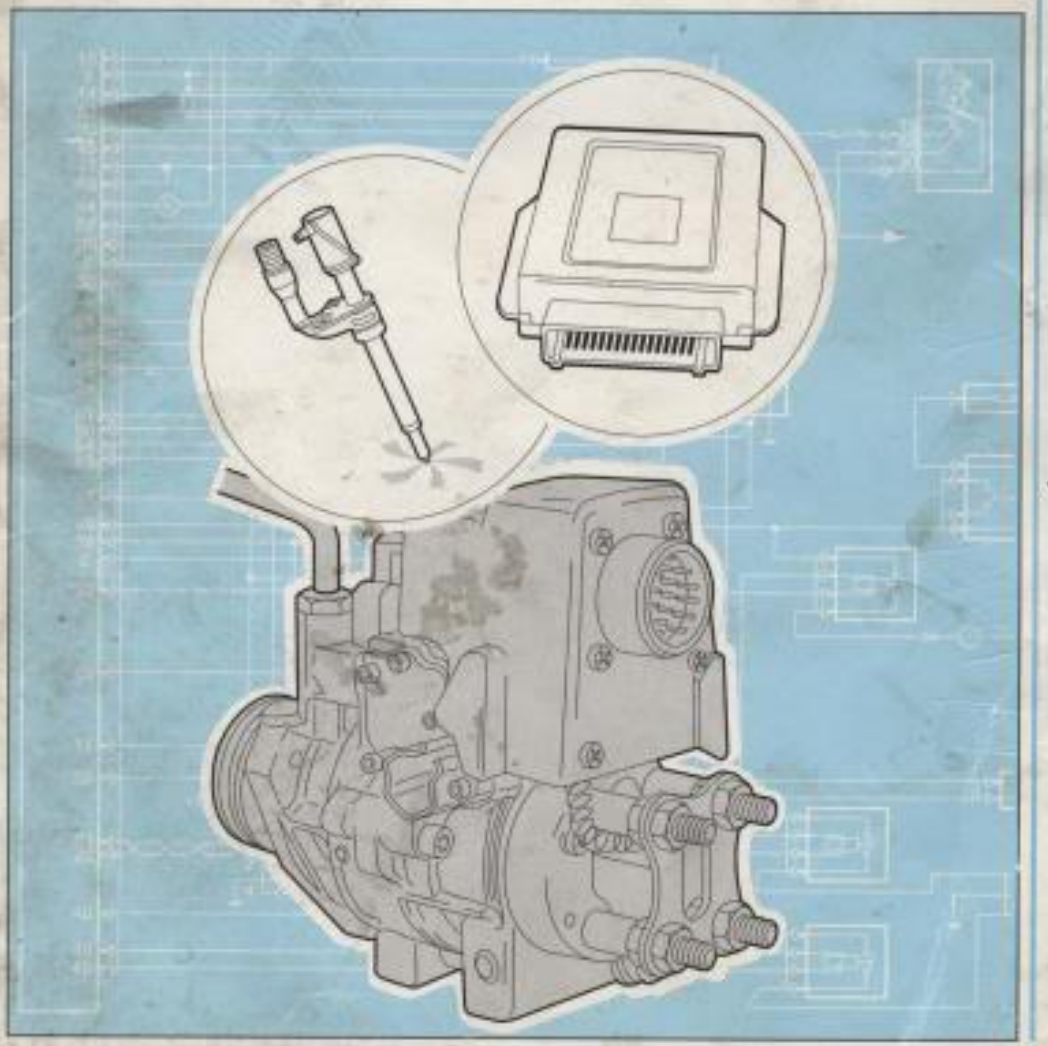
Technical Service Training

Delegate Information

CG 7659/S en 9/96

New Product Introduction	29/L

Transit EPIC Injection System



Ford

PREFACE

This Delegate Information is a training publication for comprehensive training on the Ford Transit. It is designed to provide practical training on the individual Transit components to enable the service technician to accurately diagnose customer concerns and carry out repairs and change damaged or faulty components.

The entire "Transit" training literature is divided into various individual publications (see Literature Overview). Each publication has its own CG number (order number).

To keep the training on all the components as uniform as possible, the literature is organised as follows:

- Introduction
- General
- Design and operation
- Important notes (use of special tools, tightening torques) and correct procedures for removal and installation and for dismantling and reassembly of components
- Checking and testing
- Technical data

This approach is designed to provide the course delegate with the comprehensive product knowledge required to be able to give a satisfactory service to our Ford Transit customers.

Please remember that our training literature has been prepared solely for FORD-DEALER TRAINING PURPOSES.
Repair and adjustment operations **MUST** always be carried out according to the instructions and specifications in the workshop literature.
Please make extensive use of the training courses offered by the Training Centres in order to gain extensive knowledge in both theory and practice.

INTRODUCTION

- This brochure describes the design and operation of the diesel injection system from Lucas used in the Ford Transit with the turbo diesel engine.
- The publication starts by dealing with the fuel system, the high pressure and low pressure system and the cold starting aid.
- The publication then describes the operation and diagnostics of the Lucas injection system.
- The electronic vehicle immobiliser or passive anti theft system with keycoding (PATS) was introduced to provide security against theft. This publication describes the design and operation of the PATS as used in the Ford Transit '97 with the Lucas injection pump.
- All the torque figures listed in this publication must only be used for training purposes. Refer to the workshop literature (Service Microfiche) for the latest torque figures when carrying out repairs.
- Refer to the workshop literature (Service Microfiche) for the safety precautions to be observed when handling fuel.
- Refer to the workshop literature (Service Microfiche) for the procedure to be employed when carrying out repairs.
- The description of the service checks and adjustments is provided solely for training purposes. Service checks and adjustments should always be carried out in conjunction with the Vehicle System Test Manual.

PAGE

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Diesel Injection, Service Checks and Adjustments, CG 7506

Diesel Engine Management, CG 7465

EEC V and On-Board Diagnostics, CG 7543

Diesel Injection Systems, CG 7453

New Product Introduction Transit:
- Front Axle and Steering, CG 7647
- Rear Axles, CG 7648
- Brakes, CG 7649
- Transmission and Clutch, CG 7650
- Engines, CG 7651
- Vehicle Electrical Systems and Air Conditioning, CG 7652
- Body, CG 7643
- Diesel Injection Systems, CG 7653
- DOHC Engine Management, CG 7654
- A 4 LD Basic – Automatic Transmission, CG 7446

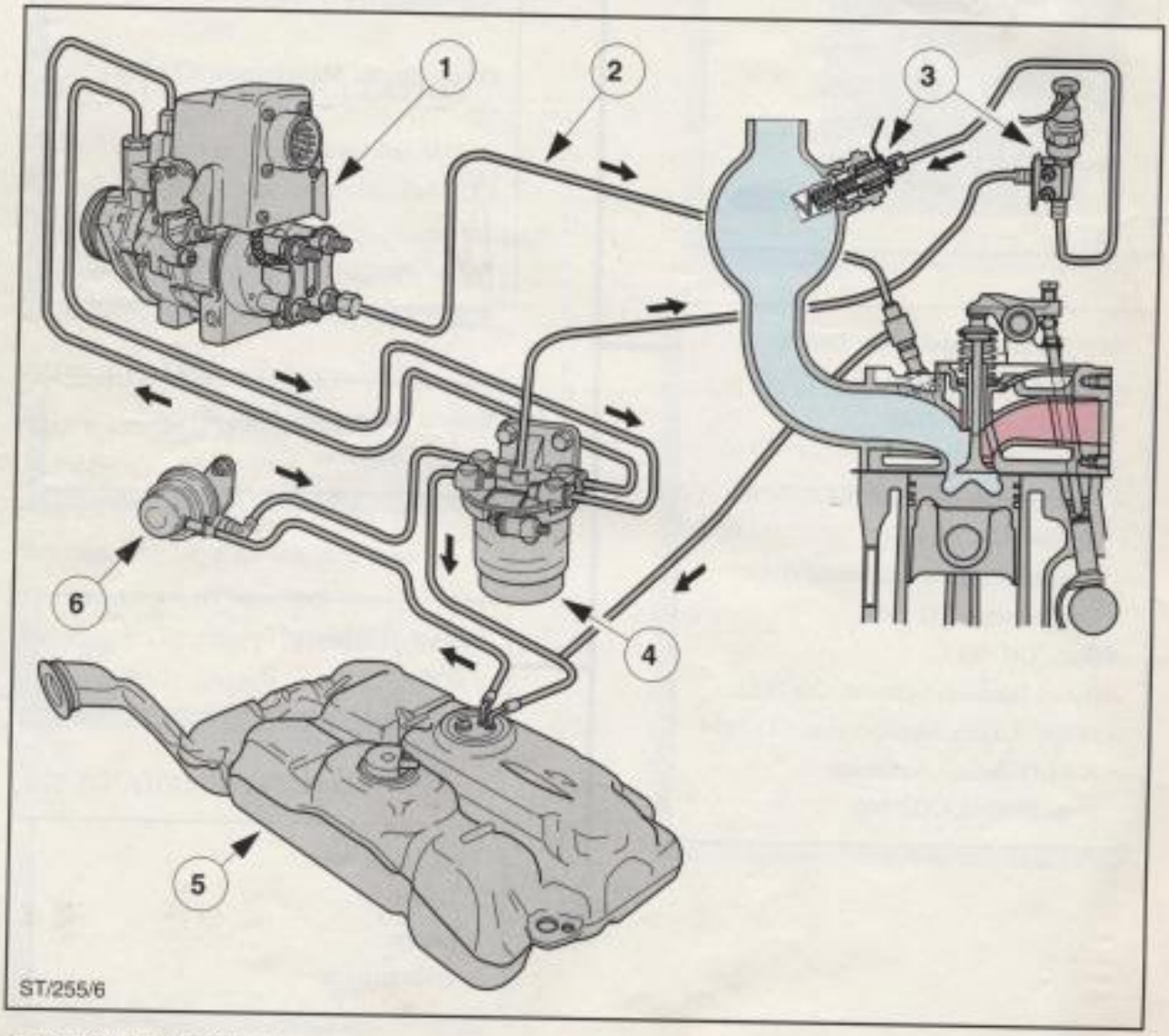
Vehicle System Test Manuals
Wiring Diagrams

Service Microfiche:
- Transit

Parts Microfiche:
- Transit
- Engine
- Transmission

Fuel supply

- For the 2.5 l DI diesel engine the fuel system consists of a low-pressure system and a high-pressure system and a cold-starting aid (flame start system).
- The low-pressure system comprises:
  - fuel tank
  - fuel supply pump
  - fuel filter for self-purging system
  - sensor for water-in-fuel indicator
  - and flame start system
- The high-pressure system comprises:
  - distributor-type injection pump
  - pressure valves
  - fuel injection pipes
  - injectors



1 Distributor-type injection pump
2 Fuel pipes
3 Flame start system
4 Fuel filter
5 Fuel tank
6 Fuel supply pump (since '90)

Low-pressure system

Fuel supply pump

- Since '90 the Transit has been fitted with a mechanical diaphragm fuel supply pump. This is located on the side of the crankcase and is driven from the cam. It pumps fuel from the fuel tank to the distributor-type injection pump at low pressure (approximately 0,1 – 0,3 bar).
- The fuel supply pump ensures a continuous supply of fuel to the distributor-type injection pump.

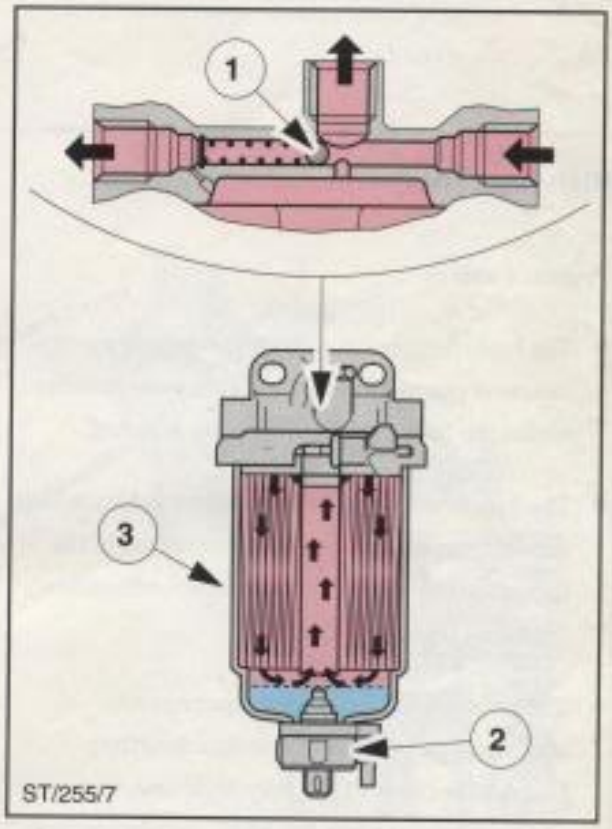
Note: Bleeding the fuel system is unnecessary.

Fuel filter

- The fuel filter is bolted to the inlet manifold and located between the fuel supply pump and the distributor-type injection pump.

Note: The fuel filter retaining bolts are very long to withstand vibrations. They must not be replaced by shorter bolts.

- The Transit has a fuel filter with a pressure holding valve. This is located in the upper part of the filter and builds up a constant pressure of 0,5 bar to supply fuel to the flame start system.

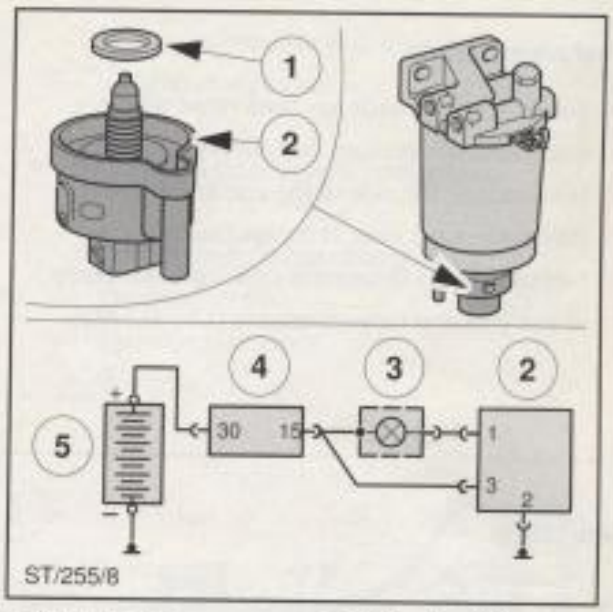


1 Pressure holding valve for flame start system
2 Sensor for water-in-fuel indicator
3 Fuel filter for self-purging system

Water-in-fuel sensor

- On the underside of the fuel filter there is a sensor for the water-in-fuel indicator. It is screwed in finger tight and has a three-pin electrical connector.
- When the accumulation of water in the fuel filter reaches an appropriate level, the water-in-fuel sensor switches on a warning light in the instrument cluster to indicate the need for servicing.

Note: When the engine is started, the warning light comes on for approximately 2 seconds.

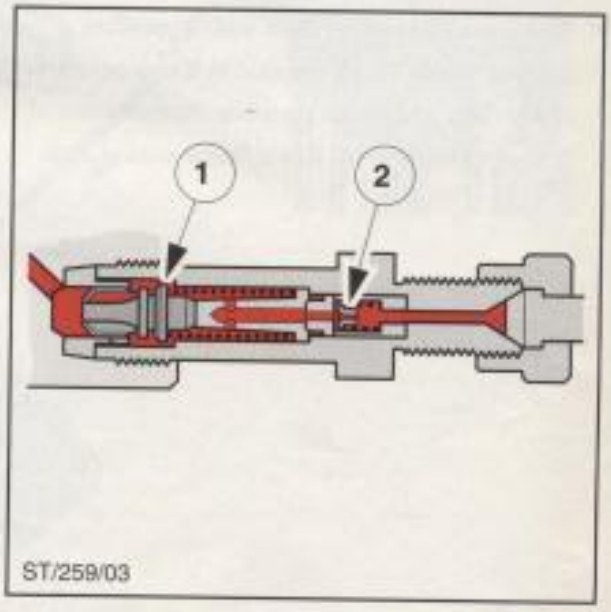


1 Sealing ring
2 Water-in-fuel sensor
3 Warning light
4 Ignition switch
5 Battery

High-pressure system

Pressure valves

- The high-pressure outlets of the distributor-type injection pump are fitted with pressure valves to which the fuel injection pipes are screwed.
- The pressure valves are non-return valves which are designed to prevent pressure surges in the fuel injection pipes. This prevents undesirable dribbling from the injectors.
- The pressure valve also incorporates an additional damping valve with a throttling function because of the very high injection pressure produced by the EPIC distributor-type injection pump.

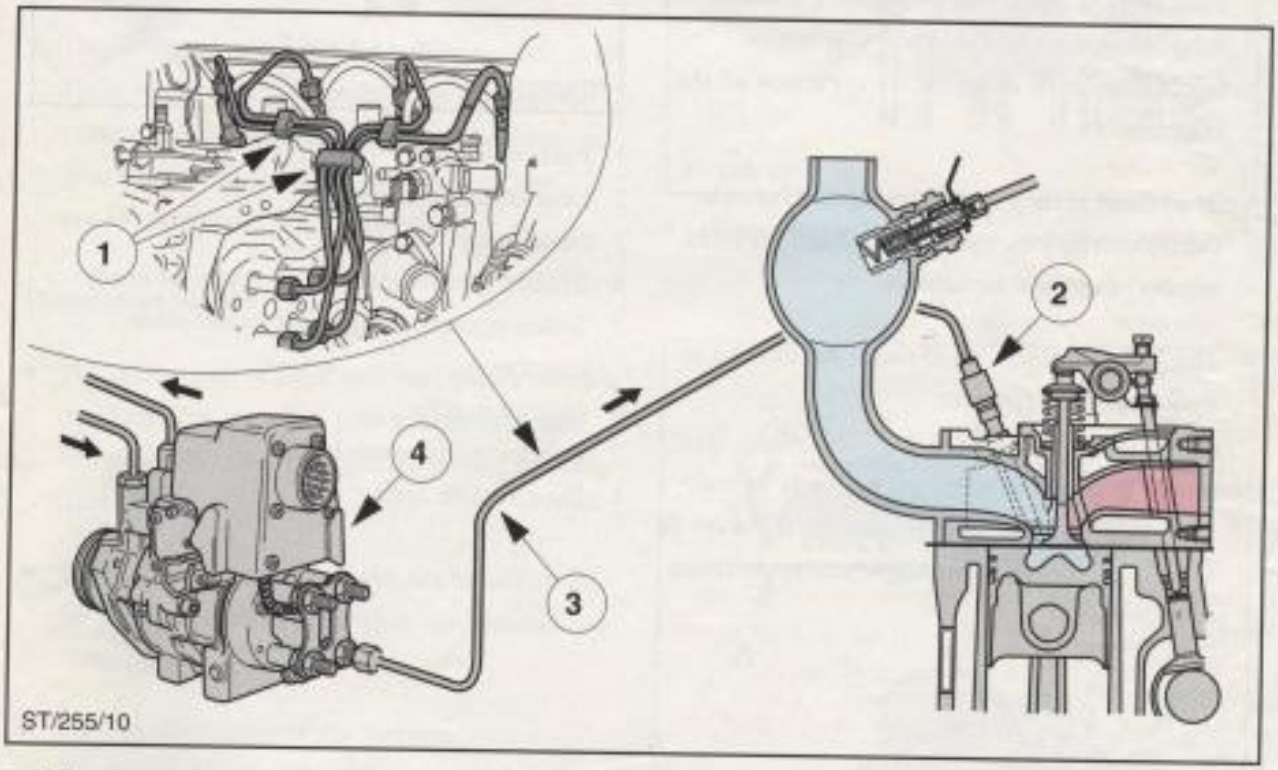


1 Valve seat cone
2 Damping valve

Fuel injection pipes

- The fuel injection pipes connect the distributor-type injection pump via the pressure valves to the injectors.
- To avoid vibration fractures, the fuel injection pipes are made of a thick-walled seamless steel pipe with large-radius bends. The fuel injection pipes are fixed and secured with clamps.
- The length, bending radii and inside diameters of the fuel injection pipes are precisely matched to the particular fuel injection system and must not be changed, e.g. by mixing Lucas and Bosch replacement parts.
- The injection order determines the arrangement of the fuel injection pipes.

