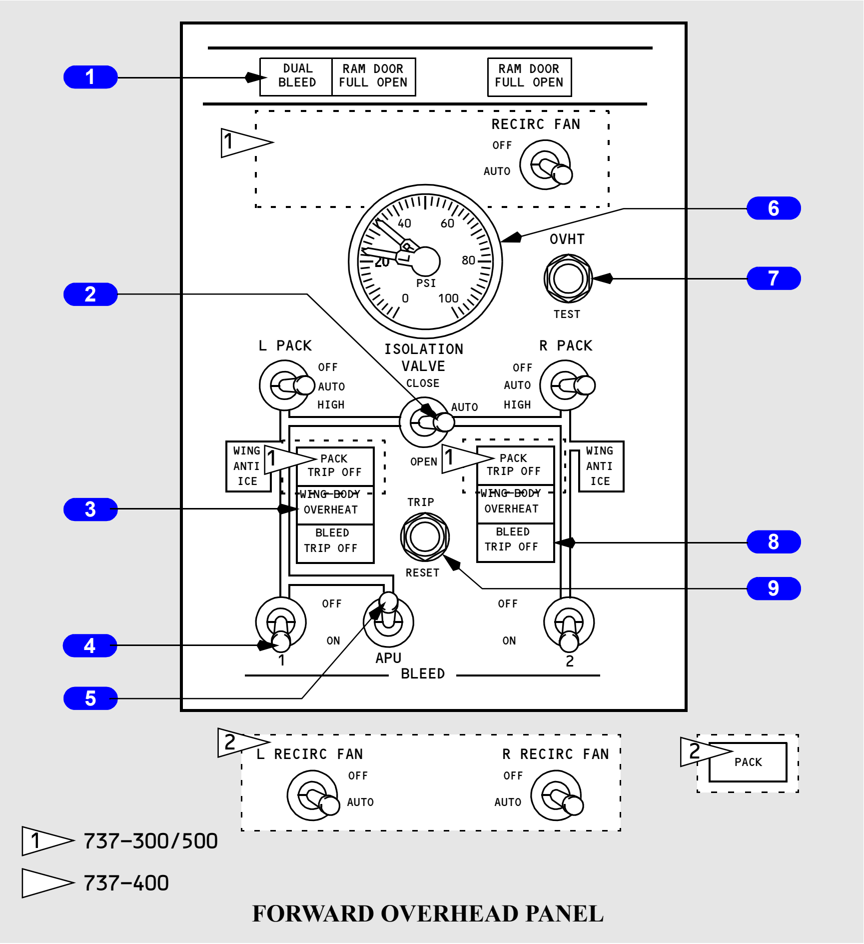
Bleed Air Controls and Indicators



1 DUAL BLEED Light

Illuminated (amber) – APU bleed air valve open and engine No. 1 BLEED air switch ON, or engine No. 2 BLEED air switch ON, APU bleed air valve and isolation valve open.

2 ISOLATION VALVE Switch

CLOSE – closes isolation valve.

AUTO –

- closes isolation valve if both engine BLEED air switches are ON and both air conditioning PACK switches are AUTO or HIGH
- opens isolation valve automatically if either engine BLEED air or air conditioning PACK switch positioned OFF.

OPEN – opens isolation valve.

3 WING–BODY OVERHEAT Light

Illuminated (amber) –

- left light indicates overheat from bleed air duct leak in left engine strut, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct
- right light indicates overheat from bleed air duct leak in right engine strut, right inboard wing leading edge or right air conditioning bay.

4 Engine BLEED Air Switches

OFF – closes engine bleed air valve.

ON – opens engine bleed air valve when engines are operating.

5 APU BLEED Air Switch

OFF – closes APU bleed air valve.

ON – opens APU bleed air valve when APU is operating.

6 Bleed Air DUCT PRESSURE Indicator

Indicates pressure in L and R (left and right) bleed air ducts.

7 Wing–Body Overheat (OVHT) TEST Switch

PUSH –

- tests wing–body overheat detector circuits
- illuminates both WING–BODY OVERHEAT lights.

8 BLEED TRIP OFF Light

Illuminated (amber) – excessive engine bleed air temperature or pressure

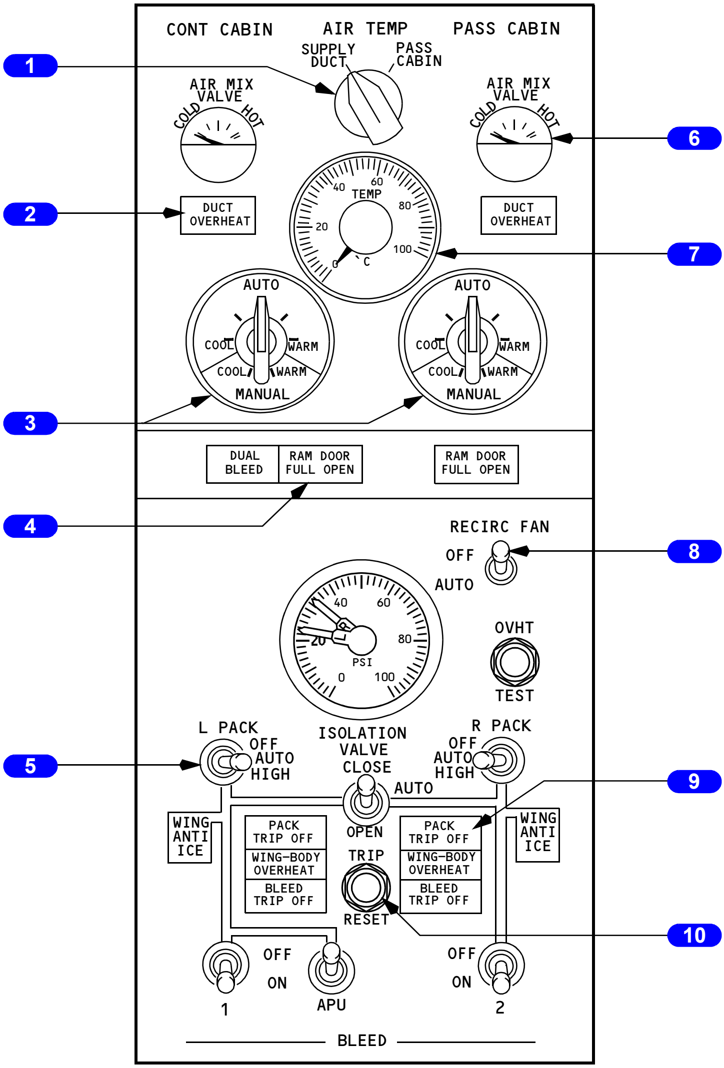
- related engine bleed air valve closes automatically
- requires reset.

9 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights (BLEED TRIP OFF, PACK and ZONE TEMP lights for 737-400)
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators (737-300/500)



FORWARD OVERHEAD PANEL

1 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects main distribution supply duct sensor for TEMP indicator.

PASS CABIN – selects passenger cabin sensor for TEMP indicator.

2 DUCT OVERHEAT Light

Illuminated (amber) –

- bleed air temperature in related duct exceeds limit
- air mix valves drive full cold
- requires reset.

3 Control (CONT) CABIN and Passenger (PASS) CABIN Temperature Selector

AUTO – automatic temperature controller controls passenger cabin or flight deck temperature as selected.

MANUAL – air mix valves controlled manually. Automatic temperature controller bypassed.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR MIX VALVE Indicator

Indicates position of air mix valves:

- controlled automatically with related temperature selector in AUTO
- controlled manually with related temperature selector in MANUAL.

7 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO – fan signalled on except when both packs operating with either PACK switch in HIGH.

