Model 257, 290
with code B01 (48V technology)

48 V on-board electrical system in general

The 48 V on-board electrical system augments the conventional 12 V on-board electrical system. It provides the energy for the combustion engine's starting procedure and it powers additional consumers. The 48 V on-board electrical system is connected through the DC/DC converter control unit (N83/1) to the 12 V on-board electrical system. In other words, the 12 V on-board electrical system replaces the conventional 12-V alternator with the DC/DC converter control unit. Apart from this, the 48 V on-board electrical system together with the 48 V on-board electrical system battery (G1/3) provides additional storage capacity throughout the overall system. The DC/DC converter control unit is the master control unit for energy management in the 48 V on-board electrical system.

The energy management in the 48 V on-board electrical system calculates the current and voltage limits for the power output of the starter-alternator (M1/10) (engine 264) or the integrated starter alternator (A79) (engine 256) to achieve an equalized charge balance for the 48 V on-board electrical system battery and to ensure starting capability is given. The drivetrain control unit (N127) is the master control unit for the traction management in the 48 V on-board electrical system. The traction management decides whether the starter-alternator (engine 264) or the integrated starter alternator (engine 256) generates drive torque in addition to the combustion engine or whether it operates in generator mode.

The 48 V on-board electrical system fulfills the following subfunctions:

- **Voltage provision**
- **Dynamic idle speed control**
- **Consumer reduction**
- **Cooling for 48-V on-board electrical system battery**

Function sequence for voltage provision

The voltage provision function comprises the following subfunctions:

- **Charge 48 V on-board electrical system battery**
- **Traction management**

Charge 48 V on-board electrical system battery

The DC/DC converter control unit reads in the data of the 48 V on-board electrical system battery via the 48 V on-board electrical system LIN (LIN B22) and calculates the permissible current and voltage limits.

Finally, the DC/DC converter control unit sends these values over the interior CAN, electronic ignition lock control unit and the suspension FlexRay to the drivetrain control unit. The drivetrain control unit evaluates this by taking the following input factors (e.g. air conditioning system ON) into account. It calculates the operating mode of the starter-alternator (engine 264) or the integrated starter alternator (engine 256) based on the current and voltage limits or based on the temperature-specific charging characteristic, to provide optimum charging of the 48 V on-board electrical system battery. The powertrain control unit then sends the calculated operating mode over the hybrid CAN to the starter-alternator (engine 264) or to the starter-alternator control unit (N129) (engine 256).

Traction management

The traction management includes, for example, the following tasks:

- Compliance with current and voltage limits
- Converting in overrun mode to recuperation
- Converting during acceleration to torque support
- Supporting the combustion engine when balancing speed while changing gear
- Moving the combustion engine into an efficient range by increasing or reducing the load

Vehicles with engine 264:

The powertrain control unit communicates via the hybrid CAN (CAN L) with the starter-alternator and evaluates its operating rate.

The DC/DC converter control unit reads in the data of the 48 V on-board electrical system battery over the 48 V on-board electrical system LIN. It evaluates all relevant information and calculates the permissible current and voltage limits. Finally, the DC/DC converter control unit sends these values over the interior CAN, electronic ignition lock control unit and the suspension FlexRay to the drivetrain control unit. The drivetrain control unit evaluates these taking into account additional input factors (e.g. air conditioning system ON) and calculates the optimal starter-alternator operating mode. The drivetrain control unit then transmits the calculated operating mode via the hybrid CAN to the starter-alternator that then adopts this mode. The CDI control unit or the ME-SFI [ME] control unit also checks the input factors for plausibility in order to rule out any overcharging or faulty charging of the 48 V on-board electrical system battery.

The drivetrain control unit compares the optimal starter-alternator operating mode with its actual output and can thus detect the energy state of the 48 V on-board electrical system. The continuous comparison and the corresponding corrections are designated as power management. Where failure to comply with the permissible current and voltage limits is detected, power management is then gradually reduced. The starter-alternator can then make available its full output.

Vehicles with engine 256:

The powertrain control unit communicates over the hybrid CAN with the starter-alternator control unit and evaluates the operating rate of the integrated starter alternator.

