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General Description

Specifications

Refrigerant

DesignationRefrigerant R134A
(HFC134A)**Charge weight**1050 g $\pm$ 50 g**Manufacturer and Type**

ICI Klea or equivalent

Compressor

Type & model

SD-7H15

Configuration

7 cylinder

ManufacturerSanden
155 cm³ per revolution

Compressor Lubricants

Designation

Polyalkylene glycol (PAG)

System Capacity

120-150 ml

Manufacturer and Type

Sanden SP 20

Standard for Recovery, Recharge and Recycle Equipment.

Feature**Requirement**

Recovery rate

0.014-0.062 m³/min. (1.36 kg in 20 minutes)

Cleaning capability

15 ppm moisture; 4000 ppm oil; 330 ppm non-condensable gases in air

Oil separator

With hermetic compressor and automatic oil return

Vacuum pump

2 stage 0.07 -0.127 m³/min.

Filter

Replaceable with moisture indicator

Charge

Selectable charge weight and automatic delivery

Hoses

Dedicated Refrigerant R134A port connections.

Charge pressure

Heating element to increase pressure

Compressor Belt Tension

Type**Condition and range**

Vee belt

All figures apply to a cold belt.

Burroughs method

New belt 578 to 623 N

If tension is below 356 N, reset at 512 to 534 N

Clavis method

New belt 147 to 153 Hz

If tension is below 110 Hz, reset at 132 to 138 Hz

Note: The tension is measured midway between the compressor and crankshaft pulleys. For a new belt, rotate engine three revolutions minimum and then re-check the tension.

Climate Control System

Features

- Refrigerant R134A (Hydro fluorocarbon), non ozone depletory.
- PAG (polyalkylene glycol) synthetic compressor lubricating oil.
- Dedicated and improved compressor for Refrigerant R134A.
- Quick fit and release self sealing charge and discharge ports.
- Triple pressure (Trinary) switch to control the compressor (incorporated into the liquid line).
- Clamp retained 'O' ring seals at the expansion valve and evaporator.
- All aluminium evaporator matrix and pipe work.
- Aluminium receiver-dryer (without sight glass) and HFC dedicated desiccant.
- Parallel flow extended height condenser.
- Single muffler situated in the suction hose.
- Improved electrical system connectors.
- Improved system control panel.
- System Recognition

Identification Features

- Aluminium pipes.
- Large diameter, quick release charge and recovery ports.
- No sight glass.

System Description

The in-car temperature and humidity are regulated by the electronically controlled air conditioning system. The system comprises four subsystems:

- heater matrix, supplied with water from the engine cooling system
- refrigeration
- vacuum
- electronic control

Apart from the ambient temperature sensor and the aspirated in-car temperature sensor, most of the components are housed in the air conditioning unit (Fig. 1) situated behind the dash board, or in the engine compartment.

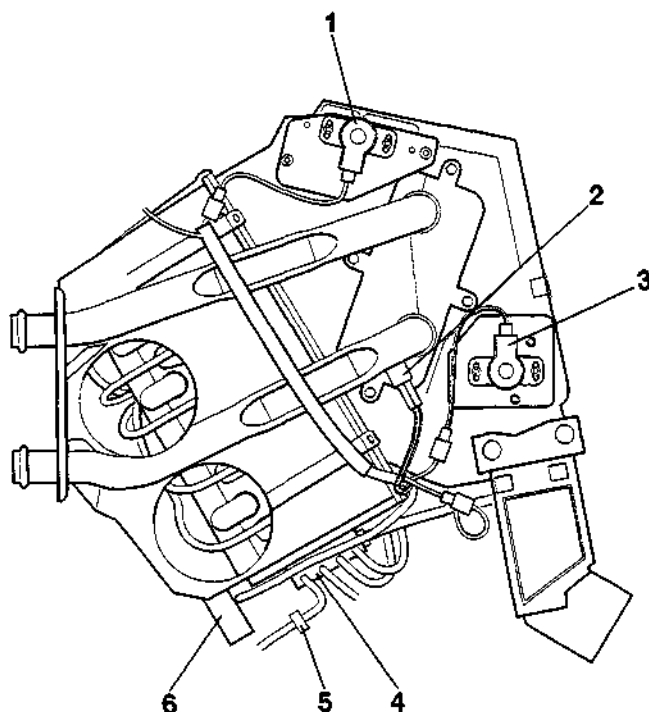


Figure 1.

Key to Fig. 1 - Left Hand Air Conditioning Unit

1. Upper feedback potentiometer
2. Water temperature switch
3. Lower feedback potentiometer
4. Vacuum valve block
5. Vacuum restrictor
6. Condensate drain tube

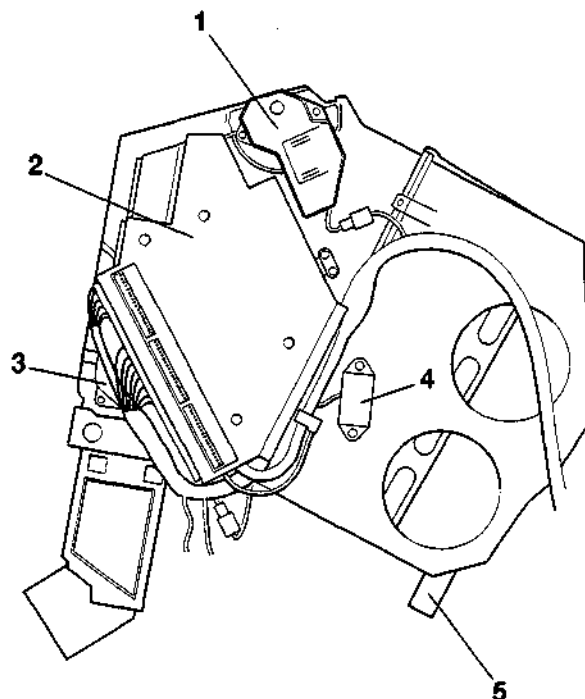


Figure 2.

Key to Fig. 2 - Right Hand Air Conditioning Unit

1. Upper servo motor
2. Electronic control module
3. Lower servo motor
4. Evaporator sensor
5. Condensate drain tube

Special Servicing Tools and Equipment

- 1 PDU system
- 1 Charging station
- 1 Leak detector
- 1 Temperature test box

- 1 Sanden compressor service tool kit
- 1 GM Type compressor service tool kit
- 1 Digital voltmeter
- 1 Multimeter

Working Practices

General

Be aware of, and comply with, all health and safety requirements.

Before beginning any repair or service procedure, disconnect the vehicle battery ground connection and protect the vehicle from dirt or damage.

Work in a well ventilated, clean and tidy area.

Recovery and charge equipment must comply with, or exceed the standard detailed in the General Description.

Handling Refrigerant

Wear eye protection at all times.

Use gloves, keep skin that may come into contact with refrigerant covered. If the refrigerant comes into contact with your eyes or skin wash the affected area *immediately* with cool water and seek medical advice, *do not* attempt to treat yourself.

Avoid inhaling refrigerant vapour, it will irritate your respiratory system.

Never use high pressure compressed air to flush out a system. Under certain circumstances a combination of HFC 134A and compressed air in the presence of a source of combustion (for instance, welding or brazing equipment), results in an explosion that releases toxic compounds into the atmosphere.

The refrigerant and CFC 12 must never come into contact with each other as they form an inseparable mixture that can only be disposed of by incineration.

Do not vent refrigerant directly into the atmosphere, always use approved recovery equipment. *Refrigerant is costly but it can be recycled.* Clean the refrigerant, using the recovery equipment and reuse it.

Carry out Leak Tests only with an electronic analyser dedicated to Refrigerant E134A.

Do not attempt to guess the amount of refrigerant in a system, always recover it and recharge with the correct charge weight. Do not depress the charge or discharge port valves to check for the presence of refrigerant.

Handling Lubricating Oil

Avoid breathing lubricant mist, it will cause irritation to your respiratory system.

Always decant fresh oil from a sealed container. Do not leave oil exposed to the atmosphere for any reason other than to fill or empty a system; PAG oil is hygroscopic (it absorbs water) and is contaminated rapidly by atmospheric moisture.

Following the recovery cycle *do not* reuse the oil when it has been separated from the refrigerant; dispose of the oil safely.

System Maintenance

Do not leave the system open to the atmosphere. If a unit or part of the system is left open for more than five minutes, it is advisable to renew the receiver-dryer. There is not a safe period in which work is to be carried out. *Always* plug pipes and units immediately after disconnection and only remove plugs when re-connecting.

If replacement parts are supplied without transit plugs and seals do not use the parts. Return them to your supplier.

Diagnostic equipment for pressure, mass and volume should be calibrated regularly and certified by a third party organisation.

Use extreme care when handling and securing aluminium fittings, always use a backing spanner and take special care when handling the evaporator.

Use only the correct or recommended tools for the job and apply the manufacturer's torque specifications.

Keep the working area, all components and tools clean.

Temperature Distribution System

The heating and ventilation unit case consists of three sections:

- the front, which contains the air conditioning system evaporator
- the rear section, which consists of two parts and contains the heater matrix and rotary flaps
- the lower outlets which direct air to footwell and rear passenger compartment and are removable.

Temperature variation within the car is achieved by all incoming air passing through the evaporator and then being directed through or around the heater matrix by rotary flaps:

- Full heating (Fig. 1)
- Defrost (Fig. 2)
- Full cooling (Fig. 3)
- Blend (Fig. 4)

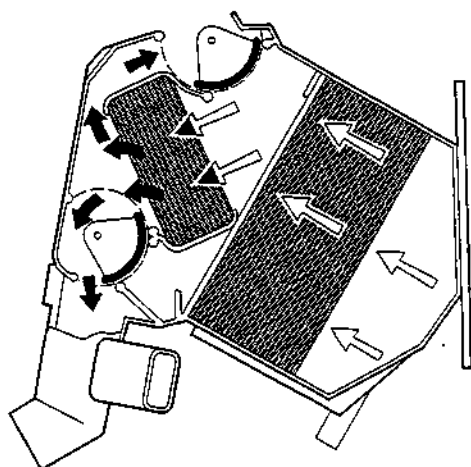


Figure 1.

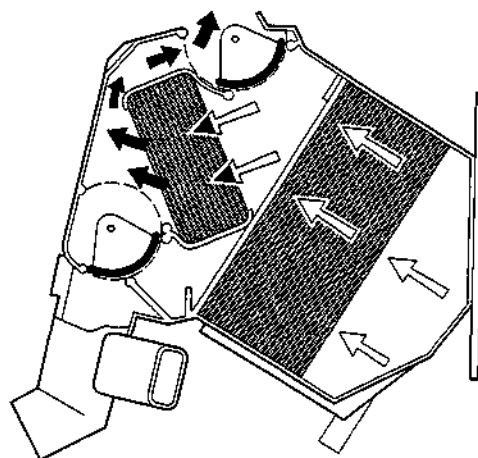


Figure 2.

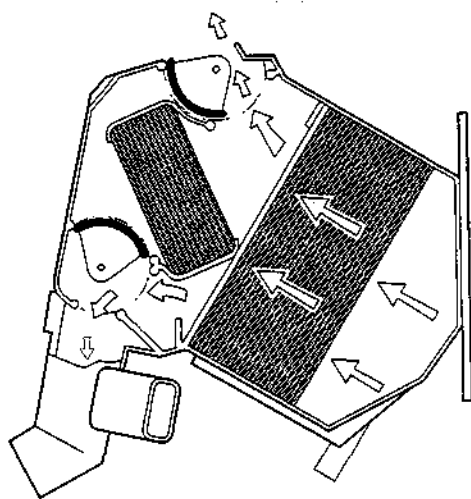


Figure 3.

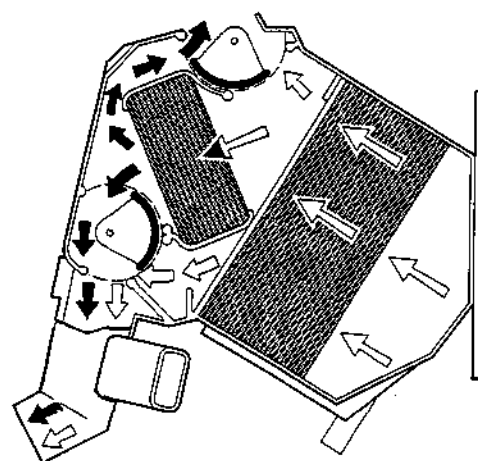


Figure 4.

The rotary flaps are opened or closed by servo motors, as directed by the control system, and flap position information is relayed to the ECM by feedback potentiometers.

(Solid arrow = Hot, Line arrow = Cold)

The Control Panel (Fig. 4) contains:

- Fan speed-defrost rotary switch (Mode-Switch),
- Air Conditioning Function Switch
- Temperature differential rotary control
- Temperature rotary control,

The control panel relays information to the ECM.

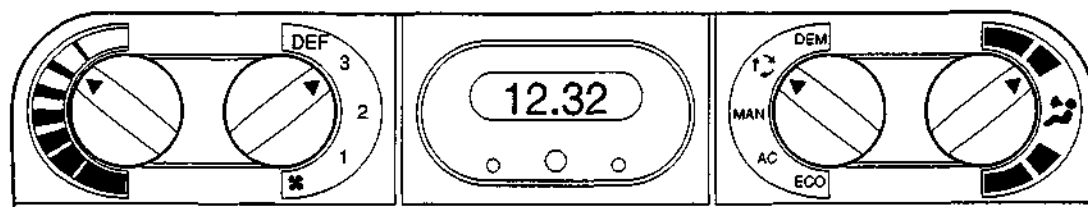


Figure 4.

Fan Speed Control (Mode Switch)

The rotary switch controls airflow from the blower motors. The switch has five positions: ❄️, 1, 2, 3 and DEFROST.

❄️	The system is not operational; a residual signal is sent to the Electronic Control Module (ECM) to ensure that the blower flaps are closed to prevent outside air from entering the system.
1, 2, 3	Selection information is relayed to the ECM. Signals are also relayed to the ECM from the temperature selector feedback circuits and various sensors. Fan speed is steplessly controlled by the ECM, within the ranges 1, 2 and 3.
DEFROST	the fans operate at maximum speed, front screen vents open fully, lower flaps close fully and maximum output is directed to the windscreen (there may be a delay of up to 30 seconds from selection to execution of this function).

Face Level Temperature Differential

This control is used to vary the temperature difference between the air coming through the face vents and that coming through the lower vents into the footwell.

Temperature Rotary Control

This is used to preset the in car heat level in either automatic or manual mode. There are three temperature sensors located in the system:

- Exterior ambient
- In-car
- Evaporator.

An input voltage is supplied to the sensors from AC4-13 of the control module. The temperature sensing signal from the sensors is transmitted to the control module via AC4-4 and AC2-4 respectively. The sensors are semiconductor devices which provide a voltage output proportional to the sensed temperature.

Air Conditioning Function Switch

When AC, DEM or Re-circulation $\updownarrow$ is selected the system engages the Air conditioning compressor using the electromagnetic clutch. The in-car temperature is automatically corrected to the pre selected level by the system sensors.

When MAN (manual mode) is selected it provides the operator selection of fan speed and in-car temperature selection facilities. The in-car temperature is not thermostatically corrected to a predetermined level by the system sensors.

When ECO is selected the system is in economy mode which allows the fan speed and heating levels to be selected but gives no cooling. The air conditioning compressor is not engaged putting a minimum load on the engine.

When manual re-circulation is selected the blower flaps are closed and only that air which is in the vehicle is re-circulated. When the ignition is turned off the blower flaps revert to the fresh air position.

Refrigeration Cycle

The Compressor draws low pressure refrigerant from the evaporator and by compression, raises refrigerant temperature and pressure. High pressure, hot vaporised refrigerant enters the Condenser where it is cooled by the flow of ambient air. A change of state occurs as the refrigerant cools in the condenser and it becomes a reduced temperature high pressure liquid.

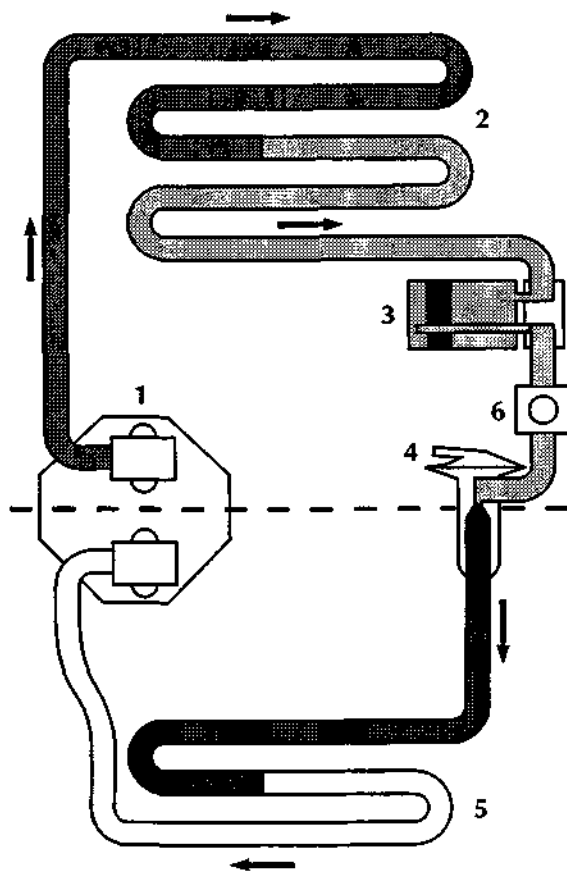


Figure 5.

- | | |
|-------------------|--|
| 1. Compressor | 4. Expansion Valve |
| 2. Condenser | 5. Evaporator |
| 3. Receiver-Drier | 6. Triple Pressure Switch (Trinary switch) |

From the condenser the liquid passes into the Receiver-Drier which has three functions:

- Storage vessel for varying system refrigerant demands.
- Filter to remove system contaminants.
- Moisture removal via the desiccant.

With the passage through the receiver-drier completed the, still high pressure liquid refrigerant, enters the Expansion Valve where it is metered through a controlled orifice which has the effect of reducing the pressure and temperature.

The refrigerant, now in a cold atomised state, flows into the Evaporator and cools the air which is passing through the matrix.

As heat is absorbed by the refrigerant it once again changes state, into a vapour, and returns to the compressor for the cycle to be repeated (Fig. 5).

There is an automatic safety valve incorporated in the compressor which operates should the system pressure be in excess of 41 bar. The valve re-seats when the pressure drops below 35 bar.

Note: The division of HIGH and LOW side is simply the system pressure differential created by the compressor discharge (pressure), suction (inlet) ports and the relative inlet and outlet ports of the expansion valve. This differential is critical to system fault diagnosis and efficiency checks.

System Protection

The trinary pressure switch, located in the liquid line, cuts electrical power to the compressor clutch if the system pressure is outside of the range of 2 Bar (1st Function) to 27 Bar (2nd Function). The third function is to switch on the cooling fans when pressure exceeds 20 bar.

General System Procedures

Leak Test

Faults associated with low refrigerant charge weight and low pressure may be caused by leakage. Leaks traced to mechanical connections may be caused by torque relaxation or joint face contamination. Evidence of oil around such areas is an indicator of leakage. When checking for non visible leaks use only a dedicated Refrigerant E134A electronic analyser and apply the probe all round the joint connection. Should a leak be traced to a joint, check that the fixing is secured to the correct tightening torque before any other action is taken.

Do not forget to check the compressor shaft seal and evaporator.

Note: Never use a dedicated CFC 12 or naked flame type analyser.

Charge Recovery (System Depressurisation)

The process of refrigerant recovery depends on the basic characteristics of your chosen recovery-recycle-recharge equipment, therefore, follow the manufacturers instructions carefully. Remember that compressor oil may be drawn out of the system by this process, take note of the quantity recovered so that it may be replaced.

CAUTION: Observe all relevant safety requirements.

- **Do not vent refrigerant directly to atmosphere and always use approved recovery-recycle-recharge equipment.**
- **Wear suitable eye and skin protection.**
- **Do not mix the refrigerant with CFC 12.**
- **Take note of the amount of recovered refrigerant, it indicates the state of the system and thus the magnitude of any problem.**

Evacuating the System

This process, the removal of unwanted air and moisture, is critical to the correct operation of the air conditioning system. The procedure depends on the characteristics of the recovery-recycle-recharge equipment and must be carried out exactly in accordance with the manufacturer's instructions.

Moisture can be highly destructive and may cause internal blockages due to freezing, but more importantly, water suspended in the PAG oil will damage the compressor. Once the system has been opened for repairs, or the refrigerant charge recovered, all traces of moisture *must* be removed before recharging with new or recycled refrigerant.

