Technical training.
Product information.

G01 PHEV Complete Vehicle.

BMW Service

General information

Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Originally Published: October 2019

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

The information contained in the training course materials is solely intended for participants in this training course conducted by BMW Group Technical Training Centers, or BMW Group Contract Training Facilities.

This training manual or any attached publication is not intended to be a complete and all inclusive source for repair and maintenance data. It is only part of a training information system designed to assure that uniform procedures and information are presented to all participants.

For changes/additions to the technical data, repair procedures, please refer to the current information issued by BMW of North America, LLC, Technical Service Department.

This information is available by accessing TIS at www.dealerspeed.net.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application
- Aftersales Information Research (AIR)

G01 PHEV Complete Vehicle.

Contents.

G01 PHEV Complete Vehicle.

Contents.

G01 PHEV Complete Vehicle.

Contents.

G01 PHEV Complete Vehicle.

1. Introduction.

The BMW X3 xDrive30e combines the best of both worlds: the dynamics and efficiency of an electric motor with the range and comfort of a combustion engine. A plug-in hybrid vehicle as a SAV, which offers an agile driving experience with intelligent technologies and dynamic acceleration.

When the electric drive and the BMW TwinPower Turbo 4-cylinder gasoline engine work together, the vehicle achieves particularly high agility and an impressive forward thrust.

The G01 PHEV is a Hybrid Generation 3.0 vehicle. The high-voltage battery SP41 is used as a high-voltage battery unit. This is a 4th generation high-voltage battery unit.

Basic information on the topic of high-voltage technology can be found in the listed documents:

Basic information	Information
• Product information **eDrive in service** • Product information **Fundamentals of high-voltage technology.**	• Product information **ST1927 SP41 High-voltage Battery** • Hybrid generation 3.0: Product information **ST1928 G30 PHEV Update**

Only Service employees who satisfy all the prerequisites are permitted to work on the designated high-voltage components: suitable qualifications, compliance with the safety rules, procedure following the exact repair instructions.

1.1. Training

Qualification to work on the high-voltage system of the G01 PHEV can be acquired via the respective **web-based training OL1922 G01 PHEV** if the service employee meets the following **requirements**:

- Valid "High-voltage Components" certification for another vehicle of hybrid generation **3.0**

OR

- Valid "High-voltage Components" certification for another vehicle of hybrid generation **4.0**

Work on the SP41 high-voltage battery requires a separate certification.

G01 PHEV Complete Vehicle.

1. Introduction.

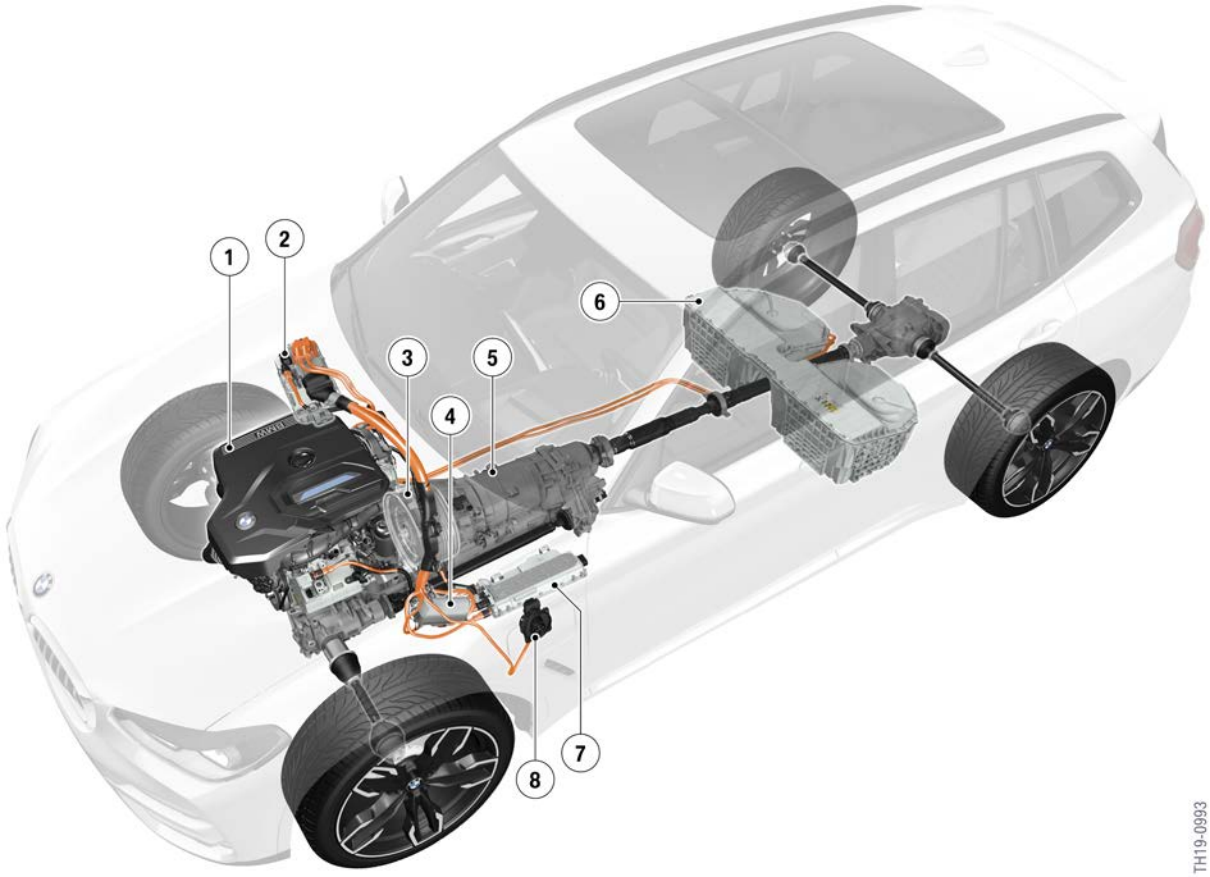
1.2. Positioning

The BMW X3 xDrive30e, whose development code is G01, is based on the G01.

The G01 PHEV is a full hybrid vehicle with lithium ion high-voltage battery which can for example be charged via an AC domestic socket outlet.

The abbreviation PHEV in the development code stands for **P**lug-in **H**ybrid **E**lectric **V**ehicle.

The continuous further development of hybrid drive systems as part of Efficient Dynamics is aimed at increasing the share of electrical power used in driving.



G01 PHEV hybrid drive

Index	Explanation
1	Combustion engine
2	Electric Machine Electronics (EME)
3	Electric motor
4	Electrical Heating (EH)

G01 PHEV Complete Vehicle.

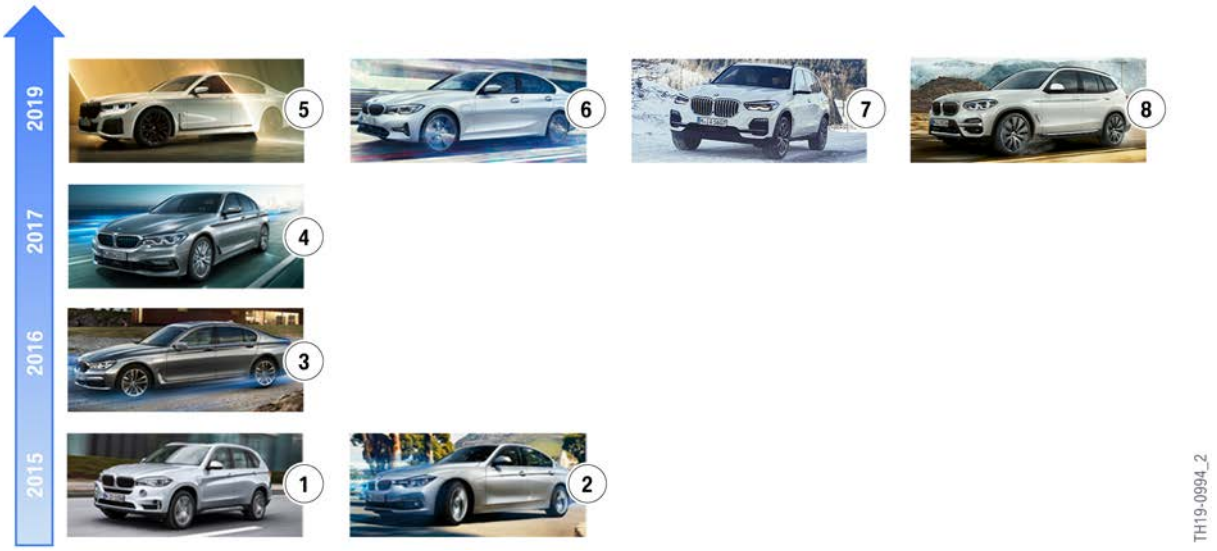
1. Introduction.

Index	Explanation
5	Automatic transmission
6	High-voltage battery unit
7	Convenience charging electronics (KLE)
8	Charging socket

The drive of the G01 PHEV consists of a 4-cylinder gasoline engine with TwinPower turbo technology (B46B20O1) and an 8-speed automatic transmission (GA8P75HZ) with an integrated electrical machine.

The electric drive of the G01 PHEV allows all-electric and thus local emission-free driving at speeds up to 135 km/h (84 mph). The maximum electric range is approximately 50 km (31 mph).

The G01 PHEV is another generation 3.0 hybrid vehicle.



BMW hybrid vehicles from 2014

Index	Explanation
1	F15 PHEV (BMW X5 xDrive40e)
2	F30 PHEV (BMW 330e)
3	G12 PHEV (BMW 740e xDrive)
4	G30 PHEV (BMW 530e, 530e xDrive)
5	G12 LCI PHEV (BMW 745e xDrive)
6	G20 PHEV (BMW 330e)
7	G05 PHEV (BMW X5 xDrive45e)
8	**G01 PHEV (BMW X3 xDrive30e)**

G01 PHEV Complete Vehicle.

1. Introduction.

1.3. Identifying features

1.3.1. Exterior

The G01 PHEV differs from the conventional G01 in the area of the exterior trim.

G01 PHEV, identifying features of exterior trim

Index	Explanation
1	Charging socket cover
2	Model designation "xDrive30e" on the tailgate, right
3	Acoustic cover with "eDrive" inscription

The model lettering must always be positioned on the vehicle so that rescue workers can detect the hybrid vehicle with the high-voltage battery unit in the event of an accident.

G01 PHEV Complete Vehicle.

1. Introduction.

1.3.2. Interior equipment

The interior equipment of the G01 PHEV also differs from the conventional G01 in various features.

G01 PHEV interior identifying features

Index	Explanation
1	Hybrid-specific displays in the instrument cluster, (KOMBI)
2	eDRIVE menus in the Central Information Display (CID)
3	Refueling button
4	eDrive button

The hybrid-specific operating conditions and the state of charge of the high-voltage battery unit are displayed in the instrument cluster and if desired in the Central Information Display. The installation location of the refueling button is in the front, bottom part of the door trim panel on the driver's side.

G01 PHEV Complete Vehicle.

1. Introduction.

1.4. Technical data

The following tables compare the G01 PHEV with the conventional G01:

Drive	Unit	BMW X3 xDrive 30i G01	BMW X3 xDrive30e G01 PHEV
Maximum power, combustion engine	[kW (HP)]	185 (248)	135 (184)
Maximum torque of combustion engine	[Nm (lb-ft)]	350 (258)	350 (258)
Maximum complete system power	[kW (HP)]	X	215 (292)
Electrical machine peak power	[kW]	X	80
Maximum torque, electrical machine	[Nm]	X	265

Vehicle performances	Unit	BMW X3 xDrive 30i G01	BMW X3 xDrive30e G01 PHEV
Acceleration 0 to 60 mph	[s]	6	5.9
Maximum speed	[km/h (mph)]	240 (150)	210 (130)
Vmax electric	[km/h (mph)]	X	135 (84)
Electric range*	miles	X	17

Consumption and emissions	Unit	BMW X3 xDrive 30i G01	BMW X3 xDrive30e G01 PHEV
Average fuel consumption basic vehicle*	[l/100 km]	from 7.2	from 2.2
Average CO emissions basic vehicle	[g/km]	from 168	from 49

Dimensions and weights	Unit	BMW X3 xDrive 30i G01	BMW X3 xDrive30e G01 PHEV
US vehicle curb weight	[lbs]	4156	4586
Fuel tank capacity	[liters (gal)]	65 (17.2)	50 (13.2)

*estimated

G01 PHEV Complete Vehicle.

1. Introduction.

1.5. Equipment

The G01 PHEV and the G01 differ not only in the technical data but also in the range of optional equipment offered. Below is a list of the key optional equipment that is **not** offered in the G01 PHEV:

- M sports suspension (OE 704)
- Adaptive M sports suspension (optional equipment 2VF)
- M Sport differential (SA 2T4)
- Compact spare wheel (OE 300)

1.6. Overview of changes to the BMW X3 xDrive30i to the X3 xDrive30e G01

Some components/systems were modified for use in the G01 PHEV. The most important changes are listed in the following table:

	BMW X3 xDrive30i	**BMW X3 xDrive30e**
Engine	B46B20**O**1	B46B20**O**1
Vacuum pump	**Mechanical** vacuum pump in the chain drive	Additional **electrical** vacuum pump
Fuel tank	Fuel tank **in front of** the rear axle	Pressurized fuel tank **below** the luggage compartment floor
Automatic transmission	**GA8HP50Z** Torque converter with converter lockup clutch	**GA8P75HZ** Electrical machine, dual-mass flywheel and separation clutch
Transmission oil pump	Only **mechanical** transmission oil pump	Mechanical and **electrical** transmission oil pump
Brakes	**Conventional** brake system	**Hybrid brake system** with modified DSC unit, brake pedal angle sensor and brake vacuum sensor
12 V voltage supply	**Vehicle battery** in luggage compartment	Vehicle battery in luggage compartment, **auxiliary battery** on right-hand side of luggage compartment (start-up system)
Alternator	**Conventional** alternator	**Electric motor electronics (EME)**
Air conditioning compressor	**Mechanical** air conditioning compressor	**Electric** A/C compressor EKK (high-voltage)
Heating	**Conventional**	**Electrical** Heating EH (high-voltage)

G01 PHEV Complete Vehicle.

1. Introduction.

1.7. Repair

1.7.1. Safe working practices for working on a high-voltage system

The following description of the repair of the high-voltage components is only a general list of the content and the procedure. **In general, only the specifications and instructions in the current valid edition of the repair instructions apply.**

Before working on or in the vicinity of high-voltage components it is essential to observe and implement the electrical safety rules:

1 The high-voltage system must be disconnected from the supply.

2 The high-voltage system must be secured against restart.

3 The safe isolation of the high-voltage system must be verified.

The following chapter provides brief descriptions on how to implement the electrical safety rules in the G01 PHEV.

Preparations

Any charging cable connected in the vehicle (charging cable and battery charger) must be disconnected. The PARK vehicle condition must be established (e.g. by holding down the media button). The tailgate must be opened and the vehicle must be asleep. This can be detected by the non-illuminated Start/Stop button. The vehicle cannot be refuelled during the enabling.

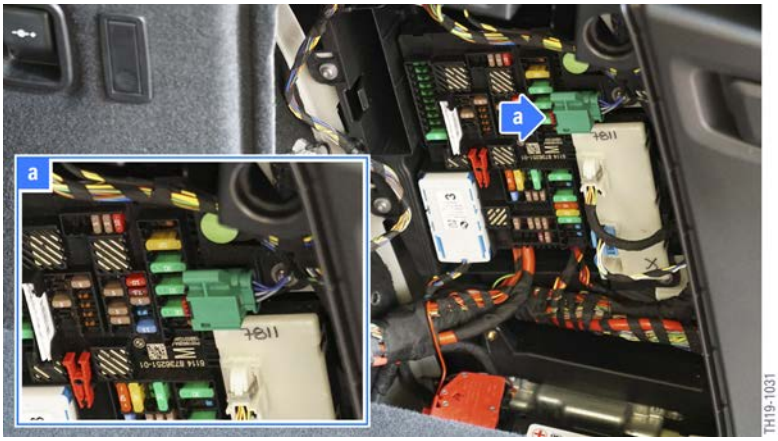
De-energizing the high-voltage system

The high-voltage system in the G01 PHEV is disconnected from the supply with the high-voltage safety plug ("Service Disconnect"). The color of the high-voltage service disconnect is **green**. The high-voltage safety plug is located as a separate component in the luggage compartment, behind a cover in front of the power distribution box.

To disconnect from the supply, the connector must be pulled open from the connector housing. This interrupts the circuit of terminal 30C in the safety box and the signal of the high-voltage interlock loop is no longer transmitted.

G01 PHEV Complete Vehicle.

1. Introduction.



G01 PHEV: high-voltage service disconnect

The de-energized state is displayed by a corresponding symbol in the instrument cluster. Only the symbol indicates whether safe work at the vehicle is possible.

1.7.2. Rescue disconnect

G01 PHEV, installation location of emergency separation point

A second rescue disconnect is necessary as a result of the requirements of the emergency services, which state that vehicles with an electrical drive system must have 2 separate rescue disconnects in the vehicle. The second separation point is always found opposite the high-voltage service disconnect in the vehicle. If the high-voltage service disconnect is located in the luggage compartment, the emergency separation point is then located in the engine compartment.

The emergency separation point is a line with terminal 30C. Terminal 30C supplies the switch contactor in the safety box with voltage. This line is cut through at the marked point to ensure that the switch contactors open. The rescue disconnect can be repaired after it has been cut through.

G01 PHEV Complete Vehicle.
2. Drive Components.

2.1. Introduction

In the G01 PHEV, the B46B20O1 is an element of the BMW hybrid drive. The 4-cylinder engine, which generates power of 135 kW (184 hp) and a maximum torque of 350 Nm (258 lb-ft) in the G01 PHEV, guarantees more sustainability and efficiency.

2.2. Modified B46 engine

For use in G01 PHEV, the B46 engine and its periphery were modified.

