Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2000.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

Volvo Trucks North America, Inc.
Greensboro, NC USA

Order number: PV776-TSP144796

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Foldout A A/C System Refrigerant Flow Diagram
Operation Numbers
The Climate Control System in the VN and VHD series vehicles serves several functions. The basic unit is designed to defrost the windshield for better visibility and safety and to heat the cab for driver comfort. By adding air conditioning the cab can also be cooled for added driver comfort and dehumidified for maximum defrosting. Some vehicles are equipped with bunk heating and cooling units for the sleeper compartment.

The cab climate control system will consist of at least the following components: intake cowling, air filter, climate control unit, distribution ducts, and a control panel. The climate control unit consists of a heater core, heater control valve, and blower assembly. If the vehicle is equipped with air conditioning, the climate control unit will also contain an evaporator and a cold control switch. A vehicle with A/C will also have a refrigerant compressor, a condenser, a receiver/dryer, and an expansion valve.

There are three variations of the cab climate control system: Heater/Defroster unit only (early VN models only), Manual heater/AC unit, and Automatic Temperature Control (ATC) unit. There are two variations of bunk heater system if A/C equipped: a manually controlled system (early models only) and an ATC system.
Cab Climate Control

Control Panel
The Climate Control Unit control panel is located on the center section of the vehicle dash. It provides the controls to operate the cab heating and air conditioning (if air conditioning is installed). One of three different control panels is installed in the vehicle: a heater/defroster panel, a heater/AC panel, or an Automatic Temperature Control (ATC) panel.

Heater/Defroster
The most basic climate control is a 40,000 BTU heater/defroster unit only with no cooling capability. This system is controlled from the cab by a slide lever control assembly which is mounted in the vehicle dash. The cab climate control unit housing is common to all three systems.

Manual Heater/AC
The manually operated heating and air conditioning system is equipped to allow ventilation, heating, defrost and air conditioning operations. This system is controlled from a dash mounted control panel through the use of slide lever controls with cables. This system can be distinguished from the heater/defroster system by the compressor push button on the control panel (button with snowflake icon).

Automatic Temperature Control (ATC)
The Automatic Temperature Control (ATC) variant of the climate control system is equipped to allow ventilation, heating, defrosting and air conditioning operations. It also features the ability to automatically maintain a constant cab outlet temperature as set by the driver. This system is distinguished by the push button labeled “aut” on the control panel.

Temperature is maintained by moving the temperature slide lever to the desired position, then pushing the “aut” button on the control panel.
Bunk Climate Control

Manual Bunk Heating/Cooling
The manually operated bunk heater system consists of a cable operated temperature and a fan speed control. The control panel is mounted on the passenger’s side wall in the bunk area.

Note: The cab air conditioning system must be ON in order to cool the bunk area.

Note: The manually operated bunk HVAC system was available on early model VN’s only.

ATC Bunk Heating/Cooling
The ATC bunk unit has an electronically maintained temperature control. This allows the unit to maintain a constant bunk temperature. The ATC unit is located on the driver’s side wall of the bunk area.
Air Conditioning Diagnostic System (APADS)

Extreme vibration and high mileage on class 8 vehicles demands unique design and protection of truck components and systems. The air conditioning diagnostic system (APADS) is designed to reduce air conditioning system maintenance and to aid in the diagnosis of the air conditioning system. The system will reduce maintenance by protecting the refrigerant compressor and other related components from damage due to the effects of a loss of refrigerant or excessively high system pressure.

The protective function is accomplished by actively monitoring system conditions and by controlling the refrigerant compressor and the engine cooling fan (it does not have the ability to control viscous type fans). The diagnostic system aids diagnosing air conditioning system problems by communicating existing or impending problems using “blink” codes to inform the technicians.

Federal Regulations
The Environmental Protection Agency (EPA) requires that refrigerants be recovered and recycled and not released into the atmosphere.

Regulations concerning the proper handling of refrigerants, certification and training of technicians, tooling, and other environmental law can be obtained by calling the EPA Hotline at 1-800-292-1996 between the hours of 10:00 AM and 4:00 PM eastern time. Information is also available at www.epa.gov/ozone/title6/609 on the EPA website.
Specifications

Climate Control Systems

Refrigerant Compressor

Make ........................................................................................................................................... Sanden
Model ......................................................................................................................................... SD7H15
Number of cylinders .................................................................................................................... 7
Cylinder capacity .......................................................................................................................... 155 cc (9.46 ci)
Mounting angle ............................................................................................................................ up to 90° left or right of center
Rotation ......................................................................................................................................... clockwise only

Compressor Clutch

Compressor clutch type ................................................................................................................ Electro-magnetic
Amperage draw ............................................................................................................................ Approx. 2.8 - 3.8 amps at 12 volts DC
Air gap (front plate to rotor pulley) ............................................................................................. 0.4 - 0.8 mm (.016 - .031 in)
Belt tension ................................................................................................................................... 55 ± 2 kgf (121 ± 5 lb)
Clutch coil resistance .................................................................................................................... Approx. 3.1 - 4.4 ohms

Refrigerant

Refrigerant type ............................................................................................................................ R134a (Tetrafluorethane)
Day cab only (VN/VHD) ............................................................................................................. 1400 g (3 lbs. 1 oz.)
Cab and bunk unit
VN420 .......................................................................................................................................... 1600 g (3 lbs. 8 oz.)
VN610 .......................................................................................................................................... 1600 g (3 lbs. 8 oz.)
VN660 and 770 ............................................................................................................................. 1700 g (3 lbs. 12 oz.)
System Oil

Oil capacity

<table>
<thead>
<tr>
<th>Component</th>
<th>Capacity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressor</td>
<td>300 ml (10.1 fl oz.)</td>
<td>Failure to use Sanden SP20 PAG oil may void the compressor warranty.</td>
</tr>
<tr>
<td>Condenser</td>
<td>35 ml (1 oz.)</td>
<td></td>
</tr>
<tr>
<td>Evaporator</td>
<td>18 ml (1/2 oz.)</td>
<td></td>
</tr>
<tr>
<td>Bunk evaporator</td>
<td>9 ml (1/4 oz.)</td>
<td></td>
</tr>
</tbody>
</table>

Sanden refrigerant compressors built for use with R134a refrigerant are factory charged with Sanden SP20 Poly Alkaline Glycol (PAG) oil. Only Sanden SP20 PAG oil may be used when adding to or changing the compressor oil on R134a air conditioning systems. Failure to use the Sanden SP20 PAG oil may void the compressor warranty.

Approved oil for Sanden R134a compressors

| Sanden SP20 PAG oil, P/N 3917742 |

Note: The compressor oil level should be checked any time the A/C system has experienced a rapid and significant refrigerant leak or when an obvious refrigerant oil leak is observed. Replacement of the compressor, condenser, or the cab or bunk evaporator requires the addition of an approved PAG oil as part of the installation procedure. The Service Procedures include steps for checking oil level and adding PAG oil to the system or component.

A/C Diagnostic System

Module type

| Index sensors and controls | APADS CM-814 |

Pressure switch settings

<table>
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<th>Low pressure switch:</th>
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<tbody>
<tr>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>close</td>
<td>close</td>
</tr>
</tbody>
</table>

| open                  | 20.7 bar (300 psi)   |
| close                 | 17.9 bar (260 psi)   |
| open                  | 2.3 bar (34 psi)      |
| close                 | 0.55 bar (8 psi)      |

Pressure switch resistance

| Switch open | 2490 ± 30 ohms |
| Switch closed | 0 ohms        |
Supply voltages

Minimum ........................................................................................................................... 11.0 ± .2 volts
Typical ............................................................................................................................... 13.5 volts
Maximum continuous ....................................................................................................... 16.0 volts

Torque Values

Compressor

<table>
<thead>
<tr>
<th>Component</th>
<th>Nm</th>
<th>ft-lb</th>
<th>in-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch retaining nut - 1/2 inch</td>
<td>31 ± 3</td>
<td>23 ± 2</td>
<td>276 ± 24</td>
</tr>
<tr>
<td>Clutch retaining nut (M8)</td>
<td>18 ± 3</td>
<td>13 ± 2</td>
<td>156 ± 24</td>
</tr>
<tr>
<td>Oil filler plug</td>
<td>20 ± 5</td>
<td>15 ± 4</td>
<td>180 ± 48</td>
</tr>
<tr>
<td>Discharge hose fitting (Swivel nut)</td>
<td>30 ± 4</td>
<td>22 ± 3</td>
<td>264 ± 36</td>
</tr>
<tr>
<td>Suction hose fitting (Swivel nut)</td>
<td>40 ± 4</td>
<td>30 ± 3</td>
<td>360 ± 36</td>
</tr>
<tr>
<td>Discharge/Suction fitting (Pad mount)</td>
<td>23 ± 2</td>
<td>17 ± 1.5</td>
<td>204 ± 18</td>
</tr>
</tbody>
</table>

Miscellaneous

<table>
<thead>
<tr>
<th>Component</th>
<th>Nm</th>
<th>ft-lb</th>
<th>in-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic pressure switch</td>
<td>18 ± 1</td>
<td>13 ± 1</td>
<td>159 ± 9</td>
</tr>
<tr>
<td>Expansion Valve &quot;H&quot; Bracket</td>
<td>10 ± 1.5</td>
<td>7.5 ± 1</td>
<td>89 ± 13</td>
</tr>
<tr>
<td>Condenser Hoses (Pad mount)</td>
<td>24 ± 4</td>
<td>18 ± 3</td>
<td>212 ± 35</td>
</tr>
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**Torquing Refrigeration System Fittings**

Torque tightening is an important step when working on the climate control system. In order to tighten refrigerant system fittings with a torque wrench, an open end “crows foot” or a tubing wrench socket must be used in conjunction with the torque wrench. To prevent the hose and tube fittings from being over tightened or under-tightened, certain steps must be followed to ensure proper torquing of the fittings.

The amount of torque applied with a wrench is determined by the distance from the center of the bolt or fitting to the end of the wrench. Torque wrenches are calibrated based on the known length of the wrench. Placing a crow’s foot on the end of a torque wrench can add to the length from the bolt or fitting center to the end of the wrench, which adds to the leverage of the torque wrench and will affect the applied torque. To ensure that the torque indicated on the torque wrench is the actual applied torque, one of two methods may be used.

The easiest method is to place the open end of the crow’s foot at a 90° angle to the torque wrench as shown. This will not change the distance from the center of the bolt to the end of the wrench handle (A).

The other method requires that the new distance from bolt or fitting center to the end of the wrench handle be measured and the difference between the actual torque and the torque reading be calculated.

Perform the following to determine the correct torque wrench reading to apply the desired torque using a crow’s foot extension in the manner shown.

1. Measure the distance from the center of the torque wrench drive to the end of the torque wrench (A).
2. Measure the distance from the center of the crow’s foot to the center of the torque wrench drive (B).
3. Multiply the desired torque (T) by the torque wrench length (A) and divide by the torque wrench plus crow’s foot distance (A + B).

\[
\frac{T \times A}{A + B} = \text{torque wrench reading (or click setting)}
\]

To apply the desired torque
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<th>Nm</th>
<th>ft-lb</th>
<th>in-lb</th>
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<td>14-18</td>
<td>168-216</td>
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<td>#8, 7/8 in. wrench steel to steel</td>
<td>37-39</td>
<td>23-29</td>
<td>276-288</td>
</tr>
<tr>
<td>#10, 1 1/16 in. wrench steel to steel</td>
<td>41-49</td>
<td>30-36</td>
<td>360-432</td>
</tr>
<tr>
<td>#12, 1 1/4 in. wrench steel to steel</td>
<td>46-54</td>
<td>34-40</td>
<td>408-480</td>
</tr>
<tr>
<td>#6, 3/4 in. wrench aluminum to steel</td>
<td>19-24</td>
<td>14-18</td>
<td>168-216</td>
</tr>
<tr>
<td>#8, 7/8 in. wrench aluminum to steel</td>
<td>24-33</td>
<td>19-24</td>
<td>228-288</td>
</tr>
<tr>
<td>#10, 1 1/16 in. wrench aluminum to steel</td>
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<tr>
<th>Tubing to condenser connections</th>
<th>Nm</th>
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<td>5/8 inch x 18</td>
<td>23 ± 3</td>
<td>17 ± 2</td>
<td>204 ± 24</td>
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<tr>
<td>3/4 inch x 18</td>
<td>34 ± 3</td>
<td>25 ± 2</td>
<td>300 ± 24</td>
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Special Tools

The following special tools are required for work on R134a climate control systems. These tools can be ordered from the vendors listed.

Compressor Oil Level Dipstick
For accurate oil level measurement, a Kent-Moore compressor oil level dipstick is recommended (P/N J-43338). Order from Kent-Moore at 1-800–328-6657.

If tool J-43338 is not available, an oil dipstick can be fabricated from a welding rod, coat hanger, etc. using these specifications.

Refrigerant Recovery/Recycling/Recharging System
The Environmental Protection Agency requires that R134a refrigerant be recovered and recycled. Volvo recommends the use of the J-39500A Recovery/Recycling unit which is available from Kent-Moore, call 1-800–328-6657.
Always follow the manufacturer’s instructions when using any recovery/recycling units.

A/C Service Center
As an alternative to the J-39500 unit, Kent-Moore now offers the J-43600 A/C Service Center. The J-43600 A/C Service Center significantly improves the time required to service A/C systems and provides many added features. For more information contact Kent-Moore at 1-800-328-6657.
Electronic Leak Detector
The J-39400 Electronic Leak Detector locates leaks in the system safely and accurately with a heat diode sensor and air pump. The leak detector is available from Kent-Moore at 1-800-328-6657.

Digital Multimeter (DMM)
The Fluke 87 digital multimeter (P/N J-39200) is available from Kent-Moore at 1-800-328-6657.

Pocket Dial Thermometer
The thermometer (P/N J-6742-03) is available from Kent-Moore, call 1-800-328-6657.

Digital Protractor
The Digital Protractor is available from Kent-Moore, call 1-800-328-6657.

Breakout Harness
Two pin Packard breakout harness is used to check pressure switches and/or wiring. The breakout harness (P/N J-43147) is available from Kent-Moore at 1-800-328-6657.


**Clutch Remover Kit**
A tool kit for removing the A/C compressor clutch assembly from the compressor used in the R134a refrigeration system without causing damage to the internal parts of the compressor or clutch. The tool kit is available from Kent-Moore at 1-800-328-6657.

**A/C Compressor Seal Tool**
A tool for removing the compressor front seal. The two prongs at one end of the tool are used to remove the seal by engaging them into the seal notches. Rotate the tool and pull the seal out. The opposite end is used to install the new seal. The A/C Compressor Seal Tool (P/N J-33942-B) is available through Kent-Moore at 1-800-328-6657.

**Clutch Holder Tool**
The Clutch Holder (999-9171) is available from Volvo.

**Air Conditioner Service Kit**
The Air Conditioner Service Kit contains various O-rings, Schrader valves, and port caps to service the R134a system. It also contains Schrader valve core removal tool J-44302 and O-ring pick J-39227. The service kit (P/N 3093536) is available from Volvo.
A/C Schrader Valve Core Removal Tool

Tool J-44302 is used for replacing the core in A/C Schrader valves. The tool is designed primarily for A/C systems that use R134a refrigerant. To order, call Kent-Moore at 1-800-328-6657.

Belt Tension Gauge

The Belt Tension Gauge (P/N J-23600-B, (BT-33-73F)) is used to check drive belt tension. To order, call Kent-Moore at 1-800-328-6657.
The purpose of the climate control system is to modify the temperature of the cab air for the comfort of the vehicle occupants and to defrost the windshield. One of three different types of climate control systems is installed on each VN/VHD series vehicle: a heating and ventilation only unit, a heating and air conditioning unit, and a heating and air conditioning unit with Automatic Temperature Control (ATC). Each of these units is comprised of components that allow for either introduction of fresh, filtered air to enter the cab or for the recirculation of cab air. Each unit also consists of a blower assembly, intake and outlet control doors, and ductwork to distribute the air to the windshield, the floor, or through the dashboard. They also have a heater control valve and a heat exchanger to heat the air in the cab.

Vehicles that have air conditioning have additional components. These include an evaporator core (which is in the climate control unit), a thermostatic expansion valve, compressor, condenser, and receiver/dryer. Units with air conditioning also have an air conditioning diagnostic system that monitors and protects air conditioning components.

The control panel for the system depends on which features are included in the system. The dash control panel houses the slide levers that control the amount of heating (or cooling), the source of air (outside or recirculated), and the distribution location (windshield vents, floor vents, or dash vents). It may also house a switch that controls the air conditioning compressor and a switch that controls whether the air temperature is controlled automatically.

Vehicles with a sleeper may have a bunk climate control unit, which consists of components for heating the bunk area, and components for cooling it if the vehicle is equipped with air conditioning.

The major components that comprise the entire climate control system are the intake ducts and filter, the climate control unit, the distribution ductwork and control doors, and the control panel. Additional components are included with the heater system and with the cooling system.
Cab Climate Control Unit

General
The cab climate control houses the heater core, heater control valve, blower, and control doors. Vehicles equipped with air conditioning systems also have an evaporator core in the climate control unit. All of the air supplied to the various vents passes through and is distributed by the climate control. Doors operated by cables from the dash control panel control the air flow outlet location to keep the cab occupants comfortable and to keep the windshield clear.

The unit is enclosed in a plastic housing that is located under the dash on the passenger side of the vehicle. The unit is accessible through a removable front panel.

Blower
The blower consists of two motor driven fans that draw air from the intake ducts and force it out of the climate control unit housing to the distribution ducts. It consists of a 12 volt DC motor that is attached to two high volume “squirrel cage” fans all enclosed in a plastic housing. The blower draws air through the intake doors and through the evaporator and forces it through the heater core and out the control doors. The motor shaft attaches to each of the fans so that they turn at the same speed. The blower assembly is located in the cab climate control unit.

The blower motor is controlled by a five position rotary switch that is located in the dash control panel. The switch allows selection of OFF or one of four speeds. The speed of the blower motor is determined by the switch, which connects different taps on a resistor coil in series with the motor circuit.

The motor circuit also contains two Positive Temperature Coefficient (PTC) devices. These devices monitor the temperature of the resistor block and increase the resistance in series with the motor if the temperature gets too high. The increasing resistance reduces the current to the blower motor to protect it. This could be necessary if there is an obstruction to the air flow, such as a frozen evaporator, the intake filter being blocked or a malfunction causing all the vent control doors to be closed.
**Heater Core**

The heater core is a heat exchanger that allows heat to be transferred from the engine coolant to the cab air. It is constructed of tubes and fins. Engine coolant is transferred from the engine to the heater core by flexible tubing. The coolant circulates through the heater core giving up its heat to the air that is passing through the fins. The amount of coolant that is allowed to flow through the heater core is controlled by the heater control valve. The valve is connected to the dash control panel temperature slide lever by a cable.

![Heater Core Diagram](image1)

1. Heater core
2. Manual heater control valve
3. Heater inlet tube

**Evaporator**

The evaporator is a heat exchanger that allows the heat of the cab air to be transferred to the liquid refrigerant in the air conditioning system. The evaporator is constructed of tubes and fins. When the A/C compressor is engaged, the R134a refrigerant enters into the evaporator tubes as a low pressure liquid. As the warmer air of the cab moves across the fins its heat is transferred to the refrigerant, causing it to "boil away" into a low pressure gas. The amount of refrigerant entering the evaporator is controlled by the expansion valve.

![Evaporator Diagram](image2)

1. Evaporator core
2. Capillary tube
3. Inlet & outlet tubes
4. Cold control switch
Automatic Temperature Control (ATC) Unit

The purpose of Automatic Temperature Control (ATC) is to maintain the cab temperature constant based on the temperature slide lever setting selected by the cab occupants. ATC consists of an electronic control module, three temperature sensors, and a solenoid operated valve. The sensors provide the module input for cab air temperature, evaporator temperature, and climate control unit outlet temperature. The solenoid valve is in the hot water return line between the manual heater control valve and the bulkhead hose connection. ATC accomplishes its function by sensing the temperatures and the desired temperature and either providing increased hot water flow through the heater core to warm the cab or sending a signal to the A/C diagnostic module to energize the A/C compressor clutch.

ATC module

The ATC module is an electronic control module that receives input from the temperature sensors and the position of the temperature control lever to determine if cab temperature is at or near the desired temperature.

When the ATC switch on the dash control panel is pressed, the control module monitors the cab temperature, evaporator temperature, and the climate control unit outlet temperature. If the temperature starts to decrease while heat is desired, the module will cycle the solenoid valve open to allow more hot engine coolant through the heater core. As temperature starts to increase, the module closes the solenoid valve to heat the cab air less. The module will continue to cycle the valve as required to maintain temperature constant. If temperature starts to increase while cooling is desired, the module sends a signal to the A/C diagnostic module to energize the compressor clutch to cool the cab more. As temperature lowers to the setpoint, the signal to run the compressor is removed and the clutch is de-energized.

The module determines desired temperature by receiving input through a shaft and gear that is connected to the temperature slide lever. As the slide lever is moved, the shaft rotates a gear on the module to electronically change the value of the desired temperature. The ATC module controls cab temperature within 1.4°C (2.5°F).

Electrical connection to the control module is made through one six pin and one four pin connector.
**Temperature sensors**

The temperature sensors are thermistor devices. These devices are constructed of a material with a Negative Temperature Coefficient (NTC). As the temperature around the sensor changes, the resistance of the device changes in the opposite direction (e.g. as temperature decreases, the resistance of the thermistor increases). This resistance change is seen by the module, which adjusts whether the solenoid valve is open more or less or whether the compressor clutch is energized more or less.

