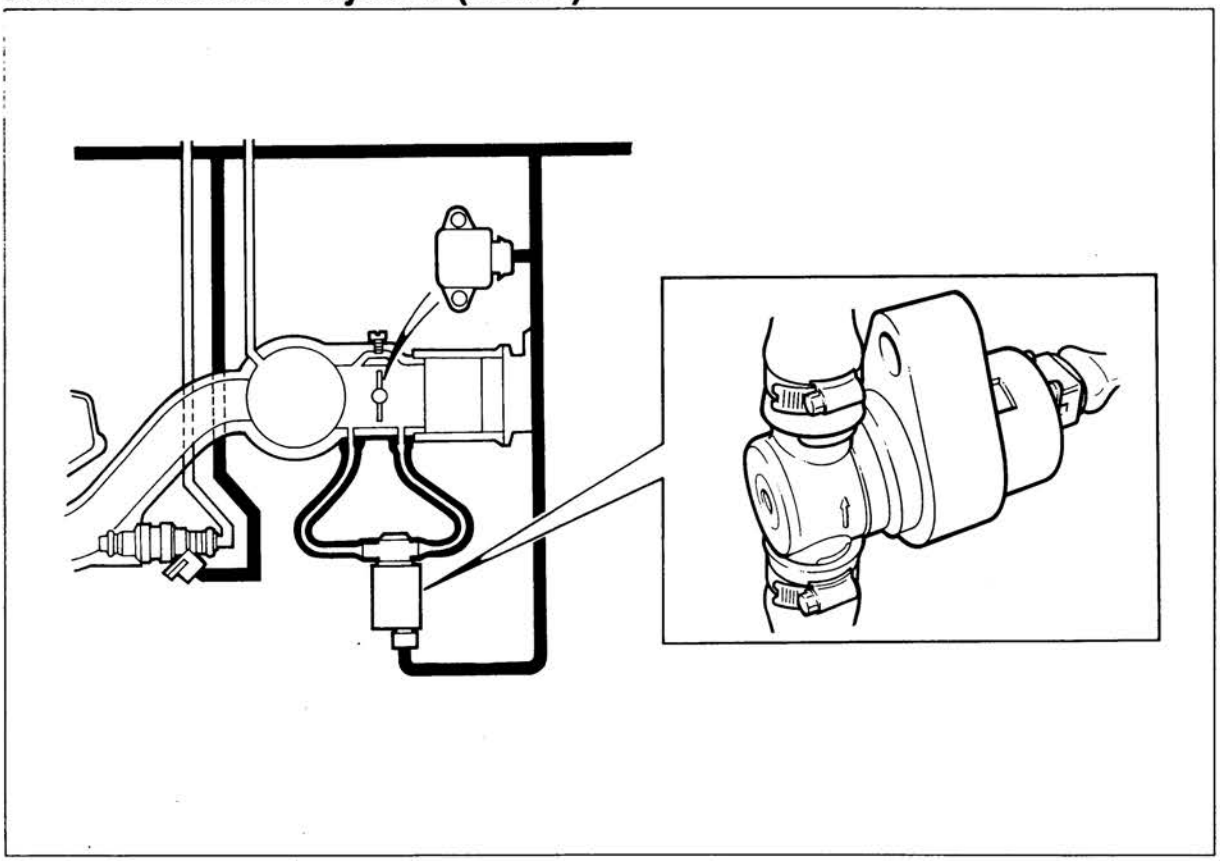
Knock sensor function

The knock sensor used earlier has been dropped in the SFI system and knocking is now controlled on the basis of information received from the ignition discharge module.

The two induction circuits which sense cylinder pairs 1 and 2 and 3 and 4 are used for this. In the event of knocking, the ECM records one or more pulse spikes in the ionization current and, with the aid of signals from the crankshaft position sensor, can then make the necessary adjustments for the cylinder in which knocking has occurred.

Several parameters are adjusted to prevent the occurrence of knocking: turbo pressure, ignition timing and fuel injection time.

Saab TRIONIC SFI system (contd.)

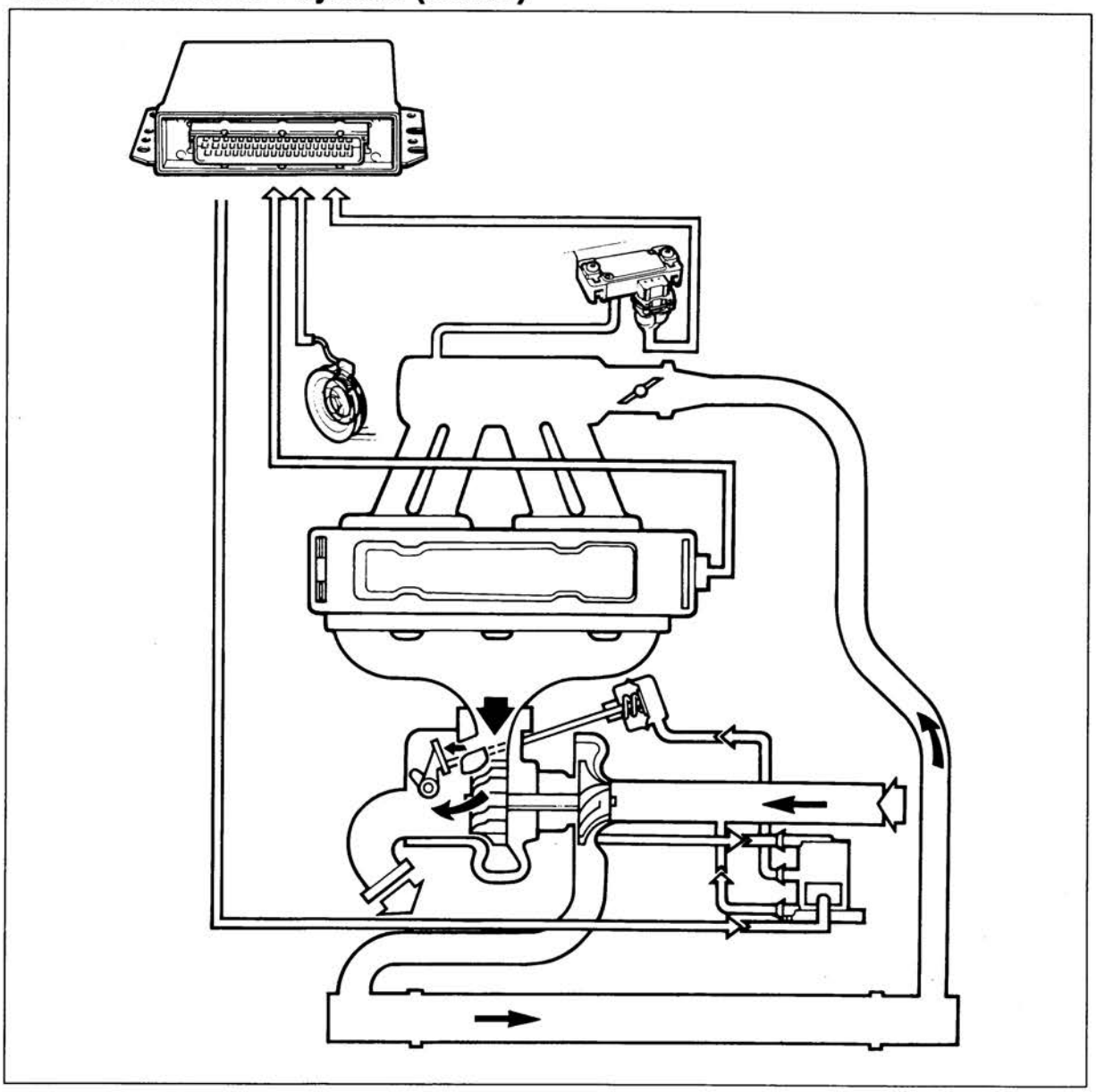


Idling control

Idling speed is controlled by means of an idle air control (IAC) valve which via a slide allows additional air to bypass the throttle plate. The valve is supplied with constant current regardless of temporary voltage variations in the car's electrical system, so the position of the slide is determined through regulation of the current (not voltage).

On cars with TCS, the idling control function is incorporated into the ETS system.

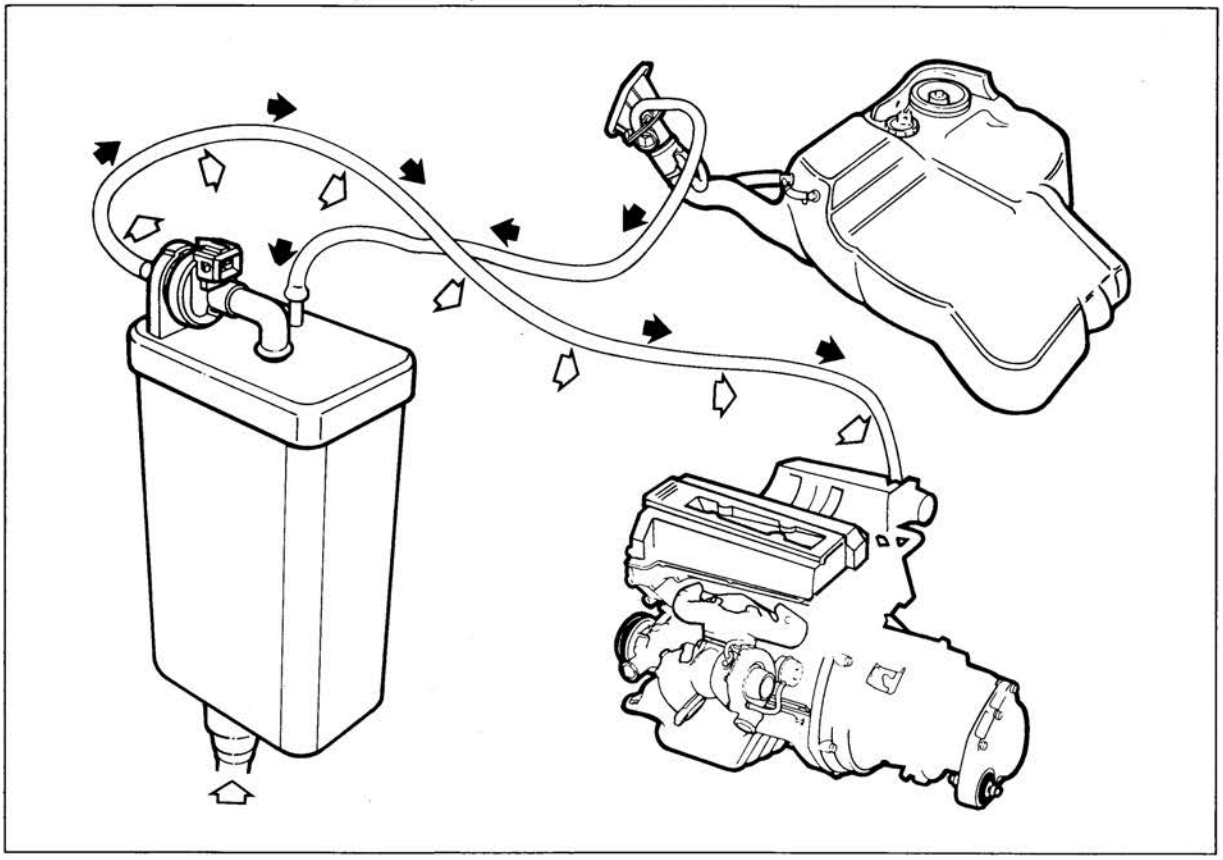
Saab TRIONIC SFI system (contd.)



Regulating the charging pressure

The charging pressure is also regulated in the SFI system via a boost pressure control valve (APC solenoid) which actuates the wastegate. Accordingly, the system works in the same way as earlier APC boost pressure control systems.

Saab TRIONIC SFI system (contd.)



Tank ventilation

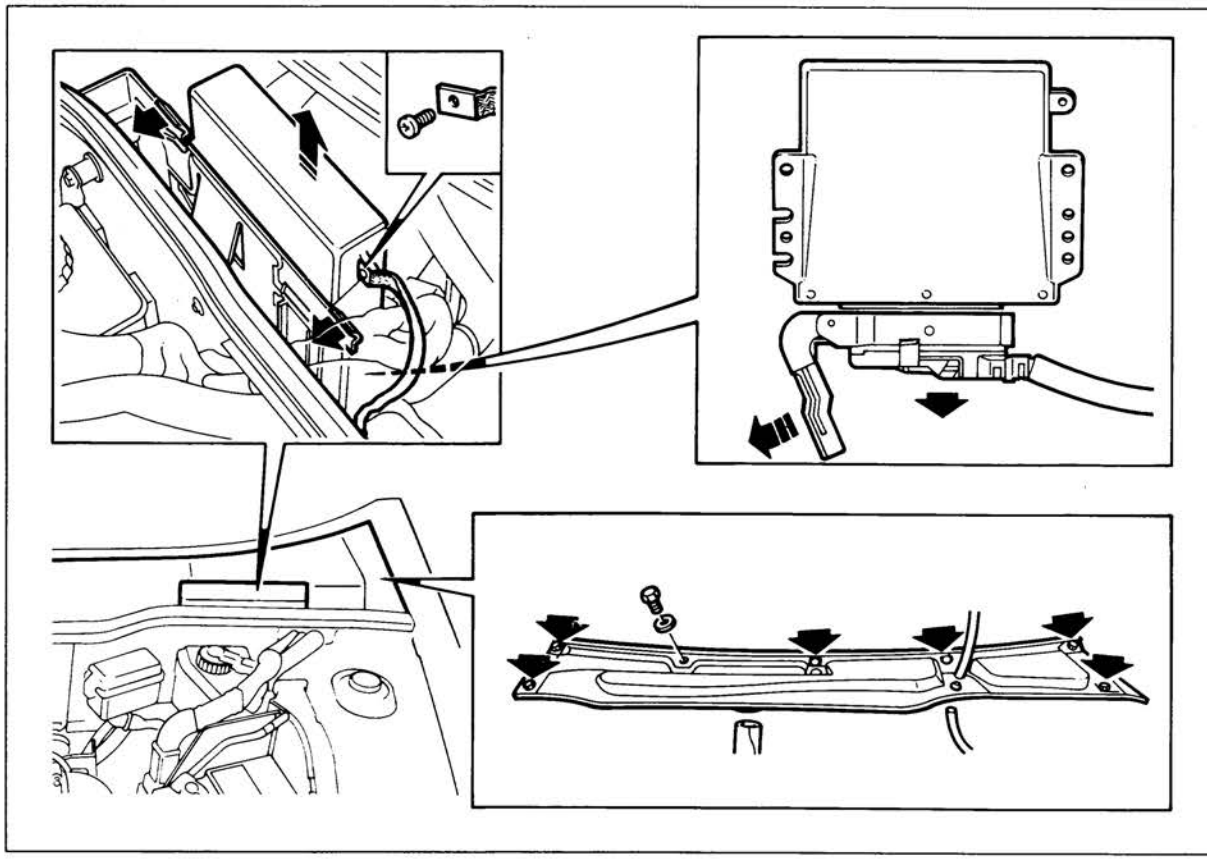
The Evaporative Emission (EVAP) system (ELCD) takes charge of petrol vapour from the fuel tank via a purge control valve which regulates the vapour entering the engine intake manifold. When the ECM senses that the engine is capable of burning this extra fuel, it weakens the mixture via the injectors and enriches it via the EVAP system.

The TRIONIC system satisfies the emission control requirements of OBD I (On Board Diagnostics) and has sufficient memory capacity for extensive workshop diagnosis.

LimpHome

Should the MAP sensor, IAT sensor or throttle position sensor fail for any reason, the system will go into open loop operation (LimpHome). In this mode the car can be driven with reduced engine power based on calculated mean values.

SFI components



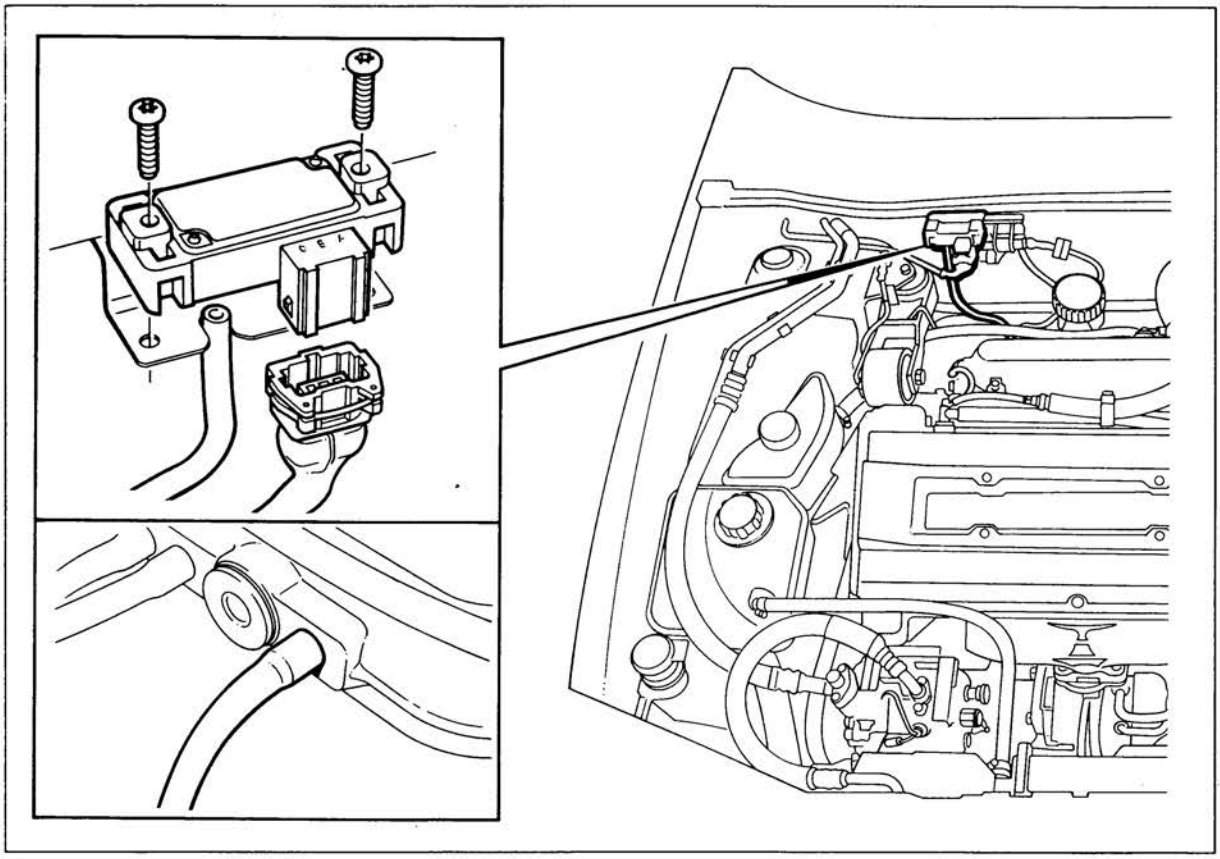
Engine control module (ECM)
The SFI engine control module, which has 70 connections, is located in the space between the front and rear bulkhead partitions, on the left-hand side.

The connector is of new design and different to those on other control systems. The new design makes it easier to connect and disconnect the wiring harness and also reduces the risk of damaging the connecting pins.

Two versions of the ECM will be available: one for cars with ETS, another for cars without ETS.

To reduce the possibility of radio interference, the casing is grounded to the car body via a separate braided ground strap and has two ventilation holes at the bottom.

SFI components (contd.)



Manifold absolute pressure (MAP) sensor

A manifold absolute pressure sensor for continuous sensing of the pressure in the intake manifold is located on the front bulkhead partition

The MAP sensor is in communication with the intake manifold via a hose, the design of which is carefully adapted to ensure that pressure information is transferred correctly. The length of the hose, its positioning, the quality of the material it is made of and other factors are decisive for ensuring correct pressure measurement.

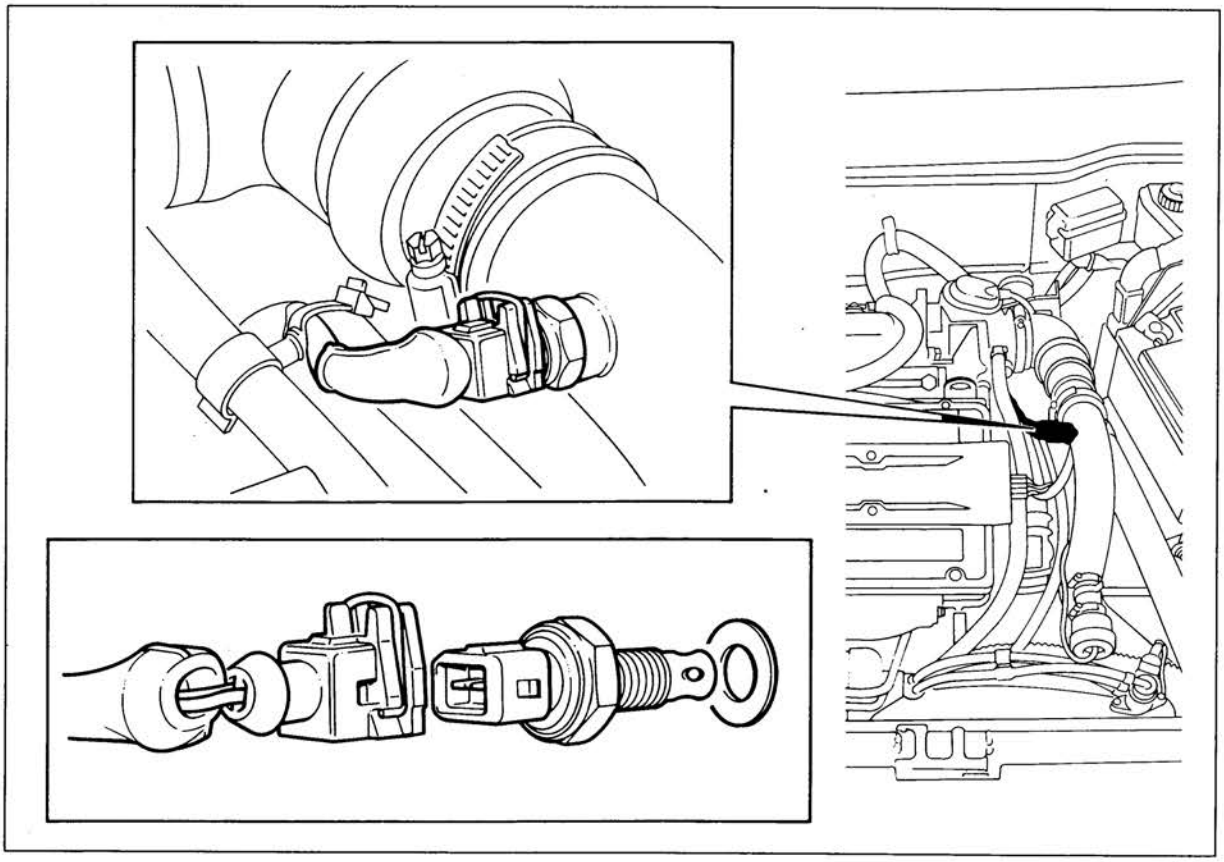
The pressure in the intake manifold is transferred via the hose to the MAP sensor where a piezoelectric crystal converts the pressure into a linear signal voltage. Low pressure produces a low voltage, high pressure a high voltage.

Pressure (bar)	Voltage (V)
-0.75	0.4
-0.50	0.9
0	1.8
0.25	2.3
0.50	2.8
0.75	3.3

On the basis of the actual air pressure and details of the air temperature in the intake manifold, the air mass can be determined instantaneously by the ECM.

Pin No.	Function	Lead colour	Connection
1	Ground	Black	Ground G7
2	Pressure signal	Blue/white	ECM, pin 22
3	Supply voltage	Grey	ECM, pin 43

SFI components (contd.)



Intake air temperature (IAT) sensor

The intake air temperature sensor is located on the intake air tube leading to the throttle body.

Through holes in the sensor, the intake air flows in and past an NTC (Negative Temperature Coefficient) resistor which acts as the sensitive element. When the temperature of the intake air rises the resistance decreases and, with a voltage applied across the resistor, the voltage drop also decreases.

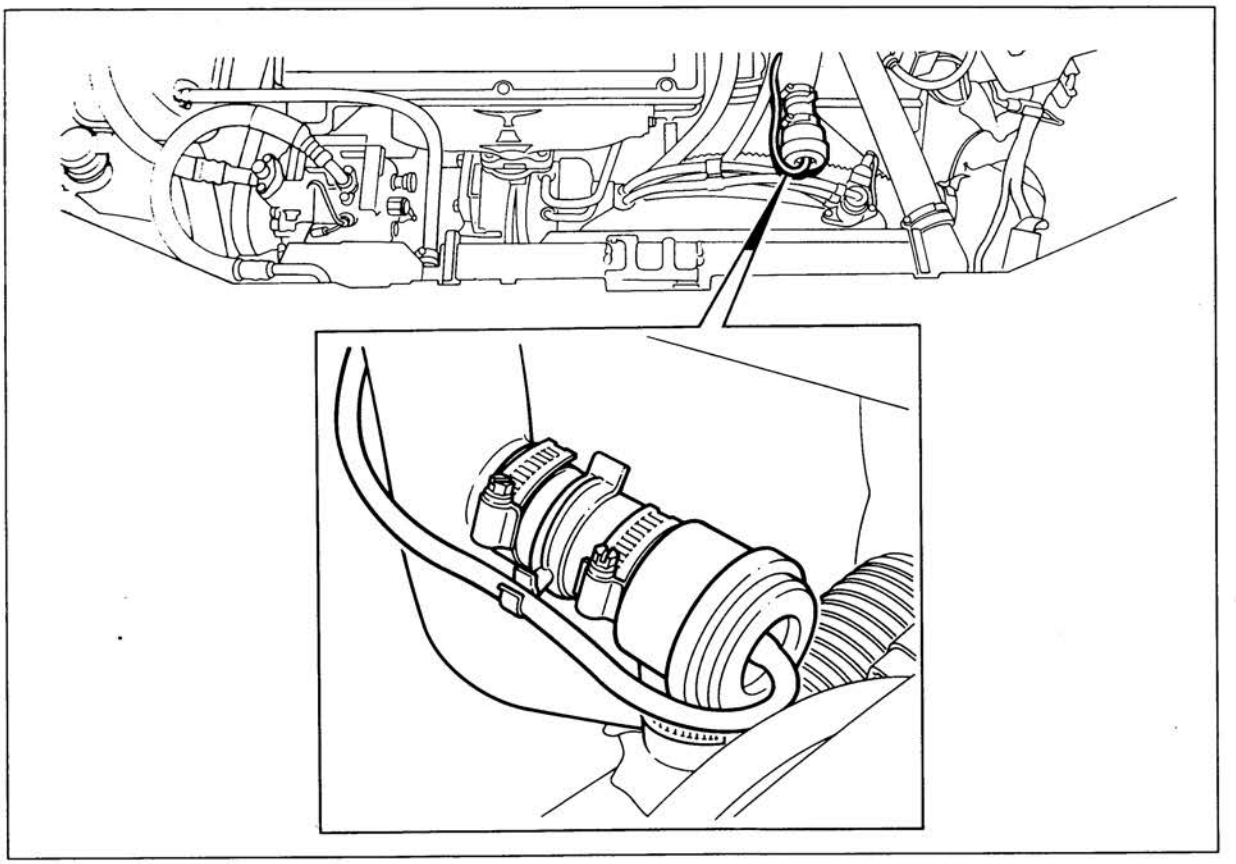
At extremely low temperatures the ECM accordingly receives a high signal voltage from the IAT sensor while a high temperature results in a low signal voltage.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

On the basis of the actual air temperature and details of the pressure in the intake manifold, the air mass can be determined instantaneously by the ECM.

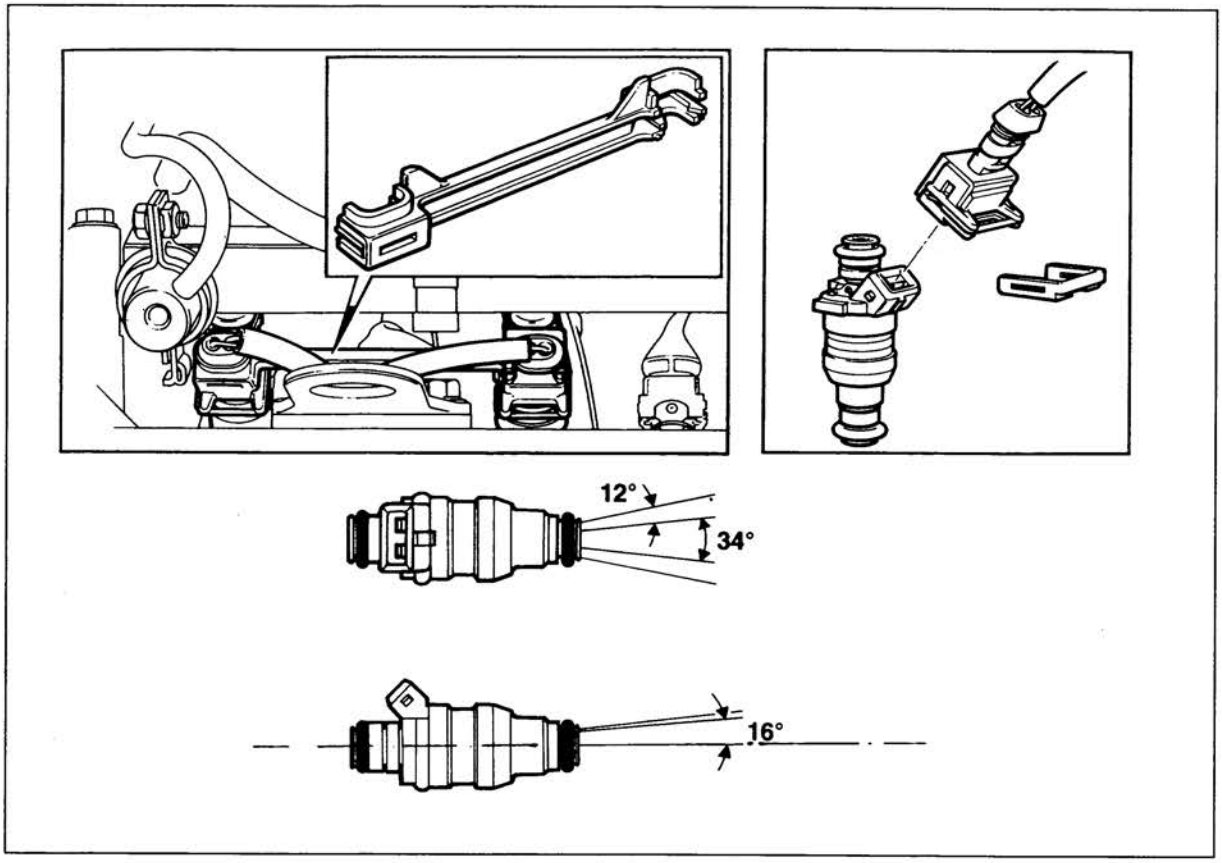
Pin No.	Function	Lead colour	Connection to/from
1	Ground	Black	Ground point on intake manifold
2	Air temperature signal	White	ECM, pin 46

SFI components (contd.)



Boost pressure bypass valve
The boost pressure bypass valve, which is the same as on earlier Saab 9000 models, has been repositioned further away from the turbocharger and now occupies the space where the mass air flow sensor was previously mounted.

SFI components (contd.)



Injectors

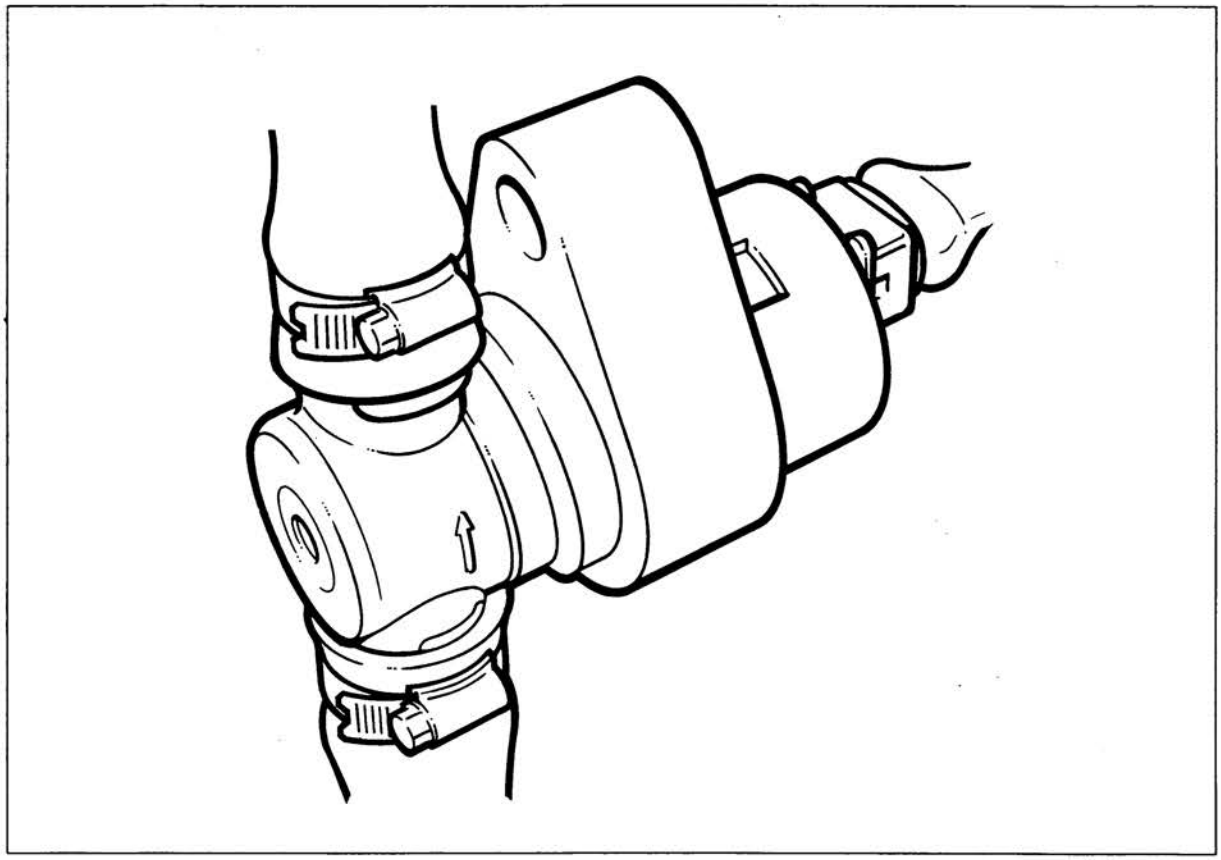
The injectors can be controlled individually for variations in the air supply, knocking tendencies and optimum emission values.

Owing to this individual control, it is necessary to fit the right connector to the right injector after carrying out any work during which the connectors have been unplugged.

To achieve optimal efficiency, the injectors are fitted with twin-jet nozzles which regulate the amount of fuel injected within extremely tight limits, each jet individually and both jets together.

This also calls for extreme precision in the location of the injectors and to ensure their exact positioning they are fixed in pairs in special mounts.

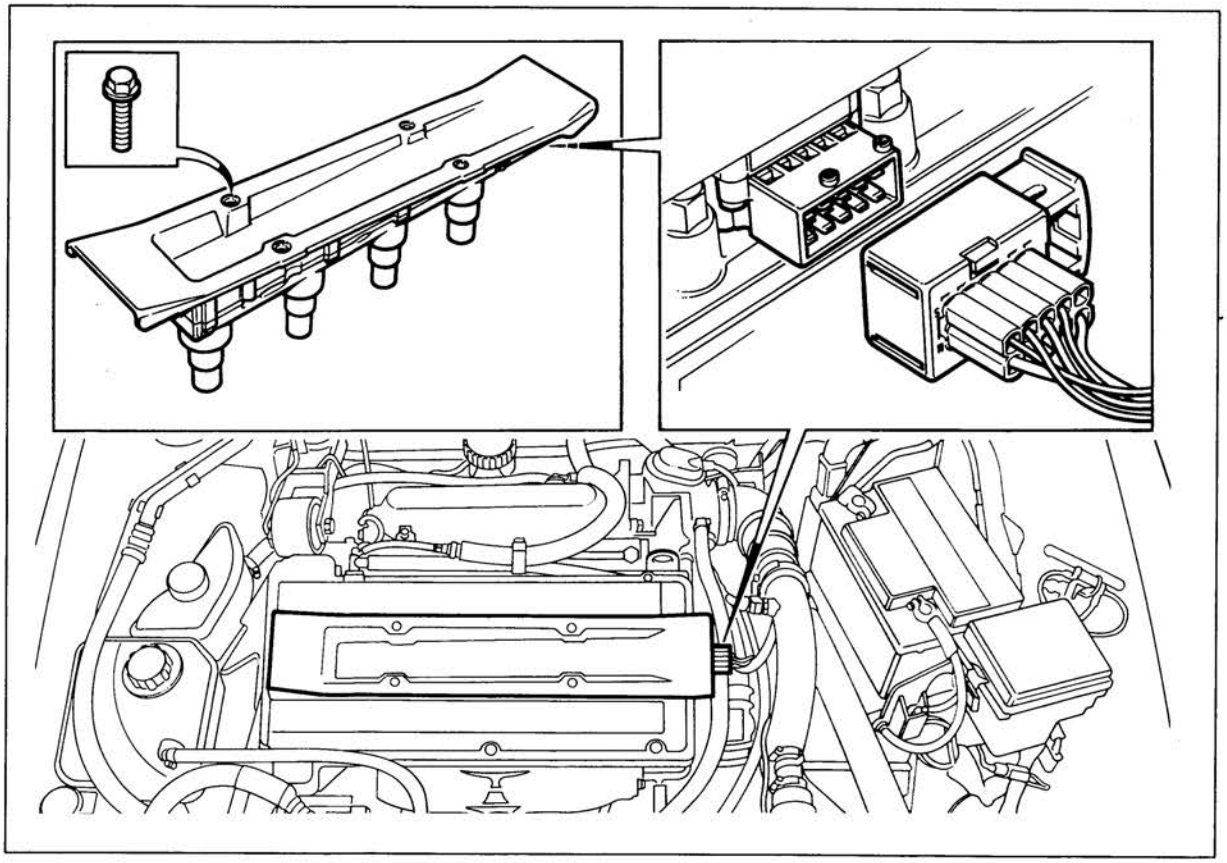
SFI components (contd.)



Idle air control (IAC) valve
The idle air control valve is similar to that used previously for LH 2.4 multiport fuel injection (AIC valve), i.e. with one coil.

The IAC valve slide is regulated by current variations in the signal from the ECM, therefore its operation is not affected by any voltage variations in the car's electrical system.

SFI components (contd.)



Ignition discharge module (IDM)

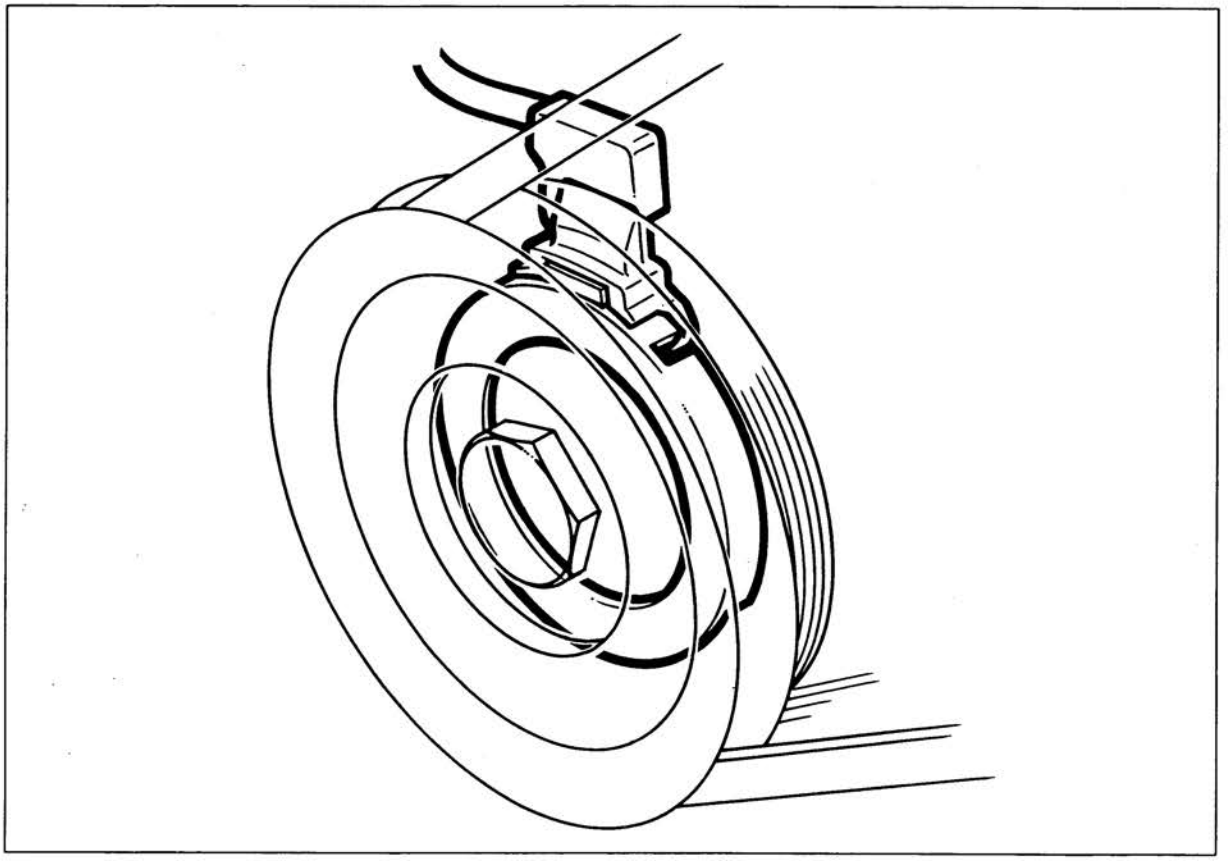
The ignition discharge module is of new design with integrated ignition coils (not replaceable) and a built-in knock sensing function.

If knocking occurs in any of the cylinders, a signal is induced and sent to the ECM, which then counteracts the knocking by regulating boost pressure, ignition timing and fuel injection.

Due to the knock sensor function and the system's sequential fuel injection arrangement, the number of connecting pins has been increased to 10.

Pin No.	Function	Lead colour	Goes to ECM pin No.
1			
2	Trigger signal, cylinder 1	Orange	9
3	Trigger signal, cylinder 2	Green	10
4	Trigger signal, cylinder 3	Blue	11
5	Trigger signal, cylinder 4	Grey	12
6	Ground	Black	Ground point G7
7	Knock sensor function	Orange	44
8	Detection 1+2	Yellow	17
9	Detection 3+4	Brown	18
10	+15 from main relay	Grey/red	87B on main relay

SFI components (contd.)



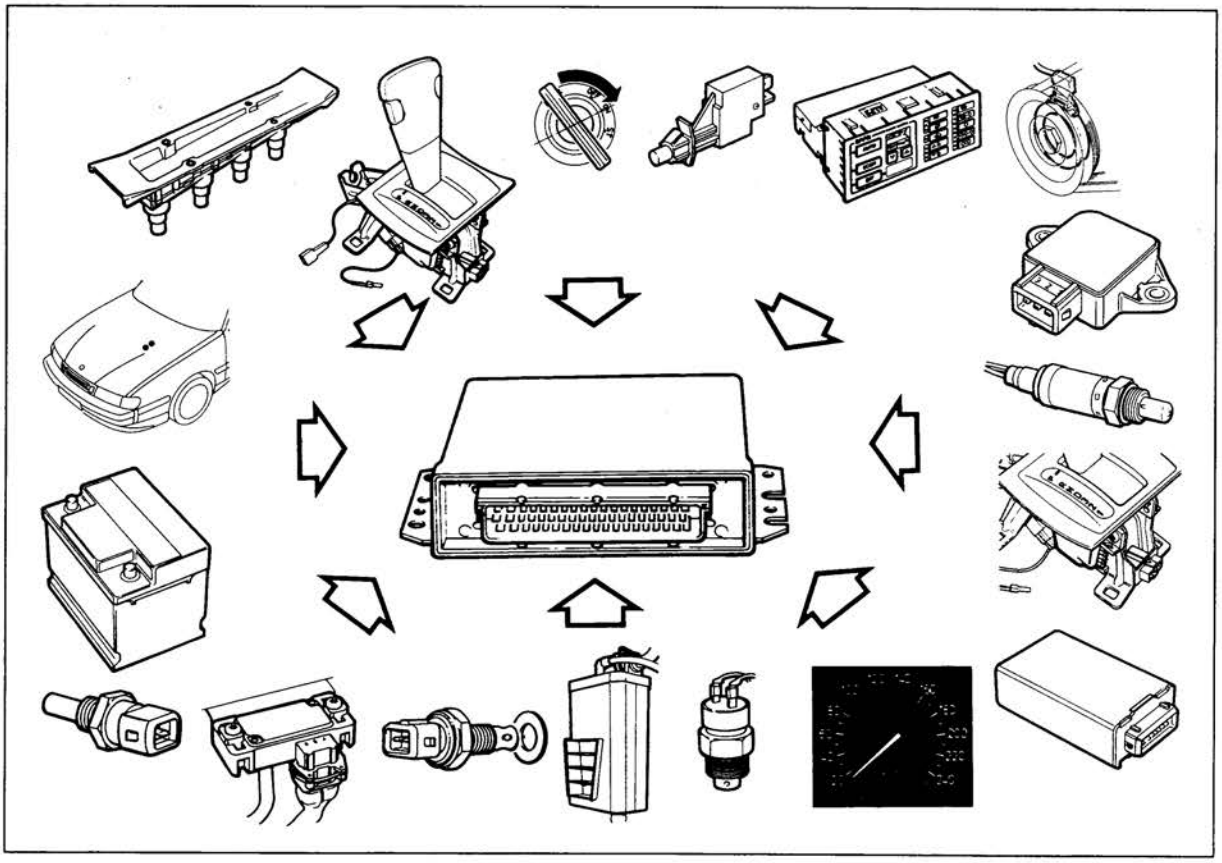
Crankshaft position sensor

The crankshaft position sensor consists of a Hall-effect sensor mounted on the cylinder block and a field rotor flange mounted on the crankshaft pulley, i.e. the same design as on earlier DI/APC electronic ignition systems.

The field rotor flange has three slots - two large and one small - which induce a signal in the Hall-effect sensor which is then sent to the ECM as information on the position of the pistons in the cylinders.

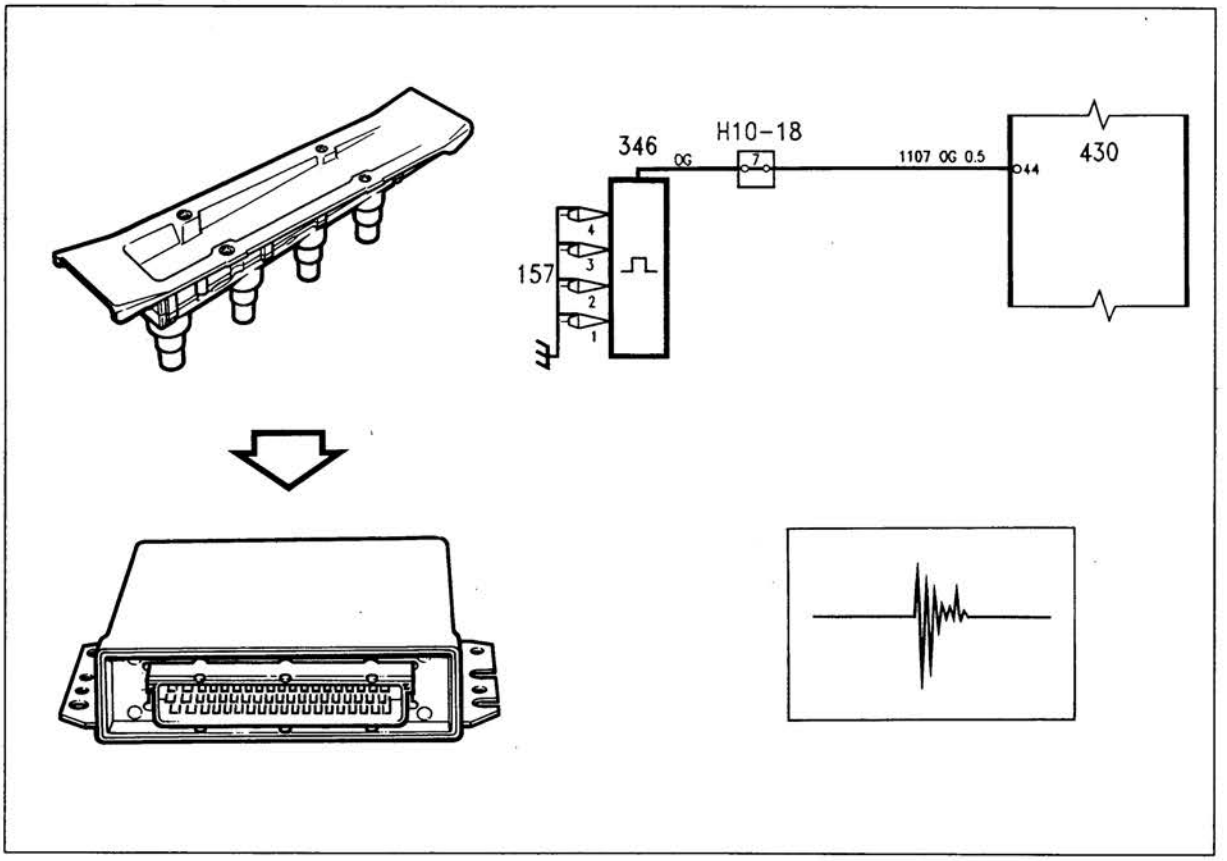
The ignition is non-adjustable.

ECM input signals



- Knocking signal (page 31)
- Combustion detection (page 32)
- DRIVE signal (page 33)
- Ignition switch (page 34)
- Brake signal (page 35)
- A/C on (pages 36 and 37)
- Crankshaft position sensor (page 38)
- Throttle position sensor (page 39)
- Heated oxygen sensor (page 40)
- Torque limiting (page 41)
- Cruise Control (page 42)
- Vehicle speed (page 43)
- Cooling fan on (page 44)
- Canister purge valve (page 45)
- Intake air temperature (page 46)
- Intake manifold pressure (page 47)
- Engine coolant temperature (page 48)
- Battery positive voltage (page 49)
- Ground (page 50)

ECM input signals (contd.)



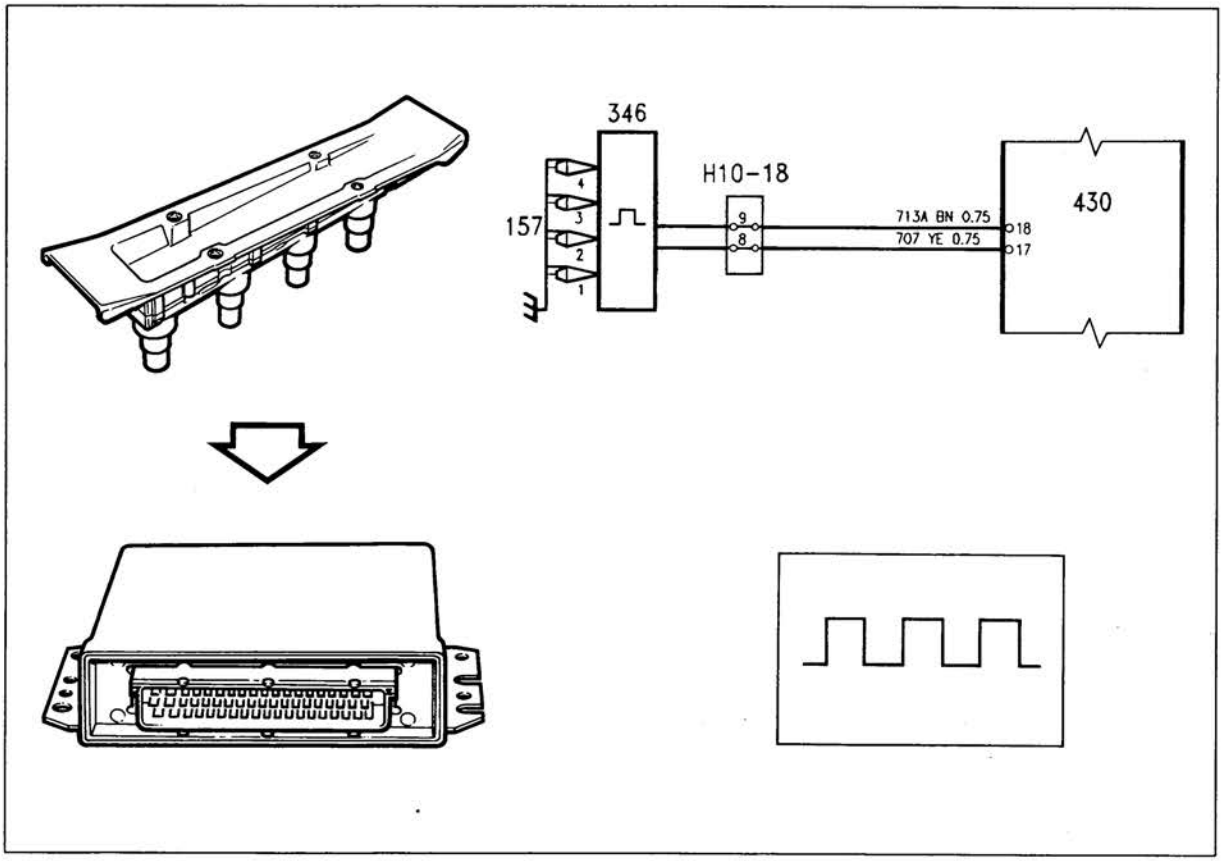
Knocking signal

The knocking signal informs the ECM when knocking occurs in any of the cylinders.

By measuring changes in the ionization current which is recorded individually for each cylinder just before or just after ignition, the electronic circuitry in the ignition discharge module (ignition cartridge) can convert the changes in the ionization current to variations in the signal which goes from pin 7 of the module to pin 44 of the ECM.

On the basis of the knocking signal, the ECM can counteract further knocking by changing the charging pressure, ignition timing and fuel injection times.

ECM input signals (contd.)



Combustion detection

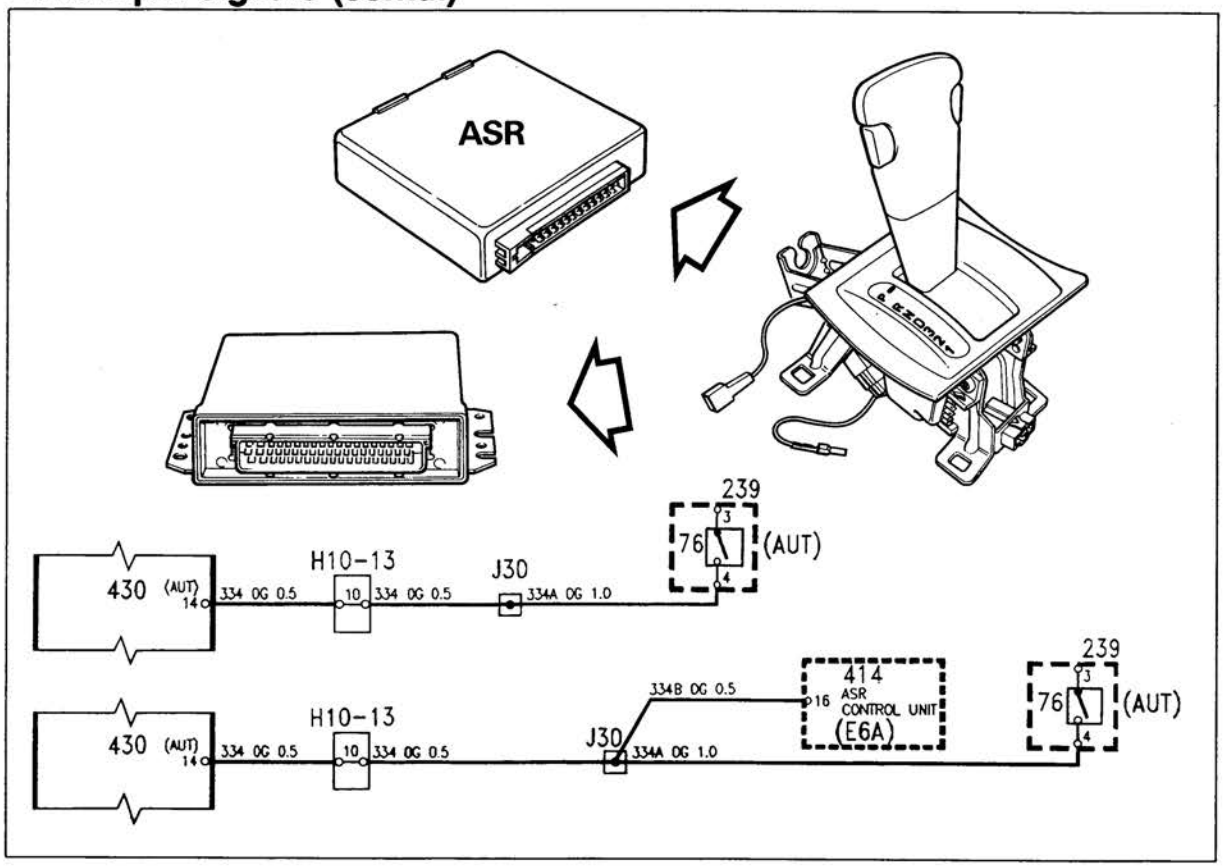
Basically, the combustion detection signal is generated in the same way as the knocking signal described on the previous page. Since a voltage is applied across the spark plugs, a weak current will flow through the spark plug where ionization (combustion) occurs.

Associated with spark plugs 1 and 2 and spark plugs 3 and 4 are sensing circuits in which the ionization current will induce a signal. This signal goes to ECM pin 17 (cylinders 1 and 2) and pin 18 (cylinders 3 and 4).

The purpose of the detection signal is to inform the ECM of the cylinder in which combustion has taken place.

Together with the positional information supplied by the crankshaft poition sensor, the ECM can now determine the correct ignition timing and fuel injection sequence.

ECM input signals (contd.)



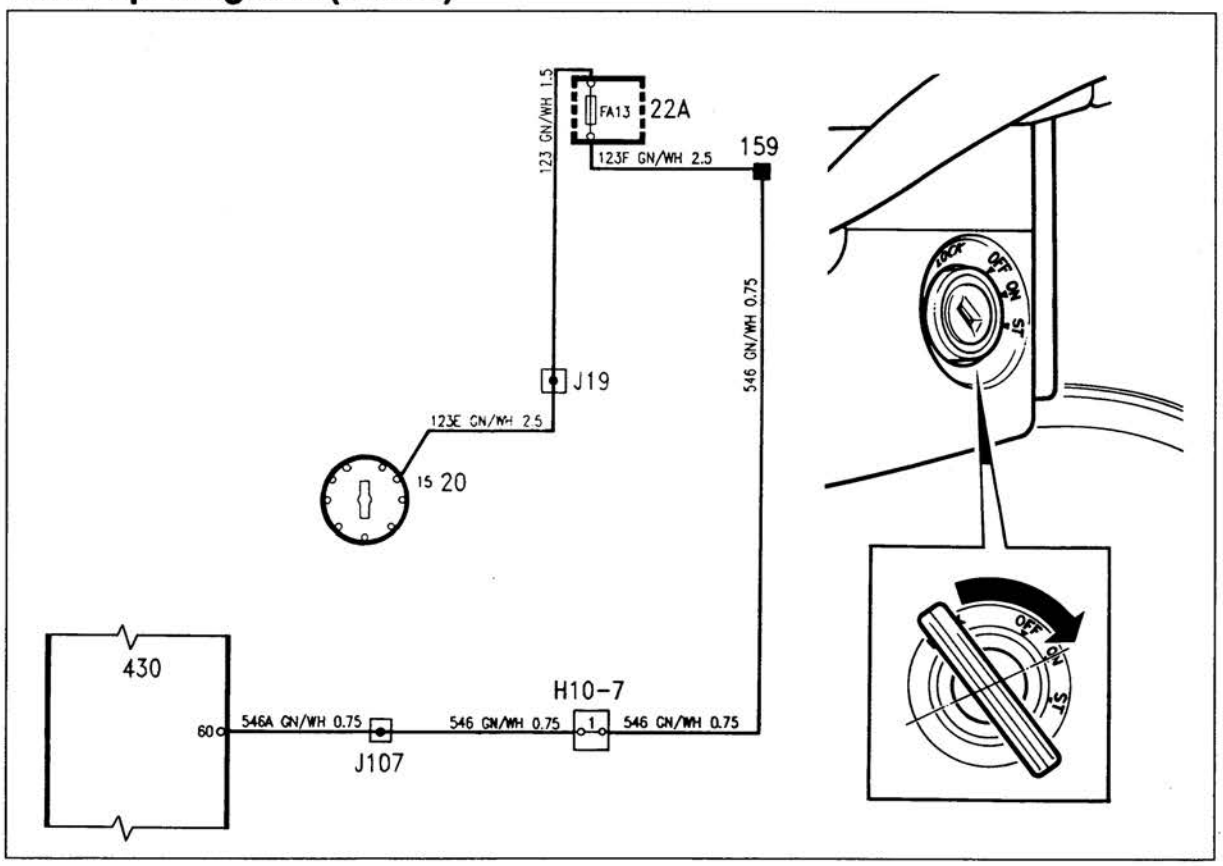
DRIVE signal

The purpose of the DRIVE signal is to inform the ECM whether the car has automatic transmission or a manual gearbox and also to cause the ECM to increase engine rpm as soon as the selector lever is moved to position R, D, 1, 2 or 3 on cars with automatic transmission.

When the ignition switch is in the Drive position, battery positive voltage will be applied to pin 3 of the transmission range switch (selector lever switch). Moving the selector lever to position R, D, 1, 2 or 3 causes the contact in the switch to close and battery positive voltage will be applied to pin 14 of the ECM.

On cars with TCS, battery positive voltage is applied to pin 16 of the ASR control module when the contact in the transmission range switch closes. A signal then goes from the ASR control unit to the ETS control module, which ensures that engine rpm is increased.

ECM input signals (contd.)



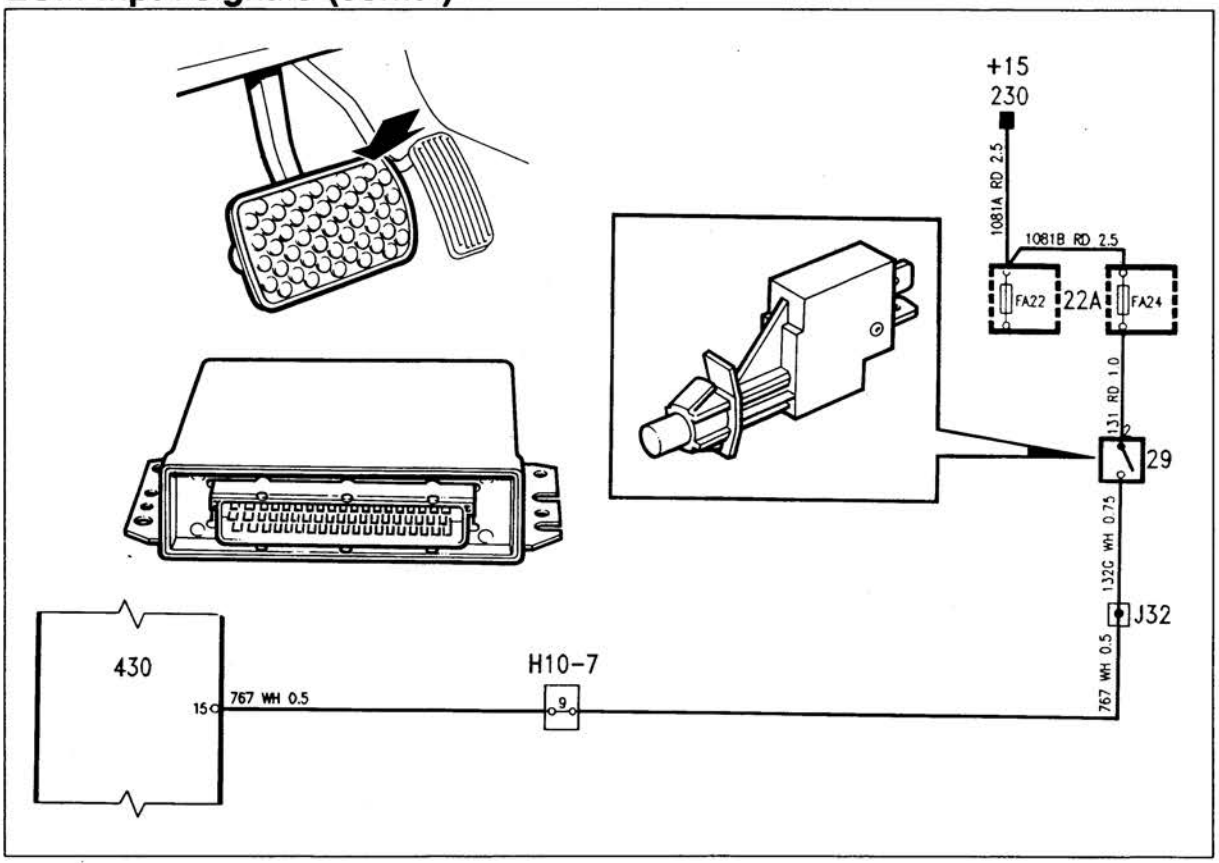
Ignition switch

With the ignition switch in the Drive or Start position, battery positive voltage (+15) goes from the ignition switch to pin 60 of the ECM.

Battery positive voltage (+30) is applied to pins 1 and 48 of the ECM.

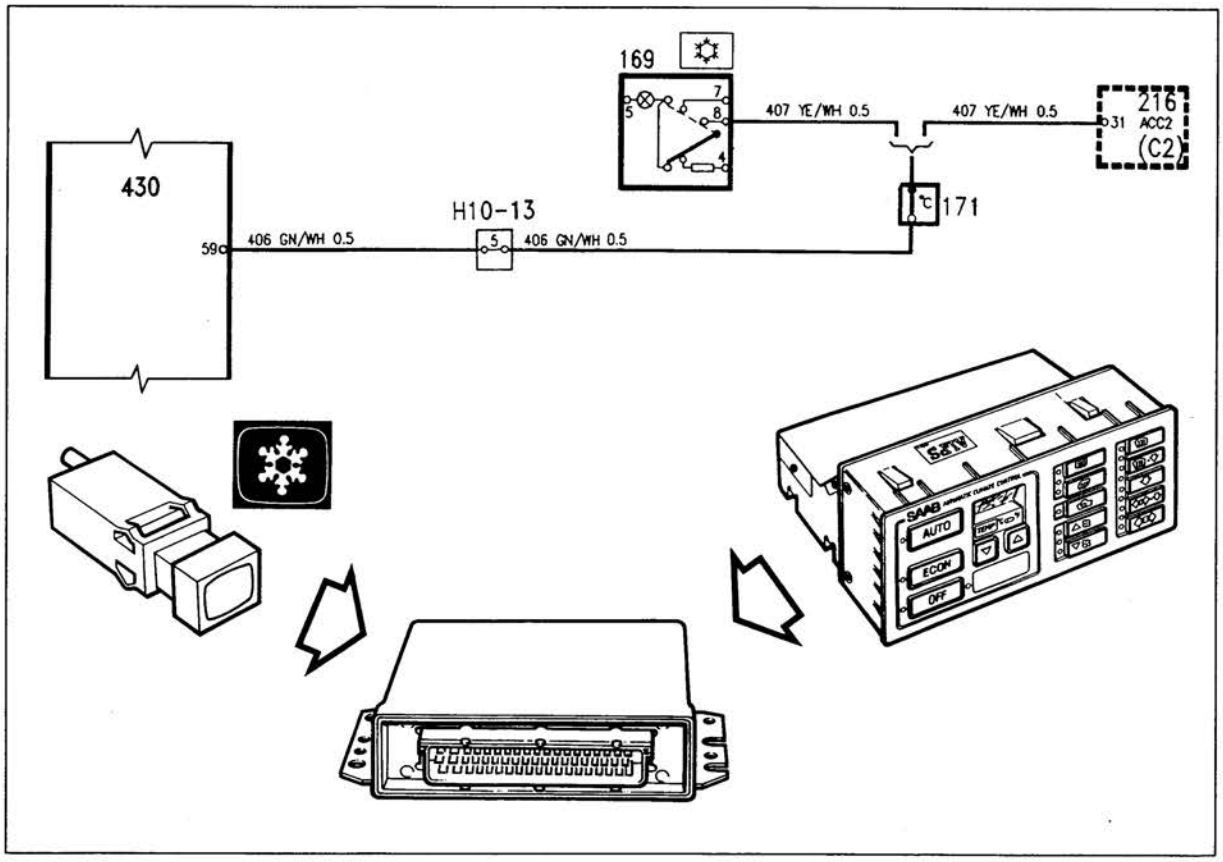
When the ignition is switched off, certain functions in the ECM remain live for an additional 12 minutes. One example is that repetition of the Before start function is prevented within a period of 12 minutes.

ECM input signals (contd.)



Brake signal
When the brake light switch closes, battery positive voltage (+30) is applied to pin 15 of the ECM.
In this situation the SFI system provides basic charging pressure only.

ECM input signals (contd.)

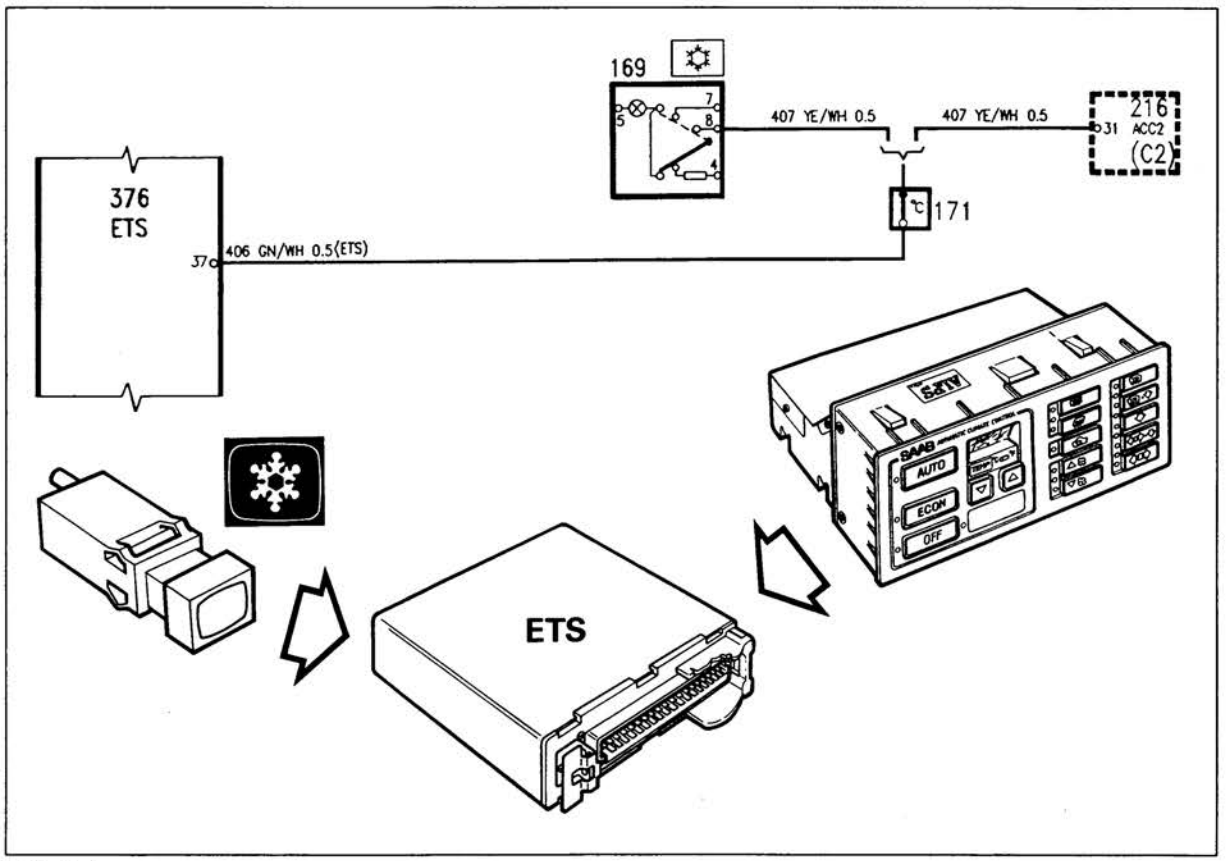


AC/ACC status

Cars without TCS:

When A/C has been activated (manually by means of the AC switch or automatically by the ACC control unit), battery voltage is applied to pin 59 of the TRIONIC control unit.

