# SERVICE MANUAL SECTION

# HEAT VENTILATION AIR CONDITIONING (HVAC) SYSTEM

**Model: 3200**
**Model: 4100**
**Model: 4200**
**Model: 4300**
**Model: 4400**
**Model: 7300**
**Model: 7400**
**Model: 7500**
**Model: 7600**
**Model: 7700**
**Model: 8500**
**Model: 8600**

**S16025**

**11/23/2005**

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# 1. SAFETY PRECAUTIONS

Refrigerant R-134a is a nonflammable, nonexplosive, and noncorrosive hydrofluorocarbon refrigerant. R-134a is heavier than air and has a slight ether-type odor. Although R-134a is classified as a safe refrigerant, the following precautions must be observed to protect the A/C system components and the person working on the system.

**WARNING – Carbon monoxide is a colorless, odorless, and dangerous gas that is present in vehicle exhaust. When it is necessary to operate the engine during vehicle service in a confined area, always use the proper equipment to vent the exhaust gasses outside of the work area.**

**WARNING – Safety goggles or other adequate eye protection must be worn when working with refrigerant. The temperature of liquid refrigerant is -20 degrees F (-29 degrees C). Serious injury or blindness will result from refrigerant contacting the eyes.**

**WARNING – If the refrigerant should contact the eyes, DO NOT rub them. Splash the eyes with cold water for at least 15 minutes to gradually get the temperature above the freezing point. See a doctor immediately.**

**WARNING – Wear nonporous gloves. Should liquid refrigerant come into contact with the skin, remove any contaminated clothing, including shoes; then treat the injury as though the skin had been frostbitten or frozen. See a doctor immediately.**

**WARNING – Be certain that pressurized refrigerant containers are not exposed to open flame or temperatures above 125 degrees F (51 degrees C). Do not discard empty refrigerant containers where they are likely to be subjected to the heat of trash burners, etc.; they may explode, resulting in personal injury or possible death. Containers must be stored, installed, and disposed of in accordance with all state and local ordinances.**

**WARNING – Never weld, solder, steam clean or use excessive heat on any of the air conditioning lines or equipment while the system is charged. Heat applied to any part will cause the pressure within the system to become excessive, which may result in an explosion and possible personal injury.**

**WARNING – Do not smoke or allow any type of fire or flame in the immediate area while servicing the air conditioning system. Refrigerant is not combustible; however, in the presence of heat it changes to a poisonous gas. Inhalation can cause death or serious injury.**

**WARNING – R-134a must not be mixed with air and then pressurized. When mixed with large quantities of air and pressurized, R-134a becomes combustible.**

**WARNING – Refrigerant must be recovered from the air conditioning system before any components of the system are removed or replaced. Removing components while pressure is in the system will cause personal injury or death.**

**WARNING – Do not remove the compressor oil fill plug to check the oil level in the refrigerant compressor while the A/C system is charged with refrigerant. The crankcase side of the compressor is under pressure and personal injury may result. It is not possible to check the oil level in the compressor on an A/C system that is under system pressure.**

**WARNING – Do not install or remove A/C testing or charging equipment while the engine is running. Serious injury may result from doing so.**

**WARNING – Always use approved refrigerant recycling equipment when working with R-134a to prevent accidental discharge. If released into the atmosphere, the refrigerant evaporates very quickly and may displace the oxygen surrounding the work area, especially in small or enclosed areas. This situation creates the hazard of suffocation or brain damage for anyone in the work area. If a leak should occur, avoid breathing the refrigerant and lubricant vapor. Thoroughly ventilate the area before continuing with service. Federal and state laws require that refrigerant be recovered and recycled to help protect the environment.**

**WARNING – While the manifold gauge set is connected to both the air conditioning system and refrigerant supply cylinder, never open the high side hand valve of the manifold gauge set while the A/C system is operating. If hot, high pressure refrigerant is forced through the gauge to the refrigerant supply cylinder; it could cause the cylinder to rupture and cause personal injury.**

**WARNING – When purging the system or components, do not use nitrogen at pressures over 200 psi. Personal injury or death may result from doing so.**

**WARNING – Always use correct replacement refrigerant hoses. Do not use hoses other than those specified for the system being serviced. The use of improper hoses may cause a hose rupture, which may result in personal injury.**

**CAUTION – Use only new or recycled R-134a refrigerant; not any of the so called "direct replacement" refrigerants. Use of a recovery machine dedicated for R-134a is necessary to reduce the possibility of oil and refrigerant incompatibility concerns.**

**CAUTION – Use only the specified PAG lubricant in the refrigerant system (International P/N 2644034R1 or Sanden SP-20). PAG oils absorb atmospheric moisture very quickly. Never leave PAG oil exposed to air for a prolonged time. Wear nonporous gloves while handling PAG oil, and tightly reseal the oil container immediately after each use.**

**CAUTION – Use only MINERAL BASED refrigerant oil (International P/N 2643016R1, or Sanden 5GS) to lubricate O-rings and fittings**

**CAUTION – Disconnect battery ground cable during service to prevent possible damage to the vehicle electrical system. If the battery must remain connected for a specific test, use extreme caution when taking measurements.**

**CAUTION – When purging the system, or components of the system, use only dry nitrogen. The introduction of compressed air into the A/C system may cause contamination of the system.**

**CAUTION – After replacing a compressor verify that the pulley alignment and belt tension are correct.**

**CAUTION – When charging the A/C system the refrigerant tank must be kept upright. If the tank is not in the upright position, liquid refrigerant may enter the system and cause compressor damage.**

**CAUTION – When pressure cleaning the A/C components under the hood, do not direct the high pressure stream directly at the actuator for the fresh air/recirculate air door.**

## 2. GENERAL DESCRIPTION

The Blend-Air air conditioning and heating system is a system of components designed to provide conditioned air to the occupants of the vehicle. The term "Blend-Air" refers to the mixing or blending together of air from the cooling and heating systems to produce a desired air temperature for the vehicle occupants. The two main modules (the heater module and evaporator module) are mounted on opposite sides of the dash panel on the passenger side of the vehicle (Figure 1).

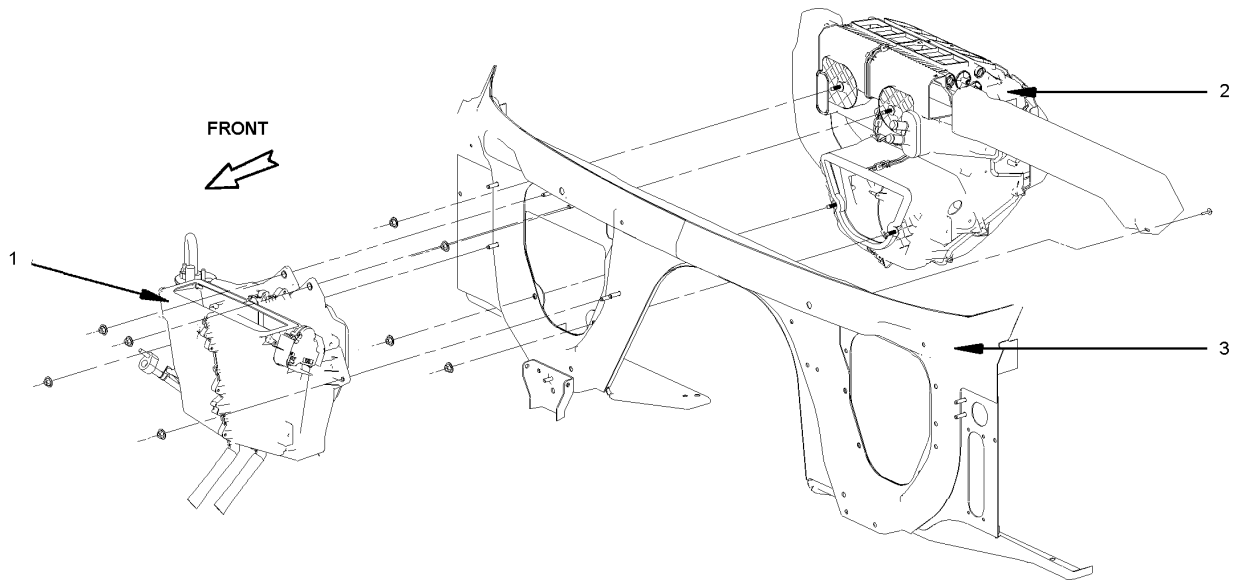


**Figure 1 Heater Housing and Evaporator Housing Locations**

1. EVAPORATOR MODULE
2. HEATER MODULE
3. DASH PANEL ASSEMBLY

The evaporator core, accumulator, orifice tube, thermistors, fresh/recirculate air door, air door actuator, and air filter are located on, or near, the dash mounted evaporator housing on the engine side of the dash panel.

The condenser, compressor, and a/c lines are located under the hood (Figure 2).

**NOTE – A heater-only version of the system is also available. The heater components and operation are identical to those described for the air conditioning and heating system. The heater-only version also uses the evaporator housing, without the refrigerant circuit components, as a means of directing air to the heater module.**

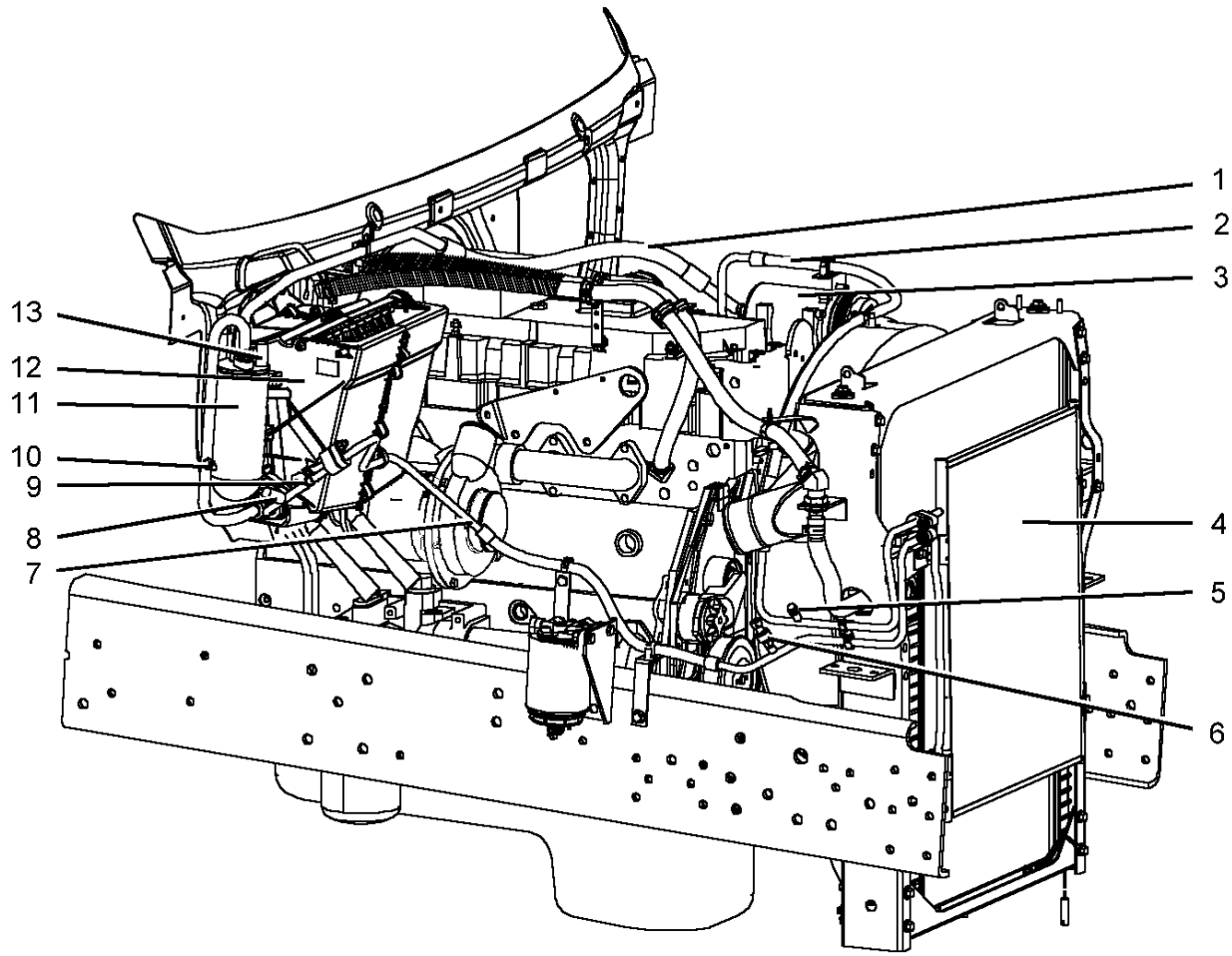


**Figure 2 Under the Hood HVAC Components (Typical Configuration Shown with Cowl Tray Removed)**

1. SUCTION LINE
2. DISCHARGE LINE
3. COMPRESSOR
4. CONDENSER
5. HIGH SIDE SERVICE PORT
6. PRESSURE TRANSDUCER
7. CONDENSER TO EVAPORATOR LINE
8. THERMISTOR (EVAPORATOR INLET)
9. A/C ORIFICE LINE
10. LOW SIDE SERVICE PORT
11. ACCUMULATOR
12. EVAPORATOR HOUSING
13. THERMISTOR (EVAPORATOR OUTPUT)

The HVAC control panel is located in the center section of the instrument panel (Figure 3). The heater core, blower motor, blower motor speed control module, blower air scroll housing, passenger floor duct, and air door actuators are located in (or on) the in-cab heater module and may be serviced without removing the heater module housing.


**Figure 3 In-Cab HVAC Components**

1. HVAC CONTROL PANEL
2. CENTER IP TRIM PANEL (BEZEL)
3. FUSE/RELAY COVER
4. HEATER REAR TRIM COVER

## 2.1. SYSTEM OPERATIONAL DESCRIPTION

### Air Distribution (General)

The following figure (Figure 4) is a cross-sectional view of the air-handling components of the HVAC system, as they are mounted in the vehicle. The figure shows the system's four air doors and indicates their range of travel.

The electrically actuated fresh/recirculate air door (13) is located in the evaporator housing (11), and is controlled by the mode control (right knob) on the HVAC control panel. When the door is in the recirculate position, outside air is blocked by the door. Recirculation air, from the cab, enters the upper rear of the evaporator housing through the upper portion of the dash panel cutout (12). With the fresh/recirculate air door in the fresh air position, fresh outside air enters the top of the evaporator housing via an air duct which is part of the cowl drain tray (14). (The recirculate air is blocked by the fresh/recirculate air door.) In both cases the air is pulled by the blower assembly (8) through the near-vertically mounted plate/fin evaporator core (10) to exit the evaporator housing through the lower portion of the dash panel cutout. An air filter (optional on some models) can be mounted vertically in front of the evaporator core. The air entering the heater housing from the evaporator housing enters the dual inlet, single scroll blower assembly and is pushed through the heater housing.

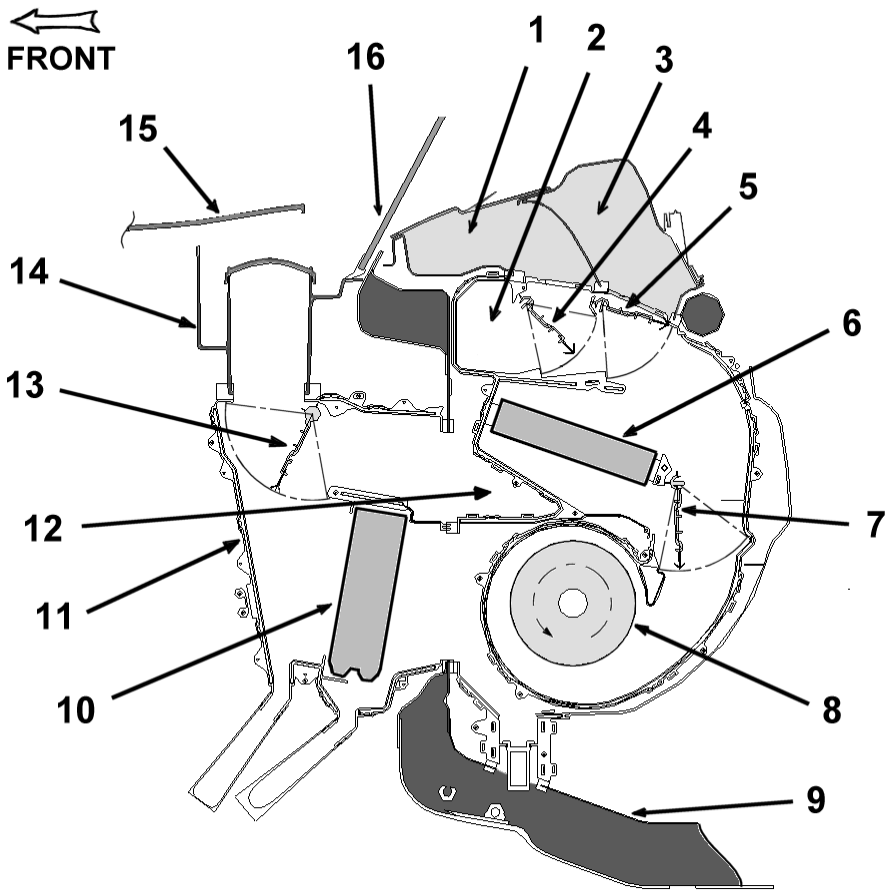


**Figure 4 Cross-Section of HVAC Air Handling Components**

1. DEFROST DUCT
2. FLOOR DUCT OUTLET FROM HEATER MODULE
3. VENT DUCT FOR INSTRUMENT PANEL (IP)
4. DEFROST/FLOOR DOOR (MODE DOOR)
5. IP VENTS/FLOOR DOOR (MODE DOOR)
6. HEATER CORE
7. TEMPERATURE BLEND DOOR
8. BLOWER ASSEMBLY
9. FLOOR (CAB INTERIOR)
10. A/C EVAPORATOR
11. A/C EVAPORATOR HOUSING
12. RECIRCULATE AIR INLET (OPEN TO CAB INTERIOR)
13. FRESH/RECIRCULATION AIR DOOR
14. COWL TRAY/HVAC AIR INLET
15. HOOD
16. WINDSHIELD

The temperature blend door (7) is controlled by the temperature control (center knob) on the HVAC control panel. The electrically actuated temperature blend door diverts air from the blower assembly (8), either through the heater core (6), or around it depending on the temperature selected for the outlet air. Engine coolant flows through the heater core at all times. The air proceeds to the mode doors.

The two mode doors, defrost/floor (4) and IP vent/floor (5), are controlled by the mode control (right knob) on the HVAC control panel. The doors are located at the top of the heater housing and are controlled together via kinematics and another electrical actuator. These mode doors direct air to the air outlets (floor ducts, instrument panel vents, and/or defrost vents) based on the mode selected by the operator. The ductwork for the instrument panel vents (3) and the defrost vents (1) is integrated into the instrument panel structure. The upper surfaces of the heater housing interface with ductwork through two large openings in the bottom of the Instrument Panel (I/P). Left-hand drive (LHD) vehicles have a passenger floor duct attached to the right side of the heater housing and a driver side floor duct (2) attached to the left side of the housing.

The speed of the system blower motor, which controls the volume of air moved through the system, is selected by the fan speed control (left knob) on the HVAC control panel.

### Air Distribution (Air Conditioning)

Figure 5A illustrates the system airflow when operating in the MAX A/C mode. In the MAX A/C mode the fresh/recirculate air door is in the recirculate position; outside air is blocked by the door. Recirculation air (REC), from the cab, enters the upper rear of the evaporator housing through the upper portion of the dash panel cutout. (This air inlet is located behind the heater housing.) The air is pulled by the blower assembly, through the evaporator core. The air entering the heater housing from the evaporator housing enters the dual inlet, single scroll blower assembly and is pushed through the heater housing. The temperature blend air door diverts air either through the heater core or past it depending on the temperature selected for the outlet air. Although the temperature control is operational while in the A/C modes, the temperature control is generally set to divert all air around the heater core. The air proceeds to the mode doors where all of the air is directed to the instrument panel vents.

Figure 5B illustrates the system airflow when operating in the NORM A/C mode. In the NORM A/C mode the fresh/recirculate air door is in the fresh air position. Fresh outside air enters the top of the evaporator housing via an air duct which is part of the cowl drain tray. The remainder of NORM A/C operation is identical to MAX A/C operation.

Figure 5C illustrates the system airflow when operating in the Bi-Level A/C mode. The Bi-Level A/C mode operation is identical to NORM A/C operation; except, the mode doors direct the output air to both the floor ducts, and the instrument panel vents.

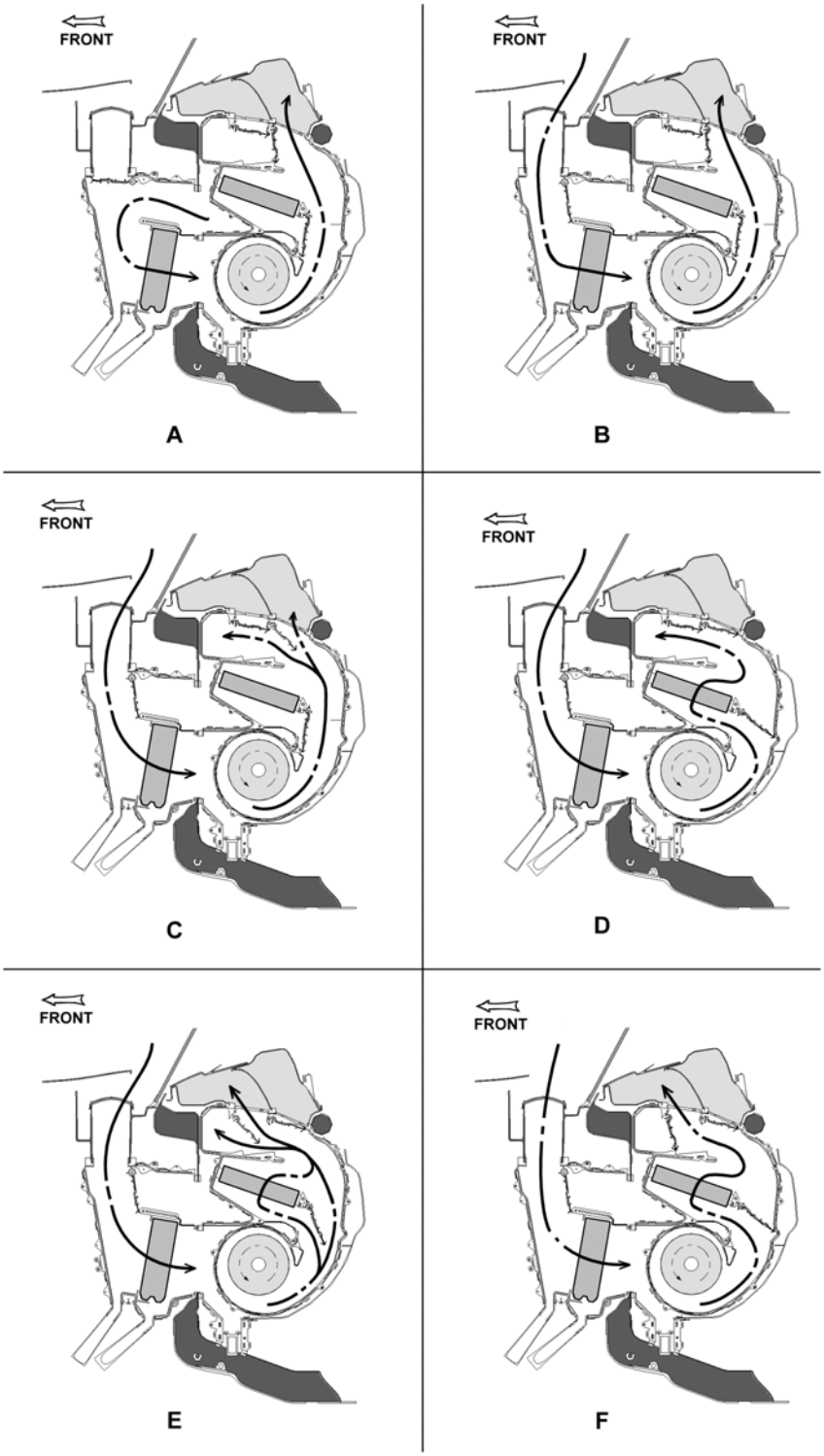


**Figure 5 System Airflow by Mode**

### Air Distribution (Heat and Ventilation)

Figure 5B illustrates the system airflow when operating in the Heat and Ventilation Vent mode. In the Heat and Ventilation Vent mode the fresh/recirculate air door is in the fresh air position. Fresh outside air enters the top of the evaporator housing via an air duct which is part of the cowl drain tray. The air is pulled by the blower assembly, through the evaporator core. The air entering the heater housing from the evaporator housing enters the dual inlet, single scroll blower assembly and is pushed through the heater housing. The temperature blend air door diverts air either through the heater core or past it depending on the temperature selected for the outlet air. The temperature blended air proceeds to the mode doors where all of the air is directed to the instrument panel vents.

Figure 5D illustrates the system airflow when operating in the Heat and Ventilation Floor mode. The Heat and Ventilation Floor mode is identical to the Heat and Ventilation Vent mode; except, the mode doors direct all of the output air to the floor ducts.

### Air Distribution (Defrost)

Figure 5E illustrates the system airflow when operating in the Bi-Level Defrost/Heat mode. In the Bi-Level Defrost/Heat mode the fresh/recirculate air door is in the fresh air position. Fresh outside air enters the top of the evaporator housing via an air duct which is part of the cowl drain tray. The air is pulled by the blower assembly, through the evaporator core. The air entering the heater housing from the evaporator housing enters the dual inlet, single scroll blower assembly and is pushed through the heater housing. The temperature blend air door diverts air either through the heater core or past it depending on the temperature selected for the outlet air. The air proceeds to the mode doors where the doors direct the output air to both the defrost ducts, and the floor ducts.

Figure 5F illustrates the system airflow when operating in the Defrost mode. The Defrost mode is identical to the Bi-Level Defrost/Heat mode; except, the mode doors direct all of the output air to the defrost ducts.

### A/C Refrigerant Flow

The refrigerant cycle (Figure 6) consists of four phases: compression, condensation, expansion, and evaporation. Consider the starting point at the compressor.

When any air conditioning position is selected on the HVAC control panel, the clutch assembly mounted to the front of the compressor becomes engaged. When engaged, the clutch armature assembly is magnetically drawn to the pulley assembly on the compressor shaft, thereby engaging the clutch and driving the compressor.

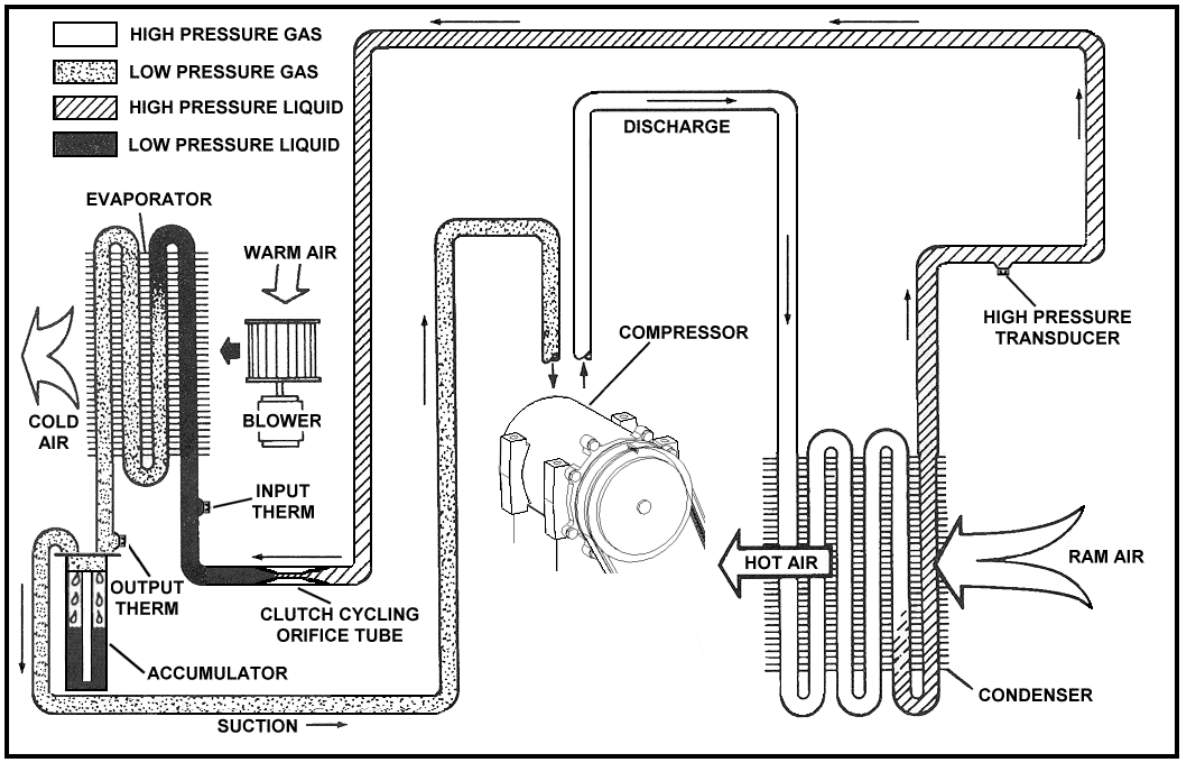


**Figure 6 A/C Refrigerant Flow Diagram**

The suction side of the compressor draws low pressure refrigerant vapor (5 to 50 psi) from the low side of the system, coming from the accumulator. The compressor then compresses the refrigerant vapor and discharges it at increased temperature and pressure (120 to 300 psi) through the high side line which connects the compressor to the condenser.

An internal lubricating system uses the suction side intake crankcase pressure differential to coat internal parts with a thin film of oil. This lubrication also travels along with the refrigerant throughout the air conditioning system to lubricate various system components.

High pressure/high temperature refrigerant vapor from the compressor enters at the top of the condenser, circulates down through the coils and exits at the bottom of the condenser as high pressure/high temperature refrigerant liquid. As the vapor condenses (changes state), some of its heat is released to the coils and fins of the condenser. This heat is continually carried away by the outside air which passes over the external fin surfaces as it flows through the condenser.

The efficiency of the condenser operation is affected by ram air flowing through the condenser. For this reason, it is important that the engine cooling fan be operating properly, and that the condenser cooling fins remain free of airborne contamination (leaves, insects, dirt, etc.) which can block the fins and cause system temperatures to run higher than normal.

When operating properly, the condenser acts as an efficient heat exchanger, containing refrigerant vapor in approximately two-thirds of the upper portion of its coils and condensed refrigerant liquid in the lower one-third portion. A pressure transducer located in the output line of the condenser is used to control system operation by providing inputs to the Refrigerant Control and Diagnostic (RCD) System. The condenser passes high temperature/high pressure liquid refrigerant to the evaporator input orifice tube.

While the high pressure/high temperature liquid refrigerant is present on the condenser side of the evaporator orifice, the suction side of the compressor is reducing the pressure in the evaporator and at the output side of the orifice. The pressure differential causes a measured amount of the high pressure liquid refrigerant to flow through the calibrated orifice and enter the low pressure evaporator as a low temperature liquid. The orifice is the dividing line between the high pressure side of the system and the low pressure side of the system.

Within the evaporator core, the lower pressure permits the liquid refrigerant to boil or evaporate, changing its state from a liquid to a low pressure/low temperature vapor; and absorbing heat from the evaporator core and the air surrounding it. Cooling and dehumidifying of the cab's interior takes place as the refrigerant vapor passes through the evaporator's finned tubes and absorbs heat from the cab air pulled through the evaporator core by the system blower. Humidity condenses on the external surfaces of the cooled evaporator fins and is channeled (drained) out of the evaporator housing through drain valves. The refrigerant exits the evaporator outlet as a low pressure/low temperature vapor and is drawn into the accumulator by the suction created by the compressor.

Thermistors are located at the input and output of the evaporator to monitor the temperature or the refrigerant at these points. The inputs from these sensors are used to control system operation by providing inputs to the Refrigerant Control and Diagnostic (RCD) System.

The accumulator performs three important functions:

- Absorbs and separates any moisture from the vaporized refrigerant using a drying agent (desiccant).
- Collects any refrigerant that is in liquid form to prevent it from reaching the compressor.
- Provides a means of revaporizing any refrigerant that has returned to the liquid state.

The low pressure vaporized refrigerant that leaves the accumulator is moisture-free and contaminant-free, and now contains the heat that was absorbed from the air passing through the evaporator core.

The compressor repressurizes the refrigerant causing it to again become a high pressure/high temperature vapor that is pumped to the condenser, where the cycle is repeated.

## 2.2. THE ELECTRICAL SYSTEM CONTROLLER AND THE RCD SYSTEM

The Refrigerant Control and Diagnostic (RCD) system is the software used by the Electronic System Controller (ESC) to control the A/C compressor. The purposes of the RCD system are:

- Verify that safe operating conditions exist before the compressor clutch is energized.
- Keep the A/C system operating within its optimum range by controlling the cycling of the refrigerant compressor.
- Detect faults or abnormal conditions within the A/C system.
- Protect the A/C compressor by deactivating the compressor when destructive conditions are detected.
- Generate diagnostic trouble codes that may be used to diagnose and isolate problems in the system.

For a more complete description of the RCD system, refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150).

## 2.3. COMPONENTS

Refer to Figure 2 for locations of the components described in the following paragraphs (See Figure 2, page 5).

## Compressor and Clutch

The system uses a Sanden Model SD7H15 compressor configured with a proprietary International rear-port head to accommodate the new “C-plate” block-style fittings. It is mounted on the engine and is belt-driven through an electromagnetic clutch which acts to engage (turn ON) or disengage (turn OFF) the compressor in response to the air conditioning system controls (HVAC control panel and RCD system). When engaged, the clutch armature assembly is magnetically drawn to the pulley assembly on the compressor shaft, thereby engaging the clutch and allowing the drive belt to drive the compressor. A pressure relief valve on the compressor offers protection to the compressor in extreme high pressure conditions.

These A/C system refrigerant and oil specifications are listed in Table 1. In addition, a label located on the compressor lists the recommended type of refrigerant and oil to be used in the system, as well as the system oil capacity.

**Table 1 A/C System Refrigerant and Oil Specifications**

| REFRIGERANT TYPE | REFRIGERANT CHARGE | REFRIGERANT OIL TYPE | REFRIGERANT OIL CAPACITY |
|---|---|---|---|
| R-134a | 30 oz. | PAG oil | 300 cc |

## Condenser

The air conditioning condenser is located at the front of the vehicle between the engine radiator and the grille. The condenser is a heat exchanger made of fin and tube construction, with “C-plate” block-style inlet and outlet fittings.

## Pressure Transducer

The pressure transducer (Figure 7) is a pressure-sensing device threaded into the refrigerant line between the condenser output and the orifice tube near the evaporator input. The transducer provides an electrical signal to the RCD system which monitors and controls the operation of the A/C system. The refrigerant system does not have to be discharged to replace the pressure transducer.

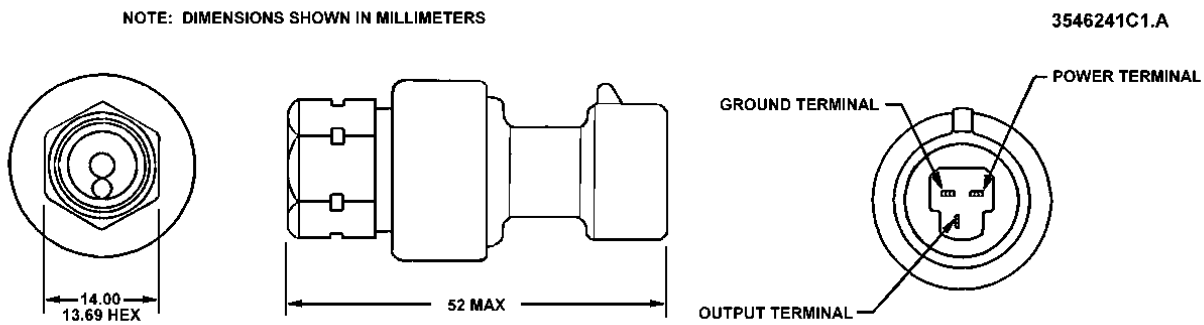


**Figure 7 Pressure Transducer**

## Orifice Tube (Evaporator Input Orifice)

The orifice tube (Figure 8) is located inside the inlet A/C line to the evaporator core. The orifice tube is directional. The end nearest to the O-ring must be inserted into the A/C line first. The orifice tube inserts snugly into the A/C line and contains a calibrated opening that allows a measured flow of the high pressure liquid

refrigerant into the evaporator during the cooling cycle. The orifice tube can be replaced without replacing the evaporator inlet line.

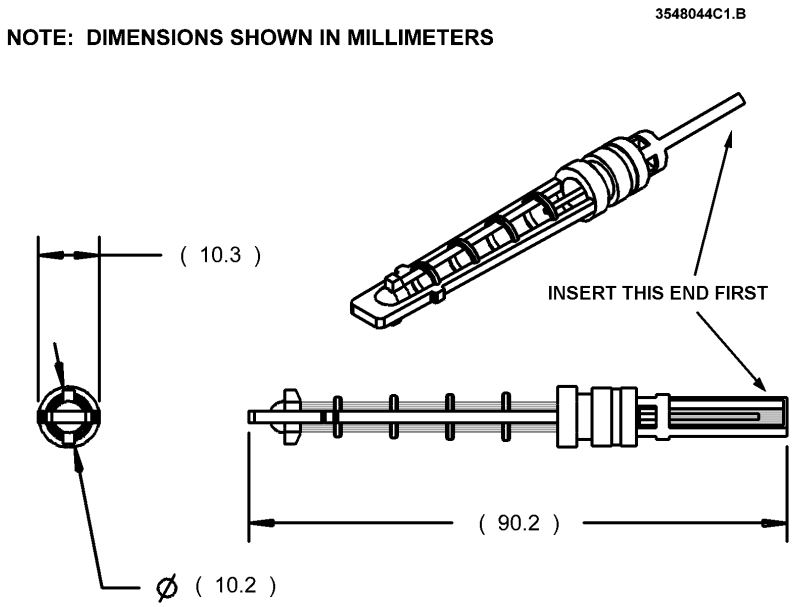


**Figure 8 Orifice Tube (Clutch Cycling Orifice Tube)**

## Evaporator

The evaporator core is located in the evaporator housing mounted on the engine side of the dash panel. The core is a cooling assembly made of plate and fin construction, with “C-plate” block-style inlet and outlet fittings. Drain valves for both condensate and rain water are incorporated into the bottom of the evaporator housing. Service access for the air filter is through the large outside air inlet in the cowl tray and the top surface of the evaporator housing.

## Accumulator

The accumulator is a canister mounted to the evaporator housing on the dash panel. A desiccant inside the accumulator is used to absorb moisture from the refrigerant. The desiccant also contains a dye to allow easier detection of refrigerant leaks. The evaporator output thermistor is mounted in the top of the accumulator where it can monitor the temperature of the refrigerant exiting the evaporator.

## Thermistors (Evaporator Inlet and Outlet)

A thermistor (Figure 9) is mounted in the evaporator input line immediately after the orifice tube. This thermistor senses the temperature of the refrigerant entering the evaporator. As mentioned in the previous paragraph, another thermistor is mounted to the top of the accumulator to sense the refrigerant temperature at the evaporator outlet. The resistance value of each thermistor is determined by the temperature of the refrigerant at its location. The resistance values of these thermistors are monitored by the RCD system which is used to control A/C system operation and detect system faults. The refrigerant system must be discharged before removing and replacing either thermistor.

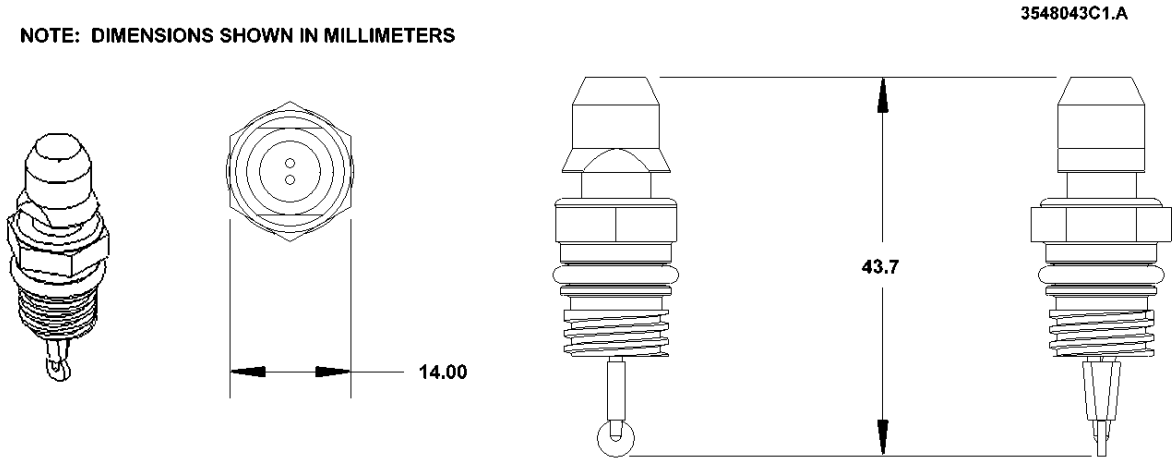


**Figure 9 Thermistor**

## HVAC Plumbing

New International “C-plate” style block fittings are utilized on all refrigerant line connections in the A/C system. This fitting incorporates a secondary moisture and dirt seal within a unique plate inserted into the block fitting. The primary O-ring seal has a larger cross section for improved sealing as well. Refrigerant hoses are constructed from steel tubing coupled to Goodyear Galaxy hose. This nylon barrier type of hose prevents the refrigerant from escaping through the walls of the hose into the atmosphere. When servicing air conditioning systems, use only replacement hoses approved for air conditioning systems.

## Cooling Fan Drive Solenoid Valve

On some models the cooling fan clutch is operated by compressed air. The air is controlled by a solenoid valve that is normally operated by the engine cooling system; however, when the HVAC pressure transducer detects a high discharge pressure, the ESC sends a signal to the engine controller to engage the cooling fan drive.

## Heater Core

The heater core is located in the heater housing mounted in the cab under the right side of the instrument panel. The heater core is a heating assembly made of fin and tube construction, with inlet and outlet fittings for connecting the heater hoses from the engine cooling system. The inlet and outlet fittings protrude through the cowl directly above the evaporator housing. Engine coolant flows through the heater core at all times. The temperature of the air output by the heating/air conditioning system is determined by diverting more or less of the input air through the heater core. The heater core is serviced from inside the cab.

## Blower Assembly

The blower assembly is located in the blower scroll housing (part of the heater unit), mounted in the cab under the right side of the instrument panel. The blower assembly used in the heater or heater-air conditioning system consists of a permanent magnet motor attached to a balanced ’squirrel-cage’ fan unit. The motor speed is controlled by the left knob on the HVAC control panel on the instrument panel. The blower provides air circulation through the heater core and evaporator, and delivery of the treated air throughout the cab interior.

## Linear Power Module

The Linear Power Module (LPM) (Figure 10) is mounted to the blower scroll housing (part of the heater unit), located in the cab under the right side of the instrument panel. The LPM is used to provide seven blower speed settings, and is controlled by the left knob (blower speed control) on the HVAC control panel. The LPM

establishes the blower speed by reading the HVAC control panel output signal (0 to 4.75 Vdc), based on the setting of the blower speed control knob. The LPM responds by acting as a variable resistance between the blower motor and ground. As the blower speed control is turned cw, the apparent resistance to ground decreases, the voltage across the blower motor increases, and the blower speed increases.

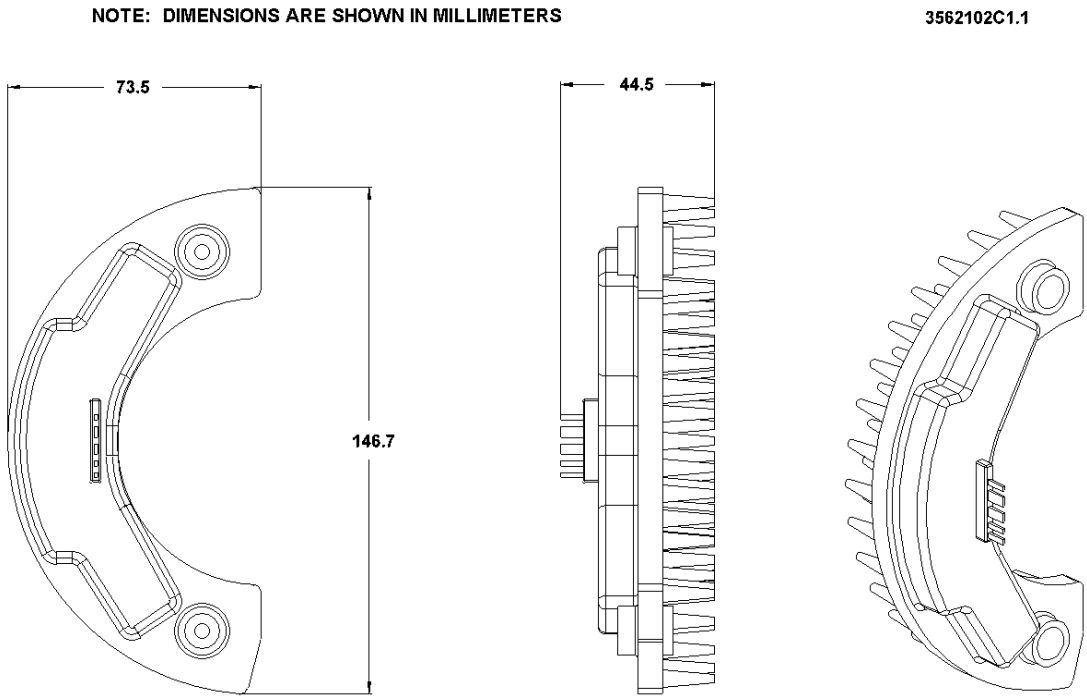


**Figure 10 Linear Power Module**

### HVAC Control Panel

The HVAC control panel is located at the top of the center console of the instrument panel. The control panel consists of three knobs actuating three long life potentiometers. Internally, the control panel contains circuitry that electronically controls the blower motor speed and the three air door actuator motors. The blower speed control is detented to provide seven distinct blower speeds, in addition to the OFF position. The temperature control has fifteen detents. The mode control is used to select the HVAC operating mode, indicated by seven mode icons and five dots (for 'in-between' modes). The 'heat only' system has five mode icons, and four dots for 'in-between' modes.

## 3. GENERAL OPERATION

The operation of the Blend-Air system is based on standard automotive air conditioning and heating principles. **NOTE — The following descriptions cover the 'heater/air conditioner' version of the system. Operation of the 'heater only' system is nearly identical, except all air conditioning information can be ignored.**

### 3.1. CONTROL ASSEMBLY

All major functions of the A/C-heater system are controlled from the control panel assembly (Figure 11). It consists of three rotary knobs which electronically control the blower fan speed, the A/C compressor clutch, and the actuators that move the air doors used to control system air distribution and temperature.

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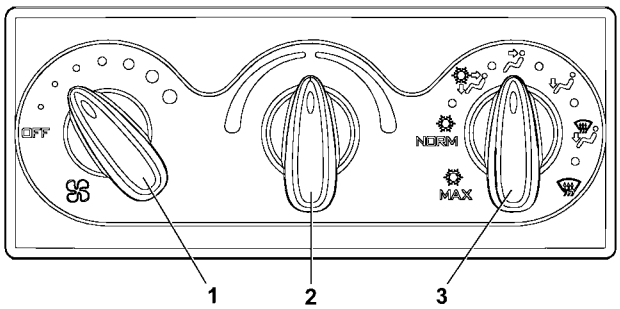
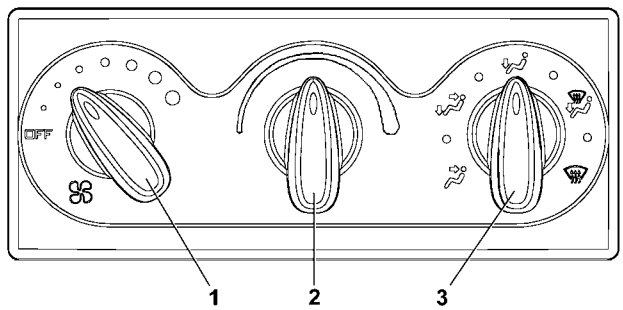
3545542C1.1.B




AIR CONDITIONER CONTROL




HEATER ONLY CONTROL

**Figure 11 HVAC Control Panel Assembly**

1. BLOWER FAN SPEED CONTROL
2. TEMPERATURE CONTROL
3. MODE CONTROL

## 3.2. BLOWER FAN SPEED CONTROL

Use this control to regulate the amount of air provided to the vents in any mode you select. Turn the knob clockwise to increase fan speed. Turning the control to the OFF position will shut off the fan, but does not prevent outside air from entering the vehicle. Turning off the fan speed control also prevents the A/C compressor from operating. On vehicles equipped with A/C, moving the mode knob to the MAX A/C position will close the fresh air door preventing outside air from entering the vehicle.

## 3.3. TEMPERATURE CONTROL

Use this control to regulate the temperature of the air discharged from the vents. The blue area of the control indicates cooler temperatures while the red area indicates warmer temperatures. This control operates the blend door that determines what portion of the system input air is deflected through the heater core. As the temperature control is rotated clockwise more air is deflected through the heater core, increasing the temperature of the system output air entering the cab.

## 3.4. MODE CONTROL

This control selects the operating mode of the system (HEAT, VENTILATE, DEFROST, and A/C) and controls which outlets in the cab are used to distribute the air. This is accomplished by electronically controlling the A/C compressor clutch, as well as, two air doors located in the in-cab heater housing. In addition to the modes indicated by icons, the mode control can select 'in between' modes indicated by dots. These positions allow fine tuning of the air distribution by providing a distribution mix that is between the mixes provided by the icons on either side of the selected dot (refer to Table 2).

The air conditioning settings are indicated by icons with snowflakes.

### MAX Air Conditioning Mode

In this mode all airflow is directed to the panel air outlets and the air is recirculated inside the vehicle. Use this mode to block out any outside odors, smoke, or dust and to cool the interior rapidly upon initial start up in very hot or humid weather. When this mode is selected, the HVAC control panel (control head) sends a signal to the ESC, requesting that the A/C compressor be turned on.

**NOTE – Continuous use of the Recirculate mode may make the inside air stuffy. Use of this mode for longer than fifteen minutes is not recommended.**

### NORM Air Conditioning Mode

In this mode all airflow is directed to the panel air outlets. Fresh (outside) air is used to cool the vehicle in this mode. When this mode is selected, the HVAC control panel (control head) sends a signal to the ESC, requesting that the A/C compressor be turned on.

### BI-Level Air Conditioning Mode

In this mode 75% of the airflow is directed to the panel air outlets, 25% of the airflow is directed to the floor air outlets, and fresh (outside) air is circulated inside the vehicle.

### Vent Mode

In this mode all airflow is directed to the panel air outlets and fresh (outside) air is circulated inside the vehicle.

### Floor Mode

In this mode all airflow is directed to the floor air outlets and fresh (outside) air is circulated inside the vehicle.

### Mix Mode

In this mode 50% of the airflow is directed to the defrost and side demist air outlets, 50% of the airflow is directed to the floor air outlets, and fresh (outside) air is circulated inside the vehicle. The A/C compressor turns on automatically when in this mode to reduce humidity levels and help reduce moisture build up on the windshield. To improve defroster efficiency, remove ice and/or snow from the windshield prior to starting the vehicle.

### Defrost

In this mode all of the airflow is directed to the defrost and side demist air outlets, and fresh (outside) air is circulated inside the vehicle. The A/C compressor turns on automatically when in this mode to reduce humidity levels and help reduce moisture build up on the windshield. To improve defroster efficiency, remove ice and/or snow from the windshield prior to starting the vehicle.

**Table 2 Air Distribution Chart**

| CONTROL KNOB POSITION | | AIRFLOW | | |
|---|---|---|---|---|
| Air Conditioner Systems | Heater Only Systems | Panel | Floor | Windshield |
| MAX A/C   | PANEL  | 100% | | |
| NORM A/C   | | 100% | | |
| DOT 1 | | 50% | 50% | |
| BI-LEVEL  | DOT 1 | 75% | 25% | |
| DOT 2 | BI-LEVEL  | 50% | 50% | |
| PANEL  | | 100% | | |

**Table 2 Air Distribution Chart (cont.)**

| CONTROL KNOB POSITION | | AIRFLOW | | |
|---|---|---|---|---|
| Air Conditioner Systems | Heater Only Systems | Panel | Floor | Windshield |
| DOT 3 | DOT 2 | 25% | 75% | |
| FLOOR  | FLOOR  | | 100% | |
| DOT 4 | DOT 3 | | 75% | 25% |
| MIX  | BLEND  | | 50% | 50% |
| DOT 5 | DOT 4 | | 25% | 75% |
| DEFROST  | DEFROST  | | | 100% |

## 3.5. DEHUMIDIFYING

In mild weather with high humidity conditions, the heater system can be operated simultaneously with the air conditioner to dehumidify moist air. Set the mode control to either the NORM or A/C bi-level position, place the fan speed control to any setting, and move the temperature control towards HOT (clockwise) until a comfortable temperature is maintained. The air conditioner will remove the humidity while the heater keeps the cab comfortable.

# 4. SYSTEM MAINTENANCE

## 4.1. PRE-SEASON SERVICING

Experience has shown that many unsatisfactory conditions incurred with heating and air conditioning systems result from lack of regular maintenance. Preventive maintenance and cleanliness of all components within the system are extremely important. A complete step-by-step pre-season checkout of the air conditioner/heater system will substantially increase satisfactory operation during the operating season.

Perform the following procedures:

1. Check the mounting fasteners of each component for looseness.

2. Check condition, tension and alignment of all drive belts. Refer to GROUP 12– ENGINE section in the Master Service Manual.

3. Check condition of heater hoses and engine cooling system hoses. Replace if necessary.

4. Verify that the vehicle coolant level is correct.

5. Check refrigerant hose retention and condition. Look for cracks, chafing, or other damage. Inspect all tubing and hoses for dirty or loose connections. All connections must be clean and tight.

**NOTE – If a patch of oily residue is found at or near a connection it may indicate a refrigerant leak. Note its location in case a system operational test indicates a refrigerant leak or a low refrigerant condition.**

**IMPORTANT –** Cleanliness of the air conditioner components cannot be over-emphasized. Lack of proper attention in this area is one of the major causes of costly and unsatisfactory unit operation.

**CAUTION – Never force the fresh/recirculate air door open. If the door position must be changed, refer to REMOVE AND INSTALL, AIR FILTER (See AIR FILTER, page 81). Forcing the door will result in a broken door shaft and a costly repair.**

6. If the system has an air filter in evaporator housing or at the housing air intake, check the filter element(s) and replace with a new element if necessary. When replacing the filter in the evaporator housing, refer to REMOVE AND INSTALL, AIR FILTER (See AIR FILTER, page 81).

7. If the system has been operated in severe service conditions (dust and debris) without an air filter at the evaporator housing; check the evaporator core fins for material that could restrict air flow. Clean the evaporator core if necessary. It is possible to inspect and clean the inlet side of the evaporator core through the air inlet on the cowl tray. If a more thorough cleaning is necessary, refer to REMOVE AND INSTALL, EVAPORATOR CORE (See EVAPORATOR CORE, page 103) to access the evaporator core.

8. If the system is a heat-only system (no A/C evaporator), and has been operated without the air filter in the evaporator housing; check the blower fan and heater core for material that could restrict air flow. Clean the blower fan and heater core if necessary. Refer to REMOVE AND INSTALL, BLOWER ASSEMBLY (See BLOWER ASSEMBLY, page 110) to access the blower assembly and the heater core.

**CAUTION – When cleaning any heat exchanger (radiator, condenser, evaporator, or charge air cooler) use caution and maintain distance from the component with the pressure washer. Do not spray the component fins at an angle as fin damage may occur and reduce efficiency.**

9. Clean all foreign material from condenser and radiator fins. As often as necessary, spray water through the condenser towards the radiator and through the radiator towards the condenser to flush debris from the fins. If necessary, spray the component with a cleaning solution, allow to soak 20 - 30 minutes, then rinse with clean water.

10. Operate air conditioner system and check operation of controls.

11. Check operation of blower.

12. Verify that the system is cooling properly in the A/C modes and heating properly in the heat modes.

13. Place the electronic gauge cluster into the diagnostic mode and verify that no HVAC diagnostic trouble codes are currently stored in the system, refer to DIAGNOSTIC TROUBLE CODES (See Diagnostic Trouble Codes, page 23).

## 4.2. OFF-SEASON CARE

This system does not require any off-season maintenance. Do not remove compressor drive belt during the off-season, as clutch and compressor bearings may become brinneled. It is not necessary to operate the A/C system periodically during the off-season because the system uses the A/C compressor while in the defrost mode, if the ambient temperature is above freezing.

## 4.3. AIR FILTER

**CAUTION – Never force the fresh/recirculate air door open. If the door position must be changed, follow the referenced procedures. Forcing the door will result in a broken door shaft and a costly repair.**

The HVAC air inlet filter is optional on some models. On vehicles with the air filter, inspect the element for dust and road dirt at the beginning of each cooling season. Clean or replace the element as needed. More frequent cleaning and/or replacement may be required on vehicles operated in severe conditions. To replace the air filter refer to REMOVE AND INSTALL, AIR FILTER (See AIR FILTER, page 81).

# 5. DIAGNOSIS AND TROUBLESHOOTING

Diagnosis and troubleshooting of the HVAC system consists of the following steps:

- Diagnosis — identifying the probable causes of the system malfunction by observing diagnostic trouble codes, making physical checks, operating the system, and identifying fault symptoms during operation.
- Troubleshooting — Isolating the fault by use of the troubleshooting tables.
- A/C System Performance Test — Using test equipment to monitor A/C system parameters during operation. This is done to help identify faults during troubleshooting and to verify correct operation after repairs.

The Diagnosis and Troubleshooting Flow Chart provides an overview of this process.

**NOTE – If your attempt to troubleshoot the HVAC system is unsuccessful after performing the procedures contained or referenced in this section, refer to SECTION 20 (See TROUBLESHOOTING QUICK TIPS, page 234) before calling Technical Services.**

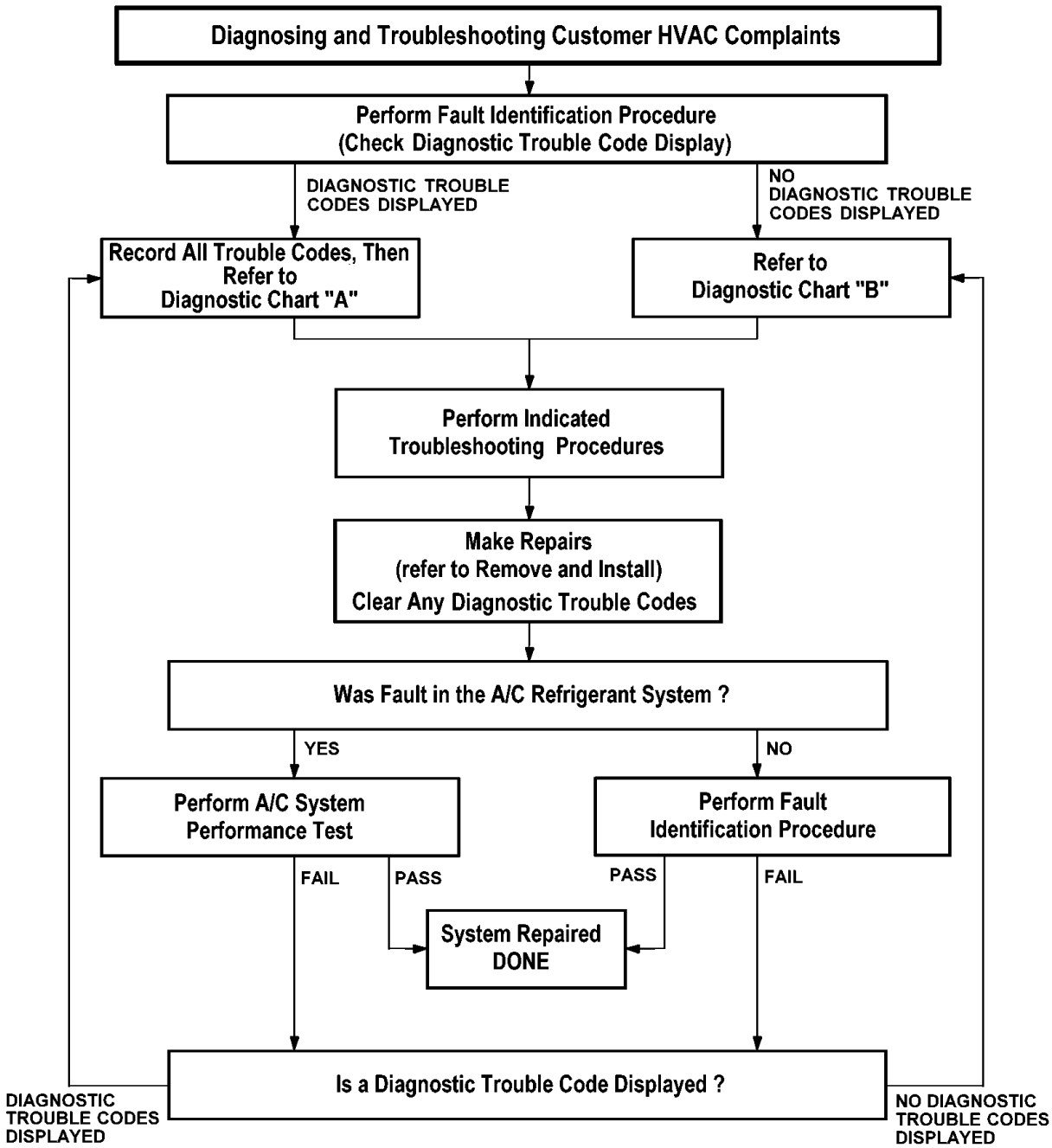



**Figure 12 Diagnosis and Troubleshooting Flow Chart**

## 5.1. DIAGNOSIS

A malfunctioning HVAC system is received because the operator feels that the system is not operating correctly. Usually, the operator will provide a symptom describing the operation of the system. Effective diagnosis begins with observing any Diagnostic Trouble Codes (DTC) logged by the Electronic Gauge Cluster (EGC). If no diagnostic trouble codes are displayed, verify the reported fault by operating the system and observing the symptoms.

**IMPORTANT –** Before starting the engine, perform a simple visual check of the HVAC system to verify that no obvious faults (missing belt, broken wire, ruptured hose, etc.) are present.

### Refrigerant Control and Diagnostic (RCD) System

The Refrigerant Control and Diagnostic (RCD) System is the software used by the Electrical System Controller (ESC) to monitor and control A/C system operation. The RCD system monitors the refrigerant sensors (transducer and thermistors) and other system parameters to determine if all parameters are within acceptable limits. This information allows the RCD system to keep the A/C system operating within its optimum range by controlling the cycling of the refrigerant compressor. When certain nondestructive conditions are detected, the RCD system will allow the A/C system to continue operating while it generates diagnostic trouble codes that may be used to diagnose and isolate the source of the problem. If destructive conditions are detected, the RCD system will protect the compressor by commanding the ESC to turn the compressor off, shutting down the A/C system. In addition, the RCD system will also generate diagnostic trouble codes that may be used to diagnose and isolate problems in the system. For a more complete description of the RCD system, refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150).

**NOTE – The RCD system is continually being improved and revised. If an invalid DTC has been set (see DIAGNOSTIC CHART 'A') (See Table 3, page 27), reflash (update) the ESC software to the latest revision.**

**If no invalid DTC's have been set, do not reflash the ESC unnecessarily. If the ESC software is suspected of being out of date, contact Technical Services at 1-800-336-4500 to determine if reflashing the ESC is necessary.**

### Observing the RCD Signals with the EZ-Tech® Service Tool

The EZ-Tech electronic service tool, running diagnostic software allows the servicer to monitor the HVAC electrical signals that pass through the ESC. Refer to Figure 93, (See Figure 93, page 231). When used in conjunction with these procedures or the electrical troubleshooting manual, the EZ-Tech allows the servicer to isolate electrical faults efficiently. See the diagnostic software manual for details on using the software.

### Diagnostic Trouble Codes

The RCD system within the ESC monitors parameters throughout the A/C system and generates diagnostic trouble codes whenever a measured parameter falls outside of its specified range. Also within the HVAC system, the HVAC control head monitors some conditions and notifies the ESC when it detects a fault. The ESC assigns a Diagnostic Trouble Code (DTC) to each of these faults. When any DTC is generated it is stored in memory even if the fault condition is only temporary. If a fault is detected once, and then not detected at a later time, the DTC for that fault is stored as an inactive **(Previously active)** fault in a memory circuit located in the Electronic Gauge Cluster (EGC). If the detected fault is still present it is considered an **Active** fault. Faults that are severe enough to inhibit HVAC compressor operation are displayed as Active faults.

The DTC's are viewed by placing the system into the diagnostic mode. The following figure (Figure 13) illustrates the format of the DTC's and shows how a typical code would appear on the LCD readout and in print. To enter the diagnostic mode:

1. Set the parking brake.

2. Place the transmission in Neutral.
3. Turn the ignition to the ON position but do not start the engine.
4. After the Electronic Gauge Cluster (EGC) performs a 'power-on-self-test' the LCD readout will display the EGC software version number.
5. Verify that the parking brake indicator is on.
6. Simultaneously depress the Cruise ON and Cruise RESUME switches.
7. If no DTC's are present, the LCD readout will display "NO FAULTS".
8. If DTC's are present, the LCD readout will first display the total number of "A"ctive and "P"reviously active faults.
9. After approximately 10 seconds the EGC will automatically scroll through the DTC's, displaying each DTC for approximately 10 seconds. The Select/Reset button on the EGC can be used to manually scroll through the DTC's.
10. To exit the diagnostic mode, turn ignition key off, release parking brake, or start engine.

**IMPORTANT –** Clearing the Previously active DTC's, as described in the following step, may result in losing useful diagnostic information. Insure that all Previously active DTC's have been reviewed before they are cleared.

While in the diagnostic mode the Previously active DTC's may be cleared by turning the left turn signal ON and simultaneously pressing the Cruise ON and Cruise SET switches. If there are no Active DTC's, the LCD readout should now display "NO FAULTS". Clearing the Previously active DTC's will not clear the Active DTC's, engine fault codes or ABS fault codes. The DTC's may also be viewed and cleared using the diagnostic service tool (EZ-Tech), running the diagnostic software.

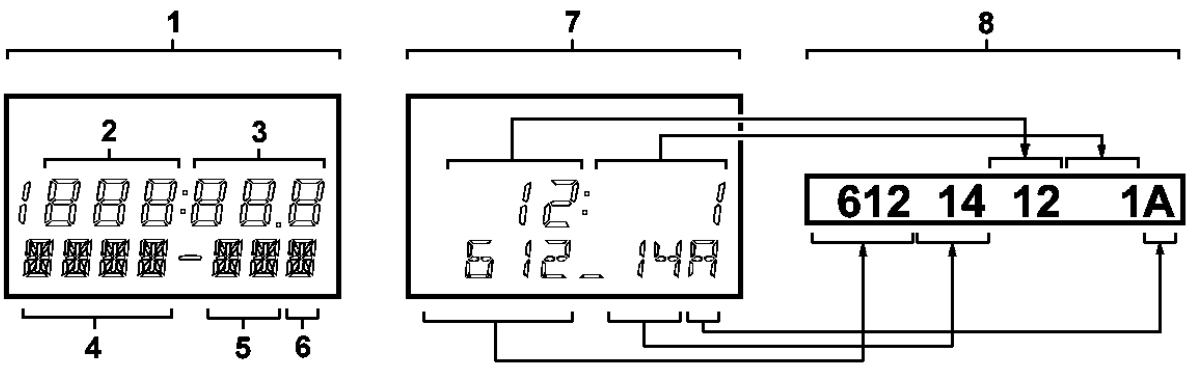



**Figure 13 Diagnostic Trouble Code (DTC)**

1. DIAGNOSTIC TROUBLE CODE FIELDS
2. BYTE 7 FIELD
3. BYTE 8 FIELD
4. SUSPECT PARAMETER NUMBER (SPN) FIELD
5. FAILURE MODE INDICATOR (FMI) FIELD
6. FAILURE ACTIVE/PREVIOUS STATUS (A/P) FIELD
7. TYPICAL DIAGNOSTIC TROUBLE CODE DISPLAY
8. PRINTED FORMAT OF TYPICAL DIAGNOSTIC TROUBLE CODE

## Fault Identification Procedure

**IMPORTANT –** Before starting this procedure, perform a simple visual check of the HVAC system to verify that no obvious faults (missing belt, broken wire, ruptured hose, etc.) are present.