There are three temperature sensors that provide input to the ATC module. One sensor is located right at the outlet of the climate control unit. It senses temperature leaving the unit regardless of which outlet vent location is selected. A second sensor is located just behind a small opening in the dash. Cab air is drawn through the opening by an ejector in the climate control unit. The ejector is connected to the dash opening by a tube. This causes cab air to be circulated by the sensor regardless of whether the climate control system is adjusted for recirculation or fresh air intake. The third temperature sensor is inserted into the fins of the evaporator.

**Valve**

The ATC valve is a solenoid operated valve that is physically located in the hot water return line between the manual heater control valve and the bulkhead hose connection. Its function is to allow or prevent hot water flow to the heater core in response to signals from the ATC module.

When ATC is not selected, the valve is de-energized and is open. This allows the manual heater control valve to have full control of the amount of hot water passing through the heater core. When ATC is selected and the desired temperature requires heat, the valve is cycled closed and open to maintain the air proper cab temperature.

**Note:** The manual heater control valve must be open to allow the ATC solenoid valve to operate properly.
Climate Control System, Air Intake

Cowling
A cowling for the intake of fresh air is located in front of the bottom of the windshield of the truck on the passenger’s side. It is a chamber that allows fresh air to be forced at a low pressure into the plastic ductwork leading to the fresh air filter. This plastic ductwork is designed to allow air in while forcing any water to drain out before it reaches the fresh air filter.

Fresh Air Filter
The VN/VHD Series trucks are designed to filter all of the air going into the cab through a fresh air filter. This filter is located under the hood on the passengers’ side. Air coming in from the cowling must pass through this filter before entering the cab climate control unit. The fresh air filter is a unique design that has very little restriction, even if the filter is dirty or wet. It will filter particles as small as 3 microns.

Fresh Air Intake Doors
A set of doors at the front of the cab climate control unit control the amount of fresh air allowed into the cab. These doors are center hinged and controlled by a cable from the dash control panel. Moving the dash control lever toward the fresh air setting opens the doors wider and allows more fresh air into the cab climate control unit. Moving the dash control lever towards the recirculated air setting closes the fresh air doors so that no fresh air enters the cab.

When blended air is selected, the doors are open to provide an air intake mix that is 80% fresh air and 20% recirculated air.
Recirculated Air Intake Door
The recirculated air door is located at the top of the cab climate control unit inside the cab. It allows air to be gathered from under the dash inside the cab and supplied to the blower. The recirculated air intake door is connected to the same control as the fresh air intake doors. As the recirculated air door is opened, the fresh air doors are closed. The recirculated air door ensures a flow path exists for air being moved by the blower motor.

Note: Recirculated air does not pass through the fresh air filter.
Climate Control System, Air Distribution

Control Doors
The control doors are located on the climate control unit housing. The doors are controlled by cables connected to a slide lever on the dash control panel. There are three doors that control where the air flowing out of the climate control unit is directed: the defroster outlet door, the floor outlet door, and the dash vent outlet door. All three doors are located on top of the climate control unit.

Defroster outlet door
When the vent control lever is moved to the defrost position on the dash control panel this door opens and directs air into the ductwork for the windshield vents and dash vents.

Floor outlet door
As the lever on the dash control panel is moved toward the floor setting this door opens and directs air into the ductwork for the floor vents and the door panel outlets.

Dash vent outlet door
As the vent control lever is moved towards the vent position this door opens and directs air into the ductwork for the dash vents. There is no gasket around this door so that some air will always flow out of the dash vents regardless of the vent control lever position.
Ductwork
The ductwork is the flexible tubing, hoses and plastic piping that is routed under the dash. Air that is circulated by the blower passes through the control doors of the cab climate control unit and is routed to the vents through the duct work.

Air Vents

*Defrost vents*
The defrost vents are located under the windshield along the dash. They are designed to allow air flow to be distributed evenly across the entire windshield surface.

*Dash vents*
The dash vents are for directing air flow to the body of the driver and passenger. Each vent has vanes for directing the flow more to either side or more upward or downward. The dashboard vents can also be individually closed. Two additional vents are provided in the face of the dash to defrost the side windows for greater visibility of the mirrors.

*Floor vents*
Floor vents are designed to provide air flow to the driver’s and passenger’s feet and to the doors for the side window vents. The side window vents are built in to the doors and provide air flow to the door glass in order to better circulate the cab air for an improved comfort level. Air is directed to the side window vents when the floor vents are selected at the control panel.
Climate Control System, Control Panel

General
The climate control unit control panel, or dash control panel, is located on the vehicle dash. It allows the operator to adjust the air intake and distribution locations and temperature. Three slide lever controls operate cables to regulate temperature, air source (recirculated, fresh or blended), and air distribution (windshield, floor, or vents). The rotary switch controls the blower motor speeds.

If the vehicle is equipped with air conditioning, a compressor control switch is included on the dash control panel. If the vehicle has the ATC function, the panel has a switch marked “aut” for that function.

Slide Lever Controls
The top slide lever is the Vent Control lever. It is used to adjust the location of the air flow coming from the climate control unit. Its cable is connected to the defrost vent door, the floor vent door, and the dash vent door.

On vehicles with A/C, a microswitch is installed at the defrost position which signals the A/C diagnostic module to engage the A/C compressor to help defrost the windshield. In the defrost position, the fan will come on in slowest speed (if it is OFF) and the compressor clutch will engage, regardless of the position of the compressor control switch, if the following conditions are met:

- All A/C diagnostic module faults are clear.
- The cold control switch is closed (temperature above 1° C (33.8° F)).

The center slide lever is the Fresh air/Recirculation lever.

It is used to adjust between fresh air, recirculated air and blended air. In the recirculate position, the outside air door is closed and the inside air door is open. Air already in the cab is recirculated by the blower in the climate control unit. In the fresh air position, air is brought into the cab from outside through the cowling and the fresh air filter. In this position, the recirculating air door is closed and the fresh air doors are open.

The bottom lever is the temperature control lever. It is used to adjust the position of the heater control valve. Sliding this lever to the warmer position (red zone) opens the valve and allows more engine coolant to flow through the heater core. Sliding this lever to the colder position (blue zone) closes the valve.
**Fan Control Switch**

The fan control switch adjusts the speed of the blower motor. It has five positions: OFF and four blower motor speeds. This switch is wired through the windings of the motor and to a resistor coil which has several taps to provide the different blower motor speeds.

When the switch is in the OFF position, the blower motor's circuit is interrupted and the motor does not run. Moving the switch to any of the on positions completes the motor's electrical circuit through one of the taps of the resistor coil so the blower will run.

**Compressor Control Switch**

The compressor control switch sends a signal to the A/C diagnostic module requesting to engage the A/C compressor clutch. When the switch button is pressed, the clutch on the compressor will engage and the refrigeration cycle will begin if the following conditions are met:

- All A/C diagnostic module faults are clear.
- The cold control switch is closed (temperature above 1°C (33.8°F)).
- The fan control switch is selected to any position other than OFF.
- The temperature in the engine compartment is above 4°C (40°F).

**Automatic Temperature Control Switch**

Some vehicles have Automatic Temperature Control (ATC). ATC keeps the air leaving the cab at a constant temperature based on the setting of the temperature control lever. If installed, this function is selected by a switch marked “aut” on the dash control panel.

The ATC system uses a solenoid controlled valve in line with the manual heater control valve. When ATC is selected, the temperature of the air coming out of the climate control unit is monitored by an ATC module. The ATC valve is then cycled open and closed to keep the outlet air temperature constant at the temperature that was coming out when the ATC button was pressed. If the slide lever is repositioned, the ATC module will adjust the cycling of the solenoid valve to control outlet at the temperature at the new setting. When the ATC is not engaged (ATC button out) the solenoid valve opens fully and the heater output is controlled by the slide lever only.

When the ATC switch (“aut”) is pressed to ON, the fan either continues to run in its selected speed or automatically starts in low speed if it was OFF, and the ATC module sends a signal to the A/C diagnostic module to cycle the compressor clutch or the heater solenoid valve.
Heater System

General
The heating system is the part of the Climate Control system that warms cab air. Its main components are the heater core and the heater control valve. These components are included in each of the three types of Climate Control system. An Automatic Temperature Control ATC valve and module may also be installed on the vehicle.

Heater Core
The heater core is a heat exchanger located inside the cab climate control unit. It is constructed of a series of small flat tubes that are surrounded by fins. Engine coolant that is circulated through the engine is also circulated through the heater core. The engine coolant enters the heater core and circulates through the tubes. Air from the blower is forced through the heater core fins. This air is heated as it moves through the fins and is then distributed through the ductwork in the dash and out to the vents.

The hot water flowing to and from the heater core can be isolated by cutoff valves located near the engine. A valve in both the supply and return lines provides for full isolation of the heater system from the engine. This allows the engine coolant system to be worked on without draining the heater system or vice versa.

Heater Control Valve
The amount of engine coolant that is allowed to circulate through the heater core is determined by the position of the heater control valve. The valve is located inside the cab climate control unit. The valve and its tubing comprise a single unit that attaches to the heater core at one end and to a flanged return tube at the other end.

As the control lever on the dash is moved from the cold position toward the hot position the control cable opens the heater control valve. This allows more engine coolant to circulate through the heater core allowing more heat to be transferred to the cab air. The valve is equipped with a friction spring mounted on one side to prevent sticking.

If the vehicle is equipped with Automatic Temperature Control (ATC), a solenoid operated valve is installed in series with the manual heater control valve. When ATC is engaged, the solenoid valve is opened or closed by the ATC module to keep the temperature of the heated air constant.

Note: The manual heater control valve must be open to allow the ATC solenoid valve to operate properly.
Air Conditioning System

VN/VHD series vehicles equipped with air conditioning have several additional components which are typical for vehicle air conditioning systems. The components include a compressor, condenser, receiver/dryer, expansion valve, and an evaporator. To effectively troubleshoot and repair air conditioning systems, technicians must understand refrigeration theory. A section on refrigeration theory is included to increase the knowledge level of technicians working on air conditioning systems.

Refrigeration Theory

Refrigeration does not produce cold, it transfers heat from one object to another. In vehicle air conditioning, heat from the air in the cab is transferred into the refrigerant in the evaporator core. The heat-laden refrigerant is then circulated to the condenser core, where the heat is transferred again to the outside air.

In order to understand the operation of a truck climate control system and how it operates it is important to understand the pressure and temperature relationship of gases and about the concept of heat transfer.

Heat is a type of energy that an object possesses. That object can be a piece of metal, a liquid, or a gas. Humans tend to classify objects with a temperature above 27°C (80°F) as “hot” and objects with a temperature below 16°C (60°F) as “cold”. Since all objects with a temperature greater than “absolute zero”, which is approximately -273°C (–459°F), contain some heat, temperature is not always a good measure of how much heat an object contains, but the “relative” temperature between two objects will help determine which object transfers its heat energy to the other.

One of the properties of heat is that it cannot be stored. An object will always naturally give up or transfer its heat to an object with less heat. This can be observed by noting that a pot of “hot” coffee will give up some of its heat to the air around it by cooling to room temperature if left standing, but will give up much more heat if placed in a freezer. If the coffee freezes and is then placed in room temperature air, it will absorb heat from the air and return to a liquid. If the coffee is then placed on a stove, it will absorb more heat by boiling. With heat transfer then, the concepts of hot and cold should be substituted for the concepts of hotter and colder or warmer and cooler to describe objects with more heat (hotter or warmer) and less heat (cooler or colder).
There are three ways that objects transfer heat from one to another. Conduction is the how heat is transferred between objects that are in contact, such as coolant running through an engine block. Convection occurs when objects transfer heat to one another by the air that surrounds them, such as cooking something in an oven. Radiation is the heat transfer that occurs through waves or particles, such as when the sun warms the air inside a closed vehicle.

The climate control system air conditioning uses a combination of conduction and convection to transfer heat from the air in the cab to the air outside of the cab. Cab air moves through the evaporator fins (convection) and gives up its heat to them. The fins in contact with the evaporator tubes transfer heat to the tubes (conduction). The refrigerant is in contact with the tubes and absorbs heat from them (conduction). Finally, the refrigerant transfers its heat to the condenser tubes (conduction), which transfers it to the condenser fins (conduction), which transfer the heat to the outside air flowing through them (convection).

The principles regarding the pressure and temperature relationships of a gas that is enclosed, such as the R134a in the air conditioning system, is an important part of refrigeration theory. This principle states that there is a direct relationship between the pressure, temperature, and state of an enclosed fluid. Changing the pressure doesn’t change the temperature but may change the state. Changing the temperature will change the pressure and may change the state.

Consider, for example, a closed container half filled with R134a at room temperature (21°C / 70°F) and at a pressure high enough to keep it as a liquid (about 4.8 bar / 70 psi). This could be considered a warm, high pressure liquid. If we allow the pressure in the container to drop significantly, the R134a will rapidly boil to a gas, absorbing heat from the container and the air around it, resulting in the container holding a hot, low pressure gas. Next, the pressure of the container is raised, but due to its temperature, the R134a remains a gas, so the container now holds a hot, high pressure gas. Finally, the container is cooled, causing the R134a to condense to a liquid state and give up most of its heat, resulting in a warm, high pressure liquid once again.

The refrigeration cycle occurs very much like the previous example, except that instead of a single container it occurs in the refrigeration components for expansion, compression, heat exchange, and the interconnecting piping. The R134a will experience pressure drop through the expansion valve, heating through the evaporator, pressure increase through the compressor, and cooling through the condenser.
Refrigeration Cycle

Note: Refer to “Foldout A A/C System Refrigerant Flow Diagram” for a diagram of the refrigerant cycle

Refrigerant is circulated under pressure through the vehicle air conditioning components. Pressure and temperature changes occur as well as transformations between gaseous and liquid states to absorb or give up heat. The following describes the basic refrigeration cycle.

1 Cool low pressure refrigerant gas enters the compressor through the suction side. The compressor, as its name indicates, compresses the refrigerant into a hot high pressure gas and forces it out of the compressor discharge pipe to the condenser.

2 Air flowing across the cooling fins of the condenser at ambient temperature removes heat from the circulating hot refrigerant gas. Sometimes air is forced through the condenser by the engine fan. This heat removal causes the refrigerant to condense to a warm high pressure liquid.

3 The warm liquid refrigerant then moves to the receiver/dryer where impurities are filtered out and moisture is removed. The receiver/dryer also serves as temporary storage for liquid refrigerant.

4 Still under high pressure, the refrigerant flows to the expansion valve which meters the amount of refrigerant passing to the evaporator. As the refrigerant passes through the valve the pressure drops and the refrigerant is atomized to tiny droplets.

5 The hot humid air of the cab is pulled through the evaporator by the blower. Since the refrigerant pressure is low, the refrigerant cannot stay in its liquid state, so it vaporizes (boils rapidly). Boiling requires heat, which is drawn from the surrounding tubes and fins, and ultimately the air flowing through the fins. The cooled cab air is then pushed through the air vents. Moisture produced from condensation at the evaporator drops into a drip pan and drains out of the cab.

6 The cycle is completed when the low pressure refrigerant is drawn into the compressor through the suction valve again.
Refrigerant Compressor

The purpose of the refrigerant compressor is to compress the refrigerant gas to a high enough pressure to ensure it will condense to liquid state when it is cooled by the condenser. It also creates the pressure difference necessary to cause the refrigerant to flow through the system.

The compressor is mounted on the engine so that it can be rotated by a pulley. The compressor location differs between the various vendor engines. It may be located on the right or left side as well as high or low on the engine depending upon which engine is in the vehicle.
The compressor is designed for heavy duty, high capacity performance. It is a seven cylinder piston type compressor that utilizes a wobble plate design. The compressor is driven by the vehicle engine through a belt and pulley arrangement. The wobble plate assembly consists of a cam rotor, a planet plate and needle bearings. The cylinders are arranged in a circle and are parallel to the axis of the compressor shaft.

As the wobble plate rotates the pistons are actuated in the cylinders. As each piston is pulled down into its cylinder, the low pressure created by this action draws the low pressure vapor refrigerant into the suction side of the compressor through the suction reed valves. The reed valves are mounted in the end of the compressor under the cylinder head. As the wobble plate moves farther around it forces the pistons to the top of their cylinders, creating pressure in the cylinder. This opens the discharge reed valves and forces the now high pressure gas out of the compressor through the discharge ports and into the air conditioning system piping.

To prevent reed valve damage due to “liquid slugging,” valve stops are incorporated into the cylinder block to limit the travel of the suction reeds.

Many refrigerant compressor components, including the compressor body, are made of an aluminum alloy. This feature reduces the weight of the compressor significantly, however it is advised to use caution when tightening compressor bolts and fittings to prevent damaging the compressor and its machined surfaces.

Early Model compressors are connected to the refrigeration hoses with swivel nuts. Later models use pad mount connections.
Electro-Magnetic Clutch

The cycling of the compressor is controlled by an electro-magnetic clutch which is part of the compressor assembly. The electro-magnet consists of a circular coil which is mounted to the compressor body. The compressor pulley is mounted on ball bearings and rotates around the coil. A hub and flange assembly is connected to the compressor shaft. The flange sits very close the pulley.

When the compressor switch on the dash panel is off, no current is applied to the electro-magnet and only the pulley rotates. When the compressor switch is placed ON, the cold control switch request compressor operation, and no faults are sensed by the A/C diagnostic system, a current is applied to the electro-magnet which creates a magnetic field. The magnetic force pulls the flange toward the pulley. The friction between the pulley and the flange causes the flange to rotate. Since the flange is attached to the compressor shaft it rotates as well.

There are several ways the electro-magnetic clutch may be deenergized:

- Placing the dash panel compressor switch OFF
- The cold control switch senses low temperature
- The A/C diagnostic module senses a system problem

Compressor clutch main components
1) Coil ring
2) Bearing
3) Pulley
4) Dust shield
5) Clutch plate
**Compressor Oil**

VN/VHD series vehicles with air conditioning utilize a Sanden heavy duty refrigerant compressor. Sanden refrigerant compressors built for use with R134a refrigerant are factory charged with Sanden SP20 Poly Alkaline Glycol (PAG) oil. Only Sanden SP20 PAG oil may be used when adding to or changing the compressor oil on R134a air conditioning systems. Failure to use the Sanden SP20 PAG oil may void the compressor warranty.

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</tbody>
</table>

The compressor oil level should be checked any time the A/C system has experienced a rapid and significant refrigerant leak or when an obvious refrigerant oil leak is observed. The procedure for checking the compressor oil level is in the Service Procedures section.

**CAUTION**

Potential equipment damage. Do NOT mix mineral oil, used in R12 refrigerant systems, with PAG oil in an R134a refrigerant system. Mixing these oils in an R134a refrigerant system could result in damage to the compressor.

**CAUTION**

Potential equipment damage. Ester based oils reduce compressor life and are not compatible with Sanden refrigerant compressors. Use only SP20 PAG oil in Sanden compressors. Use of other type oils could result in damage to the compressor.

**Note**: Replacement of the compressor, condenser, or the cab or bunk evaporator requires the addition of an approved PAG oil as part of the installation procedure. The individual service procedures for component replacement include steps for adding PAG oil to the component.
Condenser

The condenser is the heat exchanger unit that is mounted in front of the vehicle radiator. Its function is to dissipate the heat accumulated by the refrigerant from the evaporator core. It removes the heat from the refrigerant as it passes through the coils.

The parallel flow (multipass) condenser is a plate and fin type heat exchanger. It is constructed of 33 rectangular plates. Each of the plates is divided into 11 channels for refrigerant to pass through. This type of construction allows for extremely efficient heat transfer. The plates are surrounded by cooling fins typical of refrigerant condensers. The end housings of the condenser are divided into sections to cause the refrigerant to travel through only a portion of the plates before being directed to another set of plates.

As the refrigerant enters the top of the condenser as a hot high pressure vapor, it is directed through the channels of only the top 12 plates. When it reaches the other end housing it is redirected through the next lower 9 plates in the opposite direction. The third pass is through 7 plates. The fourth and final pass is through 5 plates.

Air moving across the fins, due to either forward motion of the vehicle or forced through by the engine fan, absorbs the heat given off by the refrigerant as it condenses. The refrigerant leaves the condenser as a cool high pressure liquid.

Early model condensers are connected to the refrigeration hoses with swivel nuts. Later models use pad mount connections.
Receiver/Dryer

The receiver/dryer has several functions. It absorbs moisture that may be trapped in the air conditioning system. It also stores and filters liquid refrigerant before it goes to the expansion valve. This is to prevent refrigerant from reaching the expansion valve as a gas. The outlet side of the receiver/dryer has a tube that extends to the bottom. As long as there is sufficient refrigerant in the system, the refrigerant that flows from the receiver/dryer will be in liquid form.

Moisture is absorbed by a desiccant known as XH9. The desiccant is held in two cloth bags that wrap around the discharge tube. The amount of moisture that can be absorbed by the desiccant is very small, causing the need for the refrigerant system components and piping to be completely evacuated before being charged with refrigerant. If there is more moisture in the system than the desiccant can absorb, the expansion valve may freeze and the system will not function.

There is a moisture indicator in the receiver/dryer body which provides an indication of the moisture content of the desiccant.

If moisture in the system is within limits, the sight glass should appear blue. If the indicator turns white to pink it indicates excessive moisture in the A/C system.

The filter/dryer/receiver should be replaced when the moisture indicator indicates excessive system moisture, or anytime the A/C system has been opened for repairs.
Expansion Valve

The purpose of the expansion valve is to regulate the flow of liquid refrigerant to the evaporator and provide a drop in pressure so that the refrigerant will easily absorb heat from the evaporator. The valve is an internally equalized expansion valve that compares the evaporator inlet pressure to the evaporator outlet pressure. This allows for a refrigerant flow consistent with the amount of heat that needs to be absorbed and to keep the evaporator from flooding (a flooded evaporator is highly inefficient and results in very little cooling).