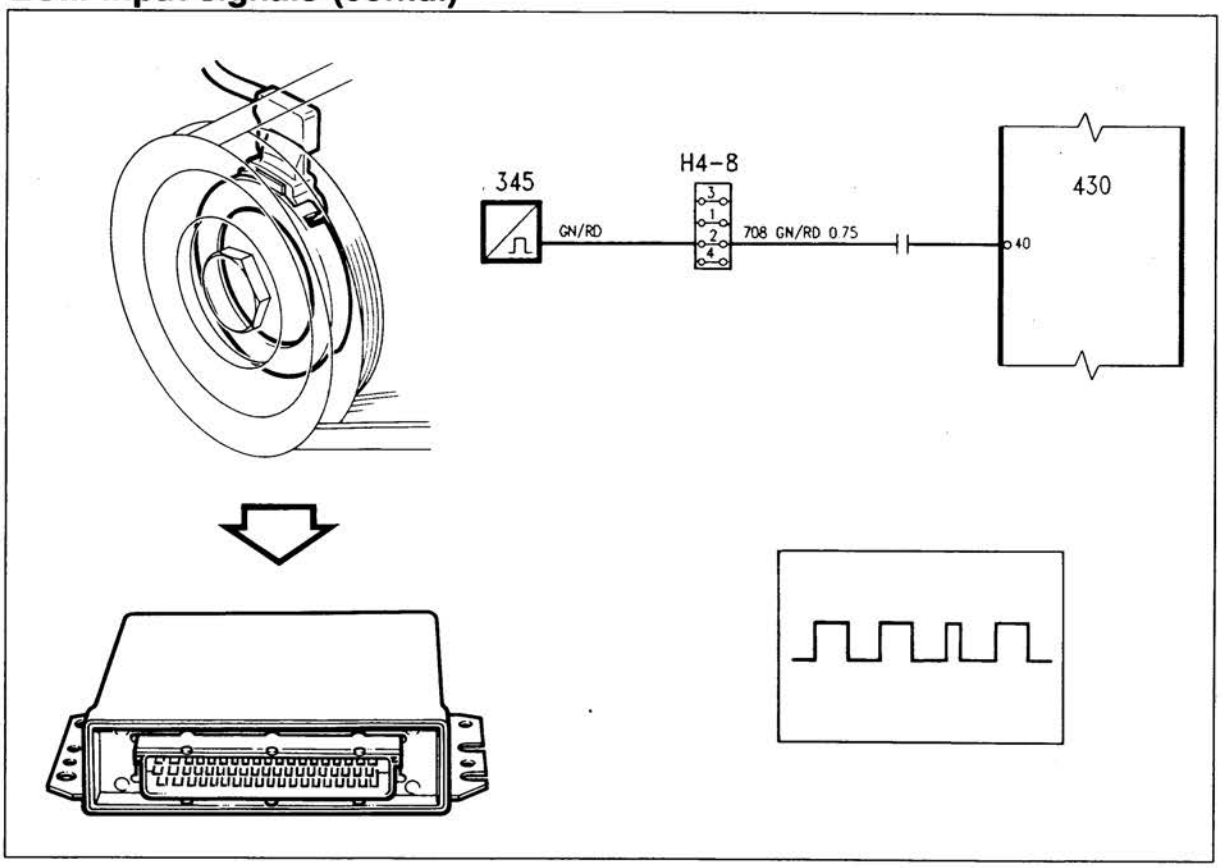
ECM input signals (contd.)



A/C status

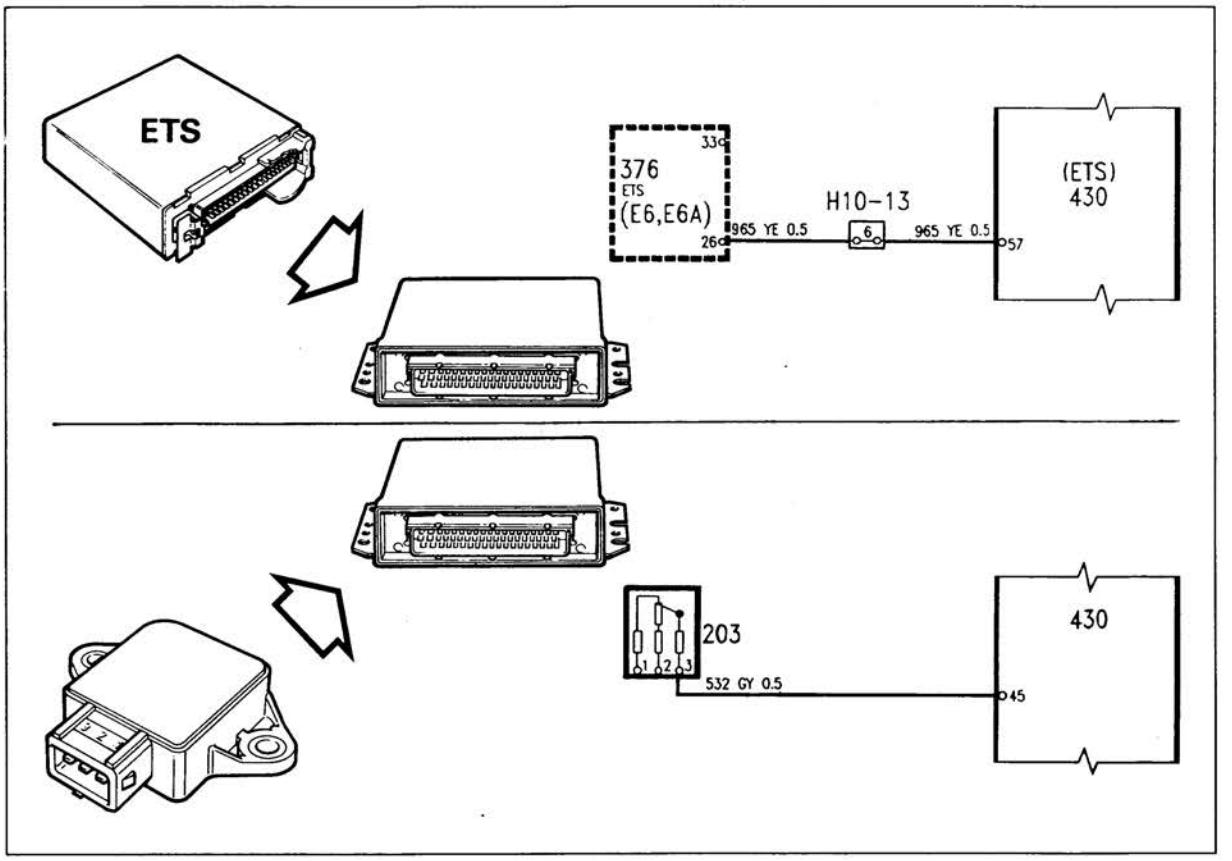
Cars with TCS:
When A/C has been activated (manually by means of the A/C switch or automatically by the ACC control module), battery positive voltage **is applied to pin 37** of the ETS control module.

ECM input signals (contd.)



Crankshaft position sensor
A signal from the crankshaft position sensor with information about the position and speed of the crankshaft is applied to pin 40 of the ECM. This signal is in the form of a square wave and its voltage is about 12 V when the Hall-effect sensor is screened by the field rotor and 0 V when any of the slots in the field rotor passes the Hall-effect sensor.

ECM input signals (contd.)



Throttle position

The throttle position signal is used by the ECM to regulate charging pressure, for adjusting the ignition timing, and for supplying a richer mixture during acceleration and a leaner mixture during deceleration. Maximum charging pressure can only occur at wide open throttle.

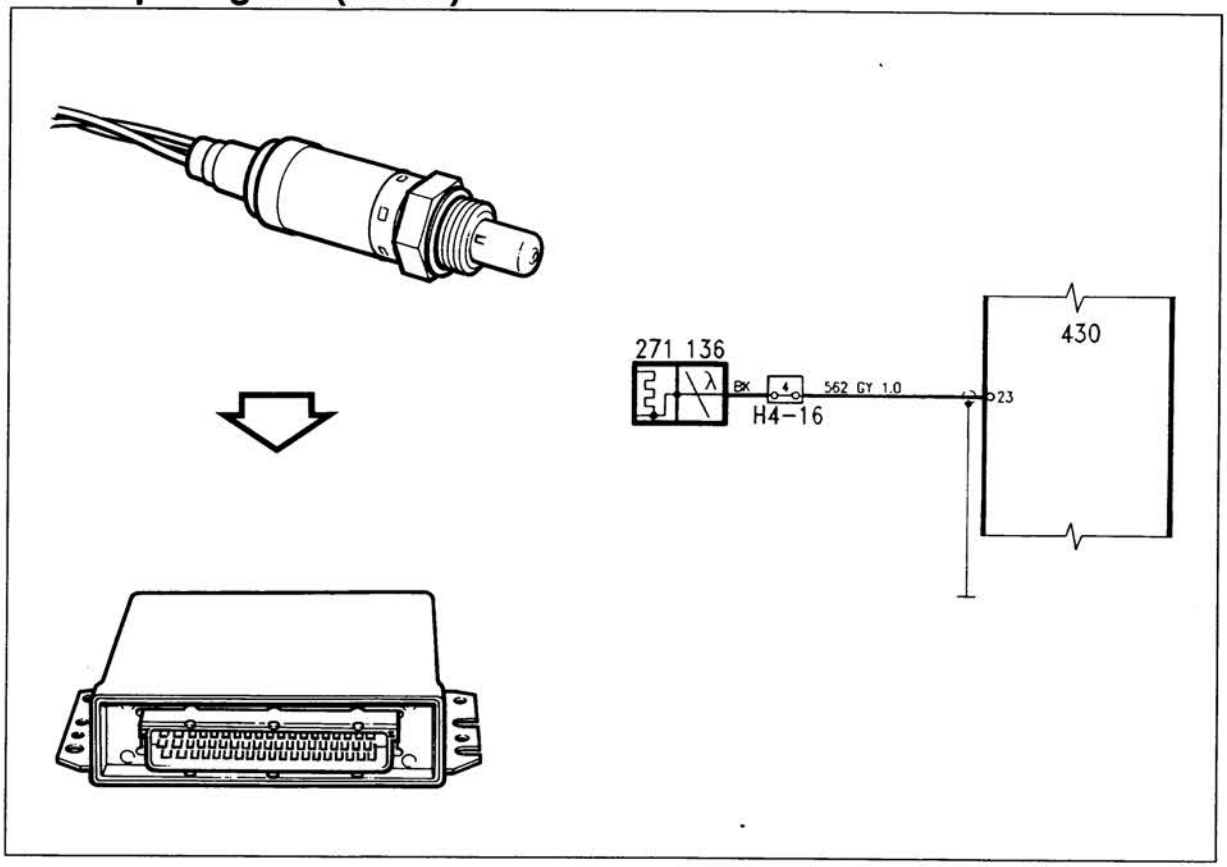
Cars without TCS:

The throttle position signal is obtained from pin 3 of the throttle position sensor and applied to pin 45 of the ECM.
Typical signal voltages are about 0.2 V DC at idling speed and about 4 V DC at wide open throttle.

Cars with TCS:

On cars with TCS the throttle position signal (PWM) is obtained from pin 26 of the ETS control module and applied to pin 57 of the ECM. The signal voltage may vary between about 0.2 V at idling speed to about 4.0 V DC at wide open throttle.

ECM input signals (contd.)

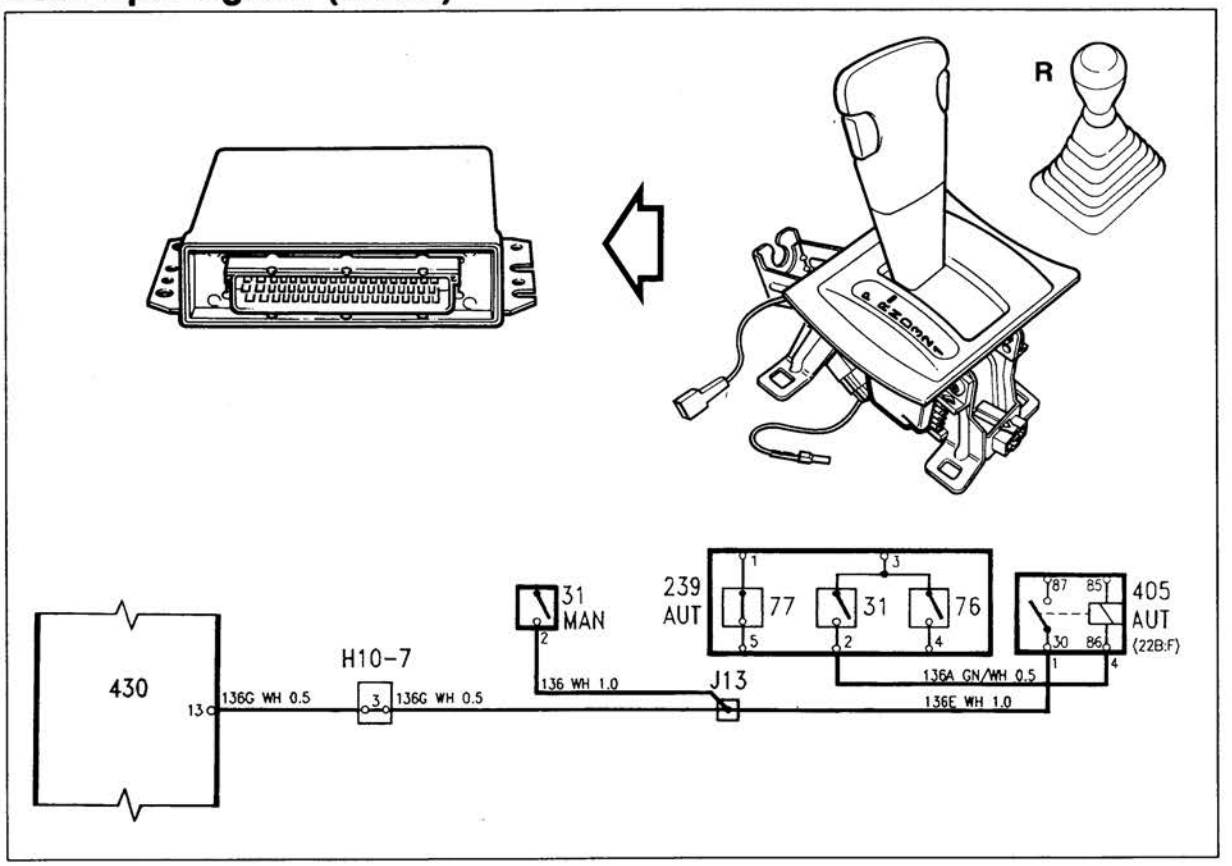


Heated oxygen sensor

The adaptive oxygen sensor function in the SFI system compensates for changes in the fuel-air mixture, partly on the basis of the signal from the heated oxygen sensor which gives a measure of the oxygen content in the exhaust gases.

The signal is applied to pin 23 of the ECM and may vary between about 0 V and 1.5 V DC.

ECM input signals (contd.)

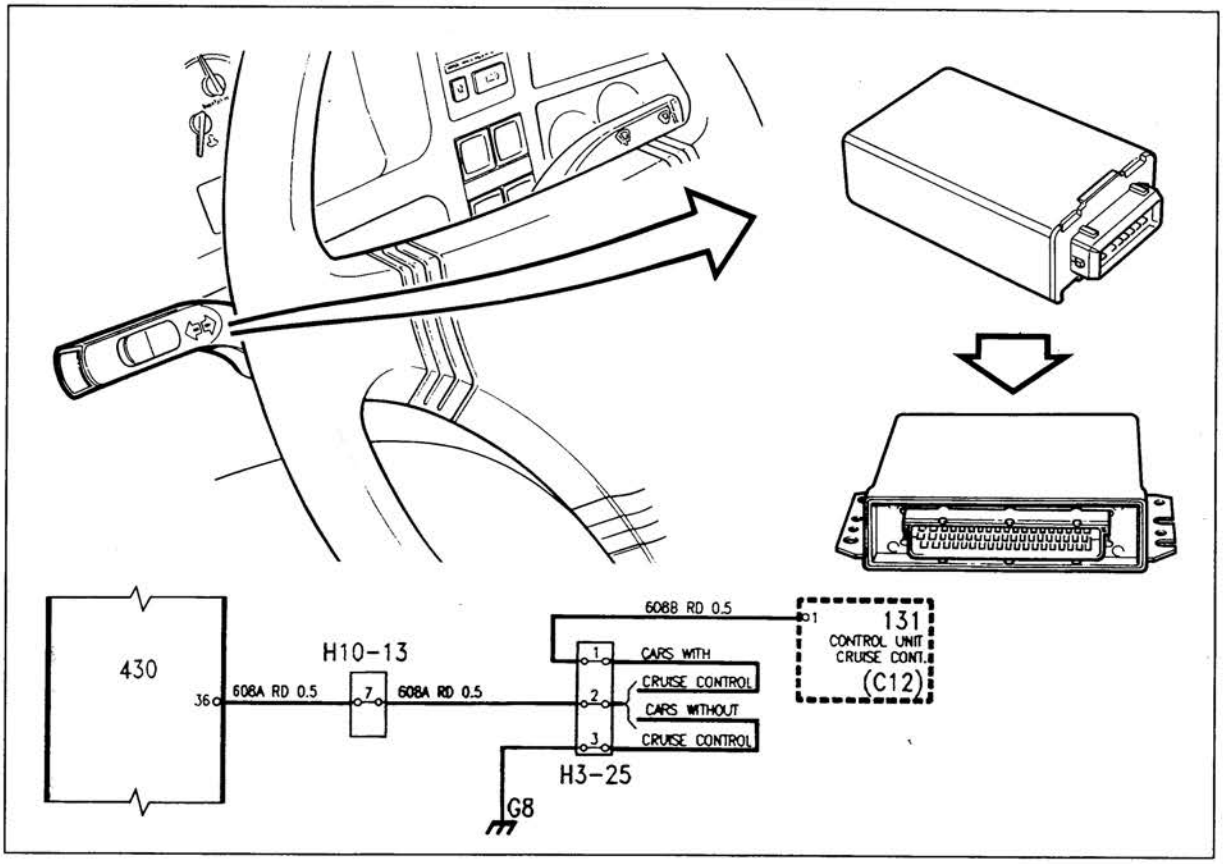


Torque limitation

To limit engine power when reverse gear is engaged, voltage is applied to pin 13 of the ECM .

Current is taken from the brake light switch and this function ensures that only basic charging pressure is available.

ECM input signals (contd.)

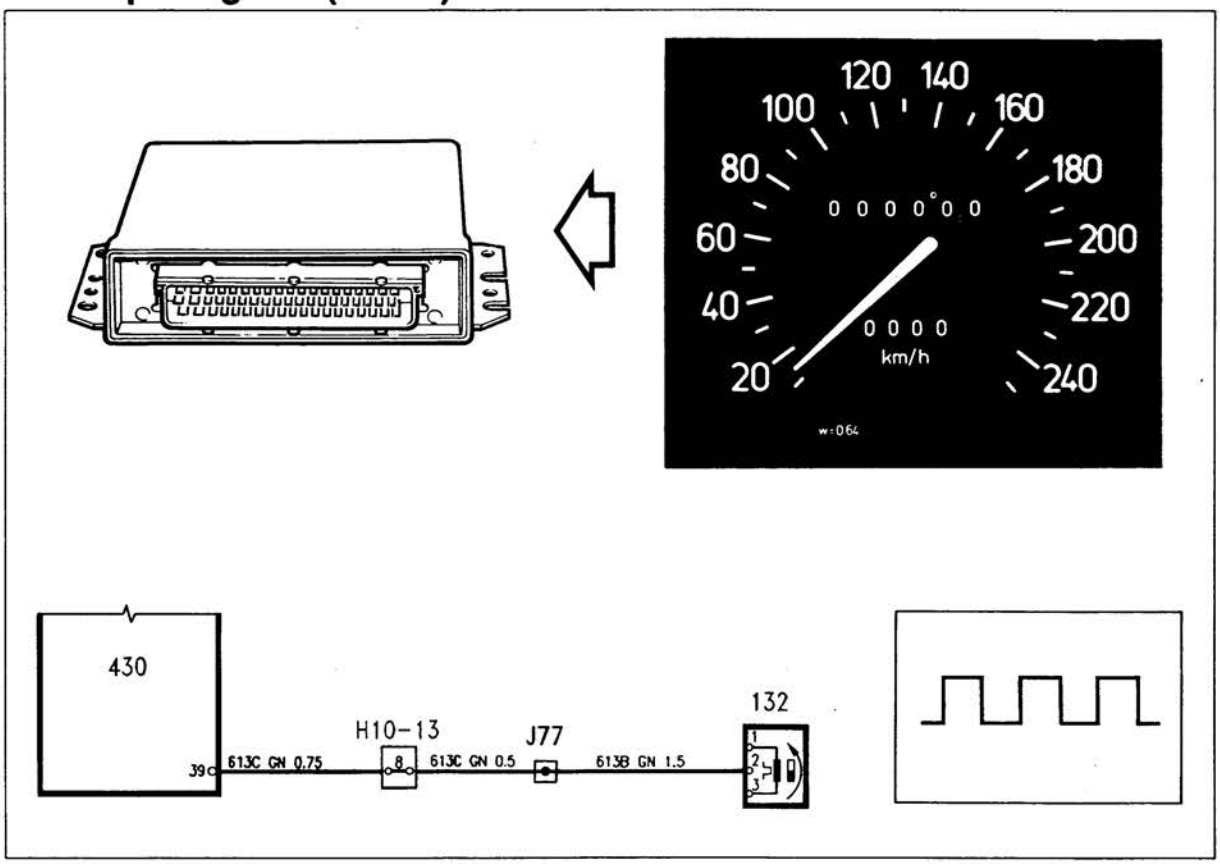


Cruise Control

Cars without TCS:
When the Cruise Control is activated, a 12 V signal is applied to pin 36 of the ECM, causing the charging pressure to be limited to basic charging pressure.

Cars with TCS:
On cars with TCS, the Cruise Control function is integrated in the ETS control module and charging pressure not limited to basic charging pressure.

ECM input signals (contd.)



Vehicle speed

A signal containing current vehicle speed information is obtained from pin 2 of the speedometer and applied to pin 39 of the ECM.

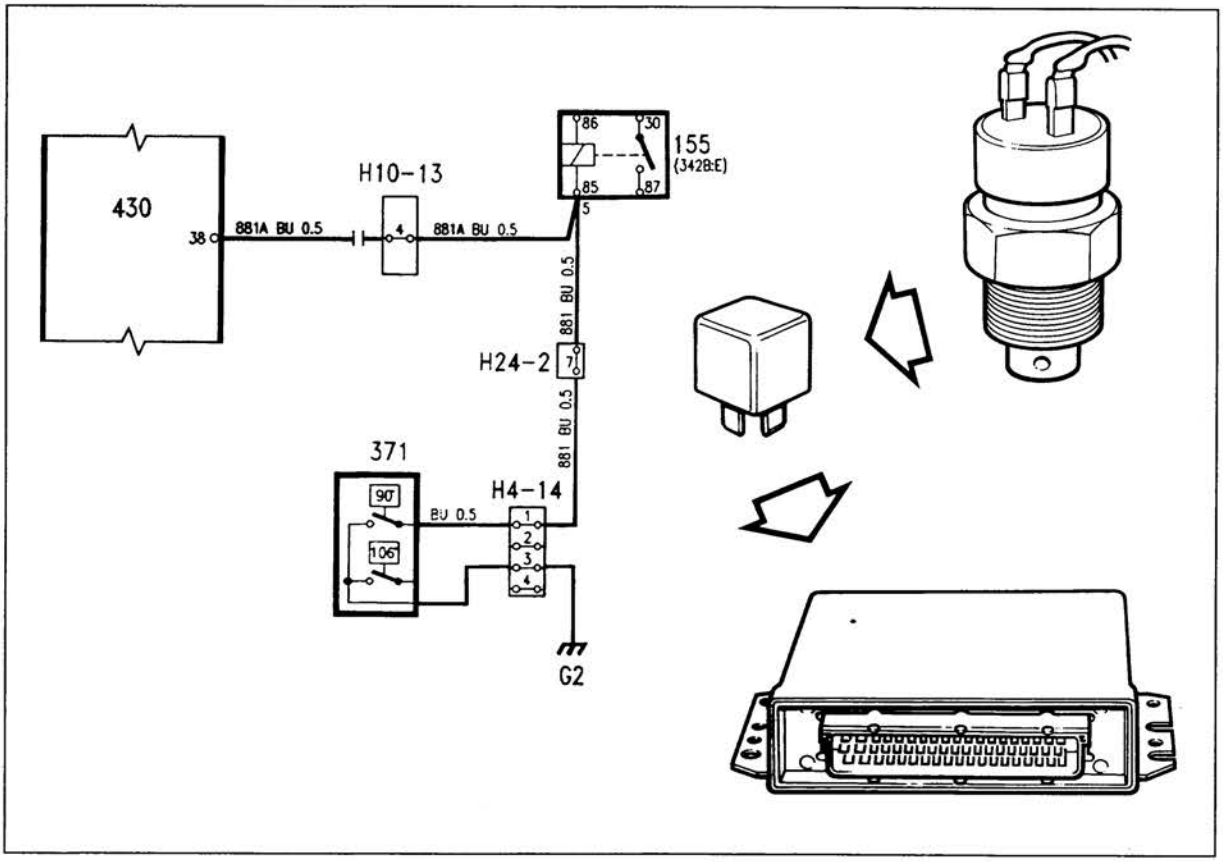
On cars with TCS the same information is also applied to pin 10 of the ETS control module.

The signal is in the form of a square wave and typical voltage varies between 0 and about 12 V.

Vehicle speed information is transmitted as variations in the signal frequency.

Idle speed control is a function which is dependent on the signal from the vehicle speed sensor, as is the ability of the ECM to limit vehicle speed to 240 km/h.

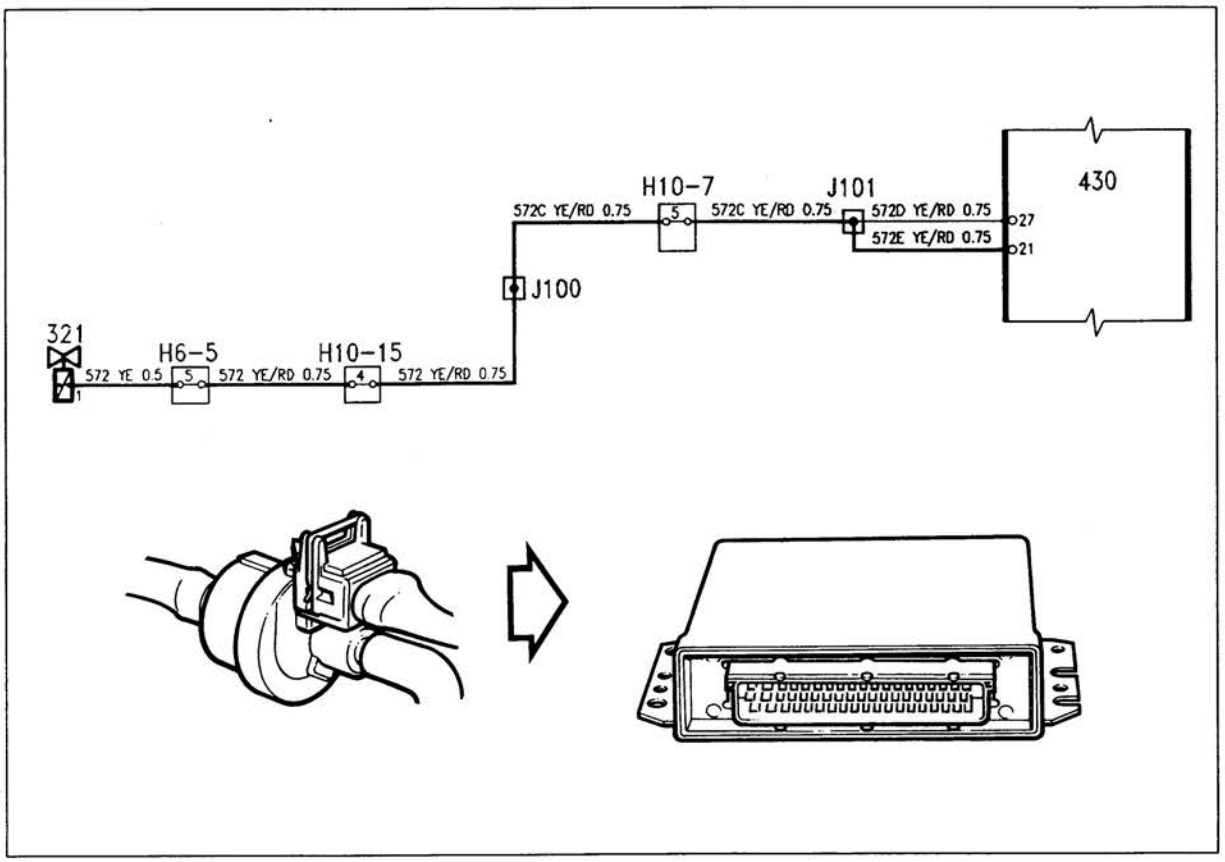
ECM input signals (contd.)



Cooling fan status

Pin 38 of the ECM is shorted to ground when the fan is activated. The reason for this is that the ECM is designed to prevent a dip in idling speed when the fan cuts in.

ECM input signals (contd.)

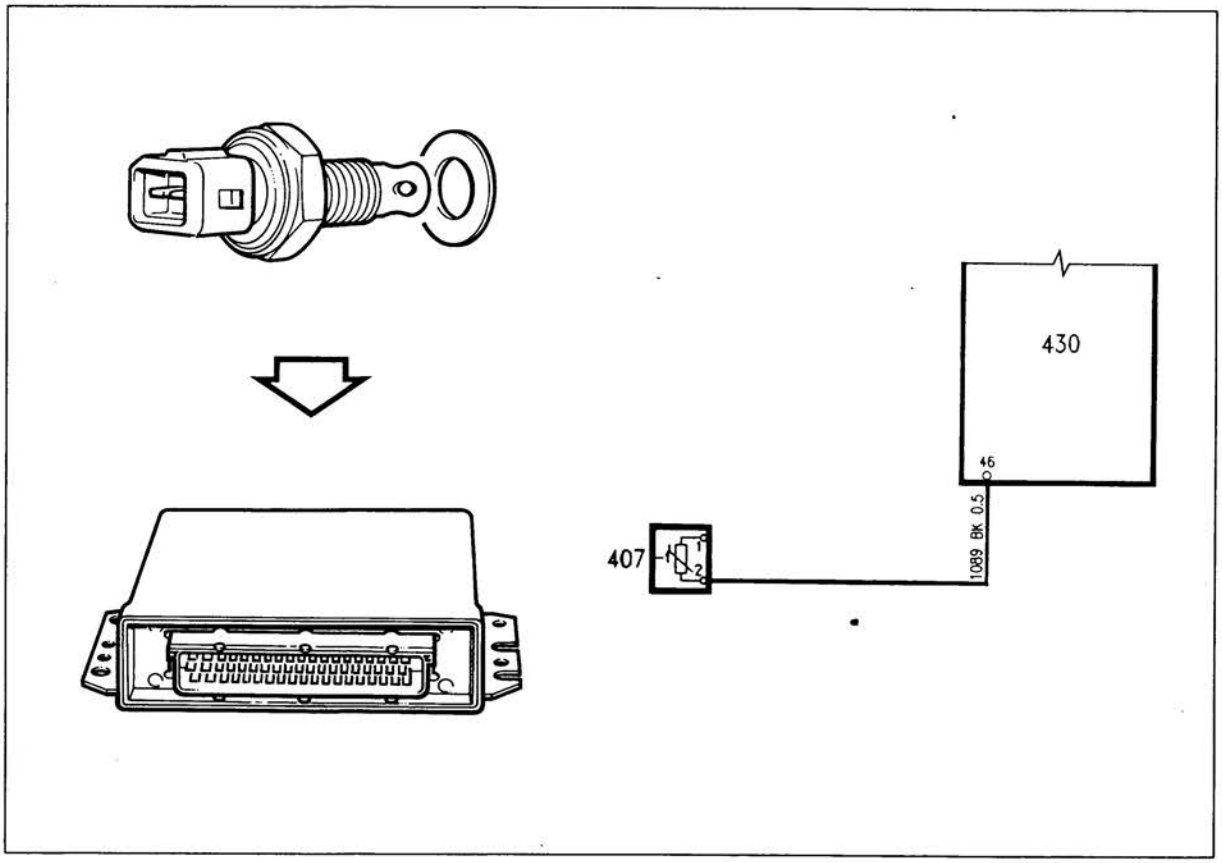


Evaporative emission system (ELCD)

The Evaporative emission (EVAP) system works in conjunction with the fuel mixture control in such a way that the ECM weakens the mixture when the EVAP system adds fuel to the fuel-air mixture.

To handle this interaction, the ECM needs to know the position of the canister purge valve. About 12 V is applied to pin 21 of the ECM when the valve is open and 0 V when the valve is closed.

ECM input signals (contd.)



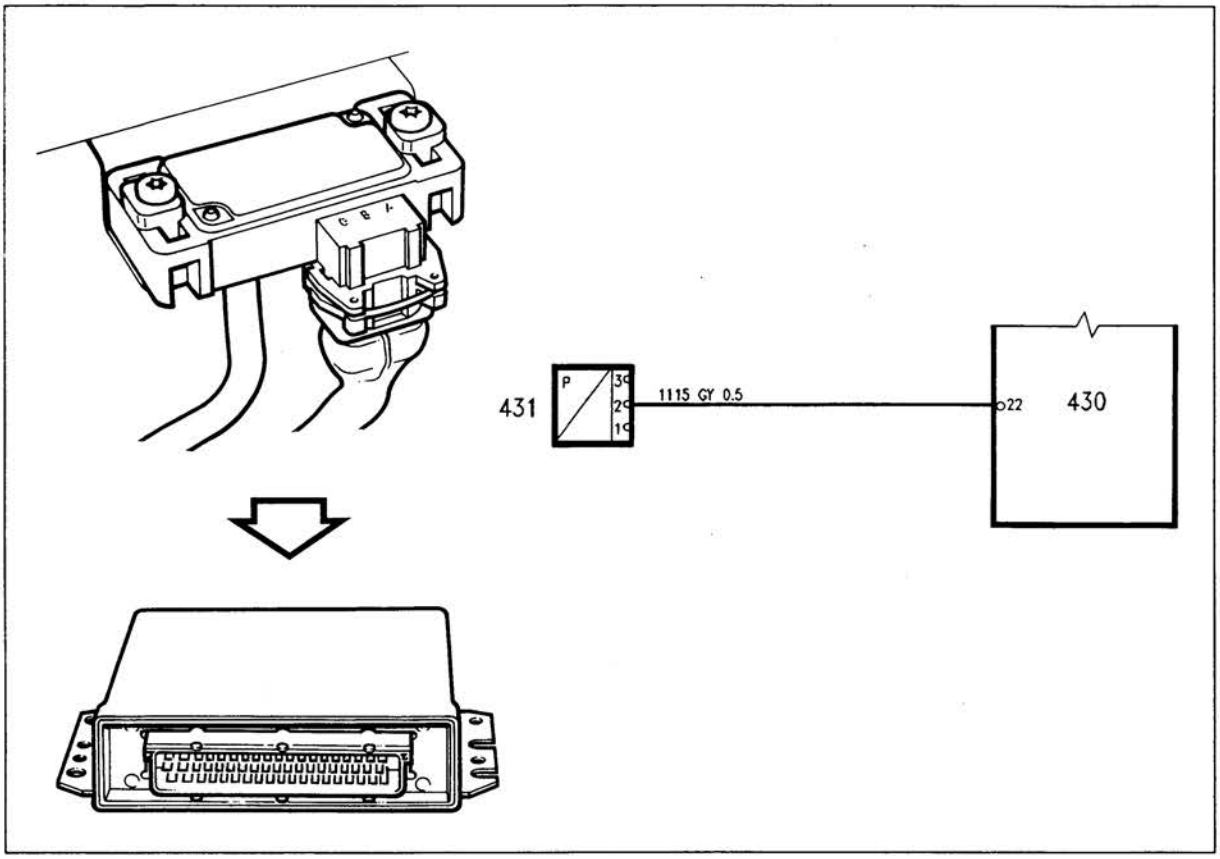
Temperature, intake air

The temperature signal from the intake air temperature sensor is applied to pin 46 of the ECM.

The signal voltage varies between 0.06—4.96 V, depending on the temperature. See the table.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

ECM input signals (contd.)

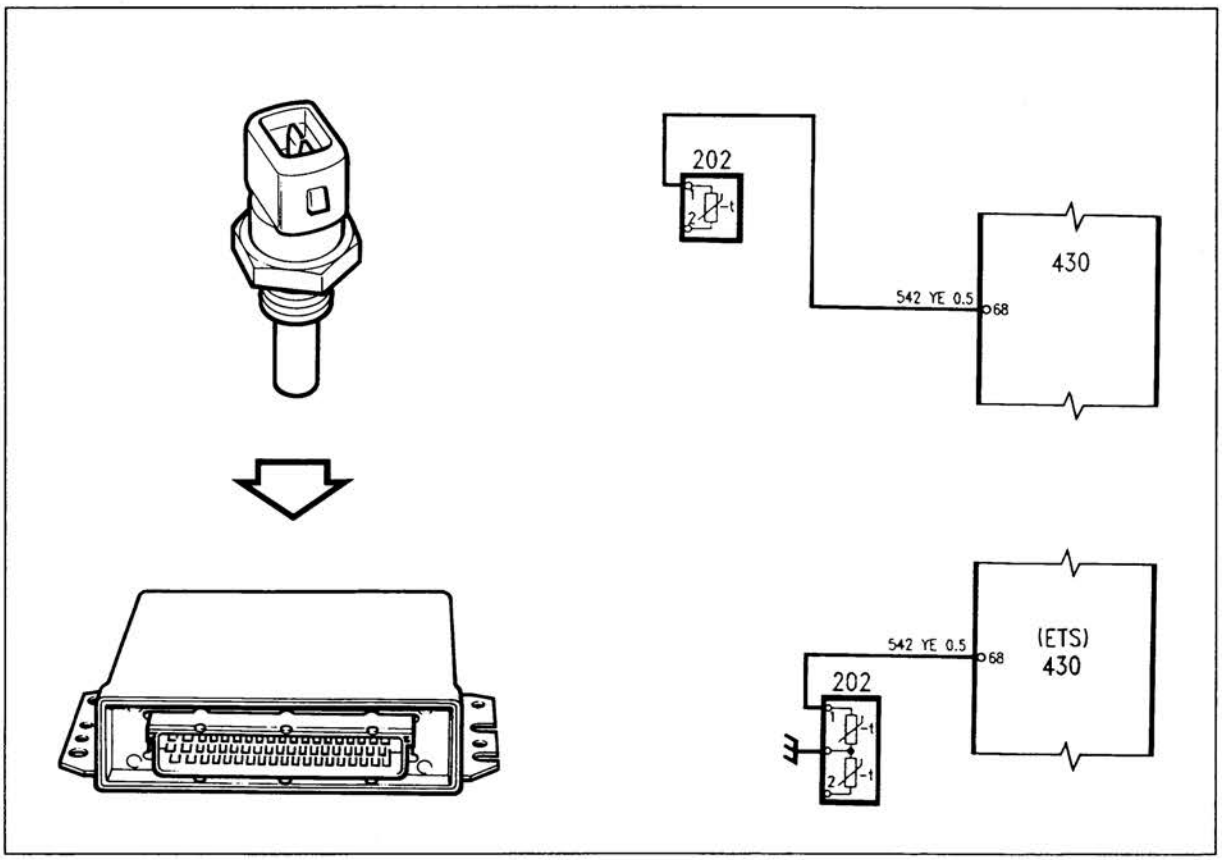


Pressure, intake manifold

Information from the manifold absolute pressure (MAP) sensor is applied in the form of a signal to pin 22 of the ECM.
Depending on the pressure, the voltage of the signal varies as shown in the table below:

Pressure (bar)	Voltage (V)
-0.75	0.4
-0.50	0.9
0	1.8
0.25	2.3
0.50	2.8
0.75	3.3

ECM input signals (contd.)



Engine coolant temperature

The ECM receives information about the engine temperature from the engine coolant temperature (ECT) sensor in the cylinder block. The resistance varies with the temperature and with it also the voltage level of the signal applied to pin 68 of the ECM.

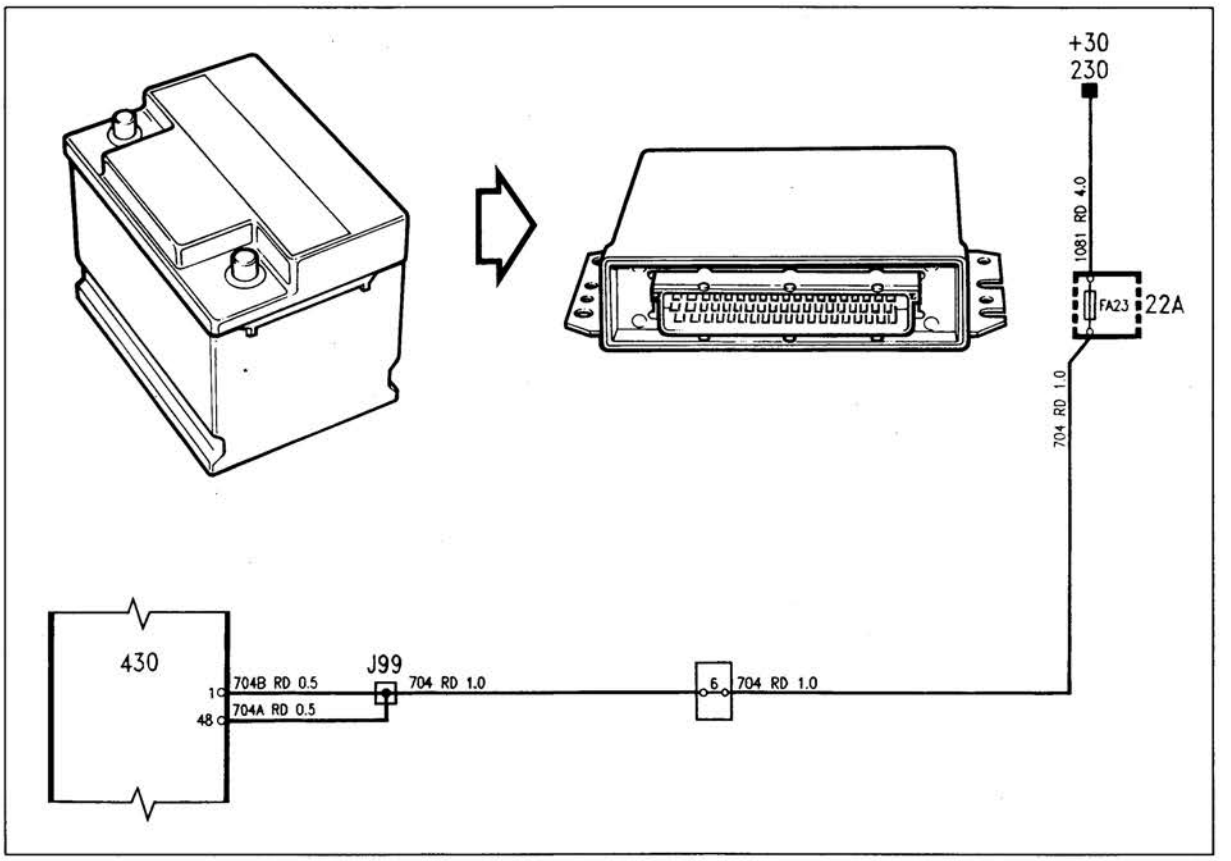
Cars with TCS have a special ECT sensor with a double function so that the temperature information signal is also applied to pin 33 of the ETS control module.

See the table below for relevant values.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

At extremely low temperatures the ECM receives a high signal voltage (3-4 V) from the sensor and at high temperatures a low signal voltage (0.5-1.5 V).

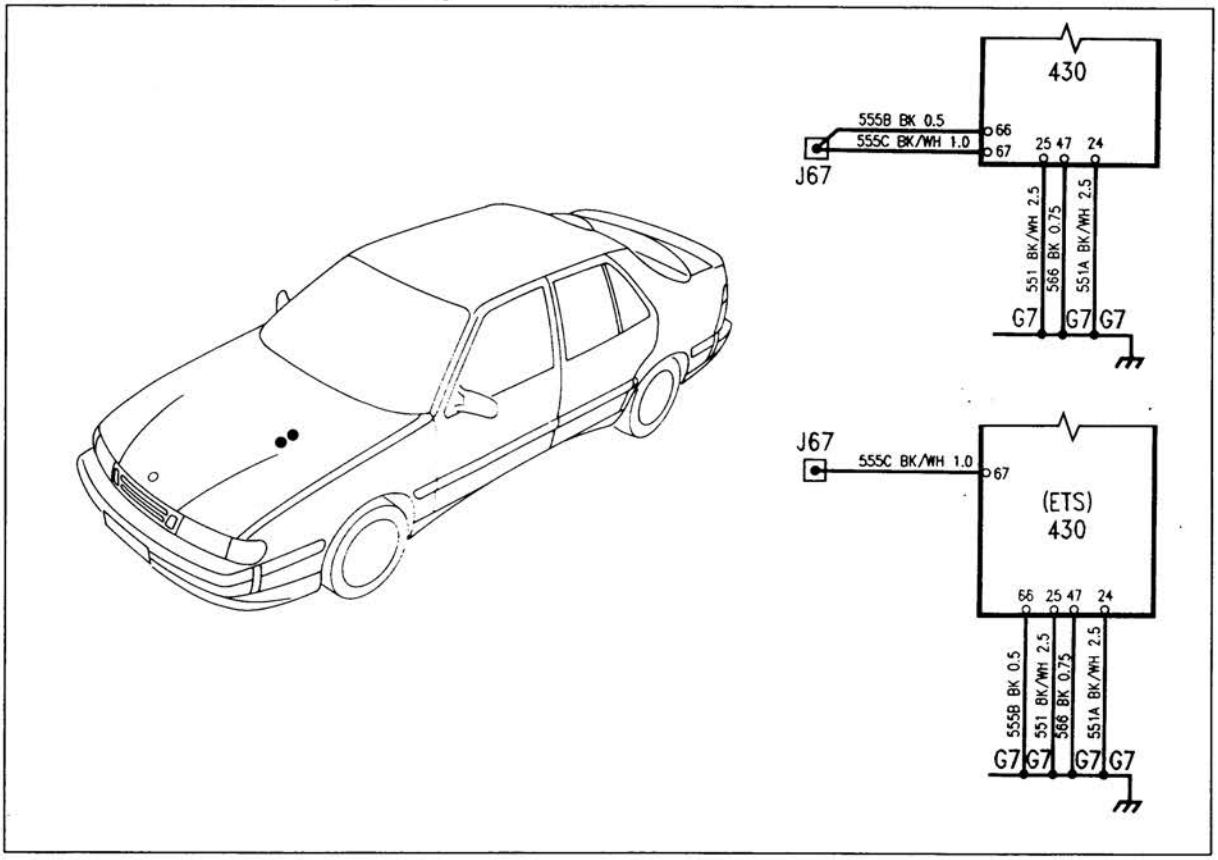
TRIONIC input signals (contd.)



Battery voltage (B+)

Battery positive voltage (+30) is applied to pins 1 and 48 of the ECM.

ECM input signals (contd.)

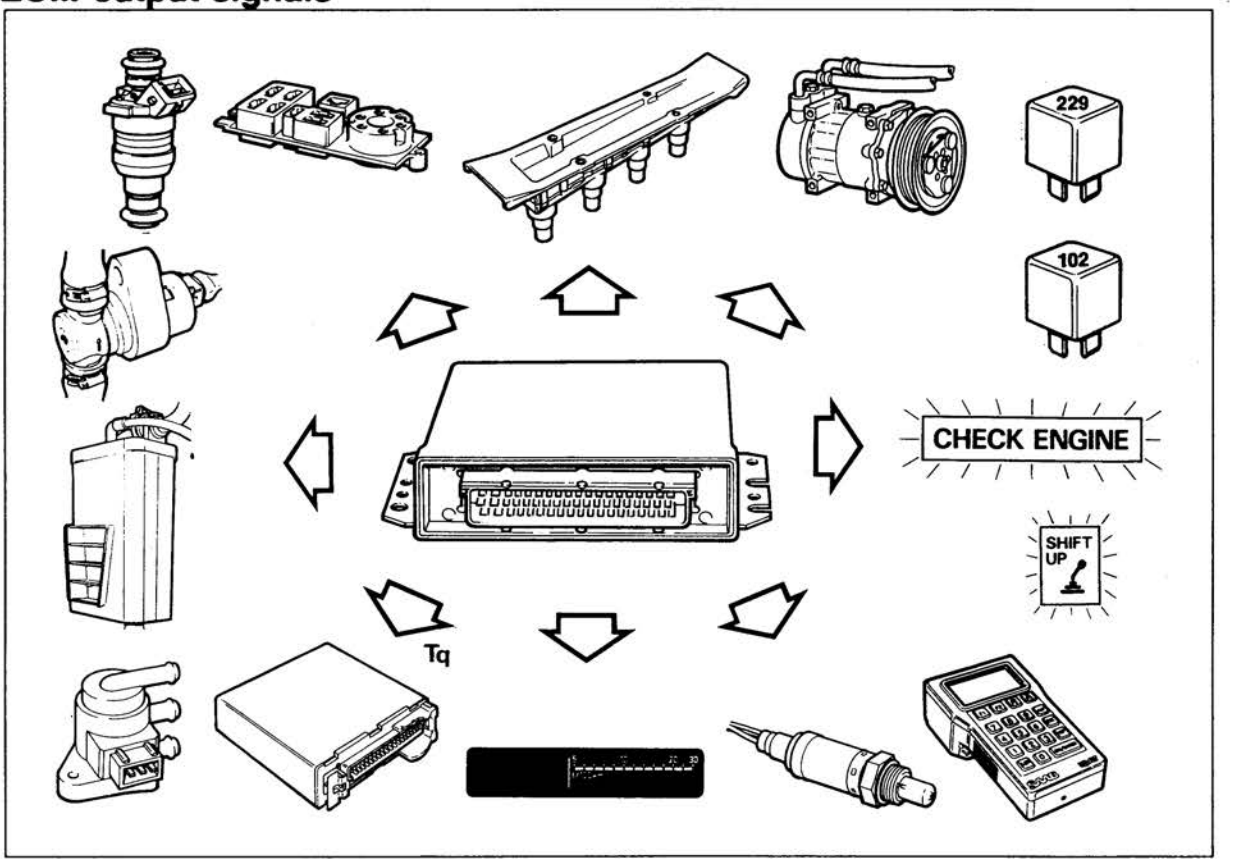


Grounding point G7

Power ground:
The ECM receives its power ground (66 as reference ground on TCS cars) via pins 24 and 25.

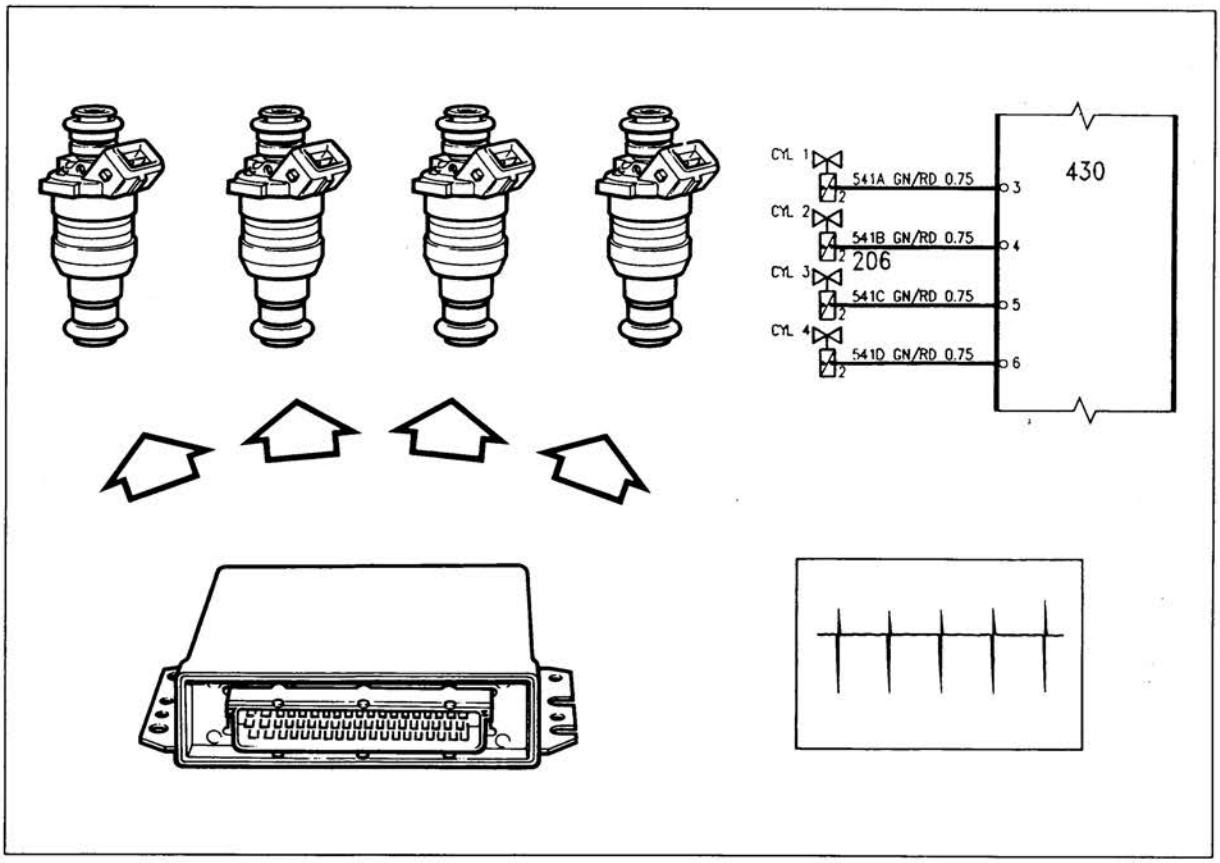
Signal ground:
The ECM receives its signal ground via pins 47 (reference ground) and 67 (on cars without TCS also via pin 66).
Since power ground, due to connection resistance and current consumption variations, has a different electrical potential to signal ground, they must be regarded as two separate components.

ECM output signals



- Injectors (4 signals) (page 52)
- Engine speed (page 53)
- Ignition pulses (4 signals) (page 54)
- A/C compressor (pages 55 and 56)
- Main relay (page 57)
- Fuel pump relay (page 58)
- Malfunction indicator lamp (CHECK ENGINE) (page 59)
- Shift up indication (page 60)
- Data link connector (diagnostics) (page 61)
- Oxygen sensor, preheating (2 outputs) (page 62)
- Fuel consumption (page 63)
- Engine load signal (Tq) (page 64)
- Boost pressure control valve (2 outputs) (page 65)
- Canister purge valve (ELC)D (2 outputs) (page 66)
- Idle air control valve (2 outputs) (page 67)

ECM output signals (contd.)

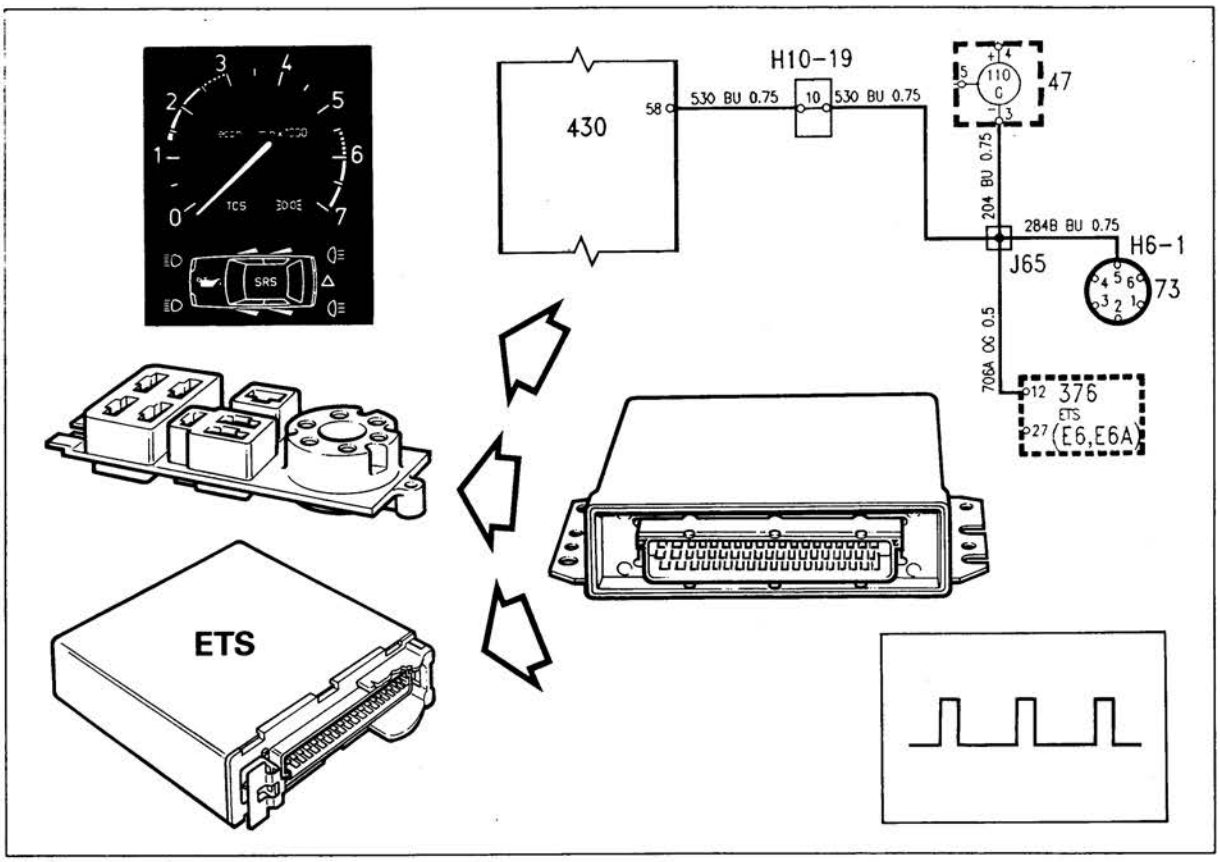


Injectors (4 signals)

The precise amount of fuel that each cylinder is to receive at any given moment is calculated on the basis of several ECM input signals.

When the engine is running, the ECM sends signals to pins 3, 4, 5 and 6 in the correct firing sequence, i.e. pins 3-5-6-4, which correspond to cylinders 1-3-4-2. Conditions are different during the starting phase.

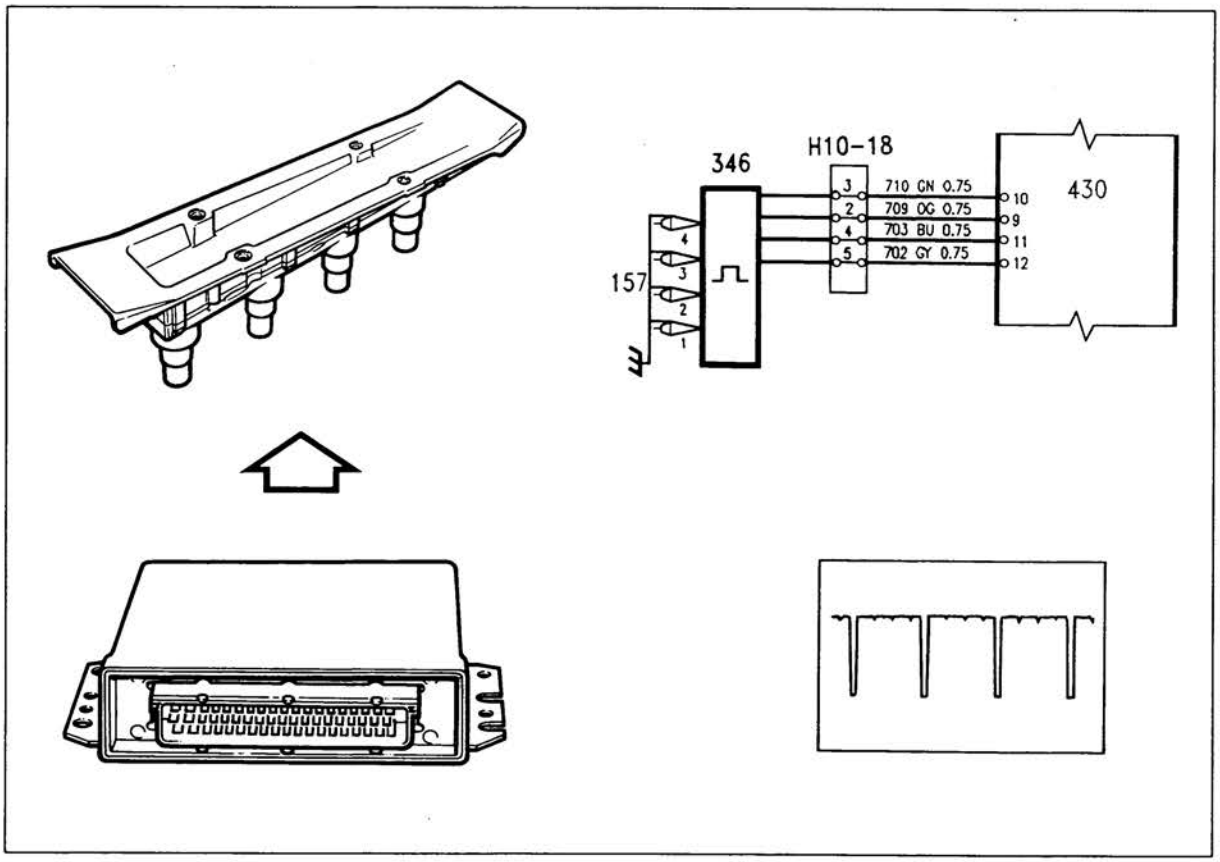
ECM output signals (contd.)



Engine speed

An engine speed signal (Td) is sent from pin 58 of the ECM to pin 3 of the tachometer (rev counter) and to pin 5 of the TSI instrument.

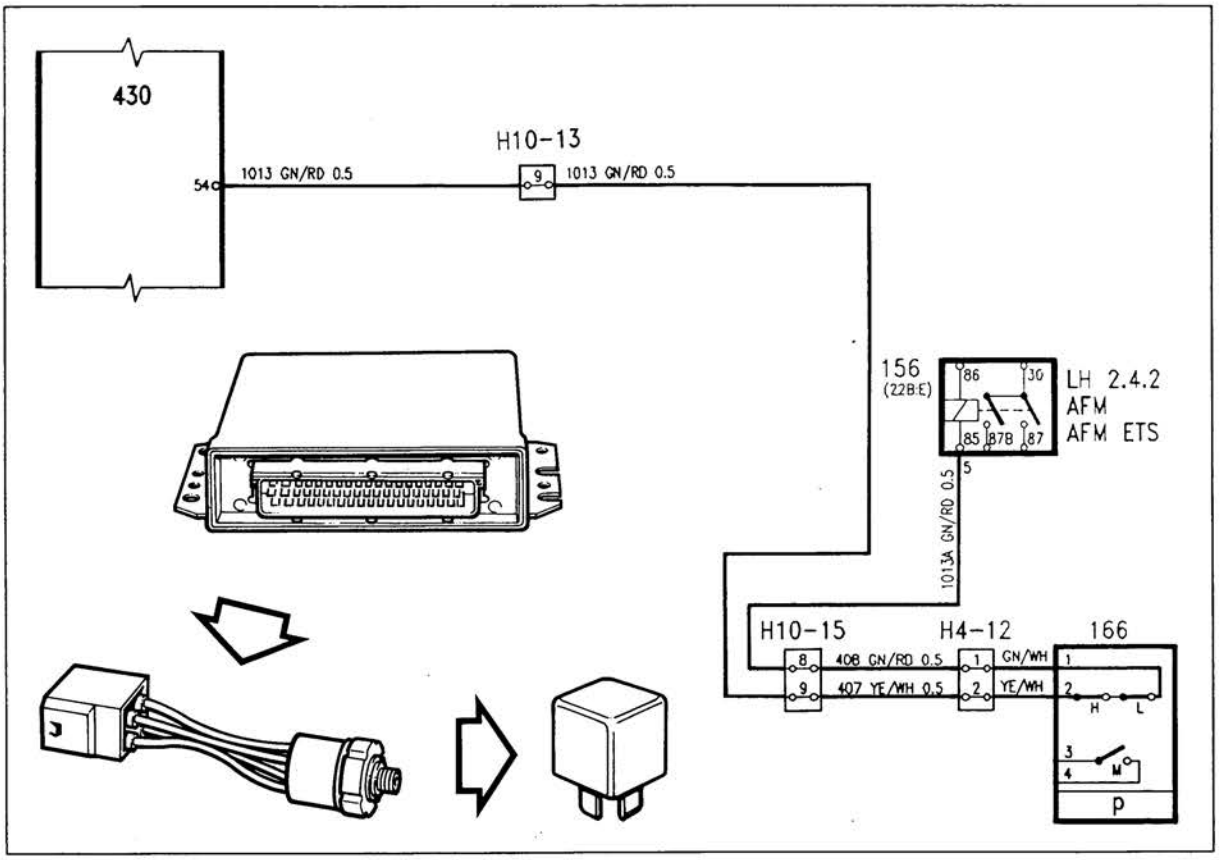
ECM output signals (contd.)



Ignition/trigger pulses, DI (4 signals)

On the basis of input signals received on pins 9, 10, 11 and 12, the ECM determines the cylinder in which a spark is to be produced.

ECM output signals (contd.)



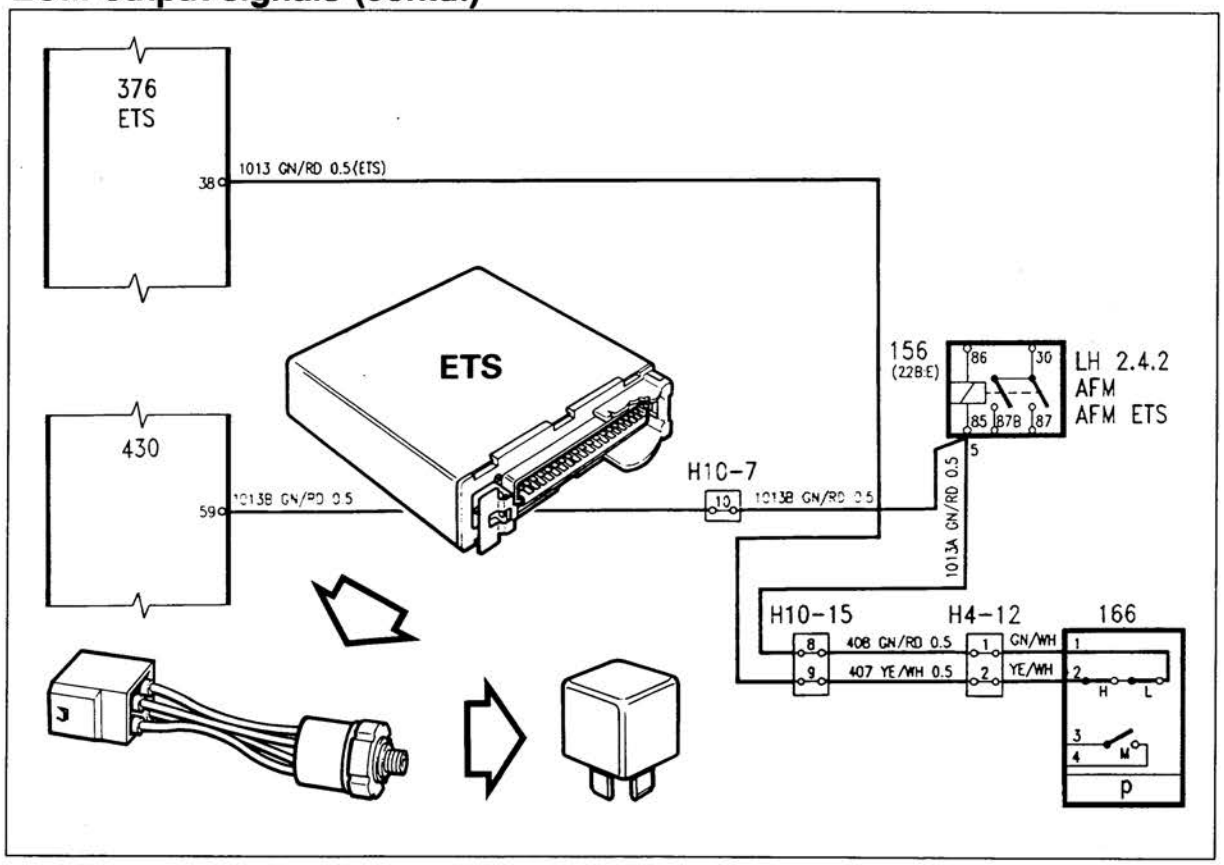
AC compressor

Cars without TCS:

On activation of A/C, a 12 V signal is applied to pin 59 of the ECM. The ECM then shorts pin 54 to ground, the A/C relay operates and battery positive voltage (+30) is connected to the compressor and fan.

Engine speed compensation is incorporated in the ECM.

ECM output signals (contd.)