**IMPORTANT –** The following test may not perform correctly if the ambient temperature is too cold. If the A/C compressor does not turn on when first attempted, allow the engine to warm up to operating temperature, and try again. If the A/C system compressor still will not turn on, a fault probably exists.

**NOTE – The engine does not need to be started to display the diagnostic trouble codes.**

**NOTE – The cycling rate of the A/C compressor will vary with the ambient temperature. In cooler ambient temperatures the compressor may cycle up to four times a minute.**

Perform the following steps to determine if a diagnostic trouble code is being generated and/or to verify a reported symptom. If a diagnostic trouble code is displayed, **stop this procedure**, record the codes, and refer to Diagnostic Chart 'A' (See Table 3, page 27). If no diagnostic trouble codes are displayed, perform the procedure and note any symptoms observed; then proceed to Diagnostic Chart 'B' (See Table 4, page 32).

1. To display diagnostic trouble codes, set the parking brake and turn the ignition key to ON (without starting the engine). Then, simultaneously press the Cruise ON switch and the Cruise RESUME switches. If no diagnostic trouble codes are present, the odometer display will read "NO FAULTS". If codes are present, the odometer will display the total number of diagnostic trouble codes currently in memory; then, the display will automatically scroll through all of the codes, displaying each code for 5 seconds. To manually scroll through the diagnostic trouble code list, press the cluster display SELECT/RESET button. The alpha character in the diagnostic trouble code will be an "A" for active faults or "P" for previously active faults. Turn the ignition key to OFF, or release the parking brake, to take the ESC and the EGC out of the diagnostic mode.

2. If no diagnostic trouble codes were displayed, start the engine and set the air conditioning control panel for maximum cooling, as follows.

    A. Set blower speed control to highest speed, full cw.

    B. Set temperature control for maximum cooling, full ccw.

    C. Set mode control to MAX A/C, full ccw.

3. Set the engine speed at 1500 RPM or above.

4. Run the air conditioning system for at least five minutes even if it appears that the system is not operating correctly.

**NOTE – In the following step, verify only that the blower is operating and air flow is present at some outlet. The air distribution system will be checked in a later step.**

5. Cycle the blower speed control through each of its settings and verify correct blower operation. (Air flow stops in the OFF position and increases as the control is rotated in a clockwise direction.)

6. Set the blower speed control to the highest setting (full cw).

**NOTE – In the following step verify that the main forced air flow is through the indicated outlets. However, it is normal for a very slight amount of bleed-through air to be present at other outlets.**

7. Slowly cycle the mode control through each of its settings and verify correct air distribution at the various air outlets as follows:
   a. MAX, NORM, and Vent Only settings direct air flow through the instrument panel vents ONLY.
   b. Bi-level setting directs air flow through the instrument panel vents and the floor ducts ONLY.
   c. Floor setting directs air flow through the floor ducts ONLY.
   d. Floor/Defrost setting directs air flow through the floor ducts and the defrost ducts ONLY.
   e. Defrost setting directs air flow through the defrost ducts ONLY.
8. Repeat the previous step and verify that the air flow at the correct outlets is strong (high).
9. Set the mode control to the Floor setting.

**IMPORTANT –** The engine coolant must be at operating temperature before the next step will work correctly.

10. Set the temperature control to the maximum heat setting (full cw), and verify that the temperature of the air flow at the floor ducts is warm to hot.
11. Set the temperature control to the maximum cooling setting (full ccw).
12. Set the mode control to the MAX air conditioning setting (full ccw), and verify that within five minutes cold air is present at the instrument panel vents.
13. Set the mode control to the Defrost setting, and verify that the compressor cycles on within two minutes.
14. Repeat the previous step with the mode control set to the Floor/Defrost setting; the compressor should continue to operate.
15. With the engine still running, place the ESC and EGC into the diagnostic mode by setting the parking brake and simultaneously pressing the Cruise ON and Cruise RESUME switches.
16. Again observe the odometer display, and note any diagnostic trouble codes displayed there. If a diagnostic trouble code is displayed refer to Diagnostic Chart 'A' and perform the action indicated for that diagnostic trouble code.
17. If no codes are displayed on the odometer display, and the system is not operating correctly, find the fault symptom in Diagnostic Chart 'B'.
18. If you are performing this test after making repairs; the fault has been repaired and the system is now operating correctly. Before returning the vehicle to service, perform an physical inspection of the HVAC system, including a refrigerant leak test; and road test the vehicle.

## DIAGNOSTIC CHART A

This chart is used to determine what action is required when a diagnostic trouble code is displayed on the odometer display. After locating the displayed code in the chart, service the system as instructed in the indicated troubleshooting table. If more than one diagnostic trouble code is displayed, it is good practice to begin by repairing the component-based faults before any faults related to the general system condition.

**NOTE – The RCD System is the software used by the ESC to control the A/C system. The ESC software is continually being improved and revised. If an invalid DTC has been set, reflash (update) the ESC software to the latest revision.**
**If no invalid DTC's have been set, do not reflash the ESC unnecessarily. If the ESC software is suspected of being out of date, contact Technical Services at 1-800-336-4500 to determine if reflashing the ESC is necessary.**

Once the system has been serviced, it should be tested to verify correct operation. If the fault was refrigerant based, verify the repairs by performing the A/C SYSTEM PERFORMANCE TEST PROCEDURE (See A/C SYSTEM PERFORMANCE TEST PROCEDURE, page 35). If the fault was not refrigerant based, verify the repairs by performing the FAULT IDENTIFICATION PROCEDURE (See Fault Identification Procedure, page 25).

**Table 3 Diagnostic Chart 'A' (HVAC Diagnostic Trouble Codes)**

| DIAGNOSTIC TROUBLE CODE | FAULT DESCRIPTION |
|---|---|
| 611 14 9 1 | Compressor clutch under current (open circuit) |
| This Diagnostic code indicates that the current in the compressor clutch circuit is <0.5A. This condition is the result of an open, or a high resistance, in the compressor clutch circuit.<br><br>Refer to AC COMPRESSOR CIRCUITS. (See AC COMPRESSOR CIRCUITS, page 165) | |
| 611 14 9 2 | Compressor clutch over current (short circuit) |
| This Diagnostic code is the result of a short to ground in the compressor clutch circuit or a short across the compressor clutch solenoid.<br><br>Refer to AC COMPRESSOR CIRCUITS (See AC COMPRESSOR CIRCUITS, page 165). | |
| 611 14 9 3 | Compressor clutch current, higher than open circuit level, but lower than normal low current level |
| This Diagnostic code is the result of one or more high resistance connections in the compressor clutch or in the clutch circuit current path.<br><br>Refer to AC COMPRESSOR CIRCUITS (See AC COMPRESSOR CIRCUITS, page 165). | |
| 611 14 9 4 | Compressor clutch current, lower than fusing level, but higher than normal high current level |
| This Diagnostic code is the result of less than normal resistance in the compressor clutch circuit (probably due to shorted windings in the compressor clutch solenoid).<br><br>Refer to AC COMPRESSOR CIRCUITS (See AC COMPRESSOR CIRCUITS, page 165). | |
| 611 14 9 6 | Compressor clutch has current flow when commanded OFF. |
| This Diagnostic code is the result of a defective ESC.<br><br>Replace the ESC. | |
| 612 14 27 1 | HVAC outlet thermistor out of range low |
| This Diagnostic code is the result of a short to ground in the outlet thermistor circuit.<br><br>Refer to AC REFRIGERANT THERMISTOR CIRCUITS (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201). | |

**Table 3 Diagnostic Chart 'A' (HVAC Diagnostic Trouble Codes) (cont.)**

| DIAGNOSTIC TROUBLE CODE | FAULT DESCRIPTION |
|---|---|
| 612 14 27 2 | HVAC outlet thermistor out of range high |
| This Diagnostic code is the result of an open, or a high resistance, in the outlet thermistor circuit.<br><br>Refer to AC REFRIGERANT THERMISTOR CIRCUITS (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201). | |
| 612 14 29 1 | HVAC inlet thermistor out of range low |
| This Diagnostic code is the result of a short to ground in the inlet thermistor circuit.<br><br>Refer to AC REFRIGERANT THERMISTOR CIRCUITS (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201). | |
| 612 14 29 2 | HVAC inlet thermistor out of range high |
| This Diagnostic code is the result of an open, or a high resistance, in the inlet thermistor circuit.<br><br>Refer to AC REFRIGERANT THERMISTOR CIRCUITS (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201). | |
| 612 14 30 1 | +5V reference line out of range low |
| This Diagnostic code is the result of a short to ground or a low resistance on the +5 Vdc reference line; or a defective ESC.<br><br>Refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212). | |
| 612 14 31 1 | This Diagnostic code is no longer valid. |
| If this Diagnostic code is displayed, the ESC software is out of date and must be updated. | |

**Table 3 Diagnostic Chart 'A' (HVAC Diagnostic Trouble Codes) (cont.)**

| DIAGNOSTIC TROUBLE CODE | FAULT DESCRIPTION |
|---|---|
| 612 14 31 2 | HVAC pressure sensor out of range high |
| This Diagnostic code is the result of the sense circuit shorted high, or an open in the 0 Volt Ref circuit.<br><br>Refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212). | |
| 613 14 1 1 | Air inlet fault |
| This Diagnostic code is logged as the result of the fresh/recirculate air door actuator motor being in the wrong position or unresponsive.<br><br>(Detected by HVAC control head.)<br><br>Refer to AIR INLET TROUBLESHOOTING table (See Table 7, page 40). | |
| 613 14 1 2 | HVAC hot/cold temperature mix control fault |
| This Diagnostic code is the result of the temperature door actuator motor being in the wrong position or unresponsive.<br><br>(Detected by HVAC control head.)<br><br>Refer to HEATER/AIR CONDITIONER TEMPERATURE MIX TROUBLESHOOTING table (See Table 8, page 41). | |
| 613 14 1 3 | HVAC mode control fault |
| This Diagnostic code is the result of the actuator motor for the mode doors being in the wrong position or unresponsive.<br><br>(Detected by HVAC control head.)<br><br>Refer to MODE SELECTION TROUBLESHOOTING table (See Table 9, page 42). | |
| 613 14 1 4 | HVAC multiple faults |
| This Diagnostic code is the result of two or more of the previous three faults being active.<br><br>(Detected by HVAC control head.)<br><br>The ESC prevents A/C compressor operation.<br><br>Refer to the appropriate following troubleshooting tables.<br><br>• AIR INLET TROUBLESHOOTING Table (See Table 7, page 40).<br>• HEATER/AIR CONDITIONER TEMPERATURE MIX TROUBLESHOOTING table (See Table 8, page 41).<br>• MODE SELECTION TROUBLESHOOTING table (See Table 9, page 42). | |

**Table 3 Diagnostic Chart 'A' (HVAC Diagnostic Trouble Codes) (cont.)**

| DIAGNOSTIC TROUBLE CODE | FAULT DESCRIPTION |
|---|---|
| 613 14 1 5 | HVAC control head fault, loss of communications with the ESC |
| This Diagnostic code is the result of an open circuit, short to ground or short to voltage on the digital diagnostic line between the HVAC control head and the ESC.<br><br>The ESC prevents A/C compressor operation.<br><br>Refer to HVAC CONTROL HEAD CIRCUITS (See HVAC CONTROL HEAD CIRCUITS, page 157). | |
| 613 14 1 6 | This Diagnostic code is no longer valid. |
| This Diagnostic code was to be logged when the ESC sensed that the system refrigerant charge was low, but not too low to operate. Under certain conditions, the sensitivity of the system could cause this code to be set even though the system was correctly charged. This Diagnostic code was discontinued with vehicles built on and after May 18, 2004.<br><br>If the ESC is registering this code, reflash the ESC; then, check the operation of the A/C system.<br><br>If the A/C system is setting DTC's, locate each DTC in table 3 and follow the instructions.<br><br>If the A/C system is not operating correctly, but is not setting DTC's; locate the symptom in DIAGNOSTIC CHART 'B' (SYMPTOM LIST) (See Table 4, page 32) and follow the instructions. | |
| 613 14 1 7 | HVAC system SERVICE NOW — LOW CHARGE |
| This Diagnostic code is logged when the ESC senses that the system refrigerant charge is too low to allow safe operation. The code may be caused by any of the following:<br><br>(1) Faulty Thermistor Circuit<br><br>(2) Refrigerant Leak<br><br>(3) Improperly Charged System<br><br>The ESC prevents A/C compressor operation.<br><br>Refer to the REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43). | |
| 613 14 1 8 | HVAC system SERVICE NOW — VERY LOW CHARGE |
| This Diagnostic code is logged when the ESC senses that the system refrigerant charge is too low to allow safe operation. The code may be caused by any of the following:<br><br>(1) Faulty Thermistor Circuit<br><br>(2) Refrigerant Leak<br><br>(3) Improperly Charged System<br><br>The ESC prevents A/C compressor operation.<br><br>Refer to the REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43). | |
| 613 14 1 9 | This Diagnostic code is no longer valid. |

**Table 3 Diagnostic Chart 'A' (HVAC Diagnostic Trouble Codes) (cont.)**

| DIAGNOSTIC TROUBLE CODE | FAULT DESCRIPTION |
|---|---|
| If this Diagnostic code is displayed, the ESC software is out of date and must be updated. | |
| 613 14 1 10 | HVAC system SERVICE NOW — HIGH HEAD PRESSURE |
| This Diagnostic code is logged when the ESC senses that the A/C refrigerant system pressure is above acceptable levels. Vehicles with viscous fan will not set this fault unless vehicle speed is greater than 20 mph. The code may be caused by any of the following:<br><br>(1) Faulty Pressure Transducer<br><br>(2) Blocked Condenser<br><br>(3) Faulty Fan or Fan Drive<br><br>(4) Restriction in High Pressure Side of System<br><br>(5) Air/moisture in System<br><br>(6) Too Much Oil in Refrigerant System<br><br>The ESC prevents A/C compressor operation.<br><br>Refer to HIGH HEAD PRESSURE TROUBLESHOOTING table (See Table 12, page 47). | |
| 613 14 1 11 | This Diagnostic code is no longer valid. |
| If this Diagnostic code is displayed, the ESC software is out of date and must be updated. | |
| 613 14 1 12 | This Diagnostic code is no longer valid. |
| If this Diagnostic code is displayed, the ESC software is out of date and must be updated. | |

After all repairs have been made, the diagnostic trouble codes may be cleared by setting the parking brake, putting the ignition key in the ACCESSORY or RUN position, turning on the left turn signal and simultaneously pressing the cruise "ON" and SET" switches.

## DIAGNOSTIC CHART B

This chart is used to determine what action is required when a fault symptom exists but no diagnostic trouble code has been logged by the ESC. After locating the fault symptom in the chart, service the system as instructed in the indicated troubleshooting table.

Once the system has been serviced, it should be tested to verify correct operation. If the fault was refrigerant based, verify the repairs by performing the A/C SYSTEM PERFORMANCE TEST PROCEDURE (See A/C SYSTEM PERFORMANCE TEST PROCEDURE, page 35). If the fault was not refrigerant based, verify the repairs by performing the FAULT IDENTIFICATION PROCEDURE (See Fault Identification Procedure, page 25).

**Table 4 Diagnostic Chart 'B' (Symptom List)**

| Symptom | Action |
|---|---|
| **IMPORTANT –** This table is designed to be used after completing the FAULT IDENTIFICATION PROCEDURE and resolving any HVAC related Diagnostic Trouble Codes that were set. | |
| No Air Flow | Refer to NO AIR FLOW TROUBLESHOOTING table (See Table 14, page 53). |
| Wrong Air Distribution | Refer to MODE SELECTION TROUBLESHOOTING table (See Table 9, page 42). |
| Low Air Flow | Refer to LOW AIR FLOW TROUBLESHOOTING table (See Table 15, page 53). |
| Insufficient Heat (Heater Mode) | Refer to INSUFFICIENT HEAT TROUBLESHOOTING table (See Table 16, page 56). |
| Insufficient Cooling (A/C Mode) (Compressor may be operable or inoperable)<br><br>**NOTE – Refer to DIAGNOSTIC CHART 'A' (See Table 3, page 27) if any Diagnostic codes are set.** | Refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57). |
| Insufficient Defrost (Defrost Mode) | Refer to INSUFFICIENT DEFROST TROUBLESHOOTING table (See Table 18, page 65). |
| Compressor Has Excessive Vibration or Noise | Refer to NOISY COMPRESSOR TROUBLESHOOTING table (See Table 19, page 68). |

## 5.2. PHYSICAL CHECKS

The Physical Checks provide a simple, convenient method of determining the condition of the A/C refrigerant system. Perform these checks when referenced from the troubleshooting tables.

### Physical Check Procedure

1. Start the engine and set the air conditioning control panel for maximum cooling, as follows:
    A. Set blower speed control to highest speed, full cw.
    B. Set temperature control for maximum cooling, full ccw.
    C. Set mode control to MAX A/C, full ccw.
2. Set the engine speed at 1500 RPM or above, and run the air conditioning system for at least five minutes.

**WARNING – Avoid contact with moving belts, pulleys and/or fan when making the following checks. Beware of extremely high temperatures at compressor outlet (discharge) hoses and tubing, as personal injury may result.**

3. With the system operating, feel all air conditioning system components and refrigerant lines for proper operating temperatures, as indicated in the following paragraphs.

   In general, from the discharge side of the compressor along the high pressure line, through the condenser and up to the input to the orifice tube, everything should be hot or warm to the touch. From the output of the orifice tube, the evaporator, the accumulator, and all the lines on the low pressure side leading back to the compressor should be cool to the touch. Any deviation from the above conditions may indicate a malfunction in the system.

The following is a brief description of symptoms or conditions that could exist if the vehicle air conditioning system is malfunctioning. The conditions are listed by system component.

### Refrigerant Compressor

**NOTE – If the ambient temperature is very low, the engine may have to reach operating temperature before the ESC will energize the A/C compressor. Before the A/C compressor can be energized the inlet thermistor must read >43°F, the outlet thermistor must read >33°F, and the pressure transducer must read >40 psi. After warmup, underhood heat will allow the compressor to cycle on at very low ambient temperatures.**

Compressor problems are usually revealed in one of five ways: abnormal noise, seizure, leakage, high suction pressure, or low discharge pressure.

**CAUTION – In the following step, the A/C compressor should be turned in a clockwise (CW) direction only (as viewed from the front).**

Resonant noises are not a cause for alarm; irregular noise or rattles are likely caused by broken parts. To check for seizure, turn the engine off, de-energize the magnetic clutch and see if the drive plate can be turned. If it won't turn, the compressor has seized.

Inspect the fittings, oil fill plug, and all gasket joints on the compressor for signs of refrigerant leakage.

Verify that the wires to the compressor clutch are in good condition and have not become disconnected.

### Condenser

The condenser is usually trouble-free. Normally, the temperature of the condenser outlet line is noticeably cooler than the inlet line.

When road debris (such as leaves or dirt build-up) cakes up, airflow over the condenser fins is reduced and the air is not able to absorb enough heat to turn the hot refrigerant gas into a liquid. High discharge pressure will result. In these cases, carefully clean off the outer surface of the condenser with soap and water and compressed air; be careful not to bend the fins.

High discharge pressure will also occur if the condenser's tubing is abnormally bent, restricting or blocking the flow of refrigerant. Frost will appear at the point where the flow of refrigerant is restricted.

Less common internal blockage (foreign material or metallic grit build-up) will restrict or stop the flow of refrigerant.

Inspect the fittings and the condenser tubing for signs of refrigerant leakage.

Reduced performance may also result from excess oil in the refrigerant system. This excess oil tends to collect in the bottom of the condenser.

### High Pressure Transducer

Verify that the wires to the high pressure transducer are in good condition and have not become disconnected.

Inspect the transducer mounting for signs of refrigerant leakage.

### Thermistors

Verify that the wires to the thermistors are in good condition and have not become disconnected.

Inspect the thermistor mountings for signs of refrigerant leakage.

**NOTE – If the electrical connection to either thermistor is suspected of being intermittent, perform the THERMISTOR CONNECTOR REPAIR procedures (See THERMISTOR CONNECTOR REPAIR, page 209).**

### Clutch Cycling Orifice Tube

A partially blocked orifice tube may cause the evaporator inlet tube to become very cold. In addition, the evaporator pressure may read very low, possibly even a negative value. A fully blocked orifice tube will result in high head pressure; however, there will be no physical symptoms at the location of the orifice tube.

### Evaporator

The evaporator coils are basically trouble-free when air flow over the fins is not blocked. Normally, the evaporator outlet tube and accumulator will feel cool to cold. External or, less often, internal blockage will cause low suction pressure, as well as, little or no cooling.

If a leak exists in the system, and it cannot be traced to other parts or fittings, suspect damage to one of the evaporator coils.

Evaporator freeze-ups are the result of the moisture in the air condensing and then freezing on the evaporator core. The ice on the fins blocks the air flow through the evaporator and stops the cooling until the ice melts. Evaporator freeze-up is generally caused by a problem with the sensing circuitry that controls the cycling of the A/C compressor (input thermistor circuit or output thermistor circuit).

A starved evaporator occurs when there is not enough refrigerant flowing into the evaporator. Starvation can be caused by a blocked orifice tube or a low refrigerant charge. A starved evaporator may cause the evaporator outlet tube or accumulator to feel warmer than usual: at or near ambient temperature.

> **CAUTION – Never force the fresh/recirculate air door open. If the door position must be changed, refer to REMOVE AND INSTALL, AIR FILTER (See AIR FILTER, page 81). Forcing the door will result in a broken door shaft and a costly repair.**

The evaporator is the most difficult of all the components to inspect visually because of its enclosed location. To detect airflow blockage due to debris, bent fins, and/or refrigerant leaks (oil smudges) inspect the inlet side of the evaporator. The fresh air/recirculate air door must be in the open (fresh air) position (the mode control cannot be set to the MAX A/C position). Remove the grille from the cowl tray air inlet, and remove the air filter, if necessary. Using a flashlight and inspection mirror, inspect the inlet side of the evaporator core.

### Accumulator

When operating normally, the accumulator will be cold. Internal blockage will cause low suction pressure as well as little or no cooling.

### Line Restrictions

A restricted suction line causes low suction pressure at the compressor and little or no cooling. A restriction in a line between the compressor and the clutch cycling orifice tube can cause high discharge and low suction pressure, and poor cooling. Generally, if the line is not entirely blocked, the area immediately after the restriction will be cold. A completely blocked line will result in high head pressures, but no physical symptoms at the blockage.

## 5.3. A/C SYSTEM PERFORMANCE TEST PROCEDURE

This test is used to determine if the air conditioning system is properly charged with refrigerant and the refrigerant cycle is functioning correctly. The test is performed using a recovery/recycling/charging station (recovery station) or a manifold gauge set, two thermometers and an electronic leak detector. When a fault is detected perform the repairs indicated. Repeat this test after repairs involving the refrigerant system to verify correct operation.

**WARNING – During system pressure tests the recovery machine is only being used to read high and low pressures. DO NOT open either hand valve on recovery station for any reason. Equipment can be damaged, and personal injury can result.**

**CAUTION – To prevent damage to the test equipment, make sure test equipment and all connections are clear of all moving parts in the engine compartment.**

**NOTE – In rare conditions, vehicles using a viscous fan drive, and being operated with no load may need to place a fan in front of the condenser large enough to develop air flow comparable to normal ram air flow.**

1. If the system has not yet been diagnosed, perform step 2 with the engine and A/C system **at ambient temperature**. The engine and A/C system must NOT have been run within the last 30 minutes.

   If this test is being performed to verify a repair, skip step 2 and proceed to step 3.

2. With the engine off, connect a recovery station (with an internal gauge set) to the low and high side A/C service ports. A known good manifold gauge set may also be used. Refer to FIGURE 41 (See Figure 41, page 127) and/or FIGURE 43 (See Figure 43, page 130).
   a. Determine (and record) the ambient temperature (within a degree or two).
   b. Record the system pressures indicated on the high and low gauges connected to the A/C system. Both gauges should read close to the same value when the truck is not running.
   c. Compare the pressure readings recorded in the last step to the pressures shown in TABLE 46. (The table is part of the Performance AC Chart TMT-3416.)

d. If the pressure on the gauges is more than 10 psig higher than the pressure listed in the chart, the A/C system contains air or some non-condensable gas in the refrigerant system. The system needs to be discharged, evacuated, and recharged using a recovery system. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).

   EXAMPLE: If the ambient is 75°F, the A/C system pressure should be in the 78–79 psig range. If the pressure is 90 psig or higher it indicates that there is air or some non-condensable gas in the system.

   **NOTE – A refrigerant identifier can also be used to verify the contents of the A/C system. Refer to SECTION 7.3 (See REFRIGERANT IDENTIFICATION, page 124).**

e. If the pressure on the gauges is more than 10 psig lower than the pressure listed in the chart, the system is undercharged. The system needs to be discharged, evacuated, and recharged using a recovery system. Undercharged systems should be inspected for a possible leak before being discharged. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).

f. If no faults have been noted, proceed to step 3.

3. Run the remainder of the test under the following conditions:

   - Park the vehicle so there is no solar loading and no wind.
   - Position a thermometer approximately 30 to 60 cm (12 to 24 inches) in front of the vehicle grille to measure ambient temperature of air entering the condenser.
   - If not connected previously, connect a recovery station (with an internal gauge set) to the low and high side A/C service ports. A known good manifold gauge set may also be used. Refer to FIGURE 41 (See Figure 41, page 127) and/or FIGURE 43 (See Figure 43, page 130).
   - If the vehicle has a solenoid-controlled fan drive, engage it. The fan can be operated with a jumper wire or by disconnecting the solenoid valve, depending on the system.
   - Slowly close the hood, being careful not to damage test equipment connections.
   - Insert a thermometer into the passenger side, left instrument panel vent. Do not allow thermometer to touch the side of the duct.
   - Run the engine at 1500 RPM.
   - Open the windows and close both cab doors.
   - Set the air conditioning control panel as follows: mode control to NORM A/C, blower control to high (full cw), and temperature control to maximum cooling (full ccw).
   - Operate the system for at least five minutes, or until the gauge readings settle. Check the gauge readings on the recovery station. If the A/C system is operating properly, the high and low pressure readings will be within the listed pressure ranges in the following SYSTEM PRESSURE TEST CHART. If the gauges are not reading within the System Pressure Chart ranges, refer to ABNORMAL GAUGE READINGS (See ABNORMAL GAUGE READINGS, page 37).

**Table 5 System Pressure Test Chart**

| Ambient Air Temperature (°F) | Ambient Air Temperature (°C) | Relative Humidity (% RH) | Vent Air Temperature Left Passenger (°F) | Vent Air Temperature Left Passenger (°C) | Refrigerant Pressure High Side Service Port (psig) | Refrigerant Pressure Low Side Service Port (psig) | Compressor Cycling ? |
|---|---|---|---|---|---|---|---|
| 70 | 21.1 | 30-50 | 44-50 | 6.7-10.0 | 93-130 | 14-35 | Yes |
| 70 | 21.1 | 70-90 | 47-60 | 8.3-15.6 | 100-145 | 20-35 | Yes |
| 80 | 26.7 | 30-50 | 45-55 | 7.2-12.8 | 145-170 | 18-24 | Yes |
| 80 | 26.7 | 70-90 | 50-60 | 10.0-15.6 | 160-180 | 23-33 | No |
| 90 | 32.2 | 30-50 | 50-58 | 10.0-14.4 | 200-212 | 25-30 | No |
| 90 | 32.2 | 70 | 58-62 | 14.4-16.7 | 220-228 | 30-34 | No |
| 100 | 37.8 | 30-50 | 60-66 | 15.6-18.9 | 250-270 | 34-40 | No |
| 100 | 37.8 | 70 | 68-72 | 20.0-22.2 | 280-288 | 40-44 | No |

## 5.4. ABNORMAL GAUGE READINGS

**WARNING – During system pressure tests, DO NOT open either hand valve on the recovery station for any reason. Equipment can be damaged, and personal injury can result.**

**CAUTION – To prevent damage to the test equipment, make sure test equipment and all connections are clear of all moving parts in the engine compartment.**

**NOTE – In rare conditions, vehicles using a viscous fan drive, and being operated with no load may need to set a fan in front of the condenser large enough to develop air flow comparable to normal ram air flow.**

If abnormal pressure readings are indicated during the System Performance Test Procedure, and no HVAC related Diagnostic Trouble Codes have been set, refer to the following table. If HVAC related Diagnostic Trouble Codes have been set, locate the code in CHART A and perform the action indicated.

**Table 6 Abnormal Pressure Troubleshooting Chart**

| SYMPTOM | POSSIBLE CAUSES | ACTION |
|---|---|---|
| Low Suction - High Discharge Pressure | (1) Restriction in system between compressor discharge port and outlet of the orifice tube.<br><br>(2) Intermittent condition may indicate freezing of orifice tube due to moisture in system. | Reference:<br><br>• HIGH HEAD PRESSURE TROUBLESHOOTING table (See Table 12, page 47). |
| Extremely Low Suction - Normal to Low Discharge Pressure | (1) Restriction in system between outlet of the orifice tube and compressor discharge port, usually at orifice tube.<br><br>(2) Low refrigerant charge.<br><br>(3) Freezing of orifice tube due to moisture in system. | Reference:<br><br>• REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43).<br>• INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57). |
| High Suction - Normal to Slightly Low Discharge Pressure | (1) Compressor not functioning.<br><br>(2) Orifice tube missing. | Reference:<br><br>• COMPRESSOR TROUBLESHOOTING table (See Table 13, page 51).<br>• INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57). |
| High Suction - High Discharge Pressure | **IMPORTANT –** These readings may indicate normal operation for a stationary vehicle. Operate a large fan in front of the condenser and recheck readings.<br><br>(1) Excessive air, water or oil in system.<br><br>(2) Overcharged system.<br><br>(3) Condenser plugged with debris.<br><br>(4) Engine fan not operating properly. | Reference:<br><br>• REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43).<br>• HIGH HEAD PRESSURE TROUBLESHOOTING table (See Table 12, page 47). |

**Table 6 Abnormal Pressure Troubleshooting Chart (cont.)**

| SYMPTOM | POSSIBLE CAUSES | ACTION |
|---|---|---|
| High Suction - Normal to Slightly High Discharge Pressure | **IMPORTANT –** These readings may indicate normal operation for a stationary vehicle. Operate a large fan in front of the condenser and recheck readings.<br><br>(1) Excessive air, water or oil in system.<br><br>(2) Overcharged system.<br><br>(3) Condenser plugged with debris. | Reference:<br><br>• REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43).<br>• HIGH HEAD PRESSURE TROUBLESHOOTING table (See Table 12, page 47). |
| Low Suction - Low Discharge Pressure | (1) Low refrigerant charge.<br><br>(2) Compressor not functioning properly. | Reference:<br><br>• REFRIGERANT CHARGE TROUBLESHOOTING table (See Table 10, page 43).<br>• COMPRESSOR TROUBLESHOOTING table (See Table 13, page 51).<br>• INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57). |

## 5.5. TROUBLESHOOTING TABLES

**Table 7 Air Inlet Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Jammed/Damaged Recirc Door<br>• Defective Fresh Air/Recirc Air Door Actuator or Control Circuit<br>• Internal Actuator Slippage | | | |
| 1. | OFF | Remove fresh air/recirc air door actuator. Grasp the door shaft and manually move door through its full range of movement. | Fresh air/ Recirc air door. | Door should move freely throughout its range. | Go to next step. | Isolate and repair cause of door jam. |
| 2. | OFF | Inspect the end of the door shaft that is driven by the actuator. | Fresh air/ Recirc air door. | Door shaft should be free of excessive wear. | Trouble-shoot fresh air/recirc air door actuator and related control circuit.<br><br>Refer to RECIRCU-LATION ACTUATOR MOTOR CIRCUIT (See RECIRCULATION ACTUATOR MOTOR CIRCUIT, page 175). | Replace fresh air/recirc air door. |

**Table 8 Heater/Air Conditioner Temperature Mix Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Jammed/Damaged Temperature Door<br>• Defective Temperature Door Actuator or Control Circuit<br>• Internal Actuator Slippage | | | |
| 1. | OFF | Remove temperature door actuator. Grasp the door shaft and manually move door through its full range of movement. | Temperature door. | Door should move freely throughout its range. | Go to next step. | Isolate and clear cause of door jam.<br><br>(If door jam cannot be cleared, replace blower scroll housing.) |
| 2. | OFF | Inspect the end of the door shaft that is driven by the actuator. | Temperature door. | Door shaft should be free of excessive wear. | Isolate to defective temperature door actuator or related control circuit.<br><br>Refer to TEMPERATURE ACTUATOR MOTOR CIRCUIT (See TEMPERATURE ACTUATOR MOTOR CIRCUIT, page 188). | Replace blower scroll housing assembly. |

**Table 9 Mode Selection Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Jammed/Damaged Mode Doors or Kinematics<br>• Defective Actuator or Control Circuit<br>• Internal Actuator Slippage | | | |
| 1. | ON | Remove actuator from kinematics that drive the mode doors. Set blower speed to full cw. Grasp the kinematics input shaft (normally mates to actuator) and manually rotate the shaft through its full range of movement. | Kinematic gear train for mode doors. | Rotating the kinematics input shaft through its full range should move the mode doors to direct the air flow as follows:<br>Full ccw = dash vents<br>Full cw = defrost vents<br>Mid position = floor ducts | Go to next step. | Isolate and clear cause of door jam or kinematics gear train jam.<br><br>(If the jam cannot be cleared, replace heater housing assembly.) |
| 2. | OFF | Inspect the kinematics input shaft and gear train for wear or damage that may cause slippage. | Kinematic gear train for mode doors. | Shaft and gear train should be free of excessive wear. | Isolate to defective mode actuator or related control circuit.<br><br>Refer to MODE ACTUATOR MOTOR CIRCUIT (See MODE ACTUATOR MOTOR CIRCUIT, page 181). | Replace heater housing assembly. |

**Table 10 Refrigerant Charge Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Faulty Thermistor Circuit<br>• System Leak<br>• Improperly Charged System | | | |
| 1. | ON | Review diagnostic trouble codes to determine if any thermistor codes were logged. | Review list of diagnostic trouble codes recorded from the EGC while in the diagnostic mode. | No trouble codes were logged for the thermistors. | Go to next step. | Locate the thermistor trouble code in CHART 'A' (See Table 3, page 27), and perform the action indicated. |
| 2. | OFF | Connect ZTSE4477 breakout box between connector (4004) and ESC.<br><br>Connect EZ-Tech service tool to diagnostic connector.<br><br>**IMPORTANT –** After connecting EZ-Tech, turn key on but do not start engine. A/C system must be OFF, and close to ambient temperature. | | | Go to next step. | |
| 3. | ON | **NOTE – The engine must not be running, and A/C system must be near ambient temperature for this step.**<br><br>After A/C system has cooled to near ambient temp (engine OFF for at least 30 minutes), use EZ-Tech | Inlet and outlet thermistor signals | The difference between signal values must be ≤ 5°, **AND** should indicate the approximate ambient temp. | Go to step 5. | Go to next step.<br><br>**NOTE – If the electrical connection to either thermistor is suspected of being intermittent, perform the THERMISTOR CONNECTOR** |

**Table 10 Refrigerant Charge Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | to observe both thermistor signals. | | | | **REPAIR procedures (See THERMISTOR CONNECTOR REPAIR, page 209).** |
| 4. | ON | Using a DMM and the breakout box, measure voltage of thermistor **that is reading incorrectly**. | On breakout box:<br><br>Inlet thermistor (pin 7 to pin 26)<br><br>Outlet thermistor (pin 6 to pin 26) | Refer to THERM-ISTOR CROSS REFER-ENCE TABLE.<br><br>Thermistor voltage should equate to the temp indicated on EZ-Tech. | Thermistor is defective. Replace thermistor. | ESC is incorrectly interpreting the thermistor value. Replace ESC. |
| 5. | OFF | Connect recovery station to A/C system. | | | Go to next step. | |
| 6. | OFF | **IMPORTANT –** A/C system must be near ambient temperature for this step.<br><br>A. Determine ambient temp. within a degree or two.<br><br>B. Record system pressures indicated on recovery station gauges. | Thermometer and recovery station gauges | Gauge readings must be within 10 psig of the table values. | Problem is not a refrigerant charge problem. Review table 3 for Diagnostic Trouble Codes, and/or table 4 for a more accurate symptom. | If gauges are >10 psig **higher** than the table listings, system contains air or some non-condensable gas. Discharge, evacuate, and recharge the system. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).<br><br>If gauges are >10 psig **lower** than the table |

**Table 10 Refrigerant Charge Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | C. Compare gauge readings to table 46 (See Table 46, page 237). | | | | listings, system is undercharged, proceed to the next step. |
| 7. | OFF | Visually inspect all joints and seals in the air conditioning system. | All refrigerant system joints and seals. | Joints and seals clean and free of oil leakage. | Go to next step. | **CAUTION – Do not direct a high pressure stream at the actuator located on the evaporator housing.**<br><br>Clean area around dirty joint or seal, then go to next step. |
| 8. | OFF | Inspect all joints and seals using a leak detector (electronic or UV style). Refer to LEAK DETECTION. Concentrate on joints that were dirty in the previous step. | All refrigerant system joints and seals. | No refrigerant leaks detected. | System was improperly charged. Discharge, evacuate, and recharge system. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119). | Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).<br><br>Discharge system and repair leak.<br><br>Re-torque all fittings to specified levels (refer to Torque table).<br><br>Evacuate and recharge the system. |

**Table 11 Thermistor Cross Reference Table**

| TEMP (°C) | TEMP (°F) | Minimum Resistance (kOhms) | Nominal Resistance (kOhms) | Maximum Resistance (kOhms) | Nominal Voltage at ESC (See Note 1) (Volts) |
|---|---|---|---|---|---|
| -15 | 5 | 19.531 | 21.43 | 22.387 | 10.07 |
| -10 | 14 | 14.948 | 16.159 | 16.93 | 9.90 |
| -5 | 23 | 11.56 | 12.283 | 12.939 | 9.78 |
| 0 | 32 | 9.028 | 9.407 | 9.988 | 9.50 |
| 5 | 41 | 6.988 | 7.273 | 7.646 | 9.20 |
| 10 | 50 | 5.456 | 5.666 | 5.907 | 9.03 |
| 15 | 59 | 4.296 | 4.447 | 4.604 | 8.65 |
| 20 | 68 | 3.381 | 3.514 | 3.618 | 8.20 |
| 25 | 77 | 2.725 | 2.795 | 2.865 | 7.85 |
| 30 | 86 | 2.174 | 2.237 | 2.306 | 7.38 |
| 35 | 95 | 1.747 | 1.802 | 1.868 | 6.80 |
| 40 | 104 | 1.413 | 1.459 | 1.524 | 6.18 |
| 45 | 113 | 1.15 | 1.188 | 1.25 | 5.86 |
| 50 | 122 | .942 | .973 | 1.032 | 5.20 |
| 55 | 131 | .773 | .803 | .853 | 4.80 |
| 60 | 140 | .637 | .667 | .709 | 4.20 |
| 65 | 149 | .529 | .56 | .591 | 3.85 |
| 70 | 158 | .443 | .469 | .495 | 3.42 |
| 75 | 167 | .373 | .395 | .417 | 3.14 |
| 80 | 176 | .315 | .334 | .352 | 2.78 |
| 85 | 185 | .267 | .283 | .299 | 2.36 |
| 90 | 194 | .227 | .241 | .255 | 2.10 |
| 95 | 203 | .194 | .206 | .218 | 1.82 |
| 100 | 212 | .166 | .177 | .187 | 1.63 |
| Note 1: Thermistor voltages are nominal and will vary with the ignition voltage. | | | | | |

**Table 12 High Head Pressure Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| **NOTE – Trucks may temporarily cycle the A/C system off during stationary operation, without setting a 'High Head Pressure' trouble code. This is normal operation. Refer to the description of the REFRIGERANT CONTROL AND DIAGNOSTIC (RCD) SYSTEM,(See Refrigerant Control and Diagnostic (RCD) System, page 150).** | | | | | | |
| | | Possible Causes: | • Blocked Condenser<br>• Faulty Pressure Transducer<br>• Faulty Fan or Fan Drive<br>• Restriction in High Pressure Side of System<br>• Air/Moisture in System<br>• Too Much Refrigerant Oil in System | | | |
| 1. | OFF | Visually inspect for debris blocking air flow through condenser. | Condenser, grille, and radiator | Air flow through condenser should be unrestricted. | Go to next step. | Remove debris and re-establish airflow through condenser. |
| 2. | OFF | Inspect condenser for bent fins. | Condenser | Condenser fins must not be crushed together. Fins should be reasonably straight and separated, allowing air flow between the fins. | Go to next step. | Straighten fins. If fins cannot be repaired condenser core must be replaced. |
| 3. | OFF | Inspect refrigerant hoses for kinks or pinched areas. | Refrigerant lines and hoses. | Lines and hoses must be free of kinks, pinched areas, and tight bends. | Go to next step. | Correct hose routing or replace damaged line or hose. |
| 4. | OFF | Visually check condition of cooling fan and viscous fan drive. | Cooling fan and fan drive. | Verify that fan and fan drive appear to be undamaged.<br><br>Refer to COOLING section in GROUP 12–ENGINE in the Master | Go to next step. | Repair/replace fan/fan drive as indicated in COOLING section in GROUP 12–ENGINE in the Master Service Manual. |

**Table 12 High Head Pressure Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | | | Service Manual. | | |
| 5. | OFF | If a Refrigerant Identifier is not available, proceed to the next step.<br><br>If a Refrigerant Identifier is available, verify the contents of the A/C system. Follow the instructions in SECTION 7.3, and those provided with the Refrigerant Identifier. | Connect the Refrigerant Identifier as directed in SECTION 7.3 (See REFRIGERANT IDENTIFICATION, page 124). | A/C system contents must be R-134a at a concentration of ≥98%. | Go to next step. | The system must be discharged, evacuated, and recharged with the correct type and amount of refrigerant. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119). |
| 6. | OFF | Connect recovery station to A/C system.<br><br>Connect the EZ-Tech service tool to diagnostic connector, to check the pressure transducer signal.<br><br>**IMPORTANT –** After connecting EZ-Tech, turn on key but **do not start engine**. A/C system must be OFF and close to ambient temperature. | | | Go to next step. | |

**Table 12 High Head Pressure Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 7. | ON | **IMPORTANT –** Do not start engine.<br><br>Compare transducer signal value on EZ-Tech to recovery station high side gauge. | EZ-Tech (pressure transducer signal)<br><br>Recovery station (high side gauge) | Pressure values should be within 20 psi. | Go to next step. | Replace pressure transducer or repair transducer circuit. Refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212). |
| 8. | ON or OFF | **IMPORTANT –** Do not start engine.<br><br>A. Determine ambient temp. within a degree or two.<br><br>B. Record system pressures indicated on recovery station gauges.<br><br>C. Compare gauge readings to table 46 (See Table 46, page 237). | Thermometer and recovery station gauges | Gauge readings must be within 10 psig of the table values. | Proceed to next step. | If gauges are >10 psig **higher** than the table listings, system contains air or some non-condensable gas. Discharge, evacuate, and recharge the system.<br><br>Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).<br><br>If gauges are >10 psig **lower** than the table listings, system is undercharged. Check for leaks, then discharge, evacuate, and recharge the system. |

**Table 12 High Head Pressure Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 9. | ON | **NOTE – This step is ONLY for trucks with ON/OFF fan drives. For trucks with viscous fan drives, go to the next step.**<br><br>Start engine.<br><br>Clear all DTC's.<br><br>Set controls for NORM A/C operation. | EZ-Tech (pressure transducer signal and fan request signal)<br><br>Recovery station (high side gauge)<br><br>Cooling fan | When pressure transducer signal on EZ-Tech reads 285 psi, high side pressure gauge should read approx. 285 psi, and fan request signal must turn on.<br><br>Fan drive must cycle on with fan request signal. | Go to next step. | If transducer value (on EZ-Tech) does not track approx. value on high side pressure gauge, replace pressure transducer or repair transducer circuit. Refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212).<br><br>If transducer value is correct, isolate the problem to a defective component in the fan drive circuit (ESC, engine controller, or fan drive).<br><br>Refer to the COOLING section in GROUP 12– ENGINE in the Master Service Manual. |
| 10. | ON | Clear all DTC's.<br><br>Set controls for NORM A/C operation.<br><br>Inspect condenser tubing for visual damage, frost, or cold spot. | Condenser tubes. | Condenser tubes should be free of damage and should be free of cold spots. (Refer to PHYSICAL CHECKS.) | Go to next step. | Repair or replace condenser. |
| 11. | ON | Inspect condenser-to-orifice tube hose for frost or a cold spot, indicating | Condenser-to- orifice tube hose. | Condenser -to- orifice tube hose should be uniform in | Too much moisture or oil in system. Discharge system, | Isolate restriction to orifice tube or condenser-to-orifice tube hose. |

**Table 12 High Head Pressure Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | a restriction/ blockage. | | temperature. Refer to PHYSICAL CHECKS. | replace accumulator, purge system; then, recharge. Refer to SERVICE PROCEDURES FOR R-134a (See SERVICE PROCEDURES FOR R-134a, page 119). | Replace defective component. |

**Table 13 Compressor Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| **IMPORTANT –** A thorough understanding of the REFRIGERANT CONTROL AND DIAGNOSTICS (RCD) SYSTEM is necessary to understand the interaction of the inputs required by the compressor circuit. The RCD system is designed to control the compressor; including removing power from the compressor when a fault is detected.<br><br>Before troubleshooting this circuit, place system into diagnostic mode and note DTC's indicated on EGC. Resolve any HVAC related DTC's by locating DTC's in CHART 'A' (See Table 3, page 27) and performing actions indicated.<br><br>If no HVAC related DTC's are displayed; and the system compressor and refrigerant charge are believed to be ok, refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57). | | | | | | |
| Possible Causes: | | • Uncleared Diagnostic Trouble Code<br>• Missing J1939 Data Link Information<br>• Faulty Compressor Control Circuit (Thermistors, Transducer, Control Head, ESC, Clutch)<br>• Faulty Compressor<br>• Low or No Refrigerant Charge | | | | |
| **CAUTION – In the following step, the A/C clutch should only be turned in a CW direction, as viewed from the front.** | | | | | | |

**Table 13 Compressor Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 1. | OFF | Verify that the compressor has not seized by attempting to turn the compressor clutch drive plate in a cw direction, using a clutch wrench. | A/C compressor clutch drive plate. | Drive plate should turn using a clutch wrench. | Go to next step. | Replace A/C compressor. |
| 2. | ON | Verify that the previously active Diagnostic Trouble Codes (DTC's) have been cleared.<br><br>Start engine and turn on A/C system. | Electronic Gauge Cluster, HVAC control panel, and compressor. | Compressor clutch engages **AND** system operates normally. | Problem corrected. Some DTC's must be cleared before HVAC compressor will operate. | If compressor clutch will not engage, or clutch engages, but system does not operate correctly, and/or displays DTC's; go to next step. |
| 3. | ON | Observe tachometer reading. | Tachometer | Tachometer should indicate the engine speed. | Go to next step. | If the tachometer is not indicating the engine speed, the ESC is not receiving the J1939 data link information (DTC 639 14 4 240 should be displayed). Refer to the ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE (s08250). |
| 4. | ON | Review diagnostic trouble codes to determine if any HVAC related codes were logged. | Review list of diagnostic trouble codes recorded from the EGC while in the diagnostic mode. | No trouble codes were logged for the HVAC system. | Go to next step. | Locate the diagnostic trouble code in CHART 'A' (See Table 3, page 27), and perform the action indicated. |
| 5. | OFF | Recover refrigerant from A/C system using recovery station. | A/C system and Recovery Station. | System was adequately charged. | Replace A/C compressor. | Locate and repair leak, refer to LEAK DETECTION. |

**Table 13 Compressor Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Note quantity of refrigerant recovered. | | | | Re-torque all fittings to specified levels (refer to TORQUE CHART (See Table 42, page 218)).<br><br>Charge the A/C system. Refer to CHARGING THE AIR CONDITIONING SYSTEM |

**Table 14 No Air Flow Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| Possible Causes: • Faulty Blower or Blower Control Circuit | | | | | | |
| 1. | This is an electrical malfunction.<br><br>Refer to the BLOWER MOTOR CIRCUIT (See BLOWER MOTOR CIRCUIT, page 194). | | | | | |

**Table 15 Low Air Flow Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| Possible Causes: • Blocked Recirc Air (in cab) Inlet (MAX A/C only)<br>• Blocked Heater Core (Heat Mode only)<br>• Dirty Air Inlet Filter Element<br>• Blocked Evaporator Core<br>• Faulty Blower or Blower Speed Control Circuit | | | | | | |
| 1. | ON | Check air flow with the mode control set to each mode position for about 30 seconds. | Various air outlets depending on mode selected. | Airflow is weak **only** in the MAX A/C mode. | Recirculate air inlets are blocked. (Located in cab behind heater housing.) | Go to next step. |

**Table 15 Low Air Flow Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 2. | ON | Check air flow with the mode control set to each mode position for about 30 seconds. | Various air outlets depending on mode selected. | Airflow is weak **only** when the TEMPERATURE control is set from its midrange to its full cw position. | Heater core is blocked by debris. With the key OFF, clean heater core.<br><br>Refer to heater core remove and install; **HOWEVER**, it is **not** necessary to remove the core or disconnect the heater hoses to clean the core. | Go to next step. |
| 3. | ON | **CAUTION – Never force the fresh/recirculate air door open. If the door position must be changed, follow the following procedures. Forcing the door will result in a broken door shaft and a costly repair.**<br><br>**NOTE – To open the fresh/recirc air door, turn on key, set mode control to any position except MAX A/C, turn off key.**<br><br>Remove grille from evaporator inlet on cowl tray. Remove air inlet | Evaporator air inlet. | Remove filter and check for normal air flow at high blower speed, in all modes. | Replace filter with a new filter element. | Go to next step. |

**Table 15 Low Air Flow Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | filter (if present). If no filter is present, go to next step. | | | | |
| 4. | OFF | Using a small flashlight and an angled mirror, check for debris blocking the evaporator core in the evaporator housing. | Evaporator inlet. | Verify that the evaporator core is free of debris. | Troubleshoot the blower and blower control circuit.<br><br>Refer to the BLOWER MOTOR CIRCUIT (See BLOWER MOTOR CIRCUIT, page 194). | Clean the debris from the evaporator inlet.<br><br>Check airflow. If not improved, troubleshoot the blower and blower control circuit.<br><br>Refer to the BLOWER MOTOR CIRCUIT (See BLOWER MOTOR CIRCUIT, page 194). |
| If the problem is intermittent, or occurs only after a period of A/C operation the evaporator core could be icing up due to a restriction in the evaporator core or a defective component in the thermistor control circuit. | | | | | | |

**Table 16 Insufficient Heat Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Low Coolant Level or Coolant Flow<br>• Blocked Air Flow through Heater Core<br>• Defective Temperature Door, Door Actuator, or Control Circuit | | | |
| 1. | ON | Check for correct coolant level, coolant temperature, and coolant flow through heater core.<br><br>Refer to COOLING section in GROUP 12–ENGINE in the Master Service Manual. | Coolant system and heater core. | Verify correct coolant level, coolant temperature, and coolant flow through heater core. | Go to next step. | Troubleshoot coolant system problem as indicated in COOLING section in GROUP 12–ENGINE in the Master Service Manual.<br><br>If heater core must be removed, refer to REMOVE AND INSTALL, HEATER CORE (See HEATER CORE, page 111). |
| 2. | OFF | Check for blockage of air flow through heater core. Refer to REMOVE AND INSTALL, HEATER CORE (See HEATER CORE, page 111) to gain access to the heater core; **HOWEVER**, it is **not** necessary to remove the core or disconnect the heater hoses to clean the core. | Heater core. | Verify airflow through the heater core is unrestricted. | Fault is in the Temperature Door, Door Actuator, or Control Circuit. Refer to the HEATER/ AIR CONDITIONER TEMPER-ATURE MIX TROUBLE-SHOOTING table (See Table 8, page 41). | Heater core is blocked by debris. Clean debris from heater core, before reassembling heater housing. |

**Table 17 Insufficient Cooling Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| **NOTE – Trucks may temporarily cycle the A/C system off during stationary operation, without setting a 'High Head Pressure' trouble code. This is normal operation.**<br><br>**IMPORTANT –** A thorough understanding of the REFRIGERANT CONTROL AND DIAGNOSTIC (RCD) SYSTEM, (See Refrigerant Control and Diagnostic (RCD) System, page 150) is necessary to understand the interaction of the inputs required by the compressor circuit. The RCD system is designed to control the compressor; including removing power from the compressor when a fault is detected. Before troubleshooting this circuit, place system into diagnostic mode and note DTC's indicated on EGC. Resolve any HVAC related DTC's by locating DTC's in CHART 'A' (See Table 3, page 27) and performing actions indicated.<br><br>**IMPORTANT –** Do not start the engine until instructed to do so. Some steps in this procedure require the engine and A/C system are at ambient temperature | | | | | | |
| | | Possible Causes: | • Loose Drive Belt<br>• Excessive Engine Temperature<br>• Malfunctioning Optional On/Off Fan Drive Circuit<br>• Fresh Air Leaking into Cab<br>• Defective Temperature Blend Door, Door Actuator/Circuit<br>• Defective A/C Control Head<br>• Defective A/C Thermistor<br>• Defective A/C Pressure Transducer<br>• Defective ESC<br>• Defective Compressor<br>• Incorrect Refrigerant Charge | | | |
| 1. | OFF | Check compressor drive belt condition and tension.<br><br>Refer to COOLING section in GROUP 12– ENGINE in the Master Service Manual. | Compressor drive belt | Drive belt must be in good condition and tension must be within specified levels. | Go to next step. | Replace drive belt if required and/or set belt tension to specified level. |
| 2. | OFF | Verify that the compressor has not seized by attempting to turn the compressor clutch drive plate in a cw direction, using a clutch wrench. | A/C compressor clutch drive plate. | Drive plate should turn using a clutch wrench. | Go to next step. | Replace A/C compressor. |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 3. | OFF | If a Refrigerant Identifier is not available, proceed to the next step.<br><br>If a Refrigerant Identifier is available, verify the contents of the A/C system. Follow the instructions in SECTION 7.3, and those provided with the Refrigerant Identifier. | Connect the Refrigerant Identifier as directed in SECTION 7.3 (See REFRIGERANT IDENTIFICATION, page 124). | A/C system contents must be R-134a at a concentration of ≥98%. | Go to next step. | The system must be discharged, evacuated, and recharged with the correct type and amount of refrigerant. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119). |
| 4. | OFF | Connect recovery station to A/C system. | | | Go to next step. | |
| 5. | OFF | **IMPORTANT – A/C system should be OFF for at least 30 minutes prior to test. A/C system must be close to ambient temperature.**<br><br>A. Determine ambient temp. within a degree or two.<br><br>B. Record system pressures indicated on recovery station gauges.<br><br>C. Compare gauge readings to table 46 (See Table 46, page 237). | Thermometer and recovery station gauges | Gauge readings must be within 10 psig of the table values. | Go to next step. | If gauges are >10 psig **higher** than the table listings, system contains air or some non-condensable gas. Discharge, evacuate, and recharge the system.<br><br>If gauges are >10 psig **lower** than the table listings, system is undercharged. Check for leaks, then discharge, evacuate, and recharge the system.<br><br>Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119). |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 6. | OFF | Connect ZTSE4477 breakout box between connector (4004) and ESC.<br><br>Connect EZ-Tech service tool to diagnostic connector, to check HVAC system signals.<br><br>**IMPORTANT –** After connecting EZ-Tech, turn key on but **do not start engine**. A/C system must be OFF and close to ambient temperature. | | | Go to next step. | |
| 7. | ON | Compare transducer signal value on EZ-Tech to recovery station high side gauge. | EZ-Tech (pressure transducer signal)<br><br>Recovery station (high side gauge) | Pressure values should be within 20 psi. | Go to next step. | Replace pressure transducer or repair transducer circuit. Refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212). |
| 8. | ON | **IMPORTANT –** The engine **must not be running**, and A/C system must be near ambient temperature for this step.<br><br>Use EZ-Tech to observe both thermistor signals. | Inlet and outlet thermistor signals | The difference between signal values must be ≤5°, AND should indicate the approximate ambient temp. | Go to step 9. | Go to next step.<br><br>**NOTE – If the electrical connection to either thermistor is corroded or suspected of being intermittent, perform the THERMISTOR CONNECTOR REPAIR procedures (See THERMISTOR CONNECTOR REPAIR, page 209).** |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 9. | ON | Using a DMM and the breakout box, measure voltage of thermistor **that is reading incorrectly**, based on the ambient temperature. | On breakout box:<br><br>Inlet thermistor (pin 7 to pin 26)<br><br>Outlet thermistor (pin 6 to pin 26) | Refer to THERM-ISTOR CROSS REFER-ENCE TABLE (See Table 11, page 46).<br><br>Thermistor voltage should equate to the thermistor temp indicated on EZ-Tech. | Thermistor is defective. Replace thermistor. | ESC is incorrectly interpreting the thermistor value. Replace ESC. |
| 10. | ON | **Start engine**. After initial warmup, verify engine operating temperature is normal. **Continue to monitor throughout test**. | Engine temperature gauge | Engine temperature gauge must indicate engine is not running hot. | Go to next step. | If engine is running hot, determine cause of excessive engine temperature. Repair if necessary. |
| 11. | ON | Observe tachometer reading. | Tachometer | Tachometer should indicate the engine speed. | Go to next step. | If the tachometer is not indicating the engine speed, the ESC is not receiving the J1939 data link information (DTC 639 14 4 240 should be displayed). Refer to the ELECTRICAL SYSTEM TROUBLE-SHOOTING GUIDE (s08250). |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 12. | ON | Clear all Diagnostic Trouble Codes.<br><br>Select A/C NORM mode on HVAC control head.<br><br>Set fan control to mid-range.<br><br>Verify A/C compressor cycles ON. | A/C Compressor | A/C compressor must cycle on and off, or run continuously, when in A/C modes. | Go to next step. | Go to step 16. |
| 13. | ON | Verify that recovery station gauge readings are within ranges shown in SYSTEM PRESSURE TEST CHART, (See Table 5, page 37). | Recovery station pressure gauges | Gauge readings are within ranges shown in SYSTEM PRESSURE TEST CHART. | Go to step 15. | Go to next step. |
| 14. | ON | Observe high side pressure gauge on recovery station. | Recovery station and A/C compressor | High side pressure rises to about 400 psi, then compressor shuts down until pressure drops to <250 psi. If this cycle repeats numerous times, then compressor turns OFF for 5 minutes. | In some conditions this is normal operation for a stationary vehicle.<br><br>**NOTE – Vehicles w/ On/Off Fan Drives. Verify fan drive, is operating correctly.** | Refer to ABNORMAL PRESSURE TROUBLE-SHOOTING CHART (See Table 6, page 38), and perform action listed for observed symptom. |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 15. | ON | Verify air temp at passenger vent is within normal range. | Thermometer in passenger air vent | Vent air temp must be within normal range. | Repair cab fresh air leaks as required.<br><br>Refer to GROUP 16 – CAB section in the Master Service Manual. | Isolate fault to temperature door or temperature door actuator circuit.<br><br>Refer to HEATER/AIR CONDITIONER TEMPERATURE MIX TROUBLE-SHOOTING table (See Table 8, page 41).<br><br>**IMPORTANT –** Verify all heater assembly seals and gaskets are installed correctly. |
| 16. | ON | Review diagnostic trouble codes to determine if any HVAC related codes were logged. | Review list of diagnostic trouble codes indicated on EGC while in diagnostic mode. | No HVAC related trouble codes were logged. | Go to next step. | Locate HVAC related trouble code in CHART 'A' (See Table 3, page 27), and perform action indicated. |

**IMPORTANT –** The following specific conditions must exist before the compressor can be energized.

- inlet thermistor value must be >43°F
- outlet thermistor value must be >33°F
- pressure transducer value must be >40 psi and <250 psi
- Control Head AC REQUEST signal at connector 1600, cavity 7 must be ON (<0.5Vdc)

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| **NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.**<br><br>Turn ignition key OFF.<br><br>Install breakout box at ESC connector (1600).<br><br>Start engine.<br><br>Set HVAC control head controls as follows:<br><br>• fan to midrange,<br>• temperature fully ccw,<br>• mode to NORM A/C.<br><br>Make the following checks with the engine running at idle. | | | | | | |
| 17. | ON | Verify that the control head A/C REQUEST signal is ON. | Control head A/C REQUEST signal, as indicated on EZ-Tech service tool | The A/C REQUEST signal must be ON when in any A/C mode. (Fan must be on.) | Go to step 19. | Go to next step. |
| 18. | ON | Measure voltage between connector (1600), cavity 7 and ground. | ESC breakout box (ESC connector 1600, cavity 7) | Verify that voltage is <0.5 Vdc when in any A/C mode with fan on. | Replace the ESC. | Isolate missing A/C REQUEST signal (gnd) to an open harness or a defective A/C control head. Refer to HVAC CONTROL HEAD CIRCUITS (See HVAC CONTROL HEAD CIRCUITS, page 157). |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 19. | ON | Verify that thermistor signal values are high enough to allow compressor operation. | Inlet and Outlet thermistor signals as observed on EZ-Tech service tool | Inlet thermistor >43°F<br><br>Outlet thermistor >33°F | Go to next step. | If thermistor is out of range, **but** is correctly reading ambient temperature, the system must warm up before testing can continue.<br><br>If a thermistor is indicating an incorrect temperature, refer to AC REFRIGERANT THERMISTOR CIRCUITS (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201). |
| 20. | ON | Verify that pressure transducer signal value is within range required for compressor operation.<br><br>Verify transducer value on EZ-Tech agrees with pressure observed on charging station high side gauge. | Pressure transducer signal as indicated on EZ-Tech service tool, and pressure indicated on charging station high side gauge | Pressure transducer signal value on EZ-Tech >40 psi and <250 psi | Verify that there are no active HVAC DTC's that would inhibit operation. Resolve any HVAC related DTC's by locating them in CHART 'A' (See Table 3, page 27) and performing the actions indicated.<br><br>If no active HVAC DTC's are present, replace the ESC. | If transducer signal agrees with the high side pressure gauge, refer to REFRIGERANT CHARGE TROUBLE-SHOOTING table (See Table 10, page 43).<br><br>If transducer signal disagrees with the high side pressure gauge, refer to AC PRESSURE TRANSDUCER CIRCUIT (See AC PRESSURE TRANSDUCER CIRCUIT, page 212) |
| If the cab takes a long time to cool down using the MAX A/C mode, the fresh air/recirc air door may be malfunctioning. Refer to the AIR INLET TROUBLESHOOTING Table (See Table 7, page 40). | | | | | | |

**Table 17 Insufficient Cooling Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| If the problem is intermittent, or occurs only after a period of A/C operation the evaporator core could be icing up due to a restriction in the evaporator core or a defective component in the thermistor control circuit. | | | | | | |

**Table 18 Insufficient Defrost Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: | • Blower or Blower Speed Control Failure<br>• Insufficient Heat<br>• Compressor or Compressor Control Circuit Failure<br>• Defective Mode Kinematics/Doors and/or Actuator/Circuit<br>• Blocked Defrost Ducting | | | |
| 1. | ON | Check blower operation in several modes with the temperature control set to maximum cool (full ccw) and blower set to high speed. | Various air outlets depending on mode selected. | Verify that the airflow is strong in some of the modes selected. | Go to the next step. | Troubleshoot the blower and blower control circuit.<br><br>Refer to the BLOWER MOTOR CIRCUIT (See BLOWER MOTOR CIRCUIT, page 194). |
| 2. | ON | Check for normal heater operation. With the engine running at operating temperature, set the blower speed control to high speed (full cw), set the temperature control to maximum heat (full cw), and set the mode control to the floor setting. | Floor ducts | Verify that the air at the floor ducts is hot. | Go to next step. | Refer to the INSUFFICIENT HEAT TROUBLE-SHOOTING table (See Table 16, page 56). |

**Table 18 Insufficient Defrost Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 3. | ON | **NOTE – If the ambient temperature is very low, the engine may have to reach operating temperature before the ESC will energize the A/C compressor. Before the A/C compressor can be energized the inlet thermistor must read >43°F, the outlet thermistor must read >33°F, and the pressure transducer must read >40 psi. After warmup, underhood heat will allow the compressor to cycle on at very low ambient temperatures.**<br><br>Check for normal A/C operation.<br><br>Set the mode control to NORM A/C, blower speed to high, and temperature to full ccw. | Air outlet vents. | Verify that the A/C system is cooling the air at the air outlet vents. | Go to next step. | Refer to the INSUFFICIENT COOLING TROUBLE-SHOOTING table (See Table 17, page 57). |
| 4. | ON | Check for compressor operation **while in the defrost mode**.<br><br>Set the mode control to Defrost and the blower speed control to high speed. | Compressor | Verify that the compressor cycles regularly while in the Defrost mode. | Go to next step. | The compressor is not being enabled in the Defrost mode.<br><br>Troubleshoot the HVAC control head.<br><br>Refer to HVAC CONTROL HEAD CIRCUITS (See HVAC CONTROL HEAD CIRCUITS, page 157). |

**Table 18 Insufficient Defrost Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 5. | ON | Remove actuator from gear train that drives the mode doors. Set blower speed to full cw. Grasp the kinematics input shaft (normally mates to actuator) and manually rotate the shaft through its full range of movement. | Kinematic gear train for mode doors. | Rotating the kinematics input shaft through its full range should move the mode doors to direct the air flow as follows: Full ccw = dash vents Full cw = defrost vents Mid position = floor ducts | Go to next step. | Isolate and clear cause of door jam or kinematics gear train jam.<br><br>(If the jam cannot be cleared, replace heater housing assembly.) |
| 6. | OFF | Inspect the kinematics input shaft and gear train for wear or damage that may cause slippage. | Kinematic gear train for mode doors. | Shaft and gear train should be free of excessive wear. | Go to next step. | Replace heater housing assembly. |
| 7. | | Check for defective mode actuator or related control circuit. | Mode actuator circuit. | Verify mode actuator and related control circuit are operating correctly.<br><br>Refer to MODE ACTUATOR MOTOR CIRCUIT (See MODE ACTUATOR MOTOR CIRCUIT, page 181). | Go to next step. | Troubleshoot mode actuator and related control circuit.<br><br>Refer to MODE ACTUATOR MOTOR CIRCUIT (See MODE ACTUATOR MOTOR CIRCUIT, page 181). |
| 8. | ON | Check for an obstruction in the defrost ducts. It may be necessary to remove the heater housing. | Defrost ducts | Verify that there is no obstruction in the defrost ducts. | Mode actuator is slipping internally. Replace actuator. | Clear obstruction from defrost ducts. |

**Table 19 Noisy Compressor Troubleshooting**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| | | Possible Causes: • Missing or Loose Compressor Mounting Bolts<br>• Broken or Cracked Brackets or Braces<br>• Drive Belt Idler or Pulley Loose or Damaged<br>• Drive Belt Misadjusted, Misaligned, or Worn<br>• Compressor Clutch Slipping<br>• Defective Compressor/Clutch<br>• Excessive Refrigerant Charge | | | | |
| 1. | OFF | Check torque on compressor mounting bolts. | Compressor mounting bolts. | Verify all compressor mounting bolts are present and torqued to the correct value: 23 - 29 N.m (17 - 21.4 lbf-ft). | Go to next step. | Replace missing mounting bolts. Tighten all mounting bolts to the correct value. |
| 2. | OFF | Check for broken or cracked compressor mounting brackets or braces. | Compressor mounting system. | Verify that compressor mounting brackets and braces are complete and free of cracks. | Go to next step. | Replace broken or cracked components. |
| 3. | OFF | Check compressor drive belt pulleys and idlers for damage, looseness or worn bearings. | Compressor drive belt pulleys and idlers. | Pulleys and idlers must be damage free and tight. | Go to next step | Tighten or replace loose or damaged pulleys and/or idlers as indicated in GROUP 12– ENGINE section in the Master Service Manual. |
| 4. | OFF | Check compressor drive belt for wear, misalignment or misadjustment. | Compressor drive belt. | Belt wear, alignment and adjustment must be within acceptable limits as indicated in the GROUP 12– ENGINE section in the Master Service Manual. | Go to next step. | Replace belt, or align and adjusts the belt as indicated in the GROUP 12– ENGINE section in the Master Service Manual. |

**Table 19 Noisy Compressor Troubleshooting (cont.)**

| STEP | KEY | ACTION | TEST POINTS | SPEC. | YES- IN SPEC. | NO-OUT OF SPEC. |
|---|---|---|---|---|---|---|
| 5. | ON | Check for compressor clutch slippage. | Compressor/ Clutch assembly | The clutch should engage and run with no slipping. (A slipping clutch makes a scraping noise.) | Go to next step. | Cycle clutch several times to burnish face. Recheck operation; if scrapping sound is no longer present, no further repairs are necessary. |
| 6. | ON | Run A/C SYSTEM PERFORMANCE TEST PROCEDURE(See A/C SYSTEM PERFORMANCE TEST PROCEDURE, page 35).<br><br>Check for high discharge pressure readings, indicating an excessive refrigerant charge. | A/C system, gauge set or recovery station. | Pressure readings must be within the limits indicated in test procedure table. | Replace the compressor/ clutch assembly. | Service the A/C system (discharge, evacuate, and recharge the system). Refer to SERVICE PROCEDURES FOR R-134a (See SERVICE PROCEDURES FOR R-134a, page 119). |

## 6. REMOVE AND INSTALL

**WARNING – To prevent damage to the equipment and/or personal injury, always turn the vehicle ignition key OFF before performing Removal and Installation procedures.**

**IMPORTANT –** Special attention to the following, during component remove and install, will aid in avoiding unnecessary and time-consuming problems.

