Air Delivery Description and Operation

The air delivery description and operation are divided into 3 areas:

- HVAC Control Components
- Air Speed
- Air Delivery

HVAC Control Components

The HVAC control assembly is a non-class 2 device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The HVAC unit is operated manually by a combination of electrical, mechanical and vacuum components. The case is of a 4-piece, plastic construction. The front and rear housing are assembled without the use of any fasteners. The front housing clips over the rear housing at 6 locations. Two equally sized recirculation doors are used to control airflow into the HVAC unit. Two air mix doors are used to control the airflow through the heater core. A single door is used to control airflow to the front defrost, floor and panel outlets. All doors excluding the air mix doors are vacuum operated. The air mix doors are operated mechanically. The blower motor/fan assembly, blower motor resistor, heater core and evaporator are all contained within the HVAC case. A vacuum tank is mounted to the left side of the case. Four externally mounted vacuum actuators are used to provide the selected ventilation modes. Contained within this assembly is a printed circuit board retained within the rear housing. Attached to the back of the rear housing are the following components:

- Water valve vacuum switch for water valve control/heater core flow
- Mode switch vacuum valve for operation of the HVAC vacuum actuators/doors
- Pinion and crescent gear for mechanical actuation of the water valve vacuum switch and HVAC air mix doors
- Electrical switch/connector for blower fan operation
- Electrical connector for illumination and A/C and heated rear window switching

All of these items, except the LED, A/C and heated rear window electrical connector, are removable from the rear housing. The illumination, A/C and heated rear window electrical connector is bonded to the printed circuit board. There are no replaceable bulbs contained within the unit. Five LEDs provide the necessary illumination. If an LED fails to function, the printed circuit board must be replaced. Individually serviced components are the water valve vacuum switch, the mode switch vacuum valve and the air mix door rod retainer. The 3 rotary switches and the front housing are serviced as a unit.

HVAC Switches

The HVAC control assembly contains the following switches:

A/C Switch

The A/C switch is located at the bottom of the blower fan rotary switch. With the blower fan operating, push the A/C button once. The A/C indicator lamp will illuminate, and the A/C

compressor will engage. Push the A/C button again. The A/C indicator lamp will extinguish, and the A/C compressor will disengage. Turning the blower fan to the OFF position will also cause the A/C indicator lamp to extinguish and the A/C compressor to disengage.

Rear Defogger Switch

The rear defogger switch is located at the bottom of the mode control switch. Push the rear defogger button once. The indicator lamp will illuminate, and the rear defogger window element will heat up. After 15 minutes the rear defogger will automatically turn OFF. To reactivate the rear defogger, push the button again. This will turn ON the rear defogger for another 15 minutes.

Blower Fan Switch

Four blower fan speeds are available. A fan speed must be selected before the A/C system can be engaged. The fan is in the OFF position when the indicator light is aligned with the fan symbol.

Temperature Control

The temperature control is connected via a rod and levers to the air mix doors at the HVAC case. The air mix doors control the amount of incoming air flowing through the heater core, in accordance with the selected cabin temperature. This regulates the amount of heated air mixing with the unheated or air conditioned air. The heater water valve is held in the closed position by vacuum generated by the engine. When the third detent is selected from the full cold position via the temperature control, the water valve vacuum switch located on the rear of the HVAC controller is activated and the vacuum line to the water valve is vented. This allows hot water to flow into the heater core and subsequent heating of the vehicle cabin.

Air Speed

Blower Motor and Fan

The blower motor draws air from the plenum chamber and circulates the air through the vehicle's interior. The vehicle operator determines the blower motor's speed by rotating the blower motor switch manually. The blower motor will only operate if the blower motor switch is in any position other than OFF, as long as the ignition switch is in the RUN position. The blower motor and mode switches are located within the HVAC control unit. The blower motor is housed in the blower case which is located behind the right side of the instrument panel. To provide the different fan speeds a resistor block consisting of 3 resistors contained within a ceramic heat sink is wired into the blower motor circuit.