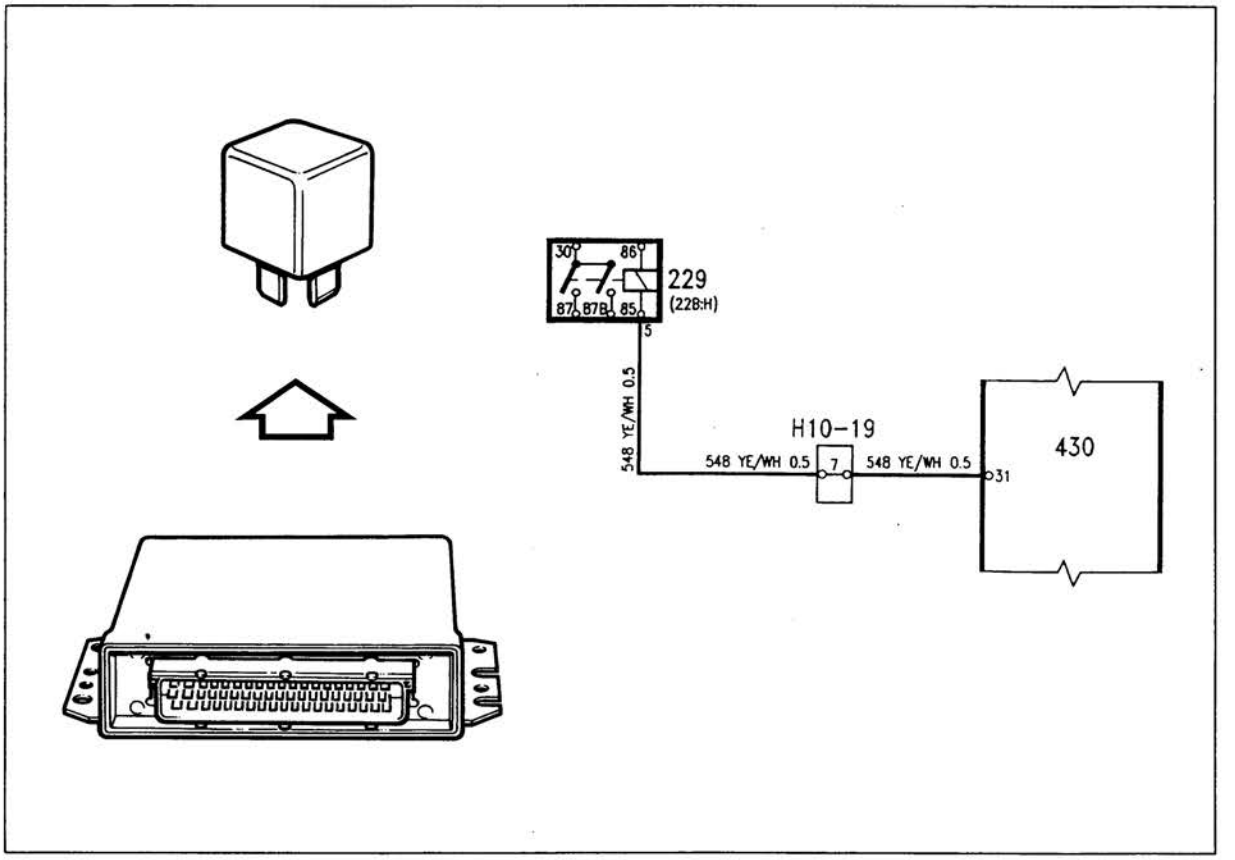


A/C compressor

Cars with TCS:
On activation of A/C, a 12 V signal is applied to pin 37 of the ETS control module. This control module then shorts pin 38 to ground, the A/C relay operates and battery positive voltage (+30) is connected to the compressor and fan.
Engine speed compensation is incorporated in the ETS control module.

To ensure that engine speed compensation is as smooth and unobtrusive as possible, a signal is applied to pin 59 of the ECM unit which causes it to add a little extra fuel.

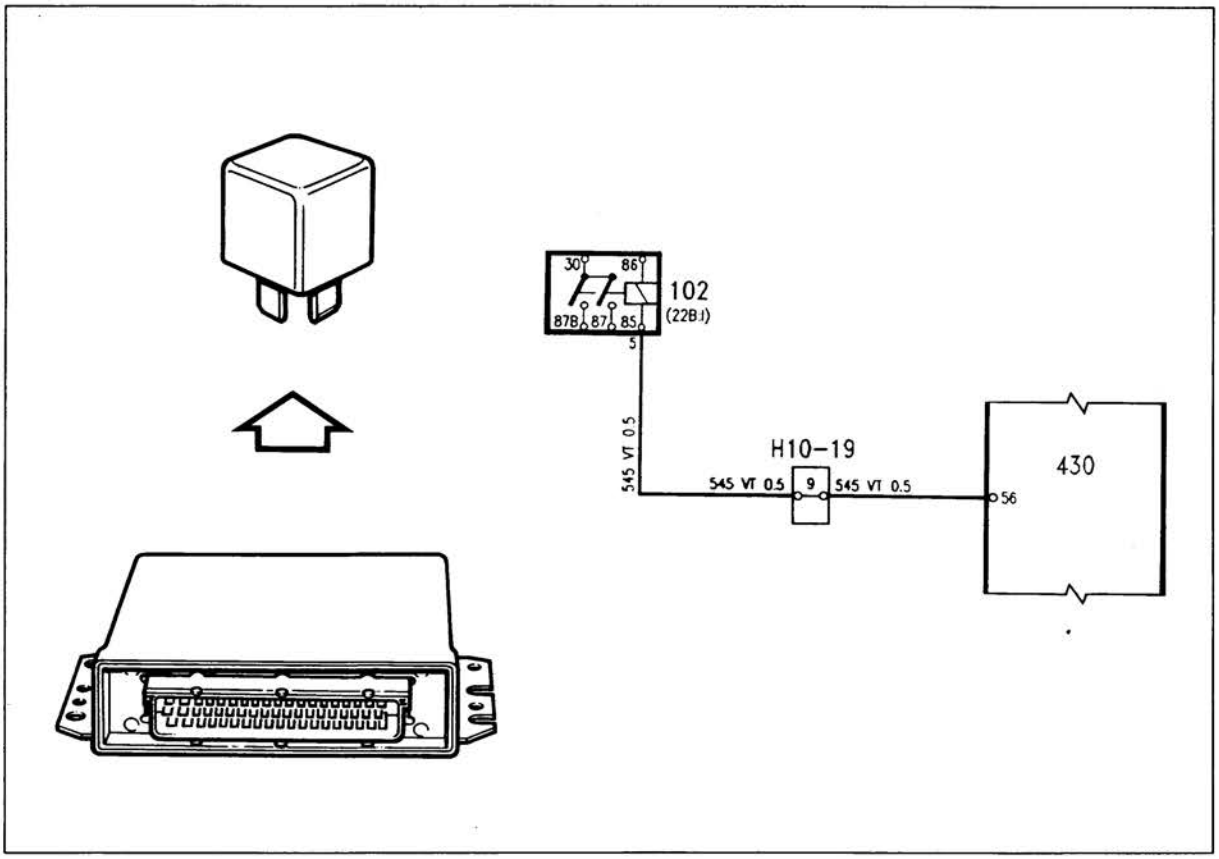
ECM output signals (contd.)



Main relay

When pulses from the crankshaft position sensor are applied to pin 40 of the ECM, pin 31 is grounded and the main relay operates.

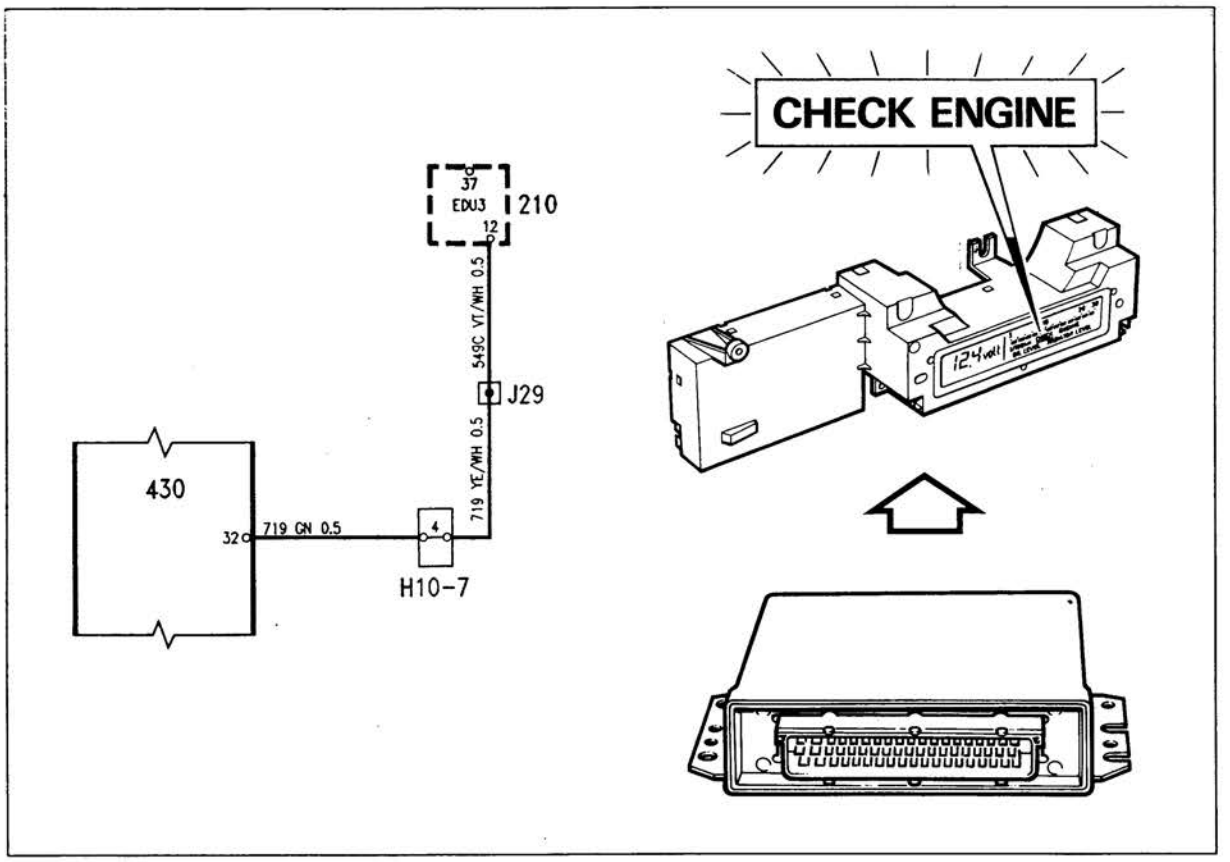
ECM output signals (contd.)



Fuel pump relay

When pulses from the crankshaft position sensor are applied to pin 40 of the ECM, pin 56 is grounded and the fuel pump relay operates.

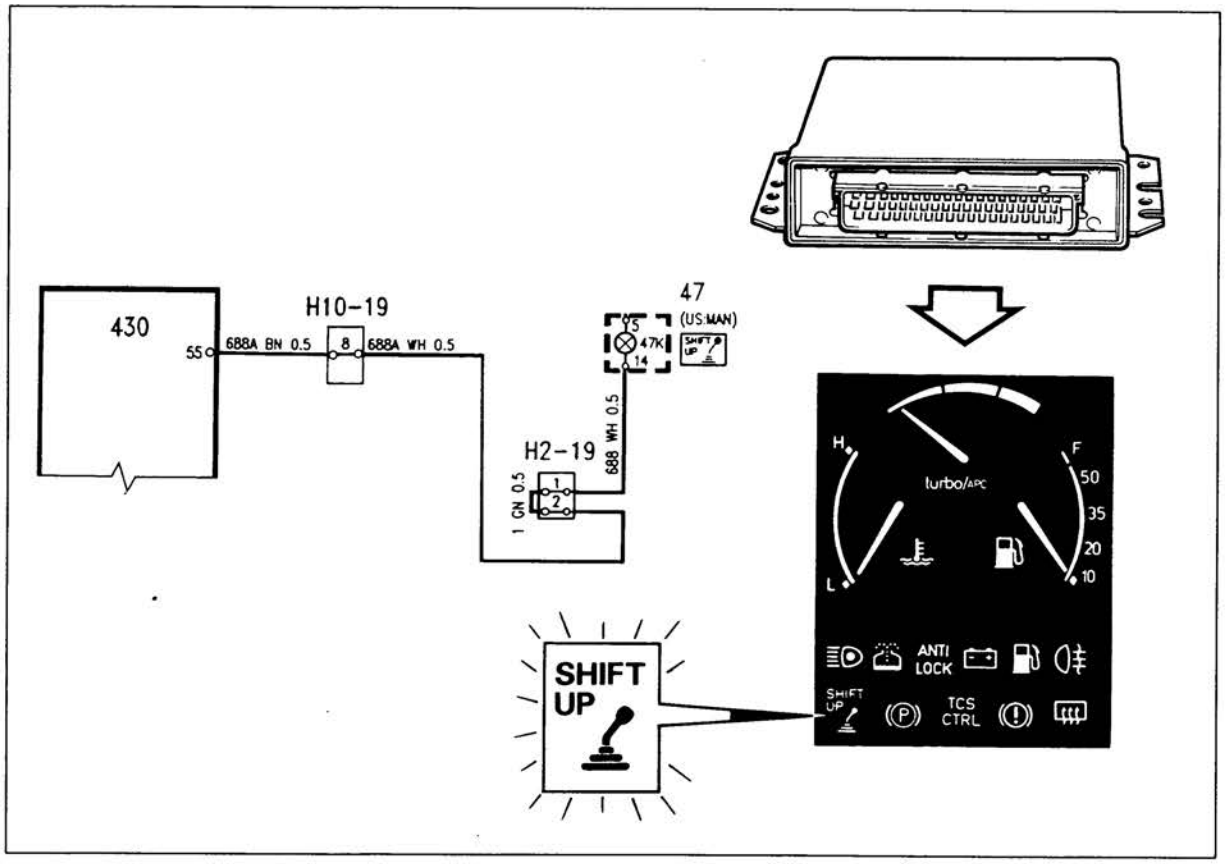
ECM output signals (contd.)



Malfunction indicator lamp (CHECK ENGINE lamp)

The malfunction indicator lamp (CHECK ENGINE lamp) is grounded via pin 32 of the ECM. The +15 supply voltage comes from terminal 159 of the fuse holder inside the glove box.

ECM output signals (contd.)



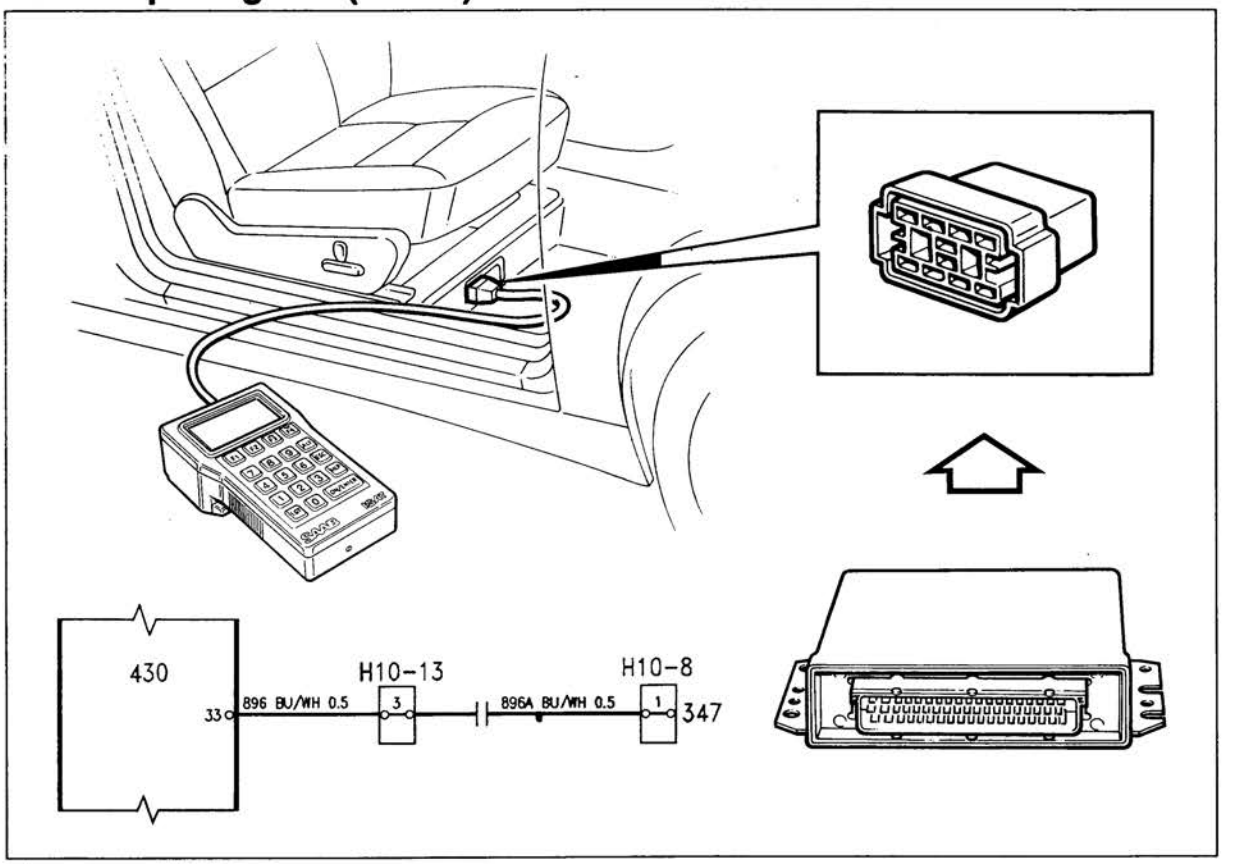
SHIFT UP indication (USA, CA)

When the load on the engine drops below a certain level at the same time as engine speed reaches certain values, the ECM shorts the SHIFT UP lamp (47K) to ground via pin 55.

The engine speed at which the lamp lights up depends on the intake manifold pressure and the gear that is engaged:

- 1st: 2000 rpm
- 2nd: 1900 rpm
- 3rd: 1800 rpm
- 4th: 1775 rpm

ECM output signals (contd.)

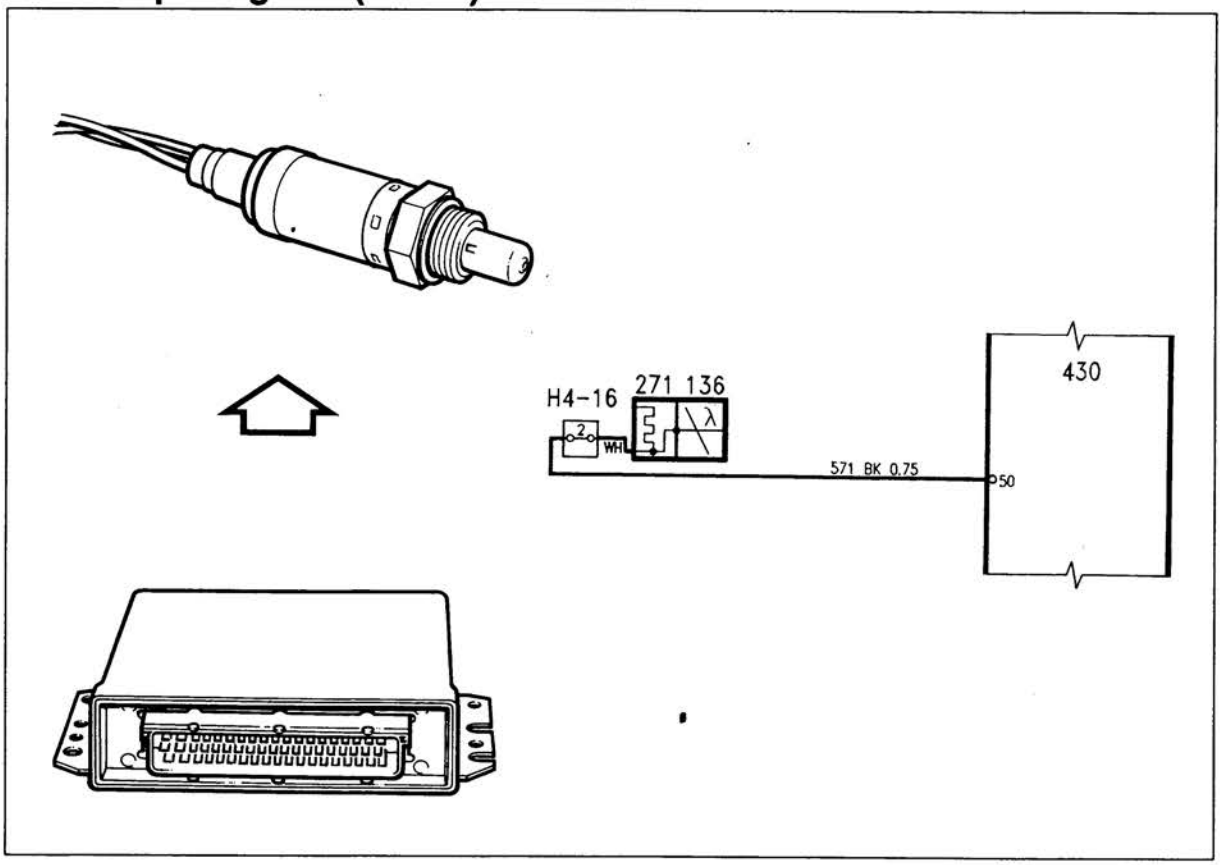


ISAT scan tool diagnostics

Communication with the ISAT scan tool takes place via pin 33 of the ECM and the black data link connector (diagnostic socket) under the right- hand front seat.

The SFI system has system number 10.

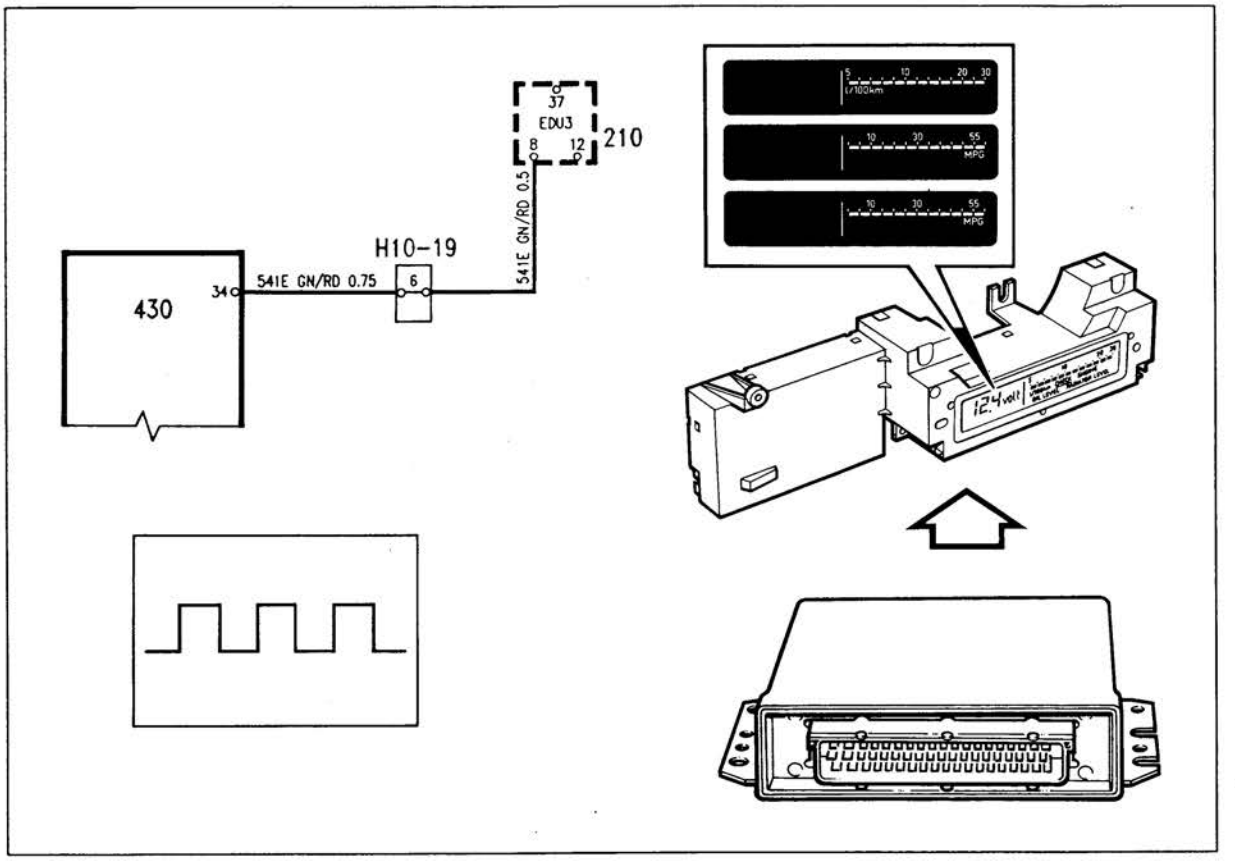
ECM output signals (contd.)



Preheating, oxygen sensor

The circuit for preheating the oxygen sensor is grounded via pin 50 of the ECM.

ECM output signals (contd.)

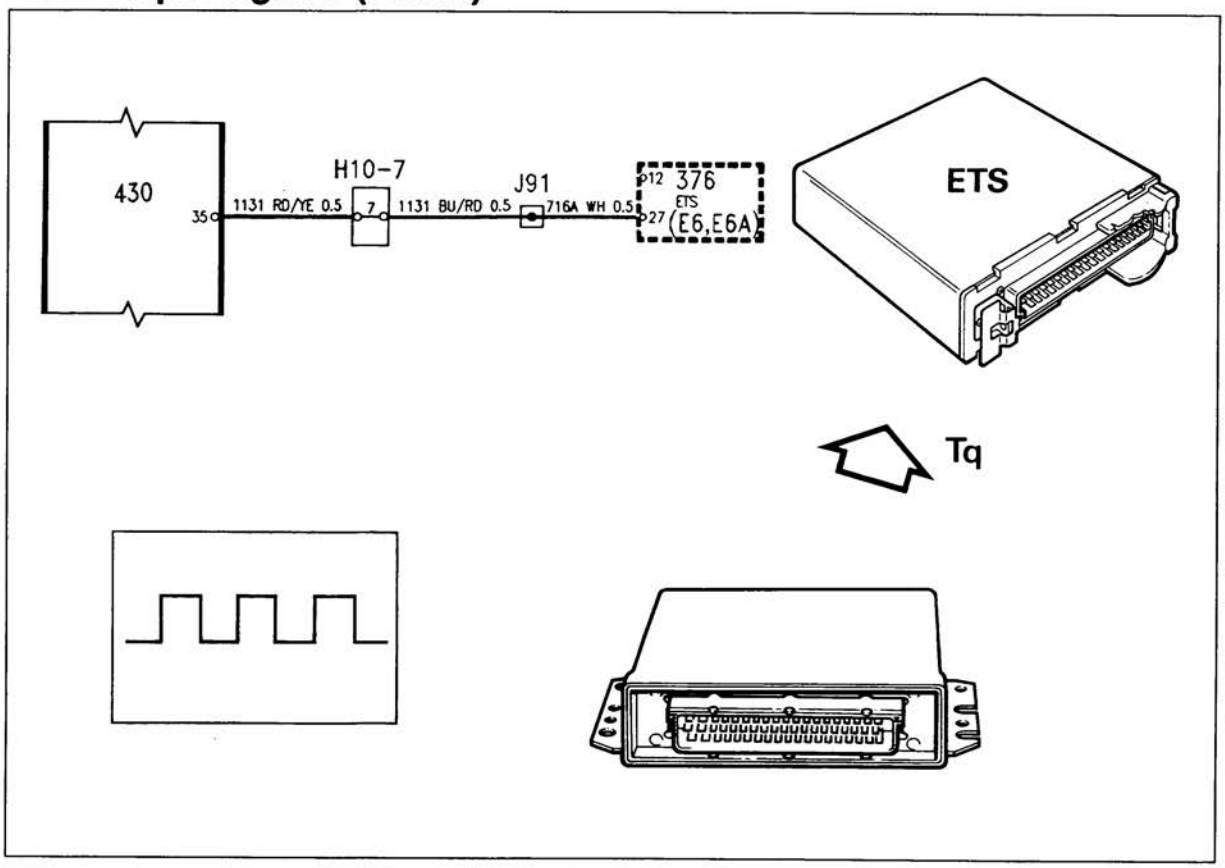


Fuel consumption

A fuel consumption signal is sent from pin 34 of the ECM to the Electronic Display Unit (EDU 3), pin 8.

This signal is the result of a calculation the ECM performs by adding the delivery flow times (opening duration) of the injectors, which for a given period of time correspond to a certain amount of fuel.

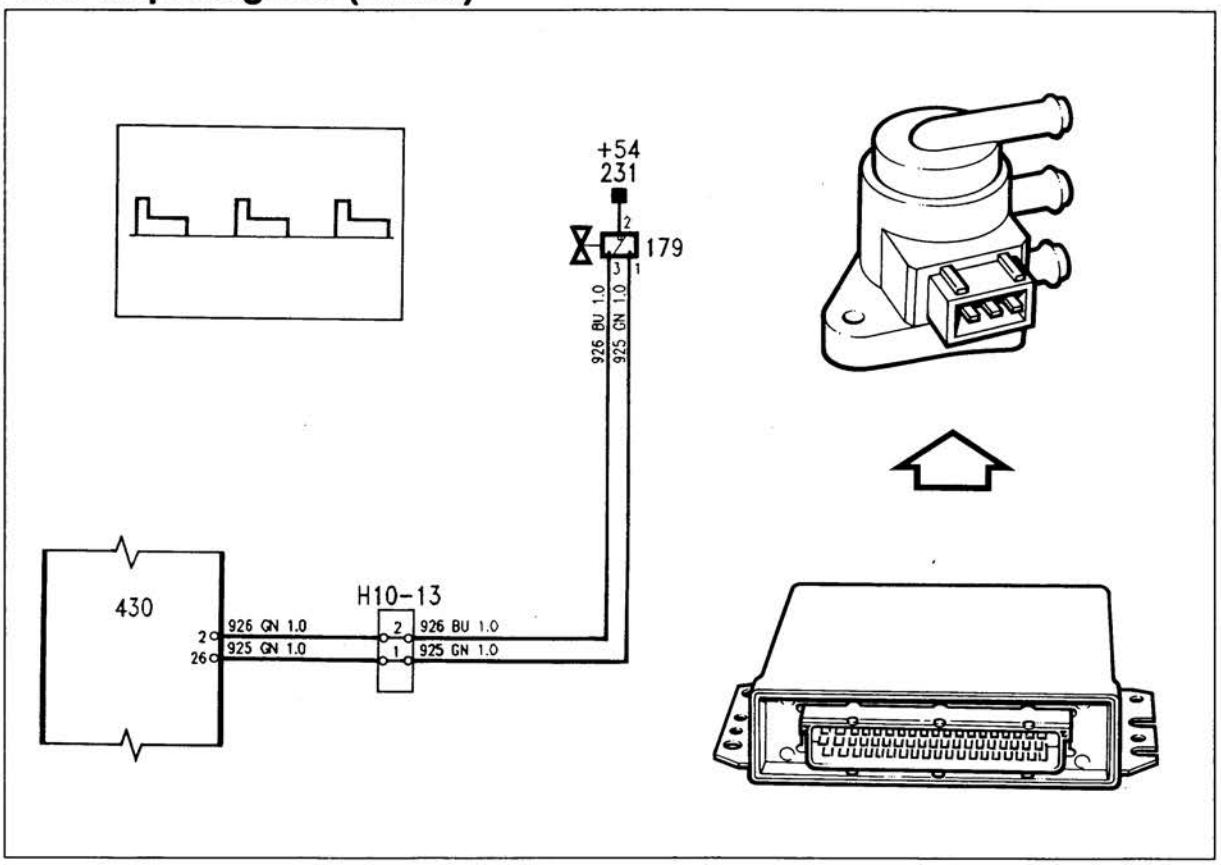
ECM output signals (contd.)



Engine load signal (Tq)

An engine load signal (Tq) from pin 35 of the ECM goes to pin 27 of the ETS control module.

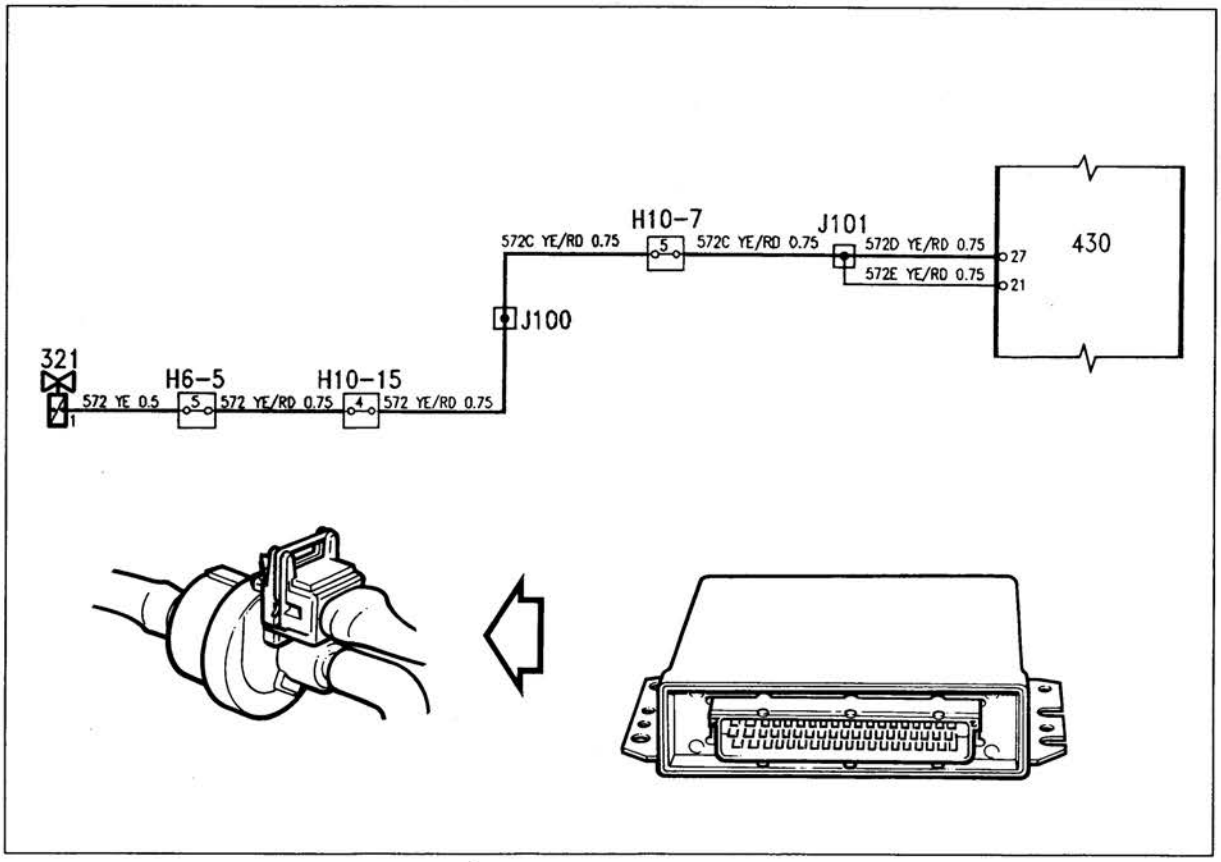
ECM output signals (contd.)



Boost pressure control valve

The boost pressure control valve (APC solenoid) has double windings which are energized by a +54 voltage supply. The coils, which operate in opposition to each other, are grounded via pins 2 and 26 of the ECM.

ECM output signals (contd.)



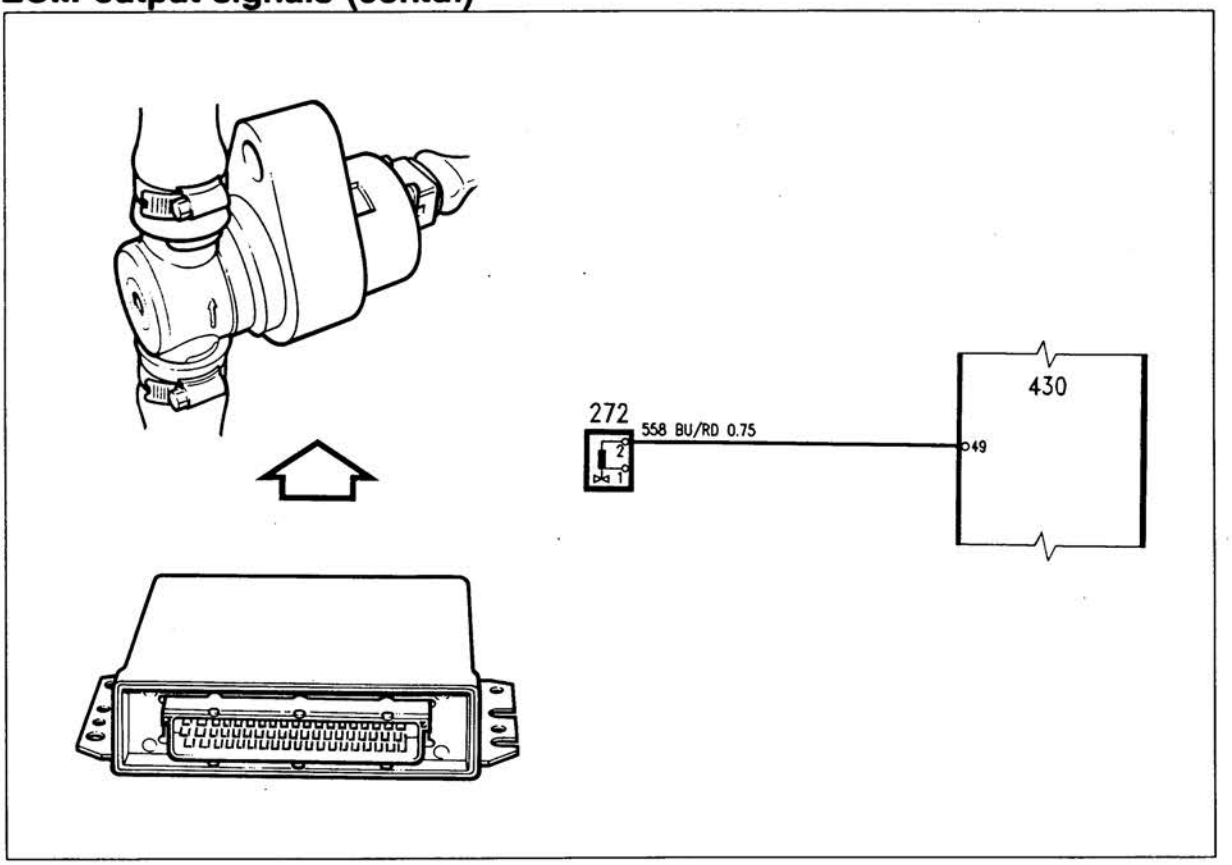
Canister purge valve (ELCD valve)
The opening times of the canister purge valve are determined by the information supplied to the ECM about:

- the composition of the exhaust gases
- engine temperature
- engine load
- engine rpm
  and other parameters.

The canister purge valve is activated by being grounded via pin 27 of the ECM.

In order to permit diagnosis of the canister purge valve, the circuit from pin 27 is also connected to pin 21.

ECM output signals (contd.)



Idle air control valve (AIC valve)

When the accelerator is released, the throttle is fully closed and the only air supplied to the engine is admitted via the idle air control (IAC) valve, which is opened and closed by signals from the ECM.

The ECM will hold the idle speed at 850 rpm when an activating signal is received from:

- A/C or ACC

The ECM is programmed to increase engine rpm when signals are received from:

- DRIVE

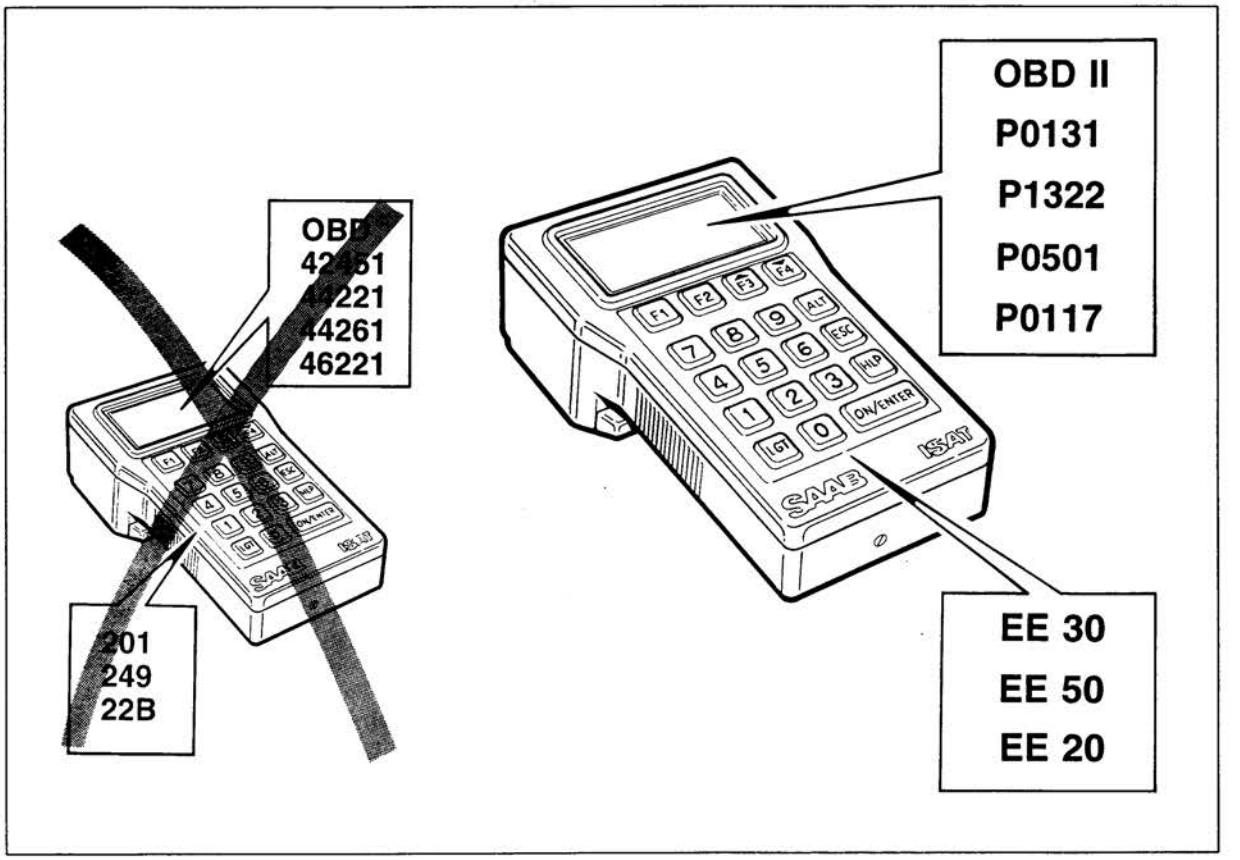
Cars with TCS

On cars with TCS, the ETS control module takes over control of idling speed. Because of the electronic throttle housing on these cars, no IAC valve is necessary.

The ETS control module sends throttle position signals to the ECM.

Fault diagnosis, TRIONIC SFI

Diagn. trouble codes and command codes adapted to new legal requirem.



OBD II

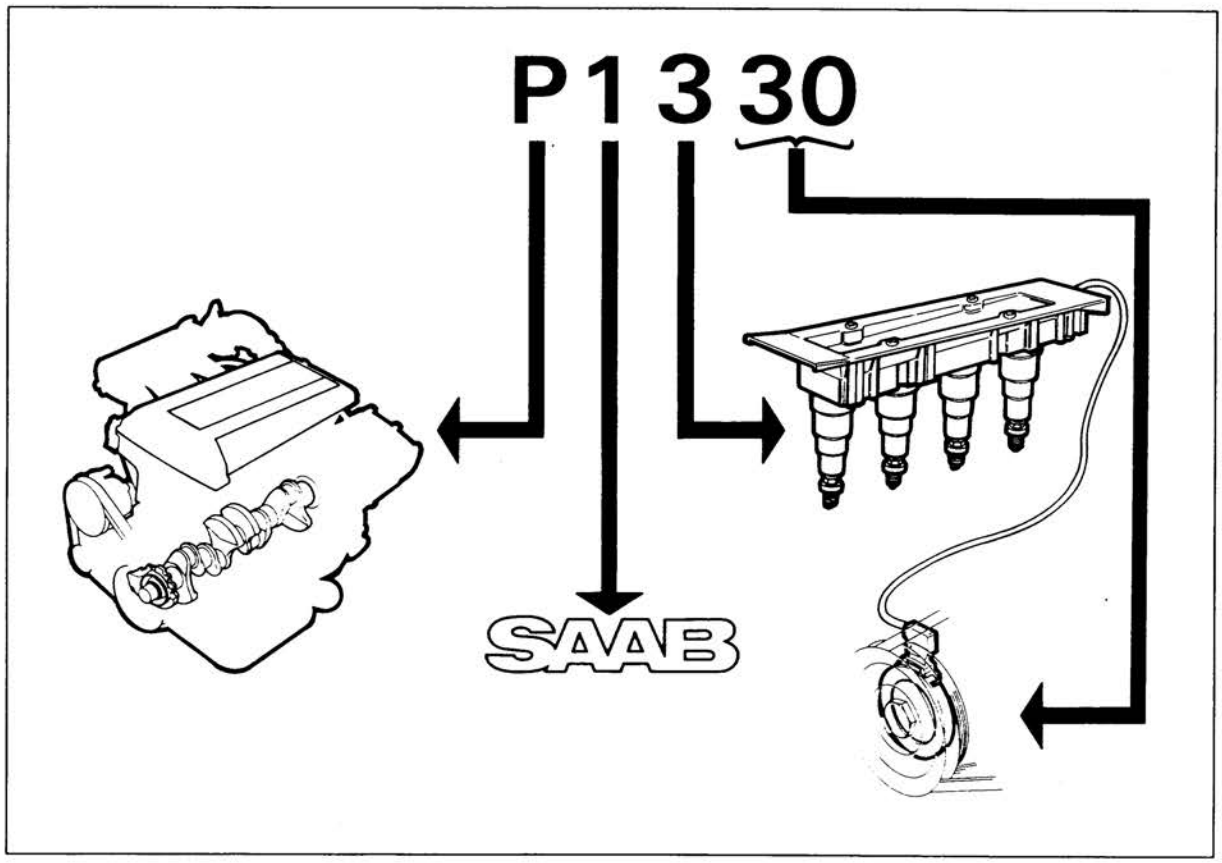
Since 1988, motor manufacturers have been required by the California authorities (and later by the authorities of other countries around the world) to incorporate "smart" electronic control systems in the car so that the occurrence of emission-related faults can be determined and located by means of OBD (On-Board Diagnostics).

For model year 1994 and later cars, the California requirements will be even stricter through the introduction of OBD II. One purpose of the new requirements is to bring about the standardization of diagnostic trouble codes (fault codes) and command codes so that different motor manufacturers will all use the same codes, which will make life easier for technicians who work on several different systems and makes of car.

Recommendations for this standardization are set forth in document SAE J-2012.

In view of the above and for practical reasons, diagnostic trouble codes for the TRIONIC SFI system from M93 are already different from those we have previously been accustomed to when obtaining and reading diagnostic trouble codes on an ISAT scan tool.

Diagnostic trouble codes and command codes (contd.)



Diagnostic trouble codes adapted to OBD II

The new diagnostic trouble codes (DTCs) consist of two parts: the first part consists of a letter and a numeral, the second part consists of three numerals (e.g. P0 111).

From the letter we can see which system is involved, as follows:

- P = Power train
- C = Chassis
- B = Body

In addition to these there is also U (Undefined) in reserve.

From the numeral or letter we can see whether the code concerns a legal requirement according to SAE (0) or whether it is a unique manufacturer code (1 or 2).

From the second numeral or letter we can see which subsystem in each main group the DTC indicates.

In Power diagnostic trouble codes, the second numeral has the following significance:

P01xx Fuel/air supply

P02xx Fuel/air supply

P03xx Ignition system

P04xx Emission control system

P05xx Engine speed/idling control

P06xx ECM and ECM output signals

P07xx Transmission

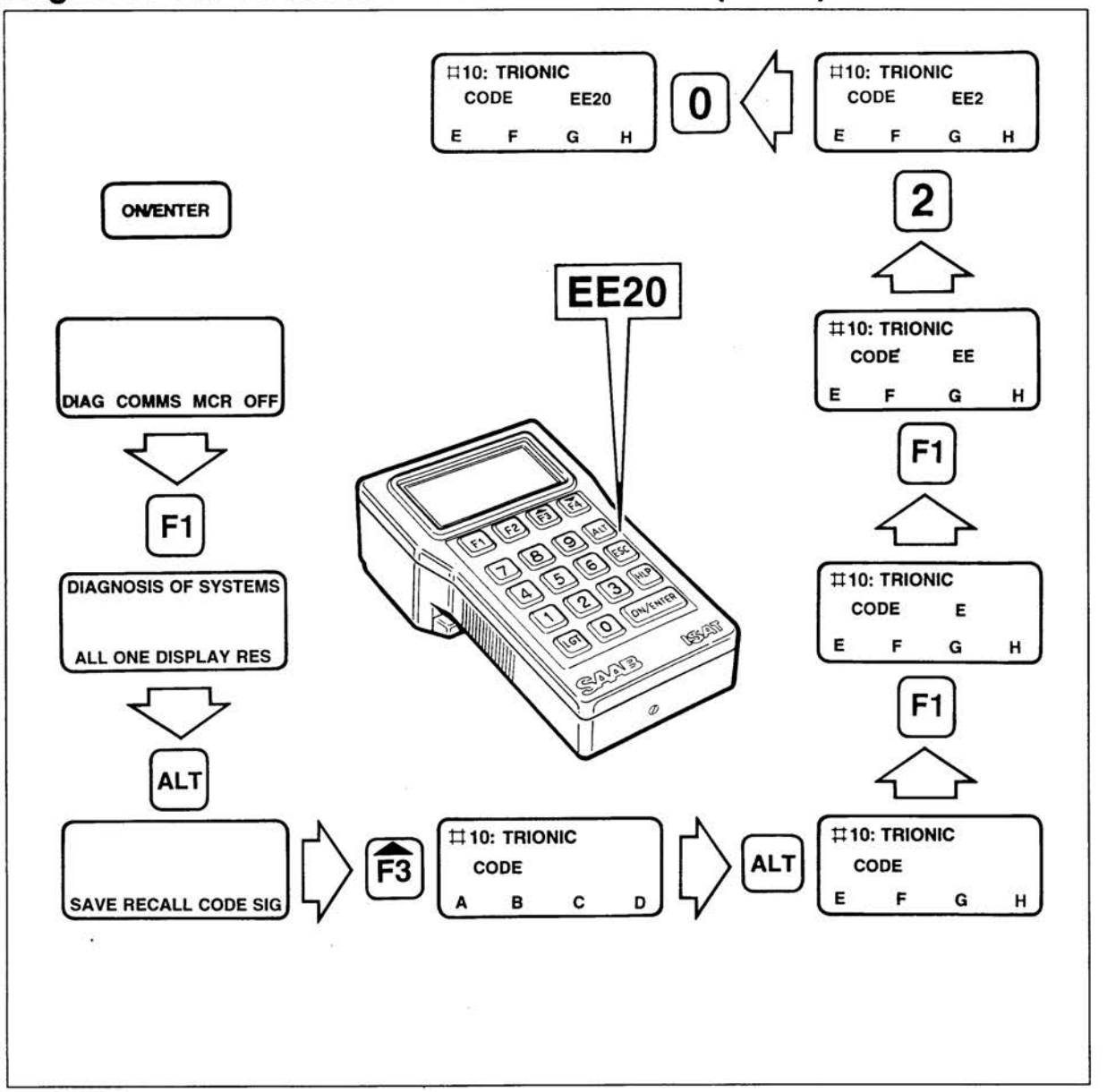
P08xx Transmission

P09xx Reserved for SAE

P00xx Reserved for SAE

The last two numerals in the DTC comprise a serial number which gives each DTC in the different groups a unique number.

Diagnostic trouble codes and command codes (contd.)



Command codes

Changed command codes do not refer back to OBD II requirements but, somewhat simplified, could be said to be an adaptation to and/or utilization of a standard used by GM.

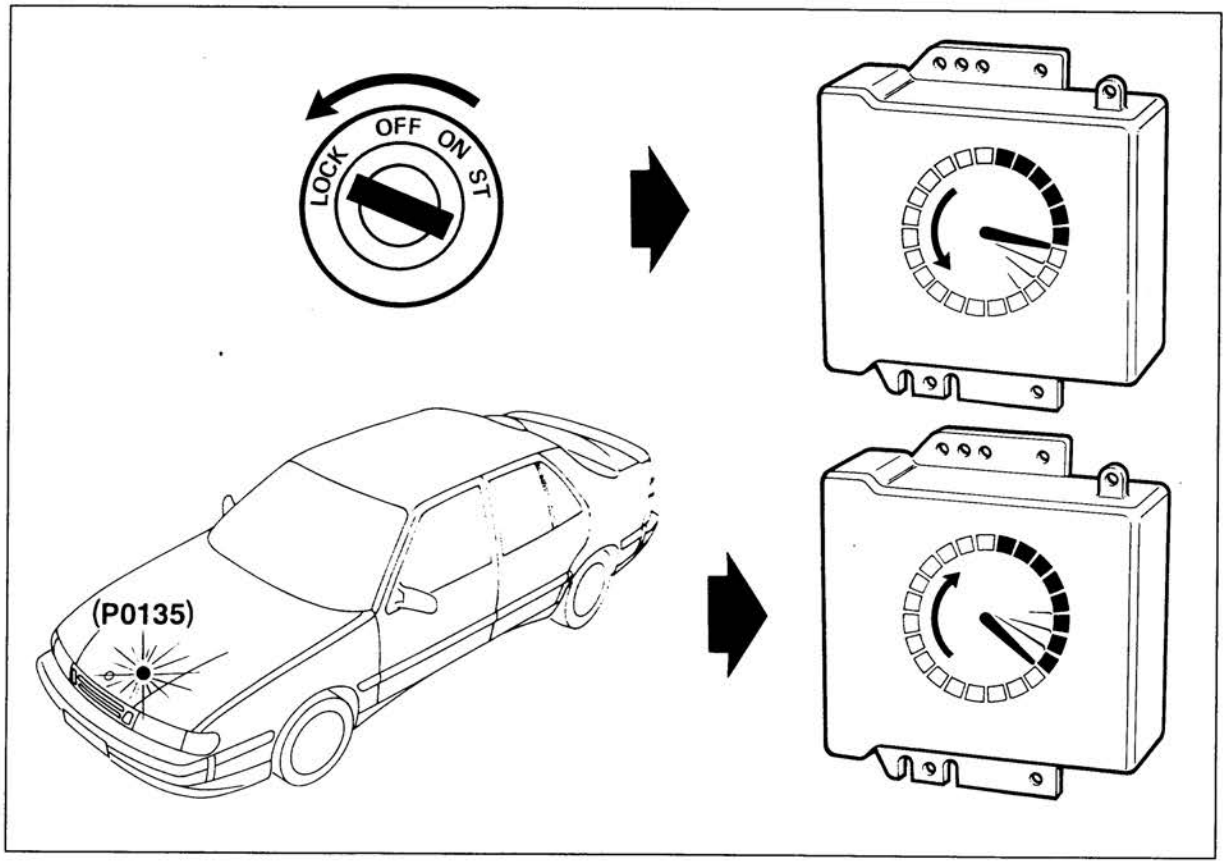
Apart from their new pattern, the command codes have also been grouped according to their purpose, as follows:

- codes for handling DTCs, identification and communication (engine switched off or running)
- codes for checking the status of components and/or functions connected to the ECM (engine running)
- codes for activating components with the engine switched off
- codes for activating components with the engine running

Note:

When command codes beginning with EE or EF are to be used, the ISAT scan tool's ALT key must be used to scroll through the letters E-F-G-H on the display, see Fig. above.

Diagnostic trouble codes and command codes (contd.)



Intermittent faults

With the introduction of the new trouble codes, the earlier unique fault code for an intermittent fault has been discontinued. This does not mean that it will no longer be possible to detect an intermittent fault, but the method of indicating one has been changed and the same trouble code is used regardless of whether the fault is permanent or intermittent.

A status flag and a counter are incorporated in the control module.

The status flag keeps track of whether the fault is permanent or intermittent.

Each occurrence of a fault is added in the counter. When the total number of fault occurrences has filled the counter to capacity, its contents are frozen.

When the ignition is switched off, the contents of both the status flag and the counter are stored in a non-volatile memory.

If the fault is intermittent and the counter has not been filled to capacity, its contents are decremented by a certain number next time the ignition is switched on.

If the intermittent fault persists, the counter again starts to add each fault occurrence until it is filled to capacity. If the fault has disappeared, the contents of the counter will be retained until the next stop/start cycle when the counter will again be decremented by a certain number.

Consequently, after a number of start/stop cycles the counter will have counted down to zero and the fault (trouble code) disappears (unless fresh fault occurrrences have been added).

If the fault is of such a nature that the CHECK ENGINE lamp (MIL) lights up, it will also go out when the counter decrements to zero.

Due to a time-limiting function in the control module, the above countdown cannot be initiated by carrying out a number of stop/start cycles in quick succession. At least 15 minutes must elapse between each cycle for the counter to decrement its contents.

Diagnostic trouble code table (■ - #10)

Engine running or ignition switched on

DTC	Malfunction/faulty component	MIL (CHECK ENGINE)	Text displayed on ISAT Scan Tool	Action, see page
P0105	Manifold absolute pressure sensor	on	FAULT NO. XXX P0105 MANIFOLD ABSOLUTE PRESSURE SENSOR	82
P0106	Manifold Absolute Pressure Sensor- Range/performance	on	FAULT NO.XXX P0106 MANIFOLD PRESSURE SENSOR RANGE/PERFORM -	82
P0107	Manifold absolute pressure sensor—signal too low	on	FAULT NO. XXX P0107 MANIFOLD PRESSURE SENSOR LOW INPUT	82
P0108	Manifold absolute pressure sensor—signal too high	on	FAULT NO. XXX P0108 MANIFOLD PRESSIRE SENSOR HIGH INPUT	82
P0110	Temperature sensor, intake pipe	on	FAULT NO. XX P0110 MANIFOLD AIR TEMPERATURE SENSOR	85
P0112	Temperature sensor, intake pipe—signal too low	on	FAULT NO. XX P0112 MANIFOLD AIR TEMPERATURE SENSOR LOW INPUT	85
P0113	Temperature sensor, intake pipe—signal too high	on	FAULT NO. XX P0113 MANIFOLD AIR TEMP. SENSOR HIGH INPUT	85
P0115	Temperature sensor, coolant	on	FAULT NO. XX P0115 ENGINE COOLANT TEMP. SENSOR	89
P0117	Temperature sensor, coolant—signal too low	on	FAULT NO. XX P0117 ENGINE COOLANT TEMP. SENSOR LOW INPUT	89
P0118	Temperature sensor, coolant—signal too high	on	FAULT NO. XX P0118 ENGINE COOLANT TEMP. SENSOR HIGH INPUT	89
P0120	Throttle angle sensor (not TCS)	on	FAULT NO. XX P0120 THROTTLE POSITION SENSOR	92
P0121	Throttle angle sensor— malfunction (not TCS)	on	FAULT NO. XX P0121 THROTTLE POSITION SENSOR RANGE/PERFORM	92

Diagnostic Trouble Code (DTC) table (■ - #10) (contd.)

Engine running or ignition switched on

DTC	Malfunction/faulty component	MIL	Text displayed on ISAT Scan Tool	Action, see page
P0122	Throttle position sensor—signal too low (not TCS)	on	FAULT NO. XX P0122 THROTTLE POSITION SENSOR LOW INPUT	92
P0123	Throttle angle sensor—signal too high (not TCS)	on	FAULT NO. XX P0123 THROTTLE POSITION SENSOR HIGH INPUT	92
P0130	Oxygen sensor, malfunction	on	FAULT NO. XX P0130 PRE CATALYST HO2 SENSOR	95
P0135	Oxygen sensor, preheating faulty		FAULT NO. XX P0135 PRE CATALYST HO2S HEATER	96
P1130	Oxygen sensor, preheating current high		FAULT NO. XX P1130 PRE CATALYST HO2S HEATER HIGH INPUT	96
P1135	Front oxygen sensor, preheating current low		FAULT NO. XX P1135 PRE CATALYST HO2S HEATER LOW INPUT	96
P0170	Fuel-air mixture, adaptation fault	on	FAULT NO. XX P0170 FUEL TRIM MONITOR	94
P0171	Fuel-air mixture lean	on	FAULT NO. XX P0171 FUEL TRIM LEAN	94
P0172	Fuel-air mixture rich	on	FAULT NO. XX P0172 FUEL TRIM RICH	94
P1322	Engine rpm Td		FAULT NO. XX P1322 ENGINE SPEED TD	111
P0325	Knock detector		FAULT NO. XX P0325 KNOCK SENSOR	102
P0335	Crankshaft sensor		FAULT NO. XX P0335 CRANKSHAFT POSITION SENSOR	98
P0443	EVAP valve control circuit (ELCD)	on	FAULT NO. XX P0443 PURGE CONTROL VALVE CIRCUIT	100

Diagnostic Trouble Code (DTC) table (■ - #10) (contd.)

Engine running or ignition switched on

DTC	Malfunction/faulty component	MIL	Text displayed on ISAT Scan Tool	Action, see page
P1443	EVAP valve, malfunction	on	FAULT NO. XX P1443 PURGE CONTROL VALVE CIRC. RANGE/PERFORM	100
P1444	EVAP valve, current high	on	FAULT NO. XX P1444 PURGE CONTROL VALVE CIRCUIT HIGH INPUT	100
P1445	EVAP valve, current low	on	FAULT NO. XX P1445 PURGE CONTROL VALVE CIRCUIT LOW INPUT	100
P0500	Speed sensor		FAULT NO. XX P0500 VEHICLE SPEED SENSOR	104
P0501	Speed sensor, malfunction		FAULT NO. XX P0501 VEHICLE SPEED SENSOR RANGE/PERFORMANCE	104
P0502	Speed sensor, signal too low		FAULT NO. XX P0502 SPEED SENSOR SIGNAL LOW	104
P0505	Idling control, IAC		FAULT NO. XX P0505 IDLE SYSTEM	106
P1500	Battery voltage		FAULT NO. XX P1500 BATTERY VOLTAGE	109
P0605	Internal monitoring function		FAULT NO. XX P0605 ENGINE CONTROL MODULE INTERNAL	*)
P1651	Internal monitoring function RAM fault		FAULT NO. XX P1651 ENGINE CONTROL MODULE INTERNAL RAM	*)
P1652	Internal monitoring function ROM fault		FAULT NO. XX P1652 ENGINE CONTROL MODULE INTERNAL ROM	*)

*). Clear the trouble code and, if possible, start the engine and drive the car to see whether the trouble code is generated afresh. If it is, change the control module.
If the car cannot be started and no other faults are in evidence, change the control module.

Command codes (■ - #10)

Engine running or ignition switched on

Command	Function/component	Text displayed on ISAT scan tool
E000	Displays number of stored diagnostic trouble codes	PA000 Stored Faults = XXX
E001-E079	Displays singular diagnostic trouble codes by number	FAULT XXX P0105 Manifold Absolute Pressure Sensor
E100	Displays check sum	PA100 XXXXX Checksum
E110-E111	Displays ECM part number	PA110 XXXXXXX TRIONIC Engine Control Module Part Number
E120-E121	Displays ECM program version	PA120 XXXXXX TRIONIC Program Version
E140-E145	Displays engine type	PA140 XXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXX TRIONIC Engine Type
E150-E151	Displays ECM serial number	PA150 XXXXXXX TRIONIC Engine Control Module Serial Nr.
2000	Erases all diagnostic trouble codes	System Reset Are you sure? YES NO PA000 System RESET
2001 -2079	Erases individual diagnostic trouble codes	PA001 PXXXX Trouble Code XXX ERASED
E9FF	Ends communication between ISAT scan tool and the ECM	PA9FF End Communication Communication ENDED
FF00	Clears Engine Stop Mode (after any 30XX code has been used)	PAF00 Engine Stop Mode CLEARED

Command codes, input signals (■ - #10)

Engine running or ignition switched on

Command	Function/component	Text displayed on ISAT scan tool
EE00	Displays engine coolant temperature -40 to 175°C	PAE00 XXX°C Engine Coolant Temperature
EE01	Displays intake air temperature	PAE01 XXX°C Inlet Air Temperature
EE10	Displays intake manifold air pressure	PAE10 XXX kPa Inlet Manifold Pressure
EE20	Displays battery positive voltage	PAE20 XX.X V Battery Voltage
EE21	Displays heated oxygen sensor's signal voltage	PAE21 XXX,XX mV Heated Oxygen Sensor Voltage
EE30	Displays throttle position	PAE30 XXX Degrees Throttle Angle
EE40	Displays current consumption of oxygen sensor's preheating circuit	PAE40 XXXXX mA Front Heated Oxygen Sensor Current
EE41	Displays knock sensing level on scale of 1—255. Rapid variations indicate knocking.	PAE41 XXX Knock Level
EE50	Displays engine speed	PAE50 XXXXX RPM Engine Speed
EE51	Displays vehicle speed	PAE51 XXX km/h Vehicle Speed
EE60	Displays status of torque limitation	PAE60 ACTIVE Torque Request
EE61	Displays position of selector lever (N/D)	PAE61 DRIVE Neut/Drive Position
EE62	Displays brake light switch position	PAE62 ON/OFF Brake Pedal Position
EE63	Displays Cruise Control switch position	PAE63 ON/OFF Cruise Control Position

Command codes, input signals (■ - #10) (contd.)

Engine running or ignition switched on

Command	Function/component	Text displayed on ISAT scan tool
EE64	Displays A/C request status	PAE64 ACTIVE AC-request
EE65	Displays malfunction indicator lamp (CHECK ENGINE) request status	PAE65 ACTIVE Check Engine Request
EE66	Displays ignition switch status	PAE66 ON/OFF Ignition Key
EF00	Displays opening duration of injectors	PAF00 XXX ms Injection Time
EF01	Displays engine load signal (Tq)	PAF01 XXX pSec. TQ Signal
EF10	Displays ignition timing (angle)	PAF10 XXX Degrees Ignition Angle
EF20	Displays opening angle of boost pressure control valve (APC valve)	PAF20 XXX Degrees APC Valve Angle
EF21	Displays opening angle of idle air control (IAC) valve	PAF21 XXX Degrees IAC Valve Angle
EF30	Displays fuel consumption signal	PAF30 XXX µl/pulse Fuel Used
EF40	Displays preheating status of front heated oxygen sensor	PAF40 PREHEATING ON Front Heated Oxygen Sensor
EF42	Displays A/C relay status	PAF42 ON/OFF AC Relay
EF43	Displays status of malfunction indicator lamp (CHECK ENGINE), ON or OFF	PAF43 ON/OFF Check Engine Lamp
EF44	Displays status of SHIFT UP lamp, ON or OFF	PAF44 ON/OFF Shift Up Lamp
EF45	Displays status of pump relay, ON or OFF	PAF45 ON/OFF Pump Relay
EF46	Displays status of main relay, ON or OFF	PAF46 ON/OFF Main Relay

Command codes (activating) (■ - #10)

Engine switched off

Note:
When a 30XX command code is used, the engine control module may in certain cases initiate an "Engine Stop Mode". This mode lasts for 12 minutes, during which time the car cannot be started nor can any other command codes besides 30XX codes be used.
To cancel the Engine Stop Mode, enter command code FF00.
If any other command code is entered, the ISAT scan tool display will read: ENGINE STOP MODE - ENTER FF00 TO CLEAR.

Command	Component/function activated	Text displayed on ISAT scan tool
3000	Injector, cylinder 1 (10 Hz)	PB000 10 Sec Activate Injector Cyl 1, 10Hz
3001	Injector, cylinder 2 (10 Hz)	PB001 10 Sec Activate Injector Cyl 2, 10Hz
3002	Injector, cylinder 3 (10 Hz)	PB002 10 Sec Activate Injector Cyl 3, 10Hz
3003	Injector, cylinder 4 (10 Hz)	PB003 10 Sec Activate Injector Cyl 4, 10Hz
3010	Ignition coil, cylinder 1 (200 Hz)	PB010 10 Sec Activate Ignition Cyl 1, 200 Hz
3011	Ignition coil, cylinder 2 (200 Hz)	PB011 10 Sec Activate Ignition Cyl 2, 200 Hz
3012	Ignition coil, cylinder 3 (200 Hz)	PB012 10 Sec Activate Ignition Cyl 3, 200 Hz
3013	Ignition coil, cylinder 4 (200 Hz)	PB013 10 Sec Activate Ignition Cyl 4, 200 Hz
3020	Boost pressure control valve (APC valve) (90 Hz)	PB020 10 Sec Activate APC Valve 90 Hz
3021	Idle air control (IAC) valve (0.6 A)	PB021 10 Sec Activate IAC Valve 0.6 A

Command codes (activating) (■ - #10) (contd.)

Engine switched off

Command	Component/function activated	Text displayed on ISAT scan tool
3022	Canister purge valve (ELCD) (8 Hz)	PB022 10 Sec Activate Purge Control Valve, 8 Hz
3040	Preheating, heated oxygen sensor (HO2S)	PB040 10 Sec Activate Front HO2S Sensor
3042	A/C relay (1 Hz)	PB042 10 Sec Activate AC Relay 1 Hz
3043	Malfunction indicator lamp (CHECK ENGINE)	PB043 10 Sec Activate Check Engine Lamp, 1 Hz
3044	Shift Up lamp (1 Hz) (manual gearbox)	PB044 10 Sec Activate Shift Up Lamp, 1 Hz
3045	Pump relay (1 Hz)	PB045 10 Sec Activate Pump Relay 1 Hz
3046	Main relay (1 Hz)	PB046 10 Sec Activate Main Relay 1 Hz

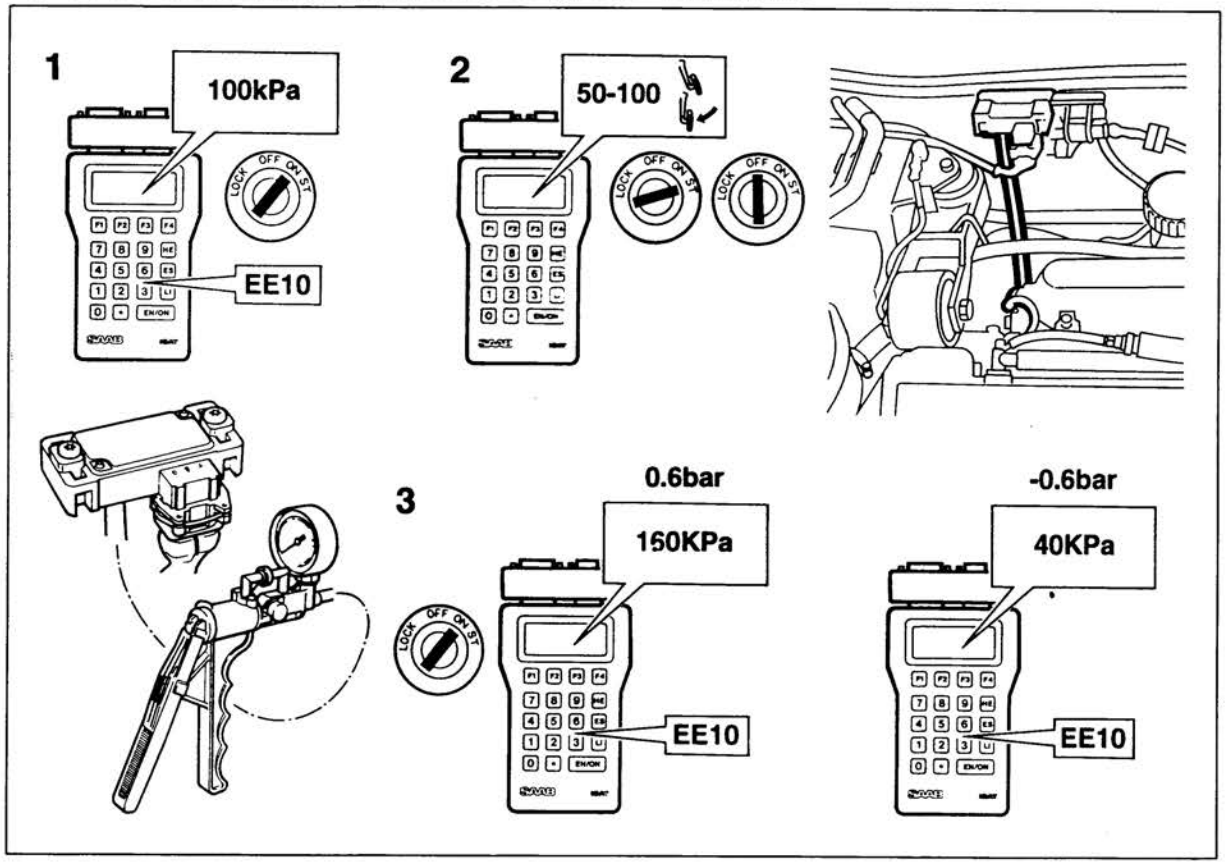
Command codes (activating) (■ - #10)

Engine running

Command	Component/function activated	Text displayed on ISAT scan tool
3120	Boost pressure control valve (APC valve) (90 Hz)	PB120 10 Sec Activate APC Valve 90 Hz
3140	Preheating, heated oxygen sensor	PB140 10 Sec Activate Front HO2 Sensor Preheating
3142	A/C relay (1 Hz)	PB142 10 Sec Activate AC Relay 1 Hz
3143	Malfunction indicator lamp (CHECK ENGINE) (1 Hz)	PB143 10 Sec Activate Check Engine Lamp, 1 Hz
3144	Shift Up lamp (1 Hz) (manual gearbox)	PB144 10 Sec Activate Shift Up Lamp, 1 Hz

Diagnostic trouble codes P0105, P0106, P0107, P0108

Manifold absolute pressure sensor, malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on, performance down (basic charging pressure only)

Diagnostic procedure

1 Check the operation of the manifold absolute pressure (MAP) sensor by entering command code EE10 on the ISAT scan tool.