A. When working on the A/C system keep the work area and tools as clean as possible. Also, clean all connections, ports or fittings before disconnecting or removing components.

B. All A/C component and refrigerant line openings should be immediately covered or plugged during removal and remain so until re-installation to prevent the entry of dirt, moisture and other foreign material. Even the slightest particle can cause problems if carried to a vulnerable place within the system.

C. Never remove protective caps from components until the moment of assembly into the system.

D. Never install non-sealed components.

E. If the accumulator is one of multiple components being installed in the system, the accumulator should be the last component installed. This reduces the amount of time that the accumulator desiccant is exposed to atmospheric moisture.

F. Anytime an A/C fitting is disconnected, the O-ring and C-plate must be replaced (Figure 14). The new O-ring must be lubricated with **MINERAL-BASED** oil. The C-plate does not require lubrication. Never use grease, penetrating oil, motor oil, Ester or PAG oil, etc. to lubricate O-rings and fittings.

G. All refrigerant hose and tubing support clamps and strap locks must be re-installed in their original positions.

Never bend a hose to a radius less than ten times the diameter of the hose.

Never route a hose any closer than two inches from the exhaust manifold or related piping.

H. Whenever possible use a backup wrench when loosening or tightening fittings (Figure 15).

I. All fittings must be tightened as specified in the TORQUE CHART (See Table 42, page 218). Use only a torque wrench known to be accurate.

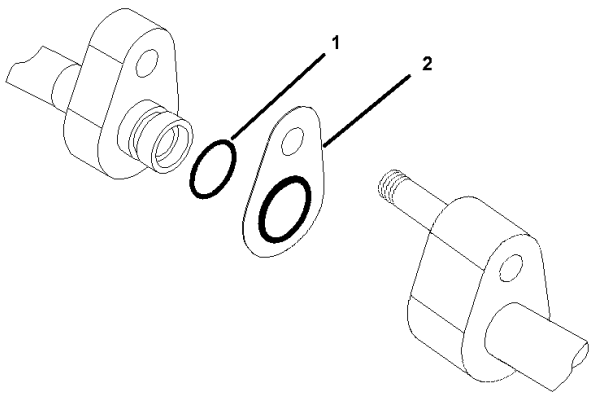



**Figure 14 Fitting C-Plate and O-Ring**

1. O-RING
2. C-PLATE

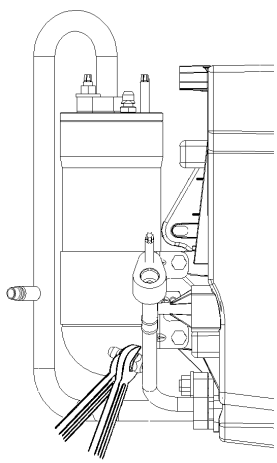


**Figure 15 Use a Back-Up Wrench When Loosening or Tightening Fittings**

**NOTE – The following figures and procedures cover most typical engine/chassis configurations. Other configurations may differ slightly due to component mounting locations and/or hose routings.**

The removal and installation procedures for this heating – air conditioning system are organized in the following order. Under hood components are covered first, followed by the in-cab components.

## 6.1. PRESSURE TRANSDUCER

> **CAUTION – The pressure transducer is not interchangeable with a pressure switch. To prevent damage to the A/C system replace a defective transducer only with the recommended part.**

**NOTE – The pressure transducer can be removed and installed without removing the refrigerant from the A/C system.**

**NOTE – Refer to Figure 16 while performing the following Remove and Install procedures.**

The pressure transducer is located on the condenser-to-evaporator refrigerant line.

### Remove

1. Disconnect the electrical connection to the pressure transducer (1).
2. Unscrew the pressure transducer from the condenser-to-evaporator refrigerant line and cap the open fitting.

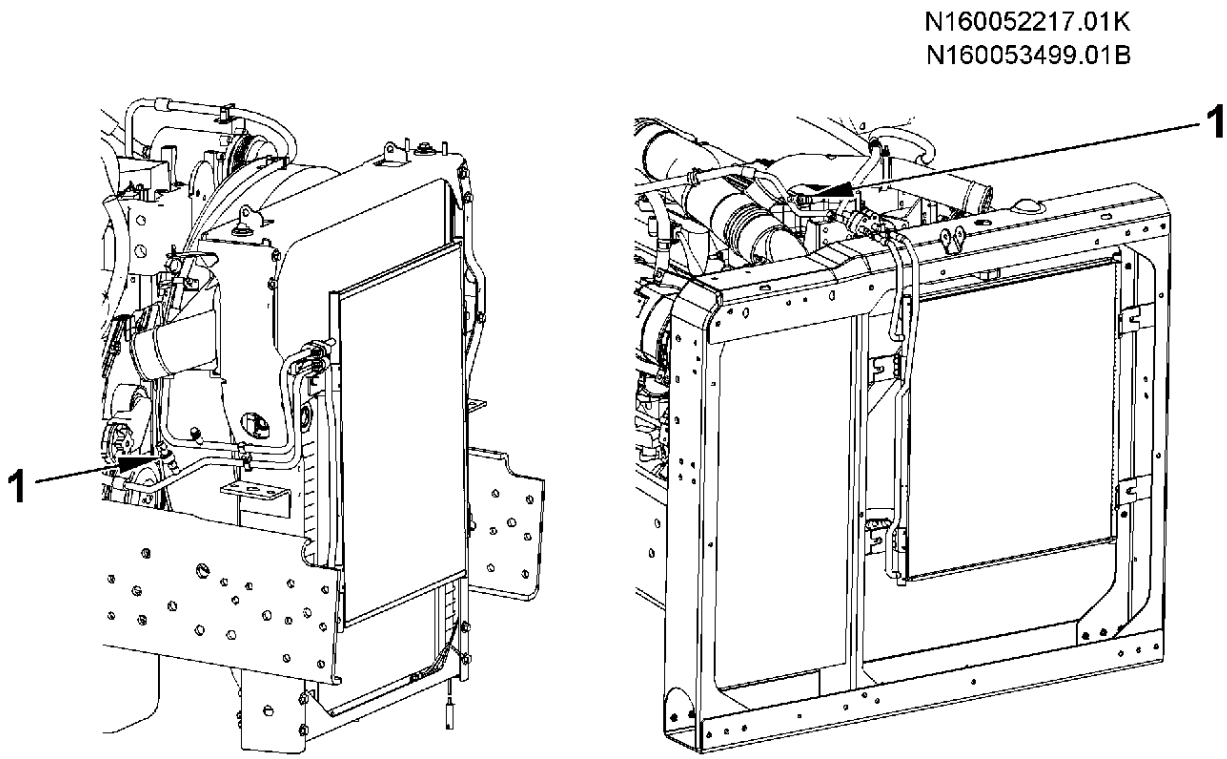



**Figure 16 Pressure Transducer Locations (Typical Locations Shown)**

1. PRESSURE TRANSDUCER

### Install

1. Install a new O-ring on the transducer fitting and lubricate the O-ring and threads with mineral-based oil.
2. Screw the pressure transducer onto the A/C line fitting and tighten to 9.5 to 20 N•m. (7 to 15 lbf-ft).
3. Connect the electrical connector to the pressure transducer (1).

## 6.2. THERMISTORS

**WARNING – The AC thermistors CANNOT be removed and installed without removing the refrigerant from the AC system. The procedures are the same for either thermistor.**

**NOTE – Refer to Figure 17 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. Disconnect the electrical connection to the thermistor being removed.

3. Unscrew the thermistor from its fitting and cap the open fitting.

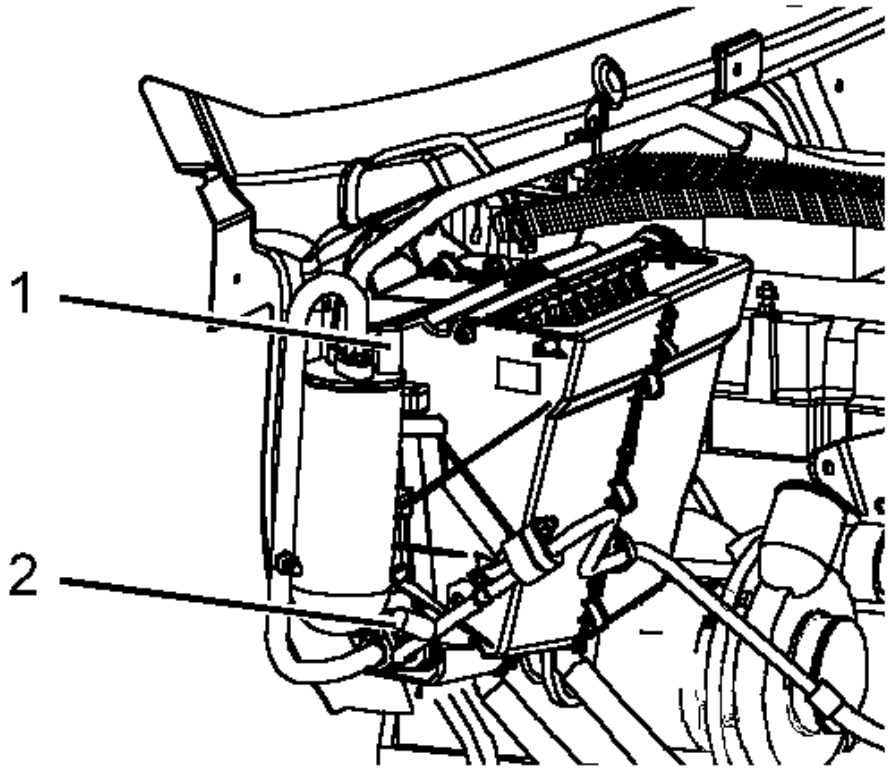



**Figure 17 A/C Thermistor Locations**

1. EVAPORATOR OUTPUT THERMISTOR
2. EVAPORATOR INPUT THERMISTOR

### Install

1. Install a new O-ring on the thermistor and lubricate the O-ring and threads with mineral-based oil.
2. Screw the thermistor into its fitting and tighten to 5.0 – 9.5 N.m (44.25 - 84.1 lbf-in).
3. Fill the cavities in the thermistor connector with the dielectric grease specified in AIR CONDITIONING SYSTEM SPECIFICATIONS (See Table 43, page 223).

**NOTE – The thermistor connector is not polarized. It may be connected in either orientation.**

4. Connect the electrical connection to the replaced thermistor.
5. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.3. CONDENSER CORE

**NOTE – Refer to Figure 18 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. Depending on the model, it may be necessary to remove nearby assemblies (right splash panel, fixed grille, or recirculation shield) to gain access to the condenser mounting bolts and A/C lines. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
3. If necessary, unclip condenser line support clamp (3) and disconnect pressure transducer wiring connector to allow the A/C lines to be moved out of the way.
4. Disconnect A/C line fittings (2) from condenser (1) and position the A/C lines out of the way.
5. Remove condenser from radiator frame by removing the mounting bolts (4).

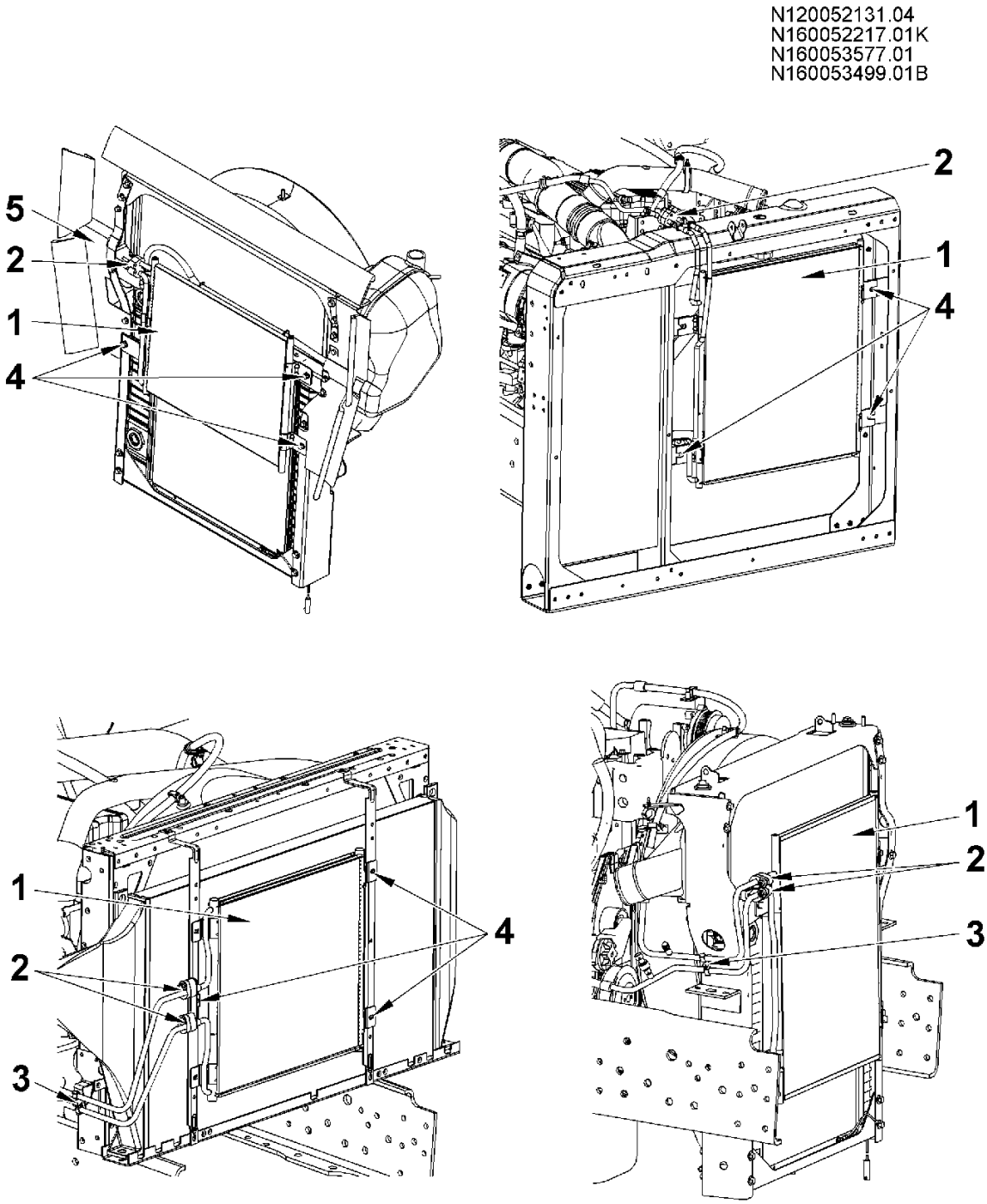



**Figure 18 Condenser Core (Typical Installations Shown)**

1. CONDENSER
2. CONDENSER LINE FITTINGS
3. A/C LINE SUPPORT CLAMP
4. CONDENSER MOUNTING BOLTS (ALL BOLTS NOT SHOWN)
5. RECIRCULATION SHIELD (RIGHT SIDE)

### Install

1. Secure condenser (1) to radiator frame using the mounting bolts (4).

2. If the system is to be flushed or purged, perform that operation before completing reassembly. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

**NOTE – Always lubricate A/C fitting O-rings with mineral-based oil during installation.**

3. Using new O-rings and C-plates connect A/C line fittings (2) to condenser. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).

4. If removed earlier, secure the A/C lines using the condenser line support clamp (3) and connect the wiring to the pressure transducer.

5. Install any assemblies that were removed to gain access to the condenser (such as right splash panel, fixed grille, or recirculation shield). Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.

6. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.4. A/C COMPRESSOR/CLUTCH

**NOTE – Refer to Figure 19 and Figure 20 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).

2. Remove or loosen compressor belt.

3. Disconnect compressor clutch wiring connector at compressor (1).

4. Disconnect refrigerant line fittings (2 and 3) at compressor.

5. Remove compressor mounting bolts, noting the locations of any brackets secured by the mounting bolts.

6. Remove compressor/clutch assembly from the engine.

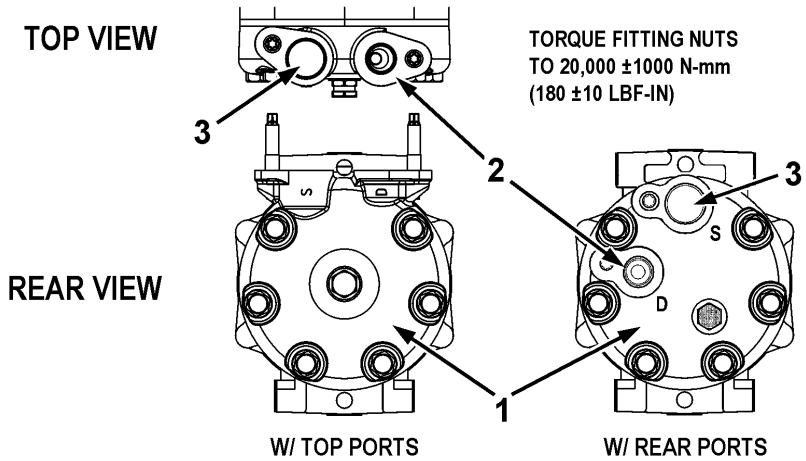



**Figure 19 A/C Compressor**

1. A/C COMPRESSOR
2. DISCHARGE PORT
3. SUCTION PORT

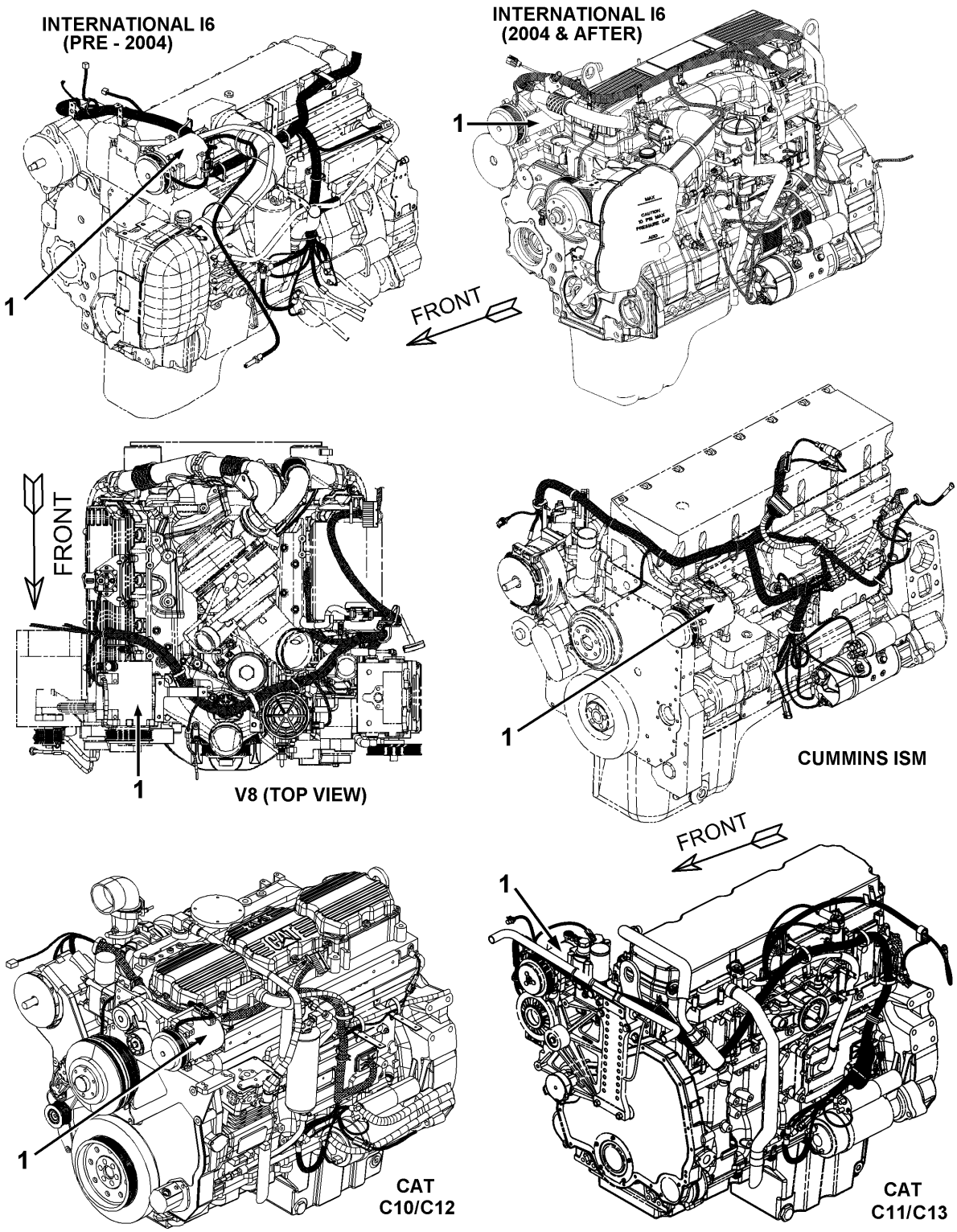



**Figure 20 Compressor Mounting Locations**

1. A/C COMPRESSOR

### Install

**NOTE – Verify that the clutch is installed on the compressor before performing the following installation procedure.**

1. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

2. Before installing the compressor, refer to OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141). The oil shipped in new compressors must be drained when determining the correct amount of refrigerant oil to be added to the system.

3. Install compressor assembly (1) including any brackets previously secured by the compressor mounting bolts. Tighten to 23 - 29 N.m (16.9 - 21.4 lbf-ft).

**NOTE – Always lubricate O-rings with mineral-based oil during installation.**

4. Using new O-rings and C-plates connect refrigerant line fittings (2 and 3) at compressor.

5. Connect compressor clutch wiring connector to engine harness.

6. Install and align compressor belt.

7. Recharge the system. Refer to:
   a. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131); and
   b. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.5. COWL DRAIN TRAY/HVAC AIR INLET

**NOTE – The cowl drain tray exists in several variations. The following procedures are for a typical medium duty installation. If your cowl drain tray appears significantly different, refer to the CAB Section in Group 16 of the Master Service Manual for procedures covering all cowl drain trays.**

**NOTE – Refer to Figure 21 while performing the following Remove and Install procedures.**

### Remove

1. Remove both windshield wipers.

2. Remove radio antenna wand.

3. Disconnect windshield washer hose (3) from bottom of cowl tray (1).

4. Remove one mounting screw (7) from the center, inside of the cowl tray.

5. Remove two mounting screws (4) securing the cowl tray air inlet to the evaporator housing (8).

6. Remove two mounting bolts (2) securing the ends of the cowl tray to the cowl.

7. Carefully remove the cowl tray (1) by lifting it off of the windshield wiper shafts.

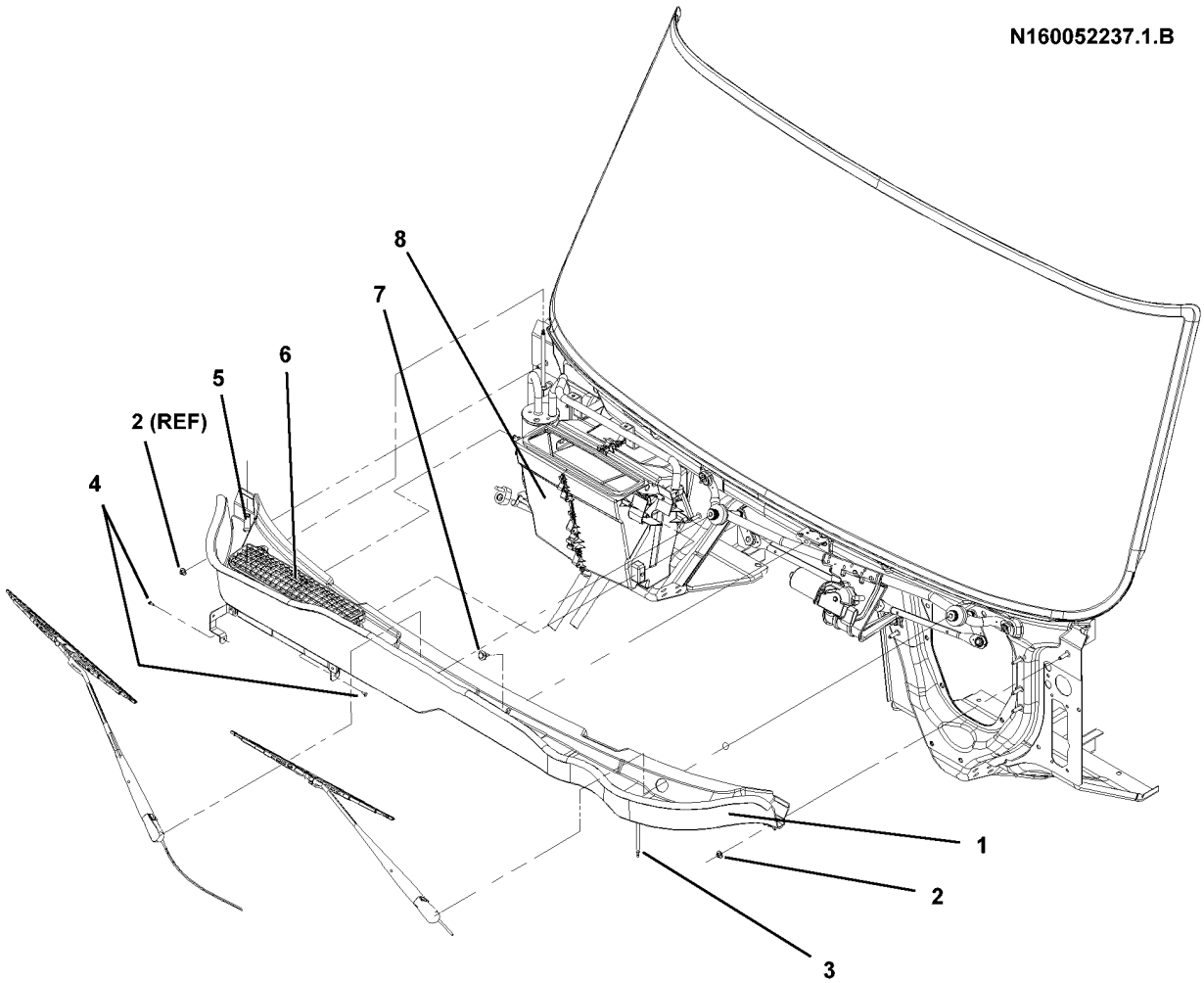



**Figure 21 Cowl Drain Tray/HVAC Air Inlet (Medium Duty Shown)**

1. COWL TRAY
2. COWL TRAY MOUNTING NUTS
3. WASHER HOSE
4. MOUNTING SCREWS (TRAY TO EVAPORATOR HOUSING)
5. ANTENNA SEAL
6. AIR INLET GRILLE
7. CENTER MOUNTING SCREW
8. EVAPORATOR HOUSING

### Install

1. Lower the tray into position so that the windshield wiper shafts protrude through their holes.
2. Secure the cowl tray (1) to the cowl using a mounting bolt (2) at each end of the cowl tray.
3. Install two mounting screws (4) securing the cowl tray air inlet to the evaporator housing.
4. Install one mounting screw (7) at the center, inside of the cowl tray.
5. Connect windshield washer hose (3) to bottom of cowl tray.
6. Install radio antenna wand.
7. Install both windshield wipers.

## 6.6. AIR FILTER

### Remove

> **CAUTION – Never force the fresh/recirculate air door open. If the door position must be changed, follow the following procedures. Forcing the door will result in a broken door shaft and a costly repair.**

1. Remove the grille covering the HVAC air inlet (6, Figure 21), located in the cowl tray at the base of the windshield.
2. Verify that the fresh/recirculate air door is open. This can be done by looking into the cowl tray air inlet.
3. If the door is open proceed to the next step. If the door is closed, proceed as follows:
    A. Turn the ignition key to the ON position (it's not necessary to start the engine),
    B. Set the blower speed control on the HVAC control panel to OFF,
    C. Turn the ignition key to the OFF position.
4. Reaching into the HVAC air inlet, located in the evaporator housing (1), remove the air filter (2, Figure 22) by compressing the top of the filter, tipping it to the front, and lifting it straight up.

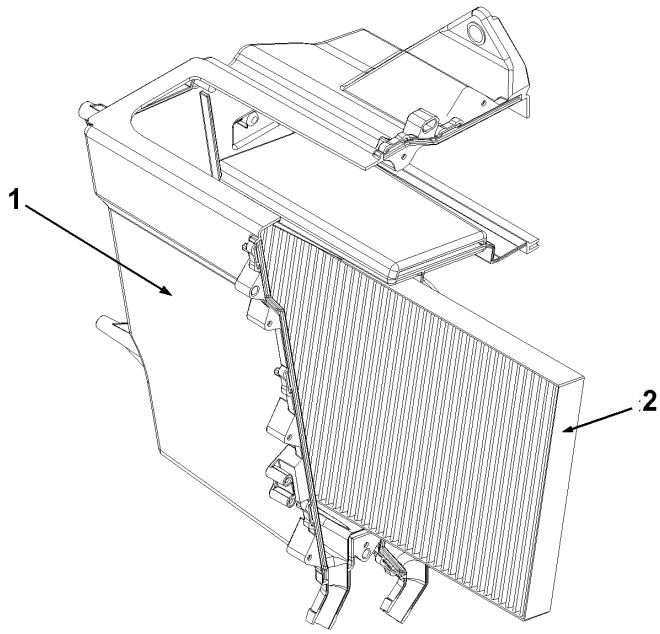



**Figure 22 Cutaway View of Evaporator Housing (Recirculate Door Not Shown)**

1. EVAPORATOR HOUSING
2. AIR FILTER ELEMENT

## Install

1. With the filter pleats vertical, place the filter (2, Figure 22) into the evaporator housing (1) through the air inlet.

2. Position the bottom of the filter as far to the rear as possible (behind the positioning rib in the housing); then compress the top of the filter and push it to the rear until it is behind the top positioning ribs. The filter is in place when it is set behind the positioning ribs at all four corners.

3. Fit can be verified by grasping a central pleat and gently pulling forward. The filter should be retained by the ribs.

4. Install the grille covering the HVAC air inlet (6, Figure 21).

## 6.7. A/C REFRIGERANT LINE (SUCTION LINE COMPRESSOR-TO-ACCUMULATOR)

N160052217.5.C
N160052217.1.D

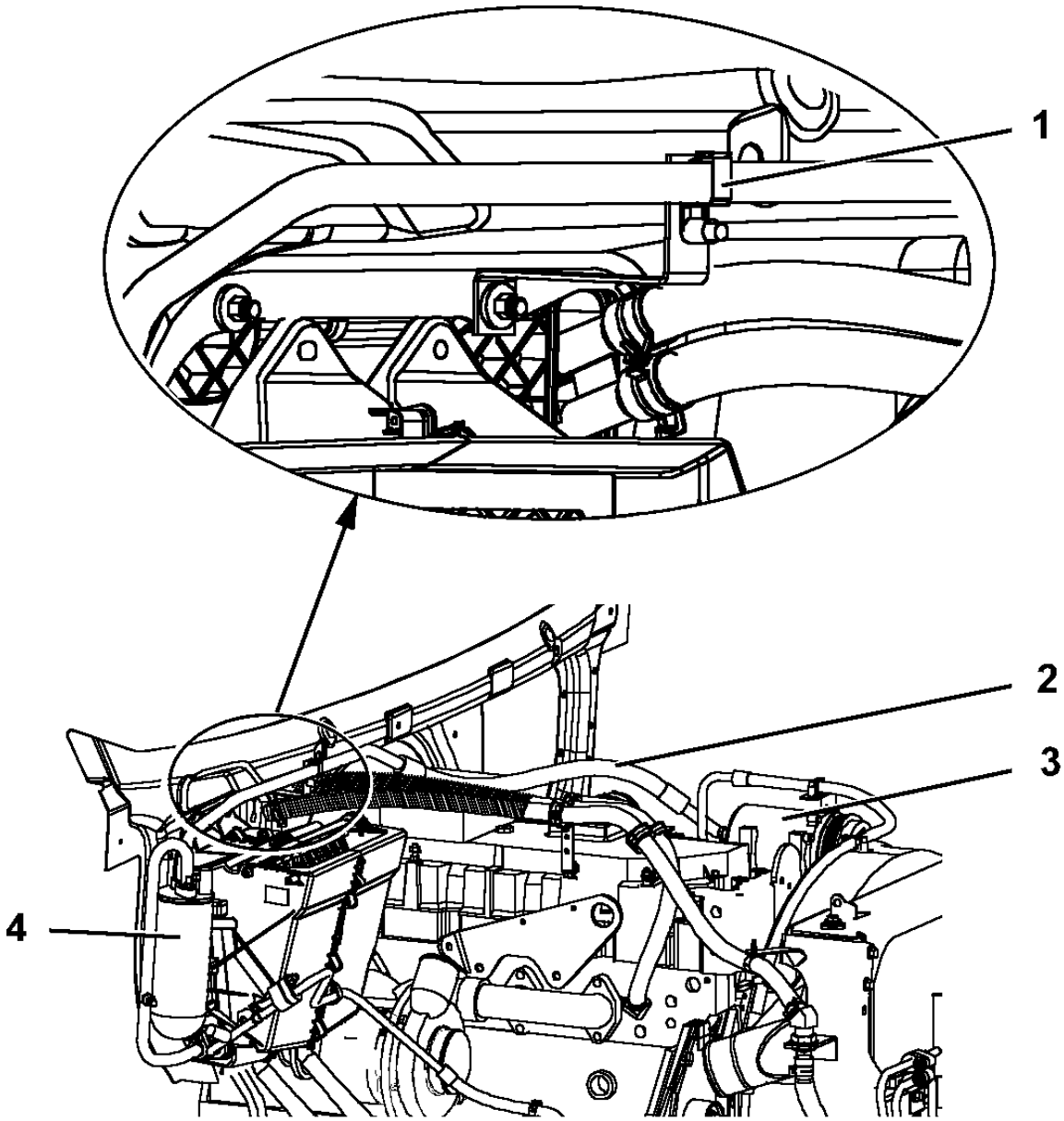



**Figure 23 A/C Refrigerant Line (Compressor-to-Accumulator)**

1. HOSE SUPPORT CLAMP
2. COMPRESSOR-TO-ACCUMULATOR LINE
3. COMPRESSOR
4. ACCUMULATOR

**NOTE – Refer to Figure 23 while performing the following Remove and Install procedures. International I6 engine is shown, other engine configurations are similar.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. Remove cowl drain tray/HVAC air inlet. Refer to COWL DRAIN TRAY/HVAC AIR INLET(See COWL DRAIN TRAY/HVAC AIR INLET, page 79).
3. Disconnect suction line (2) fitting at compressor (3).
4. Disconnect suction line fitting at accumulator (4).
5. Unclip hose support clamp (1) and plastic ties used to secure the compressor-to-accumulator line (2).
6. Remove compressor-to-accumulator suction line.

### Install

1. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).
2. Place compressor-to-accumulator suction line in approximate location.

**NOTE – Always lubricate O-rings with mineral-based oil during installation.**

3. Using a new O-ring and C-plate connect suction line fitting at accumulator (4). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
4. Using a new O-ring and C-plate connect suction line fitting at compressor (3). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
5. Secure suction line using support clamp (1) and plastic ties.
6. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.8. A/C REFRIGERANT LINE (DISCHARGE LINE COMPRESSOR-TO-CONDENSER)

**NOTE – Refer to Figure 24 while performing the following Remove and Install procedures.**

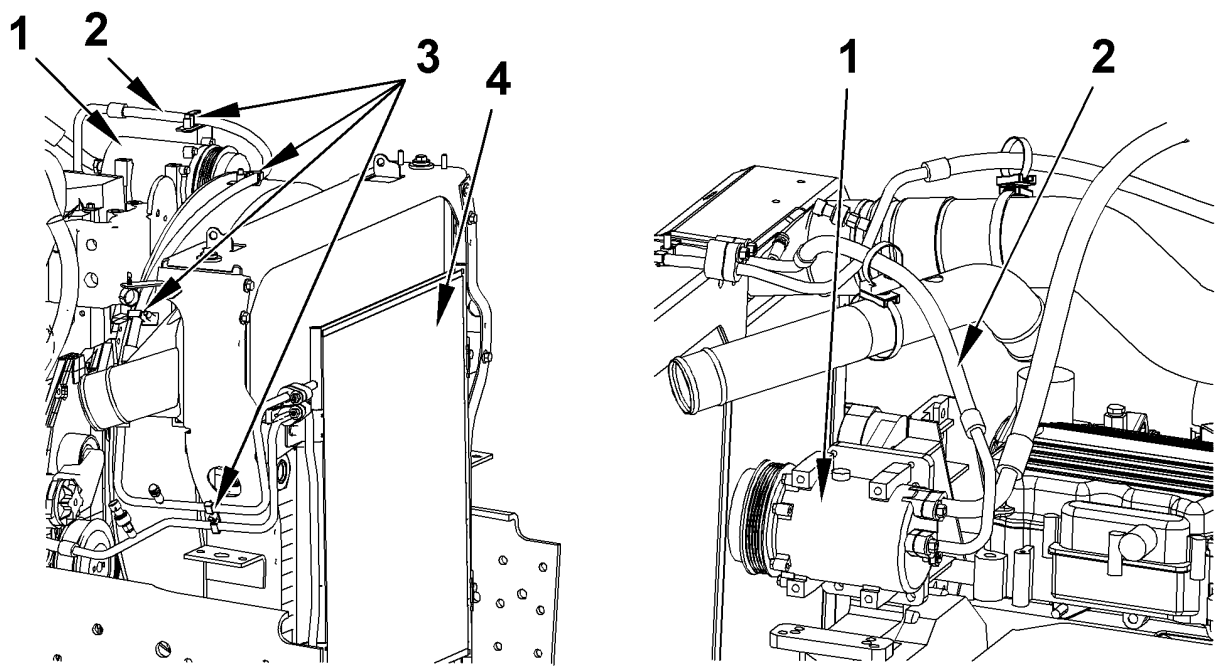
### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).

2. Depending on the model, it may be necessary to remove nearby assemblies (right splash panel, fixed grille, or recirculation shield) to gain access to the fittings, or to remove the A/C lines. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.

3. If applicable, unclip hose support clamps (3), and/or tie-wraps, securing compressor-to-condenser line.

N160052217.01K
N160053499.05.B




**EXCEPT 8600 MODELS**
**(PRE-2004 I6 ENGINE SHOWN, OTHERS SIMILAR)**

**8600 MODELS ONLY**

**Figure 24 A/C Refrigerant Line (Compressor-to-Condenser) (Shown with Recirculation Shield and Splash Panel Removed)**

1. COMPRESSOR
2. COMPRESSOR-TO-CONDENSER LINE
3. HOSE SUPPORT CLAMPS
4. CONDENSER

4. Disconnect line (2) fitting from condenser (4).

5. Disconnect compressor-to-condenser line (2) fitting at compressor (1).

6. Remove compressor-to-condenser line (discharge line).

### Install

1. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

2. Place compressor-to-condenser line (2) in approximate location.

**NOTE – Always lubricate O-rings with mineral-based oil during installation.**

3. Using a new O-ring and C-plate connect compressor-to-condenser line fitting at compressor (1). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).

4. Using a new O-ring and C-plate connect compressor-to-condenser line fitting at condenser (4) inlet. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).

5. Secure the line using support clamps (3) and/or tie-wraps, as applicable.

6. Install any assemblies that were removed to gain access to the compressor-to-condenser line (such as right splash panel, fixed grille, or recirculation shield). Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.

7. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.9. A/C REFRIGERANT LINE (CONDENSER-TO-EVAPORATOR)

**NOTE – Refer to Figure 25 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).

2. Depending on the model, it may be necessary to remove nearby assemblies (right splash panel, fixed grille, or recirculation shield) to gain access to the fittings, or to remove the A/C lines. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.

3. If necessary (for access to A/C line), disconnect clips securing transmission oil cooler lines to radiator frame.

4. Disconnect wiring connector to pressure transducer (3).

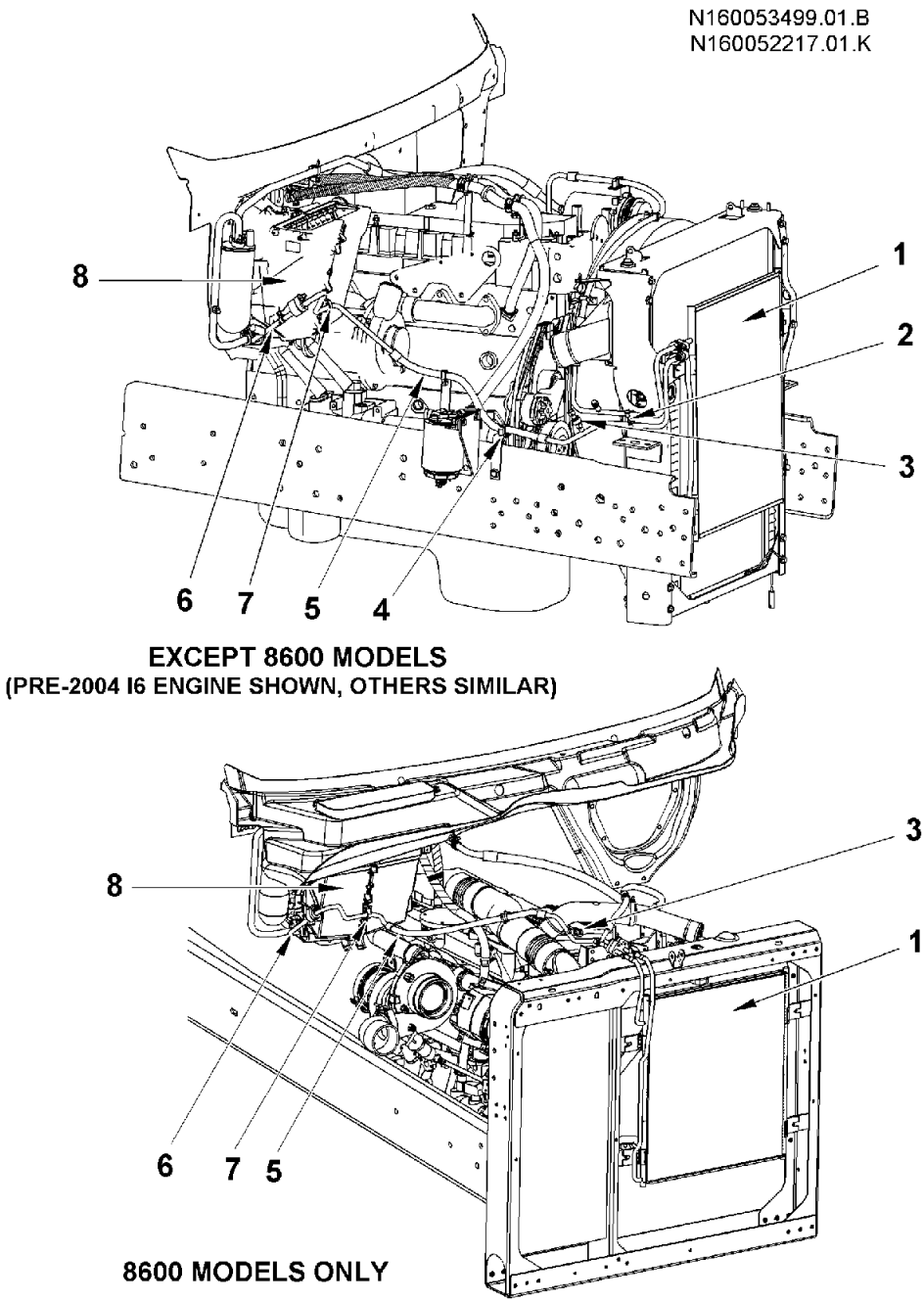



**Figure 25 A/C Refrigerant Line (Condenser-to-Evaporator) (Shown with Recirculation Shield and Splash Panel Removed)**

1. CONDENSER
2. CLAMP (RADIATOR FRAME)
3. PRESSURE TRANSDUCER
4. CLAMP (FRAME RAIL)
5. CONDENSER-TO-EVAPORATOR LINE
6. ORIFICE A/C LINE
7. CLAMP (EVAPORATOR)
8. EVAPORATOR HOUSING

5. Unclip clamp (4) securing condenser-to-evaporator line to frame rail.
6. Unclip clamp (7) securing line to evaporator housing (8).
7. Unclip hose support clamps (2) securing A/C lines to radiator frame.
8. Disconnect condenser-to-evaporator line (5) fitting from condenser (1) outlet fitting.
9. Disconnect condenser-to-evaporator line (5) from fitting on orifice A/C line (6).
10. Remove condenser-to-evaporator line (5).
11. Remove pressure transducer (3) from condenser-to-evaporator line.

### Install

1. Transfer pressure transducer (3), and any attached clamps, from removed condenser-to-evaporator line; or install new pressure transducer in new line.
2. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).
3. Place condenser-to-evaporator line (5) in approximate location.

**NOTE – Always lubricate O-rings with mineral-based oil during installation.**

4. Using a new O-ring and C-plate connect condenser-to-evaporator line to fitting on A/C orifice line (6). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
5. Using a new O-ring and C-plate connect condenser-to-evaporator line fitting to condenser (1) outlet fitting. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
6. Using clamp (4) secure line to frame rail.
7. Using clamp (7) secure line to evaporator housing (8).
8. Using support clamp (2) secure A/C lines to radiator frame.
9. Connect wiring connector to pressure transducer (3).
10. If previously moved, use clips to secure transmission oil cooler lines to radiator frame.
11. Install any assemblies that were removed to gain access to the compressor-to-condenser line (such as right splash panel, fixed grille, or recirculation shield). Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
12. Recharge the system. Refer to:
    a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
    b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
    c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.10. CLUTCH CYCLING ORIFICE TUBE

> **CAUTION – While handling the internal orifice tube in the following procedures, it is important to keep the entire A/C system as dirt free as possible.**

**NOTE – Refer to Figure 26 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. If necessary, remove right side splash panel. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
3. Unclip clamp (1) securing condenser-to-evaporator A/C line (2) to evaporator housing.
4. Disconnect condenser-to-evaporator A/C line fitting (2) from the orifice A/C line (3).
5. Using needle-nose pliers (or an orifice tube removal tool, if available), remove the internal clutch cycling orifice tube (4) from the orifice A/C line.

### Install

1. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).
2. Insure that an O-ring is installed on the internal clutch cycling orifice tube (4).

**NOTE – The internal clutch cycling orifice tube is directional. The end of the orifice tube nearest to the O-ring must be inserted into the A/C line first.**

3. Lubricate the O-ring with refrigerant oil and install the internal clutch cycling orifice tube (4) into the orifice A/C line (3). A resistance will be felt when the O-ring is seated.

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

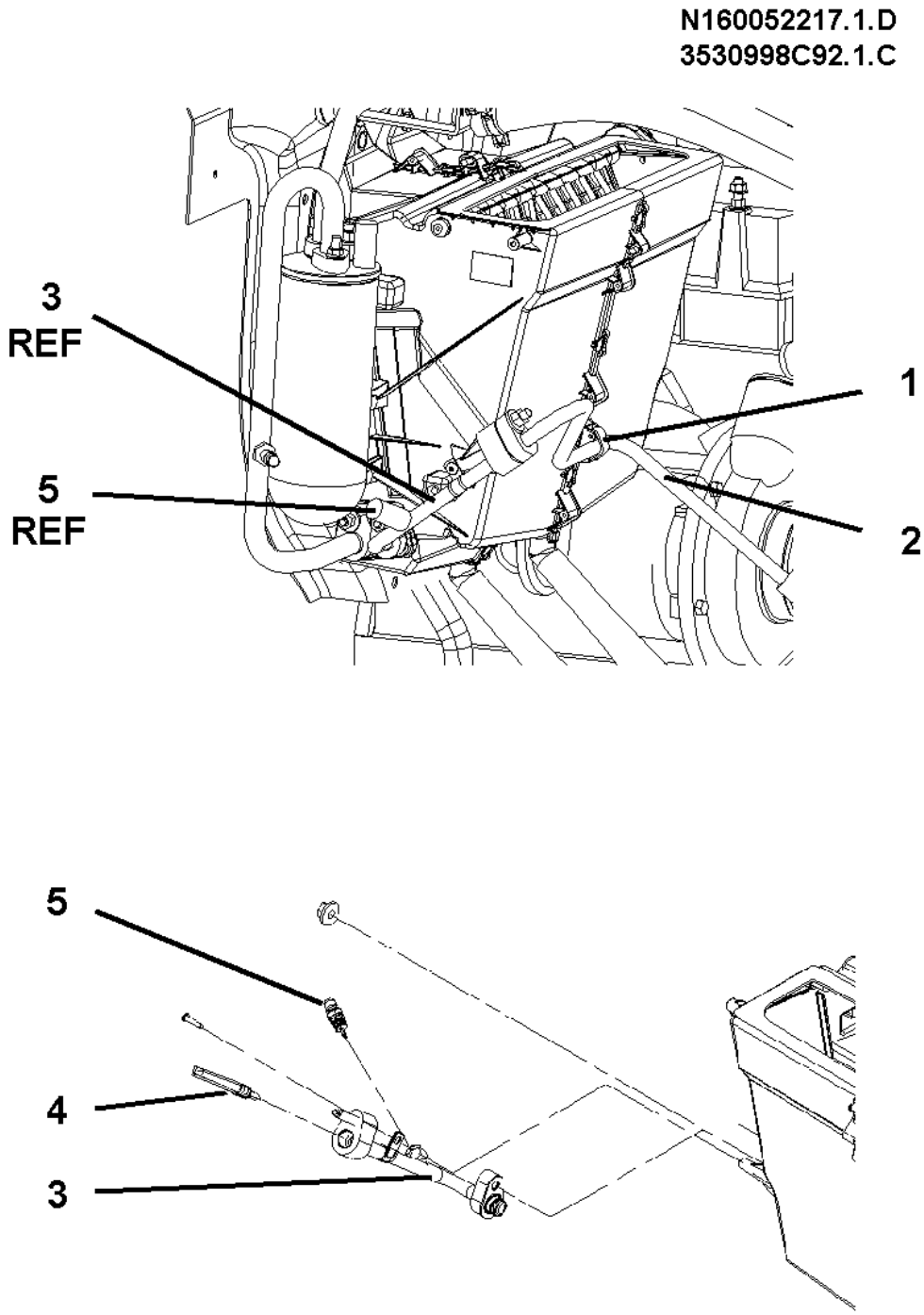



**Figure 26 Orifice Line and Components**

1. MOUNTING CLIP (CONDENSER-TO-EVAPORATOR LINE)
2. CONDENSER-TO-EVAPORATOR LINE
3. ORIFICE LINE
4. CLUTCH CYCLING ORIFICE TUBE
5. THERMISTOR

4. Using a new O-ring and C-plate connect condenser-to-evaporator line (2) to fitting on the end of the orifice A/C line (3). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
5. Secure condenser-to-evaporator line to evaporator housing using mounting clip (1).
6. Install right side splash panel, if previously removed.
7. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.11. A/C REFRIGERANT LINE (ORIFICE LINE, INCLUDING CLUTCH CYCLING ORIFICE TUBE)

**CAUTION – While handling the thermistor and the internal orifice tube in the following procedures, it is important to keep these components dirt free.**

**NOTE – Refer to Figure 26 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. If necessary, remove right side splash panel. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
3. Disconnect wiring connector to thermistor (5).
4. Unclip clamp (1) securing condenser-to-evaporator A/C line (2) to evaporator housing.
5. Disconnect condenser-to-evaporator A/C line fitting from the orifice A/C line (3).
6. Disconnect clamp securing orifice line to evaporator housing.
7. Disconnect end of orifice line (3) connected to evaporator inlet fitting.
8. Remove orifice A/C line (3).
9. If necessary, remove and retain the thermistor (5) and the clamp from the A/C orifice line.

## Install

**NOTE – If the new orifice A/C line was supplied with an internal orifice tube and clamp installed, it is unnecessary to transfer those parts from the old orifice A/C line.**

1. Transfer the thermistor (5) and the clamp from the removed orifice line to the new orifice line (3).
2. Install a new internal clutch cycling orifice tube into the new orifice line (3).
   a. Insure that an O-ring is installed on the internal clutch cycling orifice tube (4).

      **NOTE – The internal clutch cycling orifice tube is directional. The end of the orifice tube nearest to the O-ring must be inserted into the A/C line first.**

   b. Lubricate the O-ring with refrigerant oil and install the internal clutch cycling orifice tube (4) into the orifice A/C line (3). A resistance will be felt when the O-ring is seated.

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

3. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).
4. Using a new O-ring and C-plate connect one end of orifice A/C line to the evaporator inlet fitting. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
5. Secure orifice line to the evaporator housing using the clamp.
6. Using a new O-ring and C-plate connect condenser-to-evaporator line (2) to fitting on the end of the orifice A/C line. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
7. Secure condenser-to-evaporator line to evaporator housing using mounting clip (1).
8. Install right side splash panel, if previously removed.
9. Recharge the system. Refer to:
   a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
   b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
   c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.12. ACCUMULATOR

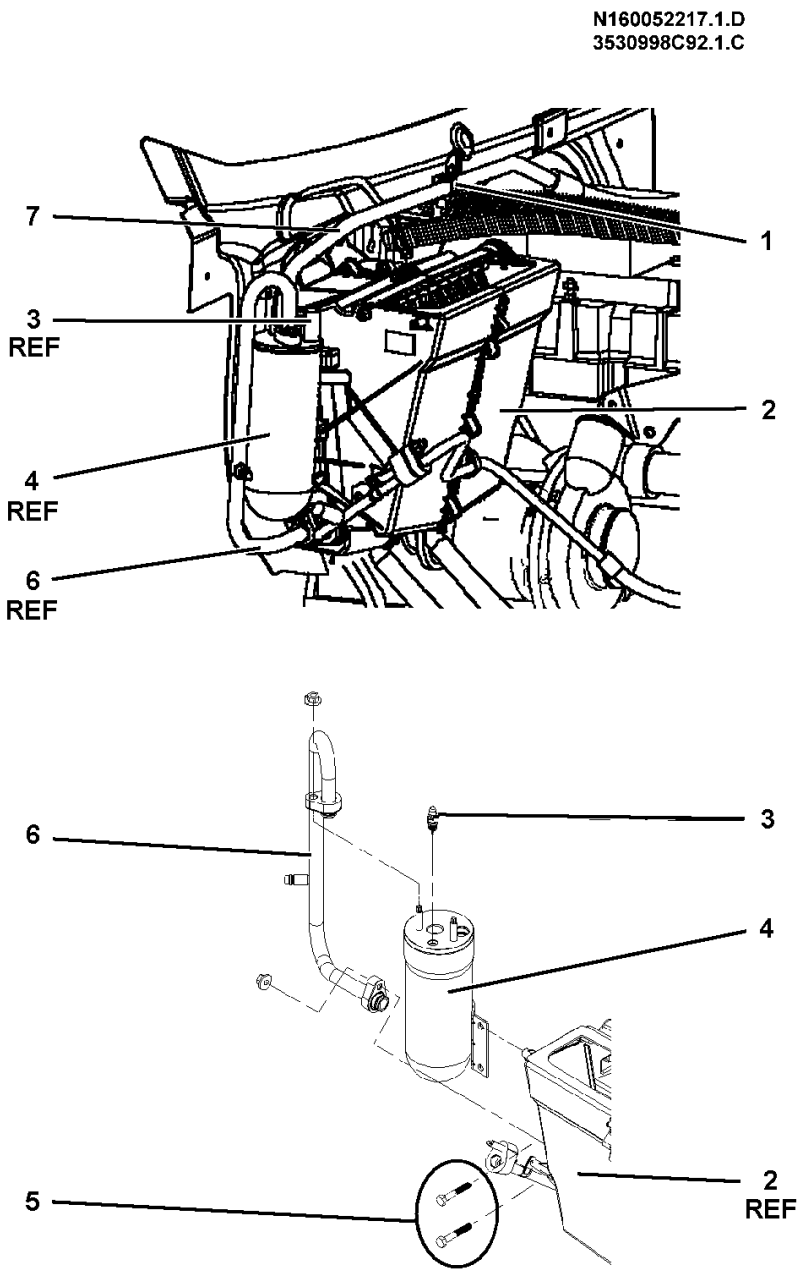



**Figure 27 Accumulator (Shown with Splash Panel and Cowl Tray Removed)**

1. MOUNTING CLAMP (ACCUMULATOR-TO-COMPRESSOR LINE)
2. EVAPORATOR HOUSING
3. THERMISTOR
4. ACCUMULATOR
5. MOUNTING BOLTS (ACCUMULATOR)
6. EVAPORATOR-TO-ACCUMULATOR LINE
7. ACCUMULATOR-TO-COMPRESSOR LINE

**IMPORTANT –** If the accumulator is one of multiple components being installed in the system, the accumulator should be the last component installed. This reduces the amount of time that the accumulator desiccant is exposed to atmospheric moisture.

**NOTE – Refer to Figure 27 while performing the following Remove and Install procedures.**

### Remove

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. If necessary, remove right side splash panel. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
3. Remove cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET (See COWL DRAIN TRAY/HVAC AIR INLET, page 79).
4. Disconnect wiring connection to thermistor (3) located on accumulator (4).
5. Disconnect end of suction line (7) connected to accumulator from compressor (accumulator-to-compressor line).
6. To allow movement of the accumulator-to-compressor line, remove or loosen the hose support clamps (1) and plastic ties used to secure the line to the cowl.
7. Disconnect evaporator-to-accumulator line (6) at evaporator outlet.
8. While supporting accumulator (4), remove two accumulator mounting bolts (5); then, remove the accumulator with the evaporator-to-accumulator line (6) attached.
9. Remove evaporator-to-accumulator line from accumulator.
10. Remove thermistor (3) from the accumulator.

### Install

1. Transfer thermistor from removed accumulator or install new thermistor (3) in new accumulator (4).
2. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

3. Using a new O-ring and C-plate install evaporator-to-accumulator line (6) on accumulator. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
4. Using a new O-ring and C-plate connect evaporator-to-accumulator line fitting to evaporator outlet. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
5. Using a new O-ring and C-plate connect fitting on accumulator-to-compressor line (7) to accumulator (4). Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).

6. Install accumulator (4) by using two accumulator mounting bolts (5) to secure the accumulator to the evaporator housing (2).

7. Connect wiring connection to thermistor (3) located on accumulator.

8. Using the hose support clamp (1) and plastic ties secure the accumulator-to-compressor line (7) to the cowl.

9. Install cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET (See COWL DRAIN TRAY/HVAC AIR INLET, page 79).

10. Install right side splash panel, if previously removed.

11. Recharge the system. Refer to:
    a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
    b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
    c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.13. ACTUATOR, (FRESH/RECIRCULATE) AIR DOOR

**NOTE – Refer to Figure 28 while performing the following Remove and Install procedures.**

### Remove

1. Disconnect wiring connector to actuator motor (1) for fresh/recirc air door.

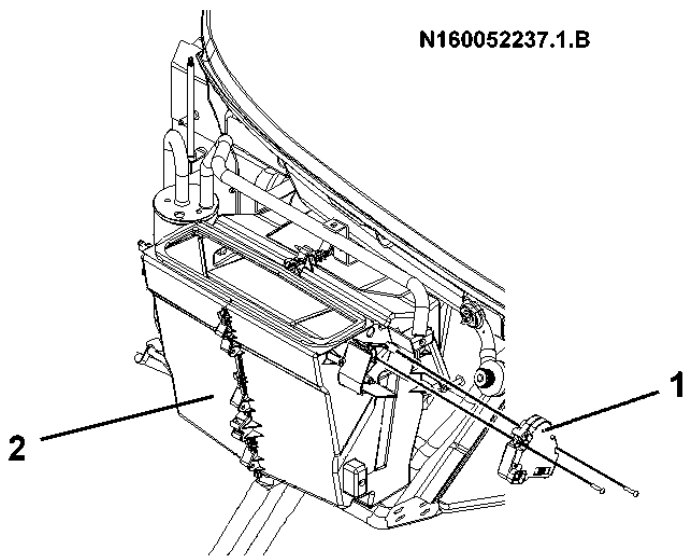



**Figure 28 Actuator for Fresh/Recirc Air Door**

1. FRESH/RECIRC AIR DOOR ACTUATOR
2. EVAPORATOR HOUSING

2. Remove two screws securing actuator (1) to evaporator housing (2).

3. Remove actuator.

### Install

**CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

1. It may be necessary to align the actuator drive collar to the door shaft before the actuator can be installed. If alignment is necessary:
   a. Place the actuator into its approximate position.
   b. Connect a 9 Volt battery across pins A and F of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)
   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.
2. Install actuator (1) on evaporator housing (2) using two screws.
3. Connect wiring connector to actuator motor for fresh/recirc air door.
4. Recalibrate the fresh/recirc air door by disconnecting the HVAC control panel assembly for at least 15 seconds. Refer to REMOVE AND INSTALL, HVAC CONTROL PANEL ASSEMBLY (See HVAC CONTROL PANEL ASSEMBLY, page 118).

## 6.14. AIR CONDITIONER (EVAPORATOR) HOUSING

### Remove

**NOTE – Refer to Figure 29 while performing the following steps.**

1. Discharge the A/C system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129).
2. If necessary, remove right side splash panel. Refer to HOOD, GRILLE, and FENDERS section in GROUP 09– FRONT END SHEET METAL in the Master Service Manual.
3. Remove cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET (See COWL DRAIN TRAY/HVAC AIR INLET, page 79).
4. If the air cleaner is mounted in front of the evaporator housing, perform steps 5 and 6; otherwise, proceed to step 7.
5. Disconnect air tube and all wiring from engine air cleaner housing.
6. Remove engine air cleaner mounting bracket from the cowl.

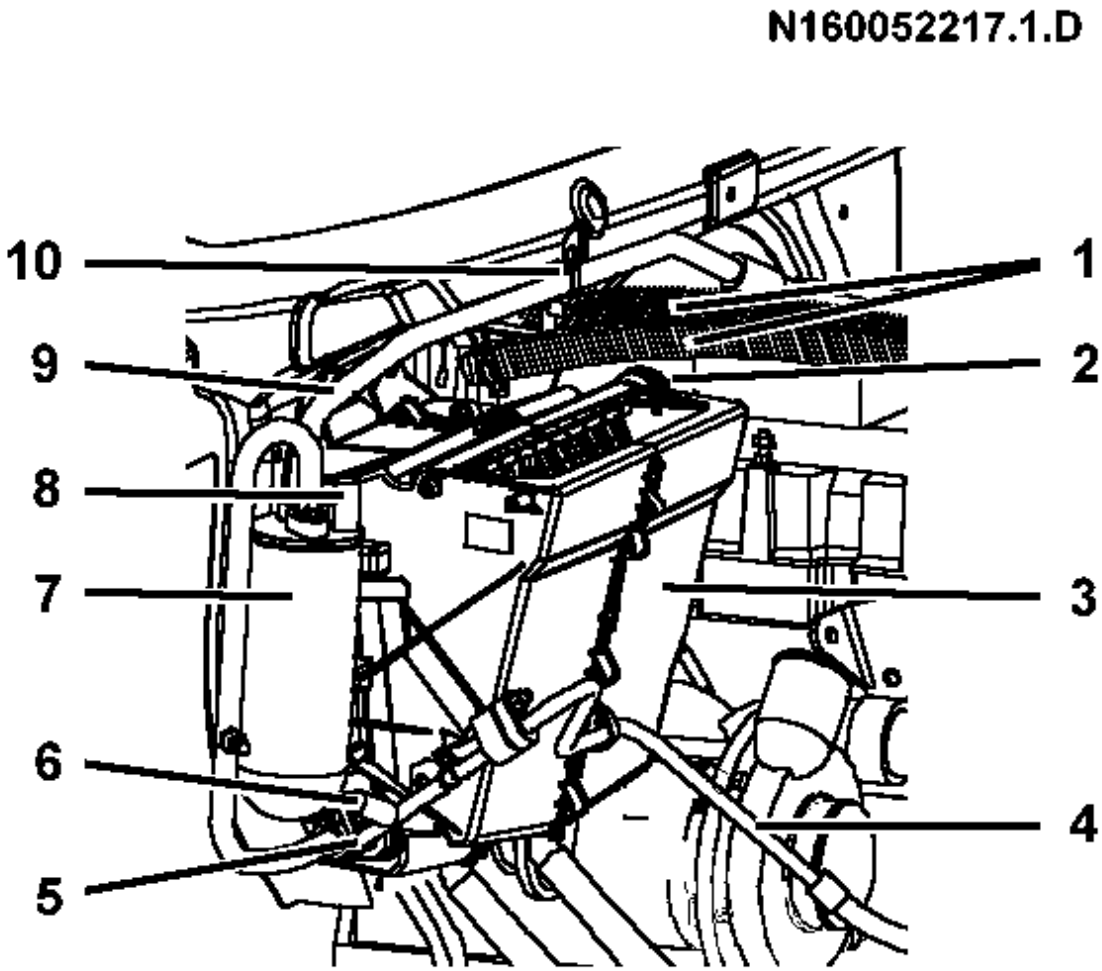



**Figure 29 Evaporator Housing (Shown with Cowl Tray Removed)**

1. HEATER HOSES
2. ACTUATOR, RECIRC AIR DOOR (HIDDEN)
3. EVAPORATOR HOUSING
4. CONDENSER-TO-EVAPORATOR LINE
5. ORIFICE LINE
6. THERMISTOR, INPUT
7. ACCUMULATOR
8. THERMISTOR, OUTPUT
9. ACCUMULATOR-TO-COMPRESSOR LINE
10. HOSE CLAMP

7. Disconnect wiring connector to actuator motor (2) for fresh/recirc air door (damper).

8. Disconnect wiring to thermistors (6 and 8) and cut plastic wire ties to allow the connectors to be moved out of the way.

