SECTION 0A

CAUTION:

This vehicle Is equipped with an AIR BAG. Refer to CAUTIONS, Section 12, In this Volume of the Preliminary Service Information before performing any service operation on or around Air Bag components, the steering mechanism or wiring.
Failure to follow the CAUTIONS could result in air bag deployment, resulting In possible personal Injury or unnecessary SRS system repairs.

GENERAL INFORMATION

CONTENTS

1. GENERAL INFORMATION

The introduction of the four wheel drive Calibra Turbo is the first Holden production vehicle that is equipped with four wheel drive at the factory. This vehicle has a substantial number of changed vehicle specifications when compared to the two wheel drive models. The following provides a summary of these features, while subsequent Sections in this Volume detail more specific information relevant to the engine management system of the new C 20 LET turbocharged engine, and the permanent, four wheel drive system.

1.1 PRINCIPLE FEATURES OF THE CALIBRA 4X4

Seats and Associated Items

Calibra 4x4 is fitted with leather trim on the seat covers, door panelling and the rear quarter panelling, as standard fitment. The seats are electrically heated and thermostatically controlled.

Instruments

While the arrangement of the instruments is the same as previous Calibra models, speedometer operation is now electronic, providing greater accuracy. The scale up to 60 km/h is now spread, providing better driver legibility in the lower speed range and the Calibra Turbo speedometer is now calibrated to a top speed of 260 km/h.

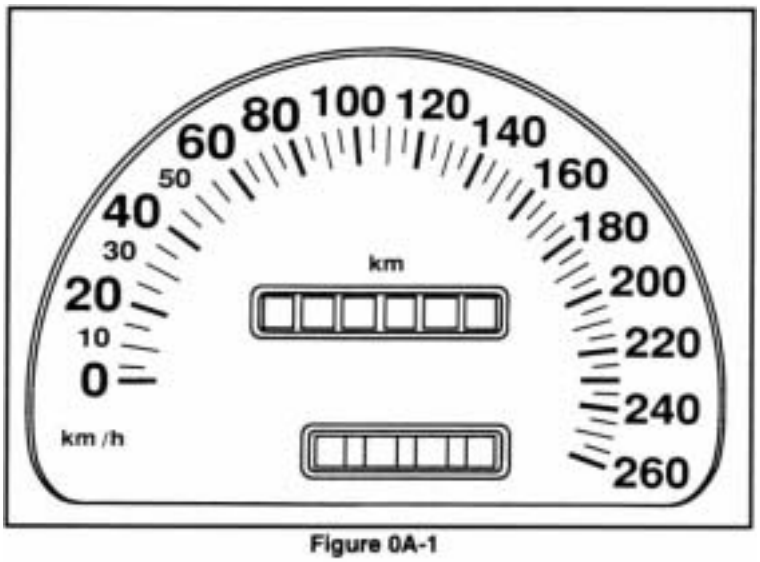


Figure 0A-1

A four wheel drive telltale lamp for the four wheel drive system in the Calibra Turbo, is now included ('1' in Figure OA-2), that is illuminated continuously or flashes when a system fault has been detected and the normally permanent four wheel drive mode is disengaged. Refer to Section 4 in this Volume for more detailed information.

Air Bag
All Calibra models are now fitted with a driver's air bag as standard equipment.

Should a fault develop in the air bag s stem, an air bag warning lamp in the instrument pane ('2' in Figure OA-2), will be illuminated.

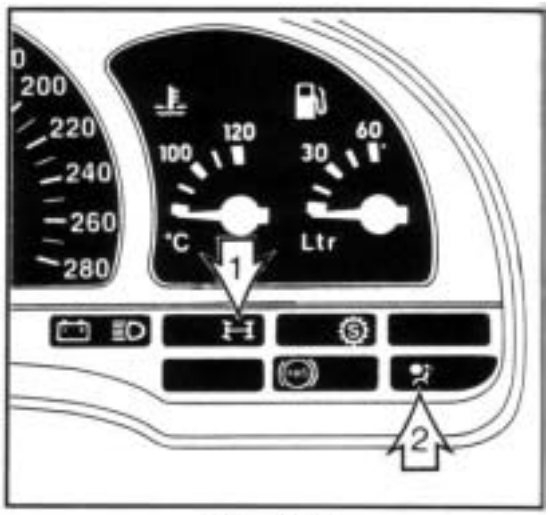


Figure 0A-2

Road Wheels
Together with revised design wheel hubs, the Calibra 4x4 is fined with 5 hole, 6J x 16, light alloy disc wheels with a rim offset of 49 mm. These wheels are fitted with 205/50 ZR 16 tyres as standard. Note that snow chains are not to be fitted to these tyre and wheel assemblies. Rear wheel hubs are also drilled to accommodate the new road wheels.

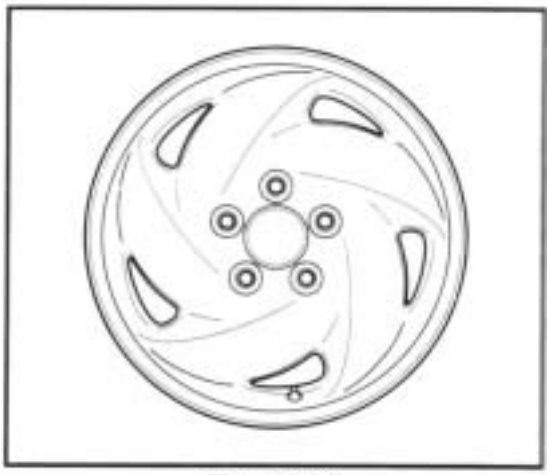


Figure 0A-3

Brakes
The front brakes on the Calibra Turbo, feature a revised design, single piston, front brake caliper with a piston diameter of 54 mm, with ventilated discs of 284 mm diameter.

The rear brakes retain the fixed caliper, two 33 mm piston design, fitted to solid discs of 270 mm.

The brake master cylinder has an increased bore size that changes from 22.2 mm to 23.8 mm to correspond to the increased diameter calipers fitted to the front brakes.

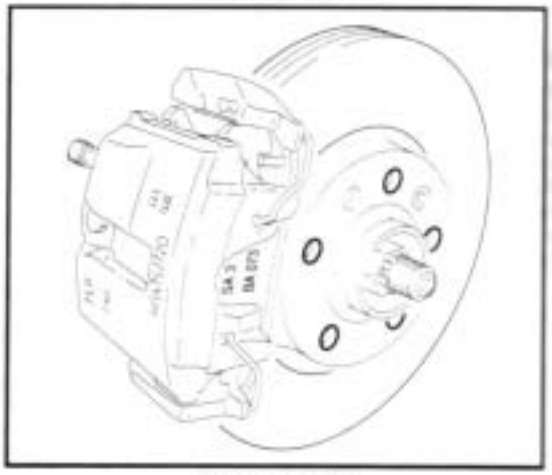


Figure 0A-4

DOHC Turbo Engine

The new 2 litre, 16 valve C 20 LET engine features a new integral turbocharger system with intake charge cooling and sequential fuel infection and knock control and is based on the existing C 20 XE engine. The engine management system used, is the Motronic 2.7, that is also used to control the intake charge pressure. For a more detailed explanation of the engine management system, refer to Section 6C in this Volume.

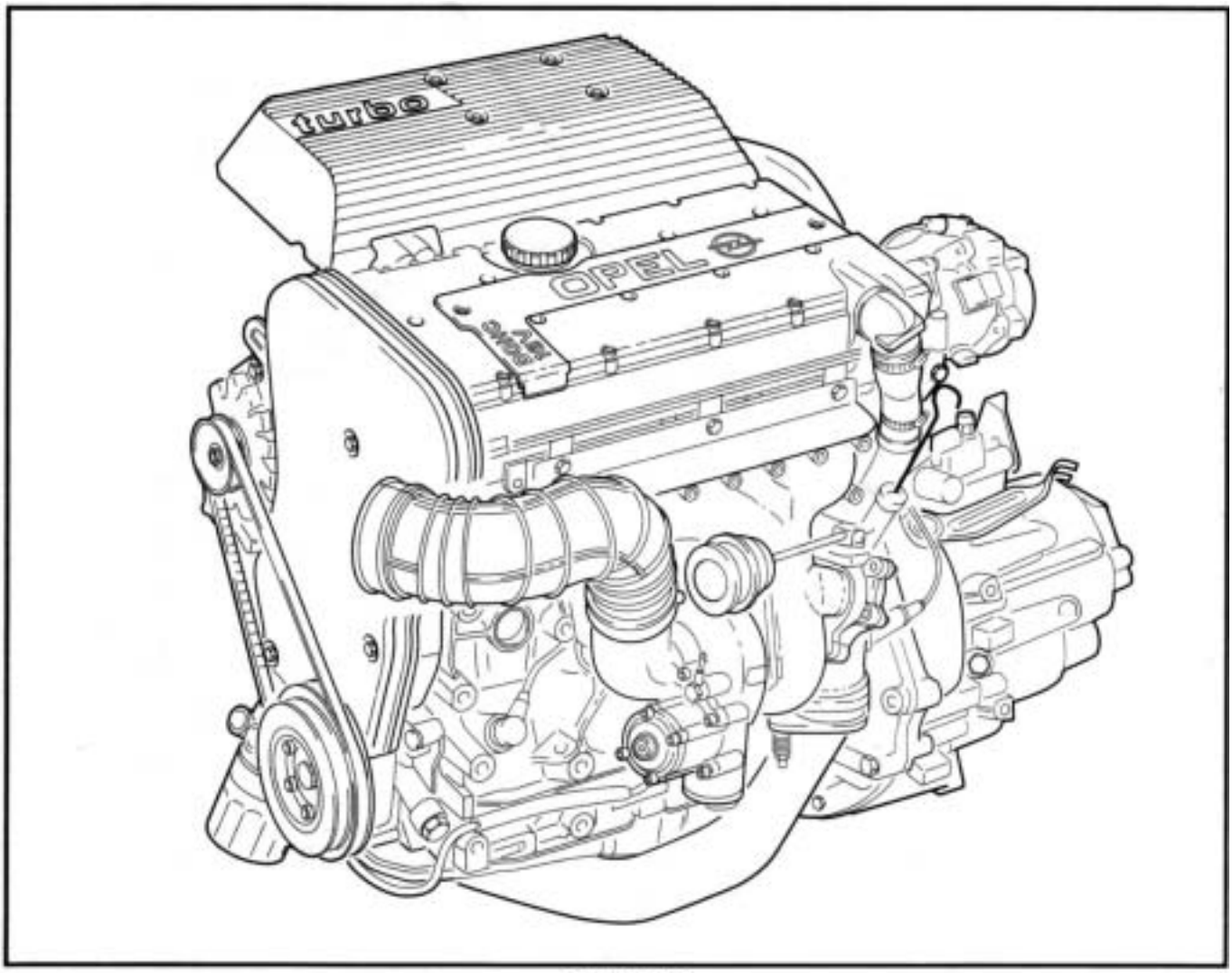


Figure 0A-5

Engine Data - C 20 LET

Displacement	1,998 cm
Bore diameter	86.0 mm
Stroke	86.0 mm
Valve Diameter	
- Inlet	33.0 mm
- Exhaust	29.0 mm
Valve Stroke	8.5 mm
Output at Engine Speed	150 kW @ 5,600 rpm
Maximum Torque at Engine Speed	280 Nm @ 2,400 rpm
Compression ratio	9.0 : 1
Spark Plugs	FR 7 LC 2
Engine Management with Knock Control and Charge Pressure Control	Motronic M 2.7
Fuel	Unleaded 91 octane

Power and Torque Curves

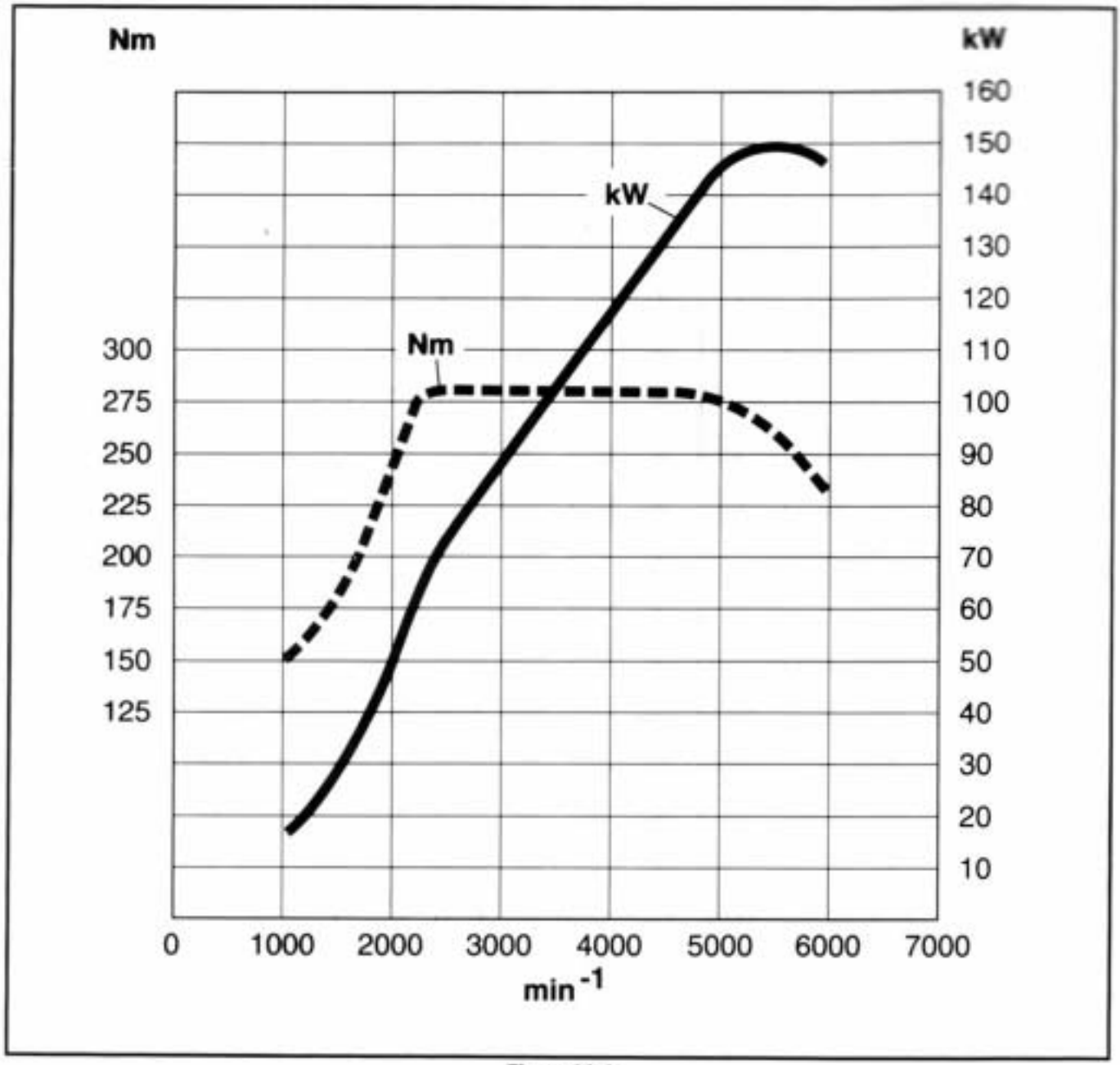


Figure 0A-6

Clutch/Flywheel

The clutch has been adapted to suit the increase in engine torque. This has been achieved by increasing the driven plate surface area and increasing the force applied by the Belleville spring in the pressure plate.

As a general design change, the flywheel used on all Calibra engines is now of the 'pot' design. This change results in a higher mass moment of inertia that contributes to smoother running and a reduction in transmission gear rollover rattle.

This now means that the clutch can be replaced only when the transmission has been removed.

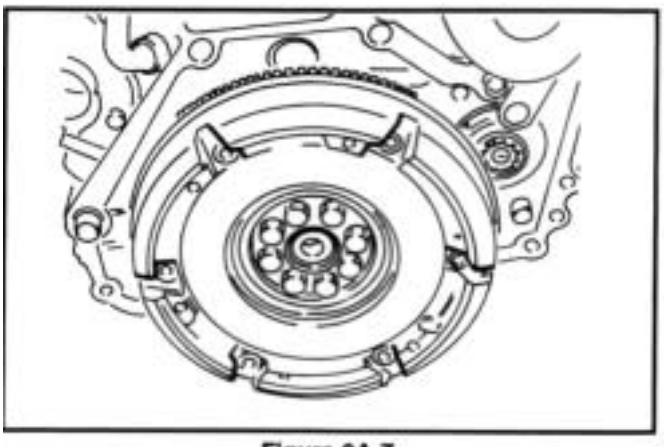
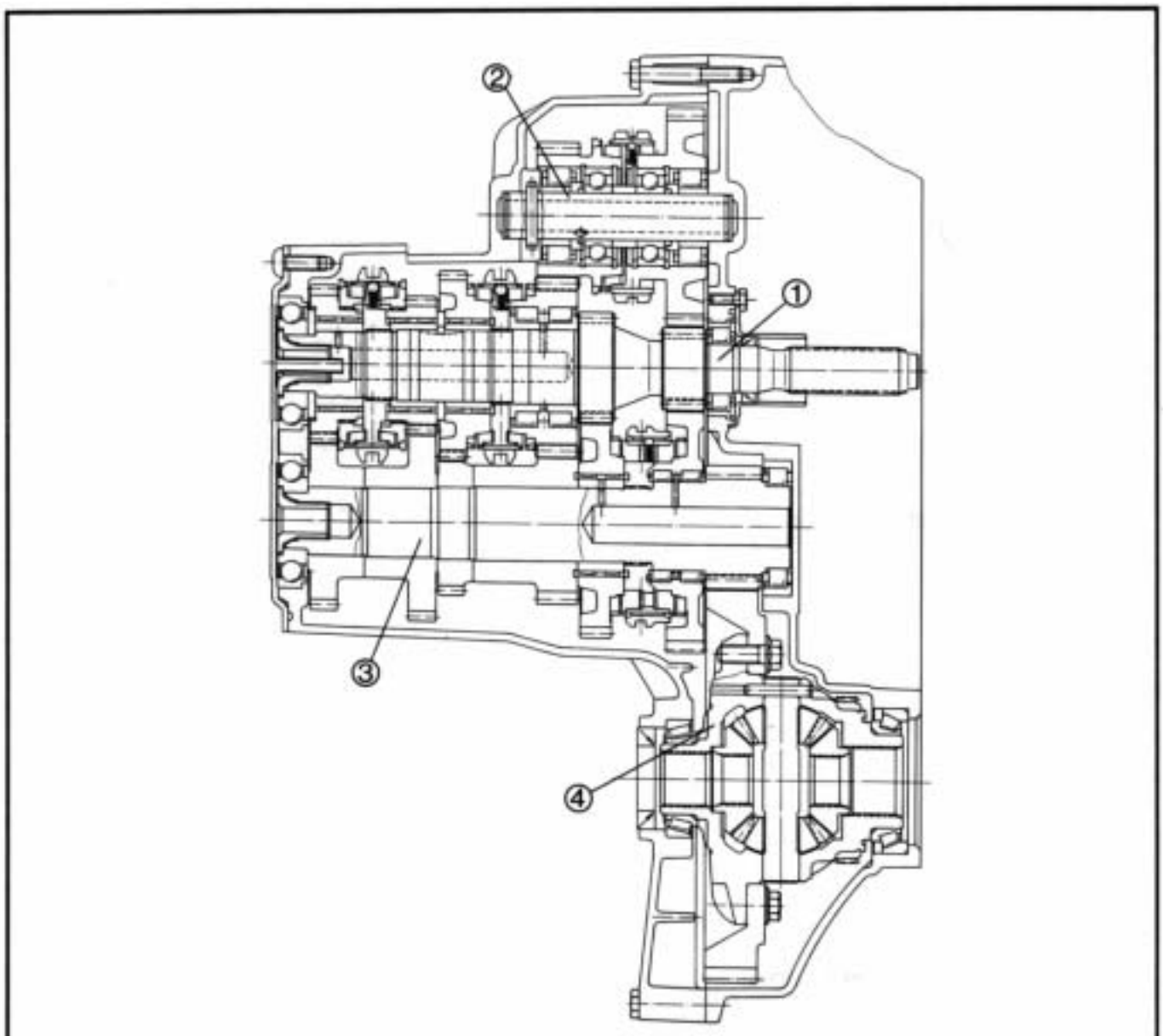


Figure 0A-7

Manual Transmission

The Calibra Turbo is fitted with a newly developed, compact, fully synchronized, 6-speed manual transmission. Known as the F 28/6, the extra sixth gear, results in low engine speed at high road speeds, providing high engine torque and low fuel consumption. Essentially, there are no serviceable components within the transmission.



1 Drive shaft with synchromesh assembly for 3rd/4th and 5th/6th gears.
2 Reverse gear with synchromesh assembly.
3 Intermediate shaft with 1st/2nd synchromesh assembly.
4 Differential with output drive ratio and axle shaft drive.

Figure 0A-8

Gear Ratios

Gear Selected	Ratio :1
1	3.57
2	2.13
3	1.46
4	1.10
5	0.89
6	0.74
Reverse	3.32
Front Output Drive Axle	3.72
Rear Output Drive Axle	3.70

Sensing Switches

In the transmission housing, in addition to the speedometer drive and reversing lamp switches, a first gear switch is also fitted. Both the reverse and first gear switch signals are used by the Motronic M 2.7, to disengage turbo boost when either starting from rest in first or reverse gear, to minimise the possibility of a loss of control of the vehicle, in these operating modes.
Refer to Section 6C ENGINE MANAGEMENT in this Volume for more information relating to these switch functions.

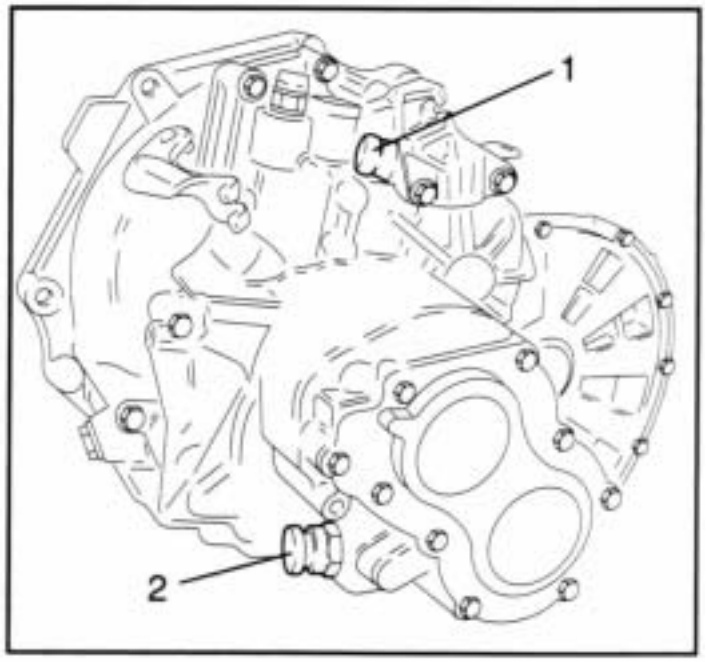


Figure 0A-9

Shift Lever

The shift selection arrangement on the leather covered shift knob has been changed to show the 6 speed ranges and reverse.

Figure 0A-10

Transfer Box

The engine torque to the rear axle is transferred to the hypoid gear in the transfer box, via a hollow shaft, which is connected to the transmission and this diverts the power flow through 90°.
The torque flows to the viscous coupling via a secondary planetary gear, comprising a ring gear, planet gears and sun gear. The outer housing of the viscous coupling is connected to the rear propeller shaft.
A mufti-disc clutch plate controls the operation of the planetary gear set, with the inner discs being splined to the ring gear and the outer discs, to the outer housing.
When the apply fluid pressure builds up from 3,600 -5,200 kPa, the clutch apply piston compresses the clutch pack, effectively locking the ring gear of the planetary gear set to the outer transfer box housing. This action engages four wheel drive operation.
When the apply fluid pressure drops below a pre-set value, a spring pushes the apply piston back, releasing the clutch pack, thereby freeing the planetary gear set.
When this occurs, four wheel drive operation ceases.
For information relating to the servicing of the transfer box, refer to page K-176 in Volume 2 of the Vectra, Cavalier, Calibra Service Instructions (PM M403278).

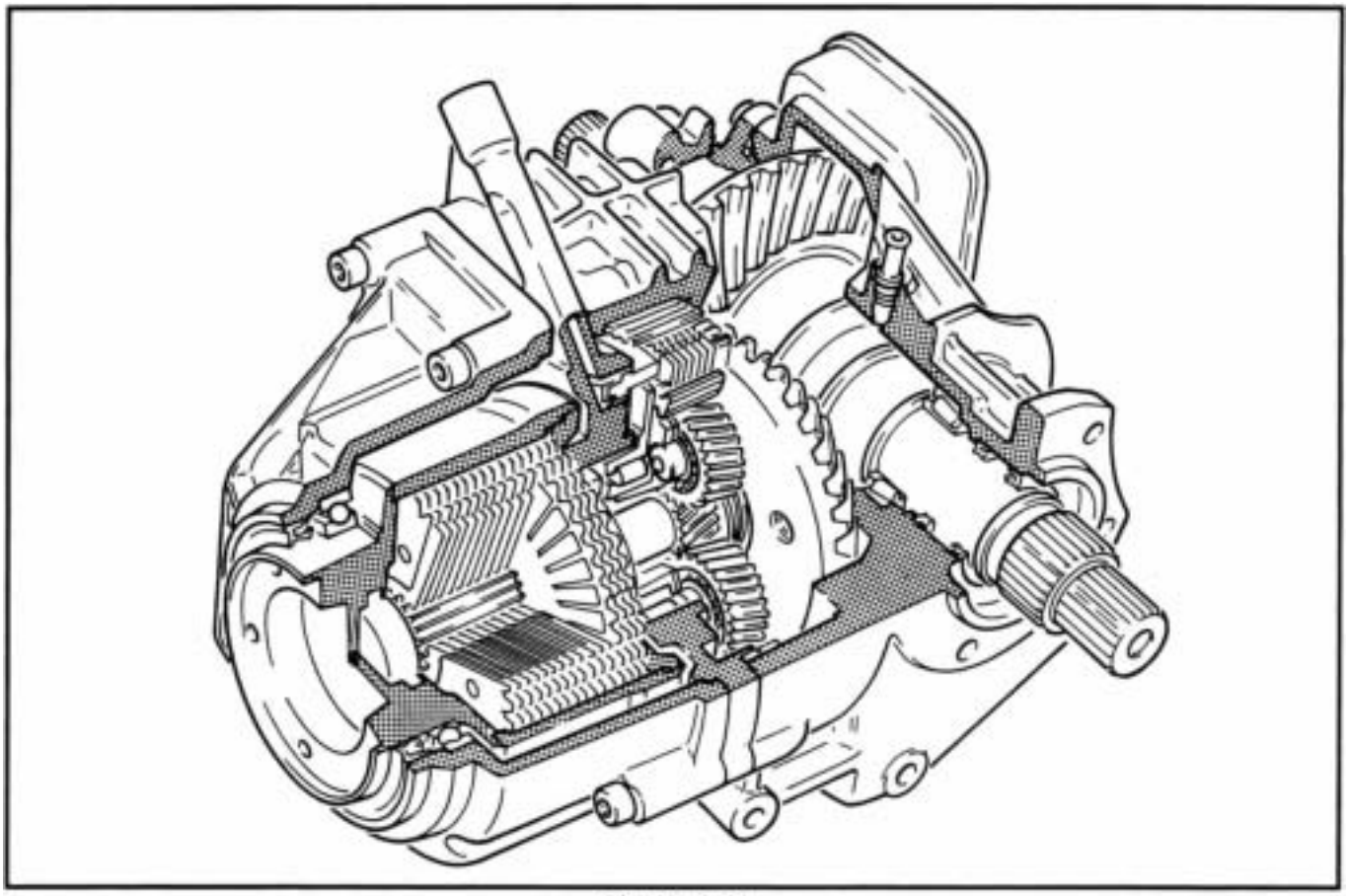


Figure 0A-11

Propeller Shaft

With the independent rear suspension, movement by the road wheels during compression and rebound, results in undesirable motions for the smooth transmission of power to the rear wheels. The effect of these motions has been overcome by using a rear propeller shaft comprised of a number of different components, as indicated in Figure OA-12.

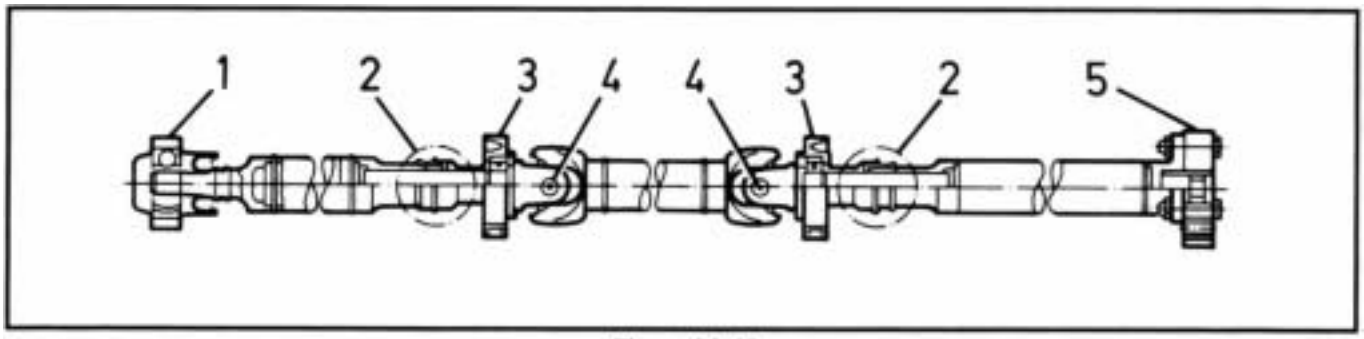


Figure 0A-12

Illustration Key
1 Homokinetic joint, front
2 Front and rear sliding gears with locking nut
3 Front and rear centre bearings
4 Universal joint
5 Single disc joint, rear

Exhaust System

The Calibra Turbo vehicle uses an exhaust system that has several special features, compared to the two wheel drive vehicle:

- The combination of the fantail manifold and front exhaust pipe are no longer used.
- Exhaust gases are now collected behind the turbocharger and passed through to the exhaust system in a short baffle manifold, that is fitted with a spherical graphite seal ring, which effectively reduces vibration transfer. The pipe diameter used for this engine is 60 mm.

- The front muffler is of an absorption design, while the rear muffler is constructed for reflection and absorption.
- The entire exhaust system is also made from stainless steel, to improve life.
- The catalytic converter has a larger, effective catalytic surface and to achieve the same outer dimensions, a metal construction has been adopted. Instead of the more conventional ceramic converter, a backing is processed from metal for the platinum/rhodium coating.

This results in:
- Low dynamic pressure.
- Operating temperatures are reached more quickly
- An extremely effective conversion (more than 90%) of noxious substances.

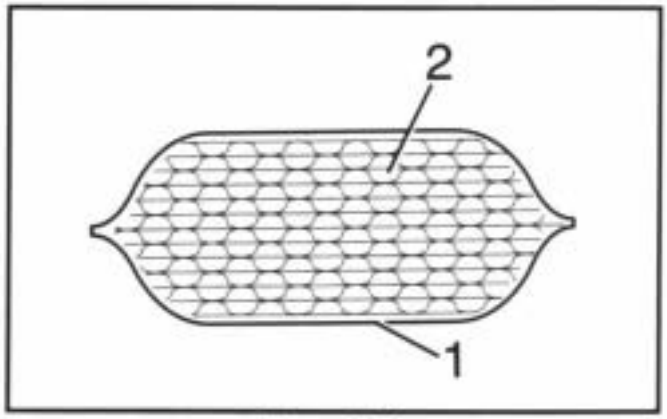


Figure 0A-13

Illustration Key:
1. Stainless steel housing.
2. Metal backing with platinum/rhodium coating.

For more detailed information relating to the turbocharger and associated controls, refer to Section 6A, ENGINE MECHANICAL in this Volume.

SECTION 4

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FOUR-WHEEL DRIVE SYSTEM

CONTENTS

1. GENERAL INFORMATION

The Calibra Turbo 4x4 is equipped with a permanent four-wheel drive system; i.e. always engaged. The drive forces are distributed to the front and rear axles by a non-wearing fluid coupling (viscous coupling) integrated into the transfer box. The amount of power transmitted to the rear wheels varies according to requirement as a result of the difference in speed between the front and rear axles. A new feature in four-wheel drive technology is that, on braking at a speed over 25 km/h, the drive train is disengaged by a hydraulically controlled multi-disc plate and the four-wheel drive is switched off.

The advantages of four-wheel drive are:

a. Good driving even on slippery roads.
b. Low slip when accelerating.
c. Increased climbing ability on slippery surfaces.

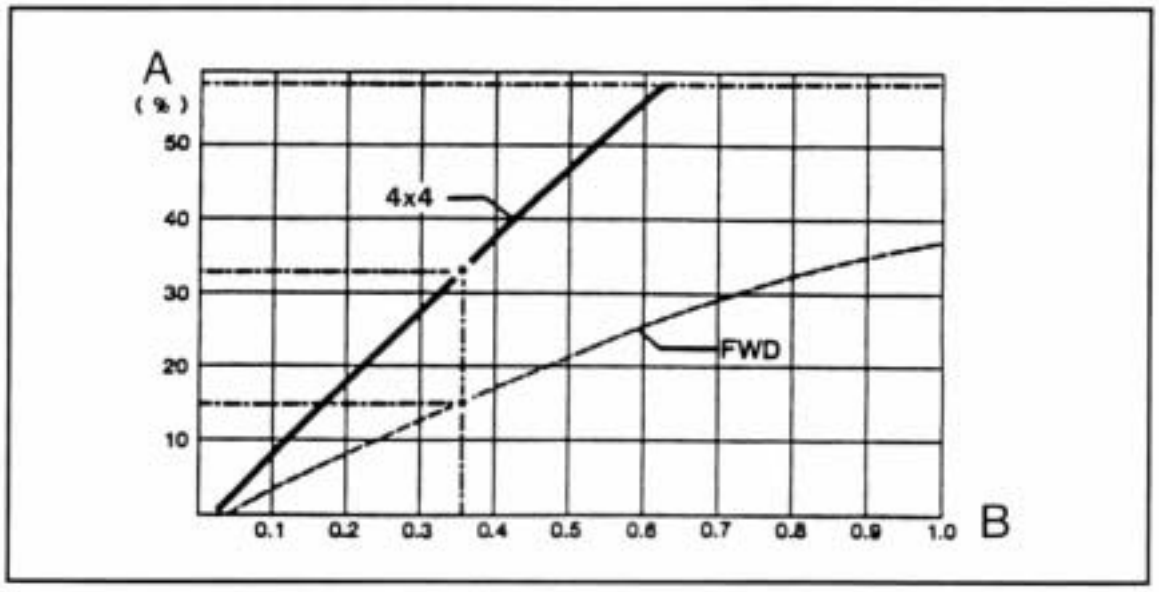


Figure 4-1

Figure 4-1 Figure 4-1 shows the climbing ability (A) at a certain frictional coefficient (B) for a four-wheel drive and for a normal front wheel drive. The constant four-wheel drive substantially increases driving and traction forces. The advantages of this can be noticed particularly when starting from rest and driving on difficult terrain such as unsealed roads or surfaces that have been made slippery by ice and snow. Driving under these road conditions presents few problems in terms of becoming bogged or losing traction, as the four-wheel drive function allows normal driving regardless of the road conditions. When braking, the same need for care applies as with a normal front wheel drive vehicle.

THE FOUR-WHEEL DRIVE FUNCTION

Engine, clutch and transmission form a unit, as in standard vehicles, and drive the front wheels. The rear wheels are driven fully automatically via:

- The transfer box (6) which is flanged onto the right hand side of the transmission and has an integrated viscous coupling and four-wheel drive cut-off,
- A three part drive shaft (7) and,
- The rear axle and differential assembly (8).

The four-wheel drive is permanently and automatically effective - without any interaction required by the driver. Primarily it is the front axle that is driven but the amount of power transferred to the rear axle is changed by the viscous coupling as required, up to almost 100%. Because it is always engaged, the viscous coupling compensates when there is a difference in speed between the drive axles.
Engine torque is therefore distributed according to the frictional relationships of the road surface.

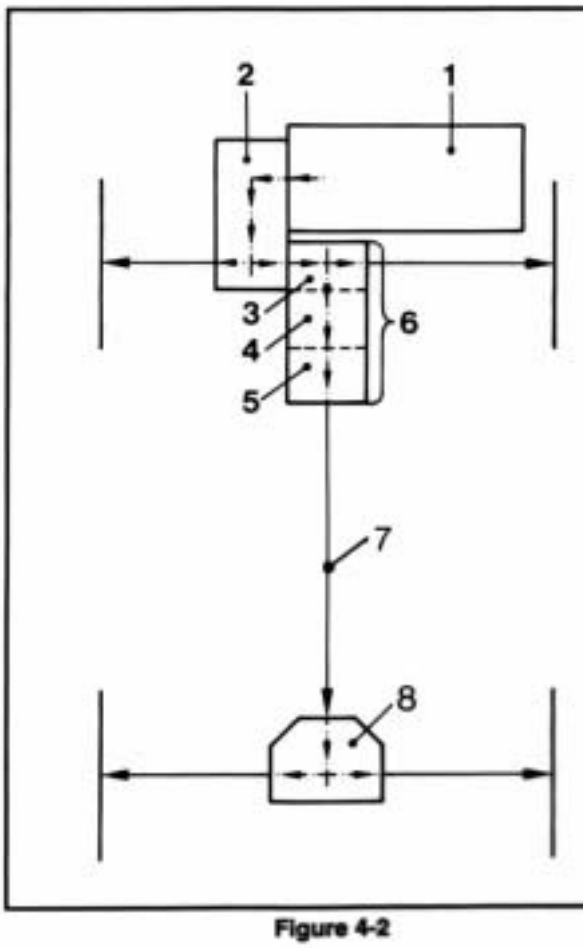


Figure 4-2

Illustration Key:

1. Engine.
2. Clutch, Transmission, Front Drive Axle and Differential, Front Wheels.
3. Angle Drive with Hypoid Gear Teeth.
4. Planetary Gear and Multi-Disc Clutch.
5. Viscous Coupling.
6. Transfer Box.
7. Drive Shaft.
8.

BRAKING SAFETY

For the first time, a new type of safety system has been integrated into this four-wheel drive design.

When brake lock occurs on road surfaces with differing coefficients of friction on the left and right hand vehicle sides, e.g. dry asphalt on one side and dirt or gravel on the other side, four-wheel drive vehicles of this size range may swerve as, owing to the system, they display mutual influence of the axes caused for example by rigid four-wheel drive and they have no ABS. The vehicle turns on is own axis when the brakes are applied.

On the Calibra Turbo 4x4, a hydraulically controlled multi-disc clutch, which is integrated into the transfer box, guards against such driving situations; i.e. the front and rear axle separated when four-wheel drive would be disadvantageous.

At vehicle speeds above 25 km/h, the gear train is separated and the four-wheel drive disengaged within a fraction of a second when the brake pedal is actuated, even at the lowest temperatures.

This means that the vehicle direction remains constant and ABS suitability guaranteed without engaging other systems.

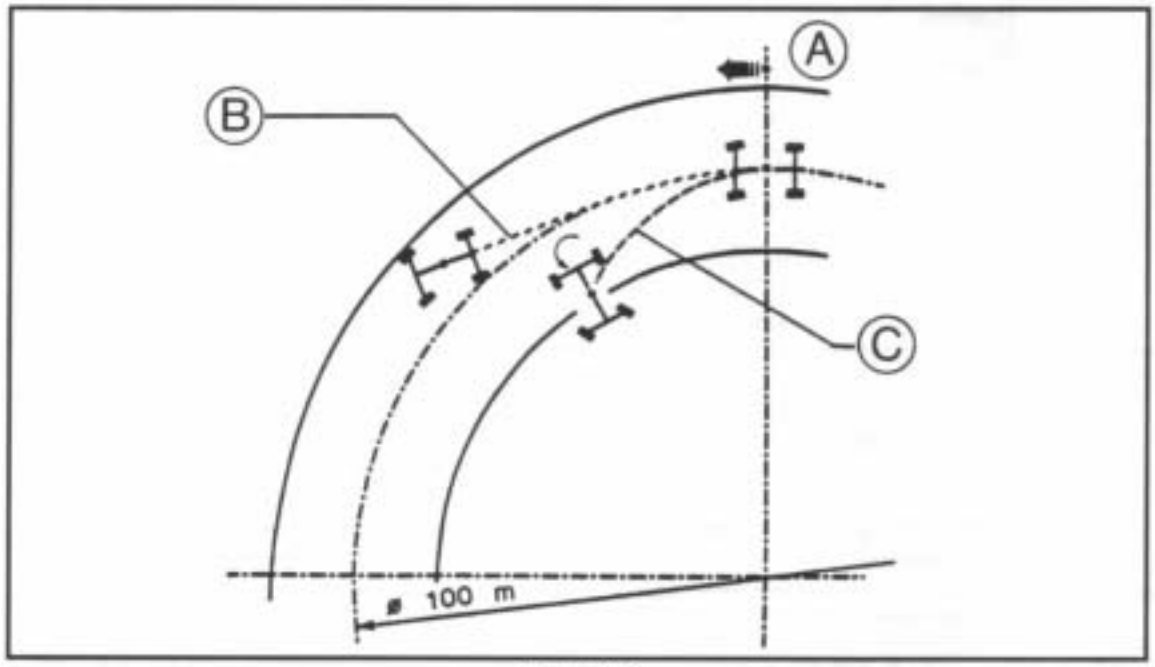


Figure 4-3

Illustration Key:

A Start of braking.

B Vehicle with four-wheel drive and rear axle disengagement (by means of multi-disc clutch).

C Vehicle without rear axle disengagement.

Figure 4-3 shows braking with (B) and without (C) rear axle disengagement and with differing road surfaces.

