640 Heating and Air-conditioning

GENERAL

This repair group covers heating and air-conditioning operation and component replacement.

If the air-conditioning system requires evacuation and recharging of refrigerant, use equipment specially designed for A/C system service and follow the equipment manufacturer's instructions.

See also:

- **020 Maintenance** for cabin microfilter service
- **170 Radiator and Cooling System** for cooling system service and electric cooling fan removal and installation
- **600 Electrical System–General**

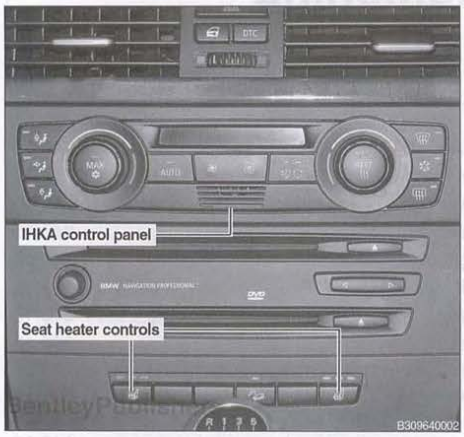
A/C system fluids

The air-conditioning refrigerant used in modern automobiles is R134a, known chemically as *tetrafluoroethane*. Strict regulations govern the handling and disposal of automotive refrigerant. Be sure to read **Warnings and Cautions** in this repair group if working with A/C and heating components.

A sticker in the engine compartment gives the manufacturer's recommendation for refrigerant capacity.

Table a. A/C system refrigerant capacity	
R134a	590 ± 10 grams (20.8 ± 0.4 oz)

A synthetic oil, *polyalkylene glycol* (PAG), is used to lubricate the A/C compressor. This type of oil is highly hygroscopic (absorbs water). Be sure to immediately reseal an opened container after use.



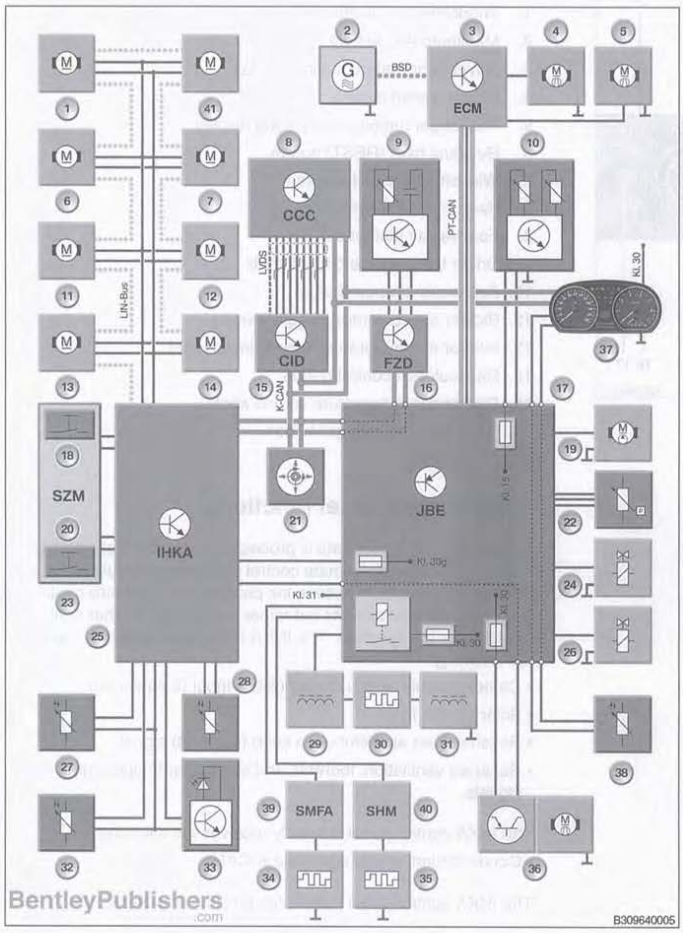
IHKA basics

The 3 Series is equipped with an integrated automatic climate control system (IHKA). The dashboard mounted control panel shares functions with iDrive (if equipped).

IHKA includes the following features:

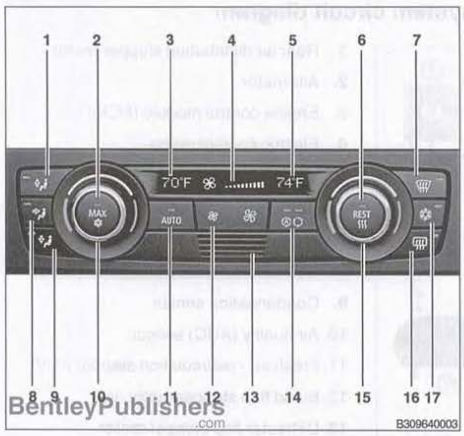
- Dual zone control system allows driver and passenger to control temperature settings separately.
- Residual heat (REST) function allows brief periods of cabin-heating with the engine OFF.
- Condensation sensor at base of interior rear view mirror.
- Eight air control flap stepper motors (seven are identical).
- Stepper motors control via LIN-bus.
- Seat heater control.
- Rear window defogger control.
- Clutchless A/C compressor.

