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Climate Control Systems and Functions

Model: All

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Describe the difference between the climate control systems used by BMW.
- Describe how temperature control is achieved in BMW climate control systems.
- Understand the features and functions of BMW IHKA Systems.

Heating and Air Conditioning Systems

There are a few different types of BMW climate control systems. Most of the current US vehicles are equipped with fully automatic climate control systems (IHKA). Each climate control system has different features and functions depending upon the vehicle application. These systems are:

IHKS

Translated from German, the acronym means “Integrated Heating and Air Conditioning Control. This system does not regulate the interior temperature of the passenger compartment automatically. IHKS is single Zone system, controlled directly by the driver to achieve the desired level of comfort and was installed on the E36/5(318ti), E36/7(Z3) and the E52 Z8 as standard equipment.

IHKR

The IHKR system is a “semi-automatic” climate control system. Interior air temperature is controlled automatically, but air distribution and blower speed are controlled from the control panel by the driver. IHKR was used on the some early vehicles such as the E34 and E36 (up to 95). The most recent use of the IHKR system was on the E39 525, E53 X5 3.0, E46 325 and the E85 Z4 as standard equipment (IHKA was available as an option). IHKR is also a single zone system, with only one temperature control for the entire passenger cabin.

IHKA

This is a fully automatic climate control system. Air distribution, blower speed and temperature regulation are controlled automatically. The system is designed to maintain the driver desired temperature setting automatically by monitoring interior temperature. The IHKA system is a dual zone system, with 2 temperature controls with some exceptions (the E46 and E83 X3 with basic single zone IHKA). The IHKA system was first installed on 7 and 8 series vehicles. The system was added to the 3 series (E36, E46), then to the 5 series E39, E53 and it is currently available on all US models.

FKA (E66)

This is a Rear Compartment Air Conditioning system (FKA), available as an option on the E66. The rear compartment air conditioner is located in the front area of the luggage compartment. The control and integration of the rear compartment air conditioning system in the IHKA refrigerant circuit is designed so that independent operation is possible for either the front or rear unit.

FKA (E70)

This is a rear climate control system that is available currently on the E70 X5. By combining IHKA with FKA the system is considered to be a true 4 zone system. Every passenger has the option to change the temperature of his sitting area independently with respect to the other occupants.

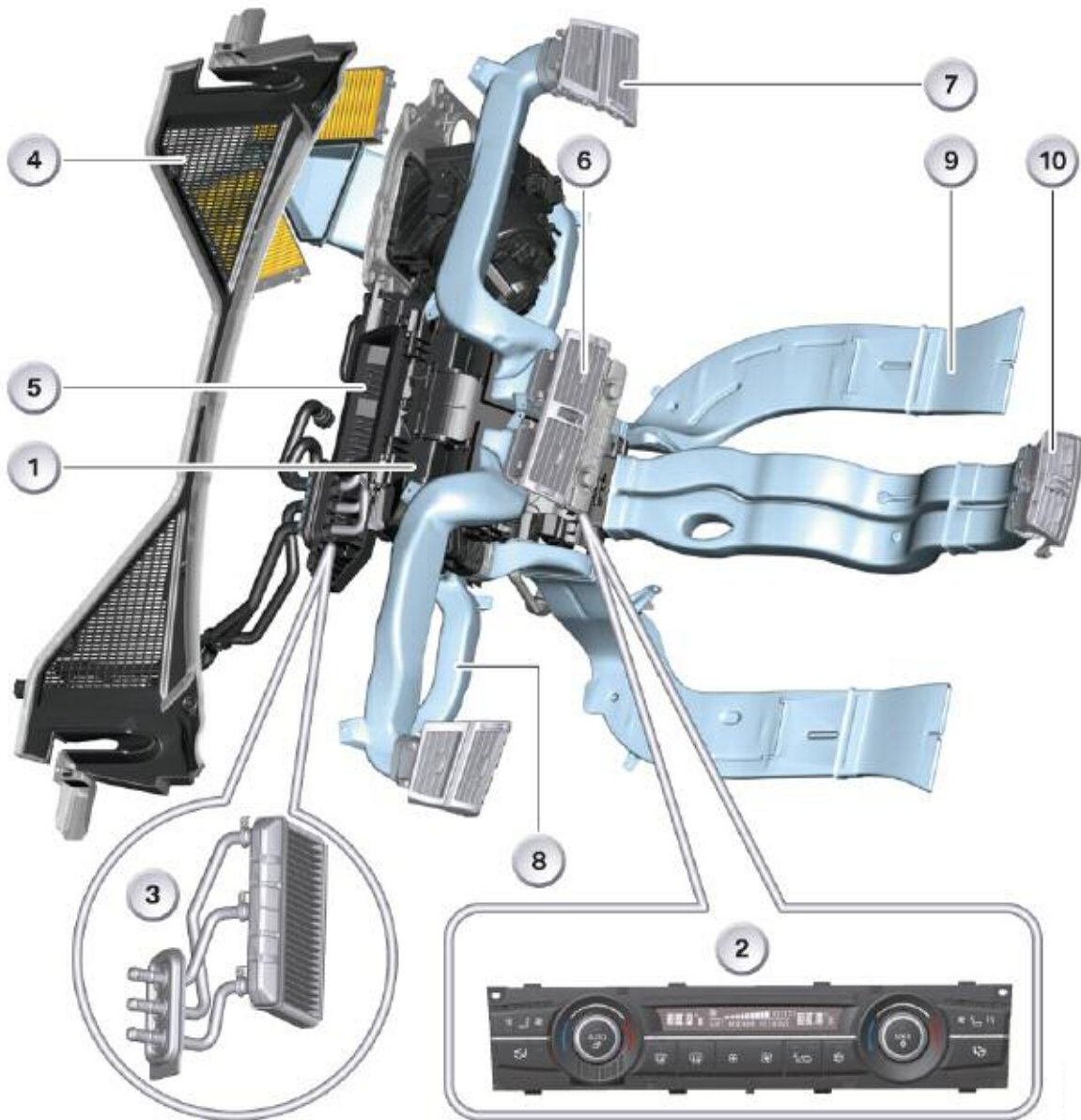
Note: BMW Climate Control Systems may be coolant (water) temperature regulated or air temperature regulated depending on the model.

E70 Dual Zone IHKA

Due to its dual section heater core, the IHKA allows separate and individual 2- zone, right/left temperature control. This is achieved in part, through the use of left and right temperature sensors. The desired temperature is fine tuned via two water control valves (left/right). The water flow through the heater core is aided with the use of an auxiliary water pump in the case of vehicles with the N62 engine (the N52 engine has an electric water pump thus no auxiliary pump is needed)

Fresh air or recirculated air can be routed directly to the air ducts via the evaporator and appropriate bypass, without being routed through the system's heater core. The air flow (fresh air or recirculated air) is first routed via the evaporator in the heating/ air-conditioning housing, provided that the A/C compressor has been activated, it is cooled and then heated to the required temperature via the heating system.

E70 Dual Zone IHKA



Index	Explanation	Index	Explanation
1	IHKA, 2-zone	6	Ventilation air outlet, front center, left/right
2	IHKA operating unit with right & left temp. controls.	7	Ventilation air outlet, front left/right
3	Two inlet pipes to HWT, two water valves	8	Footwell air outlet, front left/right
4	Fresh air intake	9	Footwell air ducts, rear left/right
5	Defrost air outlet	10	Ventilation air outlet, rear left/right

E70 Four Zone IHKA with FKA

The 4-zone air conditioning system consists of the standard 2-zone IHKA plus:

- Its own FKA controls
- Four additional outlet temperature sensors
- A separate rear blower
- Air ducts and outlets in the B-pillars
- Two separate PTC heating elements in the rear footwell air ducts
- An additional actuator motors for air flap control of the system (IHKA with FKA, total of thirteen actuator motors)

This system makes it possible to make separate left/right temperature settings for the first and second row seat area, and also provides separate front/rear blower control.

The rear blower enhances the air to flow to the rear center console and the B-pillar ventilation air outlets.

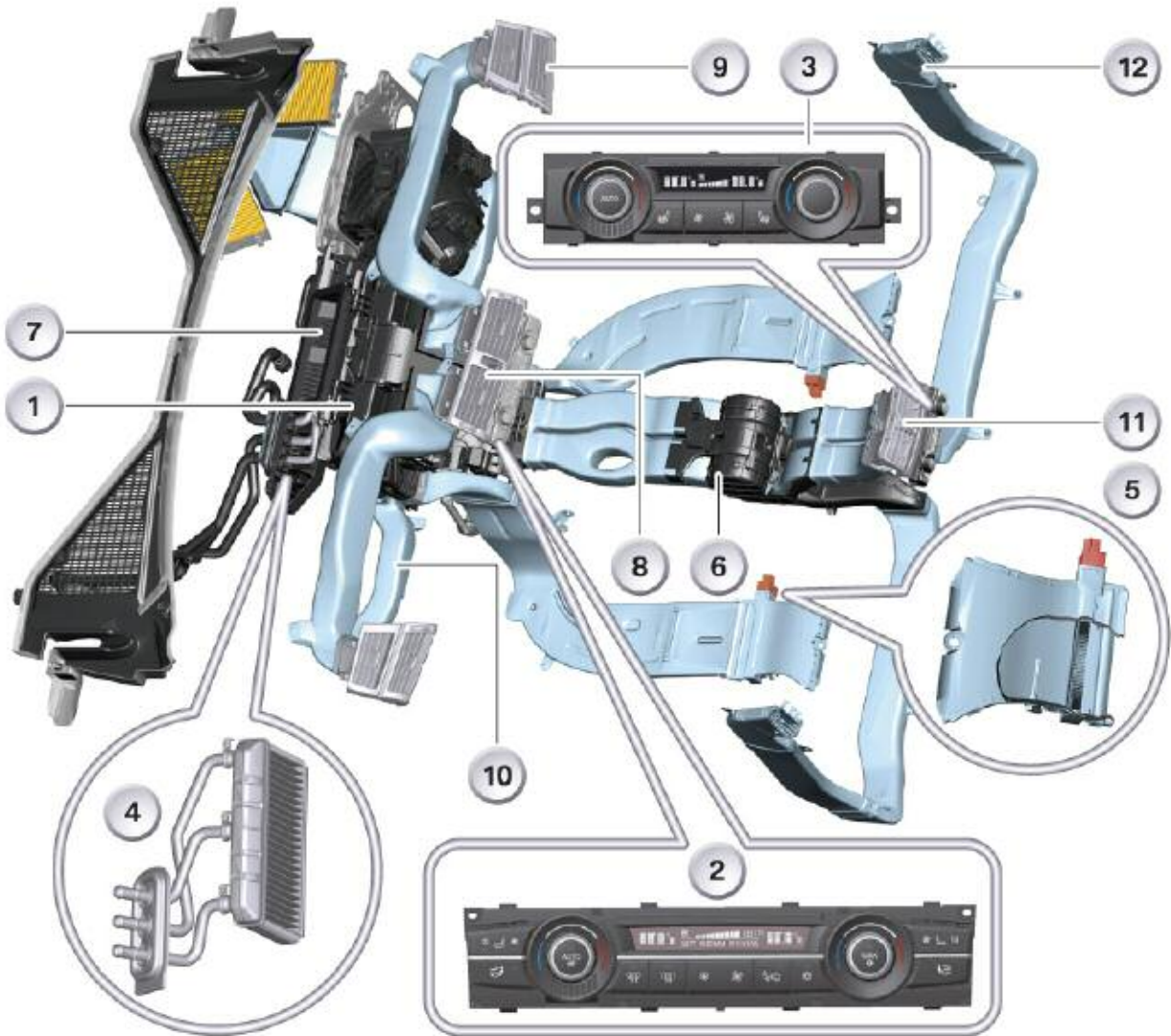
The footwell ducts that deliver air to the second row area can be switched off completely or provided with additional heating by energizing the electric PTC heating elements.

Adjustment and Operation of Rear Air-conditioning

The Climate Control Menu allows us to activate or de-activate the (FKA) rear climate control via the controller. A checked box next to “Rear Climate Control” function will show the system activated. The FKA control module settings can be taken over by selecting the “Driver Settings” function and synchronized with the settings from the driver-side IHKA controls, but as soon as the FKA controls are operated by the rear occupants the rear controls become active once again.



E70 Four Zone IHKA with FKA



Index	Explanation	Index	Explanation
1	IHKA with rear automatic A/C system, 4-zone.	7	Defrost air outlet
2	IHKA, dual front temperature controls	8	Ventilation air outlet, front left/right
3	FKA, dual rear temperature controls	9	Ventilation air outlet, front left/right
4	Two inlet pipes to HWT, two water valves	10	Footwell air outlet, front left/right
5	PTC heating element in footwell air ducts rear left/right	11	Rear ventilation air outlet, center, left/right
6	Rear blower (FKA)	12	Ventilation air outlet, B-pillar left/right

FKA Sensors

■ Rear Interior Temperature Sensor (FKA)

Same as in IHKA, the FKA control unit has an interior temperature sensor with forced ventilation located under the left temperature adjuster.