Adding Compressor Lubricating Oil

Oil can be added by three methods, two of which are direct into the system

- via the recovery-recycle-recharge station
- by proprietary oil injector.

Equipment manufacturer's instructions must be adhered to when using direct oil introduction.

The third method may be required because of rectification work to the existing compressor, or the need to fit a new compressor. From an existing compressor, drain the oil into a measuring cylinder and record the amount. Flush the unit out with fresh PAG oil and drain thoroughly. Refill the compressor with the same amount of PAG oil that was drained out originally and plug all orifices immediately ready for refitting to the vehicle. The transit lubricating oil must be drained and discarded from a new compressor before it may be fitted. An adjustment should be made to the system oil level by taking into account:

- the quantity found in the original compressor
- the quantity deposited in the recovery equipment oil separator from the charge recovery operation.

Typically, 80 ml can be drained from the original compressor and 30 ml found in the oil separator; the sum of these volumes ($80 + 30 = 110$ ml) is the amount of fresh PAG oil that must be put into the new compressor prior to fitting.

Note: The discrepancy between this figure and the nominal capacity of 135 ml is caused by normally not recoverable oil being trapped in components such as the receiver-drier or evaporator.

The above statements are only true if there is no evidence of a leak. Where a leak has been detected and rectified, the compressor must be refilled with the specified quantity.

Caution: Always decant fresh oil from a sealed container and do not leave oil exposed to the atmosphere. PAG oil is very hygroscopic (absorbs water) and rapidly attracts atmospheric moisture.

PAG oil must NEVER be mixed with mineral based oils.

Do not reuse oil following a recovery cycle, dispose of it safely.

Depending on the state of the air conditioning system immediately prior to charge recovery and the rate of recovery, an amount of oil is drawn out with the refrigerant. The quantity is approximately 30 to 40 ml; this may vary, and the figure is given only for guidance. It is most important that the oil separator vessel in the recovery equipment is clean and empty at the start of the process so that the amount drawn out may be accurately measured.

Adding Refrigerant

In order that the air conditioning system may operate efficiently it must contain a full refrigerant charge. The indications of some system defects, and the results of certain tests, shows that a low charge is the most probable cause of the fault. In such cases the charge should be recovered from the system, the weight noted, and the correct amount installed.

Note: Never attempt to guess the amount of refrigerant in a system. Always recover and recharge with the correct charge weight, this is the only accurate method.

Caution: If oil is drawn out during the recovery process, the correct amount can be added directly from your recovery-recycle-recharge station (if so equipped) prior to the charging process. It must be stressed that the need to protect compressor oil from moisture is vital, observe the procedures in Handling Lubricating Oil.

Warning: Liquid refrigerant boils at -29°C (-20°F) at atmospheric pressure. Serious injury, even blindness, can occur if the refrigerant comes into contact with the eyes.

Goggles and gloves must be worn while working with refrigerant.

First Aid

If refrigerant should contact the eyes or skin, bathe the eyes or affected area with cold water for several minutes. Do not rub. As soon as possible thereafter, obtain treatment from a doctor or eye specialist.

Functional Check

This functional check procedure is provided as a simple system validation and is structured to augment the Portable Diagnostic Unit (PDU).

Stage 1 (Cold engine only, if not proceed to Stage 2)

Procedure	Normal System Reaction
1. Ignition ON Select MIN temperature, MAN, speed 3, Mid face. (Engine Stationary)	Fans Start
2. Select MAX temperature	Fans continue to run
3. Ignition OFF Select MAX temperature and defrost Ignition ON	Fans start at maximum speed
4. Select fan speed 1	Fan speed adjusts accordingly - system OK

Stage 2

Procedure	Normal System Reaction						
1. Start up engine and warm up Select fan speed 1, MAN, MAX TEMPERATURE and mid face							
2. Open all vents	Fans start after 3 seconds						
2. Select fan speed 2	Fan speed increases then stabilises						
3. Select fan speed 3	Fan speed increases then stabilises						
4. Select defrost	Fan speed steady at high All air at screen and dash end						
5. Re-select fan speed 1 Select AUX ignition key position							
6. Slowly select MIN temperature	Solenoids switch <table> <tr> <td>1.</td><td>centre vent</td></tr> <tr> <td>2.</td><td>water valve</td></tr> <tr> <td>3.</td><td>Re-circulation</td></tr> </table>	1.	centre vent	2.	water valve	3.	Re-circulation
1.	centre vent						
2.	water valve						
3.	Re-circulation						
7. Re-select MID temperature							
8. Select DEM	Solenoid clicks Air at screen						
9. Select manual re-circulation	Solenoid click						
10. Check flap for position							
11. Run Engine to normal temperature							
12. Select: MAN, 3/4 MAX heat and fan speed 2.	Air from door vents cool, air temp from foot outlet slightly warm						
13. Select MAX temperature and air differential to hot face	All vent outlets max temp except screen vent						
14. Select temperature approx. 1/4 MAX heat and mid face level	Cool air from centre vents						
15. Select MIN temperature	Blower flaps at re-circulation position All outlets blowing cold air except screen vent						

Procedure	Normal System Reaction
16. Select ECO	Blower flaps revert to fresh air position
17. Select AC	Engine revs change then stabilise
18. Select fan speed 3	Small increase in fan speed
19. Select fan speed 2	Fan speed lower Centre vent and dash end cold footwell cool
20. Select MAX temperature allow in-car temperature to stabilise..... (Passenger side underscuttle panel must be in place)	Hot air from footwell, warm from dash end
21. Select MIN temperature and mid face level	System goes to full cooling automatically Cold air from all vent except from screen vent Centre vent open Blower at re-circulation
22. Select DEMIST and full heat	Demist vents open, centre vent closes and blower flaps revert to fresh air position
System check now complete	System good.

Note: A small amount of air will bleed from the ends of the demist-defrost vents in all cases, but there should be no leak along the length of the vents.

System Trouble Shooting

There are five basic symptoms associated with air conditioning fault diagnosis. It is very important to identify the area of concern before starting a rectification procedure. Spend time with your customer on problem identification, and use the following trouble shooting guide.

The following conditions are not in order of priority.

No Cooling

1. Is the electrical circuit to the compressor clutch functional?
2. Is the electrical circuit to the blower motor(s) functional?
3. Slack or broken compressor drive belt.
4. Compressor partially or completely seized.
5. Compressor shaft seal leak (see 9).
6. Compressor valve or piston damage^u (may be indicated by small variation between HIGH & LOW side pressures relative to engine speed).
7. Broken refrigerant pipe (causing total loss of refrigerant).
8. Leak in system (causing total loss of refrigerant).
9. Blocked filter in the receiver drier.
10. Evaporator sensor disconnected?
11. Dual pressure switch faulty?

Note: Should a leak or low refrigerant be established as the cause, follow the procedures for Recovery-Recycle -Recharge, and observe all refrigerant and oil handling instructions.

Insufficient Cooling

1. Blower motor(s) sluggish.
2. Restricted blower inlet or outlet passage
3. Blocked or partially restricted condenser matrix or fins.
4. Blocked or partially restricted evaporator matrix.
5. Blocked or partially restricted filter in the receiver drier.
6. Blocked or partially restricted expansion valve.
7. Partially collapsed flexible pipe.
8. Expansion valve temperature sensor faulty (this sensor is integral with valve and is not serviceable).
9. Excessive moisture in the system.
10. Air in the system.
11. Low refrigerant charge.

12. Compressor clutch slipping.
13. Blower flaps or distribution vents closed or partially seized.
14. Water valve not closed.
15. Evaporator sensor detached from evaporator.

Intermittent Cooling

1. Is the electrical circuit to the compressor clutch consistent?
2. Is the electrical circuit to the blower motor(s) consistent?
3. Compressor clutch slipping.
4. Faulty air distribution flap potentiometer or motor.
5. Motorised in-car aspirator or evaporator temperature sensor faulty, causing temperature variations.
6. Blocked or partially restricted evaporator or condenser.

Noisy System

1. Loose or damaged compressor drive belt.
2. Loose or damaged compressor mountings.
3. Compressor oil level low, look for evidence of leakage.
4. Compressor damage caused by low oil level or internal debris.
5. Blower(s) motor(s) noisy.
6. Excessive refrigerant charge, witnessed by vibration and 'thumping' in the high pressure line (may be indicated by high HIGH & high LOW side pressures).
7. Low refrigerant charge causing 'hissing' at the expansion valve (may be indicated by low HIGH side pressure).
8. Excessive moisture in the system causing expansion valve noise.

Note: Electrical faults may be more rapidly traced using PDU.

Insufficient Heating

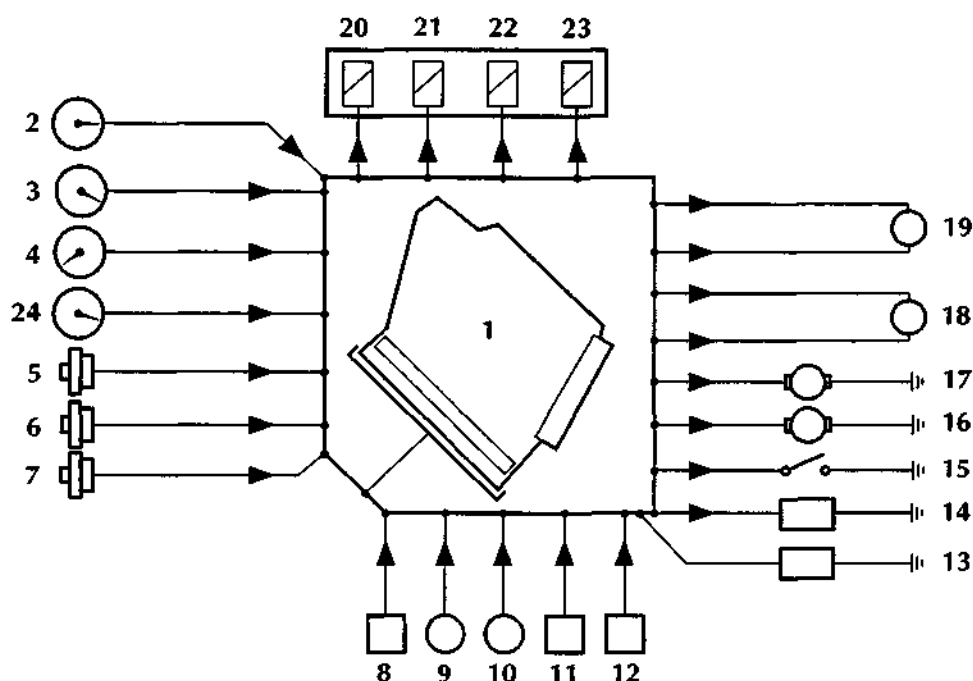
1. Water valve stuck in the closed position.
2. Motorised in-car aspirator seized.
3. Blend flaps stuck or seized.
4. Blocked or restricted blower inlet or outlet.
5. Low coolant level.
6. Blower fan speed low.
7. Coolant thermostat faulty or seized open.

Electronic Control Module (ECM)

The Electronic Control Module (ECM) is located on the right hand side of the heater unit.

The ECM has a digital microprocessor that allows the air conditioning system to maintain the selected in-car conditions. To do this it compares the signals from the in-car controls with those it receives from the system temperature sensors and feedback devices. On the basis of these comparisons it makes appropriate voltage changes to vary the blower motor speed, flap position and the state of other solenoids that effect the selected temperature demand.

The ECM is a non-serviceable component but may be interrogated for system testing. Care must be exercised when connecting the test equipment as the ECM may be irreparably damaged should any of the test pins be shorted or bent.



Figure

- | | |
|---------------------------------------|---|
| 1. Electronic control module (ECM) | 13. High speed relay |
| 2. Differential temperature control | 14. High speed relay |
| 3. Temperature control | 15. Compressor clutch |
| 4. Fan speed control | 16. Blower motor |
| 5. Ambient temperature sensor | 17. Blower motor |
| 6. Motorised in-car aspirator | 18. Lower flap servo motor |
| 7. Evaporator temperature sensor | 19. Upper flap servo motor |
| 8. Coolant temperature switch | 20. Defrost vacuum solenoid |
| 9. Lower flap feedback potentiometer | 21. Auto re-circulation vacuum solenoid |
| 10. Upper flap feedback potentiometer | 22. Centre vent vacuum solenoid |
| 11. Left hand blower motor feedback | 23. Water valve vacuum solenoid |
| 12. Right hand blower motor feedback | 24. Air conditioning function switch |

Description

The ECM (Fig 1) controls the air conditioning system so that selected temperatures are maintained. It cannot be repaired but input and output signals can be measured, using the PDU, for diagnostic purposes.

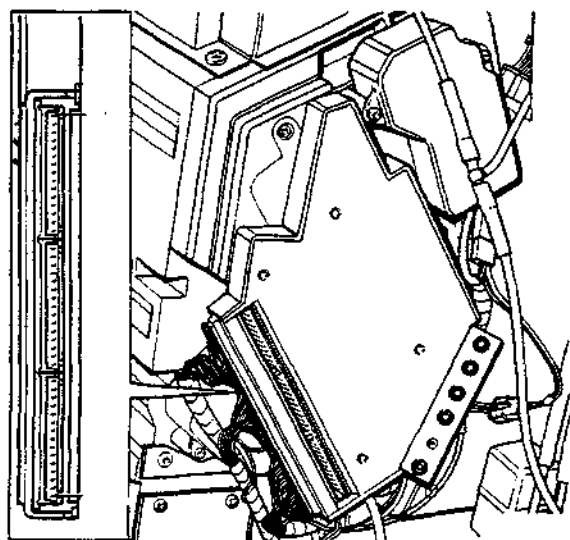


Figure 1.

The ECM is turned on when the ignition is turned on to auxiliary position 1. Its operating range is 13.5-14.2 volts.

The ECM power unit supplies +5 volts for the temperature sensors, feedback potentiometers and high speed relays.

An integrated circuit protects the ECM against reversed polarity and voltage surges.

Caution: Take care when connecting test equipment. If test pins are allowed to be shorted together, to ground or to positive supplies the ECM will be damaged.

Input-Output Voltage Signals

The following voltage signal levels are input and output from the ECM:

Digital input levels:

Low	0.16 to 1.1V
High	3.70 to 4.50V

Analogue input levels:

General	0 to 0.2885 V
Blend Flap Potentiometer	0 to 5.0V

Digital output levels

Relays	On	8.0V
	Off	1.0 to 5.0V
Vacuum manifold	Pull-in	5.6V (typical)
	Drop-out	3.5V (typical)

Analogue output levels

Blend Flap Servo Motors	0.5 to 6.5V
Blower Motors	0.5 to 2.5V

In Car Controls

Temperature Demand Switch

In-car temperatures are selected by the temperature demand switch (Fig. 1).

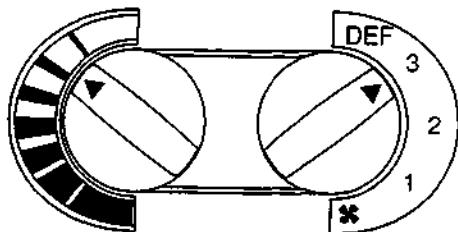


Figure 1.

The switch is coupled to a 590 ohm potentiometer (Fig. 2) supplied with +5 volts from pin 43 of the ECM. The output voltage is from zero to 2.885 volts which represents a range of temperatures from 16 to 38°C. Rotation of the switch is restricted mechanically to 180° of travel.

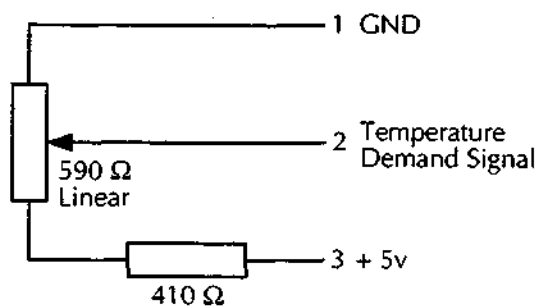


Figure 2.

Face Level Differential Controller

The face level differential control alters the temperature of the air distributed through the face level vents. The switch is coupled to a 10 K ohm potentiometer supplied with +5 volts from pin 43 of the control module (Fig. 3). Temperature, from the face vents, is decreased by moving the switch anti-clockwise and increased by moving it clockwise.

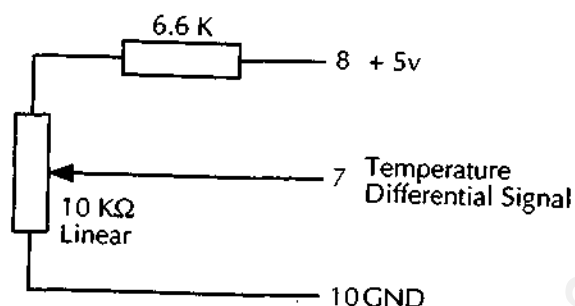


Figure 3.

Air Conditioning Function Switch

The air conditioning function switch (Fig. 4) has five positions: Economy (ECO), Air conditioning (AC), Manual (MAN), Re-circulation and Demist (DEM). These settings have the following functions:

ECO (Economy) In this setting the air conditioning compressor is switched off. No cooling is available but incoming air may be heated to the selected temperature. This mode puts a minimum load on the engine. Pin 23 at the ECM is earthed through the switch to select economy mode.

AC This setting allows the heating and cooling functions to be performed automatically, the required in-car temperature is maintained and the air is dehumidified. Pin 26 at the ECM is earthed through the switch to select this mode.

MAN (Manual) In the Manual mode the fan speed and temperature control can be set at any level and heating or cooling will be performed despite the internal temperature of the car. Pins 26 and 19 at the ECM are earthed through the switch to select this mode

(Re-circulation) With this setting selected the external air inlets are closed and conditions are maintained by circulating the air within the car. Heating and cooling functions are controlled automatically to give the required in-car temperature. Pins 9 and 26 at the ECM are earthed through the switch to select the manual Re-circulation.

DEM (Demist) Air is directed directly onto the screen in this mode. Air speed and temperature depend on the selected fan speed and in-car temperature. Heating and cooling functions are still controlled automatically to give the required in-car temperature. Pin 8 and 26 at the ECM are earthed through the switch to give the required in-car temperature.

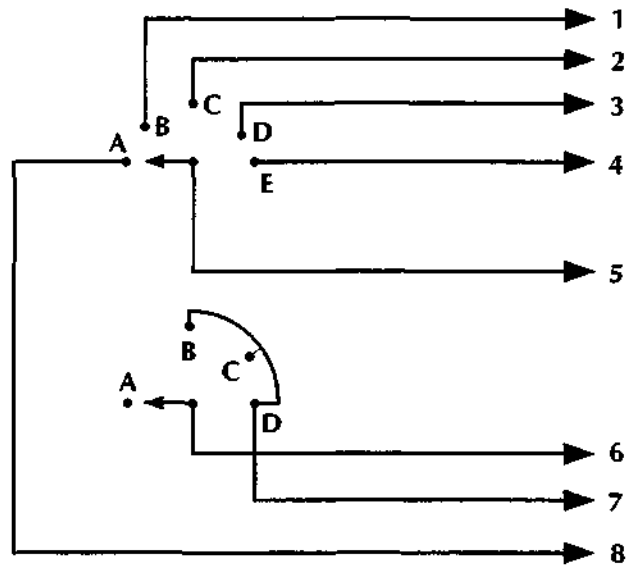


Figure 4.

Key to Fig. 4

- 1. AC signal Pin 26 ECM
- 2. MAN signal Pin 19 ECM
- 3. REC signal Pin 9 ECM
- 4. DEM signal Pin 8 ECM
- 5. Earth-ground Pin 1 ECM
- 6. Earth-ground Pin 1 ECM
- 7. AC signal Pin 26 ECM
- 8. ECO signal Pin 23 ECM
- A ECO
- B AC
- C MAN
- D Re-circulation
- E DEM

Fan Speed Control Switch (Mode Switch)

✱ On Mode

The system is not operational, a residual signal to the ECM ensures that the blower flaps are closed to prevent air entering the system.

1. Low Blower Mode

The fan speed is low and the air conditioning function switch is fully operational. Pin 13 on the ECM is earthed through the switch and a 12V signal is returned to Pin 44.

2. Medium Blower Mode

The fan runs at medium speed and the function switch is fully operational. Pin 14 of the ECM is earthed through the switch and a 12V signal is returned to Pin 44.

3. High Blower Mode

The fan speed is high and the function switch is fully operational. Pin 15 at the ECM is earthed through the switch and a 12V signal is returned to Pin 44.

DEF Defrost Blower Mode

The fan speed is high, the function switch and temperature switch are not operational, front screen vents are fully open and lower flaps are fully closed. Pin 27 at the ECM is earthed through the switch and a 12V signal is returned to Pin 44.

