TABLE OF CONTENTS

TABLE OF CONTENTS

Airbus
A318/A319/A320/A321

ATA 21
Air Conditioning

Rev.-ID: 1JAN2019
Author: KoA
For Training Purposes Only

EASA Part-66
B1/B2

Lufthansa Technical Training

Dept HAM US
Lufthansa Base Hamburg
Weg beim Jäger 193
22335 Hamburg
Germany

Tel: +49 (0)40 5070 2520

Fax: +49 (0)40 5070 4746

E-Mail: Customer-Service@LTT.DLH.DE

www.Lufthansa-Technical-Training.com

Revision Identification:

- The date given in the column "Revision" on the face of this cover is binding for the complete Training Manual.
- Dates and author's ID, which may be given at the base of the individual pages, are for information about the latest revision of that page(s) only.
- The LTT production process ensures that the Training Manual contains a complete set of all necessary pages in the latest finalized revision.

ATA 21 AIR CONDITIONING

21–00 AIR CONDITIONING-GENERAL

INTRODUCTION

The air conditioning system maintains the air in the pressurized fuselage compartments at the correct levels of:

- pressure, temperature and freshness.

Under normal conditions, the pneumatic system supplies air to the air conditioning system from:

- the main engine compressors,
- the APU compressor,
- a high pressure ground air supply unit.

The hot compressed air is cooled, conditioned and delivered to the following fuselage compartments:

- Flight Compartment
- Passenger Compartment
- Avionics Compartment
- Cargo Compartment

The air is then discharged overboard through the outflow valve 10HL. Conditioned air can also be supplied to the distribution system through a low pressure ground connection. A ram–air inlet supplies emergency air to the fuselage should the air generation system malfunction during flight.

Air Conditioning Sub Systems

The air conditioning system includes the following sub systems :

- Lavatory/galley ventilation system
- Avionics Equipment Ventilation
- Pressurization Control
- Aft/FWD Cargo Heating (option) not installed at LH.
- Aft Cargo Ventilation (only on LH A320 aircraft)

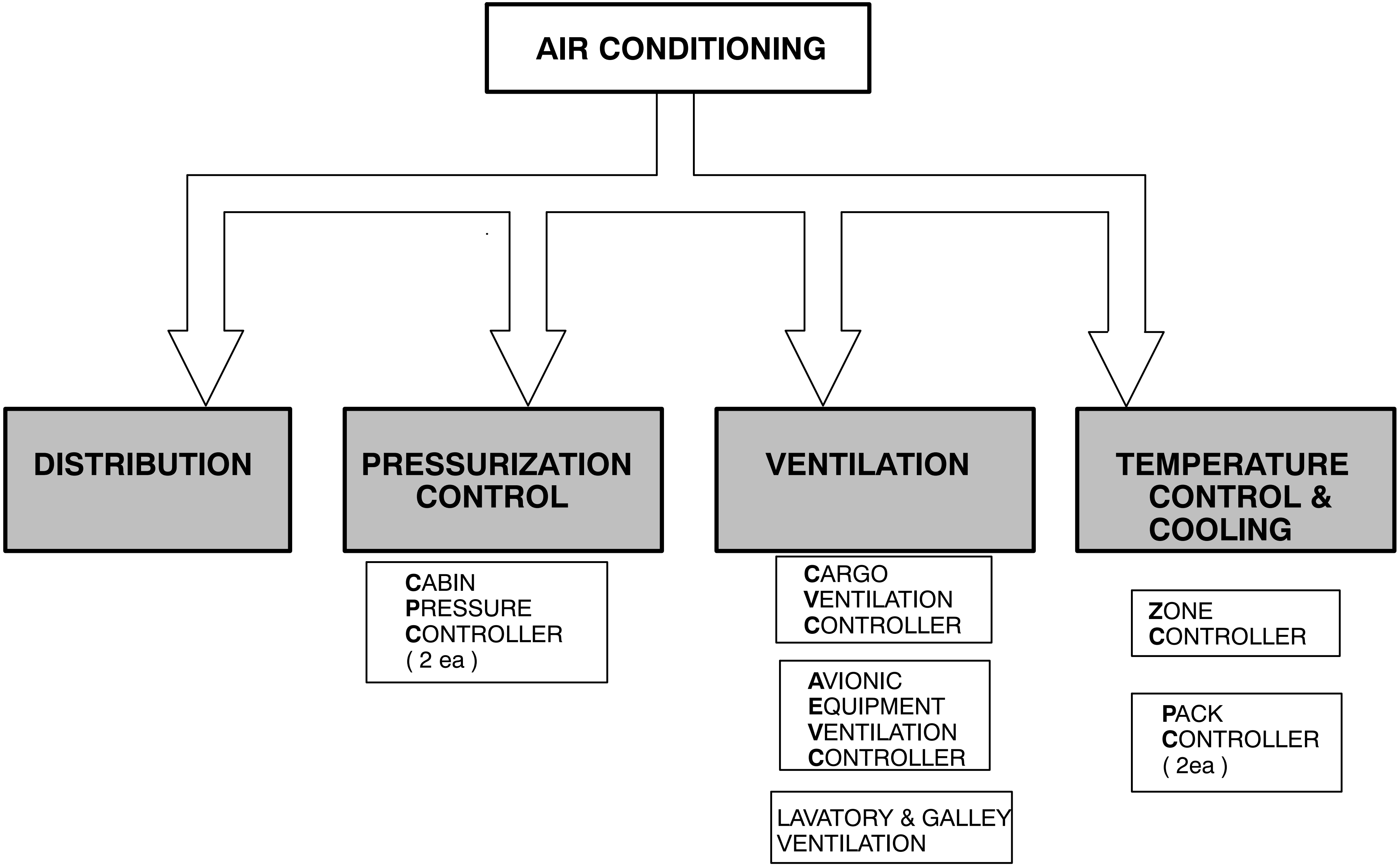


Figure 1 Introduction

AIR CONDITIONING GENERAL

The air conditioning system operation in the A318/A 319/A320/A321 aircraft is fully automatic.

The air is supplied by the pneumatic system via:

- two pack flow control valves,
- two packs,
- the mixing unit, which mixes the air coming from the packs and the cabin.

It is then distributed to the cockpit and the cabin. The temperature regulation is optimized through the hot air pressure regulating valve and the trim air valves which add hot air tapped upstream of the packs to the mixing unit air.

In an emergency, a ram air inlet can provide ambient air to the mixing unit.

The temperature regulation is controlled by:

- One Zone Controller (8HK)
- Two Pack Controllers (7HH & 27HH)

Flight deck and cabin temperature can be selected from the AIR COND. panel in the cockpit.

Low Pressure air can be supplied to the mixing unit by a ground connection.

Pack Flow Control

The pack flow can be selected by the crew through the ECON P/B on A321 aircraft or through a pack flow selector on A320 aircraft according to the number of passengers and external conditions.

Depending on the external conditions the pack flow control valve regulates for all flight phases the correct air quantity.

At sea level on ground the normal mass flow of air into the pressurized fuselage is 1.102 kg/s decreasing to 0.817 kg/s at a cabin pressure of 752 mb (8000 ft). This keeps the Volumetric flow constant at 0.926 cubicmeter/s.

Cooling and Temperature Control

The bleed air enters the pack cooling path via the pack flow control valve and is ducted to the primary heat exchanger. Then the cooled bleed enters the compressor section of the air - cycle machine and is compressed to a higher pressure and temperature. It is cooled again in the main heat exchanger and enters the turbine section where it expands and in expanding generates power to drive the compressor and cooling fan. The energy removed during this process causes a temperature reduction, resulting in very low turbine discharge air temperature. The air is then routed to the mixing unit and then to the cabin zones. Trim air valves which are controlled by the zone controller optimize the temperature (18 °C - 30 °C) by adding hot air.

The zone controller computes a temperature demand according to the selected temperature and the actual zone temperature. A signal corresponding to the lowest demanded zone temperature is sent to the pack controller to achieve the required outlet temperature of both packs.

When the cooling demand in one zone cannot be satisfied, if the bleed pressure is too low, the zone controller sends a pressure demand signal to both engines via the EIU‘s in order to increase the minimum idle and provide the necessary pressure.

Provided the APU bleed valve is open, the zone controller sends a demand signal to the ECB in order to increase the APU flow output when any zone temperature cannot be satisfied.

An avionic ventilation system, controlled by the AEVC provides cooling of the electrical and electronic components in the avionics compartment.

Air from the cabin is ducted to the AFT cargo compartment. The Cargo ventilation controller controls the air via an inlet and outlet isolation valve and a blower and extract fan.

Lavatory and galley are ventilated with cabin ambient air. Air extracted by a fan, which is continuously running with electric power available, is exhausted near the outflow valve.

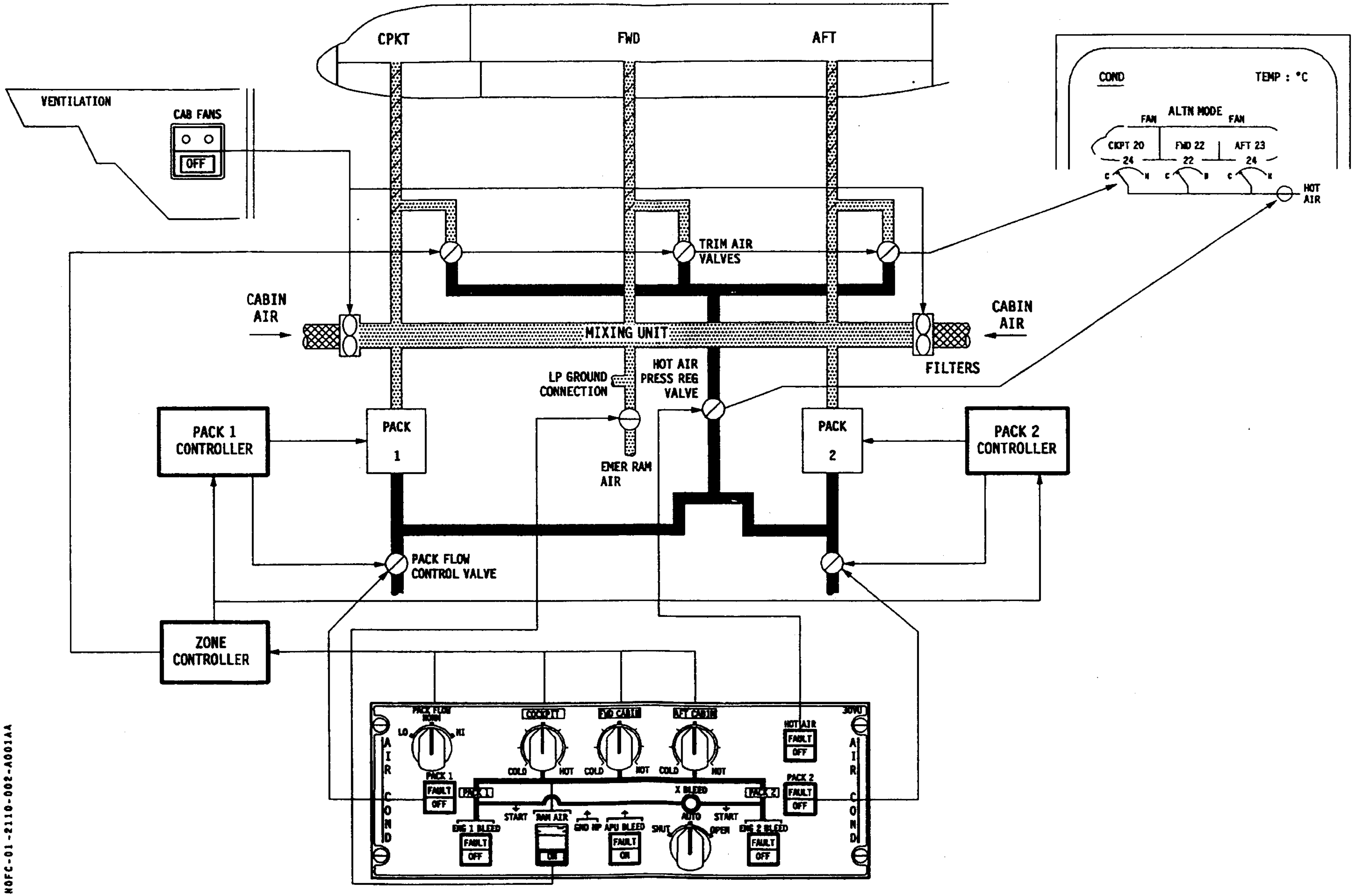


Figure 2 Simplified Air Conditioning Schematic

AIR CONDITIONING CONTROLS PANEL 30VU

The panel description is the same for **A321** except for the pack flow selector.

1 Zone temperature selectors

- 12 o'clock position: = **24 °C** (76 °F)
- **COLD** position: = **18 °C** (64 °F)
- **HOT** position: = **30 °C** (86 °F)

2 HOT AIR P/B switch

ON (P/B switch in):

- The electro/pneumatic trim air pressure regulating valve regulates hot air pressure to the hot air manifold.

OFF (P/B switch out):

- OFF light illuminates white.

  The trim air pressure regulating valve closes and the 3 trim air valves closes.

  The FAULT circuit (Duct Overheat circuit) is resetted.

FAULT:

The Fault light illuminates AMBER, associated with ECAM caution, when duct overheat is detected (88 °C or 80° C four times during one flight)

The trim air pressure regulating valve and the 3 trim air valves close automatically. The FAULT light extinguishes, when temperature drops below 70 °C and OFF is selected.

3 PACK Override P/B switch

ON (P/B switch in):

the pack flow control valve is electro/pneumatically automatically controlled.

- It opens in the following cases:
  - upstream pressure >10 psi.
  - no ACM compressor outlet overheat (230 °C)
  - no engine start sequence.

The valve closes by an electrical signal when:

- the MODE selector is set to IGN/START when on ground. (valves reopen if MASTER sw or MAN START P/B sw are not set to ON within 30 sec)
- the ENG MODE selector is set to IGN/START (or CRK) and when on either engine :
  - the Master switch is set to ON (or MAN START P/B sw is set to ON)
  - the start valve is open, and N, < 50 %.

On ground, the valves reopening is delayed 30 sec (after start valve closure) to avoid a supplementary pack closure cycle during second engine start.

- engine fire P/Bs depressed
- DITCHING selected

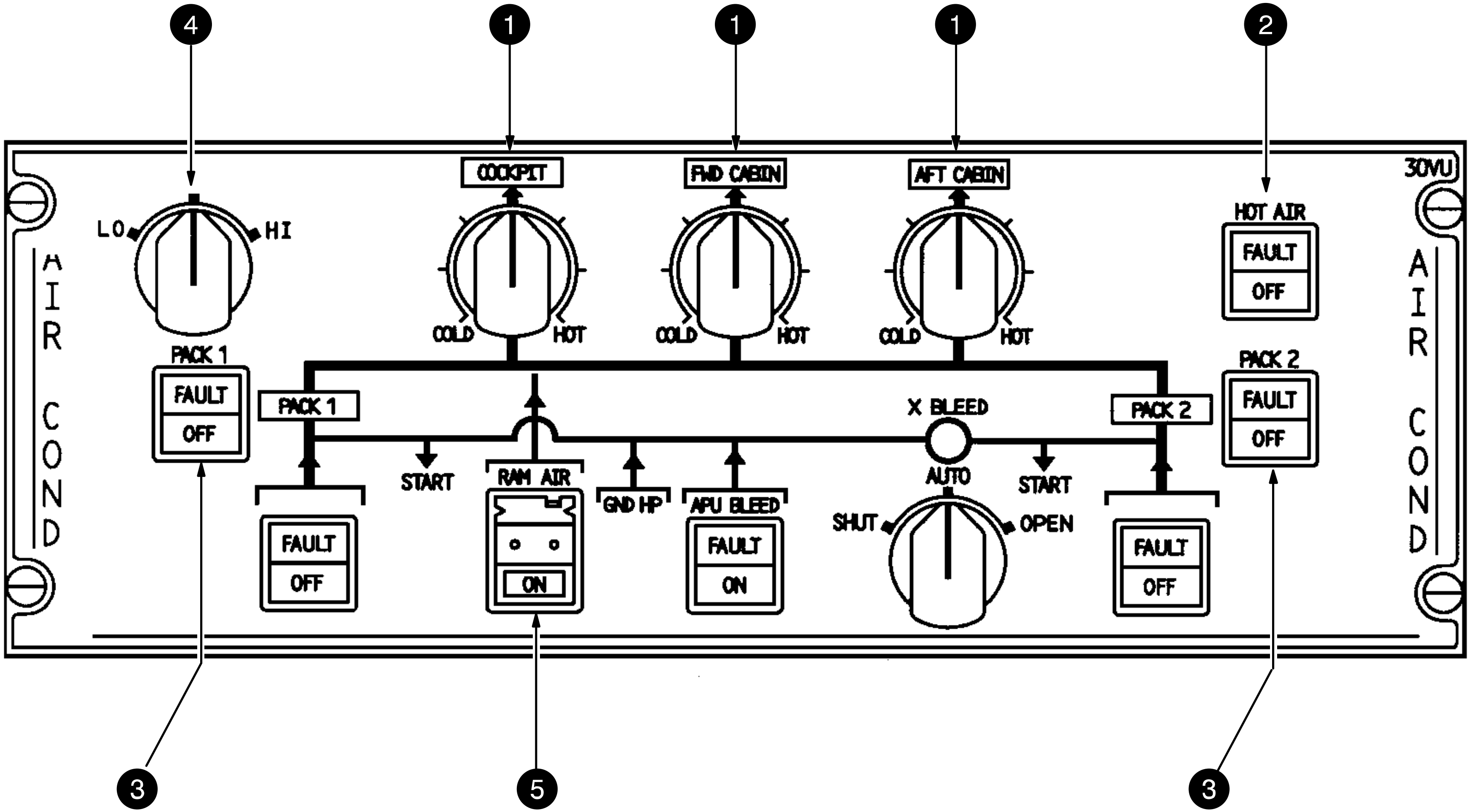
OFF (P/B switch out):

OFF light illuminates white and the pack flow control valve gets an electrical signal to move to the close position.

FAULT:

Illuminates AMBER, associated with ECAM caution, when :

- the pack flow control valve position disagrees with selected position or
- in case of compressor outlet (4 times 230 °C or 260 °C) or
- Pack outlet overheat (95 °C) condition



The panel description is the same for **A321** except for the pack flow selector.

Figure 3 Air Conditioning Panel 30VU

4 **PACK FLOW selector**

- Permits selection of pack valve flow according to number of passengers and ambient conditions (smoke removal, hot or wet conditions).
  - **LO** (80 %)
  - **NORM** (100 %)
  - **HI** (120 %).
- The manual selection is irrelevant in single pack operation or with APU bleed supply. In these cases, HI is automatically selected.
- If LO is selected, the pack flow can be automatically selected up to 100 % when the cooling demand cannot be satisfied.

5 **RAM AIR P/B switch (guarded)**

ON (P/B switch in):

- the ON light illuminates blue.

Provided the DITCHING P/B sw on the CABIN PRESS panel is in normal position :

- The RAM air inlet flap opens operated by an electrical actuator.
- **If Delta P = > 1 psi:** the outflow valve control remains normal
- **If Delta P = < 1 psi:** the outflow valve opens to 50 %

OFF (P/B switch out):

The RAM air inlet closes.

NOTE: If the Ram Air Inlet is opened on ground, the outflow valve will close to 50 %.

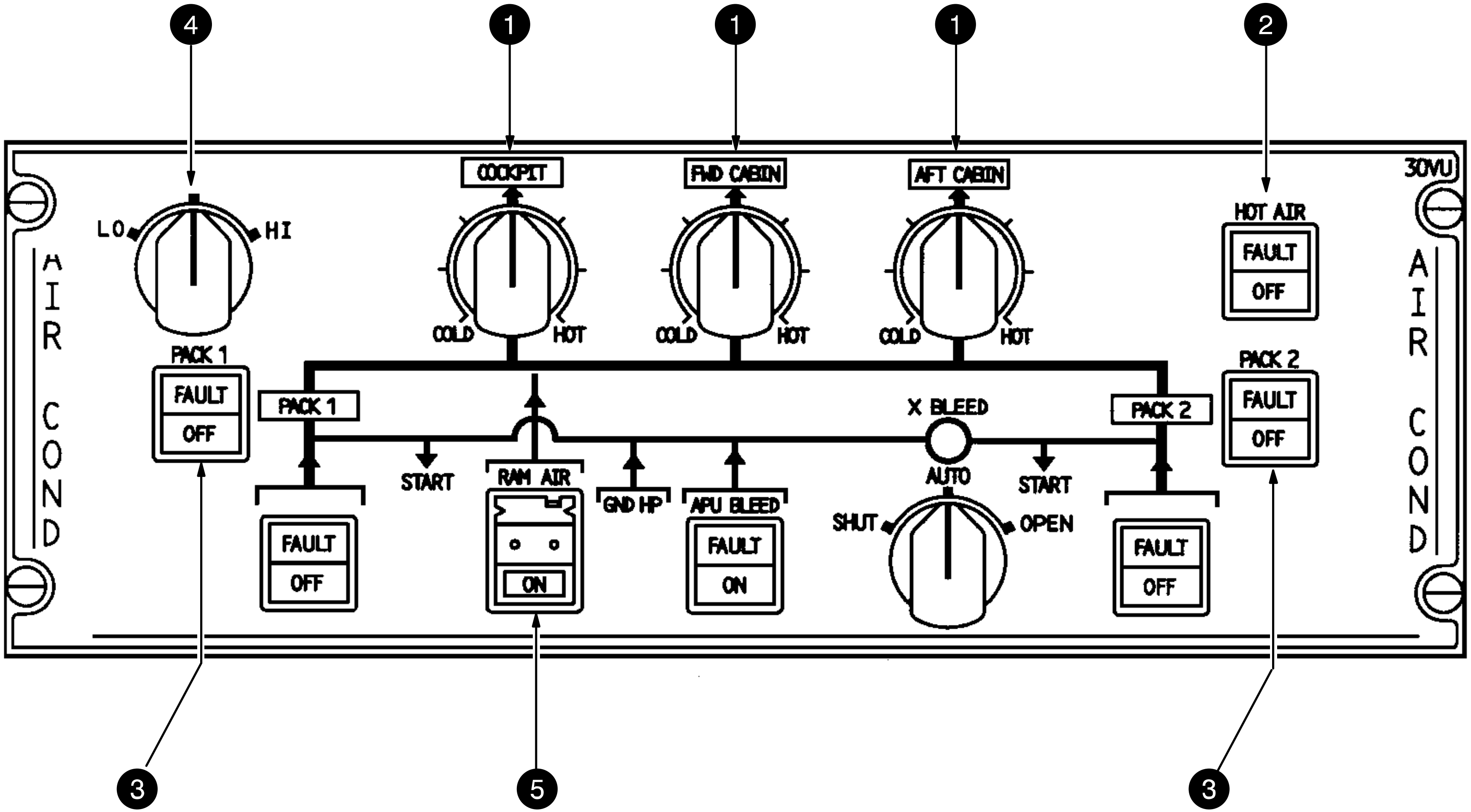


Figure 4 Air Conditioning Panel 30VU

A321 DIFFERENCES ON AIR CONDITIONING CONTROLS

ECON FLOW P/B Switch

This P/B switch permits economy or normal flow according to number of passengers and ambient conditions (smoke removal, hot or wet conditions).

ON (P/B switch in):

- ON light illuminates white.
- ECON Flow is selected (equal to 100 %).

OFF (P/B switch out):

- Normal flow is selected. Normal flow provides 20 % more than ECON Flow.

NOTE: The NORMAL FLOW is automatically selected:
In single pack operation,
with APU bleed supply or
when cooling demand cannot be satisfied.

ECON FLOW P/B

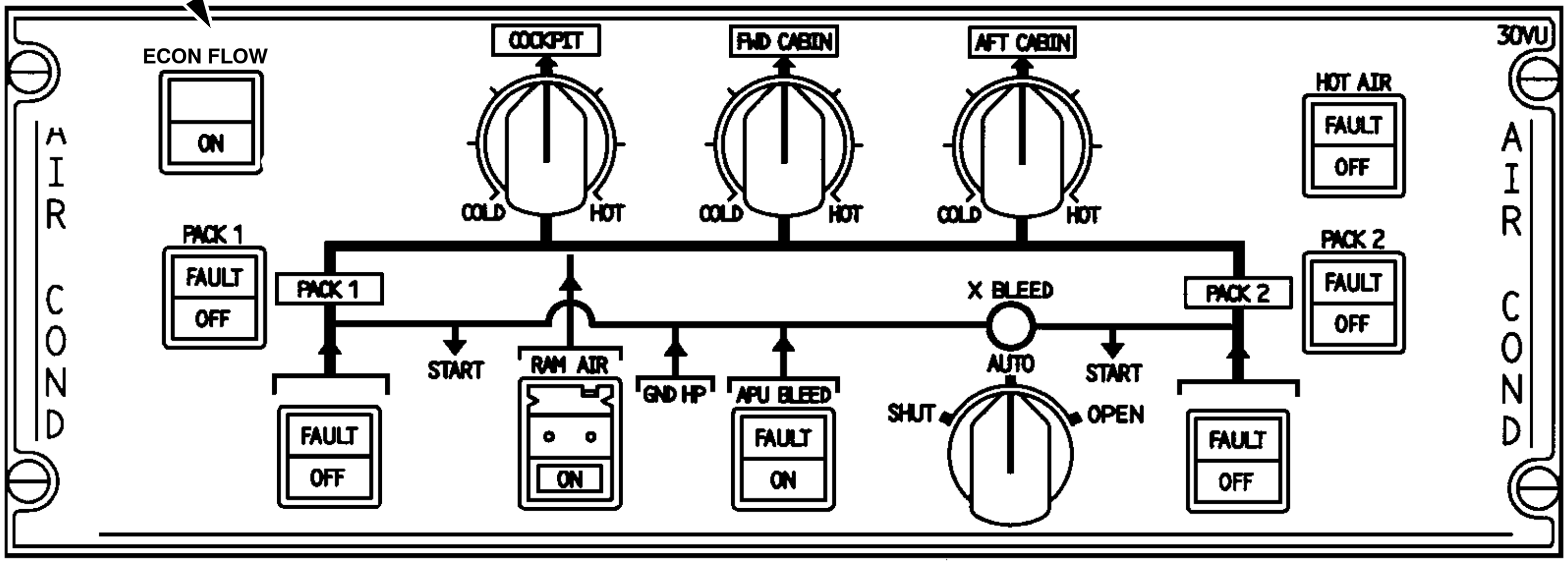


Figure 5 A321 Air Conditioning Panel

ECAM BLEED PAGE INTRODUCTION

1 PACK OUTLET TEMPERATURE

- Indication is green.
- Becomes amber if the outlet temperature is above 90°C.

2 RAM AIR INLET

- Displayed in green = FULLY OPEN IN FLIGHT
- Displayed in amber = FULLY OPEN ON GROUND
- Displayed in green = FULLY CLOSED
- Displayed in amber = VALVE OPEN AND DISAGREES
- Displayed in amber = INLET IN TRANSIT

3 PACK BY PASS VALVE POSITION

- INDICATION IS GREEN
  - C = cold VALVE CLOSED
  - H = hot VALVE OPEN

4 PACK COMPRESSOR OUTLET TEMPERATURE

- Displayed in green = NORMAL TEMPerature
- Displayed in amber = ≥ 230° C
- XX (amber) = TEMPERATURE NOT VALID

5 PACK FLOW

- Indication is normally green.
- Becomes amber if Pack Flow Control Valve is closed.

6 PACK FLOW CONTROL VALVE

- Displayed IN green = VALVE NOT CLOSED
- Displayed IN green = VALVE FULLY CLOSED
- XX Displayed in amber = VALVE POSITION NOT AVAILABLE
- Displayed in amber = VALVE FULLY CLOSED AND DISAGREES
- Displayed in amber = VALVE IN TRANSIT

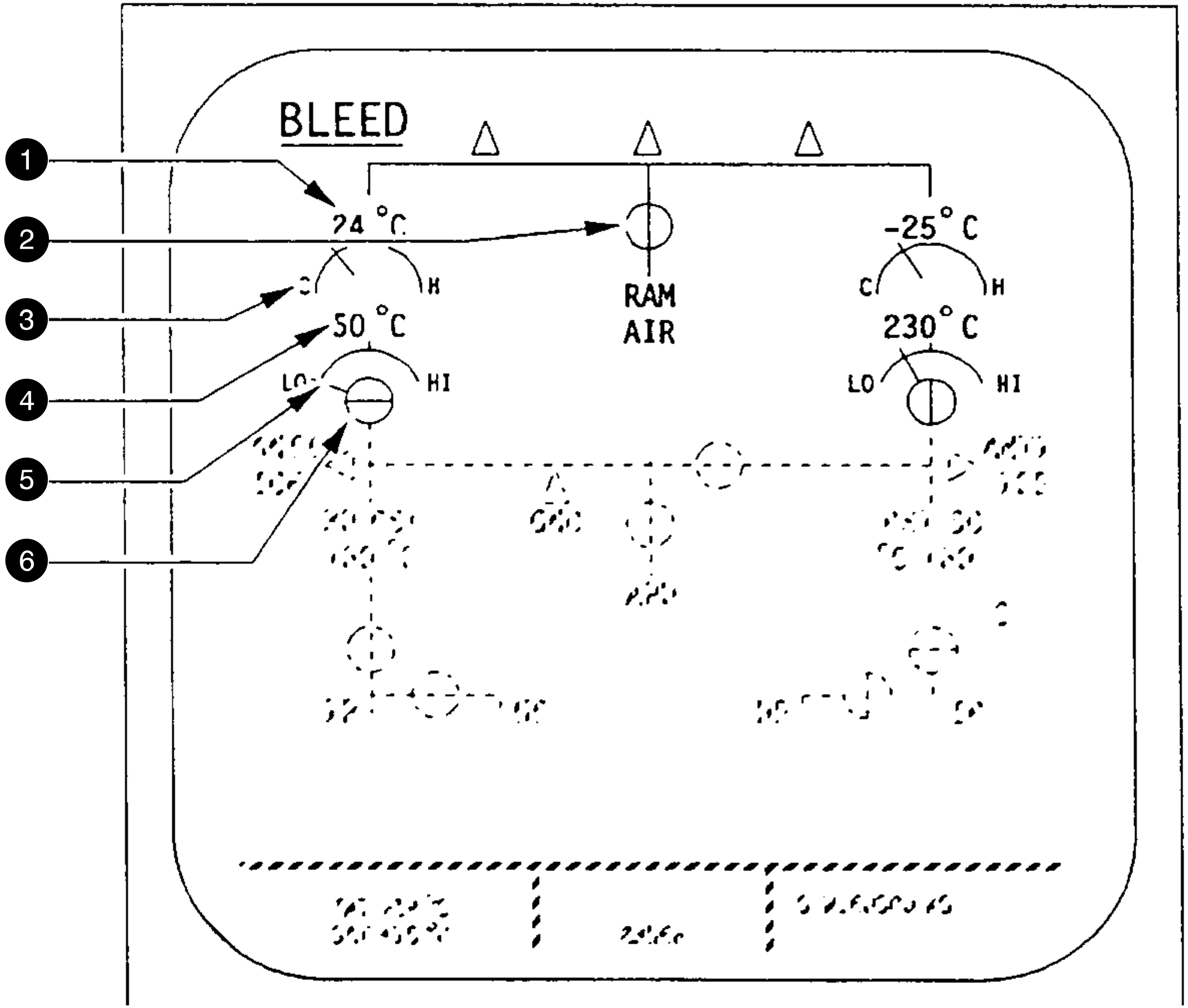


Figure 6 ECAM Bleed Page (Pack Flow and Cooling)

ECAM BLEED PAGE LAYOUT

1 ZONE CONTROLLER FAULT INDICATION

- ALTERN MODE (green): PRIMARY ZONE COTROLLER FAULT
- PACK REG (green) : ZONE CONTROLLER FAULT (BASIC REGULATION BY PACKS ONLY)
- No indication: ZONE CONTROLLER NORMAL OPERATION

2 CABIN FAULT INDICATION

- Appears in amber if fault detected.

3 ZONE TEMPERATURE

- Indication is green
- Indication amber XX for FWD/AFT cabin temperature if LAV. & GAL. FAN is INOP.

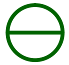
4 ZONE DUCT TEMPERATURE

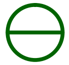
- Normally green
- Becomes amber if duct temperature reaches 80°C.

5 ZONE TRIM AIR VALVE POSITION

- Indication is green.
- Becomes amber XX if corresponding signal is not available.

6 HOT AIR PRESSURE REGULATING VALVE POSITION

-  Displayed in green = VALVE FULLY CLOSED PB AT ON
-  Displayed in green = VALVE NOT CLOSED
- 

(amber) = VALVE POSITION NOT AVAILABLE
-  Displayed in amber = VALVE POSITION DISAGREES (open)
-  (amber) = VALVE IN TRANSIT
-  Displayed in amber = VALVE FULLY CLOSED PB AT OFF OR VALVE POSITION DISAGREE.

7 TEMPERATURE

- Unit of measure (°C or °F) Iis indicated in cyan.

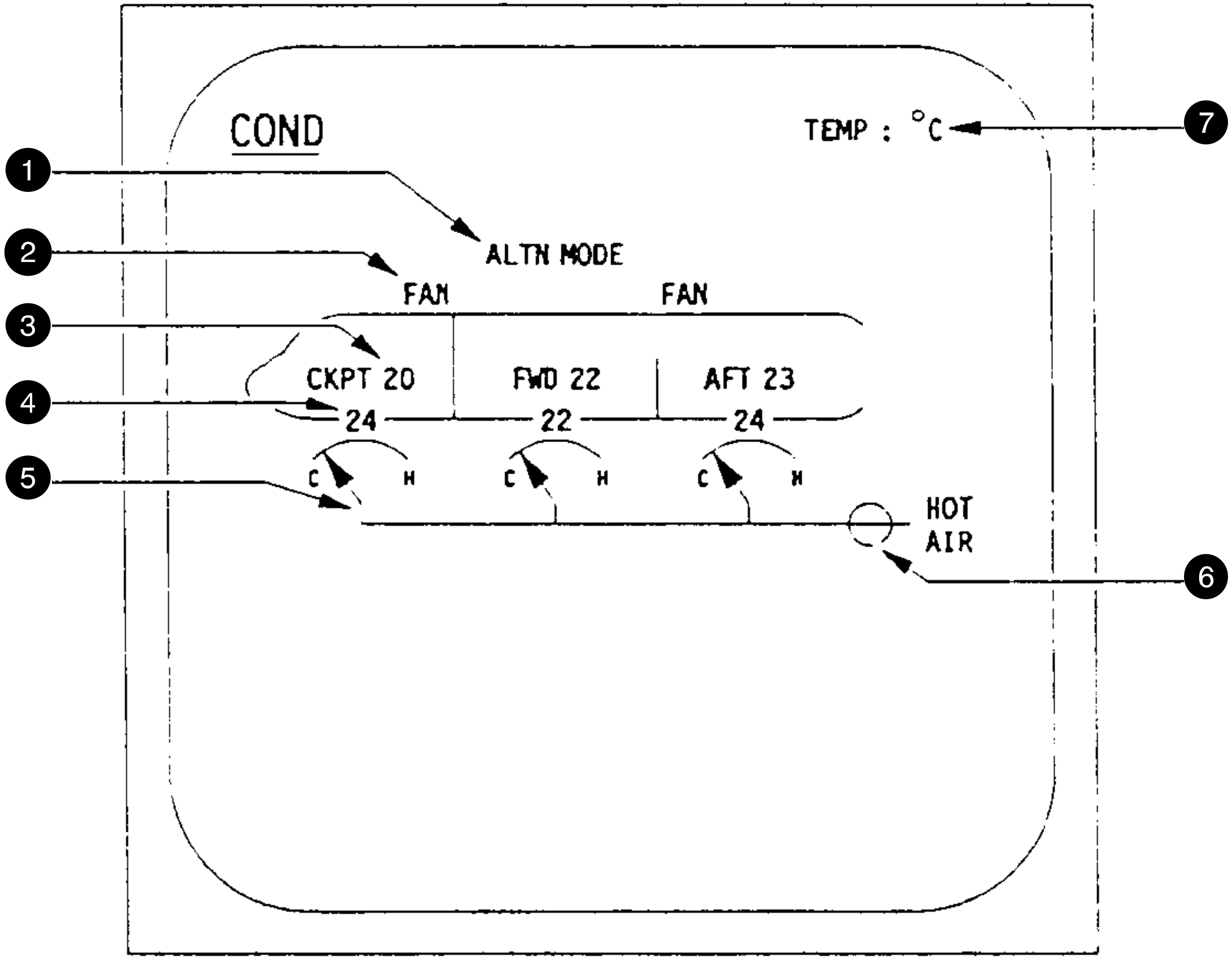
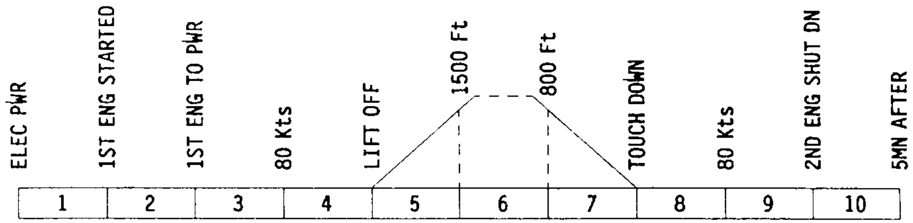


Figure 7 ECAM Cond. Page (Temperature Control)

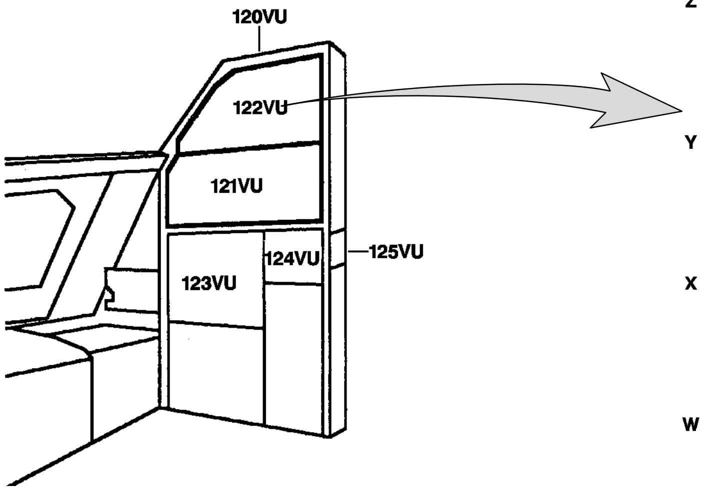
ECAM WARNING AND CAUTION INDICATION



<table>
<tr><th>E / WD : FAILURE TITLE
conditions</th><th>AURAL WARNING</th><th>MASTER LIGHT</th><th>SD PAGE CALLED</th><th>LOCAL WARNING</th><th>FLT PHASE INHIB</th></tr>
<tr><td>PACK 1 (or 2) OVHT
Pack compressor outlet temperature above 260°C or pack outlet temp above 95°C</td><td rowspan="7">SINGLE CHIME</td><td rowspan="7">MASTER CAUT</td><td rowspan="4">BLEED</td><td rowspan="3">PACK FAULT lt</td><td rowspan="3">3, 4, 5
7, 8</td></tr>
<tr><td>PACK 1 (or 2) FAULT
pack valve disagree with selected position or Pack compressor outlet temperature above 230° 4times during one flight</td></tr>
<tr><td>PACK 1 + 2 FAULT
One pack off then the other fault</td></tr>
<tr><td>PACK 1 (2) OFF
Pack pb sw at off with no failure</td><td>NIL</td><td>1, 2, 3,
4, 5, 7,
8, 9, 10</td></tr>
<tr><td>CKPT (FWD CAB OR AFT CAB) DUCT OVHT
Duct temp above 88°C or above 80°C 4 times during one flight</td><td rowspan="3">COND</td><td rowspan="2">HOT AIR FAULT lt</td><td rowspan="5">3, 4, 5
7, 8</td></tr>
<tr><td>HOT AIR FAULT
Hot air pressure regulating valve disagree with selected position</td></tr>
<tr><td>L + R CAB FAN FAULT
Both fan overheat</td><td rowspan="5">NIL</td></tr>
<tr><td>PACK 1 (2) REGUL FAULT
Pack main channel or Pack main and secondary channels failed</td><td rowspan="4">NIL</td><td rowspan="4">NIL</td><td>BLEED</td></tr>
<tr><td>ZONE REGUL FAULT
Zone controller main channel or main and secondary channels failed</td><td>COND</td></tr>
<tr><td>LAV + GALLEY FAN FAULT</td><td rowspan="2">NIL</td><td>3, 4, 5
7, 8, 9</td></tr>
<tr><td>TRIM AIR SYS FAULT
one trim air valve fault or overpressure downstream hot air valve</td><td>3, 4, 5
7, 8</td></tr>
</table>

Figure 8 ECAM Warnings and Cautions

PANEL LAYOUT



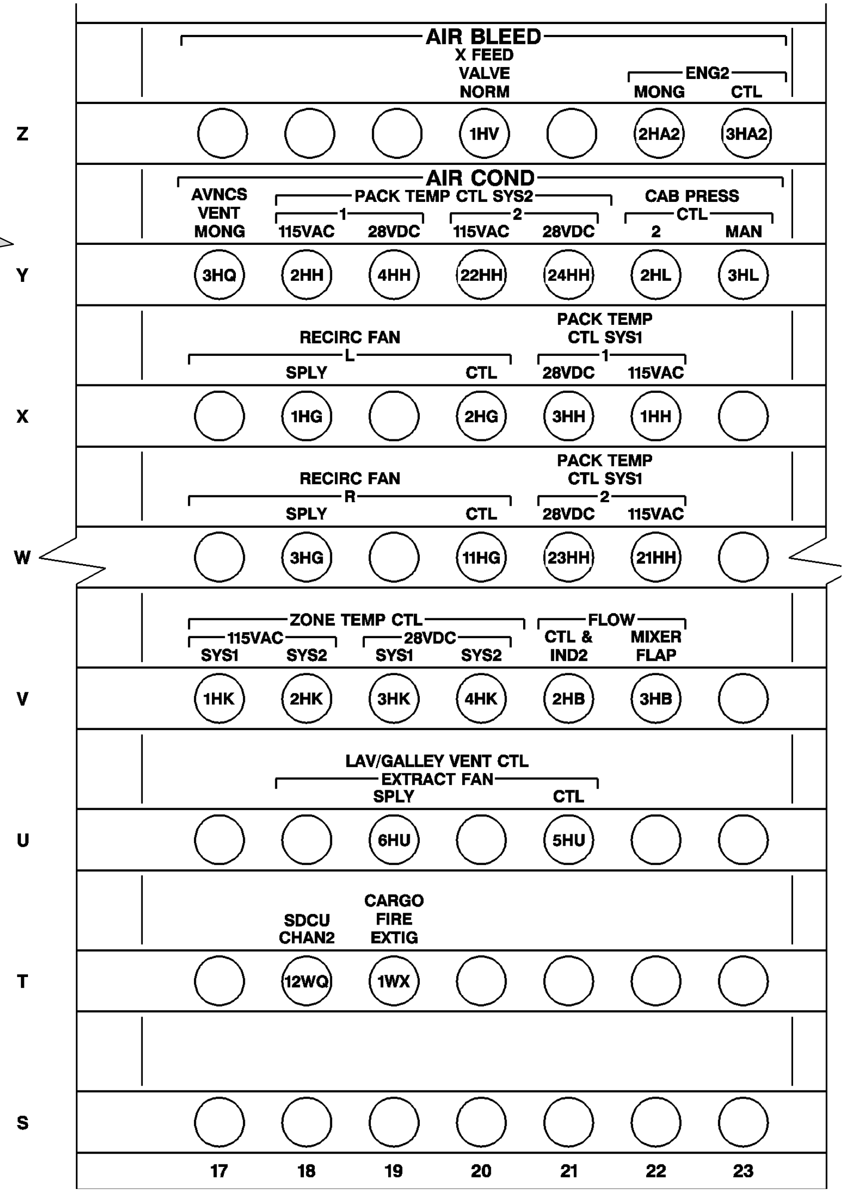
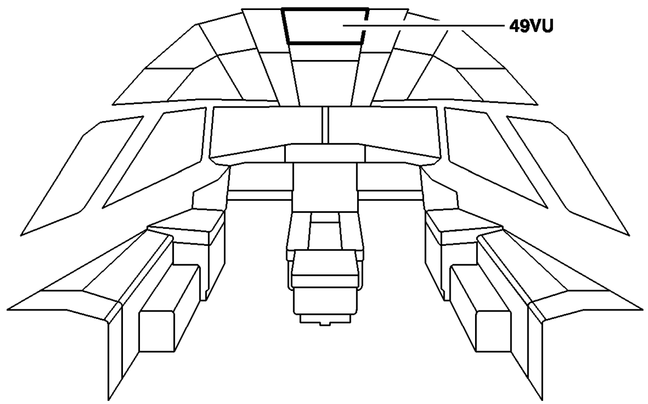


Figure 9 Rear C/B Panel 122 VU



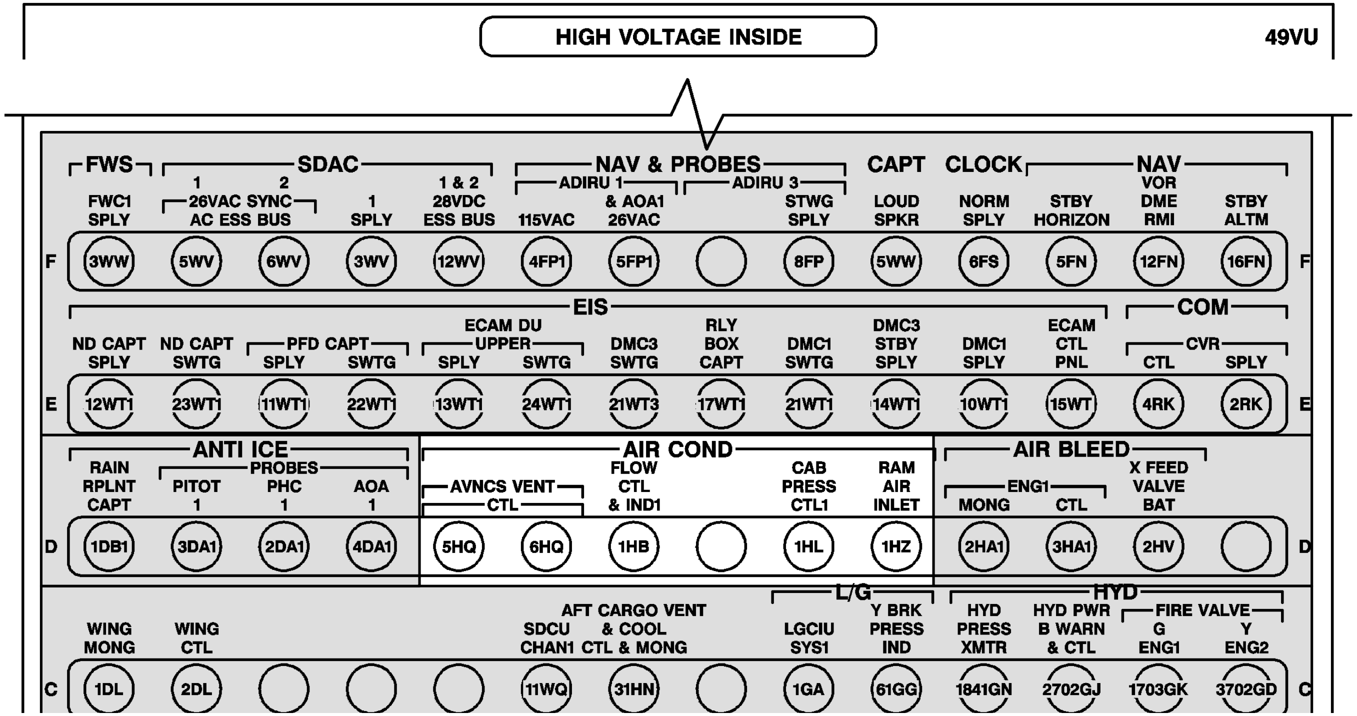


Figure 10 Overhead C/B Panel 49VU

AIR CONDITIONING BASIC SCHEMATIC DESCRIPTION

1 Pack Flow Control Valve (11HB/8HB):

- Electro pneumatic venturi type valve
- Fail safe open
- opens when press > 10 psi and no ACM OVHT (> 230 °C)

2 Pressure Sensor (10HB/9HB):

The sensor is used for pack controller to create the airflow indication on ECAM (Bleed Page).

3 Mixer Flap Actuator (20HB):

Opens when pack 1 selected to ”OFF”.

4 Flow Selector (5HB):

The selector is used for pack air flow Selection.

5 Pack Inlet Pressure Sensor (16HH/36HH):

The sensor is used for FADEC to modulate ENGINE bleed idle.

6 Bleed Temperature Sensor (18HH/38HH):

The sensor is used for CFDS in case of OVHT at pack inlet (> 280 °C)

7 Primary Heat Exchanger (10HM6/11HM6)

8 Main Heat Exchanger (10HM7/11HM7)

9 Air Cycle Machine (10HM1/11HM1)

10 Bypass Valve (10HH/30HH):

The bypass valve is electrical operated.

11 Compressor Discharge Temperature Sensor (12HH/32HH):

- the sensor monitors the ACM compressor outlet temperature.
  If the temperature is:
  - 4 times > 230 °C PACK FAULT warning appears.
  - > 260 °C PACK OVHT warning appears.

12 Compressor Overheat Temperature Sensor (15HH/35HH):

- the sensor monitors the ACM compressor outlet temperature for the ECAM indication (BLEED PAGE).
- the sensor also monitors the ACM compressor outlet temperature.
  If the temperature is :
  - 4 times > 230 °C PACK FAULT warning appears.
  - > 260 °C PACK OVHT warning appears.

13 Compressor Pneumatic Overheat Sensor (10HM9/11HM9):

This sensor is a pneumatic thermostat which operates at a ACM compressor outlet temperature > 230 °C. At this temperature it starts bleeding the open pressure of the flow control valve.

14 Reheater (10HM3/11HM3)

15 Condenser (10HM2/11HM2)

16 Water Extractor (10HM8/11HM8)

17 Water Injector (20HM/21HM)

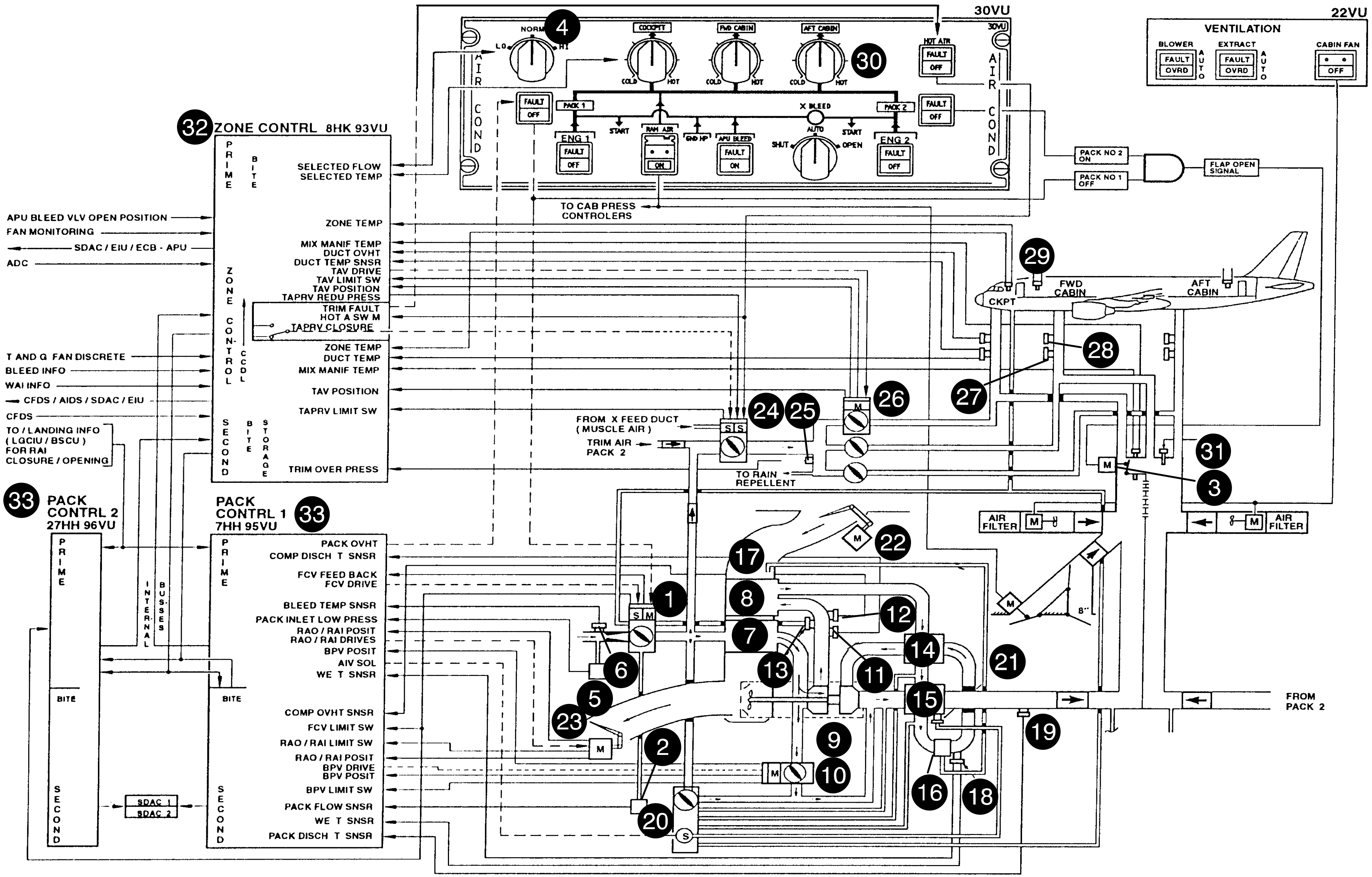


Figure 11 Air Conditioning Basic Schematic

18 **Water Extractor Temperature Sensor (11HH/31HH):**

The sensor monitors the water extractor outlet temperature for pack temperature control.

19 **Pack Discharge Temperature Sensor (13HH/34HH):**

The sensor monitors the pack outlet temperature for ECAM.

If temperature is > 95 °C the PACK OVHT warning appears.

20 **Anti Ice Valve (17HM/37HH)**

The Anti Ice Valve is pneumatic operated.

21 **Pack Outlet Pneumatic Sensor (10HM10/11HM10):**

The sensor is a pneumatic thermostat which controls the anti−ice valve in case of a pack controller fault. (the anti−ice valve regulates the pack outlet temperature to 15 °C).

22 **Ram Air Inlet Actuator (8HH/28HH)**

23 **Ram Air Outlet Actuator (9HH/29HH)**

24 **Trim Air Pressure Regulating Valve (14HK)**

The Valve is electro−pneumatic operated.

25 **Hot Air Pressure Switch (26HK)**

The switch sends a signal to the zone controller if trim air supply pressure is more than 6,5 psi (0,45 bar) above regulating pressure. (used as a monitoring signal for CFDS).

26 **Trim Air Valves (8HK,11HK,13HK):**

The valves are electrical operated and controlled by the zone controller.

27 **Duct Temperature Sensors (15HK,16HK,17HK)**

28 **Duct Temperature Sensors (15HK,16HK,17HK):**

- used for ECAM indication (COND PAGE).
- used for zone temperature control and duct OVHT detection.
  - four times 80 °C the duct OVHT warning appears.
  - >88 °C the duct OVHT warning message appears.
- used for duct OVHT detection.
  - four times 80 °C the duct OVHT warning appears.
  - >88 °C the duct OVHT warning message appears.

29 **Zone Temperature Sensor (21HK,22HK,23HK):**

- used for zone temperature control.
- used for ECAM temperature indication (COND PAGE).

30 **Zone Temperature Selectors**

31 **Mixer Unit Temperature Sensors (24HK,25HK):**

The sensors are used for pack outlet temperature demand control.

32 **Zone Controller (8HK)**

33 **Pack Controller (7HH, 27HH)**

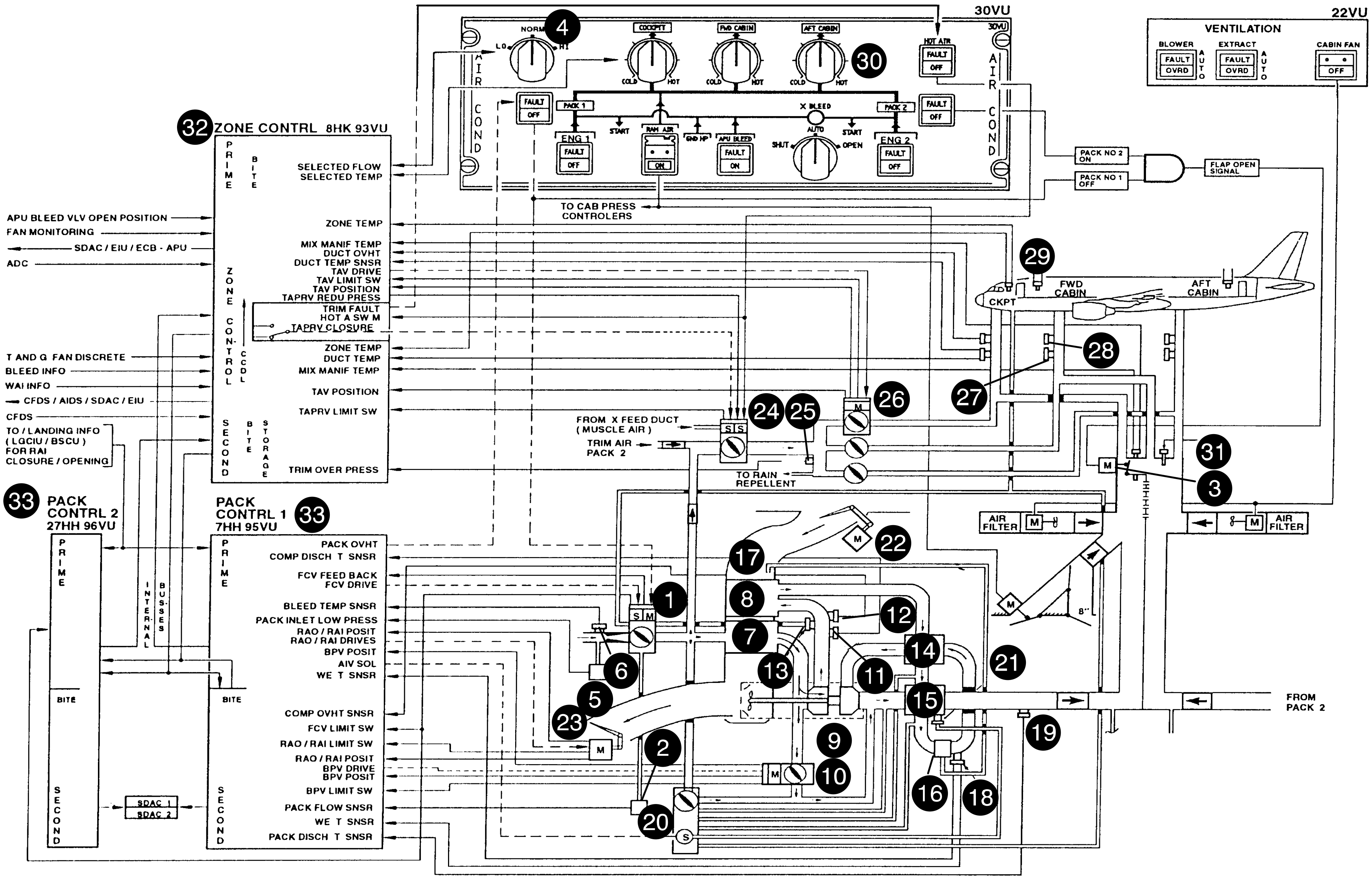


Figure 12 Air Conditioning Basic Schematic

21-50 AIR COOLING

AIR COOLING SYSTEM OPERATION

The fresh air quantity for air conditioning is defined by heating and cooling requirements.

The bleed air supply is always at a higher temperature (max 200 °C) than that required for passenger comfort. The air cooling is accomplished by two air conditioning packs. Each pack includes two heat exchangers which use ambient ram air as a heat sink, and a three−wheel air cycle machine (Compressor, turbine and fan), a high pressure water extractor circuit and a bypass valve.

The two heat exchangers are attached to the cooling ram−air inlet and outlet. Each inlet and outlet have a regulator flap which operates automatically to control the cooling airflow through the heat exchangers (the inlet flap follows the outlet flap).

During take off and landing phases, the ram−air doors are closed to prevent ingestion of foreign matter which may damage or contaminate the heat exchangers.

LOCATION

The packs 10HB and 11HB are installed in two un-pressurized compartments in the lower fuselage section in front of the main landing gear bay (Zone 190). Access is gained for each pack through 2 access panels (L/H pack 191 PB, 191 KD, R/H pack192 KB, 192FB) It is also possible to change the complete pack through this access panels. The air conditioning pack weighs approx. 79 Kg (180 lb).

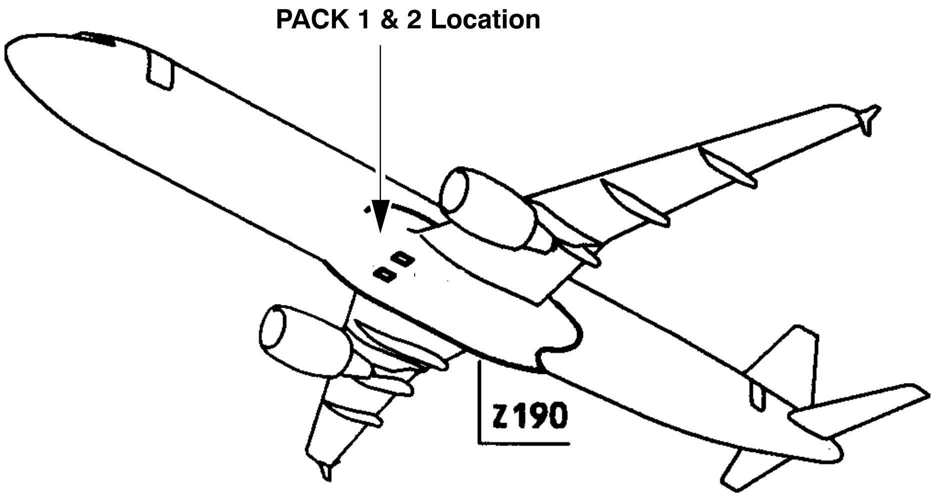


Figure 13 Pack Location

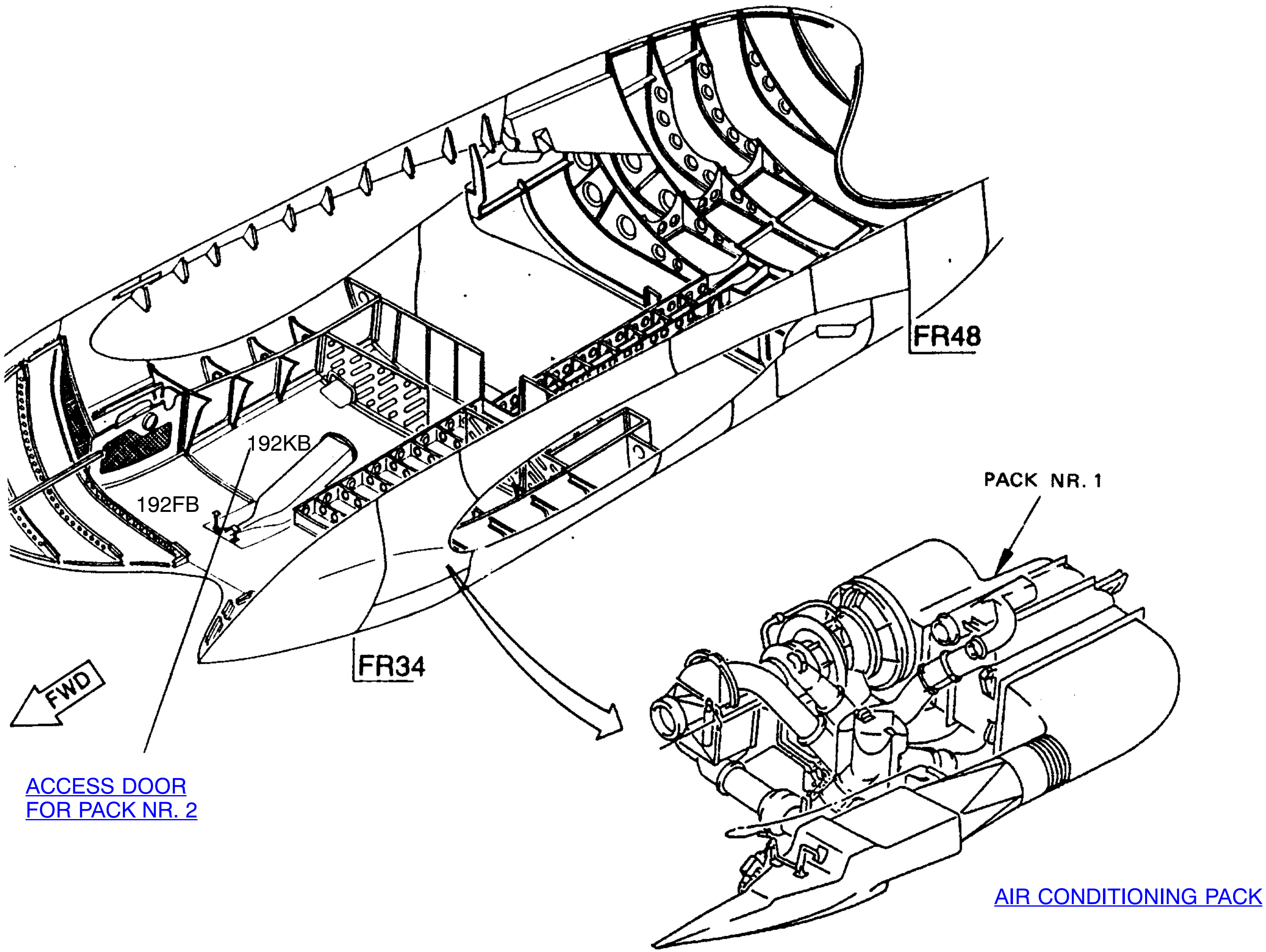


Figure 14 Air Conditioning Compartment/Components

21-51 FLOW CONTROL AND INDICATING

FLOW CONTROL COMPONENTS DESCRIPTION

1 PACK FLOW CONTROL VALVE

The flow control valves are installed upstream of the air conditioning packs.

These valves are of the venturi type. Both have a built–in butterfly valve that controls the flow and performs a shut–off function. The flow control valves control the quantity of air supplied from the pneumatic system to the air conditioning packs. They control the airflow fully pneumatically depending on the flow demand and the bleed pressure.

The airflow through the flow control valves is selected by the PACK FLOW selector switch and the PACK 1 (2) pushbutton switches.

Each PACK 1 (2) pushbutton switch controls the related flow control valve at the pack 1 (2) to the open or closed position.

The flow control valves close automatically if:

- there is an engine start, (solenoid controlled)
- the ENGINE FIRE P/B is pushed, (solenoid controlled)
- the DITCHING P/B is pushed, (solenoid controlled)
- the applicable PACK 1 (2) P/B is OFF, (solenoid controlled)
- there is a compressor overheat (>230 °C), (thermostat controlled)
- there is low bleed pressure.

A pneumatic air overheating thermostat at the compressor outlet of the air cycle machine is connected to the flow control valve. If the temperature is too high, the open pressure is vented and it is possible that the valve may be fully closed. The valve will open again if the temperature falls.

MEL. TASK 21-51-01

The Maintenance can close the valve with a manual closing device.

2 PRESSURE SENSOR

The pressure sensors measure the difference between a flow control valve reference pressure and the ambient pressure. They transmit signals to the two pack controllers. The pack controllers use these signals for calculation of the pack flow. The flow is indicated on ECAM BLEED PAGE.

3 MIXER FLAP ACTUATOR

The mixer flap actuator operates a flap in the cockpit supply port of the mixer. The flap connects the cockpit supply duct to the pack 1 mixer chamber during two pack operation.

When pack 1 is switched off, the flap changes the position and connects the cockpit supply duct to the pack 2 mixer chamber. When the flap in the mixer unit enters the airflow it causes a small airflow diversion into the cockpit duct. This results in an adequate supply of conditioned air to the cockpit.

It has a Man Override Lever with position indicator. Access is gained through the FWD Cargo Compartment to the Mixing Unit.

4 PACK FLOW SELECTOR

The crew can select between 3 positions:

- the **NORM position**, which sets the flow control valve to 100 % of the normal airflow,
- the **LO position**, which sets the flow control valve to 80 % of the normal airflow. The LO position can be selected for fuel economy purpose. But this can only be selected when there is a reduced number of passengers in the cabin,
  - In case the cabin temperature demand is not reached the zone controller automatically overrides this position to 100 % NORM.
- the **HI position**, which sets the flow control valve to 120 % of the normal airflow. The HI position is selected in abnormal hot ambient conditions or to clear smoke. The Lo and Norm position is overrided automatically in single pack operation and during APU bleed supply.

The PACK FLOW selector switch transmits the selected switch position to the zone controller. It calculates the necessary flow demand and transmits the data to the pack controllers. They set the flow control valves in the necessary reference position.

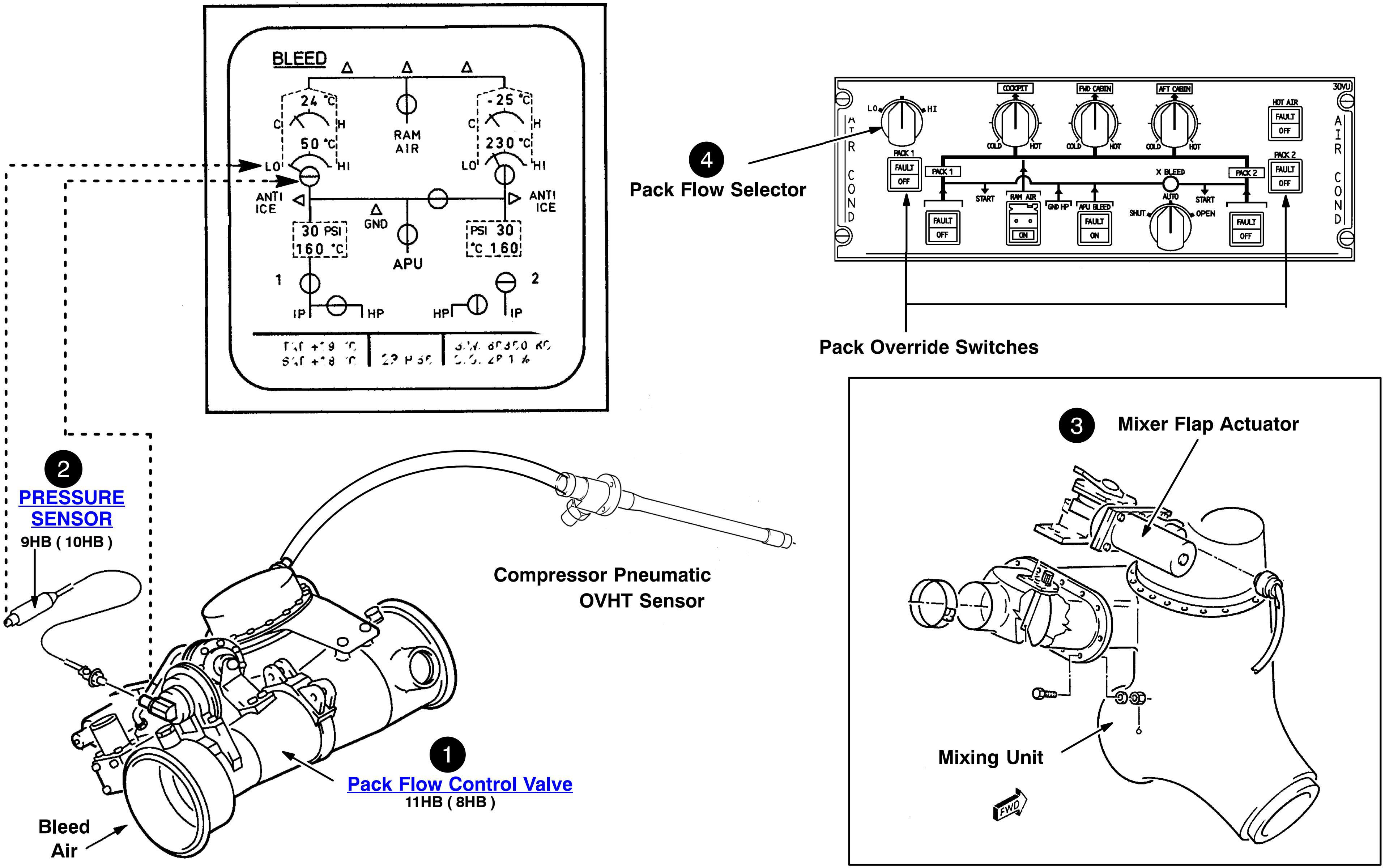


Figure 15 Flow Control Components

PACK FLOW CONTROL VALVE OPERATION

The flow control valves 11HB (8HB) are installed upstream of the air conditioning packs 10HM (11HM).

