Integrated automatic heating/air-conditioning system (IHKA), Basic and High

E60, E61, E63, E64

Introduction

The integrated automatic heating/air conditioning system (IHKA) is available in the versions Basic and High (special equipment option 534).

- **E60 and E61**

  Standard equipment: IHKA Basic (IHKA High on 545i)

- **E63 and E64**

  Standard equipment: IHKA High

The automatic air-conditioning system High generates a very high level of climatic comfort with separate adjustment for the driver's side and for the front-passenger side. [System overview ...]

New features of the IHKA:

- An **electric auxiliary heater** working on the PTC principle (positive temperature coefficient) is installed on vehicles with diesel engines

  The electric auxiliary heater is a component of the heat exchanger for the heating system. Electric heating elements made of aluminium have been added to the plates in the coolant flow of the heating system heat exchanger. The air drawn in is directly heated by these heating elements and fed into the vehicle interior through the air vents. In principle, the electric auxiliary heater works like an electric fan heater.

- **Condensation sensor**

  The condensation sensor detects an imminent misting up of the windscreen, before condensation actually forms. To prevent the windows from misting over, the IHKA control unit starts to work through a table of measures as soon as a certain level of

humidity is detected at the windscreen.

- **LIN bus (Local Interconnect Network bus)**

  The LIN bus serves to actuate flap motors, the electric auxiliary heater and the blower motor in the heating/air-conditioning system.

- **Convertible program (E64 only)**

  When the convertible top is opened and the air-conditioning system is in automatic mode, the convertible program is automatically activated.

  The convertible program adapts the air-conditioner settings (blower, airflow, temperature) to the conditions created by the open top. The settings do not have to be changed when the top is opened or closed.

  The convertible program is stored in the IHKA control unit.

Differences between IHKA Basic and IHKA High:

	Basic	**High**
Solar sensor	---	1
Condensation sensor	---	1
AUC sensor	---	1
Sensor for heating system heat exchanger	1	2
Ventilation temperature sensor	---	1
Rear compartment flap motor (air stratification)	---	1
Ventilation flap motor	1	2
Footwell flap motor	1	2

Differences/modifications from E39:

- New IHKA controls with additional functions: OFF button, temperature and airflow are set with rotary switches. On the IHKA Basic, the manual air distribution is set with the IHKA controls. On the IHKA High, the manual air distribution is set with the controller on the CID (Central Information Display) .
- Revised display concept
  The scale on the rotary switch for the blower setting has a 9-element LED display. The manual blower speed setting is shown by the corresponding LEDs lighting up. In automatic mode, the display remains off (IHKA High only).
  The LCD display from earlier versions has been discontinued. Additional air-conditioning functions such as air stratification or independent heater (option 536) are selected and activated in the Central Information Display (CID) using the controller.
- The flap drives are only operated by flap motors.
- Separate left/right-hand footwell flaps, (IHKA High only)
- Separate ventilation flaps, (IHKA High only)
- Intake fan arrangement in the heating/air-conditioning system
  The fan is located after the evaporator.
- On vehicles with diesel engine, a heating system heat exchanger is installed with integrated electric auxiliary heater. The same heating system heat exchanger is used for both Basic and High versions.
- Clutchless, externally actuated a/c compressor with regulated performance
- Sensor for automatic air-recirculation control (AUC sensor, IHKA High only)
- Solar sensor for taking external light/heat sources into account, which could affect the air conditioning in the vehicle interior (IHKA High only).

Benefits of system:

- The efficiency and functionality of the IHKA has been improved compared to the predecessor model. Despite this, the size is

some 1/3 smaller than on the E39.

- The electric auxiliary heater accelerates the heating of the vehicle interior, especially at low ambient temperatures and during the cold-start phase. This clears the windows of condensation more quickly.
- The condensation sensor automatically prevents/eliminates condensation on the inside of the windscreen, before it becomes visible.
- The variable evaporator control extracts less humidity from the air. This reduces the risk of mucous membranes drying out.

Brief description of components

Sensors:

- **Interior temperature sensor**
  The force-ventilated sensor with interior temperature sensor fan is fitted in the IHKA controls. The sensor measures the temperature of the air drawn in from the vehicle interior by the integrated interior temperature sensor blower.
- **Solar sensor (IHKA High only)**

  The solar sensor is located in the middle of the dashboard. (The installation position of the solar sensor in the E63/E64 has been turned through 180°.) This sensor is only active in automatic mode. The solar sensor takes external sources of light or heat (e.g. direct sunlight) into account, which could affect the air conditioning of the vehicle interior.
  The sensor consists of 2 photoresistors. The sensor supplies the IHKA control unit with analogue signals for the driver's and front-passenger sides. The signal depends on the intensity of sunlight.
- **Sensor for automatic air-recirculation control (IHKA High only)**
  The AUC sensor is installed at the top of the fan cowl. The sensor is exposed to the sideways downwind from the auxiliary fan. The AUC sensor detects the following pollutant emissions from spark-ignition and diesel engines:
  - Hydrocarbons (HC)
  - Carbon monoxide (CO)
  - Nitric oxides (nitrogen monoxide NO, nitrogen dioxide NO_2)
- **Condensation sensor (IHKA High only)**
  The sensor is located under the rain/light sensor. In IHKA automatic mode, the sensor measures the humidity in the vehicle interior and on the inside of the windscreen. The sensor detects an imminent misting up of the windscreen, before condensation actually forms. The condensation sensor is not active in the convertible program.

  [more ...]
- **Heating system heat exchanger sensor**
  The sensor is integrated in the heating/air-conditioning system. On the IHKA Basic, the sensor measures the delivery temperature on the driver's side, directly on the delivery side of the heating system heat exchanger. On the IHKA High, 2 sensors are installed as the delivery temperatures are measured separately at the heating system heat exchanger for the driver's side and for the front-passenger side.
- **Evaporator temperature sensor**
  The sensor measures the outlet temperature of the refrigerant at the evaporator to prevent icing from occurring.
- **Ventilation temperature sensor (IHKA High only)**
  A sensor is integrated in the air duct to measure the ventilation temperatures. This sensor measures the delivery temperature directly in the middle of the ventilation grille.
- **Refrigerant pressure sensor**
  This sensor is located in the pressure line between the condenser and the evaporator. Depending on the sensor signal, the A/C compressor is switched off by the IHKA control unit in the event of excessively high system pressure.

Control unit:

- **IHKA controls / control unit**

  The IHKA controls and the IHKA control unit are united in a single component. The Basic and High versions have different IHKA controls. [more ...]

Actuators:

- **Electric auxiliary heater**

  The heating elements of the electric auxiliary heater are integrated into the heating system heat exchanger and directly heat the air drawn in to control the temperature of the air inside the vehicle. [more ...]

- **Flap motors**

  On the IHKA Basic, 6 flap motors control the ventilation flaps. The IHKA High has 9 flap motors due to the left/right separation for the driver's side and the front-passenger side and because of the additional rear compartment flap. [more ...]

- **Blower with blower regulator**

  The blower generates the necessary airflow. The blower is installed after the evaporator in the heating/air-conditioning system (suction fan) and is equipped with 2 blower wheels.
  The blower regulator is fitted directly on the blower motor housing. The blower regulator is capable of self-diagnosis. The blower regulator is actuated by the IHKA control unit (via the LIN bus). The blower regulator controls the blower motor with a pulse-modulated signal (PWM signal).

- **A/C compressor**

  The A/C compressor compresses the refrigerant drawn in from the evaporator and presses it to the condenser. The A/C compressor used is clutch-free. That means that the A/C compressor always runs with the engine. A swash plate in the A/C compressor allows the output to be smoothly regulated. To reduce load, only the cooling output actually needed is generated. [more ...]

- **Evaporator**

  The evaporator plates are cooled by the refrigerant that has been evaporated inside the evaporator. The airflow generated by the blower is fed over the cooled evaporator plates. The air is cooled and dried and fed into the vehicle.

- **Auxiliary water pump**

  The auxiliary water pump serves to make sure that the coolant flow rate needed in the heater circuit is maintained, even at low engine speeds.
  On vehicles with diesel engine and independent heating (option 536), there is no auxiliary water pump in the engine compartment. Its job is assumed by the independent heater's auxiliary water pump and is controlled by the independent heating control unit.

- **Water valve**

  The water valve works electromagnetically and meters the coolant flow rate to the heating system heat exchanger as it is needed. This determines the temperature of the air used for heating the vehicle interior.
  On the IHKA High, a dual water valve is used for the left/right separation of the heating system heat exchanger.

- **Switchover valve**

  The switchover valve is only installed if the vehicle is equipped with independent heating (option 536).
  The switchover valve regulates the inlet to the independent heating as follows:

  - From the radiator and the auxiliary water pump

  or

  - From the return flow from the heating system heat exchanger

  The switchover valve is actuated by the independent heating control unit.

- **Auxiliary fan**

  The auxiliary fan is standard on all vehicles with IHKA. Besides the engine cooling, the auxiliary fan is also needed for cooling the condensers. [more ...]

- **Condenser with integrated drier flask**

  Refrigerant is converted from gas into liquid in the condenser. Any water that may be present in the refrigerant circuit is collected in the integrated drier flask, which is installed downstream of the condenser. The drier element can be exchanged.

- **Expansion valve**

The expansion valve is directly on the evaporator in the heating/air-conditioning system. The valve regulates the injection rate in the evaporator. Only as much liquid refrigerant is permitted to enter the evaporator as the evaporator is able to completely evaporate. Drops of liquid that have not been evaporated could cause damage in the A/C compressor.

Additional components:

- **Microfilter**

  On the IHKA Basic, fresh air for interior ventilation is fed through a system of microfilters. On the IHKA High, a microfilter with activated carbon is fitted. The activated-charcoal filter helps to provide additional purification of the incoming air from gaseous pollutant emissions. When a filter replacement is needed, this will be indicated by the Condition Based Service (CBS) display.

- **Rear air-stratification flap potentiometer (IHKA High only)**

  The selected potentiometer setting is transposed into the rear compartment flap motor position.

- **LIN bus**

  The IHKA control unit controls the following components via the LIN bus:

  - Electric auxiliary heater
  - Flap motors
  - Blower with blower regulator

- **Control and display functions via controller and Central Information Display**

  The following control and display functions are selected and activated on the CID (Central Information Display) with the controller (move controller to left in start menu):

  - Temperature control (IHKA Basic)

    The temperature for the driver's and front-passenger sides are centrally set on the IHKA controls. The temperature can be increased or decreased from this central setting using 3 selectable settings (warmer, neutral, colder).

  - Temperature control (IHKA High)

    The temperature can be increased or decreased separately on the driver's side and front-passenger side in 4 increments.

  - Independent heater (optional)

    Select between direct operation and programming with timer.

  - Independent ventilation (IHKA High only)

    Select between direct operation and programming with timer.

  - Air distribution (IHKA High only)

    The airflow for the driver's and front-passenger sides are centrally set on the IHKA controls. Deviating from these central setting, the airflow can be adjusted separately for the footwell and upper body (driver's and front-passenger sides). The driver-side setting applies for both sides in the area of the windscreen.

    >E64

    When the convertible program is active, air distribution is switched to the upper body and head. Airflow to the footwell is throttled.

  - A/C program

    The A/C program is called up as follows:

    1. Press the controller in the start menu (5. menu)
    2. Select "Vehicle settings" and press controller.
    3. Select "A/C settings" and press controller.
    4. The following settings are available in the menu level "automatic program":

- gentle
- medium
- intensive
- convertible program (selection only possible when convertible top is open)

The selection of gentle, medium and intensive is not possible when the convertible program is active.
When the convertible program is deactivated, the air-conditioning system acts as if the convertible top were closed (selection of gentle, medium and intensive is again possible).

The following control unit is also active in the IHKA:

- **Convertible top module (E64 only)**

  The convertible top module (CVM) provides the IHKA control unit with the signal whether the convertible top is open or closed.
  The convertible top module is connected to the K-CAN.
  The convertible top module is installed under the rear left side trim.

System functions

The IHKA comprises the flowing functions:

- Temperature control
- Evaporator control
- Air distribution setting
- Airflow control
- Sunlight adaptation (solar sensor, IHKA High only)
- MAX cooling (IHKA High only)
- Maximum heating
- Residual heat (IHKA High only)
- Defrost function (IHKA High only)
- Heated rear window
- Heated washer jets
- OFF
- Air recirculation mode
- Automatic air recirculation
- Automatic air-recirculation control (IHKA High)
- Program for avoiding condensation on the window surfaces (IHKA High only)
- Convertible program (E64 only)
- Independent ventilation function (IHKA High only)
- Independent heater (option 536)

Temperature control

In the heating/air-conditioning system, the air-mass flow is first cooled and dried at the evaporator (provided the air conditioner is switched on). Then the airflow is heated to the required temperature at the heating system heat exchanger.

- IHKA Basic

  The temperature in the heating system heat exchanger is controlled with the help of the heating system heat exchanger sensor and a pulsed water valve in the heater circuit. The water valve is actuated with a pulse-modulated signal (PWM signal) by the IHKA control unit. A map for the heating system heat exchanger determines the opening times for the

water valve, depending on the engine speed.

A master controller regulates the temperature inside the vehicle. Regulation is based on the specification set at the rotary switch (adjustment range: 17-27 °C) and the actual value (= interior temperature).
The lead parameter is derived from the comparison of the actual interior temperature and the corrected specification (customer setting + ambient temperature). Compared to the set specification, the interior temperature is raised in the cold so that a comfortable level is achieved even at negative temperatures, despite the temperature setting being unchanged. The ambient temperature is transmitted through the body CAN (controller area network) to the IHKA control unit.
An auxiliary regulating circuit relieves the master controller by eliminating any fault quantities that could be detected in the heating/air-conditioning system in the form of a temperature change. Disturbances are caused by:

- Fluctuations in air volume
- Fluctuations in coolant flow in engine heater circuit
- Temperature changes in fresh air

- IHKA High

  The separate temperature setting for the driver's side and the front-passenger side affects:

  - heating system heat exchanger with left/right separation
  - 2 heating system heat exchanger sensors
  - Dual water valve

  The temperature is regulated by 2 master controllers. Regulation is based on the specification set at the rotary switch and the actual value (= interior temperature).
  Through the left/right separation, 2 auxiliary regulating circuits relieve the two master controllers.
  The solar sensor compensates for additional fault quantities caused by external sources of light or heat (e.g. direct sunlight).

Note: Reaching maximum outlet temperature in ventilation area.

The maximum outlet temperature in the ventilation area is reached as follows:

- Set the rotary switch for temperature selection to maximum temperature (28 °C)
- Set temperature layering as follows with the CID:
  - IHKA Basic:
    air stratification to "red" (warmer)
  - IHKA High:
    All 4 red bars must be displayed.

Evaporator control

The evaporator temperature is regulated with the help of the evaporator temperature sensor and a controllable expansion valve. The evaporator temperature is set to the predefined specification of 2 °C. Lower temperatures are not possible due to the risk of icing.

If the "variable evaporator control" function has been encoded, the specified evaporator temperature is calculated in the range between 2 and 7 °C. The specification depends on the ambient temperature, the ventilation temperature and the refrigerant pressure. A variable evaporator control reduces dehumidification. This reduces the risk of mucous membranes drying out.

Air distribution setting

Occupants have the possibility of allowing the air distribution to be decided by the automatic program (AUTO button). Alternatively, manual selection (defrost, ventilation, footwell) allows an individual, personal air distribution.
Important for the optimal function of the air distribution is that the manually adjustable air vents are open.

Airflow control

The airflow control is dependent on the following settings and control actions:

- Manual blower setting

  The blower setting is made with the rotary switch in the IHKA controls.

- Automatic blower and flap setting

  The automatic blower and flap functions are activated when the AUTO button is pressed.

- Automatic blower speed increase

  The automatic blower speed increase function is available with both manual and automatic flap settings.
  To make a rapid heating or cooling possible from extreme interior temperatures, the standard range of adjustment is extended.

- Dynamic pressure compensation

  Without dynamic pressure compensation, the airflow through the fresh air grille would be increased disproportionately with increasing road speed. This effect is compensated for by the opening angle of the fresh-air flap being reduced as speed increases. (The road speed comes from the instrument cluster, through the body CAN to the IHKA control unit. The opening angle is regulated according to an empirically defined map.)

- Blower control

  If needed, priority levels are transmitted (through the body CAN) from the power module consumer cutoff to reduce the blower output.

- Effect of terminal 50

  During the starting process (terminal 50 ON), the blower is set to OFF to relieve the vehicle battery.

Sunlight adaptation (solar sensor, IHKA High only)

The influence on IHKA regulation by the solar sensor is assigned separately to the driver's side and to the front-passenger side.

The following functions are modified when automatic mode is activated:

- Blower (individual blower proportions of the overall blower output are increased or decreased)
- Air stratification (stratification temperature adjusted)
- Flaps (position of ventilating flaps adjusted)

MAX cooling (IHKA High)

The MAX button makes it possible for the user to select maximum cooling with just one press of a button at the IHKA controls.

When the MAX button is pressed, all functions, including the defrost function, are deactivated. The air-conditioning function is activated (if it was not already activated) and defined settings are selected (e.g. temperature control is deactivated, the dual water valve is closed).

Maximum heating

If the rotary switch for temperature selection is turned to the end stop, maximum heating is activated. Regulation of the vehicle's interior temperature is suspended. Predefined settings are selected (e.g. temperature of heating system heat exchanger regulated to maximum setting 90 °C).

Residual heat (IHKA High only)

The residual-heat function makes it possible to utilise the waste heat from the engine to heat the vehicle interior when the engine is not running. The auxiliary water pump is activated to circulate the water.

Switch-on conditions:

- REST button in IHKA controls ON

  and

- ambient temperature below 25 °C

  and

- engine temperature above 60 °C

  and

- ignition lock position R or ignition OFF

  and

- 15 minutes after terminal 15 OFF not yet expired

Defrost function (IHKA High only)

The defrost function is activated with the defrost button in the IHKA controls. This opens the defroster flap (on the inside in front of the windscreen) fully. The fresh-air/air-recirculation flaps move to the "fresh air" position. All other flaps are closed. The blower can be set manually.

Heated rear window

The heated rear window is switched on by pressing the heated rear window button in the IHKA controls. The function indicator lamp in the button lights up.

The heated rear window is switched off when the button is pressed again, or automatically when the heating period of 10 or 17 minutes has expired. If the button is pressed again during the heating phase, the afterheating phase (approx. 5 minutes) starts.

- Defrosting phase

  When terminal 15 is switched ON , the first time the system is switched on, the time span for the heated rear window is defined as follows:

  Ambient temperature down to -15 °C: Heating period: 10 minutes

  Ambient temperature below 15 °C: Heating period: 17 minutes

- Pulsing

  After the defrosting phase, the heating phase (60 minutes at 1/3 heat output pulsing) begins (on-off cycle: 3 seconds ON, 9 seconds OFF).

  The function indicator lamp in the button is off during pulsing.

Heated washer jets

The washer jets are heated, depending on the ambient temperature (under 3 °C). The IHKA control unit actuates the nozzle heating.

OFF

Press the OFF button to completely switch the IHKA controls off.

Air-recirculation mode

In air-recirculation mode, the flow of outside air can be stopped to prevent pollution from entering the vehicle, e.g. in traffic congestion. Air from the vehicle interior is continuously circulated.
To prevent the windows from misting over, air recirculation is only available for a limited period of time.

