

# BMW TIS SBT Integrated automatic heating / air-conditioning system (IHKA), Basic and High

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

E60



### Introduction

For the first time, the E60 series will be equipped as standard with an automatic air-conditioning system. This contrasts with the E39, for which the automatic air-conditioning system was only available as an option (special equipment). Compared to the previous model, the automatic air-conditioning system on the E60 is an improved system: The automatic air-conditioning system is easier to operate and is extremely efficient, even under extreme conditions.

The automatic air-conditioning system is available in two versions, Basic and High (option 534). 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

- 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 condensation, 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.

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, manual air distribution is set with the IHKA controls; on the IHKA High it is set in the Central Information Display (CID) using the controller in the centre console.



- Revised display concept  
The scale on the rotary switch for the blower setting has a 9-element LED display. The manually blower speed setting is shown by the corresponding LEDs lighting up. In automatic mode, no display is given (IHKA High only).  
The LCD display used in the IHKA controls on the E39 is not present on the E60. 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 in the centre console.
- 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 forced-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. 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 transmits an analogue signal to the IHKA control unit for each side, driver and front-passenger, depending on the intensity of the sunlight at each side.
- **Sensor for automatic air-recirculation control (IHKA High only)**  
The AUC sensor is located at on the top of the fan cowl and is impinged by 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<sub>2</sub>)
- **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. [\[more ...\]](#)
- **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.

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

- **Flap motors**

The IHKA Basic has 6 flap motors to control the air 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

- **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 and is actuated by the IHKA control unit via the LIN bus. The blower motor is actuated by a pulse-modulated signal (PWM signal) from the blower regulator.

- **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 has no clutch, i.e. it 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.

- **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 changes feeds water to the independent heater either 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.

- **Condenser with integrated drier flask**

Refrigerant is converted from gas into liquid in the condenser. In the integrated drier flask, which is installed downstream of the condenser, any water that may be present in the refrigerant circuit is collected. 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**

A data connection supplies all components on the LIN bus with the control information needed and brings the status reports back to the IHKA control unit. 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 (CID)**

The following control and display functions are selected and activated with the controller in the CID:

- **Temperature control (IHKA Basic)**  
The temperature set at the IHKA controls applies centrally for the driver's side and the front-passenger side in the footwell, upper body and windscreen. 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)**  
Direct operation and programming with timer are available.
- **Independent ventilation (IHKA High only)**  
Direct operation and programming with timer are available.
- **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 driver's side and front-passenger side for the footwell and upper body.  
The driver-side setting applies for both sides in the area of the windscreen.

### **System functions**

The IHKA comprises the following 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 (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)
- 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.

The temperature inside the vehicle interior is controlled with the help of a master controller. Regulation is based on the specification set at the rotary switch (adjustment range: 17-27 °C) and the actual value from the temperature measured by the interior temperature sensor.

The lead parameter Y (= value in %) 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. Fault quantities can be caused by

- fluctuations in airflow
- fluctuations in coolant flow in engine heater circuit
- changes in temperature of 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 controlled with the help of 2 master controllers. Regulation is based on the specifications set with the left and right-hand rotary switches and the actual value from the temperature measured by the interior temperature sensor.

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).

### **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 air intake 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 at high intensities of sunlight 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 70 °C  
and
- ignition lock position R or ignition OFF  
and
- 15 minutes after terminal 15 OFF not yet expired

### **Defrost (IHKA High only)**

The defrost function is activated with the defrost button in the IHKA controls. When defrost is activated, the defroster flap (on the inside in front of the windscreen) is opened 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

To achieve the best possible defrosting effect, after terminal 15 is switched ON, the time span for the heated rear window is determined as follows the first time it is switched on:

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.



## **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 from air recirculation/AUC/automatic air-recirculation mode to partially fresh air
- Switch from partially fresh air to fresh air in air-recirculation/AUC/automatic air-recirculation mode
- 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)

## **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 heater is switched on 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 when the engine is running (pseudo auxiliary heating)
- Telestart (via CAS)
- Low-voltage cutout

### Auxiliary heating when the engine is running (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 to the IHKA and independent heater control units via the body CAN.

### 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.