At atmospheric pressure the correct pressure should be 100 kPa. If it is not, proceed to point 5.

2 If the pressure is correct, start the engine and check whether it changes at different throttle openings.

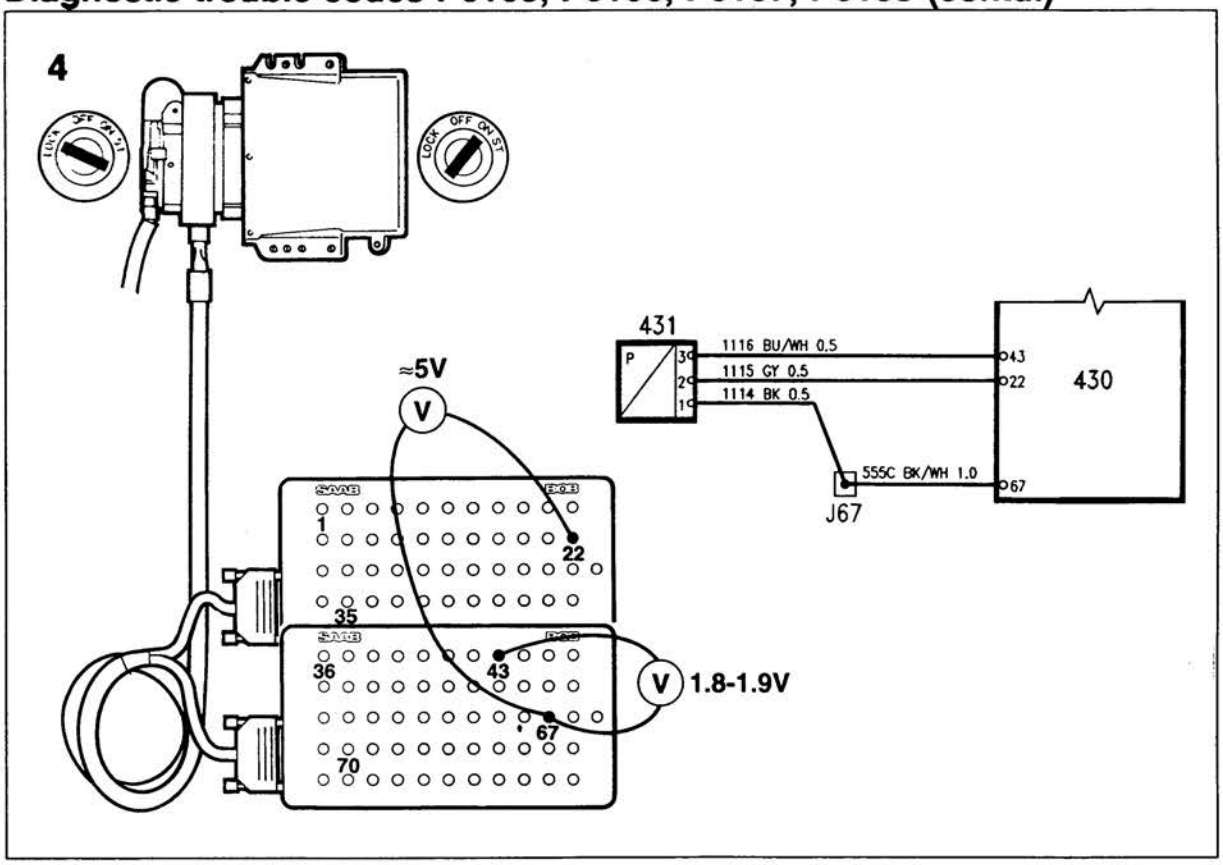
If not, inspect the hose between the MAP sensor and the intake manifold.

3 If the hose is OK, connect pressure measuring equipment 8393514 and a pressure/vacuum pump to the hose. With the ignition switch in the Drive position, pump up a pressure of 0.6 bar. Enter command code EE10 on the ISAT scan tool once again and check the result, which should now be 160 kPa.

Create a negative pressure of -0.6 bar and repeat the checking procedure. The ISAT scan tool should now show 40 kPa.

If the wrong values are obtained, continue as described below.

Diagnostic trouble codes P0105, P0106, P0107, P0108 (contd.)



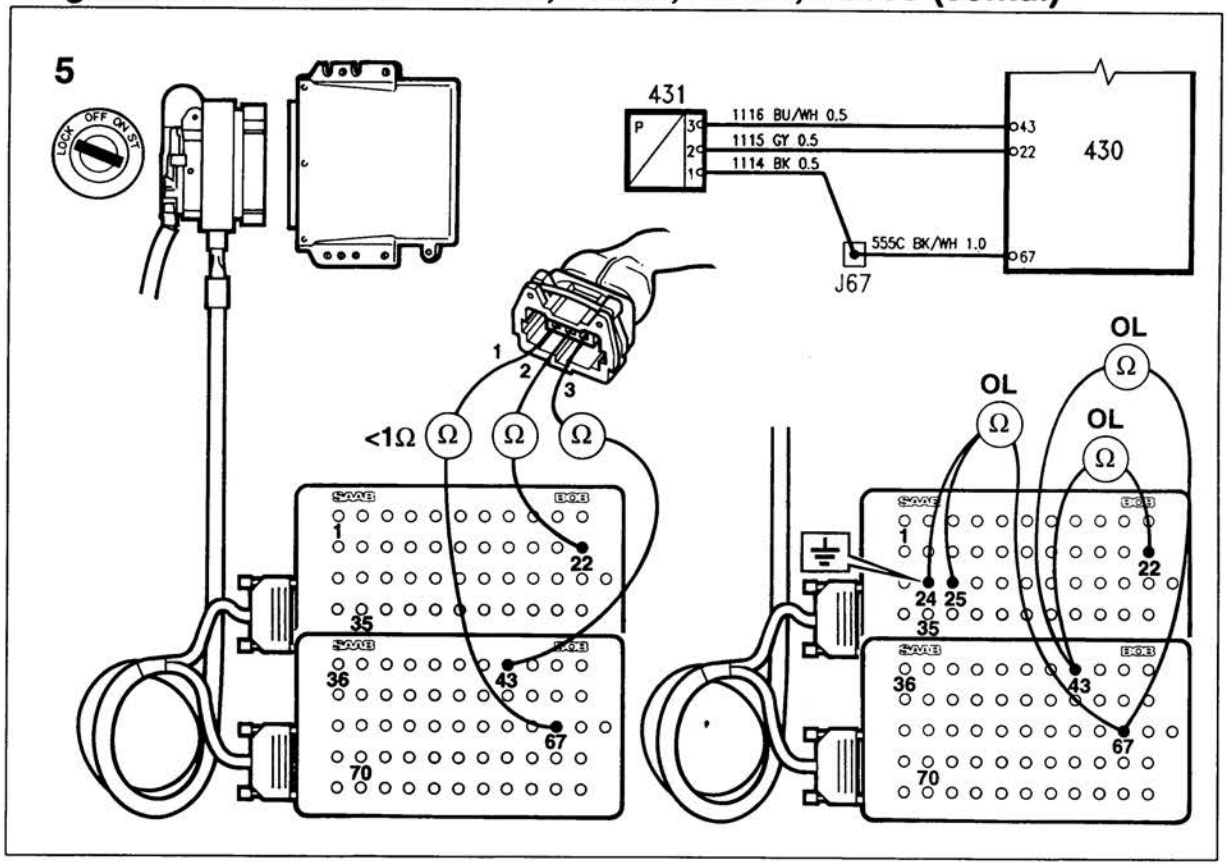
4 Switch off the ignition and connect a BOB.

With the ignition switch in the Drive position, check the signal voltage on pin 22 by taking a measurement across 22 and 67. At atmospheric pressure the voltage should be about 1.8-1.9 V.

Also check that supply voltage is present on pin 43 by measuring across 43 and 67. The supply voltage should be about 5 V.

If the supply voltage is completely wrong or absent, replace the ECM.

Diagnostic trouble codes P0105, P0106, P0107, P0108 (contd.)



5 If the signal voltage is wrong or absent, switch off the ignition and disconnect the ECM from the test cable. Also unplug the connector from the MAP sensor.

Check the leads for continuity by measuring the resistance as follows:

- across pin 43 of the ECM and pin 3 of the MAP sensor connector
- across pin 22 of the ECM and pin 2 of the MAP sensor connector
- across pin 67 of the ECM and pin 1 of the MAP sensor connector

In every case the resistance should be less than 1 ohm.

Check the leads for continuity by measuring the resistance as follows:

- across pins 43 and 22 of the ECM
- across pins 67 and 43 of the ECM
- across pins 67 and 24/25 of the ECM

In every case the resistance should be "OL".

6 If the connectors and wiring are OK, replace the MAP sensor.

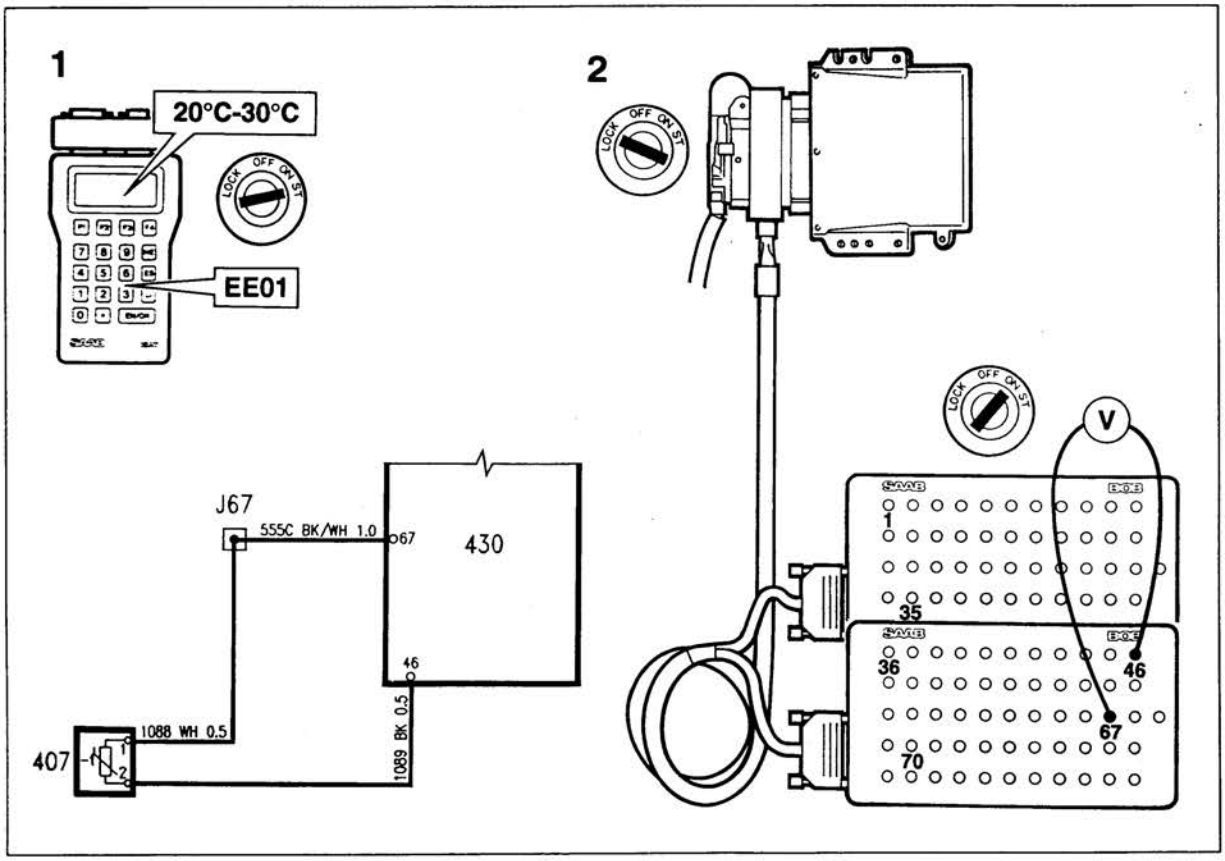
CONDITION

When road testing and checking the car after remedying a fault, vary the engine rpm for at least two minutes.

7 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, see page 149.

Diagnostic trouble codes P0110, P0112, P0113

Intake air temperature sensor, malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on, deterioration in adjustment of idling speed to compensate for load changes (e.g. engagement of A/C)

Diagnostic procedure

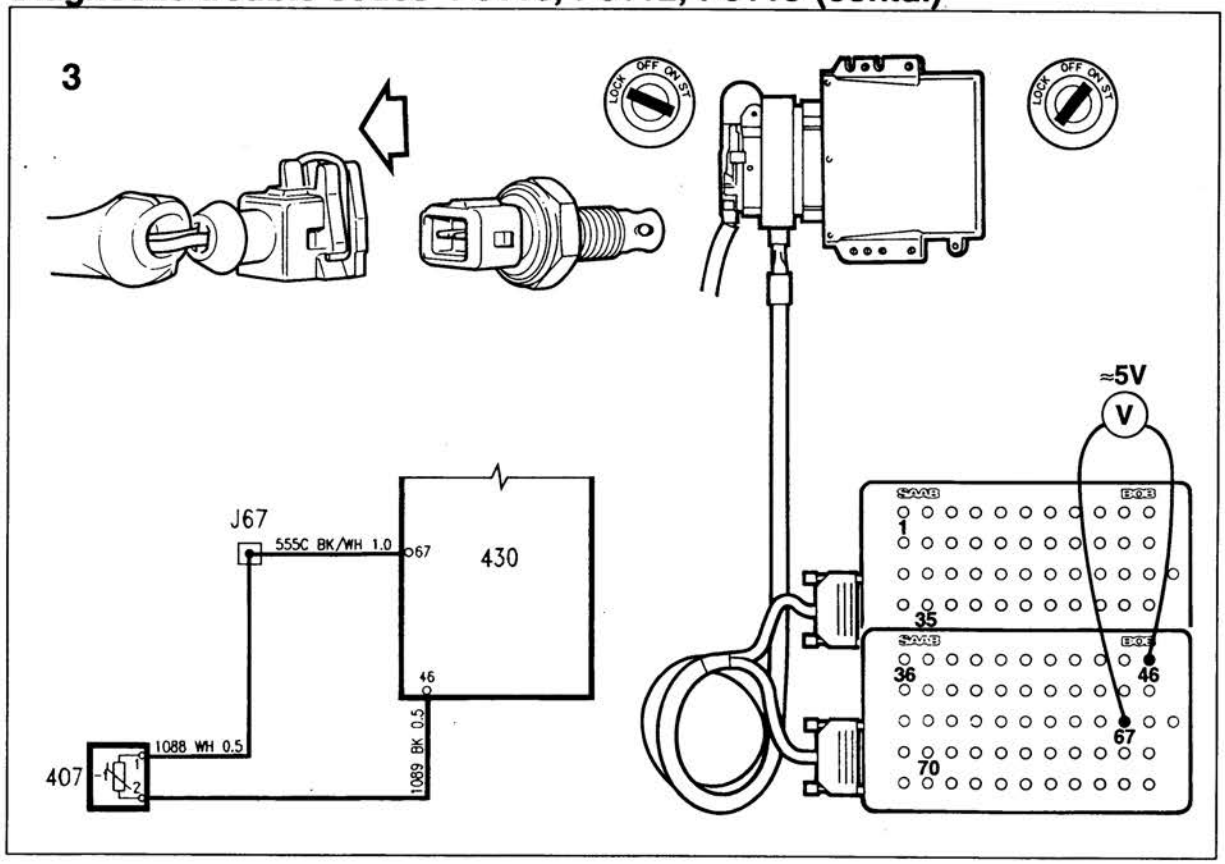
1 Check the operation of the intake air temperature (IAT) sensor by entering command code EE01 on the ISAT scan tool. Start the engine and read the temperature when it is idling. If the ambient temperature is +20°C, for instance, the ISAT scan tool should show a temperature of between +20° and +30°C.

If it does not, continue with the next point.

2 With the ignition switched off, connect a BOB to the ECM.

Turn the ignition switch to the Drive position and measure the signal voltage from the IAT sensor across pins 46 and 67. Depending on the temperature, the voltage should be as shown in the table on the next page.

Diagnostic trouble codes P0110, P0112, P0113 (contd.)



If the voltage is not in accordance with the table, continue as described below. If it is, continue with point 4.

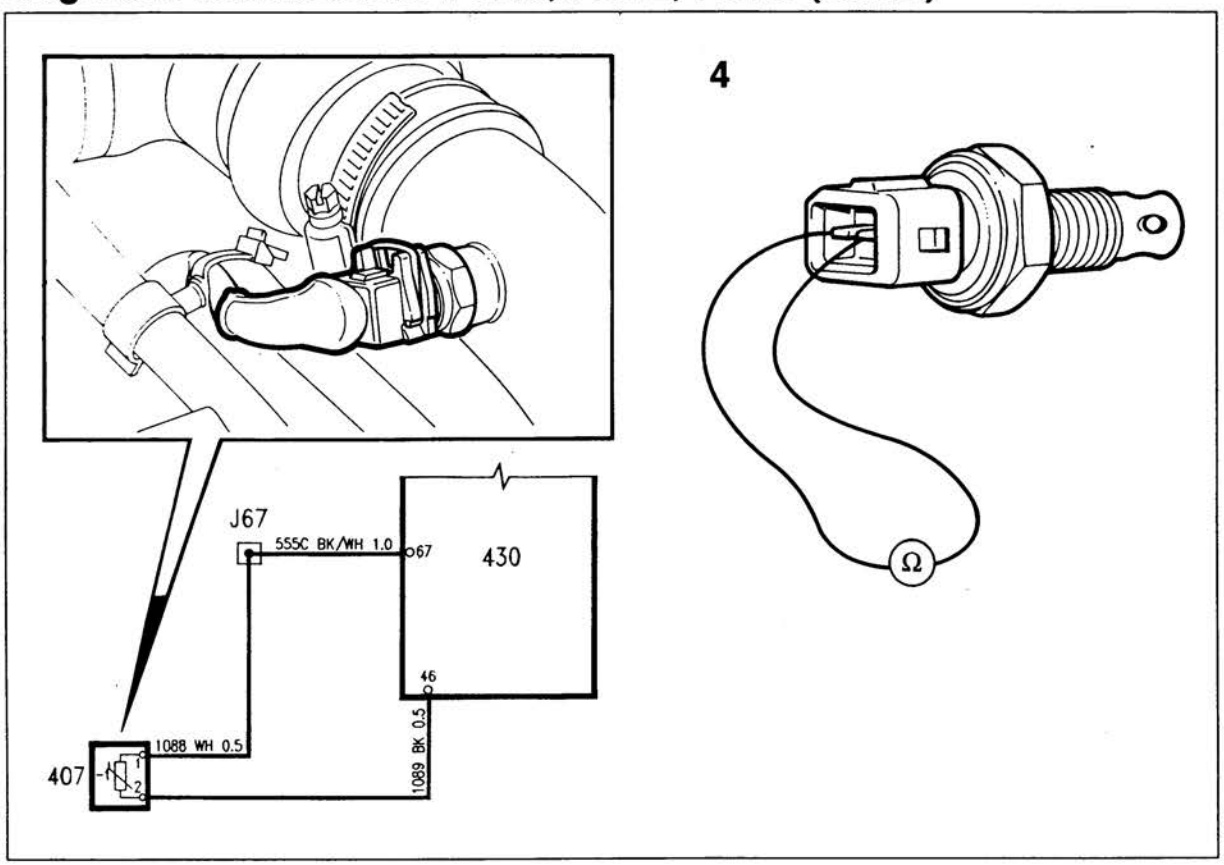
3 Unplug the connector from the IAT sensor. With the ignition switch still in the Drive position, check the voltage once again across pins 46 and 67.

The correct voltage is about 5 V.

If the voltage measured differs from this figure, see page 149.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

Diagnostic trouble codes P0110, P0112, P0113 (contd.)



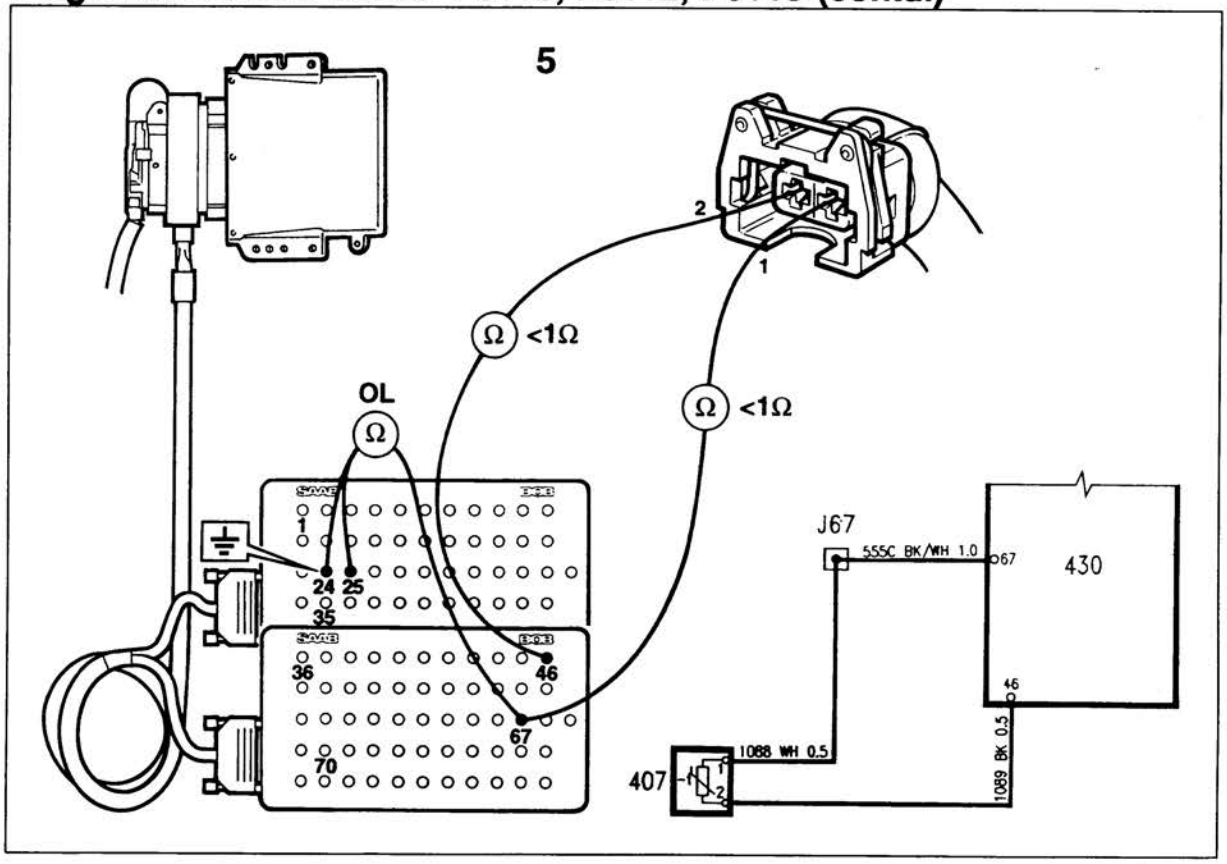
4 Check the resistance of the IAT sensor by taking a measurement across the connecting pins of the sensor.

The resistance should be as shown in the table.

If the resistance is not as shown in the table, fit a new intake air temperature sensor.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0,7	0.30-0.36

Diagnostic trouble codes P0110, P0112, P0113 (contd.)



5 Check the continuity of the leads from pins 46 and 67 of the ECM to pins 2 and 1 of the IAT sensor's connector.

Also check that the power ground and signal ground are well separated (resistance OL)

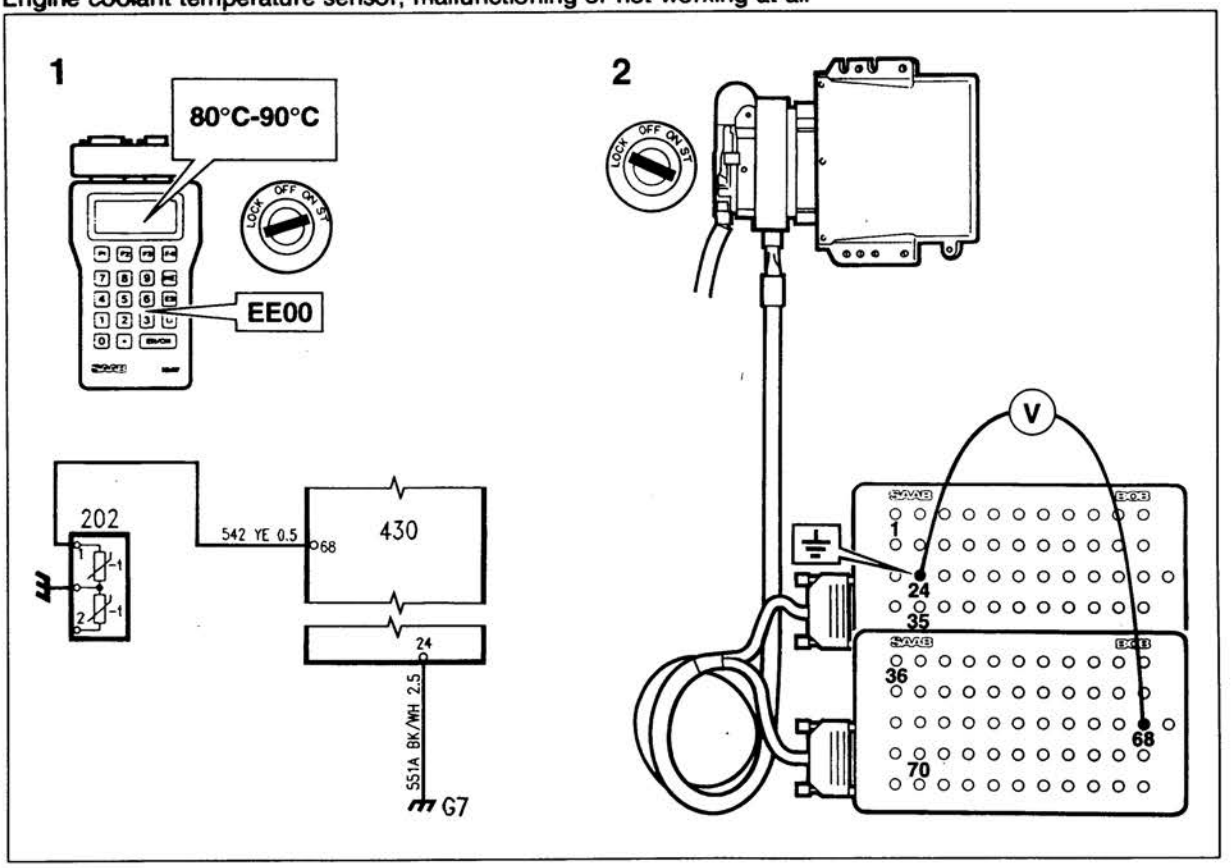
CONDITION

A DTC will be generated if the signal voltage is lower than 0.06 V or higher than 4.96 V for longer than five seconds.

6 Erase any DTCs and drive the car to see whether the fault code is generated afresh. If it is, see page 149.

Diagnostic trouble codes P0115, P0117, P0118

Engine coolant temperature sensor, malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on, poor drivability

Diagnostic procedure

1 Check the operation of the engine coolant temperature (ECT) sensor by entering command code EE00 on the ISAT scan tool.

If it is working correctly, the ISAT scan tool should show a temperature of about 80-95°C when the engine is warmed-up.

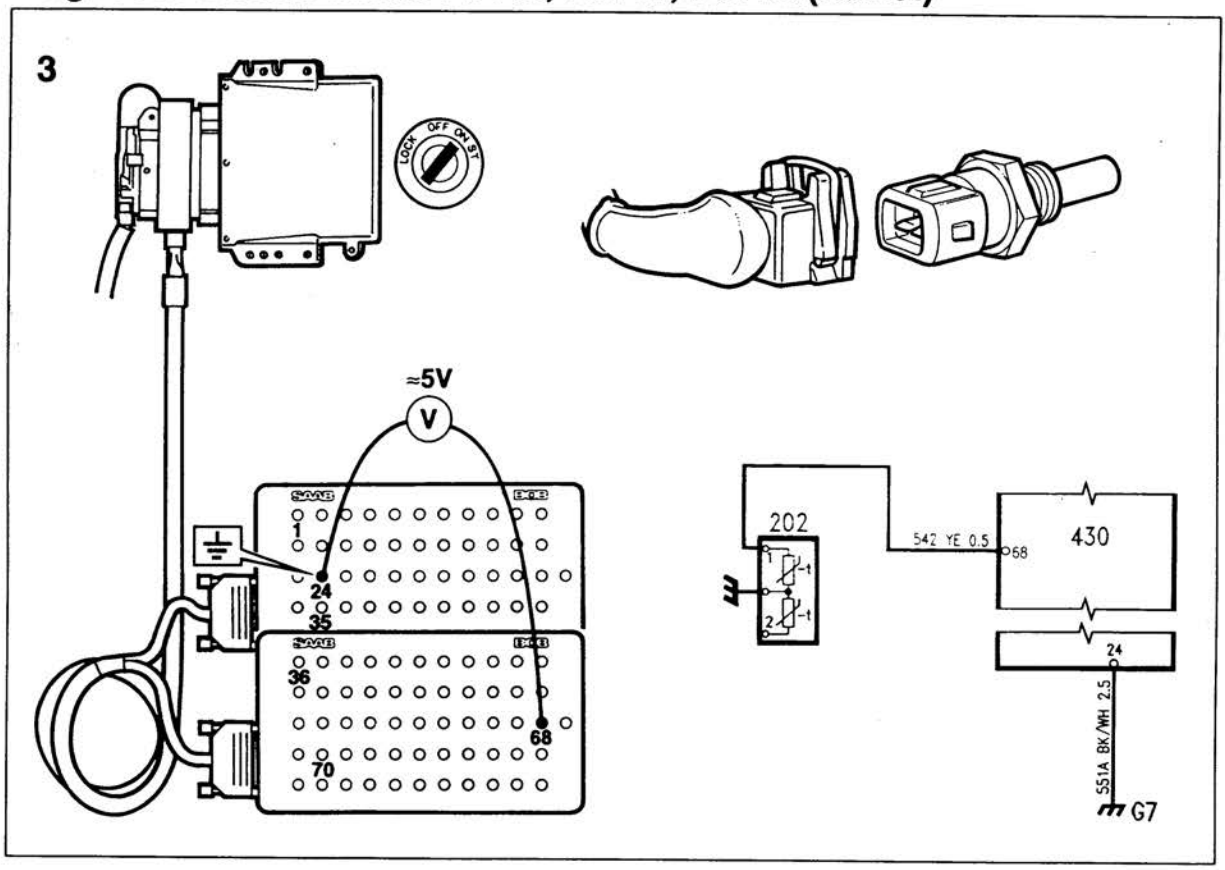
2 With the ignition switched off, connect a BOB to the ECM.

Check the signal voltage from the ECT sensor by taking a measurement across pins 68 and 24.

Depending on engine temperature, the voltage should be as shown in the table.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

Diagnostic trouble codes P0115, P0117, P0118 (contd.)



If the voltage is correct, continue with point 4. If it is not, continue as described below.

Note:

On cars equipped with TCS the engine coolant temperature sensor has two circuits, one for ETS and one for SFI. When diagnosing faults it is therefore important to remember that pin 1 corresponds to SFI and pin 2 to ETS.

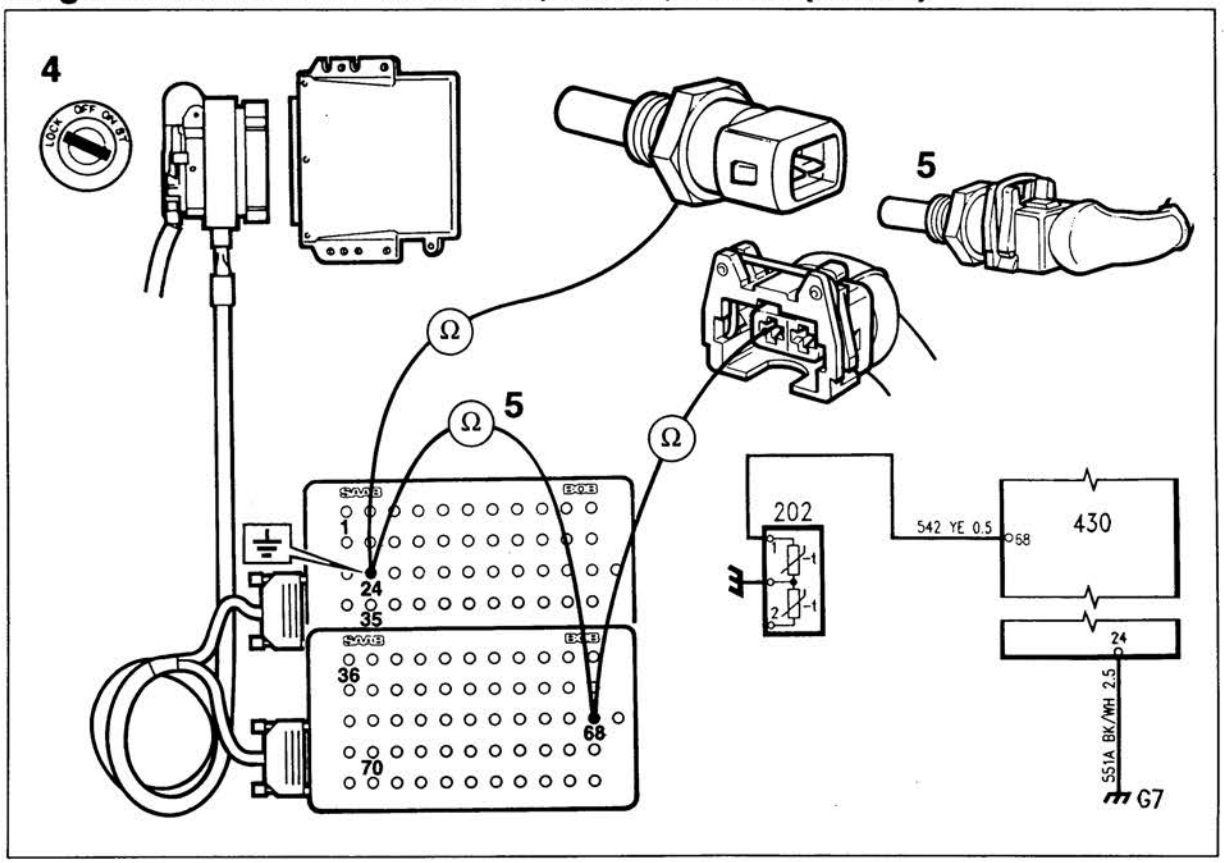
3 With the ECT sensor's connector unplugged and with the ignition switch in the Drive position, check the voltage across pins 68 and 24 once again.

It should be about 5 V. If it is not, turn to page 149.

4 With the ignition switched off and the ECM unplugged, check the continuity of the lead between pin 68 of the ECM and pin 1 of the sensor's connector. Also check that the sensor body is in good connection with signal ground (24/25).

Remedy any faults in the wiring or continue with the next point.

Diagnostic trouble codes P0115, P0117, P0118 (contd.)



5 Plug in the ECT sensor's connector and check the resistance of the sensor by measuring across sockets 68 and 24 on the BOB.

The correct resistance should be as shown in the table.

If the resistance is not correct, replace the ECT sensor.

C°	F°	Voltage (V)	Resistance (kohm)
-30	-22	approx. 4.5	20-30
-10	14	approx. 3.9	8.3-10.6
20	68	approx. 3.2	2.3-2.7
40	104	approx. 1.5	1.0-1.3
60	140	approx. 0.9	0.56-0.67
80	176	approx. 0.7	0.30-0.36

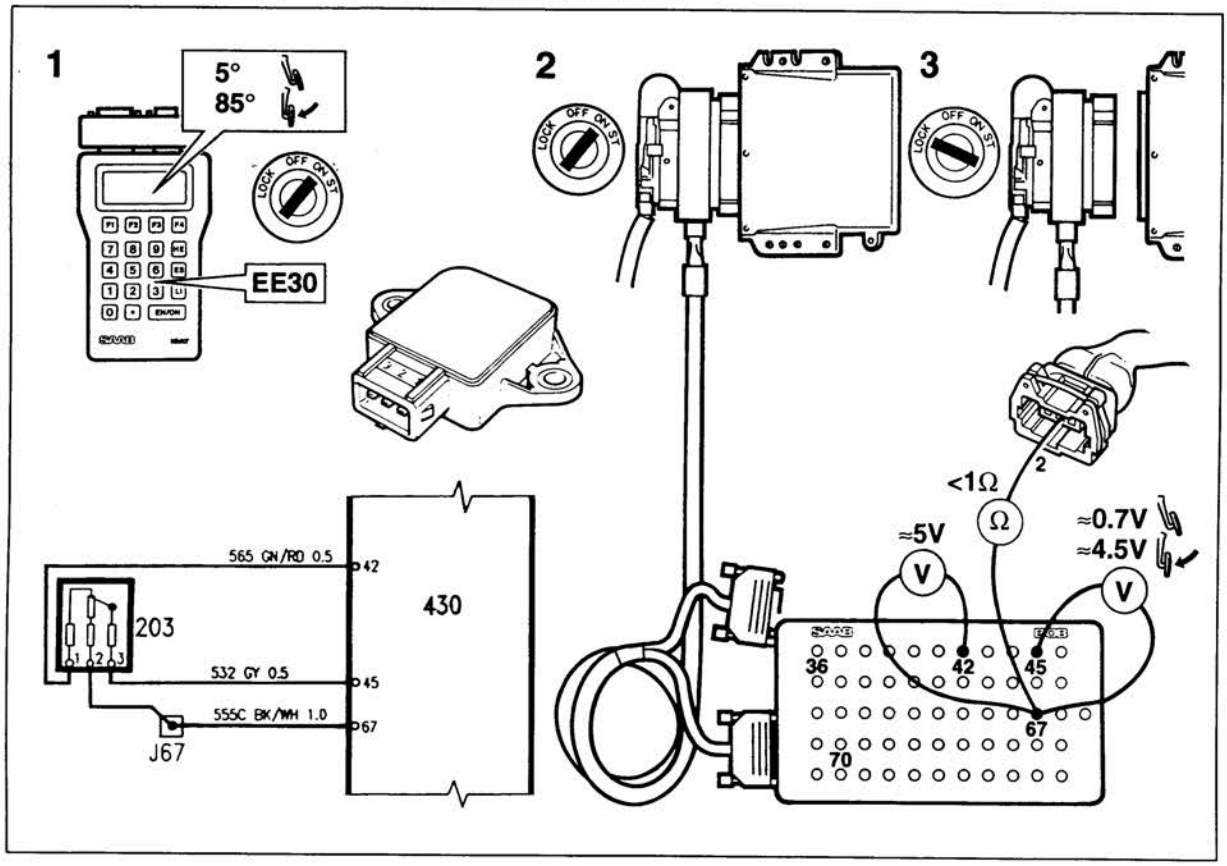
CONDITION

A DTC will be generated if the signal voltage is lower than 0.06 V or higher than 4.70 V for at least five seconds.

6 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble codes P0120, P0121, P0122, P0123

Throttle position sensor, malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on, unsteady idling

Diagnostic procedure

1 Check the operation of the throttle position (TP) sensor by entering command code EE30 on the ISAT scan tool.

With the ignition switch in the Drive position, check that the correct throttle angle is displayed: about 5° when idling and gradually increasing as the throttle is opened to about 85° at wide open throttle.

2 Switch off the ignition and connect a BOB to the ECM.

Check the signal voltage from the TP sensor by taking a measurement across pins 45 and 67. The correct voltage is about 0.7 V in the idling position and about 4.5 V in the wide open throttle position. If the voltage is not correct, continue with point 4.

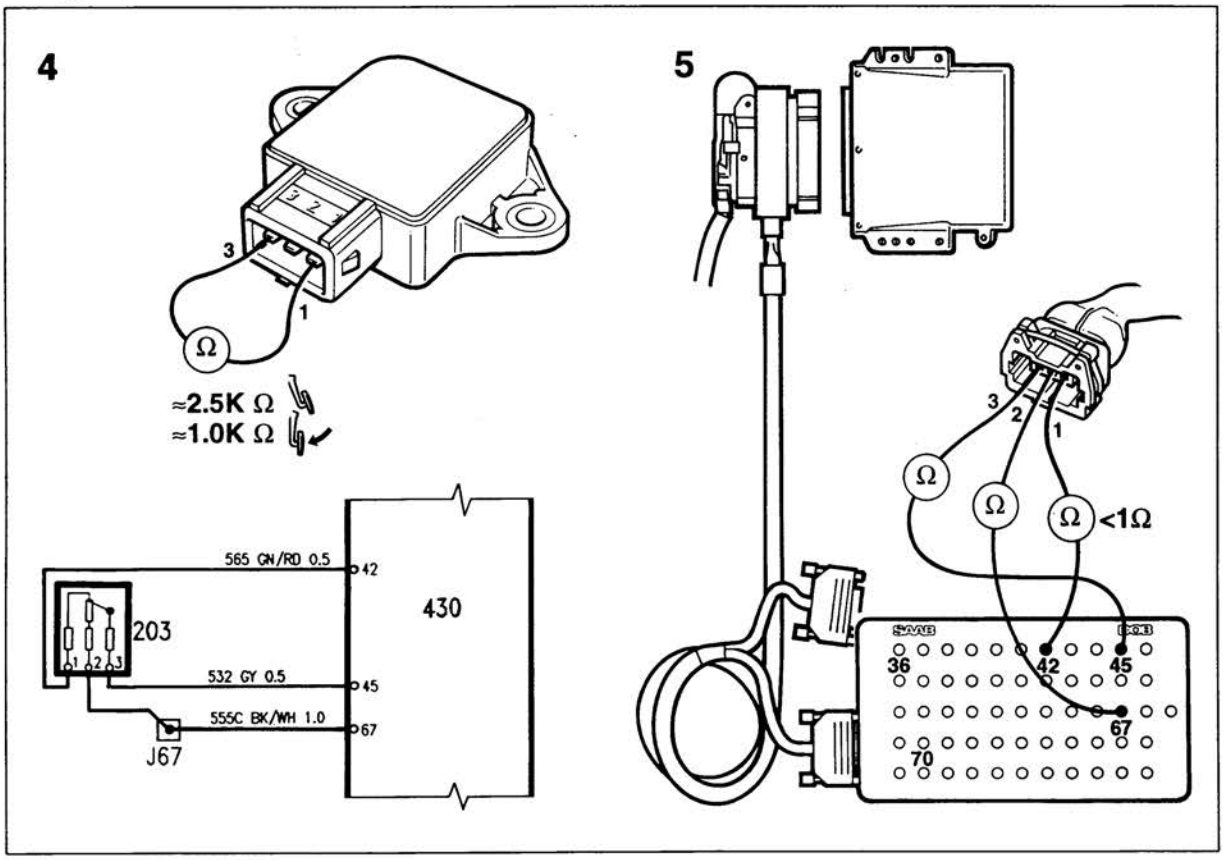
Also check the supply voltage to the sensor by taking a measurement across pins 42 and 67. The correct voltage here is about 5 V. If the voltage is not correct, continue with the next point.

3 Switch off the ignition and disconnect the ECM. Also unplug the connector from the TP sensor. Check that there is a signal ground connection between the sensor and the ECM by measuring the resistance across socket 67 on the BOB and pin 2 of the TP sensor connector. The resistance should be less than 1 ohm.

If the resistance is not correct, remedy leads and/or connectors.

If the wiring is OK, continue to page 149.

Diagnostic trouble codes P0120, P0121, P0122, P0123 (contd.)



4 Check the resistance by taking a measurement straight across pins 1 and 3 of the TP sensor. The resistance should decrease gradually, without jumps or interruptions, from about 2.5 kohm in the idling position to about 1.0 kohm in the wide open throttle position.

If the resistance is not correct, replace the TP sensor.

If the TP sensor is OK, continue with the next point.

5 Check the wiring for continuity between the ECM and the TP sensor. Remedy any faults in the wiring.

If the wiring is OK, continue as described below.

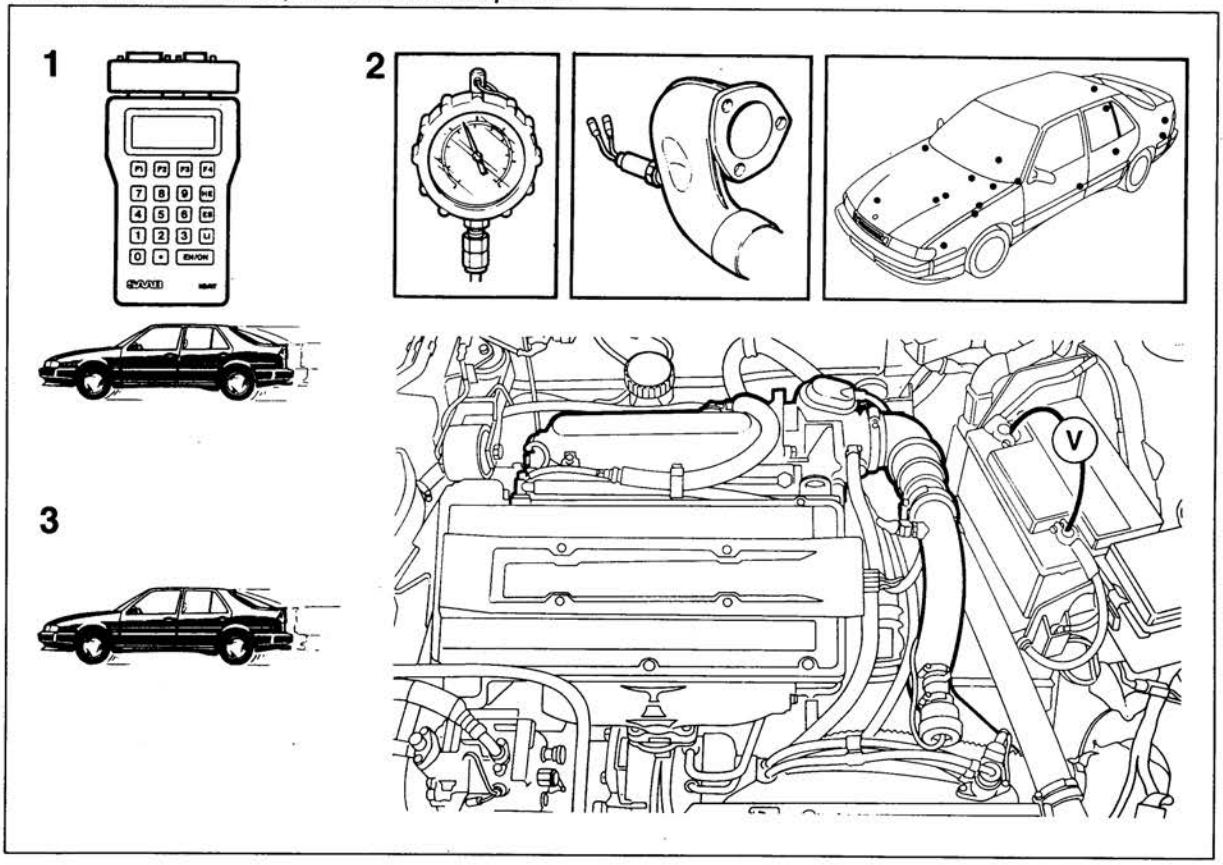
CONDITION

For a DTC to be generated, the throttle signal must be less than 0.20 V or more than 4.96 V for at least five seconds.

6 Erase any DTCs and drive the car to see whether any DTC is generated afresh. If this is the case, turn to page 149 for further diagnostic instructions.

Diagnostic trouble codes P0170, P0171, P0172

Incorrect fuel-air mixture, incorrect fuel adaptation



Fault symptom

MIL (CHECK ENGINE lamp) on, unsteady idling, high fuel consumption, poor drivability.

Diagnostic procedure

If any other DTCs are stored in the ISAT scan tool, they should be dealt with first.

1 Erase any DTCs and drive the car to see whether any DTC is generated afresh. If this is the case, continue as described below.

Note:

During the car's running-in period (up to 500 km), any of the above DTCs may be generated even though no actual fault exists.
In such case, carry out an extra careful check if the DTC is generated afresh after being erased.

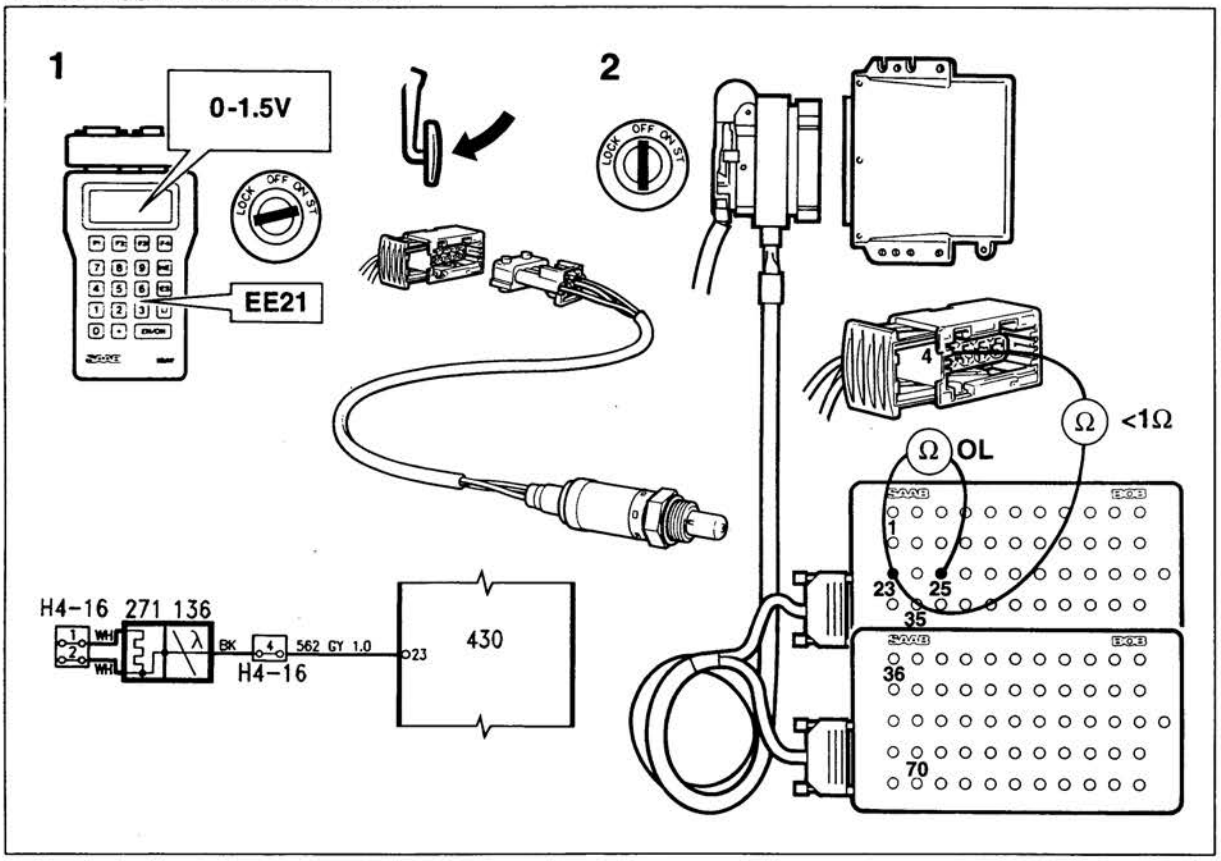
2 Check the following points:

- that the correct types of component are fitted in the fuel system
- that there is no leakage of air in the intake system
- that the fuel pressure is correct
- that battery positive voltage is correct
- that there are no leaks in the exhaust system in front of the heated oxygen sensor
- that the ground points in the system are OK

3 If no faults can be found when carrying out the above checks, erase any DTCs and drive the car to check whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P0130

Heated oxygen sensor, malfunction



Fault symptom

MIL (CHECK ENGINE lamp) on

Diagnostic procedure

1 Connect an ISAT scan tool, start the engine and run it until it reaches normal operating temperature.

Enter command code EE21 on the ISAT scan tool and read off the voltage of the heated oxygen sensor (HO2S) signal, which may vary between 0 and about 1.5 V. Rev up the engine and check whether the voltage changes.

If it does not, continue with the next point.

2 Switch off the ignition and connect a BOB to the ECM.

Unplug the cable from the HO2S.

Check the wiring between pin 23 of the ECM and pin 4 of the HO2S connector for continuity. Remedy any faults in connectors or wiring.

If the connectors and wiring are OK, replace the heated oxygen sensor.

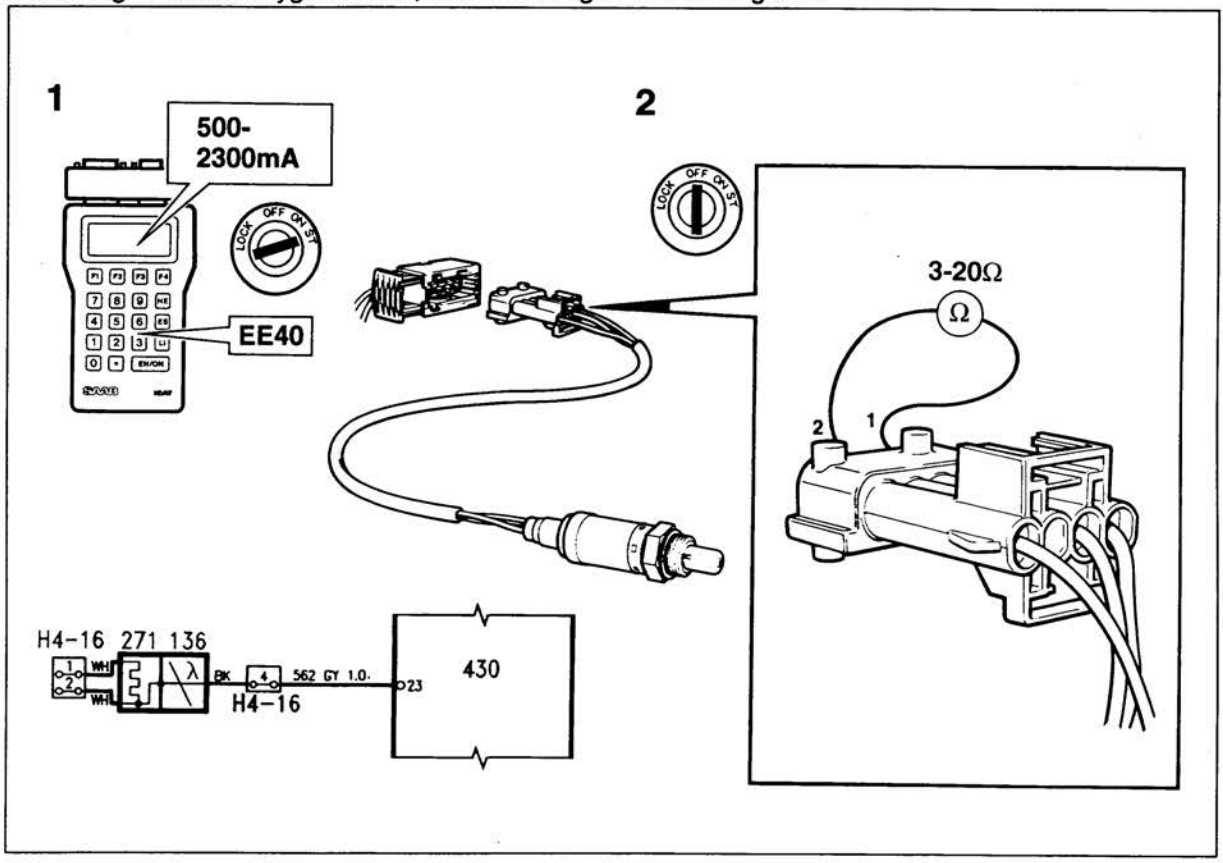
CONDITION

For DTCs to be generated, the engine must be warmed up and the oxygen sensor signal must be above 1.5 V or at remain at 0 V for at least 20 seconds.

3 Erase any DTCs and drive the car to check whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble codes P0135, P1130, P1135

Preheating of heated oxygen sensor, malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on

Diagnostic procedure

1 Connect an ISAT scan tool. Start the engine and run it at idling speed.

Enter command code EE40 and check the pre-heating current consumption. The current may vary between about 500 and 2300 mA.

If the current consumption is OK, continue with point 4. If it is not OK, continue with the next point.

2 Switch off the engine. Unplug the connector (H4-16) in the wiring between the sensor and the car's wiring harness and check the resistance across pins 1 and 2 of the sensor's connector.

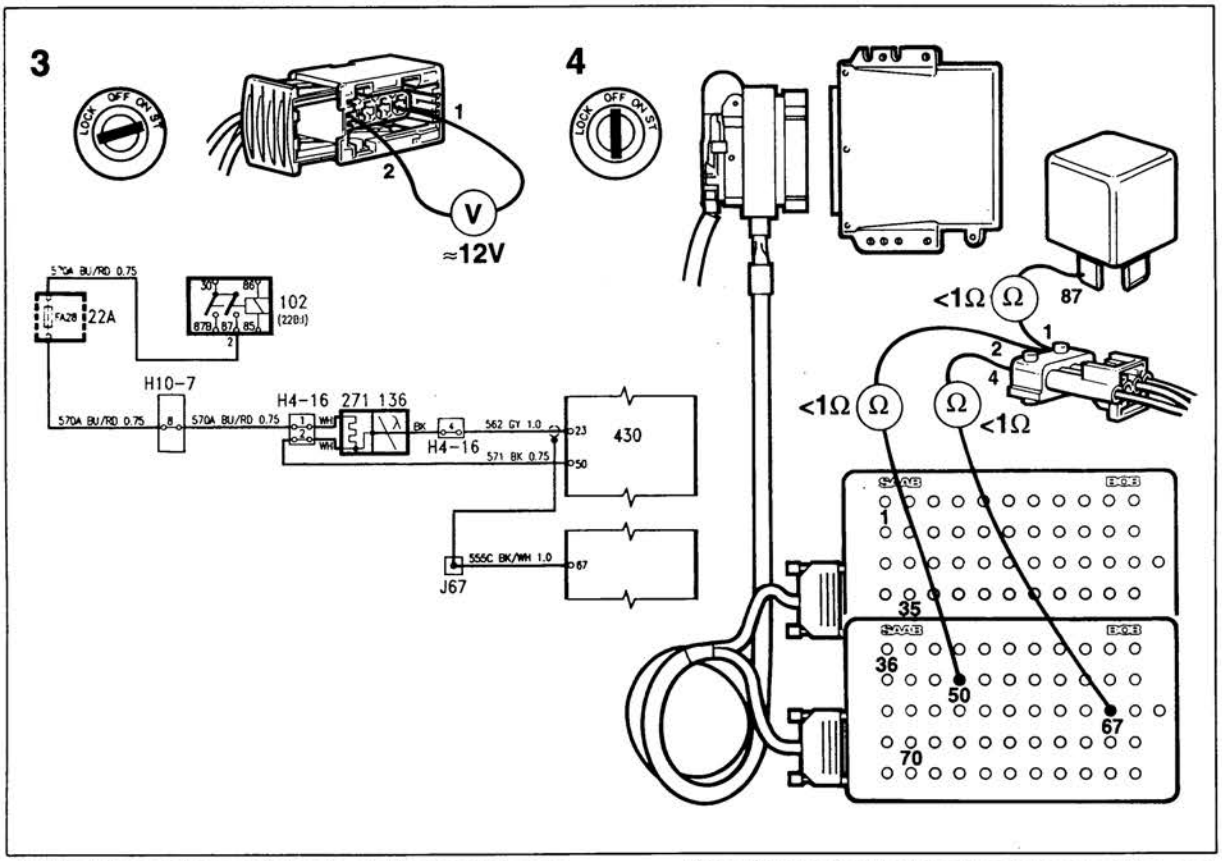
The correct resistance is 3-20 ohms.

If the resistance is not correct, replace the heated oxygen sensor.

If the resistance is OK, continue with the next point.

Diagnostic trouble codes P0135, P1130, P1135 (contd.)

Preheating of front heated oxygen sensor, malfunctioning or not working at all



3 Start the engine and check whether battery positive voltage is present across pins 1 and 2 of connector H4-16 on the supply side.

If battery positive voltage is present, turn to page 149 for further diagnostic instructions.

If there is no voltage, check whether battery positive voltage is present on pin 87B of the pump relay, see points 4 and 5 on page 123.

If battery positive voltage is present on pin 87B of the pump relay, continue by checking the wiring as described below.

4 Switch off the engine and connect a BOB to the ECM wiring harness. The ECM should be disconnected.

Check the wiring for continuity from the sensor connector and ground screening to pins 50 and 67 of the ECM and also between pin 87B of the pump relay and the connector of the sensor.

Remedy any faults in connectors or wiring and continue as described below.

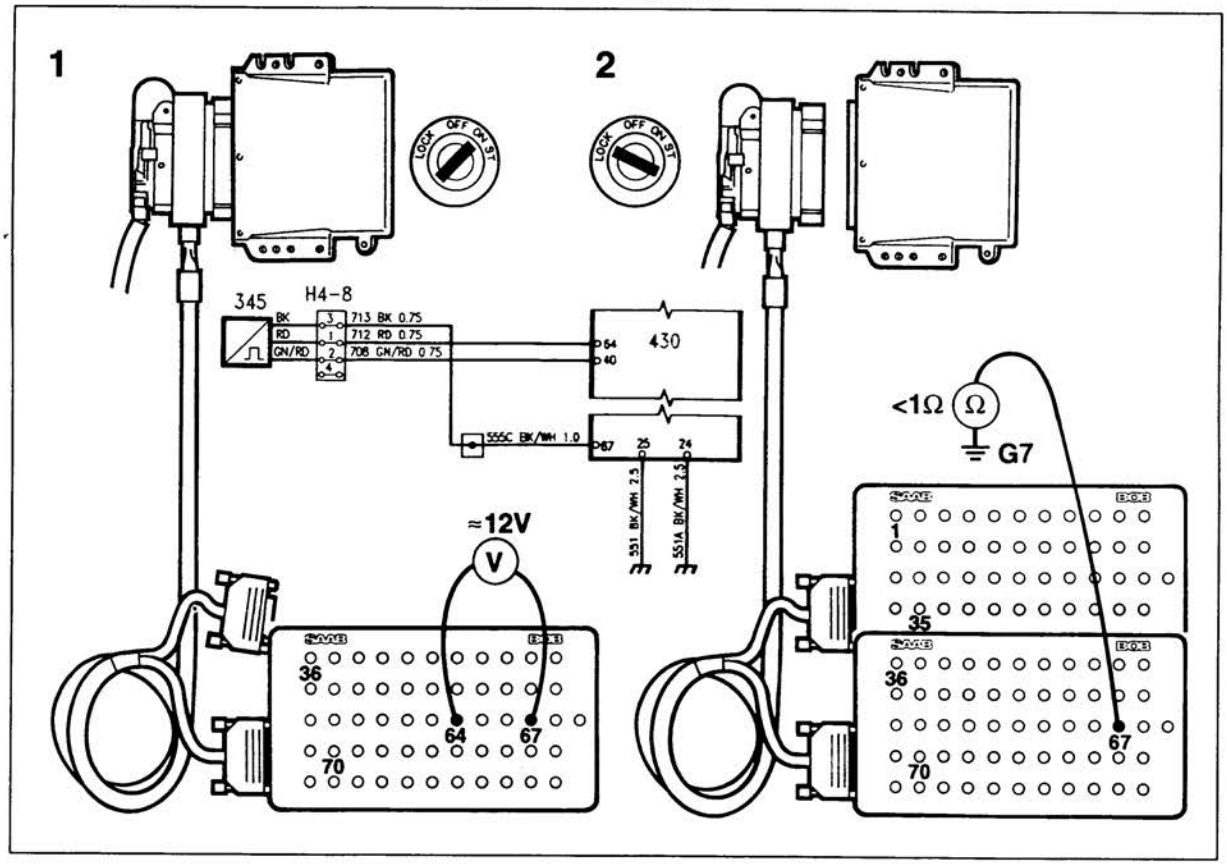
CONDITION

With the engine running, preheating should be activated for longer than 60 seconds or current consumption should be lower than 500 mA or higher than 2300 mA for longer than 60 seconds.

5 Erase any DTCs and drive the car to see whether a DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P0335

Crankshaft position sensor, malfunctioning or not working at all



Fault symptom

Engine fails to start/will not run/misfires

Diagnostic procedure

1 Connect a BOB to the ECM. Turn the ignition switch to the Drive position and check whether battery positive voltage is present across pins 64 and 67 of the ECM.

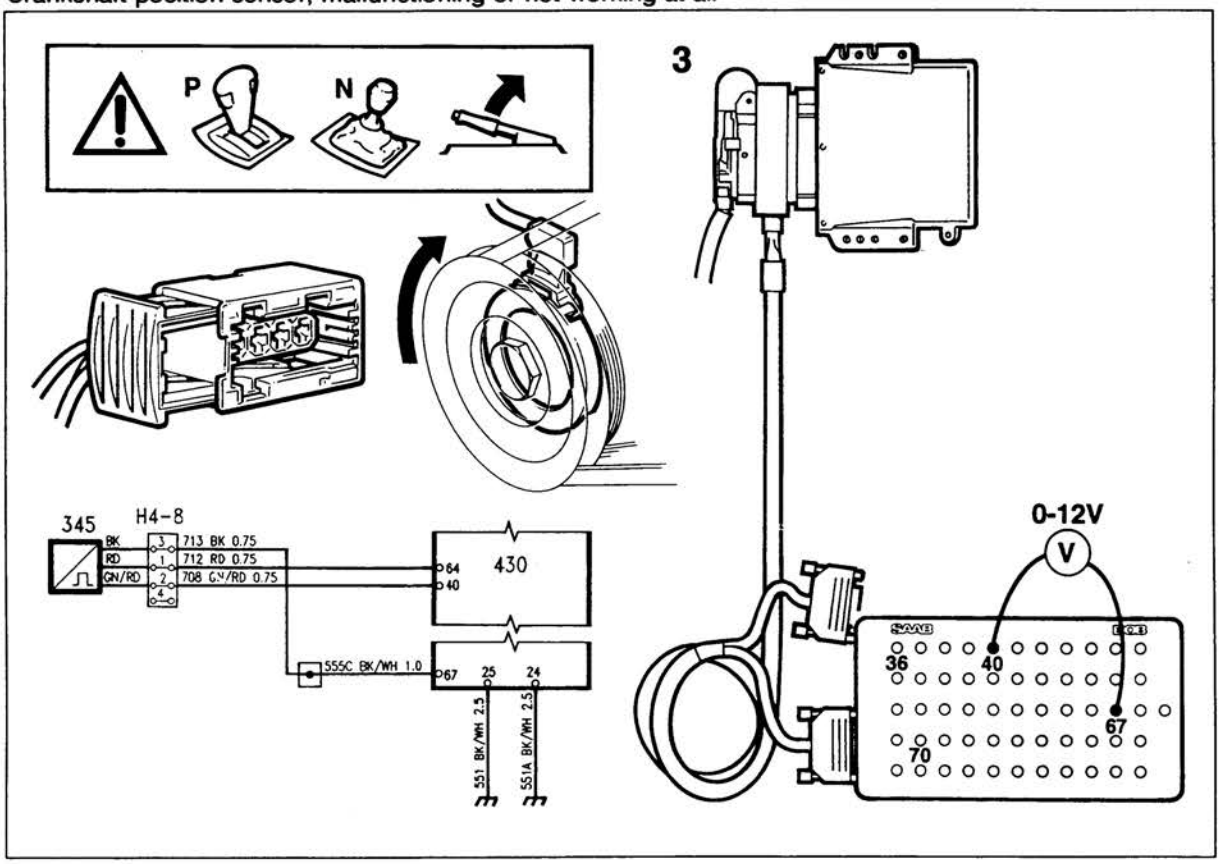
If the voltage is OK, continue with point 3. If not, go to point 2.

2 Switch off the ignition and disconnect the ECM. Check that the correct ground is present on pin 67 by measuring the resistance to grounding point G7 on the intake manifold. The resistance should be less than 1 ohm. If it is not, check and remedy the wiring or connectors.

If the wiring is OK, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P0335 (contd.)

Crankshaft position sensor, malfunctioning or not working at all



WARNING

When rotating the crankshaft, the selector lever must be in the P position (or the gear lever in neutral) and the handbrake must be applied hard.

3 Check the voltage across pins 40 and 67 of the ECM while rotating the crankshaft by means of tool 83 94 561. The voltage should alternate between 0 V and battery positive voltage.

If it does not, check the wiring between the ECM and the crankshaft position sensor for continuity.

Remedy any faults in the wiring or connectors.

If the wiring is OK, replace the crankshaft position sensor.

If no fault can be found after carrying out the above checks, turn to page 149 for further diagnostic instructions.

