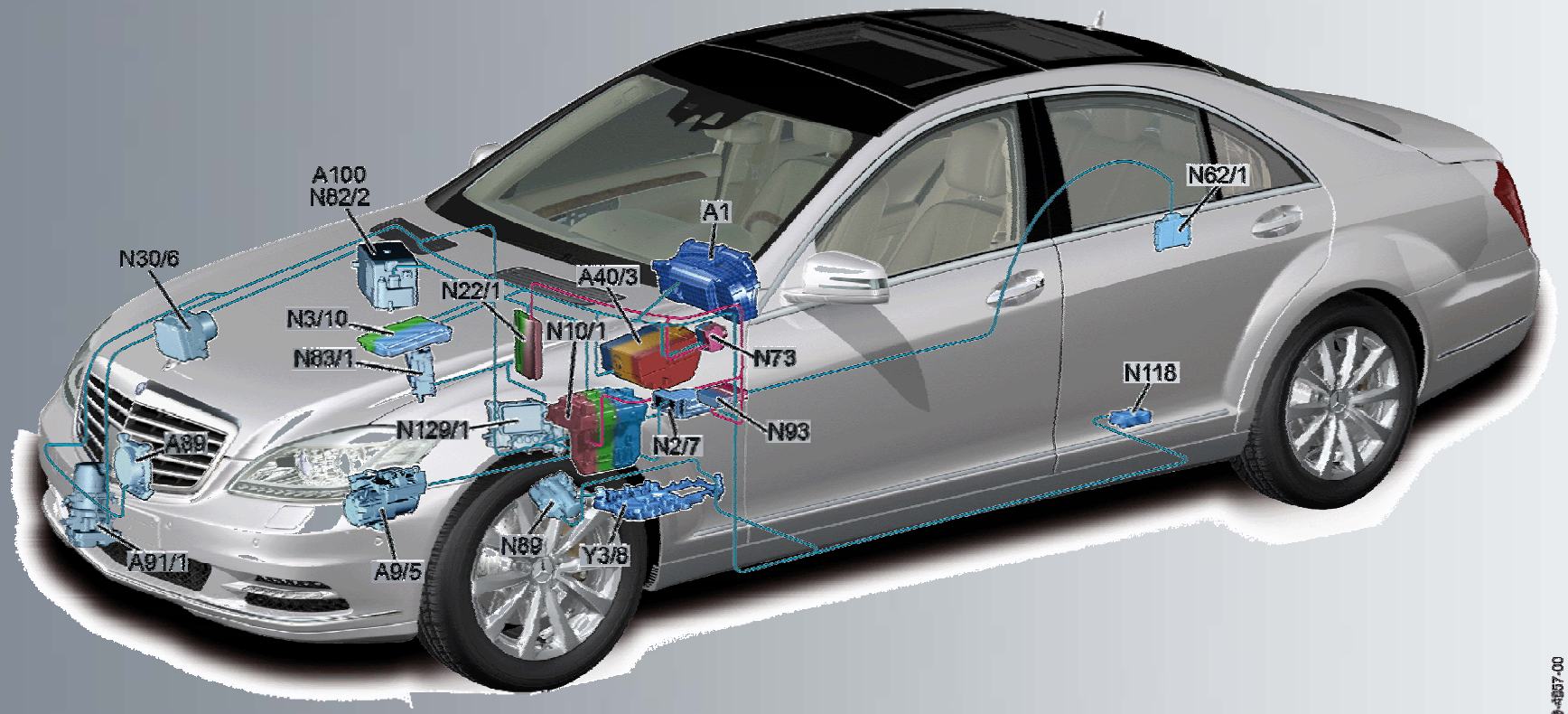
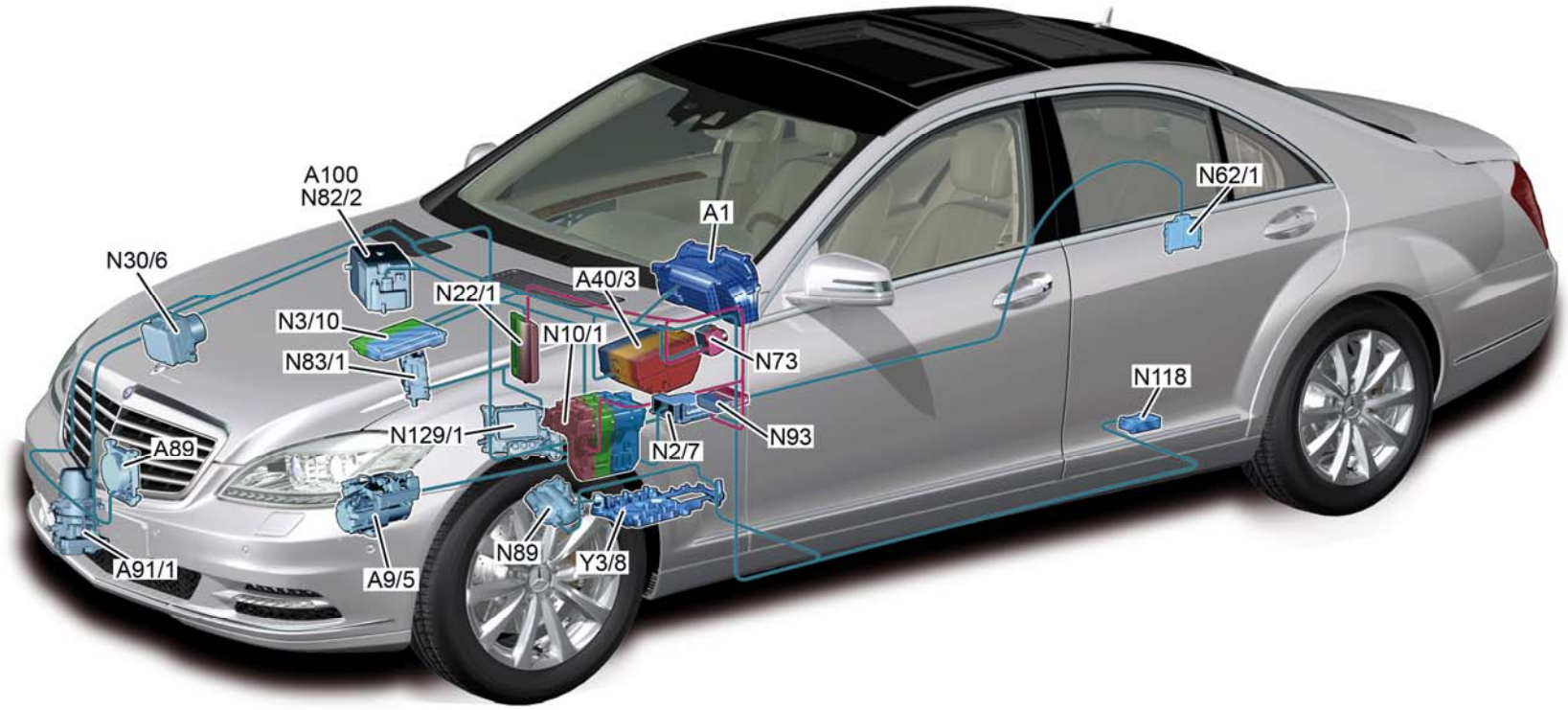
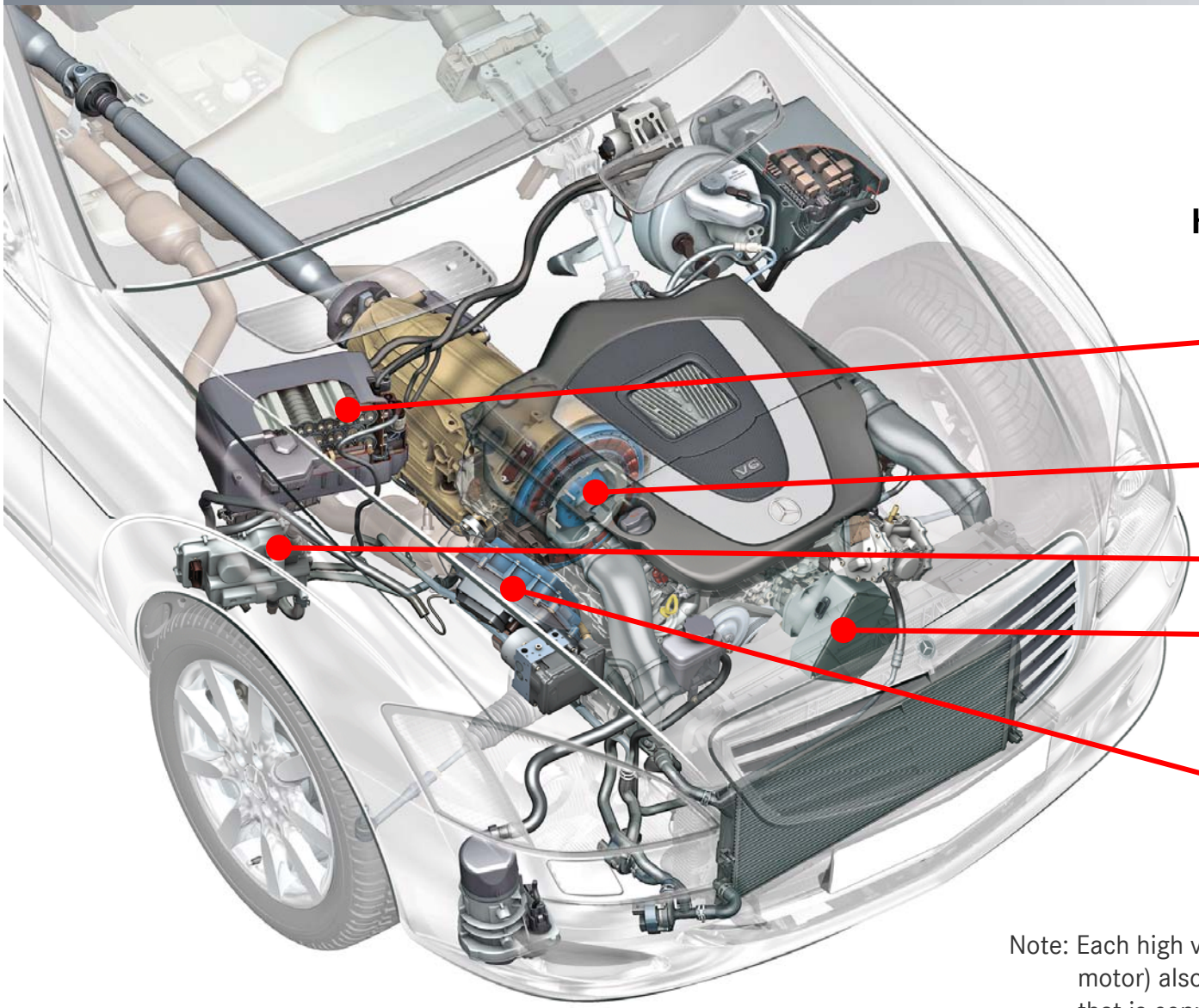
Mercedes-Benz




