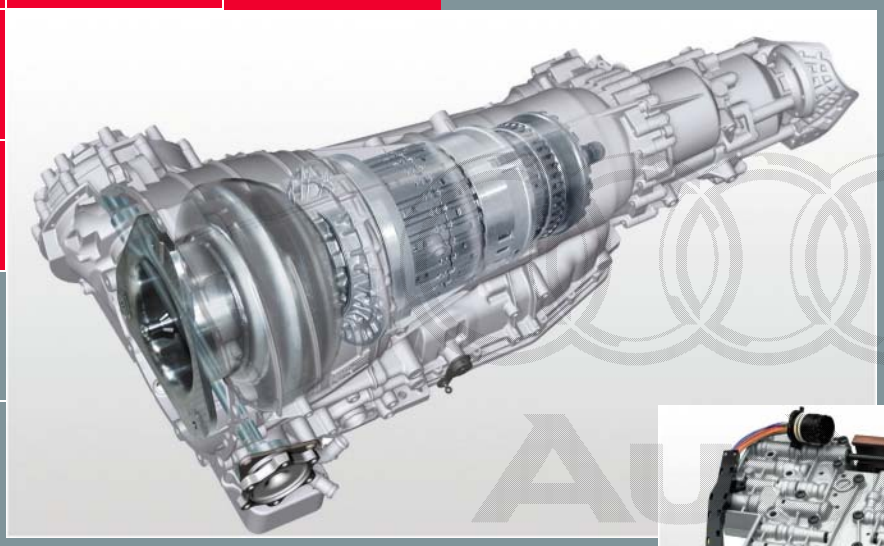
284

Service.



6-speed automatic gearbox 09E in the Audi A8 '03 - Part 2

Self Study Programme 284

For internal use only

Contents

Part 1 SSP 283

Page

The Self Study Programme contains information on design features and functions.

The Self Study Programme is not intended as a Workshop Manual.
Values given are only intended to help explain the subject matter and relate to the software version applicable when the SSP was compiled.

Use should always be made of the latest technical publications when performing maintenance and repair work.

New Note

Attention Note

Part 2 SSP 284

Page

Gearbox Control

Service

Mechatronik

A particularly noteworthy new feature of the 09E is the so-called "Mechatronik". This combines the hydraulic control system (hydraulics module), the electronic control unit and the sensors (electronics module) in one coordinated assembly. The Mechatronik is located in the gearbox in the vicinity of the sump.

Manufacturing tolerances of the hydraulics module (valves and pressure regulator) as well as of the output stages of the electronic control unit are established on a test bench and compensation is provided by way of the electronic control unit basic programming.

There is no provision for basic programming as part of service work and the Mechatronik can therefore only be replaced as a complete unit.

View from below

284_007

View from above

284_112

Mechatronik

The term "Mechatronik" covers all components responsible for
Detection of input signals required for gearbox control
Evaluation of input signals
Implementation of control and regulation algorithms
Actuation of control elements
Communication with periphery and establishment of electrical and mechanical link with signal generators and control elements

Advantages of Mechatronik:

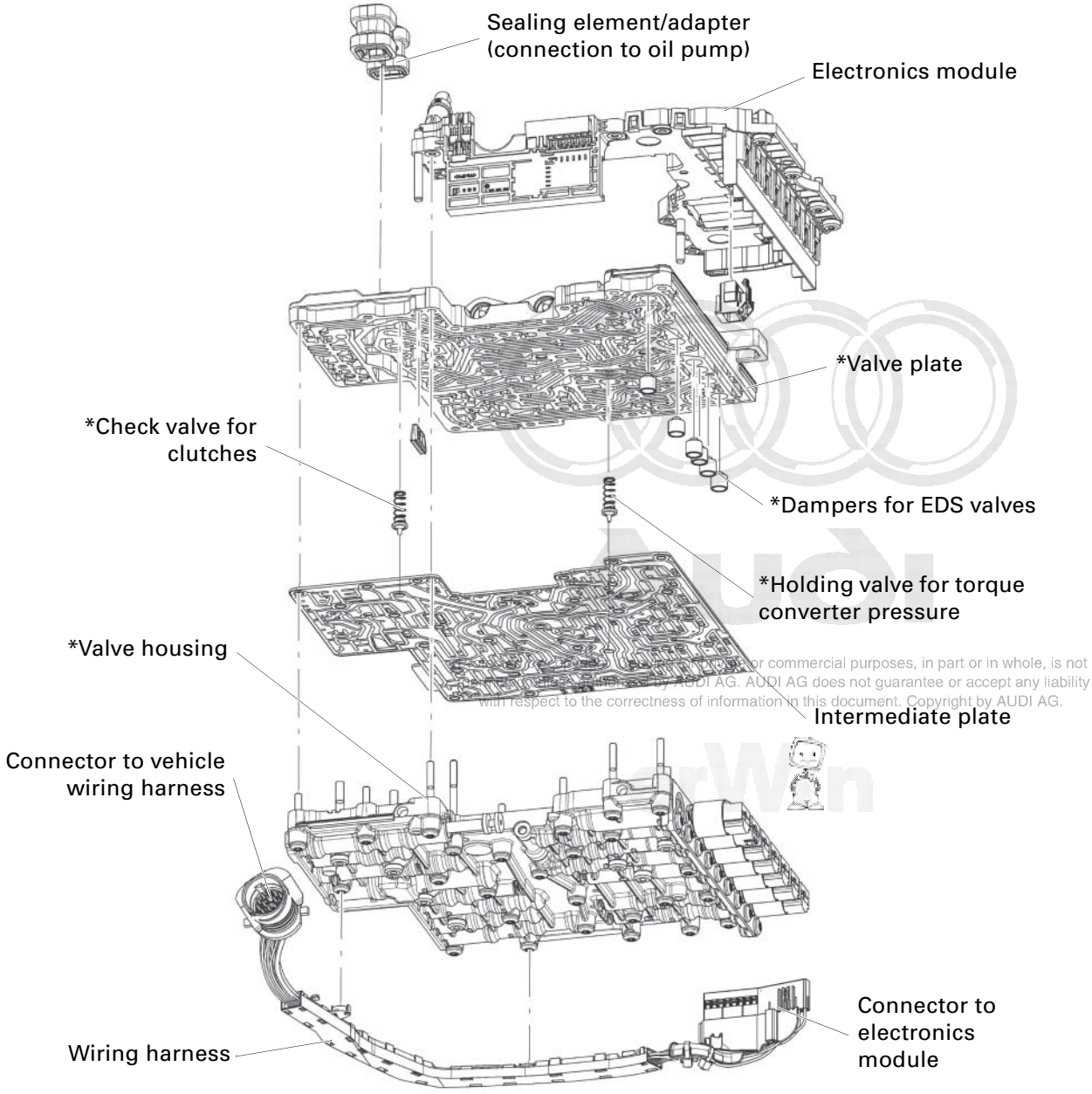
Less space required thanks to compact design.

Low-cost manufacture due to integration of components and compensation for the manufacturing tolerances of hydraulic components by appropriate programming of electronic control unit following assembly.

Lower weight due to reduction in number of pipes and housing components.

Increased reliability thanks to great reduction in number of interfaces (contacts).

Mechatronik can be calibrated and checked as one unit, thus ensuring a constant, previously unsurpassed gearshift quality.



*Hydraulics module

284_132

Electrostatic discharge ESD

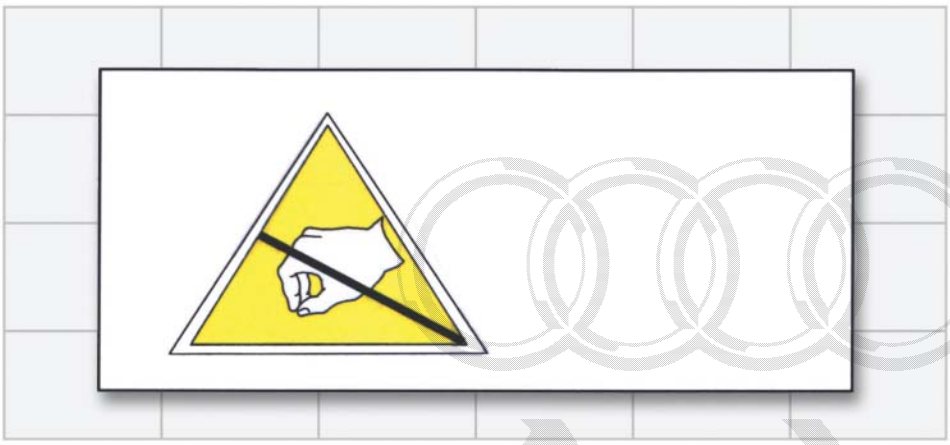
Particular attention must be paid to ESD protection on account of the use of microelectronics and the fact that some of the electronics module interfaces are open.

Before handling the Mechatronik (e.g. storage, transportation or repair), take care to discharge static by touching an earthed object or the vehicle earth when working on the vehicle.

Never touch the plug contacts of the electronics module connector.
The same applies to the contacts of the test adapter, e.g. when performing electrical checking.

The protective cap at the electronics module connector is only to be removed immediately prior to connection of the vehicle wiring harness so as to avoid unintentional touching of contacts.

The Mechatronik is always to be stored and transported in its genuine replacement part packaging. Do not remove the Mechatronik from its packaging before discharging static by touching an earthed object (e.g. water pipe, lifting platform ...).



284_069

This symbol always indicates the presence of components or assemblies in the vicinity which are susceptible to electrostatic charging.

The applicable safety precautions are therefore always to be heeded.

Audi

Description of valves

Dr.Red.V	Pressure reduction valve	The pressure reduction valve regulates the system pressure to approx. 5 bar. This pressure (pilot pressure) is used to supply the electrically switched solenoid valves, as these require a constant pilot pressure to function accurately.
HV-A HV-B HV-D1 HV-D2 HV-E	Holding valve/Clutch A Holding valve/Clutch B Holding valve/Brake D1 Holding valve/Brake D2 Holding valve/Clutch E	The holding valves switch the clutch valves, i.e. the control function (control phase) of the clutch valve during the gearshift operation is deactivated by the holding valve at the appropriate time, thus causing the clutch pressure to increase to system pressure. Both valves (clutch and holding valves) are regulated by the corresponding pressure control valve.
KV-A KV-B KV-C KV-D1 KV-D2 KV-E	Clutch valve/ Clutch A Clutch valve/ Clutch B Clutch valve/ BrakeC Clutch valve/ Brake D1 Clutch valve/ Brake D2 Clutch valve/ Clutch E	The clutch valves are variable pressure reduction valves. They are regulated by the corresponding electronic pressure control valve and determine the clutch pressure during the gearshift operation.
Sch.V	Lubrication valve	The lubrication valve reduces and safeguards the pressure required for lubrication. It also provides an upper pressure limit.

284_079

SV1	Selector valve 1	The function of SV1 is to maintain the current gear setting in the event of power failure whilst driving. A specific gear is accordingly selected for starting and mechanical emergency operation (solenoid valves deenergised). SV1 has a self-holding function which is cancelled on starting and re-activated by the electronic control unit.
SV2	Selector valve 2	SV2 routes the system pressure to the corresponding clutch/brake controls. It is regulated by solenoid valve N88.
SPV	Compensation valve	The SPV is located in parallel to the control circuit of N88. N88 is a so-called "ON-OFF valve" which implements the corresponding setting at high speed. The function of the SPV is to cushion the increase/decrease in control pressure and provide smooth gearshift operations.
Sys. Dr.V	System pressure valve	The system pressure valve is a variable pressure limiting valve which regulates the oil pressure generated by the oil pump. It is actuated by N233.
WDV	Torque converter pressure valve	The torque converter pressure valve reduces the system pressure and maintains the pressure required for torque converter flow and for the torque converter clutch. It also provides an upper limit for the torque converter pressure to prevent operating problems. Corresponding actuation of N371 vents the oil duct to the torque converter clutch chamber.
WKV	Torque converter clutch valve	The torque converter clutch valve is actuated together with the torque converter pressure valve by N371. This function involves reversal of the oil flow direction. The torque converter pressure valve (WDV) vents the torque converter clutch chamber, while the WKV applies torque converter pressure to the turbine chamber.
WS	Selector slide	The selector slide is actuated mechanically by the selector lever via a cable, directs the oil pressure for forward and reverse travel and provides the neutral positions.

284_080

Gearbox Control

Solenoid pressure control valves EDS 1-6
(N215, N216, N217, N218, N233 and N371)

The EDS convert an electrical control current into a proportional hydraulic control pressure.

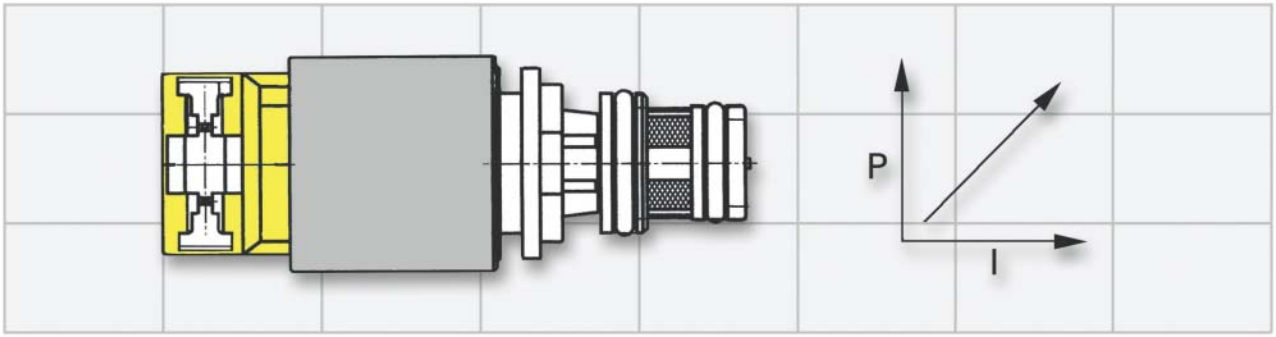
They are actuated by the automatic gearbox control unit J217 and operate the valves assigned to the selector elements.