Temperature Sensors

The system has three temperature sensors:

- the ambient sensor (Fig. 5)

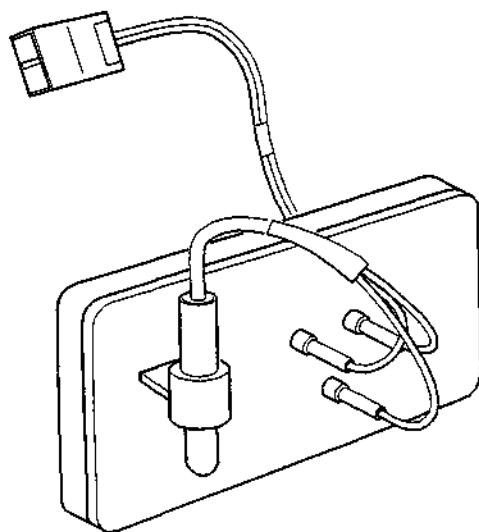


Figure 5.

- the evaporator sensor (Fig. 6)

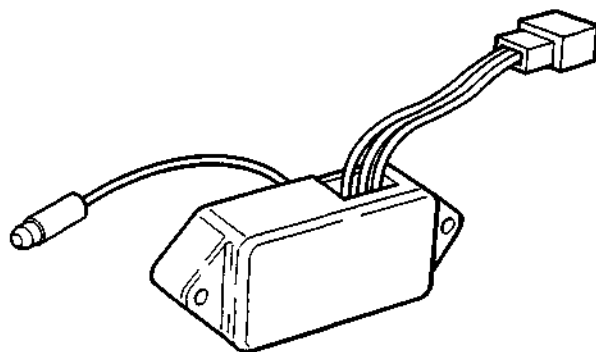


Figure 6.

- and the in-car aspirated sensor.

Each sensor contains a semiconductor whose output or sensing voltage varies with temperature changes. All three are supplied via pin 43 of the ECM. The sensing voltages are fed back into the module via the following pins (Fig. 7):

- ambient temperature sensor - pin 34
- in-car aspirated sensor - pin 4
- evaporator temperature sensor - pin 5

At 0°C the sensing voltage should be 2.732 volts. This voltage rises or falls by 0.01 volts for every 1°C change in temperature; for instance, if the temperature rises 5°C above zero, the voltage rises by 0.05 volts to 2.782 volts. Sensors have built in potentiometers which are preset at the factory and must not be adjusted.

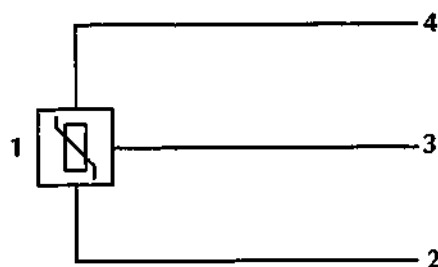


Figure 7.

Key to Fig. 7

- Sensor
- Pin 43 control module
- Sensing voltages:
Pin 4 In-car aspirated temp sensor
Pin 5 Evap temp sensor
Pin 34 Ambient temp sensor
- Earth-ground

Evaporator Sensor

The evaporator sensor allows the ECM to monitor the temperature of the refrigerant in the evaporator core continuously. When the temperature falls below 0°C the ECM de-energises the compressor's electromagnetic clutch and prevents refrigerant from flowing through the system. The clutch is re-engaged when the temperature rises.

Motorised In-Car Aspirated Sensor

The motorised aspirator (Fig. 8), which is fitted to the passenger side fascia underscuttle panel, incorporates a motor driven fan (Fig. 8-1) that draws air continuously over the in car temperature sensor (Fig. 8-2).

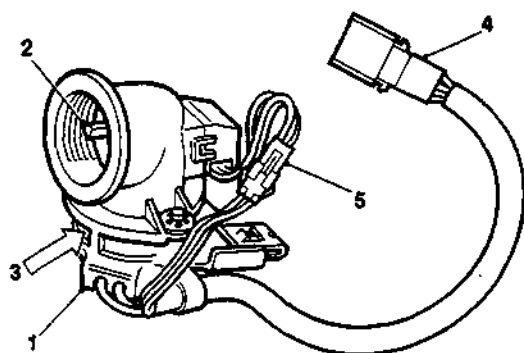


Figure 8.

Key to Fig. 8

1. Motor
2. Sensor
3. Fan
4. Connector SCAO07
5. Connector SAC030

The motor (Fig. 8-1) is supplied, independently of the air conditioning system, from the ignition switch (position 2). Its operating voltage range is 13.5 to 14.2 volts. Maximum current is 120 mA. The sensor (Fig. 8-2) has a temperature operating range of -30°C to +85°C. It is fed with 5 volts from the ECM (pin 43), while the sensing voltage is supplied to pin 4 of the ECM. At 0°C the sensing voltage is 2.732V $\pm$ 0.002V. The rate of change of sensing voltage is 0.01V $\pm$ 0.002V per 1°C.

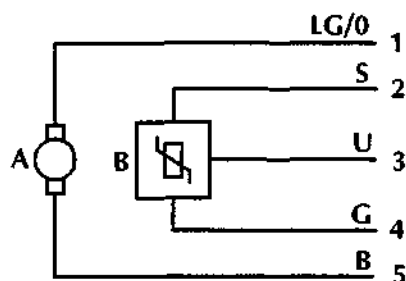


Figure 9.

Key to Fig. 9

1. Ignition switched supply to motor
2. +5V supply to sensor from pin 43 of ECM
3. Sensor voltage output to pin 10 of ECM
4. Sensor earth-ground to pin 4 of ECM
5. Motor earth-ground
- A. Motor
- B. Sensor

Ambient Temperature Sensor

An ambient temperature sensor (Fig. 10-1) is fitted in the plenum air intake to provide the ECM with information on the temperature of the air entering the air conditioning unit and so offset the in-car temperature at extremes of ambient. The voltage signal output from the sensor is proportional to the temperature of the surrounding air. The sensor temperature range is -30°C to 85°C. At 0°C the output of the sensor is 2.732V $\pm$ 0.005V. The rate of change is + 0.01V $\pm$ 0.002V per 1°C.

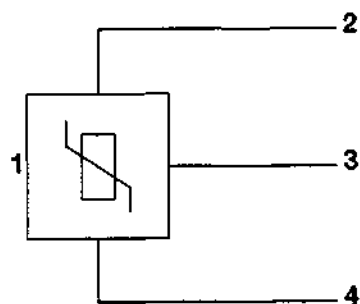


Figure 10.

Key to Fig. 10

1. Ambient temperature sensor
2. +5 volts from ECM Pin 43
3. Sensing signal to ECM Pin 34
4. Earth-ground

Water Temperature Switch

The water temperature switch (Fig. 1) is fitted to the lower side of the heater matrix inlet pipe.

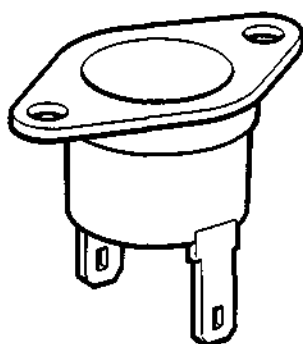


Figure 1.

It is connected to pin 21 of the ECM. The switch contacts are open to prevent the blower motors operating until the temperature of the water in the heater matrix reaches 30°C. The water temperature switch is overridden when cold air is demanded, defrost mode is selected and fan speed 3 is selected.

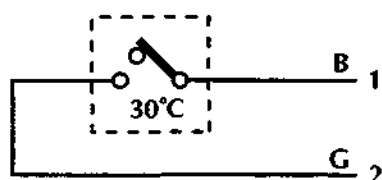


Figure 2.

Key to Fig. 2

1. Earth-ground
2. Output to Pin 21 ECM

Blower Motors

The air conditioning system has two blower motors (Fig. 1-7) that operate together to maintain the flow of air into the car at the desired level. The motors are supplied from an ignition switched supply through transistorised control circuits fitted in the motor outlets. The circuits steplessly vary the speed of the motors at 1 and 2 selections of the mode switch and operate the motors to high speed when 3 is selected. The electronic components are assembled on a heat sink and include a power transistor (Fig. 1-9) and feedback diode (Fig. 1-8). The switches are supplied and controlled by the ECM.

When the mode switch is set to 3, the high speed relay (Fig. 1-10) is energised from pin 16 of the ECM, opening a path to earth-ground, and allowing full battery voltage to be applied to the motor. At 1 and 2, the motor is supplied with a continuously variable voltage by the power transistor and the earth-ground return is made via the ECM. The feedback diode enables the ECM to sense the voltage at the negative terminal of the blower motor.

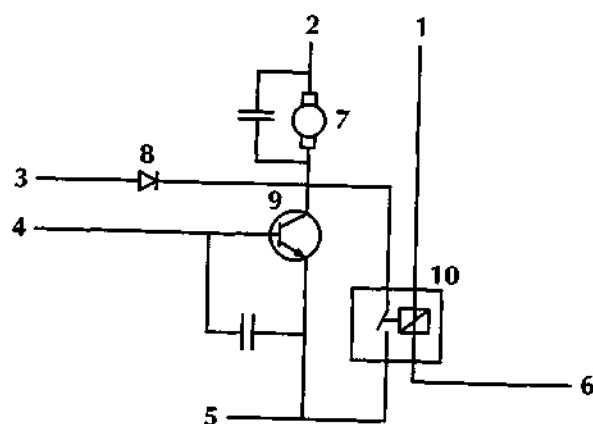


Figure 1.

Key to Fig. 1

1. Output signal from Pin 16 ECM
2. Power feed
3. Blower feedback
Left hand Pin 22, Right hand 33
4. Blower output Left Pin 31, Right 32
5. Control switch earth-ground
6. ECM earth-ground Pin 45
7. Blower motor
8. Feedback diode
9. Power transistor
10. High speed relay

Potentiometers

Lower Feedback Potentiometer

The lower feedback potentiometer determines the position of the lower blend flap in the air conditioning unit and feeds this information to the ECM. The ECM is thereby able to command the lower flap servo motor to move the flap to a new position and maintain the temperature of the air to the feet and rear outlets at the desired level.

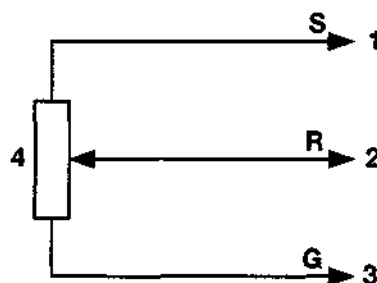


Figure 1.

1. +5 volts from ECM Pin 43
2. Feedback signal to ECM Pin 29
3. Earth-Ground

The potentiometer is supplied with +5V from pin 43 of the ECM and returns its feedback signal via pin 29. The feedback signal is 100mV (COLD AIR) to 1.2V (HOT AIR). The potentiometer also provides a single feedback signal of 2.9V when the blend flap is in DEFROST. In this position, the feet and rear outlets are closed and all air is directed to the screen.

Upper Feedback Potentiometer

The upper feedback potentiometer determines the position of the upper blend flap in the air conditioning unit and feeds this information to the ECM enabling it to command the upper flap servo motor to move the flap to a new position and maintain the desired temperature of the air at the dashboard, centre, screen and side demist vents.

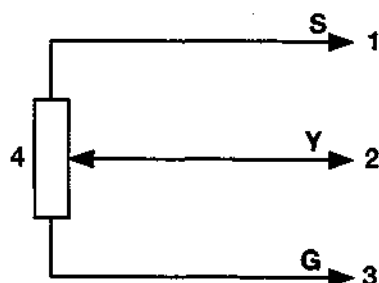


Figure 2.

1. +5 volts from ECM Pin 43
2. Feedback signal to ECM Pin 30
3. Earth-Ground

The potentiometer is supplied with +5V from pin 43 of the ECM and returns its feedback signal via pin 30. The feedback signal is 100mV (COLD AIR) to 1.9V (HOT AIR).

Servo Motors

Lower Servo Motor

The lower blend flap assembly has two inlets and a single outlet which are wholly or partially blocked by the flap to control the temperature of air entering the lower half of the vehicle.

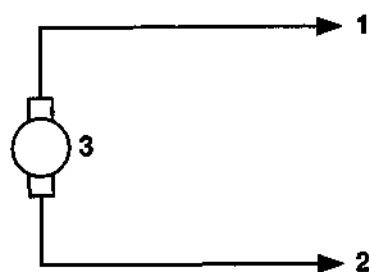


Figure 1.

1. Energising voltage Lower Servo ECM Pin 37 (Upper ECM 40)
2. Energising voltage Lower Servo ECM Pin 41 (Upper ECM 42)

A servo motor (Fig. 1) drives the lower blend flap to the desired position via a 1500:1 reduction gear box. The motor is bidirectional and energised from pins 37 and 41 of the ECM. The energising voltages have the following values: LOW $\pm$ 0.0V to 2.0V; HIGH $\pm$ 7.0V to 9.5V.

Upper Servo Motor

The upper servo motor (Fig. 1) drives the upper blend flap to the desired position through a 1500:1 reduction gearbox. Like the lower servo motor it is bi-directional and energised by the ECM (pins 40 and 42). The energising voltages are:

- LOW + 0.0V to 2.0V
- HIGH + 7.0V to 9.5V.

Vacuum System

The flaps in the cabin air distribution vents and the water valve in the pipeline from the engine coolant system to the heater matrix are all operated by vacuum actuators. The vacuum for these is supplied by four solenoids mounted in pairs behind the front footwell outlets. Each solenoid and its associated pipe work is identified by a colour:

- Defrost Green
- Auto Re-circulation Blue
- Water valve Red
- Centre vent Black.

The vacuum supply pipes to the re-circulation and centre vent actuators are fitted with restrictors in order to slow down the operation of the flaps and avoid hunting. The re-circulation flaps can take up to 30 seconds to move to a new position.

Vacuum is piped to the solenoids from the engine manifold through a reservoir. The solenoids are energised by signals from the ECM in response to demand, sensing and feedback signals.

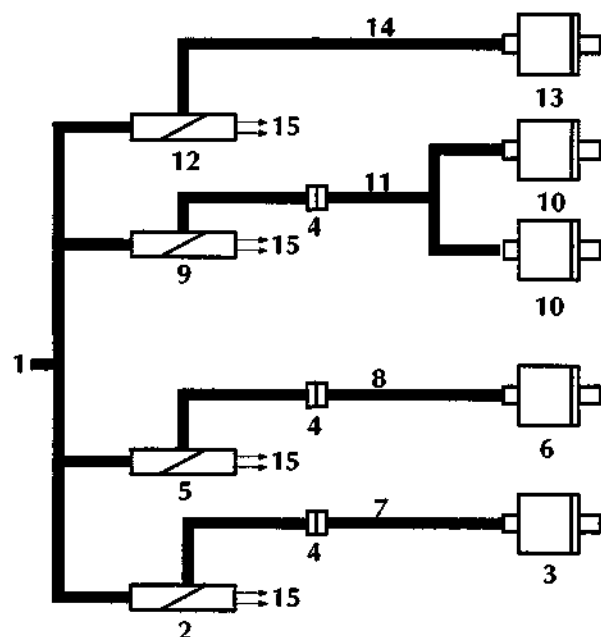


Figure 1.

Key to Fig. 1

1. Vacuum reservoir
2. Defrost solenoid
3. Defrost-demist actuator
4. Restrictors
5. Centre vent solenoid
6. Centre vent actuator
7. Defrost vacuum pipe
8. Centre vent vacuum pipe
9. Recirc. solenoid
10. Recirc. actuator
11. Recirc. vacuum pipe
12. Water valve solenoid
13. Water valve actuator
14. Water valve vacuum pipe

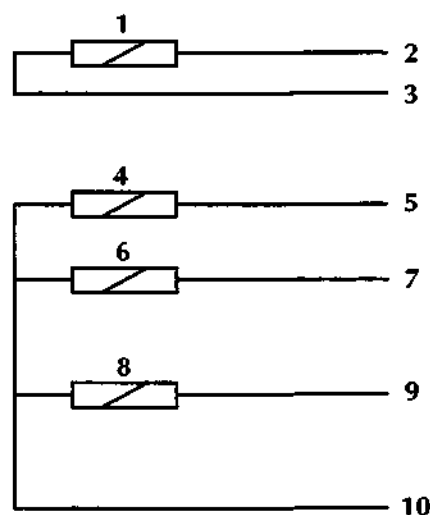


Figure 2.

Key to Fig. 2

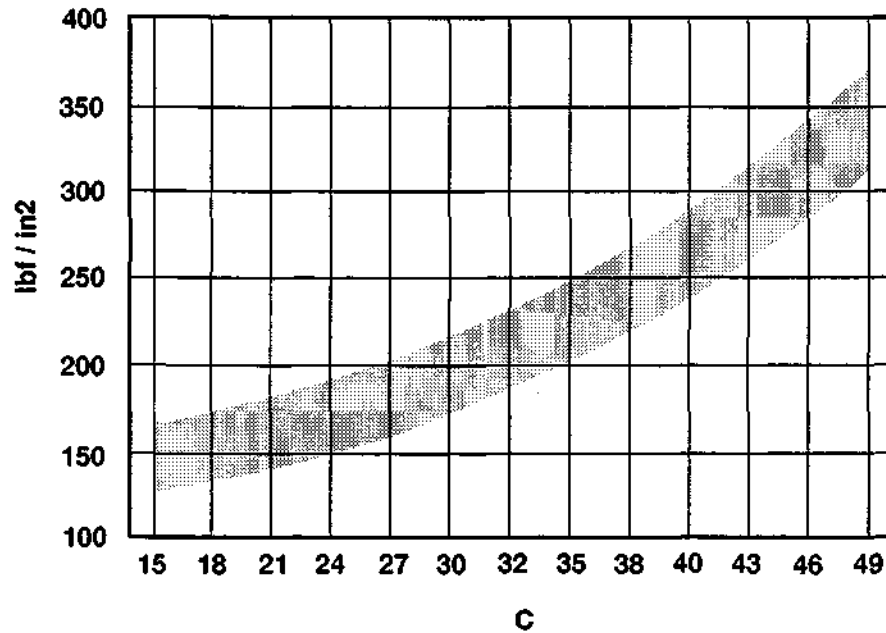
1. Defrost (Green) solenoid
2. +12V Defrost input from ECM pin 12
3. Defrost output to ECM Pin 11
4. Recirc (Blue) solenoid
5. +12V Recirc. input from ECM Pin 3
6. Water valve (Red) solenoid
7. +12V Water valve input from ECM Pin 17
8. Centre vent (Black) solenoid.
9. +12V Centre vent input from ECM Pin 18
10. ECM earth-ground

Pressure-Temperature Graphs

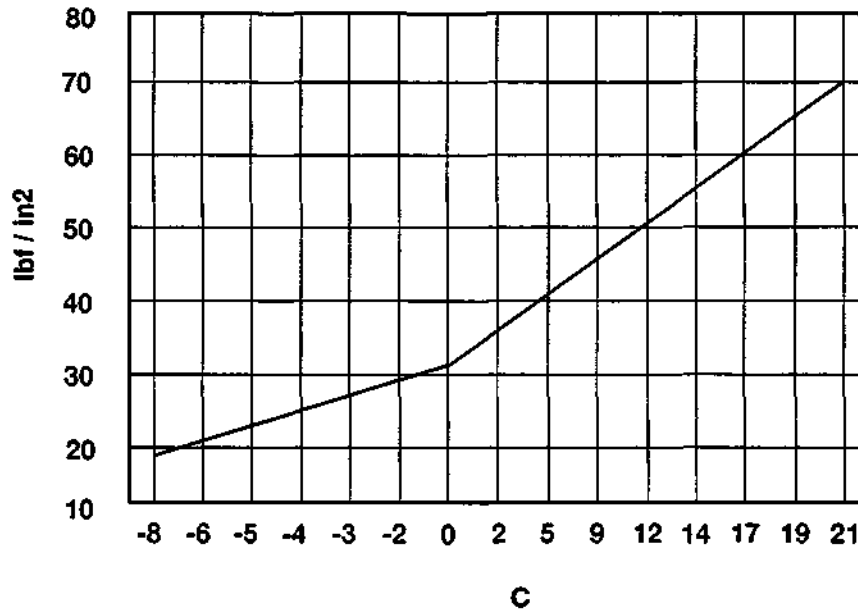
To obtain Bar multiply the lbf/in² by 0.068

To obtain kgf/cm² multiply lbf/in² by 0.07

High Side (lbf/in²) - Ambient (°C)



Low Side (lbf/in²) - Ambient (°C)



System Fault Diagnosis

Probable causes of faults can be found by comparing actual system pressures, registered on the manifold gauge set or recovery-recharge-recycle station, and the pressure to temperature relationship graphs found on the previous page. The chart below shows the interpretation that may be made by this difference. The 'Normal' condition is that which is relevant to the prevailing ambient and evaporator temperatures.

