

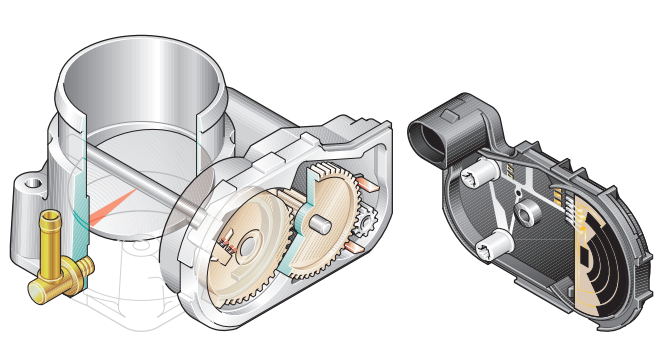
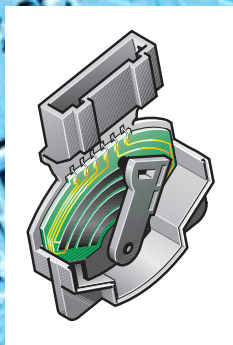
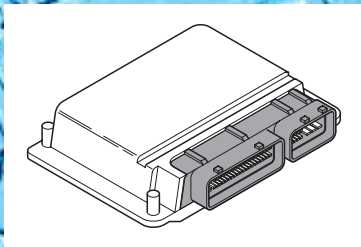
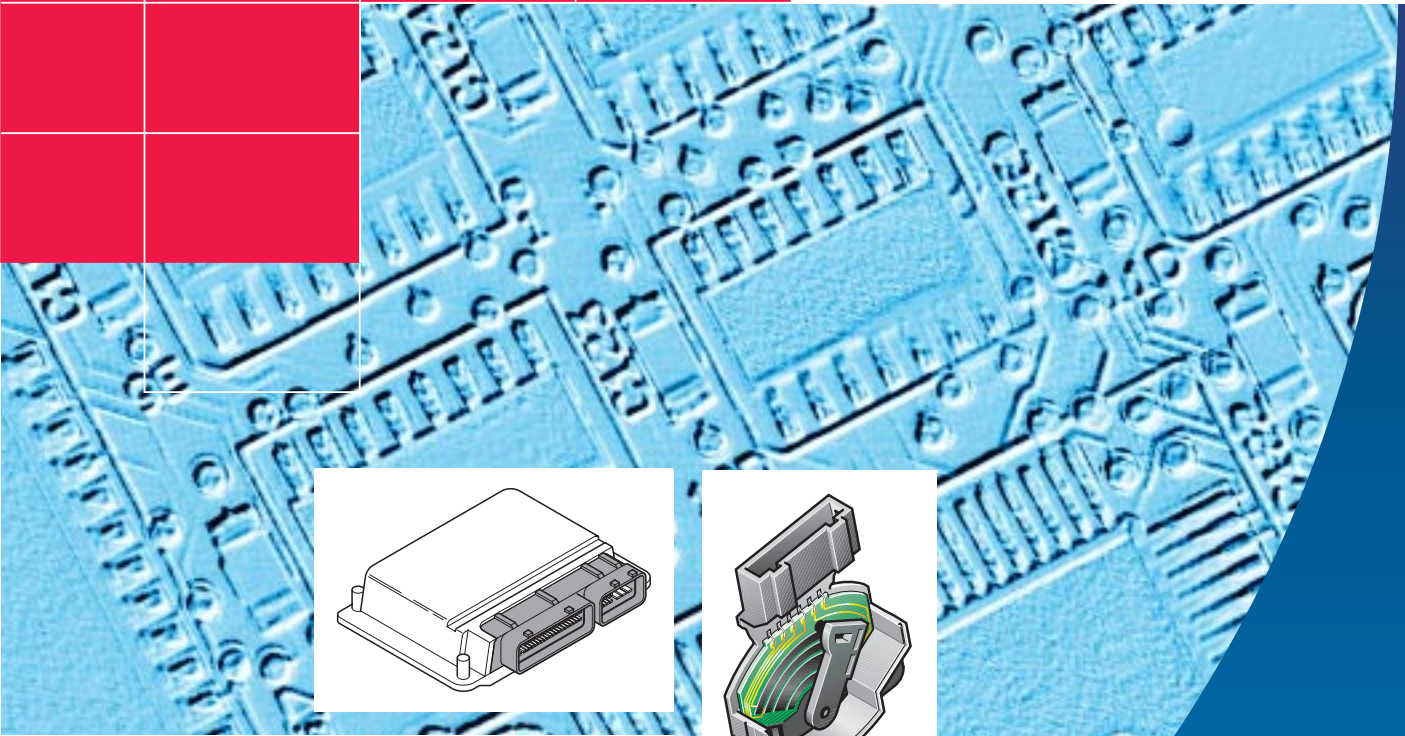
Service.



Self-Study Programme 210

Electronic Power Control

Design and Function



With the Electronic Power Control system, the throttle valve is actuated only by an electric motor.

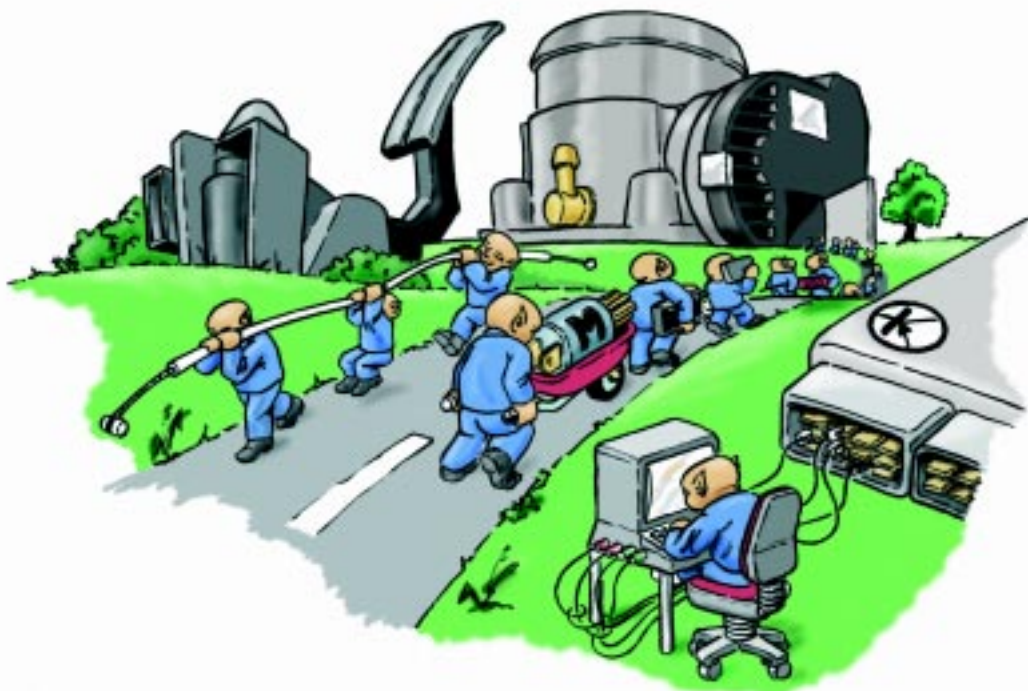
This eliminates the need for a Bowden cable between the accelerator pedal and the throttle valve.

It means that the driver input is relayed to the engine control unit via the accelerator pedal. The engine control unit then sends a corresponding command to the throttle valve positioner.

By positioning the throttle valve, the engine control unit can regulate engine torque even if the driver has not depressed the accelerator pedal.

The result is better co-ordination between and within the engine management systems.

We will now demonstrate that the Electronic Power Control is more than just a substitute for the Bowden accelerator cable.



New



Important
Note



**The Self-Study Programme
is not a Workshop Manual.**

Please always refer to the relevant Service Literature for all inspection, adjustment and repair instructions. Service literature.

Table of contents



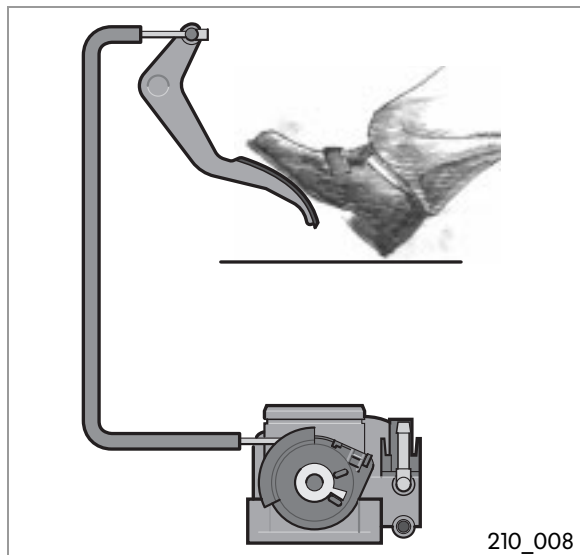
Introduction	4
Throttle valve positioning	4
System description	5
Control process	6
System design	7
What happens and when?	8
 System components	 10
System overview	10
The engine control unit	11
The accelerator pedal module	14
The throttle valve control unit	16
The fault indicator lamp	22
Auxiliary signals	23
 Function diagram	 25
 Self-diagnosis	 26
 Test your knowledge	 30



Introduction



Throttle valve positioning

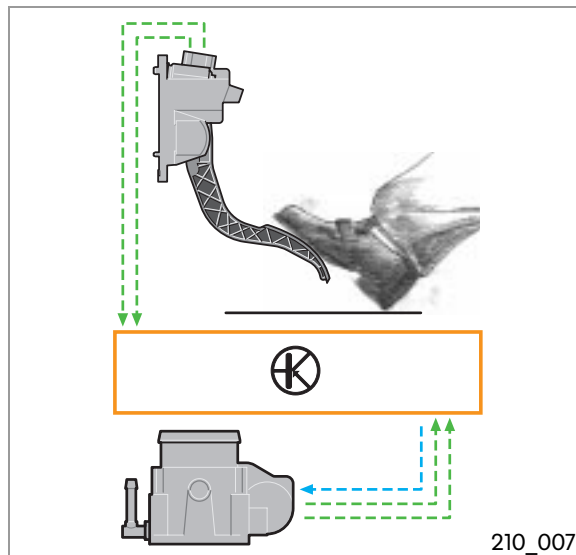


Mechanical throttle valve positioning system

With this system, the driver depresses the accelerator pedal and thus positions the throttle valve mechanically by means of a Bowden cable.