The DC/DC converter control unit reads in the data of the 48 V on-board electrical system battery over the 48 V on-board electrical system LIN. It evaluates all relevant information and calculates the permissible current and voltage limits. Finally, the DC/DC converter control unit sends these values over the interior CAN, electronic ignition lock control unit and the suspension FlexRay to the drivetrain control unit. The powertrain control unit evaluates this, taking further input factors (e.g. air conditioning system ON) into account and calculates the optimum operating mode for the integrated starter alternator. The powertrain control unit then sends the calculated operating mode over the hybrid CAN to the starter-alternator control unit, which then sets the optimum operating mode. The drivetrain control unit also checks the input factors for plausibility, to avoid any overloading or insufficient charging of the 48 V on-board electrical system battery.

The powertrain control unit compares the optimum operating mode of the integrated starter alternator against its actual output thereby enabling it to record the energy condition of the 48 V on-board electrical system. The continuous comparison and the corresponding corrections are designated as power management. Where failure to comply with the permissible current and voltage limits is detected, power management is then gradually reduced. The integrated starter alternator can then make its full output available.

i If, because of a fault, the data for the 48 V on-board electrical system battery are not available, the energy management switches to a fixed voltage, whose value is dependent on the last transmitted charge level.

Dynamic idle speed control

The dynamic idle speed control sets the engine's idle speed so that, when idling, an impermissibly high current is never drawn from the 48 V on-board electrical system battery. If consumer load is high, a higher idle speed is set so that the starter-alternator (engine 264) or the integrated starter alternator (engine 256) provides a higher current which relieves the load on the 48 V on-board electrical system battery.

Consumer reduction

If the starter-alternator (engine 264) or the integrated starter alternator (engine 256) is no longer able to provide the required electrical power, the on-board electrical system load is reduced by switching back consumers in the 48 V on-board electrical system. This serves to avoid any significantly negative charge balance for the 48 V on-board electrical system battery. This in turn retains the engine's starting capability. The consumers are reactivated when the required electrical power to stabilize the on-board electrical system voltage is available again.

Function requirements for cooling the 48 V on-board electrical system battery

- Drive train operational
- 48 V on-board electrical system battery temperature > 25°C

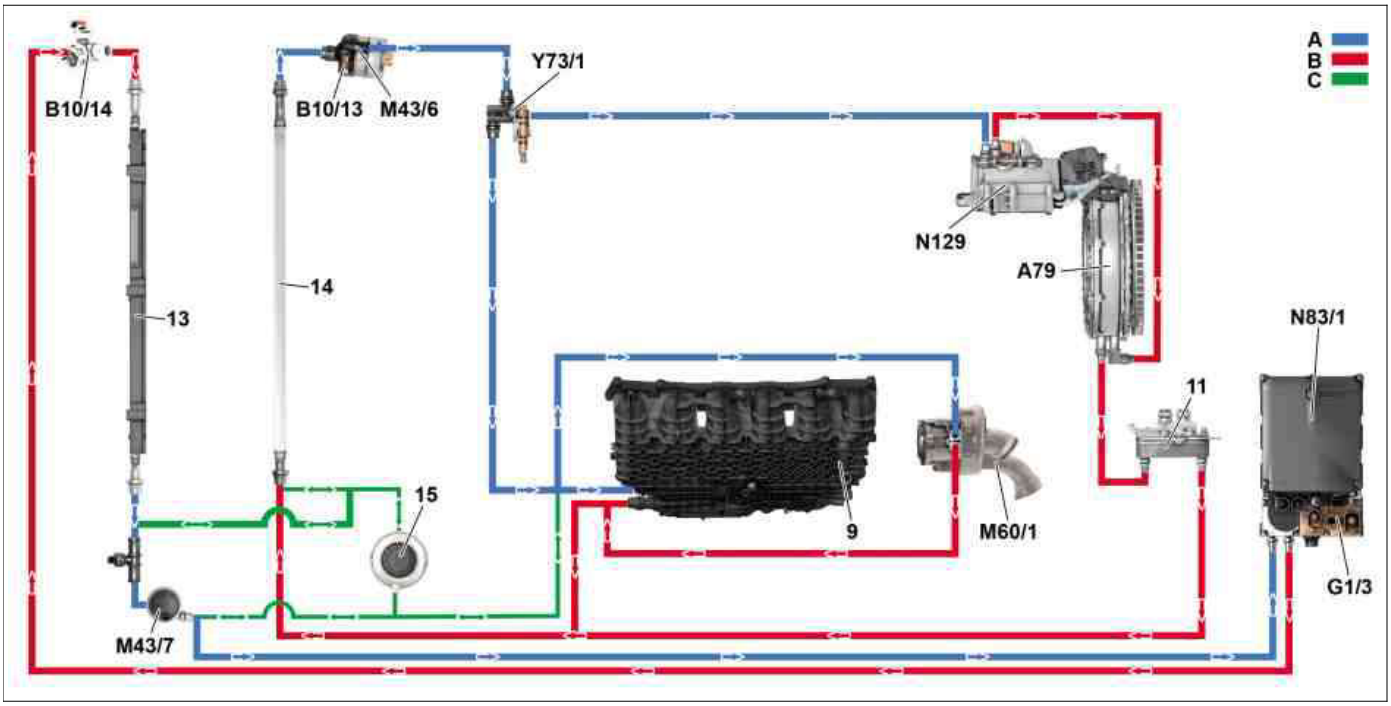
Cooling for 48-V on-board electrical system battery