These valves are of the venturi type with a nominal four–inch diameter. Both have a built–in butterfly valve that controls the flow and performs a shut–off function.

The flow control valve has three main assemblies:

- the valve body with its butterfly valve,
- the pneumatic actuator,
- the air pressure regulator.

The butterfly valve is controlled by a pneumatic actuator with a

1. flexible diaphragm

2. A return spring

closes the valve when there is no pressure supply (< 10 psi).

The pneumatic pressure regulator has :

- a pneumatic flow detector,
- an electrical flow adjustment system,
- an altimetric setting limiter.

The electrical flow adjustment system includes a stepper motor controlled by the pack controller allowing the flow at 80 %, 100 % or 120 % of its nominal value to be adjusted.

The electrical venting system includes an electromagnetic clapper. When it is energized, solenoid **S1** ensures closure of the valve by fully venting the pneumatic actuator **”A”** chamber. When the solenoid is no longer energized, the pneumatic actuator **”A”** chamber is supplied with a regulated pressure.

The microswitch actuated by a pin situated on the butterfly axis indicates fully closed and open positions.

Rapid De-compression

In case of rapid de-pressurization (Zc greater than 8000 feet), the altimetric bellows placed in the nominal flow limiter, keeps the flow at a value obtained for a Zc of 8000 feet, whatever the true altitude of the cabin (Zc).

For sudden changes in pressure upstream the pneumatic flow detector rapid response avoids flow surges.

A pneumatic air overheating thermostat at the compressor outlet of the air cycle machine is connected to the pneumatic actuator **”A”** chamber. If the temperature is too high, the pressure in chamber **”A”** is reduced by venting and it is possible that the valve may be fully closed. The valve will open again if the temperature falls.

Mechanical closing can be manually controlled by direct action on the butterfly axis, following venting of the pneumatic actuator **”A”** chamber by removing the special screw.

The pneumatic flow sensor that uses the same principle as the main flow pneumatic detector, in the regulation zone, modulates a flow through the **G9** jet that is proportional to the main flow and generates a pressure upstream of this jet. The pressure, proportional to the flow, is transmitted to an amplifier that converts it to voltage (electrical flow display function).

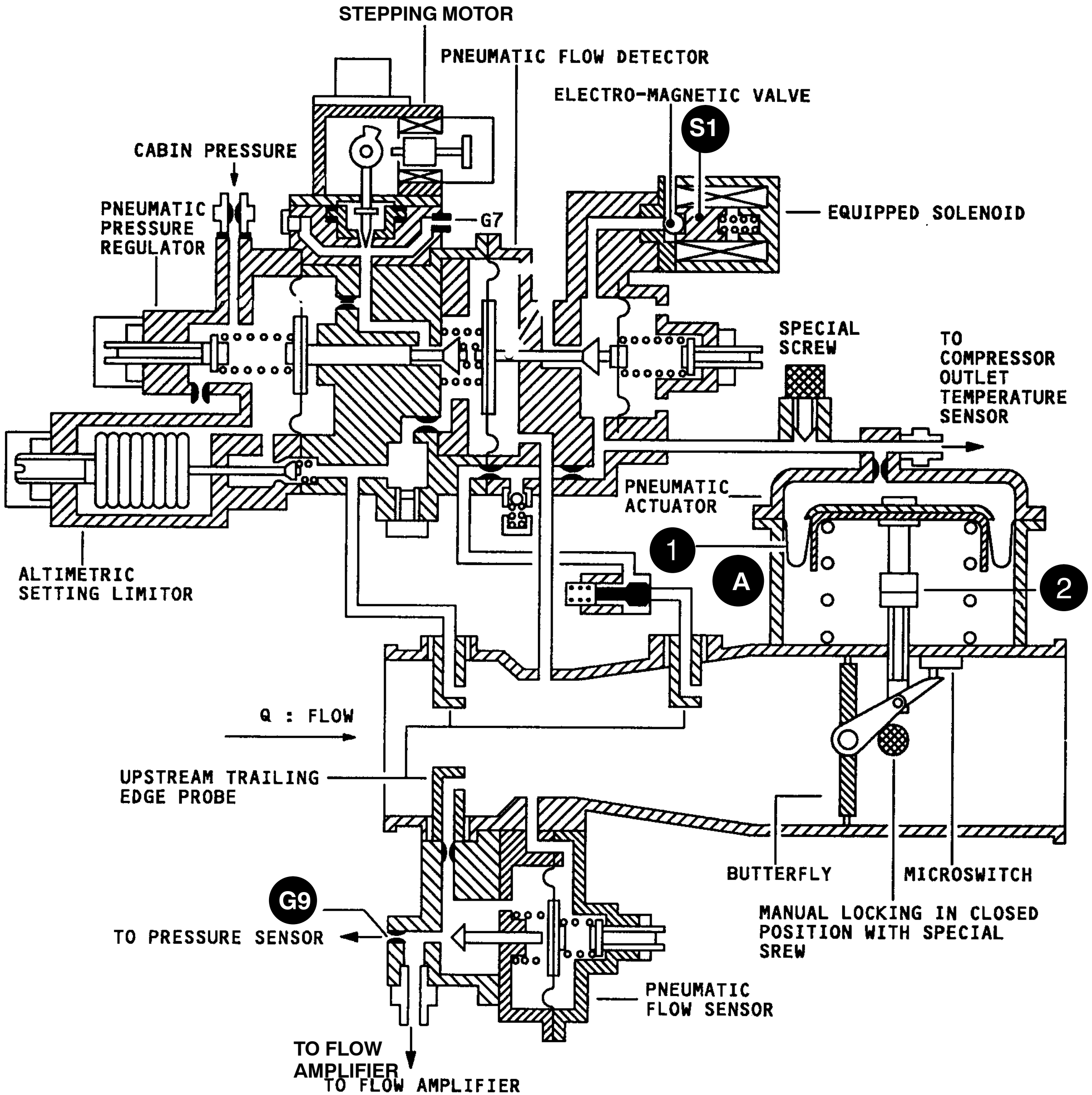


Figure 16 Pack Flow Control Valve

21-52 AIR COOLING SYSTEM

SYSTEM DESCRIPTION

The two air conditioning packs decrease the temperature and the water contained in the hot bleed air from the pneumatic system.

The air conditioning packs 10HM (11HM) are identical and are installed in the un-pressurized area of the belly fairing between the frames 35 and 41.

The air conditioning pack 10HM (11HM) consists of:

- an air−cycle machine,
- a high−pressure water extractor,
- a reheater,
- a condenser,
- a primary heat exchanger,
- a main heat exchanger,
- a fan plenum,
- a inlet plenum.

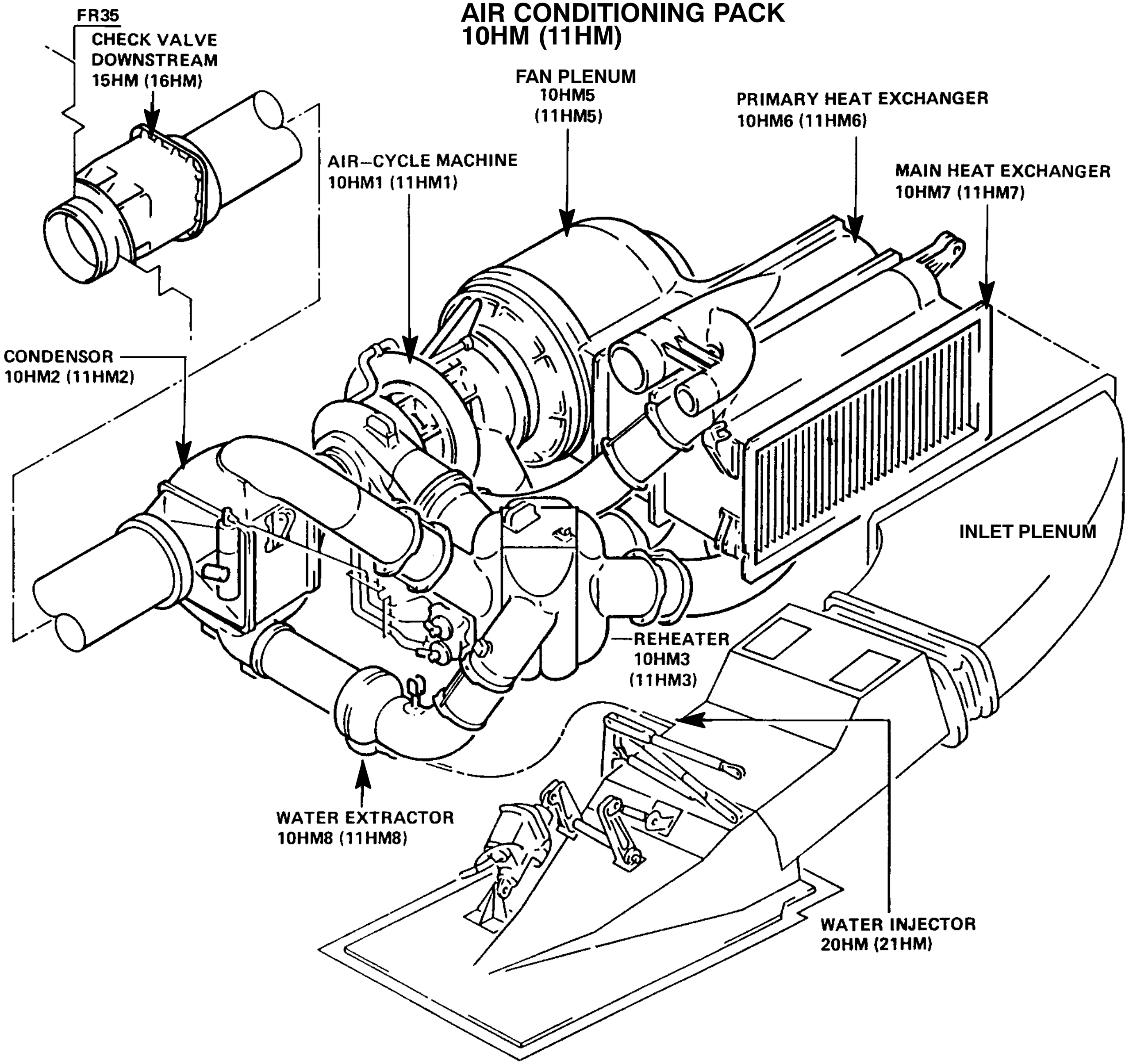


Figure 17 Air Cooling System Components

PACK NORMAL OPERATING MODE

Pack Operation

When the PACK 1 (2) pushbutton switches are pushed, the zone controller 8HK and pack controllers 7HH (27HH) control the flow control valves to supply a constant volumetric flow for all normal operation conditions to the air conditioning packs.

When the bleed air enters the system, it is cooled in the primary heat exchanger with ambient ram air. Part of this air passes through the bypass valve 10HH (30HH) .The remainder is then compressed in the air-cycle machine compressor, which increases the temperature and pressure.

It is cooled again in the main heat exchanger with ambient ram air. The air now enters the high-pressure water-extraction loop, where it is cooled to about its dew point.

The high-pressure water-extraction loop has a reheater, a condenser and a water extractor. It keeps the dew point of the air to the mixer unit lower than +10 deg. C (+50.00 deg. F). The reheater uses the turbine inlet air of the air-cycle machine to cool the air in the high-pressure water-extraction loop.

Condenser

The condenser then uses cold turbine air to further cool the air to below its dew point. The condenser is a heat exchanger, which uses the temperature difference between the turbine outlet air temperature (which is to a sea level dew point of approx. 0 deg. C (32.00 deg. F) and the reheater outlet temperature air. The condensed water is extracted and drained from the air as it passes through the high-pressure water extractor.

After the water extractor the air enters the reheater again and the temperature increases to assure a satisfactory turbine inlet temperature.

In the air-cycle machine turbine, the high pressure air expands and its kinetic energy drives the air-cycle machine and the temperature and the pressure decrease. This causes an additional condensation in the air-cycle machine turbine during ground operation and low altitude flight operation. This condensation appears as snow.

The turbine outlet air passes through the condenser. The now conditioned air leaves the air cooling system.

Freezing Prevention

To prevent freezing at low ambient temperatures and to limit high pack discharge temperatures, the water extractor outlet temperature is limited to between 2 DEG. C (35.60 DEG. F) and 70 DEG. C (158.00 DEG. F). Air is bled from the compressor inlet through the bypass valve 10HH (30HH) to the turbine outlet. This modulates pack discharge temperature to the required level, if the limits for the water extractor are not exceeded.

Anti-Ice Valve

An anti-ice valve 17HH (37HH) (Ref. 21-61-00) is used to stop (as a back-up) ice formation downstream of the turbine. When a significant pressure drop is sensed the valve opens, tapping hot air from downstream of the flow control valves 8HB (11HB). This hot air is delivered to the turbine which eliminates any ice formation.

Bypass valve

Additionally the bypass valve always maintains a minimum air-cycle machine flow to keep the air-cycle machine idling during all pack operation conditions.

The ambient ram air for heat exchanger cooling enters the air cooling system through fully modulating NACA-type inlets. After passing through the primary heat exchanger, the main heat exchanger and the plenum the air is discharged overboard through a variable outlet. When the aircraft is on the ground, the air-cycle machine fan supplies the cooling airflow. During flight the inlet and outlet areas are modulated so that the airflow is kept to a minimum. During takeoff and landing, the inlet is fully closed to prevent the dirt ingestion and contamination of the heat exchangers.

The water injector 20HM (21HM) sprays the condensed water from the water extractor into the ambient ram airflow to help cooling.

THIS PAGE INTENTIONALLY LEFT BLANK

ABNORMAL PACK OPERATIONS

Single Air Condition Pack Mode

The aircraft can fly with one air conditioning pack inoperative provided:

- FL310 is not exceeded,
- the zone controller primary channel is operative,
- the PACK FLOW Selector is set to HI (A320) or set ECON FLOW P/B Switch to OFF (A321)
- the affected PACK 1 or 2 pushbutton switch is in the OFF position and the flow
- control valve is checked closed on the ECAM system.

Heat Exchanger Cooling Mode

One air conditioning pack can also be operated on heat exchanger cooling only provided:

- the corresponding pack controller is fully operational
- the TAT indication is available,
- the affected pack is not operated until the aircraft is airborne, and the TAT is less than 12° C, and affected PACK OUTLET TEMP indication is available, and the remaining pack is operating normally.

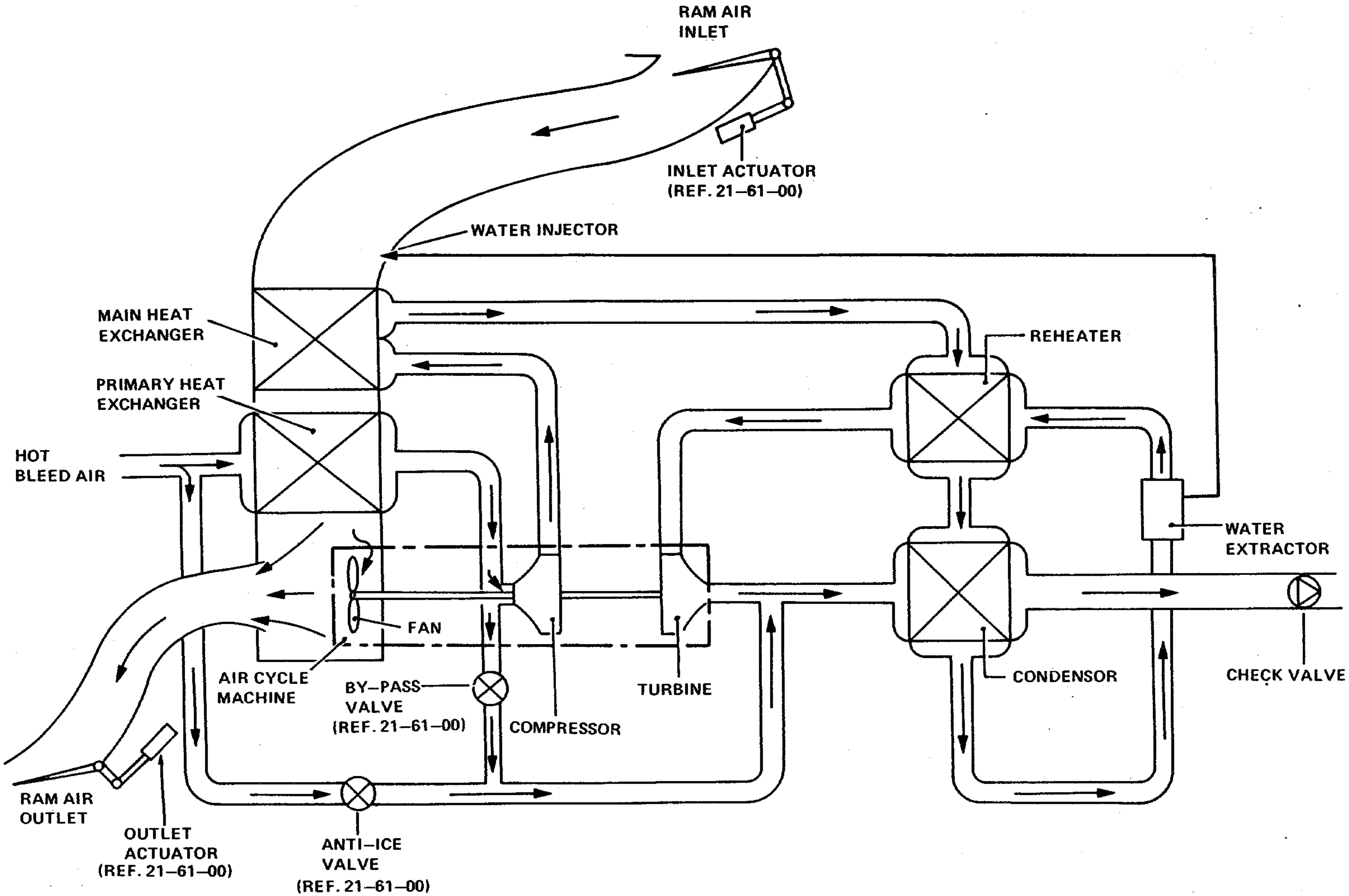


Figure 18 Pack Cooling Schematic

AIR COOLING COMPONENTS DESCRIPTION

7 PRIMARY HEAT EXCHANGER

The primary heat exchangers 10HM6 (11HM6) are installed in the ram air system between the plenums and the main heat exchangers. Ram air flows through the heat exchangers and decreases the temperature of the hot bleed air from the pneumatic system.

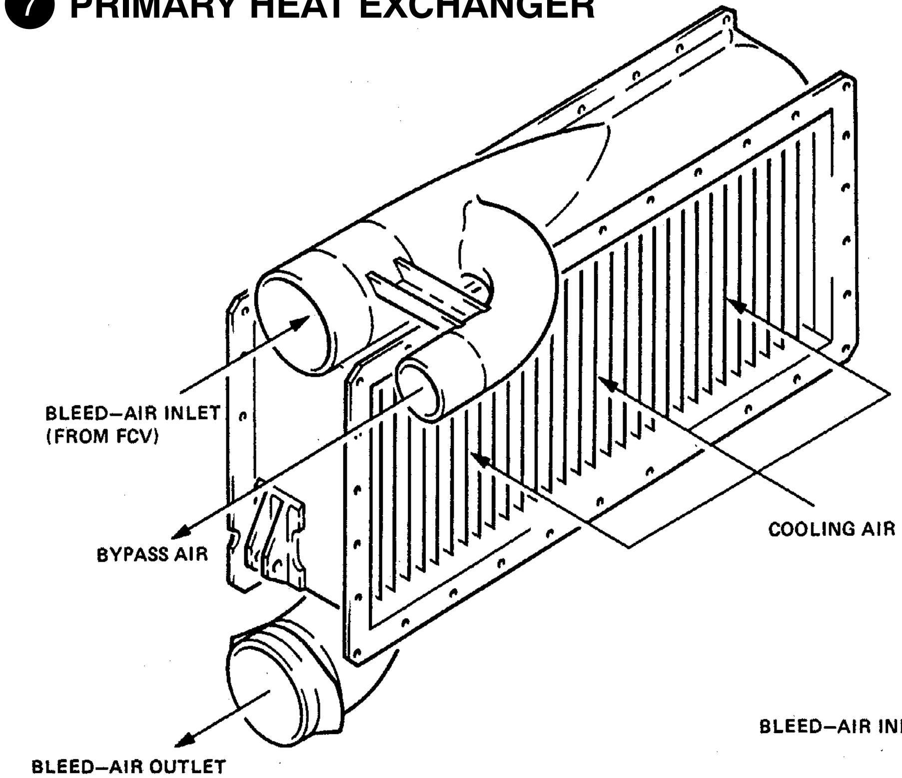
The primary heat exchanger, which is made of aluminum alloy, is a plate and fin type of single–pass crossflow configuration.

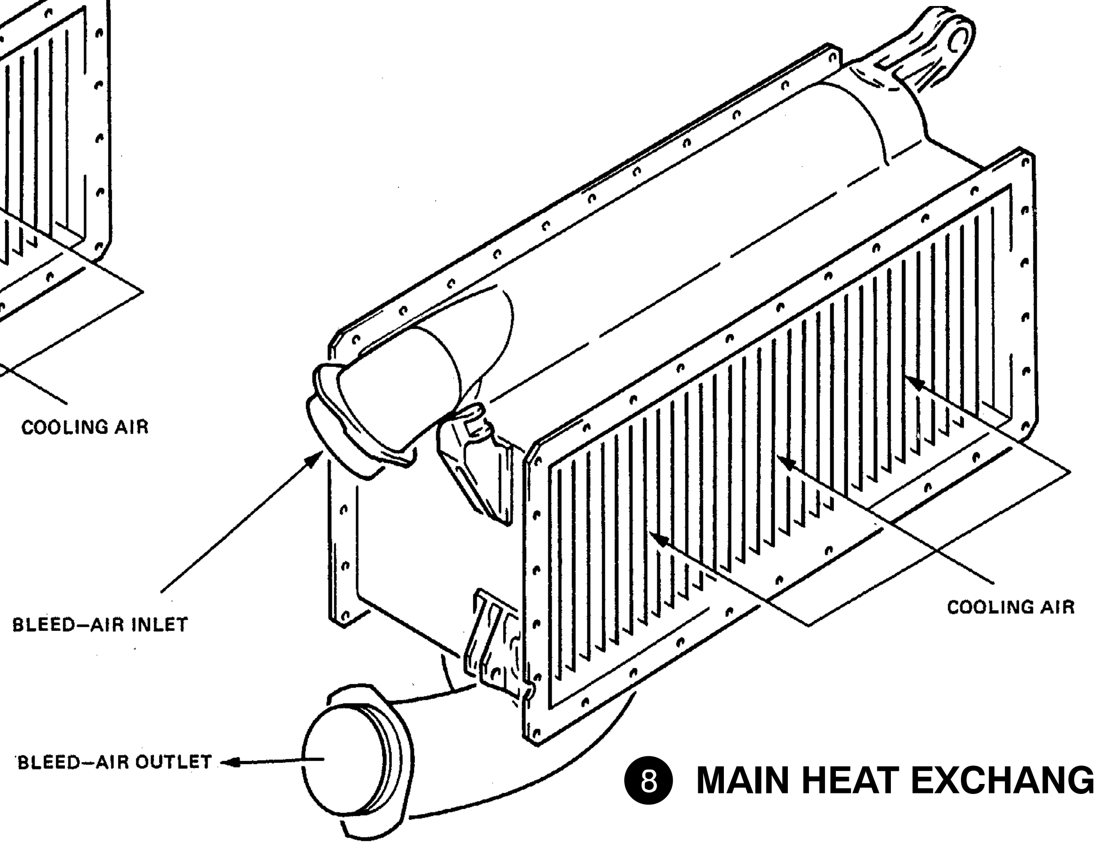
8 MAIN HEAT EXCHANGER

The main heat exchangers 10HM7 (11HM7) are installed in the ram air systems upstream of the primary heat exchangers. Ram air flows through and decreases the temperature of the hot air from the compressor of the air cycle machine.

The main heat exchanger which is made of aluminum alloy, is a plate and fin type of counterflow configuration. The heat exchanger is installed between the air–cycle machine compressor and turbine, the cooling agent is ambient ram air.

❼ PRIMARY HEAT EXCHANGER





❽ MAIN HEAT EXCHANGER

Figure 19 Primary and Main Heat Exchanger

9 AIR CYCLE MACHINE

The air cycle machines 10HM1 (11HM1) are installed between the plenums and the condensers. Air enters the compressor from the primary heat exchanger and is compressed. The pressure and temperature increase. The air then flows to the main heat exchanger. Air enters the turbine from the reheater and is expanded. The pressure and temperature decrease. The air then flows to the condenser. The expansion of the air in the turbine turns the turbine wheel, the compressor wheel and the fan wheel. The fan wheel gives a flow of ram air through the ram air system if there is no ram air effect (on the ground).

Air Cycle Machine Description.

The main component of the air–cycle machine is a rotating shaft. A turbine, a compressor and a fan are mounted along the shaft. The shaft rotates on two self–acting foil–air bearings, a double self–acting air–thrust bearing takes the axial thrust loads. Air tapped from the turbine inlet, is used to cool the bearing and then discharged into the ram airflow. Labyrinth seals reduce air leakage between static and rotating parts.

The light–alloy turbine is supplied with air through a stainless–steel nozzle and a light–alloy scroll. In case of turbine break up, the stainless–steel nozzle acts as a containment ring. The light–alloy centrifugal compressor is mounted in the center of the rotating shaft. Air is supplied from a light–alloy scroll, an outer scroll has a stainless–steel diffuser. In case of a compressor break up, the stainless–steel diffuser acts as a containment ring.

Fan air is discharged through a conical nozzle, this gives a jet–pump effect in the fiberglass plenum diffuser. The primary heat exchanger outlet is connected to the discharge ram airflow through the fiberglass diffuser.

The air–cycle machine has a de–icing system at the turbine outlet. Hot high–pressure air is tapped from the compressor scroll through a duct. It circulates through the annulus turbine outlet to prevent ice formation at the turbine outlet. After thermal exchange the air is returned to the compressor intake through a duct.

9 AIR CYCLE MACHINE

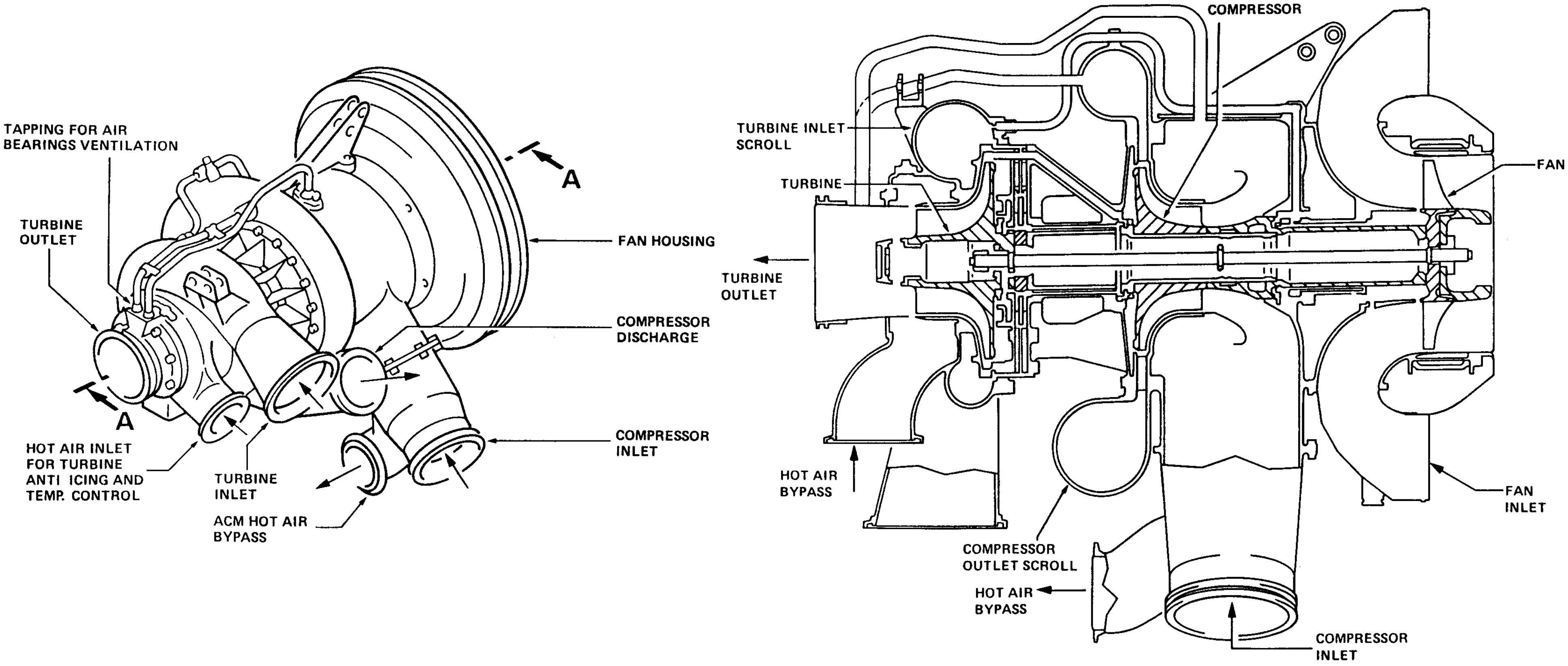


Figure 20 Air Cycle Machine.

WATER EXTRACTION LOOP COMPONENTS

14 REHEATER

The reheater 10HM3 (11HM3) are installed between the main heat exchangers and the condensers. The hot air from the main heat exchanger increases the temperature of the cold air from the water extractor.

The reheater which is made of aluminium–alloy, is a plate and fin type of single crossflow configuration.

15 CONDENSER

The condensers 10HM2 (11HM2) are installed between the air cycle machines and the mixer unit. The cold air from the turbine of the air cycle machine decreases the temperature of the hot air from the reheater. The temperature of the hot air decreases to less than its dew point and the water in the air condenses.

The condenser, which is made of aluminum–alloy, is a tubular heat exchanger with a tube to tube discharge.

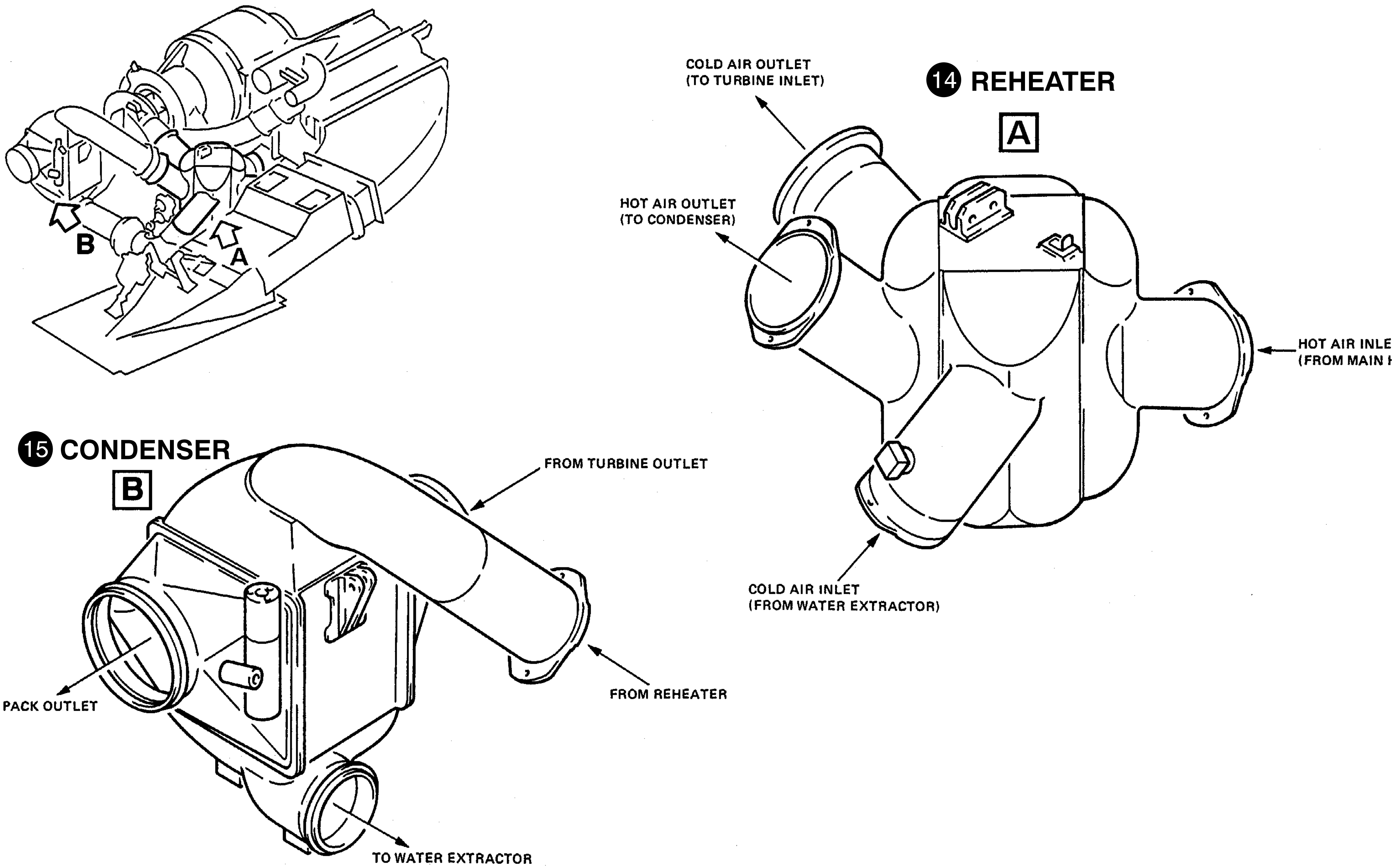


Figure 21 Reheater/Condenser

16 WATER EXTRACTOR

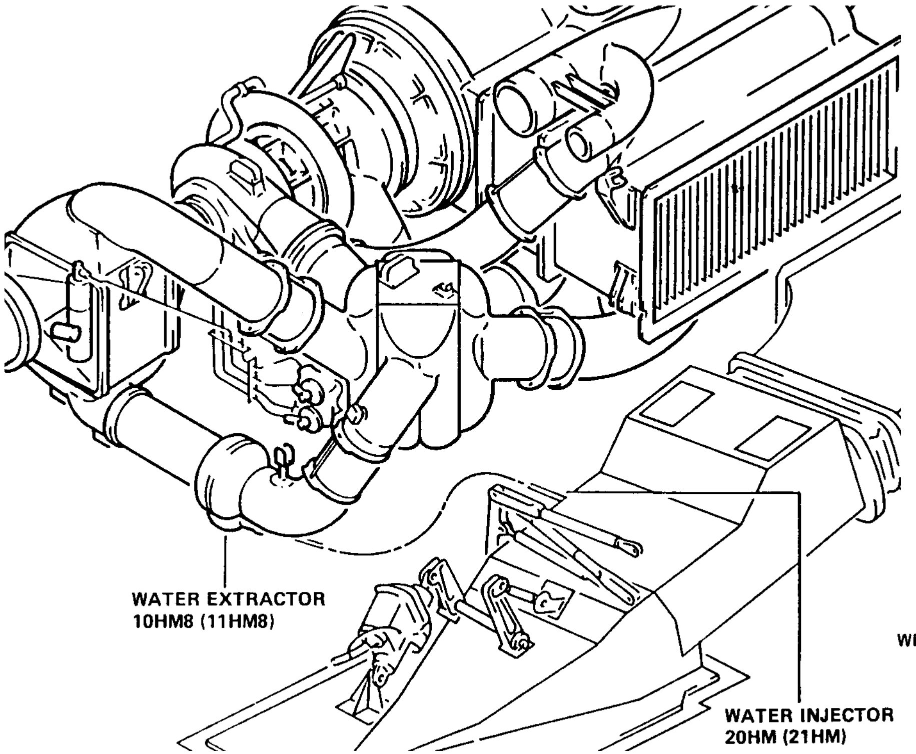
The water extractors 10HM8 (11HM8) are installed between the condensers and the reheater. They remove the water that condenses in the condensers. The condensed water and the water from the split duct drain to the applicable water injector 20HM (21HM).

Component Description

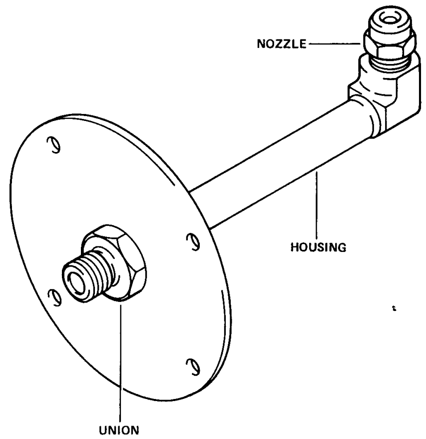
The water extractor is made from light alloy, and contains swirl vanes and a water drain inside a body. Swirl vanes centrifuge the water droplets in the air to the inner surface of the water extractor body. The water collects at the lowest point of the body. It is then drained to water injectors 20HM (21HM) which spray the water into the ram airflow. This helps the cooling capacity through the process of evaporation. The water extractor is installed at the high-pressure outlet of the condenser.

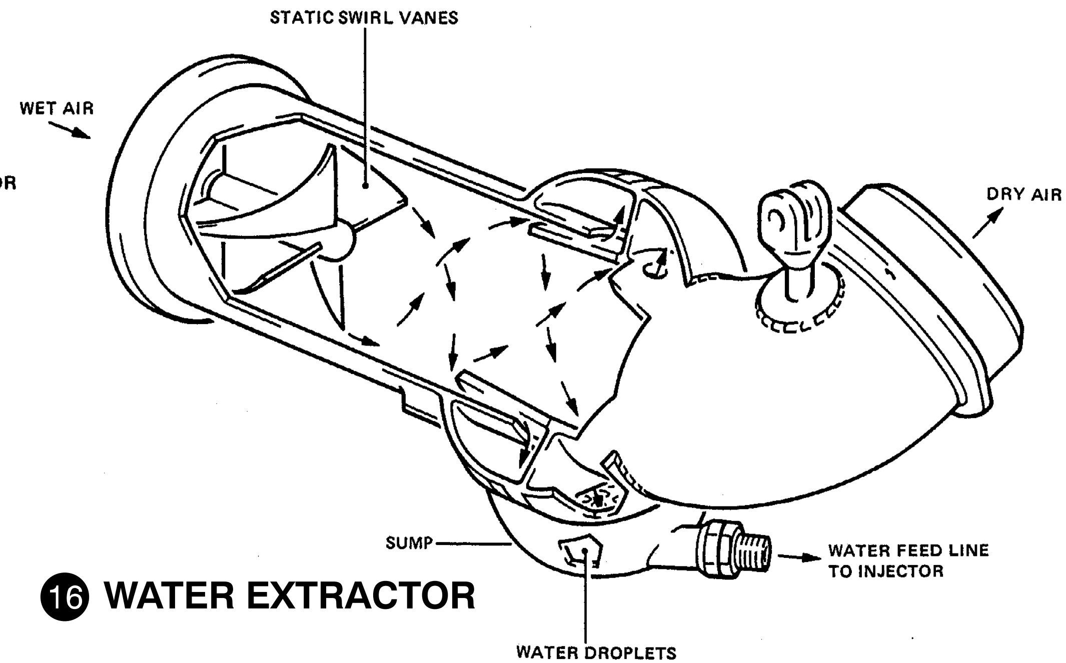
17 WATER INJECTOR

The water injector 20HM (21HM) is installed in the ram-air inlet duct, upstream of the heat exchangers. The injector nozzle is connected to the sump of the water extractor with a small diameter pipe. The water from the extractor is delivered under pressure into the ram airflow to increase the cooling capacity through evaporation.



17 WATER INJECTOR





16 WATER EXTRACTOR

Figure 22 Water Extractor/Water Injector

21-61 PACK TEMPERATURE CONTROL

OPERATION

The pack temperature control system controls the pack outlet temperature and sets its maximum and minimum limits. Two pack controllers control the system.

Each pack controller 7HH (27HH) controls the two major parameters of its related pack:

- the pack outlet temperature
  (through the water extractor outlet temperature),
- the ram−air cooling flow, which is kept to a minimum for fuel economy.

Each pack controller consists of two computers:

- one primary and
- one electrically independent secondary computer.

The primary computer is capable of modulating the system parameters to their full extent, thus optimizing the system performance. The secondary computer gives a reduced level of optimization when it operates as a back−up in the event of the primary computer failure.

During normal operation, the required pack outlet temperature is signalled from the zone controller 8HK to the pack controllers 7HH (27HH).

To get the pack outlet temperature, the pack controller modulates the bypass valve 10HH (30HH) and the ram−air inlet and outlet doors in a predetermined sequence.

This sequence is a compromise between a minimum ram airflow while maintaining adequate heat transfer rates and sufficient pack flow.

For maximum cooling, ram−air doors are fully open and the bypass valve fully closed.

For maximum heating, the ram−air doors are nearly closed and the bypass valve fully open.

The bypass valve will ensure sufficient flow through the air−cycle machine to stop the speed falling below idle.

During takeoff and landing, the ram inlet doors will be driven fully closed to stop the ingestion of foreign matter.

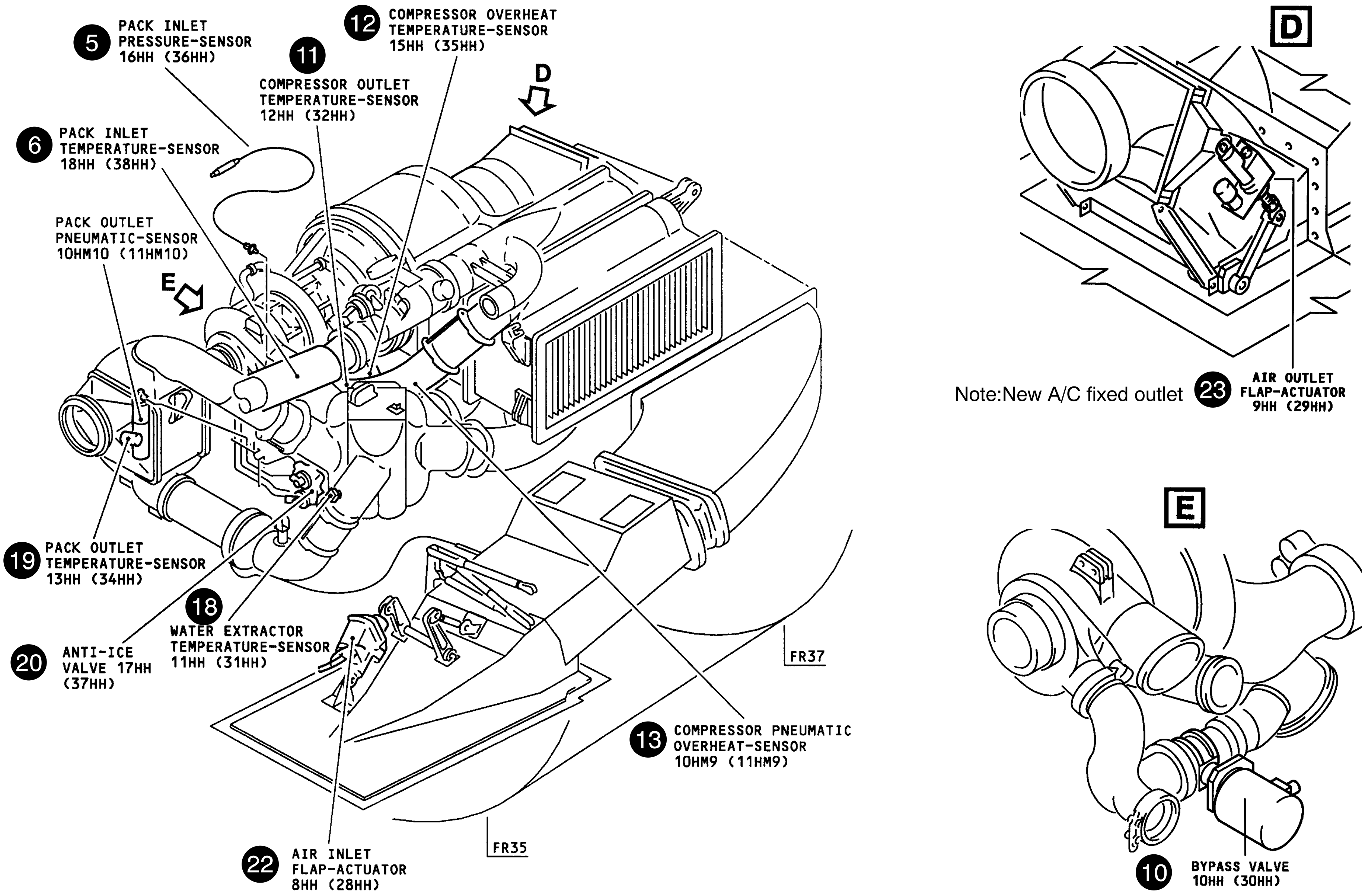


Figure 23 Component Locations

PACK COMPONENTS DESCRIPTION

5 PACK INLET PRESSURE SENSOR

The pack inlet pressure sensor 16HH (36HH) converts pressure at the pack inlet into an electrical signal, it consists of:

- a high−precision pressure transducer,
- a measurement amplifier,
- an electrical connector.

The pressure sensor is installed upstream of the flow control valves 8HB (11HB). If the pressure drops below limits, the bypass valve 10HH (30HH) preferential position is controlled to a more open position to allow for supply of a minimum required airflow. This decreases the differential pressure of the air conditioning pack 10HM (11HM). The ram−air doors are controlled to a more open position, this compensates for the decreased efficiency of the turbine/compressor cycle.

In addition, if a low pack inlet pressure is less than 30 PSI and a still not satisfied cool demand is present, a signal to the FADEC is generated via the zone controller to increase the Engine Idle RPM to therefor provide a higher bleed air pressure in return.

6 BLEED TEMPERATURE SENSOR

The bleed temperature sensor18HH (38HH) is located in the bleed air duct at the inlet of each flow control valve 8HB (11HB). It is connected to the pack controller 7HH (27HH) primary−computer. It supplies CFDS information when maintenance action is necessary due to overheat (> 280 °C) at the pack inlet. The sensor consists of one platinum resistor potted in a stainless−steel ventilated−tube housing. A 3−pin electrical connector is also included.

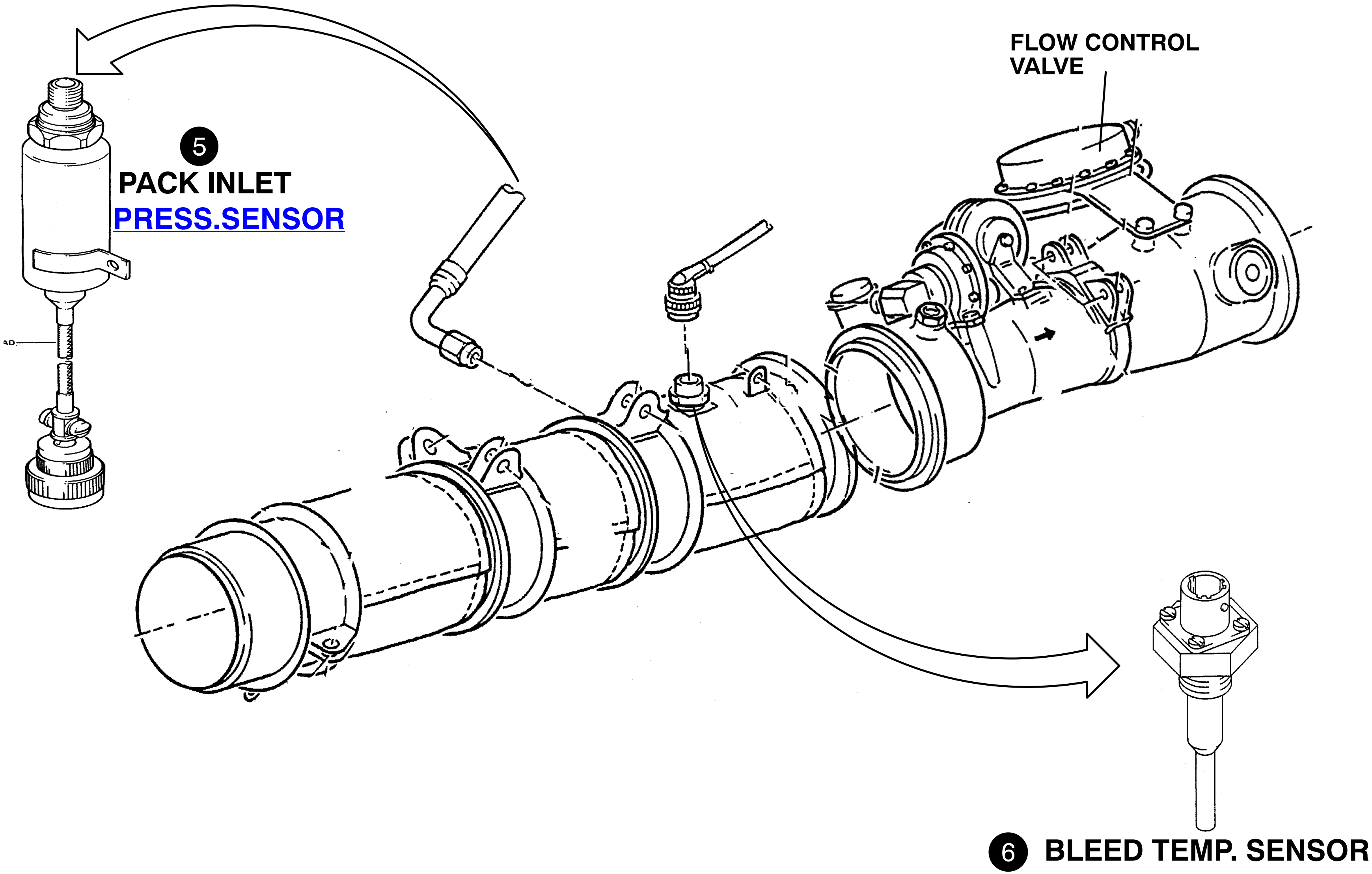


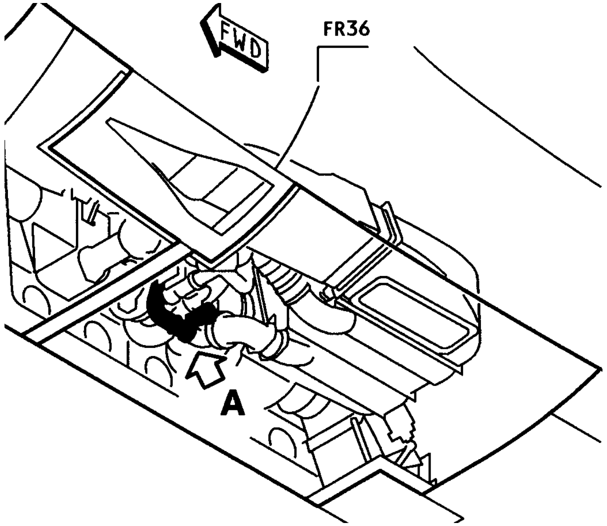
Figure 24 Pack Inlet Press.– and Bleed Temp. Sensor

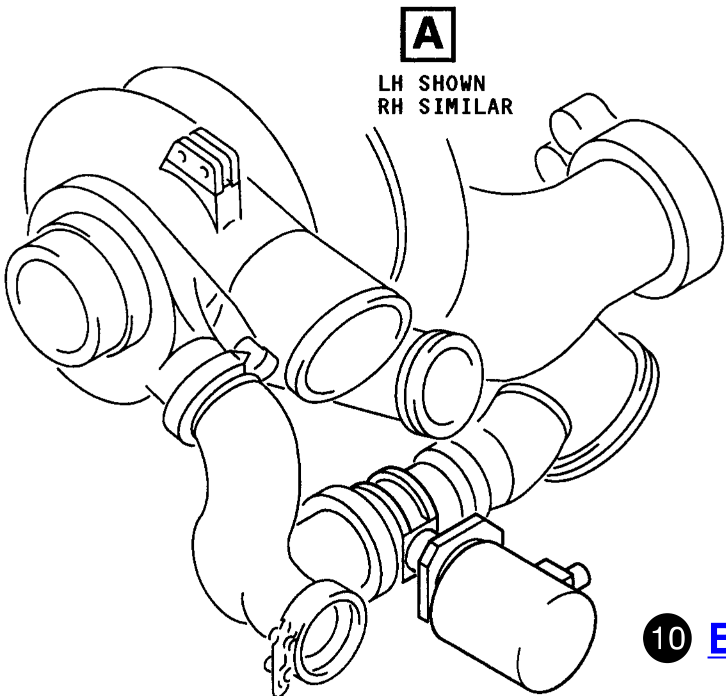
10 BYPASS VALVE

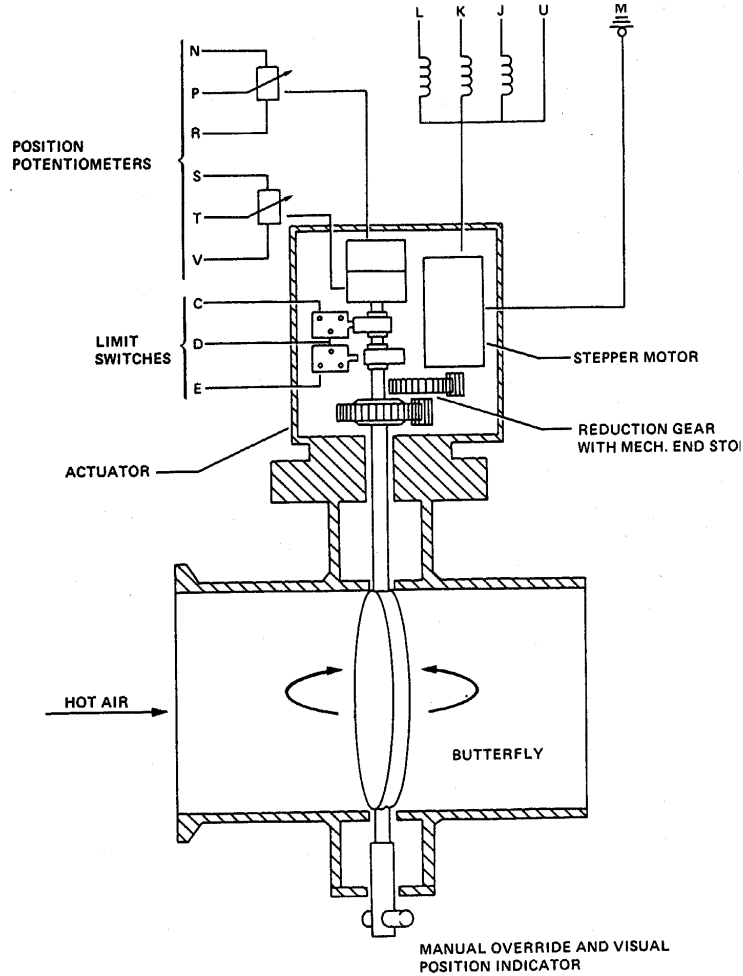
The bypass valve 10HH (30HH) is a light alloy 2−inch butterfly valve. It is located in the duct downstream of the primary heat exchanger and splits the hot airflow between the ACM and a bypass (which goes to the turbine outlet). The bypass valve gets a signal from the pack controller 7HH (27HH) (primary and secondary computer) to modulate the hot airflow. This controls the water extractor outlet temperature, thus the pack outlet temperature.

The Bypass valve normally has a preferred position of 21 DEG. which this valve always tries to position itself to. With this preferred position the valve has an ideal position to respond very quickly to changes in new pack temperature selections. If the aircraft temperature has to be changed for example to a warmer temp. the bypass valve leaves the preferred position and opens more. This increases the water extract− and also the pack outlet temperature. The pack controller registers this and now closes in response the ram air inlet−and the ram air outlet flaps so far, that the bypass valve can go back to its 21 DEG. preferred position. In addition a bypass valve which is always at nearly the same partially open position lets the air cycle machine operate with nearly the same RPM.

The bypass valve 10HH (30HH) consists of an actuator assembly and a valve body assembly. They are bolted together and internally connected. A butterfly valve on a central shaft is driven by a stepper motor through reduction gears which have mechanical end stops. Two cams (installed on the shaft) operate limit switches which signal fully open or fully closed positions to the pack controller 7HH (27HH) secondary computer. Two potentiometers (at the end of the shaft) signal the primary computer for indication and the secondary computer for BITE and indication. A manual override and visual position indicator device is installed on the bottom of the shaft.







10 **BYPASS VALVE**

Figure 25 Bypass Valve

11 COMPRESSOR DISCHARGE TEMPERATURE SENSOR

The compressor discharge temperature-sensors 12HH (32HH) are installed between the compressors of the air cycle machines 10HM1 (11HM1) and the main heat exchangers 10HM7 (11HM7).

The compressor discharge temperature-sensor 12HH (32HH) consists of one platinum resistor potted in a stainless-steel ventilated-tube housing. A 3-pin electrical connector is also included. The sensor is located in the compressor outlet duct of each air conditioning pack 10HM (11HM). It is connected to the pack controller 7HH (27HH) primary-computer for control functions and overheat detection.

12 COMPRESSOR OVERHEAT TEMPERATURE SENSOR

The compressor-overheat sensors 15HH (35HH) are installed between the compressors of the air cycle machines 10HM1 (11HM1) and the main heat exchangers 10HM7 (11HM7).

The compressor overheat sensor15HH (35HH) is located in the compressor outlet duct (close to the compressor discharge temperature sensor 12HH (32HH). The sensor is connected to the pack controller 7HH (27HH) secondary-computer for overheat detection. The sensor also provides compressor outlet temperature on ECAM. This will ease troubleshooting.

Compressor Outlet Overheat-Detection and Signals

The pack controller 7HH (27HH) primary or secondary computer can detect an overheat 260 °C (500.00 °F) at the air-cycle machine 10HM (11HM) compressor outlet. The primary through the compressor discharge temp. sensor 12HH (32HH) and the secondary through the compressor overheat sensor 15HH (35HH). The first sensor to respond will send a signal to light up the FAULT light on the related pack pushbutton switch 6HG (7HB) (installed on panel 30VU in the cockpit overhead panel). At this point, the crew must select the pack OFF manually, as the pack controller takes no automatic actions. An overheat signal is also sent on the fourth occurrence (during one flight leg), of a temperature over 230 °C (446.00 °F).

13 COMPRESSOR PNEUMATIC OVERHEAT SENSOR

The pneumatic compressor-overheat sensors 10HM9 (11HM9) are installed downstream of the compressors of the air cycle machines 10HM1 (11HM1).

They are connected to the flow control valves 10HB (11HB). If the compressor outlet temperature increases above a predetermined value (approx. 230 °C), the pneumatic compressor overheat-sensor gives a pneumatic signal to the flow control valve to reduce the airflow.

The compressor pneumatic overheat-sensor 10HM9 (10HM9) consists of a bi-metallic rod which is inserted into the hot airflow. The sensor is connected through a sensing line, to the flow control valve 8HB (11HB) shuttle valve assembly. It vents flow control muscle pressure to ambient (Ref. 21-51-00). Differential expansion in the rod will start to open the vent at 230 °C (446.00 °F) (any further increase in temperature will increase the opening area). The angle of the flow control valve is now controlled pneumatically, to stop an overheat of 260 °C (500.00 °F).

The pneumatic sensor is located in the compressor discharge duct close to the compressor overheat sensor 15HH (35HH).

Compressor Overheat

Installed at the compressor outlet is a pneumatic temperature sensor. This acts (by differential expansion) directly on the flow control valve 8HB (11HB) muscle pressure. It starts to close the flow control valve when the compressor outlet temperature reaches 230 °C (446.00 °F). Control is such that the overheat warning temperature of 260 °C (500.00 °F) should never occur.

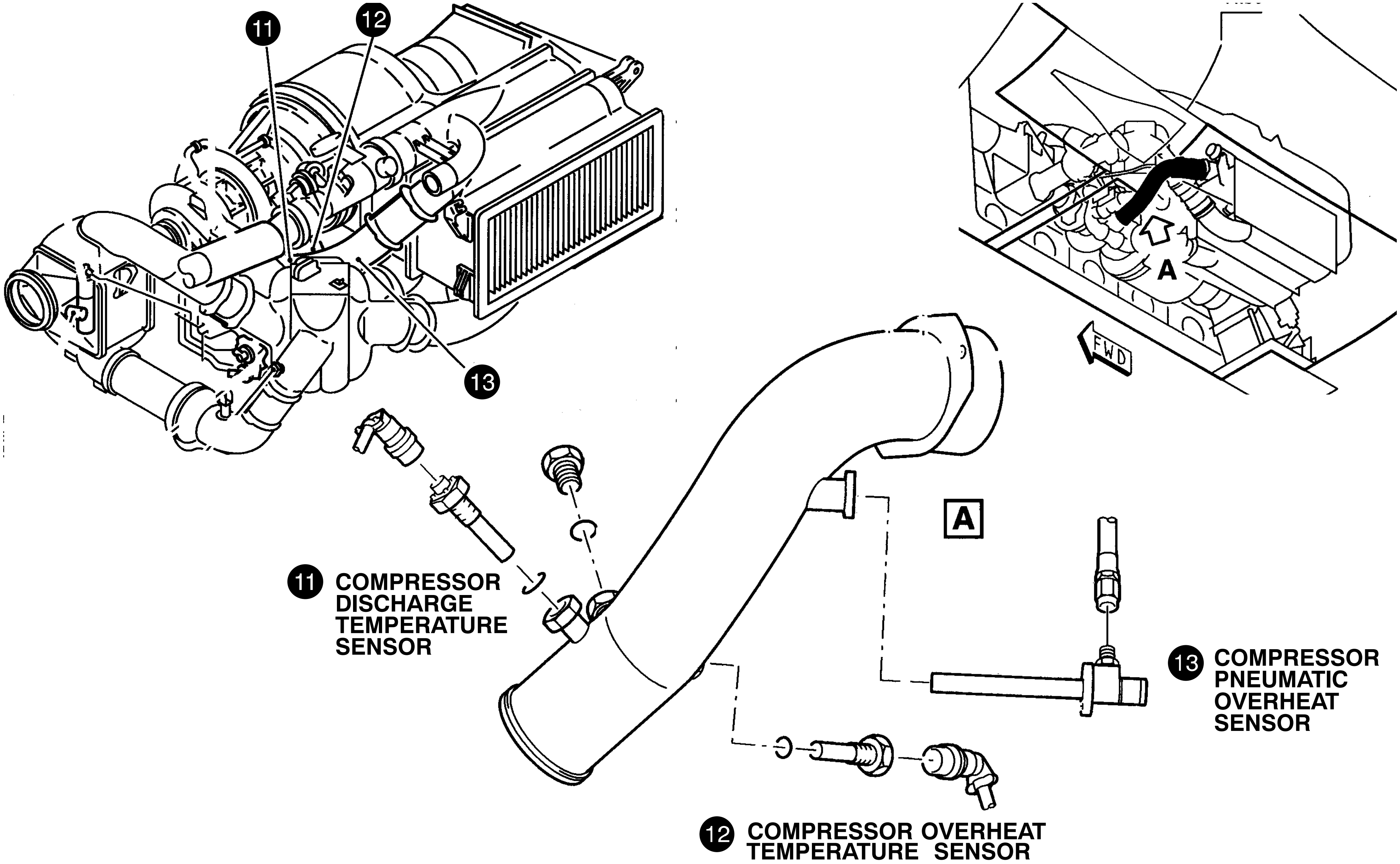


Figure 26 Compressor Discharge Temp. Sensors

COMPRESSOR DISCHARGE SENSORS LOGIC OPERATION

Compressor Outlet Overheat−Detection and Signals

The pack controller 7HH (27HH) primary or secondary computer can detect an overheat 260 °C (500.00 °F) at the air−cycle machine 10HM (11HM) compressor outlet. The primary through the compressor discharge temp. sensor 12HH (32HH), and the secondary through the compressor overheat sensor 15HH (35HH). The first sensor to respond will send a signal to light up the **FAULT** light on the related pack pushbutton switch 6HG (7HB) installed on panel 30VU in the cockpit overhead panel. At this point, the crew must select the pack **OFF** manually, as the pack controller takes no automatic actions. An overheat signal is also sent on the fourth occurrence (during one flight leg), of a temperature over 230 °C (446.00 °F).

Compressor Overheat

Installed at the compressor outlet is a pneumatic temperature sensor. This acts (by differential expansion) directly on the flow control valve 8HB (11HB) muscle pressure. It starts to close the flow control valve when the compressor outlet temperature reaches 230 °C (446.00°F). Control is such that the overheat warning temperature of 260 °C (500.00 °F) should never occur.

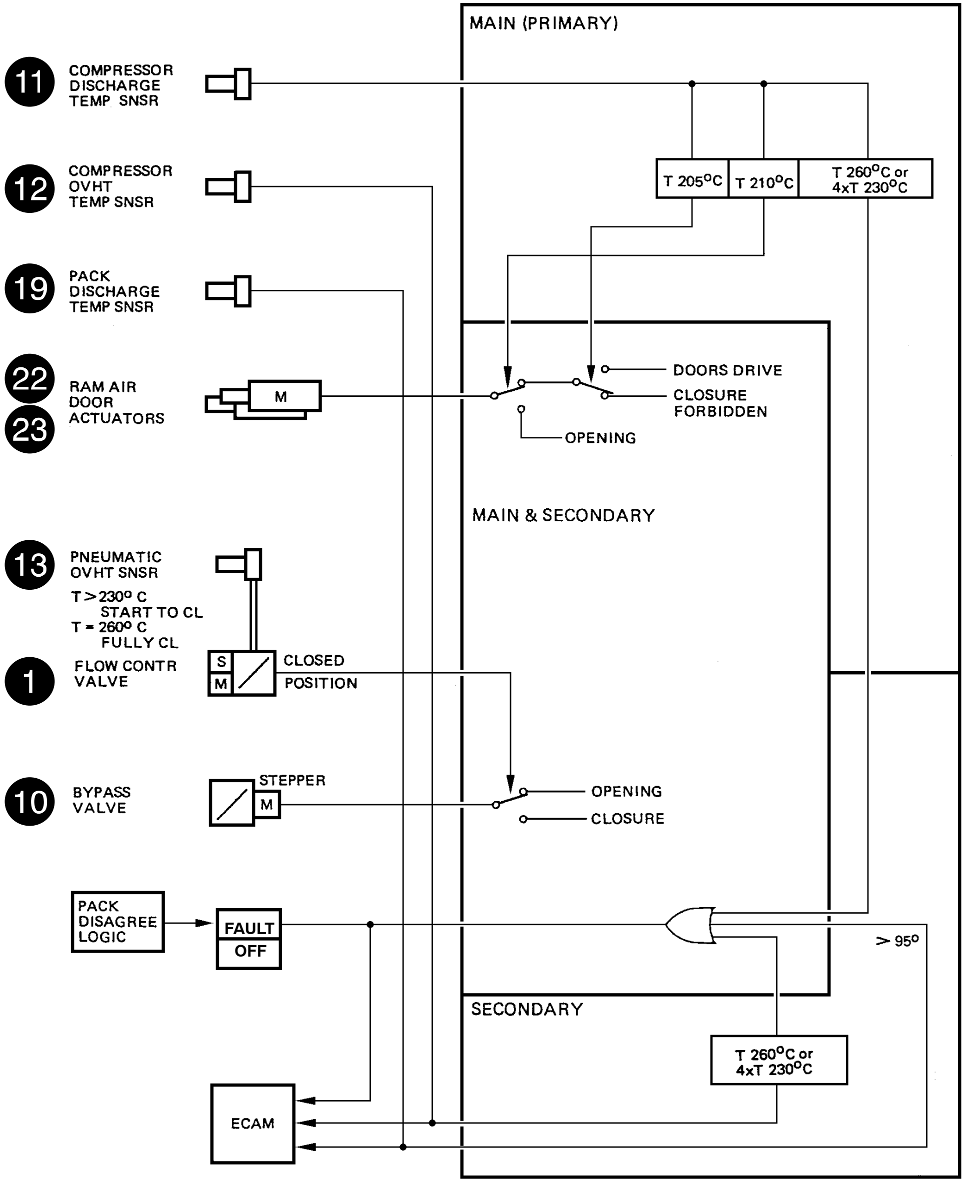


Figure 27 Compressor Discharge Sensor Logic

18 WATER EXTRACTOR TEMPERATURE SENSOR

The water extractor temperature-sensors 11HH (31HH) are installed in the water extractors 10HM8 (11HM8) upstream of the reheater 10HM3 (11HM3).

The water extractor temperature-sensor 11HH (31HH) consists of two thermistors potted in a hermetically sealed steel housing. A 6-pin electrical connector is also included. One thermistor is connected to the pack controller 7HH and (27HH) primary-computer the other to the secondary computer. They both give pack temperature control information.

19 PACK DISCHARGE TEMPERATURE SENSOR

The pack discharge temperature-sensors 13HH (33HH) are installed at the pack outlet (close to the pack outlet pneumatic-sensor).

The pack discharge temperature-sensor 13HH (34HH) is located at the pack outlet (close the pack outlet pneumatic sensor). The sensor is connected to the pack 7HH (27HH) secondary computer and monitors the pack outlet temperature which is shown on the ECAM lower display unit. it is also responsible for the PACK OVHT Message on ECAM and the illumination of the **FAULT** light in the pack override P/B switch when the pack outlet temperature exceeds 95 °C. In this case the crew has to switch the pack off.