Details of the individual modifications are provided in the following:

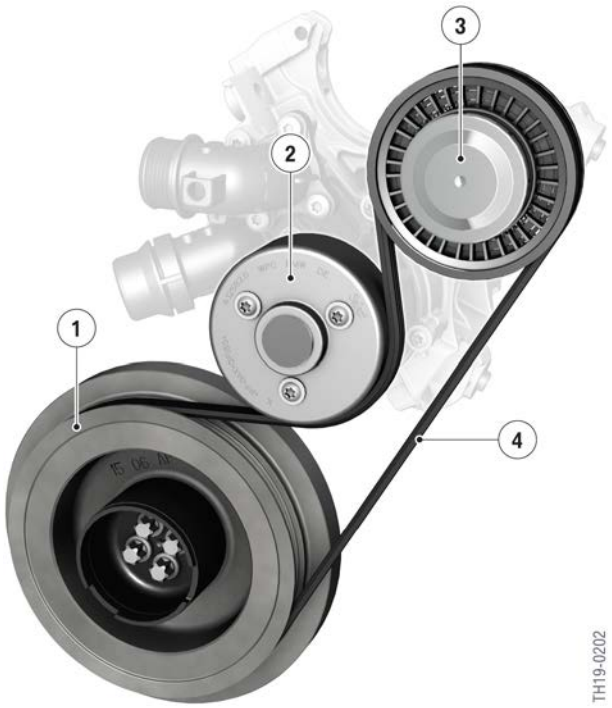
Component	Modification	Explanation
Air conditioning compressor	Electric A/C compressor (EKK)	As the combustion engine is not active during electric driving, it cannot power the air conditioning compressor. This is why an electrically driven air conditioning compressor is used.
Alternator	Electrical Machine Electronics (EME) with integrated DC/DC converter	The Electrical Machine Electronics converts the high voltage into low voltage using the integrated DC/DC converter and supplies the 12 V vehicle electrical system.
Mechanical vacuum pump	Electrical vacuum pump	As the combustion engine is not active during electric driving, it cannot power the mechanical vacuum pump. This is why an electrical vacuum pump is also used in addition to the mechanical vacuum pump.

G01 PHEV Complete Vehicle.
2. Drive Components.

2.2.1. Belt drive

For deployment in the G01 PHEV, the belt drive has been modified compared to the B46TU engine in a conventional vehicle. The width of the belt could be reduced with the deletion of the alternator and the mechanical air conditioning compressor.

The vibration damper has also been adapted to the modified belt drive. A viscous vibration damper with rigid belt pulley is deployed.



G01 PHEV belt drive B46B20O1

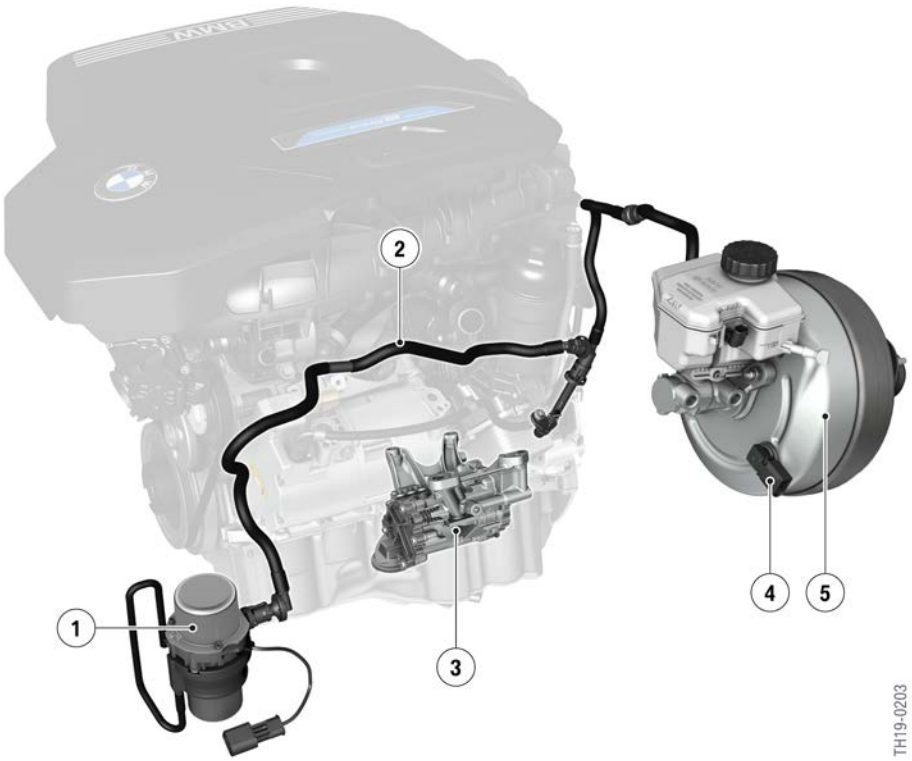
Index	Explanation
1	Viscous vibration damper with rigid belt pulley
2	Coolant pump belt pulley
3	Tensioning pulley
4	Elastic belt

G01 PHEV Complete Vehicle.
2. Drive Components.

2.2.2. Vacuum system

Various components of the G01 PHEV are shown with a vacuum supply. The B46 engine generates the required vacuum using a mechanical vacuum pump. As the vacuum supply must also be guaranteed in phases in which the B46 engine is not active, the vacuum system has been enhanced with an electrical vacuum pump. As soon as the value in the vacuum system drops below a certain threshold, the electrical vacuum pump is activated. The vacuum is measured by a pressure sensor in the brake servo, which is already known from vehicles with an automatic engine start-stop function.

The following graphic provides an overview of the respective components:



G01 PHEV vacuum system

Index	Explanation
1	Electrical vacuum pump
2	Vacuum line to electrical vacuum pump
3	Mechanical vacuum pump
4	Pressure sensor
5	Brake servo

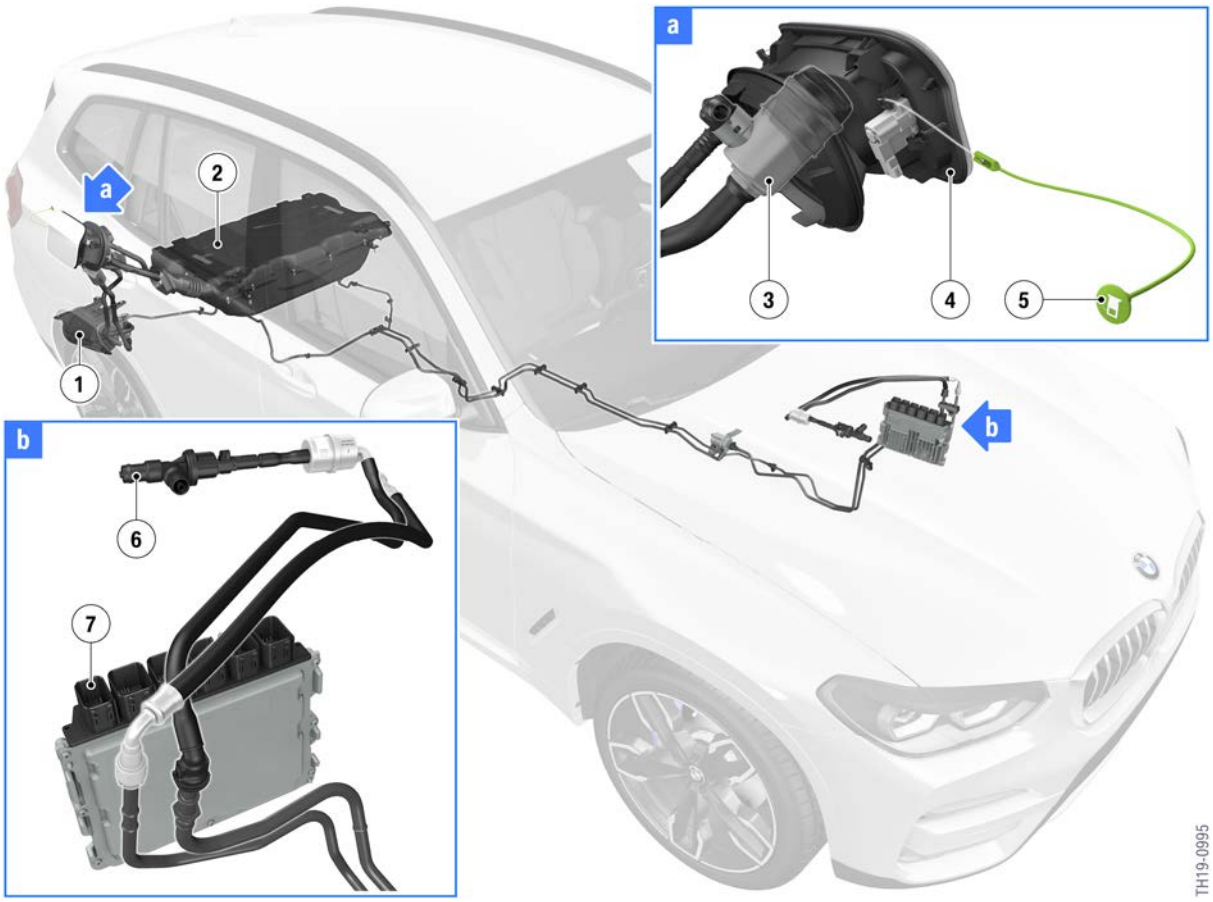
G01 PHEV Complete Vehicle.

2. Drive Components.

2.3. Fuel supply

For the operation of the combustion engine, the G01 PHEV is equipped with a pressurized fuel tank. As a result during purely electric driving it is guaranteed that the gasoline fumes remain in the pressurized fuel tank. Only with the operation of the combustion engine is fresh air drawn in by the carbon canister for purging and the gasoline fumes are directed to the combustion chamber.

2.3.1. Components and their installation location



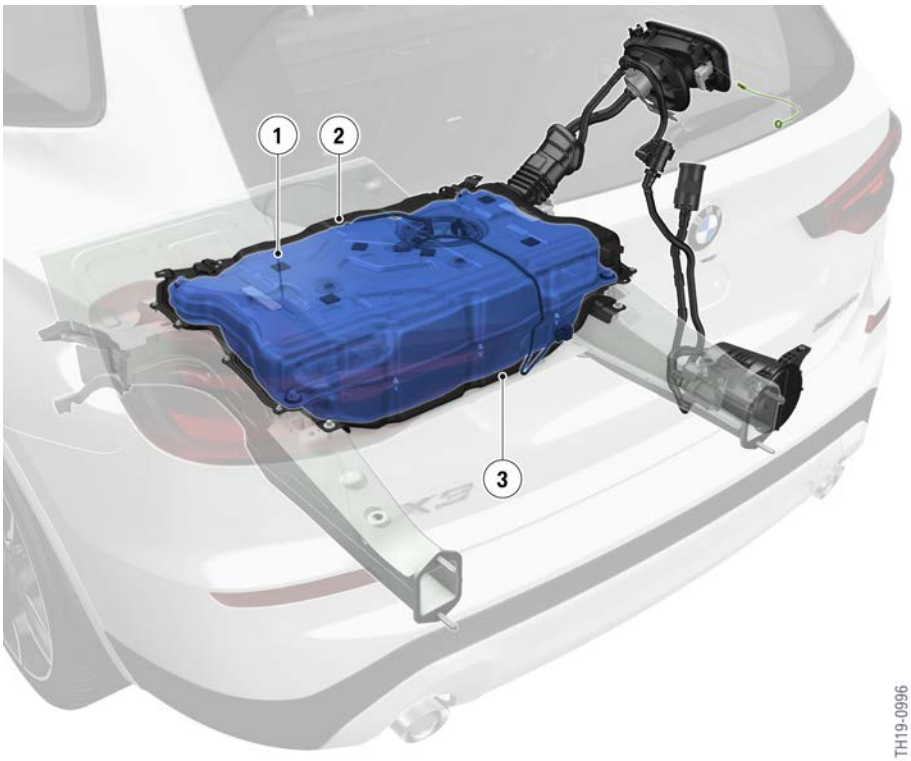
G01 PHEV components of the fuel supply in European version

Index	Explanation
1	Carbon canister
2	Pressurized fuel tank (stainless steel) in two-part housing
3	Fuel tank isolation valve (only for European version)
4	Fuel filler flap
5	Cable for emergency release of the fuel filler flap
6	Tank vent valve
7	Digital Motor Electronics (DME)

G01 PHEV Complete Vehicle.

2. Drive Components.

Pressurized fuel tank



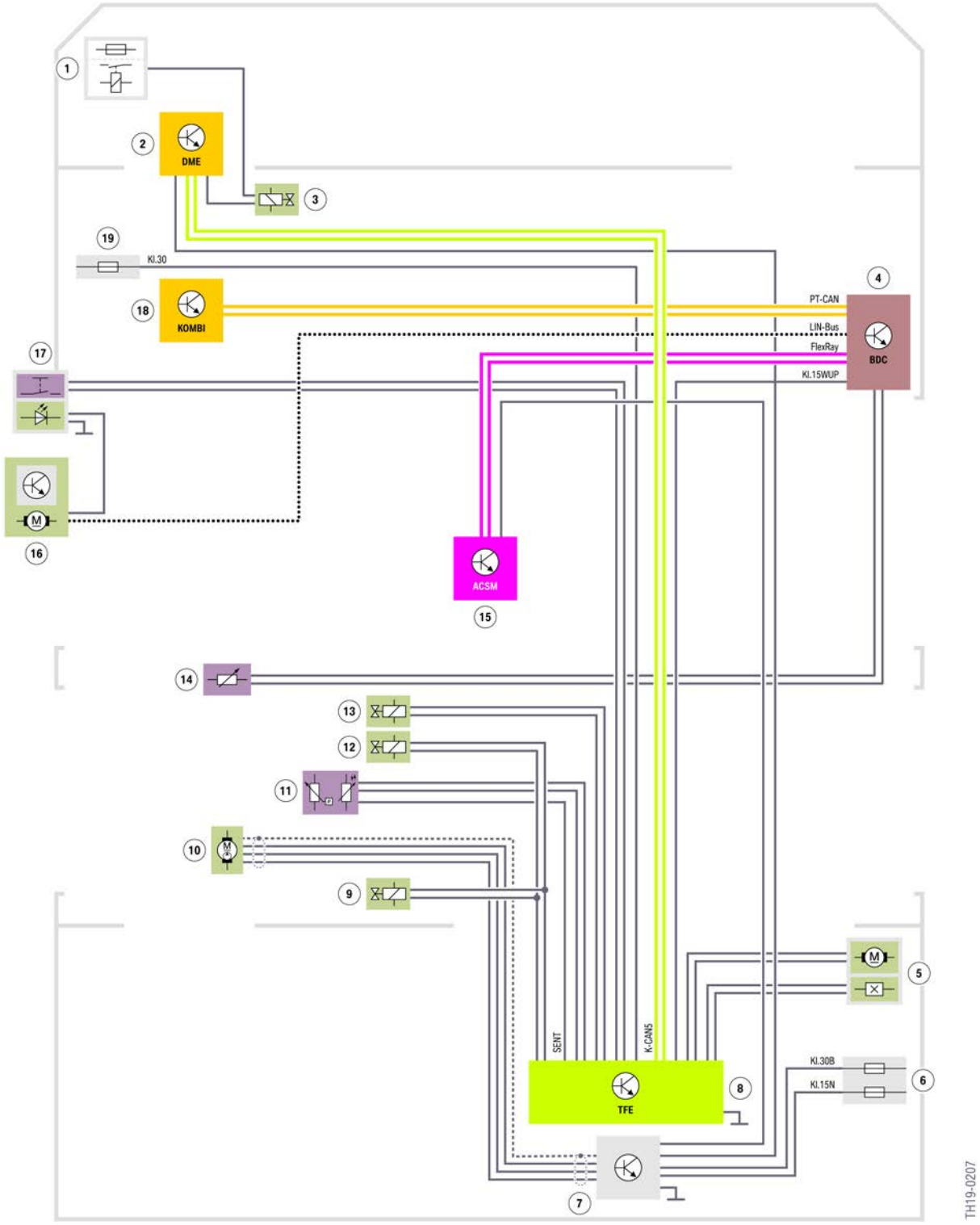
G01 PHEV pressurized fuel tank

Index	Explanation
1	Pressurized fuel tank (50 l) (stainless steel)
2	Upper housing section (steel)
3	Lower housing section (steel)

G01 PHEV Complete Vehicle.

2. Drive Components.

2.3.2. System wiring diagram



G01 PHEV, system wiring diagram for fuel supply

Index	Explanation
1	Integrated supply module
2	Digital Motor Electronics (DME)
3	Shutoff valve purge air line (only for US version)
4	Body Domain Controller (BDC)
5	Fuel filler flap lock
6	Power distribution box, rear
7	Fuel pump control electronics
8	Hybrid pressure refueling electronic control unit (TFE)
9	Fuel tank isolation valve (only for US version)
10	Electric fuel pump
11	Pressure/Temperature sensor
12	Fuel tank isolation valve (only for European version)
13	Fuel tank shutoff valve (only for US version)
14	Lever sensor for fuel level
15	Advanced Crash Safety Module (ACSM)
16	Power window motor, driver's side (supply for LED refueling button)
17	Refueling button
18	Instrument cluster (KOMBI)
19	Power distribution box, front left

In the event of a crash, the fuel pump control electronics immediately disconnect the power supply to the fuel pump drive. The fuel pump control electronics receive the information for this from the Advanced Crash Safety Module (ACSM).

2.3.3. Refueling

The pressurized fuel tank must be vented before refueling. To initiate the refueling procedure, the button in the driver's door needs to be pressed first. This button is not active when the vehicle is in "PARK" mode. The status of the button is evaluated by the hybrid pressure refueling electronic control unit.

G01 PHEV refueling button

The hybrid pressure refueling electronic control unit TFE uses a pressure temperature sensor in the fuel tank to monitor the current operating condition and then controls the pressure reduction by opening the valves in the tank ventilation path.

After completing pressure reduction, the controller drive for the fuel filler flap lock is activated and the fuel filler flap and fuel filler cap can be opened manually.

If the tank flap is not opened after a certain time, it is locked again. The time up until it is locked again depends on several factors.

The fuel vapors are temporarily stored in the carbon canister during refueling. The stored vapors are routed into the engine only when the combustion engine is running and with activated purging.