9. Unclip or remove clamps securing orifice line and condenser-to-evaporator line (4) to evaporator housing (3).

10. Disconnect end of orifice line (5) connected to evaporator inlet fitting.

11. Unclip clamps (10) and/or wire ties securing accumulator-to-compressor line (9) to cowl.

12. Disconnect end of accumulator-to-compressor line from accumulator (7).

**NOTE – Refer to Figure 30 while performing the following steps.**

13. Remove the four nuts securing the evaporator housing (1, Figure 30) to the mounting studs on the cowl.

14. Carefully remove evaporator housing from the cowl.

**NOTE – Perform only the following steps that are required to transfer parts to a replacement housing or to replace defective parts within the removed housing.**

15. To remove accumulator (8), disconnect end of evaporator-to-accumulator line (9) connected to evaporator outlet (suction) fitting; then, remove two accumulator mounting bolts (7).

16. To remove recirc door actuator (4), remove two screws securing the actuator to evaporator housing (1).

17. Remove drain tubes (5) from the evaporator housing.

**CAUTION – While separating the evaporator housing be careful not to damage the fins or fittings on the evaporator core.**

**NOTE – Before separating the evaporator housing, the old mounting gasket should be removed and discarded.**

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

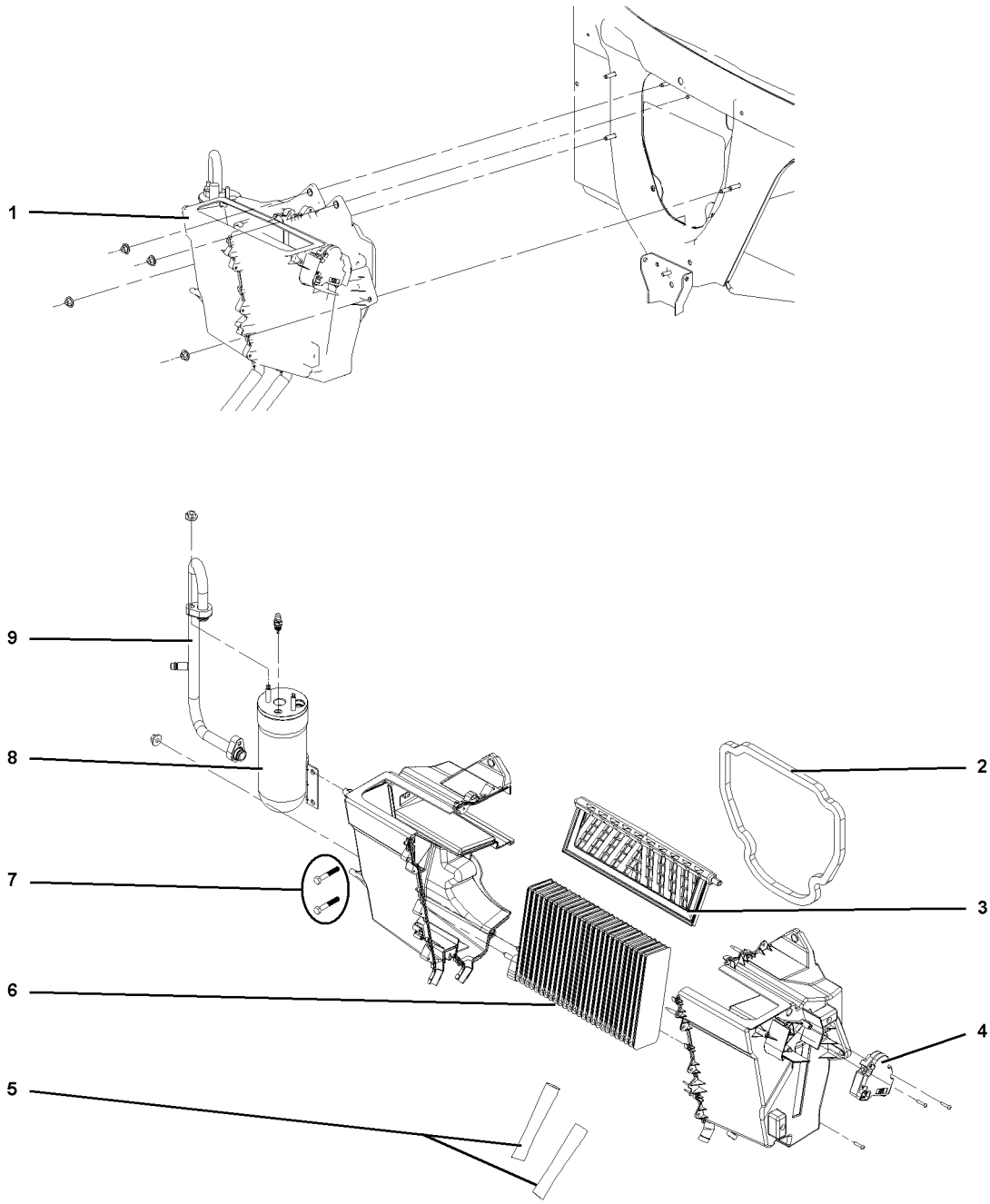



**Figure 30 Evaporator Housing Mounting and Components**

1. EVAPORATOR HOUSING
2. GASKET, EVAPORATOR HOUSING
3. RECIRCULATE/FRESH AIR DOOR
4. ACTUATOR, RECIRC DOOR
5. DRAIN TUBES
6. EVAPORATOR CORE
7. BOLTS, ACCUMULATOR MTG
8. ACCUMULATOR
9. EVAPORATOR-TO-ACCUMULATOR LINE

18. Separate the housing halves by removing one or more hi-lo thread screws, releasing the snap tabs, and pulling the halves straight away from each other.

19. To replace the evaporator core (6) refer to REMOVE AND INSTALL, EVAPORATOR CORE (See EVAPORATOR CORE, page 103).

20. To replace the fresh/recirculate air door (damper) (3) refer to REMOVE AND INSTALL, FRESH/RECIRCULATE AIR DOOR (DAMPER) (See FRESH/RECIRCULATE AIR DOOR (DAMPER), page 102).

21. When replacing a defective evaporator housing (or housing half), transfer all of the good components (evaporator core, fresh/recirculate door, door actuator, and drain tubes) from the broken housing to the new housing.

### Install

**NOTE – Depending on the level of disassembly required for the repair, some of the following steps may not be necessary for each installation.**

**NOTE – Refer to Figure 30 while performing the following steps.**

1. If the system is to be flushed or purged, perform that operation before reassembling the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

2. When installing a new evaporator housing (1) or reinstalling a housing that was removed for service, verify that all of the internal components (evaporator core and fresh/recirculate door) are installed in the housing before joining the housing halves.

3. To install the evaporator core (6) refer to REMOVE AND INSTALL, EVAPORATOR CORE (See EVAPORATOR CORE, page 103).

4. To install the fresh/recirculate air door (3) refer to REMOVE AND INSTALL, FRESH/RECIRCULATE AIR DOOR (DAMPER) (See FRESH/RECIRCULATE AIR DOOR (DAMPER), page 102).

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

5. Join the housing halves by using the snap tabs and one screw. If any of the snap tabs have been damaged, use additional hi-lo thread screws in the molded joining tabs to securely join the halves.

**CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

6. Install the fresh/recirculate air door actuator (4) by aligning the flats on the door shaft with the actuator hub, if possible. Secure the actuator with two screws. If alignment is necessary:
   a. Place the actuator into its approximate position.
   b. Connect a 9 Volt battery across pins A and F of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)
   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.
7. Install the drain tubes (5).
8. Loosely mount the accumulator (8) to the evaporator housing assembly by placing it into position and threading the two mounting bolts (7) into their holes. Do not tighten.

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

9. Using a new O-ring and C-plate connect end of evaporator-to-accumulator line (9) to outlet (suction) fitting of evaporator core. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
10. Tighten the two accumulator mounting bolts (7).
11. Using a new gasket/seal (2), install evaporator housing (1) onto the mounting studs located on the cowl using four nuts. Tighten to 6500 N.mm (57.5 lbf-in).

**NOTE – Refer to Figure 29 while performing the following steps.**

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

12. Using a new O-ring and C-plate connect end of accumulator-to-compressor line (9, Figure 29) to accumulator. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
13. Using a new O-ring and C-plate connect end of orifice line (5) to evaporator inlet fitting. Tighten to 20,000 ±1000 N.mm (180 ±10 lbf-in).
14. Connect wiring to thermistors (6 and 8) and secure wires using plastic wire ties.
15. Connect wiring connector to actuator motor (2) for fresh/recirc air door (damper).
16. Secure accumulator-to-compressor line (9) to cowl using hose clamps (10).
17. Secure orifice line (5) and condenser-to-evaporator line (4) to evaporator housing (3) using hose clamps.
18. If the air cleaner was mounted in front of the evaporator housing, perform steps 18 and 19; otherwise, proceed to step 20.
19. Install engine air cleaner mounting bracket to cowl.

20. Connect air tube and wiring to engine air cleaner housing.

21. Install cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET(See COWL DRAIN TRAY/HVAC AIR INLET, page 79).

22. Install right side splash panel, if previously removed.

23. Recalibrate the fresh/recirc air door by disconnecting the HVAC control panel assembly for at least 15 seconds. Refer to REMOVE AND INSTALL, HVAC CONTROL PANEL ASSEMBLY (See HVAC CONTROL PANEL ASSEMBLY, page 118).

24. Recharge the system. Refer to:
    a. OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141);
    b. EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
    c. CHARGING THE AIR CONDITIONING SYSTEM (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 6.15. FRESH/RECIRCULATE AIR DOOR (DAMPER)

**NOTE – Refer to Figure 30 while performing the following procedures.**

### Remove

1. Remove evaporator housing (1) from cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

> CAUTION – **While separating the evaporator housing be careful not to damage the fins or fittings on the evaporator core.**

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

2. Separate the housing halves by removing one or more screws, releasing the snap tabs, and pulling the halves straight away from each other.

3. When the housing is separated the fresh/recirc air door (3) is accessible.

4. Remove the fresh/recirc air door. If parts have been broken off of the door, verify that no parts are lodged in the housing or the evaporator core (6).

### Install

**CAUTION – While assembling the evaporator housing be careful not to damage the fins or fitting on the evaporator core.**

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

1. Align the evaporator housing halves with the evaporator core (6) and the fresh/recirc air door (3) installed between them. (If the door actuator was not removed, align the flats on the door shaft with the actuator hub.)

2. Join the housing halves by using the snap tabs and one screw. If any of the snap tabs have been damaged, use additional hi-lo thread screws in the molded joining tabs to securely join the halves.

**CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

3. If the fresh/recirculate air door actuator was previously removed, install the actuator (4) by aligning the flats on the door shaft with the actuator hub, if possible. Secure the actuator with two screws. If alignment is necessary:
   a. Place the actuator into its approximate position.
   b. Connect a 9 Volt battery across pins A and F of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)
   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.

4. Install evaporator housing (1) onto cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

## 6.16. EVAPORATOR CORE

**NOTE – Refer to Figure 30 while performing the following procedures.**

### Remove

1. Remove evaporator housing (1) from cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

**CAUTION – While separating the evaporator housing be careful not to damage the fins or fittings on the evaporator core.**

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

2. Separate the housing halves by removing one or more screws, releasing the snap tabs, and pulling the halves straight away from each other.

3. When the housing is separated, the evaporator core (6) is accessible.

4. Remove the evaporator core.

### Install

**CAUTION – While assembling the evaporator housing be careful not to damage the fins or fitting on the evaporator core.**

**NOTE – The housing halves normally snap together and are secured with one screw (hi-lo thread); however, mounting tabs are provided to allow assembling the halves with additional hi-lo thread screws if the plastic snaps are damaged during disassembly. The mounting tabs are designed specifically to use only hi-lo thread screws.**

1. Align the evaporator housing halves with the evaporator core (6) and the fresh/recirc air door (3) installed between them. (If the door actuator was not removed, align the flats on the door shaft with the actuator hub.)

2. Join the housing halves by using the snap tabs and one screw. If any of the snap tabs have been damaged, use additional hi-lo thread screws in the molded joining tabs to securely join the halves.

**CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

3. If the fresh/recirculate air door actuator was previously removed, install the actuator (4) by aligning the flats on the door shaft with the actuator hub, if possible. Secure the actuator with two screws. If alignment is necessary:

   a. Place the actuator into its approximate position.

   b. Connect a 9 Volt battery across pins A and F of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)

   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.

4. Install evaporator housing onto cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

## 6.17. HEATER TRIM COVER


**Figure 31 In-Cab HVAC Components**

1. HVAC CONTROL PANEL
2. CENTER IP TRIM PANEL (BEZEL)
3. PASSENGER SIDE INSTRUMENT PANEL COVER
4. HEATER TRIM COVER

**NOTE – The heater trim cover must be removed prior to removing any of the HVAC components located under the right side of the instrument panel (IP).**

**NOTE – Refer to Figure 31 while performing the following Remove and Install procedures.**

### Remove

1. Remove the passenger side instrument panel cover (3) by pulling the top of the cover away from the IP to release the spring clips, then lift the cover up.

2. Remove nine screws from the heater trim cover (4).

3. Remove the cover by pulling it straight back.

### Install

1. Secure the heater trim cover (4) to the heater housing with nine screws.

2. Install the passenger side instrument panel cover (3) by inserting the two tabs at the bottom of the cover into the sockets in the IP; then press the top of the cover toward the IP to engage the spring clips.

## 6.18. ACTUATOR MOTOR, TEMPERATURE BLEND DOOR

**NOTE – Refer to Figure 32 while performing the following Remove and Install procedures.**

### Remove

1. Remove the passenger side instrument panel cover by pulling the top of the cover away from the IP to release the spring clips, then lift the cover up.

2. Remove nine screws from the heater trim cover (4).

3. Remove the cover by pulling it straight back.

4. Disconnect the electrical plug connected to the temperature blend door actuator motor (6).

5. Remove the two screws securing the actuator to the blower scroll housing (3), and pull the actuator (6) straight off of the temperature blend door shaft.

### Install

> **CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

1. Carefully slip the actuator (6) onto the end of the temperature blend door shaft so that the mounting holes are properly aligned, if possible. If alignment is necessary:
   a. Place the actuator into its approximate position.
   b. Connect a 9 Volt battery across pins A and F of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)
   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.

2. Secure the actuator to the blower scroll housing (3) using two screws.

3. Connect the electrical control plug to the temperature blend door actuator motor (6).

4. Secure the heater trim cover (4) to the heater housing with nine screws.

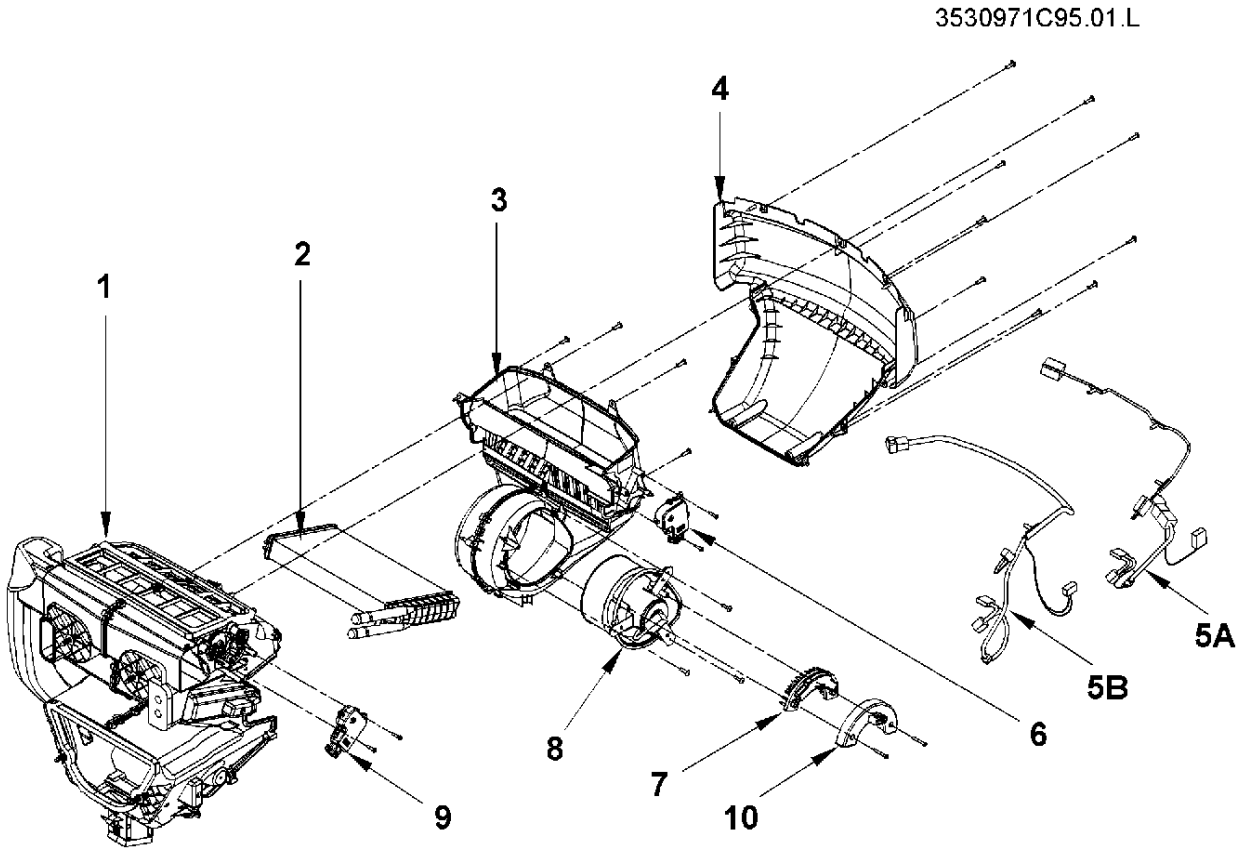



**Figure 32 Heater Unit Exploded View**

1. HEATER HOUSING
2. HEATER CORE
3. BLOWER SCROLL HOUSING
4. HEATER TRIM PANEL

5A. BLOWER WIRE HARNESS (EARLY PRODUCTION - 2 PIECE)
5B. BLOWER WIRE HARNESS (LATE PRODUCTION - 1 PIECE)

6. ACTUATOR, TEMPERATURE BLEND DOOR
7. LINEAR POWER MODULE (BLOWER SPEED CONTROL)
8. BLOWER ASSEMBLY
9. ACTUATOR, MODE CONTROL DOOR
10. LINEAR POWER MODULE COVER

5. Install the passenger side instrument panel cover by inserting the two tabs at the bottom of the cover into the sockets in the IP; then press the top of the cover toward the IP to engage the spring clips.

6. Recalibrate the temperature blend door by disconnecting the HVAC control panel assembly for at least 15 seconds. Refer to REMOVE AND INSTALL, HVAC CONTROL PANEL ASSEMBLY (See HVAC CONTROL PANEL ASSEMBLY, page 118).

## 6.19. ACTUATOR MOTOR, MODE DOOR

**NOTE – Refer to Figure 32 while performing the following Remove and Install procedures.**

### Remove

1. Remove the passenger side instrument panel by pulling the top of the cover away from the IP to release the spring clips, then lift the cover up.
2. Remove nine screws from the heater trim cover (4).
3. Remove the cover by pulling it straight back.
4. Disconnect the electrical plug connected to the mode door actuator motor (9).
5. Remove the two screws securing the actuator (9) to the heater housing (1), and pull the actuator straight off of the mode door shaft.

### Install

> **CAUTION – In the following step, never force the actuator drive collar into position. If the drive collar position must be changed, follow the following procedures. Forcing the drive collar may result in a broken actuator.**

1. Carefully slip the actuator (9) onto the end of the mode door shaft so that the mounting holes are properly aligned, if possible. If alignment is necessary:
   a. Place the actuator into its approximate position.
   b. Connect a 9 Volt battery across pins A and B of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)
   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.
2. Secure the actuator to the heater housing (1) using two screws.
3. Connect the electrical control plug to the mode door actuator motor (9).
4. Secure the heater trim cover (4) to the heater housing with nine screws.
5. Install the passenger side instrument panel cover by inserting the two tabs at the bottom of the cover into the sockets in the IP; then press the top of the cover toward the IP to engage the spring clips.
6. Recalibrate the mode air door by disconnecting the HVAC control panel assembly for at least 15 seconds. Refer to REMOVE AND INSTALL, HVAC CONTROL PANEL ASSEMBLY (See HVAC CONTROL PANEL ASSEMBLY, page 118).

## 6.20. BLOWER SCROLL HOUSING

### Remove

**NOTE – The following steps must be performed prior to removing the heater core, the heater core housing, or any of the components within the blower scroll housing.**

1. Remove passenger side IP cover, heater trim panel, and temperature blend door actuator motor. Refer to REMOVE AND INSTALL, ACTUATOR MOTOR, TEMPERATURE BLEND DOOR (See ACTUATOR MOTOR, TEMPERATURE BLEND DOOR, page 106).

**NOTE – Refer to Figure 32 while performing the following steps.**

2. Remove the four screws securing the blower scroll housing (3) to the heater housing assembly (1).

**NOTE – In the following step the wiring connections to the linear power module (LPM) and blower motor must be disconnected once the housing is partially separated from the heater housing.**

3. Carefully separate the blower scroll housing (3) from the heater housing (1).

4. With the blower scroll housing removed, the blower assembly (8), linear power module (7), and heater core (2) are accessible for service.

5. When replacing a defective scroll housing, transfer all of the good components: blower assembly (8), linear power module (7), and temperature door actuator (6), from the broken housing to the new housing.

### Install

**NOTE – Refer to Figure 32 while performing the following steps.**

**NOTE – Depending on the level of disassembly required for the repair, some of the following steps may not be necessary for each installation.**

1. If removed previously, install the blower assembly (8), using three screws.

2. If removed previously, install the linear power module (7) and LPM cover (10), using two screws.

3. Before installing the blower scroll housing, verify that the heater core (2) is installed in the heater housing (1). To install the heater core refer to REMOVE AND INSTALL, HEATER CORE (See HEATER CORE, page 111).

4. Position the blower scroll housing so that the electrical connections to the linear power module and the blower motor can be connected. After connection, position any excess wire so that it will not interfere with the installation of the blower scroll housing.

**NOTE – When installing the blower scroll housing in the following step, pay close attention to how the edges of the housing walls mate up with the walls of the heater housing.**

5. Carefully install the blower scroll housing so that the housing walls interlock with the walls of the heater housing, and the mounting holes line up.

6. Secure the blower scroll housing (3) to the heater housing using four screws.

7. Install temperature blend door actuator motor, heater trim cover, and passenger side IP cover; refer to REMOVE AND INSTALL, ACTUATOR MOTOR, TEMPERATURE BLEND DOOR, (See ACTUATOR MOTOR, TEMPERATURE BLEND DOOR, page 106).

## 6.21. LINEAR POWER MODULE

**NOTE – Refer to Figure 32 while performing the following Remove and Install procedures.**

### Remove

1. Remove blower scroll housing (3), refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING, (See BLOWER SCROLL HOUSING, page 109).

2. Detach the linear power module (7) and the LPM cover (10) from the blower scroll housing (3) by removing the two mounting screws.

### Install

1. Secure the linear power module (7) and the LPM cover (10) to the blower scroll housing (3) with two screws.

2. Install blower scroll housing, refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING (See BLOWER SCROLL HOUSING, page 109).

## 6.22. BLOWER ASSEMBLY

**NOTE – Refer to Figure 32 while performing the following Remove and Install procedures.**

### Remove

1. Remove blower scroll housing (3), refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING, (See BLOWER SCROLL HOUSING, page 109)

2. Detach the linear power module (7) and the LPM cover (10) from the blower scroll housing (3) by removing the two mounting screws.

3. Remove blower assembly (8) by removing the three screws securing it to the scroll housing (3).

### Install

1. Install blower assembly (8) by securing it to the scroll housing (3) with three screws.

2. Secure the linear power module (7) and the LPM cover (10) to the blower scroll housing with two screws.

3. Install blower scroll housing, refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING, (See BLOWER SCROLL HOUSING, page 109)

## 6.23. HEATER CORE

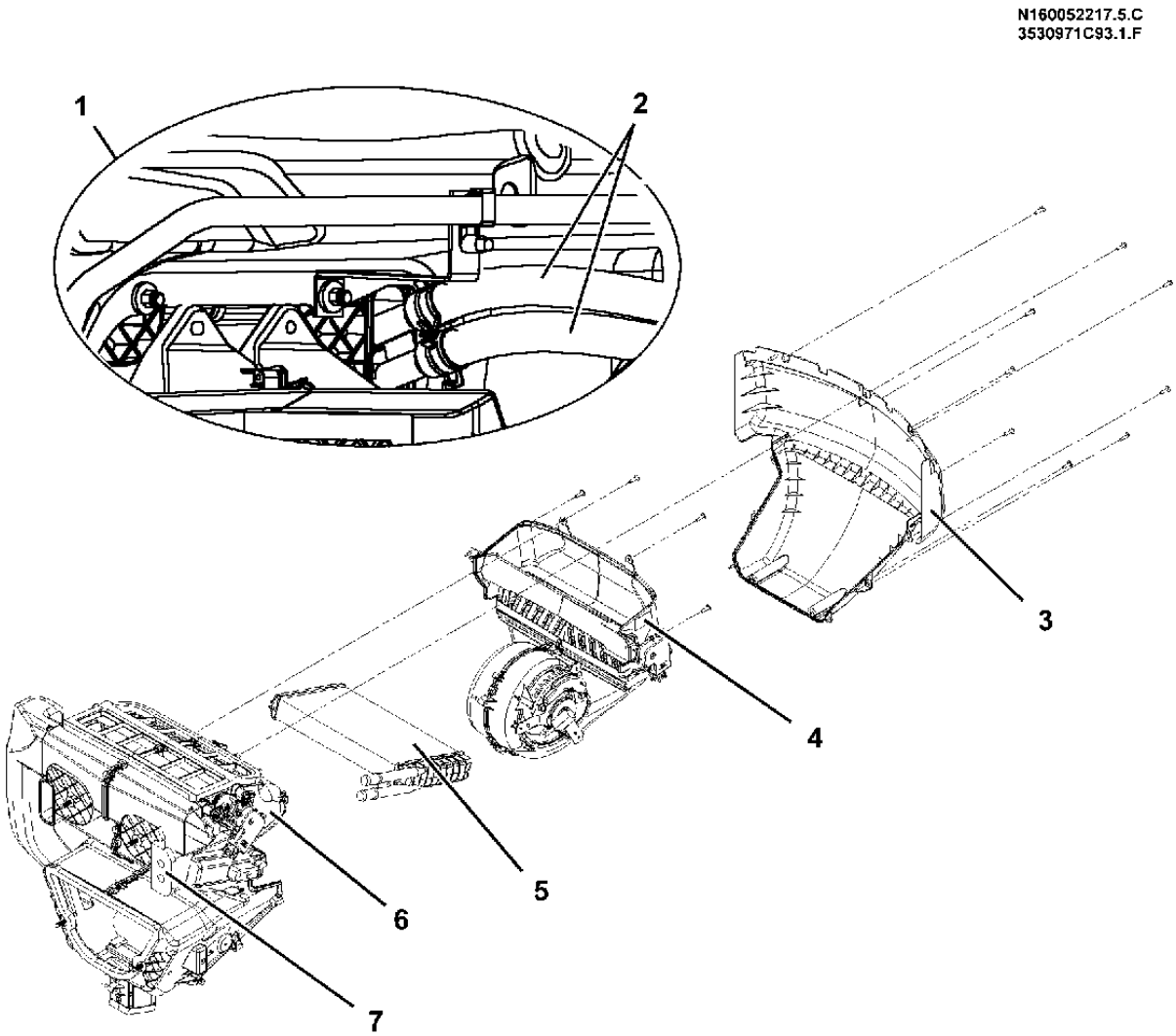



**Figure 33 Heater Component Locations**

1. VIEW OF COWL (UNDER HOOD)
2. HEATER HOSES
3. HEATER TRIM PANEL
4. BLOWER SCROLL HOUSING
5. HEATER CORE
6. HEATER HOUSING
7. SEAL, HEATER CORE TUBES

**NOTE – Refer to Figure 33 while performing the following Remove and Install procedures.**

## Remove

**WARNING – Allow the engine to cool down before removing the pressure cap from the deaeration tank. ALWAYS INSULATE the cap by wrapping it with a thick, heavy cloth. To prevent possible injury from scalding water or steam, DO NOT pull the pressure cap off immediately when it has been loosened to the first "notch." Pause momentarily to allow time for excess pressure to release through the overflow tube.**

1. Drain engine coolant. Refer to GROUP 12-COOLING in the Master Service Manual.
2. Remove cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET (See COWL DRAIN TRAY/HVAC AIR INLET, page 79).
3. Remove both heater hoses (2) from heater core tube connections on engine side of cowl.
4. From inside the cab, remove blower scroll housing. Refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING (See BLOWER SCROLL HOUSING, page 109).

**NOTE – The heater core is mounted at a slight angle and therefore retains a small amount of coolant in the core. Be careful to keep the core in an upright position until the coolant can be drained.**

5. Pull the heater core (5) out of the heater housing (6).

## Install

**NOTE – In the following step insure that the heater housing seal (7) that surrounds the heater core tubes does not become dislodged while installing the heater core.**

1. From inside the cab, carefully position the heater core (5) in the heater housing (6) so that the tube ends of the core protrude through the dash panel seal (7).
2. Install blower scroll housing (4). Refer to REMOVE AND INSTALL, BLOWER SCROLL HOUSING, (See BLOWER SCROLL HOUSING, page 109)

**NOTE – In the following step position the heater hose clamps to allow easy access for their next removal.**

3. On the engine side of cowl, install heater hoses (2) and clamps.
4. Fill the cooling system with coolant. Refer to GROUP 12-COOLING in the Master Service Manual, or the Operator Manual supplied with the vehicle.

**IMPORTANT –** Verify that the coolant system is leak-free before proceeding to the following steps.

5. Install cowl drain tray/HVAC air inlet. Refer to REMOVE AND INSTALL, COWL DRAIN TRAY/HVAC AIR INLET (See COWL DRAIN TRAY/HVAC AIR INLET, page 79).

## 6.24. HEATER HOUSING

**NOTE – Removing and installing the heater housing requires detaching and raising the Instrument Panel (IP). Replacement of the heater housing is necessary only if either the mode door mechanism or the housing itself are damaged. In either case the entire heater housing is replaced as an assembly.**

### Remove

1. Inside the cab, remove the A-pillar trim from the driver's side.

2. Remove the assist handle and the A-pillar trim from the passenger's side.

**NOTE – Refer to Figure 34 while performing the following procedures.**

3. Remove the five bolts (1) securing the top of the IP to the dash panel (located near the windshield).

4. Remove the two bolts (2) securing the steering column module to the IP.

5. Remove the two bolts (3) securing each side of the IP to the dash panel.

**NOTE – Refer to Figure 35 while performing the following procedures.**

6. To gain access to the mounting studs (6) for the heater housing (1), the evaporator housing (7) must be removed from the cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

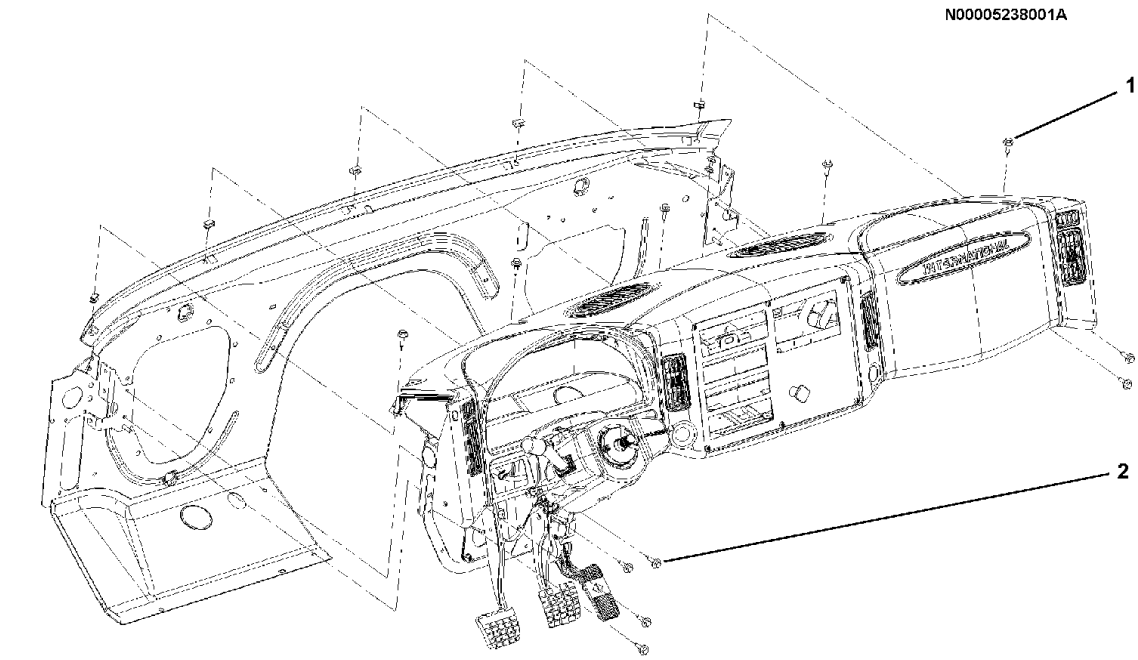
7. Remove the heater core (4) and related components, refer to REMOVE AND INSTALL, HEATER CORE, (See HEATER CORE, page 111).

8. Disconnect the HVAC wiring harness (3) from the instrument panel wiring harness.

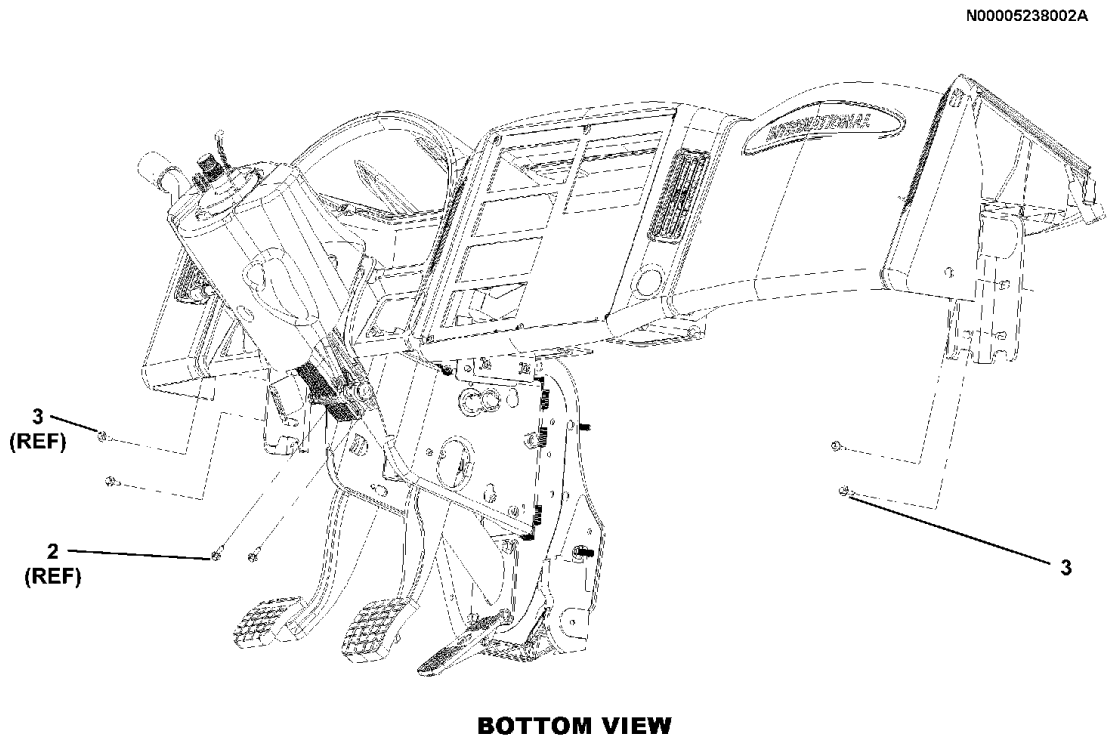
**NOTE – It may be possible to remove the heater housing without disconnecting the passenger side floor duct (10); however, the following steps are provided as an alternative.**

**NOTE – The driver side duct (5) is connected to the heater housing with a snap mount (slip-lock). This duct is also mounted to the dash panel with one mounting screw.**

**NOTE – There are two gaskets attached to the exterior of the heater housing. There is one gasket (8) where the housing mounts to the dash panel; and another gasket (9) where the IP rests on top of the housing. Try not to damage the gaskets when moving the housing or the IP.**




**TOP VIEW**




**BOTTOM VIEW**

**Figure 34 Instrument Panel Mounting**

1. TOP INSTRUMENT PANEL MOUNTING BOLTS
2. STEERING MODULE BOLTS
3. SIDE INSTRUMENT PANEL MOUNTING BOLTS

**NOTE – In the following step, it will be necessary to raise the IP slightly while removing the heater housing. This may require a second or third person.**

9. Lift the IP and brace it so that it provides the greatest amount of clearance for removing the heater housing.

10. Disconnect passenger side floor duct (10) from the heater housing. It is mounted to the side of the housing with one screw. The top of the duct is connected to the housing with a snap mount (slip-lock), and is disconnected by pulling the duct away from the housing.

11. Remove the mounting screw (11) for the driver side floor duct (5) and move the duct to the left to disconnect it from the housing.

12. On the engine side of the dash panel, remove the four nuts (6) from the heater housing mounting studs.

13. Pull the heater housing to the rear (to allow its mounting studs to clear the dash panel). The heater housing (1) should now be clear to slide out from under the IP.

14. If the mode door actuator motor (2) is being transferred to a replacement housing, remove the two screws securing the actuator motor to the heater housing (1), and pull the actuator straight off of the mode door shaft.

### Install

**NOTE – A new heater housing is supplied with the passenger side floor duct installed. It may be possible to install the heater housing without removing the passenger side floor duct; however, the following procedure is provided as an alternative installation method.**

**NOTE – Refer to Figure 35 while performing the following procedures.**

1. Disconnect passenger side floor duct (10) from the new heater housing. It is mounted to the side of the housing with one screw. The top of the duct is connected to the housing with a snap mount (slip-lock), and is disconnected by pulling the duct away from the housing.

2. Carefully slip the mode door actuator motor (2) from the removed housing, onto the end of the mode door shaft so that the mounting holes are properly aligned, if possible. Secure the actuator with two screws. If alignment is necessary:

   a. Place the actuator into its approximate position.

   b. Connect a 9 Volt battery across pins A and B of the actuator connector, to rotate the drive collar. (Reverse the connection to rotate the drive collar in the opposite direction.)

   c. Allow the drive collar to rotate until it is aligned with the door shaft, and the actuator mounting screws can be inserted. Then, disconnect 9 Volt battery.

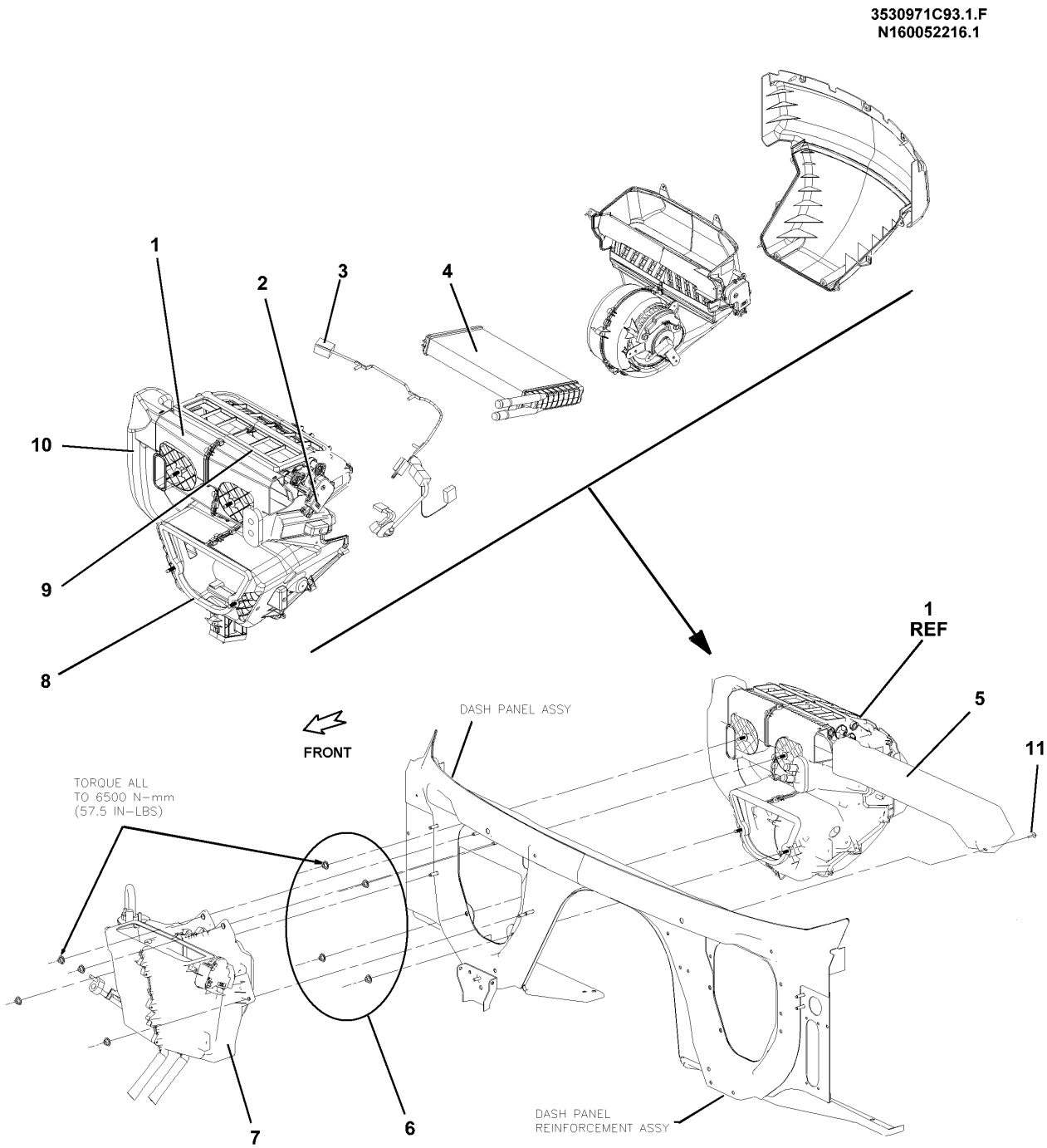



**Figure 35 Heater Housing Mounting Diagram**

1. HEATER HOUSING
2. ACTUATOR MOTOR, MODE DOOR
3. DASH WIRING HARNESS
4. HEATER CORE
5. DRIVER SIDE DUCT
6. MOUNTING NUTS, HEATER HOUSING
7. EVAPORATOR HOUSING
8. GASKET/SEAL, HEATER HOUSING COWL FACE
9. GASKET/SEAL, HEATER HOUSING TOP FACE
10. PASSENGER FLOOR DUCT
11. DRIVER DUCT MOUNTING SCREW

**NOTE – In the following step, the IP must be raised slightly while installing the heater housing. This may require a second or third person. To insure proper alignment and compression of the heater housing top gasket, the IP must remain raised until the heater housing is securely mounted.**

**IMPORTANT –** While performing the following steps be careful not to damage the gaskets when moving the heater housing or the IP.

3. Lift the IP and brace it so that it provides the greatest amount of clearance for installing the heater housing.

4. Position the passenger side floor duct (10) under the IP, approximately in its final position.

5. With the IP raised, carefully position the heater housing (1) under the passenger side instrument panel, so that its mounting studs protrude through the matching holes in the dash panel.

6. Connect the top of the passenger side floor duct (10) to the outlet of the heater housing (1). This is a slip-lock type snap joint.

7. On the engine side of the dash panel, secure the heater housing by installing four nuts (6) on the mounting studs. Tighten to 6500 N.mm (57.5 lbf-in).

8. Secure the passenger side floor duct to the side of the heater housing using one screw.

**NOTE – The driver side duct (5) is connected to the heater housing with a snap mount (slip-lock).**

9. Connect the driver's side floor duct (5) to the heater housing by slipping the end of the duct over the heater housing outlet. Secure the floor duct to the dash panel under the instrument panel using its mounting screw (11).

10. Carefully allow the IP to return to its normal resting position.

11. Connect the HVAC wiring harness (3) to the instrument panel wiring harness.

12. Install heater core (4) and related components, refer to REMOVE AND INSTALL, HEATER CORE, (See HEATER CORE, page 111).

13. Install evaporator housing (7) onto the cowl. Refer to REMOVE AND INSTALL, AIR CONDITIONER (EVAPORATOR) HOUSING (See AIR CONDITIONER (EVAPORATOR) HOUSING, page 96)

**NOTE – Refer to Figure 34 while performing the following procedures.**

14. Install the two bolts (3) securing each side of the IP to the dash panel.

15. Install the two bolts (2) securing the steering column module to the IP.
16. Install the five bolts (1) securing the top of the IP to the dash panel (located near the windshield).
17. Inside the cab, install the assist handle and the A-pillar trim on the passenger's side.
18. Install the A-pillar trim on the driver's side.

## 6.25. HVAC CONTROL PANEL ASSEMBLY

**NOTE – Refer to Figure 36 while performing the following steps.**

### Remove

> **CAUTION – Place the ignition key in the OFF position before removing or installing the HVAC control panel assembly.**

1. The trim plate is secured by five spring clips. Carefully pry the trim plate (1) from the center section of the IP.
2. Remove four screws securing HVAC control panel assembly (2) to IP.

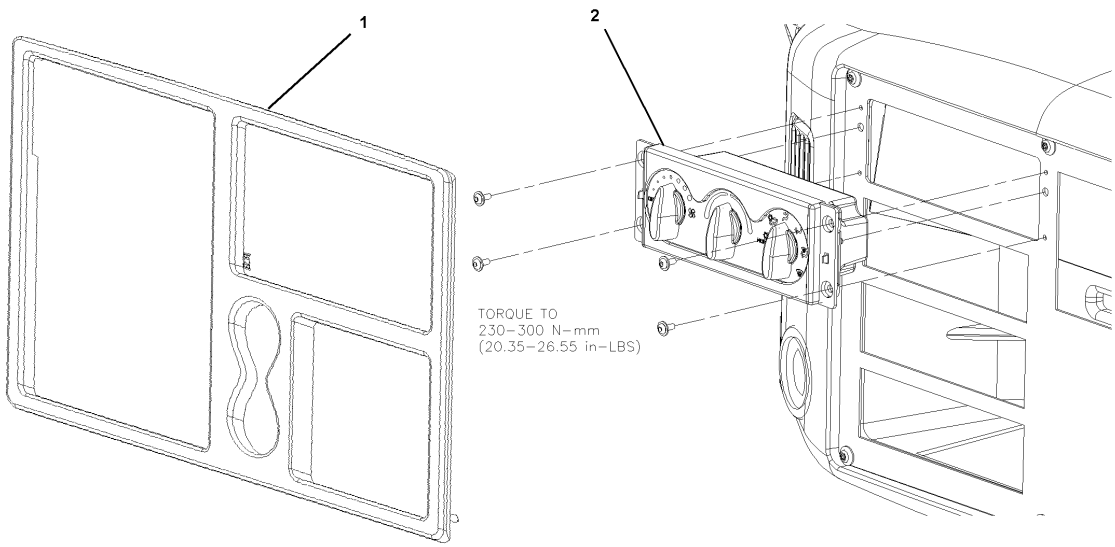



**Figure 36 HVAC Control Panel Assembly**

3. Remove control panel assembly from instrument panel by pulling it straight out of its IP mounting cavity.
4. Disconnect wiring connector from rear of HVAC control panel.

### Install

**CAUTION – Place the ignition key in the OFF position before removing or installing the HVAC control panel assembly.**

1. Connect wiring connector to rear of HVAC control panel (2).
2. With HVAC control panel assembly correctly oriented, insert it straight into the IP mounting cavity.
3. Verify that the control panel assembly is fully seated, then secure the assembly using four screws.
4. Install the trim plate (1) in the center section of the IP by aligning the spring clips and carefully pressing the trim plate into position.

# 7. SERVICE PROCEDURES FOR R-134A

## 7.1. SERVICE WARNINGS

**WARNING – Safety goggles or other adequate eye protection must be worn when working with refrigerant. The temperature of liquid refrigerant is -20 degrees F (-29 degrees C). Serious injury or blindness will result from refrigerant contacting the eyes.**

**WARNING – If the refrigerant should contact the eyes, DO NOT rub them. Splash the eyes with cold water to gradually get the temperature above the freezing point. See a doctor immediately.**

**WARNING – Wear nonporous gloves. (Nitril is the recommended material.) Should liquid refrigerant come into contact with the skin, remove any contaminated clothing, including shoes; then treat the injury as though the skin had been frostbitten or frozen. See a doctor immediately.**

**WARNING – Be certain that pressurized refrigerant containers are not exposed to open flame or temperatures above 125 degrees F (51 degrees C). Do not discard empty refrigerant containers where they are likely to be subjected to the heat of trash burners, etc.; they may explode, resulting in personal injury or possible death. Containers must be stored, installed, and disposed of in accordance with all state and local ordinances.**

**WARNING – Never weld, solder, steam clean or use excessive heat on any of the air conditioning lines or equipment while the system is charged. Heat applied to any part will cause the pressure within the system to become excessive, which may result in an explosion and possible personal injury.**

**WARNING – Do not smoke or allow any type of fire or flame in the immediate area while servicing the air conditioning system. Refrigerant is not combustible; however, in the presence of heat it changes to a poisonous gas. Inhalation can cause death or serious injury.**

**WARNING – R-134a must not be mixed with air and then pressurized. When mixed with large quantities of air and pressurized, R-134a becomes combustible.**

**WARNING – Refrigerant must be recovered from the air conditioning system before any components of the system are removed or replaced. Removing components while pressure is in the system will cause personal injury or death.**

**WARNING – Do not remove the compressor oil fill plug to check the oil level in the refrigerant compressor while the A/C system is charged with refrigerant. The crankcase side of the compressor is under pressure and personal injury may result. It is not possible to check the oil level in the compressor on an A/C system that is under system pressure.**

**WARNING – Do not install or remove A/C testing or charging equipment while the engine is running. Serious injury may result from doing so.**

**WARNING – Always use approved refrigerant recycling equipment when working with R-134a to prevent accidental discharge. If released into the atmosphere, the refrigerant evaporates very quickly and may displace the oxygen surrounding the work area, especially in small or enclosed areas. This situation creates the hazard of suffocation or brain damage for anyone in the work area. If a leak should occur, avoid breathing the refrigerant and lubricant vapor. Thoroughly ventilate the area before continuing with service. Federal and state laws require that refrigerant be recovered and recycled to help protect the environment.**

**WARNING – With the manifold gauge set connected to both the air conditioning system and the refrigerant supply cylinder, never open the high side hand valve of the manifold gauge set while the A/C system is operating. If hot, high pressure refrigerant is forced through the gauge to the refrigerant supply cylinder; it could cause the cylinder to rupture and cause personal injury.**

**WARNING – When purging the system or components, do not use nitrogen at pressures over 200 psi. Personal injury or death may result from doing so.**

**WARNING – Always use correct replacement refrigerant hoses. Do not use hoses other than those specified for the system being serviced. The use of improper hoses may cause a hose rupture, which may result in personal injury.**

**WARNING – During system diagnostic tests, DO NOT turn either hand valve on the manifold gauge set for any reason. Equipment can be damaged, and personal injury can result. When connected to the A/C system the gauges will indicate the system pressures with the valves closed (fully CW). These valves are used only while servicing the A/C refrigerant system.**

**CAUTION – To prevent damage to the test equipment, make sure test equipment is clear of all moving parts in the engine compartment.**

**CAUTION – When installing and removing any service hose or fitting, a small amount of refrigerant may escape. Always follow all safety precautions to avoid injury.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

## 7.2. SERVICE PROCEDURES

In addition to the Service Warnings above, special attention to the following rules during servicing, and component remove and install, will aid in avoiding unnecessary and time-consuming problems.

1. Perform service inside a warm, well ventilated dry shop.

2. When working on the A/C system keep the work area and tools as clean as possible. Also, clean all connections, ports or fittings before disconnecting or removing components.

3. Never use hot steam to clean the inside of the system. Dry nitrogen cleaning is recommended for this purpose.

4. All A/C component and refrigerant line openings should be immediately plugged during removal and remain so until re-installation to prevent the entry of dirt, moisture and other foreign material. Even the slightest particle can cause problems if carried to a vulnerable place within the system.

5. Never remove protective caps from components until the moment of assembly into the system.

6. Never install non-sealed components.

7. Anytime an A/C fitting is disconnected, the O-ring and C-plate must be replaced (Figure 37). The new O-ring must be lubricated with **MINERAL-BASED** oil (International P/N ZGGR6912). The C-plate does not require lubrication. Never use grease, penetrating oil, motor oil, Ester or PAG oil, etc. to lubricate O-rings and fittings.

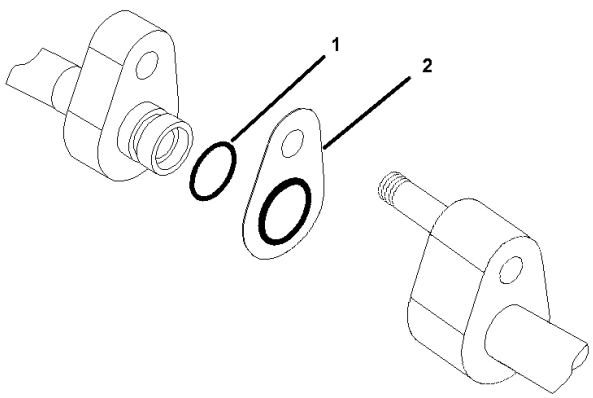



**Figure 37 Fitting C-Plate and O-Ring**

1. O-RING
2. C-PLATE

8. All refrigerant hose and tubing support clamps and strap locks must be re-installed in their original positions.

   Never bend a hose to a radius less than ten times the diameter of the hose.

   Never route a hose any closer than two inches from the exhaust manifold or related piping.

   Periodically inspect hoses for leaks or brittleness. Replace lines immediately if damaged.

9. All fittings must be tightened as specified in the TORQUE CHART (See Table 42, page 218). Use only a torque wrench known to be accurate.

10. Whenever possible use a backup wrench when loosening or tightening fittings (Figure 38).

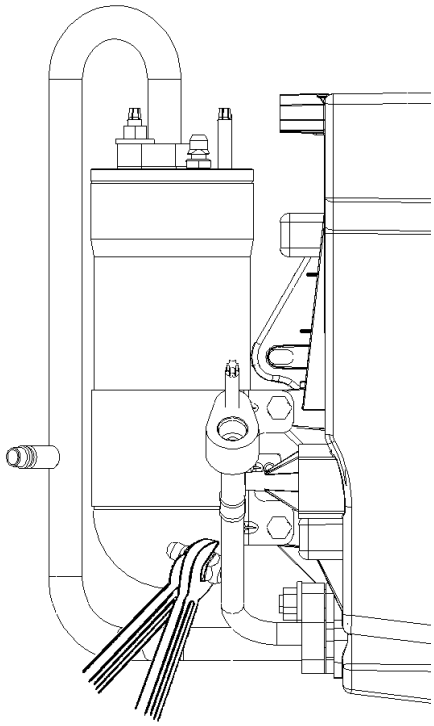


**Figure 38 Use a Back-Up Wrench When Loosening or Tightening Fittings**

11. Replace the accumulator on any system which has been opened for more than a short period (approximately 30 minutes); after the system has been flushed or purged; and/or when the system has become contaminated (such as due to a internal compressor failure). If the accumulator is one of multiple components being installed in the system, the accumulator should be the last component installed. This reduces the amount of time that the accumulator desiccant is exposed to atmospheric moisture.

12. Refrigerant oil quickly absorbs moisture. Store oil only in moisture-free containers and keep oil containers closed until ready to use. Close refrigerant oil container immediately after use.

13. The air conditioning system must be flushed or purged any time the system has become contaminated (such as due to an internal compressor failure). Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136).

14. Whenever the system is discharged, the refrigerant oil level must be checked and/or replaced as specified in OIL FILL GUIDELINES, (See OIL FILL GUIDELINES, page 141).

15. Any system that has been discharged due to leakage, or opened to replace a component, must be evacuated (and the system oil quantity must be returned to normal) before charging.

16. Use extreme care to prevent moisture from entering the system. Moisture can freeze at the evaporator input orifice and block refrigerant flow during system operation. Always properly evacuate the system after service to remove any moisture and air from the system.

17. Spare components should be sealed and stored in a warm, dry facility.

## 7.3. REFRIGERANT IDENTIFICATION

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

Before any work is done on an HVAC system the refrigerant should be identified.

Refer to Figure 39.

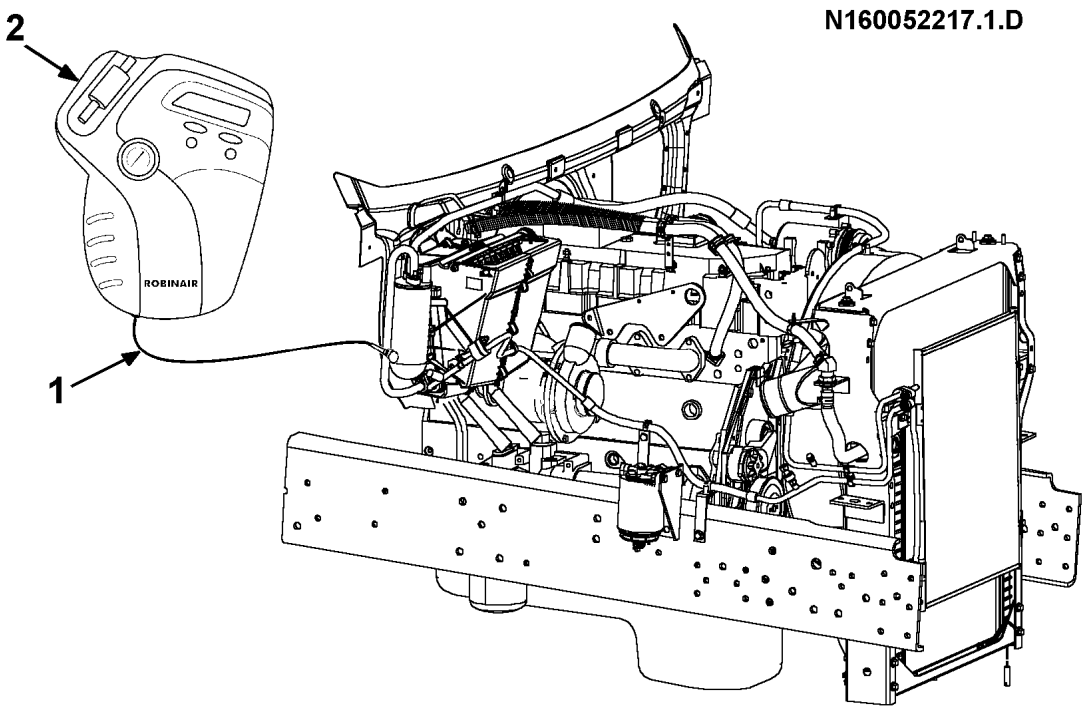



**Figure 39 Refrigerant Identification Setup Diagram**

1. SAMPLING HOSE
2. REFRIGERANT IDENTIFIER

1. Calibrate the Refrigerant Identifier per the manufacturer's instructions.
2. Connect the sampling hose to the low pressure service port located on the evaporator-to-accumulator line.
3. Connect the other end of the sampling hose to the Refrigerant Identifier.

4. Open the service valve.

5. Start the sampling procedure (refer to the manufacturer's instructions).

6. When the sampling is complete the Refrigerant Identifier will indicate a pass/fail condition, the type of refrigerant, and the percentage of concentration. International recognizes only R12 or R134a in a 98% concentration (this system must be R134a). Anything else is considered contaminated.

7. Close the service valve and disconnect the sampling hose.

## 7.4. MANIFOLD GAUGE SET

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**IMPORTANT –** The fittings on the service hoses for R-134a air conditioning systems are standard Metric SAE quick-disconnect fittings that will work only on R-134a air conditioning systems service ports.

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

This information covering the manifold gauge set hookup is provided in case service equipment with an internal gauge set is not available.

### Install

Refer to Figure 40 and Figure 41.

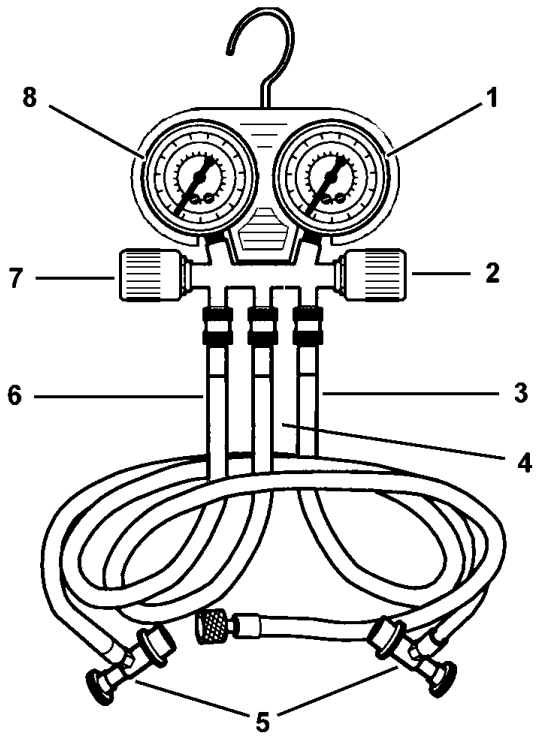



**Figure 40 Manifold Gauge Set with Quick-Disconnect Fittings**

1. HIGH PRESSURE GAUGE
2. HIGH PRESSURE VALVE
3. HIGH PRESSURE HOSE (RED)
4. SERVICE HOSE (YELLOW)
5. SAE QUICK-DISCONNECT FITTINGS
6. LOW PRESSURE HOSE (BLUE)
7. LOW PRESSURE VALVE
8. LOW PRESSURE GAUGE

1. Remove the protection caps from both service ports.

2. On the Manifold Gauge Set, verify that all valves are closed. The valves at the manifold must be set fully clockwise (CW). The valves at the quick-disconnect fittings must be set fully counter-clockwise (CCW).

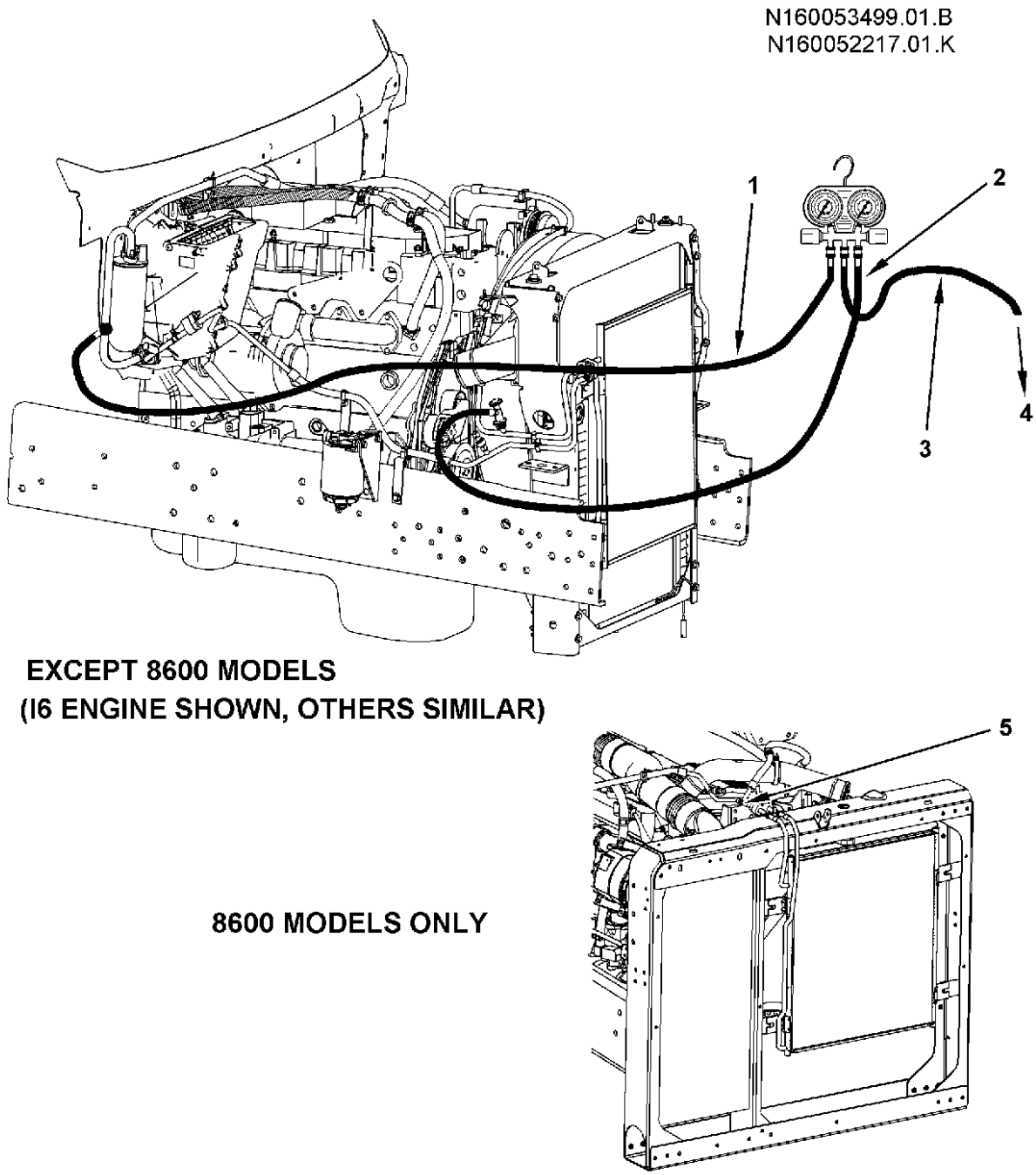



**Figure 41 Manifold Gauge Set Installation**

1. LOW PRESSURE HOSE (BLUE)
2. HIGH PRESSURE HOSE (RED)
3. SERVICE HOSE (YELLOW)
4. CONNECT TO SERVICE EQUIPMENT
5. HIGH PRESSURE PORT (MODEL 8600 ONLY)

3. Connect the Manifold Gauge Set to the system as follows:
   a. Start with the **blue** manifold suction hose, and connect it to the low pressure service port located on the evaporator-to-accumulator line.
   b. Connect the **red** hose to the high pressure service port located on the compressor-to-condenser line.
   c. Connect the **yellow** hose on the center fitting of the Manifold Gauge Set following the instructions provided with the service equipment being used.

**IMPORTANT –** DO NOT OPEN the valves on the manifold gauge set, or the valves on the Metric SAE quick-disconnect fittings, until instructed to do so in the procedures. The quick-disconnect fittings must be connected to the service ports on the vehicle; and the yellow service hose must be connected to the equipment required for each specific procedure being performed.

Once the quick-disconnect fittings are attached to the service ports, turning the knob **clockwise** (CW) pushes an internal pin down **to open** the service port valve (refer to Figure 42). Turning the knob CCW raises the pin, closing the service port valve. Once closed the quick-disconnect fitting can be removed without venting refrigerant from the system.