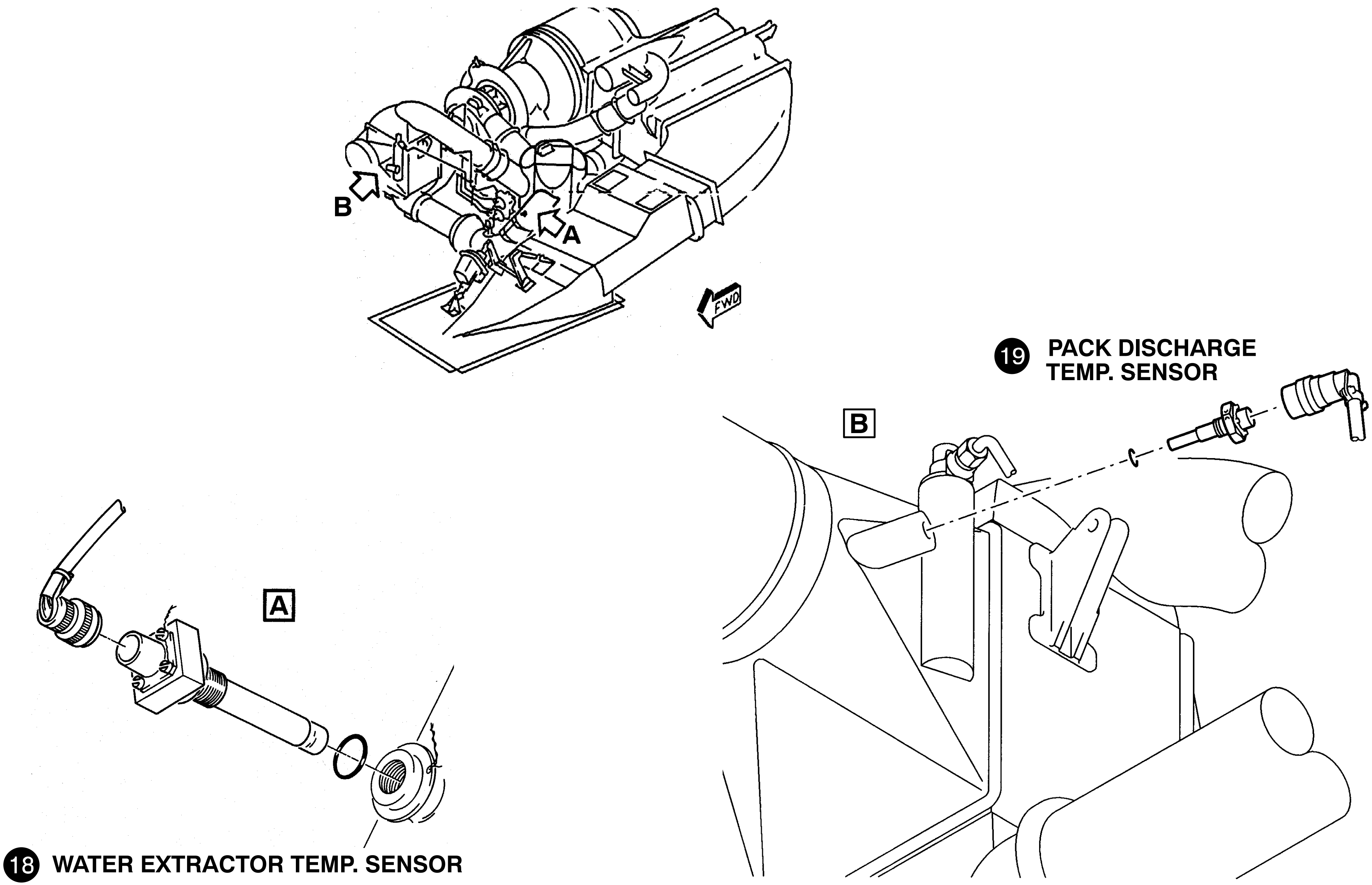


Figure 28 Water Extraction and Pack Discharge Temperature Sensor

20 ANTI ICE VALVE (17HM/37HH)

In each air conditioning pack 10HM (11HM), the anti−ice valve 17HH (37HH) is located in a duct between the upstream side of the primary heat exchanger and the turbine outlet. In normal pack operation the purpose of the anti−ice valve is to prevent ice blockage across the condenser.

The anti−ice valves are usually closed. An anti−ice valve opens if the delta−P sensors of the anti−ice valve find an unusual difference in pressure across the condenser 10HM2 (11HM2) (ice in the condensers is assumed). To detect this there are two pairs of pressure sense lines. One on the high pressure side of the condenser inlet/outlet, the other on the low pressure side of the condenser inlet/outlet. If an excessive pressure drop (indicating icing) is detected, the anti−ice valve is opened (pneumatically). This results in a surge of hot air to the turbine outlet, which melts and clears the ice blockage in the condensers and downstream equipment. After this clearance the anti ice valve shuts.

If there is a loss of a pack controller 7HH (27HH) the anti−ice valves control the pack outlet temperature. They adjust the quantity of hot bleed air added to the air cycle machine outlets. The pack outlet temperature (measured at the pack discharge pneumatic−sensors 10HM10 (11HM10) is a constant approx. 15 °C (59.00 °F).

Automatic Pack De-Icing

Each pack controller provides an automatic pack de−icing function. The pack By−Pass Valve (BPV) gets a recurrent signal from the pack controller (primary and secondary computer) to modulate the hot airflow. This increases the pack outlet temperature.

The BPV de−icing cycles are performed if :

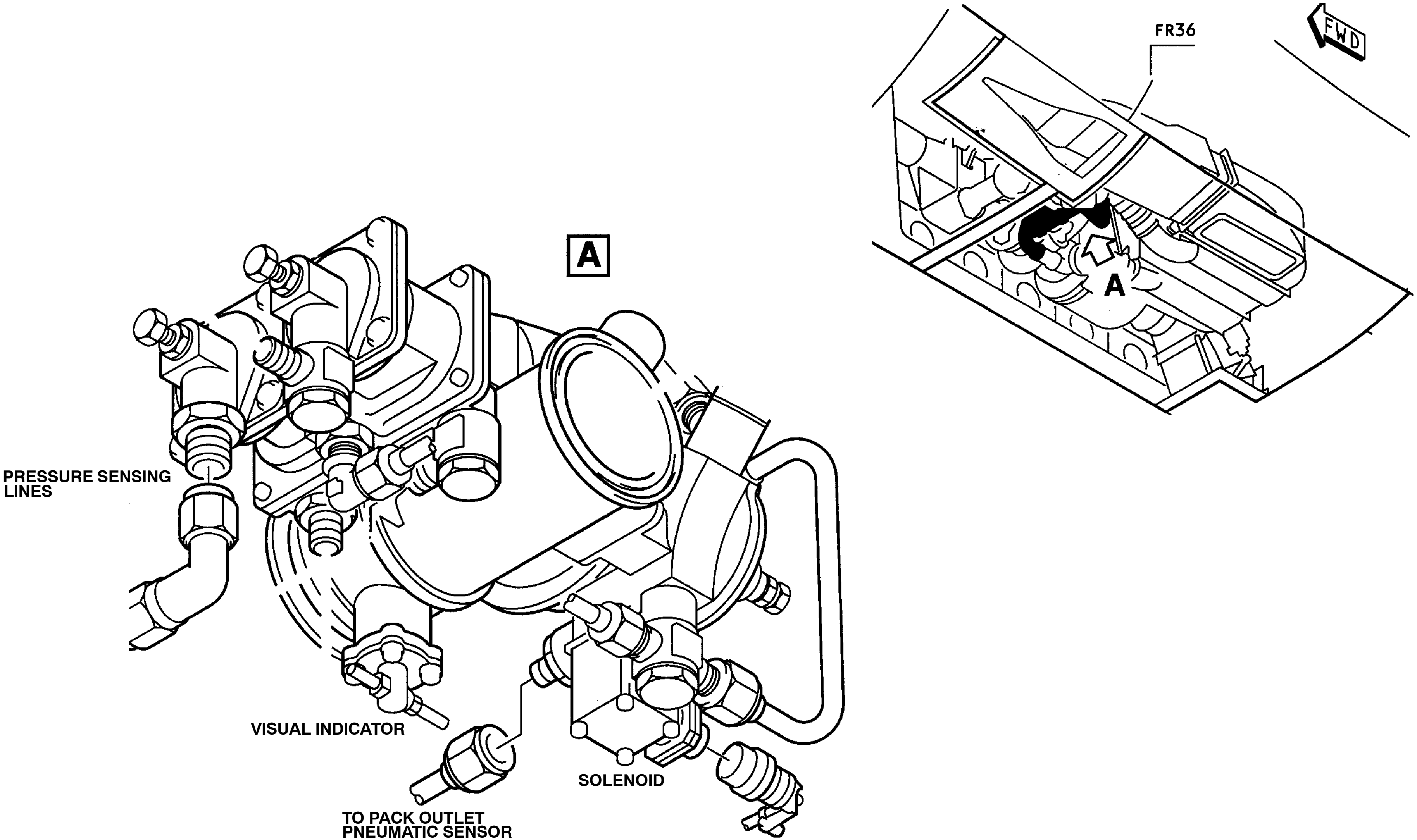
- the flow control valve is open,
- the pack discharge temperature is less than 5 °C or the BPV position is less than 25 Deg.

The period of these cycles are set to :

- 9 min for the LH pack,
- 11 min for the RH pack.

If the pack is set on or a power−on reset occurs the first period of cycle is set to :

- 4 min for the LH pack,
- 6 min for the RH pack.



20 ANTI ICE VALVE

Figure 29 Anti Ice Valve

21 PACK OUTLET PNEUMATIC SENSOR

The pack outlet pneumatic sensors 10HM10 (11HM10) are installed on the condensers 10HM2 (11HM2) at the pack outlet. They are connected to the anti−ice valves 17HH (37HH). If there is a failure in a pack controller 7HH (27HH), the pneumatic sensor transmits the pressure to the applicable anti−ice valve. If the pressure at a pneumatic temperature sensor increases or decreases (because of an increase or decrease in temperature) the anti−ice valve opens or closes to maintain the pack outlet temperature at about 15 °C (59.00 °F).

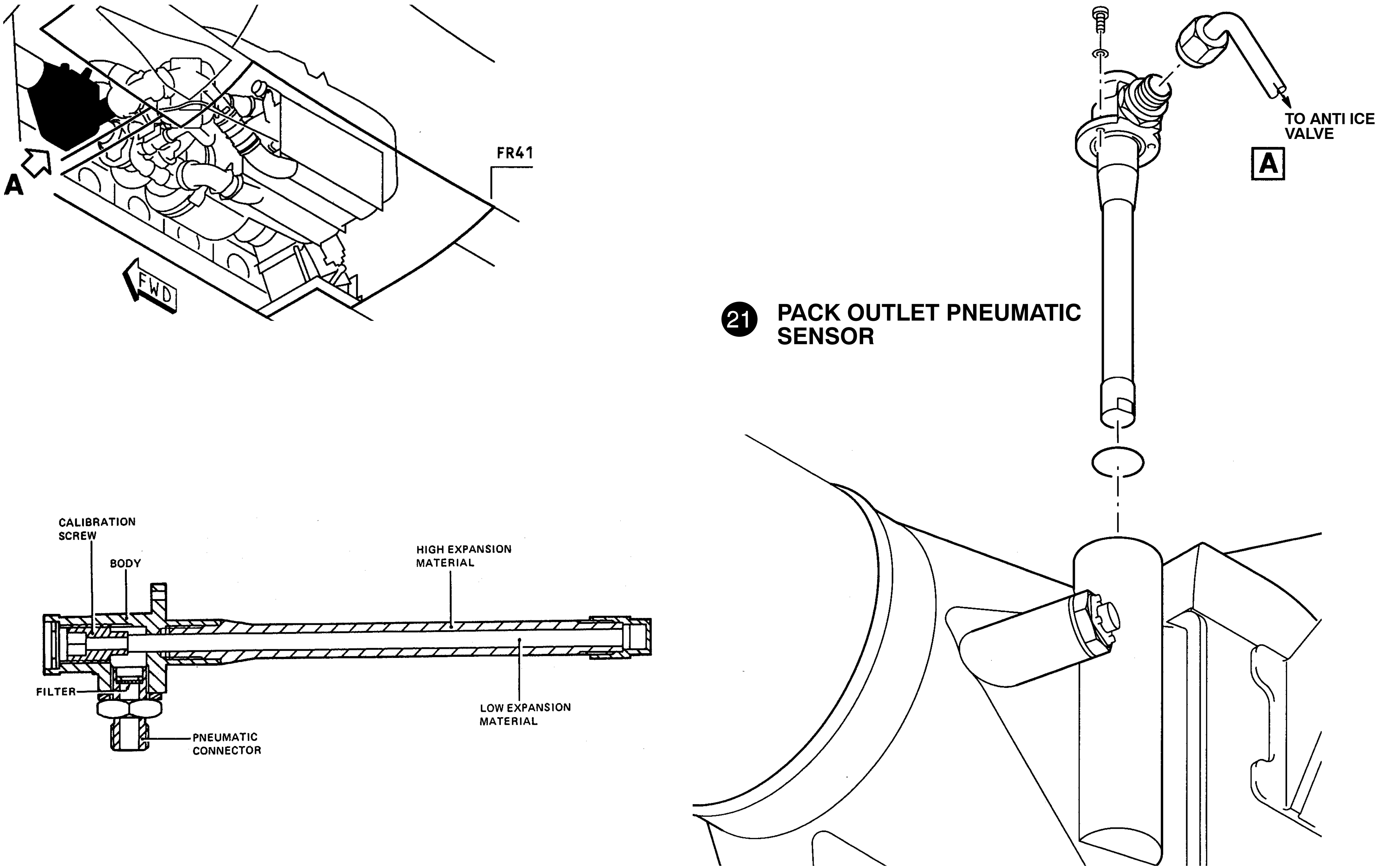


Figure 30 Pack Outlet Pneumatic Sensor

Anti−Ice Valve Operation Description.

Muscle pressure to activate the valve is drawn through a filter **(8)** through a tapping at the upstream end of the valve.

Without muscle pressure the valve remains closed because of the action of a spring **(7)**. In normal pack operation, the solenoid **(10)** is energized opening the vent valve. When muscle pressure is applied it is immediately vented and the valve remains closed.

The valve stops the build−up of ice across the condenser using a differential pressure regulator **(1)**. This differential pressure regulator opens the valve and delivers hot air to the condenser. Port **(4)** senses condenser inlet high−pressure and port **(2)** senses condenser outlet high−pressure.

When ice builds up along the flow path through the condenser the pressure drop increases rapidly.

The differential pressure between the ports **(4)** and **(2)** increases. This opens the poppet valve **(6)** which allows a high flow of muscle pressure into the pneumatic actuator, which opens the anti−ice valve. The vent restrictor **(12)** is not large enough to drop the muscle pressure very much.

The action of the valve is identical for icing of the low−pressure side of the condenser, where the pressures are sensed at ports **(5)** and **(3)**. If the pack controller 7HH, (27HH) is unable to control the bypass valve 10HH (30HH) the solenoid **(10)** is de−energized which closes the vent **(12)**. The muscle pressure supply is then governed through the pressure regulator **(9)**.

The vent flow is controlled with the pack pneumatic temperature sensor **(11)**. The pressure in the pneumatic actuator (valve angle) is controlled with the pneumatic sensor.

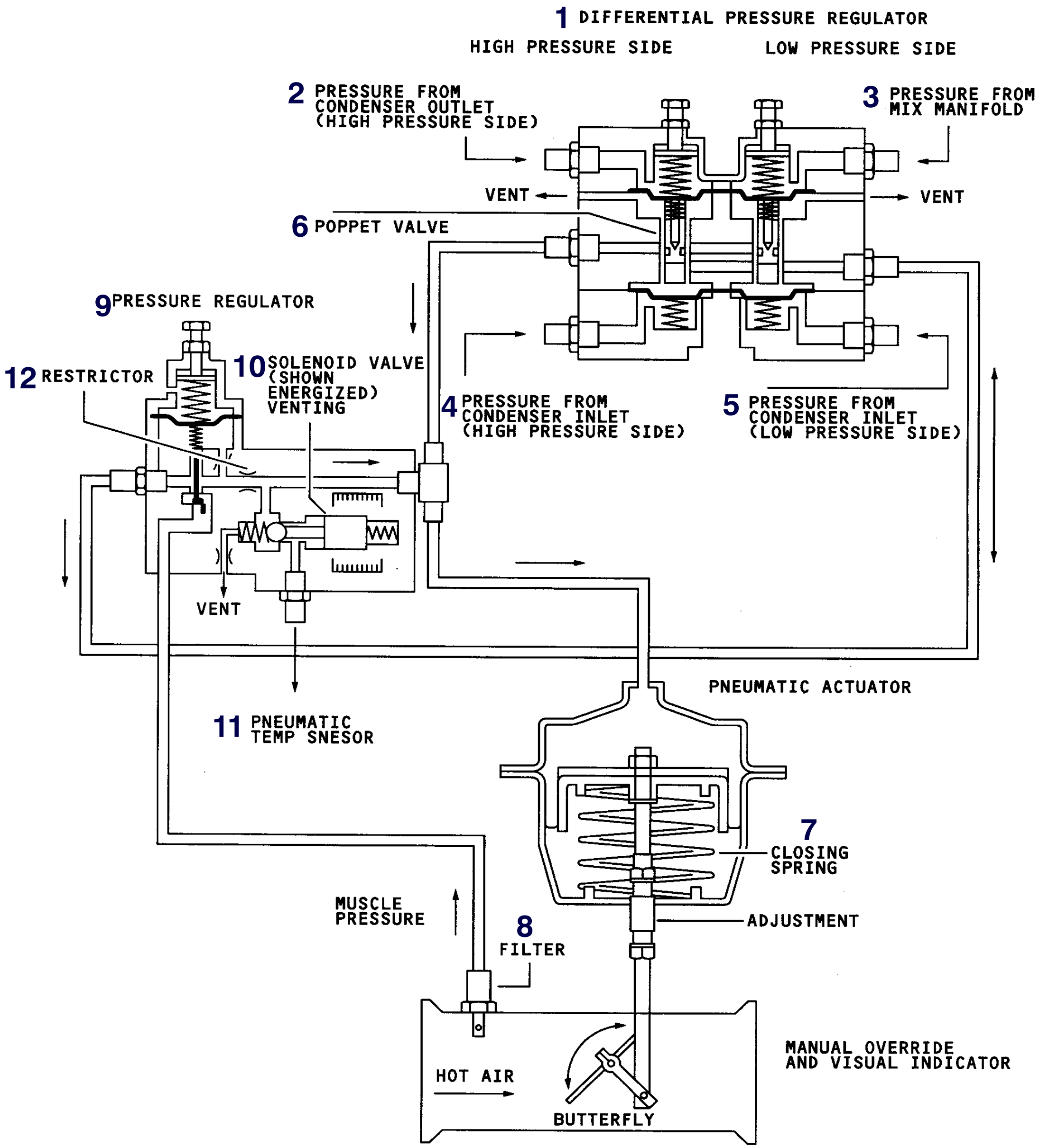


Figure 31 Anti Ice Valve Operation Description.

22 RAM AIR INLET ACTUATOR (8HH/28HH)

The ram−air inlet actuator 8HH (28HH) for each pack can be modulated only together with the ram−air outlet actuator 9HH (29HH) (to get optimum pack cooling airflow). During normal operation, the required pack outlet temperature is signalled from the zone controller 8HK to the pack controllers 7HH (27HH). To get the pack outlet temperature, the pack controller modulates the bypass valve 10HH (30HH) and the ram−air inlet and outlet doors in a predetermined sequence. This sequence is a compromise between a minimum ram airflow while maintaining adequate heat transfer rates and sufficient pack flow. For maximum cooling, ram−air doors are fully open and the bypass valve fully closed. For maximum heating, the ram−air doors are nearly closed and the bypass valve fully open. The bypass valve will ensure sufficient flow through the air−cycle machine to stop the speed falling below idle.

The actuator for the ram air inlet consists of :

- an actuator (nominal 100 mm stroke),
- an AC motor,
- a set of reduction gears,
- a torque limiting clutch (230 daN +20 %), two potentiometers, one for control through the pack controller 7HH (27HH) primary computer, the other for indication through the secondary computer, two limit switches, one for the closed position, the other for the 70 % open position.

These send a signal to the secondary computer.

The ram−air inlet is closed with the actuator fully extended and open with the actuator fully retracted.

During takeoff and landing, the ram inlet doors will be driven fully closed to stop dirt ingestion and contamination of the heat exchangers.

The facts for closing during take off are:

- aircraft on ground
- T/O engine power selected

  The doors will open as soon as the aircraft lifts off.

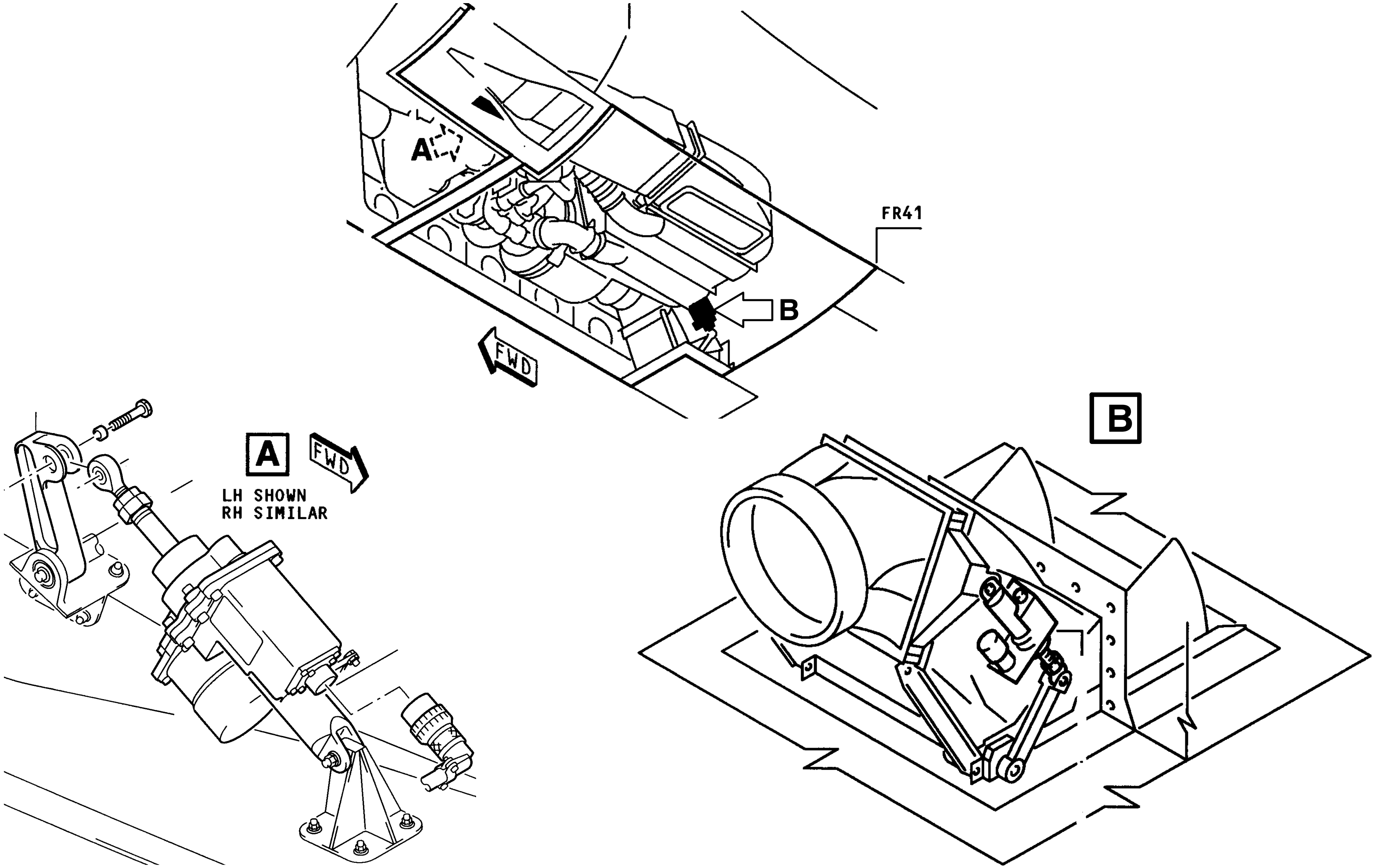
The facts for closing during landings are:

- aircraft on ground
- no T/O engine power selected
- aircraft wheel speed > 70 knots

  The doors will open as soon as the aircraft speed is longer then 20 sec. below 70 knots.

23 RAM AIR OUTLET ACTUATOR (9HH/29HH)

Ram−Air Outlet Actuator (Ref. Fig. 006) The ram−air outlet actuator 9HH (29HH) is mechanically similar to the ram−air inlet actuator 8HH (28HH). The differences are; it has a smaller AC motor, the torque setting is reduced to 200 daN + 20 % and reversed operation. That is, the ram−air outlet is closed with the actuator fully retracted and fully open with the actuator fully extended.



22 RAM AIR INLET ACTUATOR

23 RAM AIR OUTLET ACTUATOR

Figure 32 Ram Air Inlet/Outlet Actuator

33 PACK CONTROLLERS

General

The pack temperature control system controls the pack outlet temperature and sets its maximum and minimum limits. Two pack controllers control the system. Each pack controller 7HH (27HH) controls the two major parameters of its related pack:

- the pack outlet temperature (through the water extractor outlet temperature)
- the ram−air cooling flow, which is kept to a minimum for fuel economy.

The pack controller 7HH (27HH) is an electronic assembly of modular construction, mounted on a chassis with a metal cover (41MCU to ARINC 600). There are two identical pack controllers, one for each air conditioning pack 10HM (11HM).

Each pack controller consists of two computers, one primary and one electrically independent secondary computer. The primary computer is capable of modulating the system parameters to their full extent, thus optimizing the system performance. The secondary computer gives a reduced level of optimization when it operates as a back−up in the event of the primary computer failure.

The pack controllers 7HH (27HH) are the computers for the pack temperature control−system. They do the calculations necessary for operation of the air conditioning packs 10HM (11HM).

They are installed in the racks 95VU and 96VU of the avionics compartment. They have the following functions:

- to receive, to calculate and to send the necessary signals (ARINC 429 data bus) to the zone temperature controller 8HK,
- to send the necessary signals to the P/B SW 6HB (7HB) on the panel 30VU in the cockpit,
- to calculate and send the necessary signals to the air−inlet flap actuators 8HH (28HH) to open and close the ram air inlets,
- to calculate and send the necessary signals to the air−outlet flap actuators 9HH (29HH) to open and close the ram air outlets,
- to do the Built−In Test Equipment (BITE) tests,
- to monitor the temperature in the ducts of the air conditioning packs and to do the correct steps if an overheat occurs,
- to calculate and send the necessary signals to the flow control valves 10HB (11HB),
- to control the applicable bypass valve 10HH (30HH) for pack temperature control.

BITE Test

The Built−In Test Equipment (BITE) of the Pack controller monitor the hardware and system performance. They send failure data to the zone temperature controller 8HK. The zone temperature controller sends failure data to the Centralized Fault Display System (CFDS) (Ref. 31−32−00).

For MCDU data, refer to chapter 21−63−00.failure data to the zone temperature controller 8HK (Ref. 21−63−00).

The Complete BITE TEST is describe in ATA 21−63.

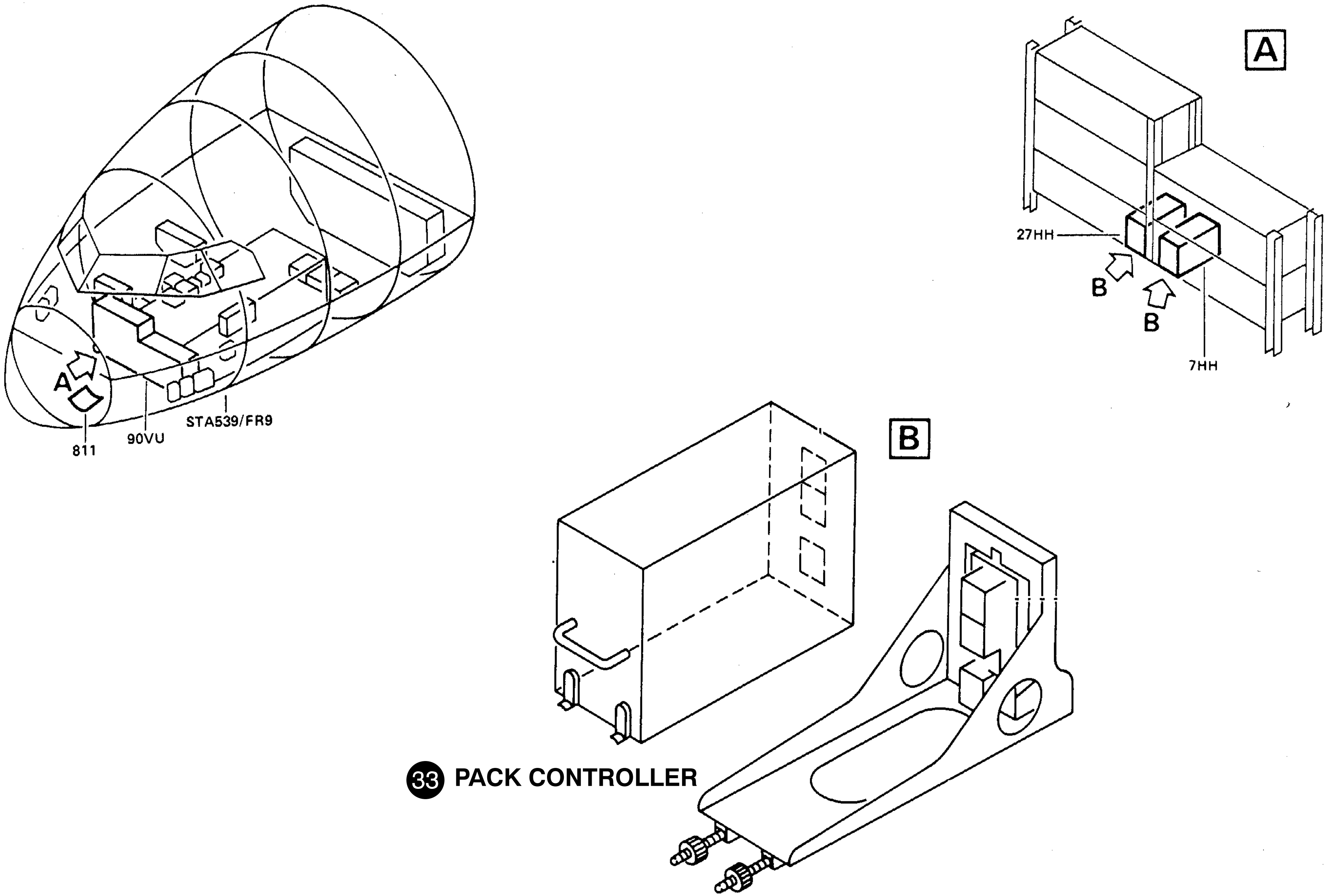


Figure 33 Pack Controller Location

21−63 COCKPIT AND CABIN TEMPERATURE CONTROL

ZONE TEMPERATURE CONTROL OPERATION

General

The cockpit and cabin temperature control system controls the temperature in the cockpit and cabin. With the temperature selectors you can set a different temperature for the cockpit and the cabin. Any temperature selections between 18 °C and 30 °C are possible The cabin is divided into the FWD zone and the AFT zone.

Hot Trim Air

Hot trim air, which is used for temperature control in the cockpit, the FWD cabin and the AFT cabin zones, is individually controlled under normal conditions in pressure and quantity.

This hot trim air is taken from the bleed air supply to the air conditioning packs 10HM and 11HM downstream of the flow control valves 8HB and 11HB. It flows through the trim−air pressure regulating valve 14HK to the trim−air check valves 18HM and 19HM and to the hot−air pressure switch 26HK. It then flows to the independently controlled trim air valves 11HK for the cockpit, 12HK for the FWD cabin and 13HK for the AFT cabin. These trim air valves are controlled by the zone controller and add an adjustable quantity of hot trim air to the cooled conditioned air from the mixer unit.

Trim Air valves and Sensors

The trim air valves are installed in the ducts to the cockpit and the two cabin areas. A back−up is provided and will take over control in a failure condition. Temperature and overheat sensors are located in the mixing unit, in the zone air supply ducts and in the cabin ceiling areas.

These sensors are used for ECAM indications as well as for zone temperature− and trim air pressure regulating valve control.

The temperatures in the different zones appear on the COND page of the ECAM.

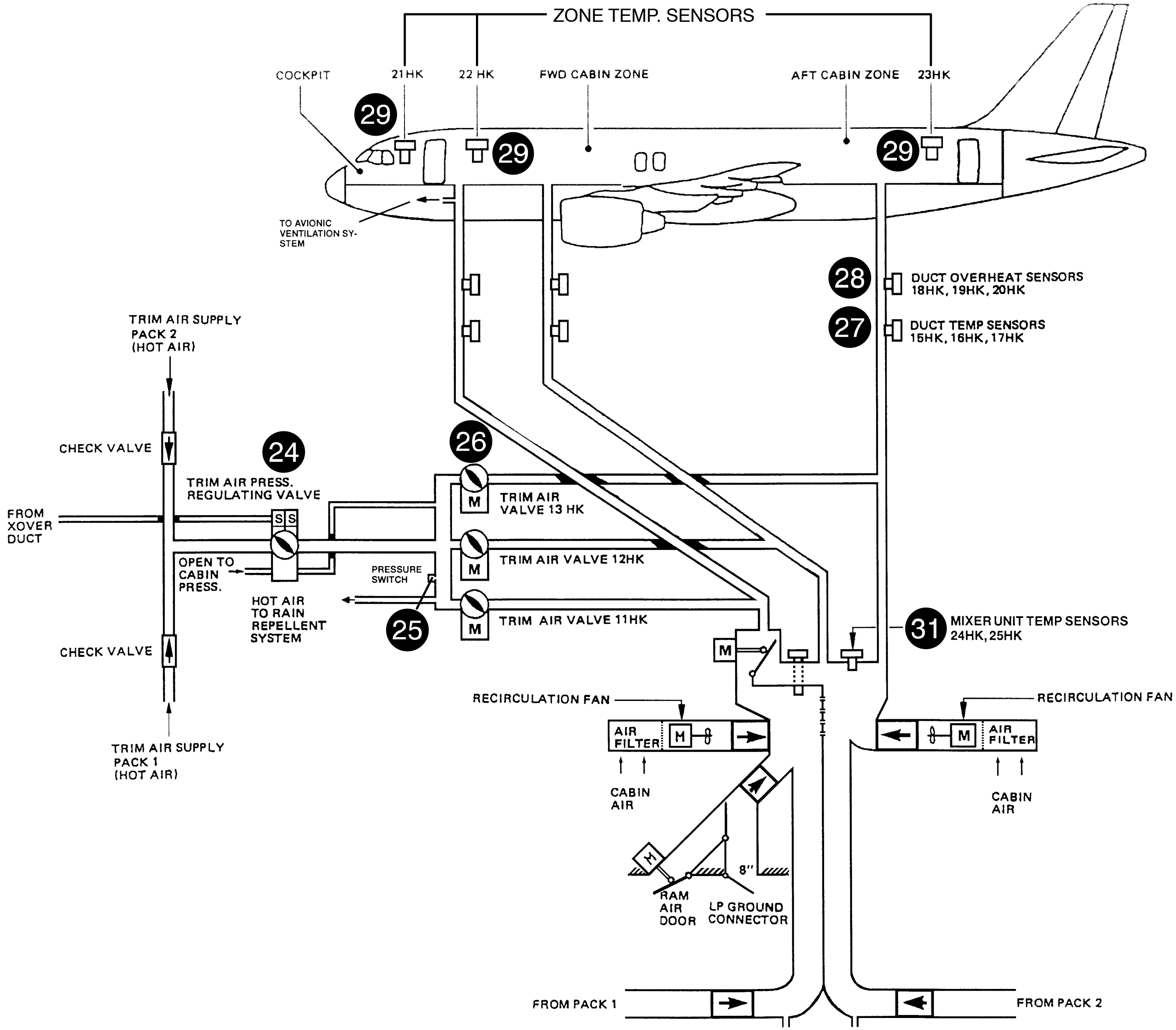


Figure 34 Zone Temperature Control Schematic

TRIM AIR PRESS. REGULATING VALVE COMPONENT DESCRIPTION

24 TRIM AIR PRESS. REGULATING VALVE

The trim−air pressure regulating−valve 14HK regulates the pressure of the air supplied to the trim−air valves 11HK (12HK, 13HK). This air is unconditioned bleed air.

The valve is a three−inch steel−butterfly type which is pneumatically actuated, and electrically signalled. The pressure regulation is controlled pneumatically and two solenoids control the ON/OFF function and the safety function.

A limit switch indicates CLOSED/NOT CLOSED to the zone controller (8HK) and the ECAM system.

Hot Air Switch

The hot−air switch 7HK installed in the cockpit overhead panel 30VU controls this valve.

With this switch in **OFF** you can shut off the trim air supply. In **AUTO** (switch depressed). The trim−air pressure regulating−valve 14HK pneumatically controls the hot−air manifold pressure to 4 psi (0.2757 bar) above cabin pressure.

The valve will electrically close automatically if the temperature in the supply duct goes above 88 °C (190.40 °F). This will also happen if the temperature in the supply duct goes above 80 °C (176.00 °F) four times in one flight.

OFF (switch released):

Comes on white, the trim−air pressure regulating−valve 14HK closes.

FAULT comes on amber when an overheat condition is detected and remains, regardless of the hot−air switch position, until the temperature falls below 70 °C (158.00 °F).

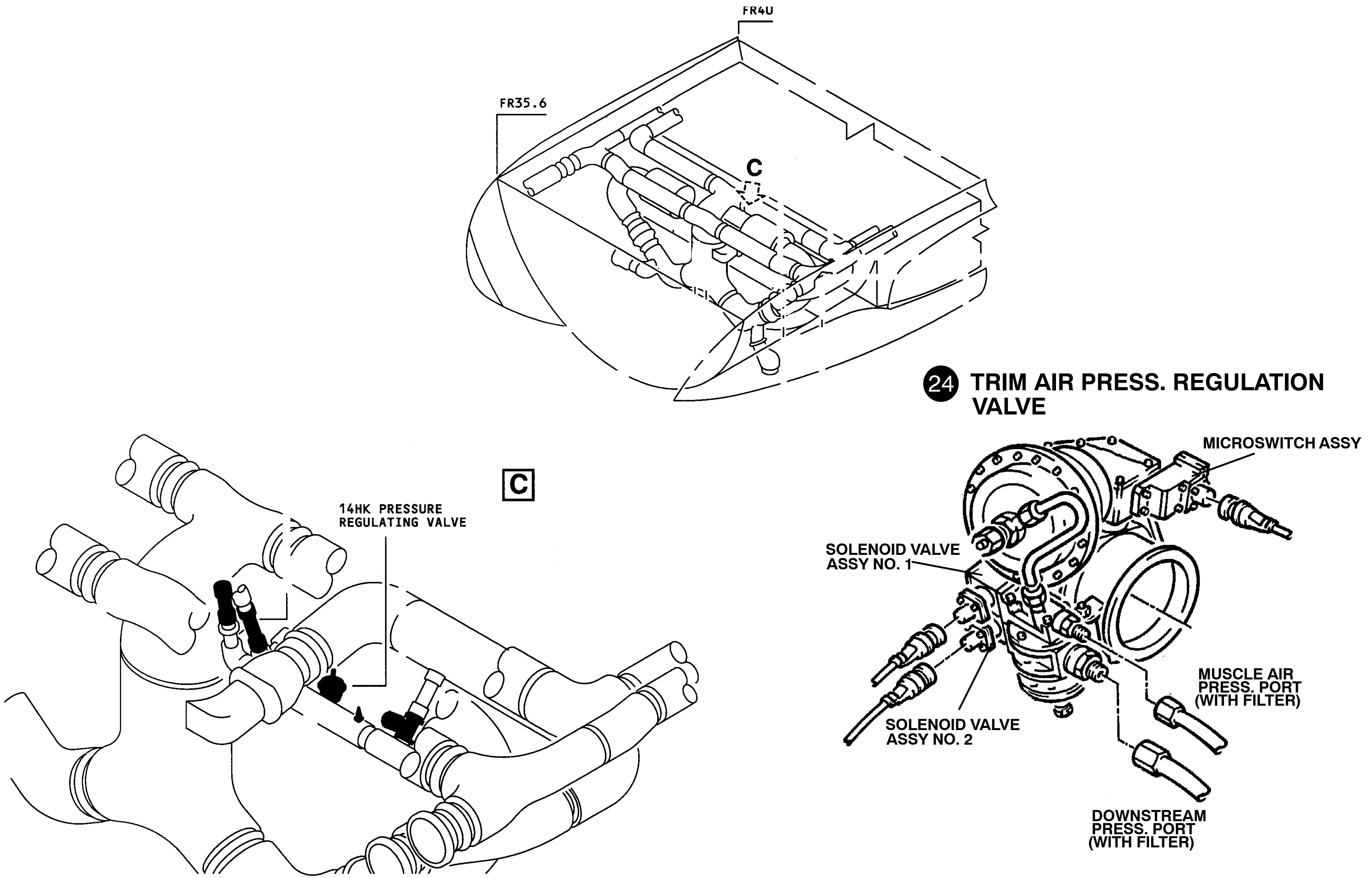


Figure 35 Trim Air Press. Regulating Valve

DUCT OVERHEAT DETECTION OPERATION

Both the primary and secondary computer of the zone controller 8HK can detect an overheat 88 °C (190.40 °F) in any one of three zone−supply ducts. The primary computer does this through the primary duct−temperature or the duct overheat sensor.

The secondary computer does this through the secondary duct temperature sensor. The first computer (primary or secondary) to detect an overheat will send a signal to make the FAULT light on the HOT−AIR switch 7HK come on. It will also close the trim−air pressure−regulating valve 14HK; the primary computer will close all three trim−air valves 11HK (12HK,13HK).

The FAULT light will stay on and the closed valves will stay closed until:

- the duct temperature goes down below 70 °C (158.00 °F),
- the HOT−AIR switch 7HK is released (to make the FAULT light go off.),
- the HOT−AIR switch 7HK is pressed again (to open the valves 14HK, 11HK, 12HK, and 13HK).

The primary computer can detect an early overheat 80 °C (176.00 °F) condition. It does this through the duct temperature sensor 15HK (16HK, 17HK) or the duct overheat sensor 18HK (19HK, 20HK).

The primary computer commands the trim−air pressure−regulating valve 14HK to reduce its setting from 280 mbar to 140 mbar when 80 °C (176.00 °F) is detected.

The higher pressure setting is commanded again when all duct temperatures are below 70 °C (158.00 °F). If an early overheat 80 °C (176.00 °F) is detected four times during one flight, the 88 °C (190.40 °F) procedure is indicated.

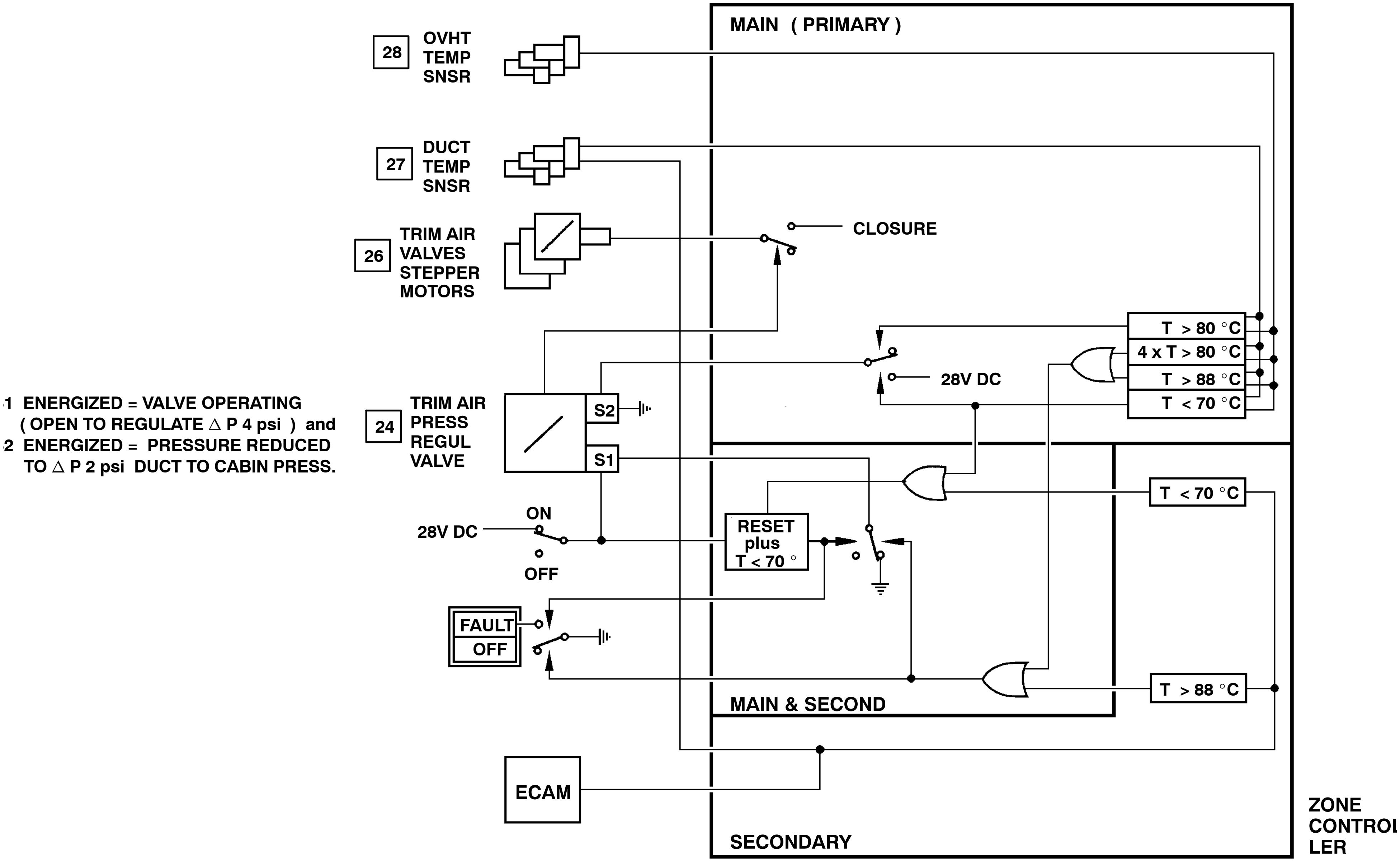


Figure 36 Duct Overheat Detection and Action Logic

ZONE- AND CABIN TEMPERATURE COMPONENTS DESCRIPTION

25 HOT AIR PRESSURE SWITCH

The hot-air pressure switch 26HK is installed downstream of the trim-air pressure regulating-valve 14HK. The pressure switch consists of a housing which contains a hermetically sealed microswitch, a stainless-steel diaphragm, a snap-action disc spring and an electrical connector.

The hot air pressure switch 26HK continuously monitors the pressure of the hot trim-air. If the pressure in the system goes to 6.5 psi (0.4481 bar), the zone controller 8HK sends a signal to the ECAM system. This signal stays until the pressure falls below 5 psi (0.3447 bar).

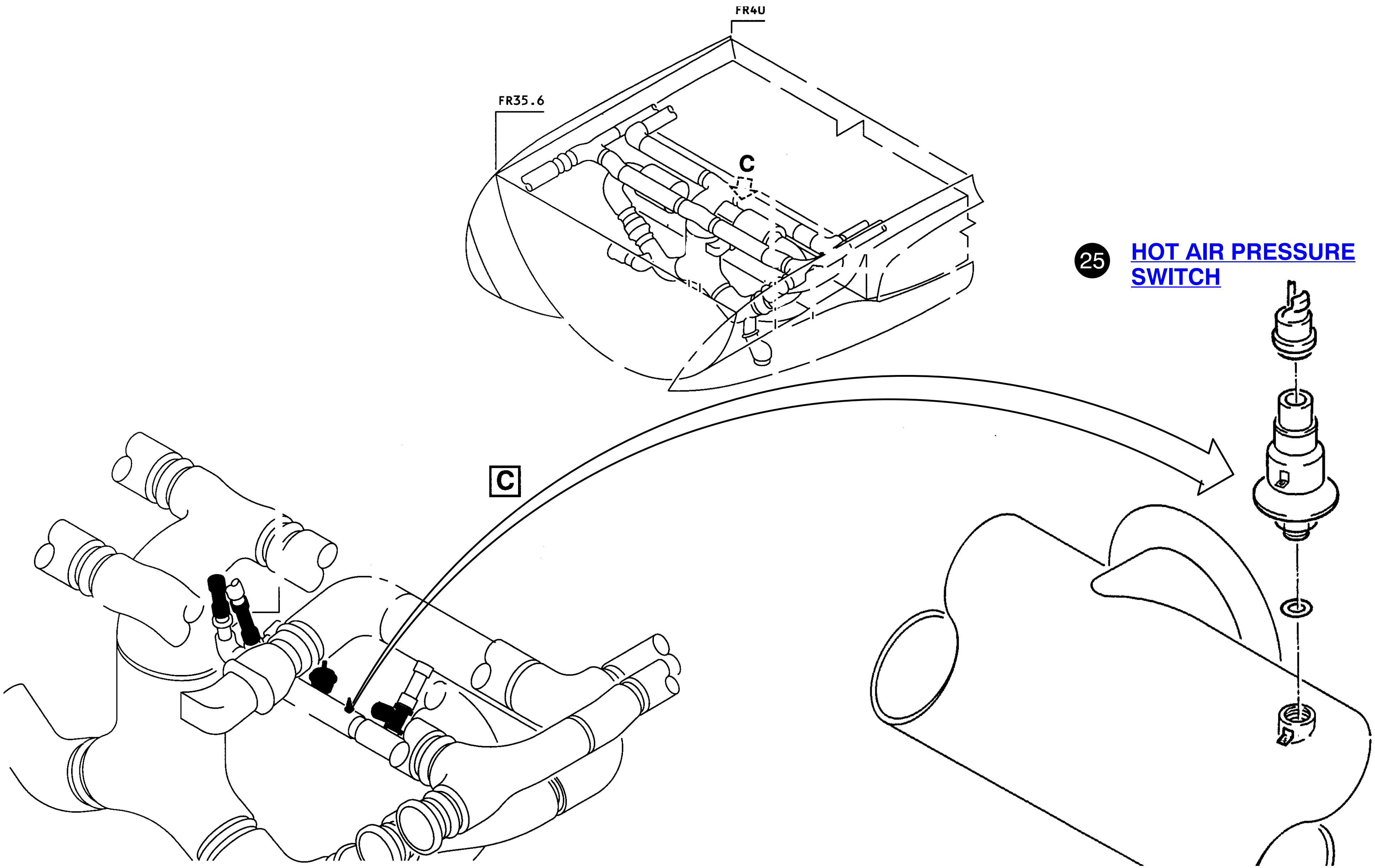


Figure 37 Hot Air Pressure Switch

26 Trim Air Valve

The trim air valves 11HK, 12HK and 13HK add an adjustable quantity of hot trim air to the cooled conditioned air from the mixer unit. The zone temperature controller 8HK controls the position of the trim air valves. The trim air valves are installed in the ducts to the cockpit and the two cabin areas.

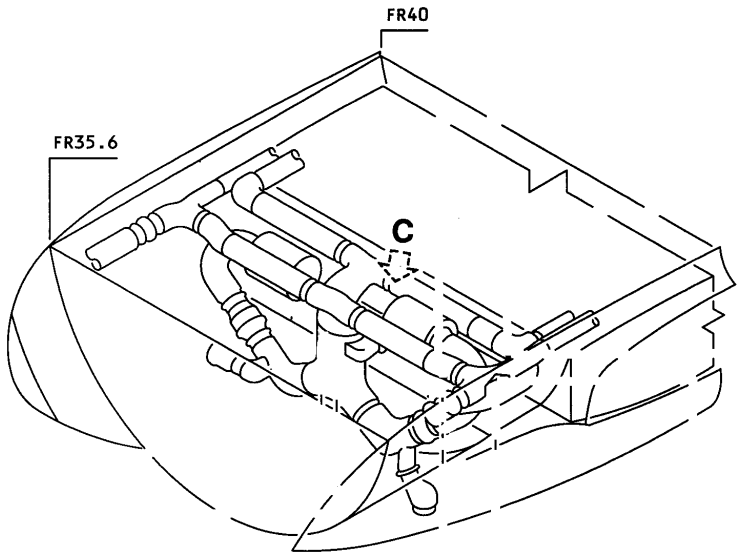
The trim−air valve 11HK (12HK, 13HK) consists of an actuator assembly and a valve body assembly. They are bolted together and internally connected.

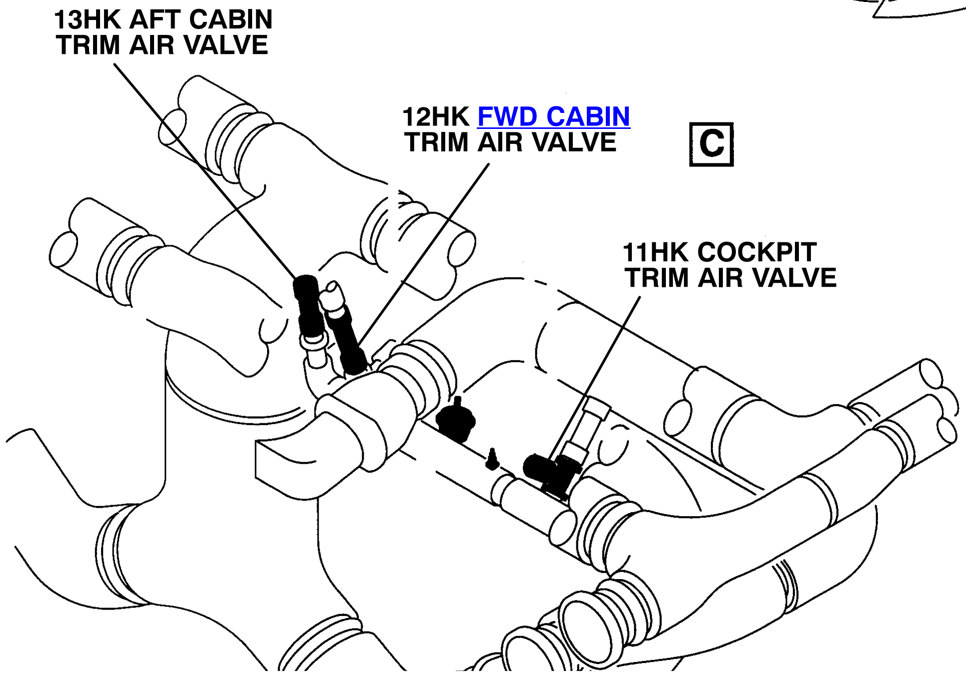
A butterfly valve is driven by a stepper motor through reduction gears which have mechanical end stops. Two cams installed on the shaft, operate limit switches which signal fully open or fully closed to the zero controller 8HK.

Two potentiometers, at the end of the shaft, signal the valve position to the zone controller main and secondary computers.

The zone controller uses this information for BITE and ECAM display.

A manual override and visual position indicator device is installed on the bottom of the shaft.





26 TRIM AIR VALVE

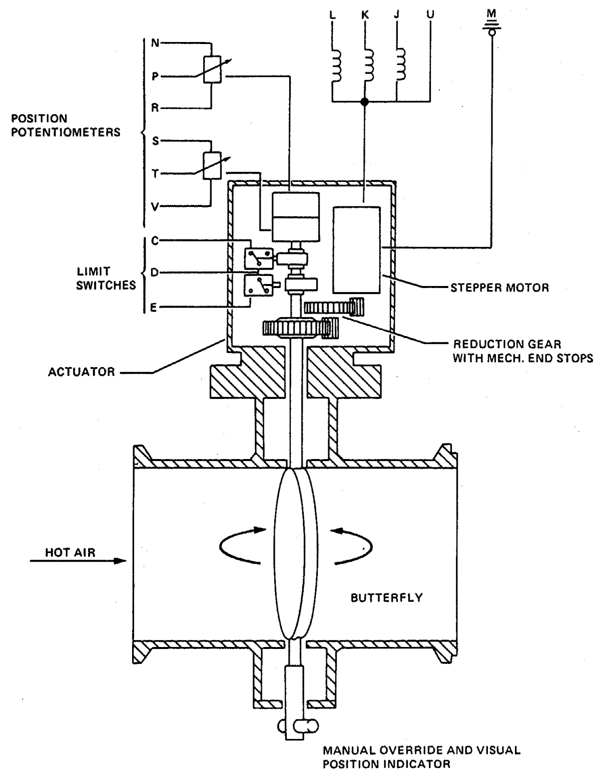


Figure 38 Trim Air Valves

27 Duct Temperature Sensor (3)

There are three duct−temperature sensors 15HK (16HK, 17HK), one installed in the main supply ducts to the cockpit, fwd cabin and aft cabin zones.

Each sensor consists of a ventilated metal body into which are potted two thermistors.

One thermistor supplies the primary computer (of the zone controller 8HK), the other supplies the secondary computer (of the same controller). Each gives control indication (ECAM) and overheat detection.

28 Duct Overheat Sensor (3)

There are three duct−overheat sensors 18HK (19HK, 20HK) one installed in the main supply ducts to the cockpit, FWD cabin and aft cabin zones. Each sensor consists of a ventilated metal body into which is potted a thermistor. The thermistor supplies the primary computer (of the zone controller 8HK) with an additional overheat facility.

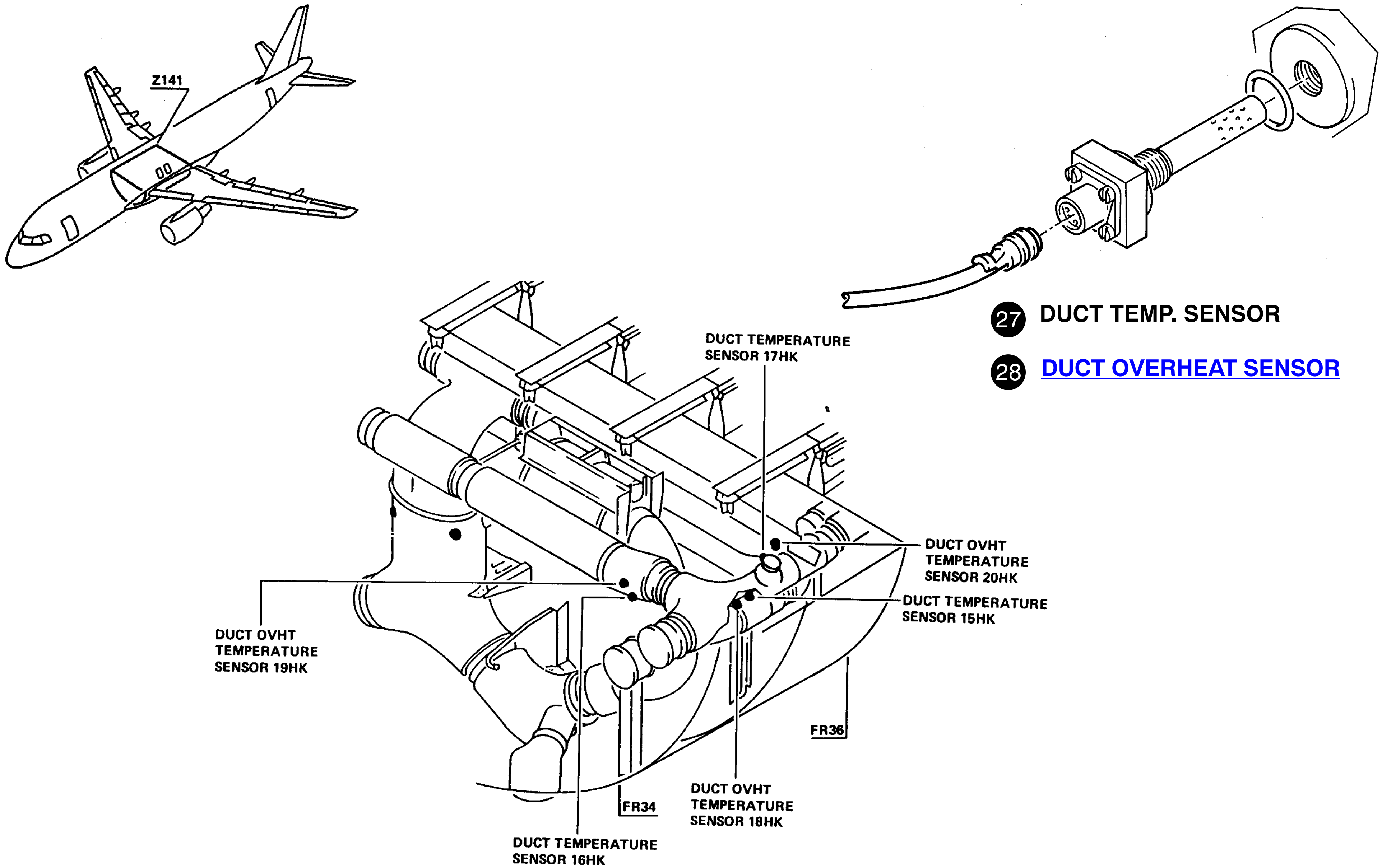


Figure 39 Duct Temperature–and Overheat Sensors

29 ZONE TEMPERATURE SENSOR (3)

There are three zone−temperature sensors 21HK (22HK, 23HK) one installed in the cockpit, fwd cabin and aft cabin zones. Each sensor consists of a ventilated plastic body into which are potted two thermistors.

One thermistor supplies the zone controller 8HK primary computer, the other the secondary computer, each performs control and ECAM indication. Also incorporated is a 6−pin connector. These zone temperature sensors are installed in separate sensor housings. To be able to measure the real cabin temperature these temperature sensing housings are connected to the lavatory and galley air extraction system for the passenger cabin and the cockpit temperature sensing housing is connected to the avionic ventilation system.

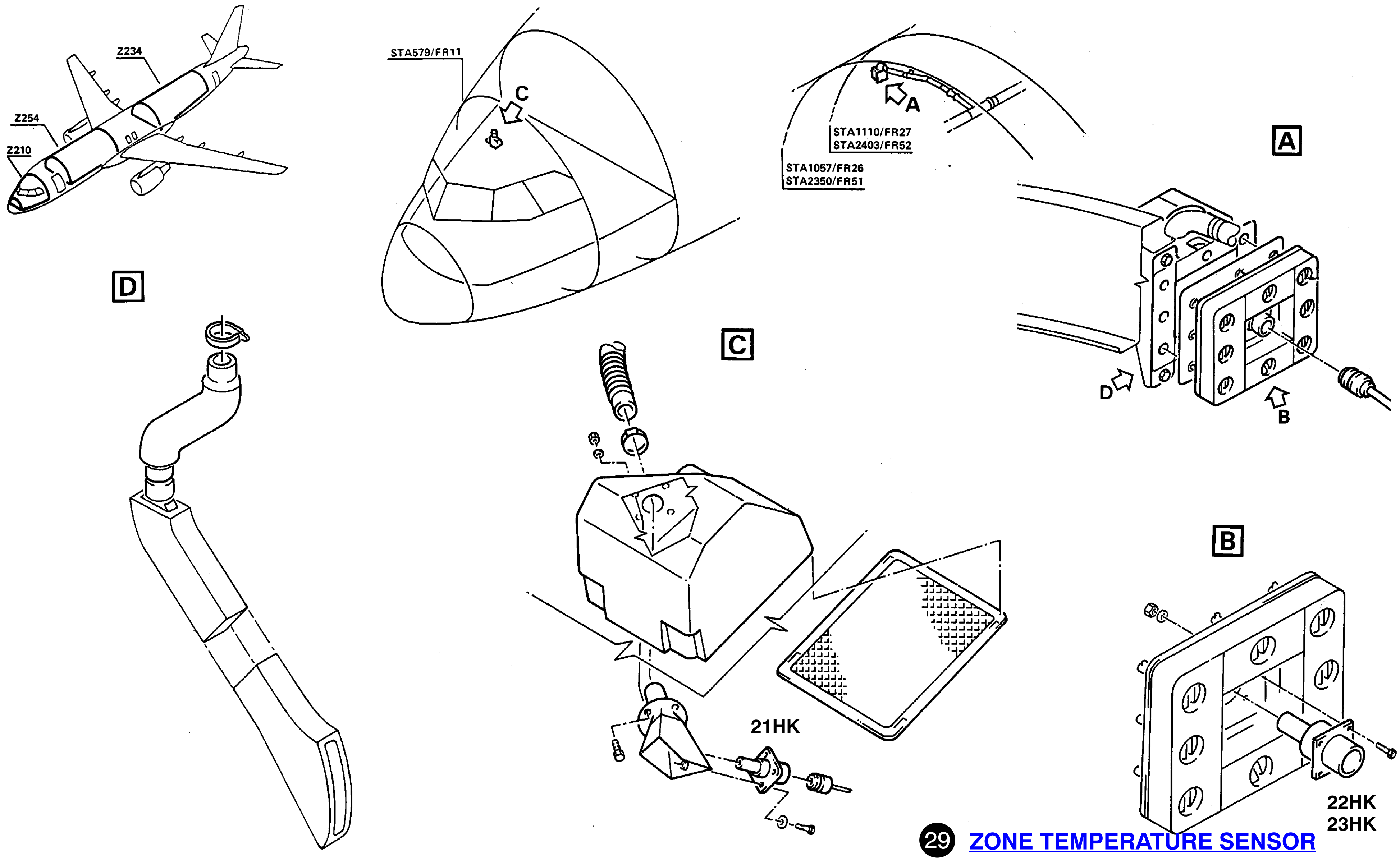


Figure 40 Cockpit and Cabin Zone Temp. Sensors

30 ZONE TEMPERATURE SELECTOR (3)

There are three zone-temperature selectors 27HK (28HK, 29HK) installed on the AIR COND panel 30VU in the cockpit overhead panel. One selector for the cockpit, FWD cabin and aft cabin zones.

Each one consists of a rotary setting potentiometer in a tubular metal housing. The temperature range is between 18 °C (64.40 °F) and 30 °C (86.00 °F). When in the 12 o'clock position the temperature is approx. 24 °C (75.20 °F). Each selector is connected to the primary computer (of the zone controller 8HK) for temperature control function.

An electrical connector is mounted on the base of the selector. The temperatures in the different zones appear on the COND page of the ECAM and on the Forward Attendant Panel (FAP).

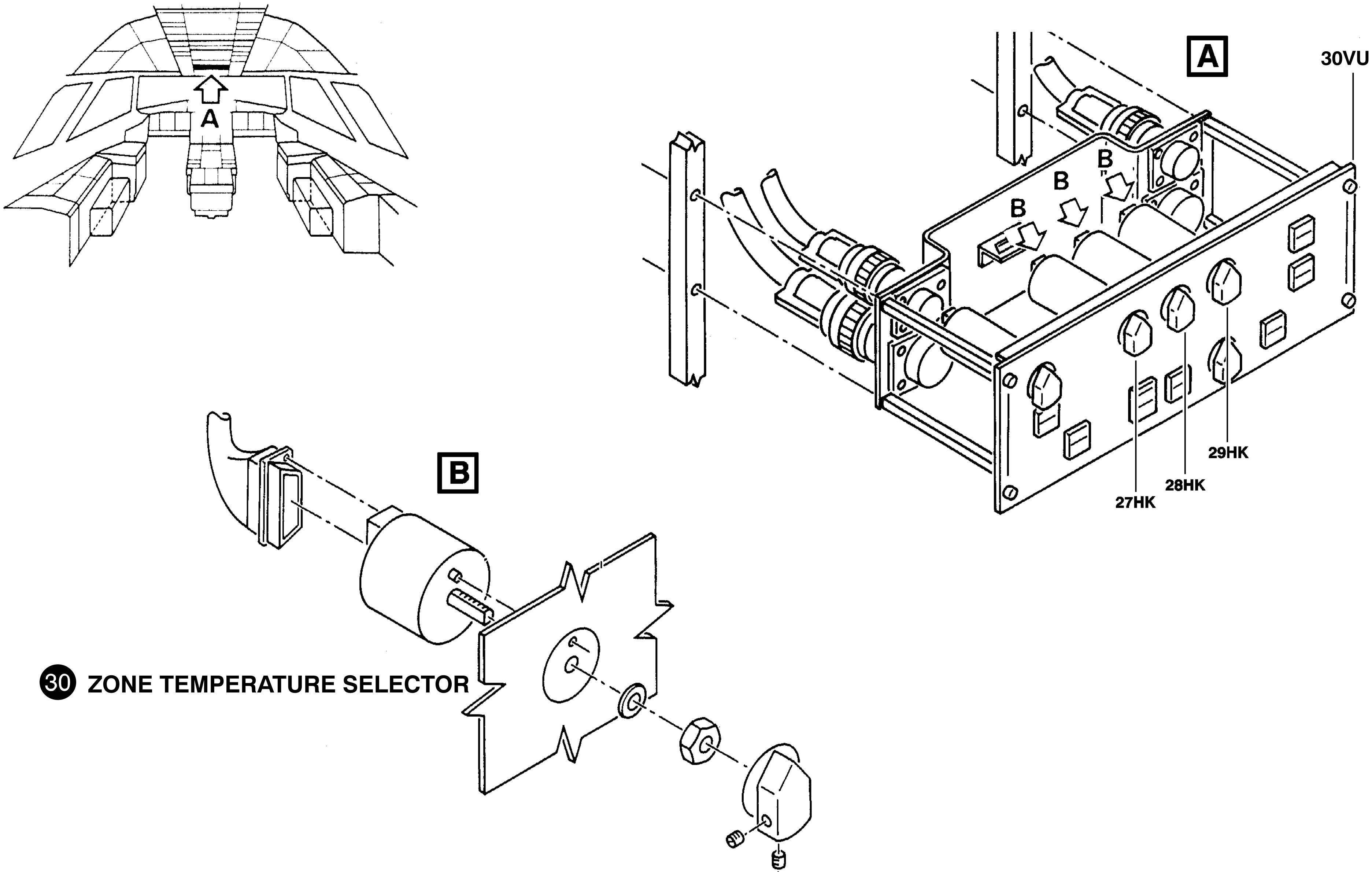


Figure 41 Zone Temperature Selectors

31 MIXER UNIT TEMPERATURE SENSOR

There are two mixer temperature sensors 24HK (25HK), one installed on each side of the mixer. Each consists of a ventilated metal body into which are potted two thermistors. One thermistor supplies the primary computer (of the zone controller 8HK), the other the secondary computer. Also incorporated is a 6-pin electrical connector.

The mix manifold temperature is needed by the zone controller to determine for the required zone temperature control the necessary pack outlet temperature which is computed in the zone controller and than signalled to both pack controllers.

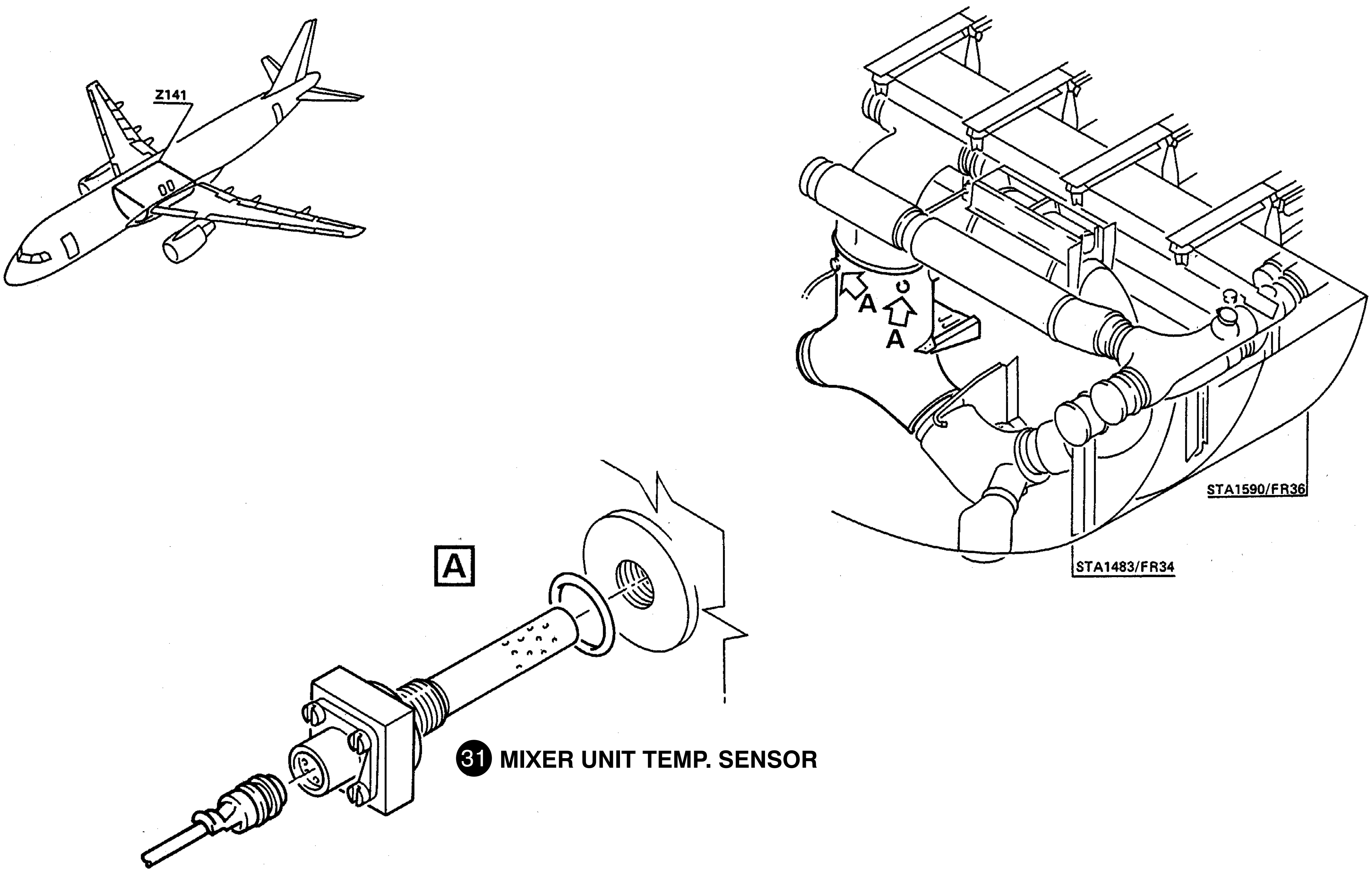


Figure 42 Mixer Unit Temperature Sensor (2)

32 ZONE CONTROLLER

The zone controller 8HK controls the temperature of the cockpit, fwd cabin and aft cabin zones. This controller contains two computers, a primary and a secondary. The primary computer gives full control of all of the system parameters. The secondary computer gives a reduced level of control when used as a back-up to the primary computer, (in the event of primary computer failure).