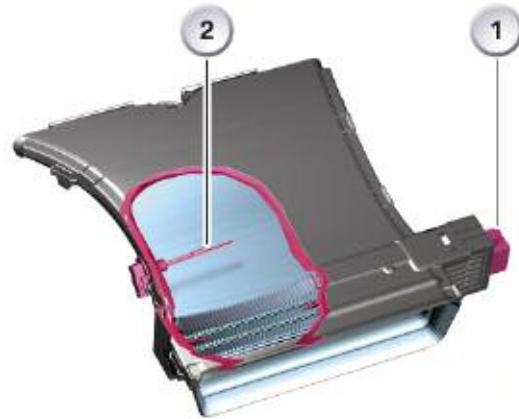
■ Rear Center Ventilation Temperature Sensors (FKA)

The delivery temperature in the FKA rear center ventilation is measured by two temperature sensors in the center ventilation outlet. See FKA Air Stratification.

■ Rear Footwell Temperature Sensors (FKA)

The delivery temperature at the rear footwell air ducts is measured by temperature sensors in each the footwell air ducts. The footwell temperature sensor default value is 55°C.

Index	Explanation
1	PTC Heater
2	Temperature Sensor



E70 FKA Rear Sensor
(below "AUTO" button)

■ Rear Interior Temperature Control (FKA)

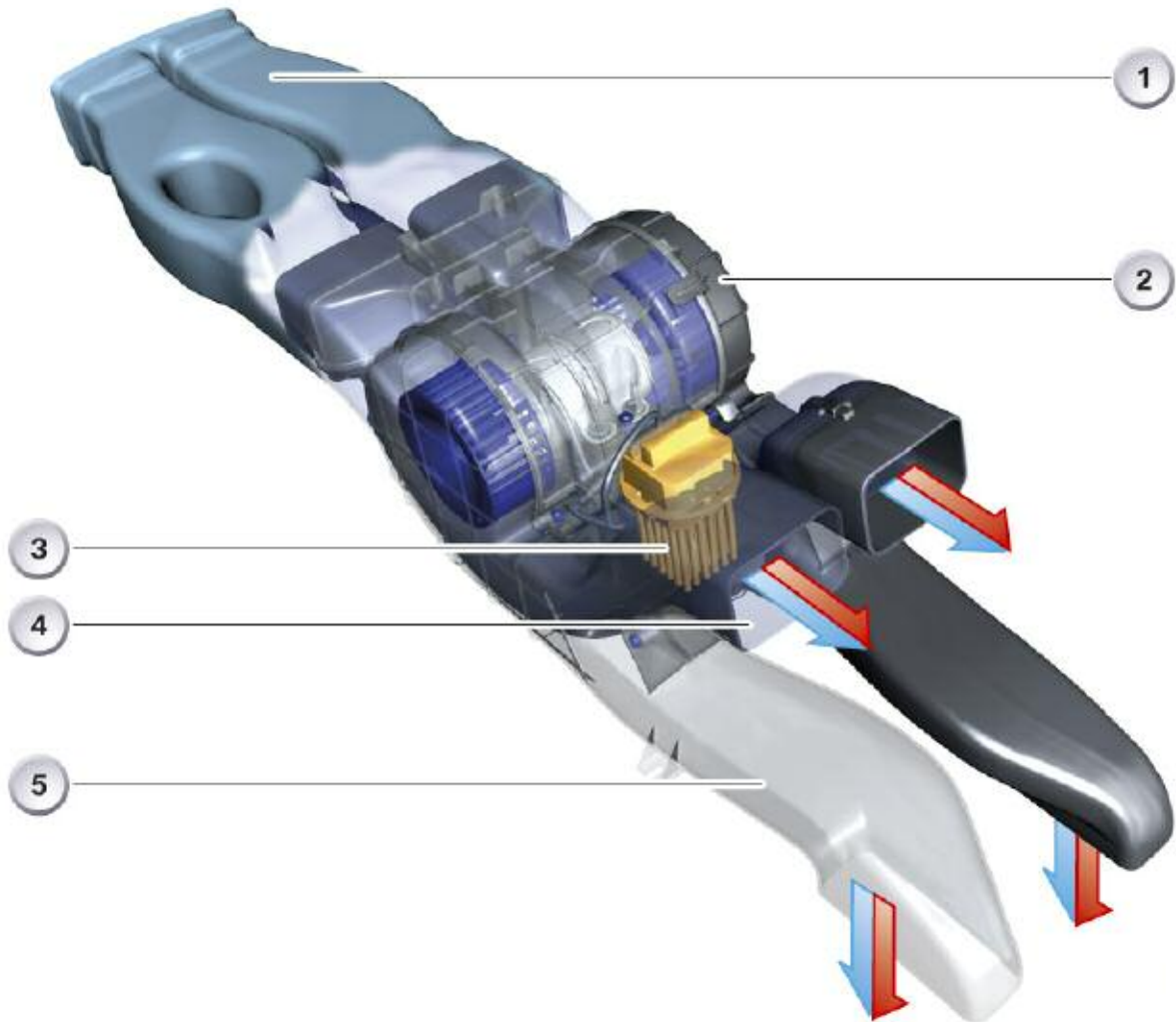
The FKA reads the signals from the interior temperature, rear footwell channel and rear ventilation temperature sensors in order to control the temperature in the rear. The sensor signal values are transmitted to the IHKA by the FKA and centrally evaluated by a controller in the IHKA.

The values of the calculated front and rear nominal temperatures are both used to calculate blower settings.

The FKA receives input from the IHKA that is used for blower control and controlling the rear footwell temperature.

Note: If the actual rear temperature is greater than the specified rear temperature, the air flow from the footwell air outlets is restricted. If the rear footwell temperatures are less than the specified values, the PTC heating element in the rear footwell channels are activated by the FKA.

E70 IHKA with FKA Blower



Index	Explanation	Index	Explanation
1	Left/right rear ventilation air duct	4	Center left/right rear ventilation outlet air ducts
2	FKA automatic rear air conditioning blower	5	Left/right B-pillar ventilation air duct
3	FKA blower final stage		

E70 IHKA with FKA Rear Air Stratification



Index	Explanation	Index	Explanation
1	E70 FKA rear center ventilation outlet	3	Left/right rear air stratification potentiometer
2	Left/right rear ventilation temperature sensors	4	Left/right rear ventilation manual shut-off flap

Note: In order to stratify the air and therefore adjust the ventilation temperature in the rear, the FKA has two potentiometers (left/right) in the rear center ventilation outlet.

E66 Rear Air Conditioning FKA

From E66 series launch, a Rear Compartment Air Conditioning system (FKA) may be installed as an option. The rear compartment air conditioner is located in the front area of the luggage compartment and consequently reduces the volume of the luggage compartment by about 20 percent (incl. trim panels).

The control and integration of the rear compartment air conditioning system in the IHKA refrigerant circuit is designed so that independent operation is possible for either the front or rear unit.

The air required for rear compartment air conditioning is drawn in via a particle filter (recirculated air filter) from the luggage compartment with the use of a rear blower fan.

The rear system shares some of the Main (front) A/C system's components like compressor, condenser and dryer and the operate independently from each other separated by two refrigerant shut off valves.

Operation of the rear air conditioning system from two separate control panels and takes place by means of push-buttons and rotary knobs, of which only those on the right are "intelligent." These two control panels must be matched with respect to each other; i.e. the right-hand control panel must be calibrated with the exact end stop values of the potentiometers of the left-hand control panel. (Refer to the relevant service information on TIS.)

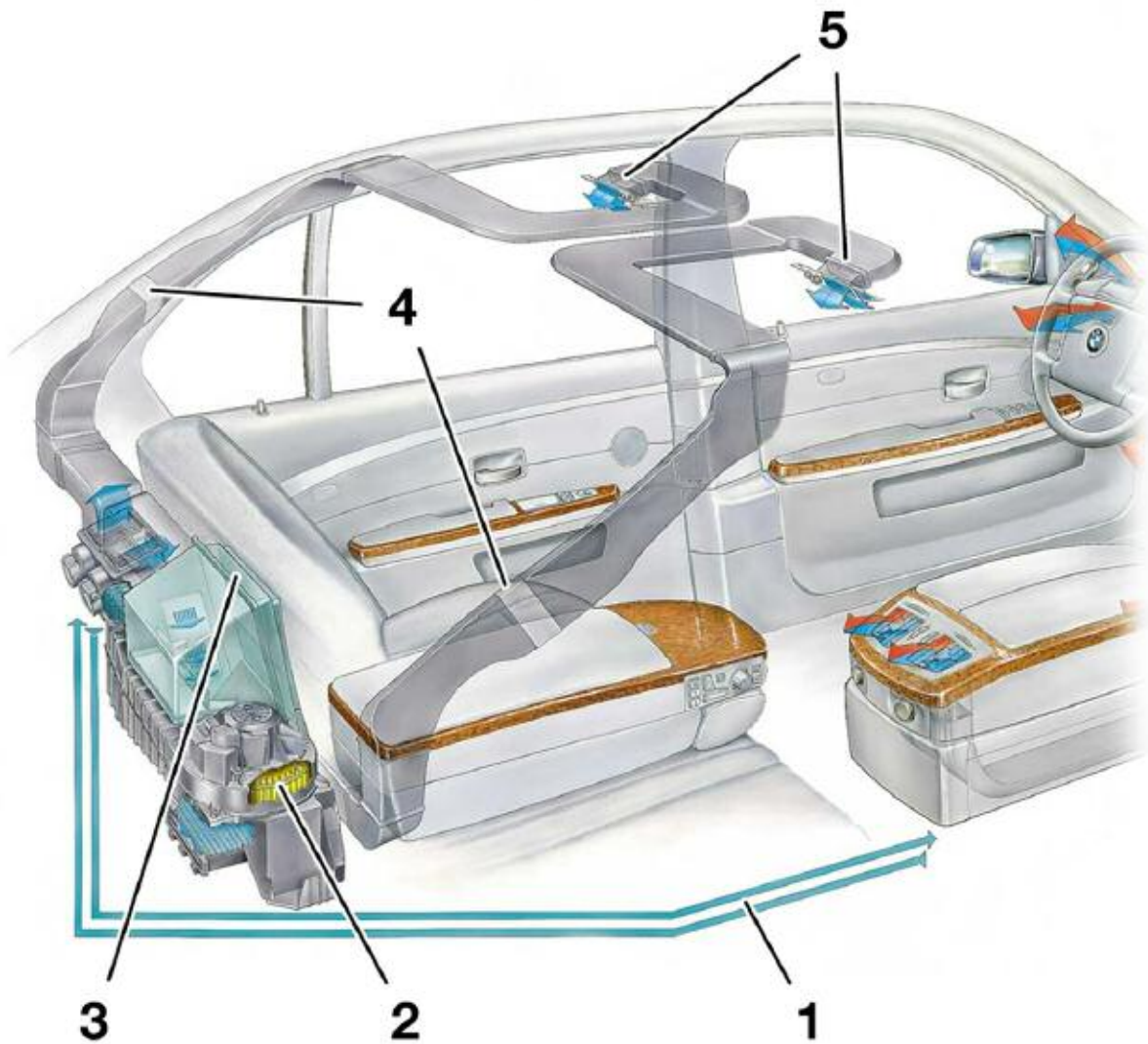
The rear compartment air conditioning system additionally supplies cold air to an integrated refrigerator box. This refrigerator box should not be confused with the electrically operated refrigerator box that is optionally available also for the E65.

The rear air conditioning system performs the following functions:

- Regulates air volume distributed through rear ducts
- Temperature and air volume control for left and right rear occupants
- Air conditioning (cooling)
- Electronic control of rear evaporator temperature
- Operation of integrated rear compartment refrigerator box

Note: Filling mode can be activated via the diagnosis interface for the rear compartment air conditioning system. In this mode, both refrigerant shut-off valves (front/rear) are opened, allowing complete recovery of the refrigerant charge.

E66 Rear Air Conditioning FKA



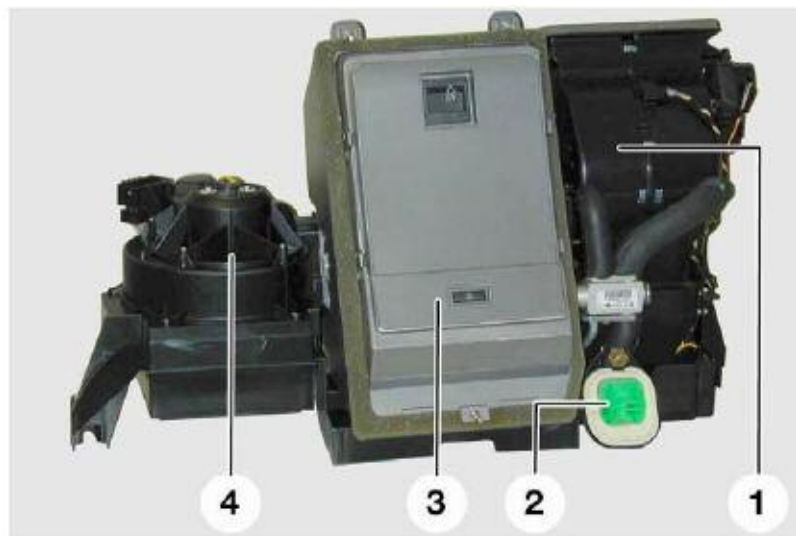
Index	Explanation
1	Pressure and Suction Refrigerant Line.
2	Blower and recirculated air filter.
3	Rear Compartment Refrigerator Box
4	Left/Right ducts to roof outlets.
5	Left/Right outlets in control units.

