

A. General

The acceleration slip control (ASR) is an automatic system for improving starting-off and accelerating capability as well as driving stability.

ASR is the logical further development of the anti-lock system (ABS). Whereas ABS prevents the wheels from locking when braking and thus maintains steering control and driving stability when braking the vehicle, ASR prevents the driven wheels from spinning when moving off and accelerating. The result is optimal driving stability with enhanced traction. The ABS basic components are supplemented for ASR by a hydraulic unit with expanded functions, a pressure supply unit, a fourth rotational speed sensor, enlarged electronic control and the electronic accelerator with control unit, potentiometer and electronic accelerator actuator.

In addition, the cruise control system is contained in the control unit of the electronic accelerator.

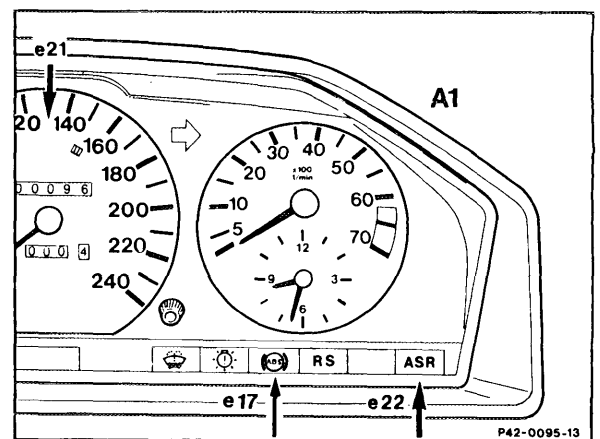
Benefits

- Improves starting-off and acceleration capability as a result of enhanced traction, particularly beneficial on road surfaces and curves with differing levels of adhesion.
- Enhances active dynamic safety as it is sufficient to have only a single wheel which is not spinning to achieve optimal traction with no loss of cornering control.
- Automatically adapts engine torque to respective adhesion capability between wheel and road surface if the driver accelerates too sharply.
- A function display indicates that the ASR control has been activated and signals to the driver that he is approaching the physical limits of the vehicle.

Driving with ASR

The instrument cluster contains displays with various symbols for the ASR.

- A1e17 ABS indicator lamp
- A1e21 ASR function display
- A1e22 ASR indicator lamp



Switching on Ignition

When ignition is switched on (ignition starter switch "position 2"), the function display and the indicator lamps in the instrument cluster light up (bulb check) and go out once the engine is running.

Driving

When driving, the function display lights up as soon as the ASR is operating. The function display remains on for approx. 1 s after end of ASR control mode. If the ASR control is activated only for a very short moment, the function display does not light up.

Control mode

The function display indicates that the ASR control has been activated and signals the driver that he is approaching the physical limits of his vehicle. This enables him to adapt his driving style better to road conditions.

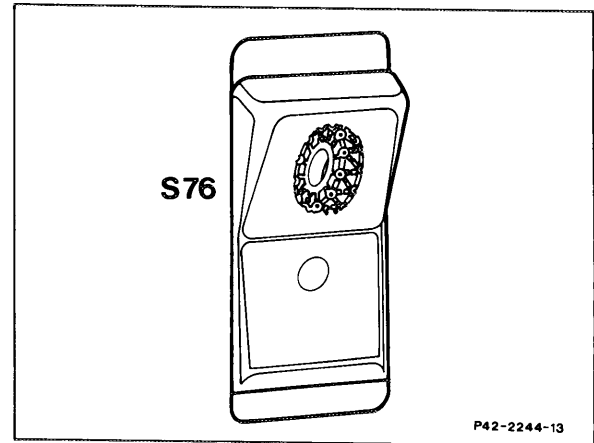
Check

If the ASR indicator lamp lights up when the engine is running, this indicates a fault in the ASR or in the electronic accelerator. The ASR system is inoperable although the ABS function is retained. If the fault occurs in the electronic accelerator, it is possible to continue driving with reduced engine output. The driver notices this from the altered operating forces of the accelerator pedal. If the ASR and ABS indicator lamps light up when the engine is running, this indicates a fault in the ABS which also involves the ASR being deactivated as well, or in the ASR which also affects the ABS system. Both systems are switched off.

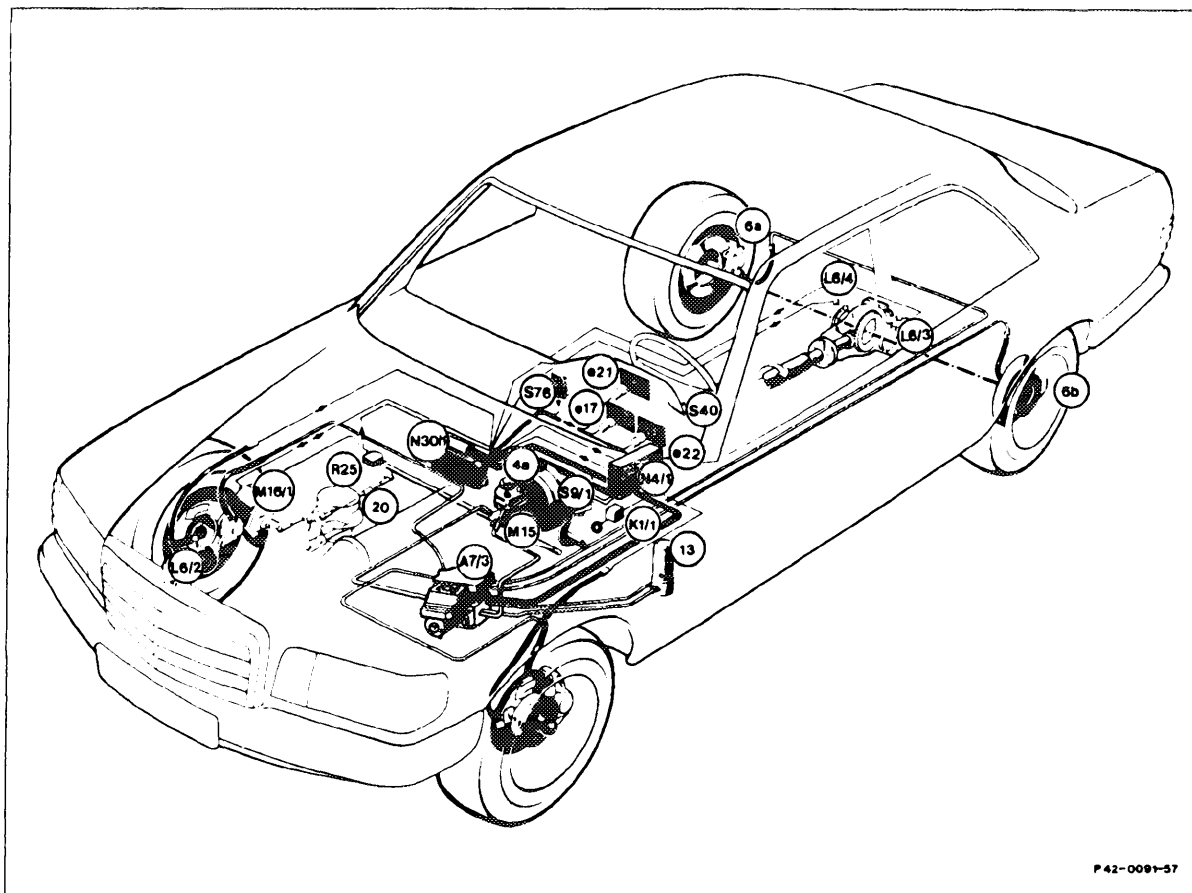
Snow chain switch (S76)

(ASR slip threshold control with indicator lamp)

The responsive, stability-oriented control of the ASR may have a detrimental effect on starting-off behavior in deep snow and with snow chains fitted. For this reason, a special control logic has been programmed into the system for the starting-off range in appropriate situations, which the driver can select by pressing the snow chain switch. When the snow chain switch is operated, the indicator lamp in the switch lights up. After approx. 50 ms continuous ASR control mode, a higher drive slip limit is permitted at the wheels to enable the vehicle to get free in the situations indicated above. As this higher slip would have a negative effect on driving stability, particularly at higher speeds, it remains limited to the speed range < 40 km/h. The higher drive slip remains stored up to 60 km/h and is automatically reactivated if vehicle speed drops below < 40 km/h. Once vehicle speed exceeds 60 km/h, the stored higher slip is erased and the indicator lamp in the switch goes out.