The valve is connected to the evaporator inlet and outlet tubes and on the tube coming from the receiver/dryer and the tube leading to the compressor (See illustration). It is located in the engine compartment next to the bulkhead where the climate control unit tubes pass through.

The amount of refrigerant allowed through the valve is controlled by a push rod and a ball. A diaphragm either forces the pushrod down which moves the ball away from its seat or pulls the push rod up which allows a spring to push the ball closer to its seat. Pressure on the bottom of the diaphragm comes directly from the pressure of the refrigerant leaving the evaporator. Pressure on the top of the diaphragm comes from a gas filled tube that is surrounded by the refrigerant leaving the evaporator. Pressure on both sides of the diaphragm causes it to move up or down depending on the refrigerant conditions of temperature and pressure.

As the evaporator outlet refrigerant pressure increases (indicating less refrigerant is needed) it forces the diaphragm upwards to close the valve more. If that pressure decreases, the diaphragm moves downward, pushing the push rod down, opening the valve more.

As the evaporator outlet refrigerant temperature increases (indicating more refrigerant is needed) the diaphragm is forced downward, opening the valve. If the temperature decreases, the pressure on top of the diaphragm decreases, and the valve closes more.
A properly operating expansion valve will have a cold outlet line from the evaporator and a warm inlet line from the drier. The expansion valve is not serviceable (adjustable) and must be replaced if it is found to be faulty.

![Diagram](image1)

1) Diaphragm housing 6) Inlet tube O-ring
2) Push rod 7) Outlet tube O-ring
3) Ball seat 8) Diaphragm O-ring
4) Inlet tube 9) Seat adjuster
5) Outlet tube

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**Evaporator**

The evaporator is the heat exchanger that allows the heat of the cab air to be absorbed by the R134a refrigerant. It is located inside the climate control unit so that cab air circulated by the blower passes through it. The evaporator is constructed of a coiled tube that is surrounded by fins. The heat of the cab air passing through the fins is transferred to the fins and to the tubes. Refrigerant is metered into the evaporator through the expansion valve and travels through the tubes of the evaporator. As the evaporator collects heat from the cab the heat is transferred to the refrigerant which boils to a vapor.

![Diagram](image2)

1) Evaporator core 6) Inlet tube O-ring
2) Refrigerant tubes 7) Outlet tube O-ring
3) Temperature sensor 8) Diaphragm O-ring
4) Cold control switch
Miscellaneous Components

Cold Control Switch
A temperature sensing switch, known as the cold control switch, causes the compressor to disengage to prevent the evaporator core from freezing. The switch is attached to a bracket on the evaporator inlet manifold and is actuated by pressure in a sealed, gas filled capillary tube. The end of the capillary tube is inserted into the evaporator fins between the tubes.

As the temperature drops, the gas in the capillary contracts, lowering the pressure on the switch. If the temperature drops to 1°C (33.8°F), the switch opens, interrupting current to the compressor clutch (via the AC Diagnostic Module).

As the temperature rises, the gas expands and the pressure on the switch increases. When the temperature reaches 4.5°C (40°F), the switch closes, and the compressor clutch will be re-energized, as long as the dash control switch is on and the A/C diagnostic module logic is satisfied for the compressor to cycle.

O-rings
Generally, the R134a air conditioning system on the VN/VHD series vehicles uses Hydrogenated Nitrile Butyl Rubber (HNBR) O-rings. The O-rings may vary in color due to being supplied by various vendors.

An Air Conditioner Service Kit (P/N 3093536) includes the various O-rings used in the A/C system. Before installation, the O-rings should be lubricated with PAG oil.
Refrigerant Ports

The air conditioning system has two ports that allow connection of pressure gauges to the system and to allow refrigerant to be removed from or added to the system.

The high pressure port is located in the compressor discharge line near the frame rail just rearward of the condenser on the driver’s side.

The low pressure port is located in the compressor suction line just forward of the receiver/dryer.

**Note:** High and Low pressure port locations may vary with vehicle/engine variants.

Each port is fitted with a Schrader valve to allow for connecting a refrigerating recovery/recharge unit. The Schrader valves are special valves which permit connecting a shutoff valve and test hose while there is refrigerant pressure in the system. The Schrader valve on the high pressure line is sized smaller than the low pressure valve to prevent incorrect hookup of the recovery/recharge equipment.

Caps must be in place on the Schrader valves when recovery/recharge equipment is not connected in order to keep dirt out of the valves.
Air Conditioning Diagnostic System

The A/C diagnostic system (APADS) is designed primarily to detect A/C system problems that may cause compressor failures. The system consists of an electronic control module and sensors that monitor the pressure between the evaporator and the compressor (low pressure) and between the compressor and the condenser (high pressure). In addition, the module itself contains circuits to sense ambient temperature and to determine the frequency of compressor clutch cycling.

When the diagnostic module senses conditions that could lead to damage to the air conditioning components it either provides a signal to activate the engine fan or de-energizes the compressor clutch.

A/C Diagnostic Module

The A/C diagnostic module (APADS module) monitors signals from two pressure switches and controls the operation of the compressor clutch. It also sends requests for fan operation to the Data Concentrator or Vehicle Electronic Control Unit (VECU) for vehicles equipped with Volvo engines or to the engine ECM (vendor engines). The module houses two LEDs which indicate the system condition. It uses blink codes to display several possible faulty conditions and to aid troubleshooting. The module is located on the engine compartment bulkhead in the upper corner on the driver's side.

The module contains circuits that analyze the condition of the air conditioning system and determine whether or not a problem exists. If a problem is detected the module may interrupt current to the compressor clutch or provide a signal to the Data Concentrator or VECU (Volvo engines) or to the engine ECM (vendor engines) to engage the fan clutch. The module houses a temperature sensor that measures ambient temperature. If ambient temperature is below 4°C (40°F), the module will not allow the compressor to run because damage may result from inadequate lubrication. It also has an internal clamping diode which eliminates the need for the external diode commonly located near the refrigerant compressor. The module receives power from a connection to the engine fan circuit through a fuse.
Connections are made to the module by a ten pin Metri-Pack connector.

The control module has two light emitting diodes (LEDs), one red and one green, which indicate whether a system problem has been detected. If a problem is detected by the diagnostic module, a fault code or “blink” code (a series of LED blinks) is activated to identify the condition. A decal is located on the face of the module with a brief explanation of the blink codes. A detailed description of the blink codes and their interpretation is included in the Troubleshooting section.

The system components are designed and constructed for reliable use while withstanding vibration, pressure washing and exposure to the environment. The module’s internal circuit card is “potted” (encased in a hardened resin) to protect it from the elements, which also makes it unserviceable. A faulty diagnostic module must be replaced.

There are several variations of the diagnostic module to accommodate the cooling requirements of different engines. If the module requires replacement it MUST be replaced with a module with an identical part number.

**System Pressure Switches**

The A/C diagnostic system pressure switch is a normally closed pressure switch that opens at a preset maximum pressure and closes at a preset minimum pressure. The “semi-smart” pressure switch has an internal resistor, rated at 2490 ± 30 ohms, installed in parallel with the electrical contacts. This resistor allows the control module to detect the difference between a switch that is functioning properly and a circuit that is open due to a faulty switch or broken wire.

The high and low pressure switch housings look alike but the similarity end there. The switches have different electrical connectors to prevent improper connection and different fitting sizes to prevent incorrect installation. Also, the open and close pressure settings are stamped into the base of the switch just above the wrench flats.

**Note:** Both switches use an O-ring seal and should be tightened to 18 ± 1 Nm (159 ± 12 in-lb). Only HNBR O-rings that are compatible with R134a refrigerant may be used.
Low Pressure Switch

A pressure switch is mounted on the compressor suction (low pressure) steel tube to monitor the compressor suction pressure. Its setpoints are adjusted so that the switch opens when pressure rises above 2.3 bar (34 psi) and closes when pressure drops below .55 bar (8 psi). The diagnostic module circuit is arranged so that when the pressure is above the 2.3 bar (34 psi) setpoint, the switch is open and the 2490 ohms of resistance is seen by the control module. This built in resistance signals to the control module that the system has sufficient pressure to operate normally. When low pressure drops below .55 bar (8 psi), the switch closes, bypassing the 2490 ohm resistor, signalling to the control module that a low pressure condition exists. If the switch wiring harness becomes “open” from damage or loss of connection, the control module will not detect the expected resistance and will show a fault using the appropriate blink code.

The low pressure switch differs physically from the high pressure switch in that it has a larger fitting (12 mm) and its connector is a male end. Also, the open and close setpoints of 2.3 bar (34 psi) and .55 bar (8 psi) are stamped on the switch base. The actual switch location depends on the engine/vehicle variant and the routing of the refrigerant tubing.
**High Pressure Switch**

A pressure switch is mounted on the compressor discharge (high pressure) steel tube to monitor the compressor discharge pressure. Its setpoints are adjusted so that the switch opens when pressure rises above 20.7 bar (300 psi) and closes when pressure drops below 17.9 bar (260 psi). The diagnostic module circuit is arranged so that when the pressure is above the 20.7 bar (300 psi) setpoint, the switch is open and the 2490 ohms of resistance is seen by the control module. This built-in resistance signals to the control module that the system pressure is outside the normal range and protective action is necessary. When high pressure drops below 17.9 bar (260 psi), the switch closes, bypassing the 2490 ohm resistor, signalling to the control module that pressure has returned to the normal range. If the switch wiring harness becomes "open" from damage or loss of connection, the control module will not detect the expected resistance and will show a fault using the appropriate blink code.

The high pressure switch differs physically from the low pressure switch in that it has a smaller fitting (10 mm) and its connector is a female end. Also, the open and close setpoints of 20.7 bar (300 psi) and 17.9 bar (260 psi) are stamped on the switch base. The actual switch location depends on the engine/vehicle variant and the routing of the refrigerant tubing.
Diagnostic System Function

The logic functions of the diagnostic module are active anytime the ignition switch is ON. The diagnostic module logic carries out actions in two categories: on start-up and during continuous operation.

The start-up operations are as follows:

- When the ignition is placed ON, the module prevents the refrigerant compressor clutch from energizing for the first 15 seconds. This allows the engine RPM to stabilize and the batteries to recover to ensure there is sufficient voltage to energize the compressor clutch.
  During cranking, available voltage may drop below the voltage required for positive compressor clutch engagement. If the compressor clutch were engaged during cranking, it is likely that the insufficient voltage would allow the clutch to slip causing undue wear and possible failure.

- At the end of the first 15 seconds after the ignition is placed ON and if temperature is above 4°C (40°F), the compressor clutch is energized for 15 seconds. If an abnormal high or low pressure condition is sensed during this 15 seconds, the compressor clutch is immediately disengaged. This allows the module to perform a diagnostic test on the air conditioning system and to circulate refrigerant and oil in the system to prevent the seals from drying out.

Once the start-up routines are complete, air conditioning must be selected through the dash controls for the system to perform its diagnostic and protective functions. Under normal conditions with the air conditioning system in operation, the low pressure switch is open and the high pressure switch is closed.

In the event that the compressor suction (low side) pressure drops below .55 bar (8 psi), the low pressure switch will close. The control module will sense the low pressure signal and interrupt the voltage to the compressor clutch.

In the event that the compressor discharge (high side) pressure exceeds 20.7 bar (300 psi) the high pressure switch opens. This signals the control module to energizes the engine cooling fan clutch. Once the fan is activated the discharge pressure should begin decreasing. If the discharge pressure does not fall below 17.9 bar (260 psi) within approximately 10 seconds, the module will de-energize the compressor clutch. The compressor will remain off until the discharge pressure is below 17.9 bar (260 psi). The fan will continue to run for a period of time which is determined by the APADS Module.

**Note:** Fan run time that is controlled by the APADS module is based on A/C system pressures. Fan run times for all other functions (coolant temperature) are governed by the engine ECMs. Certain conditions of system pressure caused by low refrigerant levels or excessively cold evaporator temperature could cause the compressor clutch to cycle rapidly (several times per minute). Excessive cycling of the clutch could cause damage to the clutch or the compressor. To prevent this damage from occurring, the diagnostic module limits the maximum number of clutch cycles to four per minute.
Control Module Logic

The control module utilizes logic rules for the protection of the air conditioning components. The following list details the logic rules that apply to the control of the fan and compressor clutch.

1. The air conditioning compressor is not allowed to run under any circumstances for the first 15 seconds after the ignition is switched on.

2. Immediately after the first 15 seconds the compressor clutch is energized for 15 seconds. If the high or low pressure switches indicate out of limits or fault conditions during this time, the compressor clutch is de-energized.

3. The compressor clutch cycle frequency is governed by the cold control switch, but is limited to a maximum of four cycles per minute.

4. When the high side pressure exceeds 20.7 bar (300 psi), a 10 second timer is initiated. If the pressure has not dropped below 17.9 bar (260 psi) before the 10 seconds has elapsed, the compressor clutch is de-energized. If the clutch is de-energized due to high pressure, it will be re-energized when pressure drops below 17.9 bar (260 psi) as long as the four clutch cycles per minute rule will not be exceeded.

5. When the low side pressure drops below .55 bar (8 psi), the compressor clutch is immediately de-energized. The clutch will reenergize when low side pressure is above 2.3 bar (34 psi) as long as the four clutch cycles per minute rule will not be exceeded.

6. If the supply voltage drops below 11.0 ± .2 volts the clutch is deenergized. The compressor clutch is allowed to be energized again when system voltage reaches 12.0 volts.

7. If the high side pressure exceeds 20.7 bar (300 psi) 12 times within a specific time interval, the clutch is latched off (prevented from energizing) until the ignition has been turned off and then on again. This is called the high pressure fault.
Bunk Heating and Cooling

Early model VN series vehicles were equipped with Bergstrom bunk climate control units. Beginning in approximately January of 1999, Behr bunk climate control units were installed in VN series vehicles. Information on both units is included in this manual.

Bunk Unit Control Panel

There are three versions of the bunk unit control panel. One is for bunk units with a manually operated heater control valve. The second is for ATC equipped VN 420, 610 and 660 vehicles. The third is for VN 770 vehicles only. The controls are the same for both Behr and Bergstrom units.

Manually Operated Bunk Unit Control Panel

The manual bunk unit control panel houses controls for the bunk unit fan speed and the heater control. The fan speed switch is a four position rotary switch in circuit with the blower motor. The heater control is a dial which is connected to a cable that is also connected to the heater control valve. The manual bunk unit control panel is located on the right side wall of the sleeper compartment to minimize the length of the control cable.

Note: The manually operated bunk HVAC system was available on early model VNs only.
**ATC Bunk Unit Control Panel**

The automatic bunk unit control panel houses controls for the fan speed and the automatic heater control. The fan speed switch is a four position rotary switch in circuit with the blower motor. The heater control is a variable resistor that provides input to the ATC module on the bunk unit. The ATC bunk unit control panel is located on the left side wall of the bunk compartment.

1. Alarm Clock/Timer
2. Fan Speed Control
3. 12V Power Outlet
4. Optional Switches
5. Interior Cab Light Switches
6. Temperature Control
7. Cigarette Lighter

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ATC Bunk Control Panel, VN 420, 610, 660

Bunk Control Panel, VN 770
Bunk Climate Control Units

Bunk Climate Control Unit (Bergstrom)

A bunk climate control unit is installed in vehicles with a sleeper cab. Its purpose and operation are the same as that of the cab climate control unit except that it has no air intake and distribution control doors. The unit consists of a plastic housing, a blower assembly, heater core and manual or automatic heater control (water) valve, an evaporator and expansion valve (if the vehicle has air conditioning), an inlet duct and filter, and an outlet duct. The unit is located under the bunk on the passenger’s side, and is accessible from inside the vehicle by lifting the bunk or from outside the vehicle through the right side storage compartment.

The tubes of the unit pass through the housing and are surrounded by one or more protective foam pads. These pads prevent the tubes from chafing against the housing or one another, and act as a barrier to block out heat, cold, water, and noise from the environment. A plastic cover is fitted over the pad(s) to reduce vibration.
Bunk Blower
The blower assembly consists of a 12 volt motor and a single squirrel cage fan. The motor and fan are mounted in the side of the bunk unit housing and are easily accessible through the right side storage compartment cover.

Blower motor
The blower draws air from the bunk area through the evaporator and heater core and forces it out through the duct to the bunk vents.

The blower motor is controlled by a four position rotary switch that is located in the bunk unit control panel. The switch allows selection of OFF or one of three speeds. The speed of the blower motor is determined by the switch, which completes the circuit from the accessory bus to ground through the motor's resistor card.

Resistor card
The resistor card houses the resistors used to control the speed of the blower motor. It is physically mounted in the airflow path. There are two resistors mounted on the card. The fan control switch places both, one, or none of the resistors in the blower motor circuit to provide the three discreet motor speeds, or interrupts the circuit altogether if the OFF position is selected. Due to the high currents they carry, the resistors are coil type.

The card also houses two thermal limiters that act as protective devices. The resistors heat up when they are carrying circuit current. The air flow generated by the blower removes the heat produced by the resistors and keeps the thermal overloads cool. If the fan should stop turning while the current is running through the resistors, they will heat up rapidly, causing the overloads to open, removing the current from the motor. If either of the overloads open, the fan will not operate at the speed for its resistor, and the resistor card must be replaced. If both overloads open, the blower motor will operate only on high speed.
**Bunk Heater Core**
The bunk heater core is the heat exchanger that heats the bunk area air. Hot engine coolant circulating through the heater core heats up the air passing through and around the fins. The heater core is a coiled copper tube surrounded by aluminum fins. It is located in the bunk unit housing next to the blower.

1. Bunk unit heater core
2. Heater core outlet
3. Heater core inlet

**Bunk Heater Control (Water) Valve**
The bunk heater control (water) valve controls the amount of engine coolant flowing through the bunk heater core. It is located outside the bunk unit housing in the water return line from the heater core. If the valve is manually controlled, it is connected to a cable that is operated by a dial on the bunk unit control panel. If the bunk unit has Automatic Temperature Control (ATC) the valve is a solenoid valve that is controlled by an ATC module located on top of the bunk unit housing. The solenoid valve will respond to signals from the ATC module to cycle open or closed to maintain bunk area temperature.
Bunk Evaporator
The evaporator is a heat exchanger that allows the heat of the bunk area air to be transferred to the liquid refrigerant in the air conditioning system. The evaporator is constructed of copper tubes and aluminum fins. When the A/C compressor is engaged, the R134a refrigerant enters into the evaporator tubes as a low pressure liquid. As the warmer bunk area air moves across the fins its heat is transferred to the refrigerant. The amount of refrigerant entering the evaporator is controlled by the expansion valve. Tubes for the inlet and outlet extend out of the bunk unit and connect to the expansion valve before continuing through the cab floor. The tubes can be disconnected either at the expansion valve or just beneath the cab to facilitate easy evaporator removal and installation.

Bunk Unit Expansion Valve
The purpose of the expansion valve is to regulate the flow of liquid refrigerant to the evaporator and provide a drop in pressure so that the refrigerant will easily absorb heat from the evaporator. The valve is an internally equalized expansion valve that compares the evaporator inlet pressure to the evaporator outlet pressure. This allows for a refrigerant flow consistent with the amount of heat that needs to be absorbed and to keep the evaporator from flooding. The valve is mounted on the evaporator tubes just outside the bunk unit housing.

The operation of this valve is similar to that of the cab climate control unit expansion valve.
Bunk Climate Control Unit (Behr)

1. Bunk Air Filter
2. Fan Motor
3. Resistor Card
4. Evaporator/Heater Core
5. Automatic Temperature Control (ATC) Module
6. Water Valve
7. Expansion Valve
8. Access Cover
9. Tube Retaining Bracket
**Behr Bunk Unit**
A bunk climate control unit is installed in all VN series vehicles with a sleeper cab. Its purpose and operation are the same as that of the cab climate control unit except that it has no fresh air intake and distribution control doors. The unit consists of a plastic housing, a blower assembly, an evaporator/heater core assembly, an automatic heater control (water) valve, and an expansion valve (if the vehicle has air conditioning), an inlet duct and filter, and an outlet duct. The unit is located under the bunk on the passenger’s side, and is accessible from inside the vehicle by lifting the bunk or from outside the vehicle through the right side storage compartment.

The tubes of the unit pass through the housing and are surrounded by one or more protective foam pads. These pads prevent the tubes from chafing against the housing or one another, and act as a barrier to block out heat, cold, water, and noise from the environment.

**Bunk Air Intake Filter**
The bunk unit air intake is through a grill on the right side bunk support wall. Behind the grill is a replaceable pleated filter, accessible from the top of the climate unit once the bunk has been lifted. This filter removes dust and other particles as air is circulated by the bunk climate unit.

**Bunk Blower**
The blower assembly consists of a 12 volt motor and a single squirrel cage fan. The motor and fan are mounted in the side of the bunk unit housing and are easily accessible through the right side storage compartment cover.

**Blower Motor**
The blower draws air from the bunk area through the evaporator/heater core assembly and forces it out through the duct to the bunk vents.

The blower motor is controlled by a four position rotary switch that is located in the bunk unit control panel. The switch allows selection of OFF or one of three speeds. The speed of the blower motor is determined by the switch, which completes the circuit from the accessory bus to ground through the motor’s resistor card.

**Resistor Card**
The resistor card houses the resistors used to control the speed of the blower motor. It is physically mounted in the air flow path. There are three resistors mounted on the card. The fan control switch places two, one, or none of the resistors in the blower motor circuit to provide the three discreet motor speeds, or interrupts the circuit altogether if the OFF position is selected. Due to the high currents they carry, the resistors are coil type.