IHKA system circuit diagram



1. Rear air distribution stepper motor
2. Alternator
3. Engine control module (ECM)
4. Electric coolant pump
5. Engine cooling fan
6. Ventilation stepper motor
7. Front air distribution stepper motor
8. Car communication computer (CCC)
9. Condensation sensor
10. Air quality (AUC) sensor
11. Fresh air - recirculation stepper motor
12. Blend flap stepper motor, left
13. Defroster flap stepper motor
14. Footwell flap stepper motor
15. Central information display (CID)
16. Roof function center (FZD)
17. Junction box electronics module (JBE)
18. Seat heater button, left
19. A/C compressor valve
20. Seat heater button, right
21. iDrive controller
22. Refrigerant pressure sensor
23. Center console switch cluster (SZM)
24. Heater valve
25. IHKA control panel
26. Auxiliary coolant pump (not for US)
27. Evaporator temperature sensor
28. Footwell temperature sensor
29. Rear window defogger lockout circuit
30. Rear window defogger
31. Rear window defogger lockout circuit
32. Ventilation temperature sensor
33. Solar sensor
34. Seat heating element, left
35. Seat heating element, right
36. Blower motor and final stage
37. Instrument cluster
38. Outside temperature sensor
39. Driver seat module
40. Seat heating module, right
41. Blend flap stepper motor, right

IHKA control panel



IHKA control panel

1. Windshield air distribution
2. Maximum A/C setting
3. Driver temperature setting display
4. Blower speed display
5. Passenger temperature setting display
6. Residual heat (REST) button
7. Windshield defrost program
8. Face vent air distribution
9. Footwell air distribution
10. Driver temperature control knob
11. Automatic program button
12. Blower speed control (toggle switch)
13. Interior air temperature sensor intake vent
14. Recirculation control button
15. Passenger temperature control knob
16. Rear window defogger button
17. A/C button

IHKA control panel functions

Climate control sensor data is processed in the IHKA control panel. Driver and passenger climate control settings and requests are also entered in the panel. However, the panel does not directly control all functions and components but rather makes use of other control modules for this purpose. The IHKA control panel directly monitors the following:

- Center console switch cluster (SZM) input (if equipped).
- Solar sensor input.
- Receives rear air distribution knob (rheostat) signal.
- Receives ventilation, footwell, and evaporator temperature sensor signals.

The IHKA control panel indirectly receives the following:

- Condensation sensor signal via K-CAN.

The IHKA control panel illuminates function and backlighting LEDs.

IHKA additional controls

Engine control module (ECM) climate control functions are:

- Actuates engine cooling fan for cooling of A/C condenser.
- Interfaces with IHKA control panel via bus network for compressor ON signal.
- Interfaces with IHKA control panel for operation of electric coolant pump for residual heat feature.

Junction box electronic module (JBE) climate control functions are:

- Output signal for seat heating.
- Rear window defogger.
- Blower motor operating voltage.
- Refrigerant control valve (in A/C compressor).
- PT-CAN gateway for bidirectional communication between IHKA and ECM.
- Receives rear air distribution knob (rheostat) signal.
- Receives refrigerant pressure sensor signal.
- Receives air quality (AUC) sensor signal.
- Splice point for outside air temperature sensor.

Roof control panel (FZD) relays condensation sensor signal to IHKA via K-CAN.

Car access system (CAS) assigns a personal identification code to each remote control key. Personal identification codes are transmitted to IHKA control panel via K-CAN. When vehicle enters sleep mode, current climate control settings are stored in IHKA control panel for remote control key in use at that time.

When vehicle is unlocked via remote control key, settings for this key are called up and executed.

Car communication computer (CCC) processes IHKA menu and submenu signals and displays them in the dashboard mounted central information display (CID), if equipped with iDrive.

Central information display (CID). Use iDrive controller to activate the following functions and display selections in CID:

- Air distribution setting. positions for defrost flaps, ventilation flaps and footwell flaps may be individually set in air distribution submenu.
- Automatic IHKA mode. Climate control intensity (low, medium or high) may be set in automatic mode submenu.

Center console switch cluster (SZM). Seat heater switches in SZM (if equipped) are connected via 14-wire ribbon cable directly to IHKA control panel.

IHKA sensors

Interior temperature sensor, mounted on IHKA control panel, samples cabin air by using a small electrical fan (non-replaceable) to suck air through the grill on the front face of the control panel. Sensor output is used by the IHKA panel to modulate interior temperature.

Evaporator temperature sensor, mounted close to the evaporator, transfers data directly via cable to IHKA control panel.

Outside temperature sensor is hard wired to the instrument cluster.