Note: The inside diameter of the fuel injection pipes is matched to the particular fuel injection system. When changing pipes, make sure that fuel injection pipes with the same inside diameter are always fitted.

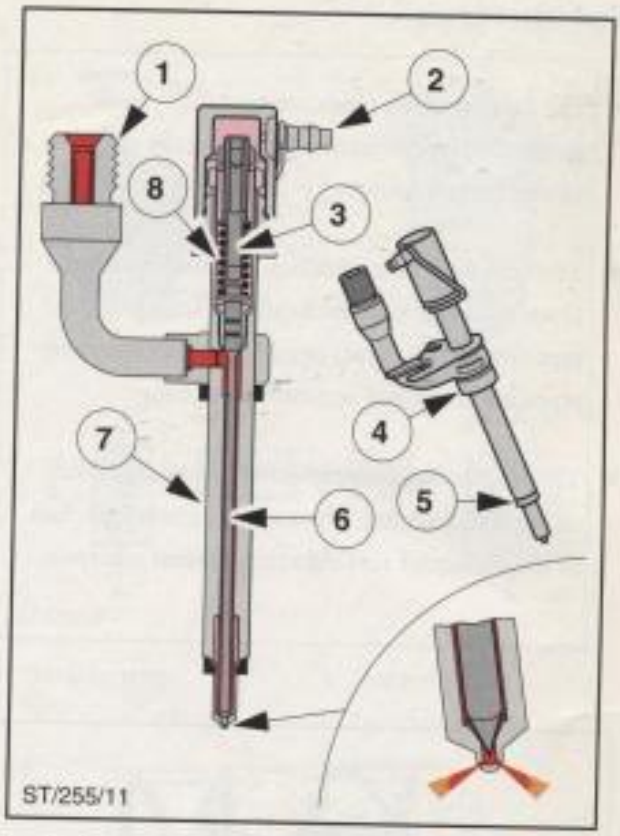


1 Clamps
2 Injector
3 Fuel injection pipes
4 Distributor-type injection pump

Injectors

- Only Stanadyne slim hole-type injectors with 5 spray holes are used on Transit diesel engines with distributor-type injection pumps.
- The reduced outside diameter enables the injector to extend into the middle of the combustion chamber.
- The injectors are needle valves which are opened automatically by the high pressure produced by the distributor-type injection pump at approximately 270 bar. The compression spring in the injector determines the opening pressure.
- After some time in use, the spring tension of the compression spring and the opening pressure drop below the specified values. When an injector has to be changed, always renew all the injectors.
- The rubber sealing ring (4) is located between the injector and the cylinder head and prevents ingress of dirt and moisture.
- The Teflon sealing ring (5) seals the injector to the combustion chamber.

Note: Both sealing rings must only be used once. The sealing rings must always be renewed whenever injectors are fitted.

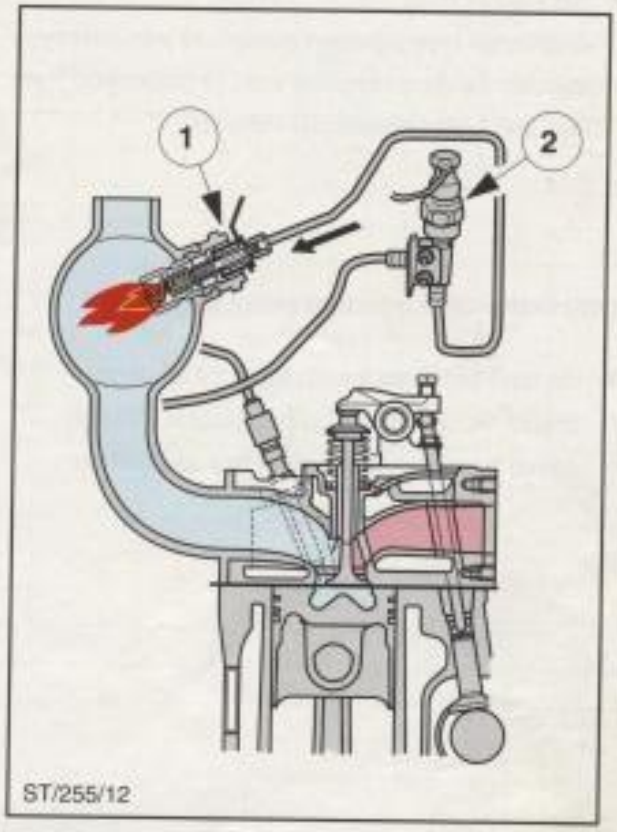


1 Fuel connection
2 Leak-off connection
3 Needle stop
4 Rubber injector sealing ring (cylinder head)
5 Teflon injector sealing ring (combustion chamber)
6 Injector needle
7 Injector with 5 spray holes
8 Compression spring

Cold starting aid

Flame start system

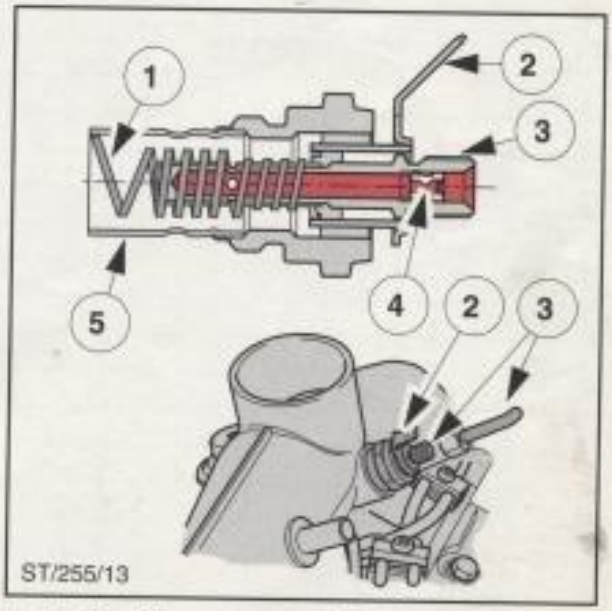
- At ambient temperatures below –5 °C the Ford Transit with the 2,5 l DI diesel engine uses a flame start system as a cold starting aid. The flame start system starting temperature can vary depending on market destination.
- The flame start system consists of a flame start burner, a solenoid valve with its own fuel supply from the fuel filter and a control module.
- The flame start burner is located in the inlet manifold and heats the intake air as it flows past. Preheating produces an ignition temperature of 400 °C during the compression stroke.
- On the Transit since '95 the ballast resistor of the flame start system was reduced in size and the control module adapted to the increased current consumption of the flame start burner. The pre-heating phase was lengthened.



1 Flame start burner 2 Solenoid valve

Flame start burner

- The central part of the flame start burner consists of a fuel inlet assembly with a vaporising tube surrounded by the heating filament and an outer flame tube.
- The vaporised fuel mixes with the intake air in the flame tube and is ignited on the heating filament.
- The throttling insert in the fuel connection determines the quantity of fuel supplied and is matched to the requirement of the diesel engine.
- On the Transit from '95 the thickness of the heating filament was increased. The current consumption is now 40 amps compared with 25 amps in the case of the Transit '92.



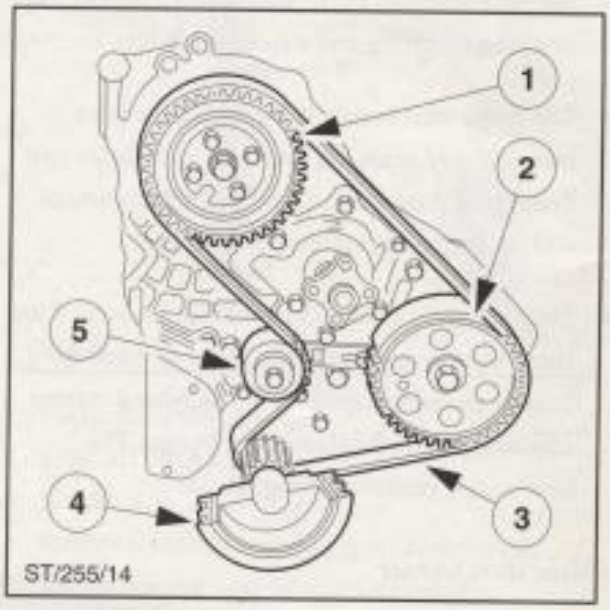
1 Heating filament
2 Electrical connection
3 Fuel connection
4 Throttling insert
5 Flame tube

Distributor-type injection pump

- Because of their compact design, distributor-type injection pumps are particularly suitable for diesel engines used in passenger cars and light commercial vehicles.
- The distributor-type injection pumps are completely filled with fuel. The fuel is also used as a lubricant for all the moving parts. Because of the high-precision fits, the fuel must be finely filtered.

Distributor-type injection pump drive

- On the Ford Transit with the 2,5 l DI diesel engine the distributor- type injection pump is driven by means of a timing belt and pulleys.



1 Injection pump timing pulley
2 Camshaft timing pulley
3 Timing belt
4 Crankshaft belt pulley
5 Timing belt tensioner pulley

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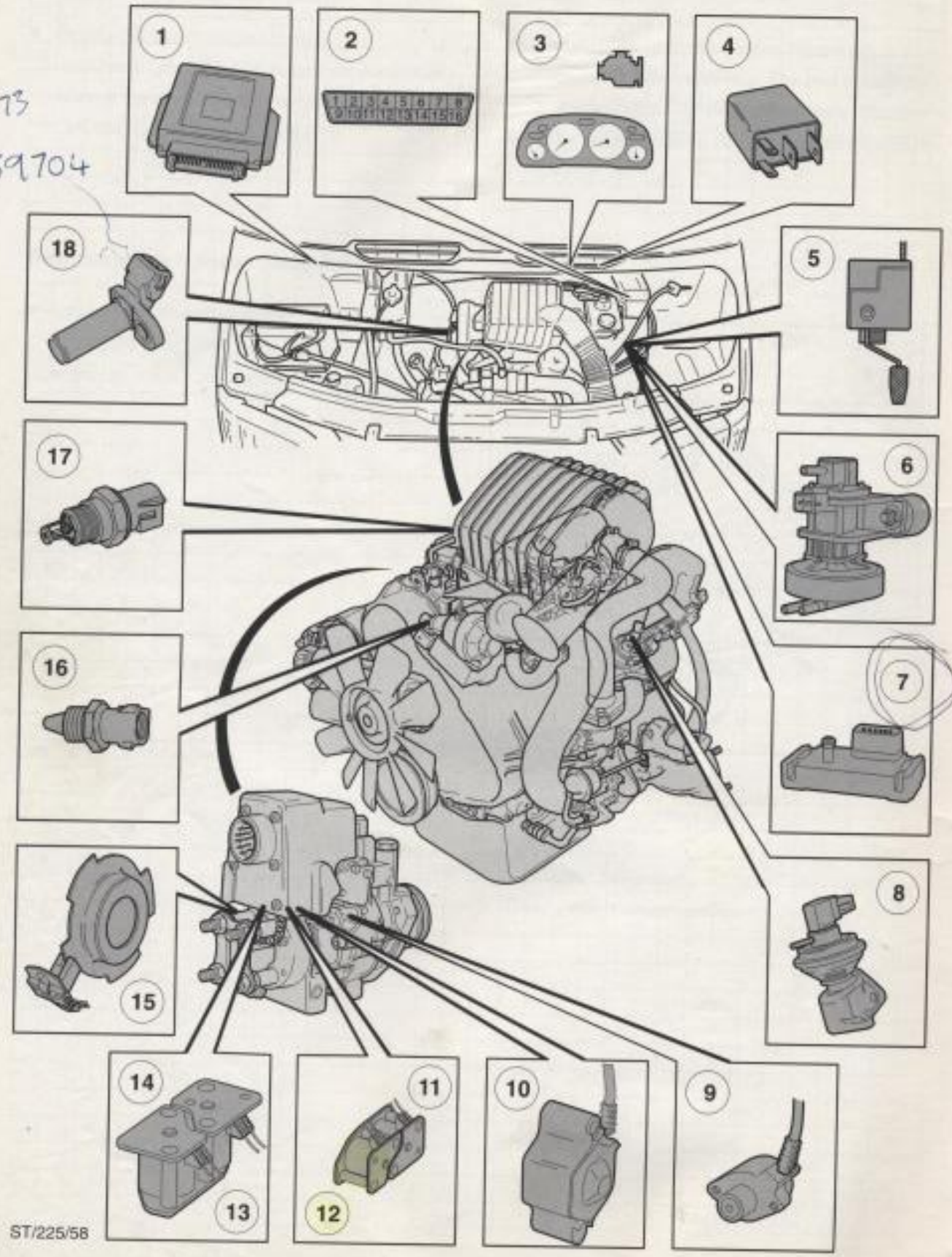


Layout of EPIC injection system in engine compartment

Transit engine compartment with 2,5 l DI turbo diesel engine

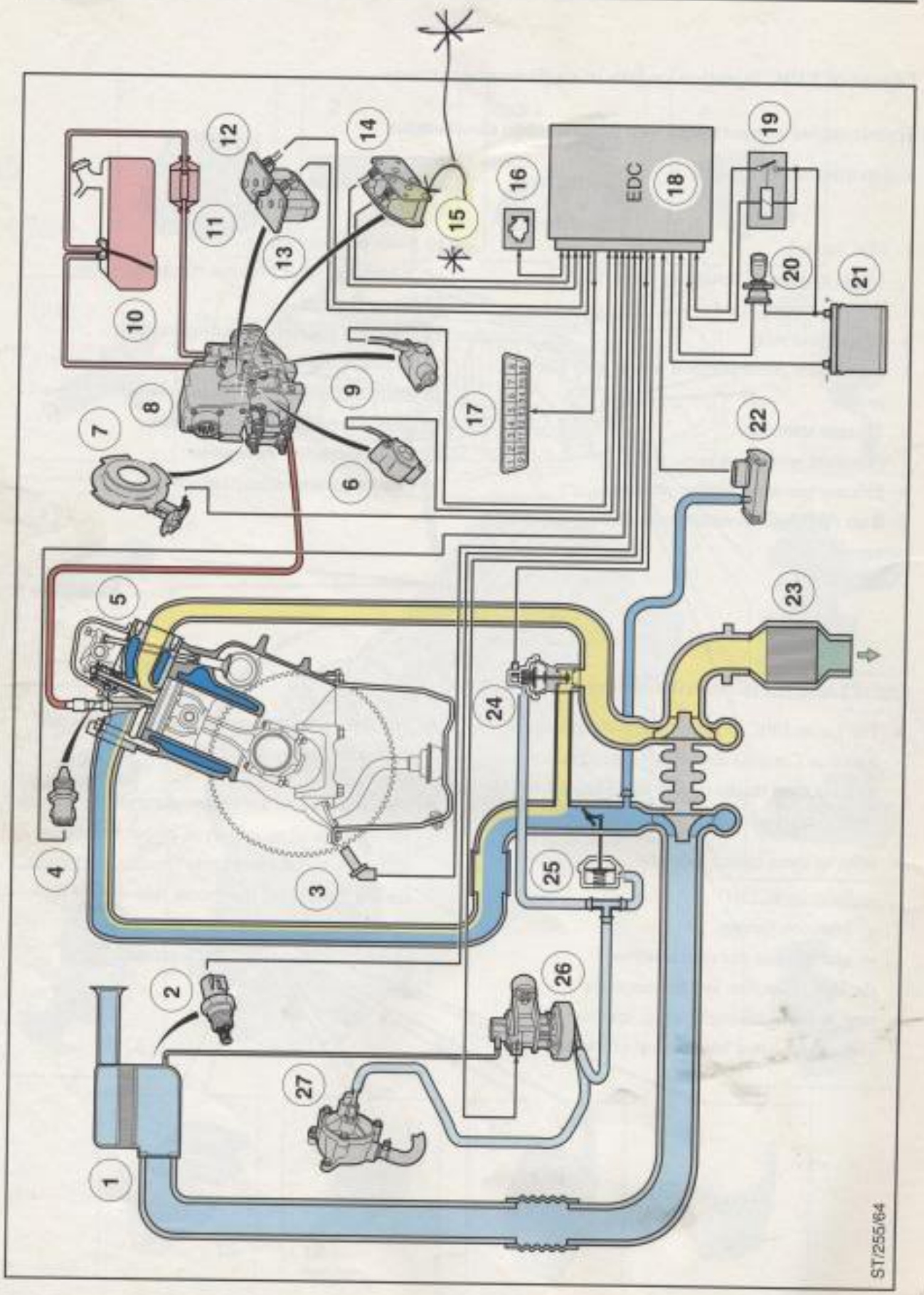
Key to illustration opposite:

1 EDC module
2 16-pin diagnostic connector from '95
3 Engine warning light
4 Power hold relay
5 Accelerator pedal position sensor with idle switch
6 Vacuum transducer
7 Manifold pressure sensor
8 Exhaust gas recirculation sensor
9 Cam ring position sensor with fuel temperature sensor
10 Rotor position sensor
11 "Charging" rotor position regulating valve
12 Shut-off valve
13 Cam ring position regulating valve
14 "Discharging" rotor position regulating valve
15 Injection pump speed/position sensor
16 Engine coolant temperature sensor
17 Intake air temperature sensor
18 Crankshaft speed/position sensor

Use of Lucas (EPIC) distributor-type injection pump

- The Lucas EPIC (Electronically Programmed Injection Control) distributor-type injection pump is used on the 63 kW and 74 kW 2,5 l DI turbo diesel engines.
- With its three closed loops for
  - quantity of fuel,
  - injection timing
  - and exhaust gas recirculation,

  the EPIC injection system meets the requirements for high power, low fuel consumption and low exhaust emissions.
- The three control loops affect one another and are controlled by the EDC module.
- Modifications to the engine management system have produced an improved power and torque characteristic at low engine speeds. In addition, for the Transit '95 the excess fuel control for starting was also improved as regards production of smoke (black smoke).


