ANTI-LOCK BRAKING SYSTEM (Bosch "ABS" - 2SH)

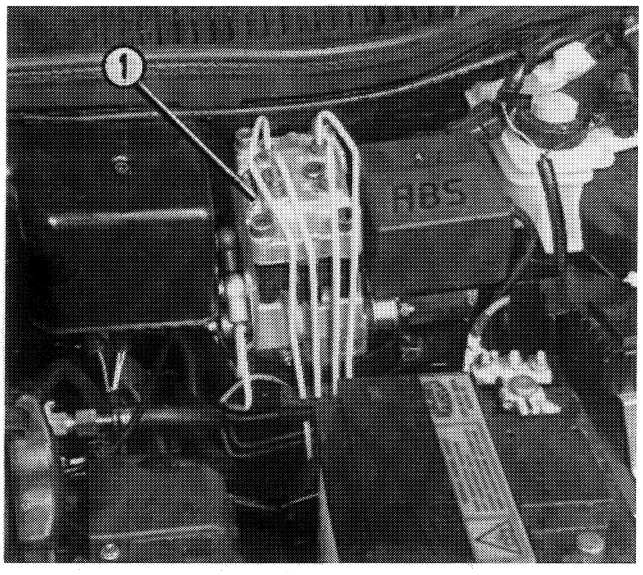
The purpose of this device is:

- to ensure greater stability and steering capacity during braking under the most difficult conditions (for example in cases of low grip on the road surface, gravel or broken road);
- to optimize the braking space, making the maximum use of the available grip.

It comprises the components of the conventional braking system and also the following components:

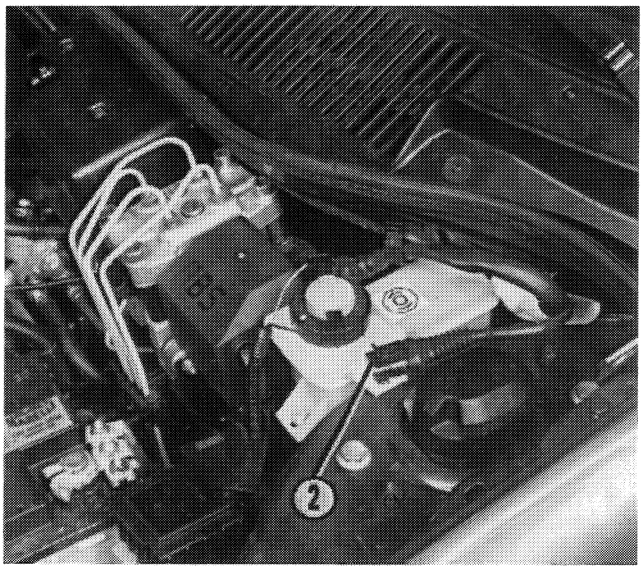
1. Hydraulic control unit with built-in electronic control unit
2. 4 rpm sensors (1 per wheel)
3. Red warning light located on the control panel which comes on to indicate a system fault
4. Stop lights switch
5. System fuse (10A)
6. Diagnostic socket for Fiat-Lancia Tester

LAYOUT OF THE COMPONENTS IN THE VEHICLE



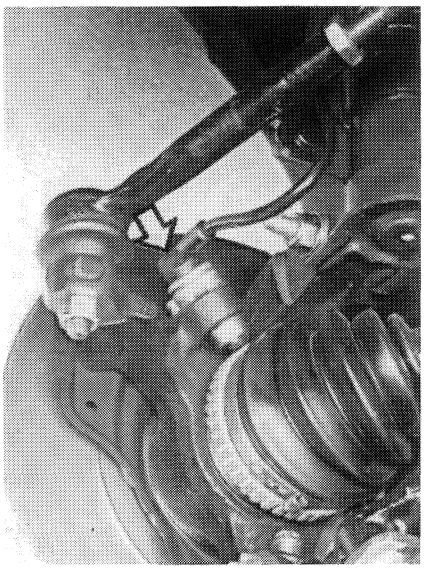
P3M044D01

1. Hydraulic control unit with built-in electronic control unit



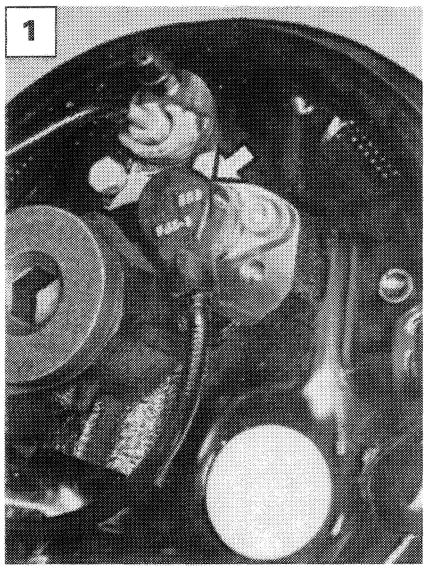
P3M044D02

2. Diagnostic socket for Fiat-Lancia Tester

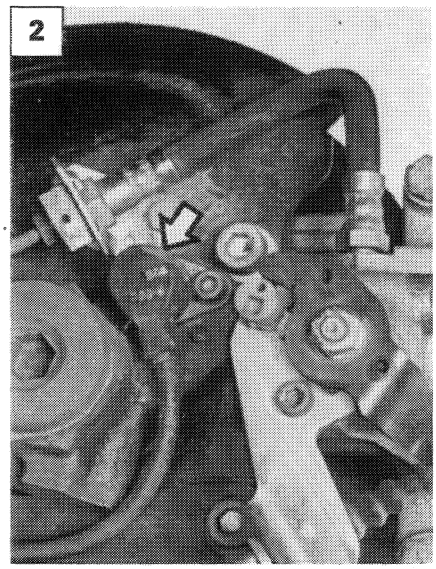


P3M045D01

Position of front wheel rpm sensor



P3M045D02

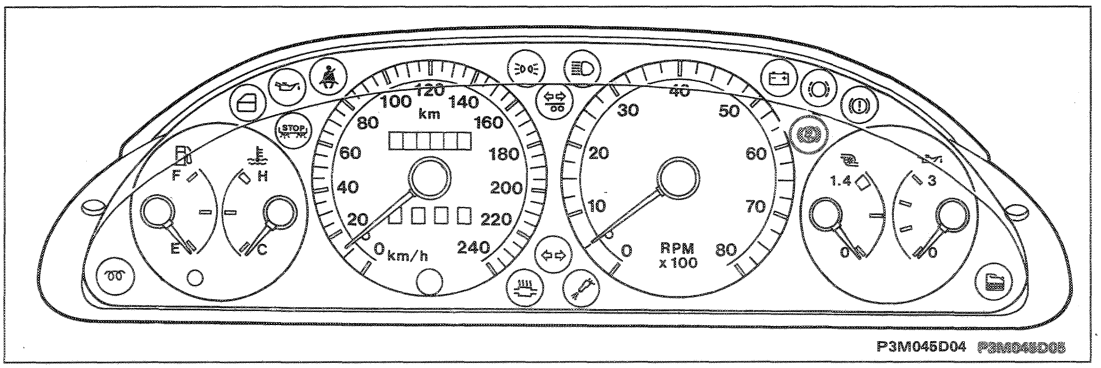


P3M045D03

Position of rear wheel rpm sensor

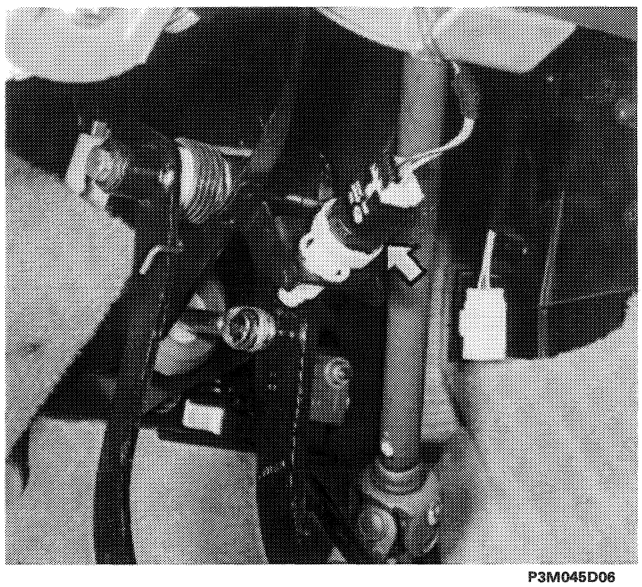
1 **Rear drum brakes**

2 **Rear disc brakes**



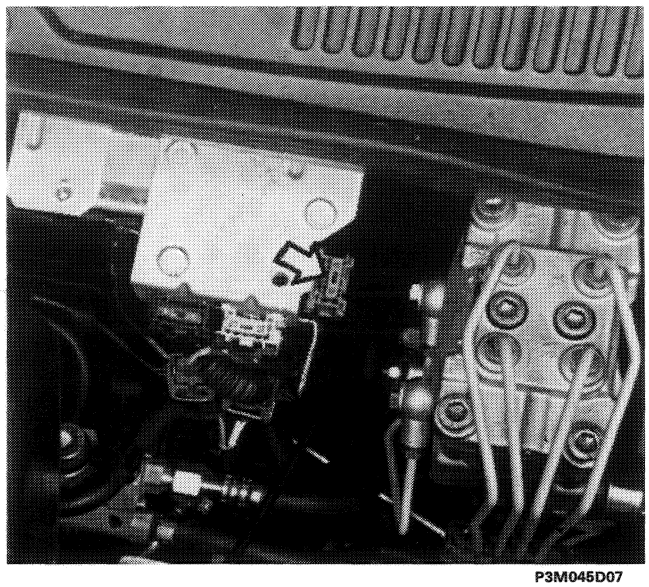
P3M045D04 P3M045D05

ABS failure warning light



P3M045D06

Stop lights switch



P3M045D07

ABS circuit fuse

ELECTRONIC CONTROL UNIT

The electronic control unit comprises printed circuits with resistors, diodes, transistors and integrated logic circuits.

It is fitted on the hydraulic control unit and is connected to the anti-lock braking system via a multiple connector.

In functional terms the electronic control unit may be divided into two parts, which are actually two separate, but identical, computers:

1. sections which process signals and logic
2. safety circuits

Both receive the same input signals which each processes on its own behalf; only when the results are identical does the electronic control unit issue the operating command to the hydraulic control unit.

If the above does not happen, there is clearly a fault in the anti-lock braking system; the system therefore **automatically switches itself off and braking takes place in the conventional manner. At the same time, the ABS fault warning light located on the control panel comes on.**

In the computer section, the signals transmitted by the rpm sensors are transformed into signals that can be used by the logic section so that it can recognize the acceleration, deceleration and "creep" values of the individual wheels.

NOTE *The peripheral speed of a wheel under braking reduces to a greater extent than the car speed; at worst, if the wheels lock completely under the braking action (peripheral wheel speed = 0) and the car is still moving, the difference between these two speeds is at its maximum.*
This difference is called "creep" or skid coefficient when expressed as a percentage.
Creep 0% = free wheel
Creep 100% = wheel locked and car moving
During braking, the braking friction increases when braking occurs with low creep values (rolling) and subsequently decreases when the sliding of the tyre becomes more marked until the wheel locks.
A number of practical tests and experiments have shown that in general, it is possible to reach the maximum braking effort with "creep" values of between 5% and 15%, and a maximum of 20%. This delimits an optimum range within which the anti-lock braking system tends to reconduct any type of car.

The logic section compares the signals received and transmits the adjustment instructions to the three solenoids located in the hydraulic control unit. If there is no braking action, the electronic control unit recognizes the vehicle's speed from the sensors' signals.

When the driver presses the brake pedal, the wheels decelerate, possibly to different degrees in relation to each other; from the combination of the wheels' individual speeds, a reference speed is worked out. This is stored in memory and constantly updated, and can roughly indicate the vehicle's speed at each moment of braking.

By comparing the speeds of the individual wheels with the reference speed, the skid signal of each individual wheel is constantly monitored.

The braking force can increase until the skid of one wheel is greater than that of the others. When this happens (a "split" situation) the electronic control unit issues the command to the hydraulic control unit's solenoids which have to intercept the braking force on the wheel which signalled a loss of grip. The wheel in question then accelerates again.

The electronic control unit also stores in its internal memory deceleration and acceleration thresholds which each individual wheel must never exceed. The rolling of the tyre during braking is thus monitored by a systematic, continuous and very rapid comparison of the wheel's skid, deceleration and acceleration values. As soon as the acceleration/deceleration, deceleration/acceleration skid and combined "split" thresholds are exceeded, the electronic control unit intervenes and controls the solenoids of the hydraulic control unit in the three adjustment stages: **increase in pressure - reduction in pressure - maintenance of pressure.**

These stages provide an intermittent but extremely fast adjustment cycle which is repeated until the vehicle stops.

The electronic control unit controls the various stages, supplying pulses of different current values to the solenoids.

It also applies to both rear wheels the same braking force that the computer supplies to the rear wheel which is most likely to become locked, i.e. the wheel with the least grip on the ground.

Usually the system stops intervening at speeds below 5 km/h to permit full locking of the wheels when the vehicle is stopped.

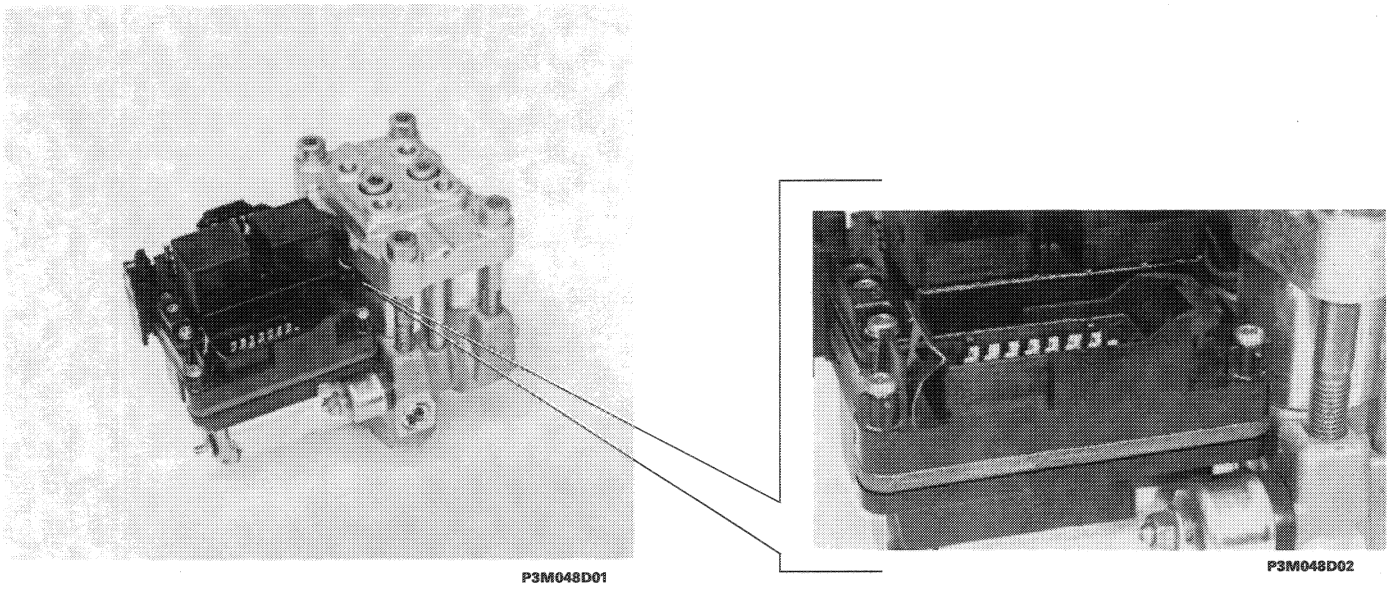
NOTE *Since the parameters controlled by the electronic control unit (wheel speed and acceleration) are affected by the inertia of the rim-tyre assembly, cars equipped with the anti-lock braking system* ***must be fitted only with the rims, tyres and brake pads recommended by the Manufacturer.***

In an aquaplaning situation, the electronic control unit already detects from the rpm sensors a faulty condition during normal, non-braking operation, since the driving wheels tend to turn at a higher speed than the vehicle's speed, while the driven wheels are slower.
This condition would involve the central control unit providing an adjustment cycle which did not meet the requirements. For this reason the anti-lock braking system automatically switches itself off temporarily (without the warning light necessarily coming on, since it is for such a short time) and switches itself on again as soon as the aquaplaning ends.

The electronic control unit also carries out the following self checks:

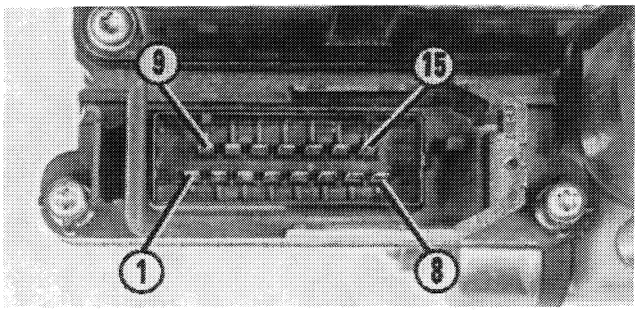
1. For about 2 seconds after the ignition has been switched on, it monitors the operation of the two computers and the relays which actuate the solenoids and the recycling pump motor;
2. After about 2 seconds and up to a speed of approximately 15 km/h, it detects the current variations on the solenoids, monitors the operation of the recovery pump motor and checks that the signals from the rpm sensors are correct;
3. Whenever the vehicle stops and moves off again, up to a speed of about 25 km/h, it measures the current variation and checks that the signals from the rpm sensors are correct;
4. During driving, it constantly compares the actual speed of the wheels with the reference speed stored in its memory, checks the memory condition and supervises the operation of the two relays;
5. During driving, it constantly monitors the battery voltage.

If any of these faults is detected, the anti-lock braking system switches itself off, and this is indicated to the driver by the warning light on the control panel coming on.

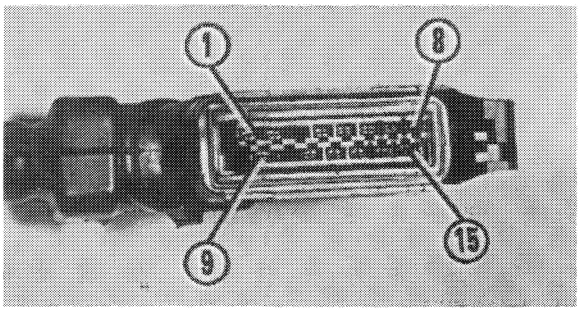

P3M048D01

P3M048D02

Location of electronic control unit



P3M048D03



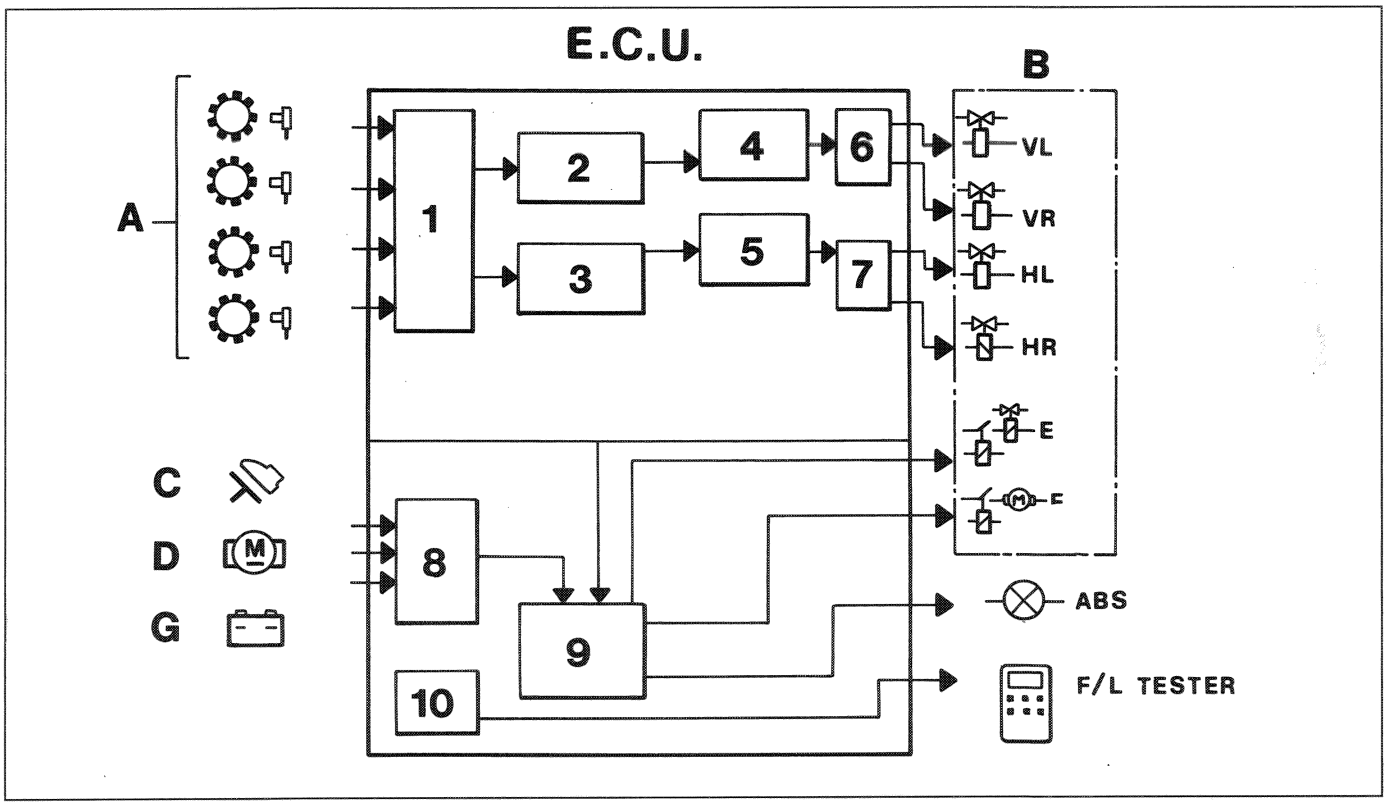
P3M048D04

Identification of the terminals on the electronic control unit and the relevant connector

N°	wire colour	Destination	N°	wire colour	Destination
1	AR	To system fault warning light on control panel	9	RN	To stop lights switch
2	M	To rear left rpm sensor	10	-	Free
3	-	Free	11	V	To front right rpm sensor
4	G	To rear left rpm sensor	12	AB	To Fiat-Lancia Tester diagnostic socket
5	M	To front right rpm sensor	13	R	To front left rpm sensor
6	R	To rear right rpm sensor	14	M	To rear right rpm sensor
7	M	To front left rpm sensor	15	BR	To Fiat-Lancia Tester diagnostic socket
8	-	Free			

Operation of the electronic control unit

The rpm sensors (A) generate an alternating voltage which is sent to an amplifier (1), located inside the electronic control unit.
The amplifier generates a square-wave signal which is sent to the computers (2) and (3), which calculate the speed of the wheels and that of the vehicle.
If the wheels are tending to lock, the computers (2) and (3) drive the current regulators (4 - for the front wheels) and (5 - for the rear wheels). These regulators generate control signals which are sent to the final stages (6) and (7), which earth the circuit of the solenoids VL - VR (front) and HA (rear) located in the hydraulic control unit (B).
The module (8) receives the signal from the stop lights switch (C) and checks its electrical connection; it also checks the supply voltage to the recycling pump motor (D) and sends information to the module (9), which is responsible for: earthing the solenoid relays (E) circuit and the recycling pump control (F) circuit, stabilizing the battery (G) voltage and managing the operation of the system fault warning light.
The purpose of the module (10) is to transmit data to the Fiat-Lancia Tester.