Vent flap temperature sensors are 3 NTC type sensors wired directly to the IHKA control panel:

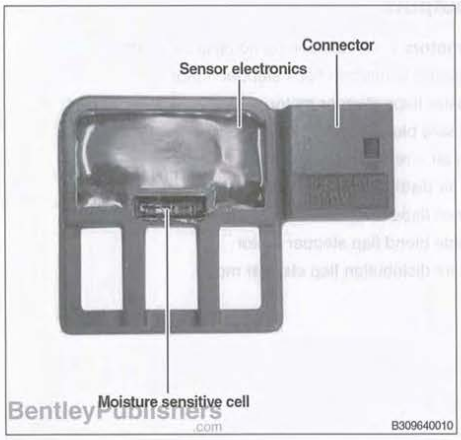
- Stratified temperature sensor
- Ventilation temperature sensor
- Footwell temperature sensor

Solar sensor, located at the front of the dashboard under the windshield, is hard wired to the IHKA control panel

Refrigerant pressure sensor is in the pressure line between the A/C condenser and the evaporator. In case of excessively high or low refrigerant pressure, A/C compressor output is reduced via signal from IHKA control panel to JBE. Sensor power is provided by JB.

Air quality (AUC) sensor, mounted on the cabin microfilter housing, is controlled and powered by JB. AUC sensor detects the following:

- Carbon monoxide (CO)
- Hydrocarbons (HC)
- Oxides of nitrogen (NO_X).



Condensation sensor, mounted under the rain and light sensor (RLS) on interior mirror base at top of windshield, is controlled and powered by the roof control module (FZD).

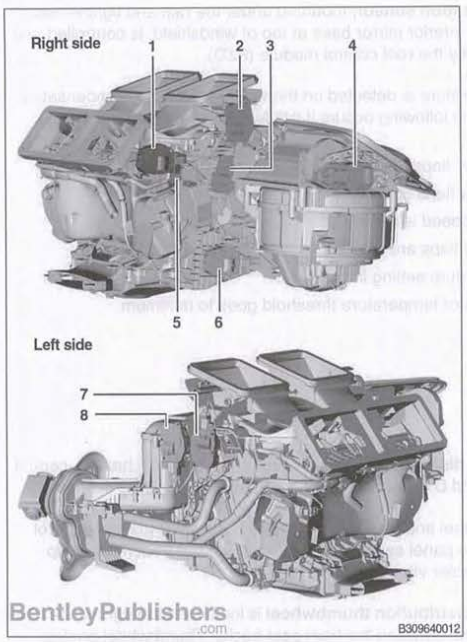
When moisture is detected on the windshield by the condensation sensor, the following occurs if IHKA system is set on automatic operation:

- Defroster flaps open further.
- Fresh air flaps open 100%.
- Blower speed is increased.
- Footwell flaps are closed.
- Temperature setting increases.
- Evaporator temperature threshold goes to minimum.

Front air distribution thumbwheel is ganged with hazard, central locking and DTC switches located in the center of the dashboard.

Thumbwheel analog voltage signal is hard wired to IHKA control panel. The panel sends position signals to the front mixing flap stepper motor via LIN-bus.

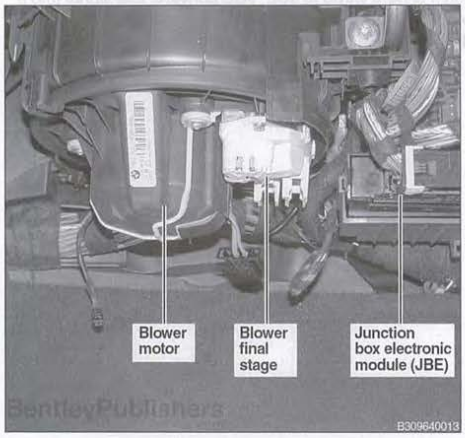
Rear air distribution thumbwheel is located to the right of the rear center vent, between the front seat backs. Thumbwheel analog voltage signal is hard wired to JBE. JBE converts this signal into a digital signal, transmitted via K-CAN to IHKA control panel, which then sends the position signals to rear mixing flap stepper motor via LIN-bus.



IHKA outputs

Stepper motors in climate control housing under the dashboard:

1. Dashboard ventilation flaps stepper motor
2. Defroster flaps stepper motor
3. Right side blend flap stepper motor
4. Fresh air – recirculation flap stepper motor
5. Rear air distribution flap stepper motor
6. Footwell flaps stepper motor
7. Left side blend flap stepper motor
8. Front air distribution flap stepper motor



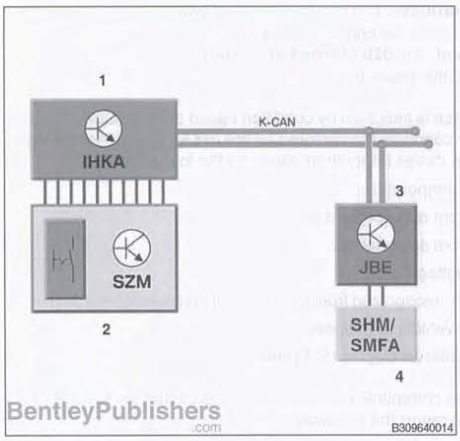
Blower and **blower output stage** are mounted in the climate control housing behind the glove compartment.

Blower output stage is activated via pulse-width modulation by IHKA control panel. This connection is spliced through junction box (JB). Operating power for the blower motor is supplied by JB.