Blower Circuit

The blower circuit consists of the following components:

- Blower Motor
- Blower Motor Switch
- Blower Motor Resistor
- Blower Relay
- Blower Inhibit Relay

The blower motor receives battery voltage through the Blower Fan fuse at all times. An additional 30-amp blade type fuse is fitted at the blower motor to protect the blower motor circuitry. The blower motor is provided a path to ground in speeds 1 , 2 , and 3, through the blower resistor, through the blower switch, through the closed contacts of the blower inhibit relay to SP100 and G102. In high speed, the blower motor is provided a path to ground through the closed contacts of the blower relay to SP100 and G102. The blower motor speed is maintained by controlling the voltage potential to the blower motor. This is achieved by increasing or decreasing the resistance within the blower motors ground path.

The blower motor switch receives power through the Heated Rear Window, HVAC and Instruments fuse when the ignition switch is in the RUN position. Ground is provided when the blower inhibit relay is energized.

The coil side of the blower inhibit relay receives ignition voltage through the Heated Rear Window, HVAC and Instruments fuse when the ignition switch is in the RUN position. The coil side and the switch side of the blower inhibit relay are permanently grounded at SP100 and G102. When the blower inhibit relay is energized, a ground path is provided to the blower switch for all blower speeds.

The coil side of the blower relay receives battery voltage through the Heated Rear Window fuse at all times. When the blower switch is in the HIGH position, the coil of the blower relay is provided a path to ground through the high speed contacts of the blower switch, through the closed switch contacts of the blower inhibit relay to SP100 and G102. This energizes the blower relay and provides the blower motor with a direct path to ground through the closed contacts of the blower relay to SP100 and G102.

Low Blower Speed

When the Low blower speed is selected, battery voltage is applied to the blower motor through the Blower Fan fuse supply voltage circuit. Voltage is decreased through 3 series resistors to achieve the desired blower speed. The blower motor is grounded through the low speed contacts of the blower motor switch, through the closed switch contacts of the blower inhibit relay to SP100 and G102. A blower ON signal is provided to the body control module (BCM) in low speed only.

Medium Blower Speeds

When the Medium 1 blower speed is selected, battery voltage is applied to the blower motor through the Blower Fan fuse supply voltage circuit. Voltage is decreased through 2 series resistors to achieve the desired blower speed. The blower motor is grounded through the low speed contacts of the blower motor switch, through the closed switch contacts of the blower inhibit relay to SP100 and G102.

When the Medium 2 blower speed is selected, battery voltage is applied to the blower motor through the Blower Fan fuse supply voltage circuit. Voltage is decreased through 1 series resistors to achieve the desired blower speed. The blower motor is grounded through the low speed contacts of the blower motor switch, through the closed switch contacts of the blower inhibit relay to SP100 and G102.

High Blower Speed

When the High blower speed is selected, battery voltage is applied to the blower motor through the through the Blower Fan fuse supply voltage circuit. When the blower switch is in the HIGH position, the coil of the blower relay is provided a path to ground through the high speed contacts of the

blower switch, through the closed switch contacts of the blower inhibit relay to SP100 and G102. This energizes the blower relay and provides the blower motor with a direct path to ground by removing the blower motor resistor from the circuit. The blower motor grounds through the closed contacts of the blower relay to SP100 and G102.

OFF

When the blower switch is in the OFF position, any A/C request will be cancelled and the A/C indicator will turn OFF. When the vehicle is moving, air flowing over the vehicle increases the air pressure just ahead of the windshield. This forces air into the HVAC air inlet and out through any desired mode setting.

Air Delivery

The blower fan is mounted within the HVAC case and draws air from the plenum chamber forcing through the evaporator and heater case assembly. Air is then directed out through the various outlets into the vehicle interior at one of 4 speeds as selected on the fan switch. The center and side ventilation outlets can be turned ON or OFF and are directionally adjustable. Turning OFF these outlets will increase airflow to the rear outlets once suitable comfort levels are achieved by front occupants. The rear outlets can also be turned ON or OFF and are directionally adjustable. The A/C system is switched OFF or ON by the A/C switch located within the blower fan switch on the left side of the controller. A blower fan speed must be selected before the A/C system will function. Outside air is used in all mode positions except when recirculate is selected. This mode can be selected via the mode control switch and is used to close off the vehicle interior from any outside air. When the recirculation mode is selected, air will flow from the center and side ventilation outlets which are generally referred to as panel vents. Recirculation mode is normally selected for:

- Quicker cooling down of the vehicle interior especially after the vehicle has been parked in direct sunlight for an extended period of time
- Reducing heat up time as no cooler outside air can flow into the vehicle interior
- Driving on unsealed roads to prevent dust entering the vehicle interior
- Driving a vehicle for extended periods in the recirculation mode may impair driving performance due to the lack of fresh air into the vehicle

Air Inlet

Air enters the vehicle at the plenum chamber located at the base of the windshield under the plenum cover. To prevent the entry of foreign matter into the HVAC unit, a removable, rectangular piece of stainless steel mesh is installed around the inner perimeter of the inlet.

