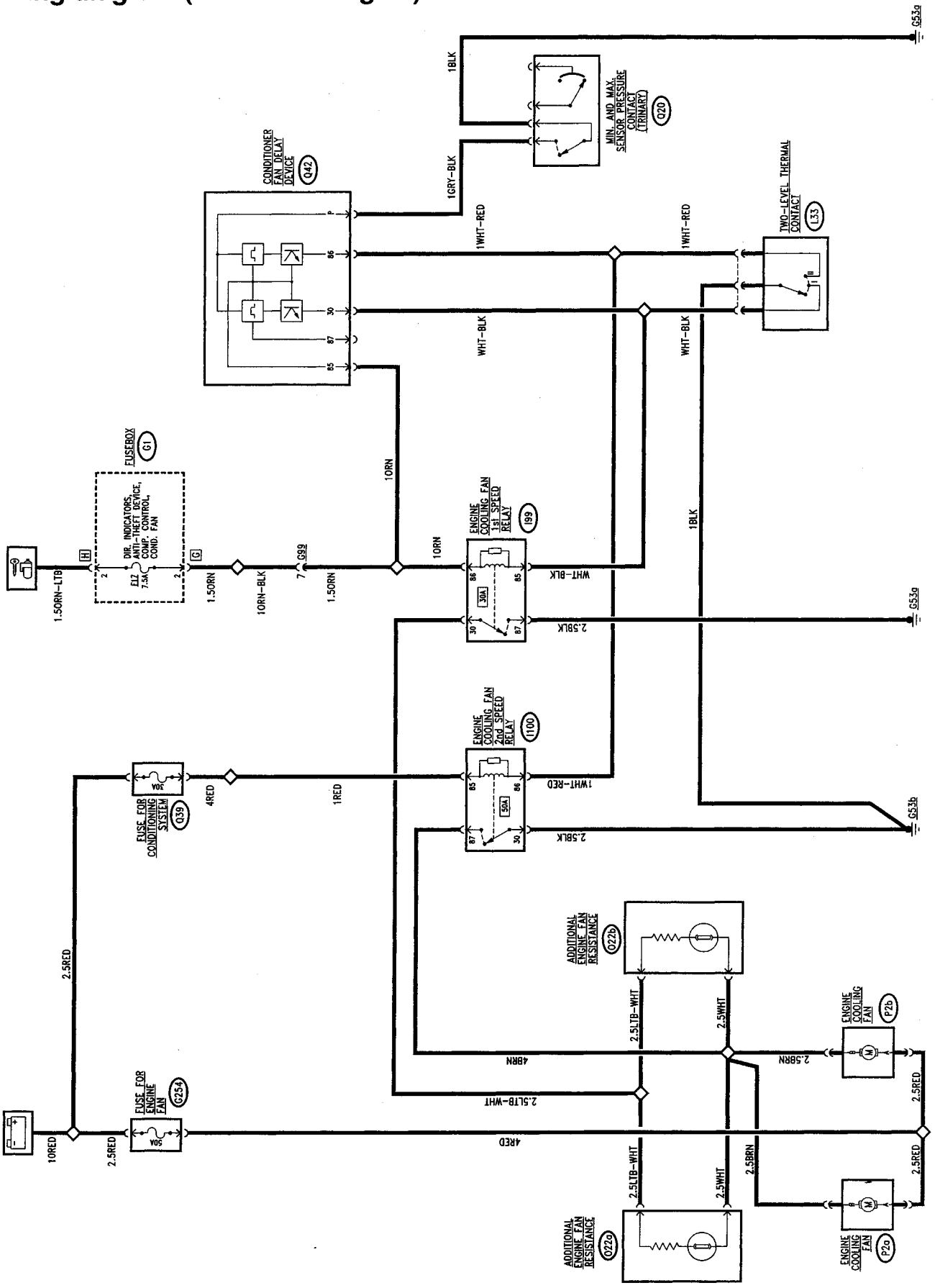
Wiring diagram (3.0 V6 24v engine)



ENGINE COOLING FAN/S CONTROL

2.0 T.S. 16v engine

Two fans **P2a** and **P2b** provide the necessary ventilation of the air for cooling the engine radiator and the conditioner system condenser.

N.B.: the two fans are in parallel and are therefore always operated together, always following the same logic:

The two fans are always supplied by battery current via the line protected by wander fuse **G254**; they are operated by an earth command signal: this signal arrives directly (2nd speed) or through the additional resistances **O22a** and **O22b** (1st speed), fitted with a safety thermal fuse.

The M2.10.4 injection - ignition control unit handles the control of the engine coolant and air conditioning system fluid fans.

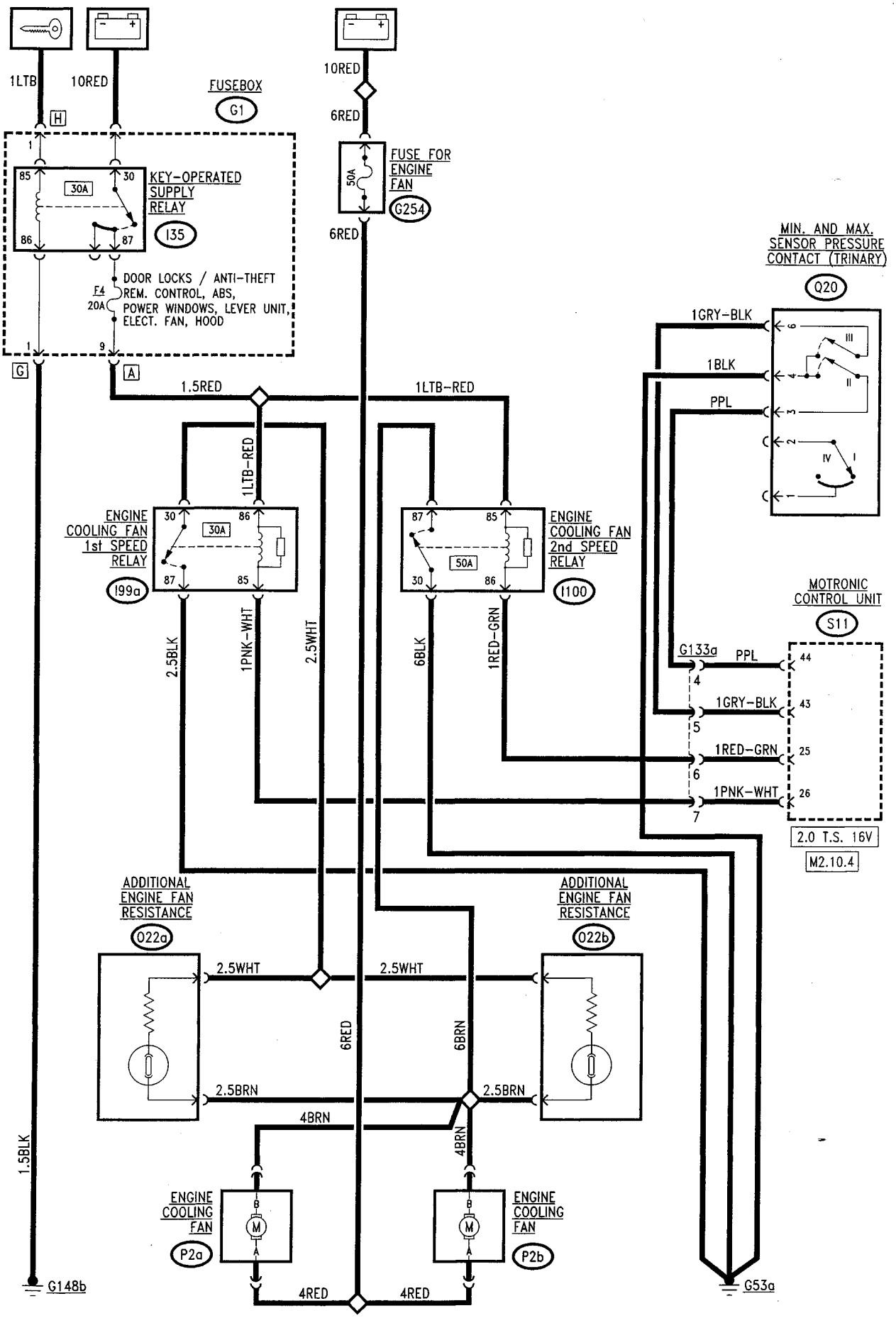
This way the thermal contact usually located on the radiator has been eliminated. The two speeds of the fans are operated depending on the engine temperature, which is detected by the special sensor: a low "earth" signal leaves pin 26 which commands the 1st speed relay I99, and a "low" (earth) signal leaves pin 25 which commands the 2nd speed relay **I100**.

Akso pressure switch **Q20** sends special signals to the control unit for engaging the fans if the pressure of the coolant fluid in the circuit exceeds determinate values:

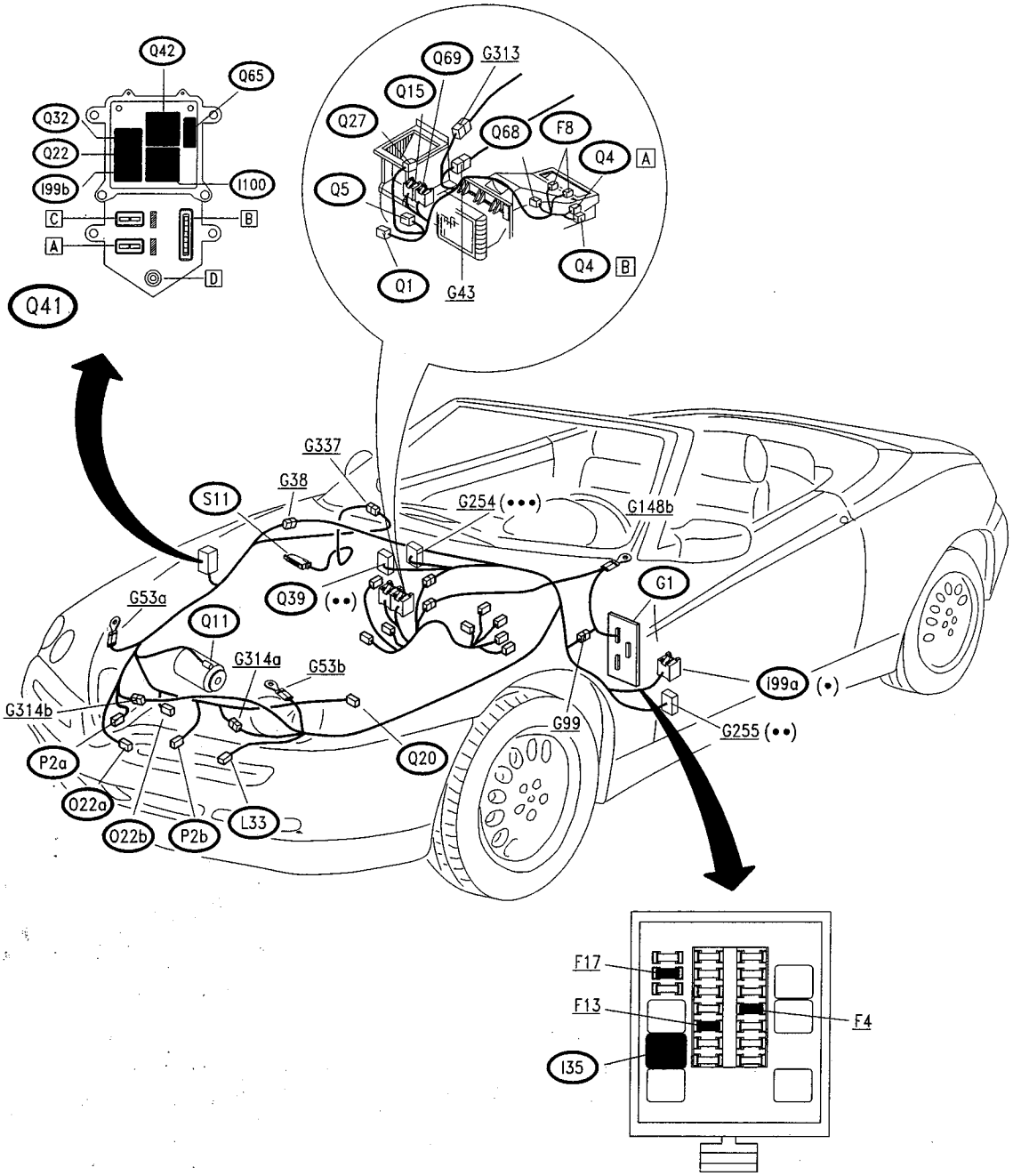
- over 15 bar appr. the signal is sent to pin 44 for engaging 1st speed;
- over 20 bar appr. to pin 43 for 2nd speed.

The "key-operated" voltage (line protected by fus **F4** of **G1**) supplies the coil of relays **I99** and **I100**; which are operated by the above-mentioned earth signals.

Wiring diagram (2.0 T.S. 16v engine)

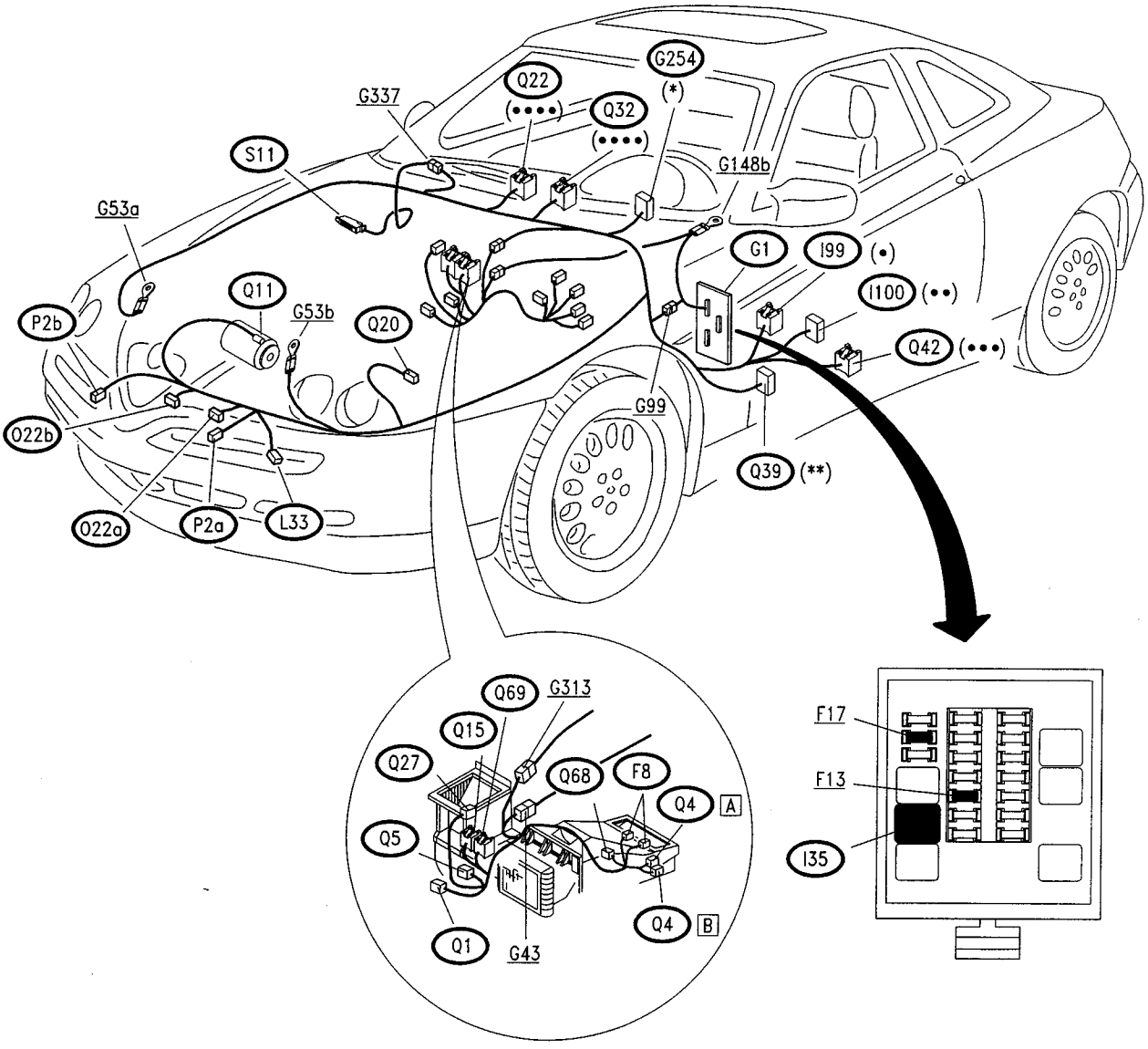


LOCATION OF COMPONENTS (3.0 V6 and 2.0 V6 TB)



(•) Yellow base
(••) Green fuseholder
(•••) Black fuse holder

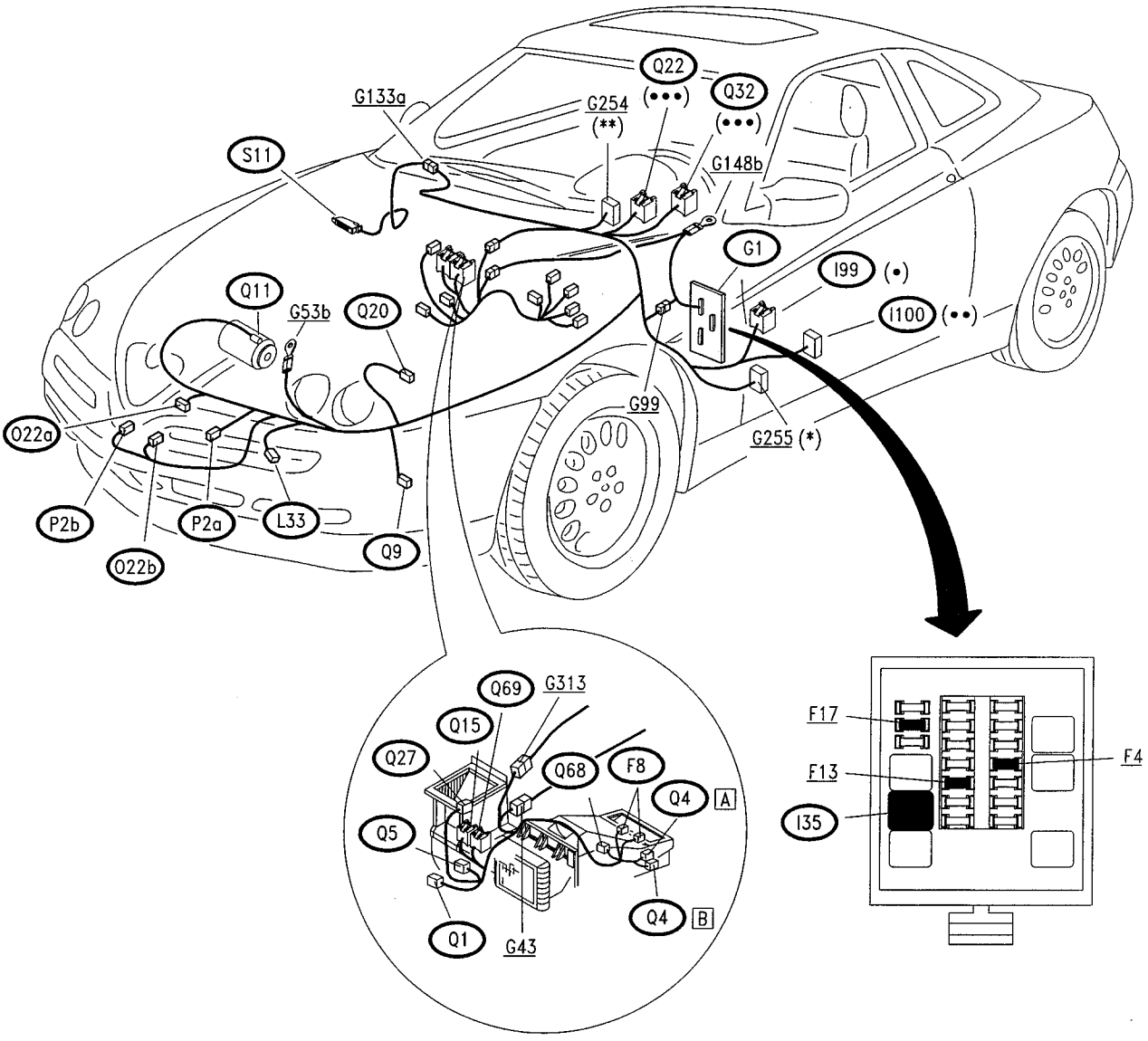
LOCATION OF COMPONENTS (3.0 V6 24v engine)



(•) Yellow base
(••) Black base
(•••) White base
(••••) Grey base

(*) Black fuse holder
(**) Green fuse holder

LOCATION OF COMPONENTS (2.0 TS 16v engine)



(•) Yellow base
(••) Black base
(•••) Grey base

(*) Green fuseholder
(**) Black fuseholder

FAULT-FINDING TABLE

NOTE:
In order to make it easier to understand, the fault-finding table for the air conditioner has been subdivided into three sections which refer to the three functions also described separately in the wiring diagrams:

– Heating, ventilation and recirculation

– Compressor control

– Engine fan/s control

Heating, ventilation and recirculation fan

Fault	Component to be checked											
	F13	G255 Q39 (*)	Q1	Q15	Q5	Q4	Q27	Q68	F8a (1)	F8b (1)	Q69
Fan cutting in	•	•	•	•							
Fan cutting in at diffferent speed					•	•					
Fan cutting in at 1st speed with the compressor on						•		•			•
Recirculation function						•	•	•			
Heating & ventilation control panel lighting									•	•	

(1) It is possible to change the single bulbs with bulb holders
(*) 3.0 V6 24v only

Compressor control

Fault	Component to be checked												
	Q39 (*)	Q65 (***)	F17	F13	Q11	Q20	Q9 (**)	Q22	Q32	Q69	Q4	Q68	S11
Compressor cutting in (in all circumstances)	•	•	•	•	•			•	•	•	•	•	•
Compressor cutting in (only in certain circumstances) (•)						•	•						•

(*) 3.0 V6 24v only

(**) 2.0 TS 16v only

(***) 3.0 V6 and 2.0 V6 TB

(•) You are reminded that the compressor is cut out by the system logic under the following conditions:

– coolant fluid pressure > 28 bar appr.;

– coolant fluid pressure < 2.5 bar appr. (circuit drained);

– coolant temperature > 160°C (only for 2.0 T.S. 16v engine);

This is also determined by the logic of the ignition/injection control unit (see the corresponding sections).

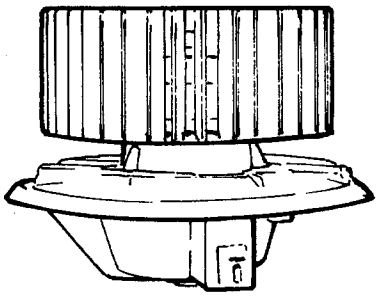
Engine cooling fan/s control

Fault	Component to be checked													
	F4 (***)	Q39 (*)	G254	F17 (*)	P2	P2a/b	O22	O22a/b	L33 (*)	S11 (**)	Q20	Q42 (*)	I99a	I99b	I100
Fan/s cutting in (in all circumstances)	•	•	•		•										
Fan/s cutting in at two different speeds (only one speed working)				•			•					•	•		•
Fan/s cutting in due to high engine temp. (at two speeds)									•	•					
Fan cutting in due to high coolant fluid pressure (at two speeds)											•				

(*) 3.0 V6, 3.0 V6 24v and 2.0 V6 TB engine
(**) 2.0 TS 16v engine
(***) 3.0 V6 24v except

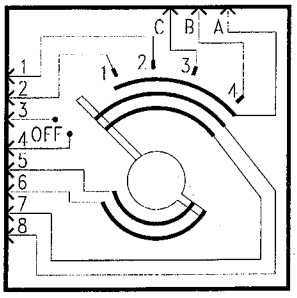
CHECKING COMPONENTS

Heating and ventilation fan Q1



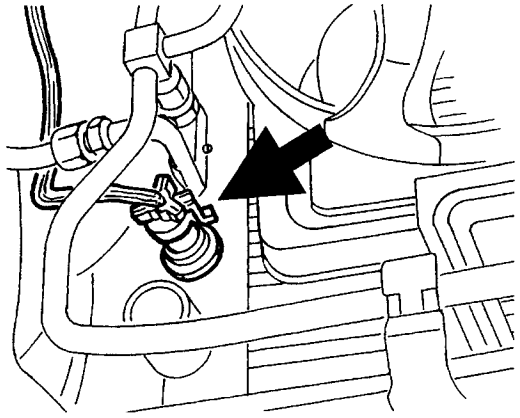
SPECIFICATIONS	
Nominal voltage	12V
Speed at 12V/25°C in free air with impeller and support	3400 $^{+200}_{-100}$ rpm
Power output at 12V/25°C at the above speed	90 W
Direction of motor rotation	leftwards impeller side

Heating and ventilation fan control Q4



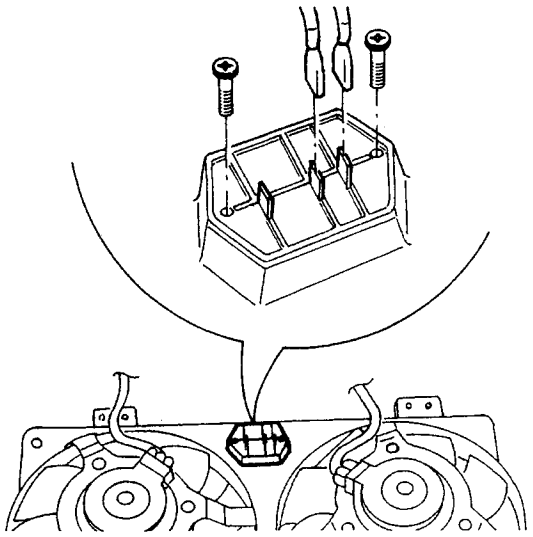
Check the contacts corresponding to the different positions of the knob.

Two-level thermal contact (L33)
(6 cylinder engines)



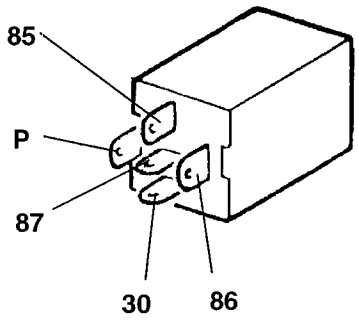
SPECIFICATIONS	
1. level:	
contact closes	92 ± 2 °C
contact opens	87 ± 2 °C
2. level:	
contact closes	97 ± 2 °C
contact opens	92 ± 2 °C

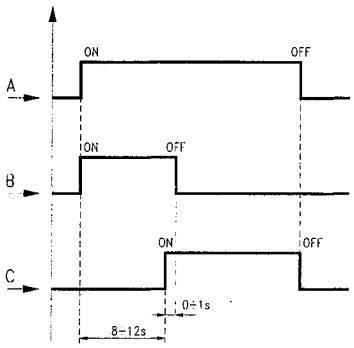
Engine fan resistance (O22)



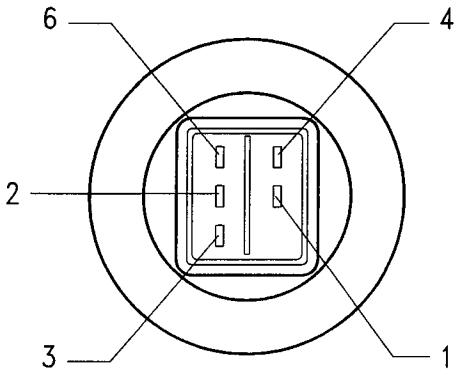
SPECIFICATIONS	
resistance	0.18 ± 10%Ω
thermal fuse cut in	126 °C

Engine fan delaying device (Q42)
(6 cylinder engines)



SPECIFICATIONS
A = pin P: earth signal B = output pin 30: 1st speed C = output pin 86: 2nd speed  Operating diagram

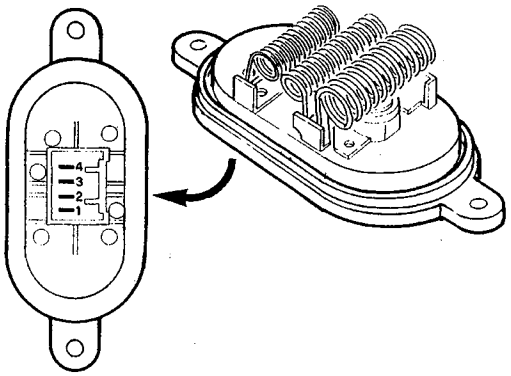
4-level pressure switch (only for 2.0 TS 16v engine)



SPECIFICATIONS	
1st level: contact opens contact closes	 2.45 ± 0.35 bar max 3.5 bar
2nd level: contact closes contact opens	 15 ± 1 bar 11 ± 2 bar
3rd level: contact closes contact opens	 20 ± 1.2 bar 16 ± 2.2 bar
4th level: contact opens contact closes	 28 ± 2 bar 22 ± 4 bar

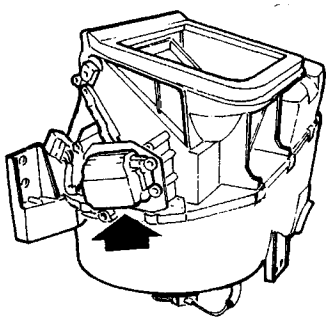
pin 1 and 2 *1st and 4th level*
pin 3 *2nd level*
pin 4 *earth*
pin 5 *N.C.*
pin6 *3rd level*

Heating & ventilation fan speed adjustment coil (Q5)



SPECIFICATIONS		
Section crossed	Total resistance	fan speed
4-1 3-1 2-1 none	2.9 Ω 0.8 Ω 0.3 Ω -	1st 2nd 3rd 4th
Thermal contact cut-in temperature		90 ± 5°C

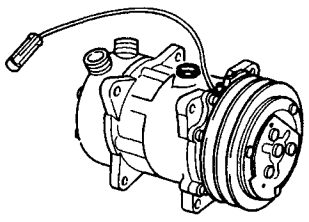
Recirculation port control motor (Q27)



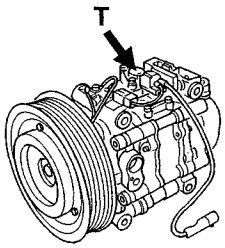
SPECIFICATIONS
12 V at pin 1 and 0 V at pin 2 = **counter-clockwise** rotation of output shaft
12 V at pin 3 and 0 V at pin 2 = **clockwise** rotation of output shaft

Compressor electromagnetic joint (Q11)

6 cylinder engines

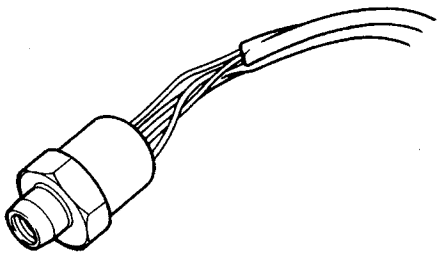


2.0 T.S. 16v



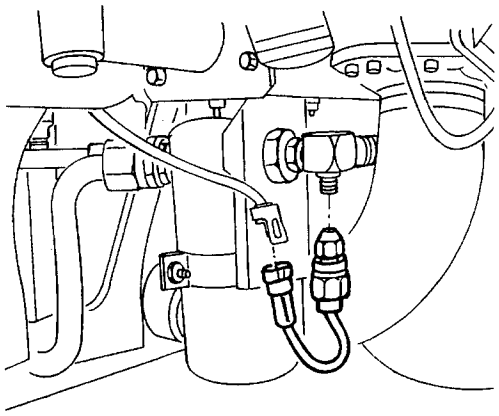
SPECIFICATIONS	
Supply voltage	12 V
absorbed current	4 A (6 cylinder) 2.2 A (2.0 T.S. 16v)
Compressor cutout thermal contact (only 2.0 T.S. 16v) (T)	
contact opens	> 160°C
contact closes	< 140°C

Minimum and maximum pressure switch (trinary) (Q20) (6 cylinder engines)



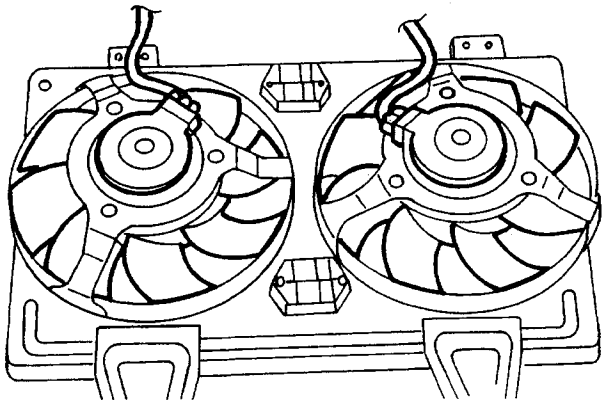
SPECIFICATIONS	
1. level: contact opens contact closes	 2.45 ± 0.25 bar 2.85 ± 0.50 bar
2. level: contact closes contact opens	 15.2 ± 0.98 bar 11.28 ± 1.99 bar
3. level: contact opens contact closes	 $28\ ^{+2}_{-3}$ bar $22\ ^{+4}_{-5}$ bar

Minimum pressure switch (antifrost) (Q9) (for 2.0 T.S. 16v engine)



SPECIFICATIONS	
Contact opening pressure	1.8 ± 0.07 bar
Contact closing pressure	3 ± 3.5 bar

Cooling fan (P2a) (P2b)



SPECIFICATIONS	
Nominal voltage	12V
Max. current absorption	26A
Speed at 12V in free air with duct	3600 ± 150 rpm (minimum)
Motor direction of rotation (shown on duct)	rightwards (impeller side)

ENGINE COOLING
(versions with heater)