Note: If erratic or unusual gauge movements are experienced, check the equipment against a known manifold gauge set.

Low Side Gauge	High Side Gauge	Symptom	Diagnosis
Normal	Normal	Discharge air initially cool then warms up	Moisture in system
Normal to low	Normal	As above	As above
Low	Low	Discharge air slightly cool	HFC 134A charge low
Low	Low	Discharge air warm	HFC 134A charge very low
Low	Low	Discharge air slightly cool or frost build up at expansion valve	Expansion valve stuck closed
Low	Normal to high	Discharge air slightly cool	Restriction in High side of system
High	Low	Compressor noisy	Defective reed valve
High	High	Discharge air warm and high side pipes hot	HFC 134A charge high or condenser malfunction
High	High	Discharge air warm	Expansion valve stuck open
		Sweating or frost at evaporator	

Fault Finding

Caution: The microprocessor is extremely sensitive and should only be tested using a digital multimeter with no less than a 3.5 digit display and a resistance of no less than 2 M ohms. The use of any other form of multimeter will damage the microprocessor irreparably.

Note: Always allow time for the servo motors and blower motors to come to a rest before starting a check.

The car should be in a workshop and the ambient temperature should be stable e.g. 24°C (75°F) for at least 30 minutes before commencing the automatic check.

At 24°C the sensor voltage is 2.972 V ± 2 mV. The rate of change is 10mV per 1°C.

Unless stated otherwise, all checks are carried out at the ECM test plugs

Mode Switch: Off Ignition Switch: Aux 2

Signal	Pin No.	Voltage
Battery supply	1	11 to 14V
Recirc input	9	0 to 2V
Earth-ground	2	0 to 40mV
Earth-ground	6	0 to 40mV
Earth-ground	10	0 to 40mV
Earth-ground	38	0 to 40mV
Earth-ground	45	0 to 40mV
From mode switch	44	0 to 12V
To mode switch	12	10 to 13.3V

Mode Switch: Low - Function Switch: Manual

Low input	13	150 to 350mV
Clutch output- Evap sensor below 2.72V	20	0.6V
Clutch output- Evap sensor above 2.72V	20	11.4V
Medium input	14	3 to 5V
High input	15	3 to 5V
Defrost	27	3 to 5V
From ON-OFF Switch.	44	10.3 to 13.3V
Output	43	4.73 to 5.2V
Recirc. output	3	0 to 200mV
HS Relays	16	0 to 200mV
Water valve solenoid	17	0 to 200mV
Centre vent solenoid	18	0 to 200 mV

Mode Switch: Medium - Function Switch: Manual

Low input	13	3 to 5V
Medium input	14	150 to 350mV
High input	15	3 to 5V
Defrost	27	3 to 5V

Mode Switch: High Servo Motors Stationary - Function Switch: Manual

Low input	13	3 to 5V
Medium input	14	3 to 5V
High input	15	150 to 350V
Defrost input	27	3 to 5V

Mode Switch: Defrost - Function Switch: Manual

Low input	13	3 to 5V
Medium input	14	3 to 5V
High input	15	3 to 5V
Defrost input	27	150 to 350mV

Mode Switch: Low, Medium or High - Function Switch: Manual

Air Differential - cold face	28	2.665 to 3.105V
Air Differential - hot face	28	0 to 200mV

Mode Switch: Low, Medium or High - Function Switch: Manual

Temp. Maximum demand	35	2.665 to 3.105V
Temp. Minimum demand	35	0 to 200mV

Mode Switch: Low, Medium or High Temperature Demand Switch: Mid-Range - Function Switch: AC

Servo motor lower flap	37	0 to 2.0V
Servo motor lower flap	41	0 to 2.0V
Servo motor upper flap	40	0 to 2.0V
Servo motor upper flap	42	0 to 2.0V

Mode Switch: Low, Medium or High Temperature Demand Switch: Mid-Range - Function Switch: AC

Servo motor lower flap	37	7.0 to 9.5V
Servo motor lower flap	41	7.0 to 9.5V
Serve motor upper flap	40	7.0 to 9.5V
Servo motor upper flap	42	7.0 to 9.5V

Mode Switch: Low or Medium Temperature Demand Switch: Mid-Range - Function Switch: AC

Recirc. input	9	10 to 12V
Recirc. output	3	0 to 500mV
Reference voltage	7	2.875 to 2.895V
Defrost output	11	0 to 500mV
High speed relays	16	0 to 500mV
Lower feedback pot.	29	0.6 to 0.9V
Upper feedback pot.	30	1.15 to 1.45V
Water temp. switch engine cold	21	260 to 460mV
Water temp. switch engine hot	21	4.5 to 5.5V
Defrost output	11	0 to 500mV
Clutch output- evaporator above 2.745 V	20	10.3 to 13.3V
Right hand Blower feedback	33	10 to 13V
Left hand Blower feedback	22	10 to 13V
Right hand Blower control	32	0 to 0.5V
Left hand Blower control	31	0 to 0.5V
Water valve solenoid	17	0 to 500mV
Centre vent solenoid	18	0 to 500mV

Mode Switch: (Auto) Low Temperature Demand Switch: Minimum

Face Level to mid-range	28	1.43 to 1.45V
-------------------------	----	---------------

Servo Motors Stopped

Servo motor lower flap	37	0 to 40mV
Servo motor lower flap	41	0 to 40mV
Servo motor upper flap	40	0 to 40mV
Servo motor upper flap	42	0 to 40mV
Lower feedback pot.	29	0 to 0.2V
Upper feedback pot.	30	0 to 0.2V

Mode Switch: Low Temperature Demand Switch: Mid-Position - Function Switch: AC

Temperature demand	35	1.43 to 1.45V
--------------------	----	---------------

Servo Motors Stopped

Servo motor lower flap	37	0 to 40mV
Servo motor lower flap	41	0 to 40mV
Servo motor upper flap	40	0 to 40mV
Servo motor upper flap	42	0 to 40mV
Lower feedback pot.	29	0.57 to 0.87V
Upper feedback pot.	30	0.6 to 0.9V

Mode Switch: Low Temperature Demand Switch: Maximum - Function Switch: AC

Temp demand	35	2.665 to 3.105V
Lower flap feedback pot	29	0.979 to 1.279V
Upper flap feedback pot.	30	1.518 to 1.9V

Mode Switch: (Auto) Face Level: Cold Face

Differential temp.	28	2.665 to 3.105V
Lower flap feedback pot.	29	0.979 to 1.279V
Upper flap feedback pot.	30	1.340 to 1.640V

Blower Motor Test

Face Level: Hot Face Temperature Demand Switch: Minimum

Differential temp.	28	0 to 200mV
Temperature demand	35	0 to 200mV

Note: Allow the servo motors to come to rest before checking voltage levels. Typical figures are given in brackets.

Mode Switch	RH Control	LH Control	RH Feedback	LH Feedback
Position	Pin No. 32	Pin No. 31	Pin No. 33	Pin No. 22
Low	1 - 2V (1.77V)	1 - 2V (1.77V)	4 - 6V (5.8V)	4 - 6V (5.63V)
Med	2 - 3V (2.28V)	2 - 3V (2.27V)	3 - 5V (3.7V)	3 - 5V (3.4V)
High	1 - 2v (1.17V)	1 - 2V (1.19V)	1 - 2V (1.22V)	1 - 2V (1.27V)

Set Face Differential Pot. to Mid Point

Mode Switch	RH Control	LH Control	RH Feedback	LH Feedback
Position	Pin No. 32	Pin No. 31	Pin No. 33	Pin No. 22
Low	1 - 2V (1.24V)	1 - 2V (1.27V)	6.5 - 9V (8.7V)	6.5 - 9V (8.7V)
Medium	1 - 2V (1.4V)	1 - 2V (1.4V)	6.9 - 9V (7.5V)	6.5 - 9V (7.5V)
High	2 - 3V (2.2V)	2 - 3V (2.2V)	3 - 5V (4.1V)	3 - 5V (4.0V)

Set Face Differential Pot. to Cold Face

Mode Switch	RH Control	LH Control	RH Feedback	LH Feedback
Position	Pin No. 32	Pin No. 31	Pin No. 33	Pin No. 22
Low	1 - 2V(1.67V)	1 - 2V(1.63V)	6.5 - 9V(6.25)	6.5 - 9V(6.1V)
Medium	2 - 3V(2.17)	2 - 3V(2.1V)	3 - 5V(4.25V)	3 - 5V(4.2V)
High	2 - 3V(2.3V)	2 - 3V(2.2V)	3 - 5V (3.7V)	3 - 5V(3.5V)

Open Water Temperature Switch Needs

Set Temperature Demand Switch to Midpoint Pin No. 35 1.43 -145V

RH Servo control	Pin 32	0 - 0.5V
LH Servo control	Pin 31	0 - 0.5V

Short Water Temperature Switch Leads

Mode Switch: Low

Clutch output	Pin 20	9.3 - 12.3V
RH Servo control	Pin 32	1 - 2V
LH Servo control	Pin 31	1 - 2V
Set diff to hot face	Pin 28	0 - 200mV
Set temp demand to minimum	Pin 35	0 - 200mV
Recirc. output	Pin 3	9.3 - 12.3V
High speed relays	Pin 16	0 - 200mV
Water valve solenoid	Pin 17	9.3 - 12.3V
Centre vent solenoid	Pin 18	9.3 - 12.3V
Defrost output	Pin 27	0 - 500mV
MODE SWITCH: DEFROST	Pin 27	150 - 350mV
High speed relays	Pin 16	9.3-12.3V
Lower feedback pot.	Pin 29	2.709-3.100V
Upper feedback pot.	Pin 30	1.714 -2.014V
MODE SWITCH: OFF	Pin 44	0-IV
Recirc. output	Pin 3	9.3-12.3V

Refrigeration

Safety Precautions

The air conditioning system is designed to use only Refrigerant E134A (dichlorodifluoromethane). Extreme care must be taken NOT to use a methylchloride refrigerant. The chemical reaction between methylchloride and the aluminium parts of the compressor results in the formation of products which burn spontaneously on exposure to air, or decompose with violence in the presence of moisture. The suitable refrigerant is supplied under the following names.

E134A KLEA or equivalent

Warning: Take care when handling refrigerant. Serious damage will occur if it is allowed to come into contact with the eyes. Always wear with goggles and gloves when working with refrigerant.

First Aid

If refrigerant should come into contact with the eyes or skin, splash the eyes or affected area with cold water for several minutes. DO NOT RUB. As soon as possible thereafter, obtain treatment from a Doctor or an eye specialist.

Good Practice

1. Protective sealing plugs must be fitted to all disconnected pipes and units.
2. The protective sealing plugs must remain in position on all replacement components and pipes until immediately before assembly.
3. Any part arriving for assembly without sealing plugs in position must be returned to the supplier as defective.
4. It is essential that a second backing spanner is always used when tightening or loosening all joints.

This minimises distortion or strain on components or connecting hoses.
5. Components must not be lifted by connecting pipes, hoses or capillary tubes.
6. Care must be taken not to damage fins on the condenser or evaporator matrices. Any damage must be rectified by the use of fin combs.

7. Before assembly of tube and hose joints, use a small amount of clean new refrigerant oil on the sealing seat.
8. Refrigerant oil for any purpose must be kept very clean and capped at all times. This prevents the oil absorbing moisture.
9. Before assembly the condition of joints and flares must be examined. Dirt and even minor damage will cause leaks at the high pressure points encountered in the system.
10. Dirty end fitting can only be cleaned using a cloth wetted with alcohol.
11. After removing sealing plugs and immediately before assembly, visually check the bore of pipes and components. Where any dirt or moisture is discovered, the part must be rejected.
12. All components must be allowed to reach room temperature before sealing plugs are removed.

This prevents condensation should the component be cold initially.
13. Before finally tightening hose connections ensure that the hose lies in the correct position, is not kinked or twisted and will not be trapped by subsequent operations, e.g., refitting or closing bonnet.
14. Check that hoses are correctly fitted in clips or straps.
15. The compressor must be stored horizontally with the sump down. It must not be rotated before fitting and charging. Do not remove the shipping plate until immediately before assembly. Always use new "O" ring seals in those joints that incorporate them. "O" ring seals should be coated with compressor oil before fitting.
16. Components or hoses removed must be sealed immediately after removal.
17. After the system has been opened the receiver-drier must be renewed.
18. Before testing, run the engine until normal running temperature is reached. This ensures that sufficient vacuum is available for test. For cooling tests the engine must be running for the compressor clutch to operate.

Compressors

Compressor Clutch Control

The compressor pulley is driven continuously when the engine is running. An electromagnetic clutch allows the compressor to be engaged or disengaged. The clutch is energised by battery supply voltage when the clutch relay RF3 is closed by a signal from the ECM (pin 21) via the engine management system.

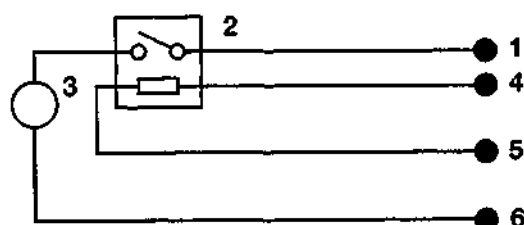


Figure 1

Key to Fig. 1

1. +ve battery supply
2. Clutch relay
3. Compressor clutch
4. Pin 20 ECM supply to clutch relay solenoid
5. Earth-Ground
6. Earth-Ground

Trinary Switch

High Side Low Pressure Switch

The high side low pressure switch (HSLP) is connected in the earth-ground return lead of the compressor clutch coil. The switch is a function of the trinary switch and monitors the pressure on the high side of the refrigeration system. If the pressure drops below 25 psi (+ 5 psi) the contacts open to de-energise the clutch coil and disengage the clutch. Low pressure occurs when there is a fault in the system, and the HSLP switch contacts remain open until the fault has been rectified.

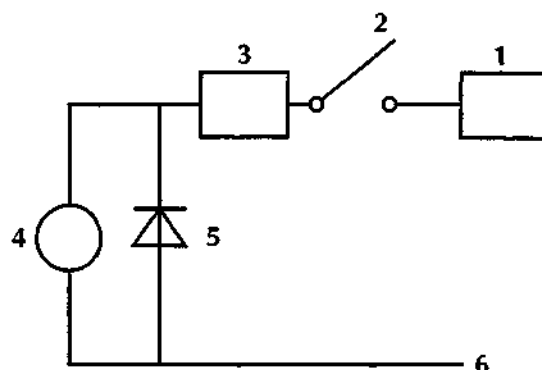


Figure 2

Key to Fig. 2

1. Clutch relay supply
2. Compressor clutch
3. HSLP switch
4. Protection diode
5. Earth-ground

Condenser

The condenser (Fig. 3) consists of a refrigerant coil mounted in a series of thin cooling fins to provide maximum heat transfer in the minimum amount of space. It is mounted directly behind the car radiator and receives the full flow of ram air induced by the forward motion of the car and the suction of the cooling fan. Refrigerant enters the inlet at the top of the condenser as a high pressure hot vapour. As the vapour passes down through the condenser coils cooled by ram air, a large quantity of heat is transferred to the outside air and the refrigerant changes to a high pressure warm liquid.

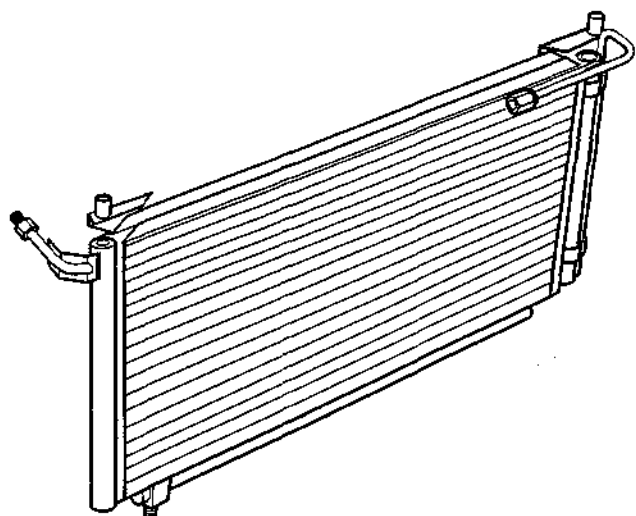


Figure 3.

Receiver-Drier

The receiver drier (Fig. 1) accepts high pressure warm refrigerant liquid from the condenser and delivers it via an expansion valve to the evaporator. It contains a quantity of molecular sieve desiccant to remove moisture from the refrigerant, and a filter to remove contaminants. It also provides a reservoir of refrigerant for the evaporator under varying operating conditions.

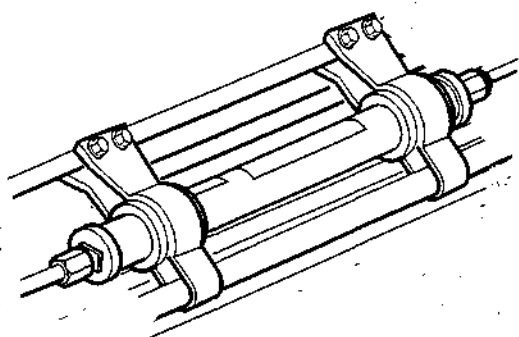


Figure 1.

Evaporator

The evaporator consists of a refrigerant coil mounted in a series of thin fins to provide a maximum amount of heat transfer in a minimum amount of space. It is housed in the air conditioning unit and all air entering the system passes across its coil.

The evaporator receives refrigerant from the thermostatic expansion valve as a low pressure cold atomised liquid. As this cold liquid passes through the evaporator coils, it absorbs heat from the surrounding air and changes into a low pressure warm vapour.

Expansion Valve

The expansion valve is the dividing point between the high and low pressure sides of the system. It automatically meters high pressure, warm liquid refrigerant via a metering orifice into the low pressure, cold side of the evaporator matrix. The valve senses outlet pipe temperature, inlet pipe pressure and regulates the flow of refrigerant into the evaporator to ensure that only vaporised refrigerant appears at the outlet.

Sanden Compressor SD7H15

The Sanden SD7H15 compressor is a 7 cylinder machine with a bore of 29.3 mm (1.15 in) and a stroke of 32.8 mm (1.29 inches).

The displacement per revolution is 155cc (9.5 cubic inches).

The magnetic clutch is engineered with the compressor as a complete assembly resulting in a relatively small unit of lightweight construction.

The compressor may be mounted up to 90° from its upright position.

The compressor incorporates a lubrication system which reduces the oil circulation ratio to a level of less than 2% at 1800 rpm.

An oil deflector and positive pressure differential lubrication system promotes oiling to the cylinder wall, piston rod assemblies, main bearings and shaft seal, and ensures that oil circulation to the refrigeration circuit is kept to a minimum. The compressor is charged with 135 cc (4.6 fluid ounces) of Sunico No 5GS oil at the factory. Only this oil or one of the equivalent oils detailed below should be used.

Key to Fig. 2.

1. Service port
2. Cylinder head
3. Hose connection
4. Anti-rotation gear
5. Oil filler plug
6. Planet plate
7. Clutch bearing
8. Electromagnetic clutch
9. Valve plate assembly
10. Cylinder and valve plate gasket
11. Cylinder block
12. Piston
13. Cam rotor
14. Needle thrust bearing
15. Front housing and 'O' ring
16. Shaft seal

Compressor Oils

Sunico No 5GS
Texaco Capella E
Virginia Chemicals 500 Viscosity

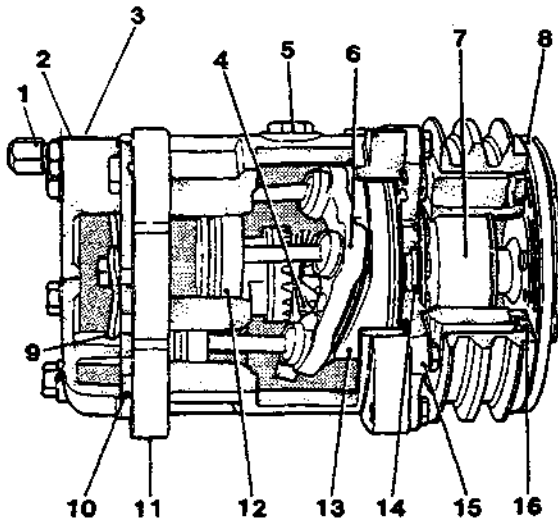


Figure 2.