The output capacity of the 48 V on-board electrical system battery is dependent on the battery temperature. To enable the 48 V on-board electrical system battery to be used in a wide temperature range, it is cooled through the low-temperature circuit 2 using water. The drivetrain control unit is responsible for the temperature control. It regulates the battery temperature with the coolant flow volume. Thermic coupling requires that the DC/DC converter control unit is cooled together with the 48 V on-board electrical system battery.

The 48 V on-board electrical system battery sends the following signals over the 48 V on-board electrical system LIN, DC/DC converter control unit, interior CAN, electronic ignition lock control unit and the suspension FlexRay to the drivetrain control unit:

- Minimum temperature of 48 V on-board electrical system battery
- Maximum temperature of 48 V on-board electrical system battery
- Temperature of 48 V on-board electrical system battery

The drivetrain control unit reads in the low-temperature circuit temperature sensor 2 (B10/14) directly.



P20.00-2653-79

Schematic diagram of low-temperature circuit (consisting of low-temperature circuit 1 and low-temperature circuit 2), shown with engine 256

13	*Low-temperature circuit 2 cooler*	*G1/3*	*48 V on-board electrical system battery*	*A*	*Coolant feed*
15	*Expansion reservoir*	*M43/7*	*Low-temperature circuit circulation pump 2*	*B*	*Coolant return flow*
A79	*Integrated starter generator*	*N83/1*	*DC/DC converter control unit*	*C*	*Ventilation/coolant expansion*
B10/14	*Low-temperature circuit temperature sensor 2*	*N129*	*Starter generator control unit*		

The drivetrain control unit evaluates the data from the low-temperature circuit temperature sensor 2 and actuates low-temperature circuit circulation pump 2 as required over the drivetrain LIN (LIN C3) an. An increase in pump output here causes an increase in the coolant flow volume and thereby to greater heat dissipation at the 48 V on-board electrical system battery. The lower the pump output the less heat is dissipated.
The waste heat in the low-temperature circuit 2 is dissipated to the surrounding area through the cooler of the low-temperature circuit 2.

i Integrated into the 48 V on-board electrical system battery is a cooling and heating element that is actuated by the DC/DC converter control unit. Additional heat can be dissipated in this manner. At low temperatures, the cooling and heating element is also used for heating to ensure that the 48 V on-board electrical system battery reaches its optimum operating temperature faster.

i The drivetrain control unit sends the "Water cooling active" signal over the suspension FlexRay, electronic ignition lock control unit and the interior CAN to the DC/DC converter control unit.

	Electrical function schematic for 48 V on-board electrical system		PE54.10-P-2078-97XBA
	Overview of energy management system components		GF54.10-P-9990FR