Heater valve controls amount of heated engine coolant sent to the heater core. Blend flaps are used to control the temperature settings on the two sides of the dual zone climate control system.

Heater valve is opened via a spring. It is operated via band pulse width modulated signal from JBE.

A/C compressor is clutchless. A swash plate in the compressor housing varies the amount of compression on the refrigerant. The compressor valve is controlled and powered by JBE.



Seat heating is controlled and powered by JBE. Request for seat heating activation is initiated from center console switch cluster (SZM) directly to IHKA control panel, then via K-CAN to JBE.

1. IHKA control panel
2. Center console switch cluster (SZM)
3. Junction block electronic module (JBE)
4. Seat heating module
   Driver seat module

Rear window defogger is controlled and powered by JBE. Defogging request is sent to JB from IHKA control panel via K-CAN.

Electric coolant pump is electronically controlled by the engine control module (ECM). When residual heat (REST) function is activated, IHKA control panel interfaces with ECM to activate the coolant pump, circulating hot or warm coolant through the heater core to warm up the passenger cabin.

IHKA non-electrical components

Refrigerant circuit consists of A/C compressor, expansion valve, evaporator and condenser. The system features:

- Aluminum refrigerant lines.
- Receiver-drier (with replaceable desiccant) integrated in the condenser.
- Clutchless compressor controlled by IHKA logic via JBE.
- Expansion valve accessible from engine compartment.

Heating circuit. Heated engine coolant is pumped by electric coolant pump through heater valve to heater core (heat exchanger). From here, coolant is routed back to engine and coolant thermostat.

Cabin microfilter. The microfilter with activated carbon is accessible from the engine compartment. For microfilter replacement, see **020 Maintenance**. Microfilter housing removal is covered in this repair group.

Filter service is indicated by condition based service (CBS) system. Microfilter condition is monitored by the IHKA control panel using a calculation model (algorithm) based on the following factors:

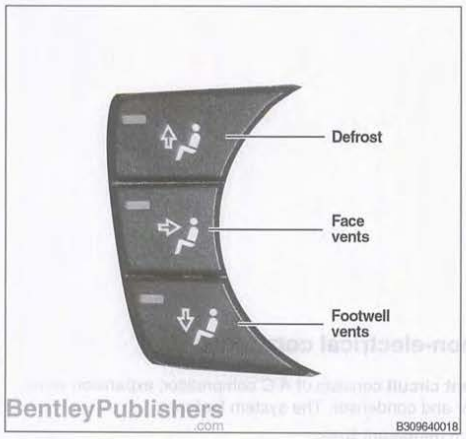
- Outside temperature.
- Signal from rain and light sensor.
- Signal from solar sensor.
- Blower voltage.
- Air quality, recognized from frequency of recirculation mode usage.
- Average vehicle road speed.
- Service interval display (SIA) timer.

IHKA panel communicates with instrument cluster via K-CAN to detect and report the following:

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

IHKA functions

Manual air distribution. For the best possible air distribution, manually adjust air vents using IHKA panel buttons. However, automatic fine adjustment for each side is possible if vehicle is equipped with iDrive.

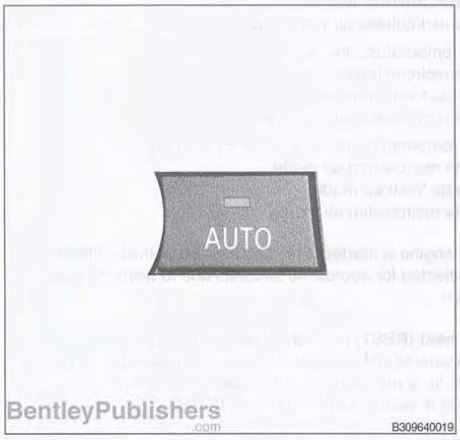


Temperature is adjusted using separate driver and passenger temperature control knobs on IHKA control panel. Interior temperature is calculated from values measured by interior temperature sensor on IHKA panel and footwell temperature sensors. System also responds to outside temperature sensor signals.

Temperature control is via 2 air blend flaps in climate control housing.

MAX button selects maximum cooling with just one press of button. With MAX button pressed:

- Defrost deactivates.
- Temperature control deactivates
- Air-conditioning activates.
- Ventilation flaps open fully.
- Recirculation mode activates.



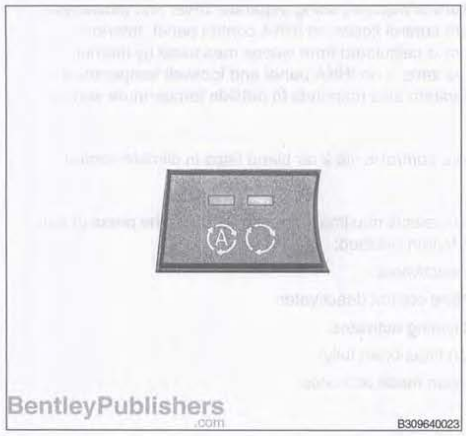
AUTO button activates automatic airflow control using programmed blower and flap settings. If one or more automatically controlled functions are set manually, automatic control for those functions is cancelled, but other functions remain automatically controlled.