When the driver depresses the accelerator pedal, the engine management system cannot control the position of the throttle valve. To regulate engine torque, the engine management system must refer to other controlled variables such as ignition timing and injection timing.

Throttle valve positioning by an electric motor drive is only possible in the idling speed range and in combination with the Volkswagen cruise control system.



Electric throttle valve positioning system

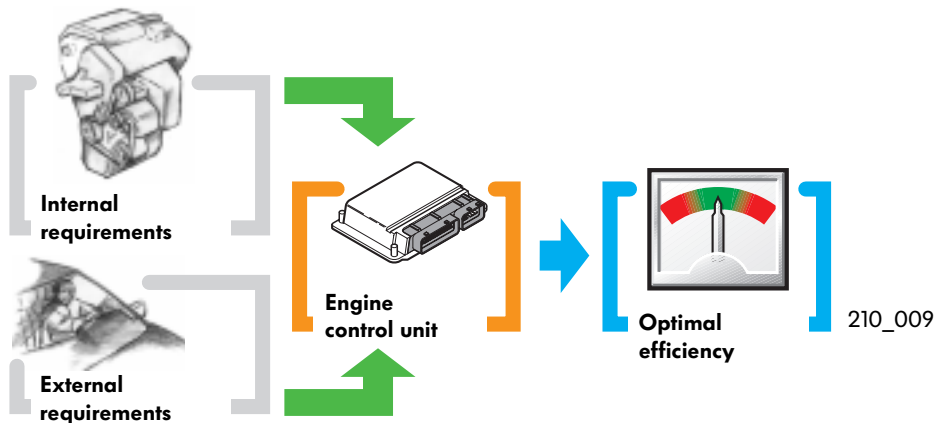
With this system, the throttle valve is positioned by an electric motor across the full adjustment range.

The driver depresses the accelerator pedal according to the engine power required. Senders register the accelerator pedal position and relay this information to the engine control unit. The engine control unit now sends a signal corresponding to the driver input to the throttle valve positioner which in turn sets the throttle valve to the appropriate angle.

If the engine torque has to be adjusted for reasons of safety or fuel consumption, however, the engine control unit can adjust the position of the throttle valve independent of the accelerator pedal position.

The advantage of this is that the control unit defines the position of the throttle valve according to the various individual requirements (driver input, exhaust emissions, fuel consumption and safety).

System description



The "tools" which the engine management system uses to influence the engine torque are: throttle valve, charge pressure, injection timing, cylinder suppression and ignition advance angle.

Engine torque control with mechanical throttle valve positioning

The various torque requirements are signalled individually to the engine control unit and then processed.
The torque demands cannot be matched optimally because the engine control unit cannot access the mechanically adjustable throttle valve directly.

Engine torque control with electric throttle valve positioning

This system permits torque-oriented engine management.

What does this mean?

First, the engine control unit gathers all the internal and external torque demands. Then it calculates the necessary control actions.
This system is more precise and efficient than the previous system.

Internal torque demands include:

- Start
- Catalytic converter heating
- Idle speed control
- Power limitation
- Speed limiting device
- Lambda control

External torque demands originate from:

- the automatic gearbox (shift point)
- the brake system (Traction Control System, engine braking control)
- the air conditioning system (air conditioner compressor ON/OFF) and
- the cruise control system



Introduction



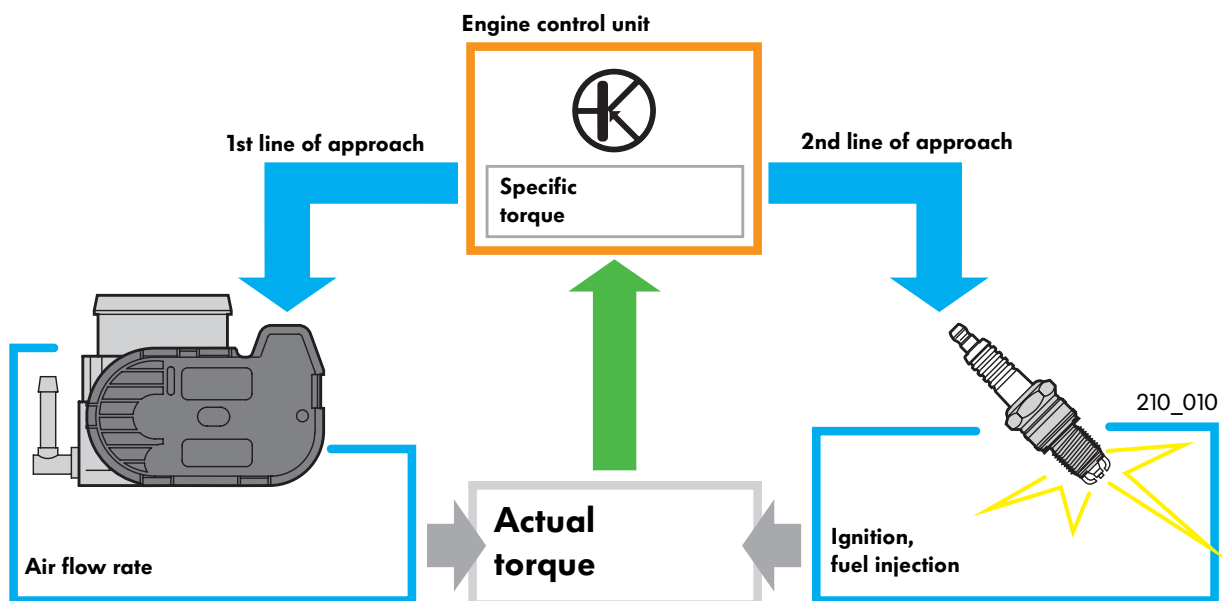
Control process

The engine management system generates a specific torque according to the external and internal torque demands.

Actual torque is calculated from the following factors: engine speed, load signal and ignition advance angle.

The engine control unit initially compares the actual torque and the specified torque. If these two values differ from one another, the system determines the corrective action necessary to make these values match.

The system pursues two lines of approach simultaneously.



With the first line of approach, the system activates the controlled variables that affect charge. These variables are also known as controlled variables for long-term torque demand.

They are:

- throttle valve angle and
- charge pressure (turbocharged engines).

With the second line of approach, the system changes the controlled variables that affect short-term torque independent of charge.

They are:

- ignition point,
- injection time and
- cylinder suppression.

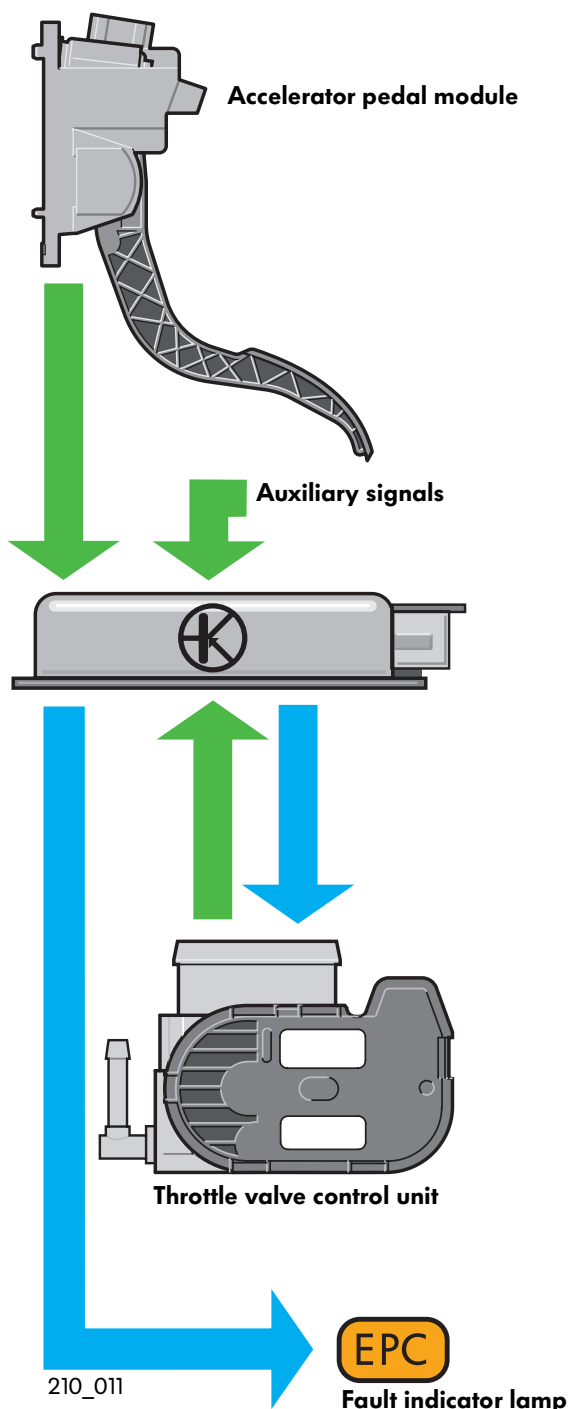


On the following pages, we will show you how the electric throttle valve positioning function works.