Two different types are fitted:

EDS 1, 3 and 6 have a rising characteristic. In other words, the control pressure increases with increasing control current.
Deenergised = no control pressure
(0 mA = 0 bar)

EDS 2, 4 and 5 have a falling characteristic. In other words, the control pressure decreases with increasing control current.
Deenergised = maximum control pressure

EDS valves with rising characteristic

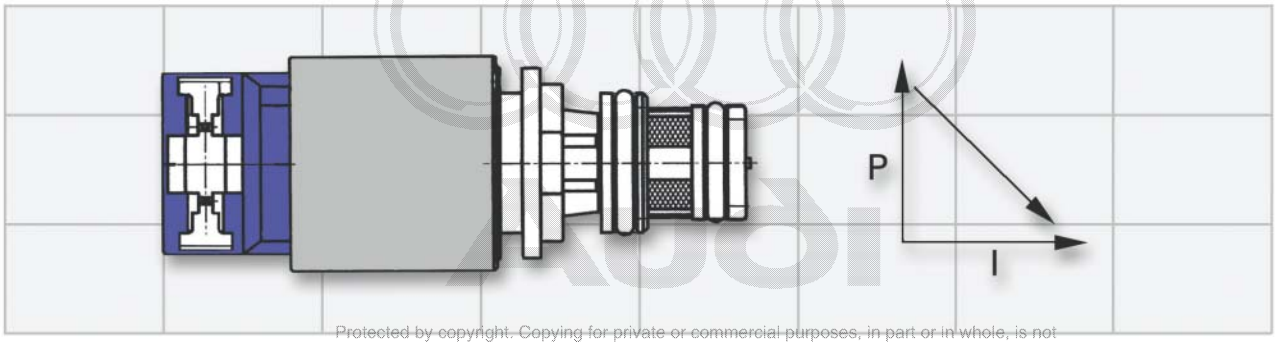


284_130

N215 (EDS1) Clutch A
N217 (EDS3) Brake C
N371 (EDS6) Torque converter clutch

P = Pressure
I = Current

EDS valves with falling characteristic



284_131

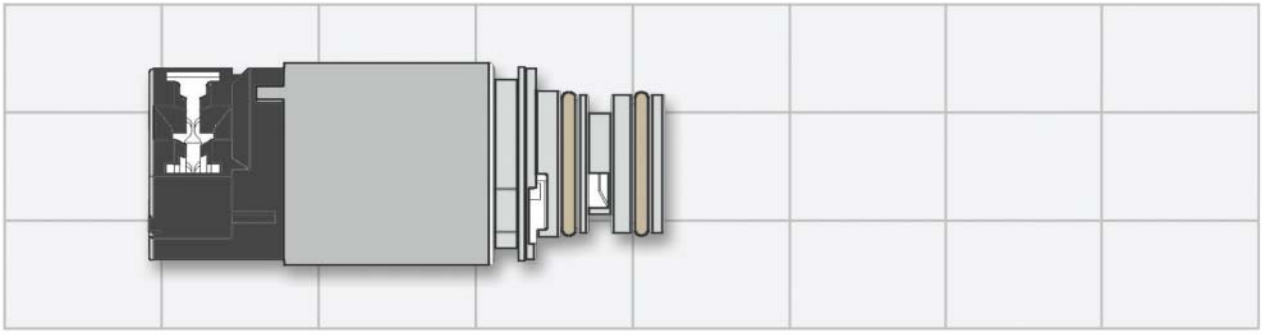
N216 (EDS2) Clutch B
N218 (EDS4) Brake D and clutch E
N233 (EDS5) System pressure

P = Pressure
I = Current

Solenoid valve MV1 (N88)

N88 is an electrically switched solenoid valve of the so-called 3/2 type, i.e. 3 connections and 2 switch positions (open/closed or on/off).

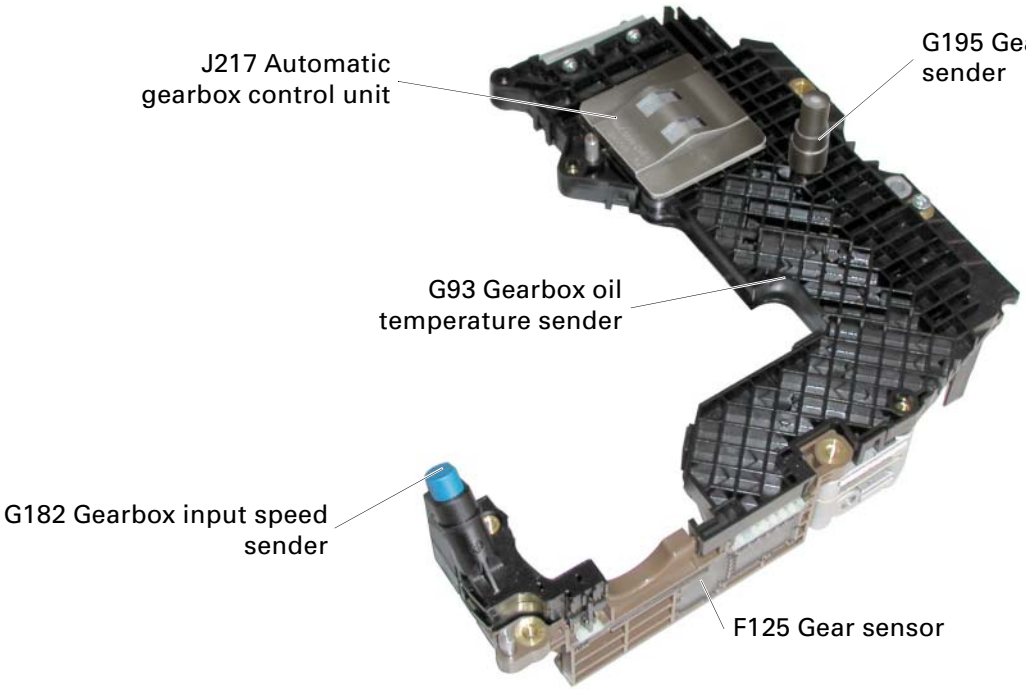
It is actuated by the automatic gearbox control unit J217 and its function is to provide corresponding hydraulic valve switching.



284_129

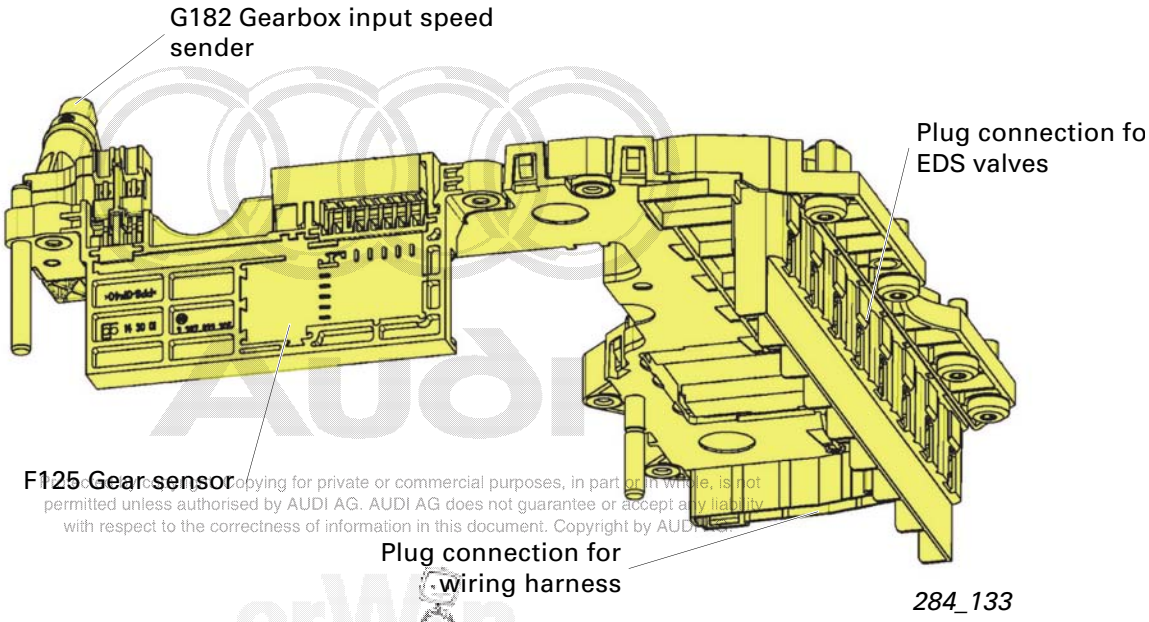
Electronics module

The electronics module combines the electronic control unit and sensors in one non-separable unit.



284_139

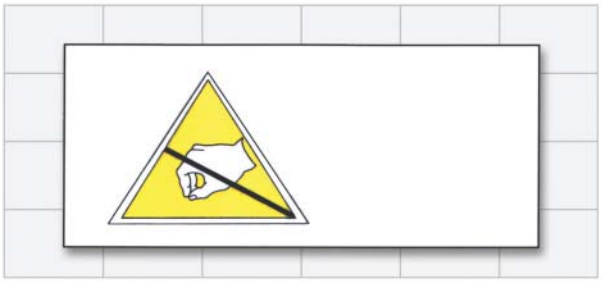
The electronics module cannot be replaced separately. The entire Mechatronik assembly has to be replaced in the event of a component fault.



284_133

Electrostatic discharge ESD

Particular attention must be paid to ESD protection on account of the use of microelectronics and the fact that some of the electronics module interfaces are open. Refer to description and notes on Page 6.



284_069

Automatic gearbox control unit J217

The electronic control unit is of the LTCC (low temperature cofiring ceramic) type and located in a hermetically sealed metal housing. The defined heat dissipation of the electronics is achieved via the ATF.

The extremely compact design of the control unit makes it suitable for integration into the Mechatronik and installation in the gearbox.

Temperature monitoring

The fact that the electronics are integrated into the gearbox (surrounded by ATF) means that greater significance is now attached to monitoring of the control unit temperature and thus also the gear oil temperature.

High temperatures have a crucial influence on the service life and proper functioning of electronic components.

Temperatures above 120°C have a detrimental effect on the service life of the electronic control unit components. As of 150°C, component damage and thus malfunctioning of the entire system can no longer be ruled out.

A so-called substrate temperature sensor is integrated into the substrate of the semiconductor components to record the temperature of the microprocessor (main computer of J217) as accurately as possible.

Explanatory note:
The term "substrate" refers to the ceramic base of the semiconductor components/ microprocessor. The substrate temperature sensor is situated directly in the substrate next to the microprocessor and records its temperature at the exact location.

Gearbox Control

Measures are taken to prevent overheating on exceeding defined temperature threshold values (hot mode).

There are 3 hot mode stages:

1st stage >124°C substrate temp. (126°C G93)

In conjunction with the DSP function the shift points are moved to higher engine speeds. The operating range in which the torque converter clutch is closed is extended.

For more details refer to Section on DSP, Page 36.

2nd stage >139°C substrate temp. (141°C G93)

The engine torque is significantly reduced (statically, up to 60 %) as a function of the further increase in temperature.

3rd stage >141°C substrate temp. (147°C G93)

The solenoid valve power supply is deactivated to prevent overheating of the control unit (malfunction, component damage). The gearbox switches to mechanical emergency running mode (refer to Page 34).
Fault "17018 Temperature-related control unit deactivation" is set in the fault memory.

In addition to accurate recording of component temperature, the substrate temperature sensor is used for diagnosis evaluation (plausibility checking) of the gearbox oil temperature sender G93 and provides a substitute value in the event of G93 failure.

All temperature data are referenced to the software version 0050 applicable at the time of compilation of the SSP. The temperature data may differ for other software versions.

Monitoring of oil temperature population

By way of G93, the automatic gearbox control unit J217 regularly checks the current gearbox temperature range. These values are stored. Corresponding evaluation provides a long-term record of the gearbox thermal load.

The service life (ageing) of the ATF is highly temperature-dependent. Sustained high ATF temperatures considerably accelerate the ATF ageing process.

Gearbox damage caused by prematurely aged (used) ATF can thus be prevented by changing the ATF.

If the oil temperature population reaches a defined count, the fault "18167 Multiple gear oil temperature overshoot" is set.

If this fault is detected during service work, the ATF and ATF filter are to be replaced. Precise details are given in the "assisted fault-finding" routine and the appropriate Workshop Manual.

Explanatory note:
The term "population" refers to any group of measured values or counter data permitting statistical analysis by means of weighting and corresponding evaluation.

New control unit generation

A higher performance control unit is to be introduced in the first quarter of 2003 in the course of further development.

This will extend the range of functions to include:

– Engine torque increase on change-down

– Introduction of variant encoding

This will further include extension of certain software functions such as the DSP.

Further details of the new control unit generation cannot be given at present as the exact definition of the functions had not yet been finalised at the time of compilation of the SSP.

Description of sensors

The speed sensors and gear sensor are designed to operate on the Hall principle. Such sensors are not susceptible to mechanical wear and their signals are not affected by electromagnetic influences, thus enhancing reliability.

The sensors G93, G182, G195, F125 form part of the electronics module. This cannot be replaced separately. The entire Mechatronik assembly has to be replaced in the event of a component fault.
For more details on the mode of operation of Hall-type speed sensors refer to SSP 268, Page 34 onwards.