Automatic air recirculation

In automatic mode, the system will automatically switch to air-recirculation mode if an extreme cooling output is called for. This allows the vehicle interior to be cooled more quickly. Air from the vehicle interior that has already been cooled is fed through the evaporator again. This reduces the temperature level much faster than it would in normal operation.

Automatic air-recirculation mode initially runs for 12 minutes in full air-recirculation mode and then continuously in partially fresh-air mode (fresh-air flap opening angle: approx. 10 %).

Automatic air-recirculation control (IHKA High)

If the AUC sensor detects an excessively high pollutant level in the environment, the IHKA control unit will automatically switch to air-recirculation mode.

Because of the lack of a fresh-air supply, air-recirculation mode is only available for a limited period of time:

- In heating mode at ambient temperatures above 6 °C, air recirculation is limited to 4 minutes. This is followed by fresh air for 1 minute.
- In air-conditioning mode at ambient temperatures above 6 °C, air recirculation is limited to 12 minutes. This is followed by fresh air for 1 minute.
- At ambient temperatures between 6 °C and 0 °C, air recirculation is limited to 3 minutes. At ambient temperatures below 0 °C, air recirculation is limited to 2 minutes. This is followed by fresh air for 1 minute.

When the engine is started and the AUC function activated, fresh air is always selected for approx. 40 seconds due to the warming phase of the AUC sensor.

Program for avoiding condensation on the window surfaces (IHKA High only)

Measures to prevent condensation on the windscreen depend on a number of conditions:

- The engine must be running
- The IHKA must be in automatic mode

The IHKA control unit evaluates condensation sensor signal (humidity). If condensation on the windscreen is imminent, the following measures are initiated in turn until the condensation has been eliminated. If one measure proves to be ineffective, the next measure is initiated. Once successful, the measures previously performed are reversed step-by-step in reverse order.

Measures against condensation on windscreen:

- Open the defrost flaps further (max. 17.5 %)
- Switch to partially fresh air from air-recirculation/AUC/automatic air-recirculation mode
- Switch from partially fresh air in air-recirculation/AUC/automatic air-recirculation mode to fresh air
- Switch off variable evaporator control
- Raise blower speed (max. 28 %)
- Reduce airflow to footwell (by about 60 %)
- Increase temperature setting (by max. 2.5 °C)

Convertible program (E64 only)

The convertible program is activated in the factory. (this factory setting can be deactivated win the Car and Key Memory)

Switch-on conditions:

- Terminal 15 ON
- Convertible top open

The convertible program comprises the following functions:

- The condensation sensor is switched off
- The blower speed increases with increasing road speed
- Air distribution is switched to the upper body and head, airflow to the footwell is throttled
- Dynamic pressure compensation is changed, i.e. as road speed increases, the volume of air fed into the vehicle through

the fresh air grille increases.

- Solar sensor control variables are changed

  When the convertible top is open, the solar sensor evaluates the surrounding brightness (darkness to intense sunshine) more strongly. For this reason, the solar sensor has a stronger effect on the IHKA controls when the convertible top is open.

In the convertible program, the blower speed can be changed manually at the IHKA controls. The automatic flap control remains active (no change to flap position).
If the convertible program is active and the flap positions are changed with the CID and controller, the convertible program will be deactivated. This means that manual settings will be assumed, unchanged settings will revert to those that the air-conditioning system had before the convertible top was closed.
The convertible program can be completely reactivated by pressing the AUTO button.

Independent ventilation function

The independent ventilation function is activated either via the Central Information Display (CID) or via Telestart (through the Car Access System (CAS)). There are 2 ways of activating the system via the CID:
Direct operation or programming using the timer.

If the independent ventilation function is programmed via the timer, the independent ventilation function will only be available at exterior temperatures above 15 °C.

The battery's charge level is constantly monitored by the intelligent battery sensor throughout the independent ventilation function. If the necessary charge level is not maintained, the IHKA control unit will deactivate the independent ventilation function.

Independent heater (option 536)

The independent heating function is activated either via the Central Information Display (CID) or via Telestart (through the Car Access System (CAS)). There are 2 ways of switching the system on via the CID:
Direct operation or programming using the timer.

Conditions required for switching the independent heater on:

- Exterior temperature below 15 °C (only applicable after programming with the timer)
- Sufficient fuel in the vehicles tank for a range of at least 50 km
- On-board supply voltage OK

The independent heater has the following functions:

- Auxiliary heating with running engine (pseudo auxiliary heating)
- Telestart (via CAS)
- Low-voltage cutout

Auxiliary heating with running engine (pseudo auxiliary heating)

When the independent heater is running, pseudo auxiliary heating mode is started when the engine is started. When pseudo auxiliary heating mode is activated, the independent heater indicator lamp goes out.
If the engine temperature is greater than or equal to the temperature of the independent heating circuit, the system will change from pseudo auxiliary heating mode to auxiliary heating. These two modes differ in that only the independent heater circuit is used in pseudo auxiliary heating mode, while in auxiliary heating mode the larger heater circuit is used.

Telestart (via CAS)

The average range of the Telestart transmitter is approx. 150 meters. The CAS forwards the signal from the Telestart transmitter through the body CAN to the following control units:

- IHKA control unit
- Independent heater control unit

Low-voltage cutout (via DME/DDE)

The battery's charge level is constantly monitored by the intelligent battery sensor throughout the independent heating operation. If the necessary charge level is not maintained, the IHKA control unit will deactivate the independent heating operation.

Notes for service staff

Service staff should note the following points:

- General information: [more ...]
- Diagnostics: ---
- Encoding/programming: [more ...]
- Car and Key Memory: [more ...]

National versions

The hardware of the IHKA controls are available temperature displays in °C (Celsius) or in °F (Fahrenheit).

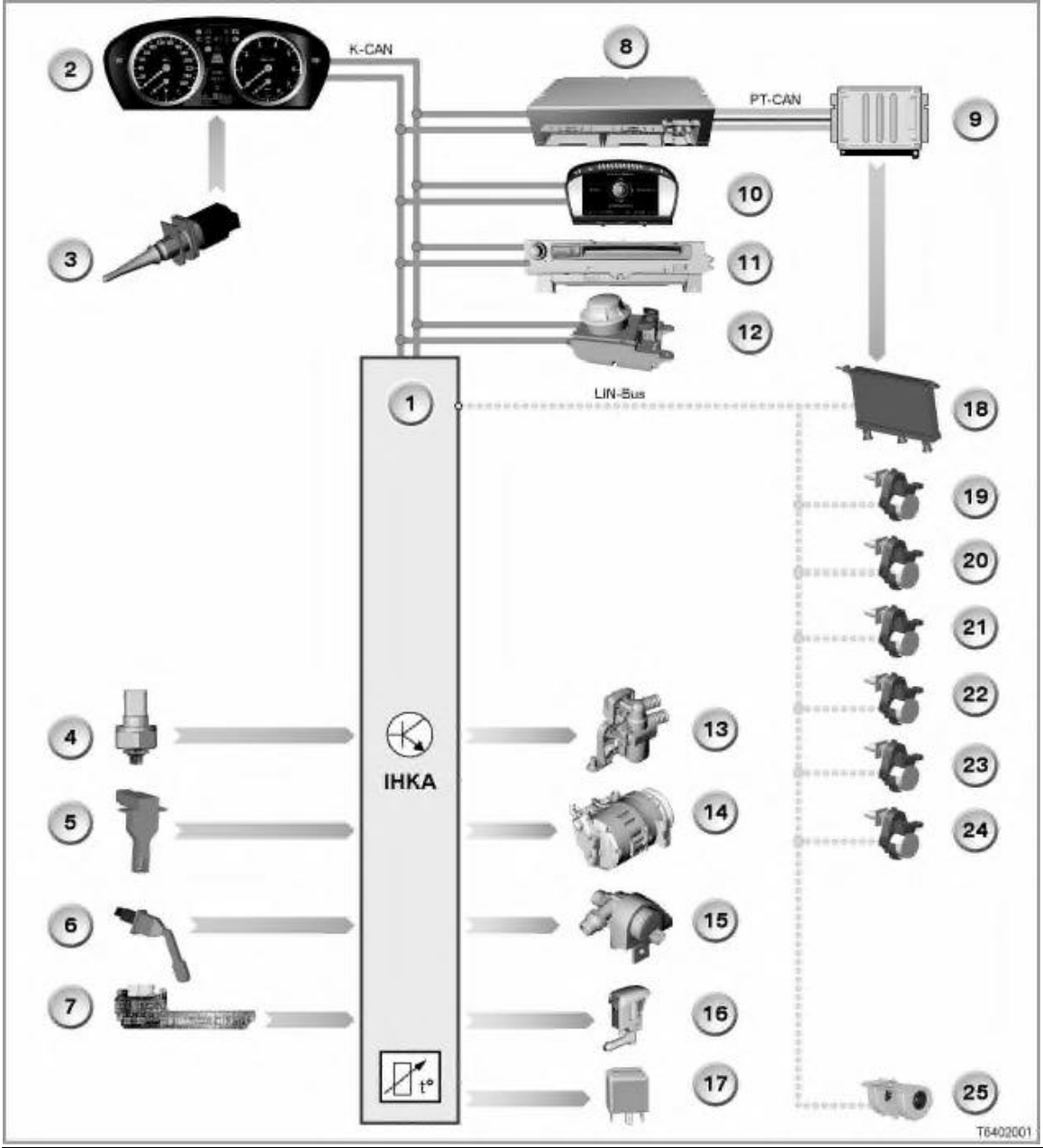
Subject to change.

E60, E61, E63, E64 - System overview, IHKA

For technical reasons, the system overview is divided up as follows:

- Input/output, IHKA Basic
- System circuit diagram, IHKA Basic
- Input/output, IHKA High
- System circuit diagram, IHKA High
- Input/output, electric auxiliary heater (diesel engine only)
- System circuit diagram, electric auxiliary heater (diesel engine only)
- Input/output, independent heater
- System circuit diagram, independent heater
- Heater circuit, engine M54B22/B30 (IHKA Basic)
- Heater circuit, engine M54B22/B30 with independent heater (IHKA Basic)
- Heater circuit, engine M54B22/B30 (IHKA High)
- Heater circuit, engine M54B22/B30 with independent heater (IHKA High)
- Heater circuit, engine M57D30TU (IHKA Basic)
- Heater circuit, engine M57D30TU with independent heater (IHKA Basic)
- Heater circuit, engine M57D30TU (IHKA High)
- Heater circuit, engine M57D30TU with independent heater (IHKA High)
- Overview of heating/air-conditioning system components

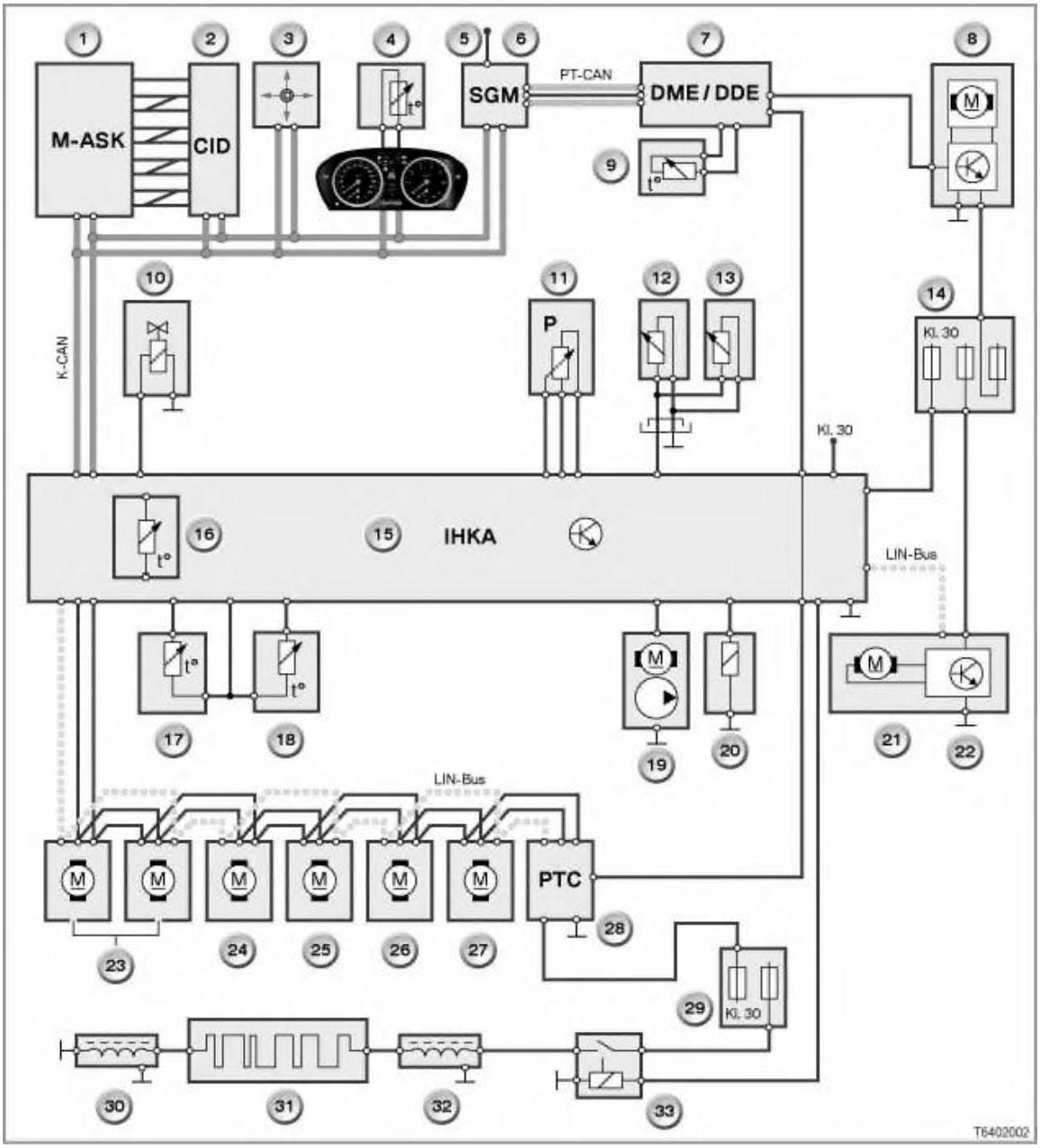
Input/output, IHKA Basic



Key	Explanation	Key	Explanation
1	IHKA controls/control unit with integrated interior temperature sensor	2	Instrument cluster
3	Ambient temperature sensor	4	Refrigerant pressure sensor
5	Sensor for heating system heat exchanger	6	Evaporator temperature sensor
7	Power distributor, front	8	Safety and gateway module (SGM)
9	Digital engine electronics (DME) or digital diesel electronics (DDE)	10	Central Information Display (CID)
11	Multi-audio system controller (M-ASK)	12	Controller
13	Water valve in heater circuit	14	A/C compressor
15	Electric auxiliary water pump	16	Heated washer jets, left and right
17	Relay for heated rear window	18	Electric auxiliary heater, integrated in heating system heat exchanger

19	Fresh-air/air-recirculation flap motor, left	20	Fresh-air/air-recirculation flap motor, right
21	Ventilation flap motor	22	Cold-air flap motor
23	Footwell flap motor	24	Defroster flap motor
25	Blower with blower regulator		
K-CAN	Body CAN	LIN Bus	Local interconnect network bus
PT-CAN	Powertrain CAN		

- System circuit diagram, IHKA Basic

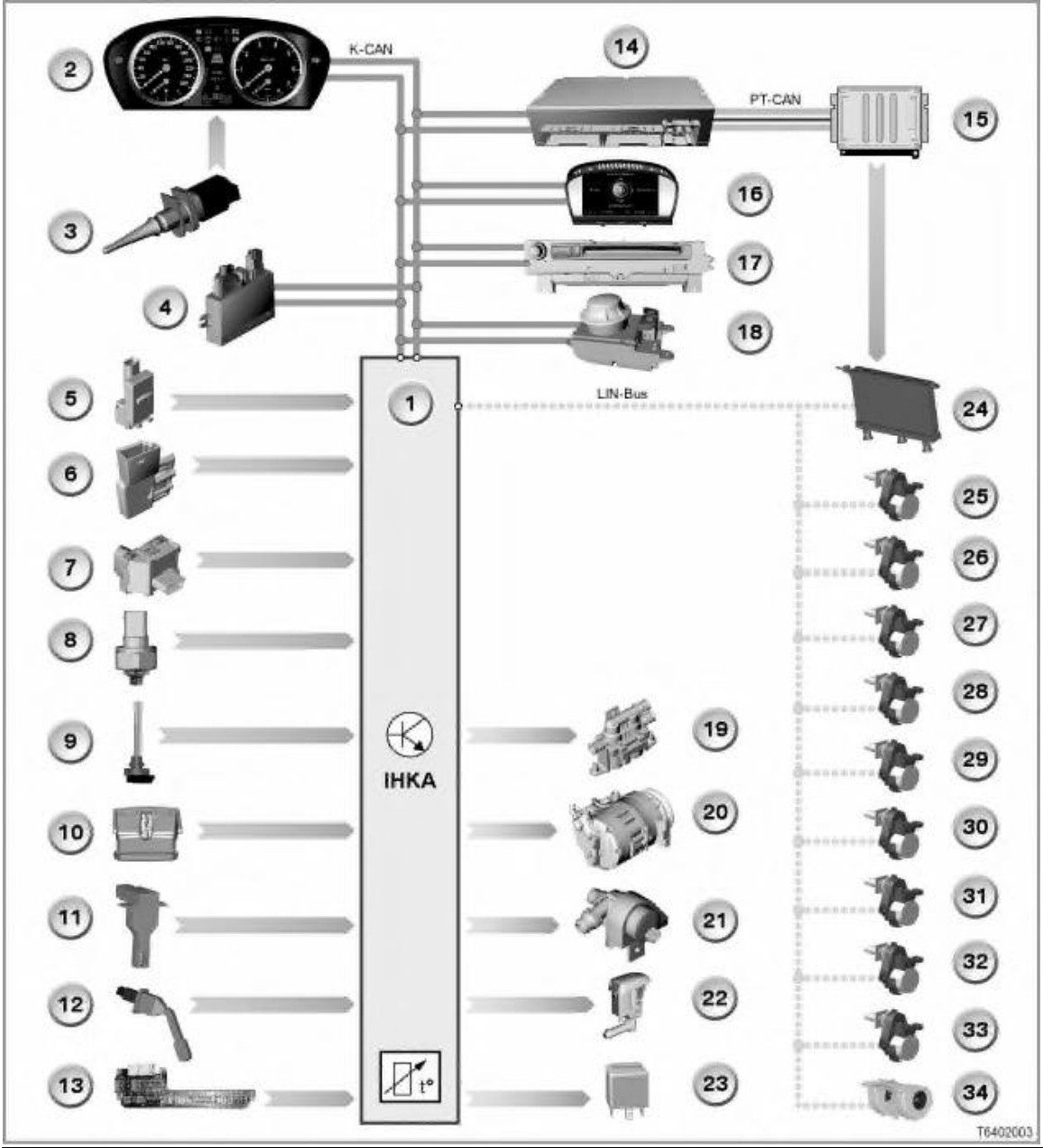


Key	Explanation	Key	Explanation
1	Multi-audio system controller (M-ASK)	2	Central Information Display (CID)
3	Controller	4	Ambient temperature sensor
5	Diagnostic wire	6	Safety and gateway module (SGM)

