MODEL 212
as of model year 2014

Function requirements, general

- "Engine running" or "Drive train operational" signal on

i The CDI control unit (N3/9) (diesel engine) or the ME-SFI [ME] control unit (N3/10) (gasoline engine) sends the "Engine running" or "Drivetrain operational" signal via the chassis CAN 1 (CAN E1), the front SAM control unit with fuse and relay module (N10/1) and the 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).

As a consequence of the variable power output of the alternator (G2) (except model 212.095) and the power electronics control unit (N129/1) (model 212.095/098/298) and simultaneous use of many consumers, overload situations may arise which have to then be buffered by the on-board electrical system. 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.

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 via ECO start/stop function additional battery (G1/13) (up to 30.11.2014 and as of 01.12.2014 with engine 642 or with CODE 460 (Canada version) or CODE 494 (USA version)) or additional battery (G1/7) (as of 01.12.2014 with transmission 722, 725 and without engine 642 and except CODE 460 (Canada version) and except CODE 494 (USA version))**

Function sequence for voltage provision

The voltage provision function sequence encompasses the following:

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

Determine charge state of battery function sequence

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 calculates the specified voltage required by the alternator (except model 212.095) to provide the required level of energy, or the required energy transfer through the DC/DC converter in the power electronics control unit (model 212.095/098/298).

Function sequence for charging on-board electrical system battery (except model 212.095/098/298)

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 optimum manner.

Depending on various factors, the specified voltage is determined using the alternator management or using the temperature-dependent charging characteristic incl. quick-charge function.

After the engine is started, quick charging is performed first at high voltage until the charge level of the on-board electrical system battery is recognized as being sufficient.

i The rapid charging occurs with a charging voltage of U = 15 V and can last from t = 20 s to 1 h.

After this, a temperature-dependent characteristic or the alternator management function (T_{batt} > 10°C) is used.

The alternator management contains lowering charging voltage (U = 12.7 V) and the regenerative (energy management) braking option in the engine's decel mode.

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 jump start mode or the workshop mode. At the same time, the alternator voltage is increased constantly to U = 14.3 V. This jump-start or workshop mode is only canceled when the vehicle speed v > 0 km/h.

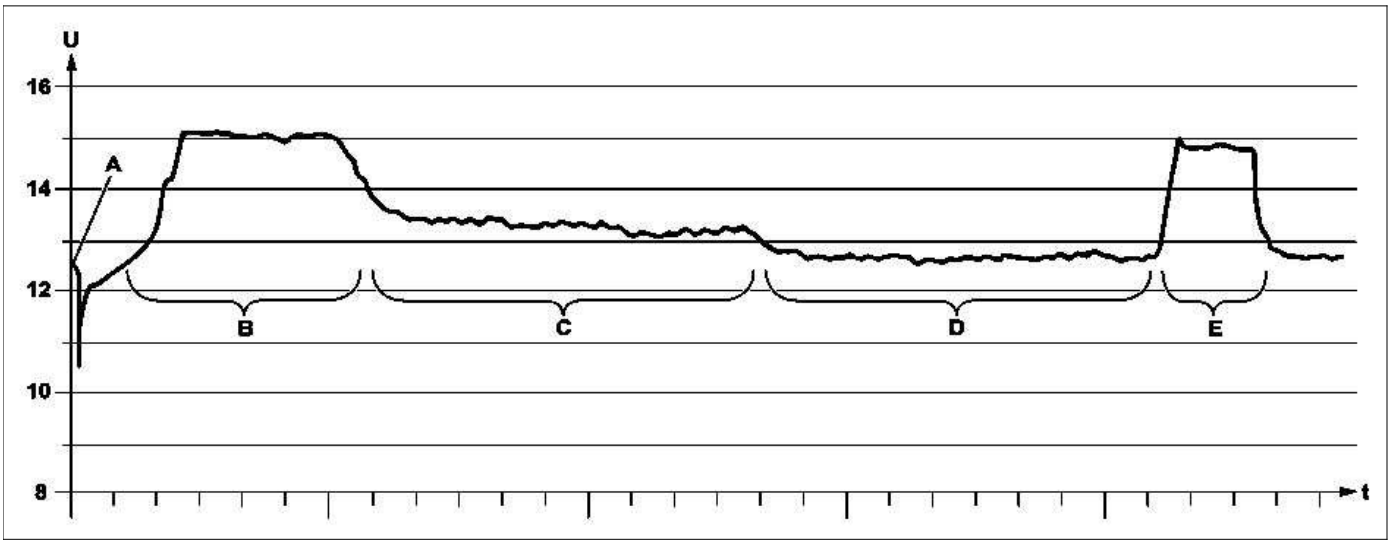
An emergency shutoff is activated when driving down long hills in order to avoid overcharging of the on-board electrical system battery resulting from long periods of deceleration fuel shutoff. This emergency shutoff deactivates regenerative braking (energy recovery) in cases of high voltage combined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

If the on-board electrical system battery is 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 following graph depicts the various phases of voltage supply.

The on-board electrical system battery is charged primarily using energy from the high-voltage on-board electrical system. For this purpose, energy that is stored in the high voltage battery (A100g1) 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 satisfy the existing energy requirements, the alternator (model 212.098/298) is switched on as a backup.



P54.10-3013-08

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

Quick 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
- Quick 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 quick charging when the on-board electrical system battery is too warm

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

Transition in alternator management (except model 212.095):
- Quick charging ended
- Temperature of on-board electrical system battery T_{batt} > 10°C
- Outside temperature $T_{outside}$ > 10°C
- Charge level of the on-board electrical system battery > 70%
- No trailer operation (with CODE 550 (Trailer hitch))

Alternator management(except model 212.095):
- Voltage U = 12.7 V, for some lighting 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 deceleration mode (model 212.095/098/298 only when the high-voltage battery 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):
- Takes place in the CDI control unit or ME-SFI [ME] control unit
- Sets the specified voltage of the energy 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 CDI control unit or the ME-SFI [ME] control unit then calculates 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.