Gearbox input speed sender G182

Due to the torque converter slip, the gearbox input speed does not correspond to engine speed (except when the torque converter clutch is completely closed).

The electronic gearbox control system requires the exact gearbox input speed (also referred to as turbine speed) for the following functions:

- Control and monitoring of gearshift operations
- Control of torque converter lock-up clutch
- Control of stationary vehicle decoupling
- Selector element diagnosis and plausibility checking of engine speed and gearbox output speed

The gearbox input speed sender G182 records the speed at the outer plate carrier of clutch A, which is connected to the planet carrier P1.

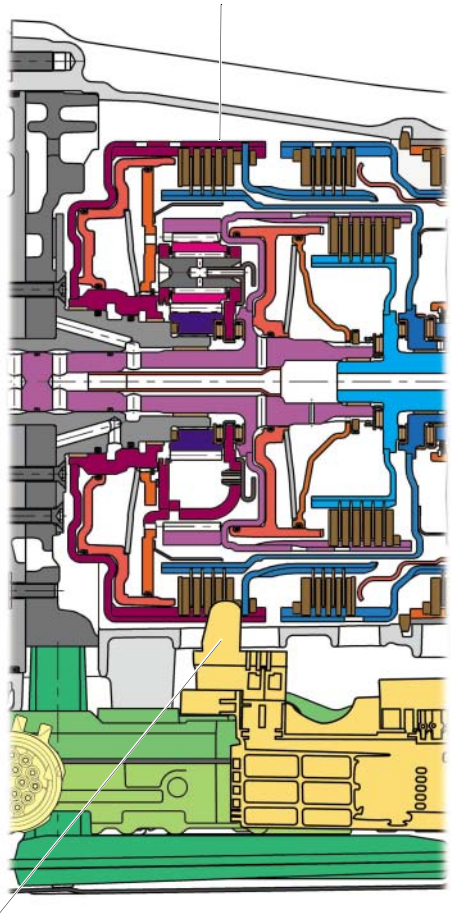
The planet carrier P1 always rotates at the same ratio with respect to the turbine shaft (1 : 0.657). The speed of the planet carrier P1 can therefore be used to calculate the turbine speed (gearbox input speed).

Safety/substitute function in the event of failure:

- 4th gear electrical emergency program
- Pressure-modulated, controlled gear engagement
- Deactivation of stationary vehicle decoupling
- Opening of torque converter clutch
- Deactivation of sports program "S"
- Deactivation of tiptronic function

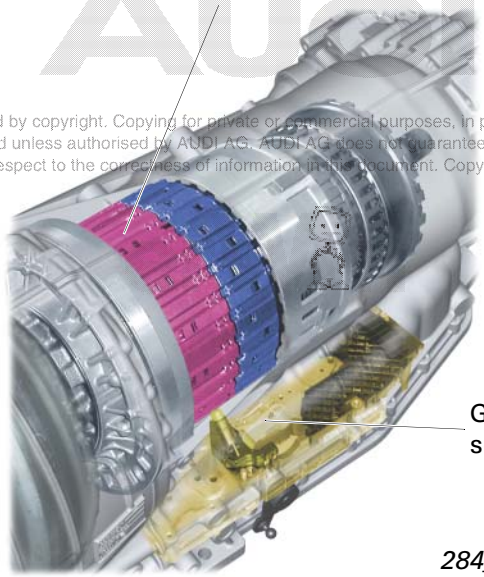
Fault display: Yes

Clutch A outer plate carrier sender wheel (connected to planet carrier PT1)



284_102

Clutch A outer plate carrier sender wheel (connected to planet carrier PT1)



G182 Gearbox input speed sender

284_103

Gearbox output speed sender G195

The gearbox output speed is one of the most important electronic gearbox control signals. The gearbox output speed, with its defined ratio in relation to vehicle speed, is required for the following functions:

- Selection of shift points
- DSP functions (e.g. driving situation assessment)
- Control of stationary vehicle decoupling (refer to Page 30)
- Selector element diagnosis and plausibility checking of engine speed and gearbox input speed

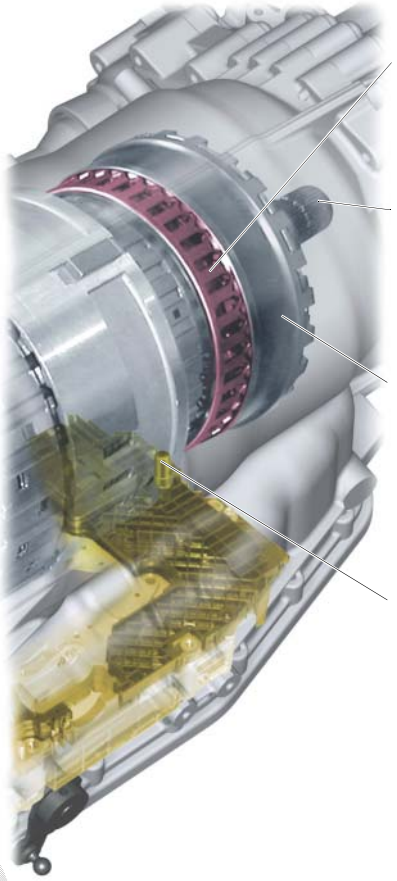
The gearbox output speed sender G195 records the speed at the ring gear H2 of the secondary planetary gear train.

The ring gear is connected to the output shaft and there is thus a defined ratio between ring gear and vehicle speed.

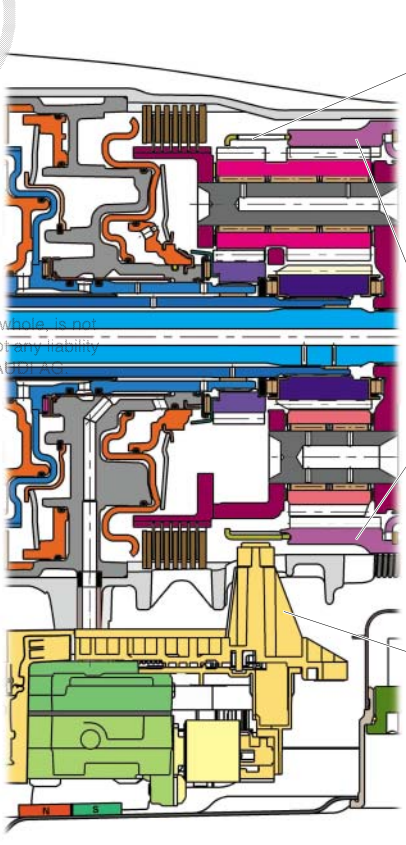
Safety/substitute function in the event of failure:

The current gear/target gear is retained.
An output speed is derived from the speed of all 4 wheels.

Fault display: Yes



284_105



284_104

Gearbox Control

tiptronic switch F189

The tiptronic switch F189 is integrated into the printed circuit board of the selector lever gate. It consists of three Hall sensors actuated by the permanent magnets on the masking panel.

F189 generates a square-wave signal with a fixed frequency at pins 6, 7 and 8 of the selector mechanism. In the corresponding switch setting, the voltage level is changed/ switched to positive or negative.

Magnet 2 is used for continuous tiptronic switch F189 diagnosis in selector lever positions D and S.

The need for this additional safety function arose from the fact that the gearbox no longer features selector lever positions 4, 3 and 2. With the new selector lever gate, prevention of change-up must be selected if required using the tiptronic function (by shifting selector lever to "tip" gate).

To safeguard this function, any problems with F189 operation are now indicated to the driver even without prior tiptronic actuation.

284_009

Safety/substitute function in the event of failure:

– Deactivation of sports program "S"
– Deactivation of tiptronic function (refer to note)

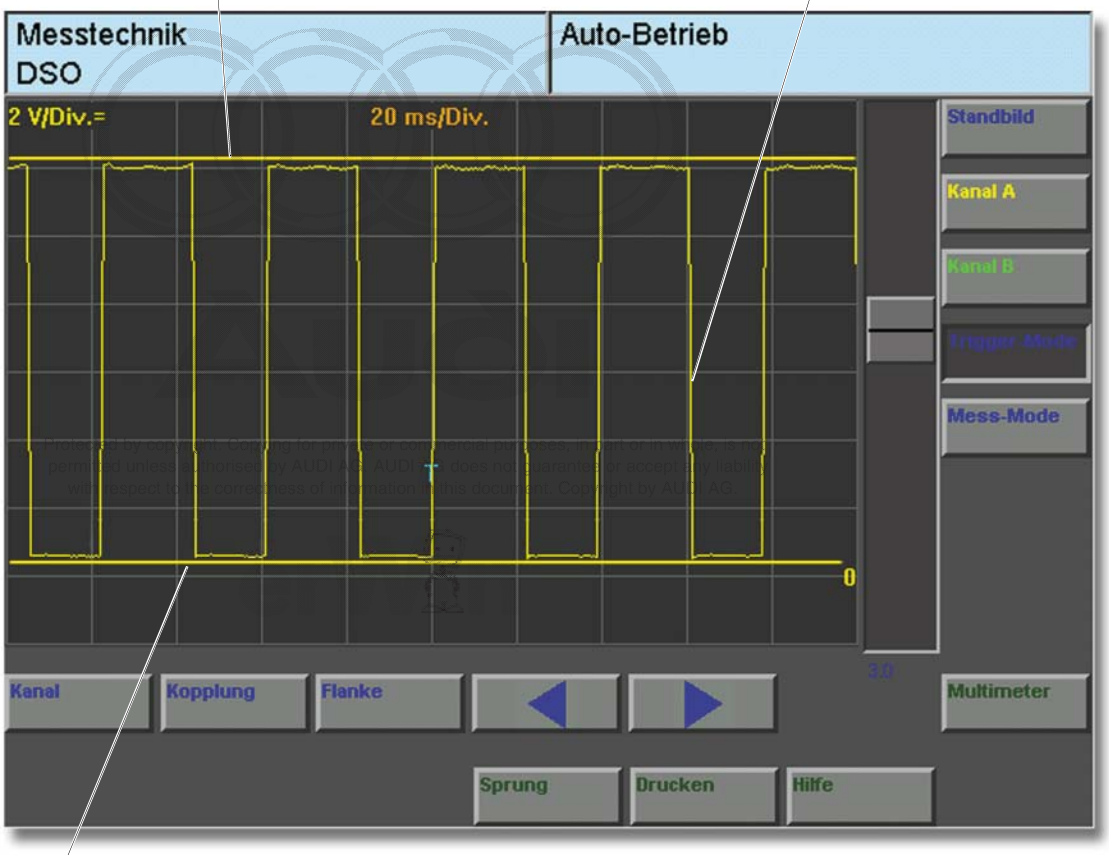
Fault display: Yes

At present, the tiptronic steering wheel function is also deactivated in position D/S. With introduction of the next control unit generation (1st quarter of 2003) it is planned to maintain the tiptronic steering wheel function in the event of F189 failure.

Tip+ or Tip- signals or "tip" gate recognition at pin 5, 4 or 1 (at gearbox)

Voltage level U_{batt} in selector lever positions P and P>R>N

Signal profile in selector lever positions D, S and D>N>R



Voltage level $U_{approx.\ 0.5\ V}$ in selector lever positions Tip+ (pin 5) or Tip- (pin 4) or gate (pin 1)

DSO connection:

Test prod DSO1	red	to pin 5/4/1	(at gearbox)
Test prod DSO	black	to pin 13	(at gearbox)

Conditions:
Ignition ON (engine not running)

284_084

Gearbox Control

Gear sensor F125

The selector lever position information is required for the following functions:

- Control of starting lock (refer to Part 1 SSP 283, Page 32 onwards)
- Control of reversing lights (Page 32 onwards)
- Control of P/N lock (selector lever lock) (refer to Part 1 SSP 283, Page 22 onwards)
- Information on driving situation (forwards/ reverse/neutral) e.g. for stationary vehicle decoupling and as information for other control units by way of bus link

The gear sensor F125 consists of 4 Hall sensors switched by a permanent magnet. The permanent magnet is actuated directly by the selector slide of the hydraulic control unit.

The Hall sensor signals are interpreted in the same way as the positions of mechanical switches. A high level signifies: Switch closed (1). A low level signifies: Switch open (0). One "switch" (Hall sensor) thus generates the two signals 0 and 1. 16 different switching combinations can be generated with 4 "switches".

5 switching combinations for recognition of selector lever positions P, R, N, D and S

4 switching combinations which are recognised as intermediate positions (P-R, R-N, N-D, D-S)

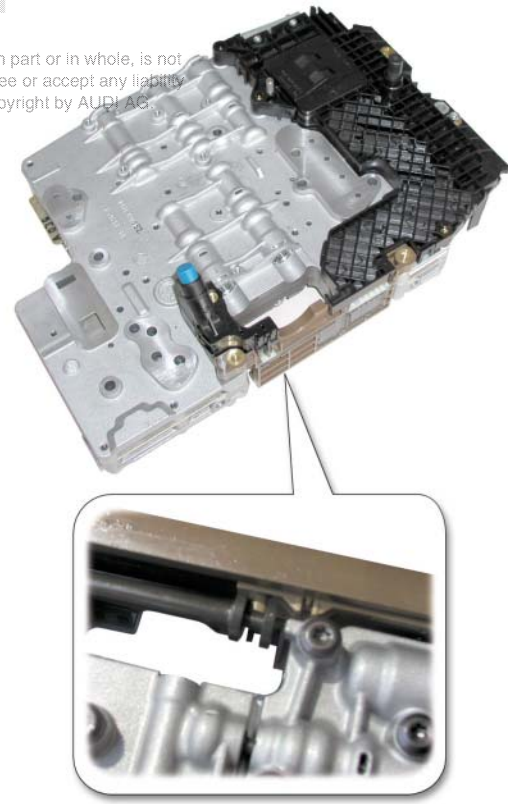
7 switching combinations which are diagnosed as not OK

Safety/substitute function in the event of failure:

Mechanical emergency running (refer to Page 34 onwards)

Fault display: Yes

The gear sensor F125 indicates the position of the selector slide in the hydraulic control unit. This is used to derive the selector lever position. If the selector lever cable is not set correctly, the selector lever position does not coincide with that of the selector slide. The gear selection indicator in the dash panel insert then does not correspond to the selector lever position.