Manifold Gauge Set

The manifold gauge set is a most important tool for fault diagnosis and system efficiency assessment. The relationship to each other of HIGH and LOW pressures and their correlation to AMBIENT and EVAPORATOR temperatures must be compared to determine system status. Because of the heavy reliance upon this piece of equipment for service diagnosis, ensure that the gauges are calibrated regularly and the equipment is treated with care.

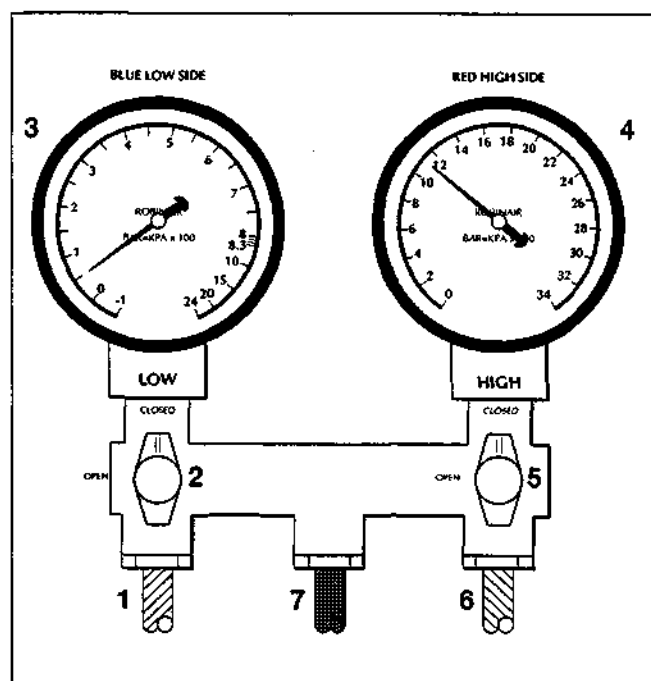


Figure 1

The gauge set (Fig. 1) consists of a manifold fitted with:

- 1 Low side service hose - BLUE.
- 2 Low Side hand valve - BLUE.
- 3 Low pressure compound gauge - BLUE.
- 4 High pressure gauge- RED.
- 5 High Side hand valve - RED.
- 6 High side service hose - RED.
- 7 System service hose - NEUTRAL COLOUR (commonly yellow).

Manifold.

The manifold is designed to control refrigerant flow. When connected into the system, pressure is registered on both gauges at all times. During system tests both the high and low side hand valves should be closed (rotate clockwise to seat the valves). The hand valves isolate the low and the high sides from the centre (service) hose.

Low Side Pressure Gauge.

This compound gauge is designed to register positive and negative pressure and may be calibrated as follows:

- Full Scale Deflection - 0 to 24 bar pressure in a clockwise direction
- 0 to 1 bar FSD negative pressure in a counter clockwise direction.

High Side Pressure Gauge.

This pressure gauge may be calibrated from 0 to 34 bar FSD in a clockwise direction. Depending on the manufacturer, this gauge may also be of the compound type.

System Checking with the Manifold Gauge Set

Connecting the Manifold Gauge Set

Caution: Only use hoses with connectors which are dedicated to HFC 134A charge ports.

Attachment of the hose quick release connectors to the high and low side system ports is straightforward, provided that the high and low valves are closed and the system is NOT operational.

Assessment of the system's operating system can be carried out by using the facilities of the Recovery-Recharging-Recycling station. Follow the manufacturer's instructions carefully and closely observe the safety procedures.

Warning: Under no circumstances should the connections be made with the system in operation or the valves open. Should the valves be open and a vacuum pump or refrigerant container attached, an explosion could occur as a result of high pressure refrigerant being forced back into the vacuum pump or container.

Stabilising the System

Accurate test gauge data can be attained only if the system temperatures and pressures are stabilised.

Ensure that equipment and its hoses cannot come into contact with moving parts or heat sources.

It is recommended that a free standing air mover is placed in front of the vehicle to provide mass air flow through the condenser-cooling system.

Checking Procedure

1. Start the engine and allow it to attain normal working temperature then set it at fast idle (typically 1200 to 1500 rpm).
2. Select full air conditioning performance.
3. With all temperatures and pressures stable or displaying symptoms of faults, begin relevant test procedures.

Connecting the Gauge Set.

A test hose connected to the fitting directly under the low side gauge is used to connect the low side of the test manifold into the low side of the system, and a similar connection is found on the high side. When connecting the gauge manifold set to the air conditioning system an access valve core removing tool is available for connecting the test hoses to the high and low sides of the system.

Using the valve removing tool it enables the valve core to be removed and held back inside the tool eliminating restrictions and, thereby, providing a full flow of refrigerant.

Warning: Do not open the high side hand valve while the air conditioning system is in operation because, high pressure refrigerant will be forced through the high side gauge and to the refrigerant container, if it is attached. This could cause the container to rupture or the fitting at the safety container valve to burst resulting in damage and personal injury.

1. With the engine switched off, remove the protective caps from the schraeder valves.
2. Fit the access valve removal tool to the schraeder valves. Ensure that both the manifold hand valves are in the closed position.
3. Connect the high pressure manifold gauge hose (to the high pressure side of the air conditioning side of the system (high side is always the line from the compressor to the condenser). Connect the low pressure or compound gauge hose to the low pressure side of the air conditioning system.
4. Using the access valve removal tool loosen and screw out the valve cores.

Purging the Test Hoses

1. With the manifold test set attached to the system.
2. Purge the high pressure test hose by cracking open the high pressure side hand valve on the manifold gauge set for 3 to 5 seconds. This allows the system refrigerant to purge the air from the test hose and discharge through the manifold centre test hose. Immediately close the high pressure side hand valve.
3. Purge the low pressure test hose in the same manner by cracking open the low pressure side hand valve manifold gauge set for 3 to 5 seconds, then close the hand valve.

Stabilising the System

The manifold gauge set is now attached to the system and the test hoses purged of air. With both hand valves closed, the system must be operated for a few minutes to stabilise all pressures and temperatures throughout the system in order to obtain accurate test gauge readings.

Proceed as follows:

1. Place all test hoses, gauge set and other equipment away from all engine moving parts. Also keep the hoses from touching the hot engine manifold.
2. Start the engine and adjust engine speed to fast idle
3. Turn on the air conditioning and set for maximum cooling with blower fans on high speed
4. Open the car doors and/or windows (to quickly eliminate car interior heat).
5. Operate the system under these conditions for 5 to 10 minutes to stabilise the system ready for testing.
6. Check the system for full refrigerant by noting the sight glass indications. Some refrigerant loss occurs over a period of time.

Note: The air conditioning system must contain a full refrigerant charge before an accurate system check can be made. An insufficient charge is indicated by a stream of bubbles or foam. If the refrigerant charge is low, the system must be fully discharged into a refrigerant recovery station and recharged with the correct weight of refrigerant 82.30.08. Do not top up a system with refrigerant.

Leak Test

A high proportion of all air conditioning work consists of locating and repairing leaks.

Many leaks are located at connections and are caused by vibration. They may only require the re-tightening of a connection or clamp.

Occasionally a hose rubs on a structural part of the vehicle and creates a leak, or a hose deteriorates which will require a replacement.

The specified maximum leakage rate at each fitting is 0.5 kg of R 134a in 40 years and a leak detector capable of operating to this accuracy must be provided. To check place the leak detector probe at the lowest point of each joint, pause for two seconds. Do not wave the probe about as refrigerant is heavier than air and flows to the lowest point. If a leak is greater than 0.5 kg in forty years is detected identify the leak point for rectification.

Check that the leaking fitting has been tightened to the correct torque. If the torque is low, rectify and repeat leak test. If the torque is satisfactory, depressurise the system, dismantle the leaking connection and check the quality of the fitting.

If the fitting is satisfactory, clean and reassemble after applying a thin film of refrigerant to the seat of a flare fitting, or a new oiled "O" ring to an "O" ring fitting.

Tighten to the correct torque.

Charge the system with 200 g of E134A and leak test the rectified system. If the system is satisfactory, depressurise, evacuate and recharge the system.

If the system is unsatisfactory, i.e. leakage greater than 0.5 kg in forty years, depressurise and replace the leaking assembly.

Pressure Temperature Relationship.

Note: Pressures shown are under exact conditions (see test conditions) and are not necessary true for every car checked. Ambient Temperature is given as the air surrounding the condenser and is taken 5 cm in front of the condenser.

Test Conditions.

Use a large fan to substitute for normal ram air through the condenser. Engine adjusted to fast idle speed.

All conditions equivalent to 30 m.p.h. or 48 km/h.

Ambient Evaporator Temp °C	High Pressure Gauge Reading lbf/in ²	Low Pressure Gauge Reading lbf/in ²	Temp °C
16	95-115	10	-16
18	105-125	12	-14
21	115-125	4	-12
24	130-150	16	-10
27	150-170	18	-8
29	165-185	20	-6
32	175-195	22	-5
35	185-205	24	-4
38	210-230	26	-3
41	230-250	28	-1
43	250-270	30	0
46	265-285	35	2
49	280-310	40	5
		45	9
		50	11
		55	14
		60	17
		65	19
		70	21

Normal operating ambient temperature range is: -24 to 43°C.

Normal operating evaporator temperature range is: -12 to 0°C.

Under normal running conditions system pressure should be, as follows:

Low side: 1.05 to 2.10 kgf/cm² 1.034 to 2.06 bar 15 to 30 lbf/in²

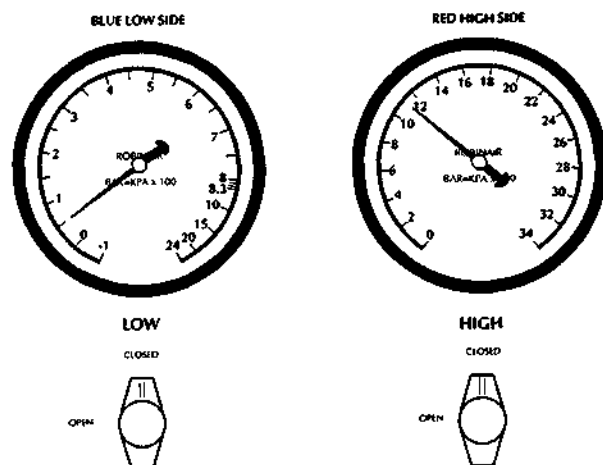
High side: 13.00 to 14.40 kgf/cm² 12.75 to 14.34 bar 185 to 205 lbf/in²

Manifold Gauge Set Check Procedures

Refrigerant Slightly Low.

Complaint.

Little or no cooling.



Condition.

1. The low side gauge reading is too low.
2. The high side gauge reading is too low.
3. A stream of bubbles evident in the sight glass.
4. The discharge air from the evaporator only slightly cool.

Diagnosis.

The system low on refrigerant due to slight leak.

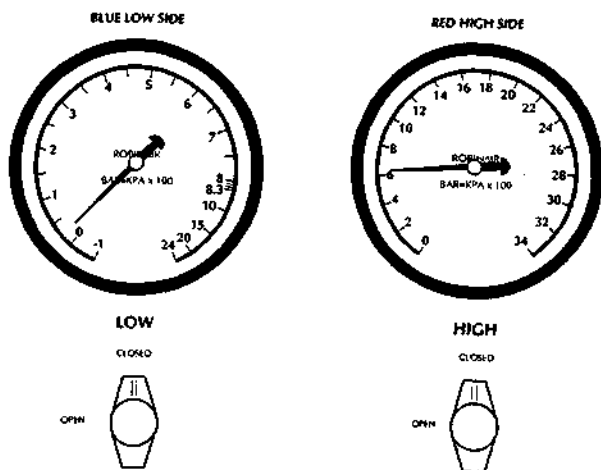
Correction.

1. Test the system for leaks.
2. Depressurise the system.
3. Repair the leaks, and if necessary renew hoses or units.
4. Check the compressor oil level. The system may have lost oil due to leakage.
5. Evacuate the system using a vacuum pump.
6. Recharge the system with new refrigerant.
7. Operate the system and check the performance.

Refrigerant Excessively Low.

Complaint.

Cooling is not adequate.



Condition.

1. The low side gauge is reading very low.
2. The high side gauge reading very low.
3. No bubbles or liquid evident in the sight glass.
4. The discharge air from the evaporator is warm.

Diagnosis.

System refrigerant excessively low. Serious leak indicated.

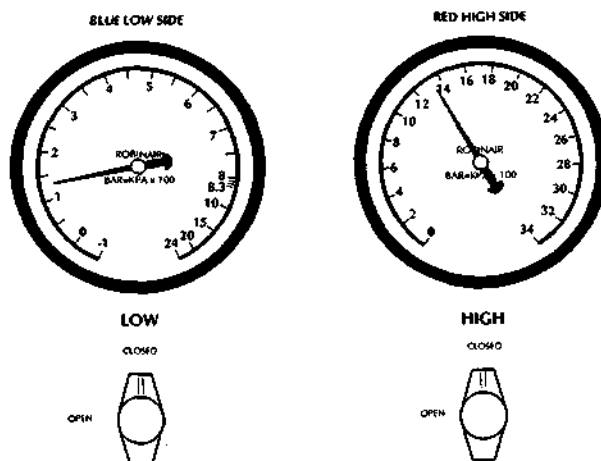
Correction.

1. Test the system for leaks.
Note: Partially recharge the system before testing the system for leaks to ensure that leak detection is obtained.
2. Depressurise the system.
3. Repair the leaks, and if necessary renew hoses or units.
4. Check the compressor oil level. The system may have lost oil due to leakage.
5. Evacuate the system using a vacuum pump.
6. Recharge the system with new refrigerant.
7. performance.

Air In The System.

Complaint.

Cooling is not adequate.



Condition.

1. The low side gauge reading is constant and does not drop. The pressure should drop until the compressor cycles (thermostat control)
2. The high side gauge reading is slightly high (or slightly lower especially if a large fan is used to substitute ram air).
3. The sight glass is free of bubbles or only shows an occasional bubble.
4. The discharge air from the evaporator is only slightly cool.

Diagnosis.

Non condensables present in the system. Air or moisture present instead of a full refrigerant charge.

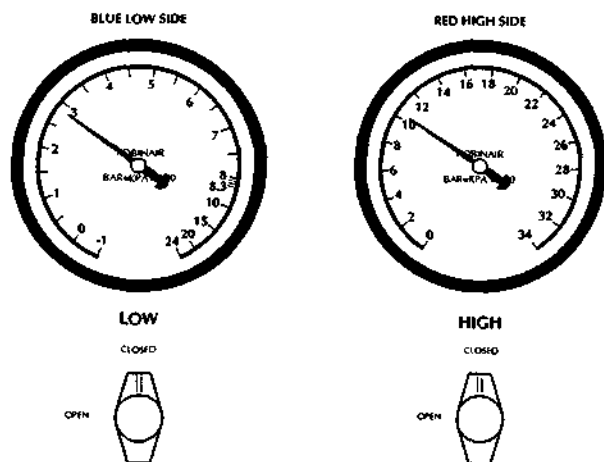
Correction.

1. Test the system for leaks. Test the compressor seal area very carefully.
2. Depressurise the system. Repair the leaks, and if necessary renew hoses or units.
3. Renew the drier bottle, probably water saturated.
5. Check the compressor oil level.
6. Evacuate the system using a vacuum pump.
7. Recharge the system with new refrigerant.
8. Operate the system and check the performance.

Compressor Malfunction

Complaint.

Cooling is not adequate.



Condition

1. The low side gauge reading is too high.
2. The high gauge reading is too low.
3. The sight glass is free of bubbles and the system is fully charged.
4. The discharge air from the evaporator is not sufficiently cool.

Diagnosis.

Internal leak in the compressor.

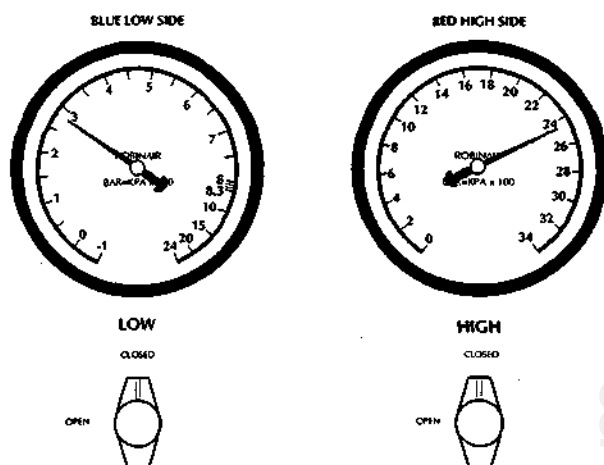
Correction.

1. Depressurise the system.
2. Renew the compressor and the drier bottle.
3. Evacuate the system using a vacuum pump.
4. Charge the system with new refrigerant.
5. Operate the system and check the performance.

Condenser Malfunction or System Overcharge

Complaint.

Little or no cooling. Overheating of the engine may also be noted.



Condition.

1. The low side gauge reading excessively high.
2. The high side gauge reading is also excessively high.
3. Bubbles may appear occasionally in the sight glass and the liquid line to the evaporator is very hot.
4. The discharge air from the evaporator is warm.

Diagnosis.

The condenser not operating correctly through lack of cooling caused by too high a high side pressure. The system may have either a normal or overcharge of refrigerant.

Correction.

1. Check the compressor drive belt for correct tension.
2. Check the condenser for clogged air passages preventing air flow through the condenser.
3. Inspect the condenser mounting for correct radiator clearance.
4. Check for correct fan operation.
5. Check the coolant pressure cap for correct type and operation.

After making the above checks operate the system and check the performance. If the Condition is not rectified.

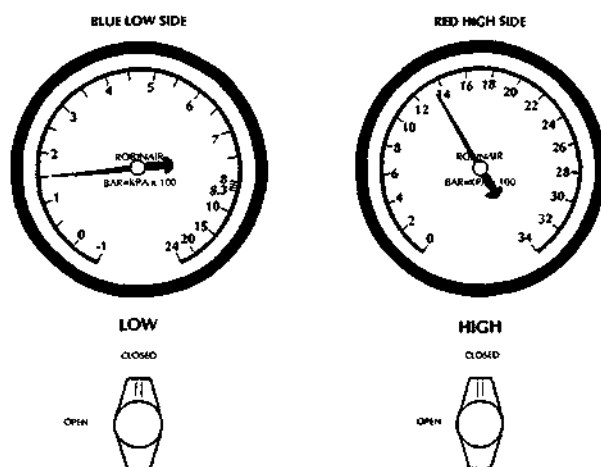
1. Inspect the system for overcharge of refrigerant and rectify as follows.
 - A. Discharge the system, until a stream of bubbles appear in the sight glass and both gauge readings drop to below normal.
 - B. Add new refrigerant until the bubbles disappear and the pressures are normal. Then add 0.25 to 0.5 lb. of additional refrigerant.
2. Operate the system and check the performance. If the gauge readings are still too high.
3. Depressurise the system.
3. Remove and inspect the condenser for oil clogging. Clean and flush the condenser to ensure the free passage refrigerant or renew the condenser.
4. Renew the receiver-drier.
5. Evacuate the system using a vacuum pump Recharge the system with new refrigerant. Operate the system and check the performance

Moisture in the System

Complaint.

Cooling not adequate during the hot part of the day.

Note: Cooling may be satisfactory during early morning / late evening but inadequate during the hot part of the day.



Condition.

1. The low side gauge reading normal but may drop into vacuum during testing.
2. The high side gauge reading normal but drops when the low side drops into vacuum. The sight glass may show tiny bubbles.
3. The discharge air from the evaporator is cold but becomes warm when the low side gauge drops into vacuum.

Diagnosis.

Excessive moisture in the system.

Desiccant agent saturated with moisture which is released during high temperatures. The moisture collects and freezes in the expansion valve which stops the refrigerant flow.

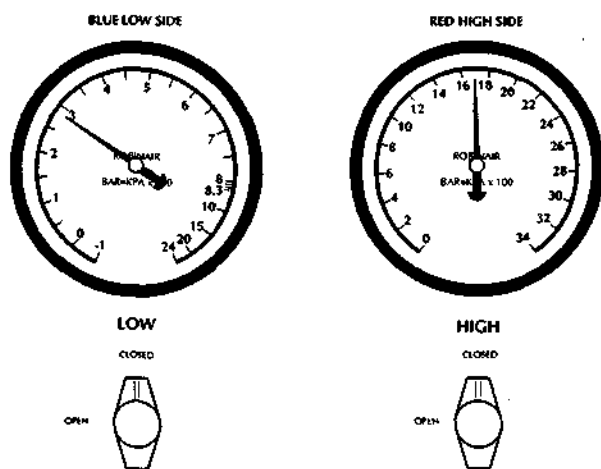
Correction.