Ducts

Air that is directed to the sides and rear of the cabin is channelled through plastic ducts attached to the sides and front of the HVAC case. Air leaving the side ducts is channelled through the left and right side instrument panel outer covers and exits through air outlets installed into the front door trims. Air entering the front doors is also directed into side window defogging outlets installed as part of the front door trims and the window frame finishing trims. Air to the rear outlets is channelled through a 2-piece rear duct installed inside of the center floor console on the left side. Air leaving this duct is divided into 2 paths by the rear ventilation outlet. The center panel outlet is installed directly to the HVAC unit center instrument bezel. Air directed to the floor is channelled through a detachable foot duct located on the underside of the HVAC unit. From the HVAC unit, air

for defogging of the windscreen enters directly into a cavity formed by the instrument panel assembly under the instrument panel pad. This air is then directed through eight openings located in the upper instrument panel, and exits through the defroster grilles installed to the top of the instrument panel pad on the left and right sides.

Body Ventilation Outlets

To allow the HVAC system to operate efficiently air must be allowed to enter and leave the vehicle even when the cabin is sealed, i.e. all movable windows are fully up. This is achieved by the installation body mounted ventilation outlets. Each outlet consists of a fluted plastic housing containing 2 flexible rubber seals. When positive cabin air pressure acts upon the seals, they will deflect outward to allow air to exit the vehicle. Air may only exit and not enter the vehicle via the body ventilation outlets. The ventilation outlet housing is retained to the body panel by 4 locking tabs located at each corner. Although not a regular maintenance item, the body outlets can be removed to clear away any dust or foreign matter that may impede them from operating efficiently. This is important for reasons of dust exclusion (outlets not sealing) or over pressurization of the cabin (outlets obstructed) causing poor HVAC system performance. The body ventilation outlets fulfil an additional function in allowing the doors or rear compartment lid to be closed without exerting undue air pressure upon the windows and dust seals of the vehicle. The body ventilation outlets are installed behind the rear bumper bar fascia. Two on the left side and one on the right side. Air moves from the cabin to the rear compartment via air grilles in the rear parcel tray and then to the outlets.

Vacuum Actuators

All ventilation doors on the HVAC unit, excluding the air mix doors, are opened and closed by vacuum actuators. These may be single stage or 2 stage type actuators. All actuators, excluding the panel actuator, have a composite metal and plastic housing with metal actuating rods. The panel actuator is the only 2 stage actuator and has an all metal housing and metal actuating rod.

Single Stage Vacuum Actuator - Operation

Each single stage actuator consists of a vacuum housing containing a spring, rubber diaphragm, and an actuating rod. When vacuum is applied to actuator the rubber diaphragm is pulled back, compressing the spring and retracting the actuating rod which is connected via one or more levers to an air distribution door. When vacuum is removed, the spring pushes the diaphragm and actuating rod back to its original position.

Two Stage Vacuum Actuator - Operation

The HVAC unit has doors that are required to open half way while another door closes fully. With normal single stage vacuum actuators this would require a complicated linkage set-up and additional actuators. To overcome this situation 2-stage actuators are used. Through their design they can move the actuating rod fully (2nd stage), half way (1st stage) and fully extended (no vacuum). This enables some doors housed within the HVAC unit to be only half open when a blend mode is selected, and other doors to be closed at the same time via another actuator. When vacuum is directed to the 1st stage vacuum port only the 1st stage rubber diaphragm is pulled (towards the rear of the housing), moving the actuator rod only half way. Once the 2nd and 1st stage ports have vacuum applied, both diaphragms are pulled towards the rear of the housing moving the actuator rod fully inwards to the 2nd stage. The extent of actuator rod travel in either 1st or 2nd stage is governed by compressing 2 springs on each vacuum diaphragm. Both these springs are of differing tensions.

Vacuum Tank

The vacuum tank is located on the left side of the HVAC case. This tank is used to maintain a vacuum to the vacuum actuators, which operate the different vent positions, during driving situations where the vacuum source is low such as full engine throttle. A one way check valve is located in the vacuum source line from the inlet manifold. Two vacuum lines are attached to the vacuum tank. The vacuum line located towards the front of the vehicle is the vacuum supply line from the engine inlet manifold. The vacuum line located towards the rear of the vehicle is the vacuum feed to the to the mode switch vacuum valve and the water valve vacuum switch mounted to the rear of the HVAC controller.

Vacuum Circuit

The vacuum generated within the engine inlet manifold is used to operate the HVAC vacuum actuators and the water valve. A vacuum tank located on the left side of the HVAC case is used to store vacuum for times when engine vacuum is low such as at full engine throttle. A check valve is fitted on the vacuum supply line between the inlet manifold and the vacuum tank to ensure that vacuum is maintained within the system at all times. The black plastic vacuum supply line on the HVAC unit supplies vacuum to the vacuum tank. The check valve is used to join the supply line to the hose connected to the inlet manifold. Vacuum from the vacuum tank is then directed through a white colored supply hose to the mode switch for HVAC door operation and from the tee to the water valve vacuum switch for water valve operation. From the water valve vacuum switch, vacuum moves into a orange plastic tube and then connects to the black hose inside the cabin at the instrument panel which in turn is connected to the vacuum operated heater water valve. When vacuum is applied to the water valve, the valve remains closed and no water will flow through the heater core. As the mode switch is turned, vacuum is directed through the mode switch and onto the desired vacuum actuators through different colored plastic tubing. This vacuum will activate the vacuum actuator rod which then moves a vent position door. Vacuum is vented from the vacuum actuator/plastic tube once the vacuum mode switch is turned to another position.

Temperature Door Control

The air mix doors control airflow through the heater core. They are mechanically connected to the temperature control dial at the HVAC controller via a rod, pinion and crescent gear assembly. As the temperature control switch is rotated from Cold to Hot, the air mix doors are moved to direct all or some of the air, depending on the position of the temperature control dial, within the HVAC unit through the heater core. There are 2 air mix doors that operate together to regulate airflow through the heater core. The front air mix door is connected through levers to the actuating rod which in turn is connected to the temperature switch on the HVAC controller. As the temperature switch is rotated the front air mix door is moved simultaneously with the rear air mix door via the relay rod connecting both air mix doors together.

The air mix door function is the only HVAC airflow control not to use a vacuum actuator. An actuating rod provides a mechanical connection between the HVAC controller and the HVAC unit. The rod is installed between the temperature switch mechanism and the air mix door levers. The amount of airflow through the heater core is determined by the degree of opening at the air mix door. When the temperature switch is rotated, the air mix door is opened or closed by the crescent gear pushing or pulling the actuating rod. The rod is attached to the crescent gear by a pivoting rod retainer. The assembled position of the retainer on the actuating rod is adjustable. The retainer must clamp the actuating rod at a specific location if the correct relative positions of the air mix door and temperature switch are to be maintained.

Mode Switch

The MODE switch is a rotary vacuum valve that directly applies vacuum to the appropriate vacuum actuator. Use the MODE switch in order to change the air delivery mode in the vehicle. The following modes are available:

- DEFOG
- FLOOR
- BI-LEVEL
- PANEL
- RECIRCULATION
- FRONT DEFROST

Recirculation

When the driver selects the RECIRCULATION mode, there is no fresh air entry into the vehicle. Air is delivered through the instrument panel outlets and a small amount is delivered to the floor. The plenum chamber (outside air) inlet to the HVAC unit is closed off by the recirculation doors. Interior air is drawn into the HVAC unit through the recirculation inlets by the blower motor fan, and is then forced through the cold evaporator fins. In the coldest position, the air mix doors are positioned to allow all air to bypass the heater core. In the hottest position, the air mix doors are positioned to direct all incoming air through the heater core. The air travels through the open panel door and is then directed out of the HVAC case to the panel vents.