OTHER FOUR-WHEEL DRIVE FEATURES

1. Unless the brakes are applied at vehicle speeds below 25 km/h, the four-wheel drive can remain engaged.
2. The four-wheel drive is also fully effective when coasting.
3. When the vehicle is stationary, the four-wheel drive is disengaged.
4. The vehicle can be raised, shunted or towed on one axle.

SYSTEM BLOCK DIAGRAM

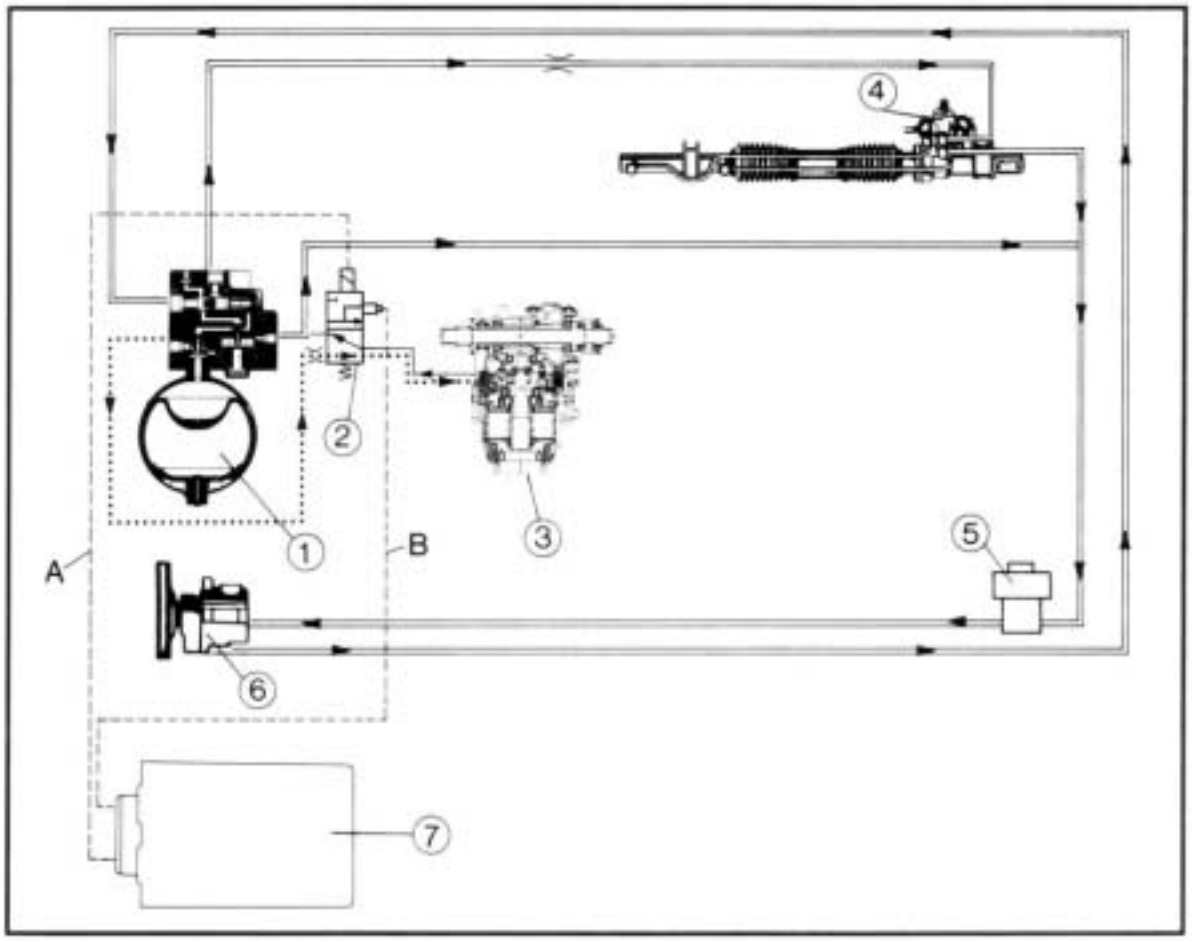


Figure 4-4

Illustration Key:

1. Hydraulic Accumulator.
2. Control Valve.
3. Transfer Box.
4. Power Steering.
5. Fluid Reservoir.
6. Fluid Pump.
7. Electronic Control Unit.

A Electrical connection, control unit to control valve.
B Electrical connection, control unit to pressure switch.

An inherent part of the new safety system used in the Calibra Turbo 4x4, is an electronic control unit that provides the necessary controls.

The system is also equipped with self-diagnosis.

A malfunction in the four-wheel drive is indicated by the illumination or flashing of the four-wheel drive telltale on the instrument panel. Instructions for customers when the four-wheel drive telltale illuminates or flashes are contained in the owner's manual.

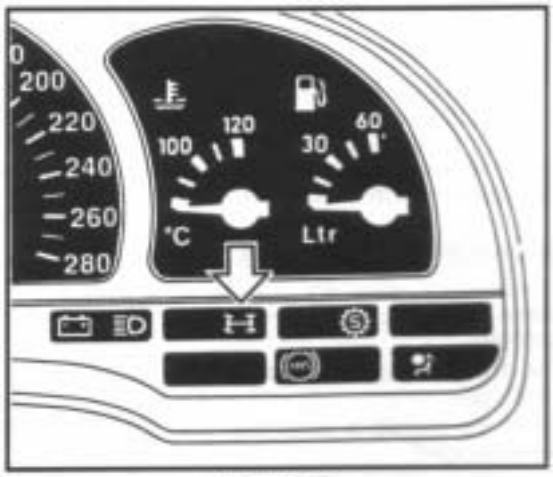


Figure 4-5

2. COMPONENTS OF THE FOUR-WHEEL DRIVE SYSTEM

As indicated in Figure 4-4, the components of this four-wheel drive system can be divided into two main groups:
Mechanical, hydraulic
Electronic, electrical

2.1 MECHANICAL, HYDRAULIC COMPONENTS

TRANSFER BOX

The transfer box is flanged onto the transmission, on the right-hand side looking toward vehicle front and consists of the following parts:

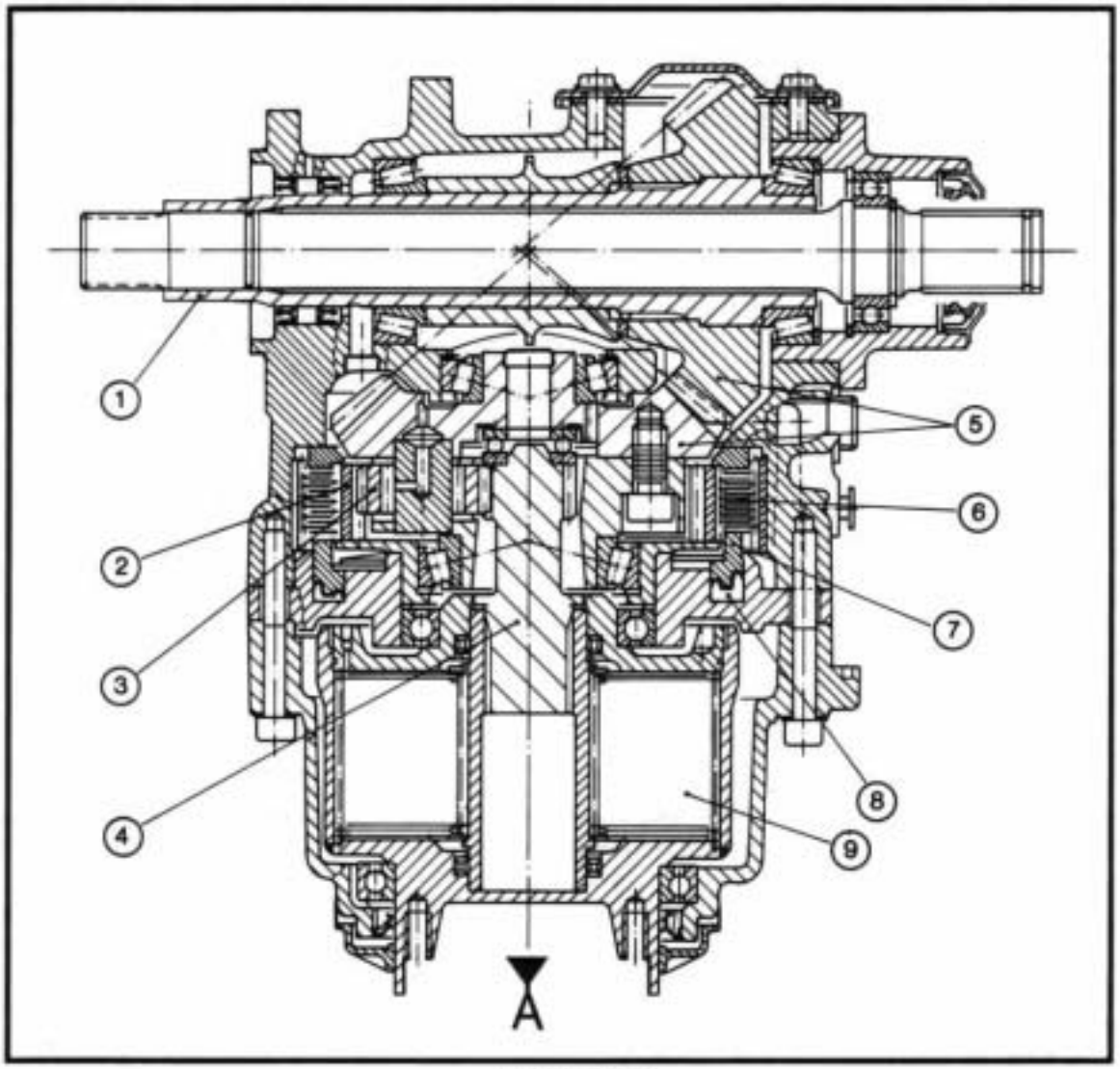


Figure 4-6

Illustration Key:

1	Drive via hollow shaft	6	Mufti-Disc Clutch
2	Ring Gear	7	Hydraulic Piston
3	Planetary Gear	8	Cylinder Chamber
4	Sun Gear	9	Viscous Coupling
5	Hypoid Gear	A	To Rear Axle

SYSTEM DIAGRAM - POWER FLOW

The torque to the rear axle is transferred to the hypoid gears via a hollow shaft, which is connected to the transmission, and this deflects the power flow by 90°.

The torque flows to the viscous coupling via a planetary gear set (comprising a ring gear, planet gears and sun gear), where the outer housing of the viscous coupling is coupled to the three-part propeller shaft.

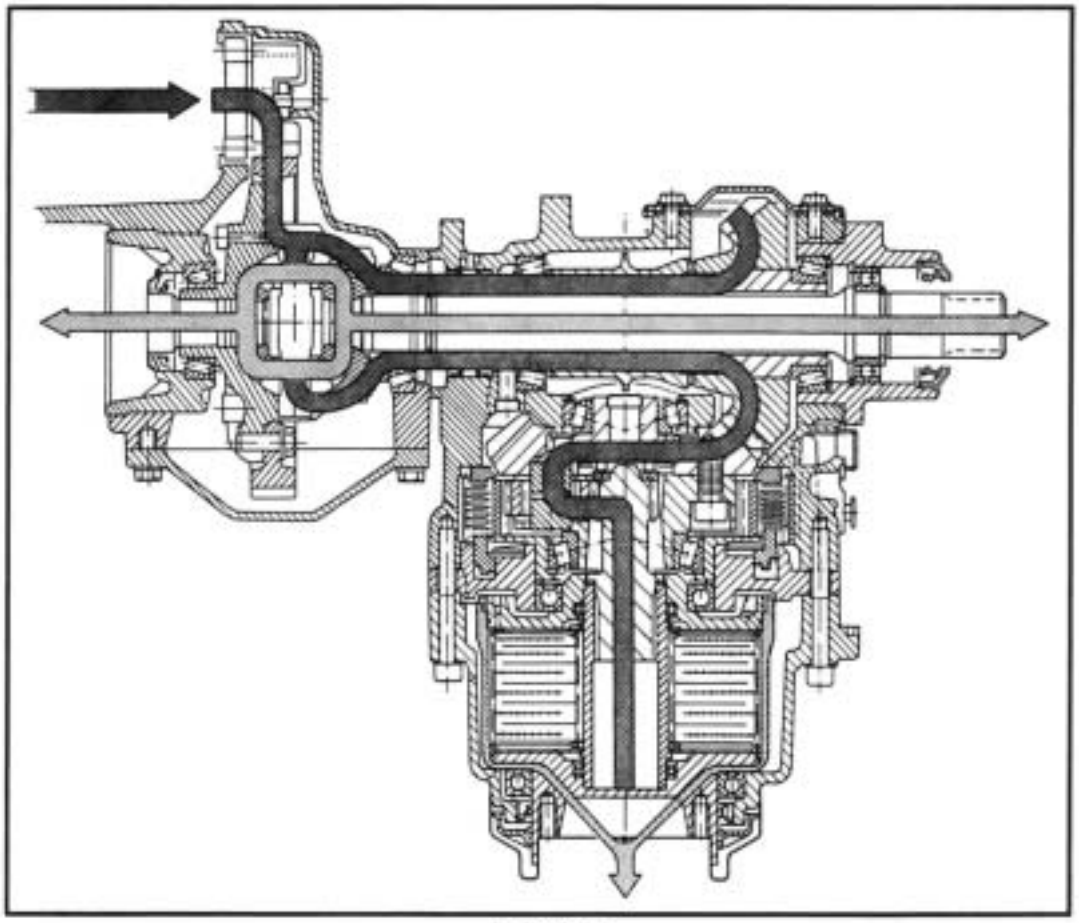


Figure 4-7

A mufti-disc clutch is positioned at the ring gear, the inner discs of which are connected to the ring gear, while the outer discs are connected to the housing and do not move.

When the fluid pressure is built up in the cylinder chamber - 3600 to 5200 kPa, a hydraulically pressurised piston compresses the disc package and effectively locks the ring gear to the outer housing. This action engages four-wheel drive.

When the pressure behind the hydraulic piston falls, a spring pushes the piston back, the multi-disc clutch releases the ring gear allowing it to turn again. This disengages four-wheel drive

VISCOUS COUPLING

The viscous coupling is a non-wearing hydraulic shear coupling which is used in the drive train to transfer torque to the rear wheels. The automatic slip-regulated torque split can be tuned to the special requirements of each vehicle.

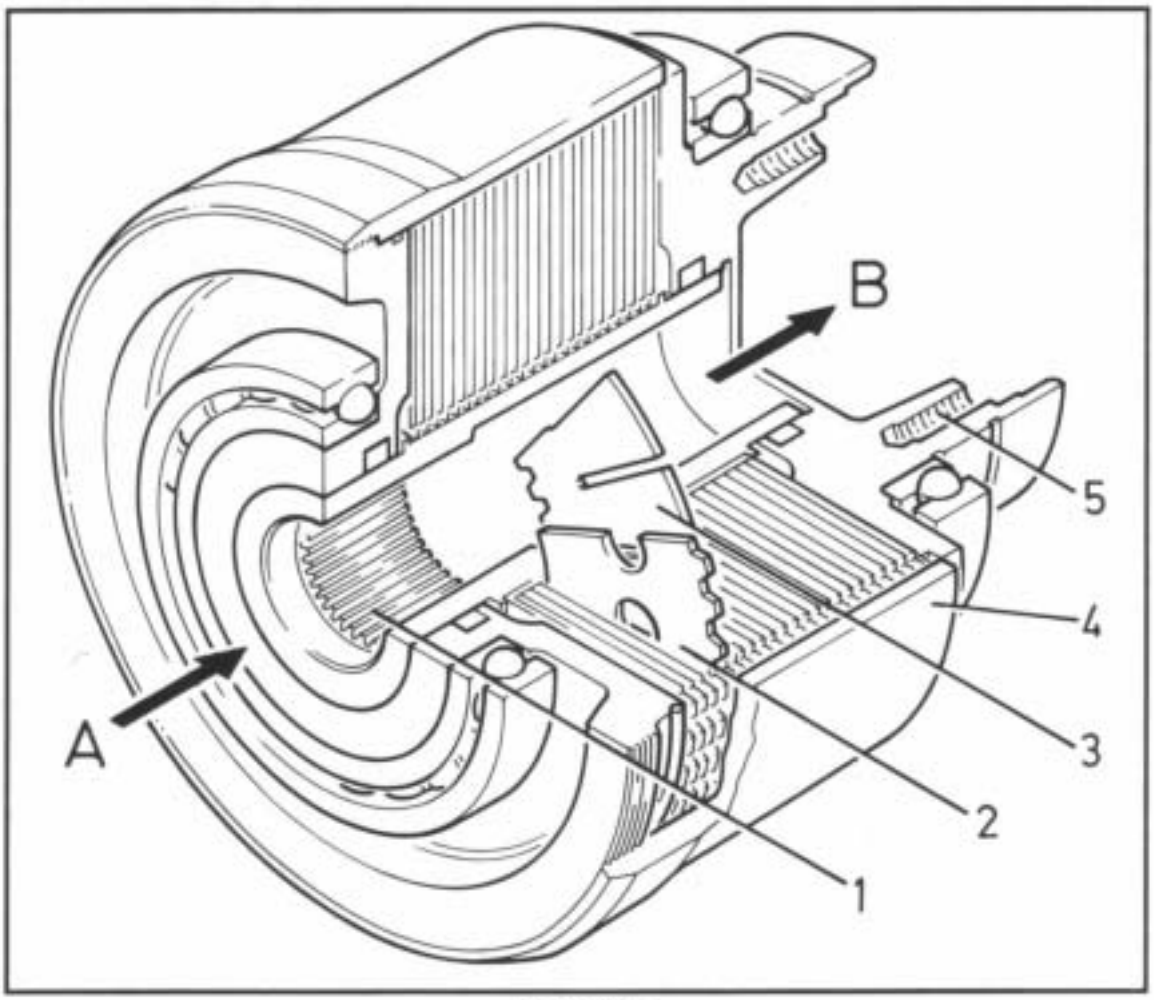


Figure 4-8

Illustration Key:

1	Hub	**5**	Connection for Drive Shaft
2	Outer Disc	**A**	Power Flow from Multi-Disc Clutch
3	Inner Disc	**B**	Power Flow to rear Axle
4	Housing		

The outer discs (2) on the input side engage in the teeth of the housing (4), while the inner discs (3) on the output side, engage in the teeth of the hub (1) of the sun gear. The special qualities of the silicon fluid allow the coupling to transfer greater drive forces. As the viscous coupling is filled with a silicon fluid and completely sealed, repair work is not possible.

4-8 FOUR-WHEEL DRIVE SYSTEM

When there is a small difference in speed between input at sun gear and output to drive shaft, the blocking resistance is overcome by the low viscosity of the silicon fluid resulting in slight slipping.
When the difference is greater, the silicon fluid is sheared off between the discs. This produces heat and the pressure in the viscous coupling housing increases.
The pressure increase causes a sharp increase in the viscosity of the silicon fluid, i.e. the silicon fluid is more difficult to shear off from the discs.
The viscous coupling begins to lock and power transfer occurs at the discs without them moving directly.

Illustration Key:
1 Outer Disc
2 Silicon
3 Inner Disc

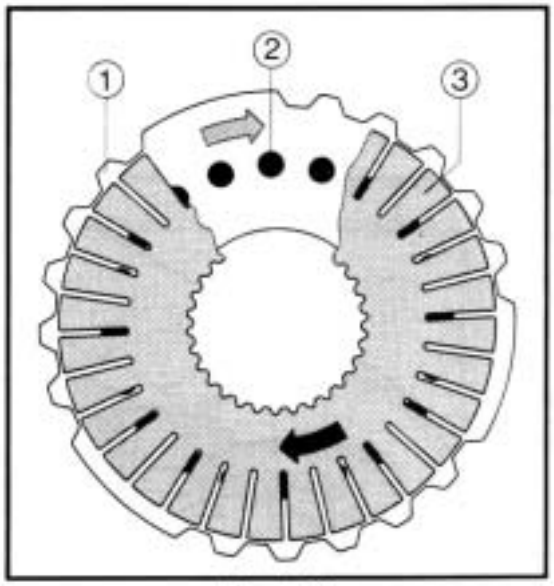


Figure 4-9

HYDRAULIC SYSTEM FOR FOUR-WHEEL DRIVE DISENGAGEMENT

Construction

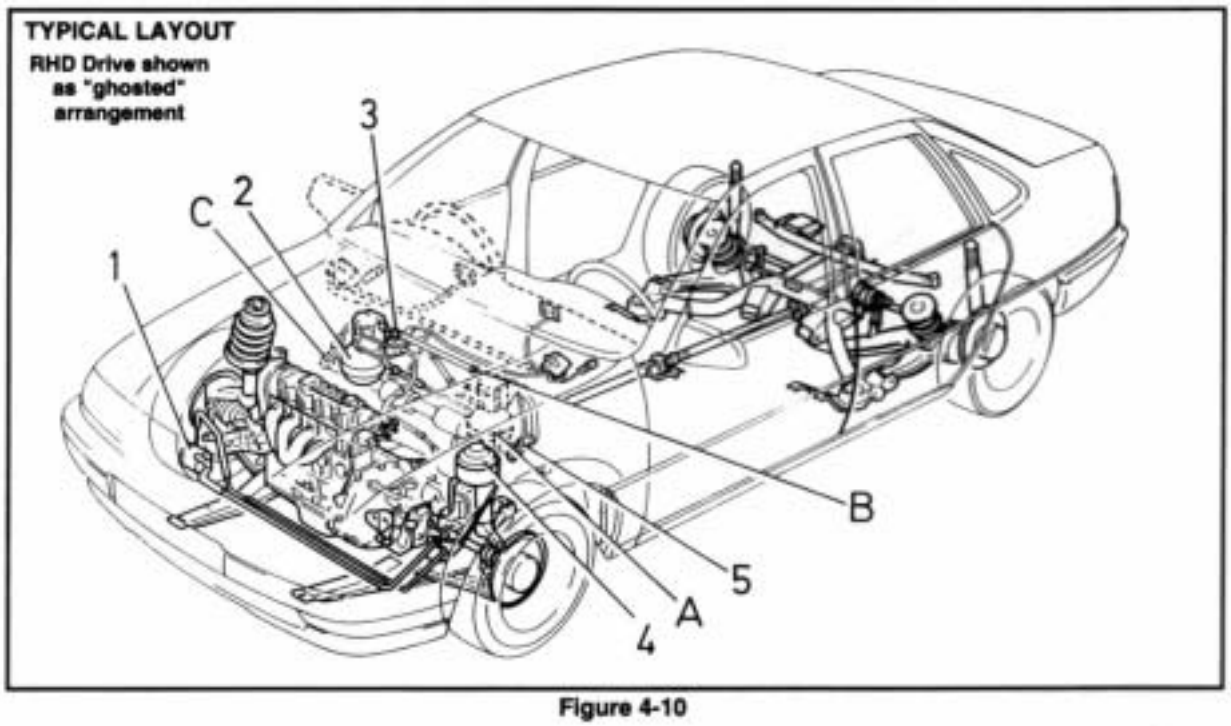


Figure 4-10

Illustration Key:
1 Fluid pump for Power Steering
2 Fluid Pressure Regulator with Hydraulic Accumulator (LHD)
A Fluid Pressure Regulator with Hydraulic Accumulator (RHD)
3 Control Valve with Solenoid Valve & Pressure Switch (LHD)
B Control Valve with Solenoid Valve 8 Pressure Switch (LHD)
4 Fluid Reservoir
5 Power Steering (LHD)
C Power Steering (RHD)

The new safety system used in the Calibra Turbo 4x4 (when the vehicle's brakes are applied), is hydraulically controlled by fluid pressure from the power steering fluid pump.

A small amount of fluid is diverted from the hydraulic circuit for the power steering by means of the fluid pressure regulator (see Figure 4-11) and fed to the hydraulic accumulator. In this way, the hydraulic accumulator is charged without impairing the power steering.

The piston of the mufti-disc clutch in the distributor housing is actuated to engage and disengage the four-wheel drive by means of an electrically operated control valve.

Fluid Pressure Regulator with Hydraulic Accumulator

Fluid supply (A) coming from the power steering pump is regulated by the throttle valve (1) and fed via the on-off valve (2) and the non-return valve (3) to the hydraulic accumulator (4).

The greater majority of the fluid supply is fed past the throttle valve to connection (C) of the power steering.

When the upper switching pressure has been reached in the hydraulic accumulator (4), the entire fluid stream is supplied to the power steering by means of appropriate action on the part of the throttle valve (1).

Illustration Key:

A From power steering fluid pump to fluid pressure regulator.
B From hydraulic accumulator to control valve.
C From fluid pressure regulator to power steering.
D From fluid pressure regulator to fluid reservoir.

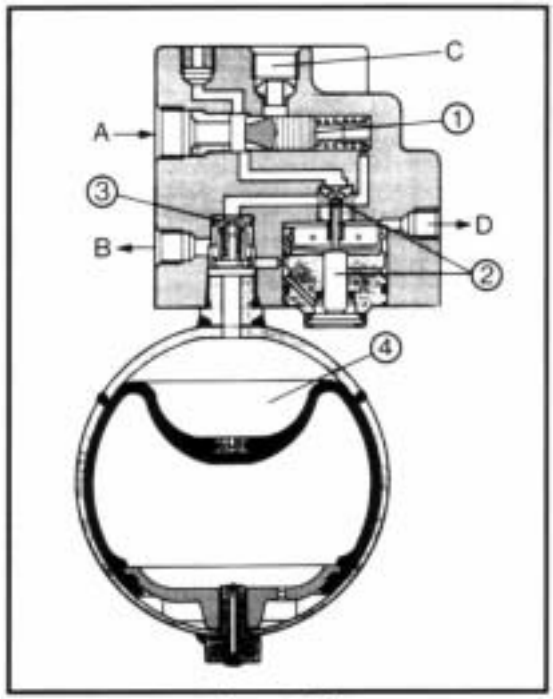


Figure 4-11

Control Valve

The control valve is mounted on the bracket for the oil pressure regulator with the hydraulic accumulator. It is an electrically operated 2/3 way seat valve.
In the neutral position, the hydraulic cylinder chamber is connected to the return line and the oil pressure supply is blocked from the hydraulic accumulator.
This releases the multi-disc clutch, disengaging the four wheel drive.
If the control valve receives voltage from the electronic control unit, the return line is closed and the hydraulic accumulator is connected to the hydraulic cylinder chamber. This applies fluid pressure to the mufti-disc clutch, engaging the four-wheel drive.

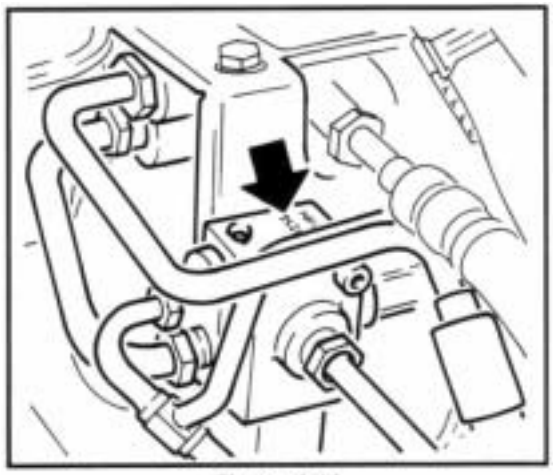


Figure 4-12

Illustration Key:

1 Valve housing
2 Valve piston
3 Electromagnet
4 Electric plug connection
5 Pressure switch
A Connection for return line
B Connection for hydraulic accumulator

NOTE: In this sectioned view, the connection to the transfer box is not shown.

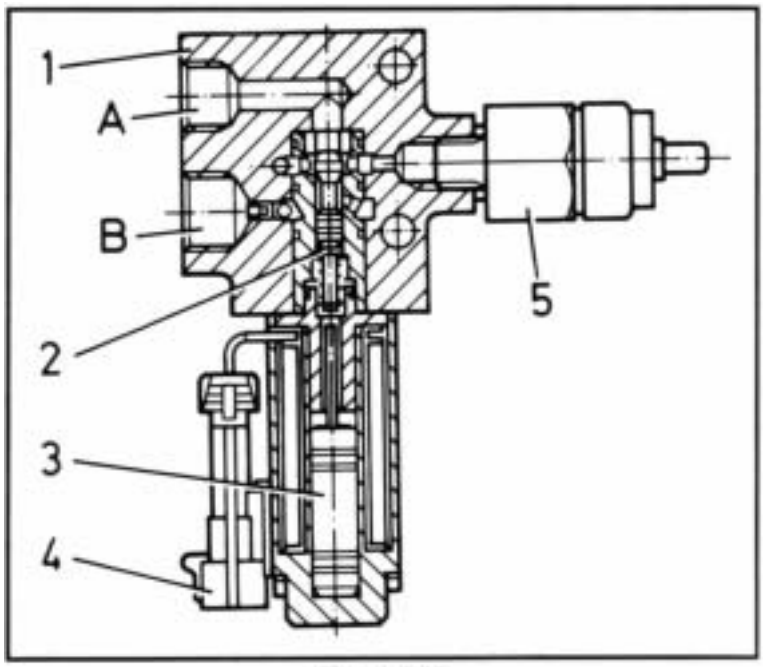


Figure 4-13

The control valve is supplied with voltage by the electronic control unit (ECU) and in this way, its functioning is monitors d. During, driving, the control valve is constantly provided with voltage except when the brake pedal is actuated at a speed higher than 25 km/h.
When the engine is switched off, the control valve receives no voltage. A hydraulic throttle in the control valve permits soft engagement of the multi disc clutch while driving.

Pressure Switch

The pressure switch, screwed into the control valve, controls the hydraulic system pressure between the control valve and the mufti-disc clutch.
The electrical contact opens when pressure rises and this signals the control unit when the required hydraulic pressure to operate the multi-disc clutch is available.

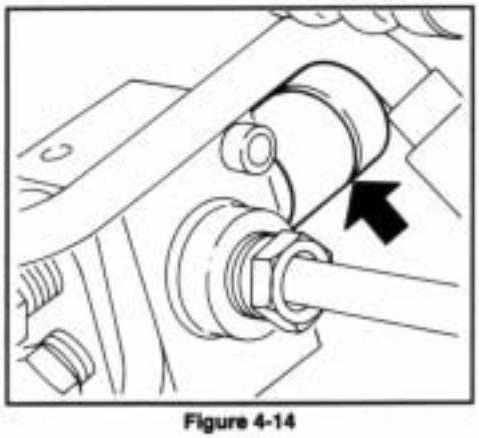


Figure 4-14

Fluid Reservoir

Because of the greater quantity of fluid present in the power steering four-wheel drive hydraulic circuits in this four-wheel drive vehicle and the fluctuations which occur due to the hydraulic accumulator, a larger fluid reservoir is installed in Calibra Turbo 4x4 vehicles than in normal power steering**.**

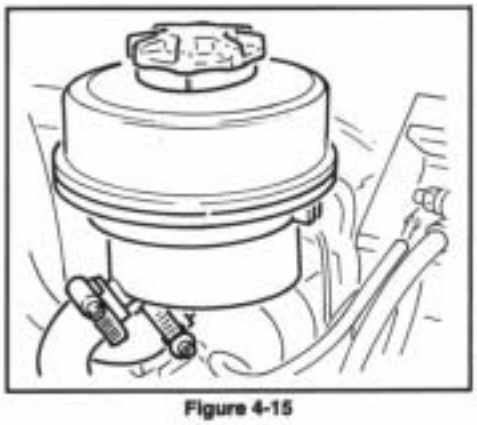


Figure 4-15

REAR AXLE, REAR WHEEL MOUNTING

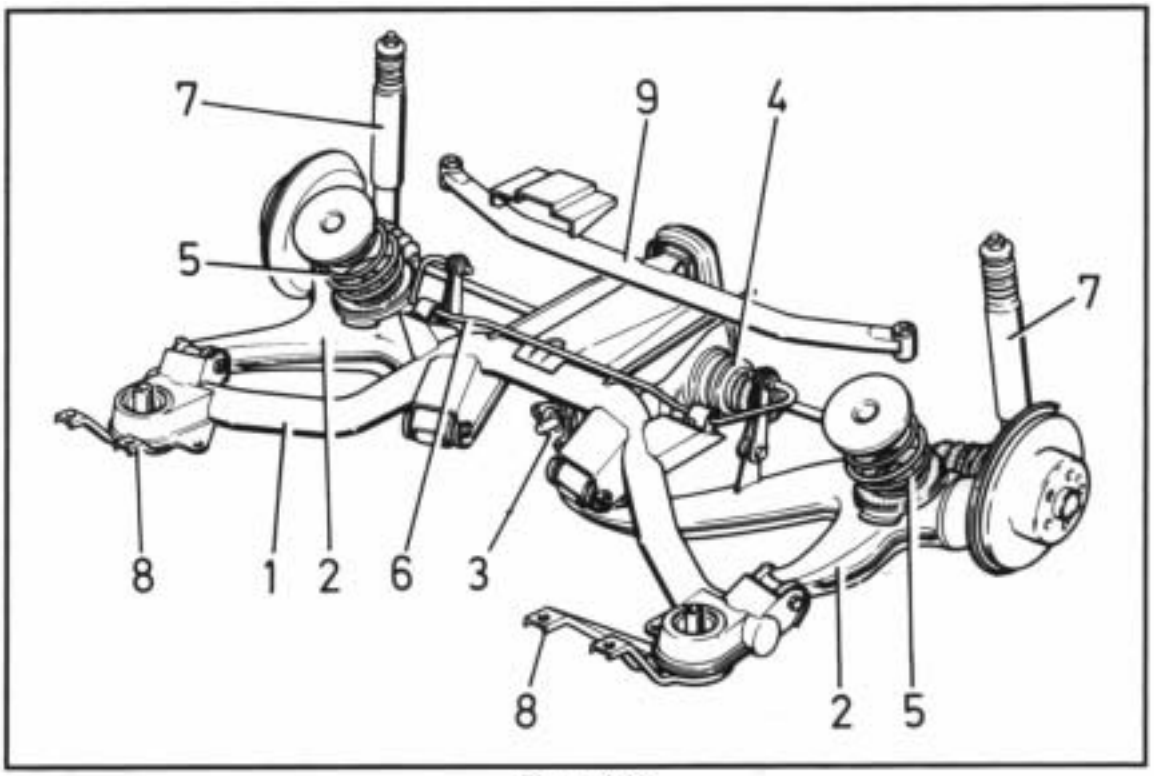


Figure 4-16

Illustration Key:

1 Tubular cross member
2 Semi-trailing arm
3 Differential assembly
4 Driveshaft
5 Rear springs
6 Stabiliser bar
7 Shock absorber
8 Bracing for cross member on underbody
9 Differential bracket on underbody

Unlike the rear axle on vehicles with front wheel drive, a new, specific semi -trailing arm rear axle mounting has been developed for the Calibra Turbo 4x4, which builds on the already familiar concept of the independent roar suspension available on the VR Commodore range of vehicles.

The semi-trailing arms have an inclined to give the vehicle a relatively high negative camber of -1°40' which provides good cornering stability.

The differential is separated from the rear axle suspension system and attached to the crossmember with four fastening bolts.

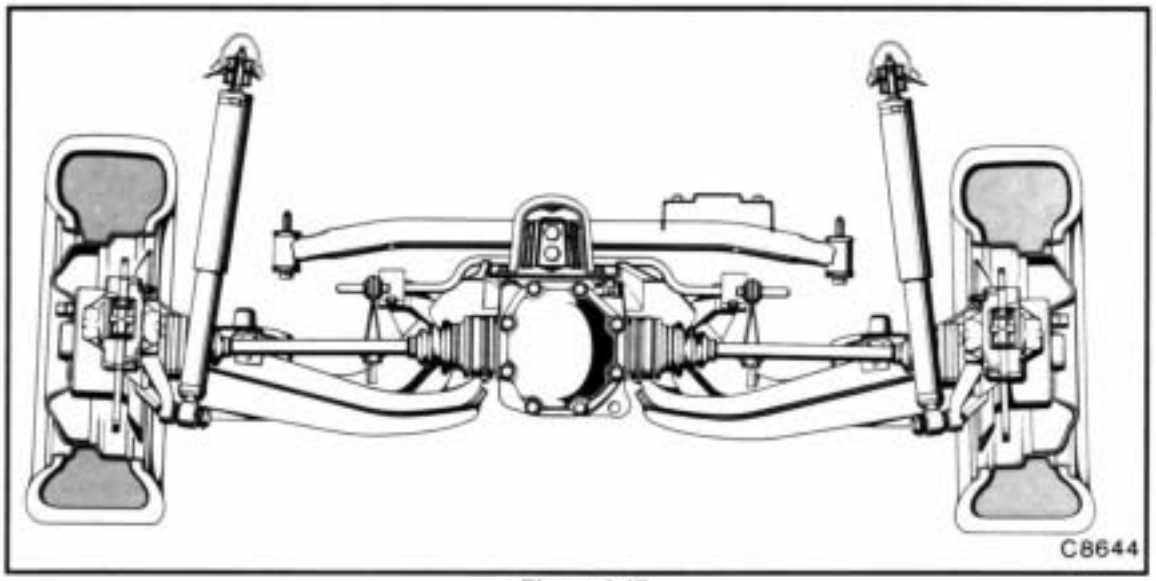


Figure 4-17

DRIVESHAFT

The drive train installed in the Calibra Turbo 4x4 is, because of the power transfer to the roar axle, a new design specific to this vehicle and differs from designs used in Holden vehicles until now.

With the independent suspension, movement that occurs at the rear wheels during compression rebound of the coil springs, creates undesirable motion for the smooth transmission of power to the rear wheels. By adopting the design shown in Figure 4-17, the effect of these undesirable motions has been eliminated.

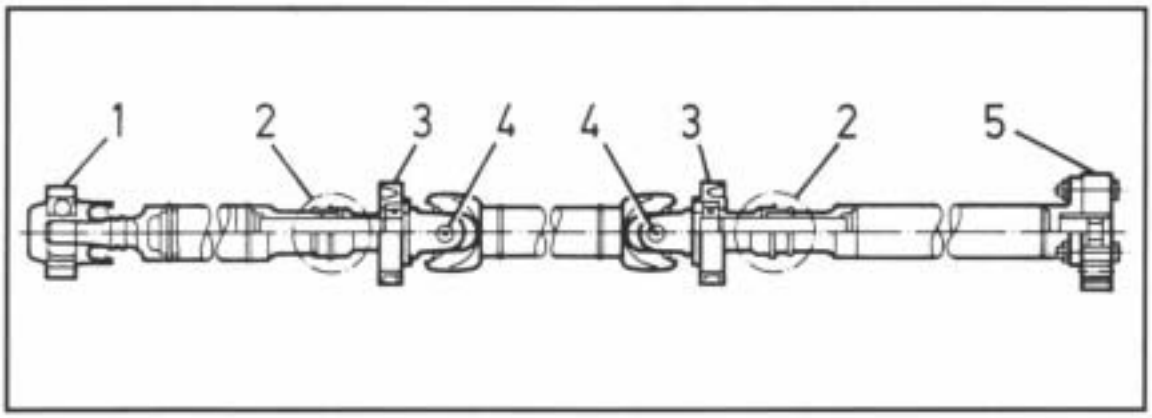


Figure 4-18

Illustration Key:

1 Homokinetic joint, front
2 Front and rear sliding gears with locking nut
3 Front and roar centre bearings
4 Universal joint
5 Single disc joint, roar

2.2 ELECTRONIC ELECTRICAL COMPONENTS

BLOCK DIAGRAM OF ELECTRONICS

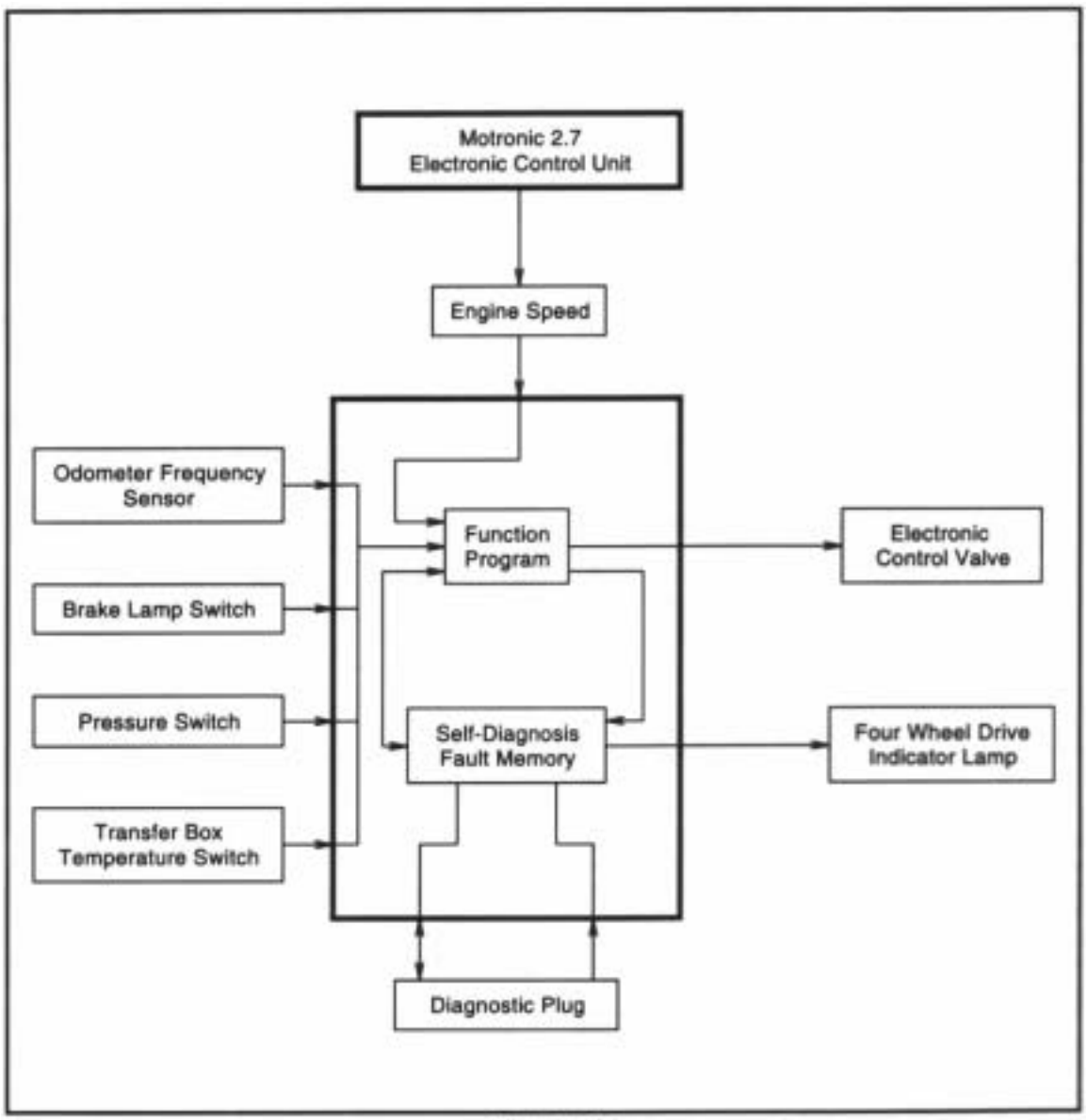


Figure 4-19

SURVEY OF FOUR-WHEEL DRIVE SYSTEM

A number of electrical/electronic signals are used by the Electronic Control Unit (ECU) to determine the optimum and safe operation of the four-wheel drive system.