P3M049D01

Automatic diagnosis

The electronic control unit has an automatic diagnosis system which monitors the main components of the ABS system and, if there are any faults, disables the ABS system and ensures conventional braking.

Diagnosis with Fiat-Lancia Tester

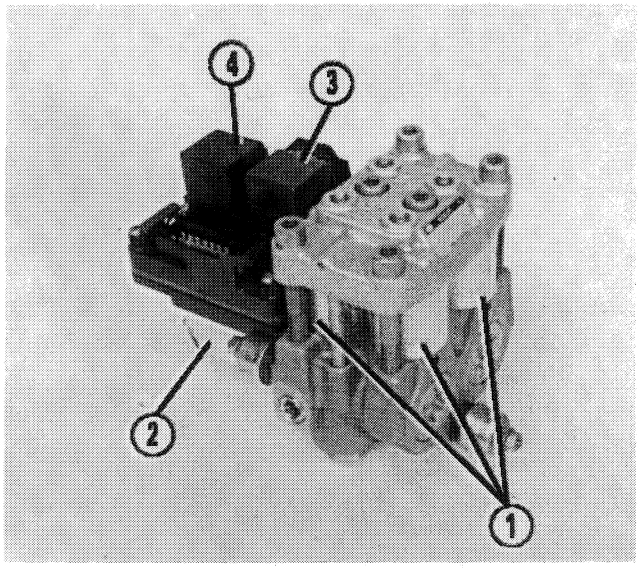
Faults in the components of the anti-lock braking system may be sought and identified using the Fiat-Lancia Tester via a specific memory.

HYDRAULIC CONTROL UNIT

The hydraulic control unit comprises the following components:

1. 4 solenoids
2. 1 recycling pump for the two sections of the hydraulic circuit with ball type inlet valves
3. 1 recycling pump relay
4. 1 safety and solenoid supply relay

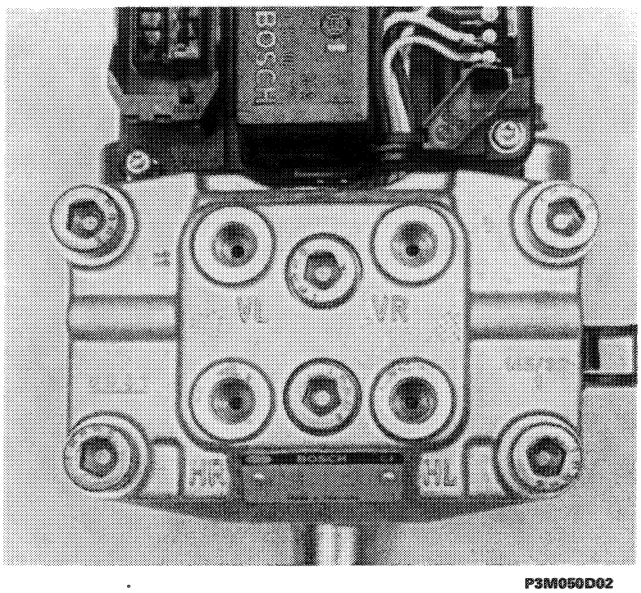
The hydraulic control unit varies the pressure of the brake fluid in the caliper pistons (or rear wheel cylinders) in accordance with the control signals coming from the electronic control unit.
The electronic control unit drives both the solenoids and the recycling pump in accordance with the signals it receives from the four rpm sensors.
The solenoids are of the 3-position type, and they receive instructions from the electronic control unit by means of a signal whose varying current makes them assume the different positions.
0 Ampere = Pressure increase stage
1.9-2.3 Ampere = Pressure maintenance stage
4.5-6 Ampere = Pressure reduction stage
The accelerator pump is actuated, via the relevant relay, by the electronic control unit during operation of the anti-lock braking system. This pump enables brake fluid to be recycled during the pressure reduction stage, making it available again upstream of the solenoid for the subsequent pressure loading.
The accumulators allow the brake fluid to be absorbed during the pressure discharge stage.



P3M050D01

View of hydraulic control unit assembly

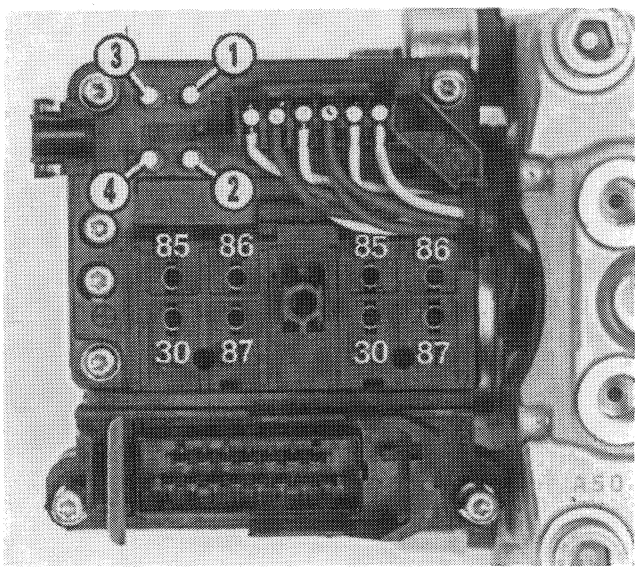
1. Solenoids for front and rear wheel brake circuit
2. Recycling pump
3. Safety and solenoid supply relay
4. Recycling pump relay



P3M050D02

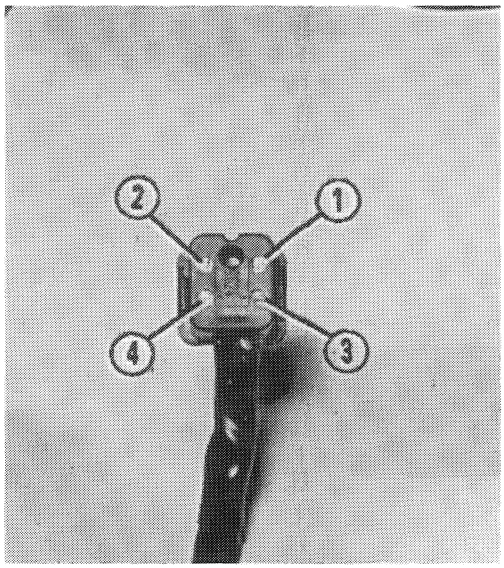
Identification of hydraulic control unit outputs

HR = to rear right brake caliper or wheel cylinder
HL = to rear left brake caliper or wheel cylinder
VR = to front right brake caliper
VL = to front left brake caliper



P3M051D01

Identification of terminals on hydraulic control unit



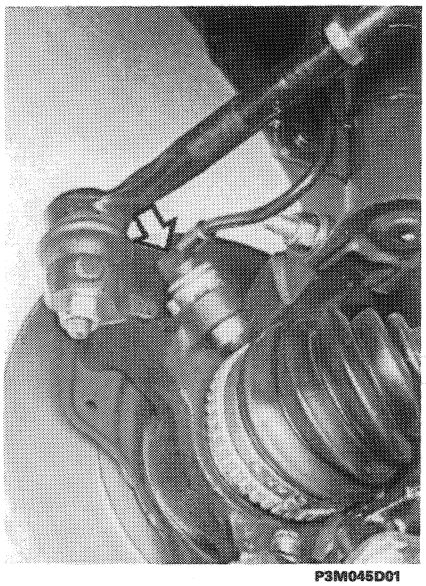
P3M051D02

Identification of terminals on hydraulic control unit connector

The hydraulic control unit cannot be overhauled so if a fault is discovered, the entire assembly must be renewed. Only the two relays and the electronic control unit may be renewed.
The spare part is supplied filled with brake fluid and with the solenoids in the open position, so the procedure for bleeding and filling the braking system is the same as for a conventional braking system.

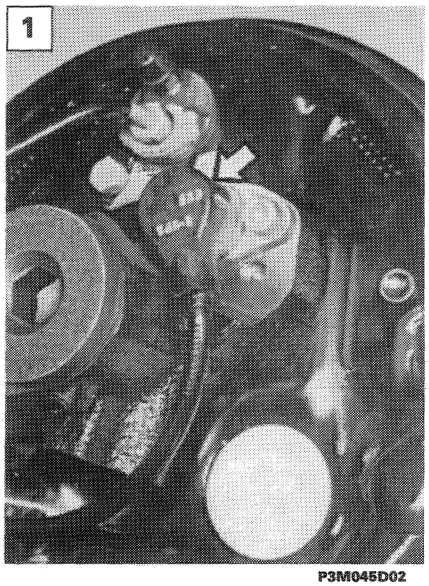
RPM SENSORS

The rpm sensors continuously supply to the electronic control unit all the information necessary for the hydraulic control unit to be driven correctly.
They measure the driving speed, acceleration, deceleration and skid of the wheels.
The sensors are of the inductive type and are mounted on their own mountings located on the front and rear wheel vertical links.
The magnetic flow lines are closed through the teeth of a toothed wheel (phonic wheel) facing the sensor which rotates with the wheel. The transition from full to empty, due to the presence or absence of the tooth, causes a variation in the magnetic flow which is sufficient to create an induced electromotive force at the sensor's terminals and so an alternating electrical signal at the electronic control unit.



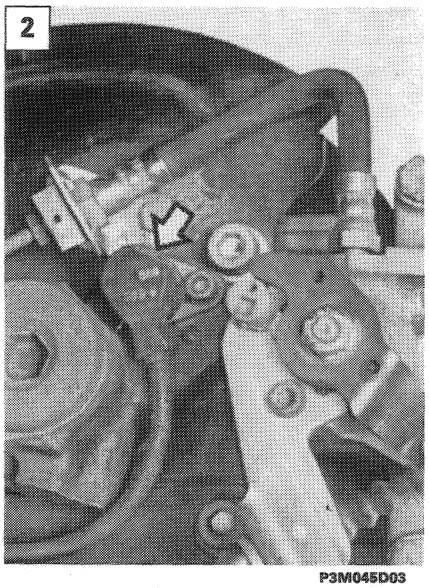
P3M045D01

Position of front wheel rpm sensor



P3M045D02

Position of rear wheel rpm sensor



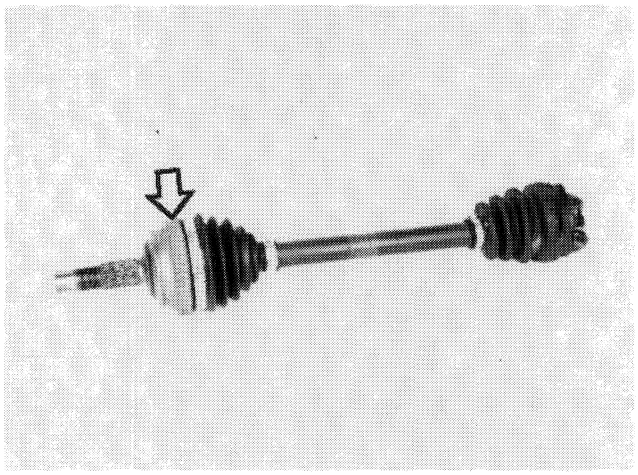
P3M045D03

1 **Rear drum brakes**

2 **Rear disc brakes**

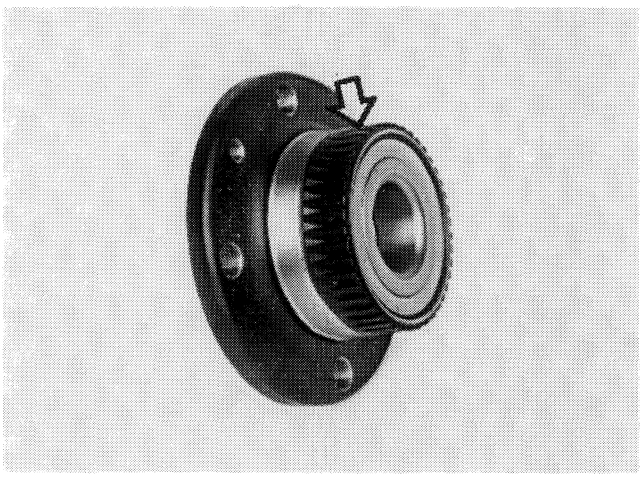
33.

The front phonic wheels are pressure fitted onto the constant velocity joints, wheel side. The rear phonic wheels are pressure fitted on the wheel hubs and comprise 44 teeth.



P3M052D01

Position of front phonic wheel



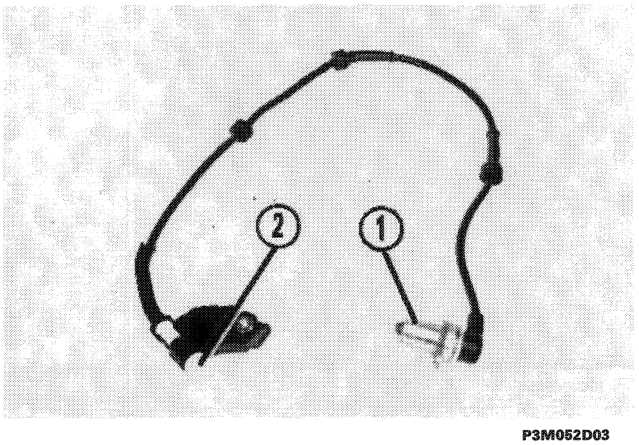
P3M052D02

Position of rear phonic wheel

The specified gap for obtaining correct signals between the end of the sensor and the phonic wheel must be between:

0.645 - 1.305 mm for the front wheels
0.06 - 1.18 mm for the rear wheels

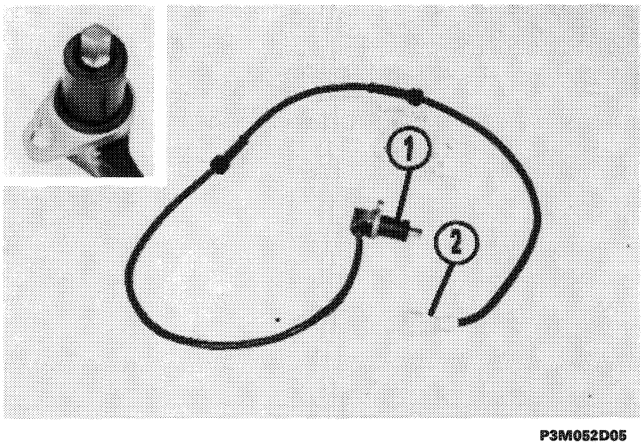
This distance cannot be adjusted, so if the gap measured is outside the tolerance limits, check the condition of both sensor and phonic wheel.
If one or more phonic wheels are broken or deformed causing a speed difference of 25% in relation to the reference speed, the electronic control unit switches off the ABS system and the ABS system fault warning light comes on. The fault detection time is about 120 seconds at a vehicle speed of over 6 km/h.



P3M052D03

1. Front wheel rpm sensor
2. Electrical connector

P3M052D04



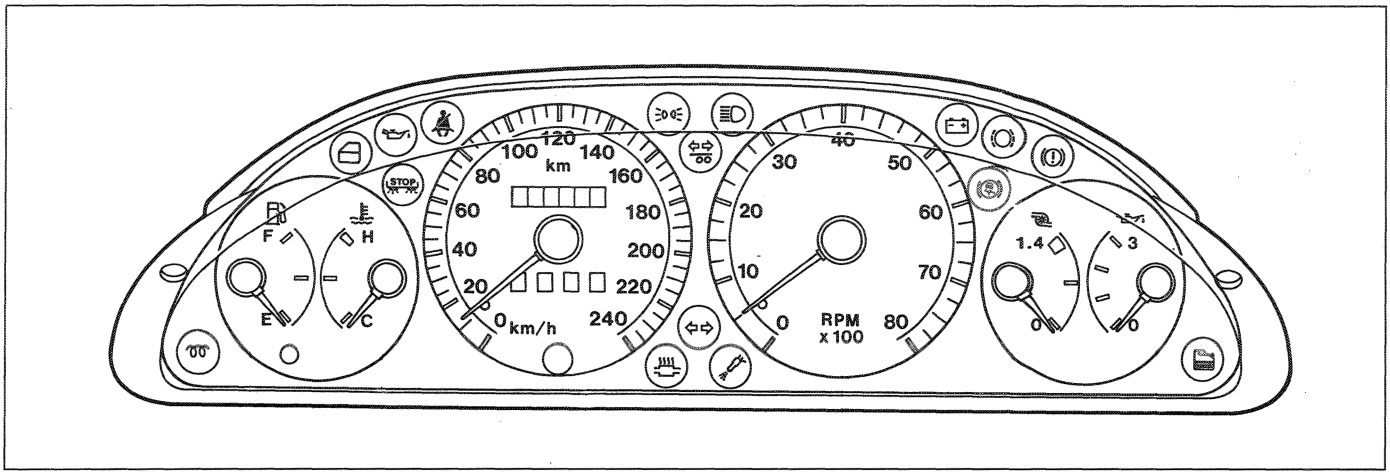
P3M052D05

1. Rear wheel rpm sensor
2. Electrical connector

The electronic control unit recognizes faults attributable to the rpm sensors when the speed of one or more wheels remains at the minimum speed for over 20 seconds when the vehicle speed is over 12 km/h. Under these conditions, the ABS system is disabled and the ABS fault warning light comes on. If the fault involves all 4 rpm sensors simultaneously, the fault is not indicated by the ABS fault system warning light coming on and the ABS system remains disabled.

ABS SYSTEM FAILURE WARNING LIGHT

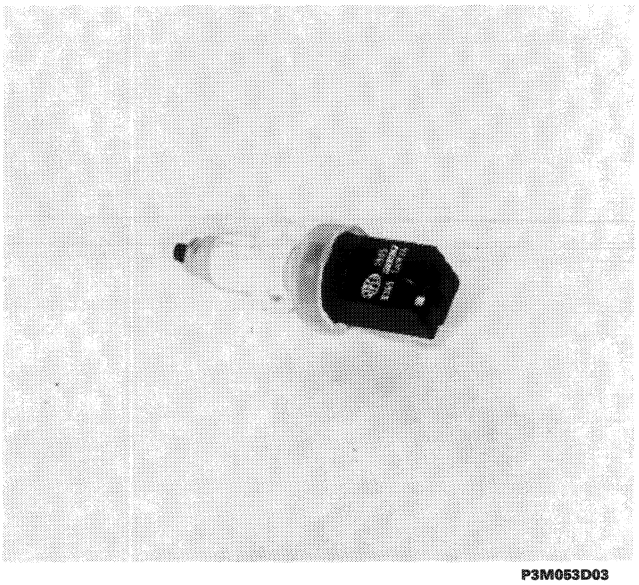
With the ignition switch at the MARCIA position, the red system fault warning light comes on and then goes out after about 2 seconds. If it does not go out after this time, this means that there is a fault in one or more of the anti-lock braking system components, and so braking will occur in the conventional manner.
If the warning light does not come on, the fault should be sought in the warning light's electrical connection, the fuse or the electrical connection between the ignition switch and the electronic control unit.



P3M053D01 P3M053D01

STOP LIGHTS SWITCH

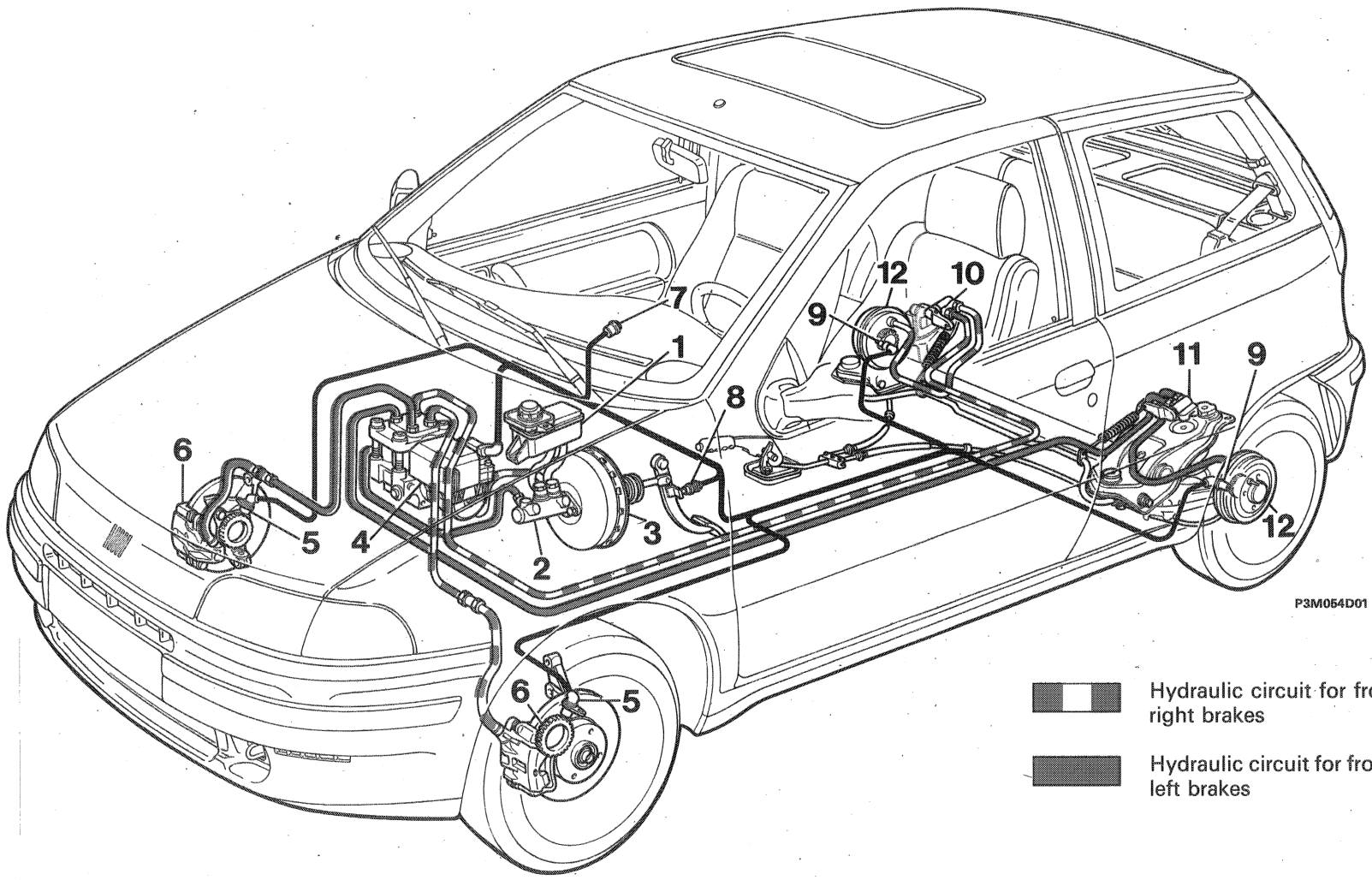
With a gear engaged and the brake pedal pressed, the electronic control unit receives the signal that the driver is braking and the anti-lock braking system is enabled.
This information is particularly useful in the case of irregular and bumpy road surfaces which could cause variations in the wheel speeds for reasons not associated with braking, so incorrect signals to the electronic control unit are avoided.