2.3.4. Service instruction

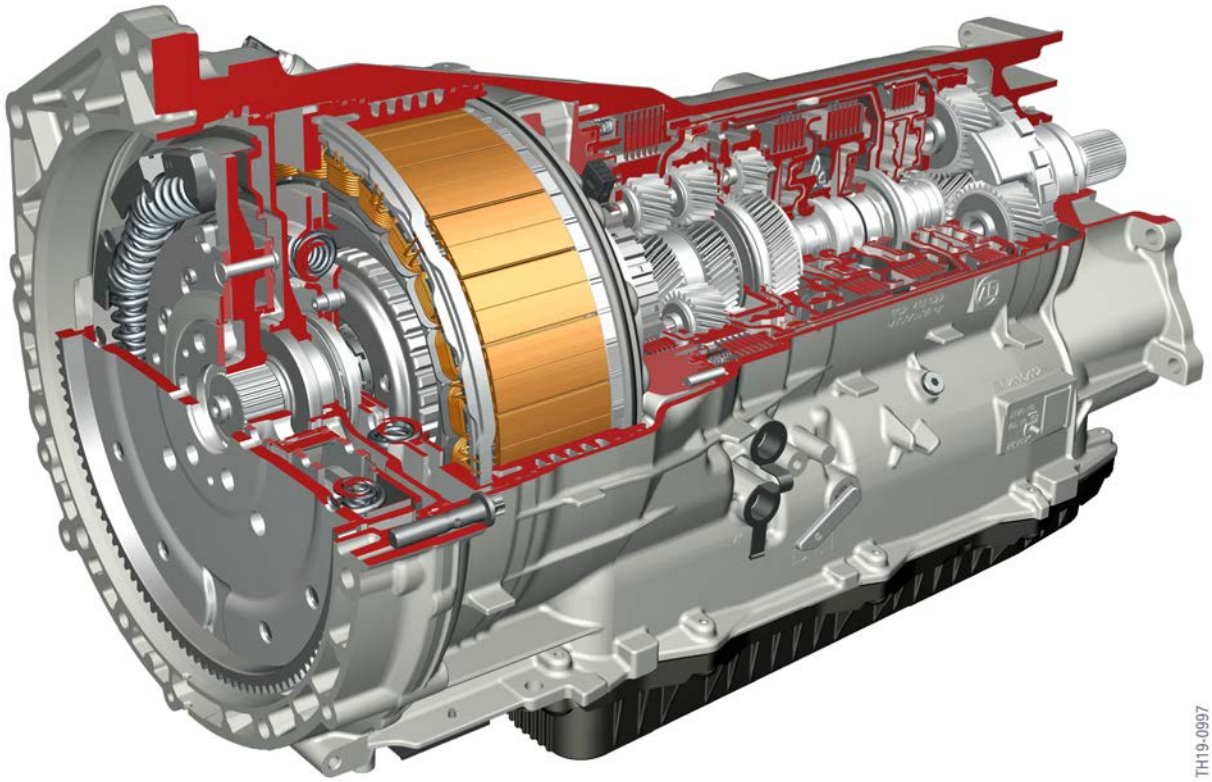
Combustion engine

The combustion engine can be started with the vehicle at a standstill, for example for an emission inspection. To achieve this, with activated driving readiness, the brake **and** accelerator must be pressed while drive position P or N is engaged. It is enough to press the accelerator gently. The driver's door must then be opened to prevent a switch-off of the combustion engine.

Pressure in the fuel tank

Before carrying out repair work on the fuel supply, the refueling procedure must be started so that the pressure in the fuel tank can be released. The fuel filler flap and fuel filler cap must be left open during repair work in order to exclude the possibility of a renewed pressure build-up.

2.4. Automatic transmission



GA8P75HZ transmission

2.4.1. Structure and function

Overview

In order to satisfy the requirements of a Plug-in Hybrid Electric Vehicle, the automatic transmission was adapted. A part of the damping system is also extracted from the transmission area and connected to the combustion engine as a dual-mass flywheel with integrated centrifugal pendulum.

With the electrical machine and the additional torsional vibration damper the housing of the GA8P75HZ transmission is longer compared with the GA8P70HZ transmission.

G01 PHEV Complete Vehicle.
2. Drive Components.

The hybrid area in the GA8P75HZ transmission can be divided into 5 components:

- Dual-mass flywheel
- Additional torsional vibration damper
- Separation clutch
- Electric motor
- Electrical transmission oil pump

Electric motor

The electrical machine, an additional torsional vibration damper and a separation clutch are integrated in the transmission housing. These are located behind the dual-mass flywheel. Everything together takes up the installation space of the hydraulic torque converter for a conventional automatic transmission.

Electrical machine in the GA8P75HZ transmission

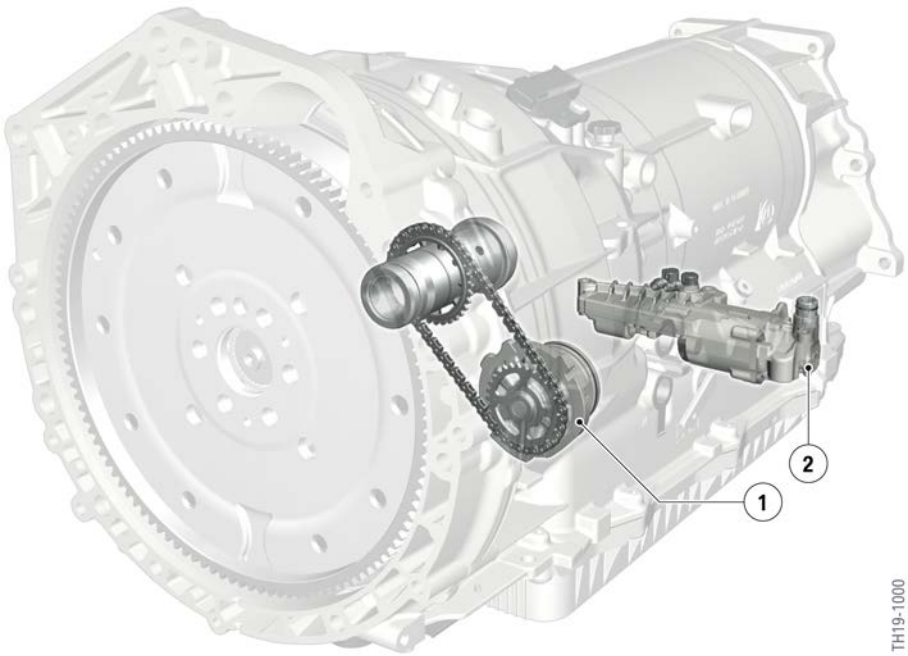
Index	Explanation
1	Electric motor

G01 PHEV Complete Vehicle.
2. Drive Components.

Oil supply

The basic functions of the oil circuit of the GA8P75HZ transmission correspond to those of the GA8HP70Z transmission.

It is a conventional pressure circulating system. In addition to the mechanical transmission oil pump known from the GA8HP70Z, an electrical transmission oil pump was integrated in the automatic transmission of the G01 PHEV in order to guarantee an oil supply when the combustion engine is at a standstill.



Transmission oil pump GA8P75HZ transmission

Index	Explanation
1	Mechanical transmission oil pump
2	Electrical transmission oil pump

G01 PHEV Complete Vehicle.

3. Electrical Machine.

3.1. Introduction

The electrical machine in the G01 PHEV is a permanently excited synchronous machine. It can convert electrical energy from the high-voltage battery unit into kinetic energy, by which the vehicle is driven. Both electric driving up to approximately 135 km/h (84 mph) as well as support of the combustion engine are possible, for example when overtaking (boost function) or for active torque support when changing gears.

In the reverse situation, the electrical machine converts kinetic energy into electrical energy during braking and in coasting (overrun) mode and stores this in the high-voltage battery unit (energy recovery).

The electrical machine is a high-voltage component.

High-voltage component warning sticker

Each high-voltage component has on its housing an identifying label that enables Service employees and vehicle users to identify intuitively the possible hazards that can result from the high electric voltages used.

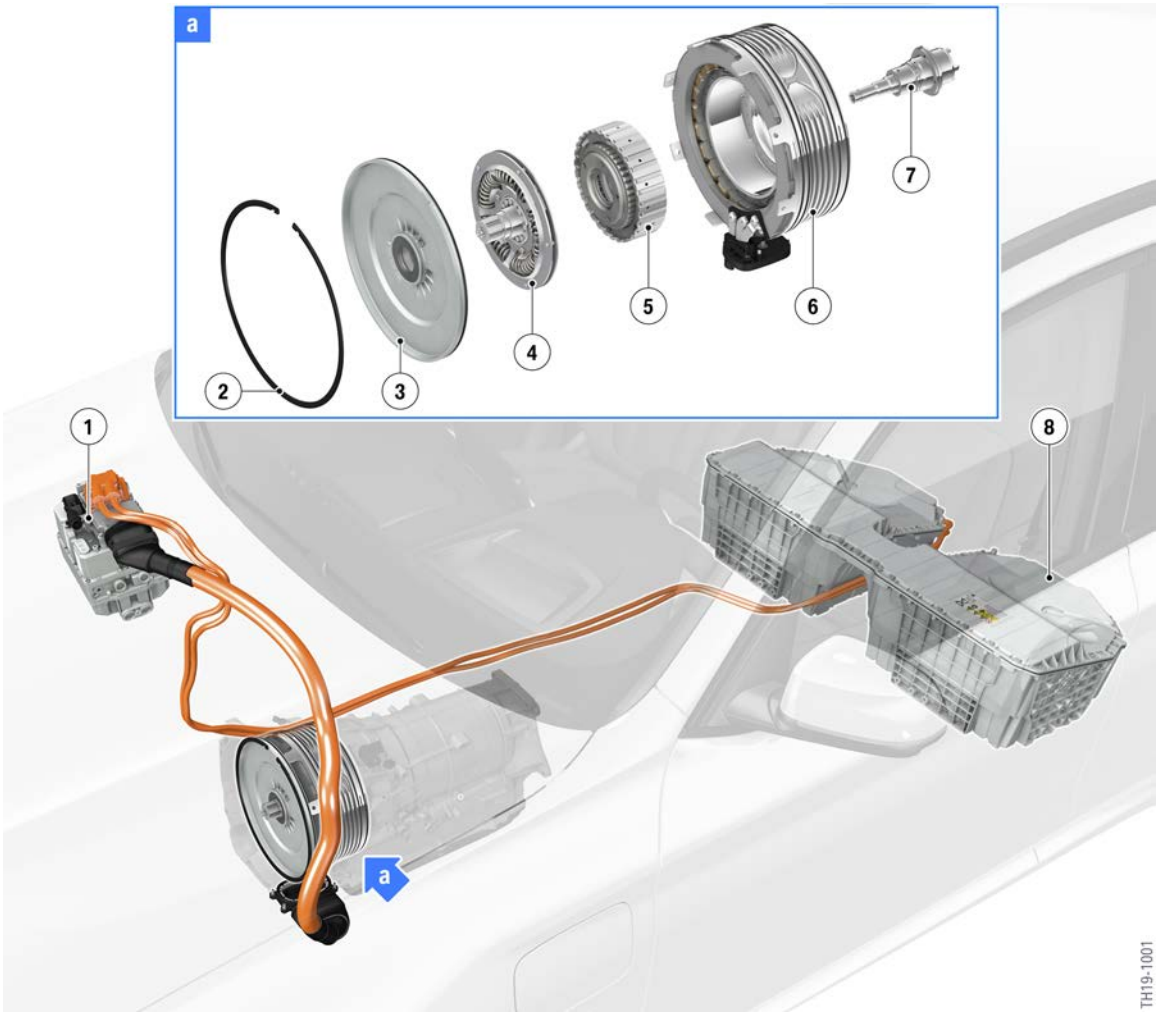
Only Service employees who satisfy all the prerequisites are permitted to work on the designated high-voltage components: suitable qualifications, compliance with the safety rules, procedure following the exact repair instructions.

For reasons of high-voltage safety the electrical machine must **not** be opened or otherwise dismantled.

G01 PHEV Complete Vehicle.

3. Electrical Machine.

3.2. Installation location



G01 PHEV electrical machine installation location

Index	Explanation
1	Electric Machine Electronics (EME)
2	Circlip
3	Lid at electrical machine
4	Additional torsional vibration damper
5	Separation clutch
6	Electric motor
7	Hollow shaft
8	High-voltage battery unit

The hybrid components are integrated as individual components in the transmission housing and roughly assume the installation space of the hydraulic torque converter in the transmission housing.

G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.

4.1. Introduction

The Electrical Machine Electronics (EME) is primarily used as control electronics for the electrical machine. It is also responsible for converting the direct current voltage from the high-voltage battery unit (nominal voltage 354.2 V) into a three-phase AC voltage for electrical machine motor operation. Conversely, when the electrical machine works as a generator, the Electrical Machine Electronics converts the three-phase AC voltage of the electrical machine into a direct current voltage and can thus charge the high-voltage battery unit. This happens, for example, during brake energy regeneration (energy recovery). For these two operating modes a bidirectional DC/AC converter is necessary which can work as both an inverter and a rectifier.

The DC/DC converter which is also integrated in the Electrical Machine Electronics ensures the voltage supply to the 12 V vehicle electrical system. This converter is a unidirectional DC/DC converter. It is only possible to convert high voltage into 12 V voltage.

The entire Electrical Machine Electronics of the G01 PHEV is located in an aluminum housing. The control unit, the bidirectional DC/AC converter and the unidirectional DC/DC converter for voltage supply of the 12 V vehicle electrical system, are located in this housing.

The EME control unit also assumes additional tasks. For example, the high-voltage power management, which manages the available high voltage from the high-voltage battery unit, is also integrated in the EME. The EME also has various output stages, which are responsible for the actuation of 12 V actuators, such as the actuation of the shutoff valve for cooling the interior.

The Electrical Machine Electronics is a high-voltage component.

High-voltage component warning sticker

Each high-voltage component has on its housing an identifying label that enables Service employees and vehicle users to identify intuitively the possible hazards that can result from the high electric voltages used.

Only Service employees who satisfy all the prerequisites are permitted to work on the designated high-voltage components: suitable qualifications, compliance with the safety rules, procedure following the exact repair instructions.

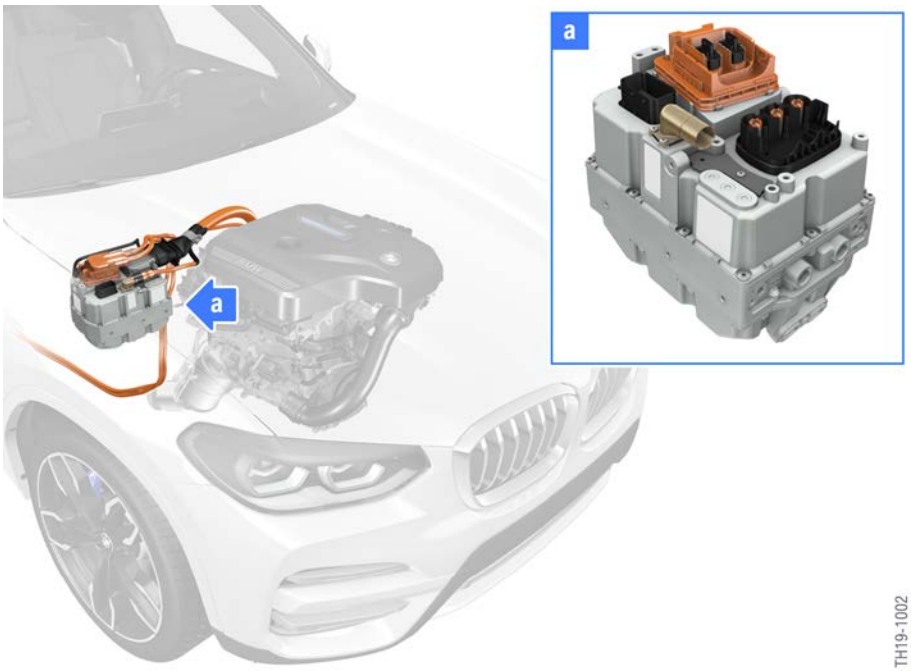
For reasons of high-voltage safety the Electrical Machine Electronics must **not** be opened or otherwise dismantled.

In the event of a fault, the complete Electrical Machine Electronics are always replaced.

After the Electrical Machine Electronics have been replaced they must be put into operation with help of the BMW diagnosis system. Observe the information in the current repair instructions.

G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.

4.2. Installation location



G01 PHEV, installation location of the Electrical Machine Electronics

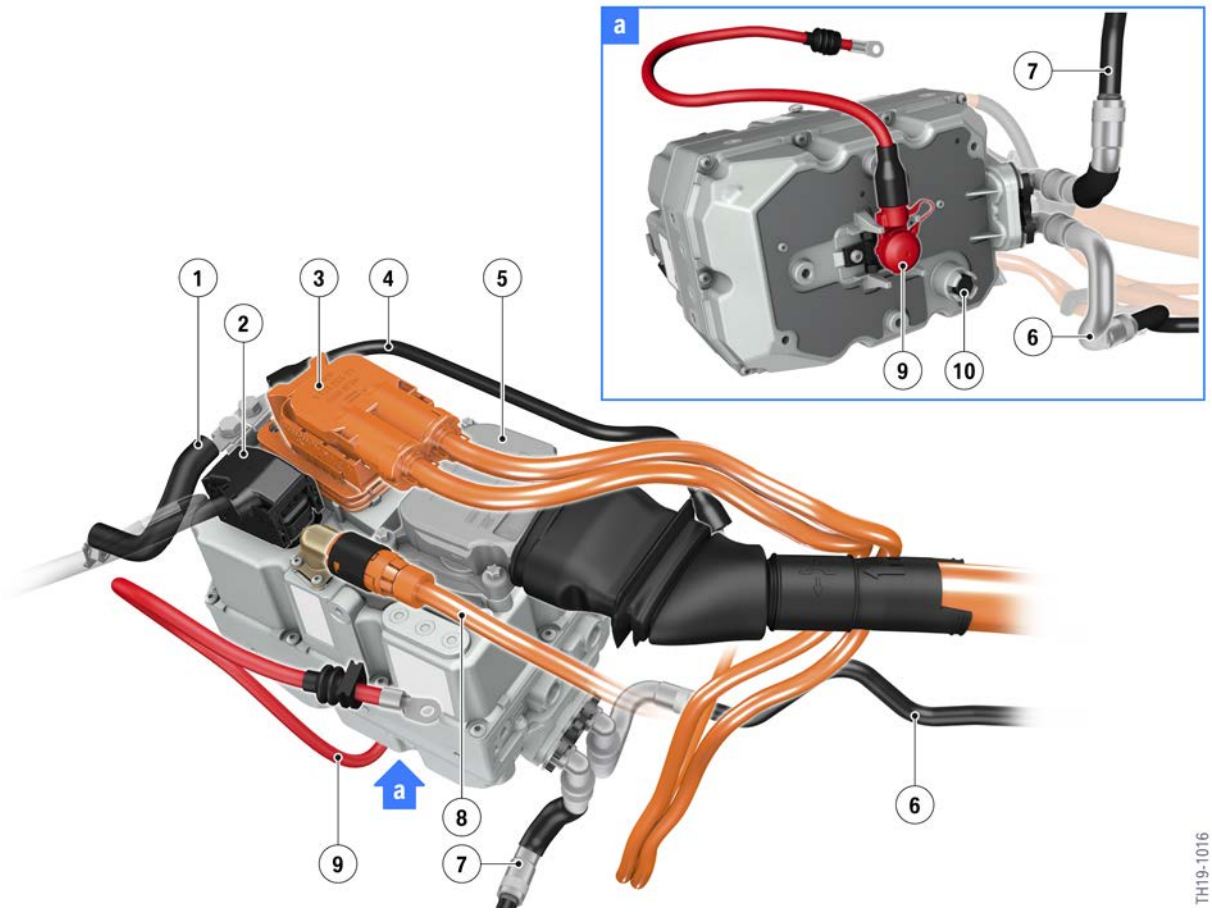
The Electrical Machine Electronics are installed on the rear right in the engine compartment in the direction of travel. In a right-hand drive vehicle the Electrical Machine Electronics is located on the left side of vehicle.

4.3. Connections

The connections at the Electrical Machine Electronics can be divided into 4 categories:

- Low-voltage connections
- High-voltage connections
- Connection for potential compensation line
- Connections for coolant lines

G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.