CONDITION

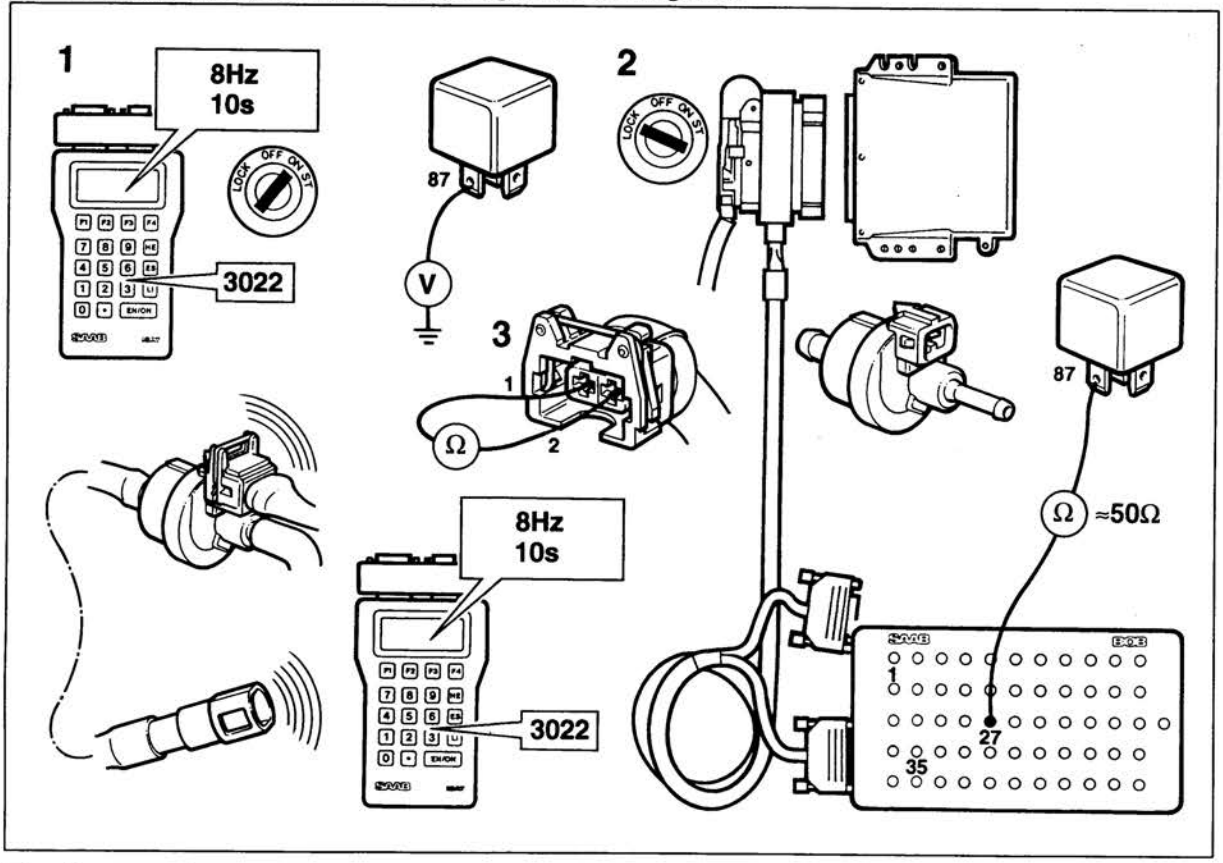
For the above DTC to be generated, the engine must be running.

Note:

If the fault persists, it may in such case prove impossible to drive the car.

Diagnostic trouble codes P0443, P1443, P1444, P1445

Canister purge valve (ELCD), malfunctioning or not working at all



Fault symptom

MIL (CHECK ENGINE lamp) on.

Diagnostic procedure

1 Connect an ISAT scan tool, contact the system and enter command code 3022. The canister purge valve should now be activated with 8 Hz for 10 seconds. Listen for the sound of the valve working. If it is, continue as necessary with physical inspection of the valve as described below.

Disconnect the valve's hose connection to the intake manifold. Listen for the sound of the valve opening and closing (pulsing).

If nothing can be heard, proceed to point 2.

2 Check whether voltage is present on terminal 87 of the main relay. See "Checking the main relay" on page 24.

3 Disconnect the wiring from the valve and check whether the 8 Hz signal (approx. 6.5 V) is present across pins 1 and 2 of the connector when command code 3022 is entered.

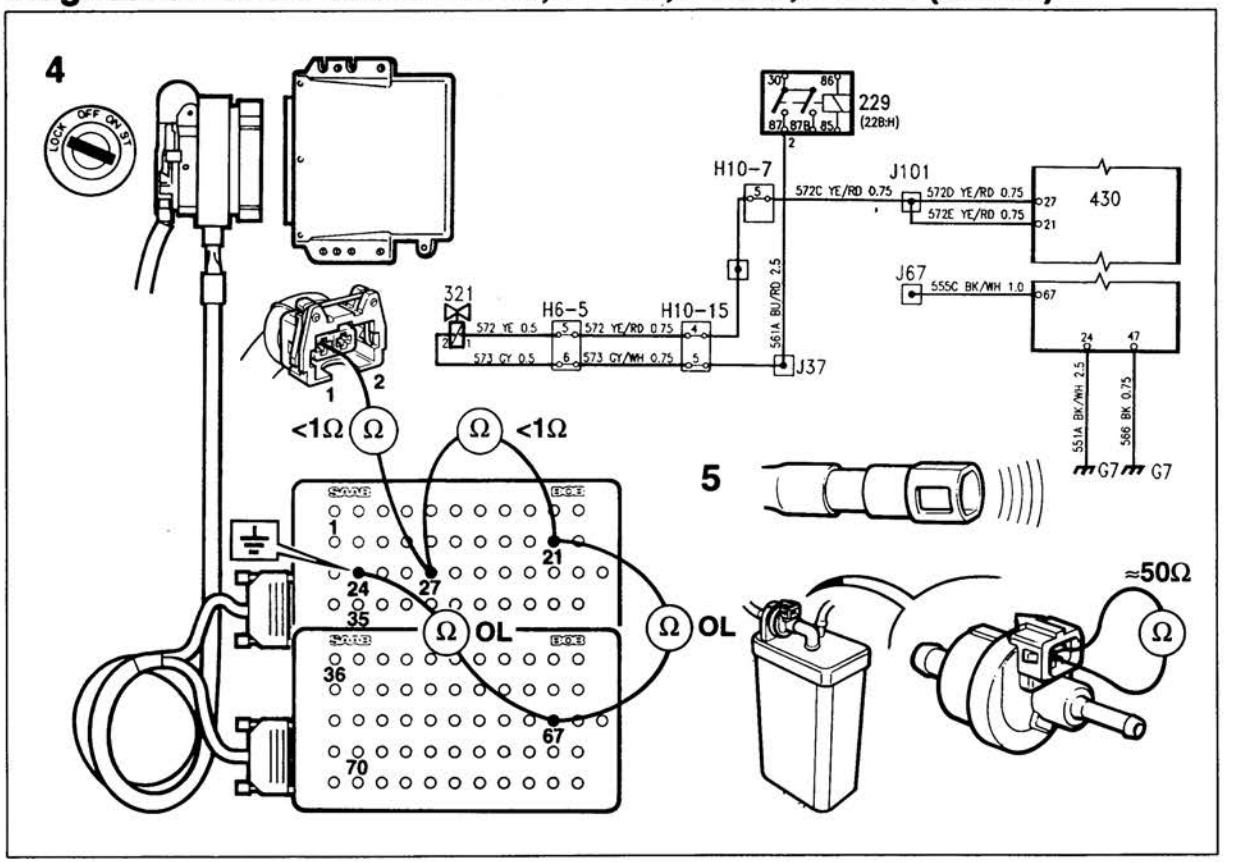
If there is no signal, continue with point 4. If the signal is present, check the resistance of the valve coil (including wiring) as described below.

With the wiring connected to the valve, the ignition switched off and a BOB connected to the ECM wiring harness (ECM disconnected), check the resistance of the circuit between pin 27 of the ECM and pin 87 of the main relay. The resistance should be about 50 ohms.

If the resistance is correct, turn to page 149 for further diagnostic instructions.

If the resistance is not correct, go to point 5.

Diagnostic trouble codes P0443, P1443, P1444, P1445 (contd.)



4 Check the wiring to the canister purge valve for continuity/shorting to ground by measuring the resistance across:

- Pin 27 of the ECM and pin 1 of the valve's connector. The resistance should be less than 1 ohm.
- Pins 27 and 21 of the ECM. The resistance should be less than 1 ohm.
- Pins 21 and 67 of the ECM. The resistance should be OL.
- Pins 67 and 24 of the ECM. The resistance should be OL (signal ground and power ground should be electrically separate).

If the resistances measured are incorrect, first check connectors H10-7, H10-15 and H6-5. If these are OK, the fault is in the wiring.

If the wiring and connectors are OK, check the valve as described below.

5 Remove the right-hand fender (wing) liner. Unplug the valve's connector and check the resistance of the valve by measuring directly across the valve pins. The correct resistance is about 50 ohms.

If the resistance is not about 50 ohms, replace the canister purge valve.

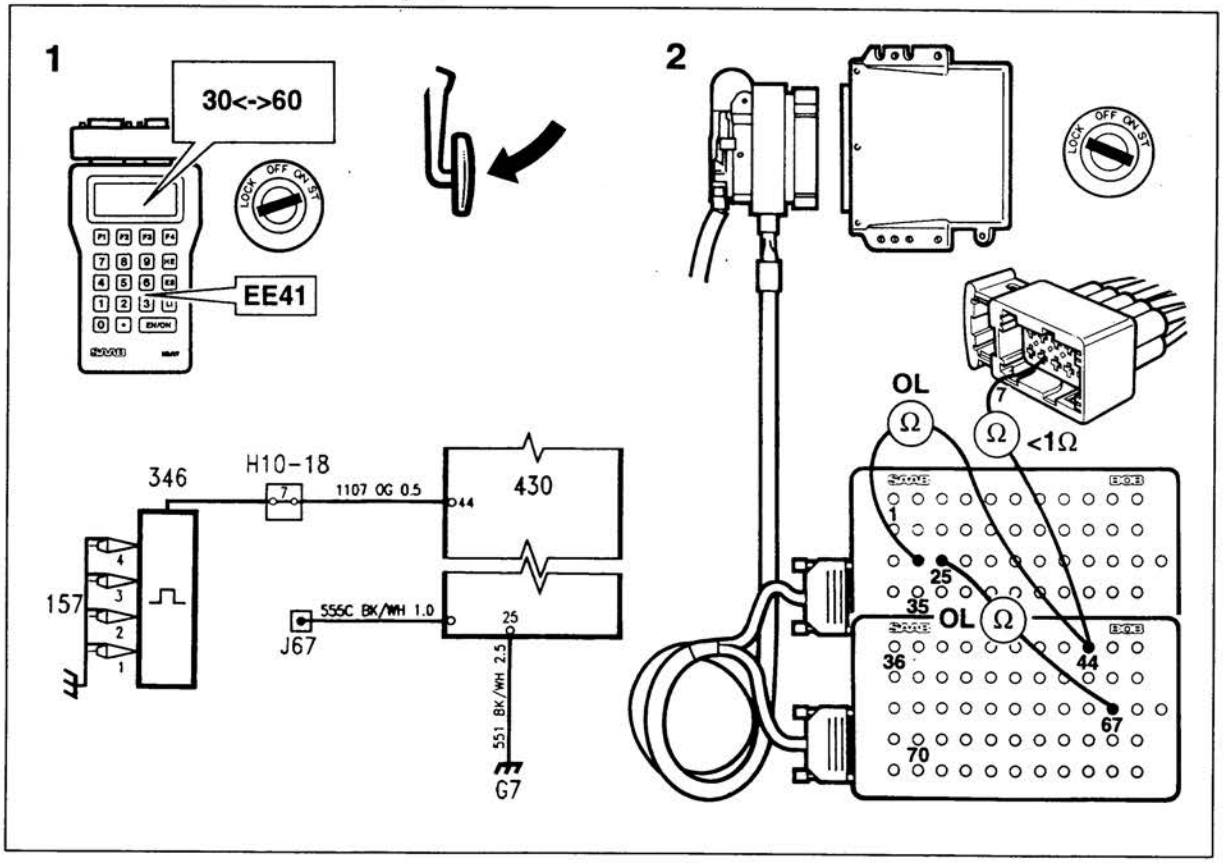
CONDITION

For any of the above DTCs to be generated, the engine must be running and the valve activated.

6 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code 0325

Knock sensing, signal low or no signal



Fault symptom

The car runs on basic charging pressure only, timing continuously retarded.

Diagnostic procedure

1 Connect an ISAT scan tool, contact the SFI system and enter command code EE41. With the engine idling, the signal displayed should be between 30 and 60. Increase engine revs and check that the signal level simultaneously increases.

Note:

The figure displayed is not related to any unit of measurement like amperes (current) or volts but is a floating value between 1 and 255. The value normally changes upwards or downwards fairly slowly. Extremely rapid changes, on the other hand, indicate knocking in one of the cylinders.

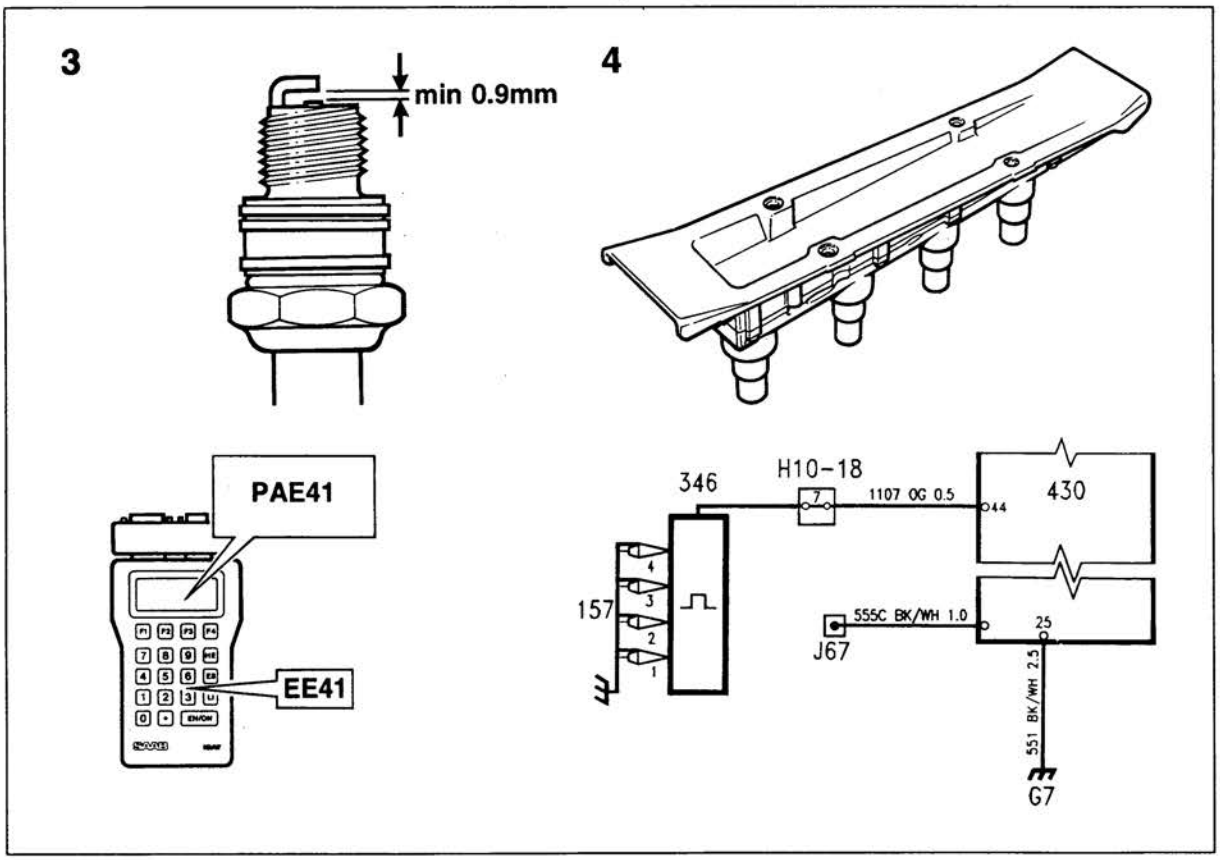
2 If the command code produces a different result, switch off the ignition and connect a BOB to the ECM wiring harness (ECM disconnected). Unplug the wiring connector from the ignition discharge module (DI cartridge).

With the ignition still switched off, check the lead between pin 44 of the ECM and pin 7 of the ignition discharge module for continuity/shorting to ground.

Also check that signal ground (pin 67) is separate from power ground (pin 25) (resistance: OL).

Remedy any faults in the wiring and connectors. If the wiring is OK, continue with point 3.

Diagnostic trouble code 0325 (contd.)



3 Check that the correct type of spark plug is fitted and that the electrode gap is 0.9 mm minimum.

If different, replace the spark plugs with the correct type and adjust the electrode gap to 0.9 mm minimum.

Check once again by entering command code EE41 as described in point 1.

4 If the fault persists in spite of the above checks, try fitting a new ignition discharge module.

If the fault still persists, continue as described below.

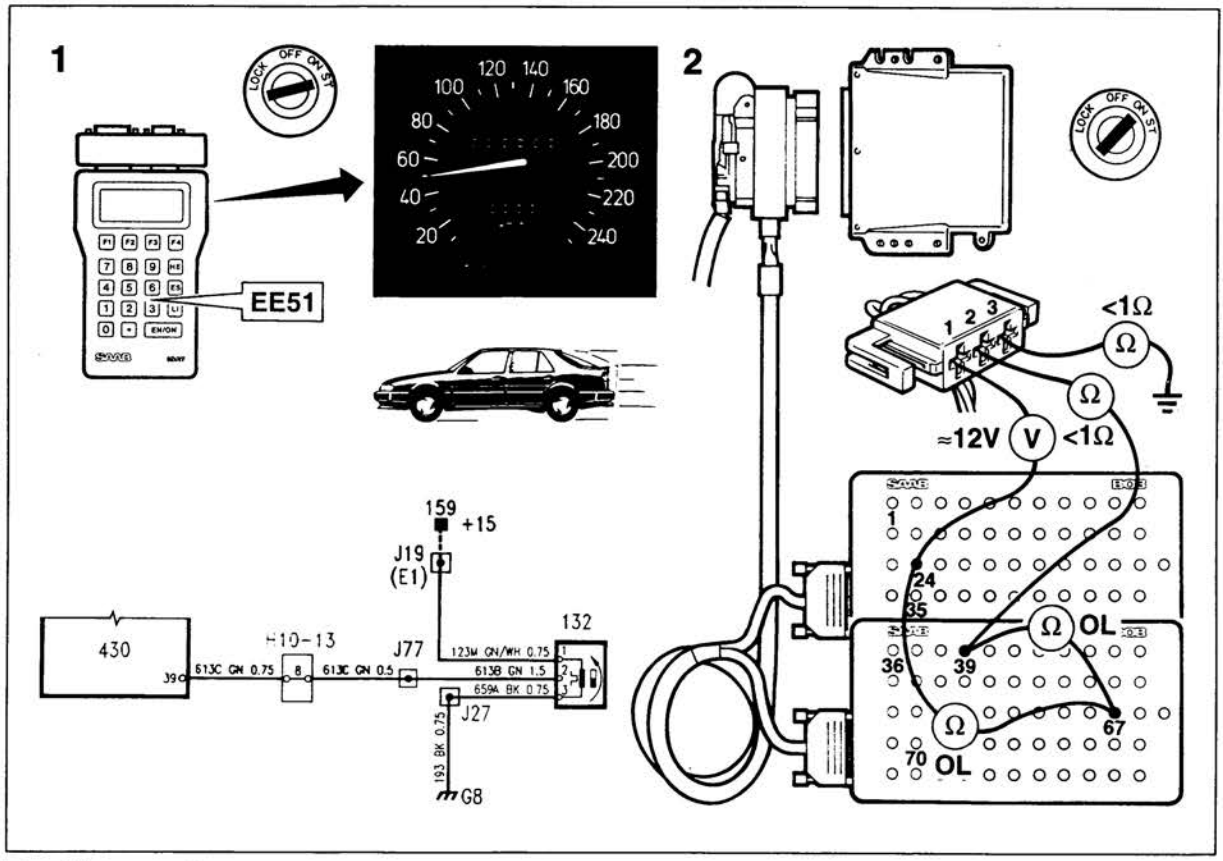
CONDITION

For the above DTC to be generated, the engine must be running and the "signal level" must be lower than 50 for at least 10 seconds.

5 Erase the DTC and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble codes P0500, P0501, P0502

Vehicle speed signal absent, too high or changes too quickly



Fault symptom

No fault symptoms noticeable

Diagnostic procedure

1 Connect an ISAT scan tool, contact the SFI system and enter command code EE51.

Drive the car, read off the speed on the ISAT's display and compare it with the speedometer reading. (If the speedometer does not work, go directly to "Checking the speedometer" on page 104).

In the event of a discrepancy in the speed readings, continue as described below.

2 Connect a BOB to the ECM wiring harness (ECM disconnected). Disconnect the wiring from the vehicle speed sensor (132).

Check the lead between pin 39 of the ECM and pin 2 of the speed sensor's connector for continuity/shorting to ground.

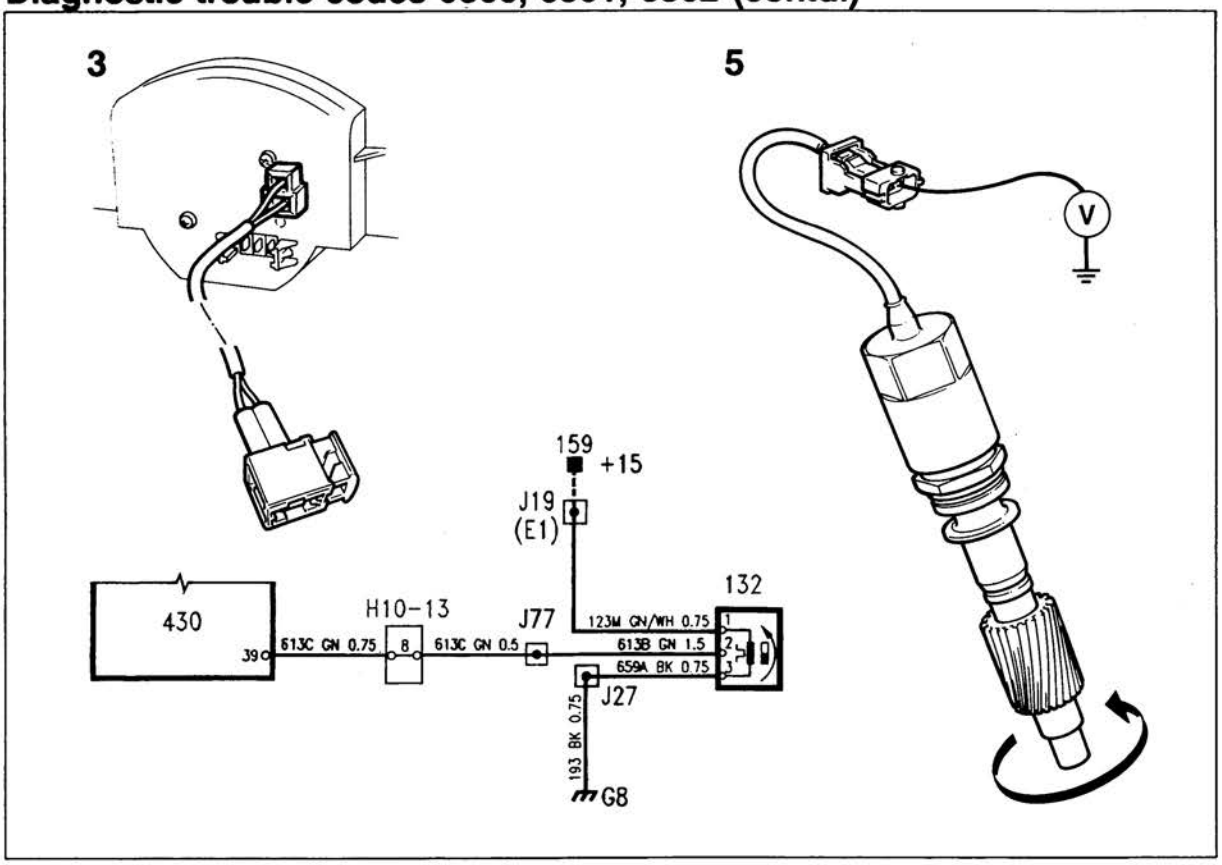
Also check that signal ground (pin 67) and power ground (pin 24) are separated (resistance: OL).

Remedy any faults in the wiring and/or connectors.

If the wiring is OK, turn the ignition switch to the Drive position and check that battery positive voltage is present on pin 1 of the speedometer and that pin 3 is correctly connected to ground. If not, check the wiring to +15 or to grounding point G8.

If the speedometer voltage and ground connection are OK, continue as described below.

Diagnostic trouble codes 0500, 0501, 0502 (contd.)



3 Check the circuit between the vehicle speed sensor and speedometer for continuity or shorting to ground.

Remedy any fault in the wiring or continue as described below.

4 Change the speedometer.

5 Remove the vehicle speed sensor from the gearbox. Rotate the sensor by hand and check that voltage pulses are obtained on pin 2 (AC range = 0.5 V). If no pulses are generated, replace the vehicle speed sensor.

CONDITION

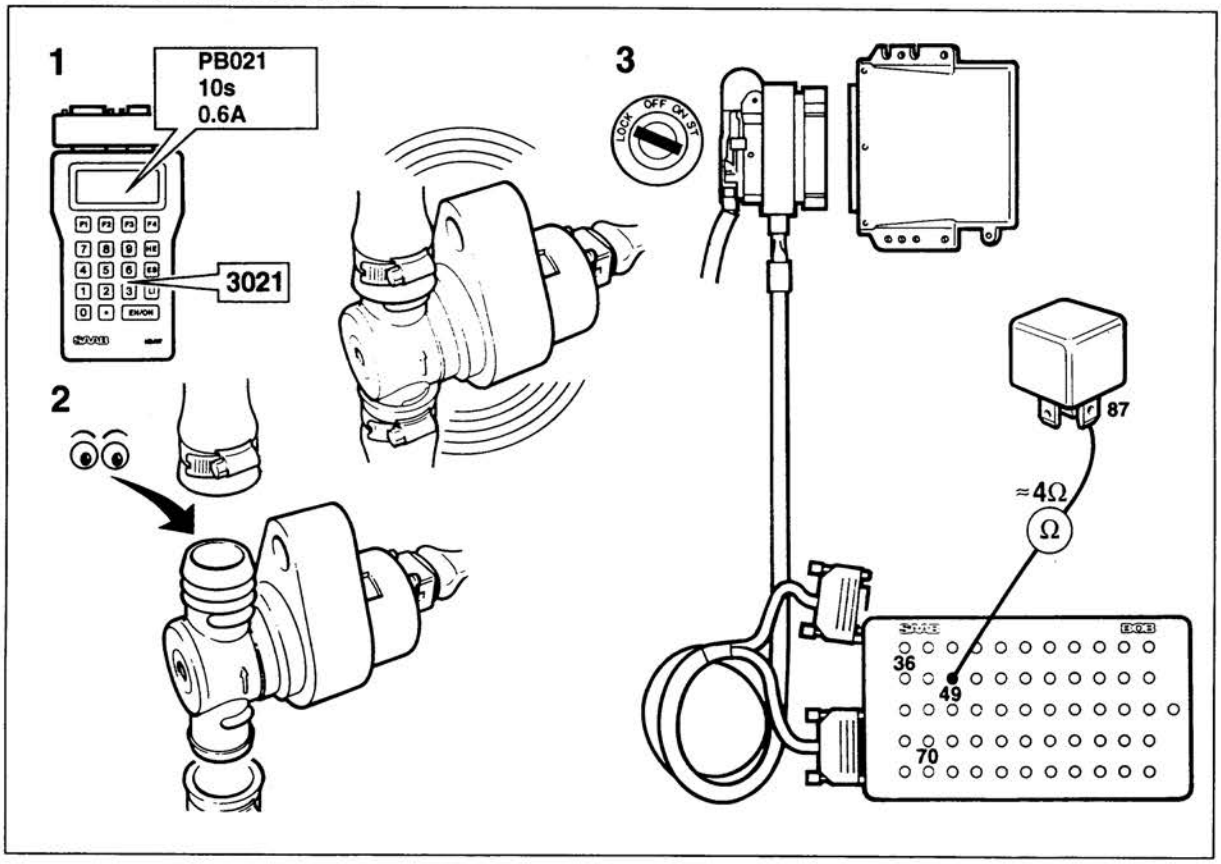
For any of the above DTCs to be generated, the engine must be running and one or other of the following must occur:

- indicated speed exceeds 250 km/h for 20 consecutive readings
- engine speed higher than 2000 rpm, brakes not applied and indicated speed 0 km/h for at least four seconds
- indicated speed increases to more than 50 km/h for one second or decreases (without the brakes being applied) by an equal amount.

6 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P0505 (cars without ETS)

Idle air control valve, malfunction



Fault symptom

Unsteady idling

Diagnostic procedure

1 Connect an ISAT scan tool, contact the SFI system and enter command code 3021 which activates the idle air control (IAC) valve for 10 seconds. Listen for the sound of the valve working (the valve works at about 200 Hz). If it cannot be heard, go to point 3.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

2 Unplug the IAC valve's connector. The slide should now return to the LimpHome position, i.e. close completely and then open again slightly after passing the closed position.

If it does not, check that the slide can be rotated without binding and without jamming in specific positions.

Note:

Some resistance is normal due to the force of the spring.

Change the IAC valve if it is faulty.

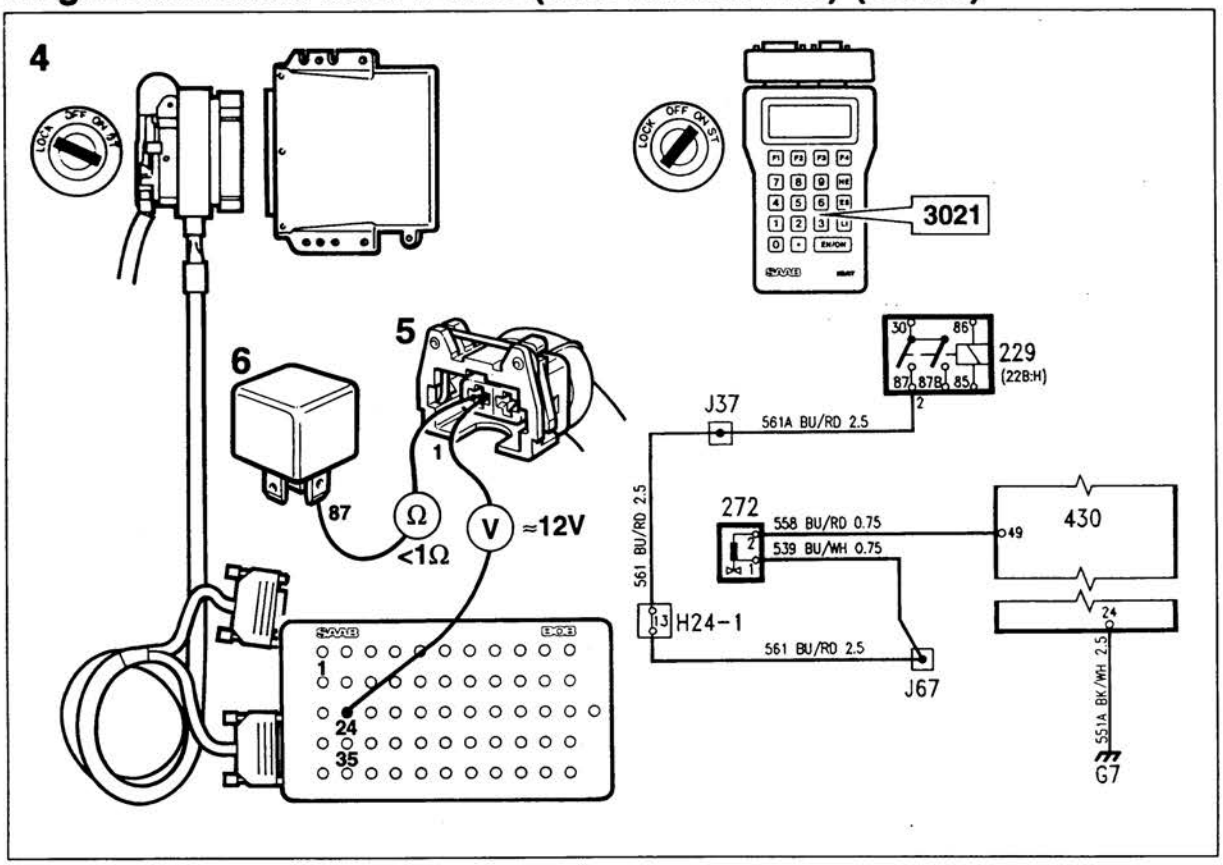
3 Reconnect the wiring to the IAC valve and check the coil by measuring the resistance between pin 87 of the main relay and pin 49 on the ECM.

The correct resistance is about 4 ohms.

In the event of a break in the circuit or a short-circuit, replace the valve.

If the valve is OK, continue with point 4.

Diagnostic trouble code P0505 (cars without ETS) (contd.)



4 With the ignition switched off, connect a BOB to the ECM and wiring.

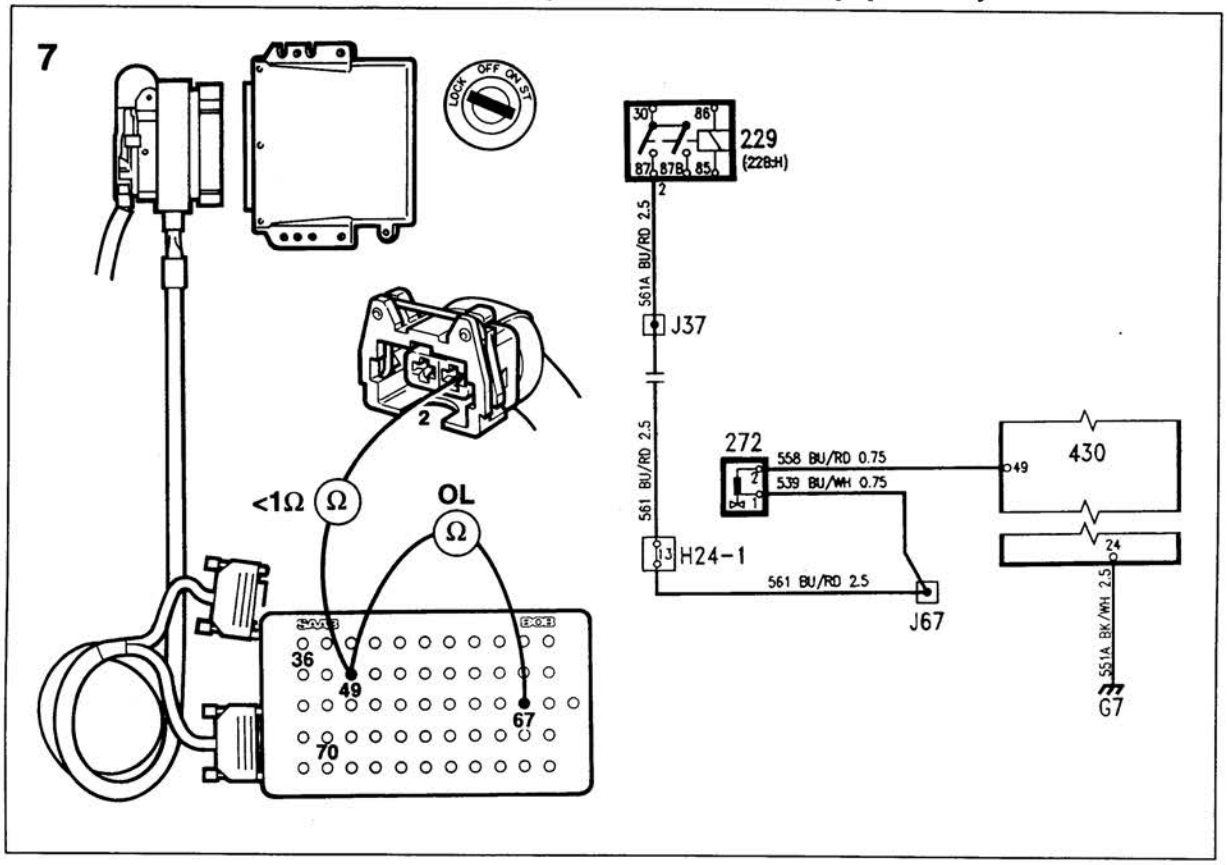
Switch on the ignition and enter command code 3021.

Unplug the IAC valve connector and check that battery voltage is present across terminal 1 of the connector and ground (pin 24 of the ECM). If voltage is present, go to point 6.

If it is not, continue checking the wiring as described below.

5 Check the wiring between pin 1 of the connector and pin 87 of the main relay. If the wiring is OK, check the main relay as described on page 124.

Diagnostic trouble code P0505 (cars without ETS) (contd.)



6 With the ignition switched off, disconnect the ECM and check the lead between pin 49 of the ECM and pin 2 of the valve's connector for continuity/shorting to ground.

If the wiring and connector are OK, continue as described below.

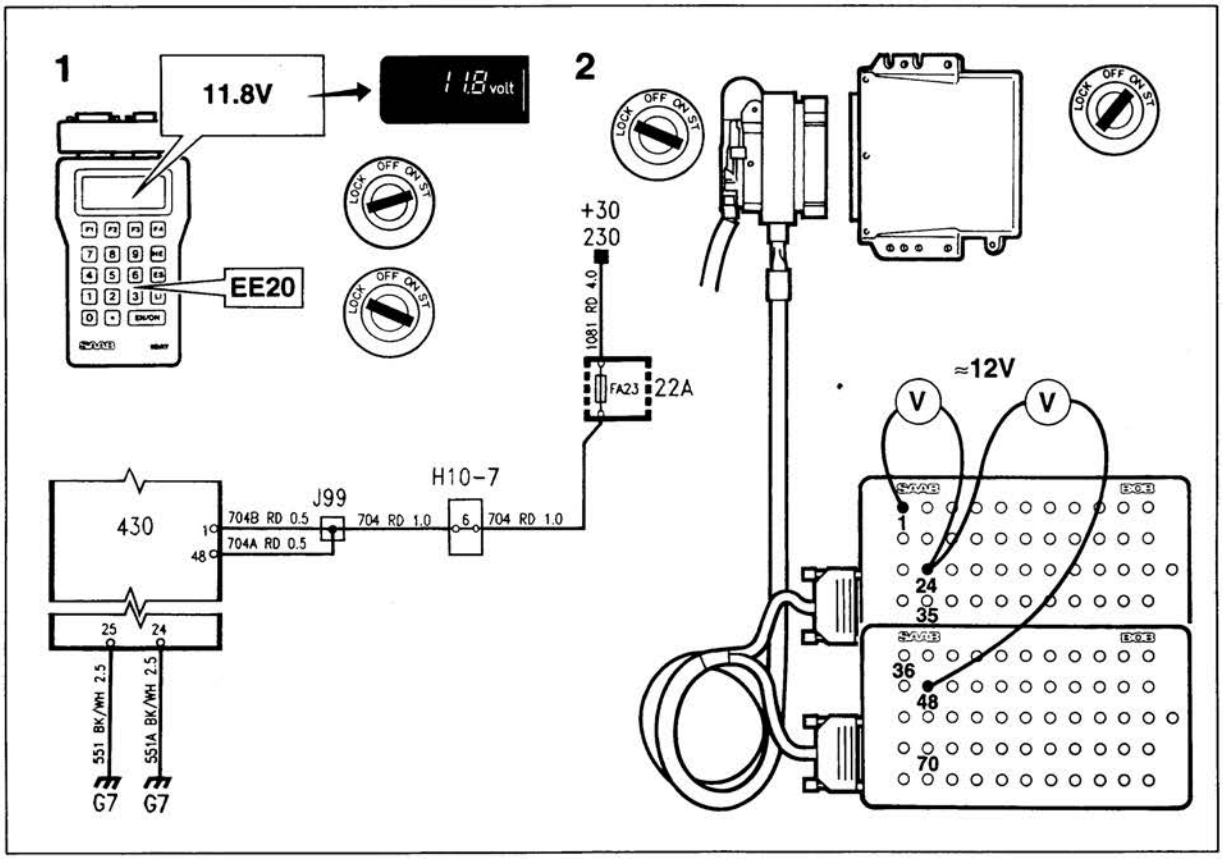
CONDITION

For the DTC to be generated, the car must be without ETS and the engine must be running at above 1200 rpm or below 700 rpm at the same time as the IAC valve's control signal is as programmed.

7 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P1500

Battery positive voltage, low or high



Fault symptom

Inaccurate fuel consumption

Diagnostic procedure

1 Connect an ISAT scan tool, contact the SFI system and enter command code EE20. Read off the battery positive voltage (B+) on the ISAT's display with the engine idling and again with it switched off. Compare the readings with those of the EDU or use a multimeter to take readings directly from the battery.

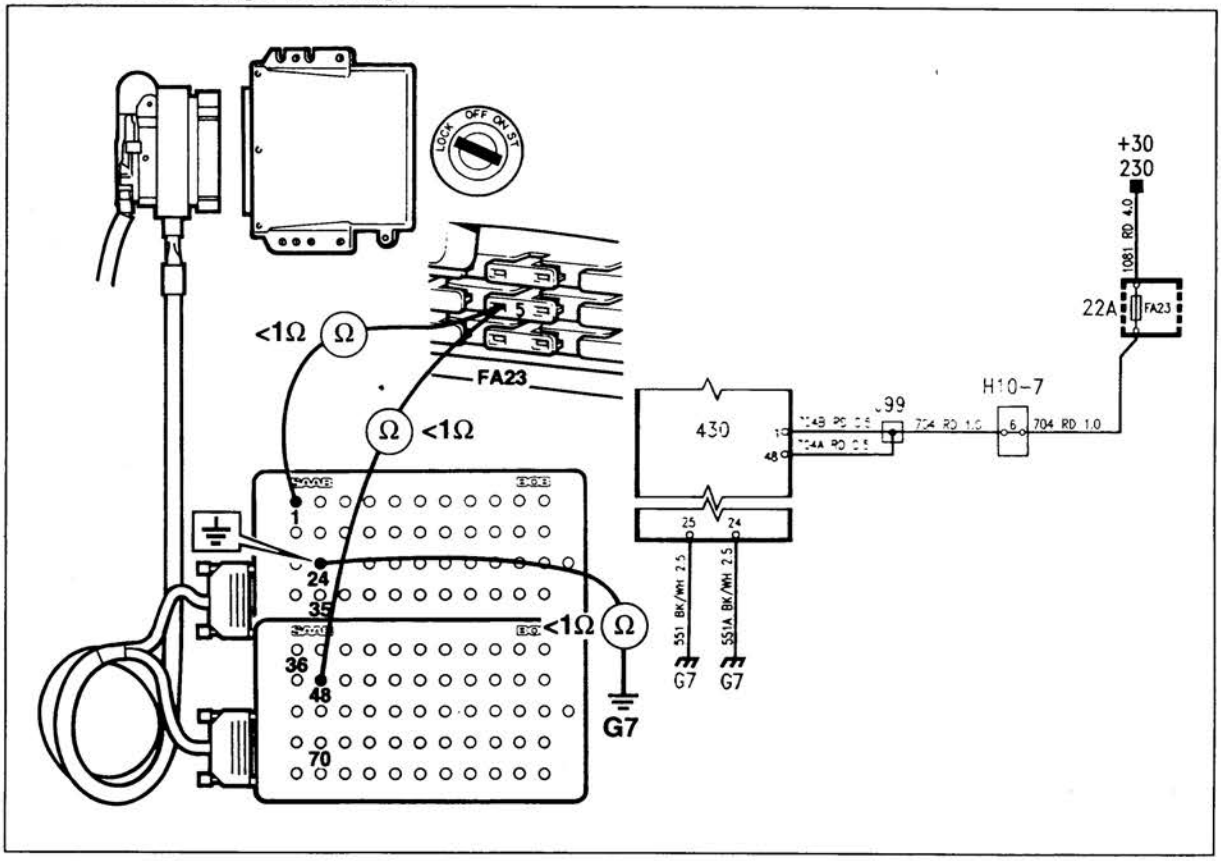
In the event of a discrepancy, check whether fuse 23 is intact and then continue as described below.

2 With the ignition switched off, connect a BOB to the ECM's wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and check whether B+ is present across the ECM's pin 48 and 24/25 and across pin 1 and 24/25.

Diagnostic trouble code P1500 (contd.)

Battery positive voltage, low or high



3 Switch off the ignition and check the wiring for continuity from fuse 23A to pins 1 and 48 of the ECM and also from pins 24 and 25 of the ECM to grounding point G7 on the intake manifold.

Remedy any faulty wiring and continue as described below.

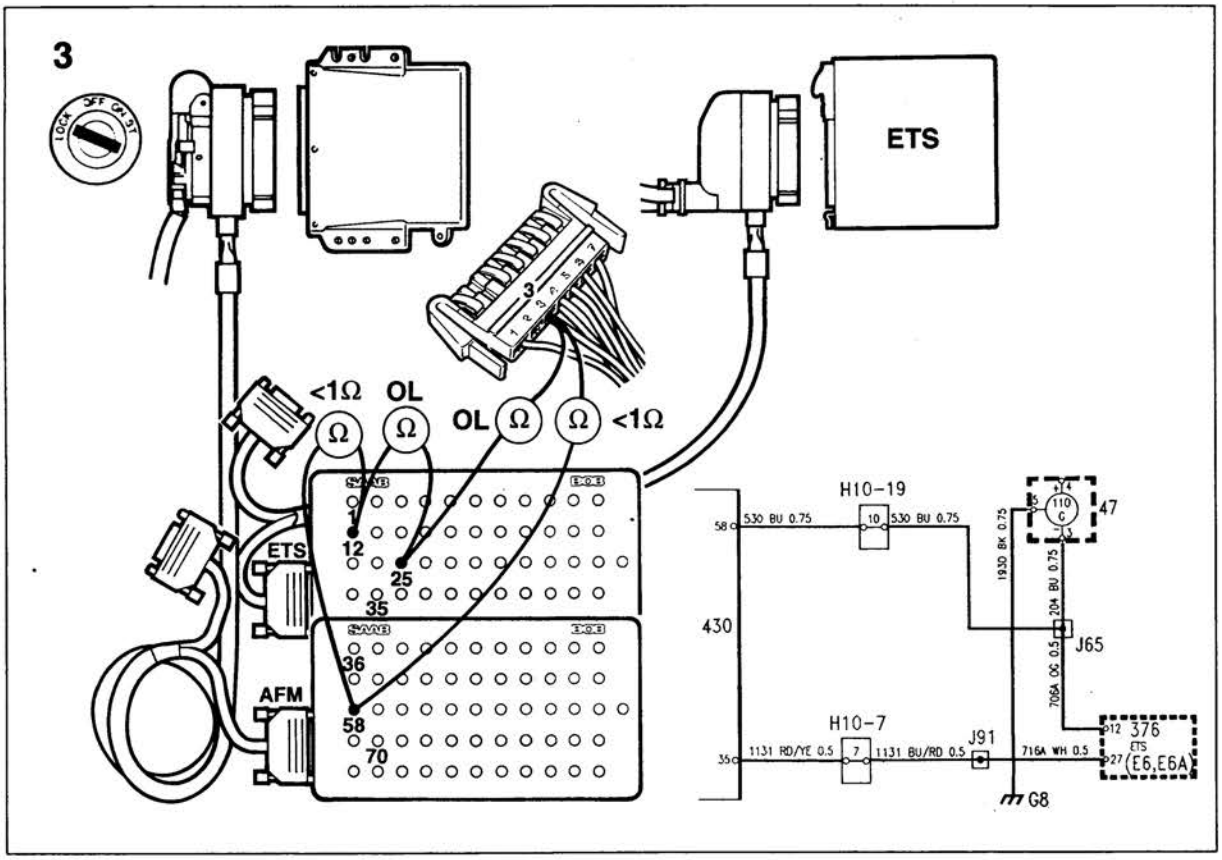
CONDITION

For the DTC to be generated, the engine must be running at more than 2000 rpm for at least 30 seconds at the same time as B+ is lower than 8 V or higher than 16 V.

4 Erase any DTCs and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Diagnostic trouble code P1322

Engine rpm, signal faulty (only cars with ETS)



Fault symptom

Engine stops, fault in the ETS system (throttle plate jammed)

Diagnostic procedure

1 Obtain a reading of any diagnostic trouble codes (fault codes) in the ETS control module, see Service Manual 2:5, and remedy the faults.

2 Check that the tachometer (rev counter) is in working order.

If it is, continue with point 4.

If it is not, check the wiring as described below.

3 With the ignition switched off, plug the 70-pin test cable into the ECM wiring harness (ECM disconnected), with only the grey connector plugged into a BOB.

Also connect the test cable for ETS (86 11 014) to the ETS wiring (control module disconnected), with only the large connector plugged into the BOB.

Also unplug the tachometer's (rev counter's) connector.

Now check the lead from pin 58 of the ECM to pin 12 of the ETS control module and to pin 3 of the tachometer's (rev counter's) connector for continuity.

Also check the circuit for shorting to ground.

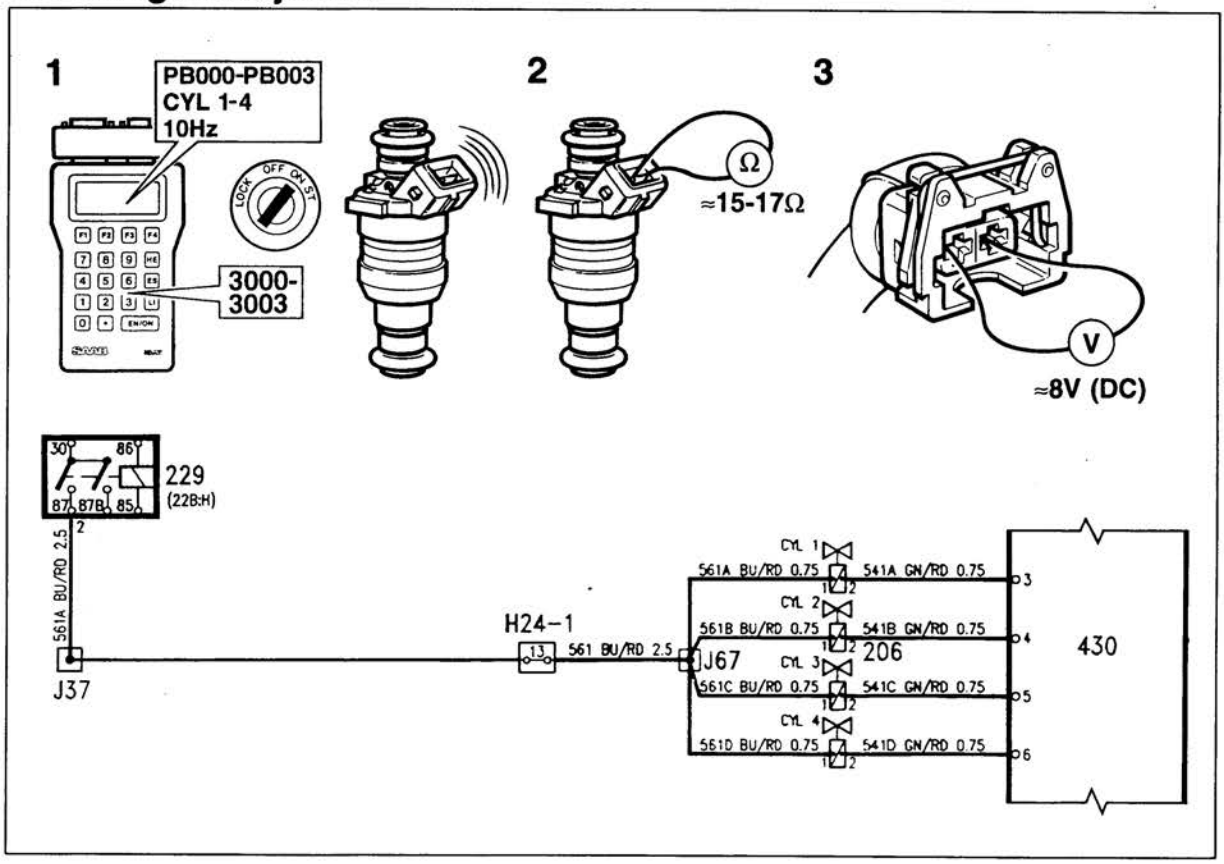
Remedy any faults in the wiring and connectors, or continue as described below.

CONDITION

For the above DTC to be generated, the car must be equipped with ETS, the engine must be running and the ETS control module must ground the rpm signal from the SFI system during at least four consecutive checks.

4 Erase the DTC and drive the car to see whether the DTC is generated afresh. If it is, turn to page 149 for further diagnostic instructions.

Checking the injectors



1 Connect an ISAT scan tool, contact the SFI system, enter command code 3000-3003 and check by listening to the sound of each injector that they are all working (10 Hz, 10 seconds). If not, continue as described below.

2 Unplug the connector of the relevant injector and check the injector's resistance. Do this by taking a measurement directly across connecting pins 1 and 2 of the injector.

The correct resistance is 15-17 ohms (@20°C).

If the resistance is different, fit a new injector.

If the resistance is OK, continue with the next point.

3 Turn the ignition switch to the Drive position and enter command code 3000-3003. Check that voltage pulses (10 Hz) (approx. 8 V DC) can be measured across pins 1 and 2 of the connector of the relevant injector.

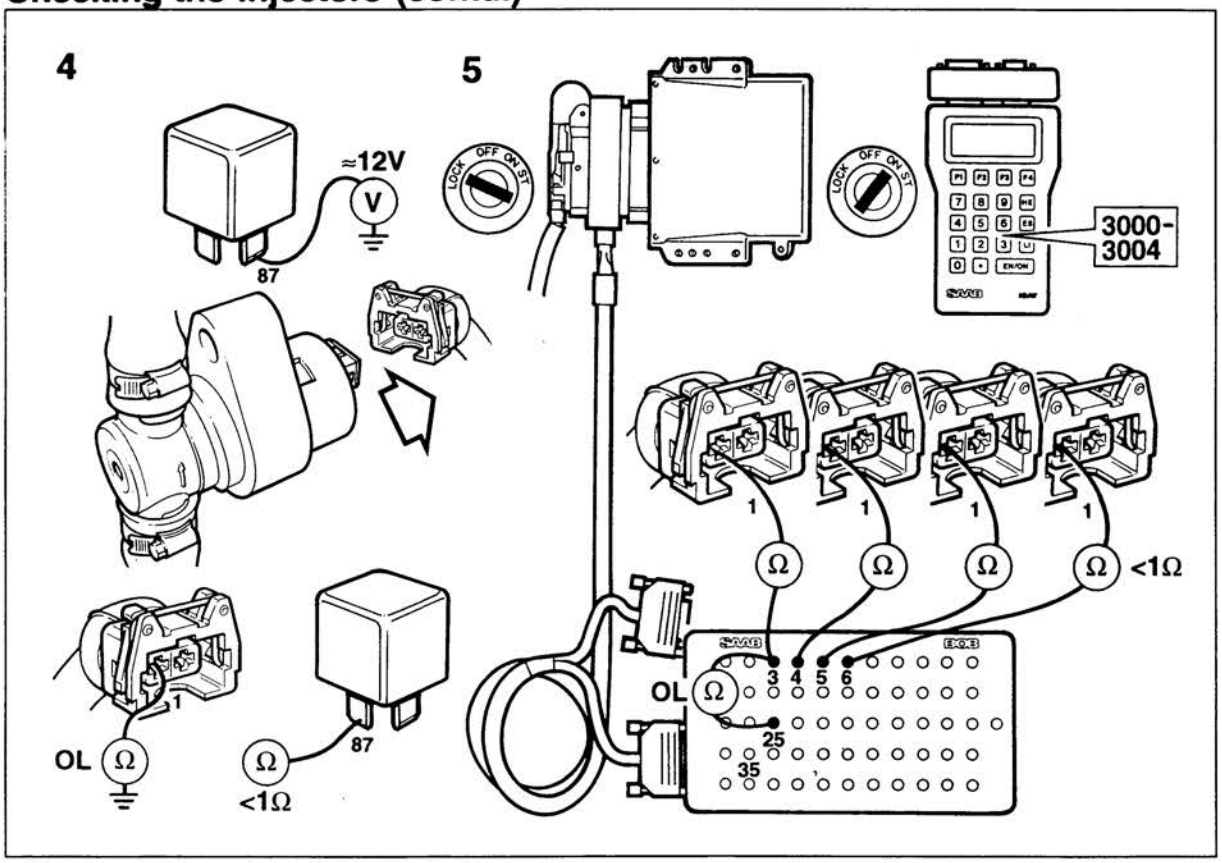
If voltage is present, continue with point 6.

If there are no voltage pulses on any of the injector connections, continue as described below.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the injectors (contd.)



4 Check that battery positive voltage is present on pin 87 of the main relay when command code 3000-3003 is activated.

If it is not, see "Checking the main relay" on page 124.

If voltage is present, check the wiring (unplug the connector for the IAC valve, where appropriate) between pin 1 of the valve connector and terminal 87 of the main relay for continuity/shorting to ground.

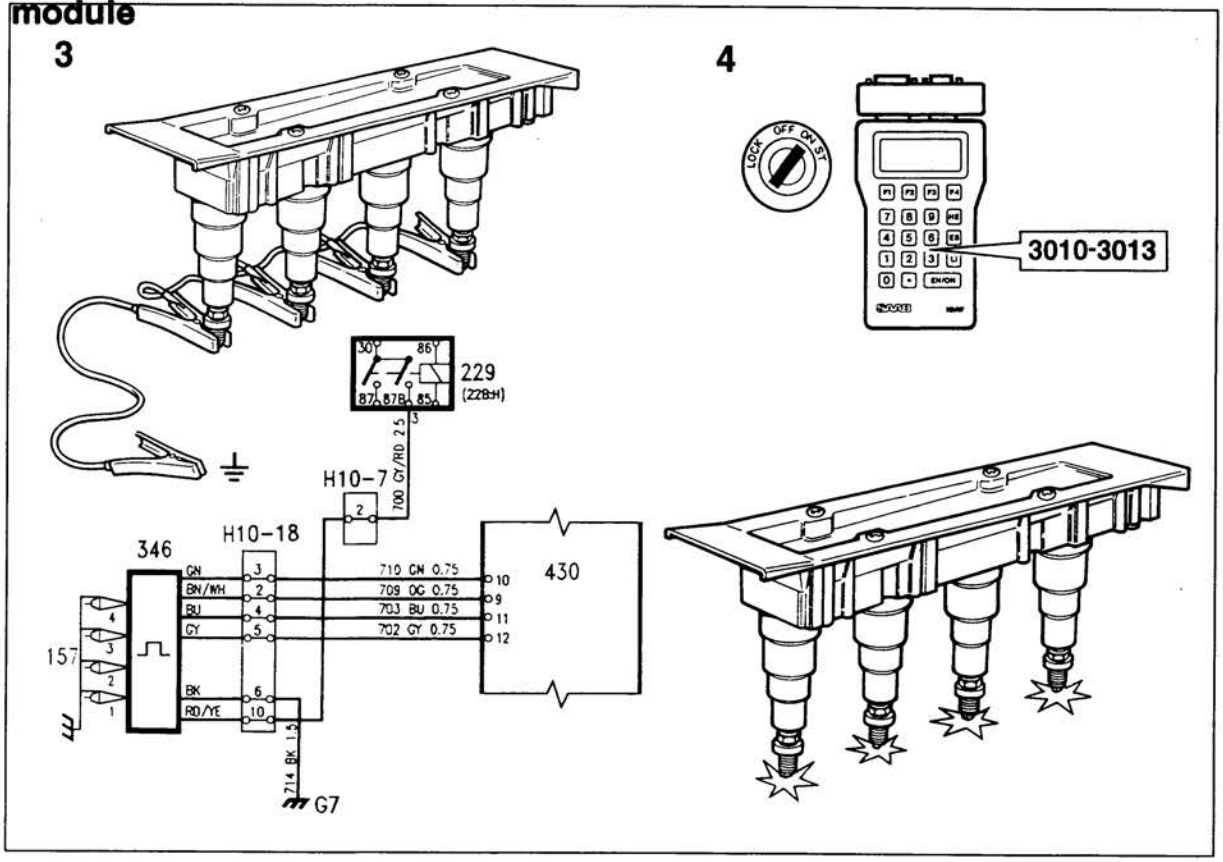
Remedy faulty wiring and connectors or continue with point 6.

5 With the ignition switched off, connect a BOB to the ECM and wiring. Check the wiring for continuity/shorting to ground between pins 3, 4, 5 and 6 of the ECM and pin 1 of the relevant injector connector.

Remedy any faulty wiring or continue as described below.

6 Drive the car to check whether any fault symptoms persist. If they do, turn to page 149 for further diagnostic instructions.

Checking the ignition discharge module



1 Remove the ignition discharge module (IDM) from the cylinder head.

2 Fit spark plugs in the spark plug connections.

3 Ground the spark plugs, using cable 86 10 867.

4 Connect an ISAT scan tool, contact the SFI system and enter command code 3010-3013.

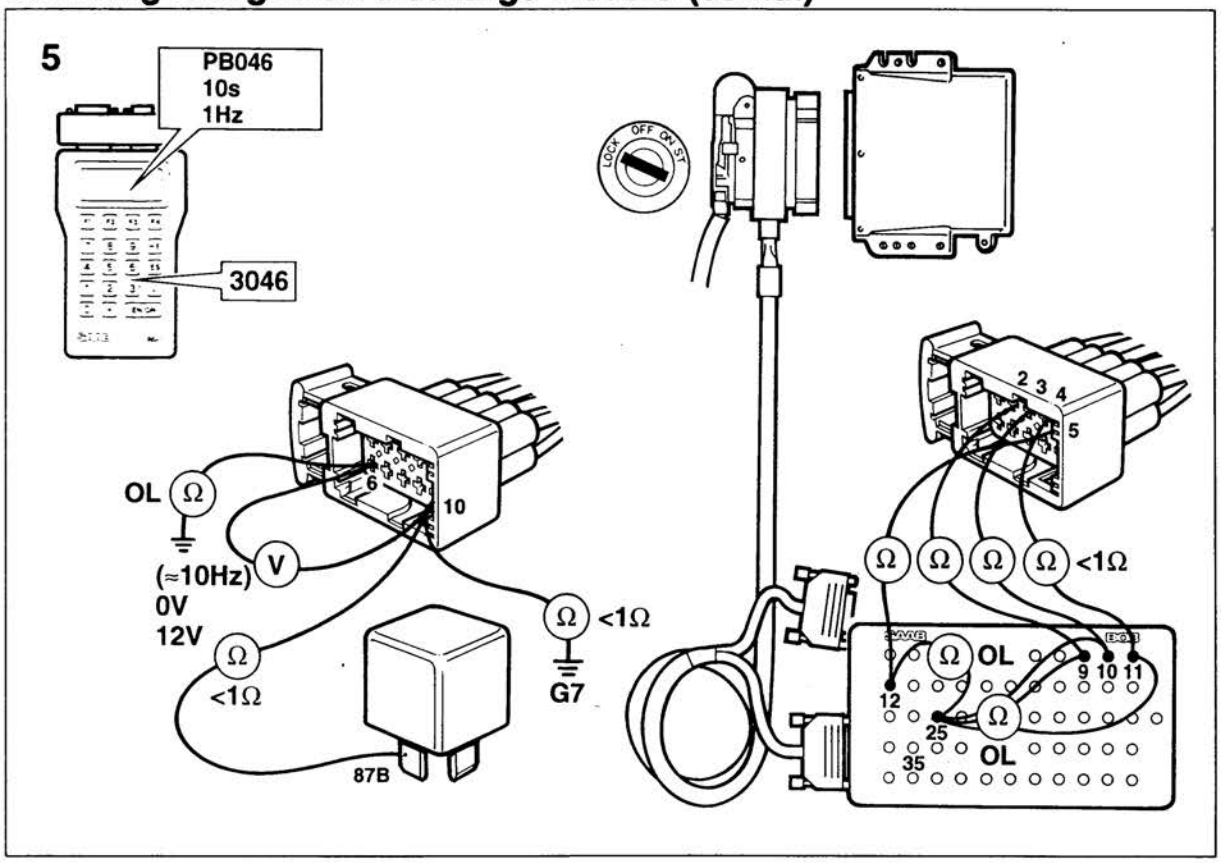
Check that the activated spark plug produces a spark. If a spark is produced, continue with point 6.

If no spark is produced by any spark plug, continue as described below.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the ignition discharge module (contd.)



5 Unplug the connector from the IDM.

Enter command code 3046 and check that battery positive voltage is obtained (1 Hz pulses) across pins 10 and 6 of the connector.

If it is not, check the lead between pin 10 of the cartridge's connector and pin 87B of the main relay and also the lead between pin 6 of the cartridge's connector and grounding point G7 for continuity/shorting to ground.

Repair any faulty wiring and/or connectors, or check the main relay, see page 124.

6 With the ignition switched off, connect a BOB to the SFI wiring (the ECM should be disconnected).

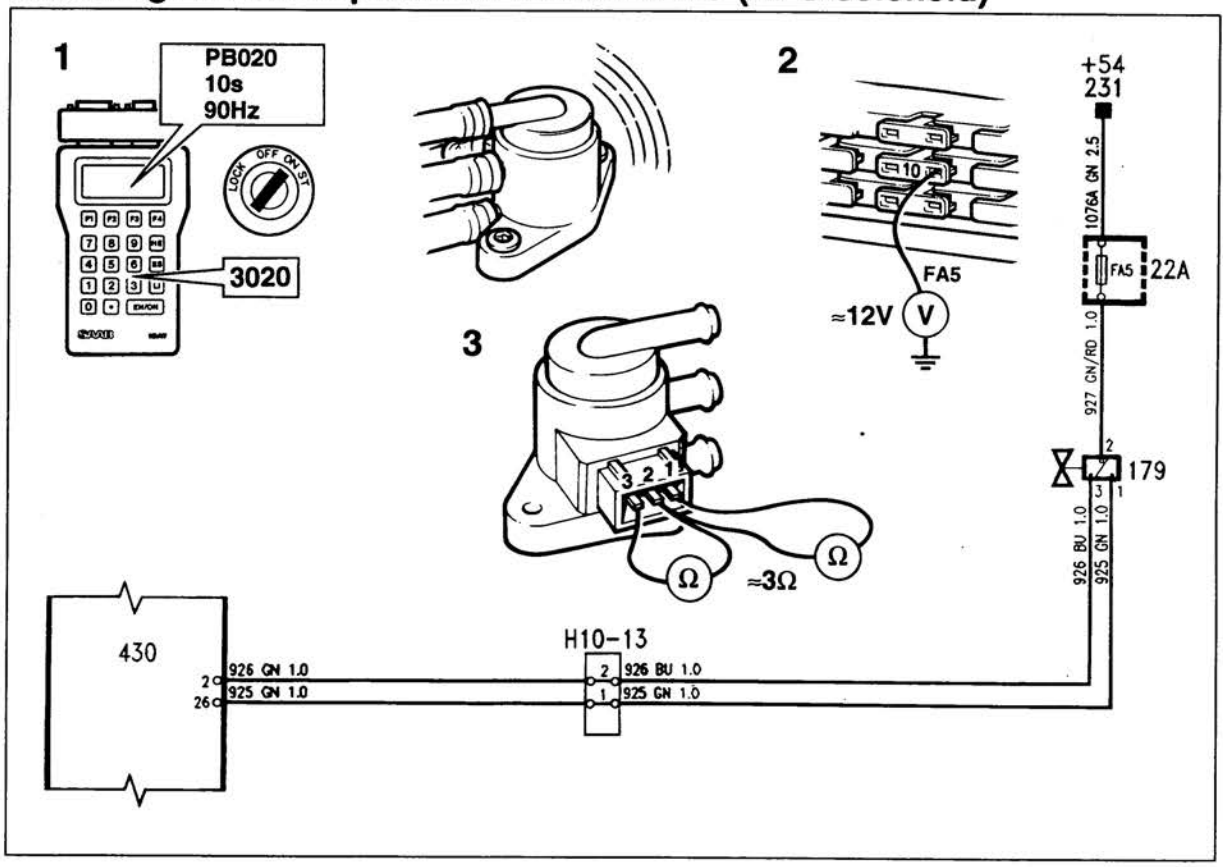
Check the trigger/ignition cable for the relevant cylinder for continuity/shorting to ground as follows:

- Pin 9 of the ECM and pin 2 of the IDM connector
- Pin 10 of the ECM and pin 3 of the IDM connector
- Pin 11 of the ECM and pin 4 of the IDM connector
- Pin 12 of the ECM and pin 5 of the IDM connector

7 Remedy any faulty cables. If the cables are OK, try a new ignition discharge module.

8 If the fault nonetheless persists when road testing/checking, turn to page 149 for further diagnostic instructions.

Checking the boost pressure control valve (APC solenoid)



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3020.

Check that the boost pressure control (BPC) valve is working by listening to it (note: low noise level!) or by feeling it vibrating (at a frequency of 8 Hz).

(A physical check of the BPC valve can be carried out as follows: blow into the valve connection to check whether the washer between the valve's poles has jammed, e.g. due to a coating of oil from the crankcase ventilation system. See also page 155. If the BPC valve is faulty, replace it.)

2 If it is not, turn the ignition switch to the Drive position and check that fuse FA5 is intact and that voltage is present up to the fuse holder.

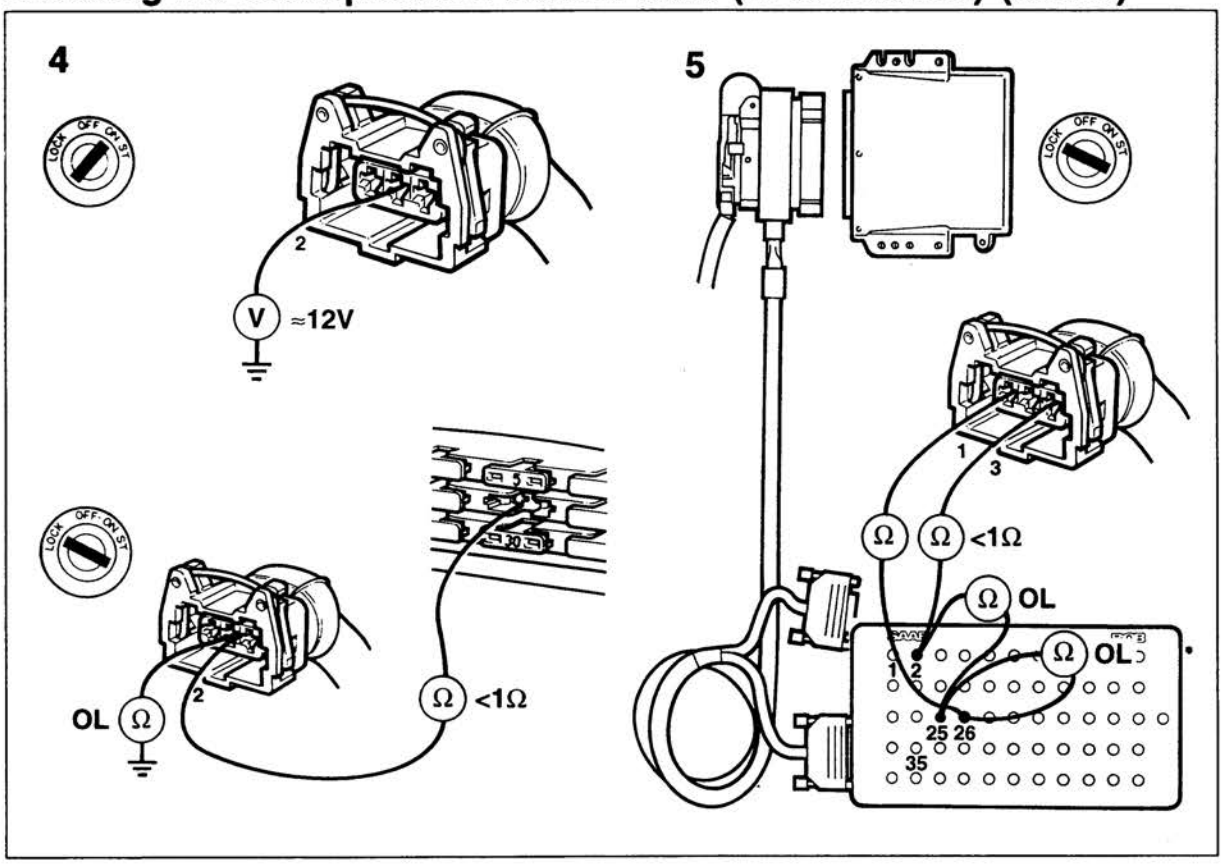
3 Unplug the valve's connector and check the resistance across pins 1 and 2 and also across pins 2 and 3 of the valve. In both cases the resistance should be about 3 ohms.