Arrangement of components



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Electrics/Electronics

A1e17	ABS indicator lamp
A1e21	ASR function display
A1e22	ASR indicator lamp
K1/1	Overvoltage protection relay
K20	Boost pump relay
L6/1	Left front axle speed sensor
L6/2	Right front axle speed sensor
L6/3	Left rear axle speed sensor
L6/4	Right rear axle speed sensor
M16/1	Electronic accelerator actuator
N4/1	Electronic accelerator control unit
N30/1	ABS/ASR control unit
R25	Electronic accelerator potentiometer
S9/1	Stop light switch
S40	Cruise control switch
S76	Snow chain switch (slip threshold selector) with indicator lamp

Hydraulics

A7	ABS hydraulic unit for ASR
A7/3	ASR hydraulic unit
M15	Boost pump
4a	Brake fluid reservoir
13	Pressure accumulator
6a/6b	Rear brake caliper with wear indicator

Mechanical parts

20	Idle travel rod (redundancy rod)
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B. Overall function ASR

The speeds of all the wheels are detected in the ABS/ASR control unit and processed. If the ABS/ASR control unit detects from the speed signals that one or both driven wheels are tending to spin, the ASR control mode is activated with the brake torque control loop and the driving torque control loop.

The following procedures are then performed:

- **Brake torque control loop**

The spinning driven wheel is braked by the relevant wheel brake until it has reached the most favorable drive slip range. This enables the other wheel to be optimally driven (locking differential effect). The spinning wheel is braked by part of the highly pressurized brake fluid in the pressure accumulator flowing out of the accumulator through the ABS and ASR hydraulic units into the brake caliper (pressure buildup). A solenoid valve modulates the pressure flow in the brake caliper during the brake torque control, in pressure buildup, pressure holding and pressure reduction. During the pressure buildup phase, the brake fluid volume is pumped out of the brake caliper through the return pump into the pressure accumulator. This control sequence is performed individually for each wheel brake of the driven wheels.

- **Driving torque control loop**

In order to reduce excessive driving torque for optimal traction, an exchange of signals takes place along the link between the ABS/ASR control unit and the electronic accelerator control unit.

The throttle valve position is reduced by the actuator in contrast to the accelerator pedal position input by the driver. A constant check is performed in the ABS/ASR control unit as to whether e.g. the control functions can be canceled as a result of a sudden improvement in road surface adhesion in order to again permit the driving torque input by the driver through the accelerator pedal at the earliest possible moment.

A distinction is made between two control ranges in the ASR control mode:

- Control mode for one spinning driven wheel and driving speeds < 40 km/h in which the control is oriented to the driven wheel which is still gripping. In this case, the slip threshold of the driving torque control is relatively high. The emphasis in this case is on achieving maximum traction.
- Control mode if both driven wheels are spinning or at driving speed < 40 km/h with the control oriented to the spinning driven wheel. The slip threshold of the braking torque control in this case is still above that for the driving torque control. Consequently, the emphasis is on achieving maximum driving stability.

C. Driving torque control loop

The driving torque control loop is based on the electrical / electronic components of the ABS/ASR and is supplemented by the electronic accelerator. The electronic accelerator is composed of the following electrical / electronic and mechanical components:

- Electronic accelerator potentiometer (R25)
- Electronic accelerator actuator (M16/1)
- Electronic accelerator control unit (N4/1)
- Accelerator control linkage and accelerator pedal
- Idle travel rod (redundancy rod)

The speed signals of the speed sensors are constantly processed in the ABS circuits and ASR microcomputers in the ABS/ASR control unit to form the following variables:

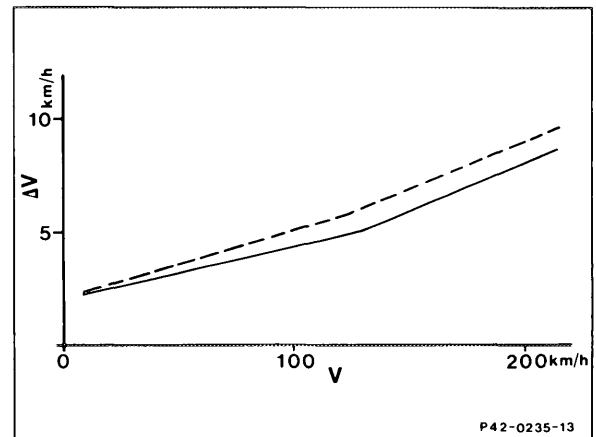
- Drive slip
- Acceleration
- Driving speed (front wheel)

If the variables calculated exceed certain given specified values, the ABS/ASR control unit signals the electronic accelerator control unit to throttle back. As a result, the electronic accelerator control unit and thus the throttle valve are controlled irrespective of the amount by which the accelerator pedal is depressed.

A function display indicates that the ASR control is activated and signals to the driver that he is approaching the physical limit of his vehicle.

The function of the ABS is not impaired by the ASR as an ASR control mode is interrupted by braking.

Depending on the speed driven, the braking torque control begins as soon as the differential speed between front and rear wheel (Δv) rises beyond the slip threshold of the braking torque control. Braking of the relevant rear wheel is controlled by building up pressure, holding pressure and reducing pressure in the corresponding rear wheel brake. Once the differential speed (Δv) again drops below the slip threshold, the system switches over to pressure buildup for a given time interval.



Slip thresholds

v = Speed

Δv = Differential speed between front and rear wheel

----- Braking torque control

————— Driving torque control

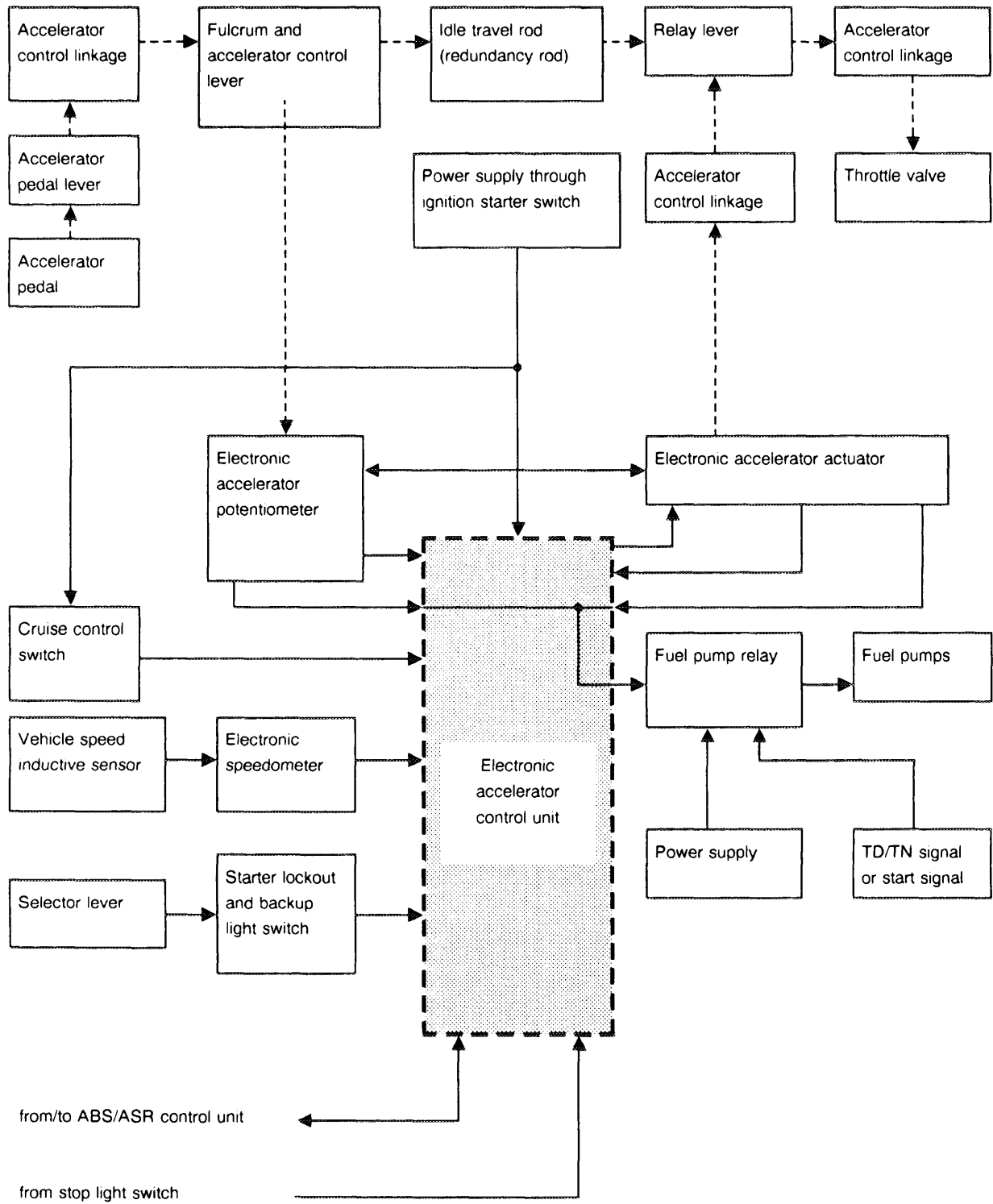
Driving

Irrespective of road condition and direction, an ASR control mode proceeds as follows:

If one driven wheel is spinning and the driving speed is < 40 km/h, the braking torque control is superimposed on the driving torque control. In this case, the braking torque control is activated first. The ABS/ASR control unit detects an impermissibly high slip and passes a signal to the solenoid valves in hydraulic unit. Thereupon, accumulator pressure flows into the appropriate brake caliper so that the relevant wheel is braked. As a result, the wheel running on the road surface offering better adhesion is supplied with torque through the differential. If the driver depresses the accelerator to full throttle, the spinning wheel moves into a higher slip range. The driving torque control is activated at approximately twice the slip of the braking torque control.

