page

FUEL SYSTEM

INTRODUCTION

From chassis no. 205884, a new hot-film flowmeter has been adopted instead of the vane-type flowmeter.

The hot-film flowmeter is more precise and, as it has no moving parts, it is more reliable than the previous version.

With the introduction of the new flowmeter, other parts have also been affected by the modification; in addition to the hot-film flowmeter the new parts (added or modified) relating to the fuel system are as follows:

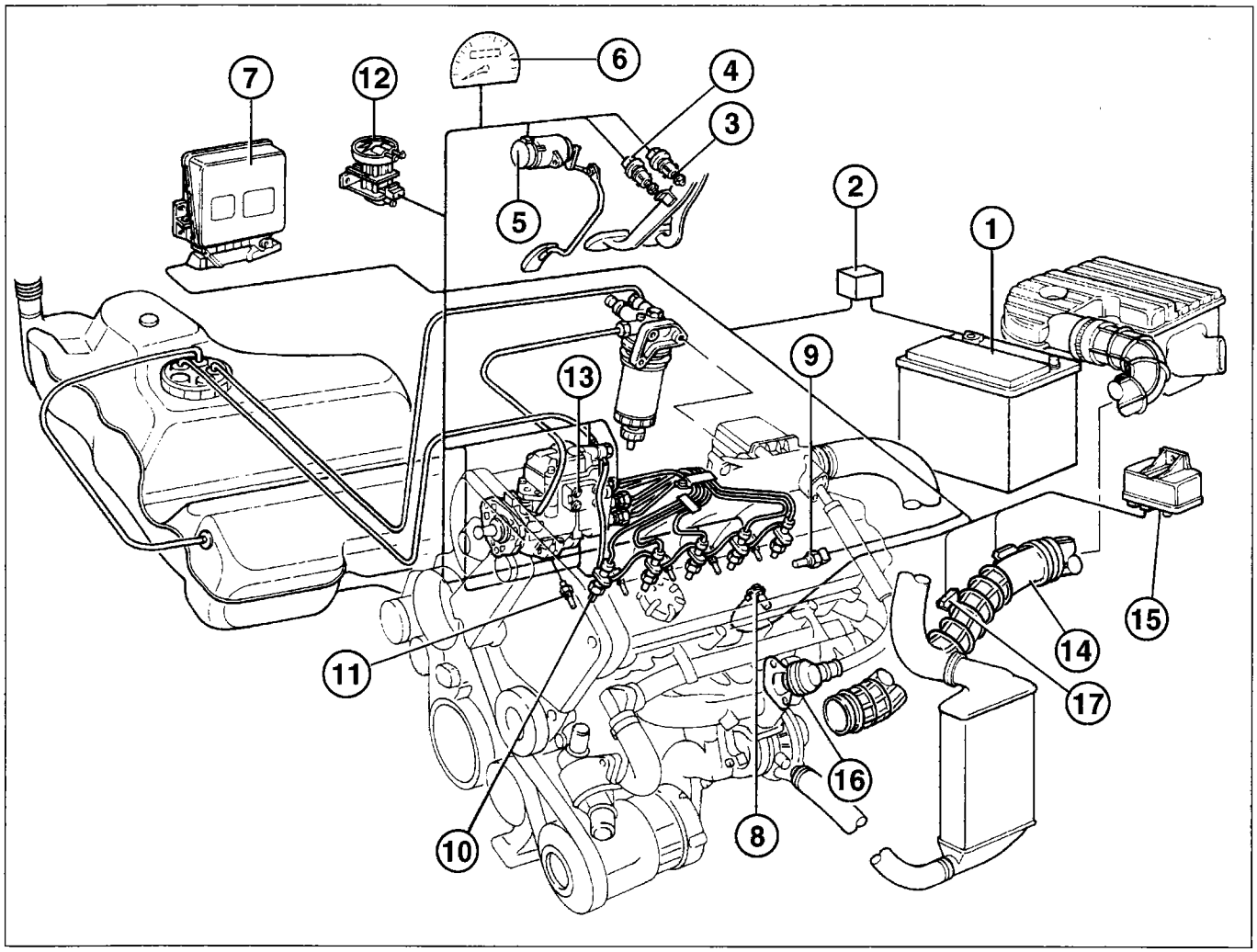
- Modified air duct connecting air cleaner to flowmeter.
- Modified air duct connecting flowmeter to turbine.
- Modified flowmeter mounting bracket.
- Replaced engine coolant temperature sender unit with a new sender unit which comprises two separate sensors: one for the fuel injection and one for the instrument panel gauge.
- Added intake air temperature sender unit which is no longer built into the flowmeter, but is a single component located upstream of the new hot-film flowmeter.
- Modified fuel injection pump: on the fuel outlet connection for the return to the tank, the 0.75 mm calibrated hole has been replaced with a valve calibrated at the pressure of about 4 bar; this allows the pump not to empty and to keep fuel under pressure in it, thus ensuring better engine starting.

- New Bosch 0.432.217.297 fuel injectors.
- New Bosch 0.432.217.296 instrumented fuel injector.
- New MSA 11 Bosch 0.281.001.741 fuel injection electronic control unit.
- New fuel injection wiring for connection to the new sensors.