# V221 Hybrid

No testing to be performed on active HV system connections.


A100
N82/2
N30/6
N22/1
A40/3
A1
N62/1
N3/10
N10/1
N83/1
N73
N118
N129/1
N93
A89
N2/7
N89
Y3/8
A91/1
A9/5
P00.19-4657-00

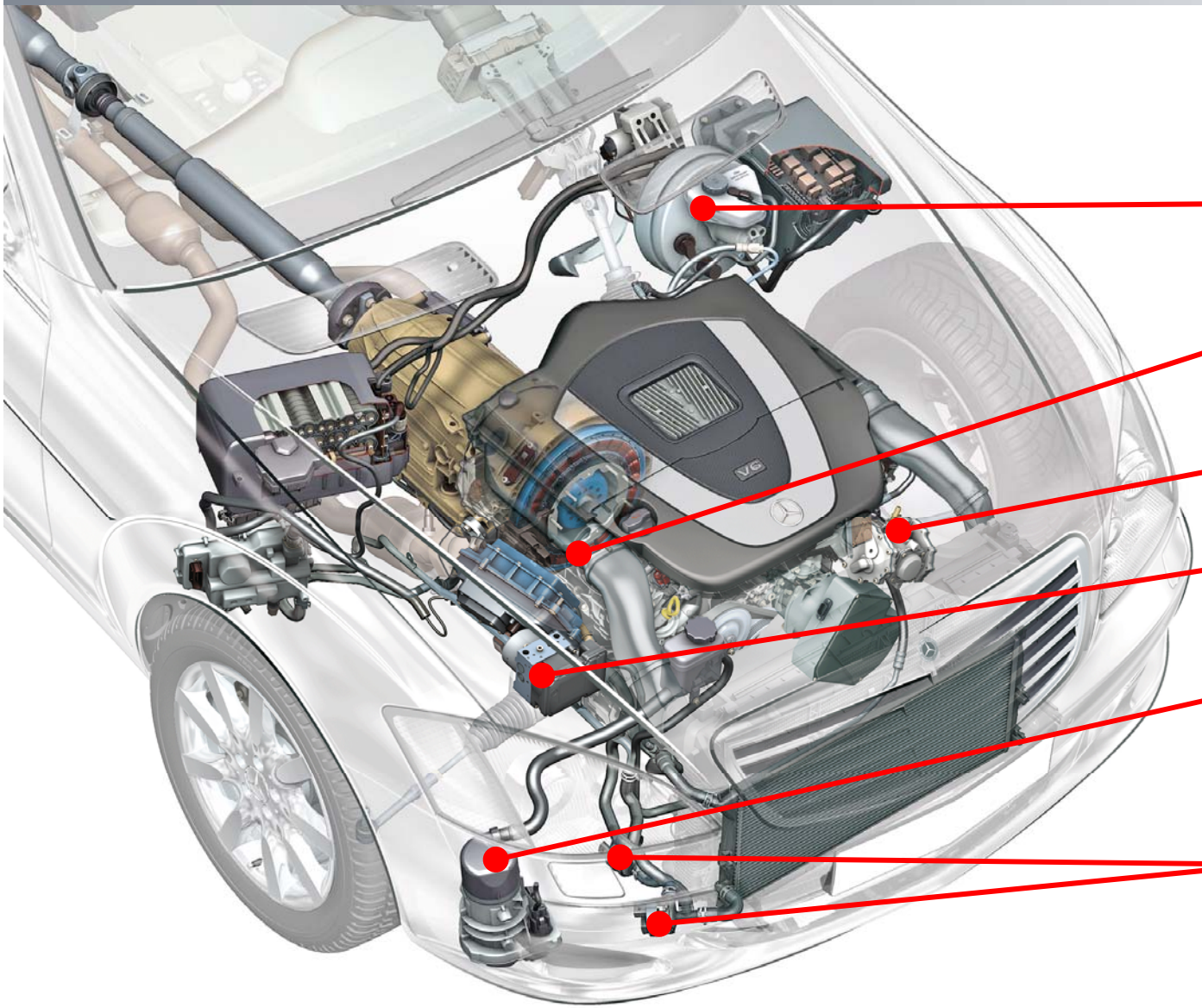


## High Voltage Components

- HV Battery (A100)
- HV Electric Motor (A79)
- HV DC/DC Converter (N83/1)
- HV Air Conditioning Compressor (A9/5)
- HV Power Electronics control module (N129/1)

Note: Each high voltage component (except HV electric motor) also has a 12 V control module within it, that is connected to regular 12 V power supply.

## 12 Volt Components



New brake pedal / booster assembly (A7/7)

Additional electric transmission oil pump (M42) & Control module (N89)

Auxiliary vacuum pump (M56)

Regenerative Braking System (RBS) control module (N30/6)

Electrohydraulic power steering pump (A91/1)

Low temperature cooling system pumps (M13/8 & M13/9)

Drive Train Sensor CAN
(X30/38)

Telematics CAN
(X30/35)

Chassis CAN
(X30/30)

Interior CAN
(X30/33)

Vehicle
Dynamic CAN
(X30/28)

Central CAN
(X30/20)

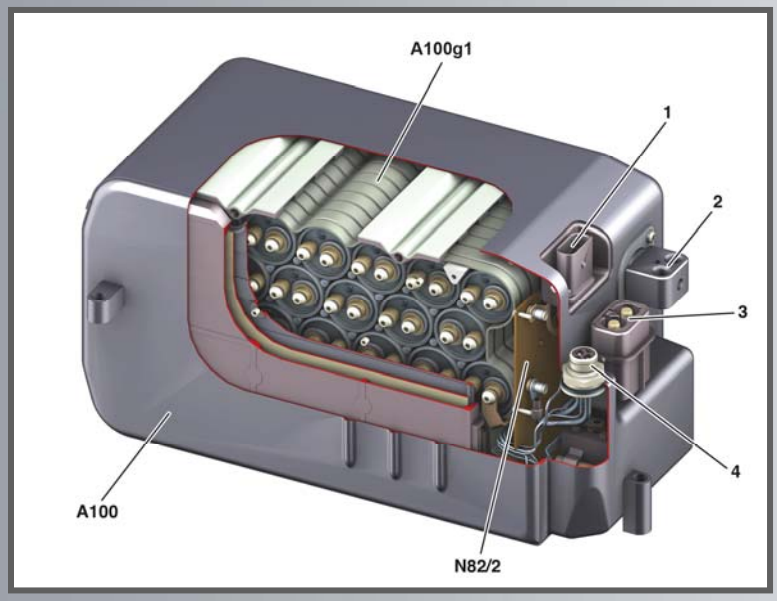
Interior CAN
(X30/34)