System Components

The rear air conditioning system consists of the following components:

- Evaporator Housing with Actuators and Flaps
- Refrigerant Circuit
 - Evaporator and Expansion Valve
 - Refrigerant Cut-Off Valve
 - Connection point for refrigerant lines
- Refrigerator Box
- Blower and Blower Control Module
- Recirculating Air Filter
- Evaporator Temperature Sensor
- Control Panel with Electronics
- Rear Air Conditioning Duct Work
- Wiring Harness with Connector

Index	Explanation
1	Evaporator Housing with Actuators and Flaps
2	Connection Point for Refrigerant Lines.
3	Refrigerator Box
4	Blower, Blower Output Final Stage and Recirculating Air Filter.

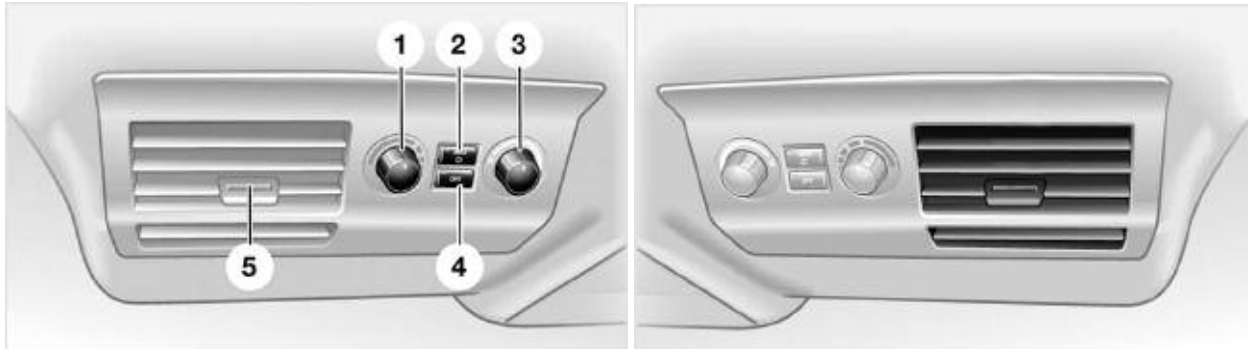


Calibration of Left/Right Control Panels

Manual operation of the rear compartment air conditioning system from two separate control panels takes place by means of push-buttons and rotary knobs, of which only those on the right are "intelligent." These two control panels must be matched with respect to each other; i.e. the right-hand control panel must be calibrated with the exact end stop values of the potentiometers of the left-hand control panel.

Start of calibration:

Start calibration by pressing all four push-buttons on both control panels simultaneously for at least 3 seconds. Be sure the ignition is in the terminal R position.



Left side Control Panel

Right side Control Panel

Index	Explanation	Index	Explanation
1	Stratification Knob	4	L/S OFF Button
2	Max AC cooling button	5	Lever for air flow directional control
3	AC Blower control Knob		

After starting the calibration procedure, the LEDs of the OFF button and MAX AC button on the left control panel flash.

- Turn both rotary knobs on the left-hand control panel to the left end stop (minimum values).
- Press the MAX AC button on the left-hand control panel. The MAX AC LED stops flashing as an indication for storage of the left end stops.
- Turn both rotary knobs on the left-hand control panel to the right end stop (maximum values).
- Press the OFF button on the left-hand control panel. The OFF LED stops flashing as an indication for storage of the right end stops.

The above procedure calibrates the left side potentiometers to the right side pots and control unit.

The FKA control unit is “smart” and will only accept values (end stop positions) that are within specified limits. If the LED’s continue to flash when the button is pushed, confirm that the dial is turned completely to the end stop.

Note: For more information please refer to the “Rear Air Conditioning” E66 training material available in TIS.

E70 Third Row Heating/Ventilation

The E70 with 3rd row seats uses a heating and ventilation system referred to as HB3SR. The blower is switched on and off using the button near the center air outlet. The air distribution at the ventilation air vents in the third row seats is controlled using a knurled adjusting wheel with control flap. A PTC heating element is activated via the limit position switch operated by the knurled adjusting wheel.

The warm air is blown out via the lower ventilation air vents.

The heating can only be activated if the blower is switched on.

The control unit for heating and ventilating the 3rd row of seats is connected to the IHKA via the LIN bus and controls the heating element (output 300W) for heating the air in the footwell of the 3rd row of seats.

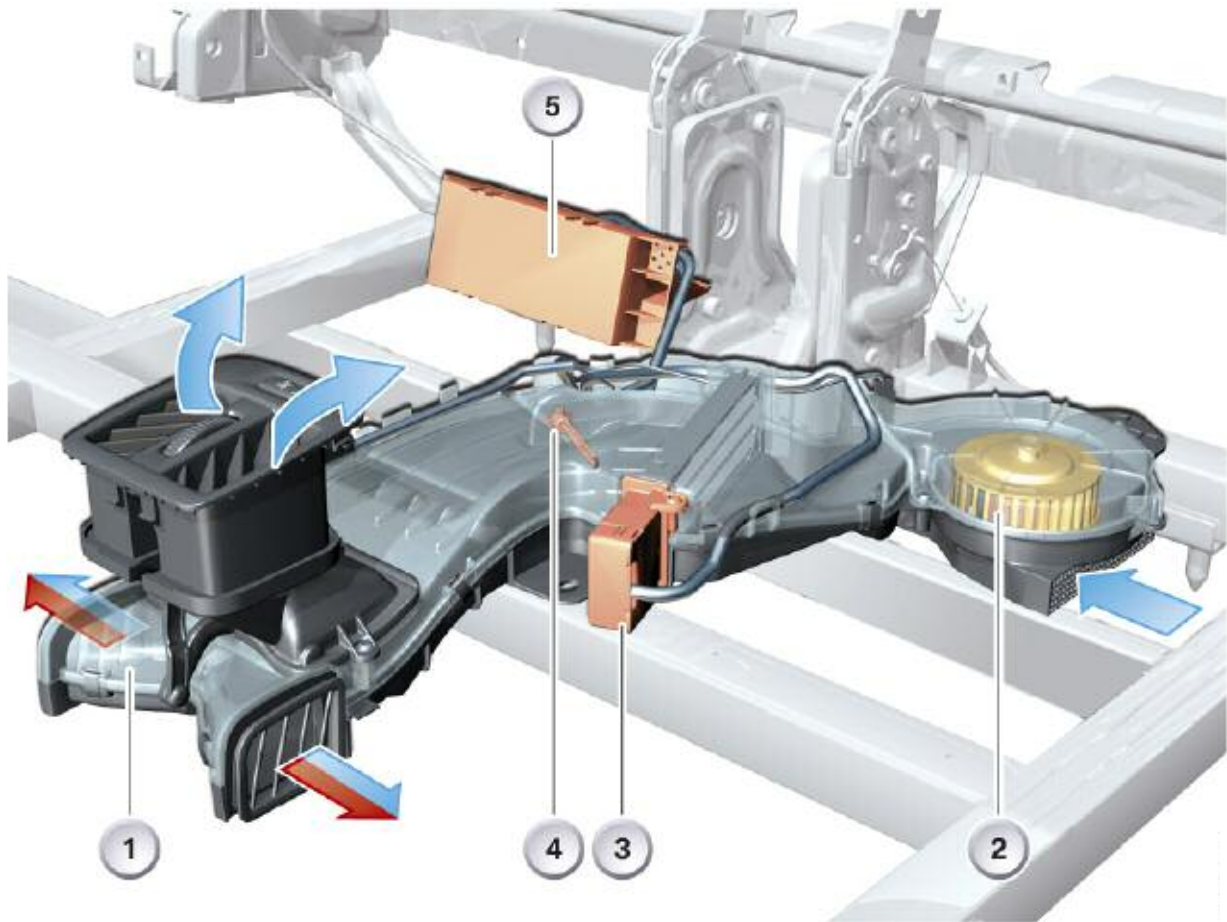
The DME (ECM) (by means of a CAN signal to the IHKA and to the HB3SR control unit via the LIN bus) can reduce the power of the heating element (power reduction of 50% or cut off) within the scope of power management.

E70 Third Row Heating/Ventilation Location



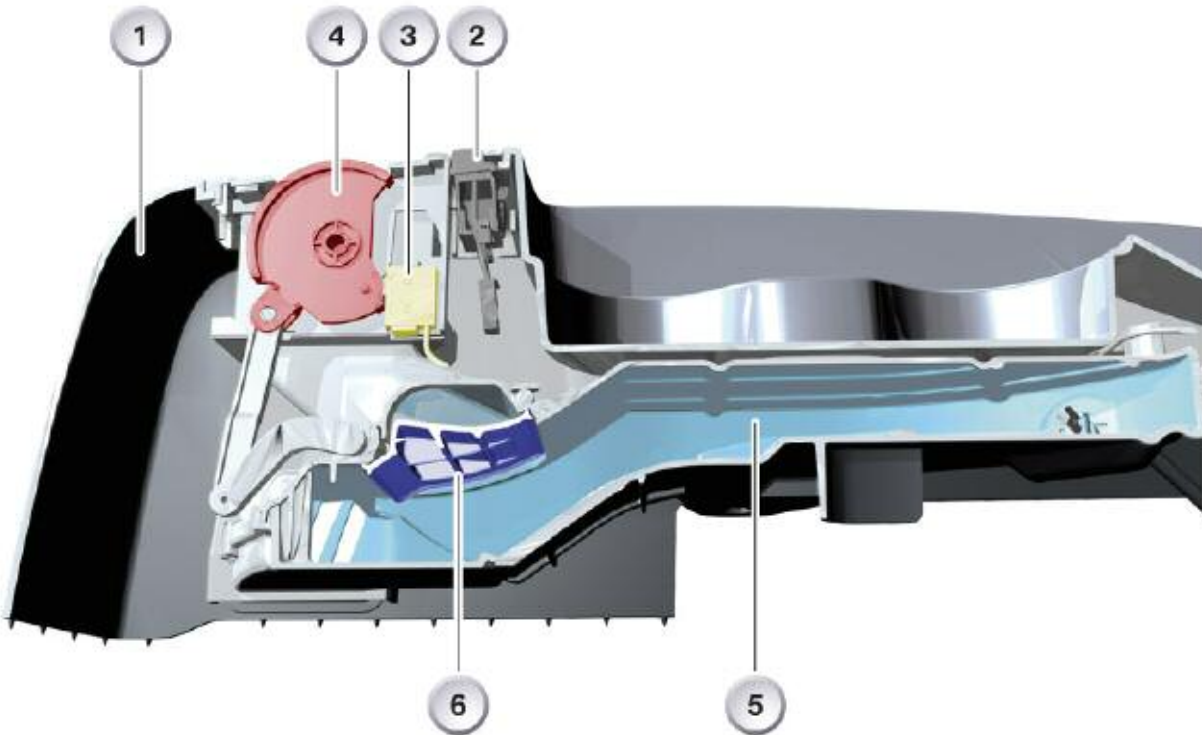
Note: This is not a rear A/C system and it is not linked with the IHKA system in the vehicle. It is linked to the vehicle electronics with efforts of power management.

E70 Third Row Heating/Ventilation



Index	Explanation
1	Heating and ventilating system the 3rd row of seats
2	Blower and heating for 3rd row seats, recirculated air intake
3	PTC heating element
4	Auxiliary heating temperature sensor
5	HB3SR control unit

E70 Third Row Heating/Ventilation Control



Index	Explanation
1	Heating and ventilating the 3rd row unit
2	Blower ON/OFF button
3	knurled wheel contact switch for PTC heating element ON /OFF (ON is in the full HOT position)
4	Air distribution flap knurled adjusting wheel
5	Air duct
6	Lower warm air routing flap

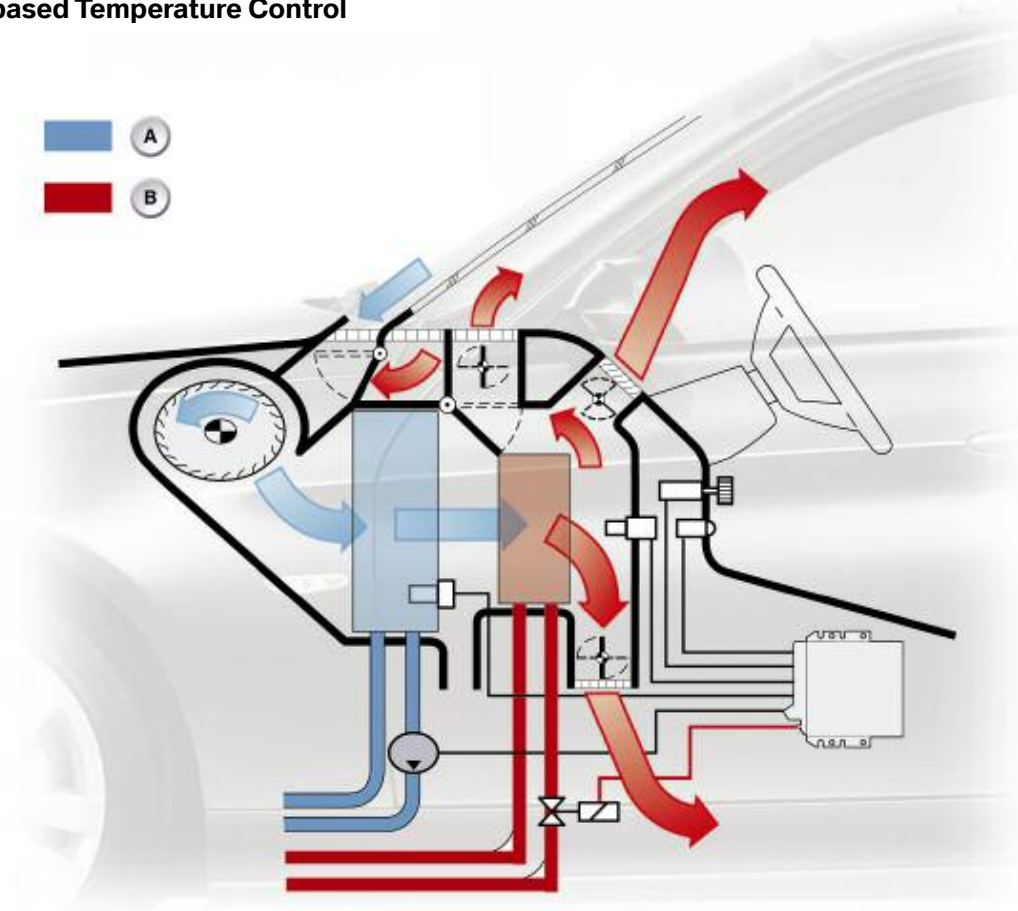
IHKA Temperature Control Methods

Coolant Temperature Controlled IHKA

The cold air that flows from the evaporator can be heated and blown into the passenger compartment at comfortable levels based on two temperature control methods; water-based and air-based temperature control. In a water-based temperature control system with one water valve or in a separate control for the driver and front passenger with two water valves, the IHKA control unit generates a pulse-width-modulated signal for the purpose of operating the water valve(s).