7

	Digital engine electronics (DME) or digital diesel electronics (DDE)	8	Auxiliary fan with output stage
9	Temperature sensor for radiator	10	Water valve in heater circuit
11	Refrigerant pressure sensor	12	Heated washer jets, left
13	Heated washer jets, right	14	Power distributor, front
15	IHKA controls / control unit	16	Interior temperature sensor
17	Sensor for heating system heat exchanger	18	Evaporator temperature sensor
19	Electric auxiliary water pump	20	Control valve in A/C compressor
21	Blower motor	22	Blower motor output stage
23	Fresh-air/air-recirculation flap motor, left and fresh-air/air-recirculation flap motor, right	24	Ventilation flap motor
25	Footwell flap motor	26	Defroster flap motor
27	Cold-air flap motor	28	Electric auxiliary heater (PTC principle)
29	Power distributor, rear	30	Locking circuit
31	Heated rear window	32	Locking circuit
33	Relay for heated rear window		
Kl.30	Terminal 30 (power supply via power distributor, front)	K-CAN	Body CAN
LIN Bus	Local interconnect network bus	PT-CAN	Powertrain CAN

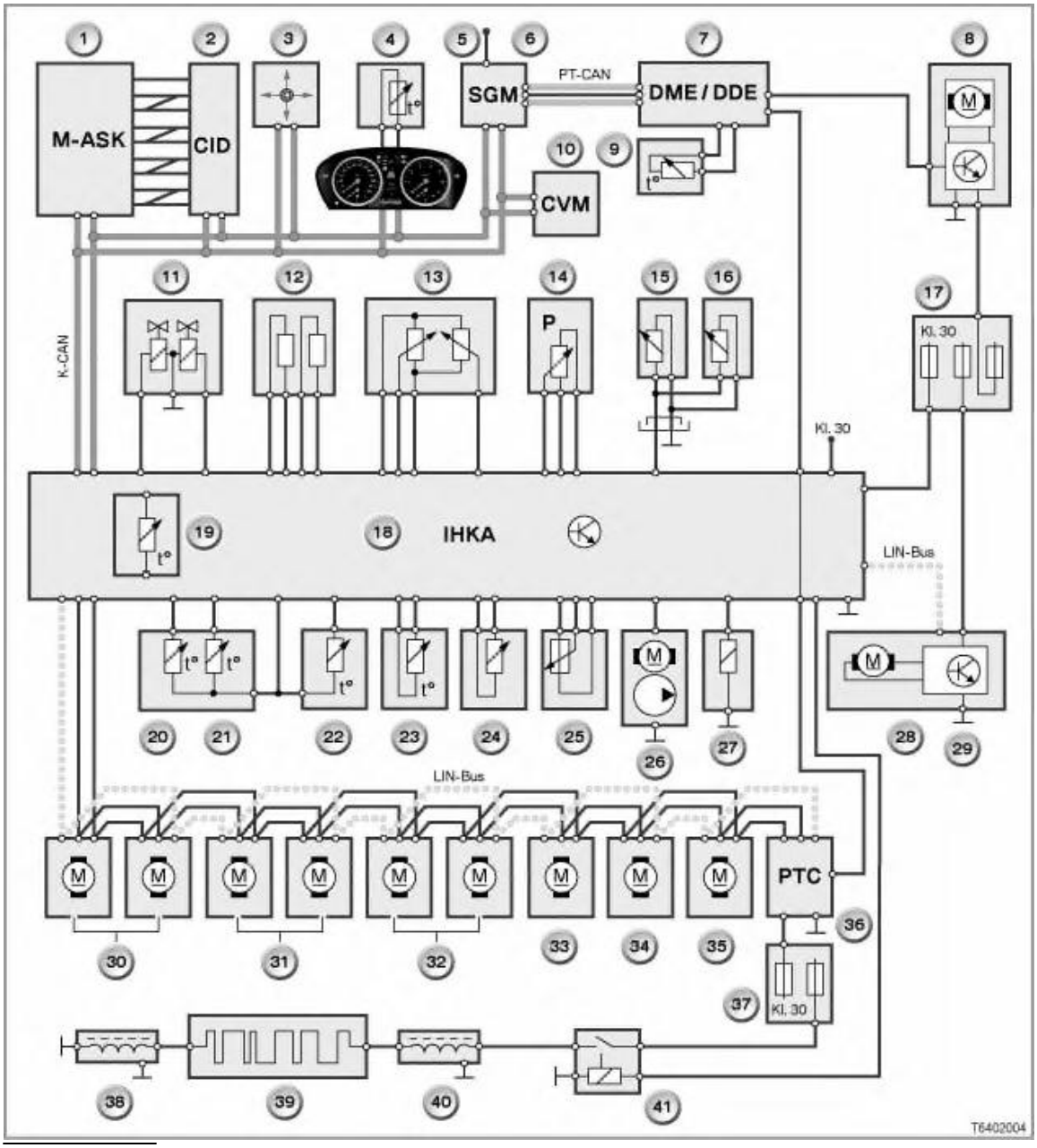
- Input/output, IHKA High



Key	Explanation	Key	Explanation
1	IHKA controls/control unit with integrated interior temperature sensor	2	Instrument cluster
3	Ambient temperature sensor	4	Convertible top module (E64 only)
5	AUC sensor	6	Condensation sensor
7	Solar sensor	8	Refrigerant pressure sensor
9	Ventilation temperature sensor	10	Potentiometer for rear-compartment ventilation
11	Heating system heat exchanger sensors, left and right	12	Evaporator temperature sensor
13	Power distributor, front	14	Safety and gateway module (SGM)
15	Digital engine electronics (DME) or digital diesel electronics (DDE)	16	Central Information Display (CID)
17	Multi-audio system controller (M-ASK)	18	Controller

19	Dual water valve in heater circuit	20	A/C compressor
21	Electric auxiliary water pump	22	Heated washer jets, left and right
23	Relay for heated rear window	24	Electric auxiliary heater, integrated in heating system heat exchanger
25	Fresh-air/air-recirculation flap motor, left	26	Fresh-air/air-recirculation flap motor, right
27	Ventilation flap motor, left	28	Ventilation flap motor, right
29	Cold-air flap motor	30	Footwell flap motor, left
31	Footwell flap motor, right	32	Defroster flap motor
33	Rear compartment flap motor (air stratification)	34	Blower with blower regulator
K-CAN	Body CAN	LIN Bus	Local interconnect network bus
PT-CAN	Powertrain CAN		

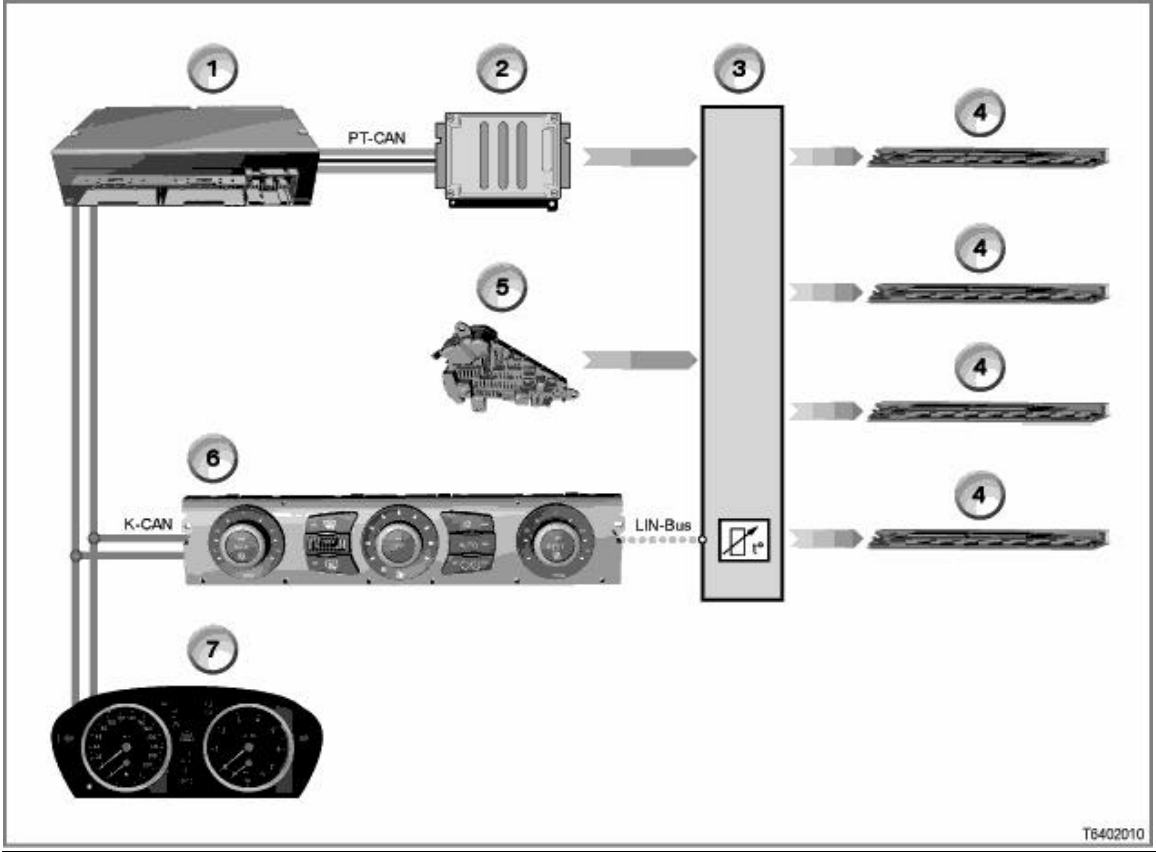
- System circuit diagram, IHKA High



Key	Explanation	Key	Explanation

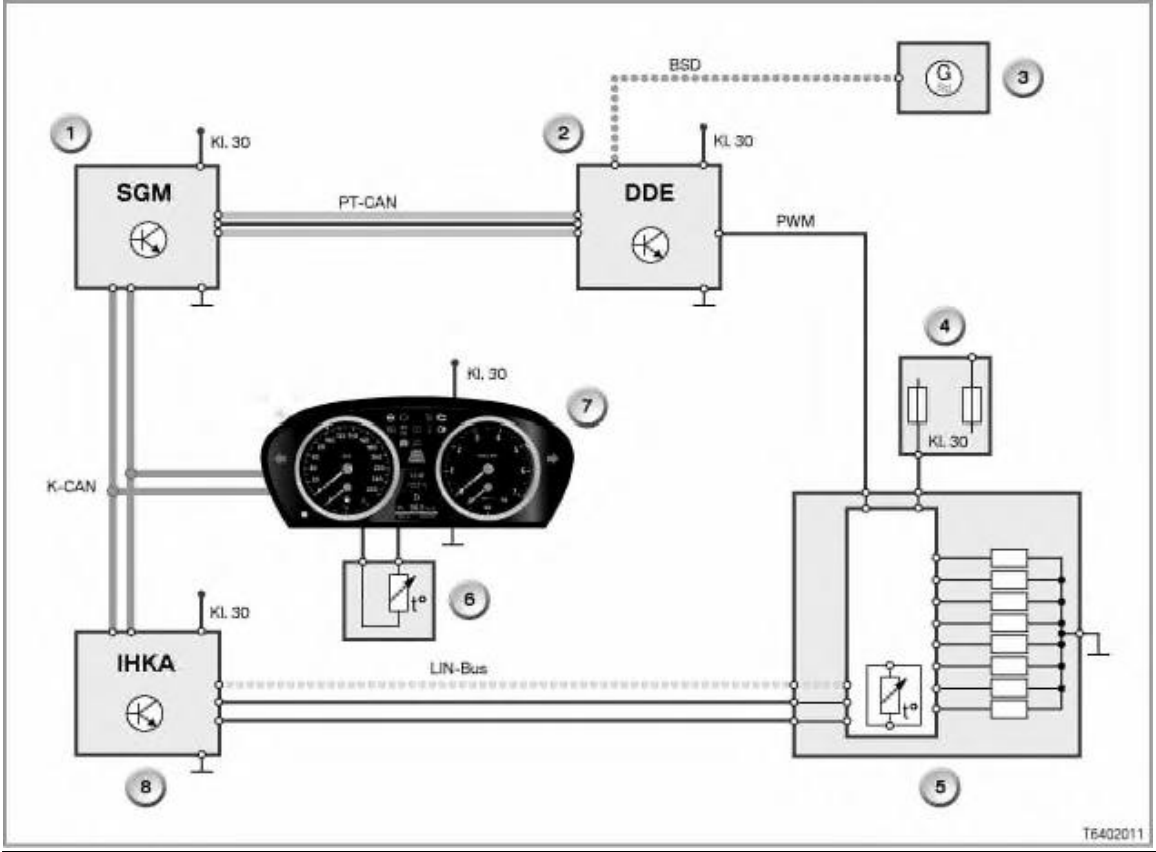
1	Multi-audio system controller (M-ASK)	2	Central Information Display (CID)
3	Controller	4	Ambient temperature sensor
5	Diagnostic wire	6	Safety and gateway module (SGM)
7	Digital engine electronics (DME) or digital diesel electronics (DDE)	8	Auxiliary fan with output stage
9	Temperature sensor for radiator	10	Convertible top module (CVM, E64 only)
11	Dual water valve in heater circuit	12	AUC sensor
13	Solar sensor	14	Refrigerant pressure sensor
15	Heated washer jets, left	16	Heated washer jets, right
17	Power distributor, front	18	IHKA controls / control unit
19	Interior temperature sensor	20	Heating system heat exchanger sensor, left
21	Heating system heat exchanger sensor, right	22	Evaporator temperature sensor
23	Ventilation temperature sensor	24	Potentiometer for rear-compartment ventilation
25	Condensation sensor	26	Electric auxiliary water pump
27	Control valve in A/C compressor	28	Blower motor
29	Blower motor output stage	30	Fresh-air/air-recirculation flap motor, left and fresh-air/air-recirculation flap motor, right
31	Ventilation flap motor, left and ventilation flap motor, right	32	Footwell flap motor, left and footwell flap motor, right
33	Defroster flap motor	34	Cold-air flap motor
35	Rear compartment flap motor (air stratification)	36	Electric auxiliary heater (PTC principle)
37	Power distributor, rear	38	Locking circuit
39	Heated rear window	40	Locking circuit
41	Relay for heated rear window		
Kl.30	Terminal 30 (power supply via power distributor, front)		
K-CAN	Body CAN	LIN Bus	Local interconnect network bus
PT-CAN	Powertrain CAN		

- Input/output, electric auxiliary heater (diesel engine only)



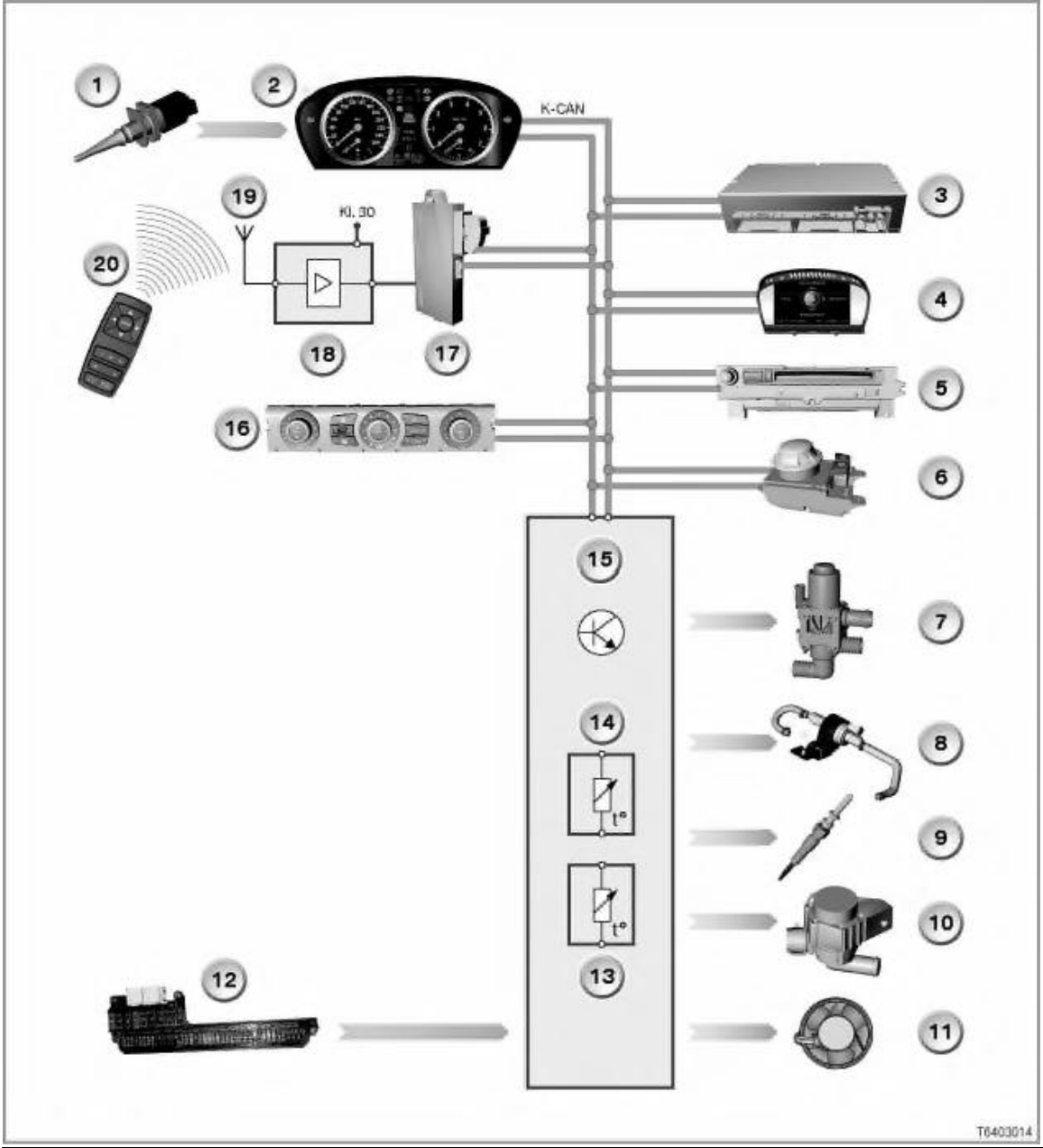
Key	Explanation	Key	Explanation
1	Safety and gateway module (SGM)	2	Digital diesel electronics (DDE)
3	Electric auxiliary heater regulator on heating system heat exchanger with temperature sensor (protection against thermal overload)	4	Heating cell in heating system heat exchanger
5	Power distributor, rear	6	IHKA controls / control unit
7	Instrument cluster with ambient temperature sensor		
K-CAN	Body CAN	LIN Bus	Local interconnect network bus
PT-CAN	Powertrain CAN		

- System circuit diagram, electric auxiliary heater (diesel engine only)