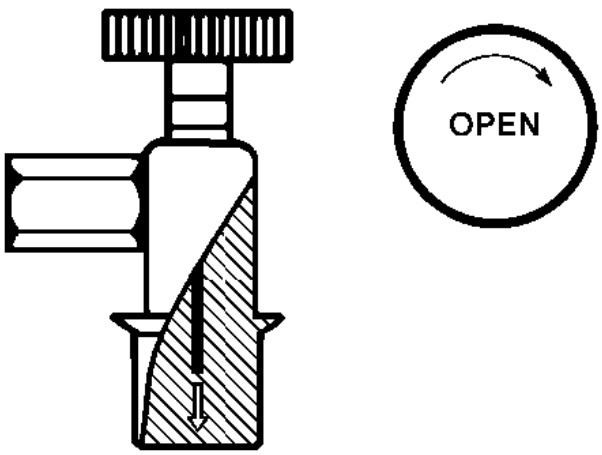



**Figure 42 Turning the Quick-Disconnect Fitting Knob Clockwise Lowers a Pin to Open the Valve in the Service Port**

**Remove**

1. Be sure the knobs on the Metric SAE quick-disconnect fittings, on the **red** and **blue** hoses, are set fully CCW.

2. Verify that the manifold gauge set valves, at the manifold, are set fully clockwise.

3. Remove the **blue** (low pressure) and **red** (high pressure) hoses from the vehicle service ports.

4. Disconnect the **yellow** hose from the service equipment currently connected to it. Follow the instructions provided with that service equipment.

## 7.5. DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY)

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

**IMPORTANT –** If the system is being discharged because a leak is suspected, the leak must be located before discharging the system. Refer to LEAK DETECTION (See LEAK DETECTION, page 146).

Refer to Figure 43.

1. Empty the 'recovered oil' catch bottle on the recovery station. This will make it easier to determine the amount of oil recovered during the refrigerant recovery procedure.

2. Remove the protection caps from both service ports.

3. On the recovery station and hose fittings, verify that all valves are closed. The valves at the recovery station must be set to the CLOSED position. The valves at the quick-disconnect fittings must be set fully counter-clockwise (CCW).

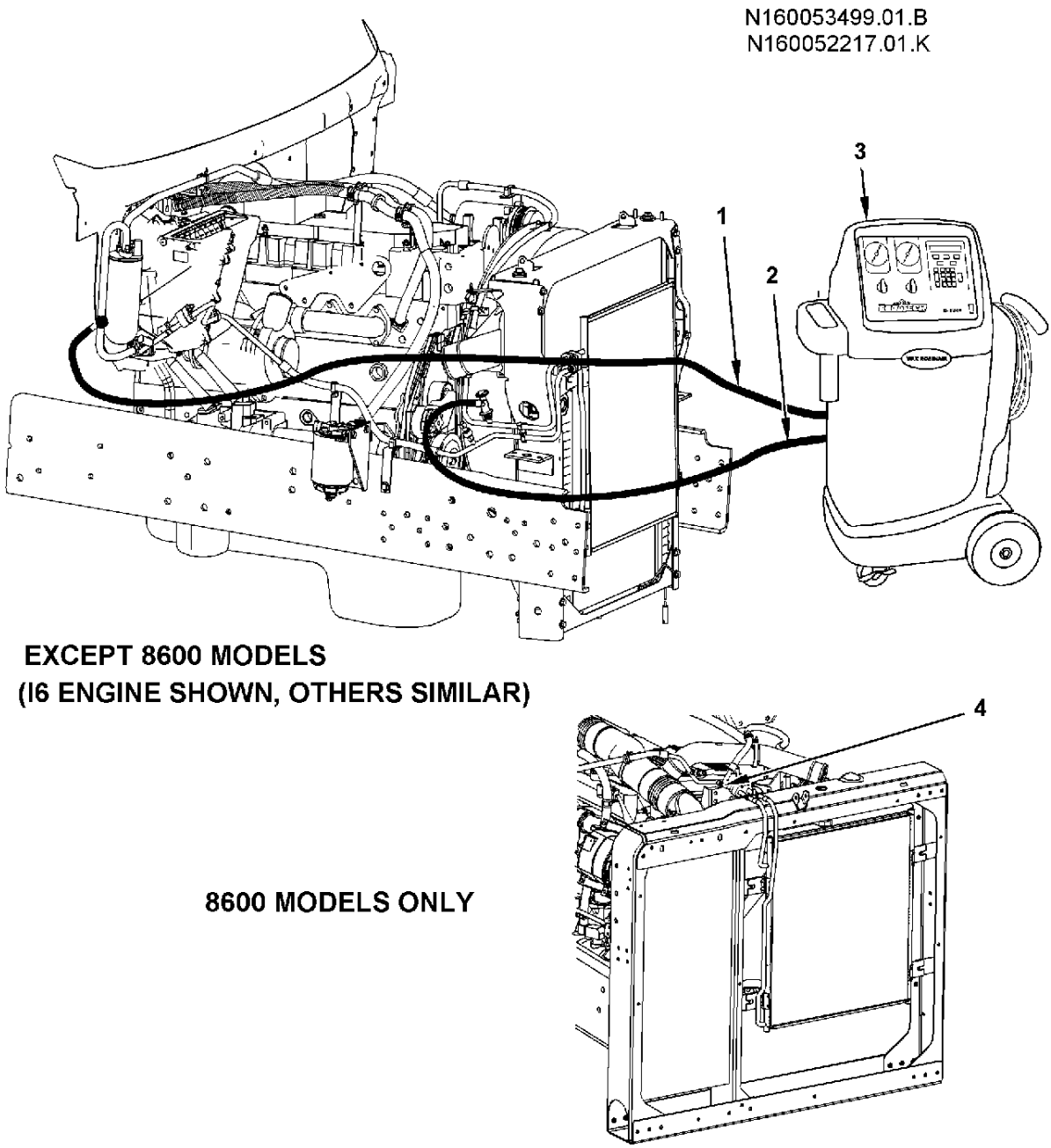



**Figure 43 Equipment Hookup for Servicing the System**

1. LOW PRESSURE HOSE (BLUE)
2. HIGH PRESSURE HOSE (RED)
3. RECOVERY/RECYCLING/CHARGING STATION
4. HIGH PRESSURE PORT (MODEL 8600 ONLY)

4. Connect the recovery station to the system as follows:

   a. Start with the **blue** low pressure hose, and connect it to the low pressure service port located on the evaporator-to-accumulator line.

b. Connect the **red** hose to the high pressure service port located on the compressor-to-condenser line.

5. Open (turn cw) the valves on the Metric SAE quick-disconnect fittings connected to the service ports on the vehicle.

6. Set both hand valves on the recovery station to the RECOVERY/VACUUM position.

**NOTE – During the recovery process in the next step, refrigerant may become trapped in the accumulator. Heating the accumulator with a heat gun will force the refrigerant out of the accumulator and assure that all of the refrigerant is recovered from the system.**

**WARNING – Never use an open flame torch to heat the accumulator. Heating the accumulator with an open flame could result in equipment damage and/or bodily injury.**

7. Turn the recovery station main power switch on and press the RECOVER button. The recovery station will automatically shut off when the refrigerant in the system has been exhausted to the storage tank.

8. Close the valves on the quick-disconnect fittings by turning them fully CCW; and set both valves on the recovery station to the CLOSED position.

9. When recovering refrigerant by use of a recovery station, system oil is separated from the refrigerant during the recovery cycle. When the refrigerant recovery operation is complete, the recovery station will drain the oil into the station's calibrated catch bottle. The amount of oil recovered may be used to determine the amount of NEW oil that must be added back to the A/C system. Refer to OIL FILL GUIDELINES, (See OIL FILL GUIDELINES, page 141).

10. Disconnect the **blue** and **red** hoses from the service ports on the vehicle.

11. Work may now begin on the air conditioning system.

## 7.6. EVACUATING THE SYSTEM

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**CAUTION – The amount of oil lost during the recovery process, component replacement, or purging/flushing must be replaced with new oil. The method for determining how much refrigerant oil must be added to the A/C system is located in the OIL FILL GUIDELINES, (See OIL FILL GUIDELINES, page 141).**

**CAUTION – Use only the specified PAG lubricant in the refrigerant system. PAG oils absorb atmospheric moisture very quickly. Never leave PAG oil exposed to air for a prolonged time. Tightly reseal the oil container immediately after each use.**

**CAUTION – Do not re-use recovered oil. Be sure to dispose of recovered oil properly to avoid an environmental hazard.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

Whenever the air conditioning system has been discharged, the system must be completely evacuated of air and moisture before being recharged. After evacuation the system vacuum should measure between 750 and 1000 microns.

1. Determine the amount of **NEW** refrigerant oil to be added to the system. Refer to OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141). If oil is being added directly to the compressor, it must be added before starting the evacuation procedure. If oil is to be added during the evacuation/charging procedure, you must follow the instructions furnished with the recovery station, or refrigerant oil injector tool, to add the oil before the charging procedure.

2. On the recovery station and hose fittings, verify that all valves are closed. The valves at the recovery station must be set to the CLOSED position. The valves at the quick-disconnect fittings must be set fully counter-clockwise (CCW).

3. Connect the electronic vacuum gauge to the recovery station, at the vacuum manifold, using a valve and 'T' fittings (refer to Figure 44).

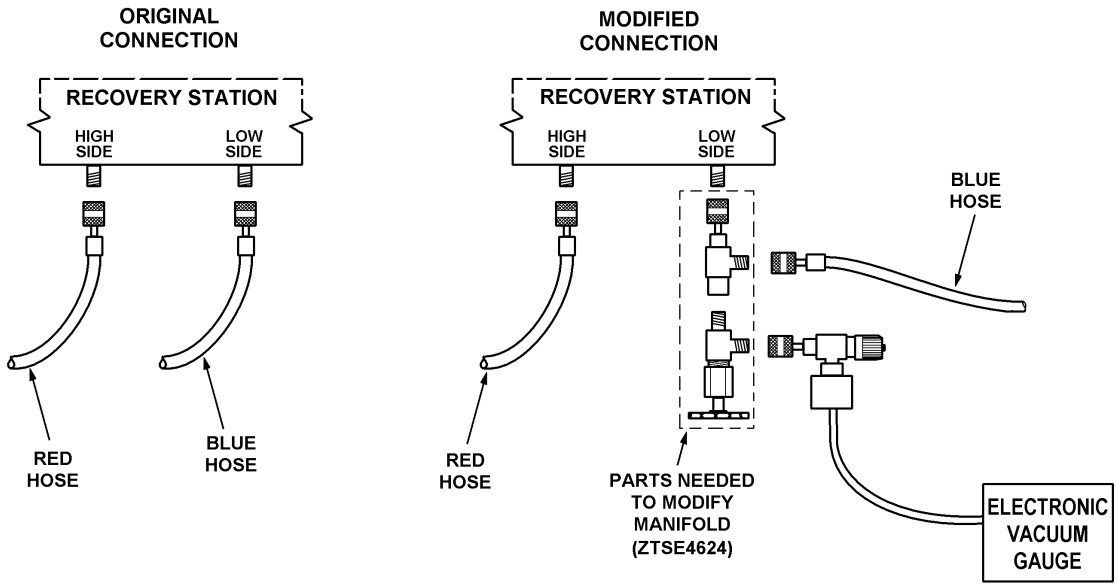



**Figure 44 Connection of Electronic Vacuum Gauge**

**CAUTION – The valve for the electronic vacuum gauge must be in the closed position (fully CCW) until instructed to open it. If the valve is open during system charging, excess pressure may damage the electronic vacuum gauge.**

4. Connect the recovery station to the system as follows (refer to Figure 43):
   a. Start with the **blue** low pressure hose, and connect it to the low pressure service port located on the evaporator-to-accumulator line.
   b. Connect the **red** hose to the high pressure service port located on the compressor-to-condenser line.
5. On the red and blue hoses, open the valves on the Metric SAE quick-disconnect fittings (turn the knobs fully CW).
6. On the recovery station, set both hand valves to the RECOVERY/VACUUM position.
7. On the recovery station, turn on main power switch and press the VACUUM button.
8. After the low pressure gauge on the station shows that vacuum is being established in the system, continue to operate the vacuum pump for ten minutes.
9. After ten minutes, set both valves on the recovery station to the CLOSED position, and observe low side gauge for one minute. The gauge should **not** indicate a rise of more than 2 inches-Hg. If the gauge rises more than 2 inches-Hg in one minute, the system has a leak which must be repaired (refer to LEAK DETECTION (See LEAK DETECTION, page 146)).
10. If there are no leaks:
    a. Set both hand valves on the recovery station to the RECOVERY/VACUUM position and press the VACUUM button.

b. Open the valve connecting the electronic vacuum gauge to the recovery station low side line.

c. Continue to operate the recovery station vacuum pump until the system has pulled a vacuum of 750 – 1000 microns as measured by the electronic vacuum gauge (10 minutes minimum).

d. Close both hand valves on the recovery station, and the valve connecting the electronic vacuum gauge to the recovery station low side line.

11. The A/C system is ready to be charged. **REMEMBER** if the full amount of refrigerant oil has not yet been added to the system, it must be added before charging the system with refrigerant, as explained in the following procedure.

**IMPORTANT –** DO NOT disconnect the recovery/recycling/charging station from the A/C system before charging the system.

## 7.7. CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE)

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**WARNING – Do not remove the compressor oil fill plug to check the oil level in the refrigerant compressor while the A/C system is charged with refrigerant. The crankcase side of the compressor is under pressure and personal injury may result. It is not possible to check the oil level in the compressor on an A/C system that is under system pressure.**

**CAUTION – Use only new or recycled R-134a refrigerant; not any of the so called "direct replacement" refrigerants. Use of equipment dedicated for R-134a is necessary to reduce the possibility of oil and refrigerant incompatibility concerns.**

**CAUTION – When charging the A/C system the refrigerant tank must be kept upright. If the tank is not in the upright position, liquid refrigerant may enter the system and cause compressor damage.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

**IMPORTANT –** If recycled refrigerant is to be used, follow the instructions supplied with the recycling equipment to purge the air from the refrigerant before charging the system.

Perform the Charging procedures, using new or recycled refrigerant, only after the following actions have been completed:

- System components repaired and/or replaced.
- System flushed or purged **(if required)**.
- Refrigerant oil added (**only** if oil was added directly to the compressor, see OIL FILL GUIDELINES).
- System completely evacuated.

**CAUTION – If the equipment being used adds system refrigerant oil during the evacuation/charging procedure, you must first determine the amount of oil to be added (refer to OIL FILL GUIDELINES), (See OIL FILL GUIDELINES, page 141). Then follow the instructions furnished with the recovery station, or refrigerant oil injector tool, to add the correct amount of NEW oil to the system during this procedure.**

1. The recovery station **blue** (suction) and **red** (discharge) hoses should still be connected as they were during the evacuation operation.

2. If necessary, add oil to return the system oil capacity to its correct level (refer to OIL FILL GUIDELINES), (See OIL FILL GUIDELINES, page 141). To add oil during the evacuation/charging process, follow the instructions furnished with the recovery station, or refrigerant oil injector tool.

**CAUTION – Due to the density of R-134a, the amount of refrigerant required to charge a typical air conditioning system has been reduced. Overcharging the system will result in excessively high head pressures during operation and may damage the compressor. Be sure to check specifications on the vehicle being serviced. This information is often located on a label on the refrigerant compressor.**

3. Determine the amount of refrigerant needed to charge the A/C system. This information can be found in the SPECIFICATIONS (See Table 43, page 223) section of this manual.

4. Following the instructions provided with the recovery station; set the recovery station to charge the system with the specified amount of refrigerant.

5. On the recovery station, set the low side valve to CLOSED, and the high side valve to CHARGE.

6. Press the CHARGE button to start the charge procedure. When the system is fully charged, the recovery station will turn off.

7. Complete the charging procedure by setting both hand valves on the recovery station to the CLOSED position.

8. Before disconnecting the recovery station from the A/C system, perform A/C SYSTEM PERFORMANCE TEST PROCEDURE (See A/C SYSTEM PERFORMANCE TEST PROCEDURE, page 35).

9. After the pressure test is completed, stop the engine, close the valves on the Metric SAE quick-disconnect fittings (turn fully ccw) at the vehicle A/C service ports.

10. Disconnect the **blue** and **red** hose Metric SAE quick-disconnect fittings from the vehicle service ports.

11. Install the protective caps on both of the vehicle service port fittings.

## 7.8. ADDING REFRIGERANT TO THE SYSTEM

Since the introduction of R-134a and the new PAG oil, relying on a sight glass clearing up when the system has a full charge is no longer reliable. DO NOT add refrigerant to the system in hopes of improving cooling. It's very possible that the system will be overcharged and cause component failure.

If it is found, during A/C system tests, that the system needs refrigerant; it will be necessary to perform the following procedures:

- discharge the system, refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129);
- evacuate the system, refer to EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131);
- and recharge the system, refer to CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE) (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

## 7.9. PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**WARNING – Dry nitrogen gas is recommended for flushing and/or purging. Do not use nitrogen at pressures over 1378 kPa (200 psi). Personal injury or death may result from doing so. Commercial cylinders of dry nitrogen contain pressures in excess of 13780 kPa (2000 psi). This pressure must be reduced, using a pressure regulator, to 1378 kPa (200 psi) for purging.**

**CAUTION – When flushing and/or purging components of the system use only dry nitrogen. The introduction of compressed air into the A/C system may cause contamination of the system.**

**CAUTION – When flushing components, use only flushing agents approved for R-134a charged air conditioning systems (refer to the Fleetrite HVAC catalog for an approved flush solvent). R-11 and any other flushing agents that were used to flush R-12 charged air conditioning systems CANNOT be used to flush R-134a systems. The residue left by these flushing products will destroy the lubrication properties of the oil used in R-134a systems.**

**NOTE – A flush gun is required to inject the flushing agent into the component being flushed. Refer to FLUSH GUN (See FLUSH GUN, page 229) for complete information on this service equipment.**

**NOTE – Special adapters are required to connect the service equipment to the block fittings used on the A/C system components. Refer to BLOCK FITTING ADAPTERS (See Block Fitting Adapters, page 230) for complete information on these service adapters. Standard fittings and adapters can be purchased or fabricated locally. Quick disconnect fittings can reduce the time required to swap hoses, adapters and components.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

Systems that have had an internal compressor failure, that have been overcharged with refrigeration oil, or that have been left open for an extended period of time, will need to be flushed, purged or both. Flushing is generally necessary only after an internal compressor failure has contaminated the refrigerant system. Flushing and purging are performed on a system after the refrigerant has been recovered and before the system is reassembled and evacuated.

Flushing removes heavy contamination, such as gritty oil and large dirt buildup, which occur after an internal compressor failure. When a part is flushed, a flushing solvent is forced through it; the liquid solvent cleans the part, picks up contaminants and flushes them out.

Purging must always be performed: after flushing the system; any time there is excessive refrigerant oil found in the system; or, when the system has been left open for an extended period of time. Purging removes flushing solvent, excessive refrigerant oil, damp air, and loose particles from A/C system components by passing a stream of inert, dry nitrogen gas through parts of the system or individual components. This assures that A/C system components are dry and free of any contaminants. If left in the system, these contaminants would have a negative effect on the life and operation of the air conditioning system.

The following procedures must be observed whenever a component or system is flushed or purged.

- Never flush or purge the entire system. Flush or purge the system in segments (never larger than one component and one hose) to lessen the chance of blowing contaminants throughout the system.
- Never flush or purge the compressor, orifice tube or accumulator.
- Flush or purge each system section or component in the opposite direction of normal refrigerant flow.
- After flushing or purging the system, change oil in the compressor (refer to OIL FILL GUIDELINES) (See OIL FILL GUIDELINES, page 141), reinstall (or replace) the orifice tube, and replace the accumulator prior to evacuating and charging the system.

**NOTE – The following procedures for flushing and purging are general. The actual fittings and adapters required for each procedure will vary according to the component or components being connected.**

### Flushing Procedure

Refer to Figure 45.

> **CAUTION – Assemblies to be flushed must be no larger than one component and one attached hose.**

1. Disconnect both ends of the component or components to be flushed, and tightly cap the rest of the system.

2. With the tank regulator (5) turned off (closed), open the main nitrogen tank valve (6), and using the input gauge on the regulator, verify that enough pressure is available to perform the flushing procedure.

3. Connect the input of the flush gun (8) to the output of the supply line from the nitrogen tank. Some form of shutoff valve should be installed at the input of the flush gun.

4. Using the correct fittings or block fitting adapters (3), connect the drain line (1) to the component to be flushed. Components are flushed in the opposite direction of normal refrigerant flow.

5. Using the correct fittings or block fitting adapters, connect the flush gun output to the component to be flushed.

6. Place the outlet of the drain line into a suitable waste container.

7. Fill the flush gun tank with an appropriate amount of flushing agent.

8. Set the supply line air regulator (5) to 75 psi.

9. Open the supply line valve (4) at the output of the tank regulator.

10. Slowly open the flush gun valve and allow the flushing solvent to flow through the system until the drain line is clear; then, close the flush gun valve. If a trigger type air gun (9) is being used on the flush gun output, actuate the trigger to release all pressure from the flush gun tank.

11. Close the supply line valve (4).

> **WARNING – The flush gun MUST be removed from the equipment setup before performing the purge procedures. The flush gun is not designed to be used at the pressures used for the purge procedures.**

12. Connect the flushing equipment to the next component to be flushed; or, empty the flush gun tank and **remove the flush gun** from the supply line.

13. Disconnect drain hose and all fittings and adapters from the component.

14. Plug the inlet and outlet of the component until it can be purged.

**NOTE – After flushing a component, that component must be purged**

**before connecting it to the air conditioning system. Refer to PURGING PROCEDURE) (See Purging Procedure, page 139).**

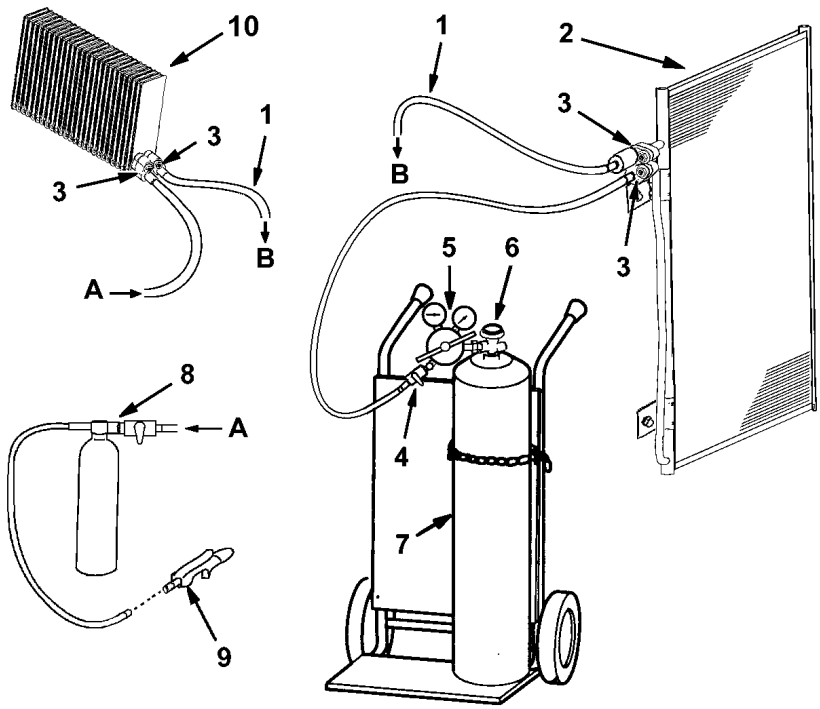



**Figure 45 Typical Flushing and Purging Setup**

A. NITROGEN IN
B. TO WASTE CONTAINER
1. DRAIN LINE
2. CONDENSER
3. BLOCK FITTING ADAPTERS
4. SUPPLY LINE VALVE
5. NITROGEN BOTTLE REGULATOR/GAUGES
6. NITROGEN BOTTLE CONTROL VALVE
7. NITROGEN BOTTLE
8. FLUSH GUN
9. TRIGGER TYPE AIR GUN
10. EVAPORATOR CORE

## Purging Procedure

Refer to Figure 45.

> **CAUTION – Assemblies to be purged must be no larger than one component and one attached hose.**

1. Disconnect both ends of the component to be purged and tightly cap the rest of the system.

2. With the tank regulator (5) turned off (closed), open the main nitrogen tank valve (6), and using the input gauge on the regulator, verify that enough pressure is available to perform the purging procedure.

3. Using the correct fittings or block fitting adapters (3), connect the drain line (1) to the component to be purged. Components are purged in the opposite direction of normal refrigerant flow.

4. Using the correct fittings or block fitting adapters, connect the nitrogen supply line output to the component to be purged. A trigger type air gun (9) may be hand–held for some components.

5. Place the outlet of the drain line into a suitable waste container.

6. Set the supply line air regulator (5) to 28 kPa (4 psi).

7. Slowly open the supply line valve (4) at the output of the tank regulator. If a trigger type air gun is being used, actuate the trigger.

8. Let the dry nitrogen flow at 28 kPa (4 psi) for one to two minutes, or until there is no trace of refrigerant flushing agent or refrigerant oil flowing from the drain tube.

9. Using the pressure regulator, raise the pressure to 1378 kPa (200 psi) and let the dry nitrogen flow for 25 to 30 seconds.

10. Adjust the pressure regulator for 0 psi; then, close the supply line valve (4).

11. If a trigger type air gun is being used, actuate the trigger to release pressure in the hose.

12. Disconnect the supply and drain lines from the part, and remove all fittings and adapters (3). Tightly cap the openings of the part until you are ready to install it into the system.

**NOTE – Always lubricate O-rings on fittings with mineral-based oil during installation.**

13. The component is now ready to be installed into the air conditioner system using new O-rings and C-plates.

14. After purging the system, change oil in the compressor (refer to OIL FILL GUIDELINES) (See OIL FILL GUIDELINES, page 141), reinstall (or replace) the orifice tube, and replace the accumulator prior to evacuating and charging the system.

## 7.10. OIL FILL GUIDELINES

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**CAUTION – Do not re-use recovered oil. Be sure to dispose of recovered oil properly to avoid an environmental hazard.**

**CAUTION – Replacement compressors contain a quantity of oil when shipped. This oil must be drained from the new compressor before refilling the compressor (and system) with the correct amount of new oil.**

**CAUTION – During normal A/C operation, oil is circulated through the system with the refrigerant, and a small amount is retained in each component. If certain components of the system are removed, some of the refrigerant oil will go with the component. To maintain the original total oil charge, it is necessary to compensate for the oil lost by adding oil to the system with the new part.**

The correct volume of refrigerant oil in the A/C system is critical for proper system operation. Insufficient oil will result in compressor failure. Too much oil decreases cooling efficiency, resulting in poor system cooling performance. In general, when servicing the system, ensure that the amount of oil (retained or added) in the repaired system (compressor and components) equals the total system capacity indicated in SPECIFICATIONS (See SPECIFICATIONS, page 218). Replacement oil may be added directly into the compressor before evacuation, or injected into the system after evacuation. The following paragraphs describe how to determine the quantity of refill oil needed under the most common conditions.

**IMPORTANT –** Unless stated otherwise, the following procedures assume that the system is not being flushed and/or purged.

A. If the refrigerant was only recovered for the purpose of measuring the refrigerant charge, or to replace a thermistor, add the amount of oil removed from the system during the refrigerant recovery procedure.

   - Total replacement oil quantity **=** oil from refrigerant recovery procedure.

B. If a compressor is replaced (and the system was **not** contaminated and had no leaks) refill the new compressor with the amount of oil removed from the system during the refrigerant recovery procedure, plus the quantity of oil that was contained in the old compressor. NOTE: New compressors must be drained of shipping oil before filling with new oil. Refer to CHECKING COMPRESSOR OIL LEVEL, that follows, for the procedures to drain and fill the oil in the refrigerant compressor.

   - Total replacement oil quantity **=** oil from refrigerant recovery procedure **+** oil drained from old compressor.

C. If a component other than the compressor is replaced, add the amount of oil removed from the system during the refrigerant recovery procedure, plus the amount indicated for the replaced component in table 20.

- Total replacement oil quantity **=** oil from refrigerant recovery procedure **+** oil indicated in component table.

D. If the amount of oil in the system is unknown (due to an oil leak, ruptured hose, etc.); refer to EXCESSIVE OIL LOSS DUE TO REFRIGERANT LEAK, below.

E. Whenever the refrigerant system has become contaminated; make the necessary repairs, flush and purge the system, and replace the compressor, orifice tube, and accumulator. Refill the system with a full refill of new oil.
NOTE: New compressors must be drained of shipping oil before filling with new oil. The replacement oil may be added to the compressor before installing it. Refer to CHECKING COMPRESSOR OIL LEVEL, that follows, for the procedures to drain and fill the oil in the refrigerant compressor.

- Total replacement oil quantity **=** total system capacity as specified in SPECIFICATIONS (See SPECIFICATIONS, page 218) **minus** 0.5 fl. oz (oil film left in new compressor after draining shipping oil).

**Table 20 Oil Capacity by Component**

| Component | Typical oil amount | |
|---|---|---|
| | cc | fl.oz. |
| Evaporator | 60 | 2.0 |
| Condenser | 30 | 1.0 |
| Accumulator | 60 | 2.0 |
| Hoses (normal length) | 10 | 0.3 |
| Thermistor | 0 | 0 |

## Oil Separation During Refrigerant Recovery

The oil removed from the system during the refrigerant recovery process must be replaced. Always empty the refrigerant station oil catch bottle, before recovering the refrigerant. After recovering the refrigerant, check the calibrated bottle to determine how much oil has been removed from the system. This quantity is used to help determine the amount of NEW oil that must be added to the system before or during the recharging of the A/C system. Do not use recovered refrigerant oil.

## Excessive Oil Loss Due to Refrigerant Leaks

**CAUTION – After servicing the A/C system, always use new O-rings and C-plates when reassembling the system components.**

When there is a significant refrigerant leak, an unknown amount of oil escapes from the system with the refrigerant. When a significant leak is detected, perform the following procedures to replace the old system oil with a full refill of new oil.

1. Use the service equipment and observation to determine the location of the leak.

2. Discharge the system. Refer to DISCHARGING THE SYSTEM (See DISCHARGING THE SYSTEM (REFRIGERANT RECOVERY), page 129),

3. Make any necessary repairs.

4. If the system does **not** appear to be contaminated, purge the system. Refer to PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM (See PURGING OR FLUSHING THE AIR CONDITIONING SYSTEM, page 136). If the system appears contaminated, such as after an internal compressor failure, it must be flushed before purging.

5. If the removed refrigerant **was not** contaminated:

    A. Reinstall the orifice tube (removed for purging).

    B. Drain and discard the old oil from the compressor. Refer to CHECKING COMPRESSOR OIL LEVEL, that follows.

    C. Refill compressor with new oil; then, install compressor.

        Total replacement oil quantity **=** total system capacity as specified in SPECIFICATIONS (See SPECIFICATIONS, page 218) **minus** 0.5 fl. oz (oil film left in compressor after draining old oil).

    D. Replace the accumulator.

6. If the removed refrigerant **was** contaminated:

    A. Replace the orifice tube.

    B. Add new refrigerant oil to a new compressor; then, install compressor. NOTE: New compressors must be drained of shipping oil before filling with new oil. Refer to CHECKING COMPRESSOR OIL LEVEL, that follows.

        Total replacement oil quantity **=** total system capacity as specified in SPECIFICATIONS (See SPECIFICATIONS, page 218) **minus** 0.5 fl. oz (oil film left in new compressor after draining shipping oil)

    C. Replace the accumulator.

7. Evacuate the system; refer to EVACUATING THE SYSTEM (See EVACUATING THE SYSTEM, page 131).

8. Recharge the system; refer to CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE) (See CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE), page 134).

9. After repairing a leak, remove all traces of the fluorescent dye from the repaired area before retesting the area. The dye can be removed with UV Dye Cleaner, ZTSE4618–2.

10. After running the system, retest the repaired area to verify the repair.

## 7.11. CHECKING COMPRESSOR OIL LEVEL

**WARNING – Do not remove the oil fill plug to check the oil level in the refrigerant compressor after the A/C system has been charged with refrigerant. The crankcase side of the compressor is under pressure and personal injury may result.**

It is not possible to check the oil level in the compressor on an A/C system that is under system pressure. If it is suspected that there is not enough oil in the A/C system, it will be necessary to remove all of the oil currently in the system and refill the system with a full oil charge.

The compressor oil level can be accurately checked only by removing the compressor from the vehicle and draining the oil into a calibrated container.

1. Verify that the system is discharged.

2. Remove the compressor.

3. Remove the oil plug and drain as much oil as possible into a suitable calibrated container (refer to Figure 46).

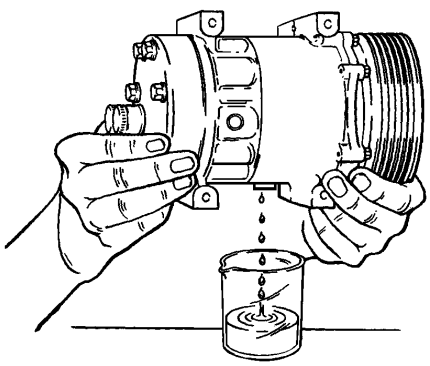


**Figure 46 Drain as Much Oil as Possible**

4. Remove the caps (if present) from the suction and discharge ports.

5. Drain remaining compressor oil from the suction and discharge ports, into the calibrated container, while turning the shaft (clockwise only) by hand or with a socket wrench on the armature retaining nut (refer to Figure 47). Replace the caps on the suction and discharge ports.

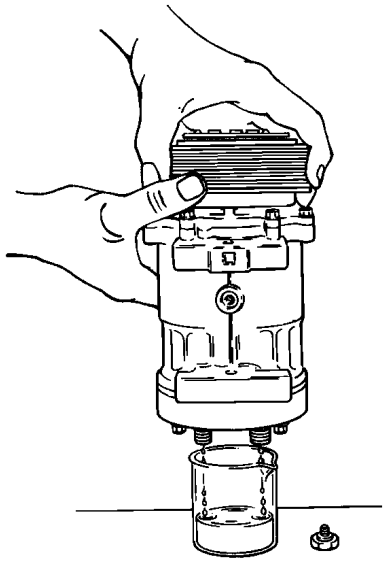


**Figure 47 Drain Oil While Turning Shaft**

6. Measure and record the amount of oil drained from the compressor.
7. Inspect the oil for signs of contamination such as discoloration or foreign material.
8. If the oil shows signs of contamination, replace the compressor.
9. If the oil is not contaminated, add the correct amount of new oil to the compressor as determined by the OIL FILL GUIDELINES (See OIL FILL GUIDELINES, page 141). Refer to Figure 48.

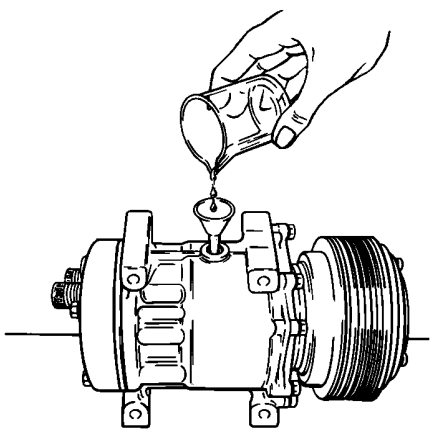


**Figure 48 Add New Oil to Compressor**

10. Install oil fill plug taking care not to twist the O-ring seal. Replace the O-ring if damaged. Torque oil plug to 15-20 N.m (11-15 lbf-ft). Do not over-tighten plug to stop a leak. Stop leaks first by fixing any seat damage, removing dirt and installing a new O-ring.

## 7.12. LEAK DETECTION

**WARNING – Before doing any of the work below, read the SERVICE WARNINGS (See SERVICE WARNINGS, page 119). Failure to read the Service Warnings and to be aware of the dangers involved when working with refrigerant could lead to serious personal injury.**

**NOTE – Refrigerant leaks are often indicated by an oily residue at the point of the leak.**

### Electronic Leak Detectors

**NOTE – To use the characteristics of the A/C system to your advantage while leak testing with an electronic leak detector; check the high pressure side of the system with the system running, and check the low pressure side of the system with the system (and engine) off.**

**IMPORTANT –** Although your service equipment may appear physically different from the equipment shown here, the function of the equipment used to perform each service procedure is basically the same. If you are performing these service procedures using service equipment different from that shown, refer to the manufacturer's instructions supplied with that equipment.

In terms of sensitivity and safety, the electronic leak detector (refer to Figure 49) is excellent for finding both slow and major system leaks. Ensure that the detector being used is intended for use with R134a refrigerant. Many leak detectors intended for use with R-12 cannot detect R134a leaks.

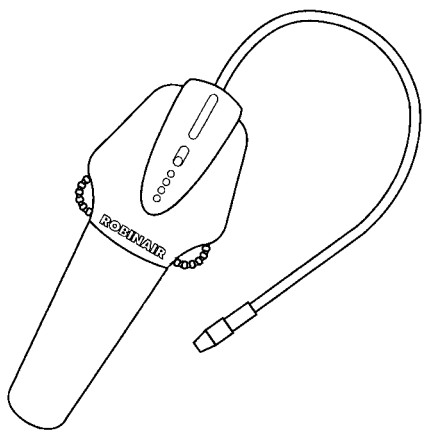



**Figure 49 Electronic Leak Detector**

The unit is a hand-held device having a flexible probe used to seek out refrigerant leaks. An audio leak indicator signals a warning in the presence of a leak. Refer to SPECIAL TOOLS (See SPECIAL TOOLS, page 223).

Before starting to look for leaks, it is recommended to clean away all oil or grease, and blow away refrigerant residue from fittings and A/C components. All suspected areas should be cleaned using soap and water, not a solvent.

It is important to become familiar with the leak detector instructions for the detector being used. The speed at which the probe is moved over the component being checked is very important in locating larger than permissible leaks. Leak check procedure should be in accordance with SAE J1628.

A detected leak should be a flow of refrigerant, not a residual condition of refrigerant that is trapped under an oil film, etc. A detected leak rate in excess of 1.0 oz./year is unacceptable.

### Ultraviolet Lamp Leak Testing

An alternate method to electronic leak testing is ultraviolet light. The desiccant located in the accumulator contains a phosphor dye that will produce a bright yellow-green trace at the leak, when illuminated by an ultraviolet (UV) lamp. This dye is also included in replacement accumulators. The kit illustrated in Figure 50 provides the UV lamp used to illuminate the suspected leaks. The kit also contains connection hoses and a dye injector, as well as, eyeglasses used to enhance the effect of the UV light on the dye. A UV dye cleaner should be used to clean the HVAC system connections after repairs have been made.

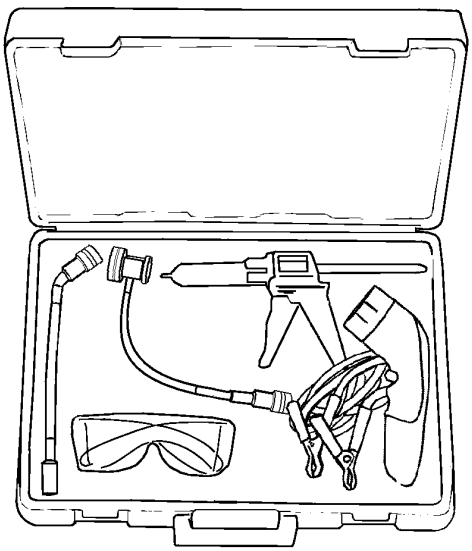


**Figure 50 Ultraviolet Lamp Kit**

It has been discovered during the use of UV light, and phosphor dyes, that other types of leaks also appear as a yellow-green trace when the UV light shines on them. If an UV lamp is used for leak detection, it is also recommended that an electronic leak detector be used to verify that any detected leaks are, in fact, refrigerant leaks. Refer to ELECTRONIC LEAK DETECTORS (See Electronic Leak Detectors, page 146).

## 8. HVAC ELECTRICAL CIRCUITS OVERVIEW

The heater/ventilation/air conditioning (HVAC) system contains both mechanical and electrical components. The next several sections cover the electrical part of the system; including descriptions, diagnosis, and troubleshooting for each of the electrical circuits.

The HVAC electrical system, refer to HVAC ELECTRICAL SYSTEM FUNCTION DIAGRAM, consists of the following components:

- the refrigerant compressor/clutch/solenoid,
- the HVAC control head,
- the electronic system controller (ESC),
- the blower motor (located in HVAC module),

- the linear power module (located in HVAC module),
- the actuator for mode control air doors (located on HVAC module),
- the temperature control air door actuator (located on HVAC module),
- the fresh air/recirculate air door actuator (located on evaporator module),
- the engine controller,
- cooling fan/fan drive/drive control solenoid,
- two AC refrigerant thermistors,
- and the AC pressure transducer.

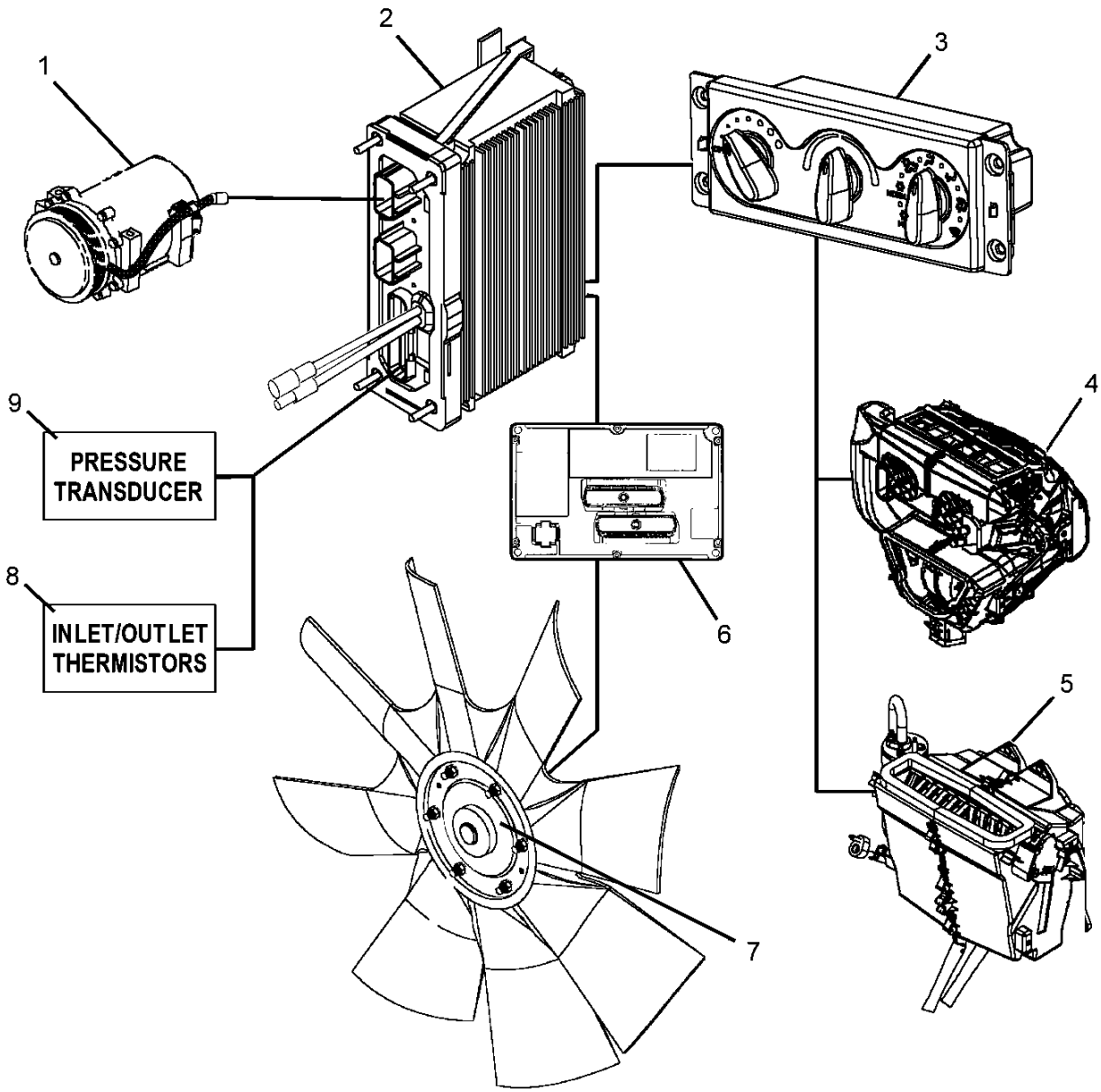



**Figure 51 HVAC Electrical System Function Diagram**

1. AC COMPRESSOR
2. ELECTRICAL SYSTEM CONTROLLER (ESC)
3. HVAC CONTROL HEAD
4. HVAC MODULE (BLOWER MOTOR, LINEAR POWER MODULE, AIR DOOR ACTUATORS)
5. EVAPORATOR MODULE (AIR DOOR ACTUATOR)
6. ENGINE CONTROLLER
7. COOLING FAN/FAN DRIVE
8. REFRIGERANT SENSORS (INLET/OUTLET THERMISTORS)
9. REFRIGERANT PRESSURE TRANSDUCER

The controls on the HVAC control head can be set to adjust the cab air temperature mix, select the blower speed, and select the system operating mode, including recirculation and distribution of cab air. The control head has a direct digital fault communication circuit to the ESC which will tell the ESC to log diagnostic trouble codes for conditions monitored by the control head (operation of the air door actuator motors). The control head also communicates with the ESC to request compressor turn on (for AC and defrost operation).

The ESC contains the circuitry and the program that controls the cycling of the air conditioner compressor. The program is known as the Refrigerant Control and Diagnostic (RCD) System. For a more complete description of the RCD system, refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150). In general the ESC monitors the refrigerant sensors (transducer and thermistors) and other system parameters to determine if all parameters are within acceptable limits. If parameters are acceptable, the ESC will turn on the compressor when requested by the HVAC control head, and will cycle the compressor to keep the system within acceptable operating parameters.

When the ESC detects readings outside of the acceptable ranges, it will generate and log a diagnostic trouble code and requests the electronic gauge cluster to turn on the CHECK AC warning light. If the ESC determines that continued operation would be destructive, it shuts down the A/C system by preventing the compressor from turning on.

Should a function of the HVAC system fail to operate, the problem could be attributed to one of the following electrical components:

- Electrical System Controller (ESC) defective
- fuse
- wiring
- HVAC control head
- blower motor
- linear power module
- air door actuator/motor
- thermistor (refrigerant temperature sensor)
- pressure transducer (refrigerant pressure sensor)
- AC compressor/clutch
- engine controller (engine RPM signal and cooling fan signal during high head pressure)

Malfunctions in the HVAC system could be attributed to either mechanical or electrical failures in the system. Diagnosis of a malfunctioning system should always begin by performing the procedures in the DIAGNOSIS AND TROUBLESHOOTING section (See DIAGNOSIS AND TROUBLESHOOTING, page 21) to determine what part of the system is malfunctioning. The procedures in the sections covering the electrical circuits will be referenced when an electrical malfunction is indicated. Use the troubleshooting procedures and table(s) in the referenced section to isolate and repair the fault.

After repairs have been made, clear the fault codes and repeat the FAULT IDENTIFICATION PROCEDURE (See Fault Identification Procedure, page 25) to verify that all faults have been repaired.

## 8.1. REFRIGERANT CONTROL AND DIAGNOSTIC (RCD) SYSTEM

The Refrigerant Control and Diagnostic (RCD) system is the software used by the Electronic System Controller (ESC) to control the A/C compressor. The purposes of the RCD system are:

- Verify that safe operating conditions exist before the compressor clutch is energized.
- Keep the A/C system operating within its optimum range by controlling the cycling of the refrigerant compressor.
- Detect faults or abnormal conditions within the A/C system.
- Protect the A/C compressor by deactivating the compressor when destructive conditions are detected.
- Generate diagnostic trouble codes that may be used to diagnose and isolate problems in the system.

To do this the RCD system monitors seven input signals from the A/C system and its environment. When certain nondestructive conditions are detected, the RCD system will allow the A/C system to continue operating while it generates diagnostic trouble codes. If destructive conditions are detected, in addition to generating diagnostic trouble codes, the RCD system will protect the compressor by commanding the ESC to turn the compressor off, shutting down the A/C system.

**NOTE – The RCD system is continually being improved and revised. If an invalid DTC has been set (see DIAGNOSTIC CHART 'A') (See Table 3, page 27), reflash (update) the ESC software to the latest revision.**

**If no invalid DTC's have been set, do not reflash the ESC unnecessarily. If the ESC software is suspected of being out of date, contact Technical Services at 1-800-336-4500 to determine if reflashing the ESC is necessary.**

The RCD software is used to control a microprocessor located in the ESC. The microprocessor cycles the A/C compressor clutch on and off by controlling a 10 Amp FET (also located in the ESC). The seven inputs used by that microprocessor are described in Table 21.

**Table 21 Inputs of the RCD System**

| Inputs to The RCD System | Descriptions of RCD System Inputs |
|---|---|
| A/C REQUEST | The A/C REQUEST signal originates in the HVAC control head, and indicates that the operator has set the controls to a combination that requires operation of the A/C system. This condition occurs when any A/C or defrost position is selected AND the fan control is NOT set to OFF. In this condition, the control head provides a chassis ground on the A/C REQUEST line, which is monitored by the ESC. |
| HVAC CONTROL HEAD DIAGNOSTICS | The control head diagnostics signals are generated by the HVAC control head to indicate the current status of several control head related circuits. In addition to the 'normal' signal, there are five signals indicating various fault conditions. The ESC monitors the DIAGNOSTICS line. Some fault conditions cause the ESC to log a fault and disable the A/C system. Lesser faults cause the ESC to log a fault, but allow the A/C system to continue to operate. |

**Table 21 Inputs of the RCD System (cont.)**

| Inputs to The RCD System | Descriptions of RCD System Inputs |
|---|---|
| HIGH SIDE PRESSURE | The HIGH SIDE PRESSURE signal is an analog signal that originates at the pressure transducer in the condenser-to-evaporator A/C refrigerant line. The ESC provides the transducer with +5V and the Zero Volt Reference (ZVR). The output signal of the transducer reflects the pressure level in the high side of the A/C system, and is monitored by the ESC. The high side pressure information is used by the ESC to disable the A/C clutch if high side pressure is too high or too low for safe compressor operation. The pressure information is also used by the ESC to control an optional on-off cooling fan drive. The high side pressure input is similar in functionality to a high-pressure cut-off switch, a low-pressure cut-off switch, and a cooling fan switch on a conventional A/C system. |
| EVAPORATOR INLET REFRIGERANT TEMPERATURE (INLET THERMISTOR) | The EVAPORATOR INLET REFRIGERANT TEMPERATURE input is actually a variable resistance that is monitored by a circuit in the ESC. The temperature of the refrigerant in the evaporator inlet A/C line, is measured by a thermistor with a negative temperature coefficient. As the refrigerant temperature increases, the thermistor resistance decreases. Under normal operating conditions, this temperature information is used by the ESC to determine when to cycle the A/C compressor clutch. |
| EVAPORATOR OUTLET REFRIGERANT TEMPERATURE (OUTLET THERMISTOR) | The EVAPORATOR OUTLET REFRIGERANT TEMPERATURE input is actually a variable resistance that is monitored by a circuit in the ESC. The temperature of the refrigerant in the accumulator, located at the evaporator outlet, is measured by a thermistor with a negative temperature coefficient. As the refrigerant temperature increases, the thermistor resistance decreases. Under light heat load conditions, this temperature information is used by the ESC to cycle the A/C compressor clutch to prevent evaporator freeze-up. The ESC also uses this temperature information, in conjunction with the high side pressure information, to determine if the ambient temperature is too low for safe compressor operation. |
| ENGINE RPM | The ENGINE RPM information is received by the ESC as a J1939 Drivetrain data link message. The ENGINE RPM information is monitored by the ESC to establish one of the conditions required for activation of the A/C compressor clutch. |
| VEHICLE SPEED | The VEHICLE SPEED information is received by the ESC as a J1939 Drivetrain data link message. The ESC uses the VEHICLE SPEED information, in conjunction with the high side pressure information, to determine if a fault should be logged for excessive high side pressure. This fault would cause the ESC to disable the A/C compressor clutch, preventing A/C system operation. |

## Normal A/C System Operation

The A/C system is activated by energizing the A/C compressor clutch. One of the purposes of the RCD system is to verify that safe operating conditions exist before the compressor clutch is energized. **ALL** of the following conditions must exist before the RCD system (the ESC) will energize the compressor clutch by supplying 12V on the clutch line.

- A J1939 engine RPM signal (indicating an engine RPM of at least 300) must have been present at the ESC for at least 8 seconds. Engine RPM signals that are temporarily lost must have been returned for at least 8 seconds.

- The A/C REQUEST line from the A/C control head to the ESC must be <0.8Vdc. This line is pulled low by the control head when an A/C or defrost mode is selected, and the Blower Speed Control is NOT set to OFF.
- The signal from the high side pressure transducer must indicate a pressure value that is <250 psi and >40 psi. A value of <250 psi indicates that an 'excessive high pressure' condition does not exists. The ESC also verifies that the pressure is >40 psi. This value is used in conjunction with the temperature value indicated by the outlet thermistor (must be >33°F) to verify that the ambient temperature is high enough for safe compressor operation.
- The value of the outlet thermistor must indicate a temperature of >33°F. The ESC uses this value, in conjunction with the pressure value indicated by the high side pressure transducer (must be >40 psi) to verify that the ambient temperature is high enough for safe compressor operation.
- The value of the inlet thermistor must indicate a temperature of >43°F, **AND** the A/C compressor clutch must have been off for ≥8 seconds.
- There must be no **active** faults detected in the transducer or thermistor circuits.
- The HVAC control head DIAGNOSTIC signal must be present at the ESC input, **AND** it must not indicate multiple faults.
- The A/C compressor clutch virtual fusing circuit in the ESC must not be faulted. The virtual fuse circuit activates when the clutch draws more than 10 Amps, indicating a fault.

Once the A/C compressor is turned on and the system is operating normally, the evaporator inlet refrigerant temperature (inlet thermistor) is used to determine when to cycle the compressor off. Too low of an evaporator temperature will cause moisture condensed on the evaporator to turn to ice and block airflow through the evaporator (evaporator freeze-up). When evaporator inlet refrigerant temperature drops to 30°F **AND** the compressor has been on for ≥7 seconds, the A/C compressor clutch is de-energized (cycled off).

After the compressor has been off for at least 8 seconds, the cycle will be repeated when the evaporator inlet refrigerant temperature again reaches 43°F. Both conditions must exist before the compressor can be energized.

Therefore, under light heat load conditions, the fastest cycle rate for the compressor is 15 seconds (8 seconds off and 7 seconds on). Under high heat load conditions, the compressor may remain energized continuously until the engine or the A/C system is shut off. This is because the evaporator inlet refrigerant temperature may not drop below 30°F.

Under some light heat load conditions, the evaporator outlet refrigerant temperature may be several degrees lower than the evaporator inlet refrigerant temperature. If the outlet refrigerant temperature drops below 24°F, **AND** at least 7 seconds have elapsed since the compressor was cycled on, the ESC will de-energize the A/C compressor clutch to help prevent evaporator freeze-up.

On vehicles equipped with an on-off fan drive, the ESC will request the engine controller to switch on the engine fan when the pressure transducer indicates a pressure greater than 285 psi. This ESC-to-engine controller communication is sent over the drivetrain data link. The engine fan will be turned on for one minute intervals until the high side pressure drops below 185 psi. Therefore, once the pressure drops below 185 psi, the fan will remain on until one minute after it was last turned on. The fan will also turn on when an AC RQST signal is received and the following conditions exist: vehicle speed < 10 mph, engine speed > 1200 rpm, high side pressure > 100 psi, and the inlet thermistor temperature >85°F.

The ESC will also de-energize the A/C compressor clutch if the pressure transducer indicates a high side pressure greater than 400 psi.

In conclusion, the RCD system (ESC) will de-energize the A/C compressor clutch if/when ANY of the following conditions occur.

- The J1939 engine RPM signal indicates that the engine has stopped **OR** the signal is lost.
- The evaporator inlet refrigerant temperature is <30°F **AND** the A/C compressor clutch has been energized for at least 7 seconds.
- The evaporator outlet refrigerant temperature is <24°F **AND** the A/C compressor clutch has been energized for at least 7 seconds.
- The high side pressure transducer indicates a pressure >400 psi.
- The A/C REQUEST line from the A/C control head to the ESC is >4.0Vdc. This normally indicates that an A/C or defrost mode is not selected, or the Blower Speed Control is set to OFF.
- The ESC has detected an **active** fault in the transducer or thermistor circuits.
- The HVAC control head DIAGNOSTIC signal is missing from the ESC input, **AND** the A/C compressor clutch has been energized for at least 7 seconds.
- The HVAC control head DIAGNOSTIC signal is indicating multiple faults, **AND** the A/C compressor clutch has been energized for at least 7 seconds.
- The A/C compressor clutch virtual fusing circuit in the ESC has been activated. The virtual fuse circuit activates when the clutch draws more than 10 Amps, indicating a fault.

### Refrigerant Charge Diagnostics

One purpose of the RCD system is to protect the A/C system by monitoring the system sensors and indicating when the refrigerant level is low before all cooling ability is lost. The RCD system enables the ESC to diagnose a refrigerant charge problem, and indicate the severity of the problem with three fault levels (marginal charge, low charge, and very low charge).

When the A/C compressor is on, the temperature difference between the evaporator inlet refrigerant (inlet thermistor) and the evaporator outlet refrigerant (outlet thermistor) is used to help determine the condition of the system refrigerant charge. In addition to the temperature differential, the RCD system considers the heat load and time to calculate the charge level (refer to VALUES FOR REFRIGERANT CHARGE DIAGNOSTICS). The following descriptions assume that the compressor is running and the cab temperature has stabilized.

With a fully charged system the temperature difference between the evaporator inlet refrigerant (inlet thermistor) and the evaporator outlet refrigerant (outlet thermistor) is minimal (< 18°F at Extreme operating temperatures). Depending on the heat load, the evaporator inlet refrigerant temperature will be slightly lower or higher than the evaporator outlet refrigerant temperature.

With an A/C system that is less than fully charged, the evaporator inlet refrigerant temperature will be much lower than the evaporator outlet refrigerant temperature. This is because there is an insufficient amount of refrigerant moving through the evaporator to absorb any more heat. The level of system charge is indicated by the magnitude of this temperature differential. The greater the temperature differential, the lower the charge level of the system.

If the RCD system determines that the charge level is too low for safe compressor operation, the ESC will de-energize the A/C compressor clutch and set either a 'SERVICE NOW low charge' fault or a 'SERVICE NOW very low charge' fault. Under Extreme operating temperatures, the 'low charge' fault is indicated by a thermistor temperature differential of $\geq$35°F, but <50°F, for a period > 30 minutes. Under Extreme operating temperatures, the 'very low charge' fault is indicated by a thermistor temperature differential of $\geq$50°F, for a

period > 15 minutes . In addition the ESC will command the EGC to turn on the CHECK AC warning indicator. The ESC will continue to inhibit A/C compressor operation until the problem is fixed and the fault is cleared.

**Table 22 Values for Refrigerant Charge Diagnostics**

| Operating Condition | Averaged Value of Outlet Thermistor (X3) | Fault Detection Thresholds (Temperature Differential between Outlet Thermistor and Inlet Thermistor) | |
|---|---|---|---|
| | | dT Low Charge | dT Very Low Charge |
| Extreme | >65°F | ≥35° | ≥50° |
| Normal | 55° — 65°F | ≥20° | |
| Cold | <55°F | ≥15° | |

**IMPORTANT –** The temperature differences in the table above must be maintained for the following time periods, before a fault code will be set.

- A low charge fault will be set if the temperature difference is in the low charge range for > 30 minutes.
- A very low charge fault will be set if the temperature difference is in the very low charge range for > 15 minutes.

**EXAMPLES**

A. Low Charge Fault under Cold Operating Conditions (X3 = <55°F):

dT ≥15° for 30 minutes.

B. Very Low Charge Fault under Extreme Operating Conditions (X3 = >65°F):

dT >50° for 15 minutes.

## System Pressure Diagnostics

Another purpose of the RCD system is to protect the A/C system from excessive pressure by monitoring the pressure transducer and other operating conditions. Under certain conditions the RCD system will cycle the A/C system off without commanding the ESC to set a fault. This allows temporary high pressure conditions to occur without disabling the A/C system. When high pressure conditions are determined to be unsafe for A/C compressor operation, the ESC will set an 'excessive pressure' fault, and will command the EGC to turn on the CHECK AC warning indicator. The ESC will inhibit A/C compressor operation until the problem is fixed and the fault is cleared.

If the pressure transducer indicates a high side pressure greater than 400 psi, the RCD system will command the ESC to de-energize the A/C compressor. The RCD system then checks the vehicle speed by monitoring the J1939 drivetrain data link.

If the vehicle speed is <20 mph, the ESC will not set a fault. The ESC will prevent the compressor from turning on until the high side pressure drops to ≤250 psi **AND** the compressor has been off for at least 8 seconds. If this cycle repeats a number of times, the ESC will disable the A/C compressor clutch for 5 minutes or until the vehicle speed exceeds 20 mph. If the vehicle speed remains below 20 mph, the ESC will permit this pattern (including the 5 minute rest periods) to continue without setting a fault.

If the vehicle speed is ≥20 mph and the high side pressure reaches 400 psi on 60 successive clutch ON cycles, the ESC will set a 'SERVICE NOW excessive pressure' fault, and will command the EGC to turn on the CHECK AC warning indicator. The ESC will inhibit A/C compressor operation until the problem is fixed and the fault is cleared.

### Pressure Transducer Diagnostics

For diagnostic purposes, the RCD system analyzes the voltage value of the high side pressure transducer to determine if the transducer circuit is operating outside of its normal range. If the RCD system detects a voltage value at either extreme of the transducer's range, it assumes that a fault exists in the circuit. The ESC will command the EGC to turn on the CHECK AC warning indicator. In addition, the ESC will inhibit A/C compressor operation until the fault is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

If the voltage value approaches 5 Vdc (indicating a pressure of ≥500 psi), the ESC will set a fault indicating that the high side pressure transducer is operating above the normal range.

The ESC will also set a fault if the transducer voltage value drops to near 0 Vdc (indicating a pressure of 0 psi or the presence of a vacuum). The fault will indicate that the pressure transducer is operating below the normal range.

### Shorted Thermistor Diagnostics

For diagnostic purposes, the RCD system analyzes the resistance values of the inlet and outlet thermistors to determine if either thermistor circuit is open or shorted to ground (or zero volt reference). Because the RCD system does not detect the full range of resistance values it cannot directly detect an open or shorted circuit.

If the RCD system reads a thermistor resistance value at the low end of its range it assumes that the thermistor circuit is shorted to ground, because this value (which corresponds to 240°F) does not reflect a normal reading. The ESC will set a fault indicating that that particular thermistor is shorted to ground. The ESC will also command the EGC to turn on the CHECK AC warning indicator. In addition, the ESC will inhibit A/C compressor operation until the short is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

### Open Thermistor Diagnostics

If the RCD system reads a thermistor resistance value at the high end of its range it cannot assume that the thermistor circuit is open because this value (which corresponds to 0°F) can also occur during normal operation. Therefore, to determine if a thermistor circuit is open, the RCD system must perform these additional checks.

- The thermistor resistance values are checked while the A/C compressor is cycled OFF.
- The high side pressure transducer value is checked to verify that the ambient temperature is not excessively low. Its value must be greater than 20 psi.
- The resistance values of the two thermistors are compared. If one indicates 0°F and the other one indicates ≥30°F, the thermistor circuit indicating 0°F is considered open.

After making these additional checks, if the RCD system determines that a thermistor circuit is open, the ESC will set a fault indicating that that particular thermistor circuit is open. The ESC will also command the EGC to turn on the CHECK AC warning indicator. In addition, the ESC will inhibit A/C compressor operation until the open is no longer detected, **AND** at least 8 seconds have elapsed since the A/C compressor clutch was de-energized.

## OBSERVING THE RCD SIGNALS WITH THE EZ-TECH® SERVICE TOOL

The EZ-Tech electronic service tool, running diagnostic software allows the servicer to monitor the HVAC electrical signals that pass through the ESC. Refer to Figure 93, (See Figure 93, page 231). When used in conjunction with these procedures or the electrical troubleshooting manual, the EZ-Tech allows the servicer to isolate electrical faults efficiently. See the diagnostic software manual for details on using the software.

# 9. HVAC CONTROL HEAD CIRCUITS

## 9.1. CIRCUIT FUNCTIONS

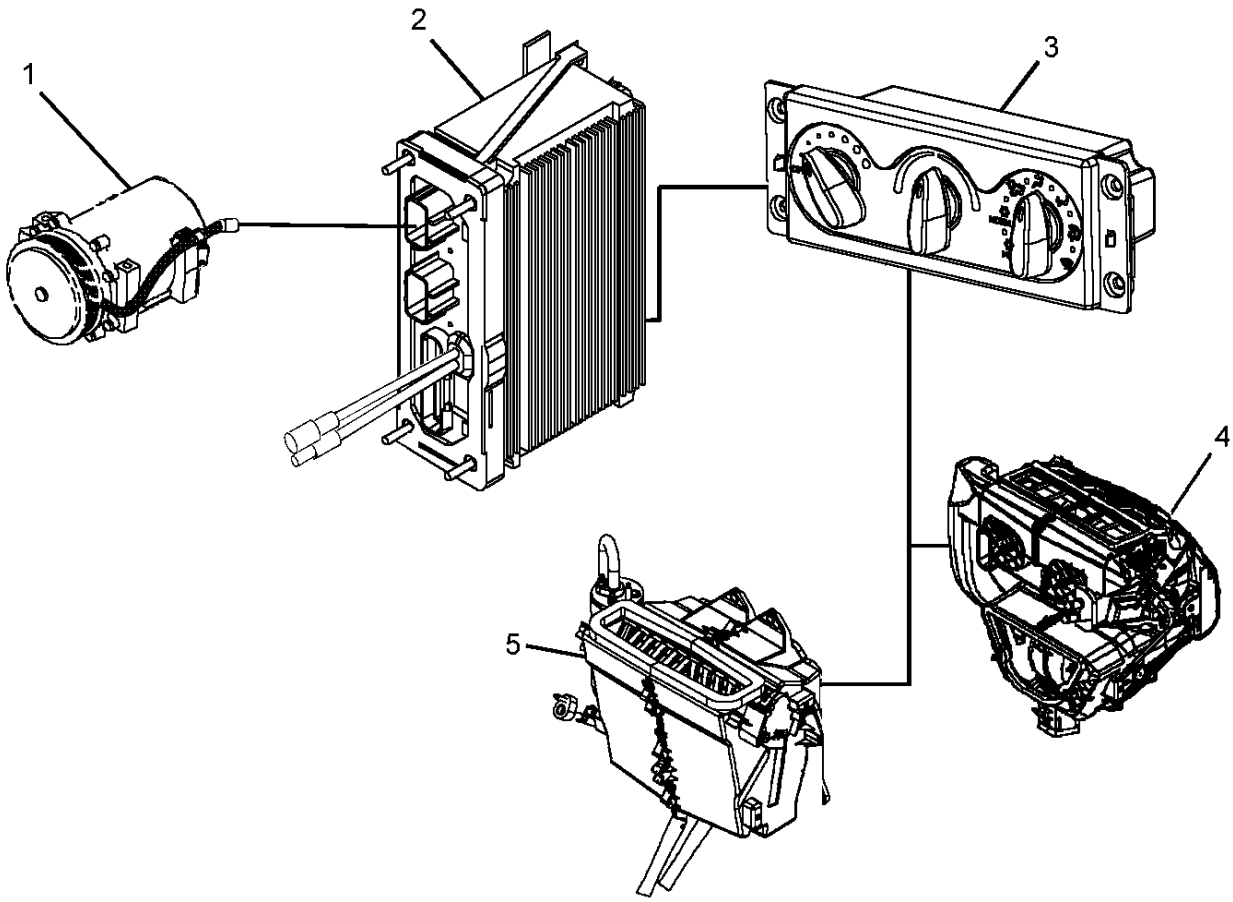



**Figure 52 HVAC Control Head Function Diagram**

1. AC COMPRESSOR
2. ELECTRICAL SYSTEM CONTROLLER
3. HVAC CONTROL HEAD
4. HVAC MODULE (BLOWER MOTOR, LINEAR POWER MODULE, AIR DOOR ACTUATORS)
5. EVAPORATOR MODULE (AIR DOOR ACTUATOR)

All major functions of the A/C-heater system are controlled from the HVAC control head (refer to HVAC CONTROL HEAD FUNCTION DIAGRAM). The HVAC control head consists of three knobs connected to potentiometers which electronically control the blower fan speed, the A/C compressor clutch, and the actuators that move the air doors used to control system air distribution and temperature. The electronic circuits in the control head allow it to communicate with the electrical system controller (ESC) to request compressor turn on and provide HVAC diagnostics. The blower speed control is detented to provide seven distinct blower speeds. The temperature control has fifteen detents. The mode control is used to select the HVAC operating mode, indicated by the seven mode icons (five mode icons on the 'heat only' system). NOTE: The following information covers the 'heater/air conditioner' version of the system; the 'heater only' system is nearly identical, except all air conditioning information can be ignored.