Connections of the Electrical Machine Electronics with lines

Index	Explanation
1	Connection for potential compensation line
2	Low-voltage connector
3	High-voltage cable (DC) to the high-voltage battery unit
4	Output, DC/DC converter –12 V
5	High-voltage cable (AC) to the electrical machine
6	Coolant feed line
7	Coolant return line
8	High-voltage connection to convenience charging electronics
9	Output, DC/DC converter +12 V
10	Ventilation

4.3.1. Connection for potential compensation lines

The insulation monitoring determines whether the isolation resistance between active high-voltage components (e.g. high-voltage cables) and ground is above or below a required minimum value. If the isolation resistance falls below the minimum value, the danger exists that the vehicle parts will be energized with hazardous voltage. If a person were to touch a second active high-voltage component, he or she would be at risk of electric shock.

There is therefore fully automatic insulation monitoring for the high-voltage system of the G01 PHEV. It is evaluated by the battery management electronics at regular intervals while the high-voltage system is active. Ground serves as the reference potential. Without additional measures only local isolation faults in the high-voltage battery unit could be determined in this way. However, it is equally important to identify isolation faults from the high-voltage cables in the vehicle to ground. For this reason all the electrically conductive housings of high-voltage components are conductively connected to ground. In this way isolation faults in the entire high-voltage electrical system can be identified from a central point by the insulation monitoring.

The high-voltage system must not be operated if the potential compensation cables are not properly connected to the high-voltage components.

If in the event of a repair the high-voltage components or the body components are replaced, the following must be observed during assembly: The connection between the housing and the body must be properly re-established. The repair instructions must be strictly observed (clean/corrosion-free/unpainted contact surfaces, tightening torques, documentation in accordance with the four-eyes principle).

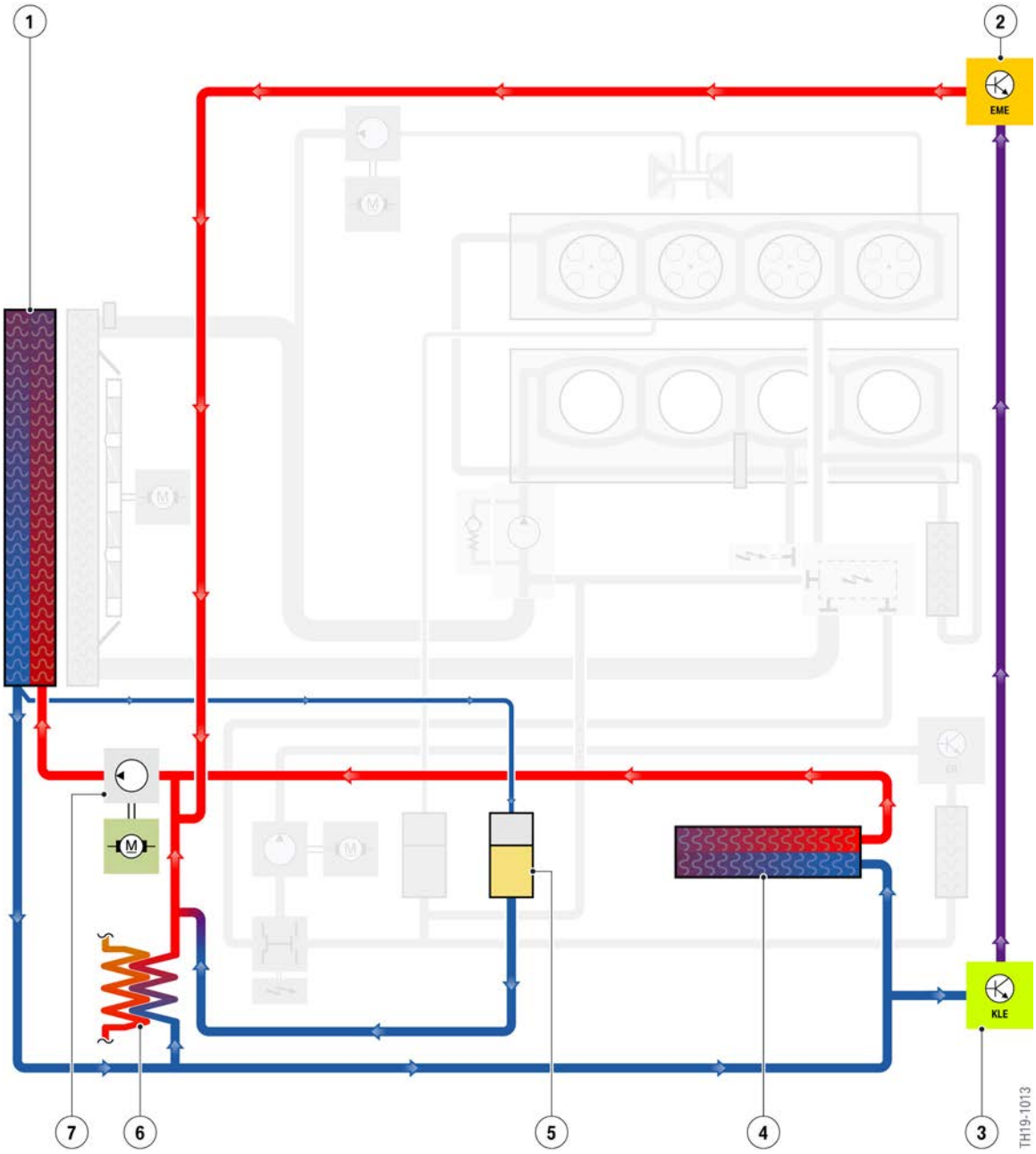
G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.

4.4. Cooling

The Electrical Machine Electronics and convenience charging electronics are cooled by the low-temperature coolant circuit.

4.4.1. Low-temperature cooling circuit

Schematic diagram

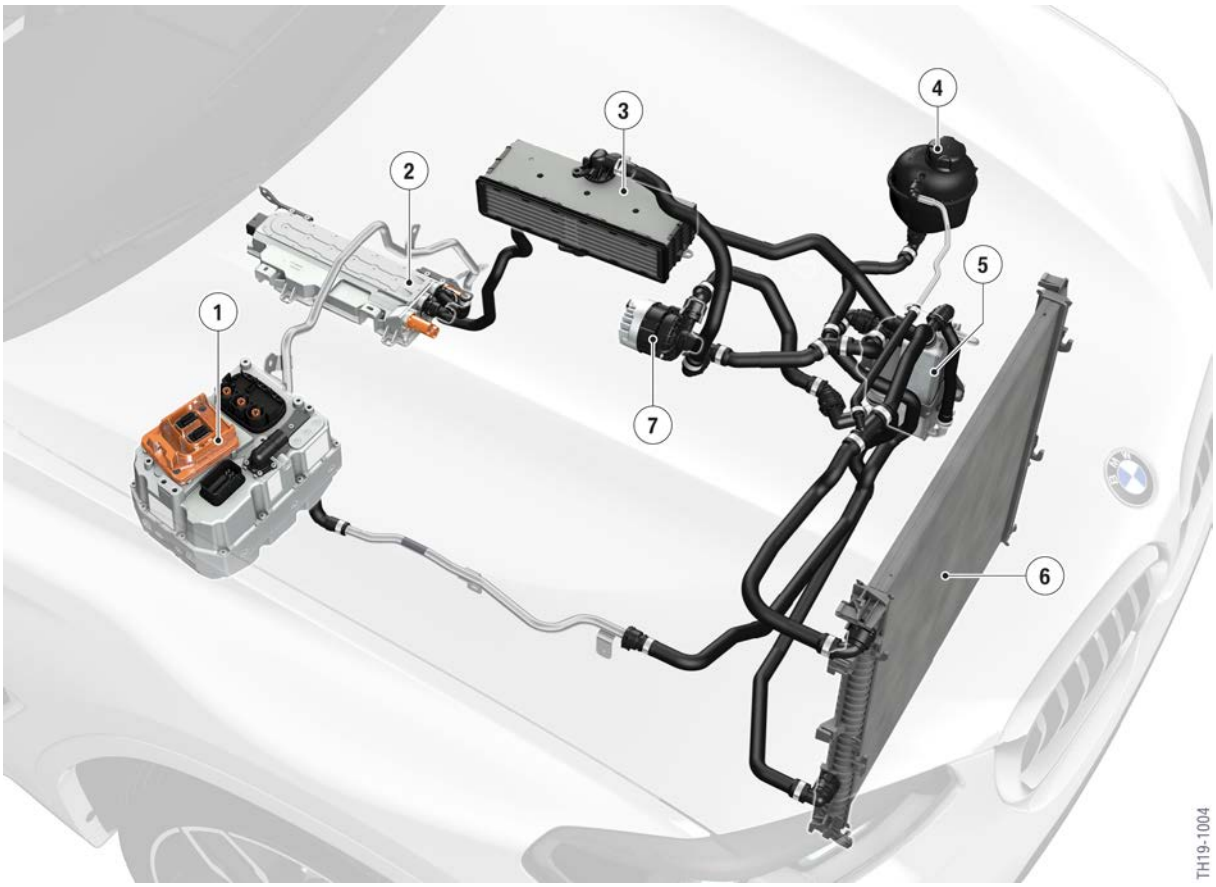


G01 PHEV, low-temperature coolant circuit (schematic diagram)

G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.

Index	Explanation
1	Coolant radiator (air-water intercooler)
2	Electric Machine Electronics (EME)
3	Convenience charging electronics (KLE)
4	Integrated indirect charge air cooler (air-coolant heat exchanger)
5	Coolant expansion tank
6	Coolant-based air conditioning condenser (coolant-refrigerant-heat exchanger)
7	Electric coolant pump

Installation location of the components



G01 PHEV installation locations of components of the low-temperature coolant circuit

G01 PHEV Complete Vehicle.
4. Electrical Machine Electronics.

Index	Explanation
1	Electric Machine Electronics (EME)
2	Convenience charging electronics (KLE)
3	Integrated indirect charge air cooler (air-coolant heat exchanger)
4	Coolant expansion tank
5	Coolant-based air conditioning condenser (coolant-refrigerant-heat exchanger)
6	Low-temperature coolant radiator (air-coolant heat exchanger)
7	Electric coolant pump

Notes for Service

There is no electrical fill level sensor installed in the expansion tank. But the following special feature should be noted for Service: A loss of coolant, for example due to a leak, in the cooling system is not identified directly due to the lack of an electrical level sensor. Instead, with a loss of coolant the temperature of the Electrical Machine Electronics will rise above the normal operating range. In this case the power of the Electrical Machine Electronics is reduced and a corresponding Check Control message is issued. The Service employee must check the following fault causes during troubleshooting:

- Loss of coolant, e.g. by a leak
- Incorrect low-temperature coolant radiator
- Electric fan does not work or is restricted
- Incorrect coolant pump
- Coolant lines or connections damaged
- Components to be cooled are faulty

If excess temperature is displayed in the cooling system, then this may have several causes, including also the loss of coolant. Therefore, during troubleshooting all components of the cooling system must be checked systematically.

The coolant pump and the electric fan can be switched on automatically when charging the high-voltage battery unit. The high-voltage battery unit must therefore not be charged when working with the engine compartment lid open or on the coolant circuit of the EME.

The activation of the coolant pump and electric fan can be effected in the following vehicle conditions:

- Vehicle condition DRIVE exists
- PAD mode is activated
- High-voltage battery unit is charged
- Preheating/precooling active

When PAD mode is activated, the power-electronics circuits of the Electrical Machine Electronics are already functional. In this way, both the high-voltage electrical system (EKK and electrical heating) and the 12 V vehicle electrical system are supplied with energy by the DC/DC converter. If due to the arising heat a cooling requirement is identified, the coolant pump is switched on, and if required also the electric fan.

When working with an open hood or at the coolant circuit of the Electrical Machine Electronics it is imperative to ensure that none of the aforementioned switch-on criteria apply in order to avoid an automatic switching-on of the coolant pump and the electric fan.

4.4.2. Automated coolant bleeding routine

When components have been replaced on the **low-temperature coolant circuit** or the cooling system has been filled, an automated coolant bleeding routine must be carried out. Otherwise, there is a risk of damage to the components to be cooled.

The actuators in the cooling system are activated during the automated coolant bleeding routine. The automated coolant bleeding routine is completed after around 10 minutes.

The following prerequisites must be fulfilled to be able to carry out an automated coolant bleeding routine on the **low-temperature coolant circuit**:

- Charging cable not connected at the high-voltage connection
- Bonnet open
- 12 V battery charger connected at the jump start terminal
- PAD mode active
- Temperature of the integrated automatic heating/air conditioning system set to the highest value
- Lowest blower speed active

Proceed as follows to start the automated coolant bleeding routine:

- Press the accelerator pedal as far as the limit position for at least 10 seconds (do not press the brake pedal while doing so)
- Release accelerator pedal

The starting and ending of the automated coolant bleeding routine is displayed in the instrument cluster.

After completing the service function, check and if necessary correct the coolant level in the expansion tank and disconnect the 12 V battery charger.

G01 PHEV Complete Vehicle.
5. High-voltage Battery Unit.

5.1. Overview

With the G01 PHEV the 4th generation high-voltage battery unit, with the designation SP41, is used.

The high-voltage battery unit is a complete system, which is made up of the following essential components:

- Cell modules including cells connected in series
- Cell supervision circuits (primary/secondary)
- Safety box
- Control unit for battery management electronics (SME)
- Four-part heat exchanger
- Wiring harnesses
- Connections (electrical system, refrigerant, venting)
- Housing and fastening parts

Work on live high-voltage components is expressly prohibited. Prior to every step which involves a high-voltage component, it is essential to disconnect the high-voltage system from the voltage supply and to secure it against unauthorized recommissioning.

5.1.1. Technical data

The table below shows the key technical data of the high-voltage battery SP41:

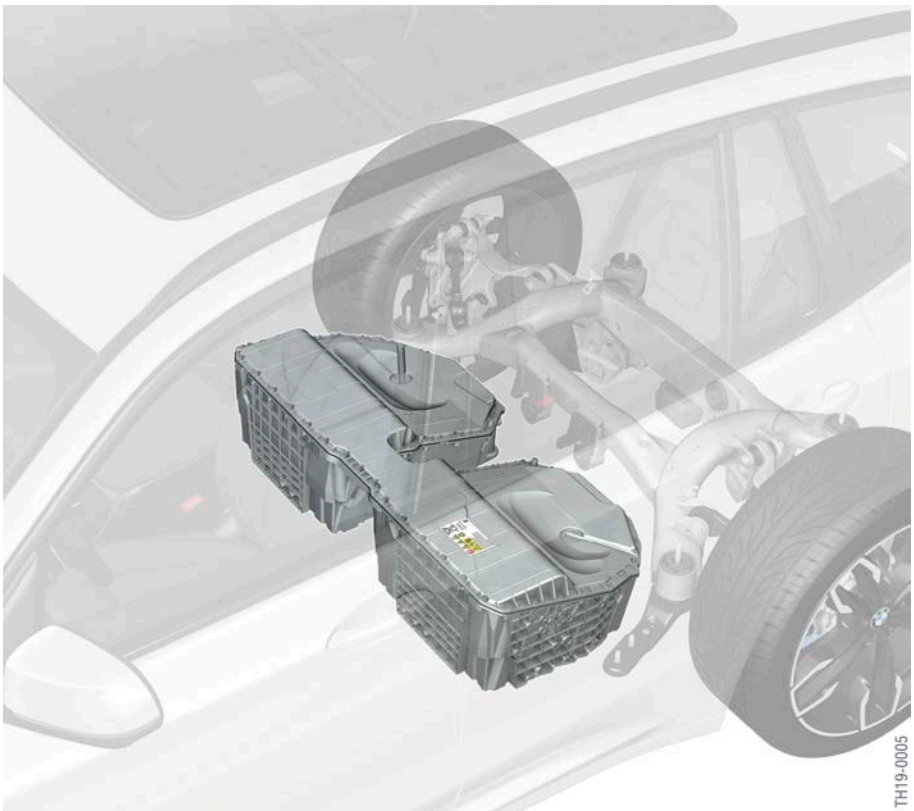
Technical data	SP41 High-voltage Battery
Voltage	355 V (nominal voltage) Min. 269 V – Max. 403 V (voltage range)
Battery cells	Lithium-ion
Number of battery cells	96 in series
Number of cell modules	6
Cell voltage	3.70 V
Battery capacity	34 Ah
Storable amount of energy	12 kWh
Usable energy	10.4 kWh
Max. power (discharge)	80 kW
Maximum power (AC charging)	3.7 kW
Weight	118.5 kg (261 lbs) (without retaining brackets)
Dimensions	541 mm x 1134 mm x 271 mm
Cooling system	Refrigerant R1234yf

G01 PHEV Complete Vehicle.

5. High-voltage Battery Unit.

Further information about the high-voltage battery unit can be found in the product information **"ST1927 SP41 High-voltage Battery"**.

5.1.2. Installation location

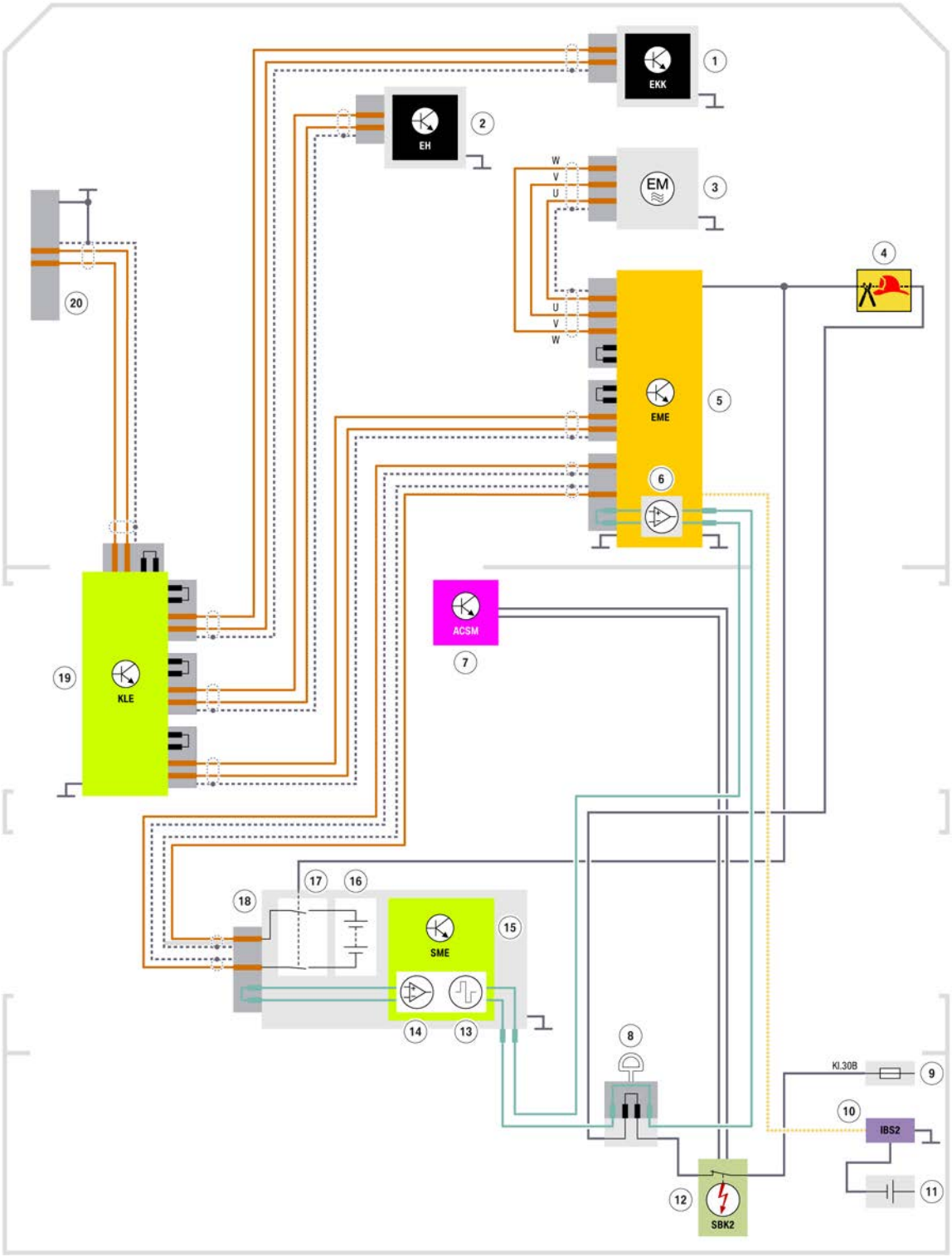


G01 PHEV, installation location of the high-voltage battery unit

G01 PHEV Complete Vehicle.