The card also houses one thermal limiter that acts as a safety device. The resistors heat up when they are carrying circuit current. The air flow generated by the blower removes the heat produced by the resistors and keeps the thermal overload cool. If the fan should stop turning while the current is running through the resistors, they will heat up rapidly, causing the overload to open, removing the current from the motor. If the overload opens, the fan will only operate on high speed, and the resistor card must be replaced.
Bunk Evaporator/Heater Core
The bunk evaporator/heater core is a heat exchanger that both cools and heats the bunk area air. During operation of the unit, hot engine coolant circulating through the heater core heats up the air passing through and around the fins. This warmer air can then be circulated by the bunk unit blower when the fan is engaged.

For A/C operation, the cab A/C compressor must be engaged. This causes the R134a refrigerant to enter into the evaporator tubes as a low pressure liquid. As the warmer bunk area air moves across the fins its heat is transferred to the refrigerant. The amount of refrigerant entering the evaporator is controlled by the expansion valve. Tubes for the inlet and outlet extend out of the bunk unit and connect to the expansion valve before continuing through the cab floor. The tubes can be disconnected either at the expansion valve or just beneath the cab to facilitate easy evaporator removal and installation.

The evaporator/heater core is a coiled copper tube surrounded by aluminum fins. It is located in the bunk unit housing next to the blower.

Temperature Controls
Bunk temperature is controlled using three components. These are:
1. Temperature Control Switch (Potentiometer)
2. Automatic Temperature Control (ATC) Module
3. Water Valve

The potentiometer is a variable resistor used to set the desired temperature. The control module compares desired (set) temperature to actual temperature, and then opens or closes the water valve to control hot water flow. The water valve allows water to flow in its normal position, and stops the flow when energized by the control module.

The temperature sensor is electronically integrated into the control module; it cannot be tested separately.

Bunk Unit Expansion Valve
The purpose of the expansion valve is to regulate the flow of liquid refrigerant to the evaporator and provide a drop in pressure so that the refrigerant will easily absorb heat from the evaporator. The valve is an internally equalized expansion valve that compares the evaporator inlet pressure to the evaporator outlet pressure. This allows for a refrigerant flow consistent with the amount of heat that needs to be absorbed and to keep the evaporator from flooding. The valve is mounted on the evaporator tubes just inside the bunk unit housing.

The operation of this valve is similar to that of the cab climate control unit expansion valve.

Water Valve
The water valve controls the amount of engine coolant flowing through the bunk heater core. It is located inside the bunk unit housing.

The valve is a solenoid that is controlled by an ATC module located on top of the bunk unit housing. The solenoid valve responds to signals from the ATC module to cycle open or closed to maintain bunk area temperature.
Troubleshooting

A/C System Troubleshooting

Climate Control troubleshooting information is divided into six troubleshooting sections:

“General A/C System Troubleshooting” page 57
“Refrigerant Compressor Troubleshooting” page 63
“A/C Diagnostic System Troubleshooting” page 65
“Engine Fan Troubleshooting” page 71
“Blower Motor Troubleshooting” page 72
“Bunk Unit Troubleshooting” page 73

General A/C System Troubleshooting

When troubleshooting an air conditioning system, refer to the following information before beginning repairs.

Verify the complaint by running the system. A properly working climate control unit provides a 14°C to 17°C (25°F to 30°F) difference between ambient and duct temperatures. In extremely hot climates, this temperature drop may not feel sufficient to some drivers, even though the air conditioning system is working properly.

If the temperature differential between the ambient and duct temperatures is 14°C to 17°C (25°F to 30°F) but the cab remains too warm, check all seals on the windows and doors for leaks. Insufficient heating or cooling can occur due to cab leaks rather than system leaks. Correct any leaks that are found.

Conduct visual inspections of all mechanical and electrical components to identify any obvious problems. Check the A/C diagnostic module LEDs for blink codes.

If the complaint has not yet been corrected, connect the recovery/recycling/recharging unit to the vehicle and check pressure readings. Refer to the following troubleshooting chart for general procedures.

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DANGER

Personal injury hazard. Always wear safety glasses and gloves. Do NOT smoke when recovering, recycling, evacuating, or recharging R134a refrigerant. Failure to handle refrigerant properly could result in serious personal injury or death. Refer to the Material Safety Data Sheets (MSDS) before servicing the air conditioning system.

WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.
General Troubleshooting Chart

Note conditions:

- Engine running
- A/C controls set to maximum cool
- Blower motor on high speed

Start

↓

Is the A/C diagnostic module displaying a slow blinking green LED?

NO → See “A/C Diagnostic System Troubleshooting” page 65

YES ↓

Is the air flow from the ducts sufficient?

NO → See “Blower Motor Troubleshooting” page 72

YES ↓

Does the compressor clutch engage properly?

NO → See “Refrigerant Compressor Troubleshooting” page 63

YES ↓

Do system pressure and duct temperatures appear correct?

NO → See “Troubleshooting Abnormal Pressures” page 59

YES ↓

Does the engine fan cycle on and off properly?

NO → See “Engine Fan Troubleshooting” page 71
Troubleshooting Abnormal Pressures

This table lists a variety of high and low system pressure conditions and the symptoms consistent with them. Included for each are general steps to correct the problem.

Refer to “Normal A/C System Pressures" page 61 to determine normal pressure values for the conditions present during troubleshooting.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Low Side Pressure</th>
<th>High Side Pressure</th>
<th>Condition</th>
<th>Recommended Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Moisture indicator starts to turn pink</td>
<td>Normal</td>
<td>Normal</td>
<td>Some moisture in refrigerant system</td>
<td>1 Recover refrigerant</td>
</tr>
<tr>
<td>2 Slightly cool discharge air</td>
<td></td>
<td></td>
<td></td>
<td>2 Replace the receiver/dryer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Evacuate, recharge, and leak test system</td>
</tr>
<tr>
<td>1 Moisture indicator has turned completely pink</td>
<td>Normal to low</td>
<td>Normal</td>
<td>Excessive moisture in refrigerant system</td>
<td>1 Recover refrigerant</td>
</tr>
<tr>
<td>2 Frozen expansion valve</td>
<td></td>
<td></td>
<td></td>
<td>2 Replace the receiver/dryer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Evacuate, recharge, and leak test system</td>
</tr>
<tr>
<td>1 Compressor cycles at incorrect temperatures</td>
<td>Normal</td>
<td>Normal</td>
<td>Defective cold control switch</td>
<td>1 Replace the cold control switch</td>
</tr>
<tr>
<td>2 Evaporator frozen causing restricted air flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Warm discharge air</td>
<td>Normal</td>
<td>Normal</td>
<td>Water control valve leaking internally</td>
<td>1 Drain engine coolant</td>
</tr>
<tr>
<td>2 A/C hose temperatures appear normal</td>
<td></td>
<td></td>
<td></td>
<td>2 Replace water control valve and adjust</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 Refill engine coolant</td>
</tr>
<tr>
<td>1 Warm discharge air</td>
<td>Normal</td>
<td>Normal</td>
<td>Air bypassing evaporator core</td>
<td>1 Check installation to insure proper air flow through the</td>
</tr>
<tr>
<td>2 A/C hose temperatures appear normal</td>
<td></td>
<td></td>
<td></td>
<td>evaporator core</td>
</tr>
<tr>
<td>1 Slightly cool discharge air</td>
<td>Low</td>
<td>Low</td>
<td>Low refrigerant charge</td>
<td>1 Conduct a leak test</td>
</tr>
<tr>
<td>2 Compressor cycles frequently</td>
<td></td>
<td></td>
<td></td>
<td>2 Recover refrigerant</td>
</tr>
<tr>
<td>3 Blink code – 1 red (possible)</td>
<td></td>
<td></td>
<td></td>
<td>3 Repair leak</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 Check the compressor oil level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 Evacuate, recharge, and leak test system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 Reset blink codes</td>
</tr>
<tr>
<td>1 Warm discharge air</td>
<td>Low</td>
<td>Low</td>
<td>Extremely low refrigerant charge</td>
<td>1 Conduct a leak test</td>
</tr>
<tr>
<td>2 Compressor cycles more often or will not engage</td>
<td></td>
<td></td>
<td></td>
<td>2 Recover refrigerant</td>
</tr>
<tr>
<td>3 Blink code - 1 red (possible)</td>
<td></td>
<td></td>
<td></td>
<td>3 Repair leak</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 Check the compressor oil level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 Evacuate, recharge, and leak test system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 Reset blink codes</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Low Side Pressure</td>
<td>High Side Pressure</td>
<td>Condition</td>
<td>Recommended Correction</td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>--------------------</td>
<td>-----------</td>
<td>------------------------</td>
</tr>
</tbody>
</table>
| 1 Slightly cool discharge air | Low | Low | Expansion valve clogged or stuck closed | 1 Recover refrigerant  
2 Replace the expansion valve  
3 Replace receiver/dryer  
4 Evacuate, recharge, and leak test system  
5 Reset blink codes |
| 2 Sweat or frost on expansion valve | Low | Low |  |  |
| 3 Blink code - 1 red (possible) | Low | Low |  |  |
| 1 Slightly cool discharge air | Low | High | Restriction in high side | 1 Recover refrigerant  
2 Locate and repair the restriction  
3 Replace the receiver/dryer  
4 Evacuate, recharge, and leak test system  
5 Reset blink codes |
| 2 Sweat or frost on high side lines | Low | High |  |  |
| 3 Sweat or frost on receiver/dryer | Low | High |  |  |
| 4 Blink code - 2 red (possible) | Low | High |  |  |
| 1 Occasional compressor noise | High | Low | Faulty compressor | 1 Recover refrigerant  
2 Replace the compressor  
3 Replace the receiver/dryer  
4 Evacuate, recharge, and leak test system  
5 Reset blink codes |
| 2 Compressor does not turn smoothly or cannot be turned by hand | High | Low |  |  |
| 3 Blink code - 3 red (possible) | High | Low |  |  |
| 1 Warm discharge air | High | High | Condenser Air flow malfunction | 1 Check for damaged fins and cleanliness of condenser, radiator, charge air cooler, or any other component that may impede airflow. Clean or straighten fins as needed.  
2 Check condenser to charge air cooler clearance (approx. 1 inch). Adjust as needed.  
3 Check that engine fan operates properly. See “Engine Fan Troubleshooting” page 71.  
4 Reset blink codes |
| 2 Very hot high side pressure hose assemblies | High | High |  |  |
| 3 Blink code - 2 red | High | High |  |  |
| 1 Warm discharge air | High | High | Refrigerant overcharge | 1 Recover refrigerant  
2 Evacuate, recharge, and leak test system  
3 Reset blink codes |
| 2 Very hot high side lines | High | High |  |  |
| 3 Blink code - 2 red (possible) | High | High |  |  |
| 1 Warm discharge air | High | High | Expansion valve stuck open | 1 Recover refrigerant  
2 Replace the expansion valve  
3 Replace the receiver/dryer  
4 Evacuate, recharge, and leak test system  
5 Reset blink codes |
| 2 A/C hose temperatures appear normal | High - Normal | High | Air in system | 1 Conduct a leak test  
2 Recover refrigerant  
3 Repair any leak found  
4 Replace receiver/dryer  
5 Evacuate, recharge, and leak test system  
6 Reset blink codes |
| 3 Blink code - 2 red (possible) | High - Normal | High |  |  |
Normal A/C System Pressures

This table lists the normal high and low pressure readings and louver (duct) temperatures for the given conditions of engine rpm, relative humidity, and ambient temperature.

**Note conditions:**
- Engine running at 1500 rpm
- Engine fan locked ON
- Main and bunk fans on high
- Fresh air mode
- Hood and doors open
- System properly charged
- Allow system to stabilize 10 minutes before taking readings

<table>
<thead>
<tr>
<th>Ambient Temperature</th>
<th>Relative Humidity</th>
<th>Discharge Pressure</th>
<th>Suction Pressure</th>
<th>Left Dash Louver at passenger seat</th>
<th>Lower Bunk Louver</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>20</td>
<td>210-255 psig</td>
<td>20-35 psig</td>
<td>57-67°F</td>
<td>58-68°F</td>
</tr>
<tr>
<td>100</td>
<td>20</td>
<td>180-220 psig</td>
<td>15-30 psig</td>
<td>52-62°F</td>
<td>55-65°F</td>
</tr>
<tr>
<td>90</td>
<td>20</td>
<td>150-190 psig</td>
<td>10-25 psig</td>
<td>47-57°F</td>
<td>45-55°F</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>120-155 psig</td>
<td>10-25 psig</td>
<td>45-55°F</td>
<td>43-53°F</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>95-130 psig</td>
<td>10-20 psig</td>
<td>42-52°F</td>
<td>40-50°F</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>190-230 psig</td>
<td>20-35 psig</td>
<td>62-77°F</td>
<td>62-72°F</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>155-195 psig</td>
<td>15-30 psig</td>
<td>47-62°F</td>
<td>48-58°F</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>120-155 psig</td>
<td>10-25 psig</td>
<td>45-55°F</td>
<td>45-55°F</td>
</tr>
<tr>
<td>70</td>
<td>50</td>
<td>95-130 psig</td>
<td>10-20 psig</td>
<td>42-52°F</td>
<td>40-50°F</td>
</tr>
<tr>
<td>90</td>
<td>80</td>
<td>165-205 psig</td>
<td>20-35 psig</td>
<td>57-72°F</td>
<td>59-69°F</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
<td>130-165 psig</td>
<td>15-30 psig</td>
<td>50-60°F</td>
<td>49-59°F</td>
</tr>
<tr>
<td>70</td>
<td>80</td>
<td>100-135 psig</td>
<td>10-25 psig</td>
<td>43-53°F</td>
<td>40-50°F</td>
</tr>
</tbody>
</table>

**Note:** Values stated are for sleeper cab models. Day cab models will have slightly lower temperature and pressure values.
**R134a Pressure vs. Temperature**

This table lists the boiling point of R134a refrigerant at the pressures listed.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Pressure</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td>psig</td>
<td>bar</td>
</tr>
<tr>
<td>16</td>
<td>-8.9</td>
<td>15.33</td>
<td>1.06</td>
</tr>
<tr>
<td>18</td>
<td>-7.8</td>
<td>16.66</td>
<td>1.15</td>
</tr>
<tr>
<td>20</td>
<td>-6.7</td>
<td>18.03</td>
<td>1.24</td>
</tr>
<tr>
<td>22</td>
<td>-5.6</td>
<td>19.45</td>
<td>1.34</td>
</tr>
<tr>
<td>24</td>
<td>-4.4</td>
<td>20.92</td>
<td>1.44</td>
</tr>
<tr>
<td>26</td>
<td>-3.3</td>
<td>22.43</td>
<td>1.55</td>
</tr>
<tr>
<td>28</td>
<td>-2.2</td>
<td>24.00</td>
<td>1.65</td>
</tr>
<tr>
<td>30</td>
<td>-1.1</td>
<td>25.62</td>
<td>1.77</td>
</tr>
<tr>
<td>32</td>
<td>0</td>
<td>27.29</td>
<td>1.88</td>
</tr>
<tr>
<td>34</td>
<td>1.1</td>
<td>29.01</td>
<td>2.00</td>
</tr>
<tr>
<td>36</td>
<td>2.2</td>
<td>30.79</td>
<td>2.12</td>
</tr>
<tr>
<td>38</td>
<td>3.3</td>
<td>32.63</td>
<td>2.25</td>
</tr>
<tr>
<td>40</td>
<td>4.4</td>
<td>34.53</td>
<td>2.38</td>
</tr>
<tr>
<td>45</td>
<td>7.2</td>
<td>39.52</td>
<td>2.72</td>
</tr>
<tr>
<td>50</td>
<td>10.0</td>
<td>44.90</td>
<td>3.10</td>
</tr>
<tr>
<td>55</td>
<td>12.8</td>
<td>50.69</td>
<td>3.49</td>
</tr>
<tr>
<td>60</td>
<td>15.5</td>
<td>56.90</td>
<td>3.92</td>
</tr>
<tr>
<td>65</td>
<td>18.2</td>
<td>63.55</td>
<td>4.38</td>
</tr>
<tr>
<td>70</td>
<td>21.1</td>
<td>70.67</td>
<td>4.87</td>
</tr>
<tr>
<td>75</td>
<td>23.9</td>
<td>78.27</td>
<td>5.40</td>
</tr>
<tr>
<td>80</td>
<td>26.7</td>
<td>88.38</td>
<td>6.09</td>
</tr>
<tr>
<td>85</td>
<td>29.4</td>
<td>95.01</td>
<td>6.55</td>
</tr>
<tr>
<td>90</td>
<td>32.2</td>
<td>104.19</td>
<td>7.18</td>
</tr>
<tr>
<td>95</td>
<td>35.0</td>
<td>113.94</td>
<td>7.86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Pressure</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td>psig</td>
<td>bar</td>
</tr>
<tr>
<td>100</td>
<td>37.8</td>
<td>124.27</td>
<td>8.57</td>
</tr>
<tr>
<td>102</td>
<td>38.9</td>
<td>128.58</td>
<td>8.86</td>
</tr>
<tr>
<td>104</td>
<td>40.0</td>
<td>132.98</td>
<td>9.16</td>
</tr>
<tr>
<td>106</td>
<td>41.1</td>
<td>137.48</td>
<td>9.48</td>
</tr>
<tr>
<td>108</td>
<td>42.2</td>
<td>142.08</td>
<td>9.80</td>
</tr>
<tr>
<td>110</td>
<td>43.3</td>
<td>146.79</td>
<td>10.12</td>
</tr>
<tr>
<td>112</td>
<td>44.4</td>
<td>151.59</td>
<td>10.45</td>
</tr>
<tr>
<td>114</td>
<td>45.6</td>
<td>156.51</td>
<td>10.79</td>
</tr>
<tr>
<td>116</td>
<td>46.7</td>
<td>161.53</td>
<td>11.14</td>
</tr>
<tr>
<td>118</td>
<td>47.8</td>
<td>166.66</td>
<td>11.49</td>
</tr>
<tr>
<td>120</td>
<td>48.9</td>
<td>171.89</td>
<td>11.85</td>
</tr>
<tr>
<td>122</td>
<td>50.0</td>
<td>177.24</td>
<td>12.22</td>
</tr>
<tr>
<td>124</td>
<td>51.1</td>
<td>182.70</td>
<td>12.60</td>
</tr>
<tr>
<td>126</td>
<td>52.2</td>
<td>188.27</td>
<td>12.98</td>
</tr>
<tr>
<td>128</td>
<td>53.3</td>
<td>193.96</td>
<td>13.37</td>
</tr>
<tr>
<td>130</td>
<td>54.4</td>
<td>199.76</td>
<td>13.77</td>
</tr>
<tr>
<td>135</td>
<td>57.2</td>
<td>214.78</td>
<td>14.31</td>
</tr>
<tr>
<td>140</td>
<td>60.0</td>
<td>230.54</td>
<td>15.89</td>
</tr>
<tr>
<td>145</td>
<td>62.8</td>
<td>247.08</td>
<td>17.03</td>
</tr>
<tr>
<td>150</td>
<td>65.5</td>
<td>264.40</td>
<td>18.23</td>
</tr>
<tr>
<td>155</td>
<td>68.3</td>
<td>282.53</td>
<td>19.48</td>
</tr>
<tr>
<td>160</td>
<td>71.1</td>
<td>301.49</td>
<td>20.79</td>
</tr>
<tr>
<td>165</td>
<td>73.8</td>
<td>321.29</td>
<td>22.15</td>
</tr>
<tr>
<td>170</td>
<td>76.7</td>
<td>341.96</td>
<td>23.58</td>
</tr>
</tbody>
</table>
Refrigerant Compressor Troubleshooting

**Note:** A fault in the compressor clutch or wiring may be indicated by the red LED on the A/C diagnostic module blinking 3 times (see “Red LED — Three blinks” page 69).

The APADS module controls the compressor operation based on logic designed to protect A/C components. It will not allow the compressor to engage for the first 15 seconds after ignition ON to prevent the possibility of engagement with low voltage.

After that first 15 seconds, the module will engage the compressor regardless of any A/C operation request from the driver. It will engage and hold the compressor on for up to 15 seconds if no faults or conditions are present that would damage components.

If the compressor engages for the 15 seconds test period, the A/C diagnostic module is able to deliver control signals to the compressor clutch and also indicates that the wiring and clutch are in working order.

**If the compressor will not engage after successfully engaging during the test period it is likely that the compressor operation request has not been received by the APADS module. After the test period, the APADS module must receive an “On Request” to initiate compressor operation. The “On Request” can be verified by the presence of 12 V at pin H of the APADS module connector (see “A/C Diagnostic Module (APADS), Simplified Schematic” page 65).**

**Note:** If system pressure is above 300 psi for more than 10 seconds or an open circuit exists in the high pressure switch circuit, the A/C diagnostic module will not allow compressor operation.

If the compressor does not engage for the 15 seconds test period and will not engage thereafter,
- a fault may exist that has not yet displayed a code,
- a mechanical fault may exist in the compressor clutch, or
- the APADS module may be faulty.

Refer to the two following troubleshooting guides.

---

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

---

**WARNING**

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.
<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Condition</th>
<th>Recommended Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Belts are squealing or slipping on the pulleys</td>
<td>Refrigerant compressor belts loose</td>
<td>1 Tighten the compressor belts to correct tension&lt;br&gt;2 Replace the compressor belts</td>
</tr>
<tr>
<td>2 Abnormal belt wear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Belts are squealing or slipping off of the pulleys</td>
<td>Incorrect pulley alignment</td>
<td>1 Align the pulley with the clutch&lt;br&gt;2 Replace the compressor belts</td>
</tr>
<tr>
<td>2 Premature belt wear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Compressor is not firmly attached or does not align properly with the belts</td>
<td>Compressor mounting bolts loose</td>
<td>1 Tighten the bolts holding the mounting to the engine and the bolts holding the compressor to the mounting according to the standard torque tables</td>
</tr>
<tr>
<td>1 Excessive gap between the armature plate and the rotor</td>
<td>Compressor clutch slipping</td>
<td>1 Adjust the gap between the clutch plate and the rotor&lt;br&gt;2 Replace the compressor&lt;br&gt;3 Replace the clutch&lt;br&gt;4 Troubleshoot the electrical system and/or the A/C diagnostic system&lt;br&gt;5 Reset blink codes</td>
</tr>
<tr>
<td>2 Internal compressor binding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Clutch failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Insufficient voltage and/or current to the compressor clutch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Blink code - 3 red</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If the complaint has not been corrected after completing the previous inspection and repair, refer to the following troubleshooting guide.

