Function requirements, general

- Engine running or drivetrain operational

i The CDI control unit (N3/9) (with diesel engine) or the ME-SFI [ME] control unit (N3/10) (with gasoline engine) sends the "Engine running" or the "Drivetrain operational" status over the chassis CAN (CAN E), front SAM control unit with fuse and relay module (N10/1) and interior CAN (CAN B) to the rear SAM control unit with fuse and relay module (N10/2).

Engine on energy management, general

Engine on energy management ensures the stability of the on-board electrical system as well as an even charge balance in the on-board electrical system battery (G1).

Energy management for driving encompasses the following subfunctions:

- **Function sequence for voltage provision**
- **Function sequence for dynamic idle speed control**
- **Function sequence for consumer reduction**
- **Function sequence for power supply over additional battery (G1/7) (without code (B03) ECO start/stop function) or additional battery for ECO start/stop function (G1/13) (with code (B03) ECO start/stop function)**

Function sequence for voltage provision

The voltage provision function sequence encompasses the following:

- **Function sequence for determine charge state of battery**
- **Function sequence for charging on-board electrical system battery (except model 212.095/098/298)**
- **Function sequence for charging on-board electrical system battery (for model 212.095/098/298)**
- **Function sequence for alternator control (except model 212.095)**

Charge on-board electrical system battery function sequence (except model 212.098/298)

Charging of the on-board electrical system battery requires that the specified voltage be determined. The specified voltage is the voltage that must be present at the terminals of the on-board electrical system battery in order to charge the on-board electrical system battery in an optimal manner.

Depending on various factors, the specified voltage is determined using the alternator management or using the temperature-dependent charging characteristic including the fast charge function. After the engine is started, fast charging is performed first at high voltage until the charge level of the on-board electrical system battery is recognized as being sufficient.

i Fast charging is done with a charging voltage of U = 15 V and may take from t = 20 s to 1 h.

After this, a switch is made to a temperature-specific characteristic or alternator management (as of T > 15 °C (up to 31.5.12), T > 10 °C (as of 1.6.12)).

As a consequence of the variable power output of the alternator (G2) (except model 212.095) or the power electronics control unit (N129/1) (for model 212.095/098/298) and simultaneous utilization of several consumers, overload situations may arise that have to then be buffered by the on-board electrical system battery. If such an overload situation lasts for an extended period or if the charging capacity of the on-board electrical system battery is low, a negative charge/discharge ratio may result that could impair the engine's starting capability.

In situations where the on-board electrical system is overloaded for prolonged periods, engine ON energy management increases the power output of the alternator (except model 212.095) or reduces comfort-related electrical consumers in order to balance the charge/discharge ratio of the on-board electrical system battery.

Function sequence for determine charge state of battery

The state of the on-board electrical system battery is recorded by the battery sensor (B95). This calculates corresponding parameters on the voltage, current and temperature measurements on the on-board electrical system battery. The charge level of the on-board electrical system battery is the ratio of the current charge to the maximum storable charge. This is based on the calculation of the internal resistance of the on-board electrical system battery. This value can be used to determine the acid density of the on-board electrical system battery. This, along with the battery capacity, is then used to compute the charge stored in the on-board electrical system battery. The rear SAM control unit reads in the calculated data from the battery sensor over the on-board electrical system-LIN (LIN B7), it also measures the voltages at circuit 30 and circuit 30g and then calculates the specified voltage required by the alternator (except model 212.095) to provide the required level of energy or the required transfer of energy through the DC/DC converter in the power electronics control unit (for model 212.095/098/298).

Alternator management includes lowering of the charging voltage (U = 12.6 V (up to 31.5.12), U = 12.7 V (as of 1.6.12)) and a regenerative braking (energy recovery) option when the engine is in decel mode.