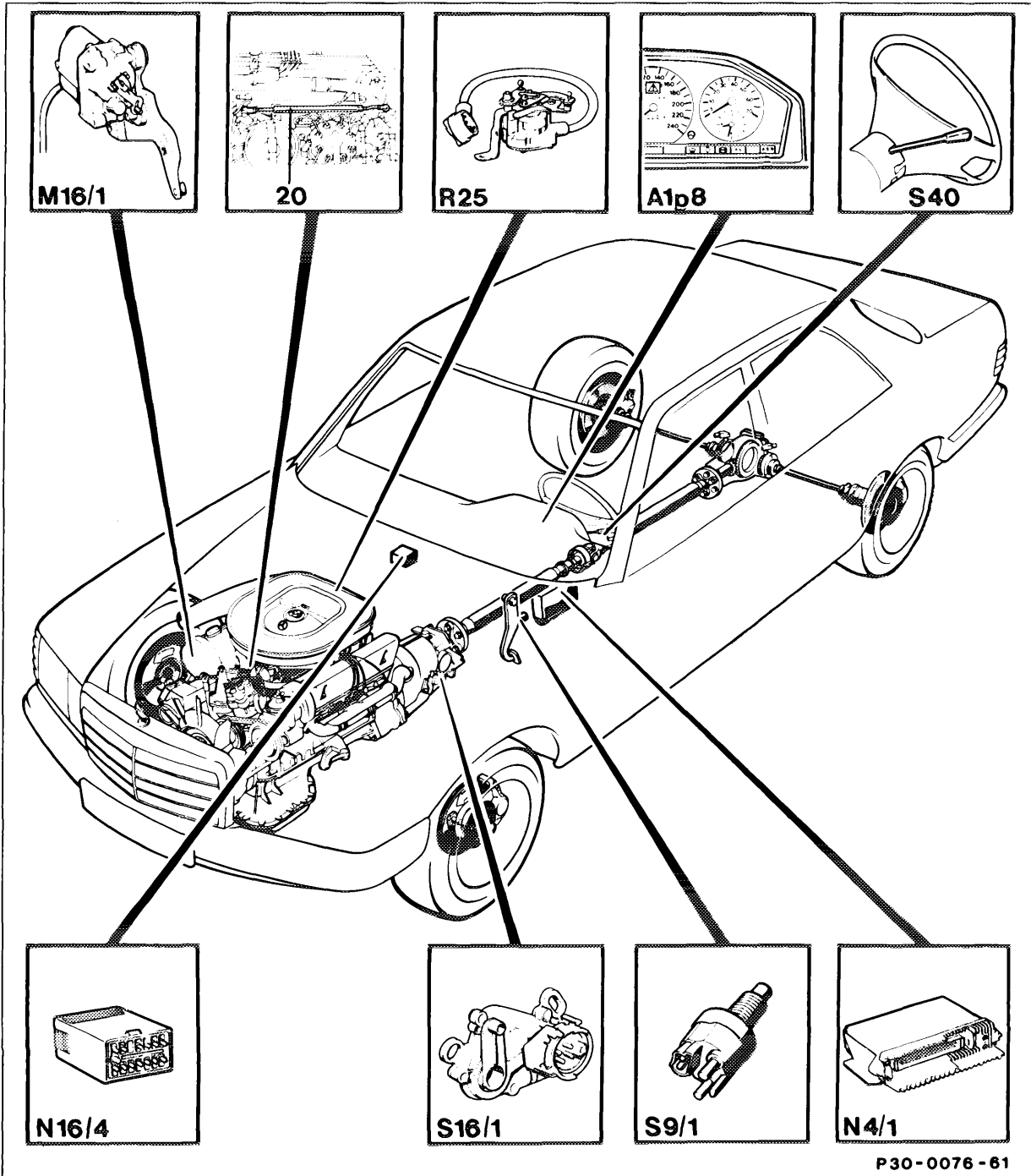
The ABS/ASR control unit passes a signal to the electronic accelerator control unit. The throttle valve is now moved by the electronic accelerator actuator against the accelerator pedal position. The driving torque is reduced. As soon as the slip has dropped below the lower slip limit, the throttle valve is slowly opened. This enables the maximum possible driving torque to be transmitted to the road. If the road conditions change, a renewed control cycle is started.

If both driven wheels are spinning or at vehicle speeds > 40 km/h, the driving torque control is superimposed on the braking torque control. The ABS/ASR control unit detects an impermissibly high slip and passes a signal to the electronic accelerator control unit. The throttle valve is moved by the electronic accelerator actuator against the accelerator pedal position input by the driver. As a result, the driving torque is reduced to the point where no slip which may impair driving stability can occur at the driven axle. The driver may detect the movement of the throttle valve by brief changes in the accelerator pedal forces. The control movement is continued until a wheel has dropped below the critical slip threshold. The remaining control cycle is then the same as for a single spinning driven wheel.



————— electric circuits
 - - - - - mechanical transmission

D. Electronic accelerator components



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A1p8 Electronic speedometer
 M16/1 Electronic accelerator actuator
 N4/1 Electronic accelerator control unit
 N16/4 Fuel pump and kickdown shutoff relay

R25 Electronic accelerator potentiometer
 S9/1 Stop light switch
 S16/1 Starter lockout and backup light switch
 S40 Cruise control switch
 20 Idle travel rod (redundancy rod)

E. Function of electronic accelerator

All the control processes as well as the mechanical adjusting movements are performed with the electrical /electronic components in combination with the mechanical components. The electronic components are supplied with the necessary voltage through **unprotected terminal 15** in the fuse box. The following components supply signals to the electronic accelerator control unit:

- Electronic accelerator potentiometer
- Electronic accelerator actuator
- ABS/ASR control unit
- Starter lockout and backup light switch
- Cruise control switch
- Electronic speedometer
- Stop light switch

The input signals are processed and monitored in the electronic accelerator control unit. The following components are activated with the output signals:

- Electronic accelerator actuator
- ABS/ASR control unit
- Fuel pump relay

When the ignition is switched on, the electronic accelerator is activated. The position of the accelerator pedal (set value) is signaled through the electronic accelerator potentiometer to the electronic accelerator control unit. An output signal for controlling the actuator is assigned to this set value in the electronic accelerator control unit.