The control is achieved with the aid of a master controller, based on digital microprocessor-controlled electronics. The temperature controls on the control panel are set accordingly for temperature selection. The adjustment range extends from 16°C to 32°C (60-70F).

Water-based Temperature Control



Index	Explanation
A	Cold air
B	Warm air

The electronics makes use of the following temperature sensors for control purposes:

- Interior temperature
- Heater core temperature (left, right)
- Outside temperature
- Evaporator temperature
- Coolant temperature

The vehicle speed and the engine speed are also evaluated. The temperature setting (display) shows the set values in °C/F.

These temperatures are defined as psychological comfort settings that may deviate considerably from the set values that are processed by the controller.

Outside Temperature

There is no separate sensor for the outside temperature. The temperature sensor located at the front end of the vehicle is responsible for all the systems that require the outside temperature. The temperature value is transferred via the bus system. The temperature set-point is corrected at low outside temperatures in that the interior temperature is raised so that comfort levels in the vehicle are maintained even at temperatures below zero; even though the temperature setting is not changed. The outside temperature sensor therefore has the task of increasing the set target temperature in the passenger compartment at low outside temperatures.

Interior Temperature

A forced-ventilated air sensor is arranged in the control panel for the purpose of measuring the interior temperature. The air flow through the sensor is provided by an integrated blower fan.

Since this is the most important value for the stability of the control circuit, the interior sensor value must be read and processed with very high resolution. Changes in temperature are realized only very subtle.

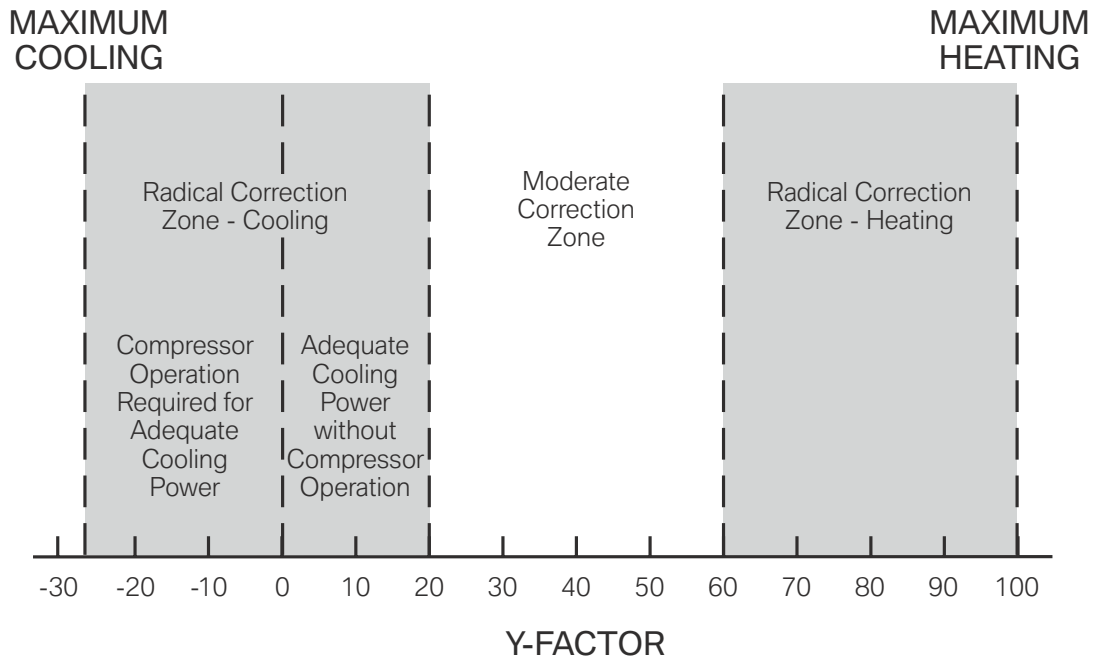
Default: 20°C (in the case of short-circuit or break [open circuit])

The Y Factor

Two sensors for left and right are integrated in the heater for the purpose of acquiring the heater core temperature. These sensors measure the outlet temperature directly at the heater core.

Default: 55°C (in the case of short-circuit or break [open circuit])

The master controller is the core of the temperature control system; this control circuit compares the actual interior temperature value with the driver's choice (target value). The reference variable Y (in %) is derived from the comparison of the actual interior temperature value with the corrected target value = driver's requested + outside temperature application.



Typical Y Factor Chart

Y Factor 0 % = water valves closed = no heating output

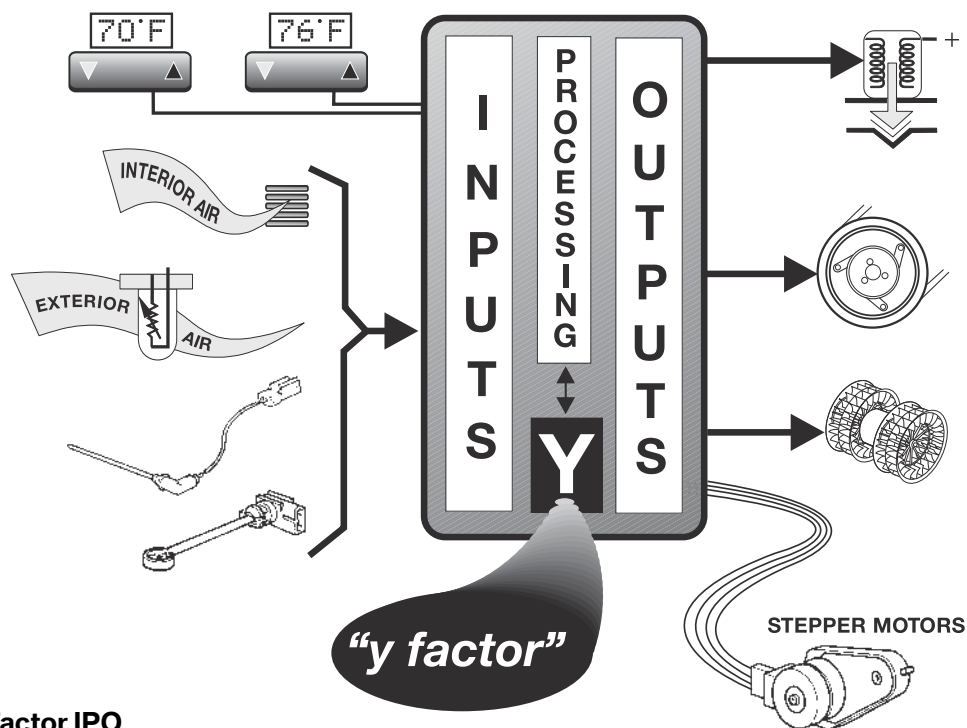
Y Factor 100 % = water valves open = full heating output

The master controller sends the signal to the two lower-ranking auxiliary controllers on the left and right (refer to IPO below). The auxiliary controller relieves the burden on the master controller in that it corrects interference such as air volume and water flow fluctuations or coolant and fresh air temperature variations that would otherwise be noticeable as variations in the temperature in the passenger compartment.

The opening time of the water valves is calculated from the difference of the auxiliary controller set-point and the actual heater core temperature. The water valves are activated pulse-width modulated with a period duration of 3600 ms.

This control variable y represents the basis for further fundamental functions of the IHKA such as:

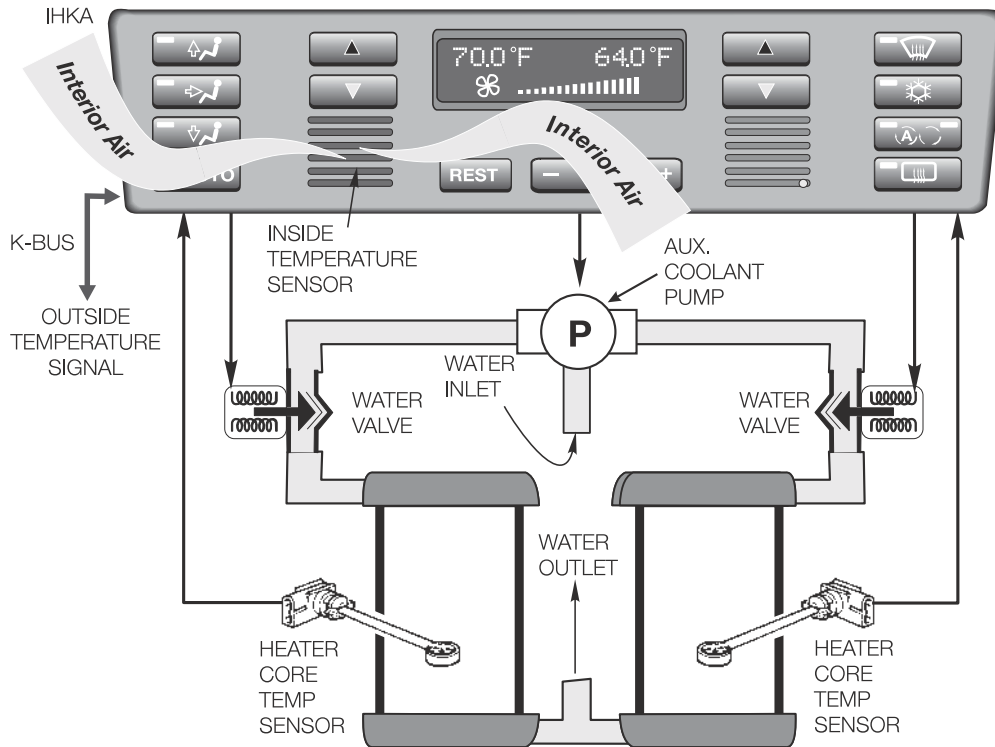
- Automatic blower output control in the automatic program
- Air distribution flap adjustment in the automatic program
- Auxiliary water pump operation ON/OFF
- Cold start interlock
- Compensation of solar sensor influence



Typical Y Factor IPO

Note: It is not possible to view the Y-Factor parameter in all vehicles and the typical Y-range of 0 to 100% temperature control has been extended from -200% to +300% to comply with current IHKA system functions.

Typical Coolant Temperature Systems



Heater Core Temperature

Due to the split design of a dual section heater core, the dual zone IHKA allows for separate 2-zone right/left temperature control by varying the water temperature on either side of the system. The heater core uses two temperature sensors and the temperature is controlled via two water valves (left/right) that regulate water flow through the system based on the requested Driver/Passenger temperature settings. As previously mentioned these water valves are electrically pulsed and are typically sprung open when deactivated.

The water valves are pulsed to regulate temperature based on the following inputs:

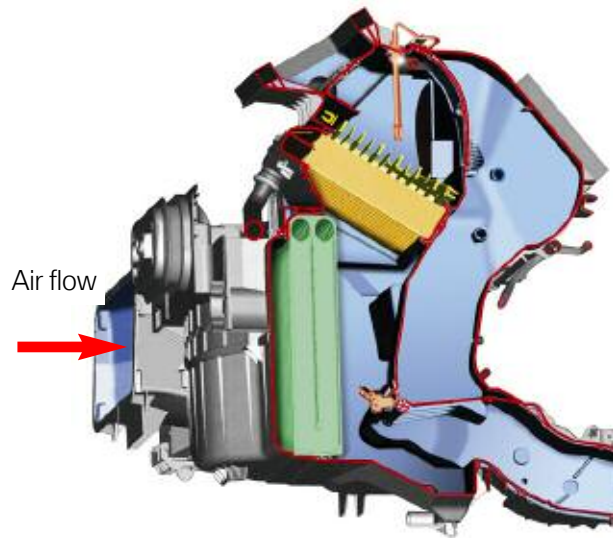
- Left/Right temperature settings
- Left/Right heater core temperatures
- Outside temperature
- Interior temperature
- “Y” factor

An auxiliary water pump is used to ensure the adequate volume of coolant through both sides of the heater core to comply with the system's requirements. This pump is typically powered directly from the IHKA control module through a final stage output.