System design

Electronic Power Control comprises:

- the accelerator pedal module together with the accelerator position senders,
- the engine control unit,
- the throttle valve control unit, and
- the fault indicator lamp for Electronic Power Control.



The accelerator pedal module

determines the current accelerator pedal position with its senders and sends a corresponding signal to the engine control unit.

The engine control unit

calculates from this signal how much engine power is required by the driver and converts this information into an engine torque value. For this purpose, the engine control unit activates the throttle valve drive in order to open or close the throttle valve further. When activating the throttle valve drive, the engine control unit makes allowance for additional engine torque demand factors such as air-conditioning.

In addition, it monitors the "Electronic Power Control" function.

The throttle valve control unit

is responsible for providing the required air mass flow.

The throttle valve drive actuates the throttle valve in accordance with the instructions issued by the engine control unit.

The throttle valve angle senders supply the engine control unit with feedback on the position of the throttle valve.

The fault indicator lamp for Electronic Power Control

indicates to the driver that there is a fault in the Electronic Power Control system.



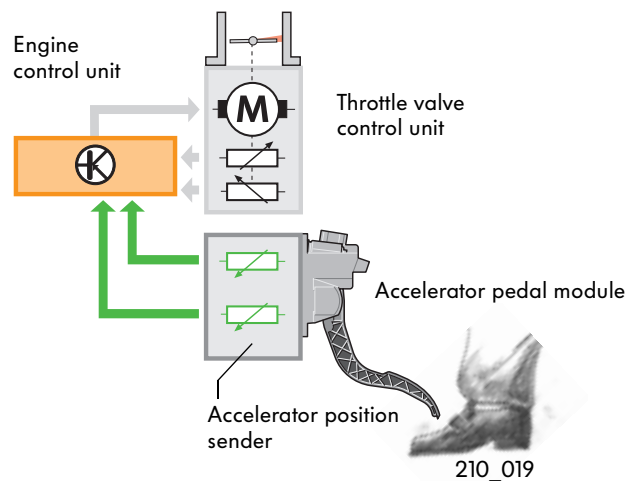
Introduction



What happens and when?

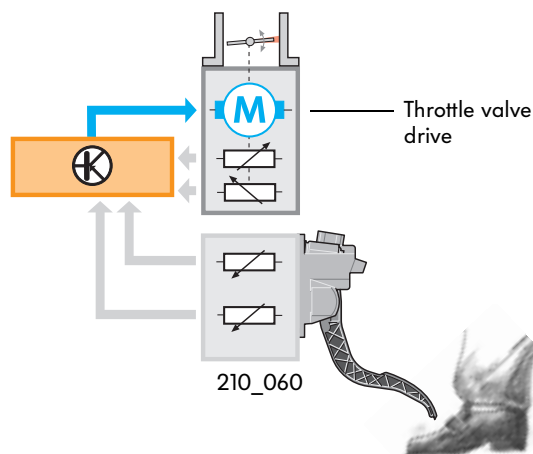
In idling mode

The engine control unit can recognise from the signal voltages of the accelerator position sender that the accelerator pedal is not depressed. The idle speed control process now commences.



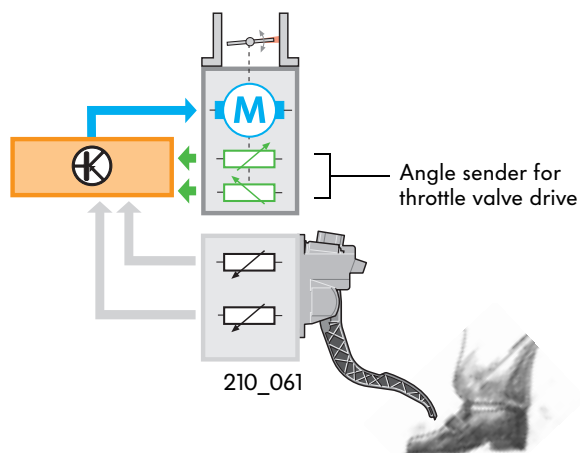
The engine control unit activates the throttle valve drive and positions the throttle valve by means of an electric motor.

The throttle valve is opened or closed further depending on the extent to which the actual idling speed deviates from the specified idling speed.

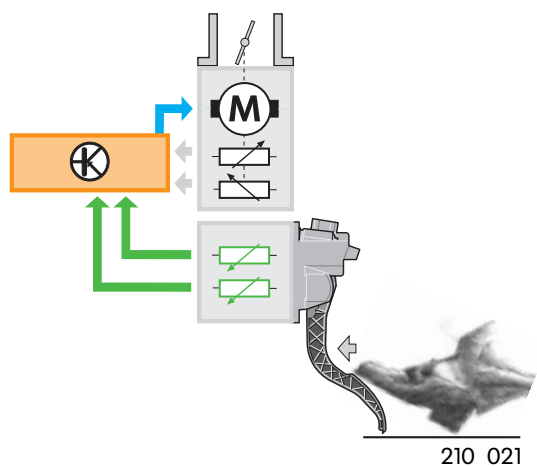


The two angle senders for throttle valve drive signal the current position of the throttle valve to the engine control unit.

They are located in the throttle valve control unit.

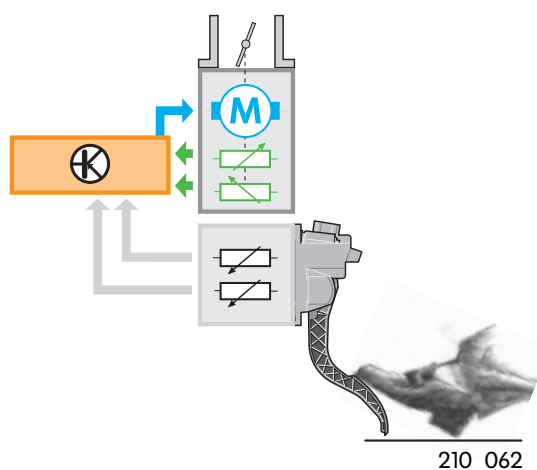


The digital idling stabilisation function also supports the idle speed control process.

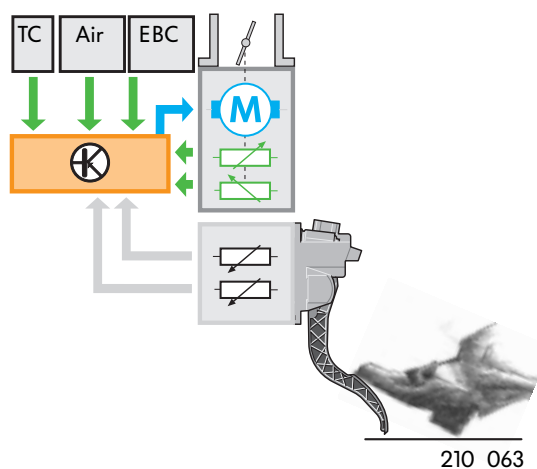


Pressing the accelerator pedal

The engine control unit can recognise from the signal voltages of the accelerator position sender the extent to which the accelerator pedal is depressed. Using this information, the engine control unit calculates the driver input and positions the throttle valve by actuating the throttle valve drive by means of an electric motor. The engine control unit also controls the ignition timing, the injection timing and, if necessary, the charge pressure.



The two angle senders for throttle valve drive determine the throttle valve position and send a corresponding signal to the engine control unit



The engine control unit makes allowance for additional engine torque demand factors when calculating the necessary throttle valve position.

These include:

- the speed limiting device
- the cruise control system
- the Traction Control System (TCS) and
- the engine braking control (EBC)

When engine torque is required, the throttle valve can be adjusted even if the driver has not changed the accelerator pedal position.



System components

System overview

Sensors

Accelerator pedal module with
accelerator pedal position
sender -1- **G79** and
accelerator pedal position
sender -2- **G185**

Throttle valve control unit **J338**
with
angle sender 1
for throttle valve drive **G187**
and
angle sender 2
for throttle valve drive **G188**

Clutch pedal switch **F36**

Brake light switch **F**
and
brake pedal switch **F47**

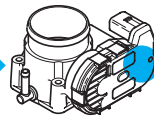
Auxiliary signals from:

- automatic gearbox,
- brake system,
- air conditioning system,
- cruise control system,
- and others

Engine control unit J...

Actuators

Throttle valve control unit
J338



Throttle valve drive **G186**



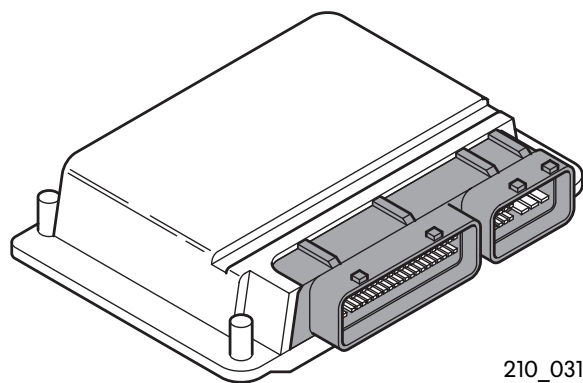
Fault indicator lamp for
electric throttle control
K132
(**E**lectronic **P**ower **C**ontrol)



The system components
may be different to those
shown in this overview
depending on vehicle
equipment specification.