Special feature as of 1.6.10:

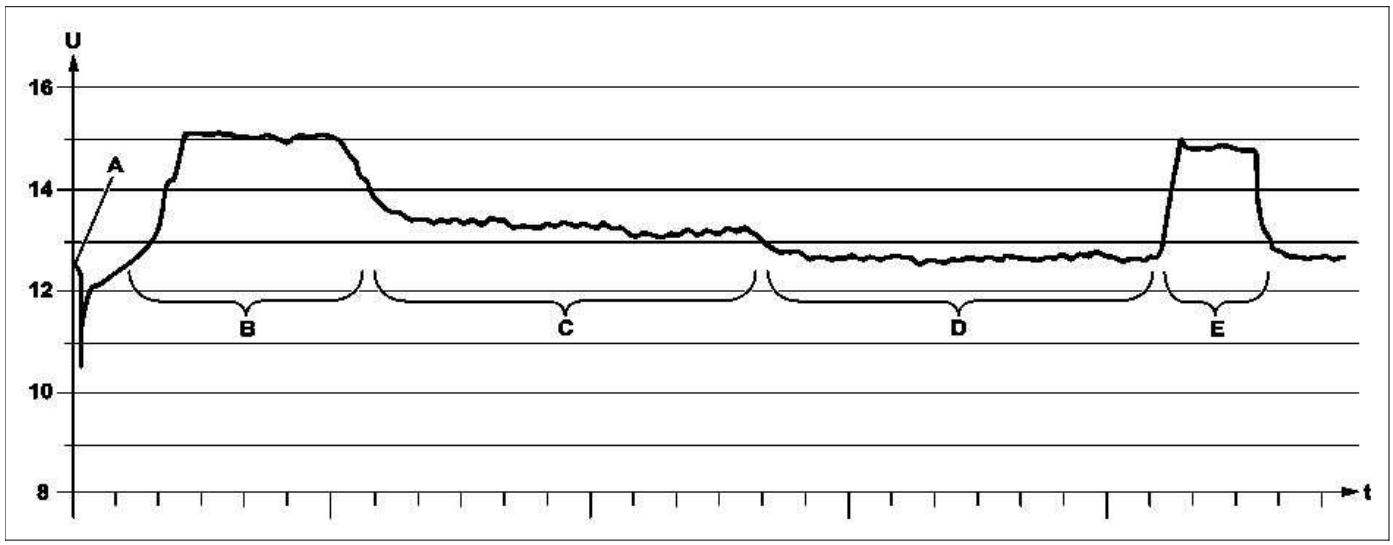
When the alternator management is active, one of the front doors is open and the ground speed is v = 0 km/h, the alternator management changes to the external starting aid or the workshop mode. At the same time, the alternator voltage is increased constantly to U = 14.3 V. This external starting aid or workshop mode is not canceled until the speed is v > 0 km/h.

A safety cutout is activated when driving down long hills in order to avoid overcharging of the on-board electrical system battery resulting from long periods of deceleration fuel shutoff. This protective cutout deactivates regenerative braking (energy recovery) in cases of high voltage combined with low power consumption.

If the on-board electrical system battery becomes fully charged (for example after driving in the cold or long downhill travel), the voltage is lowered further to return the battery to its optimum charge level of 80%.

Function sequence for charging on-board electrical system battery (model 212.095/098/298)
The on-board electrical system battery is charged primarily using energy from the high-voltage on-board electrical system. To this end, energy that is stored in the high voltage battery is fed into the 12 V on-board electrical system by the power electronics control unit (up to approx. I = 100 A). If the energy made available by the power electronics control unit does not meet the existing energy requirements, the alternator (model 212.098/298) is switched on as a backup.

The following graph shows the shows the various phases of voltage provision.