9 PACK TRIP OFF Light

Illuminated (amber) –

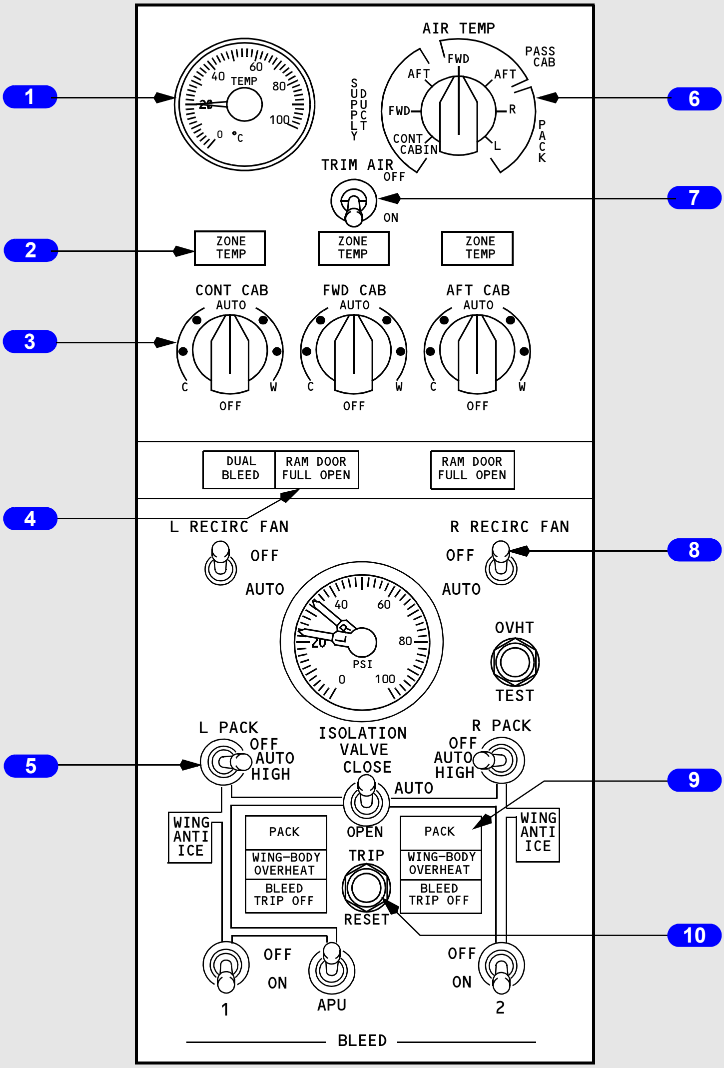
- indicates pack temperature has exceeded limits
- related pack valve automatically closes and mix valves drive full cold
- requires reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators (737-400)



FORWARD OVERHEAD PANEL

1 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector

2 ZONE TEMP Lights

Illuminated (amber) –

- CONT CAB indicates a duct temperature overheat, or failure of the flight deck primary and standby temperature control
- FWD CAB or AFT CAB indicates duct temperature overheat.

During Master Caution light recall:

- CONT CAB indicates failure of the flight deck primary or standby temperature control
- either FWD CAB or AFT CAB indicates failure of the associated zone temperature control
- lights will extinguish when MASTER CAUTION is reset.

3 Temperature Selector

AUTO – provides automatic temperature control for the associated zones. Rotating the controls towards C (cool) or W (warm) sets the desired temperature

OFF – closes the associated trim air modulating valve.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects appropriate zone supply duct temperature

PASS CABIN – selects forward or aft passenger cabin temperature

PACK – selects left or right pack temperatures.

7 TRIM AIR Switch

ON – trim air pressure regulating and shutoff valve signaled open.

OFF – trim air pressure regulating and shutoff valve signaled closed.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO –

- in flight –
  - the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH
  - the right recirculation fan operates if both packs are operating unless both PACK switches are in HIGH.
- on the ground –
  - the left recirculation fan operates unless both PACK switches are in HIGH
  - the right recirculation fan operates even if both PACK switches are in HIGH.

9 PACK Light

Illuminated (amber) –

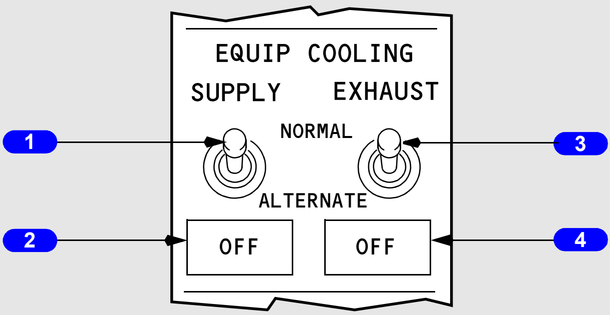
- indicates pack trip off or failure of both primary and standby pack controls
- during MASTER CAUTION light recall, indicates failure of either primary or standby pack control . Extinguishes when MASTER CAUTION is reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- lights remain illuminated until reset.

Equipment Cooling Panel



FORWARD OVERHEAD PANEL

1 Equipment (EQUIP) COOLING SUPPLY Switch

NORMAL – normal cooling supply fan activated.

ALTERNATE – alternate cooling supply fan activated.

2 Equipment Cooling Supply OFF Light

Illuminated (amber) – no airflow from selected cooling supply fan.

3 Equipment (EQUIP) COOLING EXHAUST Switch

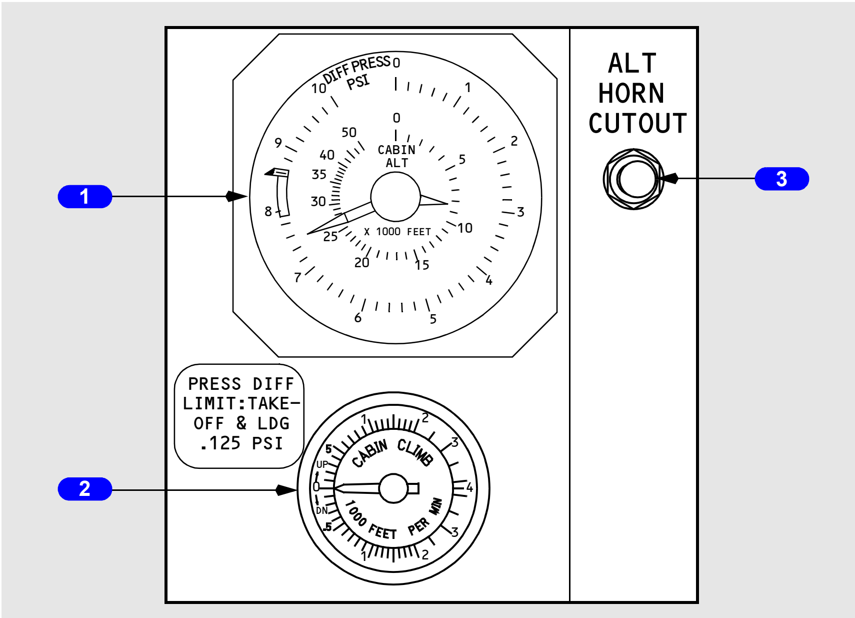
NORMAL – normal cooling exhaust fan activated.

ALTERNATE – alternate cooling exhaust fan activated.

4 Equipment Cooling Exhaust OFF Light

Illuminated (amber) – no airflow from selected cooling exhaust fan.

Cabin Altitude Panel



FORWARD OVERHEAD PANEL

1 CABIN Altitude (ALT)/Differential Pressure (DIFF PRESS) Indicator

Inner Scale – indicates cabin altitude in feet.

Outer Scale – indicates the difference between cabin pressure and ambient pressure in psi.

2 CABIN Rate of CLIMB Indicator

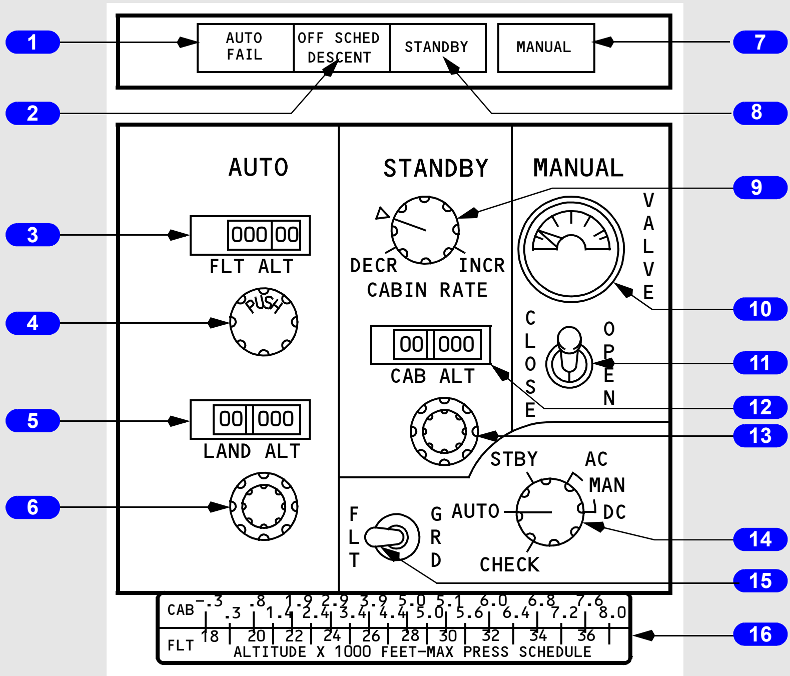
Indicates cabin rate of climb or descent in feet per minute.