1. Depressurise the system.
2. Renew the drier bottle.
3. Evacuate the system using a vacuum pump.
4. Recharge the system with new refrigerant.
5. Operate the system and check the performance.

A Large Amount of Air in the System.

Complaint.

Little or no cooling.



Condition.

The low side gauge reading is too high. The high side gauge reading is too high. An occasional bubble in the sight glass. The discharge air from the evaporator is not cool.

Diagnosis.

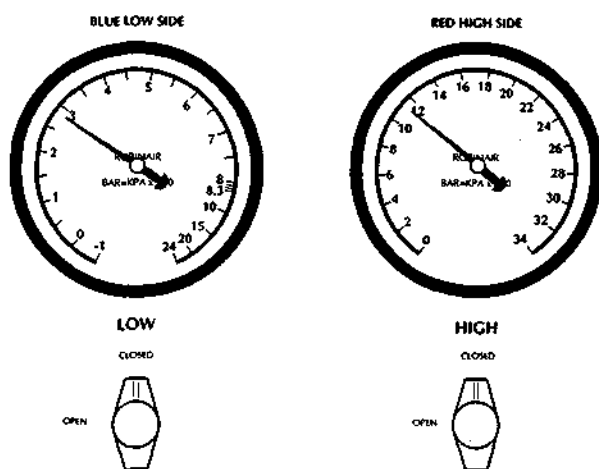
Air in the system. The refrigerant contaminated by non-condensables (air and/or moisture).

Correction.

1. Depressurise the system.
2. Renew the receiver-drier.
3. Evacuate the system using a vacuum pump.
4. Recharge the system with new refrigerant.
5. Operate the system and check the performance.

Expansion Valve Malfunction.

The valve stuck open.



Complaint.

Little or no cooling.

Condition.

The low side gauge reading is too high.

The high side gauge reading is normal or slightly low.

The discharge air from the evaporator is warm. The suction hose and the evaporator show signs of heavy sweating.

Diagnosis.

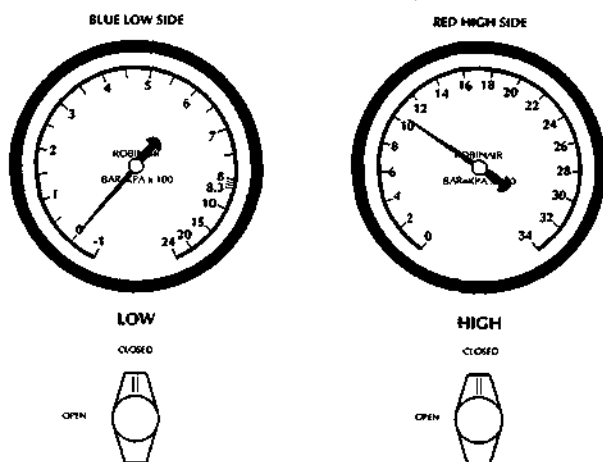
The expansion valve allowing excessive flow of refrigerant through the evaporator coils causing flooding of the coils.

Correction.

1. Depressurise the system.
2. Renew the expansion valve.
3. Renew the drier bottle.
4. Evacuate the system using a vacuum pump.
5. Recharge the system with new refrigerant.
6. Operate the system and check the performance.

Expansion Valve Malfunction

The valve stuck closed.



Complaint.

Cooling is not adequate.

Condition.

1. The low gauge reading is too low (0 or a vacuum).
2. The high side gauge reading is too low.
3. The discharge air from the evaporator only slightly cool.
4. The expansion valve shows signs of heavy sweating or frost.

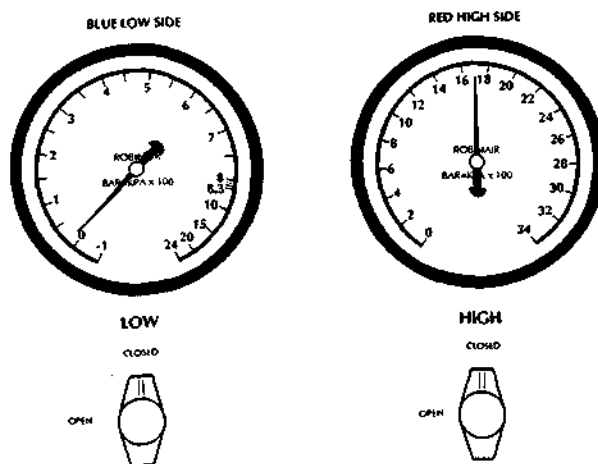
Diagnosis.

The expansion valve restricting the refrigerant flow.

Correction.

1. Depressurise the system.
2. Renew the expansion valve.
3. Renew the drier bottle.
4. Evacuate the system using a vacuum pump.
5. Recharge the system with new refrigerant.
6. Operate the system and check the performance.

Restriction in the High Pressure Side.



Complaint.

Cooling is not adequate.

Condition.

1. The low side gauge reading is low.
2. The high side gauge reading builds up to an excessively high reading.
3. The discharge air only slightly cool.
4. The high pressure liquid hose from the drier bottle to the evaporator is cool to the touch or shows signs of heavy sweating or frost.

Diagnosis.

A restriction in the receiver-drier or the high pressure liquid hose from the drier bottle. Which results in the compressor removing refrigerant from the evaporator faster than it can enter. This results in a starved evaporator.

Correction.

1. Depressurise the system.
2. Renew the drier bottle and/or the high pressure liquid hoses or other defective parts.
3. Evacuate the system using a vacuum pump.
4. Recharge the system with new refrigerant.
5. Operate the system and check the performance.

Torque Levels for the Hose Connections

COMPONENT	TORQUE	Nm
Evaporator Hose		
Hose to Expansion Valve	32.0 ±	4.0
Hose to Compressor	34.0 ±	2.0
Condenser Hose		
Hose to Compressor	34.0 ±	2.0
Hose to Compressor	25.0 ±	4.0
Condenser Pipe		
Pipe to Drier Bottle	6.0 ±	1.5
Evaporator Pipe		
Pipe to Expansion Valve	16.0 ±	1.5

Air Conditioning Procedures**Depressurising**

Note: Observe all safety precautions and do not smoke while carrying out the following procedures.

1. With the engine switched off, remove the protective caps from the schrader valves.
2. Ensure the manifold gauge set hand valves are in the closed position, then by using the access valve core remover connect the manifold gauge set to the system with the red hose to the high pressure side and the blue hose to the low pressure side.
3. Screw out the valve core to allow the refrigerant to flow.
4. Place the centre hose of the manifold set into a suitable container.
5. Slowly open the high or low side manifold hand valve and adjust the valve for a smooth refrigerant flow. Watch the refrigerant for any signs of escaping oil and adjust the hand valve to prevent any oil escaping.
6. If oil is lost during the discharge, the compressor oil level must be checked and if necessary topped up.
7. As the discharge rate slows down, open the other manifold hand valve so that refrigerant flows from both high and low pressure sides of the system.
8. Constantly adjust the hand valves to ensure that oil does not flow. When a zero reading is shown on both high and low pressure gauges the system is discharged.
8. Close both manifold hand valves.

Recovering Refrigerant

Caution: The Recovery-Recycle-Recharging equipment has special fittings to avoid cross contamination with R-12 systems. Do not attempt to adapt this unit for R-12 as system failure will result.

Warning: Follow the safety procedures as defined at the beginning of the section.

Caution: The unit's overfill limitation mechanism has been calibrated specifically for use with the 50 lb. (23 Kg) refillable refrigerant tank.

As the refrigerant is recovered it is passed through an oil separator and a filter drier before it is allowed to enter the refrigerant tank. When it is dry the moisture indicator turns green.

Recovery Procedure

Note: Run the air-conditioning system for a few minutes before starting the recovery procedure as this will enable more refrigerant to be recovered. Turn the system off before starting the procedure.

1. Attach the red (high side) hose of the unit to the high side fitting of the system on the vehicle then fit the blue (low side) fitting to the low side on the vehicle.

Note: Make sure that the Air conditioning system has pressure in it before beginning the recovery process; if there is no system pressure there is no refrigerant to recover. Also make sure that the oil drain valve is closed.

2. Open both the high and low side valves on the control panel.
3. Open the red GAS (vapour) valve and the blue LIQUID valve on the tank.
4. Turn on the MAIN POWER switch.
5. Press the RECOVERY key on the key-pad. The display shows that the unit is in the RECOVER mode and AUTOMATIC cycle. After the compressor starts the display shows the weight of refrigerant being recovered. The compressor shuts off automatically when the recovery is complete and the display shows the message 'CPL' and the final weight of the recovered refrigerant.

6. Wait for five minutes and watch the manifold gauges for a rise above 0. If a rise occurs press the HOLD/CONT key. Repeat as needed until the system pressure holds for two minutes.

Note: Drain the oil separator after each job.

7. Slowly open the oil drain valve and drain the oil into the oil catch bottle. When all the recovered oil has completely drained close the valve.
8. Replace oil lost during the recovery procedure by measuring the amount of oil in the catch bottle and adding the same amount of new oil to the system.
Note: Dispose of the recovered oil in an approved way.
9. When the recovery tank is full the compressor is shut off and the display shows the message FULL.

Evacuating and Recycling the Refrigerant

1. Open the red (high side) and the blue (low side) valves on the unit and open the red GAS (vapour) valve and the blue LIQUID valve on the tank.
2. Enter the required time using the key-pad, press enter, the display shows the entered time in minutes.
3. Start the vacuum pump by pressing the VACUUM KEY again. The recycling process begins approximately five seconds after the vacuum pump starts and the message RECYCLE is displayed.

Note: If the vacuum pump has run for ten hours or over without an oil change the message OIL flashes on the display. Change the pump oil and then press the SHIFT/RESET key and the zero key to reset the oil change timer to zero.

The digital display counts down the evacuation time.

4. Check for non-condensibles after five minutes recycling. If the gauge needles are more than 10 psi apart purge the non-condensibles from the tank by opening the purge valve on the back of the unit and continue to bleed until both needles show the same reading.

The vacuum sequence continues until the programmed time has elapsed at which point the message CPL is displayed.

5. If the moisture indicator turns green recharge with refrigerant.
or
5. If the moisture indicator has not turned green replace the unit's filter-drier, which is probably saturated.

Note: Pressing any key at this point allows the next function to be accessed.

To recycle the refrigerant only without pulling a vacuum for an indefinite period of time press the SHIFT/RESET key and the RECYCLE key on the key-pad. Press the SHIFT/RESET key to cancel.

For vacuum only press the SHIFT/RESET key and the ENTER key and then press "1". Run the vacuum pump as long as required and then press "1" or press SHIFT/RESET to cancel.

Recharging the System

1. Open the high side valve on the unit control panel. If the messages PROGRAM and CHARGE are not displayed press the CHG key to enter PROGRAM mode.
2. Key in the amount of refrigerant needed to recharge the system and press ENTER.
3. Press the CHG key; the message AUTOMATIC and the entered amount of refrigerant will be displayed. The display counts down to zero as the charging process proceeds. When the charging is complete the message CPL is displayed.

If the refrigerant transfer is too slow the charging unit emits a signal. If the message CHECK REFRIGERANT is not displayed, close the high side valve, open the low side valve and start the air conditioning system to pull the remainder of the charge into the system.

If the refrigerant transfer will not complete and the message CHECK REFRIGERANT is displayed, press the HOLD/CONT key to interrupt the cycle then reset the unit by pressing the RESET key. Recover the refrigerant already charged into the system by following the procedure for recovering the refrigerant, add new refrigerant to the tank and return to Step 1 to recharge the system.

4. If the air conditioning system is not running start it and let it run until the gauge pressure readings stabilize (compare the gauge readings with the system manufacturer's specifications).

Note: Ensure that the readings are accurate by closing both the high and low side valves on the unit's control panel.

5. Check the evaporator outlet temperature to make sure that the air conditioning system is operating properly (refer to the system manufacturer's specifications for the proper temperature).

Compressor Oil Check

Data

Special Tools

Sanden oil dipstick JD 149

Torque Figures

Oil filler plug 8-12 Nm

Procedure

Whenever a component has been replaced in the refrigerator system or there is an obvious oil leak, the following procedure should be carried out.

A Sanden oil dipstick and angle gauge are required in order to carry out the check.

1. Run the compressor for 10 minutes at engine idle speed.
2. Depressurise the system.
3. Lay the angle gauge across the flat surfaces of the two front mounting lobes. Centre the bubble and note the mounting angle.
4. Remove the compressor from the vehicle.
3. Remove the plug from the oil filler hole (1 Fig. 1).
4. Rotate the counter weight (3 Fig. 1) on the front of the clutch to allow the dipstick (2 Fig. 1) to penetrate to its fullest extent.

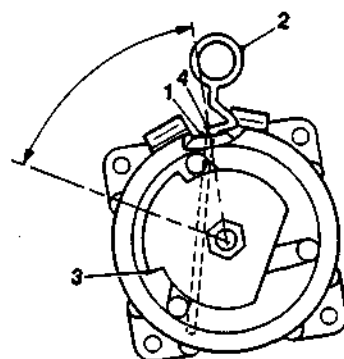


Figure 1.

5. Insert the dipstick to its stop position (4 Fig. 1). The point of dipstick angle should be facing left.
6. Remove the dipstick and check the oil level against the figures quoted in the chart below.

Mounting Angle	Acceptable Oil Level
Degrees	Increments
0°	3- 5
10°	4- 6
20°	5- 7
30°	6- 8
40°	7- 9
50°	8 - 10
60°	9 - 11
90°	10-12

If the level indicated on the dipstick does not match the increments given in the table for a particular mounting angle, add or subtract oil to the midpoint value.

7. Ensure that the "O" ring seal and seat are clean. Coat the seal with compressor oil and refit the oil filler plug.
8. Torque tighten the plug to 8-12 Nm. Do not over tighten the plug to stop a leak. If necessary, remove the plug and fit a new oil seal.
9. Refit the compressor.
10. Recharge the system with refrigerant.

8.1.01.1 Compressor Removal/Renewal

Procedure

1. Open the bonnet and fit a wing cover.
2. Depressurise the air conditioning system.
3. Disconnect the low and high pressure hoses from the rear of the compressor. Plug the hose ends to prevent the ingress of dirt.
6. Remove the compressor pivot bolt securing nut.
7. Carefully separate the muffler from the compressor and remove and discard the 'O' ring seal.
8. Fit a blanking plug to the muffler and a blanking plate to the compressor, fit and tighten the bolt that secures blanking plate.
9. Raise the vehicle to working height on a ramp.

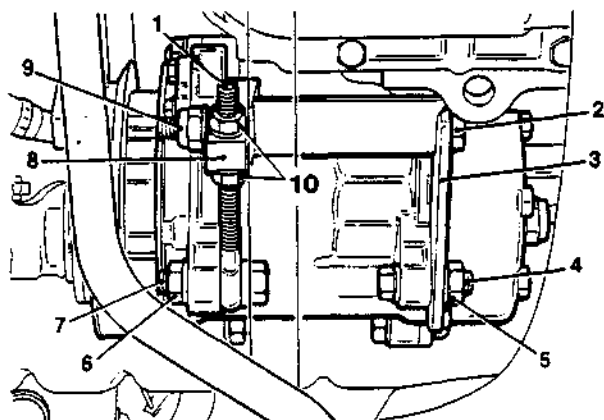


Figure 1.

10. Slacken the compressor drive belt adjuster rod and adjuster plate securing nuts and bolts (Fig. 1-4, 5, 6 and 7)
11. Slacken adjuster nut (Fig. 1-10).
12. Remove the nut and bolt (Fig. 1-4 and 5) from adjuster plate (Fig. 1-3).
13. Slacken trunnion nut and bolt (Fig. 1-9 and 2) and remove the adjuster rod (Fig. 1-1).
14. Disconnect the compressor multi-plug.
15. Remove the compressor drive belt.
16. Pivot the compressor away from engine, support the compressor and remove the top pivot bolt and lift the compressor clear of the vehicle.
17. Remove the mounting brackets from the compressor.
26. Lift the compressor up to the engine and fit the top pivot bolt (Fig. 1-2) from above.
27. Attach adjustment rod loosely to the compressor (Fig. 1-1) with nut and bolt (Fig. 1-6 and 7).
28. Loosely attach adjustment plate (Fig. 1-3) to the compressor with nut and bolt (Fig. 1-4 and 5).
29. Fit bolt (Fig. 1-2) through trunnion (Fig. 1-8) and fit nut (Fig. 1-9) to the bolt.
30. Fit the drive belt over the pulley, move the compressor away from the engine to tension the drive belt and lightly tighten the bolts and nuts.
31. To obtain the correct tension on the drive belt tighten adjuster nuts (Fig. 1-10). The belt is correctly tensioned when a load of 59- 63.6 kg (130 -140 lb) applied at the centre deflects the belt 4 mm.
32. Ensure that all securing bolts and nuts are fully tightened.
33. Lower the vehicle to the ground.
34. Remove the blanking plate and the blanking plugs from the compressor.
36. Fit new 'O' ring seals to the low and high pressure hoses and connect them to the compressor. Fit the retaining plate, fit and tighten the screw.
38. Charge the air conditioning system.
39. Remove the wing cover and close the bonnet.

8.1.02.1 Field Coil Renewal

Procedure

1. Open the bonnet and fit a wing cover.
2. Depressurise the air conditioning system.
3. Remove the compressor.
4. Remove the compressor drive clutch.
5. Remove the compressor pulley.
6. Slacken the field coil wire clamp screw (Fig. 1) and release the wire from the clamp.

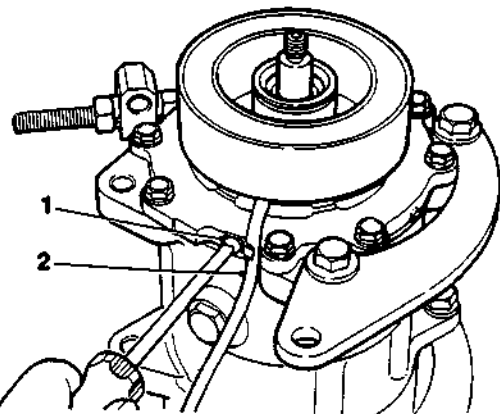


Figure 1.

7. Remove the field coil retaining snap ring and detach the field coil.
8. Clean the mating face of the compressor with a cloth moistened with an approved cleaning fluid.
9. Position the new field coil on the compressor and fit the retaining snap ring.
10. Route the wire to the compressor and fit the wire clamp, tighten the securing screw.
11. Fit the compressor pulley.
12. Fit the compressor drive clutch.
13. Fit the compressor.
14. Recharge the air conditioning system.
15. Remove the wing cover and close the bonnet.

8.1.03.1 Renew Gasket Kit

Data

Torque Figures

Cylinder head bolts 29.83 to 33.9 Nm.

Procedure

1. Open the bonnet and fit a wing cover.
2. Depressurise the air conditioning system.
3. Remove the compressor.
4. Position the compressor in a vice, tighten the vice onto the compressor body lugs.
5. Remove the outlet port blanking plate securing bolt and detach the plate.
6. Remove and discard the 'O' ring seals from the outlet port.
7. Remove the compressor cylinder head securing bolts, detach the cylinder head.
8. Detach the valve plate from the compressor.
9. Remove the gaskets from the compressor.
10. Remove all traces of gasket material from the mating surfaces of the cylinder head, valve plate and cylinder block.

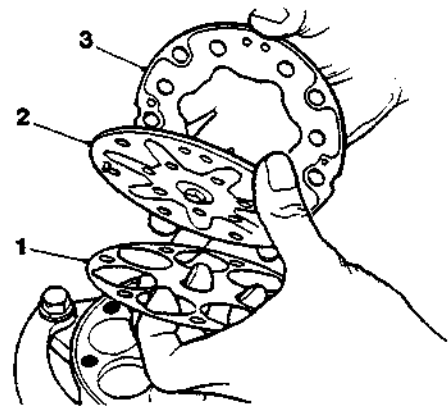


Figure 1.

11. Position new gaskets (Fig. 1-1 and 3) on the valve plate (Fig. 1-2) and then place it on the cylinder block.

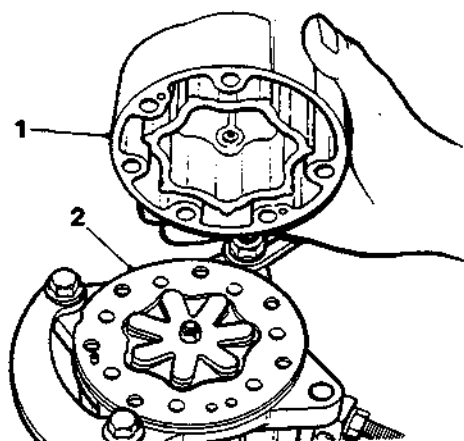


Figure 2.