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Possible Cause</th>
<th>Recommended Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of cooling - compressor runs smoothly, suction pressure is high, discharge pressure is low</td>
<td>Broken head or block gasket or broken or deformed reed valve</td>
<td>1 Replace compressor</td>
</tr>
<tr>
<td>Lack of cooling - compressor running intermittently or inoperative</td>
<td>Insufficient voltage or ground to compressor clutch (blink code 3 red)</td>
<td>1 Perform voltage drop test.&lt;br&gt;2 Repair electrical system as necessary&lt;br&gt;3 Reset blink codes</td>
</tr>
<tr>
<td></td>
<td>Excessive clutch air gap</td>
<td>1 Check air gap&lt;br&gt;2 Adjust air gap in accordance with the clutch replacement procedure</td>
</tr>
<tr>
<td>Lack of cooling - compressor running rough</td>
<td>Internal compressor damage</td>
<td>1 Perform shaft smoothness test&lt;br&gt;2 Replace compressor if necessary</td>
</tr>
<tr>
<td></td>
<td>Insufficient compressor oil level</td>
<td>1 Perform oil level check procedure</td>
</tr>
<tr>
<td>Compressor operation is rough</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compressor operation is rough</td>
<td>1 Perform shaft smoothness test&lt;br&gt;2 Replace compressor if necessary</td>
</tr>
<tr>
<td>Defective clutch, clutch pulley, or front plate</td>
<td>1 Replace clutch in accordance with the service procedure</td>
<td></td>
</tr>
<tr>
<td>Clutch slipping or engaging intermittently (blink code 3 red)</td>
<td>Ensure clutch is getting proper voltage (at least 11.4 volts)&lt;br&gt;2 If voltage sufficient, replace the clutch&lt;br&gt;3 Reset blink codes</td>
<td></td>
</tr>
<tr>
<td>Clutch makes unusual noise with clutch disengaged</td>
<td>Clutch chattering</td>
<td>1 Check air gap&lt;br&gt;2 Adjust air gap in accordance with the clutch replacement procedure</td>
</tr>
<tr>
<td></td>
<td>Defective rotor pulley bearing</td>
<td>1 Replace clutch in accordance with the service procedure</td>
</tr>
</tbody>
</table>
A/C Diagnostic System Troubleshooting

A/C Diagnostic Module (APADS), Simplified Schematic

This schematic should be used to clarify the troubleshooting procedures of the A/C diagnostic system. For detailed, vehicle specific fault tracing see “VN or VHD Electrical Schematics, Group 37”.

AC DIAGNOSTIC MODULE CONNECTOR

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAVITY</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>G</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>J</td>
</tr>
<tr>
<td>K</td>
</tr>
</tbody>
</table>
A/C Diagnostic System (APADS), General

The A/C diagnostic system (APADS) is designed primarily to detect A/C system problems that may cause compressor failures. The APADS system can interrupt compressor operation to prevent failures. The APADS system monitors A/C system pressures and current flows and warns of detected faults. These faults are indicated by “blink” codes from the red and green LED’s on the diagnostic module. By using the Fault Code Quick Reference Table, the “blink” codes can be interpreted to determine fault description. This troubleshooting information will aid the technician in identifying and correcting A/C system problems.

⚠️ DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

⚠️ WARNING

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

⚠️ WARNING

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

<table>
<thead>
<tr>
<th>LED blinks</th>
<th>Fault code name</th>
<th>Fault description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red off</td>
<td>No faults</td>
<td>No faults detected</td>
</tr>
<tr>
<td>Slow green blink</td>
<td>Control module functional</td>
<td></td>
</tr>
<tr>
<td>Rapid green</td>
<td>Low voltage</td>
<td>Low voltage to APADS control module</td>
</tr>
<tr>
<td>No LEDs</td>
<td>Power supply</td>
<td>Fuse blown, no electrical connection to APADS module or faulty APADS module</td>
</tr>
<tr>
<td>1 red</td>
<td>Low refrigerant pressure</td>
<td>Loss of refrigerant charge</td>
</tr>
<tr>
<td>2 red</td>
<td>High refrigerant pressure</td>
<td>Overcharge, restriction on high side or low air flow through condenser, air in refrigerant</td>
</tr>
<tr>
<td>3 red</td>
<td>Compressor clutch circuit</td>
<td>Compressor clutch/wiring open or shorted</td>
</tr>
<tr>
<td>4 red</td>
<td>Pressure switch wiring</td>
<td>Open switch or wire to high or low pressure switch</td>
</tr>
</tbody>
</table>
Blink Code Descriptions

The ignition switch must be on to observe all diagnostic messages. The green LED may remain illuminated constantly for the first 30 seconds of operation.

**No LED lights with Ignition switch on**

No voltage

Possible causes:

- Blown fuse
- Unseated wiring connector
- Faulty A/C diagnostic module

The A/C diagnostic module receives power through the engine fan circuit, which is only powered when the ignition is ON. If the fuse is blown and the engine is running the fan will run continuously.

Power to the A/C diagnostic module is fed through pin F of the 10 pin Metri-pack connector. If the module is receiving power and the green LED is not lit, verify the module ground connection at pin D. If voltage is supplied and the ground is good, the module may be faulty.

**Green LED — Blinking slowly**

(on 4 seconds, off 1 second)

No faults

If the green LED is blinking slowly, no faults are detected in the functions monitored by the A/C diagnostic module. **It is important to note that the A/C diagnostic module cannot monitor every conceivable condition that may cause an A/C system to fail.**

If the A/C system is not operating properly, the fault codes displayed on the module should be used as an additional tool in an overall troubleshooting strategy.

If the ambient temperature sensed by the module is below 40°F (4°C), the control module will prevent the refrigerant compressor from engaging. This is to prevent compressor damage due to a lack of proper lubrication in colder temperatures.

**Note:** If the compressor will not engage after successfully engaging during the 15 second test period it is likely that the compressor operation request has not been received by the A/C diagnostic module.

**Green LED — Blinking rapidly**

Low voltage

Possible cause:

- Vehicle electrical system below 11 volts
- Faults in power circuit to module
- Fault in ground circuit to module

The A/C diagnostic module constantly monitors the system voltage. A reduction in the available voltage supplied to the compressor clutch could cause damage to the clutch and compressor. If the voltage supplied to the module falls below a predetermined value, the compressor clutch will be disengaged and the green LED will flash rapidly.

When the system voltage rises above the required value, the compressor clutch will be allowed to re-engage.

**Note:** Voltage of less than 11.0 ± 0.2 volts supplied to the module will cause the Green LED to flash rapidly. The light will flash one to two times per second.
Red LED — One blink

Low refrigerant pressure

Possible causes:
- Refrigerant low or out
- Refrigerant leak

Fault code 1 represents a condition of low refrigerant level. The low pressure switch is a normally closed switch that opens at 34 psi. When the switch is connected to a properly charged A/C system, the switch opens. It closes once the pressure has dropped below about 8 psi.

This code can be set under two different conditions.

A) If the low pressure switch remains closed from ignition on, for a period of 180 seconds (3 minutes) the module will set fault code 1 for a complete loss of charge.

B) If the module detects 20 consecutive low pressure switch cycles within a period of time, it sets fault code 1 for a partial loss of charge. A significant amount of refrigerant must be lost before this code is set.

Red LED — Two blinks

Excessively high pressure

Possible causes:
- Fan failing to engage
- Internal restriction in condenser or high pressure hoses.
- Condenser air flow restriction
- Refrigerant overcharge

Fault code 2 represents a condition of high pressure. The high pressure switch is a normally closed switch. When the switch is connected to a properly charged A/C system, the switch remains closed. It opens once the pressure has risen above 300 psi.

When this occurs, the APADS module first removes the ground to the engine fan circuit to cause the fan to engage. If the pressure has not fallen below about 265 psi within 10 seconds of the engine fan “on” signal, the compressor will be disengaged to protect components from damage due to high pressure. If the compressor is disengaged due to high system pressure 12 consecutive times within a pre-determined time period this fault code is set.

Note: The A/C diagnostic system does not have the ability to control viscous fans. Engines equipped with viscous fans may experience an inordinate amount of this fault code.
**Red LED — Three blinks**

Improper current flow to the compressor clutch

Possible cause:
- Shorted or grounded circuit to compressor clutch
- Open circuit to the compressor clutch
- Compressor clutch failure

The A/C compressor clutch has a resistance value of approximately 3.1 to 4.4 depending on the temperature (see chart below). The APADS module supplies battery voltage to one lead of the clutch any time the key is on. The module switches the other lead, a ground, on for compressor operation or removes the ground to disengage it. The module monitors this circuit.

Two conditions can cause the module to flash this code:
A) If the circuit resistance is too low, the module senses that too much current flow is needed.
B) If the circuit resistance becomes too high, the module senses the lack of current flow.

In both instances, the module will attempt to engage the compressor again. If the condition still exists, the compressor will be shut off until the next ignition cycle and the code will be set.

An intermittent fault may also be detected when current flow is out of parameters for 8 consecutive 250 millisecond time periods (2 seconds). A typical situation that would cause an intermittent fault to occur is a frayed power wire touching ground. If this condition occurs, it may cause clutch “chatter” until the fault is recognized for 2 consecutive seconds.

---

**Approximate Clutch Resistance / VS. Temperature**

- **Resistance (Ohm)**
- **Current (A) @ 12V**

**Note:** Amperage reading at 12 V. Higher voltages will increase amperage.
Red LED — Four blinks
Pressure switch circuits

Possible causes:

- Unseated wiring connector
- Open in the wiring harness
- Defective switch
- Wrong switch

Note: The A/C diagnostic system uses “semi-smart” pressure switches with a built in resistor. These switches MUST NOT be substituted with other type switches.

Fault code 4 represents a problem with the circuit to either the high pressure or low pressure switch. Both the high and low pressure switches are normally closed switches. Each is equipped with a resistor wired in parallel to the contact points of the switch. When the switch is closed, the resistance should be less than 1 ohm. When the switch is open, the resistance should be 2.490 ± 20 ohms. This arrangement allows the module to differentiate between a switch that is properly connected and one that has a problem in the circuit or the switch itself.

In a properly charged system, the low pressure switch should read 2.490 ± 20 ohms and the high pressure switch should read less than 1 ohm.

An open circuit on either switch or its wiring will cause this fault to be displayed.

<table>
<thead>
<tr>
<th></th>
<th>OPENS</th>
<th>CLOSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Pressure switch</td>
<td>34 psi</td>
<td>8 psi</td>
</tr>
<tr>
<td>High Pressure switch</td>
<td>300 psi</td>
<td>265 psi</td>
</tr>
</tbody>
</table>

Note: Breakout harness J-43147 may be helpful in troubleshooting pressure switches.

APADS Website

If additional troubleshooting information is required visit the Index Sensors and Controls website at www.indexsensors.com under “Technical Manuals”. Select the “APADS CM-814 Product Description and Troubleshooting Manual”. Additionally, the Index technical support hotline number is 1-800-726-1737.
Clearing the A/C Diagnostic Fault Codes

After repairs are made the fault codes should be cleared from the control module. If the fault codes are not cleared after the repairs are made the control module will continue to “blink” showing the original fault. The diagnostic module has the ability to store only one fault. After each repair the fault code should be cleared and the air conditioning system operated to check for more faults.

To clear the fault codes, cycle the ignition switch “ON” then “OFF” four times (cycling the ignition switch means one second “ON” and one second “OFF”).

**Note:** If the fault codes were not “manually” cleared after the repairs were completed, they will clear automatically after the tenth ignition cycle.

---

Engine Fan Troubleshooting

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

---

**WARNING**

HOT ENGINE! Keep yourself and your test equipment clear of all moving parts or hot engine parts and/or fluids. A hot engine and/or fluids can cause burns or can permanently damage test equipment.

---

**WARNING**

Do not work near the fan with the engine running. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured. Before turning on the ignition, be sure that no one is near the fan.

**Note:** The A/C diagnostic module cannot control viscous fan operation.

The engine fan requires source voltage and a ground to the fan solenoid to shut the fan off. To start the fan the module must interrupt the ground or the source voltage to the solenoid. The fan is normally started by the Data Concentrator (VE D12A) or the engine ECM (vendor engines) upon receiving input from the A/C diagnostic module. It will also start if the fan fuse is blown.

On vehicles equipped with newer model Volvo engines (VE D12B and later), the Vehicle Electronic Control Unit (VECU) receives the “fan on” request from the A/C diagnostic module. The VECU then sends a data message to the Engine Electronic Control Unit (EECU) which engages the fan.

If the fan remains on continuously check the following:

- Engine fan solenoid fuse
- Wiring and connections
- Engine fan clutch solenoid
- Engine fan clutch
- High pressure switch or wiring open
- A/C System pressure above 300 psi
- APADS module ground circuit

If the fan fails to engage and reduce the high side pressures within 10 seconds of the command, the module will shut off the compressor.

This will often lead to a complaint of poor A/C performance especially if your diagnosis finds nothing else wrong with the system.

If the fan fails to engage check the following:

- The engine fan should engage with system pressure above 300 psi. (Dis-engage below 260 psi).
- High pressure switch or wiring shorted closed.
- Check engine ECU programming parameters.
- Wiring or connectors from A/C diagnostic module to fan control device (EECU, VECU, Data Concentrator).
### Blower Motor Troubleshooting

This table provides several typical blower motor complaints, their possible causes, and the recommended corrective action.

**Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.**

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Possible Cause</th>
<th>Recommended Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blower motor not operative</td>
<td>Blower motor fuse blown</td>
<td>1 Replace fuse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Check for short or overload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Check motor speed</td>
</tr>
<tr>
<td>Broken wire or loose connection</td>
<td>Faulty switch</td>
<td>1 Repair wire/switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Tighten loose connection</td>
</tr>
<tr>
<td>Defective motor</td>
<td></td>
<td>1 Replace motor</td>
</tr>
<tr>
<td>PTC device open (cab)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistor card fault (bunk)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blower motor slows down after running a while</td>
<td>Insufficient air flow to keep PTC devices cool</td>
<td>1 Check for air path obstructions</td>
</tr>
<tr>
<td></td>
<td>Excessive motor current</td>
<td>2 Check motor bearings, replace motor if necessary</td>
</tr>
<tr>
<td></td>
<td>Evaporator core frozen</td>
<td>3 Check motor current draw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Check cold control switch</td>
</tr>
<tr>
<td>Blower motor appears to run at normal speed but insufficient air flow at ducts</td>
<td>Obstruction of air flow</td>
<td>1 Check fresh air filter</td>
</tr>
<tr>
<td></td>
<td>Evaporator core frozen</td>
<td>2 Check air path for obstructions</td>
</tr>
<tr>
<td></td>
<td>Duct hoses leaking</td>
<td>3 Check cold control switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Check duct hoses and connections</td>
</tr>
<tr>
<td>Blower motor will not run on all speeds</td>
<td>Resistor card fault (bunk).</td>
<td>1 Replace the resistor card</td>
</tr>
<tr>
<td></td>
<td>Switch or wiring fault.</td>
<td>2 Check for proper current draw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Check for air path obstructions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Repair wiring/switch</td>
</tr>
</tbody>
</table>
Bunk Unit Troubleshooting

General

Depending on the date of manufacture, the bunk climate control unit may be supplied by Bergstrom or Behr. Decals on the units may be helpful in identifying the type of unit installed in the vehicle. Please note the following when troubleshooting bunk climate control complaints.

- For the bunk unit climate control to operate properly, the main cab climate control unit must be in proper working order. Be sure the A/C or heat works properly in the main cab unit before beginning repairs.

- For bunk A/C to work, it must be selected and operating in the main cab. There are no controls for the A/C system in the bunk climate control unit.

- Automatic temperature control is achieved by the bunk ATC water valve responding to signals from the ATC module. The ATC water valve is normally open.

- Refer to the Simplified Schematics, “Bunk Climate Control Unit (Behr)” page 74 or “Bunk Climate Control Unit (Bergstrom)” page 75.
Bunk Unit, Simplified Schematics

Bunk Climate Control Unit (Behr)

The schematic shown should be used to clarify the troubleshooting procedures for the Behr bunk climate control unit. For detailed, vehicle specific fault tracing see “VN or VHD Electrical Schematics, Group 37”.

ACCESSORY
12 VOLT

FUSE

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163-A 163-B

BLOWER MOTOR

-156

RESISTOR CARD

-156

TEMP. CONTROL SWITCH

WATER VALVE

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174

163-B

ATC MODULE

OB-A

OB

LOW MED OFF HI

BUNK FAN SWITCH

GROUND

155

159

175-A

175

156
Bunk Climate Control Unit (Bergstrom)

The schematic shown should be used to clarify the troubleshooting procedures for the Bergstrom bunk climate control unit. For detailed, vehicle specific fault tracing see “VN or VHD Electrical Schematics, Group 37”.

---

**Schematic Diagram**

- Accessory 12 Volt
- Fuse
- Bunk Fan Switch
- Resistor Card
- Atc Module
- Temp Control Switch
- Water Valve
- Ground

---
Bunk Unit Troubleshooting Chart

Note conditions:

- Engine warm and running
- Main cab A/C controls set to maximum cool
- Bunk blower motor on high speed
- Bunk temperature control switch set to maximum cool

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Check</th>
<th>Possible Cause / Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunk A/C not cooling properly</td>
<td>Is main cab A/C working properly?</td>
<td>Repair main cab A/C as needed</td>
</tr>
<tr>
<td></td>
<td>Is air flow from ducts sufficient?</td>
<td>See “Blower Motor Troubleshooting” page 72</td>
</tr>
</tbody>
</table>
|                            | Are A/C hoses to bunk unit cool (suction) and warm (discharge)? | 1 Bunk expansion valve obstructed / Replace  
|                            |                                           | 2 Obstruction in bunk A/C hoses or evaporator core / Clean or replace as needed |
|                            | Are heater hoses to bunk hot?             | Bunk water valve not closed properly. See “Bunk Component Troubleshooting” page 77 |

Note: The bunk climate control unit is not equipped with a cold control switch. In high humidity conditions, it is possible for the evaporator core to freeze. If this occurs, adjust the temperature control switch to a slightly warmer position and increase the fan speed.

<table>
<thead>
<tr>
<th>Bunk A/C not heating properly</th>
<th>Is main cab heater working properly?</th>
<th>Repair main cab heater as needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: Turn bunk temperature control to &quot;hot&quot;</td>
<td>Is air flow from ducts sufficient?</td>
<td>See “Blower Motor Troubleshooting” page 72</td>
</tr>
</tbody>
</table>
|                               | Are heater hoses to bunk hot?       | 1 Obstruction in bunk heater hoses or bunk heater core / Clean or replace as needed  
|                               |                                     | 2 Bunk water valve not opening properly, see “Bunk Component Troubleshooting” page 77 |

Note: The ATC module limits heat output to a maximum of 43° C (110° F) (Bergstrom) or 65° C (149° F) (Behr) depending on the bunk climate control unit variant.
Bunk Component Troubleshooting

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Water Valve**

The bunk water (heater control) valve must be open to allow the bunk heater to operate. Manually controlled valves must be properly adjusted. Electronically controlled water valves are normally open when not powered. With the engine warm and running and the bunk temperature set at maximum cool, disconnect the connector to the water valve. A properly operating valve will open and allow the engine coolant to circulate through the heater core. When power and ground is supplied back to the valve it should close and the heater core gradually cool.

Outputs from the ATC module on the Bergstrom unit will include a power, ground, and control wire. The control wire will supply a variable voltage from approximately 3 V to 9 V. Outputs from the ATC module on the Behr unit will supply power and ground to switch the water valve on and off (see the simplified schematics “Bunk Climate Control Unit (Behr)” page 74 and “Bunk Climate Control Unit (Bergstrom)” page 75). If the outputs from the ATC module are correct, it is likely that the water valve is defective.

**Temperature Control Switch**

The bunk temperature control switch is a potentiometer located in the bunk ATC control panel. To check its operation, with the ignition switch off, disconnect the connector to the ATC module. Back probe the ATC module connector pins to the potentiometer with a digital ohmmeter (see the simplified schematics “Bunk Climate Control Unit (Behr)” page 74 and “Bunk Climate Control Unit (Bergstrom)” page 75). Check for a smooth, variable resistance from approximately 1 Ω to 5.5k Ω. If not OK, check for faults in the wiring, connectors or potentiometer (temperature control switch).

**ATC Module**

The bunk unit ATC module is supplied power and ground via the vehicle wiring. A temperature sensor, mounted to the module, monitors the air temperature that is supplied to the ducts. It also monitors the position of the bunk temperature control switch. Based on these inputs, the ATC module sends operating signals to the water valve. There is no test for the ATC module itself. If a problem is suspected, first check the power and ground supply to the module (see the simplified schematics “Bunk Climate Control Unit (Behr)” page 74 and “Bunk Climate Control Unit (Bergstrom)” page 75). Check the inputs from the bunk temperature control switch (see “Temperature Control Switch” page 77). Output signals to the water valve may also be checked (see “Water Valve” page 77), however, if the module is faulty, it may supply output signals at inappropriate times. If all input signals are OK and the ATC module supplies inappropriate or no output signals to the water valve it is likely that the ATC module is faulty.
Service Procedures

General Work Practices

General Climate Control System Maintenance

The following precautions should be observed when performing maintenance on the climate control system.