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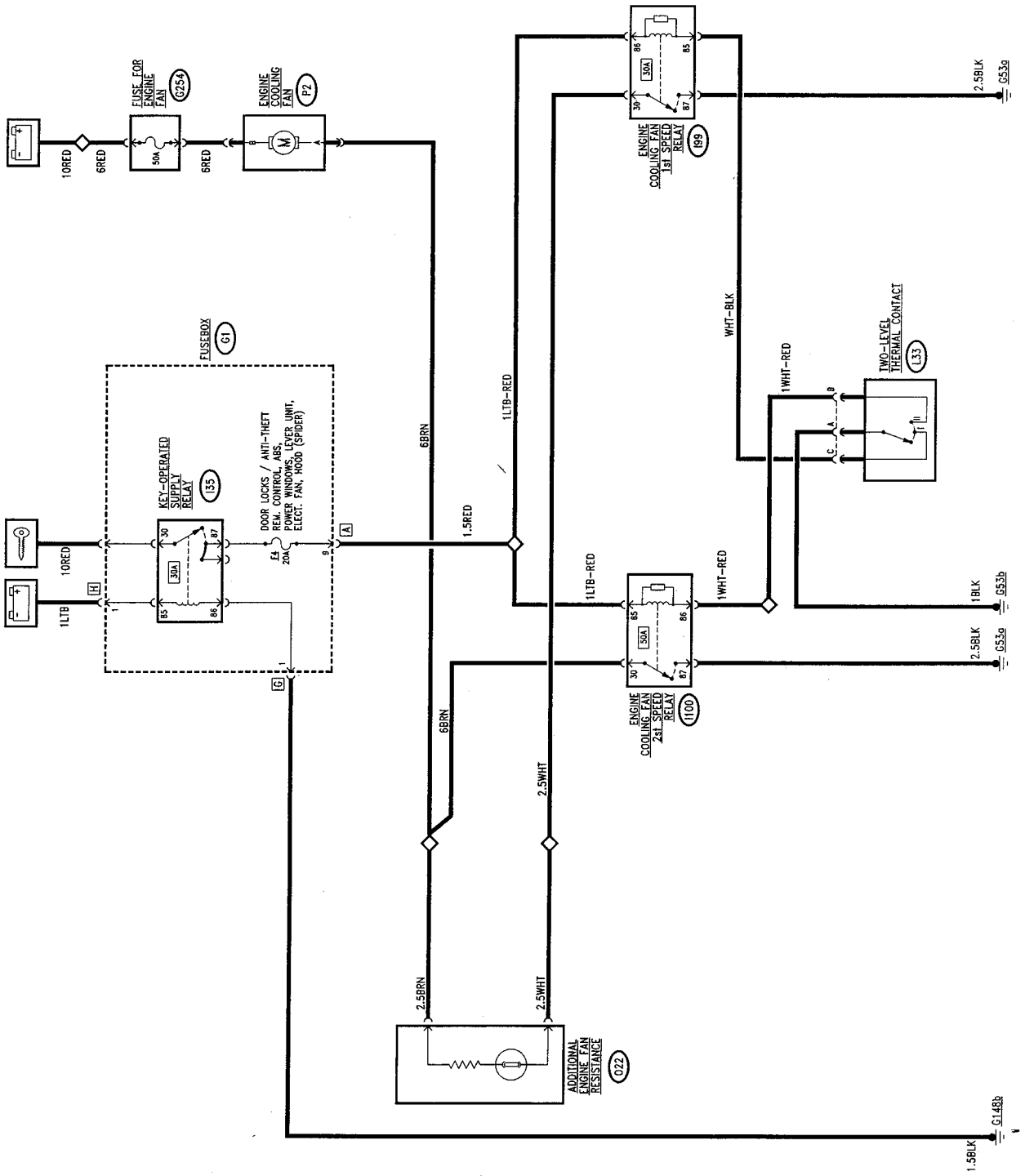
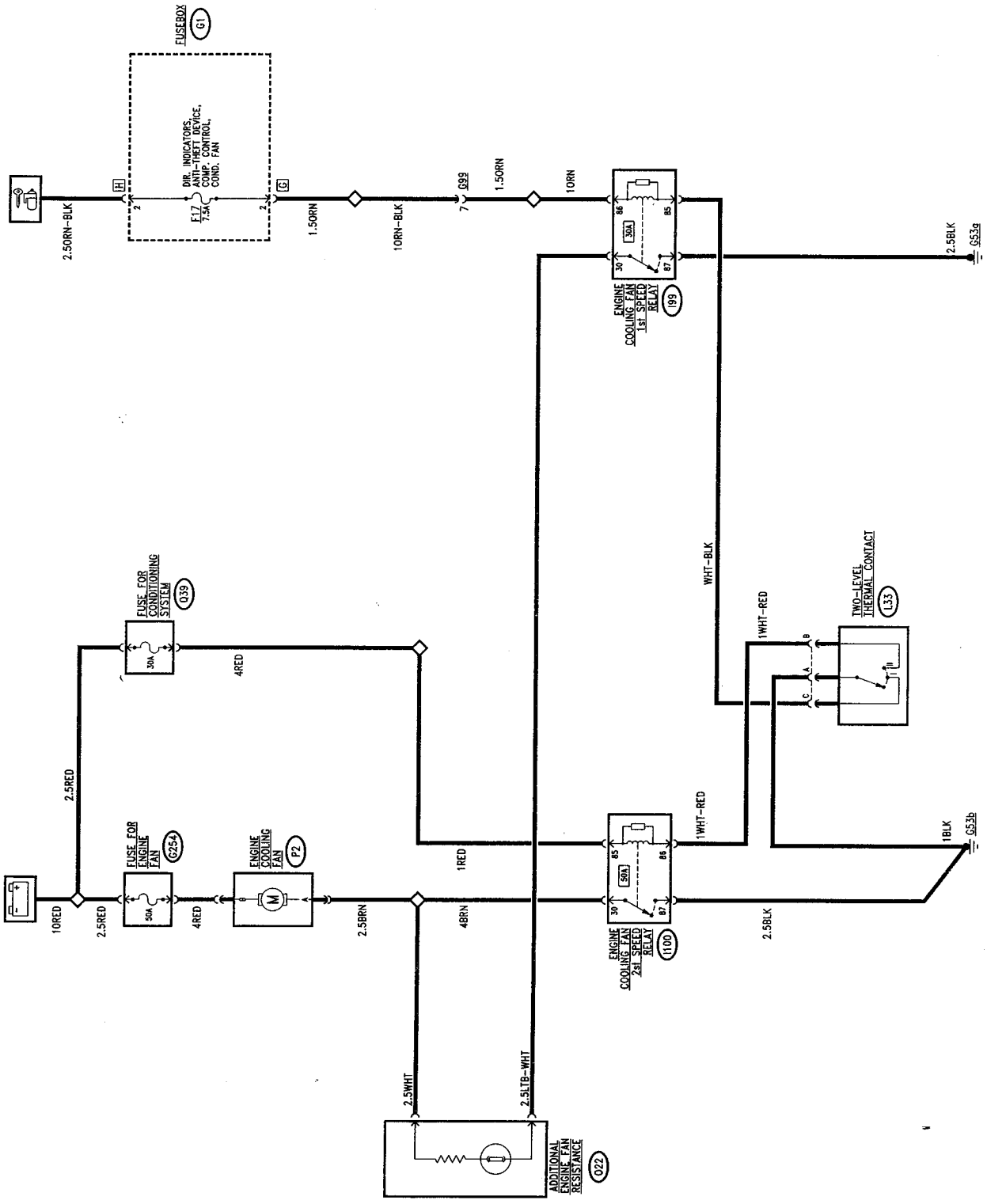
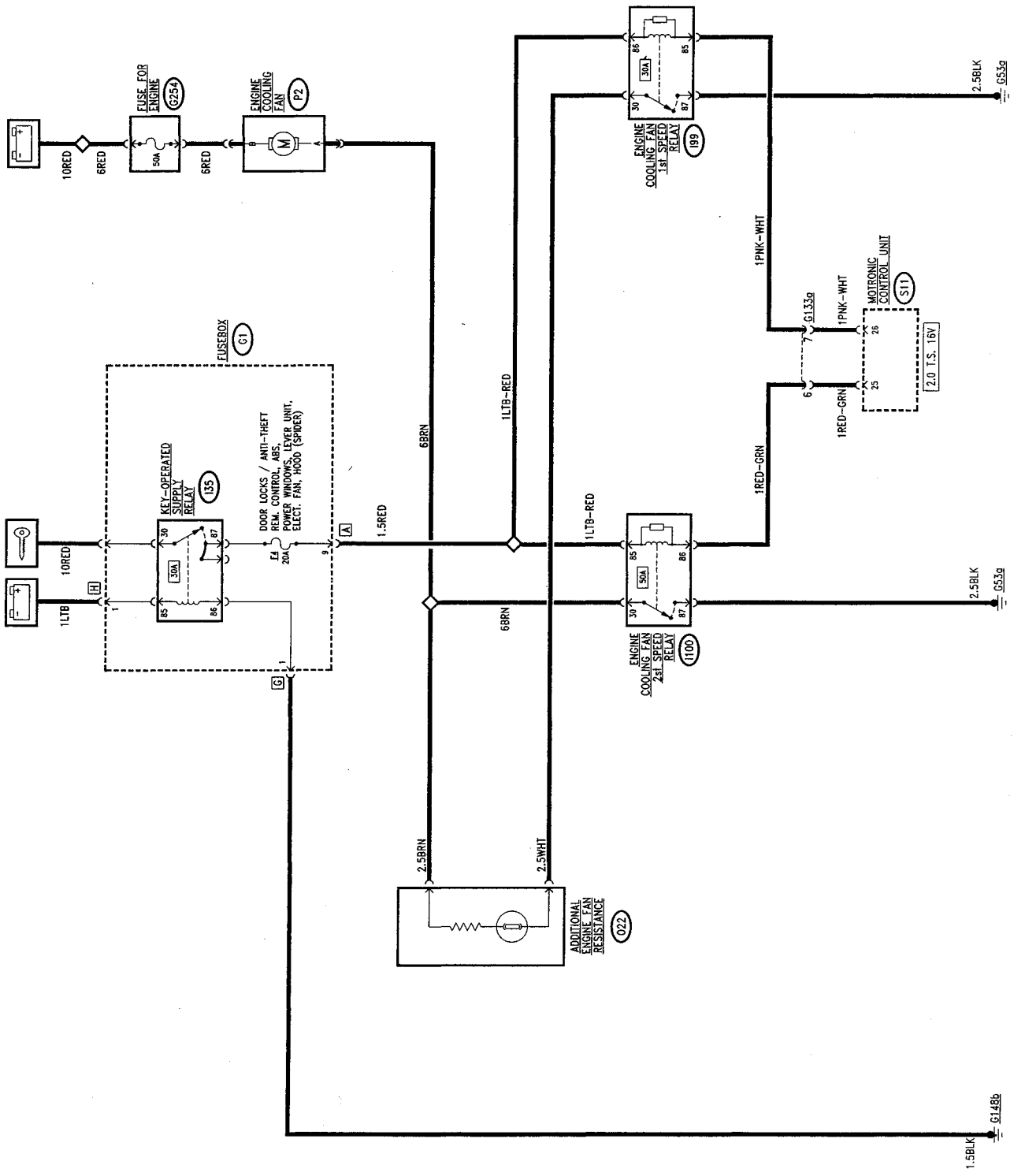
WIRING DIAGRAM (3.0 V6 and 2.0 V6 TB)



WIRING DIAGRAM (3.0 V6 24v)



WIRING DIAGRAM (2.0 TS 16v)



GENERAL DESCRIPTION

A fan helps the radiator to disperse the heat of the engine coolant, due to a thermometric switch that detects when the coolant temperature is too high and turns on the fan at two different speeds: the first one is operated at a first level of temperature of the coolant; the second is operated at a higher temperature.
N.B. This wiring diagram only refers to cars with heater: for cars fitted with air conditioner, see the "engine cooling fan/s control" electric circuit shown in the "Air Conditioner" section.

FUNCTIONAL DESCRIPTION

The fan **P2** is supplied directly with battery voltage via a special fuse **G254** (50A), and is actuated through an earth at the opposite terminal: if this earth leads directly from relay **I100** the 2nd speed is activated; when it leads from relay **I99** and crosses the additional resistance **O22**, the 1st speed is activated.

In fact, the fan operates at two different speeds, because of an additional resistance, protected inside by a thermal fuse which cuts off the electric circuit if the temperature exceeds approx. 126°C.

3.0 V6 and 2.0 V6 TB

The signal from the 1st level (87-92°C) of the two-level thermal contact **L33** energizes relay **I99** - supplied from the ignition switch by the line of relay **I35** and fuse **F4** of **G1** - thereby sending an earth signal to the additional resistance **O22** and from this to the fan, which is operated at the 1st speed.

Conversely, if the coolant fluid reaches the 2nd level (92 - 97°C) of thermal contact **L33**, the earth signal energizes the coil of relay **I100** - supplied from the ignition block via relay **I105** directly operating the fan **P2** at 2nd speed.

3.0 V6 24v engine

The signal leading from the 1st level (87-92°C) of the two-level contact **L33** energises relay **I99** - which receives the "key-operated" supply from the line of fuse **F17** of **G1** - thereby sending an earth signal to the additional resistance **O22** and from this to the fan, which is operated at 1st speed. Conversely if the coolant fluid reaches the 2nd level (92 - 97°C) of thermal contact **L33**, the earth signal energises the coil of relay **I100** - supplied by the line of wander fuse **Q39** (30A) - directly operating the fan **P2** at 2nd speed.

2.0 TS 16v engine

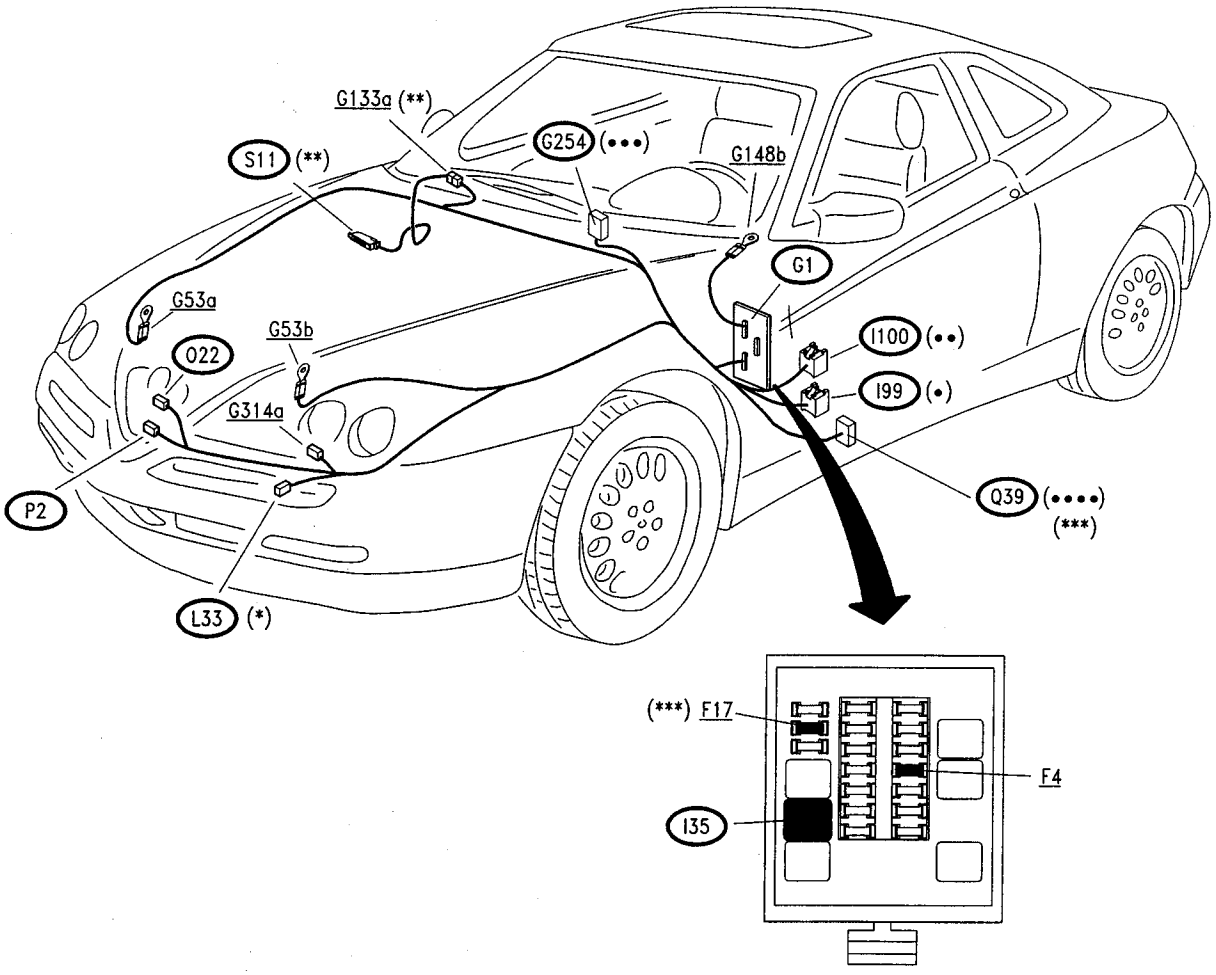
The M2.10.4 injection - ignition control unit also controls the engine coolant fluid cooling fan (thereby eliminating the thermal contact **L33** on the radiator).The two fan speeds are operated, depending on the engine temperature, detected by the control unit **S11** via the special sensor: a "low" (earth) signal leads from pin 26 which controls the 1st speed relay **I99**, and a "low" (earth signal from pin 25 which controls the second speed relay **I100**; both relays which receive the key-operated relays are supplied by the line of fuse **F4** of **G1**.

FAULT-FINDING TABLE

Fault	Component to be checked									
	F17 (***)	F4	Q39 (***)	G254	P2	L33 (*)	S11 (**)	O22	I99	I100
Fan (at all times)	•	•		•	•					
Fan (fails to start though the fluid temperature is high)						•	•			
Fan, at 2 different speeds			•					•	•	•

(*) 3.0 V6, 3.0 V6 24v and 2.0 V6 TB engine
(**) 2.0 TS 16v engine
(***) only 3.0 V6 24v engine

LOCATION OF COMPONENTS

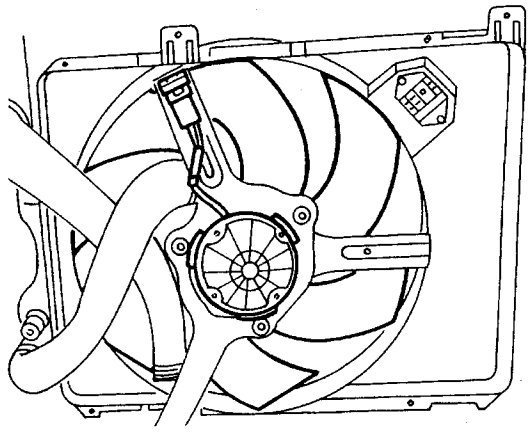


(*) 3.0 V6, 3.0 V6 24v and 2.0 TB engine
(**) 2.0 TS 16v engine
(***) 3.0 V6 24v only engine

(•) Yellow base
(••) Black base
(•••) Black fuseholder
(••••) Green fuseholder

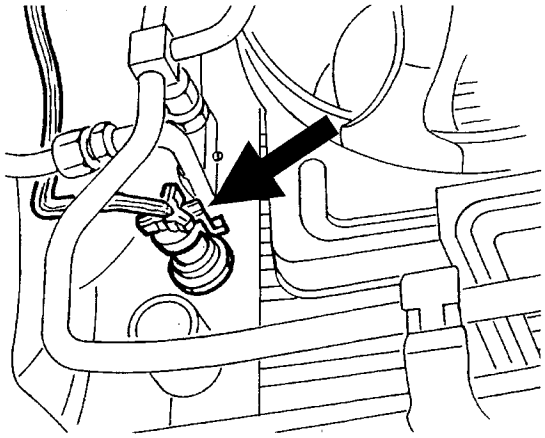
CHECKING COMPONENTS

Cooling fan (P2)



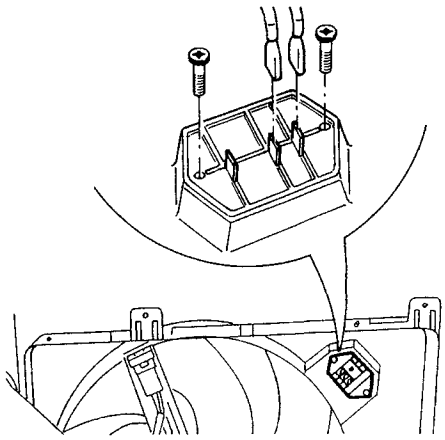
SPECIFICATIONS	
Nominal voltage	12V
Max. current absorption	25A
Speed at 12V in free air in duct	2350 ± 150 rpm (minimum)
Direction of rotation of motor (indicated on duct)	rightwards (impeller side)

Fan two-level thermal contact (L33) (6 cylinder engines)



SPECIFICATIONS	
1st level: contact closes contact opens	 92 ± 2°C 87 ± 2°C
2nd level: contact closes contact opens	 97 ± 2°C 92 ± 2°C

Fan resistance (O22)



SPECIFICATIONS	
resistance	0.18 ± 10% Ω
thermal fuse cut in	126 °C

ALFA ROMEO CODE

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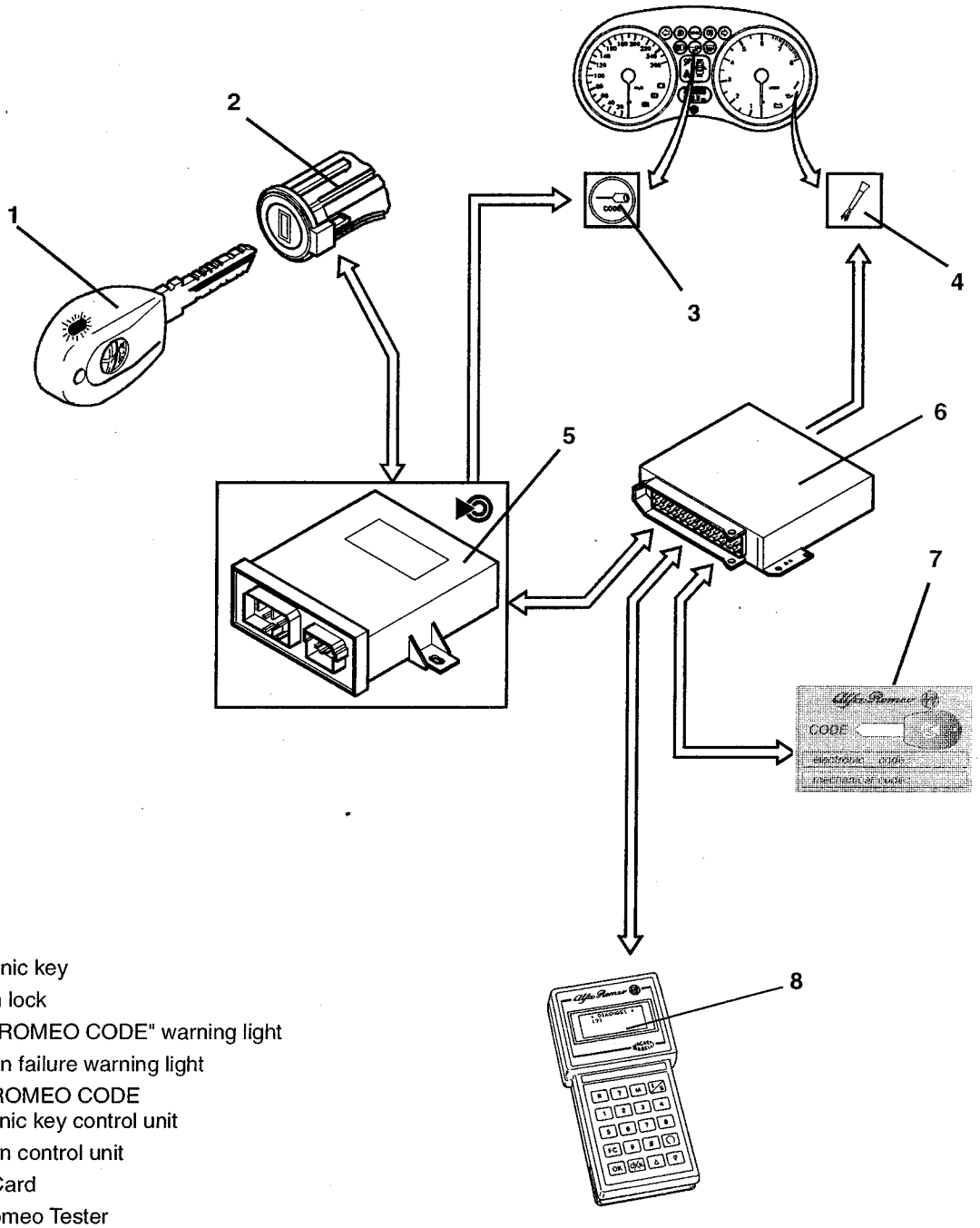
GENERAL DESCRIPTION

The car is fitted with an electronic code system (ALFA ROMEO CODE) which inhibits the control of the engine operated by the ignition keys.

Turning the key to the MARCIA position the Engine Control System Control unit (**C.C.M.**) requests the code from the Control unit of the ALFA ROMEO CODE system - Electronic Key Control Unit (**C.C.E.**). Once it has received the code, it compares it with the code in its memory (**MASTER CODE**).
If the comparison of the code received with the one memorised is positive the C.C.M proceeds with normal electronic engine management (starting, ignition, injection, etc.).
If not, (wrong code, various faults, etc.) the C.C.M. does not carry out engine management and the car will not start.
The C.C.M. offers the possibility to start the car without having received the MASTER CODE by the emergency procedures using the Code Card or the Alfa Tester (see recovery procedures).
The code transmitted to the engine control system control unit (allowing over 4 billion combinations) is computed by an algorithm which makes each transmission between C.C.M. and C.C.E. different from the previous one. (variable, crypted code).

If the code has not been recognised correctly the ALFA ROMEO CODE warning light stays on, together with the injection system failure warning light.



1. Electronic key
2. Ignition lock
3. "ALFA ROMEO CODE" warning light
4. Injection failure warning light
5. ALFA ROMEO CODE Electronic key control unit
6. Injection control unit
7. Code Card
8. Alfa Romeo Tester

DESCRIPTION OF COMPONENTS

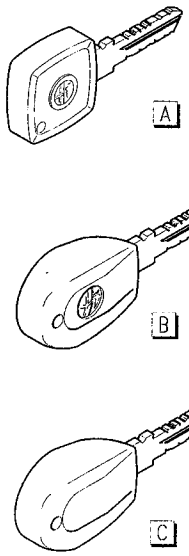
The system comprises the following components:

Keys

The following are supplied:

- An electronic key ***A:*** **"MASTER" key**
- Two main electronic keys ***B*** **(with Alfa Romeo badge)**
- An electronic **service key *C* (without Alfa Romeo badge)** only to be used when leaving the car in custody as it is impossible to use it for opening the luggage compartment and glove box.

The keys contain an electronic circuit called Transponder, which contains the code which characterises them; this is transmitted to the Electronic key control unit (C.C.E.) when the key is turned to the MARCIA position. Each electronic key possesses its own code, which must be memorised by the system's electronic control unit.



The cars are produced with the codes of the keys supplied with them already memorised, as described below:

- The C.C.E. contains the codes of the two main keys and the MASTER CODE (code of the master key)
- The C.C.M. only contains the MASTER CODE

It is very important to keep the MASTER key most carefully, since its code is memorised, through a special specific procedure (described later), in the electronic injection control unit, therefore the two control units are linked indissolubly.

If the MASTER key goes astray or is damaged, further memorising procedures of new keys will not be possible; without the MASTER key in the event of a failure to the C.C.E. it will be necessary to change the C.C.E. and the C.C.M.

The user is advised to keep the MASTER key in a safe place outside the car. In fact, it serves as an "access key" for memorising further codes (keys). The MASTER key should only be used when needing to memorise new keys.

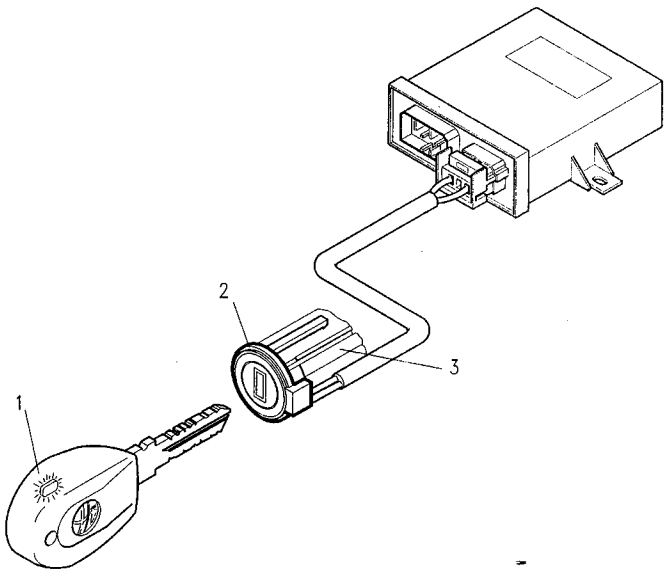
The Transponder inside the key comprises a minute integrated circuit (which contains the code), and a coil (which supplies the integrated circuit and transmits the code).

In the main keys, the Transponder is inserted in an accessible manner, while the MASTER key has the possibility to transfer the component to another MASTER key, if the need arises (for example if the ignition lock needs replacing).

The **MASTER** key is proof of the ownership of the car: it must therefore be present (together with the Code Card), when the car is sold.

Aerial

The aerial is a loop coil which is wound round the ignition lock and is connected to the C.C.E. by a specific connector (see figure) The purpose of the aerial is firstly to supply the transponder so that it can send the code and secondly to receive the Transponder signal.

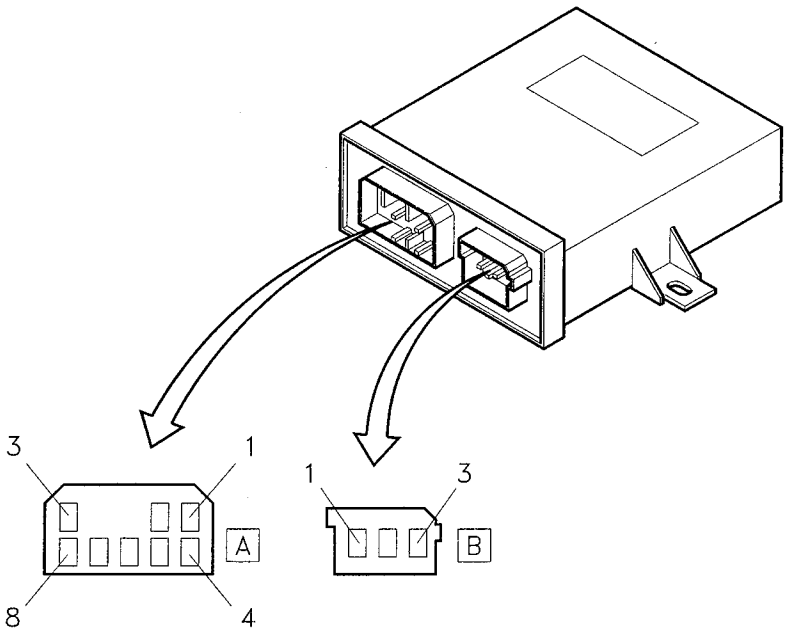


1. Transponder
2. aerial
3. ignition lock

Electronic Key Control unit (C.C.E.)

The C.C.E. is located above the fusebox; it is interfaced with the car via two connectors: B (3-way) and A (8-way) and it has the following functions:

- It detects rotation of the key in the ignition switch to the MARCIA position
- It emits an electromagnetic field to give power and activate the Transponder of the key
- It receives and computes the secret code sent by the key
- It manages the serial line (one wire) with the Motronic injection control unit
- It manages the special diagnosis warning light on the instrument cluster
- It memorises up to 8 secret codes, one of which is the MASTER CODE
- It recognises connection with the Alfa Tester and allows the use of the serial line for diagnosis



CONNECTOR A
pin 1: N.C.
pin 2: warning light signal
pin 3: direct supply
pin 4: earth
pin 5: diagnosis line K
pin 6: serial line towards the C.C.M.
pin 7: signal for outside relay (N.C.)
pin 8: key-operated supply

CONNECTOR B
pin 1: aerial signal
pin 2: N.C.
pin 3: aerial earth

Engine Control System Control Unit (C.C.M.) with software (programme) for ALFA ROMEO CODE :

Thw engine control system control units adopted on these cars are provided with functions for management of the ALFA ROMEO CODE electronic key: these functions, which are activated when the key is turned, are the following:

- Permanent memorising of the MASTER key code (MASTER CODE) by a specific procedure carried out during production testing or when the C.C.M. is changed.
- Request of the MASTER key code to the C.C.E.
- Recognition of the MASTER CODE and engine control enabling (starting the car)
- Recognition of the message (transmitted by the C.C.E.) warning that an unauthorised key has been inserted (the car will not start).
- Recovery function via the Alfa Romeo Tester (it is necessary to know the ELECTRONIC CODE written on the Code Card)
- Recovery function by entering the ELECTRONIC CODE written on the Code Card using the accelerator pedal.
- Control of the diagnosis warning light (injection failure warning light)

Absolutely never exchange the injection control units between cars to check whether they are working properly.

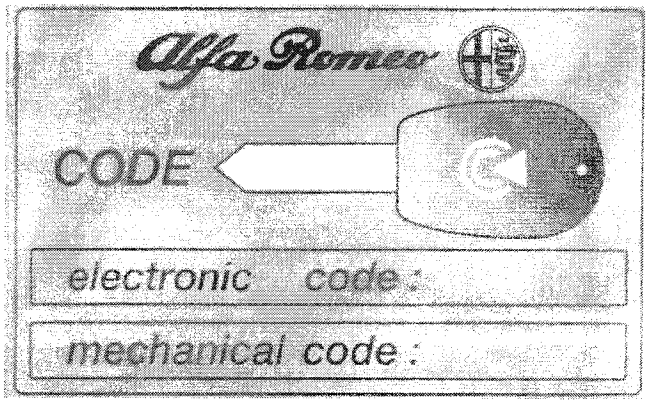
Therefore, during fault-finding operations, avoid changing the injection control unit, if you are not sure that it is the cause of the problem on the car (firstly check the actuators and sensors and the wiring, etc.) bearing in mind that the installation of a new control unit (never used before) will involve the permanent memorising of the MASTER CODE inside it of the next key that is turned to MARCIA; therefore, from that moment onwards this control unit will only work in combination with the keys and C.C.E. of that car.

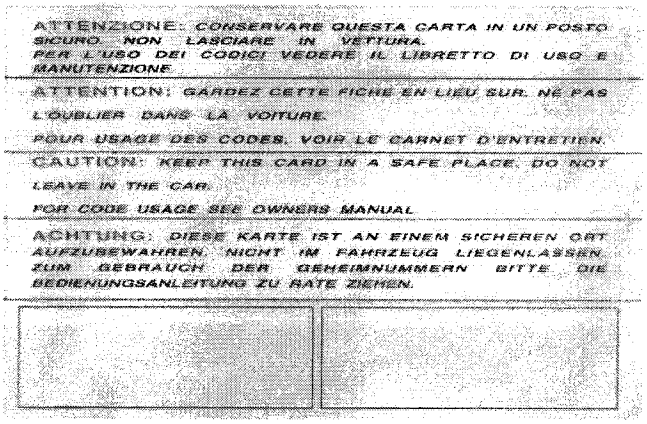
Code Card (card with secret code)

This is a memo card the size of a credit card which is supplied with the car. (see illustration).

It contains a five-digit code (**ELECTRONIC CODE**) which makes it possible to start the engine (recovery function) when the electronic keys have been lost or damaged.

Two cards are supplied.