12. Position the cylinder head (Fig. 2-1) on the cylinder block (Fig. 2-2), fit and tighten the securing bolts in the sequence shown in Fig. 3.

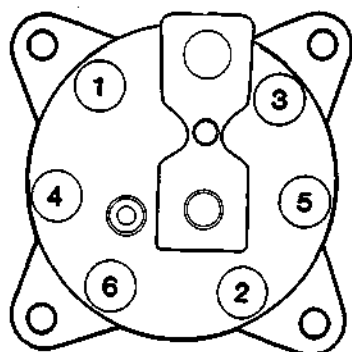


Figure 3.

13. Fit new 'O' ring seals in the compressor outlet port, position the outlet port blanking plate and fit and tighten the securing bolt.
14. Check and top up compressor oil
15. Refit the compressor.
16. Recharge the air conditioning system.

8.1.04.1 Valve Plate Renewal

Data

Torque Figures

Cylinder head bolts 29.83 - 33.9 Nm

Procedure

1. Open the bonnet and fit a wing cover.
2. Depressurise the air conditioning system.
3. Remove the compressor.
4. Position the compressor in a vice, tighten the vice onto the compressor body lugs.
5. Remove the outlet port blanking plate securing bolt and detach the plate.
6. Remove the 'O' ring seals from the compressor outlet port.

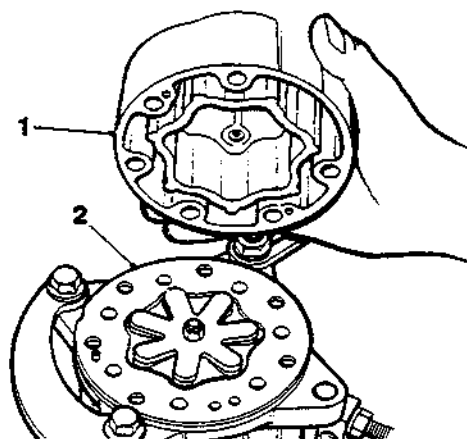


Figure 1.

7. Remove the cylinder head securing bolts and detach the cylinder head (Fig. 1-1) from the cylinder block.
8. Remove valve plate (Fig. 1-2) from the compressor.
9. Remove all traces of gasket material from the mating surfaces of the cylinder head and compressor.
10. Apply clean refrigerant oil to the gaskets and then position them on the valve plate.

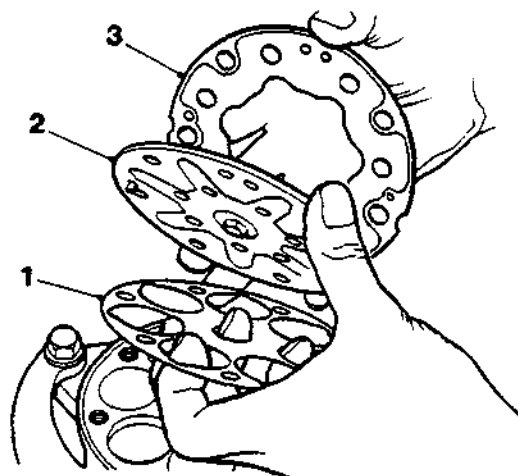


Figure 2.

11. Position valve plate and gaskets (Fig. 2-1 and 2) on the compressor and fit the cylinder head.
12. Tighten the cylinder head securing bolts in the order shown in Fig. 3.

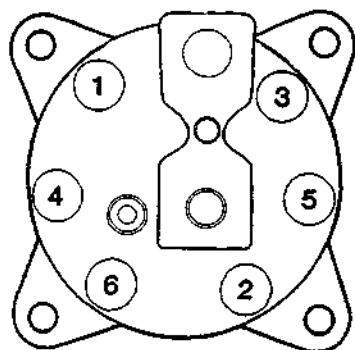


Figure 3.

13. Fit new 'O' rings to the outlet port blanking plate, position the plate on the compressor and fit and tighten the securing bolt.
14. Check compressor oil and top up in necessary.
14. Refit the compressor.
15. Remove the wing mat and close the bonnet.

8.1.05.1 Expansion Valve Renewal

1. Depressurise the air conditioning system.
2. Undo the pipe to expansion valve clamp bolt and retaining plate and disconnect the pipes (Fig. 1)

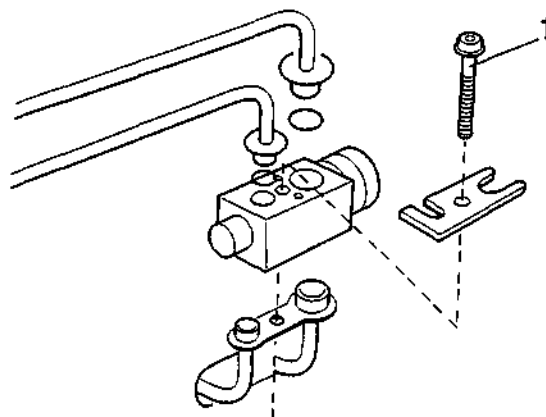


Figure 1.

3. Fit blanking plugs to the expansion valve and to the pipes.
4. Reposition the pipes to one side.
5. Unscrew the two torx head retaining screws and remove the expansion valve from the air conditioning unit (Fig. 1-1).
6. Remove and discard the 'O' rings.
7. Fitting a new valve is the reversal of the removal procedure.
8. Ensure new 'O' rings to all union connections are fitted.
9. Evacuate the system.
10. Recharge the system.

8.1.06.1 Hose-Compressor to Evaporator Renewal**Procedure**

1. Open the bonnet and fit a wing cover.
2. Depressurise the air conditioning system.
3. Remove the hose to evaporator valve clamping plate, disconnect the hose from the valve, remove and discard the 'O' ring seal.
4. Fit a blanking plug to the evaporator valve. Release the evaporator hose securing clips.
5. Remove the compressor outlet port retaining bolt.
6. Disconnect the hose from the compressor, discard the hose complete with 'O' ring seals.
7. Connect the hose to the evaporator valve and tighten clamp onto the hose.
8. Route the hose to the compressor, fit a new 'O' ring seal and connect it to the compressor.
9. Position the outlet port retaining plate on the compressor, fit and tighten the securing bolt.
10. Refit the hose to the clips.
11. Charge the air conditioning system.
12. Remove the wing cover and close the bonnet.

8.2.01.1 Air Conditioning Unit Renewal

1. Disconnect the battery earth lead.
2. Drain the engine coolant into a suitable container.
3. Depressurise the air conditioning system.
4. Disconnect the high and low pressure hoses and expansion valve from the air conditioning unit (see expansion valve renewal).
5. Slacken the coolant hose to the heater matrix pipe securing clips and disconnect the hoses from the matrix. (This will require the removal of the air intake hose for access.)
6. Remove the following items from inside the car:
 - front seats
 - underscuttle panels/knee bolsters
 - glove box assembly
 - facia trim (walnut trim)
 - radio and ashtray
 - centre console switch panel assembly
 - instrument panel and surround trim
 - steering wheel and column
 - facia assembly complete
 - hoses - distribution box to door vents
 - facia support frame

Details and drawings of the above operations can be found in the electrical and trim sections.

7. Disconnect the vacuum hoses from the blower motors, water valve and reservoir.
8. Un-clip the electrical harness from the air conditioning unit, release the electrical connections and reposition the harness to allow removal of the unit.
9. Displace and remove the footwell ventilator ducts and hoses (Fig. 1-1).

10. Disconnect the pliable trunking from the unit (Fig. 1-2).

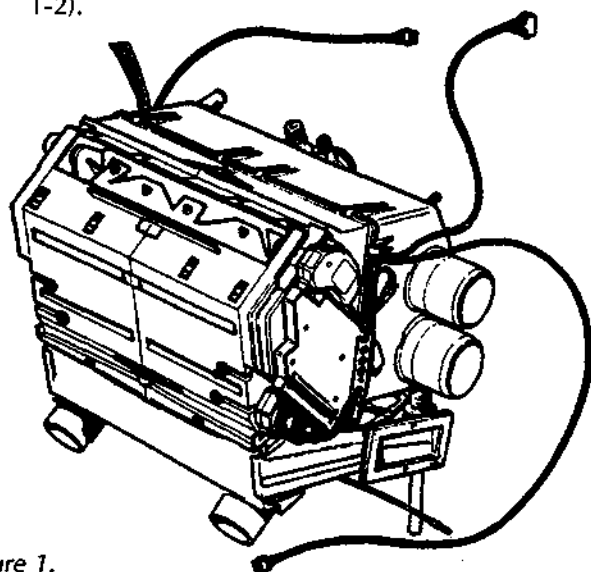


Figure 1.

11. Twist and pull out the four air conditioning unit stub pipes (Fig. 1-3)
12. Remove the screws securing the air conditioning unit support stays.
13. Displace the tunnel carpet for access to the lower fixing bolts and remove the stays.
14. Disconnect the condensate drain tubes.
15. Peel off the tape securing the windscreen demist duct to the distribution box (Fig. 1-4).
16. Remove the air conditioning unit to bulkhead securing nuts.
17. Carefully lift out the air conditioning unit complete with the distribution box.
18. Remove the distribution box securing screws and remove the assembly (Fig. 1-5).
19. Reverse the removal procedure to refit the air conditioning unit.

Note: Ensure new 'O' rings are fitted to all air conditioning hose connections.

8.2.02.1 Evaporator Unit Renewal

1. Remove the air conditioning unit assembly.
2. Remove the heater pipe guide plate securing screws and remove the guide plate.
3. Remove the screws securing evaporator sensor and withdraw the sensor from the evaporator.
4. Remove the screws securing the solenoid mounting plate and displace the mounting plates from the unit.
5. Remove the harness to casing earth bolt and displace the harness.
6. Cut and remove the harness to casing securing ratchet straps and displace the harness from the casing.
7. Displace the vacuum hose from the casing.
8. Displace and remove the casing securing clips.
9. Split the casing and remove the evaporator from the unit.
10. Remove the expansion valve guide securing screws and remove the plate.
11. Displace and remove the plate from the evaporator.
12. Fitting the new evaporator is the reversal of the removal procedure.
13. Refill the engine cooling system with coolant.
14. Recharge the air conditioning system.

8.2.03.1 Upper Servo Feedback Potentiometer Renewal

1. Disconnect the battery earth lead.
2. **(On left hand cars)** Remove the instrument pack and surround trim.
2. **(On right hand cars)** Remove the glove box assembly.
3. Remove the securing screws and the potentiometer assembly. Disconnect the electrical connector.
4. Fitting a new potentiometer is the reverse of the removal procedure.

8.2.04.1 Lower Servo Feedback Potentiometer Renew

1. Disconnect the battery earth lead.
2. Un-clip and remove the left hand underscuttle casing.

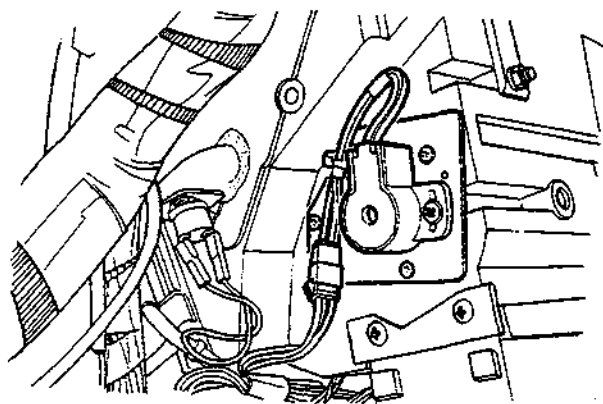


Figure 1.

3. Disconnect the electrical block connector (Fig. 1).
4. Remove the securing screw and the potentiometer assembly.
5. Fitting a new potentiometer is the reversal of the removal procedure.

8.2.05.1 Upper Flap Motor Assembly Renew

1. Disconnect the battery earth lead.
2. Remove the electronic control module.
3. Disconnect the motor block connector.
4. Remove the securing screws and motor assembly (Fig 1).

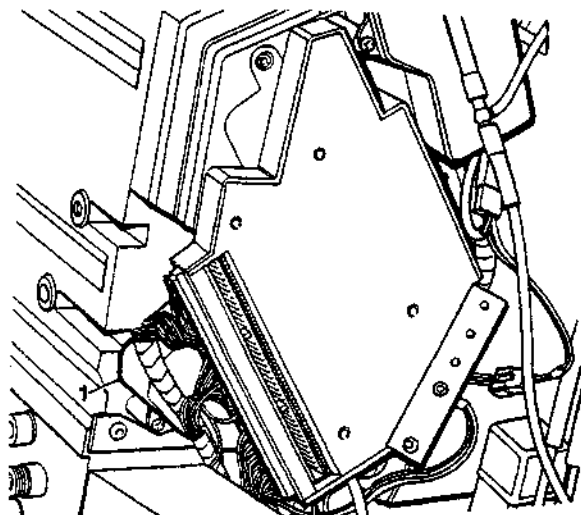


Figure 5.

5. Fitting a new motor is the reverse of the removal procedure.

8.2.06.1 Lower Flap Motor Assembly Renew

1. Disconnect the battery earth lead.
2. Remove the right hand side underscuttle casing.
3. Remove the electronic control unit.
4. Disconnect the block connector.
5. Remove the screws securing the motor to the air conditioning unit.
6. Displace the 'P' clip.
7. Withdraw and remove the motor from the air conditioning unit .
8. Fitting a new motor is the reversal of the removal procedure.

8.2.07.1 Ambient Temperature Sensor Renew

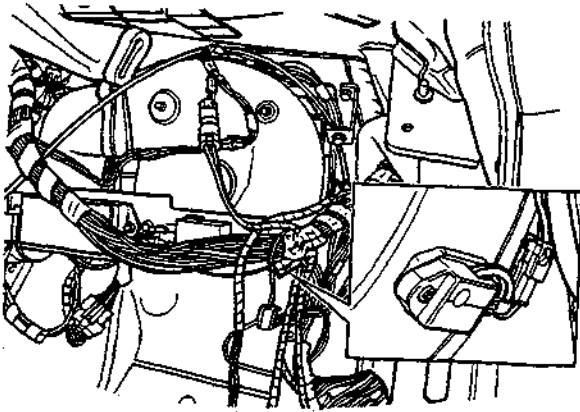


Figure 1.

The ambient temperature sensor is located in the left hand side of the air plenum chamber under the lower windshield panel (Fig. 1-1).

Procedure

1. Disconnect the battery earth lead.
2. **(On left hand cars)** Remove the steering wheel (mark the position on the column shaft for re-assembly), instrument pack and surround trim.
2. **(On right hand cars)** Remove the glove box lid and liner.
3. Disconnect the hose from the distribution box to the side vent outlet. Reposition the hose for access.
4. Disconnect the sensor block connector.
The sensor has locating clips and is a push fit into the plenum chamber.
5. Lever the sensor free.

8.2.08.1 Blower Motor Driver Side Renewal

8.2.09.1 Blower Motor Passenger Side Renewal

1. Move seat fully rearward.
2. Disconnect vehicle battery ground lead.
3. Remove the under scuttle/knee pad bolster.
4. Remove the lower brace bar/facia assembly underscuttle knee pad.

Driver Side Only

5. Remove the instrument pack, bonnet release handle mounting bracket and steering column..
6. Disconnect the air hose from the facia side air outlet.

Passenger Side Only

7. Remove the glove box lid and liner.

Both

8. Remove the nuts securing the component panel (Fig. 1-1).

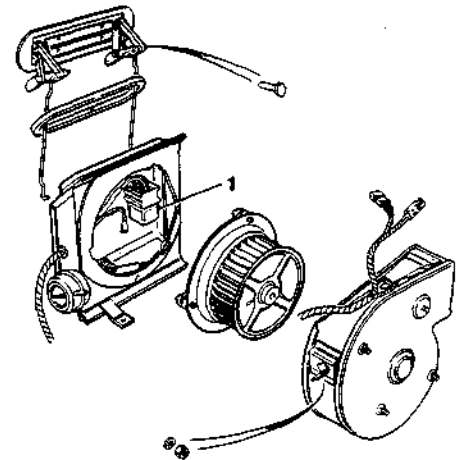


Figure 1.

9. Ease the component panel clear for access to the blower assembly mounting bolts.
10. Disconnect the pliable trunking from the stub pipes on either side of the air conditioning unit (Fig. 1-3).
11. Disconnect the blower motor electrical harness at the block connector.

12. Disconnect the vacuum pipe from the flap actuator (Fig. 1-4).
13. Open the re-circulation flap in the base of the blower assembly and fit a wedge to retain it in the open position (Fig. 1-5).
14. Remove the bolts securing the blower assembly and ease the blower unit from its location (Fig. 1-6).
15. Remove the tape securing the ducting to the assembly and remove the ducting (Fig. 1-7).

Note: To remove the blower motor assembly from the vehicle, the lower flap must be opened to allow the upper flap to disengage from the upper body aperture.

8.2.10.1 Blower Assembly Driver/ Passenger Side Overhaul

Note: Blower assemblies under warranty must not be dismantled.

1. Remove the three self tapping screws (Fig. 1-1) from the air intake casing.

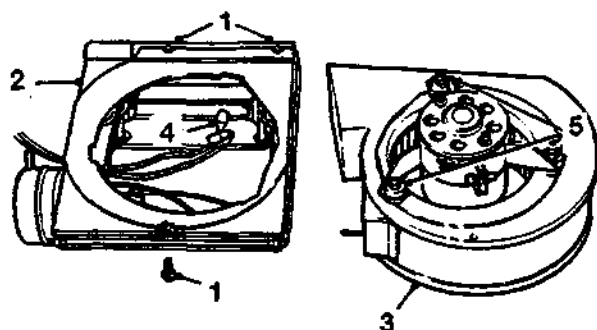


Figure 1.

2. Part the air intake casing (Fig. 1-2) from the motor assembly (Fig. 1-2) and disconnect the electrical connections at the lucar connectors (Fig. 1-4).

Note: Mark the position of the various components with paint or a scribe. This facilitates re-assembly.

3. One lucar connector has a raised projection which matches the aperture in the motor casing to ensure that the connections are replaced correctly and that the rotation of the motor is unaffected.
4. Remove the bolts securing the motor mounting bracket to the fan housing (Fig. 1-5).
5. Remove the motor and fan assembly from the fan housing.
6. Remove the mounting bracket from the motor.
7. Using appropriate Allen key, remove the impellor fan from the spindle.

Re-assembling

1. Refit the fan to the motor and secure it to the spindle.
2. Refit the mounting bracket to the motor.
3. Locate the fan and mounting assembly into the fan housing.

4. Place the flap box assembly to the fan housing and reconnect the electrical connections.
5. Fit and tighten the screws securing the flap box to the housing.
6. Raise the re-circulation flap, fit and tighten the remaining screw.
7. Refit the blower motor assembly.
8. Reconnect the battery earth-ground lead.

8.2.11.1 Blower Motor High Speed Relay Renewal

1. Remove the blower motor assembly complete.

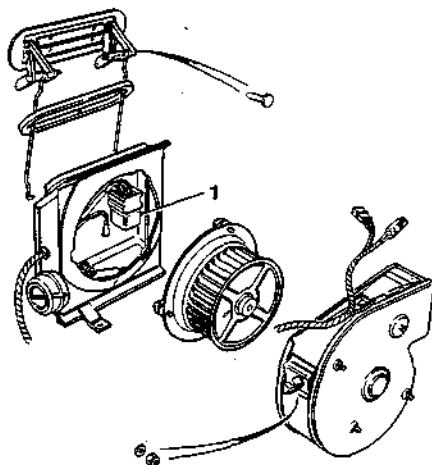


Figure 1.

2. Open the flap for access.
3. Using a suitable tool remove the relay from the blower assembly (Fig. 1-1).
4. Fit a new relay and refit the blower motor assembly.

8.2.12.1 Water Temperature Switch Renewal

1. Disconnect the battery earth lead.
2. Un-clip and remove the left hand underscuttle casing.

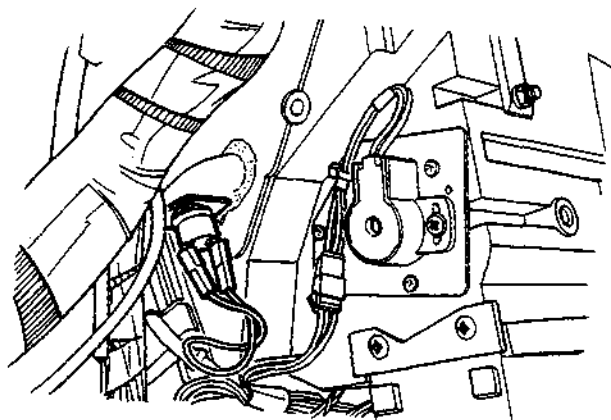


Figure .