5. High-voltage Battery Unit.

5.1.3. System wiring diagram



G01 PHEV, system wiring diagram for high-voltage battery unit in the high-voltage network

Index	Explanation
1	Electric A/C compressor (EKK)
2	Electrical Heating (EH)
3	Electrical Machine (EM)
4	Rescue disconnect
5	Electric Machine Electronics (EME)
6	Evaluation circuit for test signal of the high-voltage interlock loop in the Electrical Machine Electronics
7	Advanced Crash Safety Module (ACSM)
8	High-voltage safety connector ("Service Disconnect")
9	Luggage compartment power distribution box fuse
10	Intelligent battery sensor (IBS 2)
11	Auxiliary battery
12	Safety battery terminal (SBK 2)
13	Clock generator for test signal of the high-voltage interlock loop in the battery management electronics (SME)
14	Evaluation circuit for test signal of the high-voltage interlock loop in the battery management electronics (SME)
15	Battery management electronics (SME)
16	Cell modules of the high-voltage battery unit
17	Electromagnetic switch contactor
18	High-voltage connection
19	Convenience charging electronics (KLE)
20	Charging socket

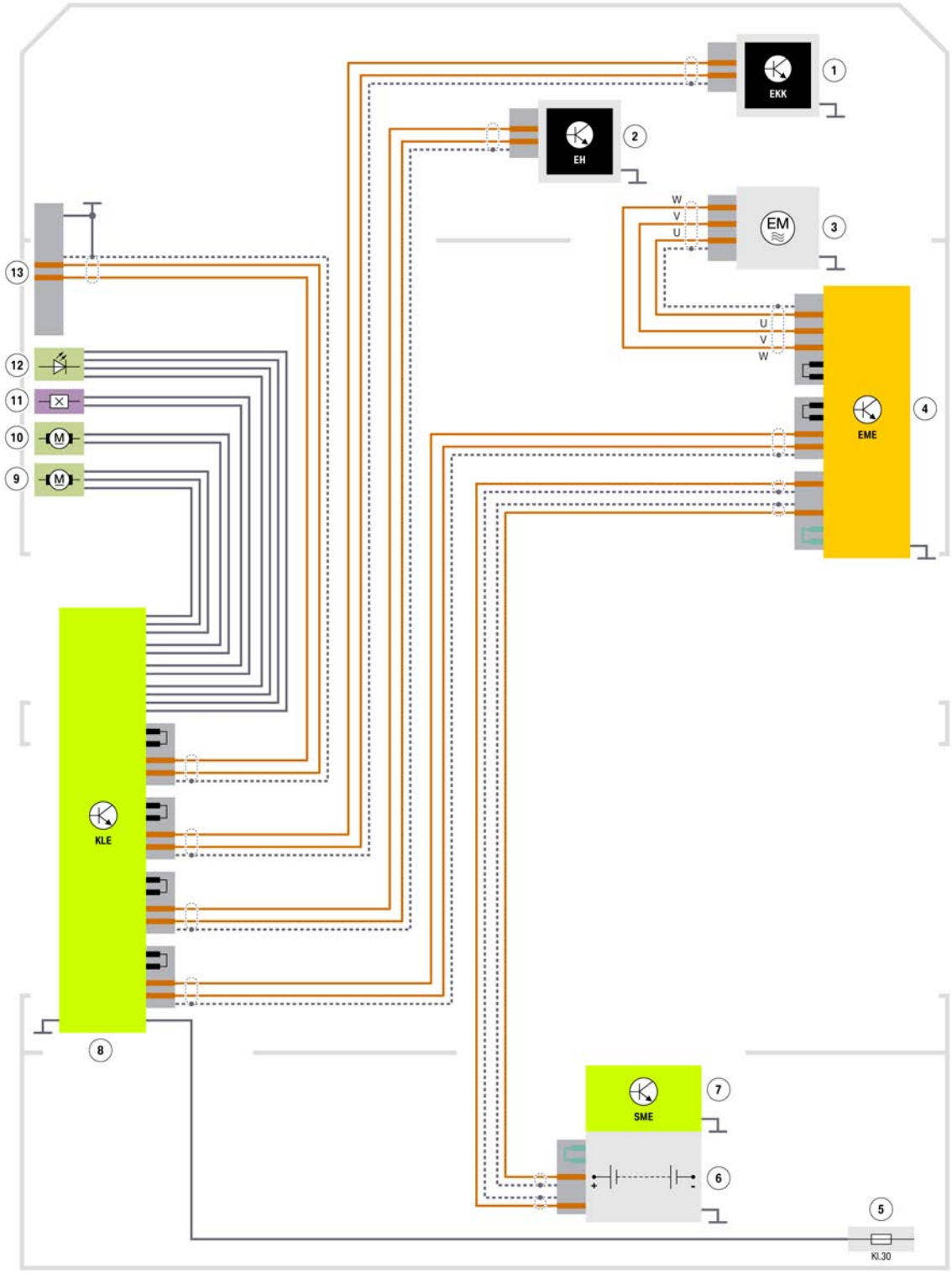
5.2. Charging

The G01 PHEV can be charged via the standard charging cable or an AC charging station.
The maximum charging power for the G01 PHEV is 3.7 kW.

G01 PHEV Complete Vehicle.

5. High-voltage Battery Unit.

5.2.1. System wiring diagram



System wiring diagram for AC charging with 3.7 kW

G01 PHEV Complete Vehicle.

5. High-voltage Battery Unit.

Index	Explanation
1	Electric A/C compressor (EKK)
2	Electrical Heating (EH)
3	Electric motor
4	Electric Machine Electronics (EME)
5	Luggage compartment power distribution box fuse
6	High-voltage battery unit
7	Battery management electronics (SME)
8	Convenience charging electronics (KLE)
9	Motor lock, charging plug
10	Motor lock, charging socket flap
11	Charging socket flap sensor
12	Locator and status lighting
13	Charging socket at the vehicle

G01 PHEV Complete Vehicle.
6. Hybrid Brake System.

6.1. Introduction

The function of the brake system of the G01 PHEV is to decelerate the vehicle safely under stable conditions. The deceleration of the vehicle is made up of a conventional hydraulic brake section and a regenerative brake section.

Thanks to regenerative braking it is possible to convert the kinetic energy of the vehicle into electrical energy with the help of the electrical machine, and to therefore charge the high-voltage battery unit.

The service brake of the G01 PHEV is based on that of a conventional G01. In this chapter only the hybrid-specific components and functions are described.

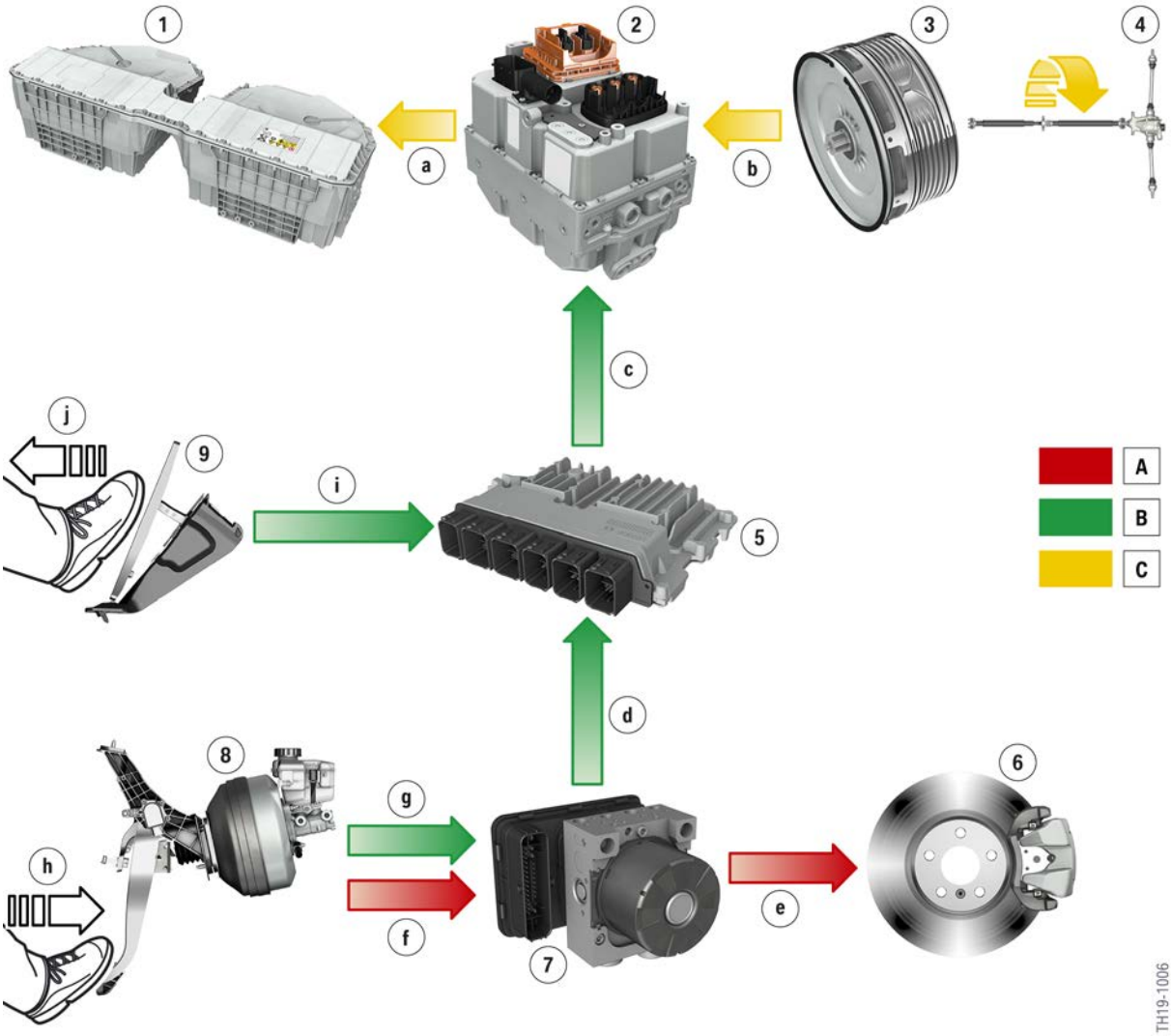
In comparison to the conventional G01, the following new or modified components are used:

- Brake pedal travel sensor
- Brake vacuum pressure sensor
- Modified vacuum brake system
- Modified DSC unit

G01 PHEV Complete Vehicle.

6. Hybrid Brake System.

6.2. System overview



System overview of hybrid brake system

Index	Explanation
A	Hydraulic braking
B	Signal path
C	Regenerative braking
1	High-voltage battery unit
2	Electric Machine Electronics (EME)
3	Electric motor
4	Drive train
5	Digital Motor Electronics (DME)
6	Wheel brakes

G01 PHEV Complete Vehicle.
6. Hybrid Brake System.

Index	Explanation
7	Dynamic Stability Control (DSC)
8	Brake pedal with brake pedal angle sensor and brake booster
9	Accelerator pedal module
a	High voltage (direct current voltage DC) for storage in the high-voltage battery unit
b	High voltage from the electrical machine (AC voltage)
c	Bus message "Accelerator pedal angle" from the DME to the EME (energy recovery in coasting overrun mode)
d	Bus message "Braking torque setpoint" from the DSC to the EME
e	Hydraulic pressure from the DSC to the wheel brakes
f	Hydraulic pressure from the brake booster to the DSC
g	Electrical signal "Brake pedal angle" from the brake pedal angle sensor to the DSC
h	Operation of the brake pedal
i	Electrical signal "Accelerator pedal angle" from accelerator pedal module to the DME (energy recovery in coasting overrun mode)
j	Releasing the accelerator pedal

G01 PHEV Complete Vehicle.

7. Low-voltage Electrical System.

7.1. Voltage supply

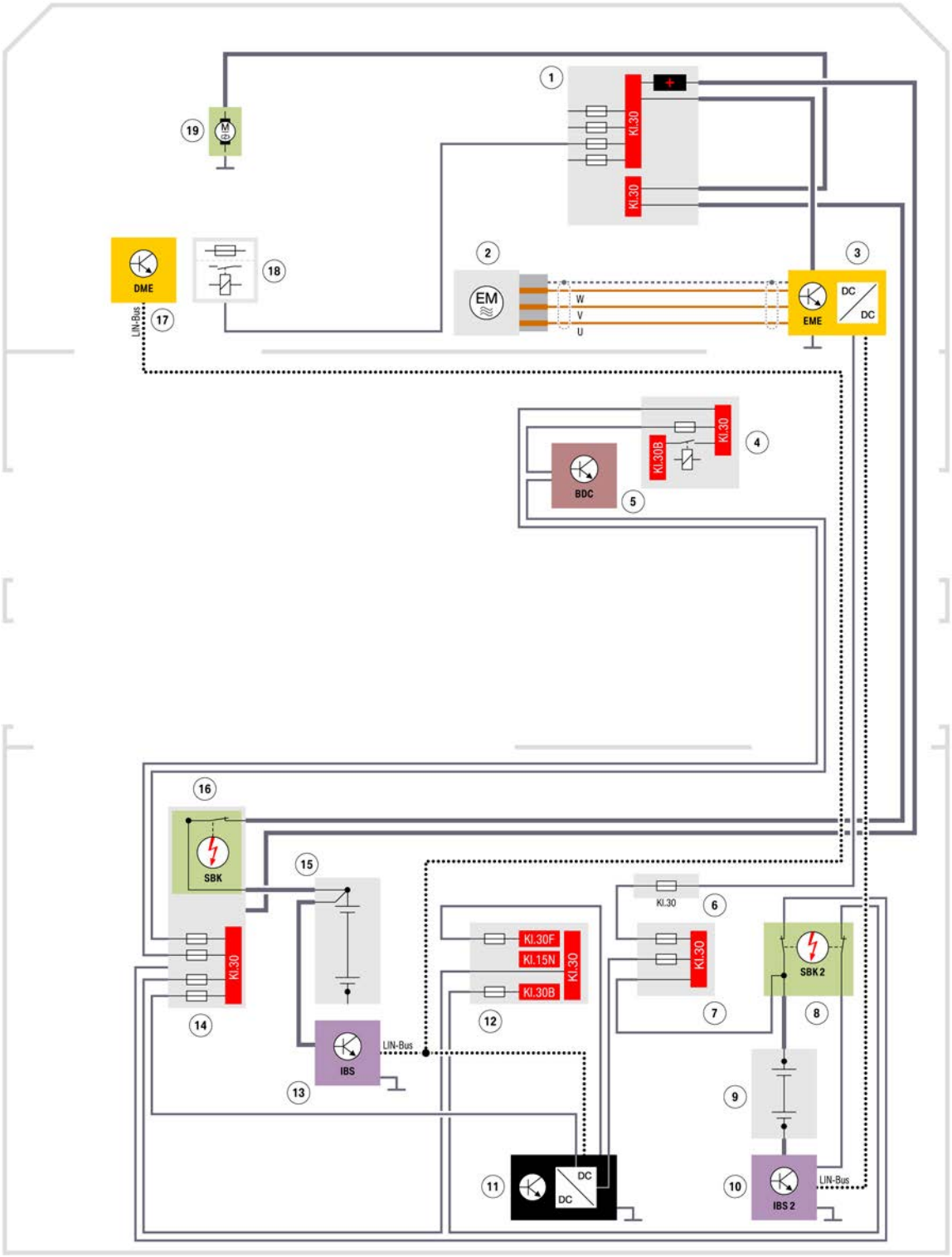
The 12 V vehicle electrical system of the G01 PHEV is essentially the same as the energy electrical system of the G01. The main difference lies in the fact that the power supply is no longer by the alternator, but by the high-voltage electrical system. The high voltage of the high-voltage battery unit is converted to the lower voltage (approximately 14 V) using a DC/DC converter in the Electrical Machine Electronics (EME). The electric voltage supply of the 12 V vehicle electrical system is thus no longer dependent on the engine speed of the combustion engine when driving.

Another difference is that the starter motor and auxiliary battery form an independent 12 V vehicle electrical system, which is connected to the standard 12 V vehicle electrical system by the charging unit for the auxiliary battery Battery Charge Unit (BCU).

G01 PHEV Complete Vehicle.

7. Low-voltage Electrical System.

7.1.1. System overview



G01 PHEV, system wiring diagram, 12 V voltage supply

G01 PHEV Complete Vehicle.
7. Low-voltage Electrical System.