NOTE: Clearly this emergency procedure only takes account of the electronic code associated with the keys, and not the mechanical parts shared with other cars.

The Code Card should not be kept in the car, but it should be kept at hand because through the code, it will be possible to start the car without the ALFA ROMEO CODE (see the specific recovery procedure).

The Code Card, as well as the ELECTRONIC CODE (**"E. CODE"**), contains the mechanical code of the keys (**"M. CODE"**): through this code it is possible to request other keys suited to the ignition switch and to be memorised in the C.C.E.

On the back there are two special spaces for applying the labels of the transmitters supplied.

OPERATION: Anti-theft strategy

Each time the ignition key is turned to MARCIA the following main operations are carried out in sequence: The injection control unit asks the C.C.E. for the MASTER CODE (the one of the MASTER key memorised previously).

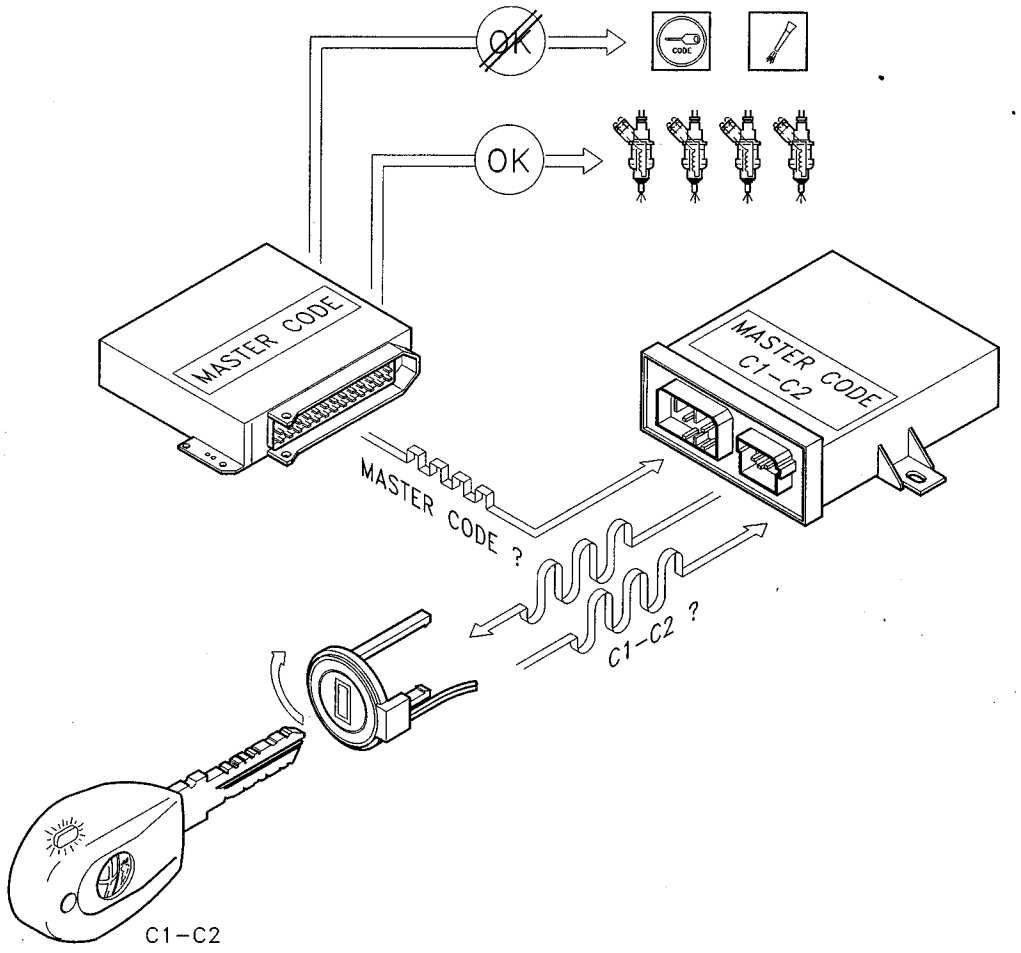
The C.C.E. checks that the code of the key engaged in the ignition lock corresponds to one of the codes contained in its memory.

If the key corresponds to one of the memorised codes:

the C.C.E. sending the MASTER CODE, to the injection control unit, **enables starting** (see illustration).

If the code of the key engaged in the ignition lock does not correspond to one of those memorised:

The C.C.E. informs the injection control unit that an extraneous key has been engaged and **starting will not be enabled** (see illustration) this situation will be indicated by the turning on of the electronic injection system failure warning light and the ALFA ROMEO CODE warning light.



C1, C2 = key codes

Interaction between key and C.C.E.

When the C.C.E. detects the engagement of the key it sends a signal to the ends of the aerial thereby generating an electromagnetic field.

This way the Transponder coil is inductively connected and it receives the energy to supply the integrated circuit to which it is connected.

At this point the integrated circuit transmits the code.

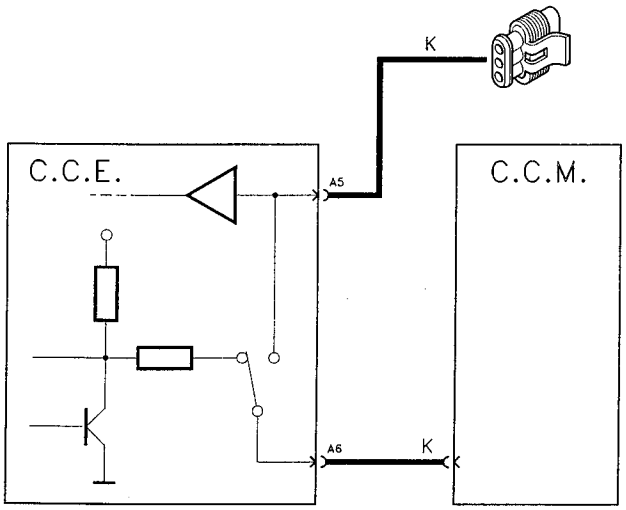
Sharing of the serial line of the diagnosis functions and the ALFA ROMEO CODE system

(M3.7 injection - 3.0 V6, 3.0 V6 24v engines and ML41 - 2.0 V6 TB engine)

Inside the C.C.E. there is a shunt relay which has the purpose of enabling dialogue between the C.C.M. and the Alfa Tester or the C.C.E. itself. Pin A6 is usually dedicated to dialogue between the C.C.E. and the C.C.M (see illustration).

Line K of the diagnosis socket is connected to the C.C.E. at pin A5.

The shunt relay is normally in such a position as to allow dialogue between the C.C.E. and the C.C.M (default position).



When diagnosis begins connecting with the Alfa Tester (turning the ignition key to MARCIA) the C.C.E., after ending dialogue with the C.C.M. recognises the request for diagnosis and pilots the relay to connect pin A5 and A6 to one another, thereby enabling dialogue between the tester and the C.C.M. The C.C.E enables connection with the Alfa Tester only when the following conditions occur contemporaneously:

- There is not activity on the serial line between the C.C.E. and the C.C.M.
- A low level (of voltage) is present on pin A5 for a time of between 500ms and 5s (a low level for over 5s is considered as a short circuit towards earth)

The relay returns to the default position when there is no activity on pin A5 for over 30s.

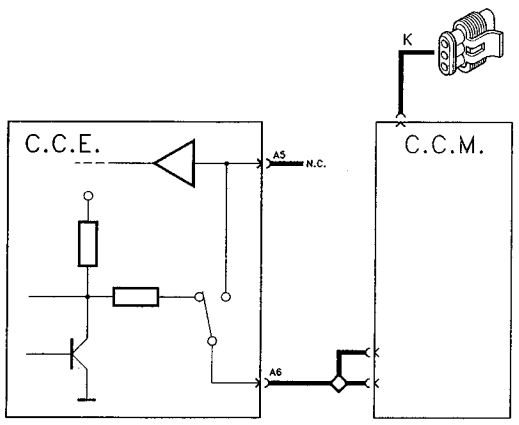
When the control unit detects that the Alfa Tester has been engaged, it turns on the ALFA ROMEO CODE warning light to indicate correct switching of the relay.

Dedicated serial line between C.C.E. and C.C.M.

(M2.10.4 injection - 2.0 TS 16v engine)

Some injection control units have a special provision for a serial line for dialogue between the C.C.M. and the C.C.E., using pin A6 of the C.C.E. (see diagram). Line K of the diagnosis socket is NOT connected to the C.C.E. at pin A5, but it leads directly from the C.C.M. to the Tester.

Diagnosis line K is enabled by the C.C.M. only at the end of dialogue between the C.C.M. and the C.C.E.



Dialogue between C.C.E. and C.C.M.

As mentioned previously, the C.C.E. and C.C.M. "dialogue" via a serial line formed of a single cable. The serial line is two-way, this means that the information travels sequentially from the C.C.M. to the C.C.E. and vice- versa. The information exchanged between the two control units may concern the following operating conditions:

A) Checking the code

C.C.E. memorised C.C.M. memorised:

Each time the key is turned to MARCIA (also during starting) the C.C.M., before starting engine management, asks the C.C.E. for the MASTER CODE. The C.C.E. can answer in one of the following three ways:

1. It sends the MASTER CODE (crypted), enabling the C.C.M. to start the car

2. It sends a code which inhibits starting the engine (if the key engaged has not been memorised, or it is a key without Transponder, aerial failure, etc.)

3. It does not answer (C.C.E. failure)

The function is governed by a programme which takes account of all the variables that might be present in the system.

B) Memorising the codes

These operations concern the system when at least one control unit (C.C.E. or C.C.M) is brand new.
The following instances may arise:

C.C.E brand new and C.C.M. brand new:

When both the control units are brand new (C.C.E. and C.C.M.) the C.C.E. answers the request of the injection control unit sending a universal code crypted by an algorithm. This condition is indicated by a characteristic flash.(1.6 Hz) of the warning light: this only takes place if the C.C.E. has detected the presence of a Transponder. Conversely, if the aerial is broken or disconnected or there is no Transponder in the key, the C.C.E. will not answer).
In this situation the system is not protected yet, and it is ready to start the key memorising procedure.

C.C.E. memorised and C.C.M. brand new:

When the ignition key has been turned to MARCIA the C.C.M. will ask the C.C.E. for the MASTER CODE to memorise it; the C.C.E. sends the MASTER CODE only if it has recognised a key among those memorised in the ignition lock: from this moment the MASTER CODE is memorised in the C.C.M. which is thus indissolubly linked with the car.

C.C.E. brand new and C.C.M. with MASTER CODE memorised:

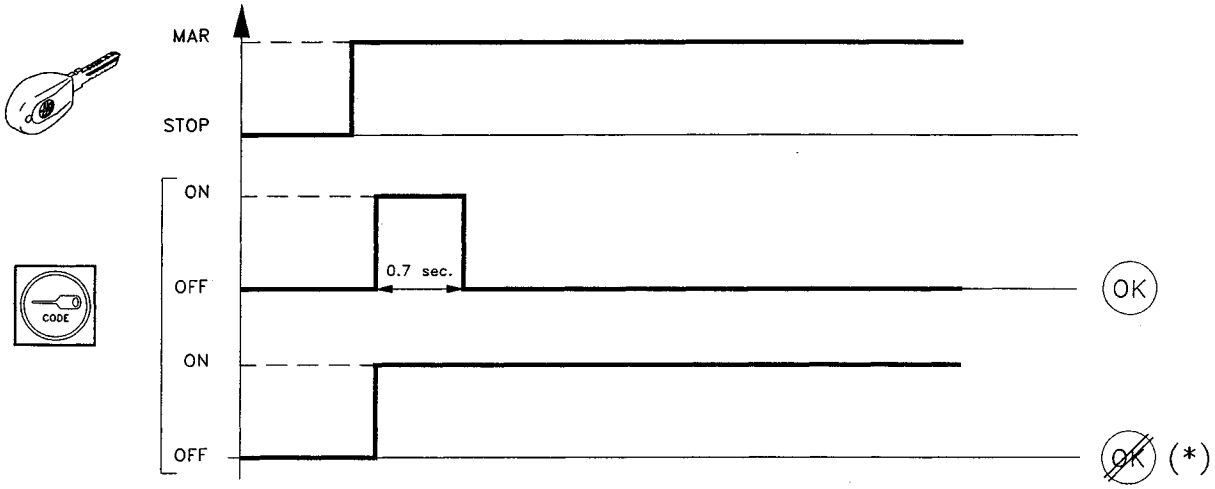
When the ignition key has been turned to MARCIA the C.C.M. asks for the MASTER CODE to be enabled for starting. As the C.C.E. is brand new, it answers sending the universal code, only if it reads a code correctly in the Transponder. (It might be a key without Transponder or with a key with the Tramsponder not working or the aerial might be disconnected or damaged, etc.).

The C.C.M. prevents the engine from being started as it does not recognise the universal code: it is necessary to memorise the keys in the C.C.E., MAKING SURE THAT THE MASTER KEY IS THE ONE WHICH OPENS AND CLOSES THE PROCEDURE (see programming).

Piloting times of the ALFA ROMEO CODE warning light

The diagnosis warning light on the instrument panel is controlled by the C.C.E. to inform the user and workshops of the system status. There are two types of characteristic flashing:

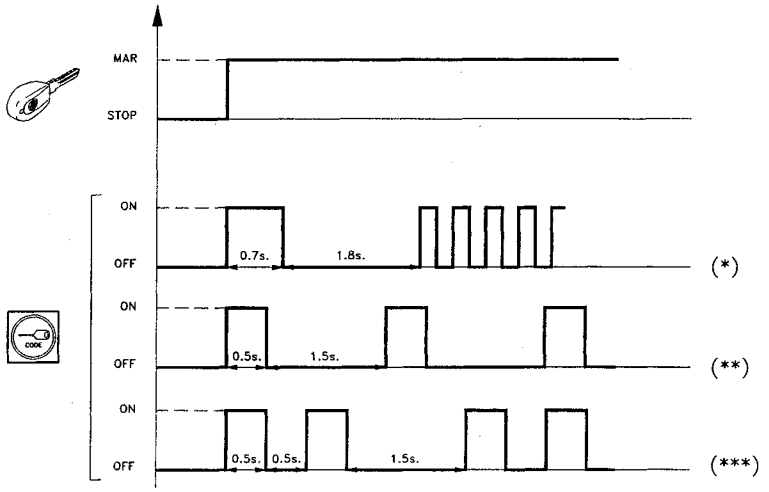
1. **When the keys have already been memorised** (see illustration) it indicates the correct operation of the system or a problem:



(1)

(*) - Transponder not recognised/absent/faulty
- lack of connection between C.C.E. and C.C.M
- aerial faulty/disconnected
- C.C.E. faulty
- re-memorising not carried out correctly

2. **When the system is still brand** new the flash (1.6 Hz after 2.5 seconds) means that the system is intact and working, the car is not protected until a key memorising procedure has been carried out, other faults detected are also indicated (see illustration)



(2)

(*) system intact, working but brand new, car not protected
(**) lack of connection between CCE and CCM
(***) -Transponder not recognised/absent/faulty
- aerial faulty/disconnected

WARNING!
If the ALFA ROMEO CODE warning light turns on momentaneously or permanently while travelling or starting the car, this does not necessarily mean a system failure, but, in certain cases, it means a condition that can be interpreted as an attempt to manipulate the vehicle by a thief.

Should this occur, to correctly check the car, turn the engine off and move the key to STOP; then turn the key back to MARCIA: the warning light should turn on and off in less than one second.

If it stays on after this procedure, repeat the operation, leaving the key at STOP for more than 30 seconds. If the warning light still stays on when the key is in the MARCIA Position, carry out diagnosis on the ALFA ROMEO CODE system.

PROGRAMMING THE KEYS

The system is capable of memorising up to 7 keys plus the MASTER KEY. Correct memorising needs two keys plus the MASTER key.

During production testing the keys were memorised and the system is tested and working. If the need arises, for servicing reasons, to replace faulty components or there is the need for more keys than those supplied, the key memorising procedure must be carried out. There are two types of ways to memorise the keys :

- **Memorising** procedure, with a brand new system (C.C.E. and C.C.M. new).
- **Re-memorising** procedure, which is carried out under the following circumstances:
  - the addition of other keys besides those already memorised in the C.C.E.
  - if it is absolutely necessary to change the ignition lock. In this circumstance, in fact, it is possible to keep the only the Transponder of the MASTER key of the old set of keys, which, once inserted in the new key (see specific procedure) makes it possible to memorise the other keys provided with the new ignition lock.
  - changing the C.C.E.

MEMORISING

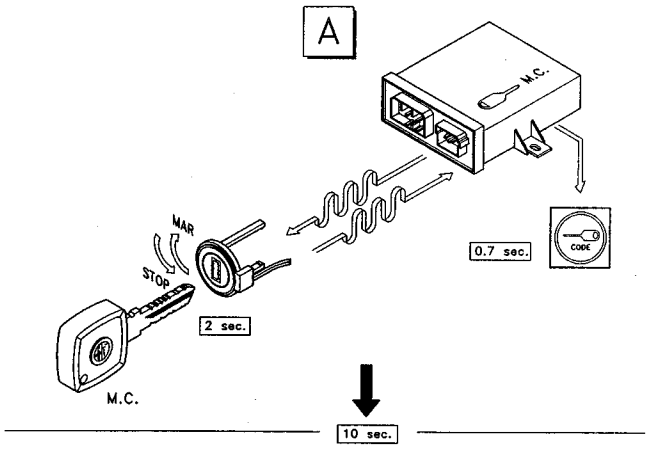
Before starting to programme the keys, it is necessary to check whether the system is brand new or if any keys have been memorised; this can be done by displaying the indications of the diagnosis warning light or connecting to the Alfa Tester. **The use of a faulty or already memorised C.C.E. would in fact involve the irreversible memorising of an incorrect code in the C.C.M. which it will no longer be possible to use in future on other cars.**

The memorising procedure is divided into two strictly consecutive phases:

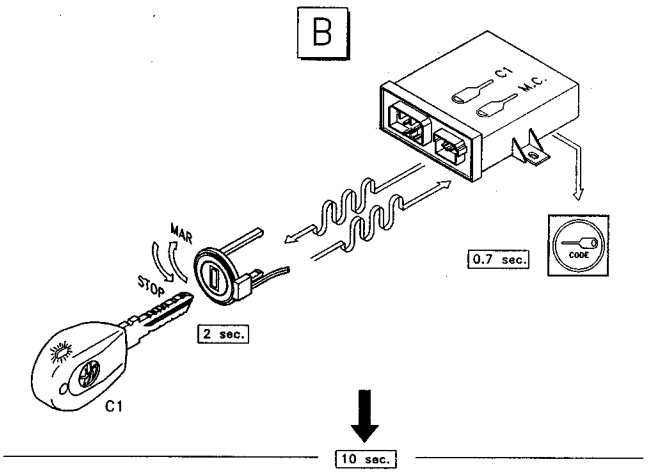
1. Memorising the keys inside the C.C.E.
2. Memorising the MASTER CODE in the engine control system control unit (if brand new)
   This is carried out only when the first one has been carried out with a positive result, turning the key to MARCIA.

MEMORISING PROCEDURE WITH BRAND NEW SYSTEM

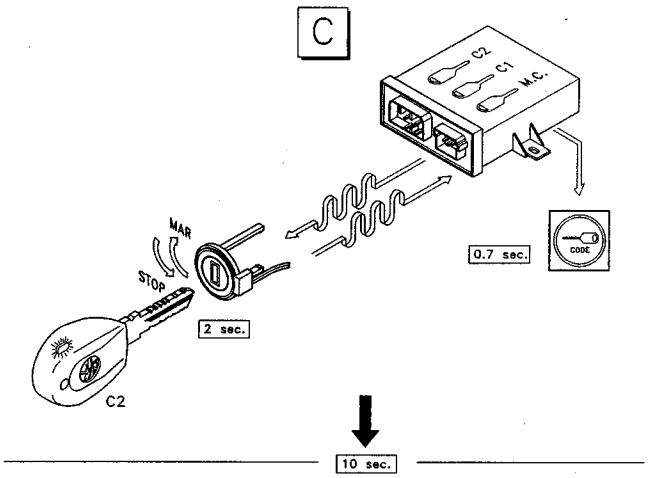
A Insert the **MASTER key** in the ignition lock
Turn the MASTER key to MARCIA and move it back to STOP as soon as the ALFA ROMEO CODE warning light goes off.



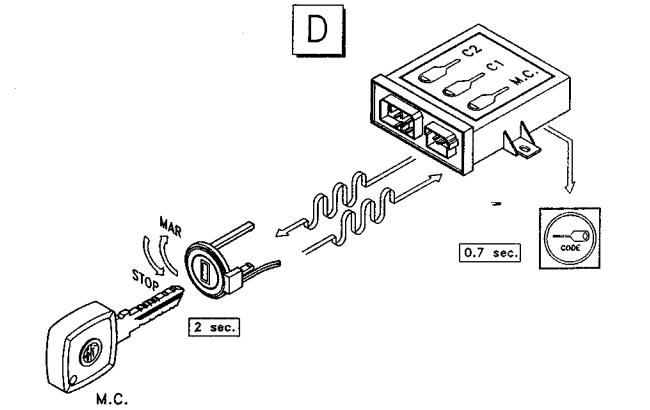
B Within 10 seconds:
Remove the MASTER key from the ignition lock, insert **a main key** in the lock
Turn the key to MARCIA. As soon as the ALFA ROMEO CODE warning light goes out, turn the key to the STOP position.



C Within 10 seconds:
Remove the key from the ignition lock, insert **a second main** key in the lock.
Turn the key to MARCIA. As soon as the ALFA ROMEO CODE warning light goes out, turn the key to the STOP position.



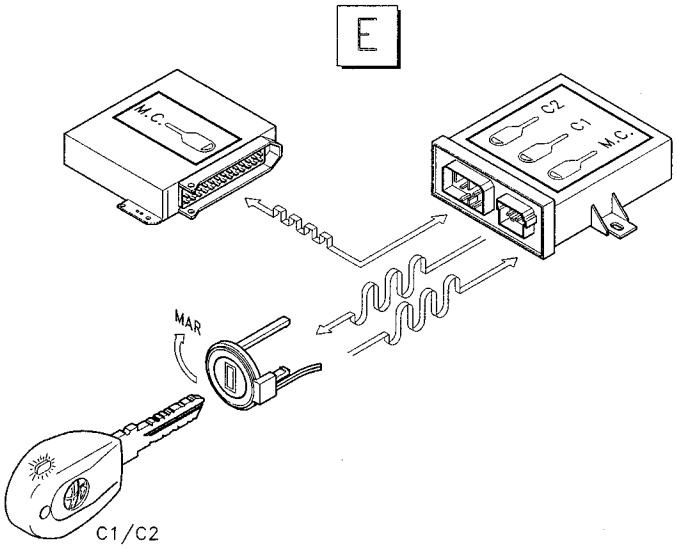
D Within 10 secondsi:
Remove the key from the ignition lock, insert **the MASTER key** in the ignition lock **again**
Turn the key to MARCIA. As soon as the ALFA ROMEO CODE warning light goes out, move it back to the STOP position.



M.C. = MASTER CODE C1, C2 = key codes

At this point the keys are memorised in the C.C.E.

E **Insert** any one of the memorised keys **and turn it to MARCIA**: the ALFA ROMEO CODE warning light will turn off and go out after 0.7 seconds. Wait for 2 seconds: if the ALFA ROMEO CODE warning light stays off, that means that the key memorising procedure has been carried out correctly, and the MASTER key code has been memorised in the injection control unit. Conversely, if the warning light flashes again (1.6 Hz), it means that the memorising procedure has not been carried out correctly.



M.C. = MASTER CODE C1, C2 = key codes

If, for any reason and in any moment, you think you have mistaken the procedure:

- **Move the key to MARCIA for more than 2 seconds or move the key to STOP for more than 10 seconds.**
- **Repeat the procedure from the start inserting all the keys.**

As may be deduced, during the procedure the key should never be kept at MARCIA for over 2 seconds, while it should never be kept at STOP for over 10 seconds.

Each time the key is turned to MARCIA, the warning light turns on (0.7 s), indicating the correct sequence of the procedure.

The above-mentioned procedure includes three keys: the MASTER key and two main keys.
Up to seven main keys may be inserted, using more keys between two insertions of the MASTER key.The MASTER key must always be inserted for the first and last time during programming.

The procedure is interrupted if the following situations occur:

- The same key is inserted twice consecutively
- The same key is inserted twice or more times between two insertions of the MASTER key
- A key stays at MARCIA for more than 2 seconds
- A key is kept at STOP (during the procedure) for more than 10 seconds

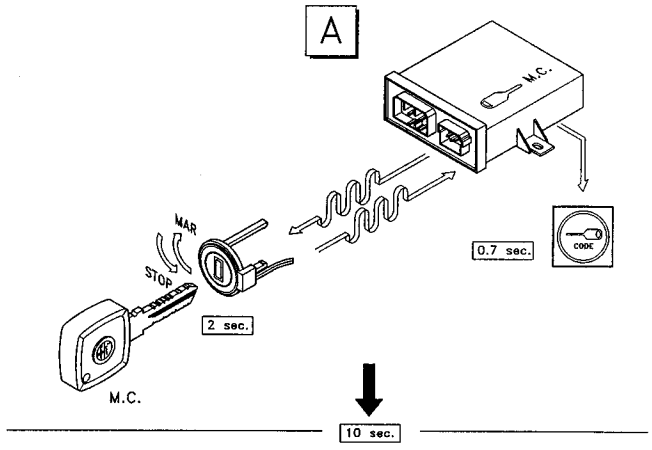
KEY RE-MEMORISING PROCEDURE

This procedure is similar to the previous one, and consists in inserting the main keys between two insertions of the MASTER Key.

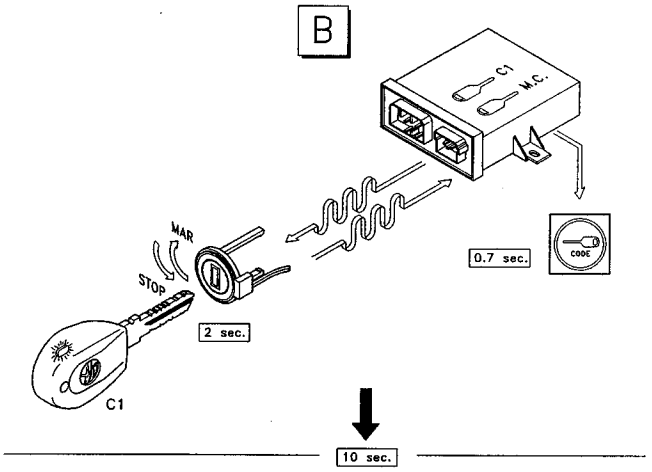
During the sequence the new main keys and the old ones are inserted.

If the main keys memorised previously are not inserted, their code will be erased from the memory of the control unit.

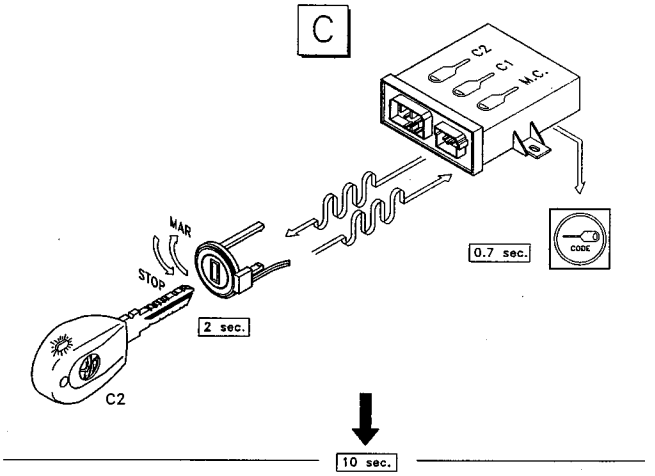
A Insert the **MASTER key** in the ignition lock
Turn the MASTER key to MARCIA and move it back to STOP as soon as the ALFA ROMEO CODE warning light goes out.



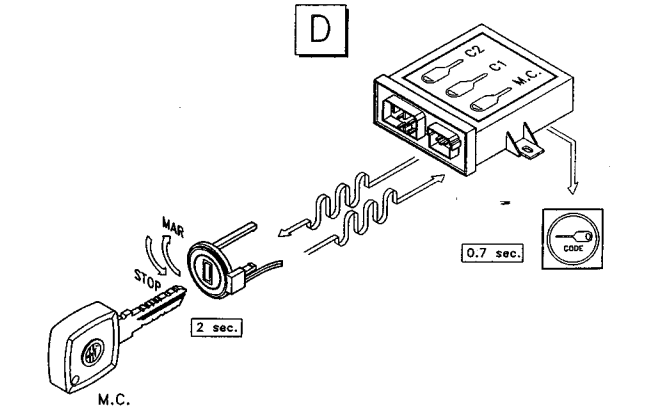
B Within 10 seconds:
Remove the MASTER key from the ignition lock, insert **a main key (known or new)** in the lock.
Turn the key to MARCIA : when the ALFA ROMEO CODE warning light goes out, turn the key to the STOP position.



C Within 10 seconds:
Insert **a second main key (known or new)** in the ignition lock
Turn the key to MARCIA : when the ALFA ROMEO CODE warning light goes out, turn the key to the STOP position.



D Within 10 seconds:
Remove the key from the ignition lock, insert **the MASTER** key in the lock **again**
Turn the key to MARCIA and when the ALFA ROMEO CODE warning light goes out, move it back to the STOP position.



M.C. = MASTER CODE C1, C2 = key codes

If, for any reason and in any moment, you think you have mistaken the procedure:

- **Move the key to MARCIA for more than 2 seconds or move the key to STOP for more than 10 seconds.**
- **Repeat the procedure from the start inserting all the keys..**

As may be deduced, during the procedure the key should never be kept at MARCIA for over 2 seconds, while it should never be kept at STOP for over 10 seconds.

Each time the key is turned to MARCIA, the warning light turns on (0.7 s), indicating the correct sequence of the procedure.

The above-mentioned procedure includes three keys: the MASTER key and two main keys.
Up to seven main keys may be inserted, using more keys between two insertions of the MASTER key.The MASTER key must always be inserted for the first and last time during programming.

The procedure is interrupted if the following situations occur:

- The same key is inserted twice consecutively
- The same key is inserted twice or more times between two insertions of the MASTER key
- A key stays at MARCIA for more than 2 seconds
- A key is kept at STOP (during the procedure) for more than 10 seconds

Memorising the MASTER CODE in the C.C.M. (if the latter is changed:

This operation takes place turning the key to MARCIA after having memorised all the keys in the C.C.E.

Warning:

- **Once the codes have been programmed, the C.C.E. is capable of transferring the MASTER CODE to the injection control unit (which stores it permanently), each time the key is turned to MARCIA.**
- **Do not use brand new C.C.M.s to check that the system is working properly.**
- **Do not swop C.C.M.s among cars.**

Memorising with brand new C.C.E. and memorised C.C.M.:

This function is carried out following the normal memorising procedure, as if the whole system were brand new; the MASTER Key must be the same with which the injection control unit was memorised previously.

WARNINGS:

- **Before starting the procedure make sure that the C.C.E. is truly brand new. The use of a faulty or already memorised C.C.E. will cause the irreversible memorisation of a wrong code in the C.C.M., which will no longer be able to be used in future on other cars.**
- **WARNING:**
  If the ALFA ROMEO CODE warning light stays on during re- memorisation, it means that the procedure has not been carried out correctly and it has been interrupted.
  Repeat the re-memorising procedure from the start.

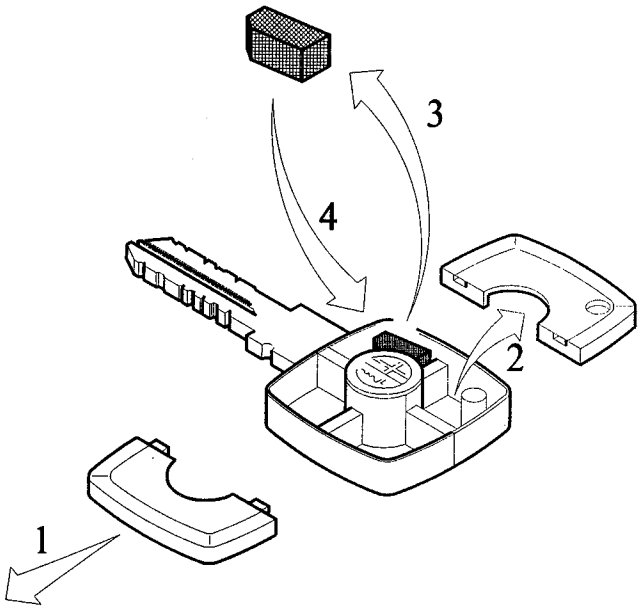
- **If the ALFA ROMEO CODE warning light stays on when the MASTER key has been inserted twice consecutively, this does not mean a malfunctioning, but that the re-memorising procedure has been opened (key at MARCIA) and interrupted (second key at MARCIA). To resume the correct operation of the warning light, move the key to STOP.**

TRANSPONDER TRANSFER PROCEDURE

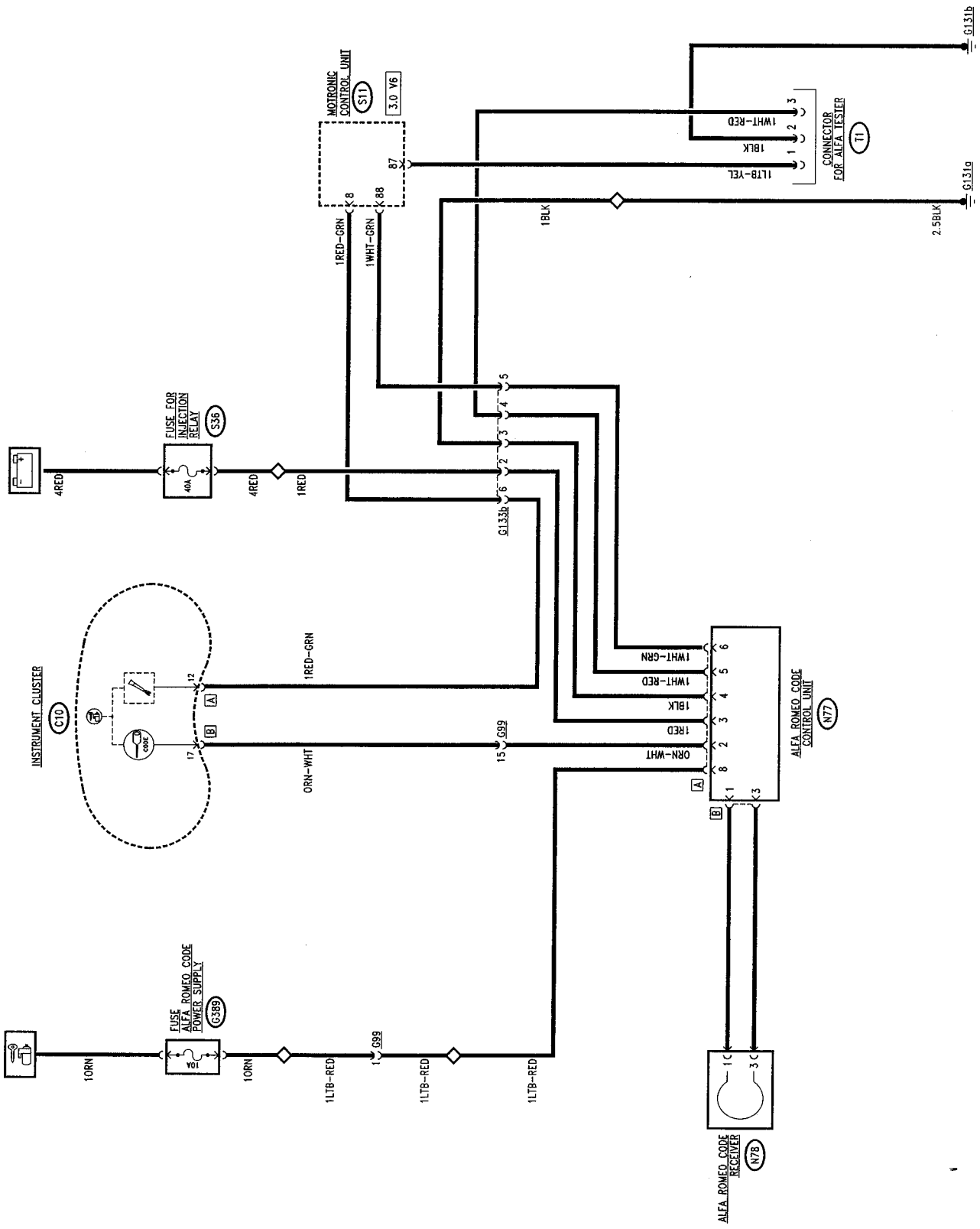
When needing to change the ignition lock or a door lock, for example, it is possible to transfer the Transponder from MASTER key to another: this way the memory of the Electronic Key Control Unit (C.C.E.) can be "re-opened" to memorise the new main keys (with new locks). Otherwise it would be necessary to change both the C.C.E. and the Master Key Control Unit (C.C.M.) as it would be impossible to re-open the memory of the latter using another Transponder.

To transfer a Transponder, proceed as follows:

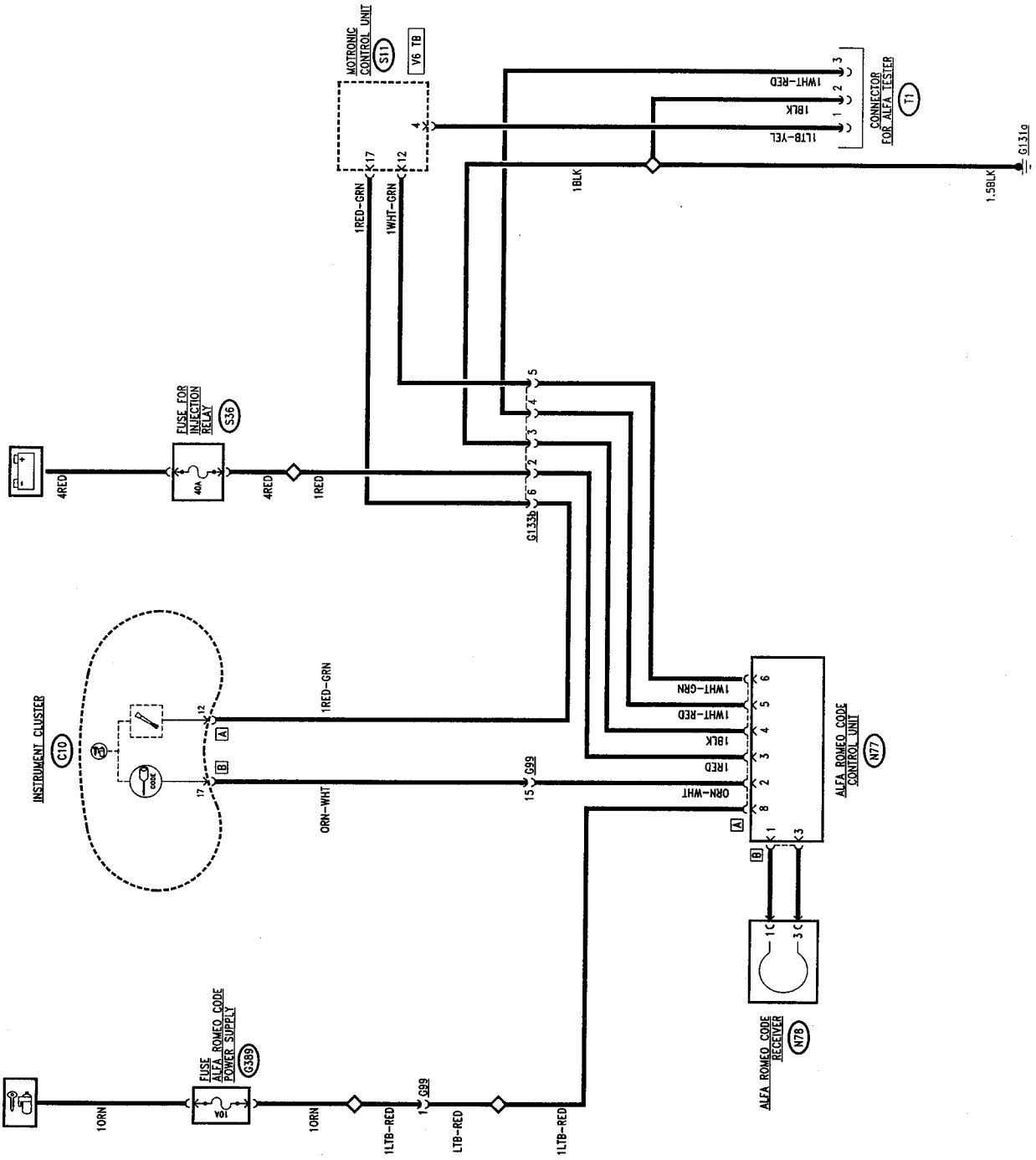
1. Open the MASTER key removing the mobile part.
2. Lift the other art, acting on the two notches. Operate carefully in order to avoid damages to the key.
3. Remove the Transponder taking care not to damage it.
4. Insert the Transponder in another MASTER key. N.B.: The Transponder rests in place in the key and is not restrained.



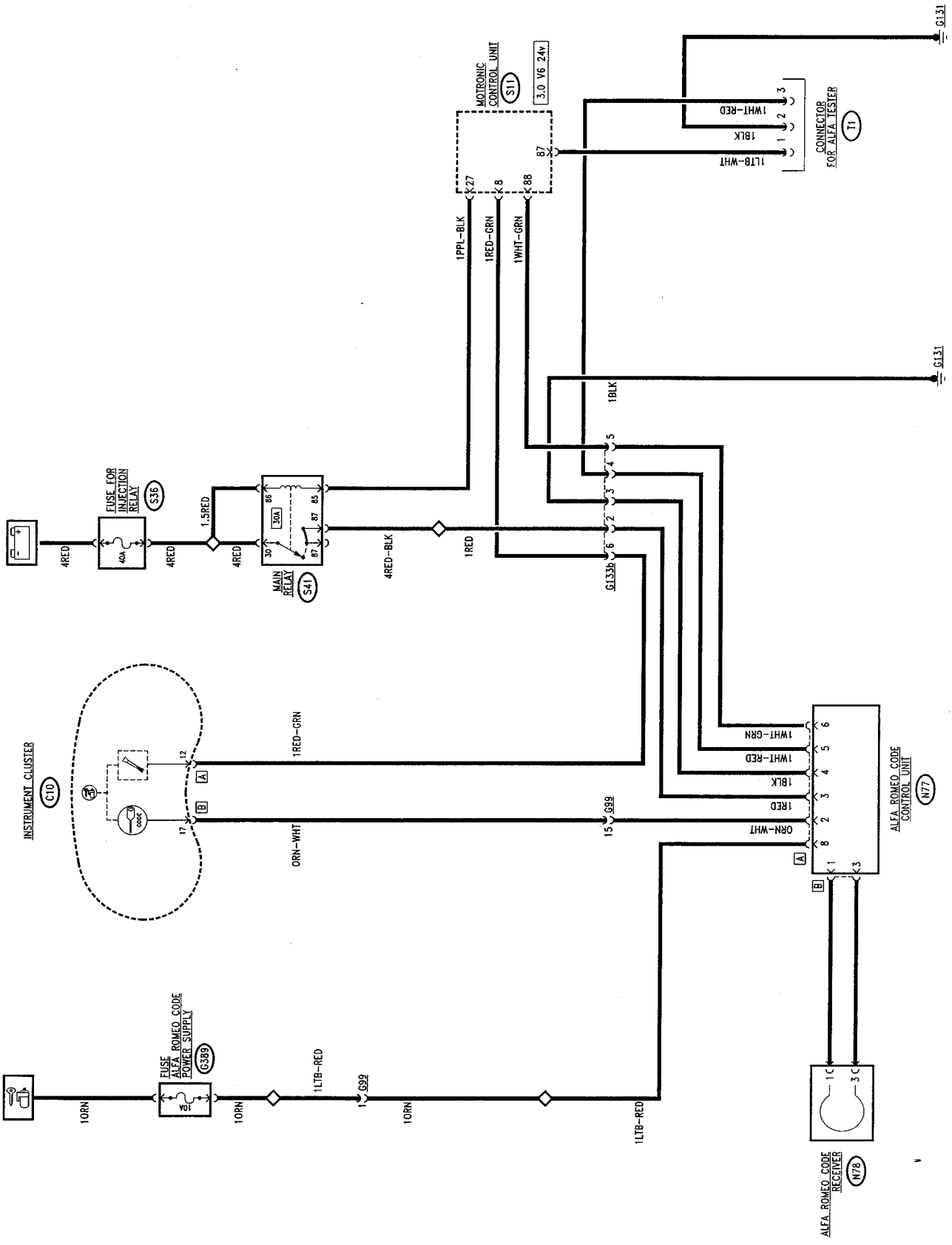
WIRING DIAGRAM (3.0 V6 engine)



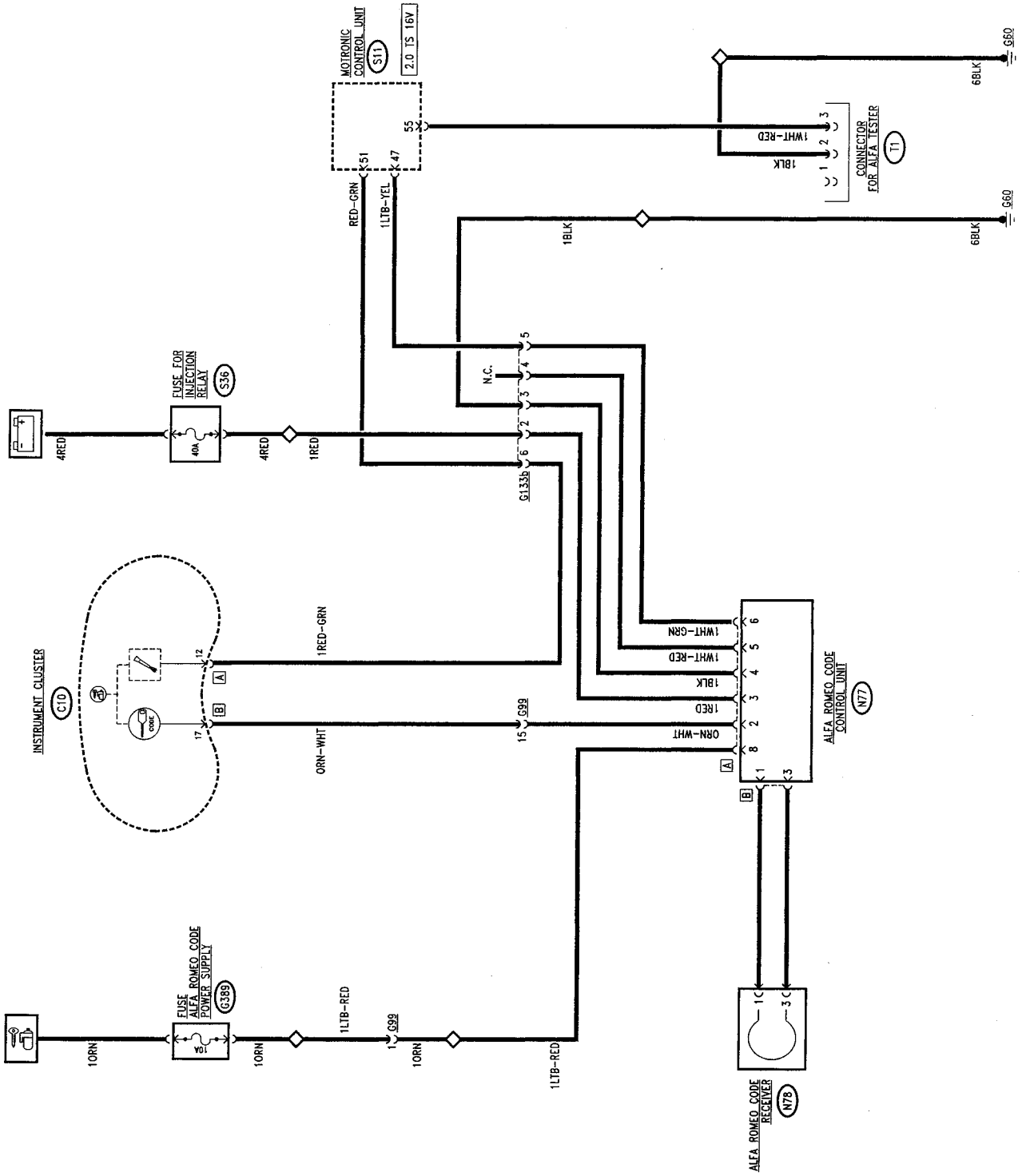
WIRING DIAGRAM (2.0 V6 TB engine)



WIRING DIAGRAM (3.0 V6 24v engine)



WIRING DIAGRAM (2.0 TS 16v engine)



FUNCTIONAL DESCRIPTION

The ALFA ROMEO CODE control unit **N77**, to be found next to the fusebox **G1**, is connected via connector B to a special pair of cables to the receiver **N78**, consisting in a coaxial aerial with the ignition switch.

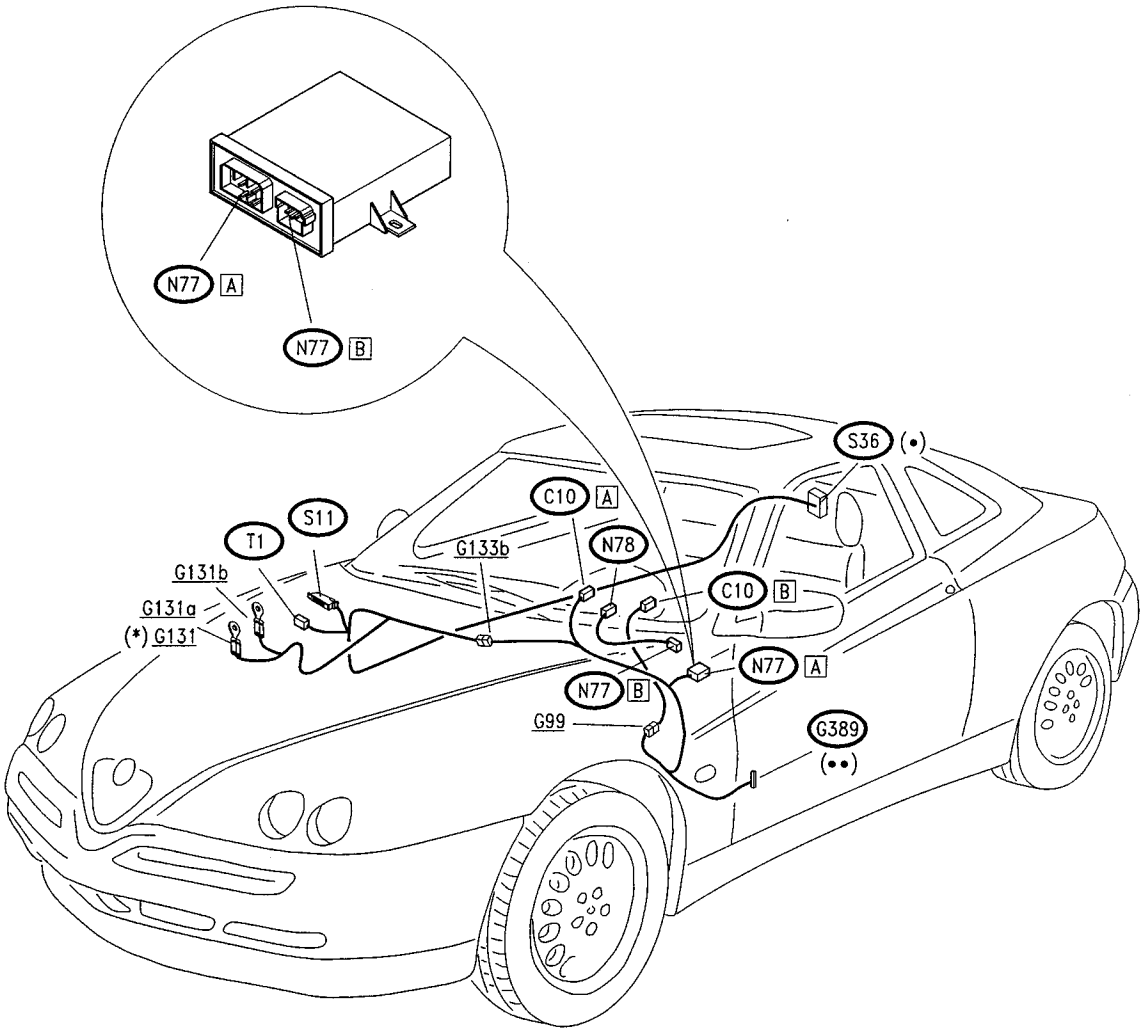
Through connector A it is connected to the Motronic control unit **S11** and to the other systems: at pin 8 it receives the "key-operated" supply through the line of wander fuse **G389**, while at pin 3 it receives the direct supply via fuse **S36** of the Motronic system, and pin 4 at earth.

The connection line with the ALFA ROMEO CODE warning light on the dashboard leads from pin 2.

3.0 V6, 2.0 V6 TB and 3.0 V6 24v engines: pins 5 and 6 manage communication between the ALFA ROMEO CODE control unit **N77** and the Motronic control unit **S11**: this communication takes place "intercepting" diagnosis line K which from **S11** leads to the diagnosis connector **T1**.

2.0 TS 16v engine: with this Motronic control unit (M2.10.4) there is a direct connection line between the control unit **N77** (pin 6) and **S11** (pin 47).

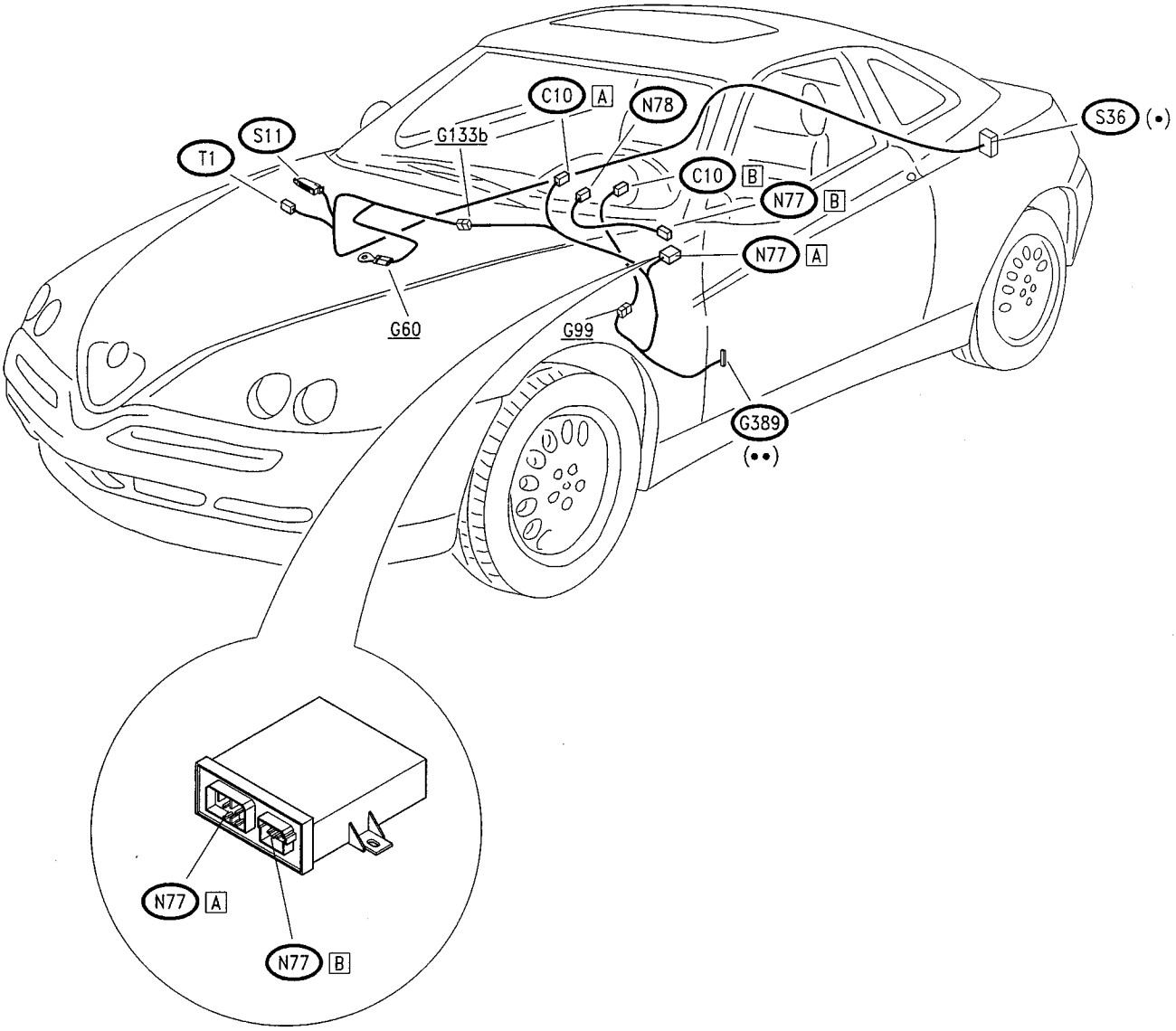
LOCATION OF COMPONENTS (3.0 V6, 2.0 V6 TB and 3.0 V6 24v)



(•) Black fuseholder
(••) Red fuseholder

(*) Only 3.0 V6 24v

LOCATION OF COMPONENTS (2.0 TS 16v)



(•) Black fuseholder
(••) Red fuseholder

DIAGNOSIS

The C.C.E. cannot be tested directly via the Alfa Tester.

To the injection control unit, which already possesses a sophisticated self-diagnosis, the possibility has been added to test and display the more important functions of the ALFA ROMEO CODE.

Dialogue between the C.C.M. and the Alfa Tester begins when the key has been turned to MARCIA and when communication between the C.C.M. and the C.C.E. has ended.

The information, concerning the ALFA ROMEO CODE, supplied to the Alfa Tester, may belong to two different environments:

Errors:
generally displayed by the tester with priority depending on the importance.

There is a counter inside the control unit, which is activated when an error is stored and it decreases each time the error is no longer present; when the counter reaches zero, the control unit erases the error from the memory.

Therefore, the error memorised can be distinguished as PRESENT or not PRESENT.

The errors memorised are:

- Serial line not active, code not received or time-out:
  this error indicates that the control units (C.C.E. and C.C.M.) have not succeeded in communicating and the probable causes can be line interrupted or short circuited or some problem on the actual control units (or - with brand new system - faulty or disconnected aerial or faulty or lacking Transponder).
- Received incorrect code:
  the injection control unit has received from the C.C.E. a code that does not correspond to its memorised MASTER CODE; the probable cause can be an exchange of the injection control unit or the use of another main key during re-memorisation.
- Incorrect code in the C.C.E.:
  this means that a key unknown to the control unit has been inserted and starting of the car has not been allowed.

Parameters:

This is the environment of the Tester after connection with the C.C.M. (if no errors are present).

This environment is used to display the engineering parameters which define the status of a system.

The parameters are the following:

- brand new C.C.M.
- Starting inhibition procedure; (an un-memorised key has been inserted, the C.C.M. has not been enabled to start by the C.C.E.)
- brand new C.C.E. connected correctly

RECOVERY PROCEDURES

The emergency procedures should be carried out, when it is not possible to start the engine with the keys available.

This procedure requires the possession of the Code Card; with the corresponding ELECTRONIC CODE (5-figure code written on the card. The procedure, (carried out either with the Alfa Tester or with the accelerator pedal) consists in entering the ELECTRONIC CODE directly in the inection control unit.

This procedure makes it possible to start the engine only once; the procedure must be repeated to start the engine again (or a "known" key must be inserted, i.e. already memorised in the control unit).

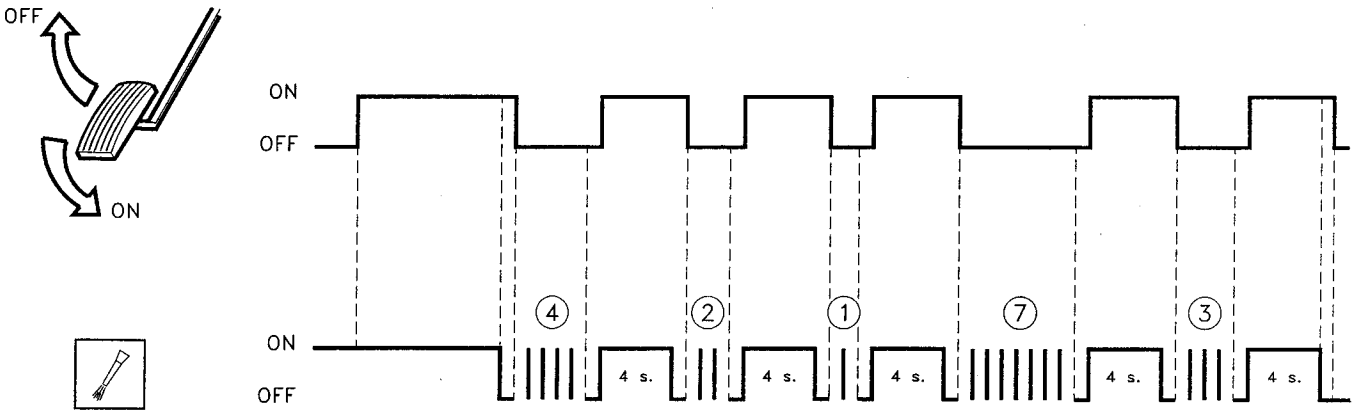
Emergency starting procedure (using the accelerator pedal)

This procedure should be carried out using the accelerator pedal and carefully watching the indications of the injection control unit warning light.

- Turn the key to MARCIA
- Press the accelerator pedal and keep it pressed until the warning light goes out.
- When the warning light goes out release the accelerator pedal.
- At this point the warning light begins to flash; after the number of flashes corresponding to the first number of the code on the Code Card (ELECTRONIC CODE) depress the accelerator pedal completely.
- The warning light turns on and stays on for 4 seconds then it goes out.
- When the warning light goes out, release the accelerator pedal
- The warning light starts to flash again; after the number of flashes corresponding to the second number of the ELECTRONIC CODE, press the accelerator fully home again.
- Proceed in the same way for the other numbers of the ELECTRONIC CODE.
- Also after the last number, keep the accelerator pressed until the warning light goes out (appr. 4 seconds)
- Release the accelerator pedal.

If the warning light flashes quickly, it means that the operation has been carried out correctly, thus the car can be started: if the warning light stays on, the code has not been entered correctly, move the key to STOP and back to MARCIA again, and repeat the procedure.

EXAMPLE: ELECTRONIC CODE = "42173"



NOTE : If this procedure is not activated correctly, check the throttle potentiometer and the corresponding wiring, and also the throttle itself (throttle stroke without obstacles or sticking); also check the supply to the C.C.M..

CONTROL SYSTEM - 2.0 T.SPARK 16v engine: BOSCH MOTRONIC M2.10.4

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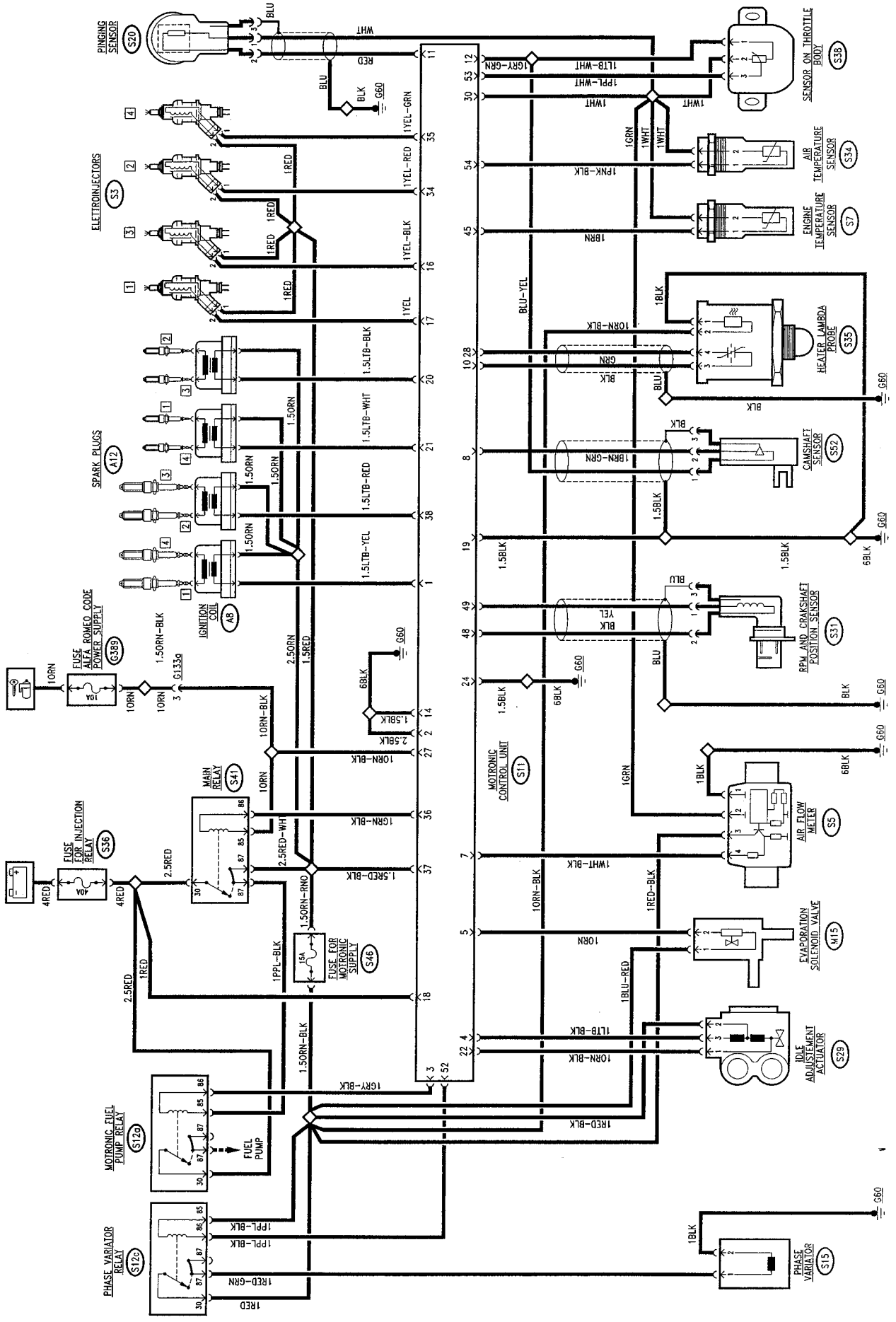
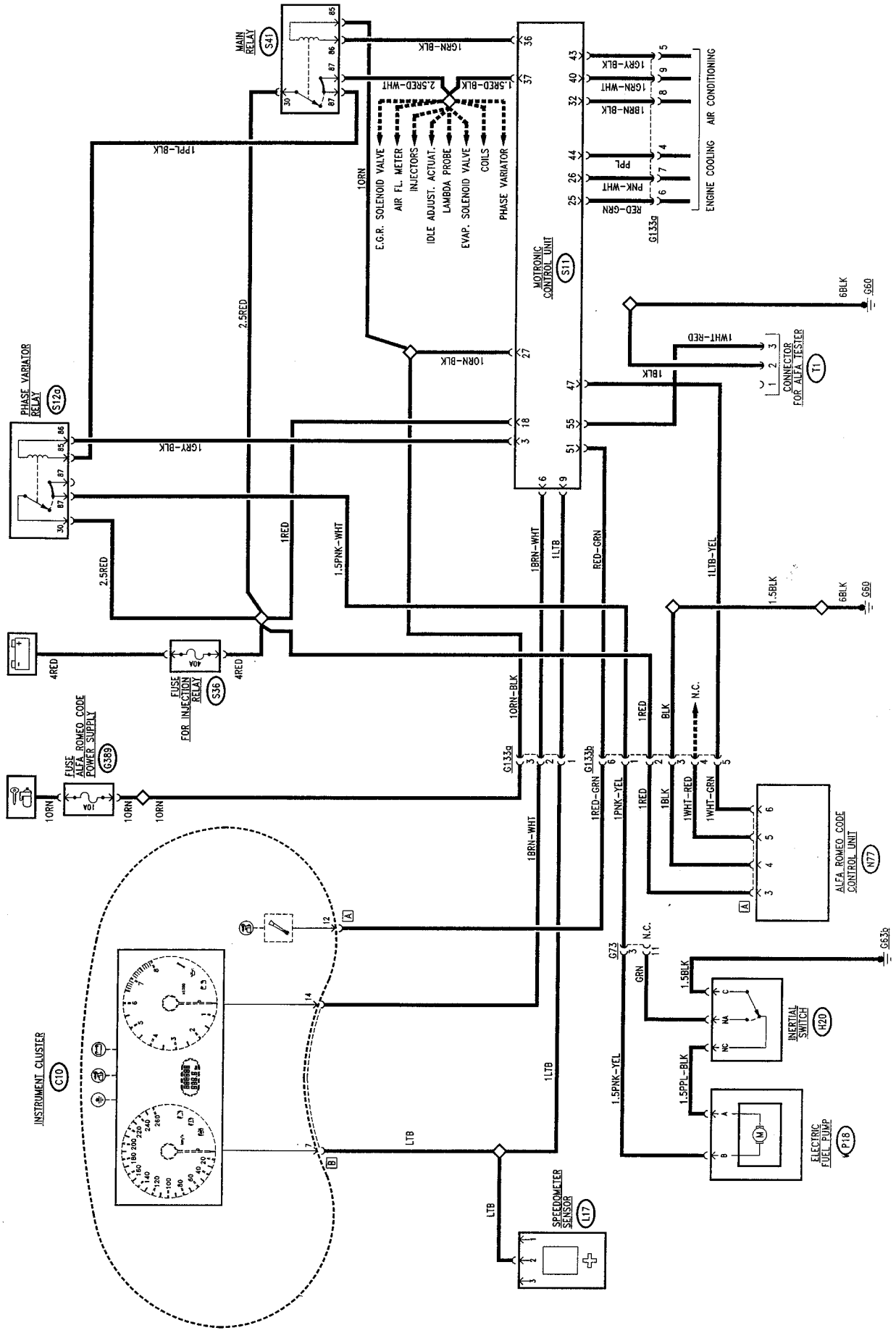
WIRING DIAGRAM "A"



WIRING DIAGRAM "B"



GENERAL DESCRIPTION

An electronic control system supervises and regulates all the parameters of the engine, optimising performance and consumption levels through response in real time to the different operating conditions: this sophisticated latest generation system consists of a single control unit which controls both ignition (static with lost spark) and injection (timed).

This is the M 2.10.4 version of the proven and reliable BOSCH MOTRONIC system.

Compared with the previous versions this new M 2.10.4 system adopts a control unit - with 55 pins - with advanced design and production technology, it also possesses many possibilities for inserting auxiliary functions (engine cooling fan).

As a result of the use of new sensors and revision of the control programmes, the system makes it possible to achieve considerable improvements in terms of consumption, emission levels and vehicle handling.

Another feature of this system is self-adaptation, i.e. the capability to recognise the changes that take place in the engine and to compensate them, according to functions which mainly correct:

– the mixture titration

– the caburetion parameters according to the command of the evaporative solenoid valve

– an adaptive programme for idle speed control.

FUNCTIONS OF THE SYSTEM

Sequential and timed injection (S.E.F.I.)

With this control unit, fuel injection is sequential and timed for each cylinder: the injection instant (delivery of fuel into the intake manifolds by the opening of the injectors) is not simultaneous for all the cylinders, but takes place for each cylinder in correspondence with the optimal point of injection, calculated by the control unit according to special maps depending on the load, speed and temperature of the engine.

Static ignition

An electronic ignition system has been adopted with "static distribution" (with semi-conductors, without distributor). This solution makes it possible to eliminate rotary components; in addition, it does not produce external sparks thus reducing the risk of interferences.

Static ignition takes place through four coils, according to the so-called "lost spark" logic: this solution exploits the different pressures and environments existing contemporaneously in a pair of cylinders: when one of the cylinders approaches the bursting stroke, with a mixture of air and fuel, the corresponding cylinder is at the end of the exhaust stroke in the presence of exhaust gas.

In a 4-cylinder in line engine, the paired cylinders are 1/4 and 2/3.

The solution adopted for this engine (T.SPARK and 16 valves) has required the adoption of a larger "central" spark plug and a smaller "side" spark plug.

Two of the four coils supply the small spark plug of the cylinder below and simultaneously the other two supply the large ones.

NOTE: This way it is also impossible to invert the spark plug cables during servicing operations.

Metering the air flow rate

The air flow meter adopted is of a more modern design known as the "hot film" type.

Outside, the air-flow meter looks like a part of duct between the intake manifold and the air cleaner.

Inside the air-flow meter there is an electronic circuit and a plate that is crossed by the air which passes into the duct. The film plate is kept at a constant temperature (appr. 120°C over the temperature of the incoming air) by a heating resistance placed in contact with it.

The mass of air flowing through the manifold tends to withdraw heat from the plate: therefore, to keep its temperature constant, a certain current needs to flow through the heating resistance: this current, suitably measured, is proportionate with the mass of flowing air.

N.B. This air flow meter measures directly the mass of air (and not the volume as in the previous versions with "floating port", thereby eliminating problems of temperature, altitude, pressure, etc.)

Cylinder detection

Following the sequential and timed injection system, a timing sensor has been introduced (cam angle sensor): this makes it possible to detect which cylinder is in the bursting stroke when the engine is started, in order to be able to start the correct injection sequence. The sensor is formed of a Hall-effect device by which the voltage signal sent to the control unit "lowers" suddenly when the tooth machined on the camshaft pulley passes in front of the actual sensor; therefore a signal is sent every two turns of the crankshaft.

Conversely, the rpm sensor sends a reference signal for each turn of the engine and each subsequent tooth of the phonic wheel informs the control unit of an increase of the angular position of the crankshaft, so that injection is sent correctly to the suitable cylinder and the spark to the corresponding pair of cylinders.

Fuel pump

The complex control logic of the fuel pump carried out by the control unit (mainly based on the rpm signal) immediately cuts off the supply to the pump as soon as the engine stops.
Moreover, the pump will not operate with the key engaged and the engine not running.

In this car, this logic is integrated - in order to further higher the standards of safety - by the **inertial switch** device: this is an electromechanical switch which, in the event of heavy shocks, opens to cut off the circuit that takes the earth to the fuel pump, which stops instantaneously. This device is particularly important as an integration of the safety guaranteed by the logic of the control unit, especially if the car is hit from behind or in the case of other accidents in which the engine does not stop immediately.

Timing variator

This T.SPARK 16 valve engine is fitted with an electro-mechanical-hydraulic timing variator which is connected to the camshaft and controls and adjusts intake timing (advance) in such a way that a larger amount of air is taken in. This device is activated by the control unit only after exceeding a determinate rpm and engine load to avoid adversely affecting correct operation of the engine at low speeds.

OPERATING LOGIC

– Identification of the "operating point":

the "point of operation of the engine" is located through two sensors: the rpm sensor informs the control unit of the speed of rotation of the engine; the air flow meter supplies the value of the mass of air actually entering the cylinders, defining the instantaneous volumetric yield of the engine.

– **Adjustment of injection times (quantity of fuel):** the control unit controls the injectors extremely quickly and precisely, calculating the opening time on the basis of engine load (rpm and air flow), also taking into account the battery voltage and the temperature of the engine. .

– Ignition adjustment (calculation of advances):

the control unit calculates the advance on the basis of the engine load (rpm and air flow); the value is also corrected according to the temperature of the intaken air and that of the engine: ignition is "static" as described previously.

– Cold starting control:

during cold starts the control unit uses special advance values and injection times.

When a determinate temperature/rpm ratio is reached, the control unit resumes normal operating conditions.

– Control of enrichment during acceleration:

upon the need for acceleration, the control unit increases injection in order to reach the required load as quickly as possible.
This function takes place through the potentiometer located on the throttle which instantaneously informs the control unit of the need to accelerate.

– Fuel cut-off during deceleration:

with the throttle closed and an engine speed above a certain threshold, the control unit de-activates fuel injection; this way the rpms decrease rapidly towards idle speed reducing the speed and fuel consumption. The cut-off threshold value varies according to the temperature of the engine and the speed of the car.

– Control of idle speed:

the adjustment of the engine idle speed is carried out through the special actuator fitted directly on the throttle body which acts on the throttle by-pass: in fact, when the throttle is closed, this valve adjusts the by-pass gap compensating the load required by the services in order to ensure that idle speed is as constant as possible.

– Maximum Rpm limiting:

above a certain threshold the control unit automatically stops the injection of fuel preventing the engine from "over-revving".

– Combustion control -lambda sensor-:

the oxygen sensor (or "lambda" sensor) informs the control unit of the amount of oxygen at the exhaust, and therefore the correct air-fuel metering.

The optimum mixture is obtained when the lambda coefficient = 1 (optimum stoichiometric mixture). The electric signal sent by the sensor to the control unit changes abruptly when the composition of the mixture departs from lambda = 1. When the mixture is "lean" the control unit increases the amount of fuel, reducing it when the mixture is "rich": this way the engine operates as far as possible around the ideal lambda rating.

The signal from the lambda sensor is processed inside the control unit by a special integrator which prevents sudden "oscillations".

The sensor is heated by an electrical resistance so that it quickly reaches the correct operating temperature (appr. 300 °C).

Through this sensor it is therefore possible to adjust engine carburetion precisely. Among other items, this makes it possible to meet emission limit regulations.

– Timing variator control:

The electro-mechanical-hydraulic timing variator, connected to the camshaft, controls and adjusts the intake timing according to the load and rpm of the engine. This device is activated by the control unit at higher engine operating speeds (above 1,600 rpm and with load above 30%).

– **Pinging control:**

Through a knock sensor the control unit is informed if any pinging or "pinging" occurs and it corrects the spark advance "delaying" it accordingly; a further correction also takes account of the air temperature, in fact, when the temperature of the intake air is high, pinging is more accentuated.

N.B. The intaken air temperature sensor to be found just downstream of the air-flow meter, is not used to calculate the engine load but to control the pinging parameters.

– **Fuel vapour recovery:**

the fuel vapours collected from the various points of the supply circuit in a special active carbon canister are ducted to the engine where they are burnt: this takes place through a solenoid valve which is opened by the control unit only when the engine is in a condition that allows correct combustion without adversely affecting the operation of the engine: in fact the control unit compensates this amount of fuel by reducing delivery to the injectors.

– **Connection with the air conditioner compressor:**

the control unit is connected with the air conditioner system and it cuts in the compressor in relation to operation of the engine.

For further details see section "Air Conditioner"

– **Connection with the radiator cooling fan**

in this version the thermal contact for controlling the cooling fan on the radiator has been eliminated. The command for the first and second speed of the fan is in fact supplied by the injection control unit in relation to the temperature measured by the coolant fluid temperature sensor.

– **Connection with ALFA ROMEO CODE system:**

as soon as the Motronic control unit receives the signal that the key has been turned to MARCIA, it "asks" the above-mentioned system for consent to start the engine: this consent is given only if the ALFRA ROMEO CODE control unit recognizes the code of the key engaged in the ignition switch as correct.

This dialogue between the two control units takes place on the special serial line which connects them.

– **Self-diagnosis:**

the control unit possesses a **self-diagnosis system**, which continuously monitors the plausibility of the signals from the various sensors and compares them with the limits allowed: if these limits are exceeded, the system detects a fault and turns on the corresponding warning light on the instrument cluster.

The warning light turns on when the engine is started to indicate the initial test of the entire system (appr. 4 seconds), it then turns off if no errors have been memorised: otherwise it stays on.

For certain parameters, the control unit replaces the abnormal values with suitable ones so that the car can "limp" to a point of the Service Network.

These "recovery" values depend on the other correct signals and they are defined individually by the control unit operating logic.

The self-diagnosis system also enables quick and effective location of faults connecting with the ALFA ROMEO Tester (see "Fault-finding"), through which all the errors memorised can be "read". It is also possible to check the operating parameters recorded by the control unit and operate the single actuators to check whether they are working properly.

COMPONENTS

The electronic control unit receives the signals leading from the **sensors** which measure the engine operating parameters. It processes them according to a logic stored inside in "maps" which correlate the different parameters in the best way possible and it operates the **actuators** accordingly so that the engine always works with the highest level of regularity and yield.

The sensors are the following:

– engine temperature sensor (**S7**);

– air temperature sensor (**S34**);

– sensor on throttle body (**S38**);

– rpm sensor (**S31**);

– cam angle sensor (**S52**);

– heated lambda sensor (**S35**)

– air-flow meter (**S5**);

– pinging sensor (**S20**);

The actuators are the following:

– injectors (**S3**);

– ignition coils (**A8**);

– fuel pump (**P18**);

– idle adjustment actuator (**S29**);

– vapour recovery solenoid valve (**M15**) ;

– timing variator (**S15**).

The control unit is also connected with:

– the climate control unit and engine cooling system;

– the ALFA ROMEO CODE control unit (**N77**);

– the instrument cluster (**C10**) to which it supplies the signal for turning on the diagnosis warning light and for the rev counter,

– the tachometric sensor (**L17**) from which it receives the car speed signal.

The system is completed by three relays: the first two - the main relay (**S41**) and the fuel pump relay **S12a** operate the fuel pump, the injectors, the coils and the other components of the system, while the third - the timing variator relay (**S12c**) supplies the corresponding component.

The supply line for the entire system is protected by fuse **S36**, while the control unit is protected by wander fuse (**S46**).
Lastly, there is an earth point (**G60**) on the engine.
Connector **T1** enables connection with the ALFA ROMEO Tester: this is located inside the car next to the control unit.

FUNCTIONAL DESCRIPTION

The Motronic control unit **S11** controls and adjusts the entire electronic ignition and injection system; all the system supplies are protected by fuse **S36** (40A).

The control unit is supplied at pin 18 directly by the battery through fuse **S46** (7.5A). At pin 37 it receives the supply from the main relay **S41**, while at pin 27 it receives the "key- operated" supply.

Pins 2, 14, 19 and 24 are earthed and serve as reference respectively for the ignition, the injectors, electronic screening and the final power stages.

The main relay **S41** controls the entire system; it is energized by a control signal - earth - leading from pin 36 of the control unit and consequently sends the supply (12V) to pin 37 of the control unit itself, to the fuel pump relay **S12a**, to the injectors **S3**, to the coils **A8**, to the EGR solenoid valve **L46** (if present), to the air flow meter **S5** to the sensor **S35**; in addition - through fuse **S46** (15A) - to the timing variator relay **S12c**, to the fuel vapour recovery solenoid valve **M15**, and to the idle speed actuator **S29**.

The fuel pump relay **S12a**, supplied by the main relay **S41**, is energized by a control signal - earth - leading from pin 3 of the control unit **S11**. Consequently, the relay supplies the fuel pump **P18**. In addition the earth reaches the pump **P18** via the inertial switch **H20** which cuts off the circuit in the event of impact.

The control unit **S11** receives numerous signals from the different sensors, thereby keeping all the engine operating parameters under control.

Through a frequency signal sent to pins 48 and 49 of the control unit, the rpm sensor **S31** supplies information about the engine rpm; the two above-mentioned signals are very low in intensity and are therefore suitably screened.

The sensor is inductive and detects the number of revolutions of the engine through the change in a magnetic field produced by the passage of the teeth of a "phonic" wheel (60-2 teeth) fitted on the crankshaft.

The cam angle sensor **S52** (timing sensor), supplied at 5 V by pin 12 of the control unit, and sends a signal in frequency corresponding to the phase to pin 8 of the control unit itself; these two signals are very low in intensity and are therefore suitably screened

The sensor comprises a Hall effect device due to which the voltage signal sent to the control unit "lowers" abruptly when the hollow machined on the camshaft passes in front of the sensor.

The heated lambda sensor **S35** supplies the control unit information about the correct composition of the air-fuel mixture detecting the concentration of oxygen in the exhaust gas; this takes place through the signal sent to pin 28 of the control unit, while pin 10 supplies the reference earth; these two signals are very low in intensity and are therefore suitably screened.
The sensor is heated by a resistance to make sure that it operates correctly also when the engine is cold; the resistance is supplied by the main relay **S41** and it is protected by a specific fuse **S45**.

The throttle body sensor **S38**, is supplied by the control unit from pins 12 and 30 and through a potentiometer it sends a signal to pin 53 which is proportionate with the degree of opening of the throttle itself.

The engine temperature sensor **S7**, connected to the electronic earth at pin 30, supplies a signal to pin 45 proportionate with the temperature of the engine coolant, detected with an NTC material (resistance that lowers with the temperature).

The intaken air temperature sensor **S34**, connected to the electronic earth at pin 30, supplies a signal at pin 54 that is proportionate with the temperature of the air entering the intake box, detected with an NTC material (resistance that lowers with the temperature).

The pinging sensor **S20**, through a frequency signal sent to pin 11 of the control unit, supplies information about the pinging conditions, while an electronic earth leads from pin 30; these two signals are very low in intensity and are therefore suitably screened.

The sensor comprises a piezoelectric plate which detects the vibrations produced when the engine is running, exploiting a particular characteristic of piezoelectric materials which generate an output voltage when subjected to mechanical stresses; this voltage is filtered and analysed by the control unit which corrects the ignition parameters accordingly.

The air flow meter **S5**, is supplied by the relay **S41**: from pin 30 of the control unit it receives the reference

earth, while it sends a signal proportionate with the air flow to pin 7.

The air flow meter is of the "heated film" type: a diaphragm is interposed in a measurement channel, through which the intake air flows: this diaphragm is kept at a constant temperature by a heating resistance; the mass of air that crosses the measurement channel tends to withdraw heat from the diaphragm, therefore, in order to maintain its temperature constant, a certain amount of current must flow through the resistance: this current, appropriately measured, is proportionate with the mass of air flowing in the channel.

On the basis of the signals received from the sensors and of the calculations carried out, the control unit **S11** controls the opening of the single injectors **S3** through special signals - of the duty-cycle type - pins 17 (cyl. 1), 34 (cyl. 2), 16 (cyl. 3) and 35 (cyl. 4). The injectors receive consent (12V) to open from the main relay **S41**.

The static ignition system is controlled by the control unit directly which automatically adjusts the advance. N.B. the power modules which generate the high voltage pulses are located inside the control unit. The control signals (earth) for the primary windings of the coils **A8** lead from the control unit, while the secondary winding sends the pulse to the spark plugs **A12**: from pins 1 and 21 for cylinders 1- 4 and from pins 28 and 30 for cylinders 2-3.

The primary windings of the coils **A8** are supplied at 12 V ("key-operated") by relay **S41**.

The power modules inside the control unit are connected to earth via pin 2.

The idle speed adjustment actuator **S29** forms a by-pass line for the flow of air; this comprises two windings: one opens and the other closes a valve that adjusts the gap of the by- pass section; it is controlled by the control unit through the duty-cycle signals of pins 22 (closing) and 4 (opening).

The vapour recovery solenoid valve **M15** allows the passage of the fuel vapours towards the engine intake where they are added to the mixture entering the combustion chamber; this valve, supplied by the main relay **S41**, is opened by the control unit when the engine is under load through a duty cycle signal from pin 5.

The timing variator **S15** mechanically controls timing advance at the intake; it is operated by the corresponding relay **S12c**: this relay is supplied by relay **S41** and it is energized via a negative signal from the control unit (pin 52), thus supplying the timing variator **S15**: this signal operates the actuator which controls the flow of oil in the hydraulic unit of the device that adjusts camshaft rotation.

The tachometric signal (car speed) reaches the control unit at pin 9 via sensor **L17**; while from pin 6 the control unit sends a "pulse" signal to the cluster which is proportionate with the number of revolutions of the engine; the signal for the "Check Engine" warning light on the cluster **C10** leads from pin 51.

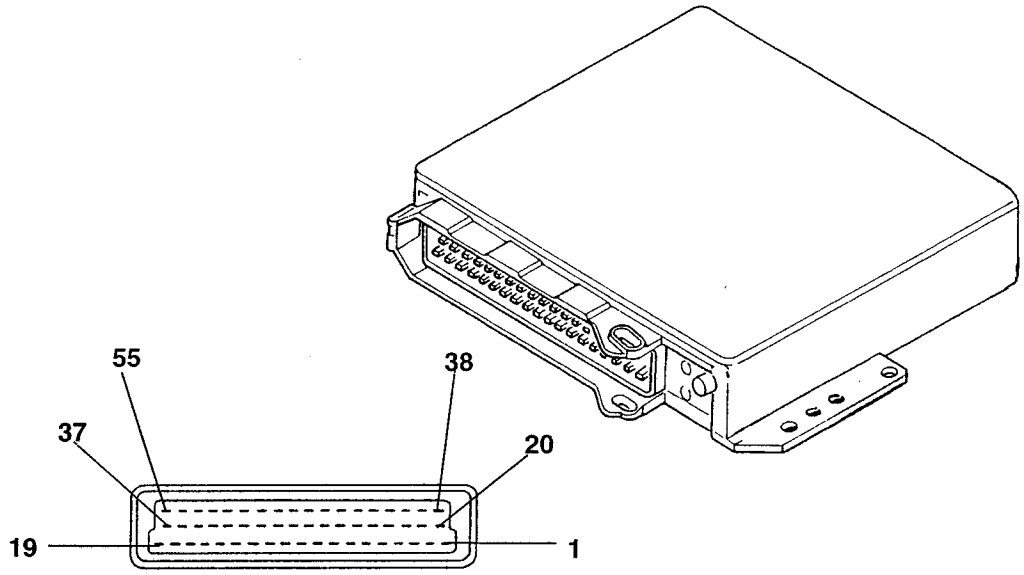
The control unit **S11** is connected with the air conditioning system through pins 32, 40 and 43.
This makes it possible to adapt the engine idle speed to the increased power each time the compressor cuts in, or to cut it out in the case of high speed or engine loads.

The control unit **S11** controls and adjusts the system for engaging the engine water cooling fan/s **P2**.

Pins 26 and 25 respectively send the command for engaging the first and second fan speed, while pin 14 recevies consent (earth) for engaging the fan from the pressure switch **Q20**.

The control unit **S11** is connected by pin 55 with the ALFA ROMEO CODE control unit **N77** via the special serial line from pin 47; this way if the ALFA ROMEO CODE system does not recognise a correct "key code" it will not enable the Motronic control unit to start the engine.

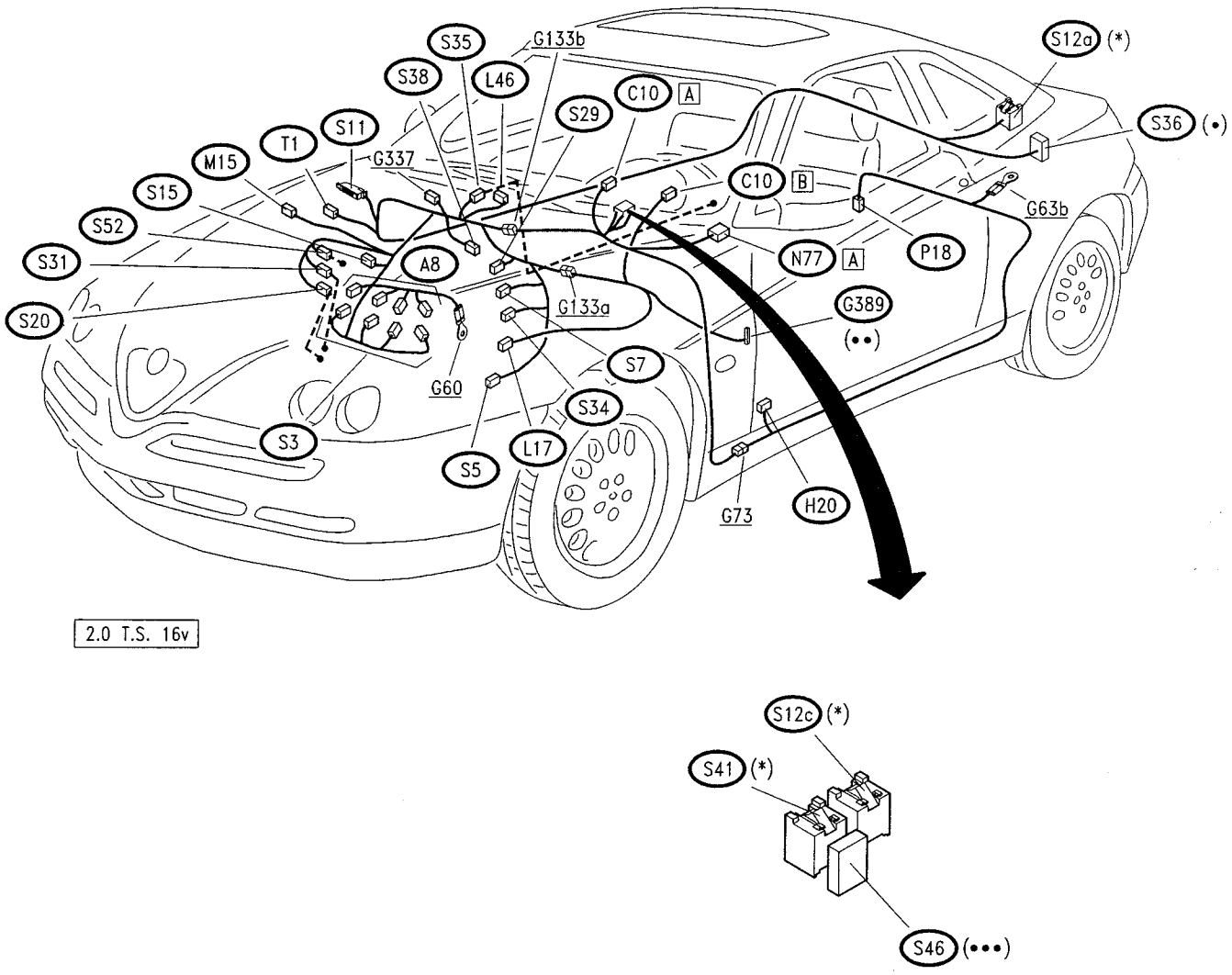
The control unit possesses a self-diagnosis system which can be used through connection to the ALFA ROMEO Tester at connector **T1**; the tester receives the fault signals from the control unit through the diagnosis line K - pin 55 -, while the earth leads from **G60**.



CONTROL UNIT PIN-OUT

1. Ignition coil control - cyl. 1 and 4 -
2. Earth for ignition
3. Fuel pump relay control
4. Idle actuator control - opening
5. Evaporative solenoid valve control
6. Rev counter signal
7. Air flow meter signal
8. Timing signal
9. Car speed signal
10. Lambda sensor signal
11. Pinging sensor signal
12. Stabilized voltage (5V) for sensors
13. N.C.
14. Earth for injectors
15. N.C.
16. Cyl. 3 injector
17. Cyl. 1 injector
18. Direct supply
19. Electronic screening earth
20. Ignition coil control - cyl. 3 and 2
21. Ignition coil control - cyl. 4 and 1
22. Idle speed actuator control - closing
23. N.C.
24. Earth for final stages 25. Fan 2nd speed command
26. Fan 1st speed command
27. "Key-operated" supply
28. Lambda sensor earth
29. N.C.
30. Electronic earth for sensors
31. N.C.
32. Conditioner compressor relay control
33. N.C.
34. Injector cyl. 2
35. Injector cyl. 4
36. Main relay control
37. Supply from main relay
38. Cyl. 2 and 3 ignition coil control
39. N.C.
40. Compressor engagement request
41. N.C.
42. N.C.
43. Fand second speed engagement request
44. Fan first speed engagement request
45. Engine temperature signal
46. N.C.
47. Connection line with ALFA ROMEO CODE
48. Signal for rpm sensor
49. Rpm sensor signal
50. N.C.
51. "Check Engine" warning light
52. Timing variator control
53. Throttle position signal
54. Intaken air temperature signal
55. Diagnosis line K

LOCATION OF COMPONENTS

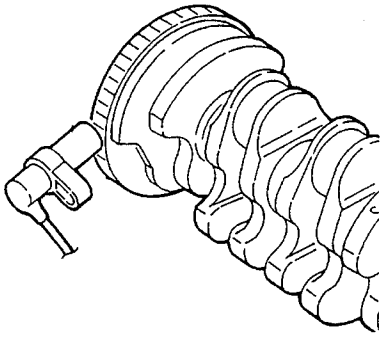


(*) Black base

(•) Black fuseholder
(••) Red fuseholder
(•••) Brown fuseholder

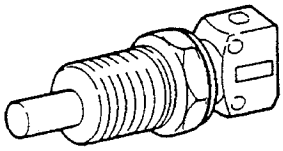
CHECKING COMPONENTS

Rpm sensor (S31)



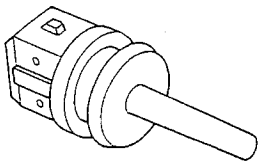
SPECIFICATIONS	
Sensor winding resistance (20 °C)	486 ÷ 594 Ω
Distance (gap) between sensor and phonic wheel	0.5 ÷ 1.5 mm

Engine temperature sensor (S7)



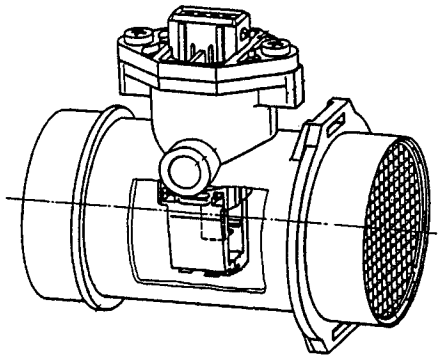
SPECIFICATIONS	
Temperature (°C)	Resistance (Ω)
- 10°C	8100 ÷ 10770 Ω
+ 20°C	2280 ÷ 2720 Ω
+ 80°C	292 ÷ 362 Ω

Intake air temperature sensor (S34)

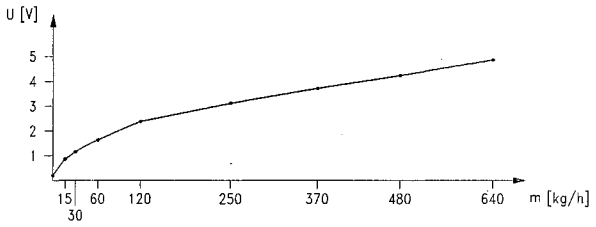


SPECIFICATIONS	
Temperature (°C)	Resistance (Ω)
- 10°C	8100 ÷ 10770 Ω
+ 20°C	2280 ÷ 2720 Ω
+ 80°C	292 ÷ 362 Ω

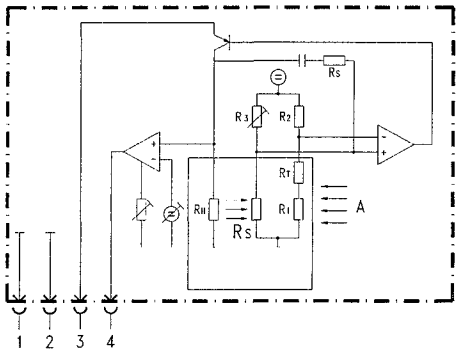
Air flow meter (S5)



SPECIFICATIONS	
Current that crosses the diaphragm:	
capacity (kg/h)	current (A)
0 640	≤ 0.25 ≤ 0.80

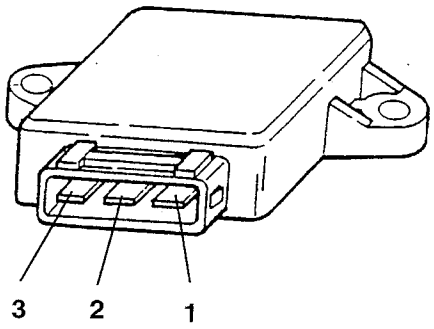


Sensor characteristic curve
m = capacity
U = voltage between pin 4 and 2



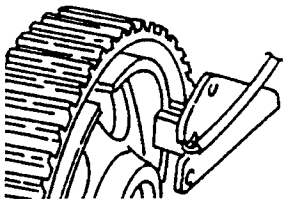
pin 1 - Earth
pin 2 - Reference earth
pin 3 - 12 V supply
pin 4 - Measurement signal
A = air
Rs = hot film sensor

Throttle position sensor (S38)

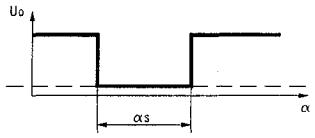


SPECIFICATIONS	
Resistance between terminals:	
1 - 2 (fixed)	≃ 2 kΩ
1 - 3 (throttle closed)	≃ 1 kΩ
1 - 3 (throttle completely open)	≃ 2.7 kΩ

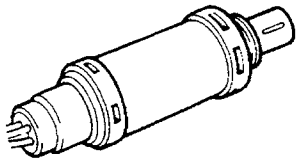
Cam angle sensor (S52)



SPECIFICATIONS
The voltage signal "lowers" abruptly when the hollow machined on the camshaft passes in front of the sensor:

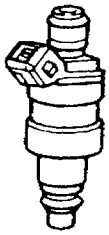


Lambda sensor (S35)



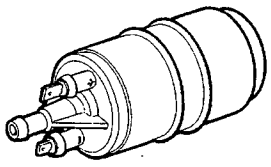
SPECIFICATIONS	
Heating resistance	3 Ω

Injectors (S3)



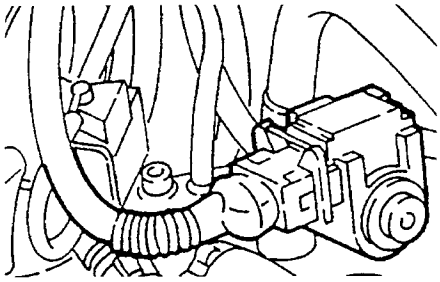
SPECIFICATIONS	
Winding resistance	15.9 ± 0.35 Ω

Fuel pump (P18)



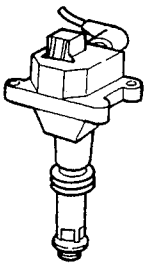
SPECIFICATIONS	
Capacity	≥120 l/h
Pressure	4 bar
Nominal voltage	12V

Idle speed adjustment actuator (S29)



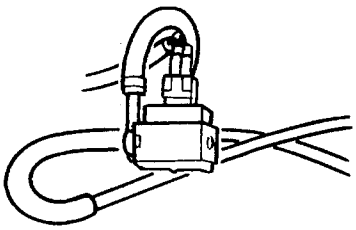
SPECIFICATIONS	
Resistance between terminals:	
1 - 3	~ 33 Ω
1 - 2	~ 17.5 Ω
2 - 3	~ 15.5 Ω

Ignition coils (A8)



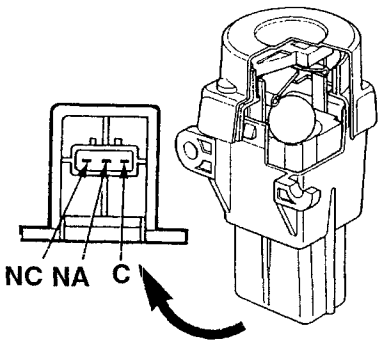
SPECIFICATIONS	
Primary resistance	0.3 Ω ± 12%
Secondary resistance	7 kΩ ± 12%

Evaporative solenoid valve (M15)



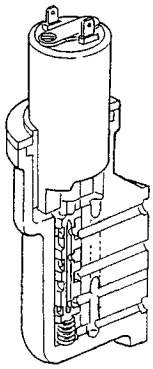
SPECIFICATIONS	
Duty-cycle signal	12 V; 10 Hz
Winding ohmic resistance ohmica	26 ± 4 Ω
When not energised the solenoid valve is normally closed	

Inertial switch (H20)



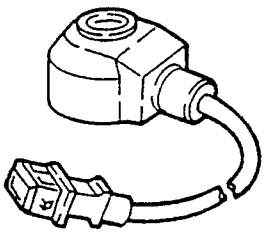
SPECIFICATIONS
Check continuity between pin NC and C: this continuity is cut off in case of a crash: the contact is closed again pressing the special push-button

Timing variator (S15)



SPECIFICATIONS	
Resistance between the two terminals	~ 10 Ω
Max. absorption at 13.5 V	1.34 A

Pinging sensor (S20)



SPECIFICATIONS		
Resonance frequency		> 20 kHz
Impedence		⊥ 1 MΩ
Allowed vibration	for long times	≤ 80 g
	for short times	≤ 400 g

FAULT-FINDING

The control unit possesses a self-diagnosis function which continuously checks the signals from the various sensors for plausibility and comparing them with the permissible limits: if these limits are exceeded, the system detects a fault and memorises it. It also turns on the special warning light on the instrument cluster,

For certain parameters the control unit replaces the abnormal values with appropriate mean values so that the car can "limp" to a point of the Service Network. These values, known as "recovery" depend on the other correct signals and are defined individually by the control unit operating logic.
The self-diagnosis system also enables quick and effective location of faults connecting with the ALFA ROMEO Tester, through which the errors memorised may be "read". It is also possible to check the operating parameters recorded by the control unit and engage the single actuators to check whether they are working properly.

Diagnosis using the ALFA TESTER

N.B. Before carrying out diagnosis with the Tester, carry out the preliminary test described below (**TEST A**).

The Tester and electronic control unit should be connected as follows:

1. Power the Tester either through the cigar lighter socket or connecting it directly to the battery using the special cable.
2. Connect the socket of the Tester to the one for the control unit (to be found next to the control unit).

The information the instrument can provide is:

– display of parameters;

– display of errors;

– active diagnosis.

Error clearing

Before ending diagnosis the contents of the "permanent" memory are cancelled through the Tester in Active Diagnosis.

Otherwise, reconnecting the Tester errors already examined would be signalled.

The contents of the "permanent memory" can be erased as follows:

– through the tester in Active Diagnosis;

– if the cause that determined the error is no longer present and the engine has been started 10 times (running for no less than 20 minutes) with at least 2 minutes between one start and the next.

N. B.:
Disconnecting the control unit for at least 30 seconds the contents of the "permanent" memory are cleared

PRELIMINARY TEST OF BOSCH M2.10.4 SYSTEM	TEST A

NOTE: Beforehand check that the ALFA ROMEO CODE system is working correctly as it may have cut off the supply to the system!

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
A1 CHECK FUSE – Check the intactness of fuses **S36**, **S46** and **G389**	OK ▶	Carry out **step A2**
	~~OK~~ ▶	Change fuses **S36**: 40A **S46**: 15A **G389**: 10A
A2 CHECK VOLTAGE – Check for 12 V at pin 30 of relays **S41** and **S12a**	OK ▶	Carry out **step A3**
	~~OK~~ ▶	Restore the wiring between the battery **A1** and relays **41** and **S12a** through fuse **S36**
A3 CHECK VOLTAGE – With the key turned, check for 12 V at pin 85 of relay **S41**	OK ▶	Carry out **step A4**
	~~OK~~ ▶	Restore the wiring between the ignition switch **B1** and relay **S41** - through fuse **G389**
A4 CHECK RELAYS – Check that relays **S41** and **S12a** are working properly	OK ▶	Carry out **step A5**
	~~OK~~ ▶	Replace any faulty relays
A5 CHECK CONTROL UNIT SUPPLY – Check for 12 V at pin 18 of the control unit **S11**; with the key turned 12 V also at pins 27 and 37 of **S11** and for appr. 0 V (very low voltage) at pin 3 and 36 of **S11**	OK ▶	Carry out **step A6**
	~~OK~~ ▶	Restore the wiring between the control unit **S11** and relays **S41** and **S12a**
A6 CHECK EARTH – Check for an earth at pins 2, 14, 19 and 24 of **S11**	OK ▶	**CONTINUE DIAGNOSIS USING THE ALFA ROMEO TESTER**
	~~OK~~ ▶	Restore the wiring between **S11** and earth **G60**

CONTROL SYSTEM - 3.0 V6 Engine: BOSCH MOTRONIC M3.7

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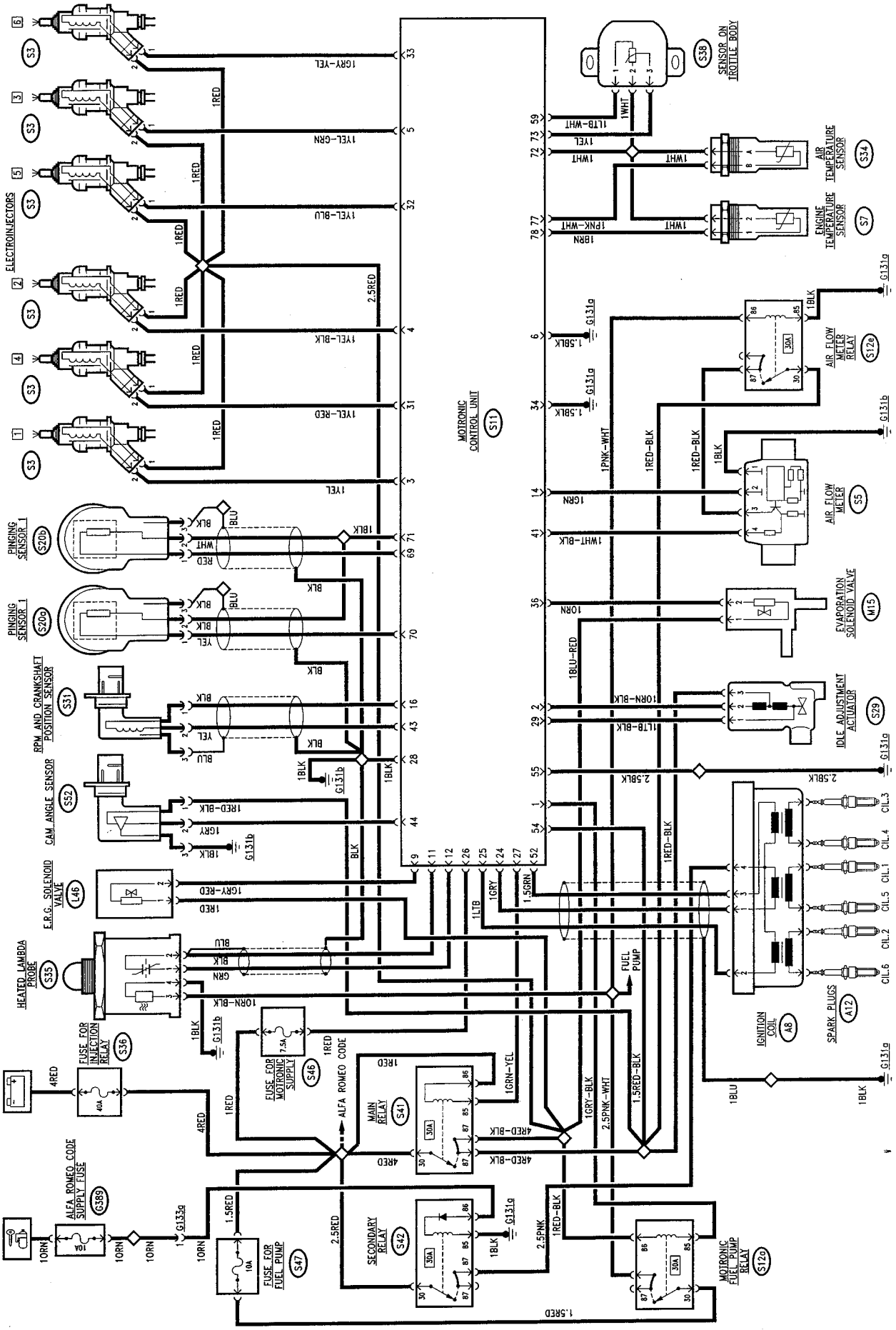
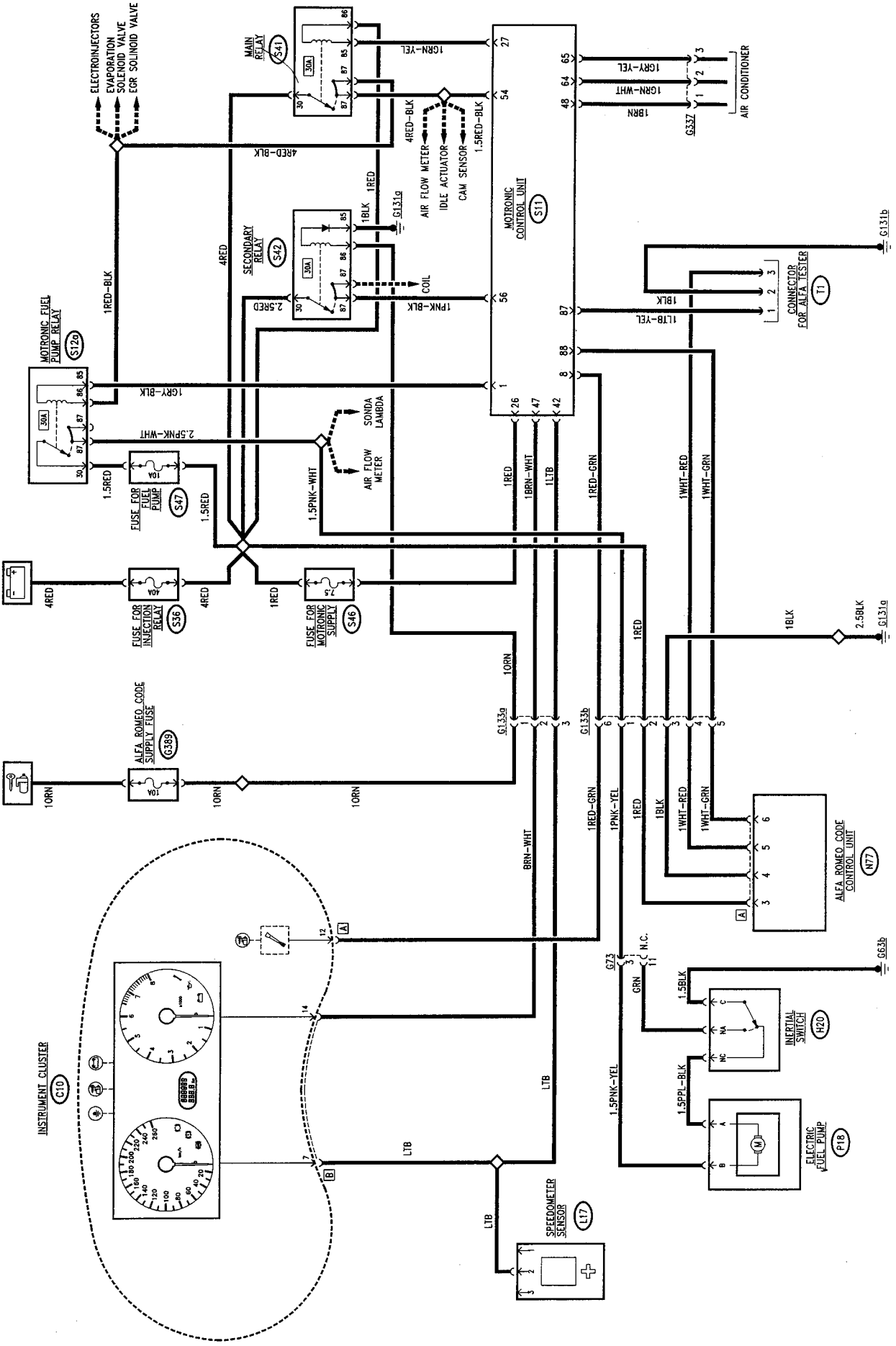
WIRING DIAGRAM A



WIRING DIAGRAM B



GENERAL DESCRIPTION

An electronic control system supervises and regulates all the parameters of the engine, optimising performance and consumption levels through response in real time to the different operating conditions: this sophisticated latest generation system comprises a single control unit which controls both ignition (static with lost spark) and injection (timed).

This is the M 3.7 version of the proven and reliable BOSCH MOTRONIC system.

Compared with the previous versions this new M 3.7 system adopts a control unit - with 88 pins - with advanced design and production technology, it also possesses many possibilities for inserting auxiliary functions.

Owing to the use of new sensors and revision to the control programmes, the system makes it possible to achieve considerable improvements in terms of consumption, emission levels and handling of the vehicle.

Another feature of this system is self-adaptation, i.e. the capability to recognise the changes that take place in the engine and to compensate them, according to functions which mainly correct:

- mixture titration
- the carburetion parameters according to the command of the evaporative solenoid valve
- an adaptive programme for idle speed control.

FUNCTIONS OF THE SYSTEM

Sequential and timed injection (S.E.F.I.)

With this control unit injection is sequential and timed for each cylinder: the injection instant (delivery of fuel into the intake manifolds through the opening of the injectors) is not simultaneous for all the cylinders, but takes place for each cylinder in correspondence with the optimal point of injection, calculated by the control unit according to special maps according to the load, speed and temperature of the engine.

NOTE: the instant considered in the design of the maps is that of the start of injection (the cylinder is in the exhaust stroke - intake valve still closed).

Static ignition

An ignition system has been adopted with "static distribution" (with semi-conductors, without distributor). This solution makes it possible to eliminate rotary components; in addition, it does not produce external sparks thus reducing the risk of interferences; lastly it reduces the number of high voltage cables and connectors; as the power modules for controlling the primary windings of the coil are inside the control unit.

Static ignition takes place through three coils, according to the "lost spark" logic: this solution exploits the different pressures and environments existing contemporaneously in a pair of cylinders: when one of the cylinders approaches the bursting stroke, with a mixture of air and fuel, the corresponding cylinder is at the end of the exhaust stroke in the presence of exhaust gas.

In a V six-cylinder engine, the paired cylinders are 1/5 6/2 and 3/4.

Metering the air flow rate

The air flow meter adopted is of a more modern design known as the "hot film" type. Outside, the air-flow meter looks like a part of duct between the intake manifold and the air cleaner.

Inside the air-flow meter there is an electronic circuit and a plate that is crossed by the air which passes in the duct.

The film plate is kept at a constant temperature (appr. 120°C above the temperature of the incoming air) by a heating resistance placed in contact with it.

The mass of air flowing through the manifold tends to withdraw heat from the plate: therefore, to keep its temperature constant, a certain current needs to flow through the heating resistance: this current, suitably measured, is proportionate with the mass of flowing air.

N.B. This air flow meter measures directly the mass of air (and not the volume as in the previous versions with "floating port"), thereby eliminating problems of temperature, altitude, pressure, etc.

Cylinder detection

Following the sequential and timed injection system, a timing sensor has been introduced (cam angle sensor): this makes it possible to detect which cylinder is in the bursting stroke when the engine is started, in order to be able to start the correct injection sequence. The sensor is formed of a Hall-effect device by which the voltage signal sent to the control unit "lowers" suddenly when the tooth machined on the camshaft passes in front of the actual sensor; therefore a signal is sent every two turns of the crankshaft.

Conversely, the rpm sensor sends a reference signal for each turn of the engine and each subsequent tooth of the phonic wheel informs the control unit of an increase of the angular position of the crankshaft, so that injection is sent correctly to the suitable cylinder and the spark to the corresponding pair of cylinders.

Fuel pump

The control logic of the fuel pump carried out by the control unit which is mainly based on the rpm signal immediately cuts off the supply to the pump as soon as the engine stops.
Moreover, the pump will not operate with the key engaged and the engine not running.

In this car, this logic is integrated - in order to further higher the standards of safety - by the **inertial switch** device: this is an electromechanical switch which, in the event of heavy shocks, opens to cut off the circuit that takes the earth to the fuel pump, which stops instantaneously. This device is particularly important as an integration of the safety guaranteed by the logic of the control unit, especially if the car is hit from behind or in the case of other accidents in which the engine does not stop immediately.

Percentage of exhaust gas recirculation

Nox (nitric oxide) is developed at high temperatures in the combustion chambers.

To reduce these emissions an E.G.R. (Exhaust Gas Recirculation) system is adopted which by recirculating part of the exhaust gases, lowers the temperature, thus the Nox produced, in the combustion chambers. In fact, part of the exhaust gas is withdrawn through the special EGR Valve and re-admitted to the intake box where it is mixed with the intaken air and burnt again in the engine. The EGR valve is modulated by a solenoid valve controlled by the injection control unit and, as a result of the type of control, in addition to reducing the amount of Nox, consumption levels are also optimised.

The percentage of exhaust gas to be returned to the engine is established by the control unit taking account of a specific characteristic curve which depends on the load, speed and temperature of the engine.

OPERATING LOGIC

– Identification of the "operating point":

the "point of operation of the engine" is located mainly through two sensors: the rpm sensor informs the control unit of the speed of rotation of the engine; the air flow meter supplies the value of the mass of air actually entering the cylinders, defining the instantaneous volumetric yield of the engine.

– Adjustment of injection times (quantity of fuel):

the control unit controls the injectors very quickly and precisely, calculating the opening time on the basis of engine load (rpm and air flow), also taking into account the battery voltage and the temperature of the engine. Injection is "sequential", i.e. the injectors are opened in correspondence of the exhaust stroke of the corresponding cylinder.

– Ignition adjustment (calculation of advances):

the control unit calculates the advance on the basis of the engine load (rpm and air flow); the value is also corrected according to the temperature of the intaken air and that of the engine: ignition is "static" as described previously.

– Cold starting control:

during cold starts the control unit uses special advance values and injection times.

When a determinate temperature/rpm ratio is reached, the control unit resumes normal operating conditions.

– Control of enrichment during acceleration:

upon the need for acceleration, the control unit increases injection in order to reach the required rpm as quickly as possible.
This function takes place through the potentiometer located on the throttle which instantaneously informs the control unit of the need to accelerate.

– Fuel cut-off during deceleration:

with the throttle closed and an engine speed above a certain threshold, the control unit de-activates fuel injection; this way the rpms decrease rapidly towards idle speed reducing the speed and fuel consumption. The cutoff threshold value varies according to the temperature of the engine and the speed of the car.

– Control of idle speed:

the adjustment of the engine idle speed is carried out through the special actuator which acts on the throttle by- pass.
This device acts as a regulator for cutting in the various services (e.g. conditioner compressor): in fact, when the throttle is closed, this valve adjusts the by-pass gap compensating the load required by the services in order to ensure that idle speed is as constant as possible.

– Maximum Rpm limiting:

above a certain threshold the control unit automatically stops the injection of fuel preventing the engine from "over-revving".

– Combustion control -lambda probe-:

the oxygen sensor (or "lambda" probe) informs the control unit of the amount of oxygen at the exhaust, and therefore the correct air-fuel metering.

The optimum mixture is obtained when the lambda coefficient = 1 (optimum stoichiometric mixture). The electric signal sent by the probe to the control unit changes abruptly when the composition of the mixture departs from lambda = 1. When the mixture is "lean" the control unit increases the amount of fuel, reducing it when the mixture is "rich" so that in this way the engine operates as far as possible around the ideal lambda rating.
The signal from the lambda probe is processed inside the control unit by a special integrator which prevents sudden "oscillations".
The probe is heated by an electrical resistance so that it quickly reaches the correct operating temperature (appr. 300 °C).
Through this probe it is therefore possible to adjust engine carburetion precisely. Among other items, this makes it possible to meet emission limit regulations.

– Knocking control:

Through knocking sensors the control unit is informed if any pinging or "knocking" occurs and it corrects the spark advance "delaying" it accordingly; a further correction also takes account of the air temperature, in fact when the temperature of the intake air is high, pinging is more accentuated.

The intaken air temperature sensor, to be found just downstream of the air-flow meter, is not used to calculate the engine load but to control the knocking parameters and spark advances.

– Fuel vapour recovery:

the fuel vapours collected from the various points of the supply circuit in a special active carbon canister are ducted to the engine where they are burnt: this takes place through a solenoid valve which is opened by the control unit only when the engine is in a condition that allows correct combustion without adversely affecting the operation of the engine: in fact the control unit compensates this amount of incoming fuel by reducing delivery to the injectors.

– E.G.R. valve control

The percentage of exhaust gas to be returned to the engine is determined by the control unit taking account of a specific characteristic curve which depends on the engine load and speed: recirculation is only activated when the engine speed is between 2500 and 4000 rpm., also in relation to the temperature of the engine (higher recirculation percentage with high temperatures).

– Connection with the air conditioner compressor:

the control unit is connected with the air conditioner system and it cuts in the compressor in relation to operation of the engine. As this service absorbs a considerable amount of power, the control unit:

- adapts the engine idle speed each time the compressor cuts in; if the engine speed falls below 700 rpm, the compressor is turned off;
- when there is the need for power (high throttle opening speed starting from below 3500 rpm, or full load, or high engine temperature - over 117°C), it momentaneously cuts out the compressor
- when the engine is being started the compressor is disabled until normal operating conditions have been reached.

– Connection with the ALFA ROMEO CODE system

on cars fitted with the ALFA ROMEO CODE system, as soon as the Motronic control unit receives the signal that the key has been turned to MARCIA, it "asks" the above-mentioned system for consent to start the engine: this consent is given only if the ALFA ROMEO CODE control unit recognizes the code of the key engaged in the ignition switch as correct. This dialogue between the control units takes place on diagnosis line K already used for the Alfa Romeo Tester.

– Self-diagnosis:

the key a **self-diagnosis system**, which continuously monitors the plausibility of the signals from the various sensors and compares them with the limits allowed: if these limits are exceeded, the system detects a fault and turns on the corresponding warning light on the instrument cluster.

The warning light turns on when the engine is started to indicate the initial test of the entire system (appr. 4 seconds), it then turns off if no errors have been memorised: otherwise it stays on.

For certain parameters, the control unit replaces the abnormal values with suitable mean ones so that the car can "limp" to a point of the Service Network.

These "recovery" values depend on the other correct signals and they are defined individually by the control unit operating logic.

The self-diagnosis system also enables quick and effective location of faults connecting with the ALFA ROMEO Tester (see "Fault-finding"), through which all the errors memorised can be displayed. It is also possible to check the operating parameters recorded by the control unit and operate the single actuators to check whether they are working properly.

COMPONENTS

The electronic control unit receives the signals leading from the **sensors** which "read" the engine operating parameters. It processes them according to a logic stored inside in "maps" which correlate the different parameters in the best way possible and it operates the **actuators** accordingly so that the engine always works with the highest level of regularity and yield.

The sensors are the following:

– engine temperature sensor (**S7**);

– air temperature sensor (**S34**);

– sensor on throttle body (**S38**);

– rpm sensor (**S31**);

– cam angle sensor (**S52**);

– heated lambda sensor (**S35**)

– air-flow meter (**S5**);

– knock sensors (**S20a** and **s20b**);

The actuators are the following:

– electroinjectors (**S3**);

– ignition coil (**A8**);

– fuel pump (**P18**);

– idle adjustment actuator (**S29**);

– vapour recovery solenoid valve (**M15**) ;

– E.G.R. solenoid valve (**L46**);

The control unit is also connected with:

– the climate control unit;

– the ALFA ROMEO CODE control unit (**N77**);

– the instrument cluster (**C10**) to which it supplies the signal for turning on the diagnosis warning light and for the rev counter;

– the sensor (**L17**) from which it receives the car speed signal.

The system is completed by four relays: the first three - the main relay (**S41**), secondary relay **S42** and the fuel pump relay **S12a** operate the fuel pump, the injectors, the coils and the other components of the system, while the fourth - the air-flow meter relay (**S12e**) supplies the corresponding component.

The supply line for the entire system is protected by fuse **S36**, while the control unit is protected by wander fuse (**S46**); another fuse protects the pump (**S47**). Lastly, there is an earth point (**G60**) on the engine. Connector **T1** enables connection with the ALFA ROMEO Tester: this is located inside the car next to the control unit.

FUNCTIONAL DESCRIPTION

The Motronic control unit **S11** controls and adjusts the entire electronic ignition and injection system; all the system supplies are protected by fuse **S36** (40A).

The control unit is supplied at pin 26 directly by the battery through fuse **S46** (7.5A). At pin 54 it receives the supply from the main relay **S41**, while at pin 56 it receives the "key- operated" supply from the secondary relay **S42**.

Pins 55, 6, 28 and 34 are earthed and serve as reference respectively for the ignition, the injectors, electronic screening and the final power stages.

Two relays control the entire system:

The main relay **S41**, acts as supply relay for the whole system; it is energized by a control signal - earth - leading from pin 27 of the control unit and consequently sends the supply (12V) to pin 54 of the control unit itself, to the fuel pump relay **S12a**, to the air-flow meter relay **S12a** to the vapour recovery solenoid valve **M15**, to the idle speed actuator **S29**, to the cam angle sensor **S52**, to the EGR solenoid valve **L46** and lastly to the injectors **S3**.

The secondary relay **S42**, energized by the "key-operated" between the fuse **G389** - supply, supplies the control unit at pin 56 and the primary windings of the coil **A8**.

The fuel pump relay **S12a**, supplied by the main relay **S41**, is energized by a control signal - earth - leading from pin 1 of the control unit **S11**. Consequently, the relay supplies the resistance of the lambda probe **S35**, the air flow meter relay **S12e**, and of course the fuel pump **P18**; this supply line is protected by a special fuse **S47** (10A).

The earth reaches the pump **P18** via the inertial switch **H20** which cuts off the circuit in the event of impact.

The control unit **S11** receives numerous signals from the different sensors, thereby keeping all the engine operating parameters under control.

Through a frequency signal sent to pins 43 and 16 of the control unit, the rpm sensor **S31** supplies information about the engine rpm; the two above-mentioned signals are very low in intensity and are therefore suitably screened.

The sensor is inductive and detects the number of revolutions of the engine through the change in a magnetic field produced by the passage of the teeth of a "phonic" wheel (60-2 teeth) fitted on the crankshaft.

The cam angle sensor **S52** (timing sensor), is supplied at 12 V by the main relay **S41**, and sends a signal in frequency corresponding to the phase to pin 44 of the control unit itself.
The sensor comprises a Hall effect device due to which the voltage signal sent to the control unit "lowers" abruptly when the tooth machined on the camshaft passes in front of the sensor.

The heated lambda sensor **S35** supplies the control unit information about the correct composition of the air-fuel mixture detecting the concentration of oxygen in the exhaust gas; this takes place through the signal sent to pin 12 of the control unit, while pin 11 supplies the reference earth; The sensor is heated by a resistance to make sure that it operates correctly also when the engine is cold; the resistance is supplied by the fuel pump relay **S12a.**

The throttle body sensor **S38**, is supplied by the control unit from pins 59 and 72 and through a potentiometer it sends a signal to pin 73 which is proportionate with the degree of opening of the throttle itself.

The engine temperature sensor **S7**, connected to the electronic earth at pin 72, supplies a signal to pin 78 proportionate with the temperature of the engine coolant, detected with an NTC material (resistance that lowers with the temperature).

The intaken air temperature sensor **S34**, connected to the electronic earth at pin 72, supplies a signal at pin 77 that is proportionate with the temperature of the air entering the intake box, detected with an NTC material (resistance that lowers with the temperature).

The knock sensors **S20a and S20b**, through a frequency signal sent to pins 69 and 70 of the control unit, supplies information about the knocking conditions, while an electronic earth leads from pin 71; these two signals are very low in intensity and are therefore suitably screened.

The sensor comprises a piezoelectric plate which detects the vibrations produced when the engine is running, exploiting a particular characteristic of piezoelectric materials which generate an output voltage when subjected to mechanical stresses; this voltage is filtered and analysed by the control unit which corrects the ignition parameters accordingly.

The air flow meter **S5**, is supplied by the special relay **S12e**: from pin 14 of the control unit it receives the reference earth, while it sends a signal proportionate with the air flow to pin 41.

The air flow meter is of the "heated film" type: a diaphragm is interposed in a measurement channel, through which the intake air flows: this diaphragm is kept at a constant temperature by a heating resistance; the mass of air that crosses the measurement channel tends to withdraw heat from the diaphragm, therefore, in order to maintain its temperature constant, a certain amount of current must flow through the resistance: this current, appropriately measured, is proportionate with the mass of air flowing in the channel.

Relay **S12e**, supplied directly with 12 V by relay **S41**, is energized by the fuel pump relay **S12a** and thus supplies the meter **S5** itself.

On the basis of the signals received from the sensors and of the calculations carried out, the control unit **S11** controls the opening of the single injectors **S3** through special signals - of the duty-cycle type - pins 3 (cyl. 1), 4 (cyl. 2), 5 (cyl. 3) 31 (cyl. 4), 32 (cyl. 5) and 33 (cyl. 6). The injectors receive consent (12V) to open from the main relay **S41**.

The static ignition system is controlled by the control unit directly which automatically adjusts the advance. N.B. the power modules which generate the high voltage pulses are located inside the control unit. The control signals (earth) for the primary windings of the coil **A8** lead from the control unit, while the secondary winding sends the pulse to the spark plugs **A12**: from pin 24 for cylinders 1/5, from pin 25 for cylinders 2/6 and from pin 52 for cylinders 3/4.
The primary windings of the coil **A8** are supplied at 12 V ("key- operated") by relay **S42**.

The power modules inside the control unit are connected to earth via pin 55.

The idle speed adjustment actuator **S29** forms a by-pass line for the flow of air; this comprises two windings: one opens and the other closes a valve that adjusts the gap of the by- pass section; a safety spring establishes a mean opening value in the event of a failure to this device; the actuator, supplied by the main relay, **S41**, is controlled by the control unit through the duty-cycle signals of pins 29 (closing) and 2 (opening).

The vapour recovery solenoid valve **M15** allows the passage of the fuel vapours towards the engine intake where they are added to the mixture entering the combustion chamber; this valve, supplied by the main relay **S41**, is opened by the control unit when the engine is under load through a duty cycle signal from pin 36.

The E.G.R. solenoid valve **L46**, controlled by the control unit, operates the actual E.G.R. valve modulating its opening: the latter is a vacuum-operated diaphragm valve: the electropneumatic valve works by changing this vacuum which is withdrawn from the same "takeoff" used for the servobrake.
The solenoid valve is controlled from pin 9 of the control unit while it is supplied at 12 V by main relay **S41**.

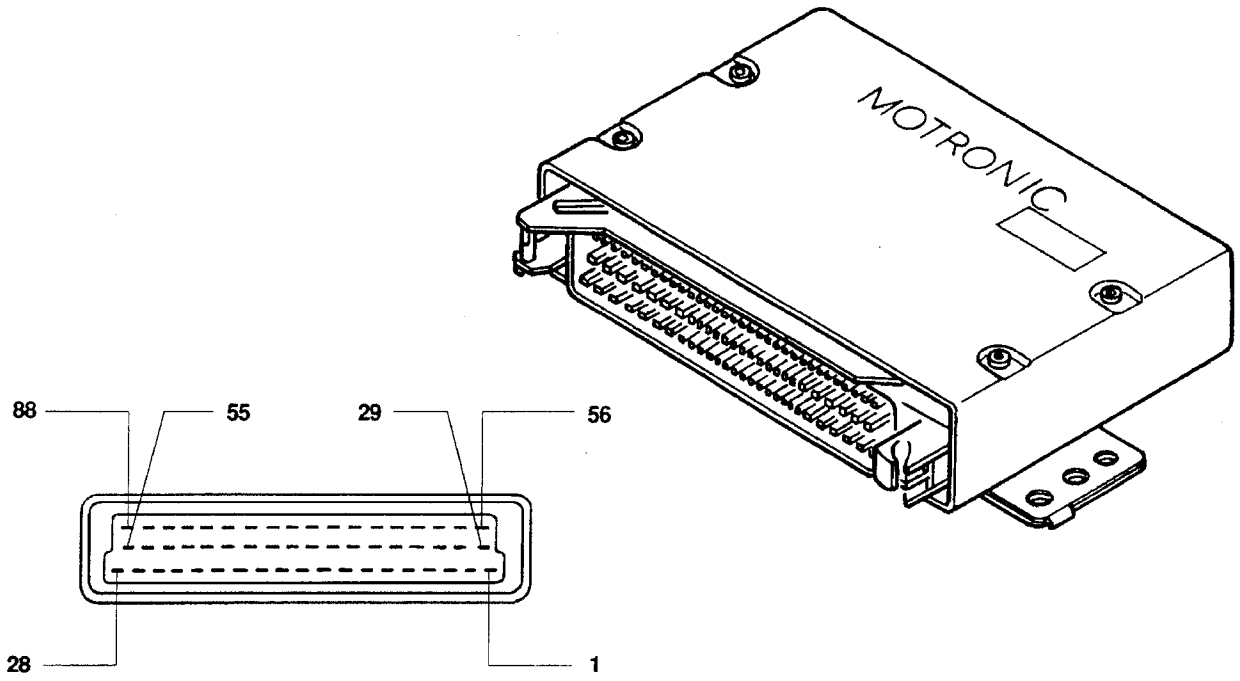
The tachometric signal (car speed) reaches the control unit at pin 42 via sensor **L17**; while from pin 47 the control unit sends a "pulse" signal to the cluster **C10** which is proportionate with the number of revolutions of the engine; the signal for the "Check Engine" diagnosis warning light on the cluster **C10** leads from pin 8.

The control unit **S11** is connected with the air conditioning system through pins 48, 64 and 65.
This makes it possible to adapt the engine idle speed to the increased power each time the compressor cuts in, or to cut it out in the case of high speed or engine loads. For further details see the "Climate Control" section.

The control unit **S11** is connected by pin 88 with the ALFA ROMEO CODE control unit **N77** via the diagnosis line K; if the ALFA ROMEO CODE does not recognise a correct "key code" it will not enable the Motronic control unit to start the engine.

The control unit possesses a self-diagnosis system which can be used through connection to the ALFA ROMEO Tester at connector **T1**; the tester receives the fault signals from the control unit through the diagnosis lines L - pin 87 - and K - pin 88 -, while the earth leads from **G60** (line K is also used by the ALFA ROMEO CODE system).