In this mode, the following applies

- Dynamic pressure compensation: Air volume at air inlet grills increases disproportionately with increasing road speed. This effect is compensated for by programmed reduction of opening angle of fresh-air flaps as vehicle speed increases.
- Blower control: If necessary, vehicle power management reduces blower output via K-CAN. See **600 Electrical System–General**.
- Starting: When engine is cranked (terminal 50 ON), electric coolant pump and blower are switched OFF to reduce load on battery.

Blower speed control is via toggle switch at center of IHKA panel. Current blower speed setting is shown by display icon.

OFF. IHKA control panel is switched OFF when blower speed is set to 0.



Recirculation mode blocks flow of outside air to prevent pollution from entering vehicle. Air inside vehicle is continually recirculated.

To make sure that there is a sufficient supply of fresh air, recirculation mode is only available for 30 minutes. The system then switches to partial fresh air circulation for 30 minutes, then switches back to full recirculation

Automatic air quality control. If air quality (AUC) sensor detects an increased level of automotive pollutants, IHKA automatically switches to recirculation mode.

To make sure there is a sufficient supply of fresh air, automatic recirculation is only available for a limited time:

- Outside temperature under 0°C (32°F):
  2 minute recirculated air mode
  20 seconds fresh air mode
  2 minute recirculated air mode, etc.
- Outside temperature 0° - 6°C (32° - 43°F):
  3 minute recirculated air mode
  20 seconds fresh air mode
  3 minute recirculated air mode, etc.
- Outside temperature above 6°C (43°F), no A/C:
  4 minute recirculated air mode
  20 seconds fresh air mode
  4 minute recirculated air mode, etc.
- Outside temperature above 6°C (43°F), with A/C:
  12 minute recirculated air mode
  20 seconds fresh air mode
  12 minute recirculated air mode, etc.

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

Residual heat (REST) function allows hot or warm engine coolant to heat up vehicle interior when engine is not running. This function is available for a run-down period of approx. 15 minutes from the time ignition is switched OFF (terminal 15 OFF).

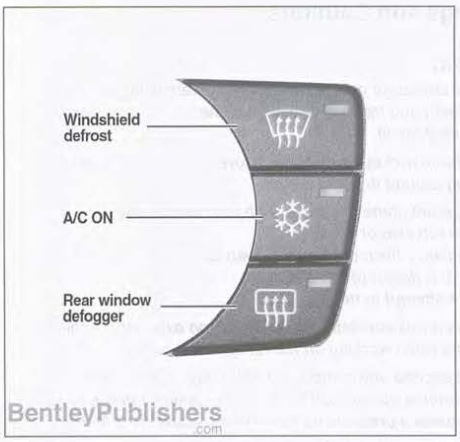
Pressing REST button signals ECM via bus system to activate electric coolant pump and circulate coolant.

REST switch-on conditions:

- Terminal 15 OFF.
- Run-down period (up to 15 minutes after terminal 15 OFF).
- REST button in IHKA controls ON.
- Outside temperature below 25°C (77°F).
- Engine temperature above 60°C (140°F).
- Battery voltage over 11.4 volts.

REST switch-off conditions:

- Terminal 15 ON.
- Residual heat ON past 15 minutes.
- REST button in IHKA control panel OFF.
- Power management switches auxiliary consumers OFF.
- Battery voltage below 11 volts.



Defrost button opens windshield defroster flaps fully. Fresh air - recirculation flaps move to fresh air position. Other flaps are closed. Blower is run at maximum speed.

A/C button switches cooling function ON in order to cool and dehumidify incoming air before it is heated. This function helps prevent or reduce condensation on windows.

Rear window defogger, toggled ON or OFF by pressing button. Defogging switches OFF automatically after programmed rear window heating time expires.

There are two rear window defogging programs. First program:

- After vehicle starts, the first time defogger is switched ON, defogging time is as follows:
  Outside temperature down to 15°C (59°F): 10 minutes
  Outside temperature below 15°C (59°F): 17 minutes.
- After initial defogging phase, rear window is heated for 25 minutes with pulsed heat output:
  40 seconds ON
  80 seconds OFF.

Second program:

- Each subsequent time defogger button is pressed:
  Defogging is switched ON for 30 minutes.
  After second heating period, output is again pulsed.

Evaporator temperature is regulated by evaporator temperature sensor and expansion valve. The minimum evaporator temperature is set to 2°C (36°F) to avoid risk of icing. Actual evaporator temperature ranges 2° - 7°C (36° - 45°F), depending on outside temperature, vent temperature and refrigerant pressure. Variable evaporator temperature control reduces excessive dehumidification of vehicle interior.

Solar sensor (active in IHKA automatic mode) modifies the following functions, depending on sunlight intensity:

- Blower output increased or reduced.
- Temperature settings using temperature control knobs increased or reduced.

Driver and passenger side (dual-zone) functions are not modified separately.