Index	Explanation
1	Power distribution box, engine compartment
2	Electric motor
3	Electric Machine Electronics (EME)
4	Power distribution box, front right
5	Body Domain Controller (BDC)
6	Luggage compartment power distribution box fuse
7	Hybrid power distribution box, luggage compartment
8	Safety battery terminal 2 (SBK2)
9	Auxiliary battery
10	Intelligent Battery Sensor 2 (IBS2)
11	Charger unit for auxiliary battery BCU (Battery Charge Unit)
12	Power distribution box, luggage compartment
13	Intelligent Battery Sensor (IBS)
14	Battery power distribution box
15	Battery
16	Safety battery terminal (SBK)
17	Digital Motor Electronics (DME)
18	Integrated supply module (PDM)
19	Starter motor

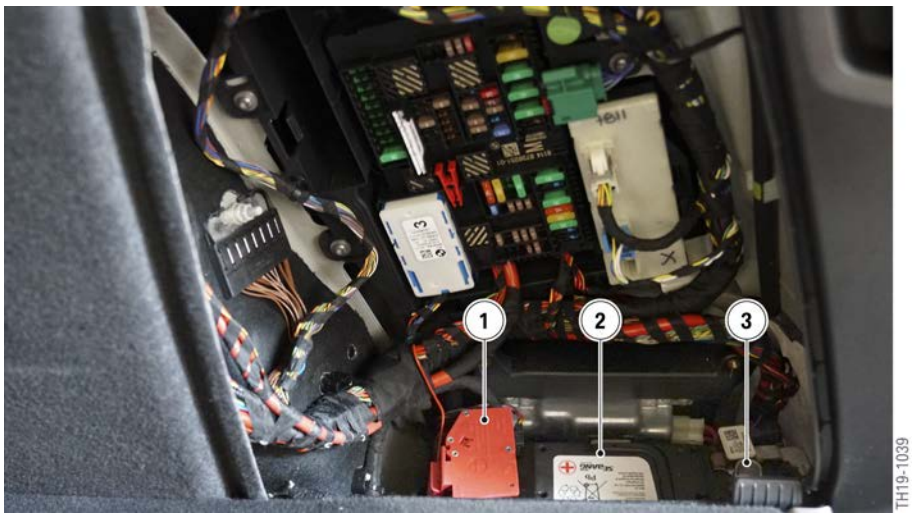
G01 PHEV Complete Vehicle.
7. Low-voltage Electrical System.

7.2. Start-up system

7.2.1. Starter motor

The combustion engine of the G01 PHEV can either be started via the conventional starter motor or the electrical machine. This is automatically decided by the vehicle using the load, the current gear and the temperature of the components.

7.2.2. Auxiliary battery



G01 PHEV, auxiliary battery

Index	Explanation
1	Safety battery terminal 2 (SBK2)
2	Auxiliary battery
3	Intelligent battery sensor 2 (IBS2)

The energy required by the starter motor is provided by the auxiliary battery. It is installed in the luggage compartment. The auxiliary battery is a lead-acid battery with a capacity of 60 Ah.

Similar to the 12 V battery, the current, voltage and terminal temperature of the auxiliary battery are measured by an intelligent battery sensor 2 (IBS2). The results are then forwarded to the Digital Motor Electronics (DME) on the LIN bus via the Electrical Machine Electronics (EME).

In the event of an accident of sufficient severity, the safety battery terminal 2 (SBK2) ensures the disconnection of the positive battery cable between the auxiliary battery and starter motor. The safety battery terminal 2 (SBK2) is located directly at the positive terminal of the auxiliary battery. The pyrotechnic activation of the safety battery terminal 2 (SBK2) for the auxiliary battery is effected by the Advanced Crash Safety Module (ACSM).

The intelligent battery sensor 2 (IBS2) receives the voltage supply via a line with a small cross-section from the safety battery terminal 2 (SBK2) of the auxiliary battery.

A change of the auxiliary battery must be registered via the workshop information system ISTA.

The positive battery cable runs from the safety battery terminal 2 (SBK2) to the starter motor.

Three other lines also leave from the safety battery terminal 2 (SBK2):

- Voltage supply for IBS2 (without fuse)
- Charger unit for auxiliary battery (protected by 60 A)
- Electrical Machine Electronics (protected by 5 A)

7.2.3. Battery charging unit

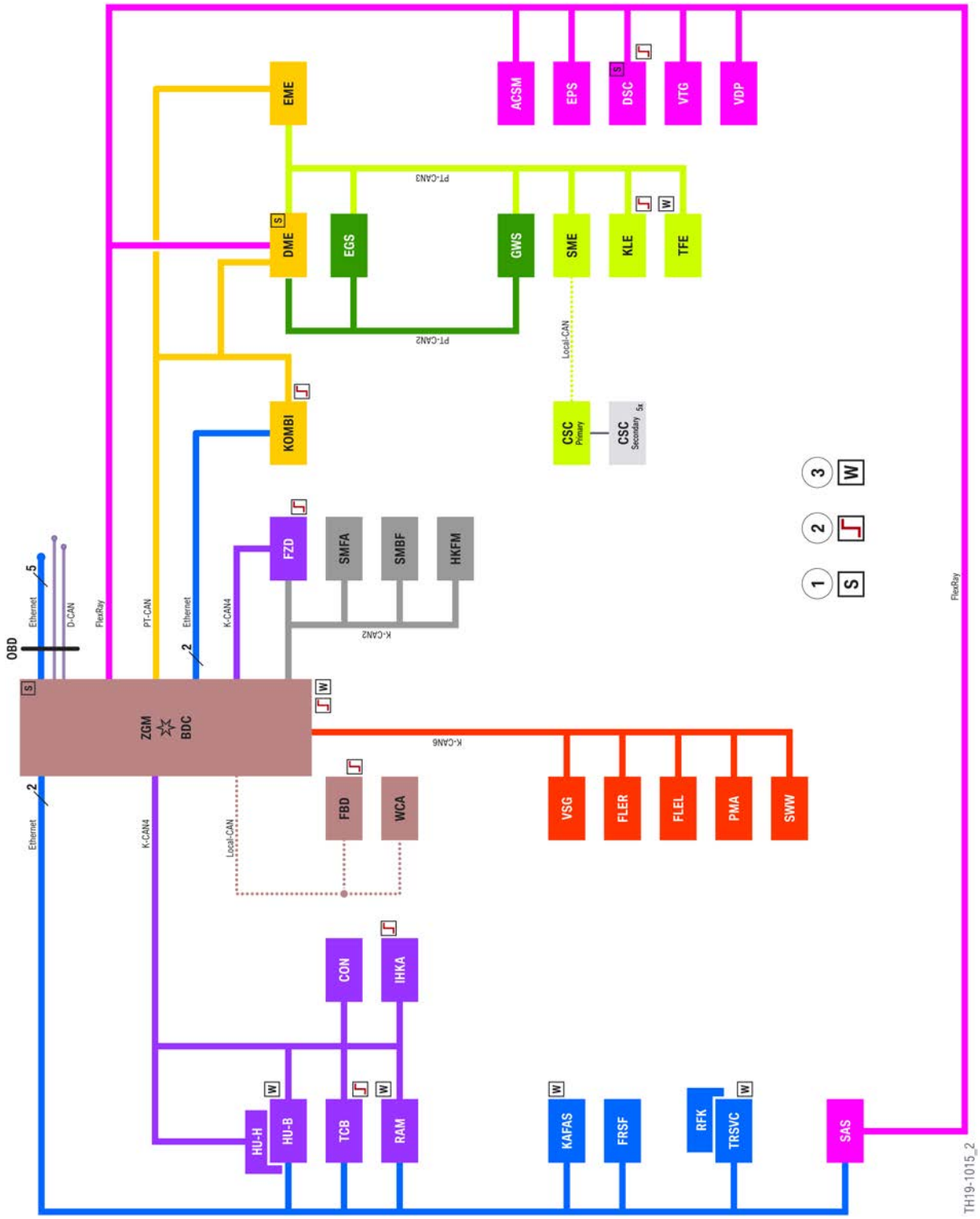
The charger unit for auxiliary battery consists of a control unit and a unidirectional DC/DC converter; it connects the start-up system with the standard vehicle electrical system. The charger unit for auxiliary battery is installed in the luggage compartment.

7.3. Bus overview

The bus systems of the G01 PHEV are based on the bus systems of the G01. All the main and sub-bus systems of the G01 are also used in the G01 PHEV. Compared with the bus systems of the G01, some new control units have been added, deleted or adapted. The resulting bus overview of the G01 PHEV is as follows:

G01 PHEV Complete Vehicle.

7. Low-voltage Electrical System.



G01 PHEV, bus overview

G01 PHEV Complete Vehicle.
7. Low-voltage Electrical System.

Index	Explanation
ACSM	Advanced Crash Safety Module
AHM	Trailer module
BDC	Body Domain Controller
CON	Controller
CSC primary	Primary cell supervision circuit
CSC secondary	Secondary cell supervision circuit
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
EGS	Electronic transmission control
EME	Electrical Machine Electronics
EPS	Electromechanical Power Steering
FBD	Remote control receiver
FLEL	Frontal Light Electronics Left
FLER	Frontal Light Electronics Right
FRSF	Front radar sensor long range
FZD	Roof function center
GWS	Gear selector switch
HU-B	Head Unit Basic
HU-H	Head Unit High
HKFM	Tailgate function module
IHKA	Integrated automatic heating / air conditioning
KAFAS	Camera-based driver assistance systems
KLE	Convenience charging electronics
KOMBI	Instrument panel
PMA	Parking Manoeuvring Assistant
RAM	Receiver Audio Module
RFK	Rear view camera
SAS	Optional equipment system
SME	Battery management electronics
SMBF	Front passenger seat module
SMFA	Driver's seat module
SWW	Lane change warning
TCB	Telematic Communication Box
TFE	Hybrid pressure refueling electronic control unit
TRSVC	Top rear side view camera

Index	Explanation
VDP	Vertical Dynamic Platform
VSG	Vehicle Sound Generator
VTG	Transfer box
WCA	Wireless charging station
ZGM	Central Gateway Module
1	Start-up node control units for starting and synchronizing the FlexRay bus system
2	Control units authorized to perform wake-up function
3	Control units also connected at terminal 15WUP

The following hybrid-specific components are connected via a LIN bus to the listed control units. These LIN bus components are diagnosed via the respective control unit.

Components	Control unit
Electric A/C compressor (EKK)	Integrated automatic heating/air conditioning (IHKA)
Electrical Heating (EH)	Integrated automatic heating/air conditioning (IHKA)
Charger unit for auxiliary battery (BCU)	Digital Motor Electronics (DME)
Intelligent battery sensor for IBS2 auxiliary battery	Electric Machine Electronics (EME)

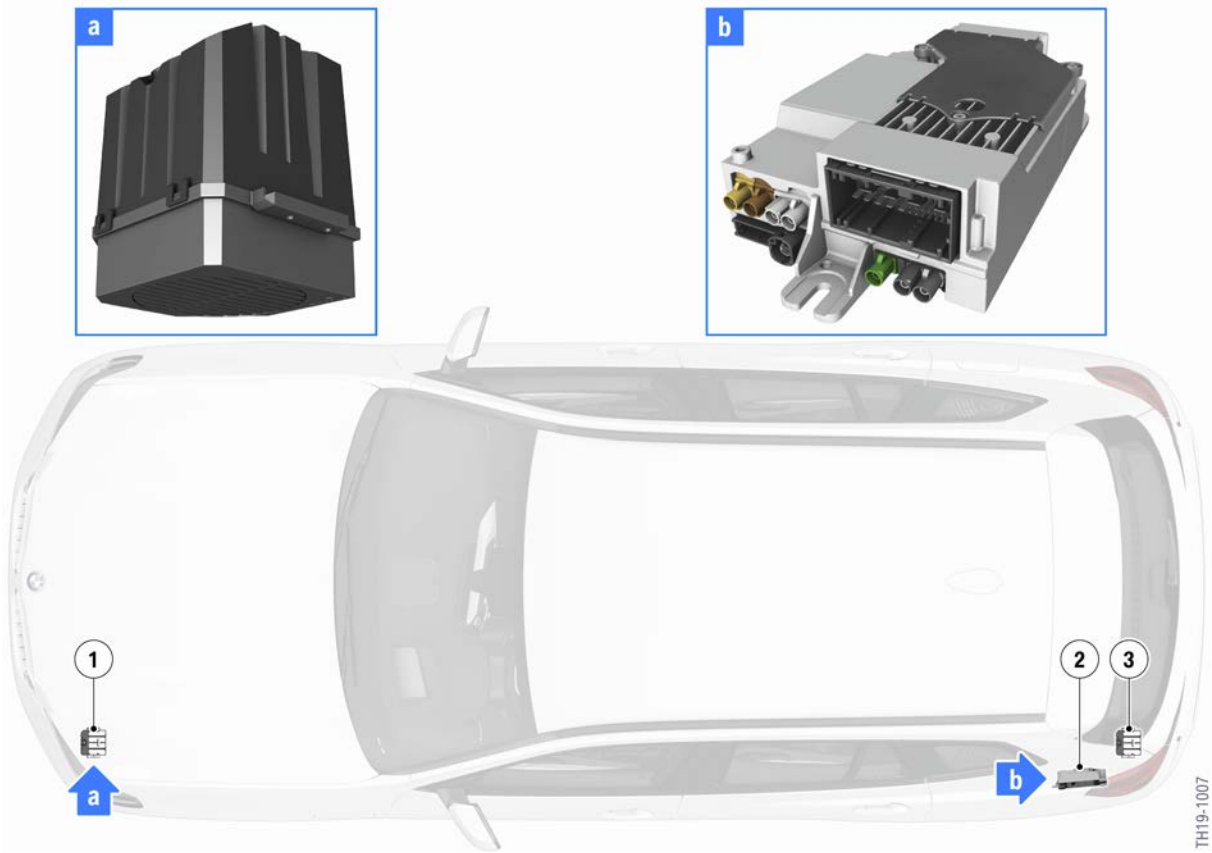
7.4. Vehicle Sound Generator

A Vehicle Sound Generator (VSG) is used in the G01 PHEV. This generates a sound during electric driving in order to alert other road users of the approaching vehicle. This is a legal requirement in many countries.

In conjunction with a receiver audio module (BMW Live Cockpit Professional), the Vehicle Sound Generator is still only an actuator and is activated via the RAM. If there is no RAM installed in the vehicle (BMW Live Cockpit and BMW Live Cockpit Plus), then the VSG is the control unit and actuator in one.

G01 PHEV Complete Vehicle.

7. Low-voltage Electrical System.



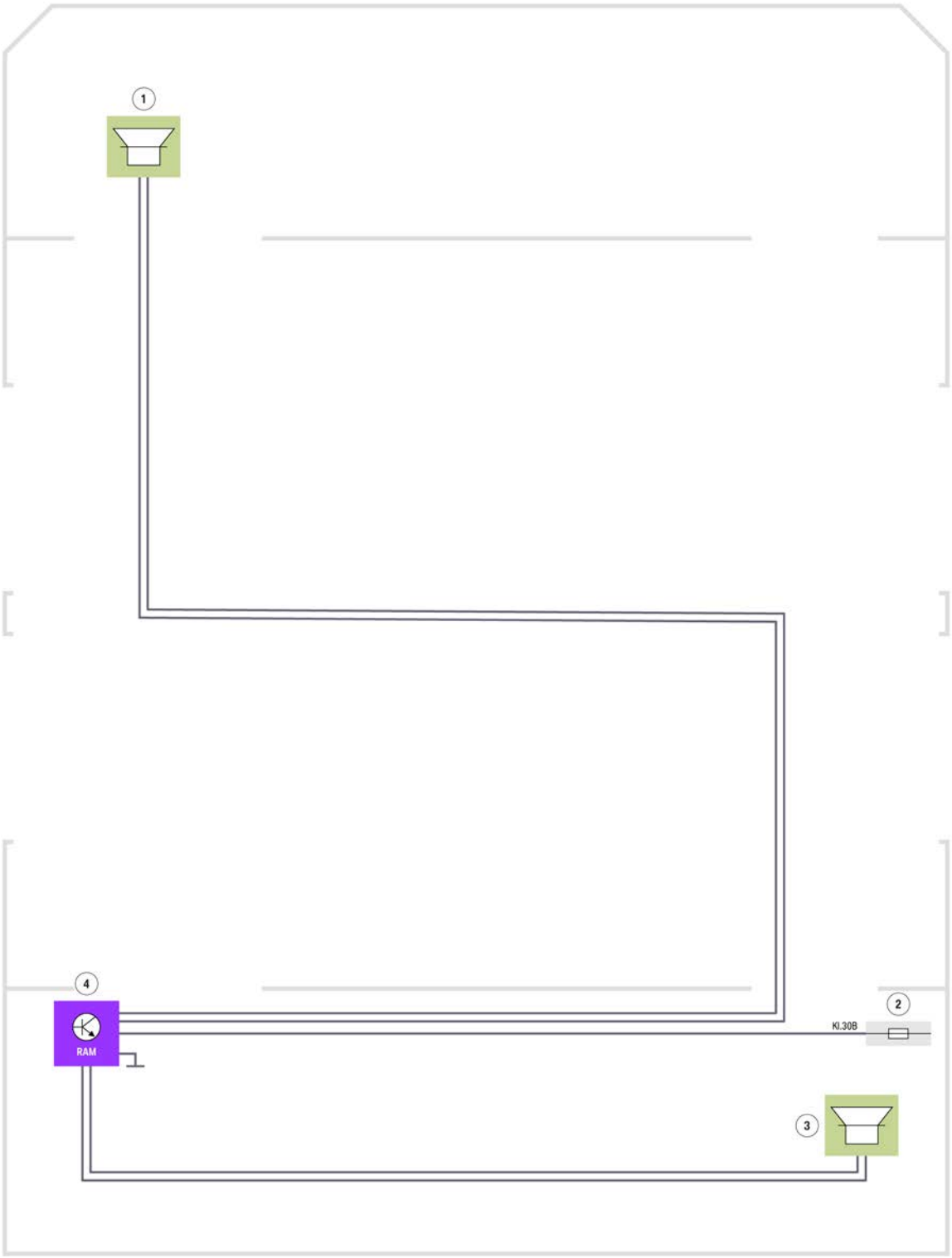
G01 PHEV, Vehicle Sound Generator

Index	Explanation
1	VSG front loudspeaker
2	Receiver Audio Module (RAM)
3	VSG rear loudspeaker

The RAM generates an artificial engine noise via the VSG loudspeaker which increases up to approximately 31 km/h (19 mph) and becomes quieter with increasing speed up to approximately 50 km/h (31 mph). The engine noise is the same when driving forwards and reversing.

G01 PHEV Complete Vehicle.

7. Low-voltage Electrical System.



System wiring diagram for Vehicle Sound Generator

Index	Explanation
1	VSG front loudspeaker
2	Fuse for rear right power distribution box
3	VSG rear loudspeaker
4	Receiver Audio Module (RAM)

Owing to legal requirements, the VSG is prescribed for every vehicle that has a purely electric drive. Deactivation of the function via the iDrive menu is no longer possible.

7.5. Adapted control units

The automatic climate control **IHKA** had to be adapted in order to enable actuation of the electric A/C compressor EKK in all operating conditions. The electric A/C compressor control unit communicates with the IHKA via the LIN bus.

To be able to show additional displays for driving readiness, electric driving, brake energy regeneration and state of charge of the high-voltage battery unit which are relevant to the driver, the instrument cluster **KOMBI** was adapted. In addition, the Check Control messages were enhanced with hybrid-specific messages.

The software of the Digital Motor Electronics **(DME)** was adapted due to the torque coordination of the electrical machine/combustion engine.

Rollover detection is required for the hybrid cars on a worldwide scale so that the high-voltage system is deactivated in the event of the car rolling over. Rollover detection is implemented with the help of the sensors integrated in the Advanced Crash Safety Module **ACSM** (roll rate sensor and vertical acceleration sensor). The ACSM had to be adapted with regard to the evaluation of these sensor signals. The safety battery terminal at the auxiliary battery is activated by the ACSM if required.