Key	Explanation	Key	Explanation
1	Safety and gateway module (SGM)	2	Digital diesel electronics (DDE)
3	Alternator	4	Power distributor, rear
5	Electric auxiliary heater regulator with temperature sensor (protection against thermal overload) and heating chains	6	Ambient temperature sensor
7	Instrument cluster	8	IHKA controls / control unit
Terminal 30	Terminal 30 (power supply)	BSD	Bit-serial data interface
K-CAN	Body CAN	LIN Bus	Local interconnect network bus
PT-CAN	Powertrain CAN	PWM	Pulse-modulated signal for electric auxiliary heater output limitation

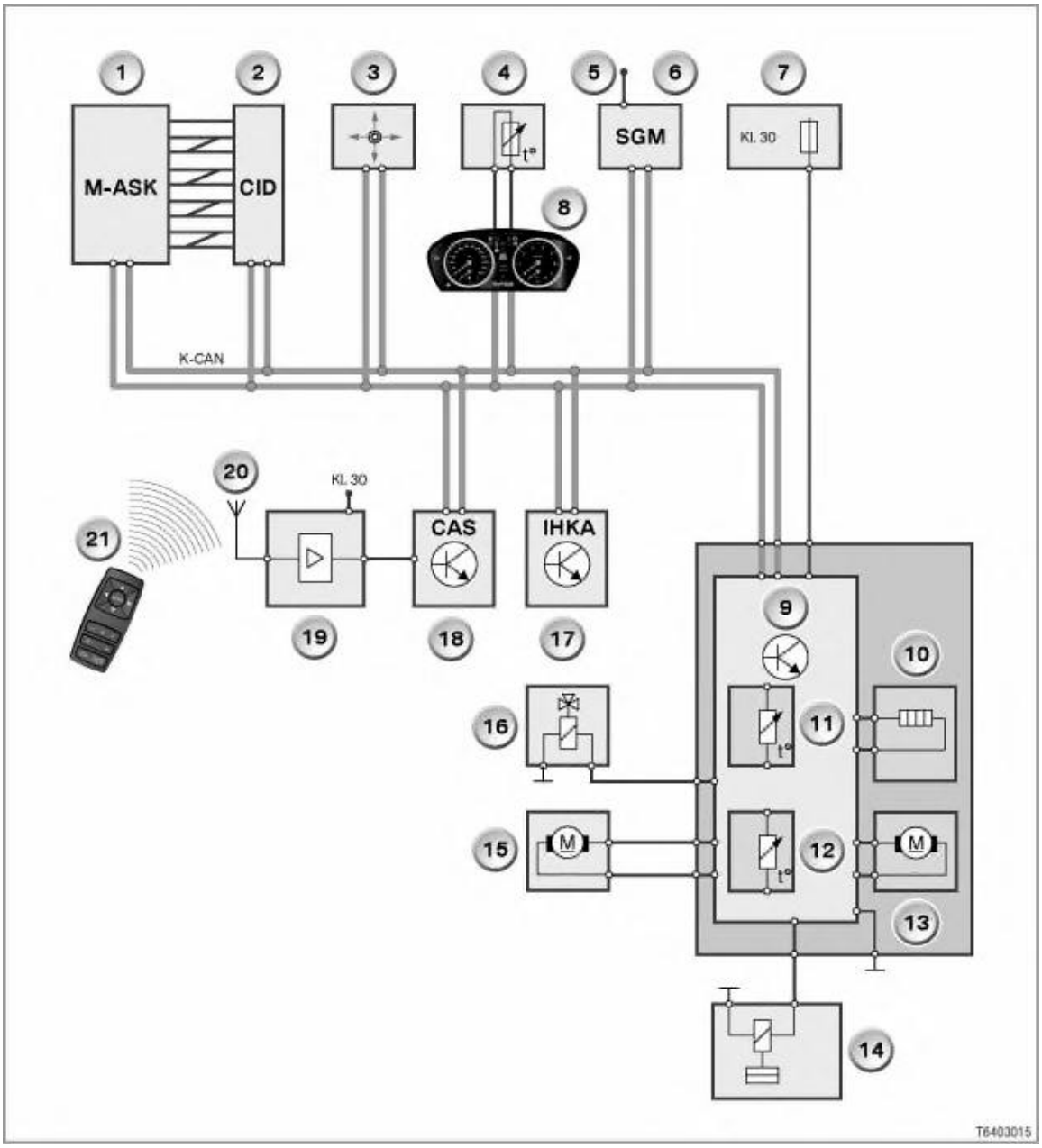
- Input/output, independent heater



Key	Explanation	Key	Explanation
1	Ambient temperature sensor	2	Instrument cluster
3	Safety and gateway module (SGM)	4	Central Information Display (CID)
5	Multi-audio system controller (M-ASK)	6	Controller
7	Switchover valve	8	Fuel pump for independent heater
9	Glow plug	10	Auxiliary water pump for independent heater
11	Combustion-air fan	12	Power distributor, front
13	Temperature sensor in independent heater circuit	14	Temperature sensor (protection against overheating)
15	Independent heater control unit	16	IHKA controls / control unit
17	Car Access System (CAS)	18	Remote control receiver
19	Aerial	20	Telestart transmitter

Terminal 30	Terminal 30 (power supply)	K-CAN	Body CAN

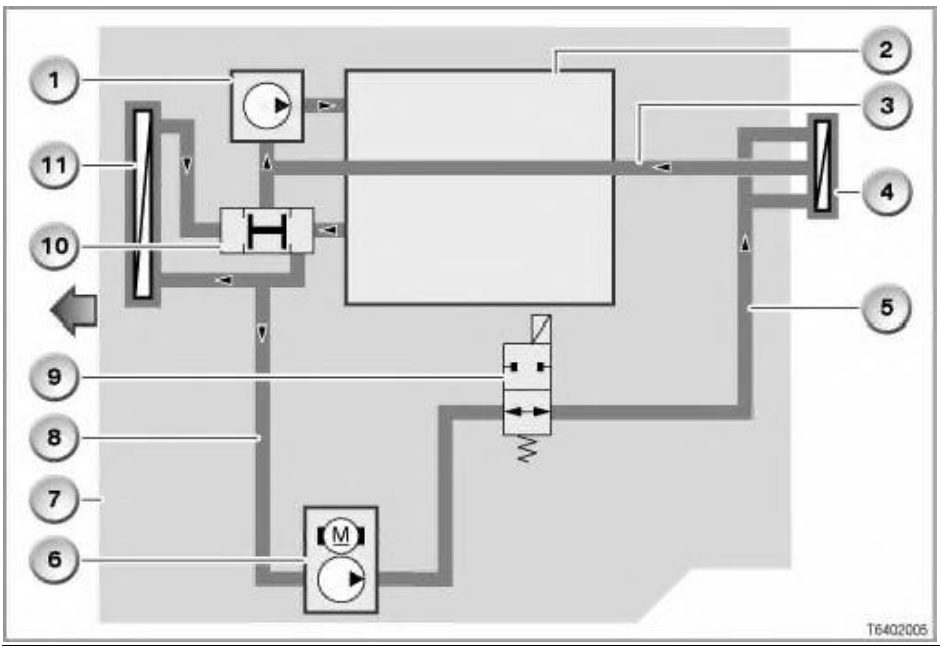
- System circuit diagram, independent heater



Key	Explanation	Key	Explanation
1	Multi-audio system controller (M-ASK)	2	Central Information Display (CID)
3	Controller	4	Ambient temperature sensor
5	Diagnostic wire	6	Safety and gateway module (SGM)
7	Power distributor, front	8	Instrument cluster
9	Independent heater control unit	10	Glow plug
11	Temperature sensor in independent heater circuit	12	Temperature sensor for overheating
13	Combustion-air fan	14	Fuel pump for independent heater
15	Auxiliary water pump for independent heater	16	Switchover valve

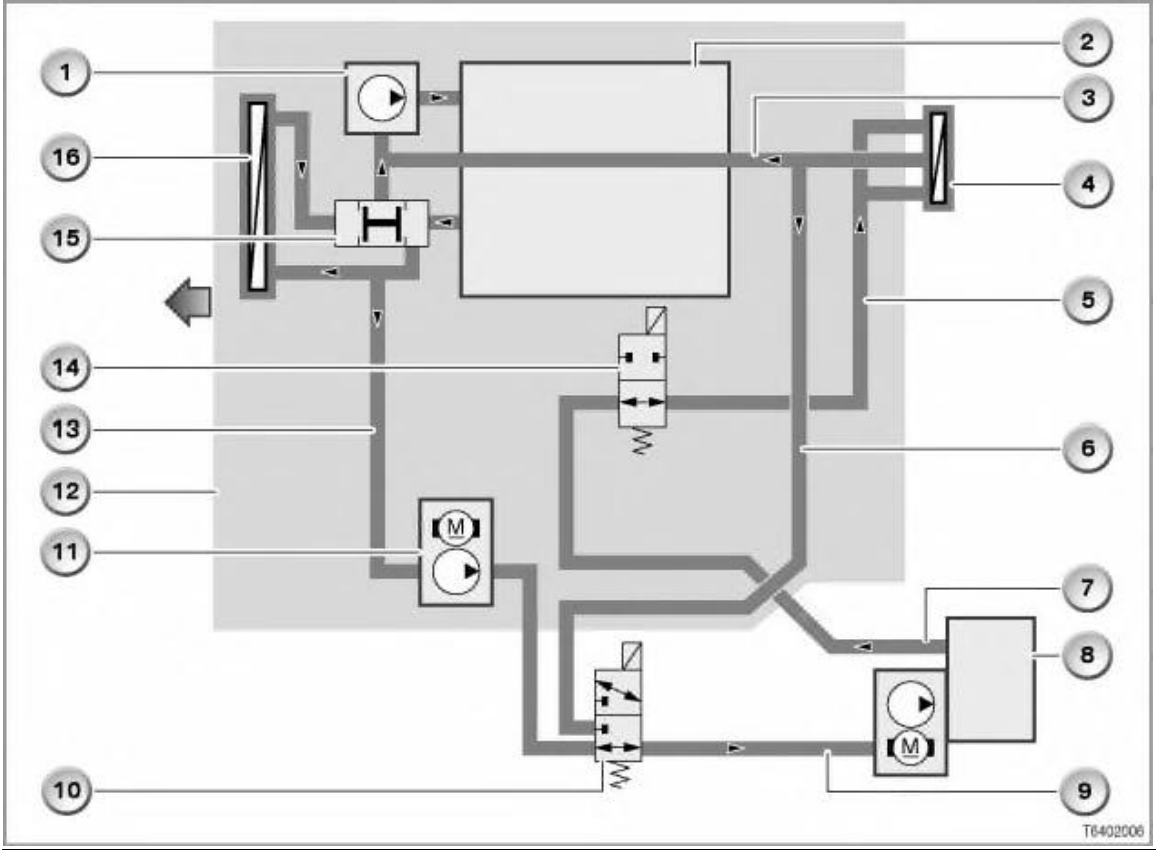
17	IHKA controls / control unit	18	Car Access System (CAS)
19	Remote control receiver	20	Aerial
21	Telestart transmitter		
Terminal 30	Terminal 30 (power supply)	K-CAN	Body CAN

- Heater circuit, engine M54B22/B30 (IHKA Basic)



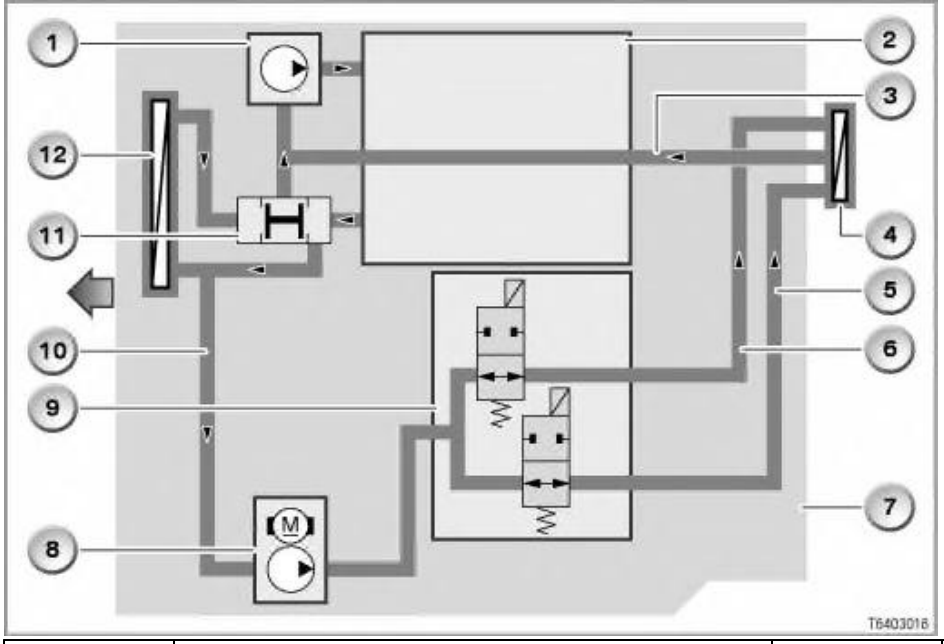
Key	Explanation	Key	Explanation
1	Water pump	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger
5	Heating system feed line	6	Electric auxiliary water pump
7	Engine compartment	8	Heating system feed line
9	Water valve	10	Thermostat
11	Radiator		
The arrow shows the direction of travel.			

- Heater circuit, engine M54B22/B30 with independent heater (IHKA Basic)



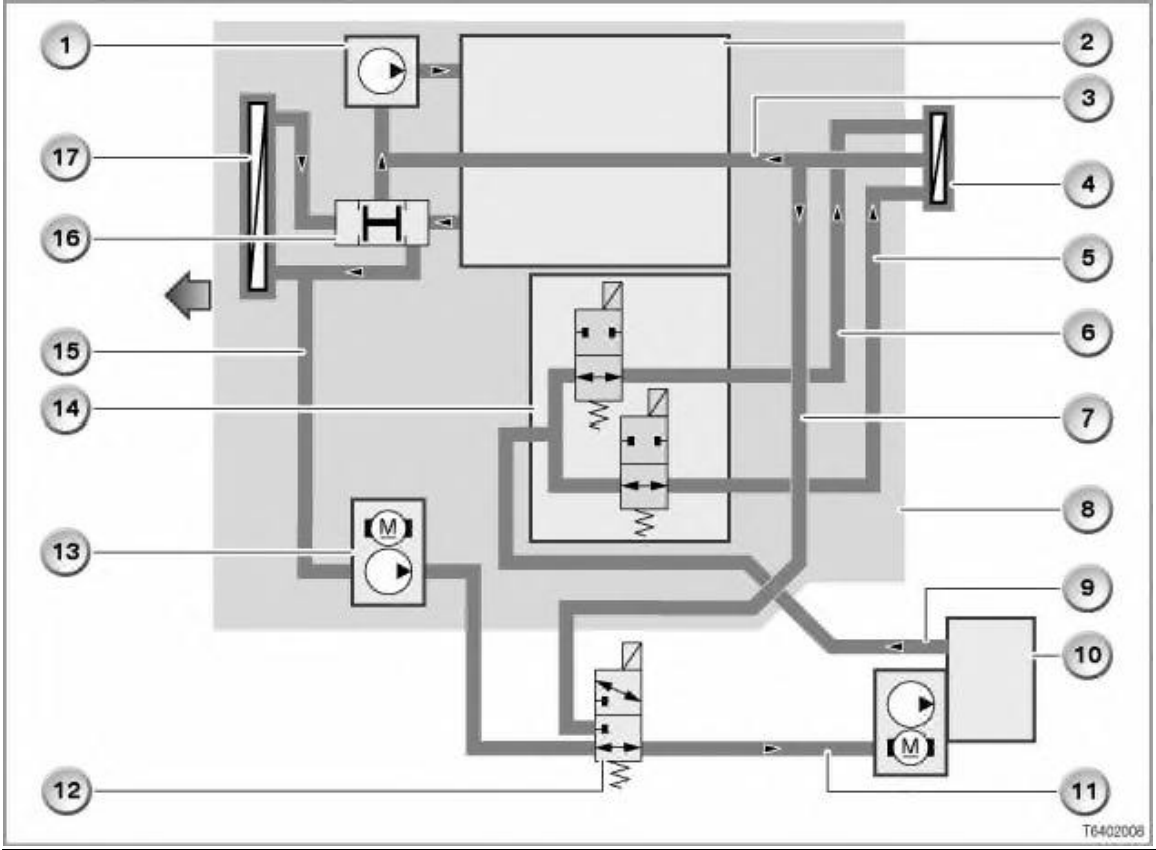
Key	Explanation	Key	Explanation
1	Water pump	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger
5	Heating system feed line	6	Return line for independent heater operation
7	Independent heater outlet	8	Independent heater with electric auxiliary water pump
9	Independent heater inlet	10	Switchover valve
11	Electric auxiliary water pump	12	Engine compartment
13	Heating system feed line	14	Water valve
15	Thermostat	16	Radiator
The arrow shows the direction of travel.			

- Heater circuit, engine M54B22/B30 (IHKA High)



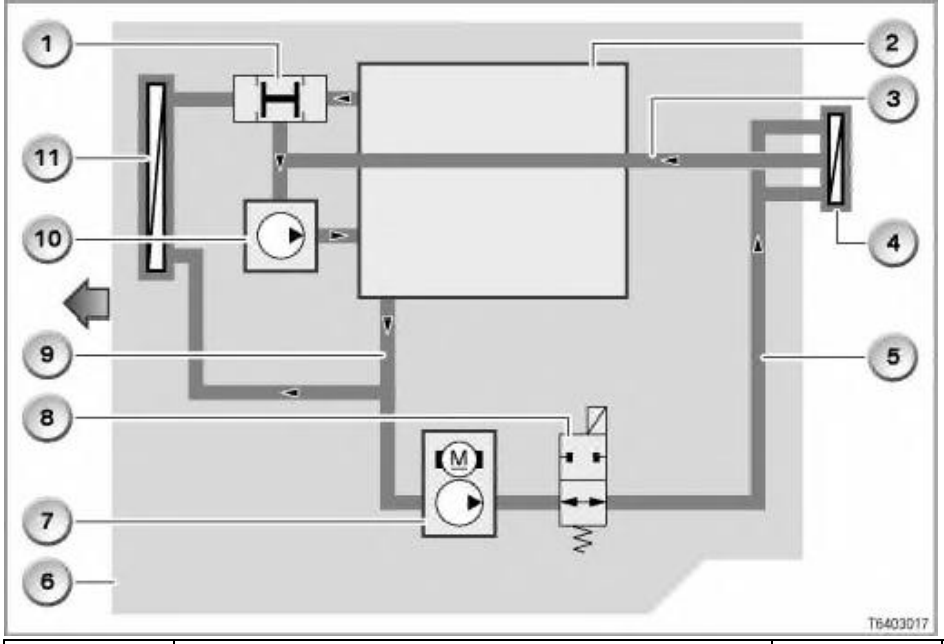
Key	Explanation	Key	Explanation
1	Water pump	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger
5	Heating system feed line, left	6	Heating system feed line, right
7	Engine compartment	8	Electric auxiliary water pump
9	Dual water valve	10	Heating system feed line
11	Thermostat	12	Radiator
The arrow shows the direction of travel.			