This section only covers the parts of the 2387 TD engine fuel system which are different in relation to the previous version.

For aspects not covered in the following pages, see the descriptions give in the "Fuel system of 2387 TD" in the basic edition, contained in volume 1.

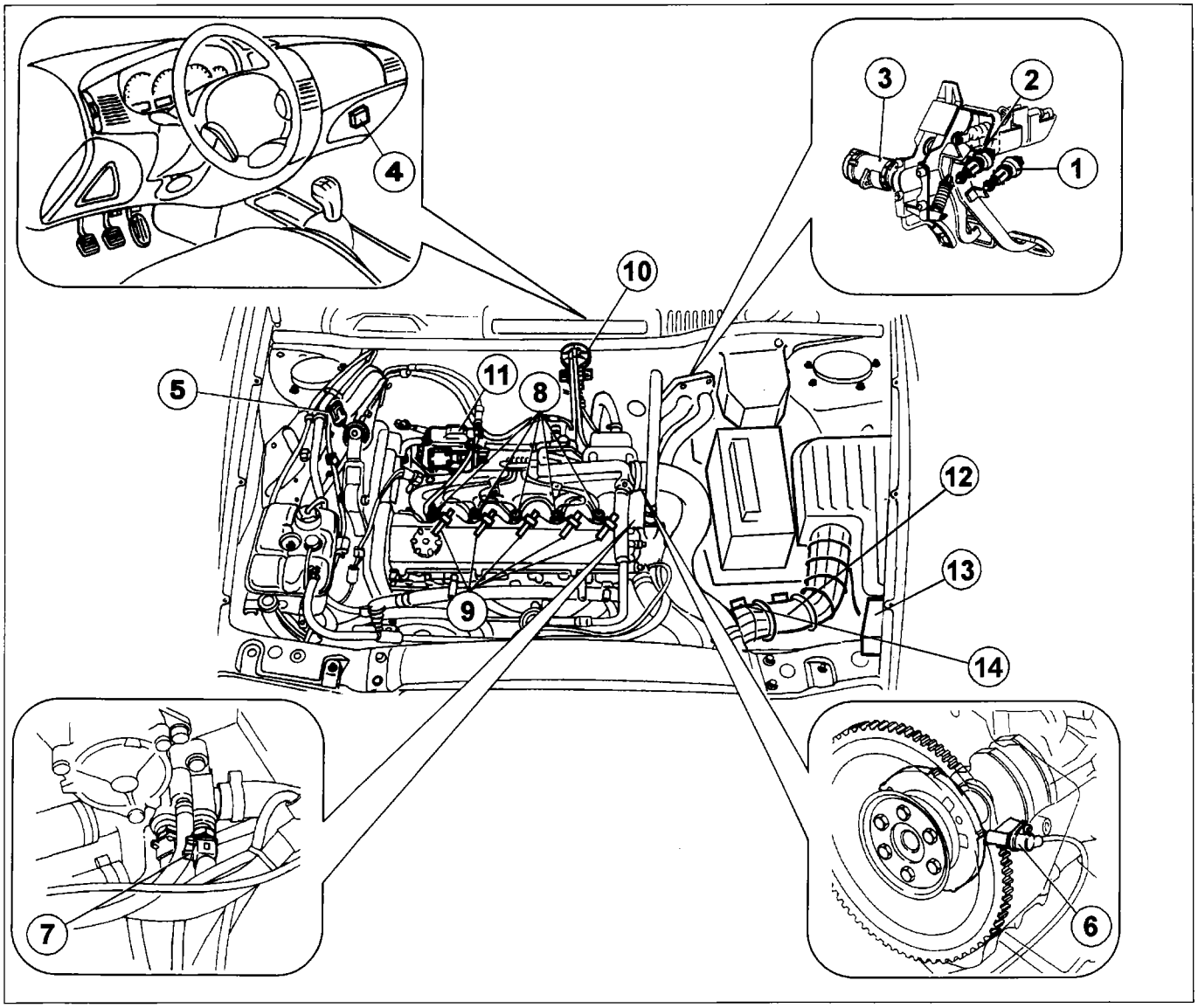
GENERAL DIAGRAM OF FUEL SYSTEM



P4F02LJ01

1. Battery
2. Relay
3. Clutch pedal switch
4. Brake pedal switch
5. Accelerator potentiometer
6. Speedometer
7. Electronic control unit
8. Engine rpm sensor
9. Coolant temperature sensor
10. Instrumented fuel injector
11. Heater plugs
12. Borg-Warner modulating valve
13. Bosch fuel injection pump
14. Flowmeter
15. Plug preheating control unit
16. E.G.R. valve
17. Intake air temperature sensor