EDC
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Schematic illustration of EPIC injection system

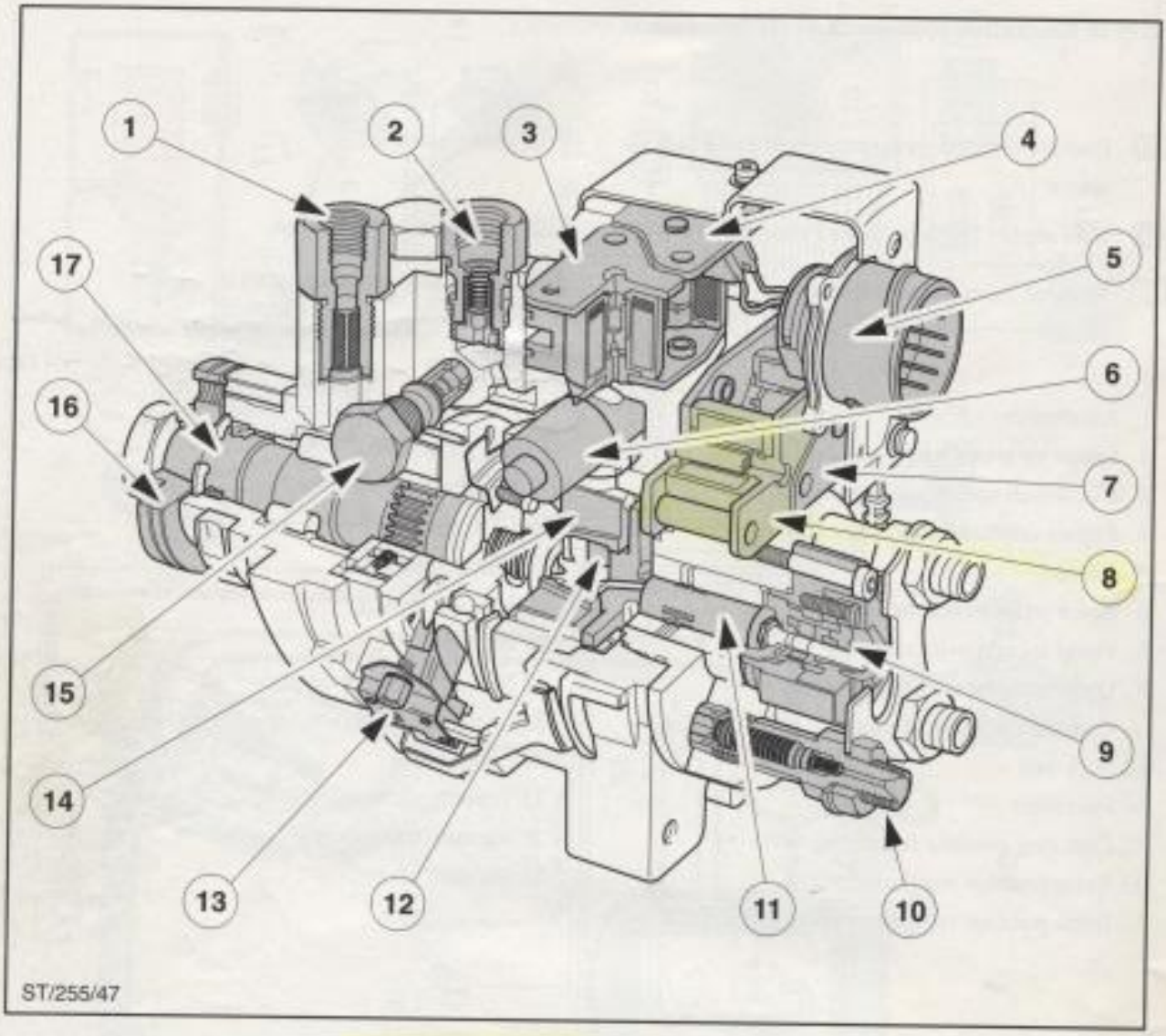
Key to illustration opposite (2,5 l DI turbo diesel engine):

- Fuel supply (low-pressure system) and fuel return
- Fuel supply (high-pressure system)
- Exhaust gases before catalyst
- Intake air
- Intake air, compressed
- Exhaust gases after catalyst

+|-
Dose not matter wich way round
~~Colour~~ colour - White + Orange wires

1 Air cleaner
2 Intake air temperature sensor
3 Crankshaft speed/position sensor
4 Engine coolant temperature sensor
5 Injector
6 Rotor position sensor
7 Pump speed/position sensor
8 Distributor-type injection pump
9 Cam ring position sensor
10 Fuel tank
11 Fuel filter
12 Cam ring position regulating valve
13 Rotor position regulating valve
14 Rotor position regulating valve
15 Electromagnetic shut-off valve
16 Engine warning light
17 Diagnostic connector
18 EDC module
19 Power hold relay
20 Ignition switch
21 Battery
22 Manifold pressure sensor
23 Oxidation catalyst
24 EGR sensor
25 Throttle plate
26 Vacuum transducer
27 Vacuum pump

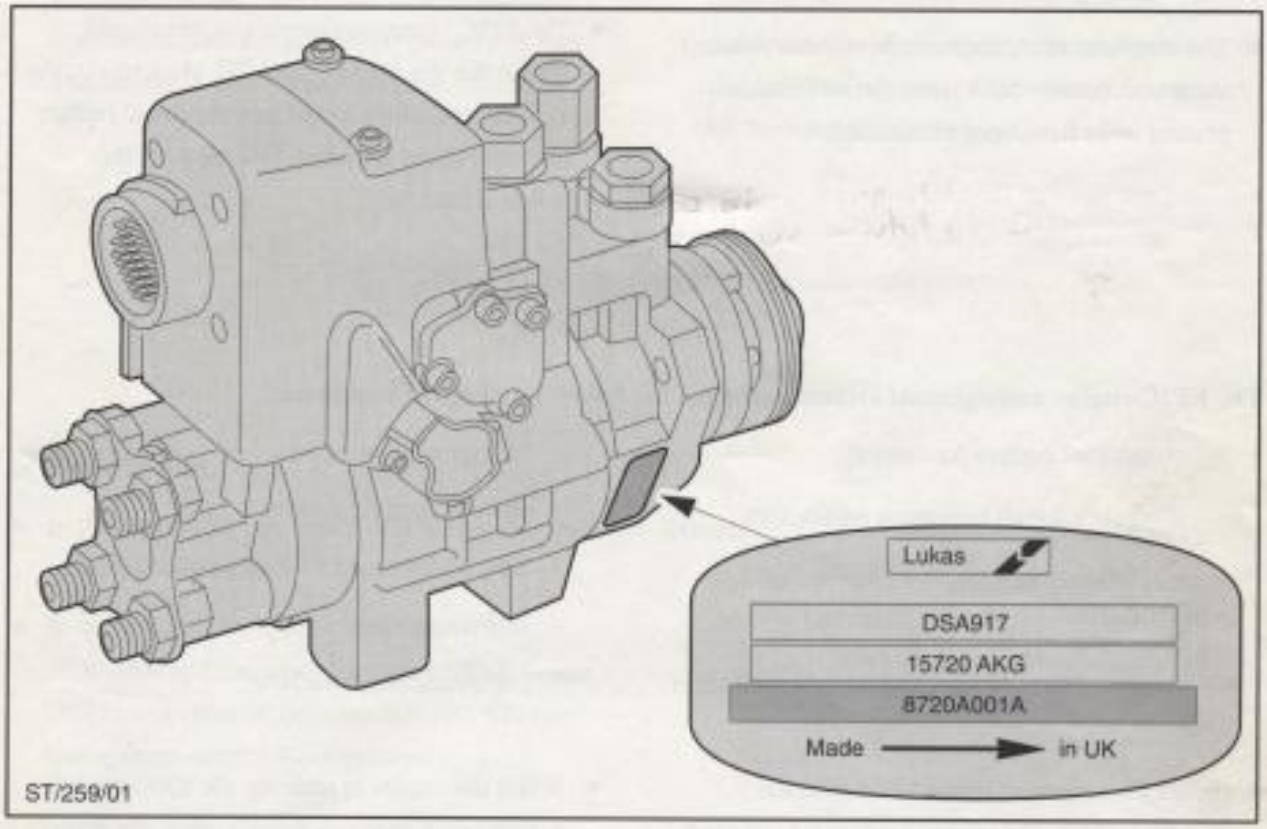
Components of Lucas EPIC distributor-type injection pump



1 Fuel inlet connection
2 Pressure holding valve
3 Regulating valve
4 Regulating valve
5 Electrical connection
6 Fuel injection timing plunger
7 Regulating valve
8 Shut-off valve
9 Rotor position sensor
10 Pressure valve
11 Rotor
12 High-pressure plunger
13 Pump speed/position sensor (Hall sensor)
14 Roller shoe
15 Transfer pressure regulating valve
16 Timing belt pulley mounting flange
17 Driving shaft

Location of type plate on injection pump

- The serial number of the injection pump is shown on the type plate (inset, grey background).



Lucas EPIC distributor-type injection pump

- This is a completely electronically controlled "fourth" generation injection pump. This injection pump is a completely new development.
- The mechanical components have been reduced by approximately 50% since the mechanical control units have been eliminated.
- The following sections describe the operation of the EPIC injection pump from '97. Most functions are the same as those of the '92 and '95 injection pumps.
- The EPIC injection system was developed further for the Transit from '97. As a result, the exhaust emissions have been improved further and the engine operation is even smoother, above all at idle.

The EPIC engine management system performs the following range of functions:

- excess fuel control for starting
- allowance for all important parameters
- maintenance of λ_{min} in all operating conditions
- control of start of injection (injection timing)
- idle speed control
- smooth running control
- driveability and full-load characteristics
- self-diagnostics
- communications facility

- When the engine is switched on with the ignition switch, the engine management system is supplied with power through the EDC module and a power hold relay.
- When the engine is switched off the EDC module performs a check and stops the engine by means of the electromagnetic shut-off valve. Then the power supply is cut by the power hold relay from the EDC module.
- While the engine is running the EDC module continuously receives signals about the actual state of the engine and distributor-type injection pump from 12 sensors and switches.
- These analogue frequency and switching signals are processed in the EDC module and compared with stored maps and characteristics. Deviations from the set values are corrected by means of the actuators.

Excess fuel control for starting

- On earlier models the fuel shut-off valve was activated by switching on. Fuel was delivered immediately during the first revolution of the pump. The pump rotor was still in the basic (full load) setting; this meant that during the first revolutions the maximum quantity of fuel was supplied, leading to formation of smoke.
- The excess fuel control for starting was already modified in the Transit '95 to prevent black smoke when starting. The fuel shut-off valve only opens when the pump rotor is in the axial position calculated by the EDC module. Thus, maximum fuel delivery is prevented unless it is needed. The position of the rotor is determined by the rotor position sensor.

Note: The fuel shut-off valve in the Transit '95 must not be used in earlier injection pumps.

Idle speed control

- In production an idle speed of 850 rpm is stored in the EDC module.
- In service the idle speed can be set with FDS 2000 and the new generation STAR tester (NGS) to a value of between 800 and 900 rpm (see section entitled Diagnostics).

Note: The new generation STAR tester (NGS) is only used in export territories in which the FDS 2000 tester still has not been introduced.

Smooth running control

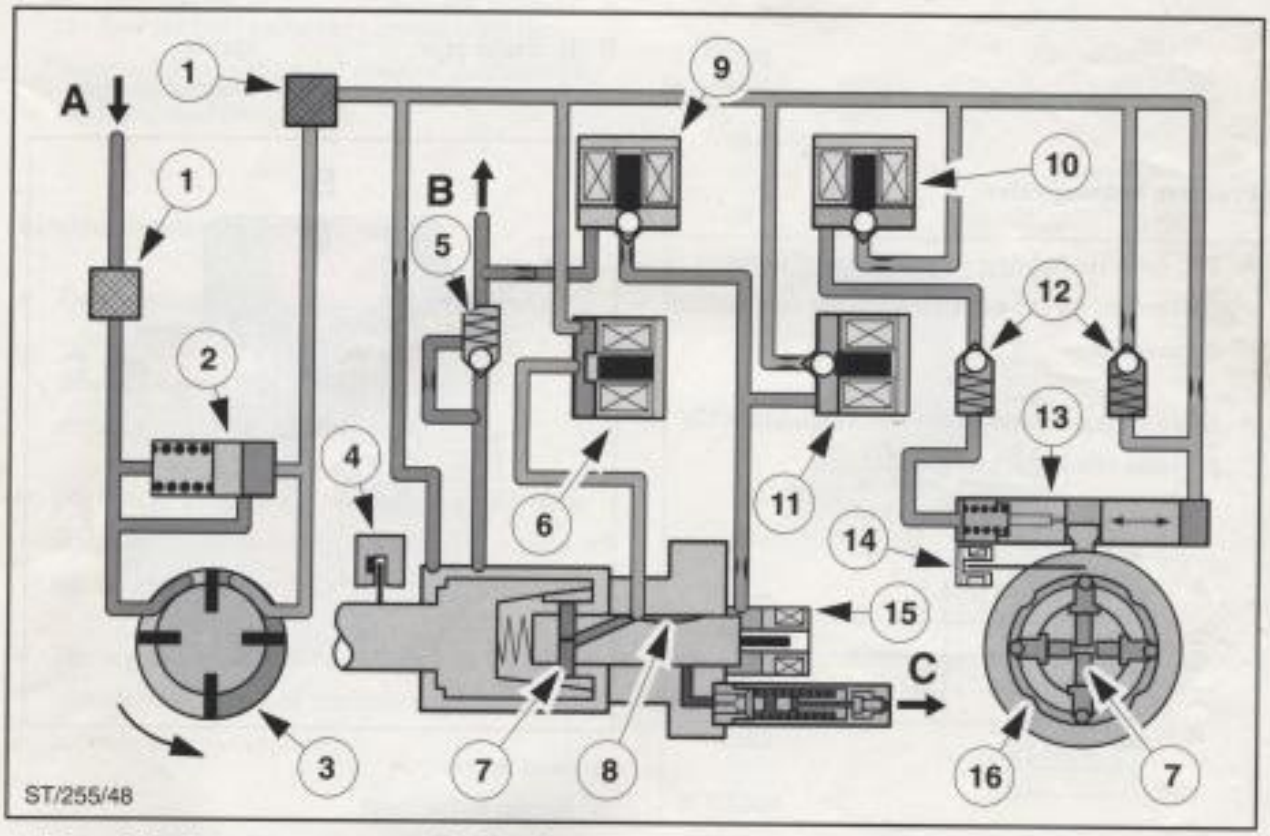
- The high speed of adjustment of the quantity of fuel injected allows the engine management system to set a different quantity of fuel for every single injection process at low engine speeds. This means that fluctuations in engine speed (uneven idling) are prevented before they can start. This smooth running control is effective from approximately 1000 rpm.

Full-load control

- To ensure that the air/fuel ratio does not drop below the minimum (λ_{min}) in any circumstances and to guarantee smoke-free engine operation, the quantity of fuel to be injected is limited according to a smoke map.
- This produces a tiny reduction in power from an altitude of 1500 m. This can be as much as 13% at an altitude of 3200 m above sea level. Full load control is effected using the signals of the charge (boost) pressure and intake air temperature sensors. A mass air flow sensor is not needed.

Fuel circuit in EPIC distributor-type injection pump

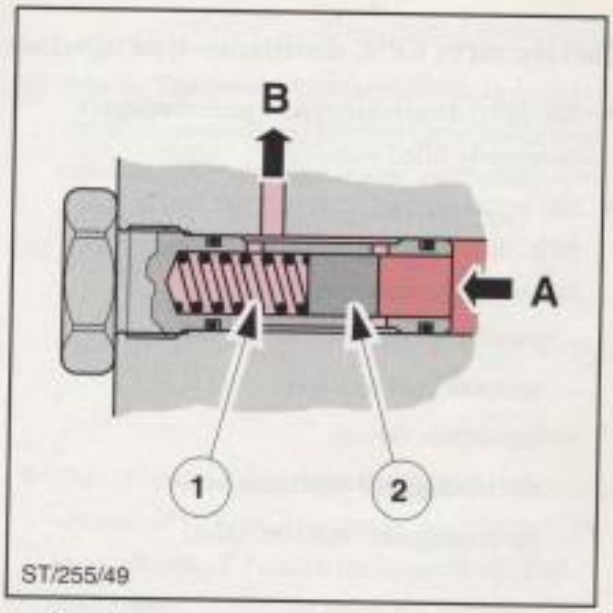
- The EPIC distributor-type injection pump is completely filled with fuel.
- The hydraulic fuel flow is controlled in the EPIC distributor-type injection pump by the following regulating valves:
  - transfer pressure regulating valve,
  - pressure holding valve,
  - non-return valves,
  - electromagnetic regulating valves,
  - electromagnetic shut-off valve.
- The spring-loaded valves are fuel-pressure regulating valves and non-return valves. The non-return valves are used to damp the automatic injection timing advance unit.
- The electromagnetic valves consist of a shut-off valve and regulating valves for the quantity of fuel. The electromagnetic valves are actuated by simple pulses of variable duration from the EDC module.



A Inlet of distributor-type injection pump
B Return to fuel tank
C To injector
1 Fuel filter
2 Transfer pressure regulating valve
3 Transfer pump
4 Hall sensor
5 Pressure holding valve
6 Shut-off valve
7 High-pressure plunger
8 Rotor
9 "Discharging" regulating valve
10 Injection timing advance regulating valve
11 "Charging" regulating valve
12 Non-return valve
13 Injection timing plunger
14 Cam ring position sensor
15 Rotor position sensor
16 Cam ring

Transfer pressure regulating valve

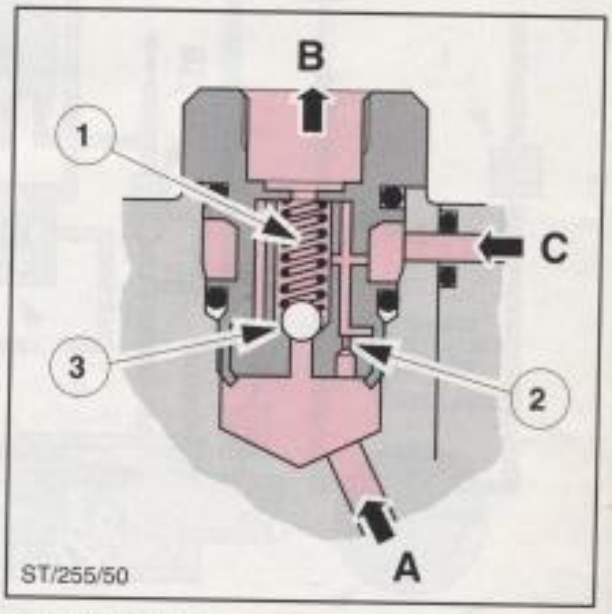
- The transfer pressure regulating valve forms a bypass to the vane pump (transfer pump). When fuel is delivered, the rising fuel pressure moves the piston against the compression spring and opens a bore through which the fuel flows back into the intake pipe.
- The control function of the compression spring allows the transfer pressure to rise proportionately according to the pump speed.
- The transfer pressure regulating valve is not adjustable.



A Transfer pressure
B To intake pipe
1 Compression spring
2 Control plunger

Pressure holding valve

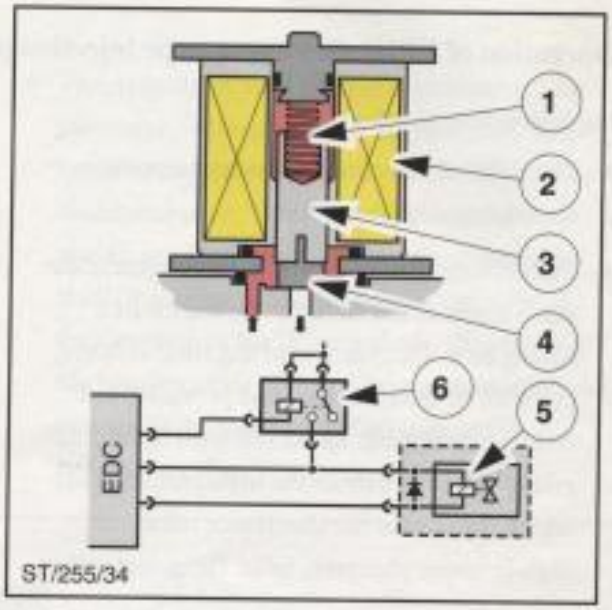
- The pressure holding valve is located in the connection for the return pipe to the fuel tank in the usual way.
- It is a spring-loaded ball valve which limits the pressure inside the pump to 0,5 bar.



A Inlet to pump
B Return to fuel tank
C "Discharging" rotor position regulating valve return
1 Compression spring
2 Vent bore
3 Valve ball

Electromagnetic shut-off valve

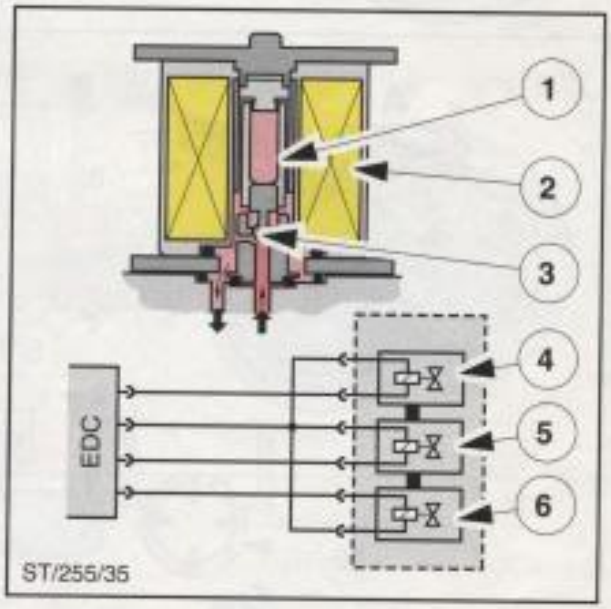
- The shut-off valve is used to stop the diesel engine.
- The shut-off valve remains open while the engine is running. When the engine is switched off the EDC module closes the shut-off valve. The engine stops because the fuel supply is cut.
- It is actuated by the EDC module when the engine is started and opens the connecting passage between the transfer pump and the charging passages of the high-pressure system.
- To avoid black smoke when the engine is started, the fuel shut-off valve only opens when the pump rotor is in the axial position calculated by the EDC module.



1 Compression spring
2 Coil
3 Armature
4 Seal
5 Shut-off valve
6 Power hold relay

Electromagnetic regulating valve

- The electromagnetic regulating valves have a valve plunger which always closes when actuated by the EDC module and cuts the flow of fuel to the actuator in question.
- For hydraulic damping the fuel passages in the injection pump have throttling inserts in front of the regulating valves.
- The regulating valves are actuated by the EDC module with pulses of variable duration according to the application.

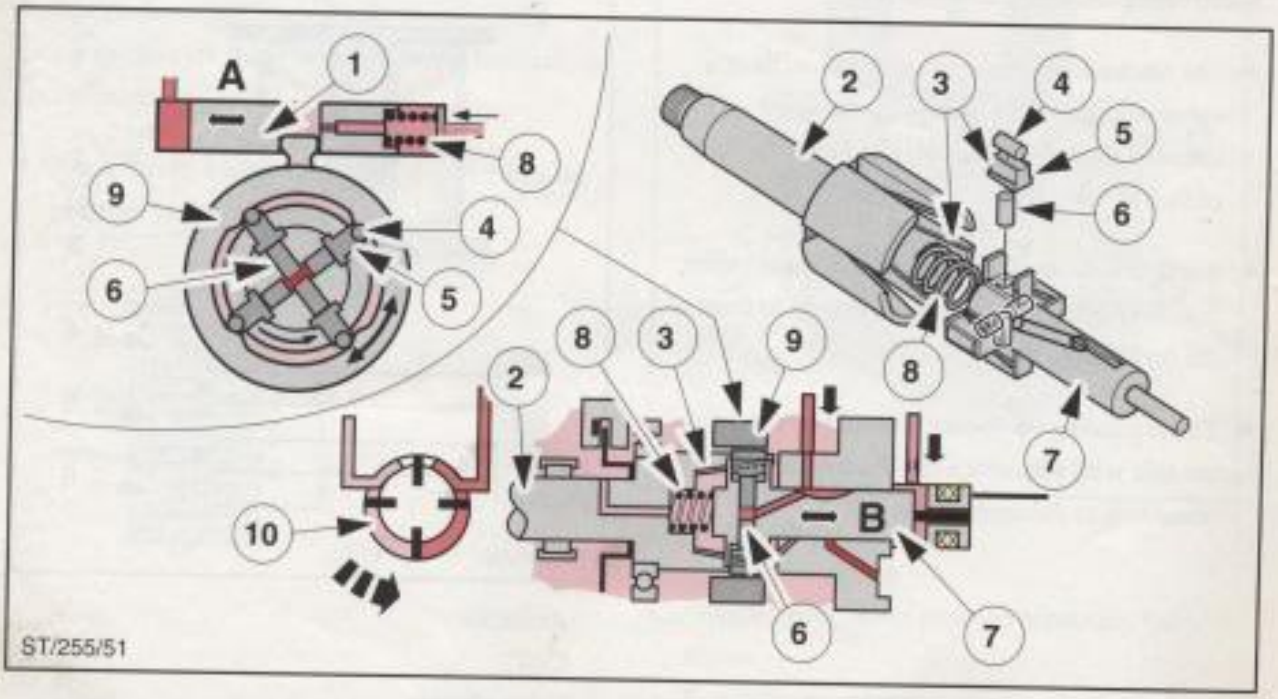


1 Armature
2 Coil
3 Valve plunger
4 "Charging" regulating valve
5 "Discharging" regulating valve
6 Cam ring regulating valve

Operation of EPIC distributor-type injection pump

High-pressure production

- The EPIC distributor-type injection pump is completely filled with fuel.
- The driving shaft is driven by the engine at the same speed as the camshaft by means of a timing belt. The rear end of the shaft is bored out with an internal taper and provided with cross-shaped guide tracks (slots). The internal end of the shaft carries the high-pressure part which consists of the distributor rotor, high-pressure plungers, roller shoes and rollers.
- The roller shoes have laterally milled sloping faces which bear against the guide faces of the tapered driving shaft. The roller shoes are adjusted by axial movement of the distributor rotor through the inclined (tapered) contact face to vary the stroke of the high-pressure plungers.
- Above the driving shaft there is a cam ring which is turned radially depending on the start of fuel injection. The driving shaft drives the distributor rotor by means of the cross-shaped recesses in which the roller shoes sit.
- When the distributor rotor turns, the rollers roll onto the cams of the cam ring and press the high-pressure plungers inwards through the rollers and roller shoes. In this way a pressure is generated that makes the fuel run through the bore of the distributor rotor to the particular injector.

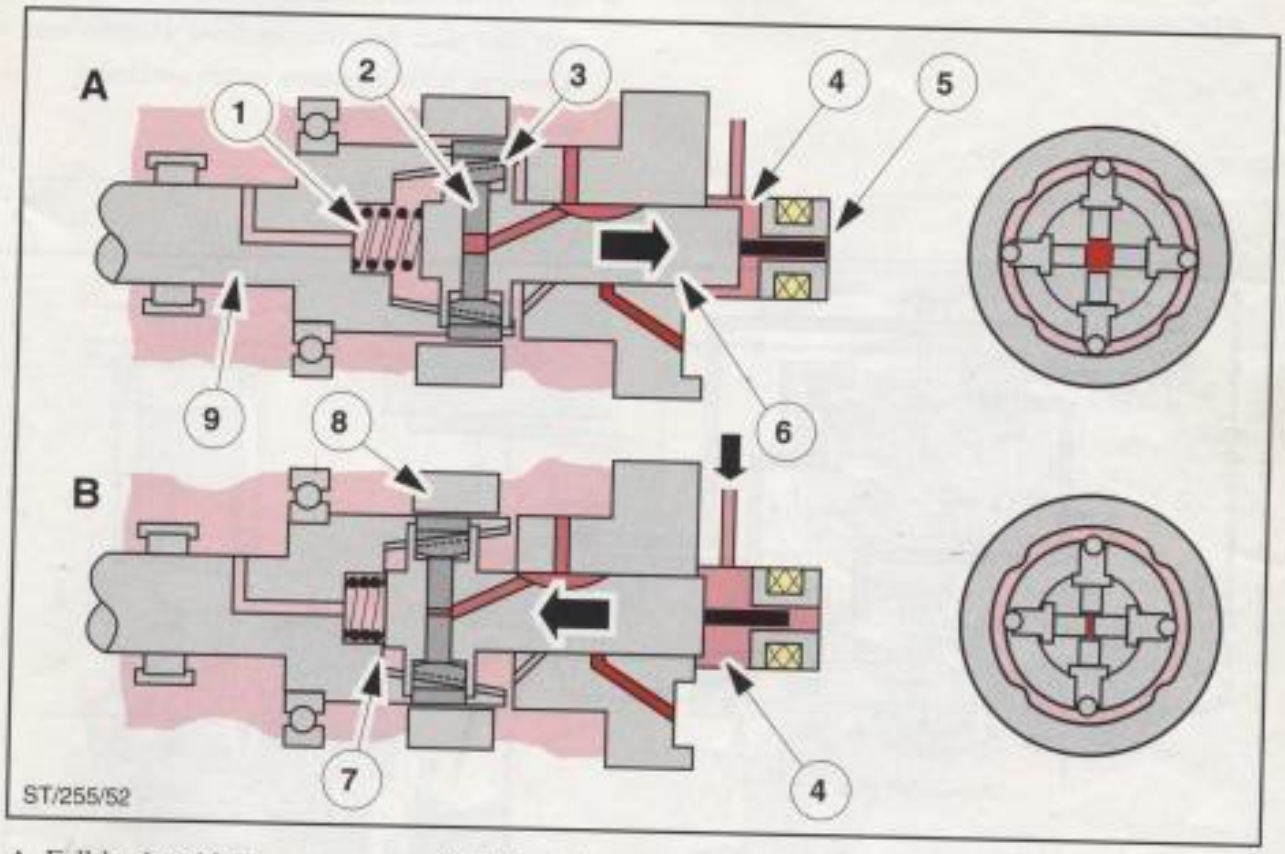


A Cam ring adjustment, radial
B Distributor rotor adjustment, axial
1 Adjusting plunger
2 Driving shaft
3 Guide faces
4 Rollers
5 Roller shoes
6 High-pressure plungers
7 Distributor rotor
8 Compression spring
9 Cam ring
10 Transfer pump

Control of quantity of fuel injected

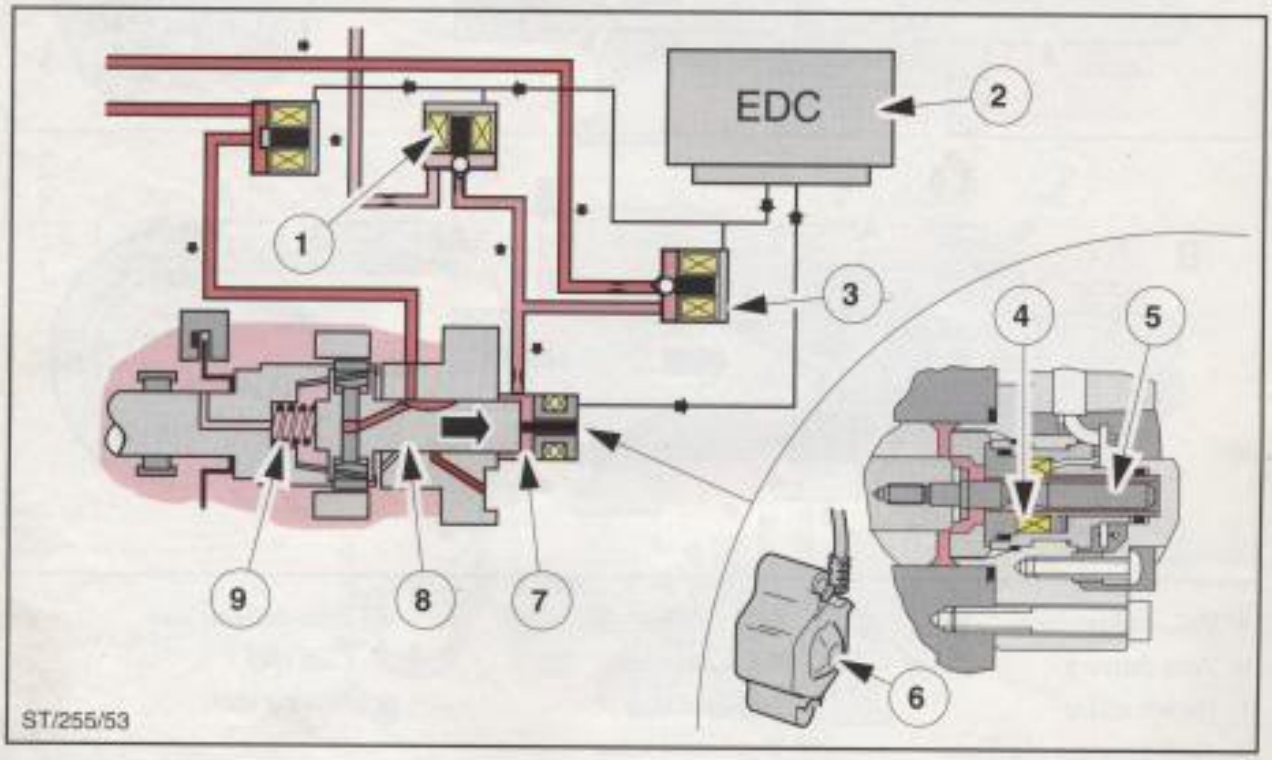
- The quantity of fuel injected is adjusted to the different engine operating conditions with maximum precision so as to achieve the desired power and exhaust emissions with optimum combustion and low fuel consumption.

- The quantity of fuel injected is determined by the stroke of the high-pressure plungers. The stroke is dependent on the axial position of the distributor rotor. While the distributor rotor moves axially in the direction of the driving shaft, the roller shoes slide along the slope in the direction of the driving shaft. The stroke of the high-pressure plungers becomes smaller and as a result the quantity of fuel injected is reduced.



A Full-load position
B Zero delivery
1 Return spring
2 High-pressure plungers
3 Roller shoes
4 Rotor chamber
5 Full-load stop
6 Distributor rotor
7 Zero-delivery stop
8 Cam ring
9 Driving shaft

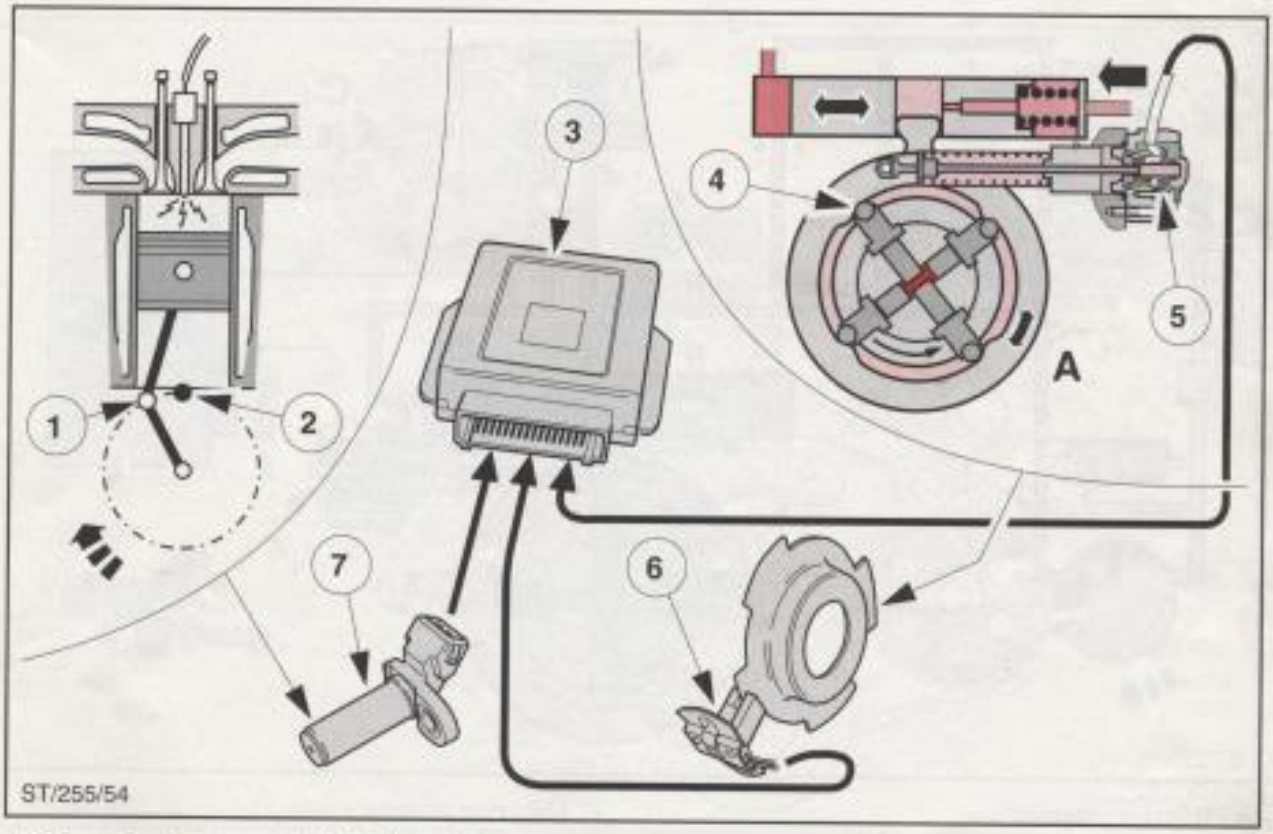
- When the engine is at a standstill, the return spring presses the distributor rotor axially into the initial position in which the high-pressure plungers achieve their greatest stroke (full load).
- In operation, a pressure chamber at the end of the distributor rotor is filled with fuel and the quantity of fuel introduced moves the distributor rotor against the compression spring to the stop (zero delivery). This pressure chamber is connected to two electromagnetic regulating valves which are controlled by the EDC module.
- The precise axial position of the distributor rotor is transmitted to the EDC module by an electrical signal from an inductive sensor (rotor position sensor). In the EDC module the actual signal of the rotor position sensor is compared with calculated set values and constantly regulated by alternately actuating the "charging" regulating valve to the pressure chamber and the "discharging" regulating valve to the fuel tank. The EDC module always only opens one of the regulating valves at the same time.
- Axial movement of the distributor rotor can only take place between injections when no load is present. Both regulating valves are closed during the injection process.



1 "Discharging" regulating valve
2 EDC module
3 "Charging" regulating valve
4 Coil
5 Soft iron armature
6 Rotor position sensor
7 Rotor chamber
8 Distributor rotor
9 Return spring

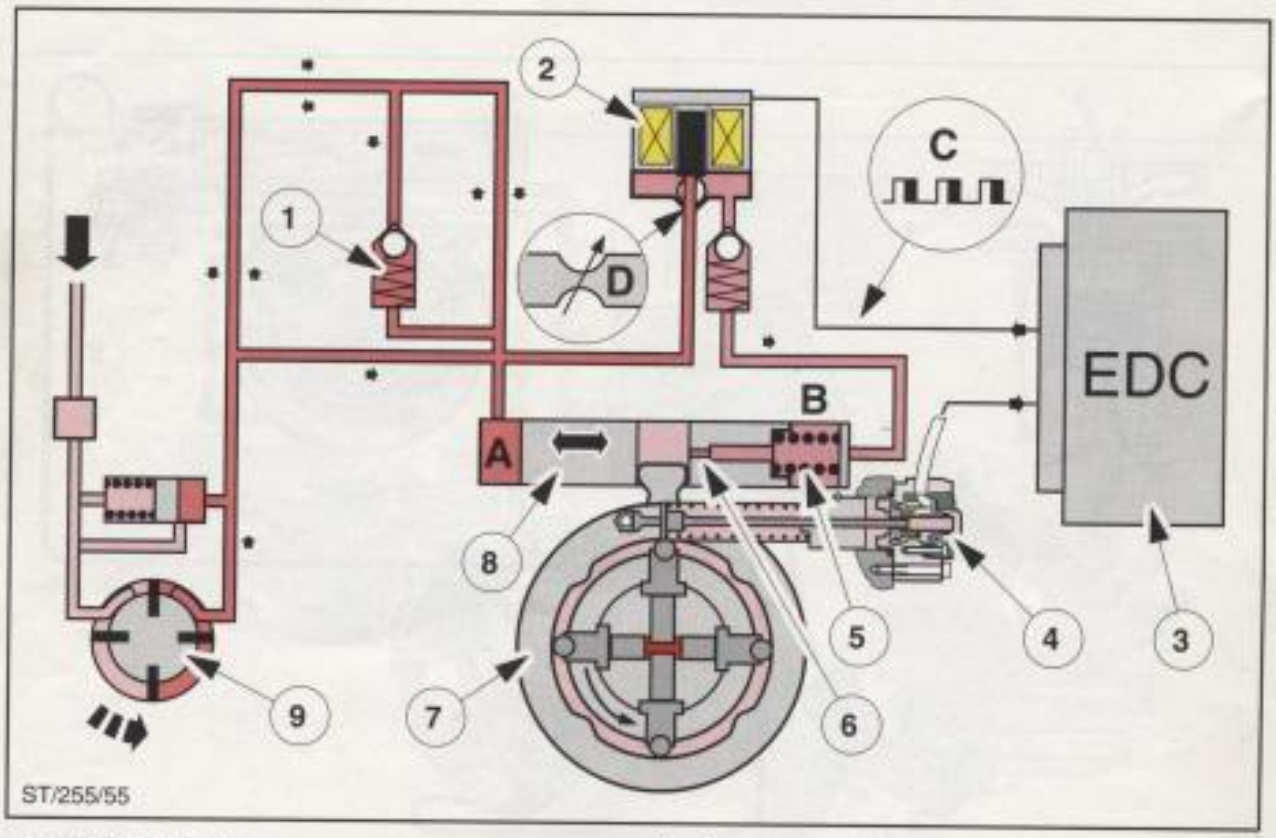
Control of start of injection (injection timing)

- The start of injection or injection timing is continuously controlled by the EDC module in the closed loop according to load and engine speed using stored maps.
- The cam ring is moved in the "advance" or "retard" direction by the injection timing plunger. The cam ring position sensor recognises the precise position of the cam ring and sends an inductive signal to the EDC module. The temperature of the fuel is also measured by the cam ring position sensor.
- For synchronisation purposes the EDC module receives the identification signal for cylinder no. 1 and the rotary angle positions from a crankshaft speed/position sensor on the engine and a Hall sensor (pump speed/position sensor).



A Cam ring adjustment for injection timing
1 Crankshaft position before TDC
2 TDC (top dead centre)
3 EDC module
4 Injection point
5 Cam ring position sensor
6 Pump speed/position sensor
7 Crankshaft speed/position sensor

- The position of the injection timing plunger is regulated by the transfer pressure, the compression spring and the electromagnetic regulating valve.
- The injection timing plunger is exposed to the transfer pressure from side A and a control pressure from side B.
- This control pressure is derived from the transfer pressure. The EDC module uses grounding pulses (C) to actuate the electromagnetic regulating valve which can open variably.
- This allows the fuel to flow into the compression spring chamber which is connected to the interior of the pump by a throttling bore (∅ 0,6 mm).
- The different chamber pressures (A and B) adjust the injection timing plunger and hence the cam ring continuously to the appropriate position between maximum advance and maximum retardation. When the chamber pressures are the same, the injection timing plunger remains in a set position.
- Both chambers have non-return valves which prevent undesired pulsing of the cam ring.

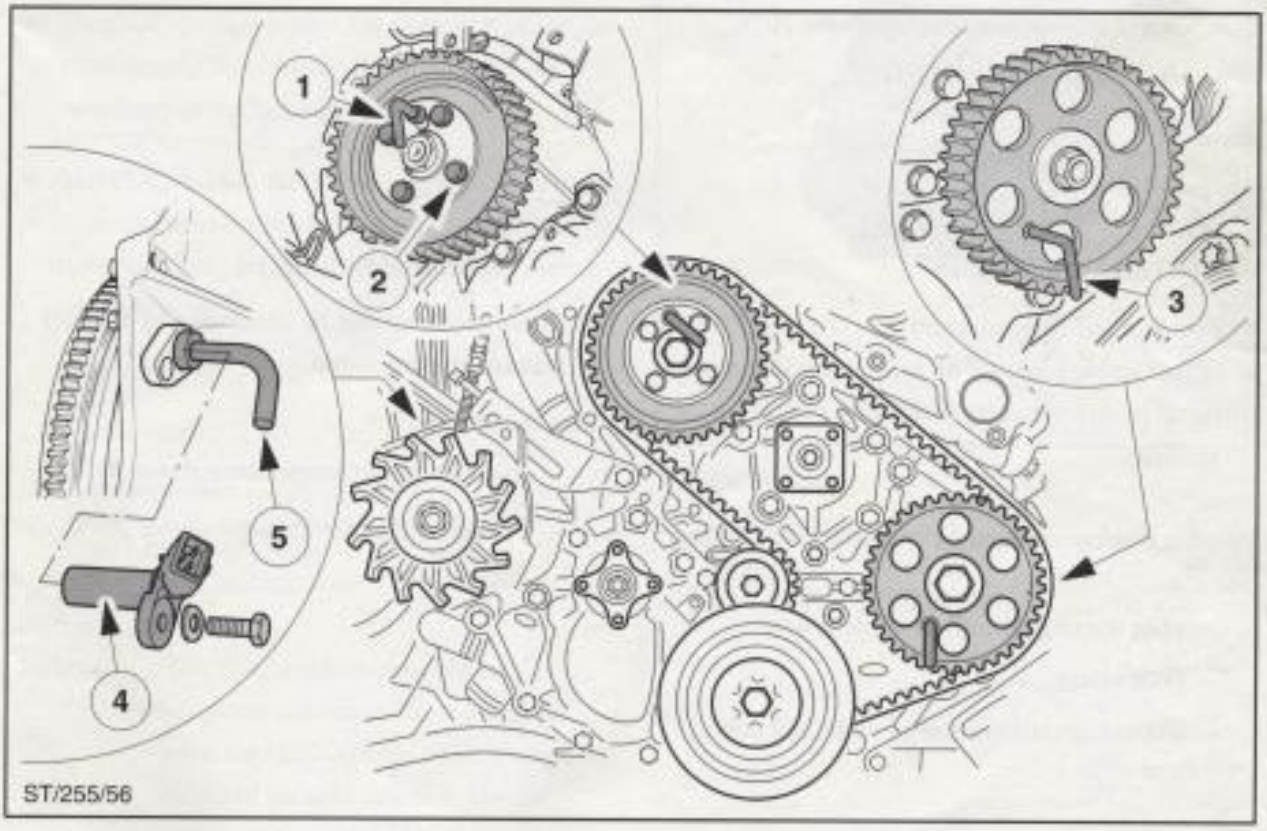


A Transfer pressure
B Control pressure
C Grounding pulses
D Variable throttle
1 Non-return valve
2 Electromagnetic regulating valve
3 EDC module
4 Cam ring position sensor
5 Compression spring
6 Throttling bore (∅ 0,6 mm)
7 Cam ring
8 Injection timing plunger
9 Transfer pump

Static injection timing

- When the static injection timing of the EPIC injection pump is set, the cam ring is positioned geometrically in relation to the position of the engine crankshaft.
- This setting is produced mechanically by inserting timing pins in the
  - camshaft,
  - flywheel and
  - injection pump,
  - and adjusting the retaining bolts of the injection pump timing pulley (in the slots).
- The crankshaft speed/position sensor must be removed first before the timing pin for the flywheel can be inserted.

Note: When tensioning the timing belt insert the timing pin for the injection pump timing pulley. Then, tension the timing belt and tighten the retaining bolts of the injection pump timing pulley (slots).



1 Timing pin for injection pump timing pulley
2 Retaining bolts of injection pump timing pulley (slots)
3 Timing pin of camshaft timing pulley (TDC position for cylinder no. 1)
4 Crankshaft speed/position sensor
5 Timing pin for flywheel (crankshaft position)

Diagnostics and service

Note: Diagnostics can only be run on the EPIC injection system with the FDS 2000 or the new generation STAR tester (NGS).

Two adjustments can be made to the EPIC injection system:

- idle speed setting,
- fuel leakage compensation.

Idle speed setting

- The idle speed can be set to a value between 800 and 900 rpm with one of the above-named testers and the accelerator pedal.

Test conditions:

- engine coolant temperature above 70 °C,
- air conditioning switched off.

Note: When the air conditioning is switched on, the idle speed is boosted to approximately 950 rpm.

Fuel leakage compensation

- Fuel leakage compensation offsets a high level of fuel leakage caused by wear in the injection pump or injector or by fuel with a very low viscosity.

Possible consequences of an excessive fuel leakage rate are:

- poor starting when the engine is hot,
- poor idling,
- limited operation strategy with fault code.

- These problems can be eliminated by the fuel leakage compensation.

Test conditions:

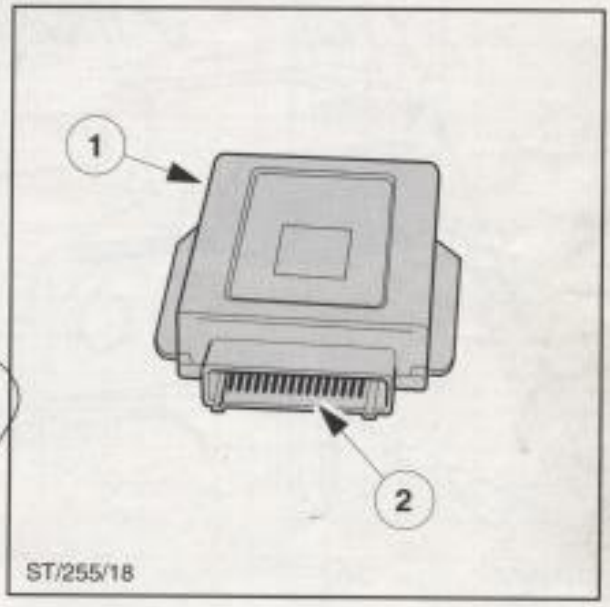
- injection pump temperature above 20 °C,
- engine coolant temperature above 70 °C.

Compensating for incorrect static timing

- The EPIC injection system is able to compensate for errors of up to 4 ° crankshaft in the static timing of the injection pump. With an error of 2 – 4 ° crankshaft a fault code appears, with an error of more than 4 ° crankshaft the system switches to the limited operation strategy.
- This is done by evaluating the signals from the crankshaft speed sensor and the pump speed/position sensor in the injection pump.

EDC module

- The EDC module has 55 connecting pins. There is only one EDC module for all vehicle variants.
- The EDC module assists the operation of the air conditioning by boosting the idle speed and switching on the auxiliary electric fan.
- The EDC module has to be individually adapted to the particular vehicle with the FDS 2000 tester or NGS (diagnosis tester for other markets) depending on.
  - power,
  - emissions,
  - transmission
  - and air conditioning.

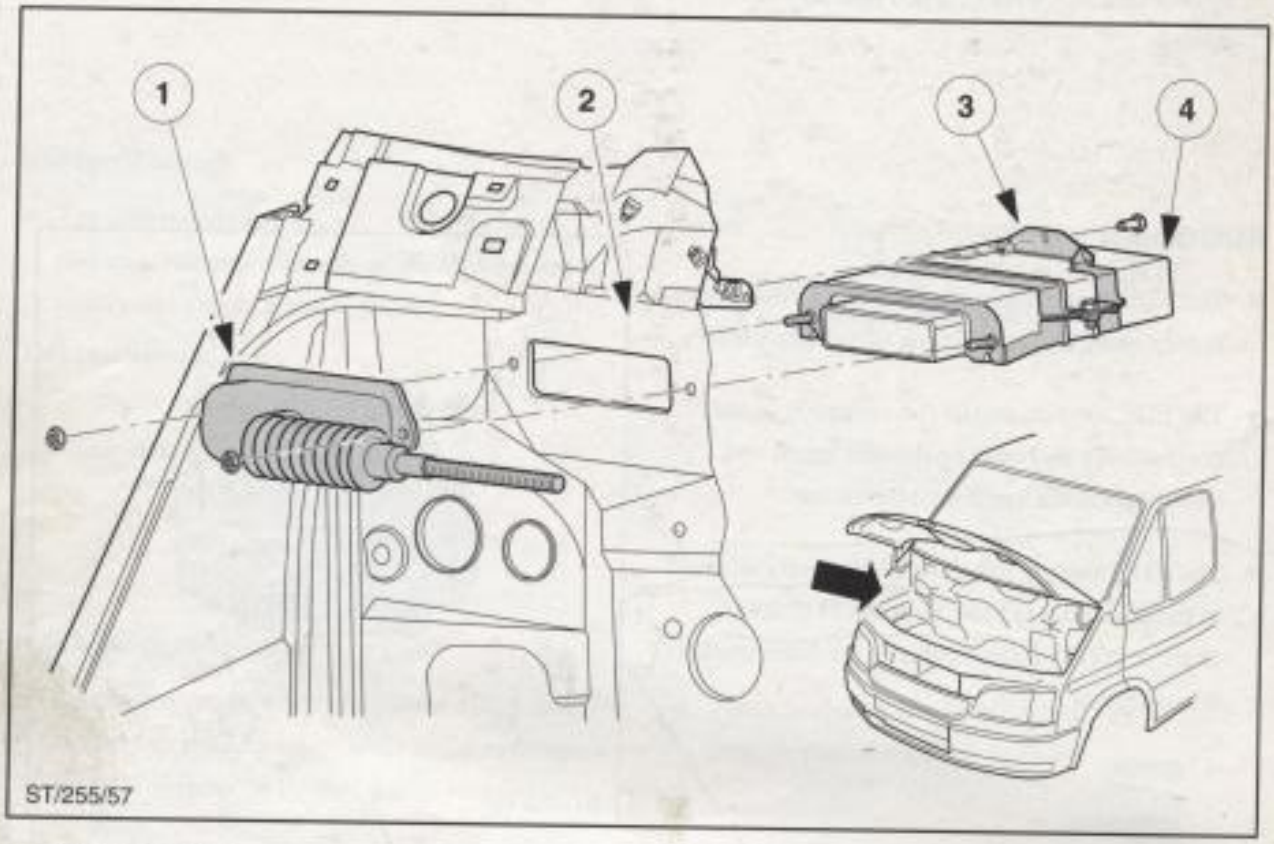


1 EDC module
2 55-pin multiplug

Note: The EDC module can only be programmed "once for one vehicle" with the FDS 2000 or NGS; it must not be fitted to other vehicles, for test purposes for example.

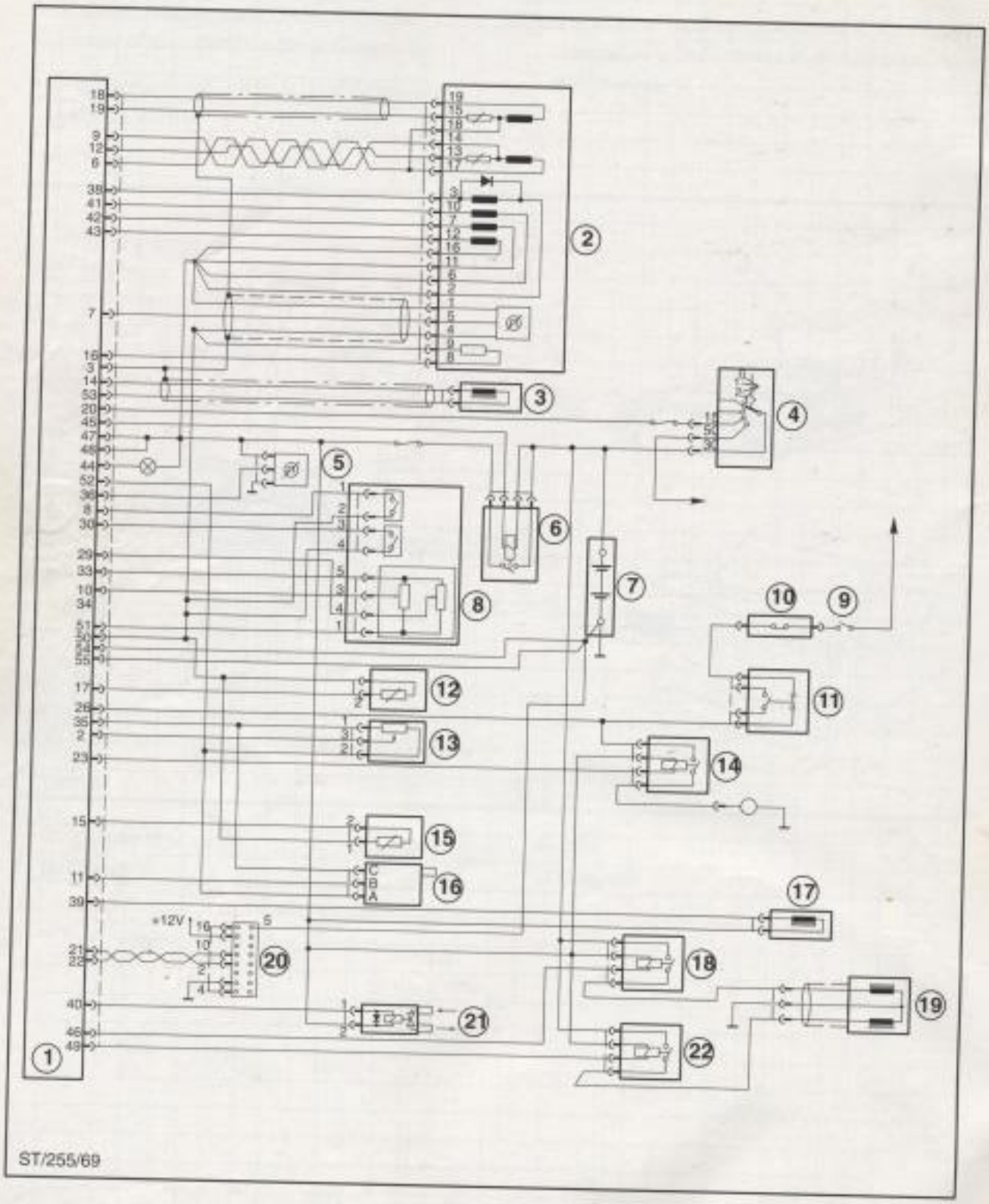
Location of EDC module in vehicle

- The EDC module is always located in the interior of the vehicle on the passenger side.
- It is fitted into the bulkhead with the bracket from the interior.
- The connecting plug is connected in the engine compartment and screwed to the bracket of the EDC module.

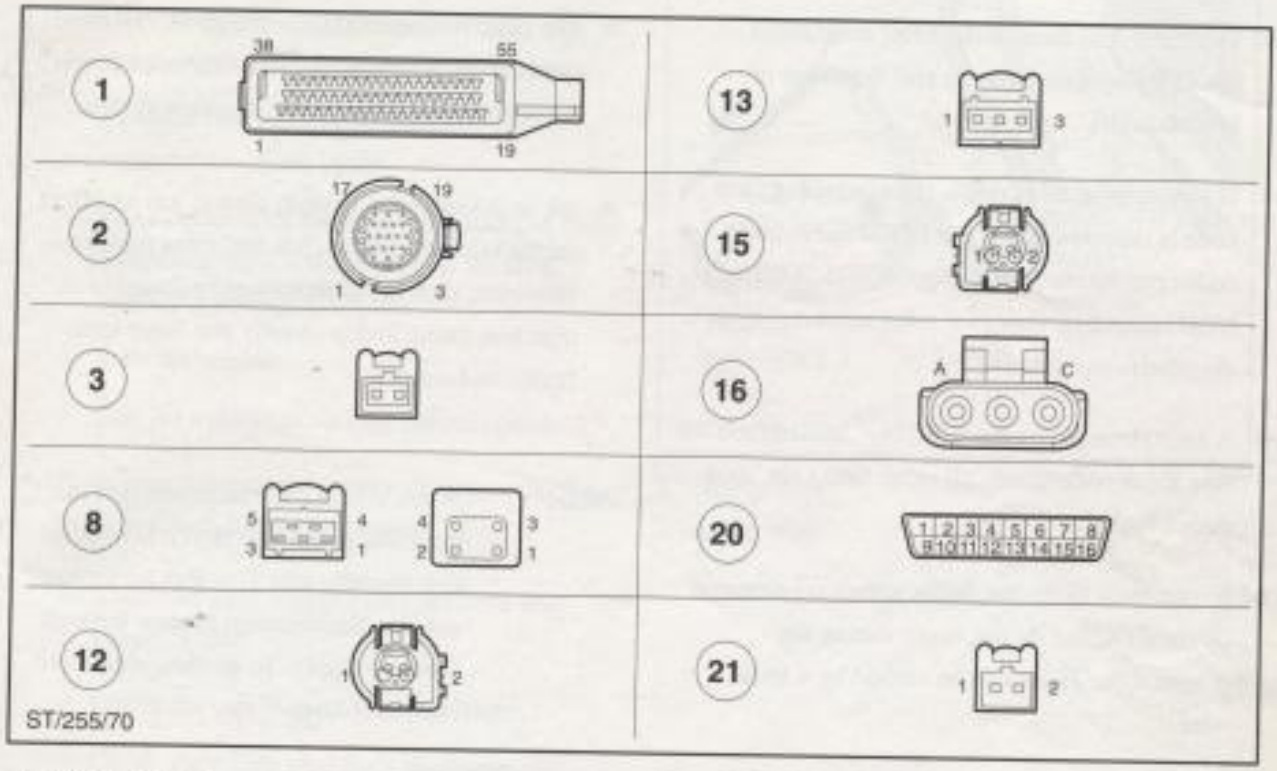


1 Connecting plug
2 Bulkhead
3 Bracket
4 EDC module

Wiring diagram of EPIC injection system



Note: For security reasons the wiring diagram is shown without the PATS.



1 EDC module
2 EPIC injection pump
3 Crankshaft position (CKP)
4 Ignition keylock cylinder
5 Vehicle speed sensor
6 Power hold relay
7 Battery
8 Pedal demand sensor
9 Switch – air conditioning
10 Pressure cycling switch – air conditioning
11 Hydraulic – air conditioning
12 Engine coolant temperature (ECT)
13 Exhaust gas recirculation (EGR)
14 Relay – air conditioning
15 Intake air temperature (IAT)
16 Manifold absolute pressure (MAP)
17 Throttle pressure valve
18 Kickdown pull in relay
19 Kickdown solenoid assy
20 Connector – diagnostics
21 Current to vacuum transducer (CVT)
22 Kickdown hold relay

Test possibilities for EPIC injection system

General

- The main functions of the EDC are control of the EPIC injection system and detection of system faults.
- If a system fault occurs, a corresponding fault code is detected inside the EDC. These fault codes can be read out using the FDS 2000 and NGS (diagnosis tester for other markets) diagnostic equipment.
- A fault detected by the EDC is a "coded fault" (see Fault code table), all other faults are "non coded faults".
- Intermittent faults are faults which are detected by the EDC but do not occur during the diagnostics. These can be caused by a loose wire.
- The most frequent faults in the EPIC injection system which indicate a faulty injection pump are attributable to air in the injection system.
- Air in the injection system always has an effect on the injection pump cam and rotor positions. However, then the fault cannot be found in the injection pump and is usually put down to a faulty fuel supply.