To avoid misunderstandings regarding the functions of F125, it is no longer referred to in this SSP as multi-function switch but rather as gear sensor. With the 09E gearbox, F125 has no direct multiple functions.

Gearbox oil temperature sender G93

G93 is integrated into the electronics module of the Mechatronik.

The ATF temperature is required for the following functions:

– Adaption of shift pressures (system pressure) and pressure build-up/reduction during gearshift operations

– Activation/deactivation of temperature-dependent functions (warm-up program, torque converter clutch, stationary vehicle decoupling etc.)

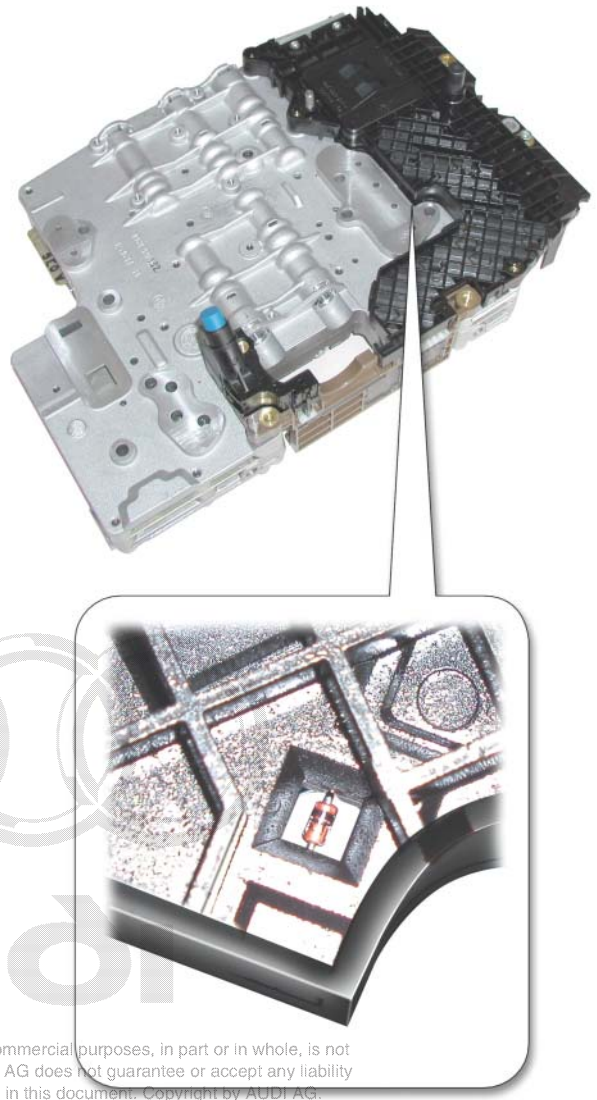
– Determination of oil temperature population

– Substitute signal for substrate temperature sender for implementation of action to reduce ATF temperature (refer to Page 13 onwards)

Safety/substitute function in the event of failure:

None

Fault display: None



284_010

Explanation of important information

"Brake pressed" information ...

... is determined from switches F and F47 (refer to block diagram, Page 26 onwards).

... is supplied to J217 by way of drive system CAN by engine control unit J623 (refer to CAN data exchange, Page 28 onwards).

... is required for P/N lock and "stationary vehicle decoupling" function.

The brake test switch F47 is supplied with voltage from terminal 15NL.

Terminal 15NL is generated by the entry and start authorisation control unit J518. It is activated when the ignition is switched on (term. 15 normal) and remains active after switching off ignition (term. 15 OFF) until J518 receives sleep acknowledgement for the drive system CAN from the gateway J533 or until the maximum run-on time (approx. 15 minutes) has elapsed.

Safety/substitute function in the event of failure:

Deactivation of P/N lock
Deactivation of stationary vehicle decoupling

Sensors and actuators (e.g. brake light switch) linked to control units involved in the run-on process are connected to terminal 15NL. This maintains the function and prevents misinterpretation of self-diagnosis.

Fault display: None

Diagnosis evaluation:

CAN information

Switch position

F	F47	Signal status	Interpretation in control unit J217
0	0	Brake not pressed	Brake not pressed
0	1	Implausible	Brake pressed
1	0	Implausible	Brake pressed
1	1	Brake pressed	Brake pressed

284_148

"Kick-down" information ...

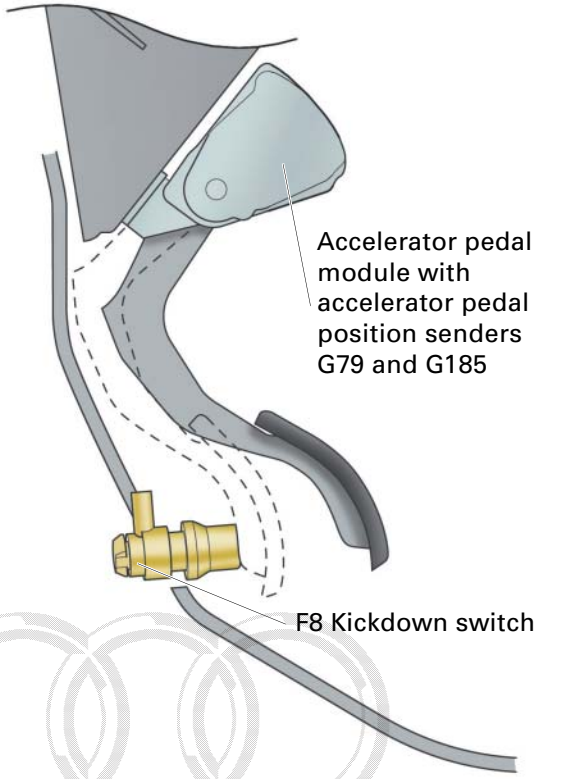
... is supplied to the engine control unit J623 by the separate kickdown switch F8. J623 evaluates the F8 switching information and transmits it to the drive system CAN (refer to CAN data exchange, Page 28 onwards).
F8 also acts as accelerator pedal stop (full throttle and kickdown positions must be set accordingly).

Safety/substitute function in the event of failure:

Self-diagnosis can only detect a short to earth.

In the event of short to earth, the kickdown signal is always applied. Kickdown takes place as a function of accelerator pedal position in line with a defined kickdown characteristic curve.

Fault display: None



284_134

"Accelerator pedal position" information...

... is supplied to the engine control unit J623 by the accelerator pedal position senders G79 and G185. J623 evaluates the signals and transmits the accelerator pedal position as information to the drive system CAN (refer to CAN data exchange, Page 28 onwards).

... forms an important item of information for shift point selection in addition to gearbox output speed.

... is used by the DSP function for evaluation of driving situations and driving style factor (sportiness rating). Refer to Page 36 onwards for more details on DSP.

Safety/substitute function in the event of failure:

Deactivation of stationary vehicle decoupling

Fault display: None

Gearbox Control

"Engine torque" information ...

... is supplied to the gearbox control unit by way of CAN data bus (drive system CAN).

... is used for regulation of system pressure, control of torque converter clutch and calculation of motion resistance in DSP.

... is used for calculation of torque request during gearshift operation.

Safety/substitute function in the event of failure:

4th gear electrical emergency program.
Pressure-modulated, controlled gear engagement.
Opening of torque converter clutch.

Fault display: Yes

"Engine speed" information ...

... is supplied to the gearbox control unit by way of CAN data bus.

... is used to control the torque converter clutch.

... is used to control stationary vehicle decoupling.

Safety/substitute function in the event of failure:

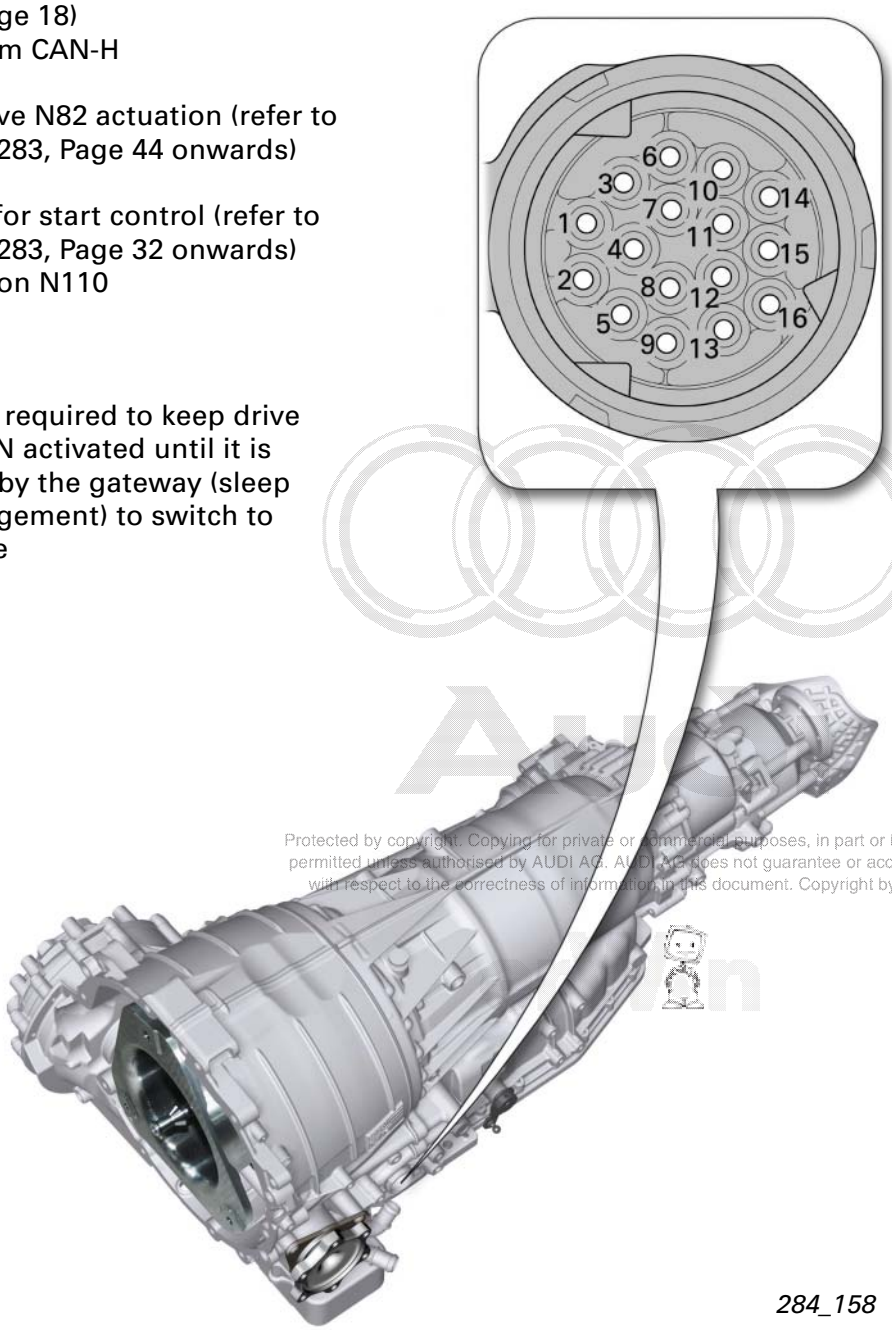
4th gear electrical emergency program.
Pressure-modulated, controlled gear engagement.
Opening of torque converter clutch.