P3M053D03

Stop lights switch

DIAGRAM OF BRAKING SYSTEM WITH ABS SYSTEM



P3M054D01 P3M054D02

Hydraulic circuit for front left and rear right brakes

Hydraulic circuit for front right and rear left brakes

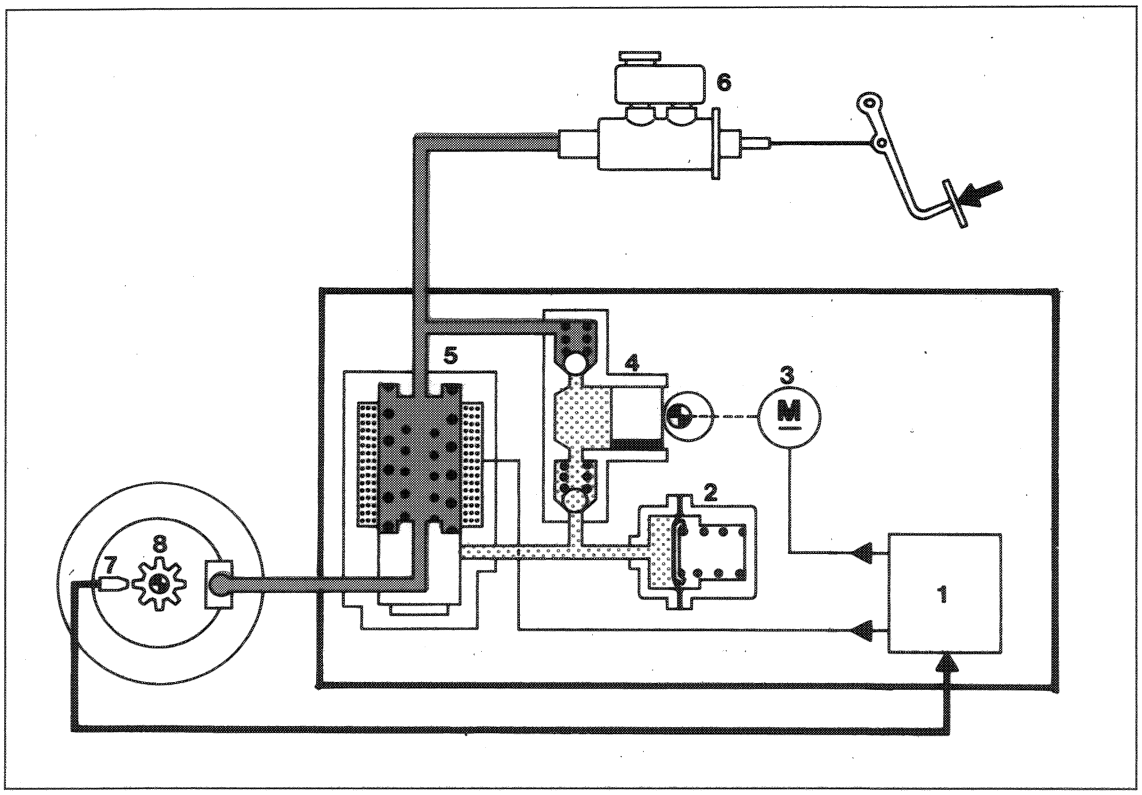
1. Brake fluid reservoir
2. Master cylinder for front and rear wheel brake circuit
3. Vacuum servo unit
4. Hydraulic control unit with built-in ECU
5. Rpm sensor for front wheels
6. Front disc brakes
7. Anti-lock braking system fault warning light
8. Stop lights switch
9. Rpm sensor for rear wheels
10. Load proportioning valve for rear right wheel
11. Load proportioning valve for rear left wheel
12. Rear drum brakes

DESCRIPTION OF OPERATION OF THE ANTI-LOCK BRAKING SYSTEM

On the basis of the signals received from the rpm sensors located on the front and rear wheels, the electronic control unit drives the hydraulic control unit which in turn varies the pressure of the brake fluid delivered to the brake calipers, passing through the three stages described below:

Pressure increase stage

When the car driver presses the brake pedal, the pressure generated by the brake pump (6) reaches the brake calipers unchanged, since the solenoids (5) of the hydraulic unit are not energized.
When the solenoids (5) are not energized, the piston inside them is subjected only to the action of the springs and it places the pipes of the brake pump (6) in direct communication with the caliper pipes.
As the braking force increases, the wheel deceleration also increases until the wheel is decelerating faster than the car (i.e. the wheel creep increases).
The creep value must not exceed a particular value beyond which the wheel loses grip with the ground and begins to skid, losing its directionality characteristics and increasing braking distances.
The rpm sensor (7) indicates when deceleration values are reached that will prejudice wheel grip, and at this point the control unit intervenes to reduce the braking force and allow the wheel to regain speed in order to recover its grip.



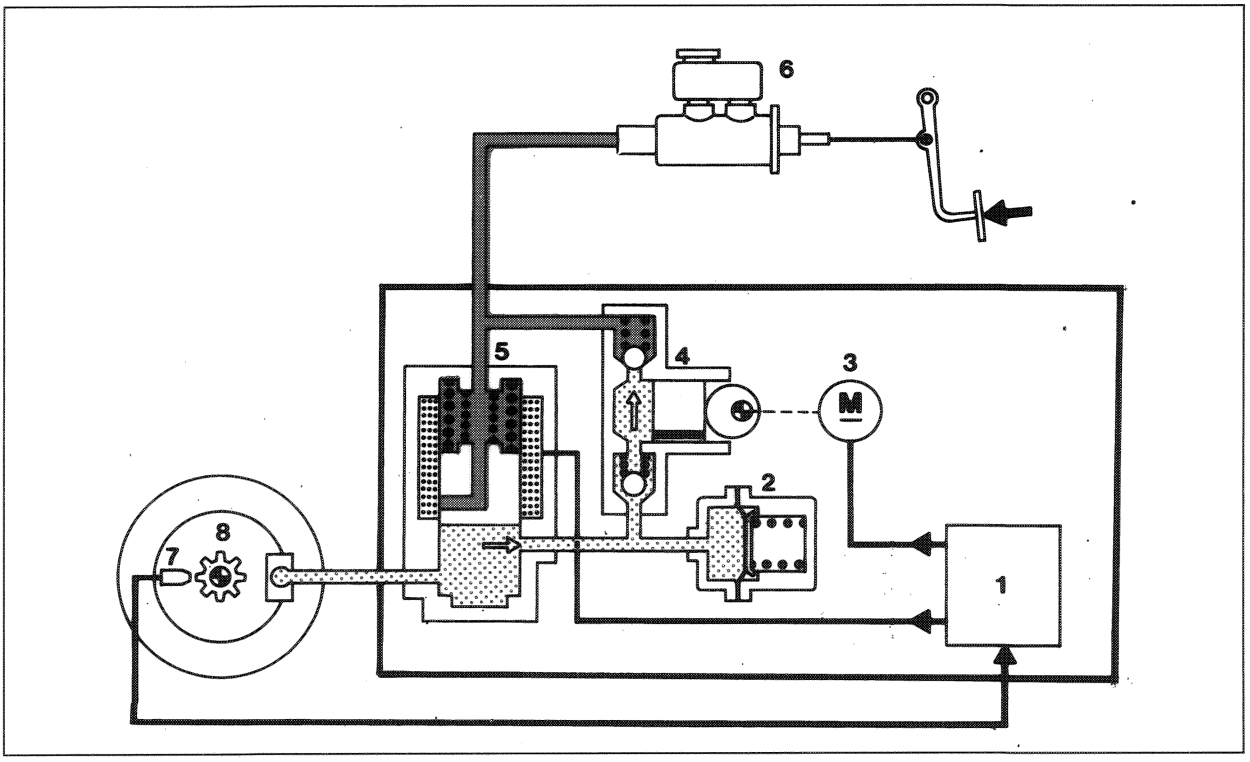
P3M055D01 P3M055D02

1. Electronic control unit
2. Accumulator
3. Recycling pump motor
4. Recycling pump
5. Solenoids
6. Brake pump
7. Rpm sensor
8. Phonic wheel

33.

Pressure reduction stage

The electronic control unit detects the wheel's tendency to lock and the anti-lock braking system intervenes.
The electronic control unit sends the energization signal (a 5 amp. current) to the solenoids (5), and the piston inside them moves upwards and interrupts the hydraulic connection between the brake pump (6) and brake caliper, at the same time opening the connection between brake caliper and recycling pump (4) (in this way some of the brake fluid is taken away from the brake calipers).
At the same time the control unit sends the command signal to the recycling pump (4) which allows the hydraulic fluid taken away from the brake calipers to be put back into circulation in the main circuit.
A series of pressure waves (or hydraulic thrusts) are generated at this stage. These may be detected on the brake pedal by the driver during braking, and should be considered normal during operation of the anti-lock braking system.
The accumulator (2) present in the circuit stores some of the brake fluid from the secondary circuit (so some pressure remains available upstream of the solenoid (5)), and this means that the pump can be rated for a low average flow rate.
During this stage, because of the reduction in the braking force, the wheel begins to accelerate, so increasing its rotation speed.

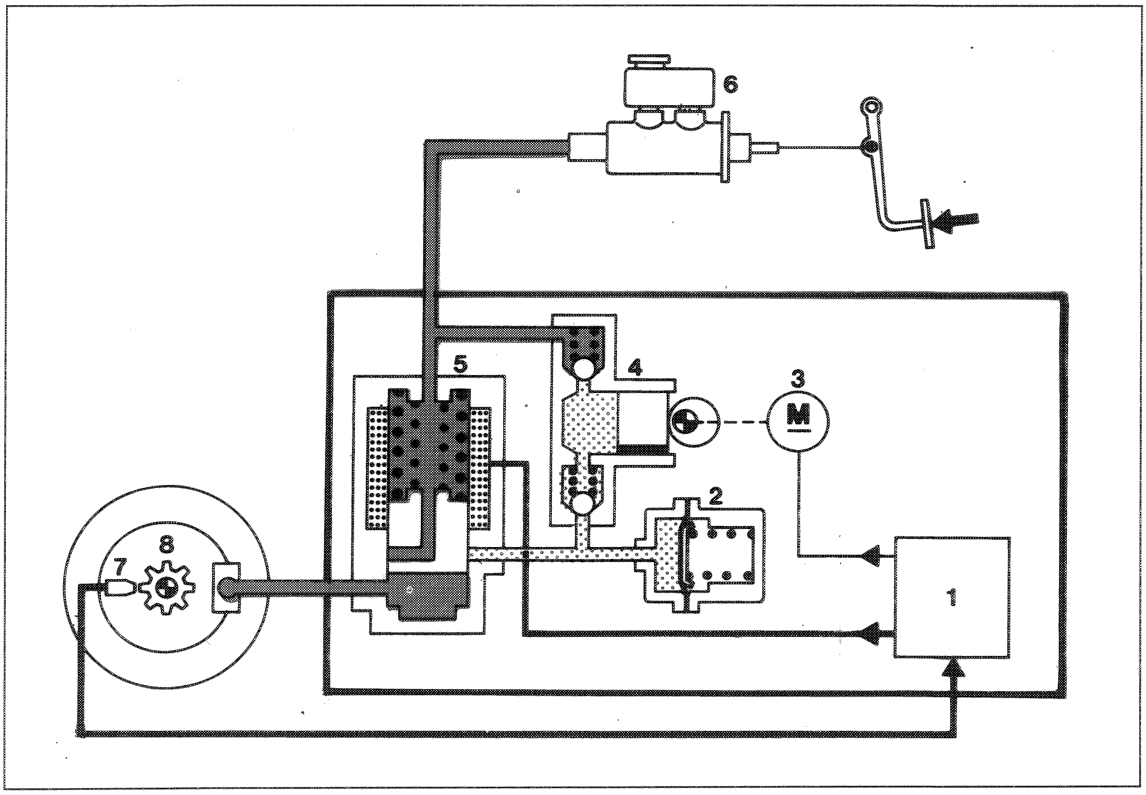


P3M056D01 P3M056D02

1. Electronic control unit
2. Accumulator
3. Recycling pump motor
4. Recycling pump
5. Solenoid
6. Brake pump
7. Rpm sensor
8. Phonic wheel

Pressure maintenance stage

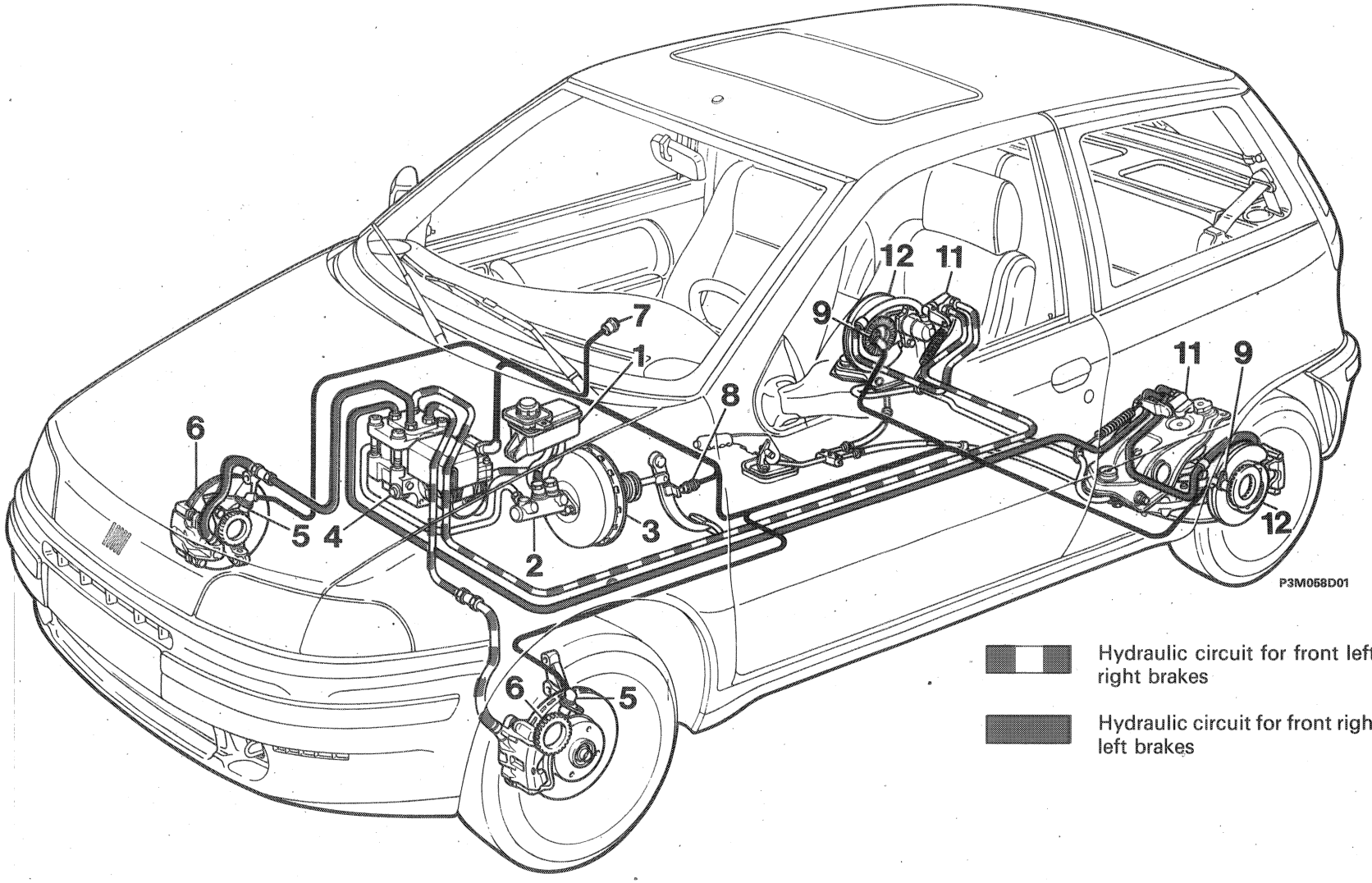
In this stage, the electronic control unit sends the solenoid (5) a low-value energization signal (approx. 2 amp.).
The connection between brake pump (6) and brake caliper is still interrupted (wait position).
The pressure send to the brake caliper is maintained constant by the recycling pump (4) whatever the pressure exerted on the brake pedal. The wheel continues to accelerate and increase speed until the rpm sensor's signal transmits a wheel rotation value which is the same as the car speed; only then will the control unit cease to energize the solenoid (5) and the pressure of the brake pump (6) will be able to reach the brake caliper again, starting the cycle from the beginning.
The cycle then is then repeated from the first stage until the pressure on the brake pedal ceases or the car stops (at 5 km/h the system switches itself off to allow the car to stop).



P3M057D01 P3M057D02

1. Electronic control unit
2. Accumulator
3. Recycling pump motor
4. Recycling pump
5. Solenoid
6. Brake pump
7. Rpm sensor
8. Phonic wheel

DIAGRAM OF BRAKING SYSTEM WITH ABS SYSTEM



P3M058D01 P3M058D02

Hydraulic circuit for front left and rear right brakes

Hydraulic circuit for front right and rear left brakes

1. Brake fluid reservoir
2. Master cylinder for front and rear wheel brake circuit
3. Vacuum servo unit
4. Hydraulic control unit with built-in ECU
5. Rpm sensor for front wheels
6. Front disc brakes
7. Anti-lock braking system fault warning light
8. Stop lights switch
9. Rpm sensor for rear wheels
11. Load proportioning valves for rear wheels
12. Rear disc brakes

INSTRUCTIONS TO BE OBSERVED ON VEHICLES FITTED WITH ANTI-LOCK BRAKING SYSTEM

Before undertaking any electric arc welding work, disconnect the electronic control unit's connector.

During paintwork operations, the electronic control unit can only be subjected to a temperature of 95°C for a short time, and to a maximum temperature of 85°C for a longer time (about 2 hours). If the above operations are likely to involve a longer duration, the hydraulic control unit must be removed.

If the battery is removed, when it is refitted, the terminals must be fully tightened.

Before removing the hydraulic control unit, the battery's negative cable must be disconnected.

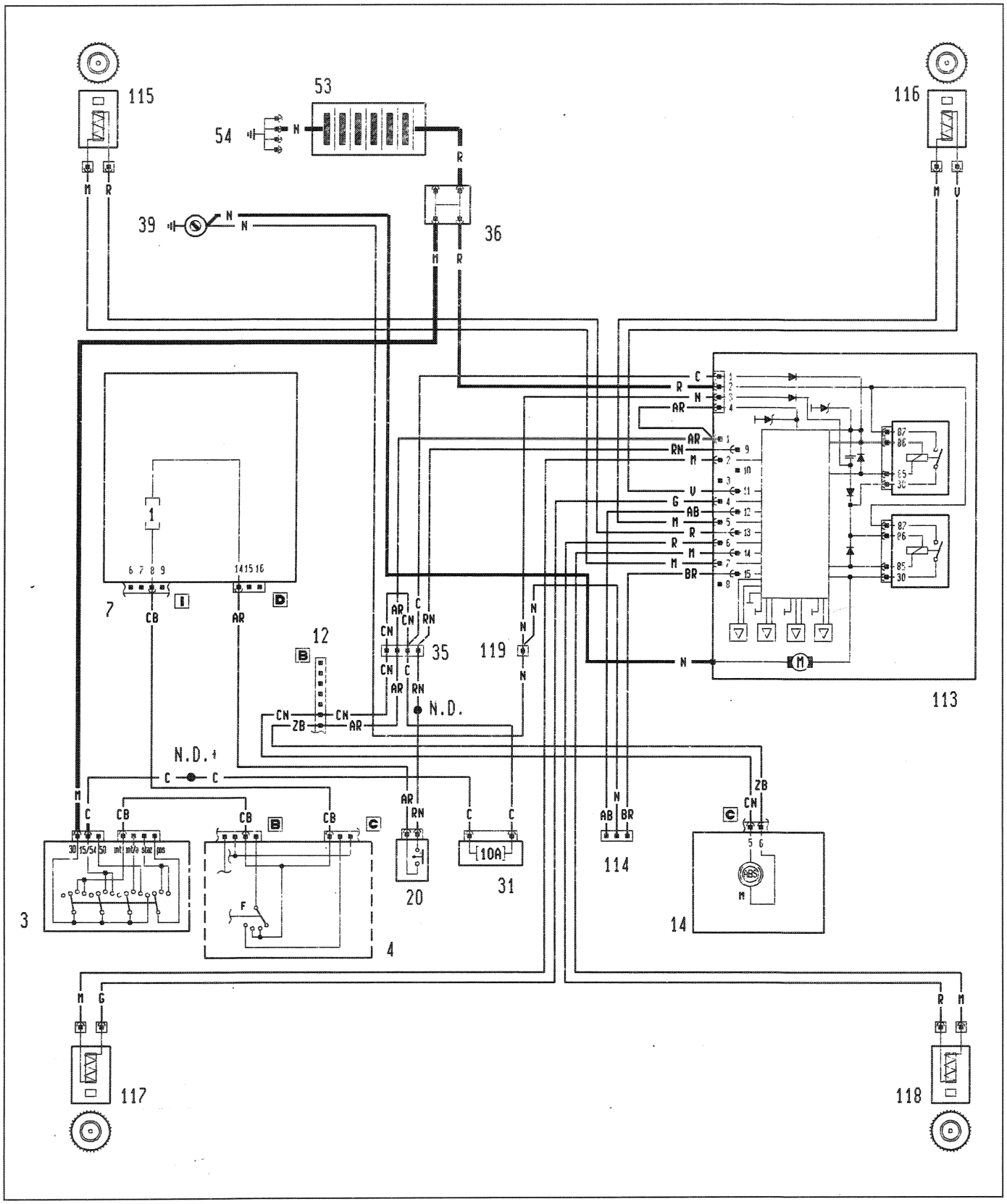
Moreover, after any repair involving the electrical system relating to the anti-lock braking system or the rpm sensors, or for specific repairs during dismantling and replacement of mechanical parts (for example spring-damper assembly, constant velocity joints, drive shafts and wheel hubs), a very short road test must be performed as follows:

a. Drive the vehicle at a speed of over 12 km/h and maintain this speed, without braking, for a period of 20 seconds in order to allow the electronic control unit to perform a dynamic check on the rpm sensors and to detect any faults, insecure contacts, incorrect positions or whether a phonic wheel is absent.

b. After performing the above procedure, if the warning light does not indicate any faults, continue the test by driving the car at 50-60 km/h for a period of 10 minutes, using the brakes normally but avoiding hard braking. This stage of the check enables the electronic control unit to recognize the presence of an unsuitable phonic wheel.