## 9.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the HVAC control head circuits. A list of the possible causes of the circuit failure is also provided. Table 23 lists and describes the Diagnostic Trouble Codes associated with the HVAC control head circuits. Table 24 provides the troubleshooting procedures for isolating the cause of the failure.

A possible failure of the HVAC control head circuits is indicated when any of the circuits or functions controlled by the control head fail to operate correctly. Any of the following symptoms **could** indicate a failure of the HVAC control head circuits:

- loss of control of the HVAC system recirculation/fresh air intake. Refer to RECIRCULATION ACTUATOR MOTOR CIRCUIT (See RECIRCULATION ACTUATOR MOTOR CIRCUIT, page 175)
- loss of control of the HVAC system in-cab air distribution. Refer to MODE ACTUATOR MOTOR CIRCUIT (See MODE ACTUATOR MOTOR CIRCUIT, page 181)
- loss of control of HVAC system blower. Refer to BLOWER MOTOR CIRCUIT (See BLOWER MOTOR CIRCUIT, page 194)
- loss of control of HVAC system air temperature. Refer to TEMPERATURE ACTUATOR MOTOR CIRCUIT (See TEMPERATURE ACTUATOR MOTOR CIRCUIT, page 188)
- loss of control of the AC compressor (AC modes and defrost modes)
- mechanical failure of one of the controls on the HVAC control head
- failure of the panel lighting on the control head
- illumination of the “CHECK AC” warning light
- logging of any of the HVAC control head diagnostic trouble codes

A failure in the operation of the HVAC control head circuits could be attributed to any of the following conditions:

- power circuits (BATT and IGN), open or shorted to ground, or fuse blown
- ground circuit open
- control head AC Request circuit open or shorted to ground (AC compressor cannot be controlled)
- diagnostic communication circuit open or shorted to ground
- panel light circuit, open or shorted to ground, external or internal to the control head
- a control or circuit within the control head is defective (refer to the section covering the malfunctioning circuit or component: MODE ACTUATOR MOTOR CIRCUIT, BLOWER MOTOR CIRCUIT, TEMPERATURE ACTUATOR MOTOR CIRCUIT, or RECIRCULATION ACTUATOR MOTOR CIRCUIT.

Refer to HVAC CONTROL HEAD POWER CIRCUITS diagram.

**Table 23 HVAC Control Head Power and Diagnostic Circuits Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 613 14 1 4 | HVAC multiple faults |
| This Diagnostic code is set when faults are sensed on two or more of the control head's output control circuits. The code is the result of faults sensed in two or more of the following circuits:<br>• the recirculation motor circuit (refer to the section covering the RECIRCULATION ACTUATOR MOTOR CIRCUIT) (See RECIRCULATION ACTUATOR MOTOR CIRCUIT, page 175)<br>• the mode actuator motor circuits (refer to the section covering the MODE ACTUATOR MOTOR CIRCUIT) (See MODE ACTUATOR MOTOR CIRCUIT, page 181)<br>• the temperature actuator circuits (refer to the section covering the TEMPERATURE ACTUATOR MOTOR CIRCUIT) (See TEMPERATURE ACTUATOR MOTOR CIRCUIT, page 188)<br>**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**<br>If a problem is found in two or more of the above circuits, repair those circuits and clear the diagnostic trouble code.<br>If a problem is **not** found in two or more of the above circuits; install the breakout box at ESC connector (1600), and check the status of the control head diagnostic line at connector (1600), terminal 8.<br>A. If the signal on the diagnostic line is an alternating voltage of 1 pulse per second (0.5 sec high/0.5 sec low), replace the HVAC control head. (Control head is indicating a multiple fault when none exists.)<br>low < 2 Vdc<br>high > 7 Vdc<br>B. If the signal on the diagnostic line is **not** an alternating voltage of 1 pulse per second, replace the ESC. | |
| 613 14 1 5 | HVAC control head fault |
| This Diagnostic code is set when communications between the HVAC control head and the ESC have been interrupted.<br>The code could be the result of any of the following conditions:<br>• power circuits (BATT and IGN), open or shorted to ground, or fuse blown<br>• ground circuit open<br>• diagnostic communication circuit open or shorted to ground<br>• defective HVAC control head<br>• defective ESC<br>Refer to TABLE 24 (See Table 24, page 161). | |

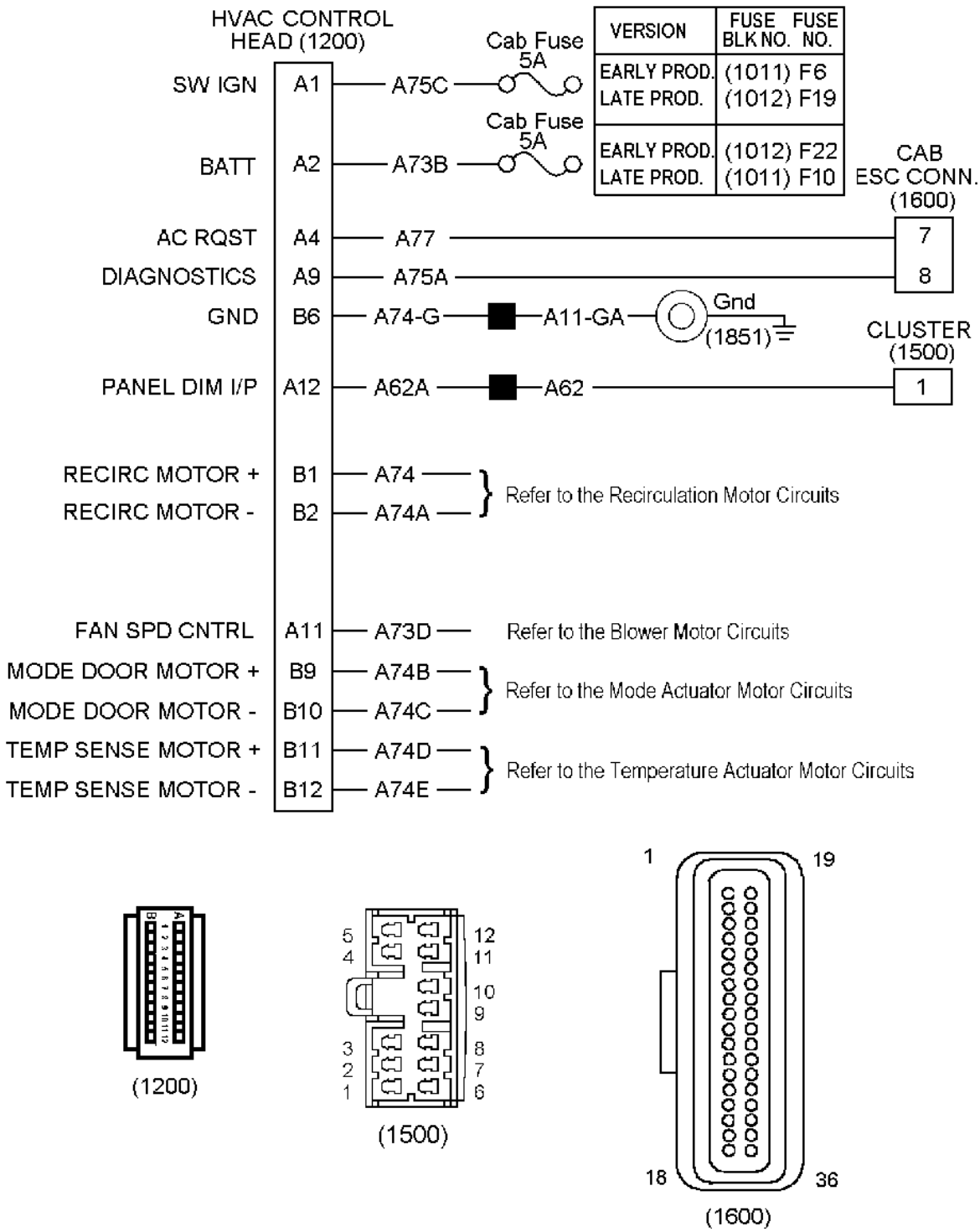



**Figure 53 HVAC Control Head Power Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(1200) HVAC CONTROL CONNECTOR
LOCATED BEHIND CONTROL HEAD
(1500) ELECTRONIC GAUGE CLUSTER CONNECTOR
LOCATED ON EGC
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ESC
(1851) GROUND STUD
LOCATED ABOVE ESC ON DASH PANEL

**Table 24 HVAC Control Head Power and Diagnostic Circuits Troubleshooting Chart**

**HVAC Control Head Circuit Troubleshooting Chart**

Install breakout box ZTSE4477 at ESC connector (1600).

Disconnect HVAC control head connector (1200).

Check with ignition key ON.

**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**

**NOTE – Always check connectors for damage and pushed–out terminals.**

| Test Points | Spec. | Comments |
|---|---|---|
| connector (1200), cavity A1 to ground | 12 ± 1.5 volts | If voltage is missing:<br>• Check for open or short to ground in circuits between connector (1200), cavity A1 and the fuse (F6 - Early Prod. or F19 - Late Prod.).<br>• Check for blown fuse. If fuse is blown, check circuit for short to ground before replacing fuse.<br>If voltage is present, proceed to the next step. |
| connector (1200), cavity A2 to ground | 12 ± 1.5 volts | If voltage is missing:<br>• Check for open or short to ground in circuits between connector (1200), cavity A2 and the fuse (F22 - Early Prod. or F10 - Late Prod.).<br>• Check for blown fuse. If fuse is blown, check circuit for short to ground before replacing fuse.<br>If voltage is present, proceed to the next step. |
| connector (1200), cavity A2 to B6 | 12 ± 1.5 volts | If voltage is missing, repair open circuit between connector (1200), cavity B6 and ground stud (1851).<br>If voltage is present, proceed to the next step. |

**Table 24 HVAC Control Head Power and Diagnostic Circuits Troubleshooting Chart (cont.)**

| | | |
|---|---|---|
| connector (1200), cavity A12 to B6<br><br>Panel lights for A/C Control Head | **IMPORTANT –** The headlight switch must be turned on for this measurement.<br><br>2 to 11 volts adjustable with the PANEL dimmer control. | If voltage is missing, isolate circuit between (1200) cavity A12 and (1500) terminal 1, and check for an open or short circuit to ground. If circuit checks ok, replace EGC.<br><br>If voltage is present, proceed to the next step. |
| connector (1200), cavity A9 to B6 (or ground)<br><br>Diagnostic circuit between HVAC control head and ESC. | 11 ± 1.5 volts | If voltage is missing, isolate circuit between (1200) cavity A9 and (1600) terminal 8, and check for an open or short circuit to ground. If circuit checks ok, replace ESC.<br><br>If voltage is present, proceed to the next step. |
| connector (1200), cavity A4 to B6 (or ground)<br><br>AC request circuit to ESC. | 11 ± 1.5 volts | If voltage is missing, isolate circuit between (1200) cavity A4 and (1600) terminal 7, and check for an open or short circuit to ground. If circuit checks ok, replace ESC.<br><br>If voltage is present, proceed to the next step. |

**Table 24 HVAC Control Head Power and Diagnostic Circuits Troubleshooting Chart (cont.)**

| **HVAC Control Head Circuit Troubleshooting Chart (Continued)**<br><br>Check with HVAC control head connector (1200) reconnected, breakout box ZTSE4477 installed at ESC connector (1600), and engine running at idle.<br><br>**NOTE – Always use breakout box to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.** | | |
|---|---|---|
| Test Points | Spec. | Comments |
| connector (1600), cavity 7 to ground. | Set blower speed to midrange.<br><br>Set temperature control fully ccw.<br><br>Check for < 0.5 Vdc when any AC or defrost mode is selected on the HVAC control head.<br><br>Check for 11 ± 1.5 volts when any other mode is selected. | If voltage readings are incorrect, replace the HVAC control head.<br><br>If voltage readings are correct, proceed to the next step. |
| connector (1600), cavity 8 to ground. | Alternating voltage, pulse rate should be 2.5 sec high/2.5 sec low.<br><br>low < 2 Vdc<br><br>high > 7 Vdc | If alternating voltage is present, replace ESC.<br><br>If voltage at test point is not alternating, replace HVAC control head. |

## 9.3. EXTENDED DESCRIPTION

The HVAC control head connector terminal A1 is supplied switched ignition voltage, via circuit A75C, from a cab power distribution panel fuse (F6 - Early Prod. or F19 - Late Prod.). HVAC control head connector terminal A2 is supplied Battery voltage, via circuit A73B, from a cab power distribution panel fuse (F22 - Early Prod. or F10 - Late Prod.). HVAC control head connector terminal B6 is supplied ground from ground stud (1851), via circuits A11-GA and A74-G.

Voltage for the control head lighting is supplied to control head connector terminal A12 from the Electronic Gauge Cluster (EGC) connector (1500) terminal 1.

When the mode selection requires the control head to request AC compressor turn on, the control head places a ground on terminal A4 of connector (1200). This signal is routed by circuit A77 to the ESC at connector (1600) terminal 7.

The HVAC control head sends a digital diagnostic signal to the ESC indicating the operating status of the control head and the circuits monitored by the control head. This signal is output from terminal A9 of connector (1200) and is routed by circuit A75A to ESC connector (1600) terminal 8.

For more information about other control head circuits: MODE ACTUATOR MOTOR CIRCUIT, BLOWER MOTOR CIRCUIT, TEMPERATURE ACTUATOR MOTOR CIRCUIT, or RECIRCULATION ACTUATOR MOTOR CIRCUIT, refer to the section covering that circuit.

## 9.4. COMPONENT LOCATIONS

Refer to HVAC CONTROL HEAD LOCATION diagram.

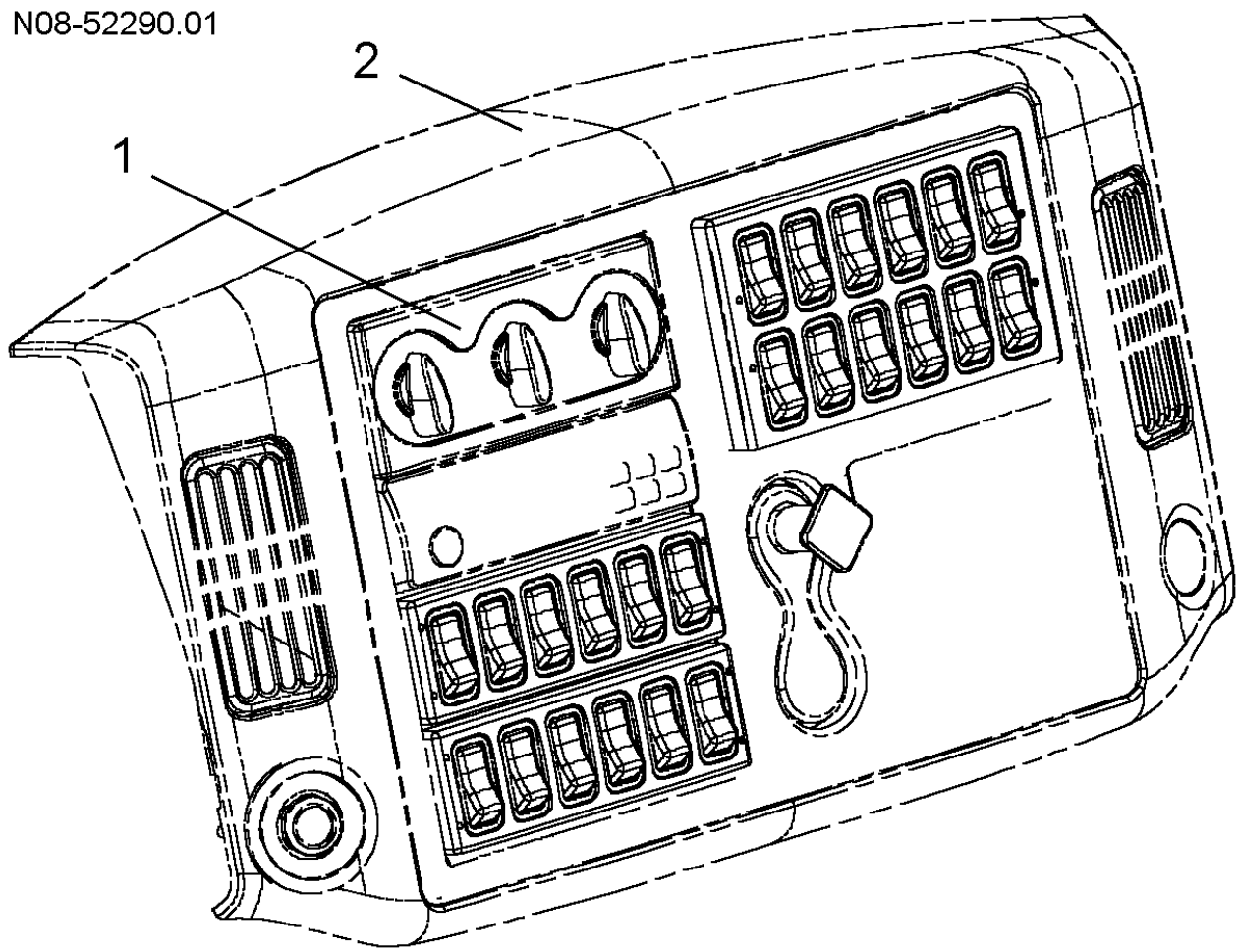



**Figure 54 HVAC Control Head Location**

1. HVAC CONTROL HEAD
2. CENTER INSTRUMENT PANEL

# 10. AC COMPRESSOR CIRCUITS

## 10.1. CIRCUIT FUNCTIONS

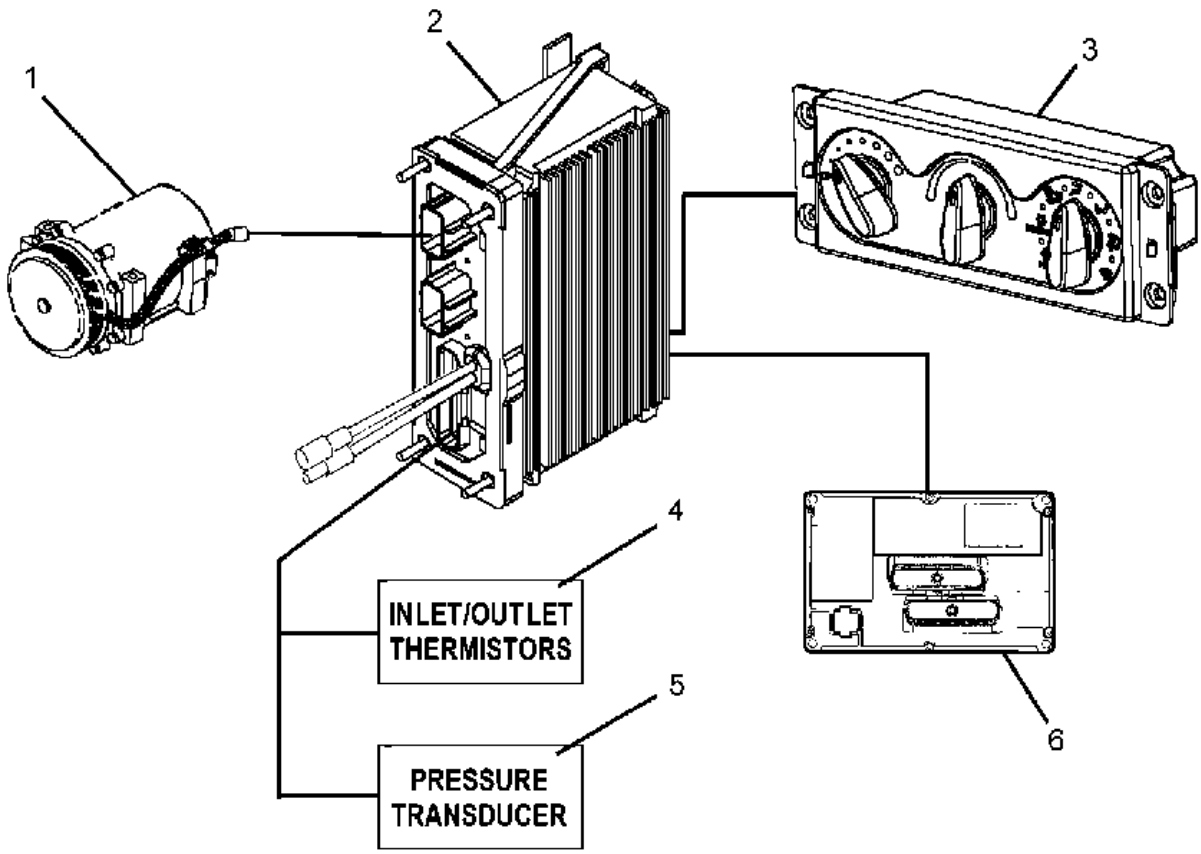



**Figure 55 AC Compressor Function Diagram**

1. AC COMPRESSOR
2. ELECTRICAL SYSTEM CONTROLLER (ESC)
3. HVAC CONTROL HEAD
4. REFRIGERANT SENSORS (INLET/OUTLET THERMISTORS)
5. REFRIGERANT PRESSURE TRANSDUCER
6. ENGINE CONTROLLER

When an air conditioning (or defrost) mode is selected on the HVAC control head, and the blower speed control is NOT set to OFF, the control head will send an AC Request signal to the Electrical System Controller (ESC). If the ESC senses that the system parameters are within operating limits, it turns on the AC compressor by providing it with power (refer to AC COMPRESSOR FUNCTION DIAGRAM).

The AC compressor is mounted on the engine and is belt-driven through an electromagnetic clutch which acts to engage (turn ON) or disengage (turn OFF) the compressor in response to the air conditioning system controls (HVAC control panel and ESC). When engaged, the clutch armature assembly is magnetically drawn to the pulley assembly on the compressor shaft, thereby engaging the clutch and allowing the drive belt to drive the compressor.

The Refrigerant Control and Diagnostic (RCD) system is the software used by the ESC to monitor and control A/C system operation. The RCD system monitors the refrigerant sensors (transducer and thermistors) and other system parameters to determine if all parameters are within acceptable limits. This information allows the ESC to keep the A/C system operating within its optimum range by controlling the cycling of the AC compressor.

## 10.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the AC compressor circuits. A list of the possible causes of the circuit failure is also provided. Table 25 lists and describes the Diagnostic Trouble Codes associated with the AC compressor circuits. Table 26 provides the troubleshooting procedures for isolating the cause of a failure within the AC compressor circuit.

During normal AC operation, the AC compressor clutch is engaged when battery voltage is supplied from the ESC. Refer to AC COMPRESSOR CLUTCH POWER CIRCUITS diagrams (Figure 56 and/or Figure 57). The RCD system, within the ESC, monitors the operation of refrigerant system. When certain 'out of tolerance' but nondestructive conditions are detected, the RCD system will allow the A/C system to continue operating while it generates diagnostic trouble codes that may be used to diagnose and isolate the source of the problem. If destructive conditions are detected, the RCD system will protect the compressor by commanding the ESC to turn the compressor off, shutting down the A/C system. In addition, the RCD system will also generate diagnostic trouble codes that may be used to diagnose and isolate problems in the system.

A failure of the AC compressor clutch circuit is indicated when one of the diagnostic trouble codes related to the compressor clutch is displayed on the EGC.

A failure in the operation of the AC compressor clutch circuits could be attributed to any of the following conditions:

- a defective compressor clutch (open, shorted, or mechanical problem)
- an open or short in the power circuits between the compressor clutch and the ESC
- an open in the circuit between the compressor clutch and ground
- a defective ESC.

The following list contains other conditions that could prevent the compressor from operating correctly; however, these conditions would not set a diagnostic trouble code related to the compressor clutch circuit.

- a missing or incorrect thermistor input to the ESC. Refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57).
- a missing or incorrect pressure transducer input to the ESC. Refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57).
- a missing AC Request (AC RQST) input to the ESC. Refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57).
- a missing control head diagnostics input to the ESC. HVAC CONTROL HEAD CIRCUITS (See HVAC CONTROL HEAD CIRCUITS, page 157).
- a multiple fault signal on the control head diagnostics input line to the ESC. HVAC CONTROL HEAD CIRCUITS (See HVAC CONTROL HEAD CIRCUITS, page 157).

- a missing engine RPM message from the engine controller to the ESC. Refer to INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57).

**Table 25 AC Compressor Power Circuits Diagnostic Codes**

| Diagnostic Codes | |
|---|---|
| 611 14 9 1 | Compressor clutch under current (open circuit) |
| This Diagnostic code is set when the compressor clutch circuit is drawing less than 0.5A current. The code is the result of an open in the compressor clutch or the clutch circuits (clutch to ground or clutch to ESC). | |
| 611 14 9 2 | Compressor clutch over current (short circuit) |
| This Diagnostic code is set when the compressor clutch current reaches fusing level (the output behaves like a 10 Amp type III circuit breaker). The code is the result of a shorted compressor clutch or a short to ground in the circuit between the clutch and the ESC. | |
| 611 14 9 3 | Compressor clutch less than normal low current but more than open circuit current |
| This Diagnostic code is set when the compressor clutch circuit is drawing less than normal current, but more than an open circuit condition. The code is the result of one or more high resistance connections in the compressor clutch or in the compressor circuit current path. | |
| 611 14 9 4 | Compressor clutch greater than normal high current but less than fusing current |
| This Diagnostic code is set when the compressor clutch circuit is drawing more than normal current, but not enough to trip the fusing circuit. The code is the result of shorted windings in the compressor clutch. | |
| 611 14 9 6 | Compressor clutch has current flow when commanded off |
| This Diagnostic code is set when the ESC is sensing a current draw in the compressor clutch circuit, even though it is commanding the compressor clutch OFF. The code is the result of a defective ESC. | |

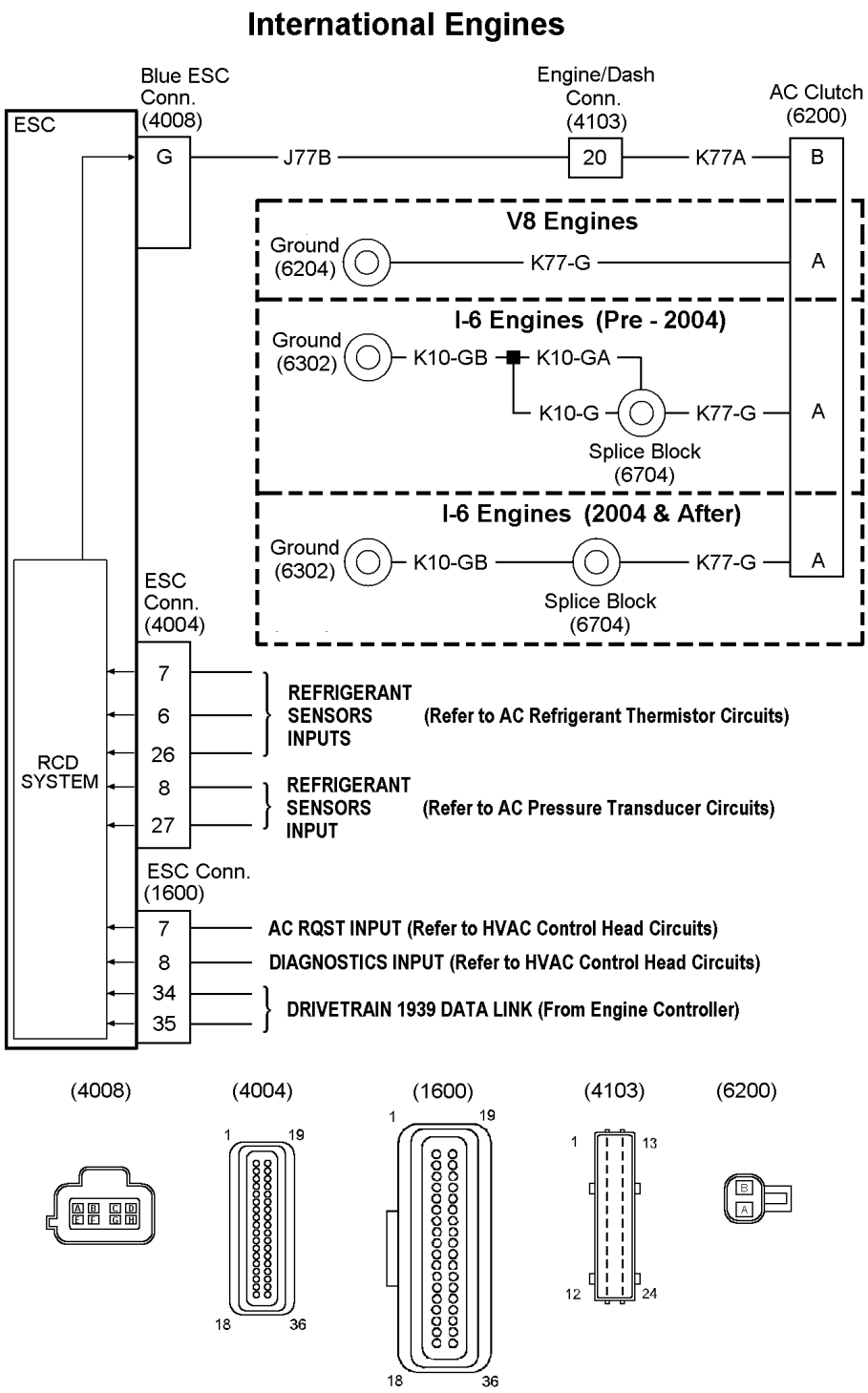



**Figure 56 AC Compressor Clutch Power Circuits (International Engines) — Always Refer to Circuit Diagram Book for Latest Circuit Information**

(4008) BLUE ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6200) COMPRESSOR CLUTCH CONNECTOR
LOCATED NEAR COMPRESSOR CLUTCH
(6204) ENGINE BLOCK GROUND
(6302) STARTER GROUND STUD
LOCATED NEAR STARTER
(6704) GROUND SPLICE BLOCK
LOCATED NEAR ENGINE CONTROLLER
(4004) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC

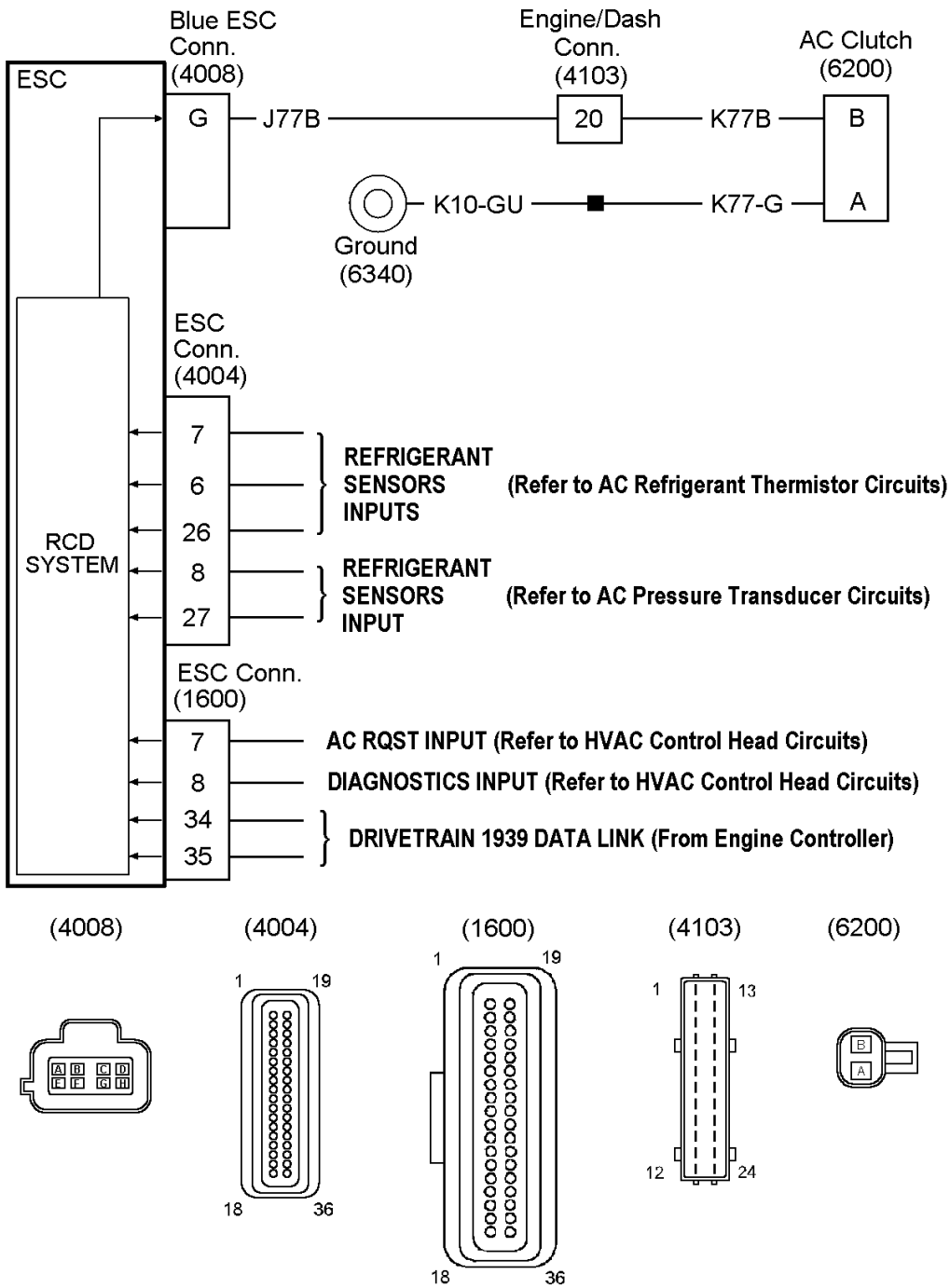



**Figure 57 AC Compressor Clutch Power Circuits (CUMMINS ISM and CAT C10/11/12/13 Engines) — Always Refer to Circuit Diagram Book for Latest Circuit Information**

(4008) BLUE ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6200) COMPRESSOR CLUTCH CONNECTOR
LOCATED NEAR COMPRESSOR CLUTCH
(6340) ENGINE BLOCK GROUND
(6704) GROUND SPLICE BLOCK
LOCATED NEAR ENGINE CONTROLLER
(4004) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC

**Table 26 AC Compressor Power Circuits Troubleshooting Chart**

**AC Compressor Power Circuits Troubleshooting Chart**

**CAUTION – If you attempt to energize the compressor clutch by applying voltage directly to the clutch with jumpers, It is extremely important that the polarity is correct. If a reverse polarity voltage is applied to the clutch, it could destroy a diode used to protect the ESC. This failure may not be evident, but it would leave the ESC susceptible to damage during compressor cycling.**

**IMPORTANT –** A thorough understanding of the REFRIGERANT CONTROL AND DIAGNOSTICS (RCD) SYSTEM (See Refrigerant Control and Diagnostic (RCD) System, page 150) is necessary to understand the interaction of the inputs required by the compressor circuit. The RCD system is designed to control the compressor; including removing power from the compressor when a fault is detected.

Before troubleshooting this circuit, place the system into diagnostic mode and note the DTC's indicated on the EGC. Resolve any DTC's related to the HVAC thermistors, the HVAC pressure transducer, or the HVAC control head. Locate codes in CHART 'A' (See Table 3, page 27) and perform action indicated. If no DTC's are being logged and the compressor will not operate, refer to the INSUFFICIENT COOLING TROUBLESHOOTING table (See Table 17, page 57).

**USE THIS CHART ONLY IF A COMPRESSOR DTC HAS BEEN LOGGED.** Refer to AC COMPRESSOR POWER CIRCUITS DIAGNOSTIC CODES (See Table 25, page 167).

**NOTE – Always check connectors for damage and pushed–out terminals.**

1. Make the following checks with the key OFF.

2. Install the breakout box at connector (4008). (Connect breakout box to compressor harness; but **do not** connect it to the ESC).

3. Disconnect connector (6200) at the compressor.

4. Use a DMM to make the following resistance checks.

**Table 26 AC Compressor Power Circuits Troubleshooting Chart (cont.)**

| Test Points | Spec. | Comments |
|---|---|---|
| The circuit from (4008) cavity G to (6200) cavity B. and the circuit from (6200) cavity B to ground. | Verify continuity from (4008) cavity G to (6200) cavity B, and verify no short circuit to ground. Verify continuity from (6200) cavity B to ground. | If resistance checks are **NOT** ok, repair the wire harness.<br><br>If the resistance checks are ok, reconnect connector (6200) and proceed to the next step. |
| The circuit from (4008) cavity G to ground. | Reconnect connector (6200).<br><br>Verify resistance of compressor clutch coil is 2.2 – 4.5 Ohms. | If resistance check is **NOT** ok, replace the entire compressor/clutch assembly.<br><br>If the resistance check is ok, replace the ESC. |

## 10.3. EXTENDED DESCRIPTION

When all of the inputs to the RCD system are present and are within operational limits, the ESC will supply battery voltage at (4008) terminal G, through dash connector (4103), to AC compressor connector (6200) terminal B. The AC compressor is supplied a ground on connector (6200) terminal A from the engine ground stud. This energizes the A/C compressor clutch which engages the compressor and starts the AC cooling cycle. The ESC will control the cycling of the air conditioner compressor depending on inputs from the HVAC control head, AC pressure transducer, inlet AC refrigerant thermistor, outlet AC refrigerant thermistor, and engine controller data link.

## 10.4. COMPONENT LOCATIONS

Refer to FIGURE 58 and FIGURE 59.

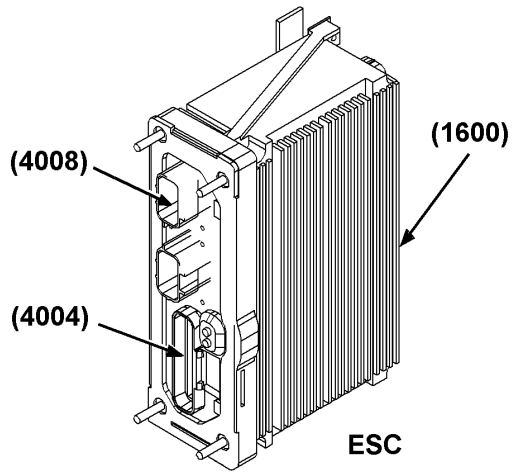



**Figure 58 AC Compressor Circuit Component Locations (on ESC)**

(1600) ESC CONNECTOR
(4004) ESC CONNECTOR
(4008) BLUE ESC CONNECTOR

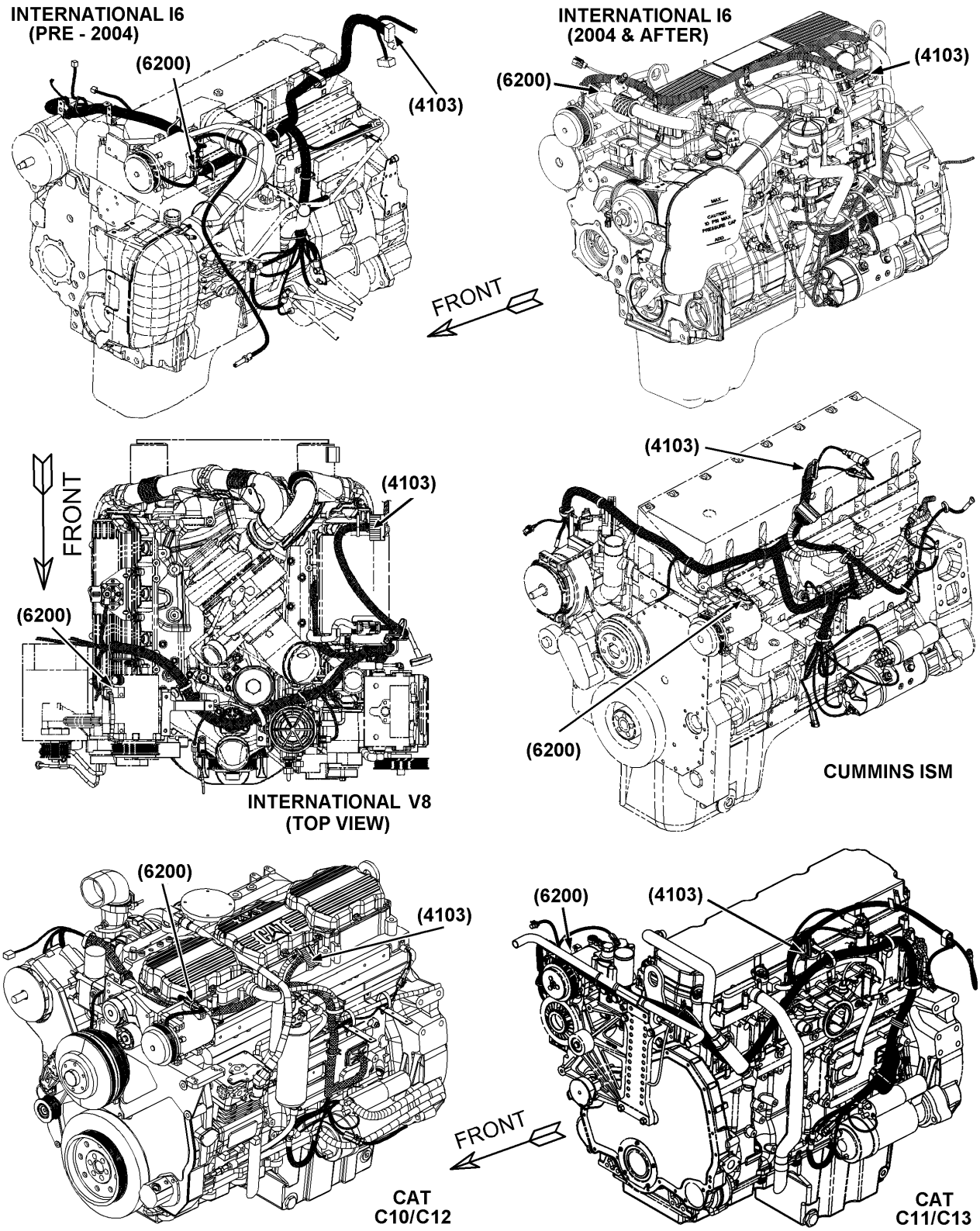



**Figure 59 AC Compressor Circuit Component Locations (on Engine)**

(4103) ENGINE/DASH CONNECTOR
(6200) COMPRESSOR CLUTCH CONNECTOR

# 11. RECIRCULATION ACTUATOR MOTOR CIRCUIT

## 11.1. CIRCUIT FUNCTIONS

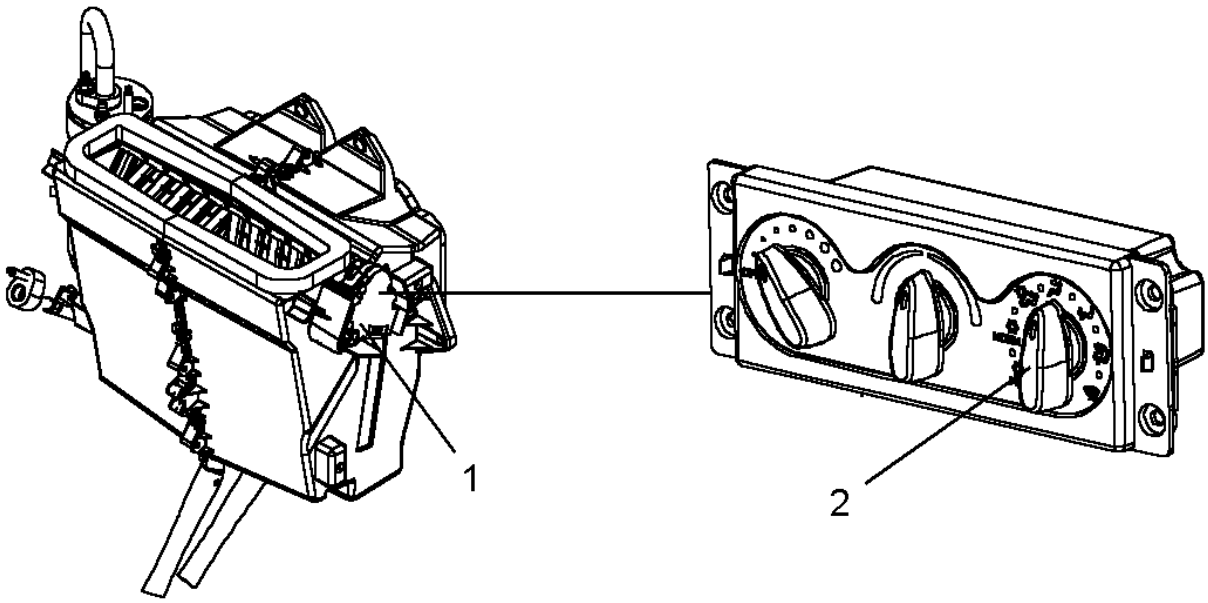



**Figure 60 Recirculation Door Motor Function Diagram**

1. RECIRCULATION DOOR MOTOR (ACTUATOR)
   LOCATED ON EVAPORATOR IN ENGINE COMPARTMENT
2. MODE SELECT CONTROL
   LOCATED ON HVAC CONTROL HEAD

**NOTE – Only systems with air conditioning use the air recirculation system. The 'heater only' systems do not have a recirculation air door or a recirculation motor.**

The RECIRCULATION DOOR MOTOR controls an air door that opens and closes the fresh air intake for the cab. When the air intake is open, fresh outside air is drawn through the system and into the cab. When the air intake is closed, outside air is blocked and the air inside the cab is recirculated by the HVAC system.

The recirculation motor is controlled by the right-hand knob (mode selector) on the HVAC control head. When a mode is selected that requires a change in position of the recirculation door, the control head will apply a drive voltage to the motor causing it to turn the recirculation door to the desired position. Circuitry within the control head senses when the door reaches the correct position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the door correctly, circuitry within the control head keeps track of the actuator position at all times based on a known starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator motor and door through a calibration procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

## 11.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the recirculation door actuator motor circuits. A list of the possible causes of the circuit failure is also provided. Table 27 lists and describes the Diagnostic Trouble Codes associated with the recirculation door motor circuits. Table 28 provides the troubleshooting procedures for isolating the cause of the failure.

A fault in the recirculation door motor circuits will be apparent when either the recirculation door diagnostic trouble code is displayed, or the air flow will not switch between interior air recirculation and fresh air when the mode selector is switched in and out of the A/C MAX position. Selecting the A/C MAX mode should cause the recirculate motor to turn the air door to close the fresh air intake. Problems in the recirculation motor circuit can be attributed to shorted or open circuits between the control head and the motor, a fault in the control head, a fault in the ESC, or a fault in the motor. Refer to the RECIRCULATION MOTOR POWER CIRCUITS diagram. A mechanical problem, such as a broken mechanism or physical blockage may also keep the recirculation door and motor from operating correctly.

Anytime the recirculation motor is provided power but does not move to its selected position, due to an electrical or mechanical problem, the HVAC control head will sense the fault. The control head will communicate this fault condition to the ESC, and the ESC will then set the corresponding diagnostic trouble code.

**Table 27 HVAC Recirculation Motor Circuit Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 613 14 1 1 | Air Inlet Fault |
| This diagnostic code is logged when the recirculation motor does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:<br>• a short to ground in the circuits between the HVAC control head and the recirculation motor.<br>• an open circuit in the circuits between the HVAC control head and the recirculation motor.<br>• a defective recirculation motor<br>• a defective HVAC control head<br>• a defective ESC<br>• a mechanical problem: blocked, binding, or broken recirculation door. Refer to AIR INLET TROUBLESHOOTING table (See Table 7, page 40). | |

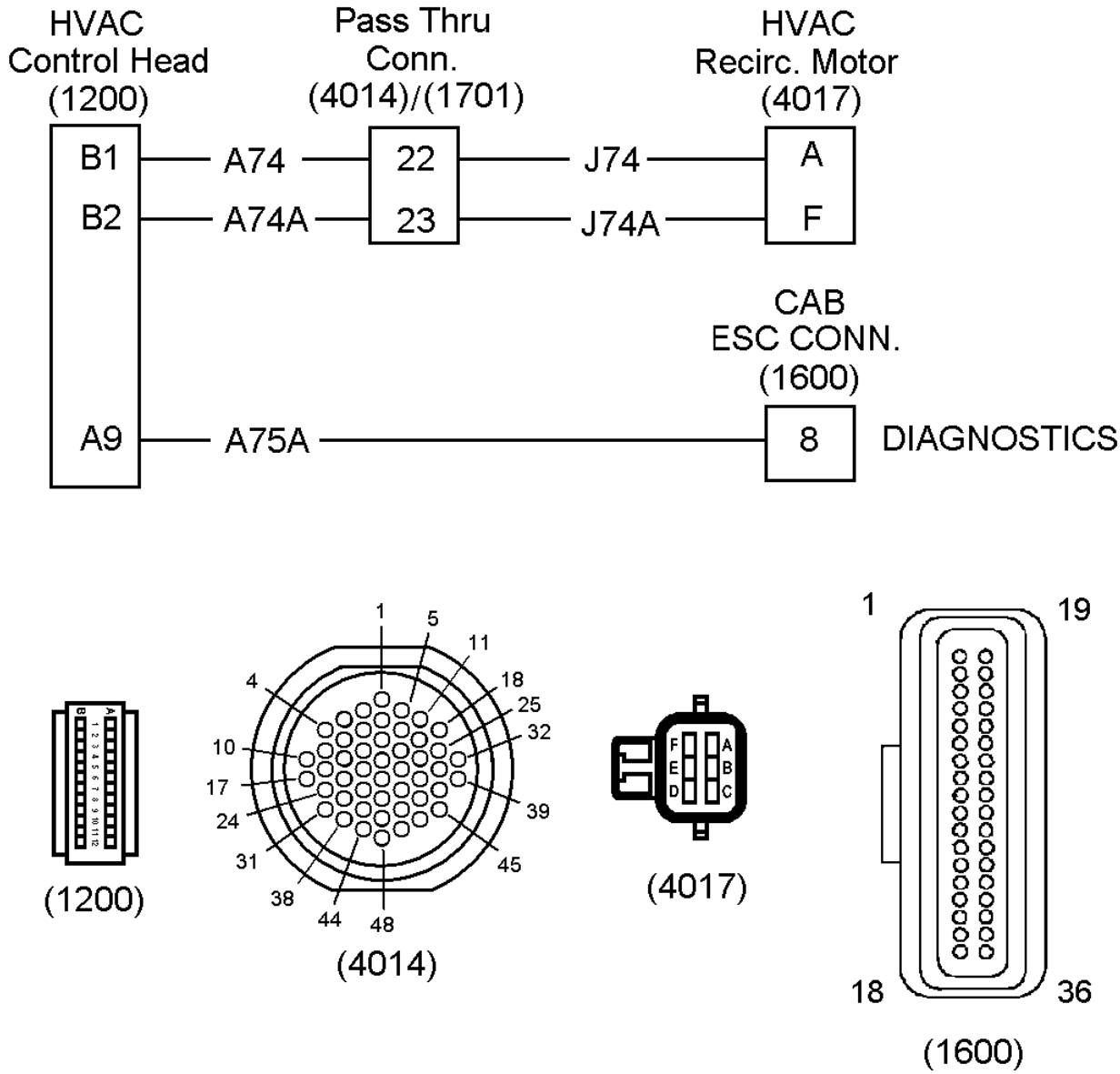



**Figure 61 Recirculation Motor Power Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(1200) HVAC CONTROL CONNECTOR (VIEWED FROM MATING SURFACE)
LOCATED BEHIND CONTROL HEAD
(4014)/(1701) PASS THRU CONNECTOR (VIEWED FROM MATING SURFACE)
LOCATED ABOVE ESC ON DASH PANEL
(4017) HVAC RECIRCULATION MOTOR CONNECTOR (VIEWED FROM MATING SURFACE)
LOCATED ABOVE ESC ON DASH PANEL
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC

**Table 28 HVAC Recirculation Motor Circuit Troubleshooting Chart**

**HVAC Recirculation Motor Troubleshooting**

Turn off ignition and disconnect connector (4017) from recirculation motor. Motor remains mounted to evaporator housing.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**IMPORTANT –** Whenever the door actuator motor is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. After reassembling the door and motor, and reconnecting the motor electrical connector, disconnect and reconnect the HVAC control head connector (1200). This will initiate the door position calibration procedure.

| Test Points | Spec. | Comments |
|---|---|---|
| While observing the recirculation door use a 9 Volt battery and jumpers to apply 9 Volts dc to terminals A and F of the recirculation motor. After noting the results, swap the jumpers to reverse the polarity of the voltage at terminals A and F. | The motor should rotate the recirculation door to one end of its travel when voltage is first applied, and to the opposite end of its travel when the voltage polarity is reversed.<br><br>**NOTE – If the actuator motor is already at the end of its travel when voltage is first applied, it may be necessary to switch polarities twice to see rotation in both directions.** | If motor and door operate correctly, proceed to the next step.<br><br>If motor does not rotate recirculation door through its entire range:<br><br>A. remove jumpers.<br>B. remove motor from evaporator housing.<br>C. reconnect 9 Volts dc to the motor and verify that the motor drive collar will rotate in both directions.<br>D. If motor still does not rotate, replace motor.<br>E. If motor does rotate, repair mechanical failure or blockage in evaporator housing. Refer to AIR INLET TROUBLESHOOTING table (See Table 7, page 40). |
| Isolate circuits between HVAC control head and recirculation motor. | Check for open circuits or circuits shorted to ground. | If faulty circuits are found, repair the circuits.<br><br>If circuits check good, reconnect all connectors and go to the next step. |

**HVAC Recirculation Motor Troubleshooting Chart (Continued)**

Check with HVAC control head connector (1200) reconnected, ESC connector (1600) reconnected thru breakout box ZTSE4477, and ignition key ON.

**NOTE – Always use breakout box to take measurements on ESC connectors.**

**NOTE – Always check connectors for damage and pushed–out terminals.**

**Table 28 HVAC Recirculation Motor Circuit Troubleshooting Chart (cont.)**

| Test Points | Spec. | Comments |
|---|---|---|
| connector (1600), cavity 8 to ground. | Alternating voltage, pulse rate should be 2.5 sec high/2.5 sec low.<br><br>low < 2 Vdc<br><br>high > 7 Vdc | If the alternating voltage, has a 4 second cycle (2 sec high/2 sec low), replace HVAC control head.<br><br>If alternating voltage, with a 5 second cycle (2.5 sec high/2.5 sec low) is present, replace ESC. |

## 11.3. EXTENDED DESCRIPTION

When the MAX A/C mode is selected on the HVAC control, it will supply a drive voltage between connector (1200) terminals B1 and B2. This drive voltage is routed through circuits A74 and A74A, connector (4014)/(1701) terminals 22 and 23, and circuits J74 and J74A, to HVAC recirculation motor connector (4017) terminals A and F. This voltage will drive the motor to close the recirculation door, blocking the fresh air intake. The HVAC control head senses and counts the reflected pulses on the drive voltage line that verify motor rotation. Once the control head senses that the door is fully closed, the drive voltage will turn off.

When any other mode is selected, the drive voltage supplied by the HVAC control will have the opposite polarity of the previous voltage. This voltage will drive the motor to open the recirculation door and the fresh air intake. Again the control voltage will stop once the door is fully open.

If the HVAC control head senses that the recirculation motor is not operating correctly, it outputs a fault signal on its diagnostic line. This signal is output from terminal A9 of connector (1200) and is routed by circuit A75A to ESC connector (1600) terminal 8.

## 11.4. COMPONENT LOCATIONS

Refer to RECIRCULATION MOTOR LOCATION diagram.

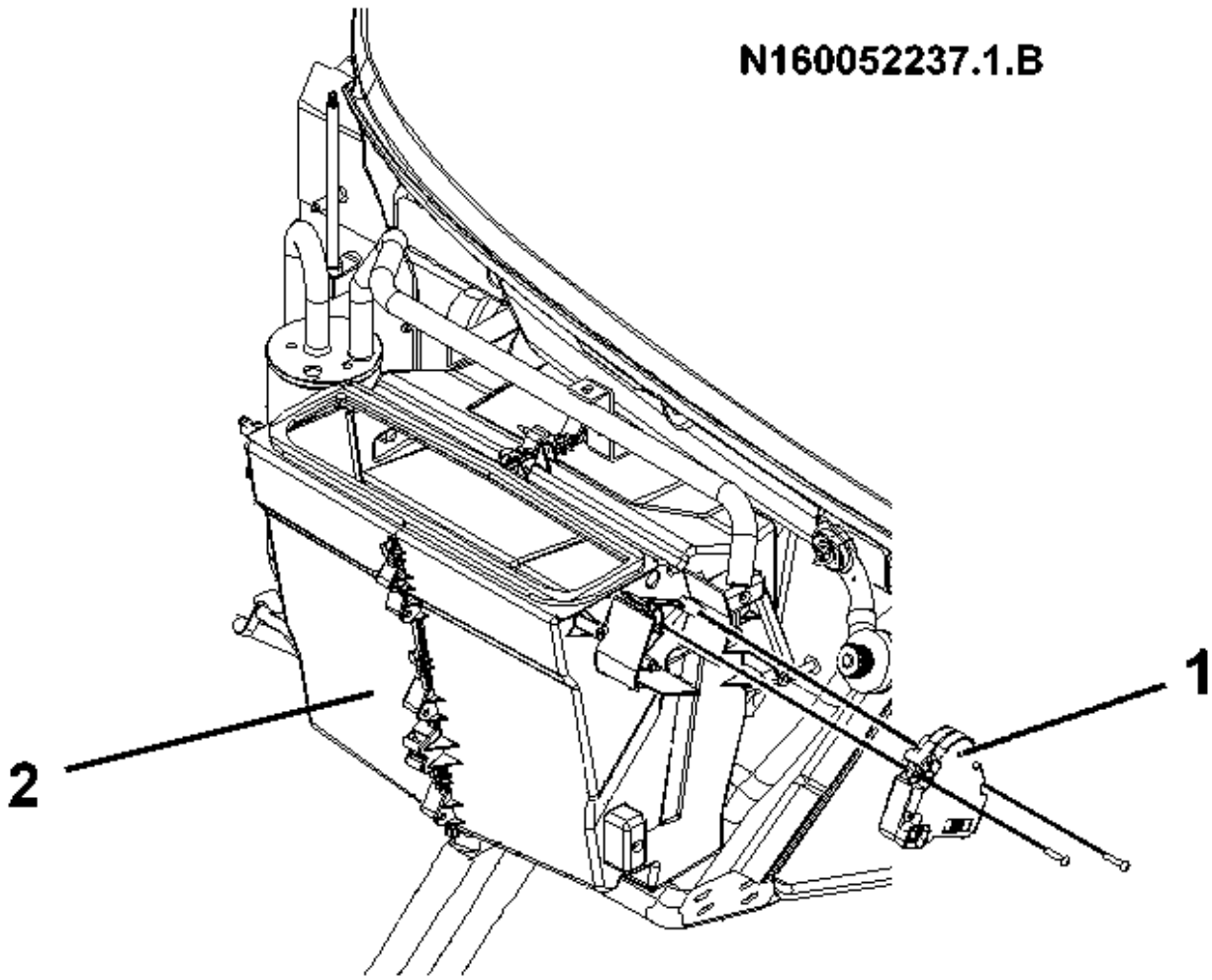



**Figure 62 Recirculation Motor Location**

1. RECIRCULATION MOTOR
2. EVAPORATOR HOUSING

# 12. MODE ACTUATOR MOTOR CIRCUIT

## 12.1. CIRCUIT FUNCTIONS

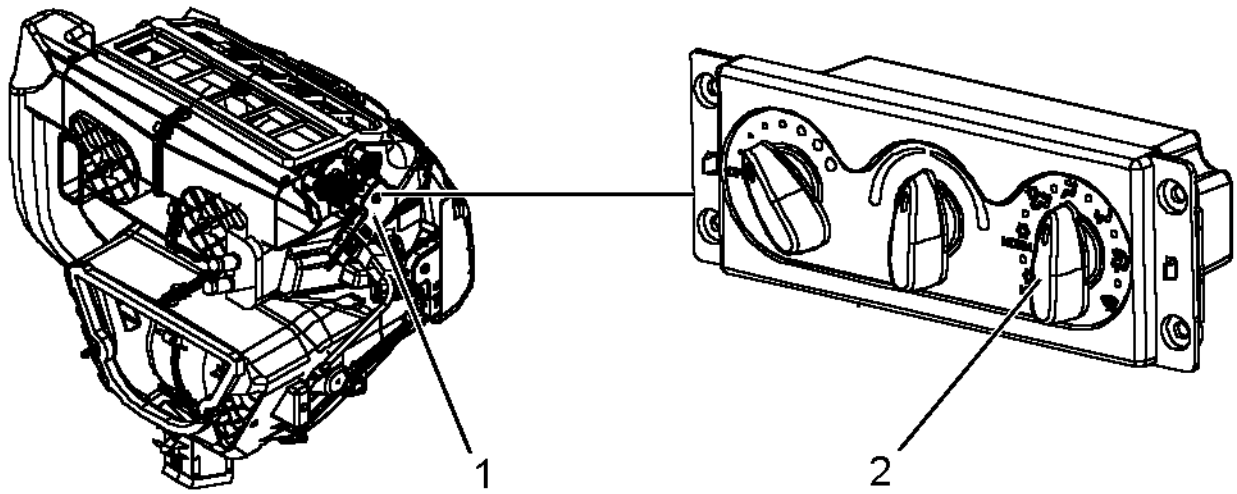



**Figure 63 Mode Actuator Motor Function Diagram**

1. MODE ACTUATOR (MOTOR)
   LOCATED ON HEATER HOUSING UNDER INSTRUMENT PANEL
2. MODE SELECT SWITCH
   LOCATED ON HVAC CONTROL HEAD

The MODE ACTUATOR MOTOR controls the two mode doors located at the top of the heater housing via a kinematics (gear drive) system. The two doors direct air flow to the air outlets (floor ducts, instrument panel vents, and/or defrost vents) based on the mode selected by the operator.

The position of the actuator motor (and mode doors) is controlled by the setting of the mode control (right knob) on the HVAC control head. When a mode is selected that requires a change in position of the mode doors, the control head will apply a drive voltage to the motor causing it to turn the doors to the desired position. Circuitry within the control head senses when the mode doors reach the desired position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the doors correctly, circuitry within the control head keeps track of the actuator position at all times based on a known starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator and doors through a calibration procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

## 12.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the mode actuator motor circuits. A list of the possible causes of the circuit failure is also provided. Table 30 lists and describes the Diagnostic Trouble Codes associated with the mode door motor circuits. Table 31 provides the troubleshooting procedures for isolating the cause of the failure.

A fault in the mode actuator motor circuits will be apparent when either the mode door diagnostic trouble code is displayed, or the correct air flow is not present at the air outlet vents selected by the mode select control. The following table provides a precise indication of the amount of air flow that should be present at each outlet, based on each setting of the mode select control. Selecting any mode (indicated by an icon) or in-between mode (indicated by a dot) should cause the mode motor to position the two mode doors to provide the air flow indicated in the AIR DISTRIBUTION CHART. Problems in the mode actuator motor circuit can be attributed to shorted or open circuits between the control head and the motor, a fault in the control head, a fault in the ESC, or a fault in the motor. Refer to the MODE ACTUATOR MOTOR POWER CIRCUITS diagram. A mechanical problem, such as a broken mechanism or physical blockage may also keep the mode doors and actuator motor from operating correctly.

Anytime the mode actuator motor is provided power but does not move to its selected position, due to an electrical or mechanical problem, the HVAC control head will sense the fault. The control head will communicate this fault condition to the ESC, and the ESC will then set the corresponding diagnostic trouble code.

**Table 29 Air Distribution Chart**

| CONTROL KNOB POSITION | | AIRFLOW | | |
|---|---|---|---|---|
| Air Conditioner Systems | Heater Only Systems | Panel | Floor | Windshield |
| MAX A/C   | PANEL  | 100% | | |
| NORM A/C   | | 100% | | |
| DOT 1 | | 50% | 50% | |
| BI-LEVEL  | DOT 1 | 75% | 25% | |
| DOT 2 | BI-LEVEL  | 50% | 50% | |
| PANEL  | | 100% | | |
| DOT 3 | DOT 2 | 25% | 75% | |
| FLOOR  | FLOOR  | | 100% | |
| DOT 4 | DOT 3 | | 75% | 25% |
| MIX  | BLEND  | | 50% | 50% |

**Table 29 Air Distribution Chart (cont.)**

| CONTROL KNOB POSITION | | AIRFLOW | | |
|---|---|---|---|---|
| Air Conditioner Systems | Heater Only Systems | Panel | Floor | Windshield |
| DOT 5 | DOT 4 | | 25% | 75% |
| DEFROST  | DEFROST  | | | 100% |

**Table 30 HVAC Mode Actuator Motor Circuit Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 613 14 1 3 | HVAC Control Head Mode Control Fault |

This diagnostic code is logged when the mode actuator motor does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:

- a short to ground in the circuits between the HVAC control head and the mode actuator motor.
- an open circuit in the circuits between the HVAC control head and the mode actuator motor.
- a defective mode actuator motor
- a defective HVAC control head
- a defective ESC
- a mechanical problem: blocked, binding, or broken mode door or gear drive mechanism. Refer to MODE SELECTION TROUBLESHOOTING table (See Table 9, page 42).