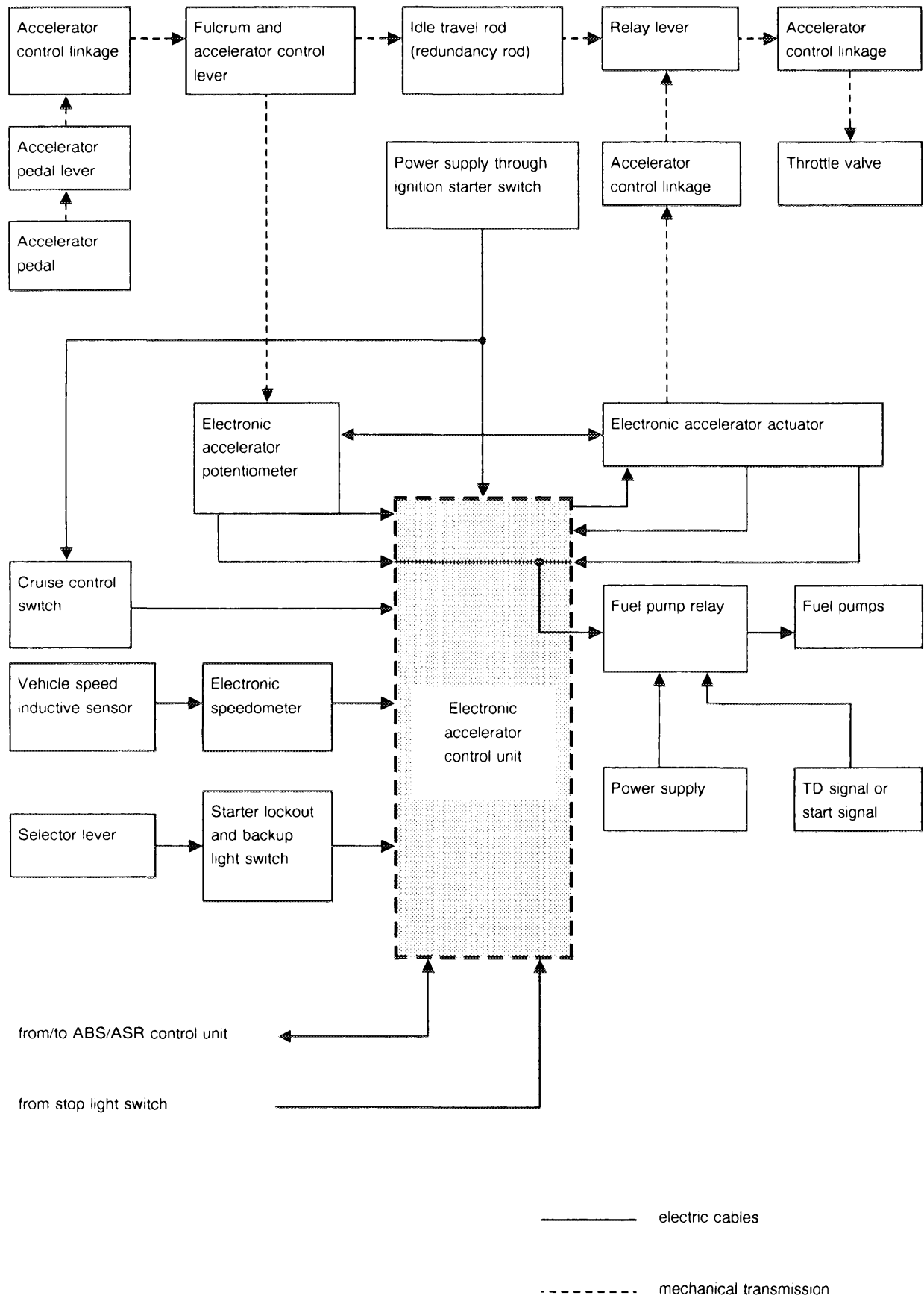
The electronic accelerator actuator thus assumes a position corresponding to the set value. The output lever of the electronic accelerator actuator is connected to the throttle valve by an accelerator control linkage. The opening angle of the throttle valve corresponds to the input set value, as a result of which the engine transmits a certain torque to the driven wheels.

If the entered set value (accelerator pedal deflection) is higher than the driving torque which can be transmitted to the road, this would result in the wheels spinning (slip). This slip is detected by the ABS/ASR control unit and a signal (throttle valve set value) is passed to the electronic accelerator control unit. As a result, the electronic accelerator actuator and thus the throttle valve can be closed against the adjusting movement of the accelerator pedal. If the throttle is excessive, the driving torque is reduced until the slip drops below a fixed value. With the electronic accelerator, it is possible to move the throttle valve between idle speed and full throttle or with the ASR to close it in the idle direction. If there is excessive driving torque at the driven wheels, the idle travel rod enables the throttle valve to be moved against the accelerator pedal position. The idle travel rod (redundancy rod) is an emergency driving device which enables the vehicle to continue to be driven at reduced engine output should the electronics fail. In addition, a cruise control system is contained in the electronic accelerator control unit.

Features:

- Throttle valve is always moved by the electrical / electronic device.
- Cruise control system is integrated in the electronic accelerator control unit.
- The vehicle can continue to be driven at reduced engine output in the event of a failure of the electrics / electronics.

Block diagram of electronic accelerator



F. Ignition starter switch "position 2"

When the ignition is switched on (ignition starter switch "position 2"), the electronic accelerator is activated. Power is supplied to the electronic accelerator control unit, electronic accelerator potentiometer and to the electronic accelerator actuator. In addition, the fuel pump relay is activated through the safety switch of the electronic accelerator actuator (voltage at terminal 15). Voltage is supplied from it to the fuel pumps for approx. 1 s. In addition, the cruise control switch is supplied with voltage through the ignition starter switch.

When the accelerator pedal is depressed, the adjusting movement is transmitted through the accelerator control linkage, fulcrum and relay lever to the electronic accelerator potentiometer.

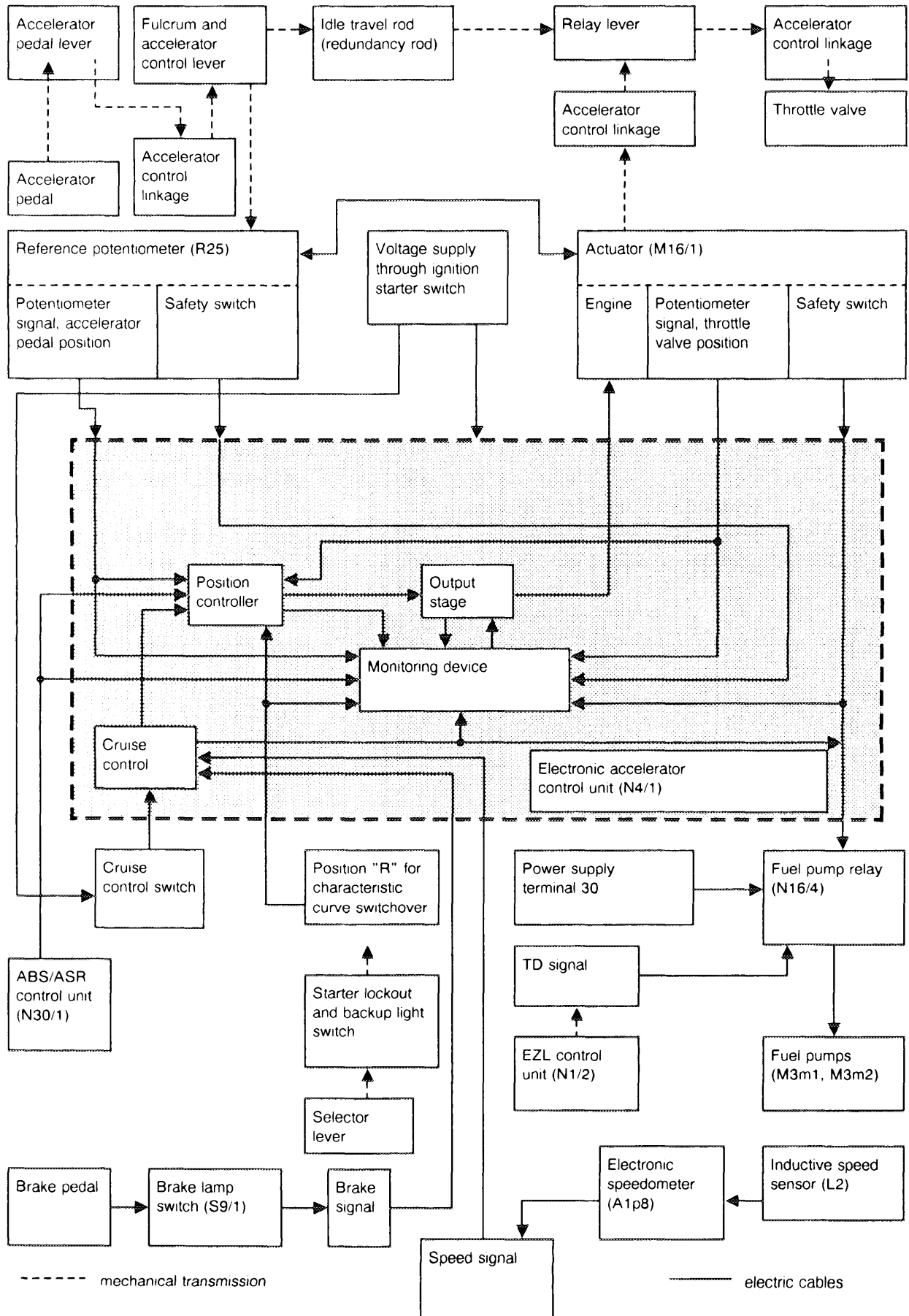
Depending on the accelerator pedal position, the potentiometer inputs a corresponding voltage signal to the electronic accelerator control unit.

A voltage signal is likewise input by the potentiometer of the electronic accelerator actuator (actual position of throttle valve). Both signals are compared in the position controller of the electronic accelerator control unit. If these signals vary, the actuator position is adapted to the set value (position of accelerator pedal). In addition, when the ignition is switched on, an exchange of information occurs between the ABS/ASR control unit and the electronic accelerator control unit.