3 Altitude (ALT) HORN CUTOUT Switch

PUSH –

- cuts out intermittent cabin altitude warning horn
- altitude warning horn sounds when cabin reaches 10,000 feet altitude.

Cabin Pressurization Panel



FORWARD OVERHEAD PANEL

1 AUTO FAIL Light

Illuminated (amber) – automatic pressurization control failure. Control automatically transfers to the standby mode.

2 OFF Schedule (SCHED) DESCENT Light

Illuminated (amber) – airplane descended before reaching the planned cruise altitude set in the FLT ALT indicator.

3 Flight Altitude (FLT ALT) Indicator

- indicates selected cruise altitude
- set before takeoff.

4 Flight Altitude Selector

Push/rotate to set planned cruise altitude.

5 **Landing Altitude (LAND ALT) Indicator**

- indicates altitude of intended landing field
- set before takeoff.

6 **Landing Altitude Selector**

Rotate to select planned landing field altitude –

- large diameter control sets 1000 foot increments
- small diameter control sets 10 foot increments.

7 **MANUAL Light**

Illuminated (green) – pressurization system operating in the manual mode.

8 **STANDBY Light**

Illuminated (green) – pressurization system operating in the standby mode.

9 **Cabin Rate Selector**

- DECR – cabin altitude rate of change equals 50 ft/min
- INCR – cabin altitude rate of change equals 2000 ft/min
- Index – cabin altitude rate of change equals 300 ft/min.

10 **Outflow VALVE Position Indicator**

- indicates position of outflow valve
- operates in all modes.

Note: Indicator moves to the full left position when no AC power is available.

11 **Outflow Valve Switch (spring–loaded to center)**

CLOSE – closes outflow valve electrically with pressurization mode selector in MAN position.

OPEN – opens outflow valve electrically with pressurization mode selector in MAN position.

12 **Cabin Altitude (CAB ALT) Indicator**

- Indicates selected cabin altitude
- Set before takeoff.

13 **Cabin Altitude Selector**

Rotate to select desired cabin altitude.

- large diameter control sets 1000 foot increments
- small diameter control sets 10 foot increments.

14 Pressurization Mode Selector

AUTO – pressurization system controlled automatically.

STBY – pressurization system controlled through the standby mode.

MAN –

- pressurization system controlled manually by Outflow Valve Switch
- AC – outflow valve operates from AC power
- DC – outflow valve operates from DC power
- all auto and standby circuits bypassed

CHECK – Tests auto failure function of auto system.

15 Flight /Ground Switch

AUTO mode –

- GRD – on the ground, drives the pressurization outflow valve full open at a controlled rate and depressurizes the airplane. After takeoff, inhibited; functions the same as FLT position
- FLT – on the ground, pressurizes the cabin to approximately (-200ft) below airport elevation. After takeoff, cabin pressure is automatically controlled in climb and descent as a function of airplane altitude. In cruise, cabin pressure is held constant.

STANDBY mode –

- GRD – on the ground, drives outflow valve open at the rate selected by the Cabin Rate Selector. After takeoff, inhibited; functions the same as FLT position
- FLT – pressurizes the airplane at a rate selected by the Cabin Rate Selector to the cabin altitude selected on the Cabin Altitude Indicator (normally -200ft below takeoff field elevation).

Flight/Ground Switch (non-standard)

FLT –

- AUTO – while on the ground, pressurizes the cabin to about 200 feet below airport altitude. Inhibited in flight
- STBY – while on the ground, pressurizes the cabin to altitude selected on the CAB/ALT selector. After takeoff, inhibited
- MAN AC or MAN DC – in flight or on the ground, each time the outflow valve switch is positioned to CLOSE or OPEN, the outflow valve moves in increments.

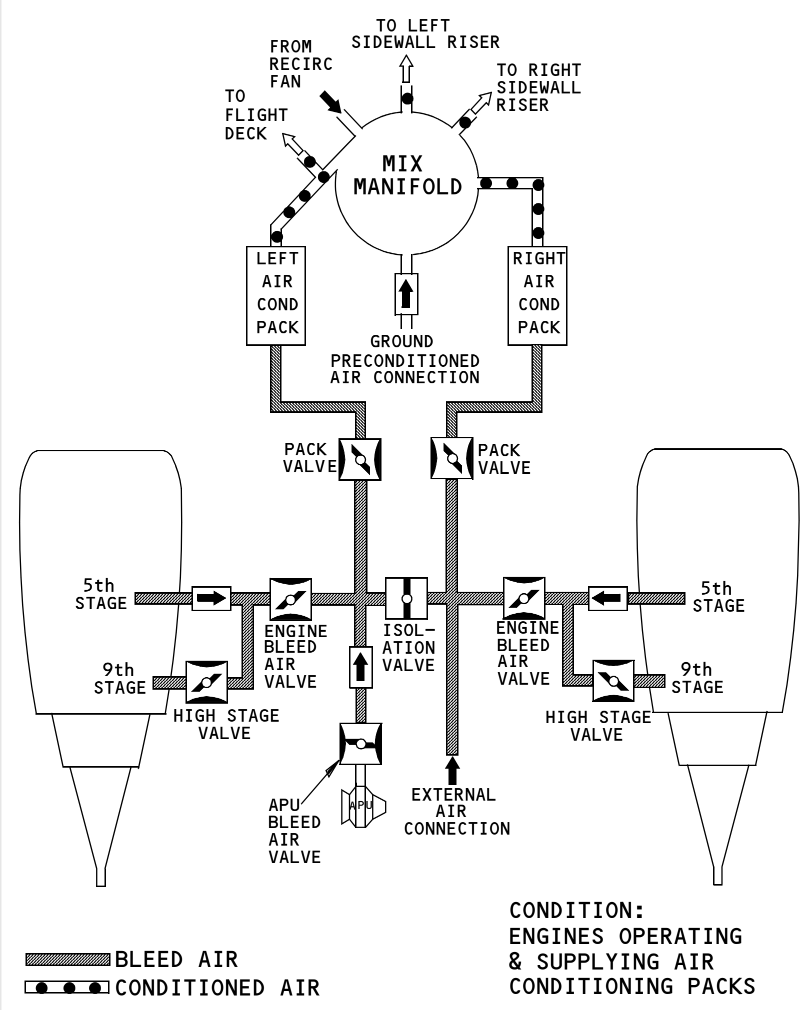
GRD –

- AUTO or STBY – while on the ground, depressurizes the airplane. Inhibited in flight
- MAN AC or MAN DC – in flight or on the ground, when the outflow valve switch is held to CLOSE or OPEN, the outflow valve moves continuously.

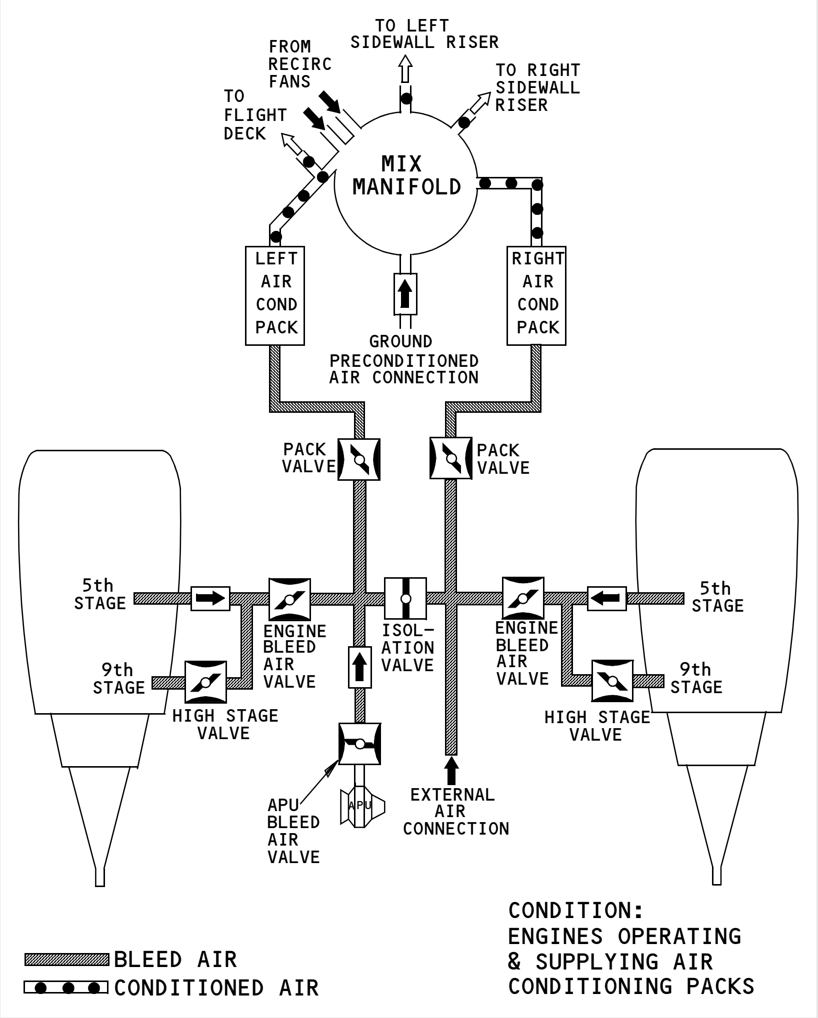
16 Cabin /Flight Altitude (CAB ALT)(FLT ALT) Placard