**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

**WARNING**

Never remove the cap on the expansion tank while the engine is still hot. Wait until the coolant temperature is below 50°C (120°F). Scalding steam and fluid under pressure may escape and cause serious personal injuries.

**CAUTION**

Potential equipment damage. Many heating and air conditioning system components are made of special alloys, which can be damaged by excessive torque. Adhere to all torque specifications and methods when torquing these components. Failure to properly torque these components could result in damage to the components.

General Air Conditioning System Maintenance

1. The most common cause of air conditioning unit malfunction is moisture in the refrigerant system. Moisture in the refrigerant will cause icing and a frozen expansion valve. To reduce the chance of moisture entering the refrigerant system during repairs, perform the following:
   - Keep the system clean and dry.
   - When opening the system, cap any open connection that will be left for more than a few minutes.
   - Keep refrigerant oil in sealed containers to prevent it from absorbing moisture from the air.
   - Keep protective covers in place on new components until immediately before they are connected to the system.
   - Do not use compressed air to clean components.

2. The compressor oil level should be checked any time the A/C system has experienced a rapid and significant refrigerant leak or when an obvious refrigerant oil leak is observed. Use the compressor oil level check procedure in the Service Procedures section of this manual.

3. Use PAG oil to lubricate O-rings, do not lubricate them until just before they are placed on the components and then immediately connect the components.

4. Always reset A/C diagnostic module blink codes following maintenance which could affect module inputs. Reset codes using the procedure in the Troubleshooting section.
Observe the following safety precautions when handling R134a refrigerant:

**DANGER**

Personal injury hazard. R134a refrigerant is a non-poisonous hydrofluoric acid that can cause burns if it comes in contact with the eyes or skin. Always work in a well ventilated area when working with R134a refrigerant. In a highly concentrated gas form, R134a refrigerant can cause unconsciousness, and at lower concentrations can affect the nervous system. Do not breathe the vapors. R134a refrigerant can also irritate the nose and throat. Failure to follow these precautions could result in serious personal injury.

**WARNING**

Possible personal injury and property damage. Do not pressure or leak test R134a refrigerant vehicle air conditioning systems or servicing equipment using compressed air. Some mixtures of air and R134a refrigerant have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Consult the Material Safety Data Sheets (MSDS) for additional information.

**CAUTION**

Potential equipment damage. Do NOT mix mineral oil (such as is used in R12 refrigerant systems) with PAG oil in an R134a refrigerant system. Mixing of these oils in an R134a refrigerant system could result in equipment damage.

**WARNING**

Personal injury hazard. Avoid breathing R134a refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose, and throat. Use proper service equipment certified to meet the requirements of SAE J2210 (R134a recycling equipment). Consult the Material Safety Data Sheets (MSDS) for additional information.

**CAUTION**

Potential equipment damage. Ester based oils reduce compressor life and are not compatible with Sanden refrigerant compressors. Use only SP20 PAG oil or equivalent in Sanden compressors. Use of other type oils could result in damage to the compressor.

**CAUTION**

Potential equipment damage. Do NOT inject red dye into the air conditioning system to test for leaks. Injecting red dye into the system could result in damage to the compressor.
8723-03-02-12
Cab Fresh Air Filter, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1
Unhook the spring from the filter unit cover. Remove the cover.

2
Slide the filter out of the filter unit.

Inspection / Cleaning

The fresh air filter should be inspected every 40,000 miles (64,000 km) for regular highway use. In very dusty conditions, it is recommended that the filter be checked every 10,000 miles (16,000 km). Replace with a new filter every 70,000 miles (113,000 km).

Note: Never use water to clean the fresh air filter. When cleaning, use compressed air, at no more than 138 kPa (20 psi).

Installation

1
Install the cleaned filter or a new filter in the filter unit.

2
Place the cover on the filter unit. Hook the cover spring over the cover.

8701-09-03-01
A/C Refrigerant Recovery/Recharge, Servicing

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Personal injury hazard. R134a refrigerant is a non-poisonous hydrofluoric acid that can cause burns if it comes in contact with the eyes or skin. Always work in a well ventilated area when working with R134a refrigerant. In a highly concentrated gas form, R134a refrigerant can cause unconsciousness, and at lower concentrations can affect the nervous system. Do not breathe the vapors. R134a refrigerant can also irritate the nose and throat. Failure to follow these precautions could result in serious personal injury.

WARNING

Personal injury hazard. Avoid breathing R134a refrigerant and lubricant vapor or mist. Exposure may irritate eyes, nose, and throat. Use proper service equipment certified to meet the requirements of SAE J2210 (R134a recycling equipment). Consult the Material Safety Data Sheets (MSDS) for additional information.

Recovery

1
Run the engine with the A/C system on to add heat to the refrigerant.

Note: Heat added to the A/C system helps achieve a faster, more complete refrigerant recovery.
2

Remove the caps from the recovery and recharge connection ports.

Note: Port locations may vary.

3

Connect the red hose to the high pressure port and connect the blue hose to the low pressure port.

4

Recover the refrigerant from the system in accordance with the recovery unit operators manual.

5

Drain the system oil into a small bottle. Record the amount of oil removed.

6

Note: When all refrigerant is recovered, the system should be at a vacuum.

Wait five minutes then check the pressure on the suction gauge. If a vacuum still exists recovery is complete. If the suction gauge does not show a vacuum or is near zero pressure, re-perform the recovery to remove remaining refrigerant.

7

Remove the recovery unit hoses from the ports and install the caps on the ports.
Recharging

1. All repairs, including checking the compressor oil level if appropriate, should be completed before recharging.

2. Remove the recovery/recharging port caps.

3. Connect the recovery/recharging unit hoses to the ports (red hose for compressor discharge, blue hose for compressor suction).

4. Evacuate the system in accordance with the recharge unit operators manual.

Note: A vacuum of 27 in. to 30 in. can be achieved in most cases. The amount of vacuum attainable varies with altitude. Locations at higher altitudes may not be able to achieve as high a vacuum.

5. Check the system for leaks by closing the suction and discharge valves on the unit. If vacuum does not stay at the level achieved in Step 4, leaks exist. Locate and repair any leaks and repeat the evacuation process.

6. Determine the correct amount of refrigerant to charge into the system from the Specifications section.

7. Open the discharge valve to charge the system. Charge the specified amount of refrigerant, then close the discharge valve.

8. When the correct amount of refrigerant has been charged into the system, reset the diagnostic blink codes, start the engine and run the compressor to allow the system to stabilize.

9. Compare the suction and discharge pressure gauge readings with the normal readings for the temperature and humidity. (Refer to the Normal A/C system pressures chart in the Troubleshooting section.)

10. If A/C system performance is acceptable, remove the suction and discharge hoses from the ports. Cap the ports.

11. If system performance is not correct, determine the cause of the problem and make appropriate repairs.
8743-06-03-01
A/C Compressor Oil Level, Checking

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

⚠️ DANGER
Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

⚠️ WARNING
HOT ENGINE! Keep yourself and your test equipment clear of all moving or hot engine parts. A hot engine can cause serious burns or can permanently damage test equipment.

1. Run the engine with the A/C engaged (compressor running) for 10 minutes at idle.

2. Recover the refrigerant using approved service procedures.

3. Remove or make adjustments as necessary to the compressor mounting, hoses, or other hardware that may interfere with gaining access to the oil filler plug. The oil filler plug and the area above it must be unobstructed to allow insertion of the oil check dipstick.

4. Determine if the compressor is an “angle right” or “angle left” mounting. See illustration. Turn the compressor clutch plate hex nut with a wrench to the 2 o’clock position for angle right mounting, or to the 10 o’clock position for an angle left mounting.

Note: A notch is cut in the compressor clutch plate to help reference the counterweight position.
Determine the mounting angle of the compressor. To do this, place a digital protractor, J-38460 or equivalent tool) across the flat surfaces of the two mounting ears on the compressor.

**Note:** It may be necessary to move mounting hardware to position the digital protractor across the mounting ears. Upper or lower mounting ears may be used. The digital protractor will also work right side up or up side down. Consult the digital protractor’s owner’s manual for further operating instructions.

6. Remove the oil filler plug and insert oil dipstick J-43338. With the dipstick properly inserted, the angled stop should be resting on the top of the compressor with the angle pointing in toward the compressor shaft. See illustration page 84.

7. Remove the dipstick and count the number of increments covered by the oil.

8. Compare the increment number obtained in step 7 and the mounting angle obtained in step 5 with the chart below. Add or remove oil as necessary to bring the oil to the proper level. See “System Oil” page 8 for approved oils.

<table>
<thead>
<tr>
<th>Mounting angle in degrees</th>
<th>Acceptable oil level in increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>5-7</td>
</tr>
<tr>
<td>10°</td>
<td>6-8</td>
</tr>
<tr>
<td>20°</td>
<td>7-9</td>
</tr>
<tr>
<td>30°</td>
<td>8-10</td>
</tr>
<tr>
<td>40°</td>
<td>9-11</td>
</tr>
<tr>
<td>50°</td>
<td>10-12</td>
</tr>
<tr>
<td>60°</td>
<td>11-13</td>
</tr>
<tr>
<td>90°</td>
<td>16-18</td>
</tr>
</tbody>
</table>

**Example:** If the compressor mounting angle is 20 degrees and the dipstick shows the oil level at increment 4, add oil in one fluid ounce increments until the oil level is at increment 8.

9. Check the O-Ring at the oil filler plug and the seat at the compressor. Reinstall the filler plug. Torque the plug to 15–25 Nm (11–18 ft-lb).

**Note:** Do not over-tighten the plug to stop a leak. If the plug leaks, remove the plug, replace the O-ring and re-torque.

10. Re-install and adjust any hardware as needed, using approved service procedures.

11. If all other A/C repairs are complete, evacuate and recharge the system using approved service procedures.
8735-03-02-01
Cab Heater Control Valve, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

**Removal**

1
Release pressure from the engine coolant system.

3
Remove the seven torx screws that hold the lower right dash panel in place. Remove the four screws that hold the center dash panel.

4
Pull the floor mat back to expose the plastic nuts. Remove the nuts, then remove the lower right and center dash panels.

5
Remove the nine clips that hold the climate control unit cover in place and remove the cover.

6
Disconnect the blower motor wiring connector.
Slide the blower out of the climate control unit.

8
Discontinue the control rod from the heater control valve.

9
Remove the two bolts that hold the heater control valve tubing to the heater core.

10
Remove the two bolts that hold the heater control valve tubing to the bulkhead outlet tube or ATC valve tube. Remove the valve.

Installation

1
Install new O-rings on both ends of the valve and tube assembly.
2
Install the valve and tube assembly on the heater core and on the flanged outlet tube. Install and tighten the four mounting bolts.

3
Connect the control rod to the valve.

4
Open the engine hot water valves. Top up the engine coolant.

5
Perform pressure test of the engine coolant system. Repair any leaks.

6
Ensure the blower tray is in place then install the blower in the climate control unit. Ensure the blower and tray are properly set into the channels in the climate control unit.

7
Connect the blower wiring connector.

8
Install the climate control unit front cover. Make sure there are no gaps around the cover, then install the nine metal clips on the cover.
Install the center under dash panel using four mounting screws. Install the lower right dash panel using seven torx screws. Pull the floor mat back and install the plastic nuts.

8712-03-02-01
Cab ATC Control Valve, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

Removal

1. Release pressure from the engine coolant system.

2. Close the engine hot water valves.

3. Remove the seven torx screws that hold the lower right dash panel in place. Remove the four screws from the center dash panel.
Pull the floor mat back to expose the plastic nuts. Remove the nuts, then remove the lower right and center dash panels.

Remove the nine clips that hold the climate control unit cover in place and remove the cover.

Slide the blower out of the climate control unit.

Disconnect the blower motor wiring connector.

Disconnect the wires from the ATC control valve.

Remove the two screws holding the ATC valve and manual valve tubes together. Remove the two screws holding the ATC valve tubing to the bulkhead outlet tube. Remove the ATC valve.

Installation

Place new O-rings on the ATC valve tube and the heater control valve tube.

Install the ATC valve and tube and tighten the four mounting screws.

Connect the ATC valve wire connector.

Open the engine hot water valves and top up the engine coolant.

Perform coolant system pressure test. Repair any leaks.
6

Ensure the blower tray is in place then install the blower in the climate control unit. Ensure the blower and tray are properly set into the channels in the climate control unit.

7

Connect the blower wiring connector.

8

Install the climate control unit front cover. Make sure there are no gaps around the cover, then install nine metal clips on the cover.

9

Install the center under dash panel using four mounting screws. Install the lower right dash panel using seven torx screws. Pull the floor mat back and install the plastic nuts.

10

Pull the floor mat back and install the plastic nuts.
**8741-03-02-01**  
**Cab Climate Control Unit, Replacement**

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Recover the refrigerant using the appropriate service procedure.

2. Loosen the clamp on the engine air filter turbocharger intake pipe.

3. Remove the four bolts holding the engine air filter housing. Remove the housing and pipe.

4. Remove the engine air filter right mounting bracket.
5
Loosen the cab air filter housing lower mounting bolt.

6
Loosen the cab air filter housing upper mounting bolt.

7
Remove the cab air filter housing.

8
Release pressure from the engine coolant system.

**WARNING**
Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

9
Close both engine hot water valves.

10
Place a drain pan under the vehicle. Remove the torx screws that hold the heater hoses to the heater box. Disconnect the hoses.

11
Remove the condensation drain tube.
Loosen the Allen head screw on the refrigerant tube H-clamp. Pull the tubes out of the expansion valve and cap the tubes.

In the cab, remove the right scuff plate.

Remove the torx screws from the right lower dash panel. Remove the four screws from the center dash panel.

Pull the floor mat back to expose the plastic nuts. Remove the plastic nuts. Remove the lower right and center dash panels.

Remove the speaker cover and speaker.
17
Remove the upper right side of the dash that covers the climate control unit.

18
Remove the plastic bars that hold the ductwork in place.

19
Remove the ductwork.

20
Label the three control cables and disconnect them from the unit.

21
Disconnect the wiring connectors for the blower, relay, and ATC (if installed).
Loosen the two bottom mounting bolts.  
**Note:** The weight of the unit should be supported by the bottom bolts when removing the upper mounting bolts.

Remove the side support bracket hardware.

Remove the left side upper mounting bolt.

Remove the right side upper mounting bolt.

Lift the climate control unit out of the vehicle.

Remove any seal material from the bulkhead opening.

**Installation**

1. If the expansion valve is removed, lubricate new O-rings with refrigerant oil and install them on the evaporator tubes, then install the expansion valve using two Allen head screws and torque the screws to $6 \pm 1 \text{ Nm} \ (53 \pm 8 \text{ in-lb})$. 

$6 \pm 1 \text{ Nm} \ (53 \pm 8 \text{ in-lb})$
2 Place a new seal around the climate control unit fresh air intake doors.

3 Install the lower mounting bolts.

**Note:** Ensure enough of each bolt sticks out from the bulkhead so that the climate control unit lower mounting flange can rest on them squarely.

4 Install and tighten the upper right mounting bolt.

5 Install and tighten the upper left mounting bolt.

6 Install the left side support bracket and tighten the nuts.
7
Tighten the lower mounting bolts.

8
Lubricate new O-rings with refrigerant oil and install them on the A/C tubes.

9
Place the H-clamp on the expansion valve tubes and insert the tubes into the expansion valve. Torque the Allen head screw to 10 ± 1.5 Nm (89 ± 13 in-lb).

10
Install the condensation drain tube.

11
Install new clamps on the heater hoses if they were removed. Install the heater hoses on the heater core tubes and tighten the clamps.

12
Open the hot water valves and top up the engine coolant.

13
Pressure test the engine coolant system. Repair any leaks.

14
Recharge the A/C system using the appropriate service procedure. Check for refrigerant leaks and repair any leaks found.

15
Connect the wiring connectors to the climate control unit.

16
Connect the three control cables.

17
Install the air duct and the two plastic bars that hold it in place.
18
Install the top right dash cover.

19
Connect the speaker wires and install the speaker using two torx head screws. Install the speaker cover.

20
Install the center under dash panel using four mounting screws. Install the lower right dash panel using seven torx screws. Pull the floor mat back and install the plastic nuts.

21
Install the scuff plate.

22
Install the fresh air filter housing using the four mounting bolts.

23
Install the engine air filter bracket using two mounting bolts.

24
Install the engine air filter and pipe using four mounting bolts.

25
Install the intake pipe on the turbocharger and tighten the clamp.

26
Start the vehicle and ensure that heating and A/C function properly.
8733-03-02-01
Cab Blower Motor, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Blower assembly removal

1

Remove the seven torx screws from the lower right dash panel. Remove the four screws from the center dash panel.

2

Pull the floor mat back and remove the plastic nuts. Remove the lower right and center dash panels.

3

Unclip the nine clips from the unit front cover, then remove the cover.

4

Disconnect the wires for the blower assembly.

5

Slide the blower assembly out of the climate control unit housing. If the plastic tray comes out with the blower, install the tray back into the climate control unit.
Blower motor removal

1

Use a small screwdriver to remove the clips on the blower motor housing.

**Note:** Be careful to prevent damaging the plastic clips while prying them off.

2

Remove the two blower motor mounting screws and hold down clamp.

Blower motor installation

3

Disconnect the wiring connector and remove the blower motor from the housing.

4

Remove the nuts that hold the fans on the motor shaft. Remove the fans.

1

Install the fans on the motor shaft. Install and tighten the nuts that hold the fans on the shaft.

2

Install the blower motor and fans in the housing.
3 Install the top of the blower motor housing and reinstall the plastic clips.

**Note:** Be careful to prevent damaging the plastic clips while installing them. The clips only install one way.

4 Install the motor clamp using the two mounting screws. Connect the wiring connector.

Blower assembly installation

1 Ensure the blower assembly tray is in place in the climate control unit housing.

2 Slide the blower assembly into the climate control unit and reconnect the wires.

3 Momentarily run the blower to verify proper operation and that there is no unusual noise.

4 Reinstall the front cover on the climate control unit. Ensure there are no air gaps then install the metal retainer clips.

**Note:** The cover should be pushed up into the channel to ensure it is properly seated.

5 Install the center under dash panel using four mounting screws. Install the lower right dash panel using seven torx screws.
Pull the floor mat back and install the plastic nuts in the lower right dash panel and the panel under the center of the dash.

8731-03-02-04
Cab Heater Core, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

**Removal**

1  Remove the climate control unit using the appropriate service procedure.

2  Remove the nine clips that hold the front cover on the climate control unit and remove the cover.
3

Disconnect the blower motor wiring connector and remove the blower assembly.

4
Remove two hex head screws that hold the expansion valve then remove the valve. Cap the tubes and expansion valve ports.

5

Remove the two screws from the evaporator tubes Y-clamp. Remove the Y-clamp. Remove the foam seal from around the evaporator tubes.

6
Disconnect the wires from the cold control switch. Remove the ATC temperature sensor from the evaporator (if equipped).

7
Remove the evaporator from the housing. Use care not to damage the evaporator tubes or fins.

8
Disconnect the control rod from the heater control valve. Disconnect the wires from the ATC valve (if equipped).

9
Remove the torx screw from the H-clamp that holds the heater tubes to the housing.
Remove the heater core and tubes from the housing.

If necessary, remove the four bolts that hold the tubes to the heater core and remove the tubes.

Installation

1. If tubes are disconnected from the core, install new O-rings on the tubes and connect them to the heater core using four mounting bolts.

2. Install the heater core and tubes into the housing.

3. Inspect the evaporator for bent fins. If required use a fin comb to straighten the fins.

4. Install the evaporator in the housing. Install the foam seal around the evaporator tubes.

5. Install the Y-clamp using two screws.
6 Remove the caps from the evaporator tubes and expansion valve ports for the evaporator tubes. Lubricate new O-rings with refrigerant oil and install them on the evaporator tubes.

7 Install the expansion valve on the evaporator tubes using two Allen screws.

8 Connect the wires to the cold control switch. Insert the ATC temperature sensor in the evaporator (if equipped).

9 Install control rod through the housing and connect the temperature rod to the control linkage.

10 Install the blower tray and install the blower unit. Connect the blower electrical connector. Connect the ATC valve connector (if equipped).

**Note:** The blower tray and unit both slide into place.

11 Install the climate control unit front cover and secure it with the nine clips.

12 Install the climate control unit in the vehicle using the appropriate service procedure.

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### 8743-03-02-07

**A/C Compressor, Replacement**

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

![DANGER]

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

#### Removal

1 Recover the refrigerant from the A/C system using the appropriate service procedure.

2 Disconnect the compressor clutch wires. Cut the tie strap and lay the wires out of the way.

3 Remove the compressor hose support bracket.

4 Disconnect compressor suction and discharge hoses and cap the ends.

**Note:** Early model compressors are connected to the refrigeration hoses with swivel nuts. Later models use pad mount connections.

5 Release compressor belt tension by loosening compressor tensioning mechanism or alternator mounting bolt(s) as appropriate for the type of compressor mounting.

6 Slip the drive belt off the compressor pulley.

7 Lift the compressor off the engine.

8 If required for further maintenance, remove the compressor mounting brackets.
Installation

1. If removed, install the compressor mounting brackets.

2. Check the compressor oil level and fill if necessary. When complete, torque the fill plug to 20 ± 5 Nm (15 ± 4 ft-lb).
   
   **Note:** SP20 PAG must be used in the Sanden compressor.

3. Install the compressor on its mounting brackets. Tighten bolts hand only tight.
   
   **Note:** Do NOT torque the bolts at this time.

4. Slip the drive belt over the compressor pulley.

5. Tighten the drive belt adjustment mechanism to achieve 55 ± 2 kg (121 ± 5 lb.) on a belt tension gauge, then tighten the compressor pivot bolt and adjustment lock bolt.