3. Note and disconnect the feed wires from the switch (Fig. 1-1).
4. Displace and remove the switch from the water pipe.
5. Fitting a new switch is the reversal of the removal procedure.

8.2.13.1 Heater Matrix Renewal

1. Disconnect the battery earth lead.
2. Remove the left hand underscuttle panel.
3. **(On right hand cars)** Remove the glove box assembly.
3. **(On left hand cars)** Remove the instrument pack and surround trim, steering column and mounting bracket.
4. Drain the coolant into a suitable container.
5. Remove the matrix cover panel securing screws.
6. Remove the rear panel, displace the front panel and foam seal for access.
7. Place rag in position.
8. Remove screws securing the feed pipe and disconnect the pipe from the matrix.
9. Remove and discard the gasket.
10. Remove the screws securing the feed pipe and disconnect the pipe from the matrix.
11. Remove and discard the gasket.
12. Disconnect the water temperature switch feed wires.
13. Remove the foam pad from the pipes.
14. Remove the front panel from the unit.
15. Undo the heater hose matrix pipe hose clips and disconnect the hoses from the pipes.
16. Reposition the pipes from the matrix.
17. Remove the matrix from the air conditioning unit.
18. Fitting a new matrix is the reversal of the removal procedure.
19. Ensure that new gaskets are fitted.

8.2.14.1 Electronic Control Module Renew

1. Disconnect the battery earth lead.
2. Remove the right hand underscuttle casing.
3. **(On left hand cars)** Remove the glove box assembly.
3. **(On right hand cars)** Remove the instrument pack and surround trim.
4. Disconnect the earth wire and three block connectors from the control module (Fig. 1-2).
5. Remove the securing screws and module from the air conditioning unit (Fig. 1-1).

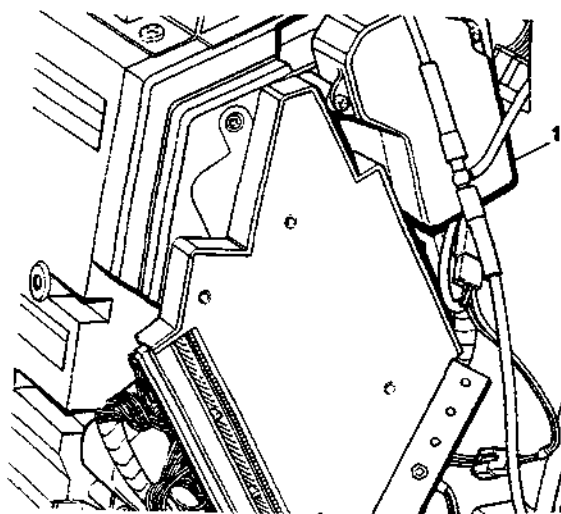


Figure 1.

6. Fitting a new module is the reversal of the removal procedure.

8.3.01.1 Vacuum System Solenoid Renewal

The flaps in the cabin air distribution vents and the water valve in the pipe line from the engine coolant system to the heater matrix are all operated by vacuum actuators. The vacuum for these is supplied by four solenoids mounted in a manifold pack located behind the front left hand footwell outlet. Failure of a solenoid will require replacement of the manifold pack.

Procedure

1. Disconnect the battery earth lead.
 2. Remove the following:
 - glove box and lid
 - facia trim (walnut strip)
 - radio and ashtray
 - centre console switch assembly
 - left hand underscuttle casing/knee bolster
- Details of the above operations can be found in the trim and the electrical sections.
2. Remove the fixings joining the centre console to the facia. This allows the front of the console to be repositioned for access.
 3. Disconnect the ducting from the left hand footwell outlet.
 4. Remove the two plastic fixings that secure the slotted footwell outlet and slide the outlet out of the unit.
 7. Cut the tie strap holding the vacuum lines and electrical harness to the underside of the air conditioning unit.
 8. Remove the screws that secure the manifold pack to the underside of the air conditioning unit and slide out the plate complete with the manifold pack.
 10. To fit a new manifold pack reverse the steps for the removal.



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The Air Conditioning System Diagnostics

The air-conditioning control module (A/CCM) is located at the right end of the air-conditioning unit.

A digital microprocessor within the A/CCM receives data signals from the operator controlled switches. Comparison of these signals with those returned from the system temperature sensor and feedback devices results in the appropriate voltage changes necessary to vary: blower motor speed, flap positions and system solenoids to respond to the drivers selected temperature demand.

The air from the two blower motors is passed through the evaporator matrix which, depending on the A/C mode selected, removes heat from the incoming air. Depending on the position of the two blend flaps, the cold air passes either directly into the vehicle outlet vents, or is passed through the heater matrix to be reheated and then passed to the vehicle outlet vents.

The amount of air passing through the heater matrix is infinitely variable depending on ambient temperature and the temperature selected within the vehicle.

Air Conditioning Diagnostics

Cable Connections to the A/CCM

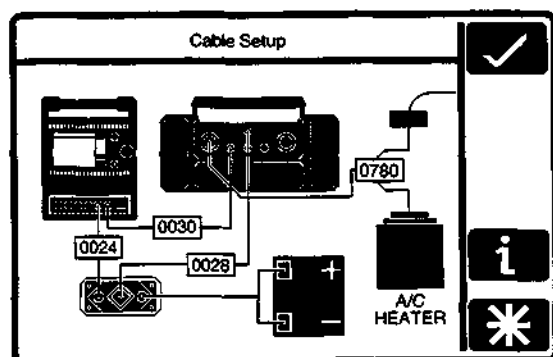


Figure 1. PDU connections to the A/CCM

1. Remove the right side underdash trim panel.
2. Connect the VBA (0024) to the vehicle battery
3. Connect the PDU to the VBA (0024).
4. Connect the VIA to the PDU using the VIA-PDU cable (0030).
5. Connect the AirCon DataLogger harness (0780) between the VIA Channel A and the Air-Conditioning Control Module on the vehicle.

Air Conditioning Signal Monitoring

The following signals can be monitored using the PDU. The abbreviated name of the signal is shown on the PDU display.

Display Name	Full Signal Name
AMBTMP	Ambient temperature sensor
ARECIP	Auto-Recirculation input
ARECOP	Auto-Recirculation output
AUX+	Auxiliary battery positive
CLUREL	Clutch relay drive output
CVSOL	Centre vent solenoid
DEFSOL	Defrost solenoid
DIFF	Temperature differential
EVSEN	Evaporator sensor
FANDEF	Fanspeed defrost
FANHIG	Fanspeed high
FANLOW	Fanspeed low
FANMED	Fanspeed medium
FIVEV	Five volt supply voltage
FORSERL	Lower servo forward drive
FORSERU	Upper servo forward drive
GND10	Ground voltage
GND2	Ground voltage
GND38	Ground voltage
GND45	Ground voltage
GND6	Ground voltage
HSREL	High speed relay drive
ICSEN	In-Car sensor
LBLOFB	Left blower feedback voltage
LBLOWOP	Left blower output voltage
LSERFB	Lower servo feedback potentiometer
MPROBE	Measurement probe
POWIN+	Switched power input
POWOP+	Power output
RBLOFB	Right blower feedback voltage
RBLOWOP	Right blower output voltage
REF	Reference signal
REVSERL	Lower servo reverse drive
REVSERU	Upper servo reverse drive
TEMPDEM	Temperature demand
USERFB	Upper servo feedback potentiometer
WATSW	Water switch
WATVAL	Water valve

The following signals are supported on the Air-Conditioning Control Module. For each signal, The signal name, mnemonic and background information are detailed.

Ambient Temperature Sensor

(AMBTMP)

A/CCM Pin 34 ref Pin 6

This sensor is located in the right hand blower motor. This signal is used to enable the A/C system to compensate for changes in ambient air temperature. The output to pin 34 is 2.732 volts at 0 degrees Celsius and changes by 0.01 volts for each degree Celsius above or below zero.

Auto-Recirculation Input

(ARECIP)

A/CCM Pin 9 ref Pin 6

This is effectively an On/Off switch for the A/C system and forms part of the fan control switch.

Switch Off - Pin 9 should be at ground

Switch On - Pin 9 should be at 10+ volts.

When pin 9 is at ground, pin 3 will be at 10+ volts causing the recirculation flaps to open.

Auto-Recirculation Output

(ARECOP)

A/CCM Pin 3 ref Pin 6

This signal will cause the recirculation flaps to close. Operating conditions should be:

A/C Off - 10+ volts at pin 3, flaps open.

Temp demand minimum - 10+ volts at pin 3, flaps open.

Defrost - 0 volts at pin 3, flaps closed.

Temp demand max - 0 volts at pin 3, flaps closed.

Auxiliary Battery Positive

(AUX+)

A/CCM Pin 1 ref Vehicle Battery -ve

This signal is the auxiliary supply to the A/CCM. Pin 1 should read battery voltage if the ignition switch is in the auxiliary or ignition on positions. Pin 1 should read 0 volts when the ignition switch is in the Off position or in position III whilst cranking the engine. Loss of this supply will cause total failure of the A/C system.

Clutch Relay Drive Output

(CLUREL)

A/CCM Pin 20 ref Pin 6

This signal responds to the input at pin 5 (evaporator sensor). When pin 5 is between 2.715 and 2.725 volts, pin 20 should read below 1 volt, and the compressor clutch will be switched off. When pin 5 is between 2.735 and 2.745 volts, pin 20 will rise to 10+ volts and the compressor will re-engage.

Centre Vent Solenoid

(CVSOL)

A/CCM Pin 18 ref Pin 6

The centre vent solenoid controls the operation of the centre vent flap. The centre vent will open to increase the cooling capabilities of the vehicle when cooling is selected. In all other conditions, the centre vent will be closed.

Solenoid energised: pin 18 should read 10+ volts and the centre vent will be open.

Solenoid de-energised; pin 18 should read below 0.5 volts and the centre vent should be closed.

Defrost Solenoid

(DEFSOL)

A/CCM Pin 11 ref Pin 6

The defrost solenoid controls the operation of the screen vents. When the solenoid is energised, the screen vents will be held closed by the vacuum created. To open the vents the solenoid is de-energised.

The solenoid is energised when a ground supply is provided to pin 11. The solenoid is de-energised when the ground supply is removed, at which point 10+ volts can be read at pin 11.

Temperature Differential

(DIFF)

A/CCM Pin 28 ref Pin 6

This sets the differential between the position of the upper and lower flaps. With minimum differential selected, pin 28 should read between 0 and 100 millivolts. The voltage at pin 28 will rise smoothly as the differential is increased, up to a maximum of 2.885 volts.

Evaporator Sensor

(EVSEN)

A/CCM Pin 5 ref Pin 6

This sensor monitors the temperature of the evaporator matrix, the output is used to trigger the compressor circuit via the A/CCM pin 20. Operating conditions are 2.732 volts at 0 degrees Celsius ± 0.01 volts for every degree Celsius above or below zero.

Fanspeed Defrost

(FANDEF)

A/CCM Pin 27 ref Pin 6

This signal is normally held at 3.6 ± 0.8 volts by the control module. When Defrost is selected from the control panel, the line is pulled down to 0.6 volts or below. This will cause the defrost flaps to open by applying system voltage (approx 11 volts) to pin 11. In addition, both fans will go to full speed i.e. high speed fan relay energised.

Fanspeed High

(FANHIG)

A/CCM Pin 15 ref Pin 6

This signal is generated from the fan speed control switch.

Switch at High, pin 15 should read 0.6 volts.

Switch at Off, L, M or D positions, pin 15 should read 3.6 ± 0.8 volts.

Fanspeed Low

(FANLOW)

A/CCM Pin 13 ref Pin 6

This signal is generated from the fanspeed control switch.

Switch at Low, pin 13 should read 0.6 volts.

Switch at Off, M, H or D positions, pin 13 should read 3.6 ± 0.8 volts.

Fanspeed Medium

(FANMED)

A/CCM Pin 14 ref Pin 6

This signal is generated from the fanspeed control switch.

Switch at Low, pin 14 should read 0.6 volts.

Switch at Off, L, H or D positions, pin 14 should read 3.6 ± 0.8 volts.

Five Volt Supply

(FIVEV)

A/CCM Pin 43 ref Pin 6

This 5 volt rail provides the power supply for all the sensors and the feedback potentiometers. Any variation in this signal would totally upset the balance of the whole system.

Flap Servo Drive Signals

The servo drive signals control the position of the upper and lower flaps. The drive signals work in pairs, two for the upper and two for the lower flaps.

Lower Servo Forward Drive

(FORSERL)

A/CCM Pin 37 ref Pin 6

Upper Servo Forward Drive

(FORSERU)

A/CCM Pin 40 ref Pin 6

Lower Servo Reverse Drive

(REVSERL)

A/CCM Pin 41 ref Pin 6

Upper Servo Reverse Drive

(REVSERU)

A/CCM Pin 42 ref Pin 6

When the flaps are stationary, all signals will be at 0.6 volts approximately. When the flap(s) is being driven, the drive line(s) will rise to approximately 6 volts.

As the flap approaches its final position, the drive signal will be pulsed to nudge the flap to the exact position required.

Note: If a drive signal rises to above 8.5 volts and the servo motor does not operate, suspect an open circuit within the servo.

Ground Voltage

(GND10)

A/CCM Pin 10 ref Pin 6

This is the ground supply from the A/CCM to the in-car sensor and should read below 10 millivolts.

Failure of this line will cause the in-car sensor to believe the vehicle temperature to be at maximum all the time, thus forcing the system into permanent cooling. Under these circumstances, pin 4 (in-car sensor output) will be approximately 5 volts.

Ground Voltage

(GND2) A/CCM Pin 2 ref Pin 6

Ground Voltage

(GND38) A/CCM Pin 38 ref Pin 6

Ground Voltage

(GND45) A/CCM Pin 45 ref Pin 6

Ground Voltage

(GND6) A/CCM Pin 6 ref Battery -ve

The four ground signals above must be at battery negative voltage at all times.

High Speed Relay Drive

(HSREL) A/CCM Pin 16 ref Pin 6

The high speed relay drive signal is used to energise the high speed relay and to run the blowers at full speed, bypassing the normal fan control circuit. The high speed relay will be energised whenever Defrost or High speed Fans is selected.

Relay energised, pin 16 should read 10+ volts

Relay de-energised, pin 16 should read below 0.5 volts.

If the signal at pin 16 is correct but only one fan responds, suspect a fault in the harness or relay.

In-Car Sensor

(ICSEN) A/CCM Pin 4 ref Pin 6

The in-car temperature sensor operates in the range 0-5 volts. Actual output is 2.732 volts at 0 degrees Celsius ± 0.01 volts for every degree Celsius above or below zero. The sensor signal forms a reference point for the whole system.

If the signal on this pin remains at less than 1 volt, suspect either a short to ground on the signal wire or an open circuit on the 5 volt supply line to the sensor.

If the signal rises to approximately 3 volts, then suspect an open circuit on the ground supply to the sensor.

Left Blower Feedback Voltage

(LBLOFB)

A/CCM Pin 22 ref Pin 6

This signal informs the control module of the present voltage applied to the left blower. The control module can then monitor and vary this voltage to change blower motor speed. With Manual selected, the blower operates in four basic ranges:

Low SpeedTemp Min: pin 22 = 5 ± 1 voltTemp Med: pin 22 = 9 ± 1 voltTemp Max: pin 22 = 5 ± 1 volt**Medium Speed**Temp Min: pin 22 = 2 ± 1 voltTemp Med: pin 22 = 6 ± 1 voltTemp Max: pin 22 = 2 ± 1 volt**High Speed**Pin 22 = 1 ± 1 volt at all temperature settings**Defrost**Pin 22 = 1 ± 1 volt at all temperature settings**Left Blower Output Voltage**

(LBLOWOP)

A/CCM Pin 31 ref Pin 6

This signal is produced by the control module to drive the blower motor. The signal can vary from 0-3 volts depending on blower motor speed. The higher the voltage, the higher the blower motor speed. This signal is amplified by a simple amplifier circuit inside the blower motor. This circuit also supplies the feedback signals to pins 22 and 33.

Note: If the signal rises above 5 volts, then suspect a fault in the amplifier circuit.

Lower Servo Feedback Potentiometer

(LSERFB)

A/CCM Pin 29 ref Pin 6

This feedback signal informs the control module of the exact position of the flaps, enabling accurate control of flap position.

Defrost - Lower flap signal should be 2.9 volts (flap closed) upper flap signal should read 1.9 volts.

Max Temp - Lower flap signal should read 1.14 volts, upper flap signal should read 1.9 volts.

Min Temp - Both lower and upper flap signals should read 130 ± 80 millivolts.

Note: If the feedback sticks low, with the fan continually running, suspect an open circuit in the 5 volts supply to the feedback potentiometer or the potentiometer itself.

Measurement Probe

(MPROBE)

Measurement probe (RED) with reference to measurement probe (BLACK).

Switched Power Input

(POWIN+)

A/CCM Pin 44 ref Pin 6

Switched power-in is a signal from the control module. Unlike the unswitched power available on pins 1 and 12, this signal is only available when the A/C is switched on.

Power Output

(POWOP+)

A/CCM Pin 12 ref vehicle battery +ve

This is the ignition power for the whole A/C system. It passes through the A/CCM via pins 1 and 12 (and a feedback protection diode) before supplying the fan control switch. Pin 12 should normally read battery voltage with the ignition switch in positions I or II. With the ignition switch off, pin 12 should read 0 volts.

Right Blower Feedback Voltage

(RBLOFB)

A/CCM Pin 33 ref Pin 6

The purpose of the blower feedback is to inform the control module of the present blower speed. This enables the control module to directly monitor and control blower motor speed. With Manual selected, the blower operates in four basic ranges:

Low Speed

Temp Min: pin 33 = 5 ± 1 volt
Temp Med: pin 33 = 9 ± 1 volt
Temp Max: pin 33 = 5 ± 1 volt

Medium Speed

Temp Min: pin 33 = 2 ± 1 volt
Temp Med: pin 33 = 6 ± 1 volt
Temp Max: pin 33 = 2 ± 1 volt

High Speed

Pin 33 = 1 ± 1 volt at all temperature settings

Defrost

Pin 33 = 1 ± 1 volt at all temperature settings

Right Blower Output Voltage

(RBLOWOP)

A/CCM Pin 32 ref Pin 6

This signal is produced by the control module to drive the blower motor. The signal can vary from 0-3 volts depending on blower motor speed. The higher the voltage, the higher the blower motor speed. This signal is amplified by a simple amplifier circuit inside the blower motor. This circuit also supplies the feedback signals to pins 22 and 33.

Note: If the signal rises above 5 volts, then suspect a fault in the amplifier circuit.

Reference Signal

(REF)

A/CCM Pin 7 ref Pin 6

This is the main reference signal for the A/CCM. All the sensors reference against this voltage. Drift in this signal will cause inconsistent temperature control.

Normal voltage should read 2.885 ± 10 millivolts

Temperature Demand

(TEMPDEM)

Temperature demand control either selects the required temperature of the system (auto mode) or the outlet temperature of the vents (manual mode). Pin 35 will vary from 0 volts at full cooling up to 2.885 volts at full heating.

Note: When defrost is selected, the signal at pin 35 is ignored. The system will go into full heating through the upper flaps only.

Upper Servo Feedback Potentiometer

(USERFB)

A/CCM Pin 30 ref Pin 6

The feedback signal informs the control module of the exact position of the flaps, enabling accurate control of the flap position.

Defrost - Lower flap signal should read 2.9 volts (flap closed, the upper flap signal should read 1.9 volts.

Max Temperature - Lower flap signal should read 1.14 volts, upper flap signal should read 1.9 volts.

Min Temperature - Both upper and lower flap signals should read 130 ± 80 millivolts.

Note: If the feedback sticks low, with the fan continually running, suspect an open circuit in the 5 volt supply to the feedback potentiometer or the potentiometer itself.

Water Switch

(WATSW)

A/CCM Pin 21 ref Pin 6

The water switch monitors the temperature of the coolant and inhibits heating by restricting fan operation at coolant temperatures below 30 degrees celsius. This enables the vehicle to warm up at a faster rate. It can be overridden by selecting Defrost.

Water Valve

(WATVAL)

A/CCM Pin 17 ref Pin 6

The water valve controls the flow of hot coolant to the heater matrix. When manual full cooling is selected, the valve will close inhibiting the heating effort of the matrix, thus enhancing the cooling effect

Full cooling selected; pin 17 should read 10+ volts and the water valve should be closed.

All other conditions, pin 17 should read below 0.5 volts and the water valve should be open.



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