Chassis CAN
(X30/31)

Interior CAN
(X30/32)

Drive Train CAN
(X30/21)

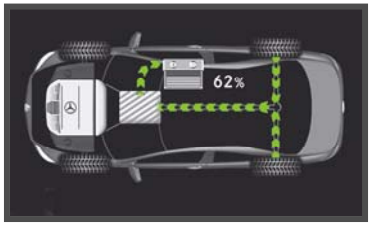
Mercedes-Benz



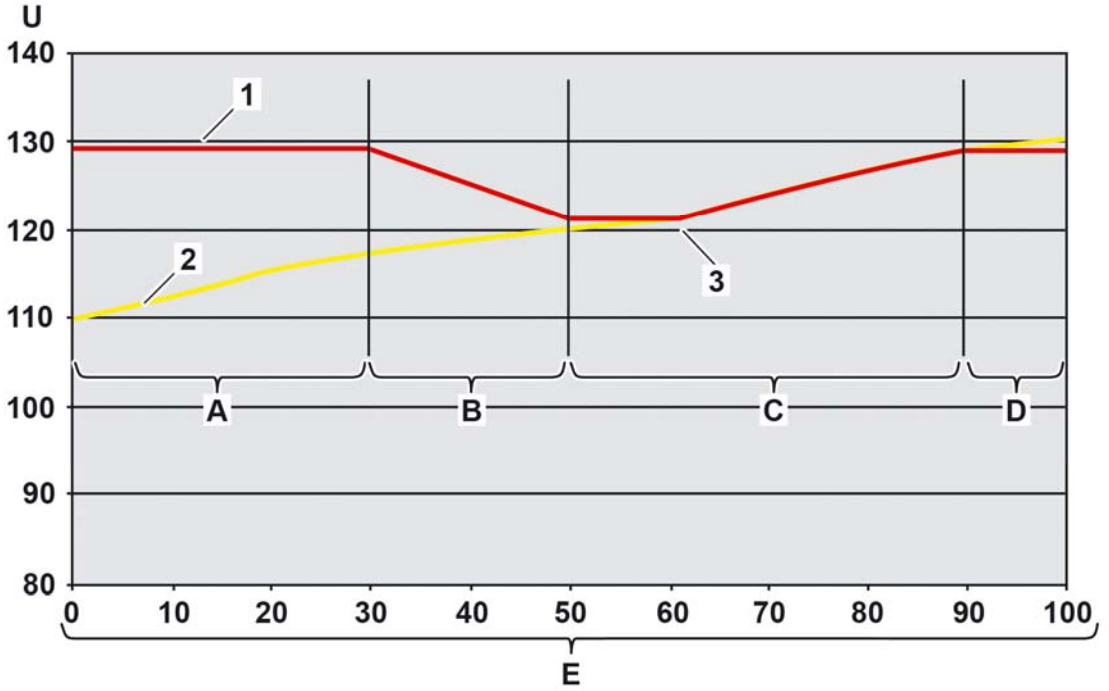

# High Voltage Battery (A100)

# HV Li-ion Battery (A100)

- Optimal charge % for Li-ion battery in display (instrument cluster or COMAND) is not 100%, instead it is around 50 – 65%.
- Battery management system control module will optimize charging to achieve the optimal state of charge, do not expect to see 100%




A Critical low charge
B Low charge
C Optimal charge
D Critical upper charge
E State of charge (SOC) in %
U Voltage
1 Charging characteristic of electric motor
2 Voltage characteristic of HV battery
3 Optimal operating state of charge



# Battery Management System (N82/2)

- Battery management system control unit (N82/2) is integrated in the high-voltage battery assembly
- High-voltage battery assembly is located in the right rear of the engine compartment
- The battery management system control unit manages the high voltage power supply
- The battery management constantly determines and monitors CAN network data as well as the following high voltage battery data:
  - High voltage interlock
  - Voltage
  - Current flow
  - Temperature
  - Status of contactors (A100s1)

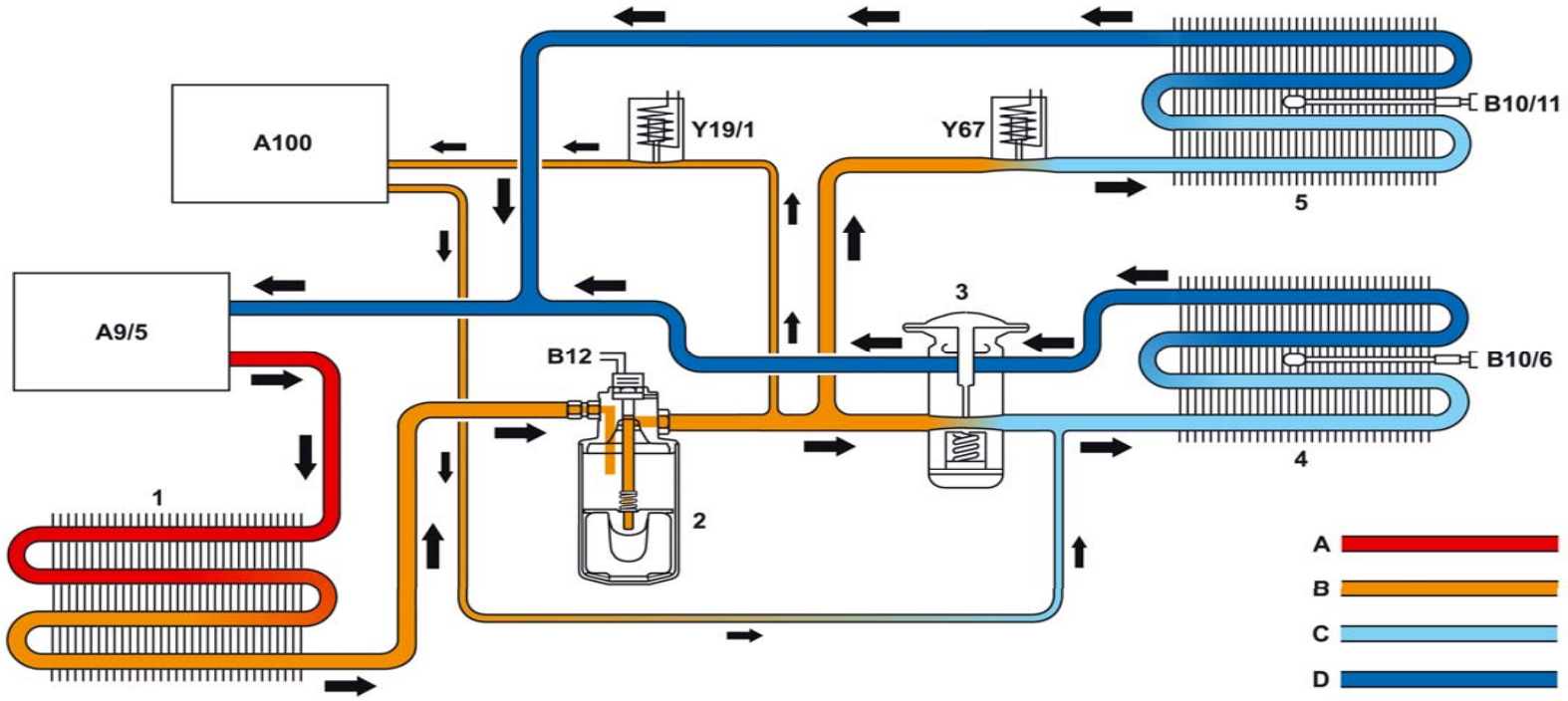
Note:
12 volt system battery with IBS system for low voltage systems, similar to MY09 V221. 12 V battery in trunk with Hybrid vehicle.