The zone controller 8HK is a 4 MCU box (to ARINC 600), it consists of a primary computer and an electrically independent-secondary computer. This secondary computer acts as a back-up if there is a primary computer failure. The primary computer will give a reduced control of the system when there is a partial loss of signals to it (under certain conditions). The secondary computer will take over command of the system (at a reduced level), if there is a failure of the primary computer.

The functions of the zone controller are as follows :

- to maintain constant temperatures at a preselected value in the cockpit, FWD cabin and aft cabin zones,
- to compute and deliver a demand signal for both pack controllers 7HH (27HH) as a reference for the pack temperature-control system.
- to elaborate a pack flow demand and supply it to both pack controllers 7HH (27HH),
- to elaborate a demand signal to the APU control,
- to elaborate and deliver an engine rpm modulation to FADEC in order to get the necessary bleed pressure,
- to give to FADEC a bleed-air valve status,
- to give BITE information on the wing anti-ice system to CFDS,
- to give BITE information of the ZC and both PCs to the CFDS,
- to perform overheat detection and corrective action,
- to calibrate, code and deliver information for the CRT displays,
- to reduce crew workload with the elimination of manual control. The system detects its own failures, and takes the necessary actions to overcome these failures automatically.

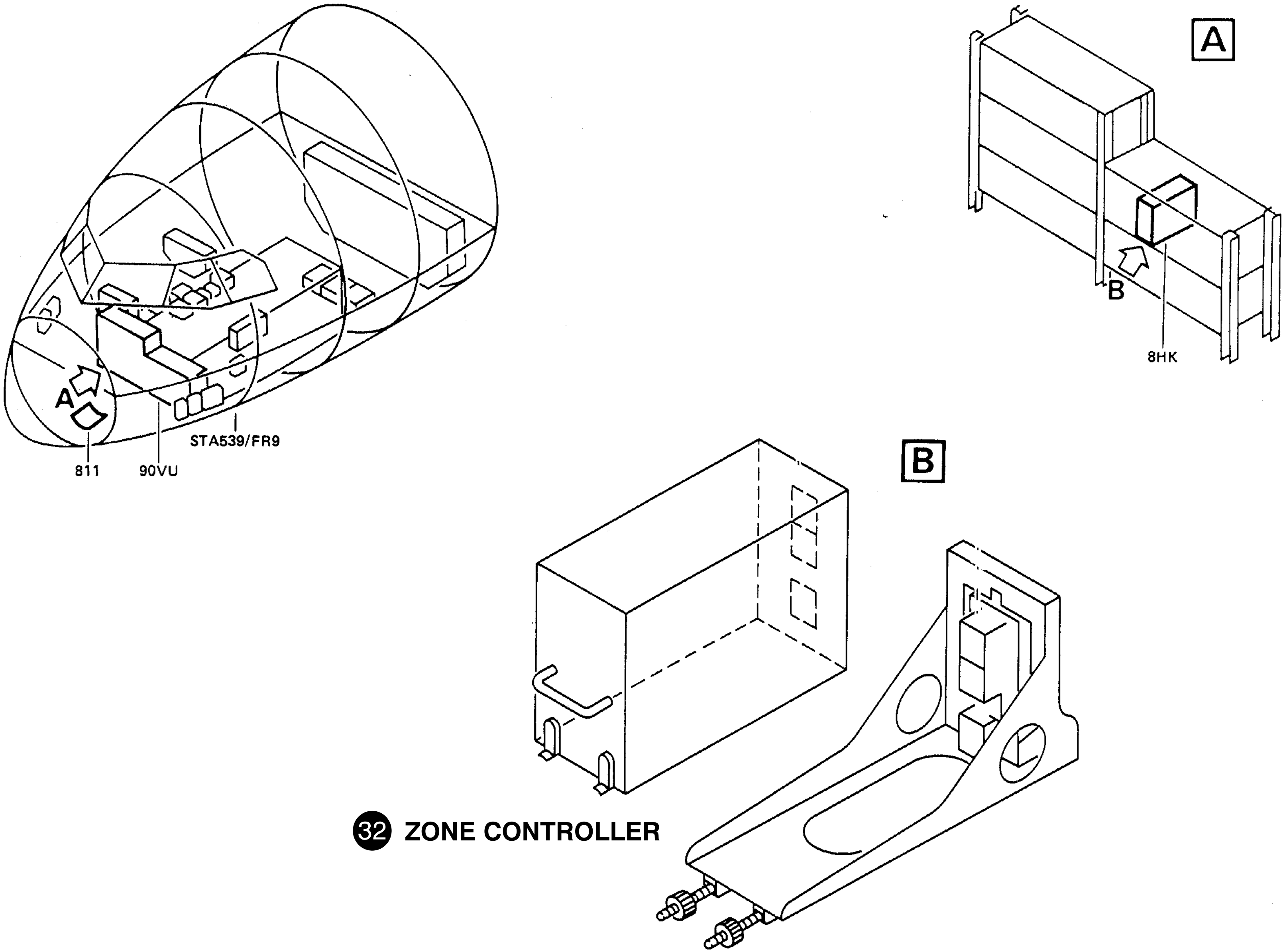


Figure 43 Zone Controller Location

21−60 TEMPERATURE CONTROL

FUNCTIONAL OPERATION

Normal Operation (Zone Controller working with Primary Computer)

The pilot selects the desired cockpit and cabin temperatures on the temperature selectors within a range from +18 °C (+64.40 °F) up to +30 °C (+86.00 ° F).

The primary computer side of the zone controller 8HK increases the zone reference temperatures selected on each temperature selector 27HK (28HK,29HK). It does this to compensate for reduced humidity and a decrease in interior wall temperature, (which is dependent on aircraft altitude).

The zone controller determines from the input values of the:

- temperature selectors,
- cabin sensors,
- duct sensors,
- mix manifold sensors,

an appropriate pack discharge temperature to the zone with the lowest supply air demand. The zone controller also determines which zone needs the lowest duct inlet temperature.

The zone duct air temperature in normally limited from +8 °C (+46.40 °F) to + 50 °C (+122.00 °F).

During pull up/down operations these limits can be overridden when the cabin temperature exceeds the nominal zone temperature (+18 °C up to +27°C).

In this case the zone inlet duct limitations will extend from +2 °C (+35.60 °F) to +70 °C (+158.00 °F). The lowest of the 3 duct demand temperatures is the required mix manifold temperature.

This temperature is than compared with the actual mix manifold temperature. The zone controller now determines the necessary pack outlet temperature from the error between actual and required mix manifold air temperature which is computed in the zone controller 8HK and signalled to both pack controllers 7HH (27HH).

The pack temperature control will only satisfy the zone with demand for the coldest air.

The other two zones will receive additional heating from the trim air system so that the mix of the trim air and of the mix manifold air supply satisfy their zone duct−air temperature demands.

NOTE: In this normal operation mode the zone temperature controller is also responsible for the FADEC signal to modulate engine idle RPM's if necessary.

It also controls the APU inlet guide vanes through the APU DEMAND signal and in addition calculates the flow demand factor of the flow control valve.

Back Up Operation (Zone Controller working with Secondary Computer)

A Failure of the primary computer (of the zone controller 8HK) will cause the secondary computer to take over to give a reduced level of control. In this failure condition, control of the trim−air system is lost. In this mode there is no individual zone temperature control possible. Separate control of cockpit and cabin is still given, but a distinction between forward and aft cabin is not made. In this mode each pack is controlled separately, pack 1 for the cockpit and pack 2 for the cabin. The zone temperature control will only be done by pack outlet temperature control.

The following reduced functions are also given:

- :24 °C (75.20 °F) replaces the selectable zone temperatures without altitude correction,
- the APU demand signal is not available, (APU gives maximum air press. fail safe)
- the flow setting optimization is not available. (High flow fail safe).

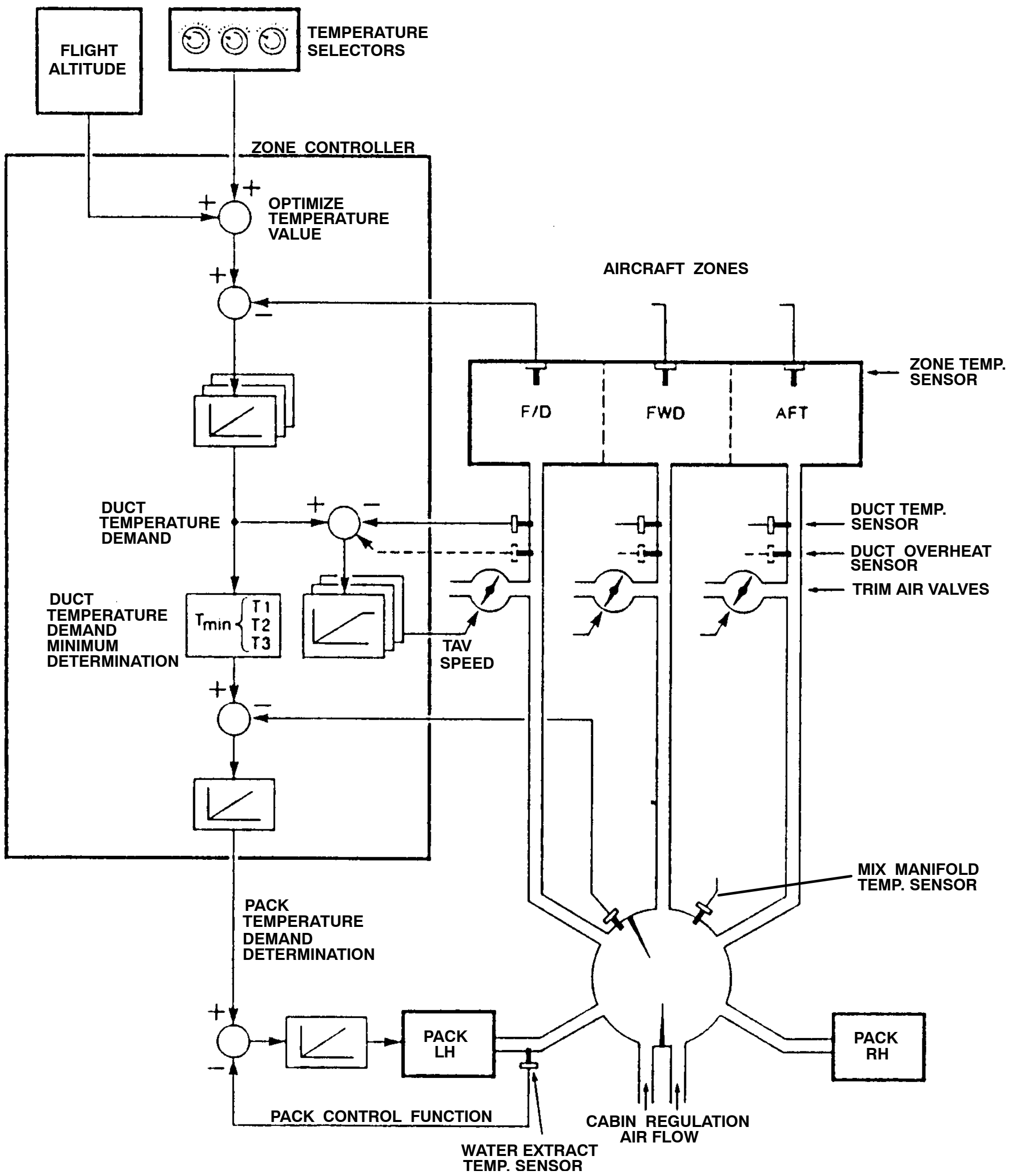


Figure 44 Temp. Control Simplified Schematic

NORMAL- AND BACK UP MODE OPERATION

NORMAL PACK TEMPERATURE CONTROL DESCRIPTION

The pack temperature control system controls the pack outlet temperature and sets its maximum and minimum limits. Two pack controllers control the system. Each pack controller 7HH (27HH) controls the two major parameters of its related pack:

- the pack outlet temperature (through the water extractor outlet temperature),
- the ram-air cooling flow, which is kept to a minimum for fuel economy.

Each pack controller consists of two computers, one primary and one electrically independent secondary computer.

The primary computer is capable of modulating the system parameters to their full extent, thus optimizing the system performance. The secondary computer gives a reduced level of optimization when it operates as a back-up in the event of the primary computer failure.

During normal operation, the required pack outlet temperature is signalled from the zone controller 8HK to the pack controllers 7HH (27HH). To get the pack outlet temperature, the pack controller modulates the bypass valve 10HH (30HH) and the ram-air inlet and outlet doors in a predetermined sequence.

This sequence is a compromise between a minimum ram airflow while maintaining adequate heat transfer rates and sufficient pack flow.

For maximum cooling, ram-air doors are fully open and the bypass valve fully closed. For maximum heating, the ram-air doors are nearly closed and the bypass valve fully open.

The bypass valve will ensure sufficient flow through the air-cycle machine to stop the speed falling below idle. During takeoff and landing, the ram inlet doors will be driven fully closed to stop the ingestion of foreign matter.

Normal Operation Mode (Pack Controller working with Primary Computer)

In Normal operation the primary computer of the pack controller 7HH (27HH) controls the system. The pack controller gets a temperature reference as a demand signal from the zone controller 8HK.

This demand signal, the preferred bypass valve 10HH (30HH) position and the measured water extractor outlet temperature, the bypass valve and ram-air outlet actuator position is used continuously to determine their necessary drive speeds.

The speed is zero, when the water extractor outlet temperature gets to the required value and the bypass valve to the preferred position.

The preferred bypass valve 10HH (30HH) position is normally 21 DEG. but is adjusted when necessary, dependent on pack inlet pressure. The ram-air inlet actuator 8HH (28HH) position is slaved to the actual ram-air outlet actuator 9HH (29HH) position.

The water-extractor outlet temperatures are limited through the temperature demand signal from the zone controller 8HK.

NOTE: The flow control valve setting of the flow control valve is only possible in the normal operation mode, when the pack controller is working with the primary computer.

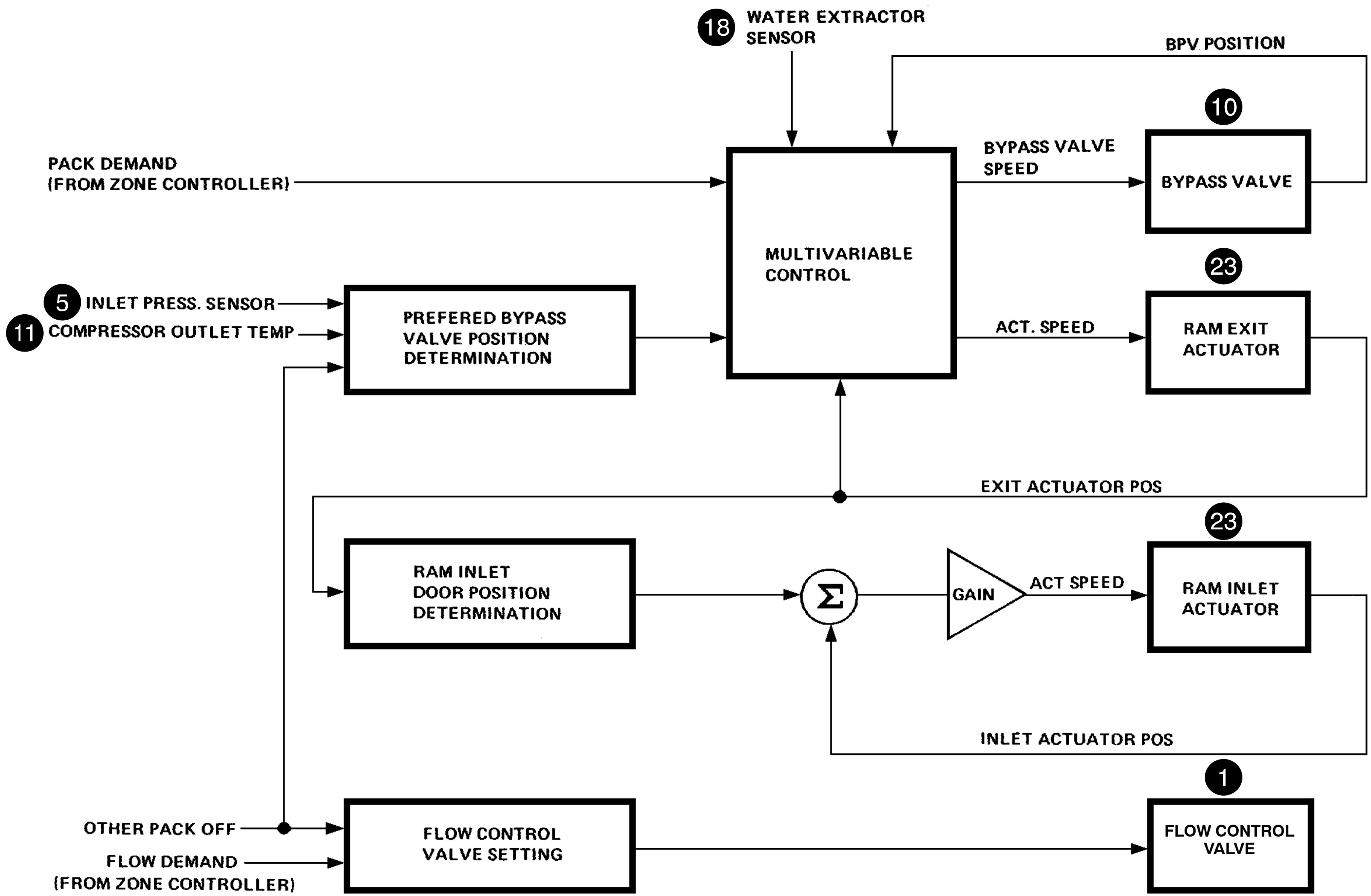


Figure 45 Pack Controller Normal Operation Mode (primary)

Back Up Operation (Pack Controller working with Secondary Computer)

If the pack controller 7HH (27HH) primary computer fails the secondary computer controls at a reduced level. The ram−air doors will open to the maximum flight position and no further optimization takes place, (the flow control reference remains at its previous setting).

Control of the water−extractor outlet temperature (to the level demanded from the zone controller 8HK) will still take place through modulation of the bypass valve 10HH (30HH). The overheat warning will still be available.

NOTE: If the zone controller 8HK (or its communications) fail completely the pack controllers 7HH (27HH) take over control. They will limit the water extractor outlet temperature to 20 °C (68.00 °F) for pack 1 (10HM) and to 10 °C (50.00 °F) for pack 2 (11HM).

If there is a failure (of the communications from the zone controller main computer and it remains active), the pack controllers take over control. They will limit the water extractor outlet temperature to 5 °C (41.00 °F) for pack 1 and to 10 °C (50.00 ° F) for pack 2. The zone controller can still use the trim−air system (Ref. 21−63−00) to increase the cabin inlet temperature, if necessary.

NOTE: In case of a complete loss of the pack controller the pack controller is unable to control the bypass valve 10HH (30HH) now the pack anti ice valve is signalled to pneumatically control the pack outlet temperature to 15 °C (59 ° C).

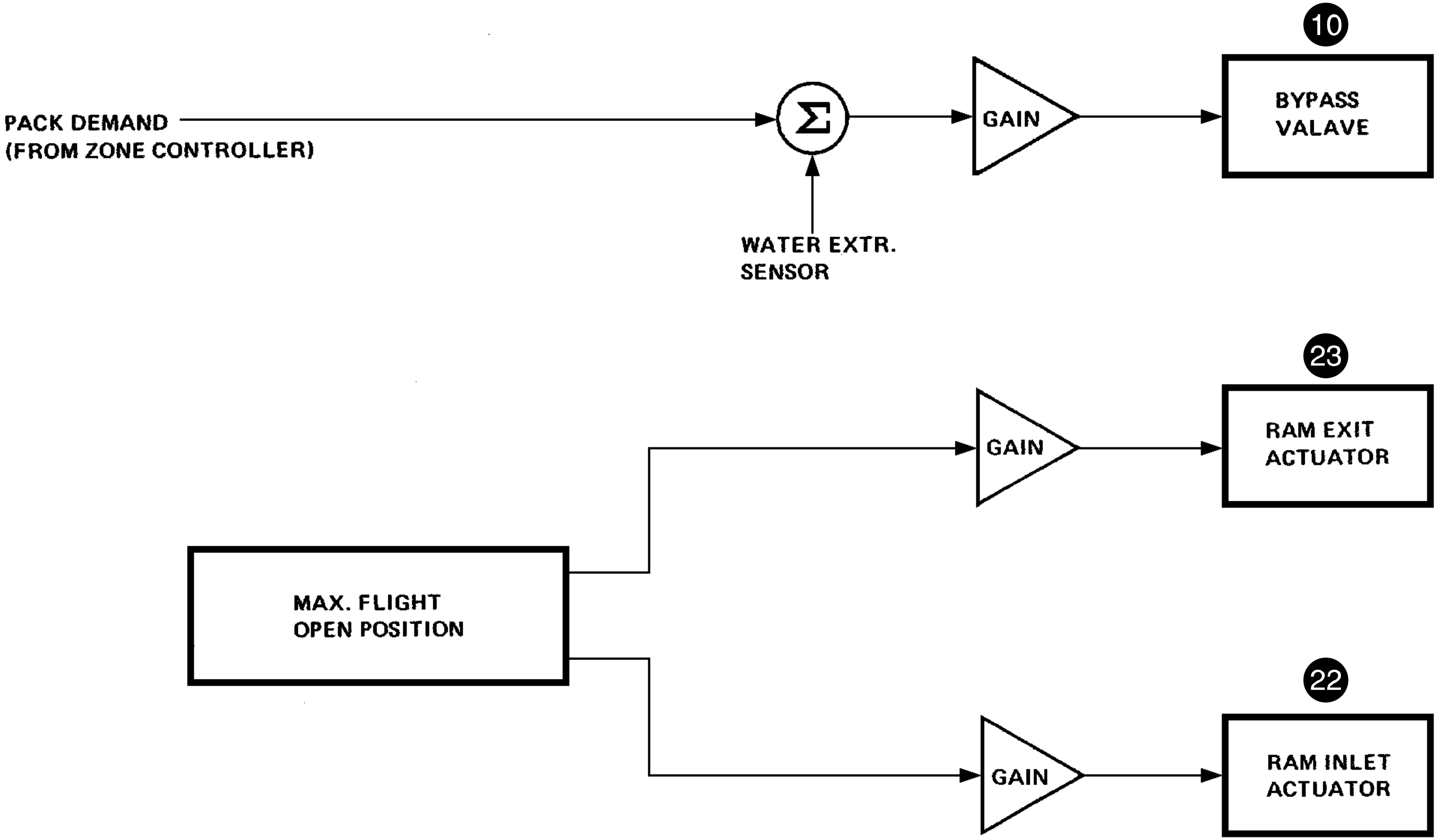


Figure 46 Pack Controller Back Up Mode (secondary)

CFDS SYSTEM REPORT/TEST (BITE)

Built−In Test Equipment (BITE)

The zone temperature controller 8HK controls the Built−In Test Equipment (BITE) function for the cockpit and cabin temperature control system.

It monitors the hardware. It sends failure data to the Centralized Fault Display System (CFDS).

There are the following tests:

- Power−up Test,
- Continuous Monitoring,
- System Test.

POWER−UP TEST

Conditions of Power−up Test Initialization

- A/C on ground
- Both pack controllers energized and having finished their power−up tests plus 5 sec delay for confirmation
- power−up test duration is 36 sec
- during test the three trim air valves are moving from cool to hot and from hot to cool this can be seen on the ECAM BLEED page if this system is available.

Results of Power−up Test

Test passed:

ECAM COND page shows normal display.

Test failed:

MASTER CAUTION with gong

ECAM warning:

COND ZONE REGUL FAULT

ECAM COND page:

Amber ”**XX**” in place of temperature indications

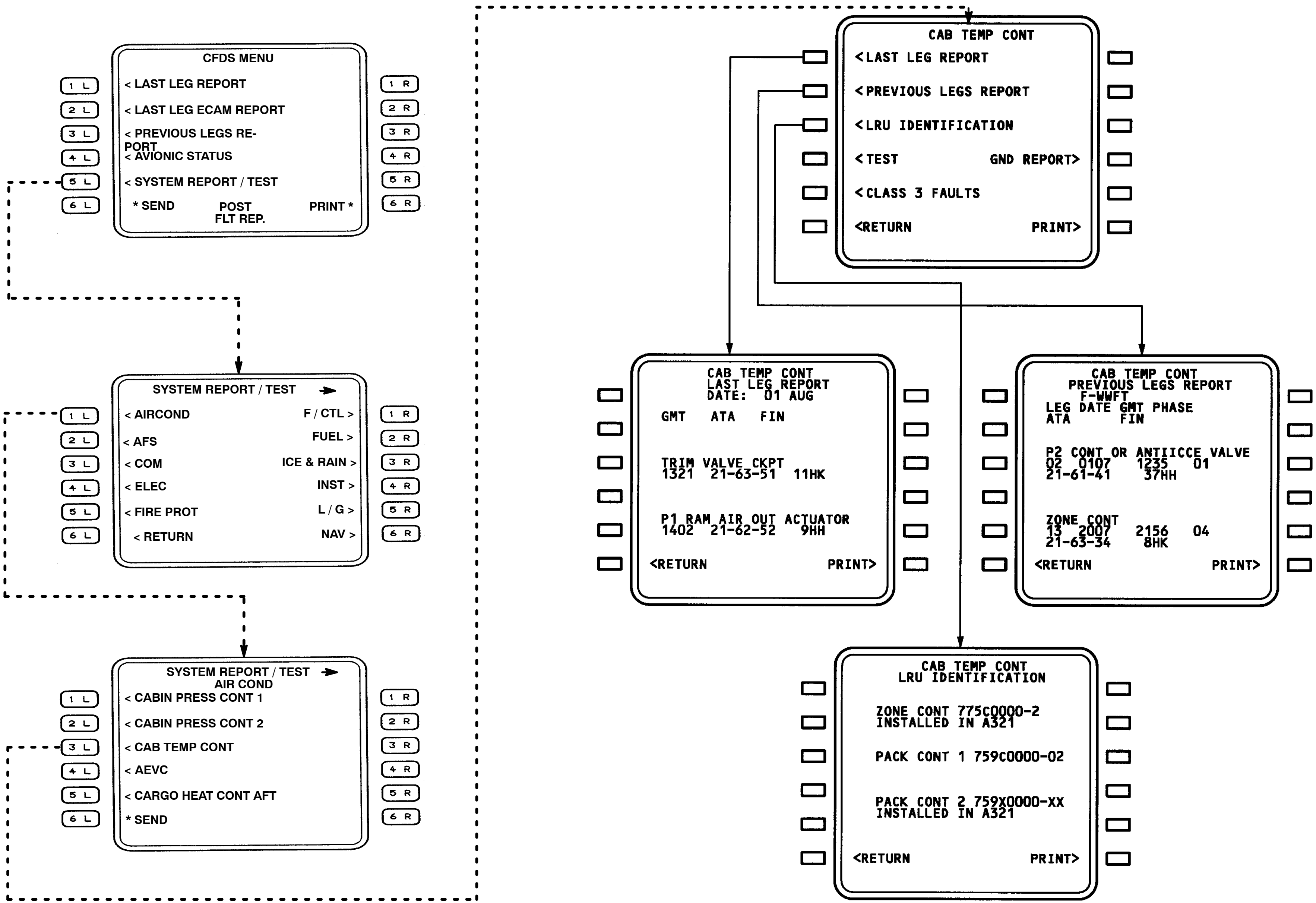


Figure 47 CFDS Cabin Temperature Control Menu (1)

SYSTEM TEST

A system test is only done if it is requested on the Multipurpose Central Display Unit (MCDU). It is done before and after a replacement of a component. It continues for not more than 300 seconds.

From the CAB TEMP CONT menu, you can set :

- <LAST LEG REPORT,
- <PREVIOUS LEGS REPORT,
- <LRU IDENTIFICATION,
- <GND REPORT,
- <TEST,
- <CLASS 3 FAULTS.

LAST LEG REPORT

If you push the <LAST LEG REPORT line key, the screen shows for each failure that occurred during the last leg the date, time, ATA number, functional designation and FIN of the component.

The screen can show a maximum of two failures at a time. If there are more failures, you must push the next page key on the MCDU keyboard. If there are no failures, NO FAULT DETECTED is shown.

PREVIOUS LEGS REPORT

If you push the <PREVIOUS LEGS REPORT line key, the screen shows all failures occurred during the last 64 flight legs:

- the aircraft identification,
- the applicable flight leg,
- the date, time and flight phase where the failure occurred,
- the ATA and FIN number of the component.

The screen can show a maximum of two failures at a time. If there are more failures, you must push the next page key on the MCDU keyboard. If there are no failures, NO FAULT DETECTED is shown.

LRU IDENTIFICATION

If you push the <LRU IDENTIFICATION line key, the screen shows the functional designation and the part number of the zone controller and the pack controllers.

Additionally to this information the line INSTALLED IN A321 will be indicated, if the pin programming of the controllers is correct. If INSTALLED IN A320 appears, no pin ’ A 321 ’ is set. The line will not be indicated if there is no valid data from the applicable controller.

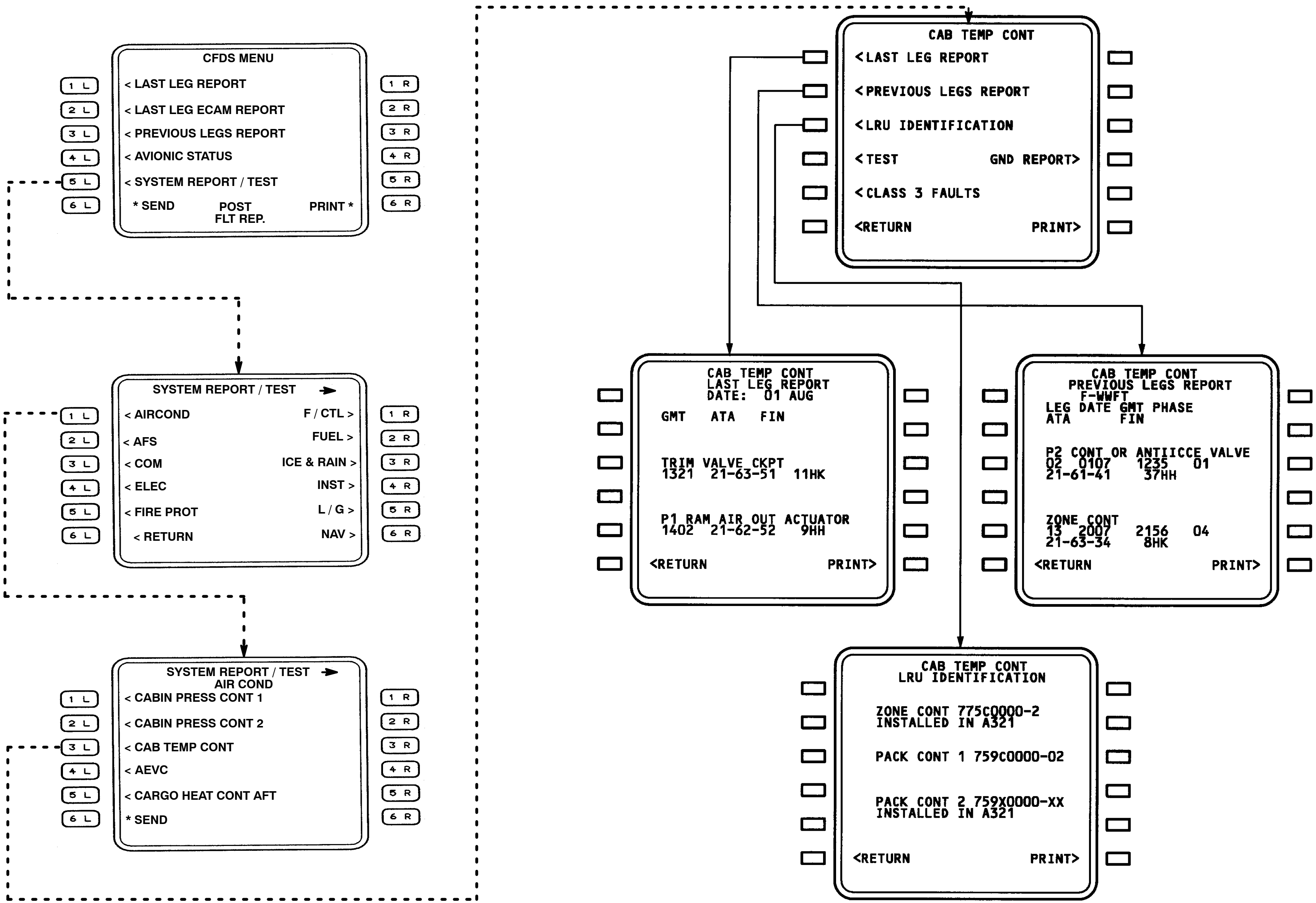


Figure 48 CFDS Cabin Temperature Control Menu (2)

CFDS SYSTEM REPORT/TEST

GND REPORT

If you push the <GND REPORT line key, the screen shows for each failure that has not been corrected from previous reports:

- the aircraft identification,
- the time the failure occurred,
- the flight phase where the failure occurred,
- the ATA number of the component,
- the functional designation of the component,
- the FIN of the component.

The screen can show a maximum of three failures at a time. If there are more failures, you must push the next page key on the MCDU keyboard. If there are no failures, NO FAULT DETECTED is shown.

TEST

If you push the <TEST line key, the <CAB TEMP CONT TEST page is shown. The screen shows PACK 1 AND PACK 2 OFF.

If you push the <CONTINUE line key, the screen shows,

- (IN PROGRESS MAX 300S),
- TEST OK if there are no failures,or in case of a failure
- the ATA number, the functional designation, the FIN of the component and END OF TEST.

When the test is activated via the MCDU, an operational test of the system is carried out through the zone controller, which is also connected to both pack controllers.

The test program includes

- Driving of trim air valves (end−to−end check of motion and speed)
- Driving of trim air pressure regulating valve
- Pressure reducing function of pressure regulation valve
- Driving of bypass valve (end−to−end check of motion and speed)
- Driving of ram air inlet and outlet doors to OPEN and CLOSE position
- Setting and resetting of pack anti ice valve command
- Driving of stepper motor of flow control valve
- Secondary computer switching
- Watch dog and digital busses

Tested elements

Valves, actuators and controller.

CLASS 3 FAULTS

If you push the <CLASS 3 FAULTS line key, the screen shows for each class 3 failure :

- the applicable flight leg,
- the date of the applicable flight leg,
- the time when the failure occurred,
- the flight phase where the failure occurred,
- the ATA number of the component,
- the functional designation of the component,
- the FIN of the component.

The screen can show a maximum of two failures at a time. If there are more failures, you must push the next page key on the MCDU keyboard. If there are no failures, NO FAULT DETECTED is shown.

These class 3 faults are minor faults which have to be repaired during A checks (every 400 hours).

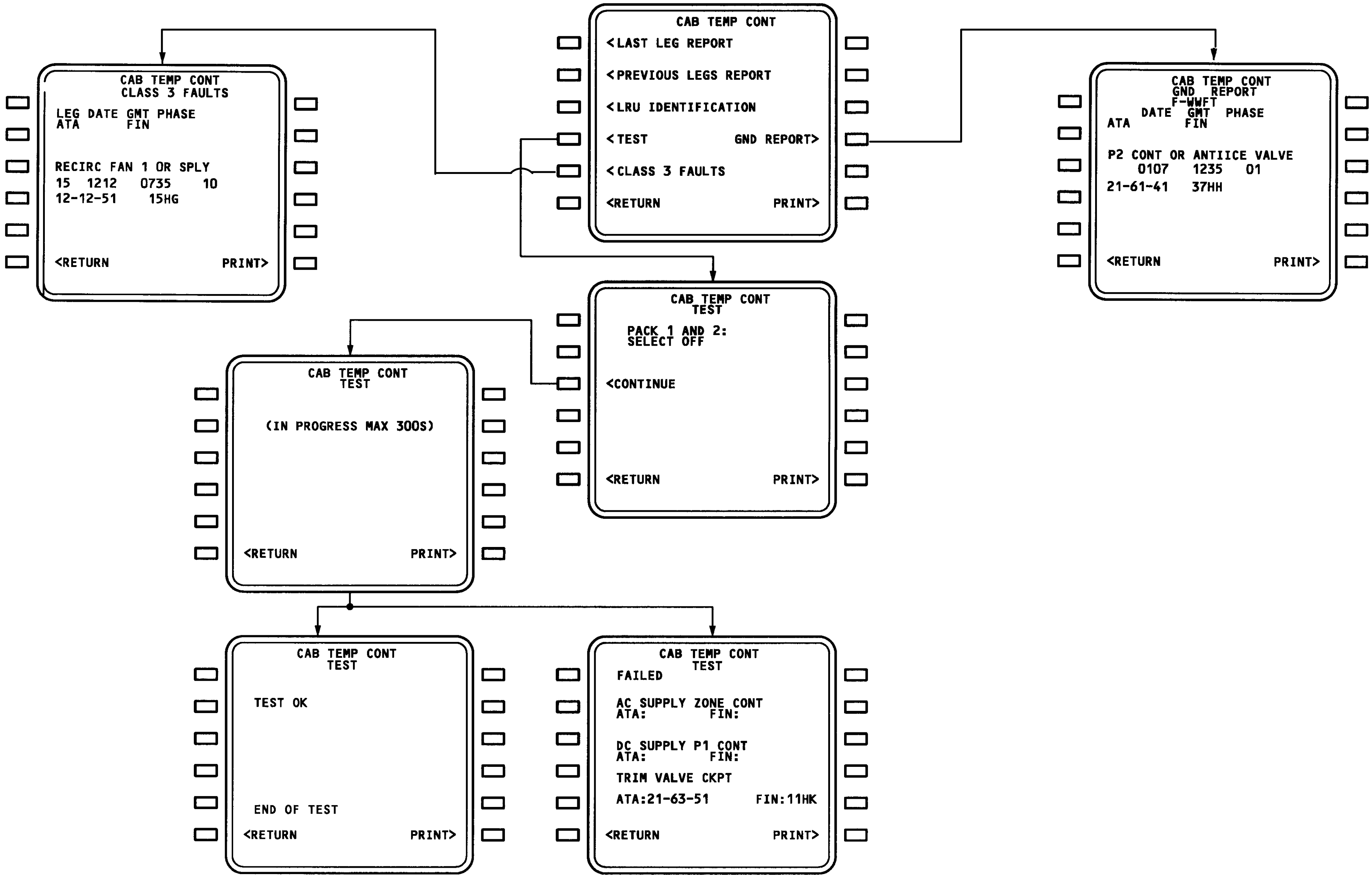


Figure 49 CFDS Cabin Temperature Control Menu (3)

21-55 EMERGENCY RAM AIR INLET

FUNCTIONAL OPERATION

Purpose

The emergency ram-air inlet gives a flow of fresh air through the aircraft if there is a failure in the two air conditioning packs.

If during a flight there is a failure in the two air conditioning packs 10HM (11HM), you can push the RAM AIR pushbutton switch 4HZ.

When you push the RAM AIR pushbutton switch:

- the altitude of the aircraft must be less than 10000 ft. (3.050 m),
- the cabin differential pressure must be less than 70 mbar (1.0 psi).

The emergency ram-air-inlet actuator 7HZ extends and the emergency ram-air inlet moves into the external airflow. Fresh air is pushed into the ram air system and flows through ducts to the mixer unit in the cabin air distribution and recirculation system.

The cabin pressure controllers 11HL (12HL) control the outflow valve 10HL to an approximately 50 % open position.

A. Emergency Ram-Air-Inlet Actuator

The emergency ram-air-inlet actuator 551HZ is installed on the emergency ram-air inlet in the LH belly fairing of the fuselage. It opens and closes the emergency ram-air inlet.

The emergency ram-air actuator 7HZ has:

- an actuator body assembly
- a split-field 28 V DC series-motor which has an electromagnetic brake
- a two-step gear-train
- a jack screw
- an actuator ram
- two indication microswitches,
- two travel limit switches
- a shop-adjustable clutch mechanism
- an electrical connector

B. Check Valve

The check valve 4022HM is installed in the duct to the mixer unit.

The emergency ram-air duct and the LP ground connection duct are connected upstream of the check valve. This makes sure that air from the mixer unit cannot flow out through the emergency ram-air inlet or the LP ground connection.

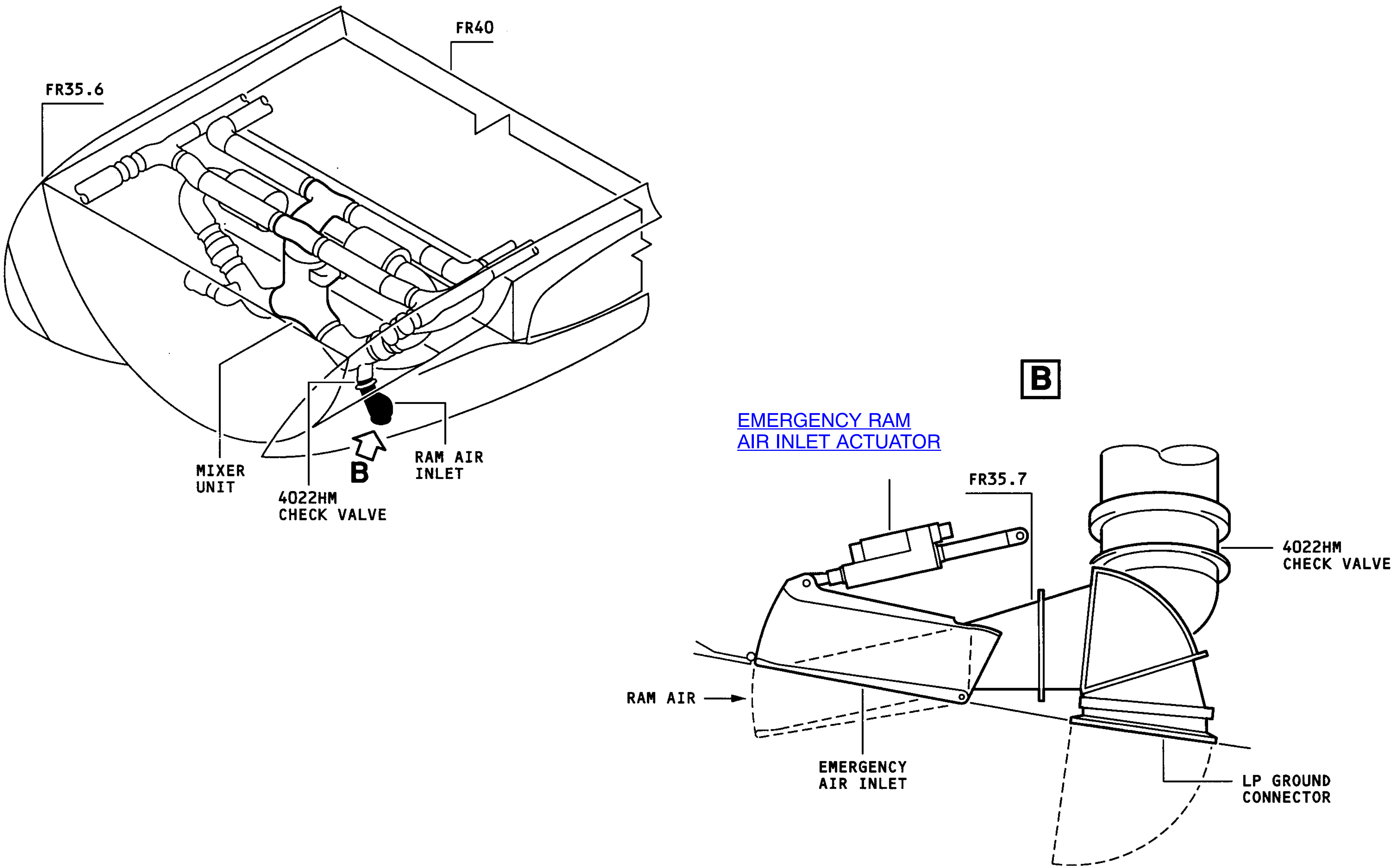


Figure 50 Emergency Ram Air Inlet

EMERGENCY RAM AIR INLET OPERATION

Opening of the Emergency Ram−Air Inlet

To open the emergency ram−air inlet you must lift the guard and push the RAM AIR pushbutton switch 4HZ.

When you push it:

- a signal is sent to the cabin pressure controllers 11HL (12HL) and the outflow valve 10HL partially opens, depending on aircraft differential air pressures and aircraft Air/Gnd information
- a signal is sent to extend the emergency ram−air−inlet actuator 7HZ and the emergency ram−air inlet moves into the external airflow,
- the ON legend in the RAM AIR pushbutton switch 4HZ comes on,
- actuator position data is sent to the SDACs,
- on the lower ECAM display unit, the BLEED page shows the RAM AIR symbol open.

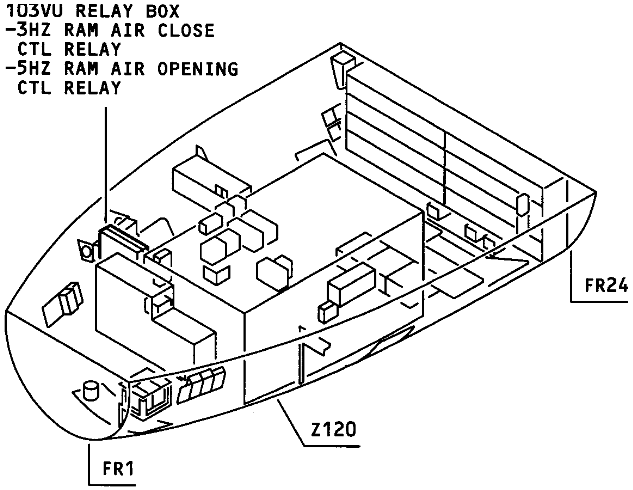
Closing of the Emergency Ram−Air Inlet

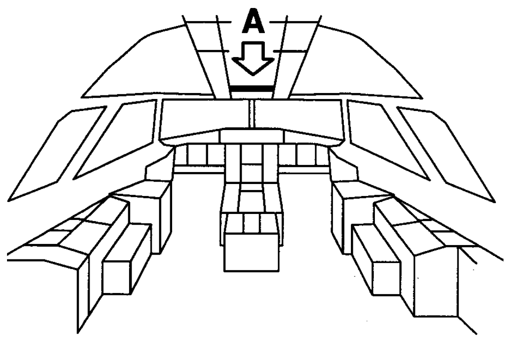
To close the emergency ram−air inlet, you must lift the guard and push the RAM AIR pushbutton switch 4HZ.

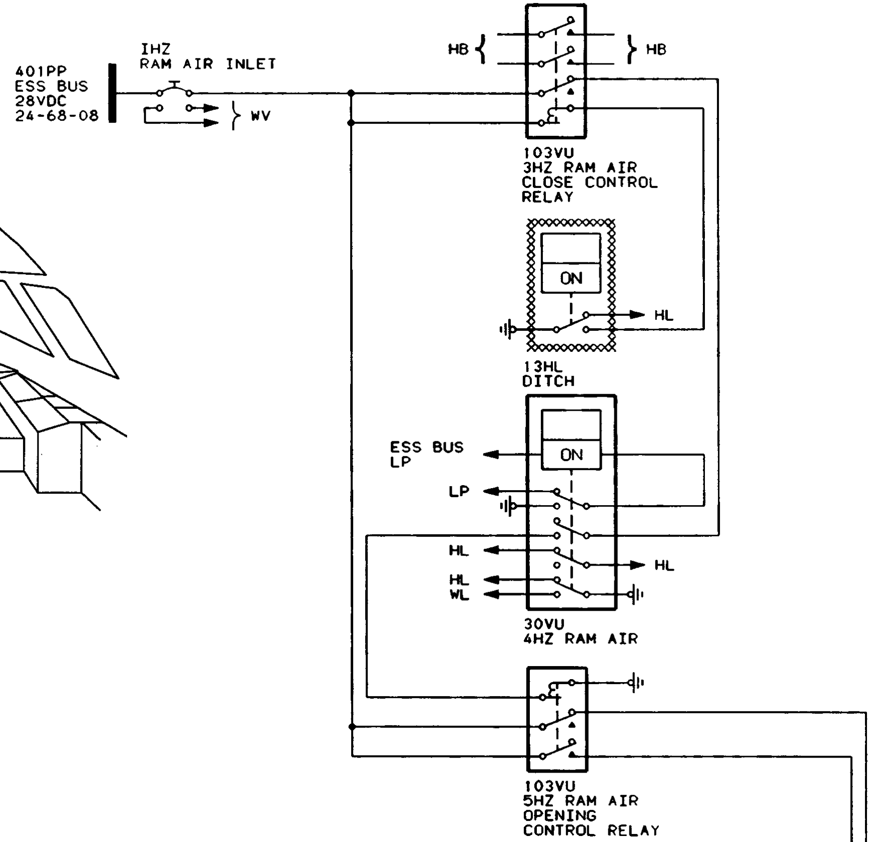
When you push it:

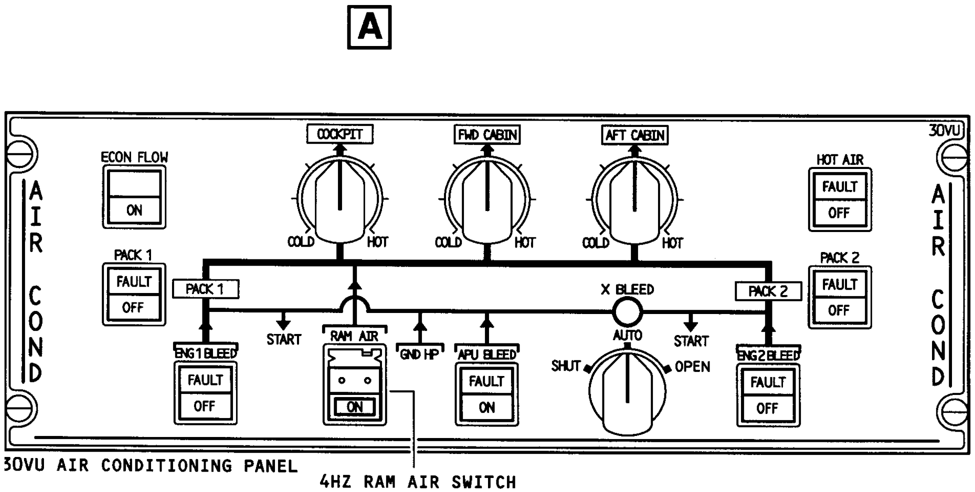
- a signal is sent to the cabin pressure controllers 11HL (12HL) and the outflow valve 10HL closes as necessary, depending on aircraft differential air pressures and aircraft Air/GND information,
- a signal is sent to the emergency ram−air−inlet actuator 7HZ and the emergency ram−air inlet closes,
- the ON legend in the RAM AIR pushbutton switch 4HZ goes off,
- actuator position data is sent to the SDACs,
- on the lower ECAM display unit, the BLEED page shows the RAM AIR symbol closed.

The emergency ram−air inlet closes automatically if you push the DITCHING pushbutton switch 13HL.









NOTE:

HL = 21-31-00	PRESSURE CONTROL AND MONITORING
HB = 21-31-00	FLOW CONTROL AND INDICATING
WV = 31-54-00	SDAC - ACQUISITION/INTERFACE
LP = 33-14-00	ANNUNCIATOR LIGHT TEST AND DIMMING

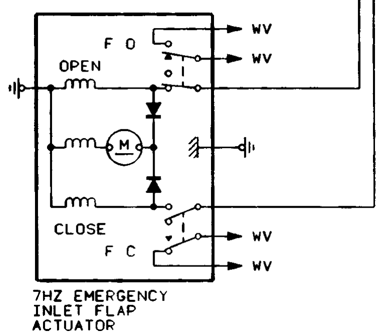


Figure 51 Emergency Ram Air Inlet Operation

21-20 DISTRIBUTION

MIXING UNIT COMPONENT DESCRIPTION

General

A mixer unit, installed under the cabin floor (between frames 34 and 36), mixes conditioned air with cabin air. The cabin air which has entered the underfloor area, is drawn through recirculation filters 4010HM (4011HM) by recirculation fans 14HG (15HG).

The recirculation fans then blow the air through check valves 4020HM (4021HM) to the mixer unit.

The quantity of cabin air mixed with conditioned air changes between 37% to 51 % (in normal operational cases). This is related to the position of the flow selector 5HB.

In an emergency situation, a ram air inlet is opened to supply sufficient air to the cockpit and cabin zones. A low pressure ground connector is also connected to the ram air system for connection to a ground air supply.

The low pressure ground air source supplies conditioned air to the system when the engines and APU are stopped.

Mixing Unit Description

The mixing unit is made in two parts, the mixing chamber and the distribution head.

The mixing chamber is made of resin and glassfiber laminate with a metal flange bonded at the top. Connected to this flange is an aluminum distribution head which distributes mixed-air to the system supply ducts.

Crossfeed ducts are installed from the distribution head to the main supply ducts. These are made of aluminum and contain noise-attenuators.

The main supply duct to the cockpit is made of aluminum at its interface with the hot trim-air system.

An electrically operated mixing flap is installed in this duct. This flap makes sure sufficient fresh air is delivered to the cockpit in case of pack 1 failure. Noise-attenuators are installed downstream of the hot trim-air interface.

The mixing unit and crossfeed ducts are insulated with glasswool and a jacket made of a Hypolon material.

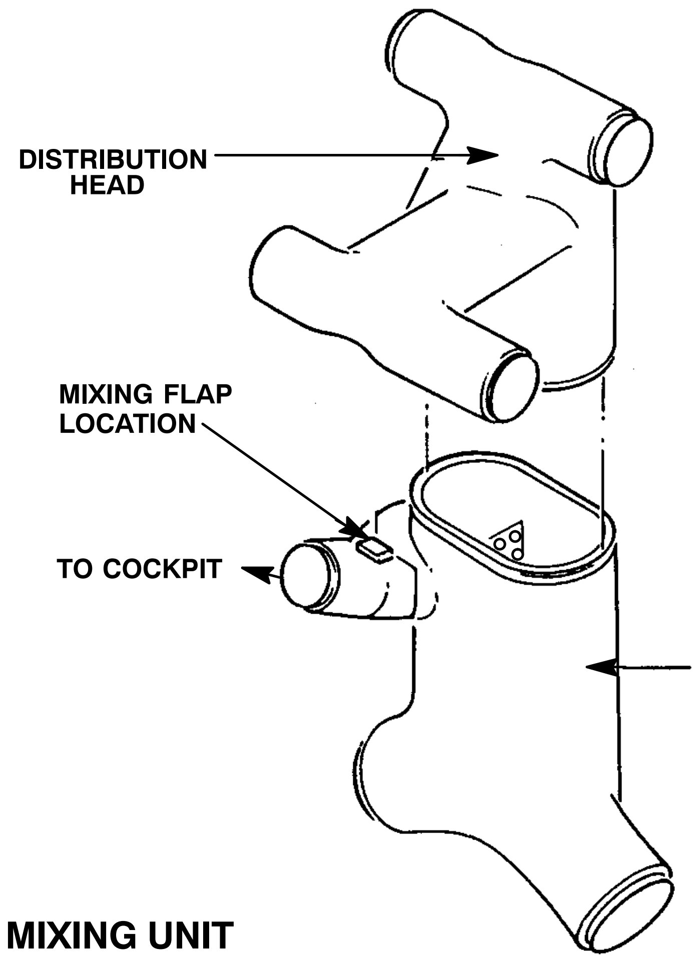


Figure 52 Mixing Unit

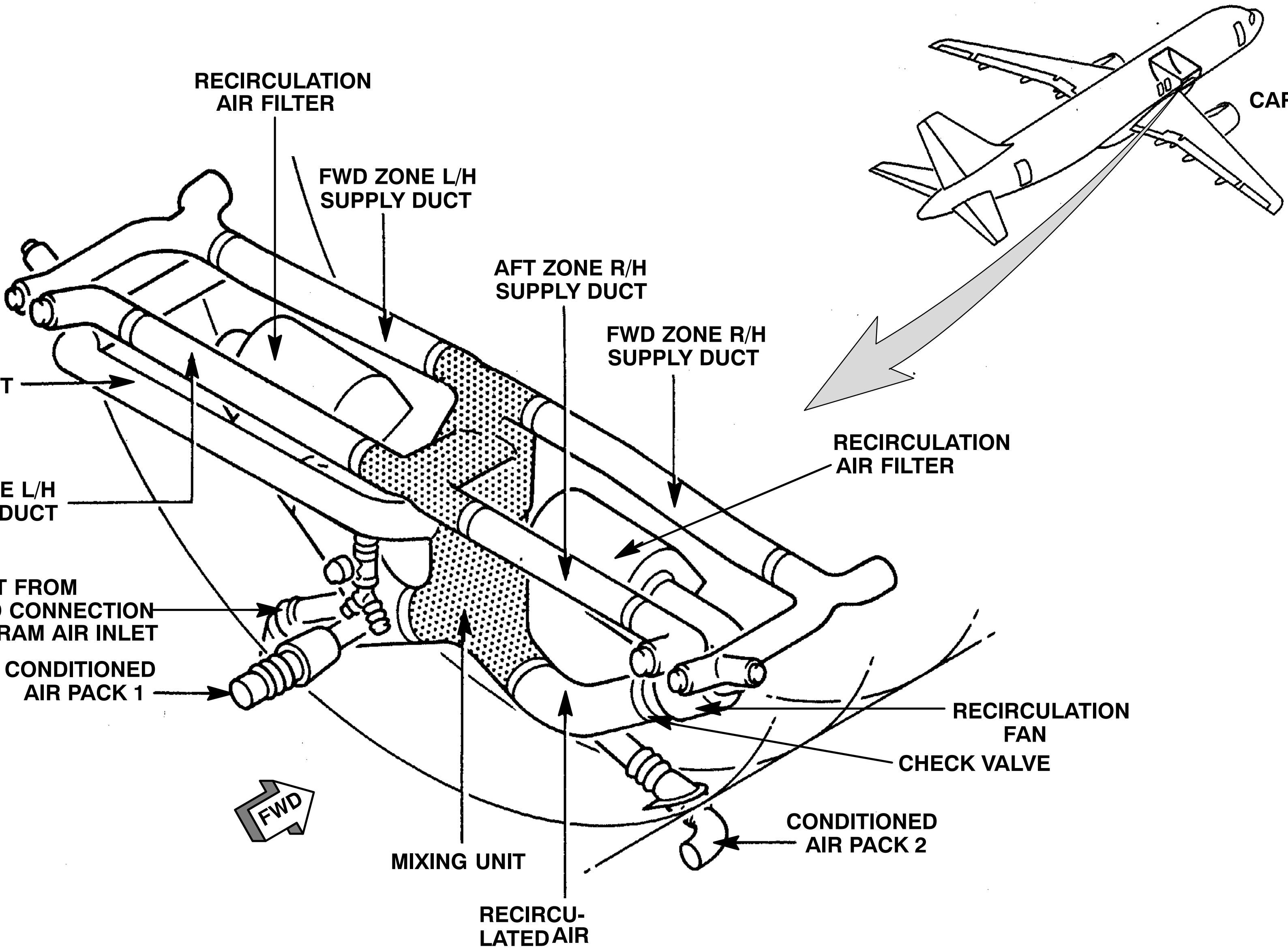


Figure 53 Mixer Unit

RECIRCULATION FAN AND FILTER OPERATION

Cabin Recirculation Fans

Cabin air from the underfloor area is mixed with conditioned air. This increases the amount of air which is blown into the distribution system.

The two recirculation fans 14HG (15HG) installed one each side of the mixing unit do this. Cabin air is drawn through two recirculation filters 4010HM (4011HM) and blown through two check valves 4020HM (4021HM) into the mixing unit. The cabin recirculation fans 14HG (15HG) are installed in line with the recirculation ducts. They are powered by a three-phase six-pole induction motor that drives a fan-wheel which has high-efficiency blades.

The fans will operate continuously at about 7700 rpm when supplied with electrical power. Thermo switches are installed inside the stators of the recirculation fans. If the temperature of the stators gets to 140 °C (284.00°F) the thermo switches isolate the electrical supply to the fans. The recirculation fans are installed on vibration-damper mountings, these prevent damage to the aircraft structure, due to fan vibration. Arrows on the fan casing show the direction of airflow through the fan and the direction that the impellor rotates.

Check Valves

A check valve 4020HM (4021HM) is installed downstream of each cabin recirculation fan 14HG (15HG) to prevent a reverse flow of the air in case of a recirculation fault.

The check valve has two semicircular flaps which are installed on a hinge-bar. A spring holds the semicircular flaps in the closed position. Airflow from the cabin recirculation fans 14HG (15HG) will lift the semicircular flaps from their seats. This will permit air to flow through the check valves 4020HM (4021HM) into the ducts. Airflow in the opposite direction through the check valve will push the semicircular flaps back onto their seats and stop the airflow. An arrow on the check valve casing shows which way air will flow through the check valve.

Recirculation Filter

Two recirculation filters 4010HM (4011HM) are installed, one upstream of each recirculation fan 14HG (15HG). Each consists of a multi-layer glassfiber filter-cartridge, installed inside a perforated Carbon Fiber Reinforced Plastic (CFRP) cylinder. The complete filter unit is installed in an open frame type housing made of aluminum. The filter unit is secured in position with an adjustable flange at one end of the housing.

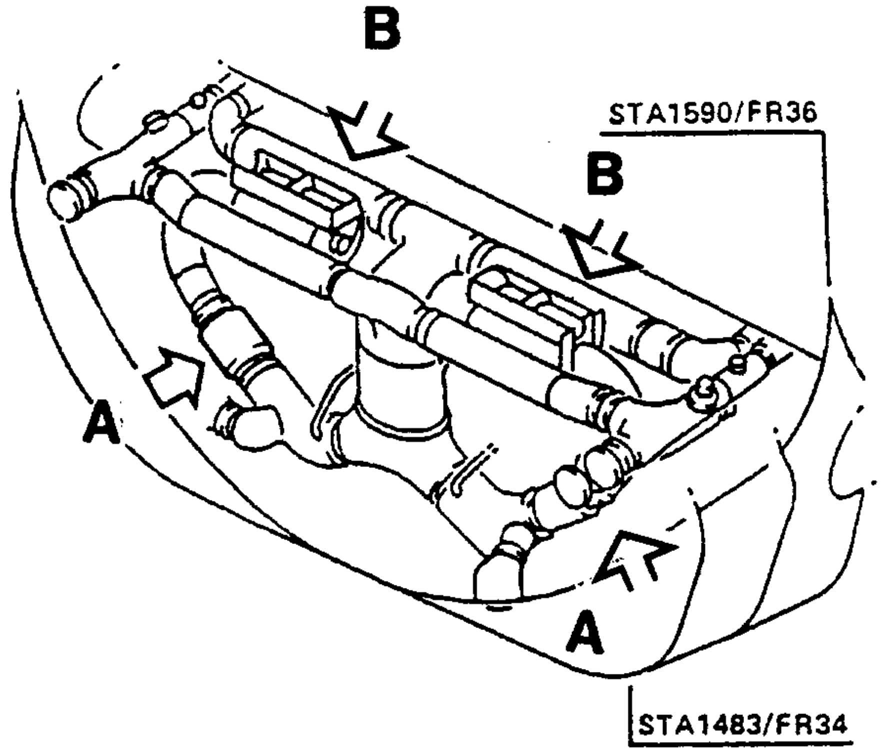
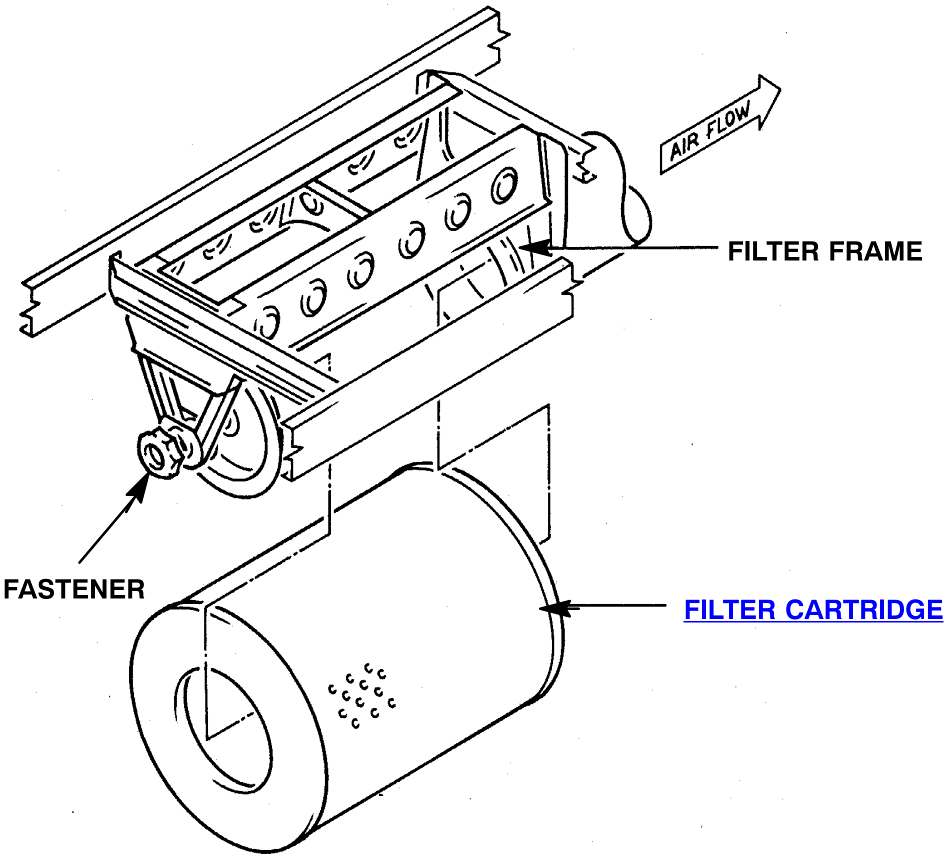


Figure 54 Location Recirculation Components

B RECIRCULATION FILTER 4010HM (4011HM)

A CABIN RECIRCULATION FAN 14HG (15HG) AND CHECK VALVE 4020HM (4021HM)



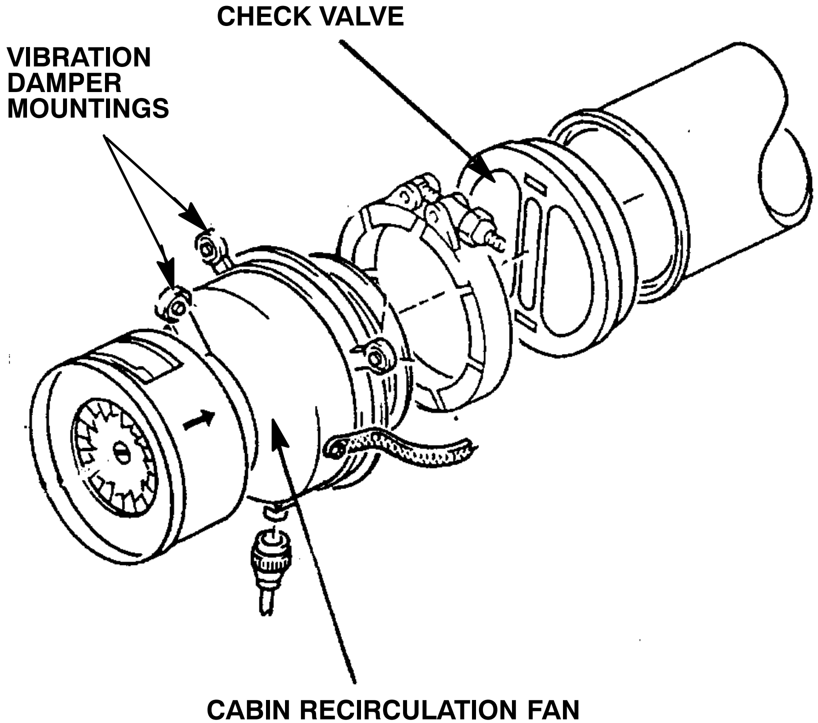


Figure 55 Cabin Recirculation System Components

AIR DISTRIBUTION GENERAL LAYOUT

Cockpit Air

Air is delivered to the cockpit by a large-diameter duct from the mixing unit.

It divides at the rear of the cockpit to go forward at the left-hand and right-hand side.

Three smaller-diameter riser ducts connect to the large-diameter duct and go up each side of the cockpit. The tops of the riser ducts connect to different air outlets in the cockpit. The outlets are made to stop draughts at crew-head level, and divide the air equally throughout the cockpit.

Distribution

Air from the mixing unit is supplied to the cockpit through a duct installed below the left-hand side of the cabin floor.

Conditioned air is supplied to the cockpit at the places listed below:

- the left-hand side of the Captain's station,
- the right-hand side of the First Officers station,
- at two positions in the left-hand ceiling area above the third crew member's station.

At these positions the airflow is adjustable in quantity and direction:

- the left-hand and right-hand ceiling areas above the lateral windows,
- the left-hand and right-hand sides below the lateral windows.

At these positions, the airflow quantity is adjustable in only at the left-hand and right-hand ceiling areas above the windshield.

NOTE: The cockpit supply duct can also be used to supply air to the avionic ventilation system when this is necessary.

For this purpose the duct is tapped in the avionic compartment.