210_037

Diagnostic connection



210_031

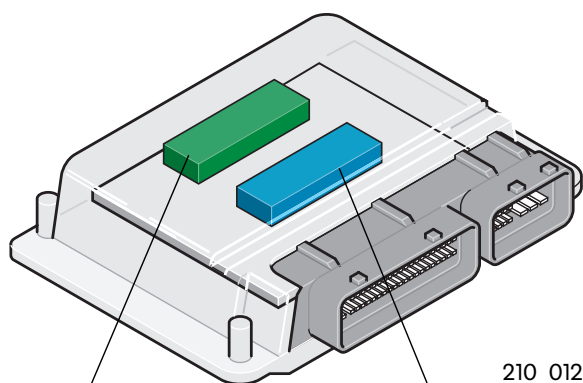
Engine control unit J...

Its tasks in the Electronic Power Control:

The EPC calculates from the input signal supplied by the accelerator position sender how much engine power the driver requires and converts this information into an engine torque by means of the actuators.

The engine control unit makes allowance for additional functions of the engine management system (e.g. engine speed limitation, road speed limitation and power limitation) and other vehicle systems (e.g. the brake system or the automatic gearbox).

The engine control unit also monitors the "Electronic Power Control" system in order to prevent malfunctions occurring.



210_012

Function processor

Watchdog processor

Design

Put in simple terms, the engine control unit comprises two processing units: the function processor and the watchdog processor.

- The function processor

receives the signals from the sensors, processes them and then activates the actuators.

The function processor also checks the watchdog processor.

- The watchdog processor

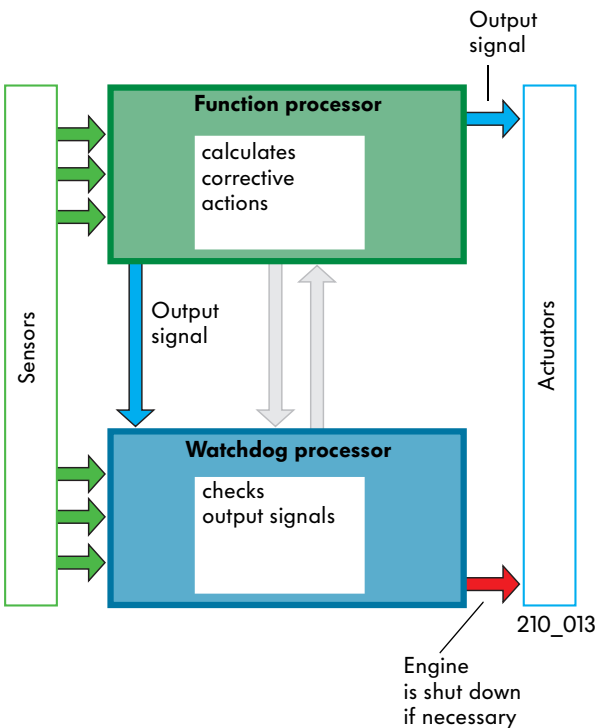
serves only to check the function processor.

System components

Monitoring function

The watchdog processor continuously monitors the functions of the function processor. At the same time, it checks the output signals of the function processor against its own calculations. The function processor and the watchdog processor check each other by means of a query & answer function.

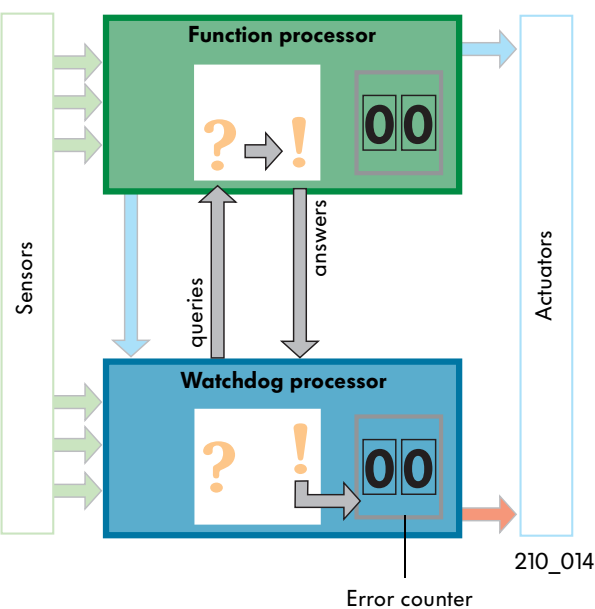
If faults are found, both processors can influence the throttle valve control unit, the ignition and the injection independently from one another in order to shut down the engine.



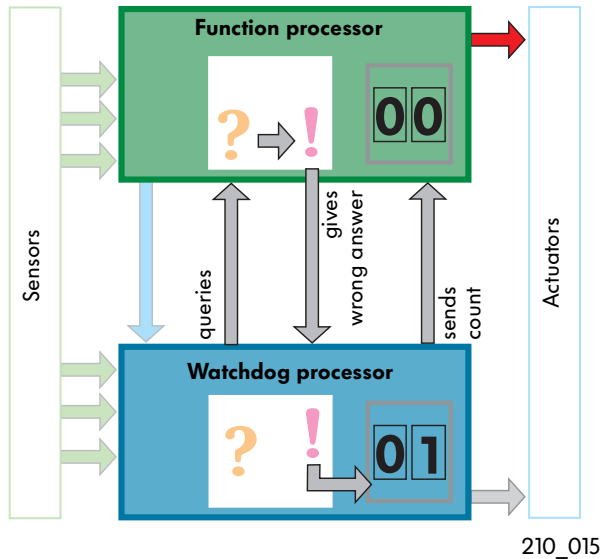
The watchdog processor checks the function processor with the query & answer function.

The watchdog processor queries the function processor with regard to, say, engine speed or ignition advance angle. Then it checks whether the answer is correct. If a wrong answer is given, the error counter of the watchdog processor is incremented.

The engine is shut down after five wrong answers. Five wrong answers can be detected in less than a half second.



The function processor checks the watchdog processor

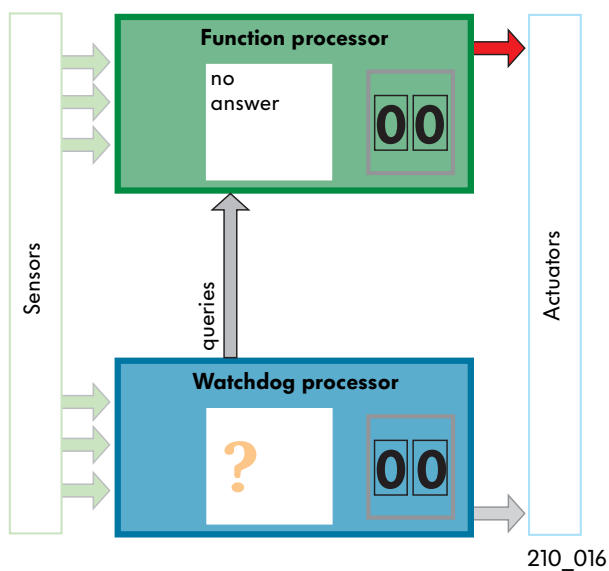


To monitor the watchdog processor, the function processor deliberately gives a wrong answer. If the watchdog processor recognises the wrong answer, this error is registered in the error counter and returned to the function processor. If the watchdog processor does not recognise the wrong answer, the error counter of the function processor is incremented.

The engine is shut down after the watchdog counter fails to recognise five wrong answers.



The function processor gives no answer or gives an answer at the wrong point in time



In this case, the engine is shut down immediately.

System components

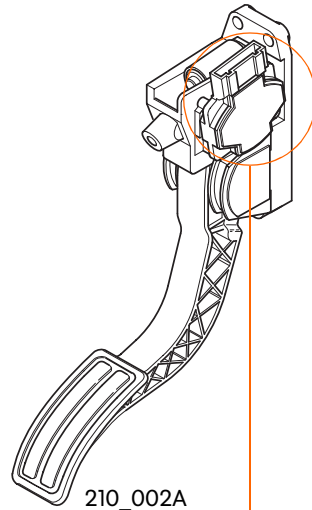
The accelerator pedal module

comprises

- the accelerator pedal,
- accelerator pedal position sender -1- G79 and
- accelerator pedal position sender -2- G185

Two senders are used to ensure maximum safety. This system configuration is also known as a "redundant system".

Redundant literally means "superfluous". In technical terms, there is redundancy when, for instance, an item of information occurs more often than is required for system operation.