Fault display: Yes

Interfaces/additional signals

Pin assignment at connector to gearbox

Pin 1 Signal for tiptronic gate/recognition (refer to Page 18)
Pin 2 Drive system CAN-L
Pin 3 Self-diagnosis K-wire (refer to Page 44)
Pin 4 Signal for tiptronic change-down (refer to Page 18)
Pin 5 Signal for tiptronic change-up (refer to Page 18)
Pin 6 Drive system CAN-H
Pin 7 Not used
Pin 8 Shutoff valve N82 actuation (refer to Part 1 SSP 283, Page 44 onwards)
Pin 9 Term. 15
Pin 10 P/N signal for start control (refer to Part 1 SSP 283, Page 32 onwards)
Pin 11 P/N actuation N110
Pin 12 Not used
Pin 13 Earth
Pin 14 Term. 30
Term. 30 is required to keep drive system CAN activated until it is instructed by the gateway (sleep acknowledgement) to switch to sleep mode
Pin 15 Not used
Pin 16 Earth



284_158

Block diagram / system layout

D1 Inhibitor reading unit

E389 tiptronic switch in steering wheel
E408 Entry and start authorisation button
E415 Entry and start authorisation switch (electronic ignition switch)

F Brake light switch
F8 Kick-down switch
F47 Brake pedal switch (test switch)
F125 Gear sensor
F189 tiptronic switch
F305 Gear selector position P switch

G85 Steering angle sender
G93 Gearbox oil temperature sender
G182 Gearbox input speed sender
G195 Gearbox output speed sender

N82 Coolant shutoff valve
N88 Solenoid valve 1
N110 Selector lever lock magnet
N215 Solenoid pressure control valve -1-
N216 Solenoid pressure control valve -2-
N217 Solenoid pressure control valve -3-
N218 Solenoid pressure control valve -4-
N233 Solenoid pressure control valve -5- (system pressure)
N371 Solenoid pressure regulating valve -6- (torque converter clutch)
N376 Ignition key withdrawal lock magnet (in E415)

J53 Starter motor relay
J104 ESP control unit
J197 Adaptive suspension control unit
J217 Automatic gearbox control unit
J285 Control unit with display in dash panel insert (selector lever position indicator FIS)
J329 Terminal 15 voltage supply relay
J428 Distance regulation control unit
J453 Multi-function steering wheel control unit
J518 Entry and start authorisation control unit
J527 Steering column electronics control unit
J533 Data bus diagnostic interface (gateway)
J540 Electric park and handbrake control unit
J623 Engine control unit
J694 Terminal 75x voltage supply relay
J695 Starter relay -2-

Output

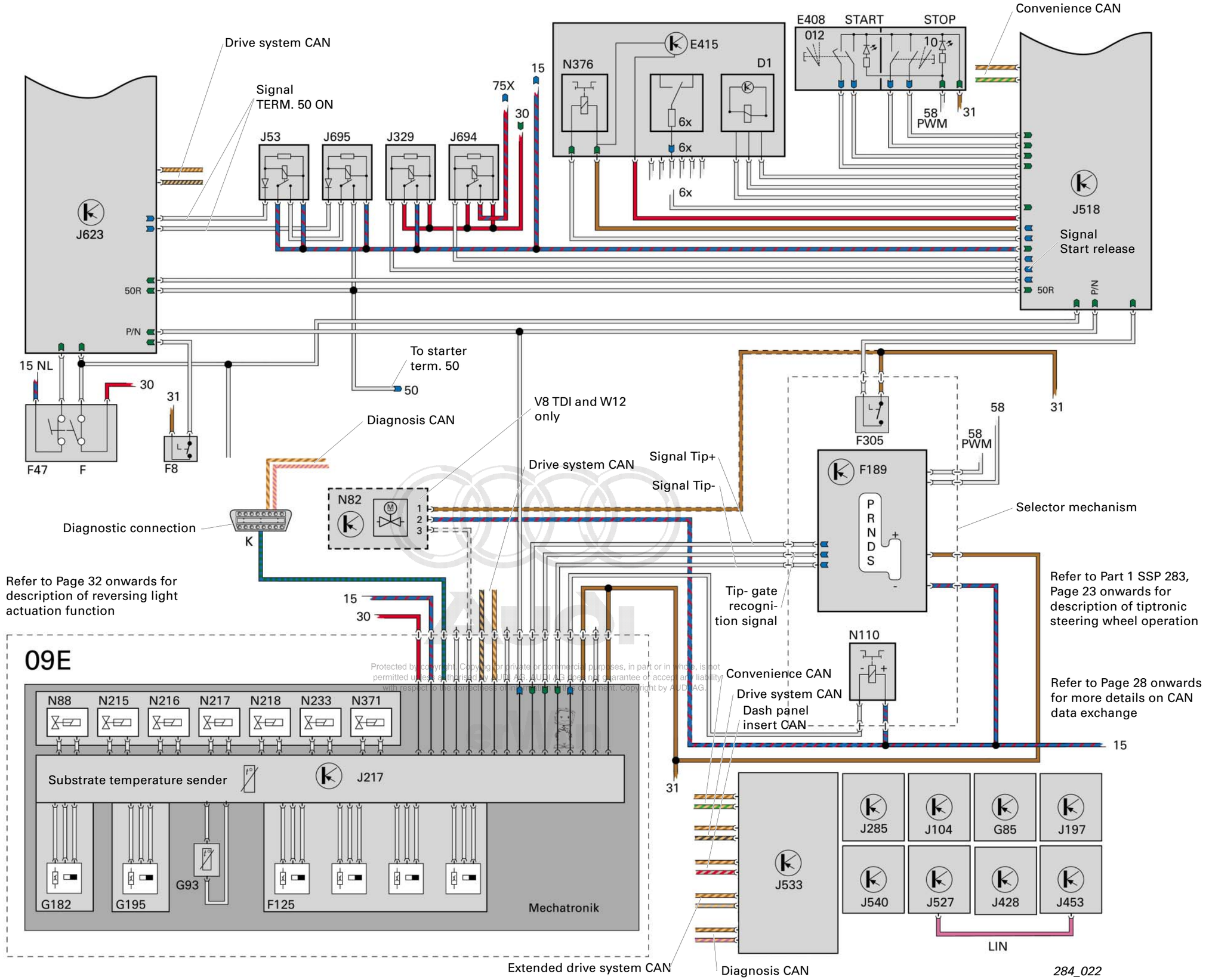
Input

Special terminals:

Terminal 15NL = 15 run-on (refer to Page 22)

Terminal 50R = 50 feedback, used for starter actuation feedback information

Terminal 58PWM = Pulse-width modulated dimming of switch illumination


Drive system CAN
Signal
TERM. 50 ON
J623
50R
P/N
15 NL
30
31
F47
F
F8
J53
J695
J329
J694
75X
30
15
N376
E415
6x
6x
6x
D1
E408
START
STOP
012
10
58
PWM
31
Convenience CAN
J518
Signal
Start release
50R
P/N
To starter
term. 50
50
Diagnosis CAN
V8 TDI and W12
only
Drive system CAN
N82
1
2
3
Diagnostic connection
K
Refer to Page 32 onwards for
description of reversing light
actuation function
15
30
09E
N88
N215
N216
N217
N218
N233
N371
Substrate temperature sender
J217
G182
G195
G93
F125
Mechatronik
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permitted unless authorised by AUDI AG. AUDI AG does not guarantee or accept any liability
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Extended drive system CAN
Signal Tip+
Signal Tip-
F305
58
58
PWM
31
F189
P
R
N
D
S
+
-
Selector mechanism
Tip- gate
recogni-
tion signal
Refer to Part 1 SSP 283,
Page 23 onwards for
description of tiptronic
steering wheel operation
N110
Convenience CAN
Drive system CAN
Dash panel
insert CAN
Refer to Page 28 onwards
for more details on CAN
data exchange
15
31
J533
J285
J104
G85
J197
J540
J527
J428
J453
LIN
Diagnosis CAN

284_022

CAN data exchange

J217 Automatic gearbox control unit

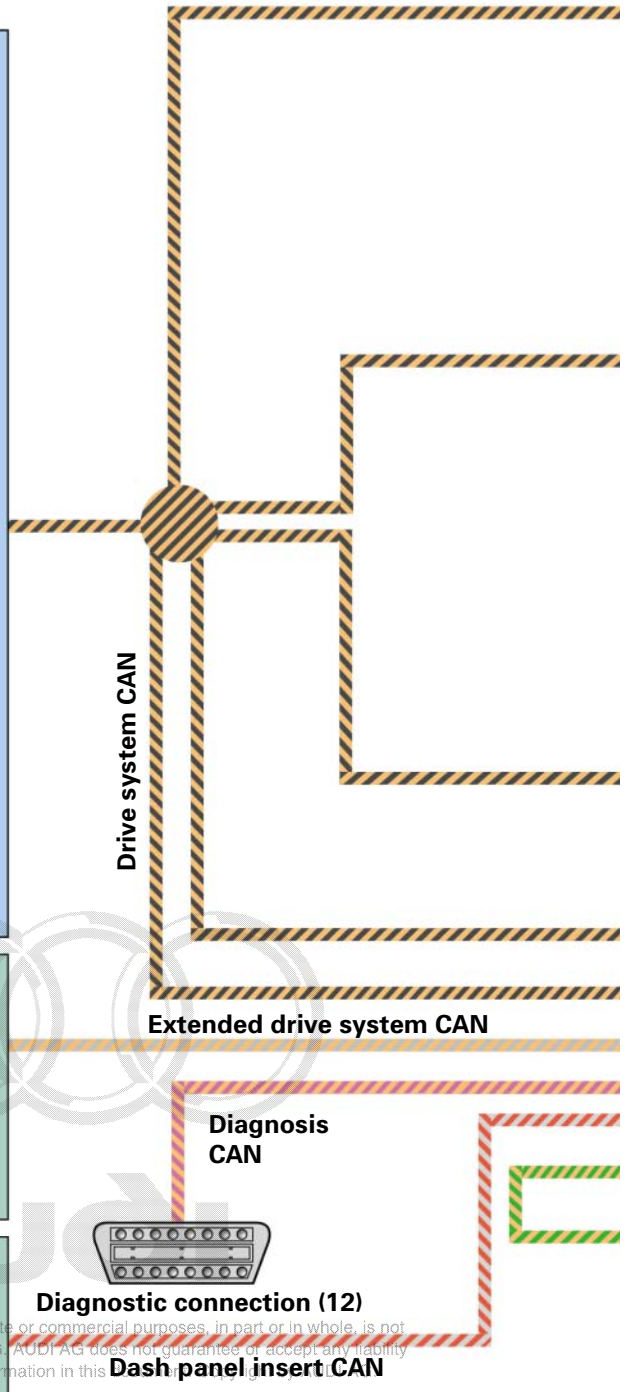
System status (all)
Fault memory entry (10)
Converter torque loss (1, 10)
Gearshift active (1, 2, 10)
Encoding in engine control unit (2)
Current gear/target gear (1, 2, 3, 10)
Selector slide position (1, 2, 3, 10)
Motion resistance index (1)
Emergency operation and self-diagnosis info OBD status (1)
Fault memory status (10)
Specified idling speed (1)
Torque gradient limitation (1) (torque converter/gearbox protection)
Torque converter/gearbox protection status (1)
Gear selection indicator (9)
Specified engine torque/gearshift (1)
Gear engaged (10)
CAN sleep indication (10)
Torque converter clutch status (1, 10)
Self-diagnosis/measured values (12)

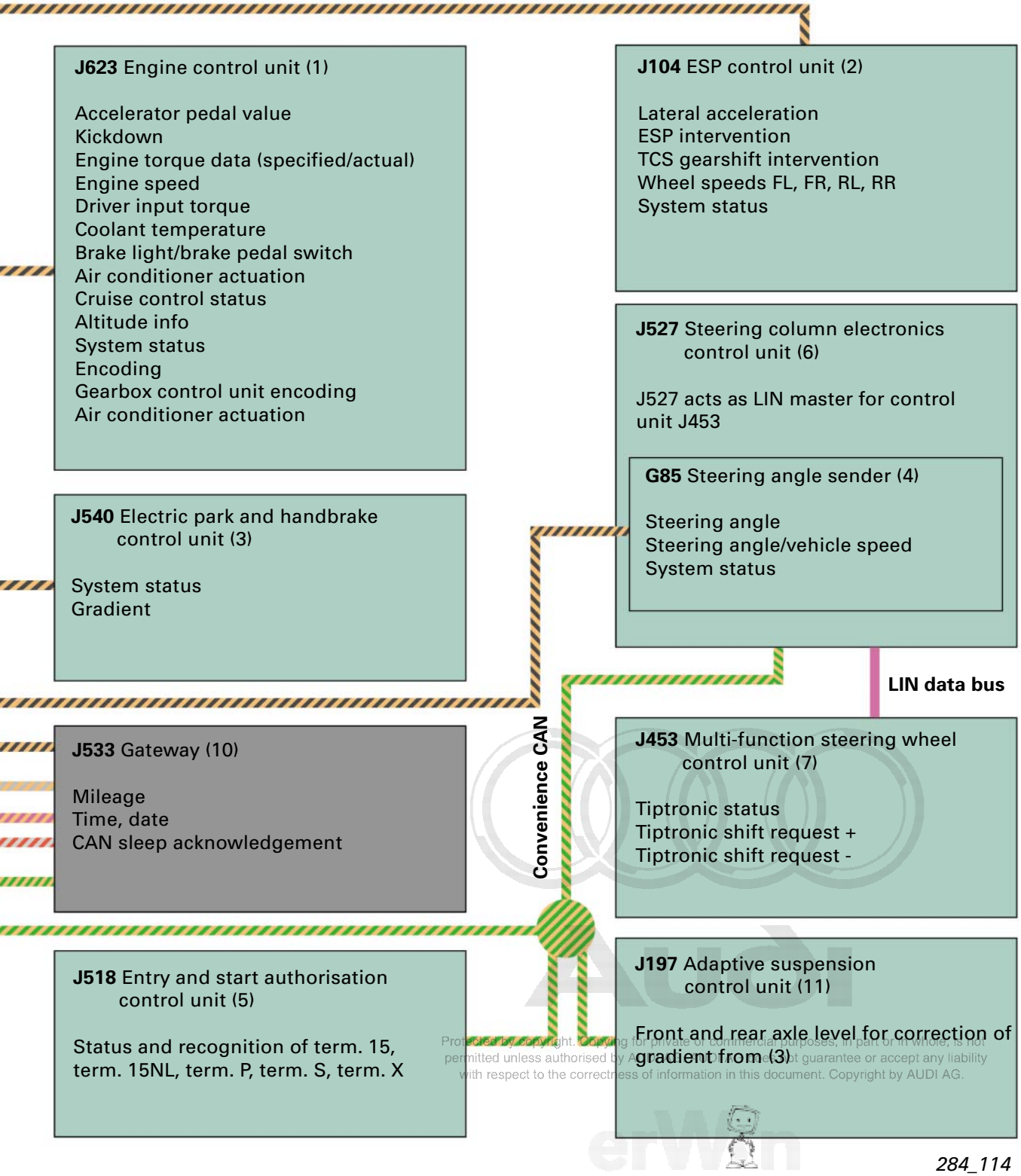
J428 (ACC) Distance regulation control unit (8)

ACC active
System status
Specified acceleration

J285 Control unit with display in dash panel insert (9)

Tyre circumference





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Functions

Stationary vehicle decoupling

Stationary vehicle decoupling is a special feature of the 09E.