Note: When a fault code indicates that the injection pump is faulty, it is imperative to make sure first that no air has got into the injection system through the fuel supply. To do this, please proceed as follows.

Test procedure

⚠ **Caution** These test possibilities are only listed for completeness. They are only employed when a test carried out with the FDS 2000 or NGS diagnostic equipment indicates ultimately that the injection pump is faulty.

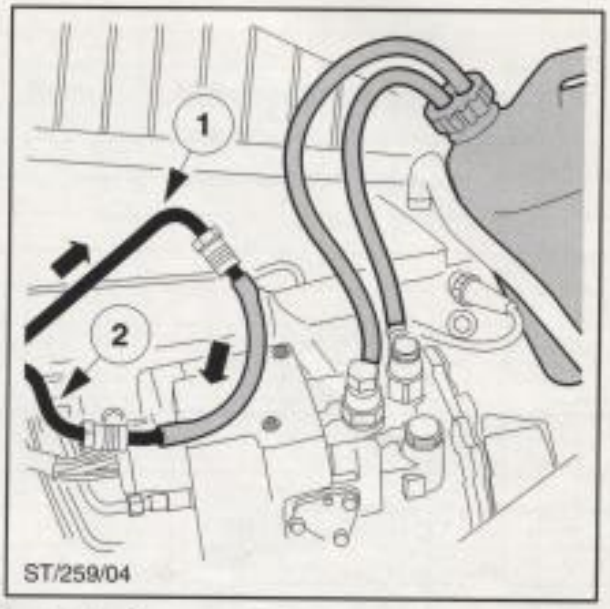
- The following steps should then be carried out:

1 Note the fault codes indicated in the diagnostic menu.
2 Never remove the injection pump at this point.
3 Exit from the diagnostic programme. When exiting, note the instructions given by the diagnostic equipment.
4 Before the pump is removed, proceed as described below.

- To eliminate a fault in the fuel supply, it must be bridged. The following steps should be carried out for this:
  - Disconnect the injection pump supply and return pipes and connect them with a hose.
  - Connect two transparent hoses to the connections on the pump.
  - Place the ends of the hoses in a fuel can filled with diesel fuel. Make sure that no air is sucked in through the hoses.
  - Start the vehicle.
  - Run the vehicle at various engine speeds.
- If the injection pump is now working correctly, there is a fault in the fuel supply.
  - Check the fuel supply using pressure test gauge 23-046.
  - Check the supply pipe for a blockage.
  - Check the return pipe for a blockage.
  - Check the fuel filter for a blockage and change it if necessary.
  - Check the fuel filter housing.
  - Check the operation of the fuel supply pump.
  - Check the fuel pipes for damage.

Note: Observance of the safety precautions and cleanliness are imperative during all work on the fuel supply (see service literature).

- If the injection pump is still not working correctly, read out the fault code and check it with reference to the following fault code table.

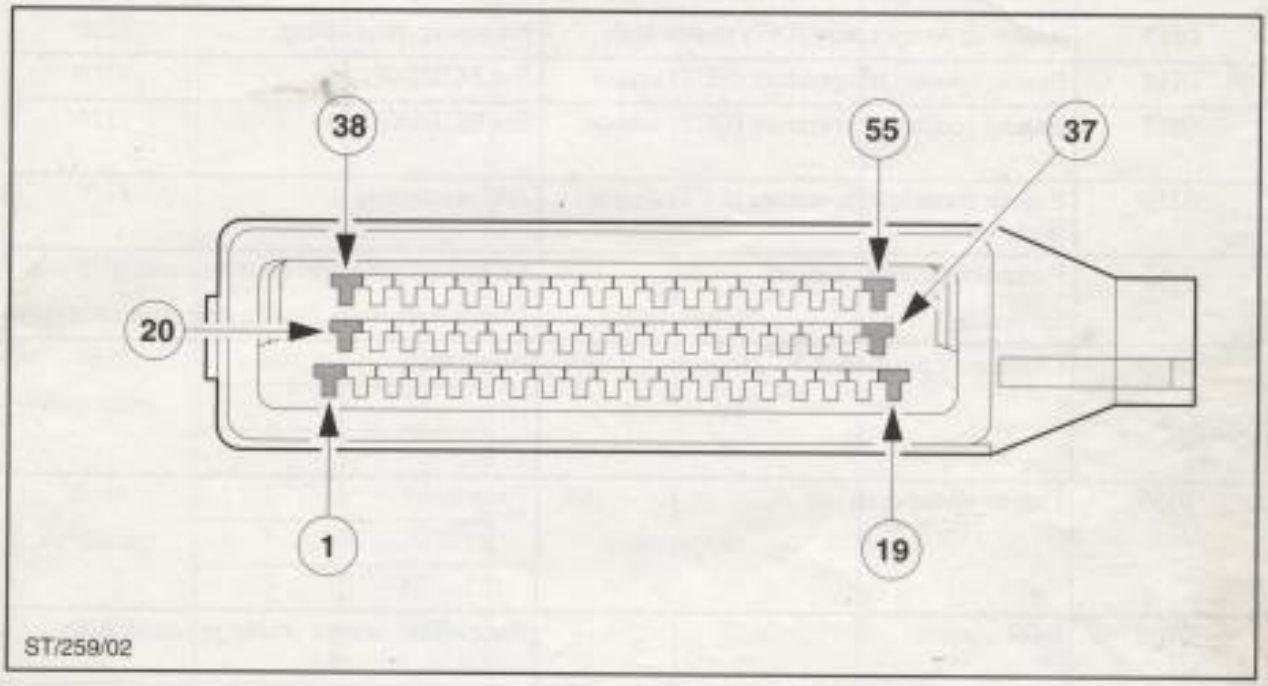


1 supply pipe
2 return pipe

Connector assignment (EDC)

- The EDC module is always located on the passenger's side in the interior on RHD and LHD variants (see Location of EDC module in vehicle).
- First the retainer must be unlocked to disconnect the connector from the EDC module.

Note: Make sure that no pin is damaged or broken when disconnecting and connecting the connector.



Connector assignment (EDC)

1 – 19 Bottom row **20 – 37** Middle row **38 – 55** Top row

Fault code table

Fault code	Cause	Remarks
0105	Boost pressure sensor	No power, poor/non existent throttle response
0110	Intake air temperature (IAT) sensor	No power, poor idling
0112	Intake air temperature (IAT) sensor low	Poor idling
0113	Intake air temperature (IAT) sensor high	No power, poor idling
0116	Engine coolant temperature (ECT) sensor	See ECT/IAT table
0117	Engine coolant temperature (ECT) sensor low	See ECT/IAT table
0118	Engine coolant temperature (ECT) sensor high	A/C no cooling
0185	Pump temperature sensor Screening	No power, poor/non existent starting Poor/non existent throttle response
0335	Crankshaft position (CKP) sensor	No power
0336	Engine speed drop	No power
0400	EGR control	Poor idling, severe smoke production
0401	EGR sensor, low Current to vacuum transducer (CVT)	Severe smoke production
0402	EGR sensor, high Current to vacuum transducer (CVT)	Severe smoke production
0500	Vehicle speed sensor	No kickdown
0605	EDC	Engine stalls, poor/non existent starting
0745	EDC	No kickdown
0750	EDC	No kickdown
1108	Boost pressure sensor, high	No power, poor/non existent throttle response

Fault code table (continued)

Fault code	Measurement Pin +	Measurement Pin –	Resistance (Ω) min.	Resistance (Ω) max.	Remarks
0105	35	52	500	3k	Current to vacuum transducer (CVT), disconnect
	11	52	10k	300k	X
0110	15	50	See ECT/ACT table		
0112					
0113					
0116	17	50			
0117					
0118					
0185 Screening	19	6	690	3,5k	at 20 °C
	3	19	Open circuit		
0335 Screening	14	53	300	1,2k	
	3	14	Open circuit		
	3	53			
0336 Screening	3	53	300	1,2k	
	3	14	Open circuit		
	3	53			
0400	47	40	4	10	
0401	35	52	1,5k	2,4k	Boost pressure sensor, disconect
	2	52	300	1k	
0402	35	52	1,5k	2,4k	Boost pressure sensor, disconect
	2	52	300	1k	
0500					Renew sensor, check wiring
0605					Renew EDC
0745					Transmission shift valve, renew
0750					Transmission shift valve, renew
1108	11	52	10k	300k	Current to vacuum transducer (CVT), disconnect
	35	52	500	3k	X

Fault code	Cause	Remarks
1109	Boost pressure sensor, low	No power, poor/non existent throttle response
1170	Shut off valve current	Engine stalls, poor/non existent starting, delayed stopping
1171	Rotor position	Poor idling, engine stalls, poor/non existent starting
1172	Rotor control, too much fuel	Engine stalls, poor/non existent starting
1173	Rotor calibration	No power, poor idling, poor/non existent starting
1174	Position of injection advance unit Shielding	No power, poor idling, severe smoke production
1175	Control of injection advance device	No power, poor idling, severe smoke production
1176	Calibration of injection advance device	No power, poor idling, severe smoke production
1177	Engine/pump synchronisation	No power, poor/non existent starting
1178	Pump fitted incorrectly	No power
1180 – 1184	Fault in accelerator pedal position sensor, pedal switches (1 and 2)	Engine stalls, poor/non existent throttle response
1185	Pump temperature sensor, high	No power, poor/non existent starting, poor/non existent throttle response
1186	Pump temperature sensor, low	No power
1187	Incorrect EDC version selected	
1189	Pump speed not available	
1190	Calibrating resistance	
1191	Power hold relay voltage	
1192	Supply voltage	No power

Fault code	Measure-ment Pin +	Measure-ment Pin –	Resistance (Ω) min.	Resistance (Ω) max.	Remarks
1109	35	52	500	3k	
	11	52	10k	300k	
1170	47	38	1	3	
1171	9	6	48	60	
	9	12	160	350	
1172	9	6	48	60	
	9	12	160	350	
	41	47	25	35	
	42	47	25	35	
1173	9	12	160	350	
1174	18	6	50	75	
Screening	3	18	Open circuit		
1175	43	47	25	35	
1176	18	6	50	75	
1177	3	7	Open circuit		Check start of fuel delivery
1178					
1180 – 1184	29	51	3k	7k	Measure with accelerator pedal released
	10	51	3k	7k	Measure with accelerator pedal depressed
	33	51	1,5k	3,5k	Measure with accelerator pedal released
	51	Ground	Open circuit		
1185	19	6	690	3,5k	At 20 °C
1186	19	6	690	3,5k	
1187					Check whether correct EDC is fitted and programmed
1189					Send injection pump to Lucas
1190					
1191	Batt. +	45	80	100	
1192					

Fault code	Cause	Remarks
1193	EGR actuation overload	
1195	Data transmission not installed	
1196	Ignition off, voltage high	Delayed stopping
1197	Ignition off, voltage low	
1198	Rotor control, too little fuel	Poor idling, engine stalls
1252 – 1255	Accelerator pedal balance between accelerator pedal position sensor and pedal switches (1 and 2)	
1256 – 1257	Accelerator pedal balance between accelerator pedal position sensor and pedal switches (1 and 2) (1 and 2)	A/C no cooling, no kickdown
1258	Accelerator pedal balance between pedal switches (1 and 2)	Poor/non existent throttle response
1300	Boost pressure calibration	No power, poor/non existent throttle response
1301	Boost pressure calibration upper limit	
1302	Boost pressure calibration lower limit	

Fault code	Measurement Pin +	Measurement Pin –	Resistance (Ω) min.	Resistance (Ω) max.	Remarks
1193	Batt. +	45	80	100	
	47	40	4	10	
1195	Batt. +	45	80	100	Enter data anew, check module
1196					Check lead voltage, relay and ground
1197					
1198	9	6	48	60	
	9	12	160	350	
	41	47	25	35	
	42	47	25	35	
1252 – 1255	29	51	3k	7k	Measure with accelerator pedal released
	10	51	3k	7k	Measure with accelerator pedal depressed
	33	51	1,5k	3,5k	Measure with accelerator pedal released
	51	Ground	Open circuit		
1256 – 1257	29	51	3k	7k	Measure with accelerator pedal released
	10	51	3k	7k	Measure with accelerator pedal depressed
	33	51	1,5k	3,5k	Measure with accelerator pedal released
	51	Ground	Open circuit		
1258	29	51	3k	7k	Measure with accelerator pedal released
	10	51	3k	7k	Measure with accelerator pedal depressed
	33	51	1,5k	3,5k	Measure with accelerator pedal released
	51	Ground	Open circuit		
1300	35	52	500	3k	Current to vacuum transducer (CVT), disconnect
	11	52	10k	300k	
1301	35	52	500	3k	
	11	52	10k	300k	
1302	35	52	500	3k	
	11	52	10k	300k	

Fault code	Cause	Remarks
1306	Operation of kickdown actuating relay	No kickdown
1307	Actuation of kickdown holding relay	
1308	Operation of air conditioning relay	A/C no cooling
1402	EGR sensor, valve position	
1605	EDC, EEPROM monitoring	Engine stalls, poor/non-existent starting
1606	EDC, power hold relay	
1608	EDC, monitoring	Engine stalls, poor/non-existent starting
1644	Pump speed sensor	No power
9317	Battery voltage too high	
9318	Battery voltage too low	Poor/non-existent throttle response
9671	Battery voltage	Poor/non-existent throttle response

Fault code	Measurement Pin +	Measurement Pin –	Resistance (Ω) min.	Resistance (Ω) max.	Remarks
1306	30	50	0	3	Measure with accelerator pedal released
	46	47	70	90	
1307	30	50	0	3	
	49	47	90	110	
1308	47	23	110	140	
1402	35	52	1,5k	2,4k	Disconnect boost pressure sensor
	2	52	300	1k	
1605	Batt. +	45	80	100	Renew EDC
1606	Batt. +				
1608	Batt. +				
1644					Check wiring loom, send injection pump to Lucas
9317	Batt. +	45	80	100	Check power supply
9318	Batt. +				
9671	Batt. +				

Temperature resistance table (ECT/IAT)

- The following table shows the temperature values for the engine temperature (ECT) and air temperature (IAT) with the associated resistance figures.

Temperature (°C)	Resistance (Ω)
10	58,75
20	37,30
30	24,27
40	16,15
50	10,97
60	7,60
70	5,37
80	3,84
90	2,80
100	2,07
110	1,55
120	1,18

Non-coded faults

- The engine warning light is not switched on.
  - Bulb faulty
  - Bulb electrical connections
  - Check circuit at pin 44 and 47 for continuity with ignition switch "On" (battery +).

Non coded faults (continued)

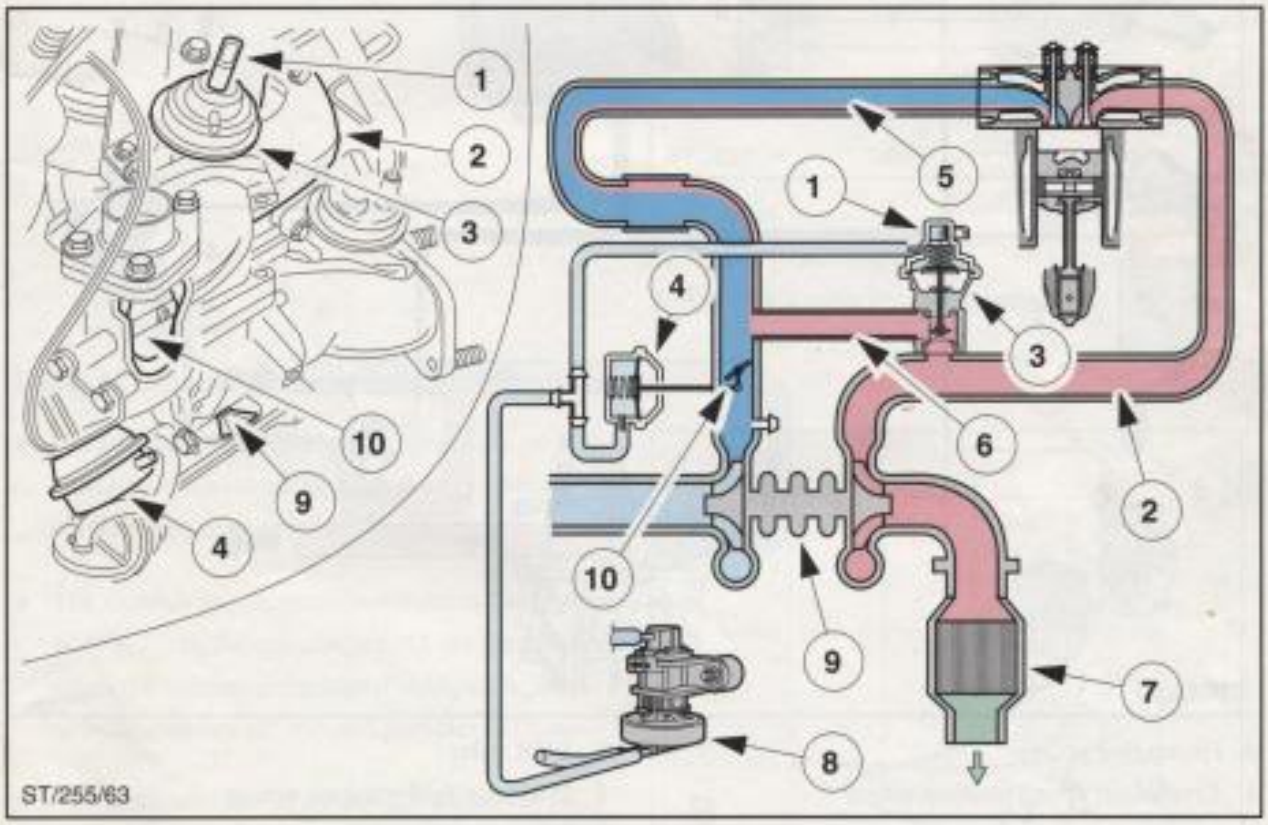
- The engine stalls while motoring or at idle and will not start again.
  - Check the fuel level and type of fuel.
  - Check the pipes to the air cleaner and turbocharger for obstruction.
  - Check the tank vent.
  - Check whether the water in fuel sensor is working correctly.
  - Check whether there is water in the fuel.
  - Check the fuel pipes for possible fuel leaks (loose connections).
- The engine refuses to start or starts badly after being stopped.
  - Check the starter motor cranking speed and condition of the battery.
  - Check the fuel delivery during starting.
  - Check the operation of the flame start system.
  - Check the engine/pump synchronisation.
- Rough idling when warm, low power, insufficient acceleration, engine stalling when pulling away.
  - Check the pipes to the air cleaner and turbocharger for blockage.
  - Check the fuel level and type of fuel (no petrol).
  - Check the operation of the EGR system.
  - Check the compressions.
- Reduced power with severe smoke production.
  - Check the pipes to the air cleaner and turbocharger for blockage.
  - Check the operation of the throttle plate.
  - Check the exhaust system for obstruction.
  - Check the load sensor hose for leaks and security.
  - Check the operation of the EGR system.
- Reduced power, no smoke production.
  - Check the pipes to the air cleaner and turbocharger for obstruction.
  - Check the air cleaner.
  - Check the delivery and return pipes for obstruction.
- The engine does not stop immediately after being switched off.
  - Short-circuit from pin 38 to pin 47 (battery +), hence shut off valve overheating (blown).
  - The spring loaded piston is not closing possibly due to dirt.

Control of exhaust gas recirculation

- The exhaust gas recirculation is used to reduce the emission of NO_x (oxides of nitrogen) in the exhaust by limiting the quantity of oxygen available for combustion at partial load. The reduction in the quantity of oxygen is achieved by recirculating a controlled quantity of exhaust gas into the inlet manifold.

- The exhaust gas is recirculated by means of the vacuum-controlled exhaust gas recirculation valve (EGR valve) which opens a bypass between the exhaust manifold and the inlet manifold. At the same time, a throttle plate in the intake air passage is adjusted by a vacuum diaphragm unit in order to assist the exhaust gas recirculation by throttling the fresh intake air.