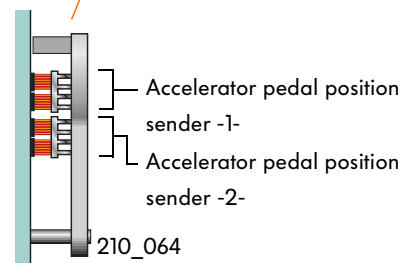
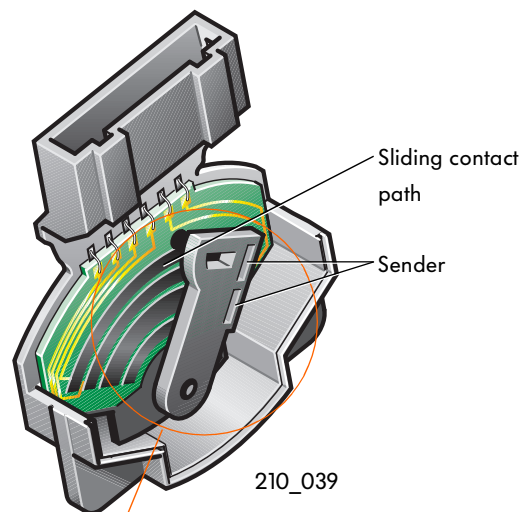


Open housing on accelerator pedal module showing senders G79 and G185.

Signal utilisation

The engine control unit is able to recognise the current position of the accelerator pedal from the signals supplied by the two accelerator position senders.

The two senders are sliding contact potentiometers and are mounted on a common shaft. The resistances of the sliding contact potentiometers and the voltages transmitted to the engine control unit vary with each change in the accelerator pedal position.



The signal voltages are indicative of kick-down and idling speed. The idling speed switch F60 in the throttle valve control unit is no longer required.

Effects of signal failure

The following happens when one sender fails:

- An entry is made in the fault memory and the fault indicator lamp for electrical throttle control is activated.
- The system initially activates the idling mode. If the second sender is found to be in the idling speed position within a defined test period, vehicle operation is resumed.
- If full throttle is desired, the engine speed is increased slowly.
- The idling speed is also registered via the brake light switch F or brake pedal switch F47.
- The convenience functions, e.g. cruise control system or engine braking moment control, are deactivated.

The following happens when both senders fail:

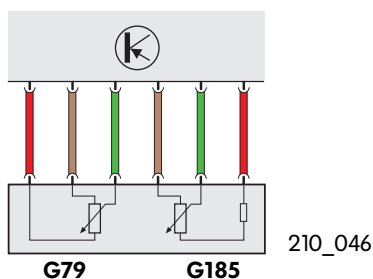
An entry is made in the fault memory and the fault indicator lamp for Electronic Power Control is activated.

- The engine runs at a higher idling speed (max. 1500 rpm) only and no longer responds to the accelerator.



Simultaneous failure of both senders may not be identified properly depending on the engine management system.

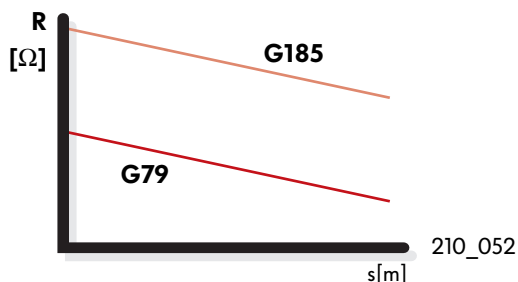
- The fault indicator lamp is not activated.
- The engine runs at a higher idling speed and no longer responds to the accelerator.



Electrical circuit

A voltage of 5 volts is present at both sliding contact potentiometers.

For safety reasons, each sensor has its own voltage supply (red), its own earth connection (brown) and its own signal wire (green).



A series-type resistor is fitted in sender G185. As a result, two different characteristics are obtained for the two senders. This is a prerequisite for the safety and test functions.



The signal from the sender is read out in percent on the associated measured value block. Hence, 100% = 5 volts.

System components

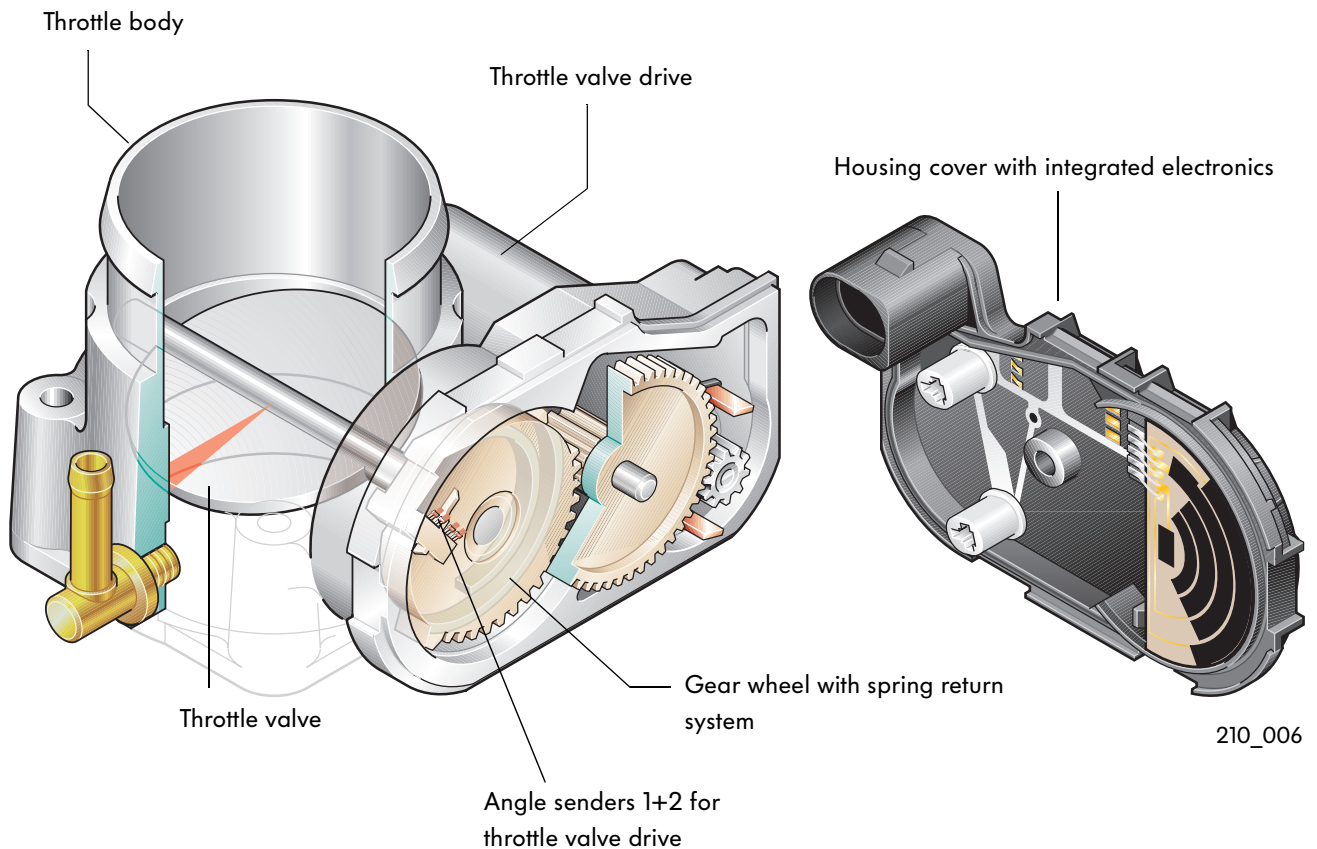
The throttle valve control unit J338

is located on the intake manifold. It ensures that the engine is provided with the required air flow.

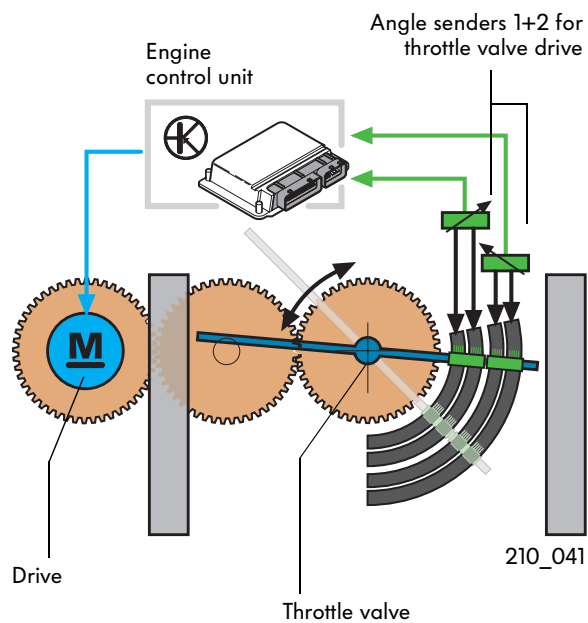
Design

It comprises

- the throttle body,
- the throttle valve,
- throttle valve drive G186,
- angle sender 1 for throttle valve drive G187 and
- angle sender 2 for throttle valve drive G188.



Do not open or repair the throttle valve control unit.
The basic setting procedure must be performed after replacing the throttle valve control unit.

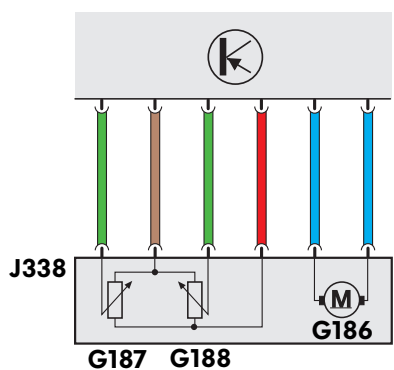


Function

To open or close the throttle valve, the engine control unit activates the electric motor for throttle valve drive.

The two angle senders provide the engine control unit with feedback on the current position of the throttle valve.