With the vehicle stationary (engine idling) and a gear engaged, the torque converter already transmits a certain torque level. With the brake released, this results in the vehicle "creeping forward". With the brake pressed, the torque transmitted represents a certain loss, as the idling speed has to be kept constant by adjusting the idling torque (further opening of throttle valve).

As well as increasing fuel consumption, constant brake application (a certain pedal force is required to hold the vehicle) results in a loss of comfort.

The stationary vehicle decoupling function reduces the torque converter power flow to the planetary gearbox with the vehicle stationary and **the brake applied** ("Brake pressed" info from F and F47) by regulating the clutch A.

In addition, stationary vehicle decoupling reduces the noise level with the engine idling as the engine load is lower.

Stationary vehicle decoupling is not activated in reverse gear.

With the current design philosophy, stationary vehicle decoupling is only activated at present in the ATF temperature range between approx. 15°C and 50°C.

Functional description:

Stationary vehicle decoupling is controlled by calculating the converter torque from engine and turbine speeds (speed difference). Further factors in the calculation are the ATF temperature and gradient.

Stationary vehicle decoupling not active:
Vehicle stationary, engine idling and turbine shaft not turning; 100 % speed difference/slip

Stationary vehicle decoupling active:
Vehicle stationary, engine idling and turbine shaft turning at a defined speed difference (approx. 120 rpm); slip approx. 20 %

To ensure immediate, smooth starting, the power flow is not completely interrupted. A low converter torque level is always transmitted, thus eliminating meshing cycles and improving clutch control action.

Stationary vehicle decoupling is deactivated immediately if a gearbox output speed (G195) is detected while the decoupling function is active. The power flow is established before the driver accelerates, thus largely preventing vehicle rollback on slopes.

Brake release ("Brake not pressed" info) also deactivates stationary vehicle decoupling irrespective of other parameters.

Exceeding a defined accelerator pedal value (with brake pressed) deactivates stationary vehicle decoupling.

This permits checking of the stall speed (stall test).

As of a gradient of approx. 5 %, stationary vehicle decoupling is no longer activated. The gradient is determined by the tilt sensor of the electric parking brake EPB, which is located in the electric park and handbrake control unit J540.

The gradient information is transmitted by way of the CAN bus (refer to CAN data exchange, Page 28 onwards).

J540 is located in the rear right side panel (refer to information given in SSP 285 Audi A8'03 Running Gear).

This has no influence on vehicle behaviour on gradients (possible rollback on releasing brake). Holding of the vehicle without the brake is still governed by idle converter torque, gradient and vehicle weight.

Engine torque intervention

In addition to the familiar engine torque reduction function during change-up (negative torque intervention), the 09E is the first gearbox to offer a "positive" torque intervention feature.

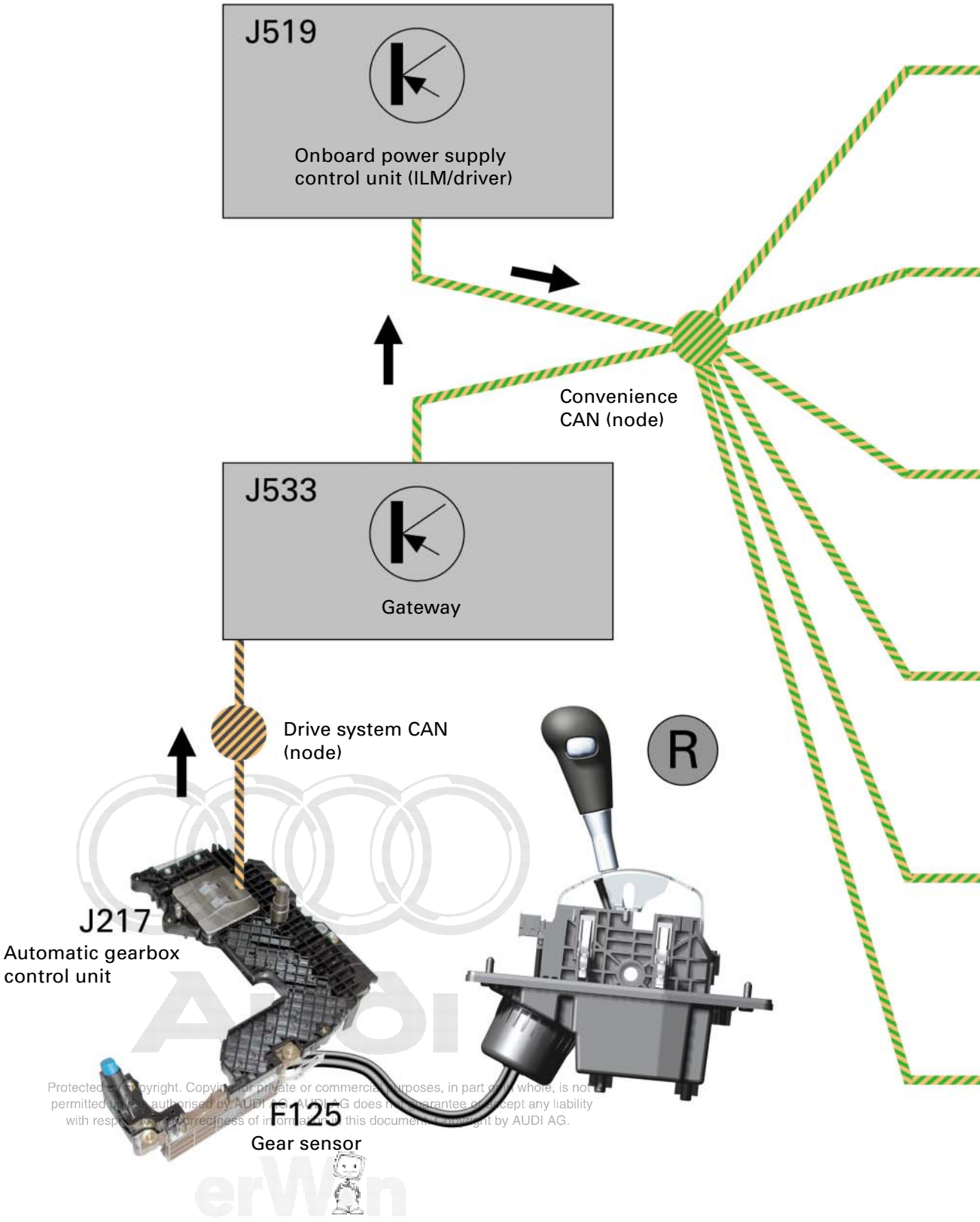
For greater gearshift comfort, the engine torque is increased on overrun change-down.

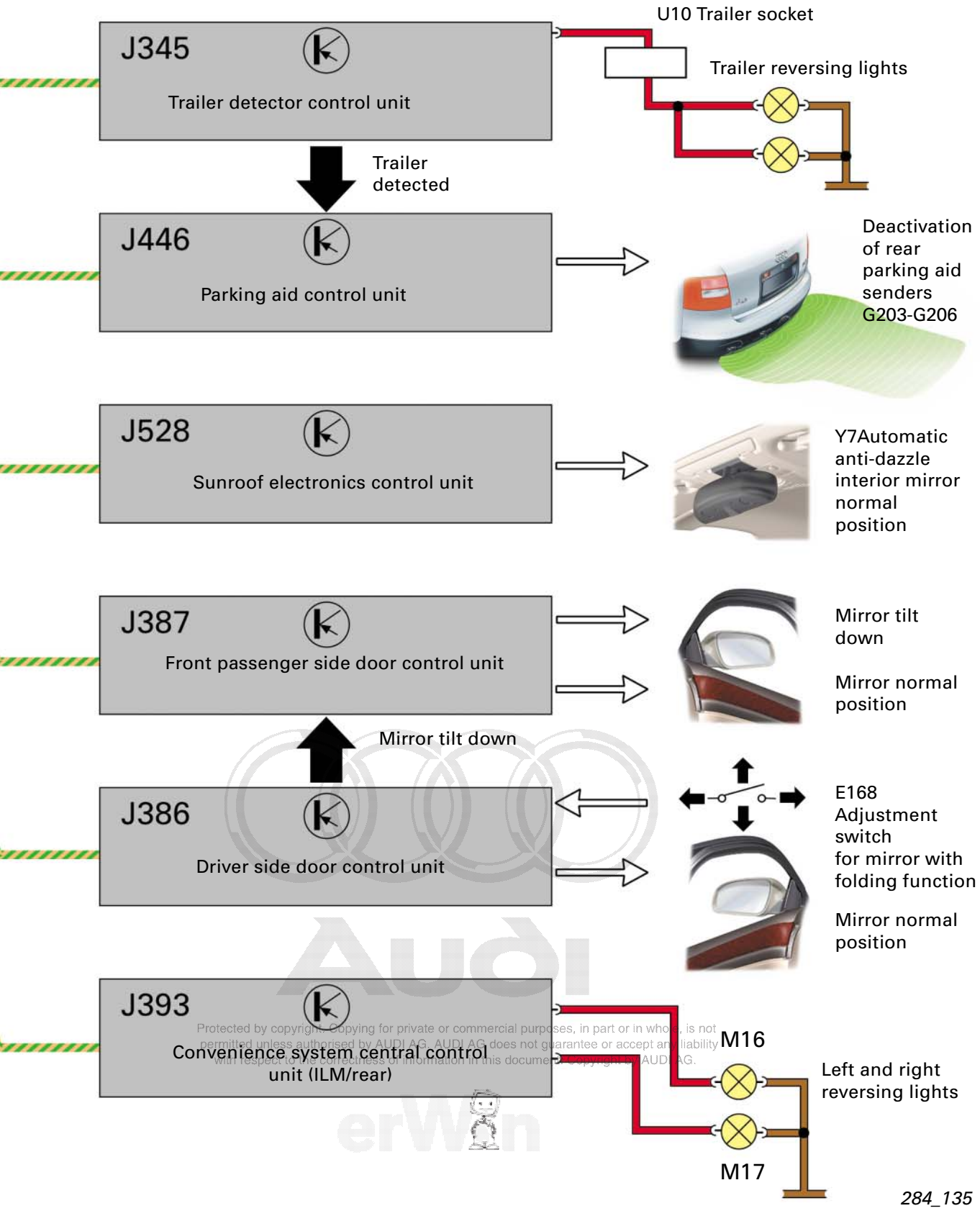
This function will not be available at the start of series production. It is due to be introduced with the control unit generation GS1904, scheduled for calendar week 02 / 03 onwards.

A precise description cannot be given at present, as the functions involved have still to be defined.

Gearbox Control

Reversing light





Emergency programs

In the event of malfunctions, emergency programs enable the gearbox control unit J217 to prevent further gearbox damage and maintain vehicle mobility.

A distinction is made between substitute programs (emergency programs) and mechanical emergency running.

Substitute programs

In the event of failure of a system sensor for example, the gearbox control unit attempts to form a substitute signal from the incoming information of other sensors. If a substitute signal can be formed, use is made of so-called substitute programs to maintain the gearbox functions to the maximum possible extent.

If this is not possible or a safe operating status cannot be achieved, the gearbox switches to mechanical emergency running.

The effect of a substitute program on vehicle handling differs greatly depending on the fault involved (refer to Description of sensors/ information).

Gearbox functions may be restricted (e.g. no gearshift, no kick-down...) or implemented with fixed characteristic values (e.g. hard gearshift).

Depending on importance, a fault display appears in the gear selection indicator.

Mechanical emergency running

Mechanical emergency running is the term used to describe the situation when solenoid valves and pressure control valves are not actuated. The power flow is controlled on a purely hydraulic basis (as a function of the position of the selector slide and hydraulic system valves) and this function is thus often referred to as hydraulic emergency running.

A distinction is made between two types of mechanical emergency running:

A) Control unit still active

B) Control unit no longer active (total failure)

The following functions remain operative in the case of mechanical emergency running with an active control unit:

- Shiftlock
- Diagnosis
- CAN communication

Fault display

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Description of mechanical emergency running function

- In the event of faults/malfunctions resulting in mechanical emergency running, 3rd gear is always engaged if 3rd gear or lower had previously been selected. 5th gear is selected if the gearbox is already in 4th gear or higher.
- 5th gear remains engaged until either the selector lever is moved to neutral position or the engine is switched off.
- A mechanical switching valve is actuated in both cases on account of the drop in hydraulic pressure. On driving off again/ restarting engine, 3rd gear is selected.
- Reverse gear is available (reverse gear lock not active).
- The maximum system pressure is set, thus causing maximum shift pressure to be applied to the selector elements. Hard jolts occur on engaging gear.
- The torque converter clutch remains open.

Gear monitoring with symptom recognition

Switching to the emergency program should be avoided in the event of short-term faults during gearshift operations.

If irregularities indicating gearshift problems occur in the course of a gearshift operation (e.g. on account of contamination of the hydraulic control unit), the emergency program is not selected immediately, but rather the target gear is skipped or the current gear maintained depending on the situation.

The gearshift operation can be repeated several times before an entry is made in the fault memory and the emergency program thus selected.

Gearbox operation is maintained to the greatest possible extent. The driver may not even notice the symptom recognition process.

Symptom recognition:
In the case of monitoring functions with symptom recognition, once-only recording of a fault does not immediately lead to a fault memory entry. A fault has to be detected n times.

