**MODEL 204.0 /2 as of model year 2009 /YoM 08**
**MODEL 204.3**
**MODEL 204.9**

**Function requirements, general**

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

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" signal 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 voltage provision**

The voltage provision function sequence encompasses the following:

- **Function sequence for determine charge state of battery**
- **Charge on-board electrical system battery function sequence**
- **Function sequence for alternator regulation**

---

**Charge on-board electrical system battery function sequence**

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 charging characteristic or alternator management (as of T > 15 °C (up to 31.5.12),
as of T > 10 °C (as of 1.6.12)).

---

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%.

Given that the power output of the alternator (G2) is dependent on engine speed and temperature, plus the fact that many consumers are used simultaneously, overload situations can arise that need to 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 works to increase the power output of the alternator or to switch off 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 the computed data from the battery sensor via the on-board electrical system LIN (LIN B7), while also measuring the voltages at circuit 30 and circuit 30g, and computes the alternator voltage required to provide the energy requested by consumers.

---

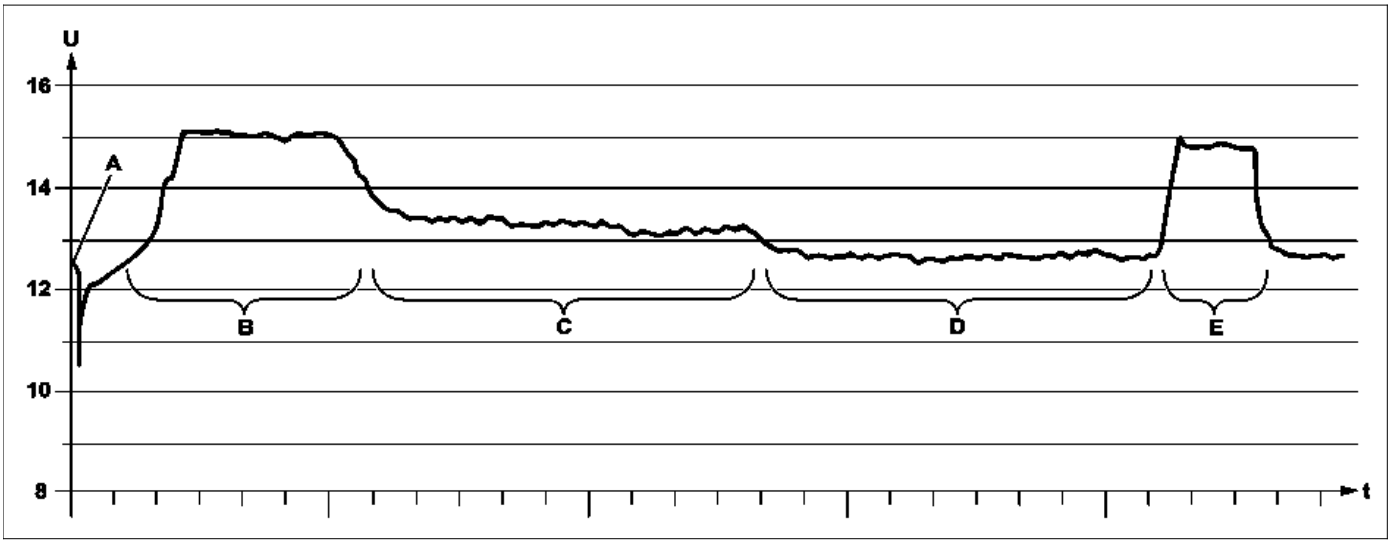
Alternator management includes lowering of the charging voltage (U = 12.6 V (up to 31.5.12), U = 12.7 V (as of 1.6.12)) and a regenerative braking (energy recovery) option when the engine is in decel mode.

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.

---

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*
*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 to alternator management:
- Fast charging ended
- Stable engine operation
- 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:
- 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:
- Stable engine operation
- CDI control unit or ME [ME-SFI] control unit detects deceleration mode

---

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

**Function sequence for alternator regulation**

Alternator regulation (alternator management)
- Takes place in the 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 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 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 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 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 behavior can also be activated using a diagnosis service in order to check the alternator, for example.

**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
- Alternator operating rate
- 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 and evaluates all relevant information and computes the required alternator current.

---

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.

The idle speed is reversed under the following circumstances:

- Engine off or alternator defective
- 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 consumer reduction function is activated as soon as the alternator is no longer able to provide the requested electrical output.

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 consumer reduction function is canceled when the alternator is again able to provide the requested electrical output to stabilize the on-board electrical system voltage.

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.

i Consumer reduction during PRE-SAFE triggering (with code (299) PRE-SAFE):

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.

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 | Heater stage 6 PTC heater booster (R22/3) (with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 2 | 2 | Heater stage 5 PTC heater booster (R22/3) (with engine 642.8/9, 646.8, 651.9) driver side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 3 | 3 | Heater stage 4 PTC heater booster (R22/3) (with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |

| | | | | |
|---|---|---|---|---|
| 4 | 4 | Heater stage 3 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) driver side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 5 | 5 | Heater stage 2 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 6 | 6 | Heater stage 1 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 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 | 10 | Mirror heater (M21/1r1) and mirror heater (M21/2r1) | Left front door control unit (N69/1) and<br>Right front door control unit (N69/2) | 3.5 |
| 10 | 12 | Rear window heater (R1) | Rear SAM control unit with fuse and relay module (N10/2) | 30.0 |
| 11 | 13 | Rear blower motor (M2/1) (with code (581) C-AAC)<br>P = 50 % | Automatic air conditioning control and operating unit (N22/7) | 5.5 |
| 12 | 14 | Blower motor (A32m1)<br>P = 50% | Automatic air conditioning control and operating unit (N22/7) | 16.0 |
| 13 | 15 | Combustion engine fan motor and air conditioning with integrated control (M4/7)<br>P = 50% | Automatic air conditioning control and operating unit (N22/7) | 31.0 |
| 14 | 16 | Circuit 15R relay (1) (N10/2kB) | Rear SAM control unit with fuse and relay module (N10/2) | 6 |
| 15 | 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** | **Shutoff stage** | **Consumers with reduced or no power** | **Executing control unit** | **Maximum Current in A** |
|---|---|---|---|---|
| 1 | 1 | Heater stage 6 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 2 | 2 | Heater stage 5 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) driver side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 3 | 3 | Heater stage 4 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 4 | 4 | Heater stage 3 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) driver side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 5 | 5 | Heater stage 2 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 651.9) passenger side | Automatic air conditioning control and operating unit (N22/7) | 18.5 |
| 6 | 6 | Heater stage 1 PTC heater booster (R22/3)<br>(with engine 642.8/9, 646.8, 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)<br>P = 50 % | Automatic air conditioning control and operating unit (N22/7) | 5.5 |
| 8 | 8 | Blower motor (A32m1)<br>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)<br>P = 50% | Automatic air conditioning control and operating unit (N22/7) | 31.0 |
| 10 | 10 | Trailer socket (X58)<br>(with code (550) Trailer hitch) | Trailer recognition control unit (N28/1)<br>(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 | 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 |
| 16 | 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 |
| 17 | 20 | Mirror heater (M21/1r1) and mirror heater (M21/2r1) | Left front door control unit (N69/1) and<br>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.

---

This causes the activation of the following engine on energy management functions:
- Idle speed increase
- Deactivation of alternator management
- 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 consumer is also switched off:
- Liftgate control unit (N121/1)
  (with model 204.2/9 with code (890) EASY-PACK liftgate)

---

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

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.

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