# HV Battery Cooling

- The battery management system (BMS) control module monitors battery cell temperature through a series of internal sensors
- The BMS will determine cooling requirements.
- BMS will control refrigerant flow through an internal cooling circuit via the high voltage battery cooling shutoff valve (Y19/1)
- Temperature sensors on the internal cooling circuit are also used to determine operation of Y19/1
- BMS requests electric refrigerant compressor via CAN
  - Step 1: BMS → ME → CGW → AAC
  - Step 2: AAC evaluates request and determines if compressor can be engaged
  - Step 3: AAC → CGW → ME → Electric refrigerant compressor
  - Step 4: Electric refrigerant compressor receives request and confirms operation over CAN
  - Step 5: With confirmation of compressor operation, BMS controls Y19/1

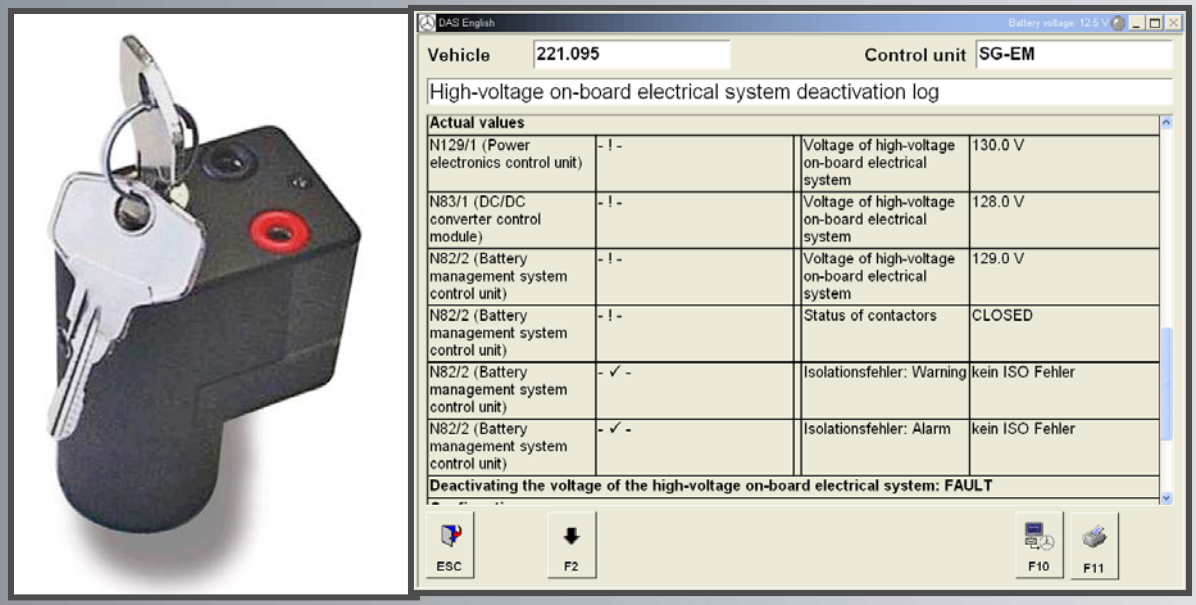
Note: Electric refrigerant compressor request has highest priority – customer cannot switch off compressor using AC off button at this time.

# HV Battery Cooling




| | |
|---|---|
| 1 | Condenser |
| 2 | Fluid reservoir |
| 3 | Expansion valve |
| 4 | Evaporator |
| 5 | Rear air conditioning evaporator |
| A9/5 | Electric refrigerant compressor |
| A100 | High-voltage battery assembly |
| B10/6 | Evaporator temperature sensor |
| B10/11 | Rear air conditioning evaporator temperature sensor |
| B12 | Refrigerant pressure sensor |
| Y19/1 | High-voltage battery cooling system shutoff valve |
| Y67 | Rear air conditioning refrigerant shutoff valve |
| A | High pressure, gaseous |
| B | High pressure, liquid |
| C | Low pressure, liquid |
| D | Low pressure, gaseous |

Mercedes-Benz




# Power Down / Up High Voltage System

# Power Down (Deactivation)

**In order to work on or near hybrid high voltage components the high voltage system must be powered down (deactivated) by a qualified person that has successfully completed the required training**

- When working on any high voltage system it is mandatory to follow all safety rules and steps, for example:

  - Provide a barrier around the vehicle
  - Maintain control of ignition key and ignition position in vehicle
  - Follow sequence of steps in deactivation log / work instructions in DAS
  - Use protective gloves when appropriate (**always** check their date and condition)
  - Remove DC-DC high voltage connection & secure service disconnect switch tool
  - Secure service disconnect key (**do not** leave key in service disconnect switch tool)
  - Ensure voltage free and print out document “deactivation log” with DAS
  - Sign and post the print-out of the deactivation log so it is visible in the vehicle

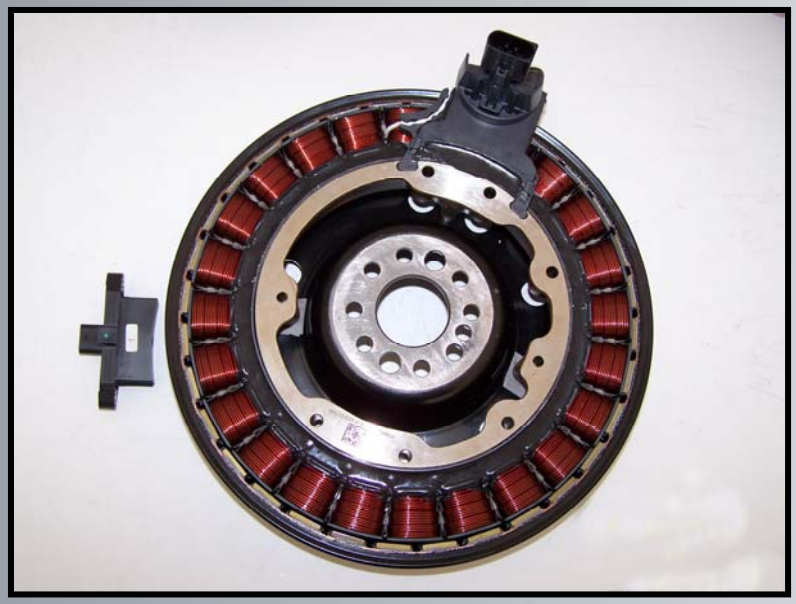
# Power Up (Initial Start up)

**In order to power up (initial start up) components of the high voltage system, a qualified person that has successfully completed the required training must complete this task.**

- When working on any high voltage system it is mandatory to follow all safety rules and steps, for example:

  - Provide a barrier around the vehicle
  - Maintain control of ignition key and ignition position in vehicle
  - Follow sequence of steps in initial start up log / work instructions in DAS
  - Remove service disconnect switch tool and reconnect DC-DC high voltage cable
  - Ensure high voltage system activated and print out document “initial start up log” with DAS
  - Sign and print out document “initial startup log” with DAS
  - Remove deactivation log from vehicle
  - Both log printouts are to be attached to Repair Order
  - Remove barrier and safety equipment if appropriate and store correctly