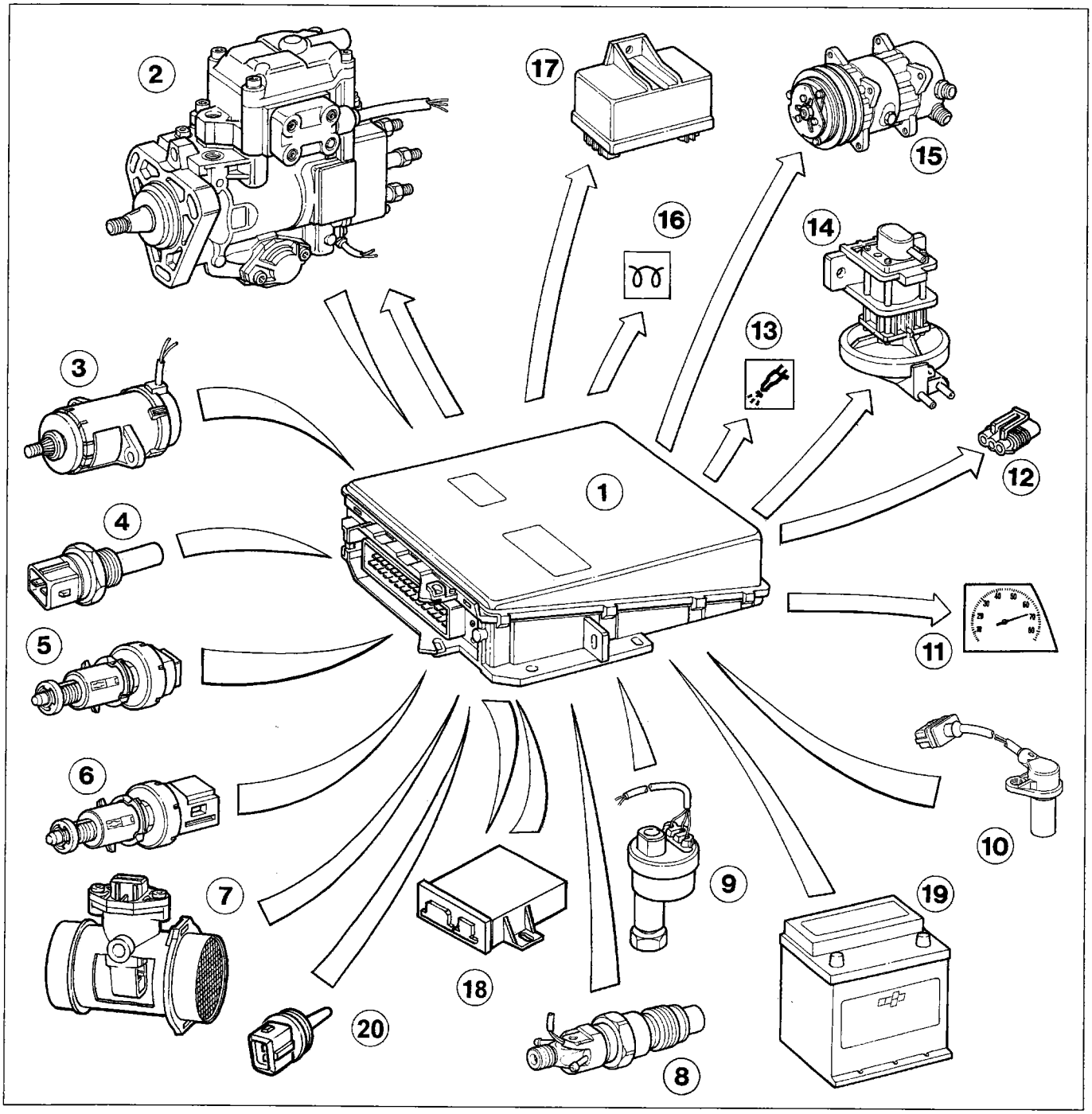
LOCATION OF FUEL SYSTEM COMPONENTS



P4F03LJ01

1. Clutch pedal switch
2. Brake pedal switch
3. Accelerator potentiometer
4. Electronic control unit
5. Diagnostic socket
6. Engine rpm sensor
7. Coolant temperature sensor
8. Fuel injectors
9. Heater plugs
10. Borg Warner modulating valve
11. Bosch fuel injection pump
12. Flowmeter
13. Plug preheating control unit
14. Intake air temperature sensor

INPUT/OUTPUT SIGNALS BETWEEN CONTROL UNIT AND SENSORS/ACTUATORS



P4F04LJ01

1. Electronic control unit
2. Injection pump
3. Accelerator pedal potentiometer
4. Engine coolant temperature sensor
5. Clutch pedal switch
6. Brake pedal switch
7. Air flowmeter
8. Instrumented fuel injector
9. Speedometer sensor
10. Engine rpm sensor
11. Rev counter
12. Diagnostic socket
13. Fuel injection fault warning light
14. Borg Warner solenoid
15. Air conditioner
16. Heater plugs warning light
17. Plug preheating control unit
18. Fiat CODE control unit
19. Battery
20. Intake air temperature sensor

The BOSCH MSA11 electronic control unit (1) receives the following information:

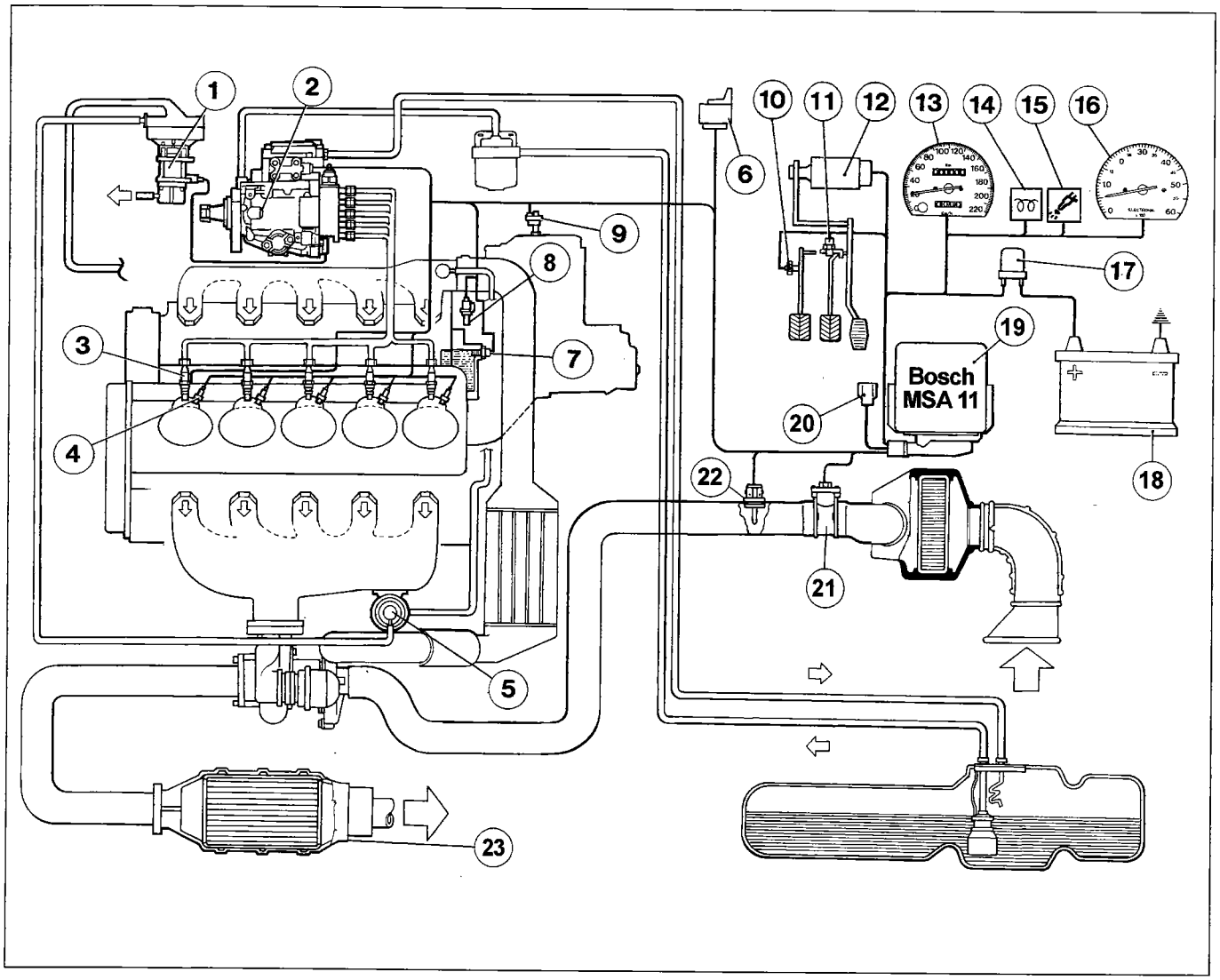
- accelerator pedal position from the potentiometer connected to it (3);
- engine rpm from the sensor mounted on the engine block (10);
- intake air quantity from the flowmeter (7);
- quantity of fuel injected from the sensor mounted on the actuator contained in the fuel injection pump (2);
- intake air temperature from the relevant sensor (20);
- diesel temperature from the sensor located in the fuel injection pump (2);
- coolant temperature from the sensor (4);
- actual start of injection (opening of fuel injector pintle) from the instrumented fuel injector (8), located on cylinder 1;
- car speed from speedometer sensor (9) located on the gearbox;
- brake operation information from the switch (6) located on the brake pedal;
- clutch operation from the switch (5) located on the clutch pedal;
- atmospheric pressure from the sensor located inside the control unit (1);
- signal requesting the switching on of the air conditioner compressor from the air conditioning system (15).

Depending on the input values, the electronic control unit (1) consults the mapped values in its memory and corrects the output values accordingly, thus managing:

- the actuator controlling the quantity of fuel contained in the fuel injection pump (2);
- the fuel injection advance regulation solenoid contained in the fuel injection pump (2);
- the engine stop solenoid contained in the fuel injection pump (2);
- the heater plug control unit (17);
- the Borg Warner (14) vacuum modulating solenoid controlling the E.G.R. valve;
- the heater plugs warning light (16);
- the fuel injection fault warning light (13);
- the rev counter (11);
- the engagement of the air conditioner compressor electromagnetic clutch (15);
- the diagnostic socket (12).