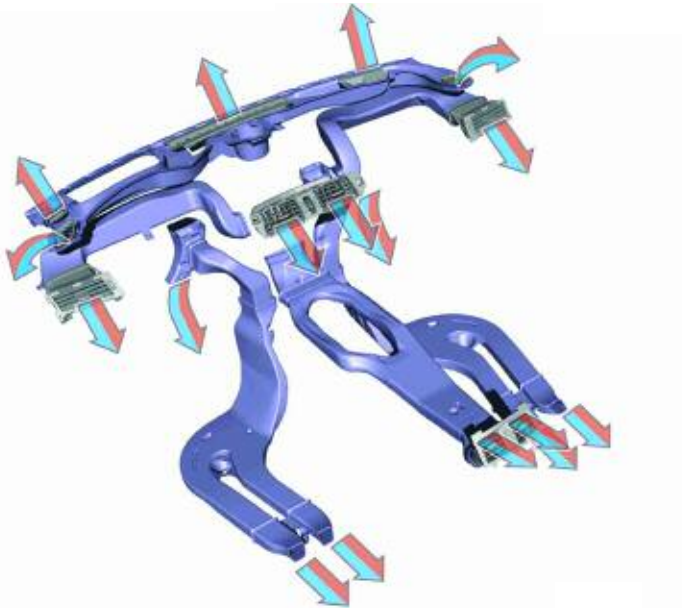
The auxiliary pump is used to supply coolant for the REST feature of the IHKA, although not all models use one. Some current vehicles use electric main water pumps and no longer need auxiliary water pumps.

The air-mass flow (fresh air or re-circulated air) is first routed via the evaporator in the heating/air-conditioning housing (provided that the compressor has been activated) to be dried and then heated to the required temperature via the heating system heater core. The air is dried as it flows through the evaporator; at the same time the condensation is led away via the drains of the heater-A/C air box housing.

E70 A/C Housing Section



E6X Air Distribution Vents



Note: Fresh air or re-circulated air can be routed directly to the air ducts via the evaporator and appropriate bypass, without being routed through the heating system heater core.

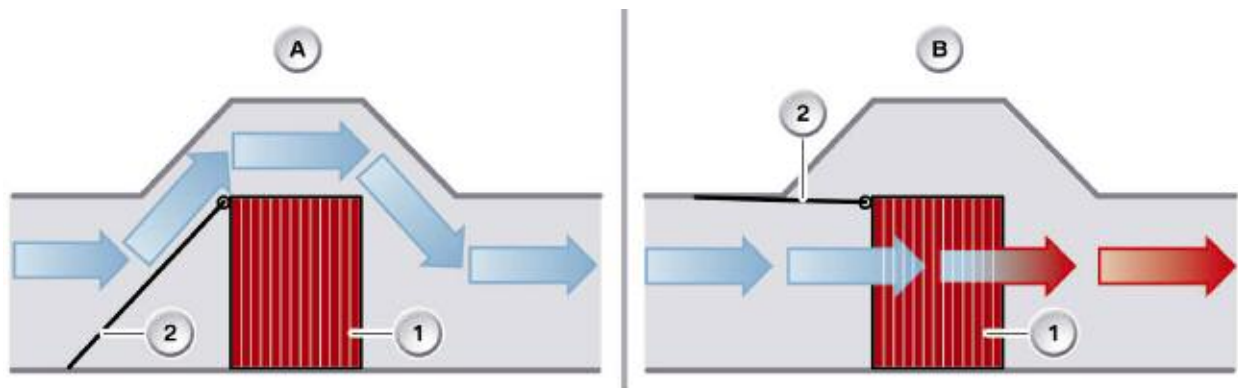
Air Temperature Controlled IHKA

The temperature for the best possible interior climate in an air controlled system is regulated with a mixer flap in this type of system. A water valve that controls the water flow rate through the heater core (as in the water base system) is not used in an air-based temperature control system. A temperature mixer flap is integrated in the heater/air box housing and is used for adjusting the requested temperature.

When the temperature mixer flap routes the fresh air or recycled air through the heater core completely, maximum heating capacity is realized. When it is not necessary to heat the air, the heater is covered off by the temperature mixer flap and the air is deflected away.

A corresponding proportion of cold air to warm air is mixed with the flap in the intermediate positions, thus achieving and controlling the out let temperature in the vehicle based on the requested customer settings and calculated values. The temperature mixer flap is operated by a stepper motor which is controlled by the IHKA/IHKR control unit.

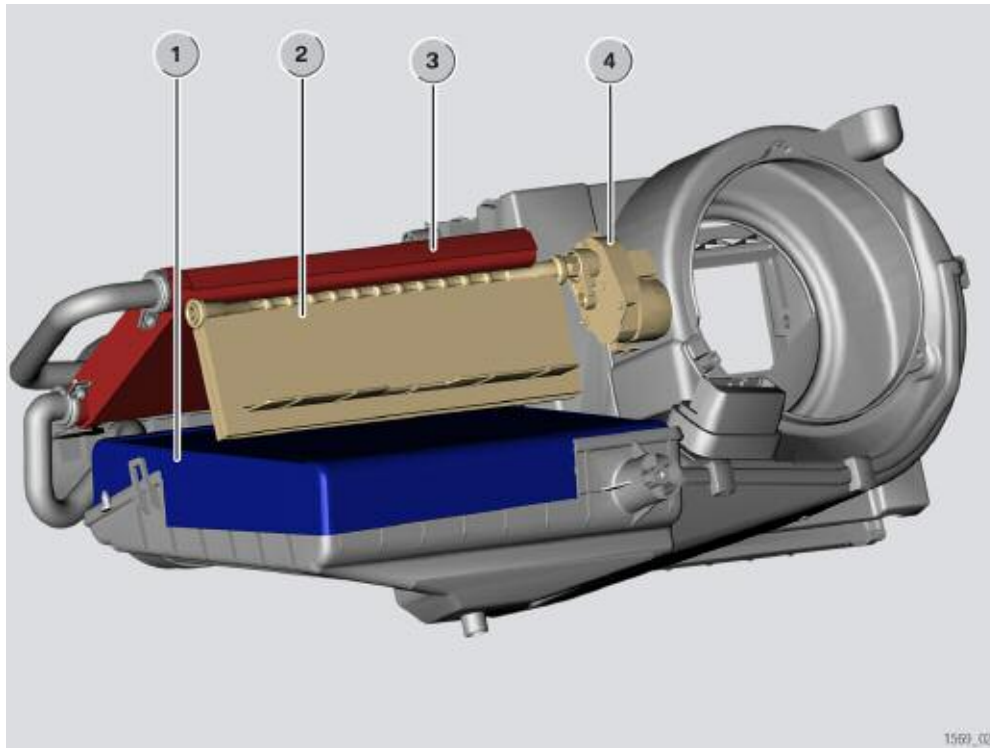
This type of temperature control is used on the E85 as a single zone and on E9X vehicles as a dual zone. A disadvantage of this control system is the large package space it requires. In the case of complaints ("poor heating output" or residual heating in "cold" setting) particular care must be taken to ensure that the mixer flap rests snugly on the stops in the corresponding end positions.



Index	Explanation	Index	Explanation
A	Heating off	1	Heat exchanger
B	Heating on	2	Temperature mixer flap

As in the water-based temperature control system (clock signal for water valves), the control variable Y is formed from the temperature set-point and the various temperature sensor input values. The respective position of the temperature mixer flap is derived from this Y value signal. It also determines the position of the air distribution flaps as well as the automatic blower output control when the automatic button is pressed.

E85 IHKS Temperature Control Flap

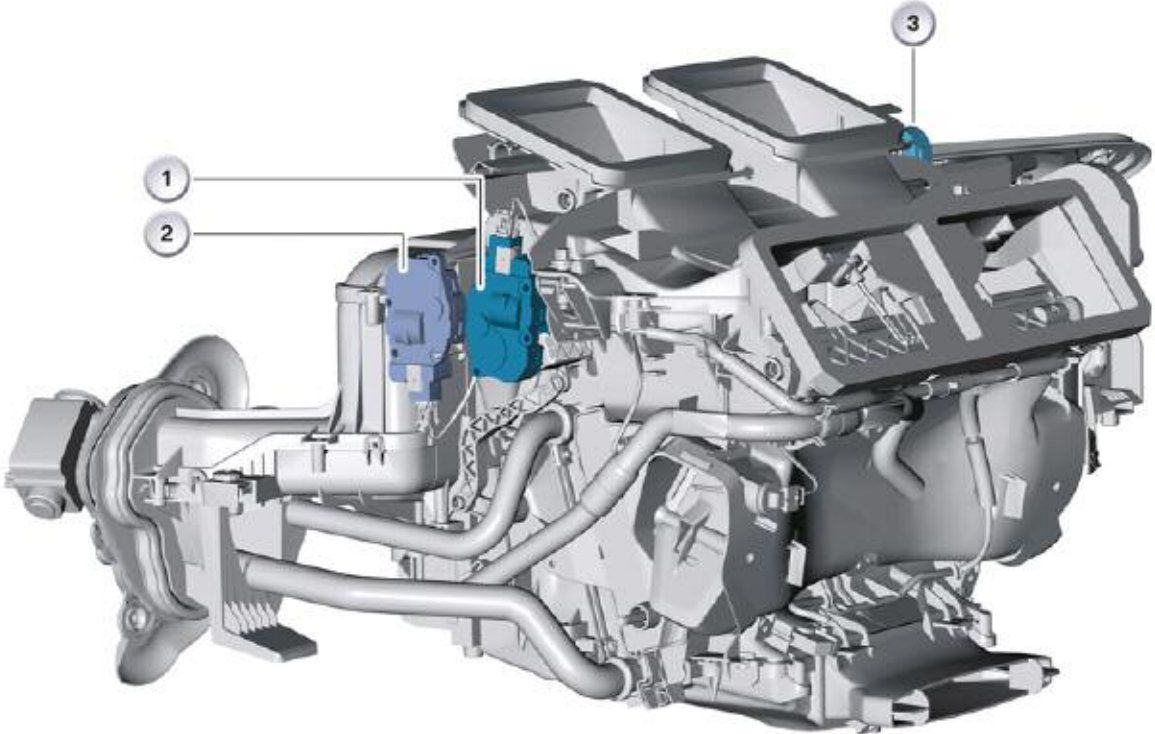


Index	Explanation
1	Evaporator
2	Mixed air flap
3	Heater core
4	Stepper motor, mixed air flap

Coolant flow is constant in the heater core as the mass air flow is fed through the evaporator. As this happens, the air is cooled and dried (providing the air-conditioning system is switched on). The mixer flap then feeds the air completely or in part over the heating system heater core, depending on the desired temperature value set at the IHKA control panel the air flow is subsequently mixed again. The air-mass is then fed through the ventilation flaps and into the vehicle interior.

The temperature inside the vehicle is controlled by means of a master controller. Control is based on the nominal values set and the calculated actual value (the nominal values are the requested temperature settings). The actual value is calculated from the temperatures measured by the interior temperature sensor and the footwell temperature sensor).

E90 Air Temperature Control



Index	Explanation
1	Stepper Motor, Air Mixing Flap, Left
2	Stepper Motor, Air Blending, Front
3	Stepper Motor, Air Mixing Flap, Right

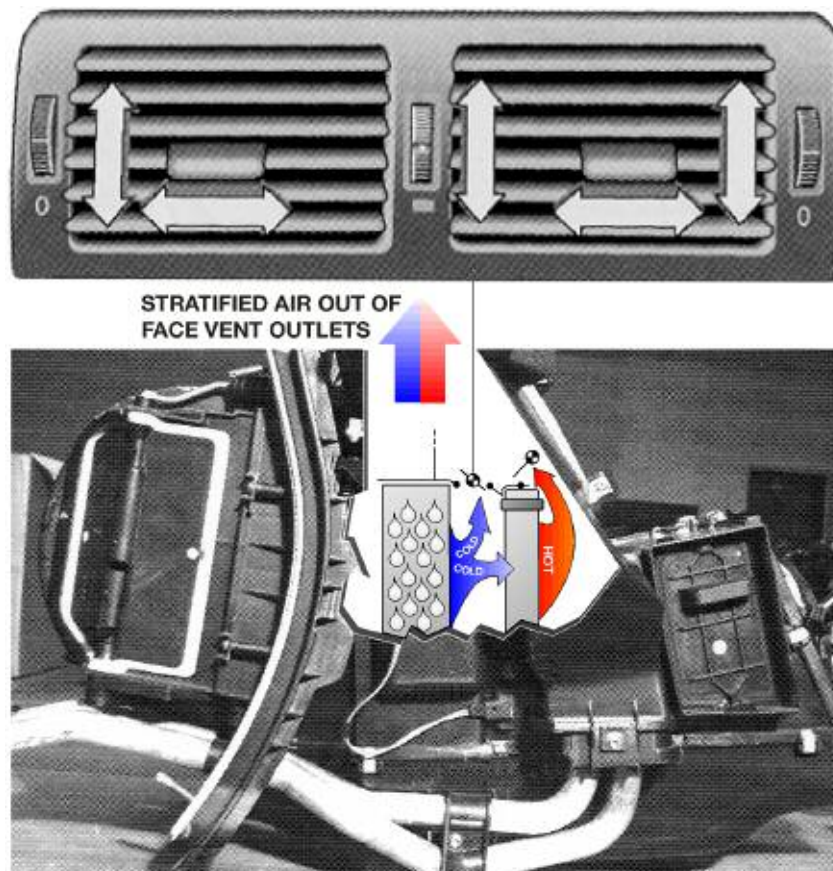
The lead parameter is calculated from the comparison between the actual value for the interior temperature and the corrected nominal value (calculated from temperature request, interior temperature and ambient temperature).