The electronic accelerator control unit checks whether the permissible throttle valve set value of the ABS/ASR control unit is below the set value input by the driver. If this set value is too large, the ABS/ASR control unit determines the maximum possible throttle valve opening.

The signals from the electronic accelerator potentiometer, electronic accelerator actuator and ABS/ASR control unit are checked by the monitoring device. The output stage is also checked by the monitoring device.

Block diagram of electronic accelerator ignition starter switch "position 2"/idling/driving



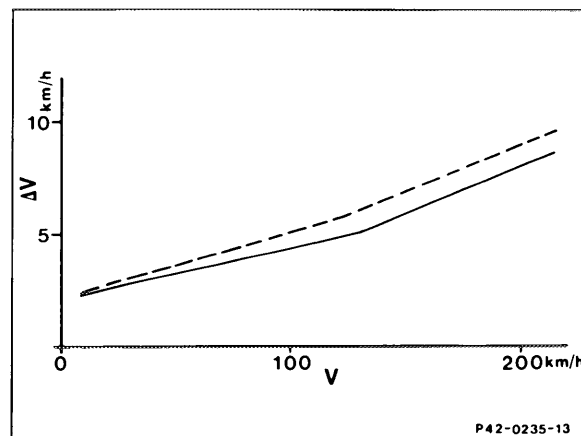
Idle speed

At idle speed, the electrical / electronic components are energized when the ignition starter switch is in "position 2". The fuel pump relay (terminal 15) is energized through the safety switch of the electronic accelerator actuator. The relay picks up in combination with the TD/TN signal, as a result of which terminals 87 and 30 are linked. The fuel pumps are energized. The input signals from the reference potentiometer as well as from the electronic accelerator actuator are supplied to the electronic accelerator control unit. These signals are processed in the position controller and the D.C. motor of the electronic accelerator actuator is controlled accordingly. When the accelerator is depressed, the entire travel of the throttle valve can be utilized. Signals are exchanged between the ABS/ASR control unit and the electronic accelerator control unit as for ignition starter switch "position 2".

Driving mode

In the driving mode, the throttle valve is adjusted by the electrical / electronic and mechanical components. The desired driving speed in this case depends on the position of the accelerator pedal.

Dependent on the speed driven, the driving torque control is activated as soon as the differential speed (Δv) rises above the slip threshold of the driving torque control. The driving torque is controlled by closing, holding and opening the throttle valve. Once the differential speed (Δv) again drops below the slip threshold, the throttle valve is opened according to the accelerator pedal input from driver.



Slip thresholds

v = Speed
 Δv = Differential speed between front and rear wheel

----- Braking torque control
————— Driving torque control

Driving with cruise control

The cruise control is operational as soon as the ignition is switched on. The vehicle must be traveling at a speed > 40 km/h, however, before the cruise control can be activated. Once the vehicle is traveling at the desired speed, it is sufficient to touch the switch in the direction "Accelerate Set" or "Decelerate Set" to maintain this speed until a new speed is fixed by the driver or the cruise control is switched off. This set speed can be varied, e.g. to adapt speed to traffic flow, by holding the switch in the direction "Accelerate Set" or "Decelerate Set" until the desired speed is reached. To perform minor changes in speed, it suffices to touch the switch in the direction "Accelerate Set" or "Decelerate Set" to increase or reduce the speed by 1 km/h.

The speed memory can only "count up" provided the throttle valve is not at full throttle and can then only "count down" provided the throttle valve is not at idle speed (i.e. in decel mode). The vehicle is accelerated in this case at a controlled speed of 0.7 m/s^2 . After the switch is released, the new speed is held. The cruise control is switched off by briefly moving the switch to the "Off" position or by touching the brake pedal, the accelerator control then adopts the accelerator position input by the driver. When the cruise control is switched off, the actuator motor is activated and moves the accelerator control to the idle position.

The system remains operational after being switched off until the ignition is switched off. If, after depressing the brake or switching off the system, the switch is moved to the position "Resume" at a vehicle speed above approx. 40 km/h, the vehicle automatically accelerates with 1 m/s^2 to the speed last fixed with the "Set" position. The speed last fixed is erased when the ignition is switched off. If the set speed is exceeded by depressing the accelerator, e.g. for overtaking, the vehicle automatically returns to the previously set speed when the accelerator pedal is again released.

If, when traveling uphill, engine power is not adequate, the driving speed drops below the set speed. The set speed is resumed again as soon as the incline levels off and provided the speed has not in the meantime dropped below 40 km/h or the vehicle has not been braked. If, when traveling downhill, the engine braking action is not sufficient, the set speed is exceeded and it may be necessary to brake the vehicle. If the vehicle has not been braked, the set speed is automatically resumed as soon as the downhill slope levels off.



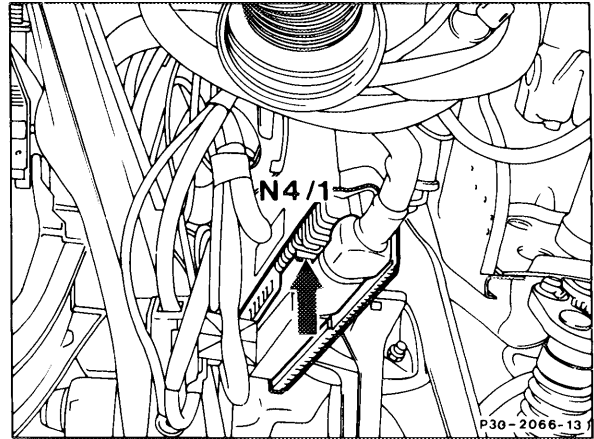
When driving with the cruise control do not engage selector lever position "N" of the automatic transmission otherwise the engine will overrev.

The speed last stored in the control unit is erased when the ignition is switched off. When the ignition is switched on again the value "0 km/h" is input to the speed memory. This ensures that, when starting off again, e.g. after changing drivers, no unknown speed is stored. The speed is constantly monitored by the electronic accelerator control unit. Any change of speed is registered and analyzed by a computer.

If the speed of the vehicle is changed with the cruise control switch, the computer in the electronic accelerator control unit ensures that the specified values for the switch positions "Accelerate/Set" of 0.7 m/s^2 or for "Resume" of 1 m/s^2 are maintained. When the cruise control is switched off, the safety circuit in the electronic accelerator control unit monitors that the electronic accelerator actuator drops back to the set value of the accelerator. If, for example, the vehicle is decelerated $> 1.5 \text{ m/s}^2$ with a faulty stop light switch, the deceleration is registered by the computer and the electronic accelerator actuator closes the throttle valve with the maximum possible speed.

G. Electronic accelerator control unit (N4/1)

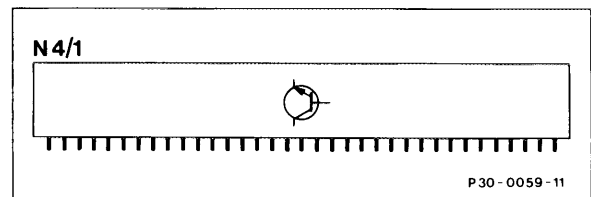
The electronic accelerator control unit is located below the instrument panel, above the pedals. It contains two printed circuit boards with electronic components. The housing is an aluminum alloy with a 35-pin plug connector. The control unit is linked to the wiring harness by a 35-pin connector which is fixed in place by a spring clip (arrow).



Voltage is supplied to the potentiometer for the electronic accelerator actuator and electronic accelerator reference potentiometer by the electronic accelerator control unit when the ignition starter switch is in "position 2". In addition, the signals input by the components are processed accordingly. The electronic control unit is split up functionally into the following components:

- Position controller with input amplifier (signal processing part)
- Output stage
- Monitoring device (safety circuit)
- Cruise control device
- ASR signal processing

The electronic accelerator control unit is configured in analog technology with the exception of the cruise control computer.



Position controller

The input signals to the position controller are converted, filtered and amplified in the upstream signal processing parts. Following this, these signals are appropriately processed in the position controller and a defined output signal generated for the output stage.

Output stage

The output signal of the position controller is passed to the output stage where it is amplified. In addition, this signal determines the positioning direction (idle speed direction or full throttle direction) of the D.C. motor in the electronic accelerator actuator. In this case, the D.C. motor is actuated with a frequency of 140-160 Hz. If the D.C. motor is blocked, a continuous current is output briefly. If the blockage persists, the output stage is shut off by the monitoring device. The output stage is short circuit proof to ground.

Cruise control device

The cruise control function is integrated in the electronic accelerator control unit. As with the previous electrical cruise control, it is activated and switched off with the cruise control switch. If the cruise control switch is constantly operated < 40 km/h and the vehicle accelerated with the accelerator pedal beyond the safety threshold, the cruise control does not switch on. The cruise control cannot be activated if the switch is operated during a brake application. When the cruise control is set, a corresponding input signal is supplied to the position controller.