Used to determine setting for cabin altitude when operating in standby and manual modes.

Air Systems Schematic (737-300/500)



Air Systems Schematic (737-400)



Introduction to Bleed Air System

Air for the bleed air system can be supplied by the engines, APU, or an external air cart/source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning/pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization
- Aspirated TAT probe

Switches on the air conditioning panel operate the APU and engine bleed air supply system.

Engine Bleed System Supply

Engine bleed air is obtained from the 5th and 9th stages of the compressor section. When 5th stage low pressure bleed air is insufficient for the bleed air system requirements, the high stage valve modulates open to maintain adequate bleed air pressure. During takeoff, climb, and most cruise conditions, low pressure bleed air from the 5th stage is adequate and the high stage valve remains closed.

Engine Bleed Air Valves

The engine bleed air valve acts as a pressure regulator and shutoff valve. With the engine bleed air switch ON, the valve is DC activated and pressure operated. The valve maintains proper system operating pressure and reduces bleed air outflow in response to high bleed air temperature.

Bleed Trip Sensors

Bleed trip sensors illuminate the respective BLEED TRIP OFF light when engine bleed air temperature or pressure exceeds a predetermined limit. The respective engine bleed air valve closes automatically.

Duct Pressure Transmitters

Duct pressure transmitters provide bleed air pressure indications to the respective (L and R) pointers on the bleed air duct pressure indicator. The indicator is AC operated.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches ON, and both air conditioning pack switches AUTO or HIGH, the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF. Isolation valve position is not affected by the APU bleed air switch.

External Air Connection

An external air cart/source provides an alternate air source for engine start or air conditioning.

APU Bleed Air Valve

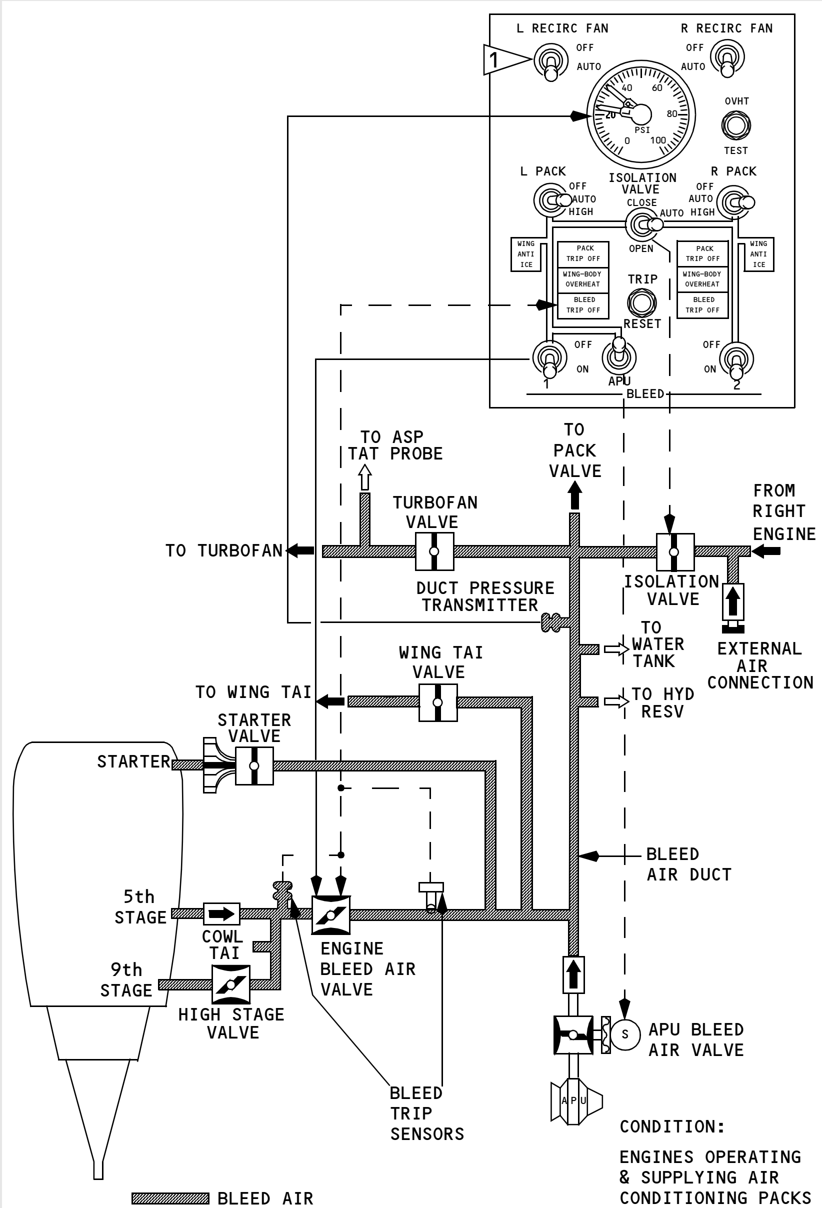
The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. The APU bleed air valve is DC controlled and pressure operated.

With both the APU and engine bleed air valves open, and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 9th stage modulating and shutoff valve. This would cause the 9th stage valve to close.

DUAL BLEED Light

The DUAL BLEED light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the DUAL BLEED light illuminated.

Bleed Air System Schematic

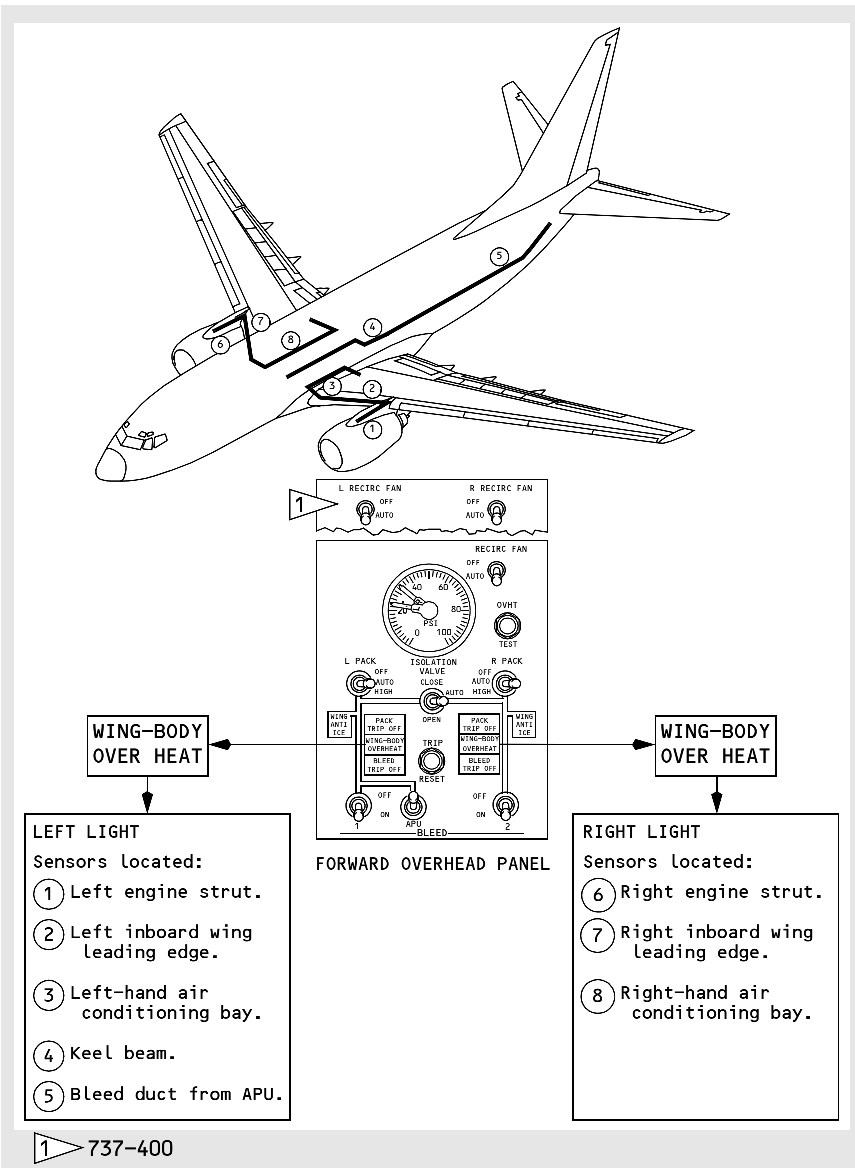


1 737-400

Wing-Body Overheat

A wing-body overheat condition is caused by a bleed air duct leak. It is sensed by the overheat sensors located as shown.

Wing-Body Overheat Ducts and Lights



Preface

This section describes the air conditioning system for the B737–300 and the B737–500. For information concerning the B737–400, see page .

Introduction to Air Conditioning System

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

Conditioned air for the cabin comes from either the airplane air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

Air Conditioning Pack

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. Normally the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2. A single pack in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow.” However, with one pack not operating, the other pack automatically switches to “high air flow” in order to maintain the necessary ventilation rate. This automatic switching is inhibited when the airplane is on the ground, or in-flight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to “high air flow” occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air/ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides "high air flow." Additionally, an "APU high air flow" rate is available when the airplane is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of ram air inlet doors.

On the ground, or during slow flight with the flaps not fully retracted, the ram air inlet doors move to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. The RAM DOOR FULL OPEN light illuminates whenever the ram door is fully open.

A turbofan is located in each ram air exit duct. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector doors extends when activated electrically by the air–ground safety sensor.

Cooling Cycle

The flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration and to a water separator which removes moisture. The processed cold air is then combined with hot air. The conditioned air flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK TRIP OFF light to illuminate.

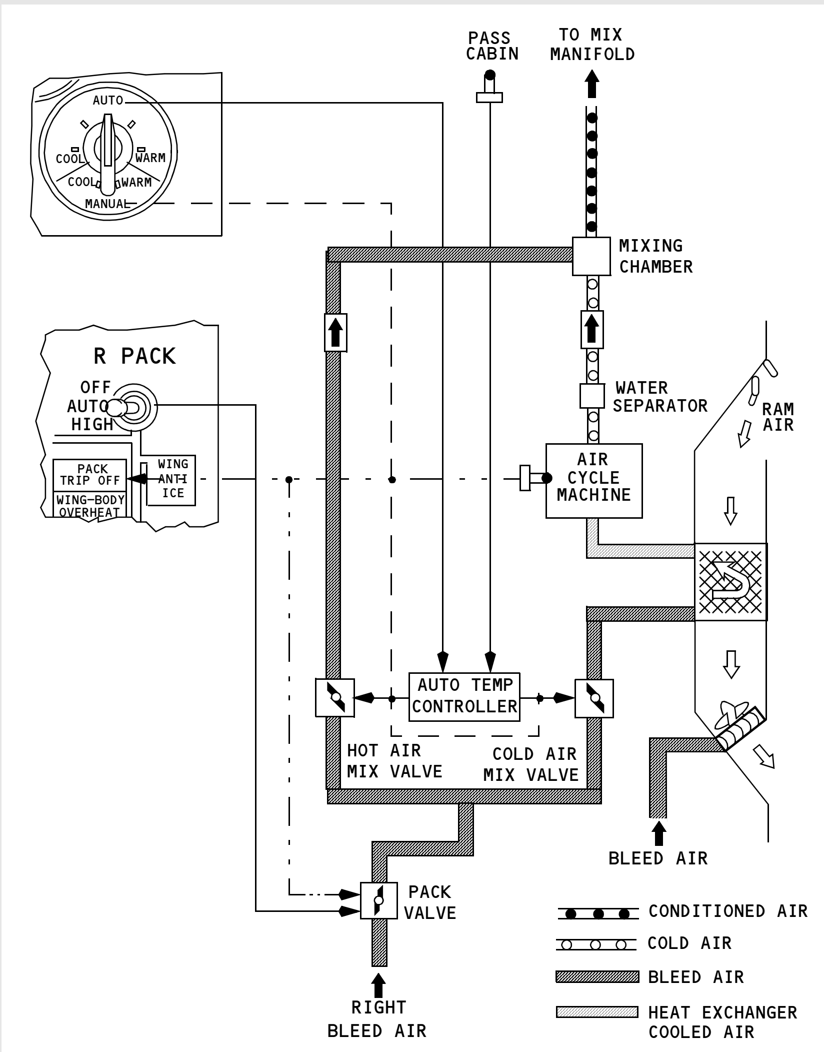
Air Mix Valves

The two air mix valves for each pack control hot and cold air according to the setting of the CONT CABIN or PASS CABIN temperature selector. Air that flows through the cold air mix valve is processed through a cooling cycle and then combined with hot air flowing from the hot air mix valve.

In the automatic temperature mode, the air mix valves are operated by the automatic temperature controller. The automatic temperature controller uses inputs from the respective temperature selector and cabin temperature sensor. The automatic temperature controller is bypassed when the temperature selector is positioned to MANUAL.

Anytime the pack valve closes, the air mix valves are driven to the full cold position automatically. This aids start-up of the cooling cycle and prevents nuisance hot air trips when the pack is turned on.

Air Conditioning Pack Schematic



Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the CONT CABIN and PASS CABIN temperature selectors.

Overheat detection is provided by temperature sensors located downstream of the packs. An overheat condition causes the appropriate mix valves to drive full cold and the DUCT OVERHEAT light to illuminate. A temperature higher than the duct overheat causes the appropriate pack valve to close and the PACK TRIP OFF light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack air output is mixed with the right pack supply and routed to the passenger cabin.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling, and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedals of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panel, respectively.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left wall of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fan is driven by an AC motor. The fan operates with the recirculation fan switch in AUTO except with both packs on and one or both in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