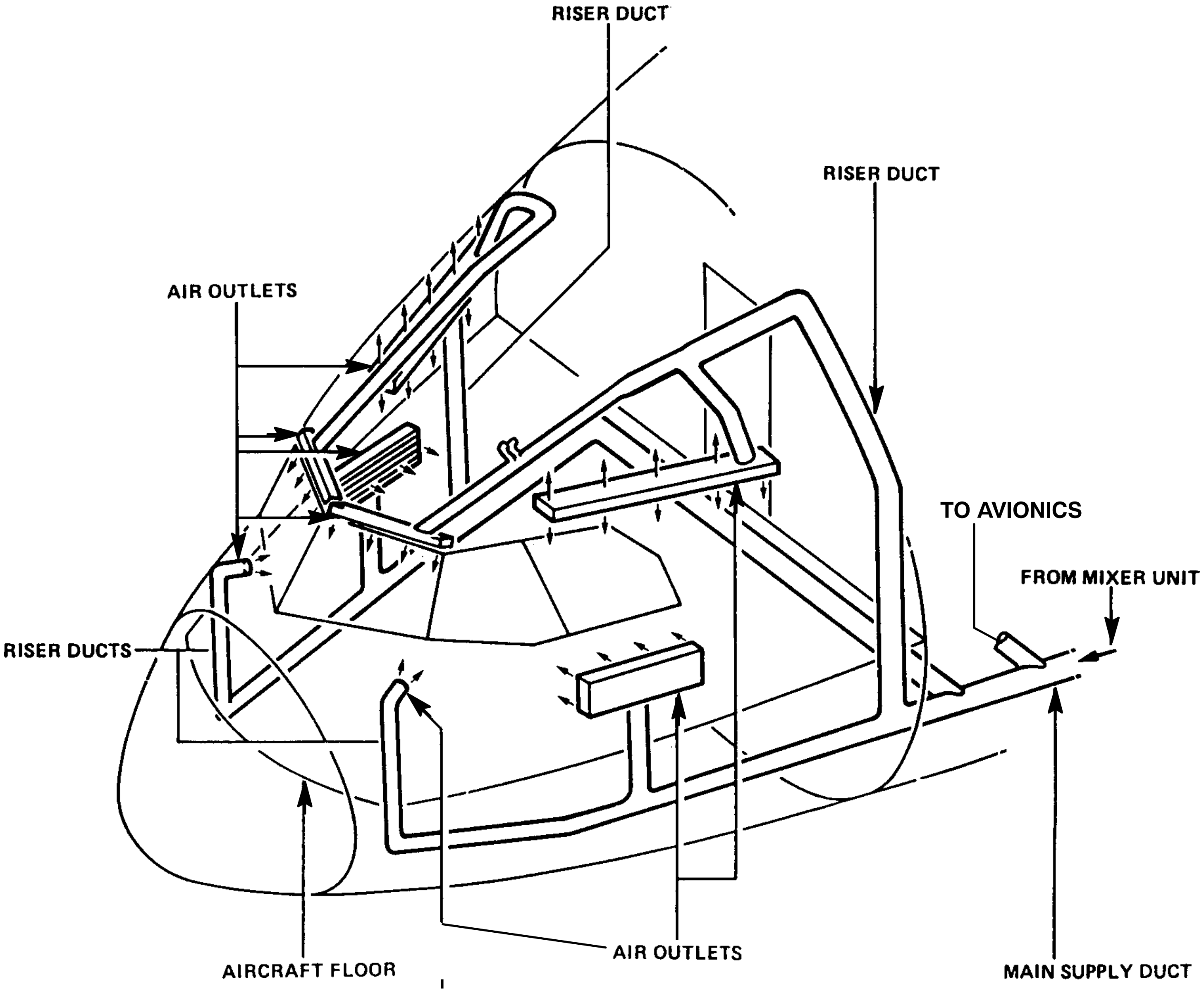


Figure 56 Cockpit Air Distribution and Locations

Passenger Air

Large-diameter air ducts supply air to the two passenger cabin zones from the air conditioning packs 10HM (11HM).

They are installed under the cabin floor along the left-hand and right-hand side. Smaller-diameter riser ducts are connected to the supply ducts. The riser ducts go up-and-around the interior of the fuselage. They are installed between every second window and start between the first two forward windows.

The top of each riser duct is connected to cabin air outlets, (one below and one above the hat racks). Riser ducts are also installed at the rear of the forward entrance doors, and forward of the rear entrance doors.

They go up-and-around the interior of the fuselage to outlets above each door. The door and cabin outlets are made to stop draughts at seat-head level, and divide the air equally throughout the cabin.

Distribution

The passenger cabin is divided into the forward and aft distribution zones. Each distribution zone has main supply ducts and small riser ducts.

The main supply ducts are installed under the cabin floor along the left-hand and right-hand side of the fuselage. The riser ducts connect to the main supply ducts and go up between every second window to outlets above and below the hat racks.

The L-shaped riser ducts connect the outlets above the doors to the main supply ducts. Most of the distribution ducts are made of resin and glass-fiber laminate with metal sleeves bonded to each end for duct interconnection. Flexible bellows, which are made of silicone laminate and glass-fiber, connect the ducts to each other. When they are installed, clamps secure the flexible bellows. Insulation shells which are made of polyethylene foam or glass wool (covered with a Hypolon material) are installed around the ducts.

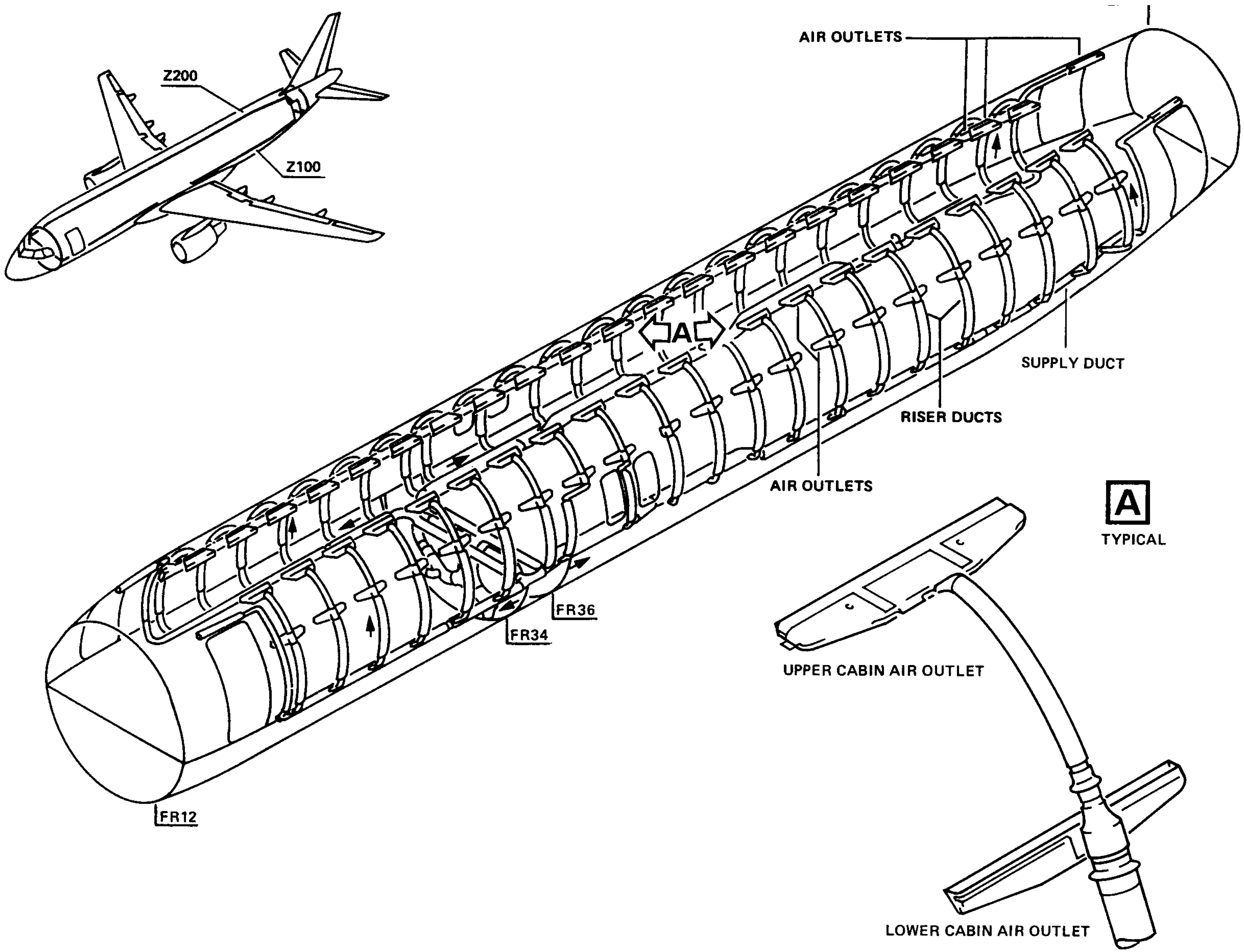


Figure 57 Passenger Cabin Air Distribution

CABIN RECIRCULATION FANS CONTROL

A pushbutton switch 4HG operates the cabin recirculation fans 14HG (15HG). The switch is installed on the overhead ventilation panel 22VU in the cockpit and is labelled CAB FANS.

A signal is sent to the Centralized Fault Display System (CFDS) if a recirculation fan fails. A signal is also sent to the Electronic Centralized Aircraft Monitoring (ECAM) for display after flight.

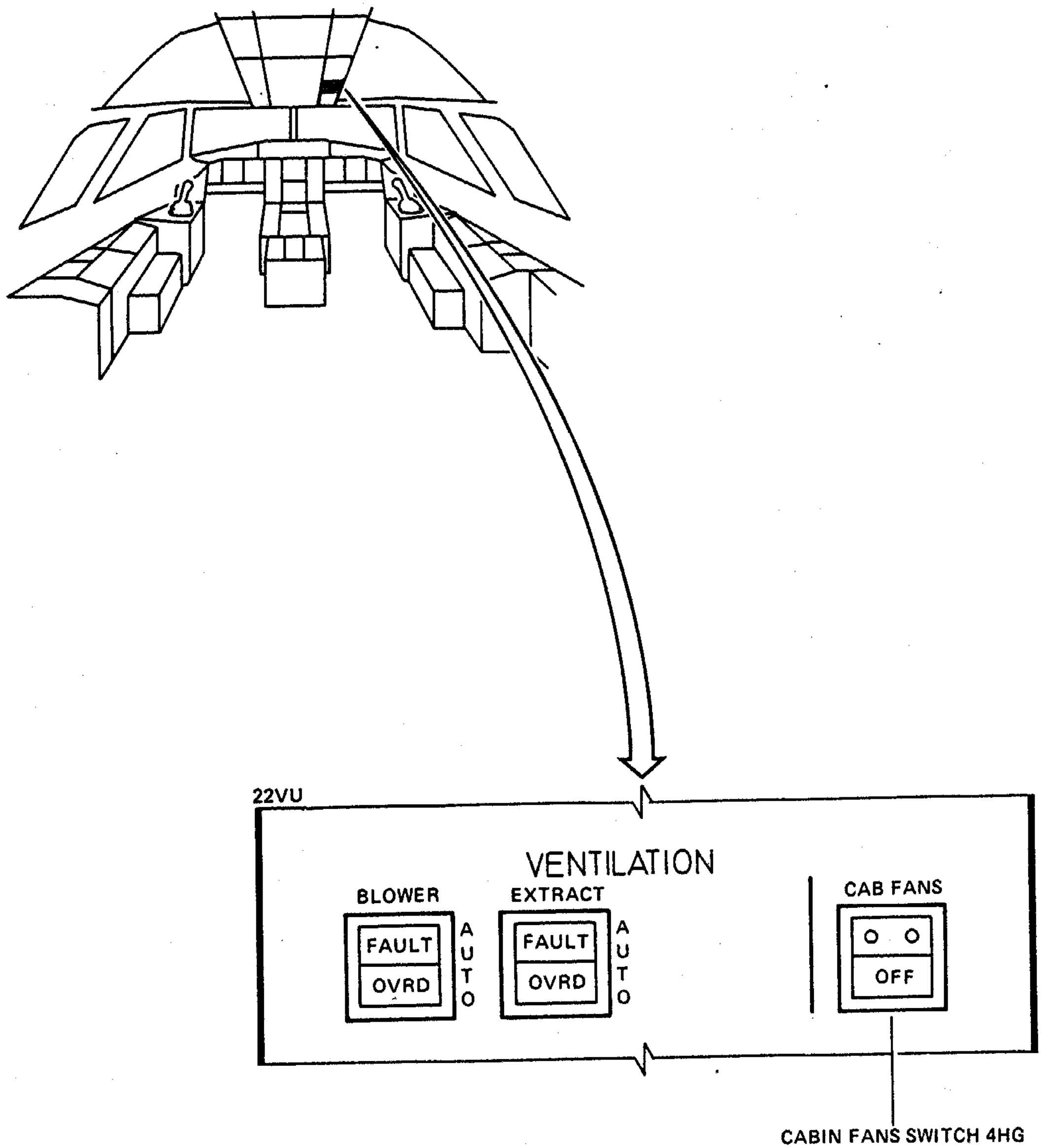


Figure 58 Cabin Fan Control

CABIN RECIRCULATION FANS PRESENTATION

Normal Operation

A pushbutton switch 4HG operates the cabin recirculation fans 14HG (15HG). The switch supplies 28 V DC from the normal busbar 101PP (204PP) through two circuit breakers 2HG (11HG) to two power relays 5HG (6HG). The power relays energize the cabin fans with 115 V AC from the normal busbar 1 and 2 101XP (204XP) through the two circuit breakers 1HG (3HG).

Malfunction Detection

OVERHEAT thermo-switches operate if the stator temperature of the recirculation fans 14HG (15HG) goes up from 134 °C (273.20 °F) to 146 °C (294.80 °F). They will remove the ground from the power relays 5HG (6HG), the fans will stop and the indicating relay will open.

The indicating relay signals the Centralized Fault Display System (CFDS) and the Electronic Centralized Aircraft Monitoring (ECAM) system. To start the cabin fans again you must push the CAB FANS switch OFF and ON.

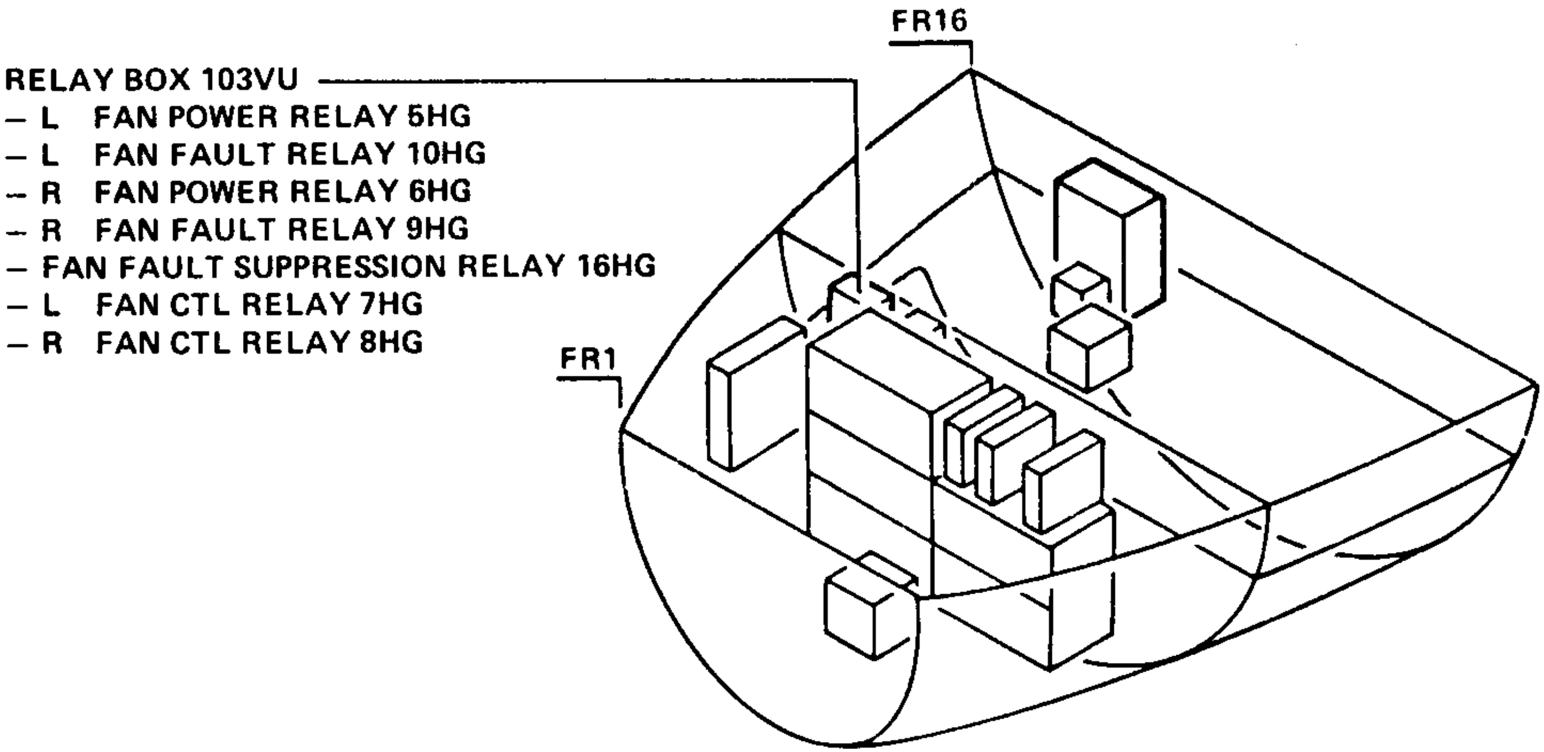


Figure 59 Relay Locations

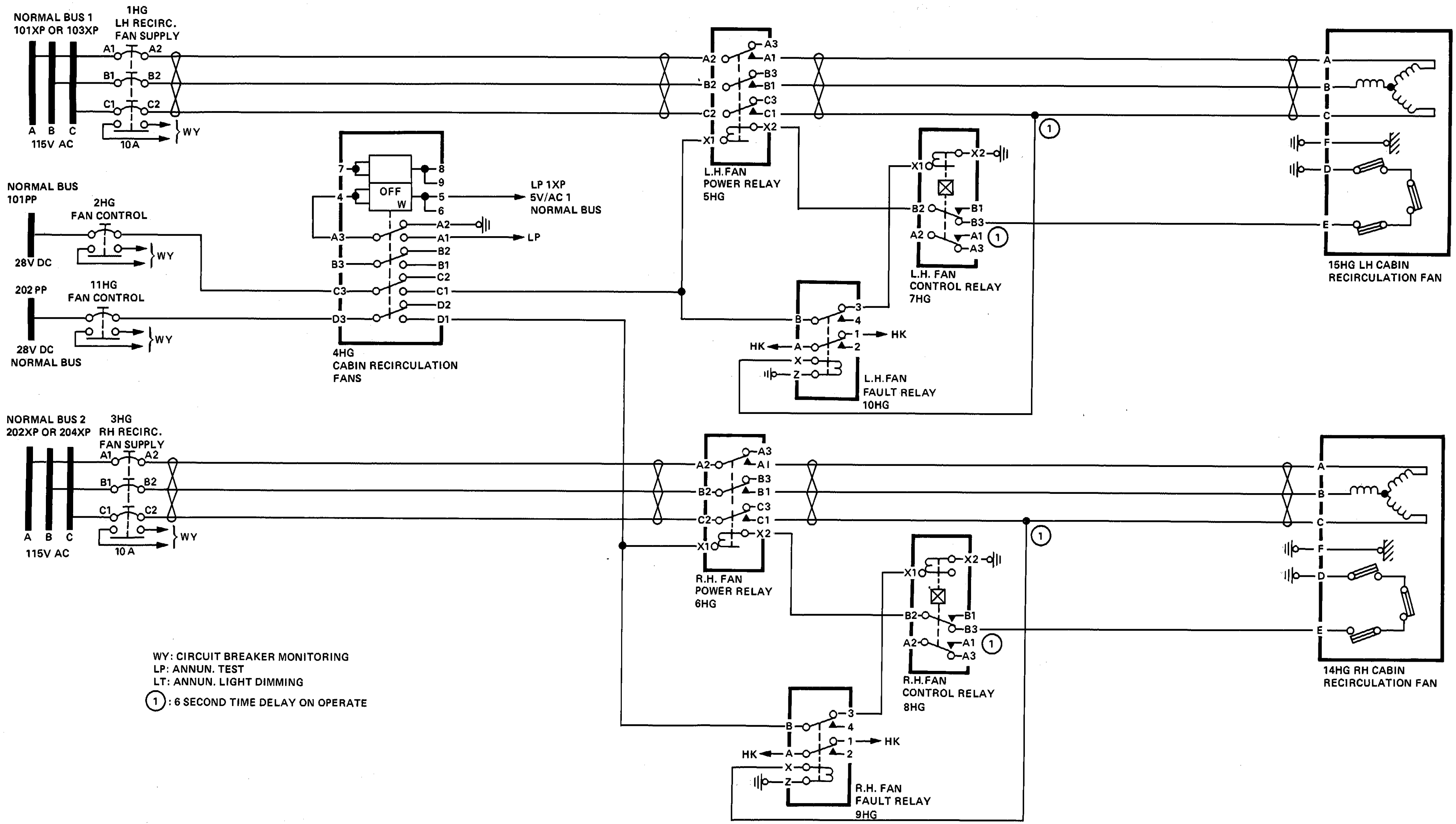


Figure 60 Cabin Recirculation Fans Electrical Schematic

21-23 LAVATORY/GALLEY VENTILATION

GENERAL DESCRIPTION

The lavatory and galley ventilation system uses air from the cabin zones and conditioned air from the main distribution ducts. Air removed from the ceiling area of the lavatory, galley units and the lavatory bowls, is delivered to the outflow valve 10HL area.

A duct system, different from the cabin distribution system, is used to prevent unpleasant smells entering the cabin.

Most of the air used for ventilation is cabin air, the extraction fan 1HU draws air into the units. Conditioned air is supplied to each lavatory and some galleys from tappings on the cabin air distribution ducts.

Restrictors are installed downstream of the tapping points to increase pressure for correct functioning of the individual outlets. The airflow from these outlets is adjustable in both quantity and direction, and they are located below the lavatory mirrors.

Extraction Fan

The lavatory and galley extraction fan 1HU is installed in line with the extraction duct. It is powered by a three–phase induction motor that drives a fan wheel which has high efficiency blades. The fan will operate continuously at about 11.700 RPM. Thermo switches are installed inside the stators of the extraction fan. If the temperature of the stator gets to 134 °C (273.20 °F) to 146 °C (294.80 °F) the thermo switches isolate the electrical supply to the fan.

The lavatory and galley extraction fan is secured by clamps to brackets on the aircraft structure in the rear underfloor area. Arrows on the fan casing show the direction of airflow through the fan and the direction that the impellor rotates.

If the impeller breaks the casing is strong enough to contain the debris.

The extraction fan 1HU removes air from the lavatory and the galley through a duct located above the cabin ceiling. This duct extends the length of the cabin from the forward utility area to the left–hand aft lavatory.

The duct divides into two dropper ducts and follows the fuselage contour downwards (on each side of a window) to the fan. The air is then removed overboard through the outflow valve 10HL.

The extraction fan operates continuously during flight and on the ground when electrical power is available to the aircraft.

Extraction Ducts

The extraction ducts are made from resin and glass-fiber laminate with metal sleeves bonded at each end for duct interconnection. All ducts are connected to each other by flexible bellows made of silicone laminate and glass-fiber secured by clamps. Capped branches along the duct allow the installation of lavatories and galleys at different locations in the cabin. At frames 28 and 51, flexible hoses from the extraction duct are connected to cabin sensor housings.

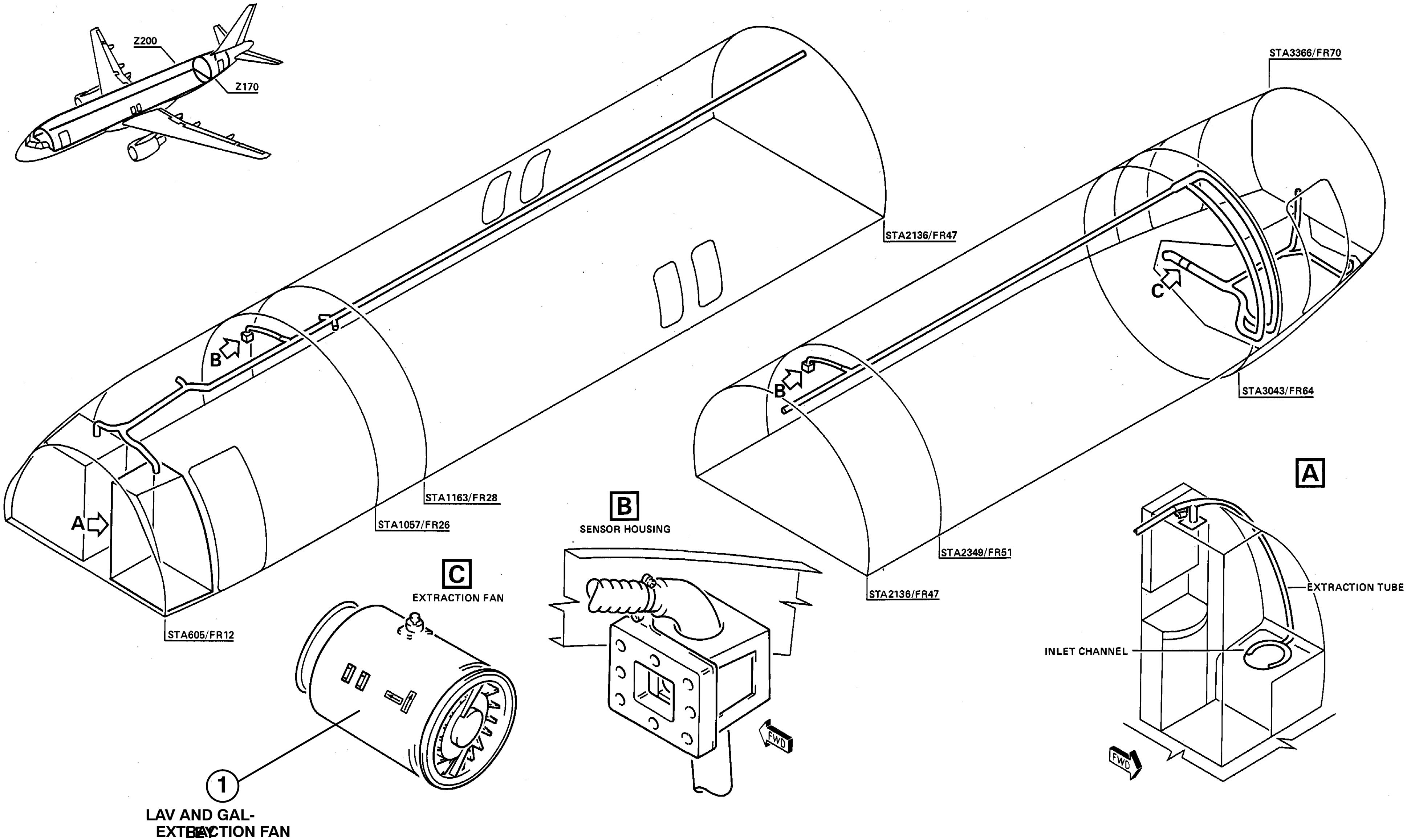


Figure 61 Lavatory and Galley Ventilation Schematic

LAVATORY & GALLEY VENTILATION OPERATION

Control and Indication

The lavatory and galley extraction fan 1HU is continuously monitored by the zone controller 8HK of the cabin temperature control system. If the fan fails, the zone controller sends a signal to the ECAM and CFDS systems.

Operation

The lavatory and galley extraction fan 1HU operates continuously. 28V DC from normal busbar 101PP through circuit breaker 5HU energizes the power relay 2HU. The power relay energizes the extraction fan with 115 V AC from normal busbar1101XP through circuit breaker 6HU.

Thermo switches, protect the fan from overheating. If the temperature of the stators go up to 146 °C (294.80 °F) the ground is removed from the power relay.

Malfunction Detection

Overheating of the lavatory and galley extraction fan 1HU causes the thermo switches to remove ground from the power relay 2HU.

This removes the electrical power, the fan stops and the indicating relay opens. The indicating relay signals the zone controller 8HK and the zone controller signals the ECAM and CFDS systems. You must not start the extraction fan again until you have found the fault and repaired it.

NOTE: In case of a extraction fan fault the temperature indication for the FWD and AFT cabin zones will be amber " XX " on the ECAM COND Page.

In addition to this the temperature control by the zone controller will control now the cabin temperature to a 15 °C constant duct temperature.

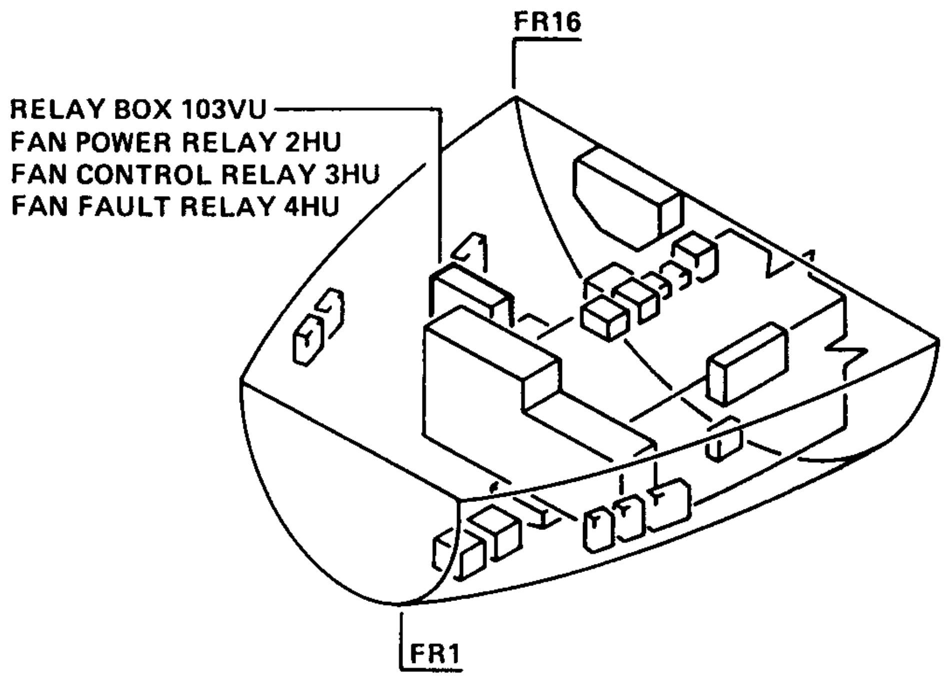


Figure 62 **Relay Locations 103 VU**

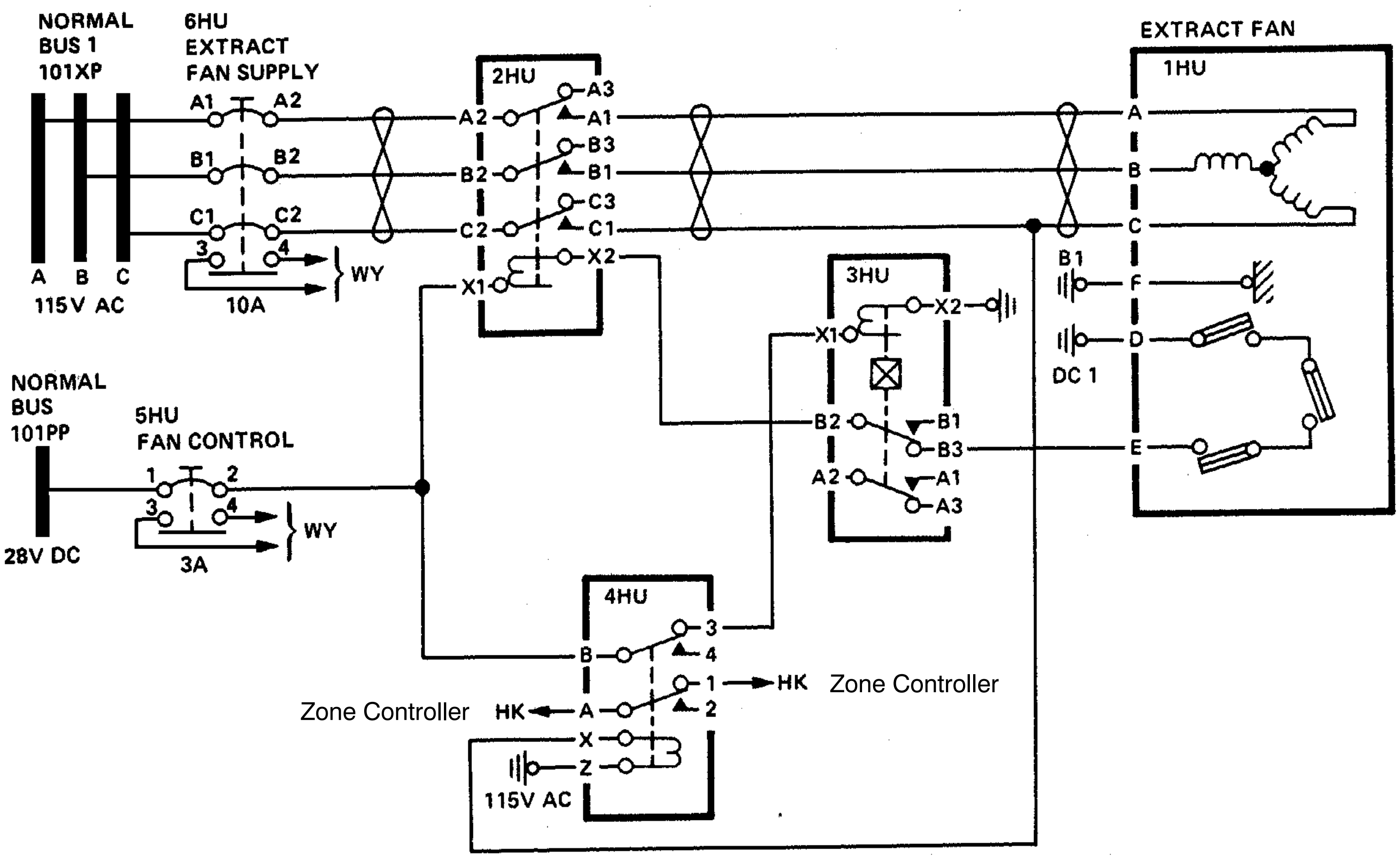


Figure 63 Lavatory & Galley Ventilation Control

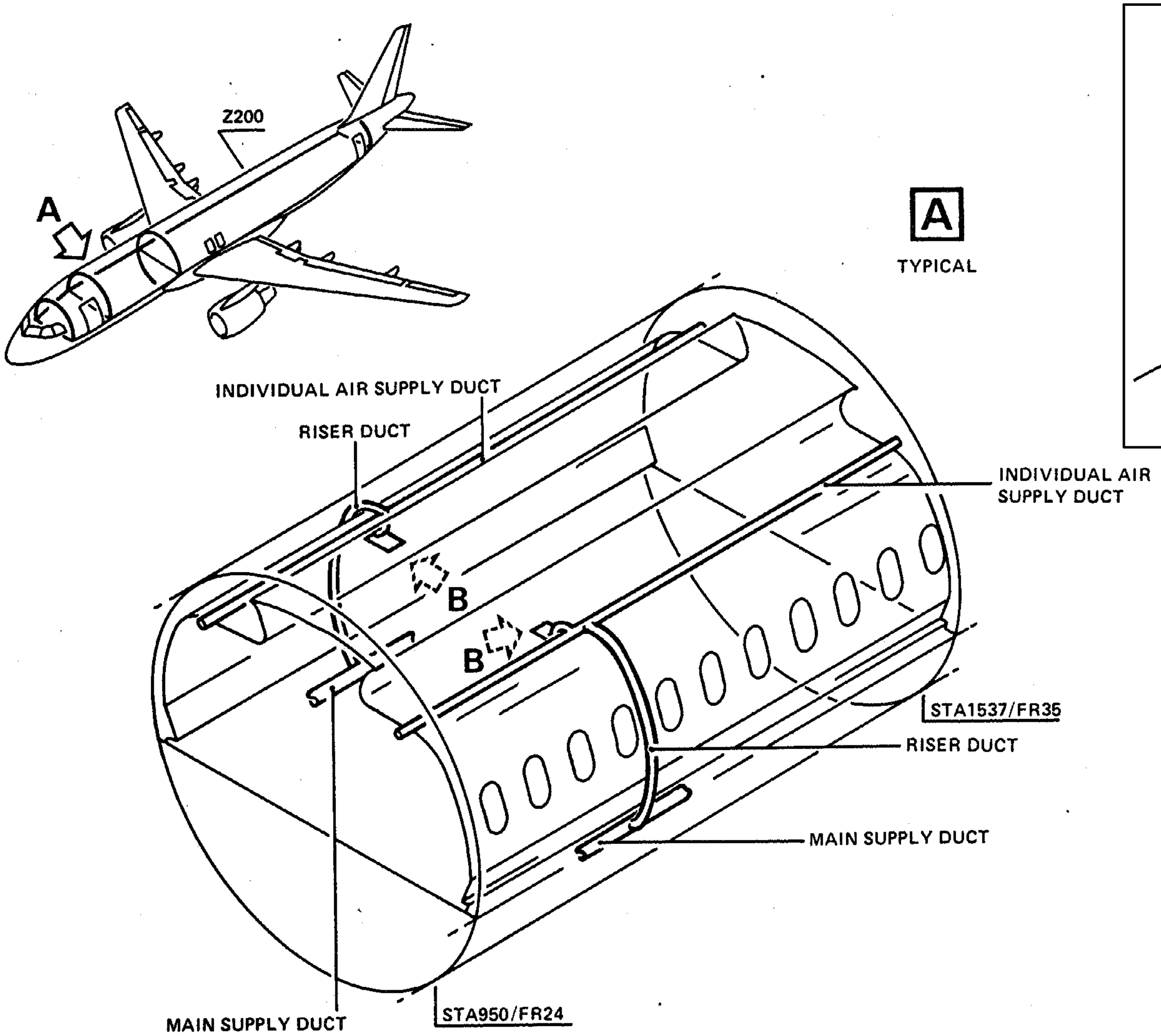
21−24 INDIVIDUAL AIR DISTRIBUTION

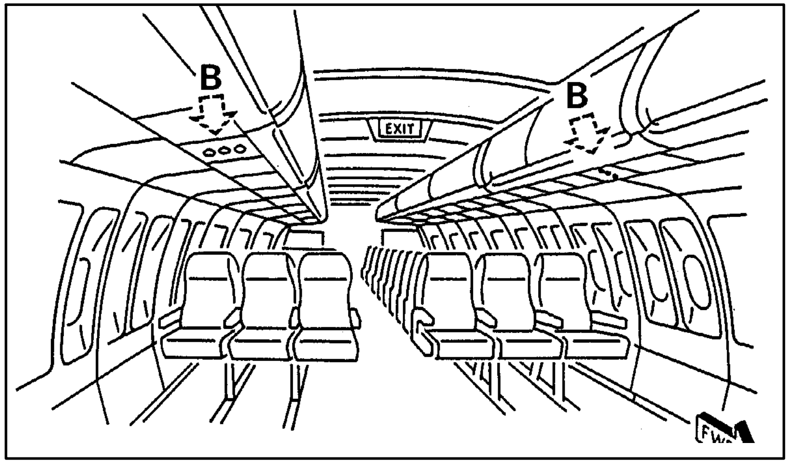
INDIVIDUAL AIR DISTRIBUTION OPERATION

Air for passenger individual ventilation is taken from the cabin main supply ducts. Small diameter riser ducts are connected to these ducts.

They deliver air to the individual air supply ducts located below the hat−rack.

The individual air outlets are connected with flexible hoses to tappings on the individual air supply ducts. The individual air outlets are located above each passenger seat row and are adjustable in airflow and direction.





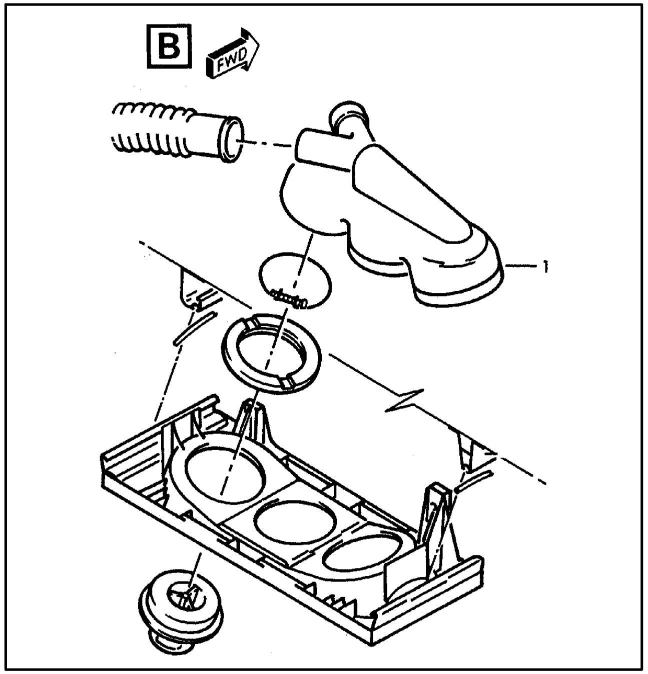


Figure 64 Individual Air Ventilation

21–40/42 HEATING

COCKPIT AIR HEATING (SB A320–21–1185)

System Description

This Service Bulletin installs heaters on the captain and first officer foot air outlets.

The electrical heaters can be switched ON/OFF from additional selector switches on the airconditioning control panel.

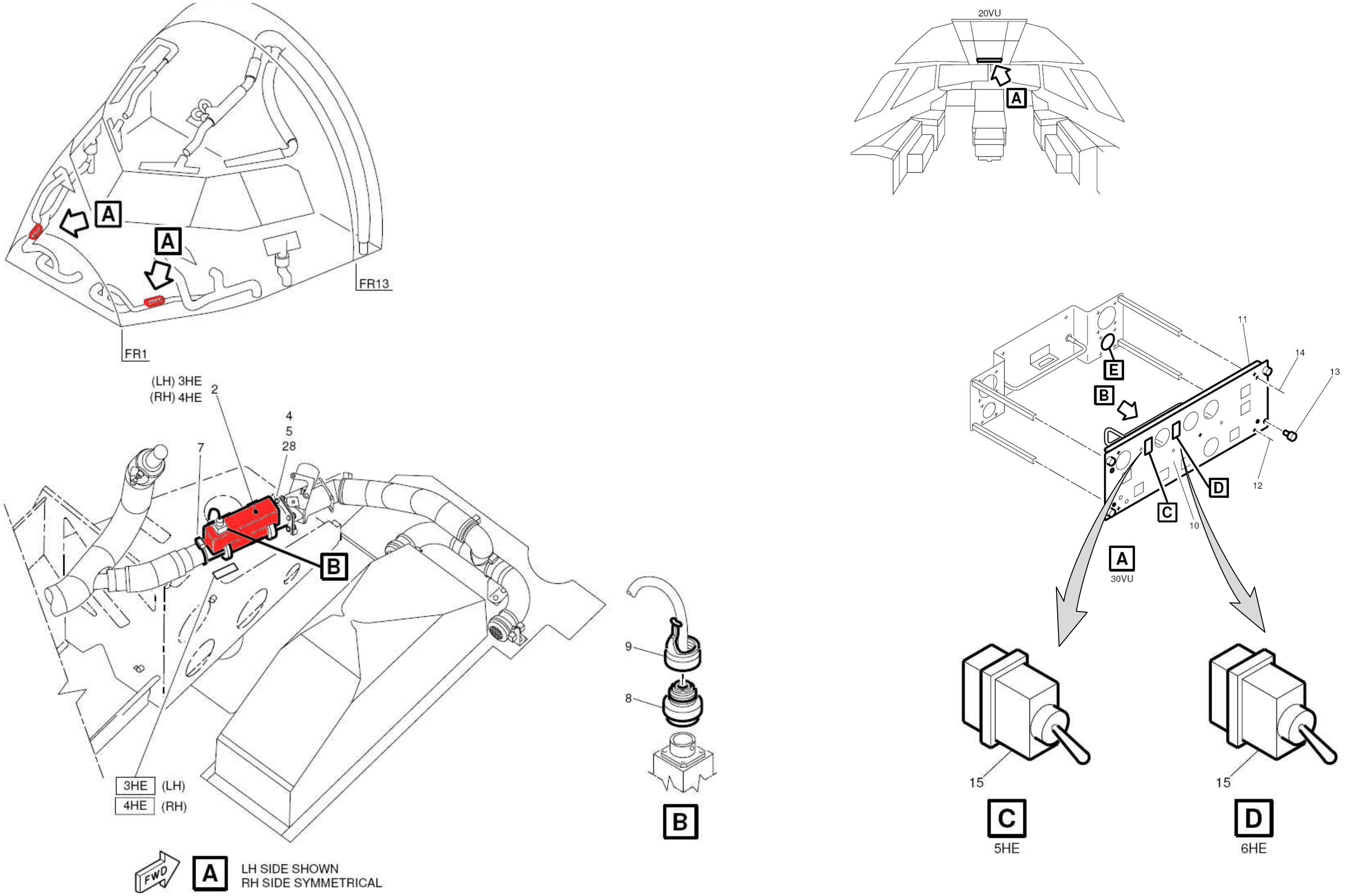


Figure 65 Additional Foot Heaters

DOOR AREA HEATING (AIR HEATER)

General

The door area heating system supplies warm air to the foot level areas at the FWD passenger and crew doors.

System Description

A door area heating system is installed for each FWD passenger/crew door area. The two systems operate independently. For each door area, a heater 4HJ1 (4HJ2) is installed between the FR21 and FR24, which heats the air from the distribution system. Ducts, a flexible hose and an air outlet supplies the heated air from the heater to the foot level area at the FWD passenger/crew door.

The CAB FANS pushbutton switch 4HG on panel 22VU, the toggle switch 2HJ1 (2HJ2) and the relays 3HJ1, 5HJ1 (3HJ2, 5HJ2), which are installed on the circuit breaker panel 2000VU, control the heater 4HJ1 (4HJ2). Thermostats protect the heater for overtemperature. The heating system operates only if the cabin air recirculation−system is switched on.

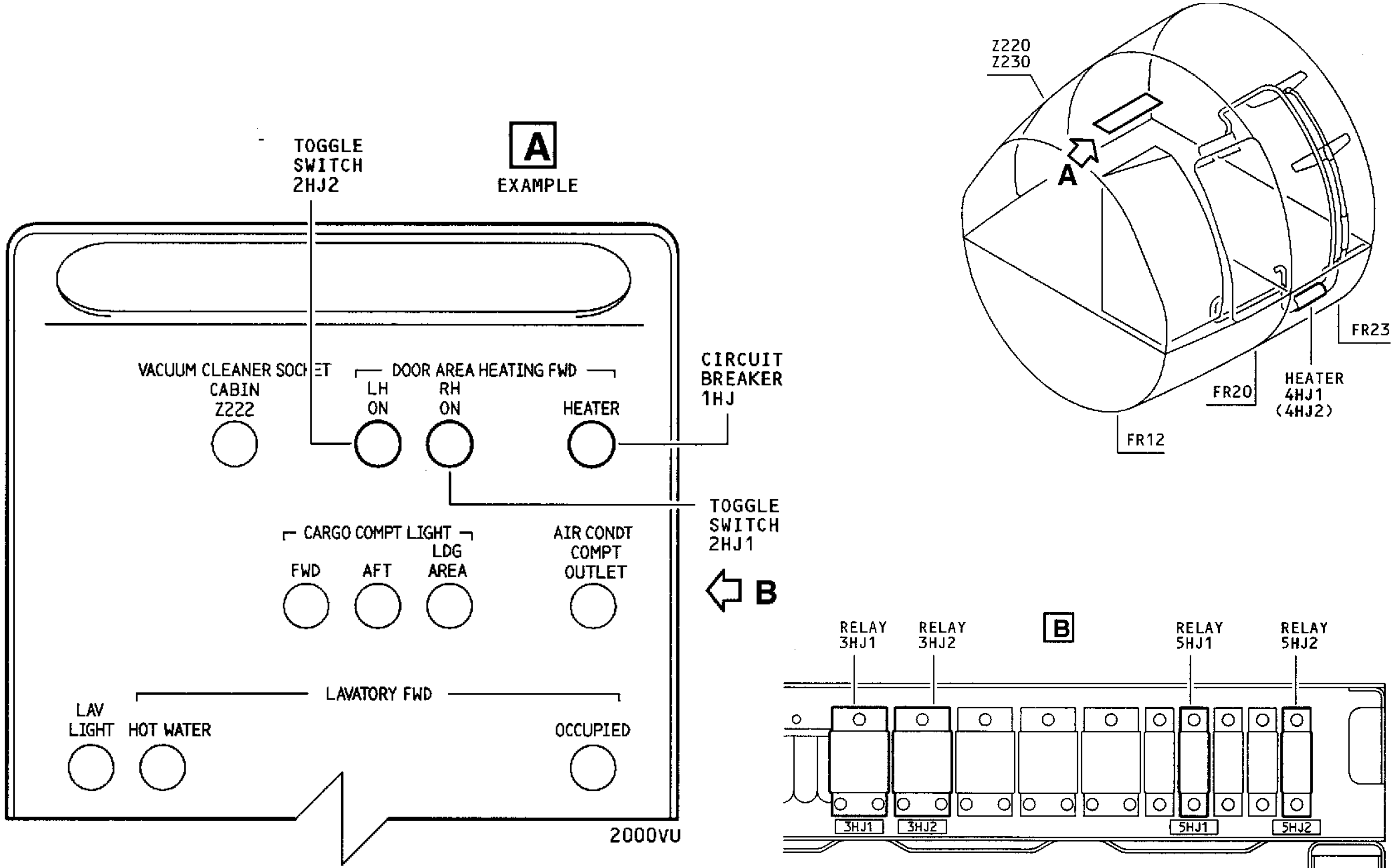


Figure 66 Door Area Heating Component Location

Operation/Control and Indication

When air is supplied from the cabin air distribution-system and the toggle switch 2HJ1 (2HJ2) is switched to on, the heater 4HJ1 (4HJ2) warms the air for the FWD door area.

When you push the CAB FANS pushbutton switch 4HG to the OFF position, the relay 5HJ1 (5HJ2) will be de-energized and the heating system stops. The heating system also stops if you switch the toggle switch 2HJ1 (2HJ2) to the off position.

If the air temperature in the heater gets to more than 50 °C (122.00 °F) the heater is switched off until the air temperature in the heater is less than approx. 45 °C (113.00 °F). Then the heater is switched on again.

If the temperature at the heater housing gets more than 85 °C (185.00 °F) a thermostat de-energizes the relay 3HJ1 (3HJ2). Thus the heater is switched off until the temperature decreases to less than approx. 80 °C (176.00 °F). Then the heater is switched on again.

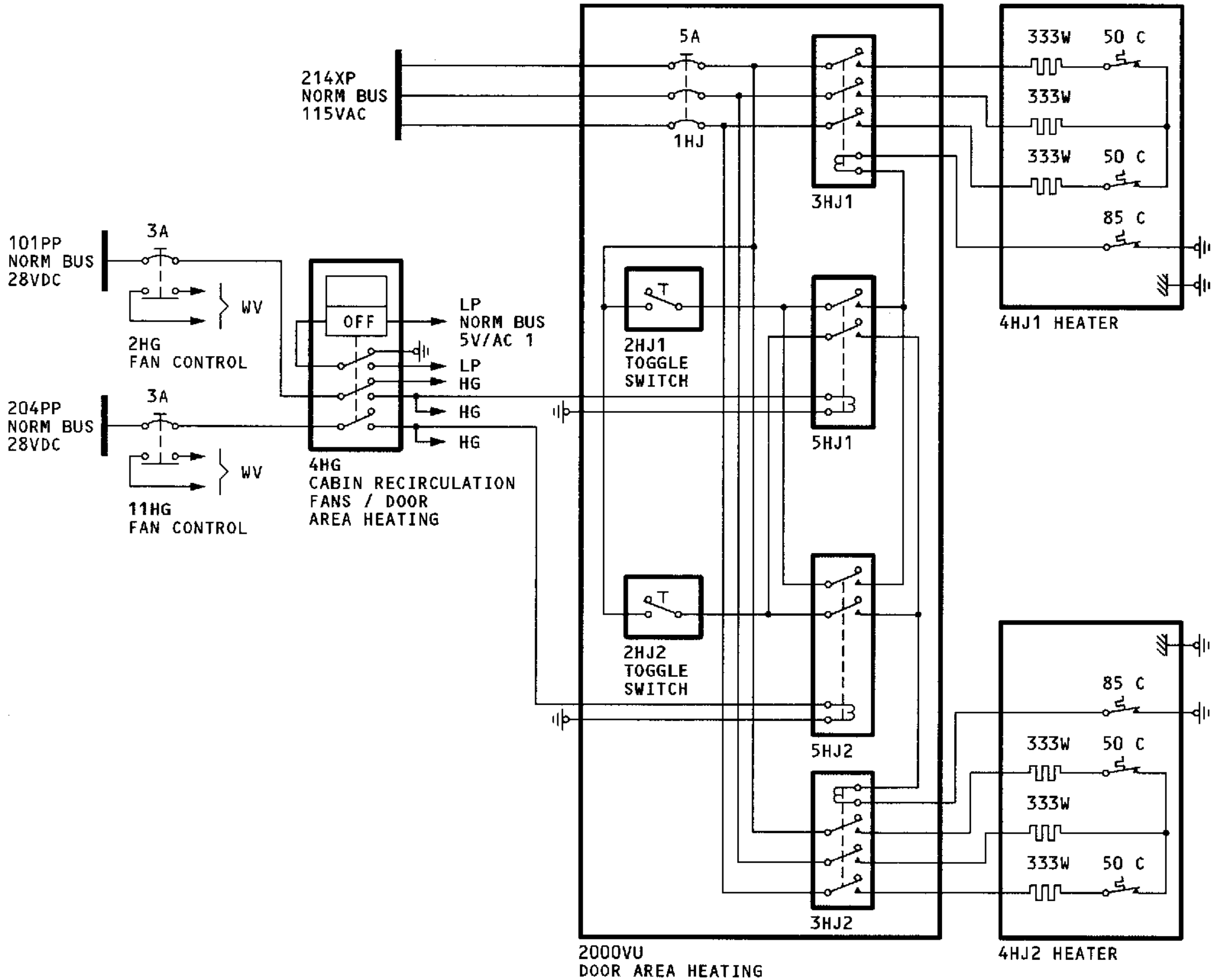


Figure 67 Door Area Heating Control

DOOR AREA HEATING (FLOOR PANEL HEATING SYSTEM SB A320–21–1143)

System /Description

In service experience has shown that the cabin temperature in the area of the FWD passenger/crew door is low. It has been requested to increase the temperature in this area.

This Service Bulletin introduces heated composite floor–panels in the area of the LH and RH FWD passenger/crew doors.

The floor panels are heated by a foil heating element in a GFRP/CFRP honeycomb compound. The floor panels are installed directly onto the floor support structure.

Two control units are installed in the FWD avionics compartment to control the temperature of the floor panels between 42 and 45 degrees Centigrade. The system is supplied by 115V AC and is controlled by 28V DC via the circuit breaker panel 2000VU.

Accomplishment of this Service Bulletin increases the cabin temperature in the area of the FWD passenger/crew doors.

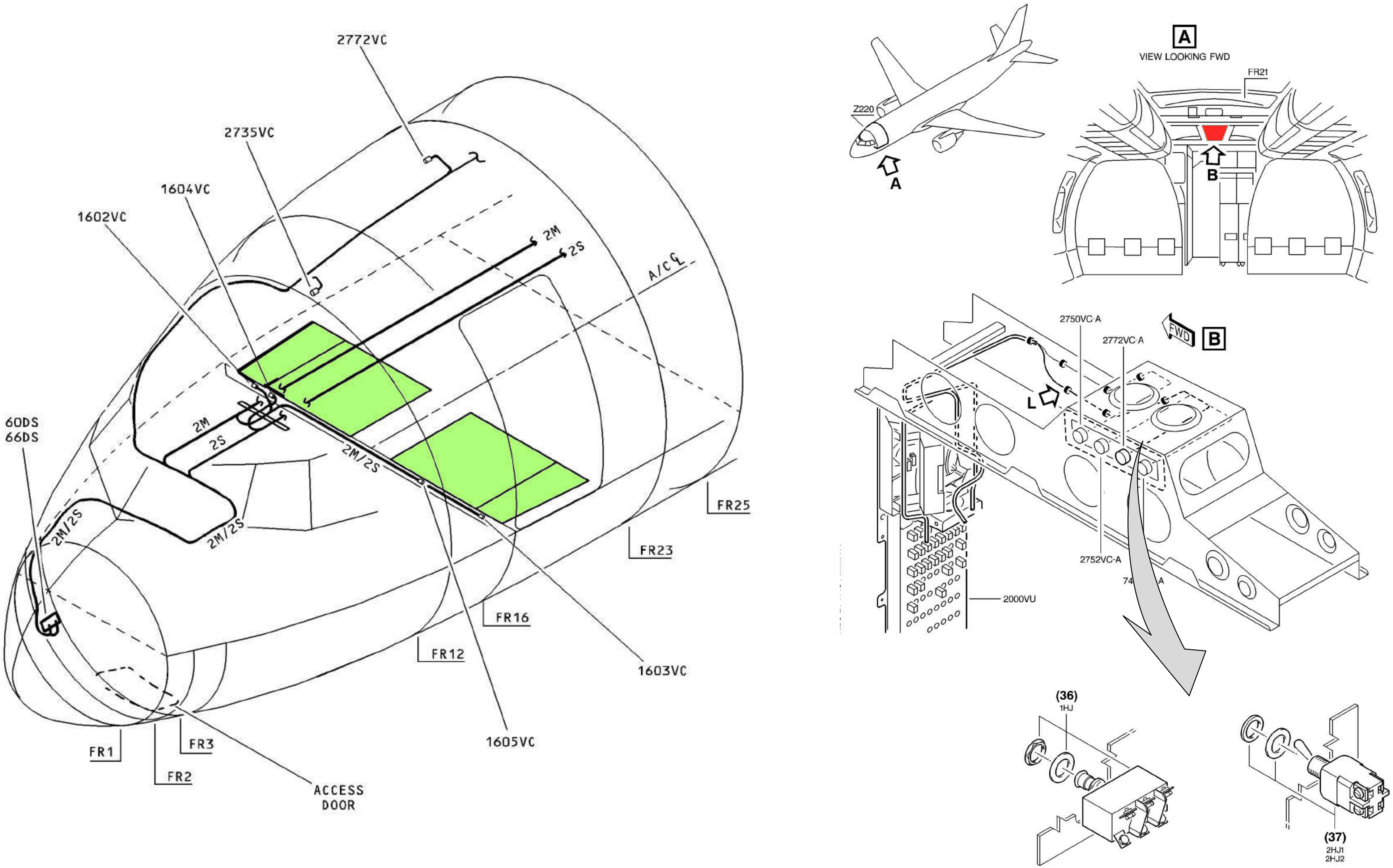


Figure 68 Heated floor panels

21–28 CARGO COMPARTMENT VENTILATION

INTRODUCTION

Purpose

The AFT cargo–compartment ventilation–system supplies air to the AFT cargo compartment. The ventilation air comes from the cabin zones through openings in the cabin floor behind the sidewall panels.

On the ground, conditioned air can be supplied additionally through a ground connector.

AFT Cargo–Compartment Ventilation–System

Suction in the AFT cargo compartment pulls cabin air into the compartment through ducts routed along the lower fuselage interior. The suction is caused when the blower fan 52HN and the extraction fan 35HN are working on the ground and in flight. Three inlets, installed along the compartment lower left–hand sidewall, direct the air towards the compartment floor area.

An isolation valve 34HN is installed in distribution ducts upstream of the compartment inlets. The AFT compartment air is extracted through two outlets near the compartment ceiling on the aft wall. The air goes through the extraction fan 35HN and an isolation valve 33HN and is discharged in the area of the outflow valve 10HL.

An external ground cooling system is installed between frames 49 and 50 forward of the AFT cargo door. Ground supplied air goes through a LP ground connector, a check valve 4028HM and an isolation valve 50HN to an outlet in the wall near the ceiling.

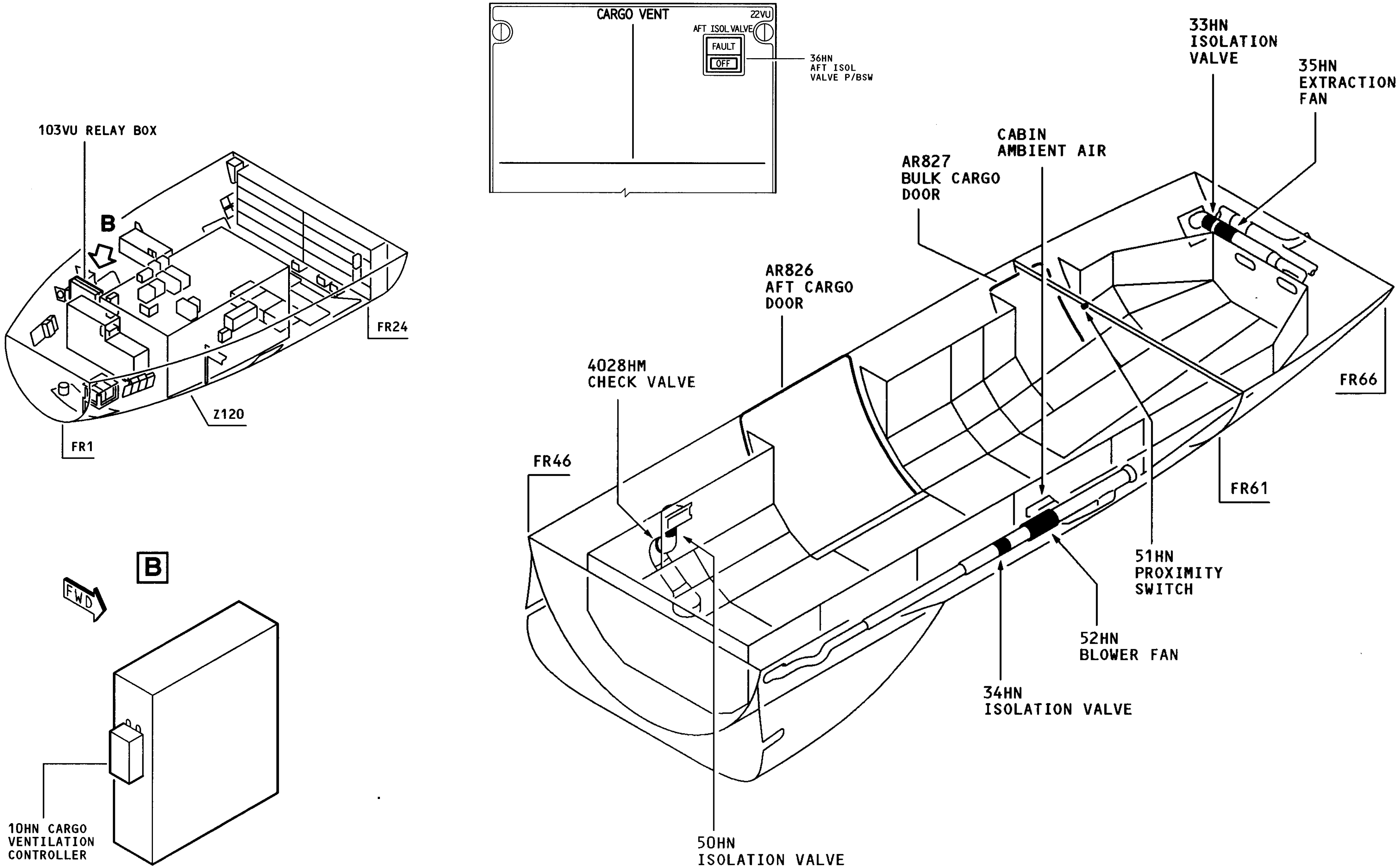


Figure 69 Cargo Compartment Ventilation System

CARGO COMPT. VENT. COMPONENTS DESCRIPTION

Blower and Extraction Fan

AFT cargo blower fan 52HN is installed in the inlet duct downstream of the isolation valve 34HN and the extraction fan 35HN is installed in the extraction duct downstream of the isolation valve 33HN. They are powered by a three−phase four−pole induction motor that drives a fan−wheel. These fans run continuously when the aircraft is on the ground or in flight. Thermo switches are installed inside the motor stators of the extraction fan. If the temperature of the stators gets to 140 °C (254 °F), the thermo switches isolate the electrical supply to the fan.

The AFT cargo blower fan 52HN and the extraction fan 35HN are secured with clamps to brackets on the aircraft structure. Arrows on the fans casing show the direction of airflow through the fans and the direction that the fan−wheel rotates. If the impeller breaks the casing is strong enough to contain the debris.

Isolation Valve (3)

The isolation valves 33HN, 34HN and 50HN are electrically operated butterfly valves. Each consists of a body assembly and an actuator housing which are bolted together and internally connected. The actuator housing contains a gear−train, two microswitches, a 28V DC motor and an electrical connector. The 28V DC motor drives the gear−train, which turns a shaft to which the butterfly valve is attached. Two microswitches signal the fully open/fully closed position of the isolation valves 33HN, 34HN and 50HN to the cargo ventilation controller 10HN. Accidental blockage of either isolation valve will cause a torque limit mechanism to disengage the gear−train. This protects the gear−train and butterfly valve from damage. A manual override and visual position indicator is connected to the end of the shaft at the top of the actuator.

Cargo Ventilation Controller

The cargo ventilation controller 10HN is a modular construction and consists of:

- a chassis and a common power supply module,
- a FWD and AFT cargo ventilation module,
- a FWD and AFT cargo power relay,
- a spare module connector,
- a spare power relay socket.

These modules are enclosed in a metal case. They are installed on the outboard side of relay box 103VU, in the avionics compartment. The cargo ventilation controller 10HN controls and monitors the aft cargo isolation−valves 33HN and 34HN, the aft cargo blower−fan 52HN and the AFT cargo extraction fan 35HN. The cargo ventilation controller sends a signal to ECAM and CFDS if there is a fault in the isolation valves or the fans.

The cargo ventilation controller 10HN only controls the cargo isolation valve 50HN. A fault message for this valve will not be generated.

Check Valve

The check valve 4028HM is installed, in line with the ground cooling inlet duct, between the low pressure ground connector and the isolation valve 50HN. The valve consists of a valve body, two semicircular flaps installed on a hinge bar and a spring which holds the flaps in the closed position. Airflow from an external source will lift the flaps from their seats and permit air to flow through the valve. Airflow in the opposite direction will push the flaps back onto their seats and stop the airflow. An arrow on the valve body shows the direction of unrestricted airflow through the valve.

Proximity Switch

The proximity switch 51HN consists of a sensor which is installed on the cargo compartment ceiling, above the BULK cargo door, and a target which is installed, in a corresponding position, on the BULK cargo door. When the target is within the detection range of the sensor (door fully open) the sensor sends a signal to the cargo ventilation controller 10HN which allows the isolation valve 50HN to open. When the target moves out of the detection range, the signal to the controller 10HN is cancelled which commands the isolation valve 50HN to the closed position. The sensor has two independent outputs which are commonly controlled. If one output fails, the other one continues to operate.

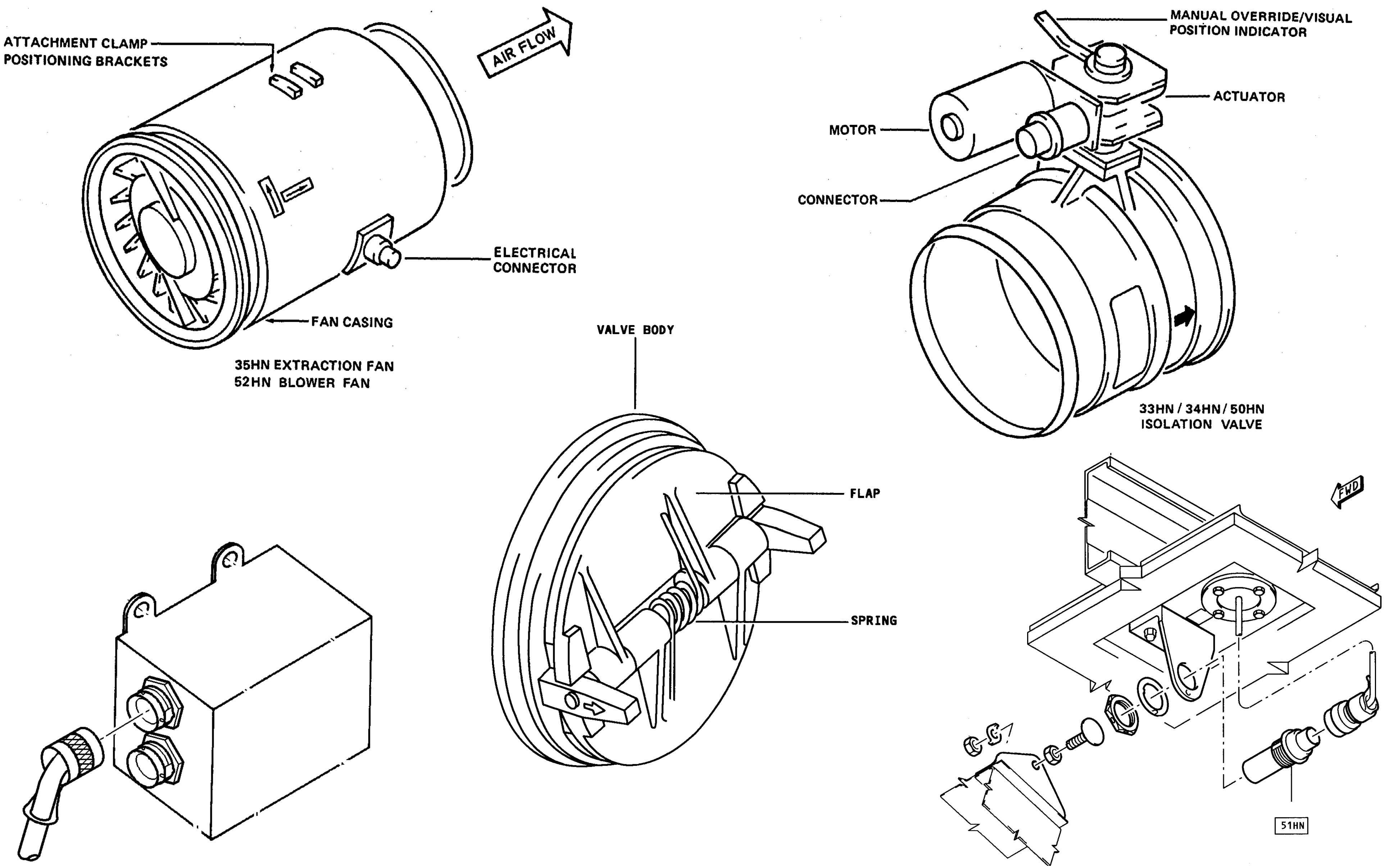


Figure 70 Cargo Compartment Ventilation and Cooling Components

CARGO COMPARTMENT VENTILATION OPERATION

Operation

The ventilation system for the AFT cargo compartment operates in the same mode on the ground or in flight. The cargo ventilation controller 10HN opens the isolation valves 33HN and 34HN. It receives a fully open signal from both valves and starts the blower fan 52HN and the extraction fan 35HN.

The controller will close the isolation valves, and stop the two fans when:

- the smoke detection control unit 10WQ detects smoke in the AFT cargo compartment (Ref. 26−16−00),
- the isolation valve switch 36HN is selected OFF.

The ground cooling for the AFT cargo compartment is controlled by a proximity switch operated by the BULK cargo door. When the BULK cargo door is fully open, the isolation valve 50HN opens and the ground air source is connected to the LP connector in the belly fairing between frames 49 and 50 (this ground air source must be stopped before you close the BULK cargo door).

Control and Indication

The AFT ISOL VALVE switch 36HN is installed on panel 22VU in the cockpit overhead panel. It controls the isolation valves 33HN and 34HN, the blower fan 52HN and the extraction fan 35HN.

The cargo ventilation controller 10HN will only start the fans if a fully open signal is received from both isolation valves. With the isolation valve switch 36HN pressed in, the isolation valves 33HN and 34HN open fully and the blower fan 52HN and the extraction fan 35HN start. With the isolation valve switch pressed out, OFF light comes on white, the isolation valves close and the two fans stop. The FAULT light comes on amber if either isolation valve is not fully open or fully closed.

If there is a extraction fan fault, the ventilation controller gives a signal to the zone controller 8HK. The zone controller generates a failure message for the Centralized Fault−Display System (CFDS).