For safety reasons, two senders are used.



Electrical circuit

Both angle senders have a common voltage supply (red) and earth wire (brown).

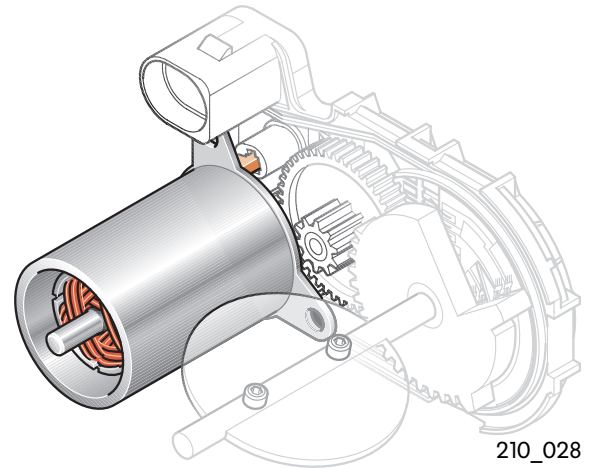
Each of the two senders has its own signal wire (green).

The throttle valve drive (blue) is activated depending on the direction of movement.

System components

Throttle valve drive G186

The throttle valve drive is an electric motor and is activated by the engine control unit. The throttle valve drive operates the throttle valve by means of a small gear. The throttle valve can be positioned in infinitely variable steps between the idling position and the full-throttle position.

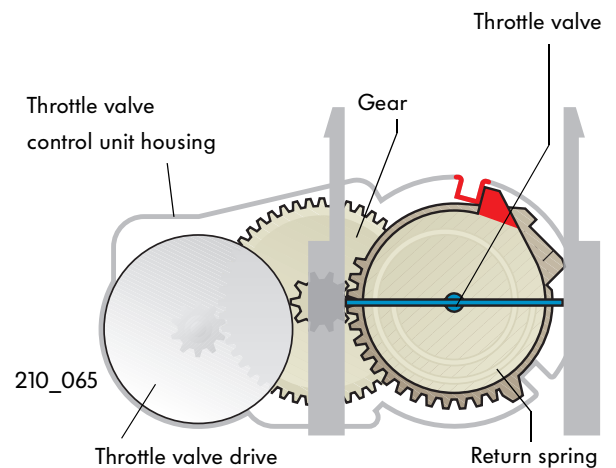


Throttle valve drive as shown at the housing cover of the throttle valve control unit.

Throttle valve position

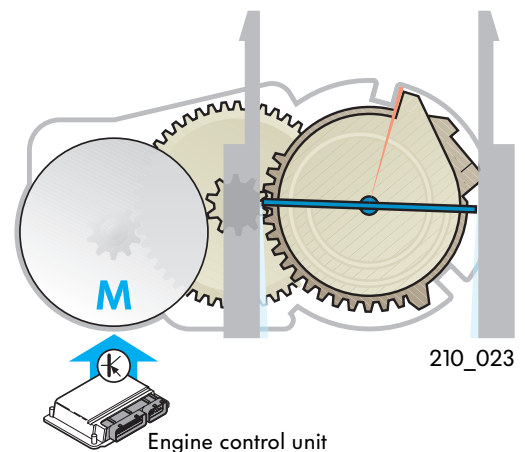
- The lower mechanical stop

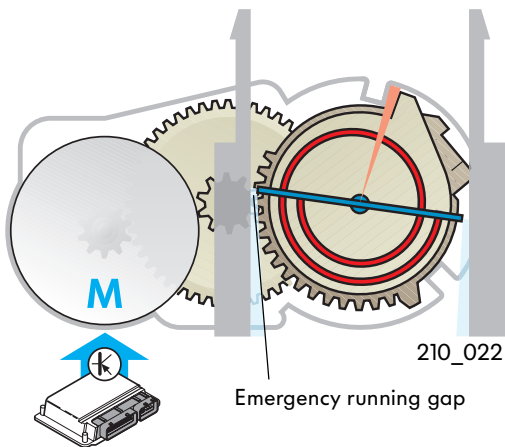
In this position, the throttle valve is closed. It is required for the basic adjustment of the throttle valve control unit.



- The lower electrical stop

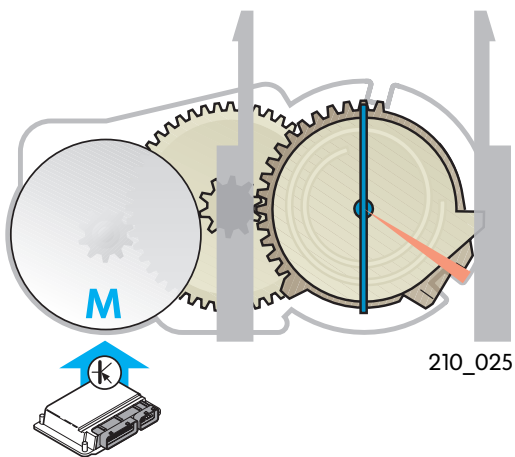
is defined in the engine control unit and is located just above the lower mechanical stop. During operation, the throttle valve is closed no further than the lower electrical stop. This prevents the throttle valve from intruding into the housing.





- The emergency running position

When the throttle valve drive is deenergised, the throttle valve is set to the emergency running position by a spring return system. In this position, only limited vehicle operation is possible at a higher idling speed.

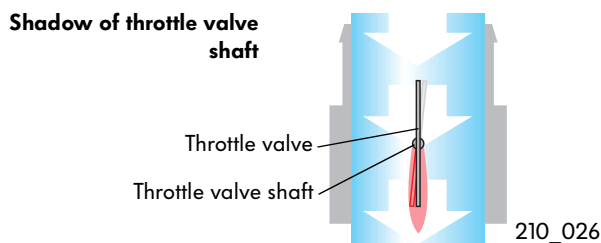


- The upper electrical stop

is defined in the engine control unit. It is the maximum opening angle of the throttle valve during vehicle operation.

- The upper mechanical stop

is positioned above the upper electrical stop. It does not affect engine power, however, because it is located in the "shadow" of the throttle valve shaft.



Effects of failure

If the throttle valve drive fails, the throttle valve is set to the emergency running position automatically.

- An entry is made in the fault memory, and the fault indicator lamp for electric throttle control is activated.
- Only emergency running functions are available to the driver.
- The convenience functions are deactivated (e.g. cruise control system).

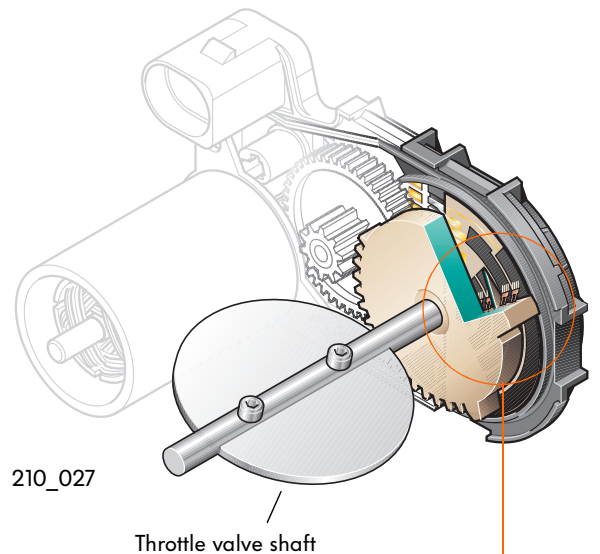


System components

**Angle sender 1 for throttle valve drive G187
and
angle sender 2 for throttle valve drive G188**

Design

The two senders are sliding contact potentiometers.
The sliding contacts are located on the gear which is mounted on the throttle valve shaft.
They scan the potentiometer strips in the housing cover.

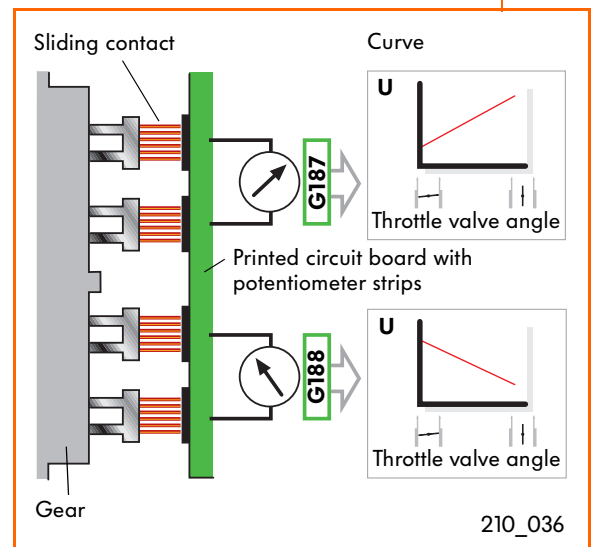


Angle senders 1 + 2

Function

The resistances of the potentiometer strips - and therefore also the signal voltages transmitted to the engine control unit - vary with every change in the accelerator pedal position.

The curves of both potentiometers are inverse. This allows the engine control unit to differentiate between the two potentiometers and to execute test functions.



Schematic diagram of sliding contact potentiometer



The angle of the throttle valve specified in percent in the measured value block.
Hence, 0% corresponds to the lower electrical stop and 100% corresponds to the upper electrical stop.

Effects of signal failure

The engine control unit receives either an implausible signal, or no signal at all from an angle sender:

- An entry is made in the fault memory, and the fault warning lamp for electrical throttle control is activated.
- Subsystems which influence torque (e.g. cruise control system or engine braking moment control) are deactivated.
- The load signal is utilised to monitor the residual angle sender.
- The accelerator pedal gives a normal response.

The engine control unit receives either an implausible signal, or no signal at all from the angle senders:

- An entry is made for both senders in the fault memory, and the fault indicator lamp for electric throttle control is activated.
- The throttle valve drive is deactivated.
- The engine runs at a higher idling speed of 1500 rpm only and no longer responds to the accelerator.



System components

The fault indicator lamp

for Electronic Power Control K132 is located in the dash panel insert. It is a yellow lamp and bears the symbol "EPC".

EPC stands for **E**lectronic **P**ower **C**ontrol.



210_040



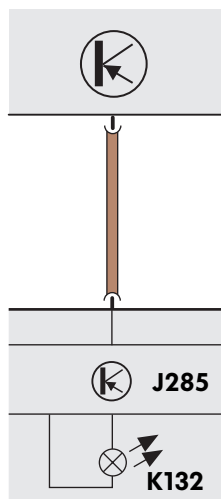
When does the lamp come on?

After turning on the ignition, the lamp comes on for 3 seconds. If there is no fault in the fault memory or if no fault is detected within this time period, the lamp goes off again.

If there is a fault in the system, the engine control unit activates the fault indicator lamp, and an entry is made in the fault memory.

Electrical circuit

The fault indicator lamp is activated directly by the engine control unit with an earth potential (brown).

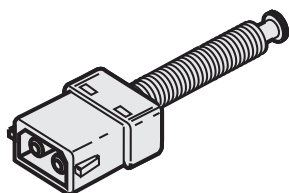


210_049

Effects of failure

A defective fault indicator lamp has no effect on the function of the throttle control, however, it leads to an entry in the fault memory.

Visual indication of additional faults in the system is no longer possible.



210_042

Signal utilisation

Both sensors are integrated in a component located on the brake pedal.
The "brake pressed" signal is utilised twice for the purpose of Electronic Power Control.

The "brake pressed" signal

- causes the cruise control system to be shut down
- is utilised as a idling speed default if an accelerator position sender fails.

Effects of signal failure

If one of the two sensors fails or if the input signals are found to be implausible, the engine control unit initiates the following actions:

- Convenience functions such as the cruise control system are deactivated.
- If an accelerator position sender is defective, too, then the engine speed is limited to an increased idling speed.

Auxiliary signals

**Brake light switch F and
brake pedal switch F47**

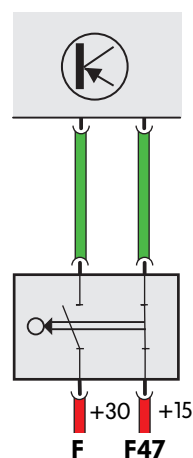
Brake pedal switch F47 serves as a backup information sender of the engine control unit.



Electrical circuit

Brake light switch F is open in the normal position and receives its voltage supply from terminal 30.

Brake pedal switch F47 is closed in the normal position and receives its voltage supply from terminal 15.



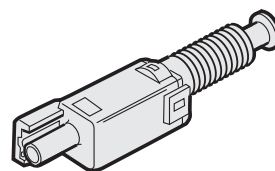
210_047

System components

Clutch pedal switch F36

Signal utilisation

Through the signal from the clutch pedal switch, the engine control unit can recognise when the clutch pedal is pressed. The cruise control system and the load change functions will then be deactivated.

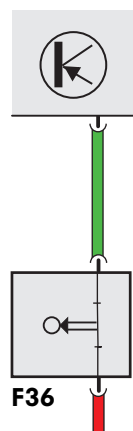


210_043



Electrical circuit

The switch is closed in the normal position and receives its voltage supply from terminal 15.

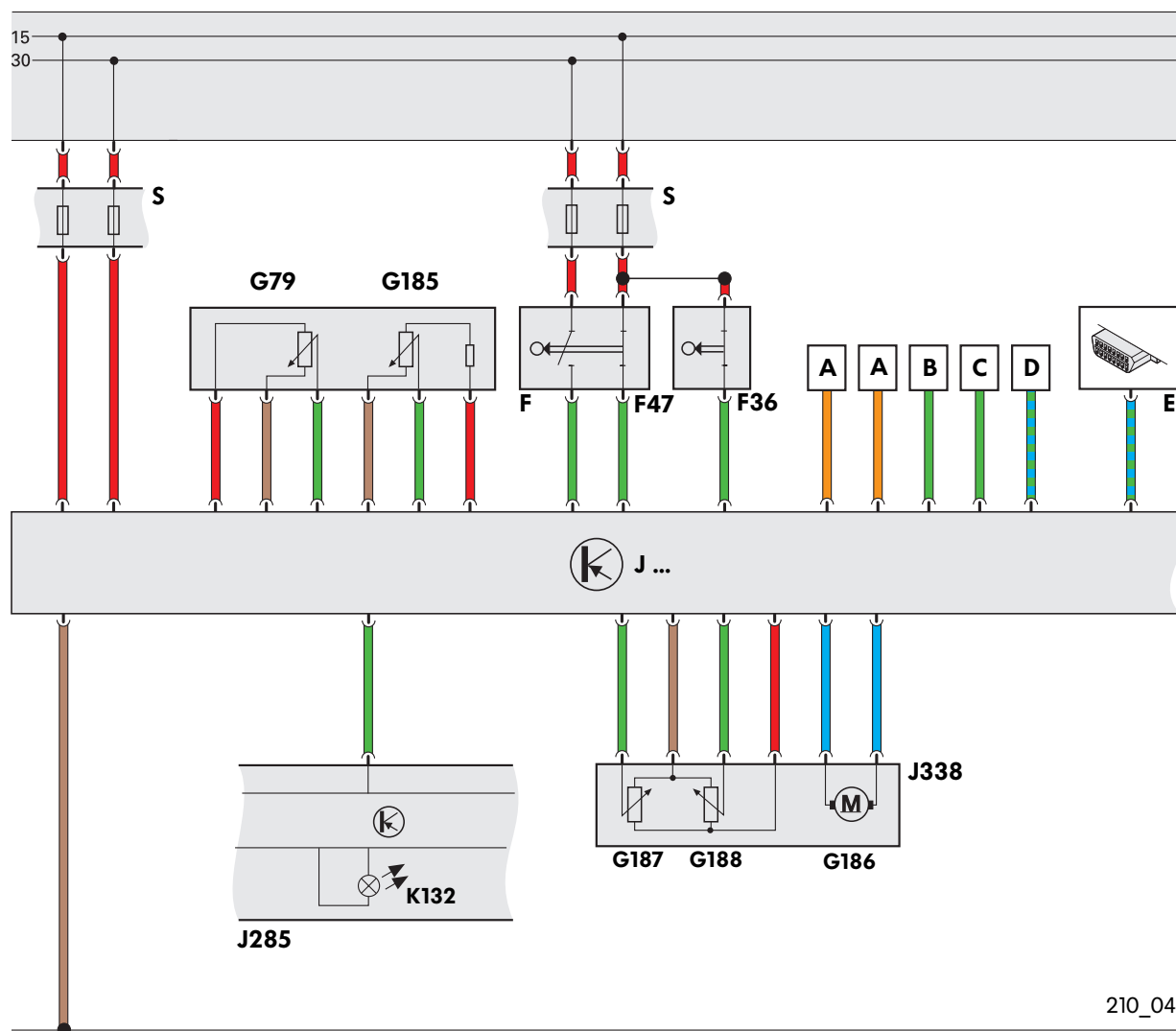


210_048

Effects of signal failure

The clutch pedal switch is not checked by the self-diagnosis function. There is no substitute function.

Function diagram



210_044

F Brake light switch
F36 Clutch pedal switch
F47 Brake pedal switch

G79 Accelerator pedal position sender -1-
G185 Accelerator pedal position sender -2-
G186 Throttle valve drive
G187 Angle sender -1-
for throttle valve drive
G188 Angle sender -2-
for throttle valve drive

J... Engine control unit
J285 Control unit with display unit
in dash panel insert
J338 Throttle valve control unit

K132 Fault indicator lamp for Electronic Power
Control

S Fuses

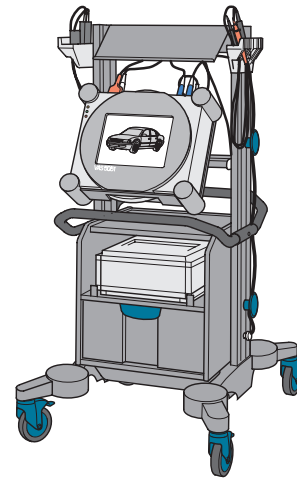
A CAN databus
B Road speed signal
C Cruise control system
D Air conditioner compressor "ON/OFF"
E Diagnostic connection



Self-diagnosis

The following functions can be executed with the Vehicle Diagnostic, Testing and Information System VAS 5051 in connection with Electronic Power Control:

- 02 – Interrogate fault memory
- 03 – Actuator diagnosis
- 04 – Basic setting
- 05 – Erase fault memory
- 06 – End of output
- 08 – Read data block



210_102

Function 04 – Basic setting

Throttle valve control unit

The basic setting procedure must be performed after the engine control unit, the throttle valve control unit or the complete engine has been replaced.

At the same time, various positions of the throttle valve are activated and stored in the engine control unit.

Please refer to the Workshop Manual!