Condensation sensor operates with engine running and IHKA in automatic mode. IHKA control panel evaluates condensation sensor signal (humidity). If condensation on windshield is imminent, the following measures are initiated in sequence:

- Open defrost flaps further.
- If in recirculation mode, switch to partial fresh-air mode.
- If in partial recirculation mode, switch to fresh air.
- Increase blower speed.
- Reduce footwell air volume.
- Increase set temperature value.

If one measure proves to be ineffective, the next measure is initiated. Once successful, the measures previously performed are performed in reverse order.

Warnings and Cautions

WARNING—

- *Do not discharge or charge the A/C system without proper equipment and training. Damage to the vehicle and personal injury may result.*
- *Wear hand and eye protection (gloves and goggles) when working around the A/C system.*
- *If refrigerant come in contact with your skin or eyes:*
  -Do not rub skin or eyes.
  -Immediately flush skin or eyes with cool water for 15 minutes.
  -Rush to a doctor or hospital.
  -Do not attempt to treat yourself.
- *Work in a well ventilated area. Switch on exhaust / ventilation systems when working on the refrigerant system.*
- *Do not expose any component of the A/C system to high temperatures (above 80°C or 176°F) or open flames. Excessive heat causes a pressure increase which could burst the system.*
- *Keep refrigerant away from open flames. Poisonous gas is produced if it burns. Do not smoke near refrigerant gases for the same reason.*
- *The A/C system is filled with refrigerant gas which is under pressure. Pressurized refrigerant in the presence of oxygen may form a combustible mixture. Do not introduce compressed air into any refrigerant container (full or empty).*
- *Electric welding near refrigerant hoses causes R-134a to decompose. Discharge system before welding.*
- *At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening (a minimum of one hour), then release the cap slowly to allow safe release of pressure.*

CAUTION—

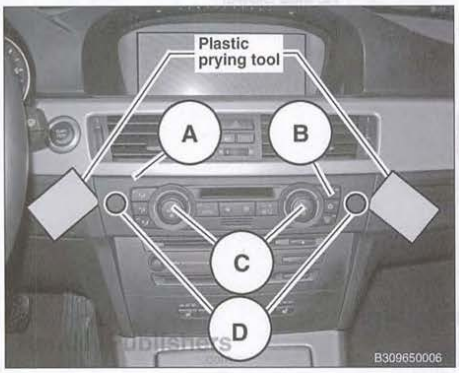
- *In the United States, any person who services a motor vehicle air-conditioner must, by law, be properly trained and certified, and use approved refrigerant recycling equipment. Technicians must complete an EPA-approved recycling course to be certified.*
- *Comply with state and local governments which may have additional requirements regarding air-conditioning servicing.*
- *It is recommended that all A/C service be left to an authorized BMW dealer or other qualified A/C service facility.*
- *Do not top off a partially charged refrigerant system. Discharge system, evacuate and then recharge system.*
- *The mixture of refrigerant oil (PAG oil) and refrigerant R-134a attacks some metals and alloys (for example, copper) and breaks down certain hose materials. Use only hoses and lines that are identified with a green mark (stripe) or marked with* R-134a.
- *Immediately plug open connections on A/C components and lines to prevent dirt and moisture contamination.*
- *Do not steam clean the A/C condenser or evaporator. Use only cold water or compressed air.*
- *To avoid damaging plastic interior trim, use a plastic prying tool or a screwdriver with the tip wrapped with masking tape.*

IHKA Component Replacement

IHKA control panel, removing and installing

Version 1: Model without iDrive

- Use plastic prying tool to carefully pry out IHKA control panel.



Version 2: Model with iDrive

- Use plastic prying tool to pry off IHKA control panel (**B**). Unclip front face (**A**) using knobs (**C**). Plastic pins are located at **D**.

- Pull panel back and unlock connector locks to detach.

– Installation is reverse of removal. Use BMW scan tool to program and code new panel. See **600 Electrical System–General**.

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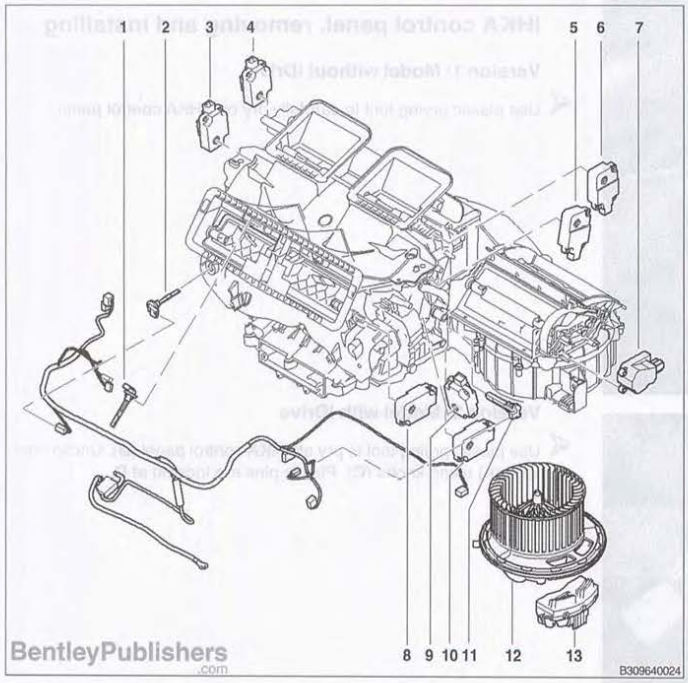
IHKA housing and components