- Heater circuit, engine M54B22/B30 with independent heater (IHKA High)



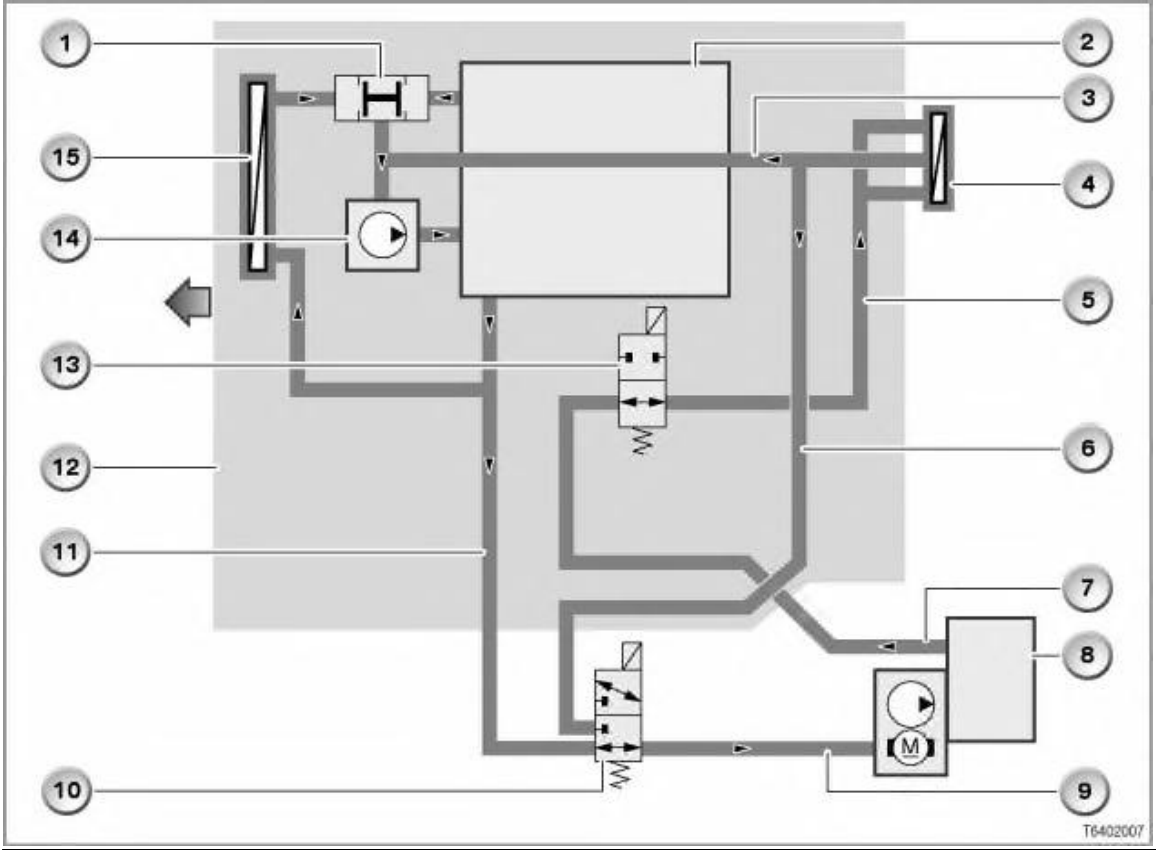
Key	Explanation	Key	Explanation
1	Water pump	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger
5	Heating system feed line, left	6	Heating system feed line, right
7	Return line for independent heater operation	8	Engine compartment
9	Independent heater outlet	10	Independent heater with electric auxiliary water pump
11	Independent heater inlet	12	Switchover valve
13	Electric auxiliary water pump	14	Dual water valve
15	Heating system feed line	16	Thermostat
17	Radiator		
The arrow shows the direction of travel.			

- Heater circuit, engine M57D30TU (IHKA Basic)



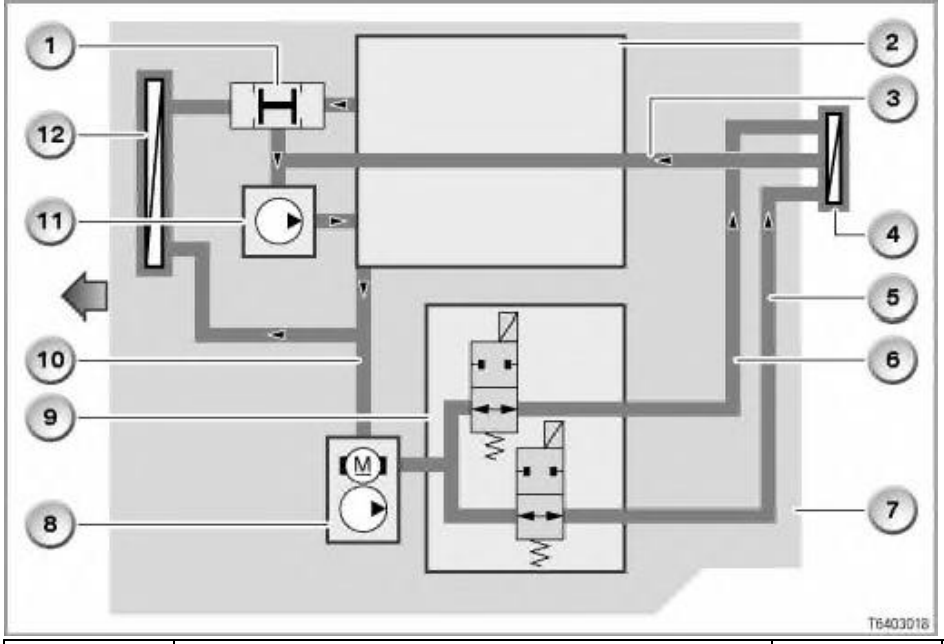
Key	Explanation	Key	Explanation
1	Thermostat	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger with integrated electric auxiliary heater
5	Heating system feed line	6	Engine compartment
7	Electric auxiliary water pump	8	Water valve
9	Heating system feed line	10	Water pump
11	Radiator		
The arrow shows the direction of travel.			

- Heater circuit, engine M57D30TU with independent heater (IHKA Basic)



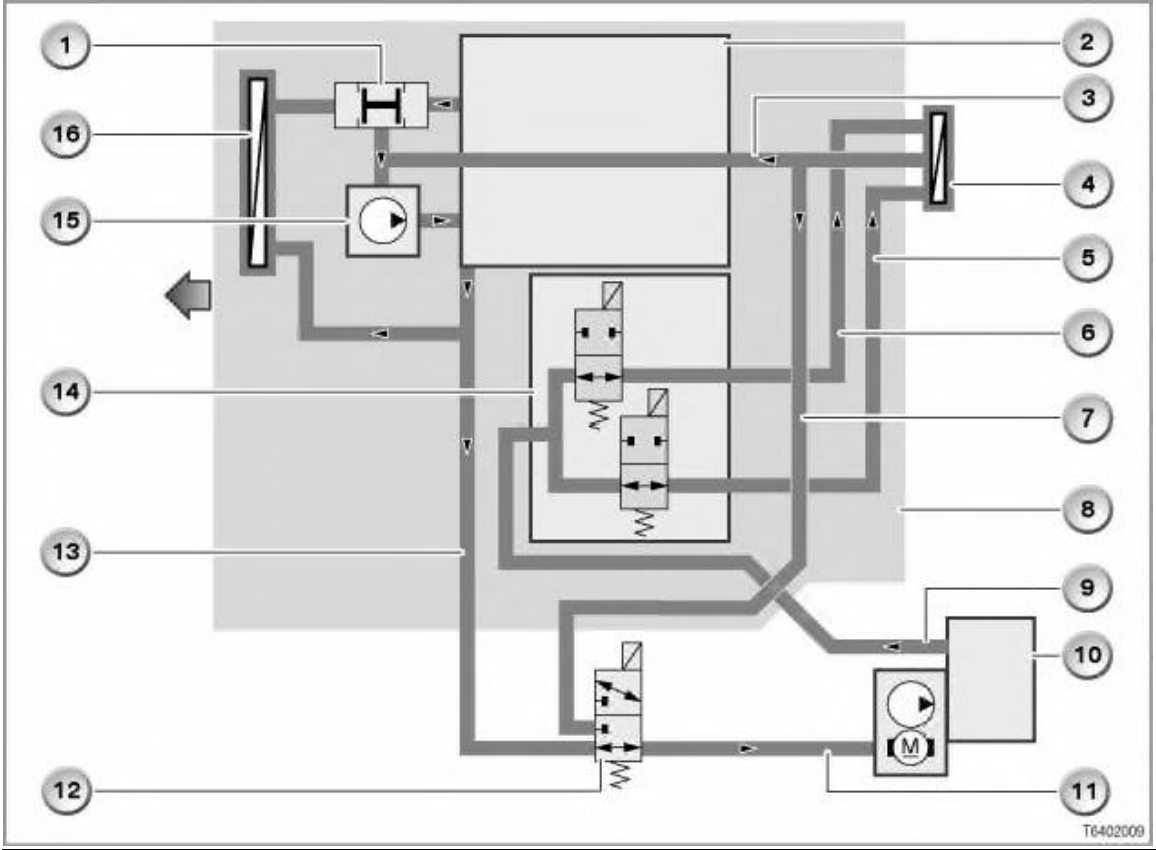
Key	Explanation	Key	Explanation
1	Thermostat	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger with integrated electric auxiliary heater
5	Heating system feed line	6	Return line for independent heater operation
7	Independent heater outlet	8	Independent heater with electric auxiliary water pump
9	Independent heater inlet	10	Switchover valve
11	Heating system feed line	12	Engine compartment
13	Water valve	14	Water pump
15	Radiator		
The arrow shows the direction of travel.			

- Heater circuit, engine M57D30TU (IHKA High)



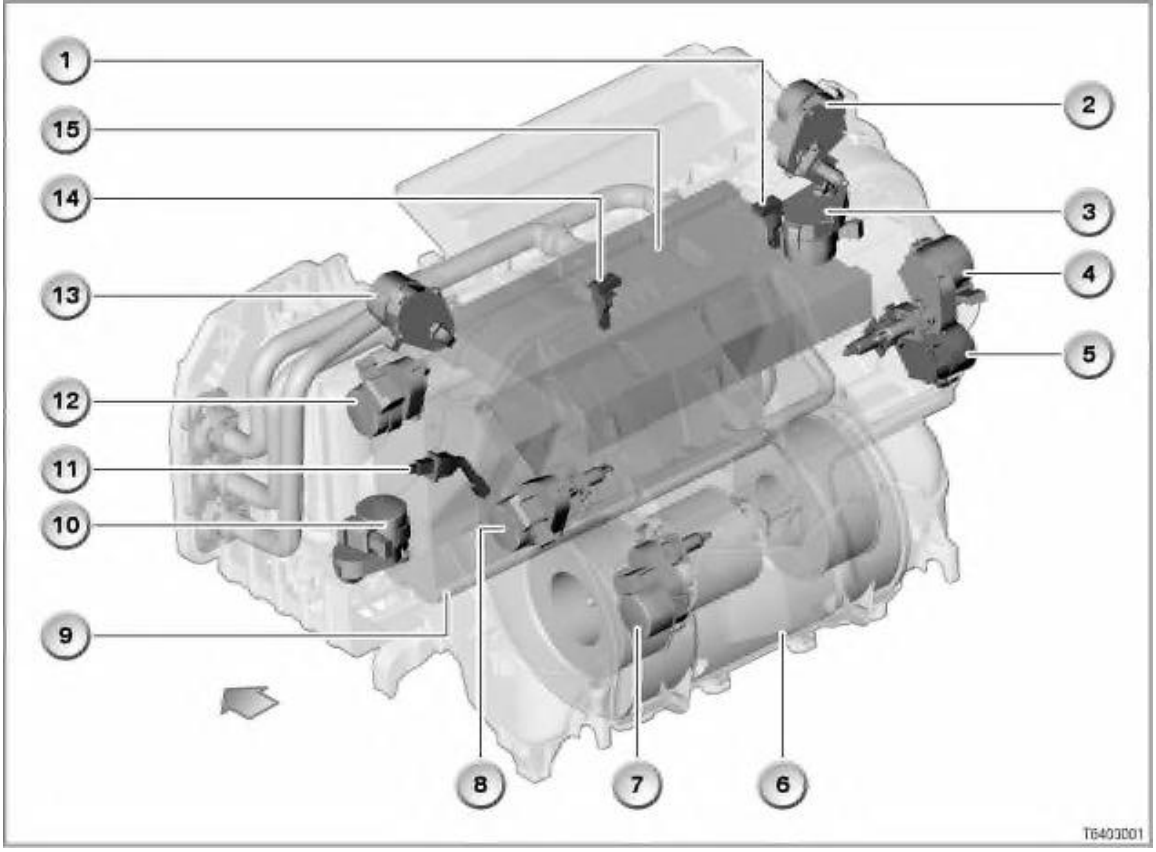
Key	Explanation	Key	Explanation
1	Thermostat	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger with integrated electric auxiliary heater
5	Heating system feed line, left	6	Heating system feed line, right
7	Engine compartment	8	Electric auxiliary water pump
9	Dual water valve	10	Heating system feed line
11	Water pump	12	Radiator
The arrow shows the direction of travel.			

- Heater circuit, engine M57D30TU with independent heater (IHKA High)



Key	Explanation	Key	Explanation
1	Thermostat	2	Engine
3	Return line from heating system heat exchanger	4	Heating system heat exchanger with integrated electric auxiliary heater
5	Heating system feed line, left	6	Heating system feed line, right
7	Return line for independent heater operation	8	Engine compartment
9	Independent heater outlet	10	Independent heater with electric auxiliary water pump
11	Independent heater inlet	12	Switchover valve
13	Heating system feed line	14	Dual water valve
15	Water pump	16	Radiator
The arrow shows the direction of travel.			

- Overview of heating/air-conditioning system components



For better clarity, the flap motors are illustrated without flaps.

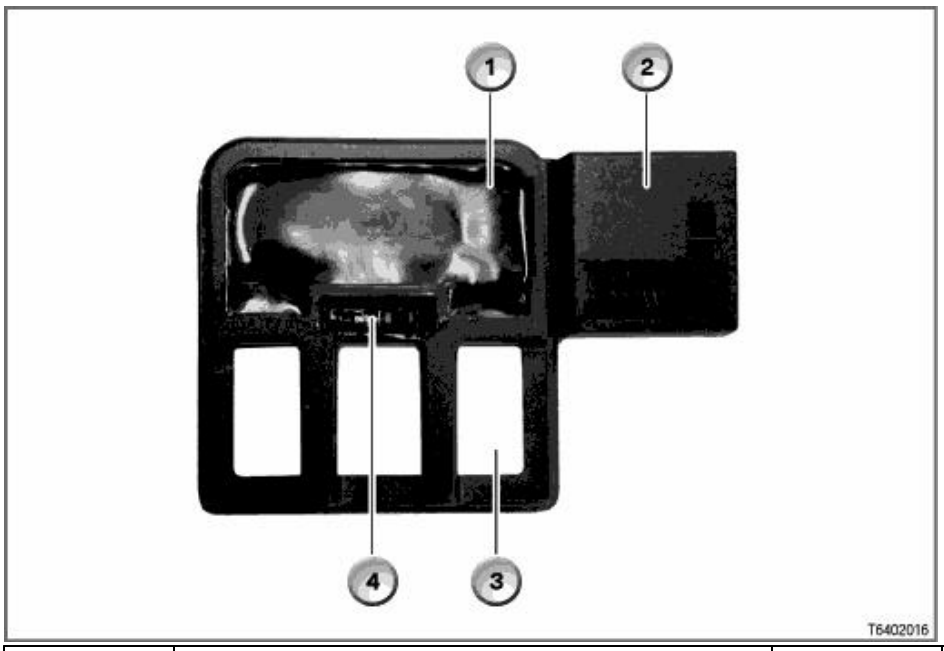
Key	Explanation	Key	Explanation
1	Heating system heat exchanger sensor, right (IHKA High only)	2	Footwell flap motor, right (IHKA High only)
3	Fresh-air/air-recirculation flap motor, right	4	Ventilation flap motor, right
5	Stratification flap motor	6	Blower
7	Rear-compartment flap motor (IHKA High only)	8	Ventilation flap motor, left (IHKA High only)
9	Evaporator	10	Fresh-air/air-recirculation flap motor, left
11	Evaporator temperature sensor	12	Defroster flap motor
13	Footwell flap motor, left	14	Heating system heat exchanger sensor, left
15	Heating system heat exchanger		
The arrow shows the direction of travel.			

E60, E61, E63, E64 - Condensation sensor

Installation location

The condensation sensor is located on the inside of the windscreen, under the mirror base cover, beneath the rain-light sensor. The condensation sensor must be positioned within the sweep range of the windscreen wiper. This ensures that changes in temperature caused by snow or ice on the outside of the windscreen have no effect.

Construction



Key	Explanation	Key	Explanation
1	Sensor electronics (protected by a sealing compound)	2	3-pin connector to IHKA control unit
3	Wet measuring cell with protective membrane made of teflon	4	Calibration shaft with laser-calibrated resistances (sensor calibration by manufacturer)

How it works

The condensation sensor is only active when the IHKA is in automatic mode.
The condensation sensor indirectly exposes condensation on the window surfaces. In other words, the condensation sensor monitors the environment in which condensation forms on the window surfaces. Humidity on the windscreen and the temperature of the windscreen inside the vehicle are measured and a frequency-dependent signal is generated.

To measure the atmospheric humidity, the condensation sensor contains a capacitive sensor element. The sensor element is a component of an electrical oscillation circuit. The oscillation circuit is detuned in proportion to the change in humidity at the windscreen. The resonant frequency of the oscillation circuit is then used as a reference to measure the air humidity. The IHKA control unit evaluates the frequency-dependent signal. Moreover, the interior and exterior temperatures and the temperatures of the windscreen inside the vehicle are evaluated.
If an air humidity of more than 65 % is detected at the windscreen, the IHKA control unit will initiate measures to prevent condensation on the windows .

E60, E61, E63, E64 - IHKA controls/control unit

Installation location

The IHKA controls/control unit is located in the middle of the dashboard, beneath the centre ventilation grille.

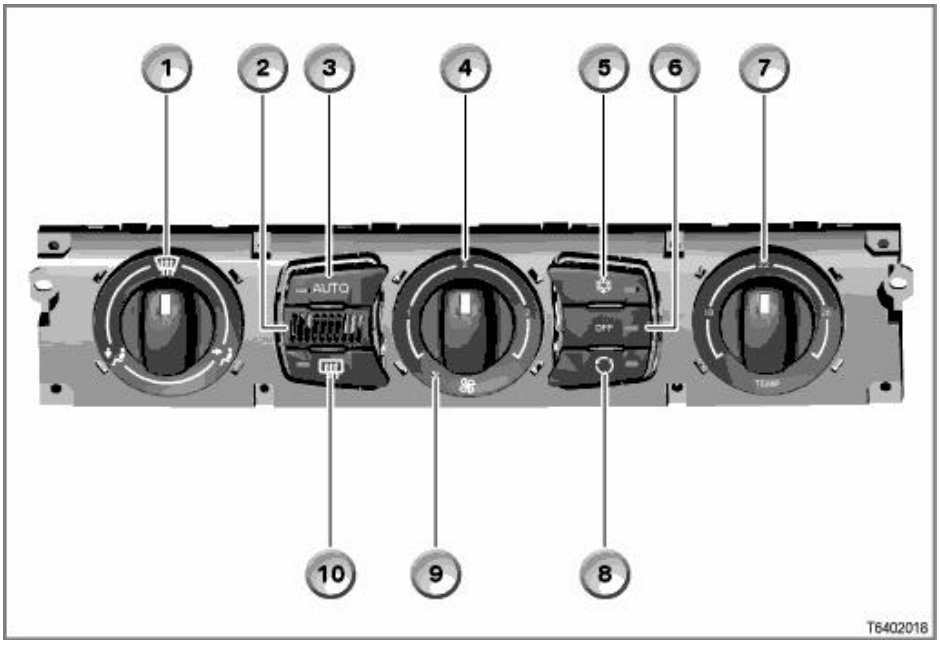
Construction

The air conditioner is available in the versions Basic and High. These each have their own IHKA controls.
Integrated in the IHKA controls is a force-ventilated sensor for measuring the interior temperature. For reasons relating to production, the display for independent heater operation is always integrated.