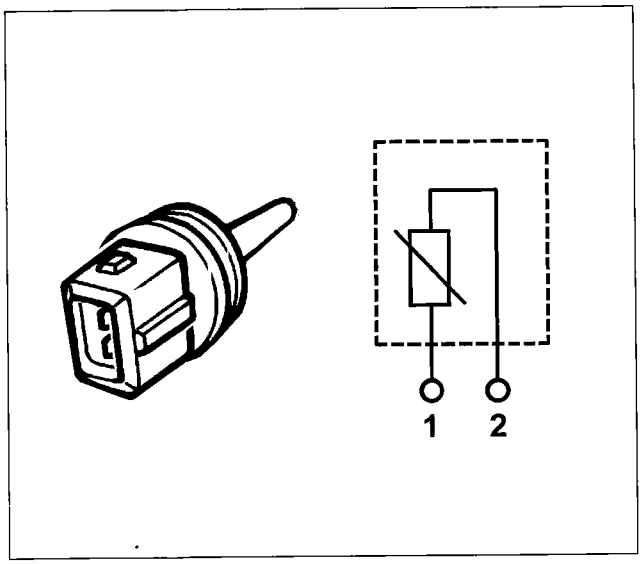
The control unit also has the function of blocking engine starting (Fiat CODE).
This function is carried out by a specific control unit (Fiat CODE) (18), which can dialogue with the electronic control unit (1), and an electronic key with a special transmitter for sending a recognition code.

FUNCTIONAL DIAGRAM OF THE FUEL SYSTEM



P4F06LJ01

1. Borg Warner modulating valve
2. Bosch fuel injection pump
3. Instrumented fuel injector
4. Heater plug
5. EGR valve
6. Plug preheating control unit
7. Coolant temperature sensor
8. Engine rpm sensor
9. Speed sensor
10. Clutch pedal sensor
11. Brake pedal sensor
12. Accelerator potentiometer
13. Speedometer
14. Heater plug warning lamp
15. Fuel injection fault warning light
16. Rev counter
17. Relay
18. Battery
19. Fuel injection control unit
20. Diagnostic socket
21. Air flowmeter
22. Intake air temperature sensor
23. Catalytic converter

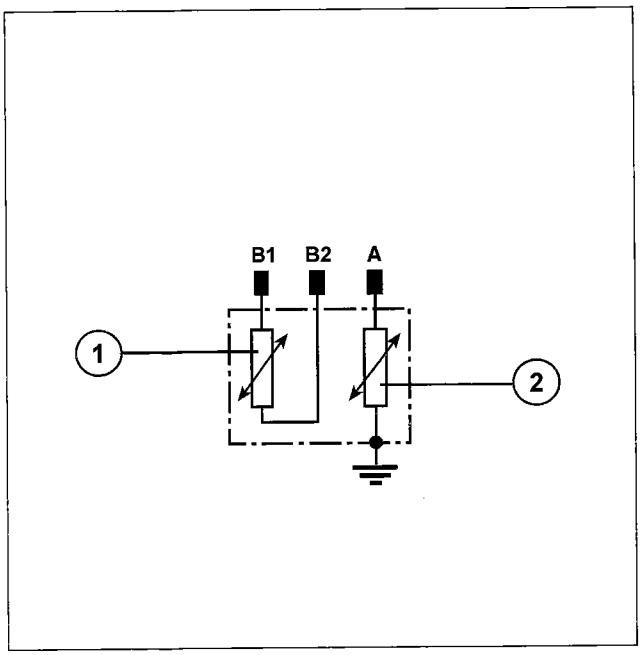


P4F31DJ01

AIR TEMPERATURE SENSOR

On this version, the intake air temperature sensor is separate from the air flowmeter; it is an ordinary NTC (Negative Temperature Coefficient) sensor, whose electrical resistance decreases as temperature increases.

As the input circuit into the control unit is designed as a voltage divider, this voltage is divided between a resistor present in the control unit and the sensor's NTC resistor. The control unit can therefore assess the changes in the sensor's resistance from the changes in voltage, and thus obtain the temperature information.



P4F07LJ01

COOLANT TEMPERATURE SENSOR

The sensor consists of a brass casing which houses the actual resistive elements, which are two NTC (Negative Temperature Coefficient) thermistors; the electrical resistance of the sensor decreases as the temperature increases.
The two NTC thermistors are separate, and they supply the temperature information to the specific gauge on the instrument panel and the fuel injection-ignition control unit.
For the NTC element relating to the fuel injection, the reference voltage is 5 Volt; as the input circuit into the control unit is designed as a voltage divider, this voltage is divided between a resistor present in the control unit and the sensor's NTC resistor. The control unit can therefore assess the changes in resistance of the sensor through the changes in temperature.

1. NTC for fuel injection
2. NTC for instrument panel gauge

INJECTION NTC

°C	Ω
-20	15970
-10	9620
0	5975
10	3816
20	2500
25	2044
30	1679

°C	Ω
40	1150
50	807
60	576
70	418
80	309
90	231
100	176

GAUGE NTC

°C	Ω
60	512-602
90	184-208
120	76-88

The tables opposite give the resistance values which the NTC elements can assume in accordance with the coolant temperature.

HOT-FILM AIR FLOWMETER

This component measures the quantity of air drawn in by the engine. The electrical signal (proportional to the air flow) which the flowmeter gives as an output is sent to the engine control unit. This is used to:
- calculate the quantity of fuel to be injected, so as to obtain the maximum fuel flow rate while maintaining an acceptible level of smoke in the exhaust;
- check the quantity of gases recirculating through the EGR valve.

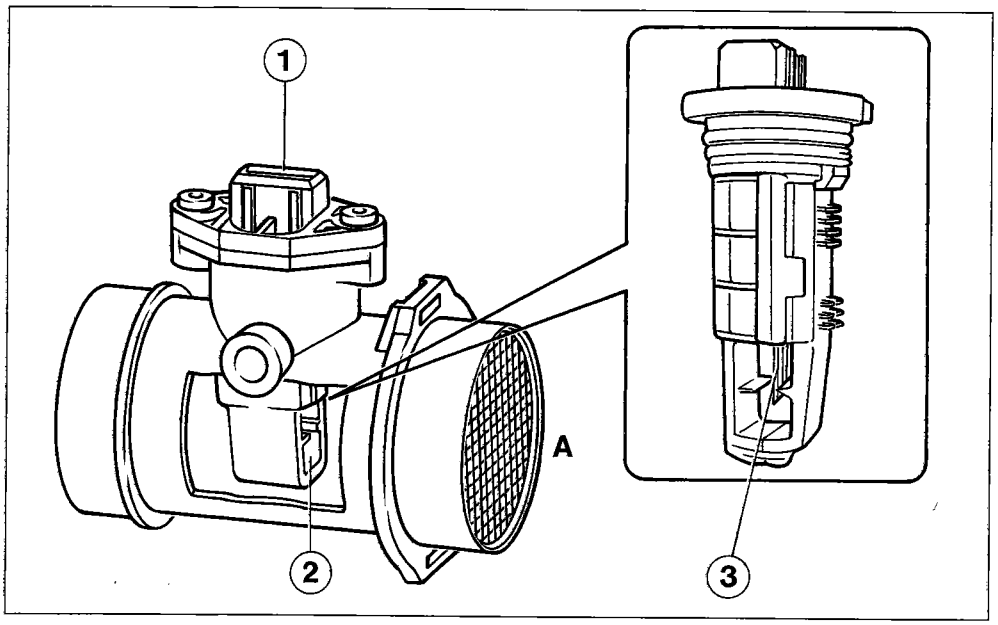
The check on the quantity of recirculating gases is based on the following equation:

Qam - Qar = Qgr

Qam = quantity of theoretical air mapped in the control unit in a particular point of engine operation;
Qar = quantity of air which really passes through the flowmeter (and is drawn in by the engine) at the same point of engine operation;
Qgr = the imbalance, compared with the theoretical value, of the quantity of recirculating gases.

If the quantity of recirculating gases is correct for a particular point of engine operation, the quantity of air drawn in by the engine must be the same as the mapped quantity. Thus Qgr must be zero. If Qam is greater than Qar, this means that the quantity of air passing through the flowmeter is less than the theoretical quantity, i.e. the quantity of recirculating gases is higher than the specified value (Qgr > 0). In this case the control system intervenes on the EGR valve to reduce the flow rate, so that the Qgr value is cancelled.

The system behaves in the same way if Qar > Qam.



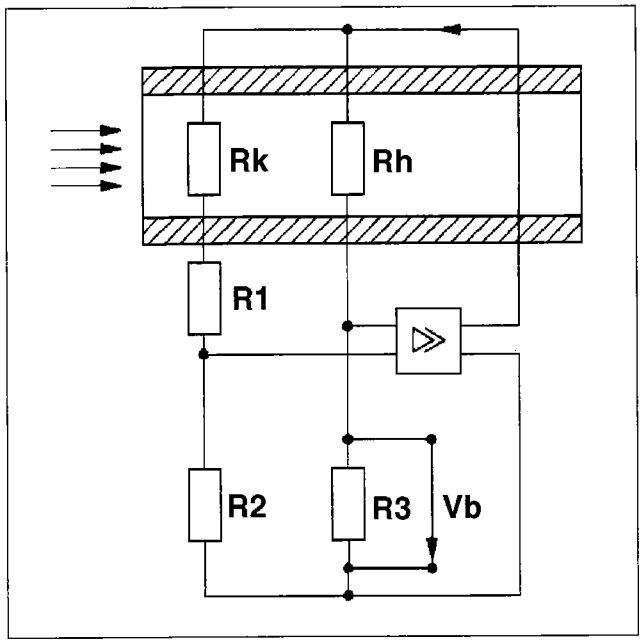
P4F08LJ01

1. Connector
2. Measuring channel
3. Hot-film sensor

A = Air input

The "hot-film" air flowmeter.
The operating principle of these sensors is based on the heat exchange between a "hot" element and the air flow enveloping it.
The heat exchanged is given by the electrical power supplied by the power supply to the hot element, to keep its temperature constant.

The principle of operation of the flowmeter may be observed from the following wiring diagram of the electrical circuit which drives the sensor:



P4F09LJ01

Wiring diagram

Rh = hot film

Rk = temperature compensation sensor

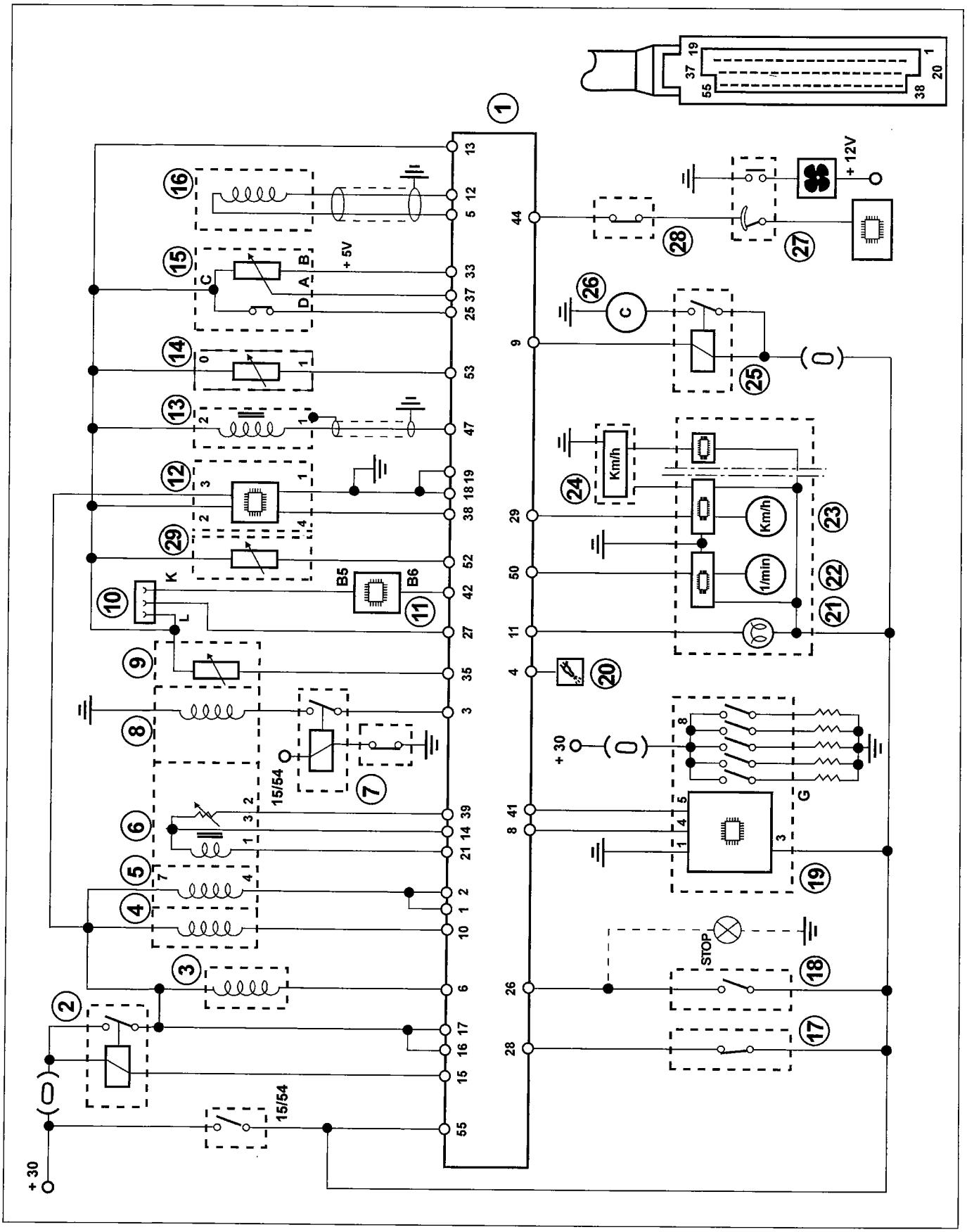
R1, R2, R3 = bridge resistors

In the diagram, the component Rh represents the hot sensor, which is kept at constant temperature in relation to the air temperature.
An increase in the quantity of air enveloping the hot element causes it to cool down, and so reduces its resistance, unbalancing the bridge.
The circuit restores the balance of the bridge by increasing the current supplied to the hot element until its resistance (and so its temperature) assumes the original balanced value.
The increase in current which passes through the hot element is proportional to the air flow passing through the flowmeter. This value thus gives the air flow: to measure precisely the current passing through the hot film, the voltage at the ends of the fixed resistor R3 is measured; this voltage thus provides the information on the mass of air passing through the flowmeter.

To compensate for the measurement error due to the variation in air temperature, the resistor Rk is in parallel to the hot film. Its high value only changes when the air temperature changes, compensating for the increase in resistance of the hot sensor, so the bridge does not undergo unbalancing due to the variation in the air temperature.