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. A separate temperature setting for the driver's side and the front-passenger side makes 2 mixer flaps necessary for a dual zone system.

Vent Temperature Stratification

Stratification in the climate control system refers to the mixing of the air temperature at the outlet vents. Hot, warm or cold air can be adjusted as it comes out of the front or rear outlet vents no matter what main temperature setting was selected on the IHKA. This is realized by mixing hot and cold air with the use of blend air flap.

Front stratification refers to the components necessary to adjust the dash outlet vent temperature to the occupant's preference. Rear stratification refers to the rear passenger compartment air delivery vents.



Typical Stratification Process

The stratification mixing flaps may be operated mechanically through the use of a Bowden cable connected to a thumbwheel adjuster mounted on or near the vent.

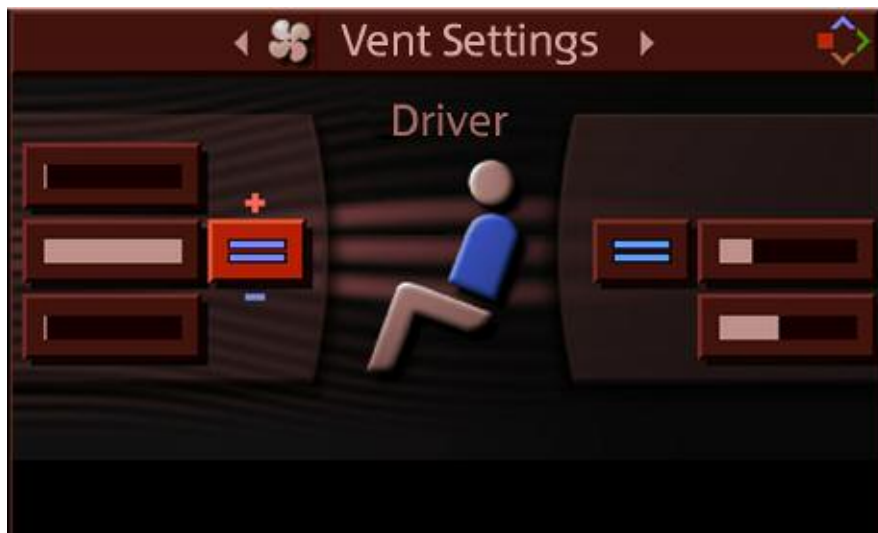
Most current BMW vehicles adjust the stratification electronically, by means of a system of air mixing flaps connected to stepper motors, which react to commands depending on the vent outlet temperature sensor readings and the settings that the occupant dialed in with the potentiometer thumbwheel adjuster at or near the out let to be adjusted.

Stratification is realized mechanically and electronically:

- Mechanical stratification is through the use of a Bowden cable connected from the air mixing flap to a thumbwheel adjuster mounted on or near the vent.
- Electronic stratification adjusts the air mixing flaps with the use of stepper motors.

The adjustment is done by manipulating the air mixing flap depending on:

- Thumbwheel and Bowden cable position (mechanical).
- Vent outlet temperature sensor readings .
- Occupant requested settings (Potentiometer position at the thumbwheel adjusters).
- Occupant selected settings on the I Drive CID screen under climate control menu.



E70 CID Vent Stratification Settings

Note: In vehicles with CID (E6X or E70) the air stratification can be adjusted through the I Drive and CID screen at the climate control settings menu or the short cut buttons.

Operation and Adjustment/Air Distribution

All control modules of the IHKA equipped E70 provide a facility for manually adjusting the air distribution using "rocker button air distribution" via the controller.

The menu has four default settings and one individually configurable setting at the driver's side, and three default settings and one individually configurable setting at the front passenger side. When the rocker button is operated, an "Air distribution" pop-up menu appears on the control display.

The air stratification (ventilation temperature) can also be adjusted via the controller in this menu at the same time as the air distribution is being adjusted Air Distribution/Ventilation.

E70 Air Stratification (Ventilation Temperature)

Adjusting the air stratification via the air blending flap adjusts the proportion of cold and warm air at the ventilation vents. This setting adjusts the ventilation temperature. Only cold air or warm air flows out of the ventilation vents at the maximum/minimum air blending flap positions.

The passenger can achieve individual cold/warm air distribution and stratification in the vehicle at a constant temperature setting using this stratification facility.

The air stratification at the front of the vehicle can only be adjusted via the controller and is displayed in the CID control menu.

The air stratification at the front can be adjusted separately for the left and right sides with the IHKA.

The air stratification in the rear can be adjusted using a potentiometer in the rear ventilation outlet.

The air blending flaps of the IHKA with FKA equipment variant can be controlled separately using two potentiometers, one in the left rear ventilation outlet, one in the right rear ventilation outlet. This means that the IHKA with FKA can provide individual 4- zone air stratification.

Note: Attention must be paid to the air blending flap settings when troubleshooting a heating and cooling performance complaint.

Automatic Programs

With the IHKA and IHKA with FKA equipment variants, two additional automatic programs can be selected via the automatic programs selection menu in addition to the standard automatic programs.

The IHKA control unit can be used to select and adjust the automatic program using the AUTO button/short cut button or via the controller or with the IDrive and CID.

The three different automatic programs:

- Soft
- Medium
- Intensive



E70 CID Automatic Program Settings

Each have their own characteristic curves for blower control, air distribution and air flap control. The individual selecting facility within these three automatic programs allows more customers to satisfactorily operate the heating/air conditioning system in their vehicles in automatic mode without having to switch to manual mode.

Operation and adjustment of the air conditioning system, automatic programs All control modules of the IHKA equipment variant have a facility for switching between the three gentle, medium and intensive automatic programs using the "AUTO Toggle button".

The display is in the form of a pull-up menu in the CID when selecting and adjusting the automatic program using the AUTO button as a rocker button . However, the selection and the current setting also appear on the display of the IHKA control module.

The automatic programs can also be selected and adjusted via the controller, with CID display. The air stratification adjusting facility appears in the air conditioning, automatic program selection menu first.

IHKA Functions and Features

BMW vehicles are equipped with various versions of climate control systems. Regardless of the version used, the objectives are basically the same. The climate control system is designed to perform the following functions:

- Remove heat from the passenger compartment when ambient temperatures are above the drivers comfort zone.
- Add heat from the passenger compartment when ambient temperatures are below the drivers comfort zone.
- Dehumidify the air entering the passenger compartment.
- Defrost front and rear windows for optimum vision and safety.
- Remove contaminants from incoming air (with microfilter-if equipped).

In addition to the above functions there are additional sub systems and additional features. These systems and features are not available on all models or package options.

These features include, but are not limited to:

- Washer jet heating
- Windshield base heating
- “Rest” feature (residual heat)
- “Service Station” feature
- Parked car ventilation
- Automatic air recirculation (AUC)
- Cold start arrest
- Air pressure compensation

Note: These features are used on most BMW vehicles and their operating strategy varies from model to model.

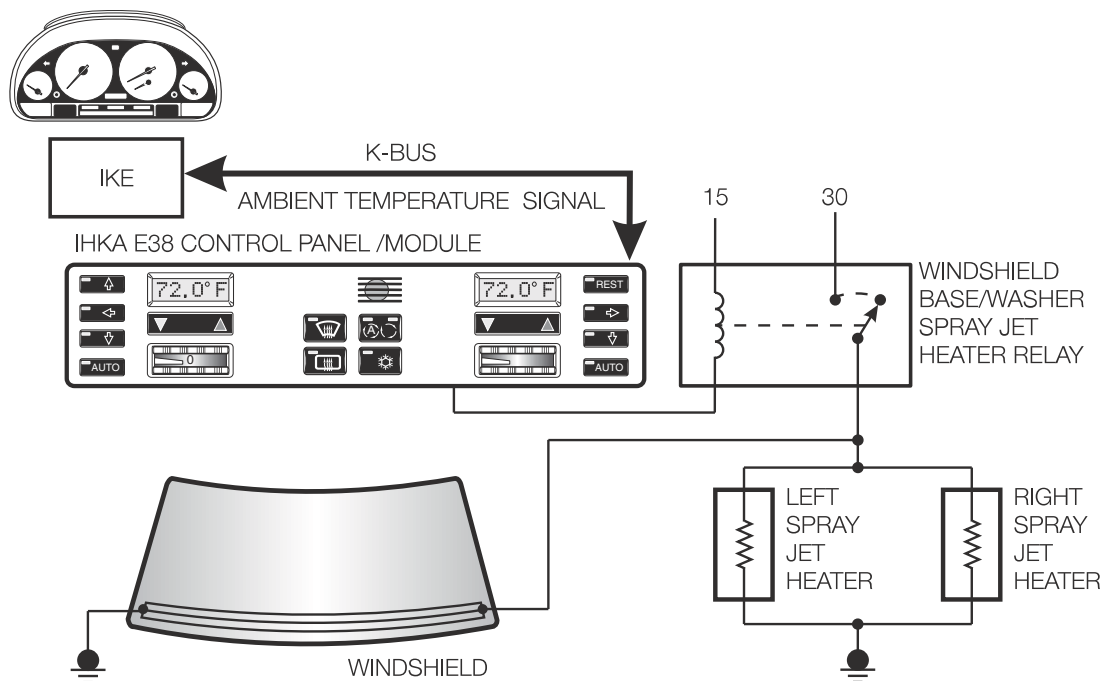
Please refer to the specific Service Information / Latest ETM as well as Training material of the vehicle and or system you are working on.

Washer Jet Heating and Windshield Base Heating

Although not all vehicles use heated washer jets most current vehicles use similar systems to achieve the same results. E38 vehicles are equipped with a windshield base/washer spray jet heater system similar to the one found on 1988 and 1989 E32 vehicles. On E38 vehicles, however, both heater systems are powered at the same time by the same relay:

- The lower portion of the windshield contains electrical resistance heating elements (similar to those on a heated rear window) which, when powered, prevent the wiper blades from freezing to the glass.
- The washer spray jet heaters are located on the underside of the hood and are designed to prevent ice from forming on and obstructing the washer nozzles. The control panel/module monitors the signal from the ambient temperature sensor (K-Bus) and automatically activates the windshield base/washer spray jet heater relay when:
 - Ambient temperature is lower than 38°F (3°C), and
 - The ignition is “on” and
 - Battery voltage is greater than 12.2 volts.

When ambient temperature exceeds 43°F (6°C), the windshield base/washer spray jet heaters are switched off.



Wiper Parked Zone Heating

In order to prevent the wiper blades freezing to the glass at low outside temperatures, the E65 use a wiper parked zone heating is activated depending on the outside temperature.

- < 3°C Wiper parked zone heating ON
- > 6°C Wiper parked zone heating OFF

Low voltage cutout of the wiper parked zone heating by the power module is possible.

Switching conditions for shutdown are applied as of priority level 5 (K-CAN message).

“Rest” Feature (residual heat)

The “Rest” feature is a new feature, providing passenger compartment heating for a short time after the ignition is switched “Off.” The feature is activated by pressing the “Rest” button on the control panel/module, if the following conditions are met:

- Ignition switch is “Off” and
- The ambient temperature is less than 59°F (15°C) and
- The left heater core temperature is greater than 158°F (70°C) and
- Battery voltage is greater then 11.4 volts and
- The time elapsed since the ignition was turned “Off” is less than 15 minutes.

When the REST feature is activated in KL R, all of the IHKA functions are operable. This includes the blower speed, air distribution control and temperature settings.

With the ignition switched OFF, the REST feature is in a preset operating mode. The blower fan runs at medium speed and the temperature is set to allow maximum heat.

“Service Station” Feature

The control panel/module continues to power both coolant valves closed automatically for about 3 minutes after the ignition is switched “Off.” This feature prevents the heater cores from being flooded with hot coolant when the engine is shut off for brief periods (e.g. during refueling).

Note: If the coolant temperature is above 15°C, the water valves are powered closed for 3 minutes when the vehicle is switched OFF.

Parked-car Ventilation

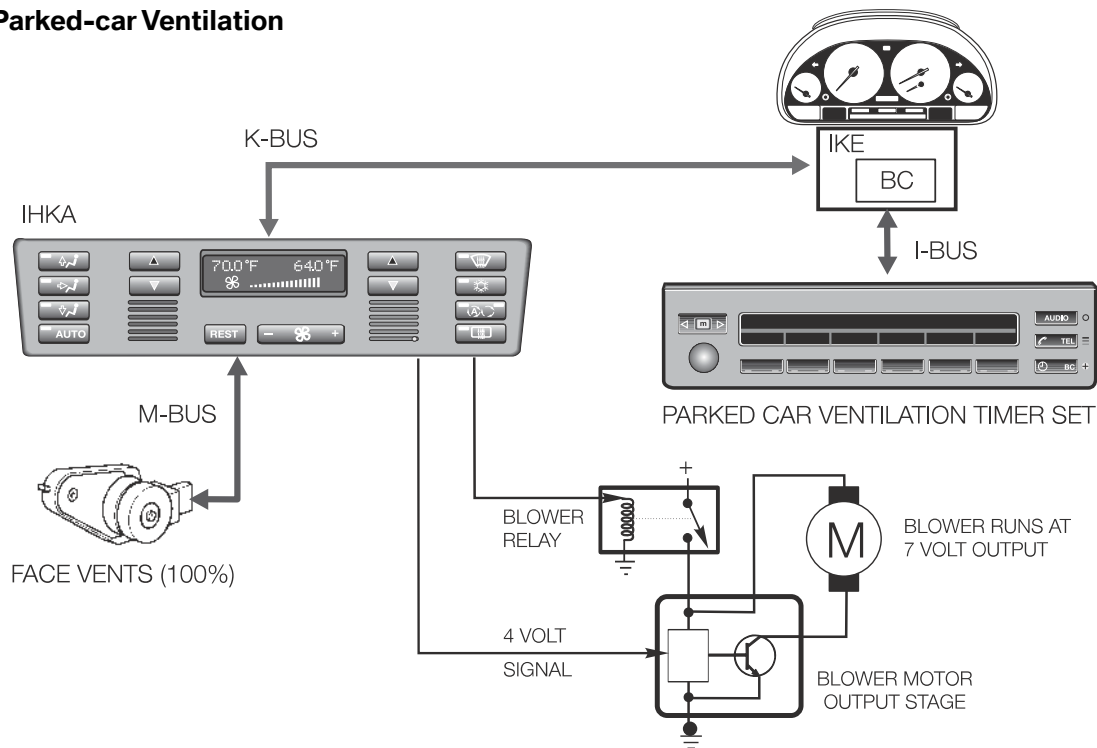
The Parked-car Ventilation blows ambient air into the passenger compartment to lower the interior temperatures. The air enters the passenger compartment through the vent outlets in the instrument panel, which can be adjusted for both direction and flow (must be open for the system to operate). The system remains on for 30 minutes. The system can be switched on and off manually.

The Parked-car Ventilation feature of the E38 IHKA system is retained on the E39 IHKA system. The feature is only available with the High BC. The signal to activate the venting function is generated by the BC function of the IKE. The signal is passed over the K-Bus to the IHKA for fan and flap activation.

The signal prompts the IHKA to open the face vent flaps to 100%. The blower relay is energized and the blower output stage is sent a 4 volt signal. The blower is run at 7 volts operating power to provide adequate venting.

If battery voltage drops below 11.5 volts the function is cancelled.

E39 Parked-car Ventilation



E65 Parked-car Ventilation

The outside temperature must be $> 50^{\circ}\text{C}$ to activate this function. Using the Control Display, the Parked-car Ventilation function has 2 control options: Direct (manual) operation and Timer programming.

Activating and Deactivating Manually:

- Ignition in position “KLR”
- Select “Indep. vent.” on the second page of the “Climate” menu and confirm to activate
- Select “Indep. ventil.” a second time and confirm to deactivate

Timer Programming (two available times):

- Ignition in position “KLR”
- Select “Indep. vent.” on the second page of the “Climate” menu and confirm
- Select “Set time1” / “Set time 2” and confirm
- Enter the desired time by turning the Controller and press to confirm

To Activate Timer:

- Select “Switch time 1” / “Switch time 2” and confirm

The Parked-car Ventilation is only available for activation within the subsequent 24 hours. After this the time will have to be reconfirmed. Terminal R “ON” (Control Panel is Active):

- Temperature control OFF (water valves closed)
- Flap program manually selectable
- Blower manually adjustable
- Function lighting ON
- Function buttons not active Terminal 15 “OFF” (Control Panel is Inactive):
- Temperature control: OFF (water valves closed)
- Flap program (0% = flap closed / 100% = flap open)
 - Warm air left and right 100%
 - Recirculating air 0%
 - Defrosting 0%
 - Footwell left and right 0%
 - Cold air left and right 100%
 - Rear seating area left and right 0%
 - Fresh air 100%
 - Blower set to 50%
- Function lighting OFF

The stationary functions are registered with the power module and are subject to deactivation by the power module (priority lever consumer shutdown > 6). The power module continuously monitors the battery state of charge while the Parked-car Ventilation function is active. When the power module issues the shutdown signal for the independent consumers, the IHKA will shut down the Parked-car Ventilation and it will not be reactivated.

The IHKA will send a CAN message "status air conditioner Parked-car Ventilation" with the "INDEPENDENT VENTILATION not active" information to the Control Display. The Control Display responds by updating the on screen display.

Note: On the E70 Parked-car stationary ventilation can be activated directly via the controller under timer control or via a remote start. When operated via the controller, the setting is displayed in the relevant control menu.

Note: These systems are used on most BMW vehicles and their operating strategy varies from model to model.

Please refer to the specific Service Information / Latest ETM as well as Training material of the vehicle and or system you are working on.

Cold Start Arrest

The cold start interlock function intervenes activation of the air distribution flaps and blower control. The cold start interlock is active at low outside temperatures and low coolant temperatures (engine cold) to prevent cold air distribution until warm air is available.

In the E85, the cold start interlock is not deactivated by a terminal change from KL15 “ON” to “OFF”. When the switch on conditions are fulfilled, the defrost air distribution flap is fully opened and the ventilation and footwell air distribution flaps are completely closed. As a result, no cold air is blown directly at the driver/passenger. The automatic blower function must be selected for intervention in blower control.

Cold start interlock is active in the AUTO program with a driver’s side heater core temperature below 20°C. In this program, the defrost flaps are 100% open, the footwell and face vents are closed. The blower fan will run at the set speed.

Dynamic Air Pressure Compensation

The E38 system prevents the flap position from being changed continuously in response to minor changes in road speed (overcompensation), buffering is included in the calculation for the desired flap position. In the 80 to 180 km/h speed range, the fresh air flap angle is reduced from 100% to 30%.

The air volume entering the IHKA system is compensated for at higher vehicle speeds. This is carried out through the road speed dependent fresh air flap operation.

In the fresh air mode, the flaps are open 100% up to a road speed of approximately 37 MPH at which point they are closed to 40%.

When the vehicle speed reaches approximately 55 MPH the flaps close to 30%.

There is a overlap built into the flap closing so that the flaps will not oscillate open/closed at one set speed.

On an E65 , as vehicle speed increases, the increase in “ram air” is controlled by Dynamic Pressure Compensation to maintain consistent air flow volume.

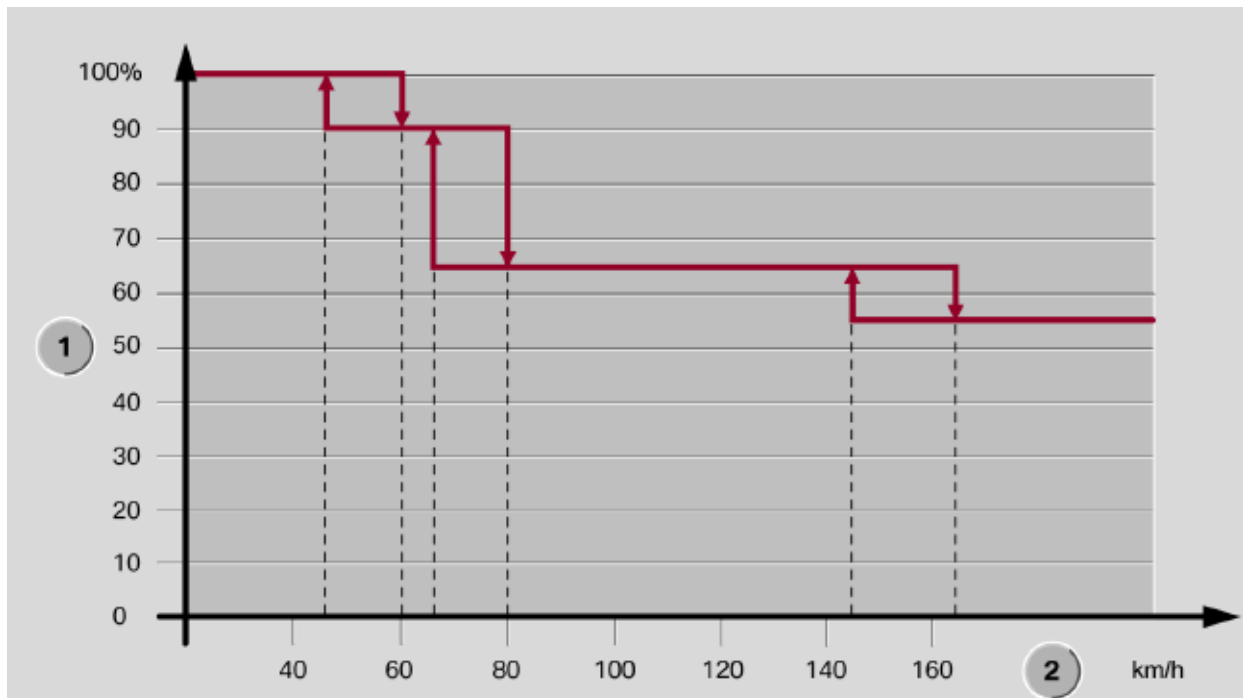
The ram air is compensated by closing down the fresh air flap to restrict the air intake duct in response to the road speed signal (over K-CAN).

To prevent the flap position from being changed continuously in response to minor changes in road speed (overcompensation), buffering is included in the calculation for the desired flap position.

In the 80 to 180 km/h speed range, the fresh air flap angle is reduced from 100% to 30%.

On an E85, to prevent uneven air volume as driving speeds vary, dynamic pressure is compensated by the fresh air flap reducing the fresh air inlet opening as the vehicle speed increases. The vehicle speed is made available via the K-bus from the instrument cluster.

The fresh air flap reduces the opening angle within a certain speed range according to a characteristic curve. The calculation of the flap position is dampened to avoid continual flap activation as a result of variations in vehicle speed.



E85 Air Pressure Compensation Strategy Chart

Index	Explanation
1	Fresh air flap opening angle
2	Vehicle speed

Note: This system is used on most all models with changes to the operating strategy.

E9X IHKA Functions

E9X IHKA Functions are in most of the BMW vehicles and only vary depending on models and option packages:

- Temperature control
- Evaporator control
- Air distribution setting
- Airflow control
- Sunlight adaptation (solar sensor)
- MAX cooling
- Residual heat
- Defrost function
- AUTO function
- Heated rear window
- OFF
- Air recirculation mode
- Automatic air-recirculation control
- Condensation sensor program
- Convertible mode

Temperature Control

The temperature for the best possible interior climate is regulated with a mixer flap in this air controlled heater/air conditioning system.

The air-mass flow is fed through the evaporator. As this happens, the air-mass flow is cooled and dried (providing the air-conditioning system is switched on). The mixer flap then feeds the air-mass flow completely or in part over the heating system heater core (depending on the desired temperature value set at the IHKA control panel). The air flow is subsequently mixed again. The air-mass flow is then fed through the ventilation flaps and into the vehicle interior.

The temperature inside the vehicle is controlled by means of a master controller. Temperature Control is based on the nominal values set and the calculated actual value (the nominal values are set with 2 temperature selector knobs).

The actual value is calculated from the temperatures measured by the interior temperature sensor and the footwell temperature sensor.

The lead parameter is calculated from the comparison between the actual value for the interior temperature and the corrected nominal value (calculated from temperature request, interior temperature and 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 to the IHKA control unit via the K-CAN. The separate temperature setting for the driver's side and the front-passenger side makes 2 mixer flaps necessary.

Front Stratification Adjustment Thumbwheel

The front adjustment thumbwheel is part of the DSC/DTC/Hazard switch cluster.

The thumbwheel signal is wired directly to the IHKA control unit as an analog/varying voltage signal. The IHKA panel sends the specific position signal to the front mixing flap motor via the LIN bus.

Rear Stratification Adjustment Thumbwheel

The rear adjustment thumbwheels is located to the right of the rear center vent. The thumbwheel potentiometer signal is wired directly to the JBE control unit as an analog/varying voltage signal.

The JBE converts this signal into a digital signal over the K-CAN to the IHKA control unit which then sends the specific position signal to the rear mixing flap motor via the LIN bus.

E90 CID Vent Stratification Settings



Evaporator Control

The evaporator temperature is regulated by means of the evaporator temperature sensor and the 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 function gradual evaporator control is encoded, the nominal value for the evaporator temperature will be calculated between 2°C 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

For the best possible operation of the air distribution, it is important for the manually adjustable air vents to be open. Occupants have the possibility of allowing the air distribution to be decided by the automatic program (AUTO button). Alternatively, individual, personal settings are possible through manual selection (defrost, ventilation, footwell). If the vehicle is equipped with navigation/CCC, it is also possible to make a fine adjustment via the CID (Central Information Display) in the submenu Air distribution. Compared to manual selection, fine adjustment offers the additional possibility of further individualization of the air distribution.

Airflow Control

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

- Manual blower setting
- Automatic blower and flap setting - The automatic blower and flap functions are activated when the AUTO button is pressed.
- Dynamic pressure compensation - The air volume at the air inlet grills increases disproportionately with increasing road speed. This effect is compensated for by the opening angle of the fresh-air flap being reduced as speed increases (dynamic pressure compensation). The opening angle is regulated according to the programming.
- Blower control - If necessary, the power management system will assign priority levels to reduce the blower output (via K-CAN).
- Effect of terminal 50 - When the engine is being started (terminal 50 ON), the electric auxiliary heater (not US) and blower are switched OFF to reduce the load on the vehicle battery.

Sunlight Adaptation (solar sensor)

How the solar sensor affects the IHKA regulation on the driver's side and on the front passenger side is not programmed separately. The following functions are modified when automatic mode is activated (depending on the intensity of sunlight):

- Blower output is increased or reduced
- Desired temperature value is increased or reduced

MAX Cooling

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. (example: temperature control is deactivated, ventilation flaps are fully opened)

Residual Heat (REST)

The residual-heat function allows the heat from the engine to be used to heat up the vehicle interior when the engine is not running (e.g. during a stop at a level crossing).

The residual-heat function is only possible for a certain run-down period (15 minutes from terminal 15 OFF). The DME is signaled to activate the electric water pump via the bus system to circulate the coolant.

Switch-on conditions:

- Terminal 15 OFF
And
- Run-down period active (up to 15 minutes after terminal 15 OFF)
And
- REST button in IHKA controls ON
And
- Ambient temperature below 25°C
And
- Engine temperature at some point above 60°C
And
- On-board supply voltage over 11.4 volts

Conditions for switching off:

- Terminal 15 ON
- Or
- Residual heat ON (15 minutes) expired
- Or
- REST button in IHKA control panel OFF
- Or
- OFF condition activated with residual heat active (terminal R)
- Or
- Prompt from power management to switch off auxiliary consumers
- Or
- On-board supply voltage less than 11 volts

Defrost Function

When the defrost function is activated, the defroster flap (on the inside in front of the windshield) is opened fully. The fresh-air/air-re-circulation flaps move to the fresh air position.

All other flaps are closed. The blower is run up to maximum output.

AUTO Function

When this button is pressed, all IHKA functions are set to automatic mode. If one or more automatically controlled functions are manually set, automatic control for the functions concerned will be cancelled.

All other functions remain automatically controlled.

Heated Rear Window

The heated rear window is switched on when the button in the IHKA control panel is pressed. The function indicator lamp in the button lights up.

The heated rear window is switched off by pressing the button again or automatically after the heating time has expired.

Defrosting Phase (1st heating period)

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 is (25 minutes with pulsed heat output on-off cycle: 40 seconds ON, 80 seconds OFF).

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

2nd Heating Period

After the 1st heating period has expired, each subsequent time the button is pressed will cause the heated rear window to be switched on for a further 30 minutes (defrosting phase).

After the 2nd heating period has expired, output is again pulsed.

OFF

The IHKA control panel is switched off when the blower speed is set to 0 (The control panel/control unit continues to run in the background).

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 inside the vehicle is continually re-circulated.

To make sure that there is a sufficient supply of fresh air, air-recirculation mode is only available for a limited time. (30 minutes air recirculation -> 30 seconds partial fresh air -> 30 minutes air recirculation -> etc.)

Automatic Air-recirculation Control

If the AUC II sensor detects an increased level of pollutants in the environment from spark-ignition and diesel engines, the IHKA control unit will automatically switch to air recirculation mode.

To make sure there is still an adequate supply of fresh air, air recirculation is only available for a limited time:

- At ambient temperatures less than 0°C: 2 minute re-circulated air mode -> 20 seconds fresh air mode -> 2 minute re-circulated air mode -> etc.
- At ambient temperatures from 0°C to 6°C: 3 minute re-circulated air mode -> 20 seconds fresh air mode -> 3 minute re-circulated air mode -> etc.
- Operation without a/c function at ambient temperatures greater than 6°C: 4 minute re-circulated air mode -> 20 seconds fresh air mode -> 4 minute re-circulated air mode -> etc.
- Operation with a/c function at ambient temperatures greater than 6°C: 12 minute re-circulated air mode -> 20 seconds fresh air mode -> 12 minute re-circulated air mode -> etc.

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

Condensation Sensor Program

The following conditions must be satisfied for the condensation sensor to operate:

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

The IHKA control unit evaluates the condensation sensor signal (humidity). If condensation on the windscreen is imminent, the following measures are initiated in sequence to prevent condensation from forming:

- Open defrost flaps further.
- Switch from air-recirculation/AUC/automatic air-recirculation mode to partial fresh-air mode.
- Switch from partially fresh air in air-recirculation/AUC/automatic air-recirculation mode to fresh air.
- Increase blower air volume.
- Reduce air volume for the footwell.
- Increase desired temperature value.

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.

Convertible Mode

The E93 Convertible with its retractable hardtop combines two vehicles in one. It is a Coupe when closed and a Convertible when open, a fact taken into account by the automatic climate control to create pleasant and comfortable heating/ventilation conditions.

This characteristic makes it possible for an individual climate control program for both states. The software automatically initiates the automatic climate control program when it detects that the hardtop is down.

Trials and customer surveys have shown that the previous air conditioning systems set up for Sedans or Coupes were not ideal for a Convertible with the top down.

The temperature and blower output stage had to be constantly readjusted for the purpose of ensuring pleasant interior conditions.

All control parameters are adapted to the requirements of driving with the top down when the hardtop is lowered.

Convertible mode requires no additional sensors. The IHKA control unit was programmed with corresponding software that takes these specific parameters into account.

Convertible mode is activated by opening the retractable hardtop. The IHKA receives the corresponding information on the status of the hardtop from the Convertible top module (CTM).

Convertible mode is always active on vehicles with no central information display (CID). On vehicles with central information display, the Convertible Mode box in the "Automatic Program" menu must first be activated. This activation is possibly only with the hardtop open and is set to active as part of initial programming.

Note: If Convertible mode is not activated, the selected automatic program (soft, medium, intensive) is activated when the hardtop is opened.

Convertible Mode Control

The aim of Convertible mode is to create an automatic climate control program that makes it unnecessary to continually make manual adjustments while driving.

When driving with the top down, the occupants consciously expose themselves to the solar radiation and outside temperature at changing driving speeds. These parameters have a decisive influence on the climate in the vehicle interior and must therefore be taken into consideration in the control concept.

The spatial separation of the interior is cancelled when the hardtop is opened thus drastically reducing the influence of the interior temperature sensor. The temperature control for the vent outlet temperature is strongly orientated on the outside temperature.

The sun's intensity has a great influence on the climate in the vehicle interior when driving with the top down. Therefore, changes in conditions such as cloudless, cloudy or daytime/night-time are included via the solar sensor to a greater extent in the temperature control than when the hardtop is up.

Unlike when the vehicle is closed, the ventilation outlets become the dominant air distribution level when the hardtop is down and are therefore always fully opened while, to achieve a comfort balance, the footwell outlets must always be restricted as soon as the operating temperature of the engine necessary for heating is reached.

Measures for keeping the windscreen/windows clear are not necessary when driving with the top down, therefore the defrost outlets always remain closed.

The driver sets the required temperature at the temperature control. Depending on the outside temperature, sun's intensity and vehicle speed, the required interior climate is maintained by the supply of correspondingly temperature-controlled air. The most comfortable conditions are achieved with the side windows closed and a wind deflector additionally installed.

The ram pressure compensation that serves the purpose of keeping the air throughput constant when the vehicle is closed is cancelled in Convertible mode. The blower output is additionally increased based on the vehicle speed in order to maintain a constant air flow about the occupants.

The increasing air volume essentially shields the occupants from increasing turbulence at higher vehicle speeds. The occupants subjectively notice no difference in temperature conditions.

The AUC function is also active in Convertible mode up to a speed of 45 MPH. It is deactivated at higher speeds. This is intended to ensure that no pollutants are blown into the interior of the vehicle via the air conditioning outlets when driving at low speeds, e.g. in urban or stop-and-go traffic. The best effect is achieved with the side windows closed.

Note: Convertible Mode was first introduced in the E64, this system served as the basis to the E93 Convertible Mode.

Condition Based Service (Cabin Filters)

Fresh Air/Recirculating Air Filter

The E9X is equipped with a carbon activated microfilter which is accessible from the engine compartment.



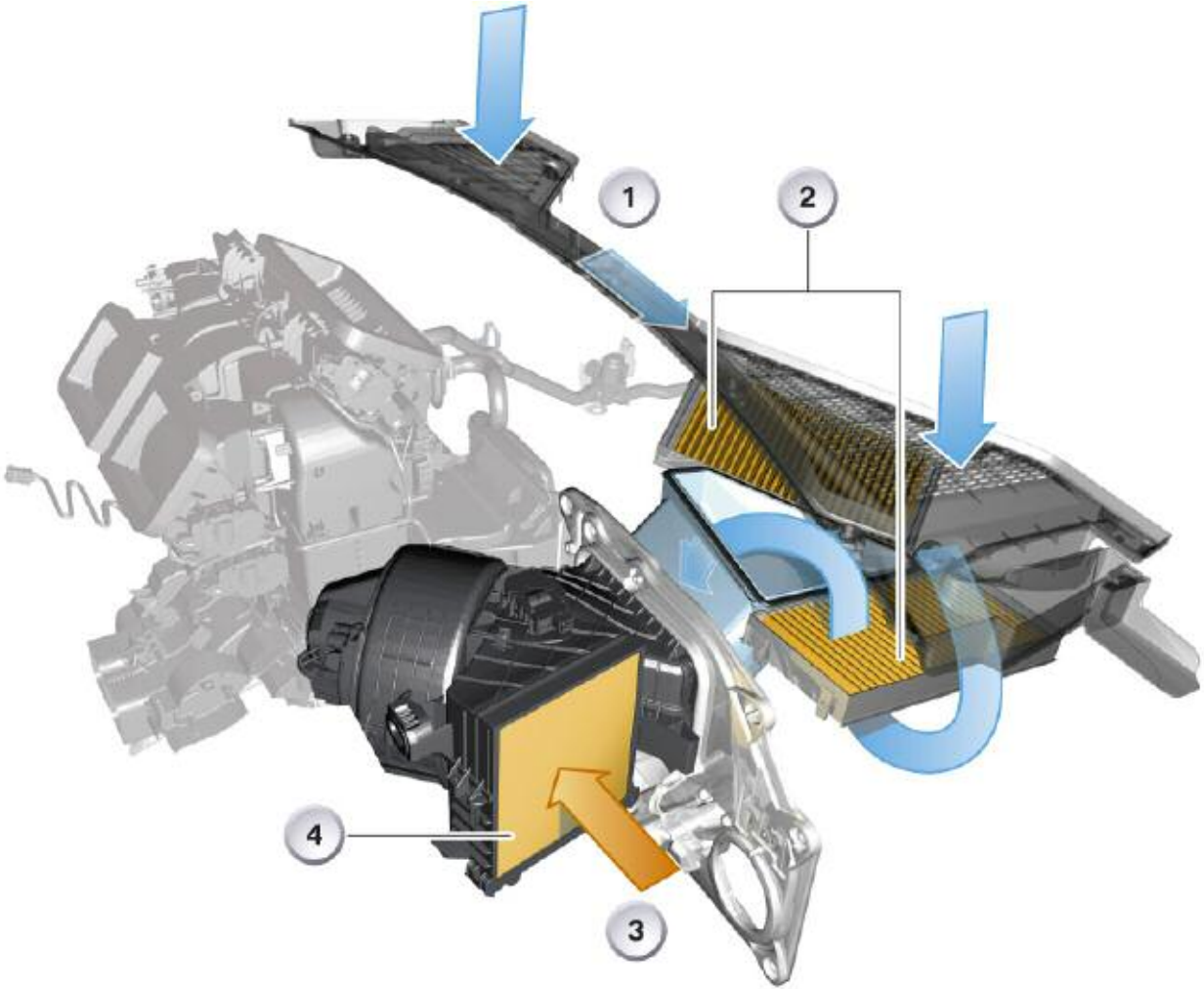
E90 Microfilter

In the E70 Fresh air is drawn in via two filter elements in the intake area in front of the bulkhead. The recirculated air is drawn in at the side by the blower via separate recirculating air filters.

Fresh Air Filtering

A particulate filter or a micro/activated charcoal "combination filter" is also used on the E70 fresh air intake. The particulate filter (also referred to as a microfilter) removes dust, pollen, soot and other dirt from the fresh air that is needed to control the climate of the vehicle. The adsorption filter (activated charcoal filter) has the job of removing the pollutants (hydrocarbons, acidic gasses) that mainly occur in high concentrations under smog conditions from the fresh air that is needed to control the climate in the vehicle.

E70 Fresh Air/Recirculating Air Filter



Index	Explanation	Index	Explanation
1	IHKA fresh air intake	3	IHKA recirculated air intake
2	IHKA fresh air filter	4	IHKA recirculated air filter

Recirculated Air Filtering

A new type of honeycomb filter is used in the recirculated air intake. The versions for fresh air particulate filters can also be used for filtering recirculated air, but are used for cleaning the air in the passenger compartment.

Filter types and equipment in the E70 All filters are electrostatically charged during manufacture and have the characteristic of attracting particles and holding them in, therefore cleaning the air.

The performance figures of an adsorption filter are initial pressure loss, particle separation, dust storage capacity, gas adsorption (such as n-butanes, sulphur dioxide, toluene) and are independent of the filter surface and the air-mass flow.

In order to be able to cope with customer specific filter usage and associated change interval increases and reductions, the filter change intervals of the E70 have not been stored in the CBS (Condition Based Service) system.

Note: The filter change intervals can be found in the relevant service literature.

Once the cover has been removed from the bulkhead, the filter can be easily replaced or cleaned. The filter change is indicated via the CBS.

The wear level of the microfilter is monitored by the IHKA control unit.

To do this, the control unit uses a calculation model (algorithm) to simulate the condition of the microfilter from the following factors:

- Outside temperature
- Signal from rain/light sensor (IHKA only, otherwise default value)
- Signal from solar sensor (IHKA only)
- Blower voltage
- Air conditions (recognized from frequent or infrequent use of air recirculation)
- Vehicle road speed
- Service interval display (SIA) timer

The IHKA control unit forwards the following data to the cluster via the K-CAN:

- Odometer reading
- Microfilter availability in percent
- Time remaining until next service