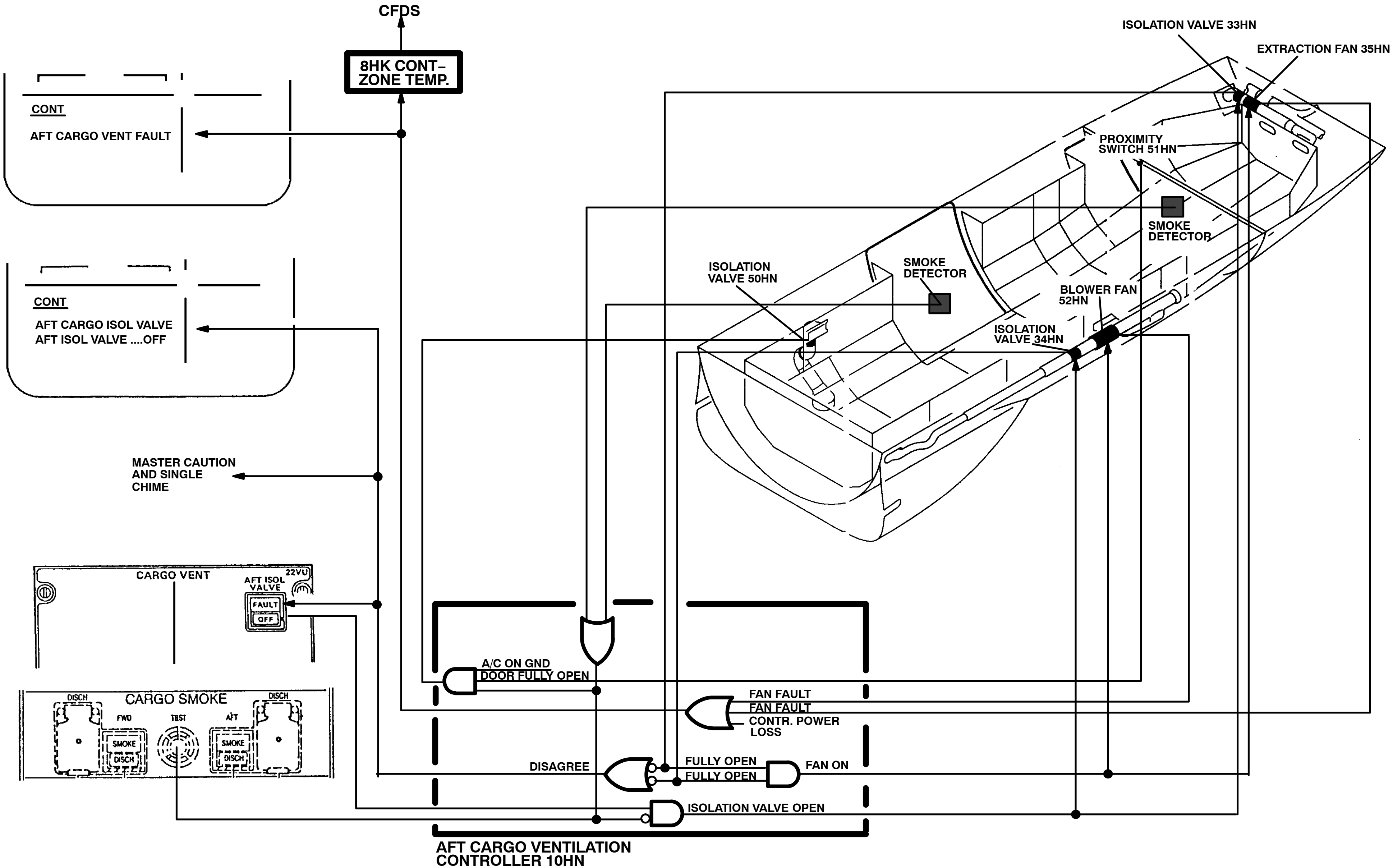


Figure 71 Cargo Compartment Ventilation Operation Logic

21−26 AVIONICS EQUIPMENT VENTILATION

PRESENTATION

The avionics ventilation system operates in different configurations. These configurations are dependent on ambient temperature, whether the aircraft is on the ground or in flight. The avionics equipment is also cooled in different ways, these are not dependent on the ventilation system configurations.

Rack Equipment

Equipment installed in the racks is cooled with air blown into the base of the racks through a sealed inlet. This air then flows through the equipment to the top of the racks and is then removed through an unsealed outlet. Other equipment installed on the racks is cooled with air blown into the base and then out at the top.

Cathode Ray Tubes (CRTs)

The CRTs located on the pilot's panel are cooled with air blown through a sealed inlet /outlet on the panel.

Pedestal Instruments

The pedestal instruments are cooled with air blown through the instruments on the upper panel and around the instruments on the lower panel. The air then goes into the avionics compartment through vents in the cockpit floor.

Cockpit Panels

The overhead circuit breaker and power panels are cooled with cockpit air. This is drawn around the back of the panels and into the avionics ventilation system.

Transformer Rectifiers

The transformer rectifiers are cooled with avionics compartment air. This air is drawn through the equipment into the avionics ventilation system.

Window Controllers

The window controllers are cooled with air blown through the equipment into the avionics compartment.

Radar

The radar is cooled by air blown into the equipment through a sealed inlet and blown out through an unsealed outlet.

Batteries (Independent Circuit)

The batteries are cooled with avionics compartment air drawn through an inlet, around the batteries and overboard through a venturi. The ventilation airflow only takes place during flight because of the cabin differential pressure.

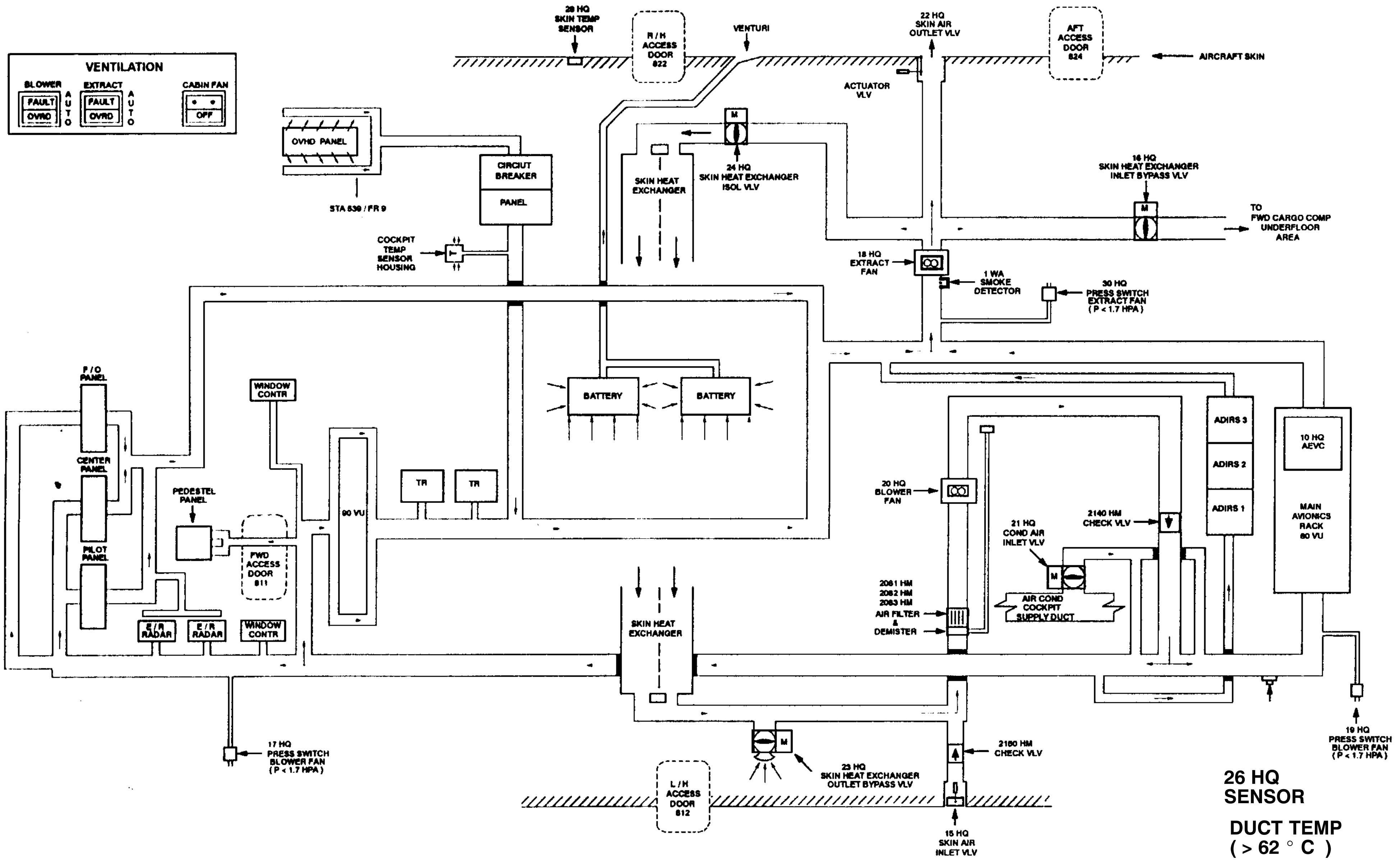
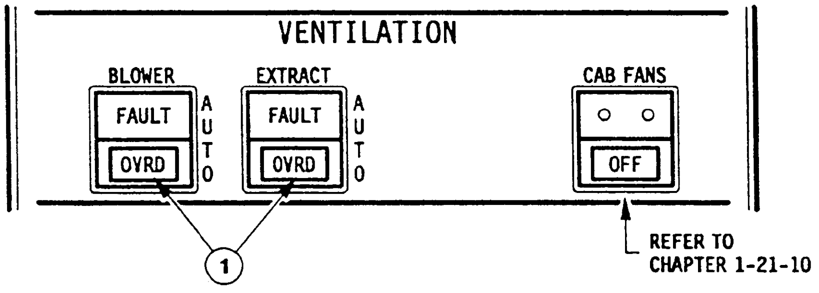


Figure 72 Avionics Equipment Ventilation Schematic

AEVC CONTROL-WARNINGS AND CAUTIONS

OVERHEAD PANEL



(1) BLOWER pb sw and EXTRACT pb sw

AUTO : *When both pb switches are at AUTO*
. On ground before TO power application : the ventilation system is in open circuit configuration (closed configuration when skin temperature below ground threshold)
. On ground after TO power application, or in flight : the ventilation system is in closed circuit configuration.

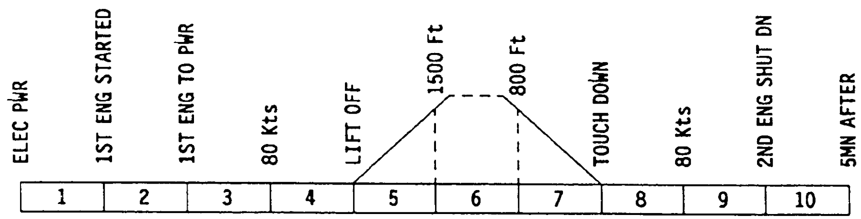
OVRD : *When either pb switch is at OVRD :*
. The system goes to closed circuit configuration
. Air from air conditioning system is added to ventilation air (The blower fan stops if BLOWER pb sw set at OVRD position).

When both pb switches are at OVRD :
. Air is provided from the air conditioning system and then extracted overboard.
Extract fan remains energized.

FAULT lt : Comes on amber accompanied by ECAM activation in case of :
BLOWER FAULT lt : – Blowing pressure low *
– Duct overheat *
– Computer power supply failure
– Smoke warning
EXTRACT FAULT lt : – Extract pressure low *
– Computer power supply failure
– Smoke warning

* If the warning occurs on ground, engines stopped, the external horn is triggered.

WARNINGS AND CAUTIONS

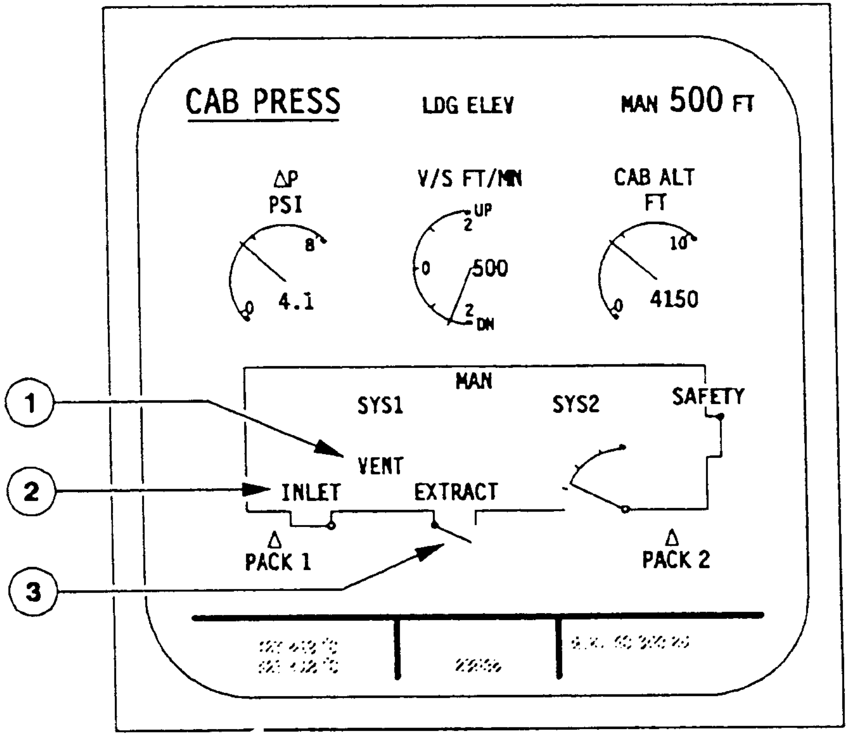


E / WD : FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
BLOWER FAULT Blowing pressure low or duct overheat				BLOWER* FAULT lt	3, 4, 5, 7, 8
EXTRACT FAULT Extract pressure low				EXTRACT* FAULT lt	
SKIN VALVE FAULT 1) Extract valve fully open in phase 3 or 2) Extract valve fully open in flight or 3) Inlet valve not fully closed in flight	SINGLE CHIME	MASTER CAUT	CAB PRESS	NIL	4, 5, 7, 8
AVNCS SYS FAULT Power up test not satisfactory or AEVC not supplied or valves position disagree				BLOWER and EXTRACT FAULT Lts**	3, 4, 5 6, 7, 8 9

* Associated with ground external call.
** Only in case of AEVC power supply failure on ground.

Figure 73 AEVC Panel Description and ECAM Warnings

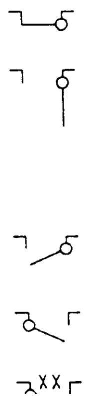
ECAM CAB PRESS PAGE



(1) VENT indication
Normally white. Becomes amber in case of BLOWER FAULT or EXTRACT FAULT or AVNCS SYS FAULT

(2) INLET and EXTRACT indications
Normally white. Corresponding indication becomes amber in case of BLOWER FAULT or EXTRACT FAULT

(3) INLET and EXTRACT valves position



Valve fully closed
Normally green – Amber in case of disagreement

Valve fully open
Normally green – Amber in case of disagreement

Note : On ground due to the accuracy of the temp sensors, the indication closed or open may become amber when the temperature is close to the valves opening or closing threshold.

Valve in transit (for inlet valve only). Amber.

Valve partially open (for extract valve only) : extract valve closed with small internal flap open.
Normally green – Amber in case of disagreement

Valve failed in transit. Amber.

Figure 74 AEVC-ECAM Display

AVIONICS EQUIPMENT VENTILATION PRESENTATION

The avionics equipment is cooled with air supplied in different ways. These are an open circuit, a closed circuit, a partially open circuit and cockpit supply air (in failure cases) as listed hereafter:

AEVC System Schedule

System Schedule depends on certain configurations:

- skin temperatures,
- aircraft air−ground position,
- eng power settings.

CONFIGURATION	GROUND			FLIGHT		GROUND	EXTRACT OVRD POSITION	BLOWER OVRD POS.	DITCHING POSITION	EXTRACT AND BLOWER OVRD POSITION	
SKIN TEMPERATURE (°C)	ABOVE +11	BELOW +4	BELOW +27		ABOVE +34					CONTROLLER	
TLA	BELOW T/O		ABOVE T/O	INDIFFERENT		ABOVE T/O				ON (SMOKE)	OFF
SKIN EXCHANGER INLET BY PASS VALVE	C	O			O		(1) C	C	X	(1) C	(1) C
SKIN AIR OUTLET VALVE	O	C			PO		C	C	(1) C	(1) PO	(1) PO
SKIN AIR INLET VALVE	O	C			C		C	C	C	C	X
SKIN EXCHANGER ISOL VALVE	C	O			O		O	O	O	C	X
SKIN EXCHANGER OUTLET BY PASS VALVE	C	O			O		C	C	X	C	X
COND AIR INLET VALVE	C	C			C		O	(1) O	X	(1) O	(1) O
BLOWER FAN	ON	ON			ON		ON	OFF	ON	OFF	OFF
EXTRACT FAN	ON	ON			ON		(2) ON	ON	ON	(2) ON	(1) ON

ON : CONTROL ON

OFF : CONTROL OFF

X : CONTROL OFF-LAST POSITION

C : CONTROL FOR CLOSING

O : CONTROL FOR OPENING

PO : CONTROL FOR PARTIAL OPENING

(1) : CONTROL BY EXTERNAL CIRCUIT

(2) : CONTROL BY EXTERNAL CIRCUIT AND AEVC

Note:
Schedule may be modified on ground depending on hardware configuration (see Closed Circuit)

Figure 75 AEVC System Schedule

OPEN/CLOSED CIRCUIT CONFIGURATION LAYOUT

Open Circuit Configuration

The avionics equipment is cooled with ambient air under certain conditions. These conditions are that the aircraft is on the ground and the ambient temperature is above +11 deg. C (+51.80 deg. F). Ambient air, drawn through a skin air inlet valve 15HQ is blown through a check valve 2150HM and filter assembly 2081HM, 2082HM, 2083HM.

The air drawn by blower fan 20HQ is blown through a check valve 2140HM into the system. The air, after cooling the equipment, is drawn with an extract fan 18HQ directly overboard through an skin air outlet valve 22HQ. The skin heat exchanger is by-passed because the skin exchanger isolation valve 24HQ is closed.

GROUND OPERATION: Skin Temperature >11° C

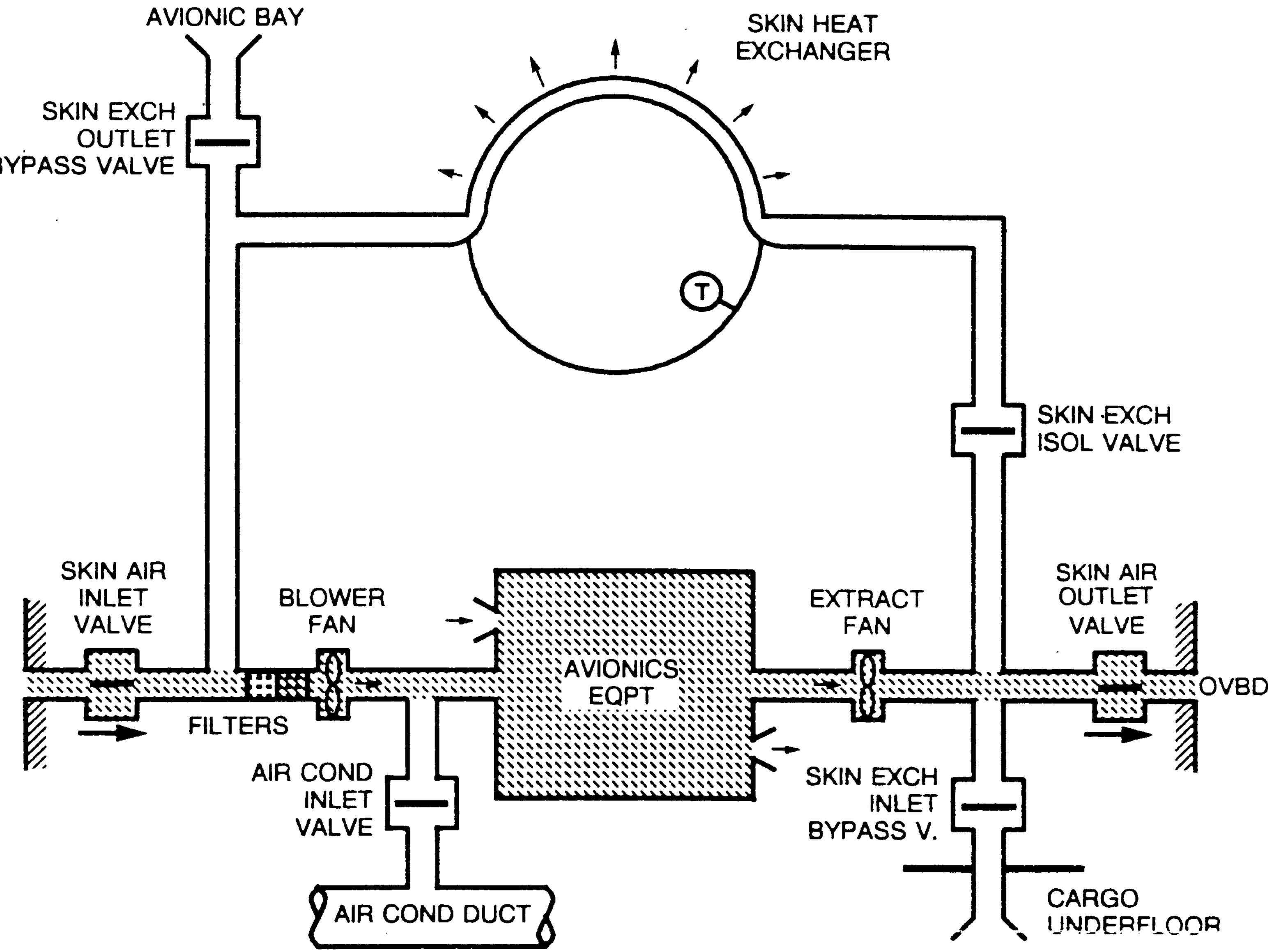


Figure 76 Open Circuit Configuration

Closed Circuit Configuration

Normally the avionics equipment is cooled with air in a closed circuit.

The conditions are that the aircraft is on the ground and skin temperature below +4 deg. C (+39.20 deg. F) or in flight below +27 deg. C (+80.60 deg. F). In these conditions, the skin air inlet valve 15HQ and the skin air outlet valve 22HQ close. The skin exchanger outlet by−pass valve 23HQ opens.

In addition, the skin exchanger isolation valve 24HQ opens to bring the skin heat exchanger into full use. Three pressure switches 17HQ (19HQ, 30HQ) at different places in the system, signal the avionics computer 10HQ when an increased pressure/airflow is detected. When this signal is received, the skin exchanger inlet bypass valve 16HQ opens and air flows into the forward underfloor area. The skin exchanger inlet bypass valve 16HQ opens depending on system pressure.

NOTE:	FLIGHT OPERATION:	Skin Temperature < 27° C or
	GROUND OPERATION:	Skin Temperature < 4° C

Hardware Modification (New Temperature Switch 34HQ)

On modified aircraft an additional temperature switch will be installed downstream of the avionic rack 80VU and a new AEVC logic introduced.

This logic keeps the AVS in close loop (circuit) configuration on ground as long as downstream cooling air temperatures are below 40 deg C in order to avoid condensation in the system.

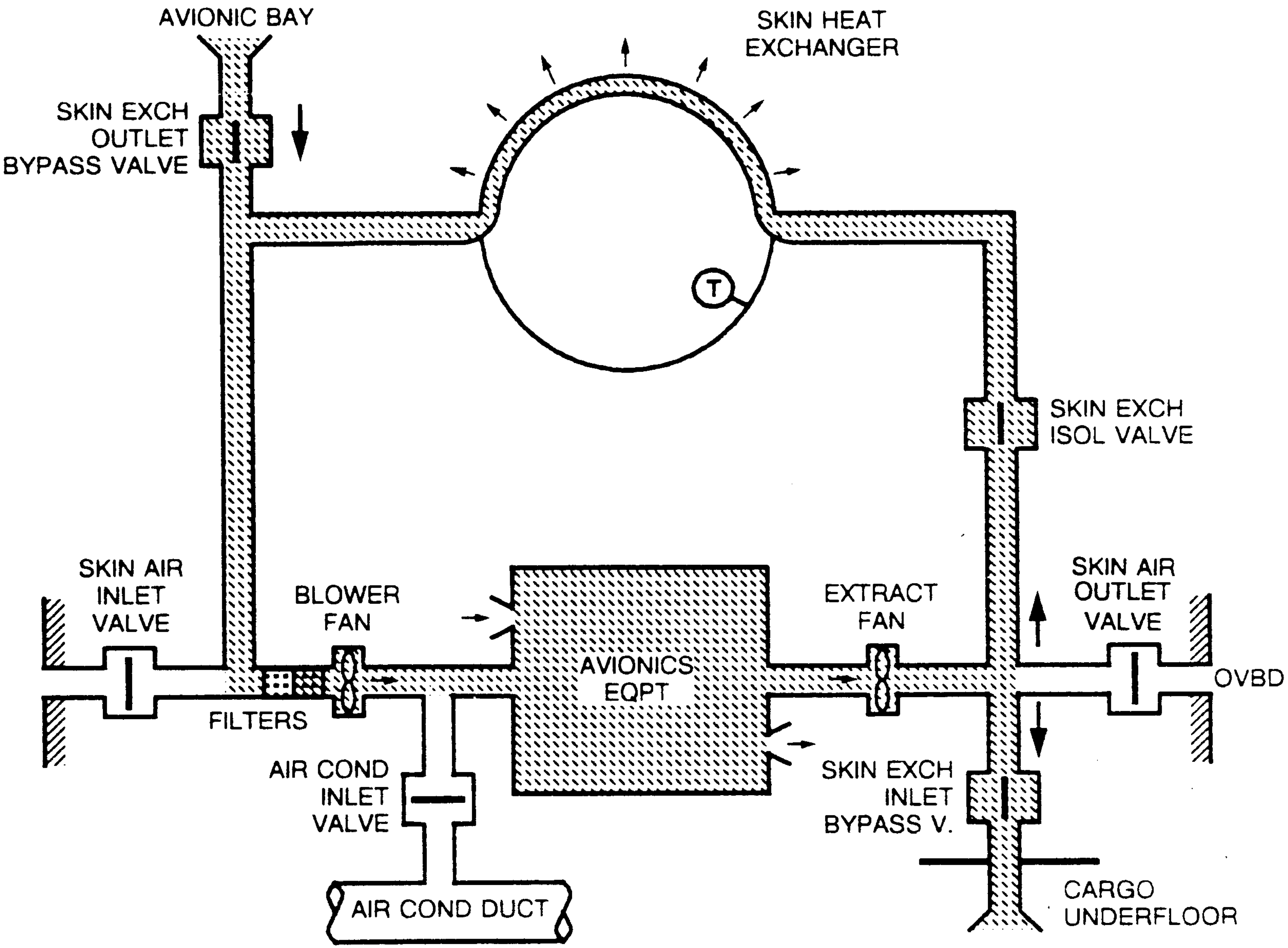


Figure 77 Closed Circuit Configuration

PARTIALLY OPEN CONFIGURATION FUNCTION

Partially Open Circuit

The avionics equipment is cooled with air in a partially open circuit under certain conditions. These conditions are that the aircraft is in flight and the skin temperature is above +34 deg. C (+93.20 deg. F).

When the avionics computer 10HQ receives an above +34 deg. C (+93.20 deg. F) signal from the skin temperature sensor 28HQ, the following happens:

- skin exchanger outlet bypass valve 23HQ opens,
- skin air outlet valve 22HQ partially opens,
- skin exchanger inlet bypass valve 16HQ opens.

The avionics is now cooled with system air and avionics compartment air coming into the system through the skin exchanger outlet bypass valve 23HQ.

The air after cooling the equipment is directed overboard through the skin air outlet valve 22HQ and to the forward underfloor area through the skin exchanger inlet bypass valve 16HQ. When the ambient temperature drops below +27 deg. C (+80.60 deg. F), the system goes back to a closed circuit configuration.

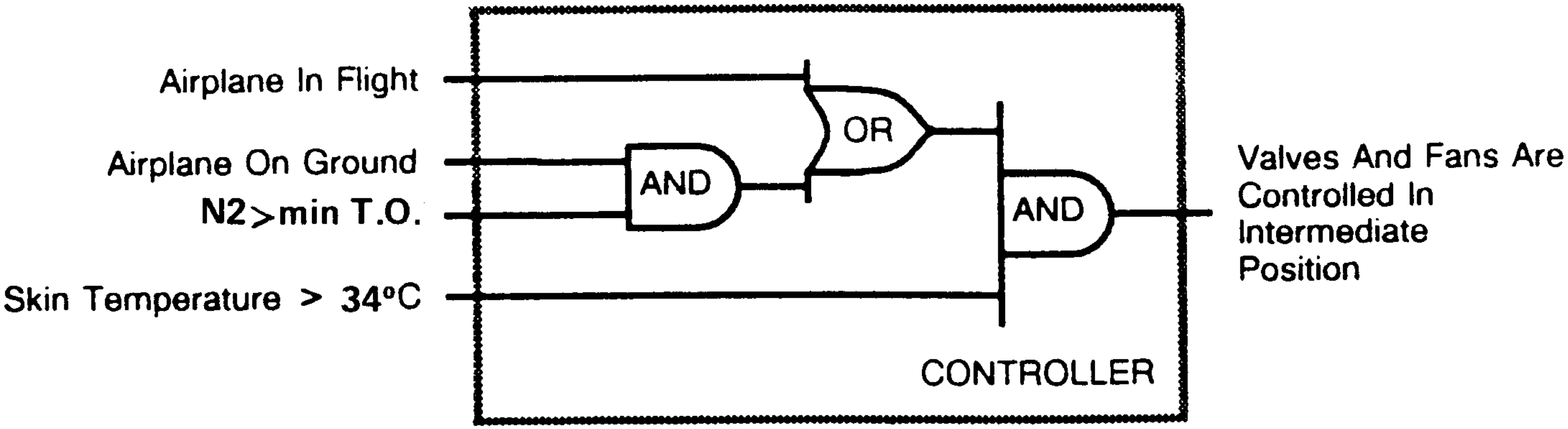


Figure 78 **Flight Operation: Skin Temperature >34 deg. C**

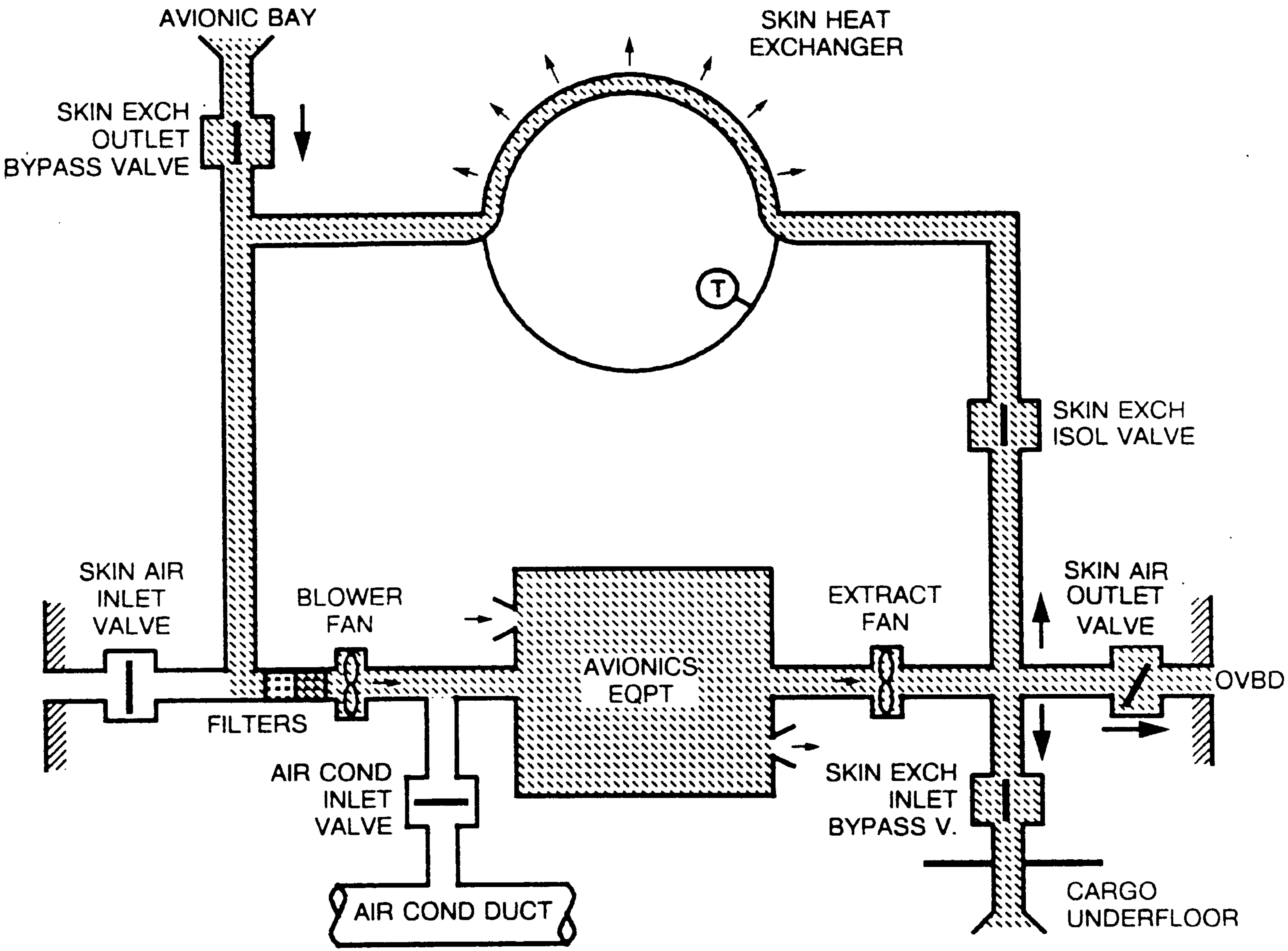


Figure 79 Partially Open Configuration

ABNORMAL FUNCTION (BLOWER OR EXTRACT FAULT)

Cockpit Supply Air

The avionics equipment is cooled with air tapped from the cockpit supply duct when one of the following failure cases happens:

1. Extraction Low Flow

The avionics computer 10HQ illuminates FAULT on the extract pushbutton switch 14HQ if the pressure switch 30HQ detects low flow. When this happens, OVRD on the pushbutton switch must be selected. This causes the conditioned air inlet valve 21HQ and skin exchanger isolation valve 24HQ to open. All other valves close.

2. Blower Low Flow/High Duct Temperature

The avionics computer 10HQ illuminates FAULT on the blower pushbutton switch 13HQ when one or both of the following happens:

- if the pressure switches 17HQ (19HQ) detect low flow,
- if the temperature sensor 26HQ senses high duct temperature.

When this happens, OVRD on the pushbutton switch must be selected.

This causes the blower fan 20HQ to stop, opens the conditioned air inlet valve 21HQ and opens the skin exchanger isolation valve 24HQ. All other valves close.

BLOWER FAULT or EXTRACT FAULT Warning

When the BLOWER pb–sw is set at OVRD position, or when the EXTRACT PBS/W is set at OVRD position.

The system is in closed circuit configuration and air from air conditioning system is added to the ventilation air.

Moreover with BLOWER PBS/W at OVRD position the blower fan is stopped, the extract fan remains energized.

With EXTRACT PBS/W at OVRD position the extract tan is controlled directly from the pb–sw. Both fans remain energized.

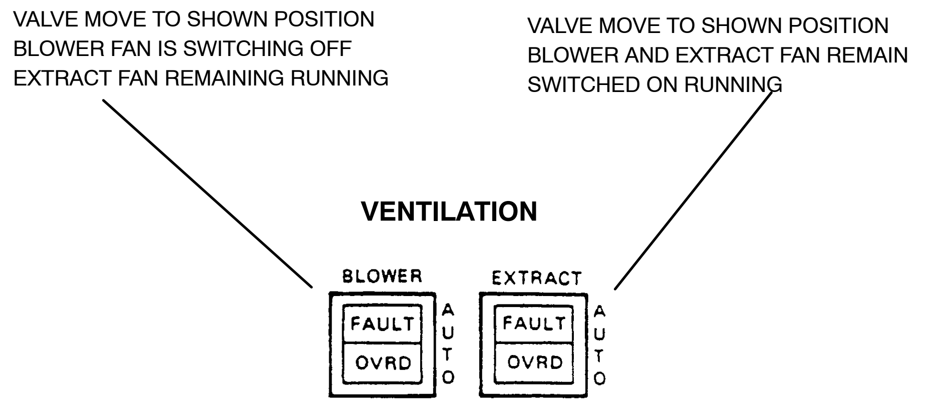


Figure 80 Blower Switches in Abnormal Configuration

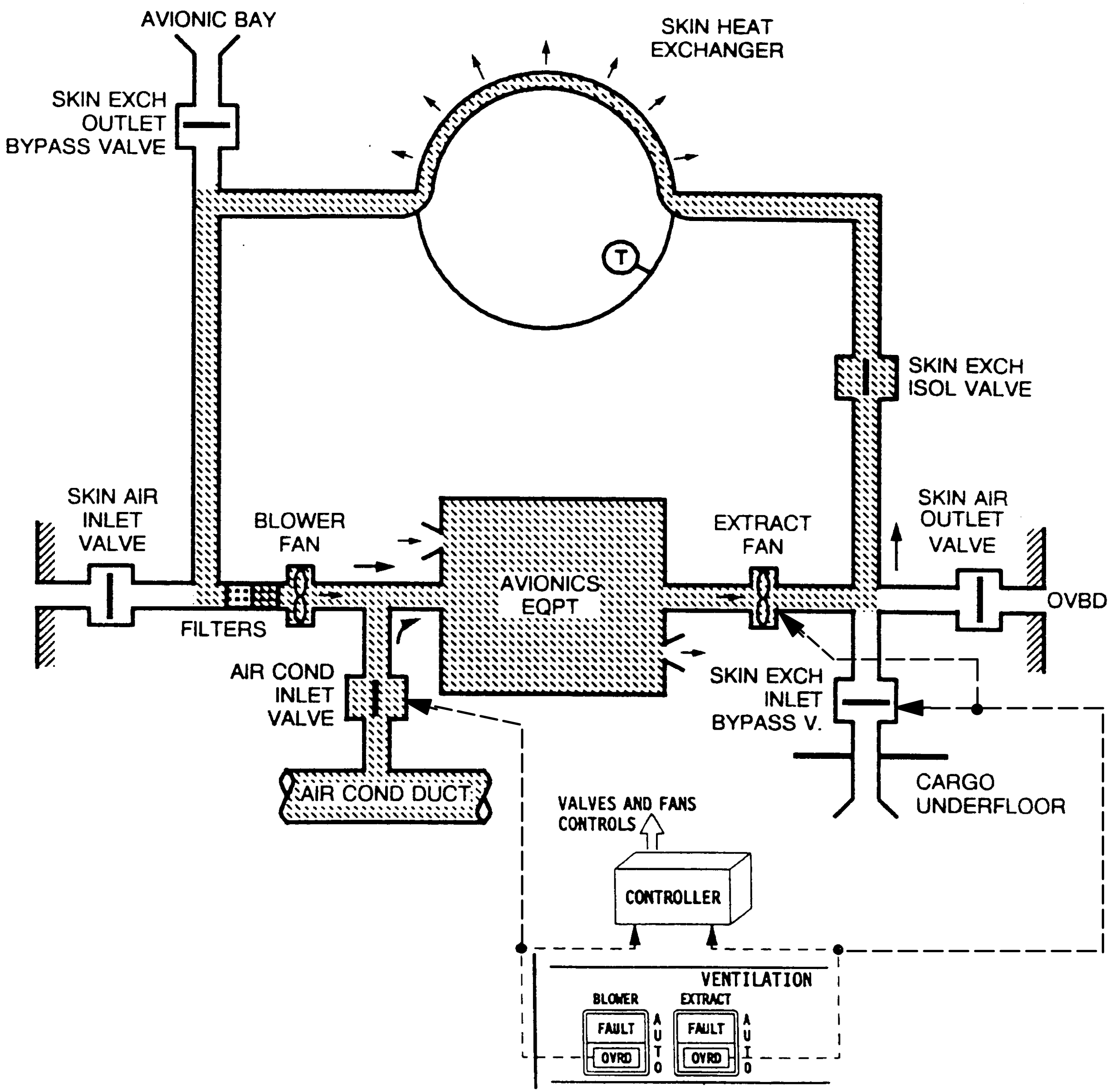


Figure 81 Blower Fault or Extract Fault

SMOKE DRILL CONFIGURATION

3. Smoke (Ref. 26−00−00)

If the smoke detector 1WA detects smoke, it triggers illumination of:

- the SMOKE legend of the GEN 1 LINE pushbutton switch on the panel 21VU
- the FAULT legends of the BLOWER and EXTRACT pushbutton switches on the panel 22VU.

When this happens, OVRD on the blower pushbutton switch 13HQ and on the extract pushbutton switch 14HQ must be selected. This causes the blower fan 20HQ to stop, opens the conditioned air inlet valve 21HQ and partially opens the skin air outlet valve 22HQ. All other valves close and the air is directed overboard through the skin air outlet valve 22HQ.

4. Computer Power Off

If the avionics computer 10HQ stops operating, FAULT on extract pushbutton 14HQ and blower pushbutton 13HQ illuminates amber. When this happens, OVRD on both pushbuttons must be selected.

This causes the blower fan 20HQ to stop, opens the conditioned air inlet valve 21HQ and partially opens the skin air outlet valve 22HQ. All other valves stay at their last controlled position.

Abnormal Operation Smoke Drill

- Both BLOWER and EXTRACT FAULT lights on.
- Both BLOWER and EXTRACT pb−sw set at OVRD position.
- Cooling air is provided by air conditioning system, and extracted overboard. Blower fan stops.

Controller Failure

Same configuration as above.

The following valves:

- Inlet Valve
- Skin Exchange Inlet Bypass Valve
- Skin Exchange Isolation Valve

remain in the position they were in before failure. Moreover the extract tan runs.

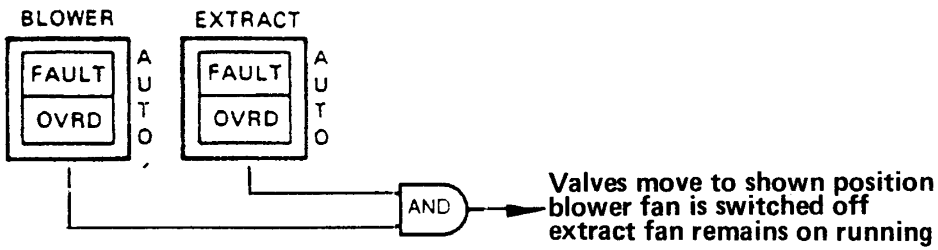


Figure 82 Blower Logic (Smoke Drill)

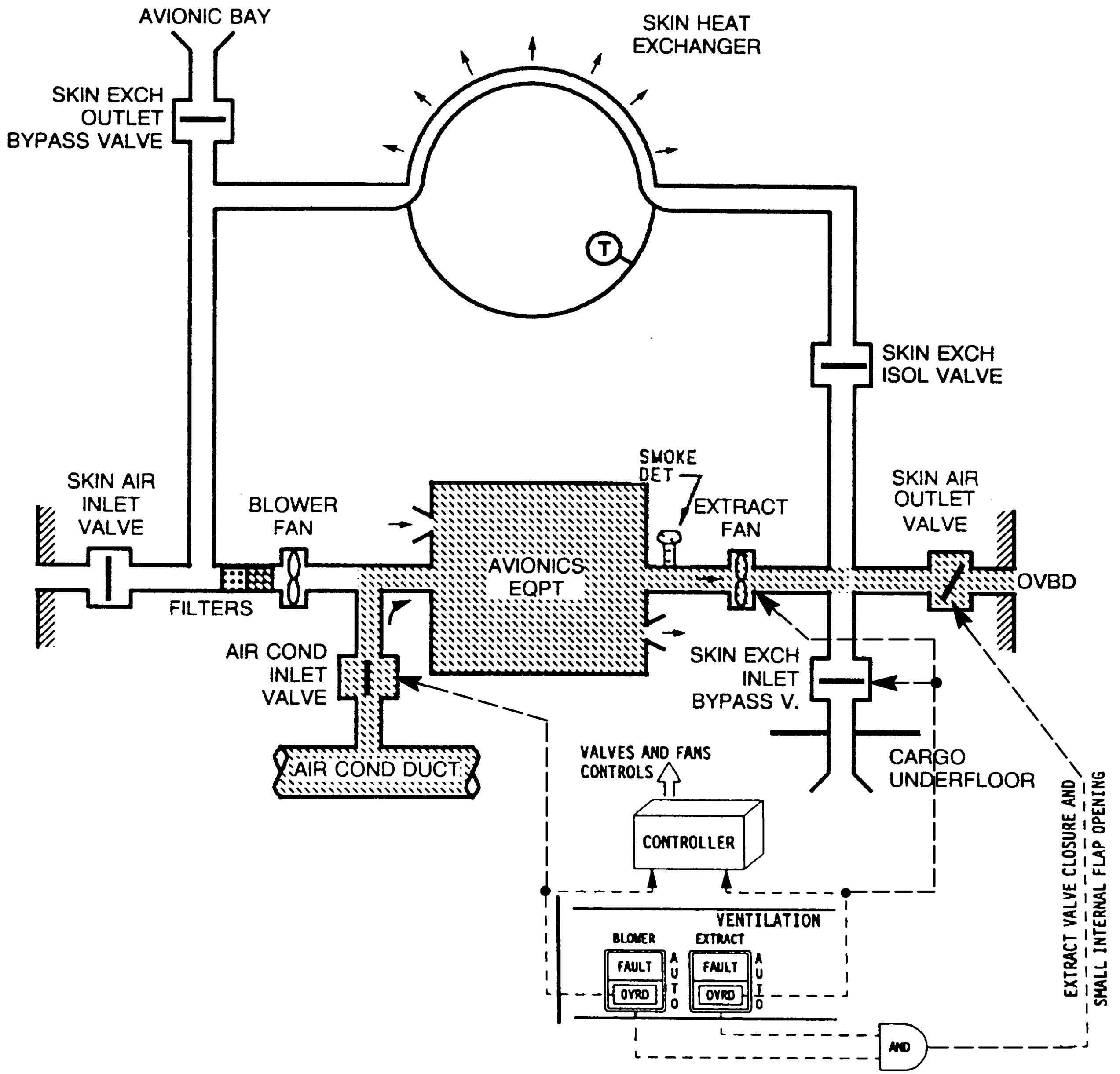


Figure 83 Smoke Drill Configuration

AVIO EQUIPMENT VENT. COMPONENT DESCRIPTIONS

1 Avionic Equipment Ventilation Computer

The avionics computer 10HQ is a 2MCU (Ref. ARINC 600) electronic assembly mounted on a chassis encased with a metal cover. The avionics computer is located on shelf 88VU in the main avionics rack 80VU. The avionics computer controls the valves and fans in the avionics ventilation system.

System condition information is sent to the avionics computer by pressure switches and temperature sensors in the system. The pressure controller and landing gear control interface unit send additional information to the avionics computer.

This information depends on the signal, Thrust Lever Angle (TLA) in take off position and Landing gear position. The avionics computer does a power−up test when electrical power is supplied, and continuously monitors system components.

2 Blower Fan

The avionics blower fan 20HQ is powered with a three phase, four−pole single induction motor. The motor drives a fan−wheel which has high efficiency blades and will operate continuously at about 11600 rpm.

A thermo switch and relay are installed on the stator of the avionics blower fan. If the temperature of the stator gets to +140 +6 −6 deg. C (+284.00 +10.80 −10.80 deg. F), the thermo switch isolates the electrical supply to the fan.

A fault indication light and reset button are installed on the fan body.

The avionics blower fan is secured with clamps to brackets on the aircraft structure in the avionics compartment. Arrows on the fan casing show the direction of airflow through the fan and direction that the impellor rotates, if the impellor breaks the casing is strong enough to contain debris.

3 Extract Fan

The extraction fan 18HQ is identical to the blower fan 20HQ.

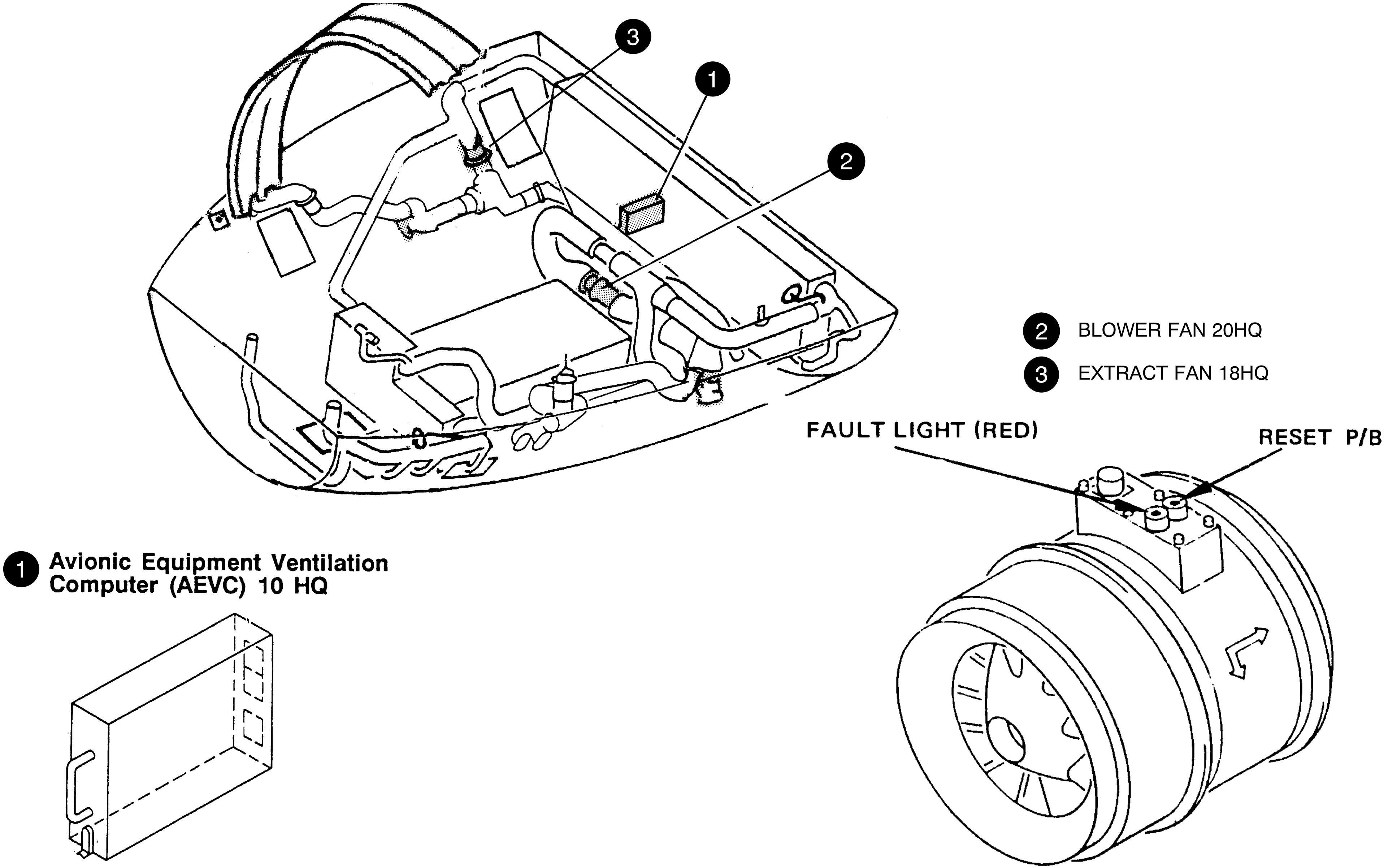


Figure 84 AEVC Computer and Blower/Extract Fan

4 Skin Heat Exchanger

A skin heat exchanger is located in the upper fuselage between frames 12 and 14 and, in normal flight operations is used to cool the avionics ventilation air.

A thermally insulated internal wall is bolted to these frames to form two rectangular ducts. This internal wall is easily removed for structural inspection.

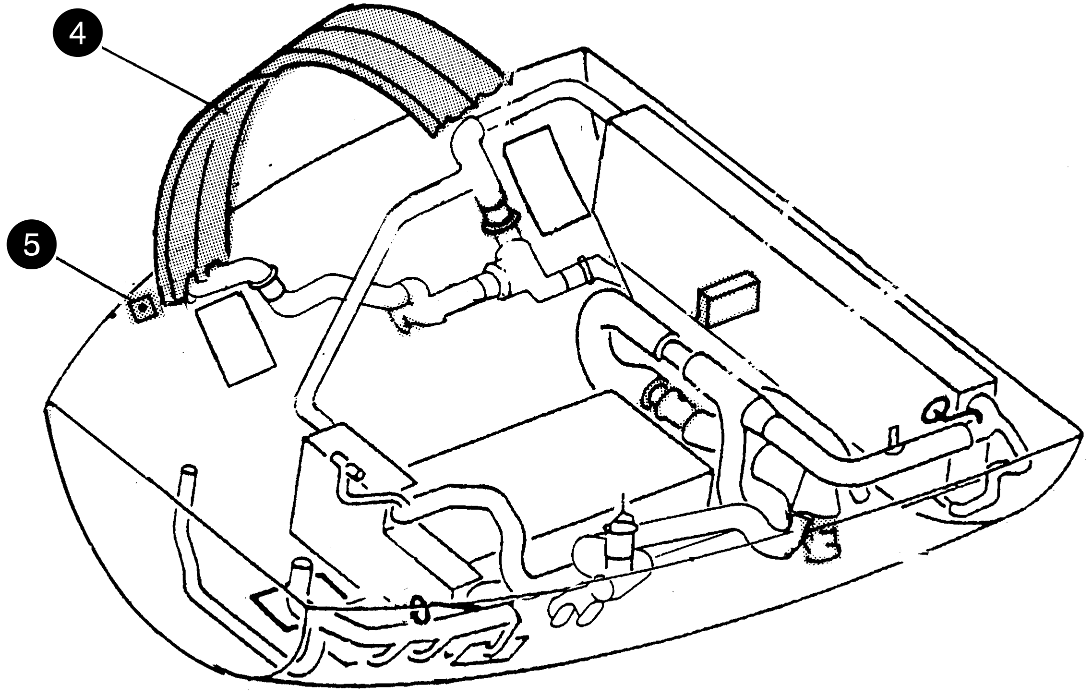
A drainage system is included to deal with any condensation when the heat exchanger is in operation.

5 Skin Temperature Sensor 28 HQ

A skin temperature sensor 28HQ is installed on the inside of the fuselage skin. It consists of a sensor element through which an electrical current passes to measure the potential difference proportional to the temperature.

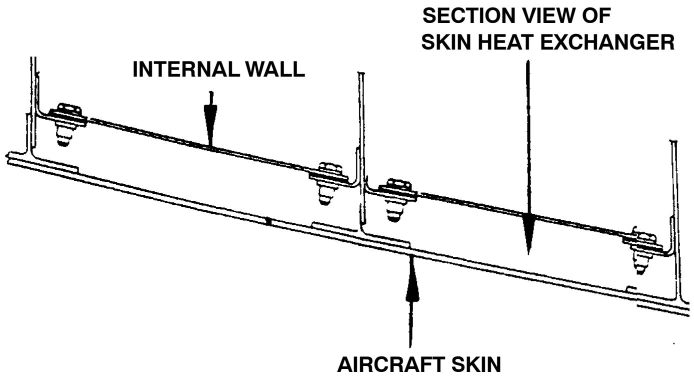
The set temperature values are as follows:

- on ground, increasing values +11 deg. C (+44.60 deg. F), decreasing values +4 deg. C (+39.20 deg. F)
- after takeoff, increasing values +34 deg. C (+96.80 deg. F), decreasing values +27 deg. C (+87.80 deg. F).



4 **Skin Heat Exchanger**

5 **Skin Temperature Sensor 28 HQ**



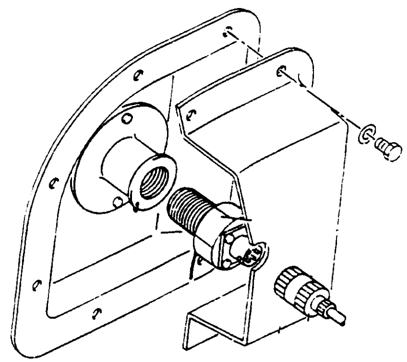


Figure 85 Skin Heat Exchanger & Skin Temperature Sensor

6 Skin Air Inlet Valve 15 HQ

The avionics skin air inlet valve 15HQ is installed in the fuselage skin at the forward−lower left−hand side. This valve is an electrically operated single flap valve which can be manually overridden.

When the aircraft is on the ground the valve is fully open, during flight it is fully closed. If, after the take off sequence signal, the valve does not close, the ground crew can manually close it.

Before the valve is closed manually, it must first be isolated electrically with a toggle switch located inside the valve.

7 Skin Air Outlet Valve 22 HQ

The avionics skin air outlet valve 22HQ is installed in the fuselage skin at the forward−lower right−hand side. This valve is an electrically operated single flap valve with a smaller flap built into it. When the aircraft is on the ground the valve is fully open, during flight it is fully closed.

The smaller flap will open during flight, when the following happens:

- when the skin temperature is above +34 deg. C (+93.20 deg. F) (partially open circuit),
- if smoke is detected in the avionics ventilation system,
- if the avionic computer 10HQ malfunctions.

When on ground, if after take off sequence signal, the valve does not close, the ground crew can manually close it. Before the valve is closed manually it must first be isolated electrically with a toggle switch inside the valve.

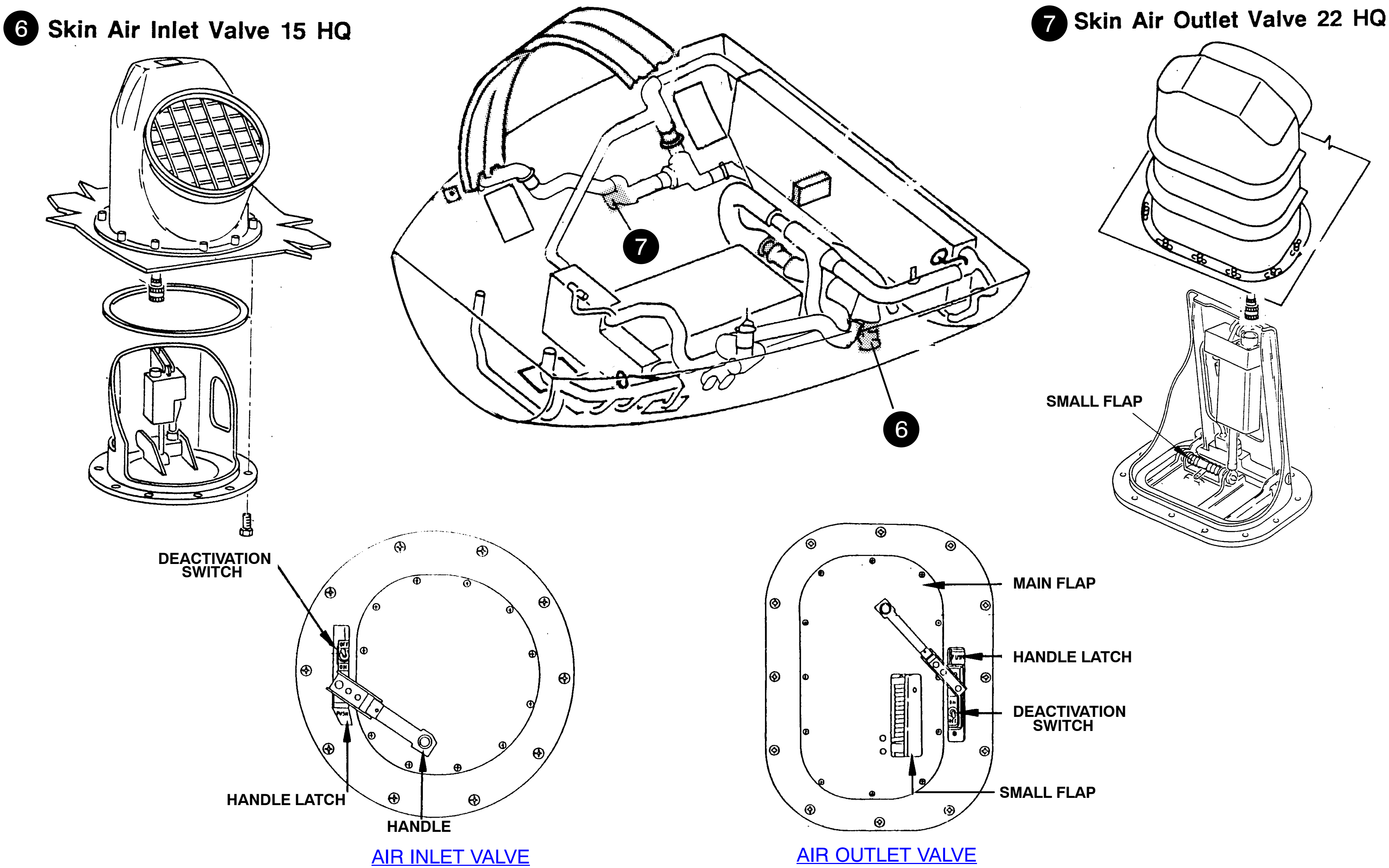


Figure 86 Skin Air Inlet- and Skin Air Outlet Valve

8 Demister Air Filter

A two-stage filter assembly is installed upstream of the blower fan 20HQ.

The first-stage is a cleanable plate type filter 2081HM which removes dust particles above 1000 microns and a multi-layer filter which removes water particles.

The second stage is a cleanable, corrugated-cartridge-barrier filter 2082HM which removes any dust particles above 400 microns (Ref. ARINC 600).

The filter assembly 2081HM, 2082HM, 2083HM is made, to allow easy access for cleaning.

9 Skin Exchanger Inlet Bypass Valve 16 HQ

The skin exchanger inlet bypass valve 16HQ is installed downstream of the extraction fan 18HQ in the tapping to the FWD underfloor area. This valve is of the butterfly type, with an actuator which moves the butterfly to the open or closed position.

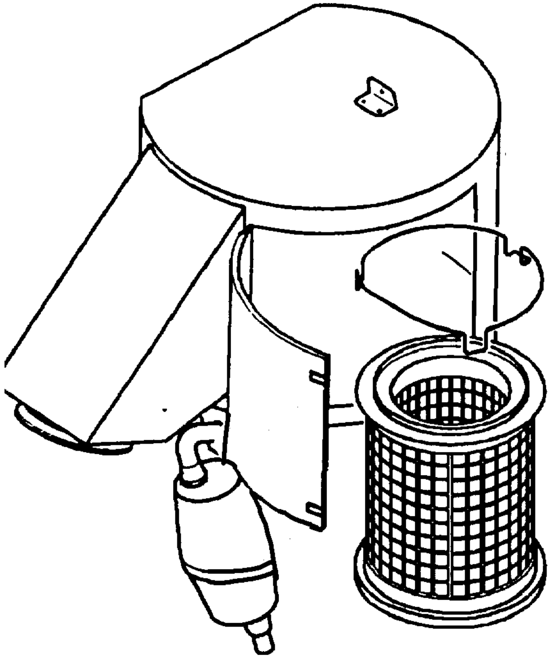
Two microswitches signal the valve position to the avionics computer 10HQ.A visual position indicator is located on the top of the actuator unit. The function of the valve is to discharge the ventilation air above the required quantity to the underfloor area.

The skin exchanger isolation valve 24HQ is installed upstream of the skin heat exchanger. This valve is identical to the skin exchanger inlet bypass valve 16HQ.

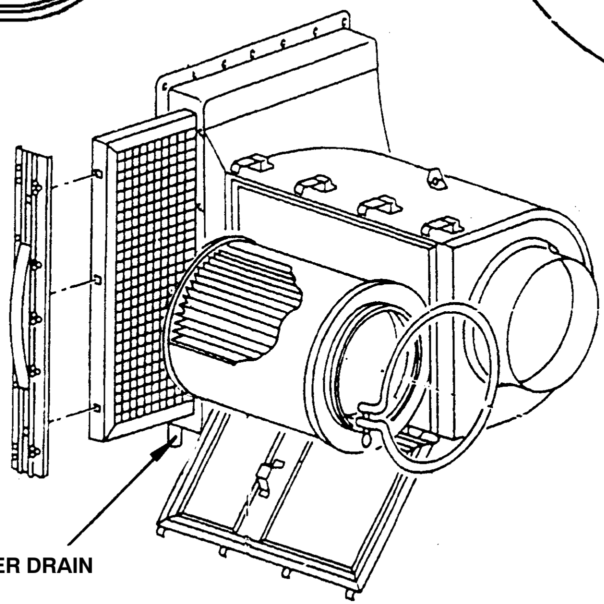
10 Skin Exchanger Isolation Valve 24 HQ

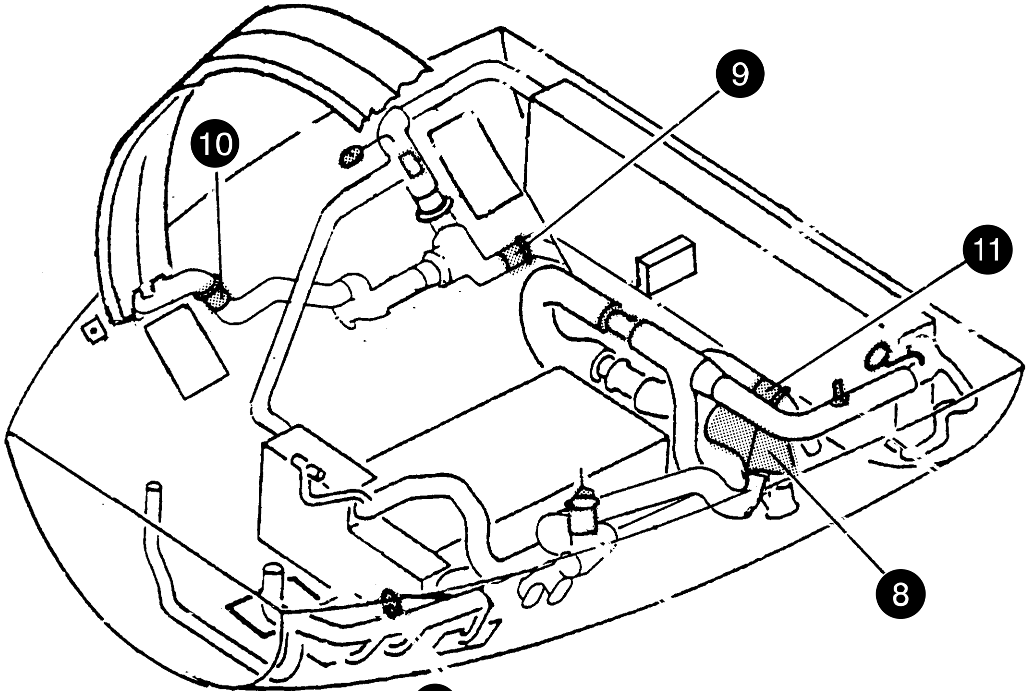
11 Conditioning Air Inlet Valve 21 HQ

The conditioned air inlet valve 21HQ is installed in a duct which connects to the cockpit main supply duct. This valve is similar to the skin exchanger inlet bypass valve 16HQ. The function is to allow cockpit supply air into the system to make sure of the cooling in failure cases.



8 **Demister Air Filter**





9 **Skin Exch. Inlet Bypass Valve 16HQ**

10 **Skin Exch. Isolation Valve 24HQ**

11 **Conditioning Air Inlet Valve 21 HQ**

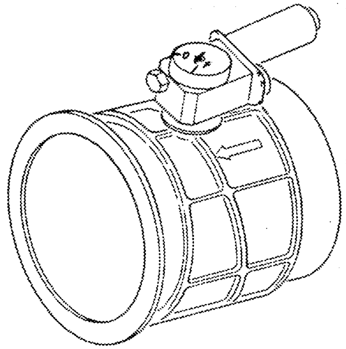


Figure 87 Demister Filter & AEVC System Valves

12 Skin Exchanger Outlet Bypass Valve 23 HQ

The skin exchanger outlet bypass valve 23HQ is installed downstream of the skin heat exchanger. This valve is identical to the skin exchanger inlet bypass valve 16HQ.

The function is to allow avionics compartment air into the system when the skin heat exchanger efficiency is degraded.

13 Air Inlet Check Valve 2150 HM

A check valve 2150HM is installed after the skin air inlet valve 15HQ.

The purpose of the check valve is to protect the system at the air inlet against possible adverse effect caused by cabin differential pressure.

14 Check Valve 2140 HM

A check valve 2140HM is installed downstream of the blower fan 20HQ.

The check valve is made to be installed in line between the ducts.

Two semi-circle flaps are installed on a hinge-bar, a spring holds these semicircle flaps in the closed position. Airflow from the blower fan 20HQ will lift the semicircle flaps from their seats.

This will allow air to flow through the check valve to the avionics ventilation system. Airflow in the opposite direction through the check valve will push the semicircle flaps back onto their seats to stop the airflow.

An arrow on the check valve casing shows which direction the air will flow through the check valve.

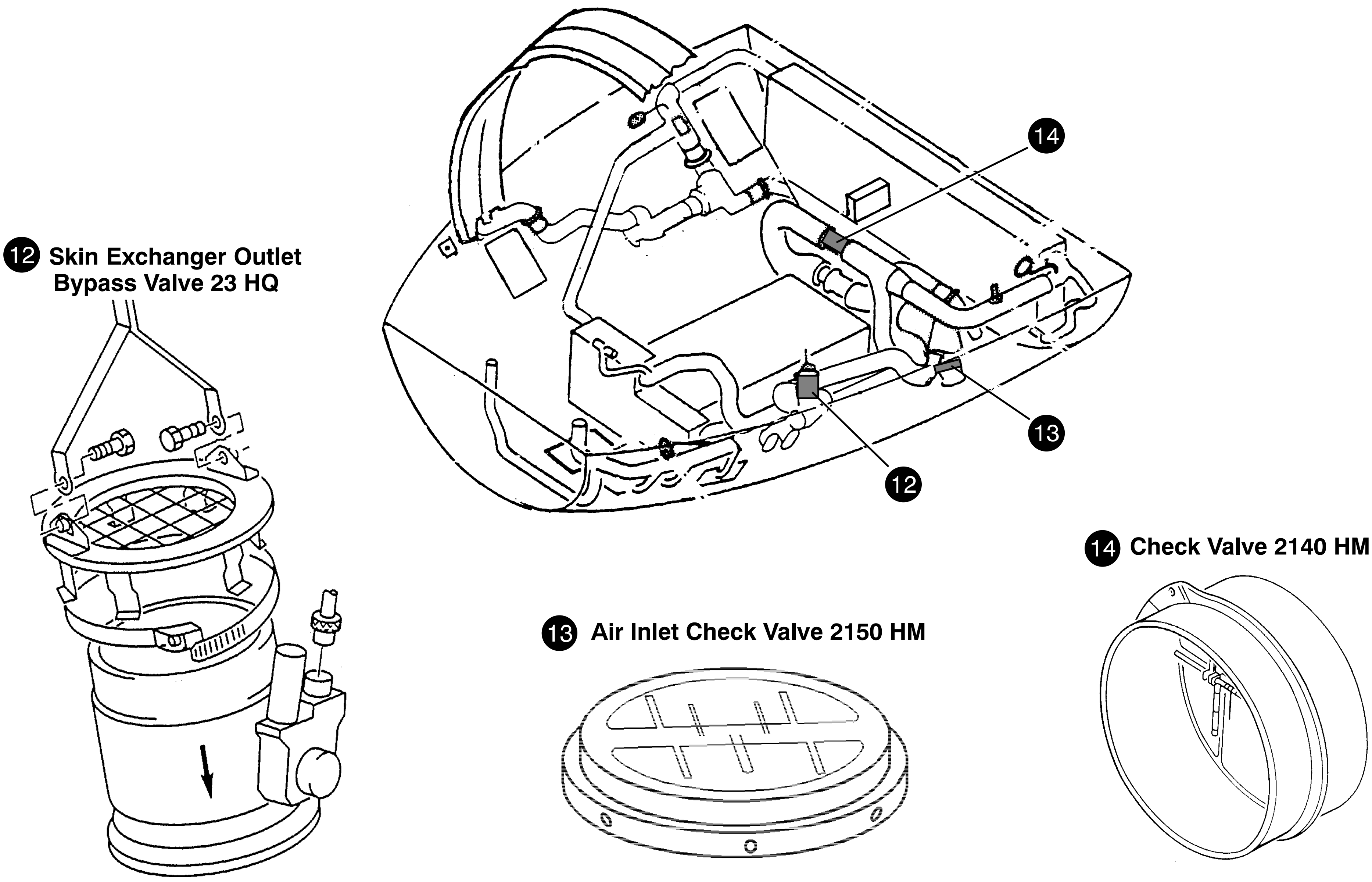


Figure 88 Skin Exchanger Outlet Bypass Valve & AEVC Check Valves

15 Pressure Switch 17HQ, 19HQ, 30HQ

Three pressure switches 17HQ,19HQ and 30HQ are installed in the avionics ventilation system, two in the blowing circuit and one in the extraction circuit. The switches are of the capsule/microswitch type with an electrical connector at the top.