Explanatory note:
Symptom "Random event; temporary characteristic"

Gearbox Control

Dynamic Shift Program DSP

The DSP has been modified in the course of further development.

The principal parameters used for evaluation of driving situation and driving style are basically the same as for earlier DSP generations.

On account of the increasing degree of networking between gearbox control and other vehicle systems such as engine or ESP, a greater volume of data is now available to provide an even better definition of the current driving situation and driving style.

This is accompanied by the substantial refinement of data processing by the gearbox control unit. As well as enhanced gear and shift point selection, the gearbox control system is now capable of implementing additional functions.

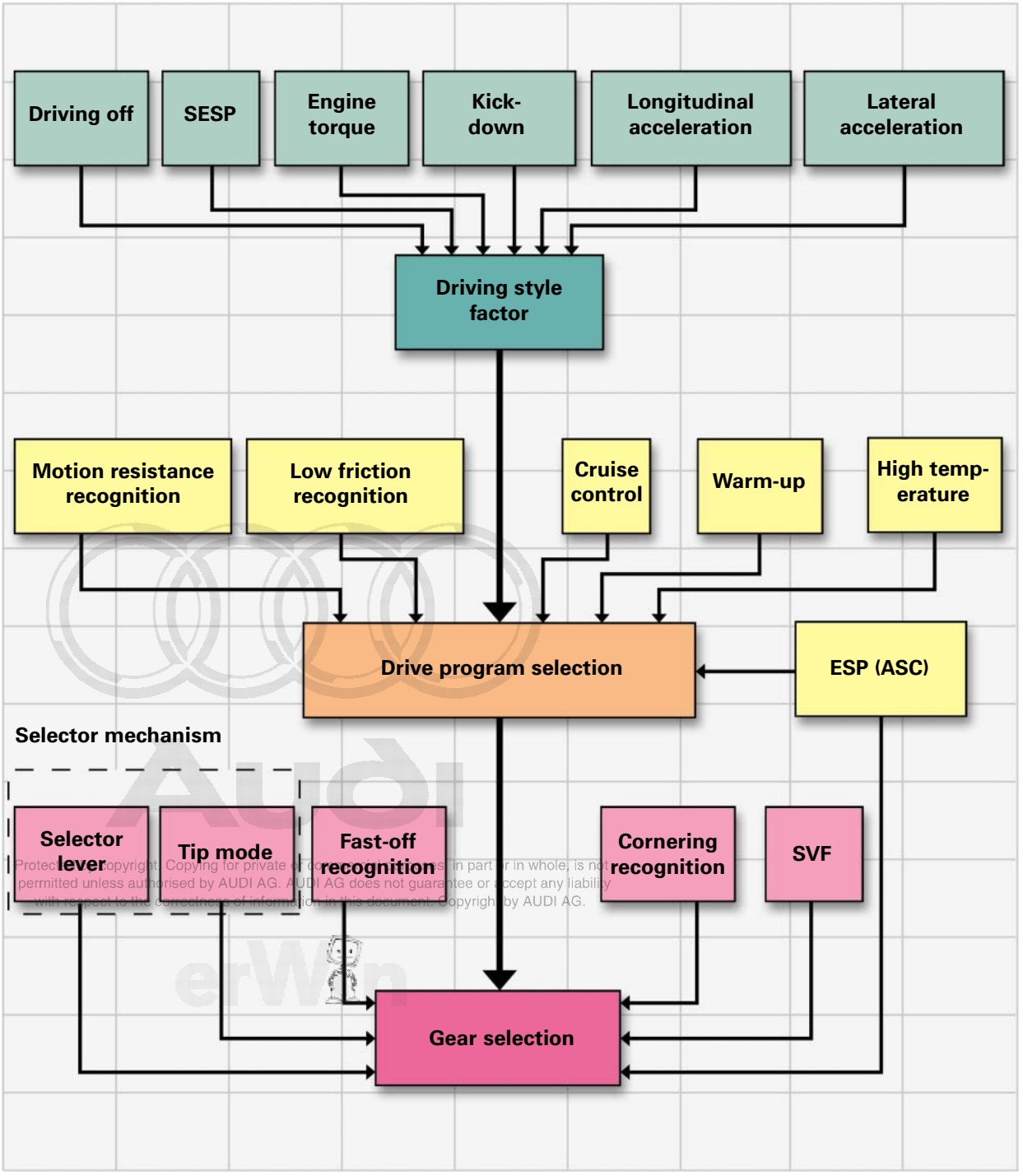
The operational structure of the DSP is basically organised in three groups:

– Driving style factor

– Situation-based drive program selection

– Gear selection

Operational structure



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Driving style factor

The DSP constantly evaluates the current driving style with a so-called sportiness rating from economical to sporty. Evaluation of the following influences the sportiness rating:

Longitudinal acceleration

Longitudinal acceleration refers to the rate at which the vehicle switches from its current speed to a different speed. This incorporates both positive (acceleration) and negative (deceleration) acceleration.

Lateral acceleration

Lateral acceleration is the force with which a vehicle is pressed outwards when cornering. The magnitude of the force is governed by vehicle speed and steering angle. The vehicle has to exceed a defined threshold value for the evaluation function to recognise and assess high-speed cornering. The weighting with regard to the sportiness rating depends on the maximum value occurring during cornering.

Evaluation of longitudinal and lateral acceleration takes place in the background and is always active (refer to Section on Gear selection, Page 42 onwards).

Driving off

On driving off, this function evaluates the situation by way of the maximum engine torque. Driving off from a standstill with high load application immediately results in allocation of a more sporty drive program.

Kick-down

If kick-down is constantly maintained, the sportiness rating is increased cyclically and this remains active for a certain period following termination of kick-down (depending on further driving style).

Spontaneous increase in sportiness rating (SESP)

Abrupt high acceleration (high positive accelerator pedal gradient) causes the counter to be set immediately to the maximum sportiness rating. Change-down takes place. The maximum value is only maintained for a few seconds and then returns to its initial level. Change-up takes place when acceleration is reduced.

At present, the sportiness rating is only determined for the drive program "S".

As part of conversion to the new gearbox control system it is planned to make use of the sportiness rating for drive program "D" as well.

Situation-based drive program selection

Motion resistance recognition

Motion resistance recognition is one of the basic functions for drive program selection. This basic function commences as soon as the vehicle is driven off with an analysis of the equilibrium between drive power (engine torque) and the motion resistance at the drive wheels (analysis of vehicle speed and speed changes).

The following factors are incorporated:

- Vehicle weight (and inertia)
- Aerodynamics (drag)
- Climbing resistance
- Rolling resistance of tyres

The end product is a motion resistance index which defines the uphill, downhill and flat road drive program.

One of 15 drive programs is selected on the basis of the sportiness rating and motion resistance index.

In addition to this matrix, driving situations (e.g. warm-up, hot mode) or a vehicle system (e.g. cruise control CCS/ACC) may be definitive for the selection of a special drive program.

25	ESP1/Flat road
26	ESP2/Hill
27	tiptronic mode
28	Hot mode/hill
29	Hot mode/flat road
30	Warm-up 1
31	Warm-up 2
34 - 38	As drive programs 4, 9, 14, 19, 24
39	As drive program 28

Drive programs

Motion resistance index	Selector lever position			Vehicle systems	
	"D"	"S" (S1 or S2 depending on driving style)		ACC	CCS
Sportiness	S0	S1	S2	S3	S4
Steep uphill	20	21	22	23	38 (24)
Moderate uphill	15	16	17	18	37 (19)
Slight uphill	10	11	12	13	36 (14)
Flat road	5	6	7	8	35 (9)
Downhill	0	1	2	3	34 (4)

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The current drive program can be read out using the diagnosis testers in measured value block 2, 1st display value.

CCS column:
For technical reasons the values displayed differ from the drive programs actually used (in parentheses).

Gearbox Control

Cruise control CCS or ACC mode
(refer to matrix for drive programs)

The function of the CCS and ACC drive programs is to minimise the gearshift frequency in the respective system mode.

To further improve shift point selection in CCS/ACC mode, drive program selection was linked to the motion resistance recognition function (refer to matrix). 5 drive programs are available for each system.

This permits more precise definition of the appropriate shift point and prevents repeated shifting between two gears.

Warm-up program

(drive programs 30 and 31)
The purpose of the warm-up program is to reduce pollutant emissions after a cold start and in the warm-up phase.

The warm-up program is activated at engine temperatures below 30°C. It is a static drive program, i.e. neither motion resistance recognition nor driving style factor are incorporated. All shift points are moved to higher engine speeds.

Petrol engines:
With petrol engines, the higher speed level achieves rapid warm-up of the catalytic converters, thus considerably shortening the response time.

The warm-up program is currently not required for V8-5V engines and is therefore not implemented.

Diesel engines:
The higher speed level reduces the engine load and fewer pollutant emissions are produced.
The engine response behaviour is also improved.

At present the warm-up program is only used with diesel engines.

Hot mode program
(drive programs 28 and 29)

The hot mode program is activated at high gearbox temperatures. It is basically a gearbox protection program designed to return the gearbox to a sub-critical temperature range.

The significant factors governing shift point selection are temperature level and motion resistance recognition.

The hot mode program is characterised by shift points at higher engine speeds and early closing of the torque converter clutch. The associated decrease in torque converter slip results in reduced warming of the ATF. The higher engine speeds ensure a greater coolant throughput in the ATF cooler and thus better cooling of the ATF.

(For more details refer to Section on Temperature monitoring, Page 13)

Electronic stability program intervention
(drive programs 25 and 26)

The action involved with various electronic stability program functions (ABS, TCS, ESP) is assisted by way of special drive programs or by gearshift prevention. Impermissible engine speeds are prevented.

Low friction recognition
(not activated at present)

A basic function of the ESP is the constant determination of road surface friction. This data is now also used by the gearbox control system.

In the event of low road surface friction (e.g. ice/snow, rain or non-compacted surfaces), drive programs are selected which reduce the torque at the drive wheels by way of higher gears and early change-up. Change-down which could lead to wheel slip is largely avoided.

Sports program
(refer to matrix for drive programs)

In the sports program the driving style factor is one of the principal criteria affecting drive program selection. 10 sports programs are available depending on driving style factor and driving situation assessment (for further details on the sports program refer to Part 1 SSP 283, Page 16 onwards).

tiptronic mode
(drive program 27)

Information on this topic can be found in Part 1 SSP 283, Page 23 onwards.

Gear selection

Selection of the required gear is always governed by the current drive program. Irrespective of this principle, the evaluation of sudden events or special short-term ambient conditions has a direct influence on gear selection.

This evaluation generally has the effect of suppressing undesirable change-up/change-down operations and prevents repeated shifting between two gears.

Fast-off recognition
(rapid load reduction)

This function is based on evaluation of the position and movement (highly negative pedal gradient) of the accelerator pedal and detects rapid load reduction by the driver.

Rapid load reduction is very often the result of a hazardous situation in which the driver abruptly releases the accelerator pedal (fast-off) to press the brake as quickly as possible.

Following detection of fast-off, change-up is suppressed until the driver presses the accelerator pedal again.

Fast-off from accelerator pedal positions close to full throttle always has this effect, whereas fast-off from a part throttle position does not automatically prevent change-up.

At present, fast-off recognition is only implemented in the "S program".

Cornering recognition

Releasing the accelerator pedal whilst cornering may lead to change-up in line with the drive program. Subsequent acceleration out of the bend then involves changing back down again (two undesirable/unnecessary gearshift operations).

The cornering recognition function suppresses such undesirable change-up operations when cornering at high speed.

The parameters governing this evaluation function are lateral acceleration, steering angle and wheel speed.

A bend is recognised if the instantaneous lateral acceleration exceeds a defined value. The threshold is defined such that only bends negotiated in a sporty manner or incorrectly judged bends are registered.

Spontaneous vehicle deceleration (SVF)

Spontaneous deceleration is recognised by way of brake pedal actuation and corresponding slowing of the vehicle (negative longitudinal acceleration).

If this is the case (only with great deceleration), the change-down point is shifted so as to implement change-down together with brake assistance at an early stage.

This takes the form of change-down being advanced in closed throttle position and taking place at a higher vehicle speed than usual.

This has the advantage that change-down is already in progress whilst the driver is still pressing the brake. The required gear is already engaged if the vehicle is then immediately to be accelerated again.

The effect of the SVF function is more pronounced on long downhill stretches. The brake then only has to be pressed gently to implement change-down.

The engine braking effect is put to better use by shifting the change-down points in the downhill drive program.

The change-up prevention function (HSV) remains active for the duration of brake actuation or closed throttle position. Only renewed acceleration cancels HSV and results in normal change-up in line with the current drive program.

Self-diagnosis

The automatic gearbox control unit J217 and the diagnosis tester communicate by means of the K-wire or by way of the CAN data bus interface.

Depending on the diagnosis tester generation used (VAG1551 or VAS 5051), data are transferred with the data log KWP 2000 on the K-wire (e.g. VAS 1551) or by means of the CAN transport protocol TP 2.0 with the data log KWP 2000 (VAG 5051).

Using the CAN data bus for the transfer of self-diagnosis data is far faster than via the conventional K-wire.

New, inter-system functions are now only available with CAN diagnosis.

Snapshot memory

The snapshot memory is used to store a wide range of gearbox control unit measured values (ambient conditions) applying at the time of the initial fault memory entry.

A new feature is that these ambient conditions can be read out in the measured value block function 08 (measured value blocks 40-48).

This considerably enhances the reproduction of faults and facilitates fault-finding, particularly in the case of sporadic faults (refer to "Assisted fault-finding").

The K-wire is still required for control units of relevance to OBD.