The following overviews show the layout and pin assignments for the

- IHKA Basic
- IHKA High

Layout and pin assignment for IHKA Basic



Key	Explanation	Key	Explanation
1	Rotary switch for air distribution	2	Opening for force-ventilated interior temperature sensor
3	AUTO button	4	Rotary switch for blower setting
5	A/C button	6	OFF button
7	Rotary switch for temperature setting	8	Air-recirculation button
9	Display for independent heater operation	10	Heated rear window button

Pin assignment: X18793, 18-pin black

Pin	Type	Description
1	E/A	LIN bus, data
2	---	---

3	E	Signal from refrigerant pressure sensor
4	V	Terminal 15, power supply for refrigerant pressure sensor
5	---	---
6	E/A	CAN-bus high
7	E/A	CAN-bus low
8	M	Earth for refrigerant pressure sensor
9	---	---
10	V	Terminal 30, power supply
11	A	Control valve in A/C compressor
12	A	Water valve
13	A	Auxiliary water pump
14	A	Relay for heated rear window
15	A	Heated washer jets
16	E	PWM signal from DDE for electric auxiliary heater
17	---	---
18	M	Earth point, terminal 31
	A = Output E = Input E/A = Input and output M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system	

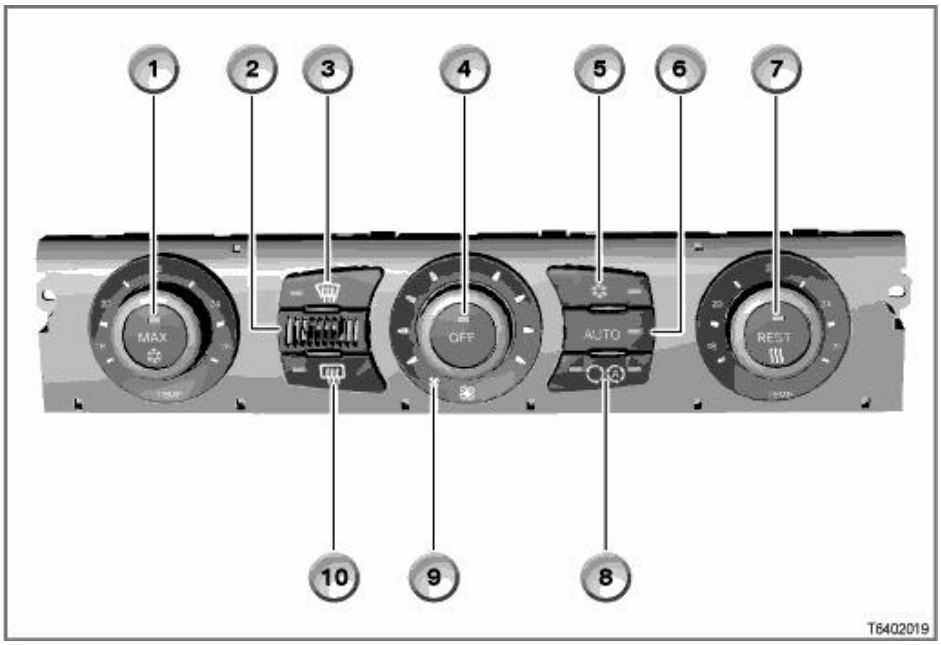
Pin assignment: X01130, 12-pin black

Pin	Type	Description
1	E	Signal from heating system heat exchanger sensor
2	---	---
3	E	Signal from evaporator temperature sensor
4	---	---
5	---	---
6	M	Earth point for sensors
7	A	PWM signal to electric auxiliary heater
8	---	---
9	---	---
10	V	LIN bus, supply
11	E/A	LIN bus, data
12	M	LIN bus, earth

A = Output
E = Input

	E/A = Input and output M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system

Layout and pin assignment for IHKA High



Key	Explanation	Key	Explanation
1	Rotary switch for temperature setting, left, with MAX button	2	Opening for force-ventilated interior temperature sensor
3	Defrost button	4	Rotary switch for blower setting with OFF button
5	A/C button	6	AUTO button
7	Rotary switch for temperature setting, right, with REST button	8	Button for outside air/automatic air recirculation (AUC)/air recirculation
9	Display for independent heater operation	10	Heated rear window button

Pin assignment: X13765, 2-pin black

Pin	Type	Description
1	V	Terminal 30, power supply
2	M	Terminal 31, earth
	M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system	

Pin assignment: X01130, 12-pin black

Pin	Type	Description
1		

2	E	Signal from right-hand heating system heat exchanger sensor
3	E	Signal from evaporator temperature sensor
4	---	---
5	---	---
6	M	Earth point for sensors
7	A	PWM signal to electric auxiliary heater
8	---	---
9	---	---
10	V	LIN bus, supply
11	E/A	LIN bus, data
12	M	LIN bus, earth
	A = Output E = Input E/A = Input and output M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system	

Pin assignment: X1527, 26-pin blue

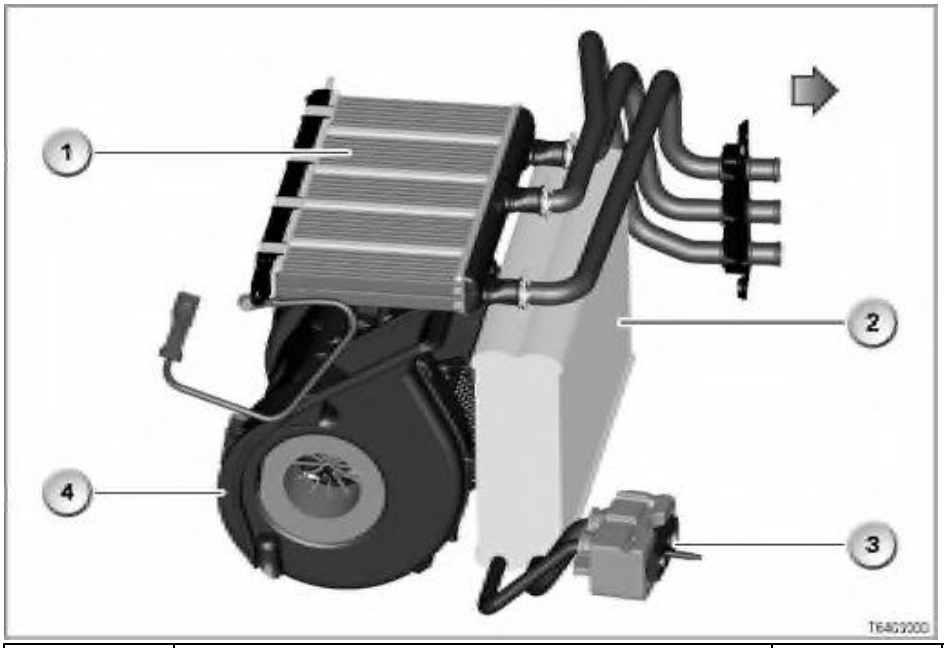
Pin	Type	Description
1	E/A	LIN bus, data
2	V	AUC sensor, supply
3	E	Signal from AUC sensor
4	V	Condensation sensor, power supply
5	E	Signal from condensation sensor
6	E/A	CAN-bus high
7	E/A	CAN bus low
8	V	Refrigerant pressure sensor, supply
9	E	Signal from refrigerant pressure sensor
10	V	Solar sensor, power supply
11	E	Solar sensor, left signal (E63/E64 right signal)
12	E	Solar sensor, right signal (E63/E64 left signal)
13	M	Solar sensor, earth
14	E	PWM signal from DDE for electric auxiliary heater
15	A	Control valve in A/C compressor
16	E	Dual water valve, left
17	E	Dual water valve, right
18	A	Auxiliary water pump

19	A	Relay for heated rear window
20	A	Heated washer jets
21	M	Refrigerant pressure sensor, earth
22	V	Rear stratification flap potentiometer, power supply (not E63)
23	E	Signal from rear stratification flap potentiometer (not E63)
24	E	Signal from ventilation temperature sensor
25	M	Earth point for AUC, ventilation temperature and condensation sensor
26	M	Rear-compartment air-stratification flap potentiometer
	A = Output E = Input E/A = Input and output M = Earth V = Supply For current specifications regarding pin assignment, please refer to BMW diagnosis system	

E60, E61, E63, E64 - Electric auxiliary heater

Installation location

The electric auxiliary heater is part of the heating system heat exchanger in the heating/air-conditioning system on vehicles with diesel engine. The heating system heat exchanger is integrated into the heating/air-conditioning system, located above the blower and perpendicular to the evaporator.



Key	Explanation	Key	Explanation
1	Heating system heat exchanger with integrated electric auxiliary heater	2	Evaporator
3	Expansion valve	4	Blower
The arrow shows the direction of travel.			

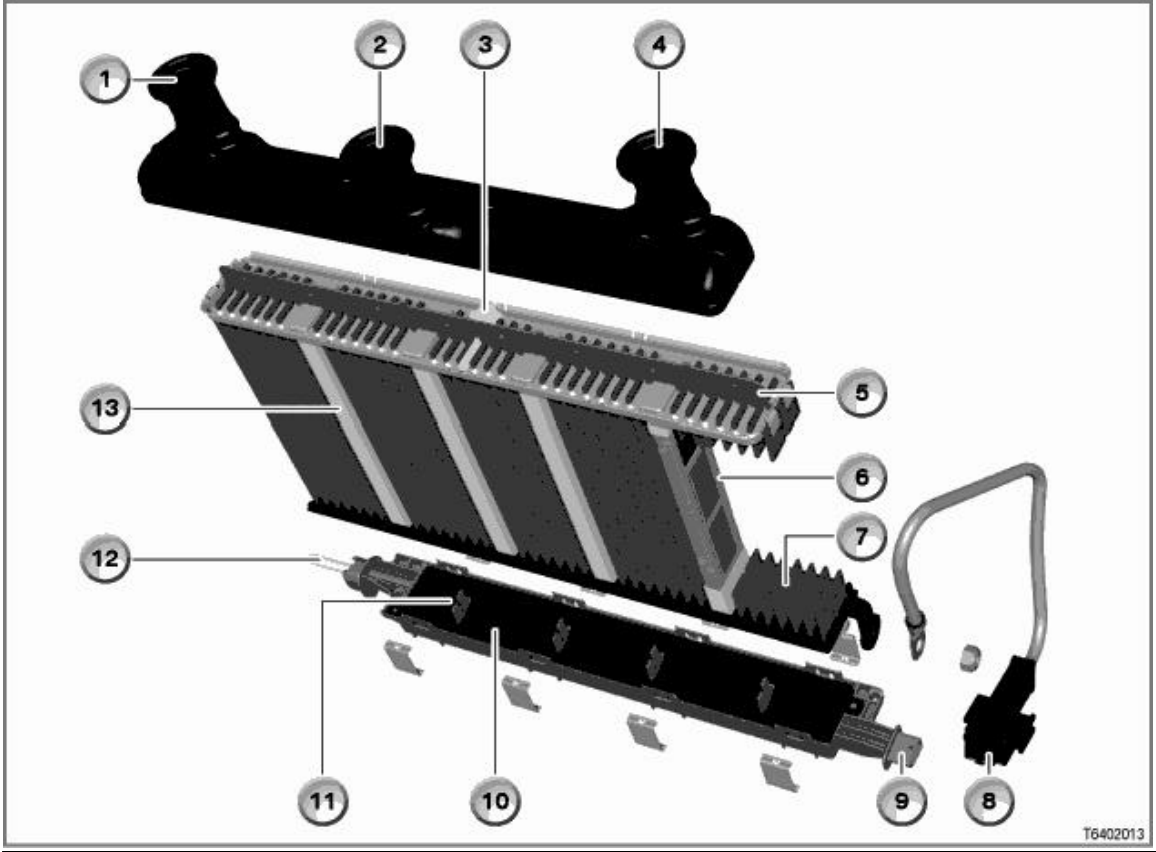
Construction

The electric auxiliary heater consists of 4 heating cells. Each heating cell contains 4 heating elements. The heating elements are grouped into pairs to form heating chains. A total of 8 heating chains can be selected in 8 heating levels.
The regulator for the electric auxiliary heater is secured directly on the heating system heat exchanger (with clamps). Regulator and heating system heat exchanger form a single unit.

The following illustrations show

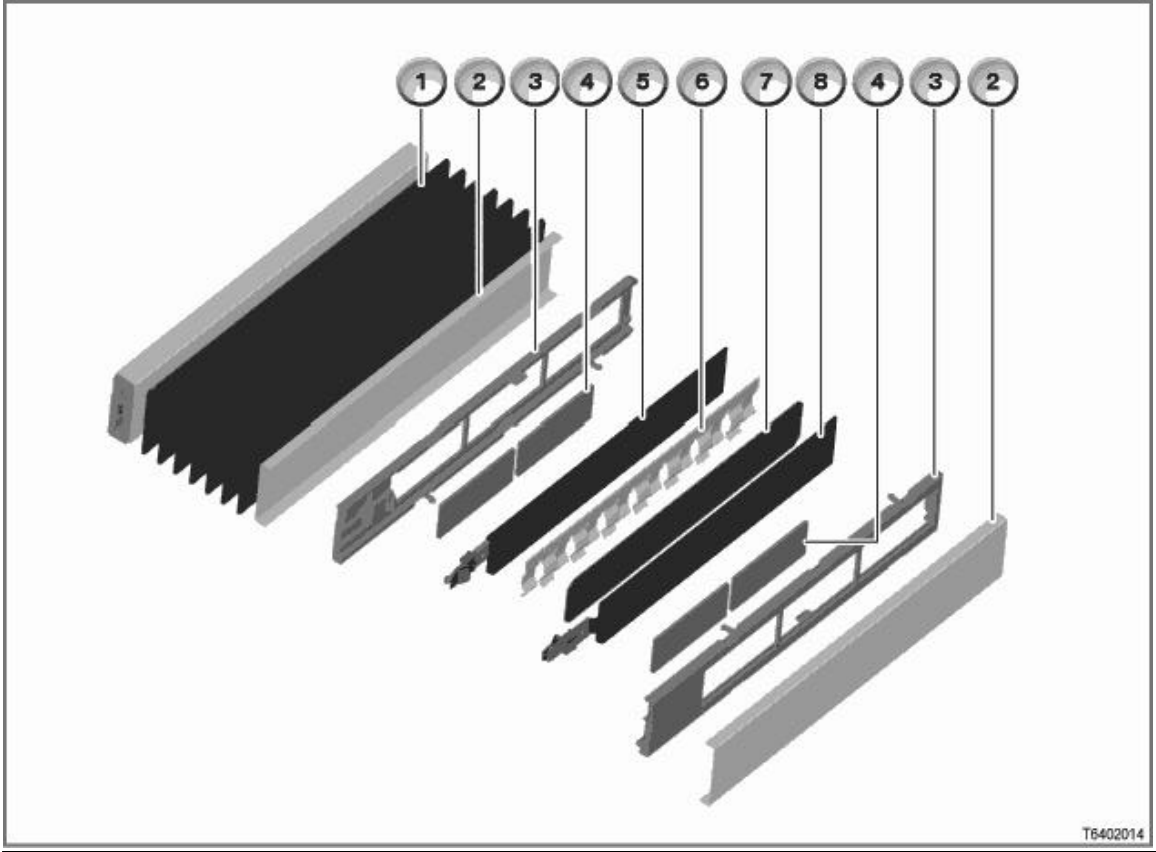
- the construction of the electric auxiliary heater
- the construction of a heating cell

Construction of the electric auxiliary heater



Key	Explanation	Key	Explanation
1	Water connection for feed line (left)	2	Water connection for return line (left and right)
3	Separating wall between left and right-hand heating feed line	4	Water connection for feed line (right)
5	Separating wall between heating feed and return lines	6	Heating cell (sectional view)
7	Heating circuit heat exchanger fins	8	Terminal 31 (earth for electrical auxiliary heater)
9	LIN bus connector	10	Regulator for electrical auxiliary heater attached to heating system heat exchanger
11	Connector (positive connection) for heating chains 1 and 2	12	Terminal 30 (power supply for electrical auxiliary heater)
13	Heating cell (heat exchanger element in electric auxiliary heater)		

Construction of a heating cell



Key	Explanation	Key	Explanation
1	Heating circuit heat exchanger fins	2	Heating cell housing and earth connection for heating elements
3	Plastic frame	4	Heating element
5	Positive contact plate for heating chain 1	6	Tensioning spring
7	Insulation between heating chain 1 and heating chain 2	8	Positive contact plate for heating chain 2

The heating elements are held in place by a plastic frame and a tensioning spring.

How it works

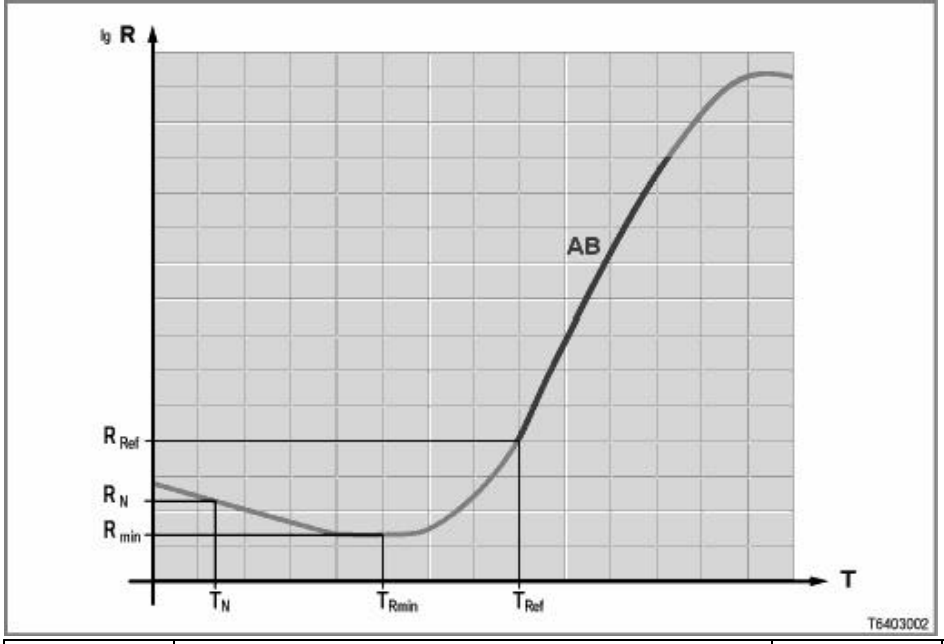
The following functions are explained:

- Heating element
- How the electric auxiliary heater is activated

Heating element

The heating element in the electric auxiliary heater are PTC resistors. The heating elements are made up of individual ceramic semiconductor resistors.

The following illustration shows the characteristic curve of a heating element.



Key	Explanation	Key	Explanation
AB	Operating range with linear, positive temperature coefficient (PTC)	T	Temperature
R_{lg}	Resistance (logarithmic representation)	T_N	Room temperature
R_{min}	Minimum resistance	T_{Ref}	Temperature at start of linear operating range
R_N	Resistance at room temperature	T_{Rmin}	Temperature of minimum resistance
R_{Ref}	Resistance at start of linear operating range		

From a certain temperature T_{Rmin}, the resistance of a heating element has a positive temperature coefficient. In other words, as the temperature rises, the electrical resistance of the heating element also increases. The maximum current draw is thus limited. In the operating range AB, the heating elements have an almost linear curve.

This electrical characteristic of the heating element resistance allows a maximum temperature of approx. 120 °C in the heating cell, which does not constitute a problem for the heating/air-conditioning system.

This "physical" over-temperature protection is maintained even if the blower were to fail.

The temperature of the heating element rises quickly when current is applied (maximum operating temperature approx. 120 °C). From about 80 °C, the heating element begins to throttle its current consumption down. The heat from the heating element is fed into the heating cell. The airflow generated by the blower flows across the heating cell. This warms up the air-mass flow. The warm air is then fed into the vehicle interior.

How the electric auxiliary heater is activated

The electric auxiliary heater is activated by the IHKA control unit via the LIN bus. The DDE (digital diesel electronics) actuates the electric auxiliary heater with a pulse-modulated signal (PWM signal). The PWM signal from the DDE tells the electric auxiliary heater regulator the maximum available electrical power (depends on resources in the vehicles electrical system).

The regulator in the electric auxiliary heater automatically controls how the heating chains are switched on and off. The individual heating levels / heating chains are switched on/off with delayed switching times. This prevents larger current fluctuations in the vehicle electrical system.

The heating chains are switched on and off by the electric auxiliary heater regulator according to set parameters:

- Heat output setting
- Permissible number of heating chains

- Electrical system
- Priority for driver's side
- Limited maximum number of heating chains
- General conditions
- Self-check (safety functions)

Heat output setting

The heat output setting is made with the rotary switch and is converted into a specified value. On the IHKA Basic (without left/right separation), the specified value for the driver's side applies.

Permissible number of heating chains

This parameter enables the heating chains to be activated and priorities to be assigned (depending on heating requirements for the driver's side and the front-passenger side). The input parameter corresponds to the maximum number of heating chains permitted.

Electrical system

This parameter provides information about the resources in the vehicle electrical system. With this information, the auxiliary heater regulator decides how many heating chains can be activated.

Priority for driver's side

This parameter ensures the driver's side is given preference. If an odd number of heating chains is activated, there will always be one heating chain more activated for the driver's side.

Limited maximum number of heating chains

This parameter provides information about the maximum number of heating chains that is permissible. The parameter depends on the resources available in the vehicle electrical system, the general conditions and the self-check functions.

General conditions

Depending on the ambient temperature, the maximum permissible number of heating chains may be limited.

If the defrost function is selected at the IHKA controls, the maximum heating level is activated, depending on the resources available in the vehicle electrical system.

Self-check (safety functions)

The self-check of the electric auxiliary heater regulator includes the following protective functions:

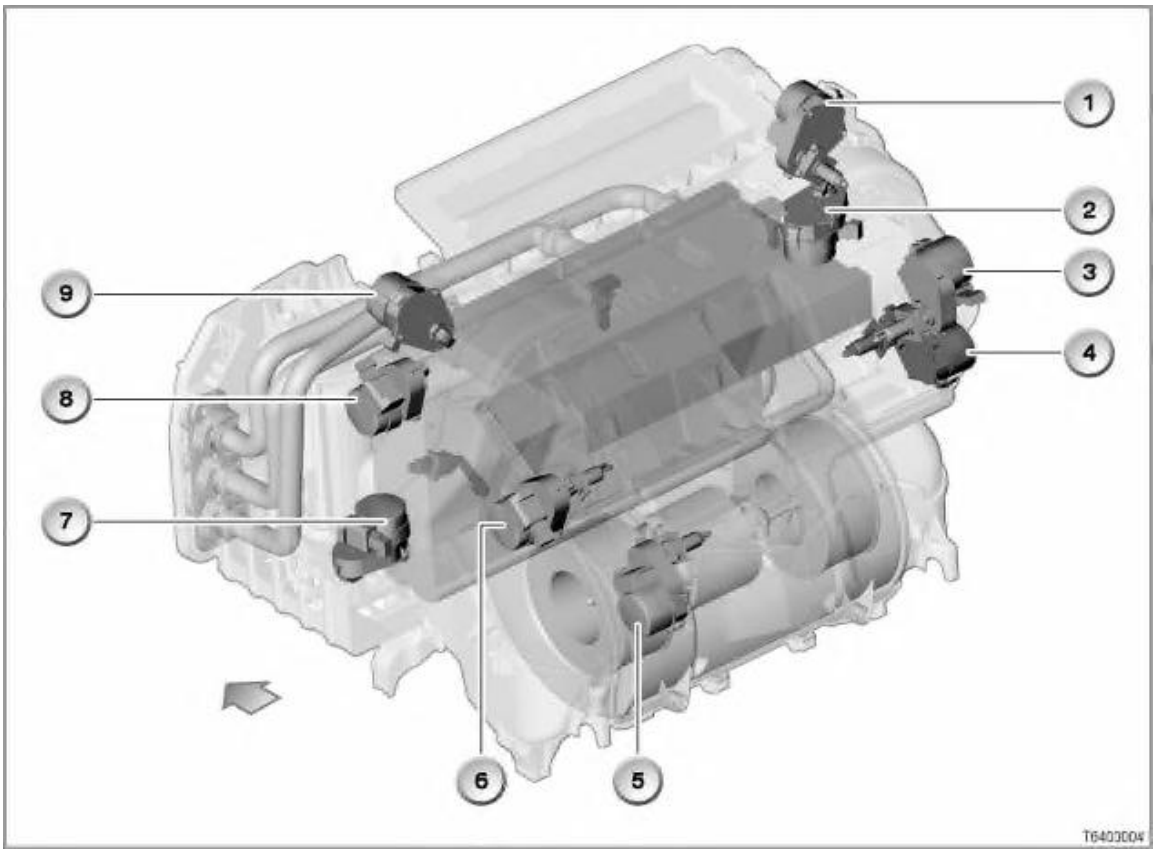
- Overvoltage
- Undervoltage
- LIN bus signal failure
- Incorrect command
- Temperature monitoring as protection against thermal overload (heating chains OFF if temperature greater than 115 °C, heating chains ON again when temperature drops below 110 °C)
- Short-circuit detection
- Open circuit
- Reset (software reset)
- Monitoring of correct order in function sequence

If one of these protective functions is activated, all active heating chains will be switched off.

If one of the heating chains is recognised as being defective, the next heating chain will be used as a substitute.

E60, E61, E63, E64 - Flap motors

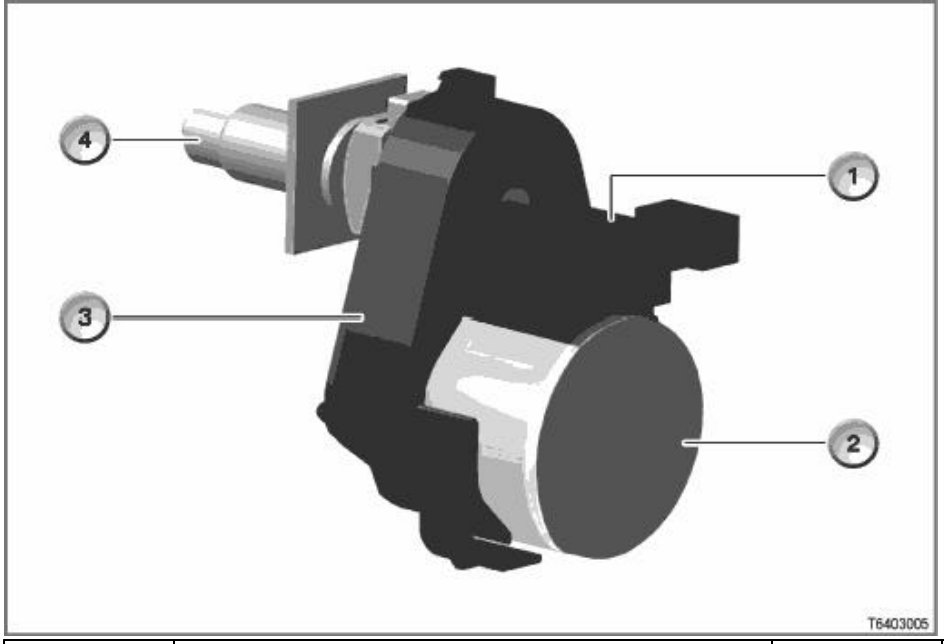
Installation location



For better clarity, the flap motors are illustrated without flaps.

Key	Explanation	Key	Explanation
1	Footwell flap motor, right (High version only)	2	Fresh-air/air-recirculation flap motor, right
3	Ventilation flap motor, right	4	Stratification flap motor
5	Rear-compartment flap motor (IHKA High only)	6	Ventilation flap motor, left (IHKA High only)
7	Fresh-air/air-recirculation flap motor, left	8	Defroster flap motor
9	Footwell flap motor, left		
The arrow shows the direction of travel.			

Construction



Key	Explanation	Key	Explanation
1	Connector housing with integrated electronic components and 3-pin connector	2	Flap motor with housing
3	Transmission	4	Output member

All flap motors are of basically the same design. External distinguishing features are merely the different output members (e.g. levers and jaws) and the location/orientation of the connector.

How it works

The flap motors are actuated by the IHKA control unit via the LIN bus and are supplied with power and with an earth connection. At rest, the IHKA control unit switches the power supply off.

The flap motors have an integrated circuit in the connector housing. This circuit controls the coil of the flap motor. The circuit is compatible with bus technology and is capable of diagnosis (LIN bus).

The flap motors for the fresh-air/air-recirculation flaps are high-speed motors. The adjusting time CLOSED/OPEN is approx. 2 seconds. The other flap motors are normal-speed motors. The adjusting time CLOSED/OPEN is approx. 7 seconds.

The number of steps of the flap motors depends on the adjustment range of the flaps to be actuated.

Example:

Stepper motor	Setting angle	Number of steps	Adjusting time CLOSED/OPEN
Fresh-air/air-recirculation flap, left	115°	640 steps	approx. 2 seconds
Fresh-air/air-recirculation flap, right	95°	530 steps	approx. 1.7 seconds
Defroster flap	72°	1440 steps	approx. 7.2 seconds
Cold-air flap	69°	1370 steps	approx. 6.9 seconds

All flap motors are actuated by the IHKA control unit via the LIN bus. Each flap motor has an address permanently stored by the manufacturer, which allows unambiguous identification during bus communications. For this reason, all flap motors are different and cannot be interchanged.

Cutoff on blocking

The integrated circuits in the flap motors recognise a blocking of the flap motor from the increased current consumption. The integrated circuits report the fault to the IHKA control unit via the LIN bus. Defective flap motors are then no longer actuated.

Reference run of all flaps

The step motors are unable to recognise the current (actual) position. They always move relative to an end position of the flaps (reference point). One of the end positions of the flaps (closed / fully open) serves as reference point.
The flaps are moved to one of the end positions

- if the IHKA control unit is exchanged, or
- if the power supply is interrupted.

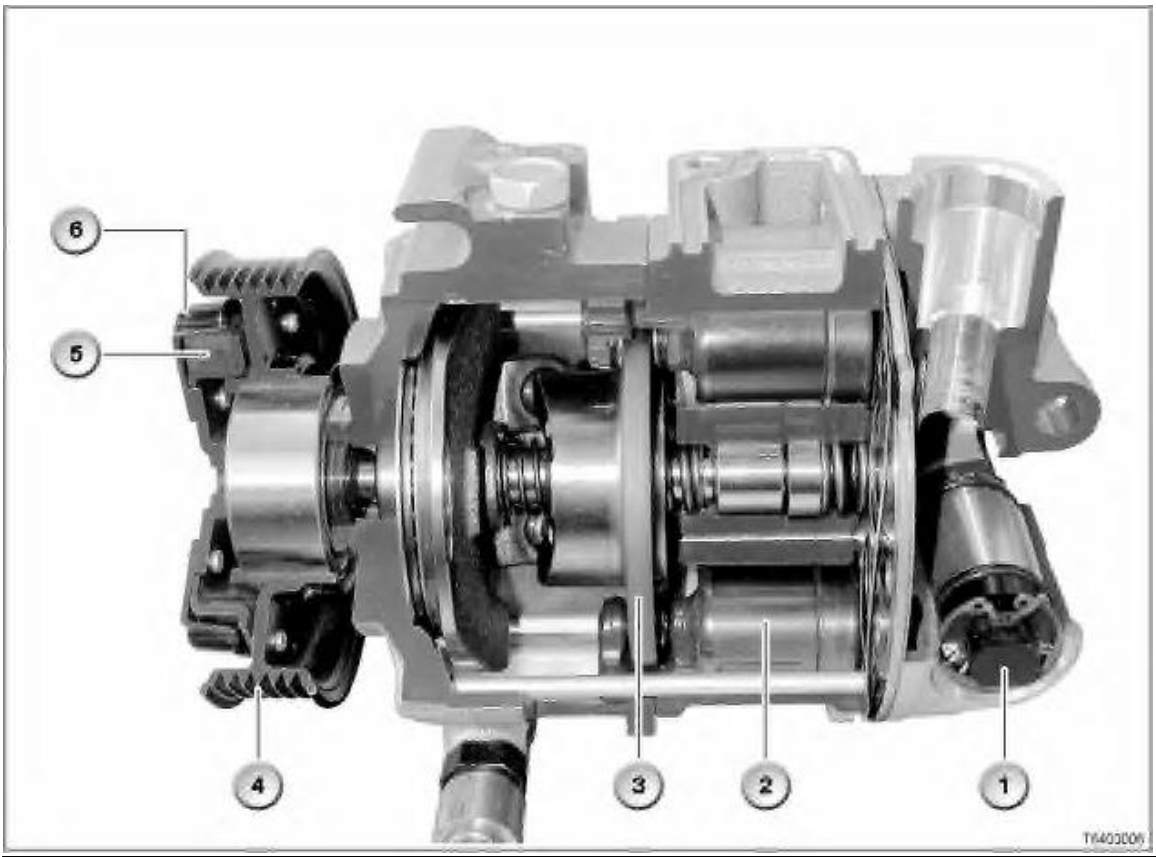
The end position is selected in such a ways that the subsequent nominal position can be reached by the shortest route.
The reference run can also be initiated by the BMW diagnosis system.

Positioning of fresh-air/air-recirculation flaps

When the vehicle is shut down (ignition OFF), the fresh-air/air-recirculation flap is moved to the "fresh air" position. This ensures that the interior will be supplied with outside (fresh) air in the event of the IHKA failing, regardless of the circumstances.

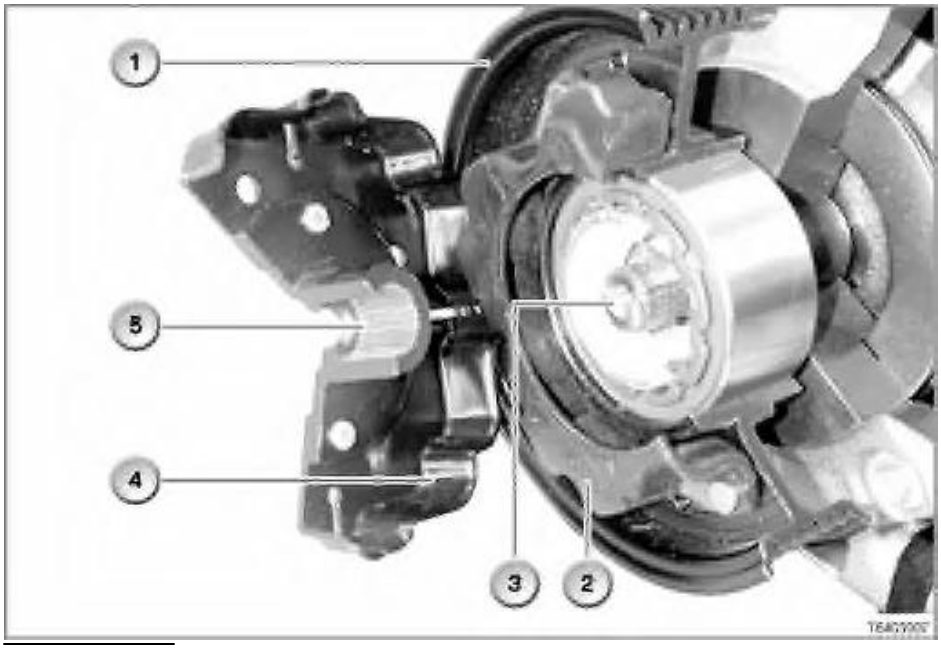
E60, E61, E63, E64 - A/C compressor

Construction



Key	Explanation	Key	Explanation
1	Electric control valve	2	Piston (7 pistons)
3	Swash plate	4	Pulley
5	Rubber element	6	Driver

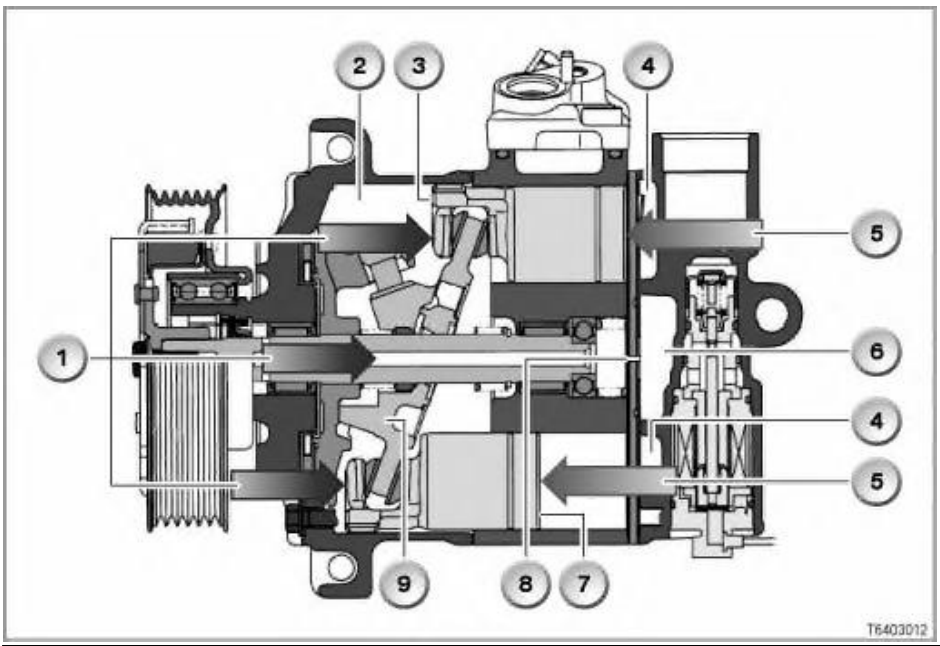
Layout of the A/C compressor drive



Key	Explanation	Key	Explanation

1	Pulley	2	Rubber element
3	A/C compressor shaft with spline teeth	4	Driver contour
5	Splines in driver		

How it works



Key	Explanation	Key	Explanation
1	Pressure: pressure in crank chamber plus spring	2	Pressure in crank chamber
3	Reverse side of piston	4	High pressure
5	Pressure: high pressure plus suction pressure	6	Suction pressure
7	Piston surface	8	Compensation bore for pressure in crank chamber and suction pressure
9	Swash plate		

Within the A/C compressor, the delivery volume and thus the pressure in the refrigerant circuit is generated by 7 pistons. The piston stroke is controlled by a swash plate.