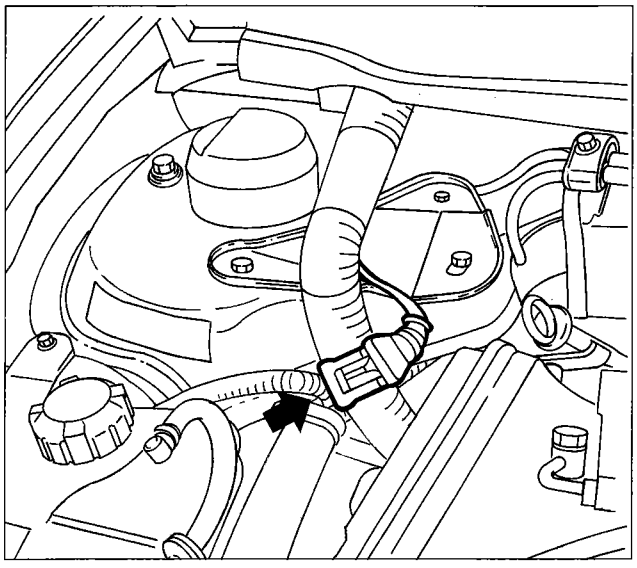
The hot element consists of platinum. For the same area, film technology offers shorter response times than hot wire. In addition, having a larger area than wire, it has greater immunity to inorganic contamination.

WIRING DIAGRAM



Key to wiring diagram

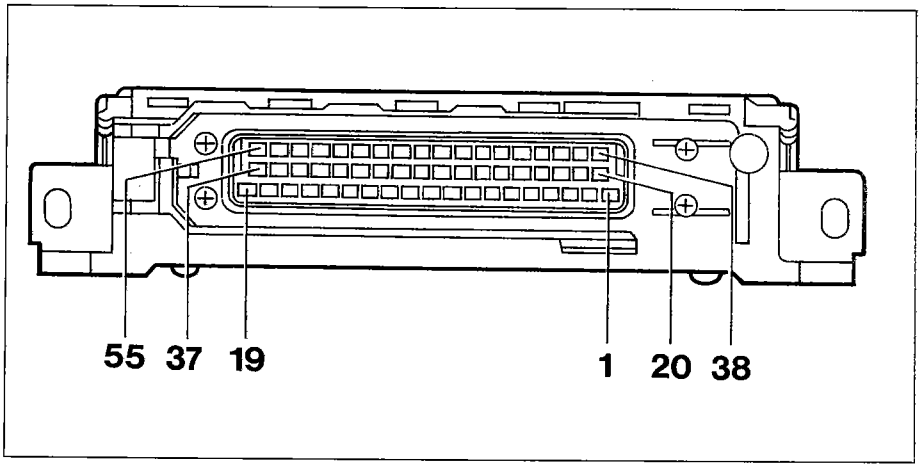
1. Electronic control unit
2. System protection relay
3. Borg-Warner modulating solenoid
4. Fuel injection advance actuator
5. Fuel quantity actuator
6. Fuel quantity actuator position control
7. Inertial switch
8. Engine cut-out solenoid
9. Fuel temperature sensor
10. Diagnostic socket
11. Immobilizer
12. Flowmeter
13. Engine rpm sensor
14. Engine coolant temperature sensor
15. Accelerator pedal potentiometer with idle switch
16. Instrumented fuel injector
17. Clutch pedal switch
18. Brake pedal switch
19. Plug preheating electronic control unit
20. System fault warning light
21. Plug preheating warning light
22. Rev counter
23. Speedometer
24. Speedometer sensor
25. Air conditioner compressor relay
26. Air conditioner compressor
27. Three-stage pressure switch
28. Anti-frost thermostat
29. Air temperature sensor



P4F21FJ01

Location of diagnostic socket

CONTROL UNIT PINS



P4F18FJ01

1. Fuel flow actuator
2. Fuel flow actuator
3. Engine cut-out solenoid
4. Infocenter
5. Instrumented fuel injector
6. E.G.R. solenoid
7. Not connected
8. Activation of plug preheating control unit
9. A.C. compressor
10. Fuel injection advance actuator
11. Heater plugs "on" warning light
12. Earth for instrumented fuel injector
13. Sensors' shared earth
14. Cursor position sensor
15. Main relay
16. Control unit supply through relay
17. Control unit supply through relay
18. Earth
19. Earth
20. Not connected
21. Cursor position sensor (reference winding)
22. Not connected
23. Not connected
24. Not connected
25. Idle switch on accelerator pedal
26. Stop lights switch
27. Not connected
28. Clutch pedal switch
29. Vehicle speed signal
30. Not connected
31. Not connected
32. Not connected
33. 5V accelerator pedal position sensor
34. Not connected
35. Fuel temperature signal
36. Not connected
37. Accelerator pedal position signal
38. Flowmeter signal
39. Cursor position sensor signal
40. Not connected
41. Heater plug operation signal
42. Line K and immobilizer
43. Not connected
44. Signal required for switching on compressor
45. Not connected
46. Not connected
47. Engine rpm sensor
48. Not connected
49. Not connected
50. Rev counter signal
51. Not connected
52. Air temperature signal
53. Engine coolant temperature signal
54. Not connected
55. Ignition key positive