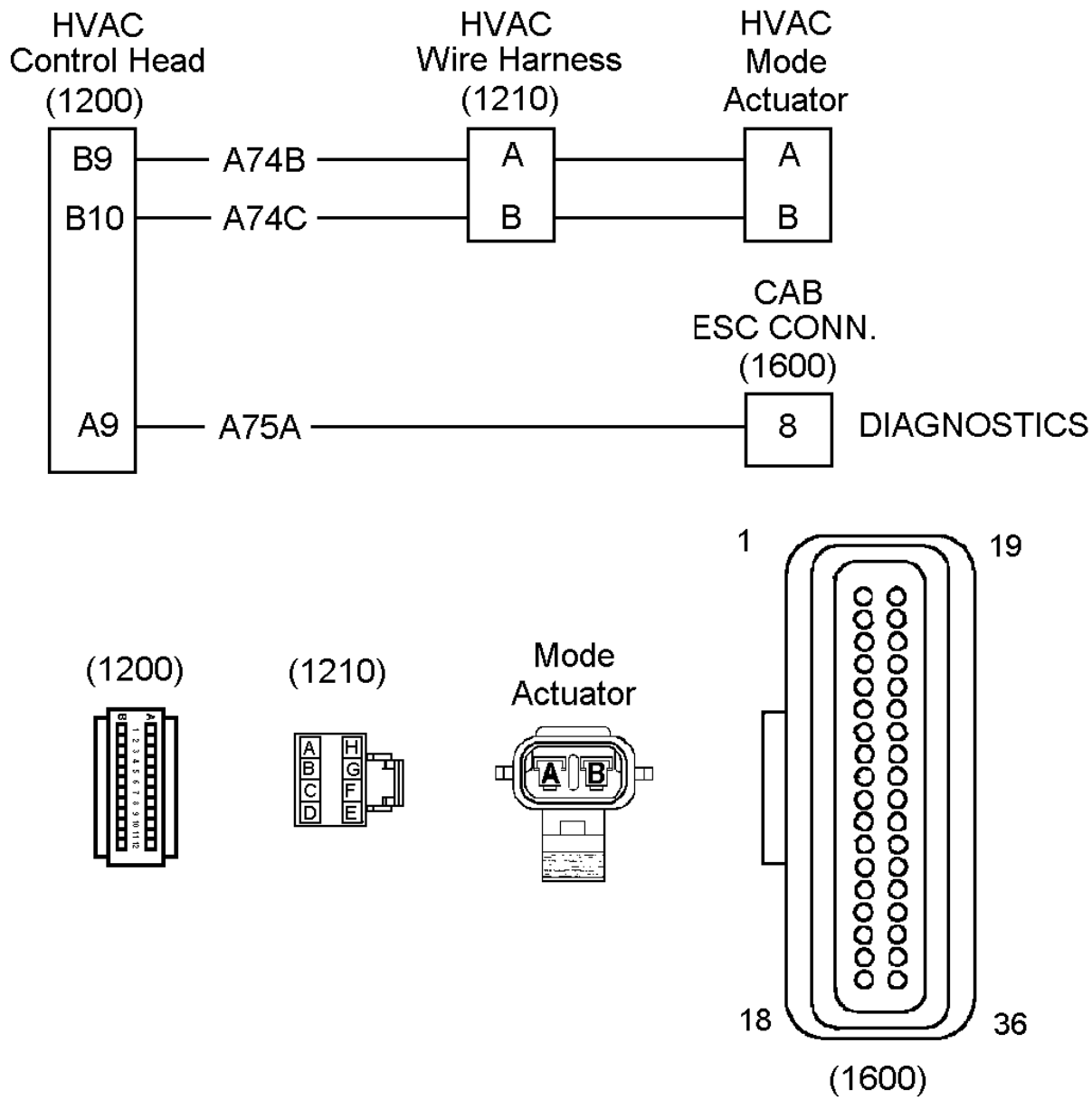



**Figure 64 Mode Actuator Motor Power Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(1200) HVAC CONTROL CONNECTOR
LOCATED BEHIND CONTROL HEAD
(1210) HVAC WIRE HARNESS CONNECTOR
LOCATED ON HEATER HOUSING ASSEMBLY
MODE ACTUATOR MOTOR CONNECTOR
LOCATED AT MODE ACTUATOR MOTOR
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC

**Table 31 HVAC Mode Actuator Motor Circuit Troubleshooting Chart**

**HVAC Mode Actuator Motor Circuit Troubleshooting**

Turn off ignition and disconnect connector from mode actuator motor. Motor remains mounted to heater housing.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**IMPORTANT –** Whenever the door actuator motor is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. After reassembling the door and motor, and reconnecting the motor electrical connector, disconnect and reconnect the HVAC control head connector (1200). This will initiate the door position calibration procedure.

| Test Points | Spec. | Comments |
|---|---|---|
| While observing the drive collar of the mode actuator motor use a 9 Volt battery and jumpers to apply 9 Volts dc to terminals A and B of the mode actuator motor. After noting the results, swap the jumpers to reverse the polarity of the voltage at terminals A and B. | The drive collar of the mode actuator motor should rotate to one end of its travel when voltage is first applied, and to the opposite end of its travel when the voltage polarity is reversed.<br><br>**NOTE – If the actuator motor is already at the end of its travel when voltage is first applied, it may be necessary to switch polarities twice to see rotation in both directions.**<br><br>**NOTE – During this step, observe the Mode door gear drive to verify that it is intact and operating correctly.** | If motor operates correctly, proceed to the next step.<br><br>If motor does not rotate through its entire range:<br><br>A. remove jumpers.<br>B. remove motor from heater housing.<br>C. reconnect 9 Volts dc to the motor and verify that the motor drive collar will rotate in both directions.<br>D. If motor still does not rotate, replace motor.<br>E. If motor does rotate, repair mechanical failure or blockage in mode doors, gear drive, or heater housing. Refer to MODE SELECTION TROUBLESHOOTING table (See Table 9, page 42). |
| Isolate circuits between HVAC control head and mode actuator motor. | Check for open circuits or circuits shorted to ground. | If faulty circuits are found, repair the circuits.<br><br>If circuits check good, go to next step. |

**HVAC Mode Actuator Motor Troubleshooting Chart (Continued)**

Check with HVAC control head connector (1200) reconnected, ESC connector (1600) reconnected thru breakout box ZTSE4477, and ignition key ON.

**NOTE – Always use breakout box to take measurements on ESC connectors.**

**NOTE – Always check connectors for damage and pushed–out terminals.**

**Table 31 HVAC Mode Actuator Motor Circuit Troubleshooting Chart (cont.)**

| Test Points | Spec. | Comments |
|---|---|---|
| connector (1600), cavity 8 to ground. | Alternating voltage, pulse rate should be 2.5 sec high/2.5 sec low.<br><br>low < 2 Vdc<br><br>high > 7 Vdc | If the alternating voltage, has a 2 second cycle (1 sec high/1 sec low), replace HVAC control head.<br><br>If alternating voltage, with a 5 second cycle (2.5 sec high/2.5 sec low) is present, replace ESC. |
| **HVAC Mode Actuator Motor Troubleshooting Chart (Continued)**<br><br>Check with HVAC control head connector (1200) reconnected, ESC connector (1600) reconnected thru breakout box ZTSE4477, and ignition key ON.<br><br>**NOTE – Always use breakout box to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.** | | |
| Test Points | Spec. | Comments |
| connector (1600), cavity 8 to ground. | Alternating voltage, pulse rate should be 2.5 sec high/2.5 sec low.<br><br>low < 2 Vdc<br><br>high > 7 Vdc | If the alternating voltage, has a 2 second cycle (1 sec high/1 sec low), replace HVAC control head.<br><br>If alternating voltage, with a 5 second cycle (2.5 sec high/2.5 sec low) is present, replace ESC. |

## 12.3. EXTENDED DESCRIPTION

Air flow through the HVAC duct work is directed by the two mode doors. When a mode is selected by the mode control, the HVAC control head will supply a drive voltage between connector (1200) terminals B9 and B10. This drive voltage is routed through circuits A74B and A74C, and connector (1210) terminals A and B, to mode actuator connector terminals A and B. The voltage will drive the mode actuator motor which will position the two mode doors, via a gear drive system (kinematics). The HVAC control head senses and counts the reflected pulses on the drive voltage line that verify motor rotation. Once the HVAC control head senses that the actuator motor has rotated enough to correctly position the doors, the drive voltage will turn off.

If the HVAC control head senses that the mode actuator motor is not operating correctly, it outputs a fault signal on its diagnostic line. This signal is output from terminal A9 of connector (1200) and is routed by circuit A75A to ESC connector (1600) terminal 8.

## 12.4. COMPONENT LOCATIONS

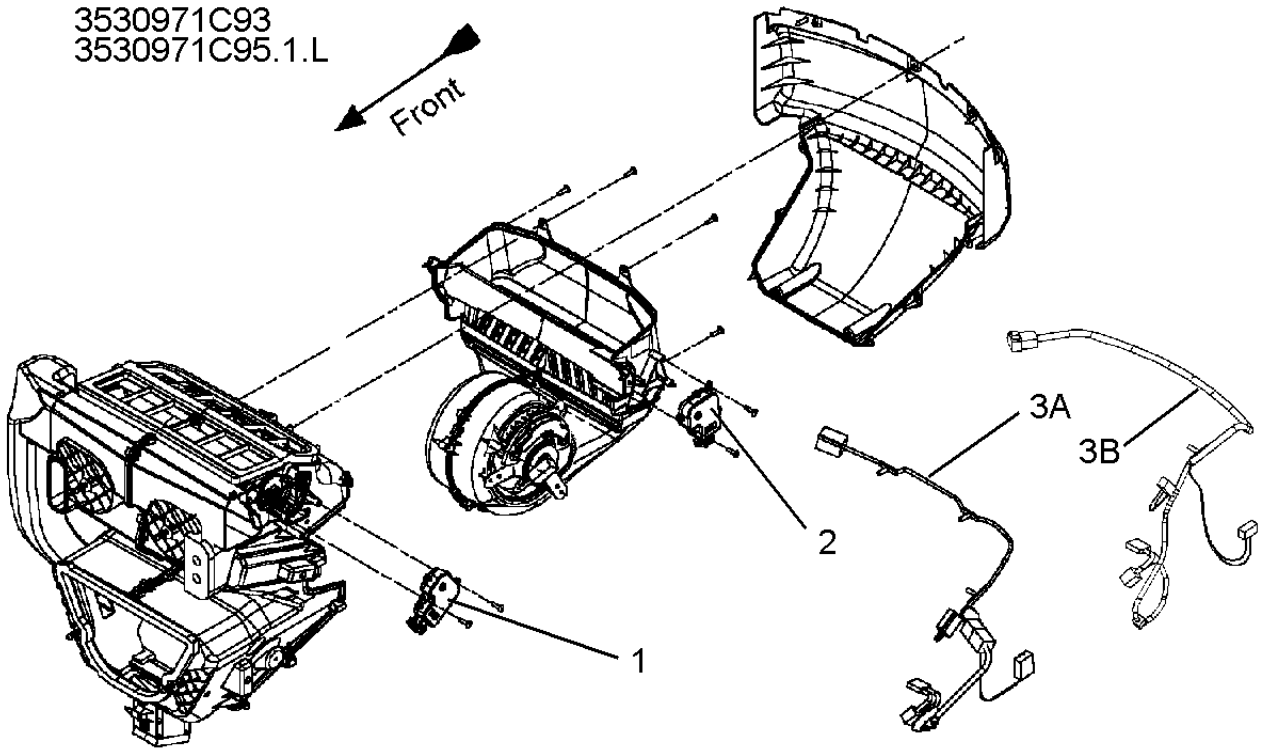



**Figure 65 Mode Actuator Location**

1. MODE ACTUATOR
2. TEMPERATURE ACTUATOR

3A. HVAC WIRE HARNESS (TWO PIECE)
3B. HVAC WIRE HARNESS (ONE PIECE)

# 13. TEMPERATURE ACTUATOR MOTOR CIRCUIT

## 13.1. CIRCUIT FUNCTIONS

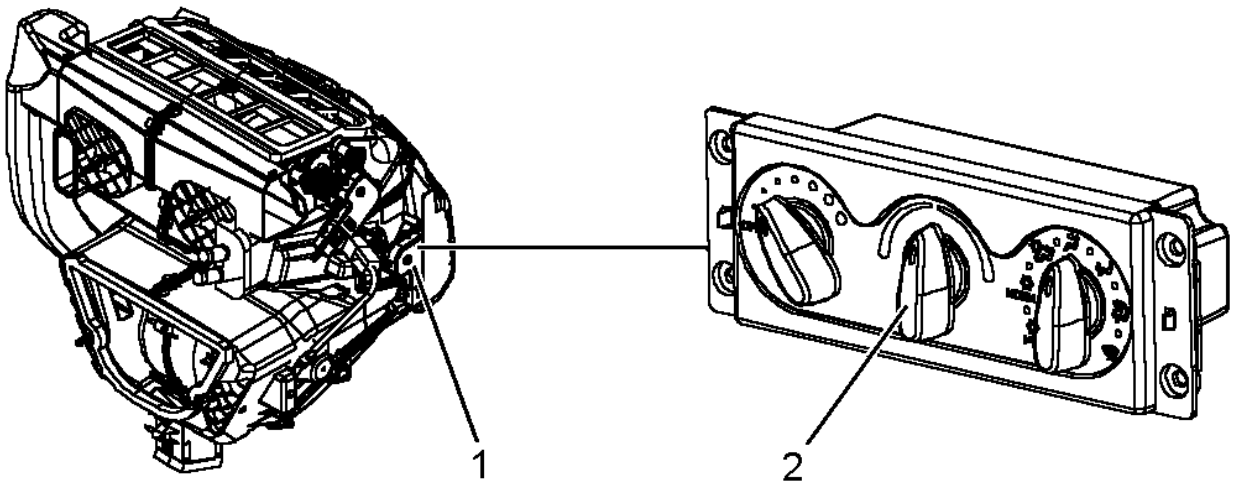



**Figure 66 Temperature Door Actuator Motor Function Diagram**

1. TEMPERATURE DOOR ACTUATOR MOTOR
   LOCATED ON CAB BLOWER HOUSING
2. TEMPERATURE SELECT CONTROL
   LOCATED ON HVAC CONTROL HEAD

The TEMPERATURE DOOR ACTUATOR MOTOR controls a temperature blend air door that regulates the temperature of the air discharged from the vents. The temperature blend door determines what portion of the system input air is deflected through the heater core depending on the setting of the temperature control (center knob) on the HVAC control panel. As the temperature control is rotated clockwise more air is deflected through the heater core, increasing the temperature of the system output air entering the cab. The temperature control has fifteen detents.

When the temperature control setting is changed, the control head will apply a drive voltage to the temperature door actuator motor causing it to turn the temperature blend door to the desired position. Circuitry within the control head senses when the door reaches the correct position, and stops outputting the drive voltage.

Because the actuator motor can be driven in either direction the drive voltage can be of either polarity. In order to position the doors correctly, circuitry within the control head keeps track of the actuator position at all times based on a known starting position. It can then drive the actuator to any position by applying a drive voltage of the correct polarity, and sensing (counting) the number of actuator motor revolutions through the actuator circuits. To establish a known starting position, the control head runs the actuator and door through a calibration procedure when battery voltage is first applied to the HVAC control head, and then at regular intervals during normal operation.

## 13.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the temperature actuator motor circuits. A list of the possible causes of the circuit failure is also provided. Table 32 lists and describes the Diagnostic Trouble Codes associated with the temperature door motor circuits. Table 33 provides the troubleshooting procedures for isolating the cause of the failure.

A fault in the temperature actuator circuits will be apparent when either the temperature door diagnostic trouble code is displayed, or the HVAC system air temperature cannot be adjusted. Problems in the temperature actuator motor circuits can be attributed to shorted or open circuits between the control head and the actuator motor, a fault in the control head, a fault in the ESC, or a fault in the motor. Refer to the TEMPERATURE ACTUATOR MOTOR CIRCUITS diagram. A mechanical problem, such as a broken mechanism or physical blockage may also keep the temperature blend air door and motor from operating correctly.

Anytime the temperature actuator motor is provided power but does not move to its selected position, due to an electrical or mechanical problem, the HVAC control head will sense the fault. The control head will communicate this fault condition to the ESC, and the ESC will then set the corresponding diagnostic trouble code.

**Table 32 HVAC Temperature Actuator Motor Circuit Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 613 14 1 2 | Hot/cold temp mix control fault |
| This diagnostic code is logged when the temperature actuator motor does not respond to voltage from the HVAC control head. The code could be the result of any of the following conditions:<br>• a short to ground in the circuits between the HVAC control head and the temperature actuator motor.<br>• an open circuit in the circuits between the HVAC control head and the temperature actuator motor.<br>• a defective temperature actuator motor<br>• a defective HVAC control head<br>• a defective ESC<br>• a mechanical problem: blocked, binding, or broken temperature door. Refer to HEATER/AIR CONDITIONER TEMPERATURE MIX TROUBLESHOOTING table (See Table 8, page 41). | |

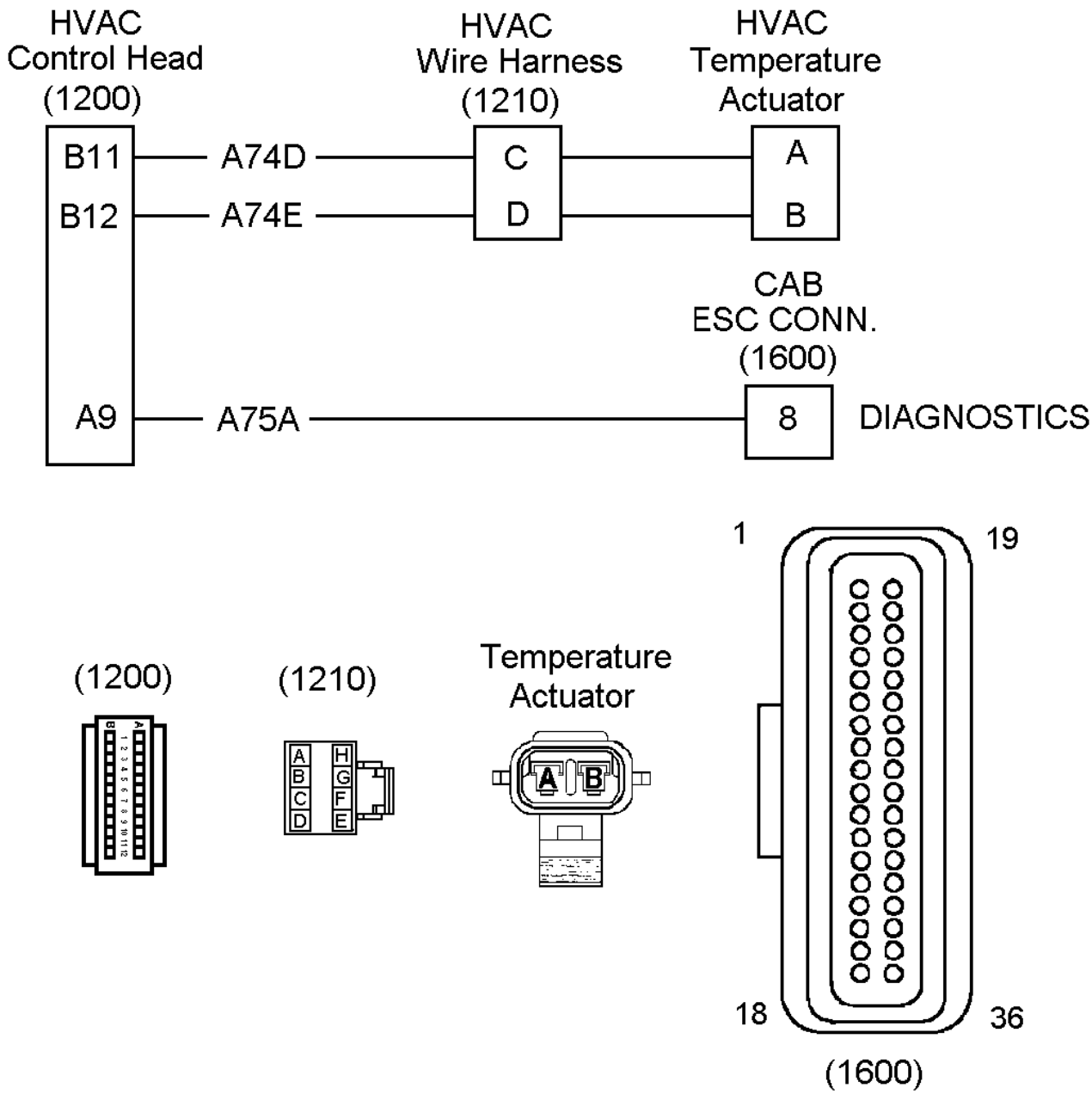



**Figure 67 Temperature Actuator Motor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(1200) HVAC CONTROL CONNECTOR
LOCATED BEHIND CONTROL HEAD
(1210) HVAC WIRE HARNESS CONNECTOR
LOCATED ON HEATER HOUSING ASSEMBLY
TEMPERATURE ACTUATOR MOTOR CONNECTOR
LOCATED AT TEMPERATURE ACTUATOR MOTOR
(1600) ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON CAB SIDE OF ESC

**Table 33 HVAC Temperature Actuator Motor Circuit Troubleshooting Chart**

**HVAC Temperature Actuator Motor Circuit Troubleshooting**

Turn off ignition and disconnect connector from temperature actuator motor. Motor remains mounted to blower housing.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**IMPORTANT –** Whenever the door actuator motor is energized while disconnected (such as during testing), it must be recalibrated after it is reconnected. After reassembling the door and motor, and reconnecting the motor electrical connector, disconnect and reconnect the HVAC control head connector (1200). This will initiate the door position calibration procedure.

| Test Points | Spec. | Comments |
|---|---|---|
| While observing the drive collar of the temperature actuator motor use a 9 Volt battery and jumpers to apply 9 Volts dc to terminals A and B of the temperature actuator motor. After noting the results, swap the jumpers to reverse the polarity of the voltage at terminals A and B. | The drive collar of the temperature actuator motor should rotate to one end of its travel when voltage is first applied, and to the opposite end of its travel when the voltage polarity is reversed.<br><br>**NOTE – If the actuator motor is already at the end of its travel when voltage is first applied, it may be necessary to switch polarities twice to see rotation in both directions.** | If motor operates correctly, proceed to the next step.<br><br>If motor does not rotate through its entire range:<br><br>A. Remove jumpers.<br>B. Remove motor from blower housing.<br>C. Reconnect 9 Volts dc to the motor and verify that the motor drive collar will rotate in both directions.<br><br>a. If motor still does not rotate, replace motor.<br>b. If motor does rotate, repair mechanical failure or blockage in temperature door or blower housing. Refer to HEATER/AIR CONDITIONER TEMPERATURE MIX TROUBLESHOOTING table (See Table 8, page 41). |
| Isolate circuits between HVAC control head and temperature actuator motor. | Check for open circuits or circuits shorted to ground. | If faulty circuits are found, repair the circuits.<br><br>If circuits check good, replace HVAC control head. |

**Table 33 HVAC Temperature Actuator Motor Circuit Troubleshooting Chart (cont.)**

| **HVAC Temperature Actuator Motor Troubleshooting Chart (Continued)**<br><br>Check with HVAC control head connector (1200) reconnected, ESC connector (1600) reconnected thru breakout box ZTSE4477, and ignition key ON.<br><br>**NOTE – Always use breakout box to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.** | | |
|---|---|---|
| Test Points | Spec. | Comments |
| connector (1600), cavity 8 to ground. | Alternating voltage, pulse rate should be 2.5 sec high/2.5 sec low.<br><br>low < 2 Vdc<br><br>high > 7 Vdc | If the alternating voltage, has a 3 second cycle (1.5 sec high/1.5 sec low), replace HVAC control head.<br><br>If alternating voltage, with a 5 second cycle (2.5 sec high/2.5 sec low) is present, replace ESC. |

## 13.3. EXTENDED DESCRIPTION

When the temperature control is set to a different temperature, the HVAC control head will supply a drive voltage between connector (1200) terminals B11 and B12. This drive voltage is routed through circuits A74D and A74E, and connector (1210) terminals C and D, to temperature actuator connector terminals A and B. The voltage will drive the temperature actuator motor which will rotate the temperature control door. The HVAC control head senses and counts the reflected pulses on the drive voltage line that verify motor rotation. Once the HVAC control head senses that the actuator motor has rotated enough to correctly position the door, the drive voltage will turn off.

If the HVAC control head senses that the temperature actuator motor is not operating correctly, it outputs a fault signal on its diagnostic line. This signal is output from terminal A9 of connector (1200) and is routed by circuit A75A to ESC connector (1600) terminal 8.

## 13.4. COMPONENT LOCATIONS

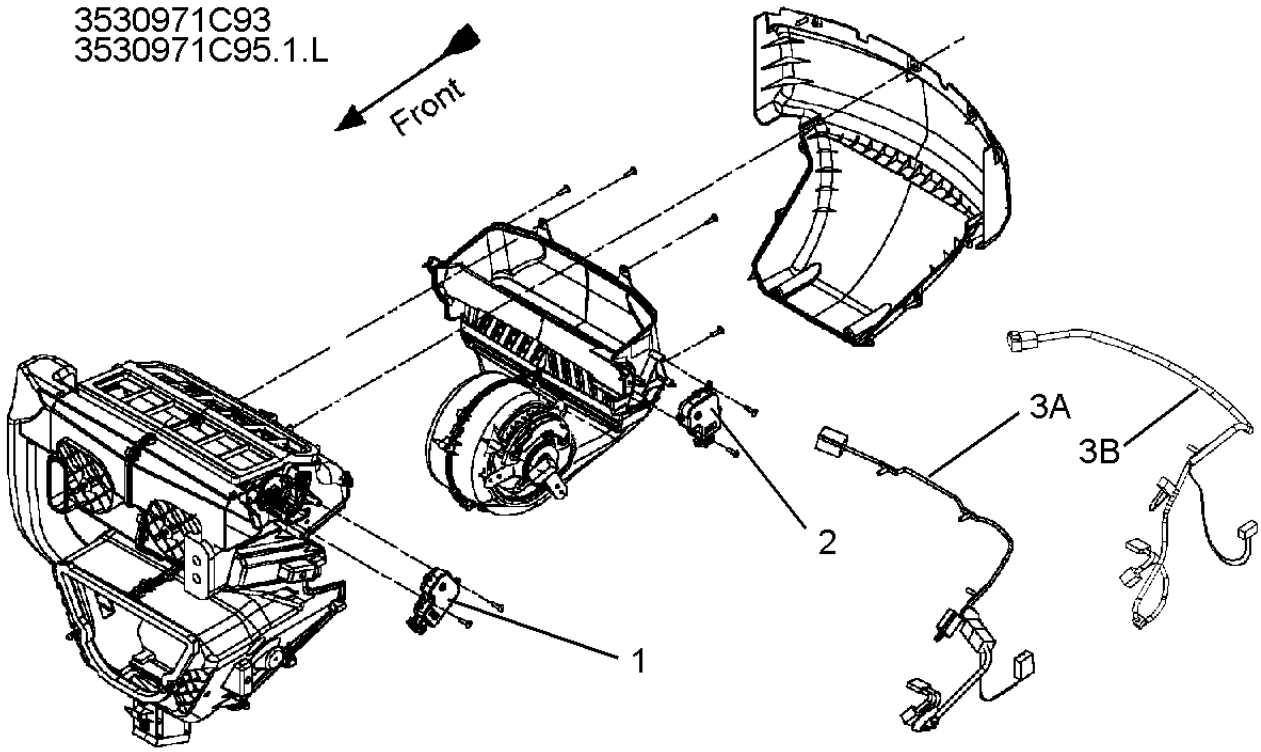



**Figure 68 Temperature Actuator Location**

1. MODE ACTUATOR
2. TEMPERATURE ACTUATOR

3A. HVAC WIRE HARNESS (TWO PIECE)
3B. HVAC WIRE HARNESS (ONE PIECE)

# 14. BLOWER MOTOR CIRCUIT

## 14.1. CIRCUIT FUNCTIONS

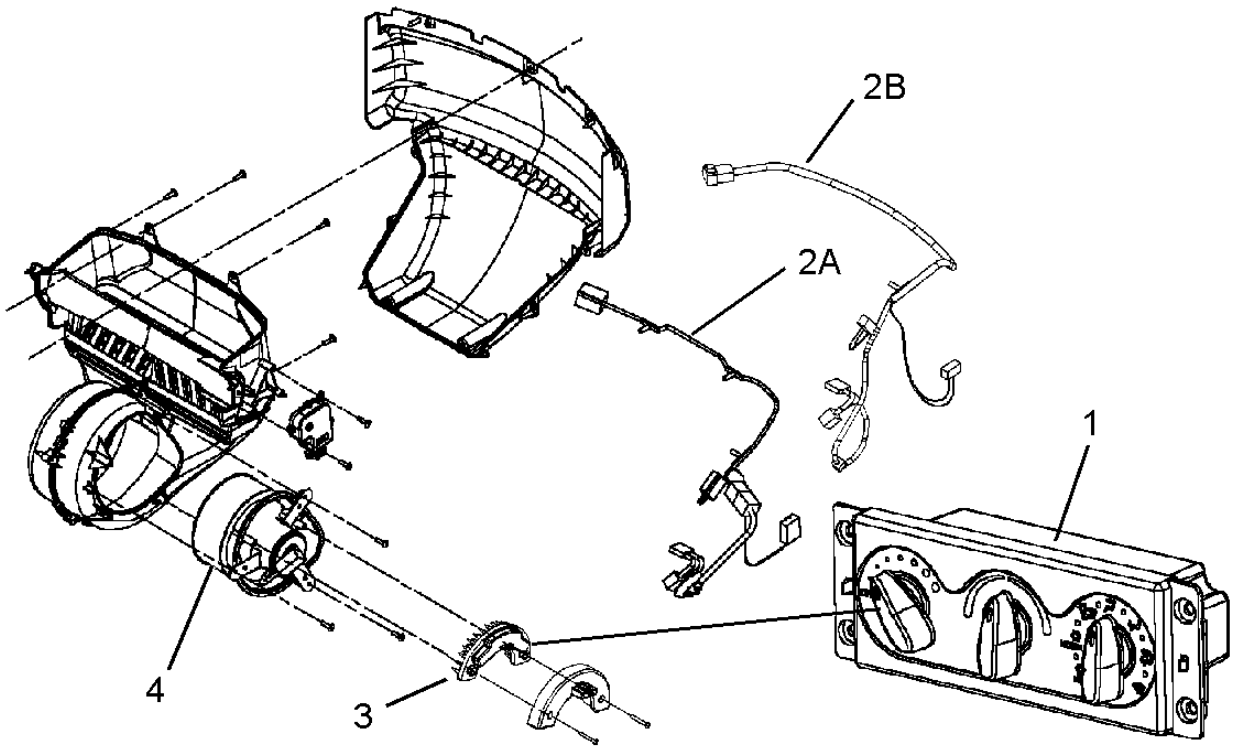



**Figure 69 HVAC Blower Motor Function Diagram**

1. BLOWER CONTROL (PART OF HVAC CONTROL HEAD)
2A. HVAC WIRE HARNESS (TWO PIECE)
2B. HVAC WIRE HARNESS (ONE PIECE)
3. LINEAR POWER MODULE
4. BLOWER MOTOR

The HVAC BLOWER MOTOR assembly consists of a permanent magnet motor attached to a balanced 'squirrel-cage' fan unit. The blower speed is controlled by the blower speed control (left knob) on the HVAC control panel, located on the instrument panel. The blower speed control is a long life potentiometer, detented to provide seven distinct blower speeds in addition to OFF.

The following paragraphs describe the three variations of the electrical circuit used for the HVAC blower motor.

In version 1 of the electrical circuit, battery voltage is routed to the Linear Power Module (LPM) and to one side of the blower motor. Based on the setting of the blower speed control, the HVAC control panel outputs a 0 to 5 Vdc signal to the LPM. The LPM responds by acting as a variable resistance between the blower motor and ground. As the blower speed control is turned cw, the apparent resistance to ground decreases, the voltage across the blower motor increases, and the blower speed increases.

In version 2 of the electrical circuit, battery voltage is still routed to one side of the blower motor; however, switched ignition voltage provides the voltage source for the LPM. The remainder of the circuit is identical to version 1. Operation and function are also identical to version 1.

Version 3 of the electrical circuit is identical to version 2 except connector (1203) has been removed, making the HVAC harness a single piece harness. Operation and function are also identical to version 2.

## 14.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the blower motor circuit. A list of the possible causes of the circuit failure is also provided. Table 34 lists and describes any Diagnostic Trouble Codes associated with the blower motor circuit. Table 35 provides the troubleshooting procedures for isolating the cause of the failure.

A fault in the HVAC BLOWER MOTOR CIRCUIT will be apparent when the blower motor runs constantly, does not run, or does not respond correctly to the speed settings of the blower control. Problems in the blower motor circuit can be attributed to open or shorted circuits between the control head and the Linear Power Module (LPM), a fault in the control head, open circuits between the LPM and ground or the power source, a failed LPM, open or shorted circuits between the LPM and the blower motor, or a fault in the motor. A mechanical problem, such as a broken mechanism or physical blockage may also cause the HVAC blower motor to malfunction.

**Table 34 Blower Motor Circuit Diagnostic Trouble Codes**

| Diagnostic Codes |
|---|
| No diagnostic trouble codes are associated with the blower circuits. |

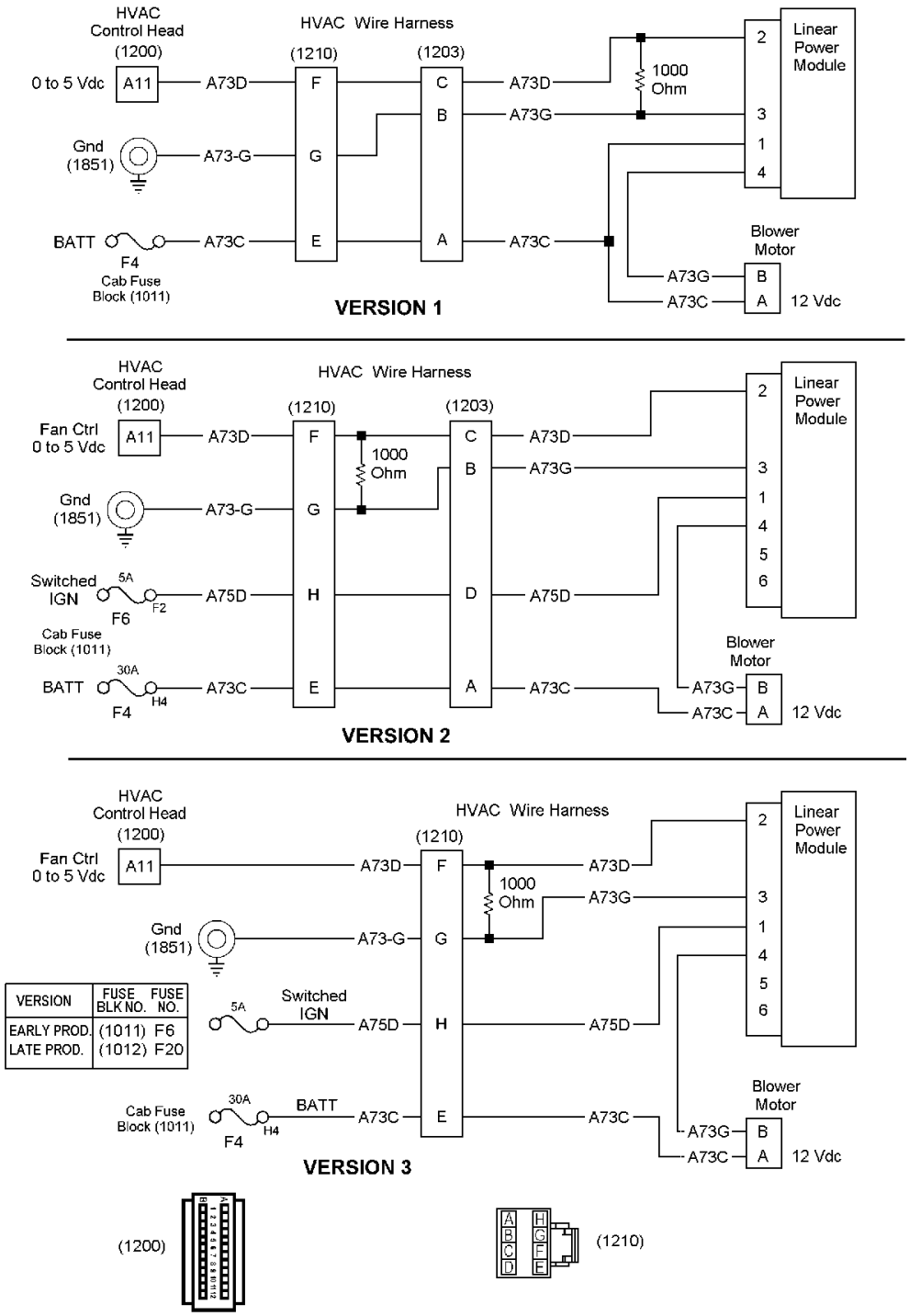



**Figure 70 HVAC Blower Motor Circuit – Always Refer to Circuit Diagram Book for Latest Circuit Information**

(1200) HVAC CONTROL CONNECTOR
LOCATED BEHIND CONTROL HEAD
(1210) HVAC CONNECTOR
LOCATED ON HEATER MODULE
(1203) BLOWER CIRCUIT CONNECTOR
LOCATED ON HEATER MODULE (TWO PIECE HARNESS ONLY)
(1851) GROUND STUD
LOCATED ON DASH PANEL ABOVE ESC (IN CAB)

**Table 35 Blower Motor Circuits Troubleshooting Chart**

**Blower Motor Circuit Troubleshooting**

Make the following checks with ignition key OFF, the Blower Motor connector connected, and the Linear Power Module connector connected.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.**

| Test Points | Spec. | Comments |
|---|---|---|
| Blower motor | Blower motor should not run constantly. | If the blower does NOT run constantly, proceed to the next step.<br><br>If the blower runs constantly:<br><br>A. Check for an open 1000 Ohm resistor between cavities 2 and 3 of the Linear Power Module connector. Replace if open.<br><br>B. If the resistor is ok, remove BATTERY voltage from the circuit and isolate the short to ground to one of the following:<br><br>• the harness circuit between Blower Motor connector, cavity B and Linear Power Module connector, cavity 4.<br>• the blower motor assembly, cavity B of its connector (when disconnected from harness).<br>• the linear power module, at terminal 4. |

**Blower Motor Circuit Troubleshooting (continued)**

Check with ignition key ON, Linear Power Module connector and Blower Motor connector disconnected.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.**

**Table 35 Blower Motor Circuits Troubleshooting Chart (cont.)**

| Test Points | Spec. | Comments |
|---|---|---|
| Linear Power Module Connector, cavity 1 to ground | 12 ± 1.5 Volts dc | If voltage is missing check for:<br>**Version 1 Circuits**<br>• a blown fuse (F4) – (before replacing fuse, check for a short circuit between fused circuit and ground)<br>• an open circuit between Linear Power Module Connector, cavity 1 and fuse F4<br>**Version 2 and version 3 (Early Production) Circuits**<br>• a blown fuse (F6) – (before replacing fuse, check for a short circuit between fused circuit and ground)<br>• an open circuit between Linear Power Module Connector, cavity 1 and fuse F6<br>**Version 3 (Late Production) Circuits**<br>• a blown fuse (F20) – (before replacing fuse, check for a short circuit between fused circuit and ground)<br>• an open circuit between Linear Power Module Connector, cavity 1 and fuse F20 |
| Linear Power Module connector, cavity 1 to cavity 3 | 12 ± 1.5 Volts dc | If voltage is missing, check for: an open circuit between Linear Power Module connector, cavity 3 and ground stud (1851). |
| Blower Motor connector, cavity A to ground | 12 ± 1.5 Volts dc | If voltage is missing check for: an open circuit between Blower Motor connector, cavity A and fuse F4. |
| Linear Power Module Connector, cavity 2 to cavity 3 | 0 to 5 Volts dc (depends on setting of Blower Speed Control) – Voltage range may differ slightly **BUT,** should be lowest when control is fully ccw, and should increase as the control is turned cw, to its highest value when control is fully cw. | If voltage is missing or does not respond correctly to Blower Speed Control, check for:<br>• an open or shorted to ground circuit, between connector (1200), cavity A11 and cavity 2 of the Linear Power Module Connector. NOTE: There is a 1000 Ohm resistor between this circuit and ground.<br>• a defective HVAC Control Head<br>**NOTE – If the blower motor will not stop running when the blower speed control is set to OFF, check for an open 1000 Ohm resistor** |

**Table 35 Blower Motor Circuits Troubleshooting Chart (cont.)**

**Blower Motor Circuit Troubleshooting (continued)**

Make the following checks with ignition key OFF, the Blower Motor connector, connected; and the Linear Power Module connector, disconnected.

**NOTE – Always check connectors for damage and pushed–out terminals.**

**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.**

| Test Points | Spec. | Comments |
|---|---|---|
| **NOTE – Connecting the indicated jumper should energize the blower. Once blower operation is checked, REMOVE jumper.**<br><br>Momentarily connect a jumper from Linear Power Module connector, cavity 4 to ground. | The blower should energize at maximum speed while the jumper is connected. | If the blower turns on replace the linear power module.<br><br>If the blower does NOT turn on:<br><br>A. Check for an open circuit between Blower Motor connector, cavity B and Linear Power Module connector, cavity 4.<br><br>B. If the circuit checks ok, replace the blower assembly. |

## 14.3. EXTENDED DESCRIPTION

When a blower speed is selected, the HVAC control head outputs a voltage (approximately 0 – 5 Volts dc) on circuit A73D. This voltage is based on the blower speed control setting. This variable voltage is input (via connector 1210) to the linear power module at terminal 2 of the Linear Power Module (LPM) connector. The LPM responds by acting as a variable resistance between terminal 4 of the LPM connector and ground. This variable resistance is in the ground path of the blower motor (terminal B of the blower motor connector). As the blower speed control is turned cw, the apparent resistance to ground decreases, the voltage across the blower motor increases, and the speed increases.

A resistor connecting the input of the LPM to ground, maintains that point at a ground potential when the blower speed control is set to OFF. This prevents the blower motor from running when the control is in the OFF position.

In version 1 of the electrical circuit, power for the LPM is routed from the battery (fuse F4 in the cab power distribution center), on circuit A73C, to LPM connector, terminal 1. Power is also routed from circuit A73C to the blower motor at terminal A of the blower motor connector. Ground for the LPM is supplied from negative stud (1851), on circuit A73–G, to the LPM connector, terminal 3.

In version 2 and version 3 (early production) of the electrical circuit, power for the LPM is routed from the switched IGN voltage (fuse F6 in the cab power distribution center), on circuit A75D, to the LPM connector, terminal 1. Power for the blower motor is routed from the battery (fuse F4), on circuit A73C, to terminal A of the blower motor connector. Ground for the LPM is supplied from negative stud (1851), on circuit A73–G, to the LPM connector, terminal 3.

The version 3 (late production) circuit is identical to the version 3 (early production) circuit except fuse F20 is used in place of F6.

## 14.4. COMPONENT LOCATIONS

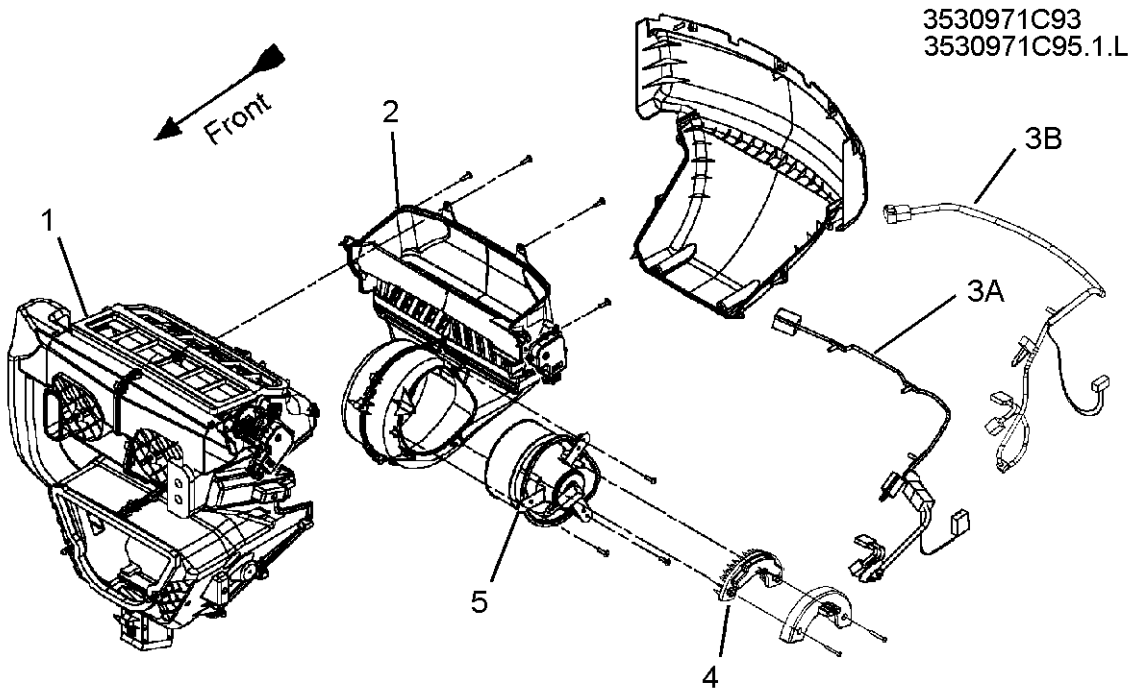



**Figure 71 Blower Motor Circuit Component Locations**

1. HEATER HOUSING
2. BLOWER HOUSING

3A. HVAC WIRE HARNESS (TWO PIECE)
3B. HVAC WIRE HARNESS (ONE PIECE)

4. LINEAR POWER MODULE
5. BLOWER MOTOR

# 15. AC REFRIGERANT THERMISTOR CIRCUITS

## 15.1. CIRCUIT FUNCTIONS

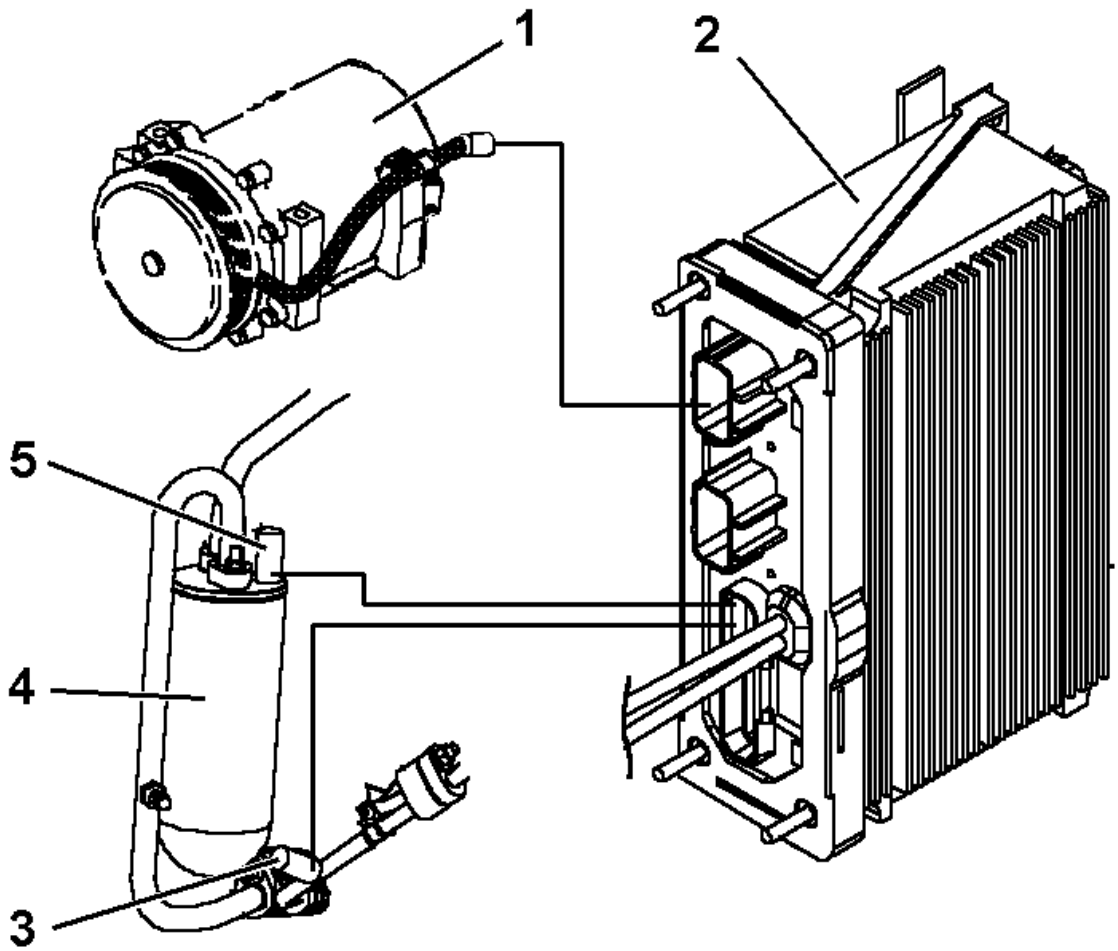



**Figure 72 AC Refrigerant Thermistors Function Diagram**

1. AC COMPRESSOR
2. ELECTRICAL SYSTEM CONTROLLER (ESC)
3. INLET THERMISTOR
4. AC ACCUMULATOR
5. OUTLET THERMISTOR

The AC REFRIGERANT THERMISTORS allow the ESC to monitor refrigerant temperatures at the inlet and outlet of the AC evaporator core. This information is used by the ESC software program (the RCD system) to help control the operation of the A/C system, and to help diagnose faults during abnormal system operation. For a complete description of the RCD system, refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150)

The ESC will generate diagnostic trouble codes if the readings received from the thermistors are either out of range high or out of range low.

## 15.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

This section describes the symptoms that may result from a failure in the refrigerant thermistor circuits. A list of the possible causes of the circuit failure is also provided. Table 36 lists and describes any Diagnostic Trouble Codes associated with the refrigerant thermistor circuits. Table 37 provides the troubleshooting procedures for isolating the cause of the failure.

A failure in the refrigerant thermistor circuits could be attributed to an open or short in the circuits between the thermistors and the ESC; an open or shorted thermistor; or a problem in the ESC. Refer to the REFRIGERANT THERMISTOR CIRCUITS diagram.

The ESC will log a diagnostic trouble code (DTC) for either a shorted thermistor circuit or an open thermistor circuit.

**NOTE – If the electrical connection to either thermistor is suspected of being intermittent, perform the THERMISTOR CONNECTOR REPAIR procedures (See THERMISTOR CONNECTOR REPAIR, page 209). Then reconnect the connector and verify that the condition still exists before proceeding with troubleshooting.**

An electronic service tool, running diagnostic software, can be used to monitor thermistor inputs to the ESC. See the diagnostic software manual for details on using the software.

**Table 36 Refrigerant Thermistor Circuits Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 612 14 27 1 | Outlet thermistor out of range low |
| This diagnostic code could be the result of any of the following conditions:<br>• a short to ground (or the 0 Volt Reference) in the circuits between the outlet thermistor and the ESC<br>• a shorted thermistor<br>• a problem in the ESC | |
| 612 14 27 2 | Outlet thermistor out of range high |
| This diagnostic code could be the result of any of the following conditions:<br>• an open in the circuit between the 0 Volt Reference and the outlet thermistor<br>• an open in the circuit between the outlet thermistor and the ESC<br>• an open thermistor<br>• a problem in the ESC | |
| 612 14 29 1 | Inlet thermistor out of range low |

**Table 36 Refrigerant Thermistor Circuits Diagnostic Trouble Codes (cont.)**

| | |
|---|---|
| This diagnostic code could be the result of any of the following conditions:<br>• a short to ground (or the 0 Volt Reference) in the circuits between the inlet thermistor and the ESC<br>• a shorted thermistor<br>• a problem in the ESC | |
| 612 14 29 2 | Inlet thermistor out of range high |
| This diagnostic code could be the result of any of the following conditions:<br>• an open in the circuit between the 0 Volt Reference and the outlet thermistor<br>• an open in the circuit between the outlet thermistor and the ESC<br>• a shorted thermistor<br>• a problem in the ESC | |

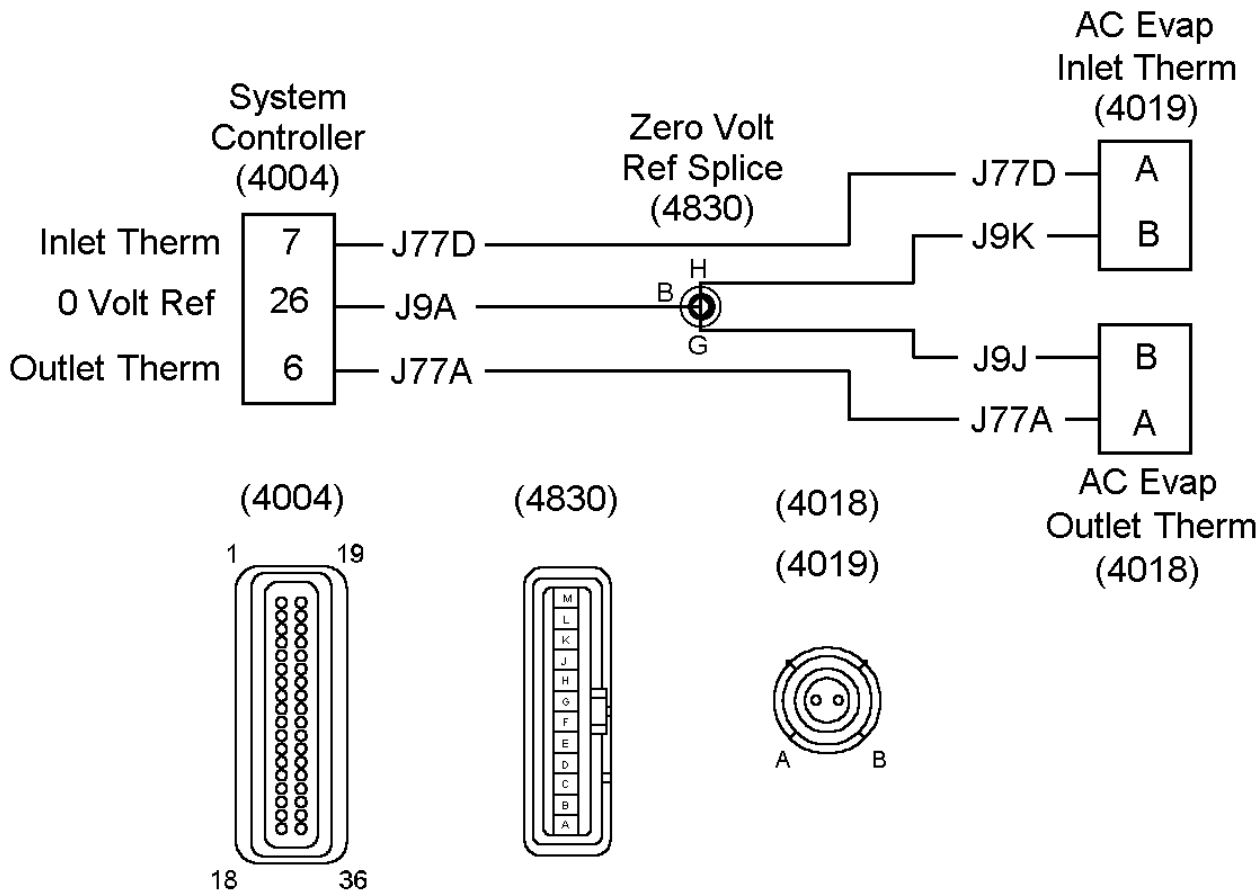



**Figure 73 Refrigerant Thermistor Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(4004) 36–WAY ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(4018) REFRIGERANT TEMPERATURE OUTLET THERMISTOR
LOCATED ON TOP OF ACCUMULATOR
(4019) REFRIGERANT TEMPERATURE INLET THERMISTOR
LOCATED NEAR BOTTOM OF EVAPORATOR
(4830) ZERO VOLT REFERENCE SPLICE
LOCATED NEAR WIPER MOTOR BRACKET

**Table 37 Refrigerant Thermistor Circuits Troubleshooting Chart**

| **Inlet Thermistor Troubleshooting** |
|---|
| Install breakout box ZTSE4477 between connector (4004) and the ESC. |
| Check with Key ON and refrigerant thermistor connector (4019) disconnected from thermistor. |
| **NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.** |
| **NOTE – Always check connectors for damage and pushed–out terminals.** |

**Table 37 Refrigerant Thermistor Circuits Troubleshooting Chart (cont.)**

**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.**

| Test Points | Spec. | Comments |
|---|---|---|
| (4019) harness connector, cavity A to ground. | 10 ± 1 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect check for:<br><br>• a short circuit between (4019) cavity A and ground<br>• a short circuit between (4019) cavity A and cavity B (0 Volt Ref)<br><br>**NOTE – If a short circuit is present, isolate the short to the circuit or the ESC.**<br><br>• an open circuit between (4019) cavity A and ESC connector (4004) terminal 7<br><br>If the voltage is incorrect and no open or shorted circuits are present, replace the ESC. |
| (4019) harness connector, cavity A to cavity B. | 10 ± 1 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect, check for open circuits between (4019) cavity B and ESC connector (4004) terminal 26. If no open circuit exists, replace the ESC. |

**Inlet Thermistor Troubleshooting — Continued**

Check with Key off.

Reconnect the thermistor connector (4019) to the thermistor.

The thermistor harness (4004) must be connected to the breakout box, but the breakout box should be disconnected from the ESC.

**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**

**NOTE – Always check connectors for damage and pushed–out terminals.**

**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.**

**Table 37 Refrigerant Thermistor Circuits Troubleshooting Chart (cont.)**

| | | |
|---|---|---|
| Connector (4019) contacts A and B, to ground (metal A/C line).<br><br>**NOTE – To prevent damage to the thermistor pins, these resistances can be measured from contacts 7 and 26, respectively, on the breakout box. Breakout box must be disconnected from ESC.** | Check for short circuits. | If either circuit is shorted to ground, replace the thermistor.<br><br>If no short circuits are present, go to next step. |
| Connector (4019) contact A to contact B<br><br>**NOTE – To prevent damage to the thermistor pins, this value can be measured between contacts 7 and 26, on the breakout box. Breakout box must be disconnected from ESC.** | Resistance value | Measure resistance. Look up equivalent temperature value in THERMISTOR CROSS REFERENCE TABLE, and compare to approximate temperature of A/C line (measure with temperature probe, if available). If temperature readings disagree, replace the thermistor. If the temperature readings agree, replace the ESC. |
| **Outlet Thermistor Troubleshooting**<br><br>Install breakout box ZTSE4477 between connector (4004) and the ESC.<br><br>Check with Key ON and refrigerant thermistor connector (4018) disconnected from thermistor.<br><br>**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.**<br><br>**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.** | | |
| Test Points | Spec. | Comments |
| (4018) harness connector, cavity A to ground. | 10 ± 1 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect check for:<br><br>• a short circuit between (4018) cavity A and ground<br>• a short circuit between (4018) cavity A and cavity B (0 Volt Ref)<br><br>**NOTE – If a short circuit is present, isolate the short to the circuit or the ESC.** |

**Table 37 Refrigerant Thermistor Circuits Troubleshooting Chart (cont.)**

| | | |
|---|---|---|
| | | • an open circuit between (4018) cavity A and ESC connector (4004) terminal 6<br><br>If the voltage is incorrect and no open or shorted circuits are present, replace the ESC. |
| (4018) harness connector, cavity A to cavity B. | 10 ± 1 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect, check for open circuits between (4018) cavity B and ESC connector (4004) terminal 26. If no open circuit exists, replace the ESC. |
| **Outlet Thermistor Troubleshooting — Continued**<br><br>Check with Key off.<br><br>Reconnect the thermistor connector (4018) to the thermistor.<br><br>The thermistor harness (4004) must be connected to the breakout box, but the breakout box should be disconnected from the ESC.<br><br>**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.**<br><br>**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.** | | |
| Connector (4018) contacts A and B, to ground (metal A/C line).<br><br>**NOTE – To prevent damage to the thermistor pins, these resistances can be measured from contacts 6 and 26, respectively, on the breakout box. Breakout box must be disconnected from ESC.** | Check for short circuits. | If either circuit is shorted to ground, replace the thermistor.<br><br>If no short circuits are present, go to next step. |
| Connector (4018) contact A to contact B | Resistance value | Measure resistance. Look up equivalent temperature value in THERMISTOR CROSS |

**Table 37 Refrigerant Thermistor Circuits Troubleshooting Chart (cont.)**

| | | |
|---|---|---|
| **NOTE – To prevent damage to the thermistor pins, this value can be measured between contacts 6 and 26, on the breakout box. Breakout box must be disconnected from ESC.** | | REFERENCE TABLE, and compare to approximate temperature of A/C line (measure with temperature probe, if available). If temperature readings disagree, replace the thermistor. If the temperature readings agree replace the ESC. |

**Table 38 Thermistor Cross Reference Table**

| TEMP (°C) | TEMP (°F) | Minimum Resistance (kOhms) | Nominal Resistance (kOhms) | Maximum Resistance (kOhms) | Nominal Voltage at ESC (See Note 1) (Volts) |
|---|---|---|---|---|---|
| -15 | 5 | 19.531 | 21.43 | 22.387 | 10.07 |
| -10 | 14 | 14.948 | 16.159 | 16.93 | 9.90 |
| -5 | 23 | 11.56 | 12.283 | 12.939 | 9.78 |
| 0 | 32 | 9.028 | 9.407 | 9.988 | 9.50 |
| 5 | 41 | 6.988 | 7.273 | 7.646 | 9.20 |
| 10 | 50 | 5.456 | 5.666 | 5.907 | 9.03 |
| 15 | 59 | 4.296 | 4.447 | 4.604 | 8.65 |
| 20 | 68 | 3.381 | 3.514 | 3.618 | 8.20 |
| 25 | 77 | 2.725 | 2.795 | 2.865 | 7.85 |
| 30 | 86 | 2.174 | 2.237 | 2.306 | 7.38 |
| 35 | 95 | 1.747 | 1.802 | 1.868 | 6.80 |
| 40 | 104 | 1.413 | 1.459 | 1.524 | 6.18 |
| 45 | 113 | 1.15 | 1.188 | 1.25 | 5.86 |
| 50 | 122 | .942 | .973 | 1.032 | 5.20 |
| 55 | 131 | .773 | .803 | .853 | 4.80 |
| 60 | 140 | .637 | .667 | .709 | 4.20 |
| 65 | 149 | .529 | .56 | .591 | 3.85 |
| 70 | 158 | .443 | .469 | .495 | 3.42 |
| 75 | 167 | .373 | .395 | .417 | 3.14 |
| 80 | 176 | .315 | .334 | .352 | 2.78 |
| 85 | 185 | .267 | .283 | .299 | 2.36 |
| 90 | 194 | .227 | .241 | .255 | 2.10 |
| 95 | 203 | .194 | .206 | .218 | 1.82 |

**Table 38 Thermistor Cross Reference Table (cont.)**

| TEMP (°C) | TEMP (°F) | Minimum Resistance (kOhms) | Nominal Resistance (kOhms) | Maximum Resistance (kOhms) | Nominal Voltage at ESC (See Note 1) (Volts) |
|---|---|---|---|---|---|
| 100 | 212 | .166 | .177 | .187 | 1.63 |
| Note 1: Thermistor voltages are nominal and will vary with the ignition voltage. | | | | | |

## 15.3. EXTENDED DESCRIPTION

The AC refrigerant inlet thermistor is tied to the ESC zero volt reference level, at ESC connector (4004) terminal 26, through circuit J9A and circuit J9K to (4019) terminal B. The inlet thermistor is also supplied approximately 10 volts from ESC connector (4004) terminal 7, through circuit J77D to (4019) terminal A. The resistance of the thermistor, and therefore the amount of voltage dropped across the thermistor, will vary according to the temperature of the refrigerant being monitored by the thermistor. The ESC will use this information as one parameter involved in determining if, and when, the AC compressor should be turned on or off.

The AC refrigerant outlet thermistor is tied to the ESC zero volt reference level, at ESC connector (4004) terminal 26, through circuit J9A and circuit J9J to (4018) terminal B. The outlet thermistor is also supplied approximately 10 volts from ESC connector (4004) terminal 6, through circuit J77A to (4018) terminal A. This thermistor functions identically to the inlet thermistor to provide the ESC with another parameter involved in determining if, and when, the AC compressor should be turned on or off.

## 15.4. THERMISTOR CONNECTOR REPAIR

If the electrical connection to either thermistor is suspected of being intermittent due to loose or corroded contacts, replace the thermistor connector and terminals. Refer to FIGURE 74 and the following procedure. Part numbers can be found in the Circuit Diagram book.

> **CAUTION – Do not fill the thermistor cavity with grease, as this could prevent a good seal.**

1. Cut harness as close to existing connector as possible.
2. Strip wires back and crimp new terminals to wires.
3. Insert terminals into connector body with light green wire in cavity A. (Gray wire in cavity B.)
4. Apply a small amount of RTV to seal connector at the wire entry point.
5. Install white cap on connector.
6. Apply a small amount of dielectric grease to connector and terminals to prevent terminals from corroding.