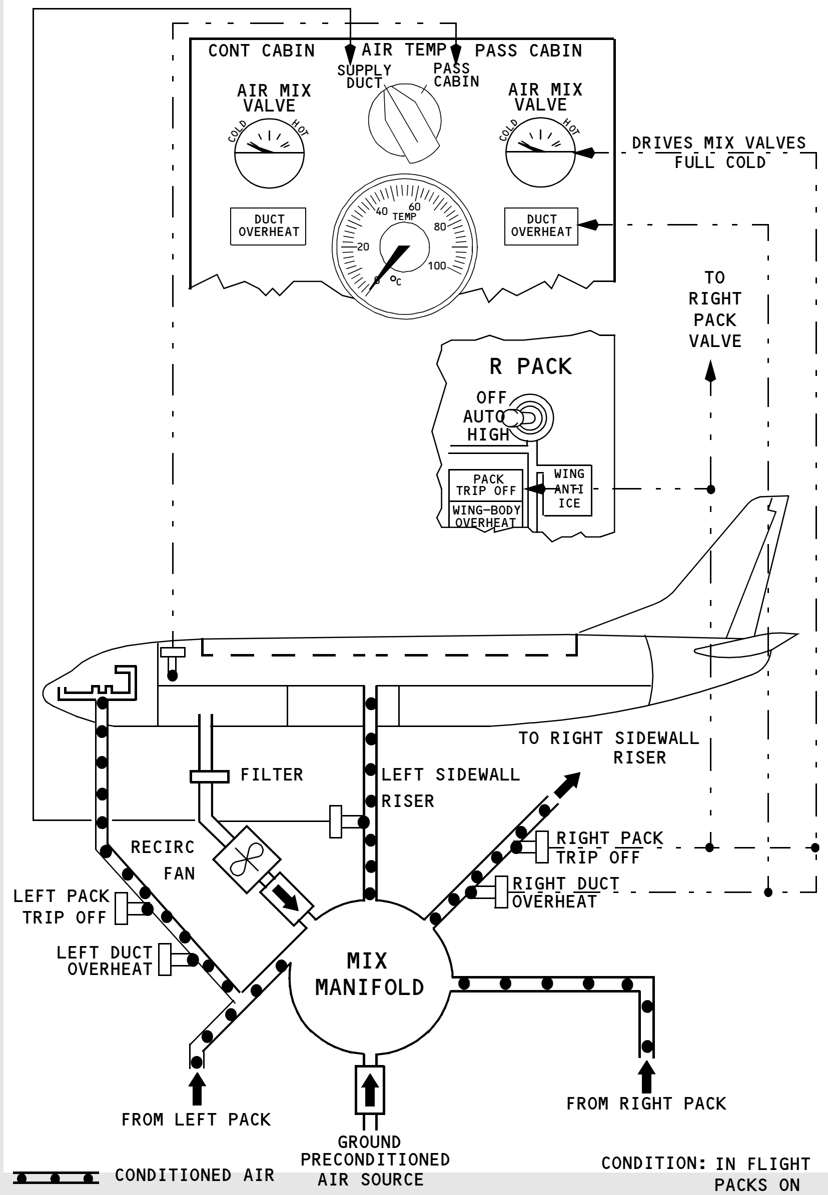
Forward Cargo Compartment

The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. On the ground, or with the cabin differential pressure less than 2.5 psi, the exhaust fan air is blown through a flow control valve and exhausted out the bottom of the airplane. With increasing airflow at greater cabin differential pressures, the flow control valve closes and exhaust air from the equipment cooling system is now diffused to the lining of the forward cargo compartment for in-flight heating.

Conditioned Air Source Connection

A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

Air Conditioning Distribution Schematic



Introduction to Air Conditioning System (B737-400)

Conditioned air for the cabin comes from either the airplane air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

Air Conditioning Pack

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. Normally, the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2. A single pack in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow”. However, with one pack not operating, the other pack automatically switches to “high air flow” in order to maintain the necessary ventilation rate. This automatic switching is inhibited when the airplane is on the ground, or inflight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to “high air flow” occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air/ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides “high air flow”. Additionally, an “APU high air flow” rate is available when the airplane is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of a ram door.

On the ground, or during slow flight with the flaps not fully retracted, the ram door moves to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. The RAM DOOR FULL OPEN light illuminates whenever the ram door is fully open.

A turbofan is located in each ram air exit duct. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

A deflector door is installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector door extends when activated electrically by the air–ground safety sensor.

Cooling Cycle

Flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration. The processed cold air is then combined with hot air which has bypassed the air cycle machine, then through a high pressure water separator which removes moisture. This conditioned air then flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK light to illuminate.

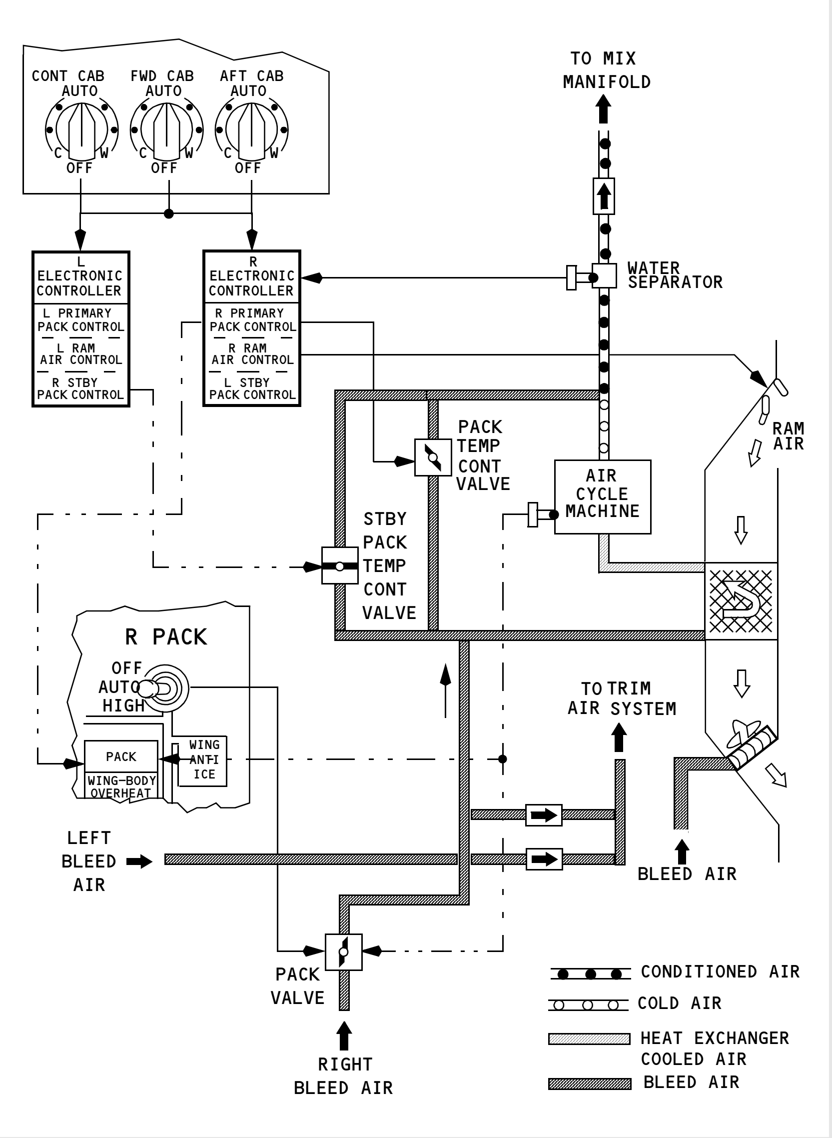
Pack Temperature Control

Electronic controllers command the pack temperature control valve toward open or closed to satisfy pack discharge requirements.

If a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller. A primary or standby pack control failure causes the PACK, MASTER CAUTION and AIR COND System Annunciator lights to illuminate during recall.

If both the primary and the standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND System Annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures cause the pack to trip off.

Air Conditioning Pack Schematic



Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

The packs produce an air temperature that satisfies the zone which requires the most cooling. Zone temperature is controlled by introducing the proper amount of trim air to the zone supply ducts. The quantity of trim air is regulated by individual trim air modulating valves.

During single pack operation with the TRIM AIR selected ON, zone temperature is controlled the same as during two-pack operation. During single pack operation with the TRIM AIR selected OFF, the pack attempts to produce an air temperature to satisfy the average temperature demands of all three zones.

If air in a zone supply duct overheats, the associated amber ZONE TEMP light illuminates, and the associated trim air modulating valve closes. The trim air modulating valve may be reopened after the duct has cooled by pushing the TRIP RESET Switch.

Zone Temperature Control Modes

The left electronic controller controls the aft cabin zone and provides backup control for the flight deck. The right controller controls the forward cabin zone and provides primary control for the flight deck.

Failure of the primary flight deck temperature control will cause an automatic switch to the back up control and will illuminate the CONT CAB amber ZONE TEMP light upon Master Caution Recall. Failure of both the primary and standby controls will illuminate the lights automatically.

Failure of the forward or aft cabin temperature control will cause the associated trim air modulating valve to close. The Temperature Selectors operate normally, but the Temperature Selector settings of the two passenger cabin zones will be averaged. The amber ZONE TEMP light will illuminate upon Master Caution Recall to indicate failure of the associated zone control.

Unbalanced Pack Temperature Control Mode

Any failure affecting the supply of trim air will cause the temperature control system to control both packs independently. If flight deck trim air is lost, the left pack will provide conditioned air to the flight deck at the selected temperature and the right pack will satisfy the demand of the passenger zone which requires the most cooling. If a passenger cabin zone trim air, or all trim air is lost, the forward and aft zone temperature demands will be averaged for control of the right pack.

If any individual zone is switched OFF, the Temperature Selector setting will be ignored by the temperature control system.

Standby Pack Average Temperature

If all zone controls and primary pack controls fail, the standby pack controls command the packs to produce air temperatures which will satisfy the average temperature demand of the two cabin zones. The trim air modulating valves will close. The flight deck zone Temperature Selector will have no effect on the standby pack controls.