With the help of this movement, the swash plate regulates:

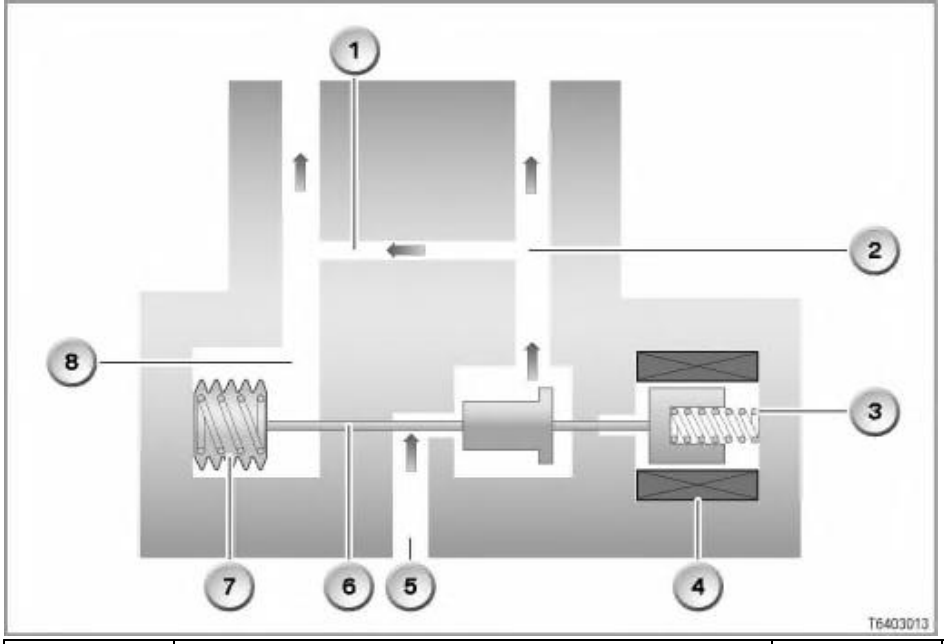
- the zero position
- the maximum displacement (100 %)
- the range of adjustment (2-100 %)

The electric control valve influences the balance of forces on the swash plate and thus the adjustment of the displacement.

An increase in pressure in the crank chamber increases the forces acting of the reverse side of pistons (towards minimum stroke). The displacement from the swash plate is decreased.

When the pressure in the crank chamber approaches the suction pressure due to equalisation through the compensation bore, the resulting forces on the surface of the pistons (towards maximum stroke) are in total greater than the forces acting on the reverse side of the pistons. The displacement from the swash plate is increased.

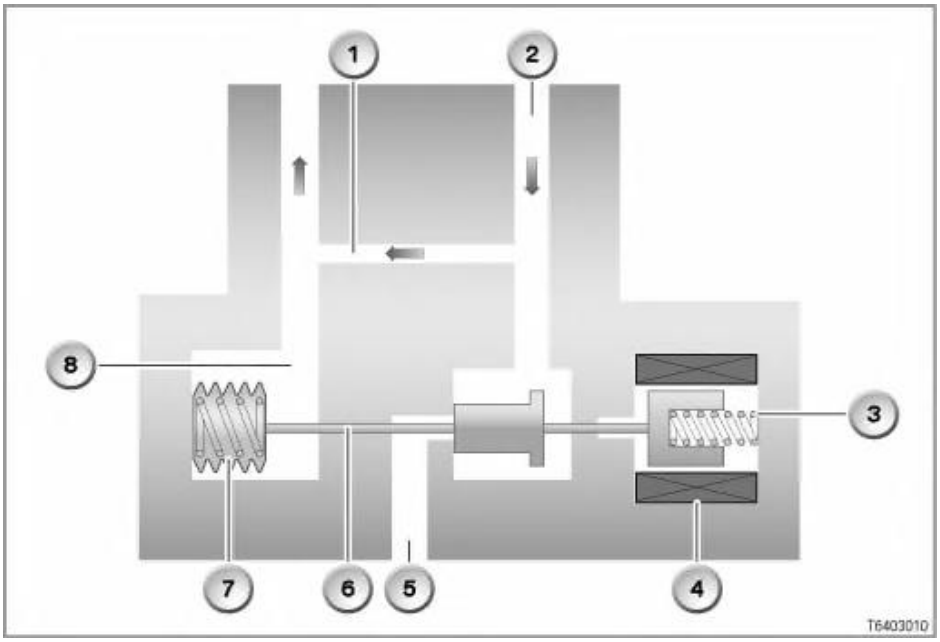
Zero position



Key	Explanation	Key	Explanation
1	Compensation bore for equalisation between pressure in the crank chamber and suction pressure	2	Pressure in crank chamber
3	Spring 2	4	Coil
5	High-pressure side	6	Valve tappet
7	Bellows with spring 1	8	Suction pressure

The electric control valve is open when no current is applied. The force from spring 1 is greater than the force from spring 2. In this situation, the suction pressure does not act on the bellows with spring 1.
Refrigerant flows from the high-pressure side into the crank chamber. The balance of forces shifts towards the swash plate. This moves the swash plate to a position that is almost vertical, not deflected. In this position, a compression coefficient of between 0 and 2 % is achieved, which serves to maintain internal lubrication.

Maximum displacement (100 %)



Key	Explanation	Key	Explanation

1	Compensation bore for equalisation between pressure in the crank chamber and suction pressure	2	Pressure in crank chamber
3	Spring 2	4	Coil
5	High-pressure side	6	Valve tappet
7	Bellows with spring 1	8	Suction pressure

The electric control valve is placed under current (by the IHKA control unit) and thus closed. The force from spring 1 is less than the sum of the forces of the coil plus spring 2 plus bellows (spring 1). In this situation, the suction pressure acts on the bellows with spring 1 and thus generates an additional force that tries to close the valve.
No refrigerant is able to flow into the crank chamber from the high-pressure side. The pressure in the crank chamber is reduced via the compensation bore until the pressure in the crank camber corresponds to the suction pressure. The balance of forces shifts. The forces that act on the surface of the piston are greater than those that act on the swash plate. The result is maximum deflection of the swash plate (maximum displacement).

Range of adjustment 2-100 %

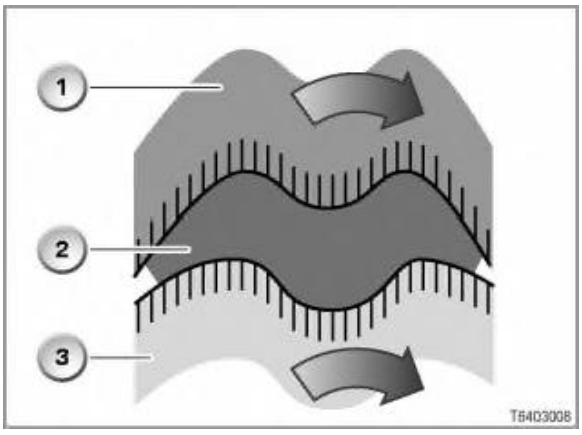
In regulated operation, the electric control valve is actuated by the IHKA control unit with a pulse-modulated signal (PWM signal), depending on the suction pressure. The electric control valve enables the springs and the bellows to change the characteristic curve. The result is a smoothly variable output adjustment between 2 and 100 % and the realisation of "variable evaporator control" between 2 °C and 7 °C.

To reduce load, only the cooling output actually needed is generated. The criteria for control and switching on/off are:

- A/C compressor speed (engine speed)
- A/C compressor load torque (CAN message from IHKA control unit to DME/DDE unit)
- Torque limitation (CAN message from DME/DDE control unit to IHKA control unit)
  Possible restriction of A/C compressor load torque at kick-down position or if coolant temperature is too high
- Limitation of refrigerant pressure

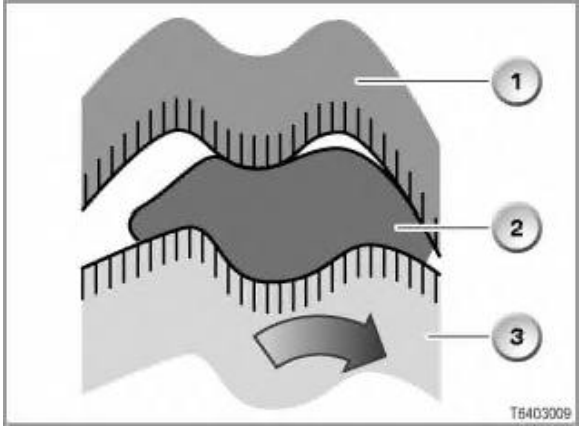
Protective function if A/C compressor is blocked

The rubber element transfers the torque from the pulley to the A/C compressor driver. Besides its function as a vibration damper, this rubber element also fulfils a protective function in the event of the A/C compressor blocking.
If the A/C compressor is blocked, the rubber element allows slip. Transmission of torque from the pulley to the driver, which is linked to the shaft of the A/C compressor, is interrupted.



Normal operation

1) Driver, connected to A/C compressor shaft
2) Rubber element, fitted to pulley
3) Pulley



A/C compressor blocked

1) Driver, connected to A/C compressor shaft
2) Rubber element, fitted to pulley
3) Pulley

E60, E61, E63, E64 - Auxiliary fan

How it works

The auxiliary fan cools the condenser. The auxiliary fan is switched on at road speeds below 70 km/h (approx. 43 mph). The auxiliary fan is switched off at road speeds above 80 km/h (approx. 50 mph).
At higher speeds, the air stream alone is sufficient to cool the condenser. At lower speeds and when stationary (idle), the cooling of the condenser must be supported or maintained by the auxiliary fan.

The speed of the auxiliary fan depends on the refrigerant pressure. Speed is regulated as follows:

- The refrigerant pressure sensor sends a signal to the IHKA control unit that is linear to the refrigerant pressure.
- The IHKA control unit calculates the fan speed needed for the auxiliary fan. The 15 possible fan speeds are assigned to pressure values in the refrigerant circuit. This demand is transmitted by the IHKA control unit through the body CAN and powertrain CAN to the DME/DDE.
- The DME/DDE control unit regulates the speed of the auxiliary fan with a pulse-modulated signal (PWM signal).

The maps for the auxiliary fan are encoded in the DME/DDE control unit. The encoded map for the fan (encoding viscous fan coupling or electric fan) always gives at least speed 1 when the air conditioner is switched on.

E60, E61, E63, E64 - General information on the IHKA for service staff

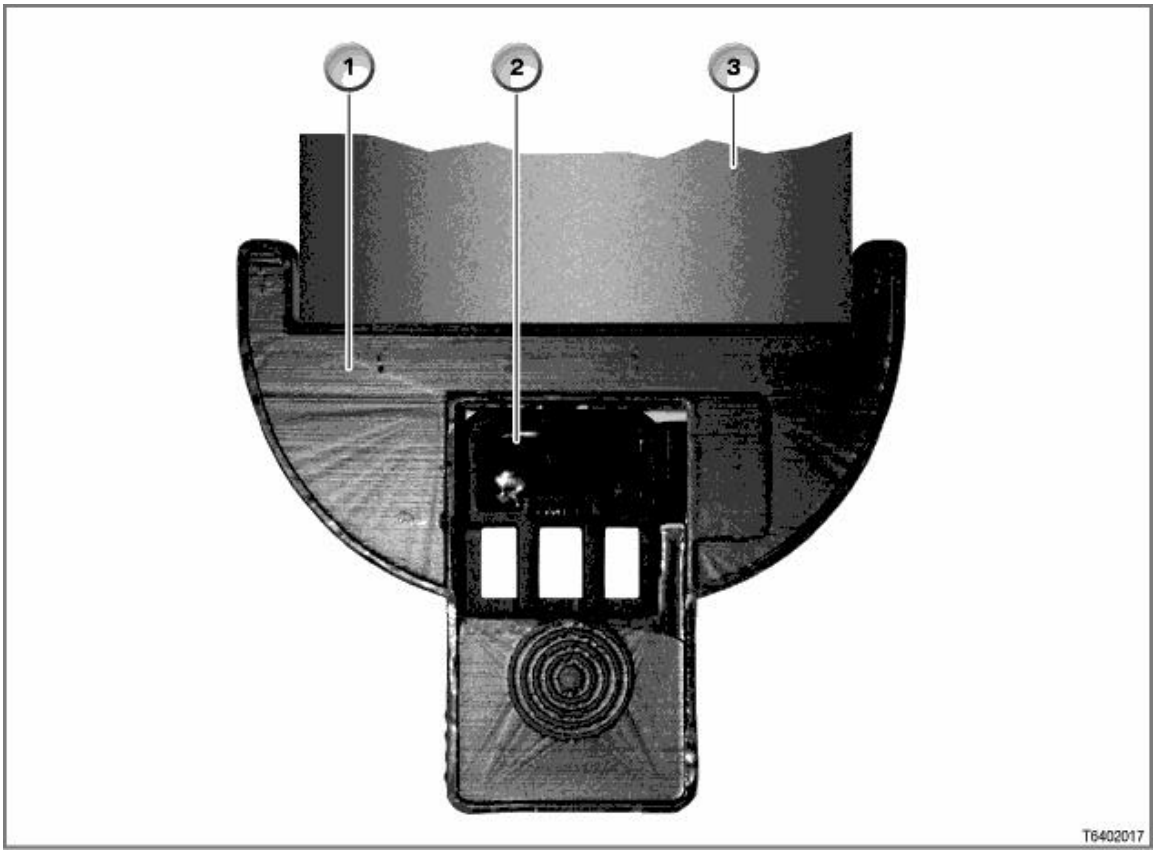
The following general information is provided for servicing the IHKA:

- Installation of condensation sensor
- Replacement of electric auxiliary heater
- Microfilter wear level
- Replacement of instrument cluster and IHKA control unit
- Running in A/C compressor

Installation of condensation sensor

Important: Use the positioning aid when installing the condensation sensor.

To prevent the rain/light sensor interfering with the condensation sensor, a minimum distance must be maintained between the two sensors. For this reason, the positioning aid supplied with the condensation sensor must be used during installation.



Key	Explanation	Key	Explanation
1	Positioning aid	2	Condensation sensor
3	Rain/light sensor housing		

Replacement of electric auxiliary heater

Important: Only replace the electric auxiliary heater and heating system heat exchanger complete.

The electric auxiliary heater and the heating system heat exchanger form a single unit. This unit must not be separated during service work. In the event of a defect, the entire unit must be replaced.

Microfilter wear level

The wear level of the microfilter is monitored by the IHKA control unit. To do this, the IHKA control unit uses a calculation model (algorithm) to simulate the condition of the microfilter from the following factors:

- Ambient temperature
- Signal from rain/light sensor (IHKA High only, otherwise substitute value)
- Signal from solar sensor (IHKA High only)
- Blower voltage
- Air conditions (recognised from frequent or infrequent use of air recirculation)
- Car road speed
- Service interval display (SIA) timer
- Odometer reading

The IHKA control unit forwards the following data to the instrument cluster (via the body CAN):

- Microfilter availability in percent
- Time remaining until next service

Replacement of instrument cluster and IHKA control unit

Important: Do not replace the instrument cluster and the IHKA control unit at the same time.

The instrument cluster and the IHKA control unit must not be replaced at the same time as the last valid data (redundant memory) for service operations would then be lost.

Running in A/C compressor

Important: Run the A/C compressor in after replacement.

If the A/C compressor has been replaced or if the refrigerant circuit has been recharged, the A/C compressor must be run in. Running in is needed to make sure that adequate lubrication (oil distribution) is available. Only perform running in with the BMW diagnosis system.

The A/C compressor must be run in the specified engine speed range during running in. The oil added by the manufacturer is then mixed with the liquid refrigerant.

Important: Do not exceed the specified engine speed.

Running in will automatically be aborted if the engine speed exceeds the specified engine speed range. Running in must then be repeated in full.

E60, E61, E63, E64 - Encoding/programming IHKA

Encoding

When encoding vehicle-specific data, the following details (among others) must be taken into account:

- Engine type
  (diesel or spark-ignition)
- National version
  (e.g. EURO version, US, Japan or hot climate, left/right-hand drive)
- Optional equipment
  (e.g. independent heater, IHKA High)
- Control unit version
  (IHKA High or IHKA Basic)

Programming

The IHKA control unit can be flash programmed via the body CAN (body controller area network).

Car and Key Memory

The following functions can be programmed either at the end of assembly or at the dealership:

Function	Explanation	Possible setting
Key-specific setting of heating, air conditioning, ventilation	The Key Memory settings for the IHKA can be activated or deactivated. If "active" is selected, the settings of the blower and air conditioning functions (AUC, air recirculation, air flaps, defroster) are stored for each key individually.	- active or - not active
OFF memory	The setting "air conditioner OFF" (IHKA controls off, flaps closed) is retained when the ignition is switched ON.	- active or - not active
Air-recirculation memory	Air recirculation is retained after restarting the engine. This function operates regardless of the key used.	- active or - not active
Blower correction	In automatic mode, the blower speed can be raised or lowered by 10 %.	- raise - not active - lower
Correction of nominal values for flaps	The temperature setting in the display can be corrected by the said amount.	- + 3 degrees - + 2 degree - + 1 degree - not active - - 1 degree - - 2 degrees - - 3 degrees
Convertible program	The A/C settings are adapted to take account of the open convertible top. The settings do not have to be changed when the convertible top is opened or closed.	- active or - not active *Note: Only change this setting when the convertible top is open.* This setting can only be changed in the CID when the convertible top is open.

Key Memory

When terminal 15 is switched off, the control settings for 4 different users can be stored in the EEPROM (electronically erasable programmable read-only memory) of the IHKA control unit. These key-dependent control setting are reactivated when terminal 15 is switched on again with the respective remote control (radio-control key). The IHKA control unit receives the number of the current remote control as a CAN message from the Car Access System (CAS) (via the body CAN). There are 4 remote controls for each vehicle.

In addition to the data records for the 4 remote controls, the IHKA also receives a fifth data record that can be assigned to a mechanical key. This data record serves as a standard setting, e.g. in the event of no valid remote control being recognised.

The following data are stored in the EEPROM of the IHKA control unit for each remote control and as a standard setting for the mechanical key:

- Air-stratification flap setting
- Blower speed setting in manual mode
- Defroster-flap setting in manual mode
- Ventilation-flap setting, top right, in manual mode
- Footwell-flap setting, left, in manual mode
- Footwell-flap setting, right, in manual mode
- Ventilation-flap setting, left, in manual mode
- Ventilation-flap setting, right, in manual mode