33.

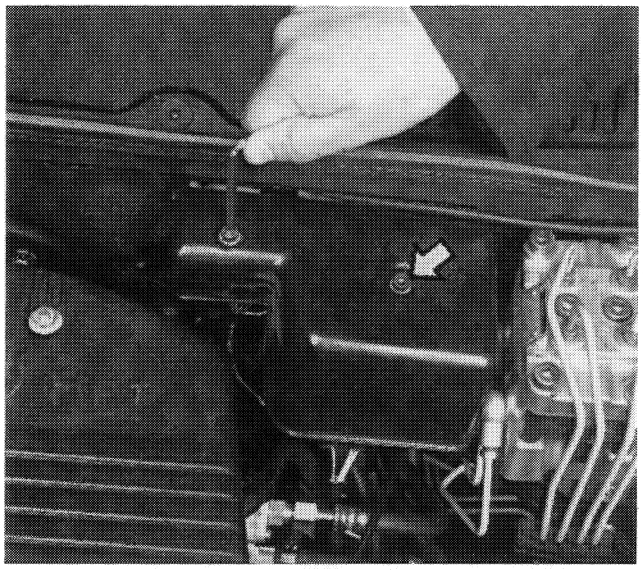
WIRING DIAGRAM



Key

3. Ignition switch
4. Stalk unit:
   F. Side lights/dipped beam headlamps switch
7. Junction unit
12. Connection between dashboard cables/front cables
14. Instrument panel
    M. ABS failure warning light
20. Braking light switch
31. 10A fuse protecting anti-lock braking system
35. Connection between front cables/ABS cables
36. Connector block
39. Front left earth
43. Right tail-light cluster
53. Battery
54. Battery earth
113. ABS electronic control unit
114. Diagnostic socket for ABS system
115. Sensor on front left wheel
116. Sensor on front right wheel
117. Sensor on rear left wheel
118. Sensor on rear right wheel
119. ABS cable system connection

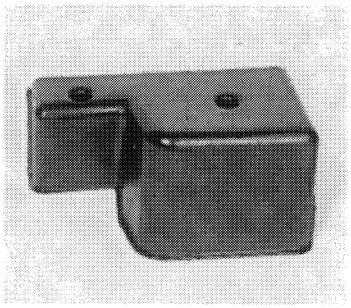
N.D. Connector blocks



P3M062D01

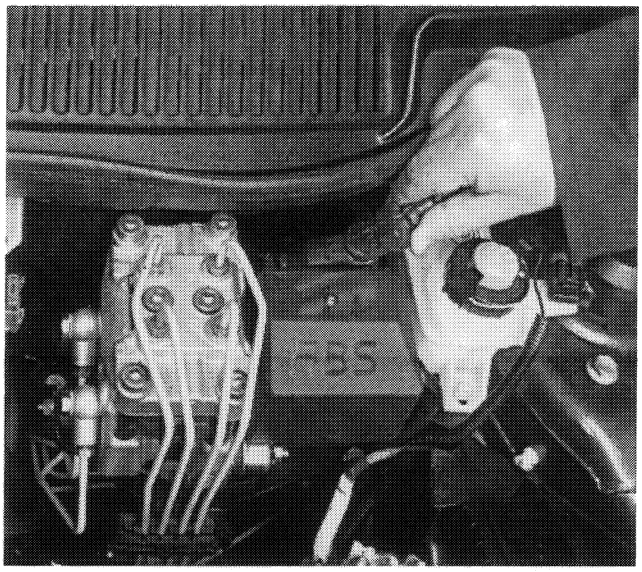
HYDRAULIC CONTROL UNIT

Removing-refitting



P3M062D02

Dismantling-fitting fuse and relay cover

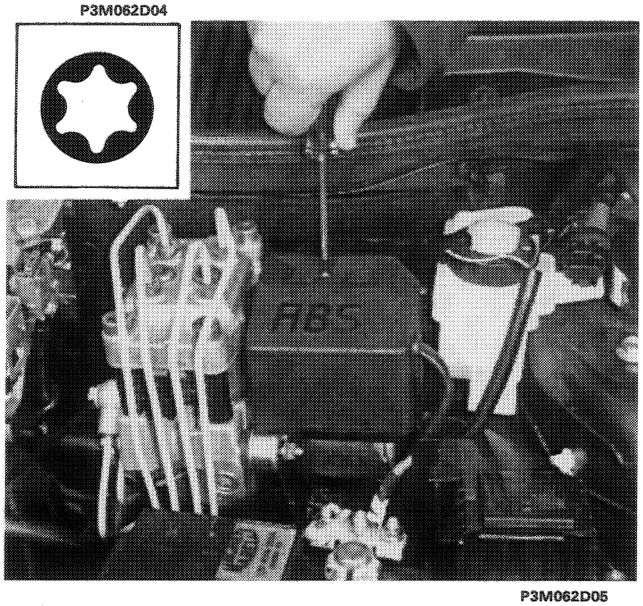


P3M062D03

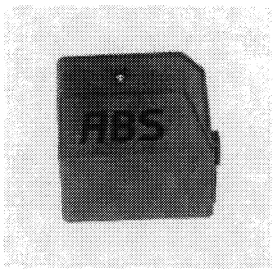
Before removing the hydraulic control unit, disconnect the battery's negative cable.

Dismantling-fitting multi-connector on electronic control unit

P3M062D04



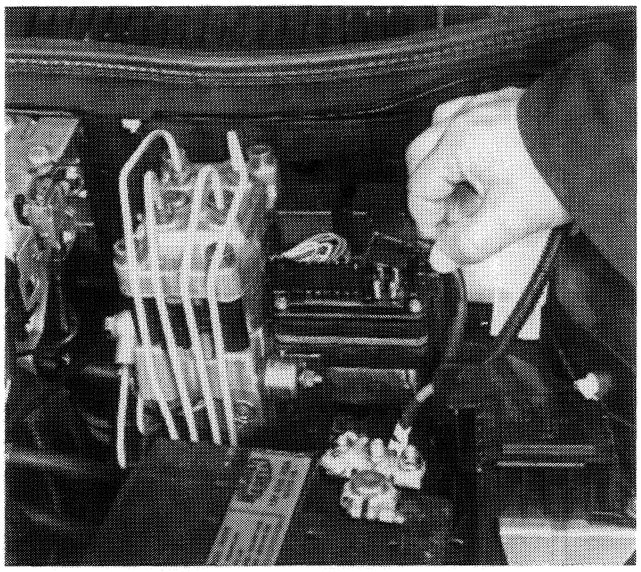
P3M062D05



P3M062D06

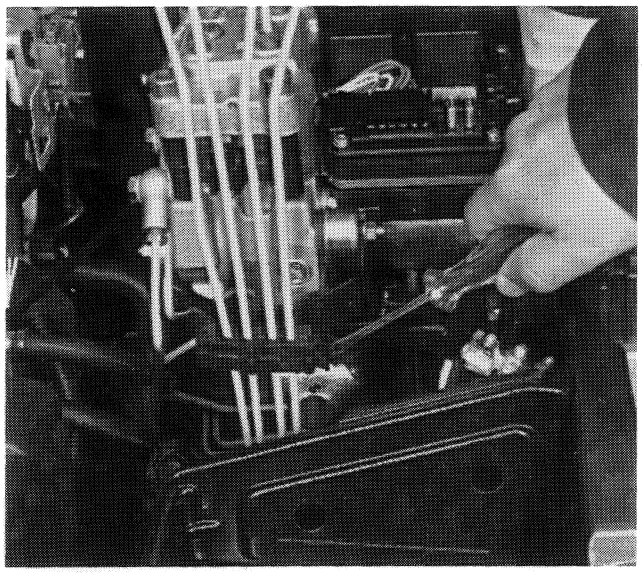
Dismantling-fitting relay cover

Remove the star-headed screw (see insert) using an appropriate screwdriver (for example USAG 326 TX 15).



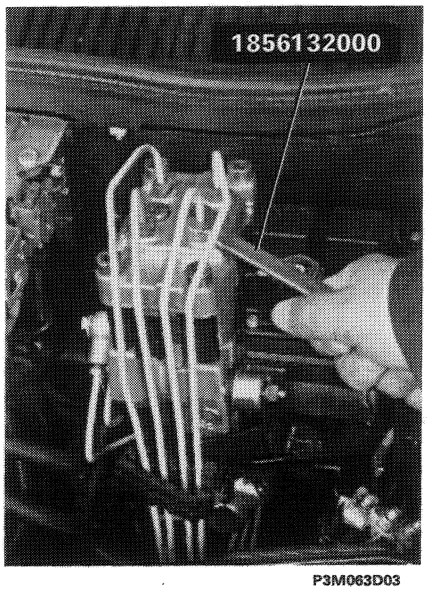
P3M063D01

Dismantling-fitting hydraulic control unit electrical connector

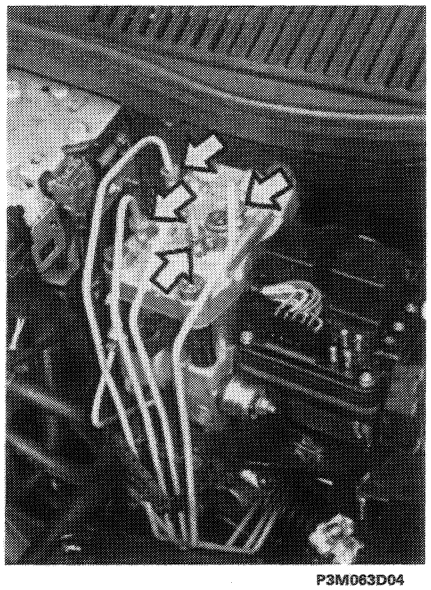


P3M063D02

Dismantling-fitting brake pipe retaining clip

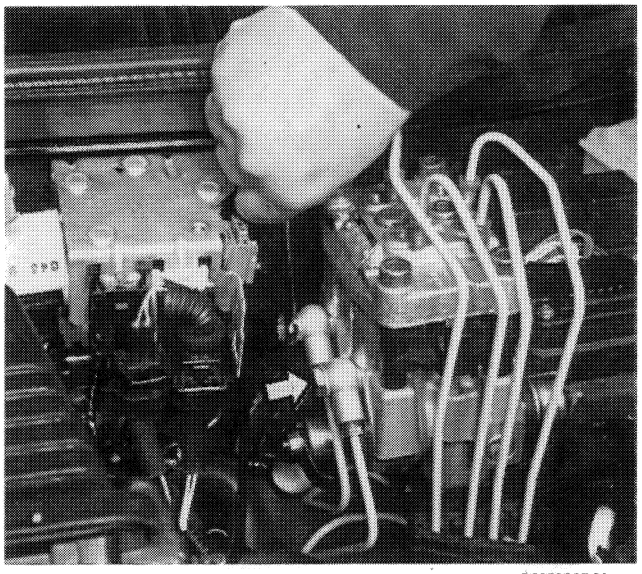


P3M063D03



P3M063D04

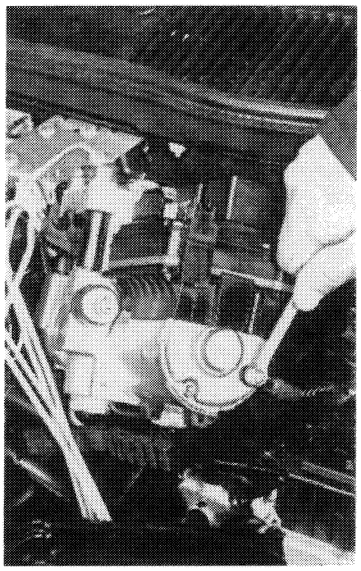
Dismantling - refitting brake pipes on hydraulic control unit



P3M064D01

Dismantling-fitting brake pipes on hydraulic control unit

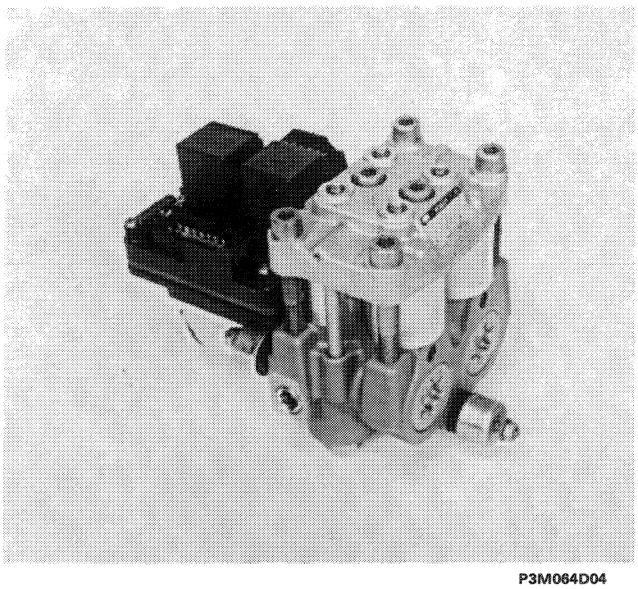
P3M064D02



P3M064D03

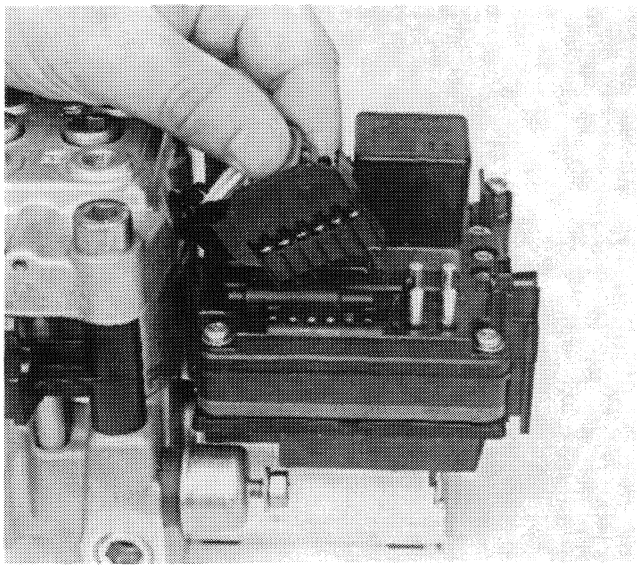
Removing - refitting hydraulic control unit

Bleed the hydraulic system



P3M064D04

Hydraulic control unit

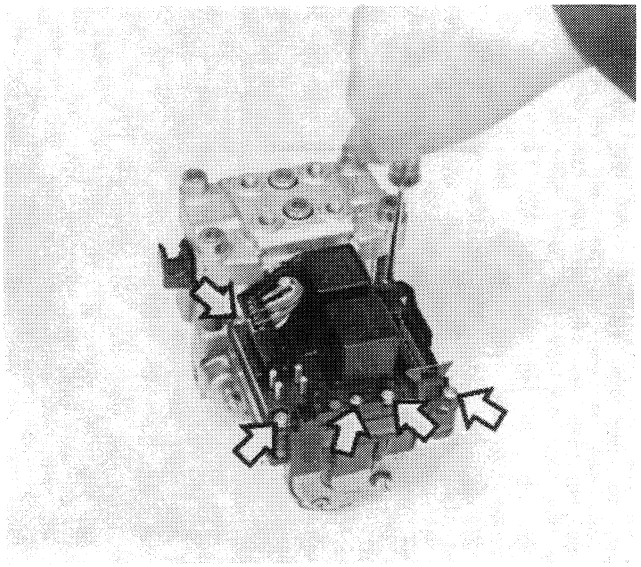


P3M065D01

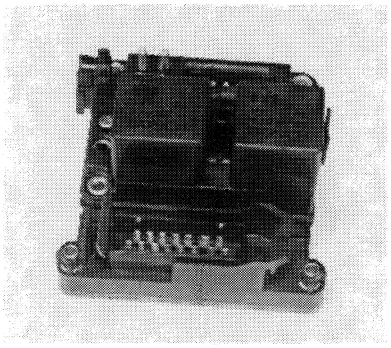
ELECTRONIC CONTROL UNIT

Dismantling-fitting

Dismantling-fitting electrical connector

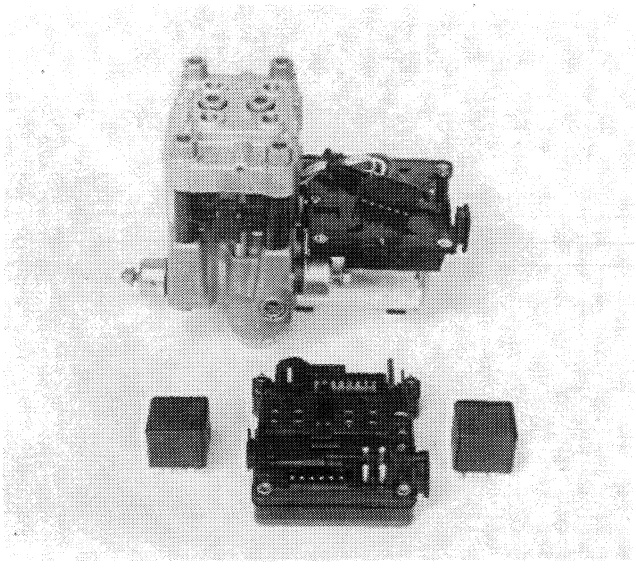


P3M065D02



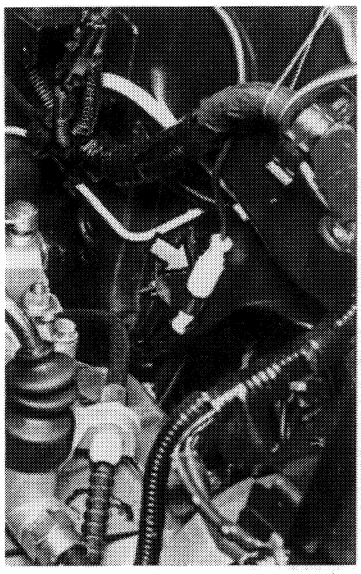
P3M065D03

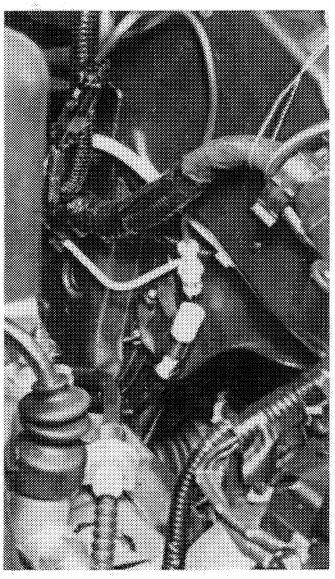
Dismantling-fitting electronic control unit



P3M065D04

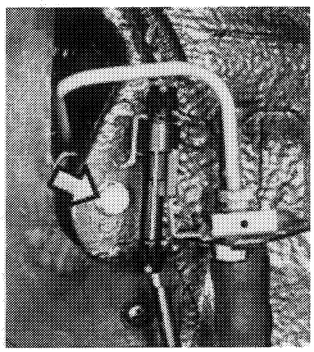
Components of the hydraulic control unit



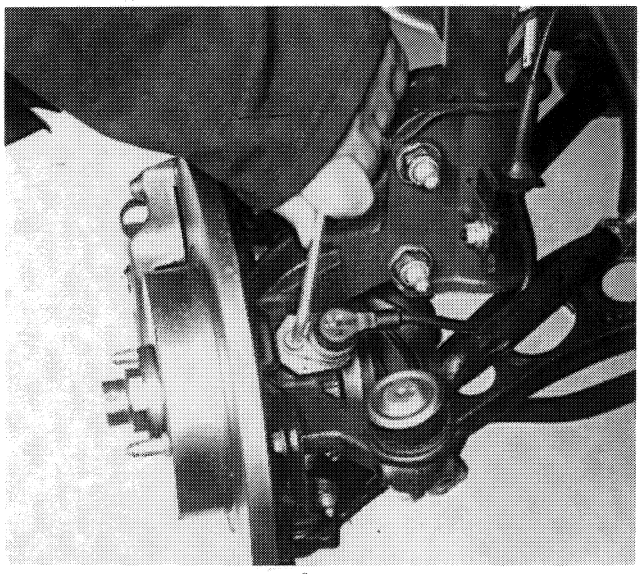


FRONT WHEEL RPM SENSOR

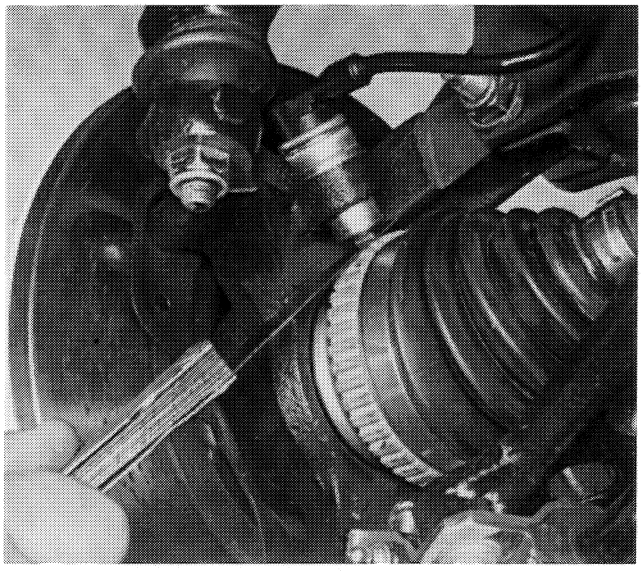
Removing-refitting



Disconnecting electrical connector



Removing-refitting sensor

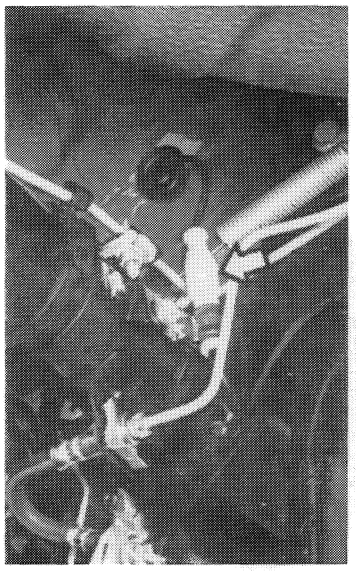


0,645 ÷ 1,305

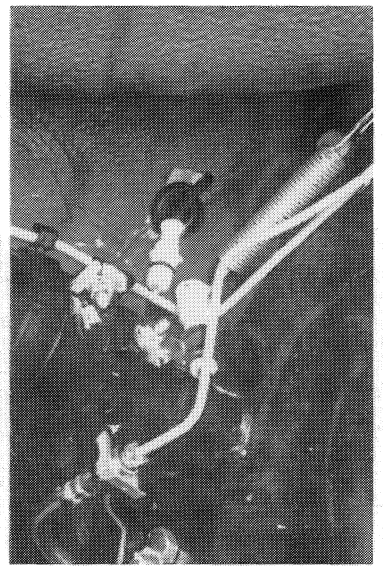
CHECKING GAP BETWEEN RPM SENSOR AND PHONIC WHEEL

Checking gap between rpm sensor and phonic wheel on frong wheel constant velocity joint

The gap cannot be adjusted since no suitable shims are supplied. If the gap measured is outside the tolerance limits, check the condition of the sensor and the teeth of the phonic wheel.



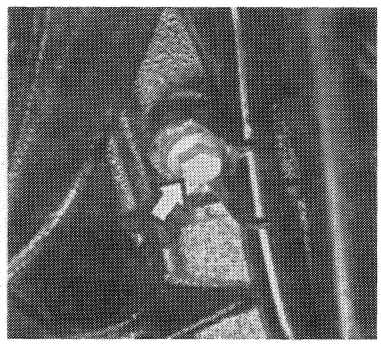
P3M067D01



P3M067D02

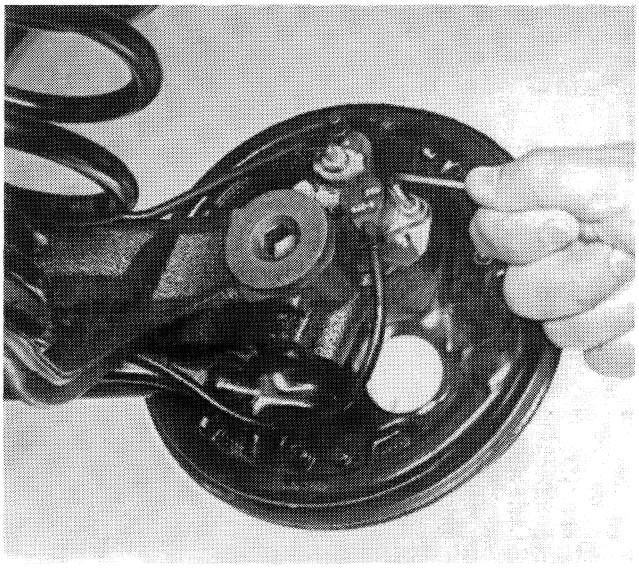
REAR WHEEL RPM SENSOR

Removing-refitting



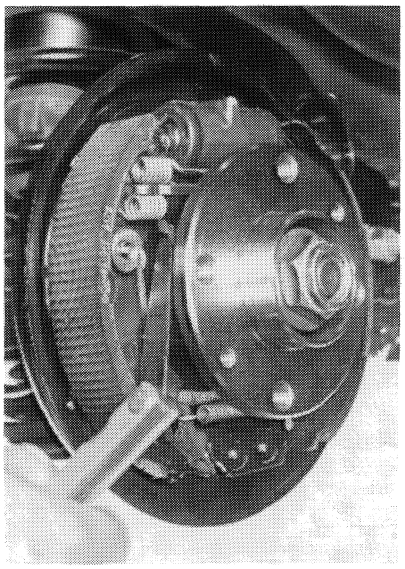
P3M067D03

Disconnecting electrical connector

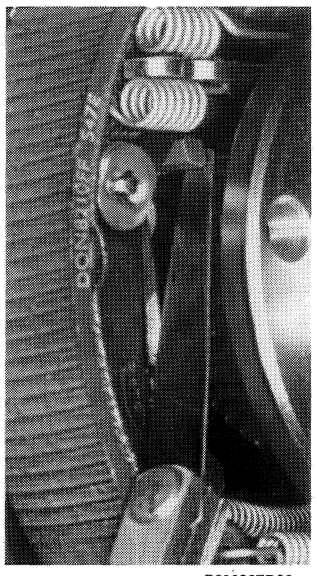


P3M067D04

Removing-refitting sensor



P3M067D05



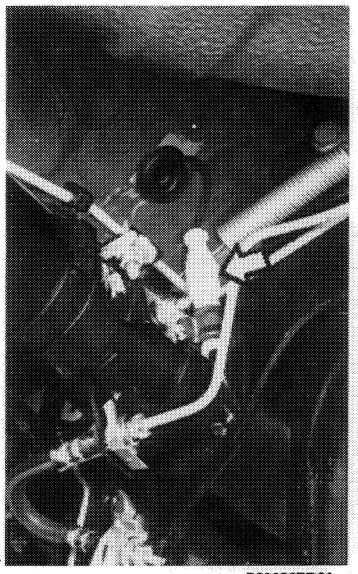
P3M067D06

0,06 ÷ 1,18

CHECKING GAP BETWEEN RPM SENSOR AND PHONIC WHEEL

Checking gap between rpm sensor and phonic wheel on rear wheel hub

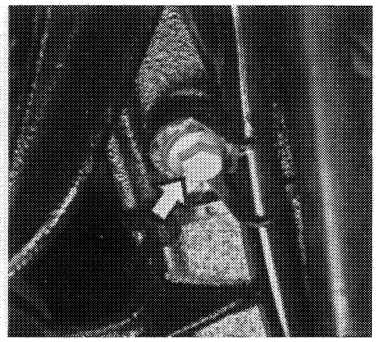
The gap is not adjustable since no suitable shims are supplied. If the gap measured is outside the specified tolerance limits, check the condition of the sensor and the teeth of the phonic wheel.


P3M067D01

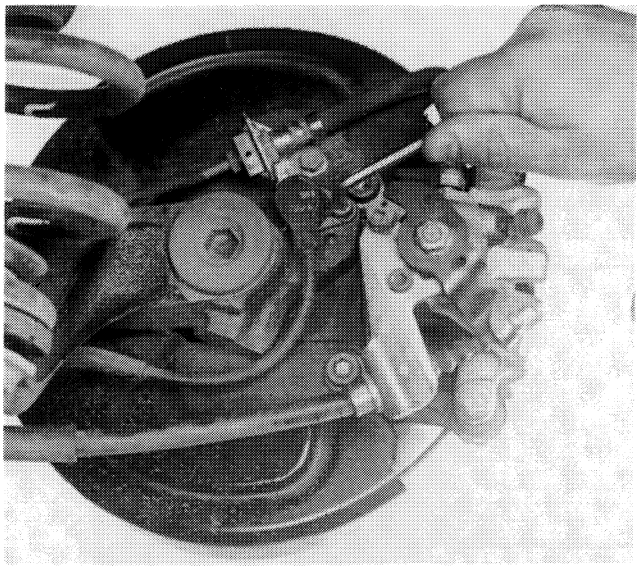

P3M067D02

REAR WHEEL RPM SENSOR

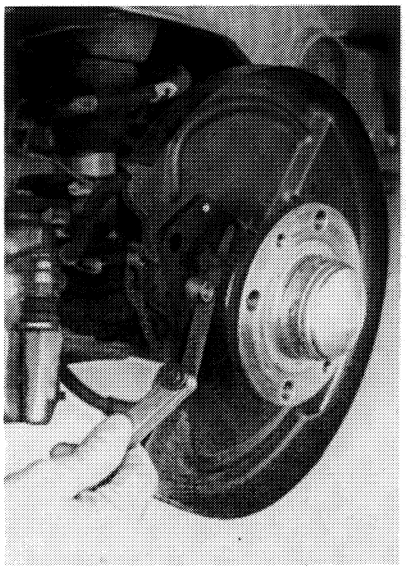
Removing-refitting

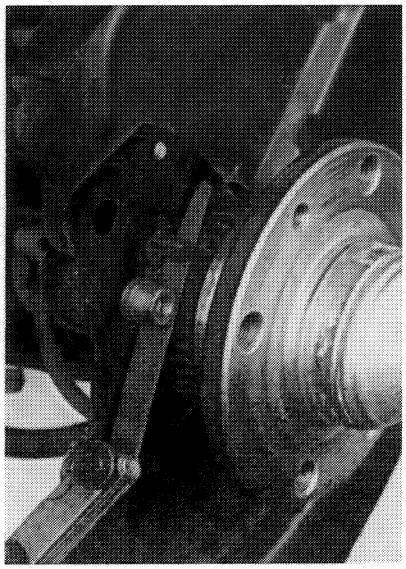

P3M067D03

Disconnecting electrical connector


P3M068D01

Removing-refitting sensor


P3M068D02


P3M068D03

0,06 ÷ 1,18

CHECKING GAP BETWEEN RPM SENSOR AND PHONIC WHEEL

Checking gap between rpm sensor and phonic wheel on rear wheel hub

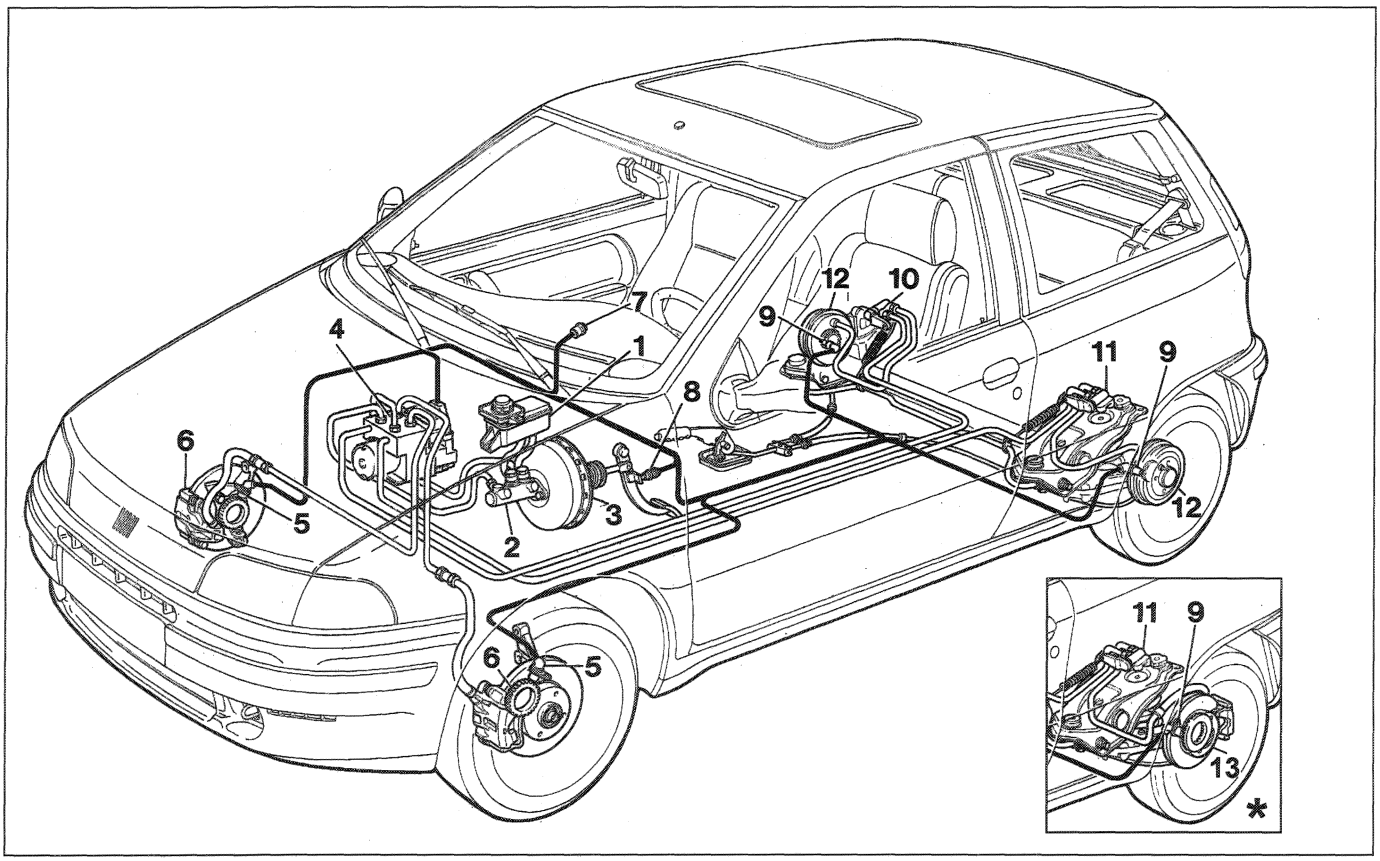
The gap cannot be adjusted since no suitable shims are supplied. If the gap measured is outside the specified tolerance limits, check the condition of the sensor and the teeth of the phonic wheel.

ANTI-LOCK BRAKING SYSTEM (Bosch 5.3 ABS)

SYSTEM STRUCTURE

The Bosch 5.3 A.B.S. system derived from the previous 2S version is more compact (easier to fit), lighter and more reliable.
The valves have been made more modular through the use of new microhybrid electronic components. Magnetic flux has been optimised through the use of new more compact valve case shapes and the number of hydraulic components has been reduced through direct moulding of nozzles, which were previously assembled separately.

The main system components are as follows:
- new type of electronic control unit, more powerful and versatile than on previous models;
- hydraulic control unit responsible for modulating braking pressure to the brake calipers by means of eight solenoids, two for each wheel;
- four sensors (5) and (9), one for each wheel, which measure wheel angular rotation speed



P3M01AD01

Diagram of Bosch 5.3 anti-lock braking system

1. Brake fluid reservoir
2. Master cylinder for front and rear wheel brake circuits
3. Vacuum brake servo
4. Hydraulic control unit with built-in ECU
5. Front wheel rpm sensor
6. Front disk brakes
7. Fault warning light
8. Brake light switch
9. Rear wheel rpm sensor
10. Load proportioning valve for right rear wheel (pressure regulator for version 1108 - 1242 SPI)
11. Load proportioning valve for left rear wheel (pressure regulator for version 1108 - 1242 SPI)
12. Rear drum brakes
13. Rear brake discs

The system also includes:
- hydraulic system lines;
- special electrical wiring;
- switch on brake pedal for measuring braking conditions;
- warning light (7), located on the control panel.

When in test mode (see paragraph on "Blink Codes"), the warning light (7) emits a series of blink codes to provide information on faults saved in the control unit CMOS EEPROM memory.

COMPONENTS

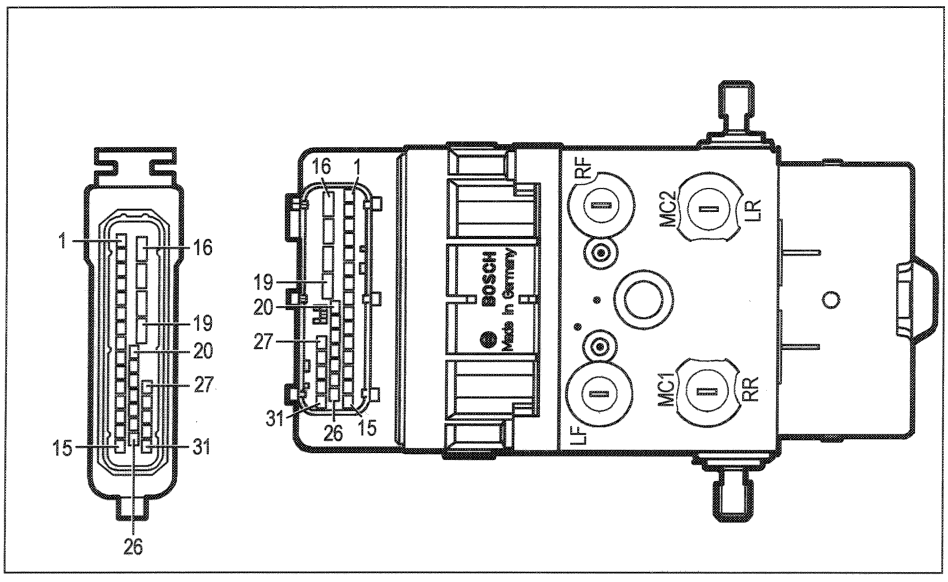
Electro-hydraulic control system

The hydraulic control unit consists of two sections fastened to one another: an electronic control unit and a hydraulic control unit.
The electronic control unit is connected to the wiring of the A.B.S. by means of a multiple connector with 31 terminals, of which 17 are used.
The electronic control unit governs the hydraulic unit by processing signals from the sensors with the aid of programs mapped in its memory.
The hydraulic control unit is connected to the brake pump and ABS components by means of the braking system pipes.
The main change compared to the previous model has been the replacement of three-way valves with two two-way solenoids on each wheel.
Compared to the previous version, the 5.3 unit is lighter and the valves are smaller. Valve opening and closure mechanism is more effective and size has been reduced further through the use of tiny microhybrid electronic circuits which are about 30% smaller than components used previously.

ELECTRONIC CONTROL UNIT

The electronic control unit is made up of hybrid circuits with integral resistances, diodes, transistors and logical circuits. The system is based on two CMOS microprocessors . Each runs the same program independently and monitors the another. Both receive the same input signals and process them independently. The electronic control unit sends an operational control to the hydraulic control unit only when both signals are identical.

Otherwise, if the ABS contains a fault for example, the device cuts itself out and braking takes place in conventional manner. The fault warning light on the instrument panel comes on at the same time.



P3M02AD01

Fault data are recorded in a non-volatile memory. One of the two microprocessors contains a CMOS EEPROM memory, which saves its contents even if the battery is disconnected. This memory saves fault codes so that they can be read using a tester during service.

Signals (alternating or analogue) sent to the electronic control unit by the rpm sensors are converted into square wave (or digital) signals by the input amplifier.
The frequency of these signals provides the control unit with the corresponding values of speed, acceleration or deceleration for individual wheels.
A reference speed is processed from a combination of individual peripheral wheel speeds. This is continually updated to indicate vehicle speed instant by instant.

When the driver presses the brake pedal, the wheels may decelerate at different rates. The peripheral speeds of individual wheels are compared with the reference speed to monitor slip for each individual wheel.

If braking effort causes one wheel to slip with regard to the others (the effect known as*split*), the electronic control unit commands the hydraulic control unit solenoids to reduce braking effort to the wheel experiencing loss of grip. The affected wheel therefore picks up speed.

NOTE *The peripheral speed of a braked wheel drops at a faster rate than the vehicle speed. With the wheels fully locked by the braking action (peripheral wheel speed = 0) and the vehicle still moving, the difference between these two speeds is maximal.*
This difference is known as "creep" or percentage slip when expressed as a percentage.
Creep 0% = wheel free to turn
Creep 100% = wheel locked and vehicle moving
During braking, the friction coefficient increases if braking occurs with low creep (rolling) and decreases when the tyre slows in relation to the surface until it locks altogether.
A considerable number of practical tests and research have shown maximum braking effort can generally be achieved with "creep" levels between 5% and 15%, to a maximum of 20%. These figures mark an optimal range which the anti-lock braking system will tend to keep to regardless of the vehicle type.

The electronic control unit also contains deceleration and acceleration thresholds which should never be exceeded by individual wheels.
The rolling speed of a braked wheel is thus controlled through a systematic, continuous and extremely swift comparison of wheel slip, deceleration and acceleration.

As soon as acceleration/deceleration and *split* values are exceeded, the electronic control unit cuts in. Hydraulic unit solenoids are driven through three control stages to reduce, maintain, or restore pressure generated by the driver on the brake pedal (see page 9) the wheel calipers. Braking status is therefore restored to within specified optimal limits.

These stages give rise to an intermittent but extremely rapid control cycle, which is repeated until the vehicle comes to a halt. The electronic control unit controls the various stages by sending currents of different intensity to the solenoids. The unit also ensures that both rear wheels receive the same braking effort applied to the rear wheel with the greatest tendency to lock, i.e. with the least grip (to ensure better directional stability).

If one of the tyres is deflated, the ABS can cut in to control braking conditions if necessary.

The ABS is also active when the vehicle brakes when reversing.
The device normally stops working at speeds lower than 2.75 km/h to allow the wheels to lock fully when the vehicle comes to a standstill.

Because the parameters monitored by the control unit (wheel speed and deceleration) are influenced by wheel/tyre inertia, vehicles fitted with an anti-lock braking system ***must only be fitted with rims, tyres and brake linings recommended by the Manufacturer.***

When chains are fitted, the signals generated by the new rolling conditions are filtered by the control unit so that the anti-lock braking system is not cut out if the vehicle is driven over hard, compact snow.

Under conditions of poor grip and/or incorrect drive torque distribution (aquaplaning), the rpm sensors on each wheel inform the electronic control unit of anomalous conditions during driving because the drive wheels tend to turn at a different speed to the driven wheels.

Under these conditions, the electronic control unit would undergo an inappropriate regulation cycle. The anti-lock braking device would cut out temporarily (although for such a short time that the warning light would not necessarily come on) and come back on as soon as the conditions of poor grip were removed.

This function prevents a sudden braking manoeuvre from being transmitted to the automatic transmission when it would cause the steel belt to slip over the two pulleys and damage one of the two components

The electronic control unit is equipped with a safety circuit which monitors system efficiency each time the car is about to start off and during motion.
The safety circuit carries out the following self-checks:

1. after inserting the ignition key and for about 2 seconds, it checks the operation of the control unit, the solenoid relays and the sensor connections;
2. after starting the engine, as soon as vehicle speed exceeds 6 km/h, it operates the solenoids and scavenging pump to check operation. It also checks that all four speed signals are present;
3. whenever the vehicle exceeds a speed of 24 km/h from a standing start, it checks that all 4 speed signals are present;
4. during motion, it continually compares wheel peripheral speed with a calculated reference speed, checks memory conditions and governs the operation of both relays;
5. battery voltage is monitored during motion.

If one of these faults is detected, the anti-lock braking system turns itself off without affecting the normal operation of the conventional braking system. A warning light on the control panel comes on to inform the driver of the situation.

The electronic control unit is informed that the driver is braking by a signal reaching the switch on the brake pedal. This information is useful for controlling the braking manoeuvre and also in cases where the vehicle is braked forcefully when the vehicle accelerates so suddenly that the wheels skid or when the road surface is uneven (bumps, steps) and causes wheel speed to alter for reasons unconnected with the braking manoeuvre.

Under these conditions, the microprocessors adopt a strategy based on wheel speed changes at these specific times in order to restore the current braking parameters to correct levels. Because these conditions are specific to certain individual braking circumstances, system efficiency is not impaired if the brake pedal switch is not connected to the control unit. For this reason, the warning light does not come on and the ABS is not deactivated.

HYDRAULIC CONTROL UNIT

The hydraulic control unit is connected to the brake pump and brake caliper cylinders through the brake system pipes. This unit and the electronic control unit make up the electro-hydraulic control unit.

The hydraulic control unit is responsible for altering brake fluid pressure in the brake calipers when control signals are received from the electronic control unit.

It consists of eight two-way solenoids (two for each hydraulic circuit) and a dual circuit scavenging pump (2).

The eight solenoids and the scavenging pump are driven by the electronic control unit on the basis of signals from the four rpm sensors. In particular, the pump allows brake fluid to be taken up during the pressure reduction stage so that more fluid is made available upstream of the solenoids for the subsequent pressure increase stage.

The accumulators allow brake fluid to be absorbed during the pressure reduction stage.

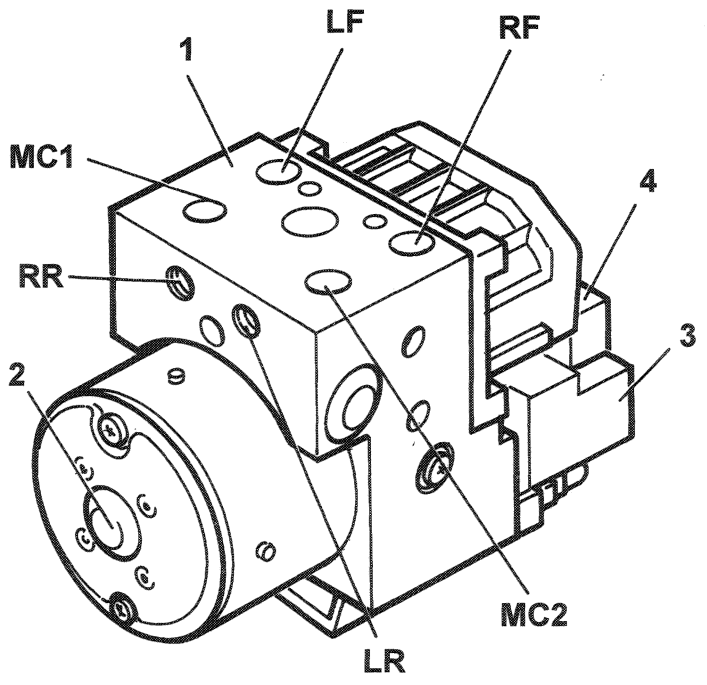
The unit is connected to the braking system by means of fittings identified by stamped codes as shown in the figure.

The electro-hydraulic control unit cannot be serviced and cannot become faulty unless it is tampered with.

A new unit must be fitted if old one is found to be faulty.

New units are supplied full of brake fluid (DOT 4) and with solenoids inactive. The braking system is bled and refilled in the same way as a conventional system.

NOTE *To avoid mistakes when connecting the various braking system circuits during repairs, the hydraulic modulator unit connections are different sizes (M10x1 and M12x1). Fittings can also be identified by stamped codes as shown in the figure.*



Identification of hydraulic control unit outlets

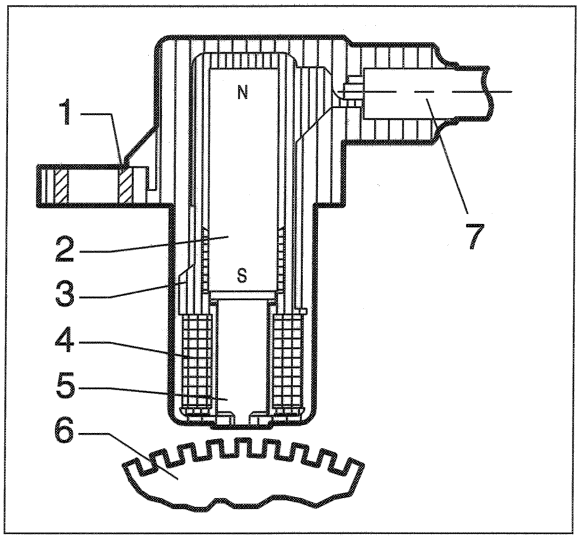
P3M05AD01

MC1. Inlet fitting from brake pump M12x1
MC2. Inlet fitting from brake pump M12x1
LF. Outlet fitting to left front brake caliper M10x1
LR. Outlet fitting to left rear brake caliper M10x1
RF. Outlet fitting to right front brake caliper M10x1
RR. Outlet fitting to right rear brake caliper M12x1

1. Hydraulic control unit
2. Scavenging pump
3. Electronic control unit
4. 31 terminal connector

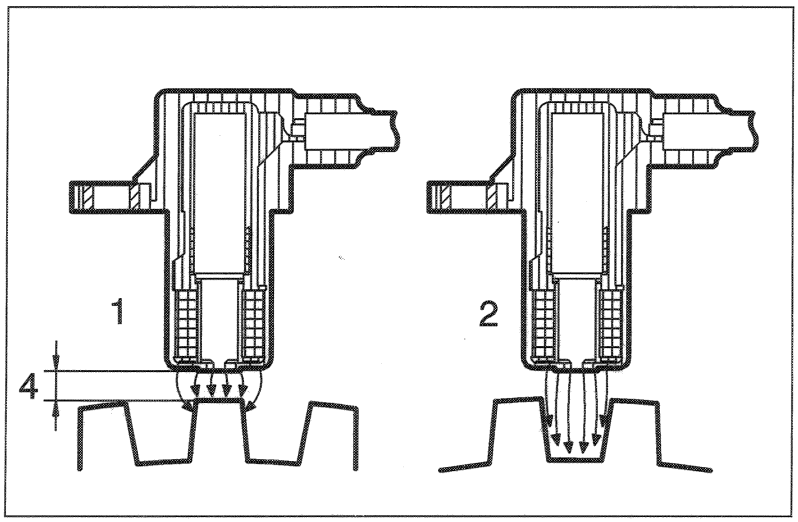
BOSCH DF6 wheel rpm sensors

These sensors measure speed of motion, acceleration, deceleration and wheel slide.
The inductive sensors are fitted in special housings on the front and rear wheel pillars.
Lines of magnetic flux close through the teeth of a toothed wheel (phonic wheel) which faces the sensor and is turned with the wheel. The changeover from full to empty due to the presence or absence of a tooth brings about a change in the magnetic flux of sufficient entity to create an electromotive force at the sensor terminals and thus send an alternating electrical signal to the electronic control unit.
Internal sensor parts (coil and permanent magnet) are fully embedded in a protective resin and surrounded by a plastic case. A brass bush fitted in the sensor case is used to secure the case without giving rise to deformation.
The design of the DF6 rpm sensor is more simple than previous types and the sensor operates more effectively.

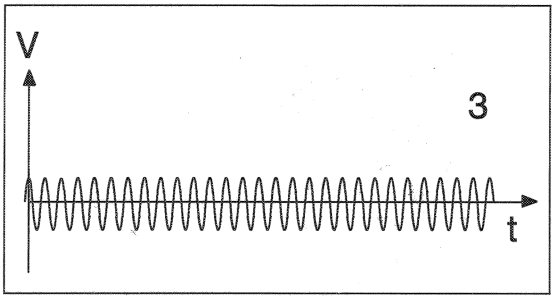


P3M06AD01

1. Brass bush
2. Permanent magnet
3. Plastic sensor case
4. Winding or coil
5. Polar core
6. Crownwheel or phonic wheel
7. Two-stranded coaxial lead or electrical connection



P3M06AD02



P3M06AD03

1. Peak magnetic flux
2. Minimum magnetic flux
3. Plot of induced alternating voltage
4. Gap

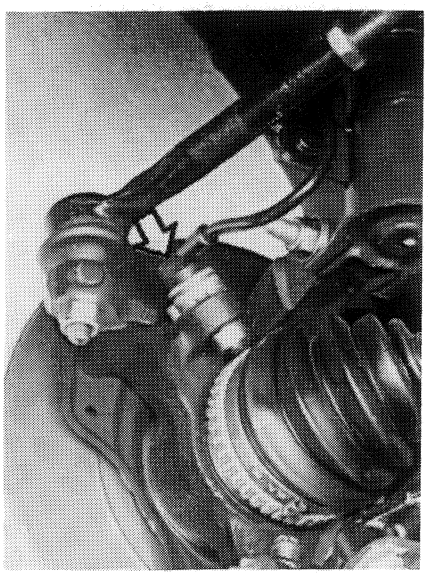
In order to receive correct signals, the specified gap between the end of the sensor and the phonic wheel must be between:

0.64 - 1.30 mm for the front wheels
0.25 - 1.15 mm for the rear wheels

This distance cannot be adjusted. When gap is not as specified, check condition of the sensor and phonic wheel.

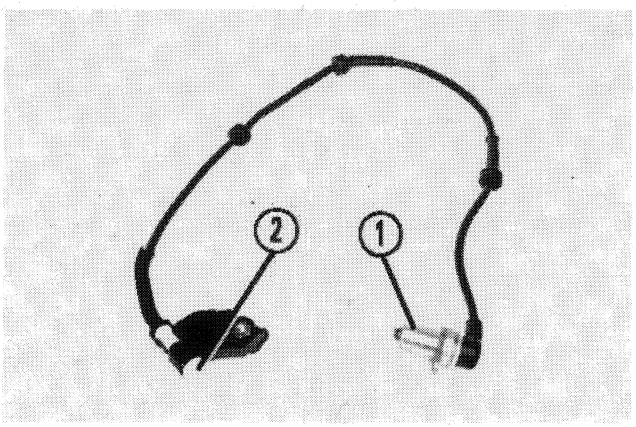
Sensor resistance is 1600 ± 100 Ω

NOTE *The sensor undergoes heat-induced changes with time and the application of water-repellent grease during installation will prevent the sensor from being damaged during removal.*



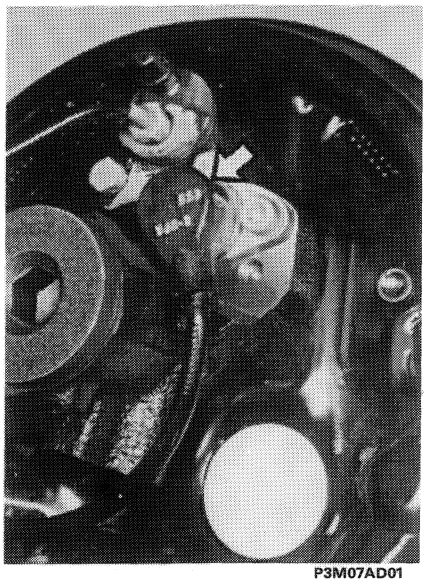
P3M045D01

Position of front wheel rpm sensor



P3M052D03

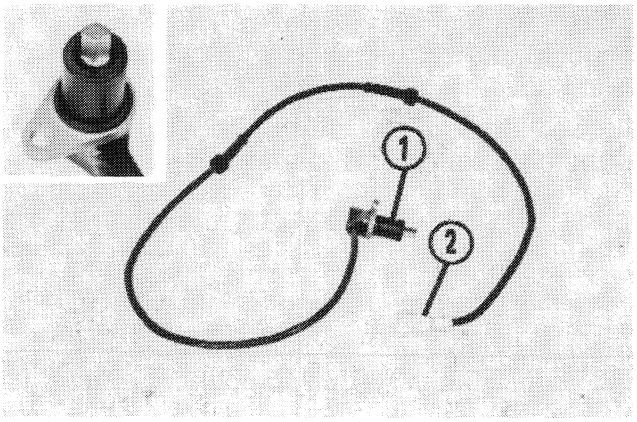
1. Rpm sensor for front wheels
2. Electrical connection



P3M07AD01

Position of rear wheel rpm sensor (GT version)

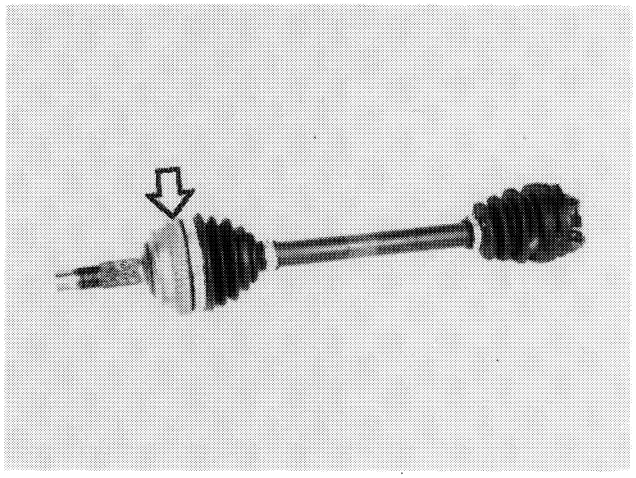
P3M052D04



P3M052D05

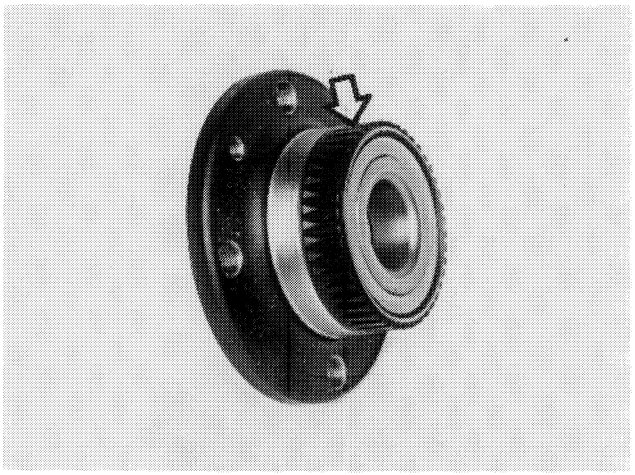
1. Rpm sensor for rear wheels (GT version)
2. Electrical connection

The front phonic wheels are press-fitted to the wheel end of the constant velocity joints. The rear phonic wheels are press-fitted to the wheel hubs and consist of 44 teeth.



P3M052D01

Position of front phonic wheel



P3M052D02

Position of rear phonic wheel

ABS failure warning light.

The warning light consists of a conventional bulb which is activated when the ignition is turned on (+15). The light goes off only if the ABS control unit battery voltage reaches pin 6 on the panel.

With the ignition turned to MARCIA position, the red ABS fault warning light comes on.

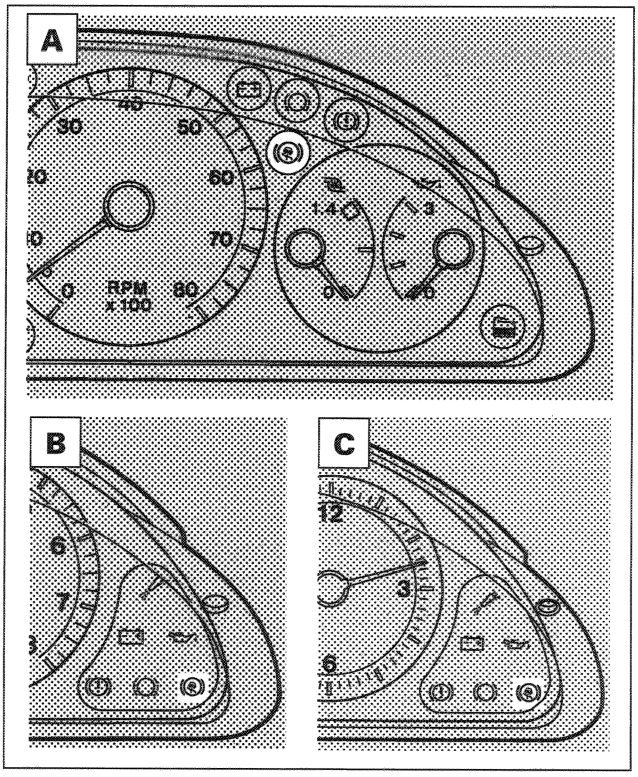
After about 2 seconds (if the check system does not detect any faults), the warning light goes off.

If the warning light stays on, one or more components of the ABS must be faulty. Under these circumstances the ABS system is disenabled and braking is able to take place only in conventional manner.

If the warning light does not come on (when the ignition is turned on), the fault must lie in the warning light bulb, or in the electrical connection (+15) between the A.B.S. control unit and instrument panel.

The A.B.S comes on at about 3 km/h.

The system test cycle begins at a speed of about 6 km/h. If the system components pass the tests, the warning light stays off. If the components fail the test, the warning light comes on and the ABS is automatically deactivated. Braking takes place in conventional manner.



P3M08AD01

A GT - ELX TD version

B S - ED version

C SX - EL - 6 speed - ELX petrol version

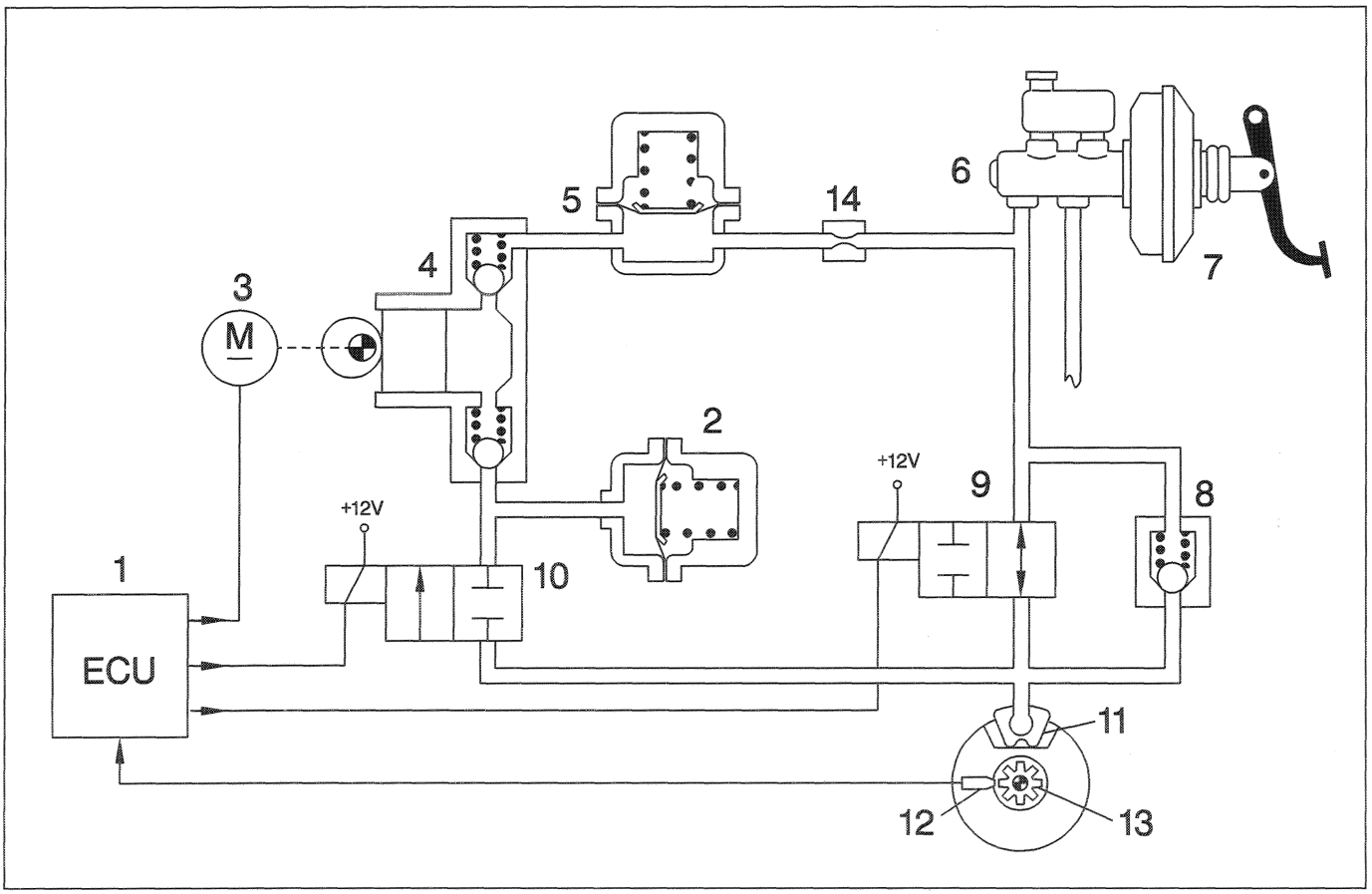
If battery charge is too low, the warning light may come on and the A.B.S. be cut out. This could occur, for example, when the vehicle is driving through a town at low speed with all services activated.

DESCRIPTION OF OPERATION OF ANTI-LOCK BRAKING SYSTEM

Rest position

Each branch of the Bosch 5.3 ABS is fitted with two two-way solenoids. All solenoids are managed by control unit (1).
When deactivated, charging solenoid (9) (not earthed from the control unit) is open so that that fluid can flow through to the brake caliper.

Pressure is maintained by supplying this valve with electricity so that it closes.



P3M09AD01

1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Scavenging pump motor
4. Scavenging pump
5. High pressure accumulator (damping chamber)
6. Brake pump
7. Servo brake
8. Quick pressure reduction valve
9. Charging solenoid
10. Discharge solenoid
11. Brake calipers
12. Rpm sensor
13. Phonic wheel
14. Restriction

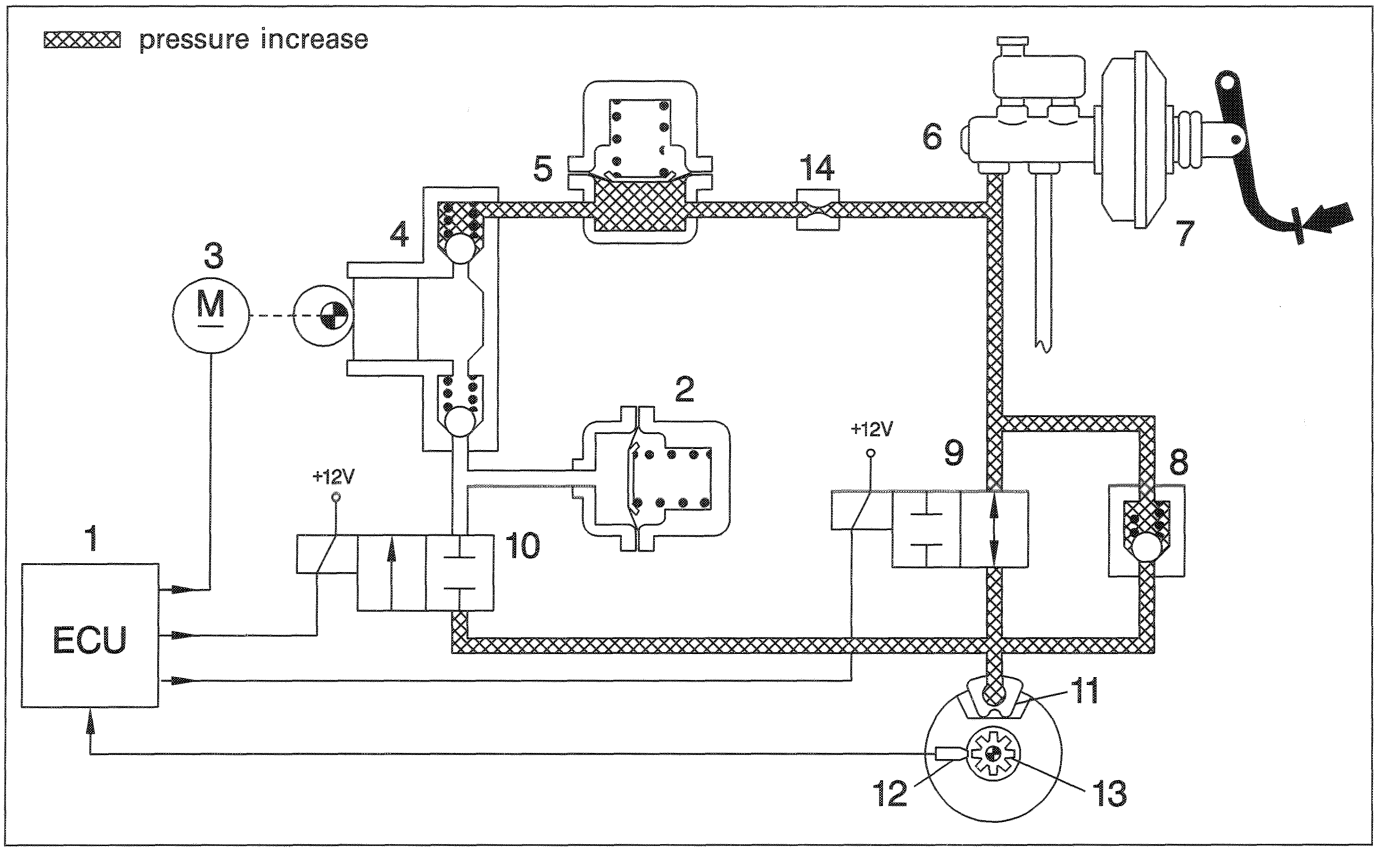
When discharge solenoid (10) is deactivated (not earthed from the control unit), it closes so that fluid cannot drain to the low pressure accumulator (2).

Accumulators (2) and (5) temporarily store brake fluid made available during the pressure reduction stage.

Scavenging pump (4) directs brake fluid flowing out of the brake calipers during the pressure reduction stage to the brake pump through the relevant accumulator.

According to signals received from the rpm sensors on the front and rear wheels, the electronic control unit governs the electro-hydraulic control unit which in turn alters the presure of brake fluid directed to the calipers through three stages: pressure increase, maintenance or reduction.

Pressure increase stage



P3M10AD01

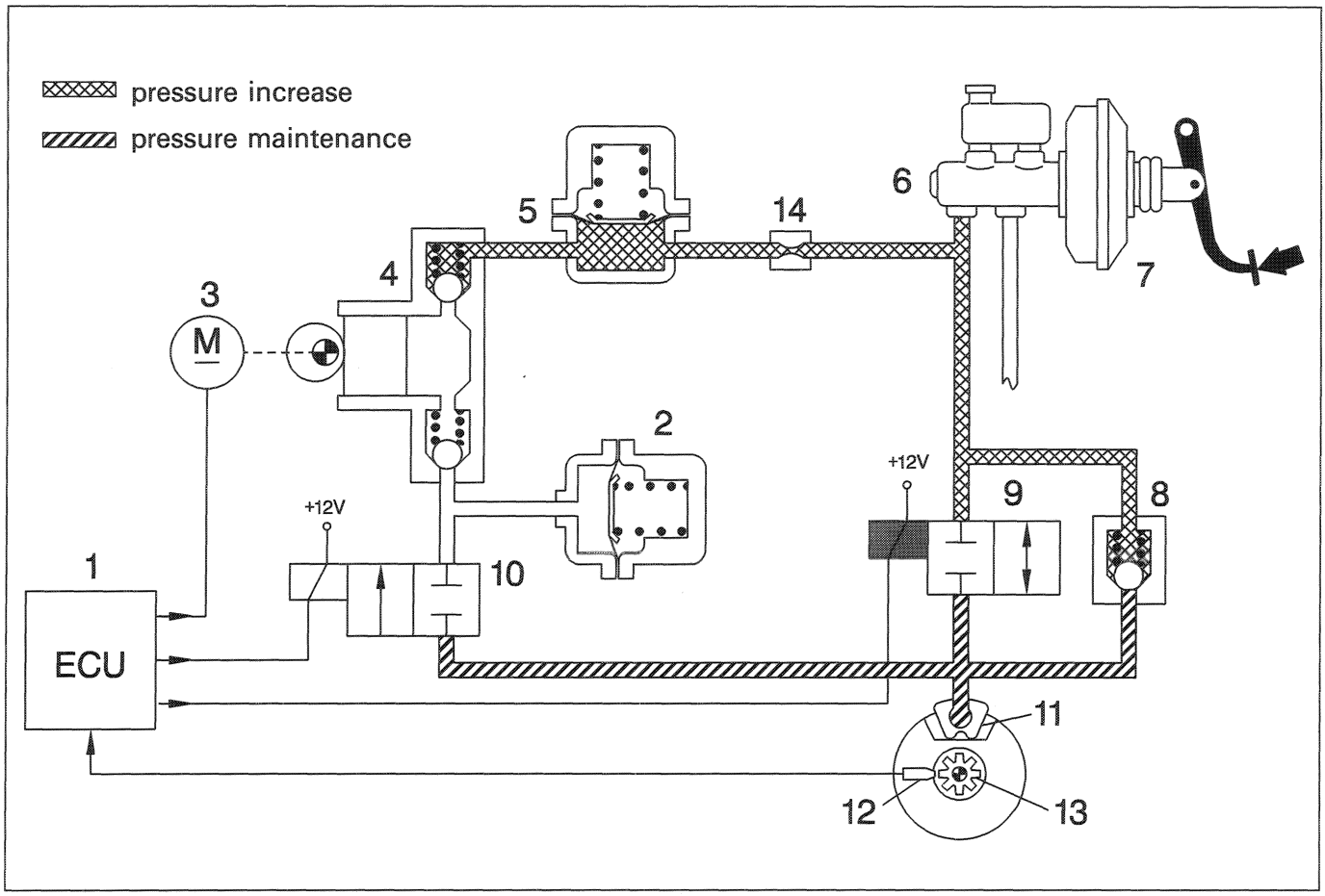
1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Scavenging pump motor
4. Scavenging pump
5. High pressure accumulator (damping chamber)
6. Brake pump
7. Servo brake
8. Quick pressure reduction valve
9. Charging solenoid
10. Discharge solenoid
11. Brake calipers
12. Rpm sensor
13. Phonic wheel
14. Restriction

When the vehicle driver presses the brake pedal, pressure generated by the brake pump (6) reaches the brake calipers without undergoing changes because solenoids (9) and (10) of the hydraulic unit are not earthed from the electronic control unit.

When braking effort increases, wheel deceleration also increases. This brings about faster vehicle deceleration (i.e. wheel creep increases).
Creep level should never exceed a certain threshold. Above this, the wheel loses its grip on the ground and begins to slide. Directionality is lost and stopping distances increase.

Rpm sensor (12) indicates when deceleration reaches levels which could impair wheel grip on the ground. Electronic control unit (1) now controls hydraulic unit solenoids to reduce braking effort and allow wheel speed to increase in order to restore grip.

Pressure maintenance stage



P3M11AD01

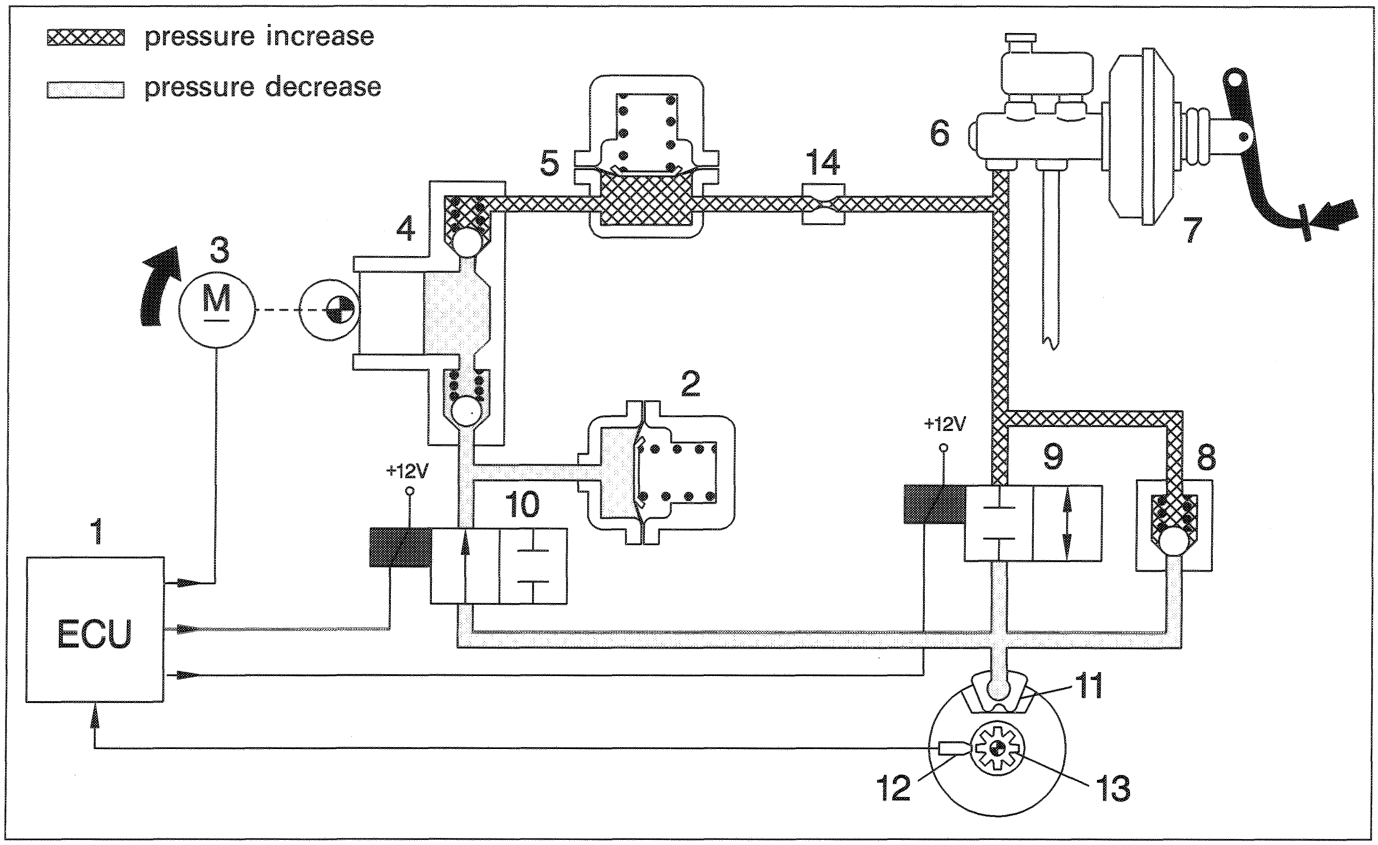
1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Scavenging pump motor
4. Scavenging pump
5. High pressure accumulator (damping chamber)
6. Brake pump
7. Servo brake
8. Quick pressure reduction valve
9. Charging solenoid
10. Discharge solenoid
11. Brake calipers
12. Rpm sensor
13. Phonic wheel
14. Restriction

During this stage, electronic control unit (1) earths charging solenoid (9) which closes; discharge solenoid (10) is already closed because it is not earthed.

The hydraulic connection between brake pump (6) and brake calipers (11) is cut (resting position). Pressure in brake caliper (11) is maintained constant at the previous value, regardless of the pressure on the brake pedal.

Although braking effort keeps slowing the wheel down, wheel speed actually alters according to grip on the ground until the signal from rpm sensor (12) records a reading comparable with the reference speed calculated by electronic control unit (1).
The control unit now moves on from the pressure maintenance stage to the increase stage (if the wheel is accelerating) or the decrease stage (if the wheel is locking).

Pressure reductionn stage



P3M12AD01

1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Scavenging pump motor
4. Scavenging pump
5. High pressure accumulator (damping chamber)
6. Brake pump
7. Servo brake
8. Quick pressure reduction valve
9. Charging solenoid
10. Discharge solenoid
11. Brake calipers
12. Rpm sensor
13. Phonic wheel
14. Restriction

Control unit (1) records wheel tendency to lock and activates the hydraulic control unit to keep wheel deceleration within permitted threshold levels.

Electronic control unit (1) earths input solenoid (9) and output solenoid (10).
Input solenoid (9) remains closed to keep the connection between brake pump (6) and brake caliper (11) open. Output solenoid (10) opens to ensure a hydraulic connection between brake caliper (11), low pressure acccumulator (2) and scavenger pump (4) in order to remove a portion of the fluid from brake caliper (11) and reduce pressure on the caliper.
At the same time, electronic control unit (1) activates engine (3) controlling scavenging pump (4), so that fluid removed from brake caliper (11) can be re-introduced into the main circuit.

The circuit accumulator (2) or low pressure reservoir stores part of the brake fluid removed from the calipers. Brake fluid is taken up through the circuit of scavenging pump (4) before being drawn up and sent to the main circuit of brake pump (6) through damping chamber (5) and restriction (14).
A series of pressure waves (or hydraulic surges) generated during this stage is damped by damping chamber (5) and restriction (14).

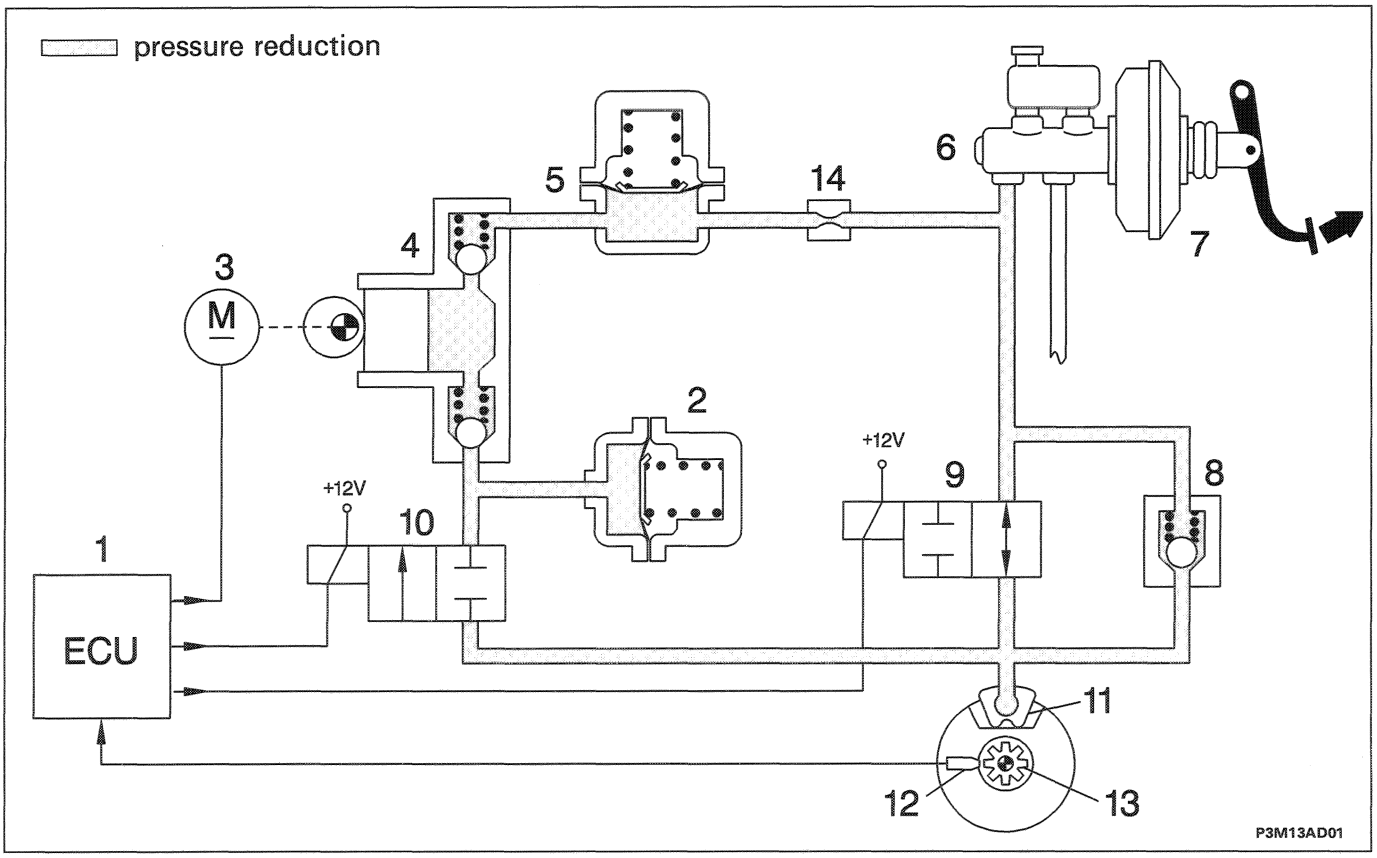
Slight surges at the brake pedal are quite normal during operation of the A.B.S. system. As braking effort falls during this stage, the wheel tends to return to the reference speed calculated by electronic control unit (1).

The type of braking is therefore intermittent or in steps: a repetitive series of stages governed by braked wheel rolling speed. This takes place so quickly and at such high frequency that the driver is not even aware of the cycle. Because the device works so quickly, wheel inertia also helps to ensure the wheel does not slip too much.

On vehicles without an A.B.S., the driver is able to operate the brake pedal at a rate of 2 cycles per second (2 presses and 2 releases).
The cycles increase from 4 - 10 per second with an A.B.S. (according to grip).
The A.B.S. normally stops working at speeds less than 2.75 km/h to allow the wheels to lock fully when the vehicle comes to a standstill.

NOTE *The scavenging pump is dual circuit, free piston type controlled by an electric motor which turns continually during scavenging stages.*
Pistons are not fitted to the electric motor but moved through their stroke by the cam only when the brake fluid arrives. The pump may therefore only move through a pressure stroke. A suction stroke is not possible due to the lack of mechanical connection between motor and pump

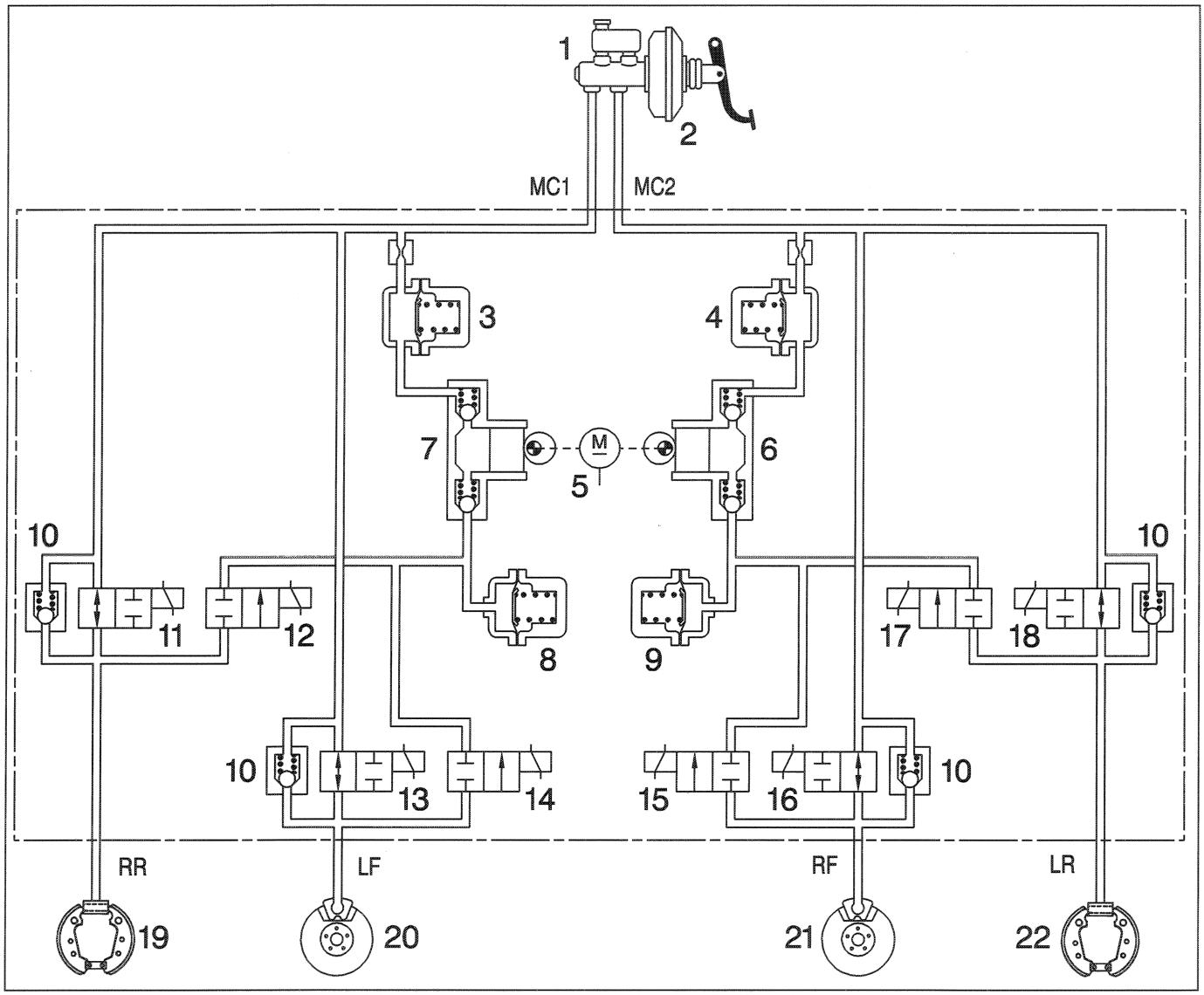
Brake pedal release



1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Scavenging pump motor
4. Scavenging pump
5. High pressure accumulator (damping chamber)
6. Brake pump
7. Servo brake
8. Quick pressure reduction valve
9. Charging solenoid
10. Discharge solenoid
11. Brake calipers
12. Rpm sensor
13. Phonic wheel
14. Restriction

To allow quick pressure reduction on the brake caliper (11) when the brake pedal is released, the system is fitted with a check valve (8) in parallel with input solenoid (9).