As a result, the position of the throttle valve is fixed. If the driver demands a higher speed by depressing the accelerator pedal, the cruise control device is not active. If the ASR detects drive slip during the cruise control mode, the reduction in engine power (lower speed) has priority over the cruise control mode. Once the drive slip has been eliminated, the cruise control resumes the previously stored speed provided the driver does not demand any other function.

Monitoring device

The monitoring device performs safety functions. The following functions are checked:

- The operating ranges of the electronic accelerator reference potentiometer and electronic accelerator actuator.
- The cables to the electronic accelerator reference potentiometer and electronic accelerator actuator for short circuit or interruption.
- The function of the safety switches in the electronic accelerator reference potentiometer and electronic accelerator actuator.

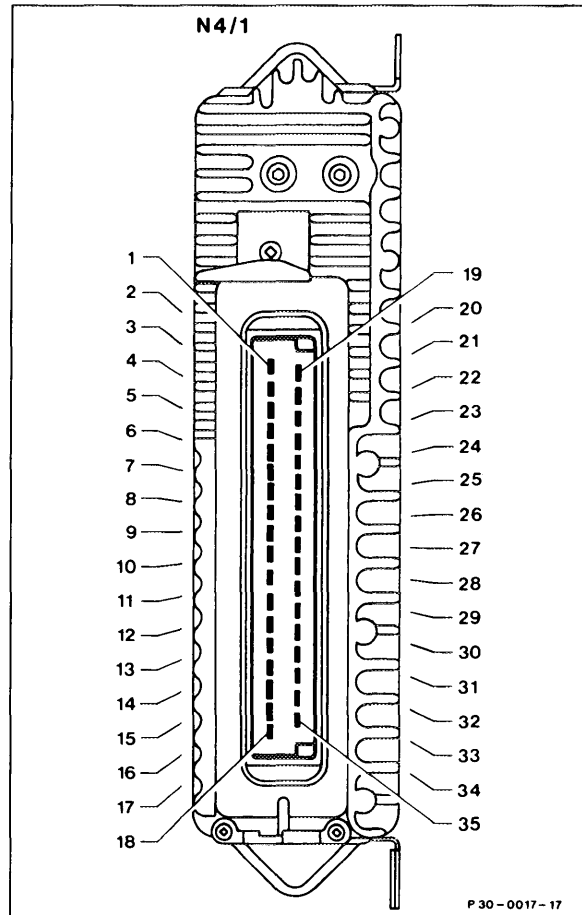
- The positioning accuracy of the electronic accelerator actuator, related to the set position, which is fixed either by the accelerator pedal (reference potentiometer), cruise control or by the ABS/ASR control unit.
- Short circuit of output stage of D.C. motor.
- Battery voltage at electronic accelerator control unit. Below a battery voltage of 6 V, the electronic accelerator control unit switches off, and switches on again when the voltage rises.

The function of the safety switch is independent of the electrical / electronic control function of the driving torque control loop. The current through the safety switches of electronic accelerator reference potentiometer and electronic accelerator actuator is looped through the control unit. Consequently, in the driving mode or at idling speed the fuel pump relay (terminal 15) is energized. The safety switch in the electronic accelerator reference potentiometer closes when the accelerator is depressed before the safety switch in the electronic accelerator actuator opens.

The situation is reversed when the accelerator pedal is released. Depending on the position of the accelerator pedal, the contact in the electronic accelerator reference potentiometer or in the electronic accelerator actuator is closed. To avoid any interruption in the voltage supply occurring when a rapid adjustment movement is made to idle speed, a switching transistor is connected additionally to the output of the electronic accelerator control unit. When the safety switch in the electronic accelerator reference potentiometer opens, this transistor assumes the voltage supply to the fuel pump relay for max. 150 ms. In the cruise control mode, the safety switch in the electronic accelerator reference potentiometer is open, as is the safety switch in the electronic accelerator actuator. The switching transistor (as already indicated) assumes the task of the safety switch of the electronic accelerator reference potentiometer to ensure that the fuel pump relay is able to maintain the voltage supply of the fuel pump (terminals 30 and 87 jumped by relay contact). The safety switches including switching transistor are likewise covered by the monitoring device.

Pin assignment of electronic accelerator control unit

- 1 Voltage supply, terminal 15 unprotected
- 2 Voltage supply, terminal 15 unprotected
- 3 Electronic accelerator actuator (motor)
- 4 Electronic accelerator actuator (motor)
- 5 Reference potentiometer, ground
- 7 Do not create contact!
- 8 Not assigned
- 9 Reference potentiometer, voltage supply (+)
- 10 Not assigned
- 11 Battery ground (W10) only on Model 126.036/037/044
- 12 Electronic speedometer speed signal
- 13 Safety switch, reference potentiometer
- 14 Stop light switch
- 15 Reference potentiometer (wiper signal)
- 16 Cruise control switch (Decelerate, Set)
- 17 Not assigned
- 18 Cruise control switch (Resume)
- 19 Do not create contact!
- 20 Electronic accelerator actuator (motor)
- 21 Electronic accelerator actuator (motor)
- 22 Battery ground (W10)
- 23 Battery ground (W10)
- 24 Not assigned
- 25 Not assigned
- 26 Electronic accelerator actuator, potentiometer voltage supply (+)
- 27 Not assigned
- 28 Electronic accelerator actuator, potentiometer (wiper signal)
- 29 Electronic accelerator actuator (safety switch)
- 30 Fuel pump relay, terminal 15, contact 9
- 31 To ABS/ASR control unit (throttle valve actual value)
- 32 Cruise control switch (Accelerate, Set)
- 33 Starter lockout and backup light switch, drive stage "R"
- 34 From ABS/ASR control unit (throttle valve set value)
- 35 Cruise control switch (Off)



Speed signal

The speed signal from the electronic speedometer is input to the electronic accelerator control unit for the cruise control function. It is used by the electronic accelerator control unit only for the cruise control. If there is no speed signal, this does not impair acceleration nor the driving torque control.

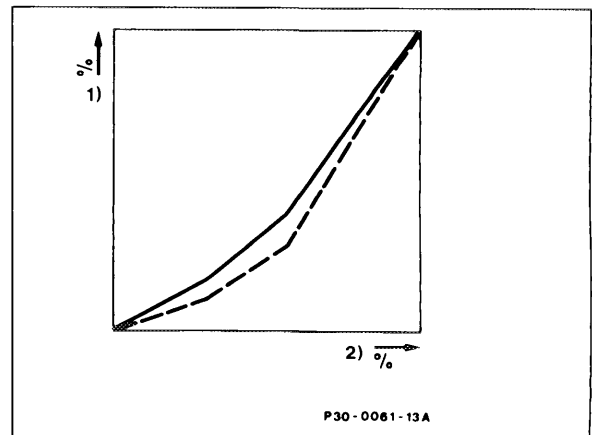
Stop light switch signal

When the brake is applied, the cruise control device is supplied with a signal change through the stop light switch. This means that the ground connection is interrupted. The cruise control function is immediately canceled. At the position controller, the input signal of the cruise control device is canceled. As a result, the electronic accelerator actuator is controlled so that the throttle valve is moved back to the set point by the accelerator pedal. The position of the accelerator pedal has priority. If there is no ground signal from the brake switch, the cruise control is switched off. This does not impair acceleration nor the driving torque control.

Selector lever position signal

When the driving position "R" is engaged by the selector lever, the position controller is supplied with an input signal from the starter lockout and backup light switch. As a result, a characteristic curve switchover is performed in the position controller. When reversing, the throttle valve is opened less rapidly up to approximately half pedal travel. This achieves enhanced comfort for reversing.

- 1 Throttle valve angle
- 2 Accelerator pedal travel



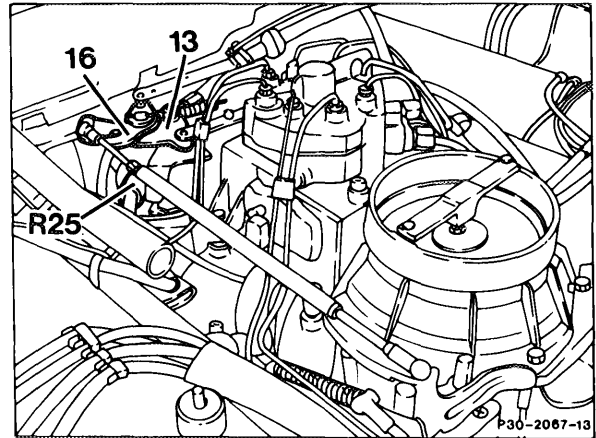
ABS/ASR control unit signal

An exchange of information occurs (200 times per second) between the ABS/ASR control unit and the electronic accelerator control unit. The electronic accelerator control unit detects from the shape of the signal from the ABS/ASR control unit whether drive slip exists and what maximum throttle valve opening is permissible. Depending on the slip conditions at the driven wheels, the throttle valve can also be fully closed by an appropriate ASR control signal.