   **CAUTION**
   
   Possible component damage. Do NOT pry on the compressor housing or pulley when tensioning the drive belt. Prying on the compressor housing or pulley could damage the compressor.

   If the compressor mounting does not have adjustment hardware, then pull up on the compressor (or alternator) bracket with a pry bar until the drive belt is tight, then tighten the adjustment bolt and pivot bolt.

6. Remove the cap from the end of the suction hose. Lubricate a new O-ring with refrigerant oil and place it on the hose connection. Install and tighten the hose connector hand tight.

7. Remove the cap from the end of the discharge hose. Lubricate a new O-ring with refrigerant oil and place it on the hose connection. Install and tighten the hose connector hand tight.

8. Torque the suction swivel nut connector to 40 ± 4 Nm (30 ± 3 ft-lb), the discharge hose swivel nut connector to 30 ± 4 Nm (22 ± 3 ft-lb), or pad mount connectors to 23 ± 2 Nm (17 ± 1.5 ft-lb).
   
   **Note:** Refer to the Specifications section for information on torquing refrigerant fittings.

9. Install the hose support bracket.

10. Connect the compressor clutch wires. Secure them with a tie strap.

11. Recharge the A/C system using the appropriate service procedure. J-39500A
8743-03-02-12
A/C Compressor Clutch/Coil, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

⚠️ DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Note: Compressors with Splined Shaft Armatures are not serviceable at this time. Splined Shaft Armatures may be identified by the absence of threads in the armature plate spanner holes.

⚠️ WARNING

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

Removal

1
Recover the refrigerant in accordance with the refrigerant recovery procedure.

2
Remove the compressor in accordance with the removal section of the compressor replacement procedure.

3
Place the compressor in a vise. Clamp the compressor at the mounting ears. Do NOT clamp the sides of the compressor body.

4
Hold the clutch plate in place with the clutch holder. Remove the clutch hex nut.

5
Set clutch puller on the clutch plate. Screw the three bolts into the clutch plate finger tight.

6
Turn the puller center bolt clockwise until the clutch plate is loose, then remove the clutch plate.

Note: If necessary, hold the clutch plate from turning using clutch holder.
7 Remove the shims from the compressor shaft.

8 Remove the dust cap.

9 Tap the shaft key loose with a drift, then remove the key.

10 Remove the pulley snap ring.

11 Attach the pulley remover jaws.
12
Insert the pulley removing pilot between the jaws.

13
Attach the puller to the jaws.

14
Rotate the puller bolt until the pulley rotor is loose.

Note: Only perform Steps 15 through 17 if the coil is to be removed.

15
Remove the coil snap ring.

16
Loosen the screw on the clip that holds the coil wires.

17
Remove the coil ring.
Installation

Note: Only perform Steps 1 through 3 if the coil is removed.

1. Place the field coil on the compressor body. Ensure the alignment tab fits into its slot on the compressor flange.

2. Install the coil snap ring.

3. Install the coil wires through the clip and tighten the clip screw.

4. Install the pulley squarely on the housing hub. Press it on by hand.
Place the pulley installer ring in the cavity on the pulley. Place the installer driver on the ring and tap the driver until the pulley bottoms out on the housing hub.

Install the pulley snap ring.

Install the shims on the compressor shaft.

Insert the shaft key into the groove in the shaft.

Install the bearing dust cap.
10 Place the clutch plate on the shaft. Ensure the keyway lines up with the shaft key.

11 Using the clutch plate driver, tap the clutch plate until it bottoms out on the shims.

12 Install the shaft hex nut.

13 Hold the clutch plate from turning with the holder 9999171. Torque the shaft hex nut to 34–41 Nm (25–30 ft-lb).

14 Measure the gap between the rotor pulley and the clutch plate with a feeler gauge. The gap should be 0.41–0.79 mm (0.016–0.031 in.).

15 If the air gap is not within tolerance, remove the clutch and add or remove shims as necessary to correct the gap.

16 If the gap is not consistent around the clutch plate, gently pry the clutch plate up where the gap is smallest and lightly tap it down where it is largest.

17 Recheck the gap and repeat the previous step until the gap is consistent and within tolerance all the way around the clutch plate.
18
Remove the compressor from the vise.

19
Check the compressor oil level in accordance with the appropriate procedure and fill if necessary.

20
Install and reconnect the compressor in accordance with the installation section of the compressor replacement procedure.

21
Recharge the refrigerant system in accordance with the appropriate procedure.

8743-03-05-01
A/C Compressor Shaft Seal, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

**Note:** Compressors with Splined Shaft Armatures are not serviceable at this time. Splined Shaft Armatures may be identified by the absence of threads in the armature plate spanner holes.

**Removal**

1
Recover the refrigerant in accordance with the refrigerant recovery procedure. Remove the compressor in accordance with the removal section of the compressor replacement procedure.
Place the compressor in a vise. Clamp the compressor at the mounting ears. Do NOT clamp the sides of the compressor body.

Hold the clutch plate in place with the clutch holder. Remove the clutch hex nut.

Set clutch puller on the clutch plate. Screw the three bolts into the clutch plate finger tight. Turn the puller center bolt clockwise until the clutch plate is loose, then remove the clutch plate.

**Note:** If necessary, hold the clutch plate from turning using the clutch holder.

Remove the shims from the compressor shaft.

Remove the dust cap.

Tap the shaft key loose with a drift, then remove the key.
Using snap ring pliers, remove the felt ring.

Remove the shaft seal snap ring.

Press the shaft seal removal tool into the shaft seal and turn until the tabs are under the metal lip.

Lift out the seal assembly.

Installation

1. Ensure the shaft seal cavity is clean and contains no foreign material.

2. Coat a new shaft seal assembly with refrigerant oil.
3
Install the shaft seal on the seal removal tool and press it firmly into the seal cavity by hand.

4
Remove the seal removal tool by twisting until the tool tabs are lined up with the slots in the seal assembly, then pull out the tool.

5
Install the shaft seal snap ring with the flat side down.

6
Install the felt ring in the shaft seal cavity.

7
Tap the felt ring into the cavity.

8
Install the shims on the compressor shaft.
Insert the shaft key into the groove in the shaft.

10
Install the bearing dust cap.

Place the clutch plate on the shaft. Ensure the keyway lines up with the shaft key.

11

Using the clutch plate driver, tap the clutch plate until it bottoms out on the shims.

12

Install the shaft hex nut.

13

Using the clutch plate driver, tap the clutch plate until it bottoms out on the shims.

14

Hold the clutch plate from turning with the clutch holder. Torque the shaft hex nut to 34–41 Nm (25–30 ft-lb).
Measure the gap between the rotor pulley and the clutch plate with a feeler gauge. The gap should be 0.41–0.79 mm (0.016–0.031 in.).

If the air gap is not within tolerance, remove the clutch and add or remove shims as necessary to correct the gap.

If the gap is not consistent around the clutch plate, gently pry the clutch plate up where the gap is smallest and lightly tap it down where it is largest.

Recheck the gap and repeat the previous step until the gap is consistent and within tolerance all the way around the clutch plate.

Remove the compressor from the vise.

Check the compressor oil level in accordance with the appropriate procedure and fill if necessary.

Install and reconnect the compressor in accordance with the installation section of the compressor replacement procedure.

Recharge the refrigerant system in accordance with the appropriate procedure.

---

**8743-03-02-03 A/C Compressor Head, Replacement**

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**WARNING**

Always wear appropriate eye protection to prevent the risk of eye injury due to contact with debris or fluids.

**Note:** The following procedure applies to compressors with swivel nut type hose ports only.

**Removal**

1. Recover/Recycle the R134a from the A/C system, following the equipment manufacturer’s operating procedures.

2. Disconnect the high and low pressure hoses from the compressor and cap the open fitting to avoid contamination.

3. Remove the compressor from the mounting bracket.
4
Remove the oil plug and drain as much oil as possible into a suitable container.

5
Drain the oil from the suction and discharge ports into the container while turning the shaft clockwise only.

6
Measure and record the amount of oil drained from the compressor. Inspect the oil for signs of contamination such as discoloration of foreign material.

7
Make sure all internal pressure has been relieved.

8
Remove the cylinder head bolts.

9
Use a small hammer and gasket scraper to separate the cylinder head from the valve plate. Be careful not to scratch the gasket surface of the valve plate.

10
Carefully lift the cylinder head off the valve plate.

11
Carefully remove the old head gasket from the top of the valve plate with a gasket scraper.

--- CAUTION ---
Be careful not to disturb the valve plate to cylinder block joint. If the valve plate comes loose from the cylinder block the cylinder block gasket will have to be replaced.
Installation

1. Remove any residual oil from the cylinder head bolt holes.

   **CAUTION**
   If this step is not performed, hydraulic pressure can be created when the bolts are tightened. This pressure can break the cylinder block.

2. Install the head gasket over the locating pins, checking for the correct orientation (gasket embossment should face the cylinder head).

3. Install the new cylinder head.

4. Install the cylinder head bolts and tighten in a star pattern. Torque them first to 19.6 Nm (14 ft-lb) then finish by torquing them to 34 ± 2 Nm (25 ± 1.5 ft-lb).

5. Add the correct amount of new Type 20 Pag oil to the compressor. Check the compressor oil level, see “A/C Compressor Oil Level, Checking” page 84.

6. Reinstall the oil plug. The seal and O-ring must be clean and not damaged. Torque the plug to 20 ± 5 Nm (15 ± 3 ft-lb).
7 reinstall the compressor and hoses.

8 evacuate and recharge the system following the equipment manufacturer’s operating procedures.

9 start the vehicle and check that the system is operating properly.

---

8746-03-02-01 A/C Condenser, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1 Recover refrigerant from air conditioning system using the appropriate service procedure.

2 Remove the grille mounting screws and remove the grille from the hood.
Group 87 Climate Control Service Procedures

3

Remove the suction and discharge hoses from the condenser. Cap the hoses and the condenser fittings.

Note: Be sure to use a backup wrench when removing the hoses.

Note: Early model condensers are connected to the refrigeration hoses with swivel nuts. Later models use pad mount connections.

4

Remove the condenser mounting bolts. Remove the condenser.

Installation

1

Remove the caps from the condenser fittings. If the condenser is new add 1 ounce of SP20 PAG oil to the condenser, otherwise verify there is sufficient oil in the condenser. Reinstall the caps.

2

Mount the condenser on the vehicle using the four mounting bolts. Torque the condenser mounting bolts to 28 ± 4 Nm (250 ± 35 in-lb).

3

Lubricate new O-rings with refrigerant oil. Remove the caps and install new O-rings on the condenser hoses.

4

Install the suction and discharge hoses. Torque the fittings to the values given in the Specifications section.

Note: Be sure to use a backup wrench when torquing hose fittings.

Note: Early model condensers are connected to the refrigeration hoses with swivel nuts. Later models use pad mount connections.
Reinstall the grille in the hood.

Recharge the refrigerant system in accordance with the appropriate procedure.

8747-03-02-01
Receiver/Dryer, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1. Recover the refrigerant from the A/C system using the appropriate service procedure.

2. Disconnect refrigerant hoses from the receiver/dryer. Cap the hoses and the receiver/dryer fittings.
Loosen the band clamp on the receiver/dryer and slide it up the receiver/dryer.

4 Remove the receiver/dryer from the bracket.

Installation

1 Ensure the band clamp is on the receiver/dryer. Slide it up to the top of the receiver/dryer cylinder.

2 While holding the band clamp at the top of the cylinder, place the receiver/dryer in the bracket.

3 Slide the band clamp down into the slot on the bracket and tighten the clamp.

4 Lubricate new O-rings with refrigerant oil. Remove the caps from the receiver/dryer hoses and install the O-rings on the hoses.

5 Connect the refrigerant hoses to the receiver/dryer.

6 Torque the hose connections to the appropriate values in the Specifications section.

7 Perform the compressor oil level check procedure.

8 Recharge the refrigerant system using the appropriate service procedure.
8745-03-02-01
Cab Expansion Valve, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Recover the refrigerant using the appropriate service procedure.

2. Loosen the band clamp on the turbocharger intake hose at the turbocharger.

3. Remove the four engine air filter housing mounting bolts.

4. Remove the engine air filter housing and turbocharger intake pipe.

5. Remove the Allen head screw from the expansion valve H-clamp.

Remove the two Allen head screws from the expansion valve.

Remove the expansion valve.

Remove and discard the O-rings from the evaporator tubes. Cap the tubes.

Installation

1. Remove the caps from the four refrigerant tubes.

2. Lubricate new O-rings for the four tubes with refrigerant oil and install them on the tubes.

3. Install the expansion valve on the evaporator tubes. Tighten the two Allen screws on the expansion valve.

4. Insert the refrigerant tubes in the expansion valve.

5. Install the H-clamp on the refrigerant tubes and tighten the Allen screw.

6. Perform the compressor oil level check procedure.
7  Recharge the refrigerant system using the appropriate procedure.  

8  Install the engine air filter housing using four bolts. Place the end of the turbocharger air intake hose on the turbocharger intake.

9  Tighten the band clamp on the turbocharger intake hose.

---

8745-03-02-02
Cab Evaporator, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

![DANGER]

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1  Remove the climate control unit using the appropriate service procedure.

2  Remove the nine clips that hold the front cover on the climate control unit and remove the cover.

3  Disconnect the blower motor wiring connector and remove the blower assembly. Disconnect the ATC valve connector (if equipped).

4  Remove two hex head screws that hold the expansion valve then remove the valve. Cap the tubes and expansion valve ports.
Remove the two screws from the evaporator tubes Y-clamp. Remove the Y-clamp. Remove the foam seal from around the evaporator tubes.

6
Disconnect the wires from the cold control switch. Remove the ATC temperature sensor from the evaporator (if equipped).

7
Remove the evaporator from the housing. Use care not to damage the evaporator tubes or fins.

Installation

1
Add the proper oil to the replacement evaporator before installing, see “System Oil” page 8.

2
Install the evaporator in the housing. Install the foam seal around the evaporator tubes.

3
Install the Y-clamp using two screws.

4
Remove the caps from the evaporator tubes and the expansion valve ports for the evaporator tubes. Lubricate new O-rings with refrigerant oil and install them on the evaporator tubes.

5
Install the expansion valve on the evaporator tubes using two Allen screws.

6
Connect the wires to the cold control switch. Insert the ATC temperature sensor in the evaporator (if equipped).

7
Install the blower tray and install the blower unit. Connect the blower electrical connector. Connect the ATC valve connector (if equipped).

Note: The blower tray and unit both slide into place.
8712-03-02-03
Cold Control Switch, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Remove the blower assembly using the appropriate service procedure.

2. Cut the cable tie from the switch wires then disconnect the wires.

3. Pull the sensing tube out of the evaporator.

4. Loosen the nut that holds the cold control switch in place and slide the switch out.

**Installation**

1. Mount the cold control switch on its bracket.
2 Connect the wires to the switch. Install a plastic cable tie to hold the wires in place.

3 Carefully insert the sensing tube into the evaporator fins.

4 Install the blower assembly using the appropriate service procedure.

**8712-03-02-04**

A/C Diagnostic Module, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1 Ensure the vehicle ignition is OFF.

2 Disconnect the module 10 pin Metri-Pack connector.

3 Cut the plastic cable tie from the module wiring.

4 Remove the module mounting bolts. Remove the module.
Installation

1 Install the module on the bulkhead using the two mounting bolts.

2 Route the module wires behind the brake system foot valve and connect the connector.

3 Install a plastic cable tie to hold the wires in place.

4 Reset the module blink codes by turning the vehicle ignition ON for one second and OFF for one second four times.

5 Start the vehicle and verify the A/C system operates properly.

8712-03-02-05
A/C Diagnostic System Pressure Switch, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1 Ensure the vehicle ignition is OFF.

2 Disconnect the pressure switch electrical connector.

3 Cut the plastic cable tie from the wiring.

4 Loosen and remove the switch from its Schrader valve connection.
Installation

1
Lubricate a new O-ring with refrigerant oil and install it on the Schrader valve.

2
Install a new switch on the Schrader valve. Torque the switch to 18 ± 1 Nm (159 ± 9 in-lb).

3
Connect the electrical connector.

4
Install a plastic cable tie to hold the wires in place.

5
Turn the ignition switch to on and verify there are no faults sensed by the diagnostic module. Reset any blink codes.

6
Start the vehicle and verify the A/C system operates normally.

8748-03-02-03
A/C System Hose, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1
Recover the refrigerant from the system using the appropriate service procedure.

2
Using a backup wrench for counter torque, loosen and remove the fittings from one end of the hose. Cap the open connection.

3
Remove any clamp holding the hose in place and any cable ties holding wires to the refrigerant hose.

4
Using a backup wrench for counter torque, loosen and remove the fittings from the connected end of the hose. Cap the open connection.

Installation

1
Lubricate new O-rings with refrigerant oil. Place one O-ring on each end of the hose.

2
Remove the caps from the hose fittings on the vehicle.

3
Connect both ends of the hose to the fittings on the vehicle and tighten the connections hand tight.
4 Torque the fittings to the appropriate torque value listed in the Specifications section.

5 Perform the compressor oil level check procedure.

6 Recharge the refrigerant system using the appropriate service procedure. J-39500A

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### 8701-06-02-01

#### A/C Refrigerant Leak, Checking

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

<table>
<thead>
<tr>
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<tbody>
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<td>Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.</td>
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1 Ensure there is refrigerant in the system.

2 Refer to the manual for the leak detector to be used for proper operation of the leak detector. Ensure the leak detector will sense the presence of R134a.

3 Using the leak detector, check the following locations for leaks.
   - Compressor threaded connections
   - Compressor crimp connections
   - Compressor shaft seal
   - Condenser tube connections
   - Receiver/dryer connections
   - Cab expansion valve
   - Cab evaporator connections
   - Bunk unit expansion valve (if installed)
   - Bunk unit evaporator connections (if installed)
   - Pressure switch connections
   - Schrader valve connections
   - All refrigerant tubing bends and weld joints

4 Repair or replace any leaking component, hose, or tube using the appropriate service procedure.

5 Recheck for leaks after performing any repair or replacement.
8749-03-02-01  
Schrader Valve Core, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

⚠️ DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

If it has been determined that a Schrader valve core is leaking, use tool J-44302 to check that the valve is fully seated. If the valve continues to leak it may be replaced following the procedure below. An Air Conditioner Service Kit (P/N 3093536) includes the various Schrader valves used in the A/C system.

1. Recover the refrigerant using the appropriate service procedure.

   J-39500A

2. Remove the defective valve with removal tool J-44302.

   J-44302

3. Check the valve body for cleanliness. Lubricate the replacement valve with refrigeration oil. Install the replacement valve with tool J-44302. Tighten until it is fully seated.

   J-44302

4. Evacuate and recharge the system using the appropriate service procedure.

   J-39500A

5. Start the vehicle. Check for leaks and proper system operation.

8712-03-02-06  
Climate Control Panel, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

⚠️ DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1. Remove the torx screws from the lower right dash panel. Remove the screws from the center dash panel.

   W8001167

2. Pull the floor mat back and remove the plastic nuts. Remove the lower right and center dash panels.
3 Remove the ash tray.

4 Remove the torx screws from the ash tray bracket. Remove the bracket.

5 Remove the switch support panel by pulling the panel up and sliding it out.

6 Remove the light switch panel by prying it loose with a small screwdriver. Allow it to rest on the lower dash.

7 Disconnect the cables from the control panel levers by removing the plastic lock tabs. Use care not to bend the cables.

8 Disconnect the wire connectors from the control panel.

9 Install the control panel into the dash. Install and tighten two torx screws.

10 Install the light switch panel by pushing into place until it snaps in.

11 Install the ash tray support bracket using two torx screws.

12 Install the ash tray.

13 Install the panel under the center dash using four torx screws.

14 Install the lower right dash panel using seven torx screws.

15 Pull the floor mat back and install plastic nuts on the lower right panel and the panel under the center dash.
8741-03-02-03
Bunk Climate Control Unit, Replacement

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1
Recover the refrigerant from the A/C system. See Service Manual “Climate Control”, group 87.

2
Remove the air intake grill. Use a Torx 20 socket to remove the 4 screws that holds the grill in place.

3
Disconnect the wiring harness connectors.

4
Remove the outlet Rubber Duct. No tools needed.
Remove the 4 bolts that holds the Climate Control Unit in place. Use a wrench with a 12 mm socket to remove the 2 front bolts. Remove the upper christmas tree fastners on upholstery to gain access to the bolts. Use a wrench with 13 mm socket and remove the 2 floor mounting bolts.

The Heater should now be loose. Remove it from its mounting location and out from the vehicle. The easiest way should be by grabbing it from outside the vehicle through the right side storage compartment.

Installation

1. Note the position of the piping on the bottom of the Climate Control Unit. Lift the unit and place it into the right side of the compartment and make sure the piping goes through the hole cut out in the floor board. Make sure the wiring harness isn’t blocked and that the bolt holes line up on the sides.

2. Use a wrench with 12 mm socket and install the 2 bolts in the front side. **Note:** At this point don’t tighten the bolts all the way down. This could make it hard to install the 2 bolts in the floor board.

3. Use a wrench with 13 mm socket and install the 2 bolts in the floor board. Torque all 4 bolts to $24 \pm 4 \text{ Nm}$ ($18 \pm 3 \text{ ft-lb}$).
4. Install the upholstery and pop the christmas tree fasteners back in place.