1. **B62** Center vent temperature sensor
2. **B109a** Footwell vent temperature sensor
3. **M153** Blend flap stepper motor, left
4. **M4729** Air distribution flap motor, front
5. **M154** Blend flap stepper motor, right
6. **M35a** Defroster flap stepper motor
7. **M111** Fresh air - recirculation flap stepper motor
8. **M38** Center vent flap stepper motor
9. **M31** Footwell flap stepper motor
10. **M4723** Air distribution flap motor, rear
11. **B14b** Evaporator temperature sensor
12. **M30** Blower
13. **N2** Blower final stage

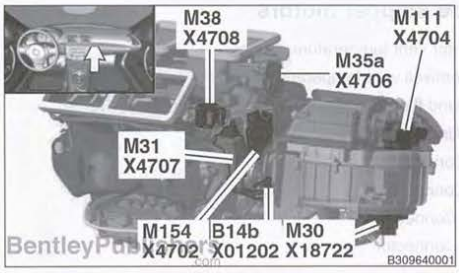
Stepper motors

The IHKA system utilizes eight stepper motors that are wired in series for climate control operation. IHKA control panel operates stepper motors via LIN-bus.

Stepper motors can be replaced without removing the dashboard or climate control housing.

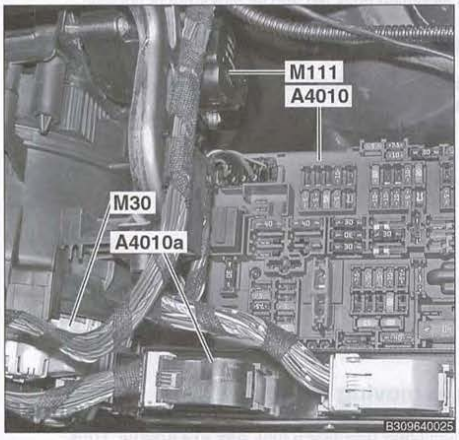
Seven of the eight stepper motors used are identical and have the same part number. A different stepper motor is used only for the fresh air – recirculation motor.

After replacement, use BMW scan tool or equivalent to program stepper motor locations.

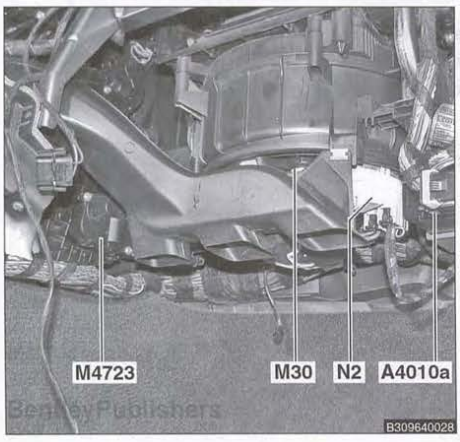


Right side stepper motors

- **B14b** Evaporator temperature sensor
- **M30** Blower motor
- **M31** Footwell flap stepper motor
- **M35a** Defroster flap stepper motor
- **M38** Center vent flap stepper motor
- **M111** Fresh air - recirculation flap stepper motor
- **M154** Blend flap stepper motor, right
- **X4702** Connector
- **X4704** Connector
- **X4706** Connector
- **X4707** Connector
- **X4708** Connector
- **X01202** Connector
- **X18722** Connector

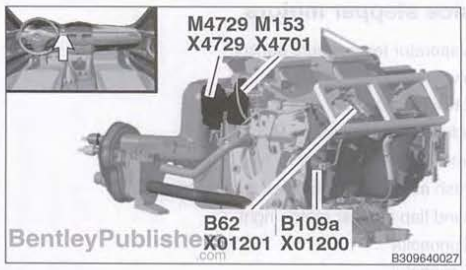


- **A4010** Junction box (JB)
- **A4010a** Junction box electronics module (JBE)
- **M30** Blower
- **M111** Fresh air - recirculation flap stepper motor



- **A4010a** Junction box electronics module (JBE)
- **M30** Blower
- **N2** Blower final stage
- **M4723** Air distribution flap motor, rear

– To gain access to right side stepper motors:
- Remove right lower dashboard trim. See **513 Interior Trim**.
- Remove glove compartment. See **513 Interior Trim**.