- The EGR valve and the vacuum diaphragm unit controlling the throttle plate are actuated by the vacuum from the CVT valve (vacuum transducer). Proportionately up to 50 % of the exhaust gas can flow into the inlet manifold behind the throttle plate through the opened EGR valve.



Schematic illustration of exhaust gas recirculation control

- Exhaust gases
- Combustion
- Intake air
- Intake air, compressed

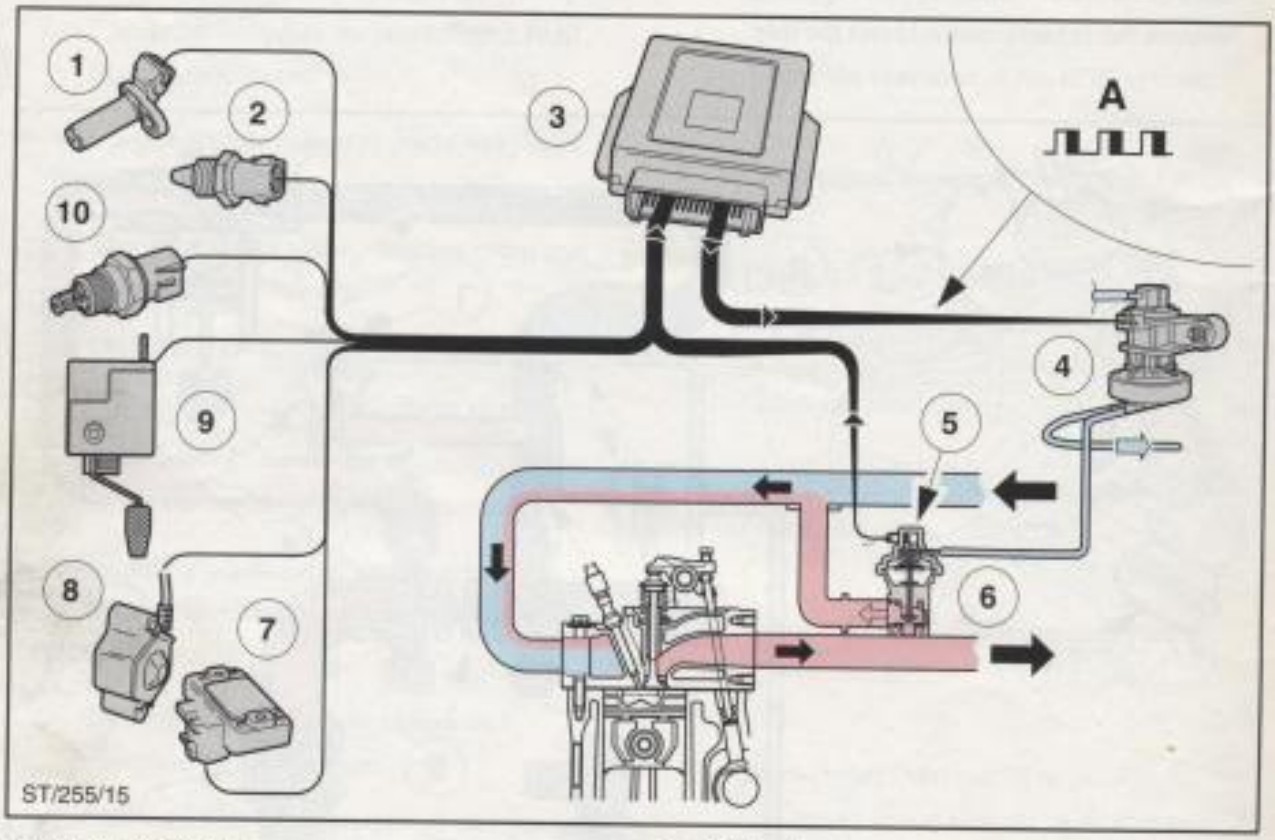
1 EGR sensor
2 Exhaust manifold
3 EGR valve
4 Vacuum diaphragm unit
5 Inlet manifold
6 Connecting pipe
7 Oxidation catalyst (optional)
8 Vacuum transducer (CVT)
9 Turbocharger
10 Throttle plate

- To control the exhaust gas recirculation, a set value for the opening of the EGR valve is calculated in the EDC module from a map for the engine speed and quantity of fuel injected and the characteristics for the
  - engine temperature,
  - manifold pressure and
  - intake air temperature,

  and a dynamic anticipatory allowance (acceleration or deceleration according to the accelerator pedal position).

- By actuating the vacuum transducer (CVT valve) through ground, the effective vacuum in the vacuum transducer is altered by the EDC module so that the calculated set value matches the signal at the EGR valve.

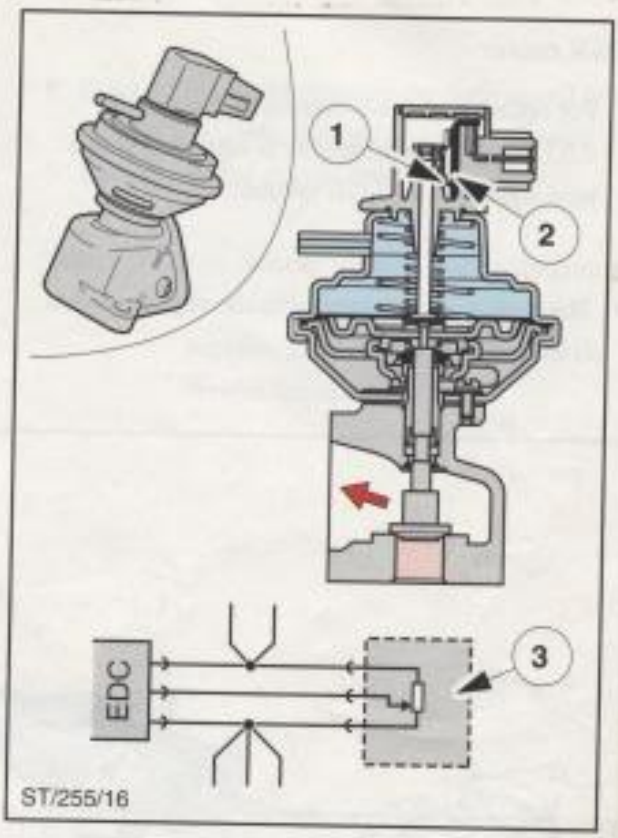
- The controlled vacuum alters the position of the throttle plate through the vacuum diaphragm unit in parallel. The adjustment of the throttle plate is limited by stops on the housing.



A Grounding pulses
1 Crankshaft speed/position sensor
2 Engine coolant temperature sensor
3 EDC module
4 Vacuum transducer (CVT valve)
5 Exhaust gas recirculation sensor
6 EGR valve
7 Inlet manifold pressure sensor
8 Rotor position sensor
9 Accelerator pedal position sensor
10 Intake air temperature sensor

Exhaust gas recirculation sensor

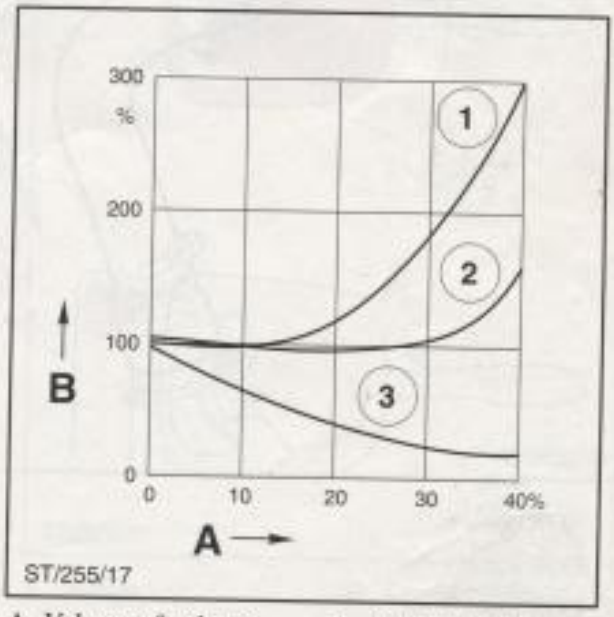
- The EGR valve contains an exhaust gas recirculation sensor.
- The exhaust gas recirculation sensor is a potentiometer based on a carbon film resistor.
- The movement of the push rod is transmitted to the contact of the potentiometer. The EDC module recognises the opening value of the EGR valve from the incoming voltage signal.



1 Contact
2 Carbon film resistor
3 Exhaust gas recirculation sensor

Effect of exhaust gas recirculation on emissions

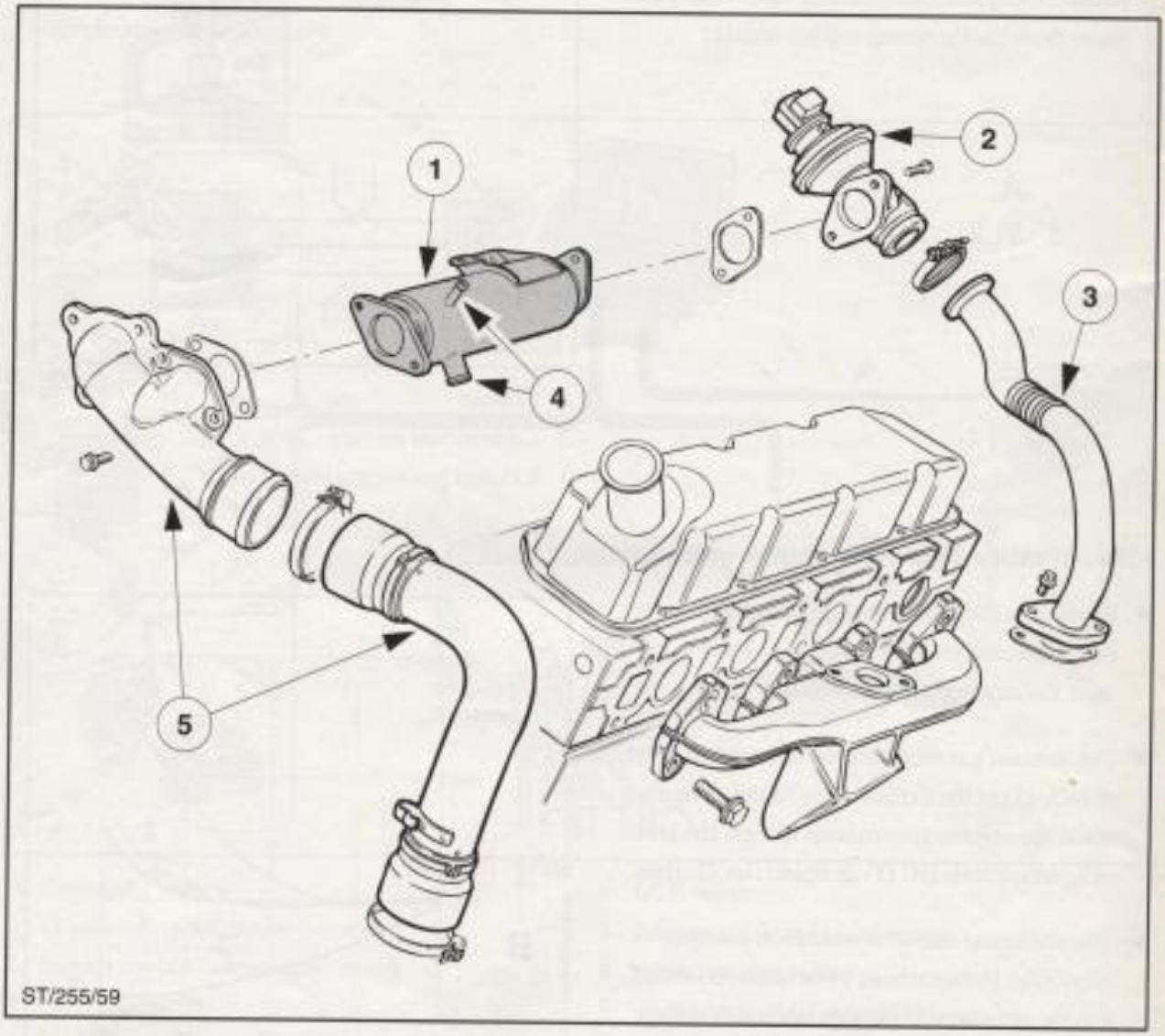
- Exhaust gas recirculation and optionally an oxidation catalyst are employed to be able to meet the required emission limits.
- The exhaust gas recirculation reduces the level of NO_x (3) in the exhaust gas. At the same time, when the volume recirculated is high, the level of hydrocarbons HC (1) and particles (2) rises.
- The additional use of an oxidation catalyst allows the hydrocarbons to be reduced further and the emissions to be kept optimally within limits.



A Volume of exhaust gas recirculated
B Emissions
1 Hydrocarbons
2 Particles
3 Level of NO_x

EGR cooler

- For optimum exhaust emissions, the 63 kW 2,5 l DI turbo diesel engine is equipped with a new water-cooled EGR system.
- The EGR cooler is located in the engine coolant circuit.
- The recirculated exhaust gas flows through the EGR cooler and is cooled before it passes into the inlet manifold.
- Cooling the recirculated exhaust gas lowers the combustion temperature and reduces the formation of NO_x (oxides of nitrogen).



1 EGR cooler
2 EGR valve
3 EGR pipe
4 Coolant connections
5 Inlet manifold

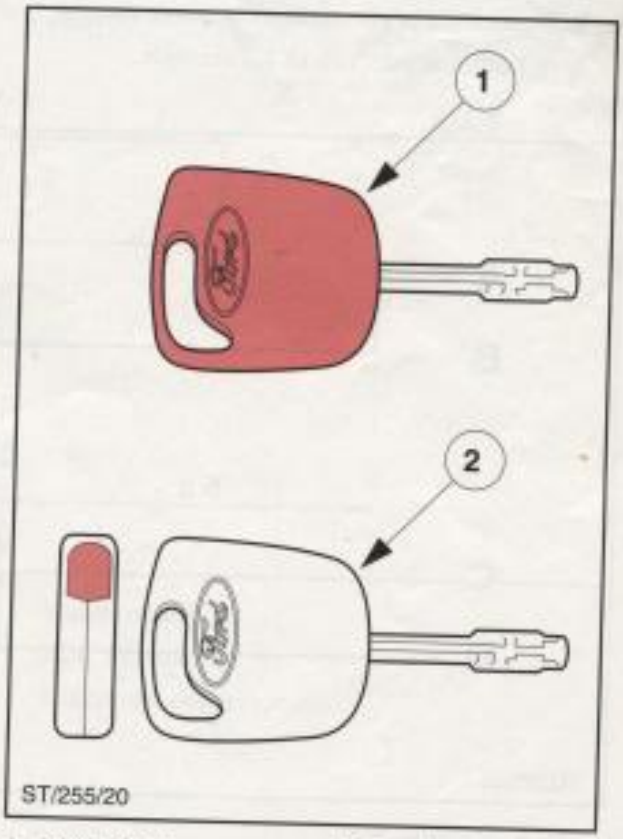
Passive anti-theft system (PATS)

- The passive anti-theft system (PATS) is an electronic vehicle immobiliser.
- The PATS is activated directly by means of the ignition switch through the ignition key in which an electronic code is stored.
- Each ignition key has an integral transponder which exchanges information with the transmitter/receiver (transceiver) on the lock cylinder of the ignition switch.
- While the ignition key is turned from position 0 to position II to start the engine, the code entered is received by means of the transceiver and transmitted to the PATS module.
- If the code entered matches the code stored in the PATS module, the PATS module allows starting and the engine fires.

Note: For security reasons, wiring diagrams for the PATS are only available on request. They do not form part of the service literature.

Keys

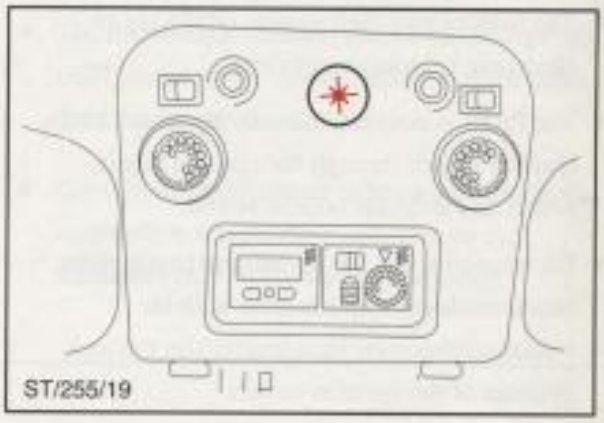
- The vehicles are delivered with three keys: a red "master key" which should be kept in a safe place and two "duplicate keys" each marked with a red dot.
- Only the two duplicate keys should be used for the vehicle.
- If one of the duplicate keys is lost, a replacement key can be coded using the master key.
- The plastic housing of the keys contains an electronically coded transponder. There are 18 trillion possible codes.



1 Master key 2 Duplicate key

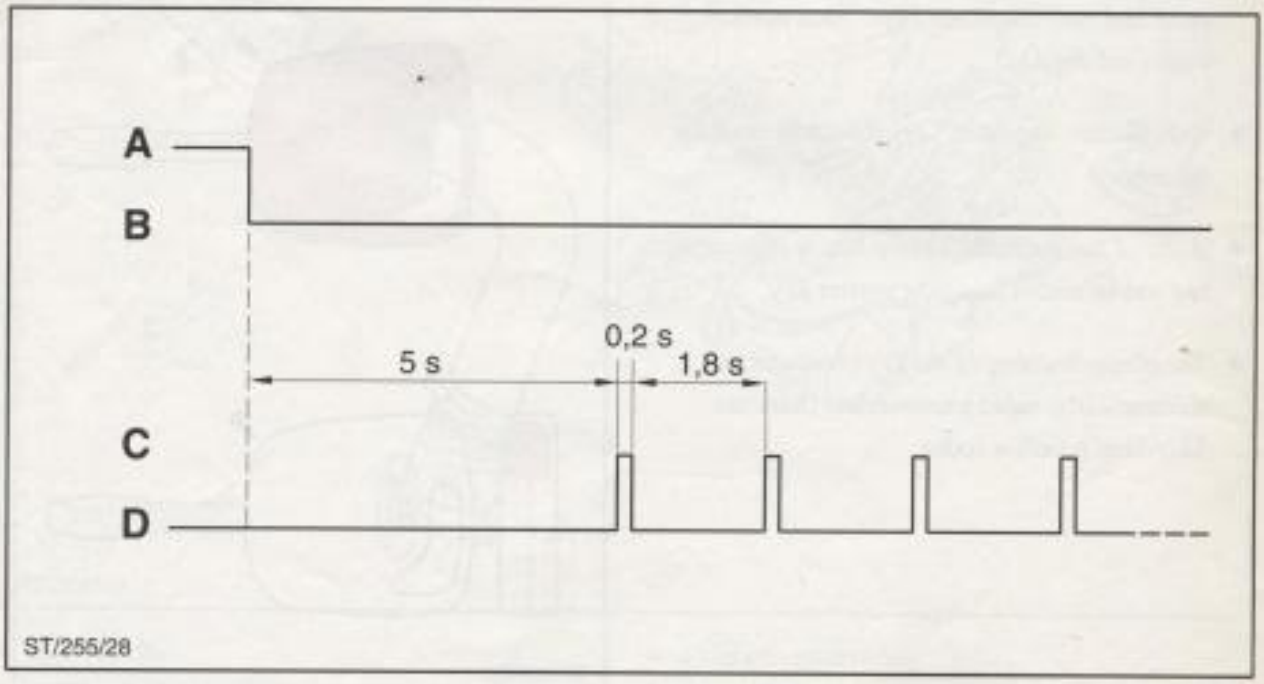
LED indicator light

- The red LED indicator light is located between the sun visors above the rear mirror.
- The LED indicator light indicates the current status (activated or deactivated) of the electronic vehicle immobiliser. In addition, the LED indicator light indicates fault codes.