This is also possible even if the driver or the cruise control inputs full throttle. The electronic accelerator control unit constantly informs the ABS/ASR control unit by means of a similar feedback signal (throttle valve actual value) of the momentary position of the electronic accelerator actuator and thus of the throttle valve. The ABS/ASR control unit can thus check during an ASR control cycle whether the electronic accelerator follows the control commands of the ASR device. If a fault exists in the electronic accelerator range (without cruise control function) (actuator does not have voltage supply), the feedback signal disappears and the ASR device shifts to fault. The ASR indicator lamp (A1e22) lights up.

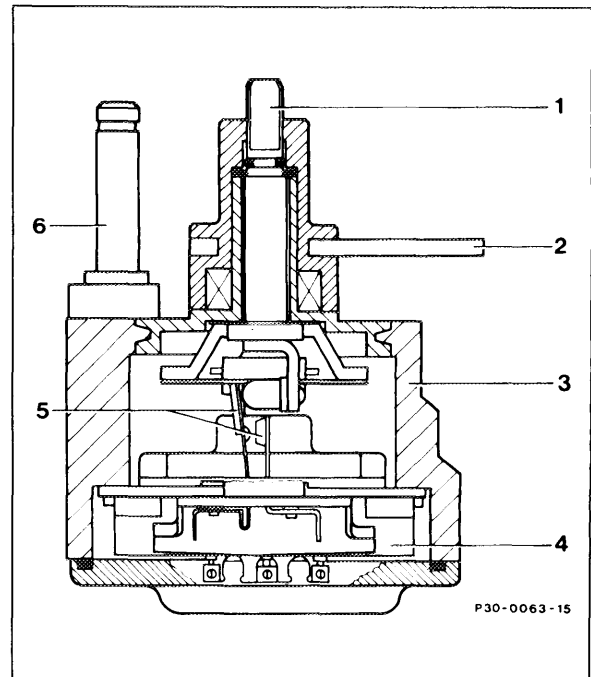
H. Electronic accelerator reference potentiometer (R25)

The electronic accelerator reference potentiometer is attached to the intake manifold at the level of engine cylinder No. 4. It consists of a variable electrical resistor (potentiometer) and a safety switch. The safety switch is designed as a double-contact switch. Both components are operated by the potentiometer shaft to which the accelerator control lever is attached. The fulcrum lever is mounted on the pin next to the potentiometer shaft. In ignition starter switch "position 2" or when the engine is running, the potentiometer is activated with a constant voltage by the electronic accelerator control unit. The potentiometer position is altered by the adjusting movement at the accelerator pedal through the accelerator control linkage, fulcrum and accelerator control levers. The potentiometer feeds back a defined variable voltage to the electronic accelerator control unit as a function of the accelerator pedal position. This signal is further processed in the position controller of the electronic accelerator control unit. If the accelerator pedal is not depressed (idle position), the safety switch of the electronic accelerator reference potentiometer is open. Voltage is supplied to the input side of the safety switch when the ignition is switched on or when the engine is running. The switch point of the safety switch is 4-6° adjustment angle above the idle stop.



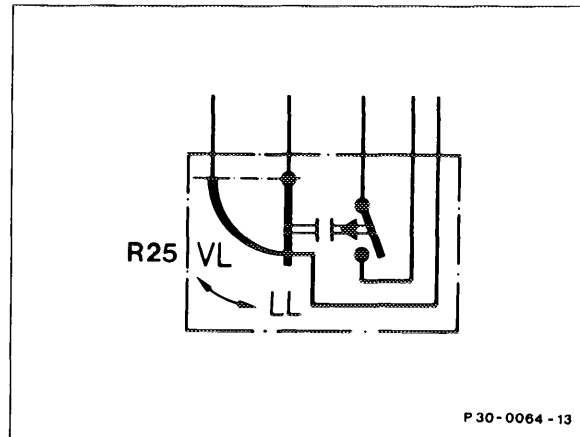
R25 Reference potentiometer

- 13 Accelerator control lever
- 16 Fulcrum lever



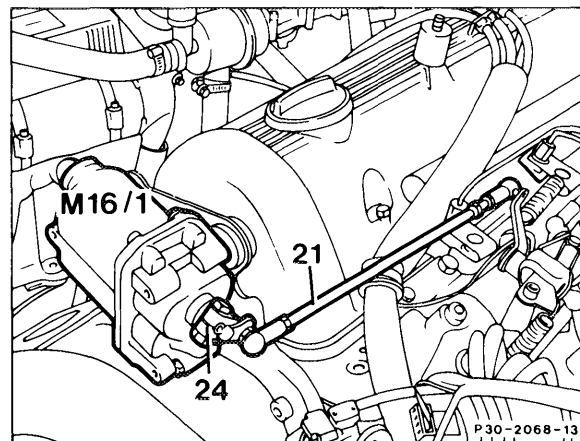
- 1 Adjustment shaft
- 2 Reference potentiometer relay lever
- 3 Housing
- 4 Potentiometer
- 5 Safety switch
- 6 Pin for fulcrum lever

If the safety switch is closed, terminal 15 at the fuel pump relay is energized. If the accelerator pedal is moved from full throttle toward idle speed, the safety switch opens at approx. 6–4° before idle speed stop. In the idle position, the closed safety switch in the electronic accelerator actuator (M16/1) adopts this voltage supply. The maximum current flow must not exceed 1 A. The switch is not short circuit proof to ground.



I. Electronic accelerator actuator (M16/1)

The electronic accelerator actuator is attached to the face end of engine cylinder 1 by a mounting bracket. It consists of a D.C. motor with multi-stage gear to which the output lever for the accelerator control linkage is attached. In addition, the wiper for the potentiometer and the safety switch are coupled to the output shaft. Here, too, the safety switch is designed as a double-contact switch. When the ignition starter switch is in "position 2" or when the engine is running, the potentiometer is controlled with a constant voltage from the electronic accelerator control unit. The output signal of the potentiometer to the electronic accelerator control unit acts as a position feedback of the momentary throttle valve position. This signal is further processed in the position controller of the electronic accelerator control unit. If deviating signal tones are received, the electronic accelerator control unit alters the position of the throttle valve.

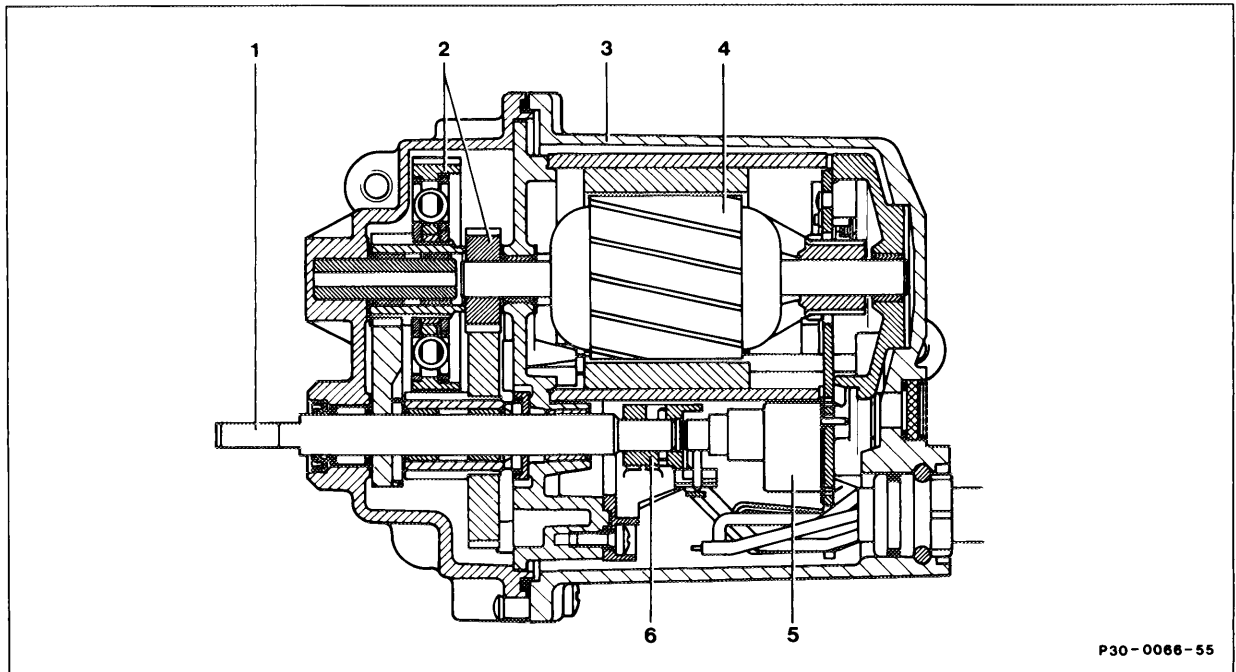


M16/1 Electronic accelerator actuator

- 21 Connecting rod
- 24 Output lever

The adjustment range of the electronic accelerator actuator is 88–92°. This enables the throttle valve to be moved by the accelerator control linkage from idle speed through to full throttle stop and vice versa.