5. Install the outlet Rubber Duct. Start with the end to the piping that goes up to the top of the can.

6. Connect all wiring harness connectors.

7. Install the Air Intake Grill. Torque the 4 screws to 5 ± 0.8 Nm (43 ± 7 in-lb).

8. Install the A/C lines (1) with new O-rings. Torque the fittings to:
   - 3/4 Fitting 35 ± 4 Nm (26 ± 3 ft-lb)
   - 1 1/6 Fittings 50 ± 4 Nm (37 ± 3 ft-lb)

   Install the coolant lines (2) and put the hose clamps back on and tighten those.
8721-03-02-01
Bunk Fresh Air Filter, Replacement
(Behr)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**Note:** The bunk unit air filter should be inspected at regular maintenance intervals, approximately every 70,000 miles. The filter should be changed after 100,000 miles.

The filter can be cleaned with compressed air, at no more than 20 psi.

1. Raise the bunk and lock it in upright position.

2. Pull filter straight up to remove.

3. Replace with a new filter, P/N 3949891. Be sure the arrows on top of the filter are pointing toward the climate unit.

4. Lower the bunk.

8739-03-03-02
Bunk Blower Motor Resistor, Replacement
(Behr)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**Danger:**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Make sure the vehicle ignition is OFF before beginning this procedure.

2. Raise the bunk and lock it in an upright position.

3. Disconnect the two harness connectors from the resistor pack.
Remove the two mounting screws and lift out the resistor pack.

Installation

1. Place the new resistor, coil side down, into slot on top of the climate unit. Replace the two mounting screws to secure. Torque screws to 2 ± 0.35 Nm (20 ± 3 in-lb).

2. Reconnect the harness connectors to the resistor pack.

3. Lower the bunk.
8733-03-02-02
Bunk Blower Motor, Replacement
(Bergstrom)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Disconnect the wiring connector from the motor.

2. Remove the Phillips screws from the bunk unit cover. Lift the cover up and out of the track.

3. Remove blower motor mounting screws.

4. Remove fan retaining nut.

5. Rotate the blower assembly so that the flat edge of the mounting plate is to the left to gain clearance around the heater tubes, then remove the blower.
Installation

1
Install the fan on the motor shaft. Install and tighten the retaining nut hand tight.

2
Install the blower in the bunk unit housing with three Phillips screws. Tighten the screws.

3
Install the bunk unit cover.

4
Connect the blower motor wire connector.

Pull the fan off the shaft.
8733-03-02-02
Bunk Blower Motor, Replacement

(Behr)
Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER
Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1
Raise the bunk and lock it in an upright position.

2
Remove access cover by prying off top locator pegs.

3
Disconnect fan motor harness connector.

4
Remove the three retaining screws on the motor bracket.

5
Extract motor and wheel assembly through access opening. The fan motor assembly must be rotated slightly to clear the expansion valve and water valve tubing.

Note: The fan motor and cage assembly is a single component, and should not be disassembled.
**Installation**

1. Place fan motor assembly into access opening, rotating slightly to clear the expansion valve and water valve tubing.

2. Line up the fan motor onto the bracket. Secure with the three screws. Torque the retaining screws to \(2 \pm 0.35 \text{ Nm} \) (\(20 \pm 3 \text{ in-lb}\)).

3. Connect the fan motor harness connector.

4. Replace access cover and lower bunk.

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**8735-03-02-02**

**Bunk Heater Control Valve, Replacement**

*Bergstrom*

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

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**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

---

**Removal**

1. Release pressure from the engine coolant system.

---

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

---

2. Close the engine hot water valves.

3. Remove the bunk unit cover panel.

4. Disconnect the cable from the heater control valve by removing the clip from the valve.

5. Remove the four torx screws from the manual heater control valve.

6. Remove the valve.
Installation

1

Install new O-rings on the heater tubes.

2

Install the valve on the tubes using the four torx screws. Tighten the screws.

3

Open the engine coolant hot water valves.

4

Top off the radiator.

5

Perform pressure test of the coolant system to test for leaks.

6

Tighten or repair any leaks found.

7

Install the bunk unit cover

8739-03-02-01
Bunk Water Valve, Replacement
(Behr)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.
Removal

1

1) Tube Retaining Bracket
2) Brass Tube Fitting
3) Flange Fitting
4) Flange Fitting
5) Water Valve

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and serious burns.

Release pressure from the engine coolant system.

2

From under truck, close off water inlet line with crimp jaw pliers. Disconnect water line.

3

Raise bunk and lock in an upright position.

4

Remove access cover by prying top off locator pegs.

5

Disconnect valve harness connector.

6

Remove tube retaining bracket.
Group 87 Climate Control

Service Procedures

7 Disconnect fitting on brass tubing near top left of access hole. Extract valve and tubing as one piece.

8 Disconnect tubing from the valve by removing both flange connectors and their O-rings.

Installation

1 Attach the tubing to the water valve with the two flange connectors. Be sure to use a new O-ring for each connector.

2 Place water valve and tube assembly into the bunk climate unit, fitting the lower inlet tubing into the bunk floor. Line up the brass tubing and connect the upper tube fitting. Torque tighten upper fitting 11 to 14 Nm (8 to 10 ft-lb).

3 Connect valve harness connector. Attach tube retaining bracket.

4 Replace access cover. Lower bunk cover.

5 Connect water inlet line and remove crimp jaw pliers.

6 To check coolant level, first start engine and allow it to reach normal operating temperature. Add coolant as needed.
8712-03-02-02
Bunk ATC Control Valve, Replacement
(Bergstrom)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Release pressure from the engine coolant system.

**WARNING**

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

2. Close the engine hot water valves.

3. Remove the bunk unit cover panel.

4. Disconnect the wire from the ATC valve.

5. Remove the torx screws which hold the valve to the heater tubes. Remove the valve.

6. Remove and discard the old O-rings from the heater tubes.

**Installation**

1. Install new O-rings on the heater tubes.

5

6
2

Install the ATC valve on the heater tubes.

3

Install and tighten the torx screws in the ATC valve.

4

Connect the wire connector to the ATC valve.

5

Open the engine hot water valves.

6

Top off the radiator.

8

Tighten or repair any leaking connections.

9

Install the bunk unit cover panel.

8741-03-02-02
Bunk Control Module, Replacement

(Behr)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1

Make sure vehicle ignition is OFF before beginning this procedure.

2

Raise the bunk and lock it in upright position.

3

Disconnect the harness connector from the control module.

Perform pressure test of the coolant system to check for leaks.
Remove the two mounting screws and lift out the control module.

Installation

1 Install the new controller, inserting the sensor into the climate unit. Replace the mounting screws to secure. Torque the screws to 2 \( \pm 0.35 \) Nm \( (20 \pm 3 \) in-lb). 

2 Reconnect the harness connector to the controller.

3 Lower the bunk.

8731-03-02-03
Bunk Heater Core, Replacement
(Bergstrom)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1 Release pressure from the engine coolant system.

WARNING

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

2 Close the engine hot water valves.

3 Remove the right rear fuel tank fairing.

4 Place a container to catch engine coolant under the cab below the bunk unit.

5 Loosen or remove the clamps on the bunk unit heater hoses.

6 Disconnect the heater hoses from the bunk unit under the cab to allow the coolant to drain.

7 Remove the bunk unit cover.
8
Loosen the four torx screws that hold the heater control valve to the heater core outlet tube.

9
Remove four bunk unit mounting bolts (two from the bunk unit bulkhead and two from the cab floor).

10
Remove the outlet air duct elbow by removing three torx screws.

11
Raise the back end of the bunk unit slightly to provide clearance to remove the tube separator from under the bunk unit housing.

12
Lift the heater core out of the bunk unit. Be careful not to damage the tubes or fins.

---

**Installation**

1
Insert the heater core into the bunk unit housing. Guide the long tube through the hole in the base of the unit. Be careful not to damage any of the tubes or fins.

2
Install new a O-ring on the heater core tube. Connect the tube to the heater control valve and install the valve screws.

3
Raise the bunk unit slightly and install the tube separator.

4
Install and tighten the four bunk unit mounting bolts.

5
Install the air outlet duct elbow using three torx screws.

6
Connect the heater core outlet tube to the heater control valve using four torx screws.

7
Install the heater hoses and tighten the clamps.

8
Open the engine hot water valves.
9 Top off the radiator.

10 Perform pressure test of the coolant system to check for leaks.

11 Tighten or repair any leaking connections.

12 Install the bunk unit cover using four Phillips screws.

13 Install the fuel tank fairing.

8745-03-02-03
Bunk Evaporator, Replacement (Bergstrom)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1 Recover the refrigerant from the A/C system using the appropriate service procedure.

2 Remove the bunk unit cover.

3 Loosen and unscrew the fittings on the top of the expansion valve.

**Note:** Use a backup wrench when loosening refrigeration fittings.
Lift the evaporator out of the bunk unit housing. Cap the evaporator tubes and plug the expansion valve ports.

**Installation**

1. Add the proper oil to the replacement evaporator before installing, see “System Oil” page 8.

2. Remove the caps from the evaporator tubes and the plugs from the expansion valve.

3. Lubricate new O-rings with refrigerant oil and install them on the evaporator tubes.

4. Insert the evaporator into the bunk unit housing.

5. Connect the evaporator tubes to the expansion valve. Torque the 1/2 in. tube fittings to 13.5–17.7 Nm (18–24 ft-lb)

6. Recharge the A/C system.

7. Install the bunk unit cover.

---

**8745-03-02-06 Bunk Evaporator/Heater Core Assembly, Replacement (Behr)**

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

---

**WARNING**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Removal**

1. Raise the bunk cover and lock it in an upright position.

2. (770 Bunk Storage Cover Removal)

   **Note:** For removal of the Evaporator/Heater Core on the 770, the bunk storage cover must be removed as follows:

   First remove the 3 torx bolts on the bottom of the side storage compartment. Then remove the 3 Philips screws with snap covers. Remove the side storage compartment.

3. (770 Bunk Storage Cover Removal)

   Remove the 6 torx screws to the duct cover under the storage compartment. Remove the duct cover.

4. (770 Bunk Storage Cover Removal)

   Remove the 3 torx bolts to the bunk cover’s wooden base. Remove the wooden base.
5

**DANGER**

Personal injury hazard. R134a refrigerant is a non-poisonous hydrofluoric acid that can cause burns if it comes in contact with the eyes or skin. Always work in a well ventilated area when working with R134a refrigerant. In a highly concentrated gas form, R134a refrigerant can cause unconsciousness, and at lower concentrations can affect the nervous system. Do not breathe the vapors. R134a refrigerant can also irritate the nose and throat. Failure to follow these precautions could result in serious personal injury.

Recover the refrigerant from the A/C system using the appropriate service procedure. Be sure to note the amount of oil removed.

6

**WARNING**

Personal injury hazards. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and serious burns.

Release pressure from the engine coolant system. Drain the engine cooling system.

7

To protect the filter during this procedure, remove the filter from the climate box.

8

Disconnect all harness connectors to the bunk climate unit: the control module, water valve, resistor card, and the fan blower motor.

9

Remove the bunk unit access cover by prying off the locator pegs.
10 Remove the rubber duct from the climate unit.

11 Remove the 2 front top cover support bolts. To access the bolts, it is necessary to remove the plastic clip holding the carpet trim to the bunk support wall.

12 Remove the 10 top cover mounting screws. Remove the bunk unit top cover.

13 Using a backup wrench to prevent bending the tubes, loosen the 4 fittings on the expansion valve.

14 Remove the bottom tube retaining bracket.

15 Raise the evaporator tubing slightly and remove the valve.

16 Disconnect the fitting to the water valve.

17 From under the truck, disconnect the water hose to the evaporator/heater core tube.

18 Remove the evaporator/heater core from the vehicle.

Installation

1 Add the proper refrigerant oil to the evaporator before installing. See “System Oil” page 8.

2 Install the evaporator/heater core into the vehicle.

3 Connect and secure the water hose to the evaporator/heater core tube.

4 Connect the fitting to the water valve and torque to 12.5 ± 1.5 Nm (9 ± 1 ft-lb).

5 Lubricate 4 new O-rings with refrigerant oil and install them on the expansion valve refrigerant tubes.
6 Install the bottom tube retaining bracket.

7 Install the new expansion valve on the bottom tubes coming up from the cab floor. Then install the tubing. Use a backup wrench to hand-tighten the tube fittings. Tighten the fittings hand tight.

**Note:** Be careful not to damage the O-rings when re-connecting the tubing.

8 Torque tighten the fittings on the expansion valve to:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Torque (Nm)</th>
<th>Torque (ft-lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8 in.</td>
<td>31.63 ± 3.4 Nm</td>
<td>23 ± 2.5 ft-lb</td>
</tr>
<tr>
<td>3/4 in.</td>
<td>23.73 ± 3.4 Nm</td>
<td>17.5 ± 2.5 ft-lb</td>
</tr>
<tr>
<td>5/8 in.</td>
<td>13.6 ± 3.4 Nm</td>
<td>10 ± 2.5 ft-lb</td>
</tr>
</tbody>
</table>

9 Install the top cover of the climate unit, using the 10 mounting screws to secure. Torque tighten the mounting screws to 2 ± 0.35 Nm (20 ± 3 in-lb).

10 Install the top 2 front support bolts, pulling back the support wall carpeting to access.

11 Install the side access cover.

12 Install the rubber duct. Connect all wiring to the bunk unit: the control module, water valve, resistor card, and the fan blower motor.

13 Install the bunk filter and lower the bunk cover.

14 (**770 Bunk Storage Cover Installation**) Replace the wooden base to the bunk storage cover. Secure with the 3 torx bolts. Torque to 2 ± 0.35 Nm (20 ± 3 in-lb).

15 (**770 Bunk Storage Cover Installation**) Install the duct cover with 6 torx screws. Torque to 2 ± 0.35 Nm (20 ± 3 in-lb).

16 (**770 Bunk Storage Cover Installation**) Install the side storage compartment, using 3 torx bolts in the bottom and 3 Phillips screws along the windows. Torque all screws to 2 ± 0.35 Nm (20 ± 3 in-lb).

17 Install engine coolant.

18 **WARNING**

Possible personal injury and property damage. Do not pressure or leak test R134a refrigerant vehicle air conditioning systems or servicing equipment using compressed air. Some mixtures of air and R134a refrigerant have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Consult the Material Safety Data Sheets (MSDS) for additional information.
CAUTION

Potential equipment damage. Do NOT inject red dye into the air conditioning system to test for leaks. Injecting red dye into the system could result in damage to the compressor.

Recharge the refrigerant system. Leak test all bunk unit connections.

WARNING

Personal injury hazard. Do NOT remove hot water hoses, valves, clamps, or heat exchangers when the engine cooling system is hot and under pressure. Removing these components while the system is hot and under pressure could cause scalding and burns.

After engine has reached operating temperature, shut off engine and release pressure from the engine coolant system. Recheck for proper coolant level. Add coolant as necessary.

8745-03-02-04
Bunk Expansion Valve, Replacement

(Bergstrom)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

DANGER

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

Removal

1
Recover the refrigerant from the A/C system using the appropriate service procedure.

2
Remove the bunk unit cover panel.

3

Using a backup wrench to prevent bending the tubes, loosen the four fittings on the expansion valve.
4

Raise the evaporator slightly and remove the valve.

5

Remove and discard the O-rings from the four refrigerant tubes. Cap all four tubes.

安装

1

润滑四个新的O形圈并加制冷剂油。移除制冷剂软管的端盖，并将O形圈放置在软管上。

2

安装膨胀阀在从驾驶室地板上延伸过来的软管上。拧紧接头。手紧1/2英寸的接头。

3

将蒸发器软管插入膨胀阀。拧紧接头。手紧5/8英寸的接头。

4

拧紧膨胀阀上的接头。1/2英寸的接头打扭力13.5–17.7 Nm (18–24 ft-lb)。5/8英寸的接头打扭力20–24 Nm (27–33 ft-lb)。

注意：在拧紧制冷剂接头时，请使用备份扳手。

5

重新充制冷剂。密闭所有码头单元的连接。

6

安装码头单元盖子。
8745-03-02-04
Bunk Expansion Valve, Replacement

(Behr)

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

**Note:** To access the bunk climate unit expansion valve, the top cover to the bunk unit must be removed. On the VN770, however, the bunk cover panel must also be removed. See additional 770 note.

**Removal**

1

**DANGER**

Personal injury hazard. R134a refrigerant is a non-poisonous hydrofluoric acid that can cause burns if it comes in contact with the eyes or skin. Always work in a well ventilated area when working with R134a refrigerant. In a highly concentrated gas form, R134a refrigerant can cause unconsciousness, and at lower concentrations can affect the nervous system. Do not breathe the vapors. R134a refrigerant can also irritate the nose and throat. Failure to follow these precautions could result in serious personal injury.

Recover the refrigerant from the A/C system using the appropriate service procedure. Be sure to note the amount of oil removed.

2

Raise the bunk cover and lock in an upright position.

3

To protect the filter during this procedure, remove the filter from the climate box.

4

Disconnect all harness connectors to the bunk climate unit: the control module, water valve, resistor card, and the fan blower motor.

**VN 770 Bunk Storage Cover Removal**

5

**Note:** For removal of the expansion valve on the 770, the bunk storage cover must be removed. See steps 5–7.

To remove the cover, first remove the three torx bolts on the bottom of the side storage compartment. Then remove the three Phillips screws with snap covers. Remove the side storage compartment.

6

Remove the six torx screws to the duct cover under the storage compartment. Remove the duct cover.

7

Remove the three torx bolts to the bunk cover’s wooden base. Remove the wooden base.
8
Remove the bunk unit access cover by prying off the locator pegs.

9
Remove the rubber duct from the climate unit.

10
Remove the two front top cover support bolts. To access the bolts, it is necessary to remove the plastic clip holding the carpet trim to the bunk support wall.

11
Remove the ten top cover mounting screws. Remove the bunk unit top cover.

12
Using a backup wrench to prevent bending the tubes, loosen the four fittings on the expansion valve.

13
Remove the bottom tube retaining bracket.

14
Raise the evaporator tubing slightly and remove the valve.

15
Remove and discard the O-rings from the four refrigerant tubes. Cap all four tubes.
Installation

1
Lubricate four new O-rings with refrigerant oil. Remove the caps from the refrigerant tubes and place the O-rings on the tubes.

2
Install the bottom tube retaining bracket.

3
Install the new expansion valve on the bottom tubes coming up from the cab floor. Then install the top tubing. Use a backup wrench to hand-tighten the tube fittings. Tighten the fittings hand tight.

Note: Be careful not to damage the O-rings when re-connecting the tubing.

4
Torque tighten the fittings on the expansion valve.
- Tighten the 7/8 inch fittings to 31.63 ± 3.4 Nm (23 ± 2.5 ft-lb).
- Tighten the 3/4 inch fittings to 23.73 ± 3.4 Nm (17.5 ± 2.5 ft-lb).
- Tighten the 5/8 inch fittings to 13.6 ± 3.4 Nm (10 ± 2.5 ft-lb).

7
Replace the side access cover.

8
Replace the rubber duct. Connect all wiring to the bunk unit: the control module, water valve, resistor card, and the fan blower motor.

9
Replace the bunk filter and lower the bunk cover.

770 Bunk Storage Cover Installation

10
Replace the wooden base to the bunk storage cover. Secure with the three torx bolts. Torque tighten to 2 ± 0.35 Nm (20 ± 3 in-lb).

11
Replace duct cover with six torx screws. Torque tighten to 2 ± 0.35 Nm (20 ± 3 in-lb).

12
Replace side storage compartment, using three torx bolts on bottom and three Phillips screws along window. Torque tighten all screws to 2 ± 0.35 Nm (20 ± 3 in-lb).

13
Lower the bunk cover.

6
Install the top two front support bolts, pulling back the support wall carpeting to access.

5
Install the top cover of the climate unit, using the ten mounting screws to secure. Torque tighten the mounting screws to 2 ± 0.35 Nm (20 ± 3 in-lb).
**WARNING**

Possible personal injury and property damage. Do not pressure or leak test R134a refrigerant vehicle air conditioning systems or servicing equipment using compressed air. Some mixtures of air and R134a refrigerant have been shown to be combustible at elevated pressures. These mixtures, if ignited, may cause injury or property damage. Consult the Material Safety Data Sheets (MSDS) for additional information.

**CAUTION**

Potential equipment damage. Do NOT inject red dye into the air conditioning system to test for leaks. Injecting red dye into the system could result in damage to the compressor.

Potential equipment damage. Do NOT mix mineral oil (such as is used in R12 refrigerant systems) with PAG oil in an R134a refrigerant system. Mixing of these oils in an R134a refrigerant system could result in equipment damage.

Recharge the refrigerant system. Leak test all bunk unit connections.

---

**Shaft Smoothness Test**

Before working on the vehicle please read the “General Work Practices” page 79 and 80.

**DANGER**

Before working on a vehicle, set the parking brakes, place the transmission in neutral and chock the wheels. Failure to do so can result in unexpected vehicle movement and can cause serious personal injury or death.

1. Recover the refrigerant in accordance with the appropriate service procedure. J-39500A

2. Disconnect the refrigerant hoses from the compressor. Cap the ends of the hoses.

3. Ensure the compressor clutch is dis-engaged.

4. Using a socket and ratchet on the compressor shaft hex nut, slowly rotate the compressor shaft clockwise, feeling for severe rough spots or “catches”.

5. If rough spots or catches are felt, replace the compressor.
One of our objectives is that workshop personnel should have access to correct and appropriate service manuals where it concerns fault tracing, repairs and maintenance of Volvo trucks. In order to maintain the high standards of our literature, your opinions and experience when using this manual would be greatly appreciated. If you have any comments or suggestions, make a copy of this page, write down your comments and send them to us, either via telefax or mailing directly to the address listed below.

To
Volvo Trucks North America, Inc.
Dept. 516 Service Publications
7825 National Service Road
P.O. Box 26115
Greensboro, NC 27402-6115
USA
Fax (336) 393-3170

Comments/proposals


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