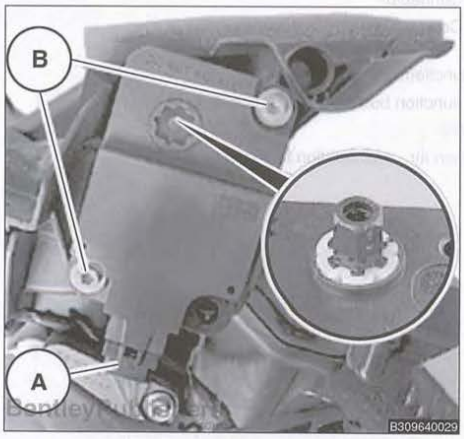


Left side stepper motors

- **B62** Center vent temperature sensor
- **B109a** footwell vent temperature sensor
- **M153** Blend flap stepper motor, left
- **M4729** Air distribution flap motor, front
- **X4701** Connector
- **X4729** Connector
- **X01200** Connector
- **X01201** Connector

– To gain access to left side stepper motors, remove left lower dashboard trim (pedal cluster trim). See **513 Interior Trim**.

Stepper motor, removing and installing



➢ To remove stepper motor:
- Detach electrical connector (**A**).
- Remove mounting bolts (**B**) and tilt motor out of housing.

– During installation, do not twist teeth of motor drive (**inset**).

– After replacement, use BMW scan tool or equivalent to program stepper motor locations.

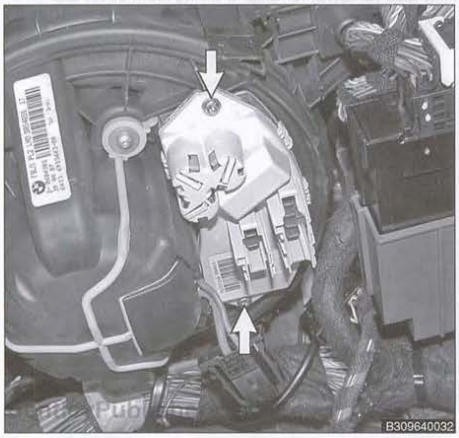
Blower, removing and installing

– Remove right lower dashboard trim. See **513 Interior Trim**.

➢ Working at blower:
- Pull off right footwell duct
- Detach electrical connector (**arrow**) at blower final stage.

NOTE—
- *Glove compartment removed for purpose of illustration.*

➤ Press carefully on lock lug (**arrow**) and rotate blower in direction of **curved arrow** to remove.



➤ If necessary, separate blower final stage by removing screws (**arrows**).

– When installing blower, make sure lock lug snaps audibly into place.

Cabin microfilter housings, upper and lower, removing

– Open engine hood and place in service position. See **020 Maintenance**.

➤ Remove upper microfilter housing screws (**arrows**). Lift off microfilter upper housing and microfilter.

Microfilter replacement is covered in **020 Maintenance**.

Cabin microfilter housings, upper and lower, removing

➤ Right side: Unclip E-box cover and detach rubber lock tab ((**arrow**) to lift off cover. Detach AUC sensor and wire from lower microfilter housing and lay aside.

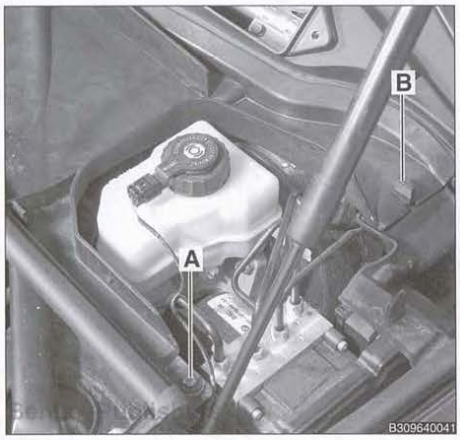
– Left side: Brake fluid reservoir cover removal is similar.

➤ Unclip locking tabs (**arrows**) for engine wiring loom cover and take off cover.

➤ Lift wiring harnesses over edge of plastic loom (**arrows**).

Cabin microfilter housings, upper and lower, removing

Reach through wire loom opening with plastic prying too and unclip engine wiring loom cover underneath microfilter housing.



Working at left side of housing, remove housing hold-down screw (**A**) and detach rubber lock tab (**B**). Repeat operation on right side of housing.

Slide housing forward and up (**arrows**) to remove.

– Installation is reverse of removal.

CAUTION—

- *Make sure upper microfilter housing seals securely to lower housing. A bad seal may allow water leaks into the cabin, IHKA housing or blower.*

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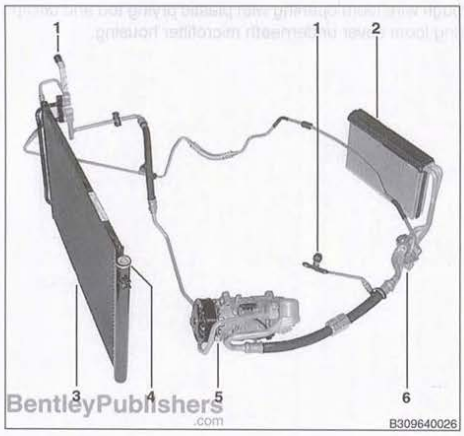
Air-conditioning components in engine compartment



Air-conditioning components in engine compartment

1. Refrigerant service port
2. Evaporator
3. Condenser
4. Receiver-dryer port
5. A/C compressor
6. Expansion valve