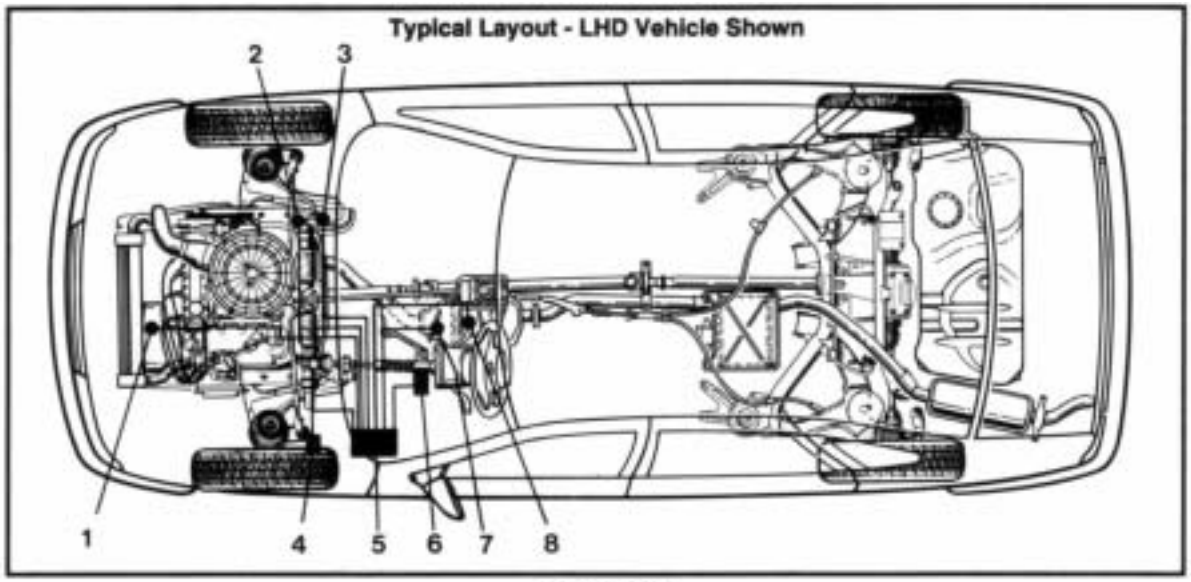


Figure 4-20

Illustration Key:

1 Pulse pickup for engine speed signal
2 Control valve
3 Pressure switch
4 Diagnostic plug (ALDL)
5 Electronic control unit
6 Odometer frequency sensor
7 Brake lamp switch
8 Four-wheel drive telltale
9 Transfer box fluid temperature switch

Inductive Pulse Pickup

The inductive pulse pickup is required for the evaluation of the engine speed and its transmission to the electronic control unit.
The sensor pick-up is located in the side of the engine block, while the sensor disc consists of a toothed ring that is attached to the crankshaft.

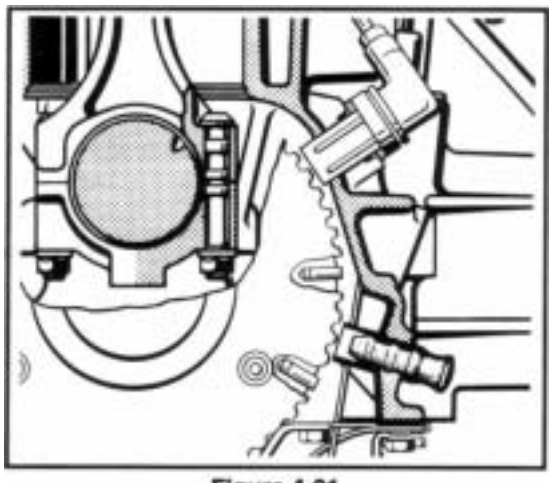


Figure 4-21

Control Valve and Pressure Switch

Construction and method of operation are described under 'Hydraulic System for Four-Wheel Drive Disengagement' (See page 4-8 in this Section).

Diagnostic Plug

The diagnostic plug is located in the engine compartment on the left hand side behind the strut tower.
(The plug k=n has not changed from previous two wheel drive models.)
The four-wheel drive can be checked with the hand tester TECH 1 and the Program Module "OPEL 87-94 ECU', when used with the 10 pin adapter, SD28224.

Using the optional diagnostic plug KM-640, stored trouble codes of the four-wheel drive can also be called up in switch position "J".

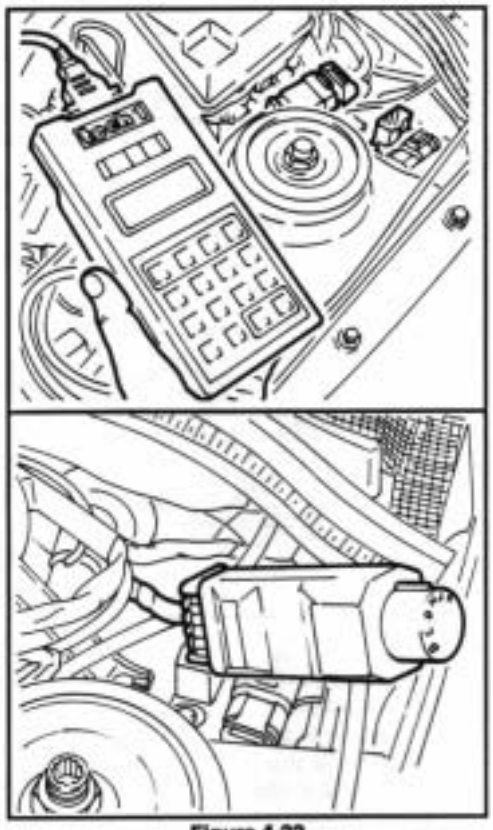


Figure 4-22

Electronic Control Unit

The electronic control unit's function is to switch from four-wheel drive to normal front wheel drive, depending on programmed parameters.

One condition for disengagement of the rear axle from the transfer box is when braking is sensed at a vehicle speed greater than 25 km/h.

Another situation that will cause the ECU to disengage four wheel drive is in the event of an excessive transfer box fluid temperature (above 160 °C) being registered by a thermal switch mounted in the transfer box case.

Disengagement of four-wheel drive also takes place when the engine is stationary, engine speed is greater than 500 rpm, depending on brakes.

Figure 4-23

The electronic control unit also monitors the input and output signals for non-standard conditions. In the event of a fault, it switches to two-wheel drive and the four-wheel drive symbol in the instrument panel is illuminated continuously or it flashes and a trouble code Is stored in memory.

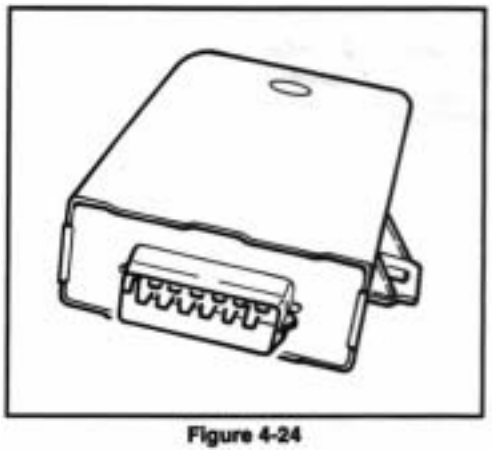


Figure 4-24

Odometer Frequency Sensor

On the Calibra Turbo 4x4, the odometer frequency sensor is located in the speedometer.
The rectangular signal produced by the odometer frequency sensor, which increases relative to vehicle speed, is received by the control unit and converted to the instant vehicle speed.

Brake Lamp Switch

On Calibra Turbo 4x4 a combined, double contact brake lamp switch is used.
When the brake pedal is depressed, the brake lamp switch interrupts the connection to the control unit.
At speeds below 25 km/h the four-wheel drive is disengaged by the hydraulic multi-disc clutch.
After completion of braking (brake pedal in normal position again) the power connection to the rear axle is immediately re-established by the application of the multi-disc clutch, i.e. the four-wheel drive functions again.

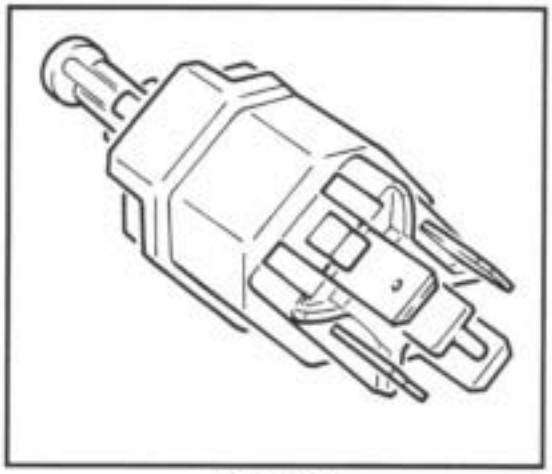


Figure 4-25

Four-Wheel Drive Telltale

When there is a malfunction in the four-wheel drive, this Is indicated immediately by the constantly illuminated / flashing four-wheel drive telltale on the right hand side of the instrument panel.
After a fault has been registered, the control valve is switched off and the four-wheel drive telltale is switched on, either constant or flashing, according to the severity of the fault.
If the fault is no longer Indicated after the ignition has been switched on and off, the function software proceeds normally again.

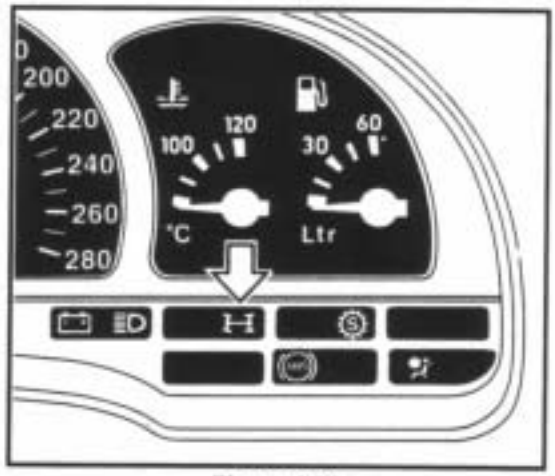


Figure 4-26

Transfer Box Temperature Switch

The function of this switch is to interrupt a voltage signal from the Electronic Control Unit if the transfer box fluid temperature exceeds 160 °C. If this should occur, the ECU will set a diagnostic trouble code 33 and disengage the four-wheel drive function. The four-wheel drive malfunction indicator lamp on the instrument panel will also be illuminated.
Excessive temperatures can be caused by;

- A lack of fluid in the transfer box.
- Transfer box fluid level too high.
- Differing amounts of tyre wear between the front and rear axles. The maximum difference in profile must not exceed 2 mm and the difference in tyre circumference must not exceed 15 mm.

NOTE: When the temperature switch interrupts the ECU voltage signal (indicating an over-temperature condition), it wild not reset itself when the fluid temperature falls. Therefore, if a trouble code 33 is set, the switch MUST be replaced.

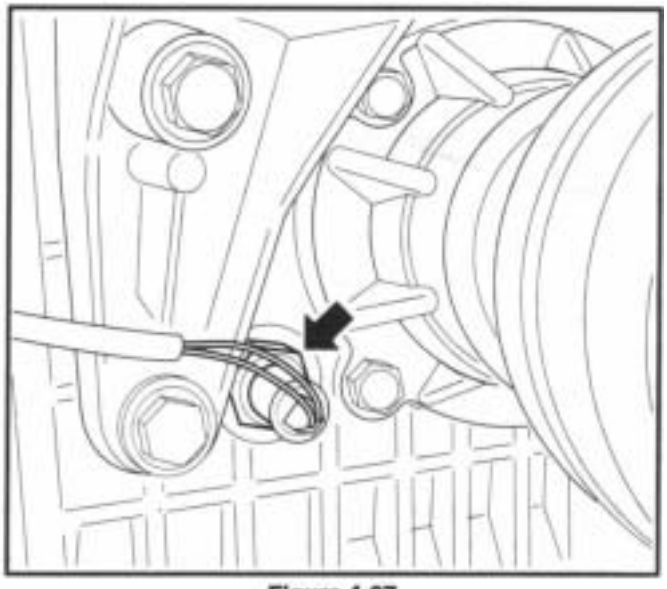


Figure 4-27

3. SERVICE OPERATIONS

HYDRAULIC FLUID LEVEL CONTROL

The fluid level can only be checked when the mufti-disc clutch pressure accumulator is full.
With ignition ON, operate the brake approximately 10 to 15 times until fluid level does not rise any more, then check fluid level.
- With hot fluid (80°C), fluid level max. at the upper marking (1).
- With cold fluid (20°C), fluid level min. at the lower marking (2).

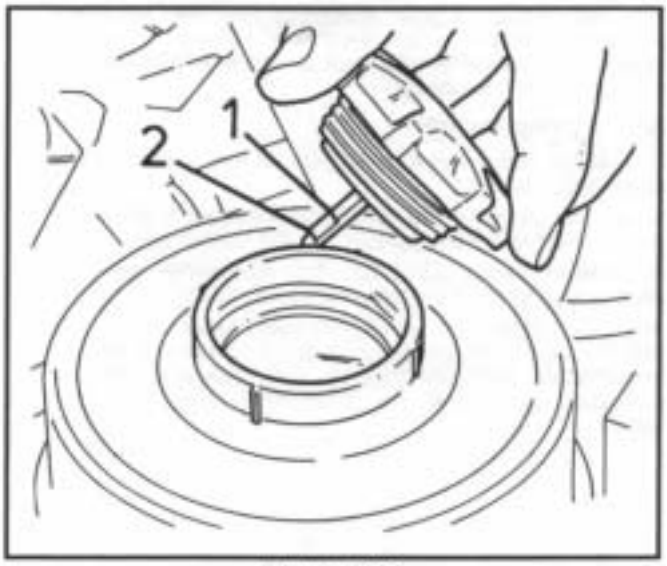


Figure 4-28

SYSTEM BLEEDING

An Allen screw fixed in the control valve (arrow) serves to bleed the entire hydraulics - four-wheel drive and power steering. This Allen screw must be opened approximately 3 turns and the engine should run for approximately 10--15 minutes.
The hydraulic system bleeds itself.

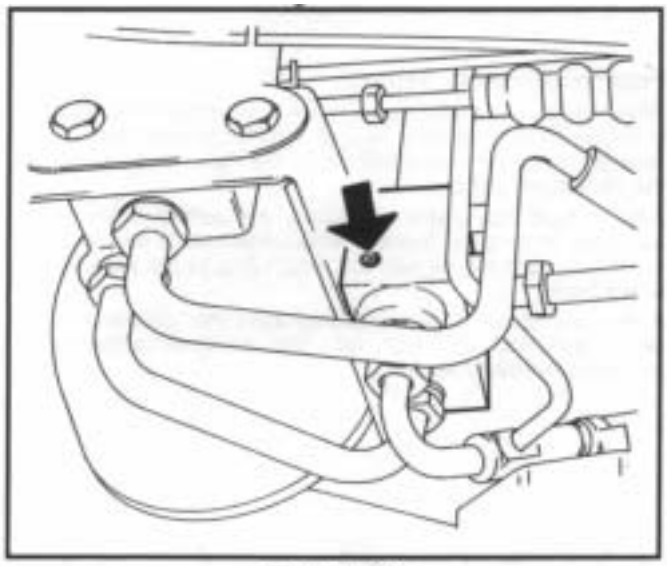


Figure 4-29

TRANSFER BOX MAINTENANCE

Fluid Change
The oil in the transfer box is a synthetic fluid and does not require changing.

Fluid Level Check
1. Remove the wiring harness connection from the temperature switch.
2. Remove the switch from the transfer box, using a thin walled 19 mm ring spanner. If necessary, the outer diameter may need to be ground down to provide clearance.
3. The fluid level should be at the lower edge of the aperture.

Fluid Level Top-up
Using the recommended synthetic fluid, top up the transfer box fluid level, using a funnel and the transfer box vent hose, as shown in Figure 4-30, until the fluid reaches the lower edge of the temperature switch opening.
NOTE: The fluid will flow very slowly.
Reinstall the temperature switch tighten to the recommended torque specification and reinstall wiring.

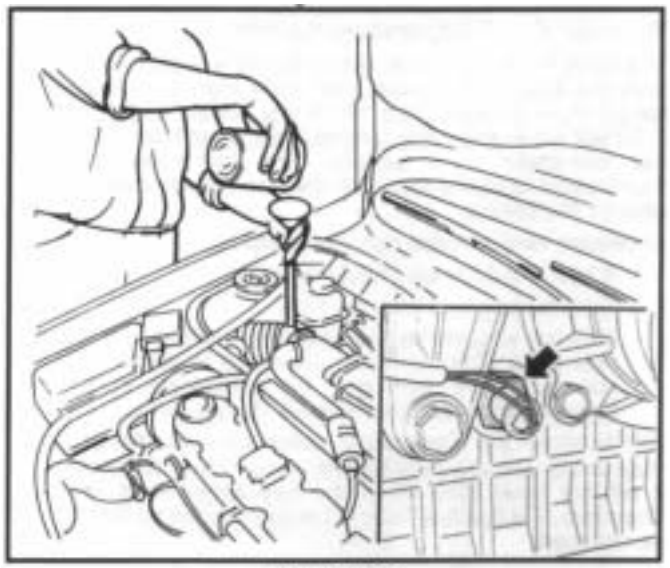


Figure 4-30

TRANSFER BOX TEMPERATURE SWITCH
TORQUE SPECIFICATION ..... 25 Nm

3.1 SERVICE TIPS

REAR AXLE

a. The rear wheel drive shafts are held in the differential by self-locking rings.
b. The homokinetic joints are micro-encapsulated and therefore require no maintenance.
c. As the same special tools are used for differential repairs as for the VR Commodore IRS, no new special tools are required.

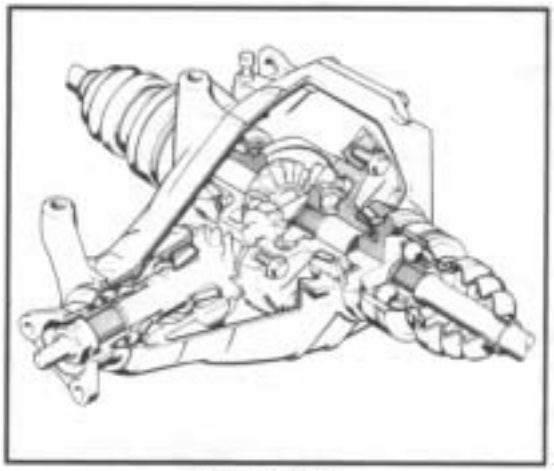


Figure 4-31

DRIVELINE

An essential advantage of the drive shaft is that, when installing and removing the transmission, distributor gear or differential, the drive shaft need not be removed from the vehicle. Depending on the type of repair, either the front or the rear locking nut of the sliding gear (refer Figure 4-18) is loosened and the homokinetic joint (front) or the single disc joint (rear) moved down the drive shaft tube.
This provides enough space for installing or removing major components.

SYSTEM ISOLATION

When running the Calibra Turbo 04 on a chassis dynamometer, the four-wheel drive must be disengaged by removing fuse F 19.

TRANSMISION/TRANSFER BOX OVERHAUL

At the time of publication, essentially there are no serviceable items released for either of these two components, except for some gaskets.
For further service information relating to the transfer box, refer to page K-176 in Volume 2 of the Vectra, Cavalier, Calibra Service Instructions (P/N M40327B).

EXTRACT FROM THE WIRING DIAGRAM

COMPONENT IDENTIFICATION		
Abbreviation	**Description**	**Wiring Diagram Location**
F19	Fuse in Fuse Box.	357
K83	4x4 Electronic Control Unit.	350 - 357
P61	Temperature Sensor- Transfer Box.	355
S117	Control Valve Pressure Switch.	353
Y44	Solenoid Switch.	357
X13	ALDL Diagnostic Plug - 10 pin	351
ABBREVIATIONS		
ABS VR	Wheel speed sensor RHF	
ABS VL	Wheel speed sensor LHF	
INS	Circuit to 4x4 Malfunction Indicator Lamp	
WEG	Circuit to Odometer frequency sensor	
CROSS REFERENCE TO OTHER ELECTRICAL CIRCUITS		
367	Motronic M2.7 Electronic Control Unit - pin 43	
564	Battery Voltage via Fuse F2.	
565	Brake lamp switch	
700	Brake lamp switch	
1121	ABS Electronic Control Unit - pin 22.	
1122	ABS Electronic Control Unit - pin 17.	

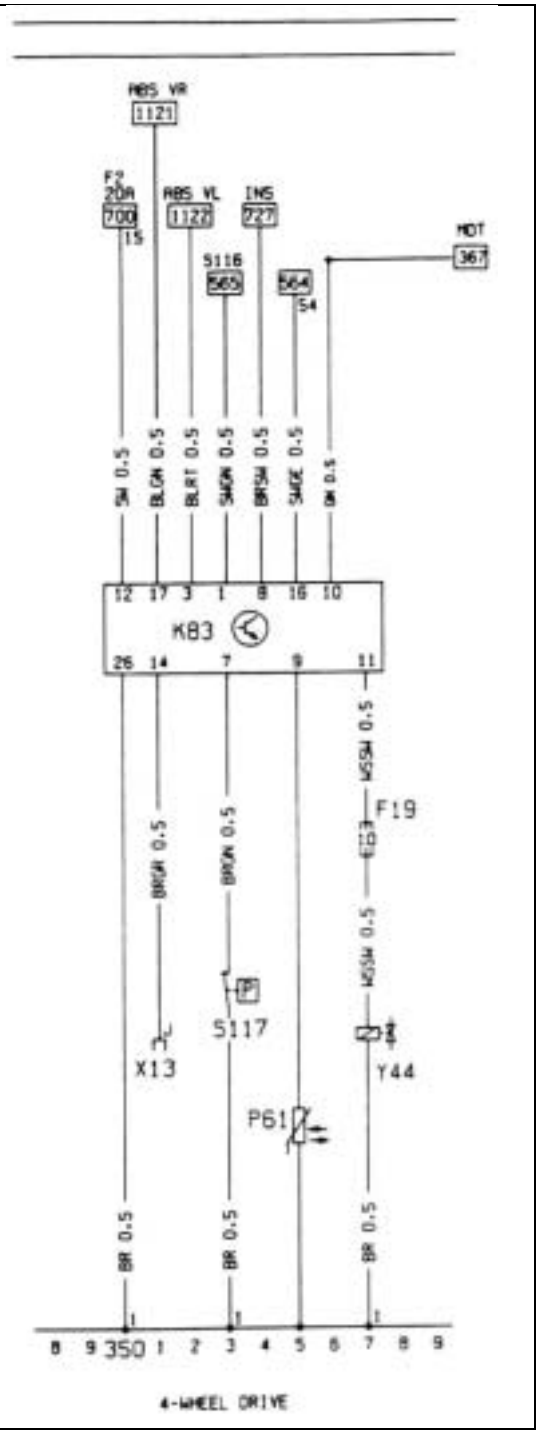


Figure 4-30

TERMINAL ASSIGNMENT OF WIRING HARNESS PLUG FOR ELECTRONIC CONTROL UNIT K 83

Terminal Assignment

1 Open signal from brake lamp switch.
2 Unoccupied.
3 ABS control unit, LHF wheel speed sensor.
4 Unoccupied.
5 Unoccupied.
6 Unoccupied.
7 Signal lead for pressure switch.
8 4x4 Malfunction indicator lamp. " too
9 Signal lead for temperature sensor.
10 Signal, engine speed.
11 Signal lead for control valve.
12 Supply voltage, via fuse F2.
13 Unoccupied.
14 Diagnostic data lead, four-wheel drive.
15 Unoccupied.
16 Closed signal from brake lamp switch.
17 ABS control unit, RHF wheel speed sensor.
18 Unoccupied.
19 Unoccupied.
20 Unoccupied.
21 Unoccupied.
22 Unoccupied.
23 Unoccupied.
24 Unoccupied.
25 Unoccupied.
26 Earth.

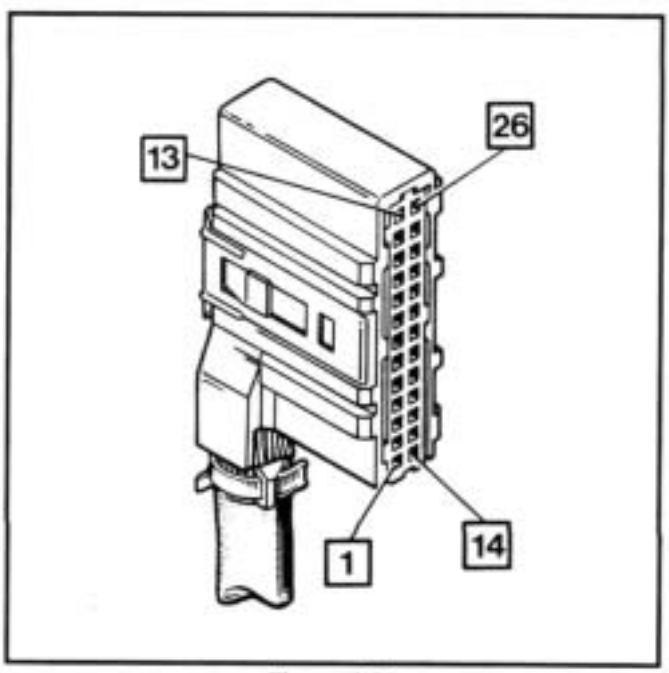


Figure 4-31

DIAGNOSTIC TROUBLE CODES

Stored Trouble Code	Information Sensor	Possible Cause of Fault	Telltale
12	Start of Diagnosis		
15	Fluid Temperature Sensor (Transfer Box)	Circuit interruption.	On
31	Inductive Pulse Pick-up (Engine Speed)	Failure of engine speed signal.	On
32	Pressure Switch	Pressure switch open, despite solenoid valve off.	Flashes
33	Solenoid	Circuit interruption.	On
34	Solenoid	Short circuit to earth.	On
37	Brake Lamp Switch	Failure of signal from brake lamp switch	On
39	ABS Control Unit	Front wheel speed sensor/circuit fault.	On
55	Electronic Control Unit	ECU defective.	Flashes
71	Brake Lamp Switch	Circuit interruption.	On
72	Brake Lamp Switch	Short circuit to earth.	On
73	Brake Lamp Switch	Failure in brake lamp switch	On
74	Pressure Switch	Pressure switch closed, despite solenoid valve on.	On
75	Fluid Temperature Sensor (Transfer Box)	Short circuit to earth.	On

4. DIAGNOSIS

INTRODUCTION

When used in conjunction with the TECH 1 diagnostic tool, fitted with the 'Opel/Vauxhall 87-94 ECU GB' program module cartridge, the following information will assist in the accurate diagnosis and troubleshooting of the four wheel drive electronic/electrical system.

GENERAL INSTRUCTIONS/SAFETY MEASURES

Readout of data using TECH 1 takes place with the ignition ON and/or with the engine operating. During communication between TECH 1 and the four wheel drive ECU, ensure that the four wheel drive indicator lamp is constantly illuminated.

Safety Measures

- Allow at least 20 seconds after switching off the ignition and disconnecting/reconnecting plugs to/from the electronic control module.
- Never disconnect the battery from the vehicle electrical system with the engine running.
- During any welding operations, always remove electronic control units from the vehicle.
- At temperatures above +80 °C (drying oven), electronic control units must be removed from the vehicle.
- Never use a quick charger for starting.
- Take care when working around high voltage components of the ignition system.
- Only use a high impedance digital multimeter when taking any electrical measurements.
- Should the battery be disconnected, volatile memories must be re-programmed such as the clock board computer and radio. In the case of radio coding and radio station programming the customer should be informed about the decoding and deleted station programming.

CHECKING WITH TECH 1

Observe all directions listed in the Operator's Manual, before connecting the unit.

Connecting TECH 1 to the Vehicle

1. Ignition OFF.
2. Connect TECH 1 to diagnostic plug in the engine compartment.
3. Select OPEL/VAUXHALL 87-94 ECU with the 'YES' key.
4. Enter Model Year '4' - Model Year 1994_.
5. Select vehicle type using the 'NO' key, then confirm with the 'YES' key.
6. Engine OFF, ignition ON, confirm with 'YES' key.
7. When 'AUTOMATIC SYSTEM IDENTIFICATION? (YES/NO) appears in the display, the following will be a guide to selection:' ° If the 'YES' key is pressed, each electronic system equipped with self-diagnosis is automatically checked. Therefore if any trouble codes are present, they will be displayed. If the 'NO key is pressed, the electronic chassis system and the four wheel drive system should be selected. Then if any trouble codes are stored they will be displayed after the data has been checked.

Procedure

- Note any trouble codes present.
- Dial 'F0: DATA LIST' with the 'YES' key.
- Start the engine which should be at operating temperature.
- Compare all displayed data with the nominal values in the tables that follow.
- If any variation is noted, carry out trouble shooting according to instructions.
- Test codes for which no steps in the 'F0: DATA LIST - Quick Check' apply, should be handled as follows:
  - Determine in which wiring or sub-assembly the fault lies that could have led to the setting of the trouble code
  - (see Trouble Code Table).
  - Measure the affected wiring or sub-assembly, using a high impedance, digital multimeter.
  - Replace any defective parts.

TROUBLE CODE TABLE

Trouble Code	Information Sensor Causing Fault	Reference in F0: DATA LIST	Trouble Code is Stored When…
15	OIL TEMPERATURE SENSOR - VOLTAGE HIGH	09	▪ Open circuit occurs in oil temperature sensor circuit. ▪ The fault will be recognised when the engine is under load. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.
31	INCORRECT RPM SIGNAL	02	**Engine speed is more than 8,000 rpm (which is outside permissible limits).** ▪ The fault will be recognised when the engine is under load. **Results**: ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.
32	PRESSURE SWITCH HIGH PRESSURE 4x4 OFF	07	**When Stationary:** ▪ Engine is running. ▪ The system pressure is higher than 1,000 kPa, even though the four wheel drive is switched OFF. ▪ The above conditions must exist for at least 0.5 seconds. **When Driving:** ▪ The system pressure is higher than 1,000 kPa, even though the four wheel drive is switched OFF. ▪ The above condition must exist for at least t second. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will flash.

TROUBLE CODE TABLE - Cont'd.

Trouble Code	Information Sensor Causing Fault	Reference in F0: DATA LIST	Trouble Code is Stored When…
33	SOLENOID VALVE VOLTAGE HIGH	08	▪ A short or open circuit exists in the Solenoid Valve or its electrical circuit ▪ The fault will be recognised when the engine is under load. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.
34	SOLENOID VALVE VOLTAGE LOW	08	▪ A short circuit exists in the Solenoid Valve or its electrical circuit ▪ The fault will be recognised when the engine is under load. **Results**: ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.
37	CONTINUOUS BRAKING	–	**Stationary:** ▪ The engine is running. ▪ The system pressure is lower than 1,000 kPa. ▪ The engine is started, the vehicle started from rest and the speed exceeds 50 km/h, then comes to rest and braking has been identified at least once (or operated longer than 0.1 seconds). The fault will then be identified and stored. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.

TROUBLE CODE TABLE - Cont'd.

Trouble Code	Information Sensor Causing Fault	Reference in F0: DATA LIST	Trouble Code is Stored When…
39	NO ABS SIGNAL	03, 04	▪ No wheel speed sensor signal has been received by the ABS Electronic Control ▪ Module from the left hand front wheel. ▪ Engine speed is more than 2,300 rpm. ▪ The above conditions must exist for at least 15 seconds. **Results:** ▪ Four Wheel Dive will be switched off and the four wheel drive indicator lamp will be illuminated.
55	REPLACE ECU	–	▪ When the solenoid valve is burnt out or open circuited. This fault will only be recognised when the solenoid valve is activated by the control unit. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will flash.
71	BRAKE SWITCH VOLTAGE HIGH	05,06	▪ Engine is running. ▪ The electronic control unit recognises battery voltage at both inputs simultaneously, at ▪ ECU terminals 1 and 16. ▪ The above conditions must exist for at least 10 milliseconds. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated. **Hint:** ▪ The ECU recognises this condition as an error in logic as the two signals (at terminals 1 and 16) should only occur one at a time, not simultaneously. That is, if one switch contact is closed, the other should be open.

TROUBLE CODE TABLE - Cont'd.

Trouble Code	Information Sensor Causing Fault	Reference in F0: DATA LIST	Trouble Code is Stored When…
72	BRAKE SWITCH VOLTAGE LOW	05,06	▪ The engine is running. ▪ The ECU recognises voltage at both inputs simultaneously, at control unit terminals 1 and 16. ▪ The above conditions must exist for at least 10 seconds. **Results:** ▪ Four Wheel Drive will be switched *off* and the four wheel drive indicator lamp will be illuminated. **Hint:** ▪ The ECU recognises this condition as an error in logic as the two signals (at terminals 1 and 16) should only occur one at a time, not simultaneously. That is, it one switch contact is closed, the other should be open.
73	STOP WITHOUT BRAKING	05, 06	▪ The engine is running. ▪ With the vehicle stationary, after coming to rest from above a speed of 60 km/h, without using the brake. ▪ The above conditions must exist for at least 2 seconds. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.

TROUBLE CODE TABLE - Cont'd.

Trouble Code	Information Sensor Causing Fault	Reference in F0: DATA LIST	Trouble Code is Stored When…
74	PRESSURE SWITCH LOW PRESSURE 4x4 ON	07	**When Stationary:** ▪ The engine is running. ▪ The system pressure is less than 1,000 kPa, even though the four wheel drive is ▪ switched ON. ▪ The above conditions must exist for at least 80 seconds. **When Driving**: ▪ The system pressure is less than 1,000 kPa, even though the four wheel drive is switched ON. ▪ The above condition must exist for at least 0.5 second. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.
75	OIL TEMPERATURE SENSOR VOLTAGE LOW	09	▪ The oil temperature is above or close to 140 °C with a vehicle speed above 190 km/h. ▪ The oil temperature is above 180 °C. ▪ The fault will be recognised when the engine is under load. **Results:** ▪ Four Wheel Drive will be switched off and the four wheel drive indicator lamp will be illuminated.

m
N

F0: DATA LIST - Quick Check

Test Stop No. P	TECH 1 Display	Test Conditions	Nominal Values	Possible Trouble Codes	ECU Terminal Number
01	BATTERY VOLTAGE	Ignition ON. All electrical loads switched OFF. Engine running in Neutral.	11.5 to 13.5 V 13.0 to 15.0 V	- -	12
02	ENGINE SPEED	Engine running in Neutral, at normal temperature.	880 - 1,020 rpm	31	10
03	FT LEFT WHEEL SPEED	Ignition ON. With the front of the vehicle raised off the ground, slowly rotate the left hand front road wheel. OR Drive the vehicle at a speed of approximately 50 km/h.	Approx. 5 km/h OR TECH 1 & Speedometer readings should be approximately the same.	39	3
04	FT RIGHT WHEEL SPEED				17
05	BRAKE SWITCH 1	Ignition ON. Brake not applied. Brake applied.	Closed – 12 V Open – 0 V	37, 71, 72, 73	1
06	BRAKE SWITCH 2	Brake not applied. Brake applied.	Open – 0 V Closed –12 V		18
07	PRESSURE SWITCH	Ignition ON. Engine running In Neutral, at normal temperature.	Closed – 0 V Open – 12 V	32, 74	7
08	SOLENOID VALVE	Ignition ON. Engine running In Neutral, at normal temperature.	Inactive – 0 V Active – 12 V	33, 34	11
09	OIL TEMPERATURE	Ignition ON. Oil temperature: 30 °C 52 °C 70 °C 91 °C 110 °C 730 °C 752 °C 185 °C	 30 °C approx. 4.98 V 52 °C approx. 4.38 V 70 °C approx. 3.75 V 91 °C approx. 3.13 V 110 °C approx. 2.50 V 130 °C approx. 1.88 V 152 °C approx. 1.25 V 185 °C approx. 0.83 V	15, 75	9
10	CHECK LIGHT	Ignition ON.	ON - 0 V	-	8

4.3 F5: ACTUATOR TEST

SOLENOID VALVE

Test Conditions	Nominal Values
Test Point: ECU Terminal No. 11 **Possible Trouble Codes:- 33, 34** ▪ Engine OFF. ▪ Ignition ON. ▪ Vehicle Stopped. ▪ With TECH 1 connected as per the Operator's Manual, press F5: at the Main Menu, then select the desired actuator test with the arrow keys and confirm with YES. ▪ Follow the instructions on the TECH 1 display. **TECH 1 Display:** SOLENOID VALVE **Hint:** The Electronic Control Unit (ECU) activates the four wheel drive indicator lamp, for 2 seconds ON and OFF. This test should not be continued for more than 30 seconds.	**Alternatively:** Inactive: 0 V **and** Active: 12 V

FOUR WHEEL DRIVE INDICATOR LAMP

Test Point: ECU Terminal No. 8 **Possible Trouble Codes: -** ▪ Engine OFF. ▪ Ignition ON. ▪ Vehicle Stopped. ▪ With TECH 1 connected as per the Operator's Manual, press F5: at the Main Menu, then select the desired actuator test with the arrow keys and confirm with YES. ▪ Follow the instructions on the TECH 1 display. **TECH 1 Display:** CHECK LAMP **Hint:**Check Lamp - ON The Electronic Control Unit (ECU) activates the four wheel drive indicator lamp, for 1 second ON and OFF. This test should not be continued for more then 30 seconds.	**Alternatively:** ON: 0 V Check Lamp - ON **and** OFF: 12V Check Lamp – OFF

5. SPECIFICATIONS

Electronic Control Unit

Broadcast Code	JZ

Transmission

Lubricant	Gear Oil 80W GL4 to Holden's Specification HN1820, HN1855 or equivalent
Lubricant Capacity	1.8 litre

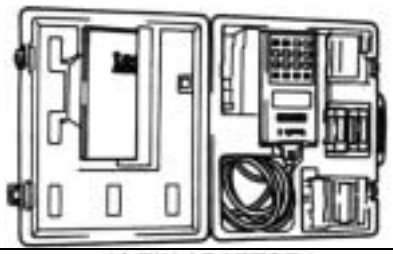
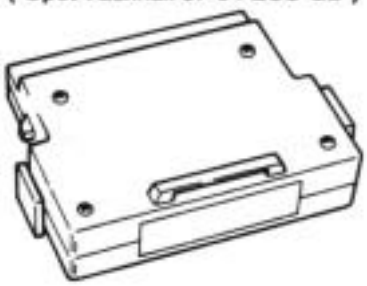
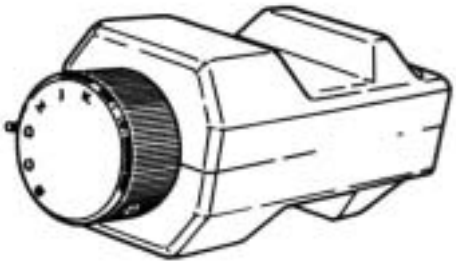
Transfer Box

Lubricant Type	Synthetic Lubricant to Holden's Specification HN2157, such as Castrol SYNTRANS 75W/85 or equivalent.
Lubricant Capacity	600 ml approximately
Maximum Permissible Fluid Temperature	160 °C

Power Steering/4x4 Hydraulic System

Fluid Type .	Dexron® IIE or III Automatic Transmission Fluid

6. SPECIAL TOOLS

TOOL No. REF. IN TEXT	TOOL DESCRIPTION	COMMENTS
SERVICE KIT 7000018	TECH 1 SCAN TOOL 	Previously released.
SD28224	10 PIN ADAPTOR 	Previously released. Required to interface between the Calibra diagnostic connector and the TECH 1 cable.
09017102	PROGRAM MODULE ("Opel/Vauxhall 87-94 ECU GB") 	New release
N/A	DIGITAL MULTIMETER 	Commercially available
KM-640	DIAGNOSTIC SWITCH 	Available optional tool

SECTION 6A

CAUTION:

This vehicle Is equipped **with an AIR BAG.** Refer to CAUTIONS, Section 12, In this Volume of the Preliminary Service Information before performing any service operation on or around Air Bag components, the steering mechanism or wiring. Failure to follow the CAUTIONS could result In air bag deployment, resulting in possible personal Injury or unnecessary SRS system repairs.

ENGINE MECHANICAL

CONTENTS

1. GENERAL INFORMATION

As the 2.0 litre DOHC, C 20 LET, turbocharged engine used in the four-wheel drive Calibra, is based on the familiar, C 20 XE, naturally aspirated engine, this Section only discusses the mechanical differences between the two engines. For information relating to the Motronic M 2.7 engine management system, refer to Section 6C in this Volume.