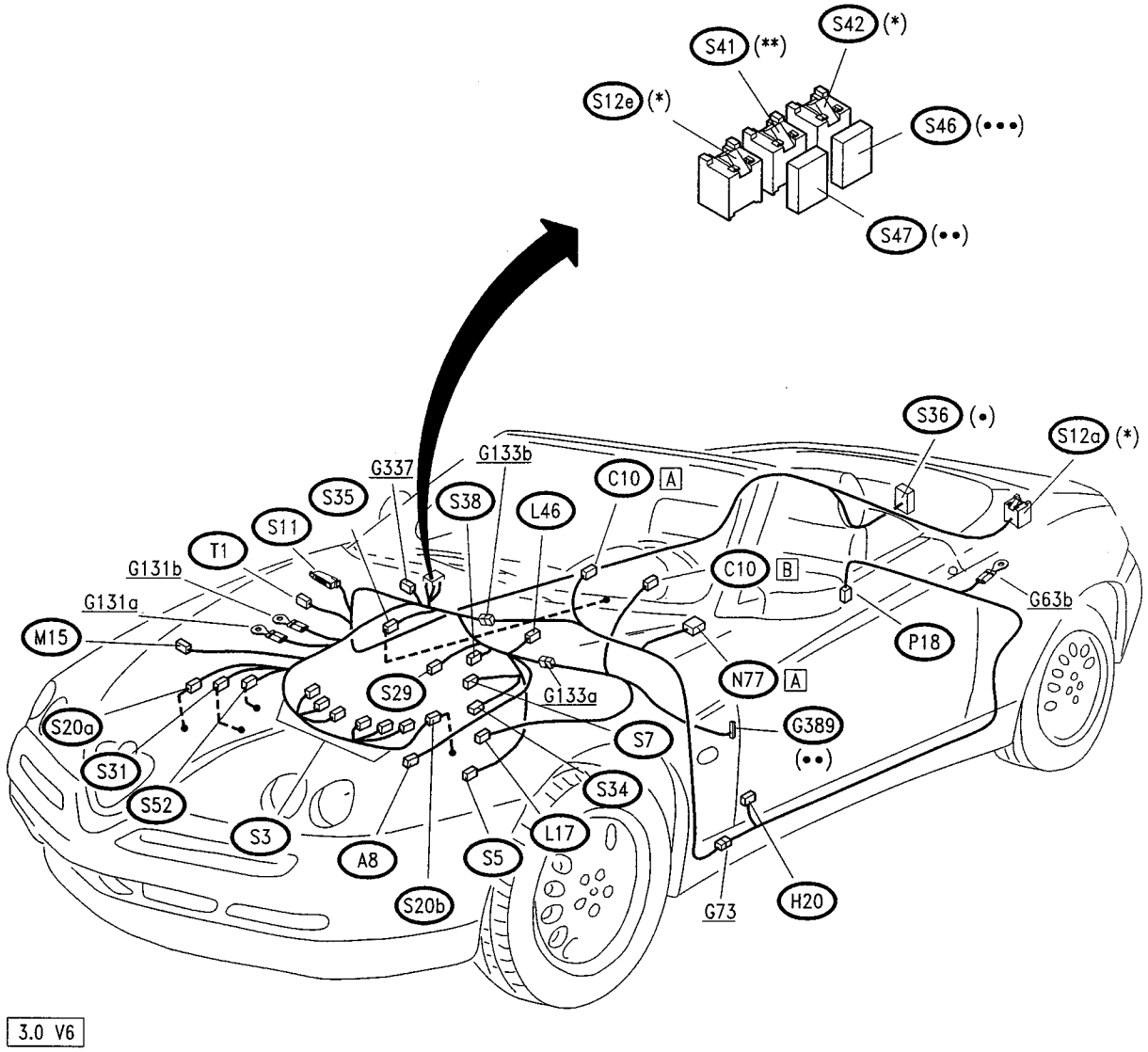
ELECTRONIC CONTROL UNIT



CONTROL UNIT PINOUTS

1. Fuel pump relay consent
2. Idle actuator control (open) signal
3. Electroinjector control, cylinder no.1
4. Electroinjector control, cylinder no.2
5. Electroinjector control, cylinder no.3
6. Earth for final stages (injectors)
8. "Check Engine" warning light
9. E.G.R. solenoid valve control
11. Lambda sensor earth
12. Lambda sensor signal
14. Earth for air flow meter
16. Rpm sensor signal
24. Ignition cylinders no.1 and 5
25. Ignition cylinders no.2 and 6
26. Direct 12V supply
27. Main relay control
28. Electronic earth (sensor screening)
29. Idle speed actuator signal (closed)
31. Electroinjector control, cylinder no.4
32. Electroinjector control, cylinder no.5
33. Electroinjector control, cylinder no.6
34. Earth for final stages
36. Evaporative solenoid valve signal
41. Air-flow meter signal
42. Car speed signal input
43. Rpm sensor signal
44. Camanglesensor
47. Engine rpm signal output
48. Climate control unit relay control
52. Ignition cylinders no. 3 and 4
54. Supply from main relay 12V
55. Earth for ignition
56. "Key-operated" supply from secondary relay
59. Reference voltage (5V) for throttle sensor
64. Climate control system signal (compressor cut in request)
65. Climate control system signal (system control)
69. Knock sensor signal 2
70. Knock sensor signal 1
71. Earth for knock sensors
72. Electronic earth for sensors
73. Throttle angle sensor signal
77. Air temperature sensor signal
78. Water temperature sensor signal
87. Diagnosis, line L
88. Diagnosis, line K (also for ALFA ROMEO CODE system)

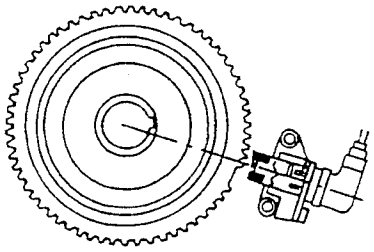
LOCATION OF COMPONENTS



(•) Black fuseholder
(••) Red fuseholder
(•••) Brown fuseholder
(*) Black base
(**) Grey base

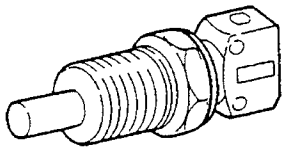
CHECKING COMPONENTS

Rpm sensor (S31)



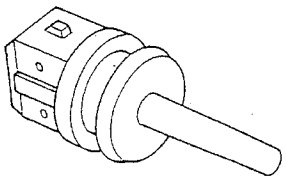
SPECIFICATIONS	
Sensor winding resistance 20 °C	~ 540 Ω
Gap between sensor and phonic wheel	0.5 ÷ 1.5 mm

Engine temperature sensor (S7)



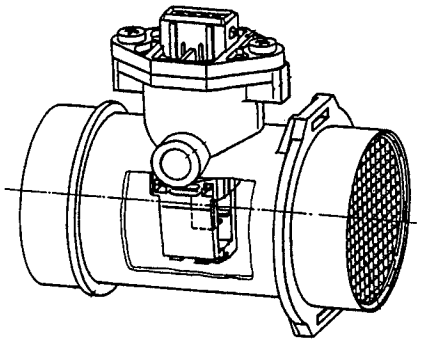
SPECIFICATIONS	
Temperature (°C)	Resistance (Ω)
- 10°C	8100 ÷ 10770 Ω
+ 20°C	2280 ÷ 2720 Ω
+ 80°C	292 ÷ 362 Ω

Intaken air temperature sensor (S34)

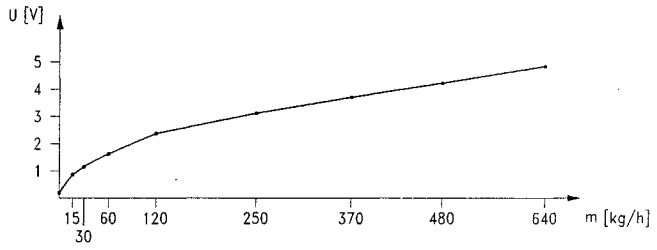


SPECIFICATIONS	
Temperature (°C)	Resistance (Ω)
- 10°C	8100 ÷ 10770 Ω
+ 20°C	2280 ÷ 2720 Ω
+ 80°C	292 ÷ 362 Ω

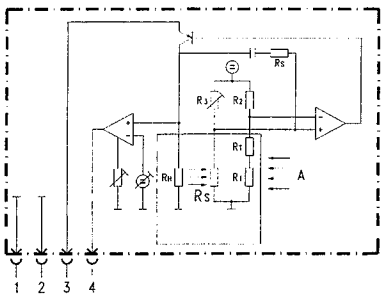
Air flow meter (S5)



SPECIFICATIONS	
Current that crosses the diaphragm:	
flow rate (kg/h)	current (A)
0 640	≤ 0.25 ≤ 0.80

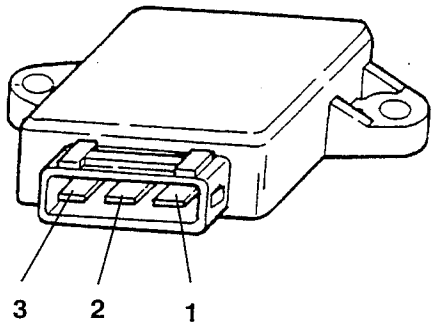


Characteristic curve of sensor
m = flow rate
U = voltage between pins 4 and 2



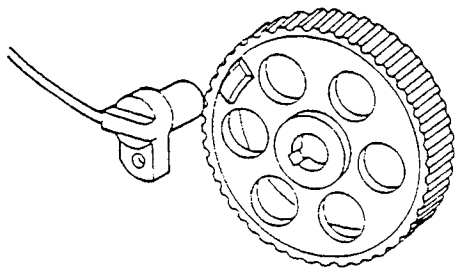
pin 1 - Earth
pin 2 - Reference earth
pin 3 - 12 V supply
pin 4 - Measurement signal
A = air
Rs = hot film sensor

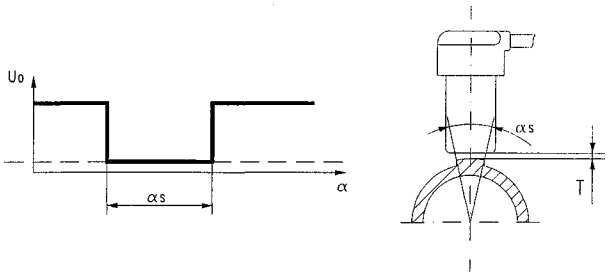
Throttle position sensor (S38)

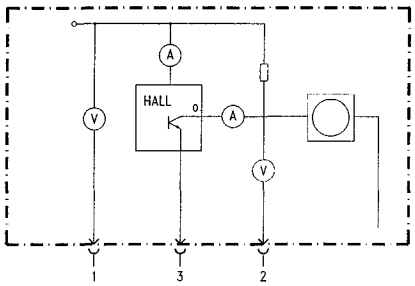


SPECIFICATIONS	
Resistance between terminals:	
1 - 2 (fixed)	≃ 2 kΩ
1 - 3 (throttle closed)	≃ 1 kΩ
1 - 3 (throttle completely open)	≃ 2.7 kΩ

Cam angle sensor (S52)

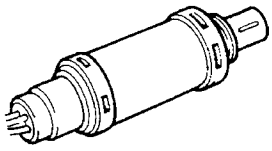


SPECIFICATIONS
The voltage signal "lowers" sharply when the tooth machined on the camshaft passes in front of the sensor itself:

Gap T = 0.1 ÷ 1.5 mm



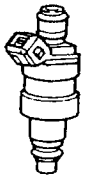
pin 1 - Supply
pin 2 - Signal output
pin 3 - Earth

Lambda probe (S35)



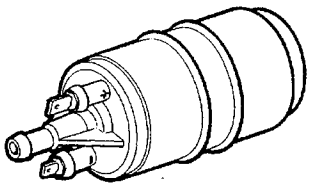
SPECIFICATIONS	
Heating resistance	3 Ω

Electroinjectors (S3)



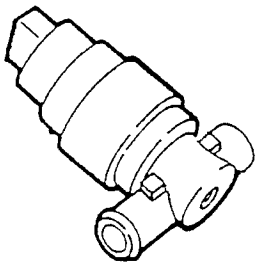
SPECIFICATIONS	
Winding resistance	15.9 ± 0.35 Ω

Fuel pump (P18)



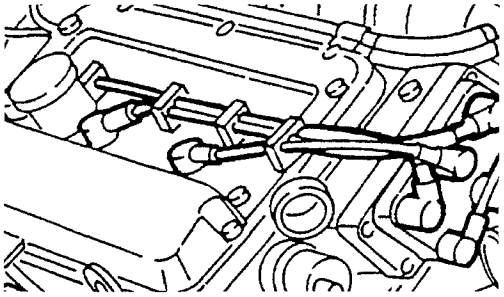
SPECIFICATIONS	
Flow rate	≥120 l/h
Pressure	4 bar
Nominal voltage	12V

Idle speed adjustment actuator (S29)



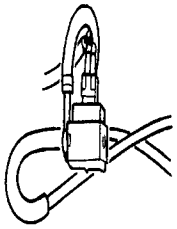
SPECIFICATIONS	
Resistance between terminals:	
1 - 3	~ 26 Ω
1 - 2	~ 13 Ω
2 - 3	~ 13 Ω

Ignition coil (A8)



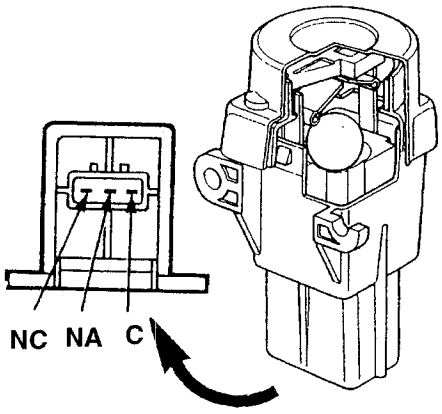
SPECIFICATIONS	
Primary resistance	0.5 Ω
Secondary resistance	13.3 kΩ

Evaporative solenoid valve (M15)



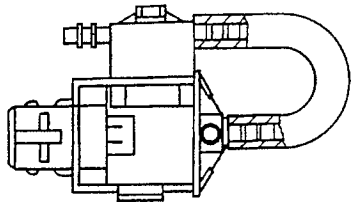
SPECIFICATIONS	
Duty-cycle signal	12 V; 10 Hz
Ohmic resistance of the winding	26 ± 4 Ω
When not energized the solenoid valve is normally closed	

Inertial switch (H20)



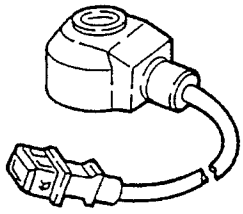
SPECIFICATIONS
Check the continuity between pins NC and C: this continuity is cut off in the event of a crash; the contact is re- connected by pressing the special pushbutton

E.G.R. Solenoid valve (L46)



SPECIFICATIONS	
Duty cycle signal	12V; 15.3 Hz
Ohmic resistance of winding	~ 30Ω

Knock sensor (S20a) (S20b)



SPECIFICATIONS		
Resonance frequency		> 20 kHz
Impedance		≥ 1 MΩ
Vibration allowed	for long periods	≤ 80 g
	for short periods	≤ 40 g

FAULT-FINDING

The control unit possesses a self-diagnosis system which continuously monitors the signals leading from the different sensors for plausibility and compares them with the allowed limits: if these limits are exceeded the system detects a fault, memorizes it and turns on the warning light on the instrument cluster.

For certain parameters the control unit replaces the abnormal values with suitable mean values to enable the car to "limp" to a point of the Service Network.

These "recovery" values depend on the other correct signals and are defined each time by the operating logic of the control unit.

The self-diagnosis system also makes it possible to quickly and effectively locate faults by connection with the ALFA ROMEO TESTER, through which all the errors memorised may be "read". It is also possible to check the operating parameters recorded by the control unit and command the engagement of the single actuators to check whether they are working properly.

Diagnosis using the ALFA TESTER

N.B. Before carrying out diagnosis with the Tester, make the preliminary check given on the next page (**TEST A**).

The Tester and the control unit should be connected as follows:

1. Power the Tester either through the cigar lighter socket or connecting it directly to the battery using the special cable.
2. Connect the Tester socket to that of the control unit (the socket is to be found next to the control unit).

The Tester can give the following information:

– display of parameters;

– display of errors;

– active diagnosis.

Error clearing

Before ending diagnosis the contents of the "permanent" memory must be erased using the Tester in the Active Diagnosis mode.

PRELIMINARY CHECK OF THE BOSCH M3.7 SYSTEM	TEST A

NOTE: Check beforehand that the ALFA ROMEO CODE is working properly which might have cut off the supply to the system!

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
A1 CHECK FUSE – Check intactness of fuses **S36**, **S46**, **S47** and **G389**	OK →	Carry out **step A2**
	~~OK~~ →	Change fuses **S36**: 40A **S46**: 7.5A **S47** : 10A **G389** : 10A
A2 CHECK VOLTAGE – Check for 12 V at pin 30 of relays **S41, S42** and **S12a** and also at pin 86 of **S41**	OK →	Carry out **step A3**
	~~OK~~ →	Restore the wiring between the battery **A1** and relays **S41, S42** and **S12a**
A3 CHECK VOLTAGE – With the key turned, check for 12 V at pin 86 of relay **S42**	OK →	Carry out **step A4**
	~~OK~~ →	Restore the wiring between the ignition switch **B1** and relay **S42** and through fuse **G389**
A4 CHECK RELAYS – Check the correct operation of relays **S41**, **S42** and **S12a**	OK →	Carry out **step A5**
	~~OK~~ →	Change any faulty relays
A5 CHECK CONTROL UNIT SUPPLY – Check for 12 V at pin 26 of control unit **S11**; with the key turned 12 V also at pins 54 and 56 of **S11** and appr. 0 V (very low voltage) at pin 1 and 27 of **S11**	OK →	Carry out **step A6**
	~~OK~~ →	Restore the wiring between the control unit **S11** and the relays and between the control unit and fuse **S46**
A6 CHECK EARTH – Check for an earth at pins 6 and 34. Also check for an earth at pin 85 of **S42** and at pin 85 of **S12a**	OK →	**CONTINUE DIAGNOSIS USING THE ALFA ROMEO TESTER**
	~~OK~~ →	Restore the wiring between **S11** and the relays and earth **G131a**

CONTROL SYSTEM - V6 TB Engine: MOTRONIC ML4.1 / EX212K

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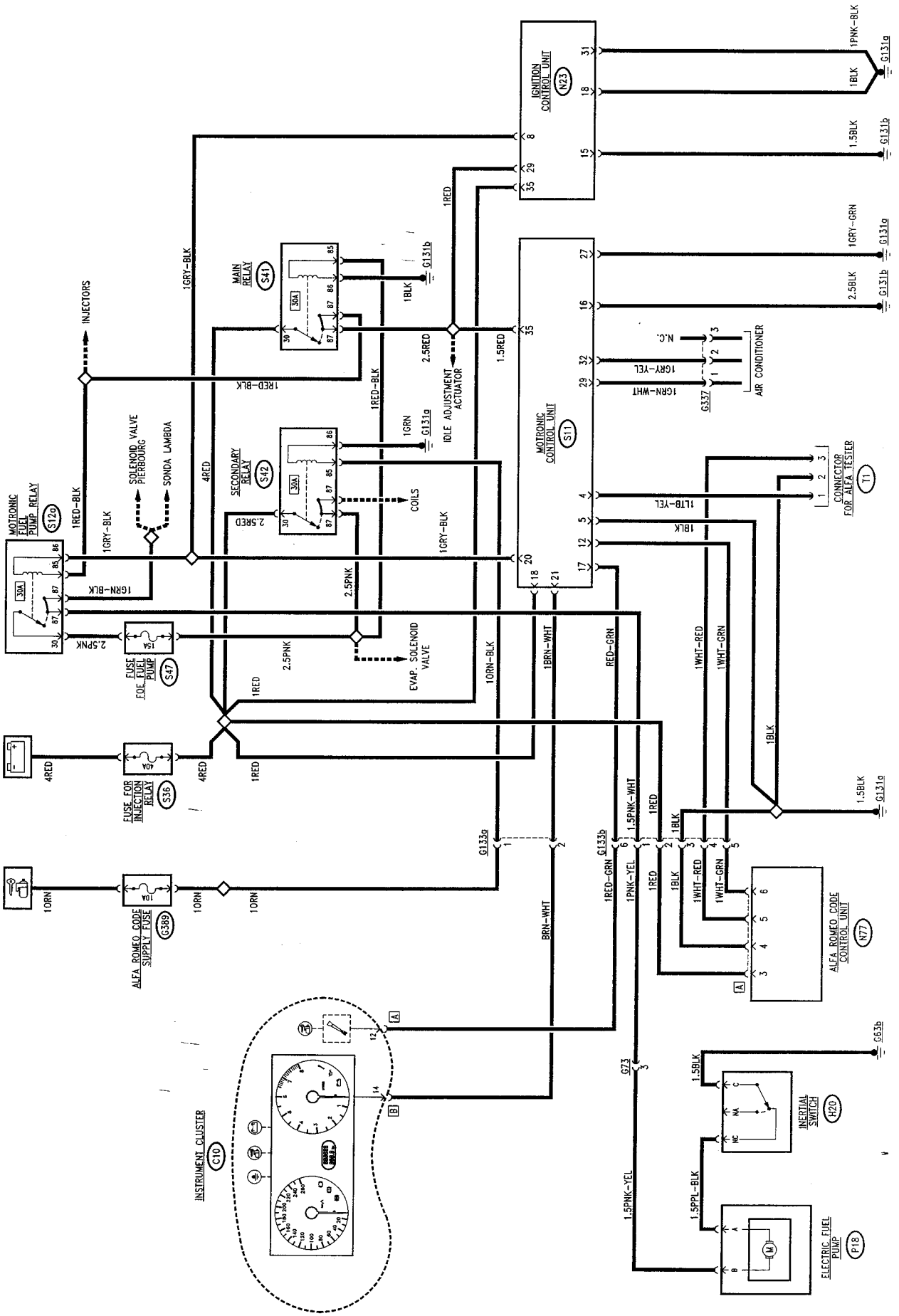
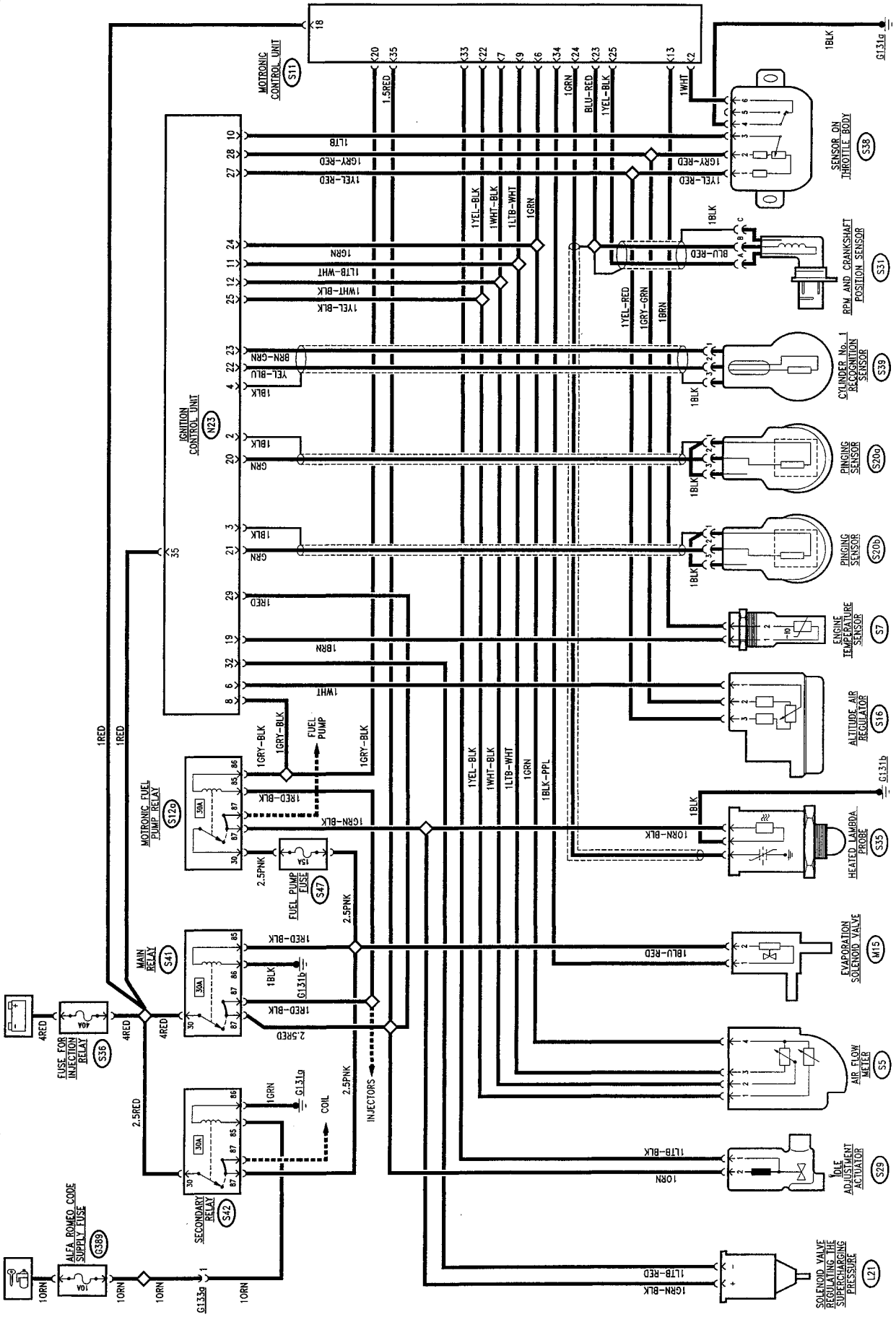
FAULT-FINDING 29C-16

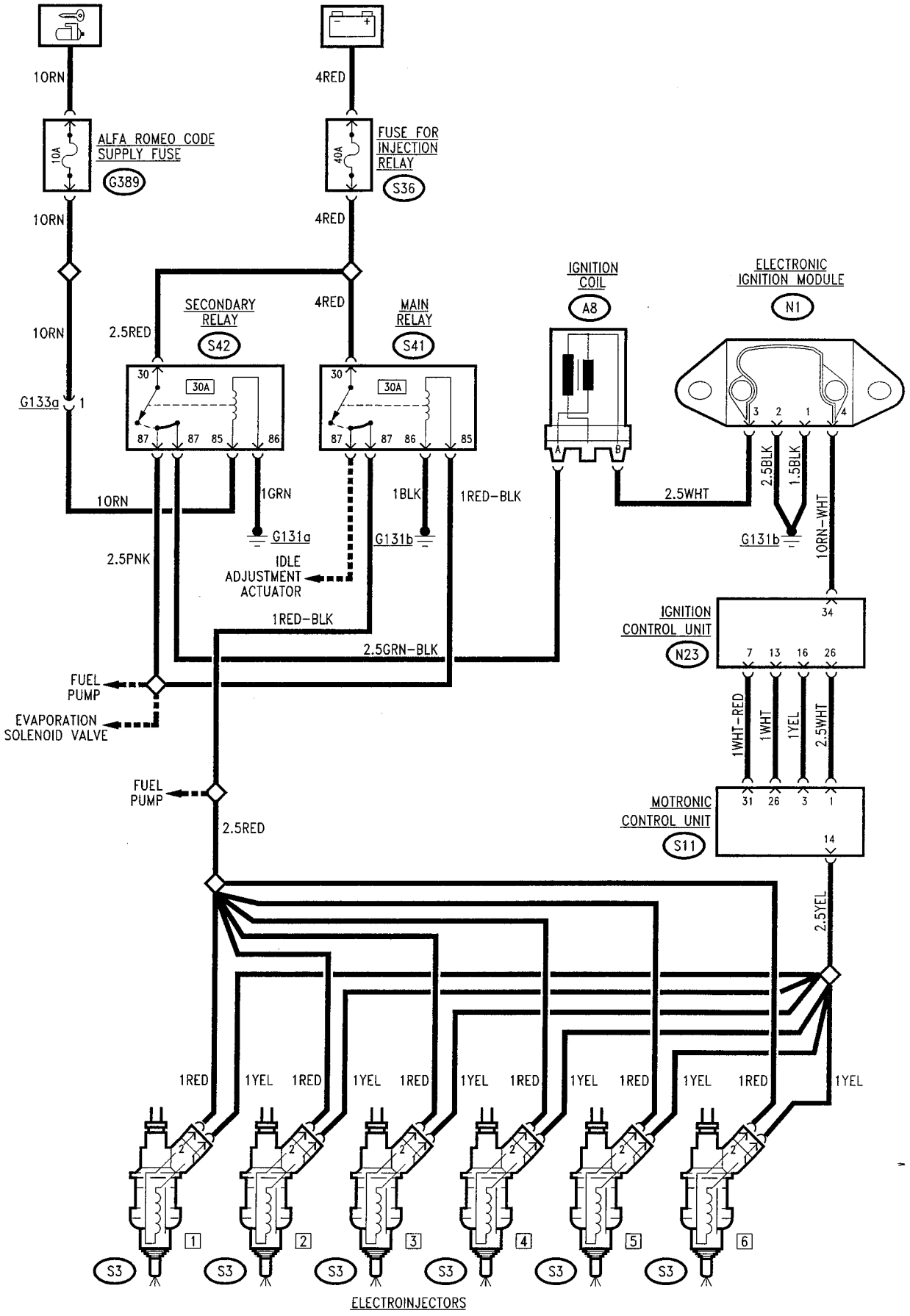
WIRING DIAGRAM A



WIRING DIAGRAM B



WIRING DIAGRAM C



GENERAL DESCRIPTION

In this system the ignition and injection functions are operated by two control units, the Motronic ML4.1 and EZ212K both made by BOSCH. The experience acquired and the continuous research developed in this sector have made it possible to bring forward an up-dated, fine-tuned system, simplifying and reducing as far as possible the data detection sensors and making the control actuators more precise and powerful. In order to optimise the performance of the vehicle during acceleration and at top speeds, in the EZ212K control unit, a new OVERBOOST function control has been implemented which makes it possible to increase the supercharging pressure according to a certain logic, while the ML4.1 control unit determines the necessary fuel enrichment.

SYSTEM FUNCTIONS

The system functions are essentially the following:

– injection times adjustment;

– spark advance adjustment;

– cold starting control;

– control of enrichment during acceleration;

– fuel cut-off during deceleration;

– constant idle speed control;

– maximum rpm limiting;

– evaporative solenoid valve control;

– lambda probe control;

– CONNECTION WITH THE alfa romeo code system.

– self-diagnosis.

Injection times adjustment

Digital technology has made it possible to optimise consumption and performance levels through programmed maps memorised inside the electronic control unit, in relation to engine rpm and load.

With the help of sensors which detect the many variables involved, the ML4.1 control unit controls the electroinjectors extremely quickly and accurately.

The injection time is mainly corrected on the basis of the battery voltage and engine temperature.

Spark advance adjustment

The gap on the phonic wheel due to the lack of two teeth gives the ML4.1 control unit a reference; each side of the subsequent tooth determines the angular position of the crankshaft. This reference is sent to the ML4.1 control unit, which, according to a map programmed inside the control unit itself and in relation to the engine rpm and load, establishes the correct advance rate. The advance determined in this way is transferred to the EZ212K control unit which, on the basis of the signals received from the pinging, temperature and throttle angle sensors, delays the advance if necessary, selectively on the cylinder that needs it.

Control of cold starting

During cold starting, the system controls the spark advance and the injection time. The spark advance depends solely on engine rpm and temperature and the advance rate is at its highest at a temperature of -30°C. The injection time is obtained from a value programmed in the ML4.1 control unit and corrected through the measurement of the intake air temperature, engine temperature, battery voltage and engine rpm. During starting, the control unit provides injection at each ignition pulse, therefore in four phases per engine cycle. Once a pre-established rpm (depending on the engine temperature) has been reached, the control unit operates injection at each turn of the crankshaft.

Control of enrichment during acceleration

Each time acceleration is required if the change in the signal of the air-flow meter exceeds a predetermined increase, the ML4.1 control unit not only adapts injection to the new requirement, but increases it further in order to quickly reach the rpm required. When nearing the established rpm, the increase of injection is gradually eliminated.

Fuel cut-off during deceleration

Fuel cut-off during deceleration is of the adapted type. With the detection of the throttle closed condition and engine speeds above 1080, fuel injection is de-activated. As the supply is lacking, the engine rpm will fall more or less rapidly according to the conditions of the vehicle. Before reaching idle speed, the dynamics of the lowering of the rpm is monitored. If this is above a certain value, the fuel supply is partially re-activated according to a logic which involves smoothly accompanying the engine to idle speed. Once this condition has been reached, the normal idle speed functions are reactivated and fuel cut-off will only be reactivated after exceeding the fuel cut-off threshold to prevent the engine from "gasping" The thresholds for resuming the fuel supply and cut off vary depending on the temperature of the engine. Another fuel cut off logic is developed inside the ML4.1 control unit which comes into operation during partial deceleration, i.e. when a lower engine load is required. This function is active only if the new condition lasts for a pre- established length of time and after adapting the ignition angle to the new situation.

Constant idle control

The adjustment of idle speed is controlled under all operating conditions by the constant idle speed actuator with single coil. When the engine is running at idle speed, the purpose of the actuator is to bring the real rpm to the nominal rpm rating acting on the throttle by-pass. In addition to controlling the idle speed, it also acts as an additional air valve and regulator for the cutting in of the air conditioner compressor. In addition to the constant idle speed actuator, idle rpm is also corrected by the adjustment of the spark angle (advance) as this has a more rapid effect.

Maximum rpm limiting

After exceeding a maximum rpm threshold (6,500 rpm) the injection of fuel is cut off to prevent the engine from over-loading.

Adaptation of idle speed with air conditioning system.

When the conditioner is turned on, the compressor absorbs power from the engine, which at idle speed would tend to stop. To avoid this drawback, 12V is supplied to pins 29 and 32 of the ML4.1 control unit which will adapt the idle speed to the new requirement for power, operating the corresponding actuator.

Evaporative solenoid valve control

The fuel vapours gathered by the various points of the circuit in a special active carbon canister are sent to the engine where they are burnt: this takes place through a solenoid valve wich is opened by the control unit only when the engine is in a condition to allow correct combustion without "disturbing" it: in fact, the control unit compensates this amount of incoming fuel by reducing delivery to the injectors.

Lambda probe control

The oxygen sensor (or "lambda" probe) informs the control unit of the amount of oxygen present at the exhaust, therefore of the correct fuel-air metering.

The optimum mixture is obtained when the lambda coefficient = 1 (optimum stoichiometric ratio).
The electric signal that the probe sends to the control unit changes abruptly when the mixture composition departs from lambda = 1. When the mixture is "lean" the control unit increases the amount of fuel and reduces it when the mixture is "fat": this way the engine always operates as far as possible around the ideal lambda rating.
The lambda probe signal is processed inside the control unit by a special integrator which prevents sharp "oscillations".
The probe is heated by an electrical resistance so that it quickly reaches the correct operating temperature (appr. 300°C)
Therefore through this probe it is possible to adjust engine carburetion accurately, thereby keeping exhaust emission within the specified limits.

Connection with the ALFA ROME CODE system

On vehicles fitted with ALFA ROMEO CODE, as soon as the Motronic control unit receives the signal that the "key is at MARCIA", it "asks" the ALFA ROMEO CODE system for consent to start the engine: this consent is only given if the ALFA ROMEO CODE control unit recognises the code of the key engaged in the ignition as correct. This dialogue between the two control units takes place on diagnosis line K already used for the Alfa Romeo Tester.

Self-diagnosis

The Motronic ML4.1 and EZ212K control units are fitted with a self-diagnosis system. In the event of a system malfunction, the control units detect the fault and, where possible, they replace the missing signals with fixed parameters. However, only the Motronic ML4.1 control unit is capable of memorising and maintaining the data also when the engine is turned off. Therefore, also the errors of the EZ212K control unit are stored in the ML4.1 control unit, via the serial line which connects them. When required by the operator, the faults can be read on the Motronic ML4.1 control unit using the Alfa Romeo Tester.