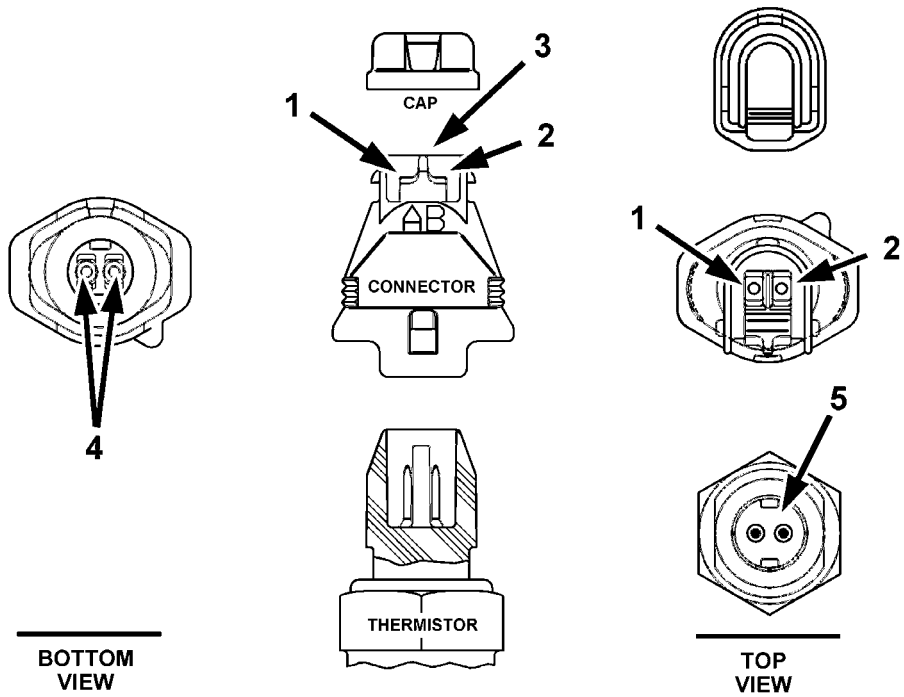



**Figure 74 Thermistor Connector Repair**

1. CAVITY “A” – LHT GREEN WIRE, NEW TERMINAL
2. CAVITY “B” – GRAY WIRE, NEW TERMINAL
3. APPLY SMALL AMOUNT OF RTV
4. APPLY DIELECTRIC GREASE TO TERMINALS
5. DO NOT FILL THERMISTOR CAVITY WITH GREASE

## 15.5. COMPONENT LOCATIONS

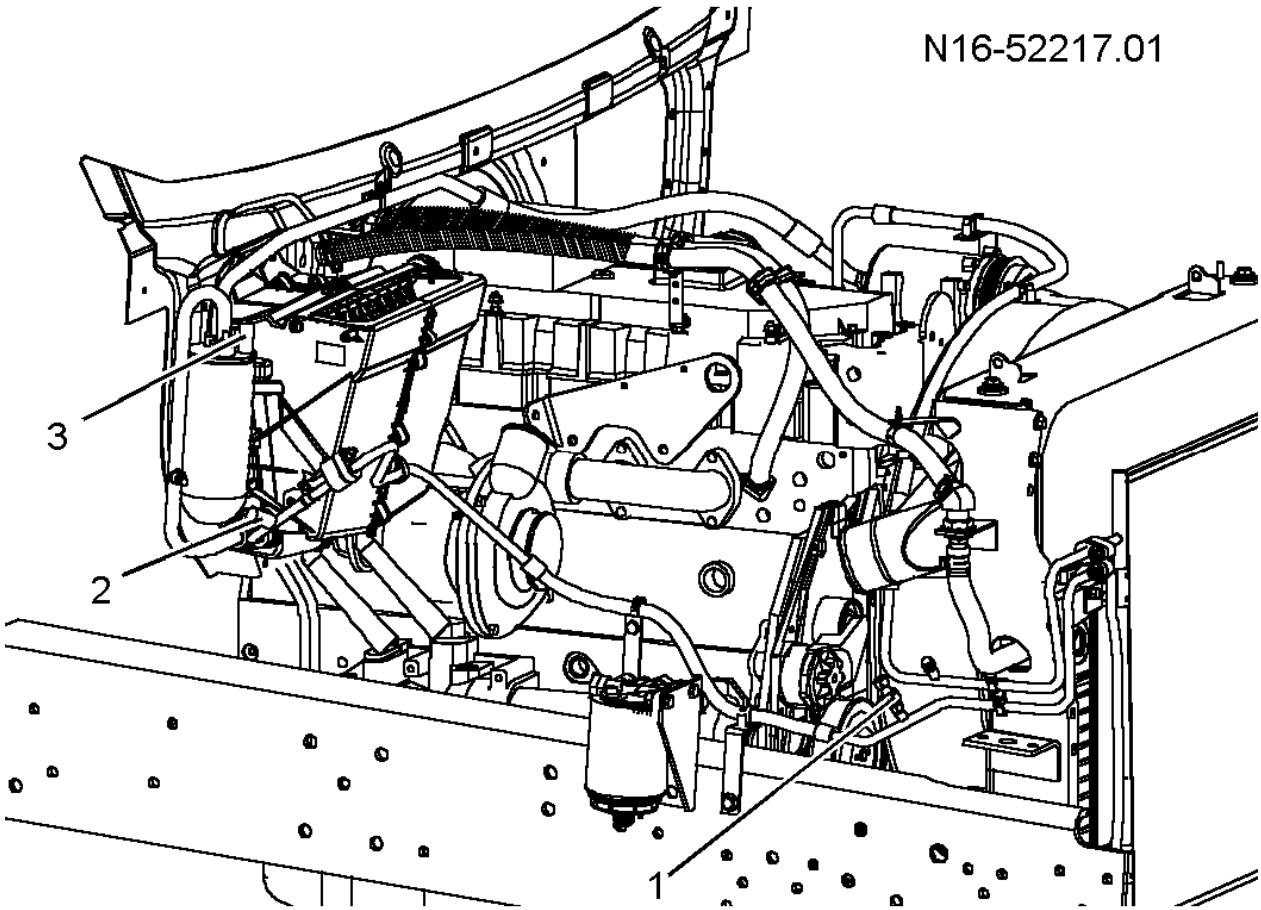



**Figure 75 Refrigerant Thermistor Locations (Thermistor Locations are the Same for All Engines)**

1. PRESSURE TRANSDUCER
2. INLET THERMISTOR
3. OUTLET THERMISTOR

# 16. AC PRESSURE TRANSDUCER CIRCUIT

## 16.1. CIRCUIT FUNCTIONS

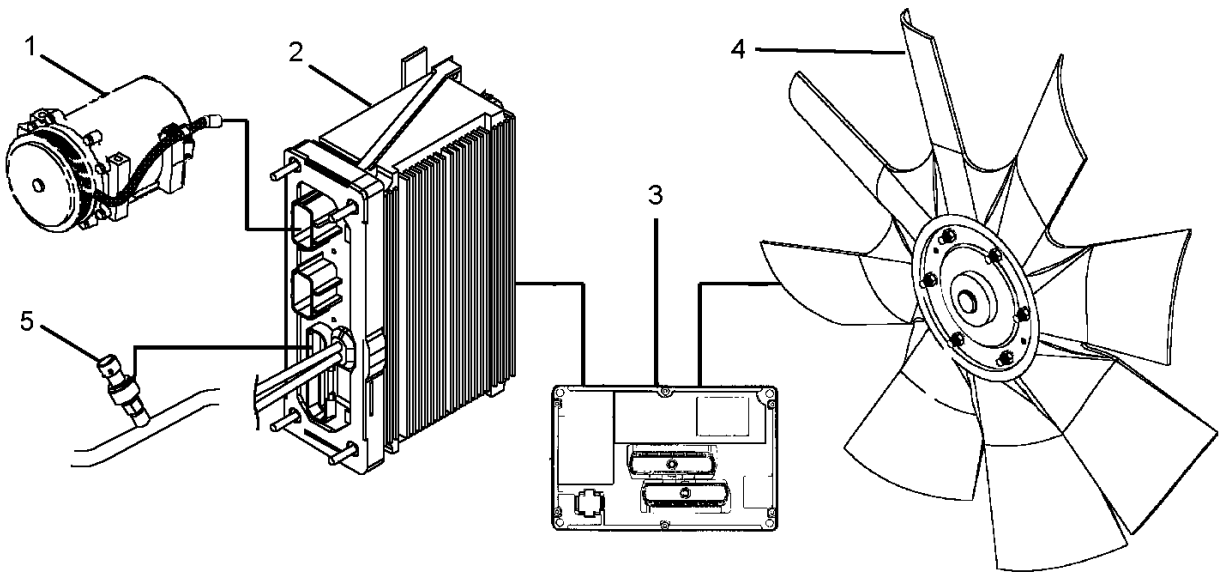



**Figure 76 Pressure Transducer Function Diagram**

1. AC COMPRESSOR
2. ELECTRICAL SYSTEM CONTROLLER (ESC)
3. ENGINE CONTROLLER
4. ENGINE COOLING FAN
5. AC PRESSURE TRANSDUCER

The refrigerant PRESSURE TRANSDUCER allows the ESC to monitor the refrigerant pressure in the A/C system. This information is used by the ESC software program (the RCD system) to help control the operation of the A/C system, and to help diagnose faults during abnormal system operation. For a complete description of the RCD system, refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150).

The ESC will generate diagnostic trouble codes if the readings received from the pressure transducer are either out of range high or out of range low.

## 16.2. FAULT DETECTION MANAGEMENT

**NOTE – The testing method for troubleshooting the electrical systems covered in this manual is a basic voltage test. An alternate method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.**

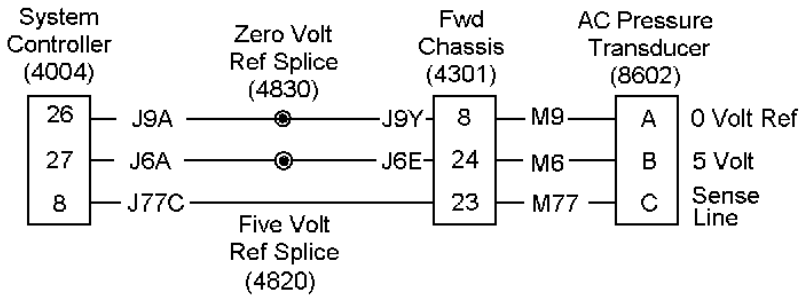
This section describes the symptoms that may result from a failure in the pressure transducer circuits. A list of the possible causes of the circuit failure is also provided. Table 39 lists and describes any Diagnostic Trouble Codes associated with the pressure transducer circuits. Table 40 provides the troubleshooting procedures for isolating the cause of the failure.

A fault in the PRESSURE TRANSDUCER CIRCUITS should be indicated by the presence of a diagnostic trouble code. The fault could be attributed to an open or short in the power and sensing circuits between the transducer and the ESC, a short or open in the transducer, a misreading transducer, or a problem in the ESC.

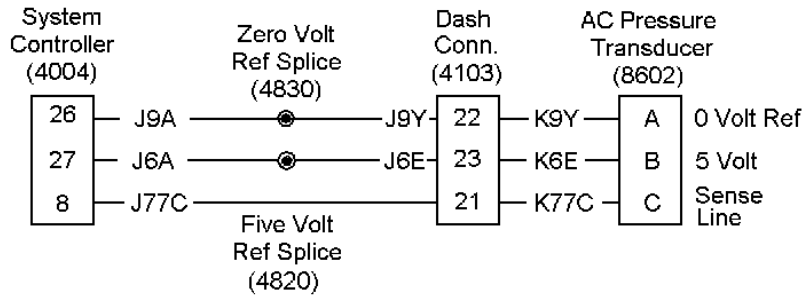
An electronic service tool, running diagnostic software, can be used to monitor transducer inputs to the ESC. See the diagnostic software manual for details on using the software.

**Table 39 Pressure Transducer Circuit Diagnostic Trouble Codes**

| Diagnostic Codes | |
|---|---|
| 612 14 30 1 | +5V reference line out of range low |
| This fault could be the result of any of the following conditions:<br>• no 5 volt reference output from the ESC<br>• a short to ground (or zero volt reference) on the 5 volt reference line<br>• a defective pressure transducer (internally shorted)<br>• a defective ESC | |
| 612 14 31 1 | This Diagnostic code is no longer valid. |
| If this Diagnostic code is displayed, the ESC software is out of date and must be updated. | |
| 612 14 31 2 | HVAC pressure sensor signal out of range high |
| This fault could be the result of any of the following conditions:<br>• no zero volt reference output from the ESC<br>• an open circuit on the zero volt reference line between the pressure transducer and the ESC<br>• a short circuit between the sensor output and the 5 volt reference line<br>• a defective pressure transducer<br>• a defective ESC | |




**ALL MODELS EXCEPT REGIONAL HAUL - HDD**




**REGIONAL HAUL - HDD**

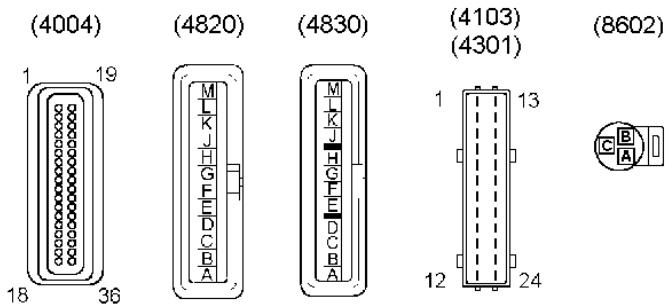



**Figure 77 Pressure Transducer Circuits—Always Refer to Circuit Diagram Book for Latest Circuit Information**

(4004) 36–WAY ELECTRICAL SYSTEM CONTROLLER CONNECTOR
LOCATED ON ENGINE COMPARTMENT SIDE OF ESC
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4301) FORWARD CHASSIS CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME RAIL
(4820) 5 VOLT REFERENCE SPLICE PACK
LOCATED NEAR WIPER MOTOR BRACKET
(4830) ZERO VOLT REFERENCE SPLICE PACK
LOCATED NEAR POWER DISTRIBUTION CENTER
(8602) AC PRESSURE TRANSDUCER
LOCATED NEAR POWER DISTRIBUTION CENTER

**Table 40 Pressure Transducer Circuits Troubleshooting Chart**

| **Pressure Transducer Connector (8602) Troubleshooting**<br><br>Disconnect connector (8602) from the AC pressure transducer.<br><br>Connect the breakout box to the ESC at connector (4004).<br><br>Connect the high side gauge of the AC recovery station to the high side service port.<br><br>Check with Key on. The engine does not need to be running.<br><br>**NOTE – The AC system does not need to be running for these checks.**<br><br>**NOTE – Always use breakout box ZTSE4477 to take measurements on ESC connectors.**<br><br>**NOTE – Always check connectors for damage and pushed–out terminals.**<br><br>**NOTE – When making resistance checks (for short circuits), always remove power and isolate the circuit being checked.** | | |
|---|---|---|
| Test Points | Spec. | Comments |
| (8602) harness connector, cavity B to ground. | 5±0.5 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect, check for an open circuit between cavity B of (8602) and pin 27 on ESC connector (4004), or a short circuit from cavity B to ground. If the circuits are ok, replace the ESC.<br><br>**NOTE – If 5 volts is shorted to ground or missing out of the ESC, air pressure gauges will also read incorrectly. Pin 27 on (4004) and pin 27 on the cab 36–way connector (1600) are connected inside the ESC. A short to ground on either connector will ground out the voltage at both connectors. Refer to the ELECTRICAL SYSTEM TROUBLESHOOTING GUIDE (S08250) for information on the other circuits connected to the 5 Volt reference line.** |
| (8602) harness connector, cavity B to cavity A. | 5±1 volt. | If voltage is correct, go to next step.<br><br>If voltage is incorrect, check for open circuit between cavity A of (8602) and splice pack (4830), or between (4830) and zero volt reference from ESC (4004) terminal 26. If the circuits are ok, replace the ESC. |

**Table 40 Pressure Transducer Circuits Troubleshooting Chart (cont.)**

| | | |
|---|---|---|
| (8602) harness connector, cavity B to cavity C. | 5±1 volt. | If voltage is correct, check for a short circuit from cavity C to ground. If there is no short circuit, go to next step.<br><br>If voltage is incorrect, check for an open circuit between cavity C of (8602) and pin 8 on ESC connector (4004). |
| **Pressure Transducer Connector (8602) Troubleshooting (Continued)**<br><br>Reconnect connector (8602) to the AC pressure transducer.<br><br>Check with Key ON. The engine does not have to be running. | | |
| (4004) harness connector, cavity 8 to cavity 26. | Sense voltage | Measure the Sense signal voltage. Look up the equivalent pressure value in the PRESSURE TRANSDUCER VOLTAGE table (See Table 41, page 216), and compare to the pressure value indicated on the AC recovery station high side gauge. Values must be within 20 psi.<br><br>If values disagree, replace the pressure transducer.<br><br>If values agree, replace the ESC. |
| **TROUBLESHOOTING CONCLUSION** | | |
| If voltages are not present at the harness connector and there are no open or shorted circuits, replace the ESC. | | |

**Table 41 Pressure Transducer Voltage**

| PRESSURE (PSI) | Nominal Voltage (Volts) |
|---|---|
| 0 | <0.25 |
| 20 | 0.42 |
| 25 | 0.48 |
| 40 | 0.62 |
| 50 | 0.71 |
| 75 | 0.92 |
| 100 | 1.15 |
| 150 | 1.59 |
| 185 | 1.90 |
| 200 | 2.03 |
| 250 | 2.48 |
| 285 | 2.80 |
| 300 | 2.92 |

**Table 41 Pressure Transducer Voltage (cont.)**

| PRESSURE (PSI) | Nominal Voltage (Volts) |
|---|---|
| 350 | 3.38 |
| 400 | 3.81 |
| 420 | 3.99 |
| 450 | 4.26 |
| 475 | 4.48 |
| 500 | 4.71 |

## 16.3. EXTENDED DESCRIPTION

The refrigerant pressure transducer allows the ESC to monitor refrigerant pressure in the A/C system.

The AC pressure transducer (8602) receives 5 volts from ESC connector (4004) terminal 27 to (8602) terminal B. A zero volt reference is supplied from ESC connector (4004) terminal 26 to (8602) terminal A. The AC transducer will provide a voltage, relative to the system pressure, from connector (8602) terminal C to ESC connector (4004) terminal 8. The ESC will generate diagnostic trouble codes if the readings received from the pressure transducer are either out of range high or out of range low.

## 16.4. COMPONENT LOCATIONS

Refer to PRESSURE TRANSDUCER LOCATIONS diagram.

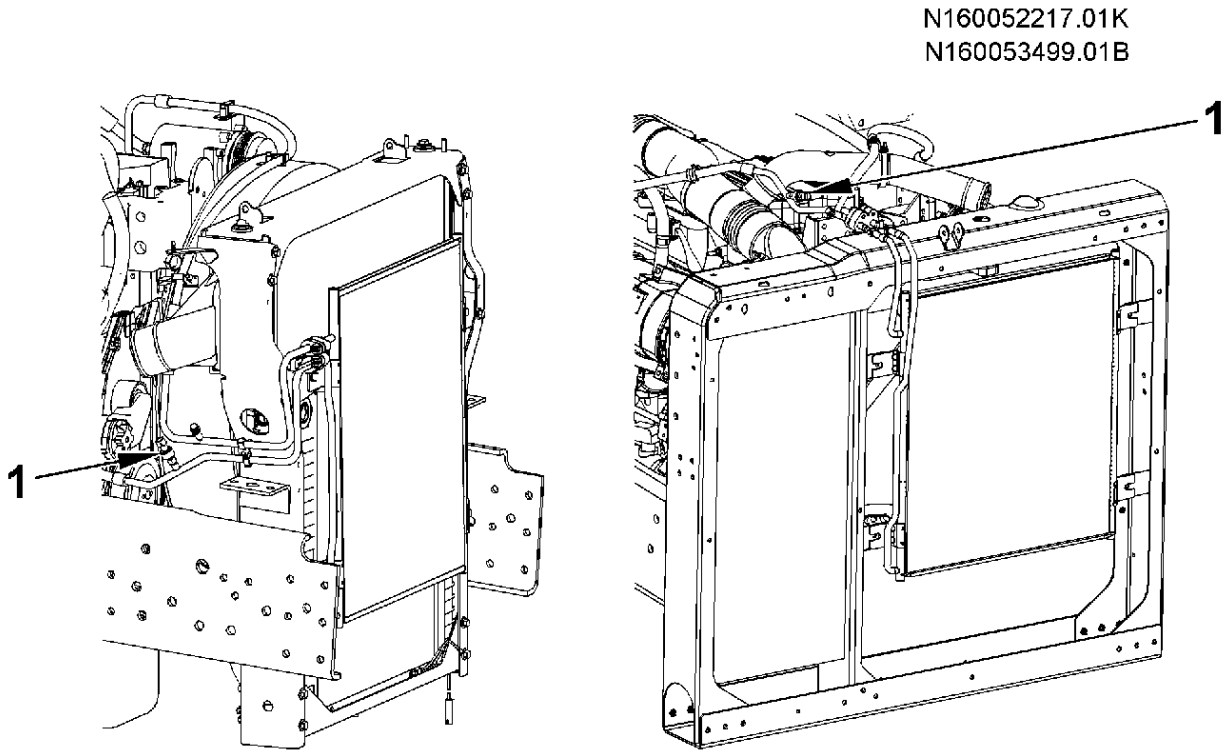



**Figure 78 Pressure Transducer Locations (Typical Locations Shown)**

1. PRESSURE TRANSDUCER

# 17. SPECIFICATIONS

## 17.1. TORQUE CHART

**Table 42 Torque Chart**

| Item No.* | Item Description (Quantity) | Torque Value | | |
|---|---|---|---|---|
| | | N•m | Lbf-ft | Lbf-in |
| 1 | Thermistor (2) | 5–9.5 | 3.7–7 | 44.3–84.1 |
| 2 | Freon Compressor Mtg Bolts (4) | 23–29 | 17–21.4 | 203.6–256.7 |
| 3 | Air Conditioner Block Fittings (9) | 19–21 | 14.2–15.8 | 170–190 |
| 4 | Pressure Transducer (1) | 20–22 | 14.8–16.2 | 177–194.2 |
| 5 | Condenser Mtg. Bolt (Qty Varies by Model) | 23–29 | 17–21.4 | 203.6–256.7 |
| 6 | Recirculation Shield Mtg Bolt (Qty Varies by Model) | 23–29 | 17–21.4 | 203.6–256.7 |
| 7 | Accumulator Mtg Bolt (2) | 5.4–7.6 | 4–5.6 | 47.5–67.5 |
| 8 | Air Cleaner Bracket Mtg Bolt (3) | 19.6–24 | 14.5–17.7 | 173.5–212.4 |
| 9 | Cowl Tray Mtg Bolt (2) | 22–25 | 16.2–18.4 | 194.2–221.3 |
| 10 | Evaporator Housing Mtg Bolt (4) | 5.4–7.6 | 4–5.6 | 47.5–67.5 |

**Table 42 Torque Chart (cont.)**

| Item No.* | Item Description (Quantity) | Torque Value | | |
|---|---|---|---|---|
| | | N•m | Lbf-ft | Lbf-in |
| 11 | Heater Housing Mtg Bolt (4) | 5.4–7.6 | 4–5.6 | 47.5–67.5 |
| 12 | Air Tube to Air Cleaner Clamp | 4.5–5.5 | 3.3–4.1 | 39.8–48.7 |
| 13 | Instrument Panel Mtg Bolts, Top (5) | 9.5–12.0 | 7–8.9 | 84.1–106.2 |
| 14 | Instrument Panel Mtg Bolts, Sides (4) | 21–26 | 15.5–19.2 | 185.9–230.1 |
| 15 | Steering Column (Driver Control Module) Mtg Bolts (2) | 19.6–24 | 14.5–17.7 | 173.5–212.4 |
| *Refer to the three torque location diagrams (Figure 79, Figure 80, and Figure 81) that follow this table. | | | | |

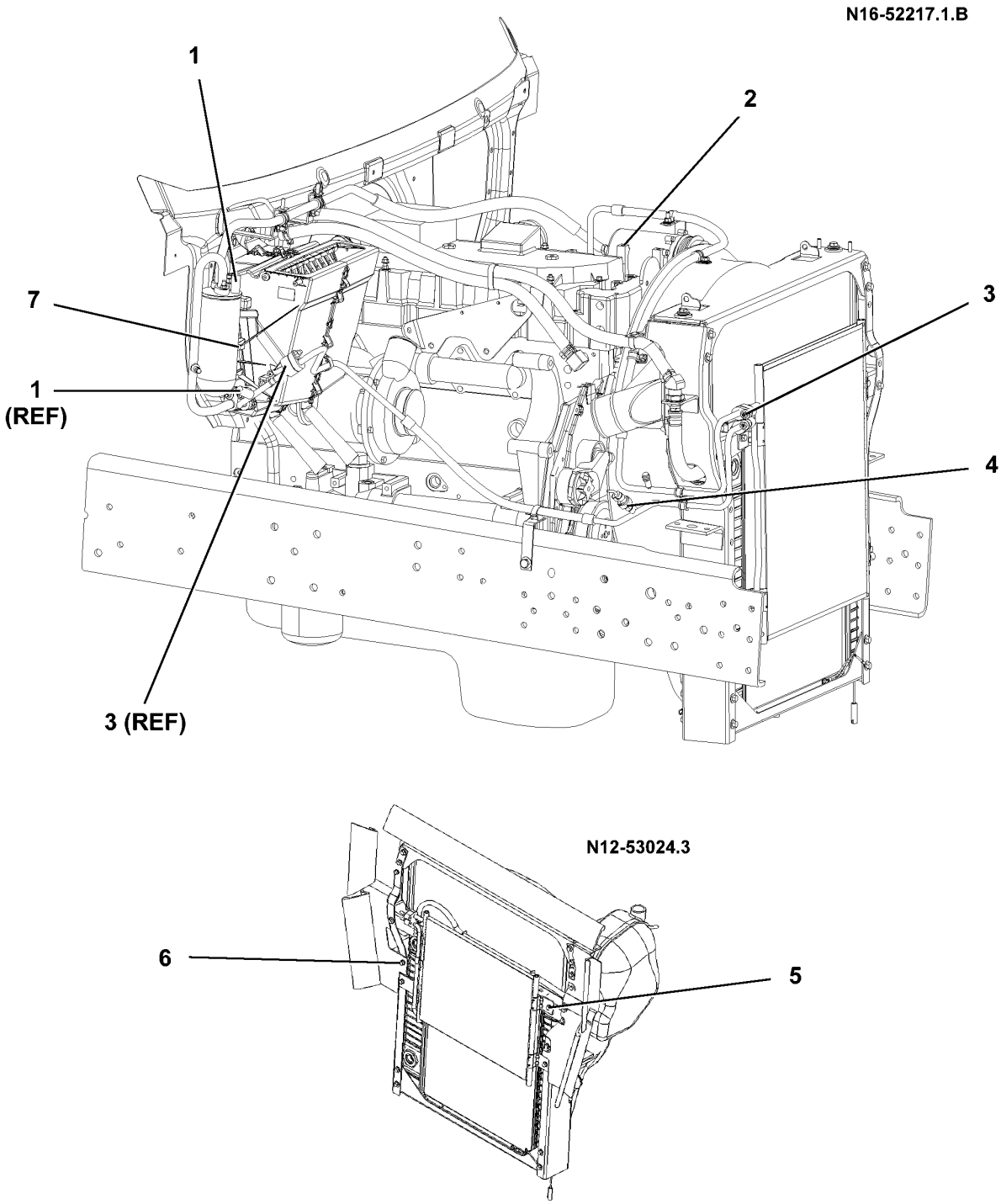



**Figure 79 Torque Locations, View 1 (Pre-2004 I6 Engine Shown, Others Similar)**

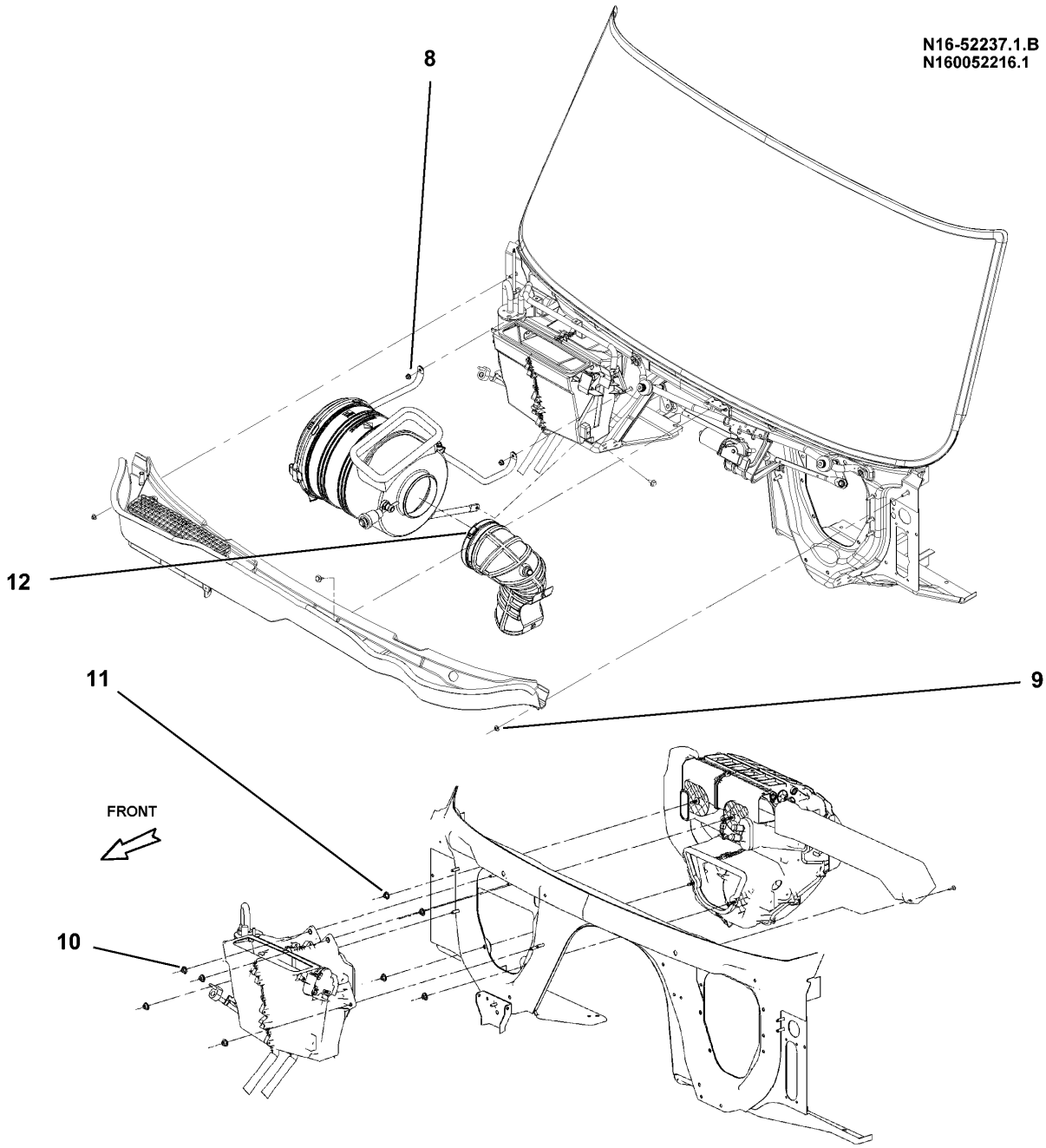
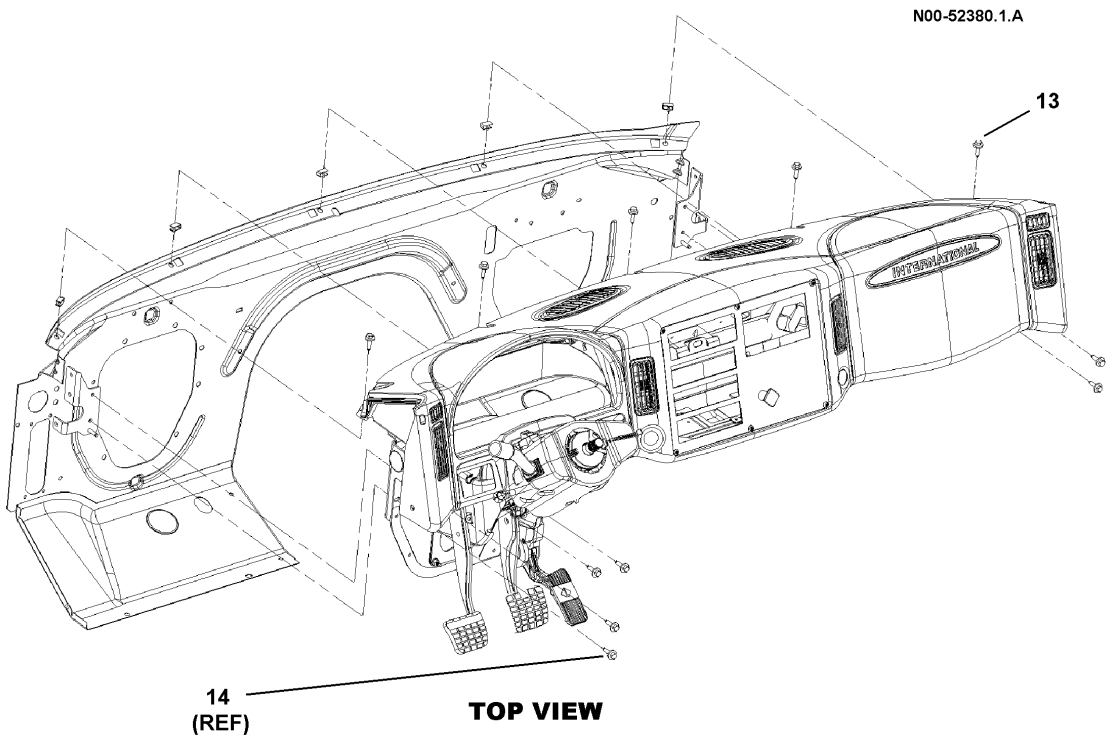



**Figure 80 Torque Locations, View 2**



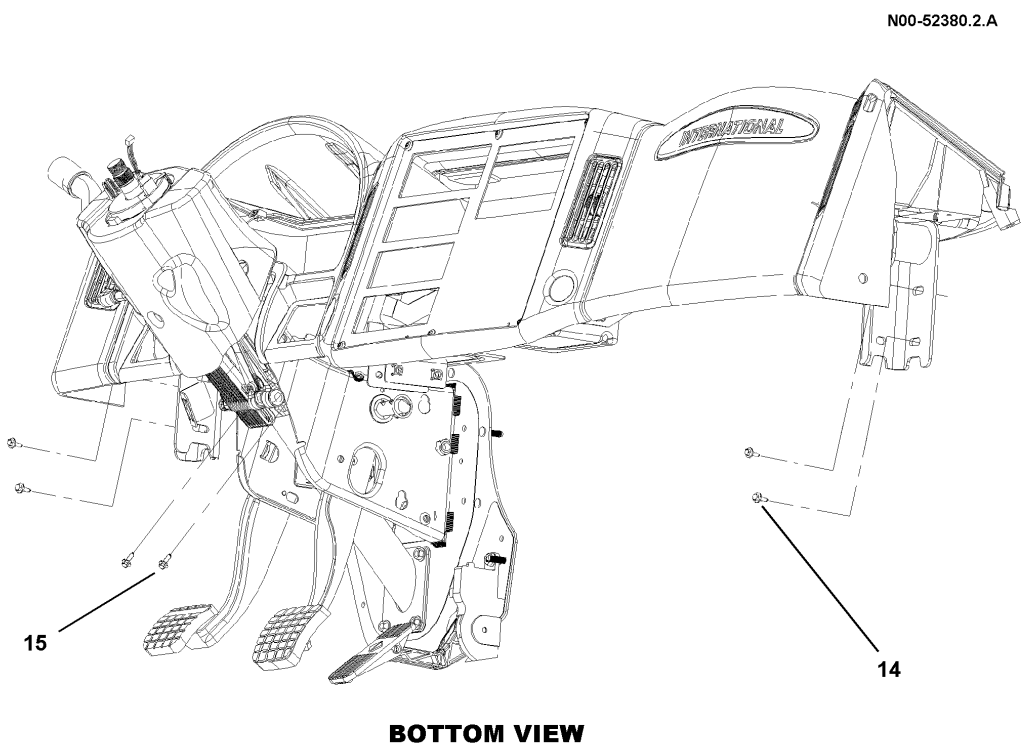




**Figure 81 Torque Locations, View 3**

## 17.2. AIR CONDITIONING SYSTEM

**Table 43 Air Conditioning System Specifications**

| ITEM | SPECIFICATION |
|---|---|
| Refrigerant Type | R-134a |
| Refrigerant Quantity (Full Charge) | 30 oz. (0.85 kg) |
| Compressor Oil Type | International P/N ZGGR6822 (Sanden SP-15)<br><br>**NOTE – SP-15 is interchangeable with Sanden SP-20 that was used in Early Production trucks.** |
| Compressor Oil Capacity | 300 cc (10.14 fl.oz.) |
| Lubricating Oil Type (O-rings, threads, etc.) Do NOT use as compressor refrigerant oil. | International P/N ZGGR6912<br><br>(Mineral Oil) |
| Dielectric Grease (for thermistor connectors) | International P/N 1831731C1 |
| Compressor Belt Drive Tension | Controlled by auto-tensioner. |

# 18. SPECIAL TOOLS

**CAUTION – The servicing tools recommended for this system were designed specifically for use with R-134a A/C systems. Servicing tools designed and/or used for R-12 A/C systems must not be used when servicing R-134a systems unless they are specifically identified as being compatible with both systems.**

Servicing air conditioning efficiently and effectively requires proper tools and equipment. The recommended tools, as well as, alternate service tools are shown and discussed below.

The tools listed in the following table can be ordered through the International tool supplier. The tools shown in Figure 82 can be obtained from local sources.

**Table 44 Special Service Tools**

| DESCRIPTION | PART NO. |
|---|---|
| Recovery/Recycling/Recharging Station (R-134a) | ZTSE4615 |
| Manifold Gauge Set (R-134a) | ZTSE4623 |
| Electronic Vacuum Gauge | ZTSE4620 |
| Electronic Vacuum Gauge Manifold | ZTSE4624 |
| Refrigerant Identifier | ZTSE4616 |
| Electronic Leak Detector | ZTSE4617 |
| Ultraviolet Lamp Leak Detector | ZTSE4618 |
| Digital Thermometer | ZTSE4619 |

**Table 44 Special Service Tools (cont.)**

| DESCRIPTION | PART NO. |
|---|---|
| Block Fitting Adapters | |
| Male Adapter, ½ Inch | ZTSE4503 |
| Male Adapter, ¾ Inch | ZTSE4501 |
| Female Adapter, ½ Inch | ZTSE4504 |
| Female Adapter, ¾ Inch | ZTSE4502 |
| Breakout Box | ZTSE4477 |
| Electronic Service Tool (EST), EZ-Tech and Interface Communications Cable | |
| Dry Nitrogen, Cart, Regulator | Obtain Locally |
| Flush Gun | Obtain Locally |

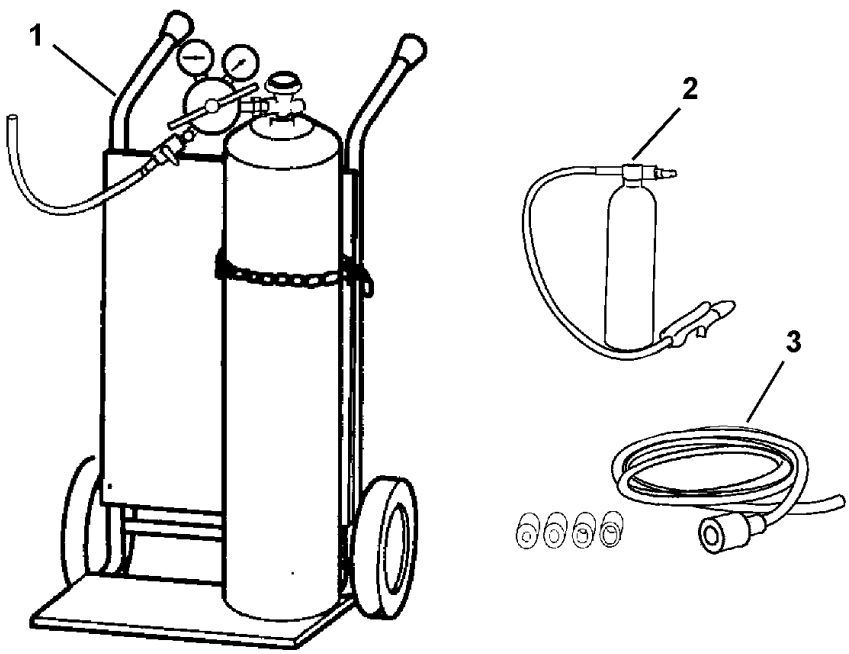



**Figure 82 Service Tools that may be Obtained Locally**

1. Nitrogen Cylinder, Regulator and Cart
2. Flush Gun
3. Drain Hose with Compression Fitting and Adapters

## 18.1. RECOVERY/RECYCLING/RECHARGING STATION

The Recovery/Recycling/Recharging Station (ZTSE4615) for R-134a is a totally integrated A/C service system, which recovers, recycles, evacuates, and recharges R-134a quickly and accurately (refer to Figure 83).

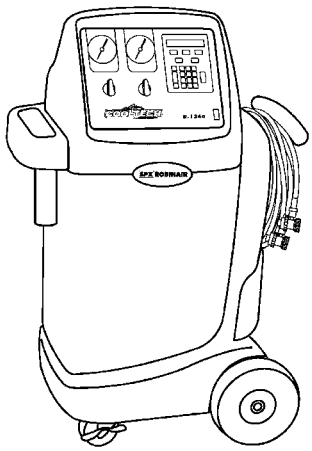


**Figure 83 Recovery/Recycling and Charging Station, ZTSE4615**

With its built-in manifold, all A/C service work is done with one hookup. The unit is programmed at its panel-mounted keypad. Computerized controls and solenoids precisely monitor evacuation and charging time. It is designed to automatically shut off after the recovery cycle. A moisture indicator will change from yellow to green when recycling is complete.

## 18.2. MANIFOLD AND GAUGE SET

The manifold gauge set (ZTSE4623) for R-134a systems consists of the necessary pressure and vacuum gauges, and control valves and fittings for evacuating and charging air conditioner systems (refer to Figure 84). The unit features sidewheel style, color-coded valve handles, 63.5 mm (2.5 inch) vibration-free gauges, hose holders, a hanging hook, and two 183 cm (72 in) color-coded hoses with Metric SAE quick-disconnect fittings (with valves). The hose connection fittings on the manifold gauge set have Acme threads.

**IMPORTANT –** The manifold gauge set and service hoses **must be dedicated** to R-134a.

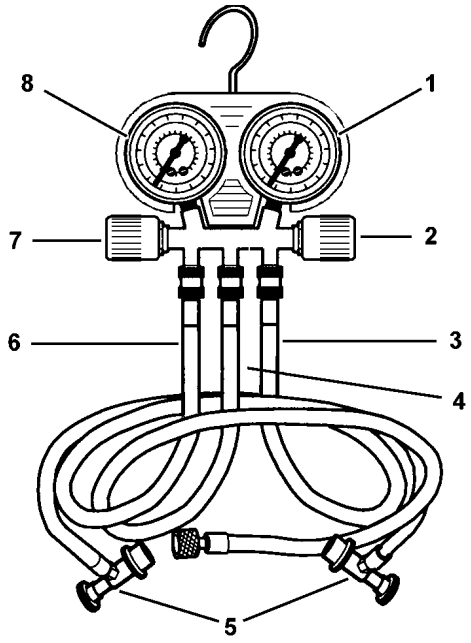



**Figure 84 Manifold and Gauge Set (Shown with Hose Set and Quick-Disconnect Fittings)**

1. HIGH PRESSURE GAUGE
2. HIGH PRESSURE VALVE
3. HIGH PRESSURE HOSE (RED)
4. SERVICE HOSE (YELLOW)
5. METRIC SAE QUICK CONNECT FITTINGS
6. LOW PRESSURE HOSE (BLUE)
7. LOW PRESSURE VALVE
8. LOW PRESSURE GAUGE

## 18.3. ELECTRONIC VACUUM GAUGE AND MANIFOLD

Before recharging the A/C refrigerant system, a vacuum must be drawn in the system to boil away all of the moisture in the system. A vacuum level of 500 to 1000 microns is sufficient to evacuate the system and remove all of the moisture. An accurate way to measure a vacuum at these levels is with an electronic vacuum gauge (refer to Figure 85). The electronic vacuum gauge (ZTSE4620) measures vacuum levels from 10 to 20,000 microns in twenty steps.

The vacuum gauge is susceptible to damage from high pressures. Therefore, it must be connected to the recovery station through a manifold that allows the gauge to be isolated from the recovery station low pressure line when high pressures are present (refer to Figure 86).

**CAUTION – Close the valve on the electronic vacuum gauge manifold before recharging the A/C system.**

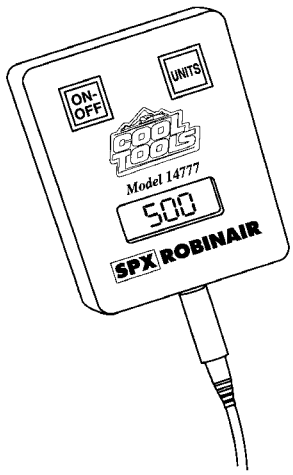



**Figure 85 Electronic Vacuum Gauge, ZTSE4620**

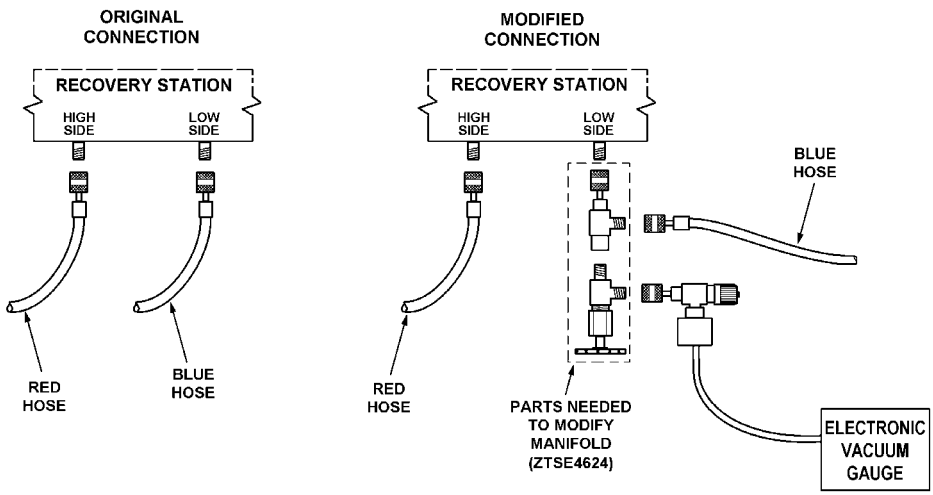



**Figure 86 Electronic Vacuum Gauge Manifold, ZTSE4624**

## 18.4. REFRIGERANT IDENTIFIER

In today's environment there are a lot of alternative and blended refrigerants; International only recognizes R-134a for this A/C system. The only way to know for sure if you can safely recover the refrigerant in an A/C system is through the use of a refrigerant identifier (refer to Figure 87). The refrigerant identifier (ZTSE4616) samples the refrigerant; then displays the type and purity of the refrigerant in the system. The refrigerant identifier is supplied as part of a kit which includes the necessary hoses and fittings.

**CAUTION – When red spots or discoloration begins to appear on the white outside diameter of the filter element, THE FILTER MUST BE REPLACED. Failure to properly maintain the sample filter may result in severe instrument damage that is not covered under warranty repairs.**

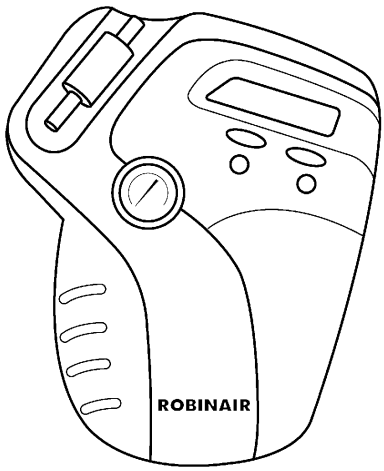



**Figure 87 Refrigerant Identifier, ZTSE4616**

## 18.5. ELECTRONIC LEAK DETECTOR

Electronic Leak Detector (ZTSE4617) detects leaks in air conditioning systems by utilizing 100 per cent solid state electronic circuitry (refer to Figure 88). An LED provides a low battery warning. The LED also indicates when calibration is accomplished without the usual, inconvenient, external reference leak source. An audio leak indicator ensures efficient operation even in bright sunlight. The power source is four "AA" alkaline batteries. This detector may be used for both R-12 and R-134a systems.

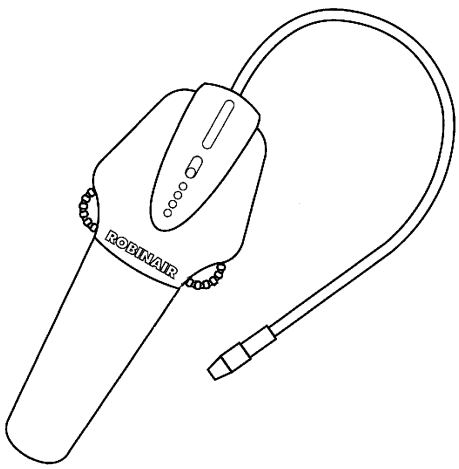



**Figure 88 Electronic Leak Detector, ZTSE4617**

## 18.6. ULTRAVIOLET LAMP LEAK DETECTOR

An ultraviolet leak detector is used with phosphor dye to detect very minute leaks. Leak Detector (ZTSE4618) is for use under all ambient lighting conditions, **except** direct sunlight (refer to Figure 89). It uses a special self-ballasted bulb, which eliminates the need for an external transformer. When this light is shined on a suspected area, leaking refrigerant will be visible as a bright yellow-green glow. The leak detector kit includes the accessories needed to inject dye into other systems.

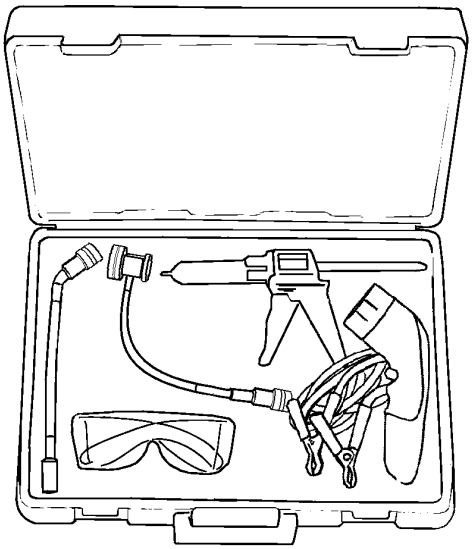


**Figure 89 Ultraviolet Lamp Leak Detector, ZTSE4618**

## 18.7. FLUSH GUN

If the refrigerant system has been contaminated, such as due to an internal compressor failure, it must be flushed and purged before it can be repaired and recharged. A flush gun (refer to Figure 90) is used, along with compressed dry nitrogen, to force a flushing agent through the hoses and components of the refrigerant system. The flush gun and drain hose with compression fitting/adapter can be obtained locally.

> **WARNING – The nitrogen supplied to the flush gun must not exceed 75 psi.**

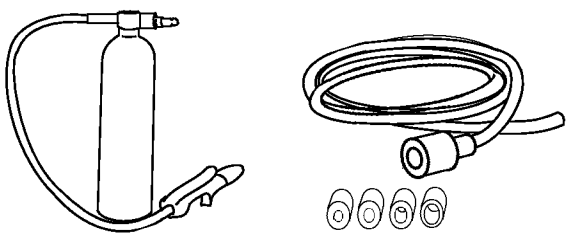


**Figure 90 Flush Gun and Drain Hose (Obtain Locally)**

## 18.8. DIGITAL THERMOMETER

Two thermometers are needed for A/C system testing and diagnostics. Digital thermometers provide a simple and accurate means of measuring air temperature (refer to Figure 91).

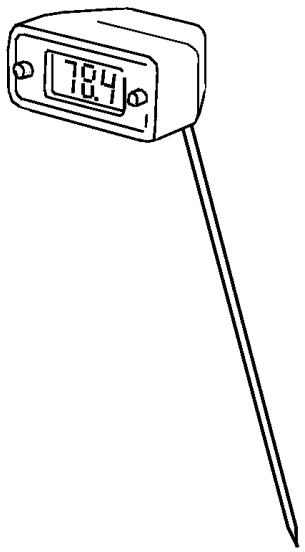



**Figure 91 Digital Thermometer, ZTSE4619**

## 18.9. BLOCK FITTING ADAPTERS

When performing flushing and/or purging operations, adapters are required to connect the service equipment to the HVAC system components (refer to Figure 92). The minimum quantities of each adapter, required to service the HVAC system, are indicated in the figure callout list.

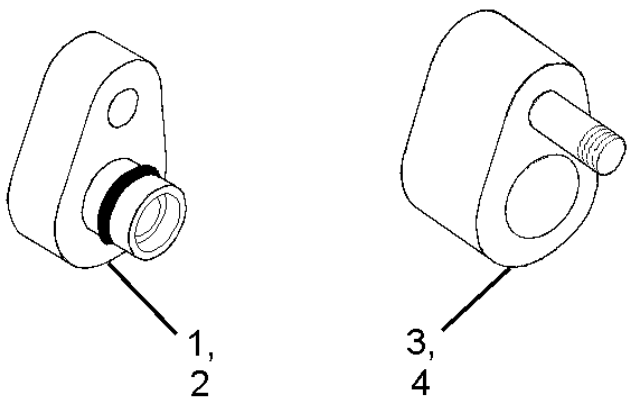



**Figure 92 Block Fitting Adapters**

1. MALE ADAPTER (1/2 INCH), ZTSE4503 (Minimum Required Quantity: 2)
2. MALE ADAPTER (3/4 INCH), ZTSE4501 (Minimum Required Quantity: 1)
3. FEMALE ADAPTER (1/2 INCH), ZTSE4504 (Minimum Required Quantity: 2)
4. FEMALE ADAPTER (3/4 INCH), ZTSE4502 (Minimum Required Quantity: 2)

## 18.10. ELECTRONIC SERVICE TOOL (EST), EZ-TECH

The EZ-Tech electronic service tool (refer to Figure 93), running diagnostic software allows the servicer to monitor the HVAC electrical circuits. The EZ-Tech is connected to the vehicle diagnostic connector through an interface communications cable. When used in conjunction with the electrical troubleshooting manual, the EZ-Tech allows the servicer to isolate electrical faults efficiently. See the diagnostic software manual for details on using the software.

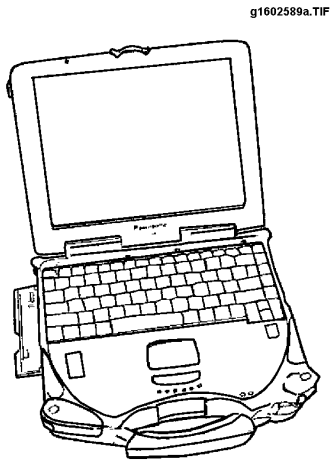



**Figure 93 Electronic Service Tool, EZ-Tech**

# 19. GLOSSARY

Refer to the following terms for a better understanding of the heater/air conditioning system.

- ACCUMULATOR - A combination desiccant, filter, and storage container for liquid refrigerant.
- ACTUATOR - An electrical device that performs a mechanical action based on an electrical input, (similar to a servo motor).
- AIR CONDITIONER - A device used to control the temperature, humidity, cleanliness and movement of air.
- AIR PRESSURE - The pressure exerted in every direction at any given point. Normal atmospheric pressure (that is, the pressure caused by the weight of the atmosphere) at sea level is 101.60 kPa (14.696 psi).
- AMBIENT AIR TEMPERATURE - The temperature of air around an object; the outside temperature.
- BLOWER - A motor and fan used to draw air through the evaporator, and force it through the heater core and into the cab.
- LINEAR POWER MODULE - An electrical module that controls the amount of voltage going to the blower motor, based on an input signal from the HVAC control head panel (and blower speed control). The amount of voltage going to the blower motor determines the speed of the blower.
- BOILING POINT - The temperature at which a liquid changes to a gas, at a certain pressure.
- BULK CHARGING - Use of large containers of refrigerant for charging a refrigerant system. Normally used for charging empty systems.
- CFM - Cubic feet per minute. The metric equivalent of one CFM is 28.3 Liters per minute.
- CHARGE - A specific amount of refrigerant or oil by volume or weight. Also, the act of placing an amount of refrigerant or oil into the air conditioning system.
- COLD - The absence of heat. (The lowest possible temperature is believed to be -273 degrees C (-459 degrees F).
- COMPRESSOR - An assembly used to draw low pressure, low temperature refrigerant gas from the evaporator and squeeze it into a high pressure, high temperature gas. This causes the refrigerant to have a higher temperature than the surrounding air, allowing the condenser to change the gas back into a liquid. A secondary purpose of the compressor is to move refrigerant and oil through the system.
- CONDENSATE - Water, taken from the air, which forms (condenses) on the outer surface of the evaporator.
- CONDENSER - A heat exchanger that is used to remove heat from refrigerant, changing it from a high temperature, high pressure gas into a high temperature, high pressure liquid.
- CONTAMINANTS - Anything other than refrigerant or refrigerant oil in the system. Usually means water in the system.
- DEHUMIDIFY - To remove water from the air, at the evaporator coils.
- DESICCANT - A drying agent used in the refrigerant system (in the accumulator) to remove moisture.
- DISCHARGE - To remove some or all of the refrigerant from the air conditioning system using a recovery/recycling station.
- DISCHARGE LINE - Connects the refrigerant compressor outlet to the condenser inlet. (High pressure line).
- DISCHARGE PRESSURE - Pressure of the refrigerant leaving the compressor; high side pressure.
- DISCHARGE SERVICE PORT - A fitting that is located in the system on the discharge (high pressure) side of the compressor. It allows the connection of service equipment for monitoring high side pressure and for performing other service related tasks.

- DRYING AGENT - See "Desiccant."
- EVACUATE - Evacuation pumps the contents out of the refrigerant system, creating a vacuum. It dehydrates all traces of moisture and is used to determine if the system has any leaks before installing a charge of refrigerant in the system.
- EVAPORATE - A change of state from a liquid to a gas.
- EVAPORATOR CORE - A component of the air conditioning system in which liquid refrigerant changes to a gas after it absorbs heat from the air. Also collects cab moisture.
- FLUSHING - A process of forcing a solvent through a refrigerant part to remove dirt and contaminants. Flushing is used to remove heavy contamination, such as gritty oil and large dirt buildup, that cannot be removed by purging.
- FREEZE-UP - Failure of a unit to operate properly because of ice forming at the orifice tube orifice or on the evaporator coils or fins.
- HEAD PRESSURE - Refrigerant pressure from the discharge side of the compressor to the condenser and orifice tube.
- HUMIDITY - The amount of water vapor in the air.
- LEAK DETECTOR - A device used to detect a leak in the air conditioning system.
- LOW SUCTION PRESSURE - Low side pressure that is lower than normal due to a system problem.
- MAGNETIC CLUTCH - An electrical coupling device used to engage or disengage the refrigerant compressor.
- MANIFOLD GAUGE SET - A manifold that is complete with gauges and charging hoses and used to measure or test pressure.
- MICRON - A metric measurement of mercury equal to one-thousandth of one millimeter. Therefore, one-tenth of an inch of mercury equals 2540 microns. Measurement in microns is the only accurate way to determine the amount of pressure that is left in a refrigerant system by a high vacuum pump.
- MINERAL BASED OIL - A type of oil used on seals and O-rings in A/C systems to lubricate them and keep them from drying out.
- NITROGEN - A colorless, odorless, dry, inert gas that can be used to purge light contaminants from air conditioning parts.
- ORIFICE TUBE - A device that causes a pressure drop of the refrigerant and also regulates flow.
- OVERCHARGED - Too much refrigerant or oil in the system.
- PAG OIL - A specific type of oil carried by the refrigerant and used to lubricate the components of some A/C systems.
- PRESSURE TRANSDUCER - A device with electrical characteristics that vary according to the pressure it senses.
- PULSE WIDTH MODULATION - A type of electrical signal that uses pulses to represent specific values.
- PURGE - To remove damp air, traces of refrigerant, and loose dirt from a system part by blowing pressurized dry nitrogen through the part.
- REFRIGERANT (R-134a) - The cooling agent used in automotive air conditioning systems.
- REFRIGERATION CYCLE - The complete circulation of refrigerant through an air conditioning system, accompanied by changes in temperature and pressure.
- SUCTION PRESSURE - Compressor inlet pressure (the system low side pressure).

- SUCTION SIDE SERVICE PORT - A fitting that is located in the system on the suction (low pressure) side of the compressor. It allows the connection of service equipment for monitoring low side pressure and for performing other service related tasks.
- THERMISTOR - A device, used as an sensor for an electrical circuit, that changes its apparent resistance based on the temperature it senses.
- THERMOSTATIC VACUUM GAUGE - A high vacuum gauge sensitive to pressures ranging from atmospheric pressure to less than 1 micron, with scales reading from 25,000 microns to 1 micron.
- VACUUM - Refers to pressure that is less than atmospheric pressure.
- VACUUM PUMP - A mechanical device used to evacuate and place a high vacuum in the refrigerant system.
- VAPOR - The gaseous state of material.

# 20. TROUBLESHOOTING QUICK TIPS

**IMPORTANT –** The Refrigerant Control and Diagnostic (RCD) System is the software used by the Electrical System Controller (ESC) to control the A/C system. The ESC software is continually being improved and revised. If an invalid DTC has been set, reflash (update) the ESC software to the latest revision. Refer to TABLE 3 (See Table 3, page 27). If no invalid DTC's have been set, do not reflash the ESC unnecessarily. Contact Technical Services at 1-800-336-4500 to determine if reflashing the ESC is necessary.

Generally, this section should be referenced only after attempting to troubleshoot the A/C system according to the instructions in SECTION 5 (See DIAGNOSIS AND TROUBLESHOOTING, page 21). As stated in that section, the first steps in troubleshooting the HVAC system should always be:

1. Retrieve and record all active and/or inactive Diagnostic Trouble Codes (DTC's) through the LCD readout on the Gauge Cluster.
2. If DTC's are present, locate the DTC in TABLE 3 and follow the instructions.
3. If DTC's are NOT present, locate the symptom that describes the system malfunction in TABLE 4 (See Table 4, page 32), and follow the instructions.

If, after performing the indicated troubleshooting procedures, the HVAC system is still not performing correctly, review the information in this section. Before calling Technical Services perform the procedures in SECTION 20.3. **(Record all measurements and indications. These will be helpful to Technical Services when they are contacted.)**

This section contains the following information:

- an abbreviated list of HVAC system operating parameters that may be useful during troubleshooting,
- a list of some of the more common conditions that prevent normal A/C system operation,
- a list of the measurements and tests that should be performed before contacting Technical Services for help in troubleshooting the HVAC system.

## 20.1. HVAC SYSTEM OPERATING PARAMETERS

This section contains an abbreviated list of HVAC system operating parameters. These parameters can be monitored to troubleshoot the A/C system using the EZ-Tech with the diagnostic program.

A. The following conditions are required for A/C system activation:

- the engine must be running.
- the HVAC controls must be set for A/C operation (A/C mode selected and Fan control NOT set to OFF).
- there must not be any active “loss of engine” DTC’s.
- there must not be any active A/C DTC’s, other than single actuator motor codes.

B. Engine fan operational parameters (with optional on-off fan drive):

- fan turn on pressure (at A/C system pressure transducer) – 285 psi
- fan turn off pressure (at A/C system pressure transducer) – 185 psi
- minimum fan on time – 60 sec.

C. A/C system (compressor) cycle times:

- minimum A/C compressor on time – 7 sec.
- minimum A/C compressor off time – 8 sec.

D. Table 45 lists the conditions required for A/C compressor clutch engagement and disengagement.

**Table 45 Conditions Required for A/C Compressor Clutch Engagement/Disengagement**

| A/C PARAMETER | CLUTCH CAN ENGAGE # | CLUTCH WILL DISENGAGE ## |
|---|---|---|
| A/C Output Thermistor | >33°F | <24°F ** |
| A/C Input Thermistor | >43°F | <30°F |
| A/C Pressure Transducer | between 40 and 250 psi. | >400 psi. |
| # Clutch will engage if all listed parameters are within specified levels, and all other required conditions are met.<br><br>## Clutch will disengage if any listed parameter is not within the specified level.<br><br>** On vehicles built 10/9/01 and after. If evaporator freeze up occurs on vehicles built before 10/9/01, reset parameter 1942 (outlet temperature) to 24 degrees F. | | |

## 20.2. COMMON CONDITIONS THAT CAUSE POOR OR NO A/C OPERATION

This section lists some of the more common conditions encountered with malfunctioning HVAC systems.

A. If the AC Request line (wire A77) is open from the HVAC control head to the ESC, the A/C system will not operate and a DTC will not be set by the ESC. **Check for this condition using the EZ-Tech (see SECTION 20.3 or SECTION 9).**

B. If a thermistor value is displayed as 0 (zero) in the diagnostic software, check the thermistor wiring for an open circuit. (This could also be caused by corrosion on the thermistor connector contacts.) Note the thermistor DTC, if one is set; then, refer to SECTION 15 (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201) to troubleshoot the thermistor circuits.

**NOTE: If the electrical connection to either thermistor is suspected of being intermittent, perform the THERMISTOR CONNECTOR REPAIR procedures (See THERMISTOR CONNECTOR REPAIR, page 209).**

C. If the thermistor value is displayed as NA in the diagnostic software, check the thermistor wiring for a short to ground. Note the thermistor DTC, if one is set; then, refer to SECTION 15 (See AC REFRIGERANT THERMISTOR CIRCUITS, page 201) to troubleshoot the thermistor circuits.

D. The high head pressure DTC (613-14A-1-10) will activate when the pressure transducer measures 400 psi if vehicle speed is over 20 mph. Refer to SECTION 8.1 (See Refrigerant Control and Diagnostic (RCD) System, page 150) for a more complete understanding of the pressure transducer circuit. Refer to TABLE 12 (See Table 12, page 47) to troubleshoot a high head pressure condition.

E. On some vehicles it was possible for DTC 613-14A-1-6 (Marginal Charge) to be set and latched when there was no malfunction. With the current ESC software version, this is now an invalid code. If this code is being displayed, refer to DTC 613-14-1-6 in TABLE 3 (See Table 3, page 27) for instructions on how to proceed.

   To clear a latched, active HVAC code (such as 613-14A-1-6):

   1. Turn the HVAC Fan control to OFF.
   2. Using the Cruise Control switches place the ESC into diagnostic mode to display the DTC's. Refer to DIAGNOSTIC TROUBLE CODES (See Diagnostic Trouble Codes, page 23).
   3. Clear the inactive DTC's.
   4. Cycle the ignition switch off and then back on.
   5. Place the ESC into the diagnostic mode again. The HVAC code should now be inactive.
   6. Clear the inactive DTC's.

F. Excessive oil in the system will cause the system to not operate properly, and too little oil can damage the compressor. When performing any service that requires charging the system, carefully follow the procedures in SECTION 7.10 (See OIL FILL GUIDELINES, page 141) to insure that the correct quantity of oil is maintained in the system.

## 20.3. BEFORE YOU CALL TECH SERVICES

If, after performing the troubleshooting procedures in SECTION 5 (See DIAGNOSIS AND TROUBLESHOOTING, page 21) and reviewing the information in this section, the HVAC system is still not performing correctly, proceed with the following steps. **(Record all measurements and indications. These may be helpful to Technical Services if they are contacted.)**

**IMPORTANT –** To perform the following steps, the engine and A/C system must NOT have been run within the last 30 minutes. The temperature of the A/C system MUST BE approximately the same as the ambient temperature.

1. With the engine off, connect a recovery station (with an internal gauge set) to the low and high side A/C service ports. A known good, manual, manifold gauge set may also be used. Refer to Figure 41 (See Figure 41, page 127) and/or Figure 43 (See Figure 43, page 130).

2. To determine if the A/C system is undercharged; or, if there is air or a non-condensable gas in the A/C system:

   a. Determine (and record) the ambient temperature (within a degree or two).

b. Record the system pressures indicated on the high and low gauges connected to the A/C system. Both gauges should read close to the same value when the truck is not running.

c. Compare the pressure readings recorded in the last step to the pressures shown in TABLE 46. (The table is part of the Performance AC Chart TMT-3416.)

d. If the pressure on the gauges is more than 10 psig higher than the pressure listed in the chart, the A/C system contains air or some non-condensable gas in the refrigerant system. The system needs to be discharged, evacuated, and recharged using a recovery system. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).

EXAMPLE: If the ambient is 75°F, the A/C system pressure should be in the 78–79 psig range. If the pressure is 90 psig or higher it indicates that there is air or some non-condensable gas in the system.

**NOTE – A refrigerant identifier can also be used to verify the contents of the A/C system. Refer to SECTION 7.3 (See REFRIGERANT IDENTIFICATION, page 124).**

e. If the pressure on the gauges is more than 10 psig lower than the pressure listed in the chart, the system is undercharged. The system needs to be discharged, evacuated, and recharged using a recovery system. Undercharged systems should be inspected for a possible leak before being discharged. Refer to SECTION 7 (See SERVICE PROCEDURES FOR R-134a, page 119).

3. Connect the EZ-Tech service tool to the vehicle's diagnostic connector.

4. To evaluate the A/C system performance using the diagnostic program, perform the following steps:

a. Without starting the engine, turn the ignition key ON.

b. Open the diagnostic program.

c. Set the program to monitor the following signals, then record their values:

- the A/C Input Temp Sensor (thermistor)
- the A/C Output Temp Sensor (thermistor)
- the A/C Pressure Sensor (transducer).

d. From the gauges connected to the A/C system, record the system pressures.

e. Set the HVAC Mode control to the Normal A/C position. Using the diagnostic program, monitor and record the A/C Request signal while switching the HVAC Fan control between OFF and any other position. The A/C Request signal should be OFF when the Fan control is OFF, and ON when the Fan control is in any other position. If the signal is not functioning correctly, refer to SECTION 9 (See HVAC CONTROL HEAD CIRCUITS, page 157) to troubleshoot the circuit.

f. If the recorded thermistor values are not within 5 degrees of each other, refer to TABLE 10 (See Table 10, page 43) to troubleshoot the circuit.

g. If the recorded pressure transducer value is not within 20 psig of the gauges, refer to SECTION 16 (See AC PRESSURE TRANSDUCER CIRCUIT, page 212) to troubleshoot the circuit.

**Table 46 System Pressure Versus Ambient Temperature**

| Temperature °F | R134A PSIG | Temperature °F | R134A PSIG |
|---|---|---|---|
| 40 | 35.07 | 80 | 86.99 |
| 45 | 40.07 | 85 | 95.23 |
| 50 | 45.46 | 90 | 104.3 |

**Table 46 System Pressure Versus Ambient Temperature (cont.)**

| | | | |
|---|---|---|---|
| 55 | 51.23 | 95 | 113.93 |
| 60 | 57.42 | 100 | 124.12 |
| 65 | 64.04 | 105 | 134.92 |
| 70 | 71.11 | 110 | 146.33 |
| 75 | 78.66 | | |

5. Perform the A/C System Performance Test in SECTION 5.3 (See A/C SYSTEM PERFORMANCE TEST PROCEDURE, page 35) and record the readings.

6. If further assistance is still needed, contact Technical Service with all recorded results.