A low flow indication is given at a differential pressure of 1.7 mbar plus 1.3 or minus 0.5 mbar.

16 Duct temperature Sensor 26HQ

The duct temperature sensor 26HQ is installed upstream of the main avionics rack 80VU. It consists of a thermistor mounted in a stainless-steel tube, an electrical connector is mounted at the top.

If an overheat condition is detected the same indications and actions as a blowing low flow will occur.

The set temperature values are:

- increasing temperatures 62deg. C +1deg. C (143.6deg. F +1.8deg. F).
- decreasing temperatures 60deg. C +1deg. C (140deg. F +1.8deg. F)

17 Duct temperature Sensor 32HQ (option)

The sensor is the same as 26HQ.

Depending on temperatures the fan speed controller switches to low or high speed for extract or blower fan.

- increasing temperatures 40deg. C high speed mode.
- decreasing temperatures 35deg. C low speed mode.

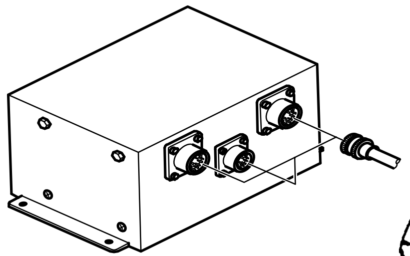
Fan speed controller 31HQ (option)

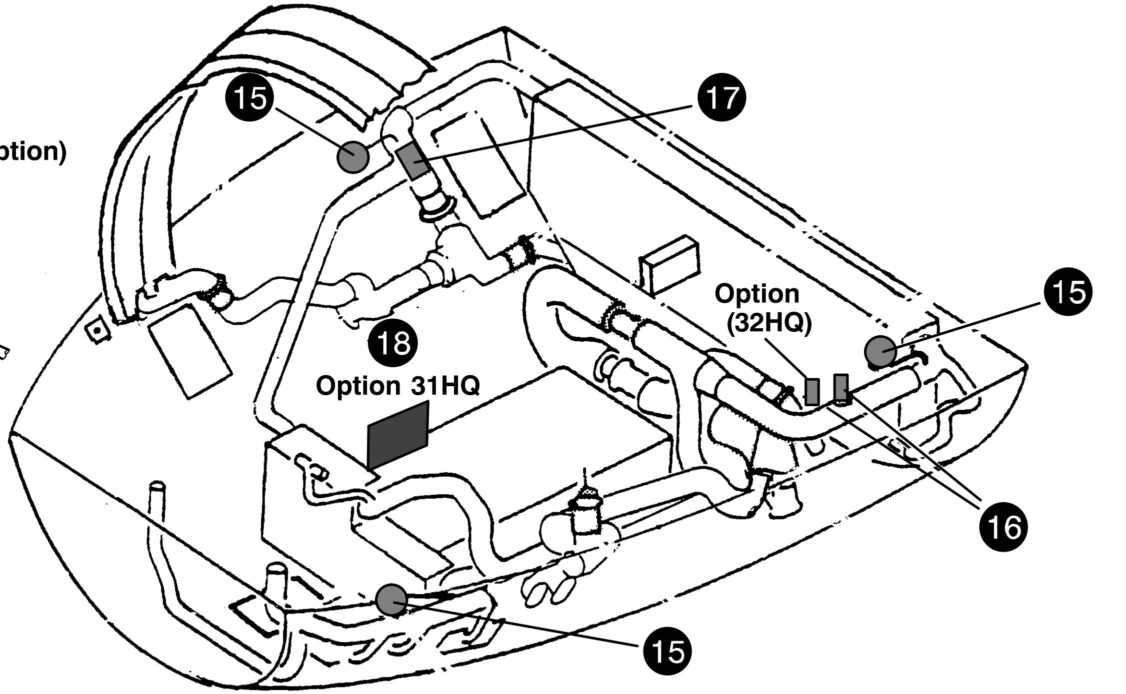
The fan speed controller 31HQ is located on the nose landing-gear wall, on the avionics compartment side. The controller powers both fans with segregated circuits depending on the blowing air temperature. (LH MSN 1337 and on)

18 Smoke Detector 1WA

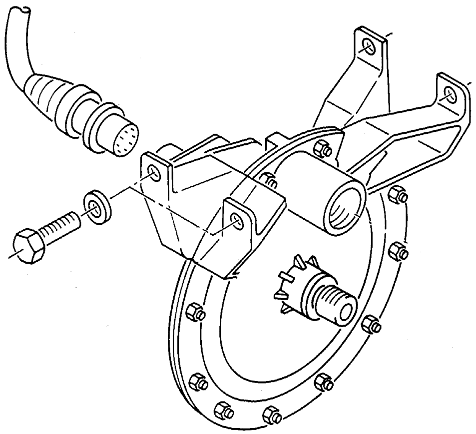
A smoke detector 1WA is installed upstream of the extract fan 18HQ. It is of the duct ionization type with an electrical connector for connection to the warning circuits and avionics computer 10HQ (Ref. 26-00-00).

18
Fan Speed Controller 31HQ (option)

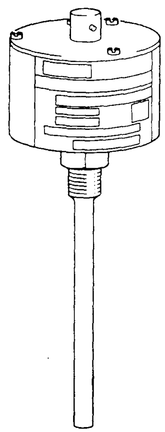




15 Pressure Switch 17HQ / 19HQ / 30HQ



16 Duct Temperature Sensor(s) 26HQ (32HQ)



17 Smoke Detector 1WA

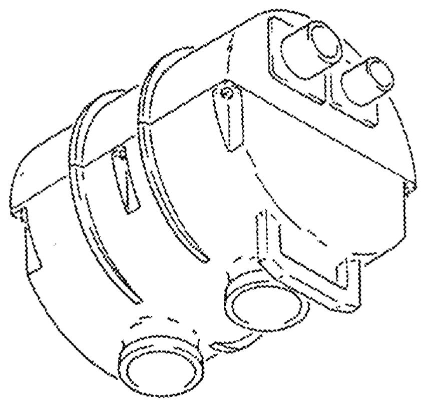


Figure 89 Pressure Switch, Duct Temp. Sensor & SMK Detector

CFDS OF AEVC SYSTEM

System report/Test AEVC

The AEVC BITE has 3 menus:

- < LAST LEG REPORT
- < TEST
- < CLASS 3 FAULTS

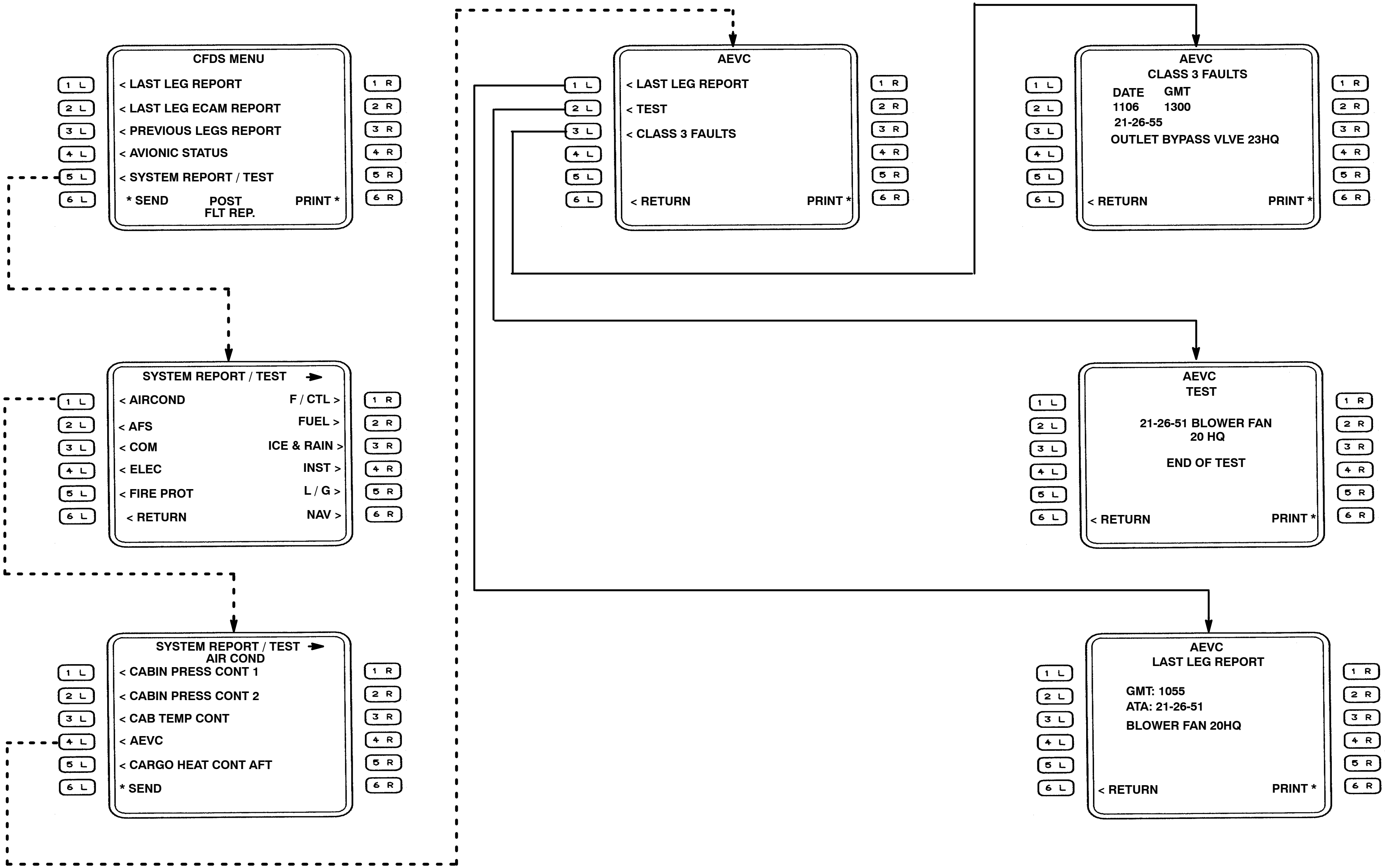


Figure 90 CFDS AEVC Menu

21-30 PRESSURIZATION SYSTEM

GENERAL DESCRIPTION

The pressurization control system makes sure that the pressure in the pressurized fuselage is safe and comfortable for the passengers and crew.

The system consists of:

- 2 CPC (**C**abin **P**ressure **C**ontroller)
- 1 flap−type outflow valve with 3 motors (2 auto & 1 manual motor)
- 1 control panel
- 2 safety valves

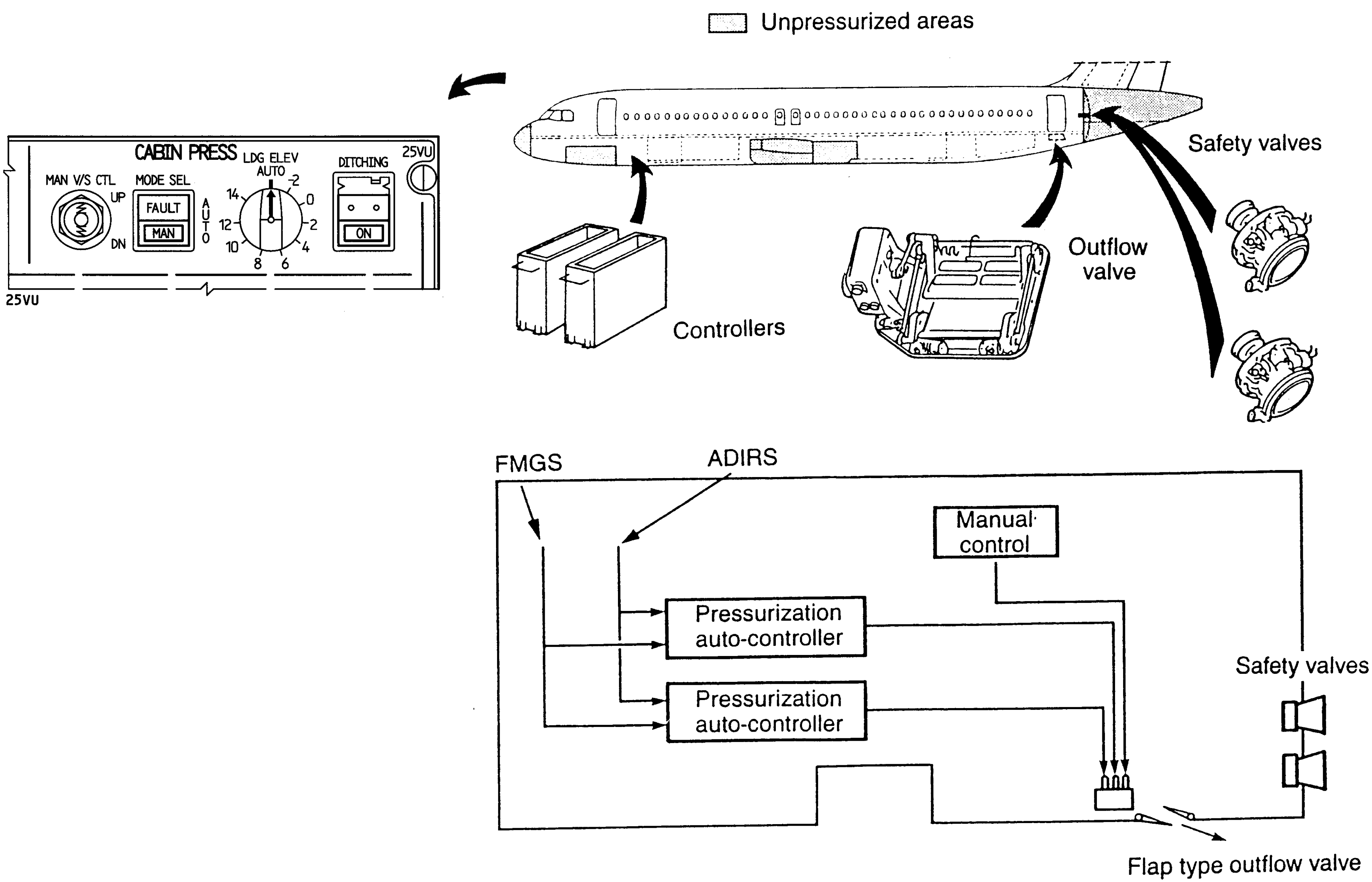


Figure 91 Cabin Pressure System General

AIR CONDITIONING SYSTEM PRESENTATION

General

The system has two identical, independent, automatic systems. Each system has a Cabin Pressure Controller (CPC) 11HL (12HL) which controls the pressure through a flap−type outflow valve 10HL. This valve is installed in the lower right−hand fuselage skin behind the aft cargo compartment.

Only one CPC operates the system at the time, with the other system on hot standby. The change of control from one CPC to the other is fully automatic after each flight, on landing. The CPC will also changes in flight if there is a failure or part failure of one of the control systems.

Two safety valves 6HL (7HL) prevent excessive positive and negative differential pressure in the cabin. These valves are installed in the aft pressure−bulkhead above the aircraft floatation line.

A DITCHING pushbutton switch 13HL (guarded black) closes the outflow valve in ditching configuration. (only when system operates in Auto/Semi auto Mode)

Automatic operation

In the automatic operation the CPCs use the data from the Flight Management and Guidance System (FMGS) and the Air Data/Inertial Reference System (ADIRS).

The active CPC sends control signals through a RS422 bus to the to the outflow valve electronic box, the auto−motor and a gearbox drive the outflow valve to the demanded position. The feedback module gives the position signals to the CPCs via the electronic box for control purposes and indication on the Electronic Instrumentation System (EIS). A landing field elevation (LDG ELEV) selector 20HL is installed on the CABIN PRESS overhead panel 25VU. Under normal condition the LDG ELEV selector is selected in the AUTO position. Then the CPCs 11HL (12HL) use the landing field elevation data from the FMGS.

In all other cases the LDG ELEV selector signal overrides the FMGS data (semi−automatic operation). Semi - Automatic operation

If the data from the FMGS is not available, the landing field elevation can be adjusted with the LDG ELEV selector on the CABIN PRESS overhead panel 25VU manually. Then the CPCs controls the outflow valve with data from the ADIRS and the LDG ELEV selector.

Manual operation

The cabin pressure can be controlled manually from the CABIN PRESS overhead panel. When the MODE SEL pushbutton switch is pushed to the MAN position and the MAN V/S CTL switch is set to UP or DN, the manual motor and the gearbox moves the outflow valve flaps to the commanded position. The feedback module sends position signals to the backup part of the CPC 1 for indication. The backup part gives the excess cabin altitude and the pressure data to the EIS. The data is shown on the PRESS page of the ECAM.

OPERATION IN CASE OF A FAILURE

1. Failure in the active CPC

If the BITE detects a failure, the status changes automatically to standby and the other system takes over the control. Minor failures which are stored in the class 3 memory, do not lead to a system failure. The CPC sends a signal to the EIS and on the E/WD the related warning appears. The CPC also keeps the failure data in its memory which can be indicated on the MCDU.

2. Failure in the standby CPC

If the BITE detects a failure, the system stays in standby−fail. Minor failures which are stored in the class 3 memory, do not lead to a system failure. The CPC sends a signal to EIS and on the ECAM upper display unit the related warning appears. The CPC also keeps the failure data in its memory which can be indicated on the MCDU.

3. Failure in both CPCS

If in both CPCs failures appear, the crew must control the cabin pressure manually. (FAULT LT in Mode Sel. PB ”ON”). The CPCs send a signal to EIS and on the ECAM upper display unit the related warning appears. The CPCs also keep the failure data in its memory which can be indicated on the MCDU.

CPCs Reset

For the reset of the CPCs the subsequent circuit breakers must be opened for at least 2 seconds:

- for the CPC 1, the circuit breaker which is installed on the circuit breaker panel 49VU,
- for the CPC 2, the circuit breaker which is installed on the C/B panel 122VU. When the circuit breaker for the related CPC is closed again the CPC power−up test starts.

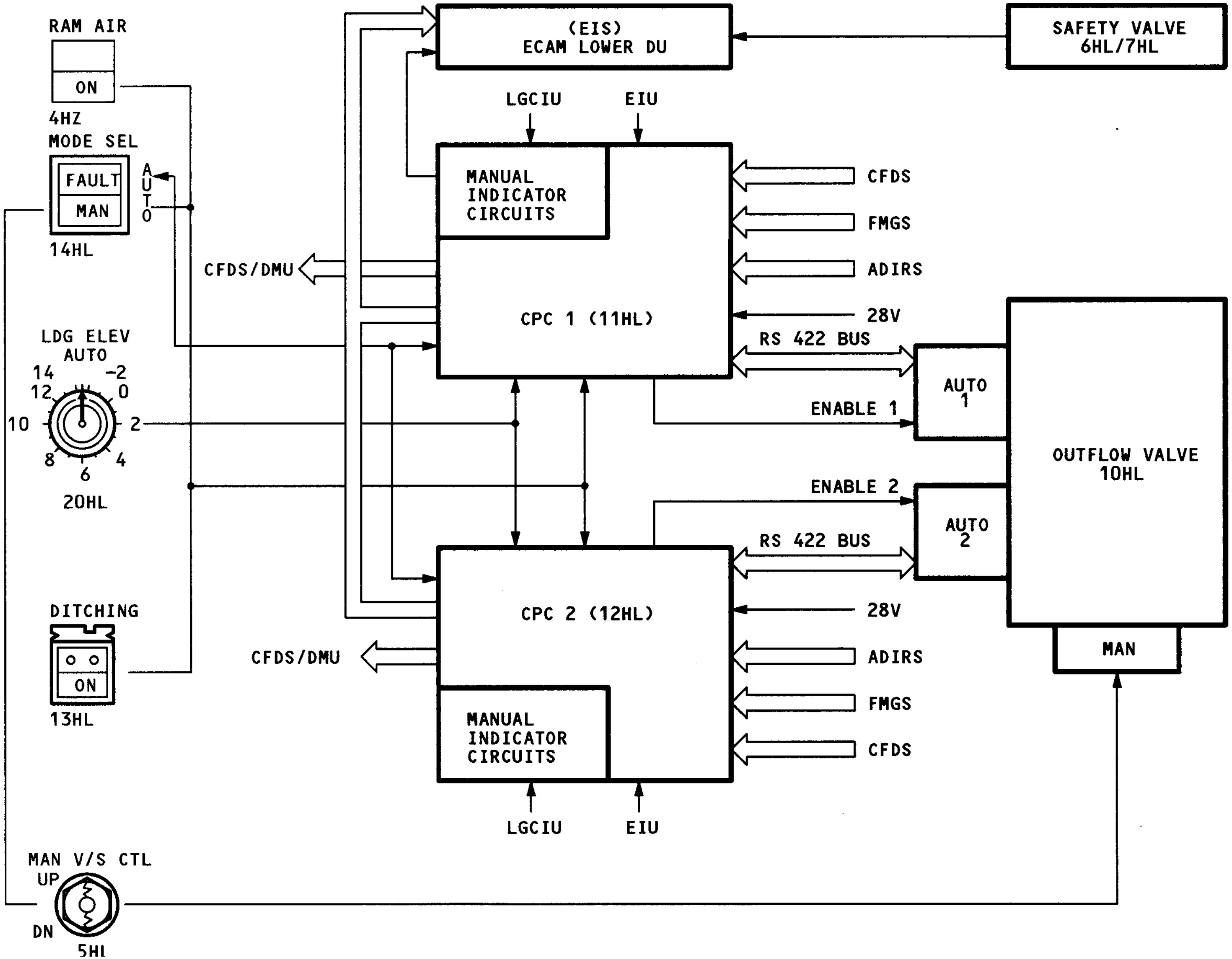


Figure 92 Pressurization Control

MODE DESCRIPTION AND LIMITS FUNCTION

Pressure Schedules and Rate Limits

In automatic operation no action of the crew is necessary. The CPCs receive landing elevation and QNH data from the FMGC and pressure altitude data from the ADIRUs.

The active CPC sends demand signals to the electronic box of the outflow valve. The related auto−motor controls the outflow valve flap through a gearbox to the demanded position. The feedback module sends the position data through the electronic box to the CPC. On the PRESS page of the ECAM lower display unit the system status is shown.

70 seconds after each aircraft landing the active CPC changes to standby and the standby CPC changes to active. The CPCs pressurize the aircraft through 6 modes.

Ground Mode (GN)

Before take−off and 55 seconds after landing, the active CPC controls the outflow valve to the fully open position to make sure that there is no residual delta−P in the aircraft. At touchdown, the CPCs controls the cabin V/S at −500 ft/mn. to release the remaining delta pressure.

Take−off Mode (TO)

To avoid a pressure surge during aircraft rotation, the CPC pre-pressurizes the aircraft with a rate of −500 ft/mn until the delta pressure reaches 0.1 psi. The cabin is pre-pressurized as power is set to take-off (N2 > min TO signal).

Climb Mode (CE)

This mode is initiated at lift-off. The active CPC controls the pressure in relation of the actual rate of climb of the aircraft.

Cruise Mode (CR)

The cabin altitude is controlled to a constant delta−P. The max delta P is 8.06 psi which correspond to a cabin altitude of 8000 ft is reached at 39000 ft cruise level.

When the selected landing field elevation is more than 5200ft. above the cabin altitude, during cruise and higher than 8000ft. the cabin altitude is increased to keep the difference constantly 5200ft.

Descent Mode (DE)

The active CPC optimizes the pressure rate so that the cabin pressure reaches the landing field pressure just prior to landing. The maximum decent rate is limited to −750 ft/mn.

As with take−off, to avoid a pressure bump during touch down the fuselage is pressurized with a delta p of 7 mbar (0,1 psi).

At touch down the fuselage de-pressurizes with a cabin rate of (500 ft/min) to the landing field pressure. The outflow valve will be driven to its fully open position after 55 sec. and the system transfers 70 s after the GN mode is set independent of the differential pressure.

Abort Mode (AB)

The purpose of the abort mode is to prevent the cabin climbing if the aircraft does not climb after take−off. (For example, if an engine failure happens after V1 the aircraft must take−off). The system will switch to the climb mode after take−off. If the aircraft descends, instead of climbing, while the altitude is below 8000 ft. the system switches into the abort mode. The cabin pressure is then kept to the value before take−off.

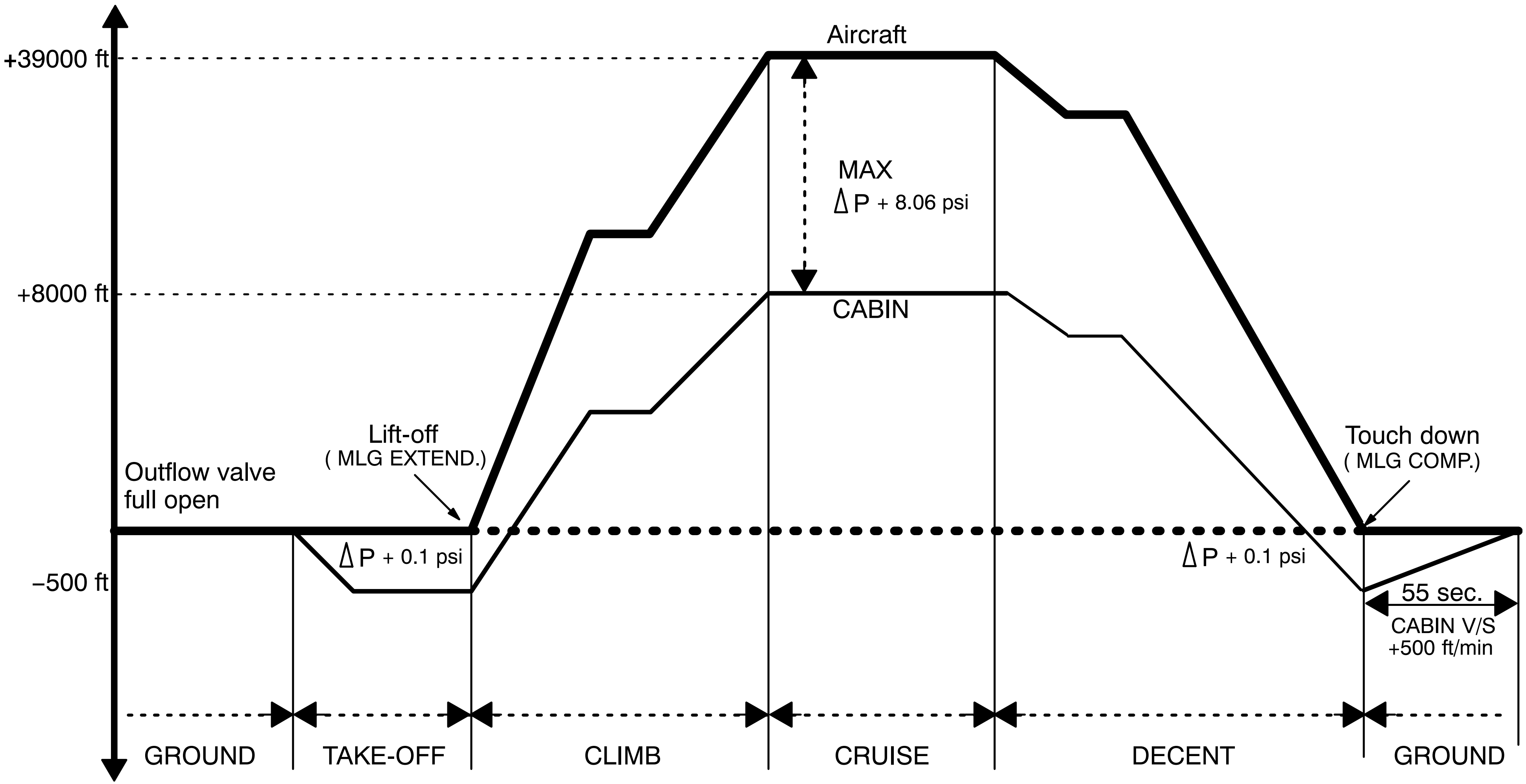


Figure 93 Pressurization Flight Profile

21–31 PRESSURE CONTROL AND MONITORING

CABIN PRESS PANEL LAYOUT

General

During normal operation the system operates automatically and no inputs from the crew are required. The only direct input the system needs is from the landing–field elevation selector 20HL. The selector knob is set to the AUTO position for normal operation. This makes sure that the controllers 11HL (12HL) take the landing–field elevation input–signal from the FMGS. In all other cases the landing–field elevation selector output–signal overrides the input–signal from the FMGS.

1 Landing–Field Elevation Selector

The landing–field elevation selector 20HL is installed on the CAB PRESS panel 25VU, located on the overhead panel in the cockpit. The crew is able to select a landing field elevation when the input knob is pulled and turned in a clockwise direction.

The range of the landing–field elevation selector is from 2000 ft below sea level to 14000 ft above sea level. The selector knob drives a dual (redundant) potentiometer which supplies a separate output to each controller 11HL (12HL).

With the selector knob in the AUTO position, the controllers will automatically take the FMGS landing–field elevation data to elaborate an optimized pressure schedule. If there is no signal from FMGS, the crew must select destination landing–field elevation. There is a dented in the AUTO position and a mechanical stop between this and 14000 ft.

2 Manual Mode Selection Switch

Fault light amber illuminates when both controllers are defective, switch released white MAN light illuminates, FAULT extinguishes, manual control is then operative with the MAN V/S CTL toggle switch to control outflow valve 10HL position.

3 Manual V/S CTL Toggle Switch

Manual control of outflow valve 10HL when MAN on mode sel switch 14HL is illuminated.

- UP : Valve opens,
- DN : Valve closed.

NOTE: Due to slow outflow valve operation, toggle switch must be maintained in UP or DN position until target V/S is reached in this configuration the power supplies to the AUTO motors are cut off, and the MAN motor is activated to control the outflow valve

4 Ditching switch (guarded black)

When the switch 13HL is pressed in ON illuminates and the aircraft goes into the ditching configuration, this closes:

- the outflow valve 10HL,
- the air conditioning packs 0010HM (0011HM),
- the avionics air–outlet valve 22HQ, if open,
- the emergency ram–air inlet, if open,

NOTE: The outflow Valve will not automatically close if it is under manual control.

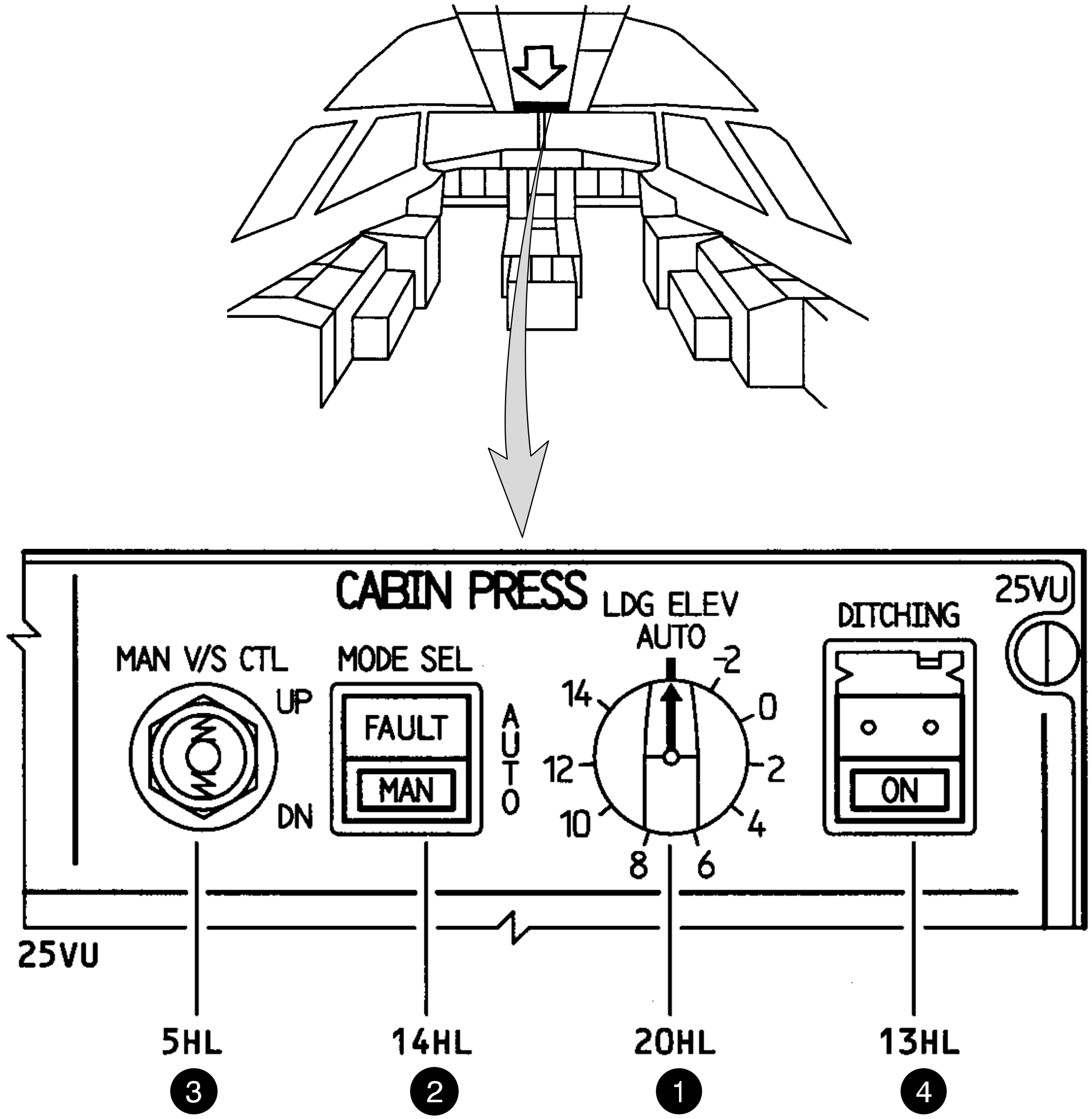


Figure 94 Pressure Controls and Indications

ECAM CAB PRESS PAGES INTRODUCTION

① LDG ELEV AUTO / MAN

- AUTO is displayed in green when LDG ELEV selector is in AUTO position.
- MAN is displayed in green when LDG ELEV selector is not in AUTO position.
- Not displayed when the MODE SEL pb sw is in MAN position.

② Landing elevation

Landing elevation selected either automatically by the FMGS or manually by the pilot is indicated in green. (Inhibited when the MODE SEL pb sw is in MAN position)

③ Cabin vertical speed

Green, in normal range.
Amber, when V / S ⩾ 2000 ft / mn.
Advisory (digital indication pulsing) at V / S > 1800 ft / mn (reset at 1600 ft / mn).

④ Cabin differential pressure

Green, in normal range.
Amber, when out of normal range : △p ⩽ – 0,4 psi or ⩾ 8.5 psi.
- Advisory (digital indication pulsing) if △p > 1.5 psi (reset at 1 psi) during flight phase 7.

⑤ Cabin altitude

Green, in normal range.
Red, for excessive cabin altitude : ⩾ 9550 ft
- Advisory (digital indication pulsing) if cabin altitude ⩾ 8800 ft (reset at 8600 ft).

⑥ Active system indication (SYS 1 or SYS 2 or MAN)

SYS 1 or SYS 2 : Green when active, amber when FAULT, not displayed when inactive.
MAN : Appears green when the MODE SEL pb sw is at MAN

⑦ Safety valve position

SAFETY is white and indication is green when both safety valves are fully closed.
SAFETY is amber and indication is amber when either valve is not closed.

Note : The cabin differential pressure at safety valve opening can be a value between 8.2 and 8.9 psi. This is due to the reduced delta-P accuracy (in MAN mode) combined with the cabin differential pressure decrease caused immediately after the safety valves open.

⑧ Outflow valve position

Indication is green, when operating normally.
Indication is amber, when valve is fully open (more than 95 %) when in flight.

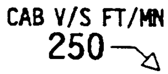
① LDG ELEV AUTO / MAN

Identical to CAB PRESS page.

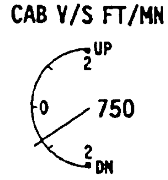
② Cabin vertical speed

Green, in normal range.
Amber, when out of normal range : V / S ⩾ 2000 ft / mn

AUTO MODE:



MAN MODE:



③ Cabin altitude

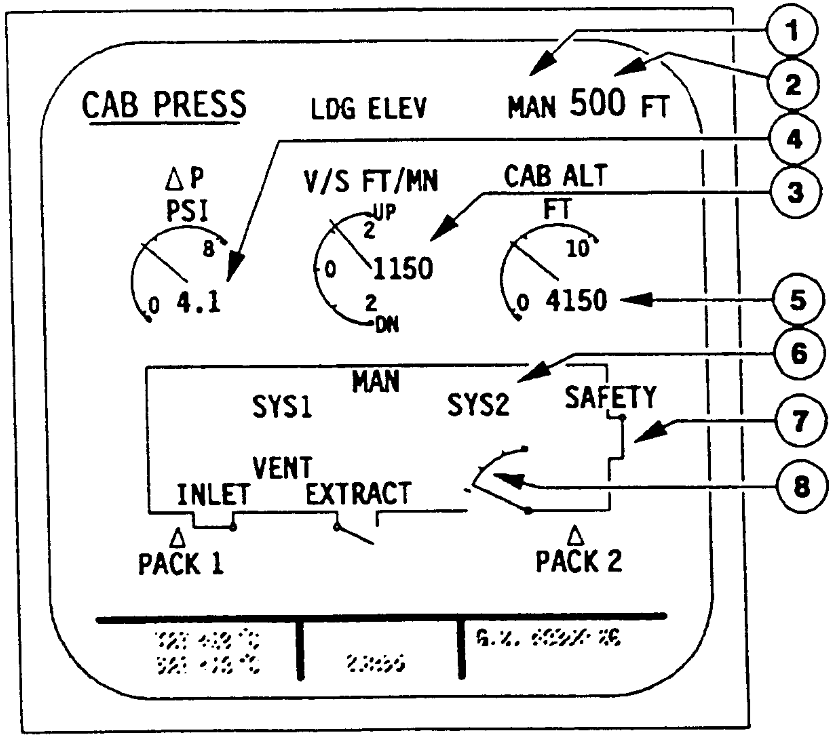
Green, in normal range.
Red, for excessive cabin altitude : ⩾ 9550 ft.

④ △p indication

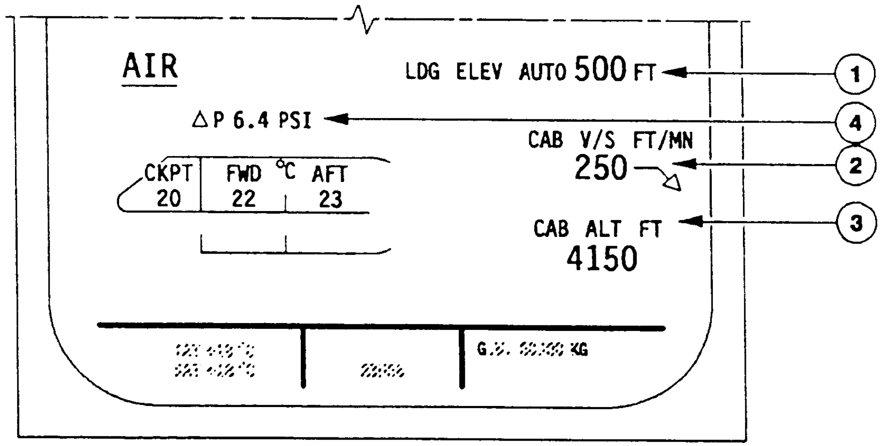
Normally green.
Amber when out of normal range △P ⩽ - 0.4 psi or ⩾ 8.5 psi.

Figure 95 Presentation of ECAM Pages

ECAM CAB PRESS PAGE



ECAM CRUISE PAGE



AUTO MODE: (2) **MAN MODE:**

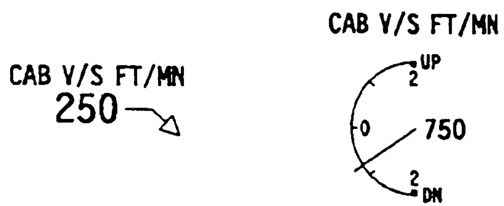


Figure 96 ECAM Cabin Pressurization & Cruise Page

PRESSURIZATION COMPONENT DESCRIPTION

PRESSURE CONTROLLERS

The CPCs 11HL (12HL) have functions as follows:

- automatic cabin pressure control,
- back−up indication for manual control,
- alarm functions (ECAM warnings),
- self−monitoring and failure indication (BITE + CFDS).

Two identical CPC are used for redundant system control, each contains:

- a cabin pressure sensor,
- the ARINC bus interface to SDAC (ECAM), CFDS, FMGS and ADIRS,
- the discrete interface to the LGCIU and EIU,
- the digital control logic,
- the interface with the landing−field elevation selector,
- the interface with the other CPC,
- the interface with the outflow valve 10HL actuator.

A separate electrically supplied part of the CPC1 is the back−up circuit and contains:

- a pressure sensor,
- an analog circuit.

These generate the limit function output discrete and the analog system display outputs. The controller is is installed in shelves 95VU and 96VU of the main rack 90VU. The CPC receives signals from different sources. All signals sent are digital or discrete. The CPC back−up indication circuit sends only analog signals to the EIS.

SYSTEM CONTROL INTERFACES

Engine Interface Unit (EIU) discrete signals

- thrust lever angel in take-off position
- N2 at or above idle

This signals are used for pre-pressurization and pressurization sequences.

LGCIU Interface

The LGCIU1 (5GA1) and LGCIU2 (5GA2) give a discrete signal for the flight/ground status to the CPCs.

This signal is used for pre-pressurization, pressurization, sequences and system transfer.

ADIRU Interface

- static pressure
- baro correction
- ADIRU validation

This signals are used for all sequences and ADIRU/CPC priority selection.

Air Conditioning panel/Cabin press panel interfaces

- emergency ram air inlet selection, used for outflow valve full opening.
- ditching for closing outflow valve in auto mode.
- landing field elevation and manual mode selection for manual operation

CFDS Interface

The BITE in the CPCs and the outflow valve actuator drive electronics, can isolate faults down to component level. This information is given to the CFDIU (1TW) via an ARINC 429 data bus.

FWC Interface

Controller 1 signals both FWCs to produce a level 3 warning in manual mode (excessive cabin altitude 9550 ft).

SDAC Interface

Signals warnings and indications, used in auto mode (ARINC and discrete signals from controllers), manual mode (3 analog signals from controller1).

CIDS Interface

Signal excess cabin altitude (11300 ft), used for passenger signs.

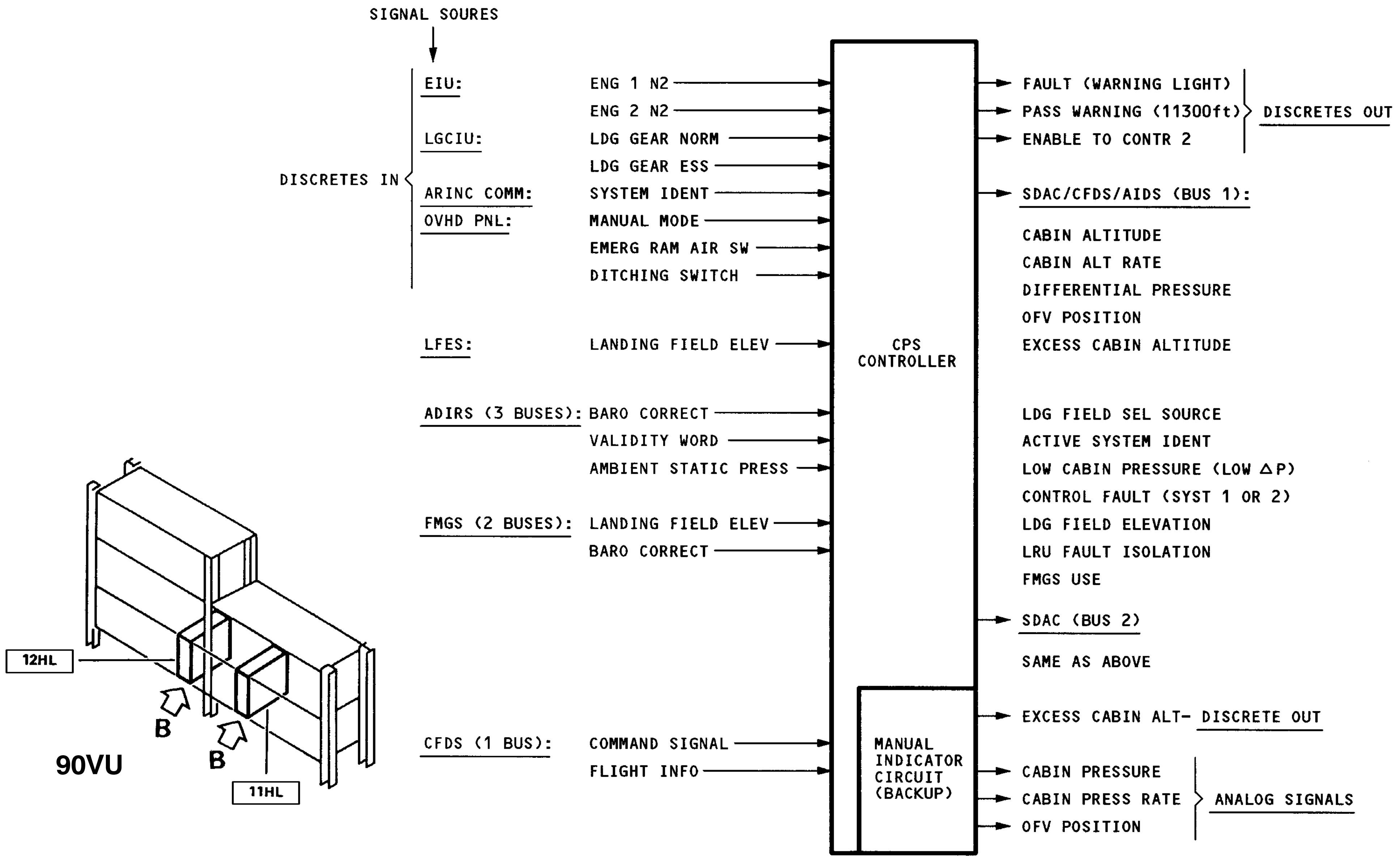


Figure 97 Pressure Controller

OUTFLOW VALVE

General

The outflow valve 10HL is of the dual−gate type, designed to produce thrust recovery. The valve is installed below the aircraft floating line, on the right−hand side of the fuselage behind the aft cargo compartment.

The outflow valve has:

- two outflow valve electronic boxes,
- two automatic motors,
- a manual motor,
- a feedback module,
- an outflow valve body,
- a gearbox.

Only one motor is active at any one time. During this time the other motors are locked.

Outflow Valve Electronic Boxes

The outflow−valve electronic boxes contains the electronic circuits which are divided into the following sections:

- the data input section (RS422 receiver),
- the microcontroller and memory section,
- the motor drive section,
- the valve position feedback section (RVT position),
- the BITE circuits,
- the data output section (RS422 transmitter),
- the power supply module.

The box communicates with the CPC 11HL respectively 12HL via the RS422 bus.

A pressure switch is installed in each box. It operates independently from the automatic operation. It closes the outflow valve if the pressure in the fuselage is less than the atmospheric pressure at an altitude of 15000 ft. (4571.91 m).

Automatic Motors

The automatic motors are DC brushless type with electromechanical brake. They are used in automatic operation.

- Motor 1 - CPC1
- Motor 2 - CPC2

Manual Motor

The manual motor is a DC brush type.

It is used in manual operation only when the toggle switch is used.

Feedback Module

The feedback module is a Rotary Variable Transformer (RVT). It sends position data to the cabin pressure controllers 11HL and 12HL through the outflow valve electronic boxes.

Potentiometer sends position data to the manual backup circuit of the cabin pressure controller 11HL.

Outflow Valve Bodies

The outflow valve body has two gates, one forward and one aft. The gates are installed in a rectangular frame. The forward gate opens outwards and is mechanically connected to the aft gate. The aft gate opens inwards and is mechanically connected to the gear box and the forward gate. At low valve angles the valve gates make a two−dimensional nozzle that directs the outflow of air and gives thrust recovery.

Gearbox

The gearbox transmits the movement from the activated motor to the outflow valve flap.

A mechanical stop limits the rotation of the drive shaft for the valve flap movement.

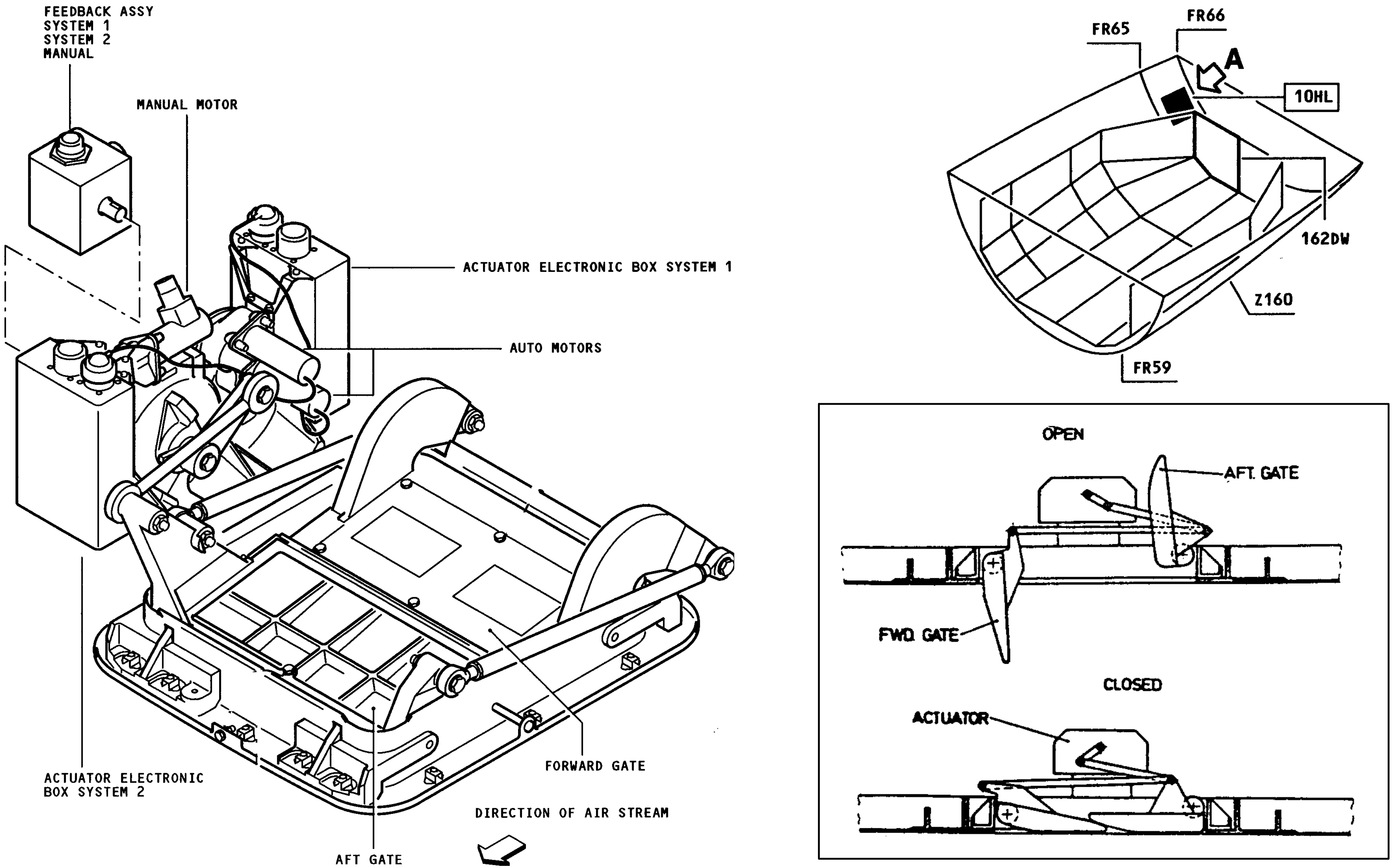


Figure 98 Outflow Valve (10HL)

SAFETY VALVES

General

For limitation of maximum positive/negative differential pressure two safety valves 6HL (7HL) are installed on the aft pressure bulkhead. The valves are located above the aircraft floatation line, which stops water entering the fuselage in the event of ditching.

Microswitches indicate the valve position on ECAM, the valves are normally closed.

Description

The safety valves 6HL (7HL) are poppet−type pneumatic valves and consists of two main elements, a valve part and control part. The valve part consists of a base, housing and cap, the control part is integral with the main valve housing.

Operation

The pneumatic safety valves use a balanced poppet to give precise limit control of the cabin−to−ambient pressure differential. The valves control cabin−pressure in modulating the amount of air allowed to flow into or out of the cabin. An opposing reference spring force senses the cabin−to−ambient differential across the control diaphragm.

When cabin−to−ambient differential pressure control set point is reached, the control piston force overcomes the reference spring force. The control poppet now starts to control valve pressure, positioning the valve poppet to regulate cabin pressure.

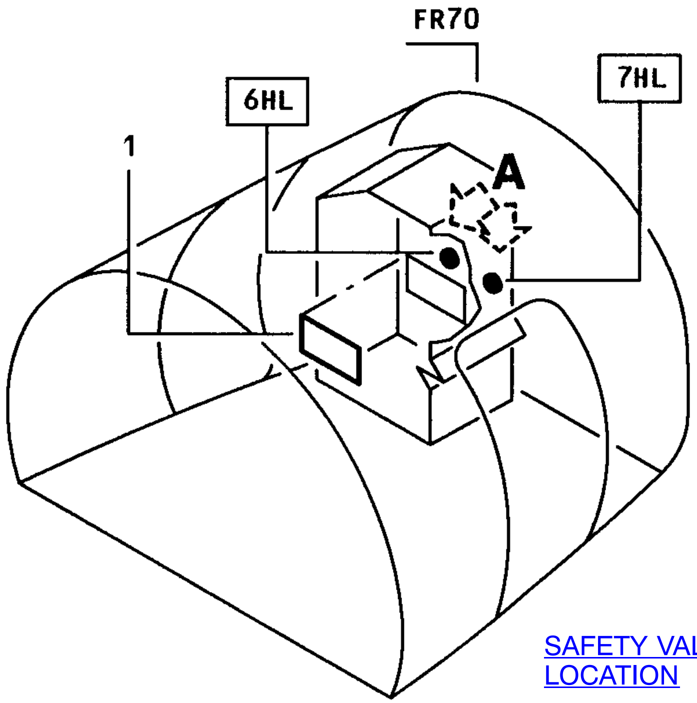
The safety valve differential pressure limitations are as follows:

- positive valve setting pressure, (8.6 psi +/− 0.1 psi)
- maximum positive overpressure, (9.0 psi)
- negative valve setting pressure, (−0.27 psi +/−0.02 psi)
- maximum negative differential (−0.5 psi) pressure (two valves operating),
- maximum negative differential (−1.0 psi) pressure (one valve operating).

When one of the safety valves is open there is no indication. This is a correct function. However, should the safety valve stay open for more than 60s, it then becomes a fault and the following occurs:

- the amber MASTER CAUTION lights come on,
- a single chime is heard,
- on the ECAM lower display unit the PRESS page comes on and the amber safety valve symbol shows open,
- on the ECAM upper display unit the warning message CAB PR SAFETY VALVE OPEN and the required actions come on.

The delta−p shown on the ECAM at this time will be between 8.2 and 8.5 psi.



SAFETY VALVE LOCATION

Figure 99 Safety Valve Location

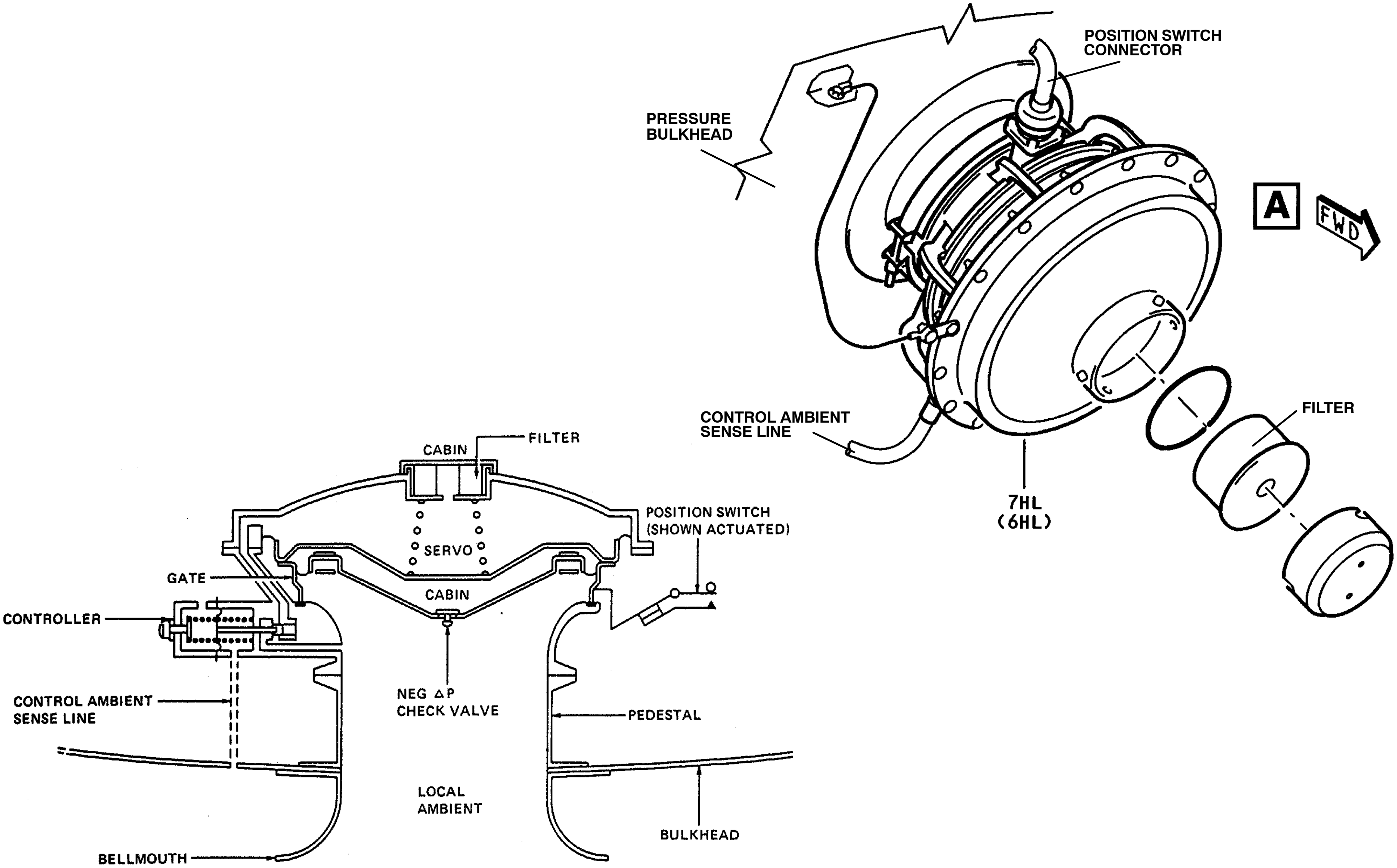


Figure 100 Safety Valves (6HL and 7HL)

CFDS CPC SYSTEM REPORT/TEST (BITE)

MCDU Maintenance Messages

If there is a failure, a maintenance message is shown on the MCDU. A failure in the CPCs can be class 1 or class 3. Class 1 failures require immediate maintenance action, as they always lead to a loss of the affected system with operational consequences.

The CAB PRESS CONT 1(2) menu has 5 options:

- LAST LEG REPORT
- PREVIOUS LEGS REPORT
- LRU IDENTIFICATION
- TEST/CALIBRATION
- CLASS 3 FAULTS

Fault Codes

If a fault is detected by the CPC BITE, a fault code for shop maintenance is shown on the CFDS in addition to the related CFDS maintenance message.

A subsequent table in the TSM & AMM shows the possible fault codes with their attached fault origins.

LAST LEG REPORT

The Last Leg Report shows the Faults of the last flight leg. The report shows:

- the maintenance message of the failure,
- a fault code for shop maintenance,
- the date and time when the fault occurs,
- the ATA number of the maintenance message,
- the FIN of the failed component.

PREVIOUS LEGS REPORT

The PREVIOUS LEGS REPORT shows all failure that occurred during the last 63 legs. The MCDU screen shows:

- the flight number (aircraft tail number),
- the maintenance message of the failure,
- a fault code for shop maintenance,
- the leg number,
- the date and time when the fault occurs,
- the flight phase,
- the ATA number of the maintenance message,
- the FIN of the failed component.

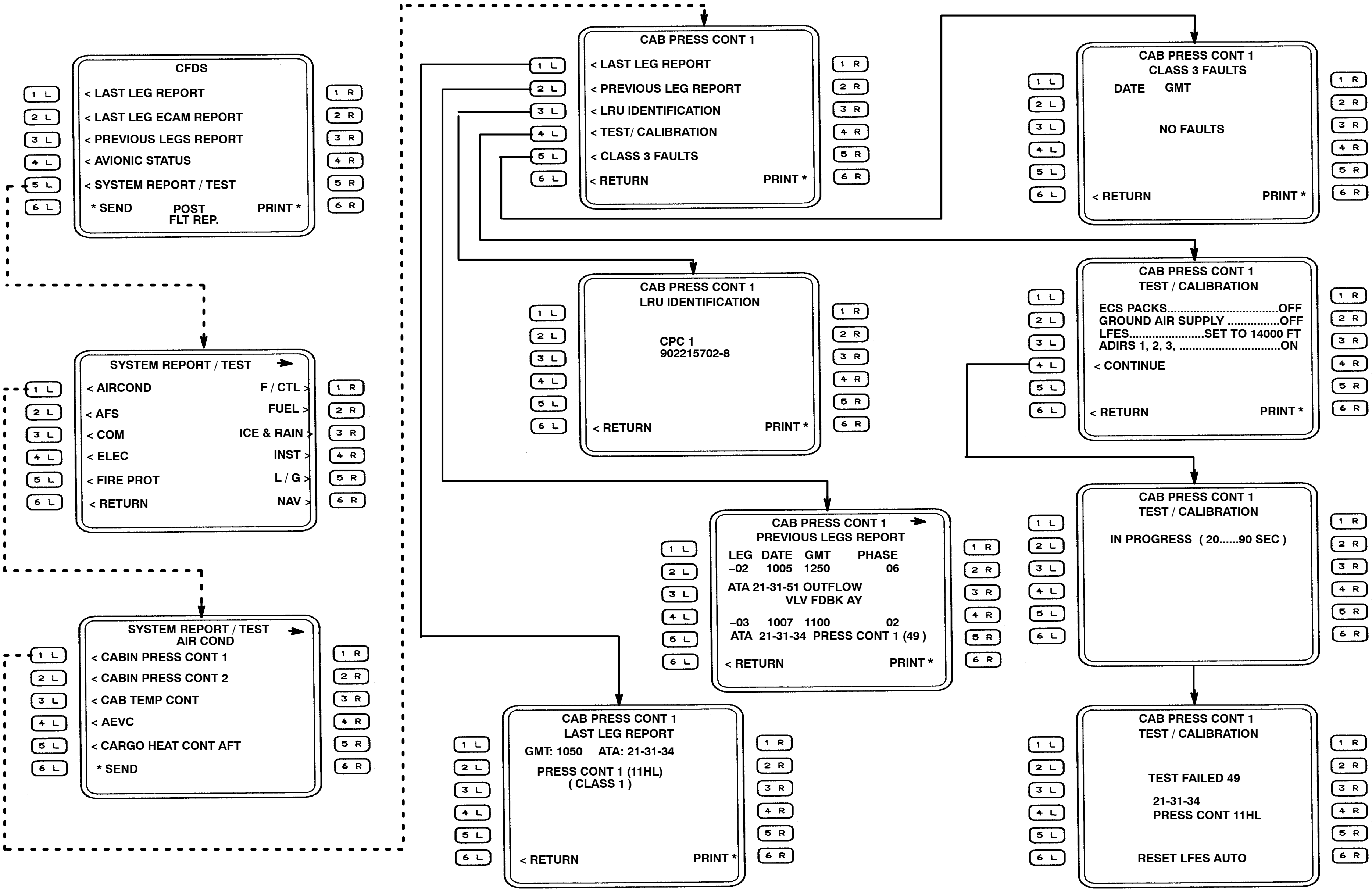


Figure 101 CFDS CPC Menu

LRU IDENTIFICATION

The LRU IDENTIFICATION Page shows the Part/Number of the main Electronic Units which are installed in the system.

Example: 9022-15702-8 (Part/Number) Cabin Pressure Controller1

TEST/CALIBRATION

When the TEST/CALIBRATION line key is pressed, the MCDU shows:

ESC PACKS . OFF,

GROUND AIR SUPPLY OFF,

LFES . SET TO 14000 ft,

ADIRS 1; 2; 3 . ON,

MODE SEL AUTO,

When the CONTINUE line key is pressed, the test starts and the message (IN PROGRESS 90 SEC) comes on. During the Test the Outflow Valve is driven to the open and closed position. During the test also the end of travel stops of the outflow valve are calibrated in the CPC.

After the test, one of the subsequent is shown:

- TEST OK if there are no failures,
  RESET LFES --->AUTO
- TEST FAILED :
  TRY C/B RESET + NEW TEST RESET LFES --->AUTO
- NO TEST:
  MODE SEL AUTO + NEW TEST

CLASS 3 FAULTS

A class 3 failure is not as important, but should be observed for frequent recurrence.

The MCDU screen shows:

- the maintenance message of the failure,
- a fault code for shop maintenance,
- the leg number,
- the date and time when the fault occurs,
- the flight phase,
- the ATA number of the maintenance message,
- the FIN of the failed component.

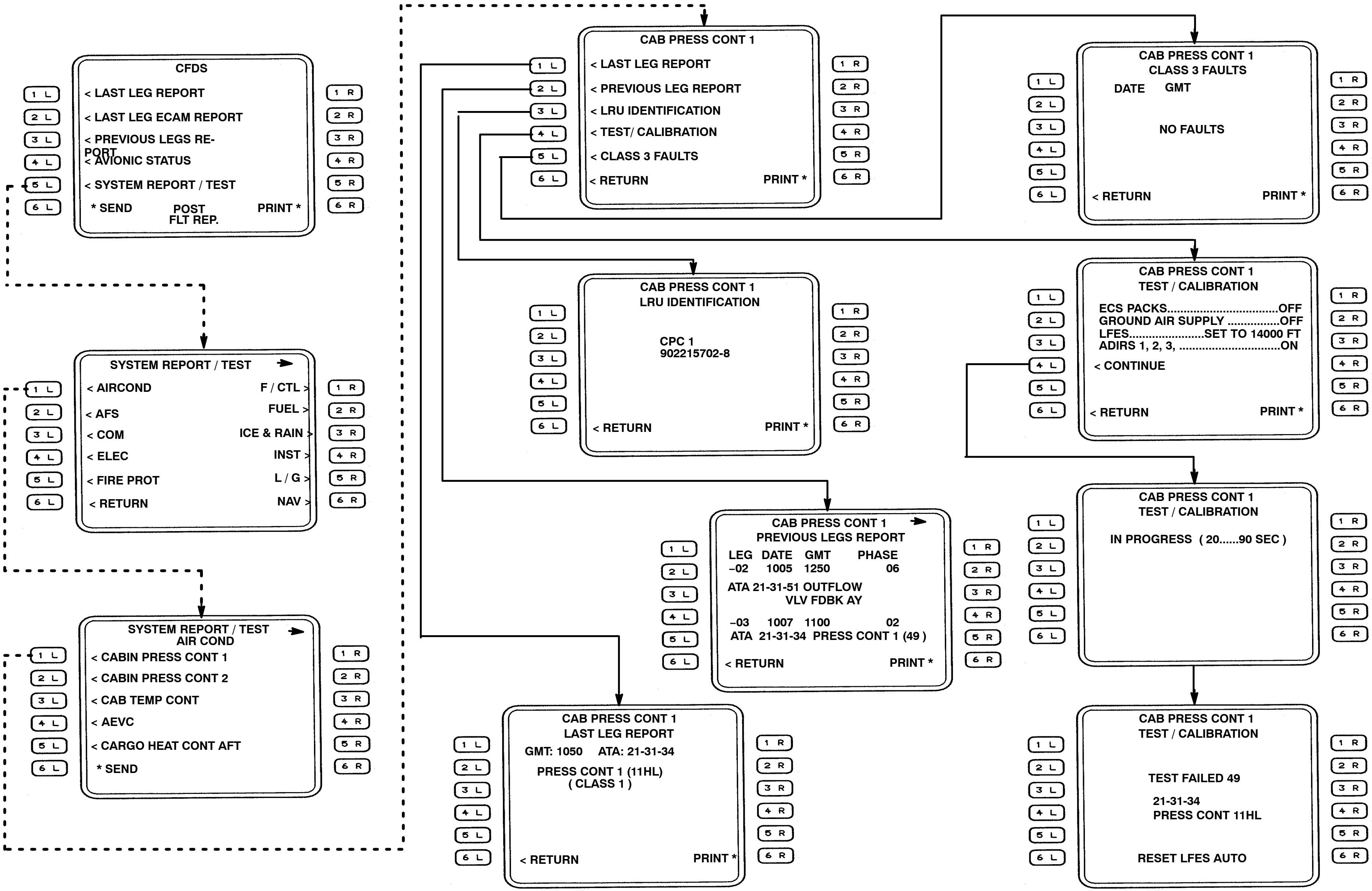


Figure 102 CFDS CPC Menu

PRESSURIZATION TEST OF THE FUSELAGE

There are 3 Pressurization Tests in the AMM ATA Chapter **05-53-00.**

- Test at a **Differential Pressure of 4 psi. (TASK 05-53-00-780-001)**
  Reason for the Job:
  To find possible leaks in the repaired area after small structural repairs.
- Test at **Differential Pressure of 8 psi. (TASK 05-53-00-780-002)**
  Reason for the Job:
  To find possible leaks in the repaired area after major structural repairs.
- Test at a **Differential Pressure of 8.4 psi. (TASK 05-53-00-780-003)**
  Reason for the Job:
  To measure structural leakage.

AIDS Alpha Call up:

- ”PDC” CABIN DIFF. PRESSURE
- ”VSCB” CABIN VERTICAL SPEED
- ”ZCB” CABIN ALTITUDE
- ”OVP” OUTFLOW VALVE POSITION

THIS PAGE INTENTIONALLY LEFT BLANK

21–50 AIR COOLING

GENERAL DESCRIPTION (DIFFERENCES)

A319–A321 CLASSIC (FIGURE 1)

Pack Cooling Air Control

The zone controller signals the required pack outlet temperature to the pack controllers. To get this temperature, the pack controller modulates the bypass valve and the ram air inlet/outlet doors.

This is done in a pre–determined sequence, and is a compromise between the following:

- minimum ram–air flow,
- maintaining adequate heat transfer rates,
- sufficient pack flow.

A priority control overrides this ram–air optimization, if the compressor outlet temperature gets to 180 DEG C (356.00 DEG F) .

During takeoff and landing, the ram–air inlet doors are fully closed to stop the ingestion of foreign matter.

Pack Temperature Control

The pack temperature control system controls the pack outlet temperature and sets its maximum and minimum limits. Two pack controllers control the system.

Each pack controller controls the two major parameters of its related pack:

- the pack outlet temperature (through the water extractor outlet temperature),
- the ram–air cooling flow, which is kept to a minimum for fuel economy.

Each pack controller consists of two computers, one primary and one electrically independent secondary computer.

The primary computer is capable of modulating the system parameters to their full extent, thus optimizing the system performance.

The secondary computer gives a reduced level of optimization when it operates as a back–up in the event of the primary computer failure.

A318–A321 ENHANCED (FIGURE 2)

The A318 Air Conditioning system is designed with several changes.