Fixed Cabin Temperature

If all Temperature Selectors are positioned OFF, the pack controls will cause the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain 65°F (18°C) as measured at the pack temperature sensor.

Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the Temperature Selectors.

Overheat detection is provided by temperature sensors located downstream of the packs and the mix manifold. An overheat condition causes the appropriate trim air modulating valve to close and the ZONE TEMP light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack output is routed to the mix manifold.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedal of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panels.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left walls of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fans are driven by AC motors. Each recirculation fan operates only if the respective RECIRC FAN switch is selected to AUTO. In flight, the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH. The right recirculation fan operates in flight if both packs are operating unless both PACK switches are in HIGH. On the ground, the left recirculation fan operates unless both PACK switches are in HIGH and the right recirculation fan operates even if both PACK switches are in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

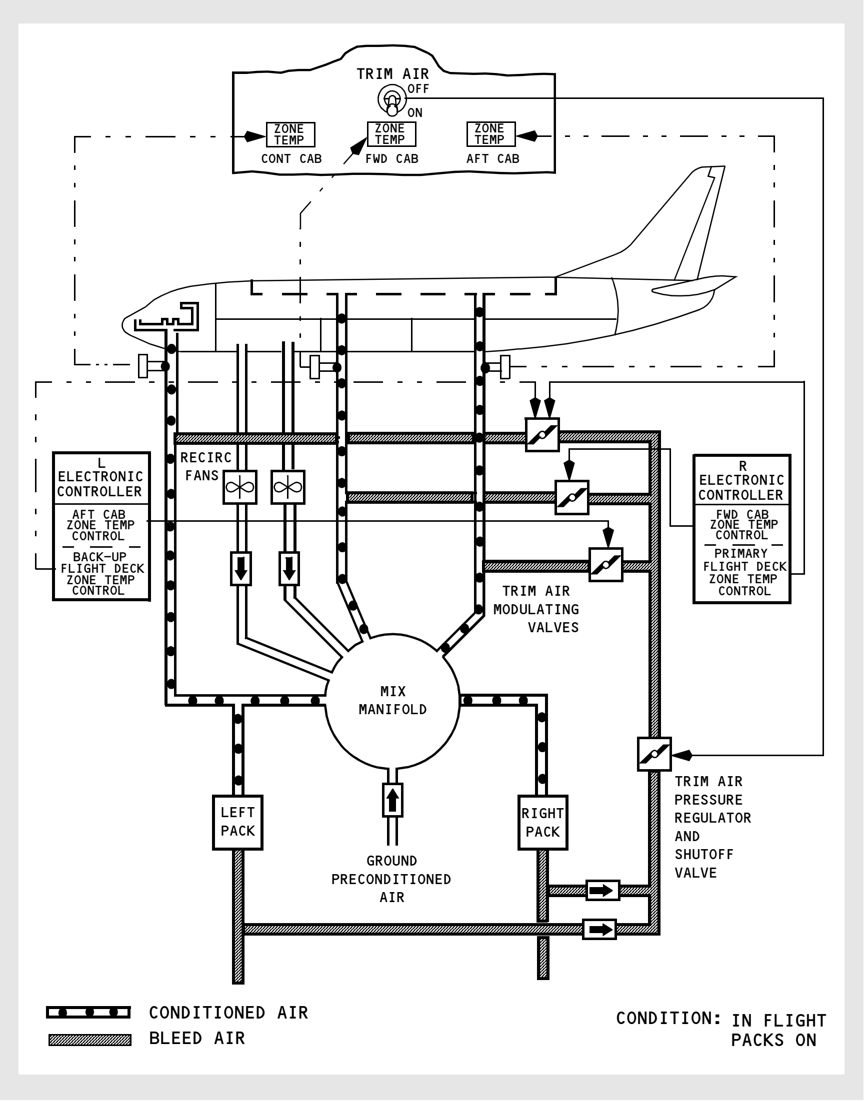
Forward Cargo Compartment

The forward cargo compartment is warmed in flight when more than 2.5 psi pressure differential exists. Air from the E & E compartment flows up and around the forward cargo compartment lining. The right recirculation fan maintains this warming air flow. When the right recirculation fan is off, the forward outflow valve remains open to ensure this warm air flow (except when closed in order to maintain pressurization).

Conditioned Air Source Connection

A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

Air Conditioning Distribution Schematic



Introduction to Pressurization System

Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system (CPCS). The CPCS includes one automatic controller and one standby controller available by selecting AUTO or STBY, and two manual (MAN) pilot-controlled modes.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valves.

Pressure Relief Valves

Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 8.65 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

Cabin Pressure Controller

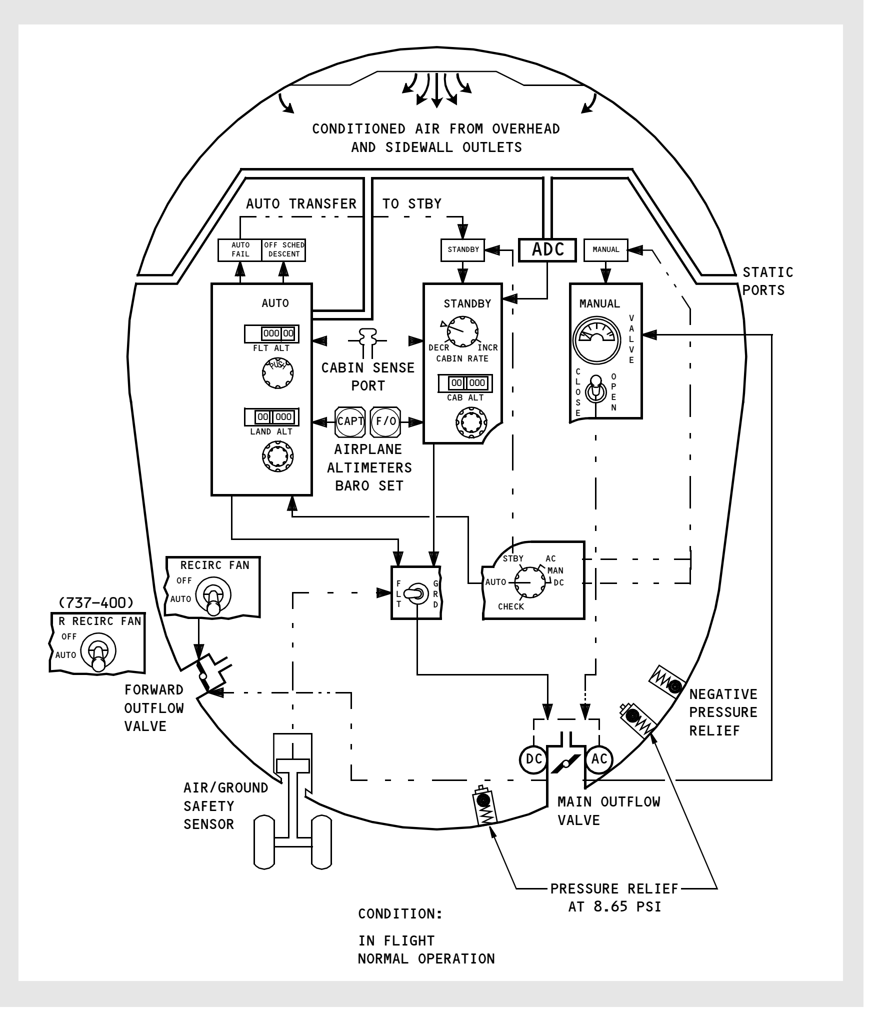
Cabin altitude is normally rate–controlled by the cabin pressure controller up to a cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 37,000 feet. The cabin pressure controller controls cabin altitude in the following modes:

- AUTO – Automatic pressurization control; normal mode of operation. Uses AC motor.
- STBY – Semiautomatic pressurization control; standby mode of operation. Uses DC motor.
- MAN AC – Manual control of the system using the AC motor.
- MAN DC – Manual control of the system using the DC motor.

In the automatic mode of operation, airplane altitude is sensed directly from the static ports. In the standby mode, airplane altitude is sensed electrically from the air data computer (ADC). Barometric corrections to these pressures come from the Captain’s altimeter in AUTO and the First Officer’s altimeter in STBY.

The controller receives additional information from the air/ground sensor and the cabin pressure altitude sensing port.