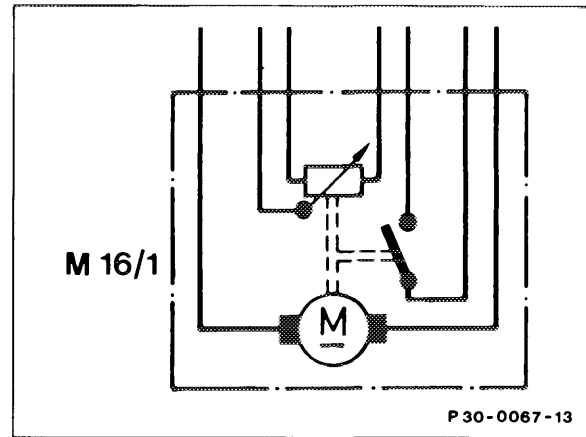
The D.C. motor features a high positioning rate. The total adjustment angle is covered in approx. 120 ms. At the same time, this ensures a high positioning accuracy.



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- | | | | |
|---|----------------|---|---------------|
| 1 | Output shaft | 4 | Armature |
| 2 | Reduction gear | 5 | Potentiometer |
| 3 | Housing | 6 | Safety switch |

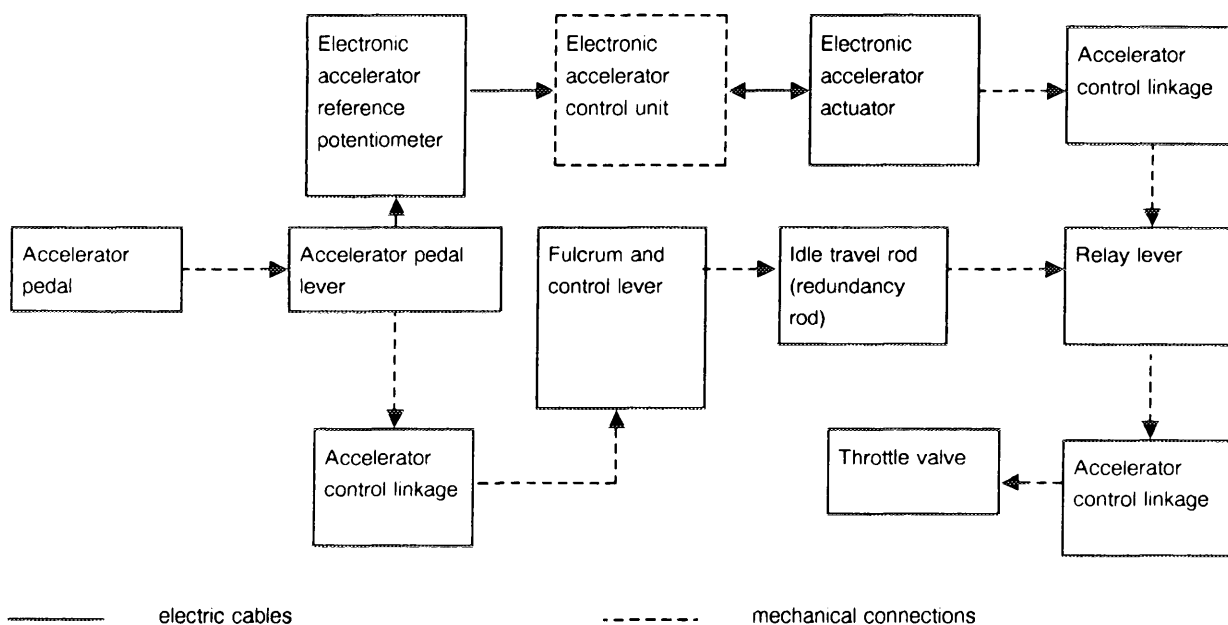
The power consumption at maximum positioning rate is 8 A. If the accelerator pedal is not depressed, the safety switch is closed. It is energized when the ignition starter switch is in "position 2" or when the engine is running, and at the same time terminal 15 at the fuel pump relay is also energized. When the accelerator pedal is depressed, the safety switch opens. The switching point is approx. 8–12° above the idle position. The safety switch of the electronic speedometer reference potentiometer (R25) now assumes the voltage supply for the fuel pump relay. To avoid any switching lag when the accelerator pedal is moved rapidly, a switching transistor assumes the voltage supply for the fuel pump relay for a defined period (see monitoring device, electronic accelerator control unit). The maximum current flow must not exceed 1 A. The switch is not short circuit- proof to ground.



The position of the accelerator pedal is input to the electronic accelerator reference potentiometer through the accelerator pedal, accelerator pedal lever, accelerator control linkage, fulcrum and control levers. The throttle valve is then always adjusted by means of the electrical / electronic components - electronic accelerator reference potentiometer, electronic accelerator control unit and actuator.

The throttle valve is operated by the output lever of the electronic accelerator control unit and actuator by means of the accelerator control linkage and relay lever. The adjustment travel ranges from idle speed stop to full throttle stop. If a fault occurs in the electrical / electronic components, the throttle valve can be adjusted by means of the idle travel rod (redundancy rod). This enables the vehicle to be operated at approx. 2/3 engine output.

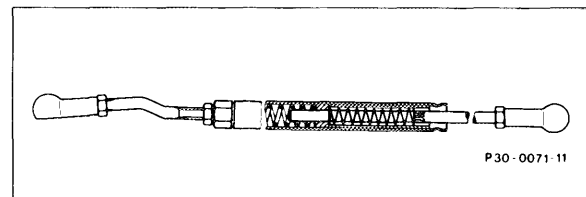
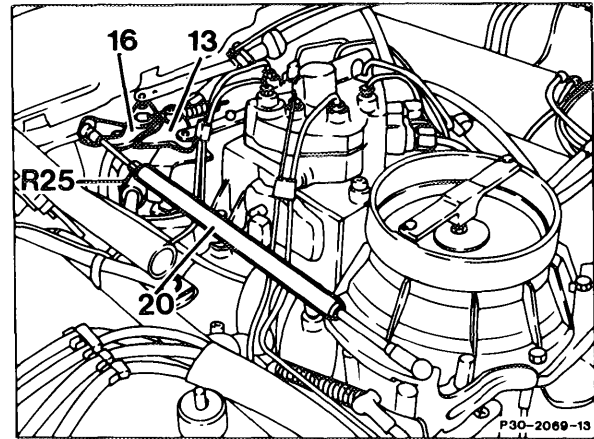
Block diagram accelerator control



Idle travel rod (redundancy rod)

The idle travel rod (20) is a spring-tensioned accelerator control rod. It connects the accelerator control lever at the electronic accelerator reference potentiometer with the relay lever on the throttle valve side. When the throttle valve is adjusted electrically / electronically, the idle travel rod is also moved. It performs the following tasks:

- If excessive driving torque exists at the driven wheels, the idle travel rod enables the throttle valve to be moved against the accelerator pedal position. This adjustment movement is assisted by the return springs on the throttle valve relay lever and on the throttle valve. A fixed accelerator control linkage in place of the idle travel rod is impractical as this would not permit an ASR control mode.
- In the cruise control mode, the control pressure cable of the automatic transmission is operated from the electronic accelerator actuator. This enables the transmission to shift down at high engine load.
- If there is any fault or failure in the electrical / electronic components, the idle travel rod performs the adjustment of the throttle valve. This ensures that the vehicle can still be driven and permits approx. 2/3 of available engine output to be utilized. The emergency driving facility is activated. The driver can detect this from the higher accelerator pedal forces and by the ASR indicator lamp lighting up.



**K. Matching engine – electronic accelerator reference potentiometer –
 electronic accelerator actuator – electronic accelerator control unit**

Engine	Model	Electronic accelerator reference potentiometer Part No.	Electronic accelerator actuator Part No.	Electronic accelerator control unit Part No.
116, 117	126	006 548 85 17	003 545 50 32	126 545 00 32 up to 10/88 126 545 07 32 11/88 – 07/89 126 545 08 32 as of 08/89