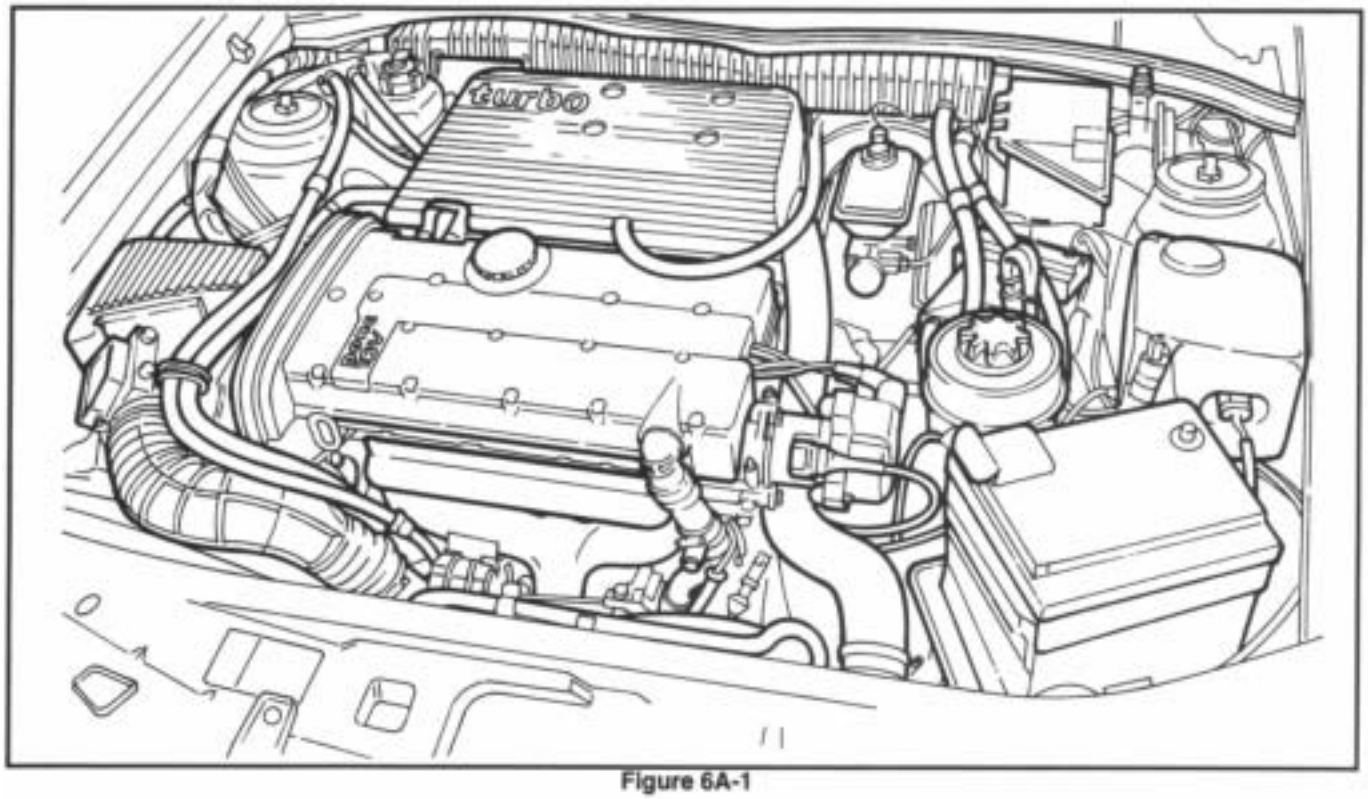


Figure 6A-1

1.1 ENGINE MECHANICAL CHANGES

ENGINE BLOCK

An additional tapping into the main oil gallery (1) is used for the turbocharger oil return line (2)

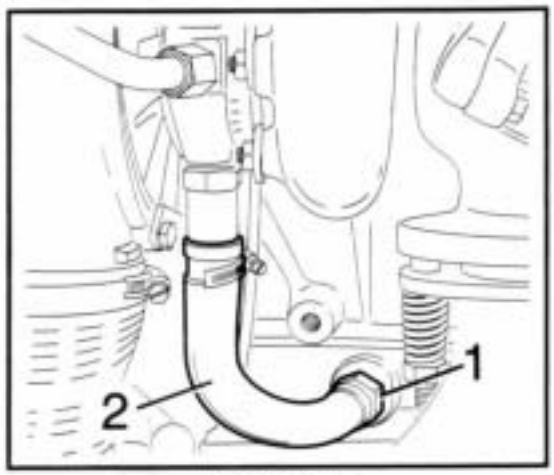


Figure 6A-2

Replacing the previously used plug behind the oil filter housing, is the oil supply line for the turbocharger (1).

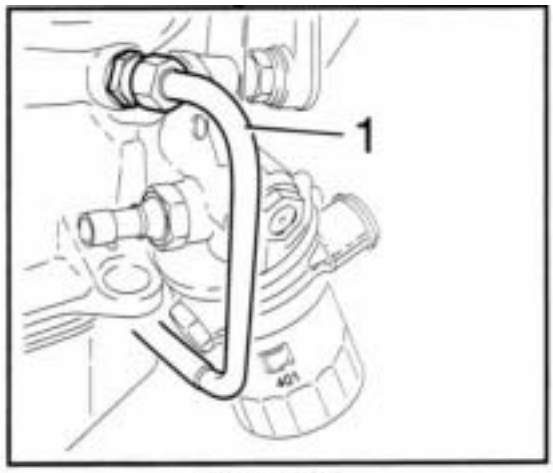


Figure 6A-3

CRANKSHAFT AND PISTONS

A revised design crankshaft damper is used to match the changed engine performance
Pistons with recessed crowns are used, which effectively reduces the compression ration from 10.5: to 9.0:1.

CYLINDER HEAD

Heat resistant bolts are used on the exhaust manifold side.
The cylinder head gasket is of a special steel design.

CAMSHAFT

Valve timing has been changed by decreasing the valve lift from 9.5 - 8.5 mm and a smaller valve overlap angle has been used to match the intake system to the turbocharger output.

2. TURBOCHARGER SYSTEM

The most exceptional technical feature of the "integral" turbocharger system used in the CALIBRA TURBO 4x4, is the combining of exhaust manifold and turbine housing into one component.

This integral turbocharger system design has several advantages:

- Low weight.
- Minimal thermal loss:
  Because the hot exhaust gases only have to travel a short distance to the turbine, very little energy is lost in heating other components. This means that the turbocharger responds very quickly.
- High efficiency:
  As there is no turbocharger flange, the exhaust gases flow into the exhaust turbine with minimal swirl.

2.1 OVERVIEW OF COMPONENTS

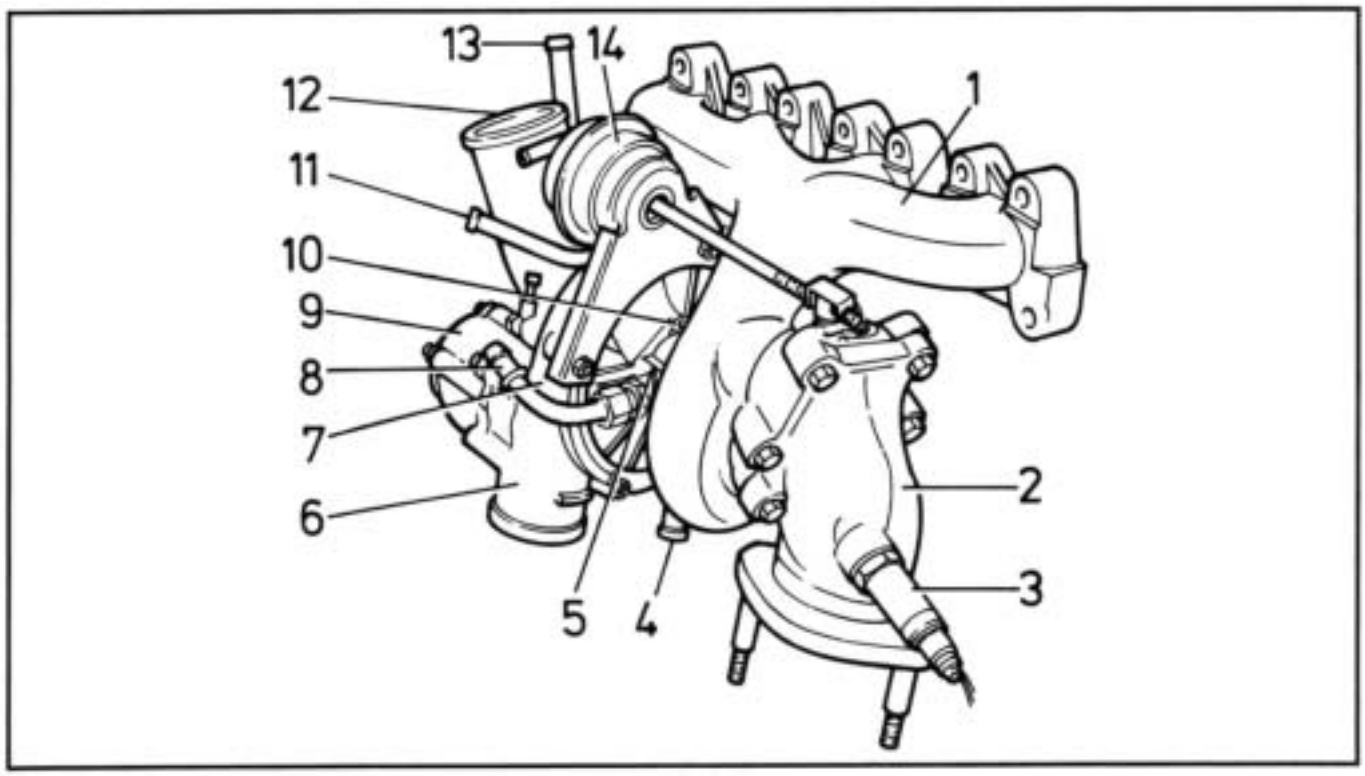


Figure 6A-4

Illustration Key:

1. Exhaust manifold with integrated turbine casing
2. Bypass manifold
3. Oxygen sensor
4. Oil return to engine block
5. Bearing housing
8. Pressure side of compressor housing
7. Compressor housing
8. Coolant feed from radiator
9. Air bypass valve
10. Oil feed
11. Coolant return to compensation tank
12. Intake side of compressor housing
13. Connection for engine ventilation
14. Control unit with actuating rod for charge pressure control valve

Turbocharger

The turbine housing and the charge pressure regulating valve are integrated into the exhaust manifold. The compressor housing, with the bearing housing and the air bypass valve, is bolted onto the exhaust manifold.

There are bolted connections on the bearing housing for pressure circulating lubrication and fluid cooling.

On the pressure side of the compressor housing, there is a connection for the pressure hose to the charge pressure bypass valve.

On the intake side of the compressor housing, there is a connection for the hose to the engine full load ventilation. The hose serves at the same time as a vacuum supply for the charge pressure bypass valve.

Note: After operation at high engine speeds, or extreme engine loads, allow the engine to run at low load, i.e. allow the engine to idle for approx. 30 seconds before switching off. This helps to protect the turbocharger.

Control Unit for Charge Pressure Regulating Valve

The control unit for the charge pressure regulating valve is fastened to the compressor housing with a retainer.

In the control unit, there is a spring-loaded diaphragm which closes the charge pressure regulating valve with its spring force. When vacuum is applied by the charge pressure bypass valve, the diaphragm opens the charge pressure regulating valve against the spring force, so that the exhaust gasses can flow directly into the exhaust through the bypass channel.

Air Bypass Valve

The air bypass valve is bolted to the pressure side of the compressor housing.

In the air bypass valve, there is a spring-loaded diaphragm, which closes the bypass channel under the action of spring force. To prevent excessive pressure increase between the turbocharger and the throttle valve when the throttle valve is suddenly closed (e.g. sudden deceleration), the bypass channel is opened via the air bypass valve and the pressure side of the compressor housing is ventilated to the intake side, effectively dumping boost pressure to atmosphere. This prevents the turbine from decelerating too quickly and this reduces 'lag' time for the turbocharger to respond, when acceleration is resumed.

The air bypass valve is actuated via a vacuum connection in the throttle body.

Charge Cooler

When the air in the turbocharger is compressed, the air
temperature is increased, effectively reducing its density.
The charge cooler reduces this temperature by
approximately 40 °C, thus supplying the engine with a greater mass of air, as the atmospheric density is higher.
This results in a greater final compression and therefore an increase in engine output.

The charge cooler is located on the left beside the water cooler.

Engine Ventilation

The engine is ventilated at full load via a vacuum hose to the intake side of the compressor housing. At idle speed, the engine is ventilated via a vacuum hose between the intake manifold and the cylinder head cover. It is equipped with a return valve to protect the crank drive when the charge pressure increases.

2.2 CHARGE PRESSURE CONTROL

The charge pressure is controlled via the pulsed charge pressure bypass valve (3). It is actuated by the Motronic M 2.7 control unit (1) and connects - depending on the calculated charge pressure nominal value - the control unit (4) for the charge pressure regulating valve alternately with the intake side or with pressure side of the compressor. Depending on the length of pulse of the pressure or vacuum present, a median vacuum forms in the control unit which pulls the diaphragm against the force of the spring.
The aperture of the charge pressure regulating valve (5), and thus the exhaust gas throughput through the turbine housing, is set by the actuating rod.
The charge pressure is limited to maximum 0.8 bar.
If the intake air temperature sensor (2) reports to the control unit that the charge air temperature is too high, the charge pressure is reduced. If there is a signal from the switch for 1st gear recognition (7) or the switch for reverse gear recognition (8), the charge pressure is limited according to the characteristic curve, depending on engine speed and load signal, so that an engine torque of 230 Nm is not exceeded.

FUNCTION DIAGRAM - CHARGE PRESSURE CONTROL

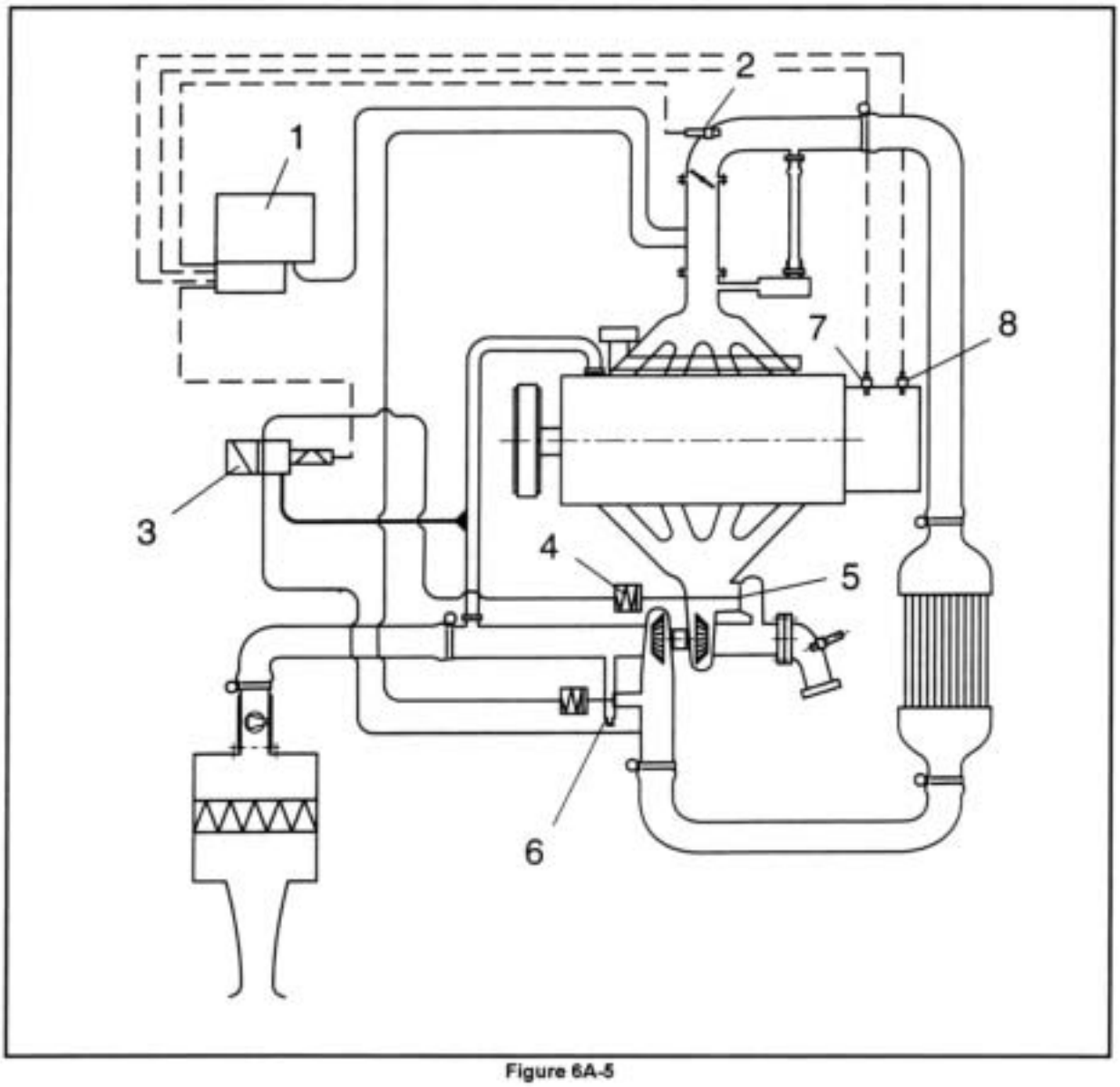


Figure 6A-5

Illustration Key:

~~Signal wiring~~
1. Motronic M 2.7 control unit
2. Intake air temperature sensor
3. Charge pressure control bypass valve
4. Charge pressure regulating valve control unit

Pressure/vacuum hoses
5. Charge pressure regulating valve
8. Air bypass valve
7. Switch - 1st gear recognition
8. Switch - reverse gear recognition

2.3 SCHEMATIC OF PRESSURE/VACUUM LINES

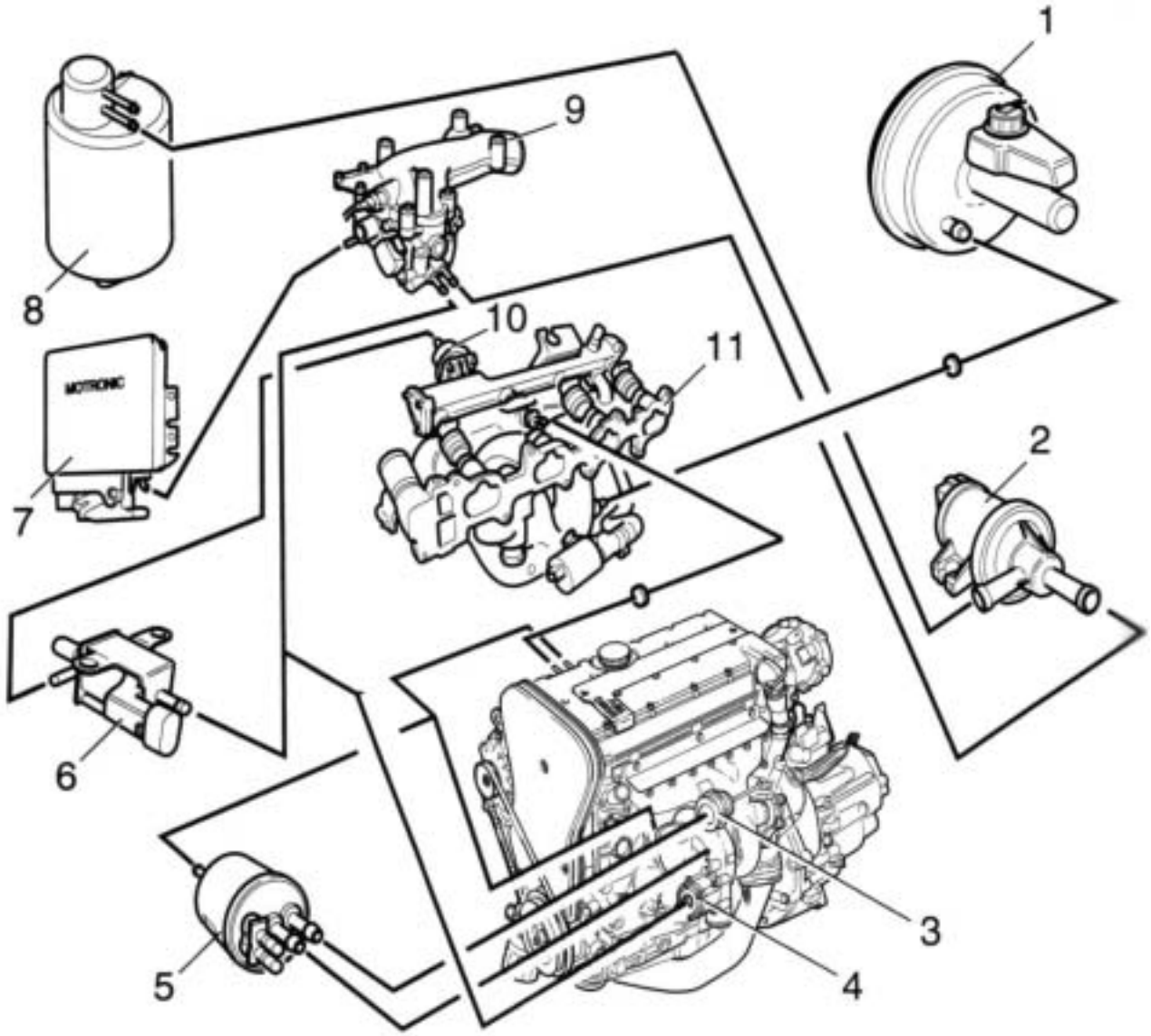


Figure 6A-6

Illustration Key:

1. Brake servo
2. Tank vent valve
3. Charge pressure regulating valve control unit
4. Air by-pass valve
5. Charge pressure control bypass valve
6. Hot start valve
7. Motronic M2.7 control unit
8. Active carbon canister - tank vent
9. Throttle valve manifold
10. Fuel pressure regulator
11. Intake manifold

3. SPECIFICATIONS

Engine	
Lubricant Specification	Service classification SF or SG. Viscosity grade 20W/40 for normal use.
Lubricant Capacity	4.5 litre (including oil filter)
Engine Idle Speed	860 - 1,020 rpm (see Section 6C in this Volume for more details)

SECTION 6C

CAUTION:

This vehicle is equipped with an AIR BAG. Refer to CAUTIONS, Section 12, In this Volume of the Preliminary Service Information before performing any service operation on or around Air Bag components, the steering mechanism or wiring. Failure to follow the CAUTIONS could result in air bag deployment, resulting in possible personal Injury or unnecessary Air Bag system repairs.

ENGINE MANAGEMENT

CONTENTS

1. GENERAL INFORMATION

Even though the Motronic M 2.7, engine management system used in the CALIBRA TURBO 4x4, provides optimised ignition control, sequential fuel injection, air flow metering and knock control, as in the Motronic M 2.5 and M 2.8, used in 2 wheel drive Calibra models, it also controls the charge pressure produced by the turbocharger.

While this description describes the features of the Motronic M 2.7 engine management system, it will also prove useful as a general overview for both the M 2.5 and the M 2.8 versions.

1.1 MOTRONIC M 2.7 SYSTEM OVERVIEW

Illustration Key:

1. Fuel tank
2. Tank vent valve
3. Active carbon canister - tank vent valve
4. Idle speed adjuster
5. Intake air temperature sensor
6. Inductive pulse pick-up
7. Inductive pulse pick-up sensor gear
8. Knock sensor
9. High voltage distributor
10. Coolant temperature sensor
11. Oxygen sensor
12. Turbocharger
13. Bypass valve - charge pressure control
14. Hot-wire mass air flow meter
15. Ignition module
16. Control unit with diaphragm, spring and actuating rod for charge pressure control valve
17. Fuel filter
18. Injection valves
19. Fuel pressure regulator
20. Hot start valve
21. Charge cooler
22. Throttle valve potentiometer
23. Fuel pump
24. Vibration damper
25. Diagnostic plug
26. Recognition – 1st gear
27. Recognition - Reverse gear

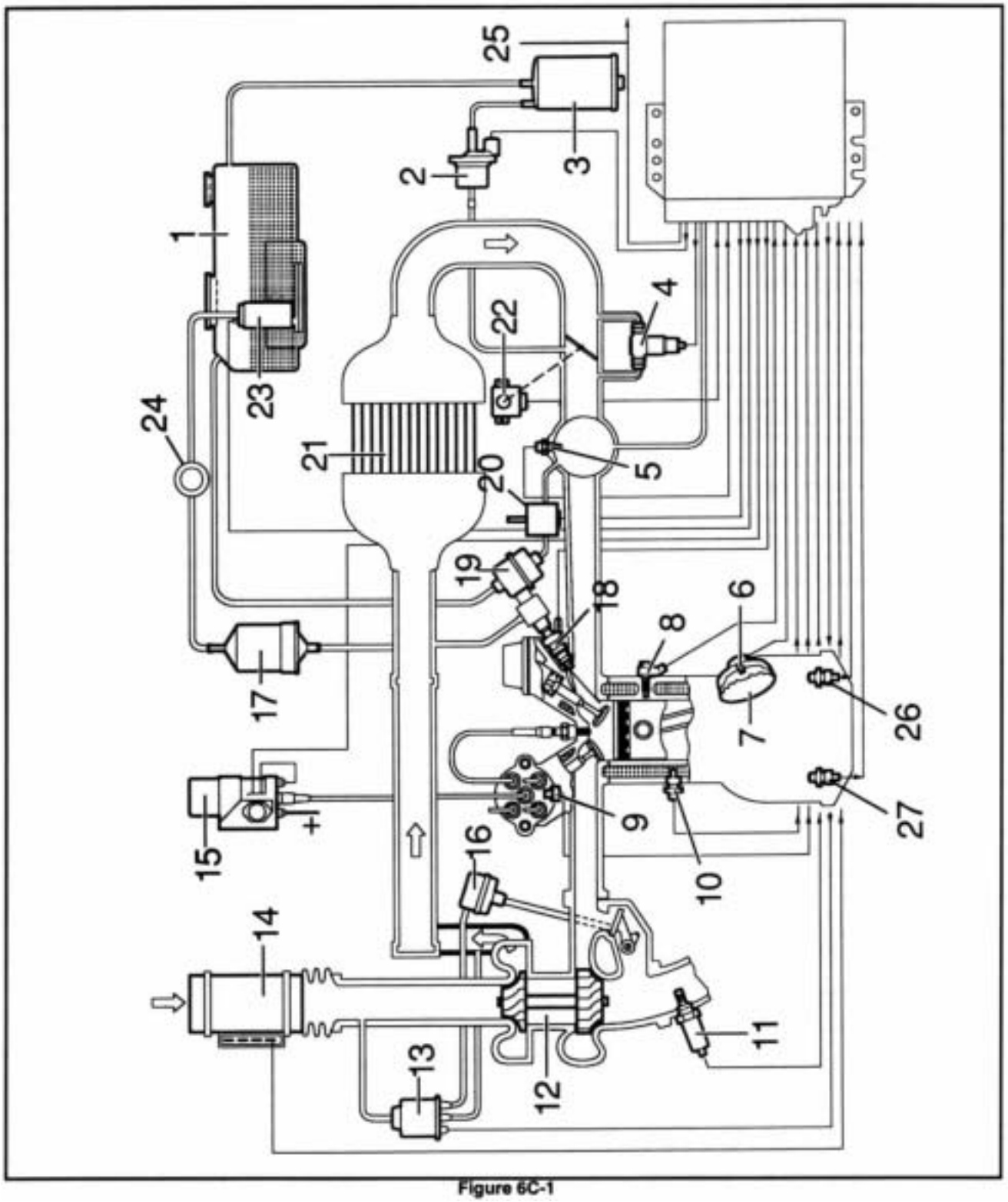


Figure 6C-1

1.2 COMPONENT DESCRIPTIONS

To provide a logical sequence to the various components that make up the Motronic M 2.7 engine management system, the following descriptions will proceed through various sub-systems of:

Fuel Flow.
Air Flow.
Electrical/Electronic

FUEL FLOW SUB-SYSTEM

FUEL PUMP, FILTER AND PULSATION DAMPER

The in-tank electric fuel pump is of the familiar roller-cell design that pumps fuel through the in-line fuel filter, via a fuel pulsation damper, into a fuel distribution manifold at a pressure of 250 kPa, maintained by a pressure regulator, mounted at the outlet end of the distribution manifold.
From the pressure regulator, excess fuel is directed back to the fuel tank.
The fuel filter is installed to match the direction of fuel flow.
The function of the non-adjustable fuel damper is to absorb fuel flow pulsations from the action of the fuel pump rollers.

FUEL PUMP RELAY

Fuel pump operation is controlled by a fuel pump relay that prevents fuel from being pumped when the engine is switched ON but not operating such as might occur in an accident. If no ignition pulse is received by the Motronic M 2.7 control unit, the fuel pump relay is de-activated, preventing fuel pump operation.

FUEL PRESSURE REGULATOR

Flange mounted to the outlet end of the fuel distribution manifold, the pressure regulator is a diaphragm controlled unit that maintains a fuel pressure that is a constant 250 kPa, relative to the intake manifold pressure.
Location is as shown in Figure 6C-3 ('1').

Illustration Key:
1. Fuel inlet. 2. Fuel return line. 3. Valve plate.
4. Valve plate holder.
5. Diaphragm. 6. Pressure spring.
7. Intake manifold pressure connection

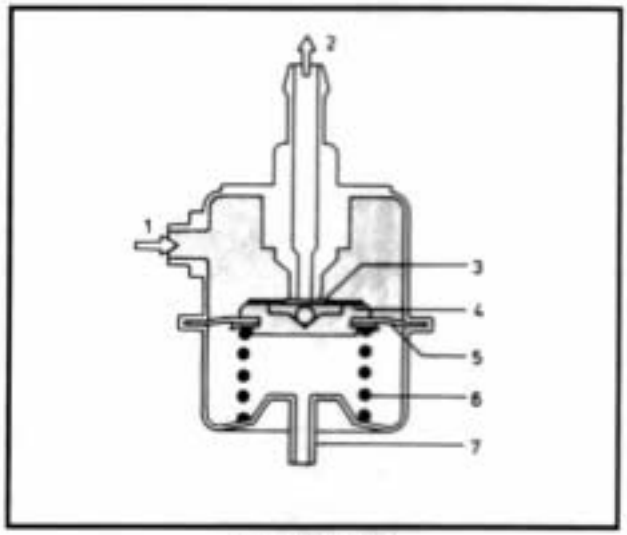


Figure 6C-2

FUEL DISTRIBUTION MANIFOLD

The design is such that the fuel distribution manifold capacity is sufficient to reduce pressure variations and noise. This means that each of the fuel injectors attached to the manifold, are all supplied with the same fuel pressure.
In addition to the fuel pressure regulator ('1'), a non-return valve ('2') is also fitted to the distribution manifold, that provides a convenient point at which to check system fuel pressure.

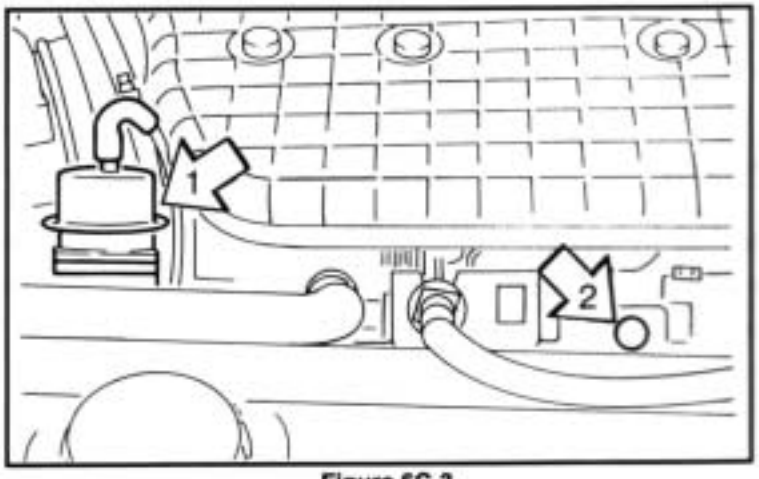


Figure 6C-3

INJECTION NOZZLES

The fuel injection nozzles are opened by pulsed electrical signals from the control unit. The longer the pulsed signal (pulse width), the more fuel is injected into the intake manifold.

The fuel injection nozzles are unique to the Motronic M 2.7, as they have been modified to provide an increased flow rate, compared to other systems.

FUEL TANK VENT VALVE

The function of the fuel tank vent valve is to control the purging of stored fuel vapour from the activated charcoal canister. This control is achieved by the control unit activating the Vent Valve when engine operating
conditions are such that exhaust emission levels will not be unduly affected by the burning of the stored fuel vapours.
Once activated, the electro-magnetic valve opens, allowing intake manifold vacuum to draw the fuel vapours into the engine. The vapours are replaced with fresh air via a vent hose fitted to the base of the canister.

Compared to the valve fitted to earlier Motronic systems, the tank vent valve for the Motronic M 2.7. is a pressure sealed version to withstand the high pressures involved.

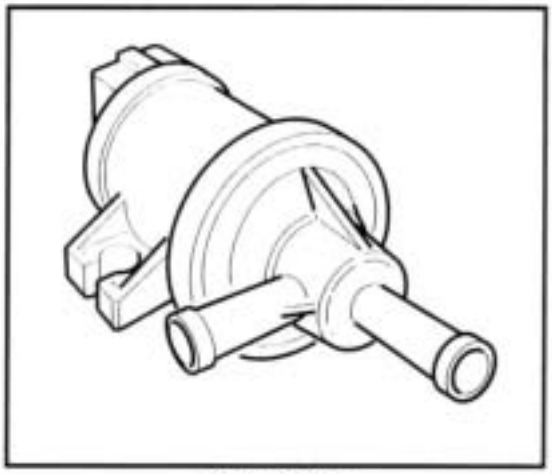


Figure 6C-4

HOT START VALVE

To prevent a fuel vapour lock occurring in the fuel system on hot engine starts, fuel pressure is increased, dependent on engine coolant temperature. This is achieved by the fuel pressure regulator vacuum connection to the engine intake manifold, being routed via the hot start valve, to atmosphere.
When cranking signals are received by the control unit and engine coolant temperature is above pre-set parameters, the Hot Start Valve is activated effectively closing off intake manifold vacuum from the pressure regulator valve, allowing atmospheric pressure to act on the regulator diaphragm. This action produces the maximum fuel pressure in the fuel distribution manifold for starting. Refer to Figure 6A-6 in this Volume for hose
connections.
Unique to the Motronic M 2.7, the hot start valve is bolted onto the throttle valve manifold.

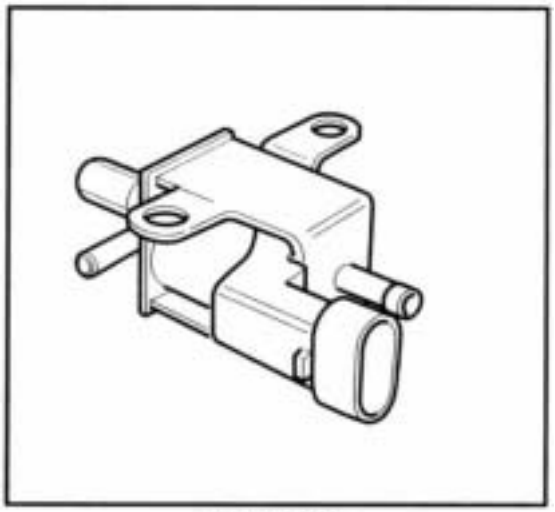


Figure 6C-5

AIR FLOW SUB-SYSTEM

HOT-WIRE MASS AIR FLOW METER

Introduced with the Motronic M 2.5, the calibration of the air flow meter for the M 2.7 has been modified to suit the increased air flow rate. The optimal means of determining the load on a petrol engine is to measure the air mass taken in by the engine. The reading thus obtained, is independent of air pressure, height above sea level (important when traveling in mountains) and air temperature.

Construction of Hot Wire Air Mass Meter

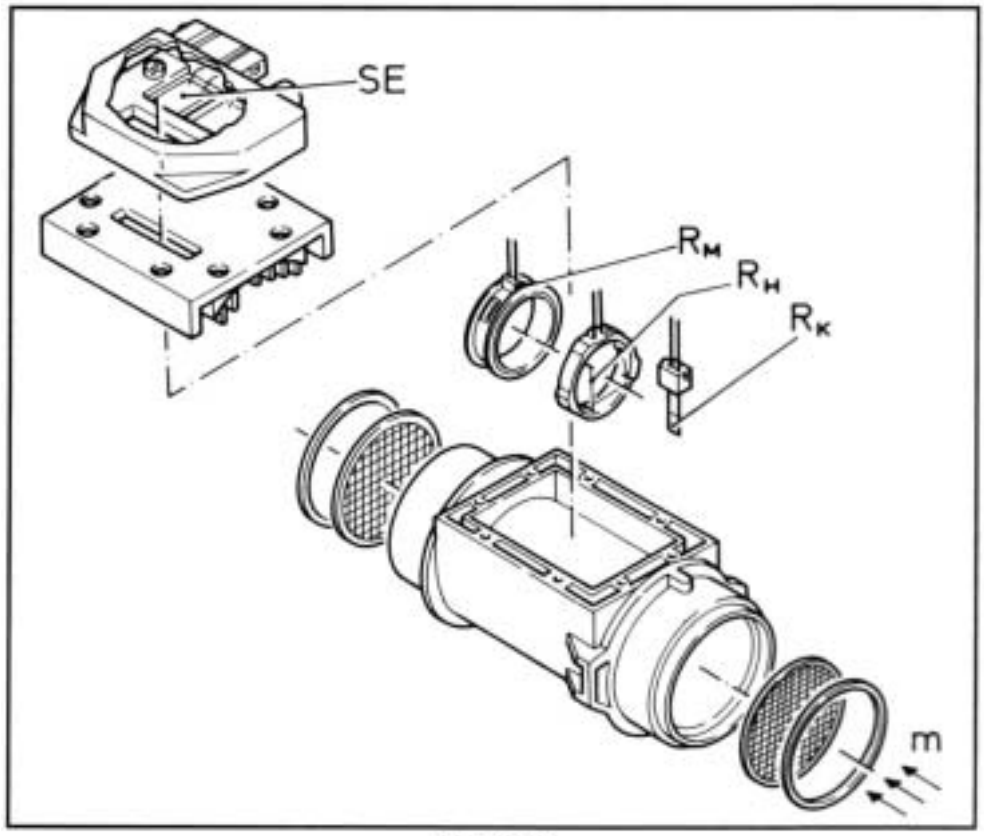


Figure 6C-6

Illustration Key:
m Intake air mass
SE Control electronics
RK Temperature sensor
RH Hot wire
RM Precision resistance

Operation

Measurement is made by guiding the air mass (m) into the engine, past a thin, electrically heated wire (hot wire, RH).

This hot wire is part of an electrical bridging circuit and is monitored by an electronic control unit (SE).

The electronic control unit (SE) regulates the flow of heating current (I) through the hot wire so that the hot wire always has a constant temperature.

If the mass of the intake air rises, this results in the hot wire cooling down proportionally.

Then the electronic control unit in the air mass meter (SE) increases the heating current so that the hot wire returns to constant temperature.

The heating current flows through the precision resistance (RM), causing a voltage drop that is always in the same proportion as the intake air mass.

This voltage drop is recorded at terminals 2 and 3 and conducted to the Motronic M 2.7 control unit as an air mass signal.

This heating current is therefore a measurement of the air mass flowing into the engine.

To avoid faulty measurement due to contamination, the hot wire is burnt free after each operation. A pre-condition for this burning free period is that an engine speed of 1,000 rpm and an engine temperature in excess of 31 °C must have been reached. This means that the hot wire is not burnt free every time the ignition is switched ON or OFF.

Provided these pre-conditions are fulfilled, the burning free begins approx. 4 seconds after the ignition is switched off and lasts for approximately 1.6 seconds when the process is visibly recognisable by the red glowing hot wire.

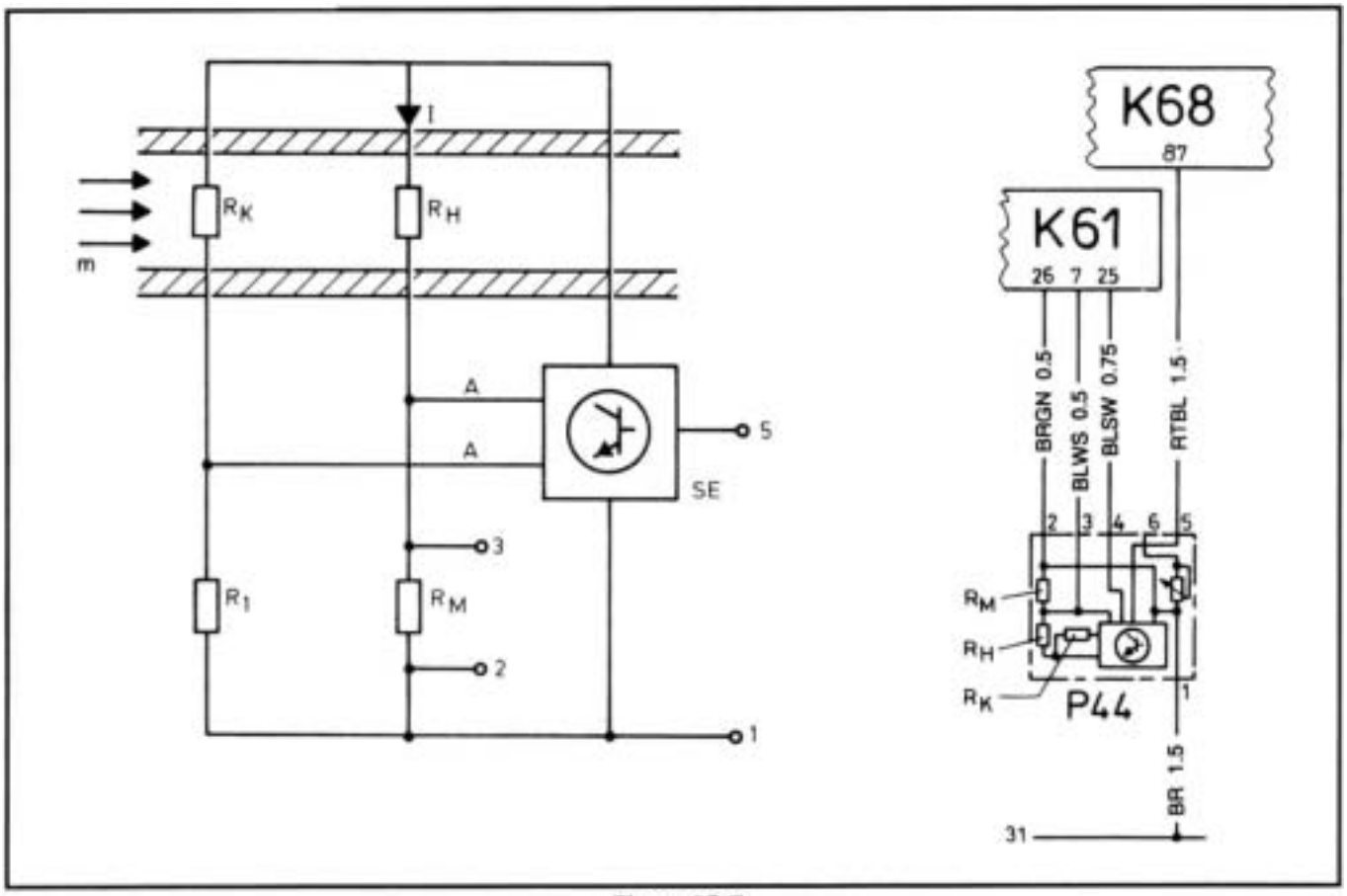


Figure 6C-7

Illustration Key

I	Heat current
m	Intake air mass
SE	Control electronics
RK	Temperature sensor
RH	Hot wire
Rl	Resistor in the measuring bridge of the control electronics (for better clarity, shown outside of the control electronics)
RM	Precision resistance measurement
A	Measuring leads
P 44	Hot wire air mass meter
P 44/Ter.1	Ground
P 44/Ter. 2	Ground to Motronic M 2.5 control unit
P 44/rer. 3	Signal lead hot wire air mass meter
P 44/Ter. 4	Signal 'bum free' (pulsed ground)
P 44/Ter. 5	Voltage supply +12 V
P 44/Ter. 6	Not used with Motronic M 2.7
K 61	Motronic M 2.7 control unit
K 68	Fuel pump relay

Should the hot wire air mass meter or the lead between the hot wire air mass meter and the Motronic M 2.7 control unit become defective, then the Engine Telltale Lamp will be lit and a diagnostic trouble code (DTC) will be stored in the Motronic M 2.7 control unit.

OTC 65: Voltage CO potentiometer too low.
OTC 66: Voltage CO potentiometer too high.
OTC 73: Voltage hot wire air mass meter too low.
DTC74: Voltage hot wire air mass meter too high.

Once a trouble code is logged, the control unit sets a default value which allows the vehicle to still operate until the fault can be located and corrected. Refer to 5.

CHECKING PROCEDURES - Motronic M 2.7 in this Section for further details of these and other diagnostic trouble codes.

THROTTLE BODY

The throttle body has a compound throttle valve and is mounted on the intake manifold below the pre-volume chamber.
The design has been developed to achieve smooth and fine control over this high performance engine.

Illustration Key:
1. Primary throttle valve (1st stage)
2. Secondary Throttle valve (2nd stage)
3. 'Rucksack'

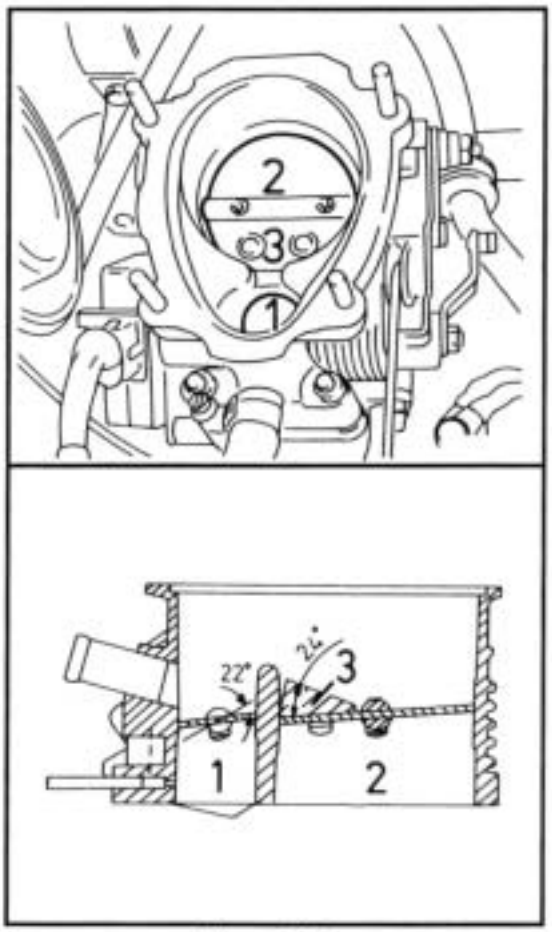


Figure 6C-8

Only the relatively small primary stage opens for the first 22° of throttle angle i.e. the second stage does not start to open until the primary has opened more than 22°. Even then, the second stage is restricted from opening by the 'rucksack' on its lower half, until a throttle angle of 24° has been attained. This staged and controlled opening provides a perfect transition from stage 1 to 2.

IDLE SPEED ADJUSTMENT

A by-pass hose around the throttle valve is installed, that has an electric idle speed adjuster inserted into it. Depending on the aperture left open by the rotary spool valve, the amount of air that by-passes the throttle valve will affect the engine idle speed.
The position of the rotary spool valve is determined by the action of the motor working against a return spring that tries to close the valve. When the two are 'balanced' by a constant battery voltage being applied to the motor by the control unit, a specific bypass aperture is achieved that determines the engine Ore speed.
Control of the voltage to the motor is determined by the internal control unit program 'Idle Speed Adjustment', that serves as a final controlling element of the idle speed adjustment. This device replaces the auxiliary air valve that has been used in the past, with the 'L' Jetronic fuel injection systems. With the variable flexibility provided by the control unit, the idle speed can be varied or maintained, independent of the load conditions on the engine.

Illustration Key:
1. Electrical connector
2. Housing
3. Permanent magnet
4. Armature
5. Air channel by-passing throttle valve
6. Rotary spool valve

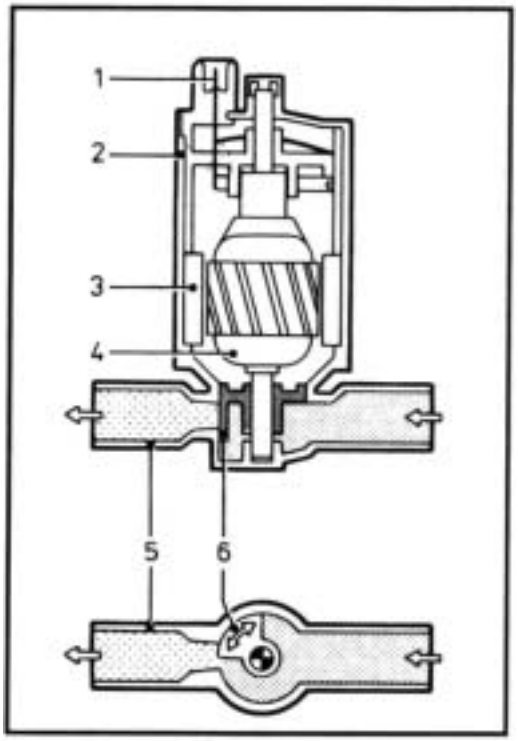


Figure 6C-9

BYPASS VALVE - CHARGE PRESSURE CONTROL

Illustration Key:
1. Charge pressure control bypass valve
2. Charge pressure regulating valve control unit
3. Air bypass valve

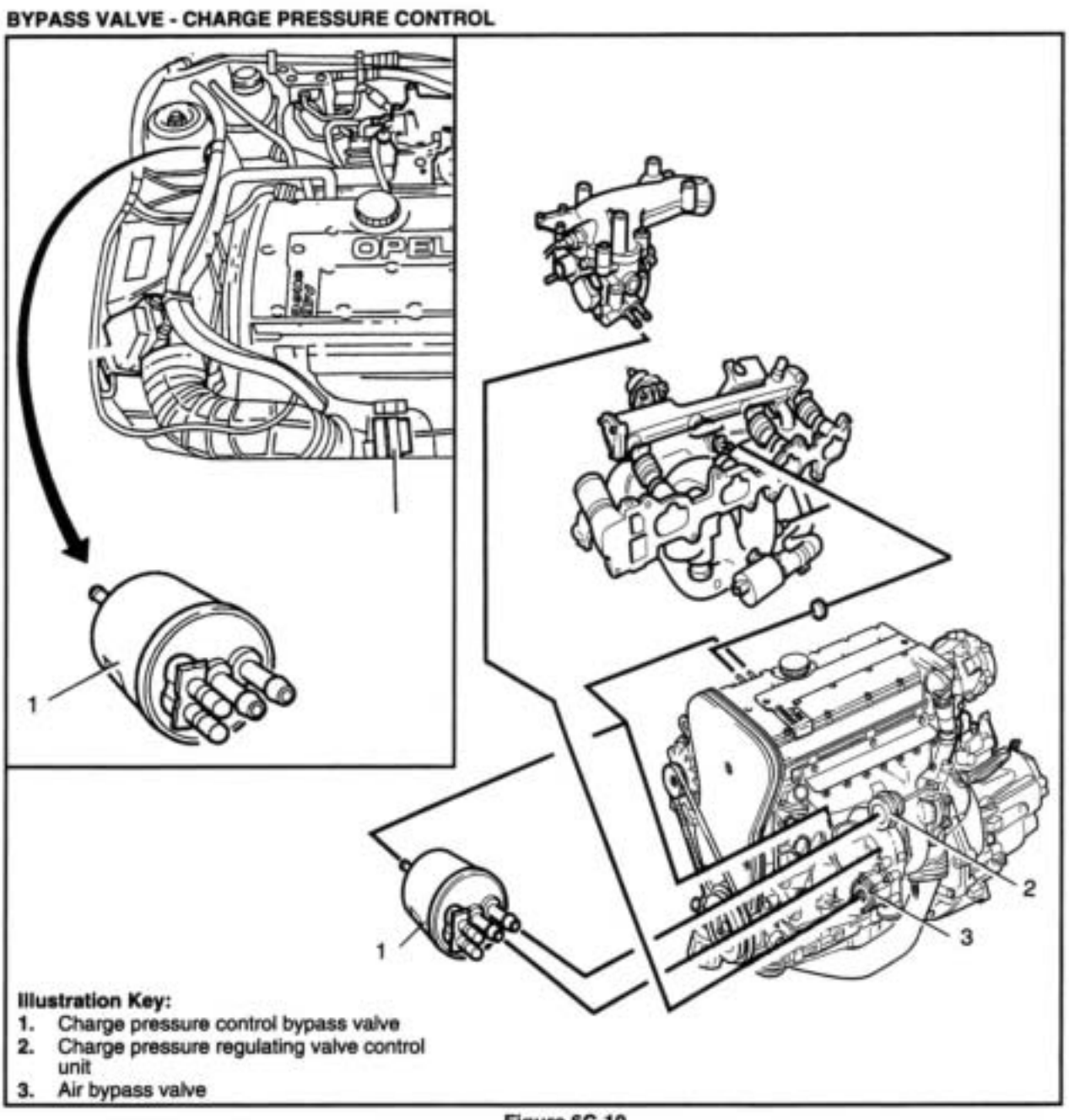


Figure 6C-10

Intake air, charge pressure control is carried out via this pulsed, 3-way valve ('1) which, depending on the actuation from the Motronic M 2.7 control unit, applies the charge pressure regulating valve control unit ('2'), to either the intake or pressure side of the turbocharger, thereby controlling the amount of boost provided.

Refer to Section 6A, ENGINE MECHANICAL, in this Volume for further information relating to the turbocharger operation.

The charge pressure control bypass valve is fastened by a retainer to the coolant return hose of the turbocharger, as shown in the above inset.

ELECTRICAL/ELECTRONIC SUB-SYSTEM

With the complexity of the electrical/electronic interface with other vehicle components, the following block diagram shows the input signals required by the Motronic M 2.7 control unit to make decisions about the output circuits controlled by the control unit.

A brief description of the Motronic M 2.7 control unit follows, together with some of the input signal sources.

MOTRONIC M 2.7 BLOCK DIAGRAM

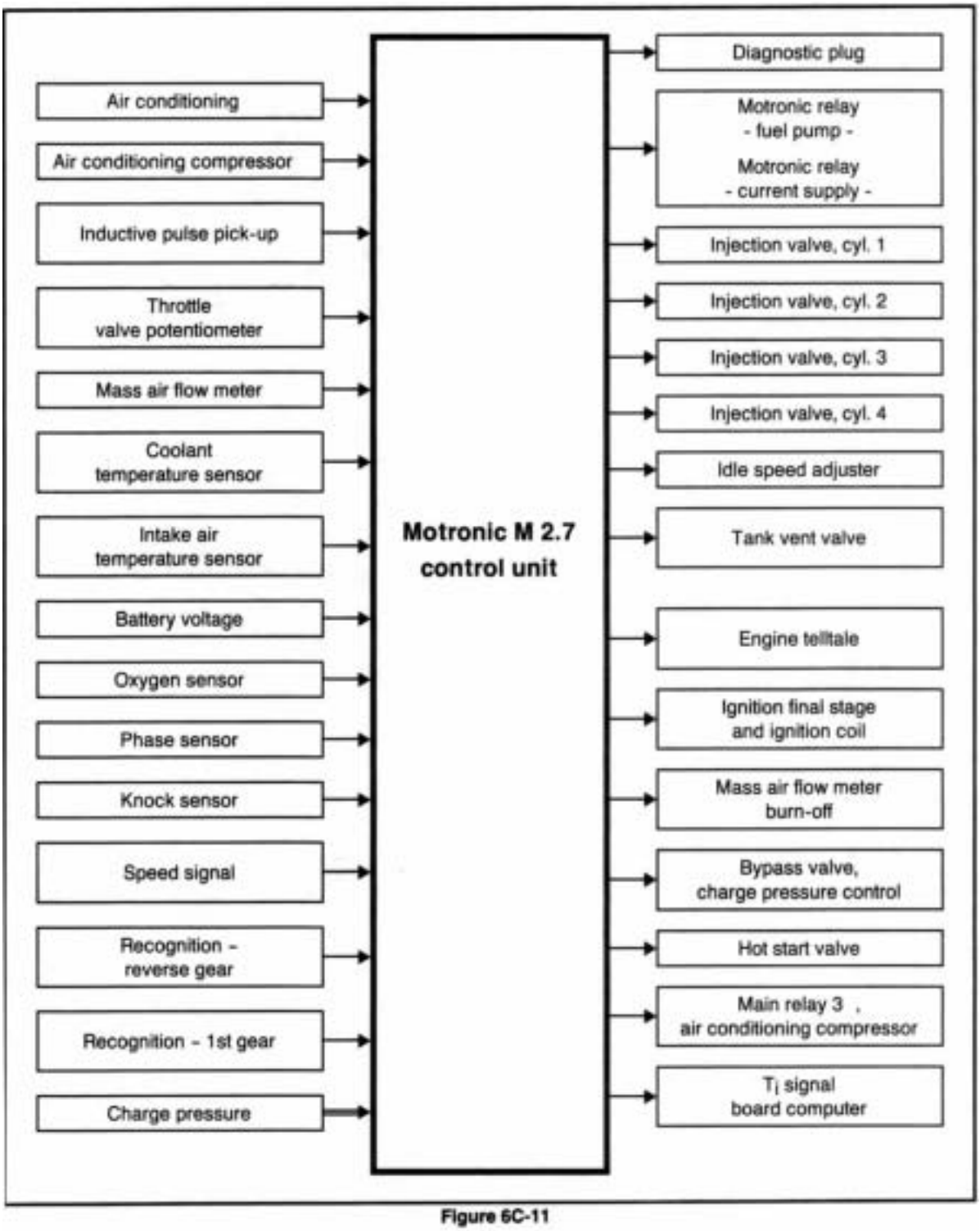


Figure 6C-11

MOTRONIC M 27 CONTROL UNIT

This unique control unit has an internal charge pressure sensor fitted, that measures the intake air pressure via a connection to the throttle body, by a plastic hose (arrowed), routed in with the wiring harness.
The 55-pin wiring harness plug can only be disconnected after the control unit has removed.

Coding -Control Unit		
Engine	Part Number	Alpha Code
C 20 LET	90 461 295	JZ

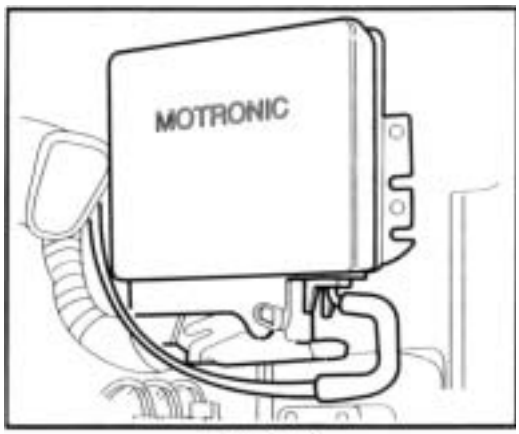


Figure 12

INTAKE AIR TEMPERATURE SENSOR

For an exact determination of the intake air temperature, after the air to air inter-cooler, a temperature sensor (arrow) is installed in the throttle valve manifold.

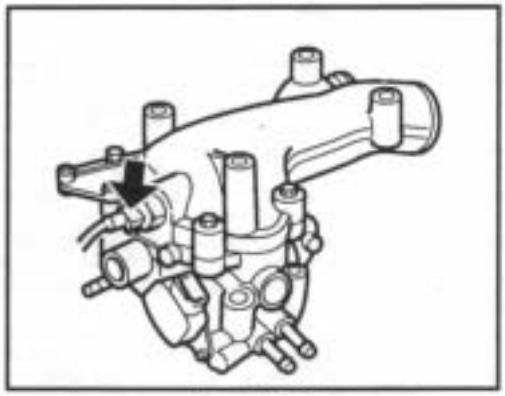


Figure 6C-13

THROTTLE VALVE SENSOR

The throttle valve sensor determines the throttle valve position and thus sends load information to the Motronic M 2.7 electronic control unit.

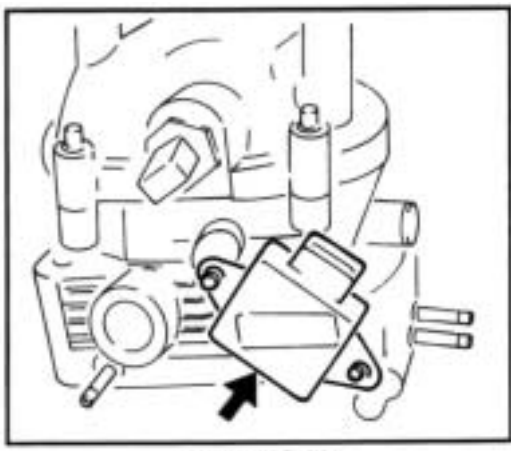


Figure 6C-14

HIGH VOLTAGE DISTRIBUTOR

With the Motronic M 2.7 operating in a cylinder selective fashion; i.e. the calculations for fuel infection, ignition point and knock control are determined for each individual cylinder, the control unit needs to know when No.1 cylinder is firing.
This is achieved by having a Hall sensor in the high voltage distributor providing a signal when this occurs and the control unit then triggers m accord with the pre programmed firing order of 1.3, 4, 2.

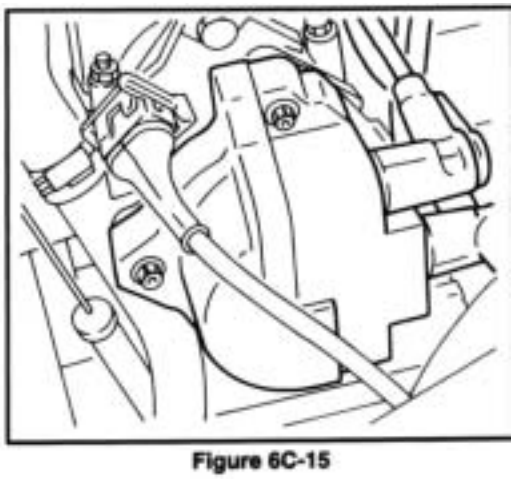


Figure 6C-15

OXYGEN SENSOR

The oxygen sensor is boiled into the baffle manifold of the turbocharger and is a three wire unit.
Current for the heater element is fed via the fuel pump relay, while the remaining two leads are for earth and signal circuits.
The electrical heating element ensures that the sensor is operational as soon as possible after a cold engine start, providing accurate control of the fuel/air mixture.

CRANKSHAFT IMPULSE SENSOR

The inductive crankshaft sensor has two functions:

- To sense the engine speed and transmit this to the
- Motronic M 2.7 control unit.
- To establish the reference marks for determining the
- ignition advance angle.

Location:
The pulse sensor is mounted in the side of the engine block, while the sensor disc consists of a toothed ring attached to the crankshaft.

Operating Principle
As the teeth on the sensor ring pass the pulse sensor, the air gap changes. This causes the magnetic flux to also change, inducing an alternating voltage with the same frequency as that of the moving teeth.
The amplitude of the voltage depends upon the circumferential speed, the engine speed, the size of the air gap, the shape of the tooth, the magnetic properties of the sensor ring material and the mounting.
The amplitude, which varies between 0.5 and 100 Volts, is processed in the Motronic M 2.7 control unit and is changed to a square wave signal with a constant amplitude.
The control unit counts the edges of the square wave signals, knowing that each tooth and tooth gap take up 3° of crankshaft rotation; that is, except for the reference mark.
At the reference point position, two teeth are replaced by a gap, so that five gaps come together. This means that on only 58 of the possible 60 tooth positions are occupied.

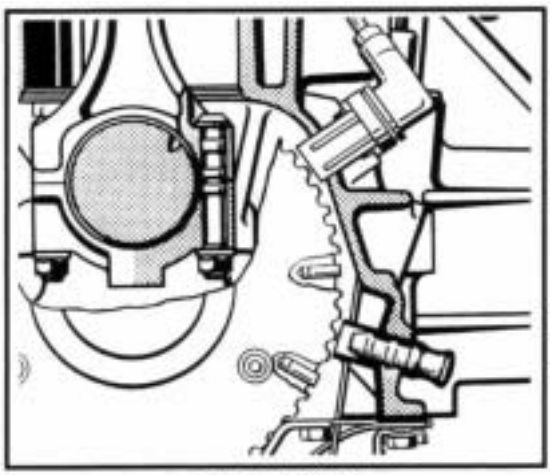


Figure 6C-16

KNOCK SENSOR

Located as shown, the knock sensor monitors vibrations in the engine block and converts them into voltage signals. These signals are filtered in the knock control computer (this is a separate microprocessor in the) and evaluated.
The sensor is an active, wide-band acceleration pick-up, consisting of piezo-ceramic material with an inherent frequency of 25 kHz and has a maximum operating temperature of 130 °C.
Should a problem develop with the sensor or its electrical wiring, the check engine telltale lamp will be lit and a trouble code stored in Me Motronic M 2.7 control unit.
DTC 16: Knock sensor or wiring to control unit defective.
DTC 18: Knock control microprocessor is defective.
Apart from this action, the control unit retards the dwell angle by 10°, bringing it into the knock-resistant range so the vehicle can be driven to the closest Holden Dealership for attention, without damaging the engine.

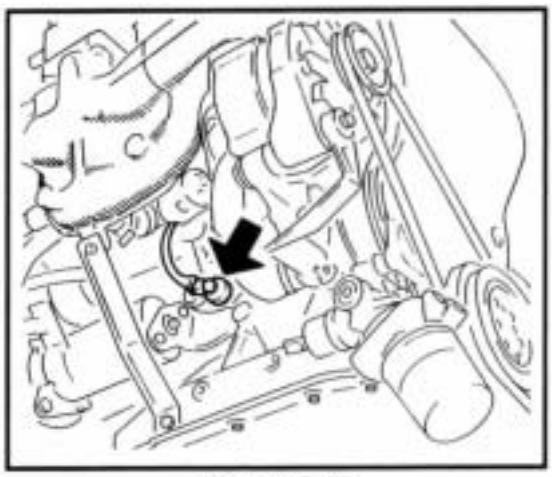


Figure 6C-17

RECOGNITION -1ST/REVERSE GEAR

When Reverse or First gear is engaged, the Motronic control unit receives a signal from one of the two switches installed in the F 28/6 transmission (refer to Section OA, in this Volume for locations). When a signal is received, turbocharger boost is disengaged to minimise the possibility of a loss of vehicle control when starting from rest in either First or Reverse gears when poor road conditions are prevalent.

WIRING HARNESS

The separate wiring harness for the Motronic M 2.7 is in a self-continued engine wiring harness that connects all sensors and actuators with the Motronic M 2.7 control unit.

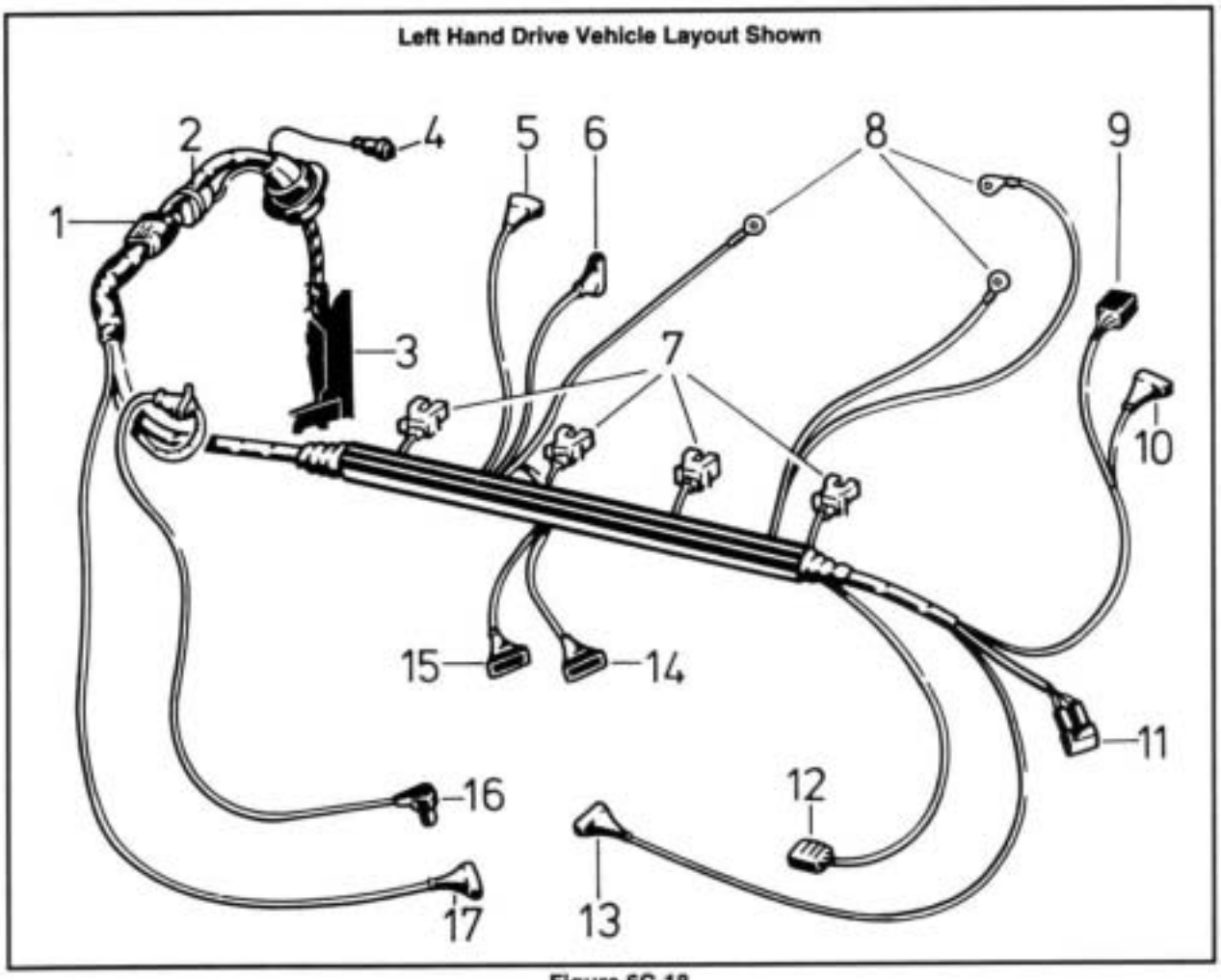


Figure 6C-18

Illustration Key

1. Diagnostic plug (ALDL)
2. Ignition coding plug
3. Motronic M 2.7 control unit plug
4. Oxygen sensor
5. Hot wire air mass meter
6. Throttle valve sensor
7. Fuel injectors
8. Earth terminals
9. Fuel pump relay
10. Trigger box
11. Engine wiring harness plug
12. Fuel tank vent valve
13. Hall sensor-cylinder recognition
14. Knock sensor
15. Idle speed adjuster
16. Crankshaft inductive impulse sensor
17. Engine coolant temperature sensor

2. SIGNAL PROCESSING

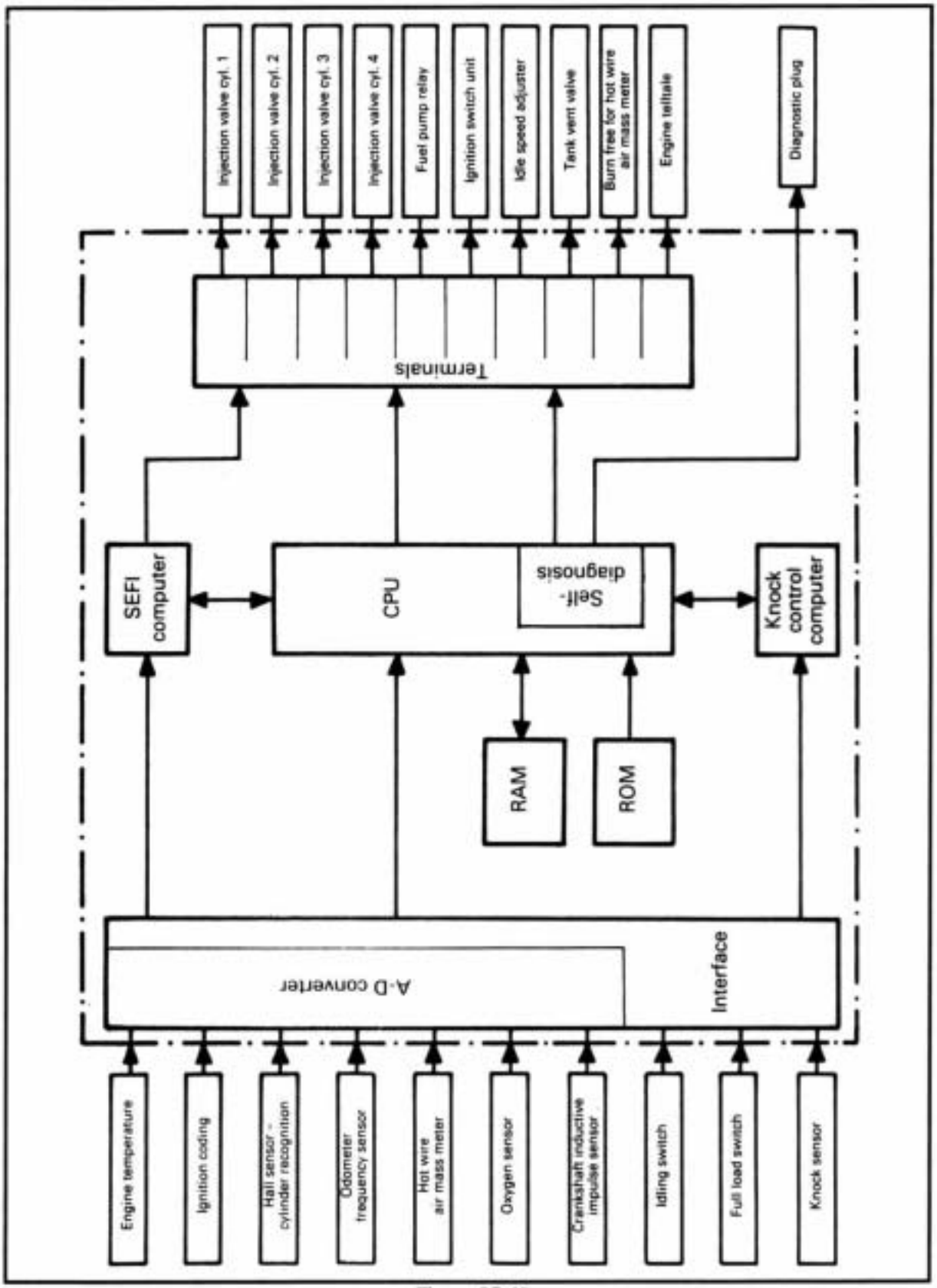


Figure 6C-19

2.1 BASIC CONTROL UNIT OPERATION

To establish a basic understanding of the way in which an electronic control unit functions, there are three different processes that perform separate tasks within the unit, which are:

a. Preparation of Input Signals:
- Interface
- A-D converter

b. Information processing:
- SEFI computer (Sequential Fuel Injection computer).
- CPU (Central Processing Unit).
- RAM (Random Access Memory, read/write memory with random access to individual data).
- ROM (Read Only Memory, non-erasable program memory).
- Knock control computer.

c. Output Controls:
- Output stages (actuating signal boosters).
- Diagnostic plug (ALDL) for connecting to TECH 1

Operation
The CPU receives commands from the ROM and executes them.
This means that the CPU:
- Loads the measured values, which are edited by the interface, into the RAM.
- Recognises the various operating conditions on the basis of these values.
- Fetches the characteristic curves and diagrams, which belong to these operating conditions, from the ROM.
- Links the measured values with the characteristic curves/diagrams in accordance with the computing rules stored in the ROM
- Computes the actuating signals and passes these on to the output stages.

The Output Stages trigger the actuators:
- Separate injection valves for each cylinder
- Idle speed adjuster
- Fuel pump relay
- Signal 'burn free' for hot wire air mass meter
- Tank vent valve
- Engine telltale (self-diagnosis)
- Trigger box

2.2 BASIC IGNITION SYSTEM OPERATION

When computing the dwell angle, a difference is made between start, idling, partial load and full load. In addition, the dwell angle is also dependent on the anti- jerk function, knock control, the idle speed control and the deceleration fuel cutoff (these latter three are discussed in 2.3 BASIC OPERATION OF KNOCK CONTROL and 2.4 BASIC FUEL INJECTION SYSTEM OPERATION in this Section).

Start
When starting, the dwell angle is calculated according to a characteristic curve dependent on engine temperature and speed.

Idling
When idling, a characteristic curve dependent on engine speed becomes effective, which is corrected by the idle speed control program component of the CPU:

- If engine idle speed falls below the nominal value, the ignition is 'advanced' to raise the engine torque.
- If the engine speed rises above the nominal value, the ignition is 'retarded" to reduce engine torque.

Partial Load
In a partial load condition, the dwell angle is based on the dwell angle map, which is dependent on load and engine speed.

A dwell angle change limitation prevents the dwell angle from changing rapidly. The anti-jerk function is an exception from this dwell angle change limitation. (See 'Anti-Jerk Function' in this Section).

Full Load
In a fully loaded situation, a characteristic curve dependent on engine speed is valid, which is subject to an attitude correction. The control unit recognises the increased altitude when, with the throttle valve fully open (full load switch closed), a pre-programmed air flow mass is not achieved. It then 'advances' the ignition to increase engine torque.

In this way a reduced performance, due to a reduced density in the intake air, resulting from low air pressure at high altitudes, is overcome.

Anti-Jerk Function

The control unit recognises jerking by comparing the engine speed at two short consecutive intervals, filtering the values and computing the difference.

- If the engine speed is rising, the ignition is 'retarded' to reduce engine torque.
- If the engine speed is falling, the ignition is 'advanced' to increase engine torque.

This prevents jerking in the partial load range. Because jerking does not occur with greater loads or higher engine speed.

For this reason, the anti-jerk function is disabled in this range.

2.3 BASIC KNOCK CONTROL OPERATION

Engines with high compression ratios cannot normally be operated with optimal spark advance as they would otherwise be damaged by detonation during combustion. As a result, the spark advance in a conventional ignition systems is set with a corresponding safety margin to the detonation limit. The use of knock control dispenses with the need for this safety margin and the need to have an octane number plug. This means that the engine is always operated with optimal spark advance and provides the following advantages:

- high performance
- good torque values
- low fuel consumption
- automatic adjustment to fuel quality
- no engine damage due to knocking combustion Function Diagram of Knock Control

FUNCTION DIAGRAM OF KNOCK CONTROL

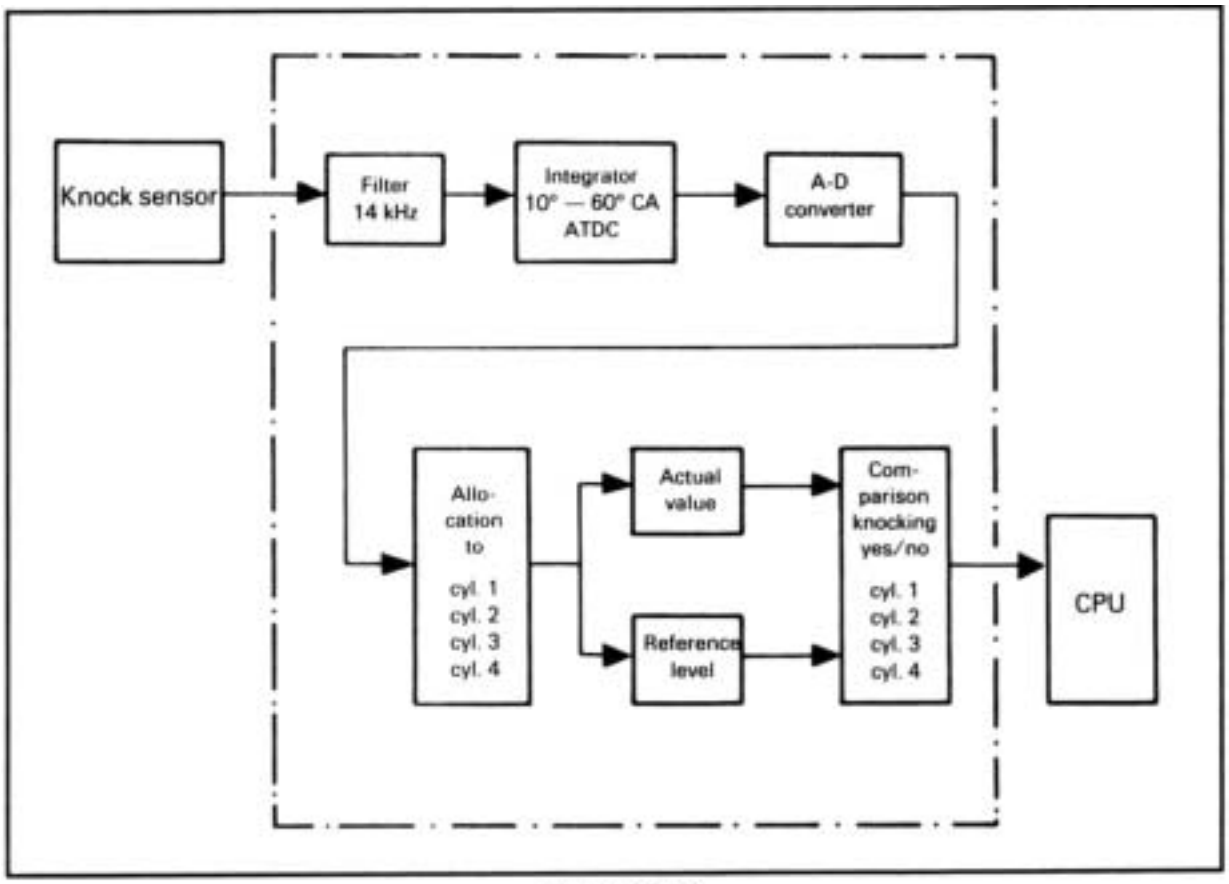


Figure 6C-20

The knock sensor supplies a structure-bome signal in which all secondary noises are also contained (e.g. engine vibrations). Because the knocking frequency of the C 20 LET engine has been determined in trials in the region of 15 kHz, only this frequency is used for further evaluation.

This frequency is conveyed to the integrator only within the measuring window (10° - 60° ATDC), where the integrator aligns the signal within the measuring window. The signal so formed, is allotted to the appropriate cylinder by the A-D converter.

The actual value of this cylinder is now compared with is reference level (average value of the last 16 phases). If the actual value exceeds the reference level by a certain amount, the combustion is recognised as knocking.

If the actual value lies below a certain level related to engine speed, then the actual value is used as a new reference level for knocking recognition. Thus the knock control reacts to even minimal engine noise.

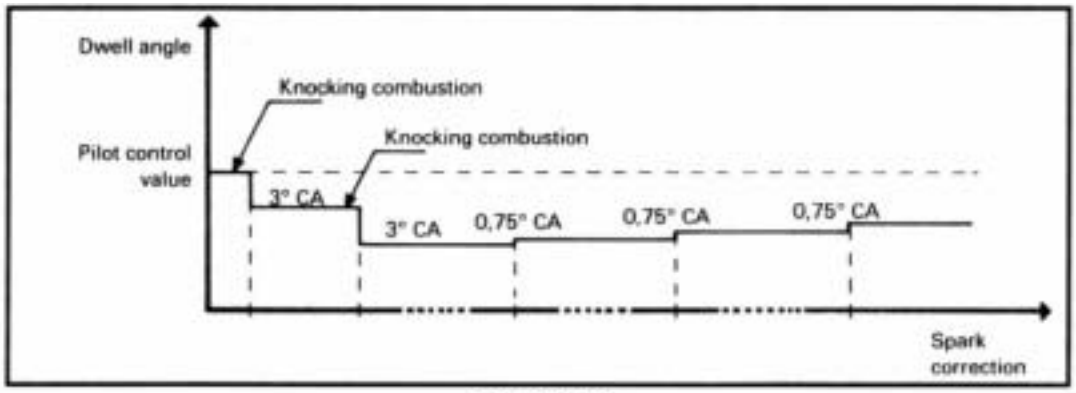


Figure 6C-21

If the knock control has recognised knocking combustion for any one cylinder, the CPU will adjust the dwell angle by 3° in a retard direction for the next phase. The dwell angle of the other cylinders is not affected by this measure (cylinder-selective control). The dwell angle adjustment in a 'retard' direction is repeated for every combustion which is recognised as knocking and for each cylinder selectively (individually). If no more detonation is sensed, the ignition is adjusted by 0.75° in direction 'advance' after 20 to 120 knock-free combustions (approx. 2 seconds). This is repeated until the pilot control value is reached again or until knocking combustion is registered. The knock control only affects the dwell angle in an engine speed dependent load range in which knocking combustion is to be expected.
As the knock limit varies from one cylinder to another in an engine and can change drastically within the operating range, every cylinder has its own ignition point for operation at the knock limit. This type of 'cylinder-selective' knock recognition and control is an essential advantage in Motronic M 2.7 because it allows the optimisation of engine performance and fuel economy.

Figure 6C-22 shows the individual cylinder knock control for a 4 cylinder engine, such as the C 20 LET fitted to the Calibra 04 Turbo.

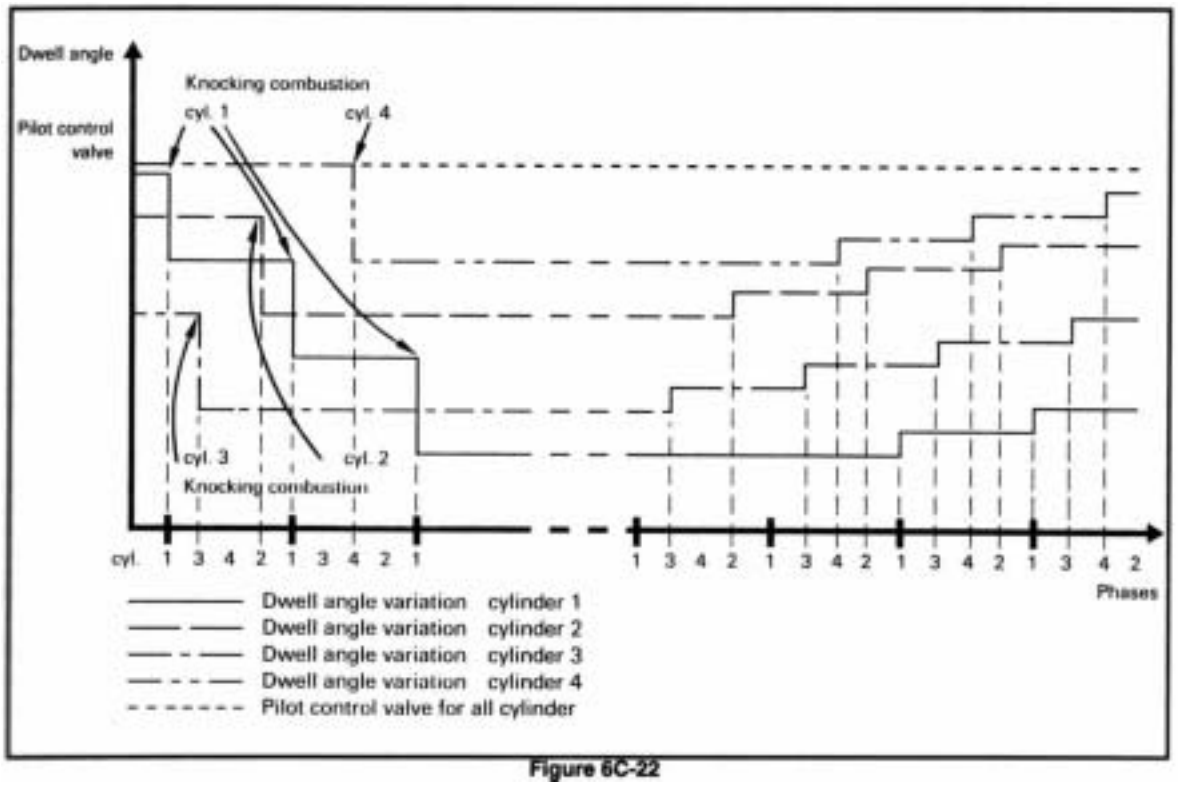


Figure 6C-22

Automatic Octane Number Adjustment

The knock control makes automatic octane number adjustment possible.

Two ignition characteristic maps are programmed in the control unit.

The knock control computer selects the appropriate ignition characteristic map for the fuel quantity according to the following criteria:

- After 50 knocking combustions the control unit switches to the map with the more retarded dwell angle (low octane number).
- After approx. 8.5 minutes of knock-free operation, the control unit switches back to the map with the more advanced dwell angle (higher octane number).

2.4 BASIC FUEL INJECTION SYSTEM OPERATION

Motronic M 2.7 continues with sequential fuel injection, as introduced with the earlier M 2.5.
What follows is an illustration of the difference between simultaneous and sequential fuel injection:

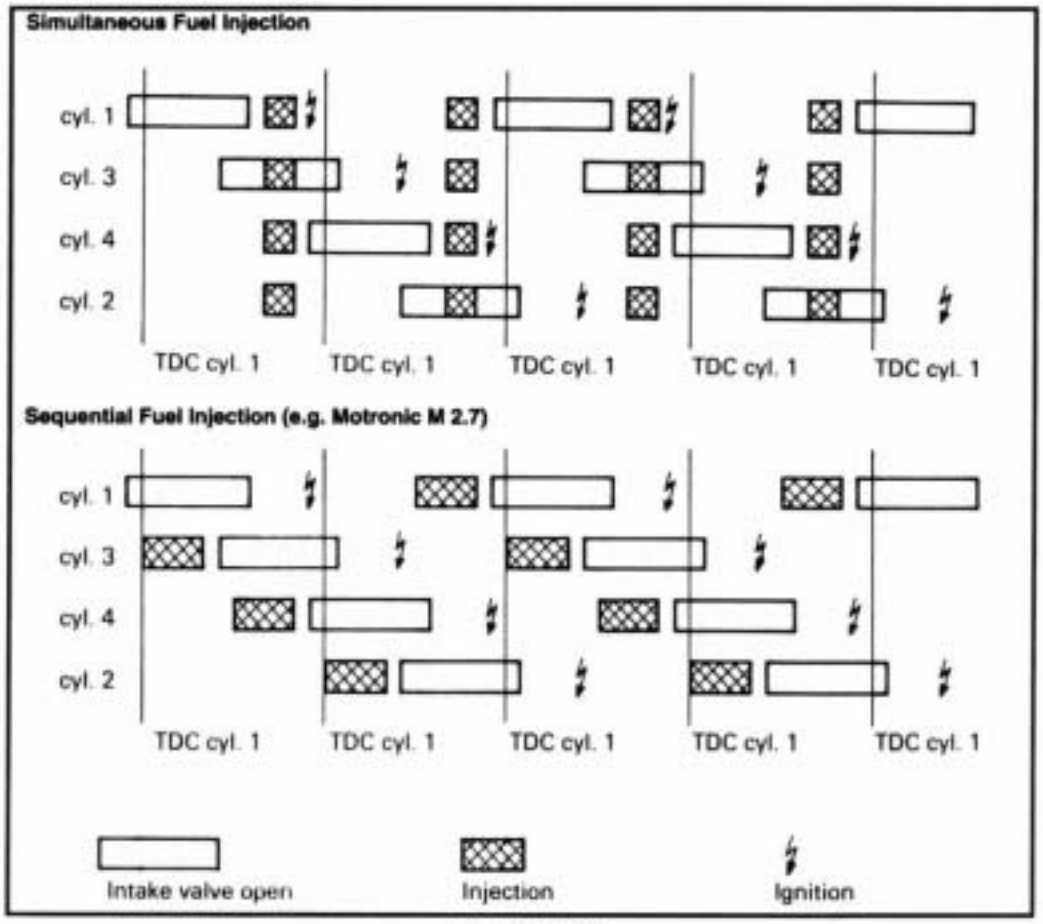


Figure 6C-23

Figure 6C-23 With simultaneous injection, all injection valves inject once per crankshaft revolution regardless of which phase each cylinder is in.

With sequential injection, only the cylinder in the induction phase is supplied with fuel.

The advantages of sequential injection are:

- exact amount of fuel required for each cylinder
- spontaneous reaction to load change
- high performance
- high torque
- low fuel consumption
- uniform mixture distribution
- improved exhaust emissions (no injection onto open intake valve) A separate microprocessor and one output stage for each injection valve are provided in the control unit to provide exact computation and triggering of the injection.

INJECTION TIMING COMPUTATION

The injection timing is dependent on the load signal.

The load signal is computed from the voltage reduction in the hot wire air mass meter, the engine speed and an injection valve constant.
In order to counteract vibrations (jerking), this signal is put through an electronic filter which collects these vibrations.

The injection timing is computed from the product of these processed load signals and all correction factors in the current operating condition.

The mixture is enriched in the following dynamic operating conditions:
- after-Start
- warming-up
- acceleration
- re-engagement after deceleration fuel cutoff

The mixture is also corrected in the following stationary operating conditions:
- when idling above an engine speed dependent characteristic curve (idling, deceleration fuel cutoff)
- at partial load via a characteristic curve dependent on engine speed and load
- at full load via an engine speed dependent characteristic curve

- **Start**
  Starting is divided into two phases.
  In phase 1 the load signal is not yet useable and is therefore replaced by a fixed value of 2.5 ms. Depending on engine temperature, it is determined whether it is a:

  Cold start (engine temperature below 0 °C)

  Normal start (engine temperature from 0°C-125 °C) Hot start (engine temperature above 125 °C)

  Phase 1 is valid as long as the engine speed has not yet exceeded an engine speed threshold, dependent on engine temperature or that 12 ignitions after starting have not been exceeded.
  Intake air mass and engine speed are not considered until phase 2.

- **After-Start**
  When starting is finished, the so-called after-start phase begins.
  Now the load signal is used together with an after-start correction to compute the injection timing.
  After a cold start, a cold start correction follows, after a hot start, a hot start correction.
  With a hot start, an injection time reduction occurs for a pre-set period of time.

- **Warm-up**
  When idling, the mixture is enriched In accordance with a characteristic curve dependent on engine temperature and engine speed.
  When not idling, a characteristic map dependent on load and engine speed is called upon.

- **Acceleration Enrichment**
  The acceleration enrichment is triggered when the intake air mass increase per second exceeds a certain value. In order to attain a better dynamic ratio during the acceleration phase, auxiliary injectors are actuated to supplement the injection extension. The extent of acceleration enrichment is determined by the degree of acceleration, the engine temperature and a characteristic map dependent on load and engine speed.

DECELERATION FUEL CUT-OFF

Conditions for deceleration fuel cutoff are:
- idle contact closed or load signal below a certain threshold
- engine speed below a threshold dependent on engine temperature

Once these conditions are met, the deceleration fuel cutoff immediately begins. That is:

- the ignition is retarded to the idling dwell angle.
- then fuel injection is switched off.

Before re-engagement occurs, either the engine speed must fall below a certain engine temperature dependent threshold, the load signal must exceed a certain threshold or the idling switch must open.

Injection is resumed and the dwell angle is slowly adjusted to the characteristic map value (soft reengagement).

If the engine speed falls very quickly, the injection reengages earlier in order to prevent the engine from dying (fast re-engagement).

If the load signal increases sharply, the ignition is immediately related to the characteristic map value so that the engine torque is increased (fast re-engagement).

OXYGEN REGULATION SYSTEM

When catalytic converters are used for exhaust gas conversion, then unleaded fuel must only be used and the air-fuel ratio may only deviate very slightly (t 0.15%) from the stoichiometric ratio (Lambda = 1, which corresponds to approximately 14 kg air to 1 kg fuel).

Only under these conditions can the exhaust constituents CO, HC, NO. be reduced by 90%.

Such accuracy in mixture formation is not possible without regulation. Therefore the computation of injection timing described above is supervised by the oxygen regulator.

Two factors are responsible for oxygen regulation:

1. The integrator regulates without delay.

2. The block learn function adapts the regulator to long term changes, as for example those which occur due to running in and aging of the engine, density and changes in quality of the fuel, air leaks etc.

Block learn function 1 is effective during idling.

Block learn function 2 is effective in the partial and full load phases.

IDLE SPEED CONTROL

The idle speed is controlled by means of the idle speed adjuster and the dwell angle adjustment. The dwell angle adjustment is a fast but limited measure that operates until the idle speed adjuster takes over regulation with the slower volume control. The dwell angle control is described in Section 2.2 BASIC IGNITION SYSTEM OPERATION, in this Section.

The idle speed adjuster is actuated in all operating conditions.

The following additional functions are fulfilled above and beyond the true idling zone:

- Auxiliary air valve: for mixture enrichment at low engine temperatures
- Vacuum limitation: If the throttle valve is closed, the control unit opens the idle speed adjuster in order to limit the vacuum in the intake system.
- Soft deceleration fuel cut-off and re engagement: before switching off the injection, the idle speed adjuster is closed and does not return to the open position until after re-engagement. In this way, together with the dwell angle control (see Section 2.2 BASIC IGNITION SYSTEM OPERATION, in this Section), a smooth deceleration fuel cutoff and reengagement is achieved.
- Idle speed modification when the air conditioning system is activated.

COMPUTING THE NOMINAL ENGINE SPEED

In order to compute the nominal idle engine speed, a characteristic curve dependent on engine temperature and engine speed is drawn on during starting. After starting, a corresponding characteristic map serves this purpose.

Apart from this, the nominal engine speed is dependent on the battery voltage. If the battery voltage falls below a pre-set value, the nominal engine speed is increased. This increase is not reversed until the voltage rises again.

At low temperatures the nominal engine speed is also increased to guarantee smooth engine running.

Computing the Nominal Air Requirement

The nominal air requirement (the air which should flow through the idle speed adjuster) is computed in accordance with the PI regulator principle (Proportional Integral Regulator). Proportional means that the idle air adjuster is opened by an amount corresponding to engine speed deficit when compared to the nominal value. The integral part results from the average of all previous engine speed deviations. This results in the equalising and compensating function of the integrator.

Idle Speed Adjuster Triggering

The nominal air requirement which has been computed is converted to a frequency with which the idle speed adjuster is triggered.

When the engine idles for quite a long period, the computed nominal air requirement is compared to the actual intake air mass and the computer adjusts its calculation by adapting to the actual situation.

In this way slowly changing conditions are taken into account. For example:

- An increased idle air requirement in brand new engines (due to greater friction).
- Air leaks in older engines.
- Diversity of engines due to manufacturing tolerances.

TANK VENTILATION

If the fuel in the tank becomes warmer due to outside influence or in passing through the fuel supply system (fuel pump, fuel line, distributor pipe), then vapours form which cannot be released into the atmosphere in a vehicle with catalytic converter.

The vapours which form in the tank are released into the atmosphere via the active carbon filter when the engine is not running The petrol vapours are retained by the active carbon and temporarily stored until the next time the engine is operated.

In the partial and full load ranges the tank ventilation valve is opened by the control unit. Due to the vacuum in the intake manifold, fresh air induction takes place via the active carbon filter when the engine is running.

The temporarily stored fuel vapours are thus expelled.

In order to prevent this flushing of the active carbon canister from interfering with the engine running, the tank ventilation valve is only triggered during active oxygen regulation, when the engine temperature is greater than 49.8 °C and when the idling switch is open.

3. MOTRONIC M 2.7 WIRING DIAGRAM

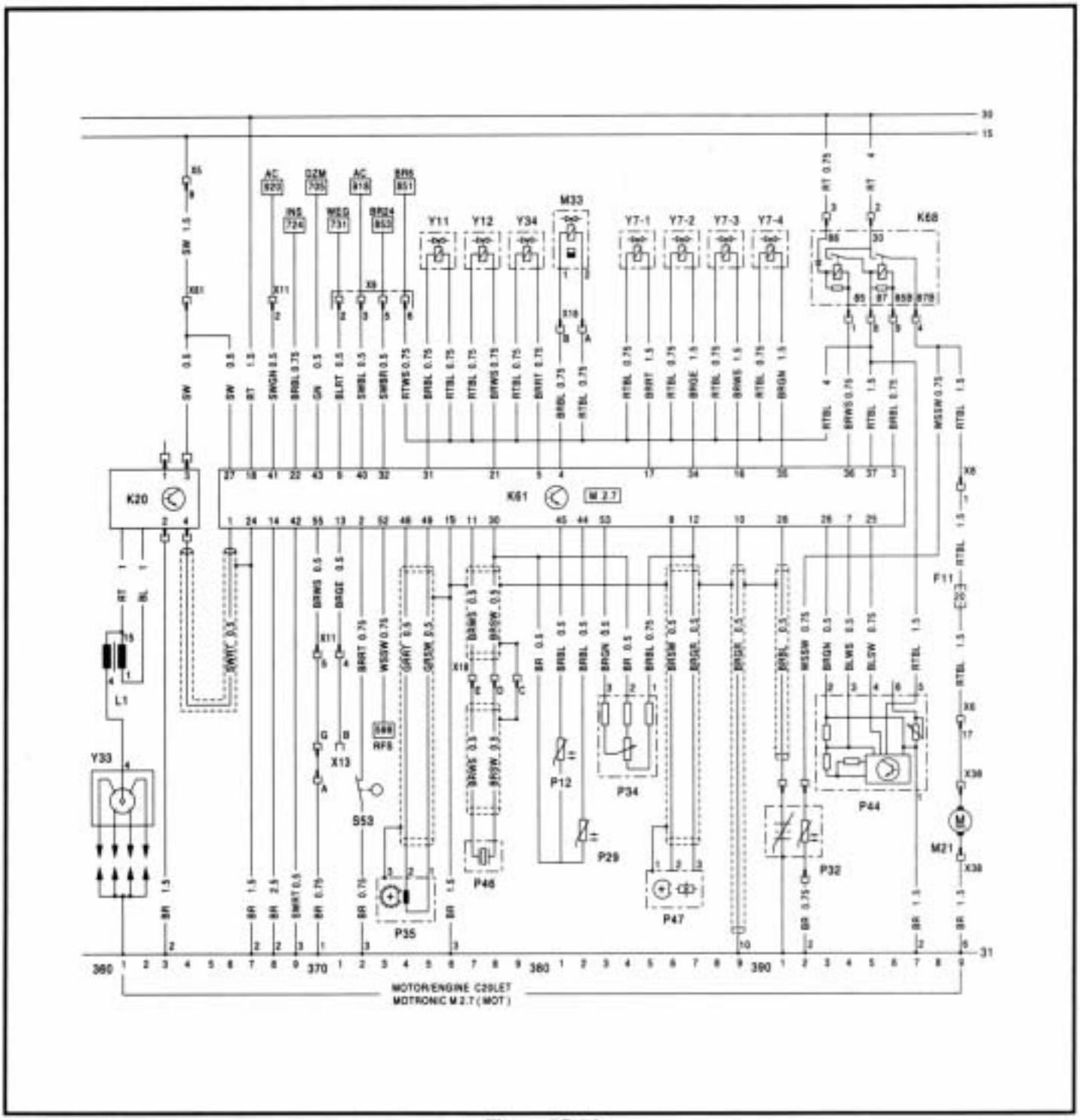


Figure 6C-24

NOTE:
This is an extract from the complete vehicle wiring diagrams as detailed in 3. WIRING DIAGRAMS in Section 12, ELECTRICAL, in this Volume.

COMPONENT IDENTIFICATION		
Abbreviation	**Description**	**Wiring Diagram Location**
F11	Fuse (in fuse box)	399
K20	Ignition module	361.to.364
K61	Motronic control unit	366.to.396
K68	Fuel pump relay	393.to.397
L1	Ignition coil	361
M21	Fuel pump	399
M33	Idle speed adjuster	381.to.382
P12	Coolant temperature sensor	381
P29	Intake air temperature sensor	382
P32	Oxygen sensor, heated	391.to.392
P34	Throttle valve potentiometer	383.to.385
P35	Inductive pulse pick-up	373.to.375
P44	Hot-wire mass air flow meter	393.to.397
P46	Knock sensor	377.to.378
P47	Phase sensor	385.to.387
S53	Recognition – 1st gear	372
S7	Recognition - reverse gear	599
X13	Diagnostic plug	371
Y7	Injection valves	374.to.391
Y11	Hot start valve	375.to.376
Y12	Bypass valve - charge pressure control	377.to.378
Y33	Ignition distributor	360.to.362
Y34	Tank vent valve	379.to.380

TERMINAL ASSIGNMENT OF WIRING HARNESS PLUG FOR MOTRONIC M 2.7 CONTROL UNIT K61

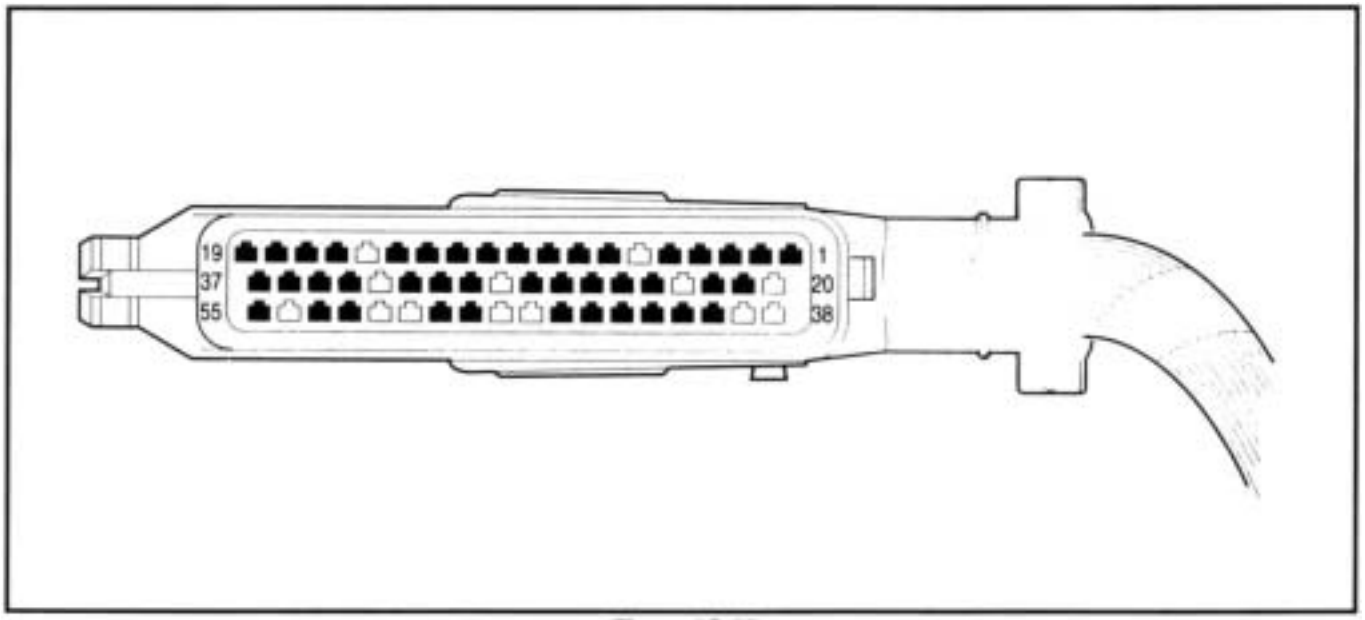


Figure 6C-25

Terminal Assignment

Ter. 1 Final stage, ignition module K 20/Ter. 4
Ter. 2 Recognition - 1 at gear S 53
Ter. 3 Ground actuation for fuel pump relay K 68 / Ter. 85 B
Ter. 4 Ground actuation for idle speed adjuster M 33
Ter. 5 Ground actuation for tank vent valve Y 34
Ter. 6 Unoccupied
Ter. 7 Signal, hot-wire mass air flow meter P 44/Ter. 3
Ter. 8 Signal, Hall sensor cylinder recognition P 47/Ter. 2
Ter. 9 Signal, odometer frequency sensor P 21
Ter. 10 Ground Ter. 31
Ter. 11 Signal, knock sensor
Ter. 12 Voltage supply, Hall sensor P 47/Ter. 3; throttle valve potentiometer P 34/Ter. 1
Ter. 13 Diagnostic excitation lead, diagnostic plug X 1 3/Ter. B
Ter. 14 Ground Ter. 31
Ter. 15 Unoccupied
Ter. 16 Ground actuation for injection valve Y 7, cylinder 3
Ter. 17 Ground actuation for injection valve Y 7, cylinder 1
Ter. 18 Battery Ter. 30
Ter. 19 Ground Ter. 31
Ter. 20 Unoccupied
Ter. 21 Ground actuation for charge pressure bypass valve Y 12
Ter. 22 Ground actuation for engine telltale
Ter. 23 Unoccupied
Ter. 24 Ground Ter. 31
Ter. 25 Ground actuation for hot-wire mass air flow meter P 44 / Ter. 4, 'burn-off' signal
Ter. 26 Ground, hot-wire mass air flow meter P 44/Ter. 2
Ter. 27 Battery Ter. 1 5
Ter. 28 Signal, oxygen sensor P 32
Ter. 29 Unoccupied
Ter. 30 Ground supply for:
- knock sensor P 46
- coolant temperature sensor P 12
- intake air temperature sensor P 29
- throttle valve potentiometer P 34

Ter. 31 Ground actuation for hot start valve
Ter. 32 Tj signal for hoard computer
Ter. 33 Unoccupied
Ter. 34 Ground actuation for injection valve Y 7, cylinder 2
Ter. 35 Ground actuation for injection valve Y 7, cylinder 4
Ter. 36 Ground actuation for fuel pump relay K 68/Ter. 85
Ter. 37 Voltage supply for:
- control unit K 61
- hot-wire mass air flow meter P 44/Ter. 5
Ter. 38 Unoccupied
Ter. 39 Unoccupied
Ter. 40 Input signal, air conditioning compressor
Ter. 41 Input switch, air conditioning ready
Ter. 42 Ground Ter. 31
Ter. 43 Tachometer
Ter. 44 Signal, Intake air temperature sensor P 29
Ter. 45 Signal, coolant temperature sensor P 12
Ter. 46 Unoccupied
Ter. 47 Unoccupied
Ter. 48 Signal, inductive pulse pick-up P 35/Ter. 2
Ter. 49 Ground, inductive pulse pick-up P 35/Ter. 1
Ter. 50 Unoccupied
Ter. 51 Unoccupied
Ter. 52 Recognition - reverse gear
Ter. 53 Signal, throttle valve potentiometer P 34/Ter. 3
Ter. 54 Unoccupied
Ter. 55 Bi directional data lead, diagnostic plug X 13/Ter. 6

4. DIAGNOSIS

INTRODUCTION

The program section self-diagnosis within the control unit, checks the sensor signals against pre-programmed, 'look-up' tables. If an open circuit should occur say, in the temperature sensor, this would result in an infinite resistance. The corresponding temperature of -35 °C is not plausible. The malfunction is therefore recognised.

Similar plausibility controls are carried out with other sensor signals.

A fault which has been recognised is stored with the corresponding trouble code.

BACK-UP OPERATION

If a fault does occur, the control unit substitutes the following values so that the vehicle is not immobilised.

Sensor/Fault	Replacement Value
Oxygen sensor circuit	450 mV
Coolant temperature sensor	40 °C
Knock sensor circuit	Ignition timing is retarded b 8.5°
Throttle valve sensor malfunction	Throttle angle 30°
Intake air temperature sensor	20 °C
Hot wire mass air flow meter	Replacement characteristic curve, dependent on engine speed and throttle valve angle.

IMPORTANT NOTES AND PRECAUTIONS

When dealing with electronic control units and systems, observe the following instructions carefully, to avoid damaging the engine, control unit or ignition coil or endangering life:

1. 'Trouble codes' in the memory of electronic systems with self-diagnosis are deleted by disconnecting the battery.
2. Never start engine when battery connections are not absolutely tight.
3. Wrong polarity of power supply (e.g. by battery terminals or ignition coil being wrongly connected) can lead to control unit being irreparably damaged.
4. Disconnect battery from vehicle electrical system before charging or using a battery booster. Assist start only with a second 12 volt battery and jump cables.
5. Never disconnect battery while engine is operating.
6. Never short-circuit ignition coil Ter. 1 to ground (e.g. to stop engine). Ignition coil and possibly also control unit could be irreparably damaged.
7. Never allow battery positive terminal and ignition coil Ter. 1 to come into contact. Control unit will be damaged.
8. Do not disconnect or connect wiring harness plug of control unit while ignition is switched on. First remove control relay or wart for approx. 20 seconds after switching off the ignition.
9. Remove control unit at temperatures over 80 °C (drying oven).
10. Remove control unit during electrical welding operations.

Trouble Code	Information Sensor	Cause of Fault
12	Start of diagnosis	-
13	Oxygen sensor	No voltage change
14	Coolant temperature sensor	Voltage low
15	Coolant temperature sensor	Voltage high
16	Knock sensor circuit	Knock signal
18	Knock control module	Defective, replace control unit
19	Inductive pulse pick-up	Incorrect engine speed signal
21	Throttle valve potentiometer	Voltage high
22	Throttle valve potentiometer	Voltage low
23	Knock control module	Defective, replace control unit
25	Injection valve, cylinder 1	Voltage too high
26	Injection valve, cylinder 2	Voltage too high
27	Injection valve, cylinder 3	Voltage too high
28	Injection valve, cylinder 4	Voltage too high
31	Inductive pulse pick-up	No engine speed signal
38	Oxygen sensor circuit .	Voltage too low
39	Oxygen sensor circuit .	Voltage too high
41	Recognition -1 at gear	Voltage too low
42	Recognition -1 at gear	Voltage too high
48	Alternator circuit .	Voltage too low
49	Alternator circuit .	Voltage too high
52	Engine telltales, final stage in control unit	Voltage too high
55	Control unit .	Defective, replace control unit
56	Idle air control system, final stage in control unit	Voltage too high
57	Idle air control system, final stage in control unit	Voltage too low
61	Tank vent valve, final stage in control unit	Voltage too low
62	Tank vent valve, final stage in control unit	Voltage too high
69	Intake air temperature sensor	Voltage too low
71	Intake air temperature sensor	Voltage too high
73	Mass air flow meter	Voltage too low
74	Mass air flow meter	Voltage too high
75	Torque control	Voltage too low
82	Injection valve, cylinder 2	Voltage too low
83	Injection valve, cylinder 3	Voltage too low
84	Injection valve, cylinder 4	Voltage too low
93	Hall sensor	Voltage too low
94	Hall sensor	Voltage too high
95	Hot start valve .	Voltage too low
96	Hot start valve	Voltage too high
113	Charge control sensor	Standard tolerance too large
114	Charge control sensor	Standard tolerance in idle range too large
115	Charge control sensor	Standard tolerance in full load range too large
116	Charge control sensor	Charge pressure too high
117	Charge pressure bypass valve	Voltage too low
118	Charge pressure bypass valve	Voltage too high

CHECKING WITH TECH 1

The Motronic control unit can be connected with TECH 1 via the ALDL plug. Trouble-shooting familiar from other electronic systems and the Actuator Test can thus be carried out. The Actuator Test can actuate the following:

- Fuel injectors 1 - 4
- Tank vent valve
- Idle speed adjuster
- Hot start valve

- Charge pressure control bypass valve –
- Ignition final stage (with checking spark plug)

Further information about the checking of the Motronic M 2.7 can be found in the 'Checking Procedures, Motronic M 2.7' that follows, in this Section.

5. CHECKING PROCEDURES

MOTRONIC M 2.7

Combined Fuel Injection and Ignition System

Checking with TECH 1
Program Module
OPEL/VAUXHALL 87 - 94 control unit

CALIBRA TURBO

5.1 TABLE OF CONTENTS **PAGE**

1 Introduction

This Section describes the checking of the Motronic M 2.7 from the C 20 LET engine with TECH 1 and the newly developed Program Module OPEL/VAUXHALL 87 - 94 ECU

1.1 The Checking System

A checking concept has been developed which has pointed the way for the checking of electronic systems in vehicles.

Using TECH 1, as well as universal checking adapters, checking leads and the optional Electronic Kit 1 (KM-609), the electronics of all vehicles can be checked.

With TECH 1 and the appropriate Program Module, it is possible to read out streams of data from electronic control units via diagnostic plugs. A precondition for this is the use of electronic systems with

- microprocessor techniques
- self-diagnosis
- serial data lead

1.2 General Instructions / Safety Measures

Readout of data using TECH 1 takes place with ignition ON and/or with engine operating. During communication between TECH 1 and the Motronic control unit, ensure that the relevant telltale illuminates constantly.

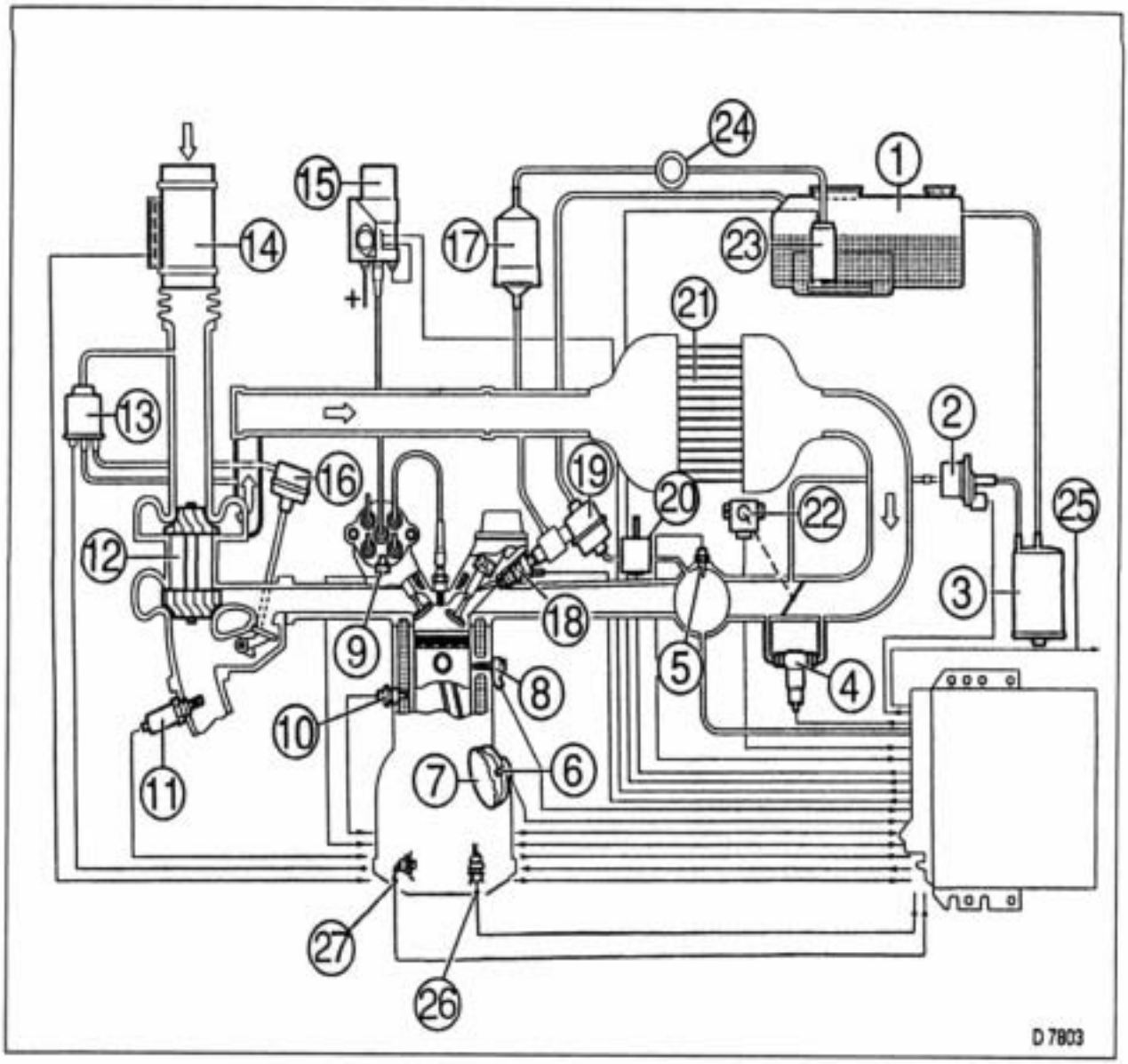
Safety Measures:

- Allow at least 20 seconds after switching off ignition before disconnecting/reconnecting plugs of electric/electronic modules.
- Never disconnect battery from vehicle electrical system with engine running.
- During welding work, always remove control units.
- At temperatures above +80 °C/+176 °F (drying oven), control units must be removed.
- Never use the quick-charger for starting.
- Caution when touching voltage-bearing parts of the ignition system.
- Use only high-resistance voltage tester for checking.

IMPORTANT: After disconnecting the battery, volatile memories must be reprogrammed. In the case of radio coding and radio station programming, the customer should be informed about the decoding and deleted station programming.

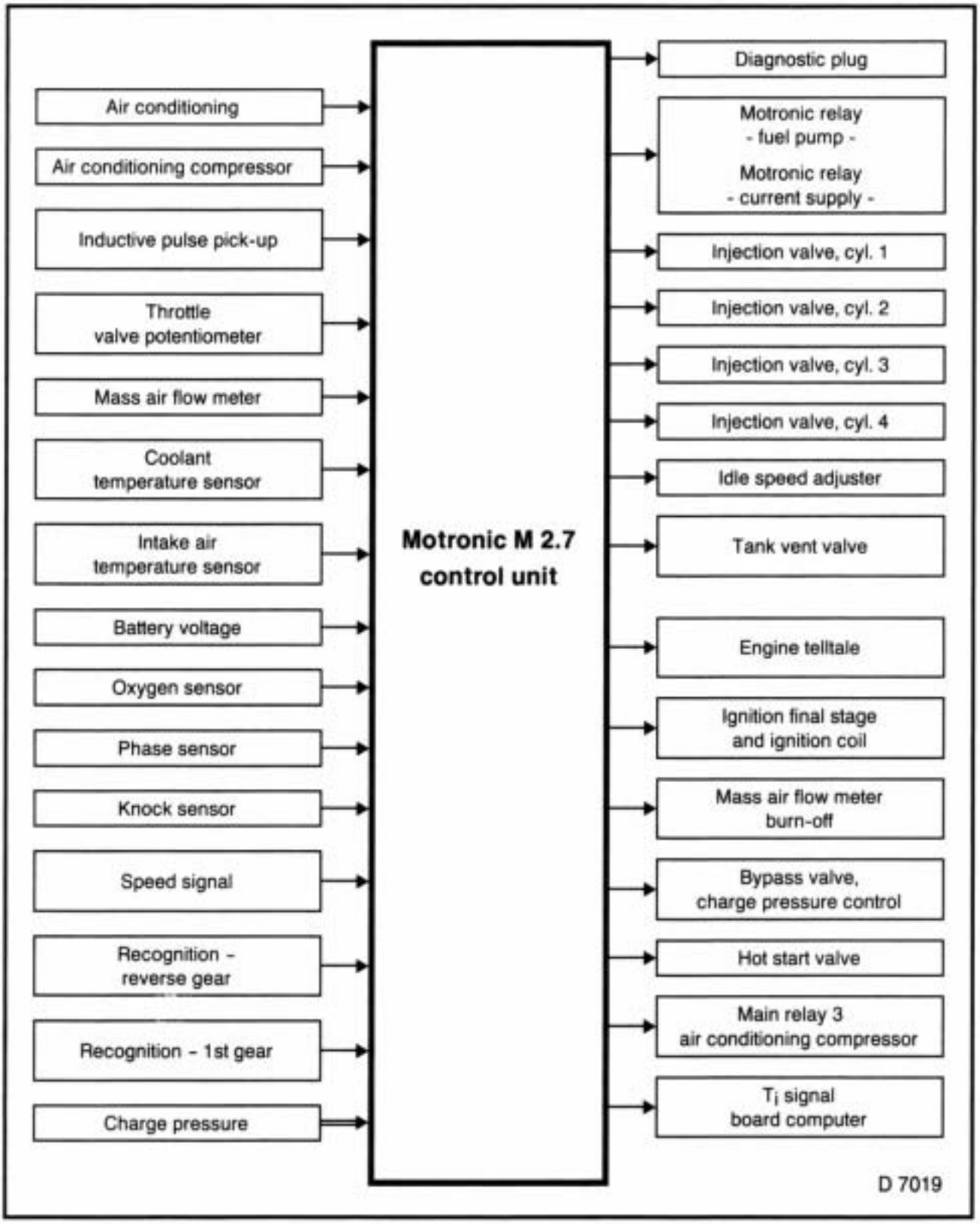
- TECH 1 Case]
- Program Module "OPEL/VAUXHALL 87 - 94 ECU"
- 10 pin Adapter Cable, SD 28224
- Electronic Kit 1, KM-609 (Available, Optional Tool)
- Multimeter, Digital (Commercially Available)
- Diagnostic Switch KM-640 (Available, Optional Tool)
- Pressure Gauge KM-J-34730-91
- Checking Spark Plug ST-125
- Injector Test Light KM-602-1
- Pressure and Vacuum Pump J23738
-

3.1 Diagram of Motronic M 2.7

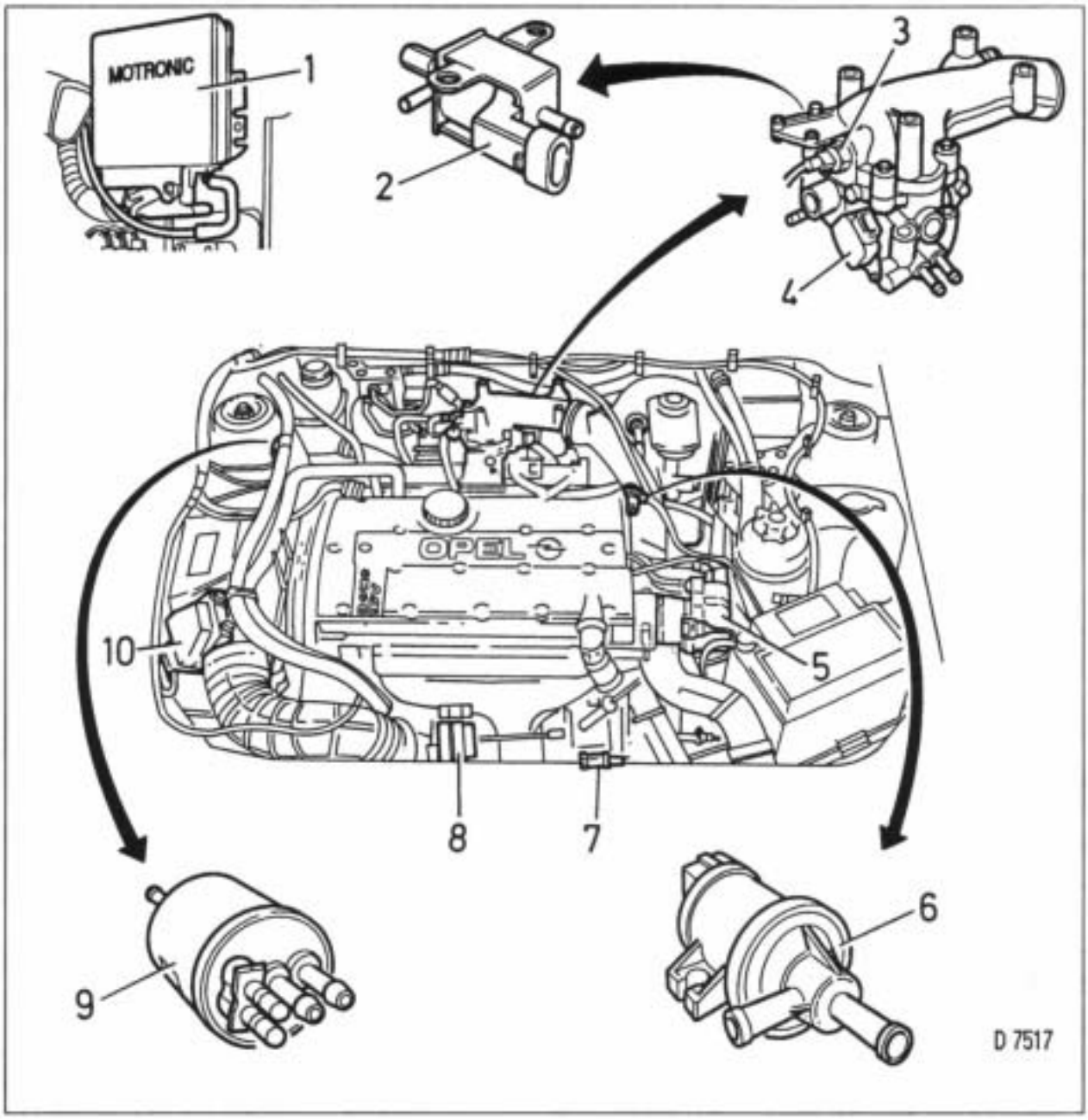


1 Fuel tank
2 Tank vent valve
3 Active carbon canister
4 Idle speed adjuster
5 Intake air temperature sensor
6 Inductive pulse pick-up
7 Pick-up sensor gear
8 Knock sensor
9 High voltage distributor with Hall sensor
10 Coolant temperature sensor
11 Oxygen sensor
12 Turbocharger
13 Charge pressure control bypass valve
14 Hot wire mass air flow meter
15 Ignition coil with trigger box attached
16 Control unit for charge pressure control valve
17 Fuel filter
18 Injection valves
19 Fuel pressure regulator
20 Hot start valve
21 Charge cooler
22 Throttle valve potentiometer
23 Fuel pump
24 Fuel pressure damper
25 Diagnostic plug
26 Switch 1st gear recognition
27 Reverse gear recognition

3.2 Block Diagram, Motronic M 2.7



3.3 Survey of Engine Compartment, CALIBRA TURBO



1 Control unit (in front right footwell)
2 Hot start valve
3 Intake air temperature sensor
4 Throttle valve potentiometer
5 Ignition distributor with integrated Hall sensor
6 Tank tent valve
7 Oxygen sensor
8 Charge pressure valve
9 Charge pressure control bypass valve
10 Hot wire mass air flow meter

4.1 Features Specific to this System

The Motronic M 2.7 system is equipped with self-diagnosis. This means:

If the Motronic M 2.7 control unit recognizes a fault in the system, it will be stored after a certain period of time. If any trouble codes are stored, the engine telltale in the instrument is switched on.

Note: The Motronic M 2.7 permits readout of measured values while travelling. For this, the snapshot mode (F3 key) must be activated. This allows sporadic faults (e.g. loose contacts) to be detected.

Important: Trouble codes can only be deleted using TECH 1 or by disconnecting the ground lead from the battery for approx. 1 minute. After diagnosis with TECH 1 is completed, the ignition must be switched off at least once. Replace closure plug on the diagnostic plug and diagnostic plug on the base.

4.2 Diagnostic Switch KM-640

Note: If TECH 1 is not available, blink code readout can be initiated using Diagnostic Switch KM-640. TECH 1 is however necessary for exact determination of faults.

4.2.1 Diagnostic Switch KM-640, Connect to Vehicle

The switch is turned to position "B" and connected to the diagnostic plug X 13 (ALDL plug) in the engine compartment.

4.2.2 Trouble Codes, Flash out using Diagnostic Switch KM-640

Using Diagnostic Switch KM-640, the diagnostic excitation lead X 13/Ter. B in the diagnostic plug (diagnostic excitation lead for the M 2.7) is connected with terminal "A" (ground). This triggers blink code readout when the ignition is ON. Any trouble codes that may be stored will now be displayed via the engine telltale.

4.3 Checking with TECH 1

Observe the directions in the TECH 1 Operating Instructions before connecting the unit.

Note: The program modules may only be changed or inserted by pressing the two outer catches with ignition OFF.

4.3.1 TECH 1, Connect to Vehicle

- Ignition OFF.
- Using the 10 pin Adapter Cable SD 28224, connect TECH 1 to the diagnostic plug X 13 in engine compartment.
- Select OPEL/VAUXHALL 87 - 94 ECU with "YES".
- Enter Model Year; "4" key - Model Year 1994.
- Select vehicle type via "NO" key, confirm with "YES" key.
- Engine OFF, ignition ON, confirm with "YES" key.
- Answer "AUTOMATIC SYSTEM IDENTIFICATION?" with "NO" key.
- Select "ELECTRONIC ENGINE SYSTEM", confirm with "YES" key.
- Select engine designation "C 20 LET" via " ↓" keys, confirm with "YES" key.
- Confirm 'COMPARE OPEL PART N0. XXXXXX XX WITH CHART 3" with "YES" key.
- Note trouble codes (if present).
- Select "F0: DATA LIST' with "YES" key and confirm with "F0" key.
- Compare all data shown on display with the nominal values in the Checking Procedures.
- If there are deviations from the nominal values, carry out checks according to instructions.

BATTERY VOLTAGE	–	Battery voltage
INTAKE AIR TEMP.	–	Intake air temperature
COOLANT TEMP.	–	Coolant temperature
MASS AIR FLOW S .	–	Hot wire mass air flow meter signal
TPS SIGNAL	–	Signal from throttle valve potentiometer
ENGINE LOAD SIG.	–	Engine load in ms, calculated from hot wire mass air flow meter signal
KNOCK RTD. CYL.1 KNOCK RTD. CYL.2 KNOCK RTD. CYL. 3 KNOCK RTD. CYL.4	–	Ignition timing adjustment of each individual cylinder when knock occurs
JAC ADAPT. SLOPE	–	Deviation of idle speed adjuster pulse from value calculated by control unit
JAC INTEGRATOR	–	Integrator value of idle speed adjuster
JAC BLOCK LEARN	–	Pattern recognition value of idle speed adjuster
02 SENSOR LOOP	–	Open/closed loop via oxygen sensor
02 INTEGRATOR	–	Integrator value of mixture - (02) - correction
02 BLM IDLE THR.	–	Learned mixture characteristic curve at idle speed
02 SENSOR	–	Oxygen sensor voltage in mV
02 BLM PART THR.	–	Learned mixture characteristic curve in partial load range
BATTERY VOLTAGE	–	Control unit voltage supply
VEHICLE SP.PULSE	–	Odometer frequency sensor

INJECTION PULSE	– Injection period in ms
ENGINE SPEED	– Engine speed at idle speed
SPARK ADVANCE	– Firing angle BTDC calculated by control unit
SIM. IDLE POS.SW	– Idle position of throttle valve potentiometer
SIM. FULL POs. SW	– Full load position of throttle valve potentiometer
MAP SENSOR	– Intake manifold absolute pressure sensor
1. SPEED IDENT SW	– Switch for 1st gear recognition
FUEL TANK VENT.	– Tank vent valve
HALL SENSOR	– Hall sensor on high voltage ignition distributor
A/C INFORMAT. SW	– Air conditioning switch
A/C COMPRESS. SW	– Air conditioning compressor
A/C CUTOFF RELAY	– AC cutoff relay for AC compressor cutoff
HOT START VALVE	– Bypass valve for fuel pressure
WASTE GATE VALVE	– Charge pressure valve
WASTE GATE BLM	– Charge pressure characteristic curve
HIM	– Hot Film Mass Air Flow Meter
ECU	– Electronic Control Unit
Master Cartridge	– Program Module
TECH 1 SELF-Test Routine	– TECH 1 self-test
PWM	– Pulse Width Modulated signal (throttle valve potentiometer) from Motronic control unit to transmission control unit

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
01	BATTERY VOLTAGE	Ignition ON, switch off all consumers Start engine Engine running at idle speed	11.5 to 13.5 V >8V 13.0 to 15.9V	48,49	27,24

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition ON	>11.5V	▪ Battery discharged ▪ Corroded contacts
▪ Start engine	>8V	▪ Alternator or regulator defective
▪ Engine running	>13V	▪ Alternator or regulator defective ▪ Control unit K61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
02	TPS SIGNAL	Ignition ON, engine OFF Throttle valve CLOSED (accelerator pedal in idle position) Throttle valve completely OPEN (accelerator pedal fully depressed)	0.1 to 0.7V 3.5 to 4.7V	21, 22	53/30

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition ON ▪ Remove plug from throttle valve potentiometer P34	>4.9V	▪ Short circuit between signal lead Ter. 3 and ground Ter. 2 ▪ Short circuit to ground in control unit lead K 61/Ter. 53 to throttle valve potentiometer P 34/Ter. 3 ▪ Control unit K 61 defective
▪ Bridge Ter. 2 with Ter. 3 on throttle valve potentiometer plug with Adapter Lead KM-609-09 from Electronic-Kit I KM-609	<0.1V	▪ Lead interruption from – Control unit K61/Ter. 30 to throttle valve potentiometer Ter. 2 – Control unit K 61/Ter. 53 to throttle valve potentiometer Ter. 3 – Control Unit K 61 defective
▪ Using multimeter, measure voltage between Ter. 1 and Ter. 2 in throttle valve potentiometer plug P 34	>4.9V	▪ Lead interruption or short circuit to ground from control unit K 61/ Ter. 12 to throttle valve potentiometer plug P 34/Ter. 2

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
03	SIM. IDLE POS. SW	Engine running at idle speed Actuate accelerator pedal slightly	ACTIVE INACTIVE	21, 22	INTERN.

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Engine running at idle speed ▪ Remove plug from throttle valve potentiometer P 34	INACTIVE	▪ Short circuit between Ter. 3 and Ter. 1 in throttle valve potentiometer plug P 34 ▪ Lead interruption from – Control unit K 61 / Ter. 53 to throttle valve potentiometer Ter. 3 – Control unit K 61 / Ter. 30 to throttle valve potentiometer Ter. 1 – Control unit K 61 / Ter. 12 to throttle valve potentiometer Ter. 2 ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
04	SIM. FULL POS. SW	Engine running at idle speed Depress accelerator pedal briefly to full load stop	INACTIVE ACTIVE	21, 22	INTERN.

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Engine running at idle speed ▪ Remove plug from throttle valve potentiometer P 34	INACTIVE	▪ Short circuit between Ter. 3 and Ter. 1 in throttle valve potentiometer plug P 34 ▪ Lead interruption from – Control unit K 61 / Ter. 53 to throttle valve potentiometer Ter. 3 – Control unit K 61 / Ter. 30 to throttle valve potentiometer Ter. 1 – Control unit K61 / Ter. 12 to throttle valve potentiometer Ter. 2 ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
05	INTAKE AIR TEMP.	Engine running at idle speed, operating temperature	10 to 74°C/ 50 to 165°F 3.9 to 1.4 V	69, 71	44/30

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Engine OFF, ignition ON ▪ Remove intake air temperature sensor plug P 29	<-35°C/ -31°F > 4.9V	▪ Short circuit between signal and ground leads in wiring harness ▪ Control unit K 61 defective
▪ Short-circuit both contacts in the temperature sensor plug using Adapter Lead KM-609-09 from Electronic-Kit I KM-609	>180°C/ 356°F < 0.1V	▪ Lead interruption from – Control unit K 61 / Ter. 44 to temperature sensor P 29 – Control unit K 61 / Ter. 30 to temperature sensor P 29 ▪ Control unit K 61 defective
Nominal values are attained		▪ Temperature sensor P 29 defective

Test values, intake air temperature sensor: 15°C to 30°C/59°F to 86°F: 1450 W TO 3300 W

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
06	COOLANT TEMP.	Engine running at idle speed, operating temperature	87 to 114°C/ 188.6 to 237.2°F 1.07 to 0.6 V	14, 15	45/30

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Engine OFF, ignition ON ▪ Remove coolant temperature sensor plug P 12	<-35°C/-31°F > 4.9 V	▪ Short circuit between signal and ground leads in wiring harness ▪ Control unit K 61 defective
▪ Short-circuit both contacts in temperature sensor plug using Adapter Lead KM-609-09 from Electronic-Kit I KM-609	>180°C / 356°F < 0.1 V	▪ Lead interruption from – Control unit K 61 / Ter. 45 to temperature sensor P 12 – Control unit K 61 / Ter. 30 to temperature sensor P 12 ▪ Control unit K 61 defective
Nominal values are attained		▪ Temperature sensor P 12 defective

Test values: coolant temperature sensor: 15°C to 30°C/59°F to 86°F: 1450 W to 3300 W
80°C / 176°F: 250 W to 360 W

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
07	MAP SENSOR	Engine running at idle speed Drive vehicle and accelerate rapidly	02.5 to 0.40 bar > 1 bar		INTERN.

Note: The pressure sensor in the control unit measures the intake manifold pressure as an absolute pressure

Notes for Trouble-Shooting

- Engine OFF
- Remove vacuum hose from control unit K61
- Connect Vacuum Pump MKM-667 to control unit K 61
- Engine running at idle speed

Nominal Value:

Display on vacuum pump	Display on TECH 1
-1.0 bar	0.0 to 0.1 bar
-0.8 bar	0.18 to 0.22 bar
-0.6 bar	0.38 to 0.42 bar
0.4 bar	0.58 to 0.62 bar
0.2 bar	0.78 to 0.82 bar
0 bar	0.98 to 1.02 bar

Cause of Fault

- Vacuum hose leaky or blocked
- Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
08	MASS AIR FLOW S.	Engine running at idle speed, operating temperature	13 to 16 Kg/h	73, 74	7/26

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Adapt Multimeter to mass air flow meter P 44 with Adapter Cables KM-609-9 and KM-609-10 from Electronic-Kit I KM-609		
▪ Ignition ON – Measure voltage at Ter. 5 to Ter. 1	11.5 to 13.5 V	▪ Interruption or short circuit from – Main relay K 68 / Ter. 87 to mass air flow meter P 44 / Ter. 5 – Central ground to mass air flow meter P 44 / Ter. 1
▪ Engine running at idle speed ▪ Measure voltage at Ter. 2 to Ter. 3	2.0 to 2.5 V	▪ Interruption or short circuit from – Control unit K 61 / Ter. 7 to mass air flow meter P 44 / Ter. 3 – Control unit K 61 / Ter. 26 to mass air flow meter P 44 / Ter. 2 ▪ Control unit K 61 defective
▪ Remove adapter cables ▪ Loosen hose clamp on intake side ▪ Connect hot wire mass air flow meter plug ▪ Engine running at an engine speed greater than 1000 rpm fro approx. 10 s. Switch off engine and remove intake hose ▪ Observe hot wire in mass air flow meter	After approx. 4 secs pause the hot wire is heated for approx. 1.5 secs (glows red)	▪ Interruption or short circuit from – Main relay K 68 / Ter. 87 to mass air flow meter P 44 / Ter. 5 – Main relay K 68 / Ter. 85 to control unit K 61 / Ter. 36 – Control unit K 61 / Ter. 25 to mass air flow meter P 44 / Ter. 4 – Mass air flow meter P 44 / Ter. 1 to ground ▪ Main relay K68 defective ▪ Hot wire mass air flow meter P44 defective ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
09	ENGINE SPEED	Engine running at idle speed, operating temperature	900 to 980 rpm	19, 31	48/49

Note:

- In the Motronic M 2.7, trouble code 31 is always set when the ignition is switched ON. This code can either be displayed via TECH 1 or flashed out when the diagnostic plug is short circuited with KM-640 in switch position “B”. If the control unit receives engine speed signals from the inductive pulse pick-up on starting, trouble code 31 is automatically deleted and does not remain stored. If trouble code 31 is not cleared on starting, a malfunction is present and trouble-shooting should be carried out.
- Trouble code 19 is set only if there is a very brief interruption of the engine speed signal at engine speeds >2000 rpm. If the interruption is longer, and if the engine speed in <2000 rpm, the data stream from the control unit to TECH 1 is interrupted.

Test step 09 is divided into 3 parts:
A) Engine does not start, trouble code 31 remains stored
B) Brief engine speed interruption, trouble code 19 may be stored
C) Engine speed deviates from nominal values, no trouble code stored

A) Engine does not start, trouble code 31 remains stored		
Notes for Trouble-Shooting	**Nominal Value:**	**Cause of Fault**
▪ Ignition OFF ▪ Check plug connection from inductive pulse pick-up to control unit	Firm connection	▪ Loose contact ▪ Corroded contacts
▪ Connect checking spark plug to lead 4 of ignition coil ▪ Start engine	Checking spark plug ignites	If no spark: ▪ Ignition coil L 1 defective ▪ Lead interruption from – Ignition coil L1 to trigger box K 20 – Trigger box K 20 to control unit K 61 / Ter. 1 – Ignition coil to ignition distributor – Ignition coil to Ter. 15 ▪ Control unit K 61 defective ▪ Lead interruption from – Pulse pick-up Ter. 1 to control unit K 61 / Ter. 49 – Pulse pick up Ter. 2 to control unit K 61 / Ter. 48
▪ Check resistance in pulse pick-up plug P 35 / Ter. 1 to Ter. 2	0.5 to 0.8 KW	▪ Pulse pick-up P 35 defective
▪ Check resistance in pulse pick-up plug P 35 / Ter. 1 to Ter. 3 and Ter. 2 to Ter. 3	Infinite W	▪ Short circuit from – Pulse pick-up P 35 / Ter. 1 to Ter. 3 – Pulse pick up P 35 / Ter. 2 to Ter. 3
▪ Nominal values are attained		▪ Segment disc/teeth corroded ▪ Metal shavings on pulse pick-up

B) Brief engine speed interruption, trouble code 19 may be stored		
Notes for Trouble-Shooting	**Nominal Value:**	**Cause of Fault**
▪ As for A) trouble code 31	As for A) trouble code 31	▪ As for A) trouble code 31
▪ Check shielding in inductive pulse pick-up P 35/Ter. 3 on control unit side to ground	0 W	▪ Interference pulses in engine speed signal led
▪ Check that segment disk is firmly seated and undamaged		▪ Segment disc loose, teeth damaged
Nominal values are attained		▪ Exchange pulse pick-up

C) Engine speed deviates from nominal values, no trouble code stored		
Notes for Trouble-Shooting	**Nominal Value:**	**Cause of Fault**
▪ See F0: DATA LIST, test step 23 and F5: ACTUATOR TEST, test step 06		

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
10	HALL SENSOR	Ignition ON Engine running at idle speed, operating temperature	INACTIVE Alternating INACTIVE and ACTIVE	93, 94	8/12

Note:
The Hall sensor on the high voltage ignition distributor is used for cylinder recognition. It informs the control unit of the crankshaft revolution on which cylinder "1" ignites. The control unit requires this information to time the fuel injection properly. If the Hall sensor malfunctions, the control unit assumes a random point in time for injection valve actuation. The Hall sensor malfunction causes cold start problems and increased fuel consumption

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition ON		
▪ Adapt multimeter to Hall sensor P 47 with Adapter Cable KM-609-16 from Electronic-Kit I KM-609		▪
▪ Measure voltage at Ter. 3 to Ter. 1	4.7 to 5.2 V	▪ Interruption of short circuit from – Control unit K 61 / Ter. 12 to Hall sensor P 47 / Ter. 3 – Ground or shielding to Hall sensor P 47/Ter. 1
▪ Measure voltage at Ter. 3 to Ter. 2 ▪ Push vehicle with gear engaged	Change between 0 and 5 V	▪ Interruption or short circuit from – Control unit K 61 / Ter. 8 to Hall sensor P 47 / Ter. 2 ▪ Hall sensor P 47 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
11	VEHICLE SP. PULSE	Engine running at idle speed Move vehicle slowly to and fro approx. 1 m/1 yd or test drive	Alternating RECEIVED and NOT RECEIVED	-	9/24
12	VEHICLE SPEED	Vehicle travelling at approx. 50 km/h (30 MPH)	TECH 1 display approximately the same as speedometer display	-	9/24

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition ON ▪ Adapt multimeter on Motronic plug to instrument panel X 9 using Adapter Cables KM-609-9 and KM-609-10 from Electronic-Kit I KM-609 ▪ Measure voltage at Ter. 2 to ground ▪ Jack up vehicle Turn on drive wheels	Voltage change between 0 and >8 V	▪ Fuse F 2 defective ▪ Instrument panel defective ▪ Ignition lock defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
13	A/C INFORMAT. SW	Ignition ON Engine running at idle speed, operating temperature Vehicles with AC: Actuate AC switch	INACTIVE 0 V INACTIVE 0 V ACTIVE 12 V	-	41/19

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Using multimeter, measure voltage at wiring harness plug X 11 / Ter. 2 to ground		
▪ Engine running at idle speed – A/C OFF – A/C ON	0 V 12 V (compressor switches on)	▪ Interruption or short circuit in lead to X 11 / Ter. 2 to A/C switch ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
14	A/C COMPRESS. SW	Ignition ON Engine running at idle speed, operating temperature Actuate AC switch The compressor now switches on automatically (vehicle interior should warm, thermostat on COLD)	INACTIVE 0 V INACTIVE 0 V ACTIVE 12 V	-	41/19

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Using multimeter, measure voltage at wiring harness plug X 9 / Ter. 3 to ground		
▪ Engine running at idle speed – A/C OFF – A/C ON	0 V 12 V (compressor switches on)	▪ Interruption or short circuit in lead to X 9 / Ter. 3 to A/C switch ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
15	1. SPEED IDENT SW	Engine running at idle speed, no gear engaged Depress clutch, engage 1st gear, wait approx. 10 s	INACTIVE 0 V ACTIVE 5 V	41, 42	2/19

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Adapt multimeter to 1st gear recognition switch S 53 using Adapter Cables KM-609-10 and KM-609-16 from Electronic Kit I KM-609		
▪ Measure voltage at Ter. 1 to Ter. 2 ▪ Ignition ON	0V	▪ Short circuit or lead interruption from – 1st gear recognition switch S 53 to control unit K 61 / Ter. 2 – 1st gear recognition switch S 53 to ground
▪ Engine running at idle speed, transmission in neutral	0V	▪ 1st gear recognition switch S 53 defective
▪ Depress clutch, engage 1st gear, wait approx. 10 sec.	5V	▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
16	HOT START VALVE	Engine running at idle speed, operating temperature **Note:** The TECH 1 display for the hot start valve is only ACTIVE 0 V if the engine temperature is >100.8°C/213.44°F when engine is started	INACTIVE 12 V	95, 96	31/24

Notes for Trouble-Shooting **Nominal Value:** **Cause of Fault**

- See Table F5: ACTUATOR TEST, test step 07

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
17	FUEL PUMP RELAY	Engine running at idle speed	ACTIVE 0V	95, 96	31/24

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition OFF ▪ Remove fuel pump relay K 68. ▪ Using multimeter, measure voltage at relay base Ter. 3 to ground	11.5 to 13.5V	▪ Interruption or short circuit to ground from fuel pump relay K 68 / Ter. 3 to Ter. 30
▪ Using multimeter, measure voltage at relay base Ter. 2 to ground	11.5 to 13.5 V	▪ Interruption or short circuit to ground from fuel pump relay K 68 / Ter. 2 to Ter. 30
▪ Remove control unit K 61. ▪ Bridge relay base Ter. 1 and Ter. 3 using Adapter Cable KM-609-09 from Electronic Kit I KM-609 ▪ Using multimeter, measure voltage at control unit plug 36. to ground	11.5 to 13.5 V	▪ Interruption or short circuit to ground from – Fuel pump relay K 68 / Ter. 3 to control unit K 61 / Ter. 36
▪ Bridge relay base Ter. 2 and Ter. 8 with Adapter Cable KM-609-09 from Electronic Kit I KM-609 ▪ Using multimeter, measure voltage at control unit plug Ter. 37 to ground	11.5 to 13.5 V	▪ Interruption or short circuit to ground from – Fuel pump relay K 68 / Ter. 8 to control unit K 61 / Ter. 37 ▪ Short circuit to ground from fuel pump relay K 68 / Ter. 8 to – Injection valves Y 7-1 to Y 7-4/Ter. 1 – Idle speed adjuster M33 / Ter. A – Hot start valve Y 11 / Ter. + – Charge pressure valve Y 12 / Ter. 2 – Tank rent valve Y 34 / Ter. A
▪ Bridge relay base Ter. 2 and Ter. 9 with Adapter Cable KM-609-09 from Electronic Kit I KM-609 ▪ Using multimeter, measure voltage at control unit plug Ter. 3 to ground	11.5 to 13.5 V	▪ Interruption or short circuit to ground from – Fuel pump relay K 68 / Ter. 9 to control unit K 61 / Ter. 3
▪ Bridge relay base Ter. 2 and Ter. 4 using Adapter Cable KM-609-09 from Electronic Kit I KM-609	Fuel pump is operating	▪ Fuse F11 defective ▪ Interruption or short circuit to ground from – Fuel pump relay K 68 / Ter. 4 to fuese F11 or oxygen sensor heating P 32 – Fuse F 11 to fuel pump M 21
Nominal values are attained		▪ Fuel pump relay defective ▪ Fuel pump M 21 defective ▪ Control Unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
18	FUEL TANK VENT.	Engine running at idle speed, operating temperature Accelerate to approx. 3000 rpm	0% >0%	61, 62	5/24

Notes for Trouble-Shooting **Nominal Value:** **Cause of Fault**

- See Table F5: ACTUATOR TEST, test step 05

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
19	INJECTION PULSE	Engine running at idle speed, operating temperature Switch off all consumers	2.0 to 2.8 ms	25, 26, 27, 28 81, 82, 83, 84	16, 17 34, 35 /14

This test step serves as a learning and checking value fro better comprehension of the system and to evaluate the system on external influences.

The injection period is composed of several elements which have an effect on the size of the signal. If the measurements of the following test steps deviate from the nominal values, carry out trouble shooting

Test Step No.	Check of	Further additional causes of fault
01	BATTERY VOLTAGE	
02	TPS SIGNAL	
05	INTAKE AIR TEMP.	
06	COOLANT TEMP.	
08	MASS AIR FLOW S.	
09	ENGINE SPEED	
11	FUEL PUMP RELAY	
20	ENGINE LOAD SIG.	
26	02 SENSOR	
27	02 INTEGRATOR	
28	02 BLM IDLE THR.	

- Injection valves defective
- Carry out F5: ACTUATOR TEST, test steps 01 to 04
- Injection valves jammed
- Electromagnetic interference caused by
  - Ignition leads (position further away from wiring harness)
  - Alternator (worn carbon brushes produce sparks)
- Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
20	ENGINE LOAD SIG.	Engine running at idle speed, operating temperature	0.9 to 1.2. ms	-	INTERN.

Note:
- The ENGINE LOAD SIG. is a processed throttle valve potentiometer signal
- The throttle valve signal is the only influencing variable on the signal

Possible causes of fault:
- Air leak in intake system
- Mass air flow meter defective; trouble codes 73, 74
- Engine speed signal senor faulty; trouble codes 19, 31
- Lead connection from throttle valve potentiometer P 34 / Ter. 3 to control unit K 61 / Ter. 53 interrupted
- Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
21	SPARK ADVANCE	Engine running at idle speed, operating temperature **Note:** Ignition timing adjustment is not possible	10 to 21° CA BTDC (not constant)	-	1/24

Note:
11 to 21°CA (nominal values) are the values programmed in the control unit. This does not mean that this pre-ignition is actually present

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Check of inductive pulse pick-up, see F0: DATA LIST, test step 09	See F0: DATA LIST, test step 09	
Nominal values are attained		▪ Lead interruptions from: – Control unit K 61 / Ter. 1 to trigger box K 20 / Ter. 4 – Trigger box K 20 to ignition coil L 1 / Ter. 1 – Trigger box K 20 / Ter. 3 to Ter. 15 – Trigger box K 20 / Ter 4 to ground ▪ Ignition coil L 1 defective ▪ Trigger box K 20 defective ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
22	IAC ADAPT. SLOPE	Engine running at idle speed, operating temperature	87 to 107 steps	56, 57	4/19

Notes for Trouble-Shooting **Nominal Value:** **Cause of Fault**

- See test step 23

Important:

- If the idle speed adjuster wiring harness plug becomes disconnected, the mechanical emergency program is activated. This increases the idle speed to 1200 to 1500 rpm

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
23	IAC INTEGRATOR	Engine running at idle speed, operating temperature	121 to 135 steps	56, 57	INTERN.

Note:

The IAC INTEGRATOR indicates the opening tendency (observance of the pulse duty ratio necessary for nominal engine speed) of the idle speed adjuster.
This means:
Values > 128 steps mean larger,
Values < 128 steps mean smaller opening cross-sections of the idle speed adjuster

The IAC INTEGRATOR requires the following information for regulation:
- ENGINE SPEED (inductive pulse pick-up)
- Throttle valve closed (via TV. POT. SIGNAL)
- COOLANT TEMP.

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ First check TPS SIGNAL and engine speed. If OK, start trouble-shooting		
▪ If IAC. ADAPT. SLOPE is constantly between 87 and 107 steps and IAC INTEGRATOR constantly at a value >128 steps	IAC ADAPT SLOPE 87 to 107 steps IAC INTEGRATOR 121 to 135 steps	▪ Lack of air – Idle speed adjuster jams, does not open – Bypass air hose blocked on kinked
▪ If IAC. ADAPT. SLOPE is constantly between 87 and 107 steps and IAC INTEGRATOR constantly at a value <128 steps	IAC ADAPT SLOPE 87 to 107 steps IAC INTEGRATOR 121 to 135 steps	▪ Throttle valve open, accelerator cable or throttle valve jams ▪ Idle speed adjuster jams, does not close ▪ Coolant temperature sensor P 12 defective ▪ Throttle valve potentiometer P 34 defective ▪ Mass air flow meter P 44 defective ▪ Mixture too rich (see test step 27) ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
24	IAC BLOCK LEARN	Engine running at idle speed, operating temperature	124 to 136 steps	56, 57	INTERN

Note:

The IAC BLOCK LEARN gives the nominal air requirements of the engine
Via the IAC BLOCK LEARN, evaluation of the learned values of the system can be made after a journey (speed influence)

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ If IAC BLOCK LEARN constantly <75 steps and simultaneously IAC ADAPT. SLOPE constantly between 87 and 107 steps IAC INTEGRATOR constantly at a value <128 steps	AC BLOCK LEARN 124 to 136 steps IAC ADAPT. SLOPE 87 to 107 steps IAC INTEGRATOR 121 to 135 steps	See test step 23
▪ If IAC BLOCK LEARN constantly >175 steps and simultaneously IAC ADAPT. SLOPE constantly between 87 and 107 steps IAC INTEGRATOR constantly at a value >128 steps	AC BLOCK LEARN 124 to 136 steps IAC ADAPT. SLOPE 87 to 107 steps IAC INTEGRATOR 121 to 135 steps	See test step 23

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
25	02 SENSOR LOOP	Ignition ON, engine cold Engine running at idle speed, operating temperature Accelerate fully	OPEN CLOSED OPEN	13, 38, 39	INTERN.
26	02 SENSOR	Ignition ON, engine cold Engine running at idle speed, operating temperature Switch off all consumers	40 to 460 mV constant value 40 to 1000 mV alternating value	13, 38, 39	28/10

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
▪ Ignition ON ▪ Remove oxygen sensor wiring harness plug ▪ Measure voltage between oxygen senor plug P 32 / Ter. C and Ter. A on control unit side using multimeter and Adapter Cable KM-609-15 from Electronic Kit I KM-609	0.4 to 0.5V	▪ Interruption or short circuit from ▪ Control unit K 61 / Ter. 28 to oxygen sensor P 32 / Ter. C ▪ Control unit K 61 / Ter. 10 to ground ▪ Oxygen sensor P 32 / Ter. A to ground
▪ Adapt multimeter with adapter Lead KM-609-14 and KM-609-15 from Electronics Kit I KM-609 to oxygen sensor plug connection ▪ Allow engine to run at 1200 to 1600 rpm with coolant temperature 85°C/185°F ▪ Measure voltage at Ter. C to Ter. A with engine running	Voltage change between 0.1 and 0.9 V	▪ If loop closes only very slowly: – Oxygen sensor heating defective – Lead interruption from K 68 / Ter. 4 to oxygen sensor P 32 / Ter. B – Lead interruption from oxygen sensor P 32 / Ter. A to ground ▪ Oxygen sensor P 32 defective ▪ Mixture constantly too rich (see test step 27) ▪ Mixture constantly to lean (see test step 27) ▪ Control unit K 61 defective
▪ Measure voltage at Ter. B to Ter. A	11.5 to 13.5 V	▪ Oxygen sensor heating defective ▪ Lead interruption from – K 68 / Ter. 4 to oxygen sensor P 32 / Ter. B – Oxygen sensor P 32 / Ter. A to ground

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
27	02 INTEGRATOR	Engine running at idle speed, operating temperature	123 to 133 steps	13, 38, 39	INTERN.

Note:
The air / fuel mixture correction of the oxygen senor regulation can be evaluated using the 02 INTEGRATOR.
If, for example, the air/fuel is too lean, the 02 INTEGRATOR value and thus the injection period is increased in steps until the oxygen sensor signal that the mixture is too rich.

The 02 INTEGRATOR is then decreased again in steps and thus the injection period shortened until the oxygen sensor indicates that the mixture is too lean (closed loop only).

02 INTEGRATOR = 128 means either	Stochiometric air/fuel ratio of approx. 14.7 parts by volume air to one part by volume fuel; i.e. for the combustion of each fuel particle, there is one air particle available
Or	The circuit has been opened by the control unit, as a fault is present, (e.g. oxygen sensor defective) or the conditions for closed loop have not yet been attained
02 INTEGRATOR <128 means:	System becomes leaner, mixture is too rich (injection period is reduced)
02 INTEGRATOR >128 means:	System becomes richer, mixture too lean (injection period is increased)

Note:
The 02 INTEGRATOR affects the injection period and thus also the amount of fuel injected. As the amount of fuel depends on the fuel pressure, incorrect fuel pressure can be detected as follows:

- Fuel pressure too high: 02 INTEGRATOR and thus injection period is reduced in steps (system becomes leaner)
- Fuel pressure too low: 02 INTEGRATOR and thus injection period is increased in steps (system becomes richer)

In order to evaluate a deviation of the 02 INTEGRATOR value, the values of the 02 BLM IDLE THR. Correction and 02 BLM PART THR. Correction must also be evaluation.
Possible interrelationships if nominal values are not attained:

- 02 INTEGRATOR <123 and BLM IDLE THR. <80 — System becomes leaner, mixture too rich
- 02 INTEGRATOR <123 and BLM PART THR. <124 — System becomes leaner, mixture too rich
- 02 INTEGRATOR >133 and BLM IDLE THR. >127 — System becomes richer, mixture too lean
- 02 INTEGRATOR >133 and BLM PART THR. >131 — System becomes richer, mixture too lean

(CONTINUED)

F0: DATA LIST (CONTINUED)

Notes for Trouble-Shooting	Nominal Value:	Cause of Fault
Measured value < 123 steps (system becomes leaner, mixture too rich)		
▪ Check fuel pump pressure (observe safety regulations) ▪ Install pressure gauge in feed and return lines ▪ Engine running at idle speed	Feed pressure: 2.2 to 2.7 bar	▪ Fuel pressure too high ▪ Pressure regulator defective ▪ Return line blocked or kinked
	Return pressure: 0.3 to 1.5 bar	▪ Baffle plate in fuel tank blocked
▪ Remove vacuum hose from fuel pressure regulator. Close off vacuum hose	Feed pressure: 3.0 to 3.5 bar Return pressure: as above	▪ Vacuum hose to pressure regulator leaky ▪ Tank vent valve constantly open ▪ Injection valves leaky ▪ Temperature sensor P 12 defective (see test step 06) ▪ Oxygen sensor P 32 defective (see test steps 25/26) ▪ Control unit K 61 defective
Measured value < 133 steps (system becomes richer, mixture too lean)		
▪ Check fuel pump pressure (observe safety regulations) ▪ Install pressure gauge in feed and return lines ▪ Engine running at idle speed	Feed pressure: 2.2 to 2.7 bar	▪ Fuel pressure too low ▪ Fuel pump defective ▪ Baffle plate in tank loose
	Return pressure: 0.3 to 3.5 bar	▪ Fuel filter dirty ▪ Dirty pre-filter
▪ Remove vacuum hose from fuel pressure regulator Close off vacuum hose	Feed pressure: 3.0 to 3.5 bar Return pressure: as above	▪ Check fuel pump supply quantity (see Technical Data) **Further causes of fault:** ▪ Injection valve defective or dirty ▪ Poor fuel quality ▪ Intake system leaky (air leak) ▪ Temperature sensor P 12 defective (see test step 06) ▪ Oxygen sensor P 32 defective (see test steps 25/26) ▪ Exhaust system leaky (in front of oxygen sensor) ▪ Control unit K 61 defective

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
28	02 BLM IDLE THR.	Engine running at idle speed, operating temperature	90 to 150 steps	13,38, 39	INTERN.

Notes for Trouble-Shooting **Nominal Value:** **Cause of Fault**

Note:

Via the 02 BLM IDLE THR., learned deviations from the ideal mixture (e.g. caused by an air leak) are detected by the control unit and stored in the permanent memory.
The learning process only occurs when oxygen control is active and the engine is operating normally.
The 02 BLM IDLE THR., is effective in the entire characteristic curve range, but predominantly in the lower engine speed range.
The correction values learned by the system are stored in a permanent memory and are thus always available, even if the supply voltage has been cut off and the engine has then been switched on again.
Using the 02 BLM IDLE THR., the values learnt by the system can be evaluated.

To evaluate a deviation of the 02 BLM IDLE THR., the 02 INTEGRATOR must be observed.
If this is also outside the tolerance range, a statement about the engine mixture condition can be made.

- See test step 27

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
29	02 BLM PART THR.	Engine running in partial load range, operating temperature	124 to 131 steps	13, 38, 39	INTERN.

Note:

Via the 02 BLM PART THR., learnt multiplicative deviations from the ideal mixture (e.g. caused by changes in the air density; changes to the density and quality of the fuel; injection faults, etc) are detected by the control unit and stored in the permanent memory.
The learning process only occurs when oxygen control is active and the engine is operating normally.
The multiplicative correction factor is effective in the entire characteristic curve range, but predominantly in the medium and upper lower engine speed ranges.
Using the 02 BLM PART THR., the values learnt by the system can be evaluated.

To evaluate a deviation of the 02 BLM PART THR., the 02 INTEGRATOR must be observed.
If this is also outside the tolerance range, a statement about the engine mixture condition can be made.

- See test step 27

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
30	WASTE GATE VALVE	Engine running at idle speed, operating temperature Vehicle travelling, accelerate briefly	0% >0%	113, 114, 115 116, 117, 118	21/24

Notes for Trouble-Shooting **Nominal Value:** **Cause of Fault**

- See Table F5: ACTUATOR TEST, test step 08

F0: DATA LIST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
31	WASTE GATE BLM	Engine running at idle speed, operating temperature	103 to 153 steps	113, 114, 115 116, 117, 118	INTERN.

Note: If the values measured in the following test steps deviate from the nominal values, carry out trouble shooting

Test Step No	Check of	Further additional causes of fault:
02	TPS SIGNAL	▪ Charge pressure valve defective (see F5: ACTUATOR TEST, test step 08)
09	ENGINE SPEED	
07	MAP SENSOR	▪ Control Unit K 61 defective

4.6 Explanation of Tables

TECH 1 is equipped with a 4 line/16 character display. Only a limited amount of information can be indicated on this display. Therefore listings of trouble codes, coding tables or additional necessary instructions are summarized in "Tables". A detailed explanation is contained in the TECH 1 Operating Instructions. The relevant table is indicated in the TECH 1 display.

4.6.1 Table 1 TECH 1 Checking

TECH 1 refers to table 1, if the equipment is correctly connected, but no data (with ignition ON) can be received by TECH 1.

- Start TECH 1 self-test. Connect TECH 1 Opel Test Adapter between TECH 1 and the diagnostic plug in the vehicle (see TECH 1 Operating Instructions).

If data can still not be received after the self-test:

- Diagnostic plug (ALDL)
- Engine telltale
- Control unit voltage supply
- Control unit ground connection

are to be checked according to Table 1.

Table 1, Diagnostic Plug ALDL and Voltage Supply, Check

Test Step No.	Test Equipment Multimeter MKM-587-A	Test of	Terminal	Notes	Nominal Values	Possible Cause of Fault, Trouble-shooting
1	Ohmmeter	Diagnostic plug (ALDL): ground	A/ground	Ignition OFF	approx. 0 Ω	▪ Transfer resistance at grounding point too high
2	Voltmeter range: 20 V DC	Diagnostic plug (ALDL): excitation lead	B/ground	Ignition ON	> 11.5 V	▪ Lead interruption between ▪ X 13/Ter. B or X 11/Ter. 4 and K 61/Ter. 13 ▪ Control unit K 61 defective
3	Voltmeter range: 20 V DC	Diagnostic plug (ALDL): voltage supply	F/ground	Ignition ON	> 11.5 V	▪ Battery voltage too low ▪ Lead interruption between ▪ X 13/Ter. F and voltage supply ▪ Fuse FS defective
4	Voltmeter range: 20 V DC	Diagnostic plug (ALDL): data lead	G/ground	Ignition ON	> 9 V	▪ Lead interruption between ▪ X 13/Ter. G or X 11/Ter. 5 and K 61/Ter. 55 ▪ Control unit K 61 defective
5	-	Telltale H 30 (ALDL): ground	-	Ignition ON	Telltale ON	▪ Telltale H 30 defective ▪ Fuse F 2 defective ▪ Lead interruption between H 30 and K 61/Ter. 22 ▪ Control unit K 61 defective
6	-	TECH 1 self-test	-	See TECH 1 Operating Instructions	-	-
	Note: After test steps 7 and 8, any trouble codes that are stored are deleted.					
7	Ohmmeter	Control unit plug K 61: ground	Ter. 14/ ground Ter. 19/ ground Ter. 24/ ground	Ignition *OFF* Disconnect plug from control unit K 61	approx. 0 Ω	▪ Transfer resistance at grounding point too high ▪ Lead interruption between K 61 and grounding point ▪ Control unit K 61 defective
8	Voltmeter range: 20 V DC	Control unit plug K 61: voltage supply Ter. 30 and Ter. 15	Ter. 18/ ground Ter. 27/ ground	Ignition OFF Remove plug K 61 Ignition ON	> 11.5 V	▪ Battery voltage too low ▪ Lead interruption between Ter. 30 or Ter. 15 and control unit K 61 ▪ Control unit K 61 defective ▪ Fuel pump relay K 68 defective

4.6.2 Table 2, Trouble Codes

The following tables give the information sensor and the possible cause of the fault for each trouble code. At the same time, the conditions are given under which the trouble code in question is set. To find out the defective circuit or defective part, the remedial measure can be read off from the F0: DATA LIST via the reference code.

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
13	02 SENSOR OPEN CIRCUIT	15, 16	**Conditions for setting fault:** The fault is recognized by the control unit if ▪ over a period of time t > 2.5 s ▪ the oxygen sensor voltage is in the region 380 to 590 mV (lead interruption, oxygen sensor defective) **Conditions for storage of fault:** The fault is stored and the replacement value called up if The following conditions are fulfilled consecutively: 1. Coolant temperature T > 70 °C/157 °F, 2. Condition 1.) is fulfilled for 3 min, 3. Load signal > 3.5 ms, 4. After conditions 1.) to 3.) are fulfilled, 5. waiting time of 5 s elapsed, 6. Trouble code 73 or 74 not recognized **Replacement value:** If trouble code 13 was recognized, the control unit takes 450 mV as replacement voltage (oxygen sensor regulation switched off).	
14	COOLANT TEMP. VOLTAGE LOW	06	▪ Engine temperature > 146 °C/295 °F (short circuit to ground) If trouble code 14 was recognized, the control unit takes a replacement value of 40 °C/104 °F, if the intake air temperature is > 0.4 °C/32.72 °F. If the intake air temperature is < 0.4 °C/32.72 °F, the intake air temperature is taken as a replacement value for 3 min after engine start, and then 40 °C/104 °F again. In general, the learn functions are blocked and the last valid values are used for calculation.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
15	COOLANT TEMP. VOLTAGE HIGH	06	▪ Intake air temperature > -20 °C/- 4 °F ▪ Engine temperature < -35 °C/- 31 °F(short circuit to battery voltage, lead interruption) If trouble code 15 was recognized, the control unit takes a replacement value of 40 °C/104 °F, if the intake air temperature is > 0.4 °C/32.72 °F. If the intake air temperature is < 0.4 °C/32.72 °F, the intake air temperature is taken as a replacement value for 3 min after engine start, and then 40 °C/104 °F again. In general, the learn functions are blocked and the last valid values are used for calculation.	
16	KNOCK SIGNAL CIRCUIT	-	▪ Engine temperature > 40 °C/104 °F ▪ Charge pressure > 8270 kPa (at 1500 rpm) or 6500 kPa (at 6350 rpm), control unit takes intermediate values from a table ▪ Since ignition ON, engine speed was once > 1250 rpm ▪ Engine speed > 2400 rpm ▪ Control unit reference voltage for knock sensor < 0.3 V ▪ Knock sensor voltage is evaluated and produces an implausible resulting value for 255 consecutive ignitions If trouble code 16 was recognized, the control unit retards the firing angle for reasons of safety by 8.4 ° CA. Knock control and charge control are switched off.	
18	KNOCK CONTROL MODULE; REPLACE ECU	-	▪ Engine temperature > 40 °C/104 °F ▪ The control unit carries out one internal knock sensor test per ignition. If this test is not passed for 255 consecutive ignitions, the trouble code is set (control units malfunction) If trouble code 18 was recognized, the control unit retards the firing angle for reasons of safety by 8.4 ° CA. Knock control and charge pressure control are switched off.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
19	INCORRECT RPM SIGNAL	09	▪ Since ignition ON, there was at least one start with correct synchronization ▪ Engine speed > 2000 rpm ▪ Incorrect engine speed signal recognized If trouble code 19 was recognized, no replacement value is used for the engine speed signal. For the mixture and requirement adaption, current values are used and neutral values are used for idle control and characteristic curve adaption. If this fault occurs, the data transfer to TECH 1 is interrupted	
21	THROTTLE POSIT. SENSOR VOLTAGE HIGH	02, 03, 04	▪ Throttle valve potentiometer voltage > 4.8 V (short circuit to battery voltage) If trouble code 21 was recognized, the control unit calculates with a throttle valve angle of 30°. Other functions recognize only partial load and full load. Recognition is dependent on the engine load signal, engine speed and the mass air flow meter signal.	
22	THROTTLE POSIT. SENSOR VOLTAGE LOW	02, 03, 04	▪ Throttle valve potentiometer voltage < 0.1 V short circuit t0 ground) If trouble code 22 was recognized, the control unit calculates with a throttle valve angle of 30°. Other functions recognize only partial load and full load. Recognition is dependent on the engine load signal, engine speed and the mass air flow meter signal.	
23	KNOCK SIGNAL OUT OF RANGE	-	▪ Engine temperature > 40 °C/104 °F The control unit carries out one internal knock sensor test per ignition. If this test is not passed for 255 consecutive ignitions, the trouble code is set (control units malfunction) If trouble code 23 was recognized, the control unit retards the firing angle for reasons of safety by 8.4° CA. Knock control and charge pressure control are switched off.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
25	INJECTOR VALVE 1 VOLTAGE HIGH	19	Short circuit to battery voltage (final stage check) Trouble code storage is taken over by the appropriate final stage module If trouble code 25, 26, 27 or 28 was recognized, the defective valve is no longer actuated. The other injection valves function normally. The learn functions are blocked and the control unit calculates with the last valid adaption values.	
26	INJECTOR VALVE 2 VOLTAGE HIGH			
27	INJECTOR VALVE 3 VOLTAGE HIGH			
28	INJECTOR VALVE 4 VOLTAGE HIGH			
31	NO ENGINE RPM SIGNAL	09	▪ Ignition ON ▪ Engine speed < 23 rpm ▪ Trouble code 19 not yet stored ▪ Since ignition ON, there has not yet been a start with correct synchronization **Note:** Trouble code 31 is always displayed when the ignition is switched on. As soon as an engine speed signal is received from the pulse pick-up on starting, the fault is deleted if the system is intact and does not remain stored. If trouble code 31 was recognized, no replacement value is used for the engine speed signal. For the mixture and requirement adaption, current values are used and neutral values are used for idle control and characteristic curve adaption.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
38	02 SENSOR CIRCUIT VOLTAGE Low	25, 26, 27, 28, 29	**Conditions for setting fault:** The fault is recognized by the control unit if ▪ over a period of time t > 2.5 s ▪ the oxygen sensor voltage is < 0.1 V (short circuit to ground) **Conditions for storage of fault:** The fault is stored and the replacement value called up if the following conditions are fulfilled consecutively: 1. Coolant temperature T > 70 °C/157 °F, 2. Condition 1.) is fulfilled for 3 min, 3. Load signal > 3.5 ms, 4. After conditions 1.) to 3.) are fulfilled, waiting time of 5 s elapsed, 5. Trouble code 73 or 74 not recognized **Replacement value:** If trouble code 38 was recognized, the control unit takes 450 mV as replacement voltage (oxygen sensor regulation switched off).	
39	02 SENSOR CIRCUIT VOLTAGE HIGH	25, 26, 27, 28, 29	**Conditions for setting fault:** The fault is recognized by the control unit if ▪ over a period of time t > 2.5 s ▪ the oxygen sensor voltage is > 1.1 V (short circuit to battery voltage) **Conditions for storage of fault:** The fault is stored and the replacement value called up if the following conditions are fulfilled consecutively: 1. Coolant temperature > 70 °C/157 °F, 2. Condition 1.) is fulfilled for 3 min, 3. Load signal > 3.5 ms, 4. After conditions 1.) to 3.) are fulfilled, waiting time of 5 s elapsed, 5. Trouble code 73 or 74 not recognized **Replacement value:** If trouble code 39 was recognized, the control unit takes 450 mV as replacement voltage (oxygen sensor regulation switched off).	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
41	1 . SPEED IDENT SWITCH VOLTAGE LOW	15	▪ Engine speed > 1520 rpm ▪ Vehicle speed is in range from 10 km/h to; 18 km/h (1520 rpm) 23 km/h (2000 rpm) 34 km/h (3000 rpm) 45 km/h (4000 rpm) 56 km/h (5000 rpm) 66 km/h (6000 rpm) ▪ Control unit recognizes dosed switch for the 1st gear recognition (should be open) (short circuit to ground) ▪ Control unit recognizes open switch for the reverse gear recognition (should be closed) ▪ Above conditions must exist for at least 15 s	
42	1 . SPEED IDENT SWITCH VOLTAGE HIGH	15	▪ Engine speed > 1520 rpm ▪ Vehicle speed > 90 km/h ▪ Control unit recognizes open switch for the 1st gear recognition (should be closed) (short circuit to battery voltage or lead interruption) ▪ Control unit recognizes dosed switch for the reverse gear recognition (should be open) ▪ Above conditions must exist for at least 15 s If trouble code 42 was recognized, the control unit decreases the charge pressure until it is at base charge pressure.	
48	BATTERY VOLTAGE LOW	01	▪ 3 min elapsed since engine start ▪ Battery voltage < 10 V If trouble code 48 was recognized, the control unit compensates for the battery voltage to a certain extent. In addition, the learn functions are blocked and the last valid values are used for calculation.	
49	BATTERY VOLTAGE HIGH	01	▪ Battery voltage > 16 V If trouble code 49 was recognized, the control unit compensates for the battery voltage to a certain extent. In addition, the learn functions are blocked and the last valid values are used for calculation.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
52	CHECK LIGHT VOLTAGE HIGH	-	Final stage diagnosis in control unit ▪ Short circuit to battery voltage	
55	REPLACE ECU	-	▪ Control unit hardware failure (RAM, ROM, EPROM defective) If trouble code 55 was recognized, the normal functions are carried out as far as possible	
56	IDLE AIR CONTROL VOLTAGE HIGH	22, 23, 24	Final stage diagnosis in control unit ▪ Short circuit to battery voltage If trouble code 56 was recognized, the learn functions are blocked and the last valid values are used for calculation.	
57	IDLE AIR CONTROL VOLTAGE LOW	20, 21, 22, 23	Final stage diagnosis in control unit ▪ Short circuit to ground If trouble code 57 was recognized, the learn functions are blocked and the last valid values are used for calculation.	
61	FUEL TANK VENT. VALVE VOLTAGE LOW	18	Final stage diagnosis in control unit ▪ Short circuit to ground	
62	FUEL TANK VENT. VALVE VOLTAGE HIGH	26	Final stage diagnosis in control unit ▪ Short circuit to battery voltage	
69	INTAKE AIR TEMP. VOLTAGE LOW	05	▪ Intake air temperature > 140 °C/284 °F (short circuit to ground) If trouble code 69 was recognized, the control unit calculates with a replacement value of 20 °C/68 °F. The learn functions are blocked and the last valid values are used for calculation.	
71	INTAKE AIR TEMP. VOLTAGE HIGH	05	▪ Engine running longer than 3 min ▪ Throttle valve dosed longer than 10 s (idle speed) ▪ Intake air temperature < -35 °C/-31 °F (short circuit to battery voltage or interruption) If trouble code 71 was recognized, the control unit calculates with a replacement value of 20 °C/68 °F. The learn functions are blocked and the last valid values are used for calculation.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
73	MASS AIR FLOW SENSOR VOLTAGE LOW	08	▪ Engine speed < 2520 rpm ▪ Short circuit to ground in signal lead of mass air flow meter (Ter.3 on plug of mass air flow meter) If trouble code 73 was recognized, the control unit calculates for the load signal with a replacement characteristic curve dependent on the engine speed and throttle valve angle. If the throttle valve potentiometer is also defective, the following replacement values are used for calculation: For engine speed < 1520 rpm with load signal - 2.0 ms For engine speed > 1520 rpm with load signal - 4.5 ms	
74	MASS AIR FLOW SENSOR VOLTAGE HIGH	08	▪ Short circuit to battery voltage in signal lead of mass air flow meter (Ter.3 on plug of mass air flow meter) If trouble code 74 was recognized, the control unit calculates for the load signal with a replacement characteristic curve dependent on the engine speed and throttle valve angle. If the throttle valve potentiometer is also defective, the following replacement values are used for calculation: For engine speed < 1520 rpm with load signal = 2.0 ms For engine speed > 1520 rpm with load signal = 4.5 ms	
75	TORQUE CONTROL VOLTAGE LOW		▪ Short circuit to ground for longer than 2.5 s If trouble code 75 was recognized, no further ignition adjustment is carried out during shifting. **Note:** Trouble code 75 can only be cleared in the next operating cycle, due to the type of request (after ignition OFF - ON). The telltale remains switched on for the entire operating cycle in which it occurred, even after the source of the fault has been eliminated.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
81	INJECTOR VALVE 1 VOLTAGE LOW	19	▪ Short circuit to ground or lead interruption Trouble code storage is carried out by the appropriate final stage module. If trouble code 81, 82, 83 or 84 was recognized, the defective valve is no longer actuated. The other injection valves function normally. The learn functions are blocked and the control unit uses the last valid adaption values for calculation.	
82	INJECTOR VALVE 2 VOLTAGE LOW			
83	INJECTOR VALVE 3 VOLTAGE LOW			
84	INJECTOR VALVE 4 VOLTAGE LOW			
93	HALL SENSOR VOLTAGE LOW	10	▪ Recognition of more than one phase information during one work cycle with correct reference mark (short circuit to ground)	
94	HALL SENSOR VOLTAGE HIGH	10	▪ Five camshaft revolutions with phase sensor information inactive with correct reference mark (short circuit to battery voltage)	
95	HOT START VALVE VOLTAGE LOW	16	▪ Short circuit to ground in lead to fuel pressure switchover valve (hot start valve)	
96	HOT START VALVE VOLTAGE HIGH	16	▪ Short circuit to battery voltage in lead to fuel pressure switchover valve (hot start valve)	
113	BOOST CONTROL OUT OF RANGE	30, 31	▪ Charge control active ▪ Engine speed > 2950 rpm ▪ Overboost function (increased charge pressure) not active ▪ Throttle valve angle > 47 ° ▪ Charge control deviation (nominal value - actual value) > 1550 kPa with positive regulation deviation **or** < -1240 kPa with negative regulation deviation ▪ Above conditions exist for 6 s If trouble code 113 was recognized, the charge control is switched off.	

Table 2, Trouble Codes

Trouble Code	Information Sensor Cause of Fault	Remedy in FO:DATA LIST No.	Trouble Code Storage when	Remarks
114	BOOST PRESSURE IDLE ABOVE UPPER LIMIT	30, 31	▪ Trouble code 21, 22 not recognized ▪ Throttle valve angle < 1.3 ° (idle range) ▪ Engine speed > 1800 rpm ▪ Intake manifold absolute pressure >7000 kPa ▪ Above conditions exist for 5 s If trouble code 114 was recognized, the charge control is switched off. The knock control remains active.	
115	BOOST PRESSURE FULL BELOW LOWER LIMIT	30, 31	▪ Trouble code 21,22 not recognized ▪ Throttle valve angle > 65 ° (full load range) ▪ Engine speed > 2500 rpm ▪ intake manifold absolute pressure <7500 kPa ▪ Above conditions exist for 5 s If trouble code 115 was recognized, the charge control is switched off. The knock control remains active.	
116	BOOST PRESSURE ABOVE UPPER LIMIT	30, 31	▪ Trouble code 114, 115 not recognized ▪ Intake manifold absolute pressure; > 15 920 kPa at 6 600 rpm > 16 770 kPa at 5 800 rpm > 17 470 kPa at 5 000 rpm > 18 320 kPa at 4 200 rpm > 19 480 kPa at 3 400 rpm > 18 470 kPa at 2 600 rpm > 16 460 kPa at 1 800 rpm > 16 000 kPa at 1 200 rpm ▪ Above conditions must exist for 1.5 s	
117	WASTE GATE VALVE VOLTAGE LOW	30, 31	▪ Short circuit to ground in leads to valve charge control	
118	WASTE GATE VALVE VOLTAGE HIGH	30, 31	▪ Short circuit to battery voltage in leads to valve charge control	

4.6.3 Table 3, System Components

This table contains all important information, such as control unit and wiring harness coding, required for the coding of each vehicle configuration.

Control Units Part Numbers

Model	Engine	Part Number	Alpha Code
CALIBRA TURBO	C 20 LET	90 461 295	JZ

Wiring Harness Coding

CALIBRA MT;
Control unit K61/Ter. 42 to ground

CALIBRA with A/C;
Control unit K 61/Ter. 40 to compressor
Control unit K 61/Ter. 41 to A/C switch

4.6.4 Table 4, Emergency Characteristics, Notes on "Engine Does Not Start"

In Table 4, there is a list of the tests required when data is received from the control unit but no trouble codes are stored and the engine does not start.

- Battery (see also F0: DATA LIST, test step 10)
- Starter
- Compression
- Primary voltage
- Secondary voltage (see also F0: DATA LIST, test step 09)
- CO and HC measurement
- Injection signal (see also F0: DATA LIST, test step 19 and F5: ACTUATOR TEST, test steps 01, 02, 03, 04)
- Engine speed signal of inductive pulse pick-up (see also F0: DATA LIST, test step 09)
- Hall sensor signal (see F0: DATA LIST, test step 10)

4.6.5 Table 5, F5:ACTUATOR TEST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
01	SELECT ACTUATOR FUEL INJECT. 1	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** Injection valve 1 is actuated at a frequency of 10 Hz (switch-on time 1.0 ms). The test is completed after max. 30 s.	Injection valve 1 is actuated and switches: clicking noise	25, 81	17/14
02	SELECT ACTUATOR FUEL INJECT. 2	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** Injection valve 2 is actuated at a frequency of 10 Hz (switch-on time 1.0 ms). The test is completed after max. 30 s.	Injection valve 2 is actuated and switches: clicking noise	26, 82	34/14
03	SELECT ACTUATOR FUEL INJECT. 3	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** Injection valve 3 is actuated at a frequency of 10 Hz (switch-on time 1.0 ms). The test is completed after max. 30 s.	Injection valve 3 is actuated and switches: clicking noise	27, 83	16/14
04	SELECT ACTUATOR FUEL INJECT. 4	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** Injection valve 4 is actuated at a frequency of 10 Hz (switch-on time 1.0 ms). The test is completed after max. 30 s.	Injection valve 4 is actuated and switches: clicking noise	28, 84	35/14

F5:ACTUATOR TEST

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Ignition ON Using multimeter, measure voltage at injection valve plug Ter. 1 to ground	11.5 to 13.5 V	▪ Interruptions or short circuit to ground from - Control unit K 61/Ter. 37 - Fuel pump relay K 68/Ter. 87 to relevant injection valve
▪ Remove wiring harness strip from all 4 injection valves. ▪ Connect Checking Lamp KM-602-1 to all injection plug cables consecutively. ▪ Start engine	Checking lamp flashes	▪ Interruptions or short circuit to ground from - Control unit K 61/Ter. 17 to injection valve cyl. 1/Ter. 2 - Control unit K 61/Ter. 34 to injection valve cyl. 2/Ter. 2 - Control unit K 61/Ter. 16 to injection valve cyl. 3/Ter. 2 - Control unit K 61 /Ter. 35 to injection valve cyl. 4/Ter. 2
Nominal values are attained		▪ Control unit K 61 defective ▪ Injection valve defective
Injection valve checking value at room temperature: approx. 16 S2		

F5:ACTUATOR TEST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
05	SELECT ACTUATOR FUEL TANK VENT	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** The tank vent valve is actuated at a frequency of 1 Hz (actuation duration 500 ms). The test is completed after max. 30 s.	Hold tank vent valve in hand: clicking noise	61, 62	5/24

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Ignition ON ▪ Using multimeter, measure voltage at tank vent valve plug Y 34/Ter. A to ground	11.5 to 13.5 V	▪ Lead interruptions from control unit K 61/Ter. 37 or from fuel pump relay K 68/Ter. 87 to tank vent valve Y 34/Ter. A
▪ Ignition OFF ▪ Disconnect control unit K 61 from wiring harness ▪ Check from tank vent valve plug Y 34/Ter. B to control unit K 61/Ter. 5 for continuity and short circuit to ground using multimeter.	Passage	▪ Lead interruption in lead from tank vent valve Y 34/Ter. B to control unit K 61/ Ter. 5 ▪ Short circuit to ground in lead from tank vent valve Y 34/Ter. B to control unit K 61 /Ter. 5
Nominal values are attained		▪ Tank vent valve Y 34 defective ▪ Control unit K 61 defective

F5:ACTUATOR TEST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
06	SELECT ACTUATOR IDLE AIR CONTR	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** The idle air stepper control switches at a frequency of 1 Hz. The test is completed after max. 30 s.	Clicking noise	56, 57	4/24

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Remove right front wheel ▪ Ignition ON ▪ Using multimeter, measure voltage at idle speed adjuster plug M 33/Ter. A to ground	11.5 to 13.5 V	▪ Lead interruptions from control unit K 61/Ter. 37 or from fuel pump relay K 68/Ter. 87 to idle speed adjuster M 33/Ter. A
▪ Ignition OFF ▪ Disconnect control unit K 61 from wiring harness ▪ Check from idle speed adjuster plug M 33/Ter. B to control unit K 61/Ter. 4 for continuity and short circuit to ground using multimeter	Passage	▪ Lead interruption in lead from idle speed adjuster M 33/Ter. B to control unit K 61/Ter. 4 ▪ Short circuit to ground in lead from idle speed adjuster M 33/Ter. B to control unit K 61 /Ter. 4
Nominal values are attained		▪ Idle speed adjuster M 33 defective ▪ Control unit K 61 defective

F5:ACTUATOR TEST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
07	SELECT ACTUATOR HOT START V.	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** The hot start valve is actuated at a frequency of 1 Hz (actuation duration 500 ms). The test is completed after max. 30 s.	Hold hot start valve in hand: clicking noise	95, 96	31/24

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Ignition ON ▪ Using multimeter, measure voltage at hot start valve plug Y 11/Ter. + to ground	11.5 to 13.5 V	▪ Lead interruptions from control unit K 61/ Ter. 37 or from fuel pump relay K 68/ Ter. 87 to tank vent valve Y 11/Ter. +
▪ Ignition OFF ▪ Disconnect control unit K 61 from wiring harness ▪ Check from hot start valve plug Y 11/ Ter. - to control unit K 61/Ter. 31 for continuity and short circuit to ground using multimeter	Passage	▪ Lead interruption in lead from tank vent valve Y 11/Ter. - to control unit K 61/Ter. 31 ▪ Short circuit to ground in lead from tank vent valve Y 11 /Ter. - to control unit K 61 /Ter. 31
Nominal values are attained		▪ Hot start valve Y 11 defective ▪ Control unit K 61 defective

F5:ACTUATOR TEST

No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
08	SELECT ACTUATOR WASTE GATE V .	Ignition ON Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the instructions in the TECH 1 display. **Note:** The charge pressure valve is actuated at a frequency of 1 Hz (actuation duration 500 ms). The test is completed after max. 30 s.	Hold charge pressure valve in hand: clicking noise	117, 118	21/24

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Ignition ON ▪ Using multimeter, measure voltage at charge pressure valve plug Y 12/Ter. 2 to ground	11.5 to 13.5 V	▪ Lead interruptions from control unit K 61/Ter. 37 or from fuel pump relay K 68/Ter. 87 to charge pressure valve Y 12/Ter. 2
▪ Ignition OFF ▪ Disconnect control unit K 61 from wiring harness ▪ Check from charge pressure valve plug Y 12/Ter. 1 to control unit K 61/Ter. 21 for continuity and short circuit to ground using multimeter	Passage	▪ Lead interruption in lead from charge pressure valve Y 12/Ter. 1 to control unit K 61 /Ter. 21 ▪ Short circuit to ground in lead from charge pressure valve Y12/Ter. 1 to control unit K 61/Ter. 21
Nominal values are attained		▪ Charge pressure valve Y 12 defective ▪ Control unit K 61 defective

F5:ACTUATOR TEST

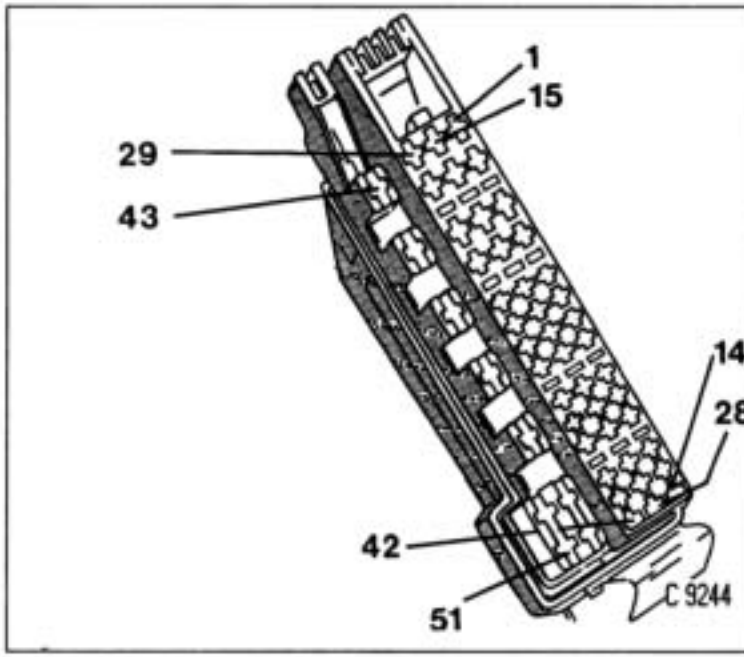
No.	TECH 1 Display	Conditions for Checking	Nominal Value	Trouble Codes	Terminal
09	SELECT ACTUATOR IGNITION SPARK	Ignition OFF Connect checking spark plug Ignition ON, engine OFF, vehicle stationary Press key F5 (Actuator Test), select the desired test with the arrow keys and confirm with YES. Follow the Instructions in the TECH 1 display. **Note:** The checking spark plug is actuated at a frequency of 5 Hz. The test is completed after max. 30 s.	Ignition spark visible at checking spark plug	117, 118	21/24

Notes for Trouble-shooting:	Nominal Value:	Cause of Fault:
▪ Ignition ON ▪ Using multimeter, measure voltage at - Control unit K 61/Ter. 27 - Ignition final stage K 20/Ter. 3 - Ignition coil L 1/Ter. 1 - Ignition coil L 1/Ter. 15 to ground	11.5 to 13.5 V	▪ Interruption or short circuit to ground of lead - Control unit K 61/Ter. 27 to ignition final stage K 20/Ter. 3 - From ignition final stage K 20 to ignition coil L 1/Ter. 15 or Ter. 1 - From ignition final stage K 20/Ter. 2 to ground
▪ Using multimeter, with 1,000 Volt DC range selected, connect between ignition coil L 1 /Ter. 1 and ground. Start engine.	300 to 400 V	▪ Interruption or short circuit to ground of lead - Ignition final stage K 20/Ter. 4 to control unit K 61/Ter. 1 - Ignition final stage K 20 to ignition coil L 1/Ter. 1 ▪ Ignition final stage K 20 defective ▪ Control unit K 61 defective
Nominal values are attained		▪ Ignition coil L 1 defective
Ignition coil resistance at room temperature:	Primary side: approx. 0.5 Ohms Secondary side: approx. 7 kOhms	

5 Terminal Assignment

5.1 Terminal Assignment of Wiring Harness Plug X 6 (51-pin)

Ter. 17 from fuel pump M 21 to fuse F 11 in fuse box
For identification of remaining terminal assignments, refer to page 6C-24.

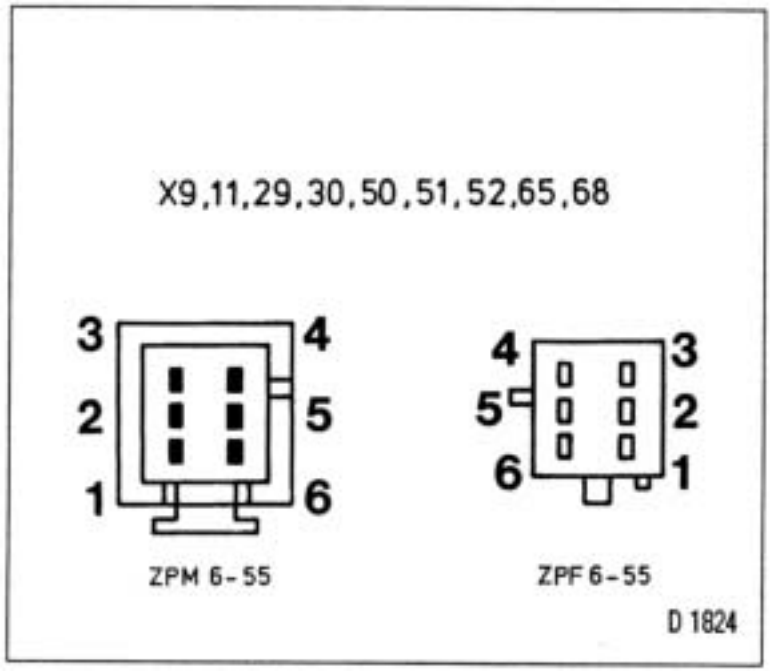


5.2 Terminal Assignment of Wiring Harness Plug X 8 (2-pin)

Ter. 1 from fuse F 11 to fuel pump relay K 68/Ter. 87b

5.3 Terminal Assignment of Wiring Harness Plug to Instrument Panel X 9 (6-pin)

Ter. 2 from Motronic control unit K 61/Ter. 9
to instrument panel connection plug X 21/Ter. 3
Ter. 3 from Motronic control unit K 61/Ter. 40
to AC connection plug X 7/Ter. A
Ter. 5 from Motronic control unit K 61/Ter. 32
to board computer U 2/Ter. 24
Ter. 6 from fuel pump relay K 68/Ter. 87
to board computer U 2/Ter. 6

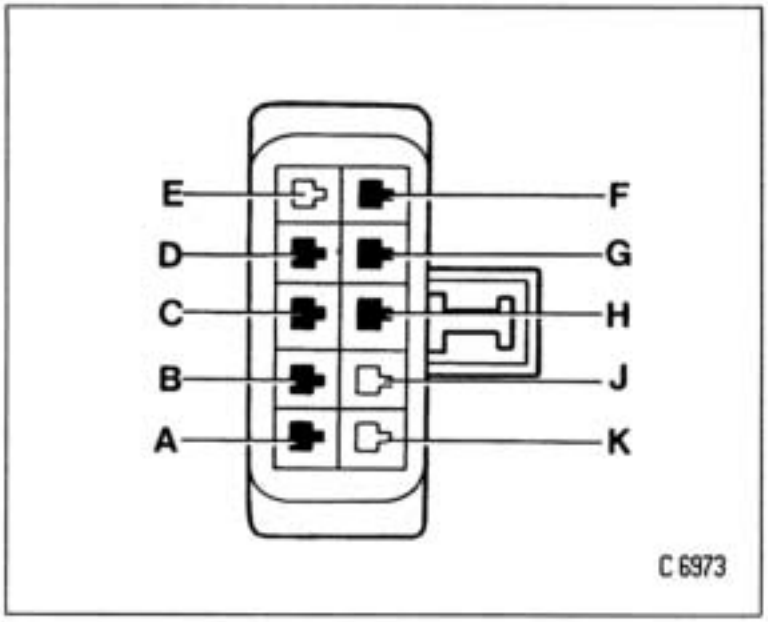


5.4 Terminal Assignment of Wiring Harness Plug to Instrument Panel X 11 (6-pin)

Ter. 4 from Motronic control unit to diagnostic plug X 13/Ter. B
Ter. 5 from Motronic control unit to diagnostic plug X 13/Ter. G

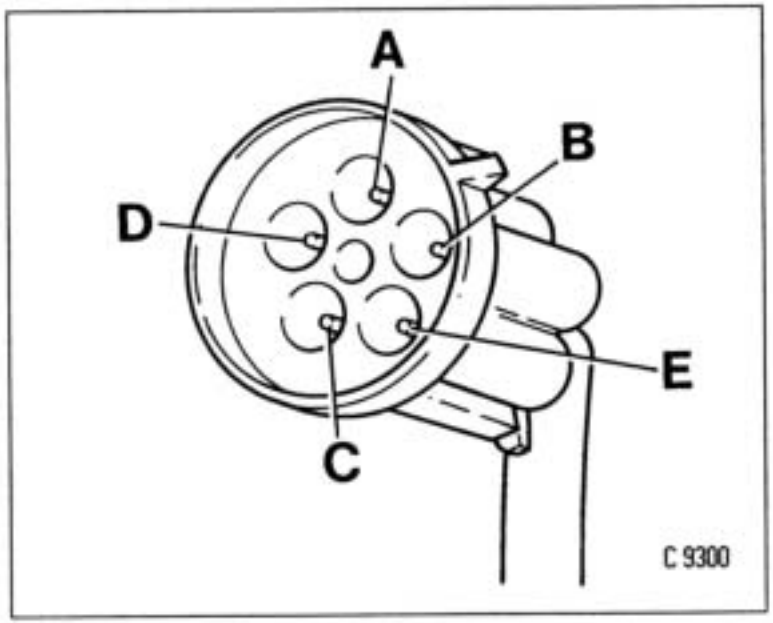
5.5 Terminal Assignment of Diagnostic Plug X 13 (10-pin)

Ter. A - Ground
Ter. B - Engine electronics diagnostic excitation lead
Ter. F - Battery voltage Ter. 30
Ter. G - Bi-directional data lead



5.6 Terminal Assignment of Wiring Harness Plug to Engine X 18 (5-pin)

Ter. A from idle speed adjuster M 33/Ter. 1 to Motronic control unit K 61/Ter. 4
Ter. B from idle speed adjuster M 33/Ter. 2 to fuel pump relay K 68/Ter. 87
Ter. C from knock sensor shielding P 46 to Motronic control unit K 61/Ter. 19
Ter. D from knock sensor P 46 to Motronic control unit K 61/Ter. 30
Ter. E from knock sensor P 46 to Motronic control unit K 61/Ter. 11



5.7 Terminal Assignment of Hot Wire Mass Air Flow Meter P 44 (6-pin)

Ter. 1 from hot wire mass air flow meter P 44 to ground

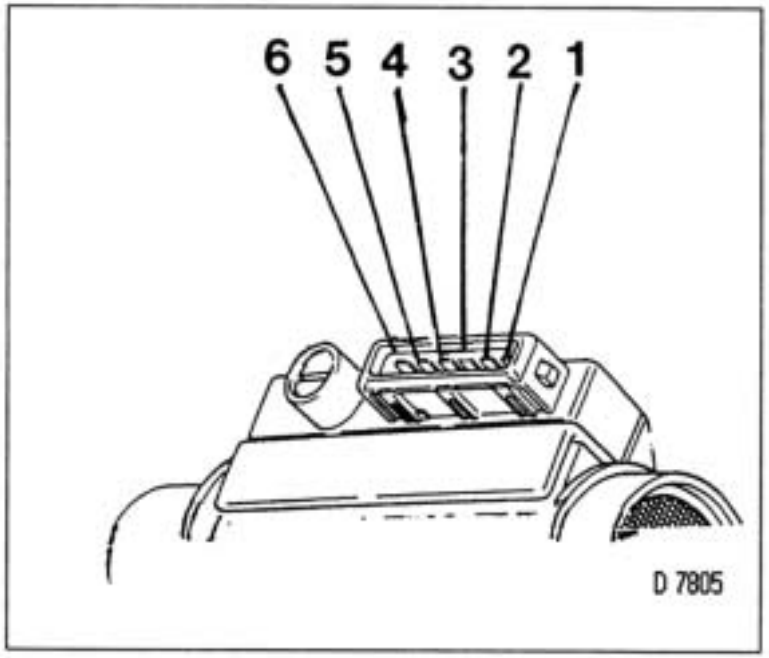
Ter. 2 from hot wire mass air flow meter P 44 to Motronic control unit K 61/Ter. 26

Ter. 3 from hot wire mass air flow meter P 44 to Motronic control unit K 61/Ter. 7

Ter. 4 from hot wire mass air flow meter P 44 to Motronic control unit K 61/Ter. 25

Ter. 5 from hot wire mass air flow meter P 44 to fuel pump relay K 68/Ter. 87

Ter. 6 internally occupied



6. Appendix

6.1 Complaints Table

If these complaints occur, check the marked test steps in more detail.

Engine starts poorly or not at all	Engine starts but stalls again	Idling problems (engine speed, exhaust)	Poor acceleration, transition faults	Misfiring (ignition, injection)	Poor engine output/no top speed	Fuel consumption too high	Engine diesels	Engine pings, knocks	Engine gets too hot	Engine stalls at traffic lamps	Telltale on permanently or intermittently	Possible Causes	Test Step No. in F0:DATA LIST
•											•	BATTERY VOLTAGE	01
•	•	•			•	•					•	TPS SIGNAL	02
		•	•								•	SIM. IDLE POS.SW	03
	•				•						•	SIM. FULL POS.SW	04
	•	•									•	INTAKE AIR TEMP.	05
•		•	•			•		•	•		•	COOLANT TEMP.	06
•	•	•	•		•						•	MAP SENSOR	07
•	•	•	•	•	•	•					•	MASS AIR FLOW S.	08
•	•		•		•						•	ENGINE SPEED	09
		•				•					•	HALL SENSOR	10
					•	•						VEHICLE SP.PULSE	11
					•	•						VEHICLE SPEED	12

Complaints Table (continued)

If these complaints occur, check the marked test steps in more detail.

Engine starts poorly or not at all	Engine starts but stalls again	Idling problems (engine speed, exhaust)	Poor acceleration, transition faults	Misfiring (ignition, injection)	Poor engine output/no top speed	Fuel consumption too high	Engine diesels	Engine pings, knocks	Engine gets too hot	Engine stalls at traffic lamps	Telltale on permanently or intermittently	Possible Causes	Test Step No. in F0:DATA LIST
		•				•						A/C COMPRESS. SW	13
		•										A/C INFORMAT. SW	14
•		•	•			•						HOT START VALVE	15
•		•	•			•		•			•	1.SPEED IDENT SW	16
•											•	FUEL PUMP RELAY	17
			•			•		•			•	FUEL TANK VENT.	18
•	•	•	•	•	•	•	•				•	INJECTION PULSE	19
			•	•	•	•						ENGINE LOAD SIG.	20
			•		•			•	•			SPARK ADVANCE	21
	•	•										IAC INTEGRATOR	22
	•	•										IAC ADAPT. SLOPE	23
	•	•										IAC BLOCK LEARN	24

Complaints Table (continued)

If these complaints occur, check the marked test steps in more detail.

Complaints: Engine starts poorly or not at all	Engine starts but stalls again	Idling problems (engine speed, exhaust)	Poor acceleration, transition faults	Misfiring (ignition, injection)	Poor engine output/no top speed	Fuel consumption too high	Engine diesels	Engine pings, knocks	Engine gets too hot	Engine stalls at traffic lamps	Telltale on permanently or intermittently	Possible Causes	Test Step No. in F0:DATA LIST
		•	•		•						•	O2 SENSOR LOOP and O2 SENSOR	25/26
		•	•		•						•	O2 INTEGRATOR	27
		•	•		•						•	O2 BLM IDLE THR.	28
		•	•		•						•	O2 BLM PART THR.	29
			•		•						•	WASTE GATE VALVE	30
			•		•						•	WASTE GATE BLM	31

Complaints Table (continued)

If these complaints occur, check the marked test steps in more detail.

Complaints: Engine starts poorly or not at all	Engine starts but stalls again	Idling problems (engine speed, exhaust)	Poor acceleration, transition faults	Misfiring (ignition, injection)	Poor engine output/no top speed	Fuel consumption too high	Engine diesels	Engine pings, knocks	Engine gets too hot	Engine stalls at traffic lamps	Telltale on permanently or intermittently	Possible Causes	Test Step No. in F5:ACTUATOR TEST
•	•	•	•	•	•	•					•	Injection valves	01, 02, 03, 04
	•	•					•				•	Tank vent valve	05
	•	•									•	Idle speed adjuster	06
•		•	•			•						Hot start valve	07
			•		•						•	Charge pressure valve	08
•			•									Ignition coil or circuit	09
	•		•		•							Pick-ups/interference impulses	-
•	•	•	•	•	•	•				•	•	Control unit defective	-