On the new Air Conditioning system, several components are replaced:

- New ACSCs (**A**ir **C**onditioning **S**ystem **C**ontrollers)
  The Zone and Pack Controllers are removed.
- FCV (**F**low **c**ontrol **v**alve)
- RAIA (**R**am **a**ir **i**nlet **a**ctuator)
- AIV (**A**nti-**i**ce **v**alve)
- Air conditioning panel 30 VU
- Pack Temperature Sensor

Some other are deleted :

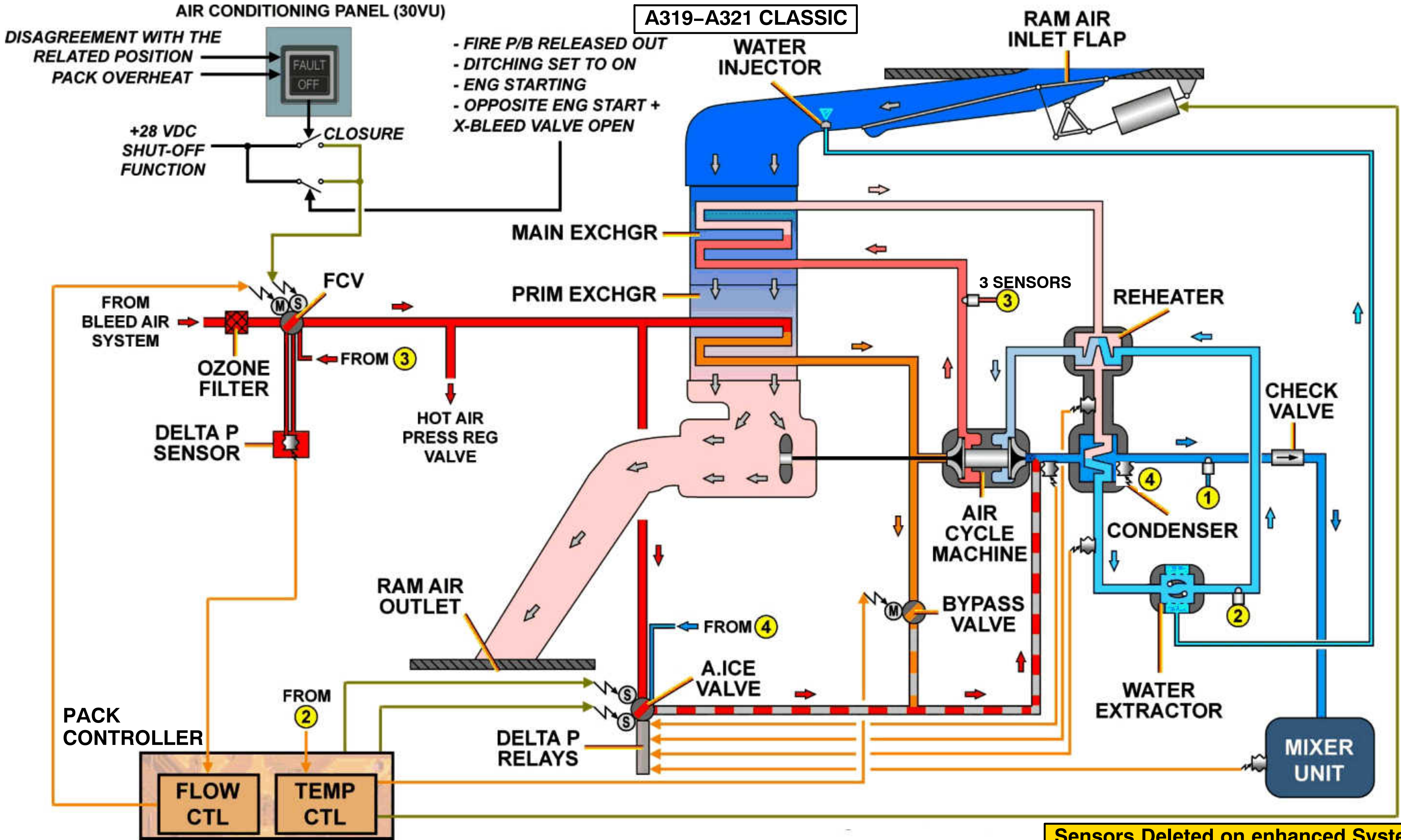
- POPS (**P**ack **O**utlet **P**neumatic **S**ensor)
- CPNOH (**C**ompressor **P**neumatic **O**ver**H**eat sensor)
- Pack flow sensor
- Pneumatic sensing pipe lines

On the A318 the new pack system includes two new ACSCs, an electrically controlled AIV, an improved FCV with integrated pressure sensors and an improved RAIA with speed and direction sensors.

On the air conditioning panel the pack flow selector is replaced by a HI FLOW pushbutton which enables NORM or HI flow.

DLH D-AISH and on:

- NORM + ECO FLOW (100%, 80%)
- 120% in single pack or APU operations
- 100% value is different within family



1 PACK DISCHARGE TEMP SENSOR
2 WATER EXTRACTOR TEMP SENSOR
3 COMPRESSOR PNEUMATIC OVERHEAT SENSOR
COMPRESSOR OVERHEAT SENSOR &
COMPRESSOR DISCHARGE TEMP SENSOR
4 PACK OUTLET
PNEUMATIC SENSOR

Sensors Deleted on enhanced System:
Compressor Pneumatic Overheat Sensor
Compressor Overheat Sensor
Pack Outlet Pneumatic Sensor

Figure 103 Air Cooling A319-A321 Classic

ENHANCED TECHNOLOGY PRESENTATION

Pack Cooling Air Control

The Air Conditioning System Controller 1 (ACSC1) in normal mode calculates the required pack outlet temperature and transmits it to the ACSC2.

To get this temperature, ACSC modulates the bypass valve and the ram air inlet door. This is done in a pre−determined sequence, and is a compromise between the following:

- minimum ram−air flow,
- maintaining adequate heat transfer rates,
- sufficient pack flow.

A priority control overrides this ram−air optimization, if the compressor outlet temperature gets to 180 DEG C (356.00 DEG F) . During takeoff and landing, the ram−air inlet doors are fully closed to stop the ingestion of foreign matter.

Pack Temperature Control

The pack temperature control system controls the pack outlet temperature and sets its maximum and minimum limits. Two ACSC control the system.

Each ACSC controls the two major parameters of its related pack:

- the pack outlet temperature (through the water extractor outlet temperature),
- the ram−air cooling flow, which is kept to a minimum for fuel economy.

Each ACSC consists of two independent lanes.

Flow Control & Indicating

High pressure air is supplied to the air conditioning system from the main pneumatic system. This air goes through two flow control units to two identical independent air conditioning packs.

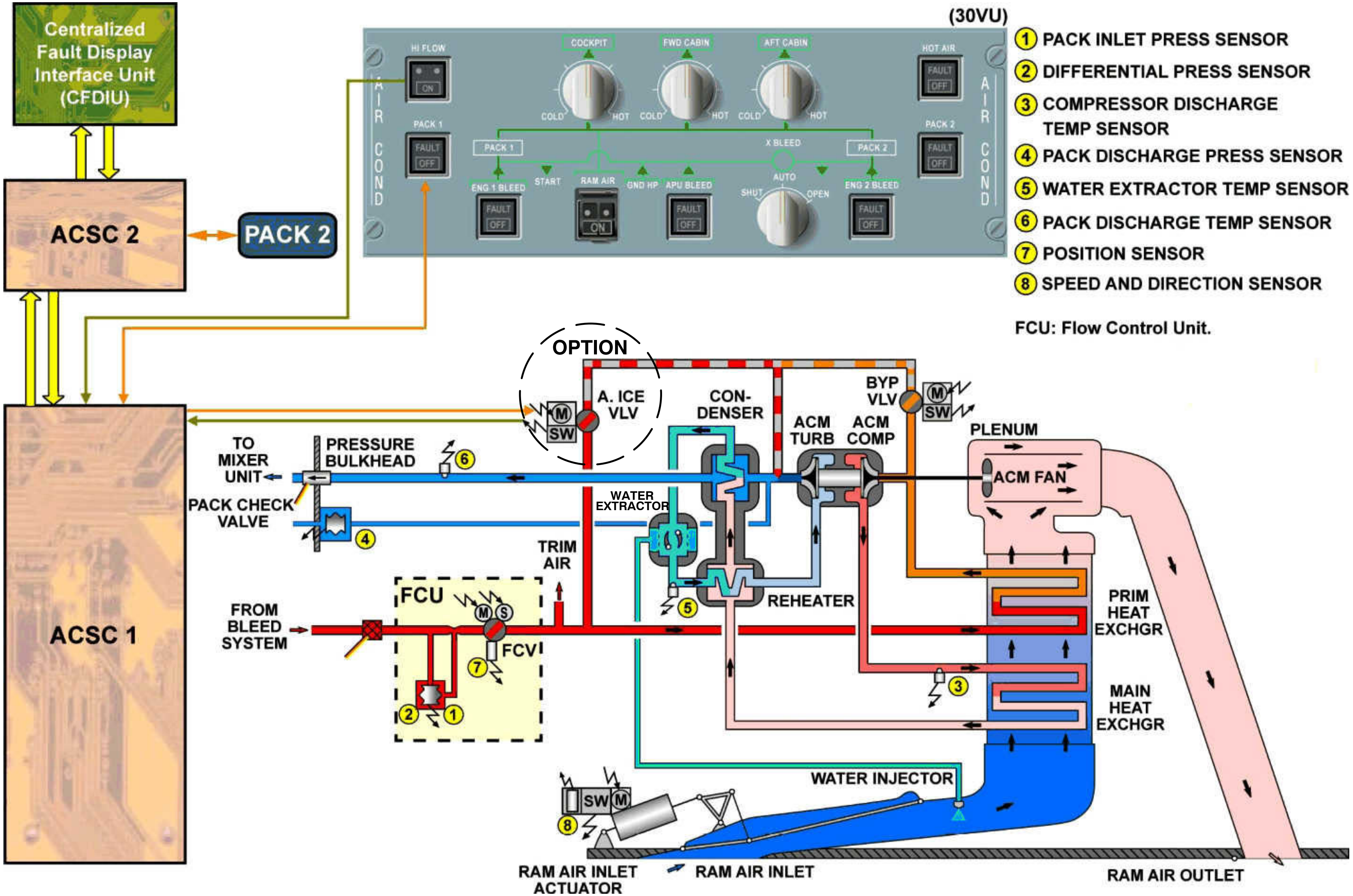


Figure 104 Air Cooling A318-A321 Enhanced

FLOW CONTROL UNITS

The flow control units 23HB (24HB) are installed upstream of the air conditioning packs. The flow control valves of the flow control units control the quantity of air supplied from the pneumatic system to the air conditioning packs.

They control the airflow fully pneumatically depending on the flow demand and the bleed pressure.

The airflow through the flow control valves is selected by the PACK 1 and/or the PACK 2 pushbutton switches.

A318

The percentage of airflow from the flow control valves is selected by the HI FLOW pushbutton switch.

The HI FLOW pushbutton switch, which is located on the AIR COND panel 30VU, has two positions:

- the NORM position, which sets the flow control valve to 100% of the normal airflow,
- the HI position, which sets the flow control valve to 120% of the normal airflow.

NOTE: This position is selected in abnormal hot ambient conditions or to clear smoke.

The HI FLOW pushbutton switch transmits the selected switch position to the ACSC 1 and via ARINC interface to the ACSC 2. The ACSC calculates the necessary flow demand. Both ACSC set the flow control valves in the necessary reference position.

A319/A320

The FLOW selector pushbutton switch, which is located on the AIR COND panel 30VU, has three positions:

the NORM position, which sets the flow control valve to 100% of the normal airflow,

the LO position, which sets the flow control valve to 80% of the normal airflow.

NOTE: The LO position can be selected for fuel economy purpose.
This position must only be selected when there is a reduced number of passengers in the cabin, the HI position, which sets the flow control valve to 120% of the normal airflow.

NOTE: This position is selected in abnormal hot ambient conditions or to clear smoke.

The FLOW selector transmits the selected switch position to the ACSC 1 and via ARINC interface to the ACSC 2. The ACSC calculates the necessary flow demand.

Both ACSC set the flow control valves in the necessary reference position.

A321

The percentage of airflow from the flow control valves is selected by the ECON FLOW pushbutton switch.

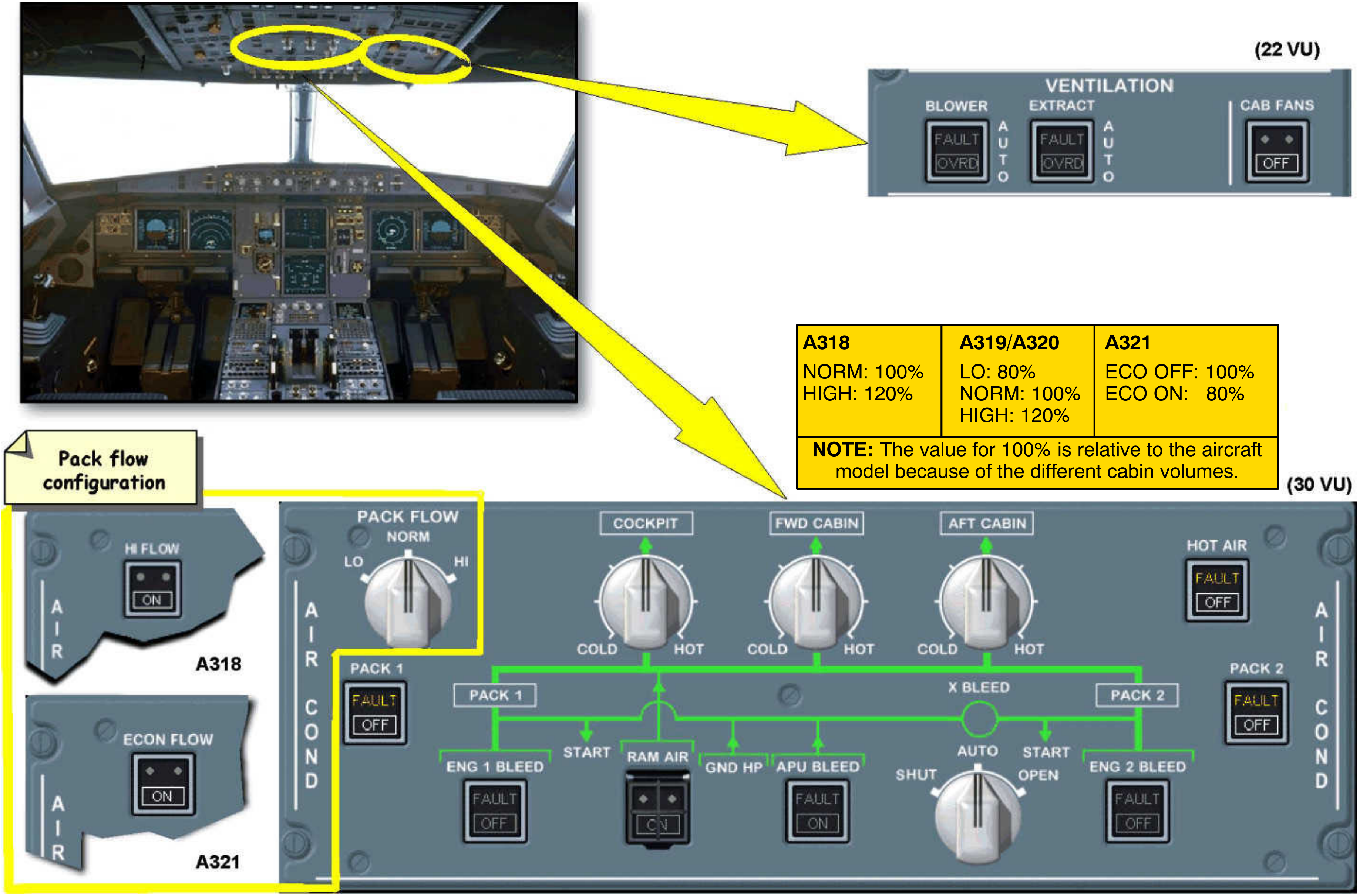
The ECON FLOW pushbutton switch, which is located on the AIR COND panel 30VU, has two positions:

- The 'off' position, which sets the flow control valve to 100% of the normal airflow and
- the ON position, which sets the flow control valve to 80% of the normal airflow.

NOTE: The ON position can be selected for fuel economy purpose.
This position must only be selected when there is a reduced number of passengers in the cabin.

The ECON FLOW pushbutton switch transmits the selected switch position to the to the ACSC 1 and via ARINC interface to the ACSC 2. The ACSC calculates the necessary flow demand.

Both ACSC set the flow control valves in the necessary reference position.



A318	A319/A320	A321
NORM: 100% HIGH: 120%	LO: 80% NORM: 100% HIGH: 120%	ECO OFF: 100% ECO ON: 80%

NOTE: The value for 100% is relative to the aircraft model because of the different cabin volumes.

Figure 105 Pack Flow Controls

21−00 AIR CONDITIONING-GENERAL

PACK SYSTEM (ENHANCED) PRESENTATION

Flow Control Valve

The FCV is an electro-pneumatic butterfly valve with the following main functions:

- control of the mass flow of bleed air entering the pack.
- isolation of the pack from the bleed air supply (crew selection, engine fire, ditching, or engine start).
- Air cycle machine overheat and low pressure start up protection (controlled by the ACSC). When ACM > 215 DEG C then Flow Reduction.

ACSC1 controls the FCV for pack 1, while ACSC2 controls the FCV for pack 2.

Under normal conditions, each ACSC uses a closed loop electronic control circuit to regulate the butterfly position and resulting pack inlet flow.

The FCV has two modes of operation:

- main: electrical control (100% to 144% depending if A318,19,20,21),
- back-up: pneumatic control (140% to 174%depending if A318,19,20,21).

In the main operating mode, the FCV position is modulated to respond to:

- changing flow demands
- control priorities (take-off, landing, pack start, etc.)
- failures and pack overheat conditions.

In the back-up mode, the FCV flow is controlled by a downstream pressure regulator.

The PACK 1 and/or the PACK 2 pushbutton switches control the related pack flow control valve to the open or closed position.

The ACSC closes the associated flow control valve automatically if:

- there is an engine start,
- there is an ENGINE FIRE pushbutton switch released,
- there is a compressor overheat,
- there is low bleed pressure,
- the DITCHING pushbutton switch is in the on position,
- the applicable PACK 1 or PACK 2 pushbutton switch is in the off position.

Anti Ice Valve

The AIV is operated by an electro-mechanical actuator.

The valve is controlled by the ACSC.

The AIV main function is to remove ice build-up from components downstream of the turbine outlet (condenser tubing, temperature sensors, check valves, mixing unit).

The ACSC uses the PDPS (**P**ack **D**ischarge **P**ressure **S**ensor) to compare the pack discharge pressure to the turbine outlet pressure. If the difference between these two pressures exceeds a predetermined limit, then icing is assumed.

As a result, the ACSC will command the AIV to open, hot air flows directly into the turbine outlet and pack discharge. This hot air will melt the ice, causing the pack discharge pressure to return to a normal value.

Once the pressures are within a certain limit, the AIV will fully close.

The AIV is identical and interchangeable with the system TAV (**T**rim **A**ir **V**alves).

NOTE: Nowadays the AIV is an option!

Pressure Sensors

Each pack has 3 pressure sensors. These sensors are used for the following purposes:

- flow control, actual flow calculation
- icing detection

The PDPS detect an increase in the ACM turbine outlet pressure relative to the aircraft cabin. This indicates icing conditions exist.

Ram Air Inlet Actuator

The RAIA (**R**am **A**ir **I**nlet **A**ctuator) is monitored and controlled by the ACSCs.

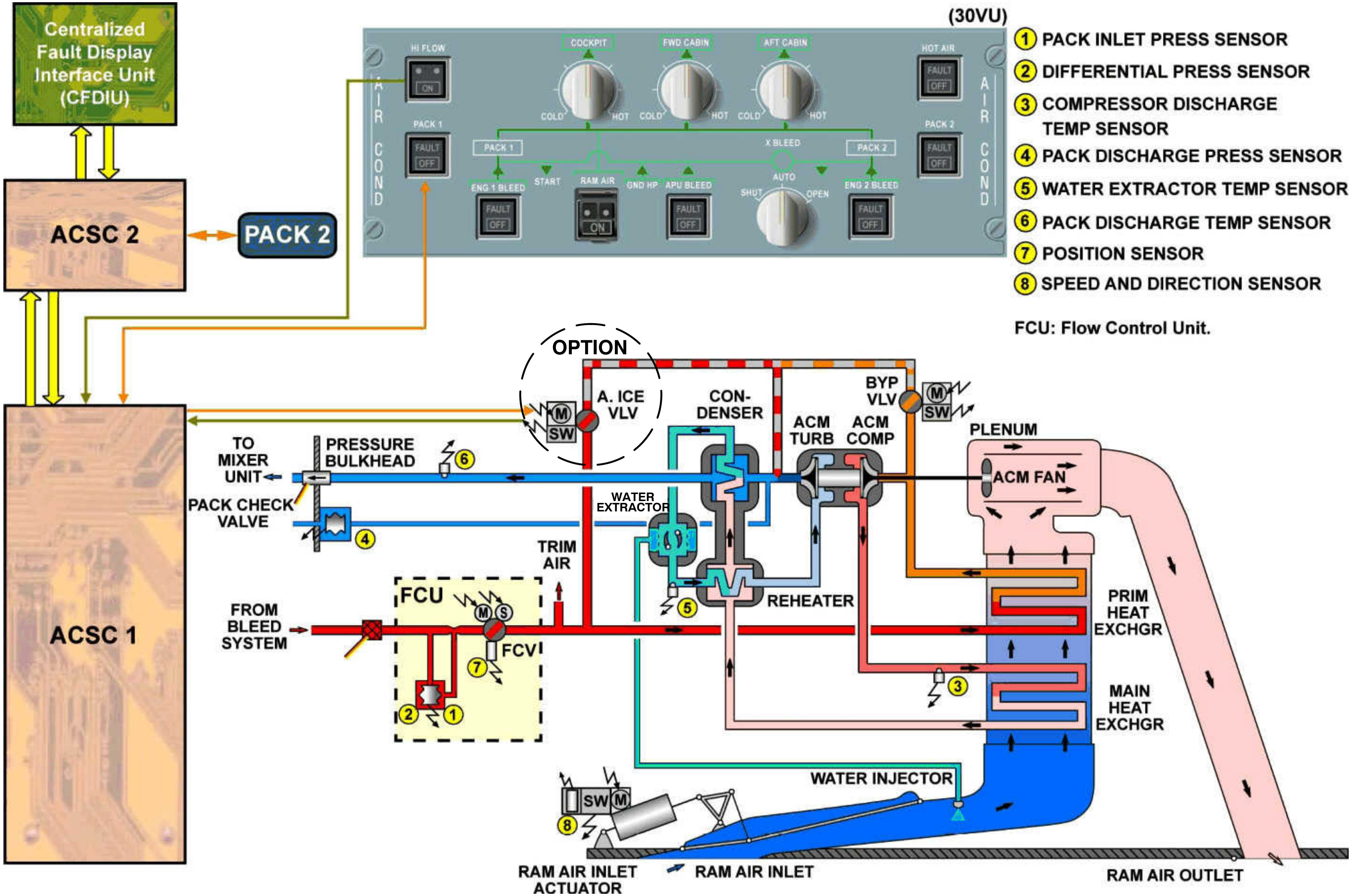


Figure 106 Air Cooling Pack System Description

FLOW CONTROL VALVE MAIN CONTROL OR BACK-UP MODE

The flow control units are installed upstream of the air conditioning packs. The flow control valves of the flow control units are electrically commanded, pneumatically actuated and have a nominal diameter of 4 in. (101.5998 mm).

Both have a built–in butterfly valve that controls the flow and can also perform a shut–off function.

The flow control valve has the following main components:

- the valve body with venturi,
- 3 chamber pneumatic actuator,
- torque–motor electrical regulation,
- contactless duplex position sensor (Hall–sensor)
- integral DPS and PIP sensors,
- downstream pressure limiter,
- on/off solenoid
- mode selection solenoid.

Actuator

The actuator has 3 pneumatic chambers, eliminating the need for a constant pressure regulator, increasing reliability and resistance to pollution. The actuator opens or closes the FCV butterfly valve using the air pressure available in the main actuator chamber.

Torque–motor and valve

The valve is positioned by a torque–motor. The position of the valve varies the amount of leakage from the actuator chamber, controlling the butterfly valve position. The torque–motor is driven directly by the ACSC.

Position Sensor

The contactless "Hall" position sensor indicates to the ACSC whether the FCV is:

- Fully closed (FC)
- Not fully closed (NFC)

DPS and PIP Sensors

The ACSC uses information from these two sensors, along with aircraft cabin altitude and bleed air temperature to calculate the actual flow through the FCV.

The two sensors are fool proofed to prevent incorrect installation.

Downstream Pressure Limiter

The downstream pressure limiter operates in the back–up mode to limit the downstream pressure to a fixed value. This will result in a pneumatically controlled flow.

Solenoid– On/Off

Determines whether the FCV is open or closed:

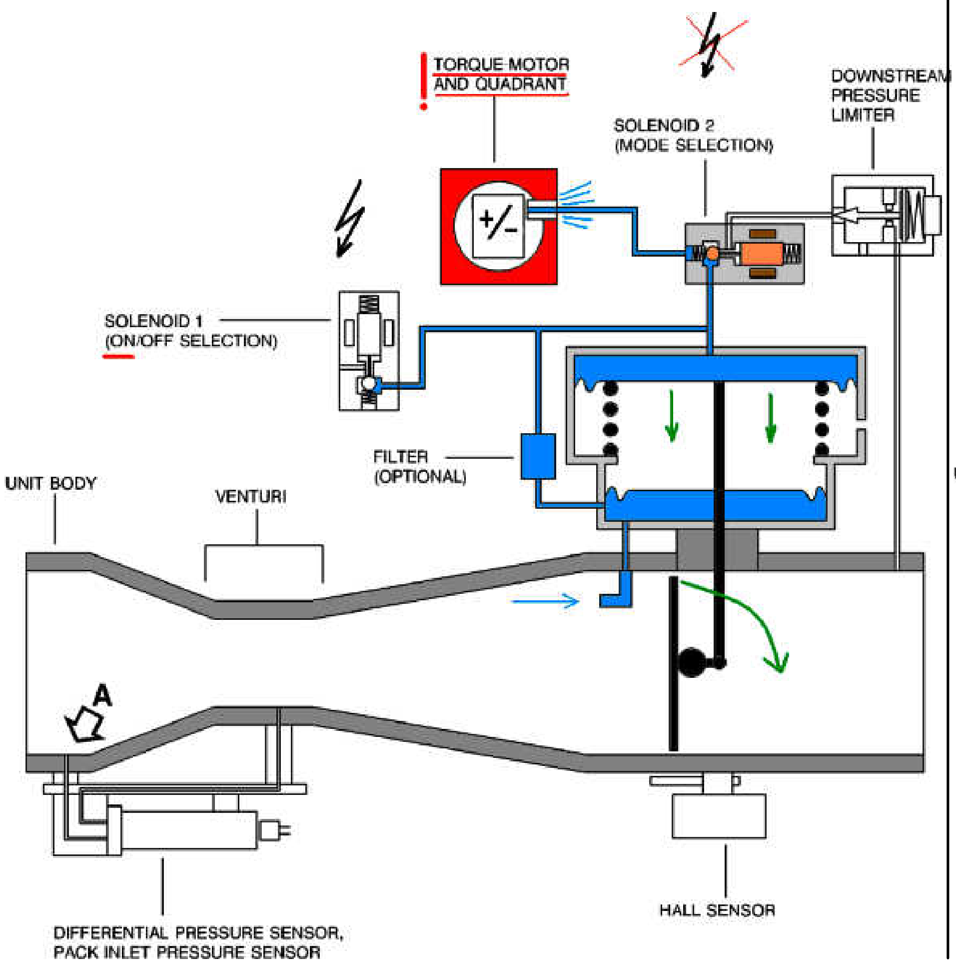
- Solenoid energized:
  FCV open and regulating
- Solenoid de–energized:
  FCV closed

Solenoid–Mode Selection

The mode selection solenoid determines whether the FCV is operating in the main control mode or the back–up mode.

- Solenoid energized:
  back–up mode
- Solenoid de–energized:
  main mode

FCV MAIN CONTROL MODE (ELEC)



FCV BACKUP MODE (PNEUM)

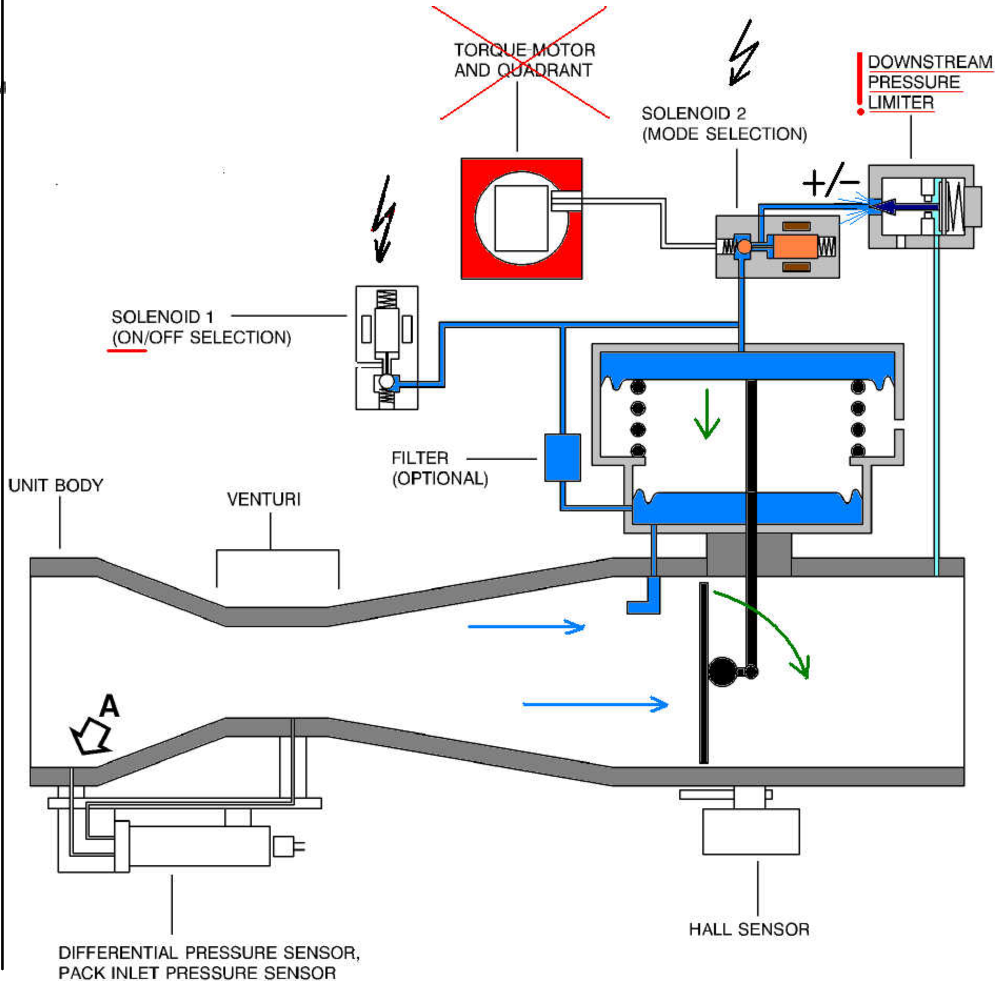


Figure 107 FCV Main Control & Backup Mode

21−00 AIR CONDITIONING-GENERAL

ACSC SYSTEM DESCRIPTION

Air Conditioning System Controller

The ACSC is a 2 lane, fully redundant computer system with independent central, processing units and duplicated hardware interfaces.

One lane is active while the other lane is passive (“hot-standby“).

If the active lane is not able to control the system, the passive lane will become active and take over system control.

The active lane switches at each aircraft landing, assuming the passive lane has no faults which are more severe than those in the active lane.

The ACSCs perform the following functions:

- temperature and zone control
- mixer-pack control
- flow control (pack FCV)
- demand calculation
- pack flow
- pack temperature
- overheat monitoring/ control (pack and ducts)
- ACS component monitoring and fault detection
- ACS failure storage
- data exchange (ACSC1, ACSC2, A/C systems)

ACSC1 and ACSC2 have different functions. Functional differences between the two controllers are determined by pin programming after installation in the aircraft.

In general, the functions allocated to each controller are as follows:

ACSC1:

- control of F/D zones, trim system and trim air pressure regulating valve,
- wing and nacelle anti ice logic.

ACSC2:

- control of cabin zones and trim system,
- CFDS interface and fault storage,
- wing anti ice fault analysis,
- mixer flap drive and monitoring.

The ACSCs 1 and 2 interface with:

- the engine FADEC system for pack shut down during engine start,
- the APU ECB for increased or decreased bleed air flow according to pack demand.

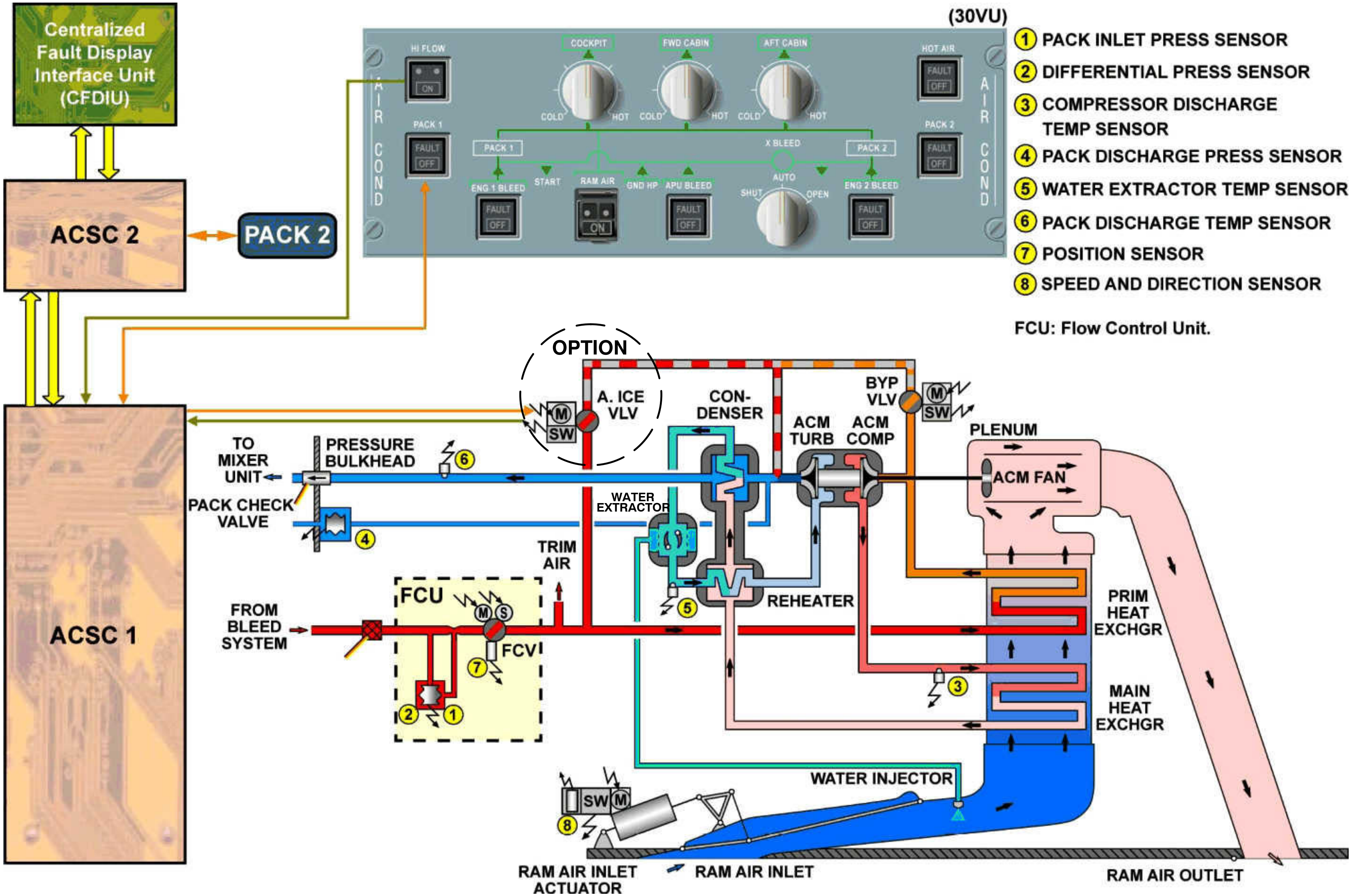


Figure 108 Air Cooling Pack System Description

21–20 DISTRIBUTION

ENHANCED PRESENTATION

There is one major modification on the A318.

During normal or abnormal operation the control of the cockpit and cabin system is now ensured by the two ACSCs.

Cabin zones demanding a higher temperature than that available from the mixer unit will receive additional hot trim-air by TAV.

Operating of the TAVs will be done by ACSC1 for cockpit and ACSC2 for the fwd and aft cabin zones.

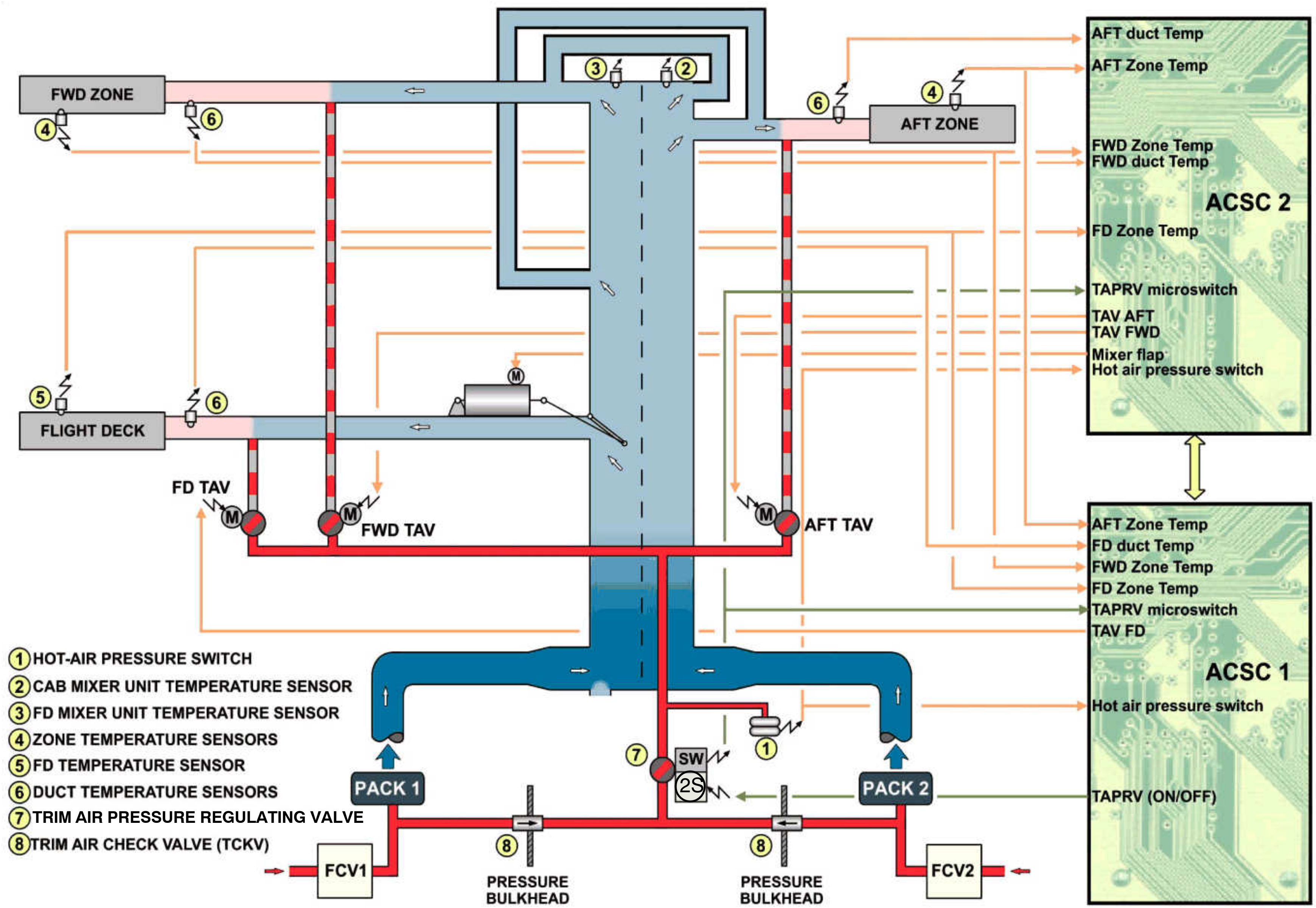


Figure 109 Air Distribution

21–00 AIR CONDITIONING-GENERAL

ACSC MAINTENANCE MENU (ENHANCED) PRESENTATION

Some minor modifications have been applied on the MCDU CAB TEMP CONT menu page such as a GROUND REPORT line is added.

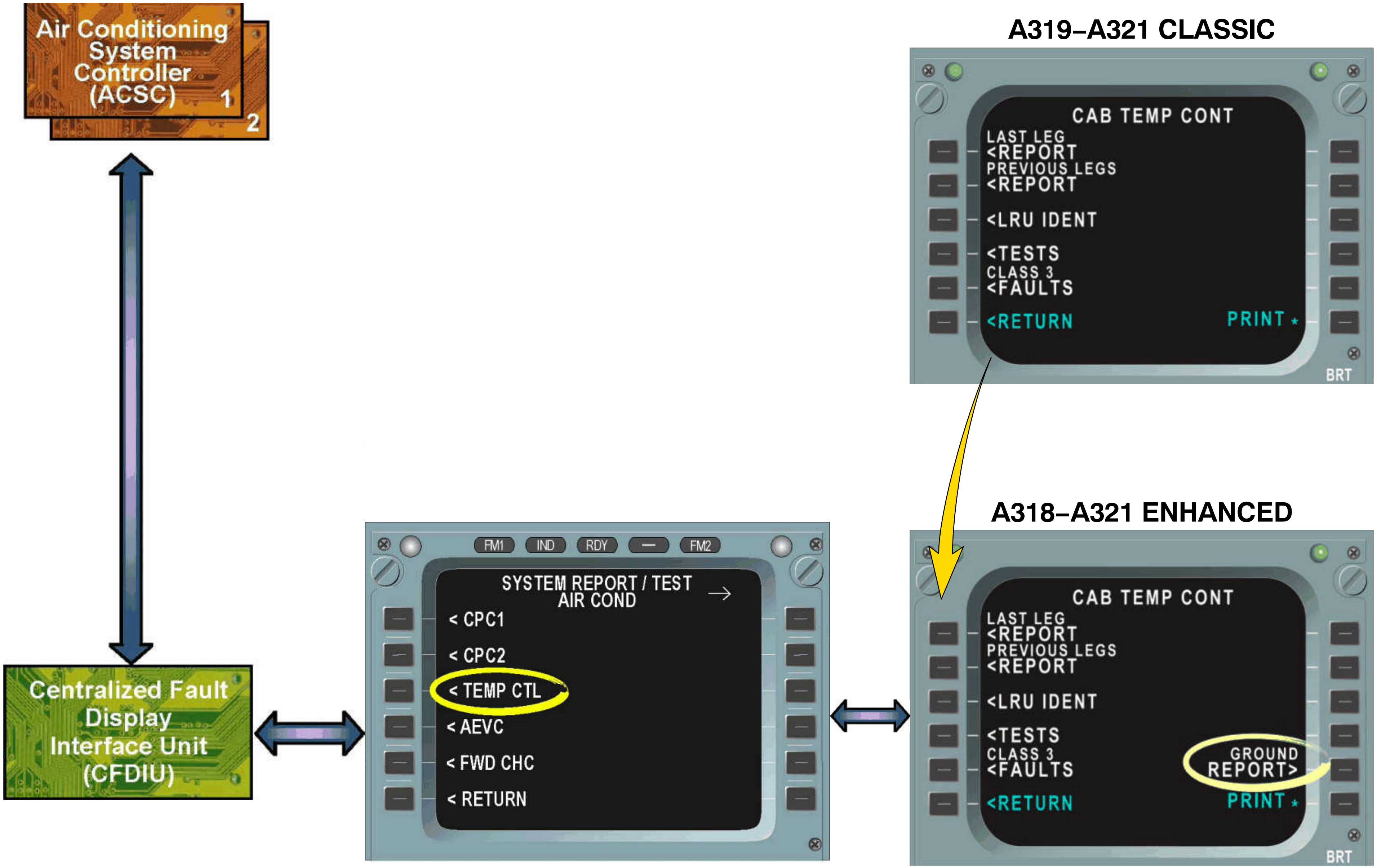


Figure 110 Air Cooling CFDS MCDU Pages

AIR COND. COMPONENT (ENHANCED) LAYOUT

ACSC

The ACSCs (**A**ir **C**onditioning **S**ystem **C**ontroller) are installed in the racks 95VU and 96VU of the avionics compartment.

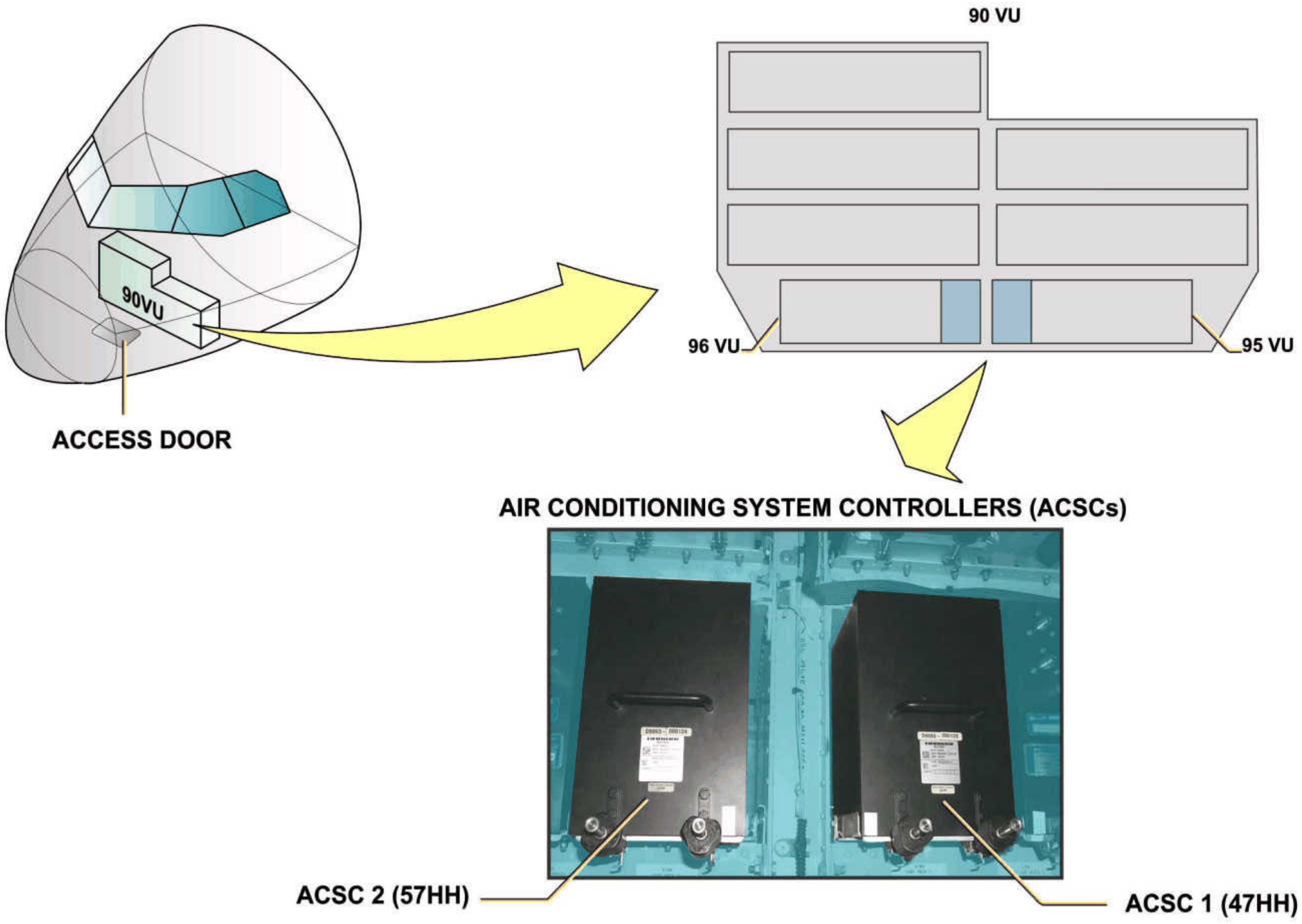


Figure 111 Air Cooling Component Location (1)

Flow Control Valve

The FCVs are located in the bleed air supply line, upstream of each pack.

The FCV has the following main components:

- inclined axis valve body with venturi
- 3 chamber pneumatic actuator
- torque-motor electrical regulation
- contactless position sensor
- integral DPS and PIP sensors
- downstream pressure sensor
- on/ off solenoid
- mode selection solenoid

Anti Ice Valve

The AIVs are installed in the ducts to the turbines of the air-cycle machines upstream of the primary heat exchangers.

Pressure Sensors

The DPS (**D**ifferential **P**ressure **S**ensors) and the PIPS (**P**ack **I**nlet **P**ressure **S**ensor) are mounted directly to the venturi on the FCV housing.

The PDPS (**P**ack **D**ischarge **P**ressure **S**ensor) is mounted to the bulkhead between the air conditioning bay and the pressurized cabin.

Ram Air Inlet Actuator

The Ram Air Inlet Actuators are installed on the ram air inlets (LH and RH) in the fuselage belly fairing.

On A318, the two Ram Air Inlet Actuators potentiometers are replaced by a contactless speed and direction sensor (“Hall“ sensor) which provides feedback information to ACSCs.

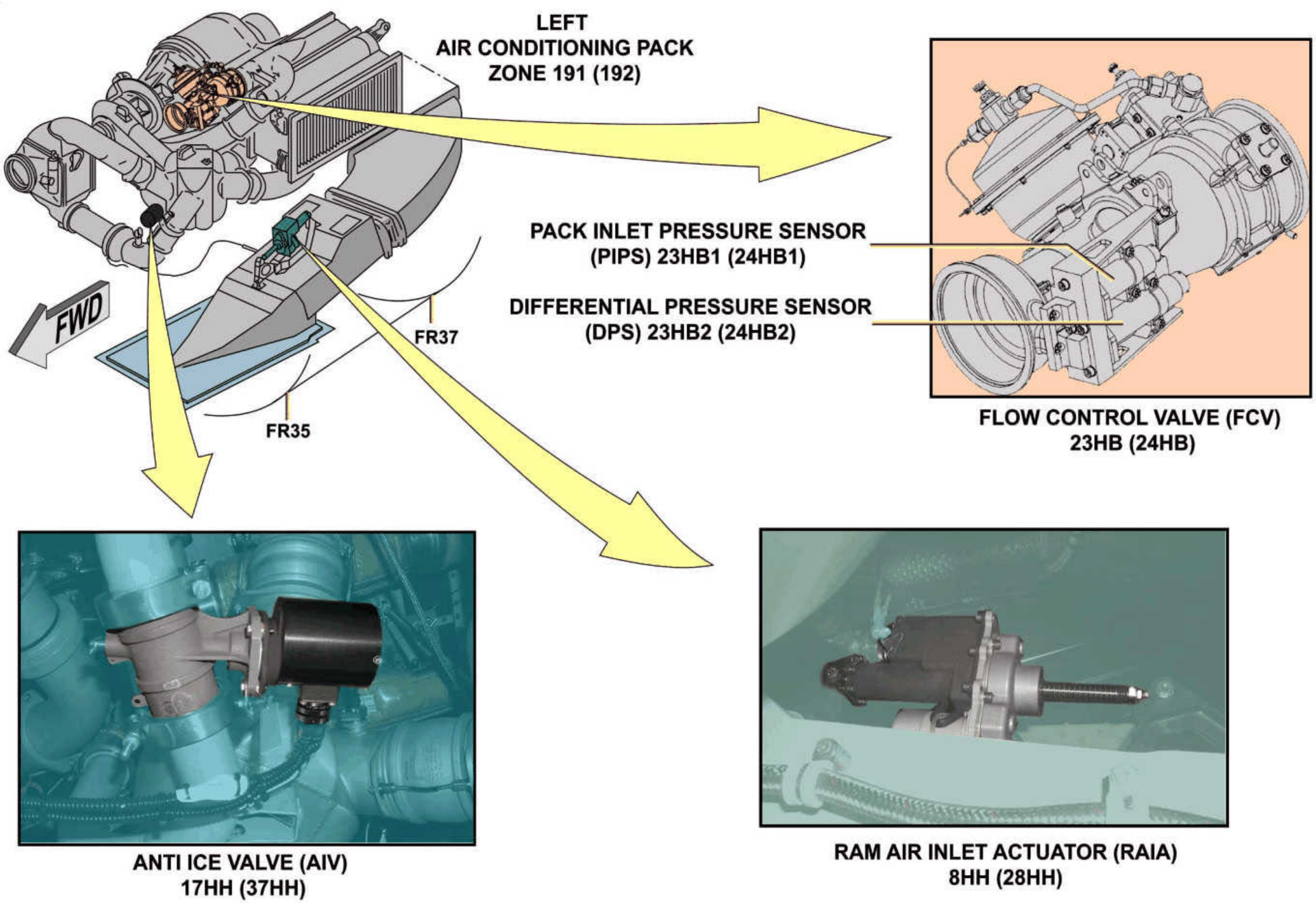


Figure 112 Air Cooling Component Location (2)

COMPONENT DESCRIPTION (ENHANCED)

Flow Control Valve

The FCVs are located in the bleed air supply line, upstream of each pack.

The FCV has the following main components:

- inclined axis valve body with venturi
- 3 chamber pneumatic actuator
- torque-motor electrical regulation
- contactless position sensor
- integral DPS and PIP sensors
- downstream pressure sensor
- on/ off solenoid
- mode selection solenoid

Anti Ice Valve

The AIVs are installed in the ducts to the turbines of the air-cycle machines upstream of the primary heat exchangers.

Pressure Sensors

The DPS (**D**ifferential **P**ressure **S**ensors) and the PIPS (**P**ack **I**nlet **P**ressure **S**ensor) are mounted directly to the venturi on the FCV housing.

The PDPS (**P**ack **D**ischarge **P**ressure **S**ensor) is mounted to the bulkhead between the air conditioning bay and the pressurized cabin.

Ram Air Inlet Actuator

The Ram Air Inlet Actuators are installed on the ram air inlets (LH and RH) in the fuselage belly fairing.

On A318, the two Ram Air Inlet Actuators potentiometers are replaced by a contactless speed and direction sensor (“Hall“ sensor) which provides feedback information to ACSCs.

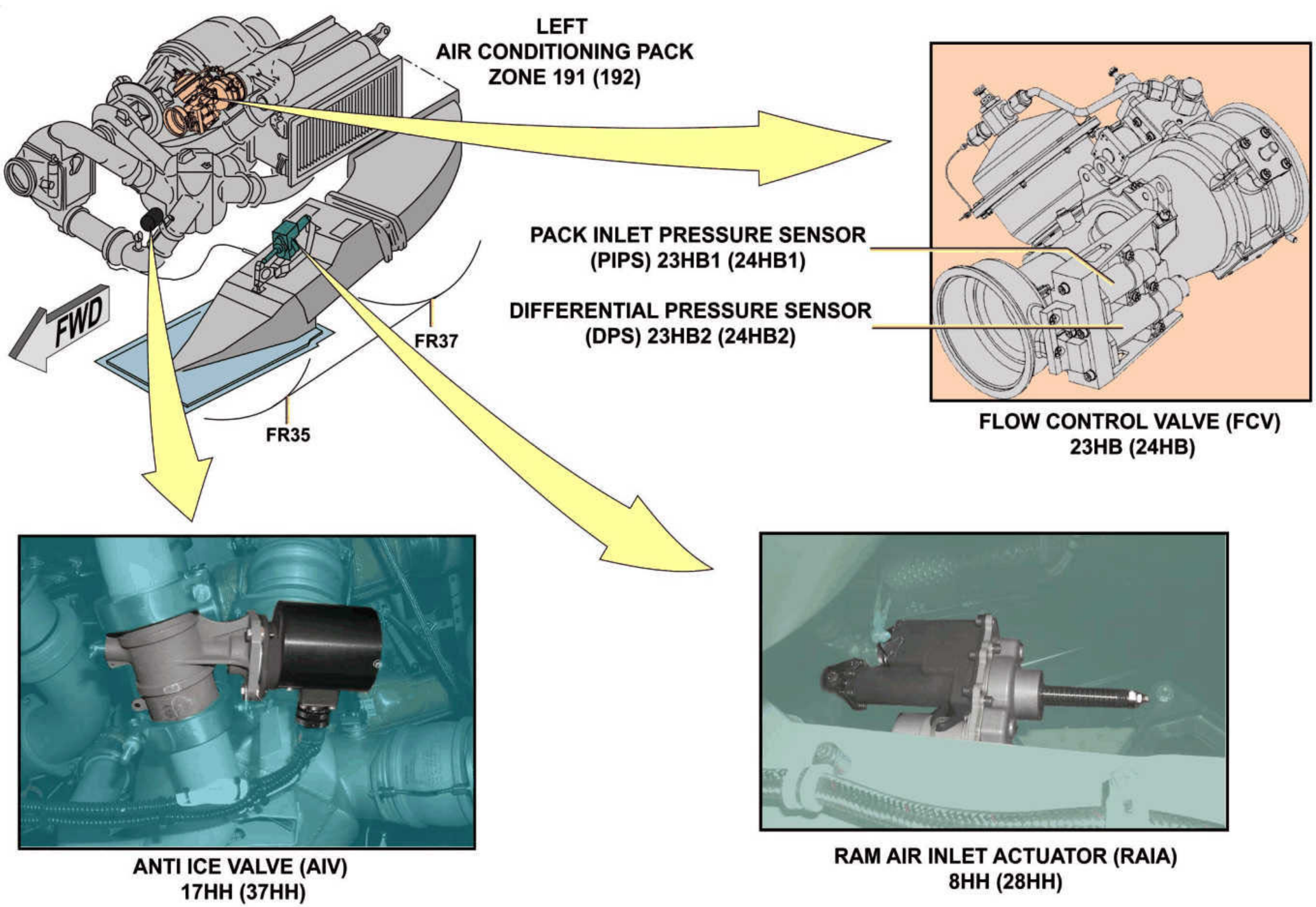


Figure 113 Air Cooling Component Location (2)

21-30 PRESSURIZATION CONTROL

RPCU (ENHANCED) INTRODUCTION

The Residual Pressure Control Unit (RPCU) controls the residual pressure in the cabin if:

- There is a failure in the two automatic control parts of the CPCs (Cabin Pressure Controller).
- The CPCs is set to the manual mode.

The RPCU opens the outflow valve automatically after landing if:

- The outflow valve is not fully open
- The CPCs is in manual mode or there is a failure of the two CPCs
- The crew did not open the outflow valve in the manual mode.

The RPCU is installed in the right-hand side of the avionics compartment. It uses the external relay 21HL to supply power directly to the manual motor of the outflow valve.

The RPCU is an electronic box with 2 connectors for the electrical interface connection. The RPCU is not attached to a rack and has no local controls or indicators.

The RPCU is permanently connected to the 28V DC BATTERY BUS 301PP and has a discrete 28V DC output for the power supply of the manual motor of the outflow valve.

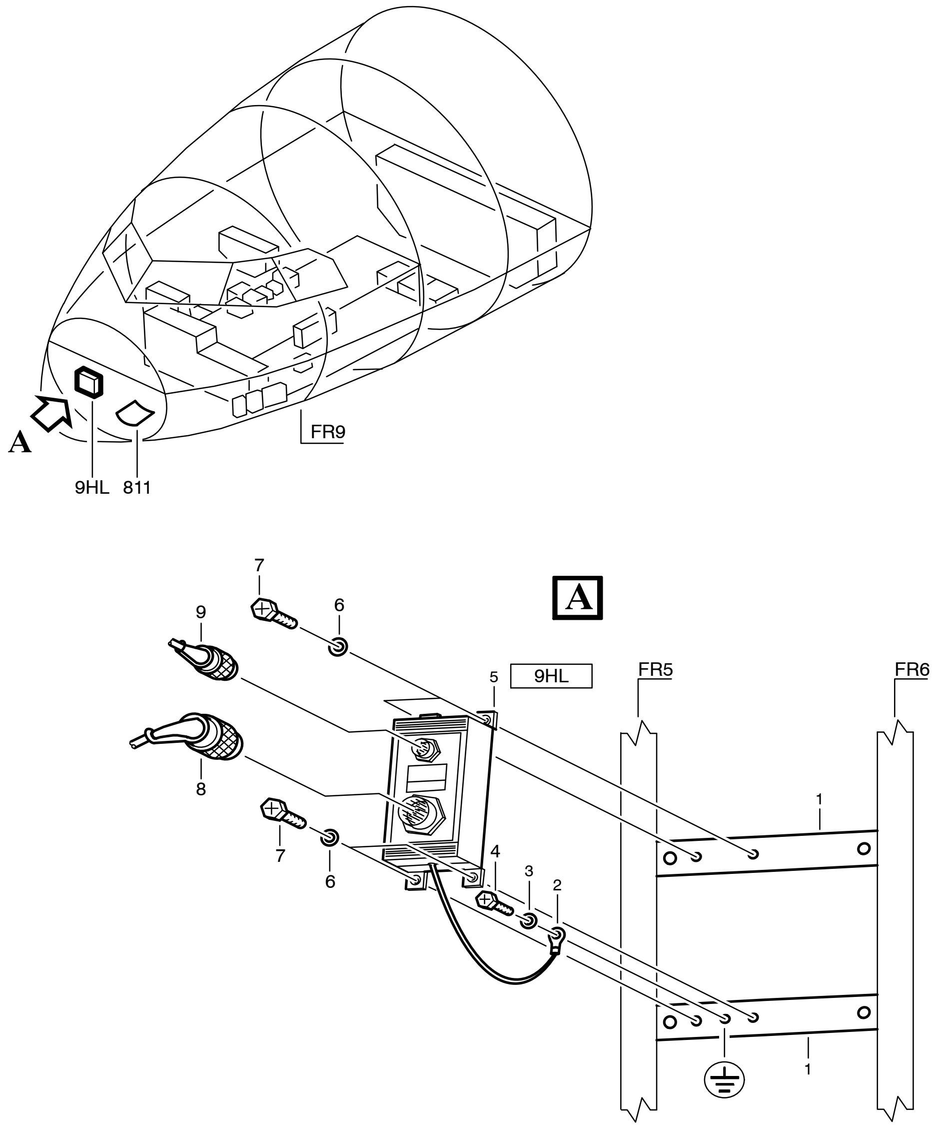


Figure 114 RPCU Location

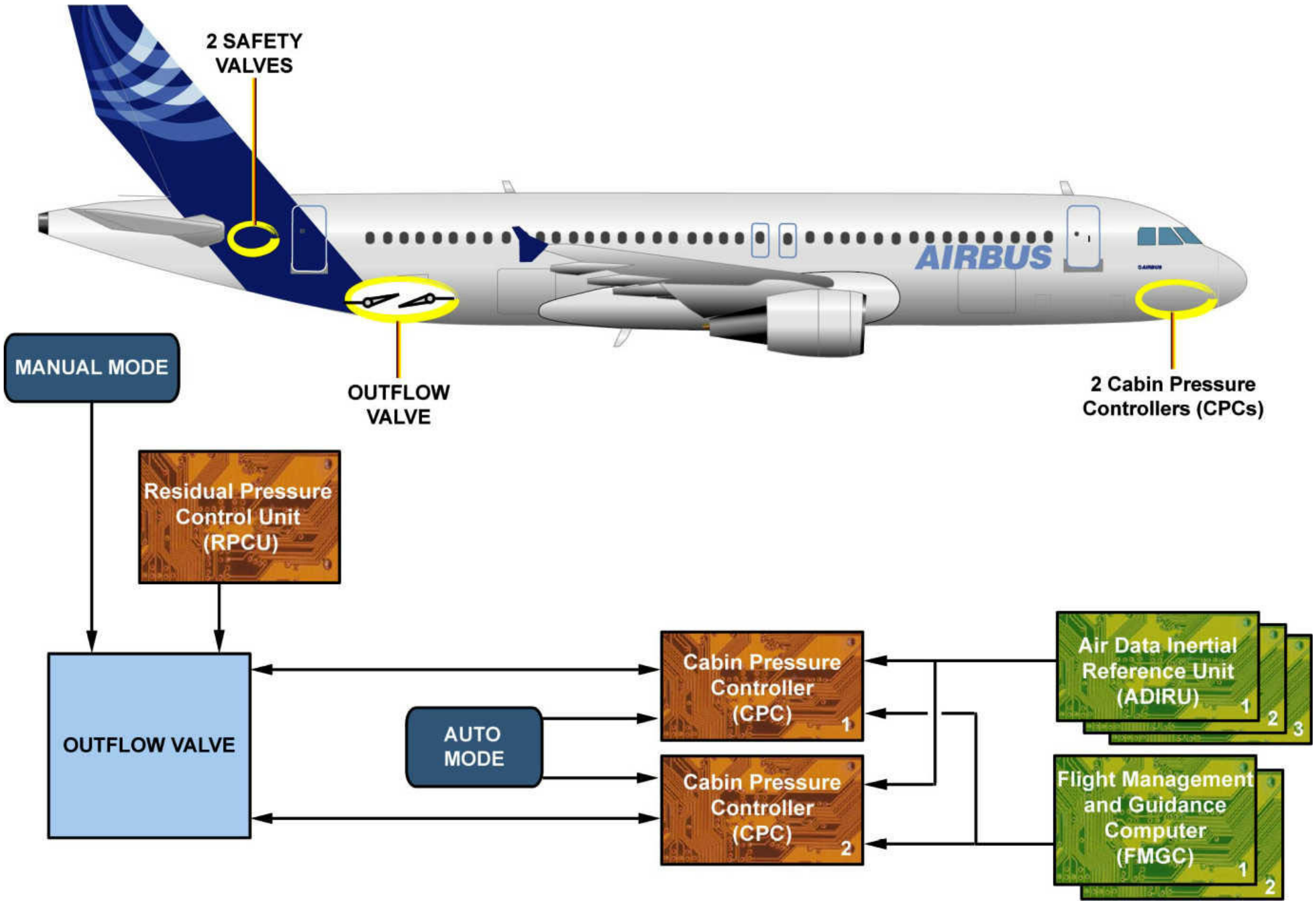


Figure 115 Residual Pressure Control Unit

RPCU ABNORMAL OPERATION (ENHANCED)

Failure mode

If in both CPCs systems failures appear, the crew must control the cabin pressure manually.

The CPCs send a signal to EIS and on the ECAM upper display unit the related warning appears.

The CPCs also keep the failure data in its memory which can be indicated on the MCDU.

If the crew cannot control the cabin pressure manually, the RPCU will open the outflow valve automatically under these conditions:

- The outflow valve is not fully open
- Both landing gears are on ground or one landing gear is on ground and the park brake is applied
- Both engine master lever switches are in the OFF position or all air data units show speed below 100 knots
- The two CPCs are in standby fail or on manual mode

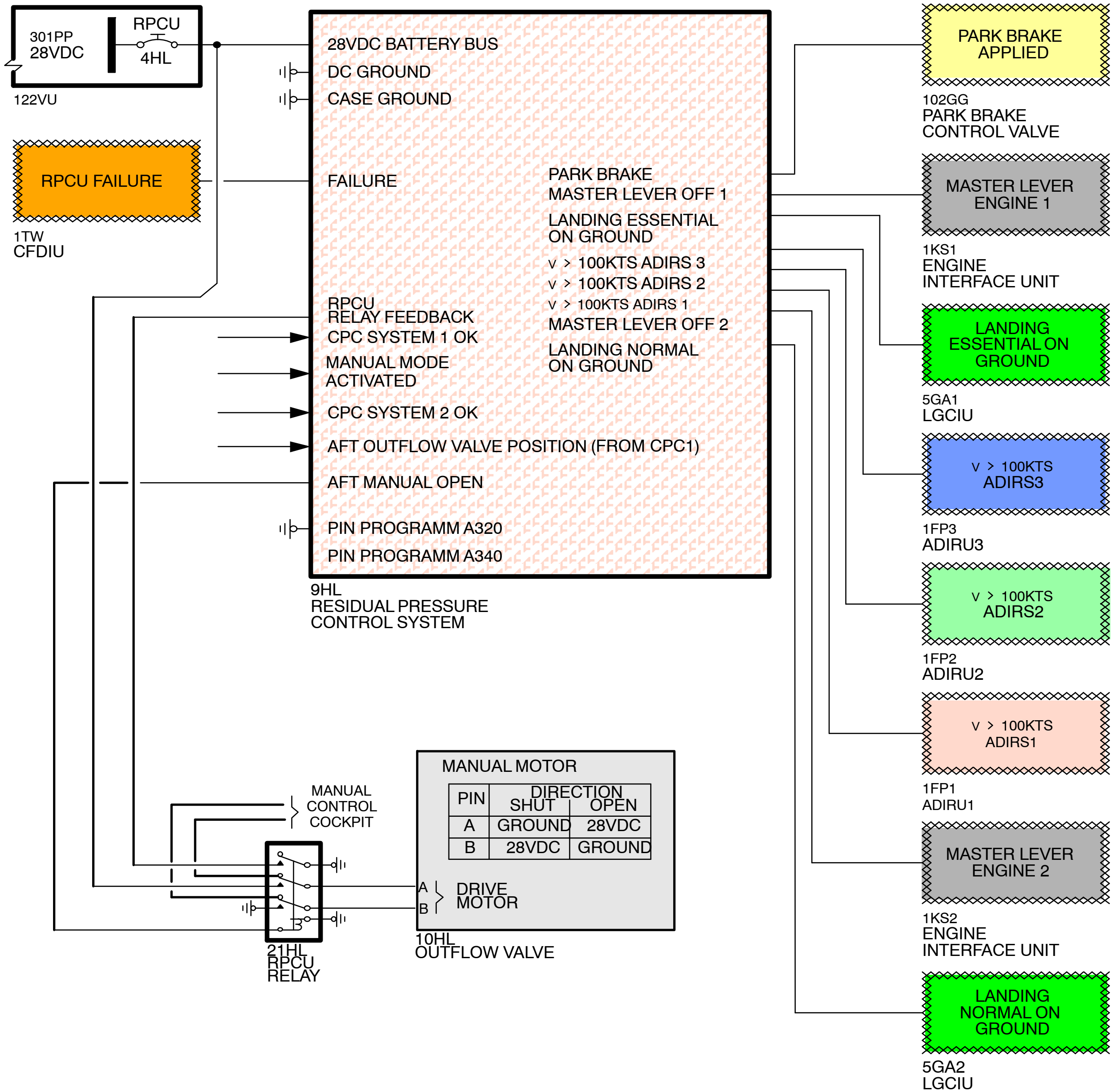


Figure 116 RPCU Schematic

10|RPCU|L3/B1/B2

21–00 AIR CONDITIONING-GENERAL

MAINTENANCE PRACTICES

When you work on the aircraft, make sure you obey all the AMM procedures. This will prevent injury to personnel and/or damage to the aircraft.

Here is an overview of the main safety procedures related to the air conditioning system:

- Make sure that air is not supplied to the air conditioning system from the main engine, the APU or a ground source during maintenance.

  Hot compressed air can cause injury to personnel. Make sure the system is depressurized.
- When you are working with harmful products, use protective clothing, rubber gloves and goggles as necessary.
- Do not touch a component until it is sufficiently cool to prevent burns.
- Make sure that there are no personnel or equipment near the ram air outlets (if installed) and inlets. Hot exhaust gases can cause injury to persons and/or damage to equipment. Use specific tools for each component.
- Keep away from the moving and energized parts when you operate or test the valves and the flaps.
- If you exchange heavy components support the unit/assembly or it will fall and become damaged or injure personnel.
- Use the specific tools named in the AMM for the air conditioning components if you replace heavy air conditioning component.
- Make sure that one door or window is open with a warning placard attached to it. The warning notice must tell the persons not to close the door or window. This prevents accidental pressurization of the aircraft.

Figure 117 Safety Precautions

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF FIGURES