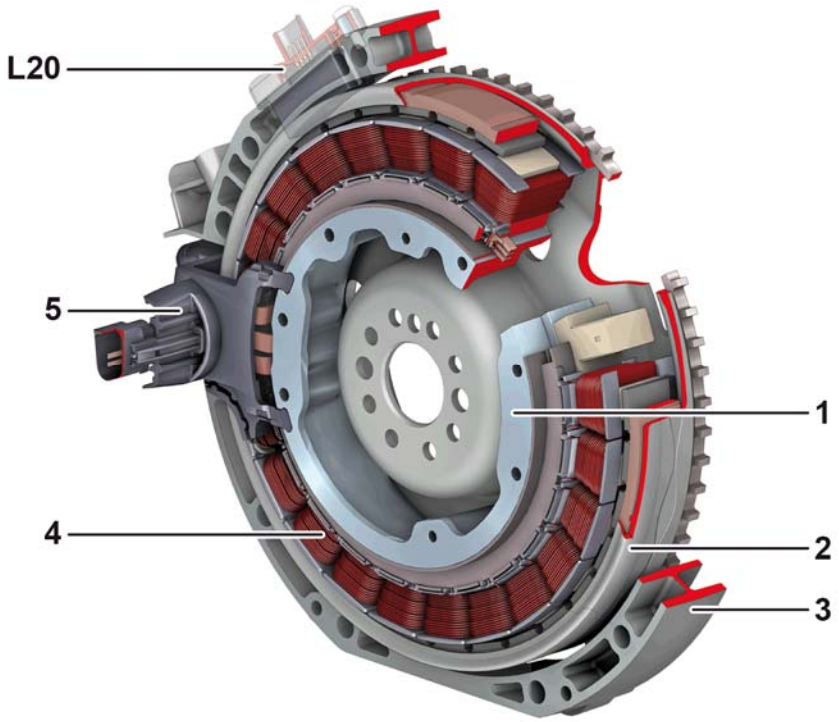
Mercedes-Benz



# Electric Motor (A79)
# & Rotor Sensor (L20)

# High Voltage Electric Motor (A79)

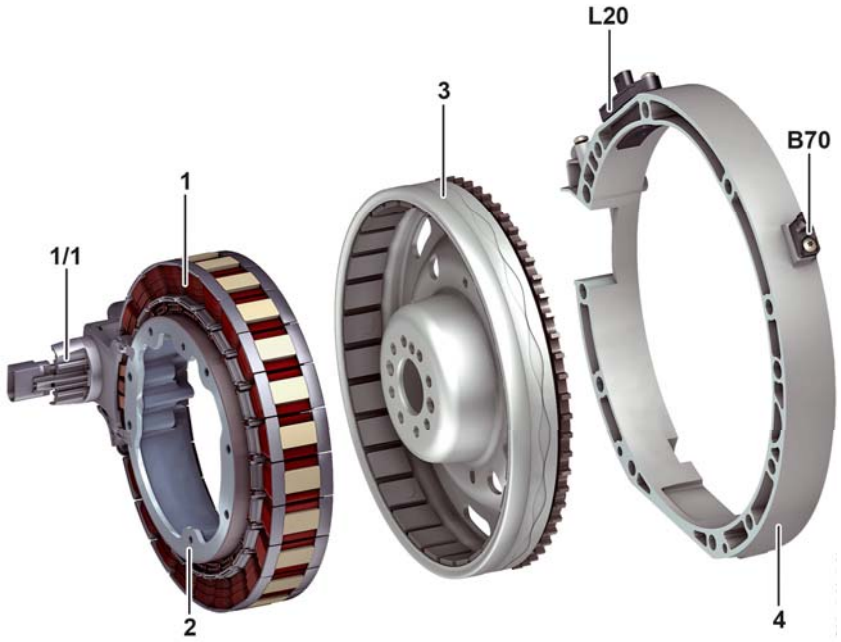
- The electric motor is installed between the engine and automatic transmission.
- It performs the function of a starter and high-voltage alternator.
- Switching between the individual operating modes (motor mode / alternator mode) is controlled by the power electronics control unit.
- Maximum boost (motor mode) output = 15 kW (20 hp)
- Maximum charging (alternator mode) output – 17 kW




1 Stator carrier
2 Rotor with increment ring and position sensor track
3 Intermediate housing
4 Stator with coils
5 Connection and temperature sensor coupling
L20 Rotor position sensor

# High Voltage Electric Motor (A79)

- Power electronics control unit monitors a temperature sensor integrated in the stator windings
- Power electronics control unit will reduce power output, if a certain temperature threshold is exceeded in order to protect the electric motor from overheating
- Power limitation will begin when stator winding temperature exceed factory specification
- 2 position sensors are installed
  - B70; crankshaft Hall speed sensor for ME
  - L20; rotor position sensor for power electronics



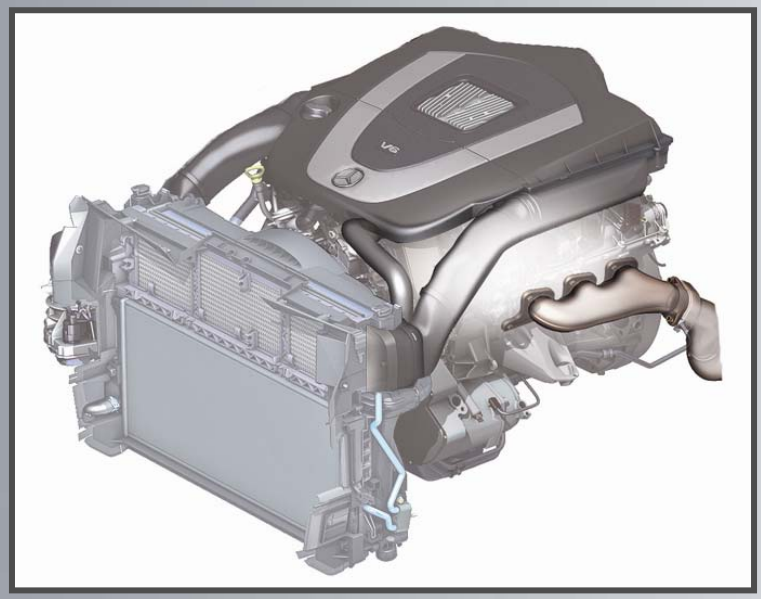

| | |
|---|---|
| 1 | Stator with coils |
| 1/1 | Connection and temperature sensor coupling |
| 2 | Stator carrier |
| 3 | Rotor with increment ring and position sensor track |
| 4 | Intermediate housing |
| B70 | Crankshaft Hall sensor |
| L20 | Rotor position sensor |

# Rotor Position Sensor (L20)

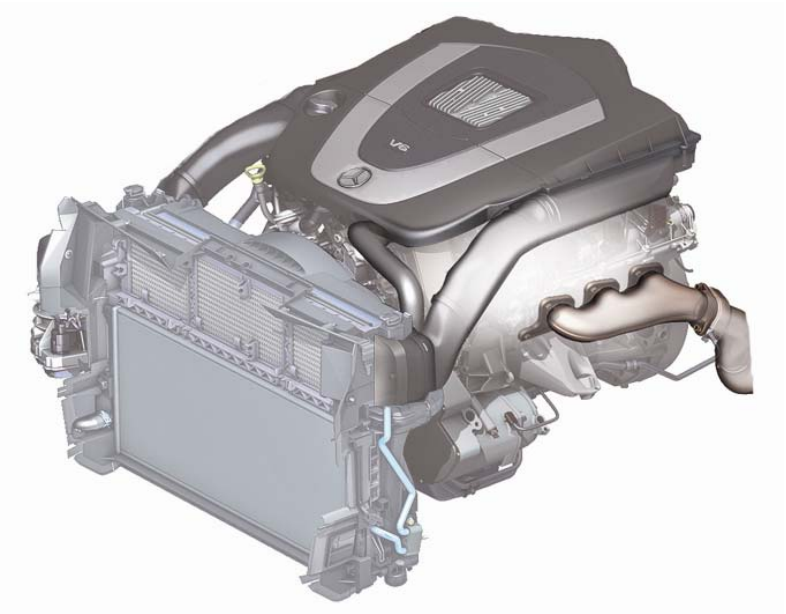
- Detects speed, rotation direction and position of the rotor ring
- L20 sensor operates on the Eddy current principle
- This particular Eddy current sensor consist of:
  - 2 transmitting sensor heads
  - 2 receiving sensor heads
- The transmitter sensor head produces a magnetic field
- The passing component (rotor) sensor track disrupts the magnetic field
- The receiving sensor head reads the magnetic field
- In this application a sine or cosine signal pattern is produced due to the shape, and position of the sensor heads & sensor track
- Operates using 5 volt reference value

Raised sensor track on rotor ring

Mercedes-Benz



# Engine M272.974



**Atkinson Principle:**
The development engineers utilized some of the benefits of the Atkinson principle whereby the expansion phase is longer than the compression phase. The intake valve is kept open slightly longer between the intake and compression phases, which improves the engine's thermal efficiency while reducing the specific fuel consumption and untreated emissions.

| Engine | |
|---|---|
| General: | 3.5 liter V6 gasoline |
| Type: | M272.974 |
| Valves: | 4 per cylinder |
| Displacement: | 3498 cc |
| Compression Ratio: | 10.7 : 1 |
| Power: | 279 hp @ 6000 |
| Torque: | 350 Nm @ 2,400 – 5000 |

Note:

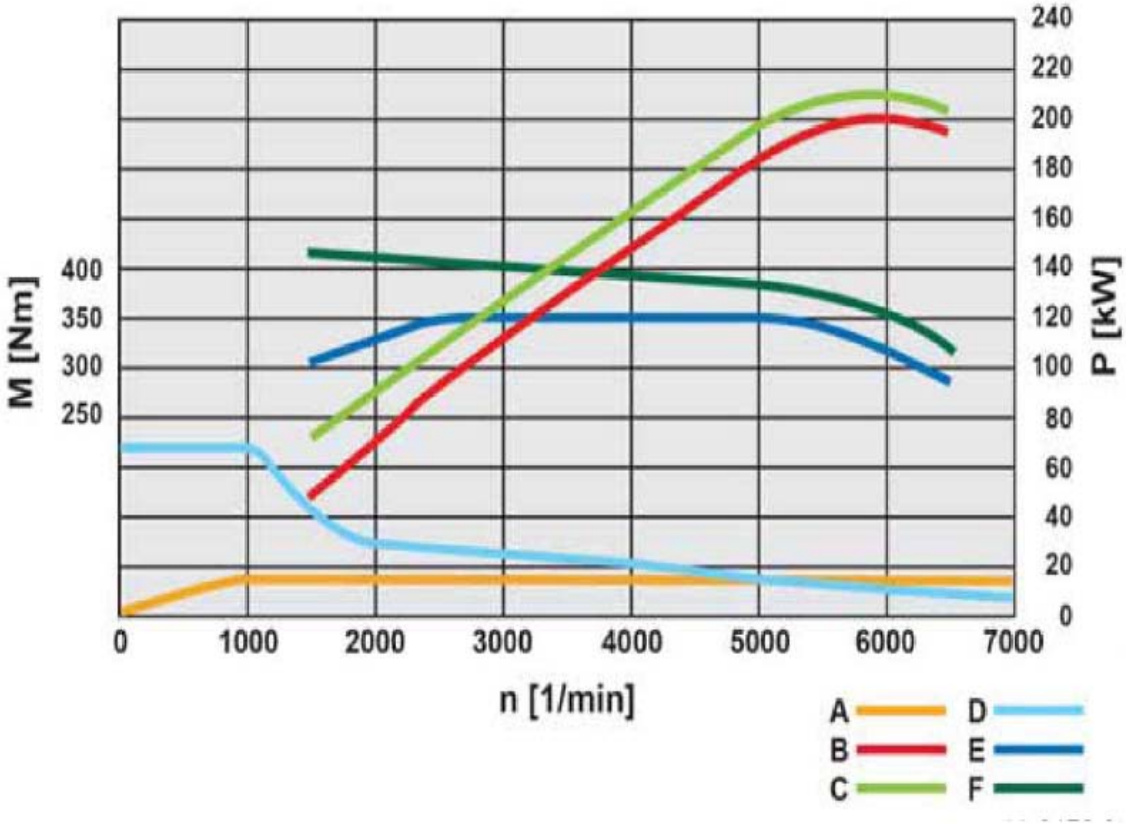
Engine 272 has been modified and optimized for the hybrid application:

- Atkinson principle
- M272 SPORT cylinder heads
- Standard M272 intake manifold (no actuation of tumble flaps)
- Modified camshafts with a different camshaft control system
- M272 SPORT pistons.
- Regulated output oil pump, to reduce engine load
- New fuel management version (ME 17.7)

# M272.974 - Power and Torque Chart

A Electric motor performance
B Combustion engine performance
C Maximum power combined (electric motor and combustion engine)
D Electric motor torque
E Combustion engine torque
F Maximum torque combined (electric motor and combustion engine)

M Torque
n Engine speed
P Power

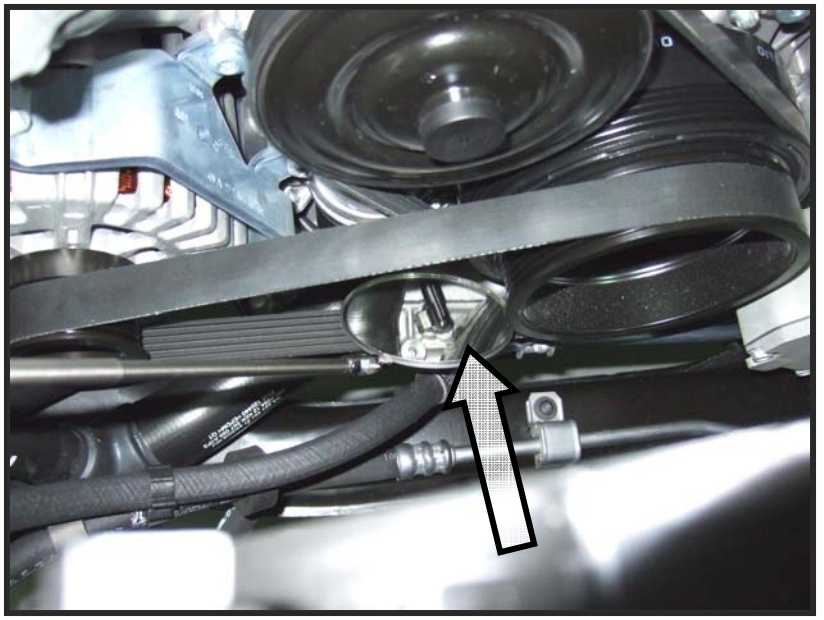



| Nm | lb ft |
|---|---|
| 400 | 295 |
| 350 | 258 |
| 300 | 221 |
| 250 | 184 |

| kW | hp |
|---|---|
| 210 | 281 |
| 70 | 94 |
| 40 | 54 |
| 20 | 26 |

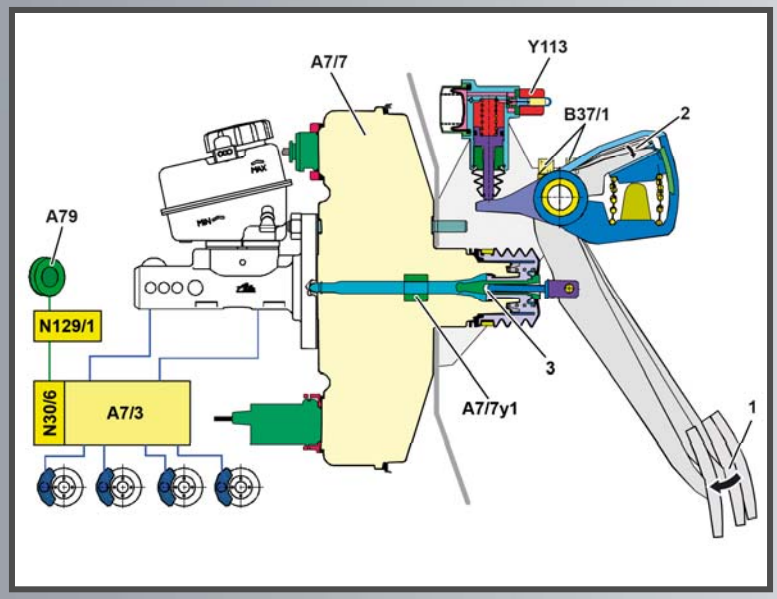
# Engine Oil Pump Valve (Y130)

- Under certain conditions the power required to operate the mechanical engine oil pump can be reduced by regulating the oil volume
- For example at idle, no load conditions
- Although a small change, it is another measure to improve fuel economy
- A engine oil pump valve (Y130), is installed to regulate oil volume
- Engine oil pump valve (Y130), is located close to the front pulley on the engine
- ME-SFI (N3/10) controls the valve according to engine load demands