The software of the Dynamic Stability Control **DSC** was adapted for the regenerative braking. This includes reading the brake pedal angle sensor which is wired directly to the DSC control unit.

The electronic gearbox control **EGS** was adapted due to the modified transmission. For instance the electric transmission oil pump is controlled by the EGS.

The receiver audio module **RAM** also assumes the actuation of the Vehicle Sound Generator loudspeaker.

G01 PHEV Complete Vehicle.
8. Displays and Controls.

8.1. Drive modes

In the G01 PHEV, the electrical drive system can be configured in the following modes using the eDRIVE button:

- Automatic eDRIVE
- MAX eDRIVE
- BATTERY CONTROL

For this purpose, the eDRIVE button is located in the center console. This button is designed as a toggle button. The three drive modes can be combined with the familiar driving modes SPORT, SPORT PLUS, COMFORT and ECO PRO (including the INDIVIDUAL settings).

G01 PHEV eDRIVE button

Index	Explanation
1	eDrive button

G01 PHEV Complete Vehicle.
8. Displays and Controls.

8.2. Automatic eDRIVE

The AUTO eDRIVE mode is always active at a vehicle restart, except if MAX eDRIVE mode is selected as a standard setting.

In AUTO eDRIVE mode, the vehicle automatically selects the optimum drive combination depending on the state of charge of the high-voltage battery unit. In the instrument cluster, the driver is provided with a visual acknowledgement about the level of requested power.

If the driver's power request exceeds the maximum available electrical power, the combustion engine is activated automatically and comfortably. A maximum speed of 110 km/h (68 mph) is possible.

Outside this efficiency-optimized eDRIVE range, the combustion engine is automatically started in case of high load and speed demands.

G01 PHEV AUTO eDRIVE

8.3. MAX eDRIVE

When MAX eDRIVE mode is selected via the eDRIVE button, and if the high-voltage battery unit is charged and/or if a sufficient state of charge exists, the driver can optionally drive without emissions with the maximum power of the electric drive.

A prerequisite for this is that the gear selector switch is not in the manual/Sport program position. The maximum electrical speed in this case is 135 km/h (84 mph). The electrical power can be controlled very conveniently and easily via the accelerator pedal so that the combustion engine is not switched on unintentionally. MAX eDRIVE mode is indicated in the instrument cluster by displaying the “MAX eDRIVE” inscription.

It is still possible to turn on the combustion engine and use the complete system power. The activation of the combustion engine can be called up at any time by changing the gear selector switch to the S position or by pressing the accelerator pedal in fully (kickdown). In the process, AUTO eDRIVE mode is automatically activated.

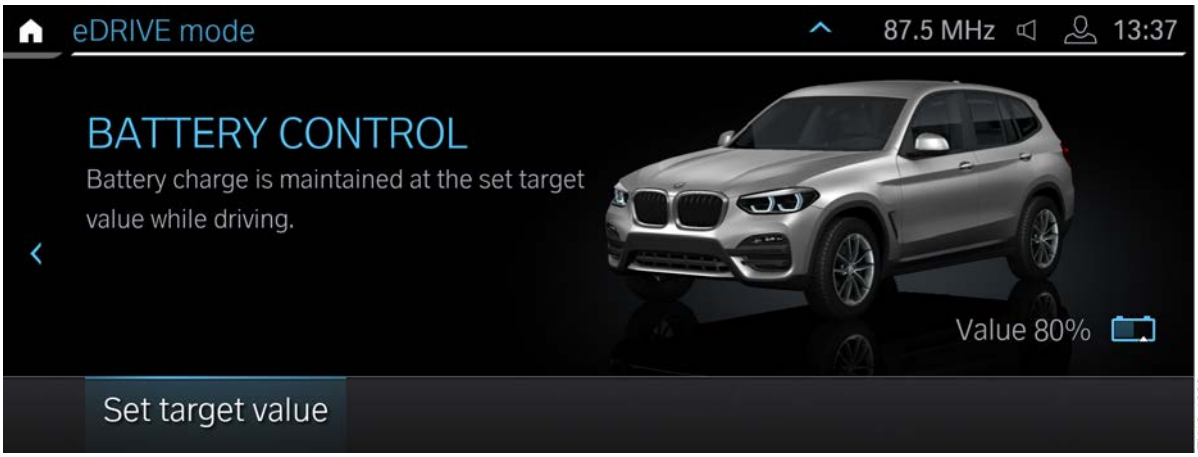
The electric range that can be attained is heavily dependent on the driving style (acceleration and speed), the route profile, as well as the active auxiliary consumers (heating or air conditioning system).

If the vehicle is driven after a long immobilization period, at very cold ambient temperatures and in MAX eDRIVE mode, this may result in a power reduction of the electrical drive or it may not be available at all. A reason for this may be an excessively low cell temperature in the cell modules of the high-voltage battery unit.

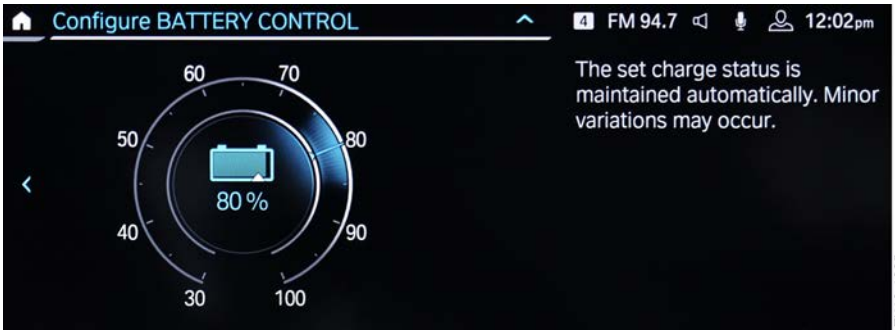
G01 PHEV MAX eDrive

8.4. BATTERY CONTROL

The eDRIVE button is also used to select BATTERY CONTROL mode. In this mode, the energy of the high-voltage battery unit is saved for later electric driving so that sufficient energy is available for subsequent urban driving. The driver can set the state of charge of the high-voltage battery within a range of 30% to 100%.



G01 PHEV BATTERY CONTROL



G01 PHEV, BATTERY CONTROL setting

8.5. SPORT driving mode

In the SPORT driving mode, a sporty engine and suspension setting provides an assured and dynamic driving experience.

The SPORT driving mode is available with 3 attributes:

- STANDARD
- SPORT PLUS
- INDIVIDUAL

In SPORT and SPORT PLUS mode, as well as if the gear selector switch is in the S position, the energy required for a boost is in the high-voltage battery unit.

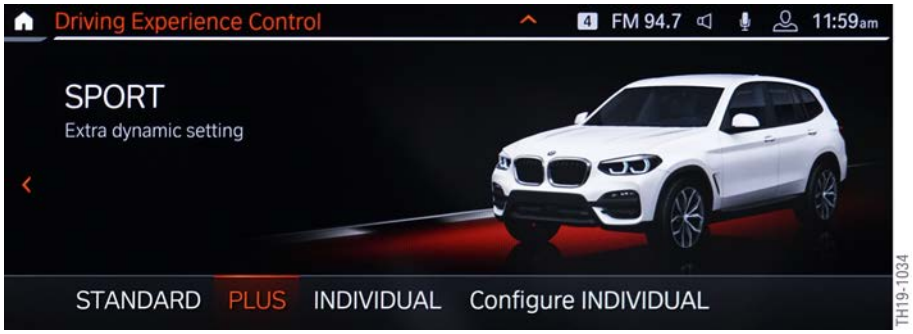
8.5.1. STANDARD

In SPORT driving mode the combustion engine is always on during the journey or under load as soon as the driving mode is activated.

8.5.2. SPORT PLUS

In SPORT PLUS mode the electrical machine supports the combustion engine with up to 80 kW. Then the electrical machine's output is limited to its continuous output.

A sportier setting of the drive acoustics in the vehicle interior is also provided by the Active Sound Design (ASD).



G01 PHEV SPORT PLUS

8.5.3. INDIVIDUAL

SPORT driving mode can be customized. The following ranges of adjustment are used:

- Damping action
- Steering
- Engine
- Gearbox

8.6. Displays in the instrument cluster

8.6.1. Operating conditions

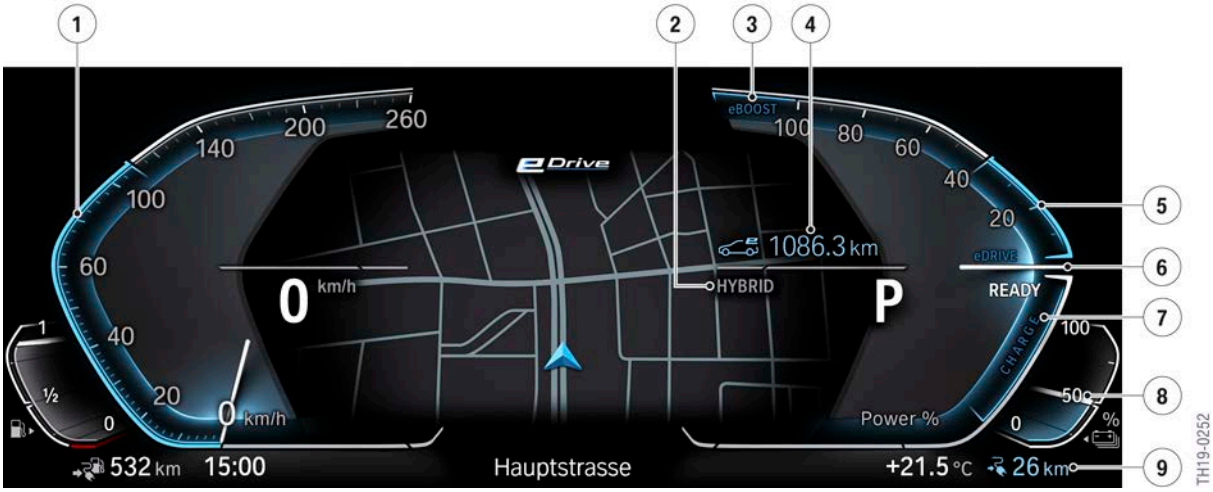
The hybrid-specific operating states and the state of charge of the high-voltage battery are displayed in the instrument cluster (KOMBI) and, if desired, in the Central Information Display (CID).

Depending on the equipment, the G01 PHEV has 2 different instrument clusters. The multifunctional instrument display is presented in this product information.

The displays shown below may appear, depending on the driving situation and driving mode.

G01 PHEV Complete Vehicle.

8. Displays and Controls.



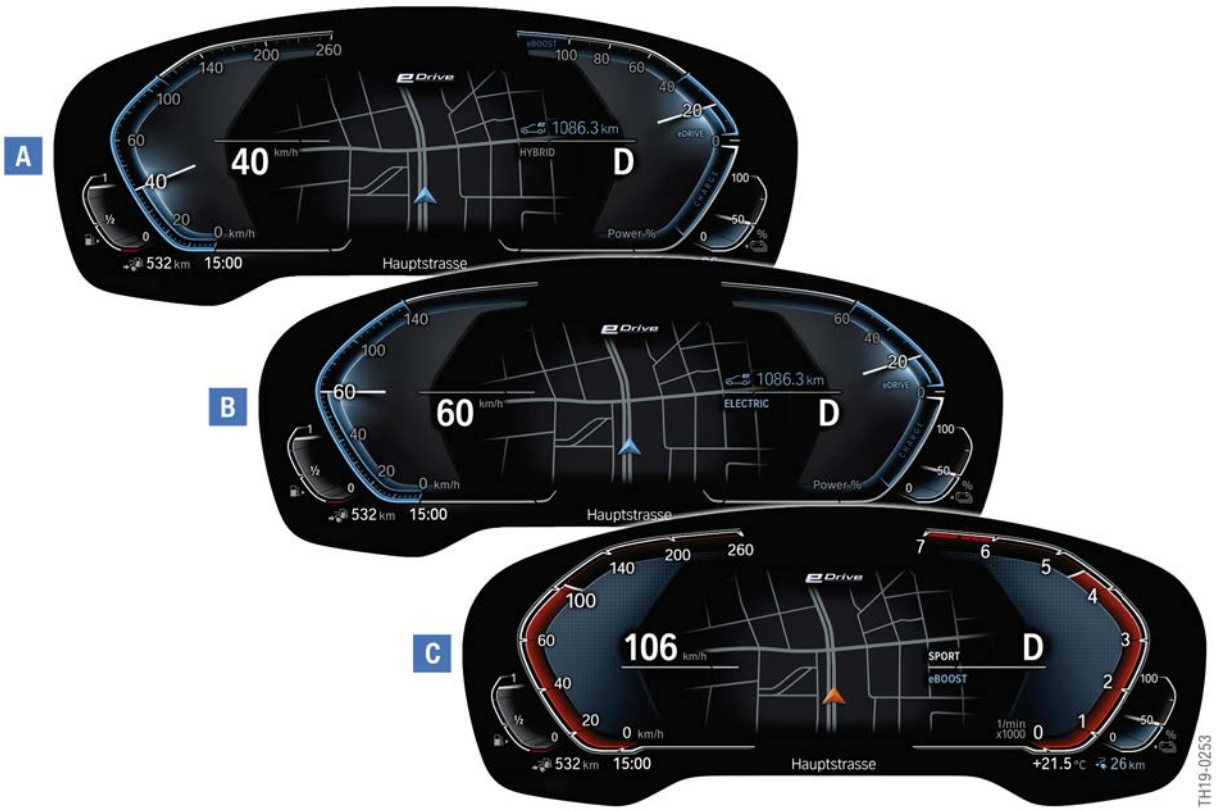
G01 PHEV hybrid-specific instrument cluster

Index	Explanation
1	All-electric driving is possible within this speed range. In MAX eDRIVE driving mode, the range is extended up to 135 km/h (83 mph).
2	Display of the driving mode
3	eBoost: the needle is in the eBoost range during powerful acceleration.
4	All-electric driving distance travelled
5	Load range: All-electric driving is possible within this range.
6	READY: Driving readiness established
7	CHARGE: The needle shows the energy recovery as a function of the deceleration or brake pedal actuation intensity.
8	Charge state of the high-voltage battery with new battery symbol complying with standard
9	Remaining electric range

G01 PHEV Complete Vehicle.
8. Displays and Controls.

8.6.2. Modes

The following graphic shows the instrument cluster (KOMBI) in the various modes:



G01 PHEV, driving modes in the instrument cluster

Index	Explanation
A	Automatic eDRIVE
B	MAX eDrive
C	SPORT

G01 PHEV Complete Vehicle.
8. Displays and Controls.

8.7. Displays in central information display

The familiar hybrid-specific displays are used:

- Trip data (previously eDrive use)
- Energy and power flow display
- Adaptation to stretch of road
- Driving style analysis

The representation of the driving style analysis has been revised. In this way, it helps to develop a particularly efficient driving style and to save fuel and/or electrical energy. The function is only available in the ECO PRO driving mode. The efficiency is visualized in the shape of a triangle with the anticipation featured on the left and the acceleration behavior on the right.

G01 PHEV, display of driving style analysis

The more efficient the driving style, the more bars are displayed in color and the higher the number of points displayed. In the case of an inefficient driving style, on the other hand, a reduced number of bars and a lower number are displayed.

G01 PHEV Complete Vehicle.
8. Displays and Controls.

8.8. Hybrid-specific Check Control messages

If faults occur in the G01 PHEV, the driver is informed thereof via Check Control messages.
The following table summarizes the key hybrid-specific Check Control messages:

Check Control message	Meaning	Cause
	Check charging cable.	Charging cable signal is faulty. Connected charging plug cannot be detected. The driver should check whether the connector is still connected before driving off.
	Acoustic pedestrian protection failed.	Internal fault in the VSG or fault with another control unit, which leads to the failure of the CAN communication.
	Isolation fault, fault in the high-voltage interlock loop.	High-voltage battery high-voltage system fault. After stopping the engine, may be no longer possible to continue journey. Please look for next BMW Service without delay.
	High-voltage system shut down.	High-voltage system is shut down and in de-energized state for maintenance, service and repairs. High-voltage safety connector (Service Disconnect) removed, circuit of high-voltage interlock loop interrupted.
	Risk of fire	Temperature in the high-voltage battery too high.

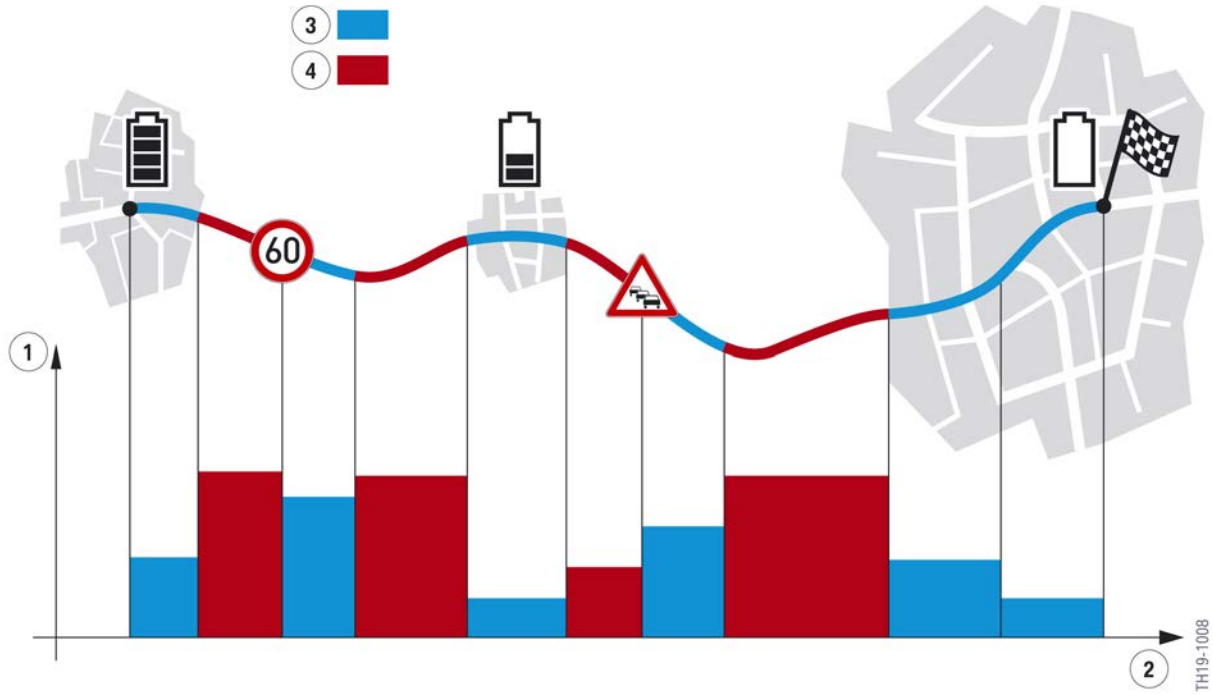
G01 PHEV Complete Vehicle.