If it is not, replace the boost pressure control valve.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the boost pressure control valve (APC solenoid) (contd.)



4 If the BPC valve is OK, turn the ignition switch to the Drive position and check that battery positive voltage is present on pin 2 of the valve's connector.

If it is not, switch off the ignition and check the lead between pin 2 of the valve's connector and the fuse holder (fuse removed) for continuity/shorting to ground.

5 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected).

Check the wiring from pins 2 and 26 of the ECM to pins 3 and 1 of the BPC valve's connector for continuity/shorting to ground.

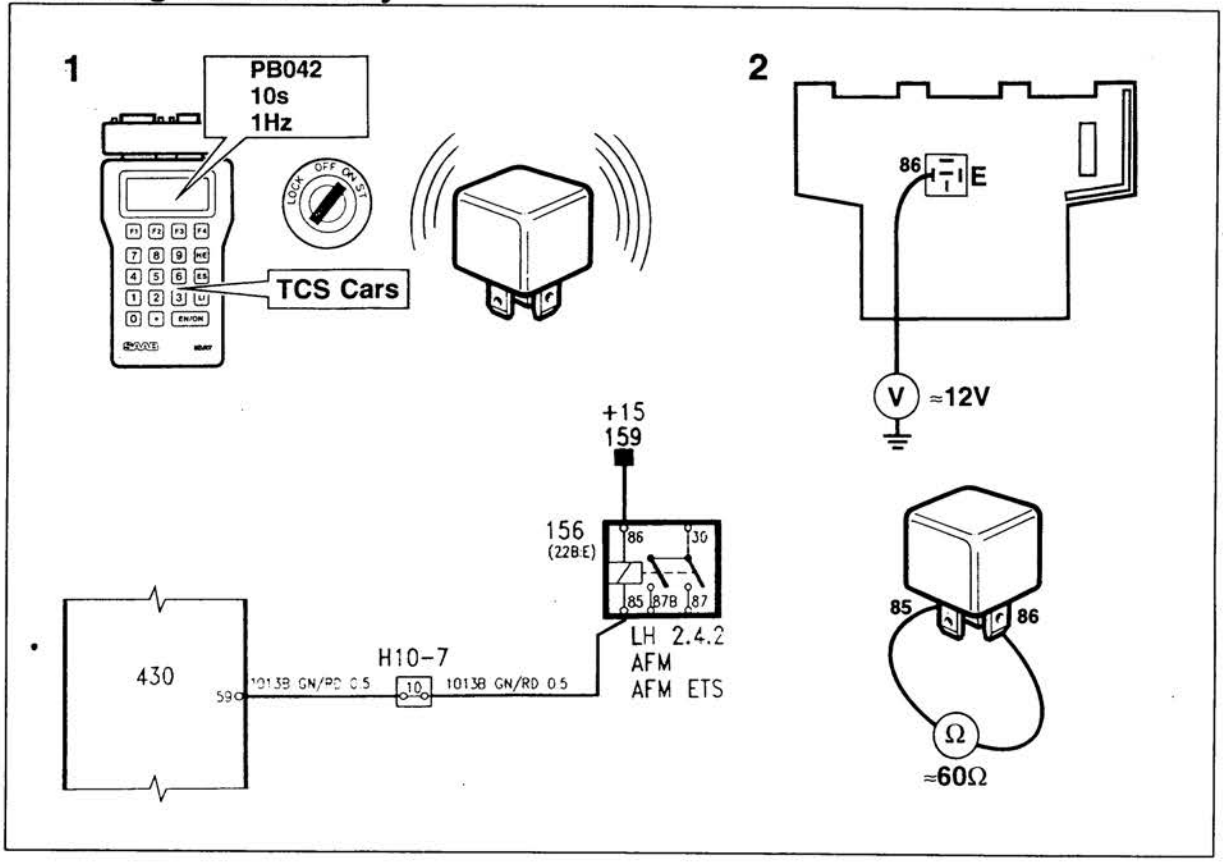
Remedy faulty wiring and/or connectors or continue as described below.

6 If problems/fault symptoms persist in spite of the above checks and possible road testing, continue with further diagnostic procedures as described on page 149.

Note

If repeated pressure monitor operation has been caused by excessive boost pressure (such as due to a defective solenoid valve), maximum negative adaption will be obtained. This means that normal maximum boost pressure will not be attained. To attain maximum boost pressure, disconnect and reconnect the control module and carry out adaption as described on page 156.

Checking the A/C relay



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3042 (not TCS).

On cars with TCS, contact the ETS system (system No. 3 in the ISAT) and enter command code 550.

Check whether the relay works (at 1 Hz for 10 seconds) by listening to the sound it makes.

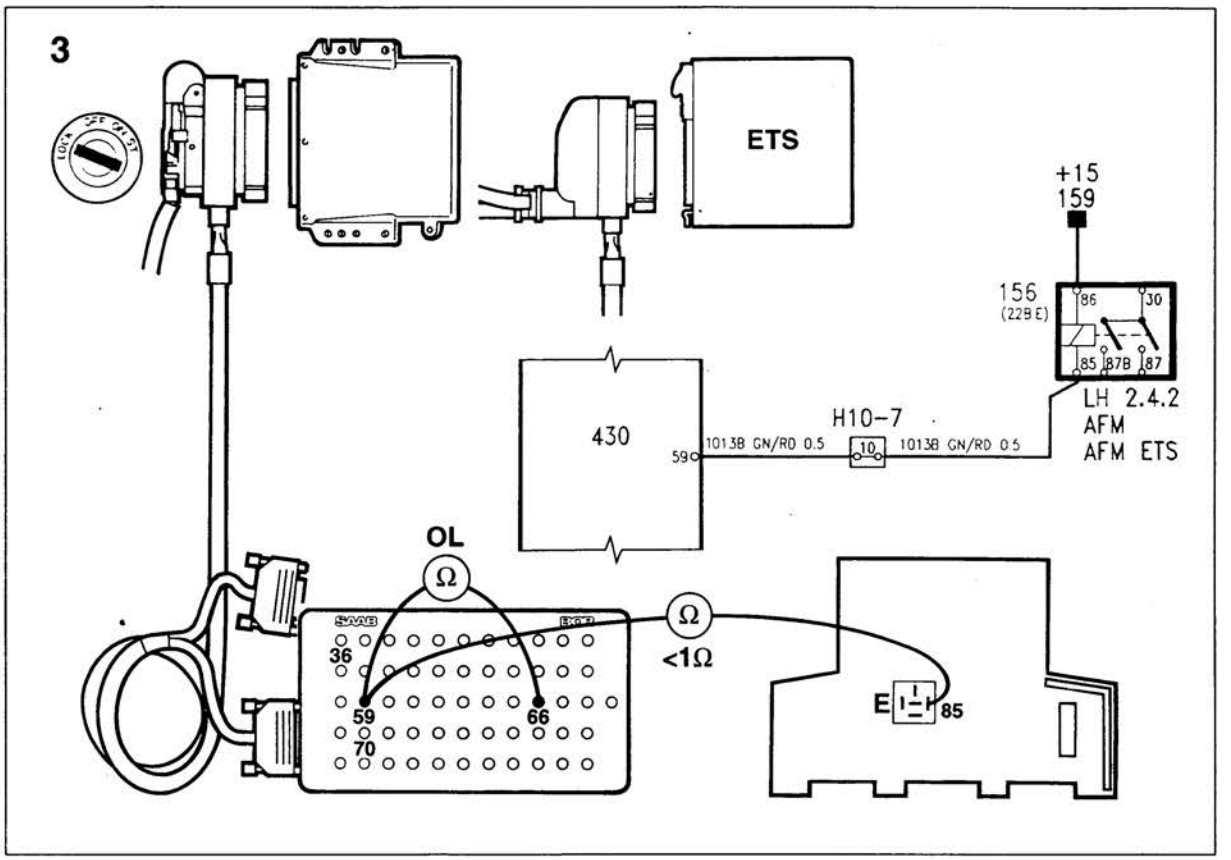
2 If it does not work, turn the ignition switch to the Drive position and check whether voltage is present on terminal 86 of the relay. If it is not, remove the relay and check whether the resistance across pins 85 and 86 is about 60 ohms.

If it is not, replace the A/C relay.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the A/C relay



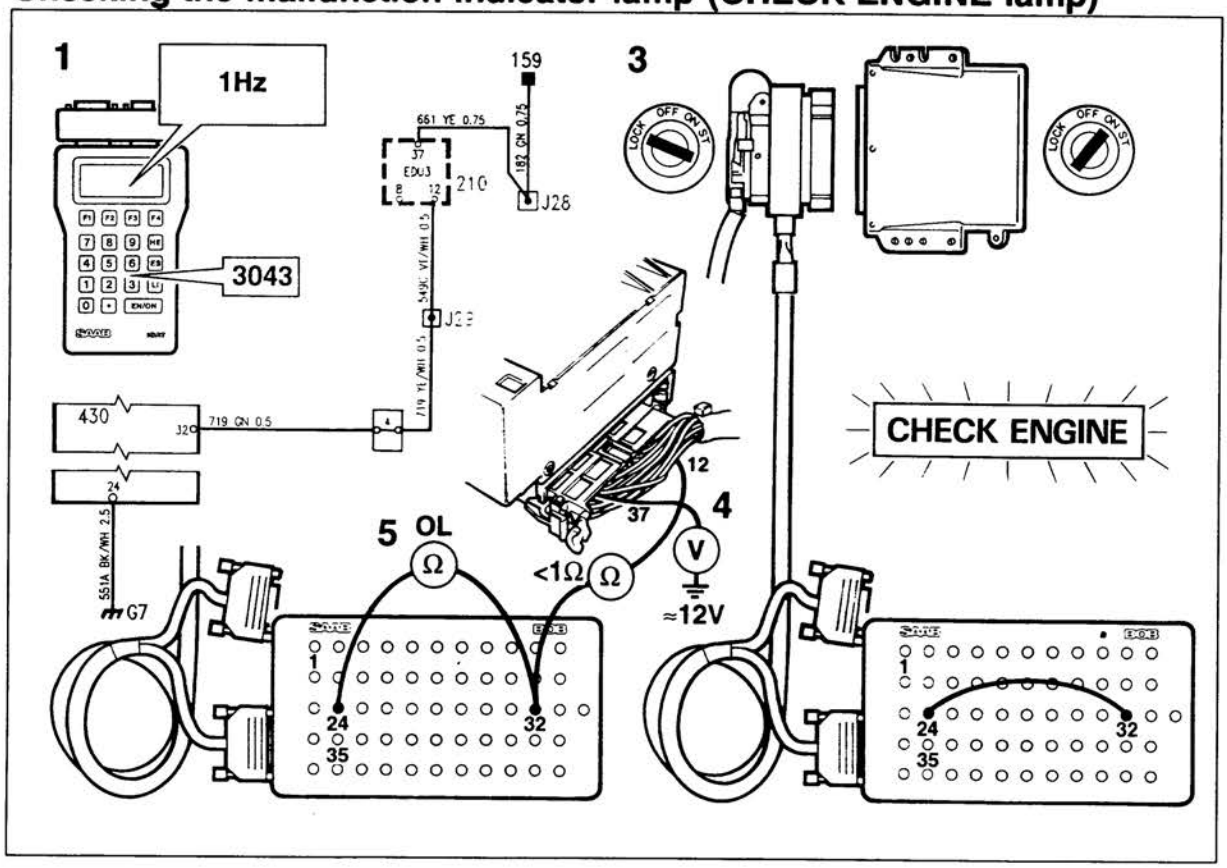
3 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected). Also unplug the ETS control module's connector.

Check the lead between pin 59 of the ECM and pin 85 of the A/C relay for continuity/shorting to ground.

Remedy any faulty leads/connectors.

4 If malfunctioning of the A/C relay persists in spite of the above checks, turn to page 149 for further diagnostic instructions.

Checking the malfunction indicator lamp (CHECK ENGINE lamp)



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3043.

Check whether the malfunction indicator lamp (MIL) flashes (at a frequency of 1 Hz).

2 If it does not, check whether the EDU is programmed for the type of car in question, see Service Manual 3:1 "Programmable EDU trip computer".

3 With the ignition switched off, connect a BOB to the ECM and cable.

Turn the ignition switch to the Drive position, connect a jumper cable between terminals 32 and 24 of the BOB and check whether the MIL lights up. If it does, continue with point 6.

If it does not, continue as described below.

4 Check whether voltage is present up to pin 37 of the EDU. If it is, the EDU is faulty and must be replaced.

If it is not, check the lead from the + 15 voltage supply.

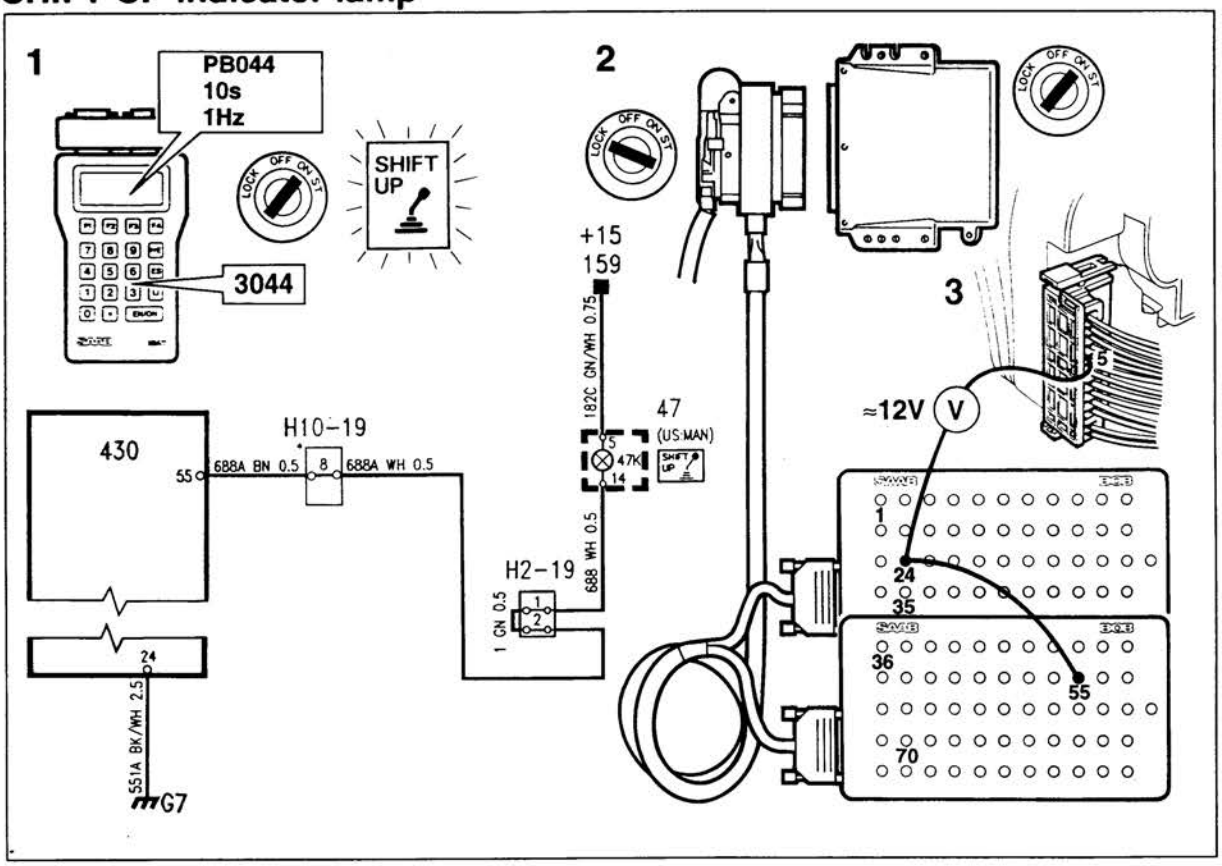
5 Remove the jumper cable and, with the ignition switched off, check the lead between pin 12 of the EDU and pin 32 of the control module for continuity/shorting to ground. Take remedial action if the lead is faulty.

6 If no fault can be found in spite of the above checks, turn to page 149 for further diagnostic instructions.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

SHIFT UP indicator lamp



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3044.

Check whether the lamp flashes (at a frequency of 1 Hz).

2 If it does not, switch off the ignition and connect a BOB to the ECM wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and connect a jumper cable between terminals 55 and 24 of the BOB.

If the lamp lights up, continue with point 4.

3 If the lamp does not light up, remove the main instrument display panel and - with the ignition switch in the Drive position - check whether battery voltage is present on terminal 5 of the SHIFT UP lamp (black connector on the right-hand side of the instrument).

If voltage is present, replace the instrument unit.

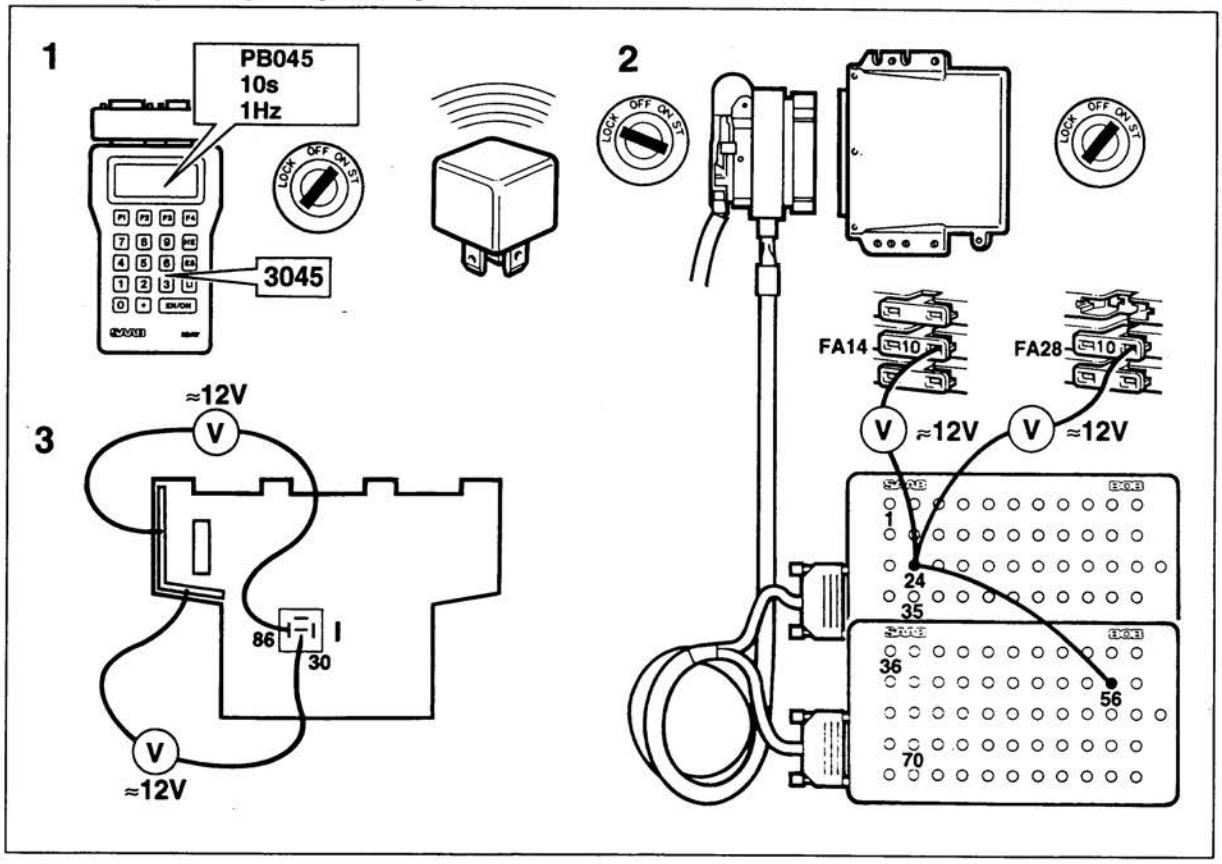
If it is not, check the +15 supply voltage lead.

4 If the fault persists in spite of the above checks, turn to page 149 for further diagnostic instructions.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the pump relay



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3045.

Check that the relay is activated at a frequency of 1 Hz (for 10 seconds).

2 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected). Check operation of the relay as follows:

Turn the ignition switch to the Drive position and connect a jumper cable across terminals 56 and 24 of the BOB. Check whether the relay is energized by measuring the voltage at fuse positions 14 and 28.

If the relay operates, continue with point 6.

If the relay operates but fastens in the energized condition, go to point 5.

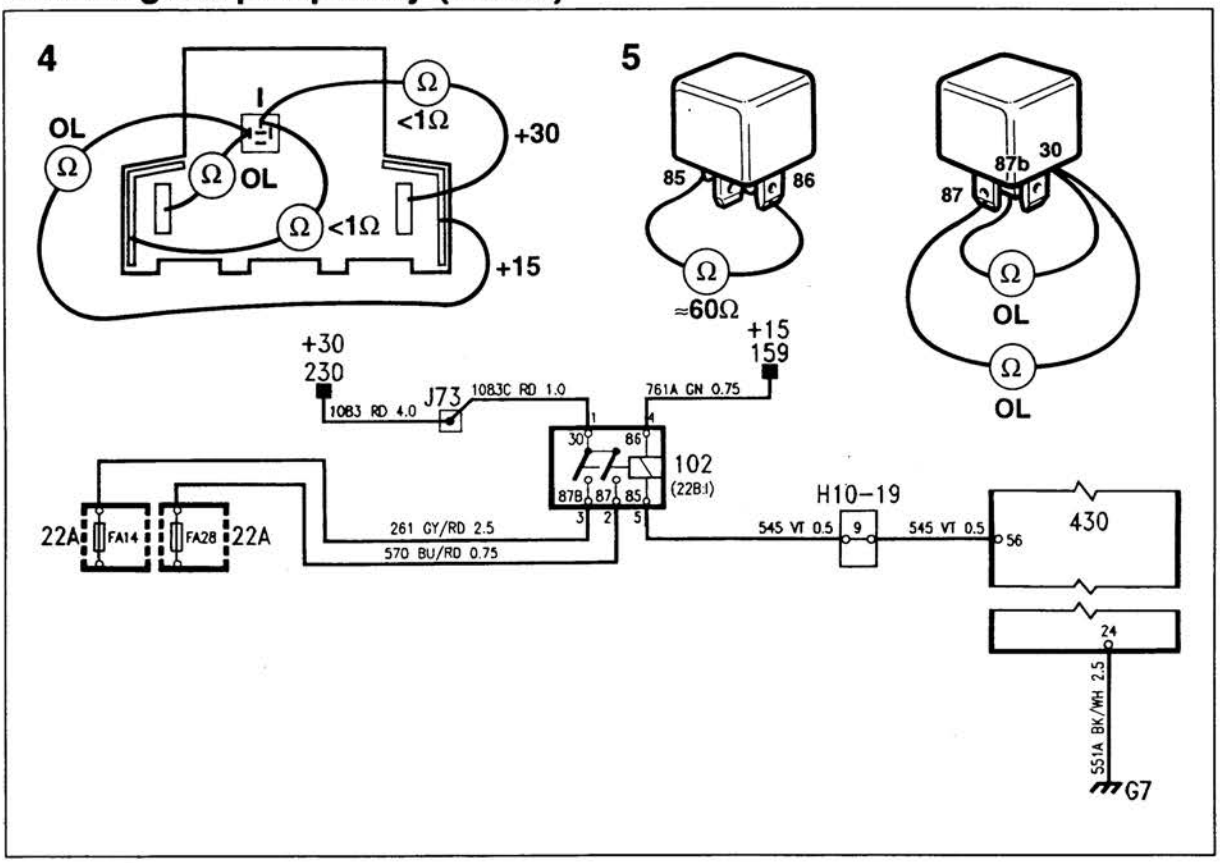
If the relay does not operate, continue as described below.

3 Check whether battery positive voltage is present up to pins 86 and 30 of the relay.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the pump relay (contd.)



4 If battery positive voltage is not present on terminals 86 and 30, check the supply cables from the +15 and +30 terminals for continuity/ shorting to ground.

If the cables are OK, check whether the resistance across terminals 85 and 86 of the relay is about 60 ohms.

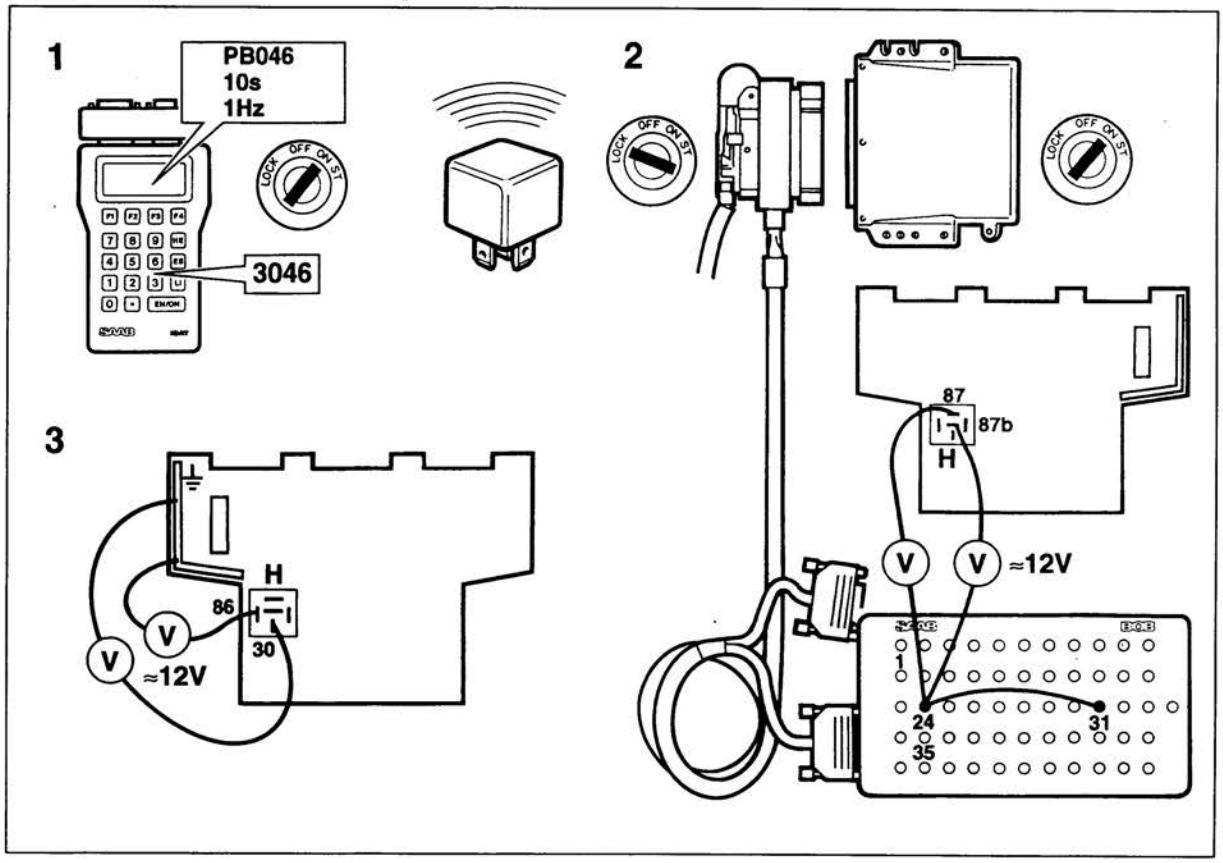
If it is not, replace the relay.

5 Check the resistance across terminals 30 and 87 and 87B of the relay. When the relay is not energized the resistance should be about 0 ohms and when energized less than 1 ohm.

If the relay is faulty, replace it.

6 If the fault persists in spite of the above checks, turn to page 149 for further diagnostic instructions.

Checking the main relay



1 Connect an ISAT scan tool, contact the SFI system and enter command code 3046.

Check whether the relay is energized at a frequency of 1 Hz (for 10 seconds).

2 With the ignition switched off, connect a BOB to the ECM. Check the operation of the relay as follows:

Turn the ignition switch to the Drive position and connect a jumper cable between terminals 31 and 24 of the BOB. Check whether the relay is energized by measuring the voltage at pins 87 and 87B.

If the relay operates, continue with point 6.

If the relay operates but fastens in the energized condition, go to point 5.

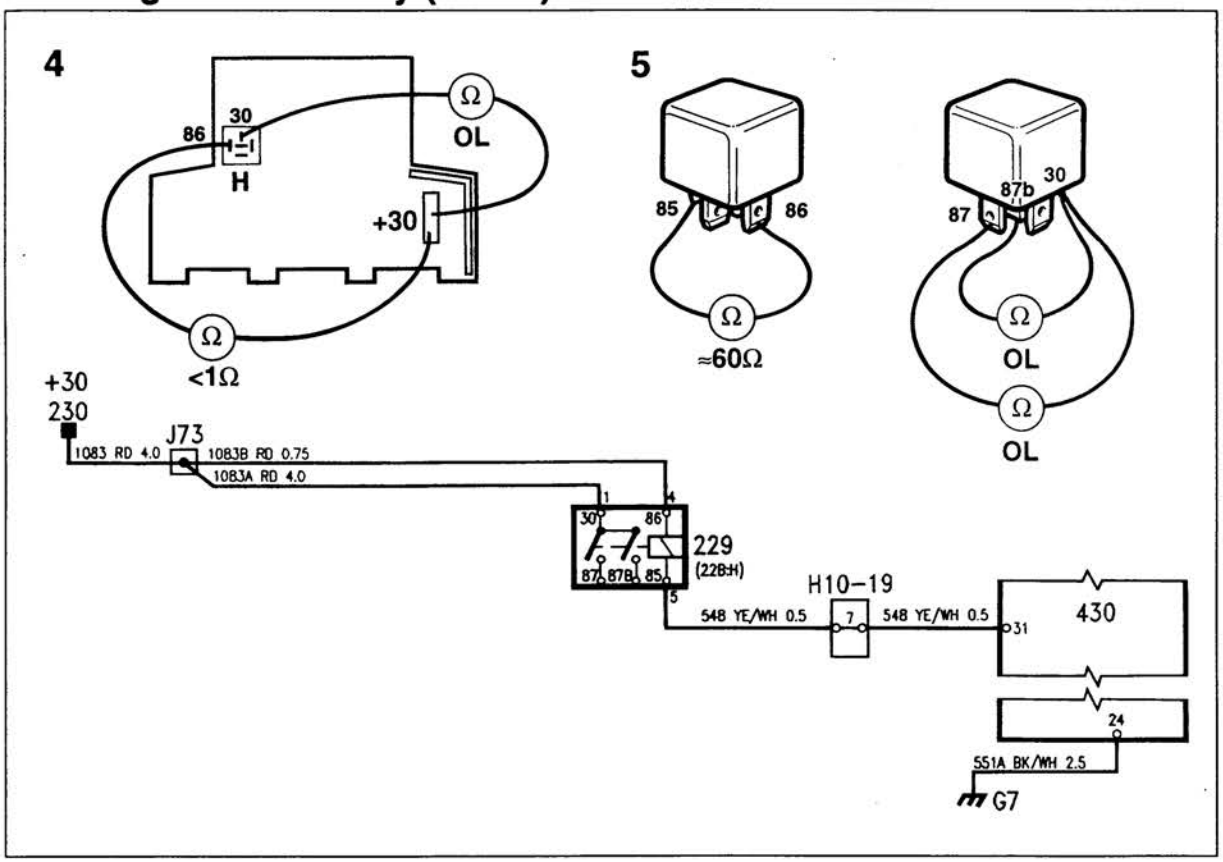
If the relay does not work, continue as described below.

3 Check that battery positive voltage is present up to pins 86 and 30 of the relay.

Note:

When command code 30XX has been used, the car cannot be started for the following 12 minutes. Use command code **FF00** to clear the function, following which the car can be started. For further information, see page 79.

Checking the main relay (contd.)



4 If battery positive voltage is not present on pins 86 and 30, check the supply cables from the +30 terminal for continuity/shorting to ground.

If the cables are OK, check that the resistance across terminals 85 and 86 of the relay is about 60 ohms.

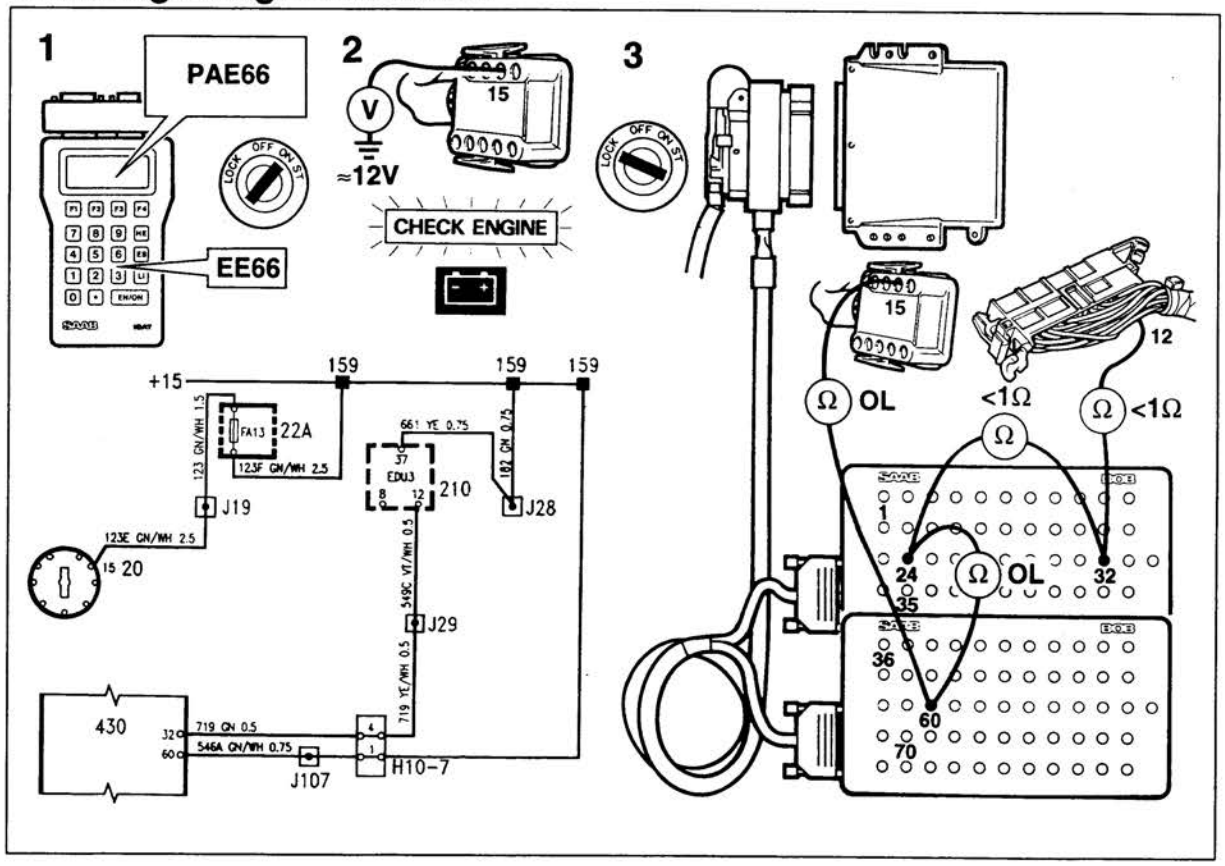
If it is not, replace the relay.

5 Check the resistance across terminals 30 and 87 and 87B of the relay. When the relay is not energized the resistance should be about 0 ohms and when energized less than 1 ohm.

If the relay is faulty, replace it.

6 If the fault persists in spite of the above checks, turn to page 149 for further diagnostic instructions.

Checking the ignition switch



1 Connect an ISAT scan tool, contact the SFI system and enter command code EE66. The status of the system will be displayed on the ISAT scan tool. With the ignition switched on, the display should show PAE66 ON.

If no communication can be established with the system, continue with point 4.

2 Check whether voltage is present on terminal 15 of the ignition switch when it is in the Drive position (look at the warning lamps or take a measurement directly on the +15 terminal).

If voltage is not present, the ignition switch is faulty and must be remedied. If voltage is present on terminal 15, continue as described below.

3 Connect a BOB to the ECM wiring harness (ECM disconnected) and, with the ignition switched off, check the lead to pin 60 of the ECM for continuity/shorting to ground.

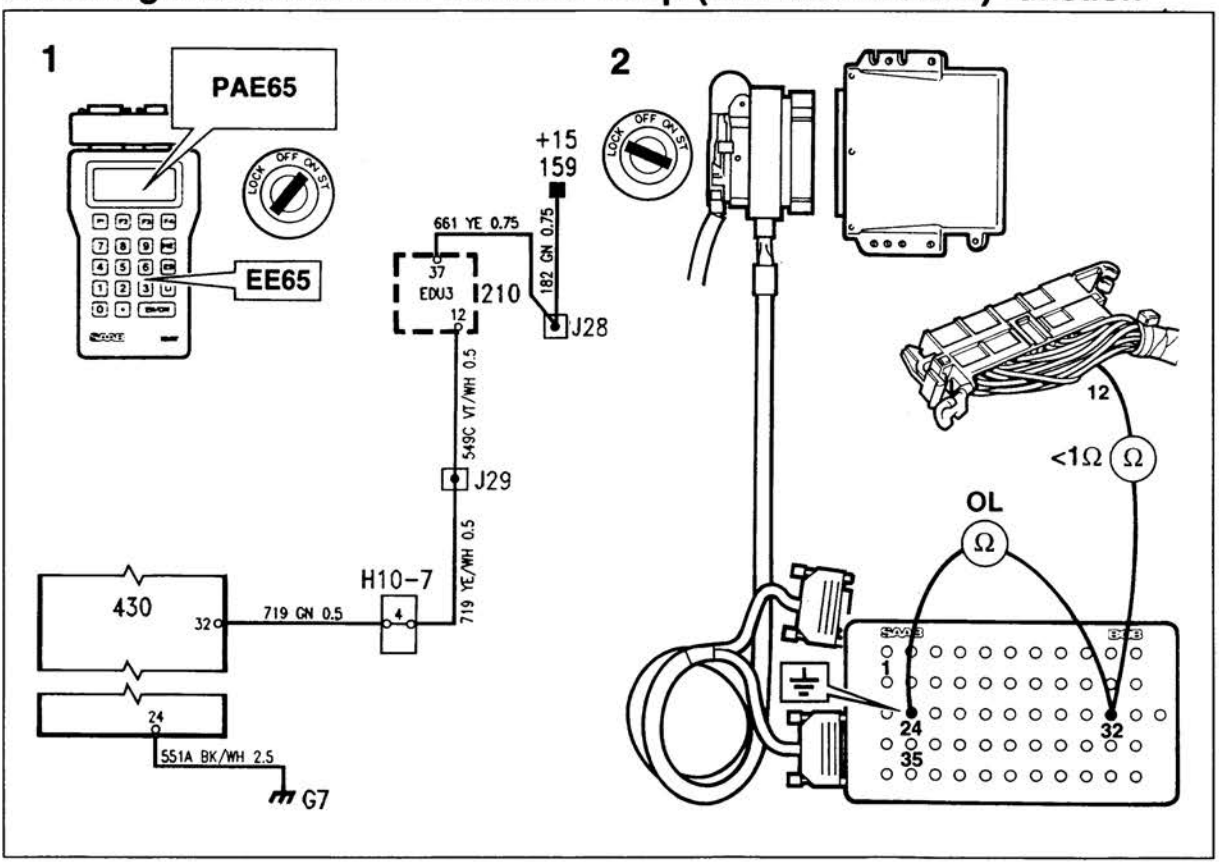
If the lead is not OK, remedy the fault or else turn to page 149 for further diagnostic instructions.

4 With the ignition still switched off, check the lead to pin 32 of the ECM for continuity/shorting to ground.

If the lead is not OK, remedy the fault or check the malfunction indicator lamp (MIL), see page 120.

If the MIL (CHECK ENGINE lamp) is OK, turn to page 149 for further diagnostic instructions.

Checking the malfunction indicator lamp (CHECK ENGINE) function



1 Connect an ISAT scan tool, contact the SFI system and enter command code EE65.

Compare the status of the system as displayed on the ISAT scan tool with the malfunction indicator lamp (MIL) in the car, according to the following table:

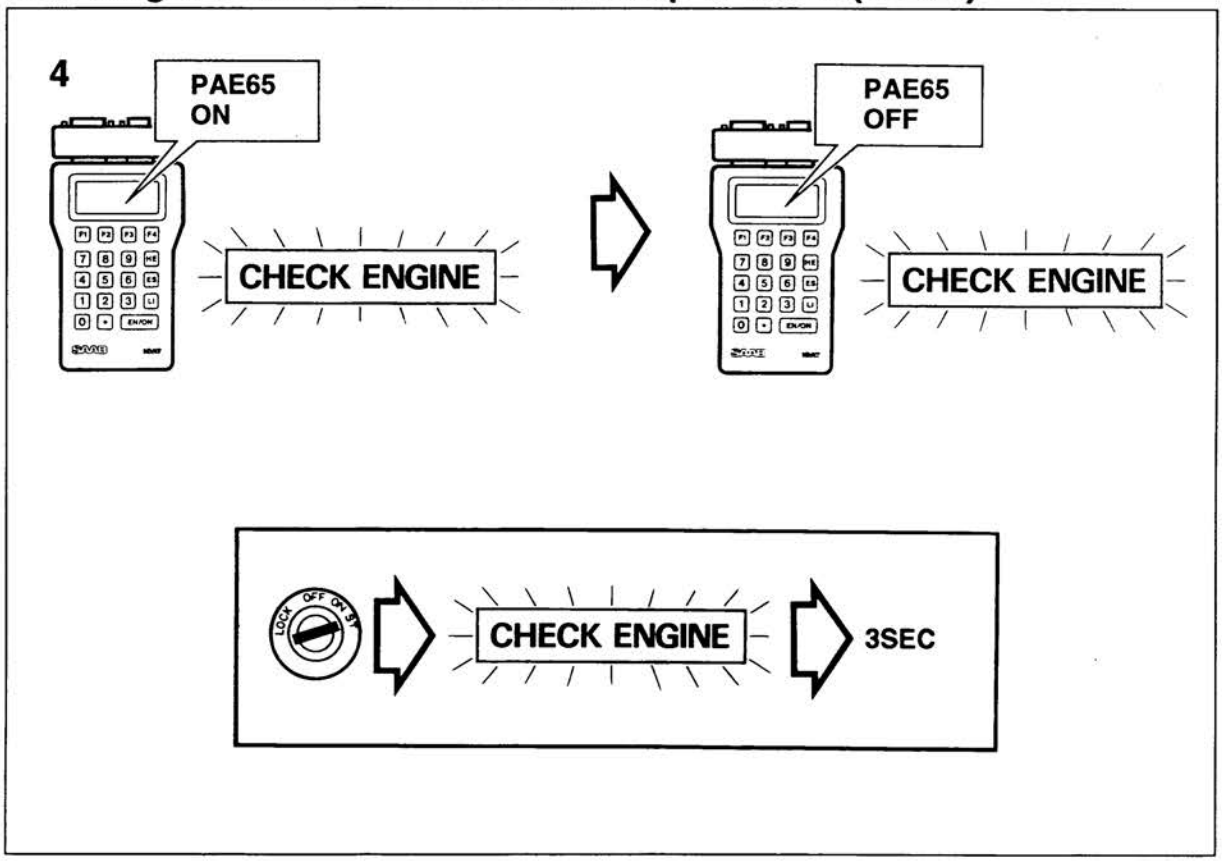
ISAT	MIL	Action
PAE65 OFF	On	See point 2
PAE65 OFF	Out	OK, no action
PAE65 ON	On *)	See point 4
PAE65 ON	Out	See point 5

**) MIL (CHECK ENGINE lamp) illuminated more than 3 seconds after ignition ON.*

2 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected) and check the lead to pin 32 of the ECM for continuity/shorting to ground.

If the lead is faulty, remedy it.

Checking the malfunction indicator lamp function (contd.)



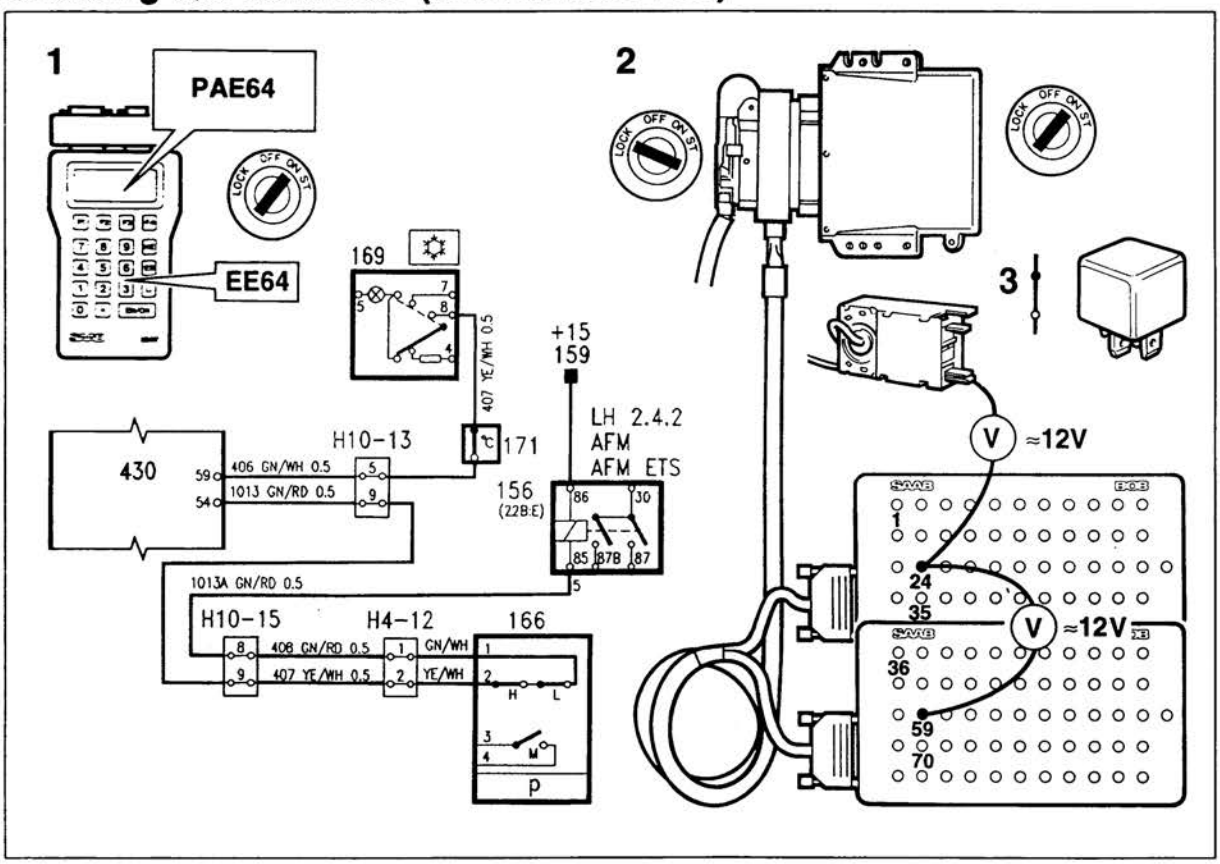
3 If the lead is OK, turn to page 149 for further diagnostic instructions.

4 PAE65-ON displayed by the ISAT scan tool at the same time as the MIL is illuminated indicates a fault in the SFI system. Use the ISAT to ascertain any faults in the SFI system, remedy the faults and then erase the DTCs.

Check as described in point 1 that PAE65-OFF is now displayed on the ISAT scan tool when the MIL is out.

5 Check the MIL, see page 120.

Checking A/C activation (cars without TCS)



1 Connect an ISAT scan tool, contact the SFI system and enter command code EE64.

The status of the system is displayed on the ISAT:

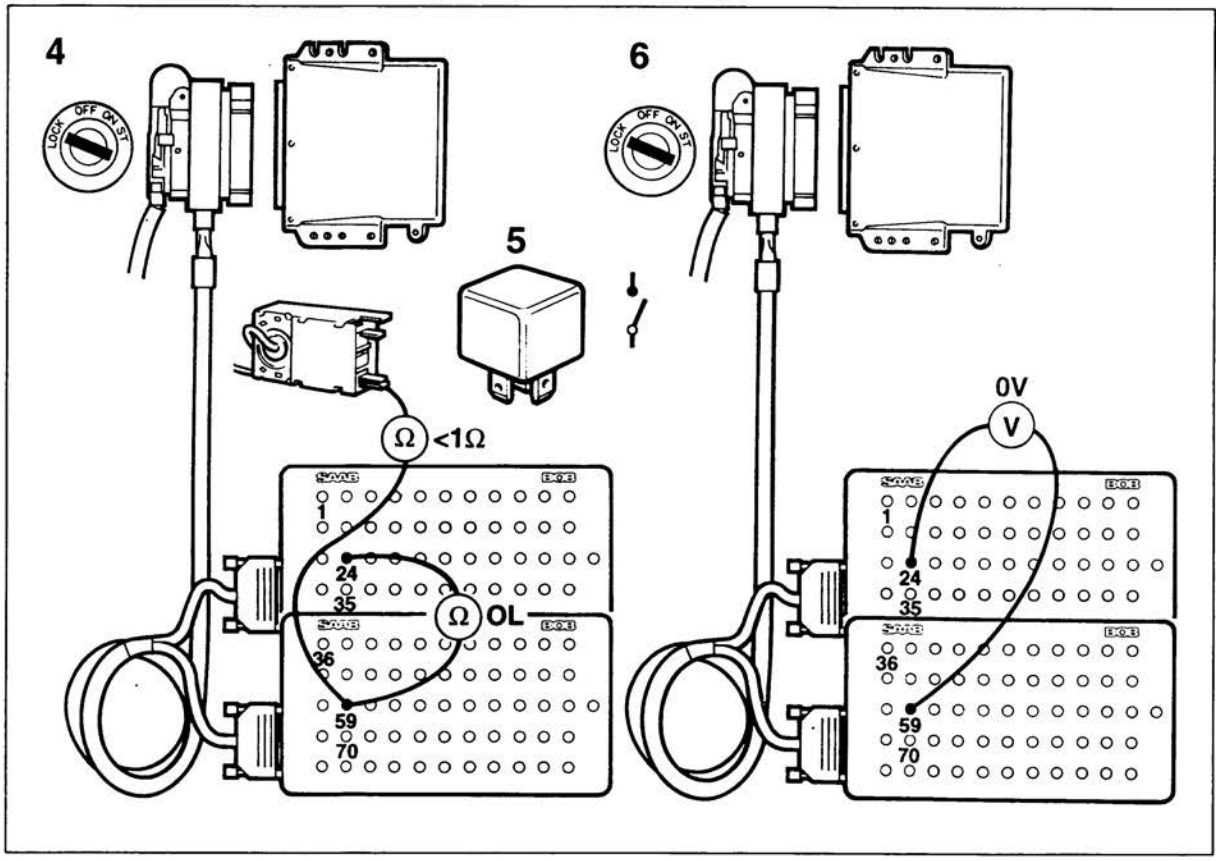
- A/C compressor switched on@PAE64-ON. If not, go to point 2.
- A/C compressor switched off@PAE64-OFF. If not, go to point 5.

2 Check whether the A/C function is OK. If it is not, connect a BOB to the ECM. Turn the ignition switch to the Drive position and, with the A/C function activated, check whether voltage is present on pin 59 of the ECM.

If it is, turn to page 149 for further diagnostic instructions.

3 If no voltage is present, check whether voltage passes through the anti-freeze thermostat when the A/C compressor is working. If it does not, check the A/C function as described in Service Manual 3:2, page 255.

Checking A/C activation (cars without TCS)(contd.)



4 If voltage is present, disconnect the ECM, switch the ignition off and use the BOB to check the lead to pin 59 of the ECM for continuity/shorting to ground.

Take remedial action if the lead and/or connectors are faulty.

5 Check that no voltage is applied to the anti-freeze thermostat when the A/C function is not activated.

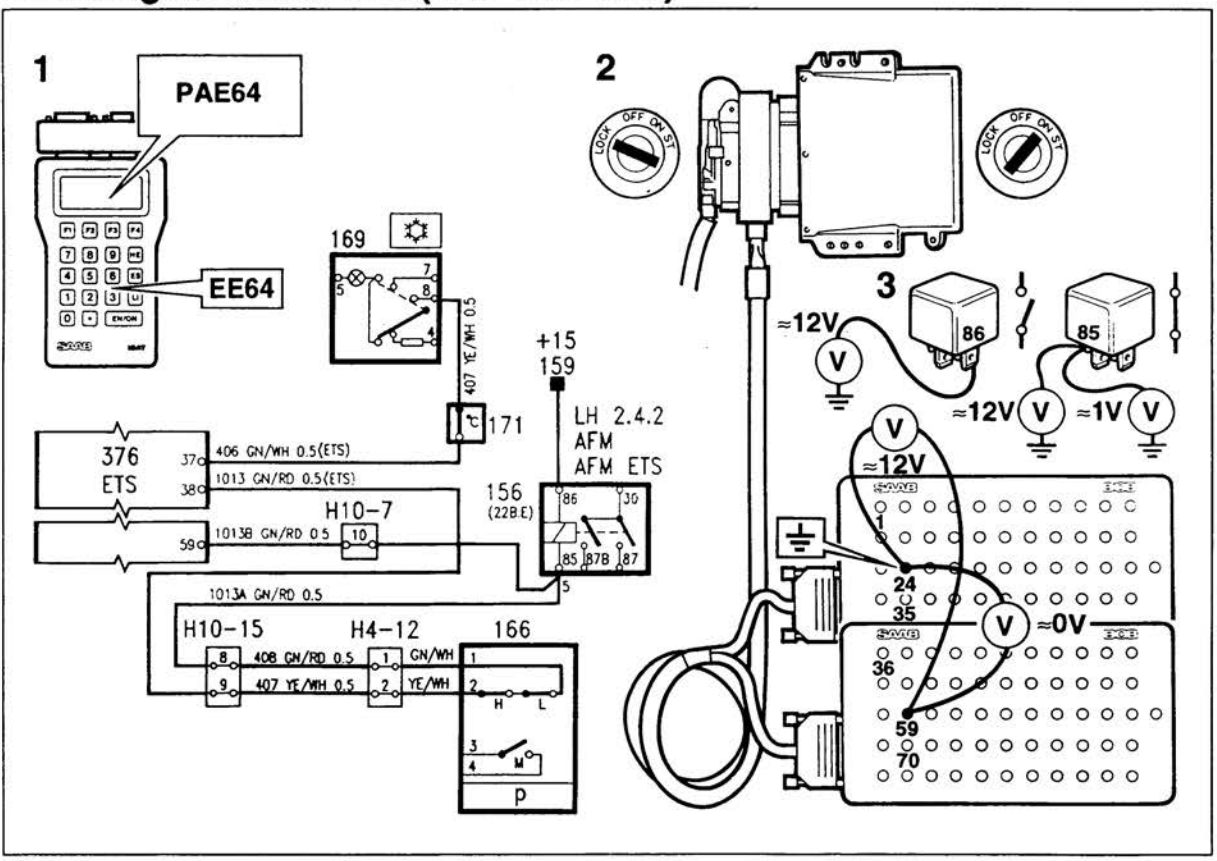
If it is, check the A/C function as described in Service Manual 3:2, page 255.

6 If no voltage is applied to the anti-freeze thermostat, use the BOB (ECM disconnected) to check the lead to the ECM for shorting to battery positive voltage or to any component connected to the lead.

Take remedial action in the event of a faulty lead and/or connector, or any component through which voltage is applied to the lead.

If the lead is OK, turn to page 149 for further diagnostic instructions.

Checking A/C activation (cars with TCS)



1 Connect an ISAT scan tool, contact the SFI system and (with the engine running) enter command code EE64.

The status of the system is displayed on the ISAT:

- A/C compressor switched off → PAE64-ON. If not, go to point 2.
- A/C compressor switched off → PAE64-OFF. If not, go to point 5.

2 Check whether the A/C function is OK.

If it is not, connect a BOB to the ECM and check whether battery positive voltage is present on pin 59 of the ECM when the A/C compressor is working.

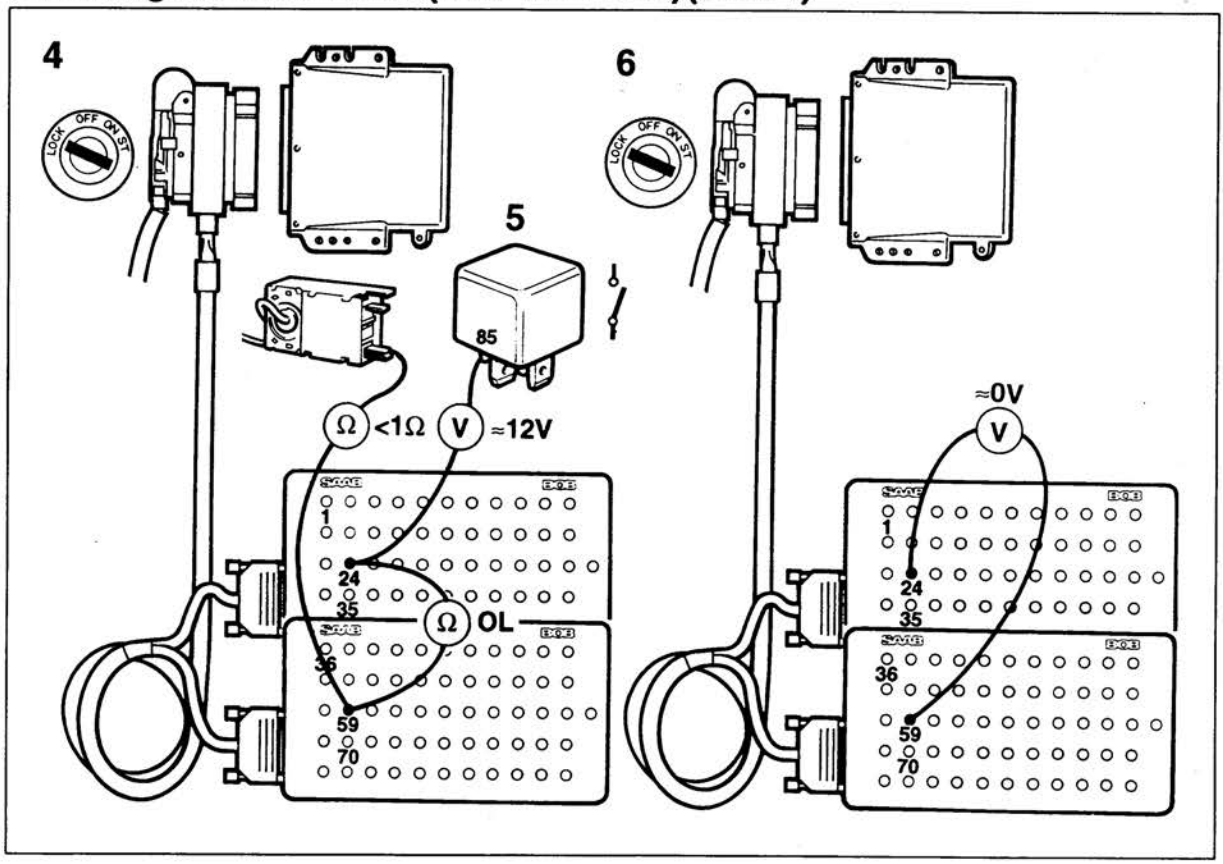
If voltage is present, turn to page 149 for further diagnostic instructions.

3 If not, check whether voltage is present on pin 86 of the A/C relay and that the voltage applied to pin 85 is about 1 V when the relay is in the operated condition (A/C compressor working).

(With the A/C compressor disconnected the voltage on pin 85 is about 12 V.)

If not, check the A/C function as described in Service Manual 3:2, page 255.

Checking A/C activation (cars with TCS)(contd.)



4 If voltage is present, disconnect the ECM, switch off the ignition and check the lead to pin 59 of the ECM for continuity/shorting to ground. Take remedial action if the wiring is faulty.

5 Check whether the voltage applied to pin 85 of the A/C relay is about 12 V when the A/C function is not activated.

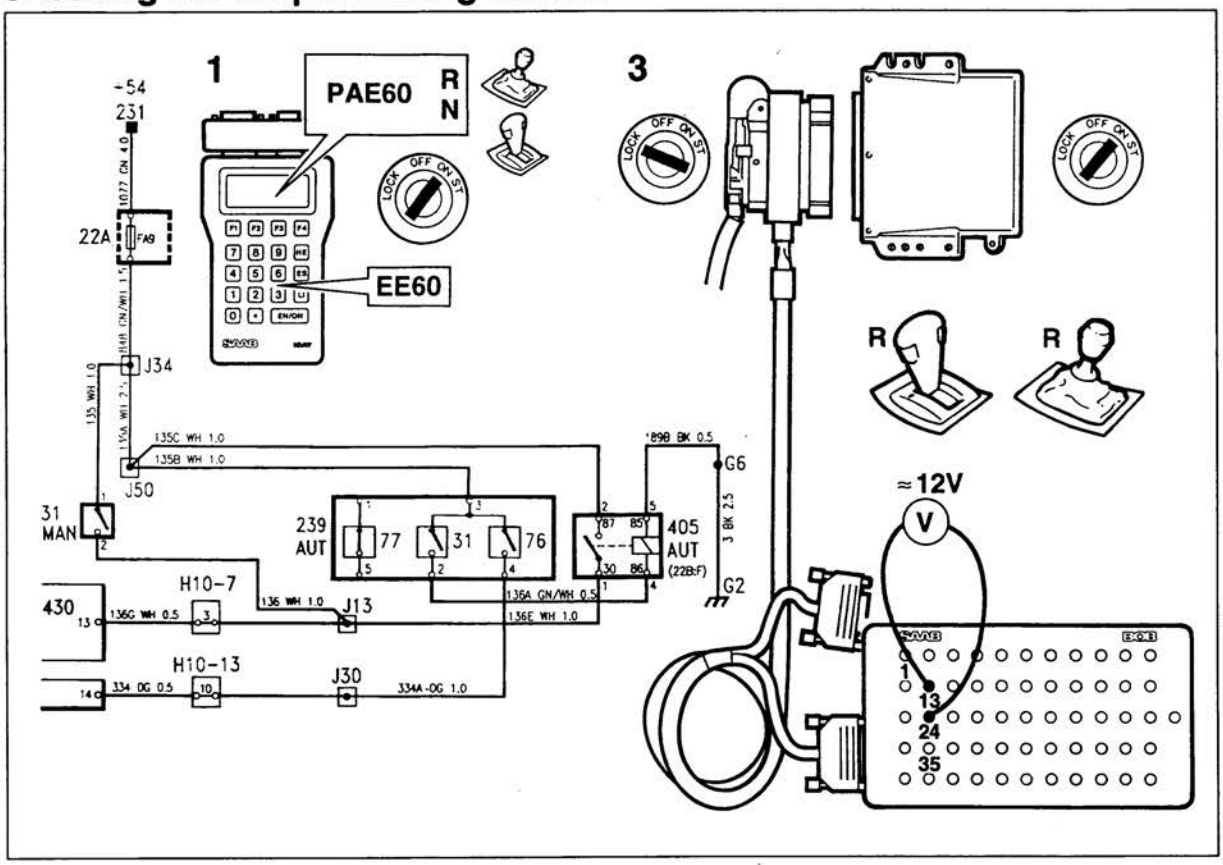
If it is not, check the relay and A/C function as described in Service Manual 3:2, page 255.

6 If no voltage is applied to the relay, use the BOB (ECM disconnected) to check the lead to the ECM for shorting to battery positive voltage or to any component connected to the lead.

Take remedial action in the event of a faulty lead and/or connector, or any component through which voltage is applied to the lead.

If the lead is OK, turn to page 149 for further diagnostic instructions.

Checking the torque limiting function



1 Connect an ISAT scan tool, contact the SFI system and enter command code EE60.

The status of the system is displayed on the ISAT:

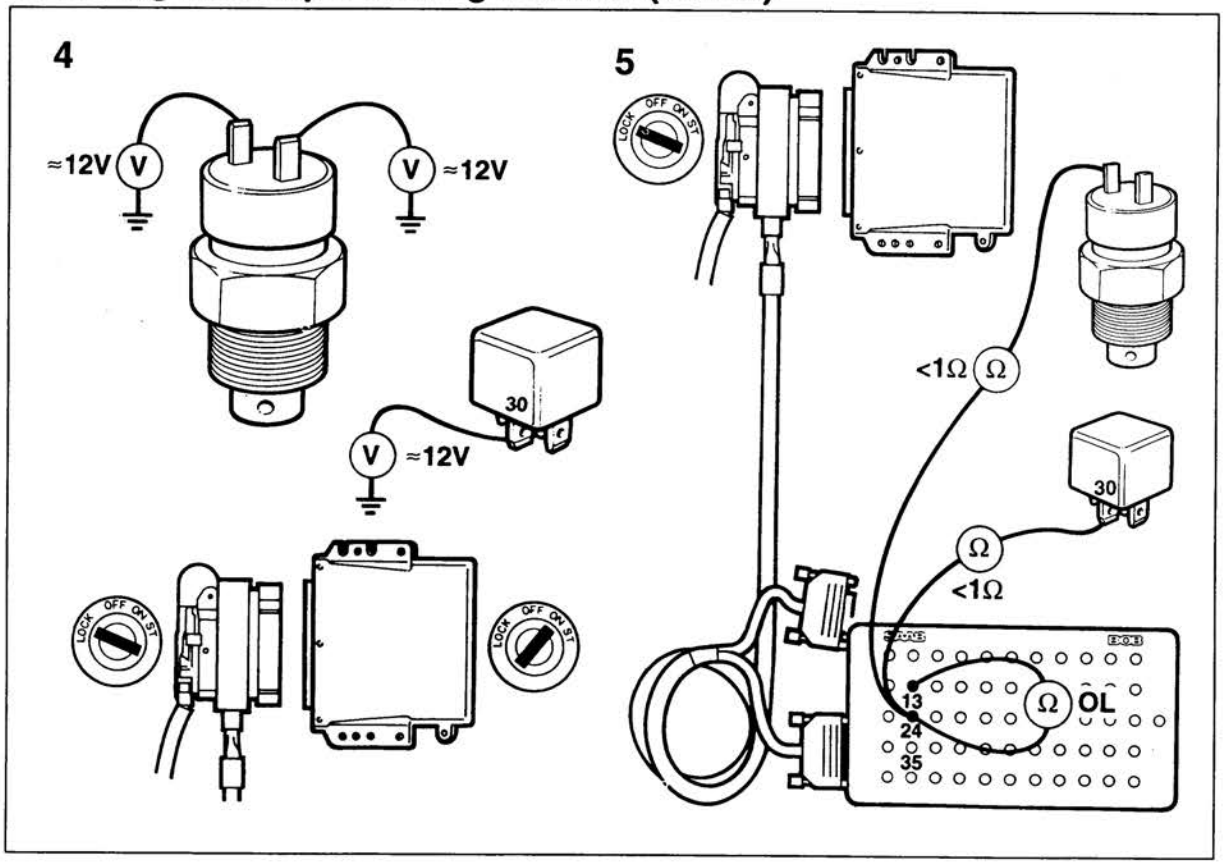
- With reverse gear selected→ PAE60-ON.
  If not, go to point 2.
- With the gear lever in neutral or the selector lever in the N position → PAE60-OFF.
  If not, go to point 6.

2 Check whether fuse FA9 is intact.

3 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected) and check (with the ignition switch turned to the Drive position) whether battery positive voltage is present on pin 13 of the ECM (reverse gear selected).

If voltage is present, turn to page 149 for further diagnostic instructions.

Checking the torque limiting function (contd.)

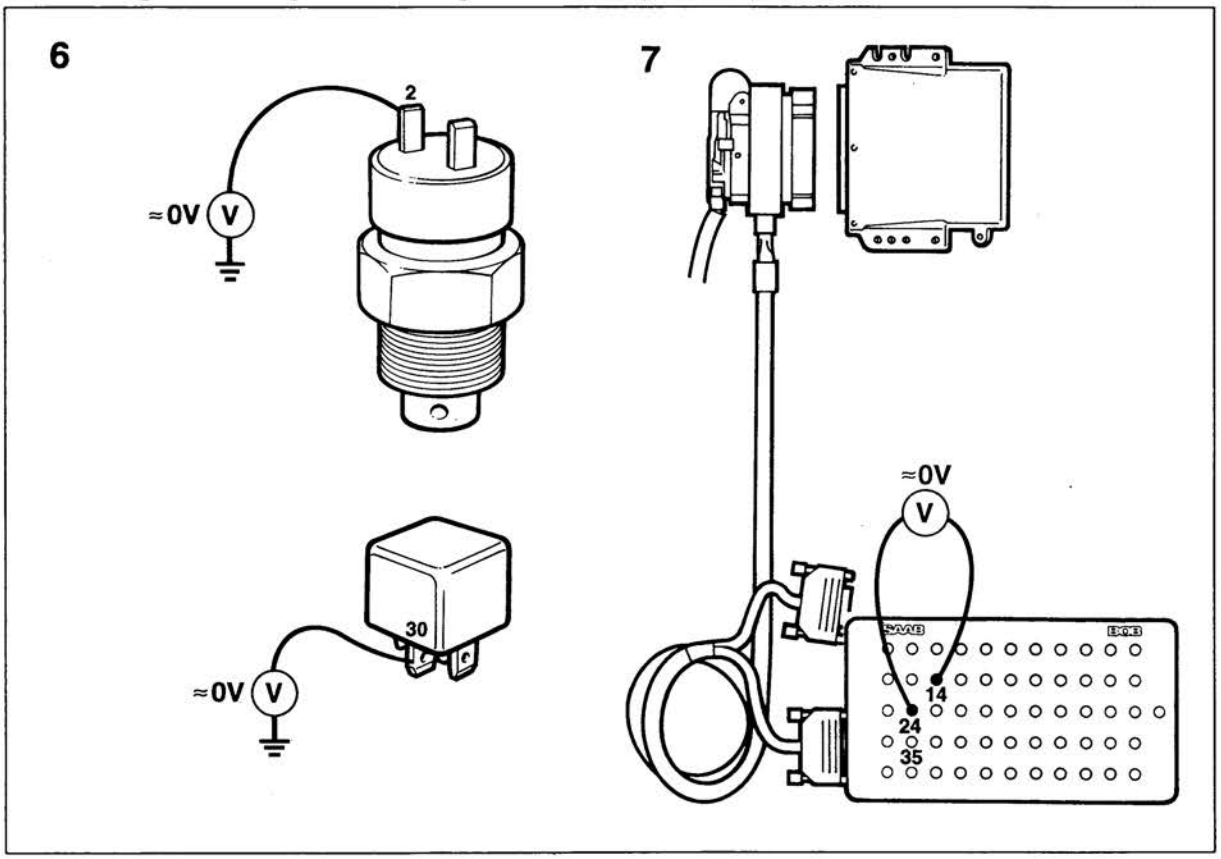


4 If no voltage is present, check whether voltage is present up to:

- **Manual:** Terminal 1 of the reversing light switch, and also terminal 2 when the switch is activated. If it is not, replace the switch or, alternatively, check the lead from terminal 1 of the switch to the fuse.
- **Automatic:** Terminal 30 of the reversing light switch when the switch is activated. If it is not, check the operation of the selector lever and the reversing light relay, see Service Manual 3:2, page 165.

5 With the ignition switched off, use a BOB to check the lead to pin 13 of the ECM for continuity/shorting to ground. Take remedial action if the lead is faulty.

Checking the torque limiting function (contd.)



6 **Manual:** Check that pin 2 of the brake light switch is not live when the switch is not activated. If it is, replace the brake light switch.

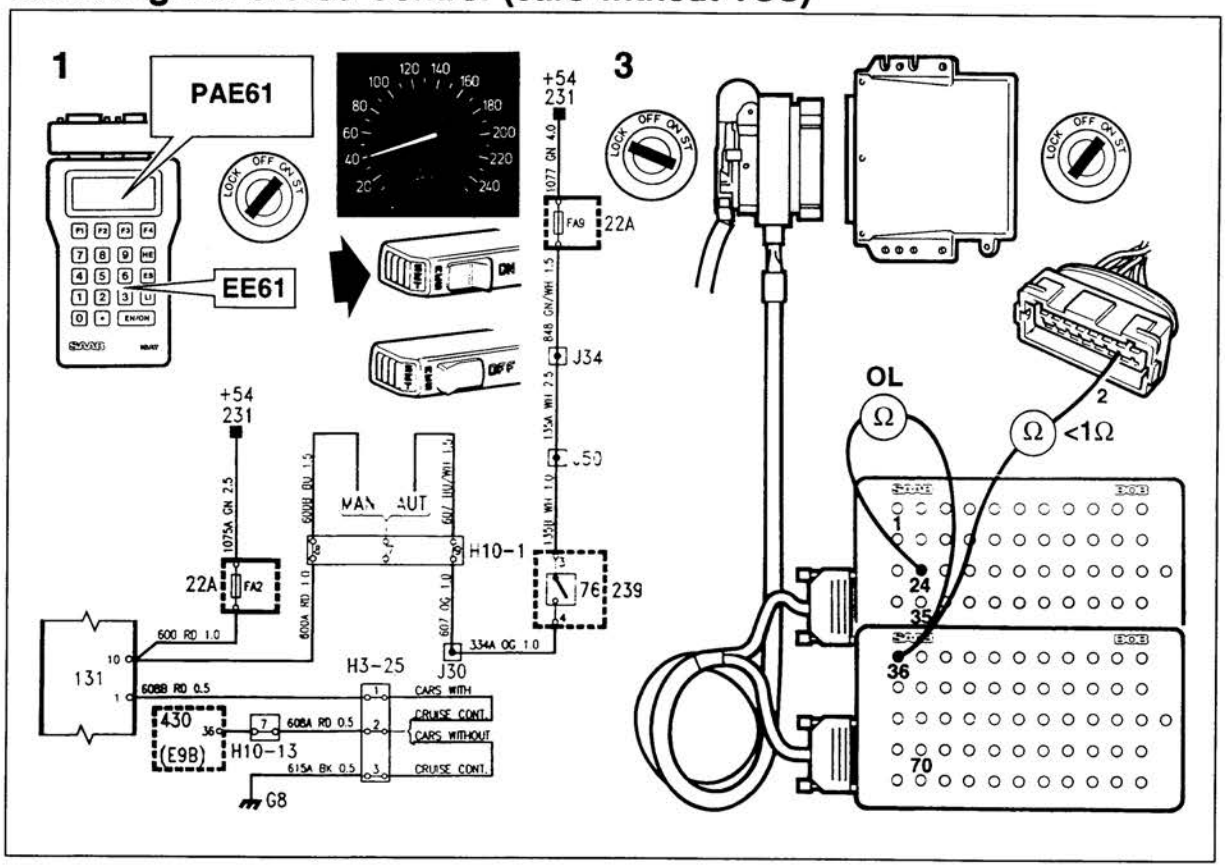
Automatic: Check that pin 30 of the reversing light relay is not live when the relay is not activated. If it is, check the operation of the selector lever and the reversing light relay, see Service Manual 3:2, page 165.

7 With the ignition switched off, connect the BOB to the ECM wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and check the lead to pin 14 of the ECM for shorting to battery positive voltage. Take remedial action if the cable is faulty.

If the cable is OK, turn to page 149 for further diagnostic instructions.

Checking the Cruise Control (cars without TCS)



1 Connect an ISAT scan tool, contact the AFM system and enter command code EE61.

The status of the system is displayed on the ISAT:

- With the Cruise Control in the "ON" position (the car must be driven faster than 40 km/h with the SET button depressed) → PAE63-ON. If not, go to point 2.
- With the Cruise Control in the "OFF" position→ PAE63-OFF. If not, go to point 5.

2 Check fuse FA2 (manual) or FA9 (automatic). Also check whether the Cruise Control is in working order.

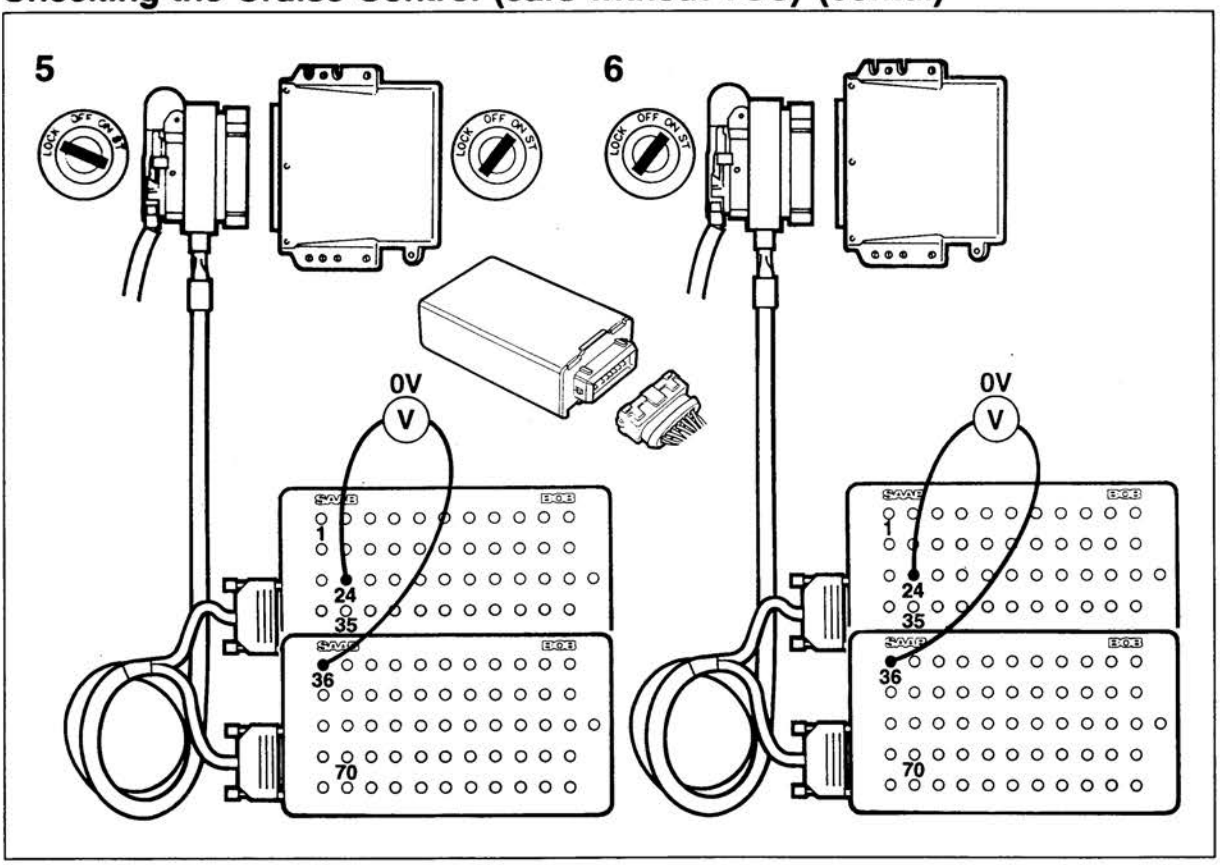
If it is not, replace the fuse or carry out a fault diagnosis of the Cruise Control system, see Service Manual 3:2, page 307.

If the Cruise Control system is OK, continue as described below.

3 With the ignition switched OFF, connect the BOB to the ECM wiring harness (ECM disconnected) and check the lead to pin 36 of the ECM for continuity/shorting to ground.

Take remedial action if the cable is faulty.

Checking the Cruise Control (cars without TCS) (contd.)



4 If the cable is OK, turn to page 149 for further diagnostic instructions.

5 With the ignition switched off, connect the BOB to the ECM wiring harness (ECM disconnected). Turn the ignition switch to the Drive position and check whether voltage is present on pin 36 of the ECM.

If it is not, turn to page 149 for further diagnostic instructions.

If it is, continue as described below.

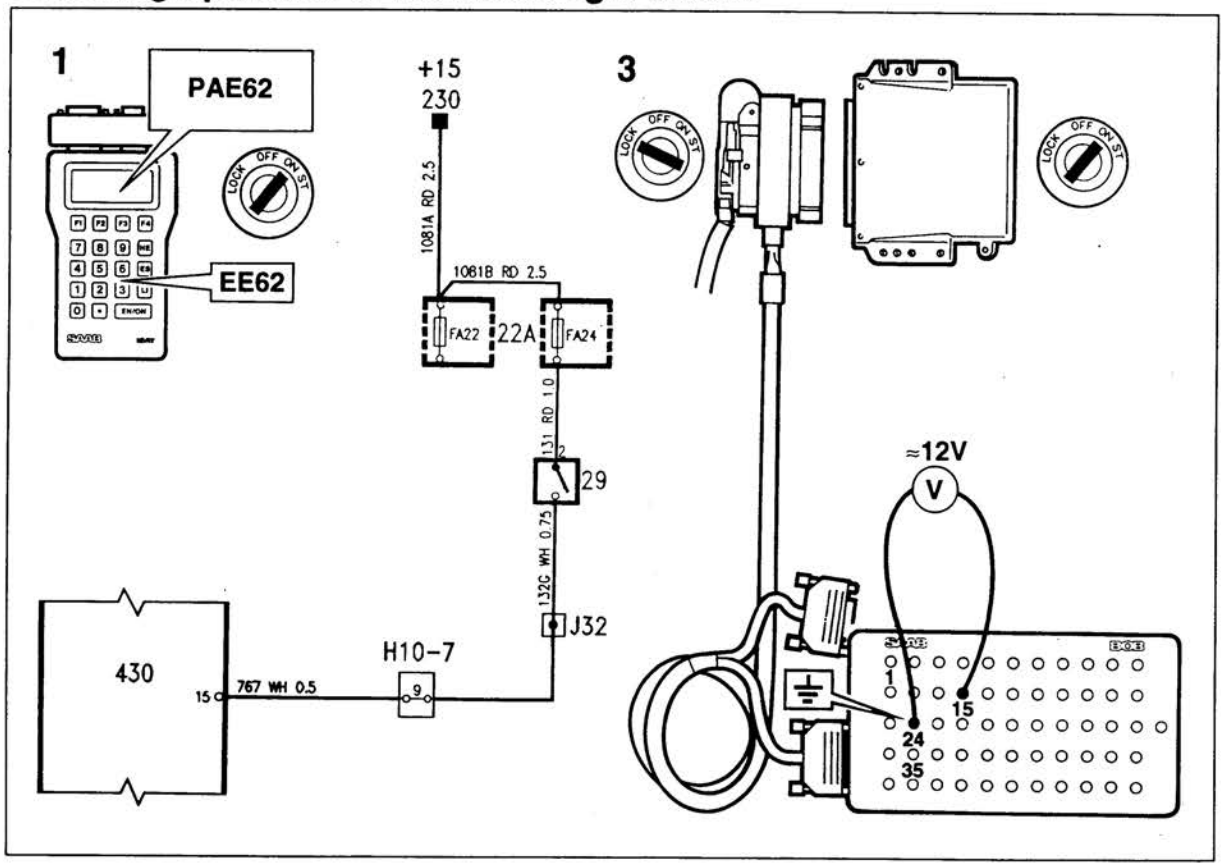
6 Unplug the connector from the control module of the Cruise Control system and check whether voltage is still present on pin 36. If it is, carry out a fault diagnosis of the Cruise Control system, see Service Manual 3:2, page 307.

If voltage is still present on pin 36 of the ECM, check the lead to it for shorting to battery positive voltage.

Take remedial action if the wiring is faulty.

7 Turn to page 149 for further diagnostic instructions.

Checking operation of the brake light switch



1 Connect an ISAT scan tool, contact the SFI system and enter command code EE62.

The status of the system is displayed on the ISAT:

- Brake pedal depressed → PAE62-ON. If not, go to point 2.
- Brake pedal not depressed→ PAE62-OFF. If not, go to point 5.

2 Check whether fuse FA24 is intact. Also check whether the brake lights work. Change the fuse if it has blown. Take remedial action if the brake lights do not work.

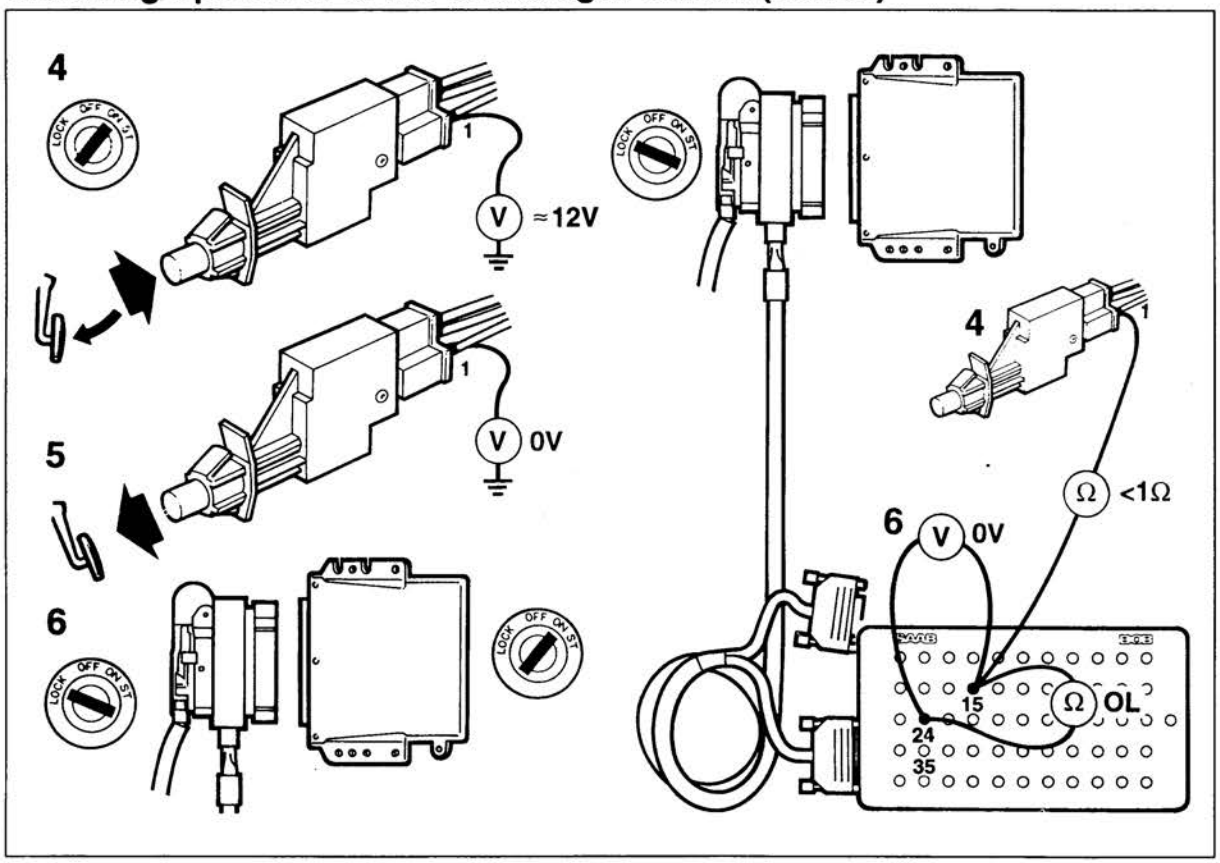
If the fuse is OK, continue as described below.

3 With the ignition switched off, connect a BOB to the ECM wiring harness (ECM disconnected).

With the ignition switch in the Drive position, check whether battery positive voltage is present on pin 15 of the ECM when the brake pedal is depressed.

If it is, turn to page 149 for further diagnostic instructions. If it is not, continue as described below.

Checking operation of the brake light switch (contd.)



4 Check whether voltage is present on pin 1 of the brake light switch when the switch is activated. If it is not, replace the brake light switch.

If the switch is OK, check the lead to pin 15 of the ECM (ignition switched off) for continuity/ shorting to ground.

Take remedial action if the wiring/connectors are faulty.

5 Check whether voltage is present on pin 1 of the brake light switch when the switch is not activated. If voltage is present, replace the brake light switch.

If the switch is OK, continue as described below.

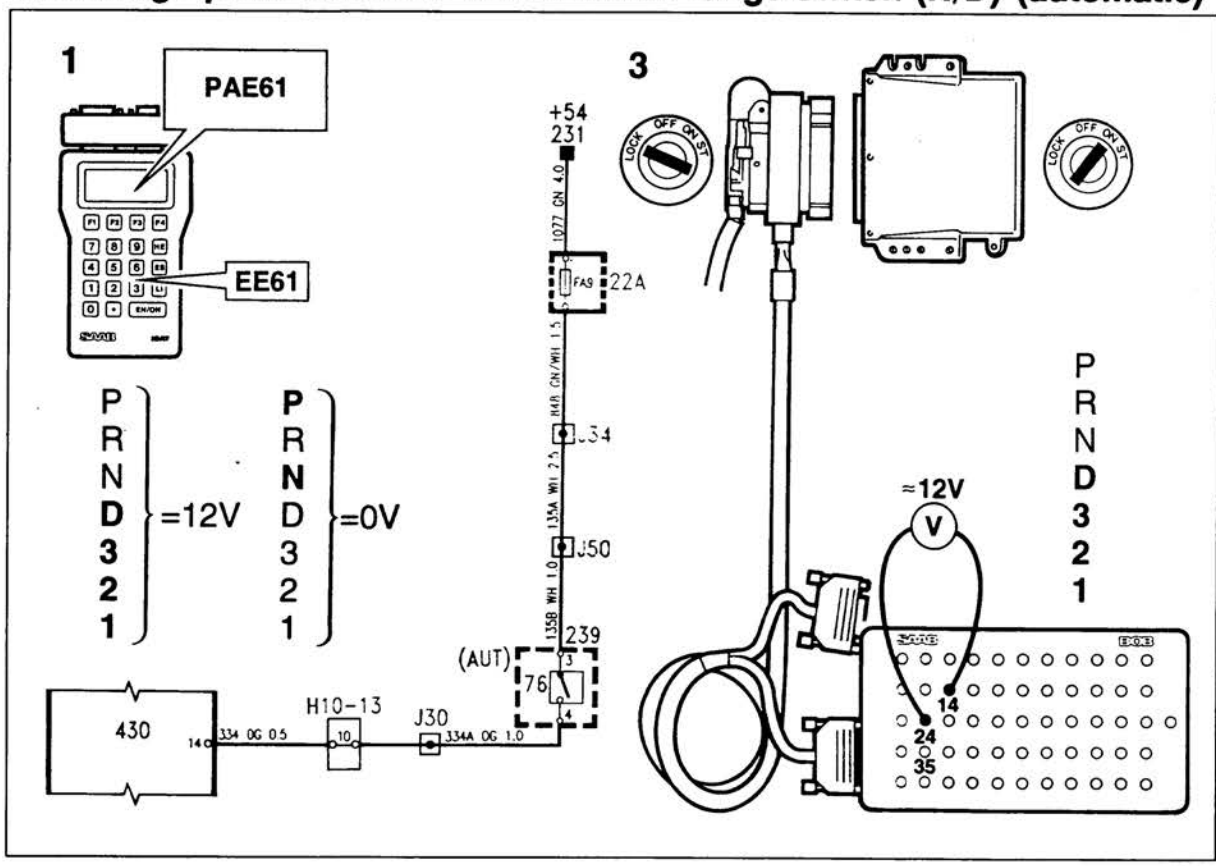
6 With the ignition switched off, connect the BOB to the ECM wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and check the lead to pin 15 of the ECM for shorting to battery positive voltage.

Take remedial action in the event of faulty wiring/ connectors or any component connected to grounding point J32 which might be the cause of voltage being applied to the circuit.

7 If the wiring is OK, turn to page 149 for further diagnostic instructions.

Checking operation of the transmission range switch (N/D) (automatic)



1 Connect an ISAT scan tool, contact the AFM system and enter command code EE61.

The status of the system is displayed on the ISAT:

- Selector lever in position D, R, 1, 2 or 3@PAE61-ON. If not, go to point 2.
- Selector lever in position N or P@PAE61-OFF. If not, go to point 6.

2 Check fuse FA9.

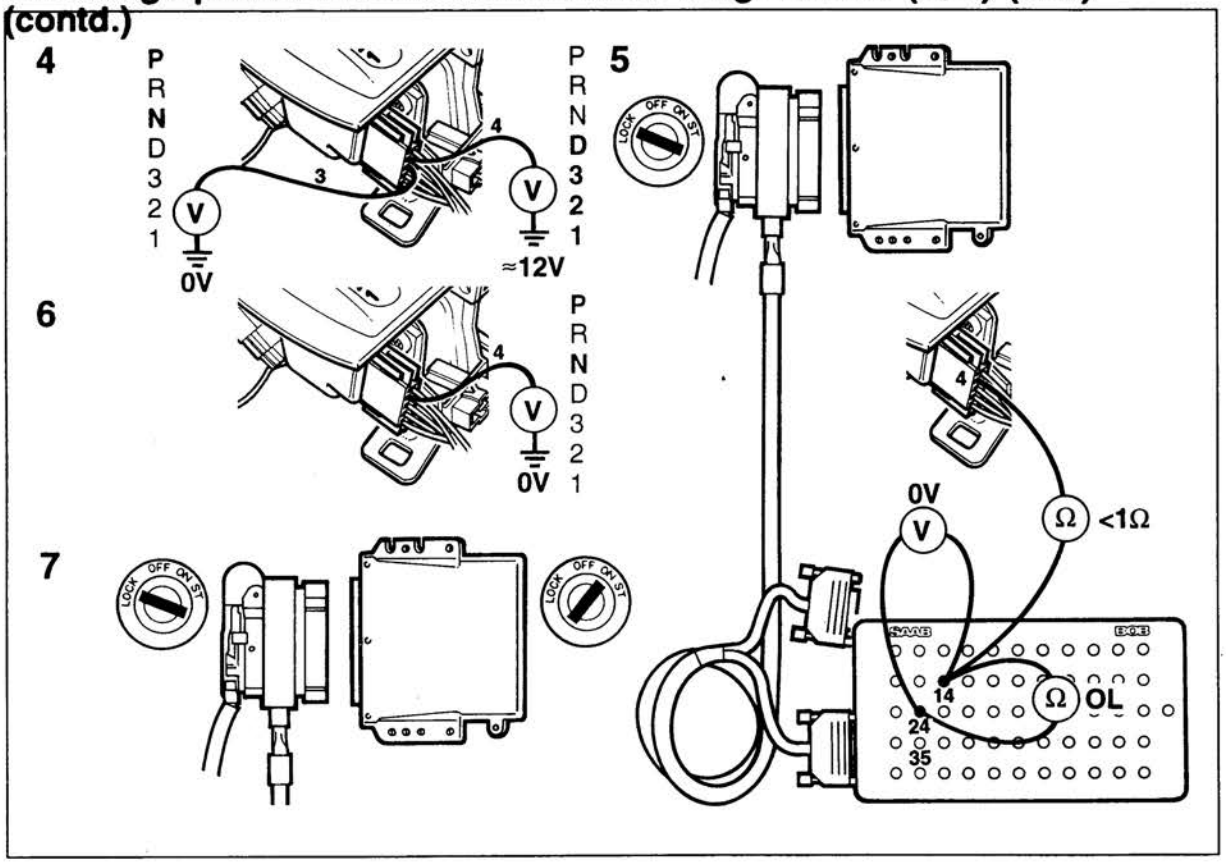
3 With the ignition switched off, connect the BOB to the ECM wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and check whether voltage is present on pin 14 of the ECM (selector lever in position D, R, 1, 2 or 3).

If it is, turn to page 149 for further diagnostic instructions.

If it is not, continue as described below.

Checking operation of the transmission range switch (N/D) (aut.) (contd.)



4 Check whether voltage is present on pin 3 of the transmission range switch (selector lever switch) and also on pin 4 when the switch is activated.

If voltage is present on pin 3 but not on pin 4, replace the switch.

If no voltage is present on pin 3, check the lead from pin 3 to fuse FA9 for continuity.

5 If the switch and lead above are OK, switch off the ignition and use the BOB to check the lead to pin 14 of the ECM for continuity/shorting.

Take remedial action if the wiring and/or connectors are faulty.

6 Check whether pin 4 of the transmission range switch is live when the switch is not activated (selector lever in position N or P). If it is, replace the transmission range switch.

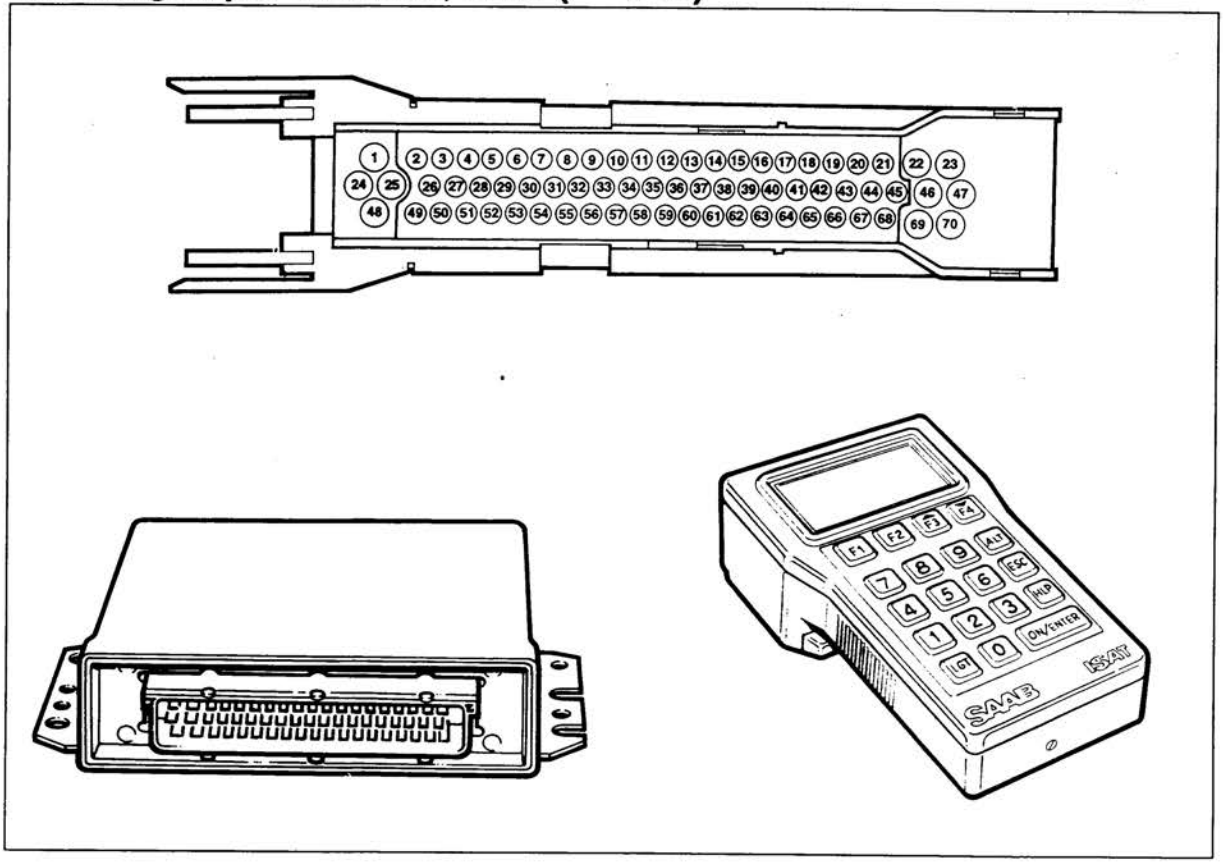
7 If the switch is OK, turn off the ignition and connect the BOB to the ECM wiring harness (ECM disconnected).

Turn the ignition switch to the Drive position and check the lead to pin 14 of the ECM for shorting to battery positive voltage.

Take remedial action in regard to faulty wiring/connectors/components causing the short circuit.

8 If the wiring is OK, turn to page 149 for further diagnostic instructions.

Checking of pin functions, ECM (■—#10)

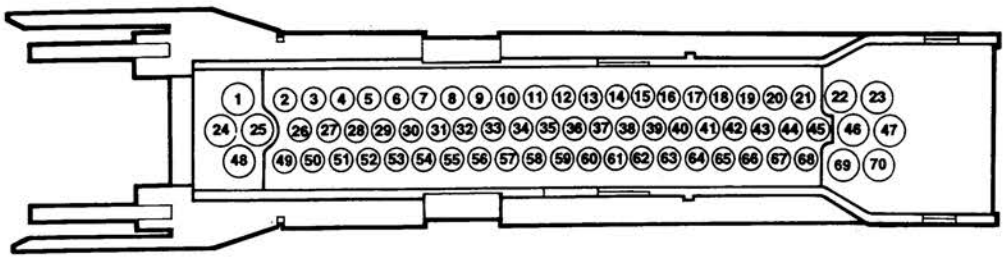


The following pages contain specified values and directions for measuring voltage levels on the engine control module (ECM).
The table covers ECMs for cars both with and without TCS.

Remember:

- Unless otherwise specified, all voltage measurements are to be carried out with all components connected and with the ignition switch in the Drive position.
- The measurements are to be carried out using a Breakout-Box (BOB) connected between the ECM and the ECM's connector.
- Some of the measurements are to be carried out with the engine running at idling speed.
- Several of the voltage levels are to be regarded as guiding values only. Use your common sense when judging whether the reading obtained is correct or not.
- If any measured value is incorrect, use the wiring diagram to determine which leads, connectors or components should be checked additionally.

Voltage measurement, ECM (■—≠10)

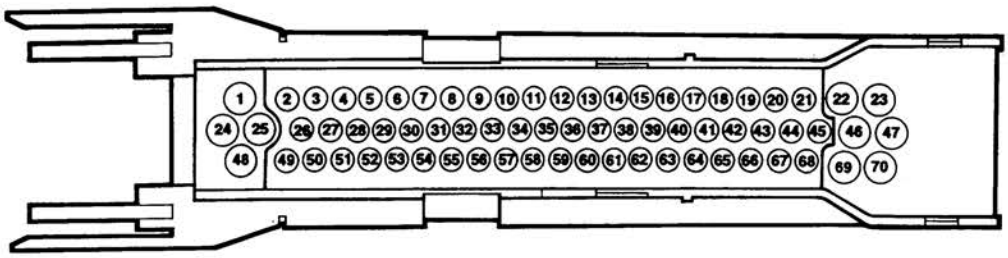


Unless otherwise specified, all measurements are to be carried out using a BOB - with the ignition switch in the Drive position, all connectors plugged in and all components connected.

Pin	Lead colour	Component/function	In-put	Out-put	Voltage (V)	Remarks/pin on component
1	RD	+30 voltage supply	X		approx. 12	
2	GN	Boost pressure control valve (APC)		X	approx. -1	pin 3
3	GN/RD	Injector, cylinder 1		X	approx. 12	When idling
4	GN/RD	Injector, cylinder 2		X	approx. 12	When idling
5	GN/RD	Injector, cylinder 3		X	approx. 12	When idling
6	GN/RD	Injector, cylinder 4		X	approx. 12	When idling
7						Not connected
8						Not connected
9	OG	Trigger/firing signal, cylinder 1		X	approx. -1*)	When idling
10	GN	Trigger/firing signal, cylinder 2		X	approx. -1*)	When idling
11	BU	Trigger/firing signal, cylinder 3		X	approx. -1*)	When idling
12	GY	Trigger/firing signal, cylinder 4		X	approx. -1*)	When idling
13	WH	Torque limiting, charging pressure	X		approx. -1*) 0	Selector lever in position R Other positions
14	OR	Transmission range N/D	X		0 approx. 12	Selector lever P, N Selector lever R, D, 1, 2, 3
15	WH	Brake signal	X		On = approx. 12 Off = 0	From brake light switch

**) Battery Voltage approximately minus 1 Volt*

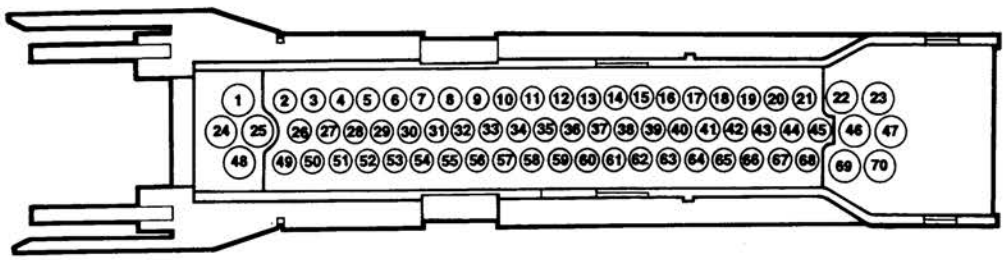
Voltage measurement, ECM (contd.) (■—#10)



Unless otherwise specified, all measurements are to be carried out using a BOB - with the ignition switch in the Drive position, all connectors plugged in and all components connected.

Pin	Lead colour	Component/function	In-put	Out-put	Voltage	Remarks/pin on component
16						Not connected
17	YE	Detection, cylinders 1 and 2	X		approx. 1	When idling
18	BN	Detection, cylinders 3 and 4	X		approx. 1	When idling
19						Not connected
20						Not connected
21	YE/RD	Signal from canister purge valve (ELCD)	X		0 approx. 12	Closed valve Open valve
22	GY	Manifold absolute pressure sensor	X		0.4-4.75 V	Atmospheric pressure = approx. 1.9 V
23	GY	Heated oxygen sensor	X		0-1.5 V	Pin 4
24	BK/WH	Power ground	X			G7 (intake manifold)
25	BK/WH	Power ground	X			G7 (intake manifold)
26	GN	Boost pressure control valve (APC)		X	approx. 12	Pin 1
27	YE/RD	Signal to canister purge valve (ELCD)		X	0 approx. 12	Closed Open
28						Not connected
29						Not connected
30						Not connected

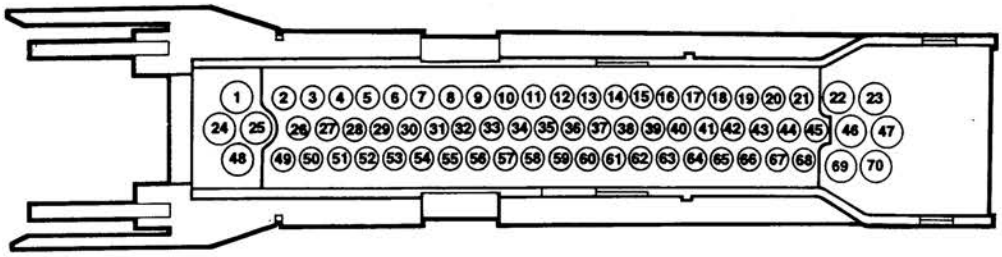
Voltage measurement, ECM (contd.) (■—#10)



Unless otherwise specified, all measurements are to be carried out using a BOB - with the ignition switch in the Drive position, all connectors plugged in and all components connected.

Pin	Lead colour	Component/function	In-put	Out-put	Voltage	Remarks/pin on component
31	YE/WH	Main relay		X		Grounds main relay, pin 85
32	GN	Malfunction indicator lamp (CHECK ENGINE)		X		Grounds lamp (on)
33	BU/WH	Data Link (diagnostics)		X		Data link connector (ISAT diagnostics socket), pin 1
34	GN/RD	Fuel consumption		X	5-15 mV	When idling
35	RD/YE	Engine load signal (Tq)		X	PWM	TCS cars only
36	RD	Cruise Control (cars without TCS)	X			
37						Not connected
38	BU	Cooling fan, 2-speed	X		On = 0 Off = 12	Position 1 only
39	GN	Vehicle speed	X		0-12	From speedometer
40	GN/RD	Crankshaft position sensor	X		0 - approx. 12	
41						Not connected
42	GN/RD	Throttle position sensor - cars without TCS only		X	approx. 5	
43	BU/WH	Manifold absolute pressure sensor		X	approx. 5	Pin 3
44	OG	Knock sensing function, ignition discharge module	X		10-30 mV	When idling
45	GY	Throttle position sensor	X		0.2-4.5	Pin 3, cars without TCS only

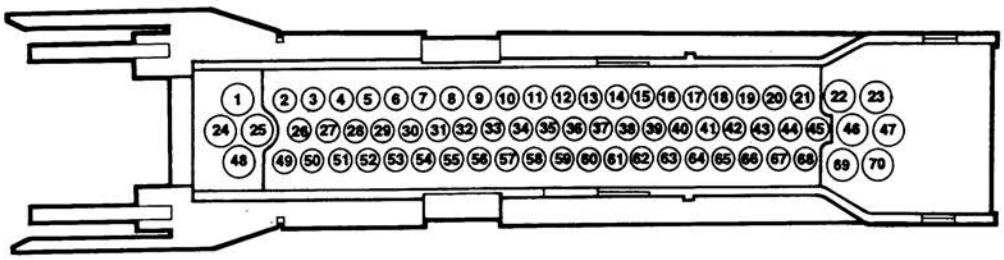
Voltage measurement, ECM (contd.) (■—#10)



Unless otherwise specified, all measurements are to be carried out using a BOB - with the ignition switch in the Drive position, all connectors plugged in and all components connected.

Pin	Lead colour	Component/function	In-put	Out-put	Voltage	Remarks/pin on component
46	BK	Intake air temperature sensor	X		0.2-4.0	90°C = approx. 1 V (pin 2)
47	BK	Reference ground	X			G7 (intake manifold)
48	RD	+30 voltage supply	X		approx. 12	
49	BU/RD	Idle air control valve		X	approx. 5	When idling (not TCS)
50	BK	Heated oxygen sensor, preheating		X	approx. 12	When sensor cold
51						Not connected
52						Not connected
53						Not connected
54	GN/RD	A/C relay		X		Grounds A/C relay, pin 85
55	BN	SHIFT-UP		X		
56	VT	Fuel pump relay		X		Grounds the relay, pin 85
57		Throttle position	X		0.2-4.0	TCS cars only
58	BU	Engine speed (RPM)		X	approx. 1	At 2000 rpm Tachometer (rev counter)
59	GN/WH	Idling compensation, A/C or ACC	X		On = 0 Off = 12 On = 12 Off = 0	TCS cars Not TCS
60	GN/WH	Ignition switch +15	X		approx. 12	

Voltage measurement, ECM (contd.) (■—#10)



Unless otherwise specified, all measurements are to be carried out using a BOB - with the ignition switch in the Drive position, all connectors plugged in and all components connected.

Pin	Lead colour	Component/function	In-put	Out-put	Voltage	Remarks/pin on component
61						Not connected
62	GY	Test socket 444				Production only
63	RD	Test socket 444				Production only
64	RD	Crankshaft position sensor		X	approx. 12	pin 1
65	RD/WH	Test socket 444				Production only
66	BK	Signal ground (not TCS) Reference ground (TCS)	X			
67	BK/WH	Signal ground	X			
68	YE	Engine coolant temperature sensor	X			Pin 1
69						Not connected
70						Not connected

Points to remember when diagnosing faults

1 The data link connector (diagnostics socket), coloured black, is situated under the right-hand front seat.

2 During diagnosis, the ignition switch should always be in the Drive position.

3 The SFI system has ISAT scan tool system number 10.

4 Retrieve and make a note of all fault codes stored in the ISAT scan tool before disconnecting the battery and the ECM.

5 If communication cannot be established between the ISAT and the system, first check fuse 21 and then the leads between terminal 33 of the ECM and pin 1 of the data link connector. Also check that the data link connector is supplied with the correct current and ground and that the pins of the connectors are undamaged and firmly located.

6 Pages 73-75 contain a list of all diagnostic trouble codes (DTCs) for the SFI system.

7 Pages 76-81 contain lists of all command codes for the SFI system.

8 To avoid damaging ECMs and/or components, always make sure that the ignition and main relay are switched off before unplugging any connectors.

9 Always check that the ECM's ground connections and supply voltages are correct.

Note:

On completion of fault diagnosis, always erase the fault memory by means of command code 2000.

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10 It may sometimes be well worth unplugging connectors to check that sockets and pins are undamaged and firmly located. Afterwards, plug in the connectors again and erase all DTCs. If possible, start the car or drive it to see whether the fault or faults persist.

11 Since all signals round the 12-volt level are proportional to battery positive voltage, the levels should be used as guidance only.

12 The 0 V signals denote ground but on a sensitive multimeter they may produce a measurable voltage reading.

13 Never switch from one unit of measurement to another (e.g. from volts, through amps to ohms) on the meter without first disconnecting the test leads.

For checking of components, see pages 112-141.

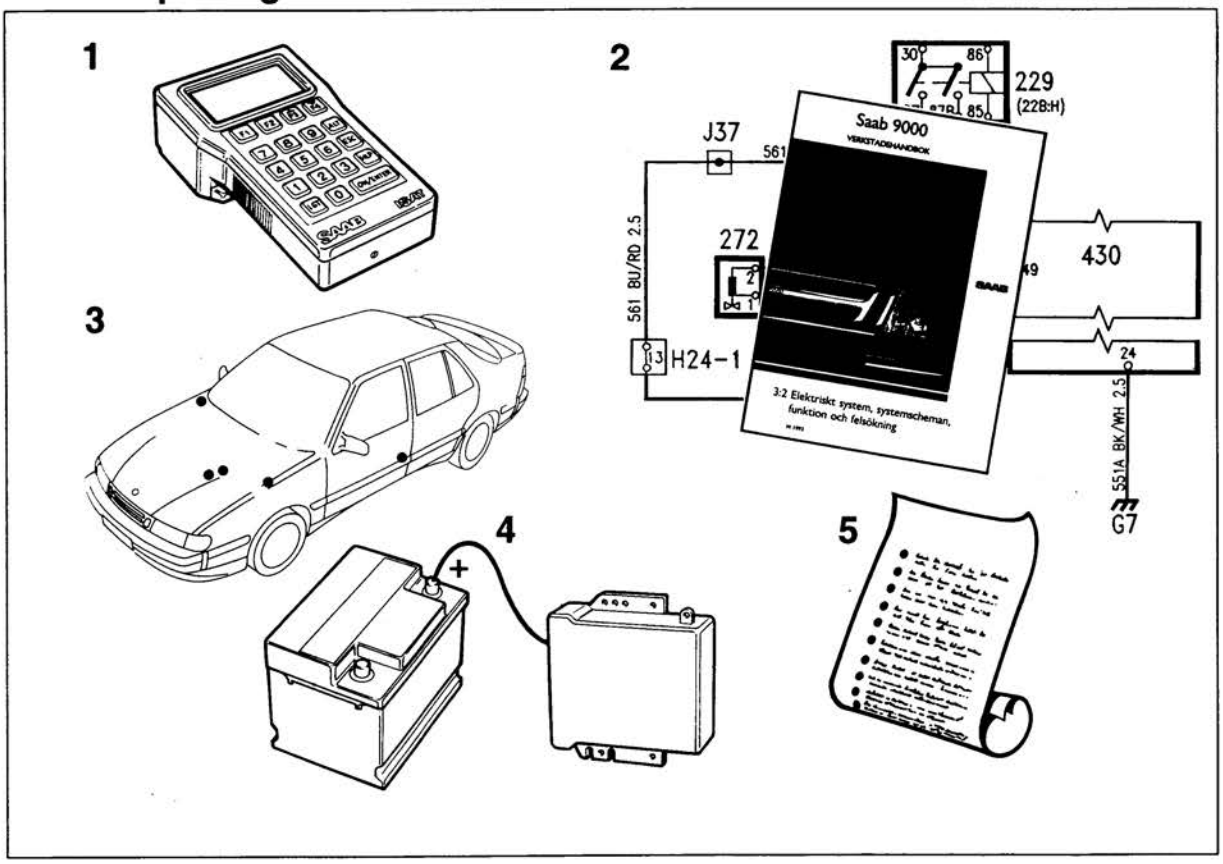
(■-#10)

This means that the ISAT scan tool should be connected to the black data link connector (diagnostics socket) and that SFI is system number 10.

Breakout-box = BOB

Always use one or more breakout boxes in conjunction with the 70-pin test cable when diagnosing faults in the SFI system's circuits and wiring.

Before replacing an ECM



When all tests have been carried out according to the relevant programme without any faults having been found, it is natural to assume that the ECM is at fault.

In view of the fact that the ECM is an exceptionally high-quality component and also extremely expensive, it is important to verify the diagnosis as far as possible.

Therefore, go through all the points very carefully before definitely pointing to the ECM as the cause of the fault.

1 Check once again that every single point in the fault-diagnosis programme of the relevant diagnostic trouble code has been carried out.

2 Study the schematic of the circuit in question and make sure you understand how it works. Relevant parts of the technical description and the electrical descriptions of operation in Service Manual 3:2 "Electrical system" may be of assistance in this respect.

3 Check all grounding points. If you have already done this, do it once again.

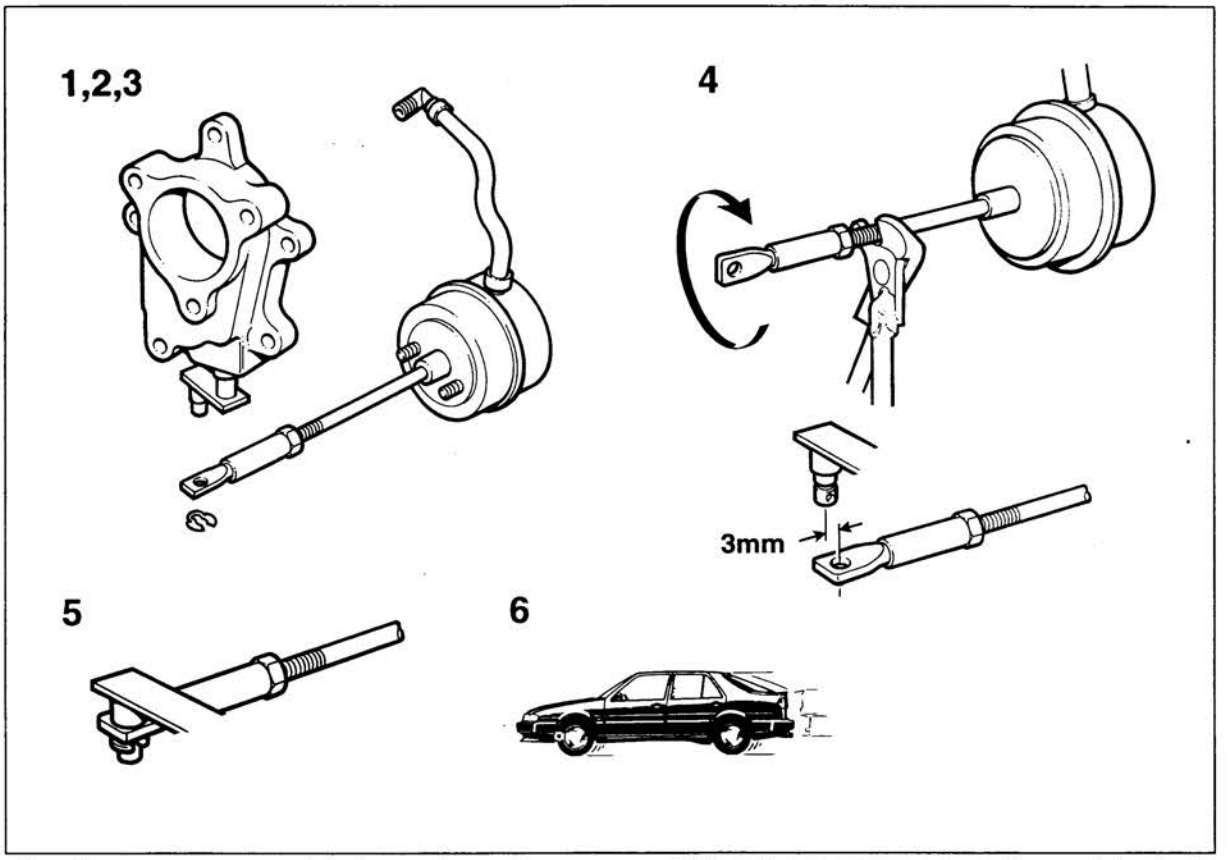
4 Check the voltage supplied to the ECM.

5 Go once more through each point listed under "Points to remember when diagnosing faults" on page 148.

6 If the original fault still persists in spite of this, then the ECM will have to be replaced.

Adjustment/replacement of components

Basic adjustment of the charge- pressure regulator



The charge-pressure regulator's membrane housing unit is adjusted at the factory and therefore shall only be adjusted in connection with a repair or the replacement of components. After adjustment, the base charge pressure should always be inspected, see **Inspection of base charge pressure (on the road)** , page 152.

Caution

When adjusting the length of the pressure rod, it is important that the pliers being used as a counterstay be placed as close to the threads as possible. Turn the end piece carefully so that ridges do not appear on the rod. Adjustment as described below should always be performed with the pressure rod disconnected from the operating arm.

The membrane-housing unit and charge-pressure regulator mounted on the turbocharger unit.

1 Undo the end piece's locknut.

2 Remove the locking ring and loosen the pressure rod from the operating arm.

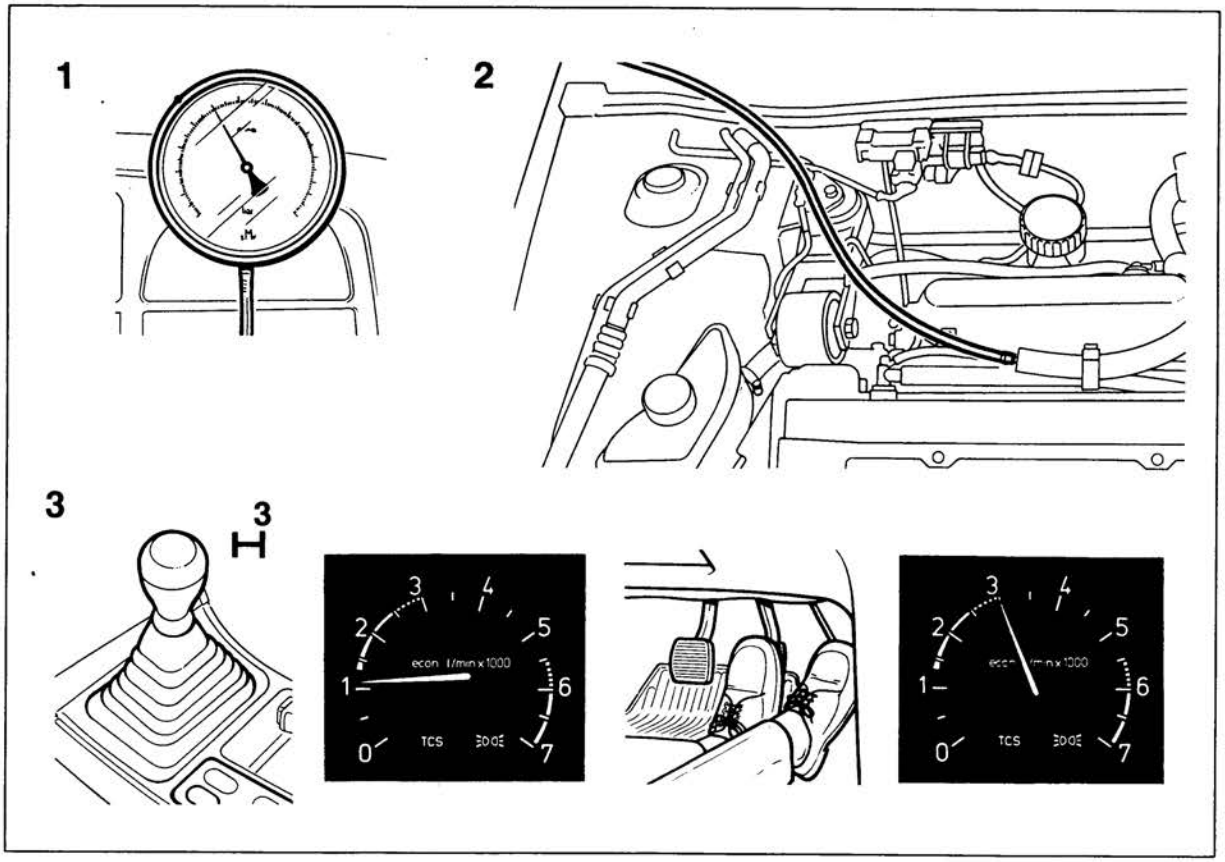
3 Move the operating arm on the regulator to the "closed" position and adjust the end piece so that the pressure rod can easily be mounted on the stud of the operating arm.

4 Then screw in the end piece 3.5 full turns on the pressure rod and tighten the locking nut. By doing this, the charge- pressure regulator has received a "prestressing" of approximately 3 mm.

5 Carefully remove and hook the pressure rod on the operating arm's stud. Mount locking ring.

6 Inspect the charging pressure by driving the vehicle and measuring on the road.

Inspection of base charge pressure



Caution

The motor should be thoroughly warmed-up.

1 Place pressure gauge (83 93 514) vertically, to reduce the risk of incorrect indications.

2 Pull the hose through the recess in the front door post to the engine compartment and connect it to the nipple between the intake manifold and the PCV fitting.

3 With third gear as the starting position (or gear position 3 on an automatic) and engine speed less than 1500 rpm, do a full-throttle acceleration.

When the engine speed approaches 3000 rpm, brake while continuing to depress the accelerator pedal so that full load is achieved at 3000 rpm.

Read the base charging pressure on the pressure gauge.

The correct pressure should be 0.4 ± 0.03 bar

4 If the base charging-pressure is outside of the tolerance limits, continue with "Adjustment of Base Charging Pressure " on the next page.

5 Remove the pressure gauge.

6 Perform the adaption according to the description on page 156

Caution

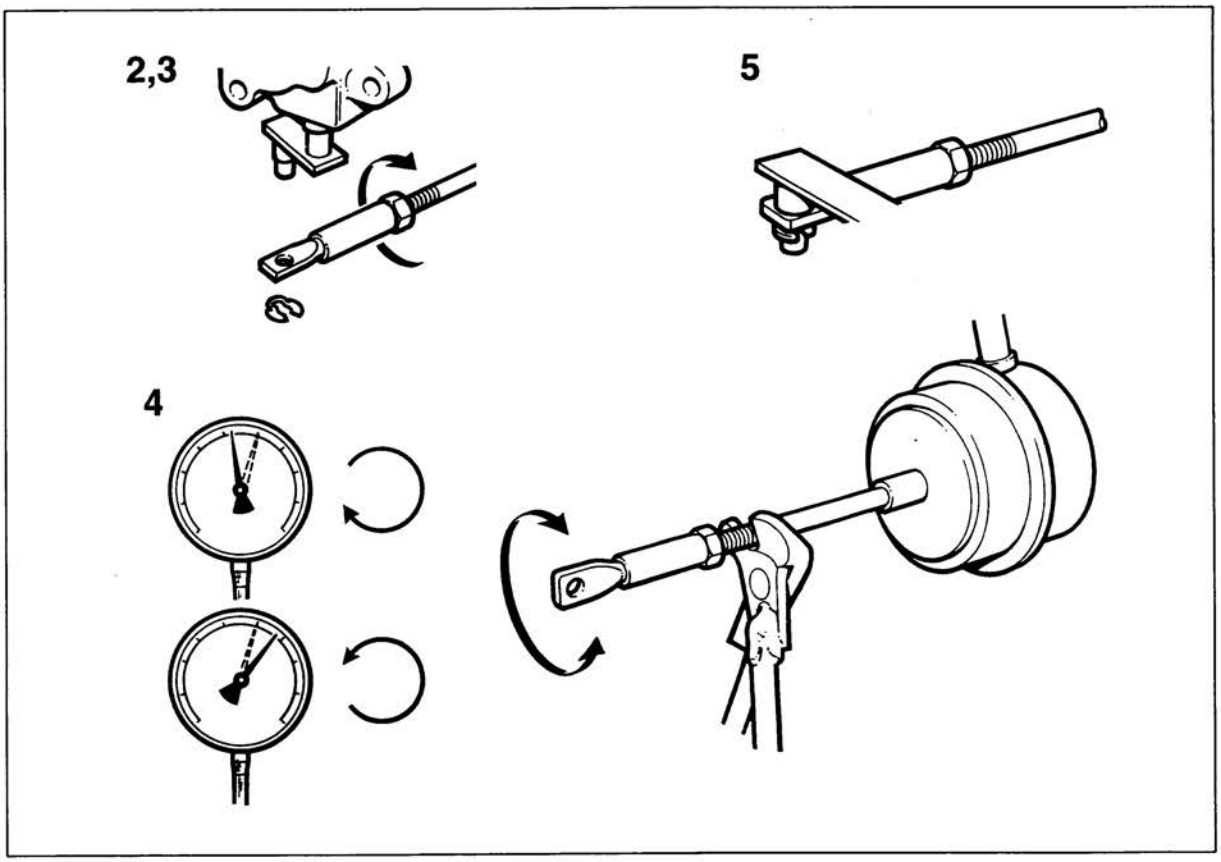
The base charging pressure is the starting point of the boost pressure control function of the SFI system and therefore must be adjusted to the correct level.

Through the adaptive function present in the system, a continuous compensation of the maximum occurs in proportion to the current charging pressure.

Increasing the base charging pressure above the indicated value will not result in a higher charging pressure, because the adaptive function will regulate the maximum charging pressure to the nominal value (negative adaption).

The maximum charging pressure is approximately 1.0 bar at 3000 rpm for vehicles with a manual gearbox and about 0.77 at 2700 rpm for vehicles with automatic transmission.

Adjustment of base charging pressure



With a starting point at the measured value of the base charging pressure (on the road), the base charging pressure is adjusted as necessary according to the following.

1 Hoist the vehicle.

2 Release the end piece's lock nut.

3 Remove the locking ring and unhook the pressure rod from the pressure regulator's operating arm.

Caution

When adjusting the end piece on the pressure rod, it is important to hold the pressure rod firmly so that it does not damage the membrane. Use 13 94 066 pliers to hold the pressure rod, which is put as close to the end of the threads as possible.

It is essential that burrs do not form on the pressure rod, because binding may be caused in the membrane-housing unit's bearing, thus destroying the system's charging pressure regulating capacity.

4 Adjust the base charging pressure by **screwing in the end piece if too low a pressure** is measured or **loosening the end piece if too high a pressure** is measured.

Turning the end piece 1 revolution results in a change in the base charging pressure by approximately 0.03 bar.

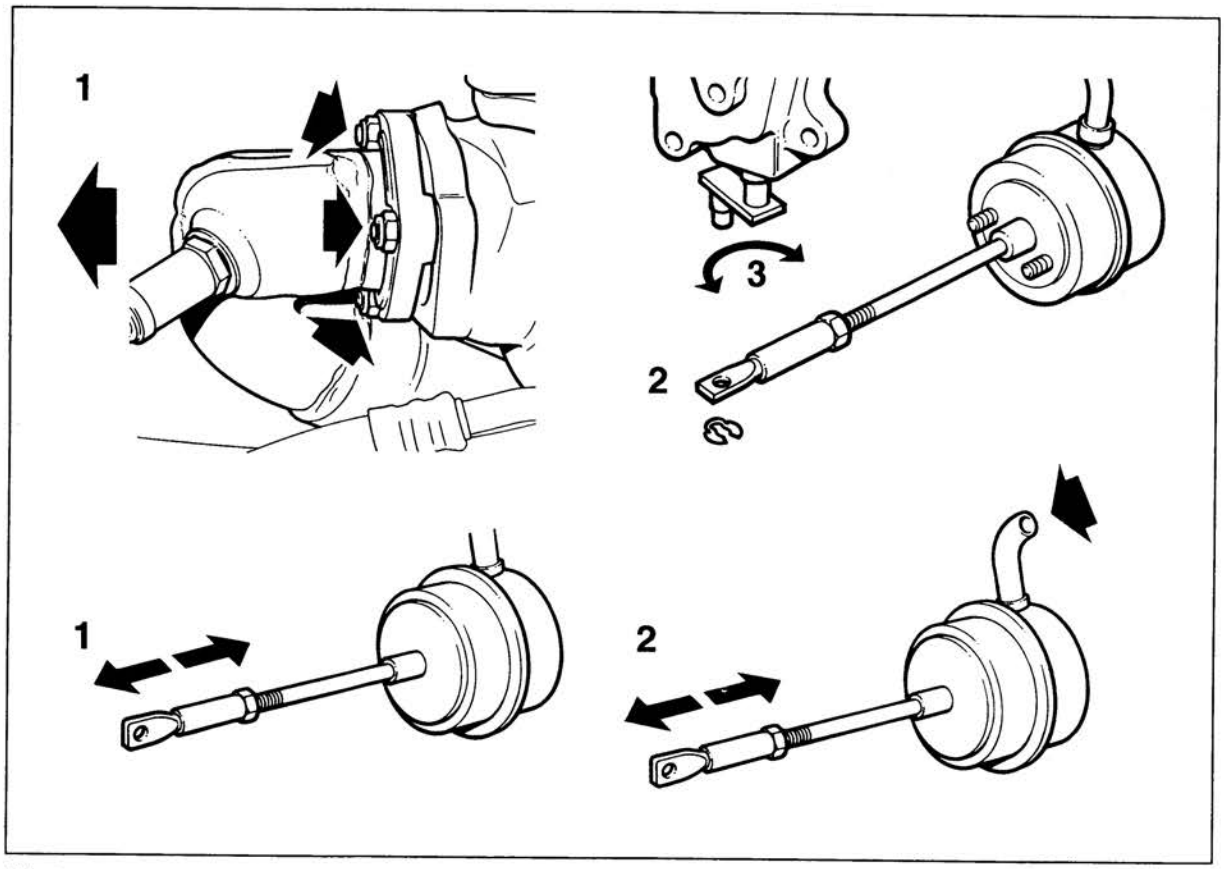
The base charging pressure should be 0.40 ± 0.03 bar

5 Connect the pressure rod to the operating arm and mount the locking ring.

6 Re-inspect the base charging pressure in order to verify that the adjustment had the desired effect, see "Adjustment of Base Charging Pressure (on the road)" on the preceding page.

If the base charging pressure cannot be adjusted, see "Inspection of Pressure Regulator and Membrane Housing Unit" on the next page.

Inspection of Wastegate and Membrane Housing Unit



Wastegate

If the base charging pressure cannot be adjusted make the following inspections.

1 Disconnect the exhaust bend from the Turbo-charging unit and visually inspect the flap valve's contact against the turbine housing.

2 Remove the locking ring and unhook the pressure rod from the Wastegate's operating arm.

3 Inspect to make sure the operating arm can be easily moved.

Replace a faulty Wastegate.

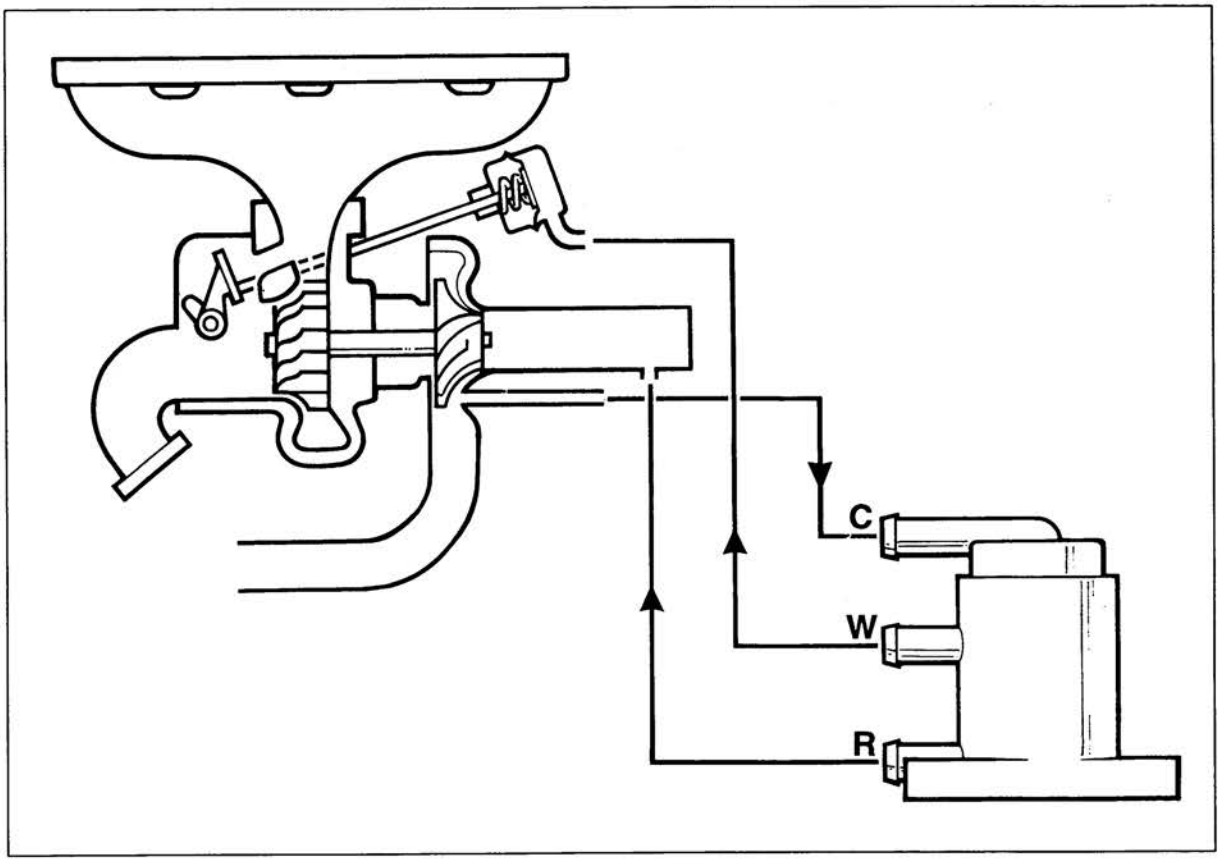
Membrane Housing Unit

1 Inspect to make sure the pressure rod can be easily moved.

2 Inspect the membrane and spring by introducing pressure via the unit's connecting nipple. Insure that the rod can be pushed out without any tendency to seize. Release pressure and insure that the rod retracts into the unit.

Replace faulty membrane housing unit.

Inspection of Boost Pressure Control Valve (APC Solenoid)



For electrical inspection of the boost pressure control (BPC) valve, see page 116.

Caution

Never test the boost pressure control valve by connecting it directly to battery current.

Inspection of Signal Hoses

1 Disconnect all of the BPC valve's hoses; from the turbo compressor, the turbo vacuum and from the wastgate valve's membrane housing unit.

2 Blow into the hose leading from the compressor (C) and ensure that air comes out of the hose to the wastgate valve (W).

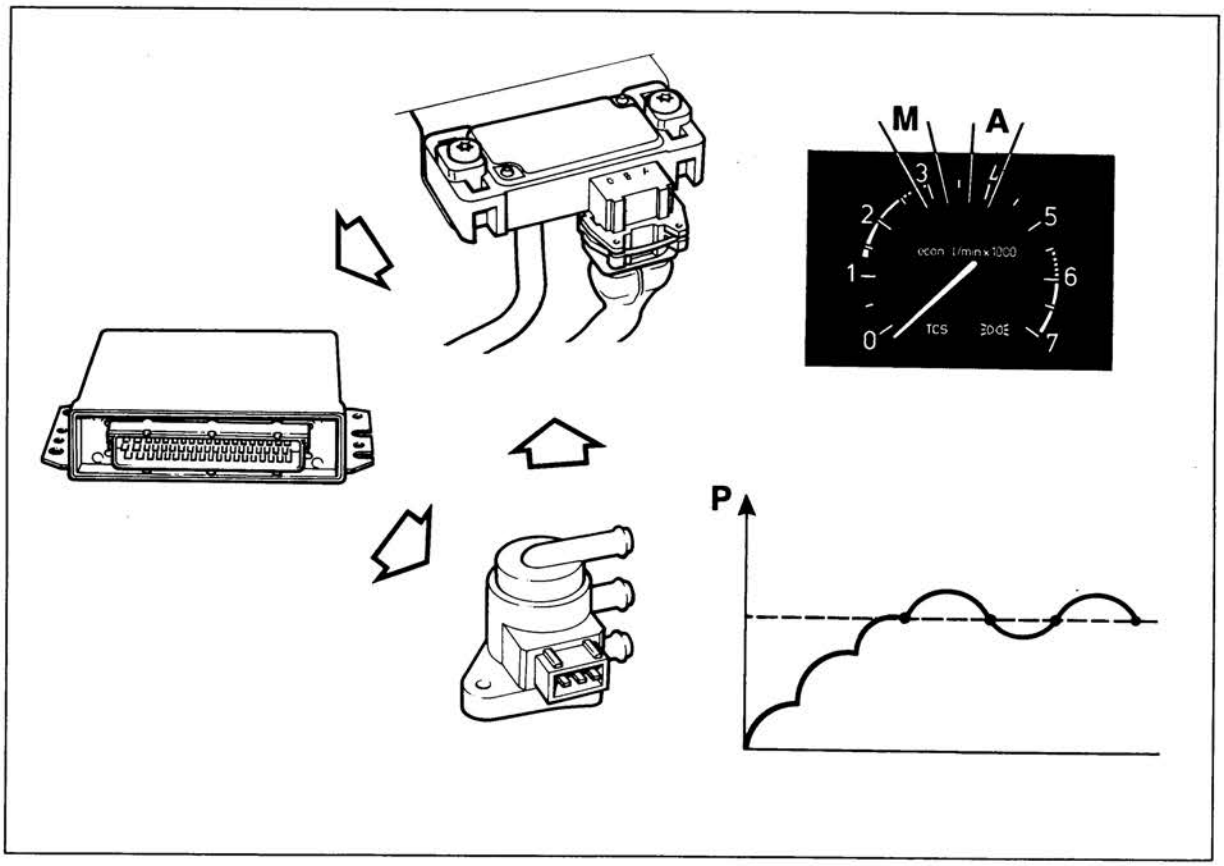
3 Also blow into the return hose from the vacuum tube (R) and ensure that air comes out of the hose to the turbo compressor (C).