Update programming

Integration of the electronic control unit into the gearbox (Mechatronik) has created the means to update the software version without replacing the control unit.

The control unit requires programs, characteristic curves and data (software) for the calculation of output signals. These are permanently stored in a so-called flash EPROM (erasable programmable read-only memory) and are thus always available to the control unit.

The EPROMs fitted to date could not be erased or programmed when installed.

To rectify problems requiring software modification, the control unit had to be replaced.

The Mechatronik control unit of the 09E features a so-called "Flash EPROM".

A flash EPROM can be re-programmed in situ. This process is known as "flash programming" or "update programming".

Flash programming requires the use of the diagnosis tester VAS 5051 equipped as follows:

- Tester software Basic CD V.02.00 or higher
- Audi CD as of version V.02.22
- Current flash CD

Programming is performed either by way of the diagnosis CAN interface (CAN transport protocol TP 2.0) or using the K-wire.

Explanatory note:

"In a flash" = "as quick as possible"

In terms of "flash programming" this means "high-speed programming".

The word "flash" is also used in a variety of terms relating to flash programming (e.g. flash CD).

"Update" = "Bring up to date, i.e. latest status"

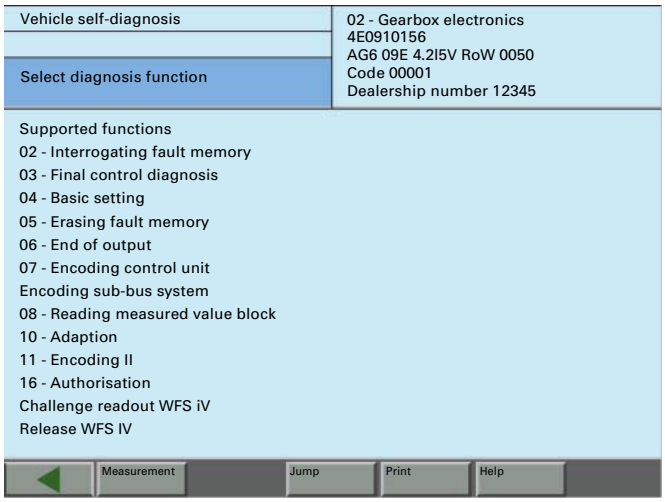
Flash programming is only necessary if problems can be rectified by means of software modification.

Sequence of operations

After inserting the current flash CD and entering into gearbox electronics diagnosis mode (address word 02), the VAS 5051 recognises whether the control unit can be programmed on the basis of the control unit identification.

VAS 5051 uses the flash CD data to determine whether a new software version is available for the gearbox control unit part number concerned.

If this is the case, "update programming" appears in the list of diagnosis functions. Programming commences after selecting the diagnosis function "update programming".



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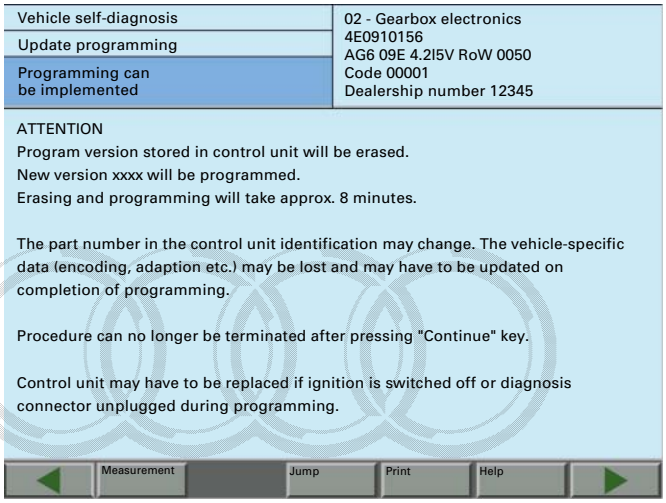

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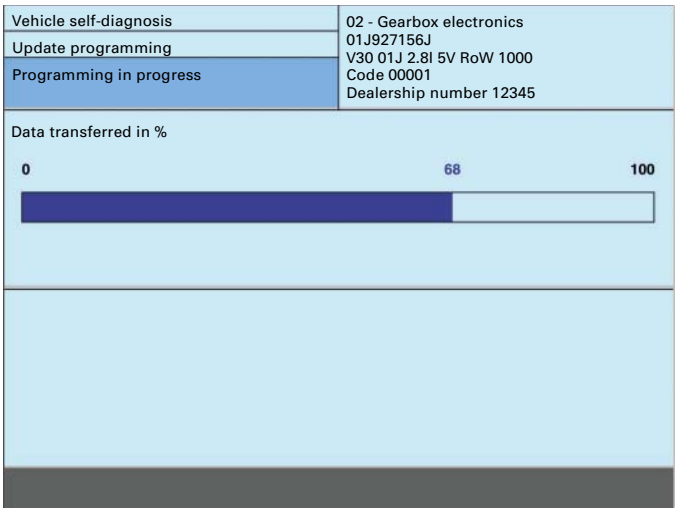
If the update programming function is not displayed, either the flash CD is not applicable to the vehicle or the current software version already corresponds to that of the flash CD.

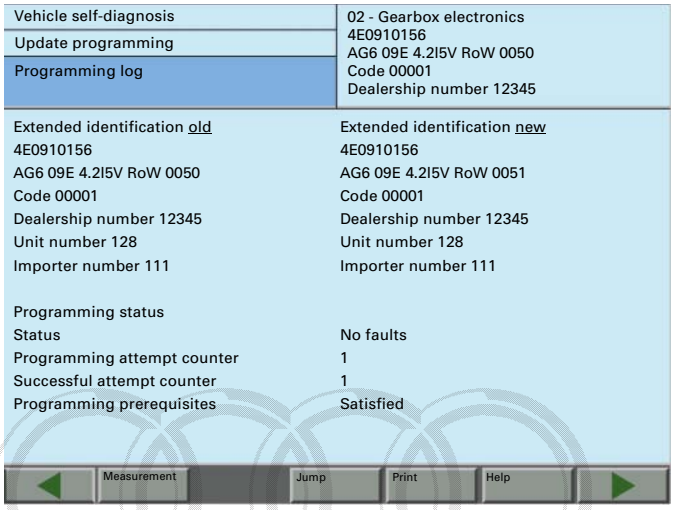
Programming is controlled by the flash CD and takes place automatically.

The programming sequence is indicated on the display, provides information on the steps in progress and issues input prompts. Programming takes approx. 5-10 minutes.



284_144

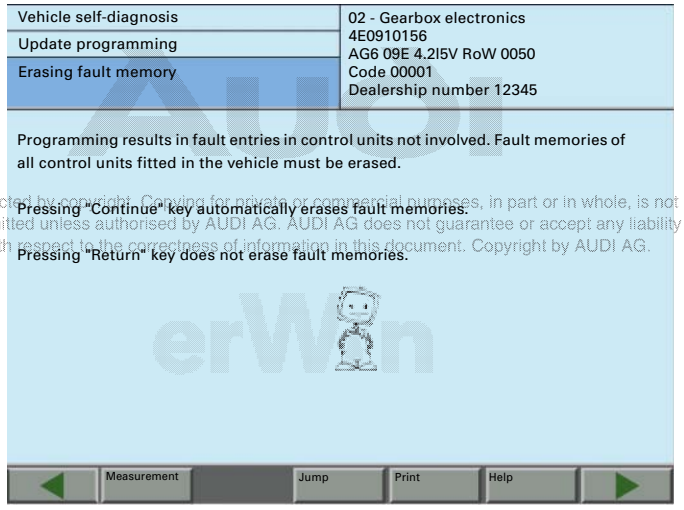
A programming log is displayed on completion of programming.



284_145

As CAN data exchange is interrupted during programming, faults are entered in the fault memories of the control units linked to the CAN.

After programming, the fault memories of **all** control units must be erased (last display).



284_146

Flash CD

The flash CD contains the data and programs for the programming sequence and the "update versions" of new software versions.

Updates are issued at regular intervals for the flash CD. The flash CD also contains the update data for other programmable control units (future systems). This means that in future there will only be one flash CD for all systems (engine, gearbox, brakes, air conditioner etc. ...).

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Only new software versions can be programmed. "Programming back" to an older version is not possible.

Flash CDs are only supplied when new software versions are available.

Special tools/workshop equipment

The following special tools/workshop equipment will initially be required for service work:

Thrust pad for radial shaft seal/selector lever
T10135

Thrust pad for radial shaft seal/flange shaft, RWD (2-part)
T10136

Thrust pad for torque converter/oil pump radial shaft seal
T10137

Thrust pad for differential flange shaft, right
T10138

Thrust pad for differential flange shaft, left (transverse shaft)
T10139

Carrier frame
3311 (attention: use new, longer bolt 3311/1)

Adapter/test box
VAG 1598/40

ATF filling system
V.A.G 1924

Towing

When the vehicle is towed, the oil pump is not driven and there is thus no lubrication of rotating components.

The following prerequisites must always be met so as to avoid serious gearbox damage:

- Selector lever must be set to position "N".
- Vehicle speed must not exceed 50 km/h.
- Vehicle must not be towed for more than 50 km.
- *On account of quattro drive, vehicle is not to be towed with front axle raised.

Tow-starting (e.g. inadequate battery charge) is not possible.

If battery is flat or has been disconnected, selector lever emergency release mechanism must be actuated to shift selector lever from "P" to "N" (refer to Part 1 SSP 283, Page 21 onwards).

*The transfer case (with Torsen differential) is lubricated by the transfer case oil pump. The oil pump is driven by the side shaft to the front axle. If the front axle is stationary, the oil pump is not driven and adequate transfer case lubrication is not guaranteed. This results in destruction of the Torsen differential.

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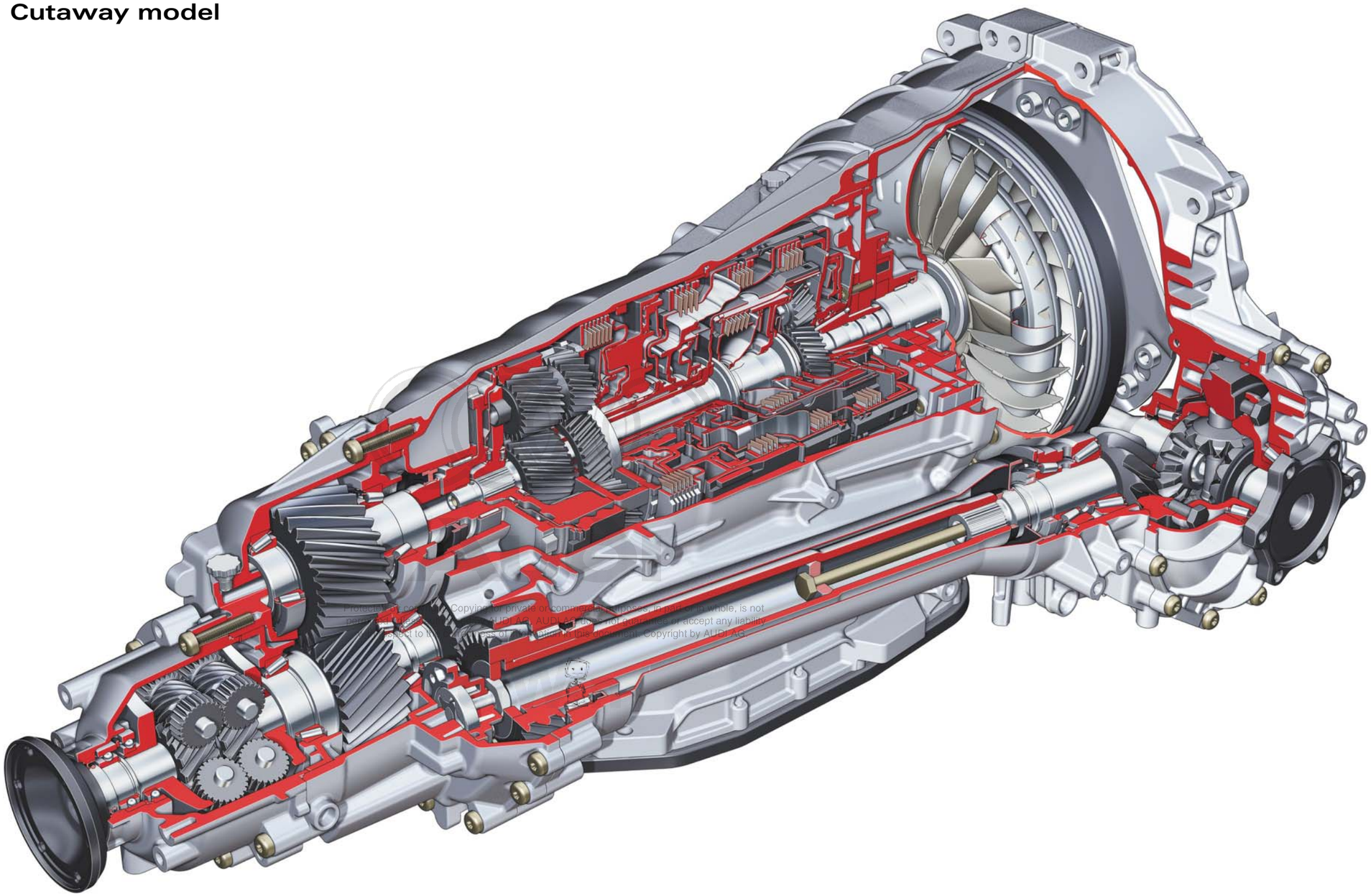
Note on repair work

Jacking mode

On account of the air suspension, jacking mode must be selected before the vehicle is raised (no wheel load).

Refer to Workshop Manual.

Cutaway model



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