P54.10-3013-08

A Engine start (circuit 50 ON)
B Fast charging
C Temperature-based charging
D Alternator management (except model 212.095)
E Charging in deceleration mode
U Specified voltage of on-board electrical system battery
t Time

Fast charging:
- Voltage up to U = 15 V
- Once after circuit 50 ON (engine start)
- Optimized charging of on-board electrical system battery, incl. during short trips
- Duration t = 20 s to 1 h
- Fast charging ends when charge of on-board electrical system battery is at 80%
- No rapid charging with trailer operation (with code (550) Trailer hitch)
- No fast charging when the on-board electrical system battery is too warm

Transition in alternator management (except model 212.095):
- Fast charging ended
- Temperature of on-board electrical system battery T_{Batt} > 15 °C (up to 31.5.12), T_{Batt} > 10 °C (as of 1.6.12)
- Outside temperature $T_{Outside}$ > 15 °C (up to 31.5.12), $T_{Outside}$ > 10 °C (as of 1.6.12)
- Charge level of the on-board electrical system battery > 70%
- No trailer operation (with code (550) trailer hitch)

Temperature-based charging:
- Fast charging ended, alternator management not possible
- Voltage range U = 13.5 to 15 V
- Linear charging characteristic

Alternator management(except model 212.095):
- Voltage U = 12,6 V (up to 31.5.12), U = 12.7 V (as of 1.6.12), for some light functions U = 13.5 V
- Charge level of the on-board electrical system battery 80%
- Reduced consumer power consumption
- With air conditioning ON and high blower setting U = 14.3 V

Transition to charging in deceleration mode:
- CDI control unit or ME-SFI [ME] control unit recognizes decel mode
  (for model 212.095/098/298 only when the high-voltage battery (A100g1) is fully charged)

Charging in deceleration mode:
- Voltage up to U = 15 V
- Activated by CDI control unit or ME [ME-SFI] control unit
- On-board electrical system battery charged when "free" energy is available

Function sequence for alternator control (except model 212.095)
Alternator regulation (alternator management)

The rear SAM control unit sends this value over the interior CAN, front SAM control unit and chassis CAN to the CDI control unit or the ME-SFI [ME] control unit. The CDI control unit or the ME-SFI [ME] control unit evaluates this, taking additional input factors (e.g. A/C ON) into consideration, and calculates the ideal specified voltage for the alternator.

The CDI control unit or the ME-SFI [ME] control unit then calculates

- Takes place in CDI control unit or ME-SFI [ME] control unit
- Sets the specified voltage of the on-board power supply management
- Switches to regenerative braking voltage in deceleration mode
- Sets a lower voltage in exceptional cases (e.g. stall prevention, cold start at high altitude, catalytic converter heating)

The alternator control actuates the alternator's power output. The rear SAM control unit reads-in the on-board electrical system battery parameters as provided by the battery sensor over the on-board electrical system LIN and calculates the required alternator specified voltage.

The CDI control unit or the ME-SFI [ME] control unit compares the alternator's specified voltage values with the alternator's output values in order to get a picture of the energy state of the on-board electrical system. This comparison is termed power management.
The CDI control unit or the ME-SFI [ME] control unit sends information on this over chassis CAN, front SAM control unit and the interior CAN to the rear SAM control unit.

As soon as it becomes apparent that the on-board electrical system voltage is not high enough, the energy management is gradually reduced. The alternator can then make its full output available.
The energy management in the CDI control unit or in the ME-SFI [ME] control unit adopts the alternator specified voltage values for the rear SAM control unit as a guideline value only, because certain vehicle conditions, e.g. engine comfort, idle stability, engine start, irregular engine operation have to be taken into consideration.

The following factors are used for dynamic idle speed control computations:
- Alternator excitation current (except model 212.095)
- Alternator operating rate (except model 212.095)
- On-board electrical system battery voltage
- On-board electrical system battery current
- Engine speed
- Consumer reduction shutoff stage
- State of on-board electrical system battery
- Engine start

The CDI control unit or the ME-SFI [ME] control unit sends the engine speed over the chassis CAN, front SAM control unit and the interior CAN to the rear SAM control unit.
Information on condition, voltage and current is recorded by the battery sensor and it sends this over the on-board electrical system LIN to the rear SAM control unit.
The rear SAM control unit reads in all relevant information, evaluates it and uses it to calculate the required alternator current (except model 212.095).