Panel

When the driver selects the PANEL mode, air is delivered through the instrument panel outlets and a small amount is delivered to the floor. The recirculation doors are closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet. Air is drawn into the HVAC unit by the blower motor, and is then forced through the cold evaporator fins. In the coldest position, the air mix doors are positioned to allow all air to bypass the heater core. In the hottest position, the air mix doors are positioned to direct all incoming air through the heater core. The air travels through the open panel door and is then directed through the center and side vents. Vacuum is applied to the mode actuator through the Brown vacuum line, and to the defrost actuator through the Red vacuum line. The mode actuator will retract, opening the panel door. The defroster actuator will retract, closing the defroster door and open the heater door through mechanical linkage.

Bi-Level

When the driver selects the BI-LEVEL mode, cool air is delivered through the instrument panel outlets while warm air is delivered through the floor outlets. The recirculation doors are closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet. Air is drawn into the HVAC unit by the blower motor, and is then forced through the cold evaporator fins. In the coldest position, the air mix doors are positioned to allow all air to bypass the heater core. In the hottest position, the air mix doors are positioned to direct all incoming air through the heater core. The air travels through the half opened panel door and the fully opened foot door. The air is then directed through the center and side vents as well as to the floor ducts. Vacuum is applied to the mode actuator through the Brown and the Blue vacuum lines, and to the defrost actuator through the Red vacuum line. Applying vacuum to both sides of the mode actuator will hold the vent door stationary in the half open position. The defroster actuator will retract, closing the defroster door and open the heater door through mechanical linkage.

Floor

When the driver selects the FLOOR mode, air is delivered through the floor outlets with some toward the windshield and side vents. The recirculation doors are closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet. Air is drawn into the HVAC unit by the blower motor, and is then forced through the cold evaporator fins. In the coldest position, the air mix doors are positioned to allow all air to bypass the heater core. In the hottest position, the air mix doors are positioned to direct all incoming air through the heater core. The air travels through the foot door and is then directed to the floor ducts. Vacuum is applied to the mode actuator through the Blue vacuum line, and to the defrost actuator through the Red vacuum line. The mode actuator retracts, closing the vent door. The defroster actuator will retract, closing the defroster door and open the heater door through mechanical linkage.

Defog

When the driver selects the MIX-BLEND mode, air delivery is divided between the floor and windshield outlets. The recirculation doors are closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet. Air is drawn into the HVAC unit by the blower motor, and is then forced through the cold evaporator fins. In the coldest position, the air mix doors are positioned to allow all air to bypass the heater core. In the hottest position, the air mix doors are positioned to direct all incoming air through the heater core. The air travels through the open front defrost door and floor door. The air is then directed to both the front windscreen and the floor ducts. Vacuum is applied to the mode actuator through the Blue vacuum line, and to the defrost actuator through the Red and the Yellow vacuum lines. The mode actuator will retract, closing the vent door. Applying vacuum to both sides of the defroster actuator will hold the defroster door stationary in the half open position. The heater door will also be held stationary in the half open position through mechanical linkage.

Front Defrost

When the driver selects the FRONT DEFROST mode, air is delivered to the windshield outlets. The recirculation doors are closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet. Air is drawn into the HVAC unit by the blower motor. This air is then forced through the cold evaporator core fins removing moisture from the air. In the hottest position, the air mix doors are positioned to direct this dehumidified incoming air through the heater core. The air travels through the open front defrost door. The heated air is then directed to the front windscreen via the front defrost outlets. By turning on the A/C system in this mode, dehumidification of incoming air will take place, front defrosting the front windscreen and side windows in a shorter period.

DEFAULT MODE

If a total loss of vacuum occurs within the system, the HVAC unit will default to the following settings. These settings will be the same in any position of the mode control switch.

- The recirculation doors will remain closed allowing outside air to enter and flow into the HVAC unit via the plenum chamber inlet
- Heated coolant will flow through the heater core regardless of the position of the temperature switch, because vacuum is required to maintain the water valve in the cold (closed) position
- The front defrost door will be positioned so that all air leaving the HVAC unit will be directed to the front defrost outlets
- The panel door and the floor door will remain closed in any position of the mode switch

- The air mix doors positions will still be determined by the temperature switch because they are controlled by mechanical linkage
- The blower fan will operate as normal