Operation

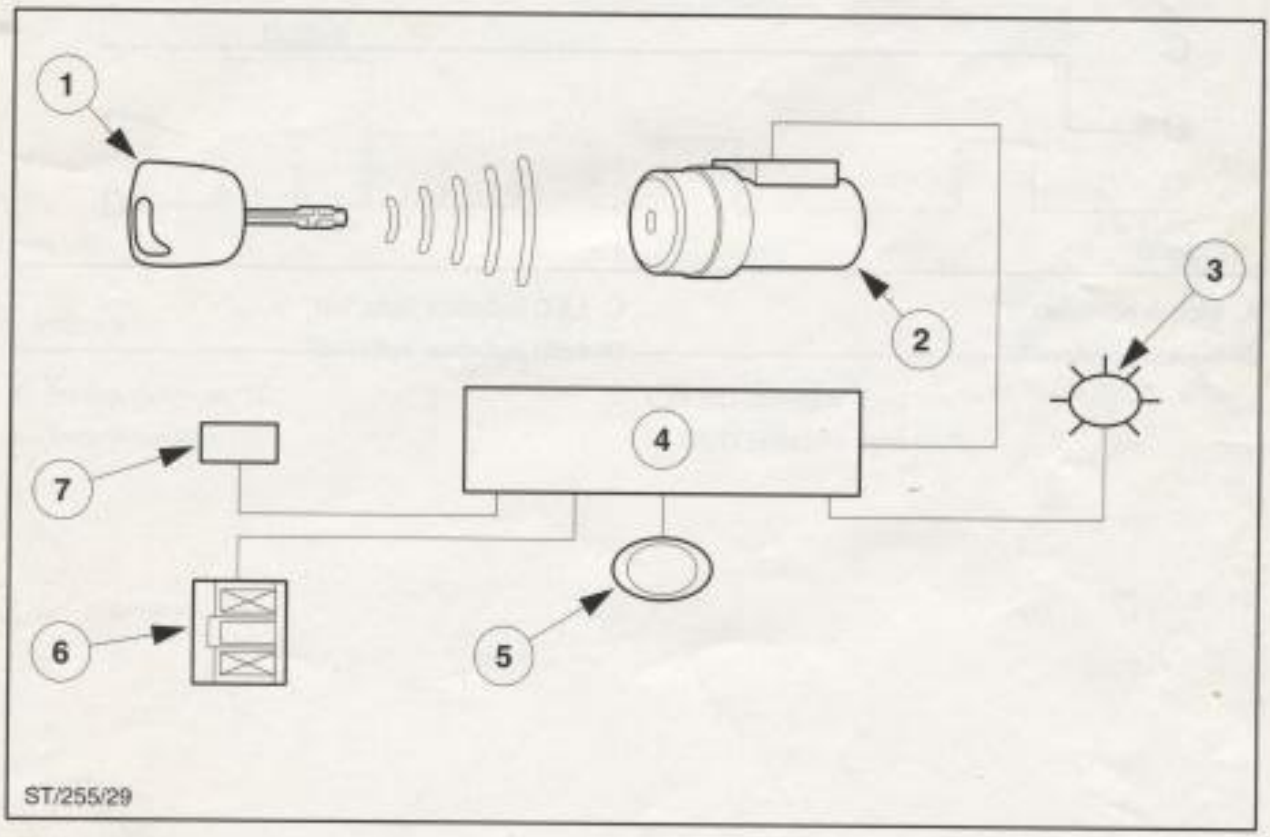
- When operating correctly, approximately 5 seconds after the engine is switched off the LED indicator light begins to blink with 0,2 second long flashes at intervals of 1,8 seconds.
- When the LED indicator light blinks, the vehicle immobiliser is activated. The engine can only be started again with a key in which a permissible code is stored.



A Starter position "II"
B Starter position "0"
C LED indicator light "on"
D LED indicator light "off"

Operation (continued)

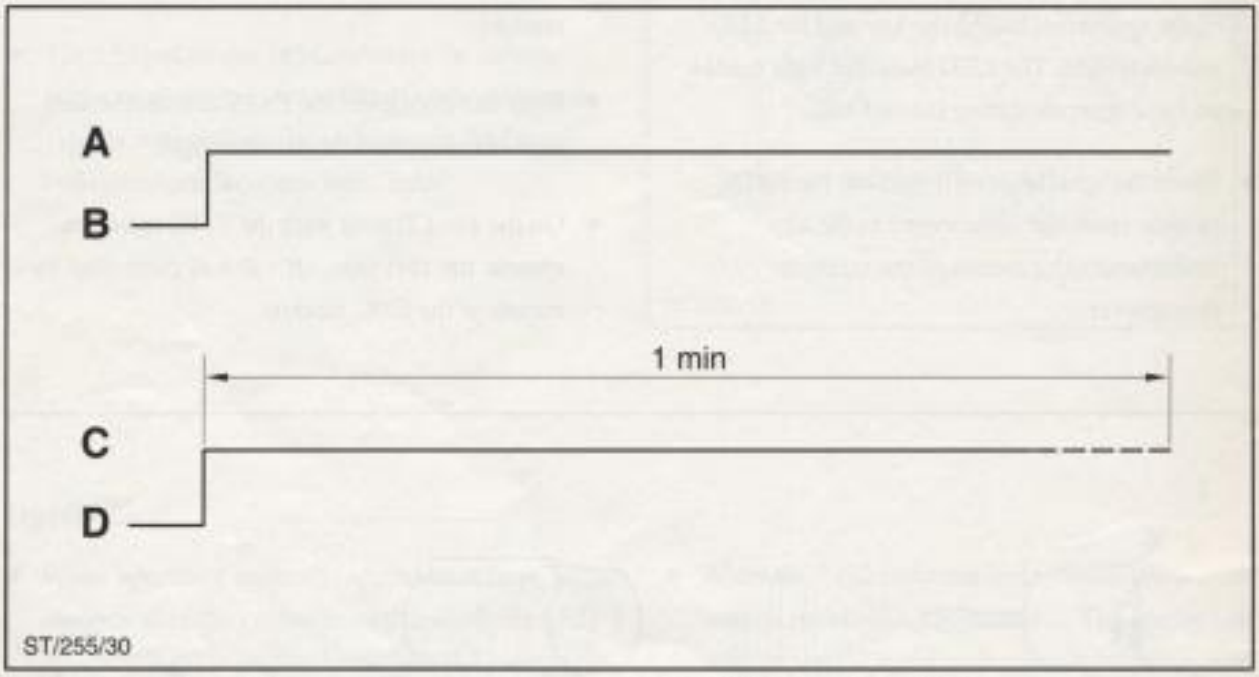
- When the ignition is switched on, the PATS carries out a self-test. This checks the operation of the system including the key and the LED indicator light. The LED indicator light comes on for 3 seconds during the self-test.
- When the ignition is switched on, the PATS module reads the code stored in the key (transponder) by means of the receiver (transceiver).
- The engine can only be started when the keycode matches the code stored in the PATS module.
- With diesel engines the PATS acts on the fuel shut-off valve and the starter motor.
- On the Ford Transit with the EPIC injection system the fuel shut-off valve is controlled by means of the EDC module.



1 Key with coded transponder
2 Receiver (transceiver)
3 LED indicator light
4 PATS module
5 Starter motor
6 EDC module
7 Diagnostic connector

Fault indication

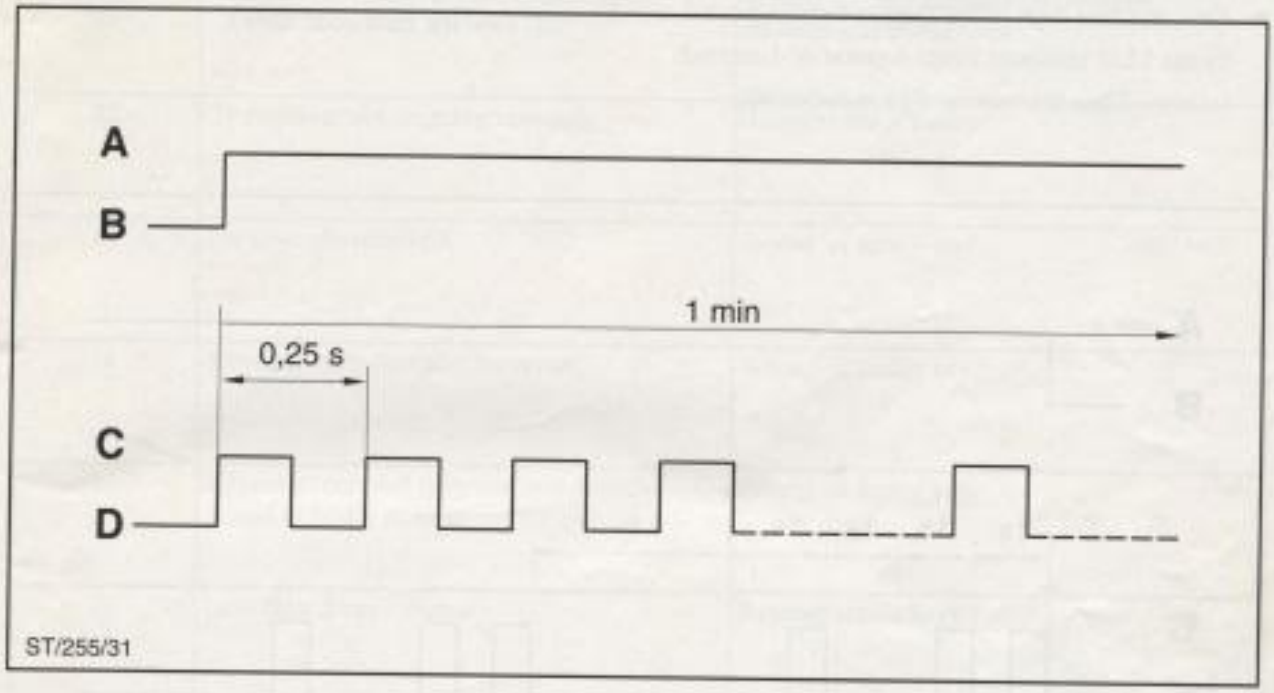
- If the LED indicator light comes on for one minute in ignition switch position "II" this means that either less than three keys are programmed or that there is a malfunction in the system.



A Switch position "II"
B Switch position "0"
C LED indicator light "on"
D LED indicator light "off"

Fault indication (continued)

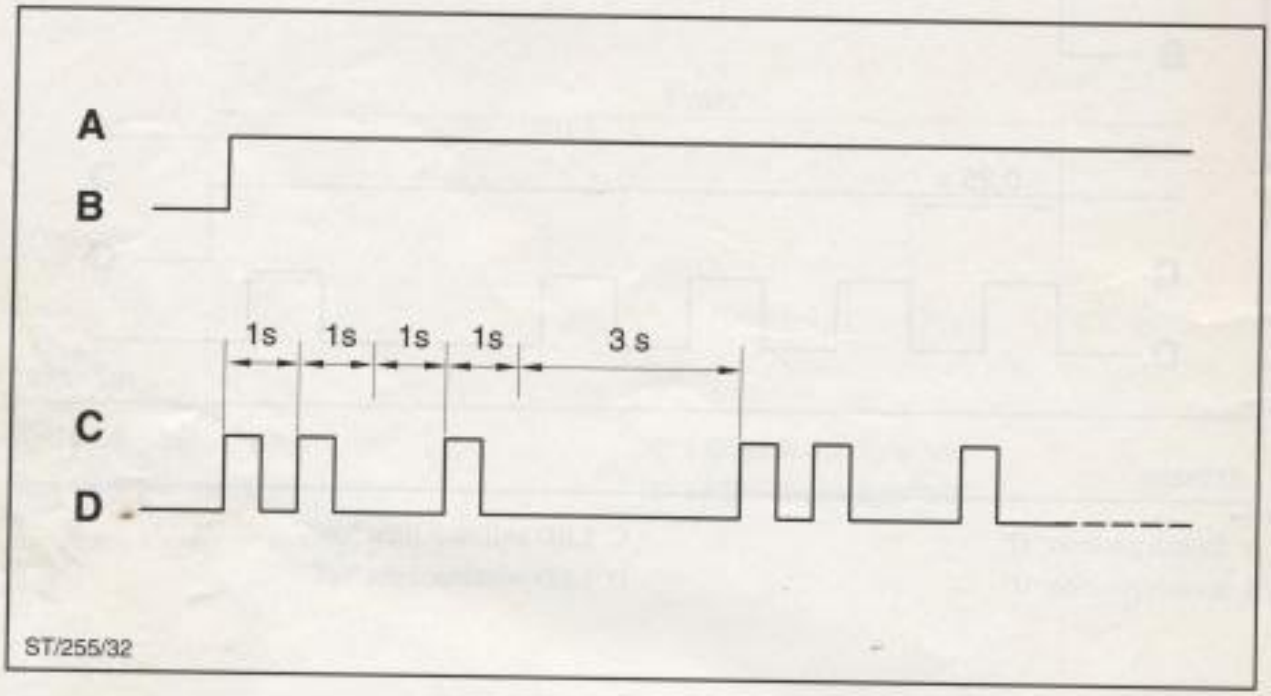
- When the system has detected a fault the LED indicator light flashes for a minute with a frequency of 4 Hz.



A Switch position "II"
B Switch position "0"
C LED indicator light "on"
D LED indicator light "off"

Fault indication (continued)

- After this minute the LED indicator light displays a two-digit fault code by flashing with a frequency of 1 Hz.
- First, the first digit of the fault code is indicated by the LED indicator light. A pause of 1 second follows. Then the second digit is indicated.
- After a further pause of 3 seconds the fault code is repeated.
- The following illustration shows the fault code "21" (see the fault code table).



A Switch position "II"
B Switch position "0"
C LED indicator light "on"
D LED indicator light "off"

Fault code table

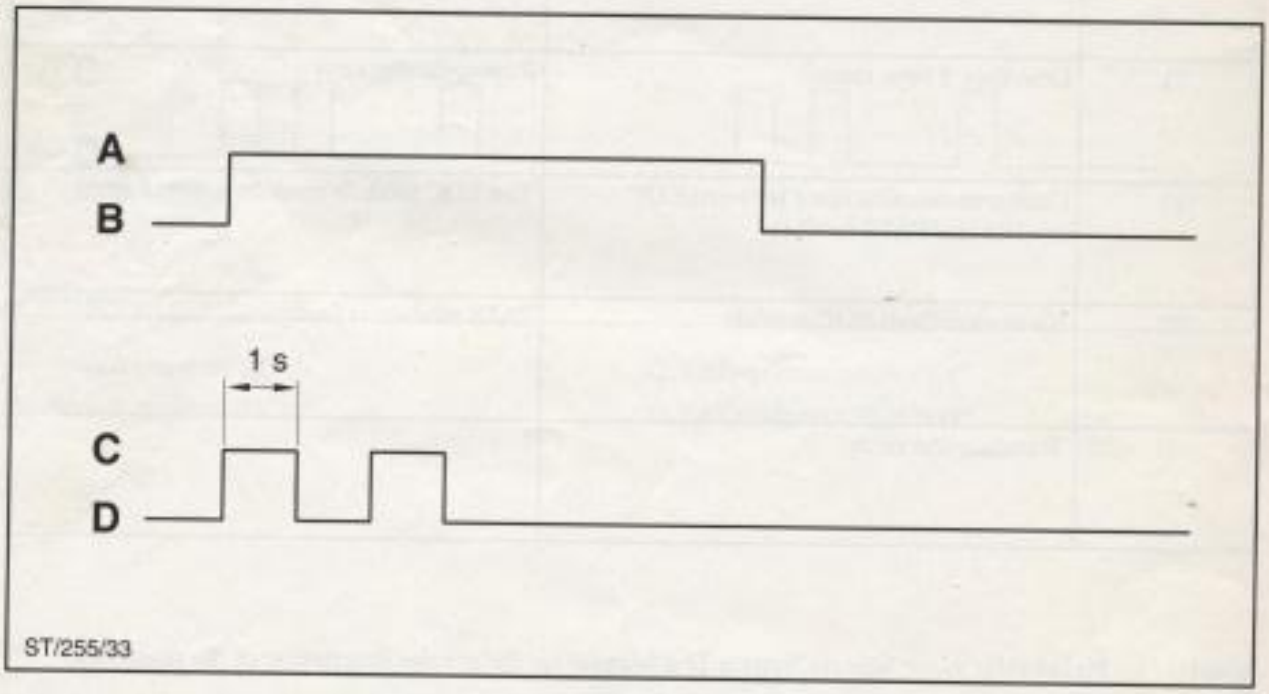
Fault code	Cause	Remark
11	Transceiver (receiver) not connected	Wiring or plug connection between PATS module and transceiver
12	Transceiver not working correctly	Transceiver is faulty
13	No keycode received	Wrong or faulty key
14	Keycode only partially received	Wrong or faulty key
15	Keycode received does not match code stored in PATS module	Wrong or faulty key
21	Less than 3 keys stored	Reprogramme keys
31	Code transmission error between EDC module and PATS module	The EDC module must be adapted anew
32	No answer from EDC module	PATS module is faulty
33	Transmission error	

Note: Please refer to the Vehicle System Test Manual for the precise description of the diagnostic options and the procedure for fault finding.

Programming keys for the first time

- When programming for the first time all three keys must be programmed at the same time.
- For this, first the red master key must be inserted in the ignition switch and the switch turned to position "II". When the master key has been checked and accepted by the PATS, the information is read and stored. Remove the master key.
- If the programming has been completed successfully the LED indicator comes on for one second at intervals of one second.
- Now the two duplicate keys can be programmed in the same way.

Note: If one of the steps is not carried out completely the programming is terminated. This is indicated by flashing of the LED indicator light as soon as the third key is used to turn the switch to position "II". The programming can be repeated after a delay of 20 seconds.



A Starter position "II"
B Starter position "0"
C LED indicator light "on"
D LED indicator light "off"

Programming a replacement key

- When replacement keys are required or a mislaid duplicate key is to be replaced up to 15 keys can be programmed for one vehicle with the master key by "reprogramming" or "extension programming".
- The programming of a replacement key can only be carried out after successful programming of the master key and the duplicate keys.
- To programme an unprogrammed key, first the red master key must be inserted in the ignition switch and the switch turned to position switch "II". When the master key has been checked and accepted by the PATS the information is read and stored. Turn the switch to position "0" with the master key.
- Within 10 seconds the unprogrammed key must be inserted in the ignition switch and the switch turned to position "II".
- In switch position "II" the information is transmitted by the PATS to the new key.
- If the programming has been completed successfully the LED indicator light comes on for one second at intervals of one second.
- The keys can also be programmed using FDS 2000 and the NGS (diagnosis tester for other markets).
- Programmed keys can only be deleted with the diagnostic testers.

⚠ **Caution** If a key is lost all the keys should be reprogrammed by a Ford dealer. This renders the mislaid key ineffective.

Checking PATS after programming keys

- Remove the key.
- Wait until the LED indicator light flashes to indicate that the system is secure.
- Insert the reprogrammed key in the ignition switch and turn the switch to position "II".
- In switch position "II" the PATS carries out a self-test. This checks the operation of the system including the keys and the LED indicator light. During the self-test the LED indicator light comes on for 3 seconds.
- Remove the key. After 5 seconds the LED indicator light begins to flash. The system is in operation.

Changing PATS module

- If the fault code "32" is indicated by the LED indicator light there is a fault in the PATS module. It must be changed.
- The PATS module is located under the EDC.
- After changing the PATS module, all the vehicle keys must be reprogrammed with the master key.

Note: Please refer to the service literature for a precise description of the procedure.

- The abbreviations conform to standard SAE J1930.
- Abbreviations which do not conform to SAE J1930 but are used within Ford are marked *.

BDC*	**B**ottom **D**ead **C**enter
CKP (CPS*)	Cran**K**shaft **P**osition
CVT*	**C**urrent to **V**acuum **T**ransducer
DI*	**D**irect **I**njection
ECT	**E**ngine **C**oolant **T**emperature
EDC*	**E**lectronic **D**iesel **C**ontrol
EGR	**E**xhaust **G**as **R**ecirculation
EPIC*	**E**lectronically **P**rogrammed **I**njection **C**ontrol
ESO*	**E**ngine **S**hut **O**ff
FDS*	**F**ord **D**iagnosis **S**ystem
HC*	**H**ydro **C**arbon
IAT (ACT*)	**I**ntake **A**ir **T**emperature
LED*	**L**ight **E**mitting **D**iode
MAP	**M**anifold **A**ir **P**ressure
NA*	**N**aturally **A**spirated
NGS*	**N**ew **G**eneration **S**tar
NO_x*	**O**xides of **N**itrogen
PATS*	**P**assive **A**nti-**T**heft **S**ystem
TDC*	**T**op **D**ead **C**entre