The idle speed is reversed under the following circumstances:
- Engine off or alternator defective (except model 212.095)
- Simultaneous occurrence of the following conditions:
  - Consumer reduction not active
  - On-board electrical system emergency mode not active
  - Consumer load no longer high

Function sequence for consumer reduction

the alternator specified voltage over the drive train-LIN (LIN C1) to the alternator, which then sets it. In addition, the CDI control unit or ME-SFI [ME] control unit checks the input factors for plausibility in order to rule out any overcharging or faulty charging of the on-board electrical system battery.

i On model 212.095 the ME-SFI [ME] control unit sends a corresponding request over the hybrid-CAN (CAN L) to the power electronics control unit.

The actual specified voltage of the alternator is therefore obtained by taking both the specified voltages sent by the rear SAM control and that of the energy management into account.

i If a fault is found in the battery sensor, the on-board power supply management switches to a fixed voltage of U = 14.3 V. This can also be activated through diagnosis to enable, e.g. the alternator to be checked.

Function sequence for dynamic idle speed control
Dynamic idle speed control sets the engine's idle speed such that no current needs to be drawn from the on-board electrical system battery when the vehicle is idling. The idle speed is increased for a higher consumer load. Idle speed increase is done in a preventive manner. In other words, the system does not respond to a lack of electrical energy, but rather sets the required idle speed based on the present load.

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i On model 212.095/098/298 the specified voltage request is sent by the CDI control unit or the ME-SFI [ME] control unit over the hybrid-CAN (CAN L) to the power electronics control unit.

The maximum possible excitation current is calculated from the current excitation current and the alternator utilization.
The maximum possible excitation current is used to calculate the maximum possible alternator current at different idle speeds.

The rear SAM control unit sends corresponding requests over the interior CAN, front SAM control unit and chassis CAN to the CDI control unit or the ME-SFI [ME] control unit, which then raises the idle speed accordingly.

If the alternator (except model 212.095) or the power electronics control unit (for model 212.095/098/298) is able again to supply the required electrical power to stabilize the on-board electrical system voltage, the consumer reduction is canceled.

The consumer reduction function is activated when the on-board electrical system voltage falls below U = 12.2 V. The first consumer's power consumption is reduced at t = 20 s following engine start. If

If the alternator (except model 212.095) or the power electronics control unit (for model 212.095/098/298) is unable to supply the required electrical power, the consumer reduction is activated. The on-board electrical load is reduced by cutting back comfort functions. This serves to avoid any significantly negative charge balance for the on-board electrical system battery. This in turn retains the engine's starting capability.

The rear SAM control unit sends the request for power reduction or shutoff via the interior CAN to the corresponding control units.

The shutoff sequence is shown as of 1.6.12 in the table below.