Accelerator pedal module

For several vehicles equipped with an automatic gearbox, it is necessary to perform the basic setting procedure after replacing the accelerator pedal module or the engine control unit, due the short travel of the accelerator pedal. At the same time, the kick-down position of the accelerator position sender is learned and stored in the engine control unit.

Please refer to the Workshop Manual!

Function 08 – Read data block

In the "Read data block" function, there are currently five display groups which refer to the Electronic Power Control.

- Display group 060 – Adaption of throttle valve control unit

In "Basic setting 04", adaption of the throttle valve control unit is started by selecting "Display group 060".

060	Throttle valve angle (potentiometer 1 - G187)	Throttle valve angle (potentiometer 2 - G188)	Learn step counter	Adaption condition
	[0...100%]	[100...0%]	[0...9]	Text: ADP running / ADP OK / ADP ERROR

- Display group 061 – Electronic Power Control

Box three in "Display group 061" shows how far the throttle valve drive has opened the throttle valve.

061	Engine speed	Supply voltage ESB / EPC	Activation of throttle valve positioner	Operating state
	[rpm]	[V]	[%]	0xxx └─ Air conditioner compressor ON └─ Drive position selected └─ A/C ready/ rear window heating ON └─ always 0



Self-diagnosis

- Display group 062 – Electronic Power Control

In "Display group 062", the values of the two angle senders for throttle valve drive and the two accelerator position senders are displayed.

These values are given as a percentage and refer to a voltage of 5 volts.

062	Throttle valve angle (potentiometer 1 - G187)	Throttle valve angle (potentiometer 2 - G188)	Accelerator pedal position sender -1- (-G79)	Accelerator pedal position sender -2- (-G185)
	[0...100%]	[100...0%]	[0...98%]	[0...49%]

- Display group 063 – Kick-down adaption

In "Basic setting 04", adaption of the kick-down shift point is started by selecting "Display group 063".

063	Throttle valve angle (potentiometer 1 - G187)	Throttle valve angle (potentiometer 2 - G188)	Accelerator pedal position	Operating states
	[0...100%]	[100...0%]	Kick-down	Text: ERROR / press / ADP running / ADP OK



- Display group 066 – Cruise control system

In "Display group 066", you can find information regarding the cruise control system.

066	Road speed (actual)	Switch position of brake, clutch and CCS	Specified road speed	Switch position from CCS control panel switch
	[kph]	xxxx ┌ Brake light switch │ ┌ Brake pedal switch │ ┌ Clutch switch │ ┌ Cruise control system enabled	[kph]	xxxx ┌ CCS slide switch (latched) in OFF pos. yes/no │ ┌ CCS slide switch (latched/ not latched) in OFF position yes/no │ ┌ SET button pressed yes/no │ ┌ CCS slide switch in RES position yes/no

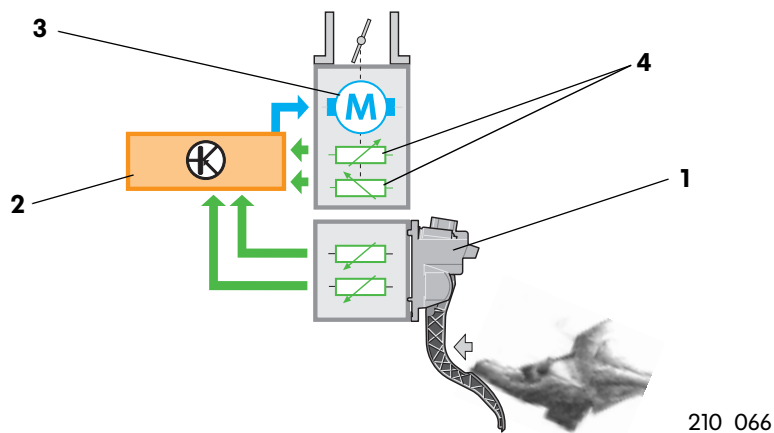


Test your knowledge

1. Name five torque demands which the engine control unit takes into account for the purpose of torque-oriented engine management.

2. What "tools" does the engine management system have to influence engine torque?

3. Describe in note form the functions of the following components.



1. Accelerator pedal module: -----

2. Engine control unit: -----

3. Throttle valve drive: -----

4. Angle sender for throttle valve drive: -----



4. What points have to be observed when the throttle valve control unit is defective?

- ☐ a) After replacing the throttle valve control unit, vehicle operation can be resumed immediately.
- ☐ b) The throttle valve control unit can be repaired using a repair kit, and the accelerator position sender must be replaced after all repair work on the throttle valve control unit.
- ☐ c) The throttle valve control unit must be replaced and the basic setting procedure must be performed.



Test your knowledge

Solutions:

- 1.) Start, catalytic converter heating, Traction Control System, engine braking control, speed limiting device, power limitation, cruise control system, air conditioning system, automatic gearbox (shift point)
- 2.) Throttle valve, charge pressure, injection time, cylinder suppression, ignition advance angle
- 3.) Accelerator pedal module:
- determines - with its senders - the momentary accelerator pedal position and transmits a corresponding signal to the engine control unit.
- Engine control unit:
- receives the signals from the sensors, processes them and then controls the actuators.
 - checks the electrical throttle control function
- Throttle valve drive:
- positions the throttle valve by means of an electric motor
- Angle senders for throttle valve drive:
- signal the position of the throttle valve to the engine control unit
- 4.) c

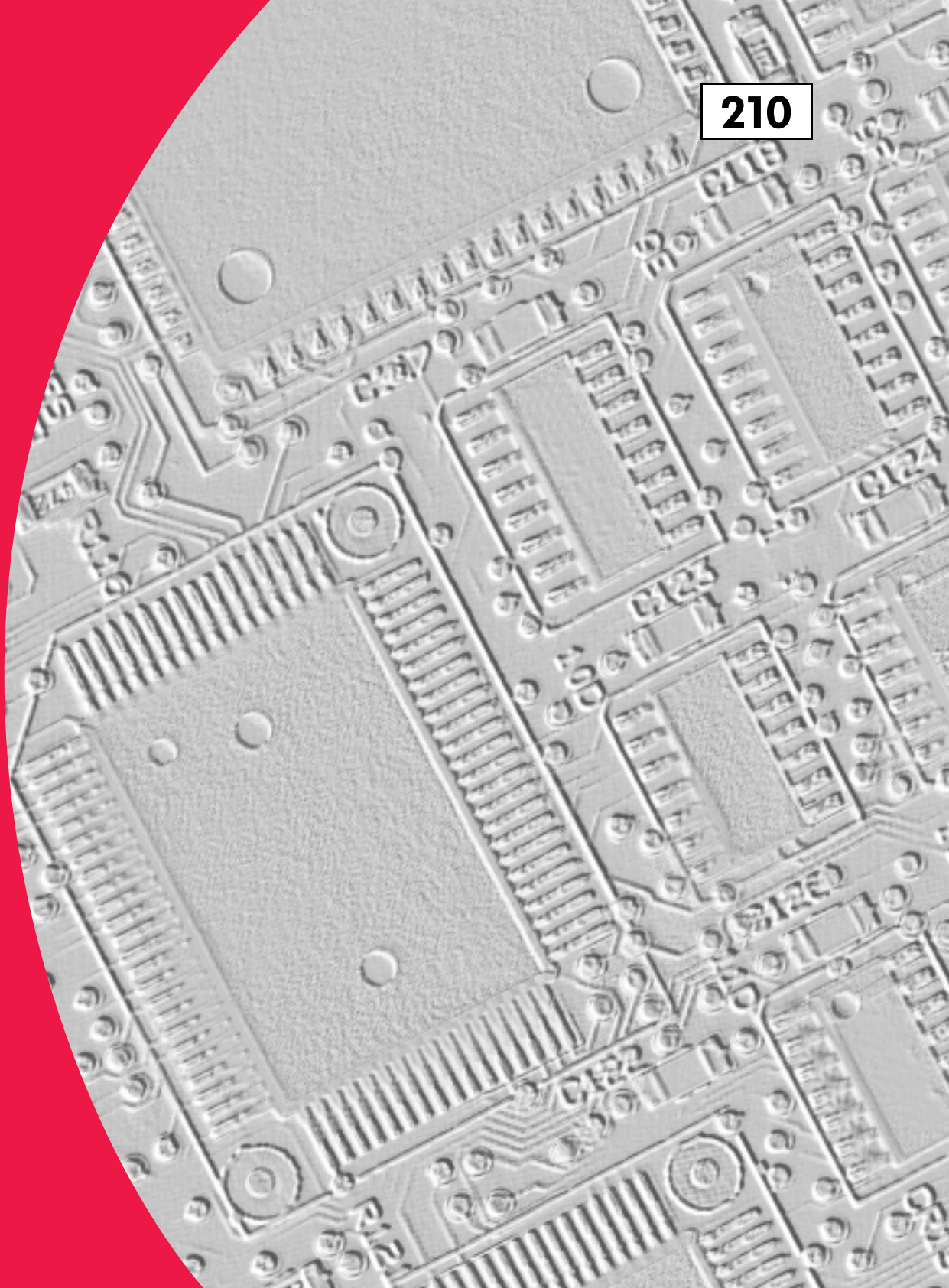




Notes







For internal use only © VOLKSWAGEN AG, Wolfsburg

All rights reserved. Technical specifications subject to change without notice.

840.2810.29.20 Technical status: 05/99

 This paper is produced from
non-chlorine-bleached pulp.