BOSCH 5.3 ABS HYDRAULIC SYSTEM DIAGRAM



Double crossover braking circuit

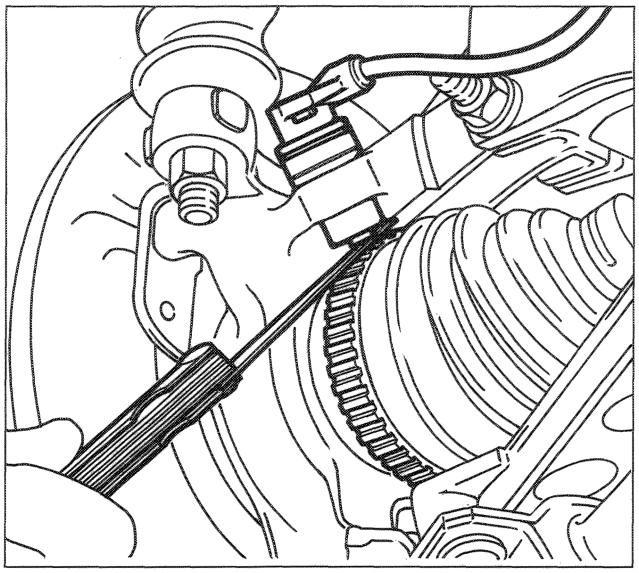
1. Brake pump
2. Servo brake
3. High pressure accumulator (damping chamber)
4. High pressure accumulator (damping chamber)
5. Scavenging pump motor
6. Scavenging pump
7. Scavenging pump
8. Low pressure accumulator (reservoir)
9. Low pressure accumulator (reservoir)
10. Quick pressure reduction valve
11. Right rear charging solenoid
12. Right rear discharge solenoid
13. Left front charging solenoid
14. Left front discharge solenoid
15. Right front charging solenoid
16. Right front discharge soleoid
17. Left rear charging solenoid
18. Left rear discharge solenoid
19. Right rear drum brake
20. Left front disc brake
21. Right front disc brake
22. Left rear drum brake

MC1. 1st stage brake pump inlet fitting
MC2. 2nd stage brake pump inlet fitting

RR. Outlet fitting to right rear cylinder
LF. Outlet fitting to left front caliper
RF. Outlet fitting to right front caliper
LR. Outlet fitting to left rear cylinder

CHECKING GAP BETWEEN RPM SENSOR AND PHONIC WHEEL

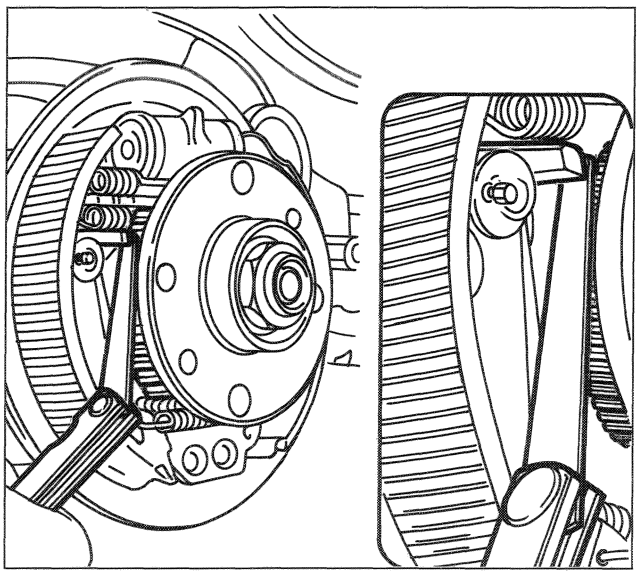
The gap is not adjustable because no shims are available for the purpose. If gap is not as specified, check condition of the sensor and phonic wheel teeth.



P3M15AD01

Checking gap between rpm sensor and phonic wheel on the front constant velocity joint

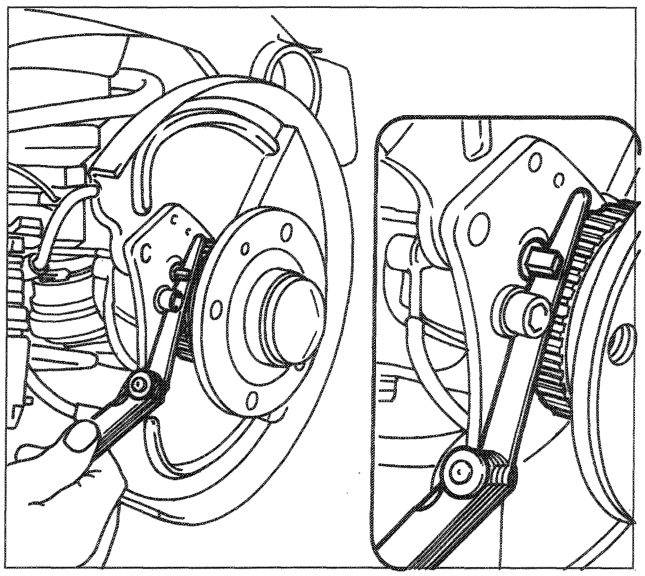
0.64 - 1.30



P3M15AD02

Checking gap between rpm sensor and phonic wheel on the rear wheel hub (for all engine versions except the GT version)

0.25 - 1.15



P3M15AD03

Checking gap between rpm sensor and phonic wheel on the rear wheel hub (for GT version)

0.25 -1.15

33.

FAULT DIAGNOSIS

Faults in the Bosch 5.3 ABS system may be searched for and identified by connecting one of the following tools to the tester socket:

- Fiat-Lancia Tester (memory module M56-A)
- S.D.C.-Computerised Test Station
- Examiner

When the Tester is connected, the A.B.S. is deactivated and the fault warning light stays on.
If the control unit reveals a fault, the system is deactivated and the fault warning light comes on. The defect is saved in a permanent memory; the Tester deletes the error at the end of the testing session or it disappears automatically after the vehicle has been started 20 times.
If two errors occur at the same time, the control unit is able to save only one.

Blink codes

The 5.3 ABS can test itself and indicate faults detected with the aid of external devices.

The system displays a series of fault codes to the operator by means of a flashing warning light on the instrument panel.
These codes are made up of two figures (e.g. lh front discharge solenoid faulty). The light blinks an appropriate number of times to display the amounts making up the code. The first set of blinks indicate decimals (e.g. 2 - two blinks) while the second set indicates integers after a gap of 1.2 ± 0.1 seconds (e.g. 9 - 9 blinks)

This procedure is not activated if faults are present:

- in control unit tester line L,
- in the warning light on the instrument panel,
- in parts of the control unit responsible for this form of self-diagnosis.

The procedure must be carried out with the vehicle at a standstill or travelling at less than 0 km/h; Otherwise the blink codes are automatically interrupted by the system, which memorises the event and causes a warning light on the control panel to come on.

The fault code indicator activation procedure must be carefully followed to ensure effective indication:

1) Connect tester socket line L to earth (lead colour AB).
2) Turn the ignition key to MAR.
3) The control unit activates the procedure and the warning light stays off.
4) Once 3.2 seconds have elapsed following procedure activation, the system emits a blink code to indicate that the procedure has been activated three times (blink code 12).
5) After a further 3.2 seconds have elapsed, the system begins to emit all the fault codes in the memory. Each code is repeated three times with a gap of 3.2 seconds between one code and the next.
6) Once all the fault codes in the memory have been emitted, the system begins the sequence again from step 4). Blink code 12 is emitted to indicate the procedure has begun and the fault codes are then repeated.
7) The procedure is halted (this operation may be carried out at any stage without affecting subsequent system operation) by disconnecting tester line L from the vehicle earth.

After a further 2 seconds, the system automatically returns to normal service status.

Blink code specifications are as follows:

- Blink frequency: 1.25 +/- 5% Hz.
- Warning light ignition time: 0.4 +/- 0.02 s.
- Warning light deactivation time: 0.4 +/- 0.02 s.
- Gap between start of procedure and emission of fault codes: 3.2 +/- 0.2 s.
- Gap between fault code emissions: 3.2 +/- 0.2 s.
- Gap between emission of tens and emission of units during the same fault code: 1.2 +/- 0.1 s.

Blink code table

Code	*Code description*
12	Start fault code indication procedure
16	LH front charging solenoid faulty
17	RH front charging solenoid faulty
19	Solenoid supply relay faulty
25	Phonic wheel (either one) damaged
26	LH rear charging solenoid faulty
27	RH rear charging solenoid faulty
28	LH front discharge solenoid faulty
29	RH front discharge solenoid faulty
31	LH rear discharge solenoid faulty
32	RH rear discharge solenoid faulty
35	Scavenging pump faulty
37	Brake pedal switch inefficient
39	LH front wheel speed sensor signal missing
41	LH front wheel speed sensor signal discontinuous or irregular
42	RH front wheel speed sensor signal missing
43	RH front wheel speed sensor signal discontinuous or irregular
44	LH rear wheel speed sensor signal missing
45	LH rear wheel speed sensor signal discontinuous or irregular
46	RH rear wheel speed sensor signal missing
47	RH rear wheel speed sensor signal discontinuous or irregular
48	Battery voltage insufficient
55	Electronic control unit faulty
56	Blink code activation procedure error
74	Warning light cable on instrument panel inefficient

INSTRUCTIONS TO BE OBSERVED ON VEHICLES FITTED WITH ANTI-LOCK BRAKING SYSTEMS

Disconnect the electronic control unit connector before carrying out welding work using an electrical welder.

If the battery is removed, tighten the battery terminals thoroughly when refitting.

Before removing the electronic control unit, disconnect the battery negative lead.

Whenever a hydraulic unit, rpm sensor, electronic control unit or wiring is changed (particularly after an accident), check the entire ABS system using a Tester.

After all repairs to the ABS system or braking system hydraulic circuit, fill using DOT 4 brake fluid and bleed. Check the seal at all connection points.

New hydraulic control units are provided full of DOT 4 brake fluid and with solenoids not supplied. The brake system is bled and filled in the same way as a conventional brake system, except that the operation takes longer.

Check that the pipes do not come into contact with the body at any point. This avoids damage to the pipe protection and also prevents noise transmission during operation of the ABS.
If connection pipes require loosening-removal, check the ABS for leaks.

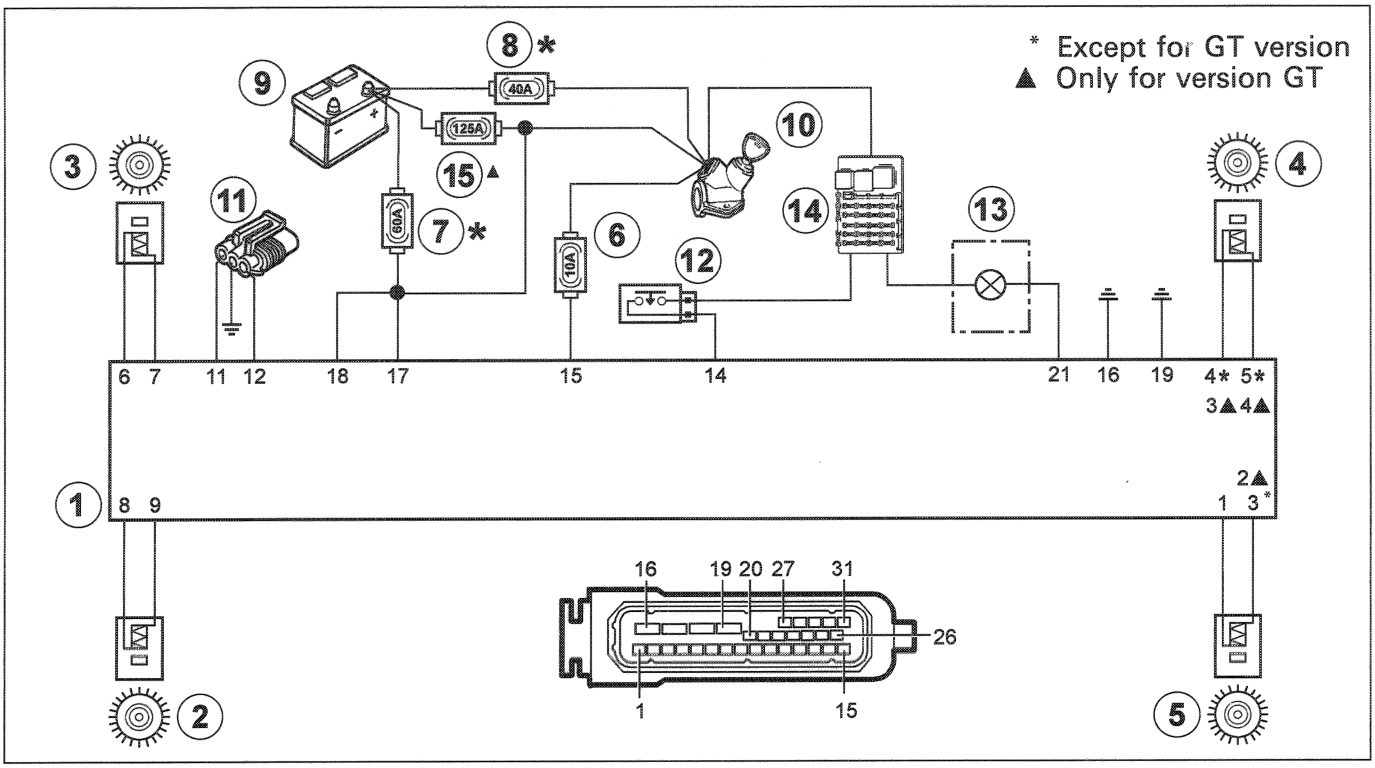
Do not add mineral oil to the brake circuit, because this could damage all the seals.
If mineral oil enters the system by accident, replace the following:
- *hydraulic unit,*
- *brake pump,*
- *calipers.*

PROCEDURE FOR ROAD TEST TO BE CARRIED OUT FOLLOWING REPAIRS TO THE ANTI-LOCK BRAKING SYSTEM

After any repair involving the anti-lock braking system electrical circuit or rpm sensors, whether due to specific repairs to the ABS system or removal and replacement of mechanical parts (e.g. spring-damper unit, constant velocity joints, drive shafts and wheel hubs), a very short road test must be carried out as follows:

1. Accelerate the vehicle to a speed greater than 12 km/h and maintain this speed. This will allow the electronic control unit to run a dynamic check on the sensors and detect any faults, inefficient contacts, incorrect positioning or the lack of a phonic wheel.
2. If the warning light does not reveal any defects after carrying out the previous operation, continue the test at a speed of 50 - 60 km/h for a period of 10 minutes. Use the brakes as normal but avoid abrupt braking manoeuvres. This stage of the test allows the electronic control unit to tell whether an inappropriate phonic wheel is present.

BOSCH 5.3 ABS WIRING DIAGRAM



P3M19AD01

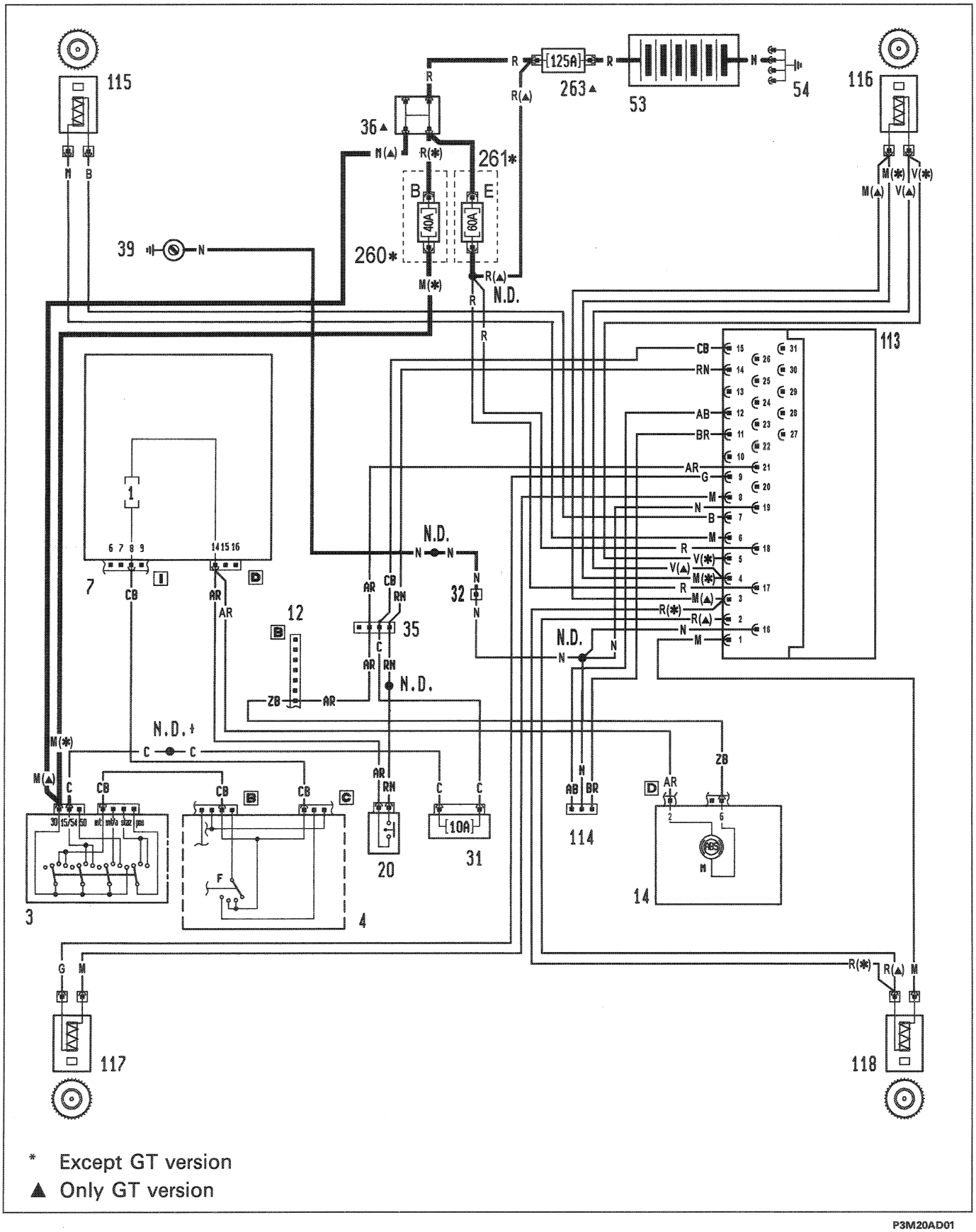
1. Electronic control unit
2. Left rear rpm sensor (RL)
3. Left front rpm sensor (FL)
4. Right front rpm sensor (FR)
5. Right rear rpm sensor (RR)
6. Fuse 10A
7. Fuse 60A (except GT version)
8. 40A fuse for services activated by ignition key (except GT version)
9. Battery
10. Ignition switch
11. Tester socket
12. Braking light switch
13. A.B.S. warning light
14. Junction unit
15. 125A fuse for services activated by ignition switch (only for GT version)

N°	Lead colour	Destination	N°	Lead colour	Destination
1	M	To right rear rpm sensor +	16	N	To earth
2▲	R	To right rear rpm sensor -	17	R	To 60A fuse +12V battery positive
3▲	R	To right rear rpm sensor -	18	R	To 60A fuse +12V battery positive
3▲-4*	M	To right front rpm sensor +	19	N	To earth
4▲-5*	V	To right front rpm sensor -	20	-	Free
6	M	To left front rpm sensor +	21	AR	To ABS warning light
7	B	To left front rpm sensor -	22	-	Free
8	M	To left rear rpm sensor +	23	-	Free
9	G	To left rear rpm sensor -	24	-	Free
10	-	Free	25	-	Free
11	BR	To K line tester socket	26	-	Free
12	AB	To L line tester socket	27	-	Free
13	-	Free	28	-	Free
14	RN	To brake light switch	29	-	Free
15	CB	To 10A fuse +15 terminal of ignition switch	30	-	Free
			31	-	Free

Identification of terminals on the electronic control unit and associated connector

33.

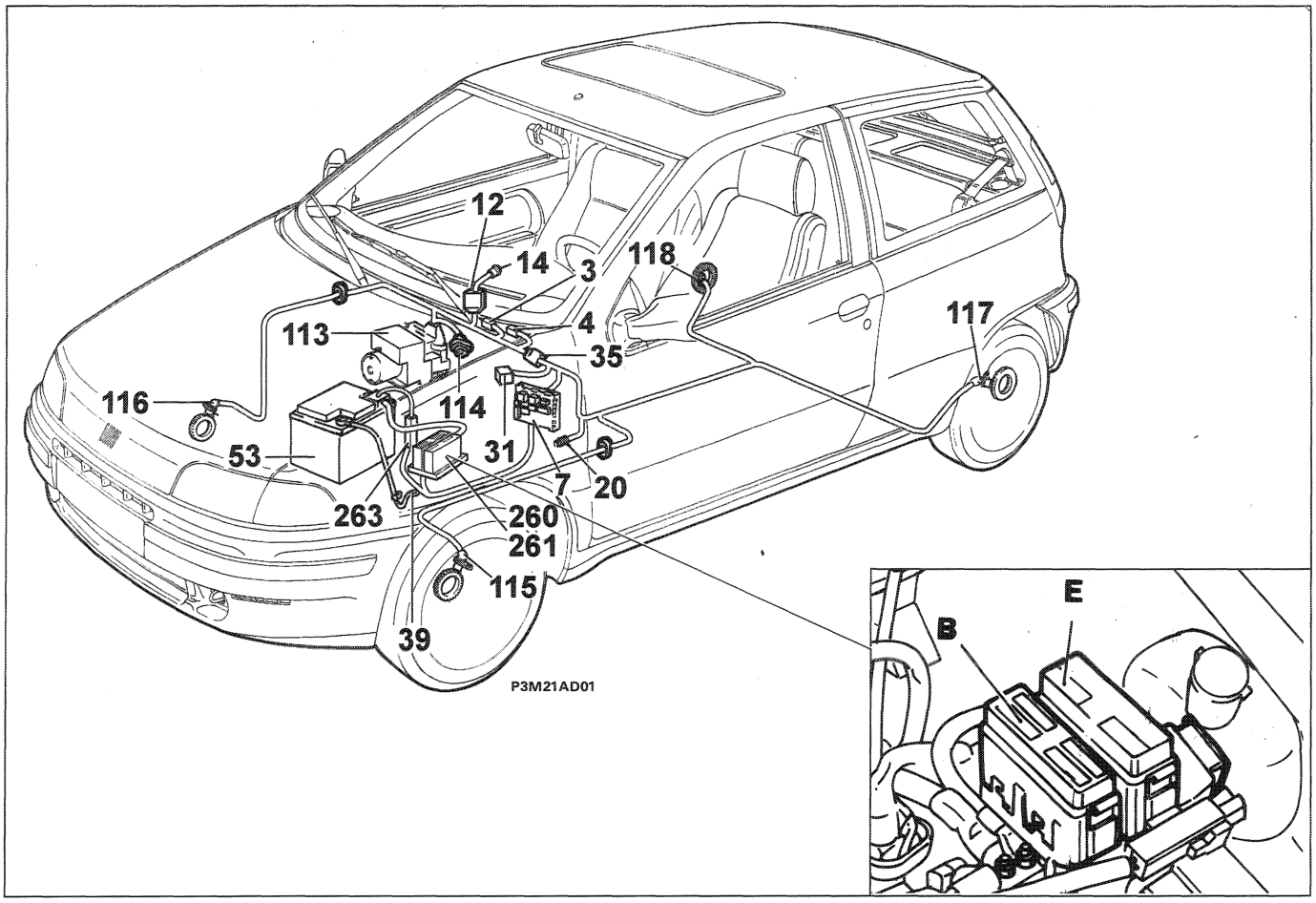
Anti-lock braking system wiring diagram (Bosch 5.3 ABS).



* Except GT version

▲ Only GT version

P3M20AD01



Wiring for anti-lock brakes (Bosch 5.3 anti-lock brakes) and warning light.

Key to components

3. Ignition switch
4. Stalk unit
7. Junction unit
12. Connection between facia wires and front wires
14. Instrument panel:
    M ABS failure warning light
20. Brake light switch
31. 10A fuse for ABS device
32. ABS wiring connection
35. Connection between front wiring and ABS wiring
36. Connector block
39. Left front earth
53. Battery
54. Battery earth
113. ABS electronic control unit (A.B.S.)
114. Diagnostic socket for ABS device
115. Sensor on left front wheel (A.B.S.)
116. Sensor on right front wheel (A.B.S.)
117. Sensor on right rear wheel (A.B.S.)
118. Sensor on left rear wheel (A.B.S.)
260. Power fuse box:
    B: 40A fuse for ignition system
261. Power fuse box:
    E: 60A fuse for ABS system
263. 125A maxi fuse protecting system
N.D. Connector block