Cabin Pressure Control System Schematic



Pressurization Outflow

Cabin air outflow is controlled by the main outflow valve, the forward outflow valve and the flow control valve. During pressurized flight, the flow control valve is closed, and the majority of the overboard exhaust is through the main and forward outflow valves. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

Flow Control Valve

The flow control valve opens to exhaust the cooling air from the E & E compartment overboard during ground operation, unpressurized flight and pressurized flight below a cabin differential pressure of 2.5 psi.

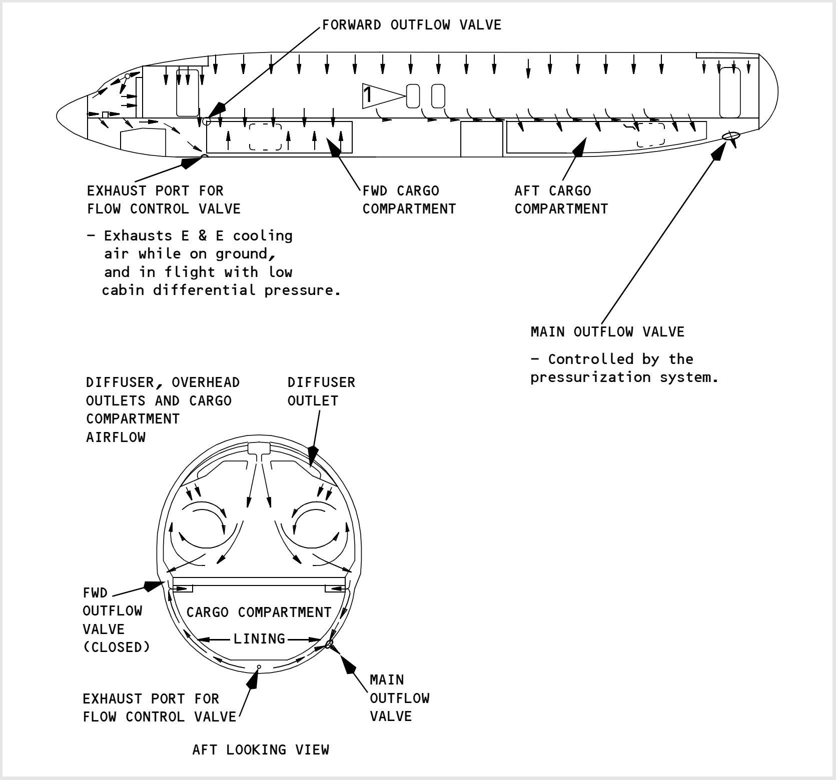
When the flow control valve closes, air is directed around the forward cargo compartment liner for inflight heating.

Outflow Valves

The main outflow valve can be actuated by either an AC or a DC motor. The AC motor is used during AUTO and MAN AC operation. The DC motor is used during STANDBY and MAN DC operation.

The forward outflow valve closes automatically to assist in maintaining cabin pressure when the main outflow valve is almost closed or when the recirculation fan (right recirculation fan on 737–400 airplanes) is operating. The forward outflow valve is the overboard discharge exit for air circulated around the forward cargo compartment. The main outflow valve is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the main outflow valve.

Pressurization Outflow Schematic



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Auto Mode Operation

In AUTO, the pressurization control panel is used to preset two altitudes into the pressure controller:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is input into the pressurization controller at all times when on the ground.

The air/ground safety sensor signals whether the airplane is on the ground or in the air. On the ground, the FLT/GRD switch is used to keep the cabin depressurized by driving the main outflow valve full open when the switch is in the GRD position. With the switch in the FLT position, the controller modulates the main outflow valve toward close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the auto controller maintains a proportional pressure differential between airplane and cabin altitude. By increasing the cabin altitude at a rate proportional to the airplane climb rate, cabin altitude change is held to the minimum rate required.

When the aircraft is operated at low gross weights it is capable of sustaining rates of climb to cruising altitude greater than the pressure controller logic can reduce cabin pressure. This may result in reaching the maximum pressure differential and causing the relief valves to open and vent the cabin.

An amber OFF SCHED DESCENT light illuminates if the airplane begins to descend without having reached the preset cruise altitude; for example, a flight aborted in climb and returning to the takeoff airport. The controller programs the cabin to land at the takeoff field elevation without further pilot inputs. If the FLT ALT indicator is changed, the automatic abort capability to the original takeoff field elevation is lost.

The cruise mode is activated when the airplane climbs to within 0.25 psi of the selected FLT ALT. During cruise, the controller maintains the cabin altitude slightly below the selected LAND ALT, if the differential pressure between the selected LAND ALT and FLT ALT is less than or equal to 7.8 psid above 28,000 feet or 7.45 psid below 28,000 feet. If the differential pressure between the selected LAND ALT and FLT ALT is greater than these values, the controller maintains a pressure differential of 7.8 psid above 28,000 feet and 7.45 psid below 28,000 feet. Deviations from flight altitude can cause the pressure differential to vary as the controller modulates the outflow valve to maintain a constant cabin altitude.

The descent mode is activated when the airplane descends to 0.25 psi below the selected FLT ALT. The cabin begins a proportional descent to slightly below the selected LAND ALT. The controller programs the cabin to land slightly pressurized so that rapid changes in altitude during approach result in minimum cabin pressure changes.

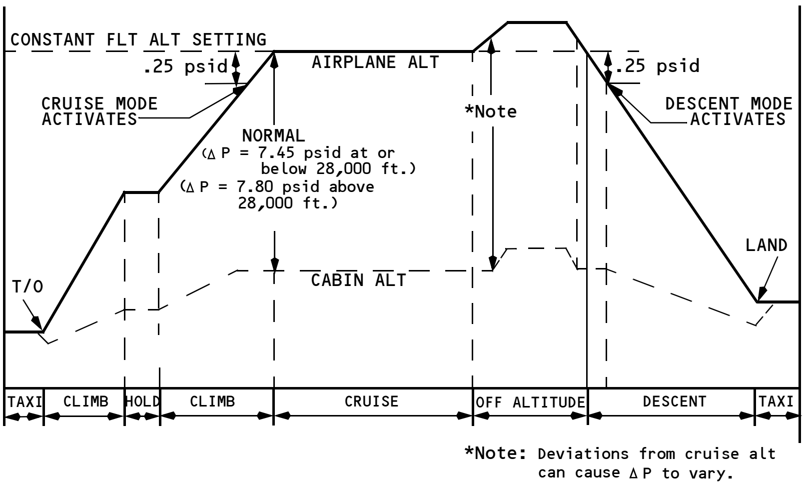
Taxiing in, the controller drives the main outflow valve slowly to full open when the FLT/GRD switch is positioned to GRD, thereby depressurizing the cabin. Having the main outflow valve full open also prevents the equipment cooling fan from depressurizing the airplane to a negative pressure.

An amber AUTO FAIL light illuminates if any one of these conditions occurs:

- Loss of AUTO AC power
- Excessive rate of cabin pressure change (1890 sea level feet/minute)
- High cabin altitude (13,875 feet).

With illumination of the AUTO FAIL Light, the pressure controller automatically trips to STANDBY mode; however, the pressurization mode selector remains in AUTO. Positioning the mode selector to STBY extinguishes the light.

Flight Path Events – Auto Mode



CABIN ALTITUDE VS. AIRPLANE ALTITUDE

Standby Mode Operation

A green STANDBY light will be illuminated when the pressure controller is in the STANDBY mode.

On the ground, the GRD position of the FLT/GRD switch drives the main outflow valve full open. The FLT position drives the main outflow valve to attempt to pressurize the cabin to the selected CAB ALT. CAB ALT should be set 200 feet below the takeoff airport altitude to pressurize the cabin properly when the FLT/GRD switch is placed to FLT prior to takeoff.

In the air, by referring to the placard below the pressurization control panel, the cabin altitude indicator is set to the isobaric cabin altitude, based on the proposed flight altitude and pressure differential. Cabin rate of climb or descent is controlled by the cabin rate selector. In descent, the cabin altitude indicator is set 200 feet below landing field altitude to insure a pressurized cabin during landing.

Manual Mode Operation

A green MANUAL Light illuminates with the pressurization mode selector in MAN AC or MAN DC.

Operation in the MAN modes assumes failure of the AUTO and STANDBY modes. Manual mode allows the pilot, by using the outflow valve switch, to modulate the main outflow valve while monitoring the outflow valve position indicator. MAN AC mode uses the AC motor to control the main outflow valve; MAN DC uses the DC motor. The rate of operation in MAN AC is faster than that in MAN DC.