*Mirror used to see from above*

Mercedes-Benz




# Regenerative Braking System (RBS)

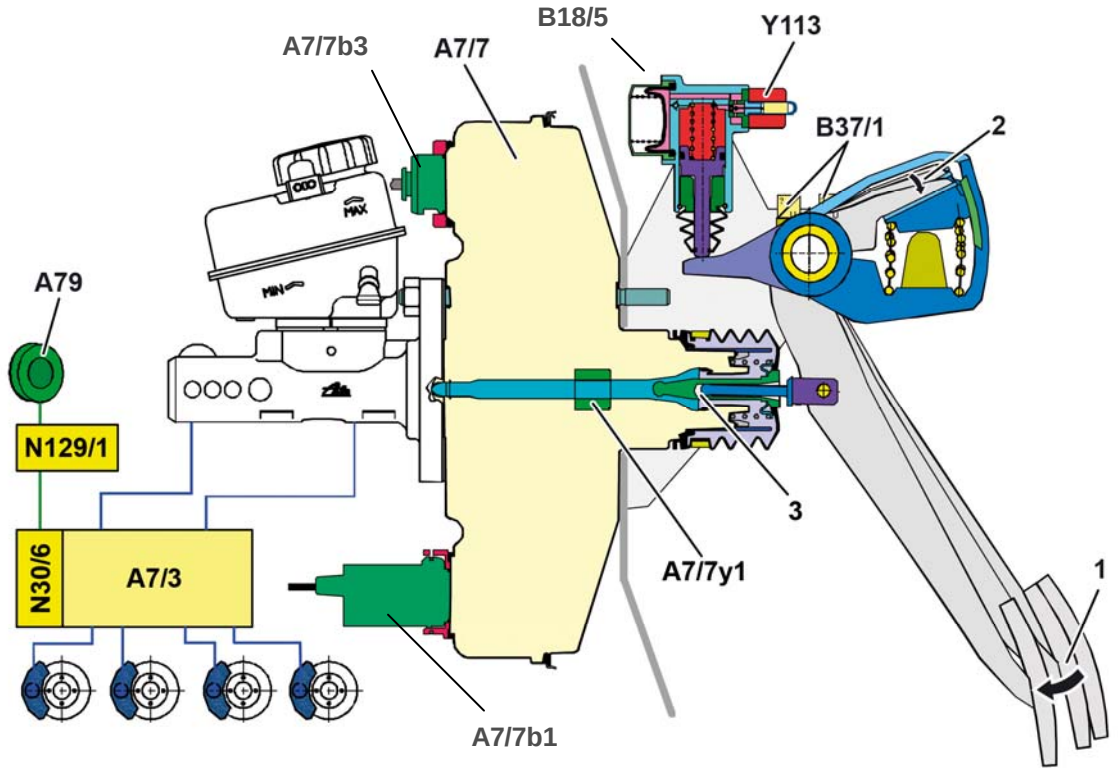
# Regenerative Braking System

- The regenerative braking system (RBS), is a brake by-wire Hybrid variation of Adaptive Brake Regulation (ABR), known from V221
- Hybrid vehicles take advantage of utilizing the same electric motor used for engine boost, to charge high voltage system
- This charging function occurs whenever the engine is running or the vehicle is coasting or braking
- In the case of braking, the RBS will request regulation of the electric motor to generate electricity
- This regulation not only produces electricity but also provides a braking reaction through the drive train
- The amount of regulation provided by the electric motor is communicated back to RBS, where it can determine the correct amount of hydraulic brake regulation to compliment the electric motors braking effect

# RBS Component Overview

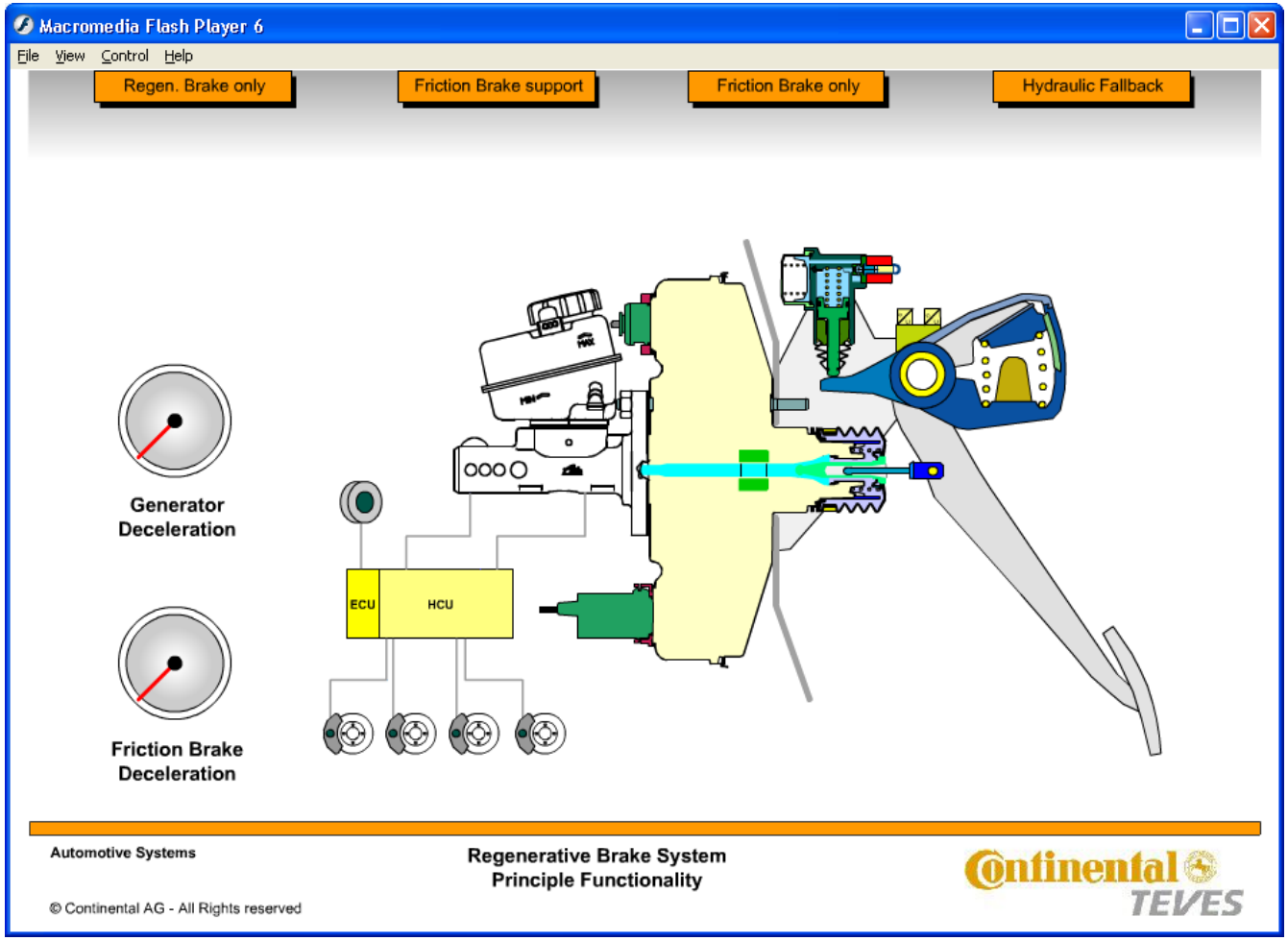
| | |
|---|---|
| A7/3 | Traction system hydraulic unit |
| A7/7 | RBS brake booster |
| A7/7b1 | RBS Membrane travel sensor |
| A7/7b3 | Vacuum sensor |
| A7/7y1 | RBS solenoid valve |
| A79 | Electric motor |
| B18/5 | Pressure sensor for pedal force simulator valve *(not shown)* |
| B37/1 | Pedal angle sensor |
| N30/6 | Regenerative braking system (RBS) control unit |
| N129/1 | Power electronics control unit |
| Y113 | Pedal force simulator valve |