Shutoff step	Switch off stage	Consumers with reduced or no power	Executing control unit	Maximum Current in A
1	1	Heating level 6, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9), passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
2	2	Heating level 5, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9) driver side	Automatic air conditioning control and operating unit (N22/7)	18.5
3	3	Heating level 4, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9) front passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
4	4	Heating level 3, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9) driver side	Automatic air conditioning control and operating unit (N22/7)	18.5
5	5	Heating level 2, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9) front passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
6	6	Heating level 1, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9), driver side	Automatic air conditioning control and operating unit (N22/7)	18.5
7	7	Seat heater level 3 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	13.2
8	8	Seat heater level 2 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	13.2
9	9	Wiper park position heater (R2/10)	Front SAM control unit with fuse and relay module (N10/1)	15,0
10	10	Mirror heater (M21/1r1) and mirror heater (M21/2r1)	Left front door control unit (N69/1) and Right front door control unit (N69/2)	3.5
11	11	Steering wheel heater electronics (A74) (with code (443) steering wheel heater)	Steering wheel heater control unit (N25/7)	8,0
12	12	Rear window heater (R1)	Rear SAM control unit with fuse and relay module (N10/2)	30.0
13	13	Rear blower motor (M2/1) (with code (581) C-AAC) P = 50 %	Automatic air conditioning control and operating unit (N22/7)	5.5
14	14	Blower motor (A32m1) P = 50%	Automatic air conditioning control and operating unit (N22/7)	16.0
15	15	Combustion engine fan motor and air conditioning with integrated control (M4/7) P = 50%	Automatic air conditioning control and operating unit (N22/7)	31.0
16	16	Circuit 15R relay (1) (N10/2kB)	Rear SAM control unit with fuse and relay module (N10/2)	6
17	18	Seat heater stage 1 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	3.3

The shutoff sequence is shown up to 31.5.12 in the table below.

Shutoff step	Switch off stage	Consumers with reduced or no power	Executing control unit	Maximum Current in A
1	1	Heating level 6, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9), passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
2	2	Heating level 5, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9) driver side	Automatic air conditioning control and operating unit (N22/7)	18.5

the cutback conditions remain unchanged, the power consumption of one further consumer will be reduced every following second.

i Consumer reduction in case of PRE-SAFE deployment:
The left front reversible emergency tensioning retractor (A76) and the right front reversible emergency tensioning retractor (A76/1) have very high starting and operation currents. The power consumption of some high power consumers is therefore reduced or the consumers shut off altogether as quickly as possible for approx. t = 2s when the reversible emergency tensioning retractors are triggered in order to reduce the load on the on-board electrical system.

3	3	Heating level 4, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9) front passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
4	4	Heating level 3, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9) driver side	Automatic air conditioning control and operating unit (N22/7)	18.5
5	5	Heating level 2, PTC [positive temperature coefficient] heater booster (R22/3) (with engine 271.8, 642.8, 651.9) front passenger side	Automatic air conditioning control and operating unit (N22/7)	18.5
6	6	Heating level 1, PTC heater booster (R22/3) (with engine 271.8, 642.8, 651.9), driver side	Automatic air conditioning control and operating unit (N22/7)	18.5
7	7	Rear blower motor (M2/1) (with code (581) C-AAC) P = 50 %	Automatic air conditioning control and operating unit (N22/7)	5.5
8	8	Blower motor (A32m1) P = 50%	Automatic air conditioning control and operating unit (N22/7)	16.0
9	9	Combustion engine fan motor and air conditioning with integrated control (M4/7) P = 50%	Automatic air conditioning control and operating unit (N22/7)	31.0
10	10	Trailer socket (X58) (with code (550) Trailer hitch)	Trailer recognition control unit (N28/1) (with code (550) Trailer hitch)	8
11	11	Circuit 15R relay (1) (N10/2kB)	Rear SAM control unit with fuse and relay module (N10/2)	6
12	12	Seat ventilation (with code (401) Front comfort seats, incl. seat heating and seat ventilation)	Rear SAM control unit with fuse and relay module (N10/2)	2.2
13	13	Seat heater level 3 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	13.2
14	14	Rear window heater (R1)	Rear SAM control unit with fuse and relay module (N10/2)	30.0
15	15	Wiper park position heater (R2/10)	Front SAM control unit with fuse and relay module (N10/1)	15,0
16	16	Seat heater level 2 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	13.2
17	17	Seat heater stage 1 (with code (873) Seat heater for left and right front seats)	Rear SAM control unit with fuse and relay module (N10/2)	3.3
18	18	Steering wheel heater electronics (A74) (with code (443) steering wheel heater)	Steering wheel heater control unit (N25/7)	8,0
19	20	Mirror heater (M21/1r1) and mirror heater (M21/2r1)	Left front door control unit (N69/1) and Right front door control unit (N69/2)	3.5

When the on-board electrical system voltage has been stabilized to a value above U = 12.2 V, consumer reduction is revoked in the reverse order with a waiting time between each of t = 1s.