Inspection of the Boost Pressure Control Valve's Throttling

There is a throttle built into the BPC valve's connection to the turbo compressor (C) which results in this opening being more prone to deposits of dirt, etc., than the others.

Inspect and ensure that the throttle is not restricted. If the hole is too small and the deposits cannot be removed, replace the BPC valve.

Adaption of Charging Pressure



Adaption of maximum charging pressure occurs continuously during normal driving. If the ECM is replaced or other steps are taken which affect the level of adaptation, a system adaptation may be conducted as follows in order to speed adaptation and thereby achieve maximum performance more rapidly.

Caution

The engine should be thoroughly warmed-up. The base charging pressure should be adjusted to the right value. Use good- quality, high-octane fuel.

Vehicles with a manual gearbox

Accelerate at full-throttle in as high a gear as possible, from approx. 2000 rpm up to 3500 rpm.

Because the minimum time for passage of adaptation area (2750-3250 rpm) should be longer than 3 seconds, it is suitable to perform the adaption on an upward incline.

The procedure is repeated until the maximum nominal charging pressure, with regard to fuel quality, etc., is achieved.

Vehicles with automatic transmission

Accelerate with as much throttle as possible without the Kick-down function being activated, from approx. 3000 rpm up to 4500 rpm.

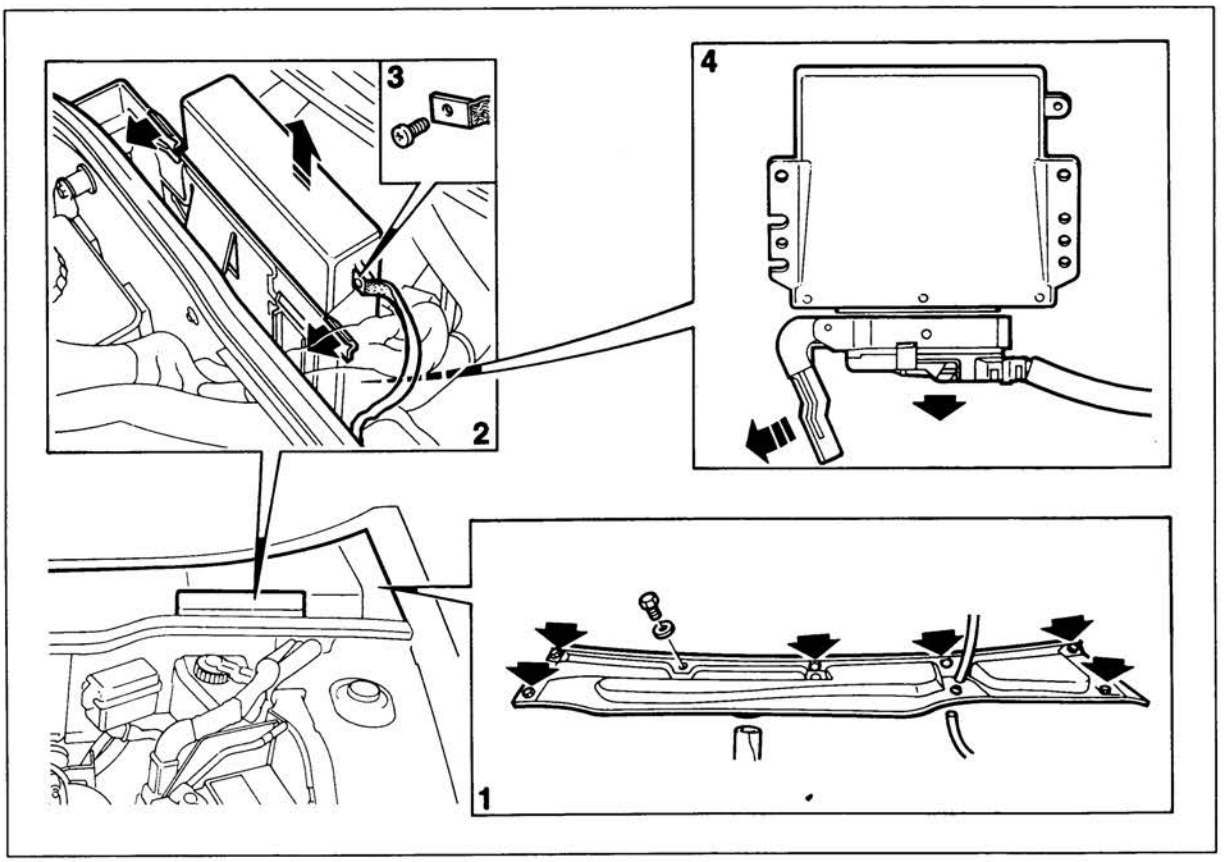
Because the minimum time for passage of the adaptation area (3750-4250 rpm) should be longer than 3 seconds, it is suitable to perform the adaptation on an upward incline.

The procedure is repeated until the maximum nominal charging pressure, with regard to fuel quality, etc., is achieved.

Note

If repeated pressure monitor operation has been caused by excessive charging pressure (such as due to a defective solenoid valve), maximum negative adaption will be obtained. This means that the normal maximum charging pressure will not be attained. To attain maximum charging pressure, disconnect and reconnect the control module and carry out adaption as described on page 148.

Replacement of the ECM



Disassembly

1 Take off the cover over the space between the bulkhead panels.

2 Pull back the locking spring and pull the ECM slightly upward.

3 Loosen the ground braid and lift the ECM completely out.

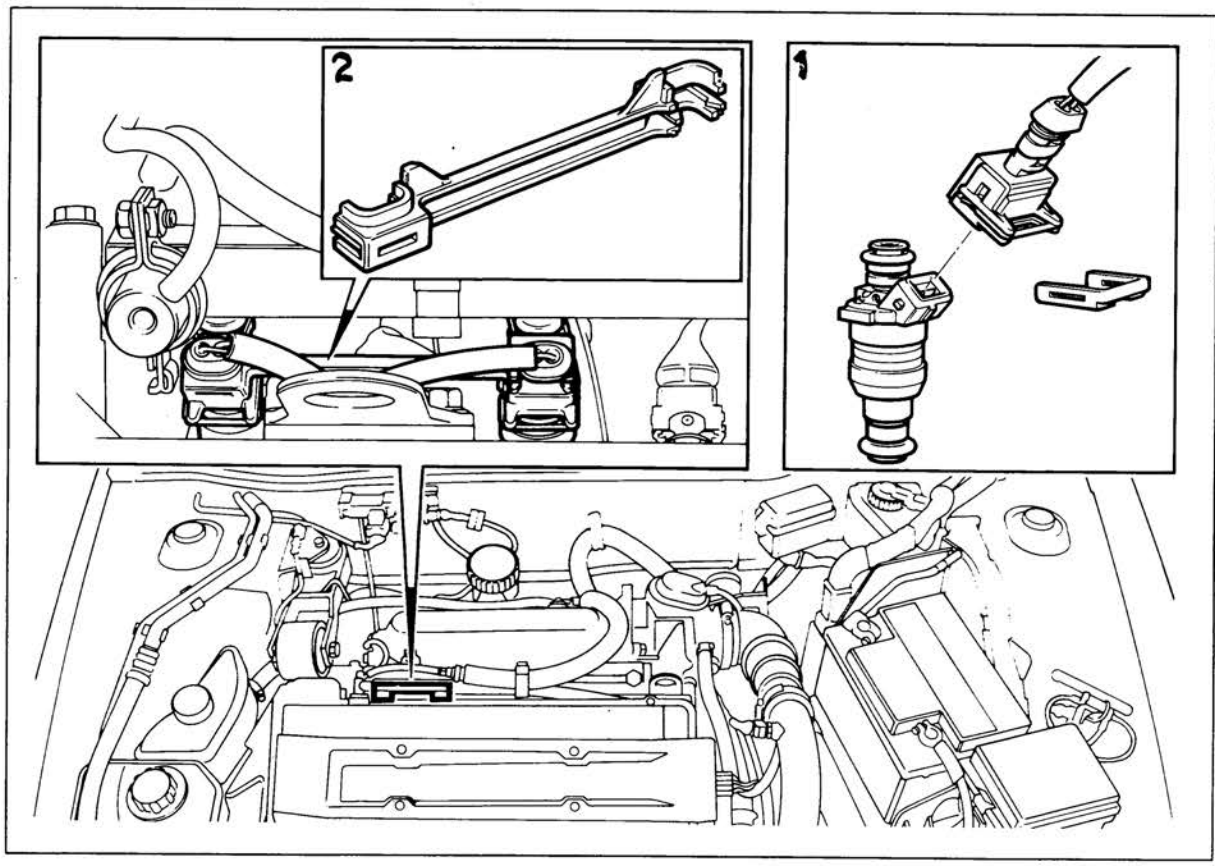
4 Unplug the connector after first releasing the catch.

Re-assembly

Match the new ECM's part number against the Technical Data.

Then mount the ECM, following the disassembly procedure in reverse order.

Replacement of injectors



Disassembly

1 Remove lock mount and loosen the contact pieces for the injector(s).

2 Check placement and remove along the holders that keep the injectors in position.

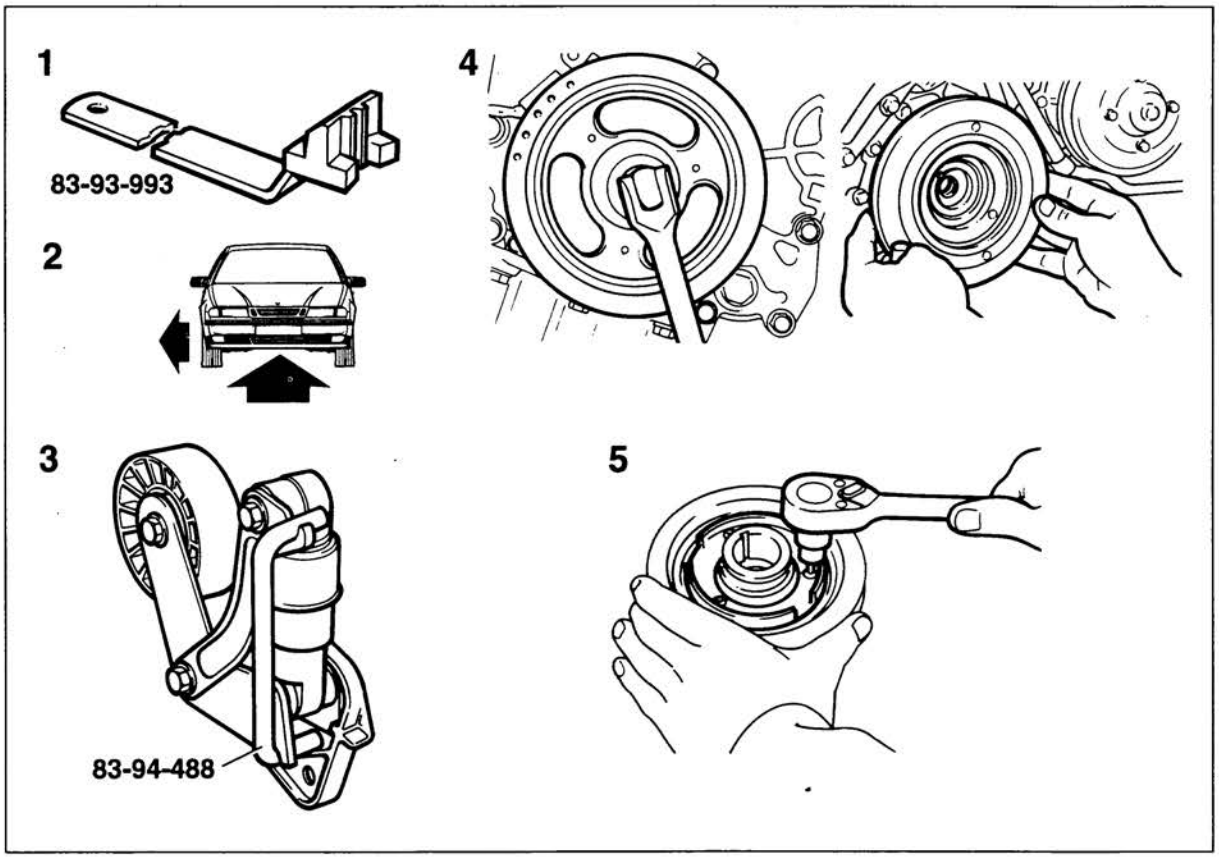
3 Remove the injector(s) to be replaced/ inspected.

Assembly

Before assembly, it is best to grease the O-rings with a little petroleum jelly.

Assemble in the opposite order as above and insure that the correct contact piece is connected to its respective injector.

Replacement of the Crankshaft Position Sensor



Aperture plate

To remove

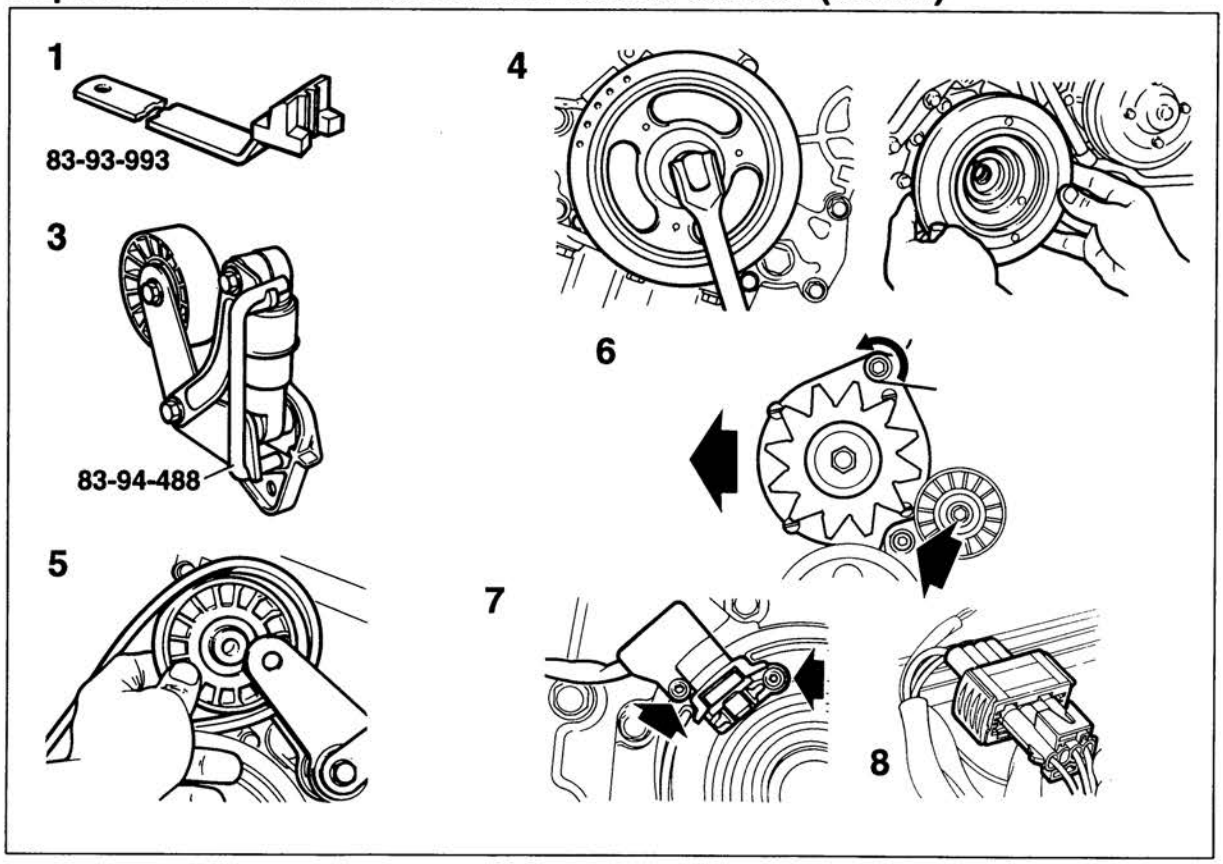
1 Fit special tool 83 93 993 to lock the flywheel.
2 Raise the car, remove the right-hand front wheel and dismantle the wing liner.
3 Compress the belt tensioner and secure it by means of clamp 83 94 488.
4 Remove the multigroove belt and dismantle the crankshaft pulley.
5 Remove the aperture plate.

To fit

Assemble in reverse order.

Belt pulley tightening torque: 190 Nm (140 lbf ft)

Replacement of the Crankshaft Position Sensor (contd.)



Hall-effect sensor

To remove

1 Fit special tool 83 93 993 to lock the flywheel.

2 Raise the car, remove the right-hand front wheel and dismantle the wing liner.

3 Compress the belt tensioner and secure it by means of clamp 83 94 488.

4 Remove the multigroove belt and dismantle the crankshaft pulley.

5 Remove the tensioning roller.

6 Undo the alternator bolts (withdraw the upper one half-way out only) and swing the alternator rearwards.

7 Remove the two retaining bolts for the hall-effect sensor.

8 Undo the clips holding the wiring (one on the coolant pipe at the rear of the engine block), unplug the connector and remove the hall-effect sensor complete with wiring.

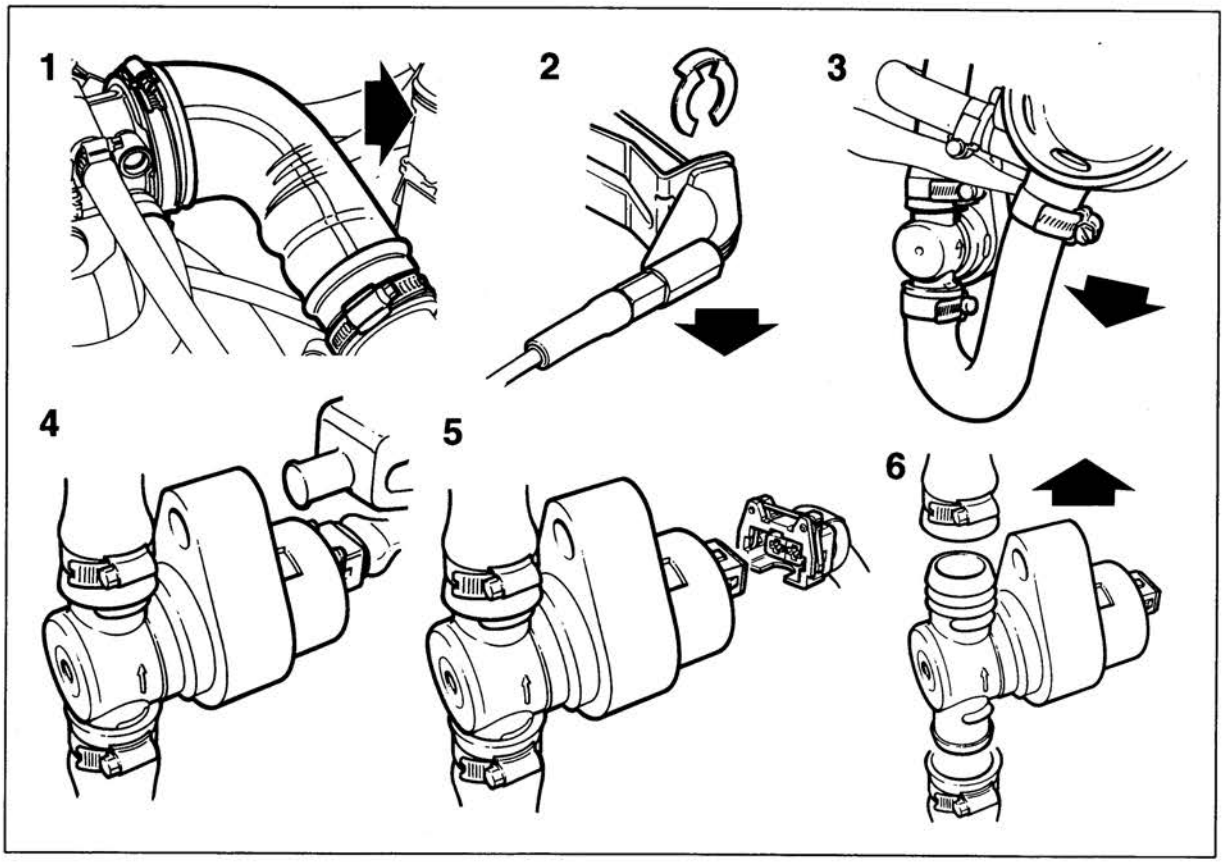
To fit

Assemble in reverse order.

Use LOCTITE 270 or the equivalent to lock the retaining bolts for the hall-effect sensor and crankshaft pulley.

Belt pulley tightening torque: 190 Nm (140 lbf ft)

Replacement of IAC valve (no TCS)



To remove

1 Remove the throttle housing's rubber hose section.
2 Remove the clip and bend aside the throttle wire sheathing.
3 Remove the IAC valve hoses from the throttle housing.
4 Pull the valve off the bracket and withdraw the hoses.
5 Unplug the valve's connector.
6 Lift out the valve and remove the two hoses.

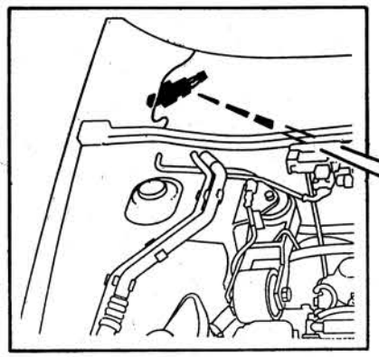
To fit

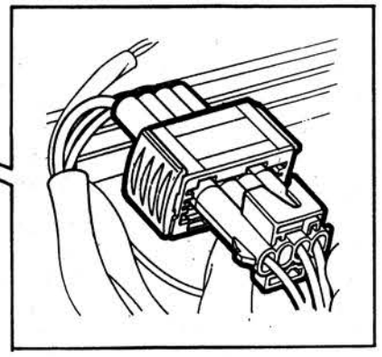
Assemble in reverse order.

Caution

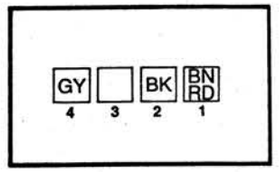
Do not tighten any of the four hose clips until the valve has been mounted and correctly positioned.

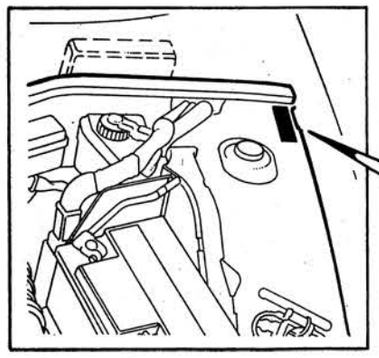
Contact fittings and ground points

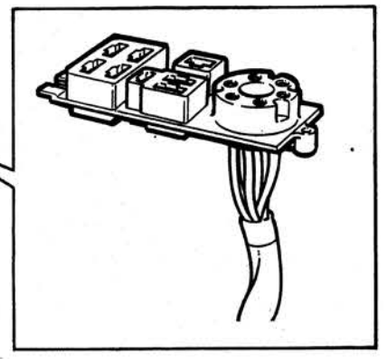




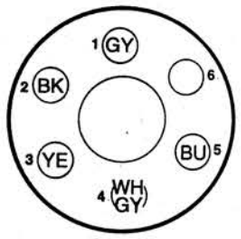
H4-16

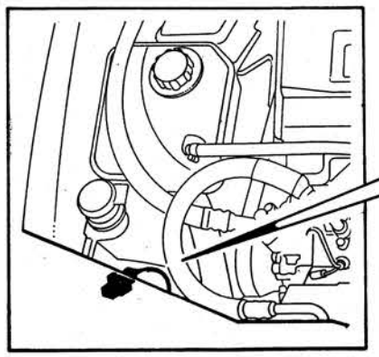


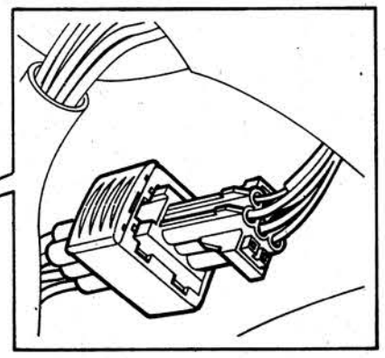




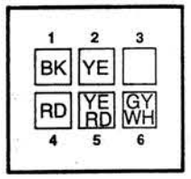
H6-1

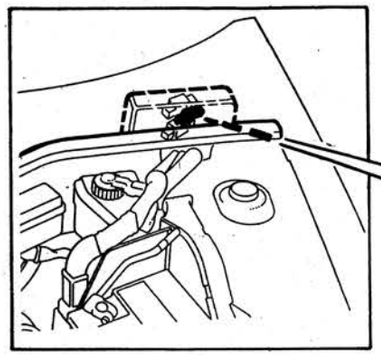


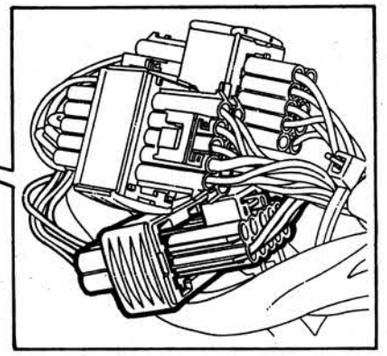




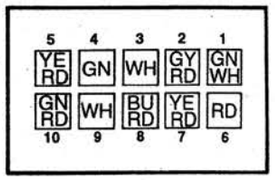
H6-5

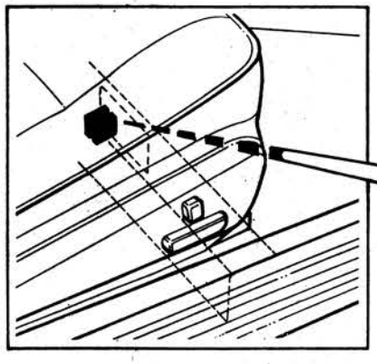


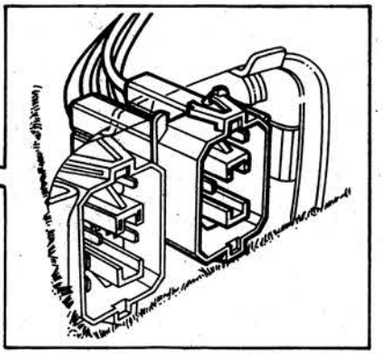




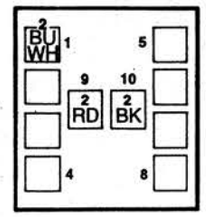
H10-7

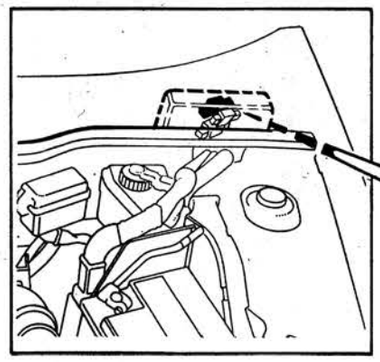


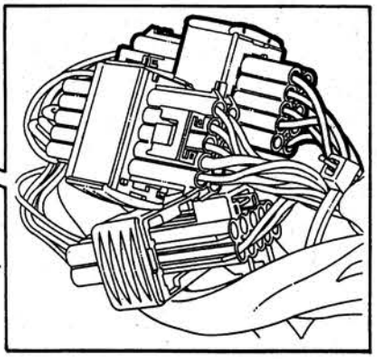




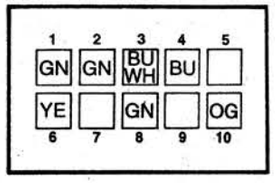
H10-8

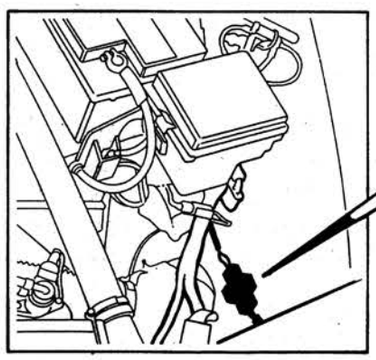


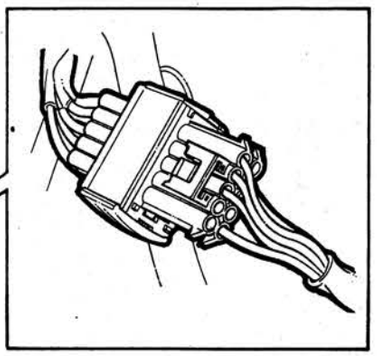




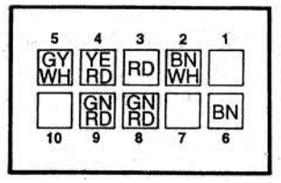
H10-13

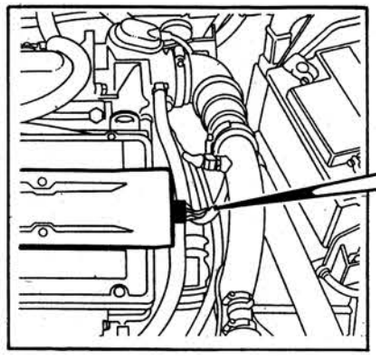


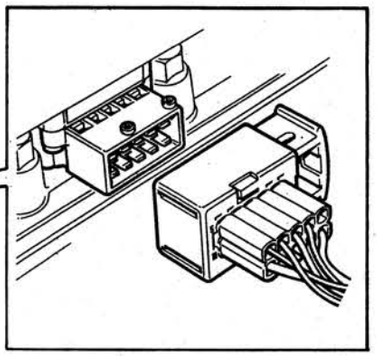




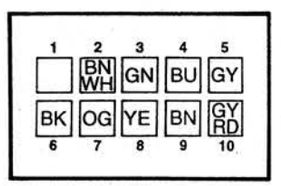
H10-15

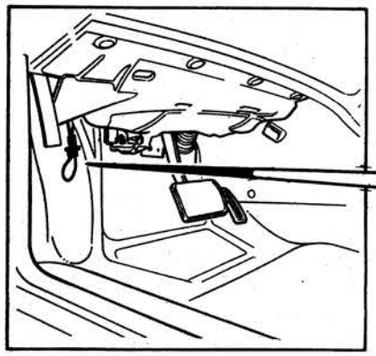


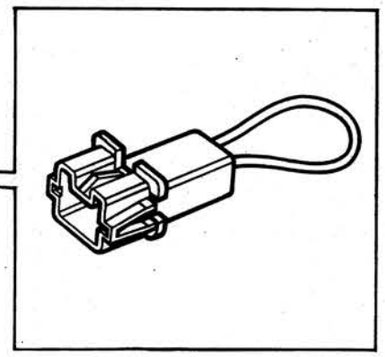




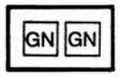
H10-18

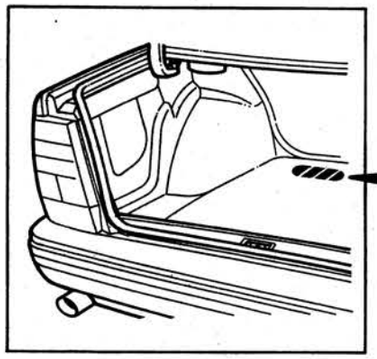


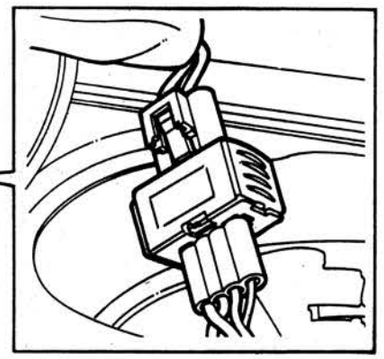




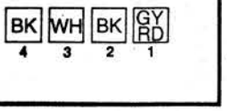
H2-19

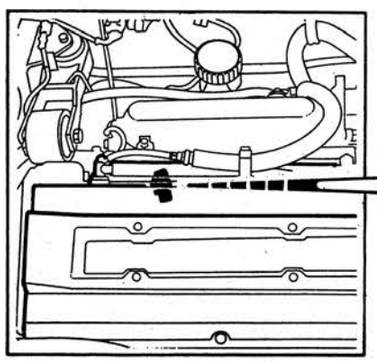


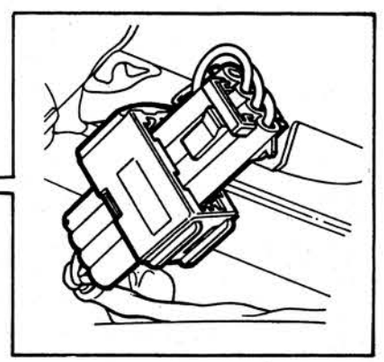




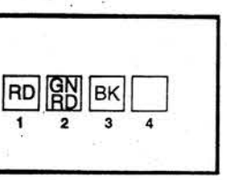
H4-4

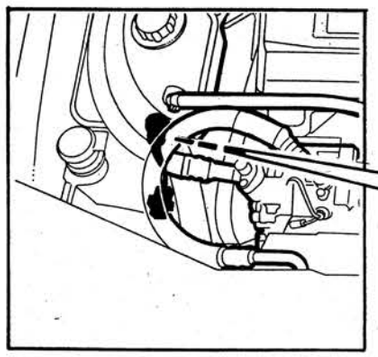


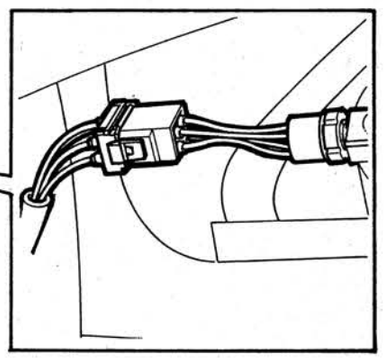




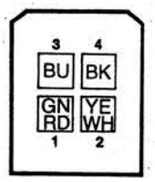
H4-8

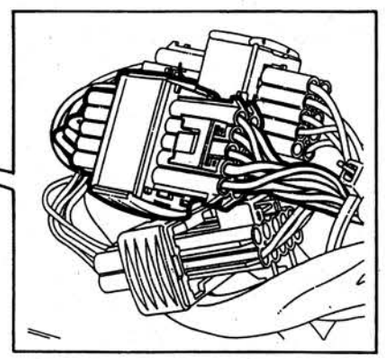




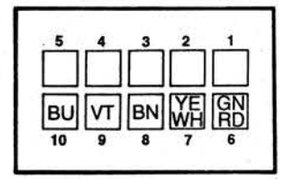


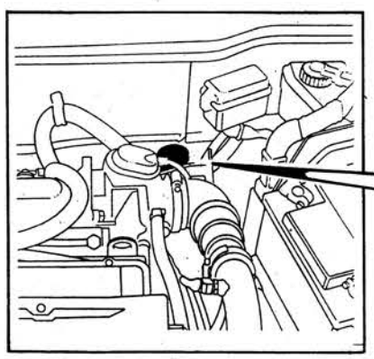
H4-12

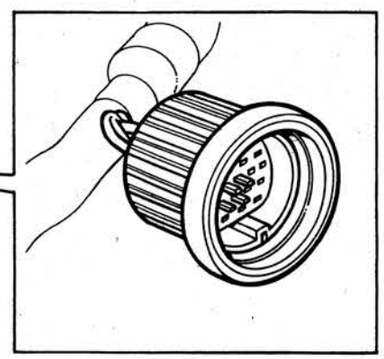




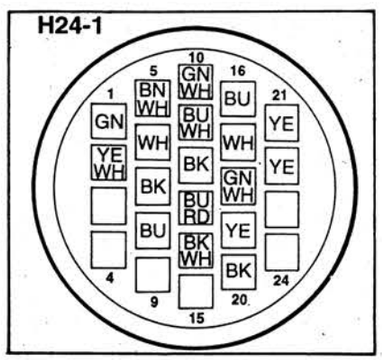
H10-19

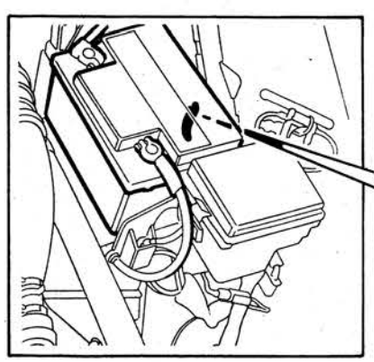


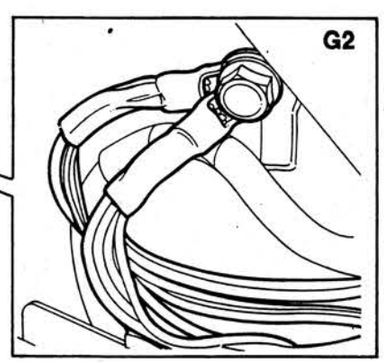




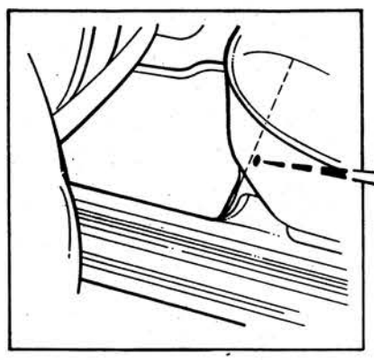
H24-1

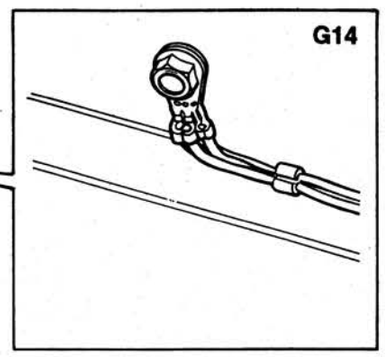




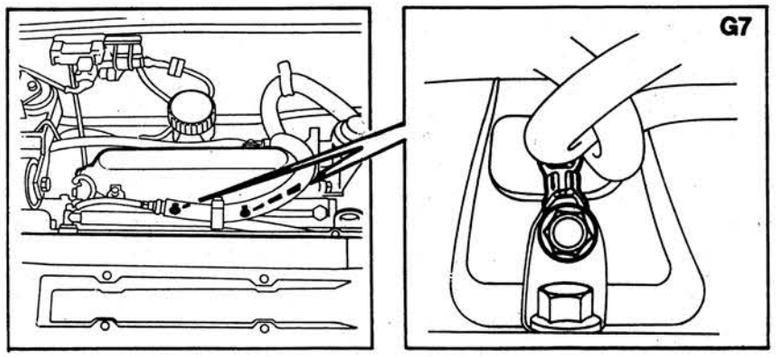


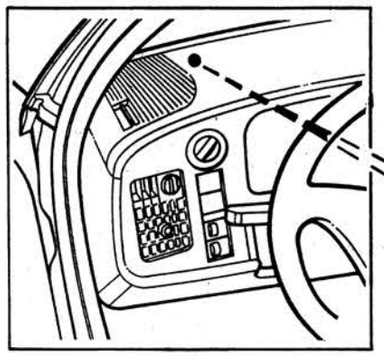
G2

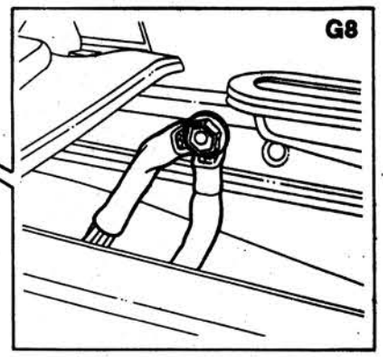


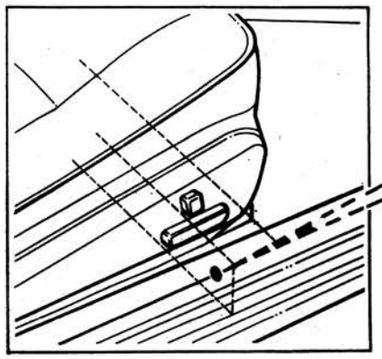


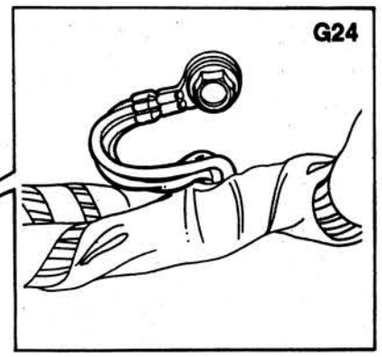
G14











TRIONIC wiring diagram (I) (without TCS)

Location of components

1	Battery in engine bay
22A	Fuse holder behind lid in glove box
47	Main instrument display panel in facia
47A	Fuel gauge
47C	Coolant temperature gauge
47K	SHIFT UP warning lamp
73 (H6-1)	Timing service instrument socket on the left-hand side of the engine bay by the modification identity plate
75	Distribution block, positive battery supply, at the battery tray
76	Switch for raising engine idling speed (automatic transmission) under the centre console by the gear selector in gear selector switch 239.
102	Fuel pump relay in the main fuse box behind the glove box (22B:I)
110	Tachometer in the main instrument display panel
131	Control module for the Cruise Control system on the left of the steering column under the facia
132	Vehicle speed sensor in the speedometer in the main instrument display panel
136	Lambda sensor on exhaust pipe at the turbo manifold
155	Relay for A/C radiator fan in the main fuse box in the engine bay (342B:E)
157	Spark plugs on top of engine under the cover
159	Distribution terminal +15 in main fuse box behind the glove box
166	Pressure switch for the A/C radiator fan on the dryer unit in front of the right-hand wheel housing
171	Anti-freeze thermostat (cycling clutch switch) for the A/C centred on the evaporator housing
179	BPC valve on the radiator fan shroud
202	Coolant temperature sensor (NTC resistor) on inlet manifold flange between cylinders 2 och 3
203	Throttle position sensor on the throttle housing
206	Fuel injectors 2.0 L: underneath the inlet manifold 2.3 L: above the inlet manifold
210	EDU trip computer in the main instrument display panel
229	Main relay for the TRIONIC system in the main fuse box behind the glove box (22B:H)
230	Distribution terminal +30 in the main fuse box behind the glove box
231	Distribution terminal +54 in the main fuse box behind the glove compartment
239	Gear selector switch (automatic transmission) under the centre console on the selector lever assembly
271	Lambda sensor preheater, integrated into the sensor
272	Idle air control valve on intake pipe, in the centre
321	EVAP canister valve in right-hand wheel housing
323	Fuel pump in fuel tank under luggage compartment floor
345	Crankshaft position sensor behind the pulley on the oil pump housing
346	Ignition discharge module on the valve cover
347 (H10-8)	Data link connector (diagnostic test socket), engine electronics, under right-hand front seat (black)
407	Air temperature sensor (NTC resistor) in the engine bay on the inlet manifold
430	TRIONIC control module in the engine bay behind the bulkhead partition
431	Manifold absolute pressure sensor in the engine bay on the bulkhead partition
443	Relay, lambda sensor preheating disconnect, under the facia on the left-hand side of the bracket for the control module for the Cruise Control system
444 (H6-10)	TRIONIC data link connector (test socket) (only for production)

Continued on the next page.

Location of components (contd.)

2-pole connector

H2-19 Under facia on left of steering column

3-pole connectors

H3-20 Behind the main instrument display panel at the speedometer (ME)

H3-25 On the bracket for the control module for the Cruise Control system

4-pole connectors

H4-4 At the fuel pump under the luggage compartment floor

H4-8 In the engine bay under the intake pipe

H4-12 At the right-hand wheel housing beside the windscreen washer fluid reservoir

H4-16 In the engine bay behind the bulkhead partition at extreme right (black)

6-pole connector

H6-5 In the front right-hand corner behind the light cluster at the washer fluid reservoir

10 pole connectors

H10-7 In the engine bay on the left-hand side of the windscreen wiper motor (black)

H10-13 On the left-hand side of the engine bay, at the windscreen wiper motor (grey)

H10-15 Behind the left-hand headlamp

H10-18 On the ignition discharge module

H10-19 On the left-hand side of the engine bay, at the windscreen wiper motor (blue)

24-pole connectors

H24-1 In the engine bay on the bulkhead partition

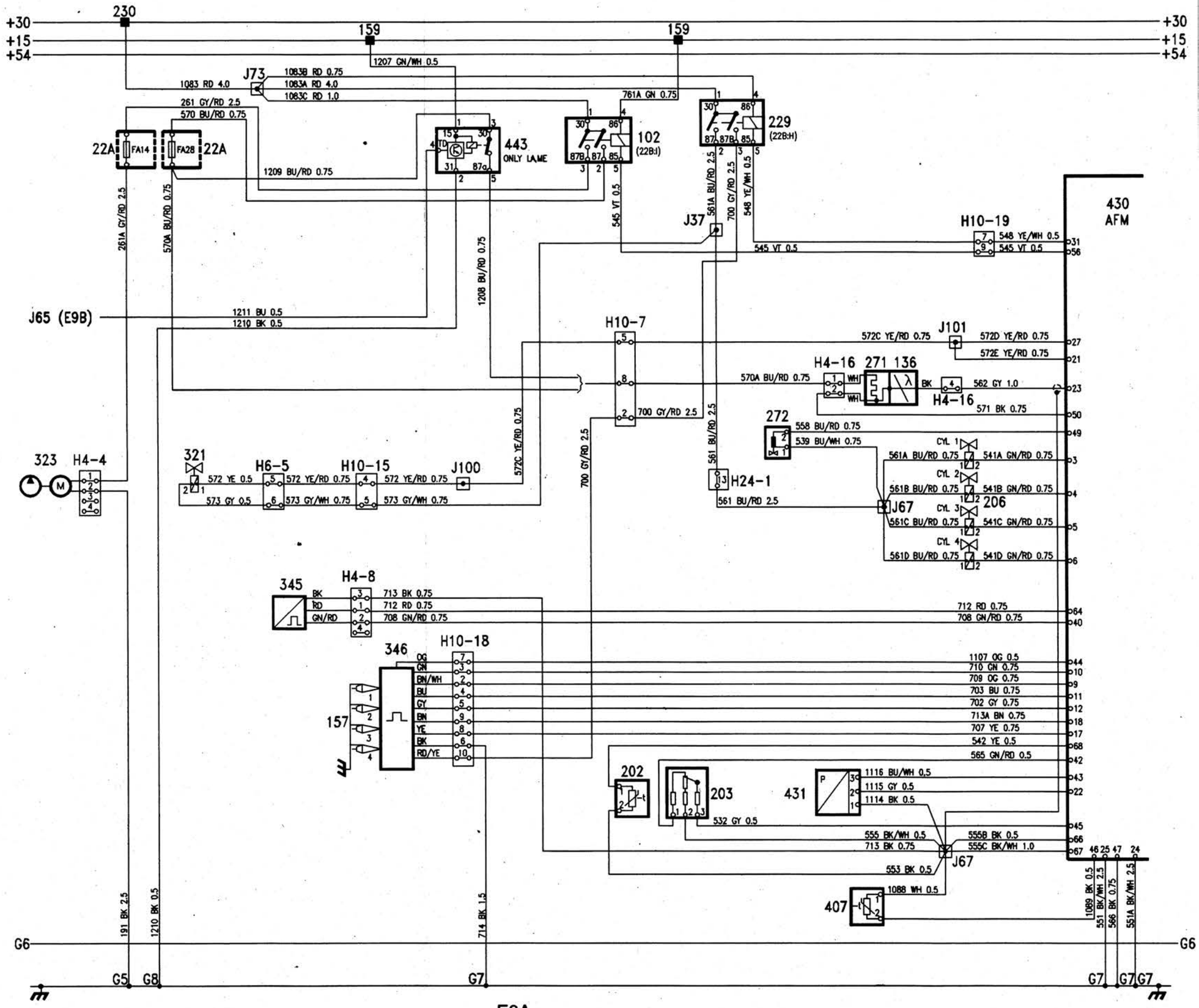
G2 Battery tray grounding point, on the left-hand wheel housing

G5 Grounding point under the rear seat on the left-hand side

G8 Grounding point on the facia at the front left-hand speaker socket

G7 Grounding point on engine, at rear of engine on the bracket under the intake pipe

G24 Grounding point, right-hand front seat member



E9A
MOTORSTYRSYSTEM TRIONIC (T16λ)
ENGINE MANAGEMENT SYSTEM TRIONIC (T16λ)

018 0303 A

TRIONIC wiring diagram (II) (without TCS)

Location of Components

1	Battery in the engine compartment
22A	Fuse holder behind lid in glove compartment
47	Main instrument display panel in facia
47A	Fuel level gauge
47C	Coolant temperature gauge
47K	SHIFT UP warning lamp
73 (H6-1)	Timing service instrument socket on the left-hand side of the engine bay by the modification identity plate 75 Distribution block, positive battery supply, at the battery tray
76	Switch for raising engine idling speed (automatic transmission) under the centre console by the gear selector in gear selector switch 239.
102	Fuel pump relay in the main fuse box behind the glove box (22B:I)
110	Tachometer in the main instrument display panel
131	Control module for the Cruise Control system on the left of the steering column under the facia
132	Vehicle speed sensor in the speedometer in the main instrument display panel
136	Lambda sensor on exhaust pipe at the turbo manifold
155	Relay for A/C radiator fan in the main fuse box in the engine bay (342B:E)
157	Spark plugs on top of engine under the cover
159	Distribution terminal +15 in main fuse box behind the glove box
166	Pressure switch for the A/C radiator fan on the dryer unit in front of the right-hand wheel housing
171	Anti-freeze thermostat (cycling clutch switch) for the A/C centred on the evaporator housing
179	BPC valve on the radiator fan shroud
202	Coolant temperature sensor (NTC resistor) on inlet manifold flange between cylinders 2 och 3
203	Throttle position sensor on the throttle housing
206	Fuel injectors 2.0 L: underneath the inlet manifold 2.3 L: above the inlet manifold
210	EDU trip computer in the main instrument display panel
229	Main relay for the TRIONIC system in the main fuse box behind the glove box (22B:H)
230	Distribution terminal +30 in the main fuse box behind the glove box
231	Distribution terminal +54 in the main fuse box behind the glove box
239	Gear selector switch (automatic transmission) under the centre console on the selector lever assembly
271	Lambda sensor preheater, integrated into the sensor
272	Idle air control valve on intake pipe, in the centre
321	EVAP canister valve in right-hand wheel housing
323	Fuel pump in fuel tank under luggage compartment floor
345	Crankshaft position sensor behind the pulley on the oil pump housing
346	Ignition discharge module on the valve cover
347 (H10-8)	Data link connector (diagnostic test socket), engine electronics, under right-hand front seat (black)
407	Air temperature sensor (NTC resistor) in the engine bay on the inlet manifold
430	TRIONIC control module in the engine bay behind the bulkhead partition
431	Manifold absolute pressure sensor in the engine bay on the bulkhead partition
443	Relay, lambda sensor preheating disconnect, under the facia on the left-hand side of the bracket for the control module for the Cruise Control system
444 (H6-10)	TRIONIC data link connector (test socket) (only for production)

Continued on the next page.

Location of components (contd.)

2-pole connector

H2-19 Under facia on left of steering column

3-pole connectors

H3-20 Behind the main instrument display panel at the speedometer (ME)

H3-25 On the bracket for the control module for the Cruise Control system

4-pole connectors

H4-4 At the fuel pump under the luggage compartment floor

H4-8 In the engine bay under the intake pipe

H4-12 At the right-hand wheel housing beside the windscreen washer fluid reservoir

H4-16 In the engine bay behind the bulkhead partition at extreme right (black)

6-pole connector

H6-5 In the front right-hand corner behind the light cluster at the washer fluid reservoir

10-pole connectors

H10-7 In the engine bay on the left-hand side of the windscreen wiper motor (black)

H10-13 On the left-hand side of the engine bay, at the wiper motor (gray)

H10-15 Behind the left-hand headlamp

H10-18 On the ignition discharge module

H10-19 On the left-hand side of the engine bay, at the windscreen wiper motor (blue)

24-pole connector

H24-1 In the engine bay on the bulkhead partition

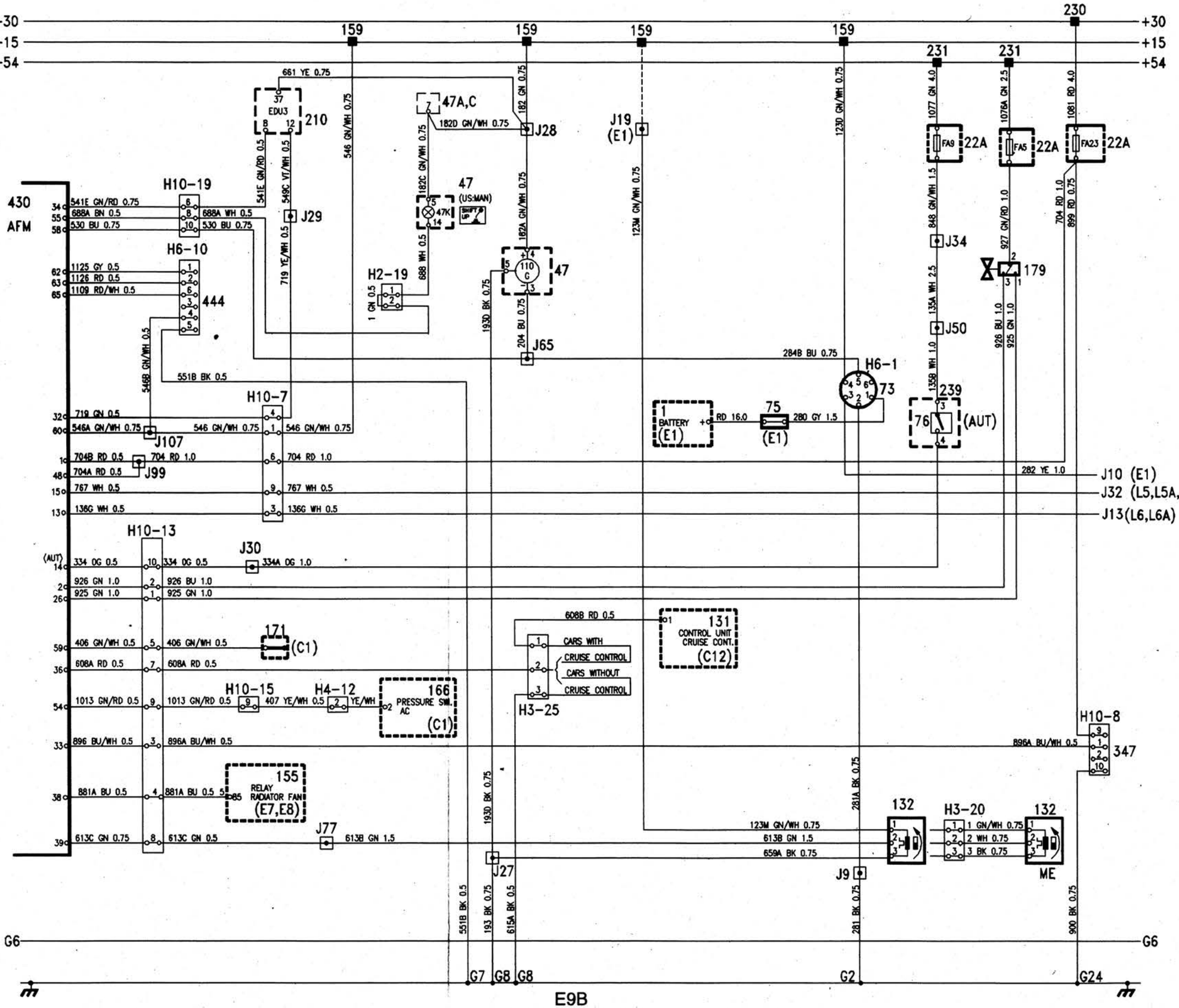
G2 Battery tray grounding point, on the left-hand wheel housing

G5 Grounding point under the rear seat on the left-hand side

G8 Grounding point on the facia at the front left-hand speaker socket

G7 Grounding point on engine, at rear of engine on the bracket under the intake pipe

G24 Grounding point, right-hand front seat member



E9B
MOTORSTYRSYSTEM TRIONIC (T16λ)
ENGINE MANAGEMENT SYSTEM TRIONIC (T16λ)

018 0304 A

TRIONIC wiring diagram (I) (with TCS)

Location of components

1	Battery in engine bay
22A	Fuse holder behind lid in glove box
47	Main instrument display panel in facia
47A	Fuel gauge
47C	Coolant temperature gauge
47K	SHIFT UP warning lamp
73 (H6-1)	Timing service instrument socket on the left-hand side of the engine bay by the modification identity plate
75	Distribution block, positive battery supply, at the battery tray
76	Switch for raising engine idling speed (automatic transmission) under the centre console by the gear selector in gear selector switch 239.
102	Fuel pump relay in the main fuse box behind the glove box (22B:I)
110	Tachometer in the main instrument display panel
132	Vehicle speed sensor in the speedometer in the main instrument display panel
136	Lambda sensor on exhaust pipe at the turbo manifold
155	Relay for A/C radiator fan in the main fuse box in the engine bay (242B:E)
156	Relay for AC and ACC radiator fan in the main fuse box behind the glove box (22B:E)
157	Spark plugs on top of engine under the cover
159	Distribution terminal +15 in main fuse box behind the glove box
179	BPC valve on the radiator fan shroud
202	Coolant temperature sensor (NTC resistor) on inlet manifold flange between cylinders 2 och 3
206	Fuel injectors 2.0 L: underneath the inlet manifold 2.3 L: above the inlet manifold
210	EDU trip computer in the main instrument display panel
229	Main relay for the TRIONIC system in the main fuse box behind the glove box (22B:H)
230	Distribution terminal +30 in the main fuse box behind the glove box
231	Distribution terminal +54 in the main fuse box behind the glove compartment
239	Gear selector switch (automatic transmission) under the centre console on the selector lever assembly
271	Lambda sensor preheater, integrated into the sensor
321	EVAP canister valve in right-hand wheel housing
323	Fuel pump in fuel tank under luggage compartment floor
345	Crankshaft position sensor behind the pulley on the oil pump housing
346	Ignition discharge module on the valve cover
347 (H10-8)	Data link connector (diagnostic test socket), engine electronics, under right-hand front seat (black)
376	ETS control module under left-hand front seat
407	Air temperature sensor (NTC resistor) in the engine bay on the inlet manifold
414	ASR control module under left-hand front seat
430	TRIONIC control module in the engine bay behind the bulkhead partition
431	Manifold absolute pressure sensor in the engine bay on the bulkhead partition
443	Relay, lambda sensor preheating disconnect, under the facia on the left-hand side of the bracket for the control module for the Cruise Control system 444
(H6-10)	TRIONIC data link connector (test socket) (only for production)

Continued on the next page.

Location of components (contd.)

2-pole connector

H2-19 Under facia on left of steering column

3-pole connector

H3-20 Behind the main instrument display panel at the speedometer (ME)

4-pole connectors

H4-4 At the fuel pump under the luggage compartment floor

H4-8 In the engine bay under the intake pipe

H4-12 At the right-hand wheel housing beside the windscreen washer fluid reservoir

H4-16 In the engine bay behind the bulkhead partition at extreme right (black)

6-pole connector

H6-5 In the front right-hand corner behind the light cluster at the washer fluid reservoir

10 pole connectors

H10-7 In the engine bay on the left-hand side of the windscreen wiper motor (black)

H10-13 On the left-hand side of the engine bay, at the windscreen wiper motor (grey)

H10-15 Behind the left-hand headlamp

H10-18 On the ignition discharge module

H10-19 On the left-hand side of the engine bay, at the windscreen wiper motor (blue)

24-pole connector

H24-1 In the engine bay on the bulkhead partition

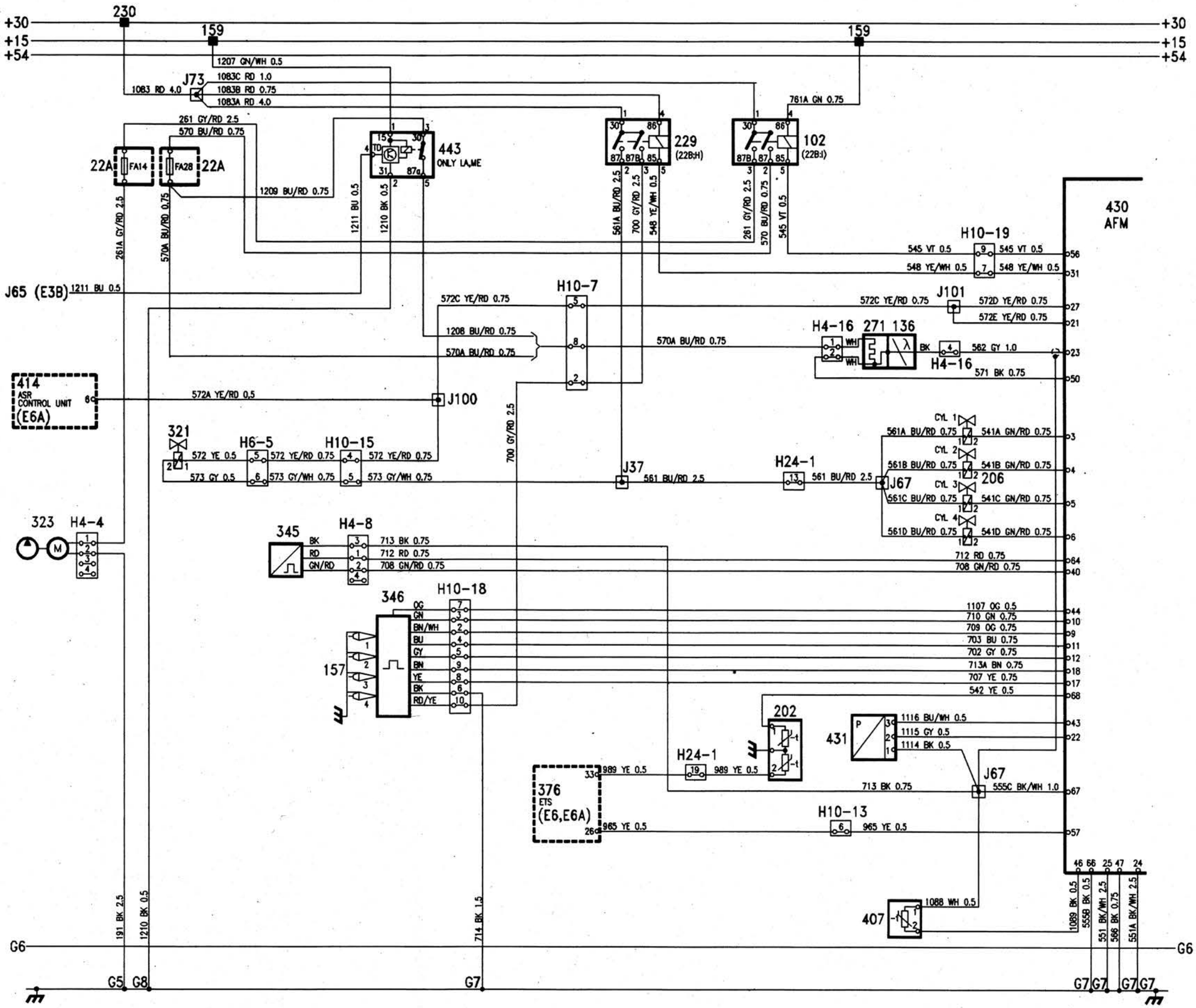
G2 Battery tray grounding point, on the left-hand wheel housing

G5 Grounding point under the rear seat on the left-hand side

G8 Grounding point on the facia at the front left-hand speaker socket

G7 Grounding point on engine, at rear of engine on the bracket under the intake pipe

G24 Grounding point, right-hand front seat member



E9C
MOTORSTYRSYSTEM TRIONIC TCS (T16λ)
ENGINE MANAGEMENT SYSTEM TRIONIC TCS (T16λ)

018 0305 A

TRIONIC wiring diagram (II) (with TCS)

Location of components

1	Battery in engine bay
22A	Fuse holder behind lid in glove box
47	Main instrument display panel in facia
47A	Fuel gauge
47C	Coolant temperature gauge
47K	SHIFT UP warning lamp
73 (H6-1)	Timing service instrument socket on the left-hand side of the engine bay by the modification identity plate
75	Distribution block, positive battery supply, at the battery tray
76	Switch for raising engine idling speed (automatic transmission) under the centre console by the gear selector in gear selector switch 239.
102	Fuel pump relay in the main fuse box behind the glove box (22B:I)
110	Tachometer in the main instrument display panel
132	Vehicle speed sensor in the speedometer in the main instrument display panel
136	Lambda sensor on exhaust pipe at the turbo manifold
155	Relay for A/C radiator fan in the main fuse box in the engine bay (242B:E)
156	Relay for AC and ACC radiator fan in the main fuse box behind the glove box (22B:E)
157	Spark plugs on top of engine under the cover
159	Distribution terminal +15 in main fuse box behind the glove box
179	BPC valve on the radiator fan shroud
202	Coolant temperature sensor (NTC resistor) on inlet manifold flange between cylinders 2 och 3
206	Fuel injectors 2.0 L: underneath the inlet manifold 2.3 L: above the induction manifold
210	EDU trip computer in the main instrument display panel
229	Main relay for the TRIONIC system in the main fuse box behind the glove box (22B:H)
230	Distribution terminal +30 in the main fuse box behind the glove box
231	Distribution terminal +54 in the main fuse box behind the glove compartment
239	Gear selector switch (automatic transmission) under the centre console on the selector lever assembly
271	Lambda sensor preheater, integrated into the sensor
321	EVAP canister valve in right-hand wheel housing
323	Fuel pump in fuel tank under luggage compartment floor
345	Crankshaft position sensor behind the pulley on the oil pump housing
346	Ignition discharge module on the valve cover
347 (H10-8)	Data link connector (diagnostic test socket), engine electronics, under right-hand front seat (black)
376	ETS control module under left-hand front seat
407	Air temperature sensor (NTC resistor) in the engine bay on the inlet manifold
414	ASR control module under left-hand front seat
430	TRIONIC control module in the engine bay behind the bulkhead partition
431	Manifold absolute pressure sensor in the engine bay on the bulkhead partition
443	Relay, lambda sensor preheating disconnect, under the facia on the left-hand side of the bracket for the control module for the Cruise Control system
444 (H6-10)	TRIONIC data link connector (test socket) (only for production)

Continued on the next page.

Location of components (contd.)

2-pole connector

H2-19 Under facia on left of steering column

3-pole connector

H3-20 Behind the main instrument display panel at the speedometer (ME)

4-pole connectors

H4-4 At the fuel pump under the luggage compartment floor

H4-8 In the engine bay under the intake pipe

H4-12 At the right-hand wheel housing beside the windscreen washer fluid reservoir

H4-16 In the engine bay behind the bulkhead partition at extreme right (black)

6-pole connector

H6-5 In the front right-hand corner behind the light cluster at the washer fluid reservoir

10-pole connectors

H10-7 In the engine bay on the left-hand side of the windscreen wiper motor (black)

H10-13 On the left-hand side of the engine bay, at the windscreen wiper motor (grey)

H10-15 Behind the left-hand headlamp

H10-18 On the ignition discharge module

H10-19 On the left-hand side of the engine bay, at the windscreen wiper motor (blue)

24-pole connector

H24-1 In the engine bay on the bulkhead partition

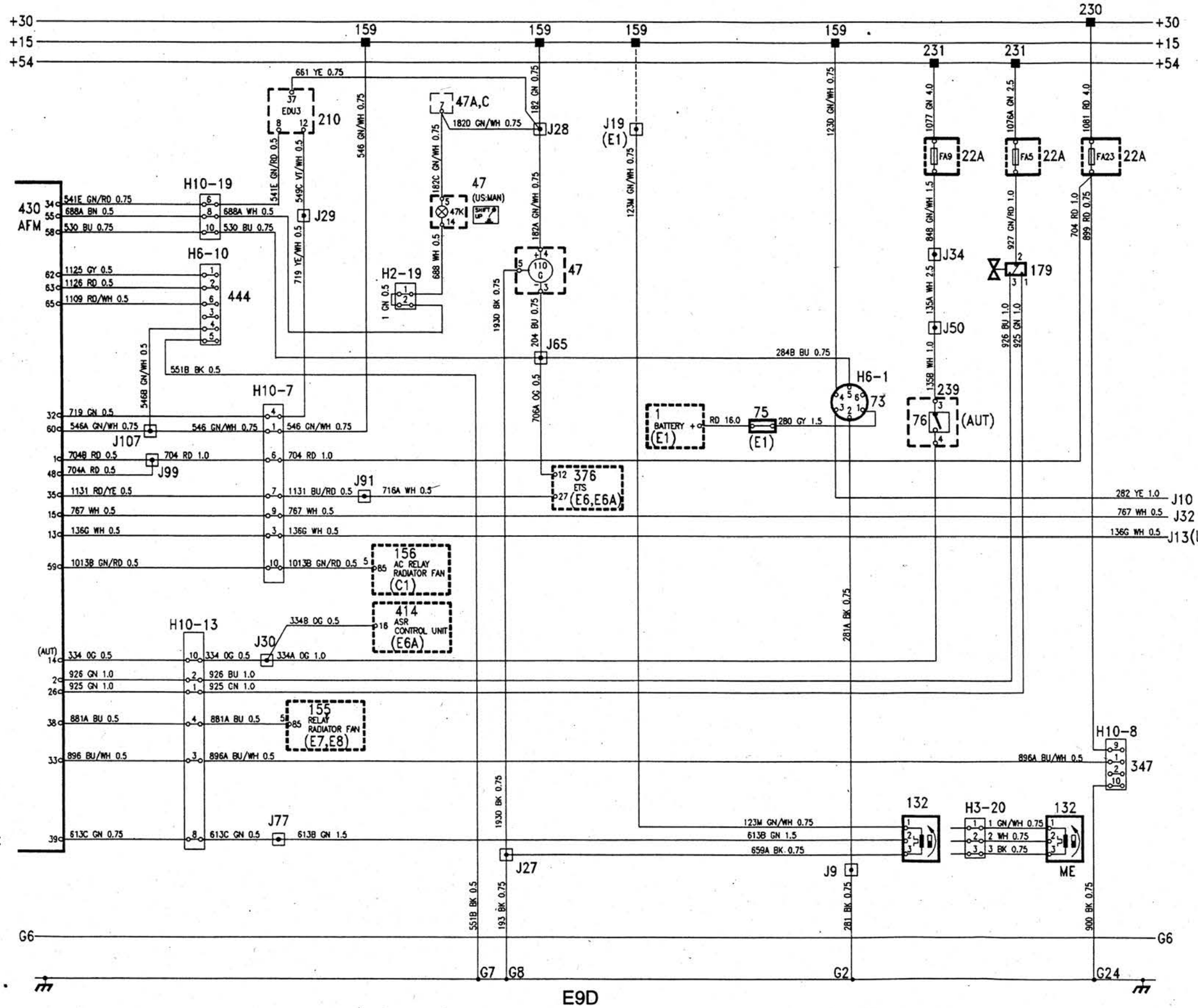
G2 Battery tray grounding point, on the left-hand wheel housing

G5 Grounding point under the rear seat on the left-hand side

G8 Grounding point on the facia at the front left-hand speaker socket

G7 Grounding point on engine, at rear of engine on the bracket under the intake pipe

G24 Grounding point, right-hand front seat member



E9D

MOTORSTYRSYSTEM TRIONIC TCS (T16λ)

ENGINE MANAGEMENT SYSTEM TRIONIC TCS (T16λ)

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