1 Pedal movement
2 Travel at pedal force simulator
3 Free travel




Typical RBS representation

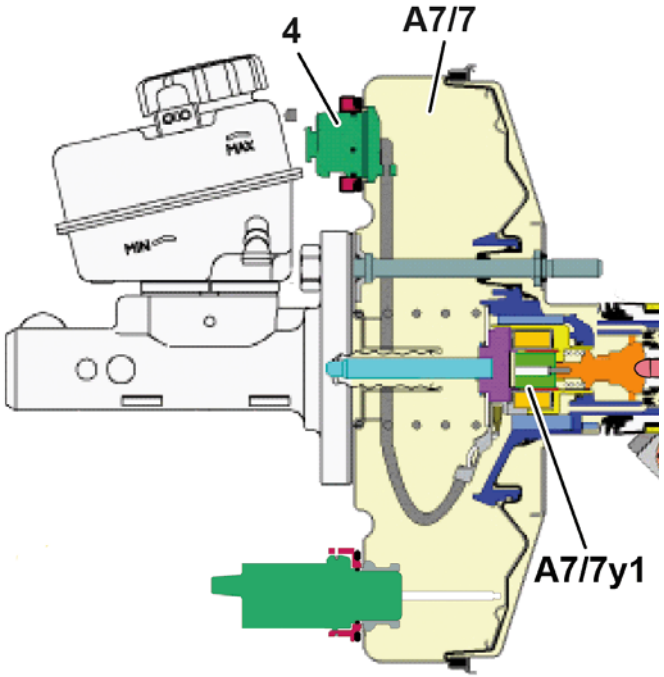
# RBS Animation




Typical RBS representation

# Regenerative Braking System (RBS)

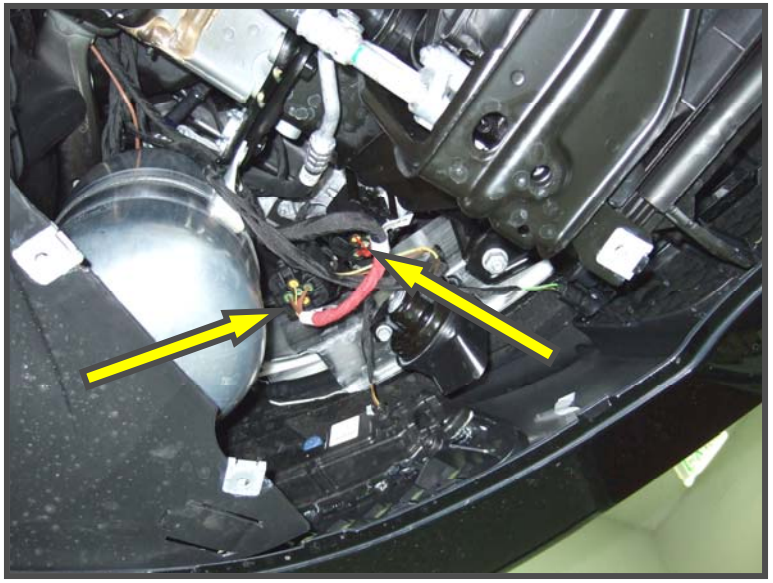
- The RBS solenoid valve (A7/7y1) in the brake booster (A7/7) is modulated by the regenerative braking system (RBS) control unit in accordance with driver braking request
- Through the modulation of this solenoid valve the master cylinder piston rod is actuated
- The hydraulic braking system functions as before utilizing the available vacuum in the brake booster




| | |
|---|---|
| 4 | Electrical connection for A7/7y1 |
| A7/7 | Brake booster |
| A7/7y1 | RBS solenoid valve |

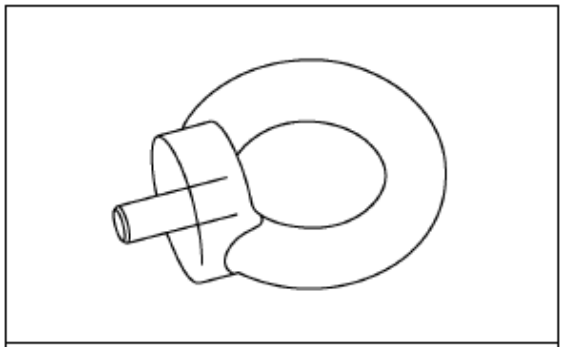
# Electric Vacuum Pump

- Located on left side of engine above electric refrigerant compressor
- Ensure adequate vacuum in RBS brake booster
- Maintain vacuum supply during start-stop operation
- Pressure sensor in brake booster reports available vacuum in brake booster to RBS control unit
- RBS control unit actuates electric vacuum pump as required via two relays:
  - K109 – power side
  - K109/1 – ground side
- Relays are located next to the AIRMATIC air tank, left front

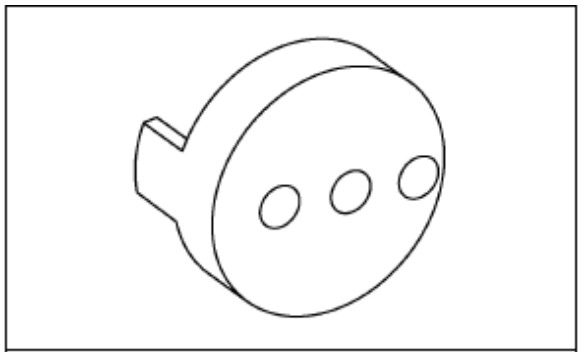
Location: Left front frame rail

# Special Tools



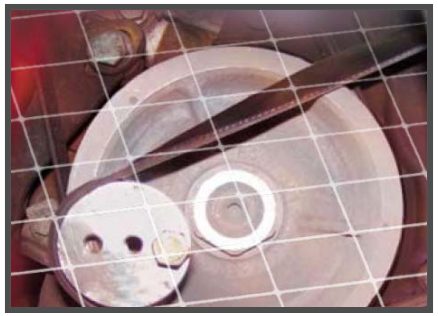
W221 589 01 62 00

These eyelets together with the engine hoist and engine crane must be used for the removal/installation of the HV battery (weight 40kg - 100kg) in hybrid vehicles. The ring bolts have a defined thread length of 13mm. It is mandatory to maintain this thread length. If a longer thread length is used the battery cells of the HV battery will be damaged and the HV battery will be unusable.

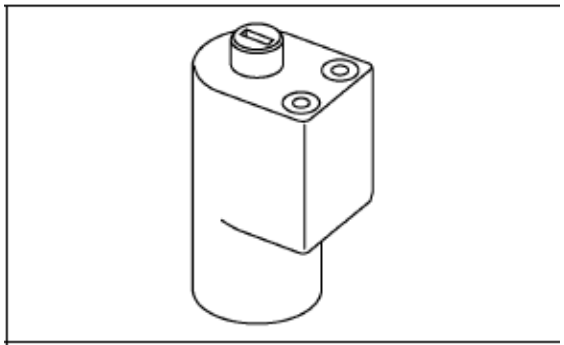


W272 589 01 61 00

Required to disassemble/assemble the elastic permanent ribbed V-belt (stretch fit belt). To remove/install belts, a clamp is fastened onto the belt pulley. Rotating the crankshaft enables the ribbed belt to be lifted off the belt pulley without damaging it (without any overstretching and twisting). It is fitted in the reverse order. The use of assembly levers or other prying tools will cause damage to the belt pulley and ribbed belt.

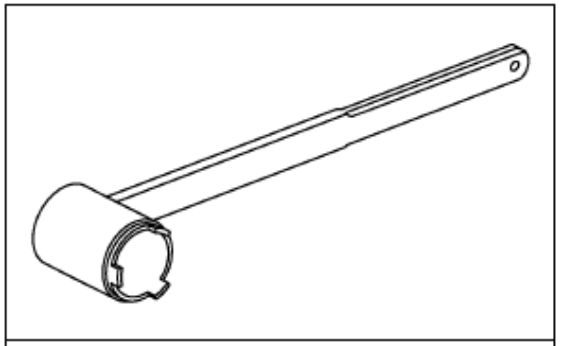


# Special Tools



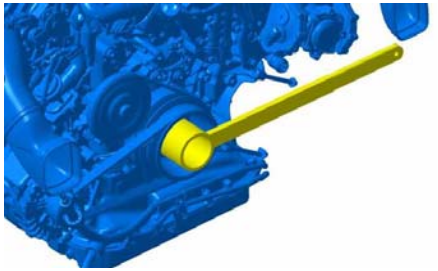
W221 589 05 63 00

For safety reasons, vehicle must not carry any voltage (0V) while work is being conducted on it (e.g. hybrid vehicles). To prevent any unauthorized reactivation of the system thereby putting people at risk, a lockable safety plug is fitted to the connecting point. This serves to ensure that only those people can put the vehicle back into service who are authorized to do so.



W272 589 00 07 00

To release the crankshaft's center bolt (e.g. replacement of crankshaft radial sealing ring) the vibration damper on this engine has to be held steady. This major assembly is equipped with 2 stretch fit belts on the vibration damper, which is why the working surface for the counter holder is seated very low in the vibration damper. For this reason, existing counter holders cannot be used on this engine.



# HV Battery Transport / Disposal

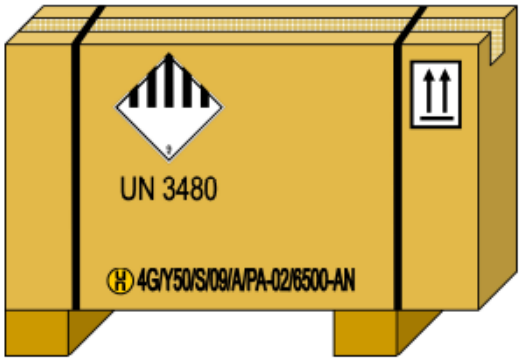
IMPORTANT:

An HV battery that has been dropped from a height of more than 21 inches (50 cm) must be disposed of.

The Li-ion HV battery is classed as hazardous material in international dangerous goods regulations.

The HV battery must be transported under the correct classification according to country or states rules:

E.g. - UN 3480 Lithium-ion battery, Class 9, PG II.




A used battery is safe for transport if the following are met:

- No cracks or significant deformation in the battery housing
- No electrolyte leaking from the battery or No free electrolyte in the battery
- No danger of the battery overheating or development of fires during transport
- No danger resulting from internal or external short circuits.