The on-board electrical system emergency mode represents a special case of consumer reduction. This is activated by the on-board power supply management in the rear SAM control unit if the voltage of the on-board electrical system battery remains below a defined voltage threshold for a certain period of time.
The on-board power supply management uses all options available through dynamic power management to enforce a positive charge balance.

If the on-board electrical system voltage drops below U = 10.6 V for t ≥ 10s, the rear SAM control unit activates the on-board electrical system emergency mode function.

- Pneumatic pump for dynamic multicontour seat (M40/1)
  (with code (432) Left and right dynamic multicontour seat)
- Left front dynamic multicontour seat control unit (N32/19) and right front dynamic multicontour seat control unit (N32/22)
  (with code (432) Left and right dynamic multicontour seat)
- AIRmatic control unit (N51/3)
  (with code (489) AIRmatic (air suspension with continuously adjustable damping) or with code (488) Steel/air suspension)

As soon as the on-board electrical system voltage has stabilized for t ≥ 10 s at a value of
U = 11.8 V or a change in circuit status from circuit 15R to circuit 15C has occurred, the rear SAM control unit ends the function on-board electrical system emergency running.

Determine function sequence of status of additional battery

This causes the activation of the following engine on energy management functions:
- Idle speed increase
- Deactivation of alternator management
  (except model 212.095)
- Consumer reduction with shutoff of short-term consumers

Unlike consumer reduction, power reduction or consumer shutoff is done with a cycle time of t = 200 ms.

In addition to consumer reduction the following consumers are switched off:
- KDS [trunk lid-control control unit] (N121)
  (on model 212.0 with code (881) Remove trunk closing (HDFS))
- Liftgate control unit (N121/1) (on model 212.2)

The triggered functions are returned in the specified sequence:
- The idle speed increase is set back.
- Power can again be supplied to the consumers that were shut off.

Power supply via additional battery function sequence
To be able to engage selector lever position "P" even with a discharged on-board electrical system battery, the electronic ignition lock control unit (N73) is also supplied with power through the additional battery.
The capacity of the additional battery is 1.2 Ah.

The power supply function over the additional battery encompasses the following subfunctions:
D **Determine function sequence of status of additional battery**
D **Function sequence of charge additional battery**

Function sequence of charge additional battery

To generate information about the availability of electric power from the additional battery, the front SAM control unit has a simple battery state recognition integrated into it. This is carried out immediately after the engine has been started. If the engine is switched off while battery state recognition is in progress, the front SAM control unit aborts battery state recognition and rejects the results from the measurement up to that time.

In addition to the battery state recognition, the voltage of the additional battery is also constantly checked. To perform this check, charging must be stopped for t = 20 ms. The check is performed every t = 5 s. The battery state recognition can also be started by means of diagnosis tester.

If there is no voltage at the additional battery or if this is discharged or defective, the fault message "Backup battery fault" is displayed in the multifunction display of the IC. The rear SAM control unit transmits the data required for this to the IC via the interior CAN.

The additional battery is permanently charged after battery state recognition when the engine is running.

The additional battery is charged via the front SAM control unit. Charging is only interrupted for as long as it takes to run the battery state recognition.

The charging current is limited by means of a resistor to P = 15 W. A diode prevents the additional battery from feeding back into the on-board electrical system.

☞PE	Electrical function schematic for alternator management		PE54.10-P-2064-97DAA
☞PE	Electrical function schematic for dynamic idle speed increase		PE54.10-P-2063-97DAA
☞PE	Electrical function schematic for consumer shutoff		PE54.10-P-2066-97DAA
	Overview of system components for energy management		GF54.10-P-9990FL