The CDI control unit or the ME-SFI [ME] control unit compares the

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 rear SAM control unit then sends this value via the interior CAN, front SAM control unit and chassis CAN 1 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.

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.

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 chassis CAN 1, front SAM control unit and 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.

Function sequence for consumer reduction

If the alternator (except model 212.095) or the power electronics control unit (model 212.095/098/298) is no longer able to supply the required electrical power, 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.

If the alternator (except model 212.095) or the power electronics control unit (model 212.095/098/298) is again able to supply the required electrical power to stabilize the on-board electrical system voltage, 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 the cutback conditions remain unchanged, the power consumption of one further consumer will be reduced every following second.

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 1, front SAM control unit and 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 power management is gradually reduced. The alternator can then make its full output available.

The power management function 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 only, because certain vehicle conditions (engine comfort, idle stability, engine start and irregular engine operation) also have to be taken into consideration.

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

i If a fault is found in the battery sensor, the energy management switches to a fixed voltage of U = 14.3 V. This behavior can be activated through diagnosis in order to check the alternator, for example.

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).

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The CDI control unit or the ME-SFI [ME] control unit transmits the request for the specified voltage via 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 operating rate (except model 212.095).

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 via the interior CAN, front SAM control unit and chassis CAN 1 to the CDI control unit or the ME-SFI [ME] control unit, which then raises the idle speed accordingly.

The idle speed is reversed under the following circumstances:

- Engine OFF
- 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

i Consumer reduction in case of PRE-SAFE® deployment:

The front left reversible emergency tensioning retractor (A76) and the front right reversible emergency tensioning retractor (A76/1) have very high starting and operating 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.

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 in the table below.

Shutoff step	Switch off stage	Power-reduced or deactivated function	Executing control unit	Maximum Currentin A
1	1	Heating level 6, heat boosting (engine 271.8, 642.8, 651.9), passenger side	Automatic climate control control and operating unit (N22/7)	18.5
2	2	Heating level 5, heat boosting (engine 271.8, 642.8, 651.9), driver side	Automatic climate control control and operating unit (N22/7)	18.5
3	3	Heating level 4, heat boosting (engine 271.8, 642.8, 651.9), passenger side	Automatic climate control control and operating unit (N22/7)	18.5
4	4	Heating level 3, heat boosting (engine 271.8, 642.8, 651.9), driver side	Automatic climate control control and operating unit (N22/7)	18.5
5	5	Heating level 2, heat boosting (engine 271.8, 642.8, 651.9), passenger side	Automatic climate control control and operating unit (N22/7)	18.5
6	6	Heating level 1, heat boosting (engine 271.8, 642.8, 651.9), driver side	Automatic climate control 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 heater	Front SAM control unit with fuse and relay module (N10/1)	15.0
10	10	Mirror heater	Left front door control unit (N69/1) and Right front door control unit (N69/2)	3.5
11	12	Rear window heater	Rear SAM control unit with fuse and relay module (N10/2)	30.0
12	13	Rear blower (with CODE 581 (Comfort automatic air conditioning)) P = 50 %	Automatic climate control control and operating unit (N22/7)	5.5
13	14	Blower in front P = 50%	Automatic climate control control and operating unit (N22/7)	16.0
14	15	Fan P = 50%	Automatic climate control control and operating unit (N22/7)	31.0
15	16	Circuit 15R relay (1) (N10/2kB)	Rear SAM control unit with fuse and relay module (N10/2)	6.0
16	18	Seat heater level 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

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 energy 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 energy 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 ≥ 10 s, the rear SAM control unit activates the on-board electrical system emergency mode function.
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:

- Trunk lid control unit (N121) (model 212.0/1 with CODE 881 (Remote trunk closing (RTC [HDFS])))
- Liftgate control unit (N121/1) (model 212.2)
- 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 variable damping)) or with CODE 488 (Steel/air suspension))

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

- Idle speed increase
- Consumer reduction

Function sequence for power supply via ECO start/stop function additional battery (up to 30.11.2014 and as of 01.12.2014 with engine 642 or with CODE 460 (Canada version) or CODE 494 (USA version)) or additional battery (as of 01.12.2014 with transmission 722, 725 and without engine 642 and except CODE 460 (Canada version) and except CODE 494 (USA version))

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 power supply function over the additional battery encompasses the following subfunctions:

- **Determine function sequence of status of additional battery**
- **Function sequence of charge additional battery**

Determine function sequence of status of additional battery

A simple battery state recognition function is integrated in the front SAM control unit in order to provide information about the availability of electrical power from the additional battery. 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 it is discharged or defective, the fault message "Backup battery fault" is shown in the multifunction display (A1p13) of the instrument cluster (A1). The rear SAM control unit transmits the data required for this to the IC via the interior CAN.

Function sequence of charge additional battery

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. The additional battery charging process is only interrupted until the battery state is recognized.
The charging current is limited by means of a resistor to P = 15 W. Feedback from the ECO start/stop function additional battery to the on-board electrical system is prevented by the on-board electrical system decoupling relay (K19/7) (transmission 711.6, 716.6) or the ECO start/stop function diode (V19) (transmission 722.9, 724.2, 725).

	Electrical function schematic for dynamic idle speed increase		PE54.10-P-2063-97DAB
	Electrical function schematic for comfort function shutoff		PE54.10-P-2076-97DAA
	Overview of energy management system components		GF54.10-P-9990FLM