FUNCTIONAL DESCRIPTION

The engine is supplied with a Motronic ML4.1 injection and ignition system controlled by control unit **S11**. The control unit **S11** contains a memorised programme which manages the injection time and the firing of the spark plugs in relation to the engine rpm and load, the intake air temperature and the temperature of the engine. The ignition signal and the spark advance supplied by the ML4.1 control unit is optimised for each cylinder by another control unit EZ212K (**N23**) on the basis of the signals received from the pinging, engine temperature and throttle angle sensors.

All the system supplies are protected by fuse **S36** (40A), that one, key operated, by fuse **G389** (10A).

The control unit **S11** is supplied at pin 18 directly from the battery via fuse **S36**. At pin 35 it receives the "key-operated" supply from the main relay **S41**.

Pins 5, 16 and 27 are earthed.

Control unit **N23** is supplied at pin 35 directly from the battery via fuse **S36**. At pin 29 it receives the "key-operated" supply from the main relay **S41**.

Pins 15, 18 and 31 are earthed.

The control unit **S11** activates the electric fuel pump through relay **S12a**: this relay is energized when pin 20 of the control unit is connected to earth; the relay supply line is protected by a special fuse **S47** (15A).

In addition, the earth to the pump **P18** passes through the inertial switch **H20** which cuts off the circuit in the event of a crash.

The control unit **S11** calculates and controls the opening time of the electroinjectors **S3** (pin 14) on the basis of the internal programme and the information received from the different sensors.

The engine speed is supplied at pin 23 and 25 of the control unit **S11** from the rpm and timing sensor **S31**: this sensor is inductive and detects the changes in the magnetic field caused by the teeth (suitably positioned) of a phonic wheel integral with the crankshaft.

The sensor on the throttle body with potentiometer **S38** makes it possible to inform the injection control unit **S11** (pin 2) on the idle speed condition (from 0 to 1 degree of throttle opening); it also informs the ignition control unit **N23** on the throttle position angle operated by the accelerator (slider of potentiometer of **S38** connected to pin 10 of **N23**).

This parameter is used to change the spark advance.

The engine coolant temperature sensor **S7** is an NTC (Negative Temperature Coefficient) resistance which supplies control unit **S11** (pin 13) and control unit **N23** (pin 19) information about the engine temperature.

The air-flow meter **S5** measures the flow rate of the air admitted to the engine and supplies control unit **S11** (pin 7) and control unit **N23** (pin 12) a signal which enables correct metering of the fuel. The signal is generated by a potentiometer which transmits a voltage to the control units corresponding to the angle of a mobile port.

The air temperature sensor (NTC) located inside the air-flow meter **S5** measures the intake air temperature (pin 22 of **S11** and pin 25 of **N23**).

The electroinjectors **S3** are operated in parallel by the control unit **S11** via pin 14 from relay **S41** on the basis of all the parameters received from control unit **S11**.

When the throttle is closed or only slightly open, control unit **S11** (pin 33) commands a flow of air through the constant idle speed actuator **S29** which acts as a throttle body by-pass line. The constant idle speed actuator S29 is controlled by a part of the programme of control unit **S11** and it is used to maintain idle speed at a constant rate under all operating conditions of the engine.

The ignition control system is integrated in control unit **S11** and makes it possible to adjust the spark through a memorised programme.

The command signal is sent from pin 1 of **S11** to control unit **N23** (pin 26). Control unit **N23** allows adjustment of the spark advance optimising the yield of each cylinder through information on the magnitude of vibrations of the actual cylinder leading from the two pinging sensors **S20a** and **S20b** (pin 20 and 21). The recognition of the cylinder in question is obtained through the magnetic sensor **S39** (pin 22 and 23) fitted on the exhaust camshaft. Account is also taken of the altitude at which the engine is operating via sensor **S16** (pin 6).

The output of the control unit **N23** (pin 34) is sent to a power module **N1** and from this (pin 3) to the ignition coil **A8**.

The evaporative valve **M15**, supplied at +12V, is opened by control unit **S11** only when the ignition key is at MARCIA and the engine is under load; conversely, it is closed when the engine is cold or running at idle speed (command from pin 34).

The pre-heated lambda probe **S35**, placed in contact with the exhaust gas, generates an electric signal, the rating of which depends on the concentration of residual oxygen in the actual exhaust gas. This signal is characterised by an abrupt change when the air-fuel mixture is less than perfect. When the voltage of the signal of the probe **S35** is low, the control unit detects that the mixture is lean and slightly increases the fuel injected. When the voltage of the signal at pin 24 of **S11** is high, the control unit detects that the mixture is rich and slightly reduces the fuel injected. The heated lambda probe **S35** is heated by a resistance supplied by relay **S12a** only when the ignition key is in the MARCIA position.

When the air conditioning system is activated a 12V current is applied at pin 29 and 32 of control unit **S11**. Control unit **S11** then adjusts the engine idle speed taking account of the new need for power due to the cutting in of the air conditioner.

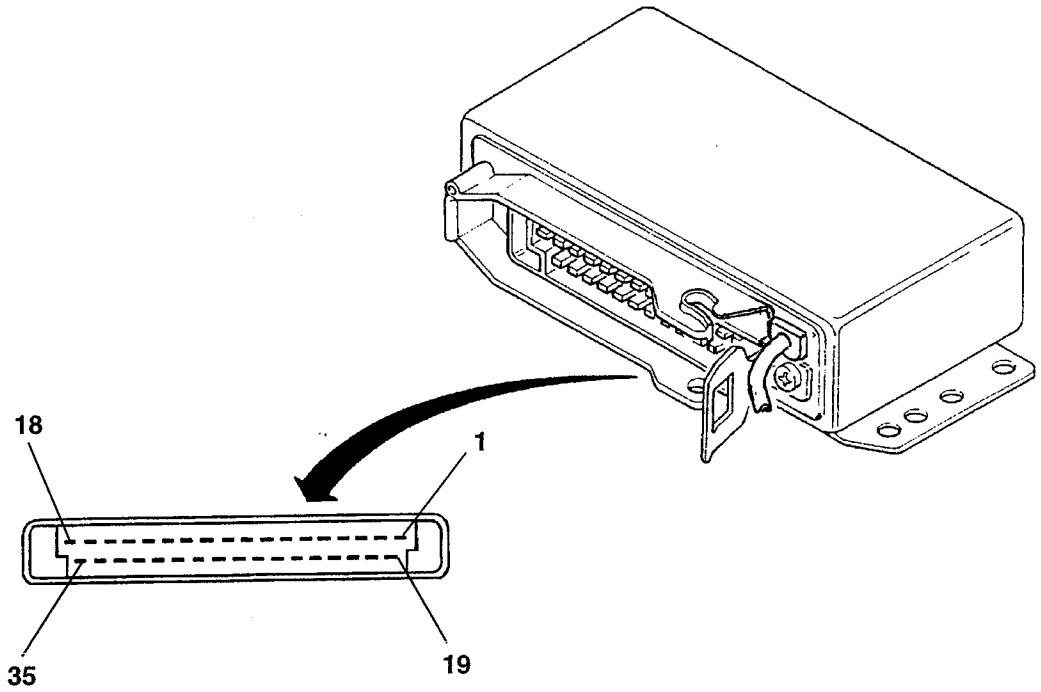
In the case of a heavy need for power, the injection control unit **S11** makes it possible to modulate the opening of the wastegate valve through a Pierburg valve **L21**.

From pin 21 the control unit **S11** sends a "pulse" signal proportionate with the engine rpm to the instrument cluster **C10**; the signal for the diagnosis "Check Engine" warning light on the instrument cluster **C10** leads from pin 17.

Control unit **S11** is connected by pin 12 with the ALFA ROMEO CODE control unit **N77** through diagnosis line K; this way if the ALFA ROMEO CODE does not detect a correct "key code" it will not give consent to the Motronic control unit which will not start the engine.

Control unit **S11** possesses a self-diagnosis system which can be used connecting with the ALFA ROMEO Tester at connector **T1**; it receives the fault signals of the control unit through diagnosis lines L - pin 4 and K - pin 12 (line K is also used by the ALFA ROMEO CODE system).

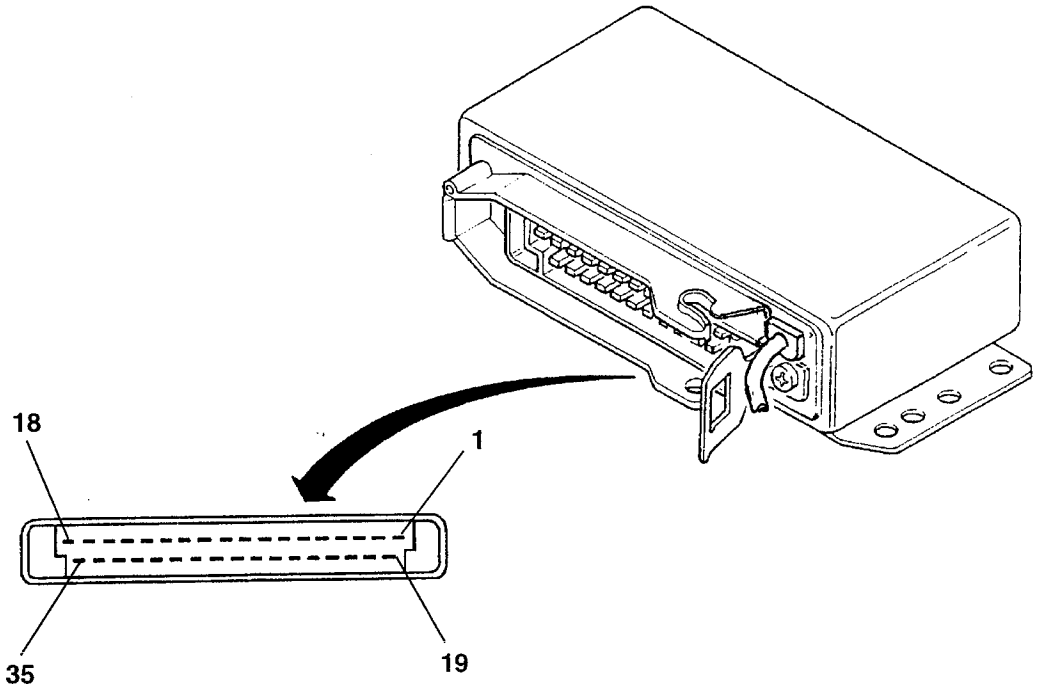
MOTRONIC ML4.1 ELECTRONIC CONTROL UNIT (S11)



CONTROL UNIT PIN-OUTS

1. to pin 26 of N23
2. switch on throttle body
3. to pin 16 of N23
4. diagnosis line L
5. earth
6. air-flow meter
7. air-flow meter
8. N.C.
9. air-flow meter
10. N.C.
11. N.C.
12. diagnosis line K- ALFA ROMEO CODE
13. water temperature sensor
14. electroinjectors
15. N.C.
16. earth
17. "Check Engine" warning light
18. supply from battery
19. N.C.
20. fuel pump command
21. rpm signal
22. air temperature sensor
23. rpm and timing sensor
24. lambda probe
25. rpm and timing sensor
26. to pin 23 of N23
27. earth
28. N.C.
29. climate control command
30. N.C.
31. to pin 7 of N23
32. climate control command
33. idle speed actuator
34. evaporative solenoid valve
35. key-operated supply

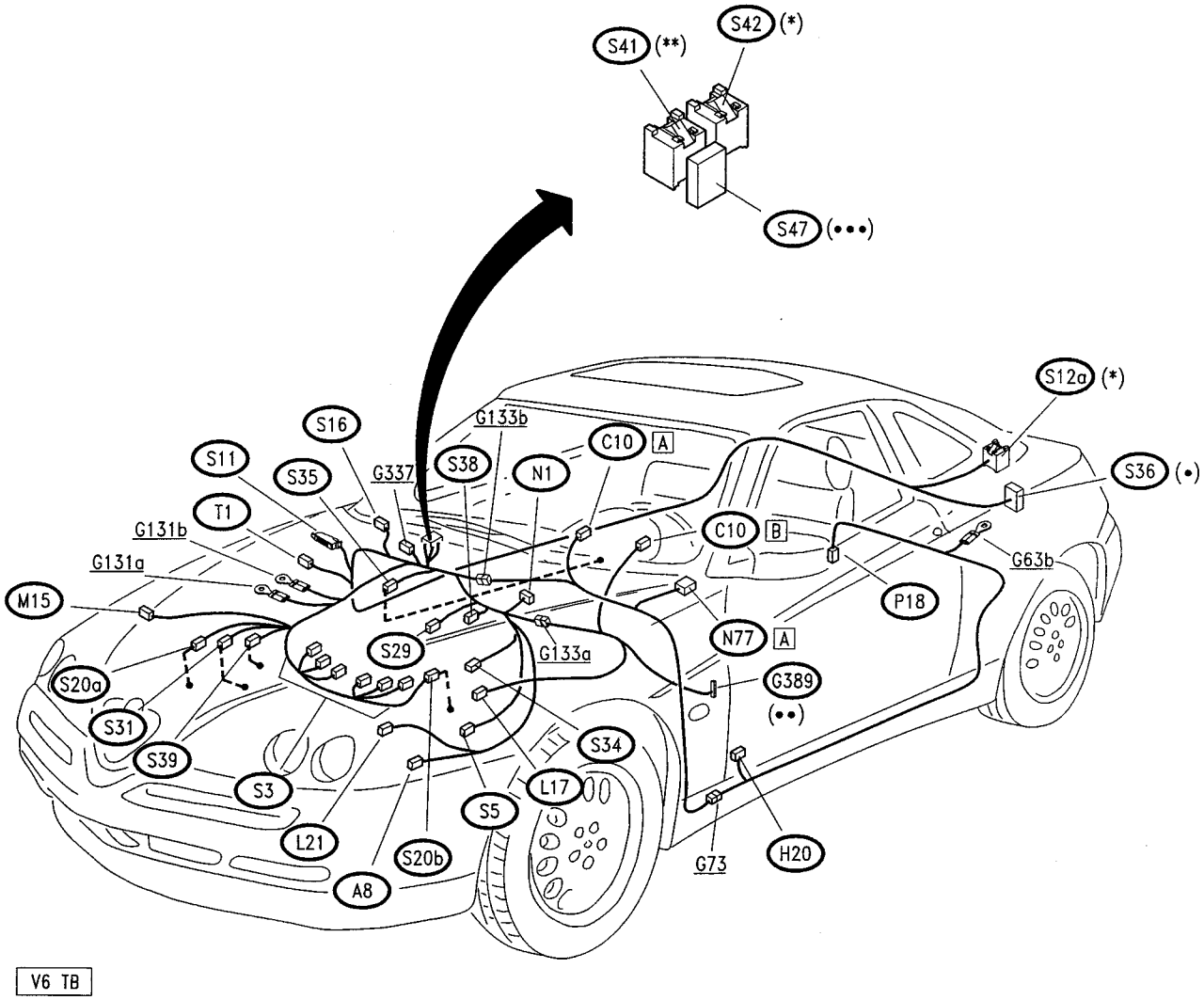
ELECTRONIC IGNITION CONTROL UNIT EZ2121K (N23)



CONTROL UNIT PIN-OUTS

1. N.C.
2. pinging sensor no. 1
3. pinging sensor no. 2
4. cyl.no. 1 detection sensor
5. N.C.
6. altitude sensor
7. to pin 31 of **S11**
8. fuel pump relay
9. N.C.
10. throttle potentiometer
11. air-flow meter
12. air-flow meter
13. to pin 26 of **S11**
14. N.C.
15. earth
16. to pin 3 of **S11**
17. N.C.
18. earth
19. water temperature sensor
20. pinging sensor no. 1
21. pinging sensor no. 2
22. cyl. no. 1 detection sensor
23. cyl. 1 detection sensor
24. air-flow meter
25. air temperature sensor
26. to pin 1 of **S11**
27. throttle potentiometer
28. throttle potentiometer
29. key-operated supply
30. N.C.
31. earth
32. Pierburg valve
33. N.C.
34. ignition module
35. battery supply

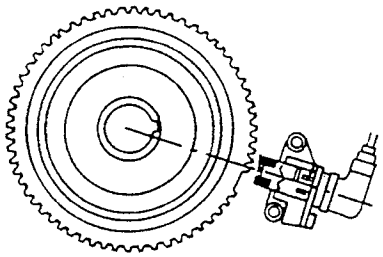
LOCATION OF COMPONENTS



(•) Black Fuseholder
(••) Red Fuseholder
(•••) Blue Fuseholder
(*) Black Base
(**) Grey Base

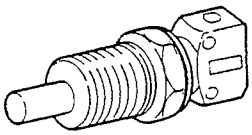
CHECKING COMPONENTS

Rpm and timing sensor (S31)



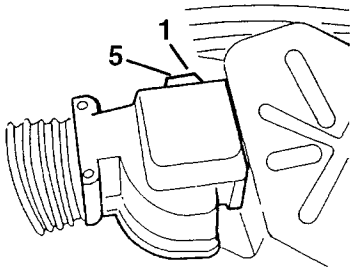
SPECIFICATIONS	
Sensor winding resistance at 20°C	~ 540 Ω
Distance (gap) between sensor and phonic wheel	0.5 ÷ 1.5 mm

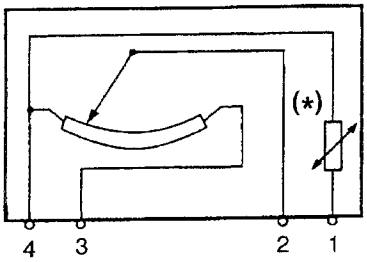
Engine temperature sensor (S7)



SPECIFICATIONS	
Temperature (°C)	Resistance (Ω)
- 10°C	8100 ÷ 10770 Ω
+ 20°C	2280 ÷ 2720 Ω
+ 80°C	292 ÷ 362 Ω

Air flow meter (S5)



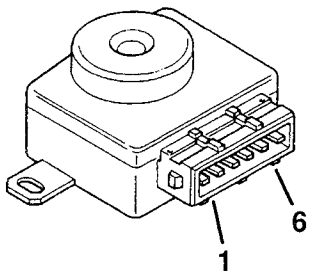


SPECIFICATIONS	
Voltage between Pin 2 e 4:	
with port shut (without air flow)	100 ÷ 300 mV
manually operating the port the voltage gradually increases up	to 4.5V

pin 1 - air temperature signal
pin 2 - air flow rate signal
pin 3 - 5V supply
pin 4 - reference earth

NOTE: The air temperature sensor (*) is incorporated in the air-flow meter

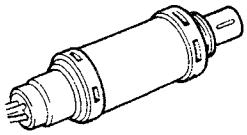
Throttle position sensor (S38)



SPECIFICATIONS
Voltage between pin 2 and 3:
The voltage changes from 0.5V (throttle closed) to 4.5V (throttle open) with no intermediate steps.

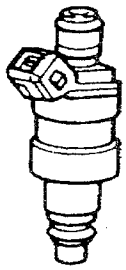
pin 1 - 5V supply
pin 2 - reference earth
pin 3 - throttle opening signal
pin 4 - earth
pin 5 - N.C.
pin 6 - idle switch signal (throttle closed)

Lambda probe (S35)



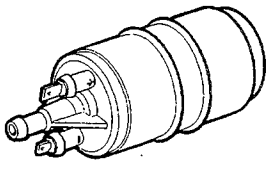
SPECIFICATIONS	
Heating resistance	3 Ω

Electroinjectrors (S3)



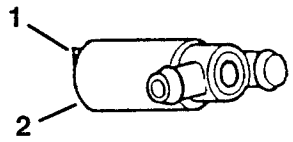
SPECIFICATIONS	
Winding resistance	15.9 ± 0.35 Ω

Fuel pump (P18)



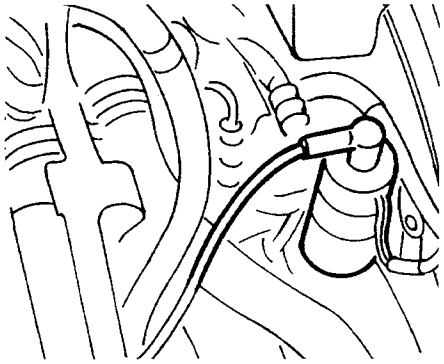
SPECIFICATIONS	
Flow rate	≥ 120 l/h
Pressure	4 bar
Nominal voltage	12V

Idle speed adjustment actuator (S29)



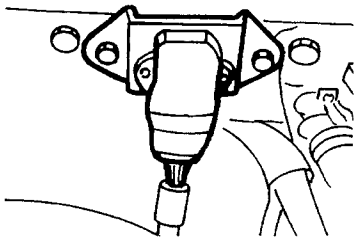
SPECIFICATIONS	
Resistance between terminals 1and 2	~ 8 Ω

Ignition coil (A8) / Distributor



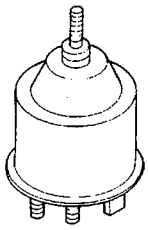
SPECIFICATIONS	
Primary resistance	0.7 ÷ 0.8 Ω
Secondary resistance	5.4 ÷ 6.6 kΩ
Distributor brush resistance	~ 1.1 kΩ

Ignition module (N1)



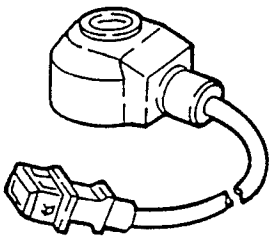
pin 1 - earth
pn 2 - earth
pin 3 - 12V at coil
pin 4 - control circuit

Pierbourg valve (L21)



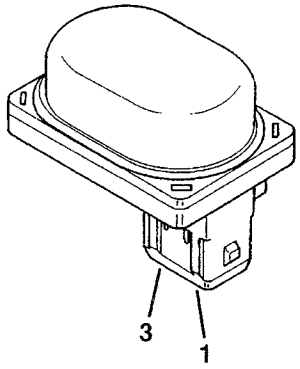
SPECIFICATIONS	
Ohmic resistance of winding	~ 30 Ω

Pinging sensor (S20a) (S20b)



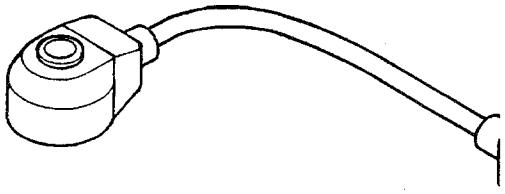
SPECIFICATIONS		
Resistence between terminals		> 20 kHz
Indipendence		≥ 1 MΩ
Vibration allowed	for long periods	≤ 80 g
	for short periods	≤ 400 g

Altitude sensor (S16)



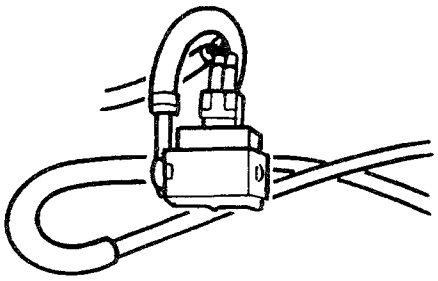
SPECIFICATIONS	
Resistence between	
pin 2 - 3	2 ÷ 3 KΩ
pin 1 - 2	0.5 ÷ 4.5 kΩ below 1.200m 2.5 ÷ 6.5 kΩ abow 1.200m

1st cylinder detection sensor (S39)



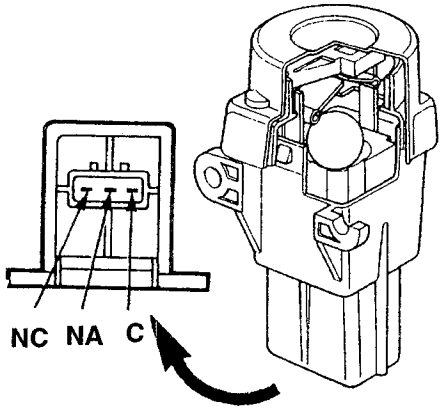
SPECIFICATIONS	
Resistence between pin 1 and 2	0.3 Ω

Evaporative solonoid valve (M15)



SPECIFICATIONS	
Flow rate (with voltage of 13.5V and vacuum of 0.6 bar)	≥ 4500 dm^3/h

Inertial switch (H20)



SPECIFICATIONS
Check the continuity between pins N.C. and C.: this continuity is connected by pressing the special pushbutton

FAULT-FINDING

The control unit possesses a self-diagnosis system which continuously monitors the signals leading from the different sensors for plausibility and compares them with the allowed limits: if these limits are exceeded the system detects a fault, memorizes it and turns on the warning light on the instrument cluster.
For certain parameters the control unit replaces the abnormal values with suitable mean values to enable the car to "limp" to a point of the Service Network.
These "recovery" values depend on the other correct signals and are defined each time by the operating logic of the control unit.
The self-diagnosis system also makes it possible to quickly and effectively locate faults by connection with the ALFA ROMEO TESTER, through which all the errors memorised may be "read". It is also possible to check the operating parameters recorded by the control unit and command the engagement of the single actuators to check whether they are working properly.

Diagnosis using the ALFA TESTER

N.B. Before carrying out diagnosis with the Tester, make the preliminary check given on the next page (TEST A).

The Tester and the control unit should be connected as follows:

1. Power the Tester either through the cigar lighter socket or connecting it directly to the battery using the special cable.
2. Connect the Tester socket to that of the control unit (the socket is to be found next to the control unit).

The Tester can give the following information:

- display of parameters;
- display of errors;
- active diagnosis.

Error clearing

Before ending diagnosis the contents of the "permanent" memory are erased using the Tester.

PRELIMINARY CHECK OF THE BOSCH M 4.1 SYSTEM	TEST A

NOTE: Check beforehand that the ALFA ROMEO CODE is working properly which might have cut off the supply to the system!

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
A1 CHECK FUSE – Check intactness of fuses **S36**, **S47** and **G389**	OK ▶	Carry out **step A2**
	~~OK~~ ▶	Change fuses **S36**: 40A **S47**: 15A **G389**: 10A
A2 CHECK VOLTAGE – Check 12V at pin 30 of relays **S41** e **S42**	OK ▶	Carry out **step A3**
	~~OK~~ ▶	Restore the wiring between the battery **A1** and relays **S41** and **S42**
A3 CHECK VOLTAGE – With the key turned, check for 12V at pin 85 of relay **S42**	OK ▶	Carry out **step A4**
	~~OK~~ ▶	Change any faulty relays
A4 CHECK RELAYS – Check the correct operation of relays **S41**, **S42** and **S12a**	OK ▶	Carry out **step A5**
	~~OK~~ ▶	Change any faulty relays
A5 CHECK CONTROL UNIT SUPPLY – Check for 12V at pin 18 of **S11**; with the key turned 12V also at pins 35 of **S11** and at pin 29 of **N23**	OK ▶	Carry out **step A6**
	~~OK~~ ▶	Restore the wiring between control units **S11** and **N23** and the relays and between the control units and fuse **S36**
A6 CHECK EARTH – Check for an earth at pins 16 and 27 of **S11** and at pins 15, 18 and 31 of **N23**. Also check for an earth at pin 86 of S42 and pin 86 of **S41**	OK ▶	**CONTINUE DIAGNOSIS USING THE ALFA ROMEO TESTER**
	~~OK~~ ▶	Restore thre wiring between **S11, N23** and the relay and earth **G131**

CONTROL SYSTEM - 3.0 V6 24v engine: BOSCH MOTRONIC M3.7.1

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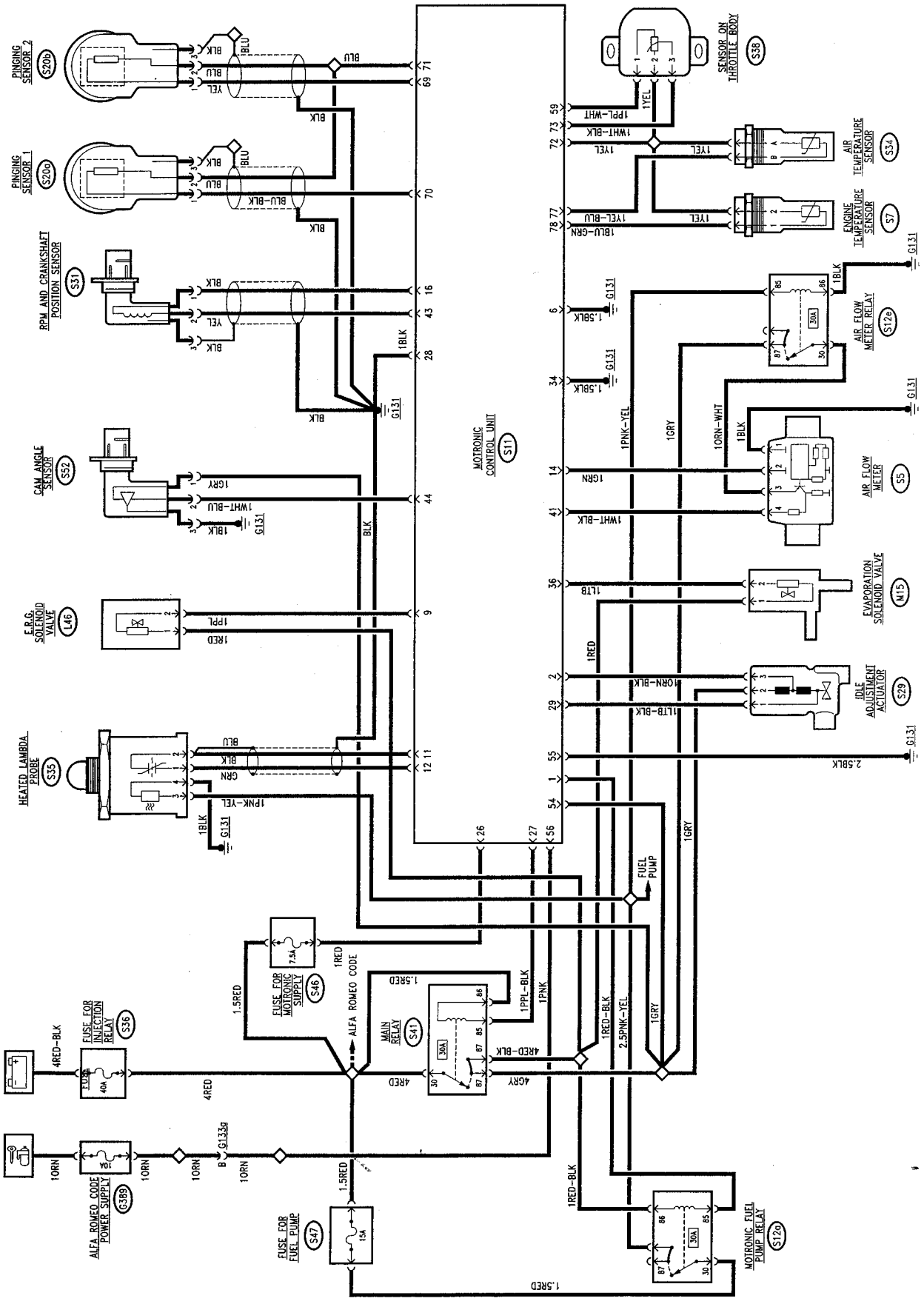
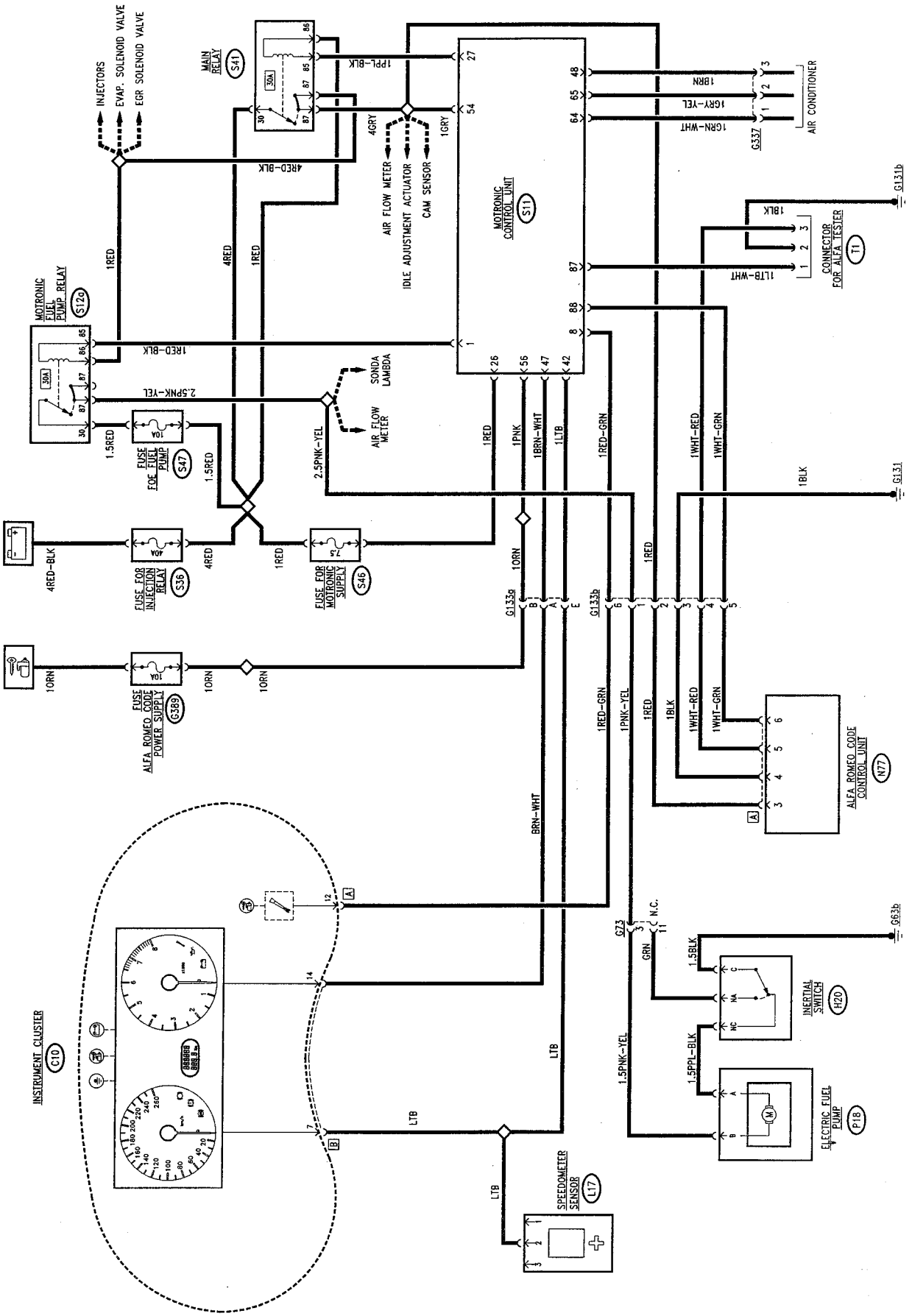
WIRING DIAGRAM A



WIRING DIAGRAM B



WIRING DIAGRAM C