9. Operating Strategy.

9.1. Anticipatory hybrid drive

Here, with active route guidance by the navigation system the route is analyzed and the operating strategy adapted to the stretch of road. The navigation and traffic data of the individual distances permit a calculation of the power required to cover these distances.

Based on these power forecasts and the state of charge of the high-voltage battery unit, a decision is made on whether the combustion engine or the electric motor is used for this distance. The aim is to reserve the electrical energy for the destination zone, the urban environment and further stretches in which the vehicle is driven at a lower speed. If necessary, the high-voltage battery must be actively charged beforehand (load point increase) for this purpose.



Anticipatory hybrid drive

Index	Explanation
1	Power forecast for the respective distance
2	Distance travelled
3	Use of the electric motor
4	Use of the combustion engine

Anticipatory use of the electrical energy can reduce consumption and also enhance the experience of electric driving for the driver. The combustion engine is stored where the driver expects and also senses it (at low speeds with a low noise level, e.g. in towns).

G01 PHEV Complete Vehicle.

9. Operating Strategy.

The following requirements must be fulfilled for the function of the anticipatory hybrid drive:

- Route guidance activated in the navigation system
- AUTO eDrive driving mode used
- COMFORT or ECO PRO mode activated

The anticipatory hybrid drive is not available in the MAX eDrive driving mode and when BATTERY CONTROL is used. In SPORT driving mode or manual Sport driving mode, the anticipatory hybrid drive is also not available as the combustion engine is permanently active.

A corresponding message is shown in the central information display upon the occurrence of a corresponding situation or in preparation for such a situation.

G01 PHEV Complete Vehicle.

10. Climate Control.

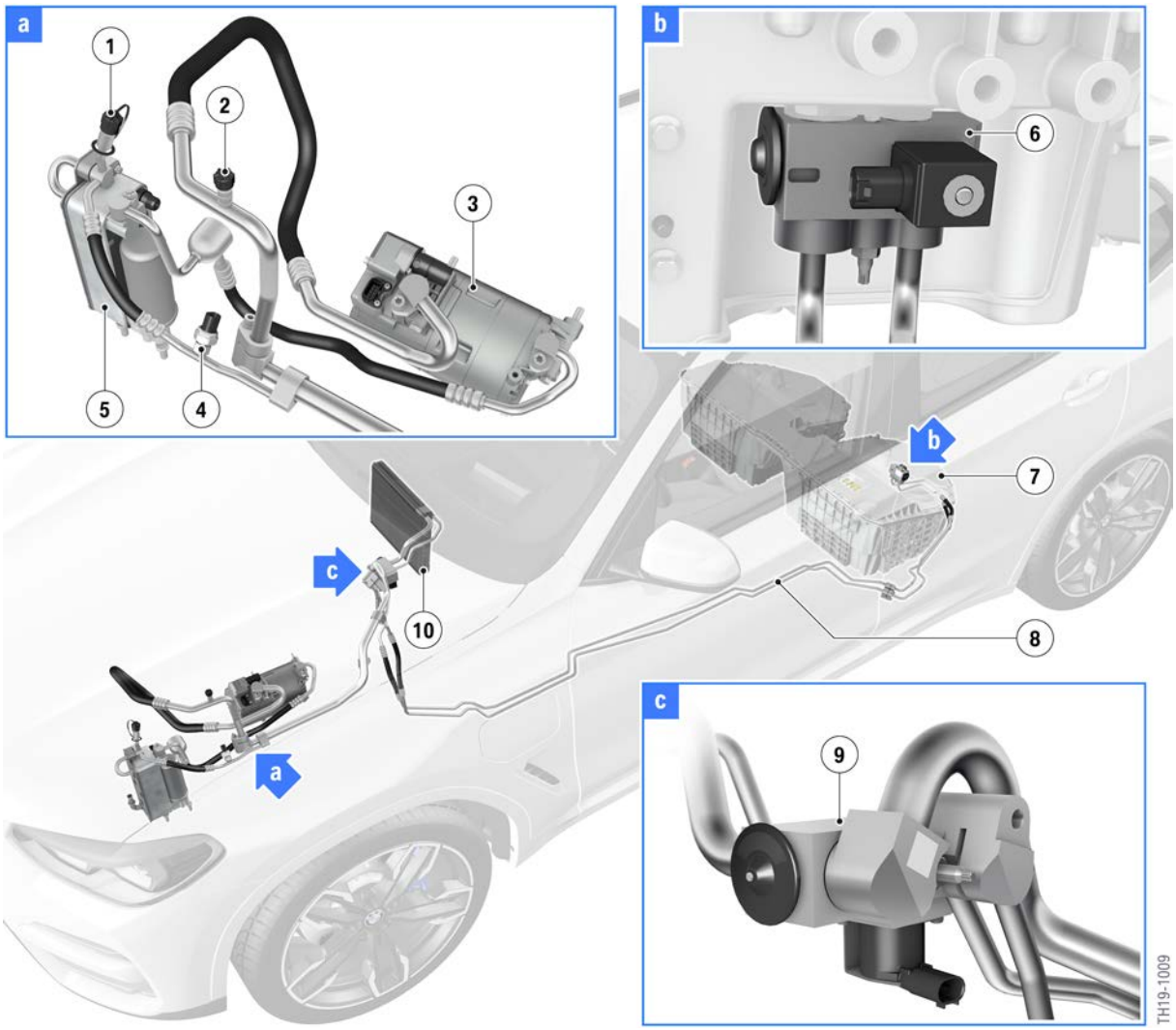
As in previous BMW hybrid vehicles, an electrically powered air conditioning compressor is used in the G01 PHEV. Because the A/C compressor has an electric motor, it is possible to operate the air conditioning independently of the combustion engine. Thus the driver can enjoy the cooling effect of the air conditioning system even while driving in pure electric mode and while stopped.

The high-voltage battery unit is cooled by the vehicle's refrigerant circuit.

Stationary air conditioning is also offered in the G01 PHEV.

10.1. System overview

10.1.1. Installation location of components

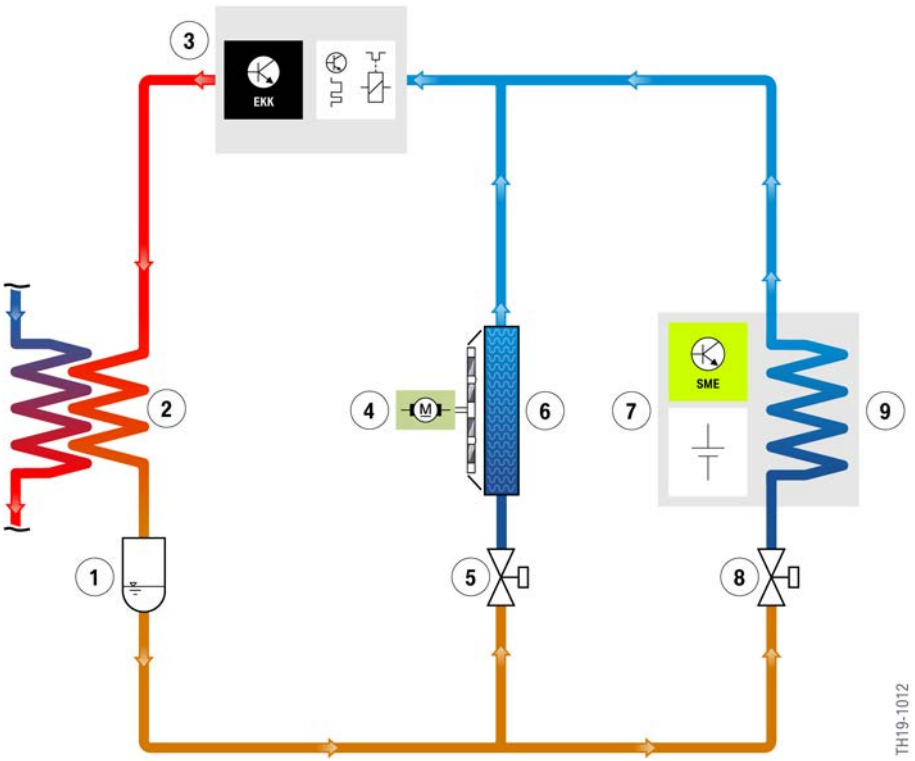


G01 PHEV, components of refrigerant circuit

G01 PHEV Complete Vehicle.
10. Climate Control.

Index	Explanation
1	Low-pressure connection (for drawing off, evacuating and filling)
2	High-pressure connection (for drawing off, evacuating and filling)
3	Electric A/C compressor (EKK)
4	Refrigerant pressure sensor
5	Coolant-based air conditioning condenser (coolant-refrigerant-heat exchanger)
6	Combined expansion and shutoff valve (high-voltage battery unit)
7	High-voltage battery unit
8	Refrigerant lines to high-voltage battery unit
9	Combined expansion and shutoff valve (interior)
10	Evaporator (vehicle interior)

10.1.2. Schematic diagram



System overview of climate control

G01 PHEV Complete Vehicle.
10. Climate Control.

Index	Explanation
1	Receiver dryer
2	Coolant-based air conditioning condenser (coolant-refrigerant-heat exchanger)
3	Electric A/C compressor (EKK)
4	Blower for passenger compartment
5	Combined expansion and shutoff valve, passenger compartment
6	Evaporator, passenger compartment
7	High-voltage battery unit
8	Combined expansion and shutoff valve, high-voltage battery unit
9	Heat exchanger

The request whether and if yes how much cooling power is required is measured and determined by the integrated automatic climate control IHKA. On the one hand, the request can come directly from the driver to cool the vehicle interior. On the other hand, the battery management electronics SME can send a request for the high-voltage battery unit to be cooled as a data bus message to the IHKA. The IHKA coordinates these cooling requirements and activates the electric A/C compressor via the LIN bus.

G01 PHEV Complete Vehicle.

11. Electrical Heating.

11.1. Overview

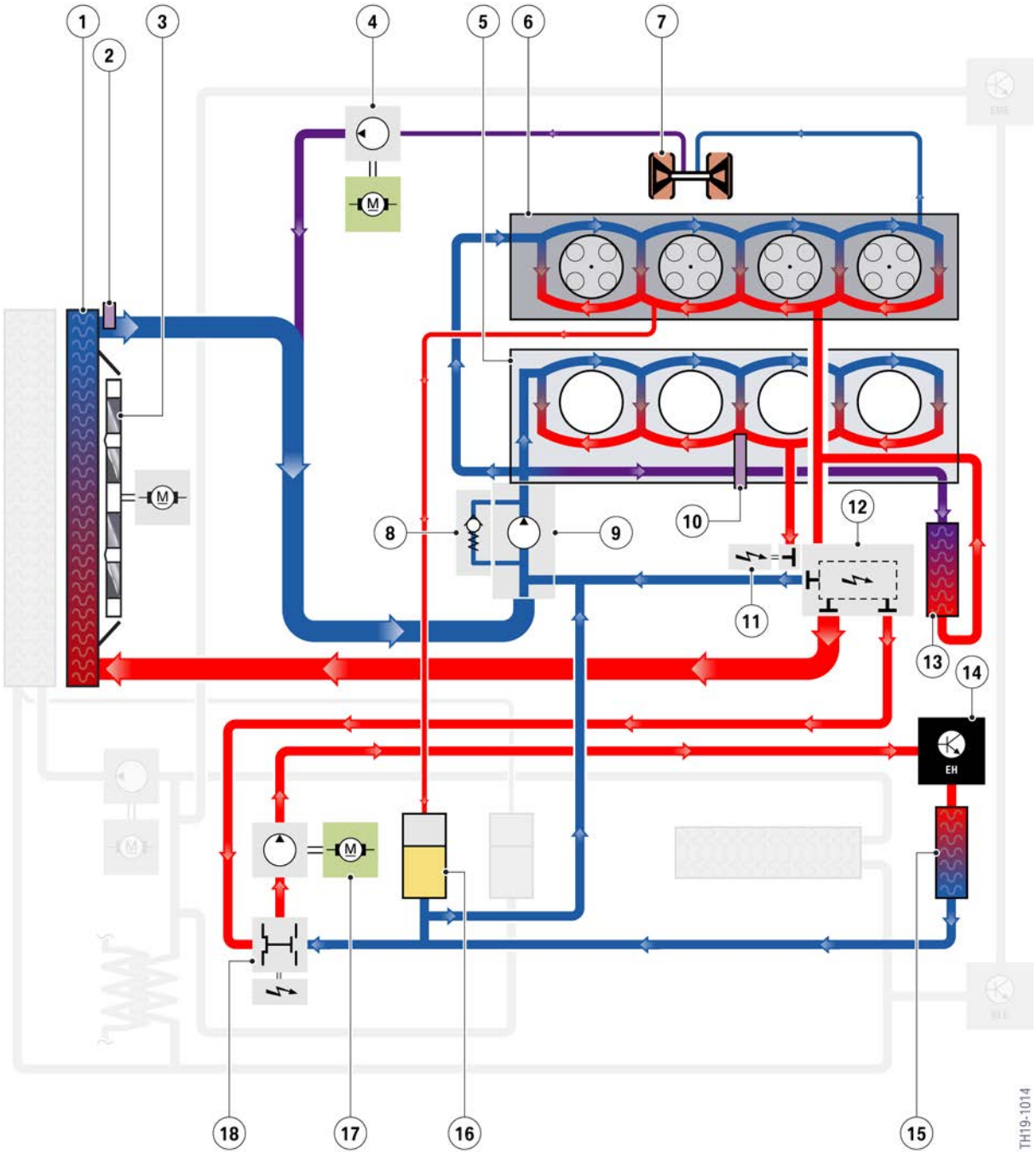
The heat exchanger for the heating system of the G01 PHEV is integrated in the coolant circuit of the combustion engine and electrical machine. With corresponding heating up by the combustion engine a sufficient heater output for heating the passenger compartment can be achieved. Due to its hybrid concept, the combustion engine of the G01 PHEV generates significantly less heat loss in many driving situations and is not able to heat the coolant circuit to the necessary temperature. This is why the G01 PHEV has electrical heating. In principle, this functions similar to an instantaneous water heater. Via a changeover valve a separate heater circuit can be formed, which is kept in circulation by an electric coolant pump.

The electrical heating is a high-voltage component!

Only Service employees who satisfy all the prerequisites are permitted to work on the designated high-voltage components: suitable qualifications, compliance with the safety rules, procedure following the exact repair instructions.

G01 PHEV Complete Vehicle.

11. Electrical Heating.



G01 PHEV, heater circuit in the coolant circuit

Index	Explanation
1	Radiator (coolant-to-air heat exchanger)
2	Coolant temperature sensor
3	Electric fan
4	Electric coolant pump

G01 PHEV Complete Vehicle.
11. Electrical Heating.

Index	Explanation
5	Crankcase
6	Cylinder head
7	Exhaust turbocharger
8	Pressure relief valve
9	Coolant pump
10	Coolant temperature sensor
11	Electric split cooling valve
12	Heat management module
13	Engine oil/coolant heat exchanger
14	Electrical Heating (EH)
15	Heat exchanger for heating system
16	Expansion tank
17	Electric coolant pump (heater circuit)
18	Electrical changeover valve

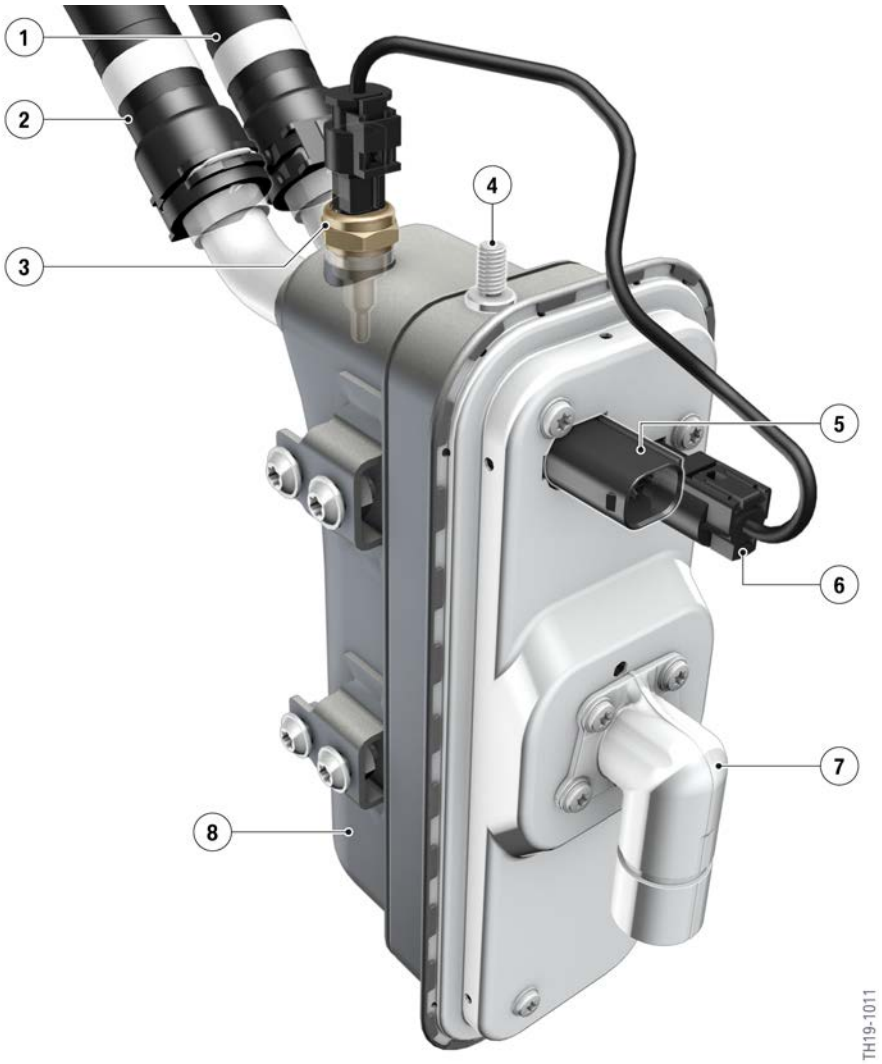
11.2. Installation locations and connections

G01 PHEV, heater circuit

G01 PHEV Complete Vehicle.
11. Electrical Heating.

Index	Explanation
1	Electrical changeover valve
2	Connection to the coolant circuit
3	Heat exchanger for heating system
4	Electrical heating
5	Electric coolant pump

11.3. Electrical heating



Connections at the electric heating

G01 PHEV Complete Vehicle.
11. Electrical Heating.

Index	Explanation
1	Coolant line
2	Coolant line
3	Coolant temperature sensor
4	Equipotential bonding line connection
5	Signal connector (low-voltage connector)
6	Coolant temperature sensor connection
7	High-voltage connector connection
8	Housing

Bayerische Motorenwerke Aktiengesellschaft
Händlerqualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany