



ERJ170

LOT OPERATIONS MANUAL part B

VOLUME 2

EMBRAER170

POLISH AIRLINES



JAA

LOT OPERATIONS MANUAL part B VOLUME 2

(LOT POLISH AIRLINES)

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AIRPLANE SYSTEMS

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INTRODUCTION

This volume of Operation Manual part B contains description of the airplane systems, related controls and indications and operating instructions according to IEM to Appendix 1 to JAR-OPS 1.045.

ITEM TO APPENDIX 1 TO JAR-OPS 1.045 (ITEM 2)

2. With reference to Operation Manual Section B, paragraph 9 (Minimum Equipment List) and 12 (Airplane Systems) operators should give consideration to using the ATA number system when allocating chapters and numbers for airplane systems.

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INTRODUCTION

This Chapter contains the area, dimensions, stations and physical locations of the major structural numbers of the airplane.

AIRPLANE BASIC DATA

The EMBRAER 170 is a low wing, conventional tail, and pressurized airplane, powered by two high by-pass ratio wing-mounted turbofan engines. The tricycle landing gear is fully retractable, with twin tires at each leg.

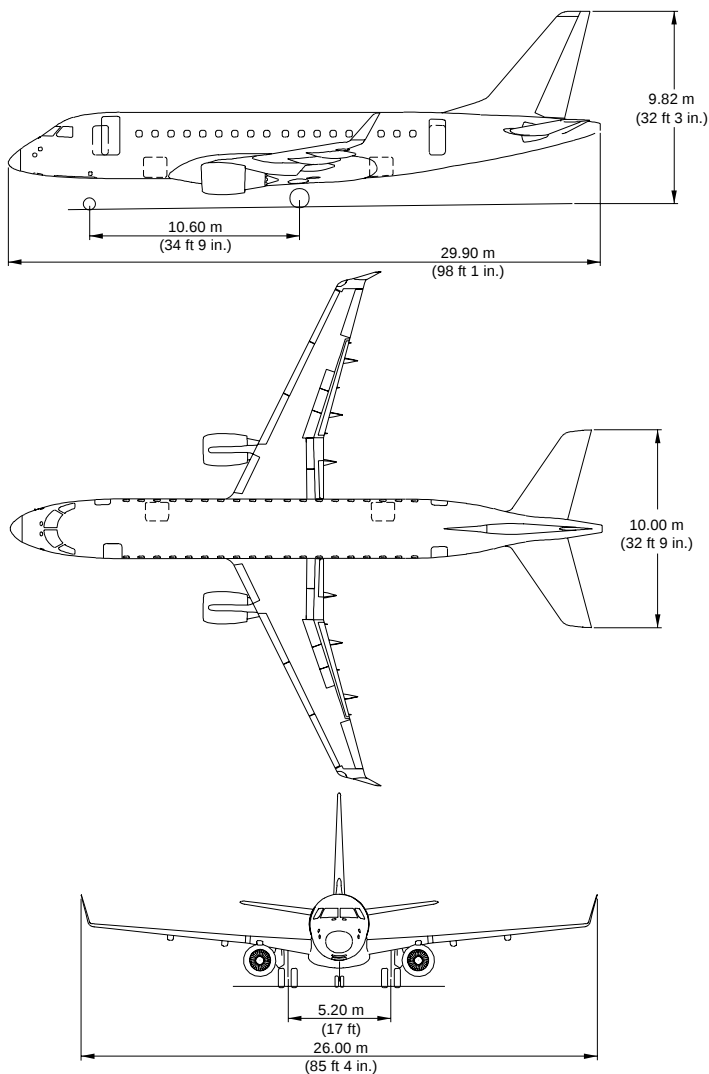
A glass cockpit panel has been developed with highly integrated on-board avionics, thus allowing pilots to better monitor the airplane's general operation.

The passenger configuration consists of four seats abreast (two to each side of the aisle) with front galley and rear toilet, which allows the carrying 70 passengers. Convenient accommodation is provided for the flight crew.

For detailed information on each system, refer to the appropriate section of this manual.

AIRPLANE DIMENSIONS

EXTERNAL DIMENSIONS

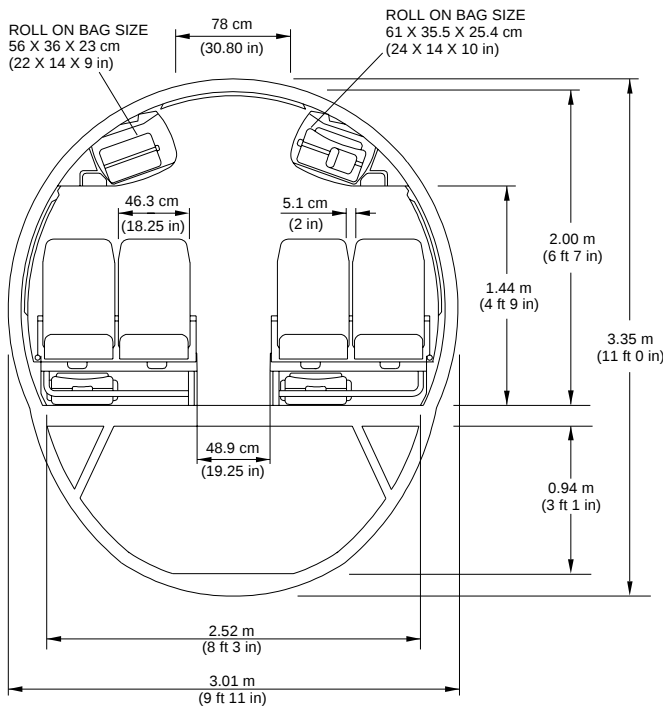


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THREE VIEW DRAWING



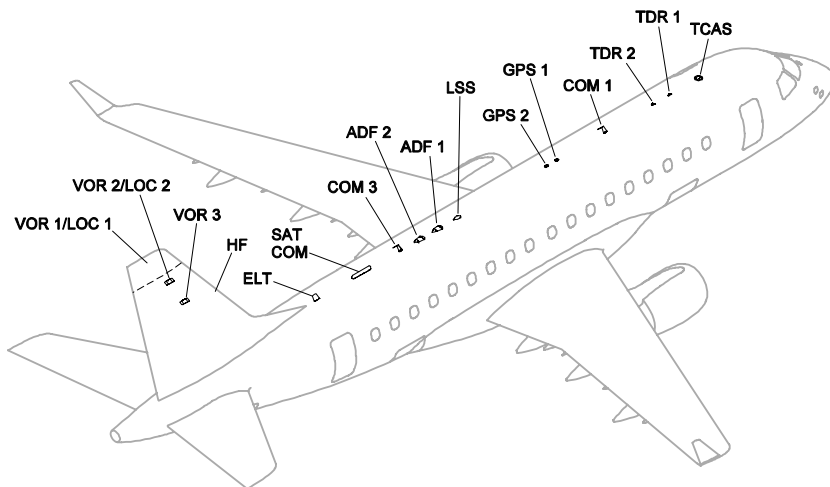
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CROSS SECTION

AIRPLANE ANTENNAS



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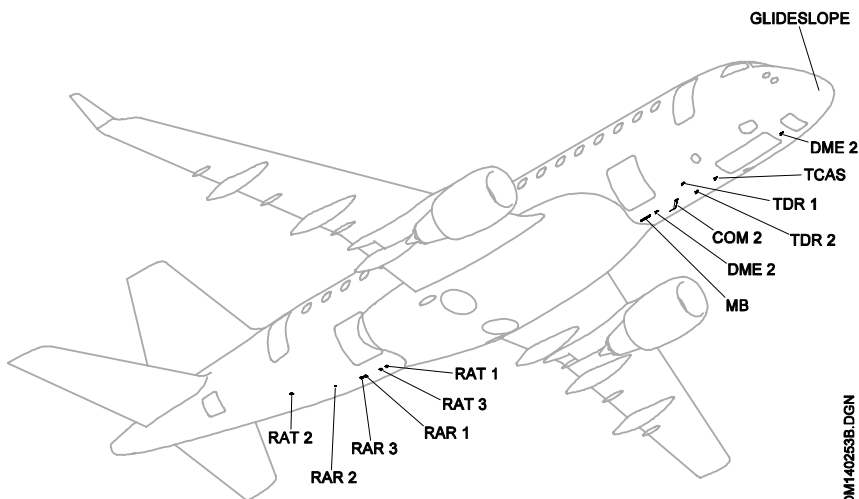
TDR: TRANSPONDER

MB: MARKER BEACON

RAT: RADIO ALTIMETER TRANSMITTER

RAR: RADIO ALTIMETER RECEIVER

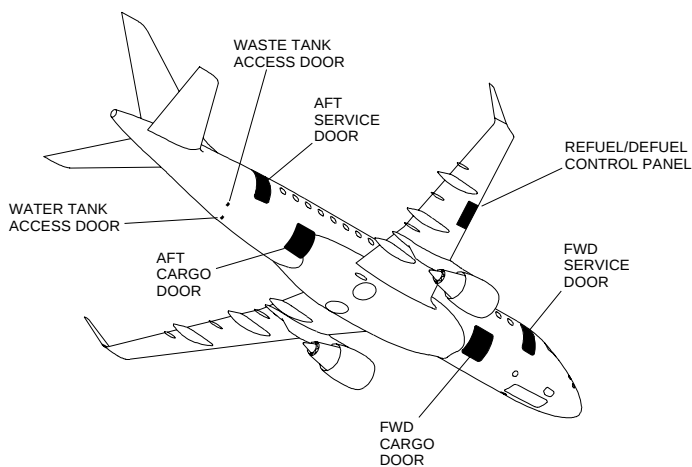
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AIRPLANE ANTENNAS

MAIN SERVICE POINTS

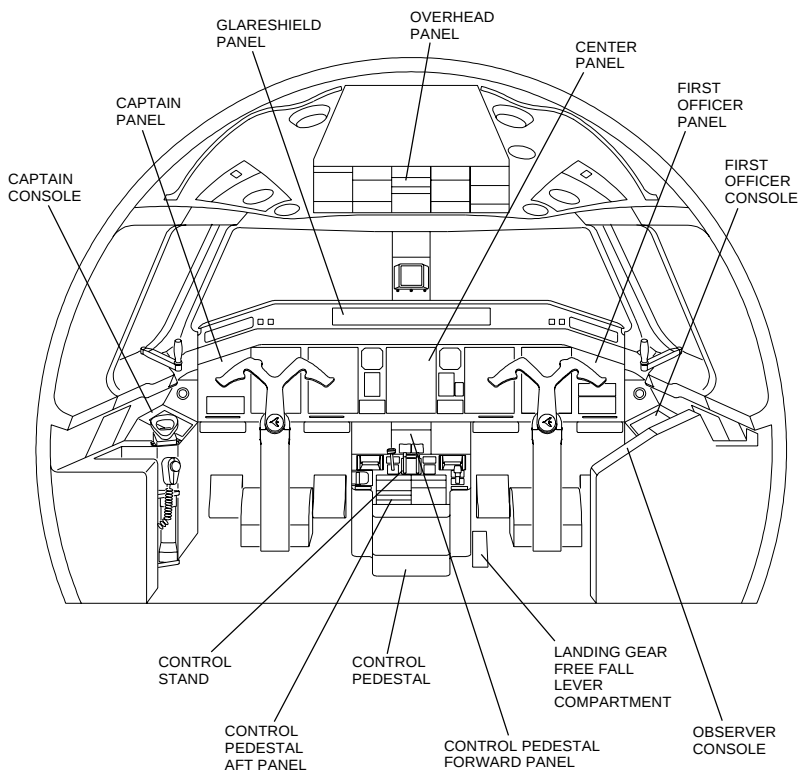


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MAIN SERVICE POINTS

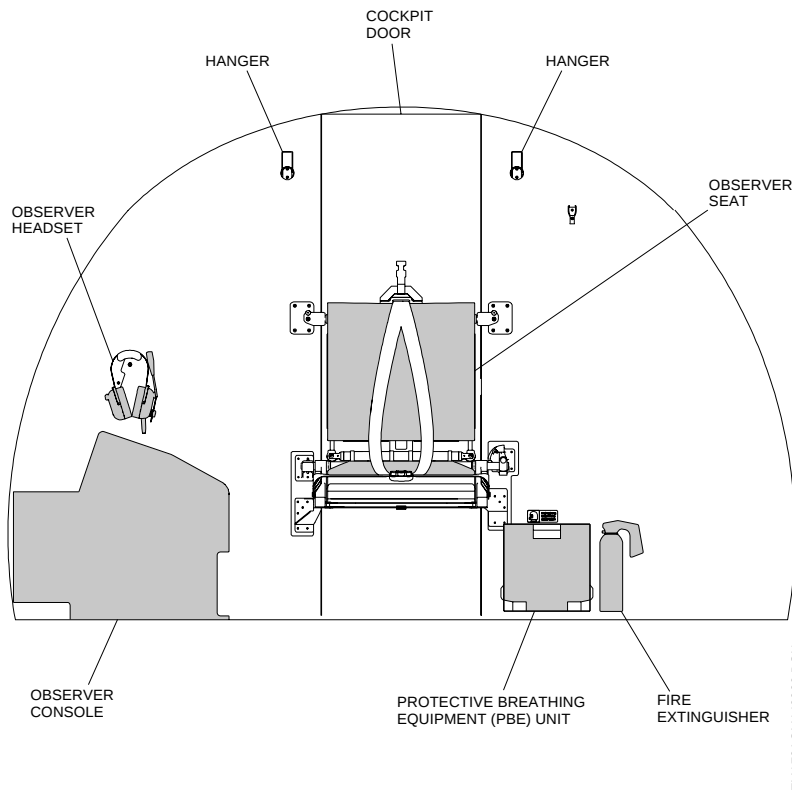
COCKPIT GENERAL

COCKPIT ARRANGEMENT



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COCKPIT PARTITION



COCKPIT PARTITION

COCKPIT PHILOSOPHY

The EMBRAER 170 flight deck is designed to:

- Provides the necessary means to accomplish the required tasks.
- Provides acceptable and reasonable workloads.
- Minimizes pilot errors and its consequences.
- Facilitates training and commonality among the EMBRAER 170 family airplane.
- Provides optimized ergonomics aimed at safety, ease of operation, control and comfort requirements.

Both pilots can access all essential information and necessary controls for safe flying and landing. Control of the airplane's systems is done via the overhead panel.

Some knobs on the overhead panel have detent protection and must be pulled out to allow the knob rotation. This protection does not allow the inadvertent knob rotation and are indicated with a detent mark between knob positions. Knob stationary positions are marked with a white rectangle, and knob momentary positions are marked with a white triangle.

System failures are primarily monitored via EICAS message. The CCD and synoptics are included as an aid to pilot monitoring systems status.

Critical systems give total authority to the pilot by employing intuitive procedures for maximum airplane performance with minimum workload. Cockpit design makes tasks as simple as possible, thus leading to increased control of situation and systems. Automation is used only to improve the task accomplishment, complementing but not substituting the crew.

DARK AND QUIET COCKPIT

The concept used to design and operate the airplane was based on the assumption that while in flight, all systems are normal when:

- Overhead, main, glareshield and control pedestal panels have no lights on.
- No aural warnings are being issued.
- The selector knobs are positioned at twelve o'clock.

A white striped bar illuminates on any button to indicate that it is not in its normal position.

MAIN / GLARESHIELD / CONTROL PEDESTAL PANELS (-DA thru -DF)



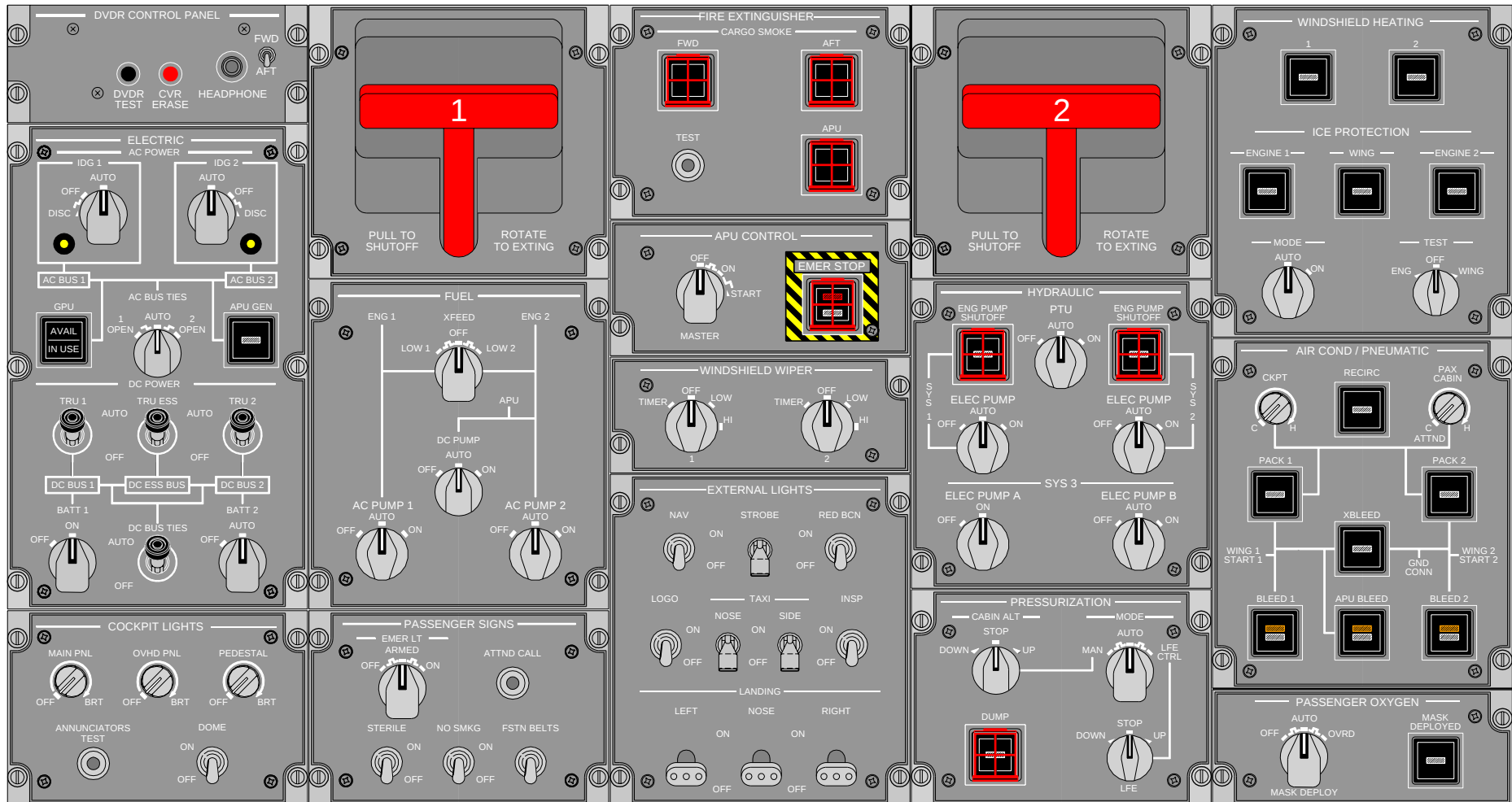
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MAIN / GLARESHIELD / CONTROL PEDESTAL PANELS (-DG and on)



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OVERHEAD PANEL



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INTRODUCTION

General guideline on ground handling and servicing of the airplane are provided herein. They are intended to make flight crews familiar with the ordinary aspects of the subject, as those tasks described herein normally are the responsibility of the maintenance personnel.

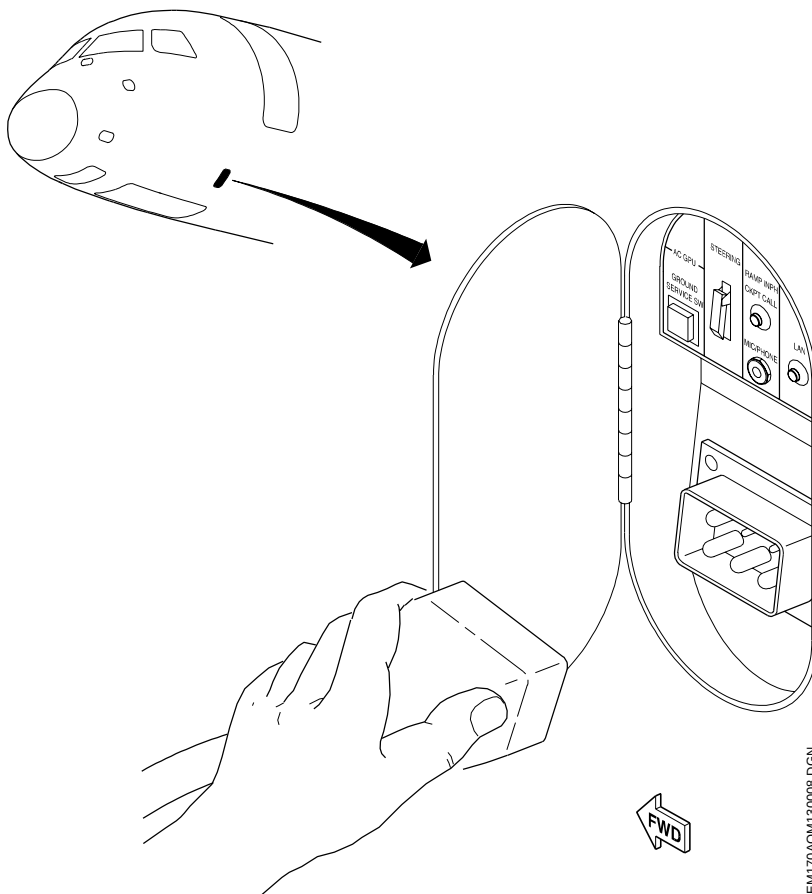
For further instructions pertaining to the subjects covered herein refer to the Aircraft Maintenance Manual.

EXTERNAL CONNECTIONS

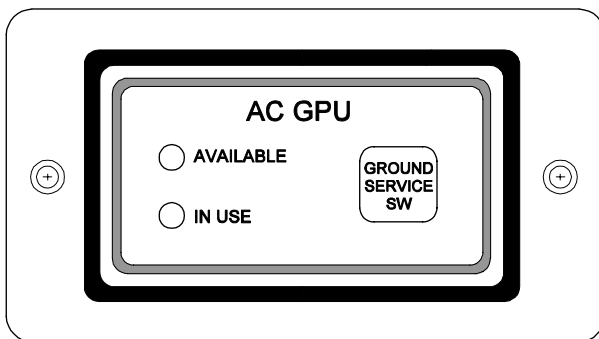
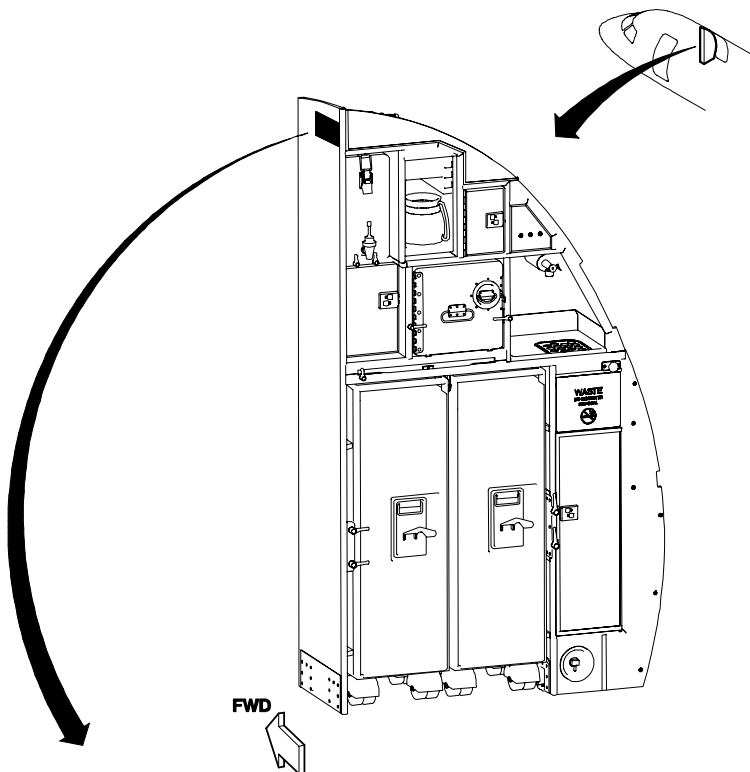
ELECTRICAL POWER SUPPLY

AC POWER SUPPLY

The 115/200-VAC, three-phase, 400-Hz AC external power supply is connected to the airplane through the receptacle installed on the left side of the forward fuselage.



AC EXTERNAL POWER CONNECTION



GROUND SERVICE PANEL – G1 GALLEY

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EXTERNAL AC POWER SUPPLY PROCEDURES

CONNECTION

Make sure that the external power supply has an earth grounded neutral with no open or floating ground in the neutral circuit. An open or floating ground can cause an electrical potential in the airplane ground circuit.

Make sure that the external power supply operates correctly before supplying power to the airplane. If the ground return circuit of the external power supply does not operate correctly, do the Static Grounding Safety Procedure.

Static Grounding Safety Procedures ACCOMPLISH

When using an AC-fed external power source, a ground connection between the hangar structure and the power source, and another one between the power source and the airplane are necessary. Attach the ground cable to the ground connection before attach it to the airplane.

GPU..... ON

Output Voltage SET

Adjust the output voltage of the external AC power supply to 115 ± 3/-2 VAC.

GPU..... OFF

AC Power Supply Connection Door OPEN

GPU..... CONNECT

Connect the GPU cable to the external AC power supply receptacle.

GPU..... ON

The AVAIL indication on the Ground Power Unit button (cockpit) turns on.

BATT 1 ON

BATT 2 AUTO

Check if only pilot MFD and EICAS displays are turned on.

BATT 2 OFF

Check if the voltage of battery 1 is greater than 22.5V.

BATT 2 AUTO

BATT 1 OFF

Check if the voltage of battery 2 is greater than 22.5V.

Ground Service Pushbutton CHECK

Make sure that the IN USE indication is OFF at the external AC power receptacle or at forward RH G1 galley.

Ground Power Unit Button..... PUSH IN

The IN USE indication turns on.

DISCONNECTION

Ground Power Unit Button PUSH OUT

The AVAIL indication turns on.

BATT 1 & 2..... OFF

GPU OFF

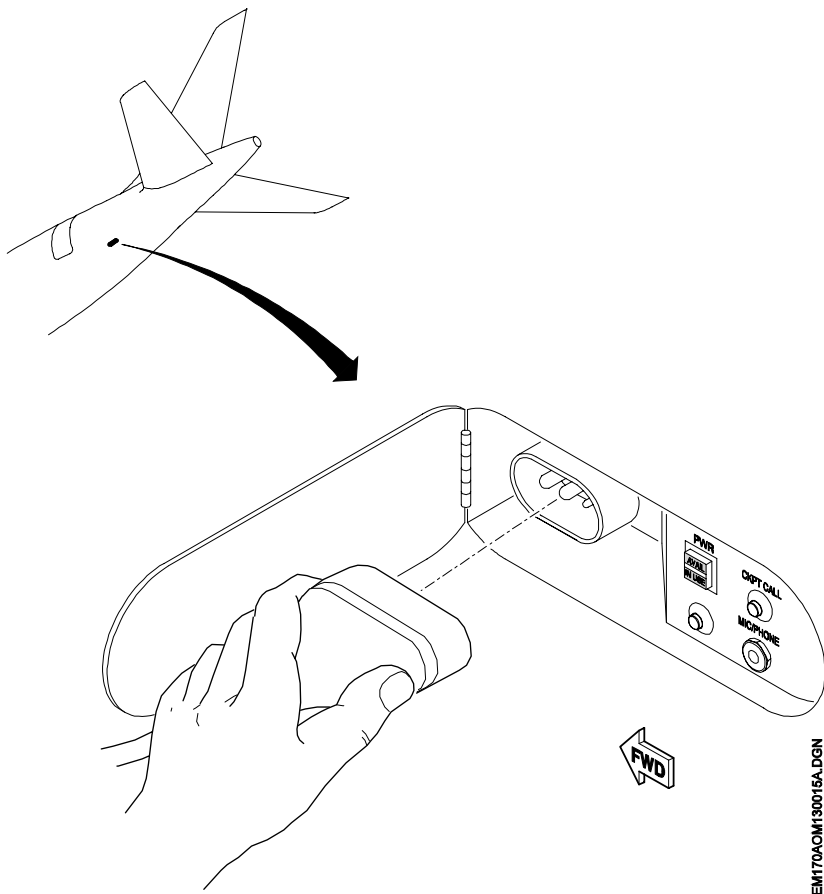
The AVAIL indication turns off.

GPU DISCONNECT

AC Power Supply Connection Door CLOSE

DC POWER SUPPLY

The 28-VDC external power supply is connected to the aircraft through the receptacle installed on the LH side of the rear fuselage. The DC power supply DC is used to start the APU.



DC EXTERNAL POWER CONNECTION

CONNECTION

Make sure that the external power supply has an earth grounded neutral with no open or floating ground in the neutral circuit. An open or floating ground can cause an electrical potential in the airplane ground circuit.

Make sure that the external power supply operates correctly before supplying power to the airplane. If the ground return circuit of the external power supply or the external power receptacle of the airplane does not operate correctly, do the Static Grounding Safety Procedure.

Static Grounding Safety Procedures ACCOMPLISH

When using an AC-fed external power source, a ground connection between the hangar structure and the power source, and another one between the power source and the airplane are necessary. Attach the ground cable to the ground connection before attach it to the airplane.

GPU ON

Output Voltage SET

Adjust the output voltage of the external DC-power supply to 28 ± 0.5 VDC.

GPU OFF

DC Power Supply Connection Door OPEN

GPU CONNECT

Connect the GPU cable to the external DC power supply receptacle.

GPU ON

The AVAIL indication on the DC GPU PWR button in the DC power supply receptacle turns on.

DC GPU PWR Button PUSH IN

The IN USE indication turns on.

DISCONNECTION

DC GPU PWR Button PUSH OUT

The AVAIL indication turns on.

GPU OFF

The AVAIL indication turns off.

GPU DISCONNECT

AC Power Supply Connection Door CLOSE



PNEUMATIC CONNECTIONS

PNEUMATIC START UNIT

The pneumatic start unit is connected to the airplane through the engine start ground connection (HP ground connection) installed in the wing-to-fuselage fairing. Pressure supplied by the unit should be set above the minimum bleed duct pressure to compensate for pressure drop.

EXTERNAL PNEUMATIC POWER SOURCE PROCEDURE

Engine & APU CHECK

Check if Engines and APU are stopped.

Pneumatic Connections Access Door OPEN

Hose Adapter CONNECT

Connect the hose adapter of the pneumatic start unit to the airplane engine start ground connection.

External Pneumatic Power Source START

Set the Pneumatic Start Unit to ON and check the minimum bleed duct pressure on ECS page (MFD) at 33 psi minus 0,5 psi for each 1000 ft above sea level. If the equipment does not have an adjustment feature, set the pressure just above the minimum bleed duct pressure required. Do not set the pressure higher than 100 psi.

External Pneumatic Power Source Valve OPEN

Engine Start ACCOMPLISH

External Pneumatic Power Source Valve CLOSE

External Pneumatic Power Source STOP

Hose Adapter DISCONNECT

Pneumatic Connections Access Door CLOSE

AIR CONDITIONING GROUND UNIT

An external conditioned air source can be connected to the airplane to supply hot or cold air directly into the cabin.

Cooling packs should be OFF, given that they are not able to control air temperature when a ground air source is being operated at the same time.

AIR CONDITIONING GROUND UNIT PROCEDURE

CONNECTION

PACKS 1 & 2..... OFF

Pneumatic Connections Access Door OPEN

Air Conditioning Ground Unit..... CONNECT

Connect the air conditioning unit to the airplane. The maximum permitted value of pressure airflow to the aircraft is 203.2 mm H₂O (8 in H₂O).

Conditioned Air..... SUPPLY

DISCONNECTION

Conditioned Air..... STOP

Air Conditioning Ground Unit..... DISCONNECT

Carefully disconnect the air conditioning unit from the aircraft.

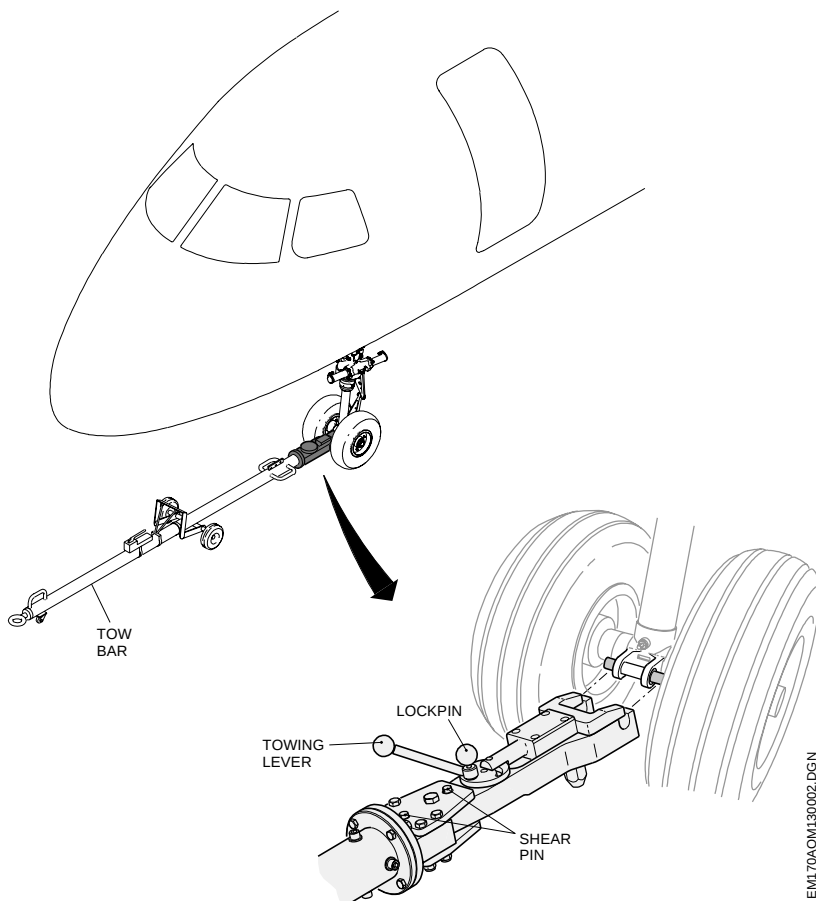
Pneumatic Connections Access Door CLOSE

TOWING

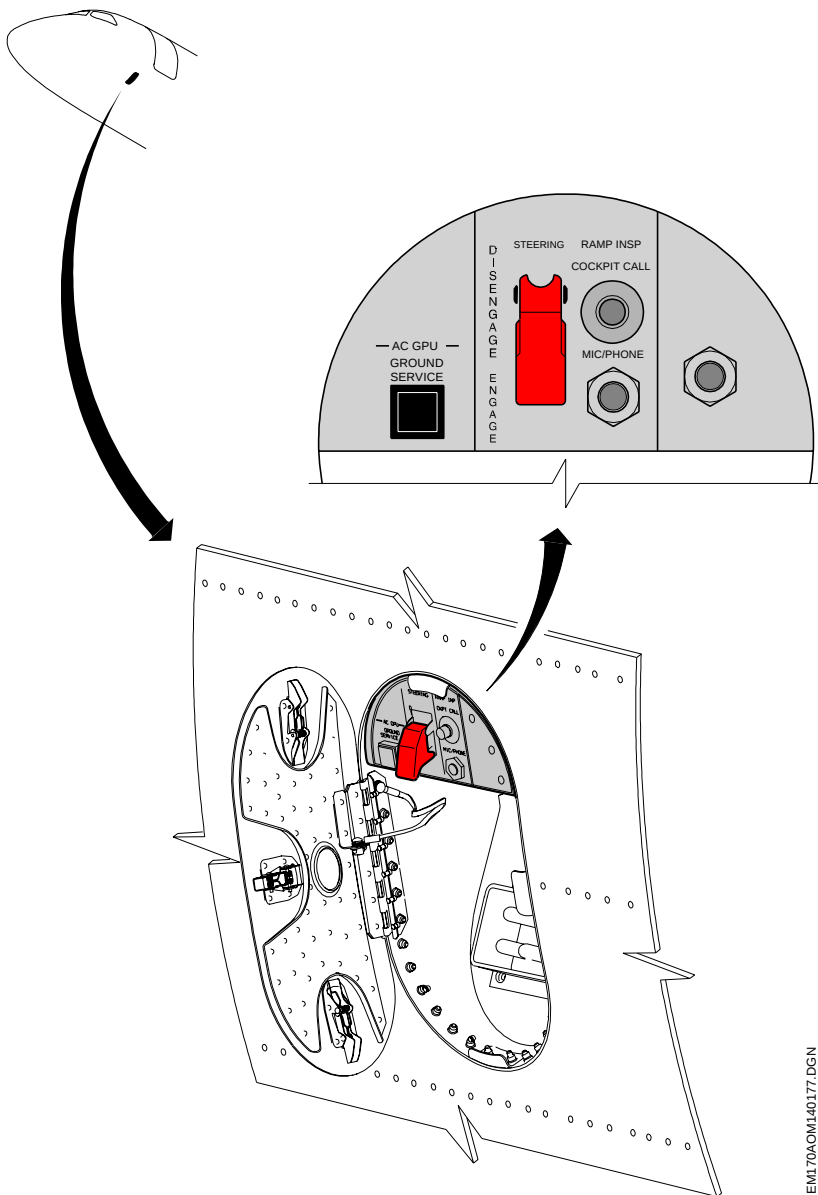
TOWING WITH TOWBAR

Ground towing can be accomplished by using a tow bar coupled to the landing gear.

The tow bar incorporates breakable sections (fuse) with the purpose of causing the tow bar to break in case of any towing abnormality, to protect the airplane structure or the nose landing gear from damage.

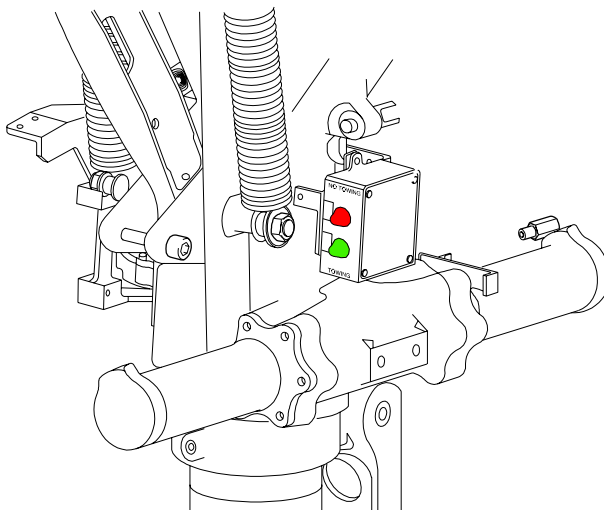


TOWING EQUIPMENT



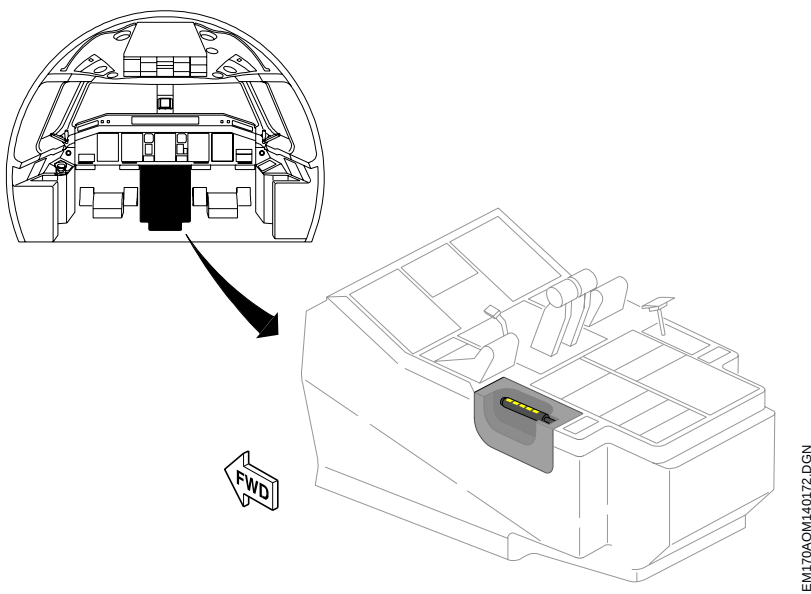
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EXTERNAL STEERING DISENGAGEMENT SWITCH

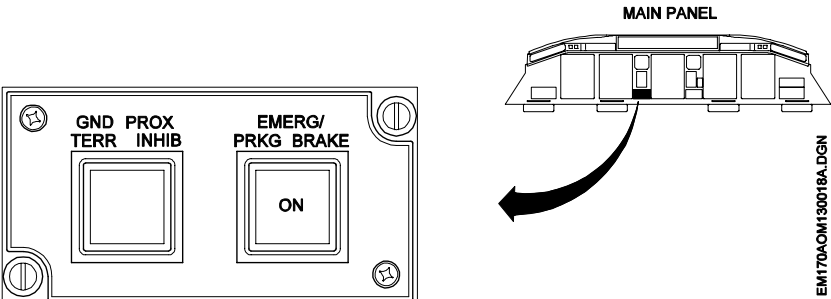


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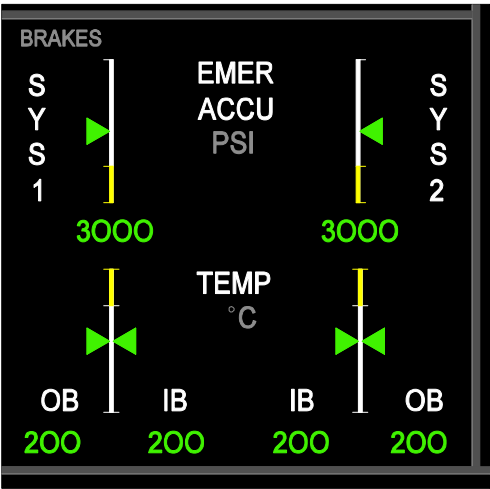
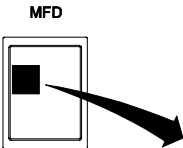
TOWING LIGHTS



EMERGENCY/PARKING BRAKE HANDLE



EMERGENCY/PARKING BRAKE LIGHT



MFD STATUS PAGE

TOWING PROCEDURES

Doors CLOSED

Close passenger doors, service doors, cargo doors and engine cowl.

Seatbelts FASTEN

All the persons in the cockpit must be in a seat and seatbelts must be fastened.

Emergency/Parking brake SET

Landing Gear Safety Pins INSTALLED

Make sure that the landing gear downlock safety pins are correctly installed on the main and nose landing gears.

Landing Gear Shock Struts CHECK

Make sure that the main landing gear and nose landing gear shock struts have sufficient extension.

RAT Stow Lock Pin INSTALL

Lock the RAT with stow lock pin and install the REMOVE-BEFORE-FLIGHT streamer.

APU ON

Energize the airplane with the APU.

Emergency/Parking Brake CHECK

Check if emergency/parking brake accumulator is pressurized. Pull the emergency/parking brake handle and check if emergency/parking brake light is ON.

Steering System DISENGAGE

Disengage the steering system setting the external steering switch to the "DISENGAGE" position.

EICAS Message CHECK

Check if the STEER OFF message is displayed on EICAS.

Towing Indication Light RED

Tow bar INSTALL

Pull the locking pin and set the towing lever to the released position. Install the towbar on the towing attachment on the NLG. Pull the locking pin and set the towing lever to the towing position.

Install the other end of the towbar to the tow tractor.

Wheel Chocks REMOVE

Remove the wheel chocks from all tires.

Emergency/Parking Brake RELEASE

Release the emergency/parking brake handle in the cockpit (brakes OFF).

Towing Indication Light GREEN

Make sure that the towing-indication light box shows the green light on.



- Towing..... ACCOMPLISH
Tow the airplane slowly straight ahead before turn. Complete the airplane towing in a straight line for a minimum of 3 meters (10 feet) or until the nose wheel steering system is in the range of ± 170 degrees.
- Emergency/Parking Brake..... SET
Check if Emergency/Parking Brake light is ON.
- Wheel Chocks INSTALL
Install the wheel chocks around all tires.
- Steering System ENGAGE
Set the external steering switch to the “ENGAGE” position.
- EICAS Message CHECK
Check if the STEER OFF message on EICAS goes off.
- Towing Indication Light..... RED
- Tow Bar REMOVE
Remove the tow bar from the tractor. Pull the locking pin and set the towbar lever to the released position. Remove the tow bar from the nose landing gear.
- APU OFF,
IF APPLICABLE
- RAT Stow Lock Pin REMOVE
- Landing Gear Safety Pins..... REMOVE
Make sure that the landing gear downlock safety pins are removed from the main and nose landing gears.

PUSHBACK

The pushback is accomplished by using a tow bar coupled to the landing gear.

Pushback procedure is performed to move the airplane from the terminal gate before flight, with passengers and flight crew members on board and to push an airplane back with the assistance of ground towing crew only.

One towing supervisor is necessary to control the towing operation. One pushback crew at each wing tip and one pushback crew behind the tail are necessary to monitor sufficient clearance during the turns.

The towing supervisor must have visual and radio communication with all the towing and flight crewmembers at all times.

PUSHBACK PROCEDURES

Seatbelts FASTEN

All the persons in the cockpit must be in a seat and seatbelts must be fastened.

RAT Stow Lock Pin CHECK

Make sure that the stow lock pin is removed from the RAT.

Landing Gear Safety Pins..... CHECK

Make sure that the landing gear downlock safety pins are removed from the main and nose landing gears.

Wheel Chocks INSTALL

Install the wheel chocks in front of and behind all tires.

Emergency/Parking Brake..... SET

Check if emergency/parking brake accumulator is pressurized. Pull the emergency/parking brake handle and check if emergency/parking brake light is ON.

Towing Indication Light..... RED

Steering System DISENGAGE

Disengage the steering system setting the external steering switch to the "DISENGAGE" position.

EICAS Message CHECK

Check if the STEER OFF message is displayed on EICAS.

Ground Equipment CHECK

Make sure that all ground equipment is removed from areas adjacent to the airplane and all external services are disconnected from the airplane.

Doors..... CLOSED

Close passenger doors, service doors, cargo doors and engine cowl.

Tow Bar INSTALL

Pull the locking pin and set the towing lever to the released position. Install the towbar on the towing attachment on the NLG. Pull the locking pin and set the towing lever to the towing position.

Install the other end of the towbar to the tow tractor.

Wheel Chocks REMOVE

Remove the wheel chocks from all tires.

Emergency/Parking Brake RELEASE

Release the emergency/parking brake handle in the cockpit (brakes off).

Towing Indication Light GREEN

Make sure that the towing-indication light box shows the green light on.

Pushback ACCOMPLISH

Tow the airplane slowly straight ahead before turn. Complete the airplane towing in a straight line for a minimum of 3 meters (10 ft) or until the nose wheel steering is in the range of ± 170 degrees.

Emergency/Parking Brake SET

Check if emergency/parking brake light is ON.

Towing Indication Light RED

Tow bar REMOVE

Remove the tow bar from the tractor. Pull the locking pin and set the towbar lever to the released position. Remove the tow bar from the nose landing gear.

Flight Crew ADVISE

Notify the pilot that towbar is removed.

Steering System ENGAGE

Set the external steering switch to the "ENGAGE" position.

EICAS Message CHECK

Check if the STEER OFF message on EICAS goes off.

Access Door CLOSE

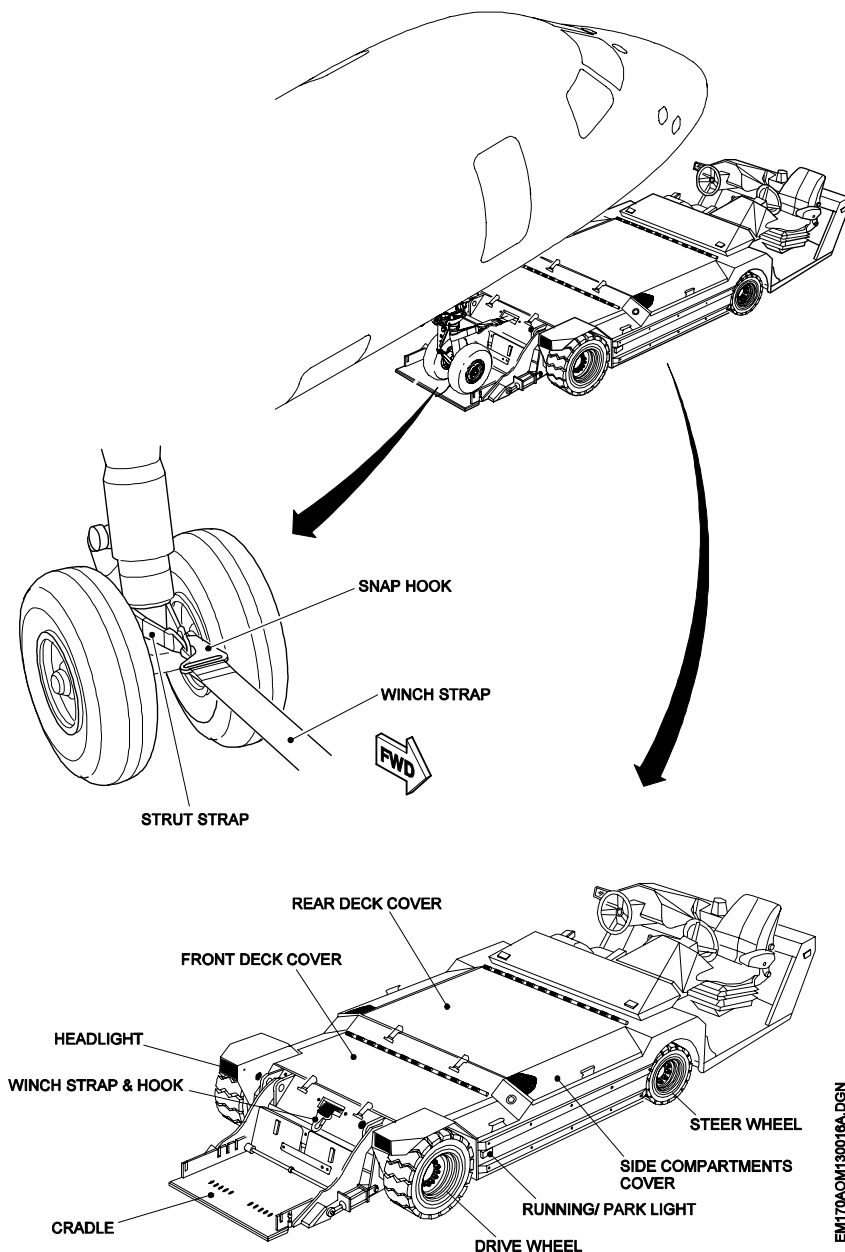
Close and latch the external steering access door.

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TOWBARLESS TOWING

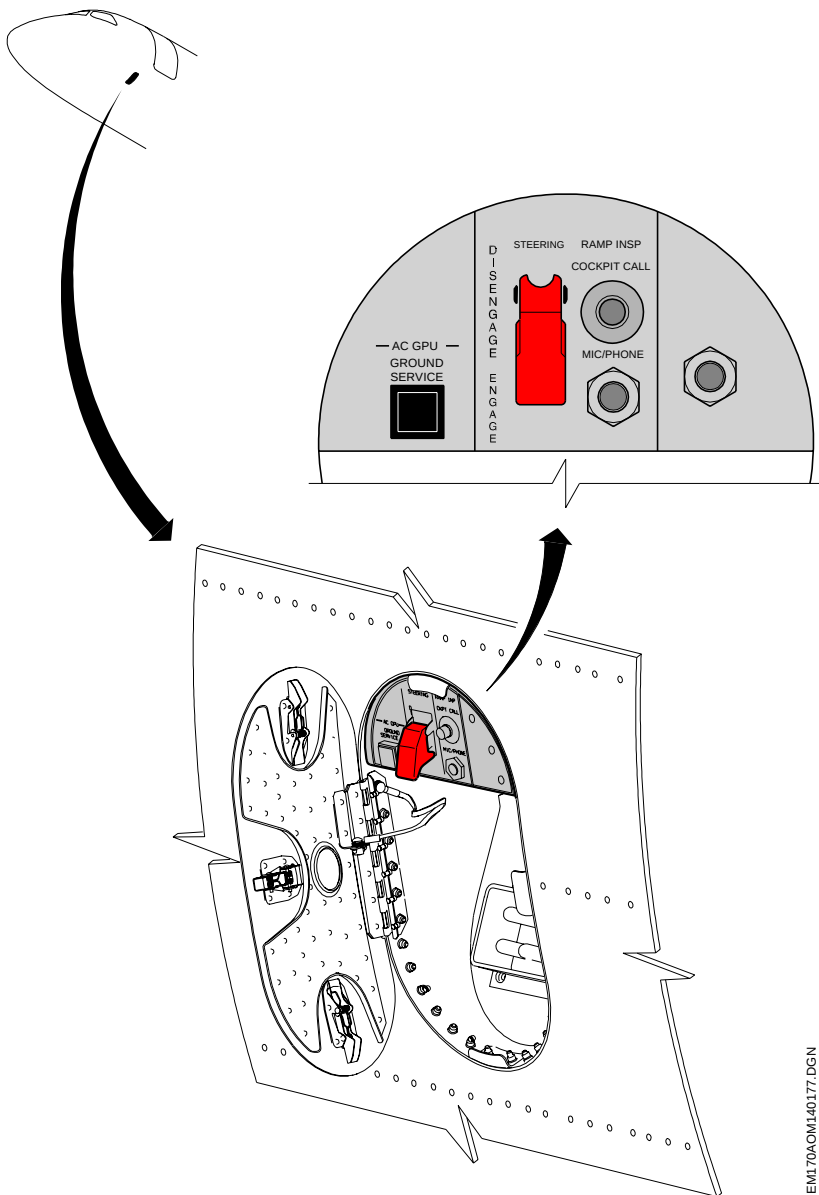
Towbarless towing is prohibited, unless the towbarless towing operations are performed in compliance with the appropriate operational requirements using towbarless towing vehicles that are designed and operated to preclude damage to the airplane nose landing gear, steering system and associated fuselage structure. For the steering system, if damage cannot be precluded, a reliable and unmistakable warning must be provided when damage to the steering system may occur.

Towbarless towing vehicles that are specifically accepted for this type of airplane are listed in the AMM Chapter 9.



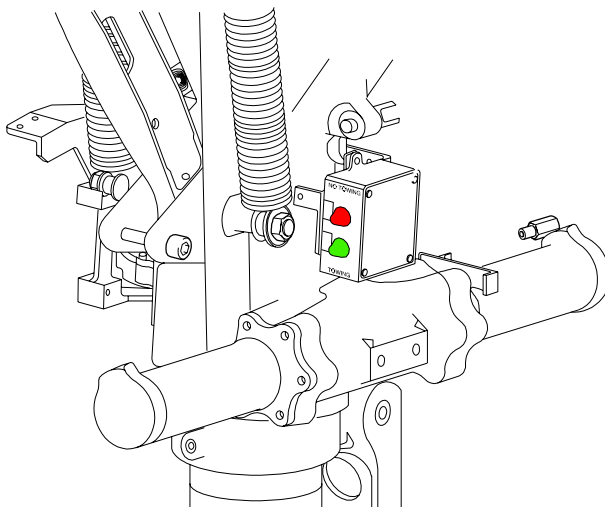
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TOWBARLESS TOWING VEHICLE



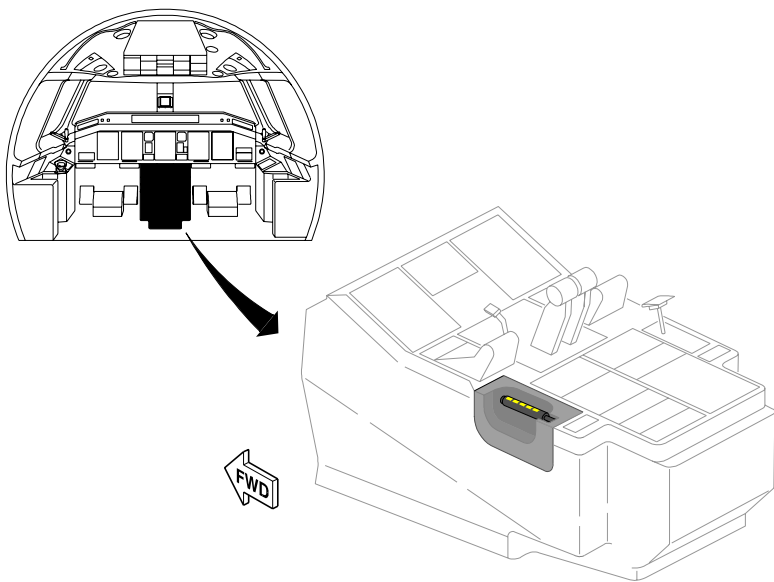
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EXTERNAL STEERING DISENGAGEMENT SWITCH

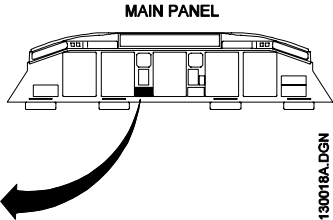
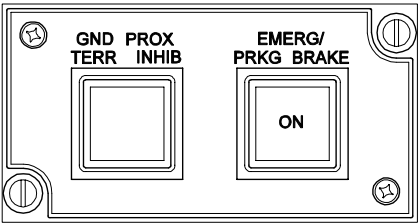


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TOWING LIGHTS

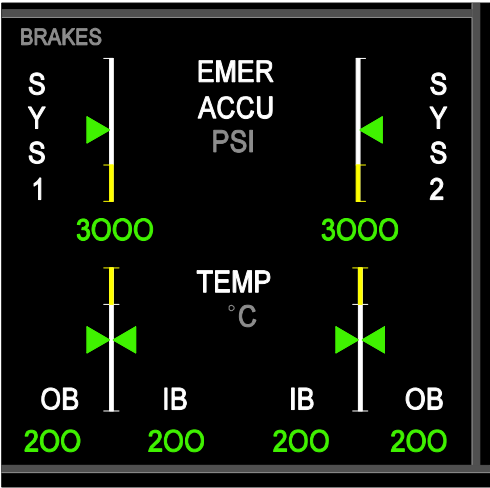
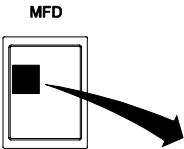


EMERGENCY/PARKING BRAKE HANDLE



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EMERGENCY/PARKING BRAKE LIGHT



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MFD STATUS PAGE

TOWING PROCEDURES

Landing Gear Safety Pins INSTALLED

Make sure that the landing gear downlock safety pins are correctly installed on the main and nose landing gears.

Doors CLOSED

Close passenger doors, service doors, cargo doors and engine cowl.

Emergency/Parking Brake..... CHECK

Check if emergency/parking brake accumulator is pressurized. Pull the emergency/parking brake handle and check if emergency/parking brake light is ON.

Steering System..... DISENGAGE

Disengage the steering system setting the external steering switch to the "DISENGAGE" position.

EICAS Message..... CHECK

Check if the STEER OFF message is displayed on EICAS.

Towing Indication Light RED

Ground Equipment..... CHECK

Make sure that all ground equipment is removed from areas adjacent to the airplane and all external services are disconnected from the airplane.

Tug Vehicle POSITION

Position the tug vehicle in line with the direction of nose wheel tire and stop the vehicle 1 m (3 ft) from the airplane wheel. Lower the nose wheel cradle to 5 cm (2 in) above the ground.

Move slowly the tug vehicle and stop the cradle 5 cm (2 in) from the nose wheel tire. Lower the cradle to the ground and raise until it does not touch the ground.

Move slowly the tug vehicle until the cradle lightly touch the tire.

Tug Vehicle Parking Brake..... SET

Strap ATTACH

Attach the strut strap to the winch strap. Unwind the winch strap to install the strut strap to the nose landing gear strut.

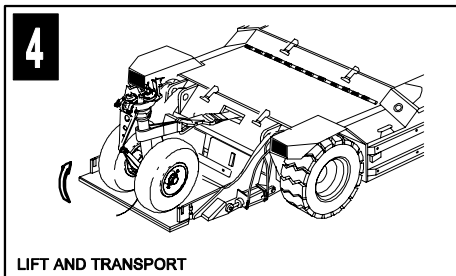
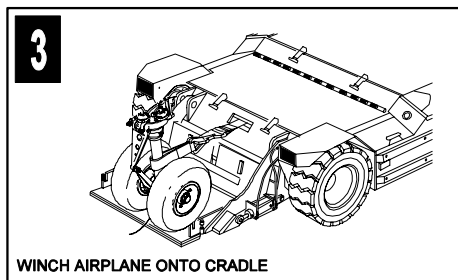
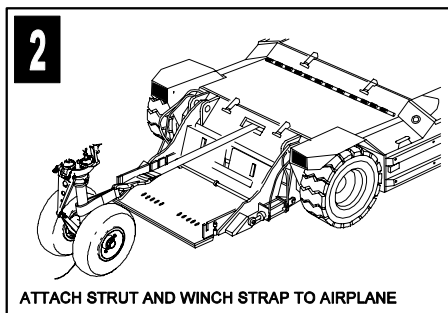
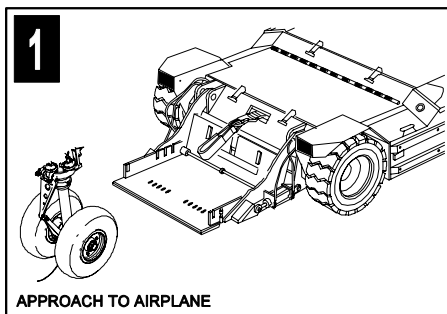
Do not install the strut strap around the wheel assembly.

Put the strut strap around the nose wheel strut counterclockwise, looking from above. Make sure that the strap is not twisted or in a position where it can cause damage to any part of the nose wheel assembly during the winch and towing operation.

Adjust the protective sleeve to the center of the strut strap. Make sure that only the strut strap attachment is in direct contact with the airplane.

Attach the other end of the strut strap attachment to the winch strap hook.

- Winch Strap..... WINCH
- Slowly winch the winch strap. Stop when the winch strap is tight and parallel to the ground.
- Emergency/Parking Brake..... RELEASE
- Release the emergency/parking brake of the airplane.
- Wheel Chocks REMOVE
- Nose Landing Gear WINCH
- Winch the airplane fully onto the cradle with the wheels centered on the cradle.
- Wheel Cradle..... LIFT
- Lift the wheel cradle to a distance from the ground sufficient to clear obstacles during towing. Monitor the tension of winch strap during lift operation.
- Tug Vehicle Parking Brake RELEASE
- Towing..... ACCOMPLISH
- Tow the airplane slowly straight ahead before turn. Complete the airplane towing in a straight line for a minimum of 3 meters (10 ft) or until the nose wheel steering system is in the range of ± 170 degrees.
- Emergency/Parking Brake..... SET
- Check if emergency/parking brake light is ON.
- Wheel Cradle..... LOWER
- Lower the nose wheel cradle until the cradle is on the ground.
- Strap..... REMOVE
- Unwind the winch strap to remove the strut strap from the NLG. Remove the strut strap from the NLG.
- Tug Vehicle REMOVE
- Slowly back the tug vehicle away from the airplane nose wheel and pull the cradle from under the nose wheel tire.
- Lift the nose wheel cradle and remove the tug vehicle.
- Steering System ENGAGE
- Set the external steering switch to the "ENGAGE" position.
- EICAS Message CHECK
- Check if the STEER OFF message on EICAS goes off.
- Towing Indication Light..... RED
- Landing Gear Safety Pins..... REMOVE
- Make sure that the landing gear downlock safety pins are removed from the main and nose landing gears.



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TOWBARLESS TOWING PROCEDURES

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PARKING

When parking, a minimum distance should be kept regarding other airplanes in order to permit airplane movement.

Landing gear control lever should be in the down position and downlock pins must be installed given that a landing gear retraction could occur and cause injuries to persons and damage to the equipment.

If the parking area has ice or snow, a mat, a layer of thick sand or other applicable material should be placed under the tires in order to prevent them from freezing.

Emergency/parking brake should be set to the PARKING position and flaps retracted if they are extended.

Having the airplane in the desired position, chocks may be placed against the landing gear wheels and covers for sensors may be installed.

PARKING PROCEDURE

Landing Gear lever..... CHECK

Check if landing Gear Lever is set to DOWN position.

Landing Gear Safety Pins INSTALLED

Make sure that the landing gear downlock safety pins are correctly installed on the main and nose landing gears.

RAT Stow Lock Pin INSTALLED

Make sure that the RAT is locked with Stow Lock Pin, and the REMOVE-BEFORE-FLIGHT streamer is installed

Airplane to Parking Position TAXI / TOWING

Taxi or tow the airplane to the position specified for parking. If there is ice or snow in the parking area, put a mat and a layer of thick sand or other applicable material to prevent freezing of tires on ground.

Mooring ACCOMPLISH,
IF NECESSARY

Emergency/Parking brake SET

Flaps RETRACT

Retract the flaps if they are extended.

Covers..... INSTALL

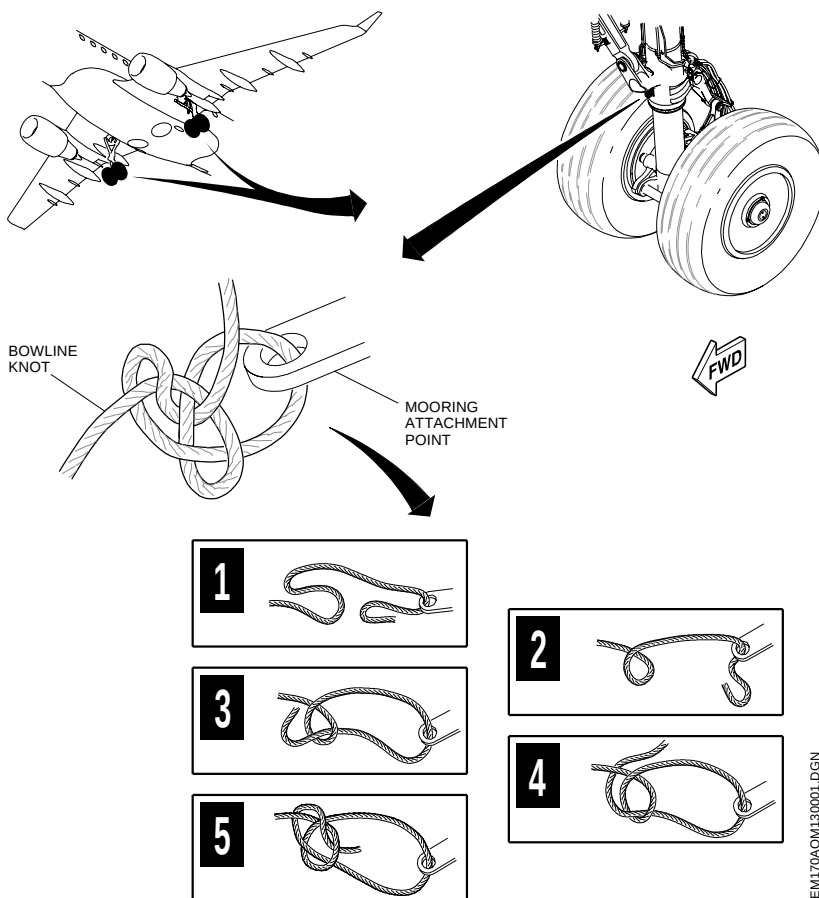
Install covers to antennas, wheels, TAT sensor, ice-detector, smart probes, flaps trailing edge and winglets.

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MOORING

Mooring is necessary when the weather conditions are bad or unknown. The area where the airplane is to be parked in and moored must be paved and level, with ground tie down anchors available.

There is one mooring attachment point installed on each primary brace strut of the main landing gear.



MOORING THE AIRPLANE



MOORING PROCEDURE

- Parking Procedures ACCOMPLISH
- Mooring PROCEED

Hold the airplane in the parking area with nylon ropes. Attach the rope to the mooring attachment point and attach the anchor with a bowline knot.

FUEL SYSTEM SERVICING

GRAVITY FUELING

Emergency/Parking Brake..... ON

Chocks IN PLACE

Aircraft and Fuel Nozzle STATICALLY
GROUNDED

Use an AC GPU or start the APU. If the power is not available use the fuel stick level indicator. Refer to fuel stick level indicator supplementary procedure.

NOTE: The battery use may cause its discharge.

Gravity Fill Cap (left/right) OPEN

Introduce the fueling nozzle into the gravity refueling adapter.

Start the fueling operation and monitor the fuel quantity in the tank.

When the fueling operation is completed:

Gravity Fill Cap (left/right)..... CLOSED

Remove the grounding cables.



PRESSURE FUELING

- EMERGENCY/PARKING BRAKE ON
- CHOCKS IN PLACE
- AIRCRAFT AND FUEL NOZZLE STATICALLY GROUNDED

Use an AC GPU or start the APU and then set the POWER SELECTION switch to the NORMAL position on the refueling/defueling control panel. If AC power source is not available, set the POWER SELECTION switch to the BATTERY position.

Gain access to the refueling/defueling control panel.

- LH and RH refueling indication lights VERIFY OFF
- Defueling indication light..... VERIFY OFF

FOR PRESSURE FUELING IN AUTO MODE

- REFUEL SELECTION switch AUTO
- Fuel Quantity on Repeater indicator SET

FOR PRESSURE FUELING IN MANUAL MODE

- REFUEL SELECTION switch MANUAL
- Pressure refueling/defueling adapter assembly cap..... REMOVE

Connect the fuel nozzle to the pressure refueling/defueling adapter assembly.

- Valve handle on fuel nozzle..... OPEN
- Pressurize the fuel system from 241.32 - 344.74 kPa (35 - 50 psig).
- LH and RH refueling indication lights VERIFY ON

Make sure that there is no fuel flow while the lights are illuminated.

- REFUELING switch OPEN
- LH and RH refueling indication lights VERIFY OFF

DEFUELING

AIRPLANE STATICALLY
GROUNDED

AC GPU CONNECTED

Defueling Open Light
(Refuel/Defuel Control Panel) OFF

Remove the cap from the pressure refueling/defueling adapter assembly and connect the fueling nozzle to the pressure refueling/defueling adapter assembly. Open the valve handle on the fuel nozzle.

Defueling Switch (Refuel/Defuel Control Panel) OPEN

Check that the defueling open light illuminates.

To defuel both tanks:

Crossfeed Selector Knob LOW 1

Fuel AC Pump 1 and 2 Selector Knobs ON

The fuel pumps must be in ON position if no suction on the fuel nozzle is applied.

To defuel left tank:

Crossfeed Selector Knob OFF

Fuel AC Pump 1 Selector Knob ON

The fuel pump must be in ON position if no suction on the fuel nozzle is applied.

To defuel right tank:

Crossfeed Selector Knob LOW 1

Fuel AC Pump 2 Selector Knob ON

The fuel pump must be in ON position if no suction on the fuel nozzle is applied.

After defueling is completed:

Defueling Switch
(Refuel/Defuel Control Panel) CLOSED

Check the defueling open light extinguished.

Crossfeed Selector Knob OFF

Fuel AC Pump 1 and 2 Selector Knobs AUTO

Remove the grounding cable and the fuel nozzle.



FUEL TRANSFER BETWEEN WING TANKS

- Emergency/Parking Brake ON
- Chocks IN PLACE
- Use an AC GPU or start the APU.
- On the refueling/defueling control panel:
 - POWER SELECTION switch NORMAL
 - DEFUELING switch OPEN
 - Defueling indication light VERIFY ON
- In the cockpit:
 - AC Pumps selector knobs..... AUTO

FOR FUEL TRANSFER FROM RH TO LH TANK

- REFUEL 1 Circuit Breaker PULL AND SAFETY
- XFEED selector knob..... LOW 1

FOR FUEL TRANSFER FROM LH TO RH TANK

- REFUEL 2 Circuit Breaker PULL AND SAFETY
- XFEED selector knob..... LOW 2

After the desired fuel transfer is completed:

- XFEED selector knob..... OFF
- REFUEL 1 or 2 Circuit Breaker RESET

On the refueling/defueling control panel:

- DEFUELING switch CLOSED
- Defueling indication light VERIFY OFF

FUEL MAGNETIC LEVER

The best readings are within the values:

- Pitch up: up to 0.8°.
- Roll: up to 0.3°.

For other ranges of airplane leveling refer to AMM Part II – Chapter 12.

LEVER INDICATION	FUEL QUANTITY					
	INTERNAL		MIDLLLE		EXTERNAL	
	LITERS	US GAL	LITERS	US GAL	LITERS	US GAL
0.2	231	61	2953	780	4214	1113
0.4	251	66	2985	789	4246	1122
0.6	272	72	3017	797	4279	1130
0.8	293	77	3049	805	4312	1139
1.0	315	83	3082	814	4344	1148
1.2	336	89	3115	823	4377	1156
1.4	358	95	3149	832	4410	1165
1.6	380	100	3182	841	4443	1174
1.8	402	106	3216	850	4475	1182
2.0	424	112	3251	859	4508	1191
2.2	446	118	3285	868	4541	1200
2.4	469	124	3320	877	4573	1208
2.6	492	130	3356	887	4606	1217
2.8	515	136	3392	896	4639	1225
3.0	538	142	3428	906	4671	1234
3.2	562	148	3464	915	4704	1243
3.4	586	155	3501	925	4737	1251
3.6	610	161	3538	935	4770	1260
3.8	634	167	3575	944	4802	1269
4.0	658	174	3613	954	4835	1277
4.2	683	180	3651	964	4868	1286
4.4	707	187	3689	975	4900	1294
4.6	732	193	3728	985	4933	1303
4.8	757	200	3767	995	4966	1312
5.0	783	207	3806	1005	4999	1321
5.2	808	213	3846	1016	5031	1329

LEVER INDICATION	FUEL QUANTITY					
	INTERNAL		MIDLLE		EXTERNAL	
	LITERS	US GAL	LITERS	US GAL	LITERS	US GAL
5.4	834	220	3886	1027	5064	1338
5.6	860	227	3927	1037	5097	1346
5.8	886	234	3967	1048	5129	1355
6.0	913	241	4008	1059	5162	1364
6.2	939	248	4050	1070	5195	1372
6.4	966	255	4091	1081	5227	1381
6.6	993	262	4133	1092	5260	1390
6.8	1020	269	4176	1103	5293	1398
7.0	1048	277	4218	1114	5326	1407
7.2	1075	284	4261	1126	--	--
7.4	1103	291	4305	1137	--	--
7.6	1131	299	4349	1149	--	--
7.8	1160	306	4393	1161	--	--
8.0	1188	314	4437	1172	--	--
8.2	1217	321	4482	1184	--	--
8.4	1246	329	4527	1196	--	--
8.6	1275	337	4572	1208	--	--
8.8	1304	344	4618	1220	--	--
9.0	1333	352	4664	1232	--	--
9.2	1363	360	4710	1244	--	--
9.4	1393	368	4757	1257	--	--
9.6	1423	376	4804	1269	--	--
9.8	1454	384	4851	1281	--	--
10.0	1484	392	4899	1294	--	--
10.2	1515	400	--	--	--	--
10.4	1546	408	--	--	--	--
10.6	1577	417	--	--	--	--
10.8	1608	425	--	--	--	--
11.0	1640	433	--	--	--	--
11.2	1672	442	--	--	--	--
11.4	1704	450	--	--	--	--
11.6	1736	459	--	--	--	--
11.8	1768	467	--	--	--	--

LEVER INDICATION	FUEL QUANTITY					
	INTERNAL		MIDLL E		EXTERNAL	
	LITERS	US GAL	LITERS	US GAL	LITERS	US GAL
12.0	1801	476	--	--	--	--
12.2	1833	484	--	--	--	--
12.4	1866	493	--	--	--	--
12.6	1900	502	--	--	--	--
12.8	1933	511	--	--	--	--
13.0	1967	520	--	--	--	--
13.2	2001	529	--	--	--	--
13.4	2035	538	--	--	--	--
13.6	2069	547	--	--	--	--
13.8	2103	556	--	--	--	--
14.0	2138	565	--	--	--	--
14.2	2173	574	--	--	--	--
14.4	2208	583	--	--	--	--
14.6	2243	593	--	--	--	--
14.8	2279	602	--	--	--	--
15.0	2314	611	--	--	--	--
15.2	2350	621	--	--	--	--
15.4	2386	630	--	--	--	--
15.6	2423	640	--	--	--	--
15.8	2459	650	--	--	--	--
16.0	2496	659	--	--	--	--
16.2	2533	669	--	--	--	--
16.4	2570	679	--	--	--	--
16.6	2607	689	--	--	--	--
16.8	2645	699	--	--	--	--
17.0	2682	709	--	--	--	--
17.2	2720	719	--	--	--	--
17.4	2759	729	--	--	--	--
17.6	2797	739	--	--	--	--
17.8	2835	749	--	--	--	--
18.0	2874	759	--	--	--	--
18.2	2913	770	--	--	--	--
18.4	2952	780	--	--	--	--
18.6	2992	790	--	--	--	--

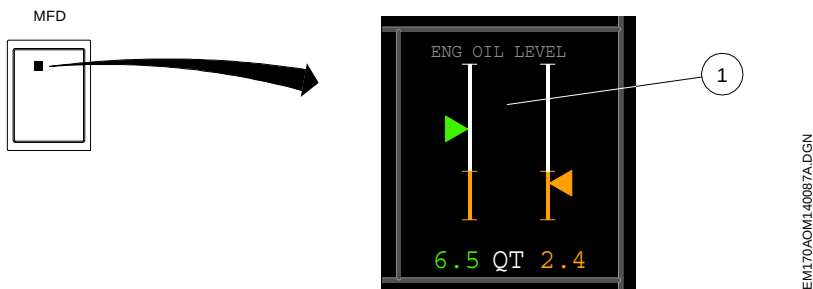


LEVER INDICATION	FUEL QUANTITY					
	INTERNAL		MIDLLE		EXTERNAL	
	LITERS	US GAL	LITERS	US GAL	LITERS	US GAL
18.8	3031	801	--	--	--	--
19.0	3071	811	--	--	--	--
19.2	3111	822	--	--	--	--
19.4	3151	832	--	--	--	--
19.6	3192	843	--	--	--	--
19.8	3232	854	--	--	--	--
20.0	3273	865	--	--	--	--
20.2	3314	875	--	--	--	--
20.4	3356	887	--	--	--	--
20.6	3397	897	--	--	--	--
20.8	3439	908	--	--	--	--
21.0	3481	920	--	--	--	--
21.2	3523	931	--	--	--	--
21.4	3565	942	--	--	--	--
21.6	3607	953	--	--	--	--
21.8	3650	964	--	--	--	--
22.0	3693	976	--	--	--	--

ENGINE OIL SERVICING

Engine oil check may be done from 20 minutes up to 8 hours after engine stop. After 8 hours from the last engine stop, it is necessary to start the engine to do the oil level check again.

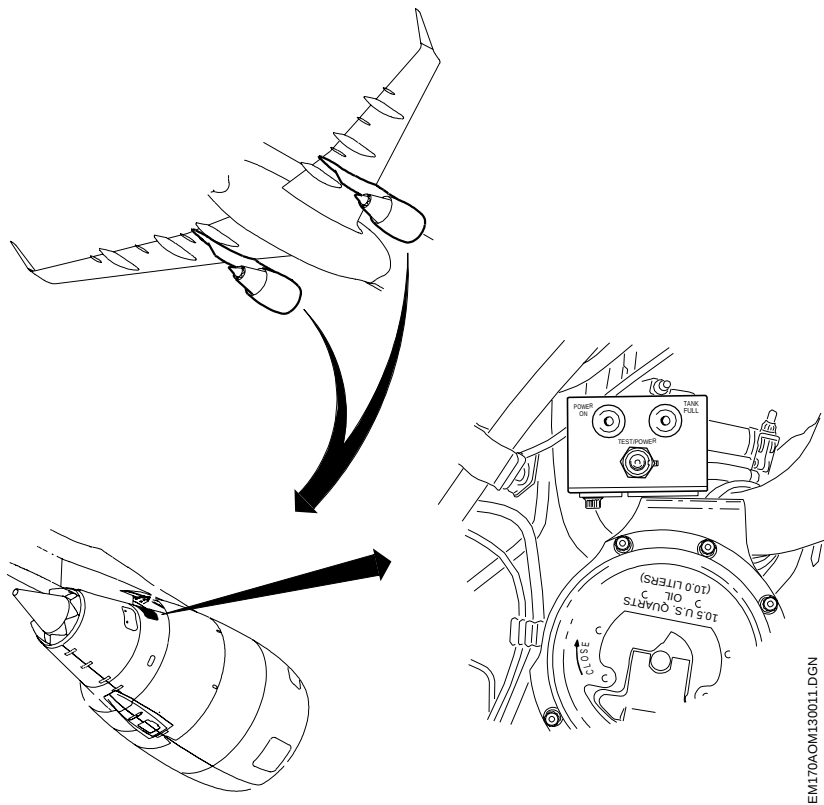
The oil level can be checked in the MFD Status page or directly in the engine.



ENGINE OIL INDICATION ON MFD

Oil level is checked in the engine holding the TEST/POWER button for 15 seconds. It is not necessary to energize the airplane for oil level check directly in the engine.

Engine oil is toxic and flammable, use personal protection equipment and manipulate the oil in a well-ventilated area.



ENGINE OIL LEVEL CHECK

ENGINE OIL LEVEL CHECK – MFD

Power Up ACCOMPLISH

MFD SET

Select the Status Page on the MFD positioning the cursor at the Systems menu.

Engine Oil Level CHECK

Check if the engine oil level in Full position. Fill the engine oil if necessary.

Power Off ACCOMPLISH

ENGINE OIL LEVEL CHECK – ENGINE

Test/Power Button..... PUSH AND
HOLD

On the oil tank level indicator, push and hold down the TEST/POWER button for 15 seconds. POWER ON and TANK FULL indicator lights turn on.

Test/Power Button..... RELEASE

Indicator Lights..... CHECK

If the POWER ON and TANK FULL indicator lights remains on the oil level is correct. If the TANK FULL indicator light turns off, add oil to the engine.

ENGINE OIL – FILLING

Access Panels..... OPEN

Test/Power Button..... PUSH AND
HOLD

Test/Power Button..... RELEASE

Check if the POWER ON light remains on. Check if the TANK FULL light turns off.

Engine-Oil Filler Cap OPEN

Follow the instructions on the cap.

Oil Reservoir FILL

Fill the oil reservoir until TANK FULL light comes on.

Engine-Oil Filler Cap CLOSE

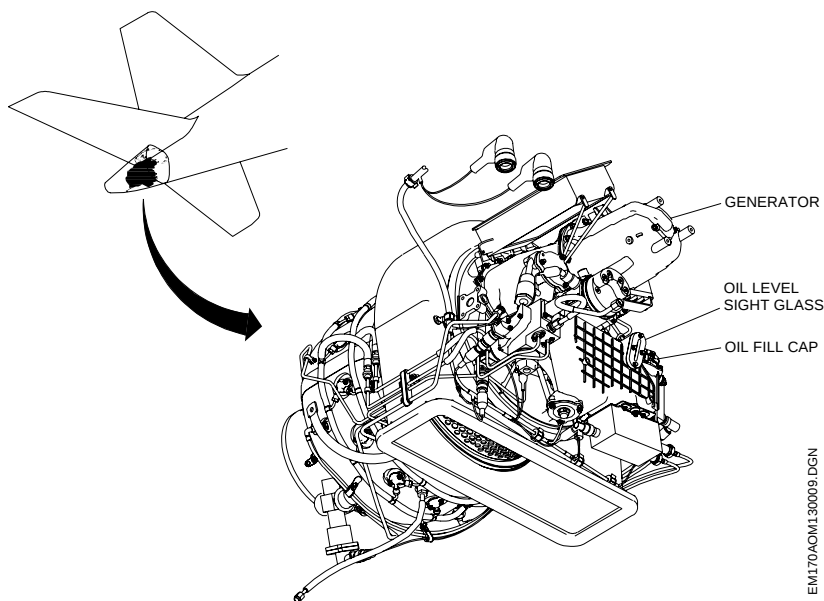
Follow the instructions on the cap.

Access Panels..... CLOSE

APU OIL SERVICING

APU oil tank servicing is done through the access at the airplane tail cone, which provides access to a sight glass and an oil filler cap when open.

The sight glass has a FULL indication that must never be exceeded. The APU oil capacity is 3.90 l (4.12 qt).



APU OIL LEVEL CHECK

APU OIL LEVEL CHECK

APU selector knob OFF
AC GPU CONNECT
Power Up ACCOMPLISH
Circuit Breakers..... OPEN

Open the following circuit breakers on the MCDU:

- APU START CMD-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FADEC-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FUEL SOV OPN-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)

Access Panel REMOVE
Inlet Silencer UNLATCH AND
OPEN
Oil Level Sight Glass..... CHECK

The oil level must be between the FULL mark and ADD mark on the oil level sight glass. Fill the oil system to the FULL mark on the oil level sight glass, if necessary.

Inlet Silencer CLOSE AND
LATCH
Access Panel INSTALL
Circuit Breakers..... CLOSE

Close the following circuit breakers on the MCDU:

- APU START CMD-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FADEC-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FUEL SOV OPN-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)

Power Off ACCOMPLISH
AC GPU DISCONNECT



APU OIL FILLING

- APU selector knob..... OFF
- AC GPU..... CONNECT
- Power Up..... ACCOMPLISH
- Circuit Breakers..... OPEN

Open the following circuit breakers on the MCDU:

- APU START CMD-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FADEC-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FUEL SOV OPN-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)

- Access Panel..... REMOVE
- Inlet Silencer..... UNLATCH AND OPEN
- Magnetic Drain Plug INSTALLED
- APU Oil Fill Cap OPEN
- Oil Reservoir..... FILL
- Fill the oil system to the FULL mark on the oil level sight glass
- APU Oil Fill Cap CLOSE AND LOCK
- Inlet Silencer..... CLOSE AND LATCH
- Access Panel..... INSTALL
- Circuit Breakers..... CLOSE

Close the following circuit breakers on the MCDU:

- APU START CMD-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FADEC-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- APU FUEL SOV OPN-SPDA2 (CBMENU/CB BY SYSTEM/CB SYSTEM-APU)
- Power Off ACCOMPLISH
- AC GPU..... DISCONNECT

LANDING GEAR

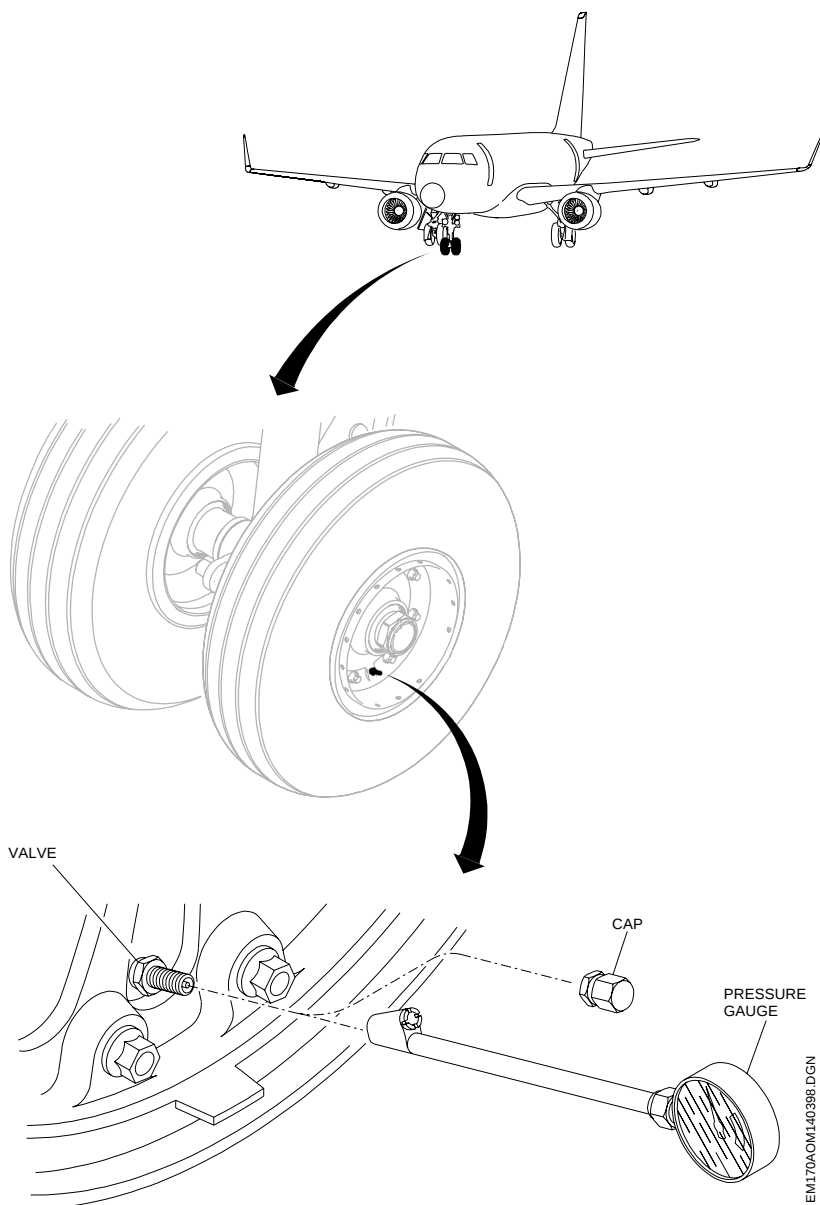
TIRE PRESSURE CHECK

The procedure is the same for the tires of the left and the right MLG.

Do not go near the airplane's tires while it is hot. If the measure of tires temperature is necessary, go to them from the front. There is tire explosion risk while tire is hot.

Tire pressure must be measured with the tires cold and on ground.

A calibrated pressure gauge is necessary to check the pressure gauge.



PRESSURE CHECK

MAIN LANDING GEAR TIRE PRESSURE CHECK

Tire Temperature CHECK

Check if the tire temperature is the same as the ambient temperature.

Wheel's Valve Cap REMOVE

Pressure Gauge CONNECT

Pressure..... CHECK

Tire pressure must be between 136 psi (938 kPa) and 146 psi (1007 kPa) with airplane on ground.

If tire pressure is at (or close to) the bottom limit of the range, it is recommended to inflate the tire to 146 psi (1007 kPa).

With airplane on jack, the pressure in the tire must be 4% lower than the pressure with airplane on ground.

If the temperature at destination airport is lower than the temperature at departure airport and the difference is greater than 25°C (77°F), increase the tire pressure by 1% for each 3°C (37,4°F) of temperature difference.

Pressure Gauge DISCONNECT

If tire pressure is between 123 psi (848 kPa) and 137 psi (945 kPa), connect the hose of tire inflation trolley to the valve on the wheel and adjust the pressure. Replacement of wheel is necessary for tire pressure below 123 psi (848 kPa). Refer to Aircraft Maintenance Manual.

Leakage CHECK

Check if there is no gas leakage from the valve.

Wheel's Valve Cap INSTALL



NOSE LANDING GEAR TIRE PRESSURE CHECK

Tire Temperature..... CHECK

Check if the tire temperature is the same as the ambient temperature.

Wheel's Valve Cap REMOVE

Pressure Gauge CONNECT

Pressure CHECK

Tire pressure must be between 102 psi (703 kPa) and 112 psi (772 kPa) with airplane on ground.

If tire pressure is at (or close to) the bottom limit of the range, it is recommended to inflate the tire to 112 psi (772 kPa).

If the temperature at destination airport is lower than the temperature at departure airport and the difference is greater than 25°C (77°F), increase the tire pressure by 1% for each 3°C (37,4°F) of temperature difference.

Pressure Gauge DISCONNECT

If tire pressure is above 112 psi (772 kPa), adjust the tire pressure to maximum of usual range.

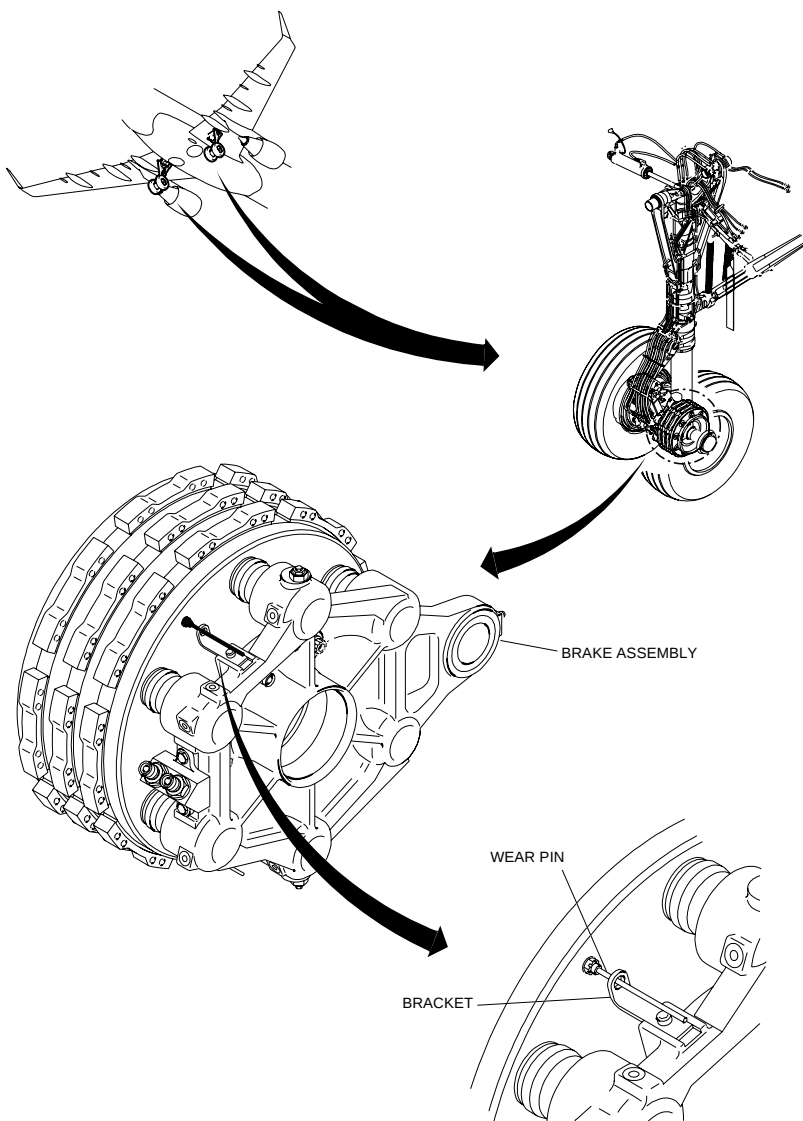
If tire pressure is between 94 psi (648 kPa) and 104 psi (717 kPa), connect the hose of tire inflation trolley to the valve on the wheel and adjust the pressure. Replacement of wheel is necessary for tire pressure below 94 psi (648 kPa). Refer to Aircraft Maintenance Manual.

Leakage..... CHECK

Check if there is no gas leakage from the valve.

Wheel's Valve Cap INSTALL

BRAKE WEAR INDICATOR CHECK



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BRAKE WEAR INDICATOR CHECK PROCEDURE

Wheel Chock IN PLACE

Put the wheel chocks around all tires.

Emergency/Parking Brake RELEASE

External AC Power CONNCT

Connect the external AC power supply to the airplane.

Hydraulic Systems 1&2 PRESSURIZE

Emergency/Parking Brake SET

Set the Emergency/Parking Brake handle totally to the parking position.

Brake Wear Pins CHECK

Check if the ends of brake wear indicators are not flush or less than flush with the bracket outer face. Brake wear indicators flush with the bracket outer face or less indicate necessity of brakes replacement. Check both main landing gear brakes.

Emergency/Parking brake RELEASE

Hydraulic Systems 1&2 DEPRESSURIZE

External AC Power DISCONNECT

Disconnect the external AC power supply from the airplane.

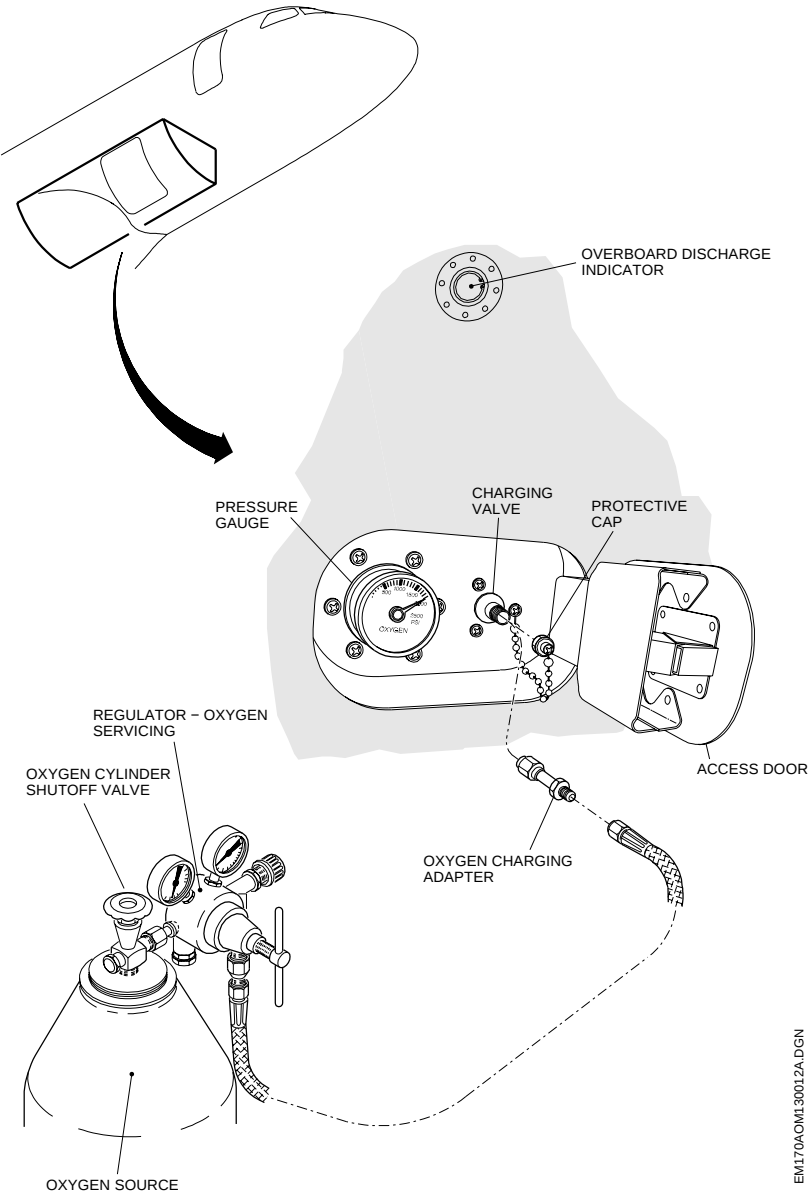
Emergency/Parking Brake SET

Wheel Chock REMOVE

OXYGEN

Flight crew oxygen is provided via a conventional, high-pressure, gaseous-type system in which the oxygen is stored in a standard 50-cu.ft., or an optional 77-cu. ft. cylinder, pressurized to 1850 psi at 21°C/70°F. The cylinder is installed in the forward cargo compartment.

When servicing crew oxygen, shutoff valve on the oxygen cylinder should be opened slowly; otherwise oxygen can become hot and can cause sudden combustion.



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OXYGEN REFILL POINT LOCATION

CREW OXYGEN

This section addresses the procedures of filling the cockpit oxygen cylinder whenever it becomes necessary:

Refill Point Location Access Door OPEN

Protective Cap..... REMOVE

Connect the oxygen source to the cockpit oxygen cylinder charging valve, make sure that there is no leakage and do not let oil, grease, flammable solvents, dust metal filings and other materials that burn touch the components that will be open to pressurized oxygen.

Fill the cockpit oxygen cylinder slowly until it reaches the required pressure.

Gauge Pressure MONITOR

After reaching the required pressure, carefully disconnect the oxygen source from the charging valve and make sure that there is no leakage.

NOTE: The filling nominal pressure is 1850 psi at an ambient temperature of 21°C (70°F). For other temperature values, refer to Oxygen Pressure Correction Chart.

Refill Point Location Access Door CLOSE

MINIMUM OXYGEN PRESSURE FOR DISPATCH

Minimum dispatch oxygen pressure in the cockpit oxygen cylinder is depicted below:

Number of Flight Crewmembers in the Cockpit	Minimum Pressure for Dispatch (psi)	
	Oxygen Cylinder Volume (ft ³)	
	50	77
2 (pilot and co-pilot)	1190	842
3 (pilot, co-pilot and observer)	1664	1150

NOTE: The minimum dispatch oxygen pressure was calculated at an ambient temperature of 21°C (70°F). When reading the External Gauge, refer to Oxygen Pressure Correction Chart for other temperature values.

CREW OXYGEN PRESSURE CHECK – EXTERNAL

Refill Point Location Access Door OPEN
Gauge Pressure CHECK

Read the oxygen pressure gauge to make sure that the oxygen pressure is above the minimum required for dispatch. If necessary, refill the cockpit oxygen cylinder.

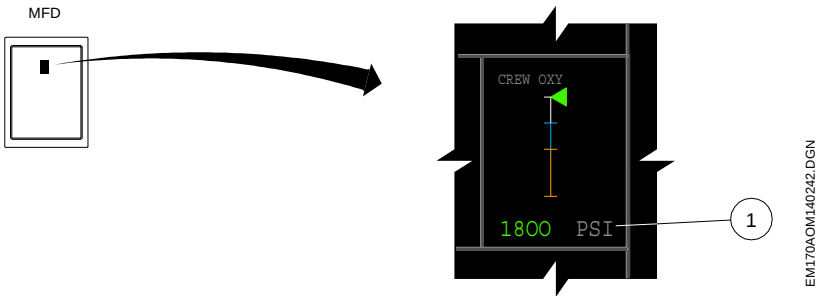
NOTE: The minimum oxygen pressure for dispatch was calculated at an ambient temperature of 21°C (70°F). For other temperature values, refer to Oxygen Pressure Correction Chart

Refill Point Location Access Door CLOSE

CREW OXYGEN PRESSURE CHECK – COCKPIT

Power Up..... ACCOMPLISH
MFD..... SET

Select the Status Page on the MFD, which provides both analog and digital oxygen pressure indication:



Cockpit Oxygen Pressure CHECK

Check the oxygen pressure range according to the following colors definition:

- Digital Pressure GREEN/Scale WHITE/Pointer GREEN:
Normal operating range (minimum for dispatch with three crew members in the cockpit).
- Digital Pressure CYAN/Scale CYAN/Pointer CYAN:
Advisory operating range (minimum for dispatch with two crew members in the cockpit).
- Digital Pressure AMBER/Scale AMBER/Pointer AMBER:
Cautionary operating range (dispatch is not allowed).

Power Off ACCOMPLISH

OXYGEN PRESSURE CORRECTION CHART

An Oxygen Pressure Correction Chart is provided for maintenance personnel or flight crew use when recharging the oxygen cylinder. Additionally, it may be used to check if the oxygen cylinder pressure is above the minimum oxygen pressure for dispatch.

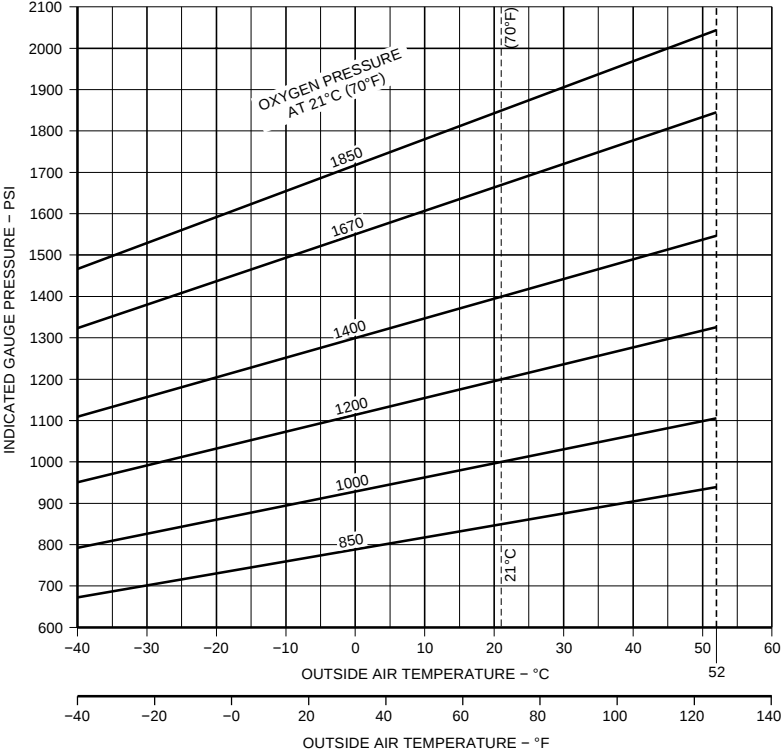
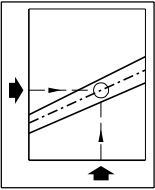
To use the chart for recharging purposes:

- Enter the chart with the ambient temperature then go vertically up to the desired pressure at 21°C. From the intersection point, trace to the left to read the indicated gauge pressure to be attained.

To use the chart for dispatching purposes:

- Enter the chart simultaneously with the ambient temperature and indicated gauge oxygen pressure. The intersection determines the oxygen cylinder equivalent pressure at 21°C, by interpolating the two adjacent standard curves.

OXYGEN PRESSURE CORRECTION CHART (CONTINUED)

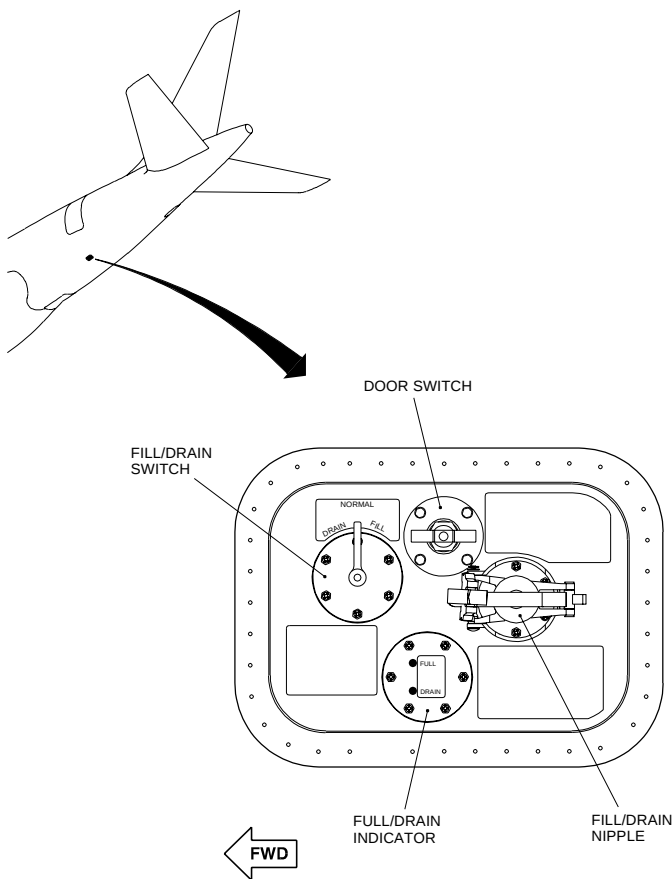


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POTABLE WATER TANK SERVICING

Potable water tank filling and draining is done through a panel installed on the rear left side of the fuselage.

Do not touch the Drain Mast, it has a heater installed and causes burns.



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POTABLE WATER TANK DRAINING AND FILLING

POTABLE WATER TANK FILL

- AC GPU..... CONNECT
- Power Up..... ACCOMPLISH
- Mid Avionics Compartment..... ACCESS
- Open the access panel and open and remove the access door.
- Circuit Breakers..... CHECK
- Check if the following circuit breakers are closed:
- WATER WASTE HTR-LICC (AC GND SVC BUS)
 - WATERWASTE CTRL1-LICC (DC GND SVC BUS)
 - WATERWASTE CTRL2-LICC (DC BUS 1)
 - SPDA1 AC GND SVC-LICC (AC GND SVC BUS)
- Aft Avionics Compartment..... ACCESS
- Open the access door.
- Circuit Breakers..... CHECK
- Check if the following circuit breaker is closed:
- WATERWASTE CTRL3-AICC (HOT BATT BUS 2)
- Potable Water Access Door OPEN
- Protection Cap..... REMOVE
- Remove the protection cap from the fill/drain nipple.
- Hose..... CONNECT
- Connect the hose to the water fill/drain nipple.
- Fill/Drain Switch..... FILL
- Fill the tank with water until the full/drain indicator shows FULL.
- Aft Flight Attendant Panel..... CHECK
- Check if the potable water level is correct on the aft FAP.
- Fill/Drain Switch..... NORMAL
- Water Supply..... CLOSE
- Hose..... DISCONNECT

Protection Cap INSTALL

Let all excess water drain out before close the fill/drain nipple. Install the protection cap in the fill/drain nipple.

Power Off ACCOMPLISH

AC GPU DISCONNECT

Aft Avionics Compartment CLOSE

Mid Avionics Compartment CLOSE

Install and close the access door and close the access panel.

Potable Water Access Door CLOSE AND
LATCH

POTABLE WATER TANK DRAIN

AC GPU CONNECT

Power Up ACCOMPLISH

Mid Avionics Compartment ACCESS

Open the access panel and open and remove the access door.

Circuit Breakers CHECK

Check if the following circuit breakers are closed:

- WATER WASTE HTR-LICC (AC GND SVC BUS)
- WATERWASTE CTRL1-LICC (DC GND SVC BUS)
- WATERWASTE CTRL2-LICC (DC BUS 1)
- SPDA1 AC GND SVC-LICC (AC GND SVC BUS)

Aft Avionics Compartment ACCESS

Open the access door.

Circuit Breakers CHECK

Check if the following circuit breaker is closed:

- WATERWASTE CTRL3-AICC (HOT BATT BUS 2)

Potable Water Access Door OPEN

Protection Cap REMOVE

Remove the protection cap from the fill/drain nipple.

Hose CONNECT

Connect the hose to the water fill/drain nipple. Use a container for liquids as auxiliary equipment to drain the water tank.

Fill/Drain Switch..... DRAIN

Make sure that the full/drain indicator shows DRAIN. Let all the water drain.

Aft Flight Attendant Panel..... CHECK

Check if the potable water level is correct on the aft FAP.

Fill/Drain Switch..... NORMAL

Water Supply..... CLOSE

Hose..... DISCONNECT

Protection Cap..... INSTALL

Let all excess water drain out before close the fill/drain nipple. Install the protection cap in the fill/drain nipple.

Power Off..... ACCOMPLISH

AC GPU..... DISCONNECT

Aft Avionics Compartment..... CLOSE

Mid Avionics Compartment..... CLOSE

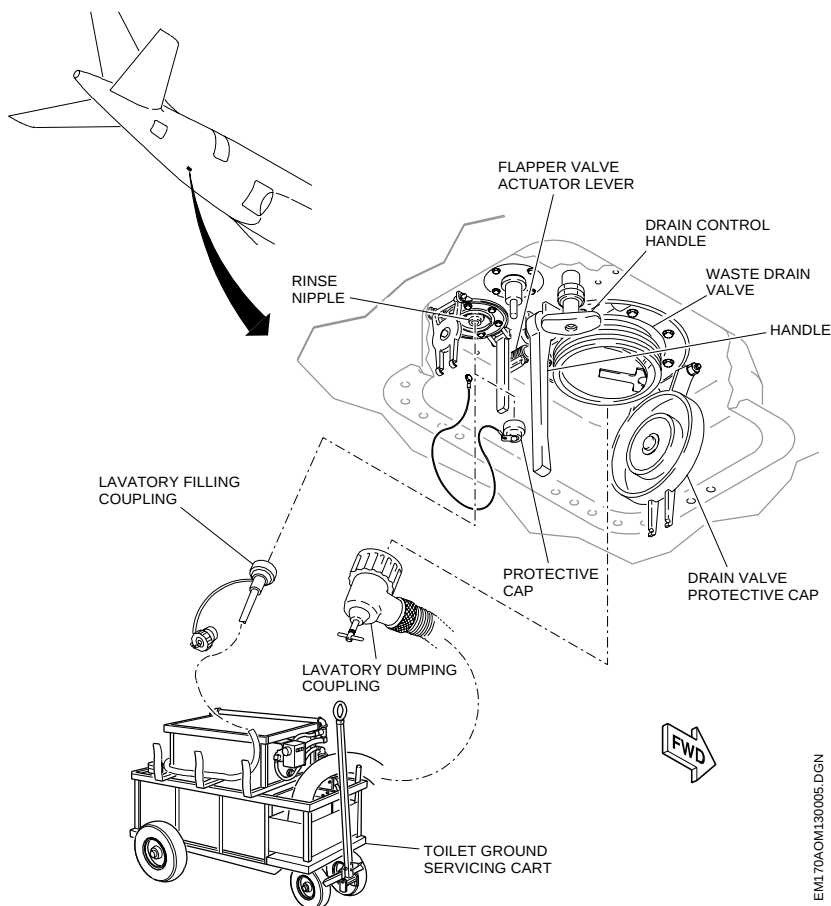
Install and close the access door and close the access panel.

Potable Water Access Door CLOSE AND
LATCH

WASTE TANK SERVICING

Toilet waste disposal servicing is accomplished by accessing a panel on the rear right side of the fuselage.

Do not let the toilet system cleaner touch the eyes or skin. If it happens, flush the eyes or skin with water and get medical aid.



WASTE TANK SERVICING



WASTE TANK SERVICING PROCEDURES

Waste Tank Panel Door OPEN

Handle PULL

Drain Valve Protective Cap OPEN

Lavatory Dumping Coupling INSTALL

Install the lavatory dumping coupling in the waste drain valve. Check if the lavatory dumping coupling is correctly installed.

Rinse Nipple Protective Cap..... REMOVE

Lavatory Filling Coupling INSTALL

Install the lavatory filling coupling in the rinse nipple.

Flapper Valve Actuator PUSH

Push the flapper-valve actuator lever to open the waste drain valve.

Drain Control Handle PULL

Pull the drain control handle to empty the waste tank.

Rinse Fluid SUPPLY

Make sure that the waste tank is completely drained before you start to supply the rinse fluid. Supply the rinse fluid for at least 2 minutes. Pre-charge the waste tank with 6-8 liters (1.6-2.1 gallons) of rinse fluid.

Drain Control Handle PUSH

Flapper Valve Actuator PULL

Lavatory Filling Coupling REMOVE

Rinse Nipple Protective Cap..... INSTALL

Lavatory Dumping Coupling INSTALL

Slowly remove the lavatory dumping coupling from the waste drain valve.

Drain Valve Protective Cap CLOSE

Handle LOCK

Waste Tank Panel CLEAN

Waste Tank Panel Door CLOSE AND
LATCH

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ATA CHAPTER 21

AIR CONDITIONING

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Pressurization System	12.21	...	18
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INTRODUCTION

The Air Management System (AMS) consist of:

- Pneumatic System.
- Environmental Control System - ECS.

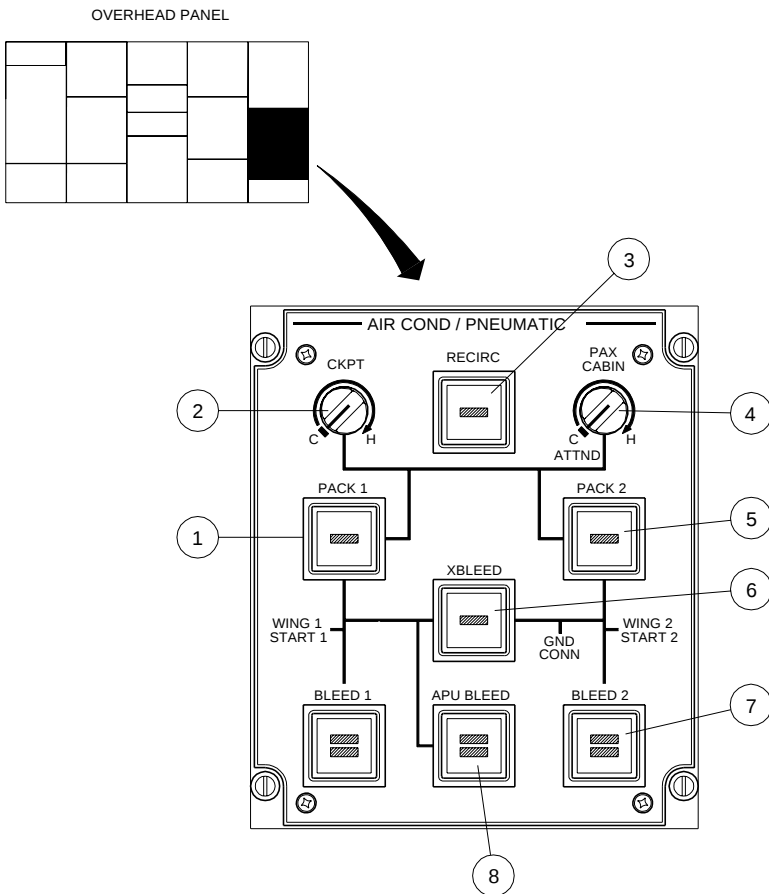
AMS Controller provides primary control for various airplane subsystems such as bleed control, environmental control, hot air leak detection, crew oxygen monitoring, wing ice protection and engine anti-ice. The AMS controller also interfaces with the smoke detector and provide fault detection, isolation, and reporting.

The Cabin Pressure Controls System (CPCS) is also part of the AMS, although it has a separate controller.

The AMS controller has two channels, which control the respective outside system. In case of a channel failure, the other channel is able to control the entire pneumatic, air conditioning and anti-ice system.

CONTROLS AND INDICATIONS

AIR CONDITIONING AND PNEUMATIC CONTROL PANEL



1 – PACK 1 BUTTON

- PUSH IN:** allows automatic operation by the AMS. This position opens the pack 1 valve, according to system logic.
- PUSH OUT:** allows manual closing the pack 1 valve.

2 – COCKPIT TEMPERATURE ROTATING KNOB

- Controls cockpit temperature according to the knob position.

3 – RECIRCULATION BUTTON

- PUSH IN:** allows automatic operation by the AMS. This position turns on both recirculation fans, according to system operational logic.
- PUSH OUT:** turns off both recirculation fans.

4 – PASSENGER CABIN TEMPERATURE ROTATING KNOB

- Controls passenger cabin temperature according to the knob position.
- Rotating the knob to the ATTND position switches the cabin temperature control over to the flight attendant control panel.

5 – PACK 2 BUTTON

- PUSH IN:** allows automatic operation by the AMS. This position opens the pack 2 valve, according to system logic.
- PUSH OUT:** allows manual closing the pack 2 valve.

6 – CROSS-BLEED BUTTON

- PUSH IN:** allows automatic operation by the AMS. This position commands the crossbleed valve, according to system logic.
- PUSH OUT:** allows manual closing the crossbleed.

7 – BLEED AIR BUTTON

- PUSH IN:** allows automatic operation by the AMS. This position commands the engine bleed valves, according to system logic.
- PUSH OUT:** allows manual closing engine bleed.

NOTE: When leak is detected, an amber light illuminates on the button.

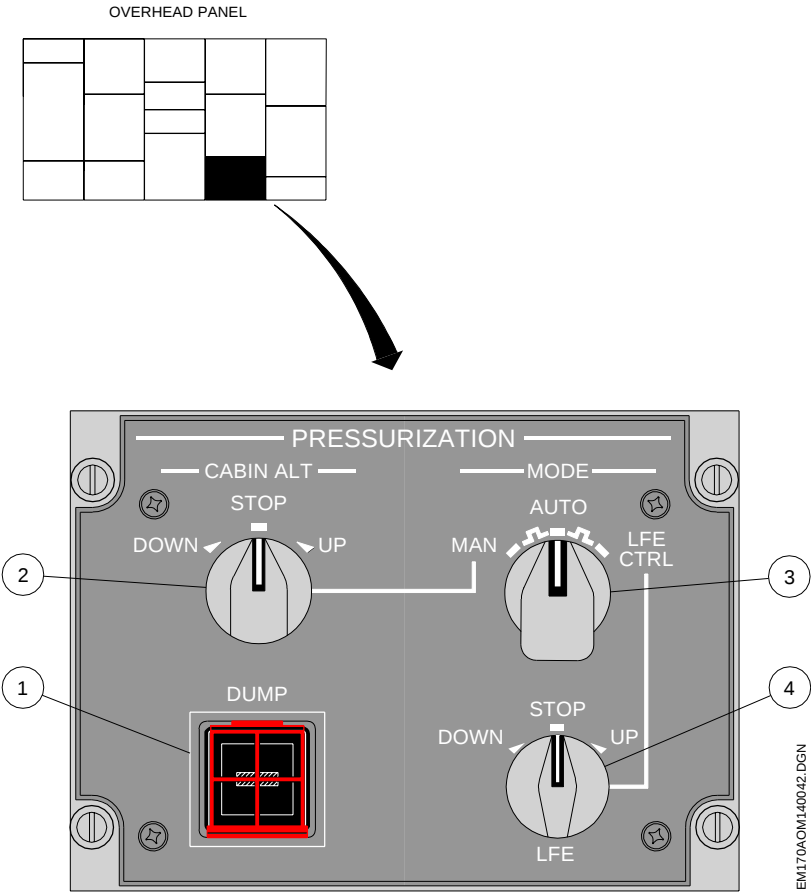
8 – APU BLEED BUTTON

PUSH IN: allows automatic operation by the AMS. This position commands the APU bleed valve, according to system logic

PUSH OUT: closes the APU bleed valve.

When leak is detected, an amber light illuminates on the button.

PRESSURIZATION CONTROL PANEL



1 – DUMP BUTTON (GUARDED)

Momentary pushbutton:

- Provides rapid cabin depressurization.
- When pressed the dump function is activated and a white striped bar illuminates on the button.

2 – CABIN ALTITUDE SELECTOR KNOB

DOWN: (momentary action) manually closes the outflow valve, decreasing cabin altitude in a 50 ft/min rate.

STOP: normal operation position.

UP: (momentary action) manually opens the outflow valve, increasing cabin altitude in a 50 ft/min rate.

NOTE: Manual actuation of the outflow valve is possible only with the PRESSURIZATION MODE SELECTOR KNOB set to MAN position.

3 – PRESSURIZATION MODE SELECTOR KNOB

MAN: allows manual control of the outflow valve.

AUTO: allows automatic operation of the pressurization system.

LFE CTRL: allows manual input of landing field elevation. The pressurization system remains in automatic mode.

4 – LANDING FIELD ELEVATION (LFE) SELECTOR KNOB

DOWN: (momentary action) decreases the LFE in 100 ft steps.

STOP: normal operation position.

UP: (momentary action) increases the LFE in 100 ft steps.

NOTE: Manual input of the LFE is possible only with the PRESSURIZATION MODE SELECTOR KNOB set to LFE CTRL position.

EICAS INDICATION

PRESSURE INDICATION ON EICAS



1 – CABIN ALTITUDE INDICATION

- Displays cabin altitudes in feet, regardless of the operating mode.

GREEN: normal operating range.

AMBER: cautionary operating range.

RED: warning operating range.

2 – CABIN RATE OF CHANGE INDICATION

- Displays the cabin rate of change in feet per minute, regardless of the operating mode.

GREEN: normal operating range.

AMBER DASHED: invalid information or value out of displayable range.

3 – DIFFERENTIAL PRESSURE INDICATION

- Displays the differential pressure between the cabin interior and the outside in pound per square inches, regardless of the operating mode.

GREEN: normal operating range.

AMBER: caution operating range.

RED: warning operating range.

4 – LANDING FIELD ELEVATION INDICATION

- Displays the landing field elevation in feet, regardless of the operating mode.

GREEN: inputs from FMS.

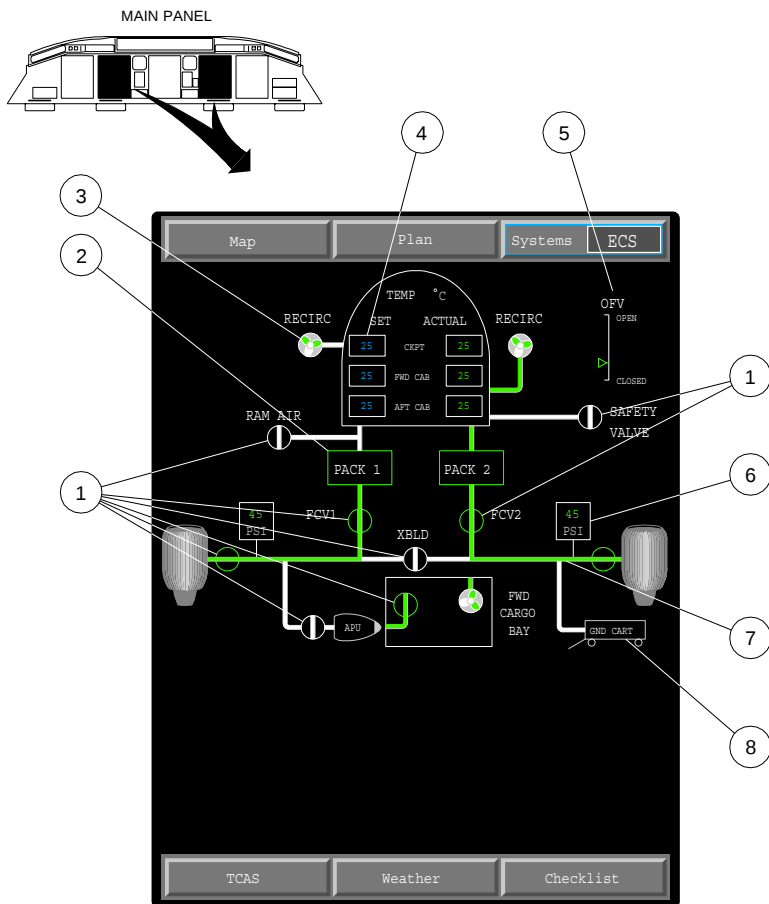
CYAN: manual input. A cyan “M” in front of altitude readout indicates manual input.

AMBER DASHED: invalid information or value out of displayable range.

NOTE: Flight plan on MCDU must be closed to display landing field elevation on EICAS.

SYNOPTIC PAGE ON MFD

Environmental control system synoptic page provides a visual representation of the system operation and parameters. It can be selected by flight crew on both MFDs.



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1 – AIR SHUTOFF VALVES STATUS

- Air shutoff valves are shown as a circle and an internal line representing the valve position.
 - OPEN: a green circle and a green line aligned with the flow line.
 - CLOSED: a white circle and a white line perpendicular to the flow line.
 - UNDETERMINED: an amber dashed circle with no line.
 - IN TRANSIT: a white circle and a white line in diagonal to the flow line.
 - FAILED CLOSED: a white circle and a white line perpendicular to the flow line covered by an amber cross.
 - FAILED OPEN: a green circle and a green line aligned with the flow line covered by an amber cross.

2 – PACK STATUS

- ON: a green rectangle.
- OFF: a white rectangle.
- UNDETERMINED: an amber dashed rectangle.
- FAILED: an amber dashed rectangle covered by an amber cross.

3 – RECIRCULATION FAN STATUS

- The recirculation fan is shown as a circle and an internal windmill, representing the fan status.
 - ON: a gray circle and a green windmill.
 - OFF: a gray circle and a gray windmill.
 - UNDETERMINED: an amber dashed circle and an amber windmill.
 - FAILED: a gray circle and a white windmill beneath an amber cross.

4 – COCKPIT/CABIN TEMPERATURE INDICATION

- Digital Temperature.
 - The digital information displays settable and actual temperature for the cockpit, forward cabin and aft cabin.

GREEN: used for all actual temperature indication.

CYAN: used for all set temperature indication.

AMBER DASHED: invalid information or value out of displayable range.

- Temperatures are set in the Passenger Cabin Temperature Rotating knob on Air Conditioning and Pneumatic control Panel. Cabin temperatures can also be set on the Flight Attendant Panel.

5 – OUTFLOW VALVE (OFV) POSITION INDICATION

- Outflow Valve Scale/Pointer.
 - The pointer on the scale indicates the actual OFV position. When the OFV is fully open at 90°, the pointer will be parked at the OPEN position, at the top of the scale. When the OFV is fully closed at 0°, the pointer will be parked at the CLOSED position, at the bottom of the scale. If the OFV signal is invalid the pointer will be removed from view.
 - Scale:
 - WHITE: always, despite of OFV position.
 - Pointer:
 - GREEN (hollow): always, despite of OFV position.

6 – MANIFOLD PRESSURE INDICATION

- Digital Pressure.
 - Colors:

GREEN: normal operating range.

AMBER: caution operating range.

GRAY: label (PSI).

AMBER DASHED: invalid information or value out of displayable range.

7 – ECS FLOW LINE

- The flow line is shown as a colorful line.
- GREEN: the associated flow line is pressurized.
- WHITE: the associated flow line is not pressurized.
- WHITE/AMBER DASHED: the associated flow line pressure information is invalid.

8 – GROUND CART

- Ground cart connection is displayed only when it is connected to the airplane.

ENVIRONMENTAL CONTROL SYSTEM (ECS)

GENERAL

The Environmental Control System (ECS) provides air conditioning for the flight deck and passenger cabin, filtered cabin air recirculation, conditioned air supply for gaspers, fan air cooling for avionics and emergency ram air ventilation for flight deck smoke clearance.

The ECS provides cargo bay ventilation. The cargo bay ventilation system is optional.

AIR CONDITIONING PACKS

Two ECS packs are installed in the wing-to-fuselage fairing. The AMS controller controls the bleed airflow to each pack independently, through the respective pack flow control valve (FCV). Engine # 1 supplies bleed air to the pack # 1 while engine # 2 supplies bleed air to the pack # 2. A single pack is capable of keeping adequate cabin/cargo hold pressurization and temperature. Single engine bleed can supply both ECS packs using the cross bleed.

RECIRCULATION FANS

Recirculated air from the passenger cabin and cockpit is ducted to the mixing manifold via two recirculation fans located in the pressurized section of the airplane. The recirculation fans draw air from the recirculation bays and impel the air back into the flight deck and cabin distribution system.

The total flow entering the cockpit and the passenger cabin is made up of approximately 52% of fresh air and 48% of recirculation air.

The recirculation fans are commanded off when:

- DUMP button is pressed;
- Smoke is detected in the recirculation bay;
- Respective pack is commanded OFF.

GASPER VENTILATION

The gasper air distribution system provides air to each pilot and passenger positions. Air flowing from the mixing manifold through the gasper check valve supplies the gasper ventilation system. When the gasper valve is opened, air from the right recirculation fan supplies gasper system.

During normal system operation the gasper shutoff valve remains closed. It automatically opens whenever the gasper air supply exceeds 35°C (95°F). This prevents hot air from blowing on the passengers during cabin heating.

ELECTRONIC COMPARTMENTS VENTILATION

FORWARD ELECTRONIC BAY (E –BAY)

The forward e-bay comprises three fans, which provide forced cooling air for # 1 Secondary Power Distribution Assembly (SPDA 1), Emergency Integrated Control Center (EICC) and all other avionics located in this e-bay. The fans draw air from the cockpit and expel air toward the underfloor recirculation bay. A flow sensor is used for fan/flow health monitoring.

CENTER ELECTRONIC BAY (E –BAY)

The center e-bay comprises three fans, which provide forced cooling air for the center e-bay electronics, Left Integrated Control Center (LICC), Right Integrated Control Center (RICC) and SPDA 2. The fans draw air from the rear cabin return and expel it towards the underfloor recirculation bay.

Flow sensors are used for fans/flow health monitoring.

AFT ELECTRONIC BAY (E –BAY)

A forced cooling is not necessary in the aft e-bay and no fan is installed in this compartment. Air flowing from passenger cabin provides cooling of aft e-bay and is expelled towards the underflow recirculation bay.

FORWARD CARGO BAY VENTILATION

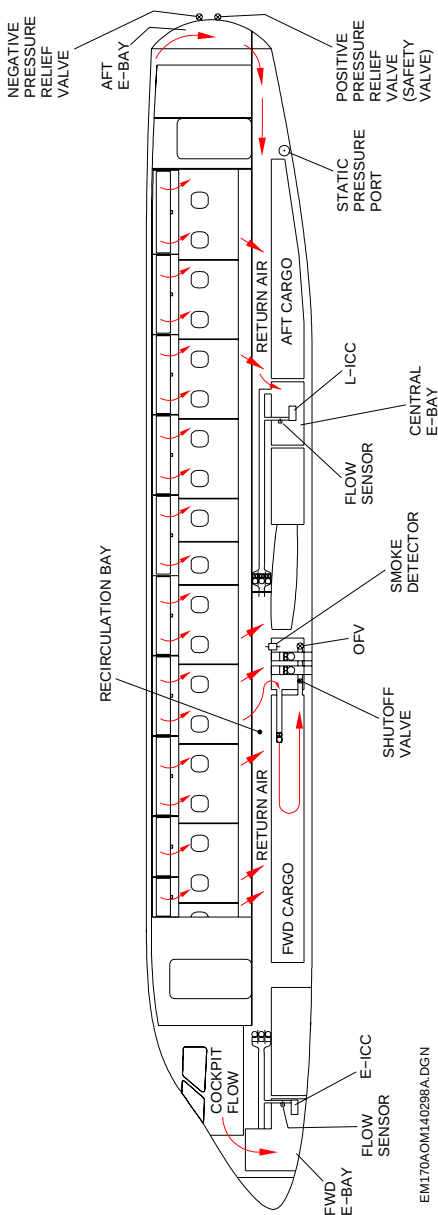
The ECS provides ventilation for live animals in the forward cargo bay. This optional system contains a fan on the side of the bay to provide underfloor recirculation air into the bay. The system also contains a shutoff valve at the outlet of the bay that closes in the event of fire and thus preventing halon from leaving the bay. In addition, in the event of fire, forward cargo compartment fan is commanded OFF to prevent halon from entering the cabin.

EMERGENCY RAM AIR VENTILATION

The pack 1 ram air ventilation consists of a ventilation valve installed in emergency ram ducting that connects the ram air duct to the pack 1 outlet ducting. The emergency ram air valve is commanded open any time the airplane is in flight and both air conditioning packs are commanded OFF or failed OFF and the airplane's flight altitude is less than 25000 ft.

The pack 2 ram air ventilation consists of a check valve installed in the emergency ram air ducting that connects the ram air duct to the pack 2 outlet ducting. The emergency ram air check valve does not require electronic control. The emergency ram air check valve will be open whenever the pressure in the ram air circuit is greater than cabin pressure.

ECS DISTRIBUTION



PRESSURIZATION SYSTEM

GENERAL

The Cabin Pressure Control System (CPCS) controls cabin pressurization and provides maximum safety and comfort during every segment of flight and ground operations.

The CPCS operates in automatic and manual modes. Normal operation of CPCS is automatic.

The system consists of:

- Cabin pressure controller (CPC).
- One cabin outflow valve (OFV).
- One negative pressure relief valve (NPRV).
- One positive pressure relief valve (Safety valve).
- Static Pressure Port.

SYSTEM COMPONENTS

CABIN PRESSURE CONTROLLER (CPC)

Basic function of the controller is to control cabin pressure by generating a command for the outflow valve to modulate airflow through the valve from the pressurized airplane volume to the surrounding environment.

The CPC has two fully independent automatic channels, which are alternated following each flight.

Both channels provide a manual function as backup, enabling the crew to control cabin pressure by directly actuating the outflow valve (OFV) position.

OUTFLOW VALVE (OFV)

The outflow valve modulates airflow from the pressurized cabin into surrounding environment. It can be modulated automatically or manually.

NEGATIVE PRESSURE RELIEF VALVE (NPRV)

A mechanical negative pressure relief valve (NPRV) relieves negative pressure if cabin pressure ever drops below outside pressure. The negative pressure relief valve opens if differential pressure between cabin and surrounding environment exceeds -0.5 psi.

POSITIVE PRESSURE RELIEF VALVE (SAFETY VALVE)

The positive pressure relief valve is a pressure relief valve and is pneumatically driven. It works independently to the CPCS without any electrical power. Its function is to protect the airplane's structure against damage due to positive overpressure. In case of outflow valve failure, the positive pressure relief valve opens if differential pressure between cabin and surrounding environment exceeds 8.6 psi.

STATIC PRESSURE PORT

The static pressure port senses the environmental static pressure and transmits it to the positive pressure relief valve in order to allow the overpressure relief device work.

The static port is electrically heated in order to assure there are no obstructions of sensing orifices due to icing.

OPERATING MODES

AUTOMATIC MODE

The CPCS reads the cruise flight level (CRFL), airplane gross weight and the landing field elevation (LFE) from the FMS before take-off. The CPCS uses this data to schedule the cabin pressure target and the rate of change to increase or decrease the pressure.

LFE can be manually selected via a rotary selector knob on the pressurization panel.

If no CRFL data is available, a backup schedule, calculated according to environmental temperature, will be used.

The CPCS provides two different nominal differential pressures. For flights below 37000 ft, a lower nominal differential pressure of 7.8 psi is used. The nominal differential pressure switches to 8.3 psi if either the CRFL from the FMS indicates a flight level above 37000 ft or the ambient pressure indicates that the airplane is above 37000 ft.

DUMP FUNCTION

The automatic mode provides a single action dump function. This function is used in the event of emergency evacuation, smoke evacuation or for fast cabin depressurization.

Selection of the dump button will deactivate the ECS packs and the recirculation fans then depressurizing the cabin at a rate of 2000 ft/min up to 12400 ft. If the cabin altitude is above 12400 ft when the dump is activated, the cabin altitude will rise due to natural leak. The cabin can be depressurized to higher altitudes using the manual mode.

MANUAL MODE

Rotating the pressurization mode selector knob to the MAN position allows manual control of the outflow valve. When manual mode is selected, both channels of the CPCS controller revert to standby state, but only one channel performs the manual operation. The channel selection is automatic.

NOTE: In manual mode there is no automatic cabin depressurization on the ground (after landing).

AMS AUTOMATION

AMS Controller functional logic provides automatic control of engine bleed, APU bleed, ECS packs, and recirculation bay smoke detection according to the airplane's operation and condition.

The left engine normally provides bleed air to the left bleed manifold and the right engine normally provides bleed air to the right bleed manifold. Each manifold supplies a dedicated ECS pack and the onside anti-ice system. If more than one bleed source is available, the AMS uses the following priority:

- Onside engine.
- Opposite engine
- APU, if activated.

APU BLEED SOURCE PRIORITIZATION

When the engine and APU bleed are available simultaneously, the AMS gives priority to APU supply bleed requirements when the following conditions are simultaneously met:

- The airplane is on the ground.
- The opposite engine bleed pressure is below the minimum for engine start.
- Ground speed is below 50 kt.
- The cross bleed valve is operating normally.

The APU bleed cannot be used for the anti-ice system operation in flight.

BLEED VALVES LOGIC

ENGINE BLEED VALVE

The Engine Bleed Valve is commanded open when the following conditions occur simultaneously:

- Respective bleed switch is set to AUTO.
- Respective engine bleed is available.
- No fire is detected in the respective engine.
- No bleed duct leak is detected.

APU BLEED VALVE

The APU Bleed Valve is commanded open when the following conditions occur simultaneously:

- APU switch is set to AUTO.
- APU Bleed is available.
- No APU and left bleed duct leak.
- Left engine bleed is unavailable.
- Anti-ice system not requested (or anti-ice system requested ON and anti-ice system is failed).

CROSS BLEED VALVE (XBLEED)

The cross bleed is commanded open when the XBLEED button is pushed in (AUTO) and any of the following conditions are met:

- One side provides manifold pressure and there is not a bleed air source on the opposite side.
- APU Bleed button pushed out for main engine start.
- Engine #2 start in the air.
- APU bleed OFF for engine #1 start in the air.
- No bleed leak, unless starting an engine.

ECS PACKS

The ECS packs 1 and 2 shall be CLOSED if any of the following conditions occur:

- A Bleed Air Source is NOT available for the pack.
- The respective Pack button is OFF.
- Any engine is starting and weight-on-wheels is true.
- The respective engine is starting, weight-on-wheels is false and the opposite engine is not starting.
- Any engine is starting AND APU is the bleed source.
- Respective bleed system duct leak.
- Respective packs BIT shutdown failures are present (PACK 1(2) FAIL EICAS message displayed).

The ECS packs CLOSE during takeoff if any of the following conditions occur:

- Thrust levers set to MAX position;
- TDS REF A/I set to ALL on the MCDU.
- TDS REF ECS set to OFF on the MCDU and APU bleed not available.

The ECS packs are recovered if thrust levers are not set to MAX position and any of the following conditions occur:

- Thrust lever reduction;
- The airplane is 500 ft above takeoff field altitude, for takeoff with two engines operating;
- The airplane is above 9700 ft, for takeoff fields at 8000 ft or below and one engine inoperative;

SMOKE DETECTION

There is one smoke detector mounted in the recirculation bay. Both recirculation fans will be commanded OFF when smoke is detected in the recirculation bay.

When smoke is detected on airplanes equipped with the forward compartment ventilation system:

- Fan operation is terminated.
- Check valve closes by mechanical springs.

The appropriate SPDA and MAU close the cargo shutoff valve prior to a forward cargo fire annunciation in the cockpit.

CPCS FLIGHT MODES

The cruise flight level and the landing field elevation are selected in the FMS before takeoff. If the FMS is not available, the landing field elevation must be manually selected using the rotary knob on the pressurization control panel. With the FMS not available, the final cruise level is calculated using the actual ambient pressure during the flight.

The system calculates a target cabin pressure and a corresponding pressure rate of change for each of the following Cabin Pressure Control System (CPCS) flight modes:

- GROUND
- TAXI
- TAKEOFF
- CLIMB
- CRUISE
- DESCENT
- ABORT

Information from the engine N2, the landing gear status, the FADEC, the ADC and the FMS is used within the cabin pressure controller to determine the current flight mode.

GROUND MODE

The airplane is on the ground but not within the takeoff run. The GROUND mode is set when landing gears are extended and engines do not provide takeoff thrust.

The outflow valve (OFV) is set fully open. The target cabin pressure is set to 0.01 psid lower than the sensed cabin pressure. The pressure rate of change is +500 ft/min for increasing and -300 ft/min for decreasing the cabin altitude.

TAXI MODE

The airplane is on the ground with doors closed and engines running. The TAXI mode is set when the doors are closed and both engines rotation (N2) is higher than 60%. This mode is only possible to be activated from the GROUND mode.

During the TAXI mode, the CPCS starts the first pre-pressurization step, increasing the differential pressure. The cabin target is equal to the ambient pressure plus an offset of 0.11 psid. This closes the outflow valve and allows the CPCS to control of cabin pressure prior to takeoff. The pressure rate of change is ± 300 ft/min for increasing or decreasing the cabin altitude.

TAKEOFF MODE

The airplane is performing the takeoff run. The TAKEOFF mode is set when landing gears are extended and engines provide takeoff thrust. Outflow valve is closed. The target cabin pressure is set to 0.15 psid above the ambient pressure. The pressure rate of change is +500 ft/min for increasing and -400 ft/min for decreasing the cabin altitude.

CLIMB MODE

The airplane climbs to the cruise flight level. The CLIMB mode is set at landing gears retraction.

The Climb mode is split into two different modes:

- Climb Internal Mode: used whenever FMS fails or cruise flight level is not available. The target cabin pressure is calculated depending on the ambient pressure. The pressure rate of change is +750 ft/min for increasing and -500 ft/min for decreasing the cabin altitude.
- Climb External Mode: used whenever a valid cruise flight level can be received from the FMS. For cruise flight level below 37000 ft the differential pressure is set to 7.8 psid. For cruise flight level above 37000 ft the differential pressure is set to 8.3 psid. The pressure rate of change is +750 ft/min for increasing and -600 ft/min for decreasing the cabin altitude.

CRUISE MODE

The airplane is flying at a constant altitude. The CRUISE mode is set when either airplane reaches cruise flight level set in FMS (climb external mode) or airplane stops to climb (climb internal mode)

- If no cruise flight level is available the target cabin pressure depends on the ambient pressure and the differential pressure from climb internal mode.
- If a valid cruise flight level is received from the FMS and flight level is below 37000 ft, the differential pressure is set to 7.8 psid. For cruise flight level above 37000 ft the differential pressure is set to 8.3 psid. The pressure rate of change is +500 ft/min for increasing and -300 ft/min for decreasing the cabin altitude.

DESCENT MODE

The airplane is descending towards the landing field. The DESCENT mode is set when the airplane starts a descent after CRUISE mode.

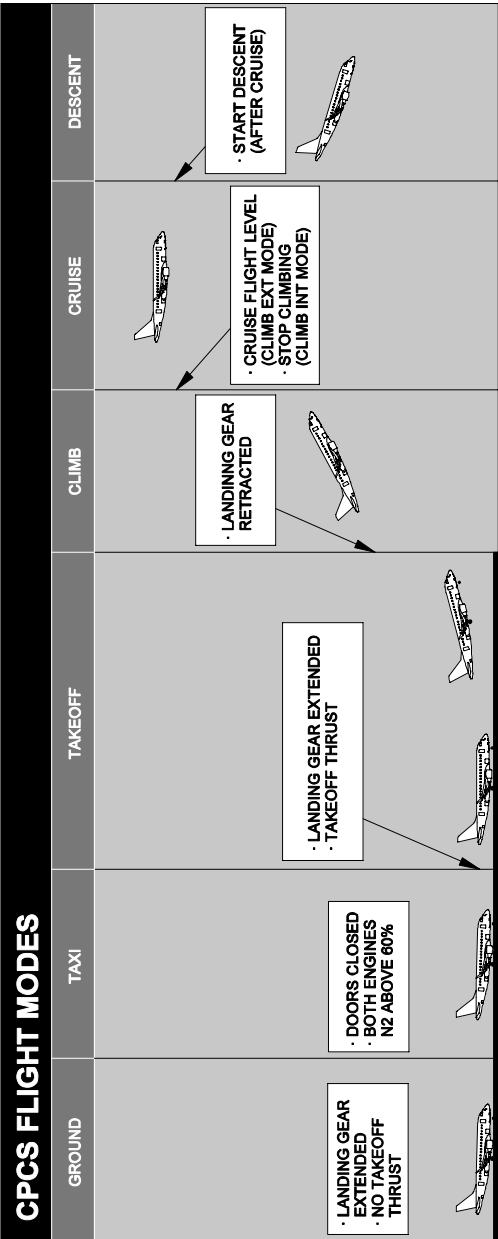
The target cabin pressure during descent mode is defined by the selected landing field elevation (LFE). If the LFE input from the FMS is not available, the pilot has to set the desired landing altitude manually at the LFE control knob on the pressurization control panel. The pressure rate of change is +500 ft/min for increasing if the current cabin altitude is above the landing field altitude. If the cabin altitude is below the landing field altitude the increase rate depends on the cabin pressure, landing field pressure and ambient pressure and is calculated within the limits +300 ft/min +750 ft/min. The decrease rate depends on the cabin pressure, landing field pressure and ambient pressure and is calculated within the limits -200 ft/min -750 ft/min.

ABORT MODE

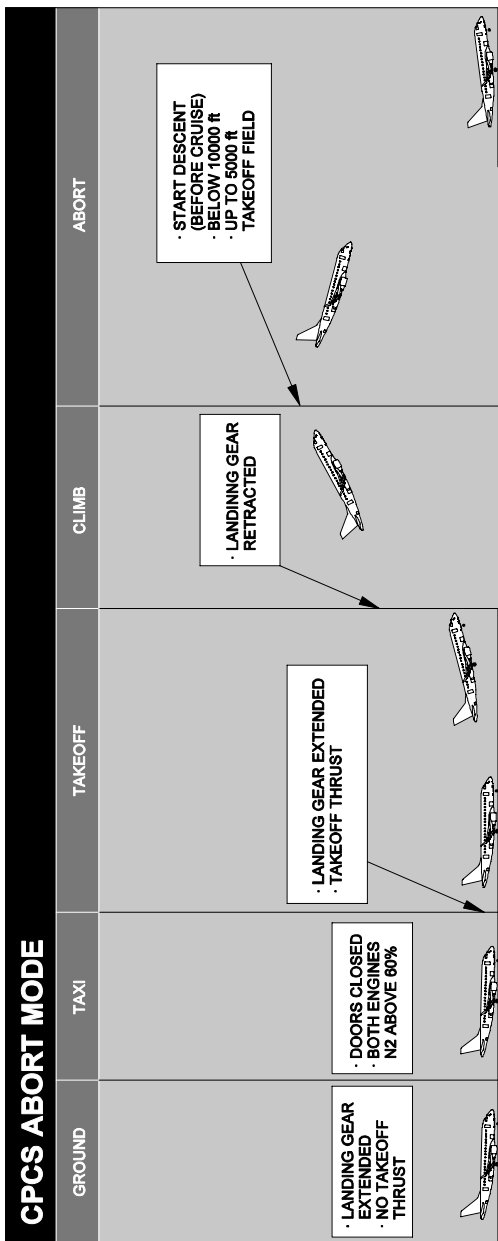
The flight is aborted and the airplane returns to the takeoff field. The ABORT mode is set when the airplane stops climbing and begins a descent. The ABORT mode is not possible if one of the following conditions occurs;

- CRUISE mode has already entered.
- Airplane is above 10000 ft.
- Airplane is 5000 ft above takeoff field.

During ABORT mode the cabin pressure is scheduled back to the takeoff altitude. The climb internal mode is used in reverse direction. The pressure rate of change is +500 ft/min for increasing and -600 ft/min for decreasing the cabin altitude.



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EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	CABIN ALTITUDE HI	Cabin altitude is equal to or higher than 9700 ft.
CAUTION	AMS CTRL FAIL	Both AMS controller channels have failed. AMS controller is not in control.
	BLEED 1 (2) FAIL	A bleed failure has been detected. Bleed is no longer available.
	BLEED 1 (2) LEAK	An overheat condition has been detected at the associated bleed system or pack.
	BLEED APU LEAK	An overheat condition has been detected in the APU bleed or both APU overheat detection system loops have failed.
	BLEED 1 (2) OVERPRESS	An overpressure condition has been detected at the associated bleed system or pack.
	CABIN DIFF PRESS FAIL	Cabin differential pressure is higher than 8.5 psid or lower than -0.3 psid.
	CENTER EBAY FANS FAIL	Center e-bay fans have failed.
	CRG FWD VENT FAIL	Forward cargo fan has failed ON or the cargo shutoff valve is failed OPEN and fire has been detected in the cargo compartment.
	FWD EBAY FANS FAIL	Forward e-bay fans have failed.
	PACK 1 (2) FAIL	Associated pack is no longer available.

TYPE	MESSAGE	MEANING
CAUTION	PACK 2 LEAK	An overheat condition has been detected at the bleed duct.
	PRESN AUTO FAIL	Both pressurization controller channels have failed in their automatic mode.
	PRESN MAN FAIL	Both pressurization controller channels have failed in their manual mode.
	RECIRC SMK DET FAIL	Smoke detector has failed.
	RECIRC SMOKE	Smoke has been detected in the recirculation bay.
ADVISORY	AMS CTRL FAULT	One of the two AMS controller channels has failed.
	BLEED 1 (2) OFF	Associated bleed is turned off.
	PACK 1 (2) OFF	Associated pack is off in flight.
	PRESN AUTO FAULT	Loss of automatic mode redundancy. One CPCS controller channel has failed.
	RAM AIR FAULT	Forward emergency ram valve has failed closed.
	XBLEED FAIL	Bleed isolation valve has failed closed. Cross bleed is no longer available.
	XBLEED SW OFF	Bleed isolation button has been pushed out.
STATUS	BLEED APU VLV OPEN	APU bleed valve is commanded open.

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AUTO FLIGHT

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INTRODUCTION

The Automatic Flight Control System (AFCS) is an integrated system that processes inputs from several airplane systems and sensors, applying the processed data to the Flight Guidance Control System (FGCS) and Thrust Management System (TMS), thus enabling their operation and producing visual and aural information.

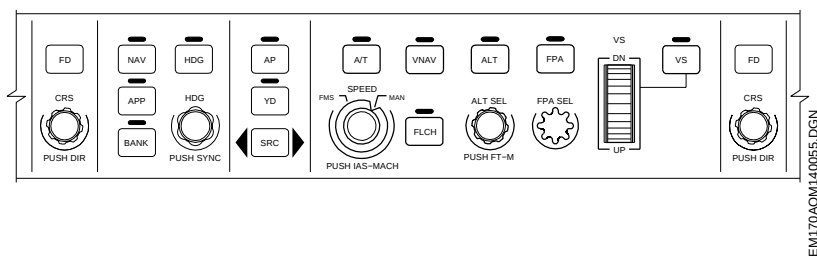
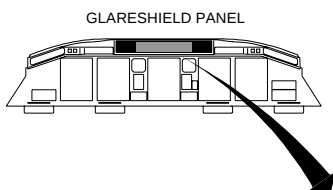
CONTROLS AND INDICATIONS

GUIDANCE PANEL

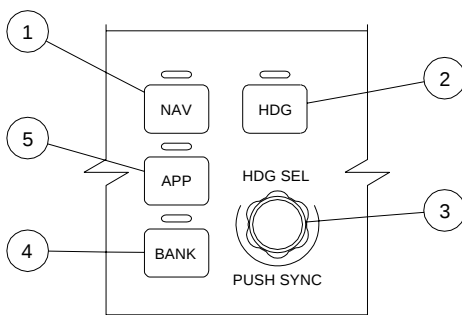
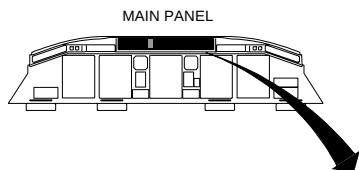
The Guidance Panel (GP) provides means for selecting functions and modes as follows:

- Lateral Guidance Control.
- AFCS Management Control.
- Vertical Guidance Control.

The GP contains two independent channels (A and B), each providing independent communication to the FGCS.



LATERAL GUIDANCE CONTROLS



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1 – NAV BUTTON

- Enables the lateral navigation modes to intercept the VOR/LOC or LNAV (Flight Management System – FMS).
- The FMA lateral mode annunciation displays the following:
 - LNAV: FMS is the navigation source.
 - LOC: the navigation source is the localizer.

2 – HDG BUTTON

- Activates the heading select mode.
- The FMA lateral mode annunciation displays HDG.

3 – HDG SELECTOR KNOB

- Enables manual selections of desired heading. Pressing this knob synchronizes the heading select with the current heading.

4 – BANK BUTTON

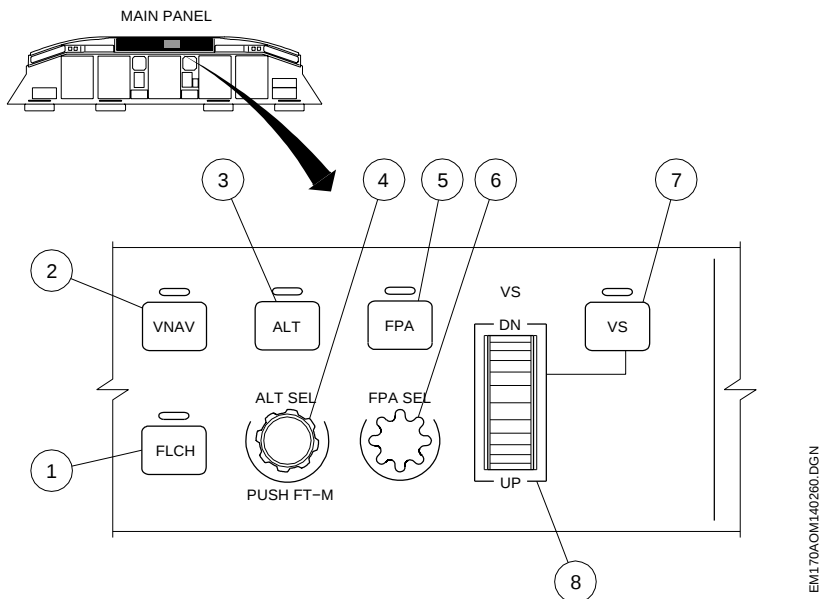
- Selects a bank angle limit of 17° used by the FGCS.
- A white arc is automatically displayed on the PFD when above 25000 ft. The white arc is manually indicated whenever the Bank Button is pushed and HDG is the active roll mode.

5 – APP BUTTON

- Activates the approach mode to intercept ILS.
- The FMA lateral mode annunciation displays the following:
 - LOC: ILS approach mode.
- The FMA vertical mode annunciation displays the following:
 - GS: ILS approach mode.
- The Autopilot Approach Status Annunciator displays the following:
 - APPR 2: CAT II ILS approach capable.
 - APPR 1: CAT I ILS approach capable.
 - APPR 1 ONLY: CAT I ILS approach capable. Requirements for CAT II ILS approach mode not accomplished.

NOTE: When the APP mode is intercepted, the heading mode (HDG) is automatically deactivated.

VERTICAL GUIDANCE CONTROLS



1 – FLCH BUTTON

- Activates the Flight Level Change mode.
- The FLCH mode is associated to Climb or Descend depending on the selected altitude.
- The Flight Mode Annunciation (FMA) vertical mode displays FLCH.

2 – VNAV BUTTON

- Activates the VNAV mode (FMS vertical navigation).

3 – ALT BUTTON

- Activates the holding of the Altitude.
- The FMA vertical mode annunciation displays ALT.

4 – ALT SELECTOR KNOB

- Selects the desired altitude.
 - Clockwise rotation: increases the altitude target.
 - Counter clockwise rotation: decreases the altitude target.

NOTE: A pushbutton in the center of the ALT SEL selector knob provides the selected altitude in meters to be displayed on the meters window (metric altitude) readout and above the ALT pre-selected window on the PFD.

5 – FPA BUTTON

- Activates the Flight Path Angle mode.
- This is the basic vertical mode.
- The FMA vertical mode annunciation displays FPA.

NOTE: Engaging the autopilot when no FD mode is active causes FPA mode to become the active mode, and the FD guidance cue to come into view.

6 – FPA SELECTOR KNOB

- Allows manually selection of desired Flight Path Angle.
- The flight path angle is limited to 9.9 degrees nose up or nose down.

7 – VS BUTTON

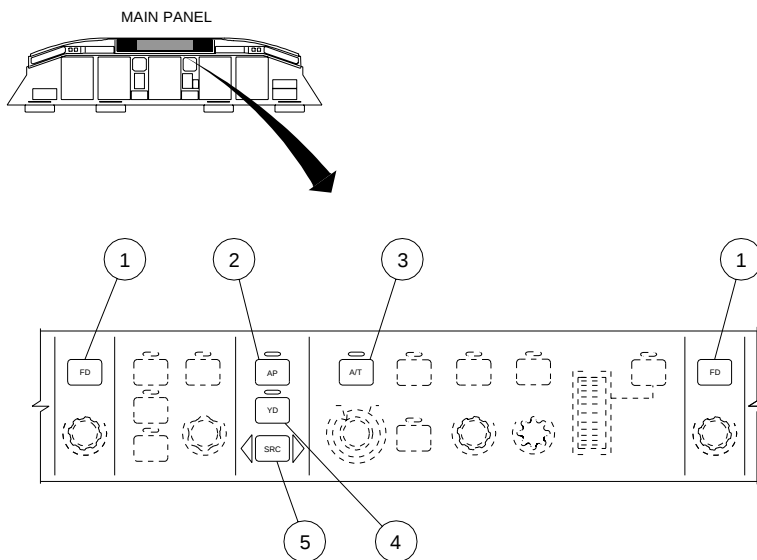
- Activates the Vertical Speed mode.
- The FMA vertical mode annunciation displays VS.

8 – VS THUMB WHEEL SELECTOR

- The thumb wheel selector allows manually selection of desired vertical speed rate.

NOTE: The VS mode must be active for the thumb wheel selector to become effective.

AFCS GUIDANCE CONTROLS



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1 – FD BUTTON

- Removes the FD command from the respective PFD when AP is not engaged.
- If the AP is engaged, the FD is not removed from the PFD selected to be the AFCS source.

2 – AP BUTTON

- Commands the autopilot engagement or disengagement.

3 – A/T BUTTON

- Commands the autothrottle engagement or disengagement.

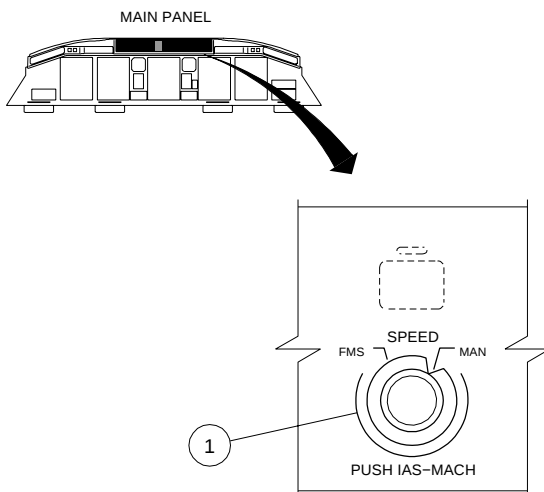
4 – YD BUTTON

- Engages or disengages the Yaw Damper/Turn Coordination function.

5 – SRC BUTTON

- Alternates the Captain or First Officer AFCS side as data source. A green arrowhead on the FMA indicates the respective source selected.

SPEED AND MODE CONTROLS



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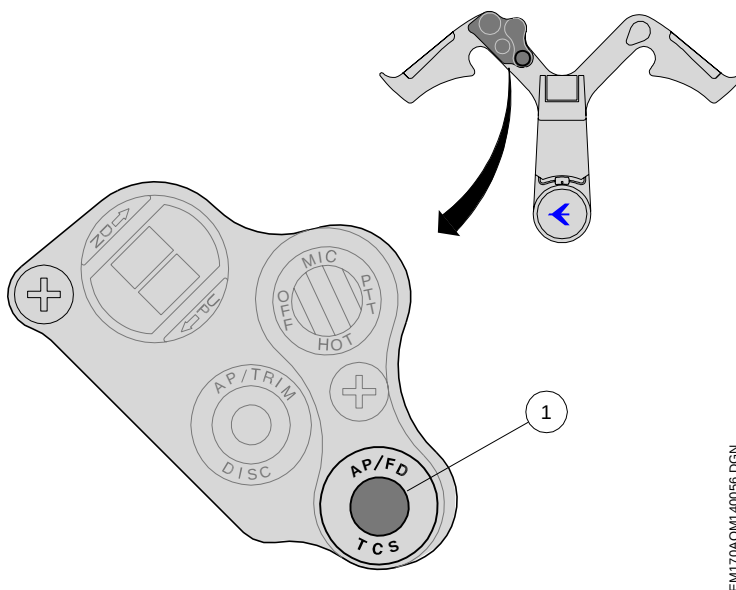
1 – SPEED SELECTOR KNOB

FMS: FMS speed control.

MAN: The desired speed is controlled manually, displayed in cyan on the PFD.

NOTE: The alternate speed selection (IAS or Mach) can be selected by pressing the speed selector knob.

AUTO PILOT/FD TCS BUTTON



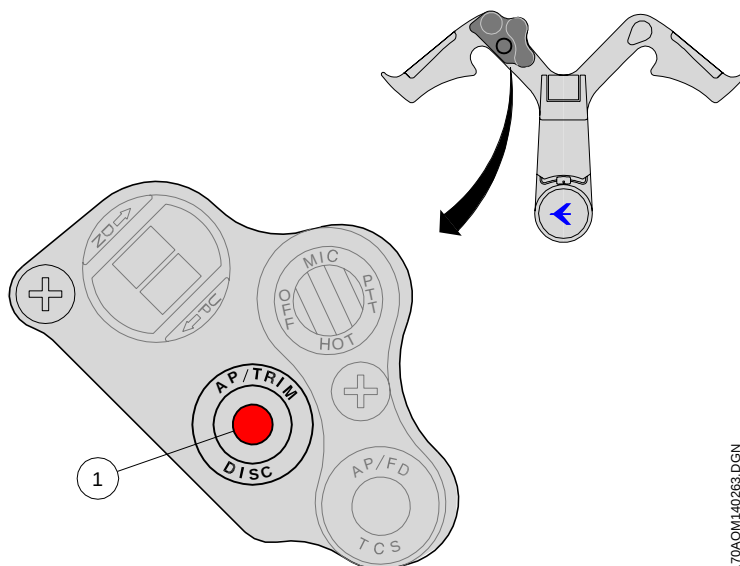
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1 – TOUCH CONTROL STEERING BUTTON (TCS)

- The TCS button allows manual airplane maneuvering (primary servos) to any desired pitch, overriding autopilot function. Release of the button cause:
 - Primary servos reengage.
 - The airplane maintains the new attitude requested.
 - Lateral control returns to previous selected lateral mode.

NOTE: After glide slope capture in APP mode with the autopilot engaged, if the TCS button is pressed and released, the autopilot regains the control and turns the airplane back towards the ILS center beam.

AUTOPILOT QUICK DISCONNECT BUTTON



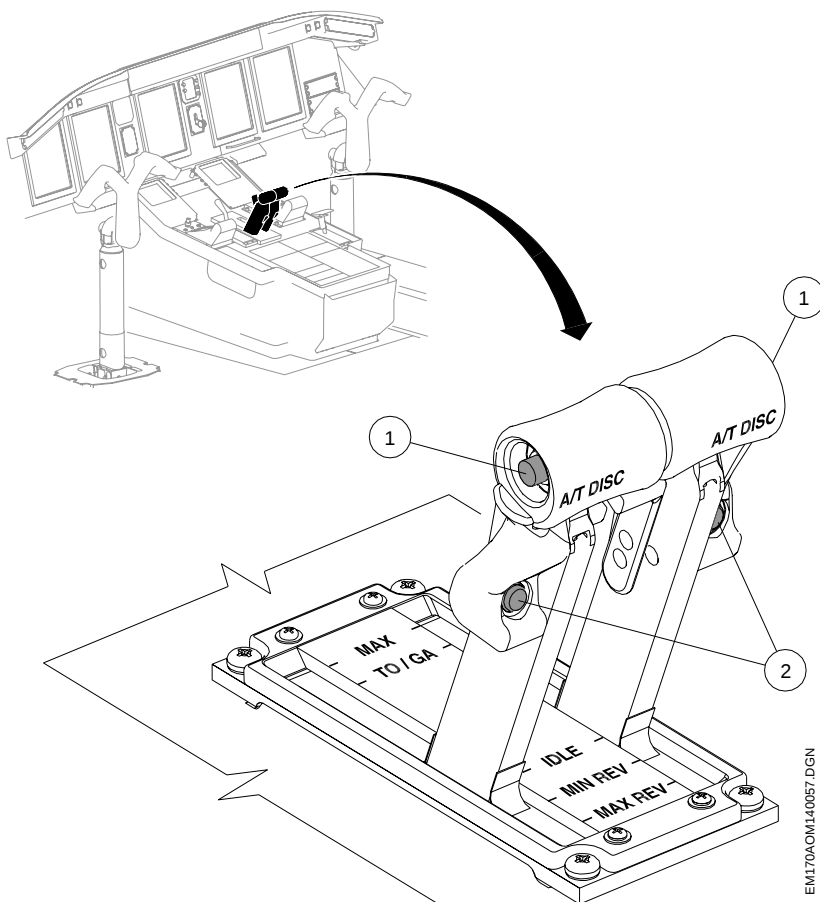
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1 – AP DISCONNECT BUTTON

- Provides the means to disengage the autopilot.

NOTE: Captain and first Officer's buttons are interconnected to allow autopilot cancellation from either side.

AUTOTHROTTLE DISCONNECT AND GO-AROUND BUTTONS



1 – AUTOTHROTTLE DISCONNECT BUTTON

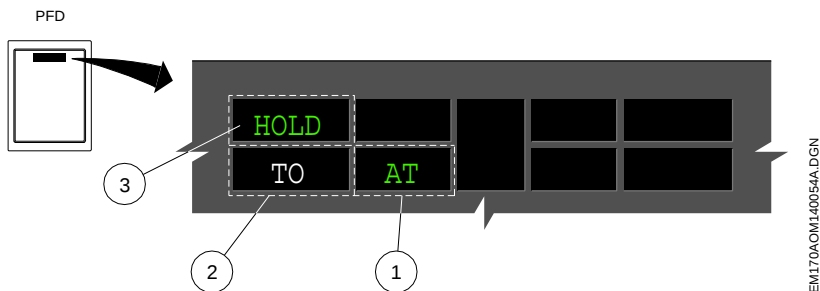
- Allows manual disengagement of autothrottle.

2 – TAKEOFF AND GO AROUND BUTTON

- Selects the TO or GA modes according to the airplane status.
- The FMA lateral mode annunciation displays the following:
 - TRK: go-around lateral mode.
 - ROLL: take-off lateral mode.
- The FMA vertical mode annunciation displays the following:
 - TO: take-off vertical mode.
 - GA: go-around vertical mode.
 - WSHR: vertical mode in windshear detection.

For Thrust Lever and Thrust Reverser Trigger descriptions, refer to ATA Chapter 71 Powerplant.

AUTOTHROTTLE INDICATIONS ON FLIGHT MODE ANNUNCIATION (FMA)



The AT mode labels displayed on FMA are the following:

- SPD_T
- SPD_E
- TO
- GA
- HOLD
- LIM
- OVRD

1 – AUTOTHROTTLE ENGAGEMENT ANNUNCIATION

- Color:
 - Green: Autothrottle engaged.
 - Amber: Autothrottle failed.

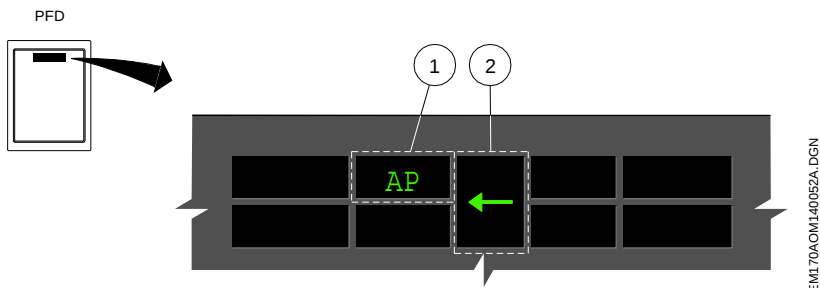
2 – AUTOTHROTTLE ARMED MODE

- Color: WHITE.

3 – AUTOTHROTTLE ACTIVE MODE

- Color:
 - Green: Autothrottle active mode.
 - Amber: The LIM label is displayed to indicate that vertical speed and target speed are incompatible with thrust rating available

AUTOPILOT INDICATIONS ON FMA



1 – AUTOPILOT ENGAGED ANNUNCIATION

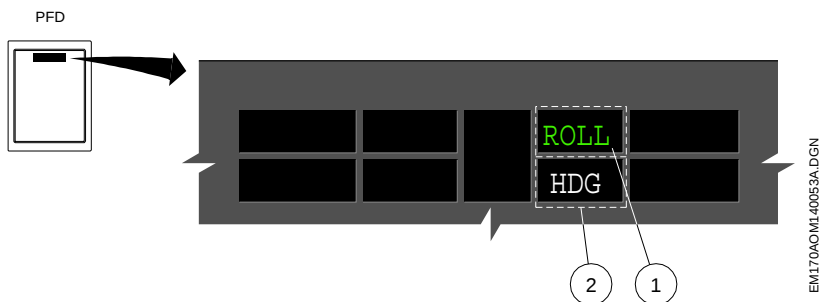
- Color:
- GREEN: Autopilot engaged.
- AMBER: Autopilot failed.

2 – FLIGHT DIRECTOR SOURCE ANNUNCIATOR

- A green arrow indicated the selected AFCS source.

NOTE: Mode annunciation is removed if Flight Director fails.

LATERAL MODE INDICATIONS ON FMA



The lateral mode labels displayed on FMA are the following:

- ROLL
- HDG
- LNAV
- LOC
- BC
- TRACK

1 – FGCS LATERAL ACTIVE MODE

Colors:

- GREEN: manually commanded on the GP.
- MAGENTA: FMS commanded.

2 – FGCS LATERAL ARMED MODE

Color: WHITE.

VERTICAL MODE INDICATIONS ON FMA



The vertical mode labels displayed on FMA are the following:

- FPA
- TO
- ASEL
- FLCH
- ALT
- VS
- OVSP
- GS
- GA

1 – FGCS VERTICAL ACTIVE MODE

Color:

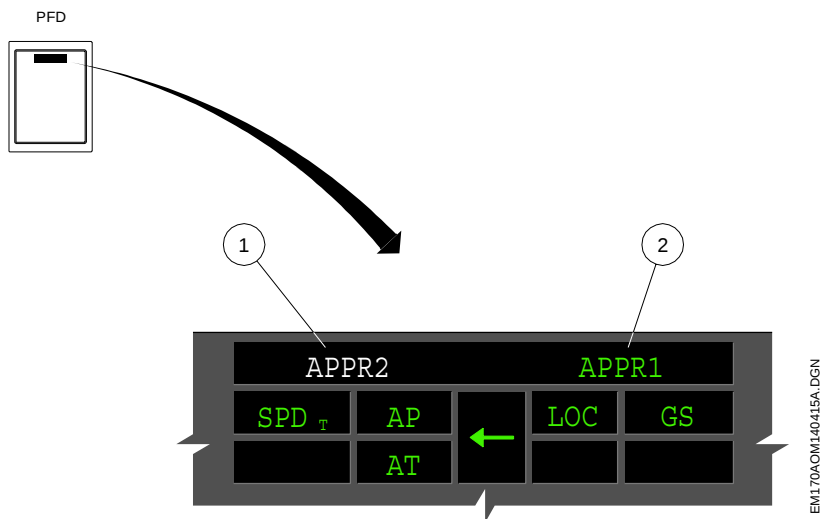
- GREEN: manually commanded on the GP.
- MAGENTA: FMS commanded.

2 – FGCS VERTICAL ARMED MODE

Color: WHITE.

NOTE: If the AFCS fails the respective mode annunciation is removed.

AUTOPILOT APPROACH STATUS ANNUNCIATOR



The autopilot approach labels displayed are the following:

- APPR 2
- APPR 1
- APPR 1 ONLY

1 – ARMED STATUS

Color:

- WHITE: Armed approach mode.
- AMBER: Alert condition.

2 – ENGAGED STATUS

Color:

- GREEN: Engaged approach mode.

FLIGHT GUIDANCE CONTROL SYSTEM (FGCS)

The FGCS system is the AFCS function that indirectly drives the primary flight controls, through either the cockpit control column or through other AFCS processing modules.

The FGCS function includes:

- Flight Director (FD) guidance.
- Autopilot (AP) with coupled Go-Around (GA), Windshear modes and Automatic Pitch Trim.
- Yaw Damper (YD) with the Turn Coordination capability.

FLIGHT DIRECTOR (FD)

A magenta diamond displayed on the Primary Flight Display (PFD) represents the FD. It provides lateral and vertical guidance integrated with the Flight Management System (FMS) or manually commanded.

The FD engagement or disengagement is commanded via FD button on the guidance panel.

The FD automatically turns on as follows:

- TO/GA button actuation.
- Autopilot activation.
- Windshear detection.

The FD is released when the Touch Control Steering (TCS) button is pressed and it resynchronizes the references when TCS is released (deactivated).

Selecting FD OFF on the GP removes the flight director information from the non-coupled side on the PFD, if AP is engaged. Flight director information is removed from both PFDs if AP is disengaged and FD is selected OFF.

Ground power-up causes both flight directors to become active, regardless of the last FD status selected.

AUTOPILOT (AP)

The autopilot provides automatic pitch and roll control of the airplane commanding dedicated servos.

The elevator AP servo is mechanically linked to the control column. The aileron AP servo is mechanically linked to the aileron control cables and wheels.

AP ENGAGEMENT/DISENGAGEMENT

The Autopilot is engaged by pushing the AP button on the guidance panel. The automatic pitch trim is ON when AP is engaged. The yaw damper automatically engages with AP engagement, although the yaw damper can be engaged or disengagement independently of the AP status.

Autopilot engagement is inhibited on the ground.

The Autopilot has two channels. One channel works as a hot spare channel. The system changes the channel automatically if the active channel fails. The pilot can changes the AP channel manually on the SETUP MCDU page.



SETUP MCDU PAGE

The autopilot disengages when any of the following conditions occur:

- The AP button is pressed on the guidance panel.
- The manual pitch trim switches are activated.
- Either quick disconnect switches are activated.
- Column shakers are activated.
- Reversion of fly-by-wire system to direct mode.
- Either the aileron or elevator control system disconnects.
- A column and control wheel force monitor sensors trips.
- Various internal monitors fail.

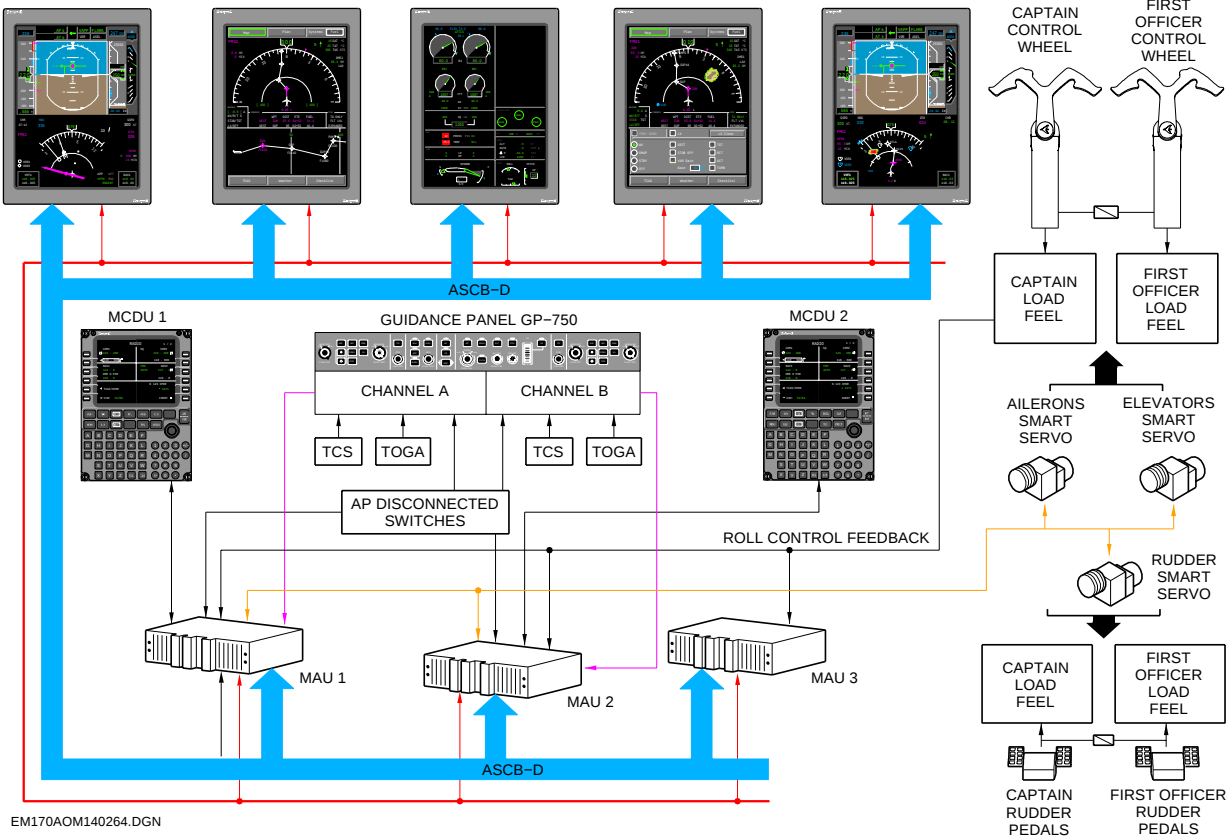
The autopilot commands the servos to disengage when TCS button is pressed. The autopilot automatically re-engages the servos and re-synchronizes the flight director when TCS button is released.

Anytime the autopilot is disengaged, an aural alarm "AUTOPILOT" is triggered and the FMA displays a flashing "AP" indication for at least 5 seconds.

An EICAS message is also displayed for abnormal disengagement of AP. Pressing once either AP disconnect button cancels the flashing "AP" on FMA and the aural alarm. The EICAS message remains displayed.

NOTE: - AP disengagement by application of force on control column and control wheel is indicated in red on FMA. The AP disengagement by application of force only on control wheel may be indicated in red on FMA and AP FAIL message may be displayed on the EICAS.

Pressing the AP disconnect button allows manual disengagement the AP. If the pitch trim is being commanded by the elevator thrust compensation (ETC) or auto configuration trim, the EICAS CAUTION message AP FAIL momentarily displays, and the FMA AP disengagement indication will be green. The second pressing in of the AP disconnect button cancels the aural alarm, which sounds at least once.



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AUTOPILOT/FLIGHT DIRECTOR SCHEMATIC

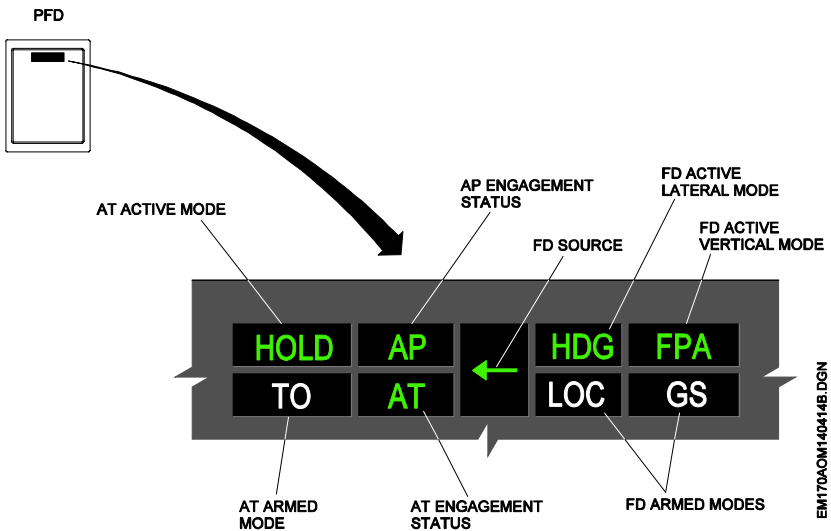
AFCS INDICATIONS ON PFD

FLIGHT MODE ANNUNCIATION (FMA)

The FMA is displayed on the top of PFD. The FMA displays indications of autothrottle, autopilot, active AFCS channel, lateral mode and vertical mode.

The FMA color code for normal operation is the following:

- Magenta: FMS commanded active/engaged mode.
- Green: Non-FMS commanded active/engaged mode.
- White: Armed mode.
- Amber: Alert condition.
- Red: Abnormal condition.



AUTOPILOT APPROACH STATUS ANNUNCIATOR

Autopilot Approach Status Annunciator is displayed on top of FMA upon pressing of APP button, using full line to clearly describe to flight crew current approach status, and some alert levels, when necessary.

Left side of the annunciator displays either the armed status (white) or the discrepancy between system capability and flight crew intention (amber). Alert function associated with amber flashing suggests the crew correct the RA Minimums, which has a digital read-out on PFD.

Right side of annunciator displays current engaged status.

The terminology used for the two system capability levels are:

- APPROACH 2 (APPR 2) – ILS CAT II capable.
- APPROACH 1 (APPR 1) – ILS CAT I capable.

FGCS LATERAL MODES

Only one lateral mode can be activated and only one can be armed at a time. The FGCS provides Lateral navigation as the follows:

The FGCS pilot selectable lateral navigation modes are:

- Roll Hold – Basic Lateral Mode (ROLL)
- Heading Select (HDG)
- Lateral Navigation (LNAV)
- Localizer (LOC)
- Back-course (BC)

Pilot non-selectable mode is:

- Track Hold (TRACK)

ROLL HOLD (ROLL)

Roll hold is the basic lateral mode and it is activated when:

- The active lateral mode is deactivated.
- The TO mode is selected on ground by pressing TOGA button.

The AP takes different actions considering the different airplane bank angles at the moment of ROLL activation.

- Bank angle at 6° or below: AP levels the wings.
- Bank angle above 6° and below 35°: AP holds present bank angle.
- Bank angle at 35° or above: AP maintains bank angle at 35°.

The TCS button can be used to adjust the bank angle between 6° and 35°.

HEADING SELECT (HDG)

The heading select mode activates when one of following conditions occur:

- The HDG pushbutton on the GP is pressed.
- LNAV, LOC or BC modes are armed.

The Heading Select mode is deselected when:

- HDG pushbutton is pressed a second time
- Selecting a different lateral mode
- LNAV, LOC or BC modes are activated.

Pressing the HDG selector knob synchronizes the heading bug with the current heading.

The FD follows the selected heading and respects the side to which the turn was commanded, regardless of turn being greater than 180 degrees.

LATERAL NAVIGATION (LNAV)

The FD provides flight director lateral guidance commands for interception, capture, and tracking.

LNAV guidance and automatic transitions are computed based on PFD data. The LNAV mode is selected when NAV button is pressed on the guidance panel. The FMS is the source of navigation.

The flight director can perform an automatic transition from LNAV to LOC mode or from LNAV to Back-Course mode (BC) via the approach preview mode.

LOCALIZER (LOC)

Localizer mode guidance is computed based on PFD data.

The LOC mode is selected via the APP button on the GP. The FD Localizer mode is selected when there is no GS signal available.

The FD automatically manages the LOC and Back-Course according to Localizer frequency, PFD information and airplane's position.

BACK-COURSE (BC)

The FD will automatically select a BC approach on the PFD.

The FGCS provides commands for capture and tracking of BC localizer indicated on the selected PFD.

TRACK HOLD (TRACK)

The track select mode is used to intercept and maintain an inertial derived airplane track from the IRS. This mode is engaged automatically when GA or TO is selected by the TOGA.

The automatic transition from ROLL to TRACK occurs when:

- IAS is greater than 100 kt.
- Bank angle is at 3° or below for more than 10 seconds.

Selecting another lateral flight director mode disengages track mode.

Canceling the vertical mode of GA does not disengage the TRACK lateral mode automatically.

FGCS VERTICAL MODES

One vertical mode can be active and up to two vertical modes can be armed at a time.

The FGCS vertical navigation modes are:

- Flight Path Angle (FPA) – basic vertical mode
- Takeoff (TO)
- Altitude Select (ASEL)
- Flight Level Change (FLCH)
- Altitude Hold (ALT)
- Vertical Speed (VS)
- Overspeed (OVSP)
- Glide Slope (GS)
- Go around (GA)

FLIGHT PATH ANGLE (FPA)

The FPA is the basic vertical mode (except for the TO).

FPA mode becomes the active FD mode when:

- FPA pushbutton in the guidance panel is pressed.
- Engaging the autopilot when no FD mode is active.
- When a lateral mode is activated and there is no vertical flight director guidance mode active.
- Deselecting the current vertical mode.

The flight path reference line (FPR) is displayed when the FPA is active. Pressing the FPR button in the display controller panel displays the FPR line, regardless of vertical mode active.

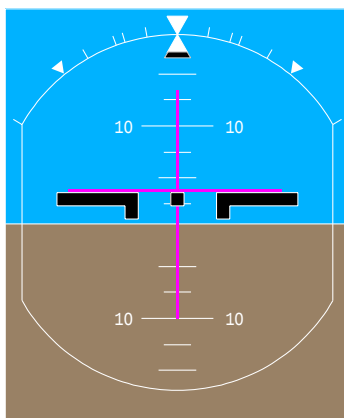
Flight path angle ($\pm 9.9^\circ$) is selected with the FPA SEL selector knob on the guidance panel.

TAKEOFF (TO)

The takeoff mode is a FD only mode and is represented by crossbars on PFD. TO mode commands the airplane to maintain a pitch attitude reference. In takeoff the autopilot engagement is not accept and FPA mode is inhibited. Lateral mode changes are allowed.

FPA indication is inhibited for 30 seconds after lift-off when taking off using raw-data information (no active mode on the FD).

Pressing the TOGA button activates the TO mode. Following a landing, the TO mode can be enabled after 5 seconds on ground (main gear weight on wheels).



PFD TAKEOFF MODE CROSSBAR

The TO mode is deactivated when:

- Another vertical mode is selected.
- AP/FD TCS button is pressed.
- AP is activated.

The TO mode first guidance is the flap-pitch based guidance:

- FLAP 1 – pitch 11°
- FLAP 2 – pitch 10°
- FLAP 4 – pitch 12°

When airborne and IAS is greater than speed target, the guidance will be speed target according to the following:

- All engines operating: $V_2 + 10$ kt.
- One engine inoperative:
 - Engine failure below V_2 : guides V_2 .
 - Engine failure between V_2 and $V_2 + 10$ kt: guides present speed.
 - Engine failure above $V_2 + 10$ kt: guides $V_2 + 10$ kt.

The V_2 is inserted on the MCDU (PERF > PERF INDEX > PERF DATA > TAKEOFF 3/3).

If speed target is not valid, the airplane guides to a fixed pitch according to the flaps in use.

In TO mode the pitch is limited to a minimum of 8° and a maximum of 18° . The maximum speed target is $V_{FE} - 5$ kt and minimum speed target is $V_{SHAKER} + 10$ kt for all engines operating. For one engine inoperative the minimum speed target is $V_{SHAKER} + 3$ kt.

ALTITUDE SELECT (ASEL)

The altitude select mode captures and levels off at the selected altitude. A green ASEL is displayed on the FMA while altitude select mode captures the pre-selected altitude, then a green ALT takes place when leveled off at the selected altitude.

NOTE: - Altitude select is armed automatically whenever any vertical FD mode is selected.

FLIGHT LEVEL CHANGE (FLCH)

The FLCH provides flight path command to Climb or Descend according to the speed selected in the Speed Selector knob. FLCH guidance is associated to SPD_E.

The selected speed is displayed in the box on the top of speed tape and when the altitude is close to 29000 ft it switches from IAS to Mach readout during climb and from Mach to IAS readout during descent.

The FLCH button on the GP activates the FLCH mode.

The FLCH mode deactivates when:

- Another vertical mode is selected
- TCS button is pressed.

The FLCH mode guides to the altitude selected via ALT SEL knob.

During a FLCH decent, selecting an altitude above the current airplane altitude will guide the airplane to climb. The airplane will not reach the altitude selected if AT is disengaged and sufficient thrust is not available.

ALTITUDE HOLD (ALT)

Pressing the ALT button on the GP enables the altitude hold mode. The altitude hold mode maintains a selected barometric altitude. The altitude can be selected via the ALT SEL knob.

After ALT mode engagement, change to another vertical mode is possible only selecting a different altitude via ALT SEL knob, otherwise the ALT indication on the FMA and the altitude digital readout in the PFD flash for 5 seconds. This logic is valid for all vertical modes, except for Glide Slope (GS). Switching from ALT mode to GS mode occurs without change in ALT SEL selection.

VERTICAL SPEED (VS)

The VS mode maintains a vertical speed rate. The VS mode is activated pressing the VS button on the GP. Vertical speed is selected rotating the vertical speed thumbwheel on the GP.

The vertical speed command range goes from -8000 ft/min to +6000 ft/min.

The increments of the Vertical Speed target value are: 50 ft/min (below 1000 ft) and 100 ft/min (above 1000 ft).

OVERSPEED PROTECTION (OVSP)

Flight Director provides overspeed protection during FLCH, VS, FPA and ASEL modes. The OVSP protection limits the airplane speed to V_{MO}/M_{MO} providing FD vertical guidance. When the OVSP protection activates, amber OVSP indication displays on the FMA. The previous active mode is displayed as armed (white) and becomes active again when OVSP protection is no longer active.

GLIDE SLOPE (GS)

The GS approach mode allows the ILS approach mode functions. The GS mode arms when the APP button is pressed and activates when the glide slope is captured.

GO-AROUND (GA)

The go-around mode automatically provides go-around guidance and thrust by pressing the TOGA switch. The flight path angle and flight director symbols are displayed when GA mode is activated.

The GA mode deactivates when:

- Another vertical mode is selected
- TCS button is pressed.

The GA mode first guidance determines pitch 8°:

When IAS is greater than speed target, the guidance will be speed target according to the following:

- All engines operating: $V_{REF} + 20$ kt.
- One engine inoperative: V_{AC} (approach climb)

The V_{REF} and V_{AC} are inserted on the MCDU (PERF > LANDING 3/3).

If speed target is not valid, the airplane guides to pitch 8°.

In GA mode the pitch is limited to a minimum of 8° and a maximum of 18°. The maximum speed target is $V_{fe} - 5$ kt and minimum speed target is $V_{shaker} + 10$ kt for all engines operating. For one engine inoperative the minimum speed target is $V_{shaker} + 3$ kt.

WINDSHEAR (WSHR)

Although it is not pilot selectable, Windshear protection will display the label “WSHR” as the vertical active mode in the FMA.

The Windshear guidance is activated when any of the following conditions is met:

- Windshear Caution or Windshear Warning condition is detected and Takeoff and Go-around button is pressed at the thrust lever.
- Windshear Warning condition is detected and thrust lever is set to TO/GA position.
- Automatically when Windshear Warning condition is detected and AFCS flight director mode is in TO or GA.

A green WSHR annunciation is displayed on the FMA when the Windshear guidance is activated.

The system provides flight path guidance angle, limited to stick shaker, wings level and aural alert.

The autopilot is disengaged when windshear guidance mode becomes active. After exiting windshear conditions, lateral and vertical modes are selected pressing the respective buttons in the guidance panel.

Windshear protection is disabled above 1500 ft AGL.

VERTICAL NAVIGATION (VNAV)

The VNAV can be engaged either manually by pressing VNAV button on the GP when the altitude is above 400 ft, or automatically upon crossing 400 ft after ground arming.

VNAV SUB-MODES

The logics for the vertical modes reside within the FGCS. VNAV only selects the appropriate vertical mode to accomplish the vertical profile. When the vertical mode is selected via the VNAV function, it is said to be a VNAV sub-mode. The VNAV sub-modes are VARM, VFLCH, VASEL, VALT and VPATH.

- **VARM:** When VNAV is selected on the GP, the initial mode is VARM. The FMS keeps VARM up to the moment that it is possible to determine which vertical mode should be used. If the FMS cannot determine which mode to use or cannot determine whether to climb or descend, it stays in VARM until the conflict is resolved. An example of conflict is set the altitude selector to a higher altitude when the next waypoint constraint is below the actual altitude. While in the VARM mode the previous AFCS vertical mode remains engaged.
- **VFLCH (VNAV Flight Level Change):** AFCS maintains the manual or FMS speed controlling the airplane's pitch attitude. When in VALT mode, the VFLCH mode can be selected by pressing the FLCH button on the GP with the Alt Selector set to an altitude different from the present airplane's altitude.
- **VASEL (VNAV Altitude Capture):** It captures the Alt Selector altitude or the FMS waypoint altitude constraints.
- **VALT (VNAV Altitude Hold):** Maintains the altitude commanded by the FMS or the Alt Selector. If the VNAV is disengaged while in VALT the active mode becomes FPA.
- **VPATH (VNAV Path):** In this mode the FMS flies a constant descent angle between two waypoints. This angle can be defined by the FMS, by a procedure retrieved from the database or entered by the pilot. The path angle can vary from 1° to 6° and it can be seen in the ACTIVE FLT PLAN page. The FMS maintains a required geometric path sending a vertical speed command to the AFCS. If the descent angle is too steep, the system might not be able to maintain the speed command shown on PFD and on the ACTIVE FLT PLAN page.

SPEED CONTROL

Speed control can be manual or automatic (FMS position) depending on the selection on the Speed Selector Knob. The FMS selection allows the FMS to send its internally defined speeds as target speeds for FGCS.

- **Manual:** If the Speed Selector Knob is set to MANUAL the pilot is responsible of controlling the speed during all flight phases.
- **FMS:** In this mode the speed command is sent to the AFCS by the FMS. The departure, climb, cruise, descent, approach and go-around speeds are set in the PERFORMANCE INITIALIZATION page 1/3. If a new schedule is desired these settings can be modified in flight.

The speed command is displayed in the ACTIVE FLT PLAN page 1/3 in CAS and MACH. VNAV selects the value, which results in the lower speed. This value is shown in bigger characters.

SPEED PROTECTION

The FMS incorporates speed reversion (transition from VPATH to VFLCH) and latched speed protection.

VPATH to VFLCH Transition: Speed reversion is active when the descent is too steep and it is not possible to maintain the selected speed. In this case, the FMS transitions to VFLCH, which maintains the speed within limits. The transition from VPATH to VFLCH automatically occurs if:

- The speed exceeds $V_{MO}/M_{MO} + 10$ kt during VPATH descents;
- FMS passes through a speed/altitude limit with a speed greater than 5 kt. In this case, the command is to level off until the speed is within + 2 kt. Then the FMS commands VFLCH down to the Alt Selector setting.
- Landing Gear/Flap speed limit is exceeded by more than 10 kt;
- In VPATH and the speed is less than $V_{REF} - 10$ kt.

NOTE: - If the Auto Throttle is not engaged the pilot is responsible for maintaining the speed.

Latched speed: It might occur when the FMS transitions from one VNAV sub-mode to another and there is a significant difference between those modes speed commands. It might also occur if there is a significant difference between the speed command and the current speed.

ILS APPROACH

During execution of the ILS approach, Autopilot Approach Status Annunciator displays the current status of the system and alerts whether the intended approach matches system capabilities.

The RA/BARO selector and RA Minimums setting inform the system about the intended approach.

When ILS modes are requested via APP button, the system arms for the highest capability available.

If all necessary requirements are not accomplished, an EICAS message is presented during flight and informs that category II ILS approach mode is not available.

The intended approach communicated to the system setting the barometric correction via control knobs on Display Controller panel (guidance panel).

- CAT1 – set RA/BARO selector to BARO (both sides)
- CAT2 – set RA/BARO selector to RA and adjust Minimums to 80 ft or above

The operational conditions to accomplish a CAT II approach are:

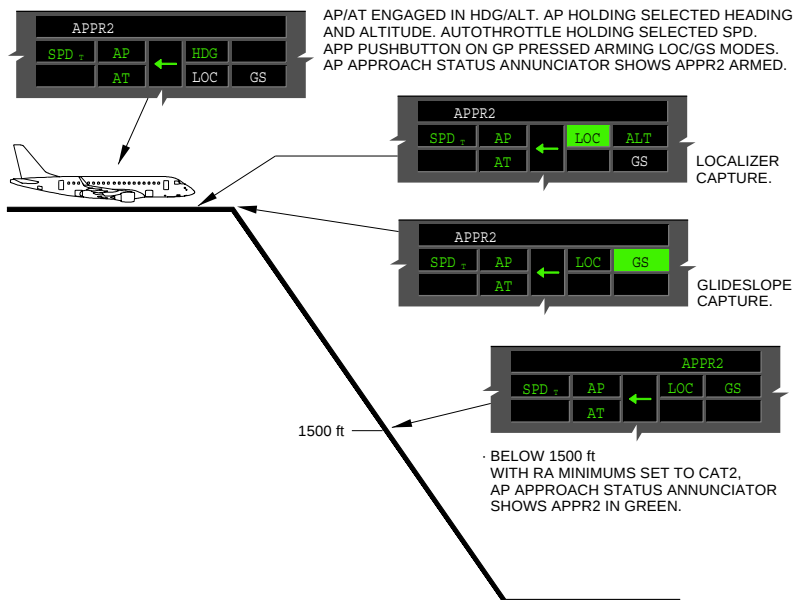
- RA/BARO set to RA and Minimums set at 80 ft or above.
- Both NAV set to correct LOC frequency.
- Both PFDs set to correct LOC inbound course (V/L or Preview).
- Flap 5.
- All described conditions established at or above 800 ft RA.

If the flap setting is the only remaining condition to be satisfied for CAT II, the armed status will remain displayed down to 800 ft RA, suggesting there is still one pilot's action pending.

The ILS approach check points are the following:

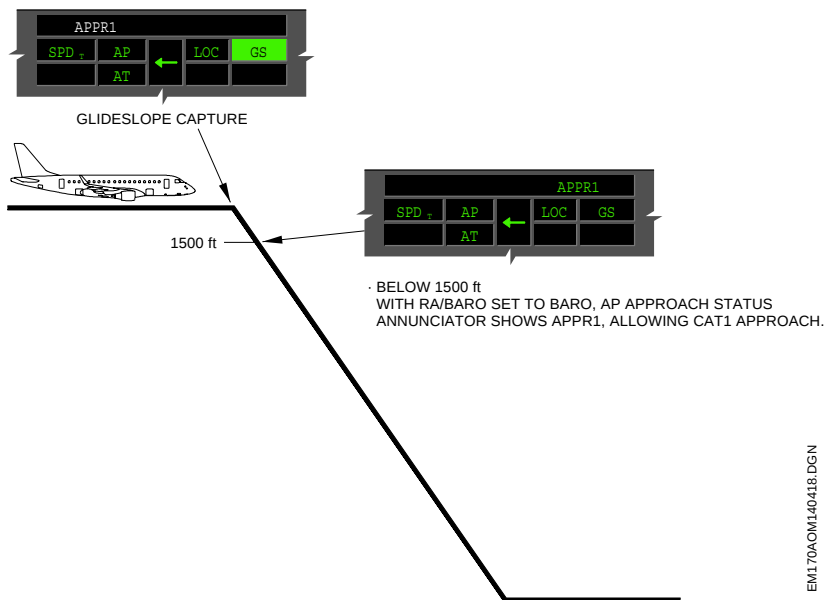
- 1500 ft RA – system starts trying to engage highest capability available.
- 800 ft RA – system “freezes” highest capability available, not allowing approach “upgrades” anymore.

APPROACH SEQUENCE – CAT II

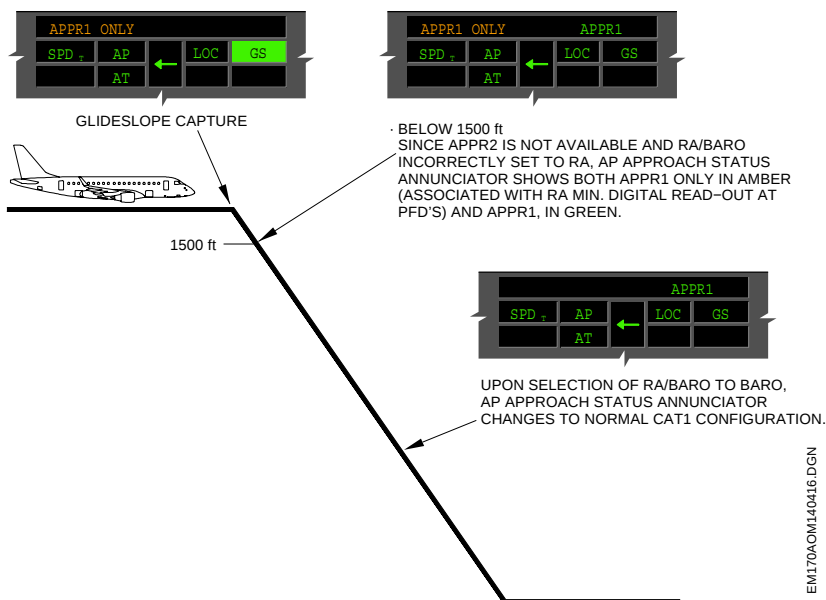


APPR 2 AVAILABLE

APPROACH SEQUENCE – CAT I



APPROACH SEQUENCE – CAT I (RA/BARO SET RA)



**APPR 2 NOT AVAILABLE – RA/BARO
INCORRECTLY SET TO RA**

YAW DAMPER

The Yaw Damper provides command to the rudder control surface and actuates independently of the autopilot and flight director system.

The YD function engages following successful AFCS on-ground power-up, assuming that valid data for calculating yaw damping is available. The YD remains engaged regardless of autopilot engagement or disengagement or even the loss of turn coordination function.

The yaw damper disengagement occurs when:

- The corresponding pushbutton on the GP is pressed.
- The fly-by-wire system turns to direct mode.

The fly-by-wire system engagement status indicates that control of the rudder surface has failed.

PREVIEW FEATURE

The preview feature allows the capture of an ILS course while still using the FMS as the basic NAV source.

The system automatically selects the ILS frequency and course if the PREV function is used with AUTO tuning enabled on the MCDU radio page. An ILS or BC procedure has to be part of the active flight plan on the FMS to allow automatic selection.

The PFD displays the CDI associated to the selected NAV frequency (LOC or VOR) with FMS selected on the PFD as the primary navigation source.

The AP will intercept the LOC while still displaying the FMS as the primary NAV source. Upon interception, the primary navigation source becomes LOC or BC, instead of FMS.

THRUST MANAGEMENT SYSTEM

The TMS is a dual channel system comprised of the following dual components:

- Auto Throttle (AT).
- Thrust Rating Selection (TRS).
- Thrust Lever Angle (TLA) Trim

Only one channel is operating at any given time. The priority channel can be selected via the MCDU.

AUTOTHROTTLE

The AT uses data from the FADEC, Thrust Control Quadrant, MCDU, AFCS Flight Director and Flight Management system to provide automatic, full flight regime energy management with a minimum of pilot inputs.

The AT system provides means to maintain the airplane within its thrust and speed envelopes. Thrust limiting is based on the active N1 rating, while speed limiting is based on the low speed and maximum speed limits (V_{MO}/M_{MO} , Gear and Flaps placard).

Gust compensation is provided to increase the lower speed limit above $1.2 V_S$ up to 5 kts in gusty conditions, with slat/flap position greater than 0 (zero).

The AT is engaged on the ground when:

- All parameters required are valid and AT is capable.
- AT TO mode armed (AT button in the GP is pressed)
- Both thrust levers above 50° TLA.

In flight, the AT engages when:

- All parameters required are valid and AT is capable.
- AT button in the GP is pressed.
- The airplane is 400 ft AGL or above.

Disengagement of AT occurs when:

- Either AT Disconnect Button on the thrust levers is pressed.
- AT button on the GP is pressed.
- TLA difference greater than 8°.
- AT monitor tripped.
- The required system parameters become invalid.
- Transition to on-ground condition (weight-on-wheels or wheels spinning), and thrust levers at Idle and AT in Retard mode.

Anytime the auto Throttle is deactivated, an aural alarm “THROTLLE” is triggered.

Pressing the AT Disconnect Button manually disengages the AT. The second press in the AT Disconnect Button cancels the aural alarm, which sounds at least once.

A single press in the AT Disconnect Button cancels the aural warning after the system automatic disengagement of AT.

“AT” flashes on the FMA anytime the Auto Throttle is disengaged. Pressing the AT disconnect button once cancels the alarm. The visual information will always flash for at least 5 seconds.

“AT” flashes green on the FMA for normal AT disengagement. For abnormal disengagement “AT” flashes red and an EICAS message is displayed. Pressing the AT disconnect button cancels the FMA visual warning but the EICAS message remains displayed.

The AT modes is described as follows:

- Speed Control Mode – Speed on Thrust (SPD_T).
- Flight Level Change Thrust Control Mode – Speed on Elevator (SPD_E)
- Takeoff Thrust Control Mode (TO)
- Go-Around Thrust Control Mode (GA)
- Takeoff Thrust Hold Mode (HOLD)
- Retard Mode

SPEED CONTROL MODE – SPEED ON THRUST (SPD_T)

The thrust levers are commanded to provide thrust rate as programmed to maintain the desired speed.

The selected speed is controlled by engine thrust during climb, descent and cruise phases.

The vertical modes related to SPD_T mode are:

- Flight Path Angle (FPA) – basic vertical mode
- Vertical Speed (VS)
- Glide Slope (GS)
- Altitude Hold (ALT)
- Altitude Select (ASEL)

FLIGHT LEVEL CHANGE THRUST CONTROL MODE – SPEED ON ELEVATOR (SPD_E)

The AT maintains a fixed thrust setting, and the AP maintains the selected speed using the elevator command.

For small flight level changes (FLCH mode), the Auto Throttle commands only the necessary thrust in order to maintain a comfortable predetermined schedule based on vertical speed.

For large flight level changes (FLCH mode), the Auto Throttle commands climb setting CLIMB rating and descent in IDLE rating.

The vertical modes related to SPD_E mode are:

- Flight Level Change (FLCH)
- Overspeed (OVSP)

TAKEOFF THRUST CONTROL MODE (TO)

Takeoff thrust mode (TO) advances the thrust levers to the TO/GA position when AT is engaged on the takeoff phase pressing the Takeoff and Go Around Button on thrust levers.

GO-AROUND THRUST CONTROL MODE (GA)

The Go-Around thrust mode (GA) advances the thrust levers to the TO/GA position.

TAKEOFF THRUST HOLD CONTROL MODE (HOLD)

The HOLD mode prevents movements on the thrust levers that could cause undesirable thrust reductions during TO phase.

HOLD mode activates when TO mode is active and IAS is greater than 60 kt. The AT servos are deenergized and thrust lever movements are not commanded up to 400 ft AGL.

An EICAS message is displayed if HOLD mode engages with TLA position below TOGA.

RETARD MODE

The Retard mode provides the retard of thrust levers to the idle thrust position during airplane flare on landing. Retard mode activates based on a valid Radio Altitude less than 30 ft and airplane is in a landing configuration. Once the airplane touches down (weight-on-wheels or wheel spin-up) the auto throttle automatically disengages.

LIMITED THRUST (LIM)

Limited Thrust (LIM) is set when the selected vertical mode requires more or less engine thrust than that available for the thrust rating selected. In these cases the AT will not be able to maintain the selected speed for climbing or descending and an amber LIM displays on FMA.

LIM is associated with Speed on Thrust mode (SPD_T).

OVERRIDE (OVRD)

The AT can be overridden by moving the thrust levers, causing no AT disengagement. In this case a green "OVRD" is displayed on the FMA. The thrust levers return to the AT commanded position after override is discontinued.

The Auto Throttle is disengaged when:

- Thrust lever is moved beyond TO/GA position.
- TLA is reduced below 40° (aborted TO case) during TO HOLD mode.

AT SINGLE ENGINE OPERATION

The AT deactivates the respective thrust lever when FADEC detects an engine failure or engine shutdown. The operating engine's thrust lever remains active for AT operation.

Reducing the thrust lever to simulate an engine failure will cause AT disengagement due to thrust lever position split.

TLA TRIM

The TLA trim functions are the following:

- Perform small thrust adjustments, with limited authority.
- Reduce excessive thrust lever movements.
- Synchronize N1 rotation speed, increasing comfort.

The TLA Trim is set ON whenever AT is engaged. TLA Trim works even if AT is disengaged, if TLA Trim is set to ON on the MCDU TRS page.

The TRS page on the MCDU is available to set either TLA Trim ON or OFF manually whenever AT is not engaged.

THRUST RATING SELECTION (TRS)

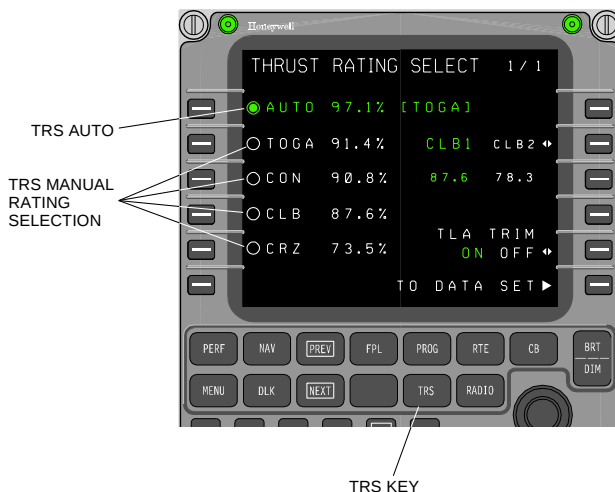
The TRS automatically determines the appropriated engine thrust rating according to the flight phase.

The thrust rating can also be manually selected via TRS page on the MCDU, pressing TRS key.

The FADEC transmits the thrust rating and N1 values provided by TRS for display on the EICAS.

The thrust ratings transmitted by the TRS are as the following:

- Take-off (TO)
- Go-Around (GA)
- Climb-1 (CLB-1)
- Climb-2 (CLB-2)
- Cruise (CRZ)
- Continuous (CON)



THRUST RATE SELECT PAGE

The Automatic Flight System has an Auto Rating Type Transition Logic that controls the engine rating changes according to flight phase, airplane configuration and number of engines running.

TO is the engine thrust rating selection on ground, and it remains in TO mode while airplane is below 400 ft AGL.

The change of engine thrust rating from TO to CLB is set when the following conditions occurs simultaneously:

- Any change in vertical mode is detected.
- Airplane altitude is above 400 ft AGL.
- Both engines are running.
- Landing gears are retracted.

If no change in vertical mode is detected, the engine thrust rating switches from TO to CLB at 3000 ft pressure altitude AFE.

The active TRS flight phase is set to CLB when the airplane is in the air and the Altitude Pre-selector is above the current Baro altitude.

In one engine inoperative condition, the engine thrust rating changes from TO to CON at 3000 ft pressure altitude AFE.

The active TRS flight phase is set to CRZ when the airplane is in the air and Baro Altitude is between 100 ft above and 100 ft below of Pre-selected Altitude for more than 90 seconds.

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EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	AP FAIL	Autopilot function is no longer operative.
	AP PITCH MISTRIM	Pitch trim and autopilot commanding pitch trim control in opposite directions.
	AP PITCH TRIM FAIL	Autopilot stabilizer trim is no longer operative.
	AP ROLL MISTRIM	Roll trim and autopilot commanding roll trim control in opposite directions.
	AT FAIL	Both AT have failed. Selected AT function is unavailable.
	AT NOT IN HOLD	AT not in TO Hold following the transition above 60 knots during TO roll and until the aircraft transitions 400 ft AGL and Go Around.
	ENG TLA NOT TOGA	TLA not at TO/GA position during takeoff and/or go-around phases.
	FD LATERAL MODE OFF	Disconnection of the lateral mode due to invalid conditions.
	FD VERT MODE OFF	Disconnection of the vertical mode due to invalid conditions.
	SHAKER ANTICIPATED	Indication that Shaker activation angles have been advanced to conservative settings.
	STALL PROT FAIL	Stall Warning function and Stall Protection functions are no longer operative.

TYPE	MESSAGE	MEANING
ADVISORY	AFCS FAULT	Latent fault to AFCS functions.
	AFCS PANEL FAIL	Both channels of the GP have failed.
	AFCS PANEL FAULT	A single channel of the GP has failed.
	AP FAULT	The AP has one channel failed.
	AP PITCH TRIM FAULT	The AP pitch trim has one channel failed.
	APPR 2 NOT AVAIL	The AP is not capable to perform a CAT 2 precision approach.
	AT FAULT	The A/T has one channel failed.
	ENG TLA TRIM FAIL	Selected Sync function is unavailable due to an internal failure or a required input failure. AT function is available.
	FD FAIL	FD is no longer available.
	FD FAULT	A single FD channel is no longer available.
	SHAKER 1 (2) FAIL	Stall warning function has failed.
	STALL PROT FAULT	AOA Miscompare Monitor (Stall Warning Subsystem) has failed
	STALL PROT ICE SPEED	The reference speed has changed. Set reference speed to ice speed.
	YD FAIL	Yaw damper function is no longer operative.
	YD FAULT	The yaw damper has one channel failed.
	YD OFF	Yaw damper function is off.

DIMENSIONS AND AREAS	ATA 06
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AIR CONDITIONING	ATA 21
AUTO FLIGHT	ATA 22
COMMUNICATION	ATA 23
ELECTRICAL POWER	ATA 24
EQUIPMENT AND FURNISHINGS	ATA 25
FIRE PROTECTION	ATA 26
FLIGHT CONTROLS	ATA 27
FUEL	ATA 28
HYDRAULIC POWER	ATA 29
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LANDING GEAR	ATA 32
LIGHTS	ATA 33
NAVIGATION	ATA 34
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ATA CHAPTER 23

COMMUNICATION

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INTRODUCTION

The EMBRAER 170 provides a complete set of Communication and Navigation functions. The main interface for the system is done through the Audio Control Panel (ACP) and the Multi-function Control Display Unit (MCDU).

The MCDUs provide radio frequency and mode control. Alternatively, the frequencies may be selected on the Primary Flight Displays (PFDs) through the Cursor Control Devices (CCDs). The system provides a backup tuning page that may be used when a failure is detected. This backup page is displayed on MCDU 2 and enables tuning for COM 1, NAV 1 and Transponder (XPDR) 1.

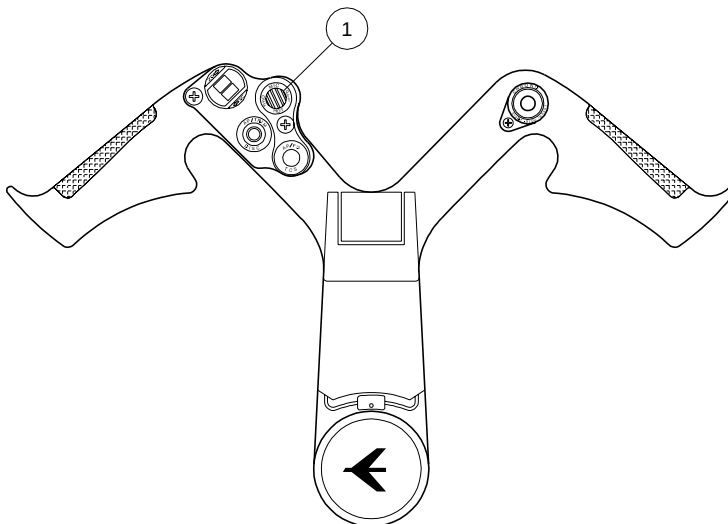
The audio system is controlled via three individual ACPs available to the captain, first officer and observer, and also provides interface with the Passenger Address (PA), Aural Warning, and Digital Voice and Data Recorder (DVDR) systems.

Optional communications equipment includes a third VHF COM, HF and Selcal systems.

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CONTROLS AND INDICATIONS

CONTROL WHEEL

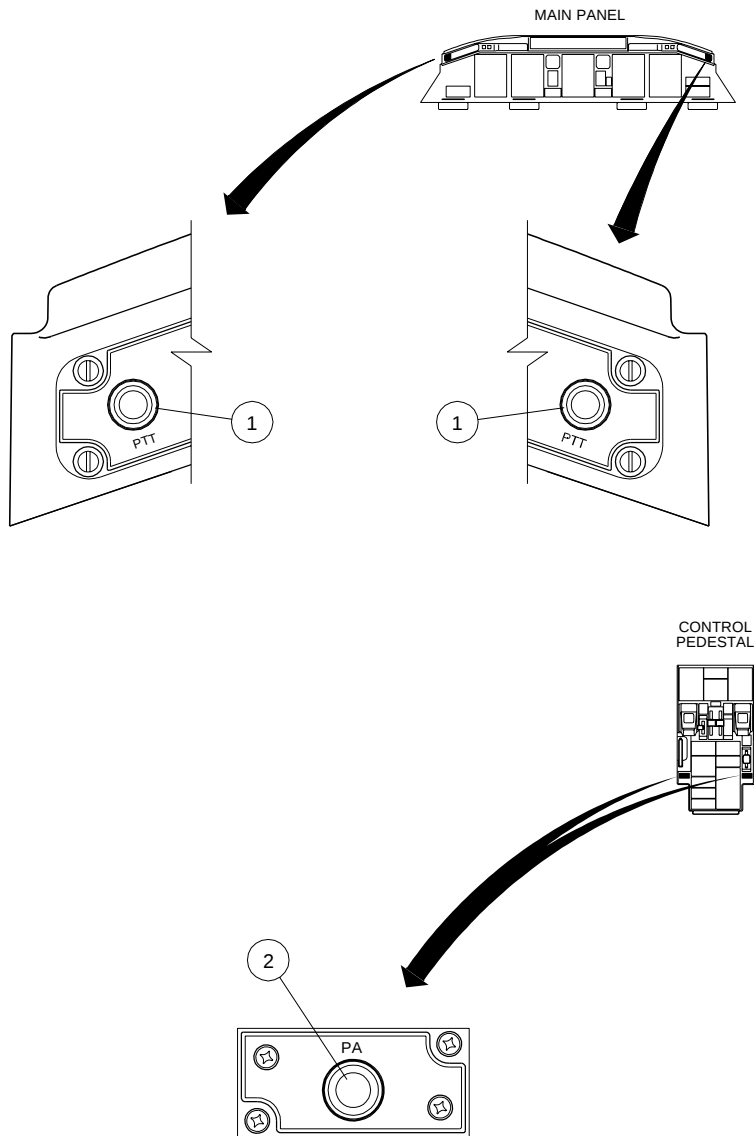


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1 – CONTROL WHEEL COMMUNICATIONS SWITCH

- PTT (momentary): allows VHF and HF transmissions, as well as voice communications to passengers.
- HOT: allows communication between crewmembers and between crewmembers and ramp station.
- OFF: allows only audio reception.

GLARESHIELD COMMUNICATION



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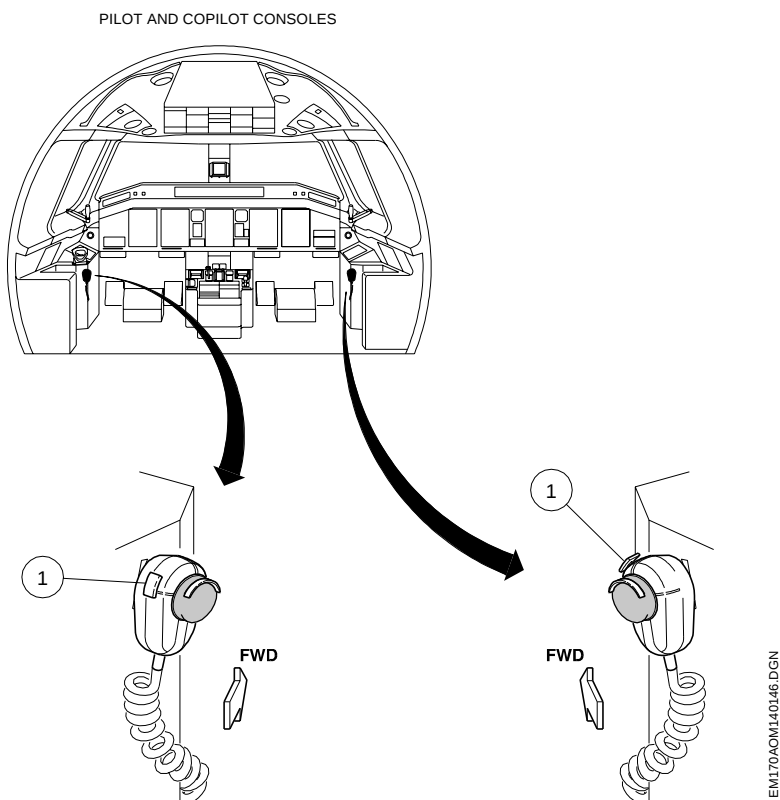
1 – GLARESHIELD PTT BUTTON

- Allows VHF and HF transmissions, as well as voice communications to passengers.

2 – PASSENGER ADDRESS PTT BUTTON

- Allows voice communications to passengers, regardless of any selection in the audio control panel.

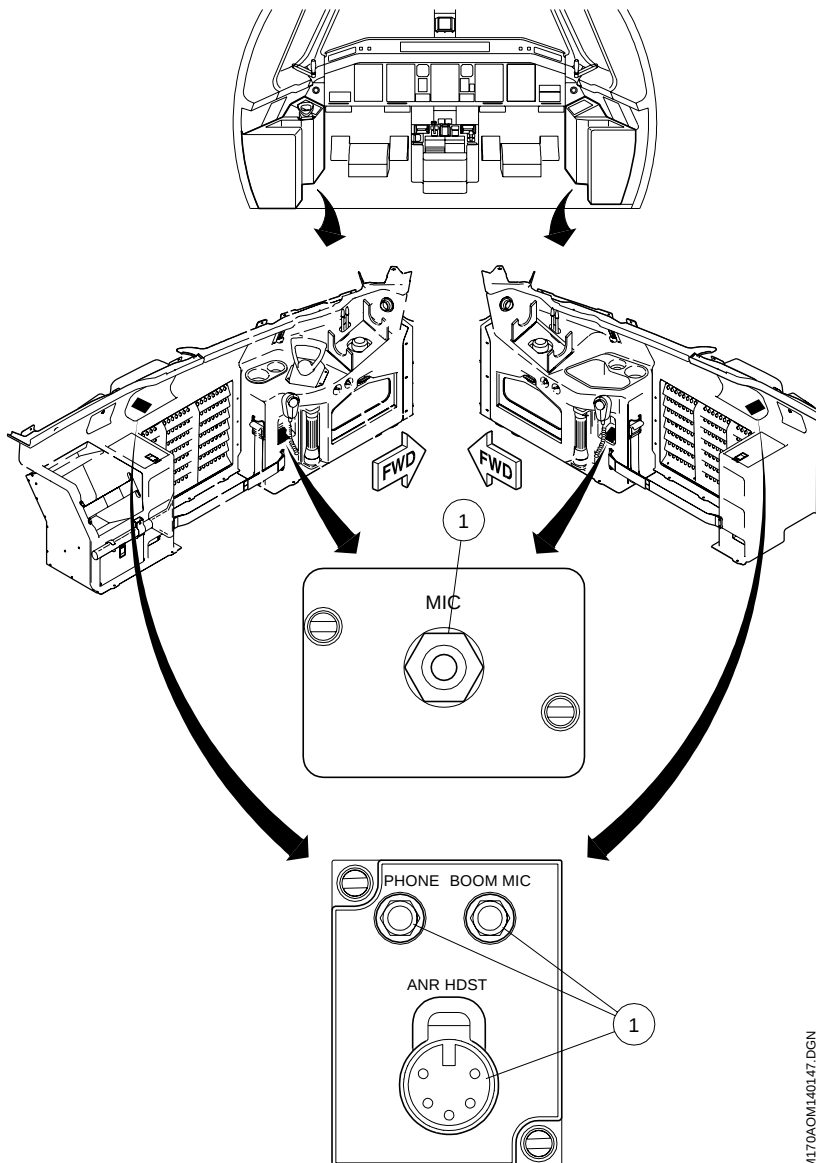
HAND MICROPHONE CONTROLS



1 – HAND MIC PTT BUTTON

- Allows transmission through the ACP, as well as communication to passengers.

CAPTAIN AND FIRST OFFICER JACK PANELS

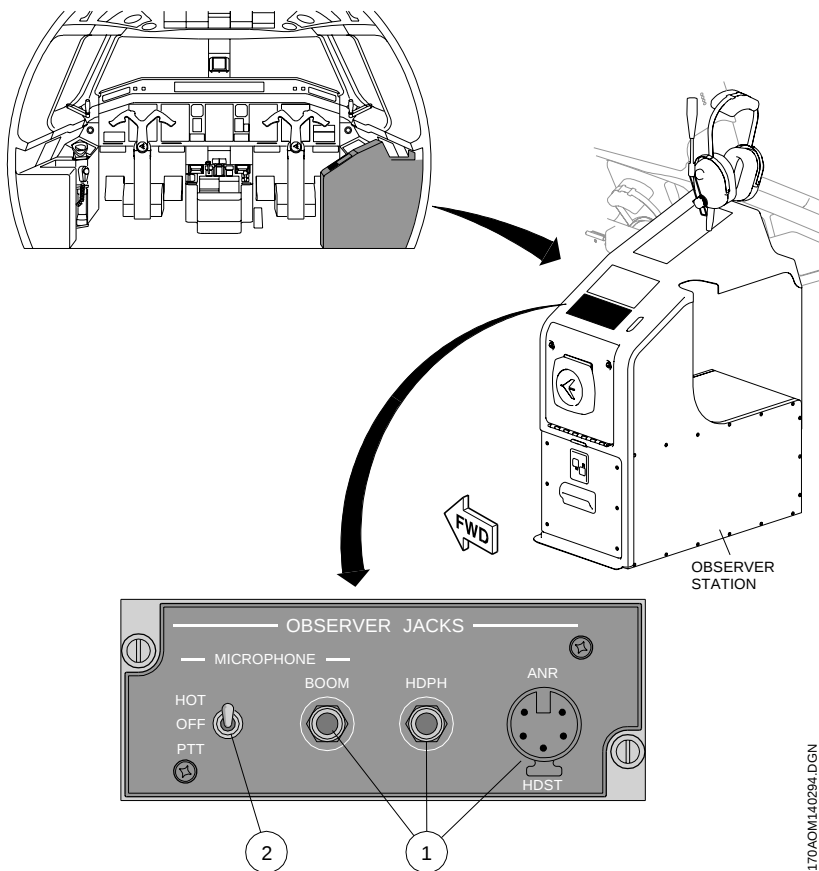


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1 – CAPTAIN AND FIRST OFFICER JACKS

- Allows plugging in headphone (PHONE), headset (ANR HDST), hand microphone (HAND MIC) and boom microphone (BOOM MIC).

OBSERVER JACK PANEL



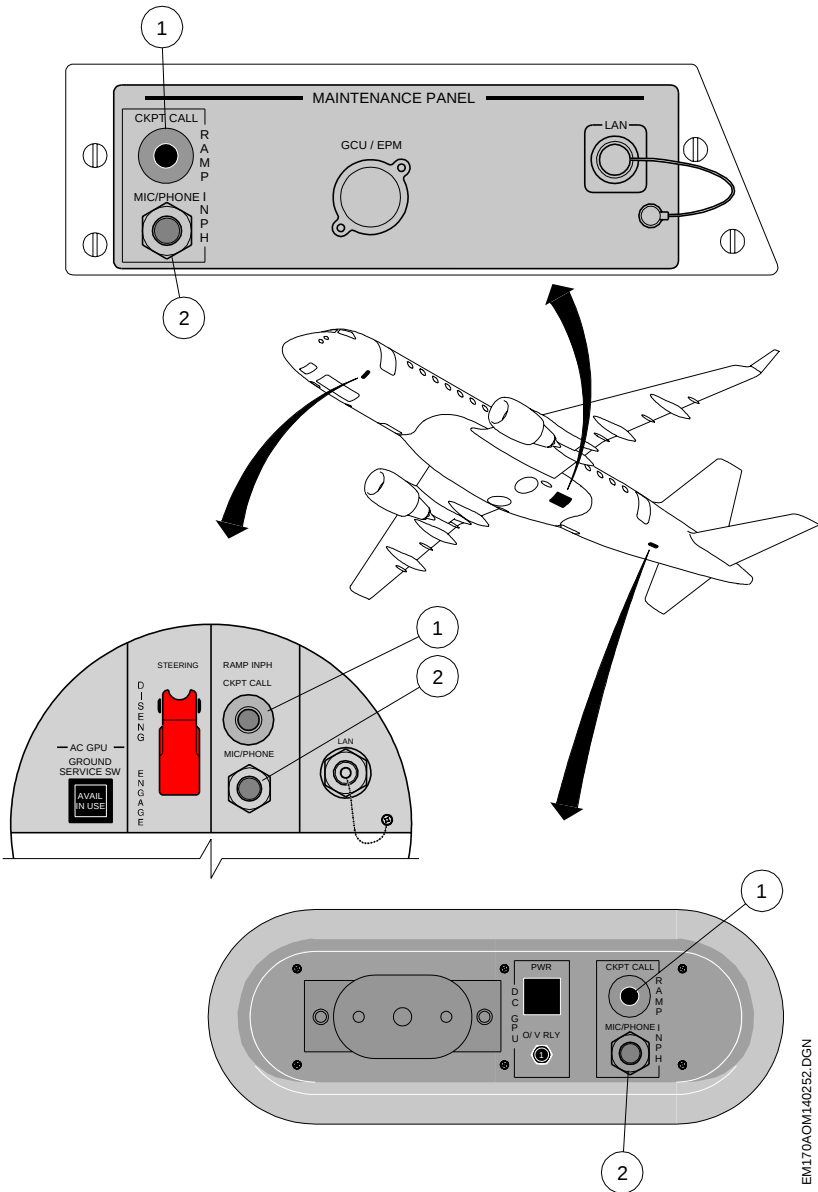
1 – OBSERVER JACKS

- Allows plugging in headphone (HDPH), headset (ANR HDST) and boom microphone (BOOM).

2 – OBSERVER COMMUNICATIONS SWITCH

- PTT (momentary): allows VHF and HF transmissions, as well as voice communications with passengers.
- HOT: allows communication between crewmembers and between crewmembers and ramp station.
- OFF: allows only audio reception.

RAMP STATION



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1 – COCKPIT CALL BUTTON (MOMENTARY ACTION)

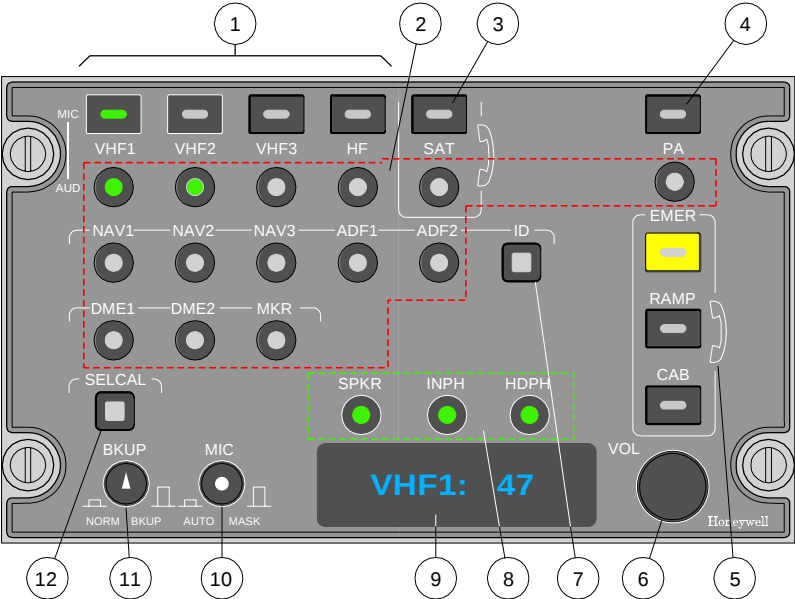
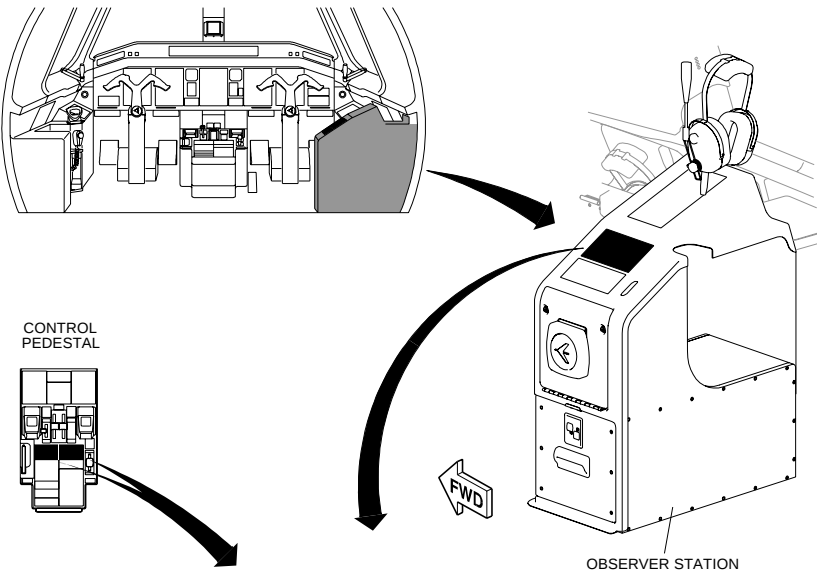
- When pressed, generates a single HI/LO tone chime and the RAMP annunciator button flashes on the audio control panel.

2 – MICROPHONE/HEADPHONE JACK

- Allow ground personnel to plug in a headphone and a microphone equipped with a PTT Button.

NOTE: Ground personnel panel is linked to the hot mic once the ramp button is selected.

AUDIO CONTROL PANEL (ACP)



1 – MICROPHONE SELECTOR BUTTONS

- Related communication channel is enabled for transmission and reception.
- When selected, a green bar illuminates inside the button.

2 – AUDIO CONTROL BUTTONS

- Related audio channel is enabled for reception.
- Automatically activated when a transmission channel is selected.
- More than one audio channel may be selected at the same time.
- When selected, a green dot illuminates inside the button.

3 – SATCOM CONTROL BUTTON

- Satellite communication channel is enabled for transmission and reception.
- When receiving a call both transmission and reception button flashes; remains steady when active for transmission.

4 – PASSENGER ADDRESS CONTROL BUTTON

- Enables PA announcements.
- When selected, a green bar illuminates on the transmission button and a green dot illuminate on the reception button.

5 – SERVICES INTERPHONE CONTROL BUTTONS

- EMER: sounds a triple HI/LO tone chime through the PA system, illuminates a red light at ceiling of the flight attendant station and enables communication between cockpit and flight attendants. When selected, a green bar flashes on button until the flight attendant picks up the handset.
- RAMP: enables communication with the ground personnel. For an incoming call, the ramp annunciator flashes and remains steady on when active. A single HI/LO tone chimes.
- CABIN: sounds a single HI/LO tone chime through the PA system, illuminates a green light at ceiling of the flight attendant station and enables communication between cockpit and flight attendants. When selected, a green bar flashes on button until the flight attendant picks up the handset.

6 – MASTER VOLUME CONTROL KNOB

- Allows adjustment of the most recently selected audio.

7 – ID FILTER BUTTON

- Activates a filter that eliminates voice on VOR and ADF audio so the identification can be heard.

8 – AUDIO SELECTION BUTTONS

- Enables the respective audio to be summed into the output on the headphone (HDPH), interphone (INPH) or cockpit speaker (SPKR).
- When selected, a green dot illuminates inside the button.

9 – ACP DISPLAY

- Displays the selected transmission channel, digital volume information and the SELCAL code (when in use).

10 – AUTO/MASK MICROPHONE SWITCH

- AUTO (PUSH IN): allows audio communication via oxygen masks.
- MASK (PUSH OUT): activates oxygen mask microphone when auto mode fails.
- Oxygen mask stowage box doors must be closed and reset in order to enable hand or headset microphone booms after using the oxygen mask microphone.

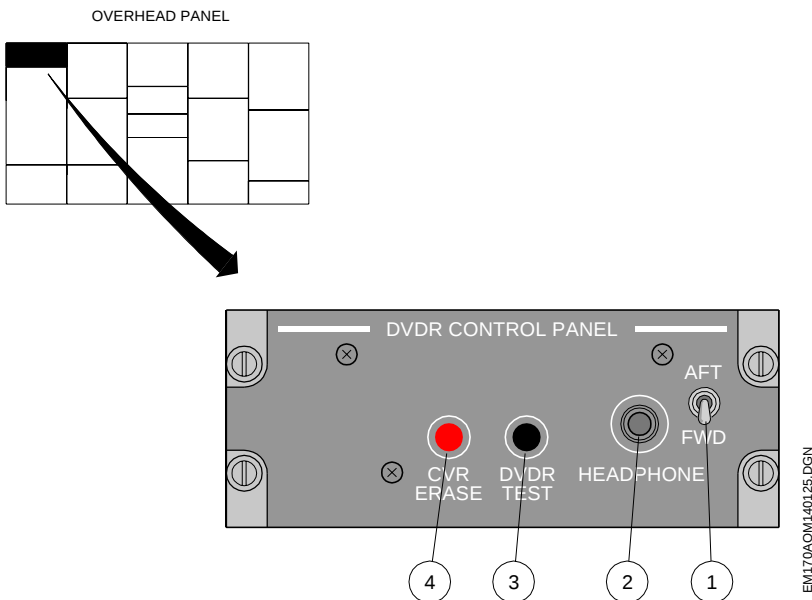
11 – BACKUP VOLUME CONTROL BUTTON/KNOB

- NORM (PUSH IN): normal operation mode.
- BKUP (PUSH OUT): activates backup operation when audio panel power fails or both digital audio buses fail.
- Minimum volume is at the extreme counterclockwise position and the maximum volume is at the extreme clockwise position.
- The VHF 1 is the radio available for Captain ACP and VHF 2 is the radio available for the First Officer ACP.

12 – SELCAL ANNUNCIATOR BUTTON

- Flashes when an incoming call is displayed.
- Pressing shows the code on the ACP display.
- Remains steady when active for transmission.

DIGITAL VOICE-DATA RECORDER



1 – SELECTOR SWITCH

- **FWD:** enables test functions of DVDR 1, which is located in the forward electronic bay.
- **AFT:** enables test functions of DVDR 2, which is located in the aft electronic bay.

2 – HEADPHONE JACK

- Monitors tone transmission during test or to monitor playback of voice audio.

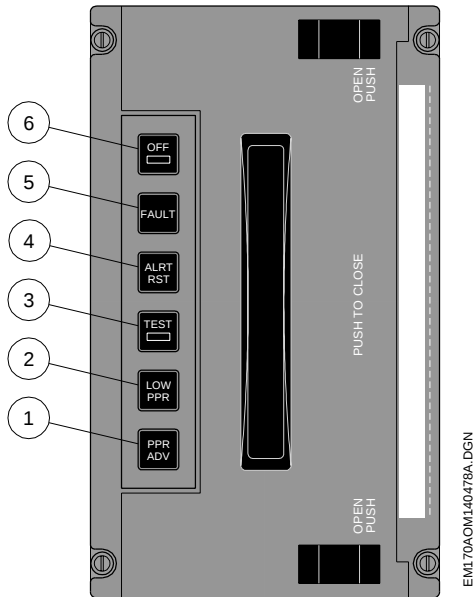
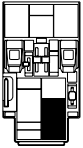
3 – TEST BUTTON

- Simultaneously tests all CVR and FDR functions on each DVDR. The DVDR on which the test will be performed is selected on the Selector Switch.
- An aural tone is heard through the headset if the unit passes the test.

4 – CVR ERASE BUTTON

- Erases the recorded audio information, provided that the airplane is on the ground and parking brake is set.

PRINTER

CONTROL
PEDESTAL

1 - PPR ADV

- Continuously advances paper while pushbutton is depressed.

2 – LOW PPR

- Illuminates when the printer senses the last remaining 10 feet of paper on the paper supply roll.

3 – TEST BUTTON

- Illuminates all indicators followed by a printout of test results and a test pattern.
- "TEST" button indicator bar will remain lit in conjunction with the "FAULT" indicator to report a self test failure.

4 – ALRT RST BUTTON

- Not functional.

5 – FAULT BUTTON

- Illuminates when senses no paper or printer door open.
- Illuminates in conjunction with test button in case of self-test failure.

6 – OFF BUTTON

- Alternatively turns the printer off and on. When power is applied to the printer, it automatically is in the on state.

COMMUNICATION SYSTEM

The communication system comprises the radio communication (VHF/HF), interphone, audio control panels and digital data voice recorder.

RADIO COMMUNICATION SYSTEM

VERY HIGH FREQUENCY

The Very High Frequency (VHF) is located in the Modular Radio Cabinet (MRC). The interface with the audio is through the audio/microphone bus, and with the MCDU/PFD through the ASCB.

The VHF frequency is tuned/activated through the MCDU (primary mean) or CCD (PFD).

A tuning backup is available in MCDU 2 in case of loss of both MAUs. As the same way if the audio bus is lost there is audio backups.

The flight crew may tune the VHF frequency on the MCDU as follows:

- Press RADIO button on the MCDU to go to RADIO page 1/2.

RADIO PAGE 1/2:

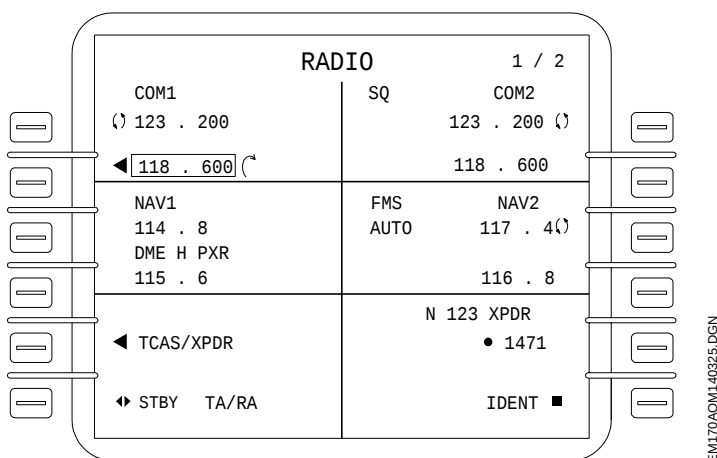
- On RADIO page 1/2 is possible to tune and activate the VHF frequency. The tuning can be accomplished using the tuning knob or the numeric buttons. If the tuning knob will be used the standby frequency must prior be boxed pressing its respective line select key. In case of the numeric keys, enter the standby frequency and press the respective line select key. To activate the standby frequency press the respective active frequency.
- Press the respective standby frequency twice if not boxed, otherwise press once, to go to COM page 1/1.

COM PAGE 1/1:

- On the COM page is possible to capture a frequency tuned in memory. Press 3L to box the memory tune and use the tuning knob to cycle the stored frequencies. Press the active frequency to capture the selected memory tune.
- Press line select key 1R to cycle to the squelch on or off.
- Press line select key 3R to cycle to the frequency spacing:
- 8.33: frequency has three decimal places.
- 25: frequency has two decimal places.
- Press line select key 6L to go to COM MEMORY page 1/2.

COM MEMORY PAGE 1/2:

- On the COM MEMORY page is possible to capture a frequency tuned in memory or store a frequency/identification. To capture a frequency press the respective memory frequency to box it and press 1L to activate the frequency. To store a frequency or its identification use the alphanumeric keys and press the respective memory line select key. Additionally the frequency can also be stored pressing the receptive memory line select key and rotating the tuning knob.



RADIO PAGE 1/2

The VHF frequency selection through the CCD is as follows:

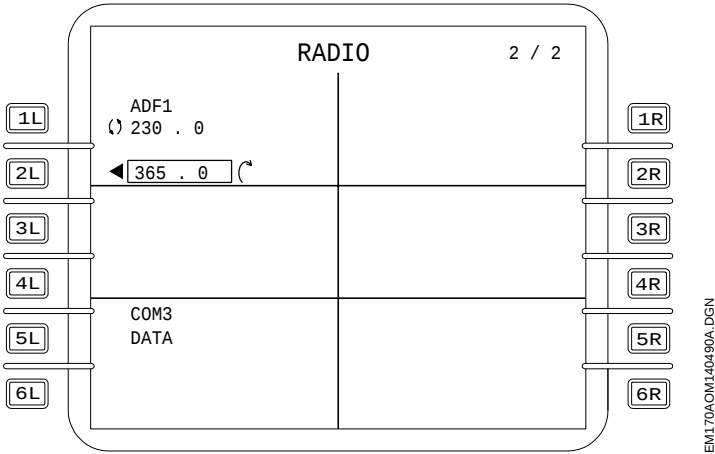
- Select the PFD through the CCD. The left and right format location buttons select respectively pilot's and copilot's PFDs.
- Tune the standby frequency through the tuning knob.

Activate the standby frequency by pressing the enter key.

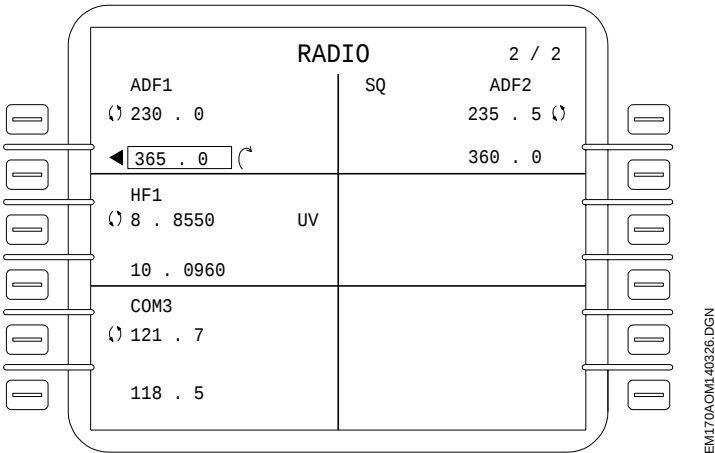
RADIO PAGE 2/2:

- To bring up the RADIO PAGE 2/2, with the radio PAGE 1/2 displayed, press NEXT button.

- On RADIO page 2/2 is possible to tune and activate the VHF 3 frequencies for voice mode. Press line select key 6L twice to go to COM 3 page 1/1, and then press line select key 2R to cycle the operational mode (data or voice). It is possible to tune a radio frequency in the same manner as VHF 1 and 2.
- The frequencies to data transmission are selected in a specific ACARS page. With data mode selected, the indication ‘DATA’ displays, otherwise VHF 3 active and stand by frequencies display.



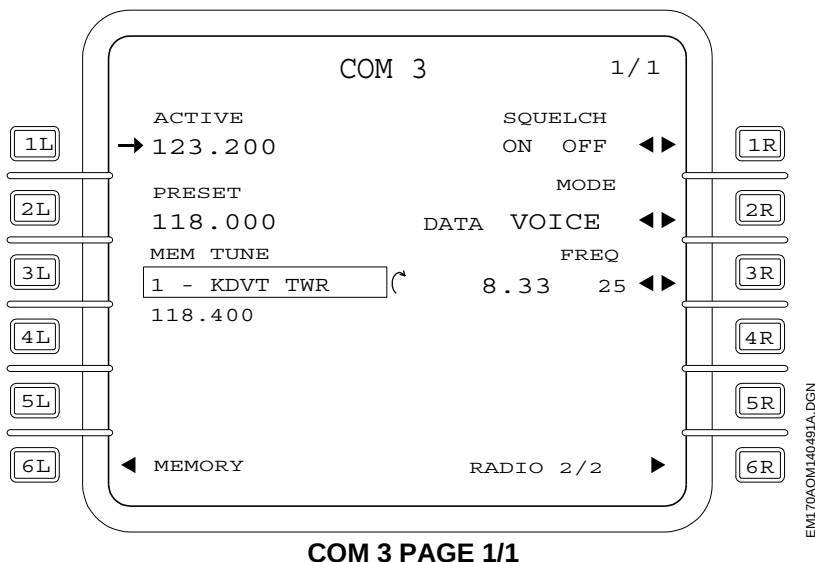
RADIO PAGE 2/2 (DATA MODE)



RADIO PAGE 2/2 (VOICE MODE)

COM 3 PAGE 1/1:

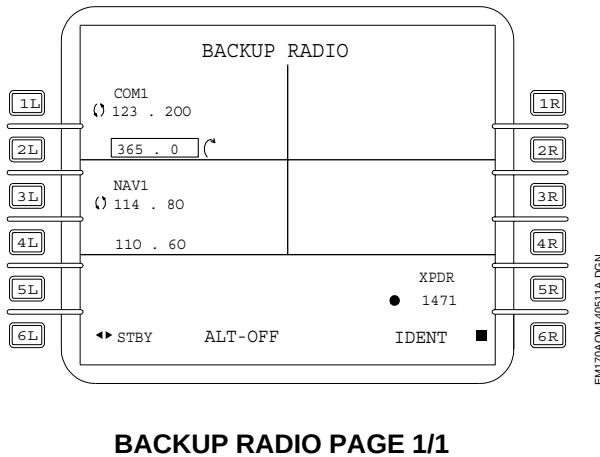
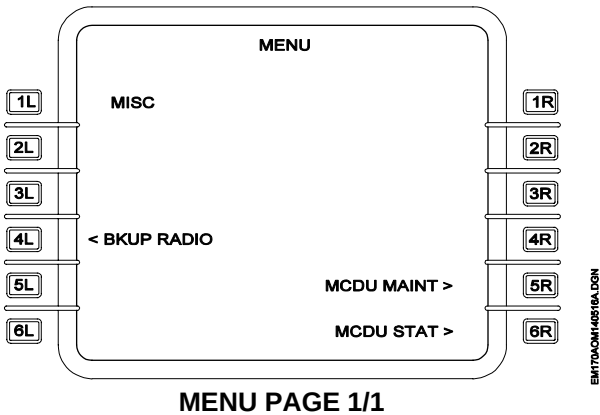
- The COM 3 page provides the same options as COM 1 (2) pages, except that is possible to select the transmission mode for VHF 3. The transmission mode is selected pressing line select key 2R to cycle the operational mode (data or voice).

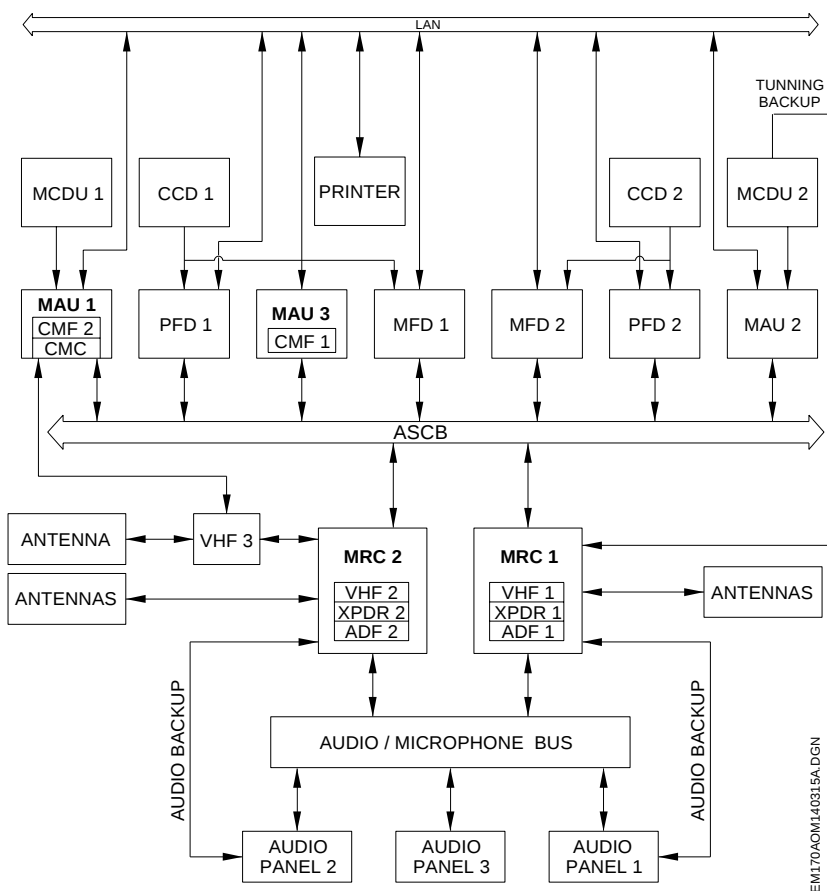




BACKUP RADIO PAGE:

- The BACKUP RADIO page provides means for tuning COM 1, VHF NAV 1 and XPDR 1 (ALT OFF mode) in case of loss of primary and secondary tuning means (tuning using MCDU and CCD)communication between MCDU and Modular Radio Cabinet. In such cases, radio access is done via a backup connection available on MCDU 2.
- The BACKUP RADIO page is available pressing MENU function button on the MCDU and then line select key 4L on Menu page. The BACKUP RADIO RADIOpage displays automatically on MCDU 2 for some failure conditions.





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NAVIGATION AND COMMUNICATION SCHEMATIC

SELECTIVE CALLING

Selective Calling (SELCAL) monitors selected frequencies on the VHF and HF radios in case of the ground station is desiring to communicate with the flight crew. Each airplane is assigned of a unique four-letter SELCAL code.

INTERPHONE SYSTEM

The interphone system provides intercommunication between the flight crew, flight attendants and ramp personnel.

The flight attendants communicate between flight attendant stations or with the flight crew using any of the attendant handsets.

Communication between flight crew and flight attendants may be done through the ACP.

Call chimes are annunciated at the beginning of the call from the cockpit to the flight attendants and vice-versa.

PASSENGER ADDRESS (PA)

The PA system allows flight crew in the cockpit and flight attendants to make announcements to the passengers. Announcements are heard through speakers located in the cabin and in the lavatories.

The pilots can make announcements using hand, headset boom or oxygen mask microphones. The flight attendants can make use of PA handset located at their stations.

Pre-recorded announcements may be provided as well as recorded music for passenger entertainment.

PA system use is prioritized. Cockpit announcements have first priority and override all others. Flight attendant announcements override the pre-recorded announcements and this one overrides the music system.

ATTENDANT CALL

The call system is used as a mean for crewmembers to gain the attention of other crewmembers and to indicate that interphone communication is desired.

Attention is gained through the use of lights and aural signals (chimes or horn). The cockpit may be called from either flight attendant station or by the ground personnel. The ground personnel may only be called from the cockpit. Flight attendants may be called from the cockpit through interphone buttons on the ACPs or flight attendant call button on the overhead panel, the other attendant station, or from any passenger seat (PSU) or lavatory. Call lights in the passenger cabin identify the source of incoming calls to the attendants.

Call system chime signals low, high or high/low tones are audible in the passenger cabin through the PA system speakers. The PA speakers also provide an alerting chime signal whenever the NO SMOKING, FASTEN SEAT BELT or RETURN TO SEAT (in the lavatory) signs and STERILE COCKPIT light illuminate or extinguish.

The attendant call lights located on the forward and aft main ceiling panel areas provide a visual indication to attendant when there is a call from the flight crew or passengers.

ATTENDENT CALL TABLE

Calling originator	Called position	Visual signal at called position	Aural signal at called position
Cockpit	Attendant Station	Green light	Single high/low tone chime
		Red light	Triple high/low tone chime
		Amber sterile cockpit light	Single high tone chime
	Passenger cabin, lavatories and galleys	No smoking or fasten belt signs illuminate/ extinguish	Single low tone chime
Cockpit (lateral console)	Ramp station	–	Horn in the nose wheel well
Cockpit (Overhead Panel)	Attendant station	–	Single high/low tone chime
Attendant station	Cockpit	CAB or EMER annunciator button flashes on the ACP	Single or triple high/low tone chime for CAB or EMER, respectively
	Attendant station	–	Single high/low tone chime
Ramp station	Cockpit	RAMP annunciator button flashes on the ACP	Single high/low tone chime
Lavatory	Attendant station	Orange light	Single high tone chime
Passenger PSU	Attendant station	Blue	Single high tone chime

AUDIO CONTROL PANEL

There are three Audio Control Panels (ACP), located at the control pedestal and observer station. Each panel controls an independent crew station audio system and allows the flight crew to select the desired radios, navigation aids, interphones and PA systems for monitoring and transmission.

The audio panel receives inputs from all audio communication channels and aural warnings. Audio warning for altitude alert, ground proximity warning system (GPWS), traffic collision avoidance system (TCAS), and windshear among others, are also heard through the speakers and headsets. These warnings cannot be controlled or turned off by the flight crew. Audio from each ACP is monitored using a headset, headphone or the related speaker, except for the observer speaker.

DIGITAL VOICE DATA RECORDER SYSTEM (DVDR)

The digital voice data recorder system (DVDR) combines a flight data recorder (FDR) and a cockpit voice recorder (CVR) in a single unit. Two DVDR units are installed. DVDR 1 is installed in the forward electronic bay, and the DVDR 2 in the aft electronic bay. Each unit is capable of receiving, recording and preserving all required data parameters and voice recording from the cockpit crew and area microphones.

The DVDR unit is capable of recording the last 120 minutes of audio information from cockpit area microphone and primary crew microphones, 25 hours of flight data, 120 minutes of digital communication messages and GMT as well.

There is DVDR's FDR data available for maintenance purposes only through the MCDU.

COMMUNICATION MANAGEMENT FUNCTION

The Communication Management Function (CMF) provides the following:

- Character-oriented communication through ACARS network.
- Communication between different airplane devices.

CMF is a dual mode active/standby system. CMF 1 resides in MAU 3 and is powered by DC bus 2. CMF 2 resides in MAU 1 and is powered by DC bus 1.

CMF has the following interfaces:

- ACARS network.
- MCDUs are the primary flight crew interface with CMF providing display and control for the CMF. CMF becomes available pressing MCDU DLK button.
- Printer receives ACARS exchanged messages via CMF.
- CMC receives fault/events reports from the CMF. CMC also provides communication between the CMF and Printer device.
- PFD displays a “MSG” flag when uplink messages are received from ground.
- EICAS alerts crew members of CMF faults.
- AWS alerts crewmembers of new ATS (Air Traffic Services) uplink messages.

ACARS

ACARS is a data link system that allows character-oriented messages to be exchanged between ground stations and the airplane. Messages are divided into two groups:

- Addressed to or by crewmembers: data link requests or free text reports;
- Automatically sent: reports of flight data, performance data and routine events.

Communication to ground stations is made through VDR 3 channel. MCDU provides interface with ACARS applications to crewmembers.

ACARS applications are:

AIR TRAFFIC SERVICE APPLICATIONS

- Application of ATIS (Air Traffic Information Service) reports enables the flight crew to send a downlink message requesting an uplink report that may be specific airport information or en-route information.
- Departure Clearance Application is used to request a departure clearance through character-oriented messages instead of voice communication.
- Expected Taxi Clearance is used to request a taxi clearance through character-oriented messages instead of voice communication.
- Flight System Message Application is used to display automatic uplink messages that provide additional information on an Oceanic or Departure Clearance.
- Oceanic Clearance Application makes the oceanic clearance request through character-oriented messages instead of voice communication.
- Pushback Clearance is used to request a pushback clearance through character-oriented messages instead of voice communication.

TWIP (Terminal Weather Information for Pilots) provides meteorological information to the flight crew.

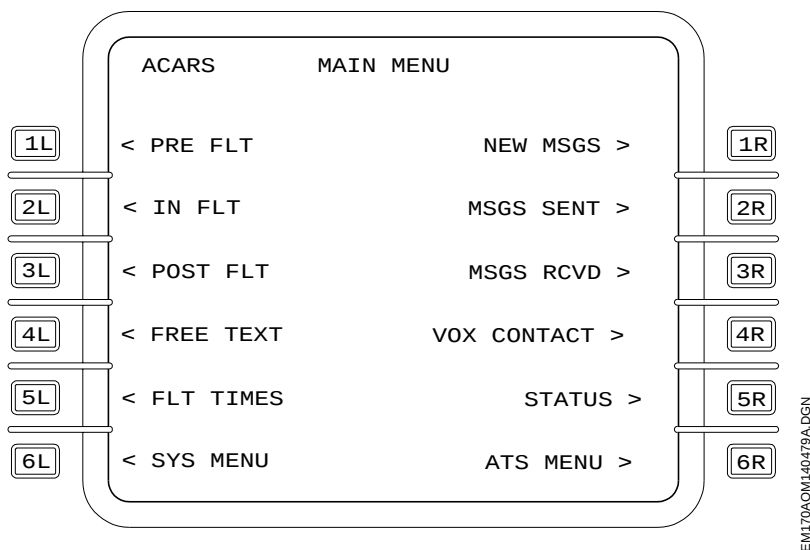
AIRLINE OPERATIONAL COMMUNICATIONS APPLICATIONS (AOC)

The airline may customize AOC applications supported by CMF using a ground-based tool. Examples of AOC applications are:

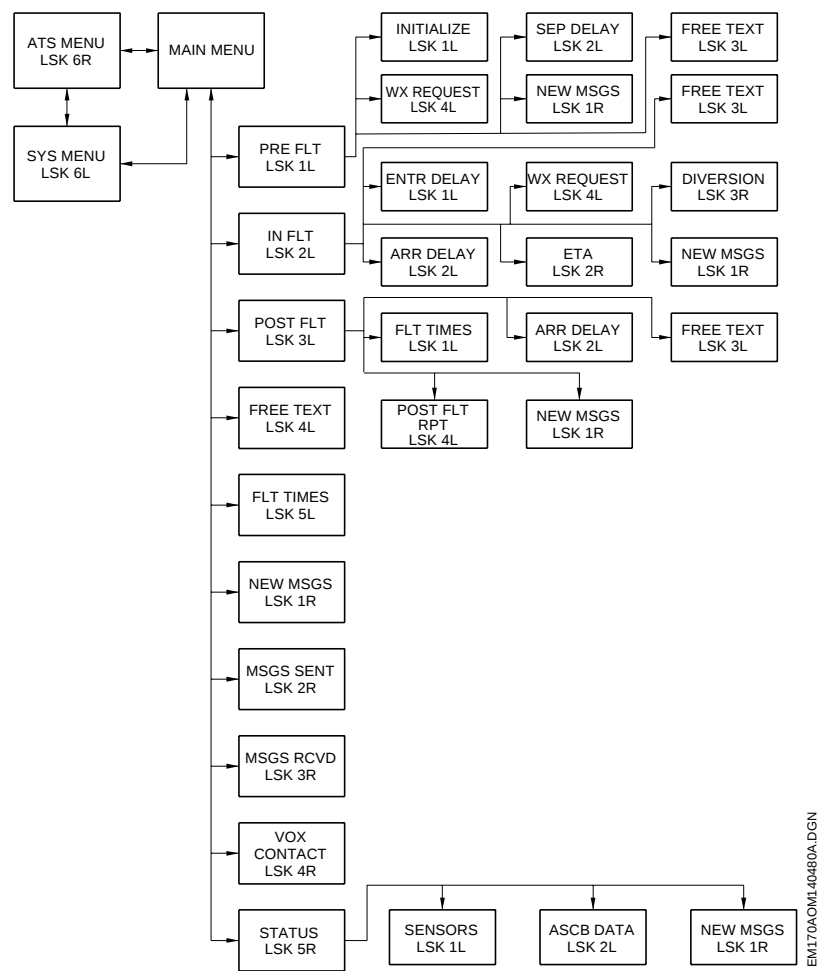
- Flight Initialization.
- Free Text.
- Weather Request.
- Out, Off, On and In events (OOOI events) are automatic reports sent to the airline operations control. Both reports and trigger events are configurable by the airline. Examples are:
 - Out events – doors closed, brakes released, etc.
 - On events – landing.
 - Off events – take off.
 - In events – gate arrivals.

ACARS WINDOW PAGES

Pushing the DLK button brings up CMF MAIN MENU page. Further access to other pages is provided through the LSK on MCDU. Although the AOC pages may be configured by the airline, the scheme below shows a basic AOC with most common functions required by airlines.



ACARS MAIN MENU



ACARS NAVIGATION WINDOWS

PRINTER

The airplane is equipped with a full-format thermal line printer device installed in the cockpit on control pedestal. DC BUS 1 powers the printer whereas a CB located in the cockpit Circuit Breaker Panel furnishes electrical protection.

The flight crew accesses printer via MCDU by CMF during all flight phases. On ground, maintenance personnel accesses printer via MFD 2 to print maintenance reports. CMF and CMC communicate with the printer via the LAN BUS.

The printer provides a self test which, in case of failure, illuminates the printer fault indicator in conjunction with printer test indicator. The Fault light also illuminates when printer door is open or paper out is sensed.



EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	NAVCOM 1 (2) FAIL	All functions hosted in associated MRC are unavailable.
	NAVCOM 1 (2) OVHT	MRC NIM has suffered an over temperature condition.
	VALIDATE CONFIG	Top level system part number was updated.
	VHF 1 (2) (3) OVHT	VHF COM has suffered an over temperature condition.
	VHF 3 FAIL	Radio 3 COM function has failed.
ADVISORY	CMC FAIL	CMC has failed
	CMF 1 (2) FAIL	The respective CMF has failed.
	CVR AFT (FWD) FAIL	Respective DVDR CVR function has failed.
	FDR AFT (FWD) FAIL	Respective DVDR FDR function has failed.
STATUS	PRINTER FAULT	Printer functionality is degraded

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ATA CHAPTER 24

ELECTRICAL POWER

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INTRODUCTION

The Electrical System generates and distributes both AC and DC power to airplane systems.

The AC system is composed of:

- Two integrated drive generators (IDGs).
- One auxiliary power unit (APU) generator.
- One inverter.
- One ram air turbine (RAT).
- One AC external power unit.

The DC system is composed of:

- Two NiCd batteries.
- Three transformer rectifier units (TRUs).
- One DC external power input.

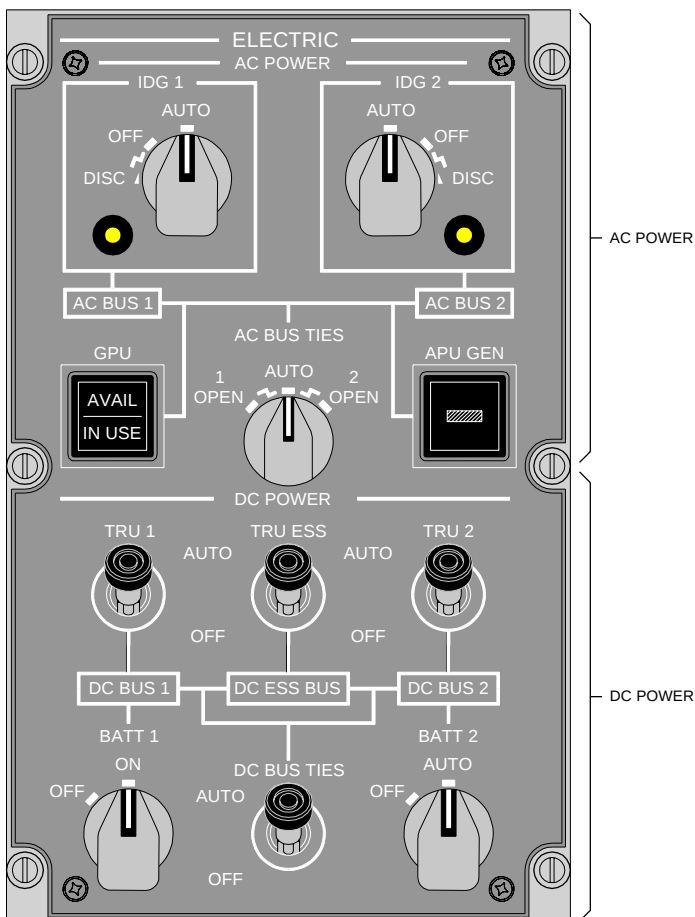
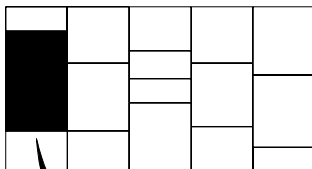
Normal operation of the electrical system is automatic.

Two independent networks provide complete segregation for electrical fault isolation purposes. In the event of a power-generating source failure, bus ties automatically connect between the networks with no significant operational degradation nor additional workload.

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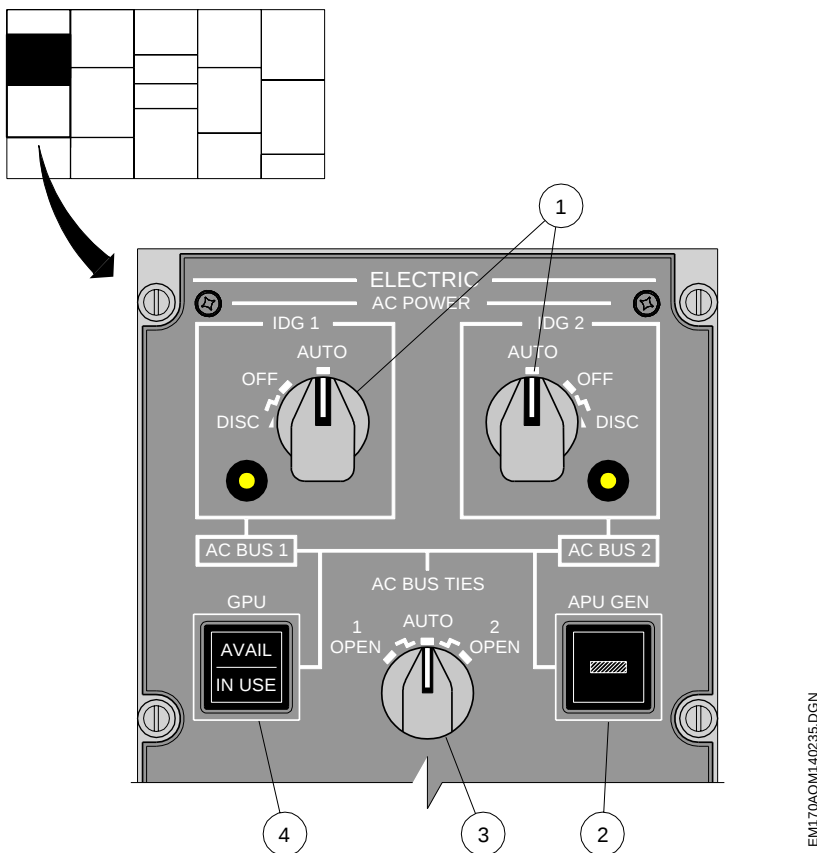
CONTROLS AND INDICATIONS

ELECTRICAL AC/DC POWER



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ELECTRICAL AC POWER



1 – IDG 1 AND IDG 2 SELECTOR KNOB

- AUTO:** allows automatic operation of the electrical system. This position closes the IDG contactor, connecting the IDG to the respective AC BUS.
- OFF:** opens the IDG contactor isolating the IDG from the respective AC BUS.
- DISC:** must be held in this position for one second to mechanically disconnect the IDG.

NOTE: An amber led, associated with the EICAS message IDG 1 (2) OIL illuminates, indicating to the pilot which IDG must be disconnected. The led will be off after IDG disconnection.

2 – APU GENERATOR BUTTON

PUSH IN: allows automatic operation of the electrical system. This position connects the APU generator to the AC BUS TIE, according to the source priority.

PUSH OUT: opens the APU generator contactor and isolates the APU generator from the AC BUS TIE. The APU generator is tripped off line and de-excited.

3 – AC BUS TIES SELECTOR KNOB

1 OPEN: opens the Bus Tie Contactor (BTC) 1, segregating AC BUS 1 from AC BUS 2.

AUTO: allows automatic operation of the electrical system. This position controls the operation of the BTCs, according to system operational logic.

2 OPEN: opens the Bus Tie Contactor (BTC) 2, segregating AC BUS 2 from AC BUS 1.

4 – GROUND POWER UNIT (GPU) BUTTON

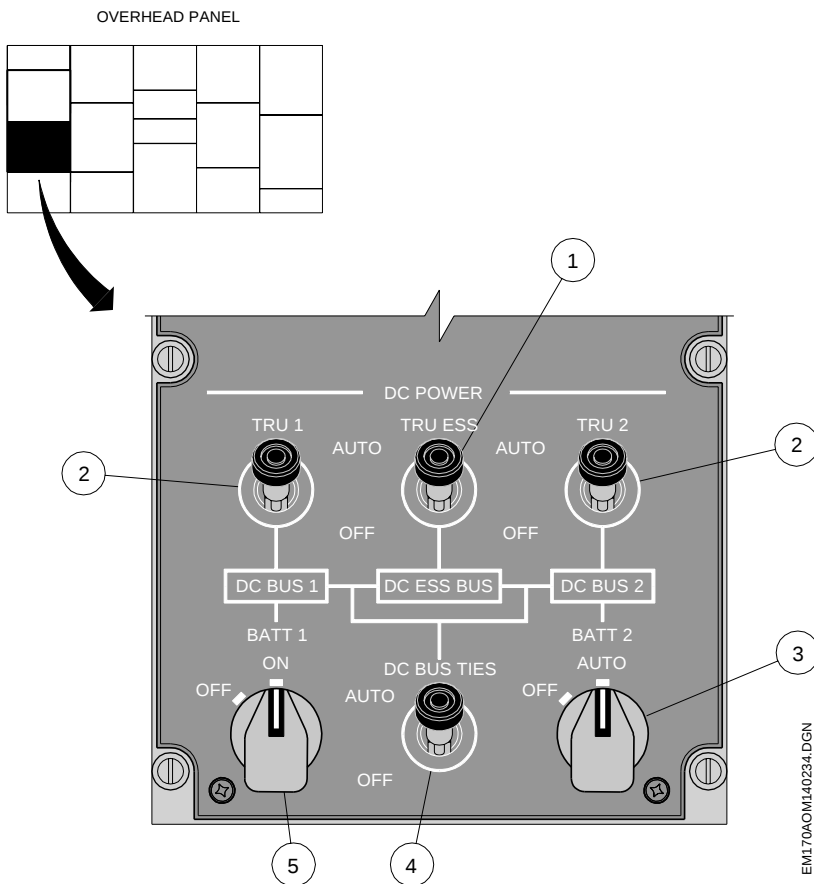
PUSH IN: connects the AC GPU to the AC BUS TIE, according to the source priority.

PUSH OUT: isolates the AC GPU from the AC BUS TIE.

NOTE: - An AVAIL light illuminates on the button when the AC GPU is properly connected to the airplane and AC power quality requirements (voltage/amperage/frequency) are satisfied.

- When pushed in, an IN USE light illuminates on the button.

ELECTRICAL DC POWER



1 – TRU ESS TOGGLE SWITCH

- AUTO:** allows automatic operation of the electrical system. This position connects the TRU ESS to the ESS BUS 3.
- OFF:** isolates the TRU ESS from the ESS BUS 3.

2 – TRU 1 AND TRU 2 TOGGLE SWITCH

- AUTO:** allows automatic operation of the electrical system. This position connects the TRU to the respective DC BUS.
- OFF:** isolates the TRU from the respective DC BUS.

3 – BATTERY 2 SELECTOR KNOB

- AUTO:** allows automatic operation of the electrical system. This position connects battery # 2 to the DC ESS BUS 2.
- OFF:** the battery supply power to the HOT BATT BUS 2.

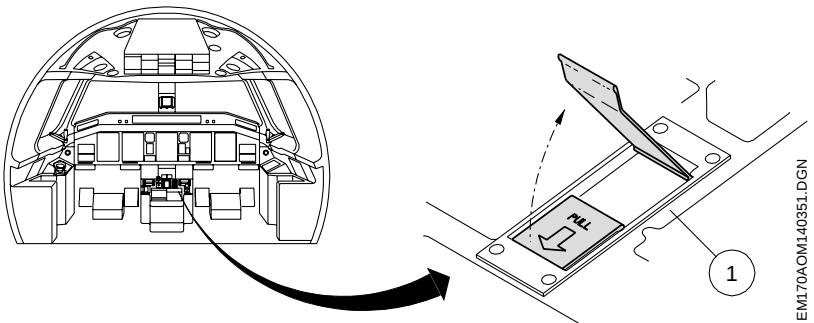
4 – DC BUS TIE TOGGLE SWITCH

- AUTO:** allows automatic operation of the electrical system. This position controls the operation of the DC Tie Contactors (ETCs/DCTC), according to system operational logic.
- OFF:** opens all tie contactors.

5 – BATTERY 1 SELECTOR KNOB

- ON:** the battery is connected to the DC ESS BUS 1.
- OFF:** the battery supplies power to the HOT BATT BUS 1.

RAM AIR TURBINE DEPLOYMENT HANDLE

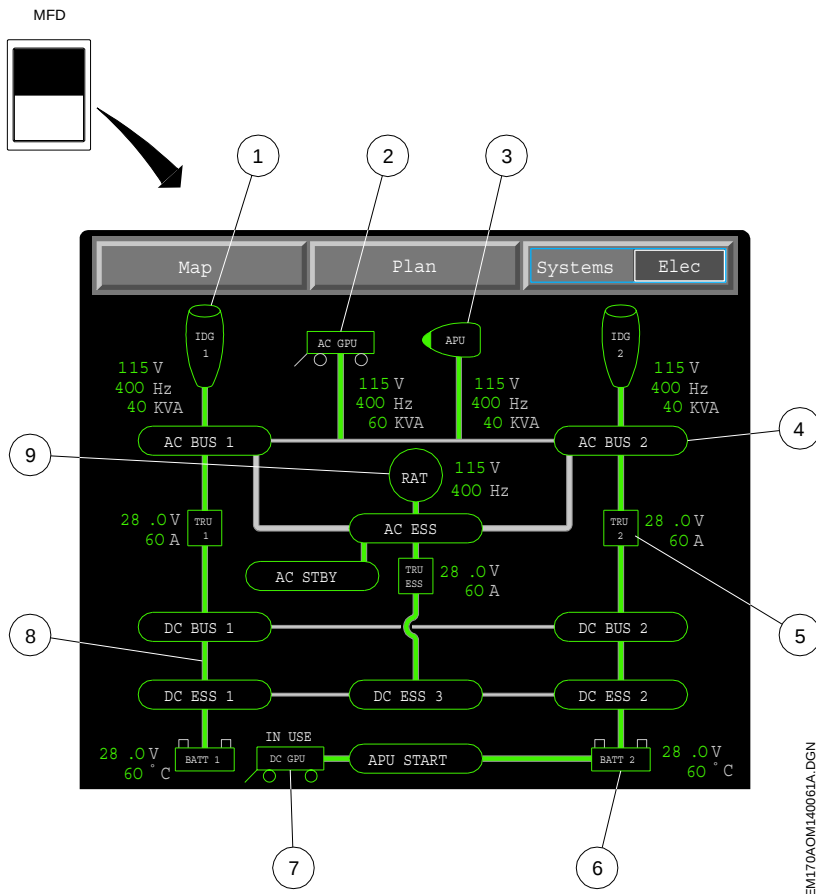


1 – RAM AIR TURBINE DEPLOYMENT HANDLE

- Manually deploys the Ram Air Turbine.

ELECTRICAL SYNOPTIC PAGE ON MFD

The electrical synoptic page provides a visual representation of the electrical system operation and parameters, and can be selected for viewing by the flight crew on either MFD.



1 – IDG (INTEGRATED DRIVE GENERATOR)

- The IDG icon and its outputs (voltage/frequency/amperage) are always displayed, even when readings are zero. If an output is invalid or out of range, the digits are replaced by three amber dashes.
- IDG icon:
 - GREEN: IDG available and the IDG selector knob in AUTO position.
 - WHITE: IDG available and the IDG selector knob in OFF position, or the engine is not running.
 - AMBER DASHED: invalid information.
- IDG parameters (voltage, frequency and amperage):
 - GREEN: for valid information.
 - AMBER DASHED: for invalid information or a value out of the valid range.

2 – AC EXTERNAL POWER (AC GPU)

- The AC GPU icon and its outputs (voltage/frequency/amperage) are displayed only when the AC GPU is connected and available. If any output is invalid or out of range, the digits are replaced by three amber dashes.
- AC GPU icon:
 - GREEN: AC GPU connected and the GPU button is pushed in.
 - WHITE: AC GPU connected and the GPU button is pushed out.
 - AMBER DASHED: invalid information.
- AC GPU parameters:
 - GREEN: AC GPU is available and the information is valid.
 - AMBER DASHED: invalid information.

3 – APU

- The APU icon and its outputs (voltage/frequency/amperage) are not displayed until the APU is available (3 seconds after 95% rpm). If any output is invalid or out of range, the digits are replaced by three amber dashes.
 - APU icon:
 - GREEN: APU available and the APU GEN button pushed in.
 - WHITE: APU available and the APU GEN button pushed out.
 - AMBER DASHED: invalid information.
- NOTE:** Whenever the EICAS CAUTION message APU FAIL is displayed, the APU icon will be white beneath an amber cross.
- APU parameters (voltage/frequency/amperage):
 - GREEN: for valid information.
 - AMBER DASHED: for invalid information or a value out of the valid range.

3 – APU

- The APU icon and its outputs (voltage/frequency/amperage) are not displayed until the APU is available (3 seconds after 95% rpm). If any output is invalid or out of range, the digits are replaced by three amber dashes.
- APU icon:
 - GREEN: APU available and the APU GEN button pushed in.
 - WHITE: APU available and the APU GEN button pushed out.
 - AMBER DASHED: invalid information.

NOTE: Whenever the EICAS CAUTION message APU FAIL is displayed, the APU icon will be white beneath an amber cross.

- APU parameters (voltage/frequency/amperage):
 - GREEN: for valid information.
 - AMBER DASHED: for invalid information or a value out of the valid range.

4 – ELECTRICAL BUSES

- The electrical bus icons are always displayed.
- BUS icons:
 - GREEN: energized bus.
 - WHITE: de-energized bus.
 - AMBER DASHED: invalid information.

5 – TRU (TRANSFORMER RECTIFIER UNIT)

- The TRU icon and its outputs (voltage/ampereage) are always displayed.
- TRU icon:
 - GREEN: TRU available, and the associated toggle switch is in AUTO position.
 - WHITE: TRU available, and the associated toggle switch is in OFF position.

AMBER DASHED: invalid information.

NOTE: Whenever the EICAS CAUTION message TRU 1 (2) FAIL is displayed, the TRU icon will be white beneath an amber cross.

- TRU parameters (voltage/ampereage):

GREEN: for valid information.

AMBER DASHED: for invalid information or a value out of the valid range.

6 – BATTERIES

- Battery icons and their outputs (voltage/temperature) are always displayed.
- BATTERY icons:
 - GREEN: voltages are greater than 18 Volts.
 - WHITE: voltages are less than 18 Volts.

AMBER DASHED: invalid information or a value out of the valid range.

- BATTERY parameters (voltage/temperature):

GREEN: for valid information.

AMBER DASHED: for invalid information.

NOTE: Whenever a battery temperature reaches 70°C for 2 seconds, the associated digits will become red and the EICAS WARNING message BATT 1 (2) OVERTEMP is displayed. 18 Volts is the minimum voltage for EICAS display on MFD.

STATUS PAGE ON MFD

Batteries voltage is displayed on the synoptic status page. It can be selected by flight crew on either MFDs.

MFD



1



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1 – BATTERIES VOLTAGE INDICATION

- Displays batteries 1 and 2 voltage.
GREEN: valid battery voltage.
AMBER DASHED: invalid information.

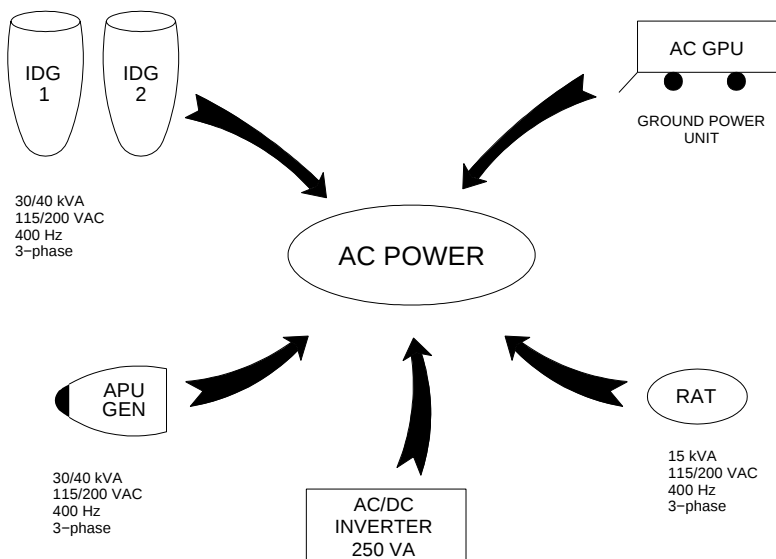
AC ELECTRICAL POWER DESCRIPTION

AC electrical power is the main source for airplane systems and comprises:

- Two integrated drive generators (IDGs).
- An auxiliary power unit (APU) generator.
- A ram air turbine (RAT).
- An inverter.

Both IDGs and the APU generator are rated at 40 KVA, 115 VAC, 400 HZ, three-phase.

On ground, the APU AC generator or AC ground power unit (AC GPU) can supply power to all AC BUSES. The APU generator may also be used in flight, as a replacement to an IDG, according to the APU operational envelope. In flight, the RAT is used as an emergency generator, supplying power to the ESS BUSES when both AC BUSES 1 and 2 are not powered.



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COMPONENTS AND OPERATION

INTEGRATED DRIVE GENERATOR (IDG)

Each engine has an IDG monitored and controlled by a dedicated generator control unit (GCU). When an engine starts, the IDG will automatically come on line, powering the respective AC BUS. The previous power source is disconnected from that AC BUS.

For automatic operation of the electrical system, the IDG selector knob must be set to the AUTO position. Moving the selector knob to OFF position, the generator line contactor opens, tripping off-line and de-exciting the selected IDG.

Manual disconnection is achieved by selecting the respective knob to the DISC position. The flight crew cannot reconnect the IDG.

APU GENERATOR

Before starting engine, when the APU becomes available, the APU generator automatically connects to the AC BUS TIES, disconnecting the AC GPU.

During the APU starting cycle, BATT 2 is isolated from the network, powering the APU START BUS exclusively. In flight, the APU can be started up within operational limits, and it replaces any IDG sources with no operational degradation.

AC EXTERNAL POWER SOURCE (AC GPU)

The AC GPU button, located on the electrical system panel, controls the AC external power. Once the AC GPU is connected to the airplane and power quality requirements (voltage/ampereage/frequency) are within accepted limits, an AVAIL light illuminates on the GPU button. The AC GPU has priority over the batteries to power the electrical system.

Pushing the AC GPU button in connects external power to the AC BUS TIE, according to AC source priority. The AVAIL light extinguishes and an IN USE light illuminates.

When the APU is started, the system operational logic automatically isolates the GPU from the AC BUS TIE. In this case, the IN USE light extinguishes and an AVAIL light illuminates on the GPU button.

NOTE: Before disconnecting the AC GPU from the airplane, the flight crew must push out the AC GPU pushbutton, even if the IN USE light has already extinguished. The AC GPU pushbutton has to be pushed out for the next connection.

Ground staff can connect the GPU directly to the AC/DC GND SVC BUSES, for ground maintenance and flight preparation, by pushing the respective button located on the front ramp panel or on the flight attendant panel at the forward right galley.

INVERTER

The AC/DC inverter converts 28 Volts DC power from batteries to 115 Volts AC power to supply the STANDBY AC BUS when an AC power source is not available.

RAM AIR TURBINE (RAT)

The RAT is an AC electrical device installed in the airplane nose section, which converts the kinetic energy of airflow across the turbine into AC power. The electrical power produced is rated at 15 KVA, 115 Volts, 400 Hz, three-phase.

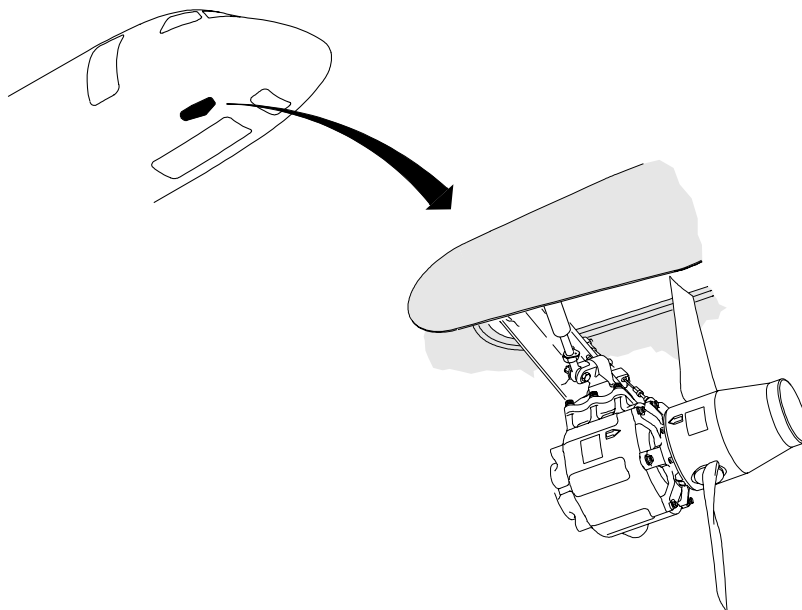
Whenever AC power sources are not powering AC buses, the RAT is automatically deployed, and after 8 seconds, supplies power to the AC ESS BUS. DC ESS BUSES are powered through the ESS TRU. To avoid total loss of power during this 8-second period, batteries are used as backup to power the DC ESS BUSES and the STANDBY AC BUS.

The RAT electrical power drives the AC Motor-driven Pump (ACMP 3A) for primary flight control tasks. These include high lift system actuation and power for essential avionics, communication and battery recharging.

In flight, there is no altitude restriction for RAT deployment.

130 knots is required to ensure the RAT continues supplying AC/DC ESS BUSES. At speeds below this, the RAT may only supply the AC ESS BUS, and the batteries will automatically provide electrical power to the DC ESS BUSES and the STANDBY AC BUS through an AC/DC inverter. As airspeed decreases, load shedding occurs and the AC ESS BUS is no longer powered.

In case of automatic RAT deployment failure, a deployment handle is provided to manually deploy the RAT.



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RAM AIR TURBINE

DC ELECTRICAL POWER DESCRIPTION

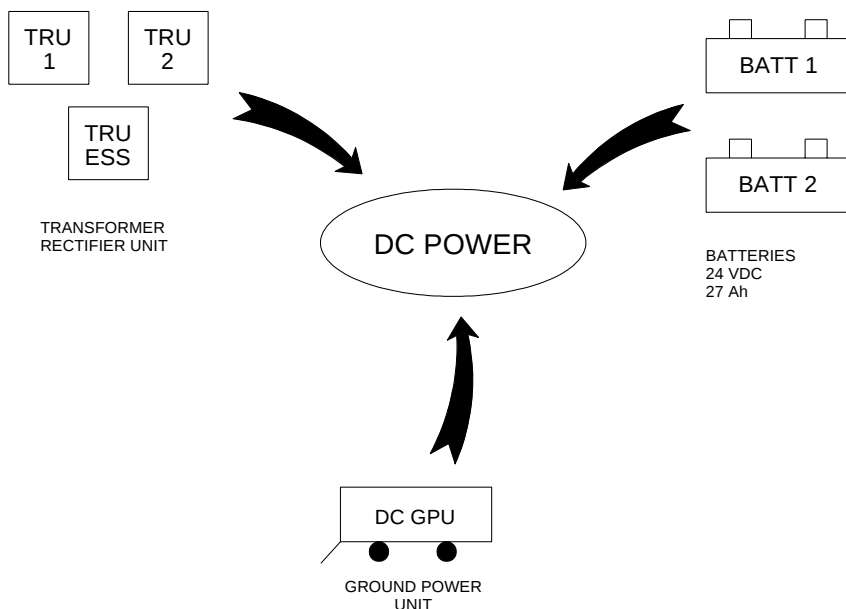
The DC electrical system comprises:

- Three transformer rectifier units (TRUs);
- Two batteries.

On ground, a DC ground power unit (DC GPU) can be connected to the airplane supplying power to only the APU START BUS.

The TRUs, rated at 300 A, are used as a primary source of the DC electrical system, converting AC power from the AC BUSES into DC power.

In certain conditions, batteries #1 and #2 are used to backup all DC ESS BUSES and the AC STBY BUS. Battery #2 also supplies the APU START BUS, during APU starting.



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COMPONENTS AND OPERATION

TRANSFORMER RECTIFIER UNIT (TRU)

Three TRUs convert 115 VAC power into 28 VDC. Each TRU works in isolation. If one of them fails, the BUSES will be powered by the remaining TRUs, since the DC BUS TIES toggle switch is selected to AUTO.

TRU 1 provides DC power to DC BUS 1, DC ESS BUS 1, DC GND SVC BUS, HOT BATT BUS 1 and battery #1 charging.

TRU 2 provides DC power to DC BUS 2, DC ESS BUS 2, HOT BATT BUS 2 and battery #2 charging.

TRU ESS provides DC power to DC ESS BUS 3.

BATTERIES

Two NiCd 24 VDC, 27A batteries power up the airplane and are also used as a backup for the DC essential electrical system.

The batteries are constantly charged by any AC source through the TRUs, including the GPU and the RAT.

In an ELECTRICAL EMERGENCY, batteries supply essential loads for 10 minutes, while the RAT is not fully deployed and also if RAT stall speed is reached.

The minimum battery #2 temperature for APU starting is -20°C .

DC EXTERNAL POWER SOURCE (DC GPU)

When DC GPU is connected during the APU starting cycle, the DC external power source, and not battery #2, provides 28 VDC power to the APU START BUS.

The DC GPU is used when the battery is no longer available or the battery #2 temperature is below -20°C .

ELECTRICAL POWER DISTRIBUTION AND CONTROL

Four Integrated Control Centers (ICCs) and two Secondary Power Distribution Assemblies (SPDAs) provide distribution and control of the electrical power, and interface with other systems.

INTEGRATED CONTROL CENTER (ICC)

The ICC is an electrical-electronic integrated device, providing power distribution and protection for the airplane electrical loads, the secondary power distribution assemblies (SPDAs) and the circuit breakers that are located on the cockpit sidewall panels.

A total of four ICCs are implemented in the electrical system.

- Left Integrated Control Center (LICC).
- Right Integrated Control Center (RICC).
- Emergency Integrated Control Center (EICC).
- Auxiliary Integrated Control Center (AICC).

Each ICC, installed in the electronics bay, incorporates thermal circuit breakers (CBs), line replaceable units (LRUs), line replaceable modules (LRMs) and AC/DC electrical buses. The LRUs and LRMs allow quick access and easy replacement of electrical components, thereby minimizing any delays due to maintenance servicing.

AC/DC electrical buses are the primary source of electrical power distribution. These buses are located inside the respective ICCs:

LICC	RICC	EICC	AICC
AC BUS 1	AC BUS 2	AC ESS BUS	HOT BATT BUS 2
AC GND SVC BUS	DC BUS 2	STBY AC BUS	APU START BUS
DC GND SVC BUS	DC ESS BUS 2	DC ESS BUS 1	
DC BUS 1		DC ESS BUS 3	
		HOT BATT BUS 1	

SECONDARY POWER DISTRIBUTION ASSEMBLIES (SPDA)

An SPDA is an electrical load management unit, which receives power from the ICC AC/DC electrical buses and distributes it to the airplane systems, according to system distribution logic.

Two independent SPDAs replace thermal circuit breakers (CBs) and electromechanical relays used in other airplanes, thereby reducing the amount of electrical hardware as well as flight crew workload.

SPDAs also have the advantage of integrating protection, logic/control and power supply. Each SPDA has a specific number of slots, into which different electronic modules are plugged. Each module has an associated function such as providing communication, data processing and power distribution.

Communication modules use ARINC 429 to integrate SPDAs, ICCs and multi-function control units (MCDUs).

Four independent DC BUSES power the SPDAs providing redundancy and ensuring system segregation:

SPDA1

- DC BUS 1
- DC ESS BUS 1
- DC ESS BUS 2
- DC GND SVC

SPDA2

- DC BUS 2
- DC ESS BUS 1
- DC ESS BUS 2
- DC GND SVC

SPDA 1 is located at the forward electronics bay and SPDA 2 is located at the center electronics bay.

Each SPDA incorporates ELECTRONIC CBs (solid state power controllers - SSPC), which protect load distribution to the following systems.

- | | |
|-------------------------------|--------------------------------|
| • Air Management System (AMS) | • Oxygen |
| • Electrical | • Engine ignition and starting |
| • Fuel | • Water |
| • Hydraulic | • APU |
| • Anti-ice | • Fire protection |
| • Lighting | |

CIRCUIT BREAKERS (CB)

Circuit Breakers are classified as either thermal or electronic CBs. Some thermal CBs are located on the cockpit sidewall panels and others inside the ICCs in the electronics bays.

The electronic CBs are located inside the SPDAs, in the electronics bays.

All CBs situated in the electronics bays are considered remote CBs.

The flight crew can visually monitor all circuit breakers located inside the cockpit and, via MCDUs, the remote CBs in the electronics bays.

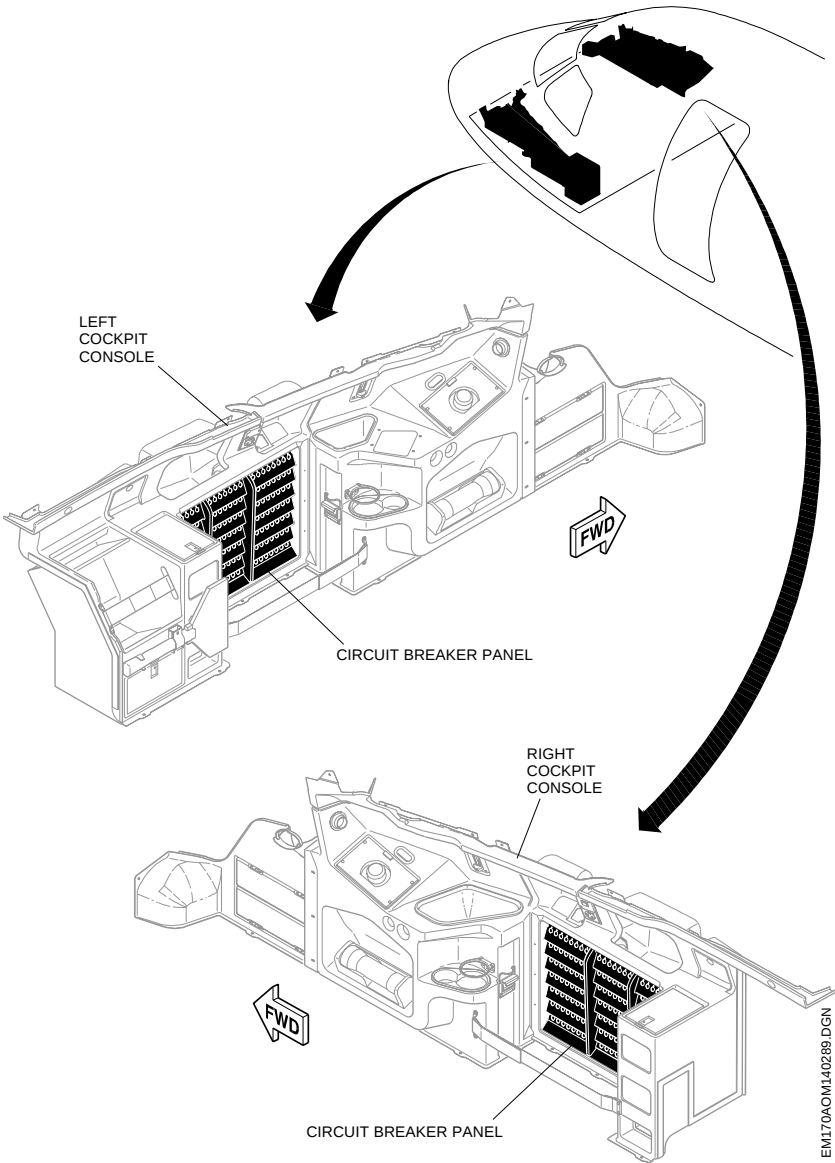
The ICC remote thermal CBs can only be reset by maintenance personal when the airplane is on ground.

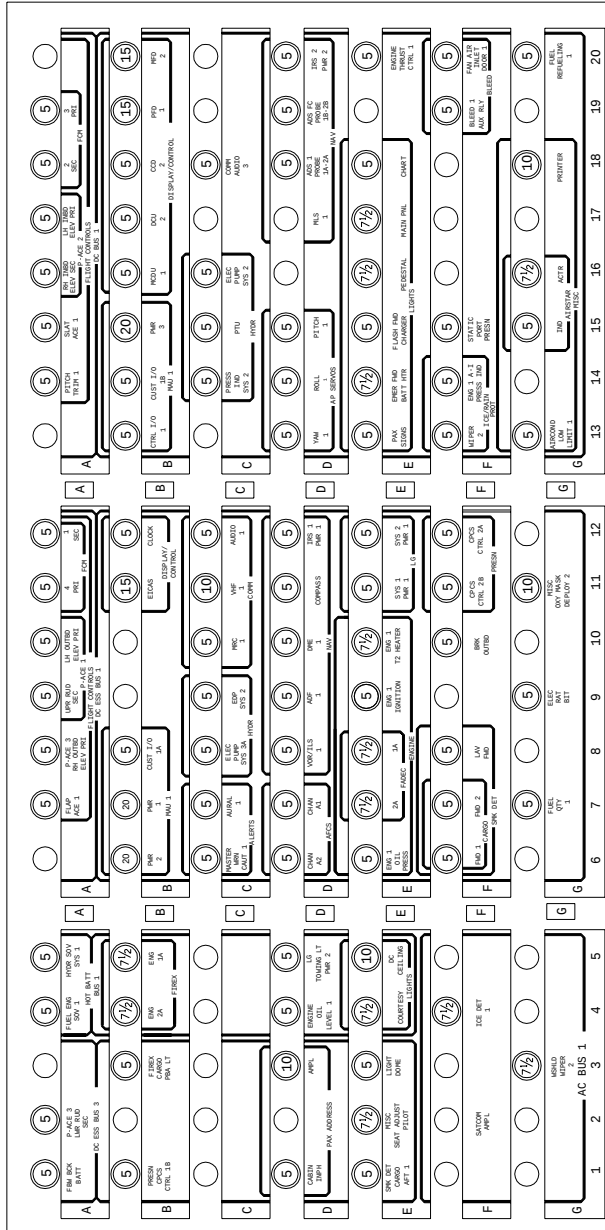
The flight crew can reset the SPDA remote electronic CBs via the MCDU.

Circuit breakers types and location		
TYPE LOCATION	THERMAL	ELECTRONIC
Remote	ICCs	SPDAs
Non remote	Cockpit	-----

CIRCUIT BREAKER PANEL

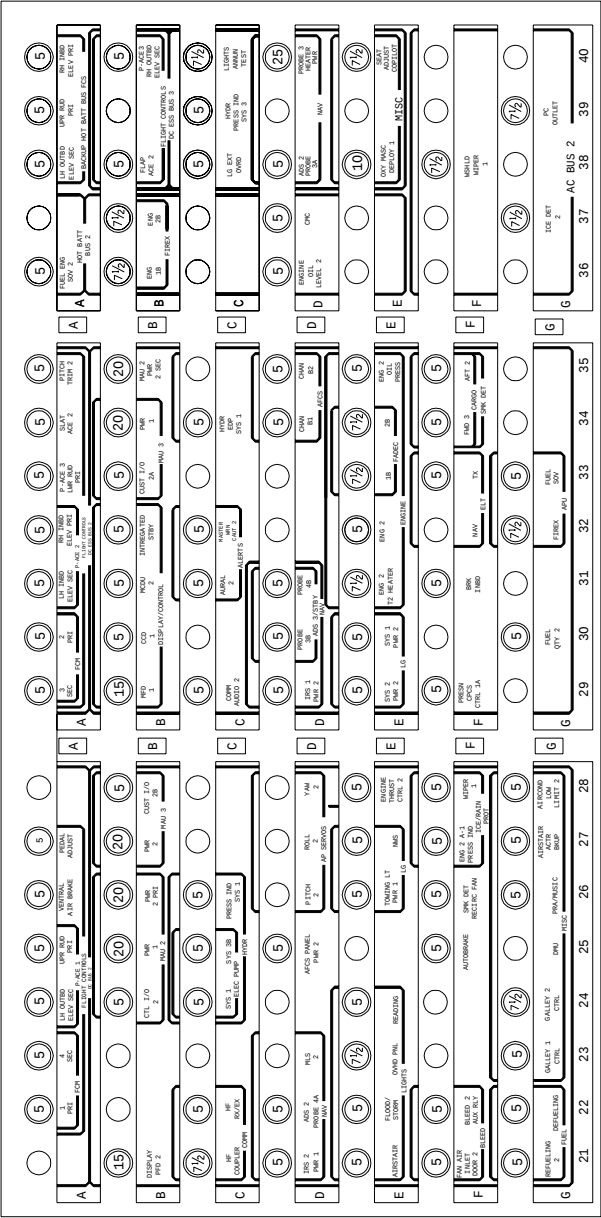
Columns and rows on the CB panel are identified through an alphanumeric naming convention.





EM170AOM140233.DGN

LEFT CB PANEL



EM170AOM140290.DGN

RIGHT CB PANEL

REMOTE CB'S

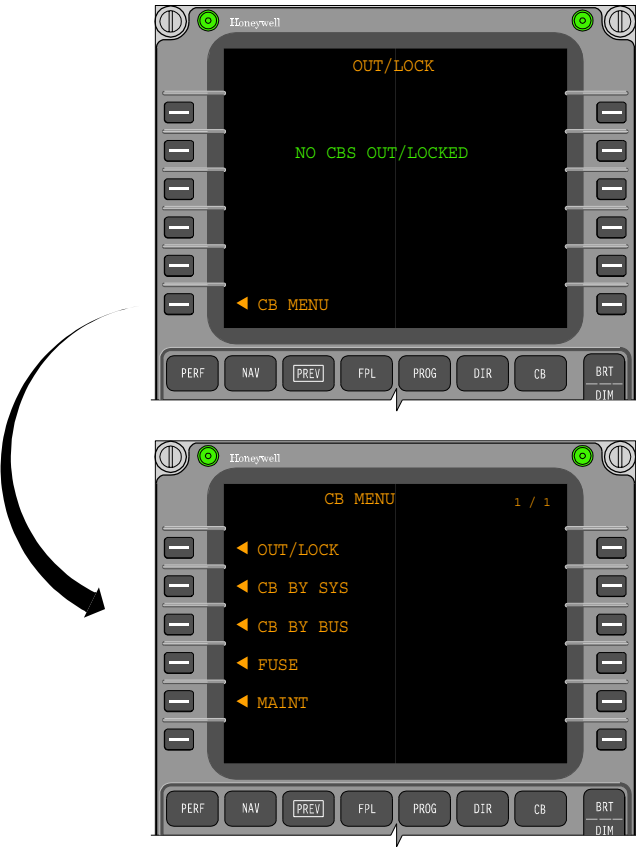
The flight crew can visually monitor remote circuit breakers located inside the electronics bays through the MCDU CB page by pressing the CB function key on the MCDU. Regardless of the page currently displayed on the MCDU, the page OUT/LOCK displays.

CB MENU status page is achieved when the line select key 6L is pressed. The following options are presented:

- OUT/LOCK (1L): displays all OUT or LOCKED CBs.
- CB BY SYS (2L): displays the status of CBs associated with the selected system.
- CB BY BUS (3L): displays the status of CBs associated with the selected BUS.
- FUSE (4L): displays fuse status.
- MAINT (5L): maintenance page.

The CB MENU page displays "NEW TRIP" on line select key 6R when a CB trip occurs. Pressing the key (6R) displays the tripped CB on the OUT/LOCK page.

NOTE: - CB menu status page is for CB status monitoring only. Report maintenance when a CB trip occurs.



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CB MENU PAGE ON MCDU

AC/DC BUS LOAD DISTRIBUTION

The following list identifies the electrical buses and the equipment powered by them. An asterisk (*) precedes optional equipments.

DC BUS 1

AFT ENTRANCE LIGHTS
 AFT FLASH LIGHTS CHARGER / AFT LAV LIGHTS
 * AIRSTAIR ACTUATOR
 COCKPIT CHART LIGHTS
 COCKPIT MAIN PANEL LIGHTING
 COCKPIT PEDESTAL LIGHTING
 COPILOT CURSOR CONTROL DEVICE
 COPILOT MFD
 CURSOR CONTROL DEVICE 2
 DIGITAL AUDIO CONTROL PANEL 3
 EMERGENCY LIGHTS POWER UNITS (ELPU)
 ENGINE 1 THRUST QUADRANT
 ENGINE 1 THRUST REV LEVER SW
 ENGINE 1 NACELLE ANTI-ICE VALVE
 FWD FLASH LIGHT CHARGER / WARDROBE LIGHT
 FWD LAVATORY LIGHTS
 FWD LAVATORY / RECIRCULATION
 FWD / MAIN ENTRANCE LIGHTS
 GALLEY AREA LIGHTS
 GALLEY G3 CONTROL
 GASPER VALVE
 GUIDANCE PANEL 2 (DISPLAY CONTROLLER 2)
 HS-ACE CHANNEL 1
 HYDR MOTOR PUMP 2B COMMAND
 LEFT IDLE LOCK SOLENOID
 LH FLT ATTN READING LT 1 COMMAND
 LH FLT ATTN READING LT 2 COMMAND
 LH FLT ATTN SEAT READING LT
 MAU 1 FCM 1 POWER B
 MAU 1 FCM 2 POWER B
 MAU 1 PWR SUPPLY 3
 MICRO IRU 2 (PWR 2)
 * MLS RECEIVER 1
 OXYGEN DEPLOY 1
 P-ACE #2-1 LEFT INBOARD ELEVATOR (P)
 P-ACE #2-2 RIGHT INBOARD ELEVATOR (S)
 PASSENGER SIGNS
 PILOT MCDU
 PILOT PFD
 PITOT / STATIC / AOA1 HEATER PWR
 PITOT / STATIC / AOA1 SENSOR
 PITOT / STATIC / AOA2 HEATER PWR
 PITOT / STATIC / AOA2 SENSOR
 * PRINTER

Continued.

DC BUS 1

RADIO ALTIMETER 1
READING LIGHTS AFT LEFT
READING LIGHTS FWD LEFT
REFUEL 1
RH FLT ATTN SEAT READING LT
SATELITE DATA UNIT
SF-ACE 1 SLAT CHANNEL 1 DC FEED
SPDA1 PWR SUPPLY FEED 1
TAT 1 HEATER PWR
* VHF COMM MOD 3
VOR 3
WATER AND WASTE SYSTEM CONTROLLER PWR 2
WEATHER RADAR CONTROL 1
WEATHER RADAR RECEIVER / TRANSMITTER (WEATHER RADAR
/ ANTENNA)
WINDSHIELD HEATER 2 CONTROL
WINDSHIELD WIPPER 2 CONTROL
WING INSPECTION LIGHTS

DC BUS 1

- * ADF MODULE 2
- * AIRSTAIR LIGHTS
- * AUTO-BRAKE MODULE
- CARGO SHUTTOFF VALVE
- COCKPIT FLOOD / STORM LIGHTS
- COCKPIT OVERHEAD PANEL LIGHTING
- COCKPIT READING LIGHTS
- COPILOT PFD
- DEFUEL
- DME MODULE 2
- * DMU
- ENGINE 2 THRUST QUADRANT
- ENGINE 2 THRUST REV LEVER SW
- ENGINE 2 NACELLE ANTI-ICE VALVE COMMAND
- FDR / CVR 2 (DVDR 2)
- GALLEY G1 CONTROL
- GALLEY G2 CONTROL
- GUIDANCE PANEL 2 (GP2)
- HF RECEIVER / EMITTER
- HYDR MOTOR PUMP 1B COMMAND
- HYDR MOTOR PUMP 3B COMMAND
- * INFLIGHT ENTERTAINMENT
- LOGOTYPE LIGHTS
- MAU 2 PWR 2 PRIMARY
- MAU 2 PWR SUPPLY 1
- MAU 3 FCM 3 POWER B
- MAU 3 FCM 4 POWER B
- MAU 3 PWR SUPPLY 2
- MICRO IRU 2 (PWR 1)
- * MLS RECEIVER 2
- MODE S DIVERSITY TRANSPONDER MOD 2
- NAVIGATION MODULE 2
- OXYGEN DEPLOY 2
- P-ACE #1-1 LEFT OUT ELEVATOR (S)
- P-ACE #1-2 UPPER RUDDER (P)
- PEDALS ADJUSTMENTS
- PITOT / STATIC / AOA4 HEATER PWR
- PITOT / STATIC / AOA4 SENSOR
- * PRE-RECORDED ANNOUNCEMENT
- * RADIO ALTIMETER 2
- READING LIGHTS AFT RIGHT
- READING LIGHTS FWD RIGHT
- REFUEL 2
- RIGHT IDLE LOCK SOLENOID
- ROLL TRIM
- SMOKE DET RECIRC FAN
- SPDA2 PWR SUPPLY FEED 1

Continued.



DC BUS 1

TAT 2 HEATER PWR
TCAS 2000
VHF COMM MOD 2
WINDSHIELD HEATER 1 CONTROL
WINDSHIELD WIPPER 1 CONTROL

DC ESS BUS 1

ADF MODULE 1
 AFT CARGO BAY BOTTLE 1 ELECTRO-EXPLOSIVE DEVICE FEED 2
 FWD CARGO BAY BOTTLE 1 ELECTRO-EXPLOSIVE DEVICE FEED 2
 AFT CARGO BAY BOTTLE 2 ELECTRO-EXPLOSIVE DEVICE FEED 2
 FWD CARGO BAY BOTTLE 2 ELECTRO-EXPLOSIVE DEVICE FEED 2
 AFT FLT ATTN PANEL IND LEDS
 APU FADEC
 AUTOMATIC FLIGHT CONTROL SYSTEM CH 1A (AIOP 1A)
 AUTOMATIC FLIGHT CONTROL SYSTEM CH 2A (AIOP 2A)
 BRAKE CONTROL SOV OUTBOARD MOD1
 BRAKE SHUTOFF VALVE SWITCHED OUTBOARD
 CABIN PRESSURIZATION CONTROL SYSTEM CONTROLLER 2A
 CABIN PRESSURIZATION CONTROL SYSTEM CONTROLLER 2B
 CLOCK
 COMPASS
 DC APU / ENGINE PUMP COMMAND
 DIGITAL AUDIO CONTROL PANEL 1
 DME MODULE 1
 * DOOR SILL HEATER COMMAND
 EICAS
 ENGINE 1 EXCITER 1A COMMAND
 ENGINE 1 START VALVE
 ENGINE 1 T2 HEATER
 ENGINE 1 OIL PRESSURE
 FADEC 1 CHANNEL A FEED 1 & FEED 2
 FADEC 2 CHANNEL A FEED 1 & FEED 2
 FDR ACCELEROMETER
 FDR / CVR 1 (DVDR 1)
 FUEL QUANTITY 1
 FWD GALLEY HEATER COMMAND
 FWD LAV SMOKE DETECTOR
 GALLEY 2 FEED 1 COMMAND
 GALLEY 3 FEED 4 COMMAND
 GUIDANCE PANEL 1 (GP1)
 IDG1 DISCONNECT SOLENOID
 INTEGRATED STANDBY
 INVERTER DC FEED
 LANDING GEAR SYS 1 PWR 1
 LANDING GEAR SYS 2 PWR 1
 MAU 1 FCM 1 POWER A
 MAU 1 FCM 2 POWER A
 MAU 1 PWR SUPPLY 1
 MAU 1 PWR SUPPLY 2
 MICRO IRU 1 (PWR 1)
 MODE S DIVERSITY TRANSPONDER MOD 1
 NAVIGATION MODULE 1
 P-ACE #1-1 LEFT OUT ELEVATOR (P)
 P-ACE #1-2 UPPER RUDDER (S)

Continued.

DC ESS BUS 1
P-ACE #3-1 RIGHT OUT ELEVATOR (P) PAX OXY DEPLOY 1 (MANUAL) PILOT MASTER WARN / CAUT 1 PITOT / STATIC / AOA4 COMMAND RAT BIT RAT DEPLOY SOLENOID RIGHT SMOKE DETECTOR F1-CARGO BAY RIGHT SMOKE DETECTOR F2-CARGO BAY SF-ACE 1 FLAP CHANNEL 1 DC FEED SPDA 1 PWR SUPPLY FEED 3 SPDA 2 PWR SUPPLY FEED 3 VHF COMM MOD 1

DC ESS BUS 2

AC FUEL PUMP 1 COMMAND
 AC FUEL PUMP 2 COMMAND
 ADS 3 / STBY PROBE 4B
 AFT FLT ATTN PANEL GALLEY MASTER SW OUT
 AFT GALLEY HEATER COMMAND
 AFT LAV SMOKE DETECTOR
 APU FIRE DETECTION
 APU FIRE EXTINGUISH
 APU FUEL SHUTOFF VALVE
 AUTOMATIC FLIGHT CONTROL SYSTEM CH 1B (AIOP 1B)
 AUTOMATIC FLIGHT CONTROL SYSTEM CH 2B (AIOP 2B)
 BRAKE CONTROL SOV INBOARD MOD 2
 BRAKE SHUTOFF VALVE SWITCHED INBOARD
 CABIN PRESSURIZATION CONTROL SYSTEM CONTROLLER 1A
 COPILOT MASTER WARN / CAUT 2
 COPILOT MCDU
 CURSOR CONTROL DEVICE 1
 DC APU / ENGINE PUMP
 DIGITAL AUDIO CONTROL PANEL 2
 * ELT EMERGENCY LOCATOR TRANSMITER (TRANSMITTER)
 * ELT NAV UNIT
 ENGINE 2 EXCITER 2A COMMAND
 ENGINE 2 START VALVE
 ENGINE 2 T2 HEATER
 ENGINE 2 OIL PRESSURE
 FADEC 1 CHANNEL B FEED1 & FEED2
 FADEC 2 CHANNEL B FEED1 & FEED2
 FUEL QUANTITY 2
 GUIDANCE PANEL 1 (DISPLAY CONTROLLER 1)
 HS-ACE CHANNEL 2
 HS-ACE CHANNEL 2 PWR
 INTEGRATED STANDBY
 LEFT SMOKE DETECTOR A2-CARGO BAY
 LEFT SMOKE DETECTOR F3-CARGO BAY
 LANDING GEAR SYS 1 PWR 2
 LANDING GEAR SYS 2 PWR 1
 MAU 2 PWR SUPPLY 2
 MAU 3 FCM 3 POWER A
 MAU 3 FCM 4 POWER A
 MAU 3 PWR SUPPLY 1
 MICRO IRU 1 (PWR 2)
 P-ACE #2-1 LEFT INBOARD ELEVATOR (S)
 P-ACE #2-2 RIGHT INBOARD ELEVATOR (P)
 P-ACE #3-2 LOWER RUDDER ACT (P)
 PILOT CURSOR CONTROL DEVICE
 PILOT MFD
 PITOT / STATIC / AOA1 AND AOA2 COMMANDS
 PITOT / STATIC / AOA3 HEATER PWR

Continued.

DC ESS BUS 2
PITOT / STATIC / AOA3 SENSOR RAM AIR DOOR 1 SF-ACE 2 SLAT CHANNEL 2 DC FEED SMOKE DETECTOR TEST SPDA1 PWR SUPPLY FEED 2 SPDA2 PWR SUPPLY FEED 2 VALVE APU FEED MOTOR OPERATED SHUTOFF FUEL

DC ESS BUS 3

ADS 2 PROBE 3A
 CABIN INTERPHONE (PA HANDSET)
 CABIN PRESSURIZATION CONTROL SYSTEM CONTROLLER 1B
 COCKPIT DOME LIGHTS
 COCKPIT PUSH BUTTON LIGHTS
 CROSS FEED VALVE
 FIREX SWITCHES
 AFT CARGO BAY BOTTLE 1 ELECTRO-EXPLOSIVE DEVICE FEED 1
 FWD CARGO BAY BOTTLE 1 ELECTRO-EXPLOSIVE DEVICE FEED 1
 AFT CARGO BAY BOTTLE 2 ELECTRO-EXPLOSIVE DEVICE FEED 1
 FWD CARGO BAY BOTTLE 2 ELECTRO-EXPLOSIVE DEVICE FEED 1
 IDG 2 DISCONNECT SOLENOID
 LANDING GEAR LEVER LOCK
 LANDING GEAR OVERRIDE SWITCH
 MID EMERG FAN COMMAND
 P-ACE #3-1 RIGHT OUT ELEVATOR (S)
 P-ACE #3-2 LOWER RUDDER ACT (S)
 PAX OXY DEPLOY 2 (OVRD COMMAND)
 PROBE 3 HEATER PWR 2
 * RADIO ALTIMETER 3
 RAM AIR DOOR 2
 RIGHT SMOKE DETECTOR A1-CARGO BAY
 RUDDER TRIM
 SEAT 1 ADJUSTMENT
 SEAT 2 ADJUSTMENT
 SF-ACE 2 FLAP CHANNEL 2 DC FEED

DC GND SVC

AFT CARGO COMPARTMENT LIGHTS
 AFT CARGO LOADING LIGHTS
 AFT ENTRANCE LIGHTS
 AFT FLASH LIGHTS CHARGER / AFT LAV LIGHTS
 COURTESY LIGHTS
 FWD CARGO LIGHTS
 FWD LAVATORY LIGHTS
 FWD / MAIN ENTRANCE LIGHTS
 GALLEY AREA LIGHTS
 SERVICE COMPARTMENT LIGHTS AFT / FWD
 SPDA 1 PWR SUPPLY FEED 4
 SPDA 2 PWR SUPPLY FEED 4
 WATER AND WASTE SYSTEM CONTROLLER PWR1

DC HOT BAT BUS 1

BATTERY 1
COURTESY / SERVICE LIGHTS FWD
DC CEILING LIGHTS
ENGINE 1 OIL LEVEL IND
ENGINE 1A FIRE EXTINGUISH
ENGINE 2A FIRE EXTINGUISH
ENGINE FUEL SHUTOFF VALVE 1
HYDR SYS SOV 1

DC HOT BAT BUS 2

BATTERY 2
CMC
ENGINE 1B FIRE EXTINGUISH
ENGINE 2 OIL LEVEL INDICATION
ENGINE 2B FIRE EXTINGUISH
ENGINE FUEL SHUTOFF VALVE 2
HYDR SYS SOV 2
PANEL REFUEL 3
WATER AND WASTE SYSTEM CONTROLLER PWR 3

APU BUS

APU START

AC BUS 1

AC FUEL PUMP 1
ENGINE 1 EXCITER 1B
* FAN CARGO BAY
GALLEY 2 FEED 1 (COFFEE MAKER)
GALLEY 3 FEED 4 (STEAM OVEN)
GREEN / WHITE STBY POSITION LT'S RIGHT
HYDR MOTOR PUMP 2B
ICE DETECTOR 1
LEFT LANDING LIGHT
LEFT RECIRC FAN
LEFT TAXI LIGHT
RED BEACON LIGHT UPPER / LOWER
RED / WHITE STBY POSITION LT'S LEFT
SF-ACE 1 SLAT CHANNEL 1 AC FEED
WINDSHIELD HEATER 2 PWR
WINDSHIELD WIPER 2 PWR

AC BUS 2

- * AFT DOOR SILL HEATER
- AFT GALLEY HEATER
- * COCKPIT LAPTOP AC OUTLETS
- ENGINE 2 EXCITER 2B
- FAN 2 FWD BAY
- FAN 2 MID BAY
- FAN AFT AVIONICS BAY
- * FWD DOOR SILL HEATER
- GALLEY 2 FEED 3 (STEAM OVEN 1)
- GALLEY 3 FEED 1 (COFFEE MAKER)
- GALLEY 3 FEED 2 HOT JUG
- GALLEY 3 FEED 5 (CHILLER)
- GREEN / WHITE MAIN POSITION LT'S RIGHT
- HYDR MOTOR PUMP 1B
- HYDR MOTOR PUMP 3B
- ICE DETECTOR 2
- RED / WHITE MAIN POSITION LT'S LEFT
- RIGHT LANDING LIGHT
- RIGHT TAXI LIGHT
- SF-ACE 2 FLAP CHANNEL 2 AC FEED
- STROBE LIGHTS WHITE LH / RH
- WINDSHIELD HEATER 1 PWR
- WINDSHIELD WIPER 1 PWR

AC ESS BUS

AC FUEL PUMP 2A
HYDR MOTOR PUMP 3A
SF-ACE 1 FLAP CHANNEL 1 AC FEED
SF-ACE 2 SLAT CHANNEL 2 AC FEED

AC GND SVC

AC OUTLET PWR1
AC OUTLET PWR2
CEILING LIGHTS
DRAIN MAST AFT
DRAIN MAST FWD
FAN 1 FWD BAY
FAN 1 MID BAY
GALLEY 1 FEED 2 (AC OUTLET)
GALLEY 3 FEED 2 (AC OUTLET)
NOSE LANDING LIGHT
NOSE TAXI LIGHT
SIDEWALL LIGHTS
VACUUM MOTOR GEN
WATER COMPRESSOR



STBY AC BUS
ENGINE 1 EXCITER 1A ENGINE 2 EXCITER 2A

ELECTRICAL DISTRIBUTION AND SYSTEM CONFIGURATIONS

Normal operation of the electrical system is automatic.

The left engine's IDG (IDG 1) normally powers AC BUS 1 and the right engine's IDG (IDG 2) normally powers AC BUS 2 and also the AC ESS BUS.

Each AC BUS powers a dedicated TRU, which rectifies the power supplying the DC BUSES from AC power to DC power. The batteries are charged whenever an AC power source is available.

The ICCs are responsible for primary load distribution while the two SPDAs are responsible for secondary load distribution and protection. The electrical system utilizes priority logic to supply every electrical bus.

The source priority order for powering AC main buses is:

- Respective IDG.
- APU generator.
- GPU (if no APU power).
- Opposite IDG.

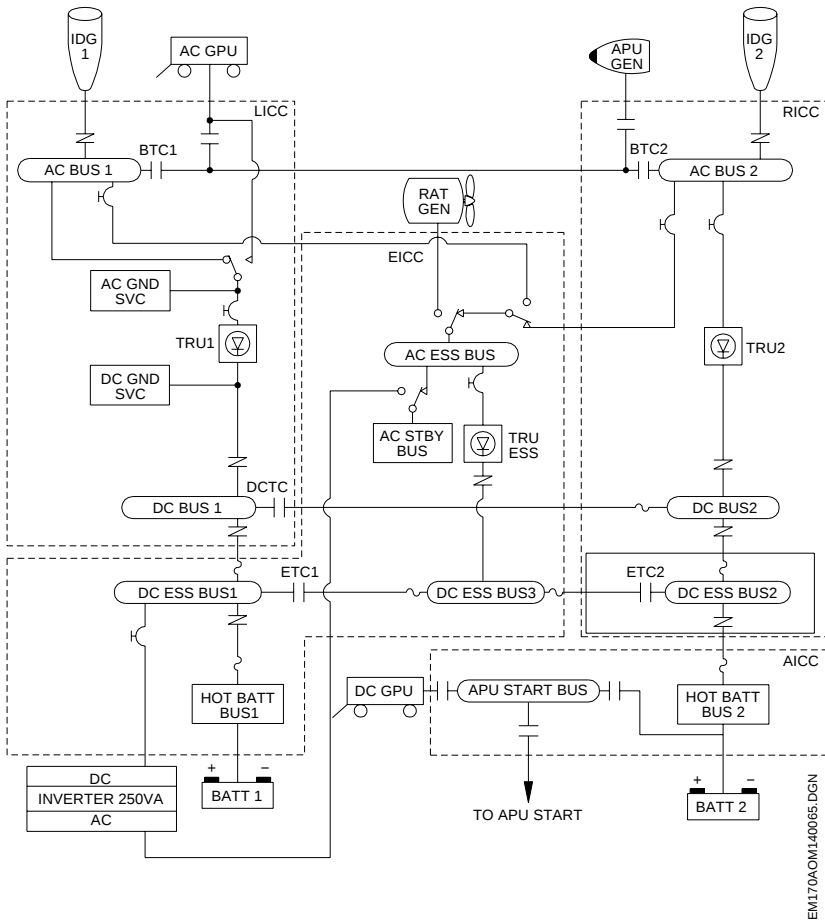
If a power-generating source fails, the electrical system automation supplies electrical power from another available source according to the priority order. At this point, both networks are connected by bus tie contactors (BTCs). If required, the SPDA will command the load shedding protection, isolating galleys and right windshield heating to prevent an overload on the remaining source.

One AC power source is sufficient to supply the whole system without significant degradation or additional workload. When an additional power source becomes available, or the load decreases, the electrical system restores power to the shed items.

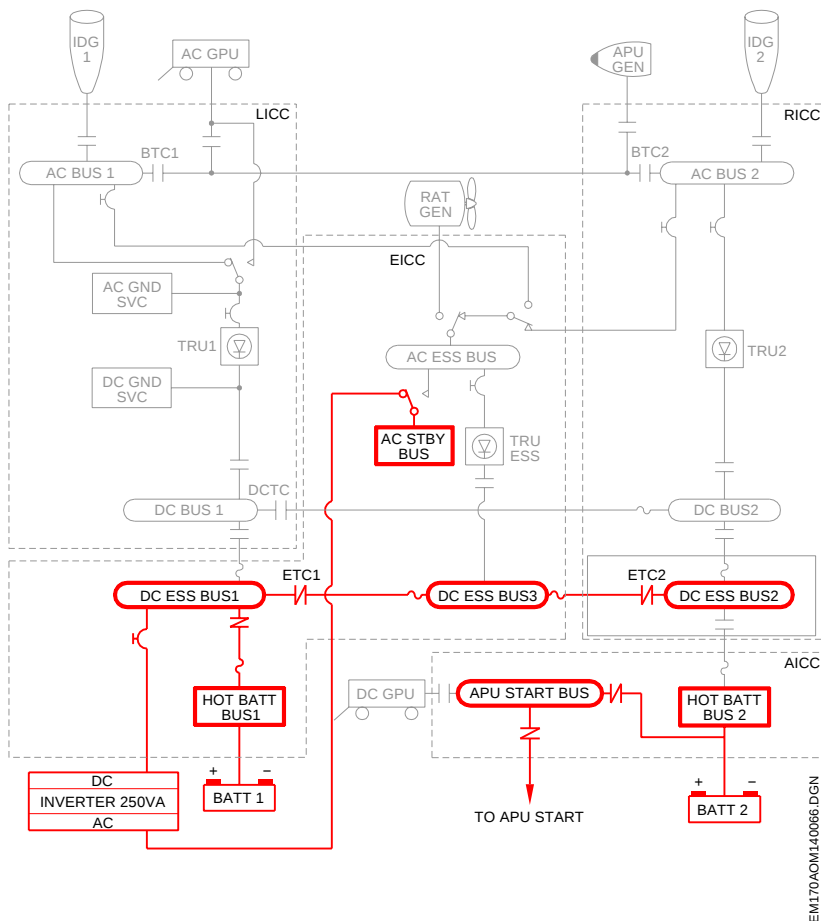
If a TRU fails, the respective DC BUS will be powered by another DC source through both essential tie contactors (ETCs) and a DC tie contactor (DCTC), according to the system logic. When a total loss of AC power occurs, the RAT will automatically deploy, supplying power to all the ESS BUSES.

SYSTEM CONFIGURATIONS

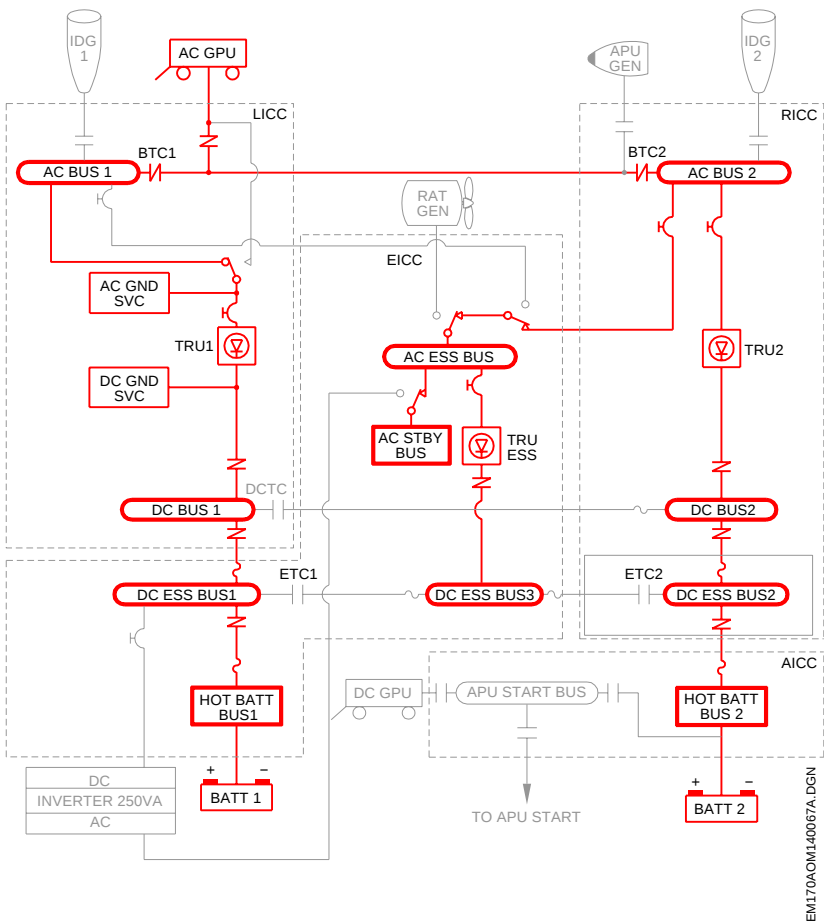
The following are some important examples of electrical load distribution achieved by the system logic.



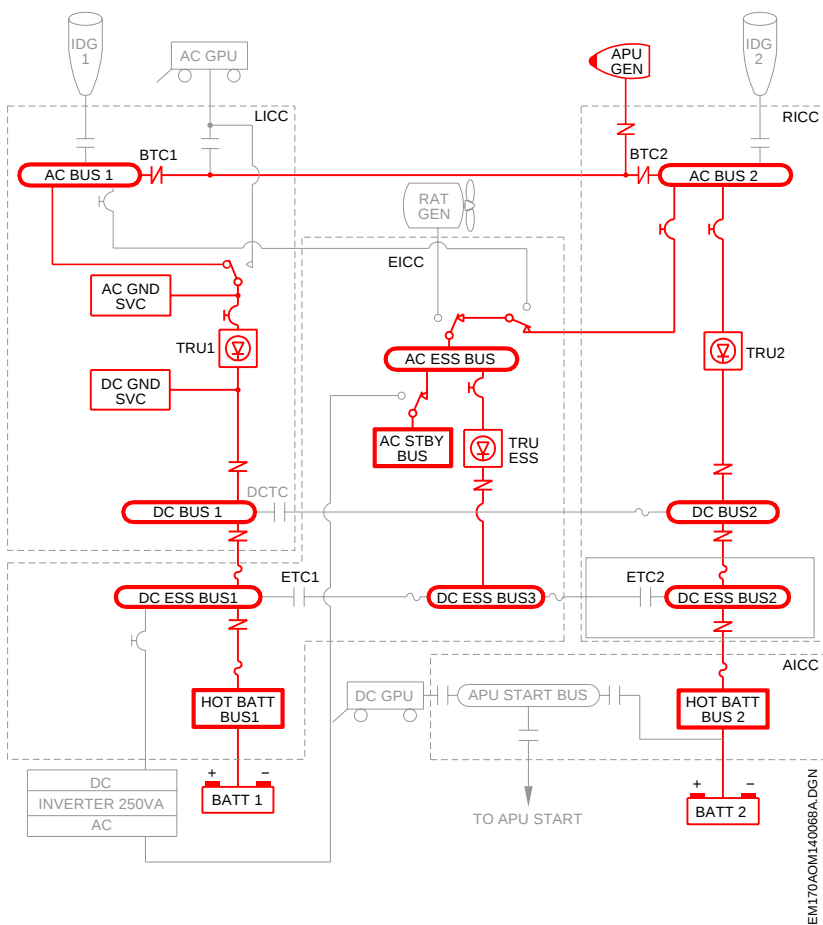
BATTERIES ONLY/APU START IN PROGRESS



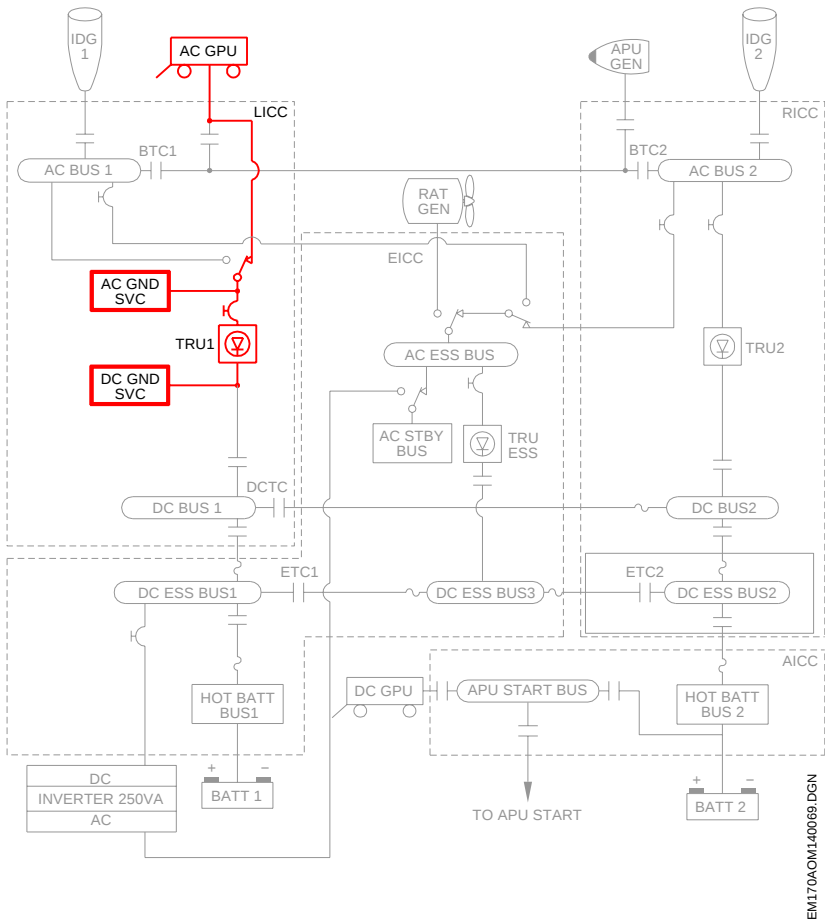
AC GPU



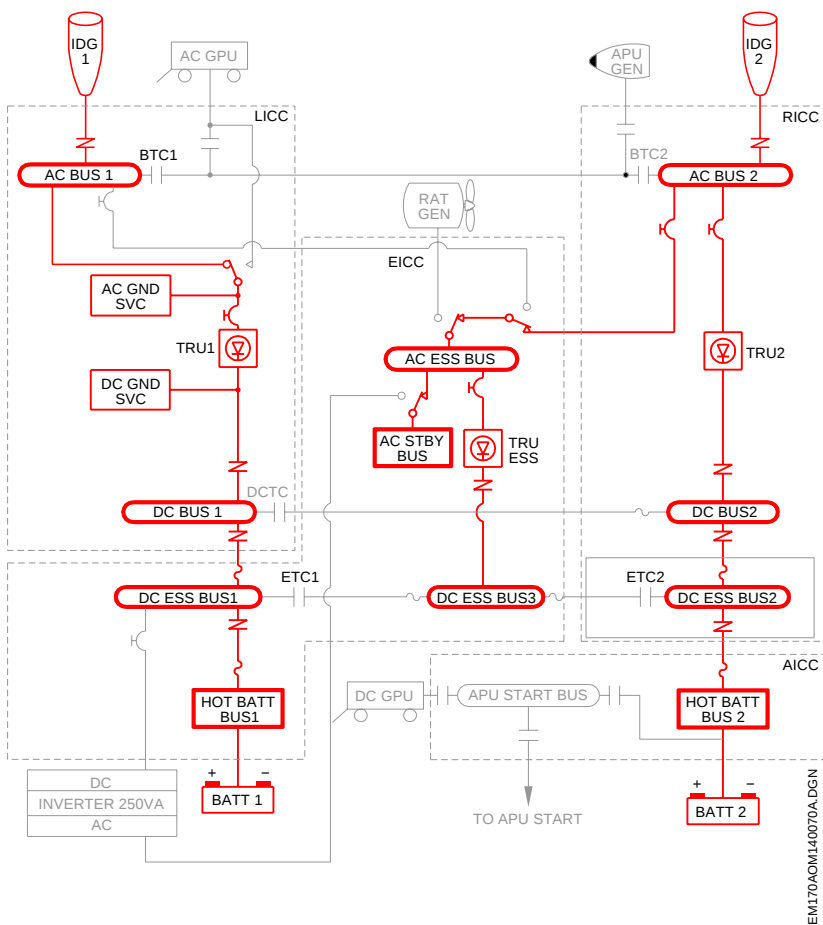
APU POWER



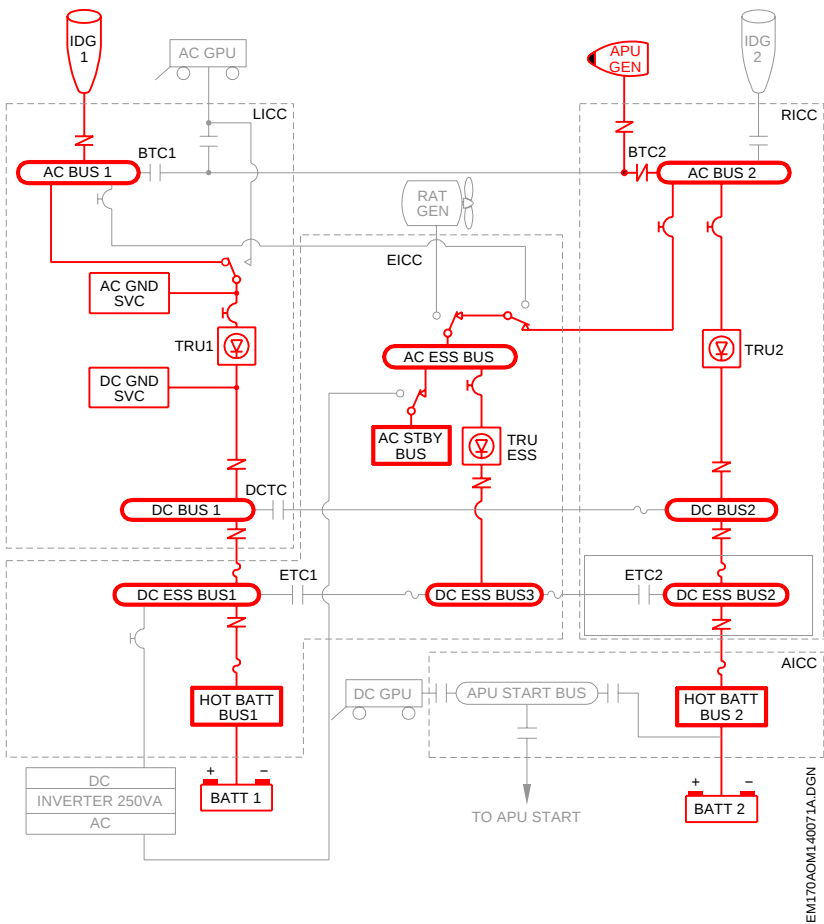
GROUND SERVICE MODE



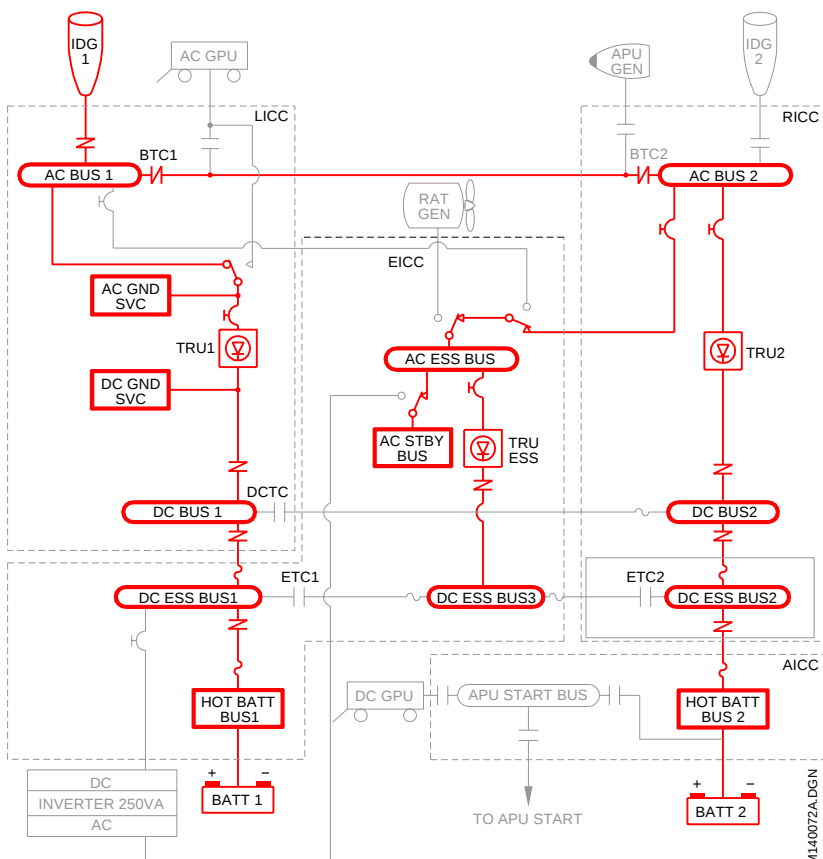
TWO IDG POWER



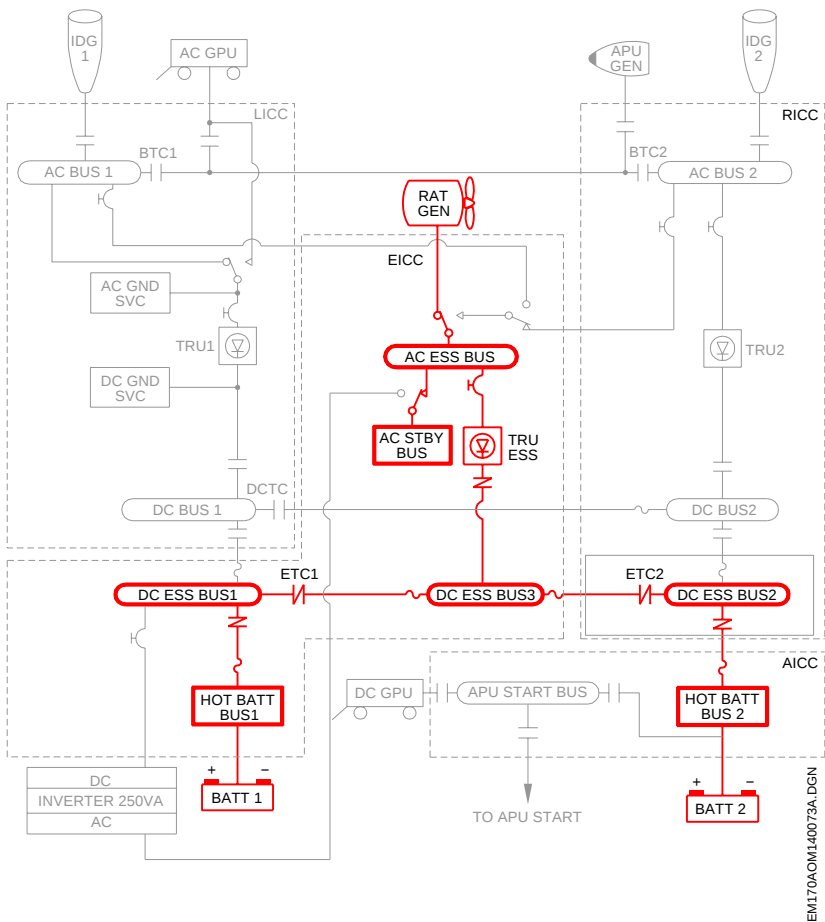
IDG FAILED AND APU GENERATOR IN USE



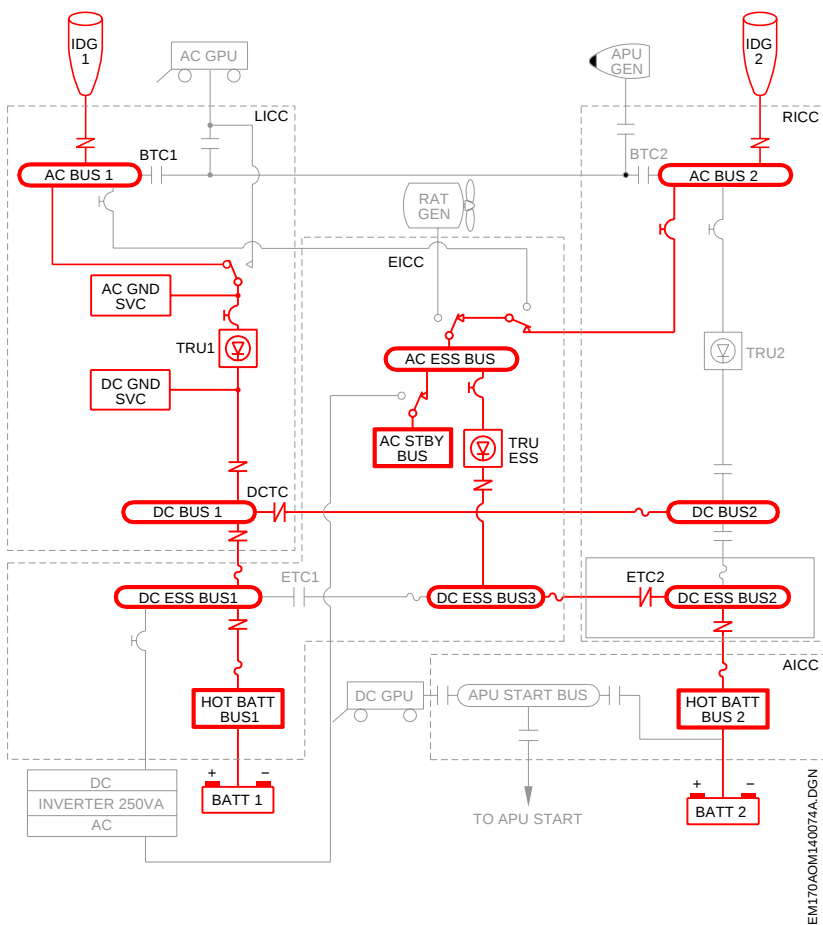
IDG FAILED AND APU GENERATOR NOT IN USE



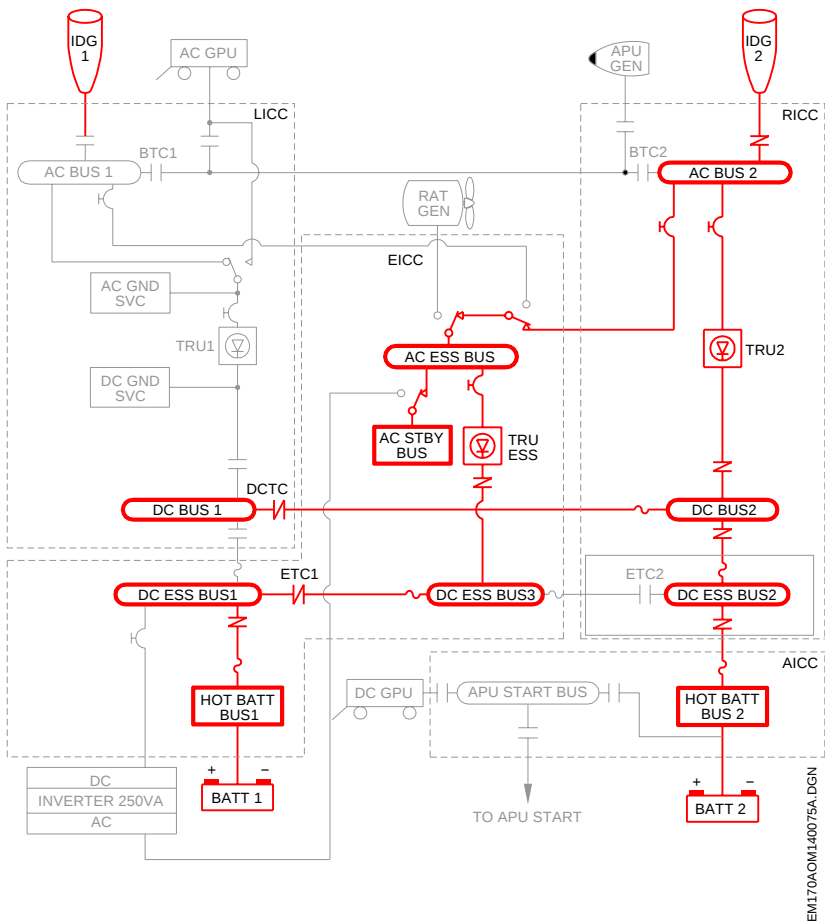
RAT POWER



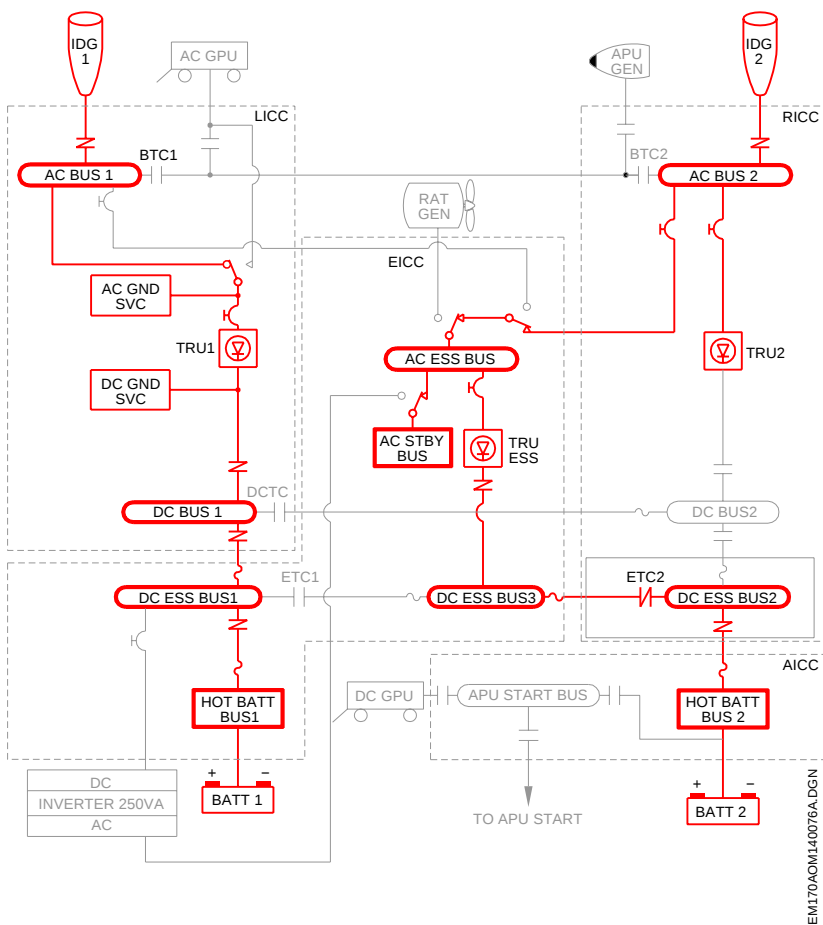
TRU FAILED



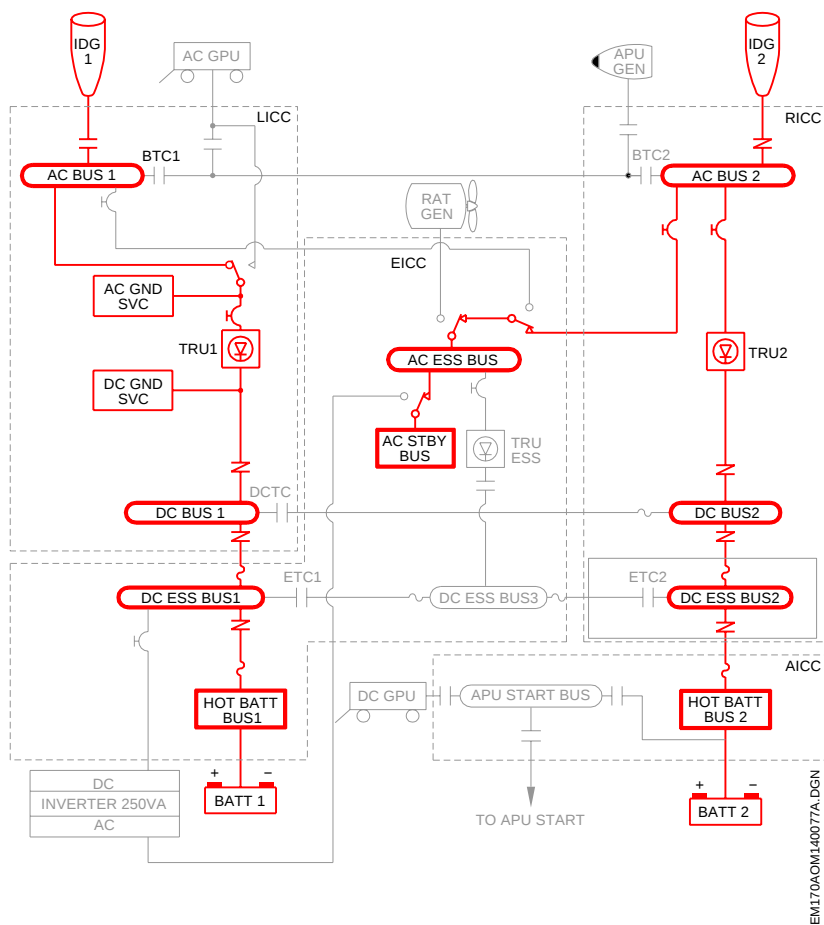
AC BUS OFF



DC BUS OFF



DC ESS BUS OFF



EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	BATT 1 (2) OVERTEMP	Associated battery temperature is above 70°C.
	BATT 1-2 OFF	Battery #1 and #2 are isolated from the electrical network.
	BATT DISCHARGING	Batteries are discharging in an electrical emergency with no RAT assistance, or on ground when the battery is the only power source supplying the airplane.
	ELEC EMERGENCY	In flight, AC main buses are de-energized.
CAUTION	AC BUS 1 (2) OFF	Associated AC BUS is de-energized.
	AC ESS BUS OFF	AC ESS BUS is de-energized.
	AC STBY BUS OFF	AC STBY BUS is de-energized.
	APU GEN OFF BUS	APU generator failure or APU GEN button is pushed out.
	BATT 1(2)DISCHARGING	Associated battery is discharging due to electrical system automation failure, or when battery is the only source supplying the system.
	BATT 1 (2) OFF	Associated battery is isolated from the electrical network.

TYPE	MESSAGE	MEANING
CAUTION	BATT 1 (2) TEMP SENS FAULT	A discrepancy between battery sensors has been detected.
	DC BUS 1 (2) OFF	Associated DC BUS is de-energized.
	DC ESS BUS 1 (2) (3) OFF	Associated DC ESS BUS is de-energized.
	GPU CONNECTED	AC or DC GPU connected (AVAIL or IN USE indication turned on) and parking brake released.
	IDG 1 (2) OFF BUS	IDG failure or IDG control button pushed out.
	IDG 1 (2) OIL	High oil temperature or low oil pressure has been detected.
	INVERTER FAIL	An inverter failure has been detected during power up built-in test.
	RAT FAIL	A failure was detected during power up built-in test in a RAT system component.
	TRU 1 (2) (ESS) FAIL	An associated TRU failure has been detected.
ADVISORY	LOAD SHED	Load shed automatically commanded.
	REMOTE CB TRIP	A remote thermal or electronic CB has been tripped.
	SPDA FAIL	A significant failure has been detected.

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AIR CONDITIONING	ATA 21
AUTO FLIGHT	ATA 22
COMMUNICATION	ATA 23
ELECTRICAL POWER	ATA 24
EQUIPMENT AND FURNISHINGS	ATA 25
FIRE PROTECTION	ATA 26
FLIGHT CONTROLS	ATA 27
FUEL	ATA 28
HYDRAULIC POWER	ATA 29
ICE AND RAIN PROTECTION	ATA 30
INDICATION AND RECORDING SYSTEM	ATA 31
LANDING GEAR	ATA 32
LIGHTS	ATA 33
NAVIGATION	ATA 34
OXYGEN	ATA 35
PNEUMATIC	ATA 36
WATER AND WASTE	ATA 38
AUXILIARY POWER UNIT	ATA 49
POWERPLANT	ATA 71

ATA CHAPTER 25

EQUIPMENT AND FURNISHINGS

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INTRODUCTION

This ATA Chapter contains a description of equipment installed for crewmembers and passengers, including galley, seats and storage areas. It also covers the airplane compartments.

Escape and life saving equipment is described in Chapter 10 Survival And Emergency Equipment.

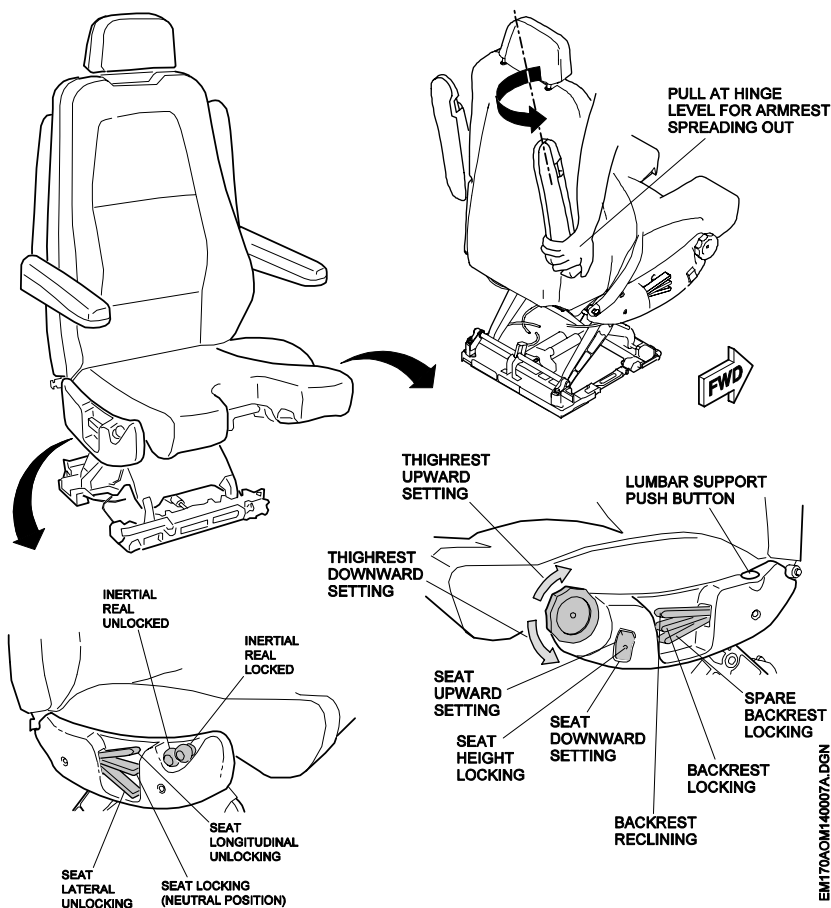
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COCKPIT

COCKPIT SEATS

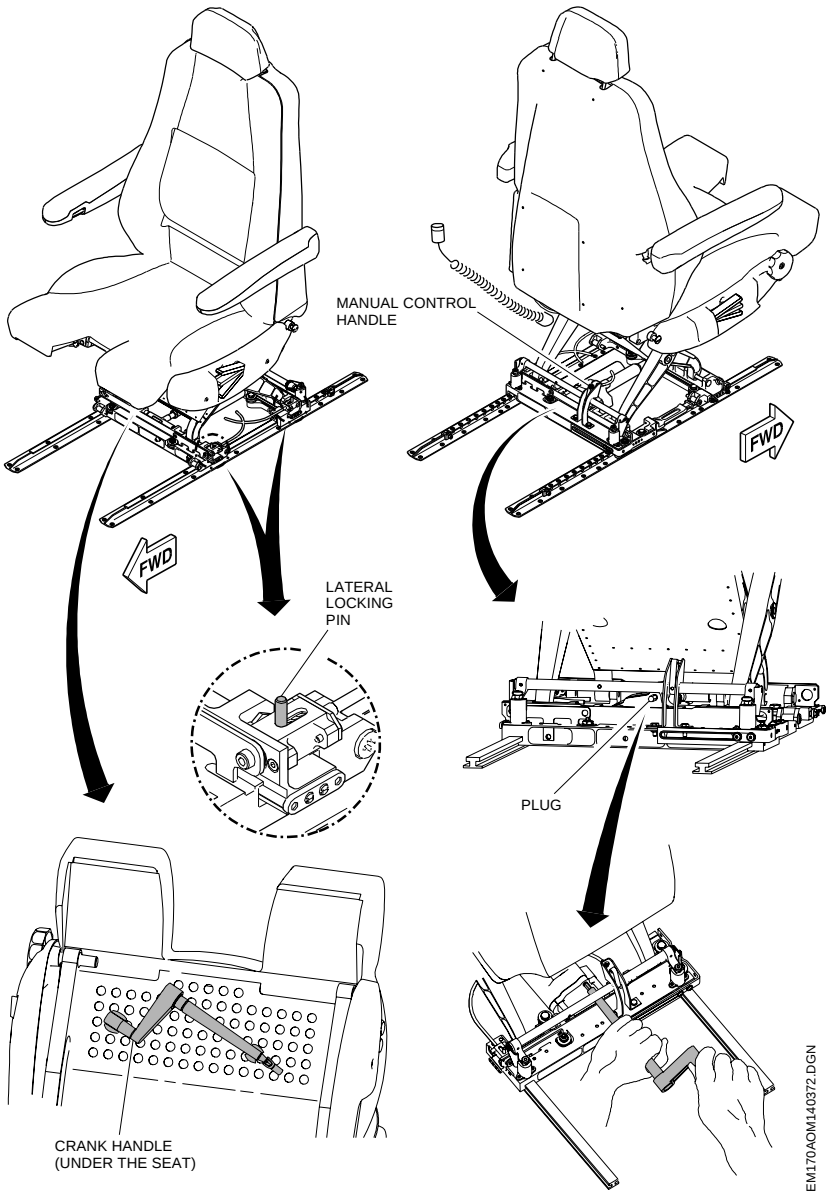
Pilot seats are fixed to slide rails that permit fore and aft adjustments. When the seats are in their aft most position, a lateral movement is also available in order to ease crew access to the seat.

Manual adjustments of pilot seats are possible for height, lateral and aft and fore movements. A crank handle is located under the seat and allows height adjustments attaching it to the plug at the aft lower part of the seat. The manual control handle allows aft and fore adjustments. Lateral movement is provided actuating both lateral locking pins.



COCKPIT SEATS

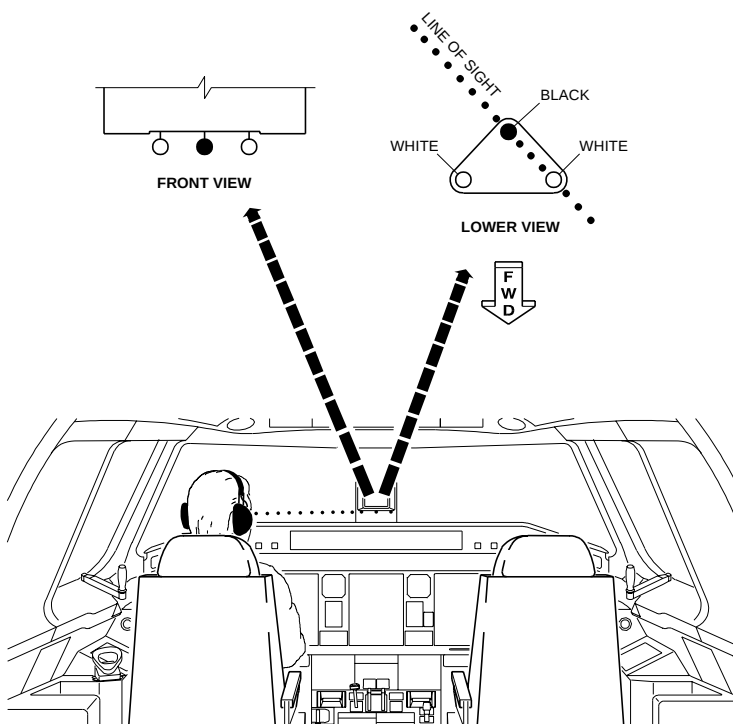
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COCKPIT SEATS MANUAL ADJUSTMENTS

PILOT SEAT ADJUSTMENT

The seat should be moved up or down until the pilot's line of sight reaches the same horizontal plane of a sight device made up of two white spheres and a black sphere. Then, move the seat fore or aft until the opposite white sphere is aligned with the black one.

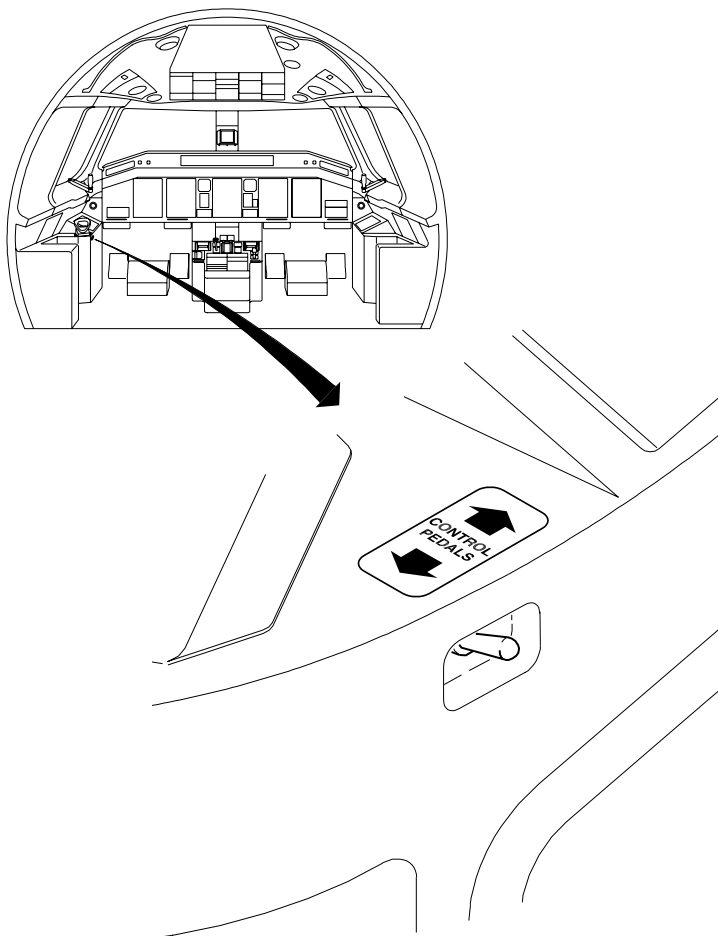


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PILOT SEAT ADJUSTMENT

PEDAL ADJUSTMENT

Spring-loaded switches installed on the captain and first officer's panels allow rudder pedals' adjustment, which is performed by electric actuators. Setting the switch, the actuator moves the pedals forward or aft, to assure the pilot's comfort and a full rudder throw from the adjusted seat position. For manual rudder pedal adjustment call maintenance.

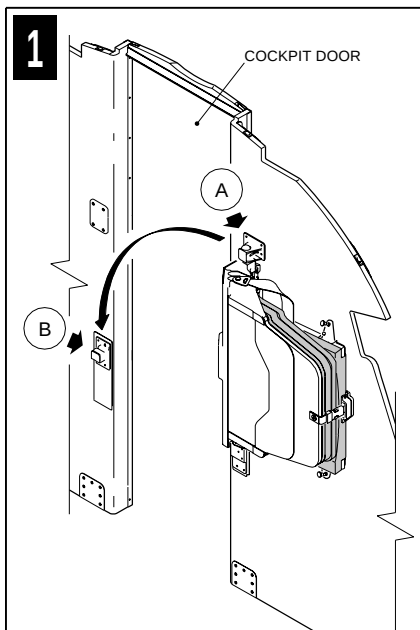


EM170AOM140009.DGN

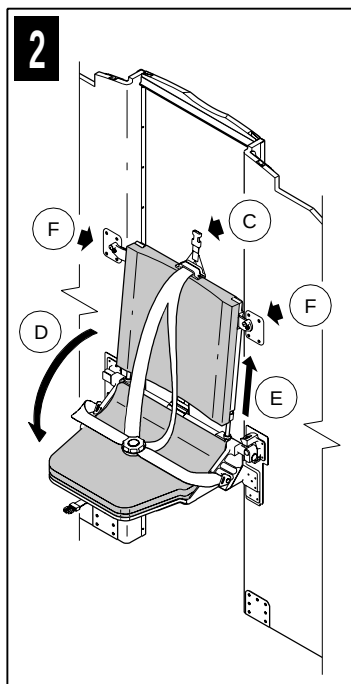
PEDAL ADJUSTMENT

OBSERVER SEAT

The observer seat is located behind and between captain and first officer's seats. When in use, it is fitted on the cockpit door. Stow it by folding and rotating away from the door area against the left side of the cockpit partition, behind the captain's seat. Cockpit door can be opened or closed with either the observer seat in use or stowed.



- (A) RELEASE THE SEAT
- (B) LET THE SEAT FOLD DOWN SLOWLY INTO POSITION



- (C) RELEASE THE STRAP
- (D) BRING THE SEAT BOTTOM TO A HORIZONTAL POSITION
- (E) PULL THE BACKREST UP TO TOP-OFF FITTING
- (F) LOCK THE BACKREST

EM170AOM140010.DGN

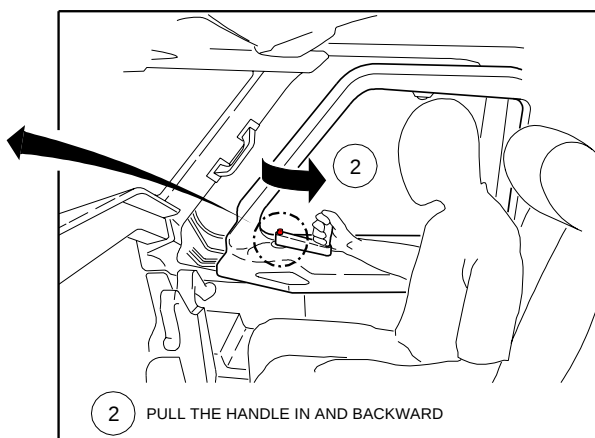
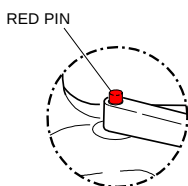
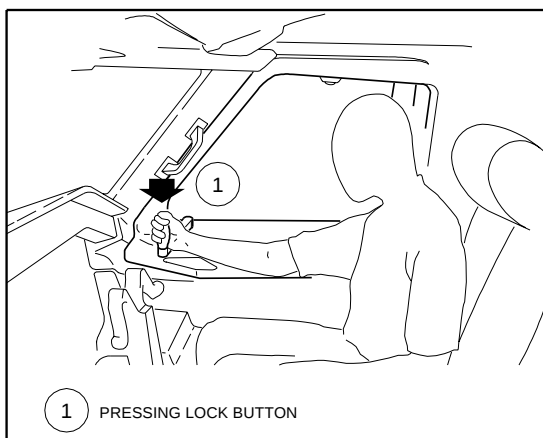
OBSERVER SEAT

COCKPIT WINDOW

Cockpit window may be totally open on the ground, in case of loss of visibility through the windshield or for cockpit emergency evacuation.

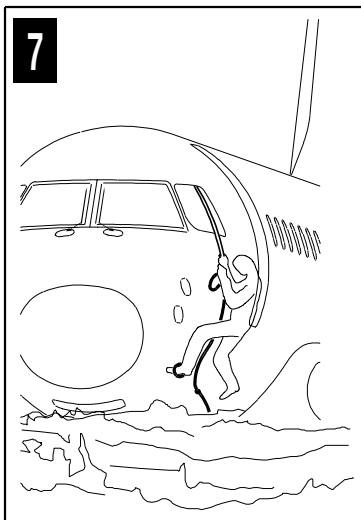
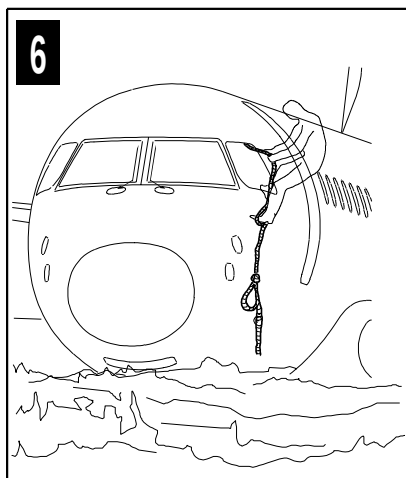
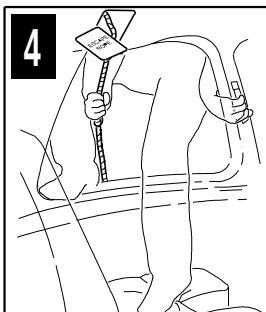
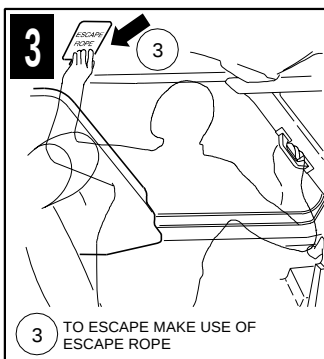
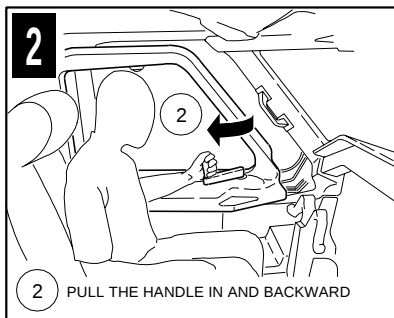
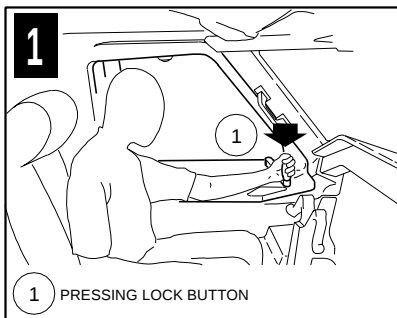
A red pin protrudes on the opening handle arm when the window is not properly locked in the closed position.

NORMAL OPENING



EM170AOM140011.DGN

EMERGENCY OPENING



EM170AOM140228.DGN

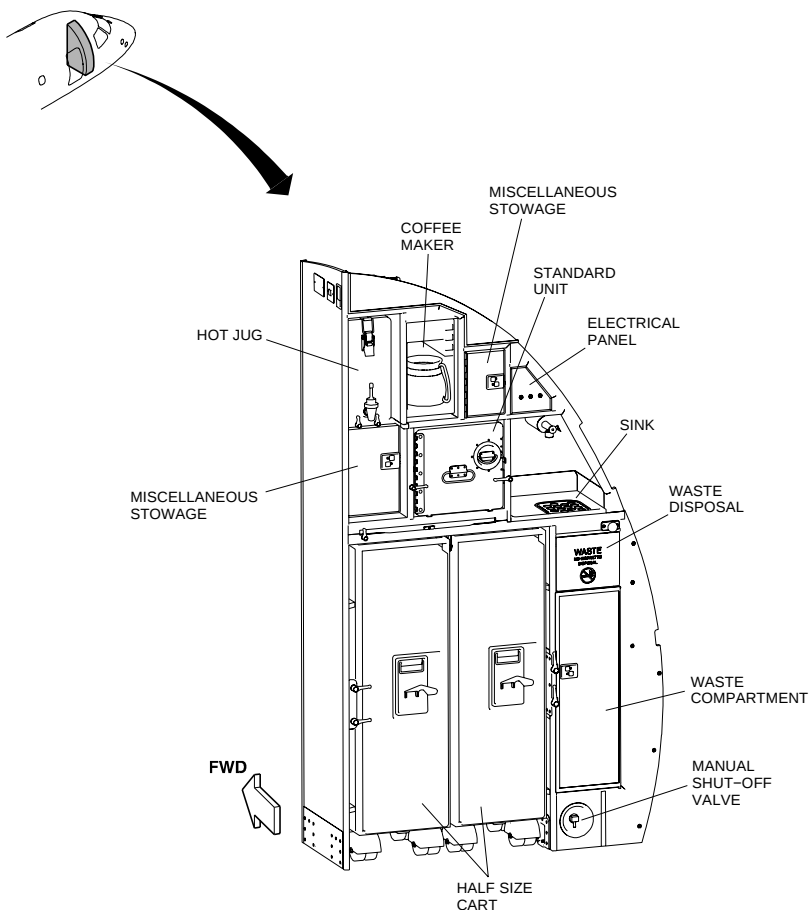
COCKPIT WINDOW EMERGENCY EXIT

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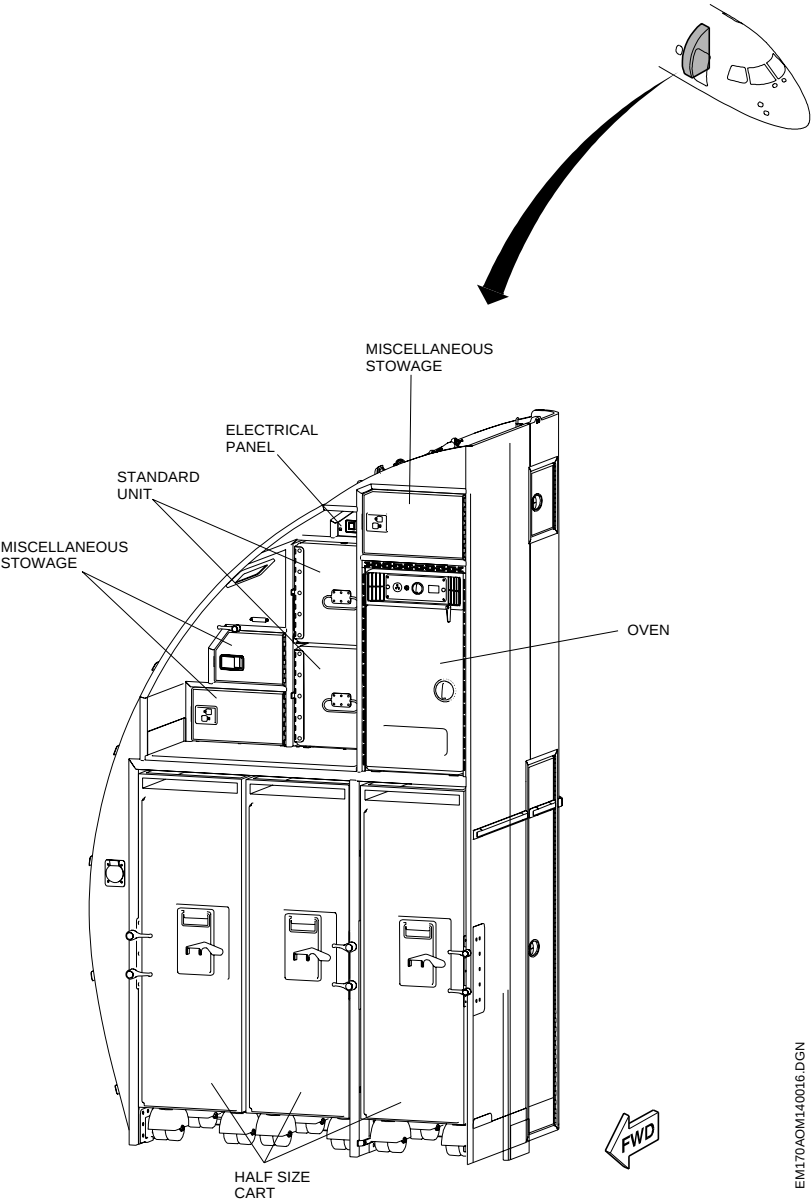
PASSENGER CABIN

GALLEY

The galleys provide means for food stowage and preparation, and also stowage for miscellaneous items. A work deck is provided to assist flight attendant with his/her tasks.

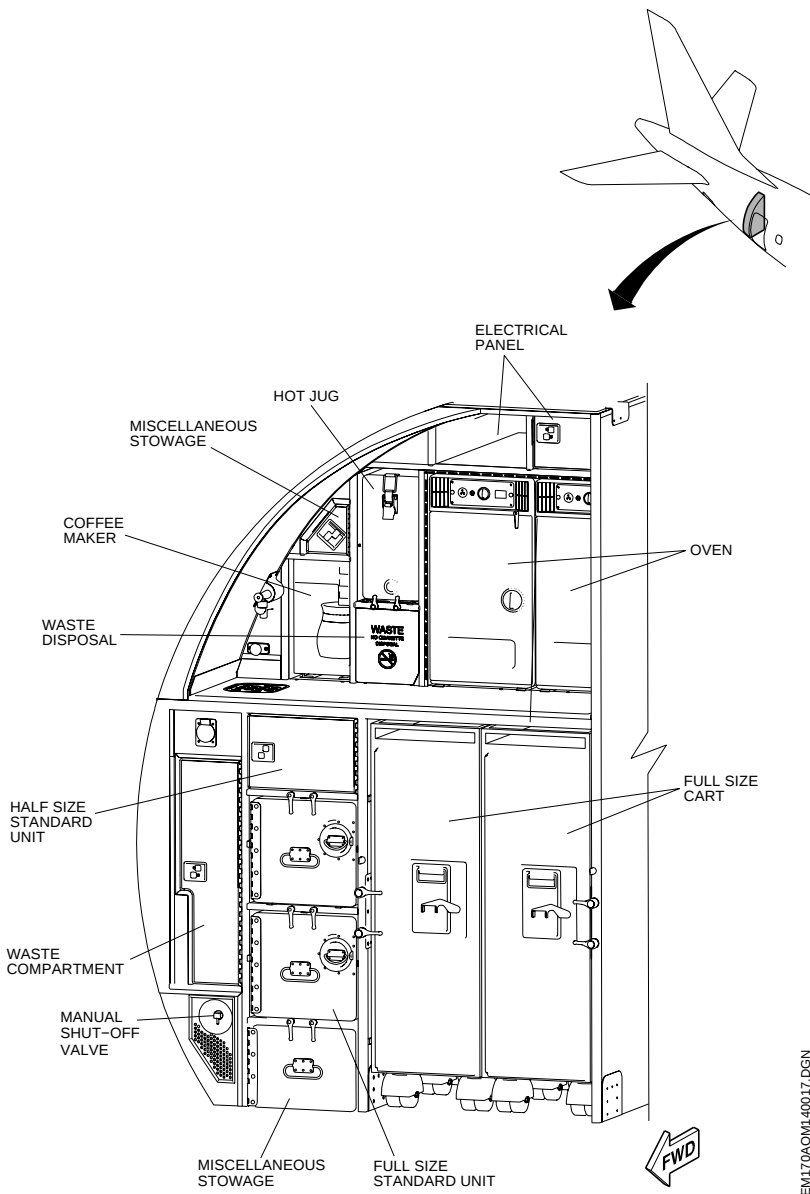


FORWARD GALLEY (G1)



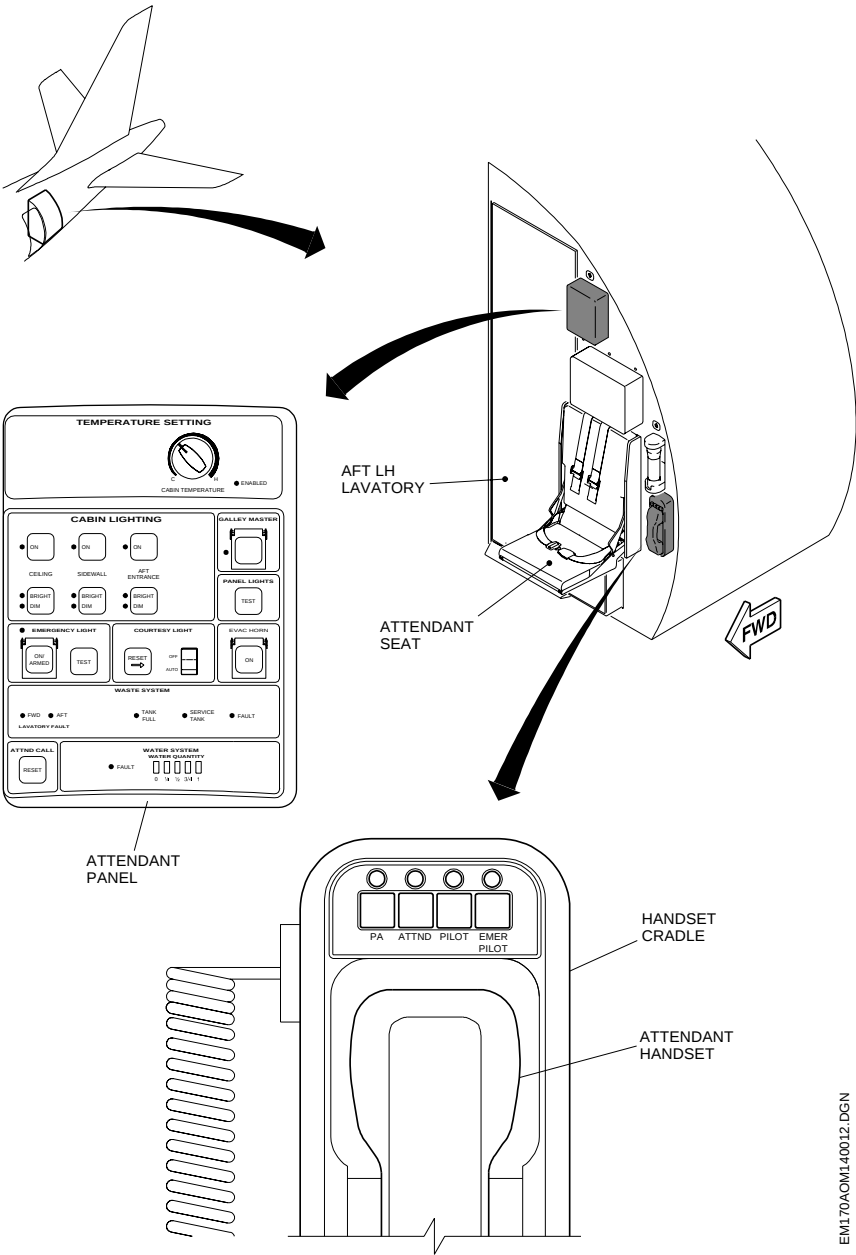
EM170AOM140016.DGN

FORWARD GALLEY (G2)

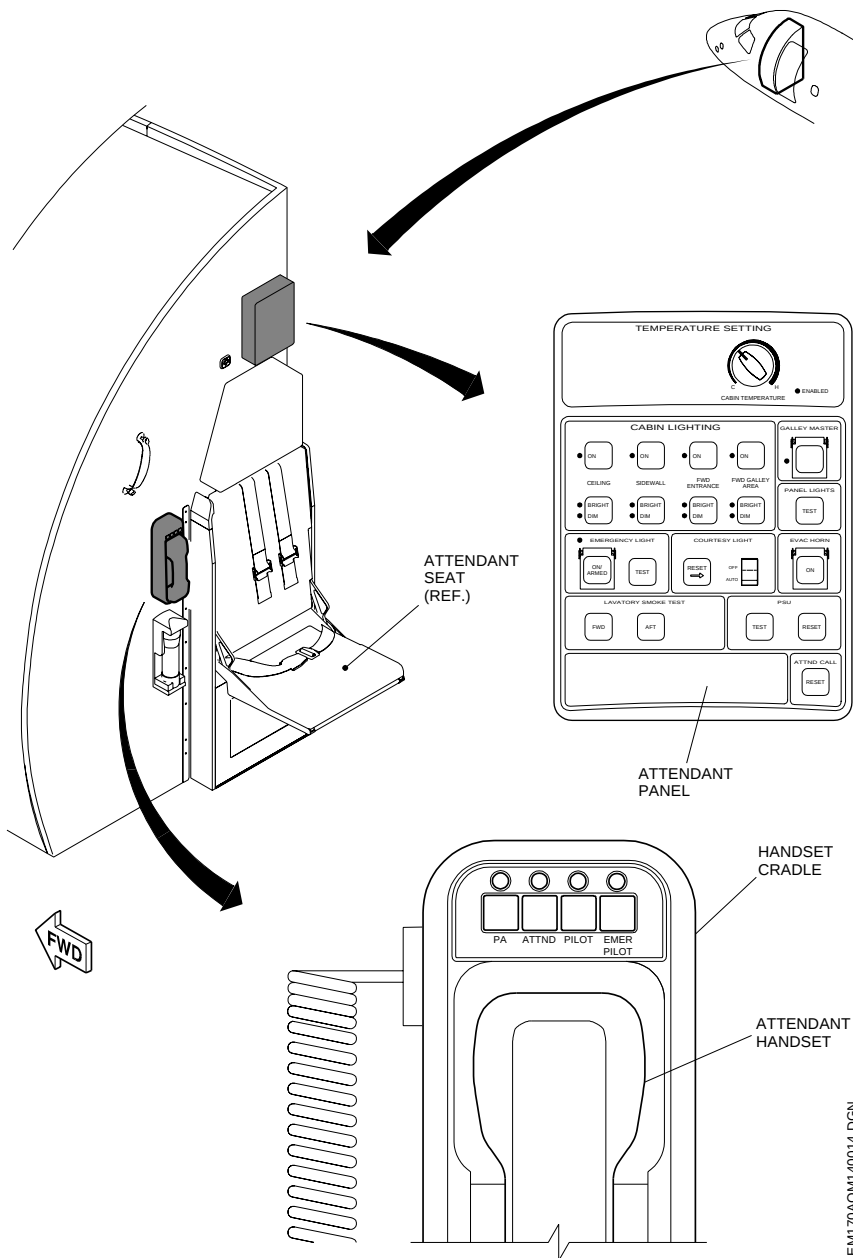


AFT GALLEY (G3)

ATTENDANT STATIONS AND SEATS

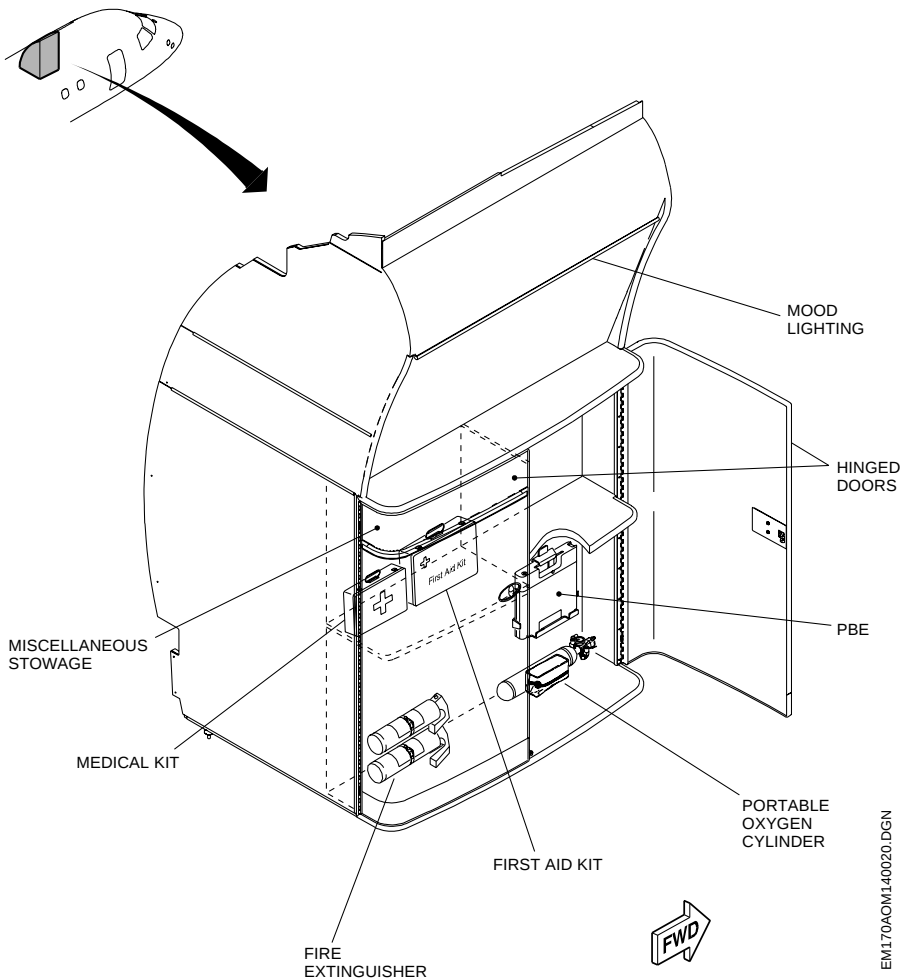


EW170AOM140012.DGN



EM170AOM140014.DGN

AIRSTAIR WARDROBE

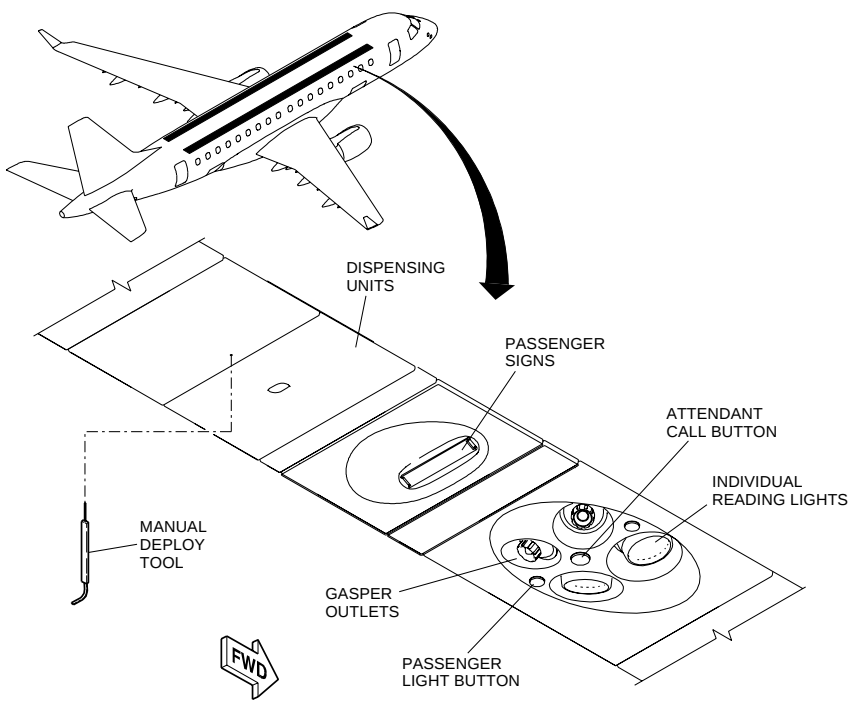


EM170AOM140020.DGN

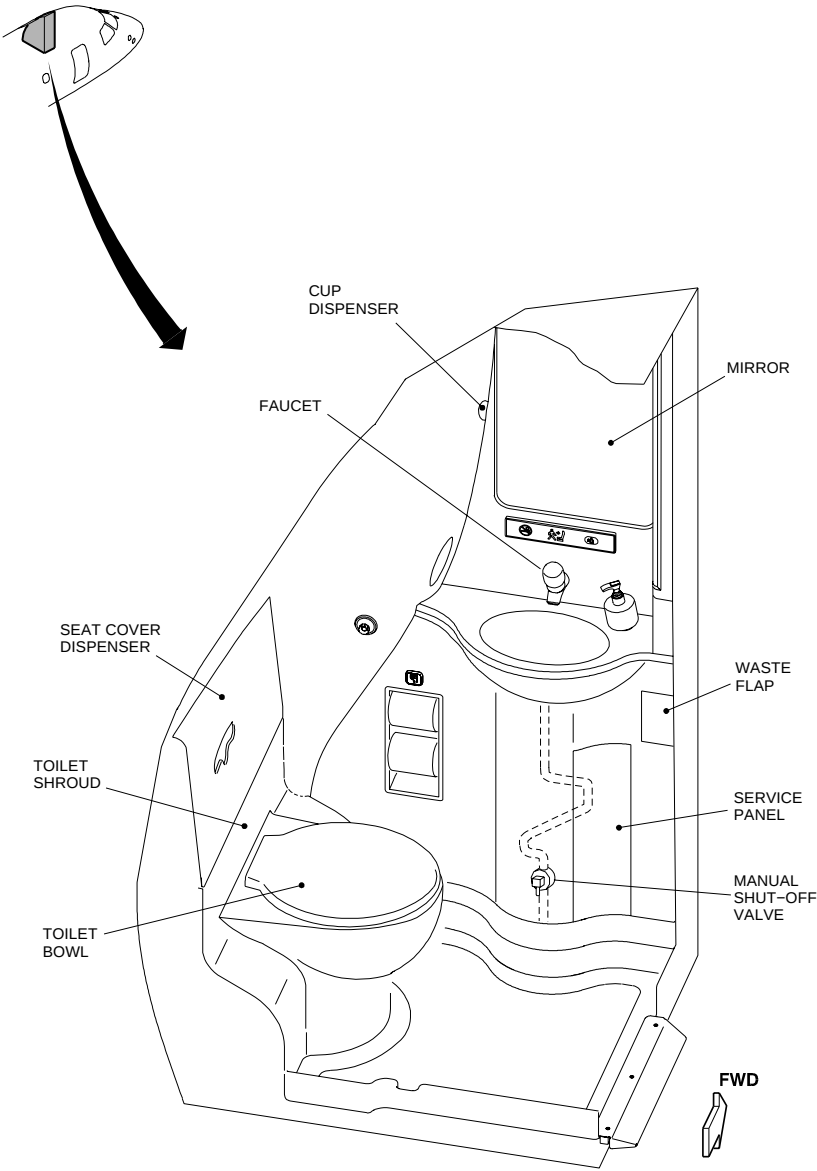
PASSENGER SERVICE UNIT (PSU)

The PSU provides:

- Reading light at each passenger seat.
- NO SMOKING and FASTEN SEAT BELTS signs.
- Pushbutton and indicator for attendant call.
- Air gasper for each individual passenger seat.
- Oxygen mask dispensing unit.
- Loudspeaker for internal communication.

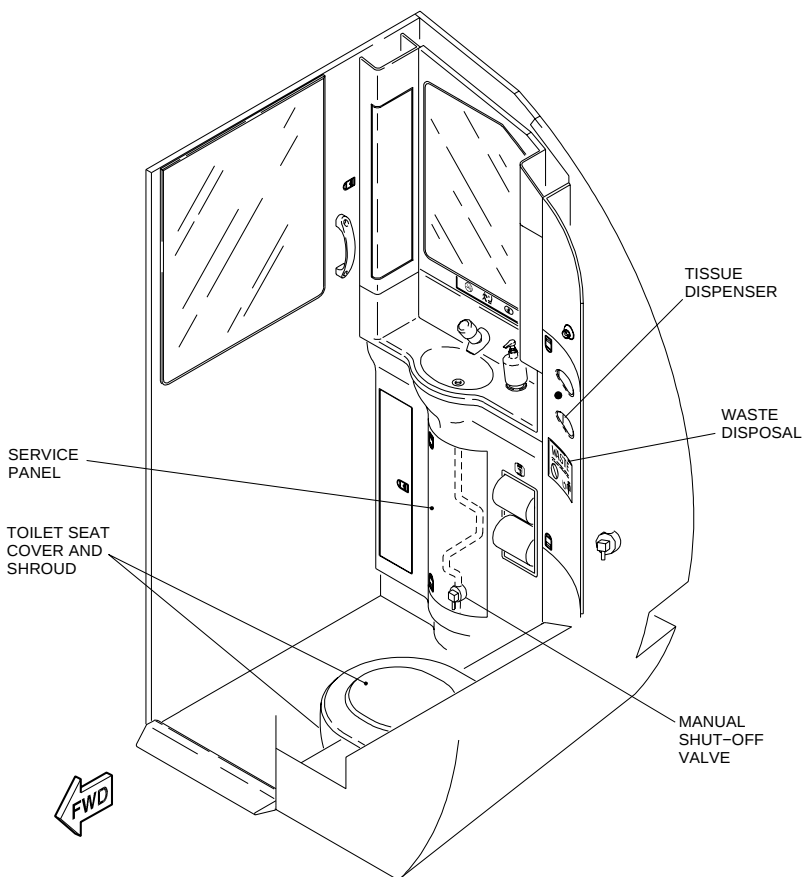
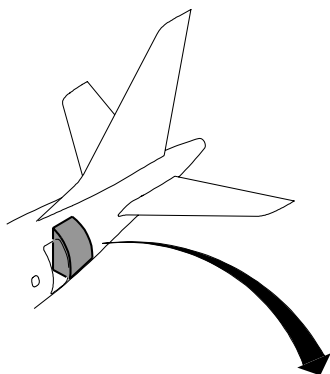


LAVATORY



FORWARD LAVATORY

EM170AOM140018.DGN



AFT LAVATORY

EM170AOM140019.DGN

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DOORS

This airplane has two jetway passenger doors on the left side (forward and aft location), two jetway service doors on the right side (forward and aft location), and a number of access doors for different airplane systems along the fuselage.

PASSENGER AND SERVICE DOORS

This airplane has one passenger door located at the left forward fuselage section and another located at the aft fuselage section. Passenger door operation is manual and it is identical for both passenger doors. Passenger doors are plug-in type and they are designed as type I doors.

One service door is located at the right forward fuselage section and another located at the right aft fuselage section. Service doors are used for galley servicing and cabin cleaning between flights. It may also be used as an emergency exit. The operation of service and passenger doors is identical.

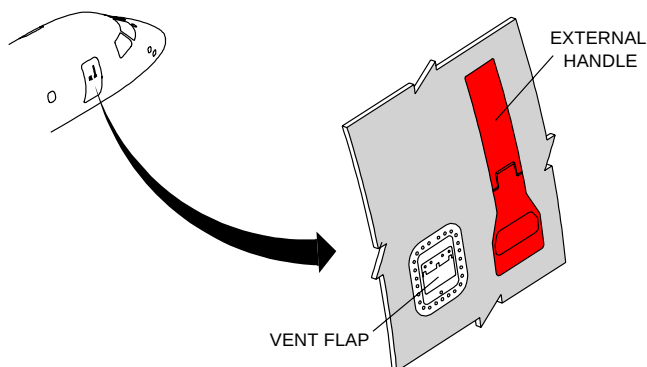
One external and three internal handles plus one vent flap are installed in each door for opening and closing operations.

DOOR' EXTERNAL HANDLE

The vent flap prevents pressurization of the airplane above 0.5 psi when the door is not fully closed, latched and locked.

The escape slide is automatically disarmed when the door is opened from outside. The vent flap opens automatically when the lower part of the external handle is pulled.

For further information on escape slide refer to escape slide description in this section.



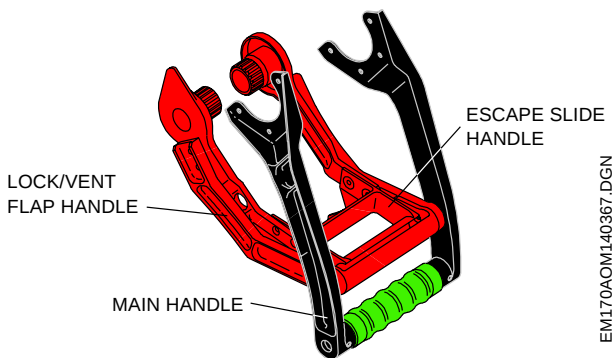
EXTERNAL HANDLE AND VENT FLAP

DOOR INTERNAL HANDLES

The main handle activates the door's latch mechanism.

The vent flap and door lock mechanism are linked together. The airplane pressurization loads the vent flap against the door structure. The effort to unlock the door (lift the lock/vent flap handle) increases with the airplane pressurization level.

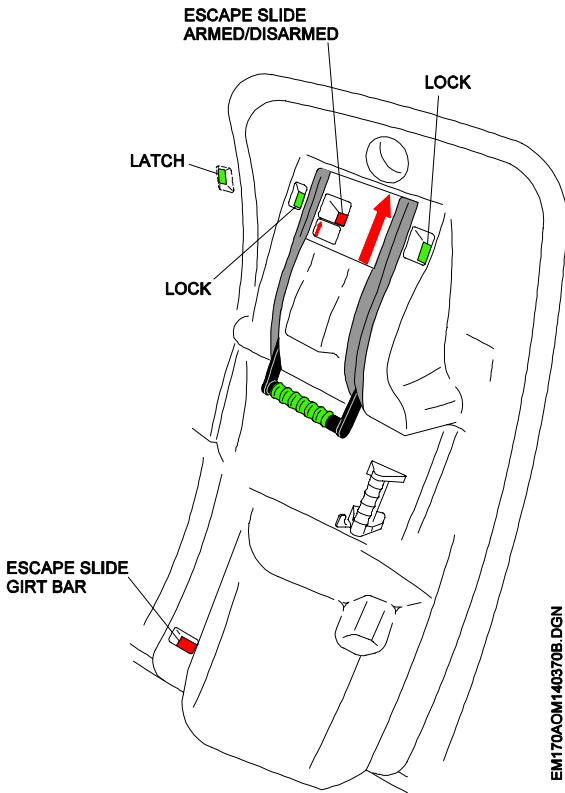
The escape slide handle arms/disarms the emergency system (escape slide and door's emergency assisting system) and engages/disengages the girt bar.



INTERNAL HANDLES

DOOR INDICATIONS

One green latch and two green lock indications are provided to ensure the door is secured in the locked position. An escape slide ARMED/DISARMED indication provides the escape slide armed/disarmed condition. A red indication in the bottom of the door provides means to verify if the girt bar is engaged.



DOOR INDICATIONS

Door's indications change according to handles' positions.

MAIN HANDLE DOWN

- Door: Closed
- Latch indication: GREEN

MAIN HANDLE UP

- Door: Open
- Latch indication: NO green indication

LOCK/VENT FLAP HANDLE DOWN

- Vent flap: Closed
- Lock indications: GREEN

LOCK/VENT FLAP HANDLE UP

- Vent flap: Open
- Lock indications: NO green indications

ESCAPE SLIDE HANDLE DOWN

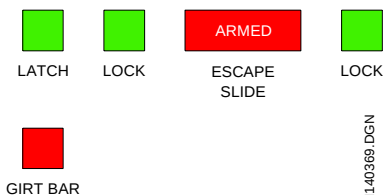
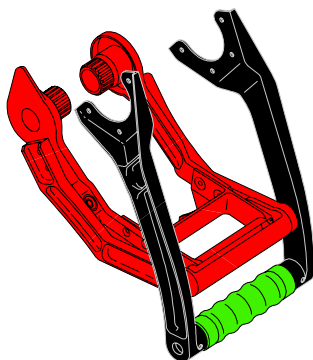
- Escape slide: Armed
- Escape slide indication: RED ARMED
- Girt bar indication: RED – girt bar connected to airplane.

ESCAPE SLIDE HANDLE UP

- Escape slide: Disarmed
- Escape slide indication: GREEN DISARMED
- Girt bar indication: NO red indication – girt bar disconnected from airplane.

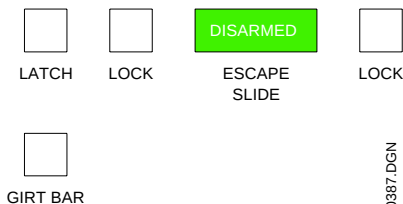
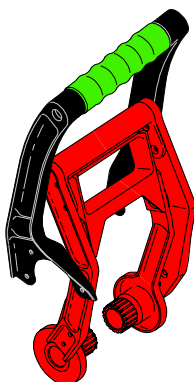
The following door indications are shown for different internal handles' positions.

- Main handle DOWN (Door closed and latched)
- Lock/Vent Flap handle DOWN (Vent Flap closed and door locked)
- Escape Slide handle DOWN (Escape Slide ARMED)



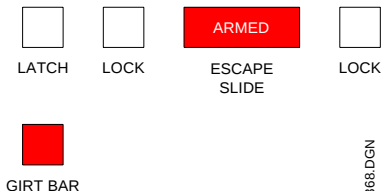
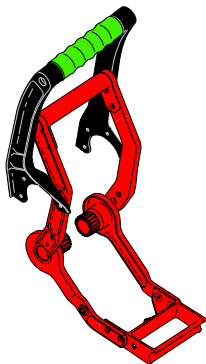
EM170A OM140369.DGN

- Main handle UP (Door unlatched and opened)
- Lock/Vent Flap handle UP (Vent Flap opened and door unlocked)
- Escape Slide handle UP (Escape Slide DISARMED)



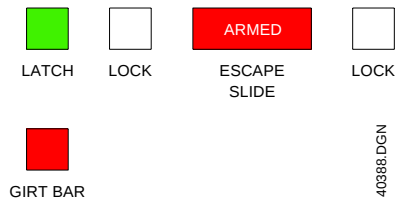
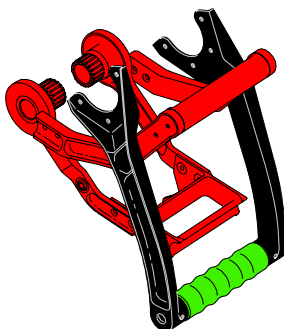
EM170A OM140387.DGN

- Main handle UP (Door unlatched and opened)
- Lock/Vent Flap handle UP (Vent Flap opened and door unlocked)
- Escape Slide handle DOWN (Escape Slide DEPLOYED)



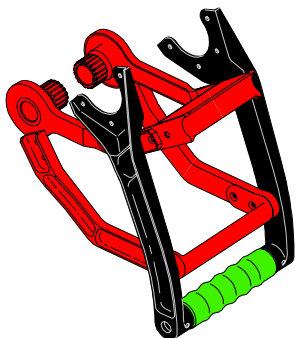
EM170AOM140368.DGN

- Main handle DOWN (Door closed and latched)
- Lock/Vent Flap handle UP (Vent Flap opened and door unlocked)
- Escape Slide handle DOWN (Escape Slide ARMED)



EM170AOM140388.DGN

- Main handle DOWN (Door closed and latched)
- Lock/Vent Flap handle DOWN (Vent Flap closed and door locked)
- Escape Slide handle UP (Escape Slide DISARMED)



LATCH



LOCK



ESCAPE
SLIDE



LOCK

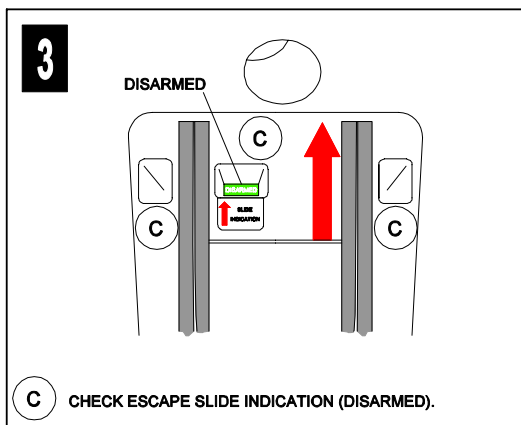
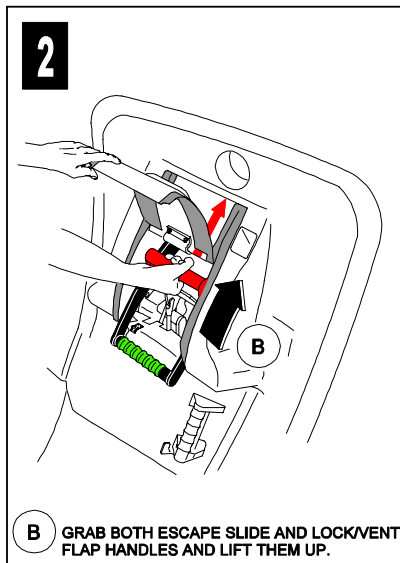
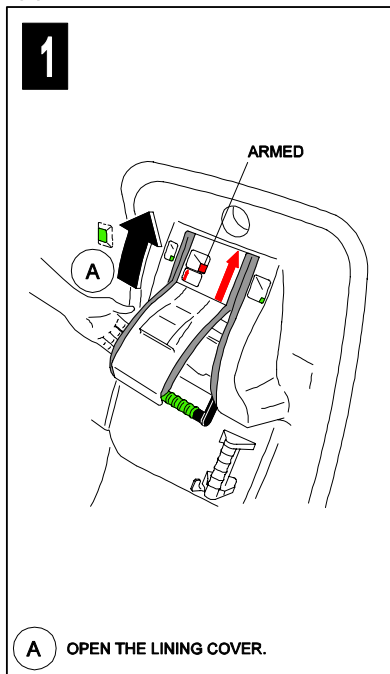


GIRT BAR

EM170AOM140389.DGN

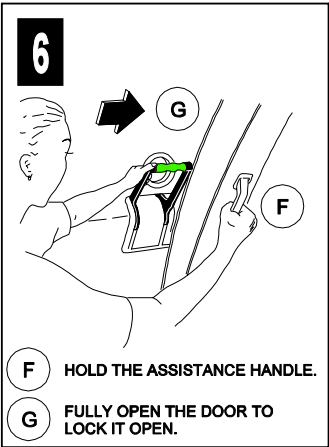
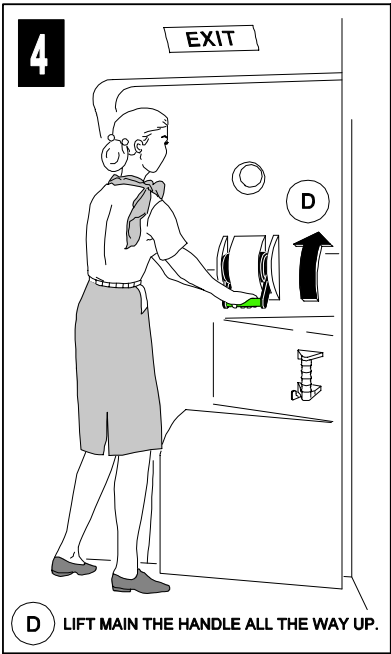
DOOR OPENING – NORMAL OPERATION

TO OPEN:



EM170AOM140328E.DGN

ESCAPE SLIDE DISARM

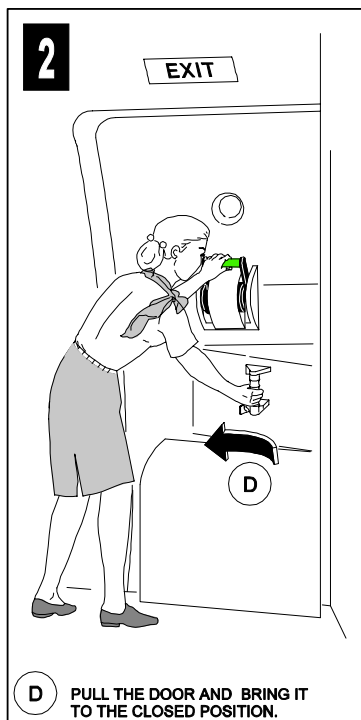
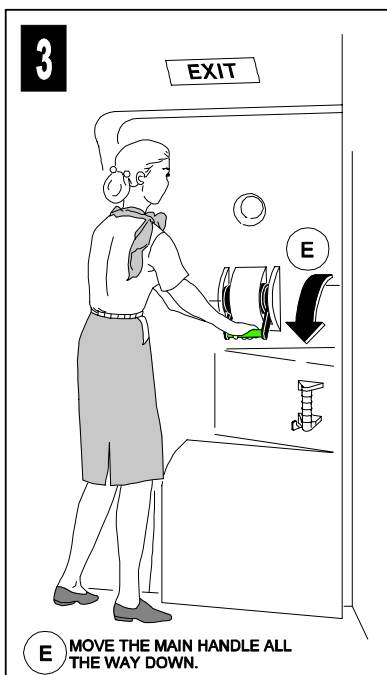
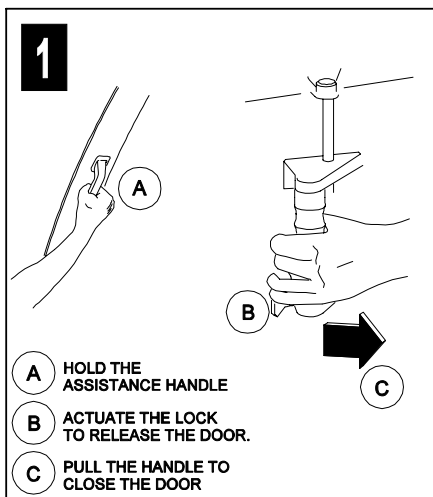


EM170AOM140328B.DGN

MAIN HANDLE ACTUATION

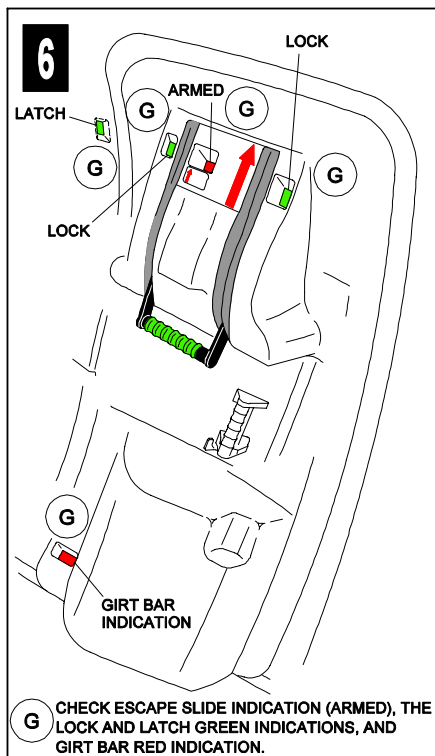
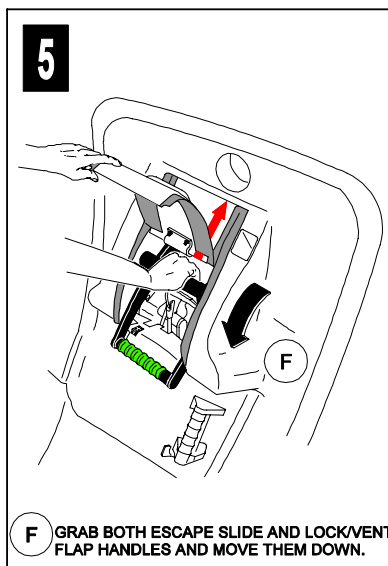
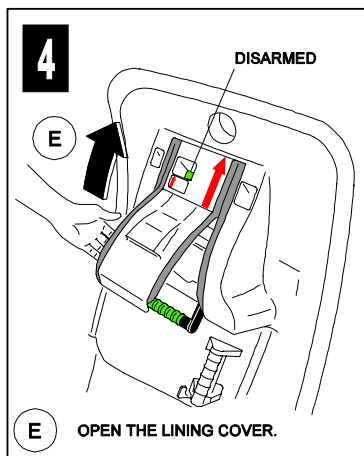
DOOR CLOSING – NORMAL OPERATION

TO CLOSE:



EM170AOM140021B.DGN

MAIN HANDLE ACTUATION

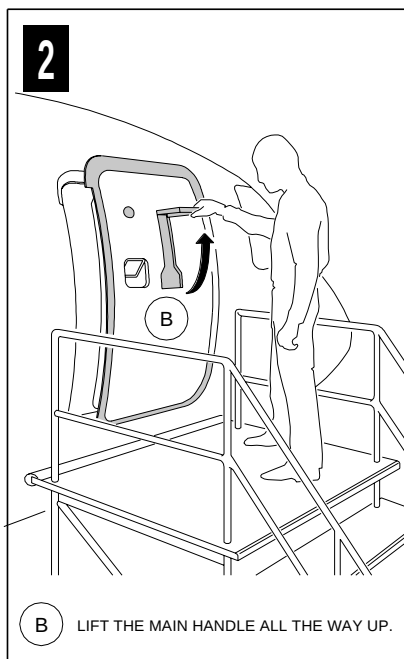
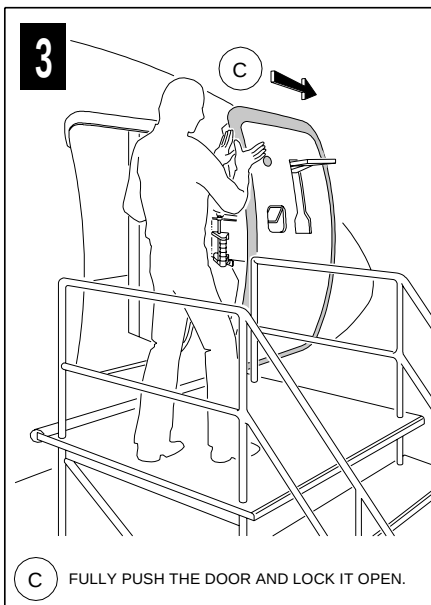
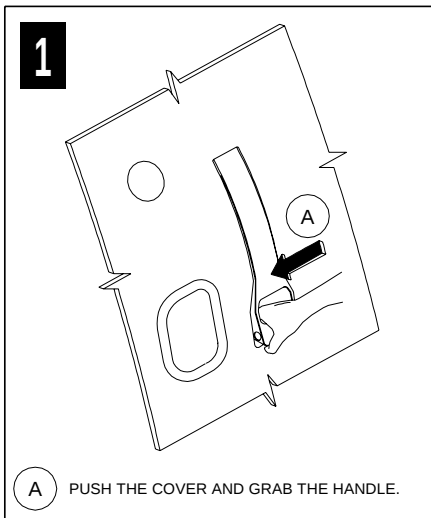


EM170AOM140330D.DGN

ARMING ESCAPE SLIDE

DOOR OUTSIDE OPENING

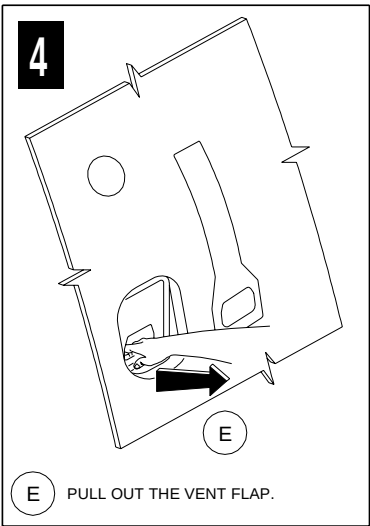
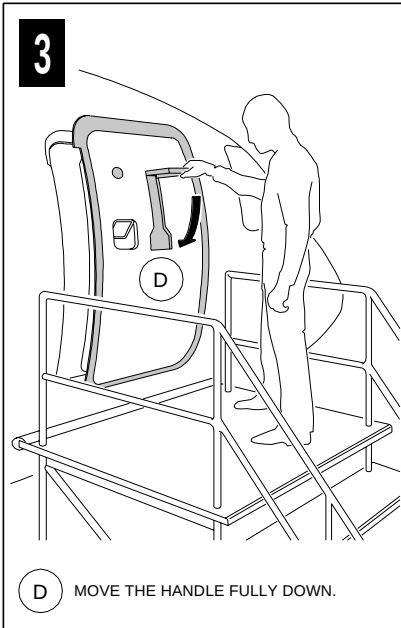
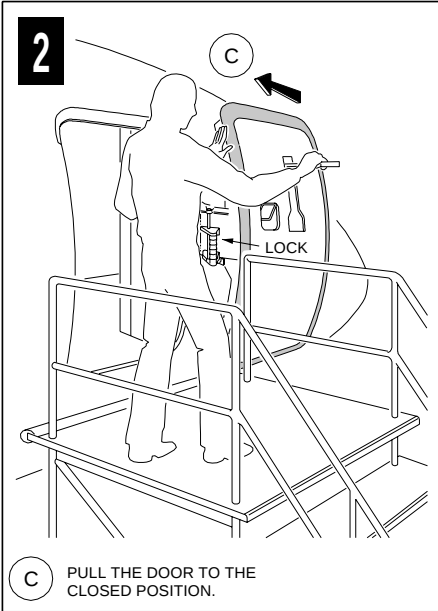
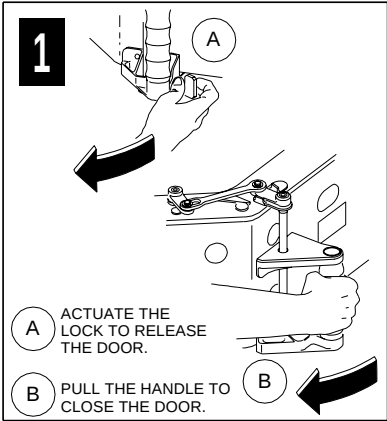
TO OPEN:



EM170AQM140025A.DGN

DOOR OUTSIDE CLOSING

TO CLOSE:



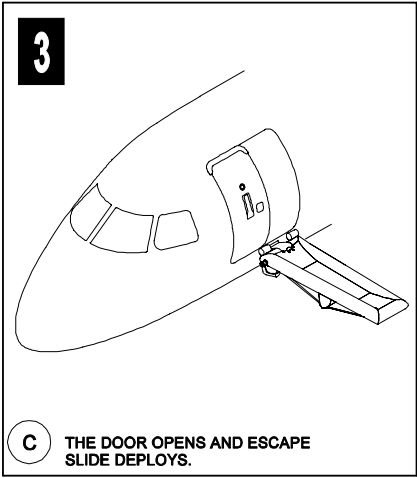
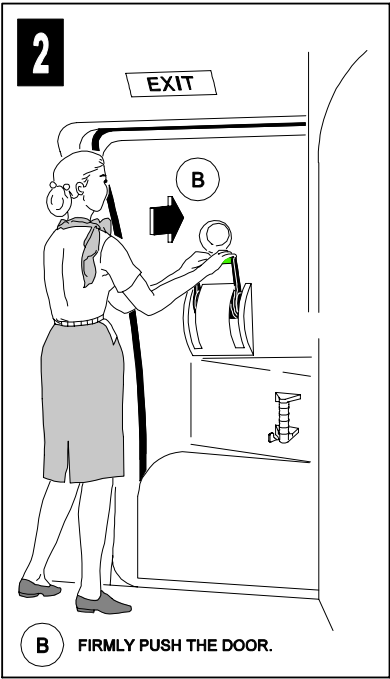
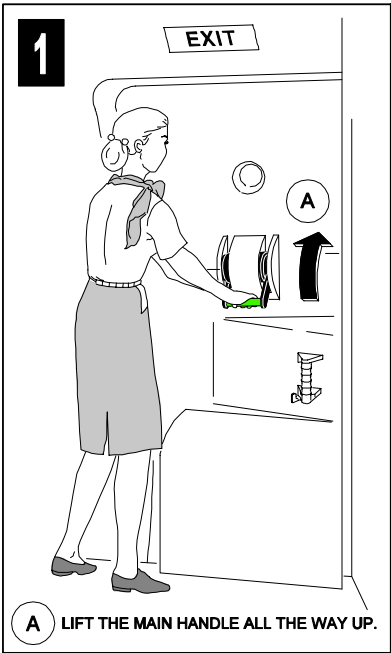
EM170AOM140026A.DGN

EMERGENCY EXITS

Both service and passenger doors are designed as type I emergency doors. Emergency slides are provided at both passenger and service doors. The direct vision windows in the cockpit are designed as emergency exits.

Opening the door from the inside in emergency mode will activate the Emergency Assisting System that will fully open the door after lifting of main internal handle. The Emergency Assisting System is installed in pax and service doors.

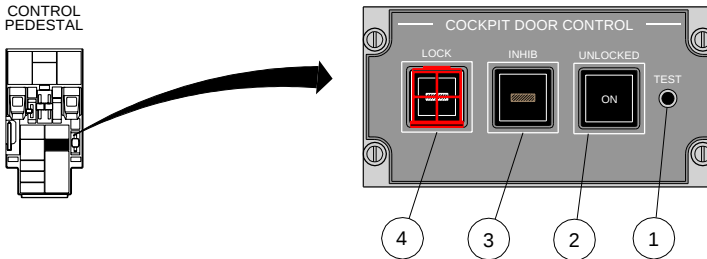
DOOR OPENING – EMERGENCY OPERATION



EM170AOM14002B.DGN

REINFORCED COCKPIT DOOR

CONTROL PANEL IN THE COCKPIT



EM170AOM140331.DGN

1 – TEST BUTTON

- Continually tests the buzzer while the test button is pressed, regardless of audio selection.

2 – UNLOCKED INDICATION

- Turns on when door is unlocked.
- Starts flashing when the EMERG CALL pushbutton on the passenger cabin control panel is pressed.
- Turns off when the INHIB pushbutton is pressed.

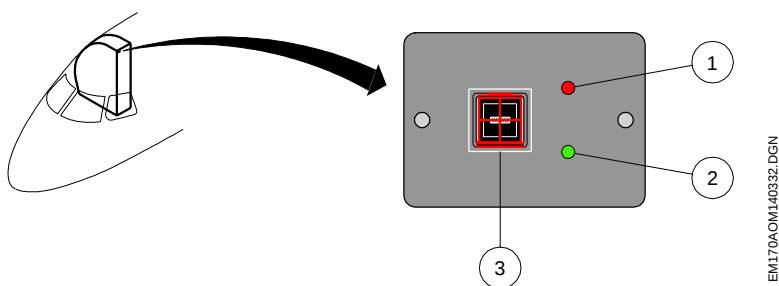
3 – INHIB PUSHBUTTON

- Inhibits, for 500 seconds, the emergency call command from cockpit door control panel in the passenger cabin.
- Lights up the red LED in the passenger cabin control panel.
- The cockpit door opens if the INHIB pushbutton is not pressed up to 30 seconds after the EMERG CALL pushbutton on the passenger cabin control panel is pressed.

4 – LOCK PUSHBUTTON (GUARDED)

- Controls the cockpit door's power supply.
- Activates and deactivates the electromechanical door latch.
- Deactivates the inhibition control.
- Resets the buzzer alarm and EMERG CALL command.
- Resets the green led on the door's control panel in the passenger cabin.

CONTROL PANEL IN THE PASSENGER CABIN



1 – RED LED

- Indicates that the INHIB pushbutton in the cockpit was pressed and EMERG CALL is temporarily inhibited.

2 – GREEN LED

- Indicates the cockpit door is unlocked.

3 – EMERG CALL PUSHBUTTON (GUARDED)

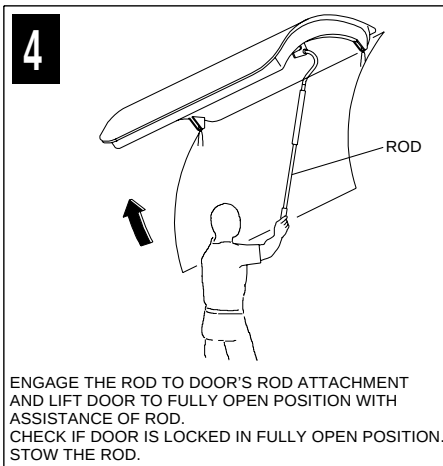
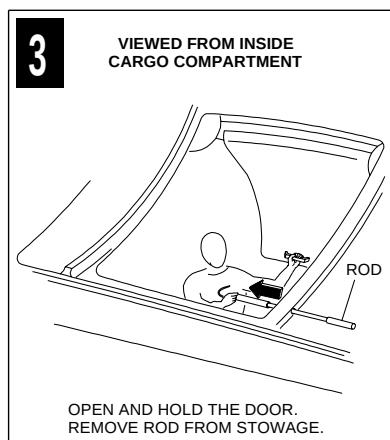
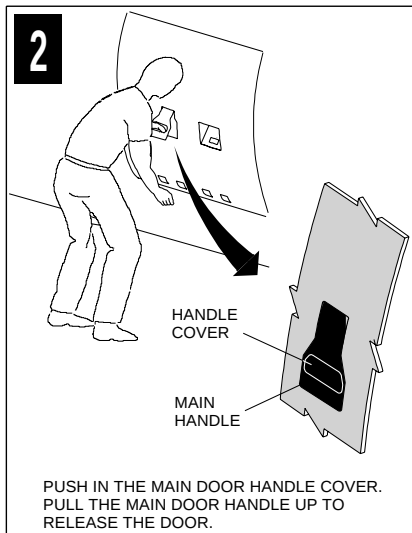
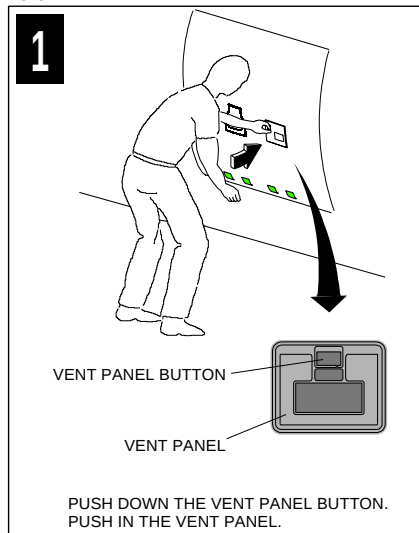
- Activates the buzzer alarm sequence in the cockpit.
- If the INHIB pushbutton is not pressed within 30 seconds after an EMERG CALL command, the hatched white indication turns off 4 seconds before the unlock of cockpit door.

CARGO DOORS

The cargo doors located aft and forward of the wing on the right side of the fuselage are manually operated from the outside. They have a locking mechanism controlled by an external handle, stowed in the lower half of the door. The vent flap prevents pressurization of the airplane above 0.5 psi when the door is not fully closed, latched and locked. The cargo doors open outwards, are hinged along the upper edge and are latched at the lower edge with four hooks.

CARGO DOORS OPENING

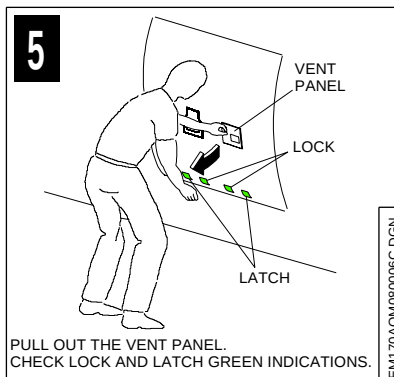
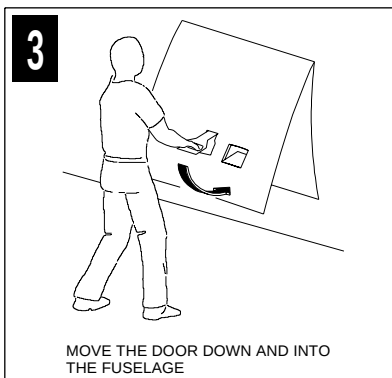
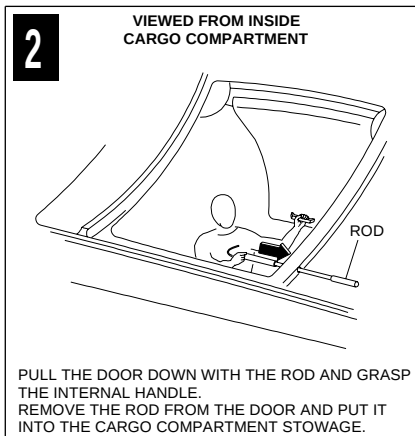
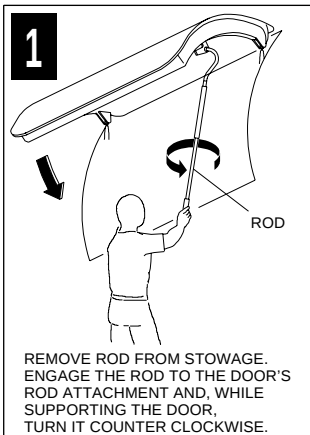
TO OPEN:



EM170AOM080005B.DGN

CARGO DOORS CLOSING

TO CLOSE:

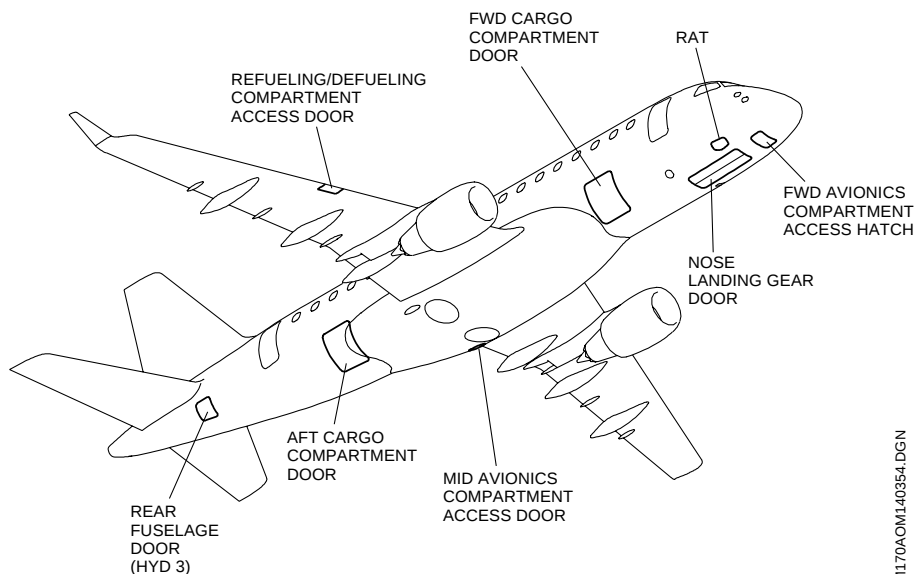


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ACCESS DOORS

A number of access doors, which provide access for servicing the airplane systems and equipment, can be found along the fuselage.

- Forward avionics compartment access door.
- Mid avionics compartment access door.
- Fueling/defueling compartment access door.
- Rear fuselage door.



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ACCESS DOORS

DOORS' WARNING SYSTEM

Door warning is provided for all doors and hatches in the pressurized airplane. Proximity sensors processed by the proximity sensor evaluation modules (PSEM), monitor the doors.

An EICAS CAUTION message displays whenever an unlocked condition of any door has occurred. Additionally, the MFD indicates the open door condition in a graphical representation.

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ESCAPE SLIDE

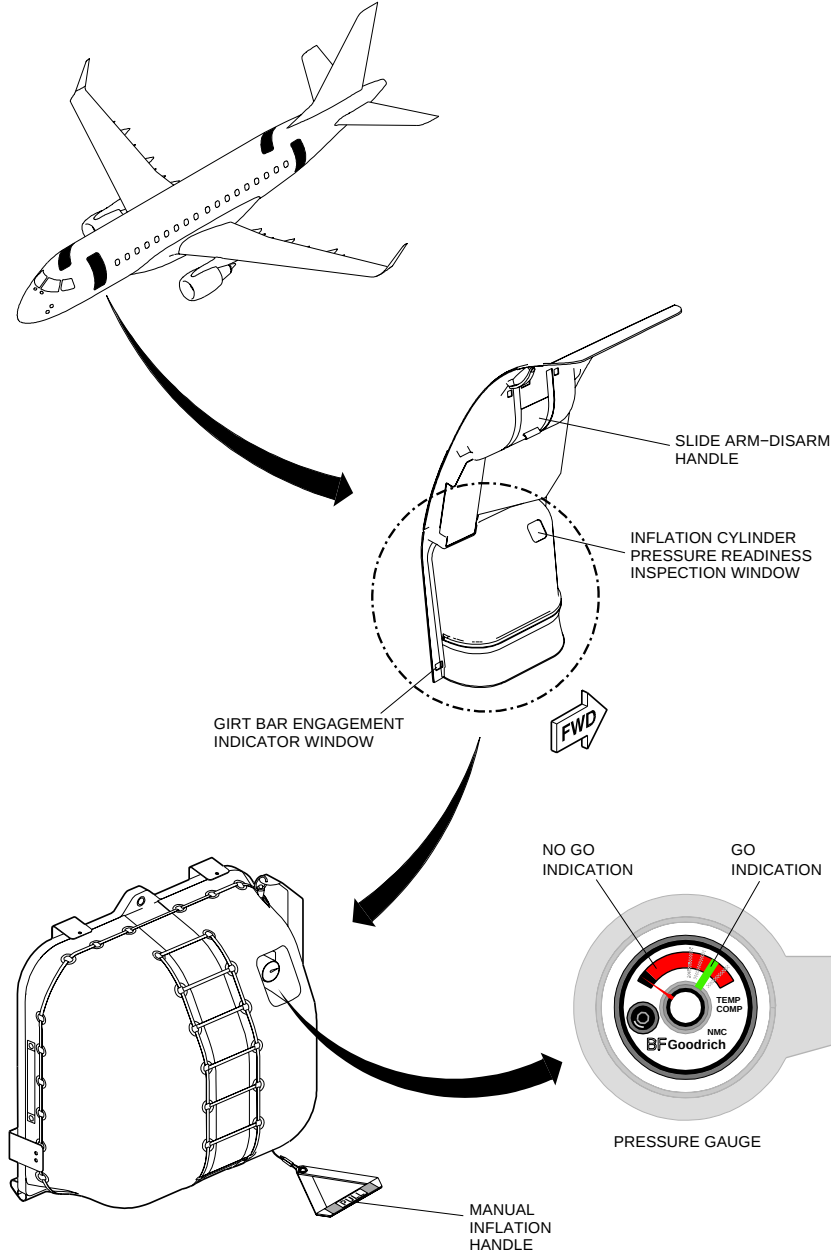
The escape slides are designed to provide passengers and crew with a means to safely descend from the airplane to the ground during an emergency evacuation. In the event of emergency evacuation, the slides deploy automatically when the exit door is opened.

Upon completion of the inflation sequence, the slide is fully inflated and ready to assist passengers and crew in descending to the ground.

The escape slides are armed by lifting the slide arming lever cover located on the door and moving the slide arming lever to the “armed” position (down). The lever movement attaches the girt bar to the cabin floor brackets. The escape slide is attached to the girt bar by means of a fabric girt.

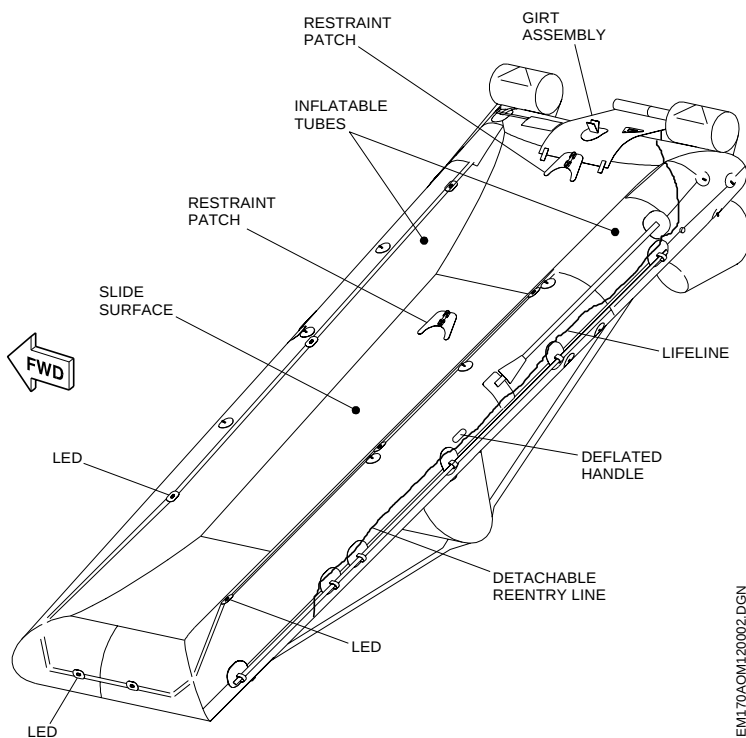
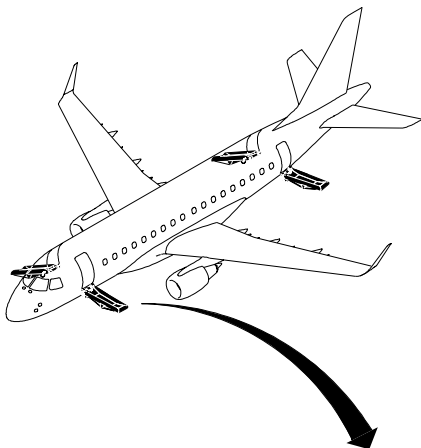
Opening the door from the outside automatically disengages the girt bar from the floor fittings, disarming the slide.

A dedicated battery powers the escape slide lights, which will be on for a minimum of 10 minutes even after escape slide disconnection.



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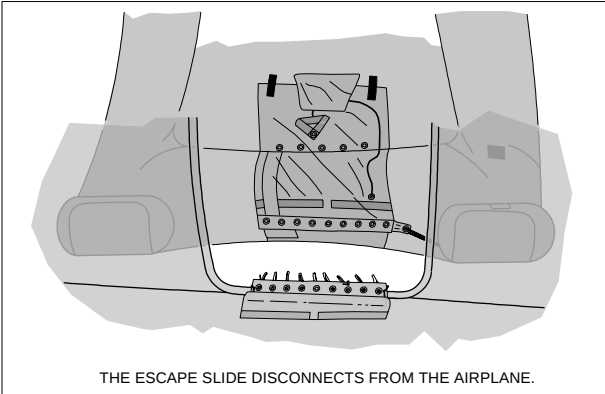
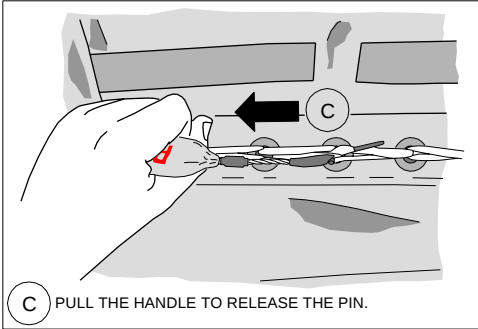
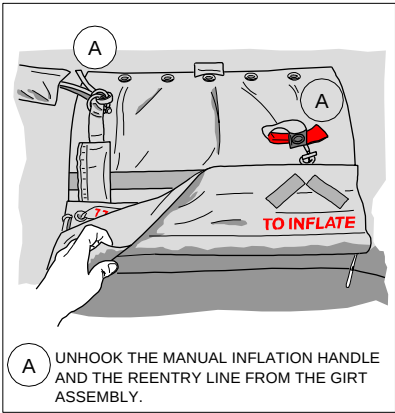
ESCAPE SLIDE – PACKED



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ESCAPE SLIDE – DEPLOYED

ESCAPE SLIDE DISCONNECTION



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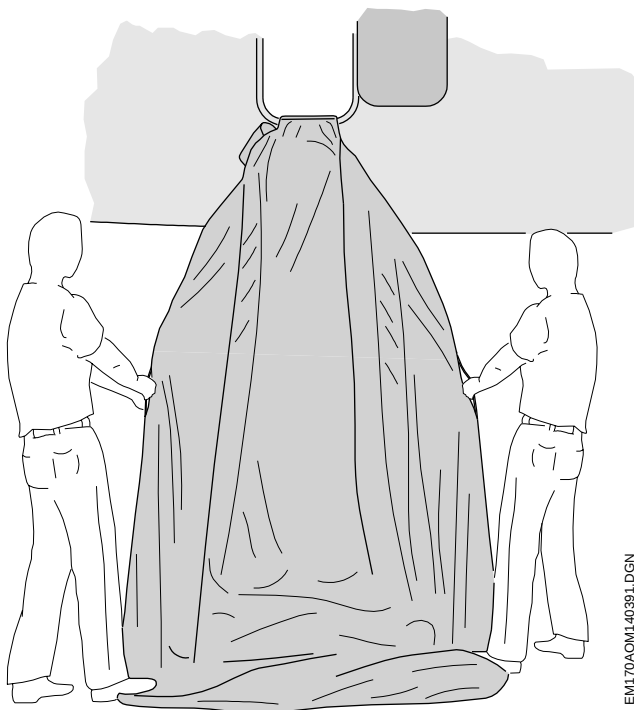
ABNORMAL OPERATION

The airplane escape slide is equipped with a manual inflation actuation control. When the inflation system does not actuate automatically, the cabin attendant should pull on the manual inflation handle, which then activates the inflation system and fully inflates the slide.

The airplane escape slide is designed to permit use with ground personnel assistance as a non-inflatable device in the event of puncture or tear. The resulting damage may deflate the escape slide.

In this case, people already positioned on the ground may pull the slide tightly by its handles while other passengers continue to evacuate from the airplane.

DEFLATED ESCAPE SLIDE OPERATION



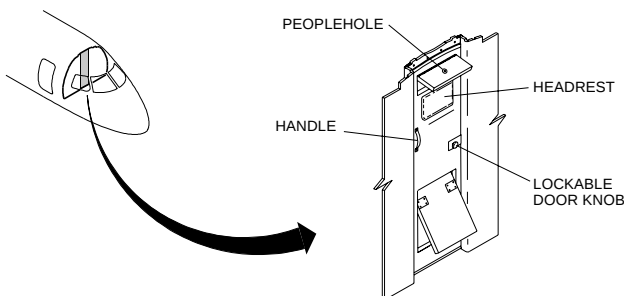
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COCKPIT DOOR

The cockpit door physically separates the cockpit and the passenger cabin. A latch on the cockpit side and a keyhole on the passenger cabin side of the door lock and unlock the aft doorknob.

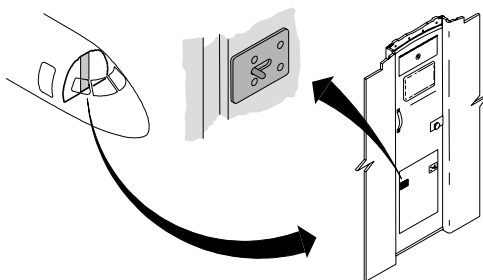
A peephole enables the flight crew to ascertain who wants to enter the cockpit.

Two decompression panels are installed on the door to equalize the pressure between the cockpit and passenger cabin in the event of a rapid decompression. A spring pressure sensor unlocks the panels.



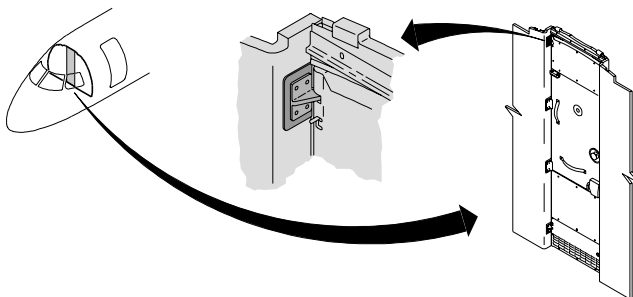
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If the door becomes jammed, the cockpit crew is evacuated by removing the lower decompression panel, sliding the locking latches inboard and pushing the panel aft.



EM170AOM140342.DGN

The cockpit door is removed disengaging both hinge pivots on the cockpit side of the door, rotating the doorknob, and pushing the door aft.



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CABIN SURVEILLANCE SYSTEM (CSS) (App. to SP-LDH and on)

GENERAL

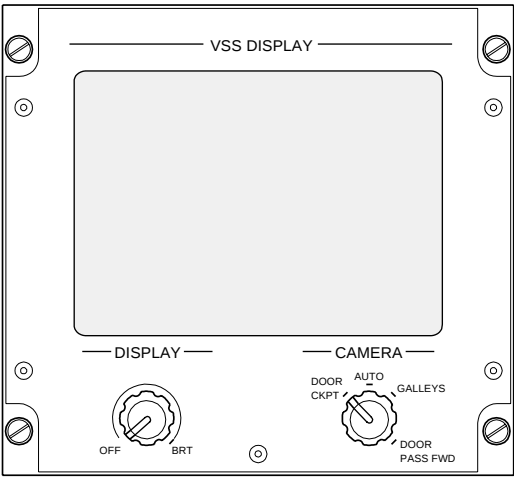
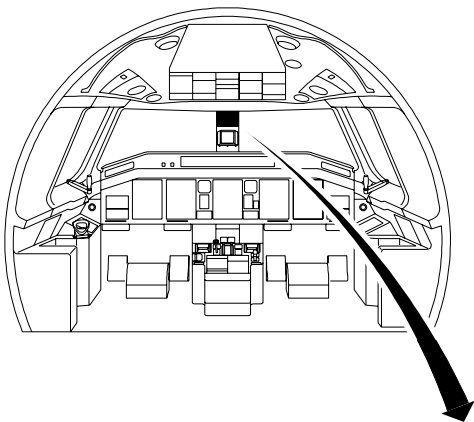
The Cabin Surveillance System (CSS) provides the means to monitor the entire door area outside the cockpit from either pilot's seats. It aids the flight crew with the identification of persons requesting entry to the cockpit and the detection of suspicious behavior or a potential threat.

The CSS is composed of three infrared video cameras and one video unit, above the compass and between the pilot seats. The DC BUS 1 powers the CSS.

VIDEO UNIT

Video display is achievable under all operational lighting conditions and provides sufficient resolution to clearly identify persons requesting entry into the cockpit. The images transmitted to the video display are not recorded.

The system is turned on by switching the BRT/OFF knob on the CSS video unit. The other knob selects the video camera that will transmit the image.

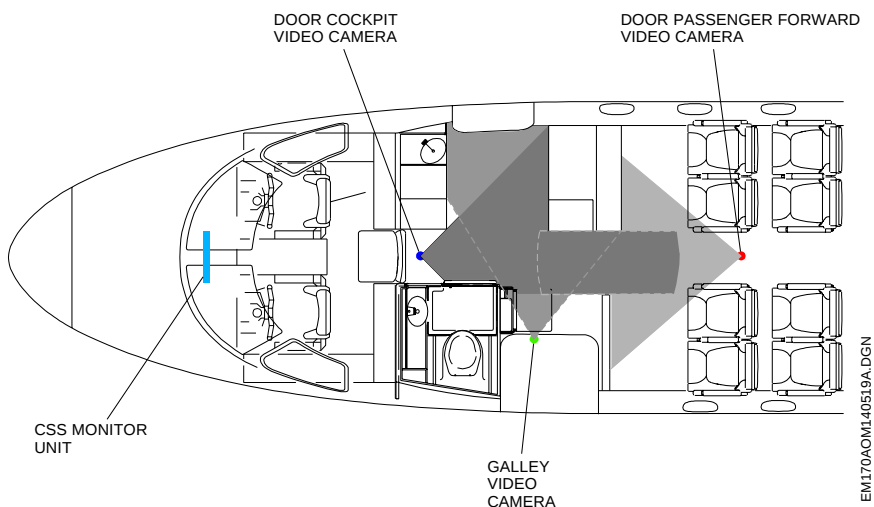


CSS VIDEO UNIT

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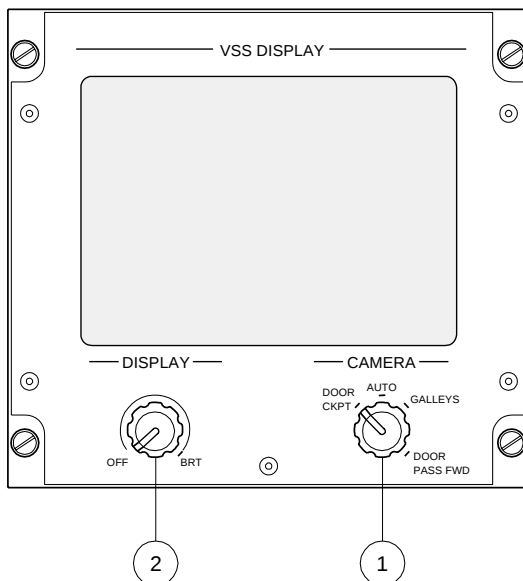
VIDEO CAMERAS

One video camera provides images of the cockpit door area. A second video camera furnishes images of the forward pax doors area, and a third video camera covers the galleys area. The CSS field of view is limited to the forward area of the first row of passenger seats. The passenger seats area and aft galleys/doors area are not monitored.



CSS VIDEO LOCATION

CABIN SURVEILLANCE SYSTEM (CSS)



1. VIDEO CAMERA SELECTOR KNOB

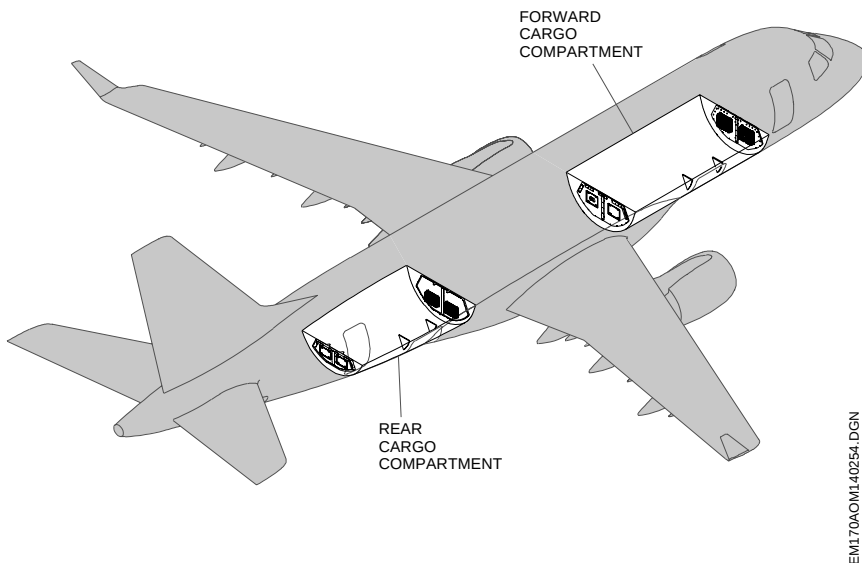
- DOOR CKPT: furnishes images of cockpit door area.
- AUTO: automatically switches the image from one video camera to another with an interval of 3 seconds.
- GALLEYS: furnishes images of the galleys area.
- DOOR PAX FWD: furnishes images of the forward pax doors area.

2. OFF/BRIGHT SELECTOR KNOB

- OFF: turns off the CSS.
- BRT: turns on the CSS and adjusts the brightness intensity.

CARGO COMPARTMENT

The EMBRAER 170 has two class C cargo compartments, which means that they are protected against damage by fire, both being equipped with a fire detector and a fire extinguishing system.



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EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	DOOR CRG AFT (FWD) OPEN	Associated baggage door open or not properly locked.
	DOOR PAX AFT (FWD) OPEN	Main door is open or not properly locked either on the ground with any engine running or in flight.
	DOOR SERV AFT (FWD) OPEN	Service door is open or not properly locked either on the ground with any engine running or in flight.
CAUTION	APM FAIL	At least three APMs have failed.
	APM MISCOMP	One or more APM's do not match.
	CHECK EICAS	Wrap-around comparison monitor of DU critical data has detected a failure. Continued operation may result in the display of misleading information.
	CHECK MFD 1 (2)	Wrap-around comparison monitor of DU critical data has detected a failure. Continued operation may result in the display of misleading information.
	CHECK PFD 1 (2)	Wrap-around comparison monitor of DU critical data has detected a failure. Continued operation may result in the display of misleading information.
	DISPLAY CTRL FAIL	Loss of all display controllers
	DISPLAY CTRL FAULT	Partial loss of display controllers
	DOOR CENTER (FWD) EBAY OPEN	Associated electronic bay is open or not properly locked.
	DOOR HYD OPEN	Hydraulic system 3 access door is open or not properly locked.
	EICAS FAULT	DU has suffered failure condition(s) that affect the functionality
	EICAS OVHT	DU has suffered an over temperature condition. Continued operation may result in the loss of DU
	EMERG LT NOT ARMED	Emergency lighting system is not armed.

TYPE	MESSAGE	MEANING
CAUTION	EMERG LT ON	Emergency lighting system is on.
	MCDU 1 (2) OVHT	Respective MCDU has suffered an over temperature condition.
	MFD 1 (2) FAULT	DU has suffered failure condition(s) that affect the functionality
	MFD 1 (2) OVHT	DU has suffered an over temperature condition. Continued operation may result in the loss of DU
	PFD 1 (2) FAULT	DU has suffered failure condition(s) that affect the functionality
	PFD 1 (2) OVHT	DU has suffered an over temperature condition. Continued operation may result in the loss of DU.
ADVISORY	APM FAULT	One or two APMs have failed.
	CCD 1 (2) FAULT	Cursor control of one or more DU's has been lost
	CMS FAIL	1 CMS has failed, dispatch relief possible
	DOOR FUELING OPEN	Fueling door open or not properly locked
	EMERG LT BATT FAULT	One of the four emergency batteries is not working properly.

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ATA CHAPTER 26

FIRE PROTECTION

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INTRODUCTION

The fire protection system provides fire detection and extinguishing capabilities for:

- Engines
- APU
- Cargo Compartments
- Lavatories

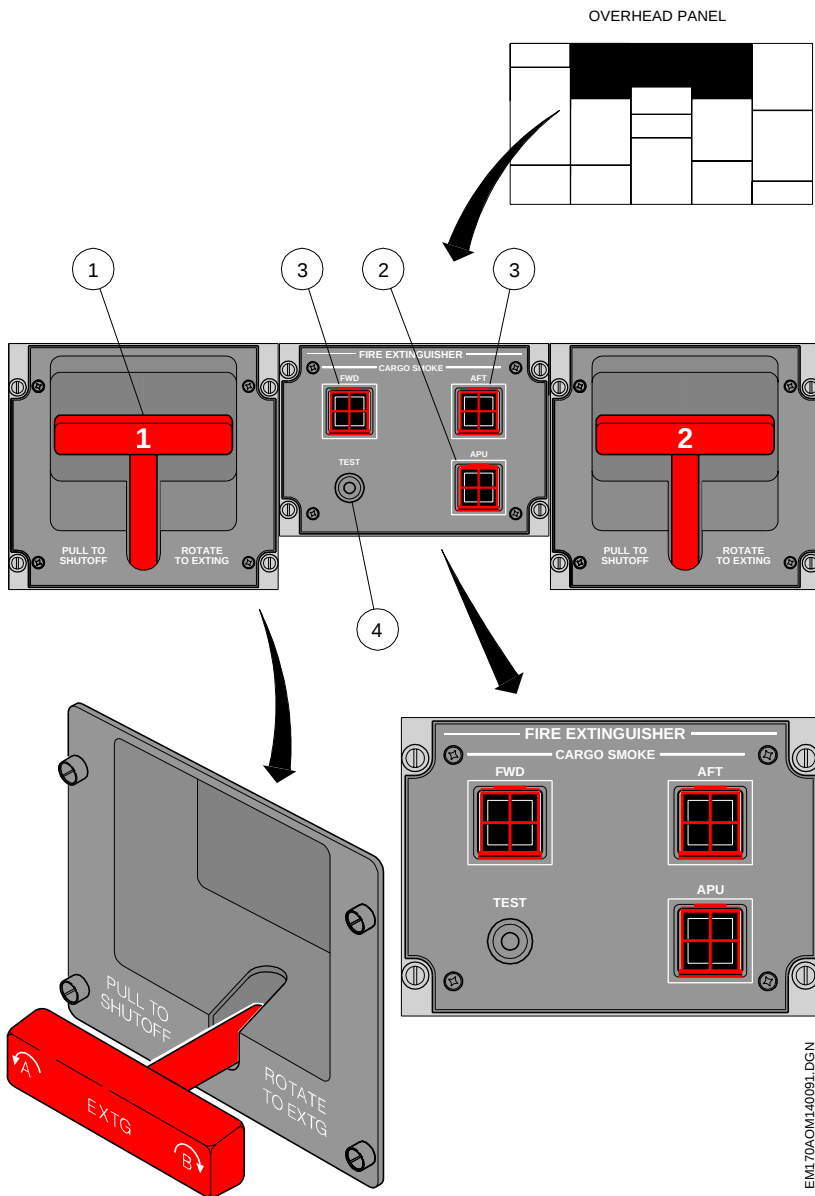
In addition, portable fire extinguishers are located in the cockpit and cabin.

In the event of fire protection system component failure, an EICAS message will be displayed.

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CONTROLS AND INDICATIONS

FIRE PROTECTION CONTROL PANEL



CARGO AND APU FIRE DETECTION/EXTINGUISHING PANEL

1 – ENGINE FIRE EXTINGUISHER HANDLE

PULL: closes the associated engine bleed air, fuel and hydraulic shutoff valves.

ROTATE (left/right): discharges fire extinguisher bottles into the associated engine.

2 – APU FIRE EXTINGUISHER BUTTON (GUARDED)

Momentary action pushbutton:

- Closes the APU fuel shutoff valve and discharges the APU fire extinguisher bottle.

3 – CARGO FIRE DETECTION/EXTINGUISHER BUTTON (GUARDED)

Momentary action pushbutton:

- Automatically discharges the high and low-rate cargo extinguisher bottles of the associated cargo compartment.

4 – FIRE DETECTION SYSTEM TEST BUTTON

Momentary action button:

- Tests the cargo smoke, engine and APU fire detection systems.

ENGINE FIRE PROTECTION

The Engine Fire Protection System provides engine fire detection and extinguishing. Electrical buses supply power to the system as follows:

- Engine fire detection:
MAU 1 (DC ESS BUS 1) AND MAU 3 (DC ESS BUS 2).
- Engine fire extinguishing:
HOT BATT BUS 1 AND HOT BATT BUS 2.

ENGINE FIRE DETECTION

The Engine Fire Detection System comprises eight pneumatic fire detectors in two loops. These loops are connected to the modular avionics unit (MAU), which receives and processes the electrical signal. An associated EICAS message is displayed whenever fire or a system fault has been detected. In the event of a fire, the system provides the following indications:

- aural warning sounds.
- the fire extinguisher handle illuminates.
- the master WARNING lights illuminate.
- the FIRE warning light on the respective ITT indicator illuminates.
- the EICAS WARNING message ENG 1 (2) FIRE is displayed.

ENGINE FIRE EXTINGUISHING

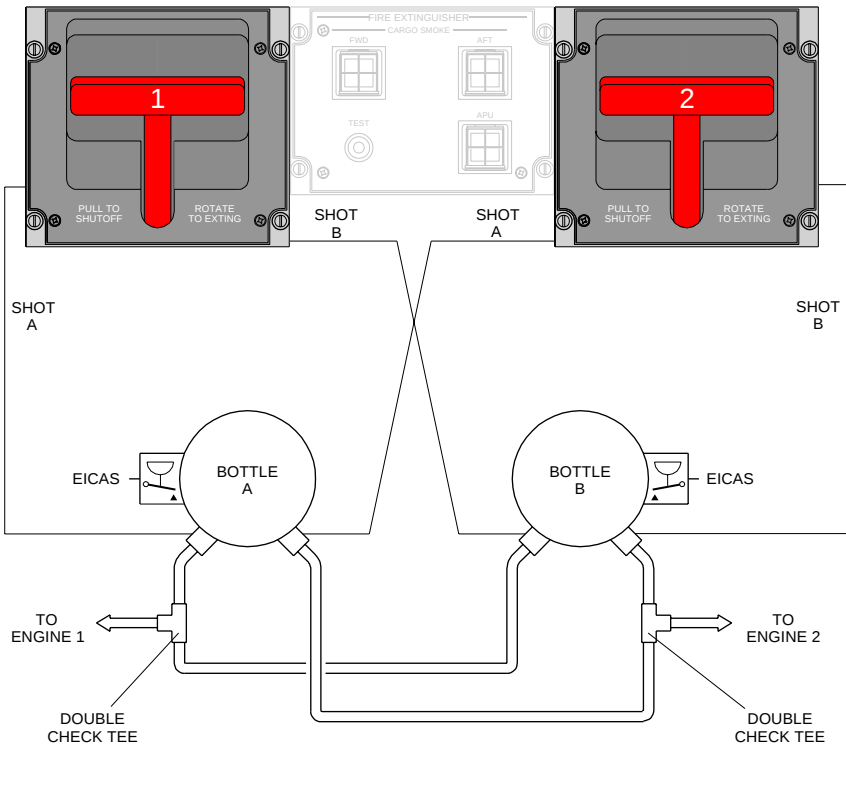
The Engine Fire Extinguishing System comprises two fire handles on the overhead panel and two fire-extinguishing bottles installed in the wing and fuselage fairing. The fire handle illuminates when fire is detected in the associated engine. Pulling the engine fire handle closes:

- the engine fuel and hydraulic shutoff valves.
- the engine bleed air shutoff valve.

Rotating the fire handles electrically controls the fire-extinguishing bottles. Either or both bottles can be discharged into either engine. Rotating the fire handle to the left side discharges extinguishing bottle A into the associated engine. Rotating in the other direction discharges extinguishing bottle B into the same engine.

NOTE: In case of engine fire extinguishing bottle shot, fire handle illumination may be lost. In this case, if the engine fire CAS message or the aural warning are still active, the second engine fire extinguishing bottle must be shot.

ENGINE FIRE SCHEMATIC



ENGINE FIRE PROTECTION SCHEMATIC

APU FIRE PROTECTION

The APU Fire Protection System provides APU fire detection and extinguishing. Essential electrical buses supply power to the system as follows:

- APU fire detection:
MAU 1 (DC ESS BUS 1) AND MAU 3 (DC ESS BUS 2).
- APU fire extinguishing:
DC ESS BUS 2.

APU FIRE DETECTION

The APU Fire Detection System comprises two pneumatic fire detectors in two loops. These loops are connected to the modular avionics unit (MAU), which receives and processes the electrical signal. An associated EICAS message is displayed whenever fire or a system fault has been detected. In the event of a fire the system provides the following indications:

- aural warning sounds.
- the red stripped bar of the APU emergency stop button illuminates.
- the master WARNING lights illuminate.
- the EICAS WARNING message APU FIRE is displayed.

APU FIRE EXTINGUISHING

The APU Fire Extinguishing System comprises one fire-extinguishing bottle installed in the rear fuselage. Pushing a dedicated button, located on the fire-extinguishing panel, discharges the APU extinguisher bottle. In the event of a fire this button illuminates when:

- the APU emergency stop button is pressed or;
- one minute after the alarm, if no further action has been taken.

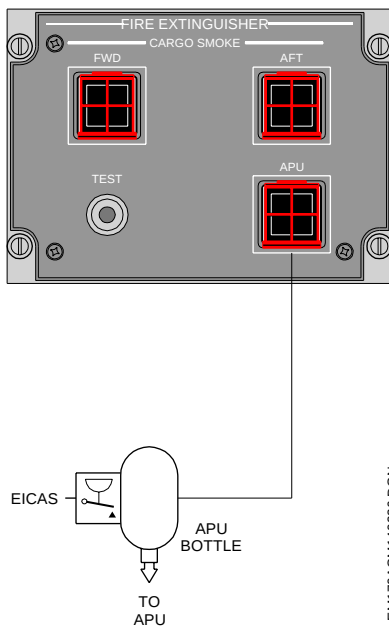
The light extinguishes when fire is no longer detected.

On ground, the APU will automatically shut down if the APU Emergency Stop Button is not pressed 10 seconds after the APU fire detection.

When the APU FIRE EXTINGUISHER button is pressed the system:

- discharges the APU fire bottle.
- shuts down the APU through the APU FADEC.
- closes the APU fuel shutoff valve (SOV).
- displays an EICAS ADVISORY message APU FIREX BTL DISCH.

APU FIRE SCHEMATIC



APU FIRE PROTECTION SCHEMATIC

CARGO COMPARTMENT FIRE PROTECTION

The Cargo Smoke Detection and Cargo Fire Extinguishing Systems protect the class C forward and aft cargo compartments. In the event of any system component failure, an EICAS message will be displayed.

CARGO COMPARTMENT SMOKE DETECTION

Each cargo compartment has an independent smoke detection system. Three smoke detectors are installed in the forward compartment and two in the aft compartment. The system is monitored by a periodic built-in test. The EICAS ADVISORY message CGR PROT FAULT is displayed whenever a system failure is detected. In the event of a fire the system provides the following indications:

- aural warning sounds.
- the master WARNING lights flashing.
- the associated cargo compartment extinguishing button illuminates.
- the EICAS WARNING message CRG AFT SMOKE or CRG FWD SMOKE is displayed. the EICAS ADVISORY message CGR ____ FIREX HI ARMED is displayed.

After smoke detection in the forward compartment, the air circulation fan in the forward compartment automatically turns off and the ventilation outflow valve closes.

CARGO COMPARTMENT FIRE EXTINGUISHING

The Cargo Fire Extinguishing System comprises two different extinguisher bottles located in the center electronics bay. The system is able to extinguish fire in either of the compartments. Pressing the associated cargo compartment button causes:

- the high-rate fire-extinguishing bottle to discharge immediately into the selected cargo compartment.
- the EICAS ADVISORY message CRG FIREX HI DISCH is displayed. the EICAS ADVISORY message CRG ____ FIREX LO ARMED is displayed.

One minute later, the second fire-extinguishing bottle discharges at a reduced flow rate and the agent remains in the selected cargo compartment for 60 minutes.

NOTE: - Pressing the associated pushbutton before the one-minute period immediately discharges the low-rate extinguishing bottle.
In case of fire on ground, the low-rate fire-extinguishing bottle is not automatically discharged. The flight crew must push the cargo fire-extinguishing pushbutton once again.

The system can be used even without a cargo smoke warning. In this case, the high rate bottle is armed by pushing the respective cargo fire extinguisher button and is indicated by the red button light and the associated EICAS message. If the button is pushed again within the next two minutes, the high-rate bottle will be discharged.

Depending on whether or not the airplane is weight on wheels, the sequence for the low-rate bottle is automatic in flight, or manual on ground. In flight, the second bottle will automatically fire after one minute. On ground the button has to be pushed twice to arm and to fire the low-rate bottle. If the button is not pressed a second time within two minutes after arming, the system will reset. When the fire test button is pressed the system will reset.

LAVATORY FIRE PROTECTION

The Lavatory Smoke Detection and Fire Extinguishing Systems protect the forward and aft lavatories. Each lavatory has a dedicated fire protection system.

LAVATORY SMOKE DETECTION

The Lavatory Smoke Detection System consists of one smoke sensor installed on each lavatory ceiling. If smoke is detected at either lavatory:

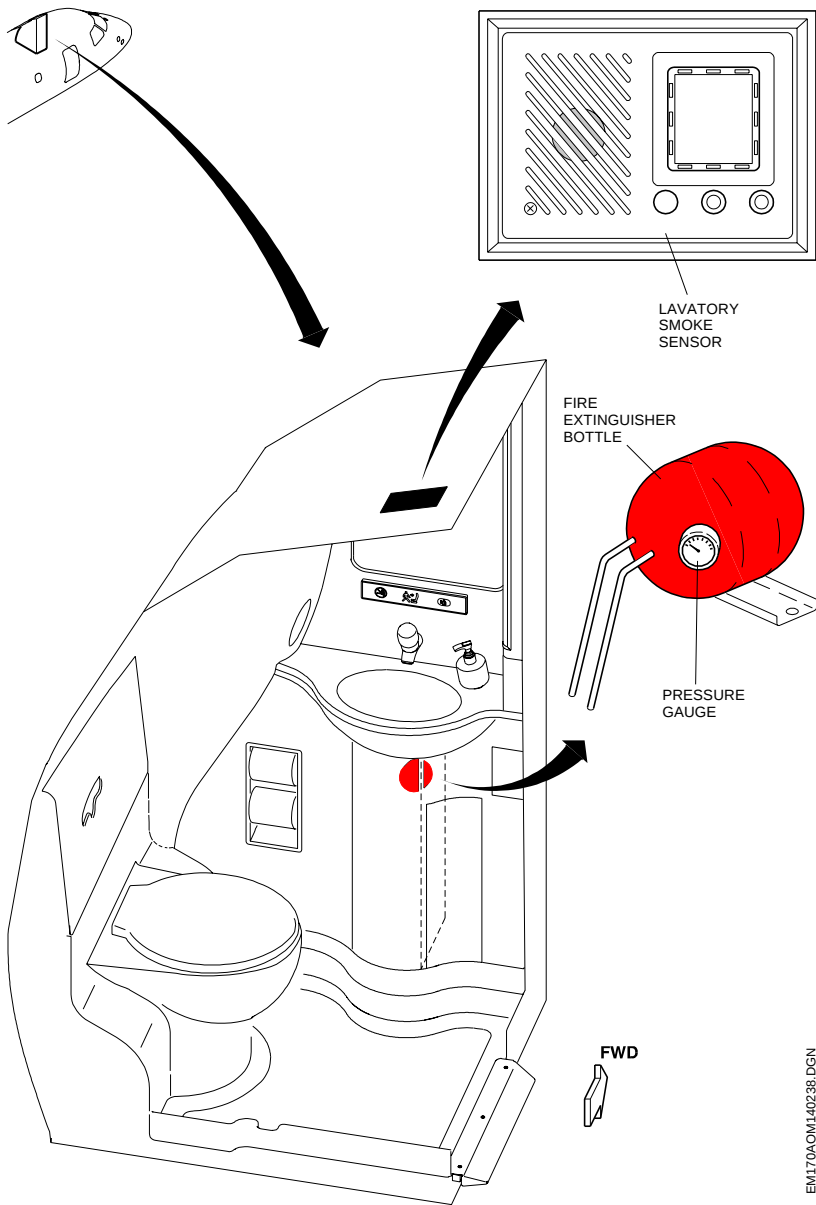
- the master WARNING light illuminates.
- the EICAS WARNING message LAV SMOKE is displayed.
- an alarm sounds in the lavatory where the smoke has been detected.
- a flashing amber light on the respective attendant lights (rainbow lights) illuminates.

LAVATORY FIRE EXTINGUISHING

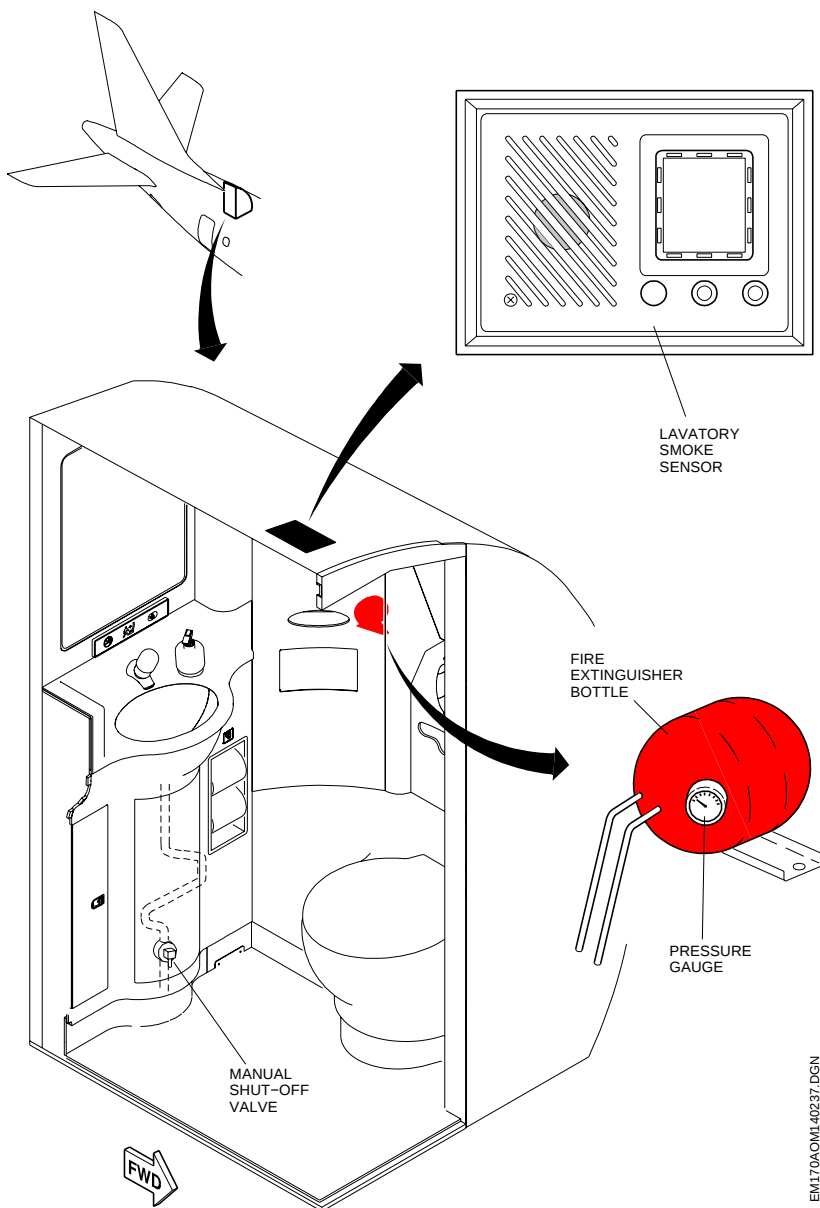
The Fire Extinguishing System consists of one fire-extinguisher bottle installed on each lavatory waste container.

When the temperature inside the waste container is high, the system automatically discharges the extinguishing agent. If required, the flight attendant can suppress the fire by using a portable fire extinguisher.

LAVATORY DETECTORS AND EXTINGUISHERS
LOCATION



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FIRE DETECTION SYSTEM TEST

The fire detection test button on the control panel provides a manual test for cargo smoke detection, engine fire detection and APU fire detection. Pressing this button causes:

- the aural warnings to sound.
- the master WARNING light to flash.
- the following messages to display on EICAS:
ENG 1 (2) FIRE.
APU FIRE.
CRG AFT (FWD) SMOKE.
- the fire extinguisher handles to steady illuminate.
- the cargo fire-extinguishing buttons to steady illuminate.
- the forward cargo compartment fan to de-activate and the ventilation outflow valve to close – only if bleed air is being provided by the engines or the APU.
- the FIRE warning light on the ITT indicator to illuminate.
- the APU fire-extinguishing button and the upper half of the APU emergency stop button to illuminate.

A flight attendant is responsible for completing the mandatory lavatory test. During this test, the smoke detectors, cabin crew and flight crew indications are tested. After the test switch is released, the EICAS WARNING message LAV SMOKE and the master warning indication are held for seven seconds.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	APU FIRE	A fire condition has been detected in the APU.
	CRG AFT (FWD) SMOKE	Smoke has been detected in the associated cargo compartment.
	ENG 1 (2) FIRE	A fire condition has been detected in the associated engine.
	LAV SMOKE	Smoke has been detected in the lavatory.
CAUTION	APU FIRE DET FAIL	APU fire detection system has failed.
	APU FIREX FAIL	APU fire-extinguisher bottle has failed.
	CRG AFT (FWD) FIRE SYS FAIL	All smoke detectors have failed in the associated compartment, or Pressure in any extinguisher bottle is low and the cartridges are intact, or any of the cartridge circuits are opened.
	ENG 1 (2) FIRE DET FAIL	Engine fire detection system has failed.
	LAV SMOKE DET FAIL	Lavatory smoke detection system has failed.
ADVISORY	APU FIREX BTL DISCH	APU fire-extinguisher bottle has been discharged.
	CRG FIRE PROT FAULT	Failures of smoke detectors in a Cargo Compartment or any SPDA internal failure, which does not render the smoke detection completely inoperative.
	CRG FWD (AFT) FIREX HI ARM	High rate Cargo Firex system armed either automatically or manually.
	CRG FWD (AFT) FIREX LO ARM	Low rate Cargo Firex system armed after High rate bottle discharged.
	ENG 1 (2) FIREX BTL A (B) FAIL	Associated fire-extinguisher bottle has failed.
	ENG FIREXBTL A (B) DISCH	Associated fire-extinguisher bottle has been discharged.
	CRG FIREX HI (LO) DISCH	Cargo high-rate (low-rate) discharge fire-extinguisher bottle has been discharged.
STATUS	CRG FIREX HI (LO) DISCH	Cargo high-rate (low-rate) discharge fire-extinguisher bottle has been discharged.

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INTRODUCTION

The Flight Control System is composed of the primary and the secondary flight control systems and their associated system components.

The primary flight control system consists of:

- Ailerons and the multi function roll spoilers for roll axis control.
- Elevators for pitch axis control.
- Rudder for yaw axis control.

The secondary flight control system consist of:

- Horizontal stabilizer.
- Flaps and Slats.
- The multi-function spoiler (when used as speed brakes or ground spoilers).
- Dedicated ground spoilers.

Hydraulic actuators control the respective flight control surfaces. These are generally referred to as Power Control Units (PCUs).

The ailerons are driven by conventional control cables that run from each control wheel back to a pair of hydro-mechanical actuators.

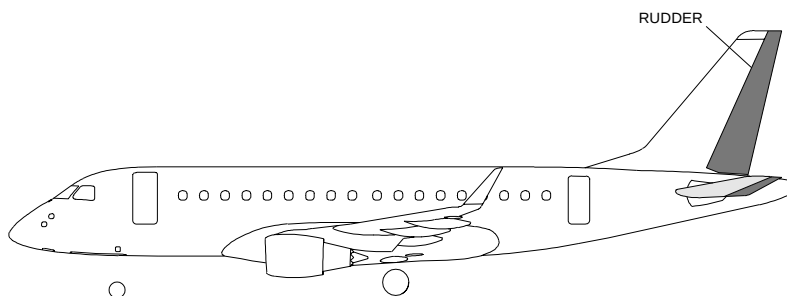
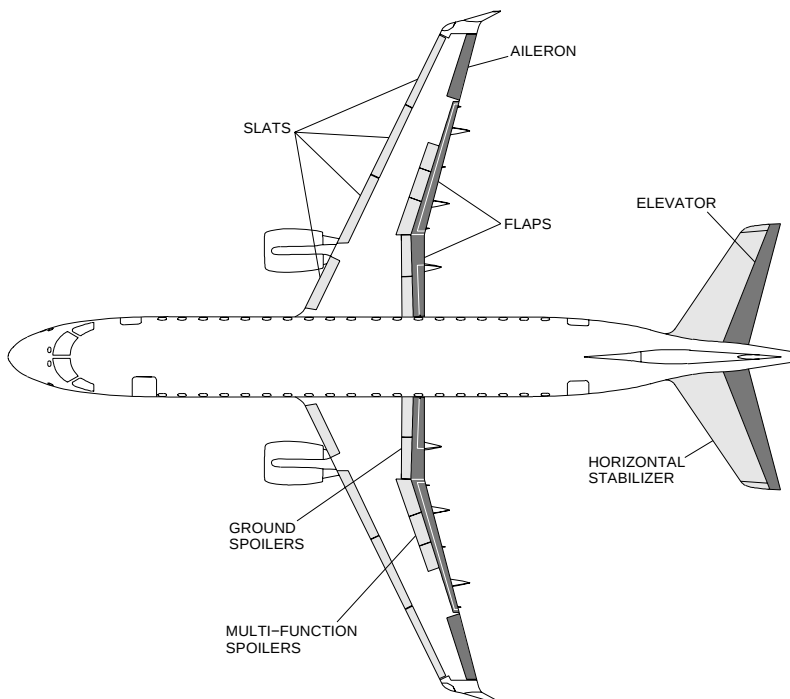
Elevators, rudders and roll spoilers as well as all secondary flight control systems, including the horizontal stabilizer, flaps and slats, ground spoilers and speed brakes, are controlled electronically using Fly-by-Wire (FBW) technology.

The primary flight control electronics are generally comprised of two complementary parts:

- The Primary Actuator Control Electronics (P-ACE).
- The Flight Control Module (FCM).

Primary Actuator Control Electronics (P-ACE) and/or Flight Control Modules (FCM) are employed to operate the respective electro-hydraulic or electro-mechanical actuators.

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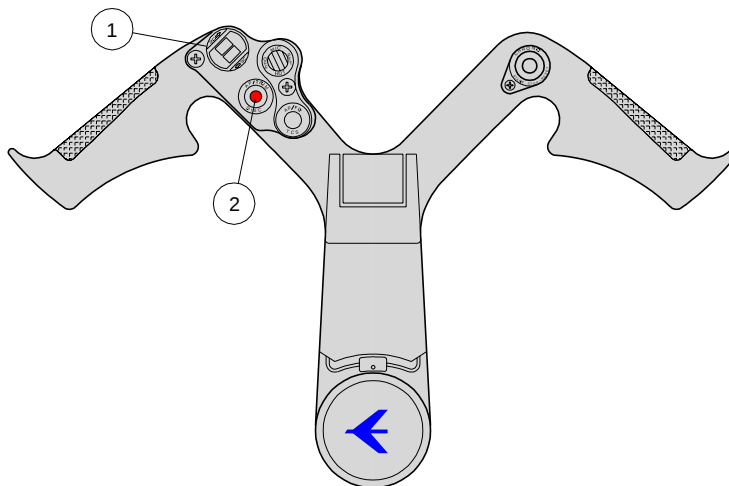


EMI170AOM140082.DGN

CONTROL SURFACE LOCATION

CONTROLS AND INDICATIONS

CONTROL WHEEL



EM170AOM140108.DGN

1 – PITCH TRIM SWITCH (SPRING-LOADED TO NEUTRAL)

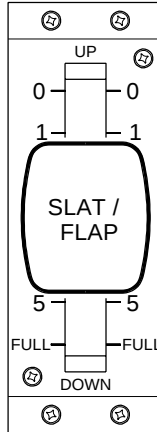
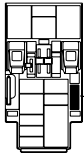
- Trims the airplane when the autopilot is not engaged.

NOTE: The Captain's pitch trim switch actuation has priority over the first officer's.

2 – AP/TRIM DISCONNECT BUTTON (MOMENTARY ACTION)

- Disable both HS-ACE channels as long as the switches remain pressed, thus disconnecting the autopilot and stopping any active trim command.
- Releasing the switch will activate the channel again.

SLAT/FLAP SELECTOR LEVER

CONTROL
PEDESTAL


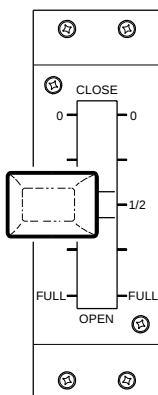
EM170ACM140106 DGN

- Selects slat/flap position by unlatching the lever and lifting a trigger below the head.
- Intermediate positions are not enabled. If lever is left at an intermediate position, flaps/slats remain in the last selected position. Position 4 is gated for normal Go Around and Takeoff. Position 5 is used for landing.
-

Lever position	Slat position	Flap Position	Detent/Gated
0	0°	0°	Detent/Stop
1	15°	5°	Detent
2	15°	10°	Detent
3	15°	20°	Detent
4	25°	20°	Gated/Stop
5	25°	20°	Detent
Full	25°	35°	Detent/Stop

SPEED BRAKE LEVER

CONTROL
PEDESTAL

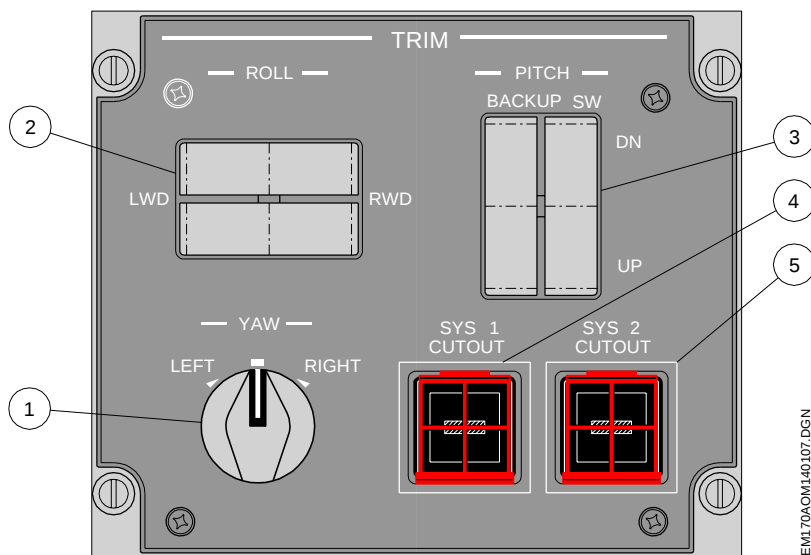
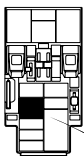


EM170AOM140105.DGN

- Symmetrically deploys the multi-function panels. All multi function spoilers' panels deploy the same angle as a response to the speed brake lever position.

TRIM PANEL

CONTROL
PEDESTAL



1 – YAW TRIM KNOB (SPRING-LOADED TO NEUTRAL)

- Actuates the yaw trim to left or right.

2 – ROLL TRIM SWITCH (SPRING-LOADED TO NEUTRAL)

- Actuates the roll trim to left or right.

3 – PITCH TRIM BACK-UP SWITCH (SPRING-LOADED TO NEUTRAL)

- Actuates the pitch trim through the back-up channel.
- Operation of the switch while the autopilot is engaged causes the autopilot to disengage.

4 – PITCH TRIM SYS 1 CUTOUT BUTTON (GUARDED)

PUSH IN: disables the HS-ACE channel 1.

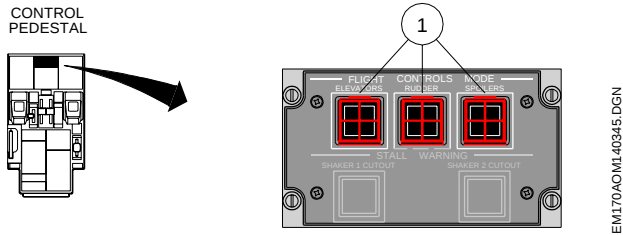
PUSH OUT enables the HS-ACE channel 1.

5 – PITCH TRIM SYS 2 CUTOUT BUTTON (GUARDED)

PUSH IN: disables the HS-ACE channel 2.

PUSH OUT: enables the HS-ACE channel 2.

FLIGHT CONTROL MODE PANEL

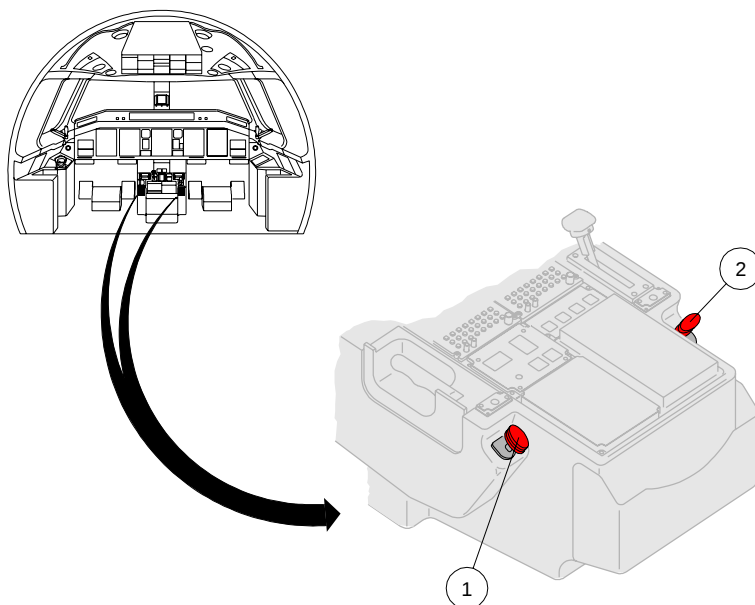


1 – FLIGHT CONTROL MODE BUTTON (GUARDED)

PUSH IN: turns the associated flight system into direct mode.

PUSH OUT: turns the associated flight system into normal mode.

DISCONNECT HANDLE



EM170AOM140347 DGN

1 – ELEVATOR DISCONNECT HANDLE

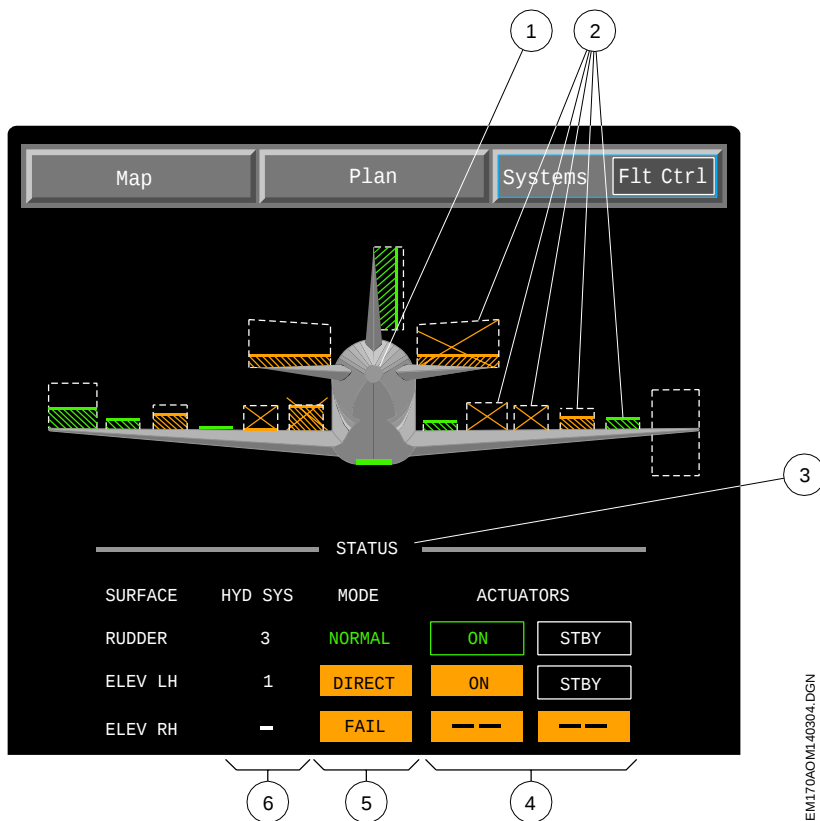
PULL: disconnects the elevator control system.

2 – AILERON DISCONNECT HANDLE

PULL: disconnects the aileron control system.

FLIGHT CONTROLS SYNOPTIC PAGE ON MFD

The flight controls synoptic page provides a visual representation of the flight control system operation and parameters, and can be selected by the flight crew for viewing on either MFD.



1 – AIRPLANE GRAPHIC

- A static display that shows the location of flight control surfaces, status of the flight control actuators and flight controls mode of operation.

2 – SURFACE POSITION STATUS

- RETRACTED: a green line aligned with the wings, elevator or rudder.
- DEPLOYED: a green line and the surface with green stripes. A white dashed box is shown only for surface position greater than 50% of its deflection.
- FAILED RETRACTED: an amber line, a white dashed box and an amber cross.
- FAILED DEPLOYED: white dashed box, surface with amber stripes and amber cross.
- NOT AVAILABLE WITH NO FAIL INDICATION: shows a white dashed box for surfaces with deflection in one direction (e.g. spoilers) and two white dashed box for surfaces with deflection in two directions (e.g. ailerons).
- NOT AVAILABLE WITH FAILURE INDICATION: shows a white dashed box and an amber cross for surfaces with deflection in one direction (e.g. spoilers) and two white dashed box and two amber crosses for surfaces with deflection in two directions (e.g. rudder).
- DIRECT MODE: shows a white dashed box and the surface with amber stripes.

3 – FLIGHT CONTROL SYSTEM STATUS ANNUNCIATIONS

- The status annunciations are shown in a table format for three surfaces. Three surfaces are listed in a column labeled SURFACE: RUDDER, ELEV LH, and ELEV RH.

4 – ACTUATOR STATUS ANNUNCIATION

- The rudder has two actuators, upper and lower. Each left and right elevator surfaces have two actuators, inboard and outboard.
- NORMAL/ACTIVE: a green ON annunciation inside a green rectangle box.
- NORMAL/STANDBY: a white STBY annunciation inside a white rectangle box.
- DIRECT/STANDBY: a white STBY DIR annunciation inside a white rectangle box.
- DIRECT/ACTIVE: an ON annunciation presented in an amber rectangle box background.
- FAIL: a “—” annunciation written in an amber rectangle box background.

5 – AXES MODE ANNUNCIATION

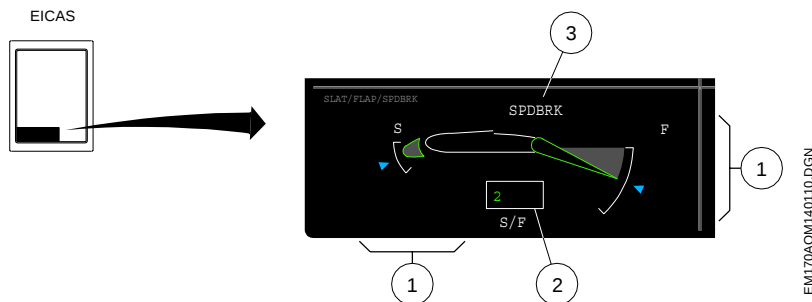
- Axes mode annunciations are shown for the rudder, the left and the right elevator. It is presented as NORMAL, DIRECT, FAIL or “-“, which represents the axes mode annunciation invalid.

6 – HYDRAULIC SYSTEM SOURCE ANNUNCIATION

- Hydraulic system source annunciations are shown for the rudder, the left and the right elevator. It is presented as 1, 2, 3 or “-“, which represents the source annunciation invalid.

EICAS INDICATIONS

SLAT/FLAP/SPEEDBRAKE INDICATION ON EICAS



1 – SLAT/FLAP POSITION

- Displays the slat/flap position. If the information is invalid, the indication will be removed from the display.
- GREEN: real-time surface position.
- The pointer shows the slat/flap commanded position along the scale and moves up the scale for decreasing values of slat/flap angle. The flap scale has tic marks at each end, representing positions at 0° and 35° while the slat scale has tic marks at each end, representing positions at 0° and 25°.

2 – SLAT/FLAP READOUT

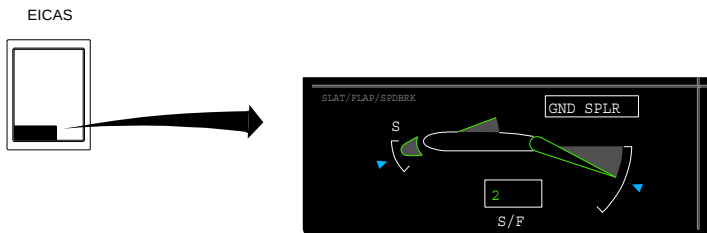
- Displays the slat/flap selector lever position. If the information is invalid, the indication will be removed from the display.
- GREEN: indicate the slat/flap selector lever position

NOTE: In case of surface jamming, an additional box will be displayed in amber, as well as the readout.

3 – SPEEDBRAKE INDICATION

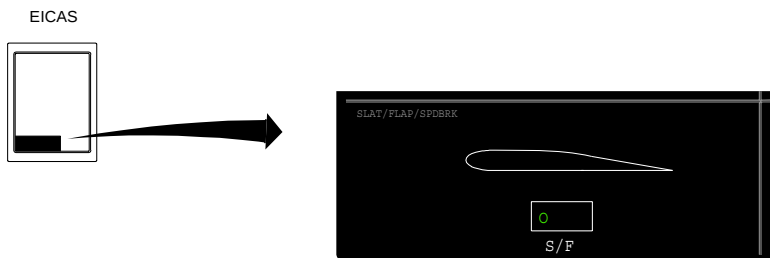
- Displays a white SPDBRK annunciation when the speed brakes are open.
- AMBER BOXED: in case of failure.

NOTE: An OPEN and GREEN speedbrake position indication and a white GND SPLR annunciation display on EICAS after airplane touchdown and below 50 knots of ground speed.

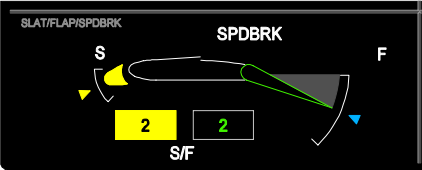


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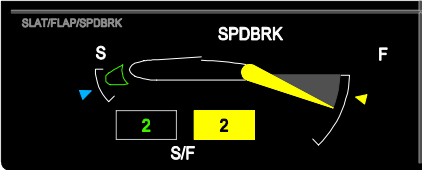
NOTE: For SLAT/FLAP/SPDBRK position 0 the legend and arrows will be removed from the display as presented below:



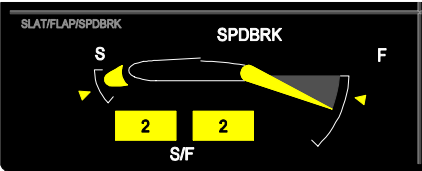
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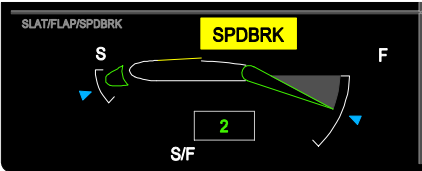
SLAT FAIL



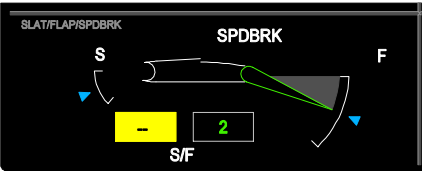
FLAP FAIL



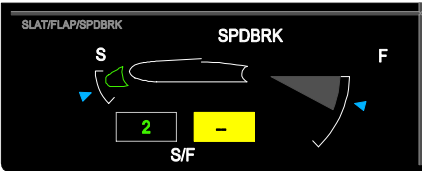
SLAT/ FLAP FAIL



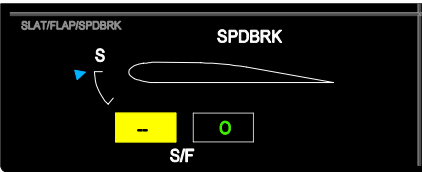
SPDBRK FAIL



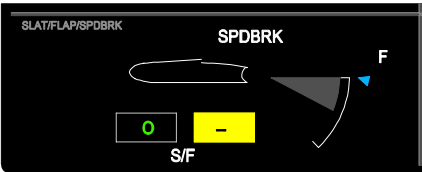
SLAT DATA INVALID OR UNAVAILABLE WHEN
SLAT/ FLAP LEVER IS NOT IN ZERO POSITION



FLAP DATA INVALID OR UNAVAILABLE WHEN
SLAT/ FLAP LEVER IS NOT IN ZERO POSITION



SLAT DATA INVALID OR UNAVAILABLE WHEN
SLAT/ FLAP LEVER IS IN ZERO POSITION

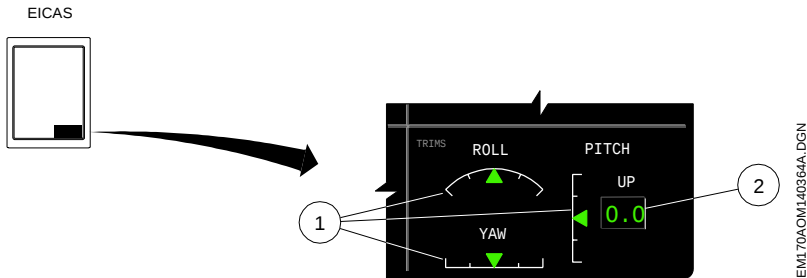


FLAP DATA INVALID OR UNAVAILABLE WHEN
SLAT/ FLAP LEVER IS IN ZERO POSITION

EM170-OM1-4011A.DGN

OVERALL DISPLAY SITUATIONS

ROLL/PITCH/YAW TRIM INDICATION ON EICAS



1 – ROLL/PITCH/YAW TRIM SCALE

- Trim position configuration is indicated through a solid green pointer in the scale.
- There are five tic marks displayed along the roll and yaw scale, positioned at -100%, -50%, 0%, 50%, 100%.
- There are five tic marks displayed along the pitch trim scale, positioned at 2°, -1.75°, -5.5°, -9.25°, and -13°. There is a green takeoff band on the scale extending from -1° to -6°, corresponding to the allowable pitch trim position for takeoff.

2 – PITCH TRIM DIGITAL READOUT

- Digital indication of the horizontal stabilizer trim position in tenth degrees
- An UP or DN indication displays above or below the readout according to the trim set.

FLY BY WIRE

Fly-by-wire is an electronic system designed to operate the flight controls replacing the control cables of a conventional airplane.

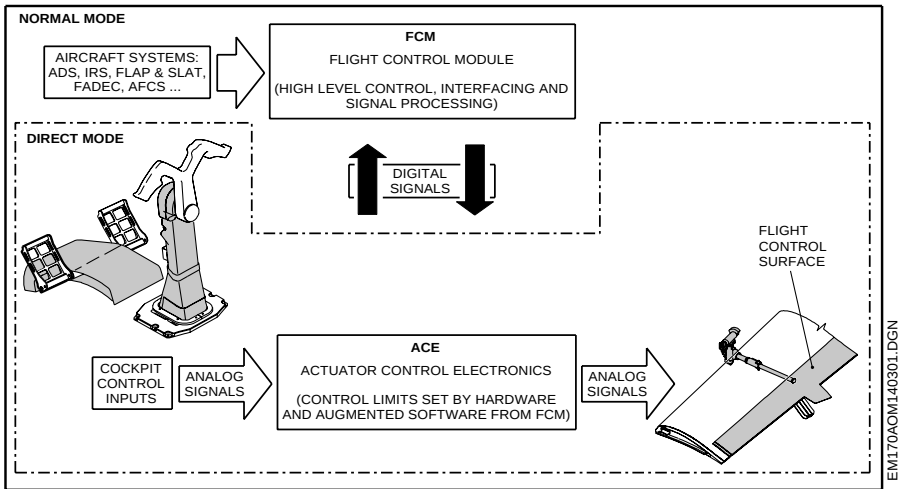
The EMBRAER 170 FBW system is composed of a set of six Actuator Control Electronics (ACEs) and four Flight Control Modules (FCMs):

- Two Primary-ACEs (P-ACE) installed in the forward electronics bay.
- Two Slat/Flap ACEs (SF-ACE) installed in the middle electronics bay.
- One Horizontal Stabilizer ACE (HS-ACE) and one P-ACE installed in the aft electronics bay.
- FCM 1 and 2 are located in the Modular Avionics Units # 1 (MAU 1).
- FCM 3 and 4 are located in the Modular Avionics Unit # 3 (MAU 3).

The three P-ACE units connect the control column directly to the respective control surface, providing direct analog control of the rudder and elevator surface actuators.

The two SF-ACE units control the slat and flaps and the HS-ACE unit controls the horizontal stabilizer.

The FCMs provide software-based assistance to the P-ACE and is required for normal-mode operation of the flight control system. The FCM units are connected to the P-ACE via the Controller Area Network Bus (CAN BUS), providing digital inputs to the P-ACE, which are combined with pilot inputs. This is used to augment pilot inputs for different airspeeds, and provides other high level functions such as angle Angle-of-attack (AOA) limiting to the P-ACE units.



FLY-BY-WIRE SCHEMATIC

MODES OF OPERATION

The Flight Control System provide two basic modes of operation:

- **NORMAL MODE:** The Flight Control Mode (FCM) provides software based airspeed gain schedules and control limits to the P-ACE, as well as high level functions such as:
 - Elevator control laws scheduling with airspeed.
 - Auto-thrust compensation with elevator.
 - Angle-of-Attack (AOA) limiting with elevator offset.
 - Rudder airspeed gain scheduling and stroke limiting.
 - Yaw damper and turn coordination via AFCS.
 - Rudder ground/lift authority change.
 - Roll spoiler scheduling with airspeed and speedbrake deployment.
 - Configuration change compensation with Horizontal Stabilizer.
- **DIRECT MODE:** The FCM is removed from the control loop (for instance, due to loss of airspeed data) and the control limits default to values set by hardware in the P-ACE.
 - Direct mode of operation is primarily the result of loss of data from all FCMs (no airspeed input) or multiple failures in both ACEs.
 - Operation is defaulted to fixed control laws configuration.
 - Control input provided by Captain and First Officer's sensors is sent directly to the surface.

Mode selection is automatic, when a channel failure is detected or manual, by using a "Mode Select" switch on the Flight Control Panel.

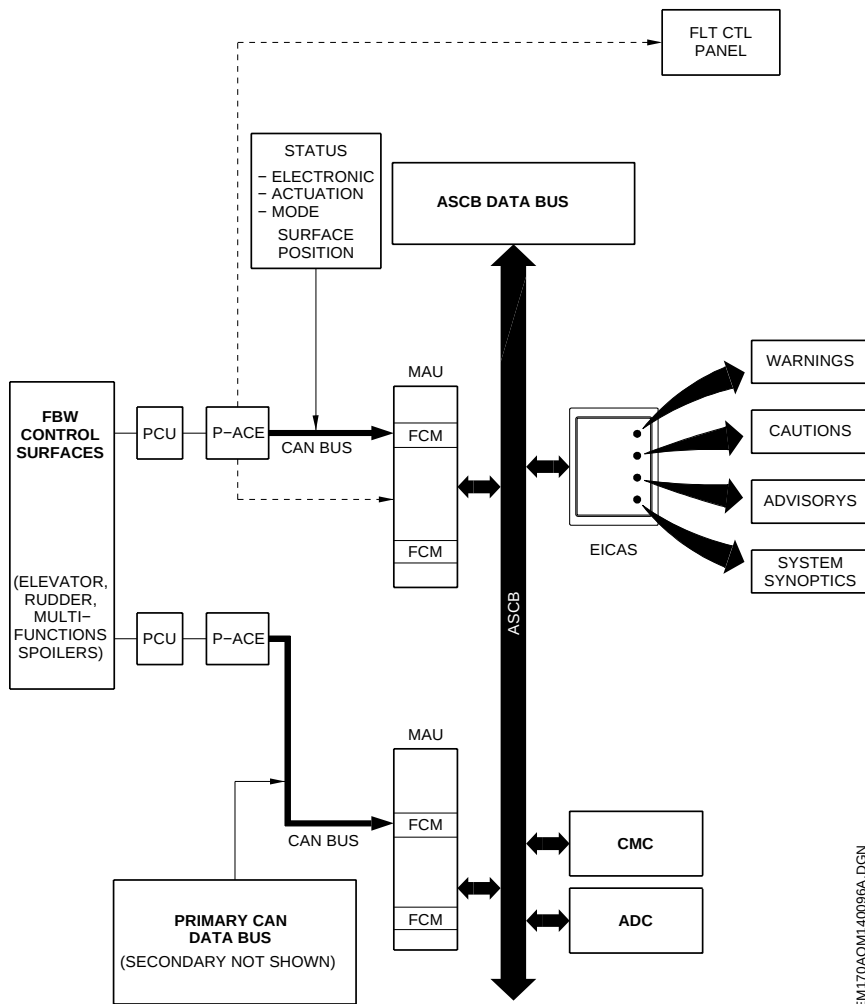
The "Mode Selection" switch toggles the Normal Channel of the active P-ACE to the Direct Channel of the standby P-ACE and continues as shown:

Pilot always has supreme control authority of the airplane since the FCMs cannot override a pilot input.

FCM, P-ACE AND AIRPLANE LEVEL COMMUNICATION

The Controller Area Network BUS (CAN BUS) is the communication link between the FCMs and the P-ACE units while the Avionics Standard Communication Bus (ASCB) provides data exchange between all FCMs, and with other components of the avionic system. The following systems provide data to the flight control system:

- Smart probes and the Air Data Application (ADA) modules provide air data for various airspeed augmentation commands.
- IRS provides aircraft attitude and accelerations to the FCMs used for AOA limiting function computation.
- The Proximity Sensor Electronic Module (PSEM) provides Weight-On-Wheels (WOW) and ground spoiler position data to the FCMs.
- Brake Control Modules (BCM) provide wheel speed signals used for ground spoiler deployment.
- The FADEC provide Thrust Lever Angle (TLA) to the FCMs used for thrust asymmetry and elevator thrust compensation, and the Automatic Flight Control System (AFCS) provides autopilot commands.
- Data is shared for the EICAS to display warnings, cautions, advisory and system status and also provided to the central maintenance computer (CMC) for system diagnostics.



AIRPLANE COMMUNICATION INTERFACE

POWER UP BUILT IN TEST (PBIT)

The Power Up Built in Test (PBIT) reduces the flight control system exposition to latent faults, ensuring that the system components are capable of executing their functions.

The PBIT expires after 20 hours (elapsed time) since the last successful PBIT and in this case the FLT CTRL BIT EXPIRED EICAS CAUTION message is displayed. These EICAS CAUTION message is related to the Electrical PBIT and Hydraulic PBIT. The message remains on EICAS until a new Electrical and Hydraulic PBIT is successfully executed.

ELECTRICAL POWER UP BUILT IN TEST

The Electrical PBIT provides detection of out-of-tolerance conditions and failures in the FCMs, P-ACEs and S-ACEs.

The Electrical PBIT is automatically performed during power up after the airplane is powered by any AC source and takes approximately 3 minutes to complete. At this point, if the FLT CTRL BIT EXPIRED message is presented, the hydraulic built in test must be performed.

The Electrical PBIT will be interrupted if any electric hydraulic pump is running or if the FCP switches are cycled or if AC power is interrupted while the test is running.

HYDRAULIC POWER UP BUILT IN TEST

The Hydraulic PBIT provides a functional test of the flight control actuators.

The Hydraulic PBIT is performed when all the three hydraulic systems are pressurized for 1 minute.

The Hydraulic PBIT will be interrupted if any flight control surface is moved while the test is running.

FLY BY WIRE (FBW) BACKUP BATTERY

In case of an extremely improbable failure that would cause complete loss of normal and emergency electrical power to the FBW, the backup power system, with no pilot intervention, keeps the appropriate number of elevator and rudder actuators operating for at least 15 minutes. Besides, there is no dedicated message to indicate the failure of this system; therefore there is no flight crew compensatory action if this happens.

A dedicated and independent backup electrical power system is provided for some elevators and rudder Actuator Control Electronics (ACEs) that are considered essential for airplane controllability even in an extreme case of total loss of the normal and emergency electrical power sources.

This backup system comprises a dedicated battery, distribution bus and circuit breakers.

The backup battery, charged by the DC ESS 3 bus during normal operation, consists of sealed lead acid cells with built-in-test (BIT) capability and an internal heater that guarantees the minimum battery temperature.

Although the battery is connected to the airplane buses, the use of an internal rectifier keeps it from powering back the buses, assuring isolation in case of failure in the main electrical power system.

PITCH CONTROL

Pitch axis control is by means of electro-hydraulic commanded elevators and an electro-mechanical horizontal stabilizer.

ELEVATOR CONTROL SYSTEM

Pilot's inputs to the elevators are through the forward and aft movement of the cockpit control columns. Also, the elevators can be automatically controlled through the FCM via autopilot.

A total of four P-ACE channels are used to independently control each of the four PCUs, providing the analog elevator control functions implemented in the P-ACE units.

Four independent FCM units, located in the MAU 1 and 3, provide high-level system augmentation to the P-ACE units, such as gain scheduling as a function of airspeed, elevator thrust compensation and AOA limiting.

The hydraulic systems responsible for actuating the actuators are:

-  Hydraulic System 1: left outboard actuator.
-  Hydraulic System 2: left & right inboard actuators.
-  Hydraulic System 3: right outboard actuator.

Because the actuators on each surface operate on active/standby mode, the P-ACE automatically alternates the active actuator every time the elevator system is powered up. The loss of hydraulic supply forces the standby PCU to become active.

If a jam in one of the elevator actuator is detected, the respective elevator surface will remain fixed at the position where the jam occurred. The pilot will be able to control the airplane using the remaining elevator.

With the elevator control system operating in normal mode, the elevator moves according to gain scheduling as a function of airspeed, reducing elevator movement with increasing airspeeds. In the event of loss of airspeed information, the FCM is removed from the control loop, and the associated P-ACE reverts to direct mode. FCM functions like elevator thrust compensator and AOA limits' are then no longer available.

A dedicated button on the Flight Control Mode panel provides the capability to the pilots to reset the elevator system to Normal Mode in case of the system defaulting to Direct Mode, or to manually default the elevator system to Direct Mode in case of wrong gain computed by the FCMs being transmitted to the P-ACEs.

When the flight control panel elevator button is pushed in, it commands all four elevator channels to change from Normal to Direct mode. In addition, pushing the button also results in the active elevator channels transitioning to the standby state, and the channels that were previously in standby will become active. This feature is also included to allow the system to transition away from the present controlling channels.

When the flight control panel elevator button is pushed out, the system recovers the Normal Mode.

The Elevator Thrust Compensation Function (ETC) helps to reduce the pilot workload by applying elevator commands to reduce the pitching moment produced by increasing or decreasing engine thrust. The ETC function is computed in the FCM as a function of N1, mach and pressure altitude. Elevator command is limited to plus or minus 5 degrees, and is applied proportionally to the amount of engine thrust above or below the reference thrust setting.

If one or more sensors required to perform the ETC function fail, the function is no longer available and the respective message will be displayed on the EICAS.

ARTIFICIAL FEEL UNITS (AFU)

With no mechanical connection between the control column and the elevator surfaces, two independent feel units provide artificial feel and centering to the control columns, which increase with the control column displacement.

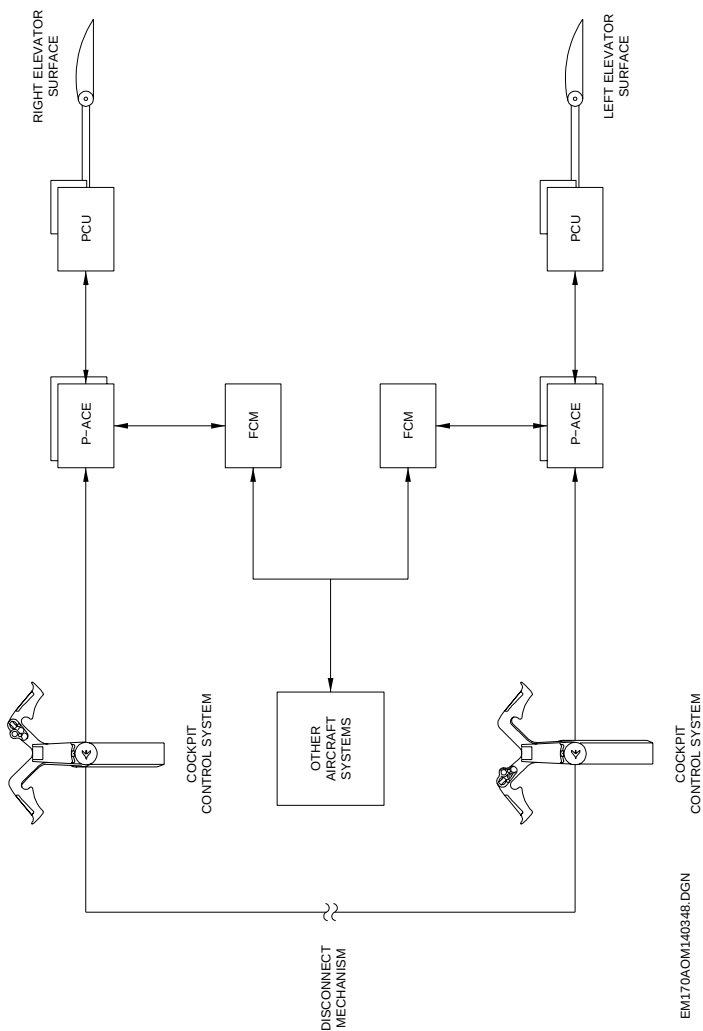
The feel units consist of a preloaded spring, which returns the columns to the neutral position. Hence there is one feel unit attached to each torque tube, in case of separation of the control column commands, the feel system is still active for the non-jammed column.

With the columns disconnected or with a single AFU disconnected, the feel loads on the column are reduced to one half of the normal loads.

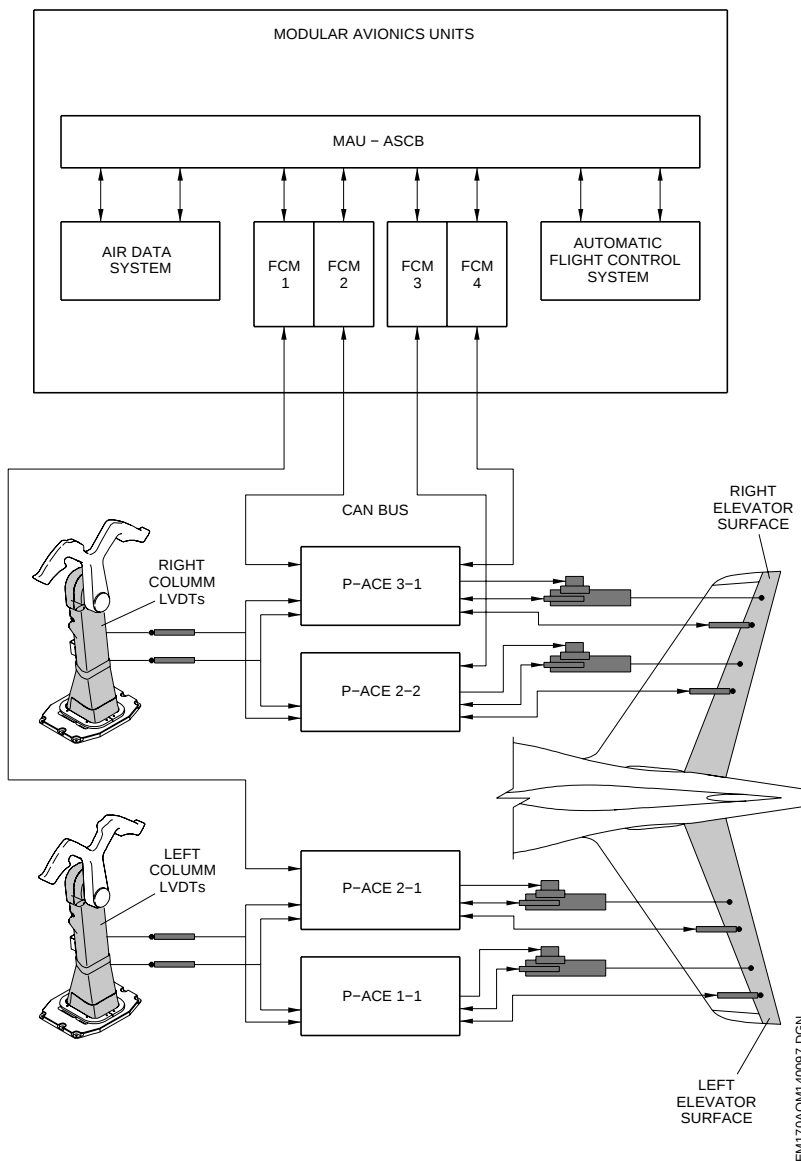
DISCONNECT MECHANISM (JAMMED COLUMN)

A disconnect mechanism is provided in order to allow separation of the First Officer and Captain's control column. In the event of a jam in one of the control columns, the disconnect mechanism can be actuated by pilots through the disconnect handle in the cockpit.

Following a disconnection the pilot of the non-jammed side retains pitch control by means of the on-side elevator. The system will remain disconnected for the remainder of the flight and ground maintenance is required to reset the disconnect unit.



ELEVATOR SYSTEM SCHEMATIC



ELEVATOR SYSTEM INTERFACE

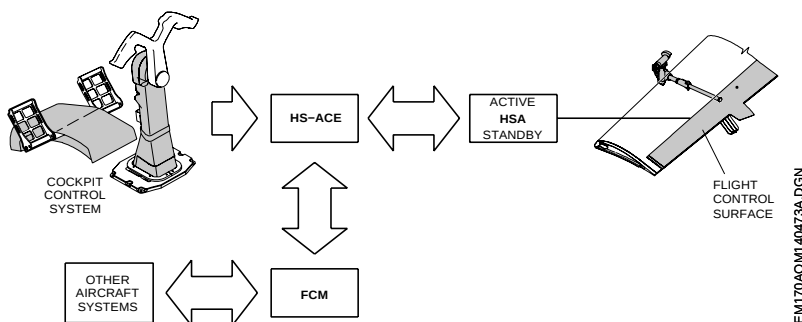
HORIZONTAL STABILIZER CONTROL SYSTEM

Control of the horizontal stabilizer is by means of an electromechanical system commanded by:

- Manual selection of the Captain or First Officer's wheel main trim switches or pedestal mounted backup trim switches which directly controls an electrical servo motor coupled to the Horizontal Stabilizer Actuator (HSA).
- Flight Controls Module (FCM) for autopilot trim and speed brake auto trim in order to actuate the electrical servomotor coupled to the Horizontal Stabilizer Actuator (HSA).

Horizontal Stabilizer Actuator Control Electronics (HS-ACE) and one Horizontal Stabilizer Actuator (HSA) are used to move the control surface.

The HSA is a single electrical-mechanical actuator. Two DC motors drive the actuator in an active/standby configuration. Stabilizer position is provided to the HS-ACE and is used for monitoring and EICAS indication.



STABILIZER TRIM

MANUAL TRIM

The manual trim is achieved through switches installed on the control columns and standby switch located on the main pedestal. Signal from either the control columns switches or the main pedestal switch controls the electric trim motor

The HS-ACE responds to all trim commands with the following priority:

1. Backup switches.
2. Captain.
3. First Officer.
4. FCM (auto-trim) commands.

In order to avoid a possible pitch trim runaway condition, manual pilot trim commands are limited to three seconds. In case of stick shaker activation, the HS-ACE is prevented from responding to any pitch trim commands by a stick shaker signal from the AFCS.

The backup trim switches and the control wheel trim switches are dual split switches, which have a 7 seconds time limitation when actuated separately. If only one half of the switch is actuated for more than 7 seconds, this switch is automatically deactivated.

In the event of an electrical emergency, only the HS-ACE channel 2 is operational at low rate. A loss of airspeed data from the FCM also results in low rate operation of the horizontal stabilizer, providing structural protection of the surface.

AUTOPILOT TRIM

The autopilot can directly operate the electric trim motor when the autopilot is engaged. If the autopilot trim function is inoperative, the autopilot cannot be engaged. If this function is lost with autopilot operations, the autopilot will be disengaged.

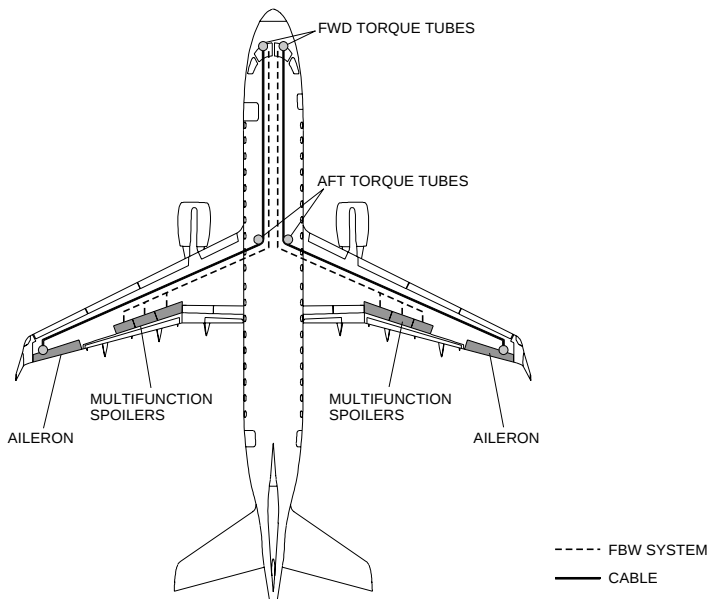
Autopilot trim function will be active only if:

- Autopilot is engaged.
- Configuration trim is operational.
- Manual electric trim is not active.
- On-side autopilot channel is priority.

NOTE: In case of an electrical failure, followed by RAT deployment, the trim function will work at half speed operation, for either manual trim or autopilot trim.

ROLL CONTROL

Roll control is provided simultaneously by the ailerons and the multifunction spoilers.



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AILERON CONTROL SYSTEM

Aileron control is accomplished through a conventional cable system, which transmits pilot control wheel inputs to two hydro-mechanical actuators for each aileron.

The hydraulic systems responsible for actuating the actuators are:

- ✚ Hydraulic System 2: left & right inboard PCU.
- ✚ Hydraulic System 3: left & right outboard PCU.

Captain and First Officer aileron control system are connected via a disconnect mechanism. In the event of a jam, the disconnect mechanism can be actuated by the pilots by means of the disconnect handle in the cockpit. Following a disconnection, half of the system remains operational. If the jam occurs on the First Officer's half of the system, the Captain retains control of the left aileron with normal artificial feel.

If the jam occurs on the Captain's side, the First Officer remains in command of the right aileron without artificial feel and roll trim since the feel mechanism is attached to the pilot's half of the system. Only one pair of multifunction spoilers will remain available after the disconnection.

Following a disconnection, the system remains separated for the rest of the flight. Maintenance action is required to reconnect the disconnected device.

In the event of a disconnection of one aileron PCU from the surface or wing structure, the other PCU attached to the surface will operate normally, but the force authority will be halved. So the aileron PCUs normally share air-loads during flight, if the FCM detects a difference in load sharing from the actuators, a message will be displayed on the EICAS.

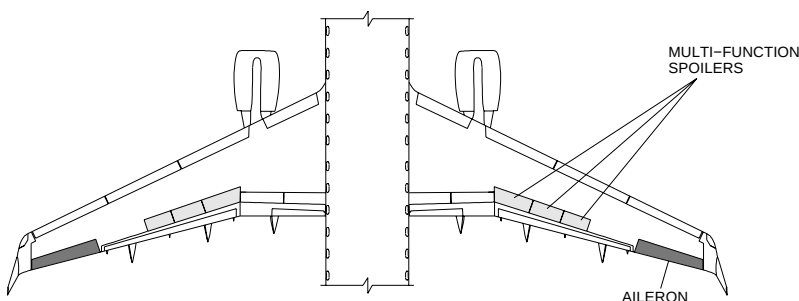
MULTIFUNCTION SPOILER CONTROL SYSTEM

The multifunction spoiler control system consists of 6 panels numbered from inboard to outboard as:

- L3, L4, L5 (left wing) and
- R3, R4, R5 (right wing).

The roll spoiler function drives all six multifunction spoiler panel deployment asymmetrically as a function of control wheel position.

As airspeed increases, less spoiler surface deflection is required and the spoiler system will limit the deployment of the surfaces for roll control.



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ROLL CONTROL SURFACES POSITION

In the event of a jam, the control wheel and the aileron on the jammed half of the system will be locked at the current position. The other half of the system can be separated from the jammed side through the aileron disconnect handle located at the control pedestal. In this case, the Captain controls the outboard spoilers, while the First Officer controls the middle spoilers. When disconnected due to jamming, the inboard spoilers become disabled.

ROLL TRIM

The aileron control system is manually trimmed by using the roll trim switch on the trim control panel, located in the cockpit on the center pedestal. The trim system is operated via the roll trim switch on the trim control panel, commanding the actuator to move, and repositioning neutral feel position of the aileron system.

The actuator is equipped with a timer, limiting a single trim command to three seconds. A quick disconnect switch, located on the control wheels, disables the roll trim actuator by interrupting DC power to the trim motor, as long as the switch remain depressed.

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YAW CONTROL

Yaw control is performed by means of an electronic control system that commands electrohydraulic actuators of the rudders.

RUDDER CONTROL SYSTEM

The rudder control system is controlled either by the pilots, autopilots and FCM high-level functions.

The rudder control system moves a single rudder surface attached to the vertical stabilizer. Two actuators, or PCUs, electrically commanded and hydraulically powered, are connected to the rudder control surface, receiving signals from the rudder control's Fly By Wire system (FBW).

Either the upper or the lower rudder actuator can control the rudder surface. The Captain commands only the upper actuator and the First Officer commands only the lower actuator.

Two independent P-ACE modules drive the upper and lower PCU, providing the analog rudder control functions implemented in the P-ACE hardware, such as pedal shaping to vary the pedal-to-surface gearing as a function of pilots input.

Four independent FCM units, located in MAU 1 and 3, provide high level system augmentation on the P-ACE units, such as yaw damping, turn coordination, as well as gain scheduling as a function of airspeed.

The rudder actuators operate in an active/standby configuration, hence the P-ACEs alternate between the active PCU every time the rudder system is powered-up.

The hydraulic systems responsible for actuating the actuators are:

- Hydraulic System 1: upper actuator, or PCU.
- Hydraulic System 3: lower actuator, or PCU.

In the normal mode, the FCMs add further high-level functions to the pilot pedal inputs. With increasing airspeed, rudder gain is reduced by the FCM in order to compensate for the increase in rudder effectiveness, and providing structural protection to the rudder surface.

A dedicated button on the Flight Control Mode panel provides the capability to the pilots to reset the rudder system to Normal Mode in case of the system defaulting to Direct Mode, or to manually default the rudder system to Direct Mode in case of wrong gain computed by the FCMs being transmitted to the P-ACEs.

When the flight control panel rudder button is pushed in, it commands both rudder channels to change from Normal to Direct mode. In addition, pushing the button also results in the active rudder channels transitioning to the standby state, and the channels that were previously in standby become active. This feature is also included to allow the system to transition away from the present controlling channels.

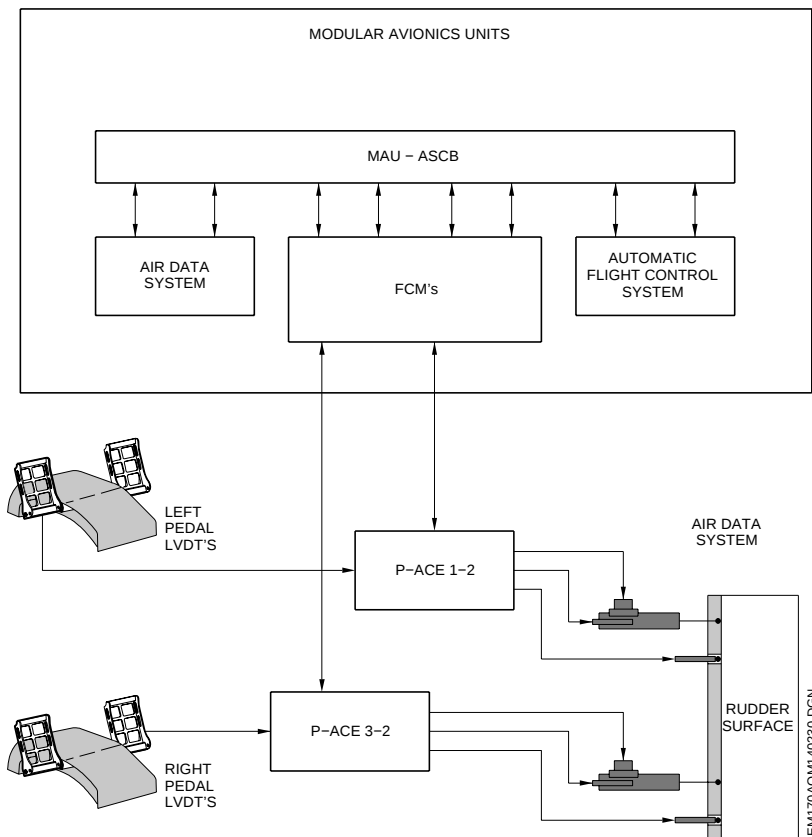
When the flight control panel rudder button is pushed out, the system recovers the Normal Mode.

The two pedal assemblies (Captain and First Officer) are connected by an interconnect rod, in such a way that the movement made by the pilot flying (PF) assembly will be transmitted to the pilot not flying assembly.

In the event of a jam in the Captain's rudder pedal assembly, the rudder remains active and will be actuated by high-level functions (yaw dumping and turn coordination). In case of a jammed PCU actuator the rudder will be hydraulically locked at the current position. Aircraft control will be established through the ailerons and roll spoilers.

RUDDER TRIM SYSTEM

Rudder trim function is limited to three seconds. If further displacement of the trim system is required the command must be released and reapplied. Position indication of the trim actuator is provided on the EICAS.

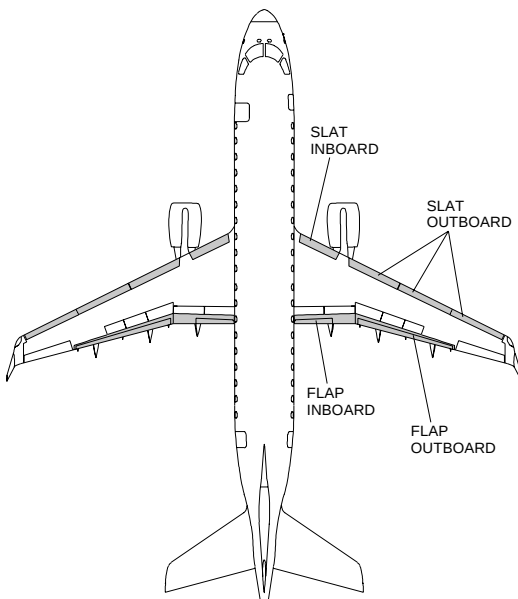


RUDDER SYSTEM INTERFACE

SLAT/FLAP SYSTEM

The high lift control system consists of flaps and slats.

The slat system controls eight slat surfaces on the leading edge of the wing (four per wing) and the flap system controls four double slotted flap surfaces on the trailing edge (two per wing).



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SLAT/FLAP PANEL LOCATION

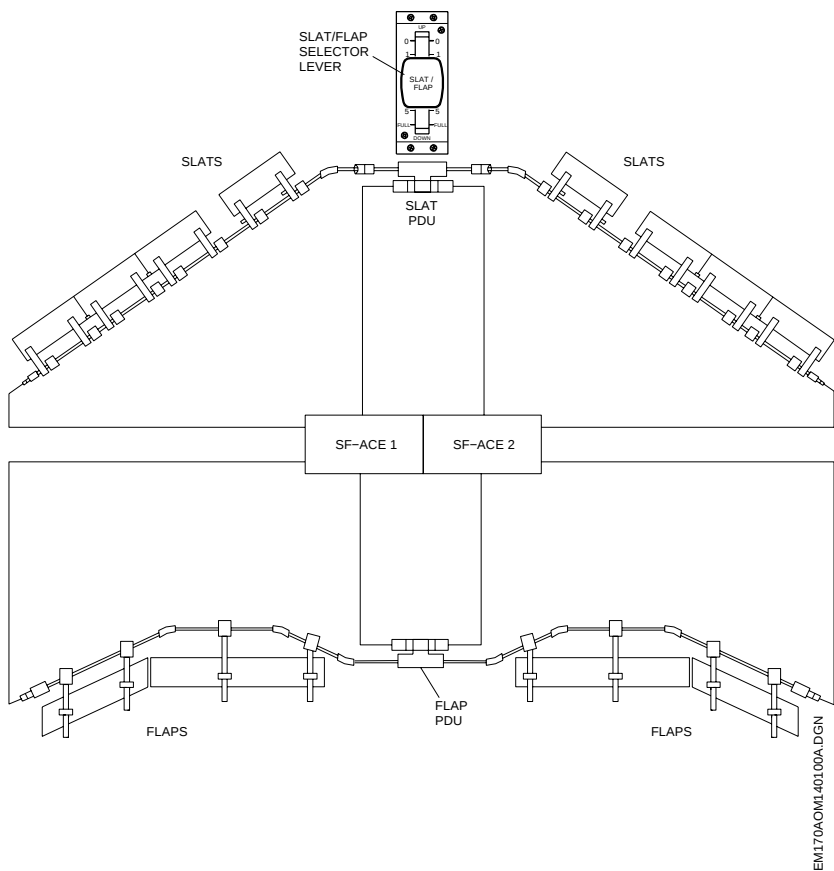
Surface position commands are given to the Slat/Flap-ACE (SF-ACE) via a Slat/Flap control lever installed on the center pedestal in the cockpit. Each SF-ACE is a dual channel unit, with one channel for flap control and one channel for slat control.

There are seven slat/flap control lever positions. Slat and flap motion is sequenced in such a way that slats extend first and flap retracts first when the motion command requires both surfaces to move. The system uses electrical power to move the surfaces.

Deployment of both slats and flaps surfaces is commanded by two SF-ACEs and electrically operated using Power Driver Units (PDUs).

A total of four flap actuators per side provide the actuation force to extend and retract the flap panels mounted on the trailing edge of each wing. The double-slotted flap consists of a main flap panel and an aft flap panel for both inboard and outboard flaps.

The SF-ACE has two independent channels that are powered by different electrical power sources. If the Ram Air Turbine (RAT) is the only source of electric power, the flap and slat operate at half speed, as only one channel remains available. Additionally, when RAT is the only source of electrical power, the SF-ACE prevents the deployment of slats and flaps beyond position three to assure adequate airspeed for the RAT.



SLAT/FLAP SYSTEM SCHEMATIC

SLAT/FLAP PROTECTION LOGIC

SKEW PROTECTION

Electronic skew sensors monitor differential movement between neighboring panels of flap (slat). If differential movement of a panel exceeds acceptable limits, the SF-ACES shuts down the flap (slat) system and the FLAP (SLAT) FAIL message displays on EICAS.

The SLAT-FLAP LEVER DISAG may appear, as the affected surface has not reached the position selected on the Slat/Flap Lever. The affected surface is inoperative for the remainder of the flight whereas the non-affected surface operates normally (i.e., in case of FLAP FAIL message the Slats operate normally and vice-versa).

STRIKE OVERLOAD

The SF-ACE monitors the PDU load and if an excessive load is detected it stops the electrical power to the respective PDU for further movement to the selected direction. The FLAP (SLAT) FAIL message displays and the SLAT-FLAP LEVER DISAG also displays, as the affected surface has not reached the selected position.

In such cases, the affected surface can be commanded in the opposite direction (i.e., for FLAP FAIL during retraction, the Flap can be commanded for extension and vice-versa).

When the strike protection actuates, the affected surface accepts to be commanded in both directions if it is returned to the previously selected position. After three unsuccessful attempts to select a position, the strike protection cuts the PDU power for both directions.

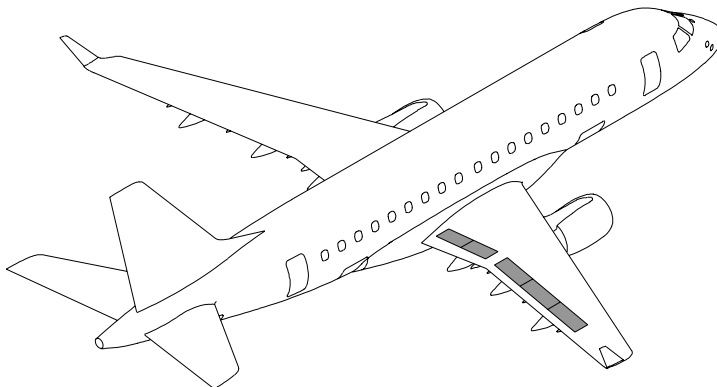
SPOILER SYSTEM

The spoiler control system consists of ten spoiler panels numbered inboard to outboard as:

- L1, L2, L3, L4, L5 (left wing) and
- R1, R2, R3, R4, R5 (right wing).

Panels L3, R3, L4, R4, L5 and R5 are called multifunction spoilers and have three modes of operation:

- Roll Control: deployed asymmetrically for roll increase as commanded by the pilots' control wheel. Displacement angle is proportional to control wheel displacement.
- Speed Brakes: deployed symmetrically during flight by speed brake handle to increase aerodynamic drag to reduce airspeed or increase rate of descent. Panel displacement is proportional to speed brake handle position.
- Ground Spoilers: deployed symmetrically during landing roll to increase wheel braking efficiency and aerodynamic drag to reduce the stopping distance. Panels are fully and automatically extended when ground spoiler deployment conditions are met.



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SPOILERS LOCATION

The hydraulic systems responsible for actuating the multi function PCUs are:

- Hydraulic System 1: left and right inboard and middle PCUs (L3, R3, L4, R4).
- Hydraulic System 2: left and right outboard PCUs (L5, R5).

The hydraulic systems responsible for actuating the dedicated ground spoilers PCUs are:

- Hydraulic System 1: left and right outboard PCUs (R2, L2).
- Hydraulic System 2: left and right inboard PCUs (R1, L1).

GROUND OPERATION

The spoiler control system provides automatic ground spoiler deployment to increase wheel-braking efficiency, reducing the lift generated by each wing, and to reduce the stopping distance producing aerodynamic drag.

During ground operation, all spoiler panels function as ground spoilers and are commanded to the fully extended or fully retracted positions.

The ground spoiler function drives all ten spoiler's panels to the limit deflection of the actuators.

MULTI-FUNCTION AND GROUND SPOILERS DEPLOYMENT

After touchdown the FCM will command all multifunction spoiler surfaces to the 40 degrees extended position and the ground spoiler surfaces to 60 degrees when the following conditions are simultaneously met:

- Weight on wheels on ground.
- Wheel speed is above 45 kts or airspeed is above 60 KIAS.
- Thrust Lever Angle (TLA) below 26 degrees

Following rollout, the spoilers will automatically retract when wheel speed is below 45 kts for at least 5 seconds. If the throttles are moved beyond 35 degrees (TLA) after landing, the spoiler panels will automatically retract.

NOTE: In the direct mode, ground spoilers are not available.

IN-FLIGHT OPERATION

ROLL SPOILERS

The roll spoiler function drives the multifunction spoiler panels asymmetrically as a function of the control wheel position.

In normal mode, the roll spoilers are also gain scheduled as a function of airspeed. A roll spoiler increase command, computed in the FCM, is added to the normal pilot input in order to modify the roll inputs for changes in airspeed results or different flap settings.

In case of loss of airspeed data, the respective FCM is removed from the control loop, and the system returns to direct mode. A fixed gain is then applied to the respective roll spoiler system for the entire flight, independent of airspeed or flap setting.

SPEED BRAKES

When acting as speed brakes, the spoiler control system deploys all six multifunction spoiler panels symmetrically up to the in-flight limit of 30 degrees following speed brake handle position.

If extended during approach, the speed brakes will automatically retract upon selection of slat/flap 2 or above.

Speed brakes will not be deployed if airspeed is below 180 KIAS, and will also automatically retract if airspeed decreases below this threshold.

In order to prevent inadvertent operation during a go-around maneuver the speed brakes will automatically retract anytime the thrust levers are advanced beyond Thrust Lever Angle (TLA) 70 degrees.

In the event of a disagreement of the speed brake handle position with actual surface position, the EICAS advisory message SPDBRK LEVER DISAG is displayed on the EICAS.

NOTE: In the direct mode, speed brakes are not available.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	ELEV (RUDDER) (SPOILER) NML MODE FAIL	Normal mode of the associated system is no longer operative.
	GROUND SPOILERS FAIL	One of the ground spoiler surfaces has extended inadvertently or has failed to extend when commanded.
CAUTION	AOA LIMIT FAIL	Stall protection function has failed.
	ELEV THR COMP FAIL	One or more sensors required to perform Elevator Thrust Compensation function have failed and the function is no longer available.
	ELEVATOR FAULT	Left and right elevator control system has reverted to direct mode.
	ELEVATOR LH (RH) FAIL	Left (right) elevator control system is no longer available.
	FLAP FAIL	Both flap electronic control channels are inoperative and the flap system is no longer available or there is a jam in the mechanical portion that prevents the flaps from moving.
	FLT CTRL BIT EXPIRED	20 hours or more have passed since the last time PBIT was activated.
	FLT CTRL NO DISPATCH	One of the components associated with the flight control system has failed to a No-Go condition.
	PITCH TRIM FAIL	Pitch trim function is no longer available.
	RUDDER FAIL	Active and standby rudder channels have failed or rudder has jammed.
	RUDDER FAULT	Indicates that the rudder control system has reverted to direct mode.
	RUDDER LIMITER FAIL	Indicates that rudder ground authority is retained after take-off.
	SLAT FAIL	Both slats electronic control channels are inoperative and the slats system is no longer available or there is a jam in the mechanical portion that prevents the slats from moving.

TYPE	MESSAGE	MEANING
CAUTION	SLAT-FLAP LVR DISAG	Flaps were commanded above V_{FE} .
	SPOILER FAULT	Airspeed gain scheduling has failed in one or more pairs of multifunction spoilers, and the system(s) has defaulted to a fixed gain.
	STAB LOCK FAULT	The mechanical device, which locks the horizontal stabilizer, has failed. Direct mode is not allowed.
ADVISORY	AILERON LH (RH) FAIL	Indicates that the left (right) aileron is no longer available or there is a mechanical disconnection in the left (right) aileron surface
	AUTO CONFIG TRIM FAIL	Pitch Trim Auto Configuration function is inoperative.
	FLAP LO RATE	One of the flap electronic control channels is inoperative and the flap system is still available but running at low speed.
	FLT CTRL FAULT	One of the components associated with the flight control system has failed.
	PITCH CONTROL DISC	Control columns are disconnected
	PTICH TRIM BKUP FL	Backup pitch trim switch is inoperative
	PITCH TRIM SW 1 FAIL	Captain's pitch trim switch is inoperative
	PITCH TRIM SW 2 FAIL	First Officer's pitch trim switch is inoperative
	ROLL CONTROL DISC	Control wheels are disconnected
	SLAT LO RATE	One of the Slats electronic control channels is inoperative and the slat system is still available but in low speed.
	SPDBRK LEVER DISAG	A mismatch exists between the speedbrake handle position and the multifunction spoiler surfaces or the ventral speed brake.

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ATA CHAPTER 28

FUEL

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INTRODUCTION

The fuel system is designed to continuously provide fuel to the engines and APU.

Fuel is stored in two integral wing tanks, interconnected by a crossfeed valve.

The fuel system incorporates:

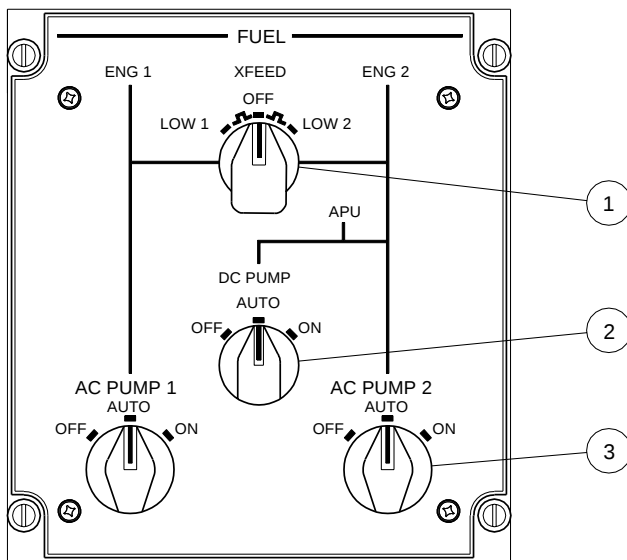
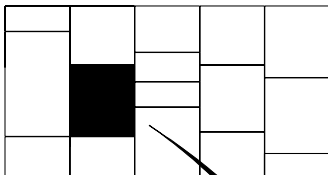
- Storage: vented integral fuel tanks in the aircraft.
- Distribution: engine/APU feeding and tank refueling/defueling.
- Indication.

The fuel system parameters and indications are displayed on both MFD synoptic pages. System messages are displayed on EICAS display.

CONTROLS AND INDICATIONS

FUEL CONTROL PANEL

OVERHEAD PANEL



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1 – CROSSFEED SELECTOR KNOB

- LOW 1:** opens the crossfeed valve and automatically turns ON activates the right AC fuel pump (AC PUMP 2), feeding supplying fuel to both engines from the right wing tank.
- OFF:** closes the crossfeed valve.
- LOW 2:** opens the crossfeed valve and automatically turns ON activates the left AC fuel pump (AC PUMP 1), feeding supplying fuel to both engines from the left wing tank.

2 – DC FUEL PUMP SELECTOR KNOB

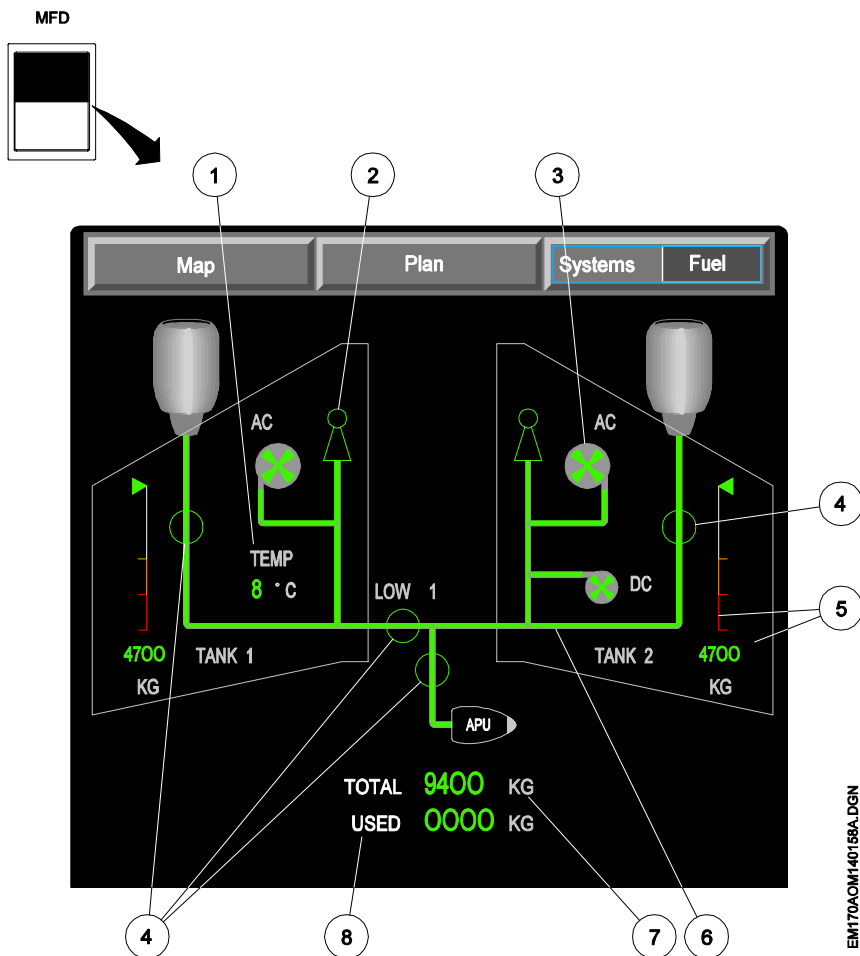
- OFF:** turns offdeactivates the DC fuel pump.
- AUTO:** allows automatically operates the DC fuel pump according to the system's logic automatic operation.
- ON:** turns on activates the DC fuel pump.

3 – AC FUEL SELECTOR KNOBS

- OFF:** turns offdeactivates the associated AC fuel pump.
- AUTO:** allowsautomatically operates the associated AC fuel pump according to the system's logic automatic operation. automatic operation
- ON:** turns onactivates the associated AC fuel pump.

FUEL SYNOPTIC PAGE ON MFD

The fuel synoptic page provides a visual representation of the fuel system operation and parameters, and can be monitored by the flight crew on either MFD.



1 – TEMPERATURE INDICATION

- Digital Temperature
 - The digital information indicates the fuel temperature measured in the left fuel tank.
 - GREEN: normal operating range.
 - AMBER: cautionary operating range.
 - AMBER DASHED: invalid information.

2 – JET PUMP INDICATION

- GREEN: the associated jet pump is activated.
- WHITE: the associated jet pump is deactivated.
- AMBER DASHED: invalid information.

3 – ELECTRIC FUEL PUMP STATUS

- The electric pumps are depicted as circles with an internal windmill, representing the pump status.
- ON: a gray circle with a green windmill.
- OFF: a gray circle with a white windmill.
- UNDETERMINED: an amber dashed circle with an amber windmill.
- FAILED ON: a gray circle with a green windmill beneath an amber cross.
- FAILED OFF: a gray circle with a white windmill beneath an amber cross.

4 – FUEL SYSTEM VALVES STATUS

- The fuel system valves are depicted as circles with an internal line representing the valve position. Above the fuel crossfeed valve, the label LOW 1 or LOW 2 is indicated whenever one engine is being fed by the opposite wing tank.
- OPEN: a green circle with a green line aligned with the flow line.
- CLOSED: a white circle with a white line perpendicular to the flow line.
- UNDETERMINED: an amber dashed circle with no line.
- IN TRANSIT: a white circle with a white line diagonal to the flow line.
- FAILED CLOSED: a white circle with a white line perpendicular to the flow line, beneath an amber cross.
- FAILED OPEN: a green circle with a green line aligned with the flow line, beneath an amber cross.

5 – FUEL TANK QUANTITY INDICATION (TANK 1 and TANK 2)

- The fuel tank quantity indication is the total amount of fuel remaining in the associated wing tank.
- Digital Quantity:
 - GREEN: normal operating range.
 - AMBER: cautionary operating range.
 - RED: low fuel quantity.
- Scale:
 - WHITE: normal operating range.
 - AMBER: cautionary operating range.
 - RED: low fuel quantity.

6 – FUEL FLOW LINE

- GREEN: the associated flow line is pressurized.
- WHITE: the associated flow line is not pressurized.
- WHITE/AMBER DASHED: the associated flow line pressure is undetermined.

7 – TOTAL FUEL QUANTITY INDICATION

- Indicates the total fuel quantity in all tanks.
 - GREEN: normal operating range.
 - AMBER: cautionary operating range.
 - AMBER DASHED: invalid information.
 - RED: low level.

8 – TOTAL FUEL USED INDICATION

- Indicates the total fuel used.
 - GREEN: normal operating range.
 - AMBER DASHED: invalid information.

EICAS INDICATION



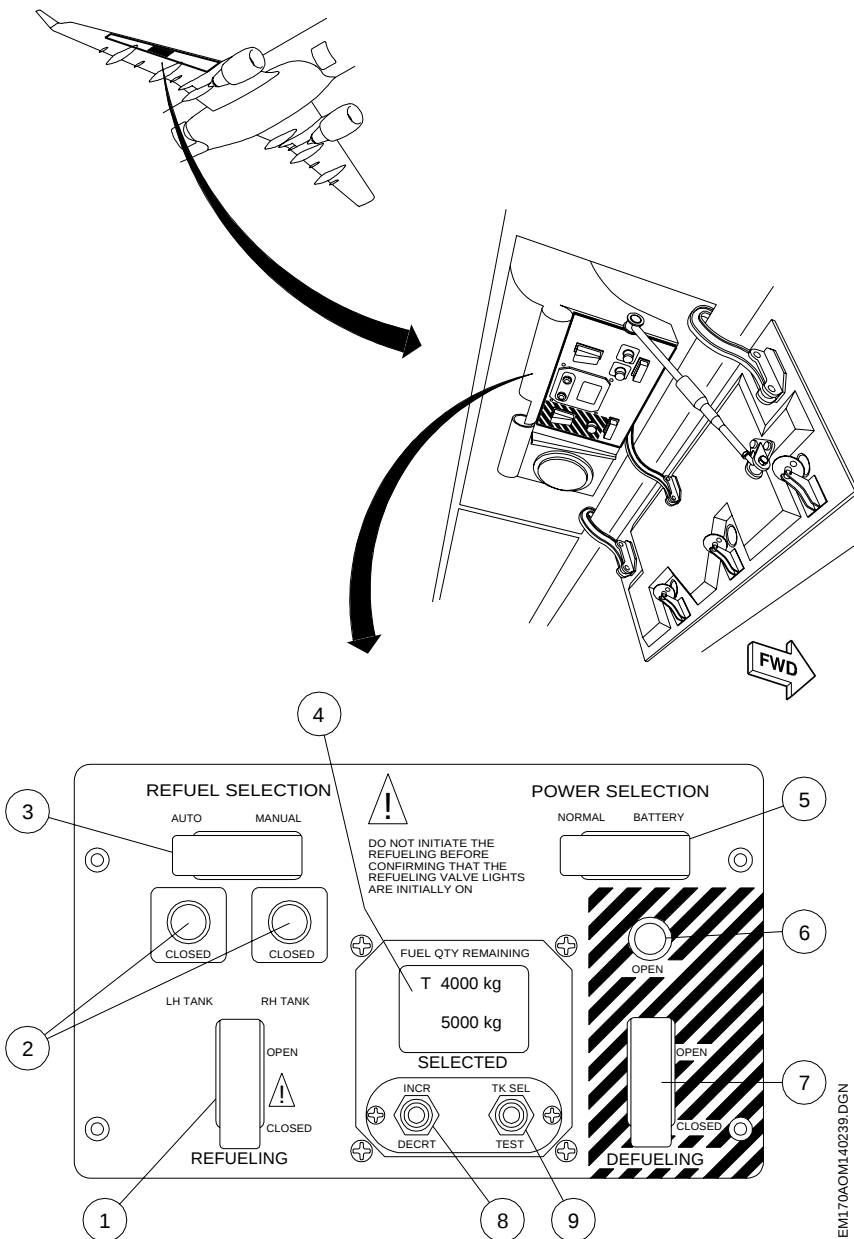
1 – FUEL FLOW INDICATION

- Indicates the left and right engine fuel flow.
GREEN: normal operating range.
AMBER DASHED: invalid information.

2 – FUEL QUANTITY INDICATION

- Indicates left and right fuel tank quantities separately. Total fuel in all tanks is indicated inside a gray box.
GREEN: normal operating range.
AMBER DASHED: invalid information.

REFUELING/DEFUELING CONTROL PANEL



1 – REFUELING SWITCH (GUARDED)

OPEN: opens the refueling valve.

CLOSED: closes the refueling valve.

2 – REFUELING CLOSED LIGHTS

- Illuminate indicating that the refueling shutoff valve is closed.

3 – REFUEL SELECTION SWITCH (GUARDED)

AUTO: automatic mode of operation.

MANUAL: manual mode of operation.

4 – DISPLAY

- The upper display indicates the fuel remaining in the associated tank as selected by the TK SEL/TEST switch (L for the left tank, R for the right tank and T for both tanks).
- The lower display indicates the total fuel quantity pre-selected via the INCR/DECRT switch. Zero is indicated when the refueling compartment door is opened.

5 – POWER SELECTION SWITCH (GUARDED)

NORMAL: DC BUS powers the refueling system.

BATTERY: HOT BATT BUS 2 powers the refueling system.

6 – DEFUELING OPEN LIGHT

- Illuminates indicating that the defueling shutoff valve is open.

7 – DEFUELING SWITCH (GUARDED)

OPEN: opens the defueling valve.

CLOSED: closes the defueling valve.

8 – INCR/DECRT SWITCH

- Spring-loaded switch.
- Increases or decreases the value for fuel quantity selected.

9 – TK SEL/TEST SWITCH

- Spring-loaded switch.

TK SEL: selects the fuel quantity that is indicated on the upper display. When the display is first powered on, the total fuel quantity is shown. Sequentially actuating the switch will select, in order: left tank fuel quantity, right tank fuel quantity and total fuel quantity.

TEST: initiates a test procedure.

FUEL TANKS

The fuel system comprises two integral fuel tanks, with one tank located in each wing. Each wing tank incorporates:

- a collector tank
- a surge tank

The collector tank (inboard section) keeps the fuel pumps submerged, ensuring a constant fuel flow to the respective engine.

A vent system is designed to ensure that the differential pressure between the tank and ambient remains within structural limits and to prevent fuel spillage during flight maneuvers and hard brakes. Each fuel tank is vented through a vent tank in the outboard section (surge tank) of the wing. Vent lines provide adequate capacity for tank venting and are supplemented by a high capacity pressure relief valve to protect from fuel tank over-pressurization.

Two water drain valves collect water by gravity in each tank.

FUEL QUANTITY INDICATION

Thirteen electrical sensors measure the fuel quantity in each tank. One additional independent fuel low-level sensor installed in each tank detects the fuel low-level condition.

On ground, three magnetic lever indicators (dripsticks) mounted under each wing, provide an alternate means for fuel measuring. They are numbered as LH3, LH2 and LH1 (left hand wing – from outboard to inboard) and RH1, RH2 and RH3 (right hand wing – from inboard to outboard). The stick indication is related to the fuel quantity through the correlation table provided on OM part B – ATA Chapter 12 Servicing – Fuel Servicing.

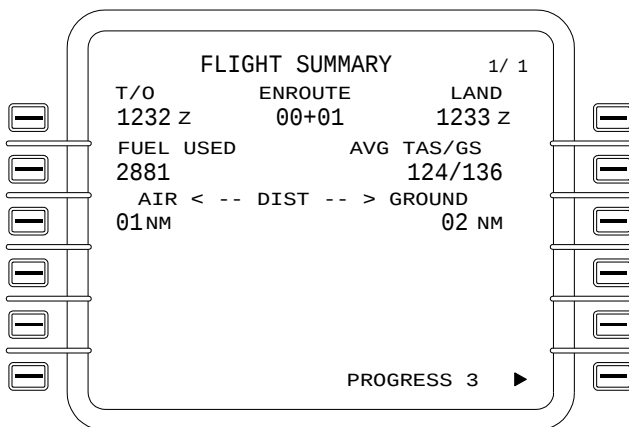
TANK	LITERS	WEIGHT (kg)
1 (left)	5854.5	4748
2 (right)	5854.5	4748
TOTAL	11709	9496

Fuel density = 0.811 kilograms per liter

MCDU FUEL USED RESET

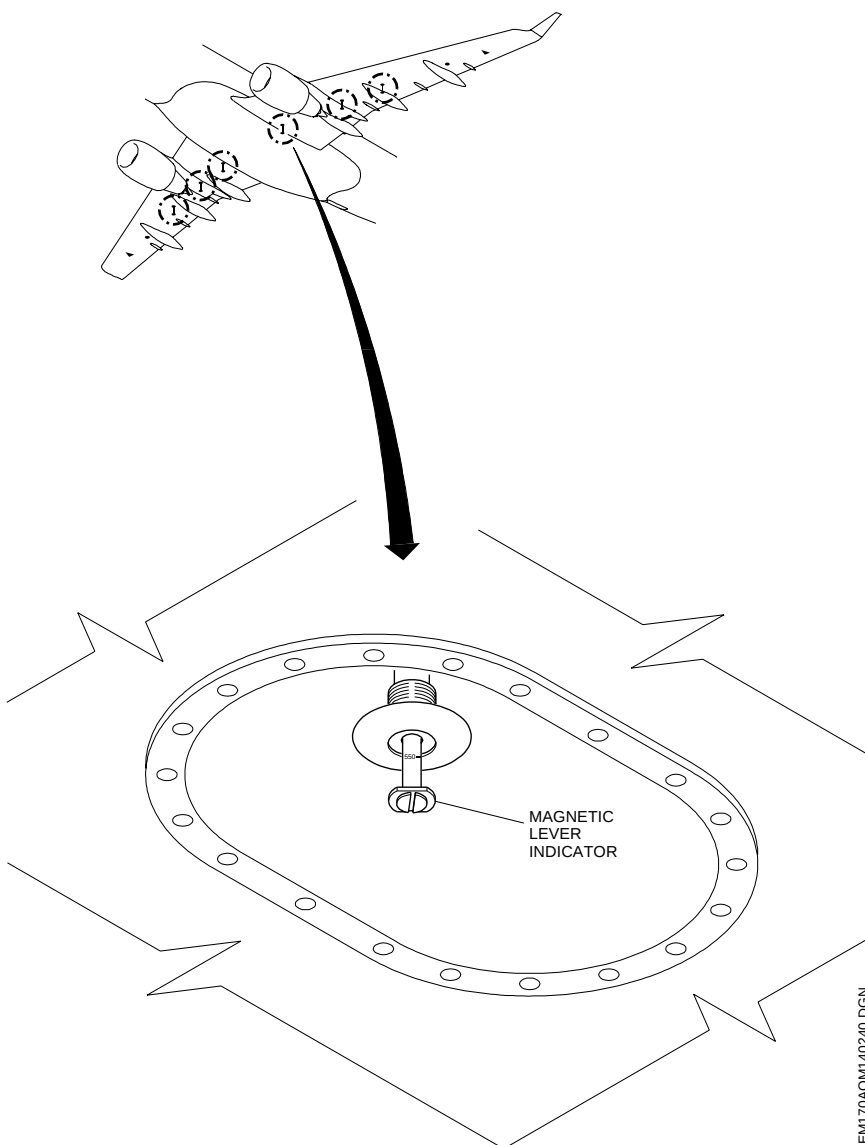
The used fuel reset is performed through the MCDU as follows:

- Press NAV button to enter in the navigation index page.
- Press LSK 3R (FLT SUM) to enter in the flight summary page.
- Press DEL button.
- Press LSK 2L to select the fuel used.



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MCDU FLIGHT SUMMARY PAGE



MAGNETIC LEVER INDICATORS

FUEL PUMPS

Each fuel tank contains the following pumps:

- Ejector fuel pump.
- AC electric fuel pump.
- Three scavenge ejector pumps.
- DC electric fuel pump (right tank only).

EJECTOR FUEL PUMP

The primary fuel pump is a venturi ejector pump (jet pump) with no moving parts, and is powered by the respective engine motive flow. It is a self-sustained pump and does not require electrical power to operate.

AC FUEL PUMP

The AC electric fuel pump supplies fuel to the following components:

- Onside engine during engine starts.
- Cross side engine during crossfeed operations.
- APU, when engine is not running.

It is also a backup pump in the event of ejector pump failure.

The left AC electric fuel pump (AC PUMP 1) is powered by AC BUS 1. The right AC electric fuel pump (AC PUMP 2) is powered by AC ESS BUS.

SCAVENGE PUMPS

Three scavenge jet pumps maintain the fuel level in the collector tank, ensuring a constant flow of fuel to the engine during normal flight.

DC FUEL PUMP

A DC electric fuel pump is installed only in the right wing tank. It provides pressurized fuel for normal APU operation and engine start, when AC power or the AC fuel pump is not available. The DC electric fuel pump is powered by the DC ESS BUS 2 and can be used in flight or on ground.

FUEL CROSSFEED

The crossfeed valve permits fuel supply to both engines from one tank in order to correct fuel imbalances and during single engine operations. Setting the crossfeed selector knob to LOW 1 position opens the crossfeed valve and activates the AC PUMP 2, feeding engine 1 from tank 2. Setting the crossfeed selector knob to LOW 2 position opens the crossfeed valve and activates AC PUMP 1, feeding engine 2 from tank 1.

NOTE: - Setting AC PUMP 1 or 2 selector knob to any position different than AUTO overrides fuel crossfeed command.

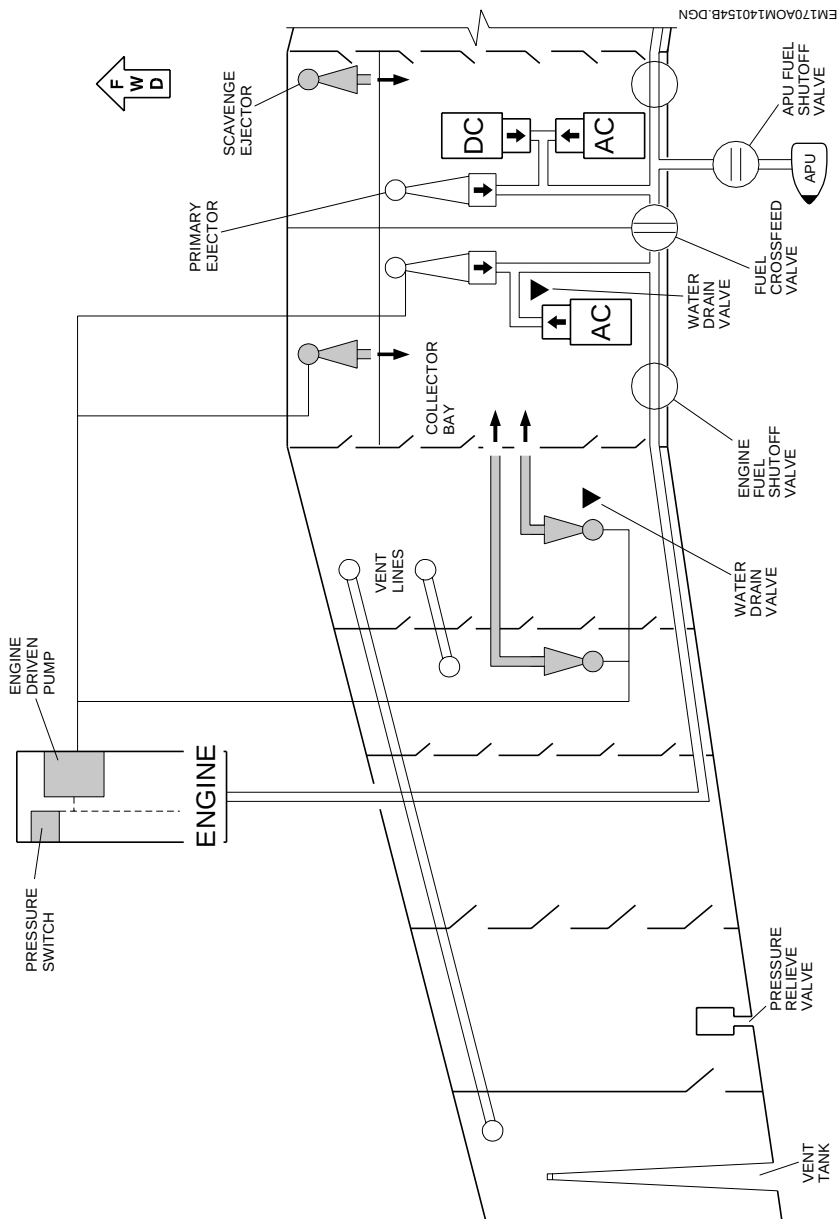
When the fuel imbalance reaches its maximum operational limit (360 kg), the EICAS CAUTION message FUEL IMBALANCE displays. When the imbalance reduces to 45 kg, the EICAS ADVISORY message FUEL EQUAL – XFEED OPEN displays, indicating that there is no fuel imbalance condition and the crossfeed valve is open.

NOTE: - If the crossfeed valve is open prior to reaching the fuel imbalance condition (360 kg), the message FUEL EQUAL – XFEED OPEN displays even if fuel imbalance is more than 45 kg.

ENGINE FUEL SHUTOFF VALVE

The engine fuel shutoff valve is installed in each wing feed line to prevent hazardous quantities of fuel from flowing into the fire zones.

The shutoff valves are normally open. Only the actuation of the fire handles on the cockpit closes the shutoff valves.



NORMAL ENGINE FEED OPERATION

FUEL LOW LEVEL WARNING

Each tank has a dedicated Fuel Low Level sensor located in the collector box. The Fuel Low Level sensor is independent of the fuel quantity indication system. Whenever the fuel level in the collector box is below the sensor level, it sends a fuel low level signal to the warning system triggering the FUEL LO LEVEL warning EICAS message.

In normal conditions, the low level warning activation point is set at 300 kg of fuel in the associated tank.

If any scavenge pump stops transferring fuel to the Collector Box, which might be caused by an engine failure, a loss of motive flow or scavenge pumps failure/blockage, the fuel contained in the Collector Box flows out so that the fuel level inside the Collector Box and the rest of the tank reaches the same level.

In this condition, if there is up to 1800 kg (3970 lb) of fuel inside that tank it is possible that the level equivalent to the low level warning activation point could be reached as the fuel level inside the collector box decreases, then FUEL 1 (2) LO LEVEL Warning EICAS Message would be displayed indicating that fuel level is below the low level sensor.

Therefore, in case of loss of the transfer system, the EICAS Warning message FUEL 1 (2) LO LEVEL may be displayed even though fuel quantity indication on EICAS or MFD Fuel System Page display is up to 1800 kg in that tank.

NOTE: - In case of loss of the transfer system followed by the EICAS warning message, fuel quantity indication monitoring during the flight is achieved through EICAS, or MFD Fuel System synoptic page.

- Engine flameout due to fuel starvation may occur if airplane is submitted to attitudes greater than 15° nose up or down, uncoordinated maneuvers or negative g's.

REFUELING AND DEFUELING

There is a single pressurized refueling point and a refuel/defuel control panel located under the right wing. When the access panel door is opened, an overhead panel lamp comes on for night or low light operation.

Pressurized refueling is performed with the airplane energized either by AC or battery power. A selector switch located on the refueling panel enables between either power sources.

Refueling operation modes can be either AUTO or MANUAL. When the refueling switch is the OPEN position, the refuel control valve opens enabling the fuel flow. In AUTO mode the FCU (Fuel Conditioning Unit) controls the refuel shutoff valve, automatically halting the refueling when the pre-selected value is reached. On MANUAL mode, the FCU is bypassed. Selection of the CLOSED position in the refueling control switch halts the refueling. In automatic mode, the desired fuel quantity may be selected on the fuel quantity remaining display via the INCR/DECRT switch.

During AUTO mode operations, the desired fuel quantity is selected on the fuel quantity remaining display via the INCR/DECRT switch.

In the pressurized refueling, both automatic and manual operations have the capability of preventing the tanks from overfilling and closing the shutoff valve when the fuel rises up to a certain level. Also the messages STOP R OVER, STOP L OVER or STOP L/R OVER appear on the Refueling/Defueling control panel display when the quantity in the right, left or both tanks, respectively, is above their capacity.

The fuel tanks may be partially or completely refueled using the gravity refuel port located on top of each wing. Following refuel completion, the individual fuel quantity can be determined using EICAS or the magnetic level indicators.

The airplane can be defueled by suction and/or pressure. The defuel shutoff valve is controlled by the DEFUEL switch located on the refuel/defuel control panel.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	FUEL 1 (2) LO LEVEL	Low-level sensors indicate that 300 kg (660 lb) of fuel remain in the respective tank.
CAUTION	APU FUEL SOV FAIL	Shutoff valve is not in the commanded position.
	ENG 1 (2) FUEL SOV FAIL	Associated shutoff valve is not in the commanded position.
	FUEL AC PUMP 1 (2) FAIL	Indicates a discrepancy between the commanded and actual associated pump state.
	FUEL IMBALANCE	Indicates an imbalance of fuel between the two tanks greater than or equal to 360 kg (800 lb). It remains displayed until the imbalance is reduced to 45 kg (100 lb).
	FUEL XFEED FAIL	Indicates a discrepancy between the cockpit control position and either the valve position or the affected pump status.
ADVISORY	DEFUEL SOV OPEN	Defuel shutoff valve is open.
	FUEL DC PUMP FAIL	Indicates a discrepancy between the commanded and actual pump state.
	FUEL EQUAL-XFEED OPEN	Crossfeed valve commanded open prior to fuel imbalance has reached 360 kg (800 lb) and the FUEL IMBALANCE message has been triggered or crossfeed valve is still open and fuel imbalance condition is suppressed after FUEL IMBALANCE message has been triggered.
	FUEL FEED 1 (2) FAULT	Respective AC pump is ON due to a failure in the primary engine feed system and the unusable fuel in the affected side is up to 98 kg. The message will not be displayed when the respective N2 is less than idle.
	FUEL KG-LB MISMATCH	Label units defined at FCU do not agree with label units set on the EICAS.
	FUEL TANK LO TEMP	Temperature sensed in the left collector bay is less than or equal to -37°C.
STATUS	APU FUEL SOV CLOSED	APU fuel shutoff valve is fully closed.
	ENG 1 (2) FUEL SOV CLOSED	Associated engine shutoff valve is fully closed.
	FUEL XFEED SOV OPEN	Crossfeed valve is open and associated AC fuel pump is operating.

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ATA CHAPTER 29

HYDRAULIC POWER

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INTRODUCTION

This Chapter contains description of the main hydraulic power, standby, and indicating systems. The airplane has three independent hydraulic systems to provide power for:

- Flight controls
- Spoilers
- Landing gear
- Nose wheel steering
- Wheel brakes
- Thrust reversers

Normal operation of the hydraulic system is automatic.

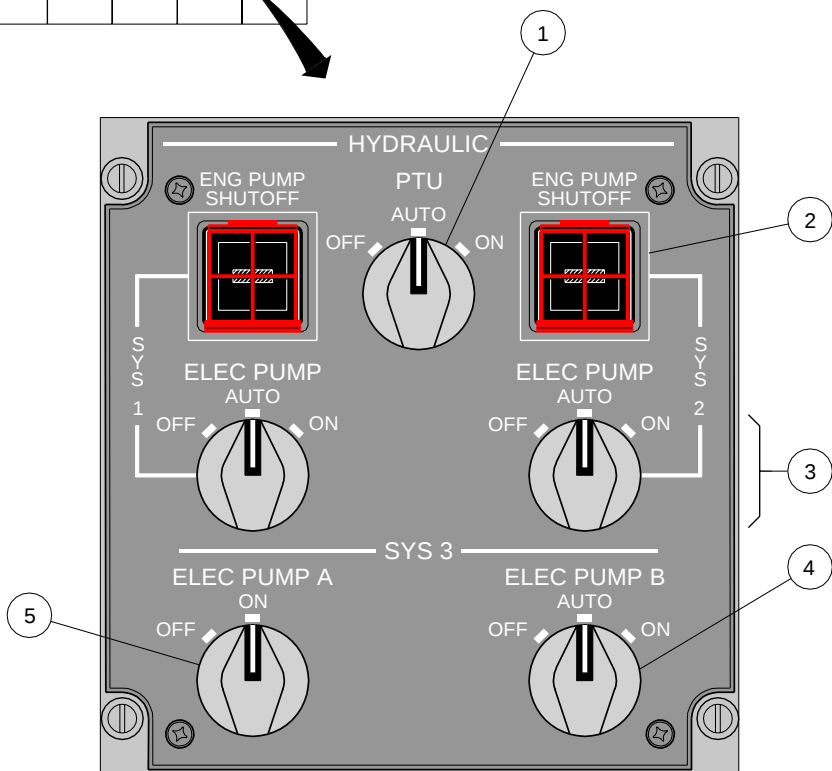
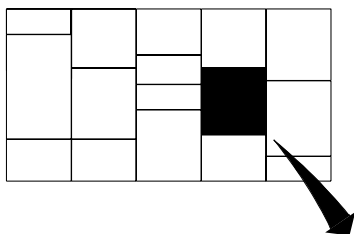
Hydraulic fluid cannot be transferred from one system to another. All three systems use skydrol hydraulic fluid and operate at a nominal pressure of 3000 psig.

The hydraulic systems' parameters and indications are displayed on both MFD synoptic pages. System messages are displayed on the EICAS display.

CONTROLS AND INDICATIONS

HYDRAULIC SYSTEM PANEL

OVERHEAD PANEL



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HYDRAULIC SYSTEM PANEL

1 – POWER TRANSFER UNIT (PTU) CONTROL KNOB (ROTARY ACTION)

OFF: turns the PTU off.

AUTO: allows the PTU to operate automatically, according to the hydraulic system logic.

ON: operates the PTU continuously, overriding the hydraulic system logic.

2 – SYS 1 AND SYS 2 ENGINE PUMP SHUTOFF VALVE BUTTONS (GUARDED)

Pushbuttons:

- Close the hydraulic shutoff valve (SOV), isolating the respective engine driven pump (EDP) from the associated hydraulic system.

3 – SYS 1 AND SYS 2 ELECTRIC HYDRAULIC PUMP SELECTOR KNOBS (ROTARY ACTION)

OFF: turns the associated electrical pump off.

AUTO: allows the associated electrical pump to operate automatically, according to hydraulic system logic.

ON: operates the associated electrical pump continuously, overriding the system's logic.

4 – SYS 3 ELECTRIC HYDRAULIC PUMP B SELECTOR KNOB (ROTARY ACTION)

OFF: turns the electrical pump off.

AUTO: allows the electrical pump to operate automatically, according to the hydraulic system logic.

ON: operates the electrical pump continuously, overriding the system's logic.

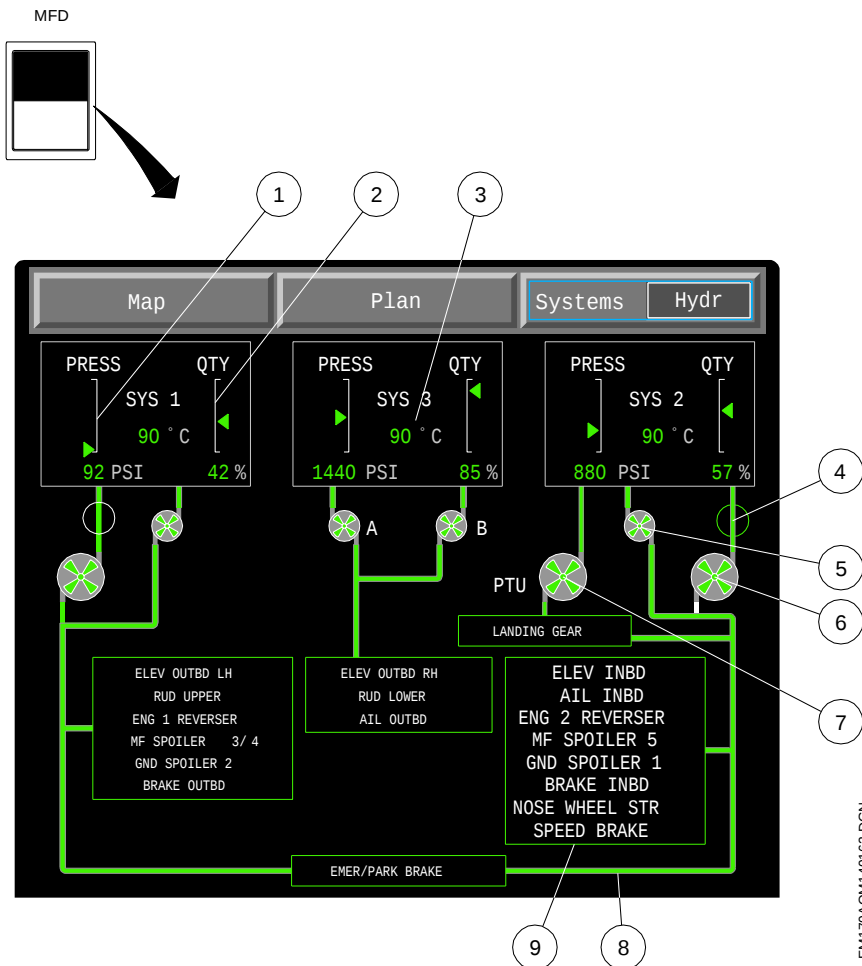
5 – SYS 3 ELECTRIC HYDRAULIC PUMP A SELECTOR KNOB (ROTARY ACTION)

OFF: turns the electrical pump off.

ON: turns the electrical pump on.

HYDRAULIC SYNOPTIC PAGE ON MFD

The hydraulic synoptic page provides a visual representation of the hydraulic system operation and parameters, and can be selected by the flight crew for viewing on either MFD. In the event of any system failure, the size of the letters inside the associated distribution box (9) increase to attract the attention of the flight crew.



1 – PRESSURE INDICATION

- Digital Pressure
 - GREEN: normal operating range.
 - AMBER: cautionary operating range.
 - GRAY: label (PSI).
 - AMBER DASHED: invalid information or a value out of the valid range.
- Pressure Scale/Pointer
 - The pointer on the scale indicates a value equal to that shown on the digital display. If the value is invalid, the pointer will be removed from the display.
 - Scale:
 - WHITE: normal operating range.
 - AMBER: cautionary operating range.
 - Pointer:
 - GREEN: normal operating range.
 - AMBER: cautionary operating range.

2 – QUANTITY INDICATION

- Digital Quantity
 - Displays the percentage of fluid remaining for each hydraulic system.
 - GREEN: normal quantity.
 - CYAN: reservoir requires refilling.
 - AMBER DASHED: invalid information or a value out of displayable range.
 - GRAY: label (%).
- Quantity Scale/Pointer
 - The pointer on the scale indicates a value equal to that shown on the digital display. If the value is invalid, the pointer will be removed from the display.
 - Scale:
 - WHITE: normal quantity.
 - CYAN: reservoir requires refilling.
 - Pointer:
 - GREEN: normal quantity.
 - CYAN: reservoir requires refilling.

3 – TEMPERATURE INDICATION

- Digital Temperature
 - Indicates the hydraulic fluid temperature measured in the reservoir.
GREEN: normal operating range.
AMBER: cautionary operating range.
RED: operating limit exceeded.
AMBER DASHED: invalid information or a value out of the valid range.

4 – ENGINE PUMP SHUTOFF VALVE STATUS

- On the synoptic page, the shutoff valve is depicted as a circle with an internal line representing the valve position.
- OPEN: a green circle and a green line aligned with the flow line.
- CLOSED: a white circle and a white line perpendicular to the flow line.
- UNDETERMINED: an amber dashed circle with no line.
- IN TRANSIT: a white circle and a white line diagonal to the flow line.
- FAILED: a white circle beneath an amber cross.

5 – ELECTRIC HYDRAULIC PUMP STATUS

- On the synoptic page, the electrical pump is depicted as a circle with an internal windmill.
- ON: a gray circle and a green windmill.
- OFF: a gray circle and a white windmill.
- UNDETERMINED: an amber dashed circle and an amber windmill.
- FAILED: a gray circle and a white windmill beneath an amber cross.

NOTE: The same icon represents the electric hydraulic pumps, the engine-driven hydraulic pumps and the PTU. However, the electric pump icons are smaller than the engine-driven pump and PTU icons.

6 – ENGINE DRIVEN HYDRAULIC PUMP STATUS

- On the synoptic page, the engine pump is depicted as a circle with an internal windmill.
- ON: a gray circle and a green windmill.
- OFF: a gray circle and a white windmill.
- UNDETERMINED: an amber dashed circle and an amber windmill.
- FAILED: a gray circle and a white windmill beneath an amber cross.

7 – POWER TRANSFER UNIT STATUS

- On the synoptic page, the PTU is depicted as a circle with an internal windmill.
- ON: a gray circle and a green windmill.
- OFF: a gray circle and a white windmill.
- UNDETERMINED: an amber dashed circle and an amber windmill.
- FAILED: a gray circle and a white windmill beneath an amber cross.

8 – HYDRAULIC FLOW LINE

- On the synoptic page, the flow line is depicted as a colorful line.
GREEN: the associated flow line is pressurized.
WHITE: the associated flow line is not pressurized.
WHITE/AMBER DASHED: the associated flow line pressure is undetermined.

9 – HYDRAULIC SYSTEM DISTRIBUTION BOX

- Each distribution box indicates the airplane's systems supplied by the respective hydraulic system.
- Distribution Box
GREEN: the associated hydraulic system is pressurized.
WHITE: the associated hydraulic system is not pressurized.
WHITE/AMBER DASHED: the associated hydraulic system pressure is undetermined.

HYDRAULIC SYSTEM 1

Hydraulic System 1 comprises one reservoir, an engine-driven pump (EDP 1), an electric hydraulic pump and an accumulator. The system powers the:

- Elevator (left hand outboard)
- Rudder (upper actuator)
- Thrust reverser (engine 1)
- Multi-function spoilers (left and right panels 3 and 4)
- Ground spoilers (left and right panel 2)
- Outboard brake
- Emergency parking brake

HYDRAULIC SYSTEM 1 RESERVOIR

A mechanical piston hydraulically pressurizes the reservoir. The fluid is supplied from the reservoir to the pumps. Leaving the pumps, the fluid is directed to the manifold, where it is filtered and routed to the airplane systems. In the return line all the fluid is re-filtered. Depending on the fluid temperature, part of the flow will be either routed to the system heat exchanger or directly back to the reservoir.

A quantity measuring system and a temperature transducer are located at the reservoir, providing information to both MFD (synoptic page) and EICAS displays.

ENGINE DRIVEN PUMP (EDP 1)

The engine-driven pump, connected to the engine 1 accessories gearbox, is the primary power source for hydraulic system 1.

An engine-pump shutoff valve (SOV) isolates the EDP from the associated hydraulic flow line. In the event of hydraulic system overheating, the flight crew commands the SOV through a guarded pushbutton on the hydraulic system control panel.

In the event of engine flameout, the FADEC logic will depressurize the respective EDP in order to reduce the torque loads on the engine and facilitate a windmill restart.

ELECTRIC HYDRAULIC PUMP 1

The electric hydraulic pump is used as a backup for the engine-driven pump (EDP), and is powered by the AC BUS 2.

The flight crew can select manual or automatic operation through a three-position selector knob on the hydraulic panel. The normal operation is automatic.

In flight, with the selector knob set to AUTO position, the hydraulic system logic activates the electric pump in case of:

- EDP or engine fail, or
- Flaps selected to any position greater the 0°.

On ground, with the selector knob set to AUTO position, the hydraulic system logic activates the electric pump in case of:

- Flaps selected to any position greater the 0° and:
 - Thrust levers set to takeoff thrust, or
 - Groundspeed greater than 50 kts.

HYDRAULIC SYSTEM 1 ACCUMULATOR

An accumulator helps to maintain constant pressure by covering transient demands during normal operation and keeping residual pressure in the reservoir to avoid pump cavitation.

HYDRAULIC SYSTEM 2

Hydraulic System 2 comprises one reservoir, an engine-driven pump (EDP 2), an electric hydraulic pump, an accumulator and a PTU. The system powers the:

- Elevator (left and right hand inboard)
- Ailerons (right and left inboard)
- Thrust reverser (engine 2)
- Multi-function spoilers (left and right panels 5)
- Ground spoilers (left and right panel 1)
- Inboard brake
- Nose wheel steering
- Landing gear
- Emergency parking brake

HYDRAULIC SYSTEM 2 RESERVOIR

The reservoir is hydraulically pressurized by a mechanical piston and is similar to hydraulic system 1.

ENGINE DRIVEN PUMP (EDP 2)

The engine-driven pump, connected to the engine 2 accessories gearbox, is the primary power source for hydraulic system 2 and its operation is identical to the hydraulic system 1 pump.

ELECTRIC HYDRAULIC PUMP 2

The electric hydraulic pump 2 and its operation are identical to the pump of hydraulic system 1. AC BUS 1 powers the electric hydraulic pump 2.

The hydraulic system allows a single engine taxi. On ground, with the selector knob in the AUTO position and after starting the engine number 1, releasing the parking brake will automatically activates the electric pump 2. Even if engine 1 is used for taxi, the electric hydraulic pump provides hydraulic power for nosewheel steering and the inboard brakes.

HYDRAULIC SYSTEM 2 ACCUMULATOR

An accumulator helps to maintain constant pressure by covering transient demands during normal operation and keeping residual pressure in the reservoir to avoid pump cavitation.

POWER TRANSFER UNIT (PTU)

The PTU is a mechanical pump, which is driven by system 1 pressure, and uses hydraulic fluid from system 2. The flight crew selects manual or automatic operation through a three-position selector knob on the hydraulic control panel. The normal operation is automatic.

During takeoff and landing, with the selector knob in the AUTO position, and flaps not set to zero, the hydraulic system logic activates the PTU if the ENGINE 2 or EDP 2 fails. In this case, the PTU will provide additional power on demand to guarantee normal landing gear retraction and extension. When the selector knob is set to the ON position, the PTU operates continuously, overriding the system logic.

HYDRAULIC SYSTEM 3

Hydraulic System 3 comprises one reservoir, two electric hydraulic pumps and an accumulator. The system powers the:

- Elevator (right hand outboard)
- Rudder (lower actuator)
- Ailerons (left and right outboard)

HYDRAULIC SYSTEM 3 RESERVOIR

A mechanical piston hydraulically pressurizes the reservoir. The fluid is supplied from the reservoir to the hydraulic pumps. Leaving the pump, the fluid is directed to the manifold, where it is filtered and routed to the airplane systems. In the return line all the fluid is refiltered and routed directly back to the reservoir. A quantity measuring system and a temperature transducer are located at the reservoir providing information to both MFD (synoptic page) and EICAS displays.

ELECTRIC HYDRAULIC PUMPS

Both electric hydraulic pumps are alternating current motor pumps (ACMPs). The electric hydraulic pump A is the primary power source for hydraulic system 3. There is no automation associated with this pump. The flight crew turns the pump on through a two-position selector knob (ON/OFF).

The electric hydraulic pump B is used as a backup for the electric hydraulic pump A. The flight crew selects manual or automatic operation through a three-position selector knob on the hydraulic control panel. The normal operation is automatic.

AC ESS BUS powers the electric pump A while AC BUS 2 powers the electric pump B.

In flight, with the selector knob in the AUTO position, the hydraulic system logic turns on the electric pump 3B whenever the electric pump 3A fails. When the selector knob is set to the ON position, the electric pump operates continuously overriding the system automation.

HYDRAULIC SYSTEM 3 ACCUMULATOR

An accumulator helps to maintain constant pressure by covering transient demands during normal operation and keeping residual pressure in the reservoir to avoid pump cavitation.

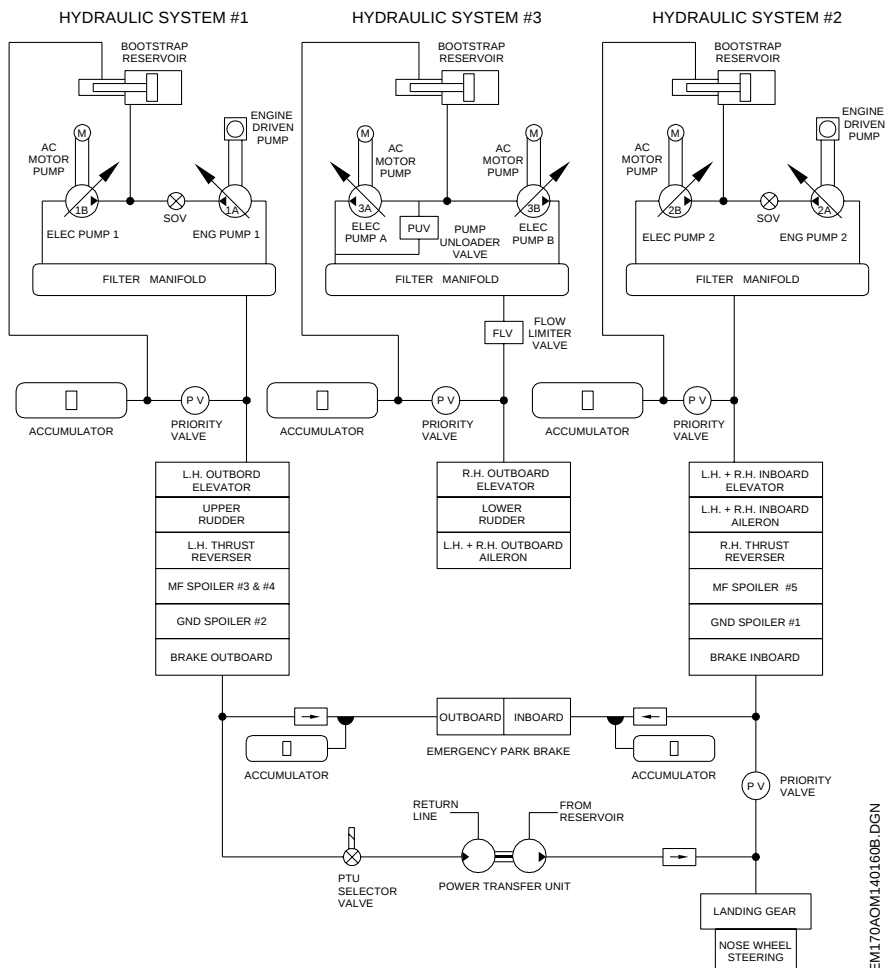
During an electrical emergency, the system 3 accumulator will provide hydraulic power to the associated flight controls, from the beginning of RAT deployment until the AC ESS BUS powers the ACMP 3A.

PUMP UNLOADER VALVE/ FLOW LIMITER VALVE

Hydraulic system 3 has two dedicated valves, which are used only in an electrical emergency to avoid overload in the RAT.

The pump unloader valve is used to reduce the discharge pressure of electric hydraulic pump A during its start-up. This will reduce the pump torque and therefore reduce the electrical power required to start the pump.

The flow limiter valve is used to reduce the amount of flow provided by the electric hydraulic pump A. This will limit the electrical power that the pump can draw and prevent the electric hydraulic pump to stall the RAT.



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HYDRAULIC SYSTEM SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	HYD 1 (2) (3) OVERHEAT	Associated hydraulic system temperature exceeded the caution operational range.
CAUTION	HYD 1 (2) (3) HI TEMP	Associated hydraulic system temperature exceeded the normal operational range.
	HYD 1 (2) (3) LO PRESS	Associated hydraulic system pressure is low.
	HYD PTU FAIL	- PTU is not supplying hydraulic power to hydraulic system 2 or; - PTU automatic operation is compromised.
	HYD 1 (2) EDP NOT D-PRESS	Depressurization of the associated engine-driven pump has failed.
	HYD 3 VLV FAIL	One or both hydraulic system # 3 valves, used during an electrical emergency condition, have failed.
ADVISORY	HYD 1 (2) EDP FAIL	Associated engine-driven pump is not providing hydraulic power to the system.
	HYD 1 (2) ELEC PUMP FAIL	Associated electric pump is not providing hydraulic power to the system.
ADVISORY	HYD3 ELEC PUMP A (B) FAIL	Associated system 3 electric pump is not providing hydraulic power to the system.
	HYD 1 (2) (3) LO QTY	Fluid level in the associated reservoir is low.
	HYD 1 (2) SOV FAIL	Associated SOV is not in commanded position.
	HYD 3 PUMP A NOT ON	ACMP 3A is not set to ON position.
	HYD PTU NOT AUTO	PTU is not in auto position.
	HYD PUMP NOT AUTO	SYS 1, 2 or 3 electric pump is not in auto position.
	HYD TEMP SENS FAIL	At least one of the hydraulic temperature sensors are failed and the system is unable to monitor the temperature of that system.
STATUS	HYD 1 (2) SOV CLOSED	Associated SOV closed.

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ATA CHAPTER 30

ICE AND RAIN PROTECTION

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INTRODUCTION

The Ice and Rain Protection System provides pneumatic anti-ice protection for the engine cowls and wing slats. The pitot and static port heating systems, windshield anti-ice system, and water lines heating system use electrical power to prevent icing.

The ice and rain protection system includes:

- Wing anti-ice system.
- Engine anti-ice system.
- Windshield heating system.
- Air data smart probe (ADSP)/TAT heating system.
- Windshield wiper system.
- Water and waste ice protection system.

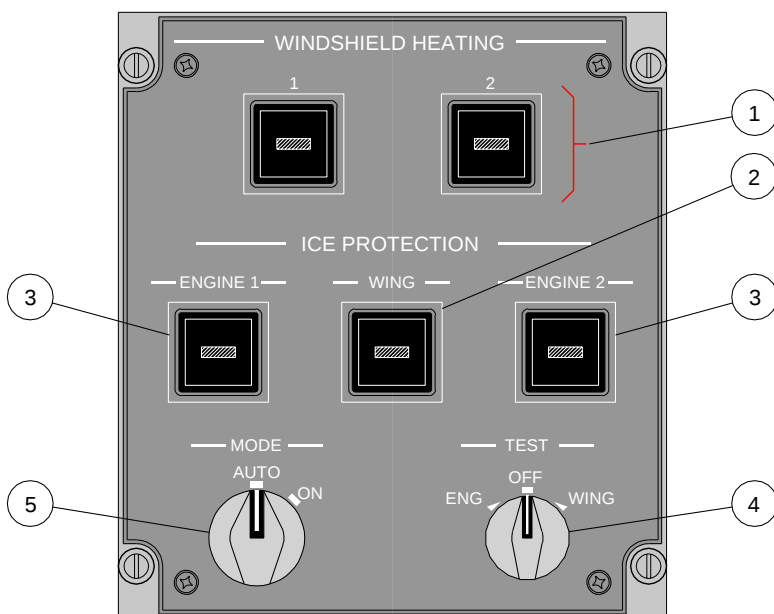
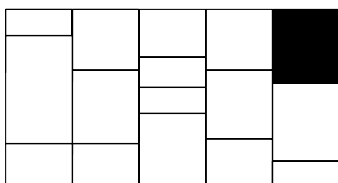
The ice and rain protection system's parameters and indications are displayed on both MFD synoptic pages. System messages are displayed on EICAS displays.

Normal operation of the anti-ice system is automatic.

CONTROLS AND INDICATIONS

ICE PROTECTION CONTROL PANEL

OVERHEAD PANEL



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1 – WINDSHIELD HEATING BUTTON

PUSH IN: activates the associated windshield heating system.

PUSH OUT: deactivates the associated windshield heating system.

2 – WING ICE PROTECTION BUTTON

PUSH IN: allows automatic operation of the wing anti-ice system.

PUSH OUT: deactivates the wing anti-ice system.

3 – ENGINE ICE PROTECTION BUTTON

PUSH IN: allows automatic operation of the associated engine anti-ice system.

PUSH OUT: deactivates the associated engine anti-ice system.

4 – ICE PROTECTION SYSTEM TEST SELECTOR KNOB

ENG: provides a test for the engine anti-ice system.

OFF: spring-loaded position.

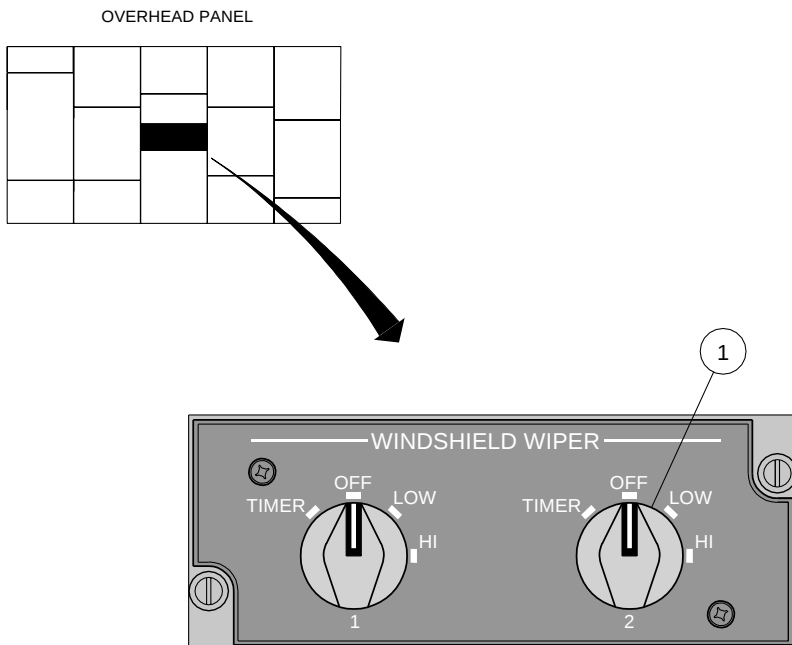
WING: provides a test for the wing anti-ice system.

5 – ICE PROTECTION MODE SELECTOR KNOB

AUTO: allows automatic operation of the wing and engine anti-ice systems.

ON: overrides the system logic inflight, activating the anti-ice system regardless of icing condition.

WINDSHIELD WIPER CONTROL PANEL

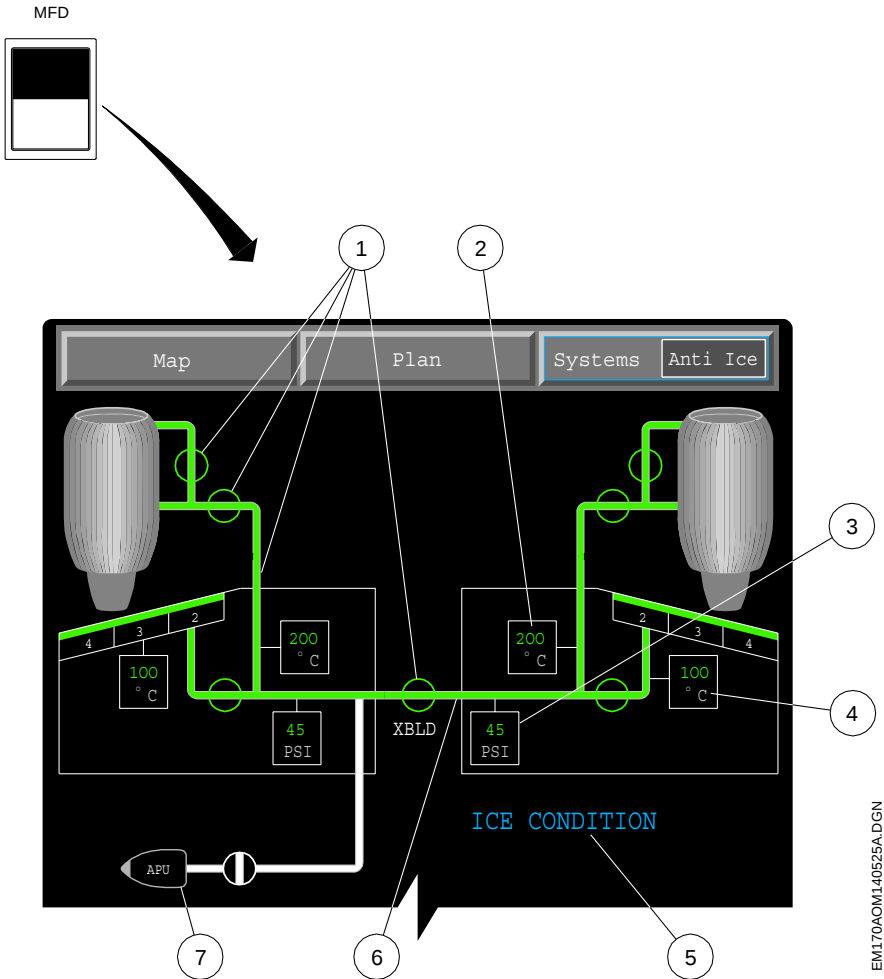


1 – WINDSHIELD WIPER SELECTOR KNOB

- TIMER:** provides eight-second intermittent operation.
- OFF:** stops windshield wipers in the stowed position.
- LOW:** windshield wipers operate at low speed.
- HIGH:** windshield wipers operate at high speed.

SYNOPTIC PAGE ON MFD

The anti-ice synoptic page provides a visual representation of the anti-ice system operation and parameters, and can be selected by the flight crew for viewing on either MFD.



1 – BLEED AIR SYSTEM VALVES STATUS

- OPEN: a green circle with a green line aligned with the flow line.
- CLOSED: a white circle with a white line perpendicular to the flow line.
- UNDETERMINED: an amber dashed circle with no line.
- IN TRANSIT: a white circle with a white line diagonal to the flow line.
- FAILED CLOSED: a white circle with a white line perpendicular to the flow line below an amber cross.
- FAILED OPEN: a green circle with a green line aligned with the flow line, below an amber cross.

2 – BLEED AIR TEMPERATURE INDICATION

- Digital Temperature
 - GREEN: normal operating range.
 - AMBER DASHED: invalid information or a value out of range.

3 – BLEED AIR PRESSURE INDICATION

- Digital Pressure
 - GREEN: normal operating range.
 - AMBER DASHED: invalid information or a value out of range.

4 – WING ANTI-ICE TEMPERATURE INDICATION

- Digital Temperature
 - GREEN: normal operating range.
 - AMBER DASHED: invalid information or a value out of the valid range.

5 – ICE CONDITION ANNUNCIATION

- The ICE CONDITION annunciation is displayed below the right bleed air manifold pressure icon, indicating that an icing condition has been detected.

6 – ANTI-ICE FLOW LINE

- The anti-ice flow line is depicted in color.
 - GREEN: the associated flow line is pressurized.
 - WHITE: the associated flow line is not pressurized.
 - AMBER: the associated flow line is overheated.
 - WHITE/AMBER DASHED: the associated flow line pressure is undetermined.

7 – APU ICON

- The APU icon is displayed on the ground only.

ICE DETECTORS

The airplane is equipped with two ice detectors installed on the left and right side of the nose section. Failure of one detector results in the loss of ice detection system redundancy. If the remaining detector senses an icing condition, the system will still automatically activate the engine and wing anti-ice systems.

Ice detector utilizes a vibrating sensor element which vibratory characteristics are changed in the event of ice build up around it. In order to allow continuous inflight ice detection, the sensor contains an internal heating element, which melts ice build up after sending icing condition signal. Once the normal vibratory characteristics are restored, the heating process stops and the sensor cools down, allowing a new ice build up.

When the system automatically activates the engine and wing ice protection, it remains activated 5 minutes after the detector is no longer sensing icing condition.

ENGINE ANTI-ICE SYSTEM

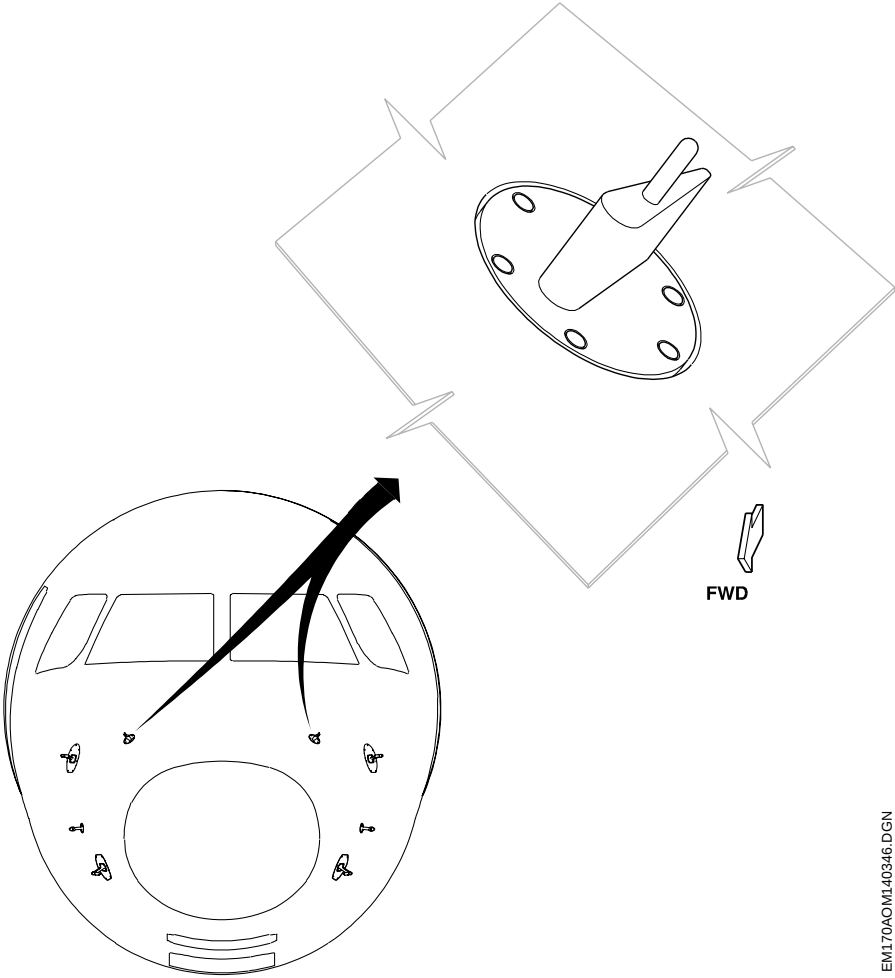
Hot air from the 10th high stage valve is supplied to the engine cowl by the respective engine bleed. Each engine anti-ice system is independent.

In case of absence of an electrical signal, the engine bleed valve is fail safe open.

WING ANTI-ICE SYSTEM

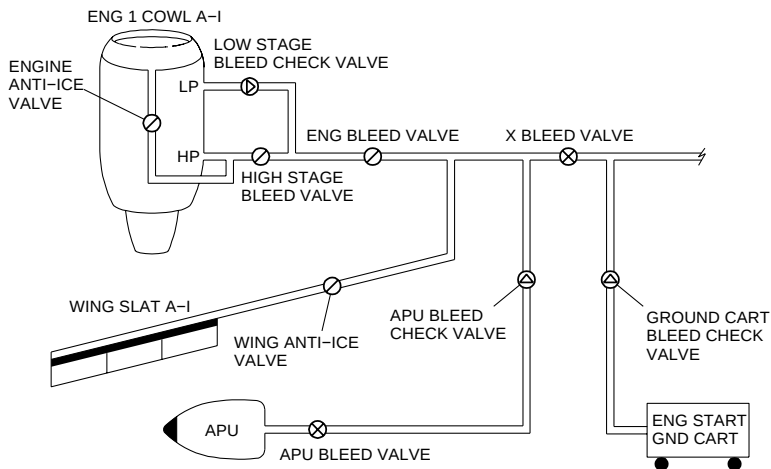
The wing anti-ice system supplies bleed air to three outboard leading edge slats on each wing.

In the event of a bleed air source failure, the system automatically opens the cross bleed valve, supplying airflow from one engine bleed to the opposite wing anti-ice.



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ICE DETECTORS LOCATION



EM170AOM140041.DGN

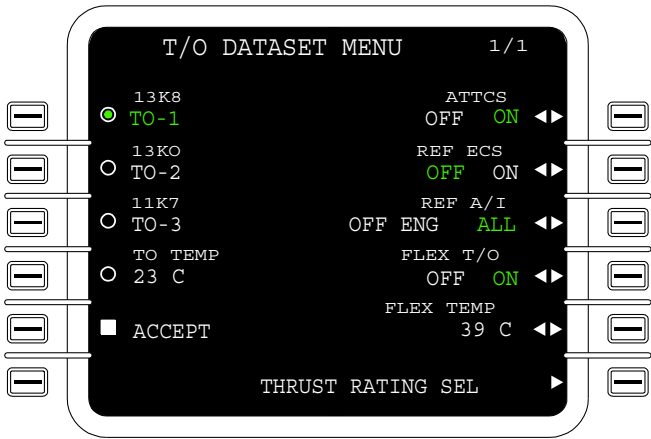
ICE PROTECTION SYSTEM SCHEMATIC

ENGINE AND WING ANTI-ICE SYSTEMS OPERATION

The engine and wing anti-ice systems operate automatically, according to the systems' logic, when the ice protection mode selector knob is in the AUTO position.

The automatic systems' operation is dependent on ice detectors and the appropriate selection of the anti-ice system made on the MCDU. In the TO DATASET MENU on the MCDU, the flight crew may select anti-ice reference OFF, ENG or ALL, according to the sequence:

- Press MENU (mode button).
- Press MISC (line select key – 1L) on MENU page.
- Press THRUST MGT (line select key – 1R) on MISC MENU page.
- Press TO DATA SET (line select key – 6R) on THRUST RATING SEL page.
- Select REF A/I (line select key – 3R) on TO DATASET MENU page.



EM170AOM140295.DGN

TO DATA SET MENU PAGE

When no ice is detected, with “ALL” selected on the REF A/I line and the ice protection selector knob set to the AUTO position, the wing anti-ice system is activated when wheel speed is greater than 40 knots and remains activated until 1700 ft above ground level or 5 minutes after liftoff, whichever happens first.

TO DATASET MENU	MODE SELECT OR KNOB	ICE CONDITION	ENGINE A-I ACTIVATION	WING A-I ACTIVATION	EICAS CAUTION MESSAGE
OFF	AUTO	NOT DETECTED	-	-	-
		DETECTED	1700 ft AGL or 2 min after liftoff	1700 ft AGL or 2 min after liftoff	-
	ON	NOT DETECTED	ENGINE RUNNING	LIFTOFF	ENG REF A-I DISAG
		DETECTED	ENGINE RUNNING	LIFTOFF	ENG REF A-I DISAG
ENG	AUTO	NOT DETECTED	ENGINE RUNNING	-	-
		DETECTED	ENGINE RUNNING	1700 ft AGL or 2 min after liftoff	-
	ON	NOT DETECTED	ENGINE RUNNING	LIFTOFF	ENG REF A-I DISAG
		DETECTED	ENGINE RUNNING	LIFTOFF	ENG REF A-I DISAG
ALL	AUTO	NOT DETECTED	ENGINE RUNNING	WSPEED > 40 kt	-
		DETECTED	ENGINE RUNNING	WSPEED > 40 kt	-
	ON	NOT DETECTED	ENGINE RUNNING	WSPEED > 40 kt	-
		DETECTED	ENGINE RUNNING	WSPEED > 40 kt	-

ENGINE AND WING ANTI-ICE SYSTEMS OPERATION

WINDSHIELD HEATING SYSTEM

The windshields are electrically heated for anti-icing and anti-fogging purposes. Left and right windshields heating are controlled by individual pushbuttons on the overhead panel. During normal operation (windshield heating buttons pushed in) the windshield heating control unit (WHCU) automatically controls the windshield temperature within a specific range.

The WHCU operates according to a load shedding logic. On the ground, if only a single power source (e.g. one IDG) is available, the windshield heating is inhibited and. Inflight only the left windshield heating is powered or the right windshield if the left one has failed.

AIR DATA SMART PROBE/TAT HEATING SYSTEM

Air Data Smart Probe (ADSP)/TAT heating operation is fully automatic. A total of four smart and two TAT probes are installed on the nose fuselage section of the airplane. Each probe has a dedicated heater, which is powered whenever an engine is running.

WATER AND WASTE HEATING SYSTEMS

Electrical heating for the water and waste systems is provided to prevent ice accumulation on fill/drain nipples and forward and rear drain masts. The water system controller monitors the system and indicates any failure on the flight attendant panel as described on Airplane General – Controls and Indications.

WINDSHIELD WIPER SYSTEM

This airplane is equipped with two independent wipers operated through dedicated control knobs on the overhead panel.

The windshield wipers will stop if operated on a dry windshield. The system remains inoperative until the wiper control knob is set to OFF position.

ICE PROTECTION SYSTEM TEST

The Ice Protection System Test selector knob provides a manual test for the wing and engine anti-ice systems for maintenance use.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	A-I WING 1 (2) LEAK	An overheating or leakage is detected in the associated wing anti-ice system.
CAUTION	A-I ENG 1 (2) FAIL	Engine anti-ice bleed valve is closed when commanded open, or duct failure detected.
	A-I LO CAPACITY	Wing anti-ice bleed air pressure and temperature capacity is low.
	A-I WING FAIL	A wing anti-ice system failure has been detected.
	A-I WING NO DISPATCH	Wing anti-ice bleed valve has failed open. Maintenance action is required.
	ICE DETECTOR 1 (2) FAIL	Associated ice detector has failed.
	WINDSHIELD 1 (2) HTR FAIL	Associated windshield heating system has failed or is overheated.
ADVISORY	A-I MODE NOT AUTO	Ice protection selector knob is not in the AUTO position.
	A-I SWITCH OFF	Ice protection button for engine and/or wing anti-ice system is pushed out.
	ICE CONDITION	An icing condition has been detected.
	A-I ENG 1 (2) FAULT	Displayed during test if there is loss of the capacity to monitor the adequate functioning of the system.
	A-I ENG 1 (2) LEAK	Indicates leakage in the internal pipe.
STATUS	A-I ENG 1 (2) VLV OPEN	Engine anti-ice valve is open.
	A-I WING VLV OPEN	Wing anti-ice valve is open.

DIMENSIONS AND AREAS	ATA 06
SERVICING	ATA 12
AIR CONDITIONING	ATA 21
AUTO FLIGHT	ATA 22
COMMUNICATION	ATA 23
ELECTRICAL POWER	ATA 24
EQUIPMENT AND FURNISHINGS	ATA 25
FIRE PROTECTION	ATA 26
FLIGHT CONTROLS	ATA 27
FUEL	ATA 28
HYDRAULIC POWER	ATA 29
ICE AND RAIN PROTECTION	ATA 30
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LANDING GEAR	ATA 32
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PNEUMATIC	ATA 36
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POWERPLANT	ATA 71

ATA CHAPTER 31

INDICATION AND RECORDING SYSTEM

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INTRODUCTION

The Indication And Recording System ATA Chapter contains description of the Flight Instruments System.

The conventional flight data information is presented on the Electronic Display System (EDS).

The airplane is provided with a variety of warnings to notify the crew on systems' status, malfunctions, and abnormal airplane configurations.

Alarm lights provide indication of a system status. An Engine Indication and Crew Alerting System (EICAS) provide the flight crew with a four-level alert messaging system. A fifth level is provided for maintenance purposes only.

In addition to the five displays in the main panel, two displays are provided through the MCDU (Multi-function Control Display Unit). Some of the more critical messages also generate an aural warning.

Sensitive warning is available through the Stall Protection System (SPS), which shakes the control column if an impending stall is verified.

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ELECTRONIC DISPLAY SYSTEM (EDS)

The EDS is an advanced system that displays primary flight, navigation and systems' information to the flight crew and comprises:

- Five Display Units (DU).
- One Guidance Panel.
- Two Cursor Control Devices (CCD).
- Two Multi-function Control Display Units (MCDU).
- One EICAS FULL panel.
- Two Reversionary Panels.
- MAU hardware.
- Control I/O modules.
- EDS application software on processor module.

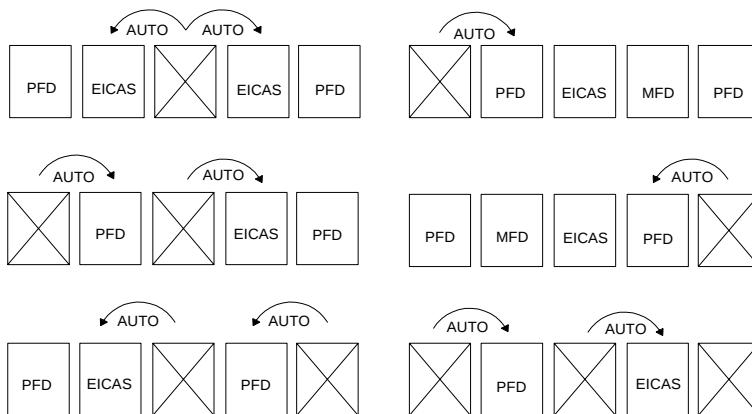
Five display units (DUs) are located on the main instrument panel. There are two Primary Flight Displays (PFD), two Multifunction Displays (MFD) and one Engine Instrument and Crew Alerting System (EICAS). They are identical and interchangeable.

The guidance panel is located in the center of the glareshield above the DUs. The two CCDs, one EICAS FULL panel and the MCDUs are located on the pedestal, whereas the reversionary panels are located on the main instrument panel.

There are four different modes for the DU reversion control for each pilot: PFD, MFD, EICAS and AUTO. Only DU 2 and DU 4 can be reverted. DU 1 and DU 5 always operate as PFDs, and DU 3 is always an EICAS. In case of failure of one display, an automatic logic transfer will allow its information to be presented in the remaining units provided that the display selector knob is set to auto position. If the failed display is recovered, it is necessary to revert manually the display selector knob to have the MFD information on DU 2 or DU 4.

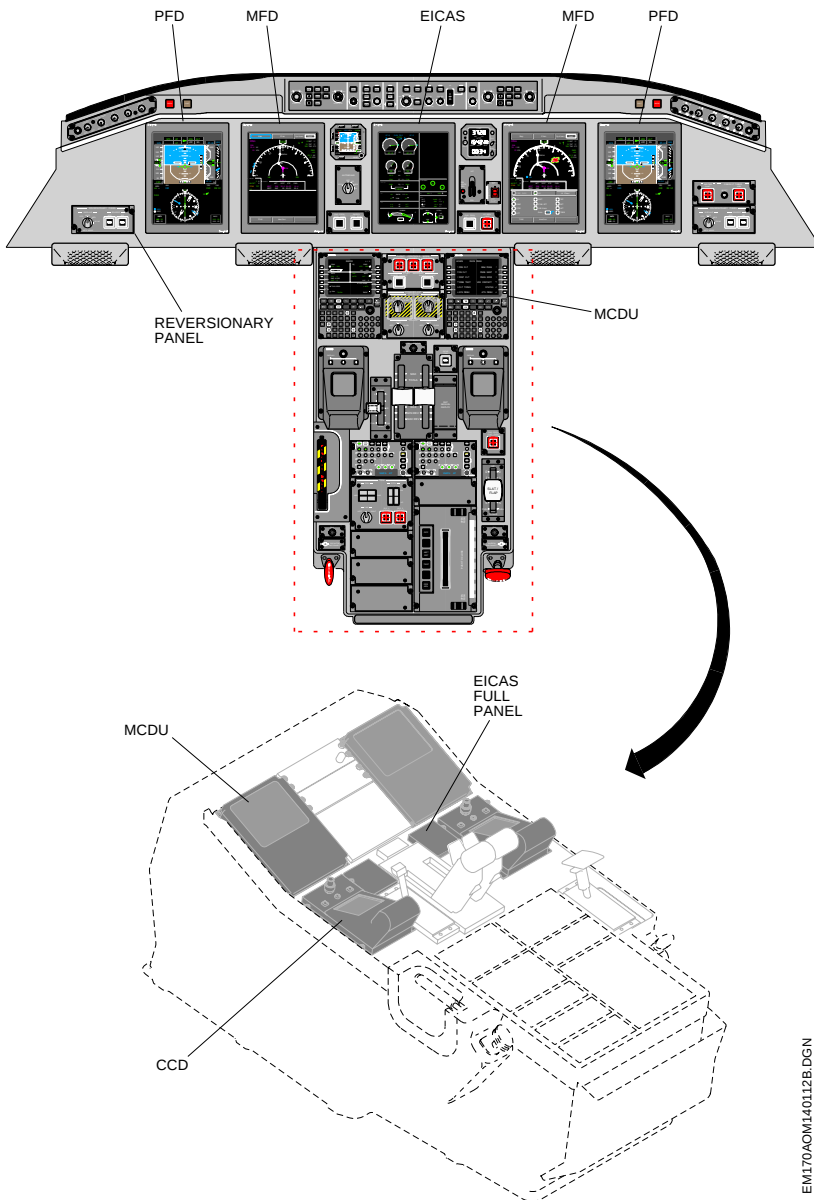
Rotating the display selector knob to a position other than AUTO forces that selection onto the MFD. When a pilot selected reversion occurs, the "failed/reverted from" DU is shutdown and the display will be blank.

The auto DU reversion function will have the following display format reversion priority (highest to lowest): PFD, EICAS and MFD.



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EDS AUTO REVERSION LOGIC



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AIRPLANE DISPLAYS

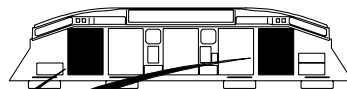
PRIMARY FLIGHT DISPLAY (PFD)

The PFD displays information such as airspeed indicator, altitude indicator, ADI, HSI, vertical speed indicator, radio aids, autopilot, flight director and radio altitude data. They are displayed in two sections, each one presenting a portion of information.

In the event of a display failure, information may be presented in the MFD by appropriately setting the reversionary panel. Certain PFD internal failures will result in a large red X covering the PFD screen. In case of mismatched information between two PFDs, no information at all will be presented.

The display controller portion of the guidance panel allows the selection of PFD HSI formats, navigation sources, weather display, and bearing pointer selection.

MAIN PANEL



AVIATE

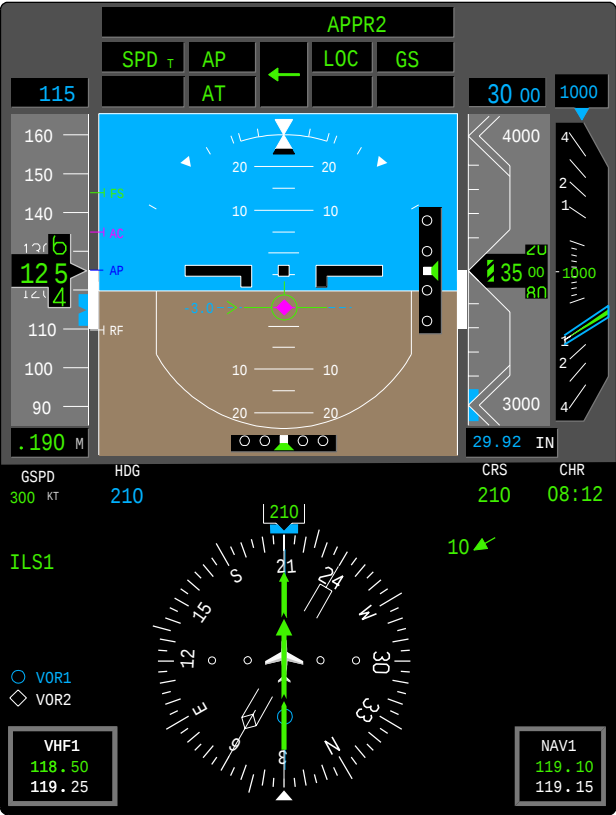
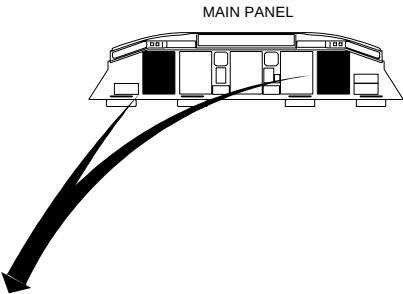
- AUTOPILOT APPROACH STATUS ANNUNCIATOR
- FLIGHT MODE ANNUNCIATOR
- ATTITUDE AND SIDE SLIP
- ALTITUDE
- AIRSPEED/MACH
- AIRSPEED TREND VECTOR
- VERTICAL SPEED
- FLIGHT PATH ANGLE
- FPA ACCELERATION POINTER
- FLIGHT DIRECTOR
- TCAS RESOLUTION ADVISORY
- WINDSHEAR
- RADIO ALTIMETER

NAVIGATE AND COMMUNICATE

- HEADING
- ILS/VOR/DME
- RADIO COMMUNICATION TUNING
- RADIO NAVIGATION TUNING
- FMS ANNUNCIATION/INDICATION
- WIND
- ELAPSED TIME

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PFD DISPLAY PHILOSOPHY

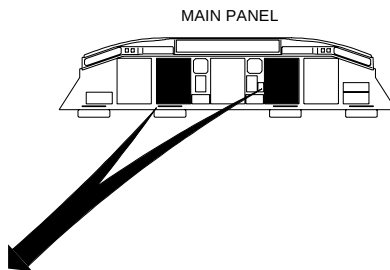


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PFD DISPLAY

MULTI FUNCTION DISPLAY (MFD)

The MFD presents map and plan navigation formats, various systems' synoptic formats selectable by the flight crew and also the status page. The MFD provides redundancy to display both the PFD and EICAS formats based upon reversion. It also has the ability to display maintenance information. The MFD consists of menu softkeys, on the top and bottom of the screen, which are used to select formats and control various systems.



NAVIGATE

- MAP
- PLAN
- SYSTEM SYNOPTIC PAGES
- TCAS
- WEATHER RADAR
- EGPWS (TERRAIN)

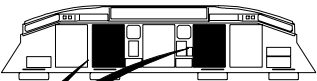
NAVIGATE (Vnav)

- TCAS ZOOM
- WEATHER RADAR CONTROLLER
- TCAS CONTROLLER

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MFD DISPLAY PHILOSOPHY

MAIN PANEL



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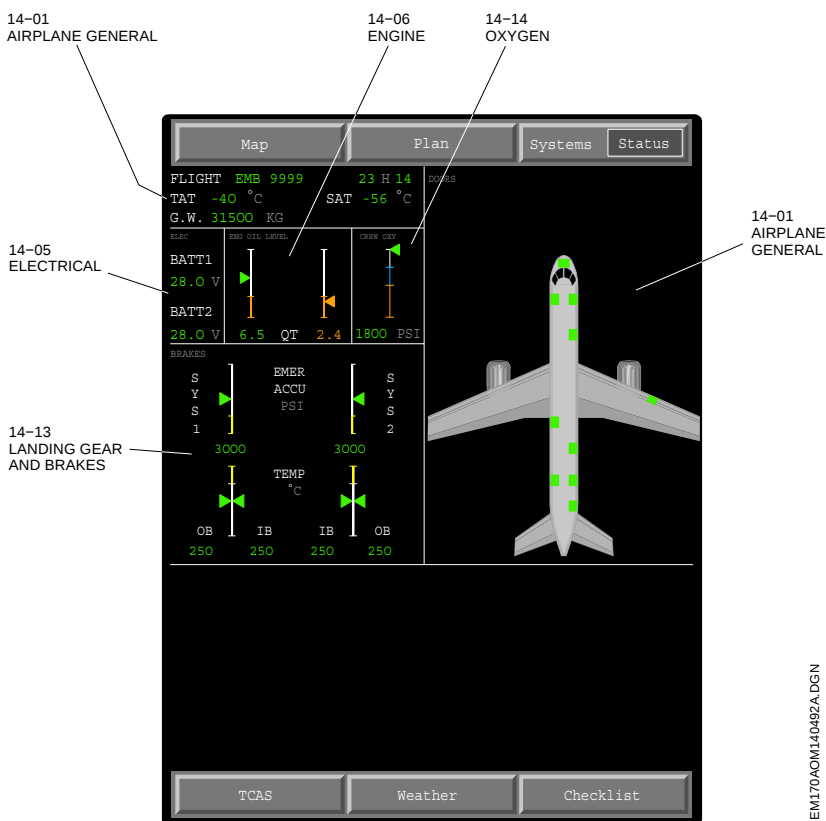
MFD DISPLAY

STATUS PAGE

A dedicated page on MFD is available for pilots to achieve status information about:

- Flight;
- Battery;
- Engine Oil level;
- Brake;
- Crew oxygen;
- Door and Access Panel.

Refer to the associated section of the AOM for more information:



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ENGINE INDICATION AND CREW ALERTING SYSTEM DISPLAY (EICAS)

The EICAS displays engine and system parameters such as flap, gear, spoilers and trim positions, total fuel quantity, APU and environmental information. The EICAS also displays crew awareness messages. For further information on engine parameters and CAS messages shown, refer to ATA Chapter 71 Powerplant and ATA Chapter 31 Warnings respectively. In case of failure in the EICAS display, its information may be presented in the MFD by appropriately setting the reversionary panel.

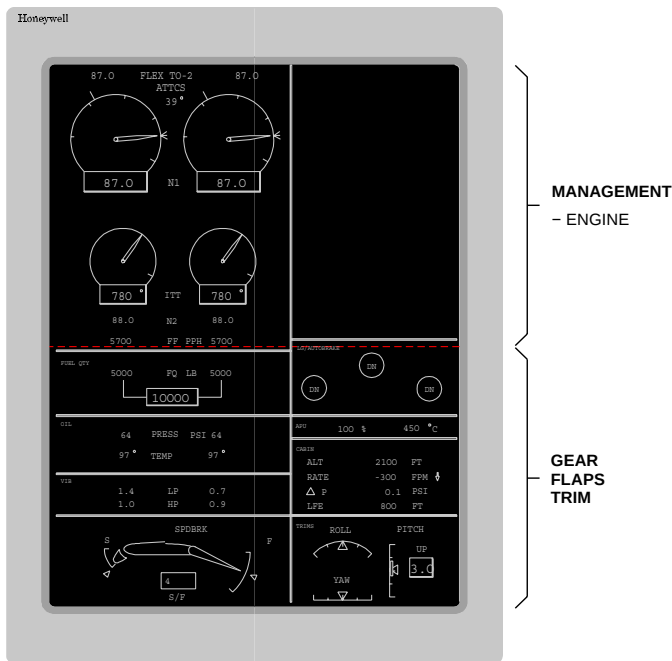
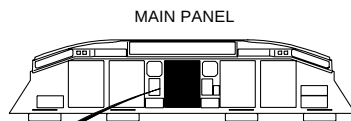
An automatic mode de-clutters the EICAS after takeoff. De-cluttering occurs 30 seconds after landing gear retraction and flap/slat retraction, if all parameters are displaying normal indications.

The following items are de-cluttered from EICAS:

- Oil pressure.
- Oil temperature.
- Engine vibration.
- Slat position.
- Flap position.
- Speed brake position.
- Landing gear position.
- Pitch trim green band.
- APU

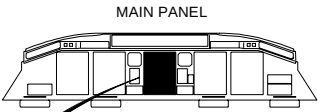
The EICAS FULL pushbutton on the control pedestal inhibits the automatic de-clutter of EICAS. The EICAS is fully displayed when a cautionary condition is detected on one of de-cluttered indications.

In normal conditions, de-clutter is disabled when the landing gear is extended and/or flap/slat different from 0.



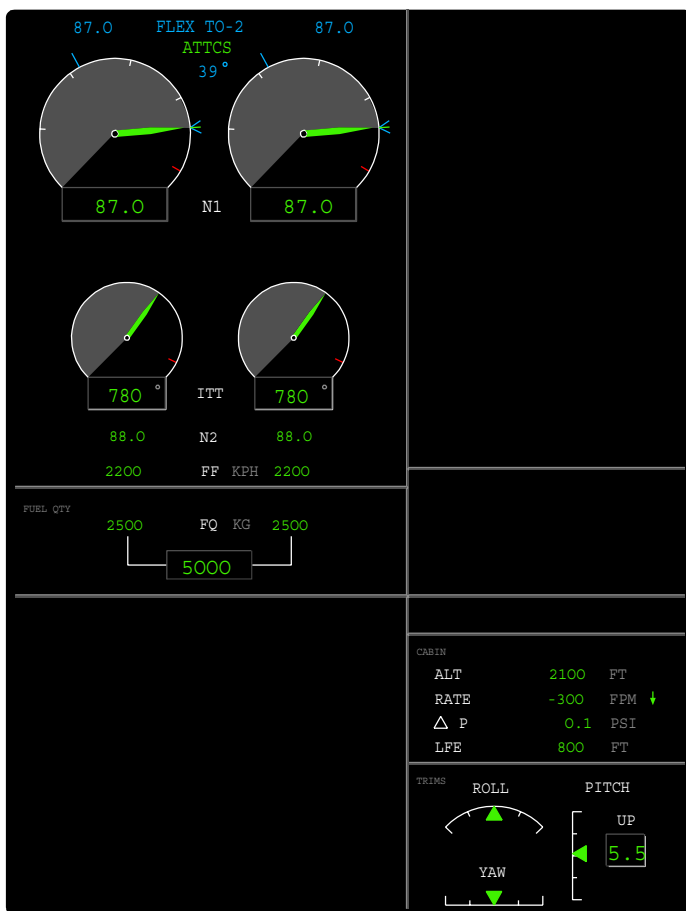
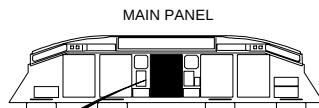
EICAS DISPLAY PHILOSOPHY

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FULL EICAS DISPLAY



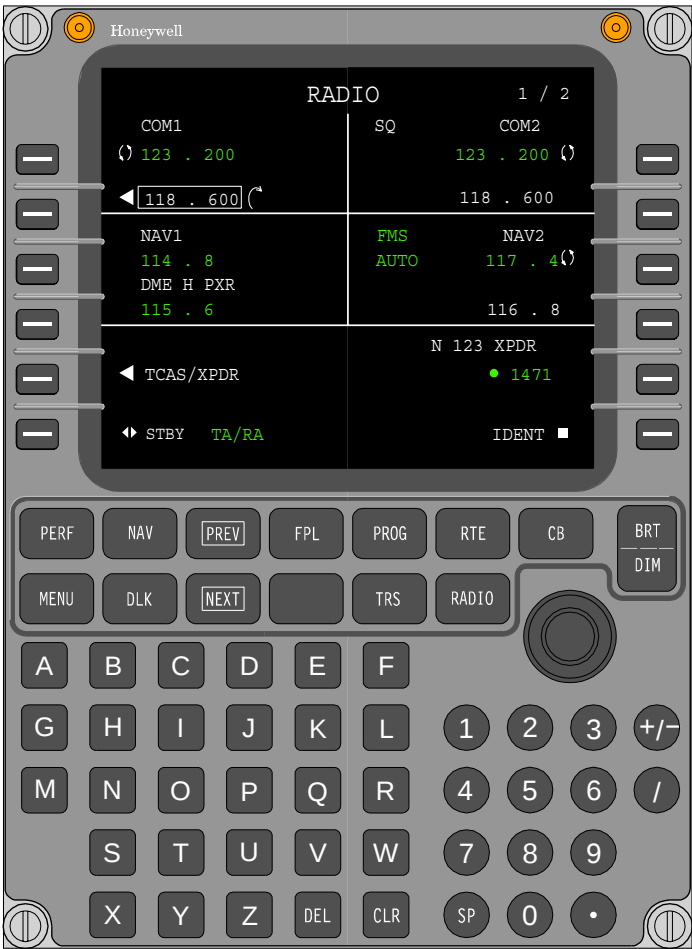
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DECLUTTERED EICAS DISPLAY

MULTIFUNCTION CONTROL DISPLAY UNIT (MCDU)

The MCDU allows radio tuning, PFD radio tuning display setup, manual engine rating selection, engine takeoff data set and avionics display setup and test.

The EDS allows either MCDU to perform any of the functions available.



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CURSOR CONTROL DEVICE (CCD)

Two CCDs are installed on the control pedestal and allow the flight crew to quickly position the cursor within the different selectable menus and displays.

Each CCD has three function keys corresponding to respective flight crew's display. Pressing a function key activates the CCD on the corresponding display (PFD, MFD or EICAS). A cyan box shows the menu in control whenever a display is selected. The middle button has a different shape to make the identification easier under low visibility conditions or turbulence.

ENTER buttons are provided on both sides of CCD.

A dual concentric rotary knob on the CCD is used to control the

- WX radar tilt angle and range selection,
- Selection of Radio frequency.
- Scrolling of EICAS messages (caution, advisory, and status).

Touching the touch pad moves the cyan box selector around the display. The touch pad has six hot spots: one in each corner and at top and bottom centers. Touching a hot spot instantly moves the cursor to corresponding position on the selected screen.

The cursor automatically goes to a default position if CCD is not operated for more than 20 seconds, provided there is not virtual controls panel and pull-down menus opened.

An opened pull-down menu closes automatically if a different display is selected. This logic is not applicable for WX radar control panel on MFD.

GUIDANCE PANEL

The guidance panel houses the display controllers, used for display control, autopilot and yaw damper engagement functions, flight director mode engagement and selection of display data source for the flight director.

MODULAR AVIONICS UNIT (MAU)

MAUs are cabinets that house modules assigned to different functions in an integrated architecture and also avionics and non-avionics functions. Among the avionics functions are the air data application, autopilot, autothrottle, data acquisition, display control functions, flight director, Flight Management System (FMS), flight control modules, global position system, monitor/warning system, stall protection/warning and windshear guidance.

MAU 1 and 2 are located in the forward electronics bay, whereas MAU 3 is located in the center electronics bay.

MAU 1 is a 20-slot cabinet while MAU 2 and MAU 3 are 16 slot cabinets. The typical layout of the MAUs, showing the location of each module, is provided on the next page.

MODULAR AVIONICS UNIT 1

SLOT	BUS	CH	POWER SUPPLY 3 DC 1	CH	BUS
20		B	SPARE		
19	2	B			
18	2	B	CMC		
17	2	B	GPS 1		
			POWER SUPPLY DC ESS 1		
16	2	B	FCM 1		
15				A	1
14	2	B	CUSTOM I/O 1		
13				A	1
	2	B	NIC 2		
	2	B	PROC 2		
12	2	B	GENERIC I/O		
11				A	1
10			AIOPB1	A	1
9					
			PROC 1	A	1
			NIC 1	A	1
8	2	B	FCM 2		
7				A	1
6			CONTROL I/O 1	A	1
5			BRAKES (OUTBD)	A	1
4			PSEM 1		
3				A	1
2			AIOPA1	A	1
1					
SLOT	BUS	CH	POWER SUPPLY 1 DC ESS 1	CH	BUS

MODULAR AVIONICS UNIT 2

SLOT	BUS	CH	POWER SUPPLY 2 DC ESS 2/DC 2	CH	BUS
16	2	B	BRAKES (INBD)		
15	2	B	CONTROL I/O 2		
14			AIOPA2		
13	2	B			
12			SPARE		
11			SPARE		
10	2	B	GENERIC I/O 2		
9				A	1
	2	B	NIC 4		
	2	B	PROC 4		
			PROC 3	A	1
			NIC 3	A	1
8			SPARE		
7	2	B	DATABASE		
6			AUTOBRAKE	A	1
5	2	B	EGPWM		
4			NOSEWHEEL STEERING	A	1
3					
2			SPARE	A	1
1				A	
SLOT	BUS	CH	POWER SUPPLY 1 DC 2	CH	BUS

MODULAR AVIONICS UNIT 3

SLOT	BUS	CH	POWER SUPPLY 2 DC 2	CH	BUS
16	1	B	ENGINE VIBE		
15			GPS 2	A	2
14			PSEM 2		2
13				A	
12	1	B	FCM 3		
11				A	2
10	1	B	GENERIC I/O 3		
9				A	2
	1	B	NIC 6		
	1	B	PROC 6		
			PROC 5	A	2
			NIC 5	A	2
8	1	B	CUSTOM I/O 2		
7				A	2
6			AIOPB2	A	2
5					
4			SPARE		
3			SPARE		
2	1	B	FCM 4		
1				A	2
SLOT	BUS	CH	POWER SUPPLY 1 DC ESS 2	CH	BUS

Where each MAU module is named as:

NIC: network interface controller.

AIOP: actuator input/output processor.

PROC 1: ADA 1 (air data application), MW 1 (monitor warning), UTIL 1 (utility), CAL/MCDU 1, and CMS 1.

PROC 2: CMF 2 (communication management function).

PROC 3: FMS 1.

PROC 4: ADA 2, MW 2, UTIL 2 (utility), CAL/MCDU 2, and CMS 2 (configuration management system).

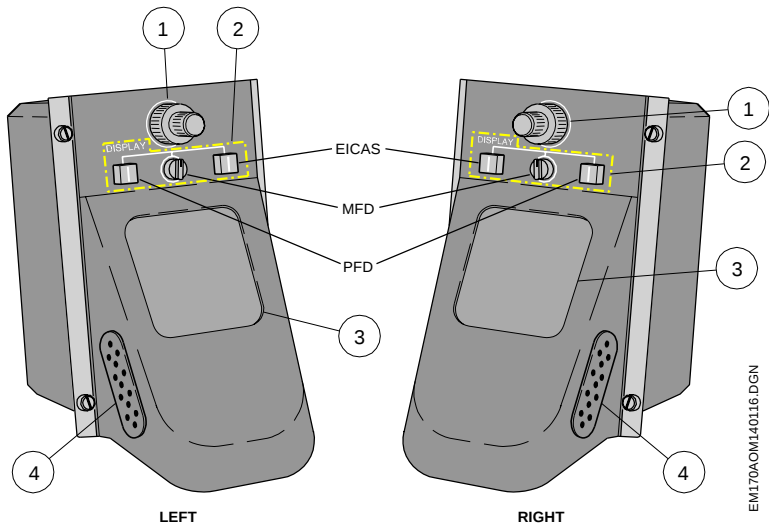
PROC 5: FMS 2, ADA 3, FBW.

PROC 6: CMF 1, ECL.

CONTROLS AND INDICATIONS

ELECTRONIC DISPLAY SYSTEM

CURSOR CONTROL DEVICE (CCD)



CURSOR CONTROL DEVICE

1 – TUNING KNOB

- Outer and inner knobs select value or mode in the data field enclosed by the cursor.

2 – FORMAT LOCATION BUTTONS

- Places cursor on associated display (PFD, MFD or EICAS)

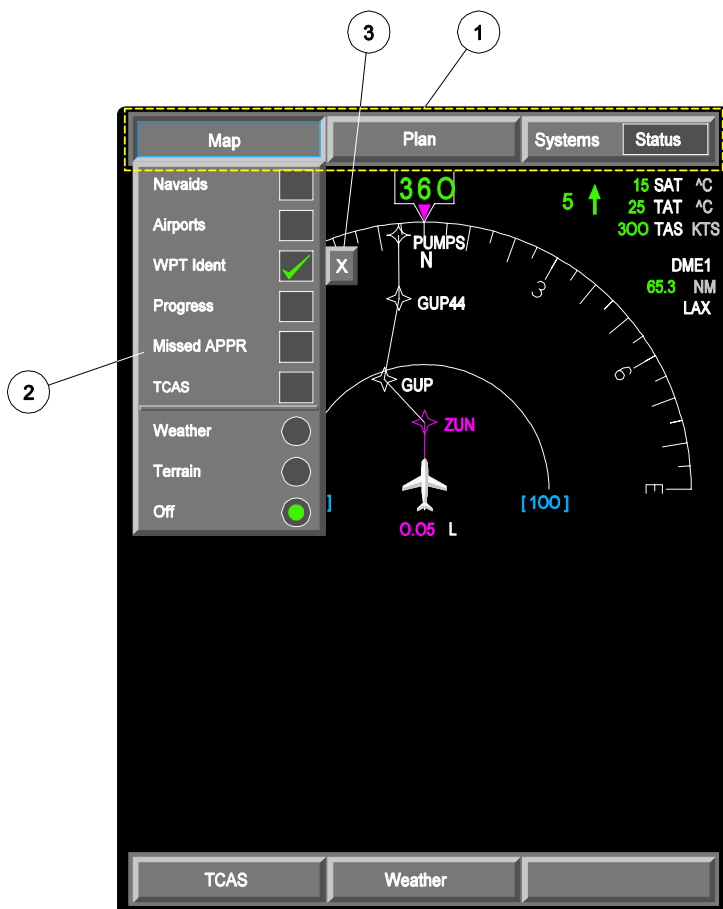
3 – TOUCH PAD

- Used to move cursor.

4 – ENTER KEYS

- Used to select soft keys.

MULTI FUNCTION DISPLAY (MFD)



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MULTI FUNCTION DISPLAY

1 – SOFT KEYS

- Selected through the CCD cursor and enter key.

2 – MENU CONTROLS

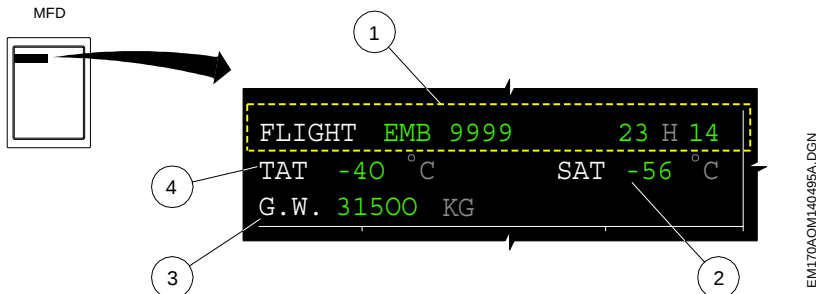
- Consist of checkboxes that can be selected and deselected for each function by using the CCD cursor and enter key. Square checkboxes are mutually selectable, while circle checkboxes are exclusively selectable.

3 – EXIT KEY

- Allows quick exit from each MFD soft key's respective menu.

FLIGHT STATUS INFORMATION

Flight number, flight time, total air temperature (TAT), static air temperature (SAT) and gross weight are displayed on the synoptic status page. It can be selected by flight crew on either MFDs.



1 – FLIGHT

- Displays airplane flight abbreviation, number and time.

2 – STATIC AIR TEMPERATURE (SAT)

- Displays static air temperature – information obtained from ADS/ADA.

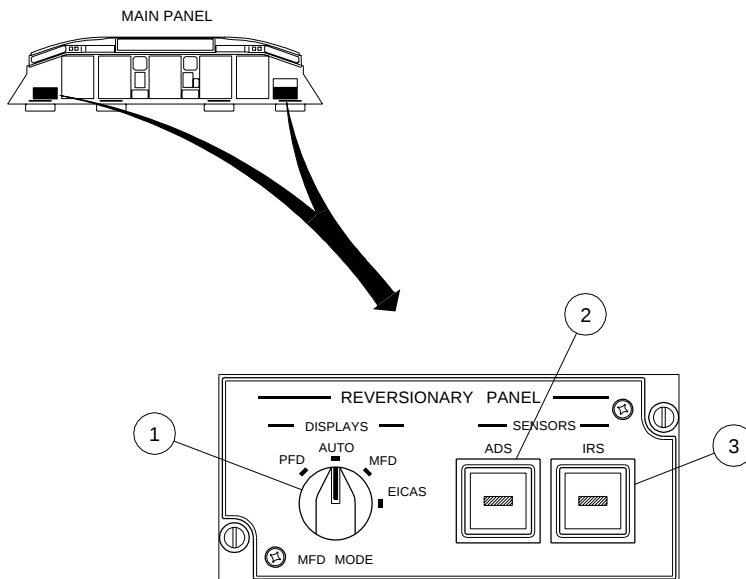
3 – GROSS WEIGHT

- Displays airplane gross weight – information obtained from FMS.

4 – TRUE AIR SPEED (TAT)

- Displays true air speed – information obtained from ADS/ADA.

REVERSIONARY PANEL



1 – DISPLAY SELECTOR KNOB

- PFD:** display PFD information in the associated display unit.
AUTO: automatically reverts the MFD in case of display failure.
MFD: display MFD information in the associated display unit.
EICAS: display EICAS information in the associated display unit.

2 – ADS SENSOR BUTTON

Momentary action pushbutton:

- Reverts the ADS source.
- When ADS source reversion is selected, a white stripped bar illuminates on the button.

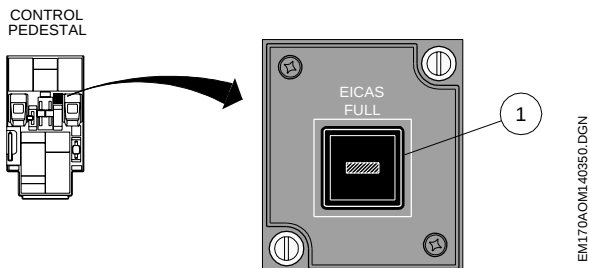
3 – IRS SENSOR BUTTON

Momentary action pushbutton:

- Reverts the IRS source.
- When IRS source reversion is selected, a white stripped bar illuminates on the button.

NOTE: Associated ADS or IRS source flag is displayed on the PFD after a reversion is performed.

EICAS FULL PANEL



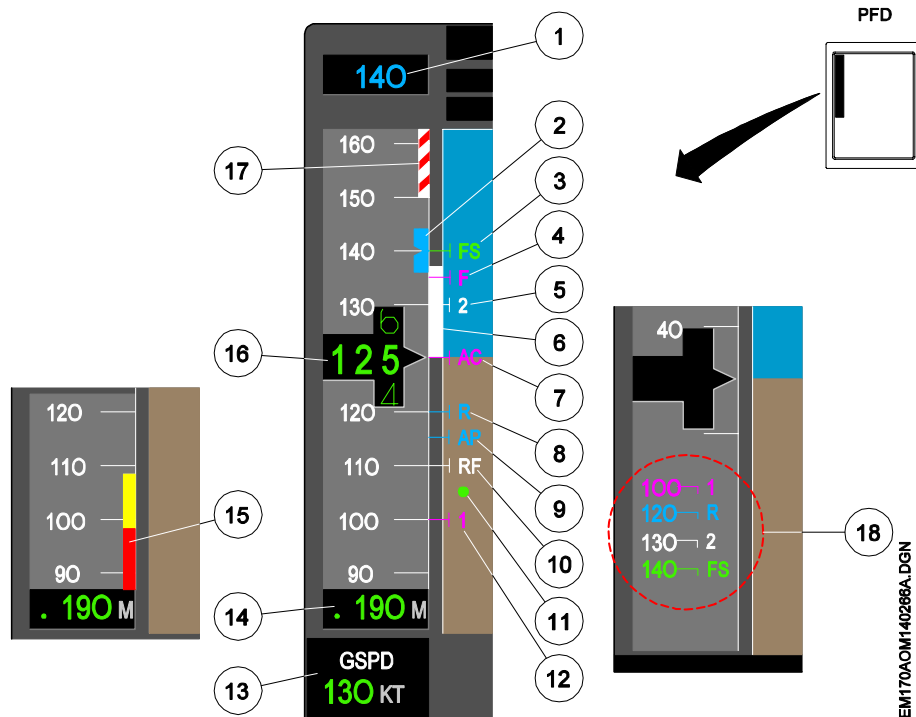
1 – EICAS FULL PUSHBUTTON

PUSH IN: Full information is presented on EICAS.

PUSH OUT: Enables the automatic EICAS de-clutter logic.

FLIGHT INSTRUMENTS

AIRSPEED TAPE INDICATIONS



1 – SELECTED AIRSPEED/MACH READOUT

- Displays speed/mach values.
MAGENTA: automatically set by the FMS.
CYAN: manually entered by the flight crew.
AMBER DASHED: invalid information.

2 – SELECTED AIRSPEED BUG

- Displayed when the FMS/AFCS commanded speed is in the displayed range of speed tape.
MAGENTA: automatically set by the FMS.
CYAN: manually entered by flight crew.

3 – VFS SPEED (FS)

- Takeoff final segment speed.

4 – FLAP RETRACTION SPEED REFERENCE (F)

- Flap retraction speed reference.

5 – V2 SPEED (2)

- Takeoff V2 speed.

6 – AIRSPEED TREND VECTOR

- Shows the airspeed at which the airplane will be within 10 seconds, if the present acceleration/deceleration rate is maintained.
WHITE: normal range.
AMBER: trend vector is at VMO/MMO barber pole or at low speed awareness tape.

7 – VAC SPEED (AC)

- Approach Climb Speed.

8 – VR SPEED (R)

- Rotation Speed.

9 – VAP SPEED (AP)

- Indicates approach speed.

10 – VREF SPEED (RF)

- Indicates reference speed.

11 – IDEAL FLAP SELECTION SPEED (DOT)

- Indicates an ideal speed to select flap positions.

12 – V1 SPEED (1)

- Decision Speed.

13 – GROUND SPEED

- Displays IRS-based ground speed.

14 – MACH AIRSPEED READOUT

- Displays the actual airplane Mach number.

GREEN: normal range.

AMBER: airspeed at or below shaker speed and above stall speed.

RED INVERSE VIDEO: airspeed at or above overspeed or, at or below stall speed.

AMBER DASHED: invalid information.

15 – LOW SPEED AWARENESS TAPE

- Indicates proximity to stall speed.

AMBER: from 1.13 of V_{stall} down to V_{shaker}.

RED: at or below V_{shaker}.

16 – AIRSPEED ROLLING DIGITS

- Displays the actual calibrated airspeed (CAS), above 30 kt.

- GREEN: normal range.

AMBER: airspeed trend vector (when displayed) or actual airspeed is at yellow low speed awareness tape.

RED INVERSE VIDEO: airspeed trend vector (when displayed) or actual airspeed is at red low speed awareness tape or at VMO/MMO barber pole.

- The airspeed trend vector when displayed has the priority over actual airspeed to define the airspeed rolling digits color.

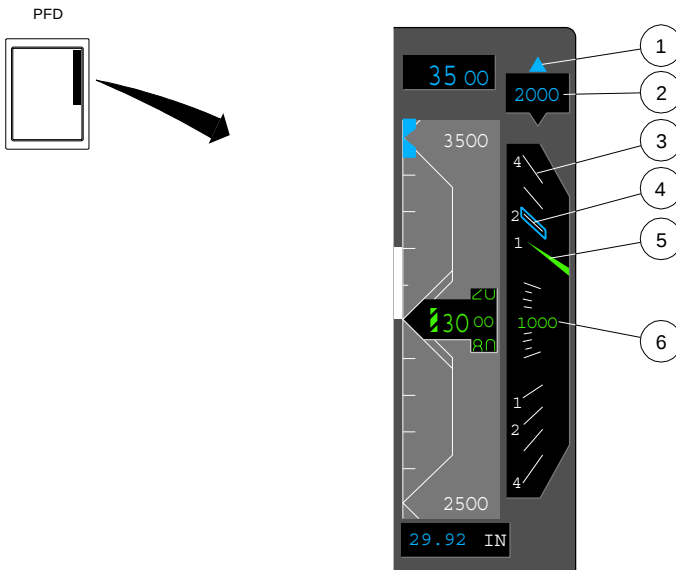
17 – VMO/MMO BARBER POLE

- Displayed when the VMO/MMO is within the viewable range, and covers speeds at or above VMO/MMO (red and white).

18 – SPEED DIGITAL READOUT

- Preview readout for takeoff bugs.

VERTICAL SPEED INDICATIONS



EM170AOM140382.DGN

1 – SELECTED VERTICAL SPEED DIRECTION ARROW

- Indicates either up or down direction. Used in conjunction with the selected vertical speed readout.

MAGENTA: automatically set by the FMS.

CYAN: manually entered by the flight crew.

2 – SELECTED VERTICAL SPEED READOUT

- Displays selected climb or descent rate.

MAGENTA: automatically set by the FMS.

CYAN: manually entered by the flight crew.

3 – VERTICAL SPEED SCALE

- Extends from – 4000 ft/min to + 4000 ft/min, with an expanded scale between + 1000 ft/min and – 1000 ft/min.
- From 0 to ± 500 ft/min:
 - One tick mark at every 100 ft/min.
- From ± 1000 ft/min to ± 4000 ft/min:
 - One tick mark at every 1000 ft/min.

4 – SELECTED VERTICAL SPEED BUG

- Displays selected climb or descent rate.
MAGENTA: automatically set by the FMS.
CYAN: manually entered by the flight crew.

5 – VERTICAL SPEED POINTER

- Displays selected climb or descent rate on the vertical speed scale.
- Displays the actual vertical speed if within the viewable range; parks at the limit if beyond viewable range.
- If the current rate is greater than ± 9999 ft/min, or the altitude data received is not valid, the vertical speed pointer is removed.

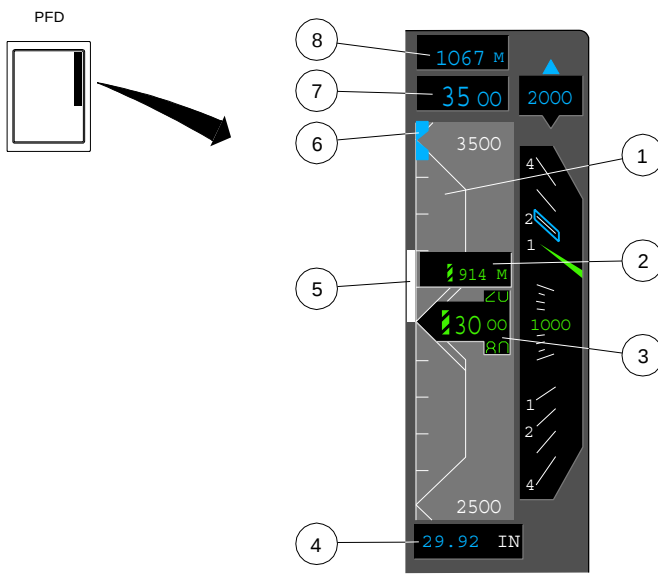
6 – VERTICAL SPEED READOUT

- Displayed when the vertical speed increases above + 550 ft/min or decreases below – 550 ft/min.
- Removed when the vertical speed decreases below + 500 ft/min or increases above – 500 ft/min.

GREEN: normal range.

AMBER DASHES: invalid information.

ALTITUDE TAPE INDICATIONS



EM170AOM140381.DGN

1 – ALTITUDE TAPE

- Indicates actual airplane altitude. The altitude tape is labeled with tick marks every 100 ft and single or double-lined chevrons at 500 or 1000 ft intervals, respectively.

2 – METRIC ALTITUDE READOUT

- Indicates actual airplane altitude in meters, with a resolution of 5 meters.
- Displayed when selected in the altitude selector knob.
- A green hashed box appears on the left side of the numeric digits when altitude is below 10000 m.
- A minus (-) symbol appears on the left side of the numeric digits when altitude is below sea level.

3 – ALTITUDE ROLLING DIGITS READOUT

- Indicates actual airplane altitude in feet. Digits are displayed with a resolution of 20 ft.
- A green hashed box appears on the left side of the numeric digits when altitude is below 10000 ft.
- A minus (–) symbol appears on the left side of the numeric digits when altitude is below sea level.

4 – BAROMETRIC CORRECTION

- Displays the barometric correction as selected.

5 – ALTITUDE TREND VECTOR

- Indicates the projected altitude at which the airplane will be within 6 seconds, based on the current vertical speed.
- This vector is displayed along the left edge of the altitude tape as a wide white line.

6 – SELECTED ALTITUDE BUG

- Positioned at the selected altitude.
MAGENTA: automatically set by the FMS.
CYAN: manually entered by the flight crew.

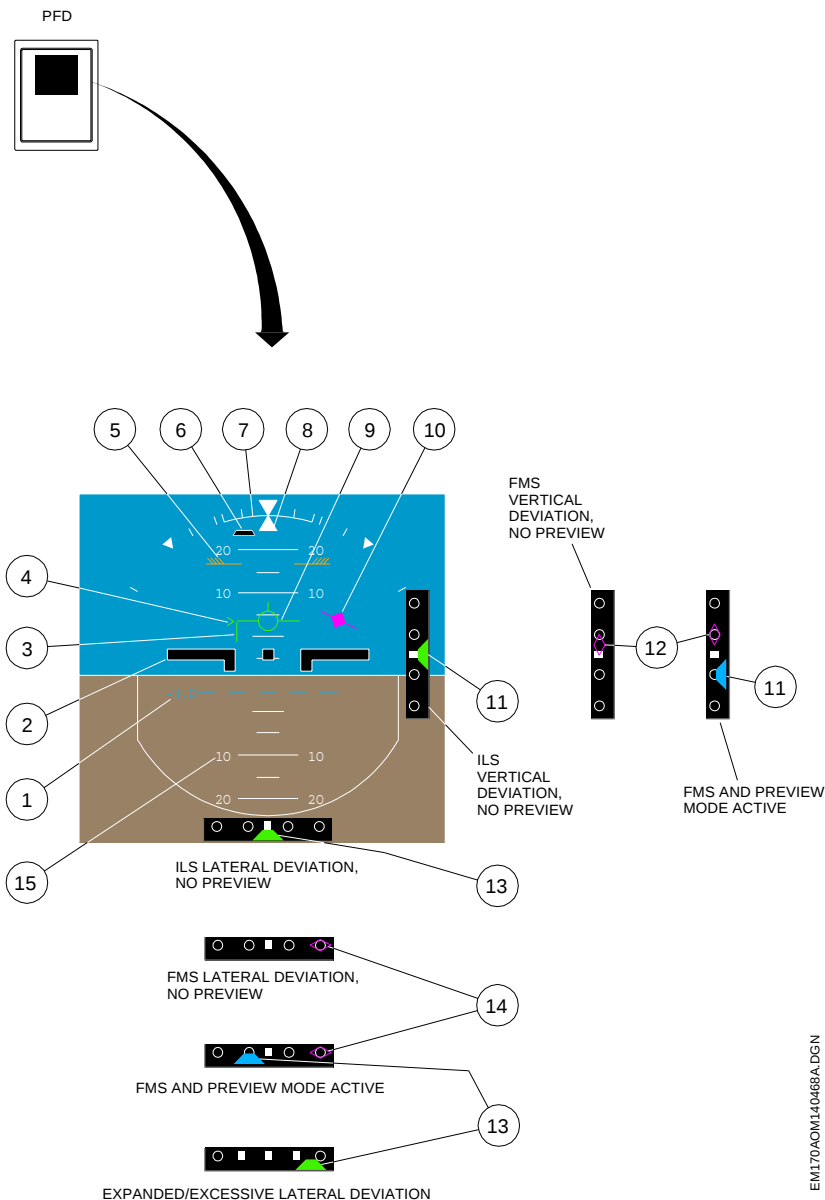
7 – SELECTED ALTITUDE READOUT

- Displays digital selected altitude in feet.
MAGENTA: automatically set by the FMS.
CYAN: manually entered by the flight crew.

8 – METRIC SELECTED ALTITUDE READOUT

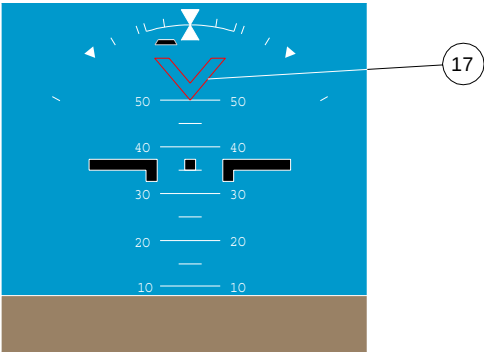
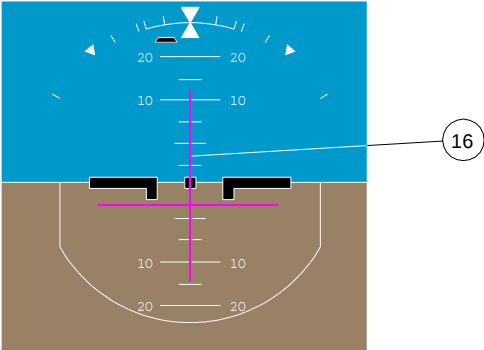
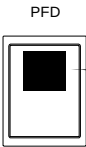
- Displays digital selected altitude in meters.
- Displayed when selected in the altitude selector knob.

ADI INDICATIONS



(Continues on the next page)

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1 – FLIGHT PATH REFERENCE LINE/READOUT (FPR)

- Indicates a selected path angle for reference, when the FPR button is pressed.

2 – AIRPLANE SYMBOL

- Fixed and used with the pitch tape to reflect airplane pitch attitude in relation to the horizon line.

3 – FLIGHT PATH VECTOR SPEED ERROR TAPE

- Indicates the difference between actual and the selected airspeed.
- Down/Up Tape indicates current airspeed is less/greater than the selected airspeed.

4 – FPA ACCELERATION POINTER

- Provides an indication of acceleration and deceleration rates along the flight path.
- Moves upward/downward for increasing/decreasing values of flight path acceleration.

5 – PITCH LIMIT INDICATOR

- Pitch based indication between stick shaker angle of attack and actual angle of attack.

GREEN: from 1.2 of V stall down to 1.13 of V stall.

AMBER: from 1.13 of V stall down to V shaker.

RED: at or below V shaker.

6 – SLIP/SKID INDICATOR

- Indicates slip or skid if flight is not coordinated.

7 – ROLL SCALE/LOW BANK LIMIT ARC

- Indicates the current airplane roll attitude. The scale has tick marks at 10, 20, 30 and 60 degrees and inverted triangles at 0 and 45 degrees.
- A low bank limit arc helps the pilot to avoid steep turns (0° up to 18°).

8 – ROLL POINTER

- Indicates the current aircraft roll attitude.

9 – FLIGHT PATH ANGLE (FPA)

- Indicates the current flight path in reference to the horizon line (green).

10 – FLIGHT DIRECTOR

- Shows lateral and vertical FD guidance cue.

11 – ILS GLIDE SLOPE DEVIATION

- Pointer: indicates current glide slope position.

GREEN: when neither FMS is in use nor preview mode.

CYAN: when the preview mode is selected.

AMBER: when the deviation from the APPR 2 vertical approach path becomes out of range of the normal scale. The indications are only active for radio altitudes between 700ft and 100ft.

- Scale: indicates deviation position:

WHITE: indicates normal deviation from the vertical path.

AMBER FLASHING: when the deviation from the APPR 2 vertical approach path becomes out of range of the normal scale. The indications are only active for radio altitudes between 700ft and 100ft.

12 – FMS VERTICAL DEVIATION

- Pointer: indicates current vertical path (magenta). Displayed in trapezoidal form when no ILS is in use. Otherwise it is presented in diamond format.
- Scale: indicates deviation (white).

13 – ILS/VOR LATERAL DEVIATION

- Pointer: indicates current localizer position.

GREEN: when neither FMS is in use nor preview mode. Also displayed in the expanded mode for APPR 2 operations.

CYAN: when the preview mode is selected.

AMBER: when the deviation from the APPR 2 lateral approach path becomes out of range of the normal scale. The indications are only active for radio altitudes between 700ft and 50ft.

- Scale: indicates deviation position.

WHITE: indicates normal deviation from the lateral path or expanded scale for APPR 2 operation.

AMBER FLASHING: when the deviation from the APPR 2 lateral approach path becomes out of range of the expanded scale. The indications are only active for radio altitudes between 700ft and 50ft.

14 – FMS LATERAL DEVIATION

- Pointer: indicates current lateral path (magenta). Displayed in trapezoidal format when no ILS is in use. Otherwise, it is displayed in lozenge format.
- Scale: indicates deviation (white).

15 – PITCH ANGLE SCALE

- Provides a pitch angle indication between the airplane symbol and the horizon line.

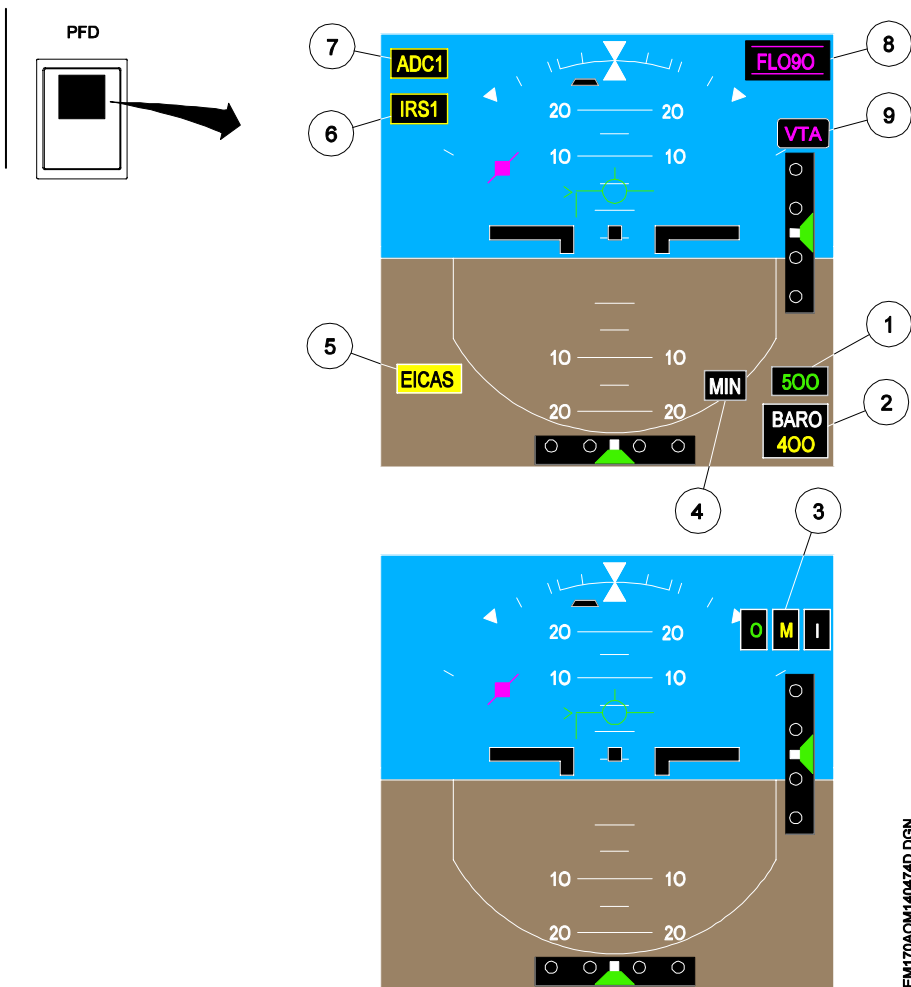
16 – TAKEOFF CROSSBAR

- In the takeoff mode, the takeoff crossbar is displayed. The horizontal line moves vertically along the center of the Airplane Symbol to provide vertical guidance. The vertical line moves vertically along the center of the Airplane Symbol to provide horizontal guidance.

17 – EXCESSIVE PITCH CHEVRON ANNUNCIATION

- Displayed whenever excessive pitch attitude is detected.

ADI ANNUNCIATIONS



1 – RADAR ALTITUDE INDICATION

- Displays actual radar altitude.

GREEN: normal operation.

AMBER: failure of one of the radar altimeters, in a dual system installation.

2 – MINIMUMS SELECTED READOUT

- Displays the selected minimum barometric or radar altitude.

WHITE: BARO/RA label and radar altimeter readout.

YELLOW: barometric altitude readout.

3 – MARKER BEACON ANNUNCIATIONS

- Displays I for inner, M for the middle or O for outer marker annunciations.

4 – MINIMUM ANNUNCIATION

- Advises that the aircraft is near or at the minimum altitude preselected by the pilot.

5 – GRAPHICS TEST DATA MONITOR ANNUNCIATION

- Indicates that the EICAS DU has failed.

6 – ATTITUDE SOURCE ANNUNCIATION

- Displays IRS1 or IRS2 to indicate that a system other than the on-side system (normal operation) is providing the data, or that both sides are using the same system.

7 – AIR DATA SOURCE ANNUNCIATION

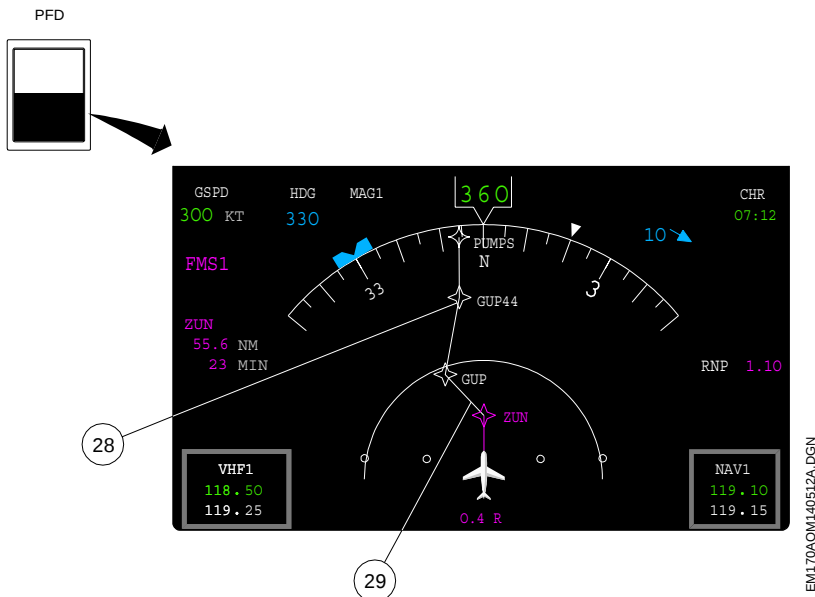
- Displays ADC1, ADC2 or ADC3 to indicate that a system other than the on-side system (normal operation) is providing the data, or that both sides are using the same system.

8 – VNAV ALTITUDE CONSTRAINT ANNUNCIATION

- Annunciates a VNAV waypoint constraint.
- Altitude constraints are displayed as follows:
 - At an altitude: constraint value is displayed without bars.
 - At or above an altitude: a bar is displayed below the constraint value.
 - At or below an altitude: a bar is displayed above the constraint value.
 - Altitude window: the constraint value is displayed between bars.

9 – VERTICAL TRACK ALERT ANNUNCIATION

- Annunciates the transition from a Climb or Descent to a Flight Level phase using VNAV.



1 – PRIMARY NAVIGATION SOURCE ANNUNCIATION

- Displays the selected navigation source.
GREEN: onside navigation source is selected.
AMBER: cross-side navigation source is selected.
MAGENTA: FMS navigation source is selected.

2 – GROUND SPEED READOUT

- Displays Ground speed based on IRS information.

3 – SELECTED HEADING READOUT

- Displays the selected airplane heading.
CYAN: valid information.
AMBER DASHES: invalid information.

4 – BEARING POINTERS

- Displays up to two bearing pointers.
CYAN: indicates bearing for ADF1, VOR1 or FMS1 (circle head).
WHITE: indicates bearing for ADF2, VOR2 or FMS2 (diamond head).

5 – COURSE SELECT POINTER

- Displays the selected course anytime the primary navigation source is a VOR or localizer, controlled by the CRS knob on the guidance panel.

GREEN: onside navigation source is selected.

AMBER: cross-side navigation source is selected.

CYAN: preview course pointer.

6 – HEADING READOUT

- Displays the actual airplane heading.

GREEN: valid information.

AMBER DASHES: invalid information.

- When an invalid information occurs a label HDG FAIL is also displayed.

7 – LATERAL DEVIATION INDICATOR

- Displays the deviation from the intended course. Indicates whether the airplane is flying left or right of the selected navigation reference.
- Incorporates the to/from pointer that indicates if the aircraft is flying to or away from the selected navigation reference.

GREEN: onside navigation source is selected.

AMBER: cross-side navigation source is selected.

8 – DRIFT ANGLE BUG

- Displays the actual aircraft ground track. Its offset relative to the top mark is the drift angle, that is, difference between ground track and heading.

9 – WIND DISPLAY

- Indicates wind magnitude and direction.
- Direction can be displayed as a single arrow (default) or as parallel and perpendicular arrows.

10 – COURSE SELECT READOUT

- Displays the selected course, controlled by the CRS knob on the guidance panel.
- The word CRS is displayed anytime the primary navigation source is a VOR or localizer.

GREEN: onside navigation source is selected.

AMBER: cross-side navigation source is selected.

CYAN: preview course.

AMBER DASHES: invalid information.

11 – CHRONOMETER READOUT

- Displays chronometer.
- Information removed after 30 seconds of inactivity (chronometer in stop or reset).

12 – LATERAL DEVIATION DOTS**13 – SECONDARY RADIO TUNING**

- Always displayed in left and right boxes and shows VHF NAV/ COMM frequencies, when radio data is valid.
- The multifunction control display unit (MCDU) is the primary means for radio tuning, while the control cursor device (CCD) and display unit (DU) are the secondary means of radio tuning.

GREEN: active frequency.

WHITE: standby frequency.

AMBER DASHES: radio data invalid.

14 – BEARING SOURCE ANNUNCIATIONS

- Display the bearing pointer sources.
 - CYAN (circle): displays the related VOR1, ADF1 or FMS1 source selected.
 - WHITE (diamond): displays the related VOR2, ADF2 or FMS2 source selected.

15 – SELECTED HEADING BUG

- Displays the airplane selected heading on both the full compass and arc modes controlled by the heading select knob on the guidance panel.

16 – PREVIEW NAVIGATION SOURCE ANNUNCIATION

- Displays the preview VOR or localizer navigation.

17 – HEADING SOURCE ANNUNCIATION

- Indicates a non-normal source condition (e.g., Captain side is using IRS 2), a same source condition (e.g., both Captain and First Officer using IRS 1) or the selection of True heading reference.

18 – COURSE SELECT PREVIEW POINTER

- Displays the selected course preview (VOR or LOC) anytime the primary navigation source is a FMS, controlled by the CRS knob on the guidance panel.

19 – DESIRED TRACK READOUT

- Displays the selected track according to data from the FMS.
MAGENTA: onside navigation source is selected.
AMBER: cross-side navigation source is selected.
AMBER DASHES: invalid information.

20 – DME DATA BLOCK INDICATIONS

- Display DME source, identifier, distance and time to the selected station.
- H label is displayed whenever the DME is in hold.

21 – RNP DATA BLOCK INDICATIONS

- Displayed when the FMS required navigation precision is the primary navigation source.
- The lateral deviation is displayed, each 1 NM represents 2 dots of deviation.

22 – MCDU ANNUNCIATIONS

- MSG label is displayed whenever a caution message appears in the MCDU.
- DR label is displayed whenever the FMS is operating in dead reckoning mode.
- DGRAD label is displayed whenever the FMS is operating in degrade mode.

23 – APPROACH SENSITIVITY MODE ANNUNCIATION

- Indicates aircraft is operating in approach mode.

24 – FMS LATERAL DEVIATION INDICATION

- Indicates aircraft's lateral deviation from the desired track.
- R/L label indicates right/left deviation.

25 – DESIRED TRACK POINTER

- Displays the desired track if FMS is the navigation mode selected.
MAGENTA: onside navigation source is selected.
AMBER: cross-side navigation source is selected.

26 – WAYPOINT DATA BLOCK INDICATIONS

- Display the identifier, distance and time to the next waypoint.

27 – SELECTED HEADING OUT OF VIEW ARROW

- Displayed on arc mode when the selected heading is not within the viewable range, and shows which way is shortest to the selected heading.

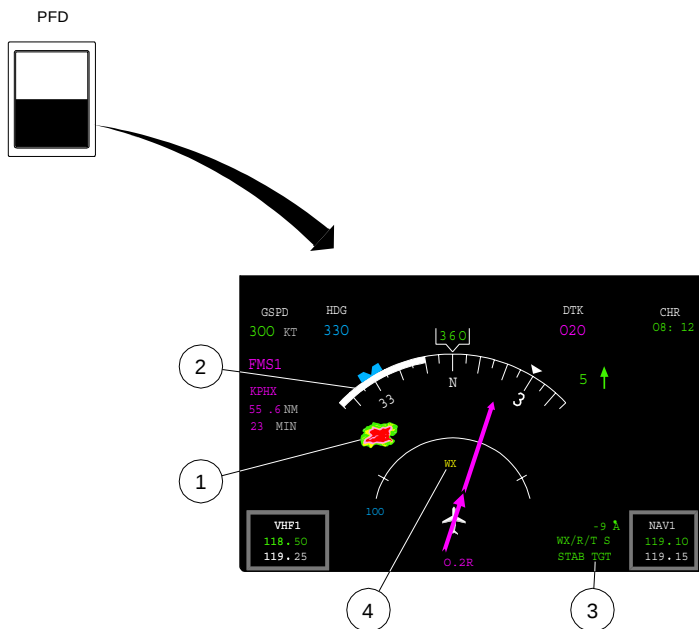
28 – HORIZONTAL TRACK LINE

- Connects waypoints.
MAGENTA: connects with next waypoint.
WHITE: connects other waypoints.

29 – WAYPOINT DISPLAY

- Indicates waypoint symbol.
- If selected, also indicates waypoint identifier.
MAGENTA: next waypoint.
WHITE: other waypoints.

HSI WEATHER RADAR INDICATIONS



1 – WEATHER RADAR RETURNS

- Displays target in colors.
- WX mode: the color indicates rain intensity. In increasing order of intensity: green, yellow, red and magenta.
- RCT mode: attenuation is too high, hiding possible severe weather areas (cyan).
- GMAP mode: color indicates surface information: black, cyan, yellow and magenta.
- TURB mode (WU880 only): areas of potentially hazardous turbulence (white).

2 – ANTENNA POSITION INDICATOR

- Indicates that antenna scan is active.

3 – WEATHER RADAR ANNUNCIATIONS

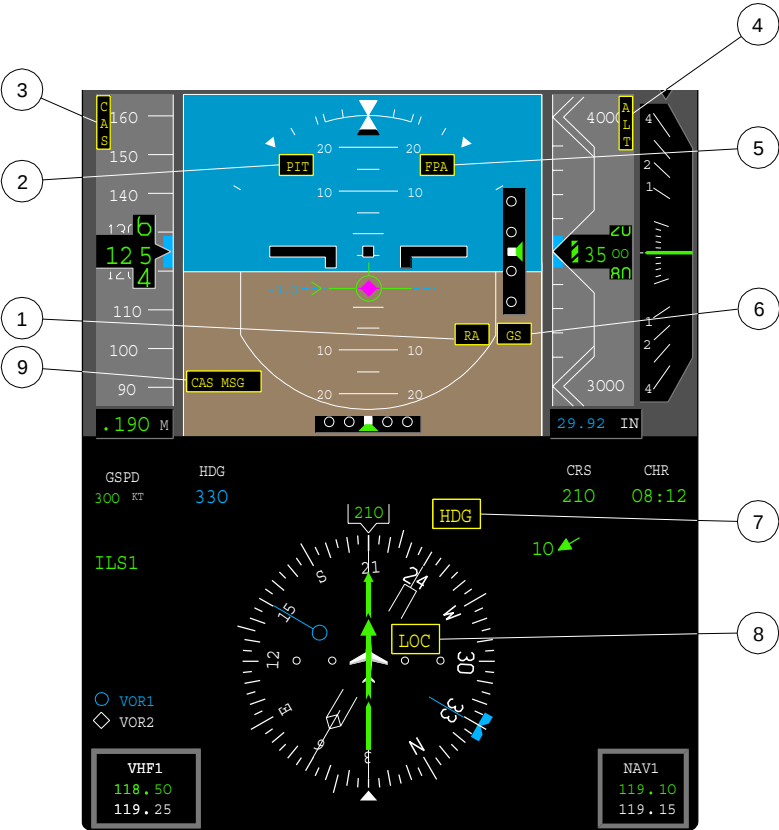
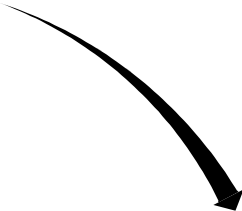
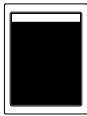
- First line:
 - CCD inner knob icon: tilt angle is modifiable.
 - Tilt angle readout: displays the tilt angle.
GREEN: non-modifiable.
CYAN: modifiable.
 - ATC annunciation: ATC is an active submode.
 - Fault code data (entire line): fault has been detected.
- Second line:
 - Weather radar mode annunciation:
GREEN (WX): normal WX.
GREEN (WX/R): normal WX with RCT.
GREEN (WX/T): normal WX with TURB.
GREEN (WX/R/T): normal WX with RCT and TURB.
GREEN (GMAP): GMAP mode.
GREEN (FSBY): forced standby.
GREEN (TEST): test mode and no faults.
AMBER (WX CTRL): invalid WX control bus.
AMBER (FAIL): failure is detected.
AMBER (OVRNG): MAP range greater than 300 NM.
WHITE (WX OFF): WX is OFF.
WHITE (WAIT): power up.
WHITE (STBY): normal standby.
 - Slave annunciation: slave mode is active.
- Third line:
 - Stabilization annunciation: radar stabilization is inhibited.
 - Target and gain mode annunciation.
GREEN (TGT): TGT selected.
FLASHING AMBER (TGT): TGT selected and alert condition.
AMBER (VAR): variable gain selected.

4 – WEATHER RADAR VIDEO ANNUNCIATION

- Indicates weather radar video failure.

ADI/HSI MISCOMPARES

PFD



EM170AOM140272A.DGN

1 – RADIO ALTITUDE MISCOMPARE ANNUNCIATION

- Displayed whenever the radio altimeter has failed or the difference between the Captain and First Officer's radio altitude is greater than a set point.

2 – PITCH, ROLL AND ATTITUDE MISCOMPARE ANNUNCIATION

- Displayed whenever a pitch, roll or attitude miscompare is detected.

3 – AIRSPEED MISCOMPARE ANNUNCIATION

- Displayed whenever airspeed miscompare is detected.

4 – ALTITUDE MISCOMPARE ANNUNCIATION

- Displayed whenever altitude miscompare is detected.

5 – FLIGHT PATH ANGLE MISCOMPARE ANNUNCIATION

- Displayed whenever miscompare is detected for FPA.

6 – GLIDE SLOPE MISCOMPARE ANNUNCIATION

- Displayed whenever glideslope/glidepath miscompare is detected.

7 – HEADING MISCOMPARE ANNUNCIATION

- Displayed whenever a heading miscompare is detected.

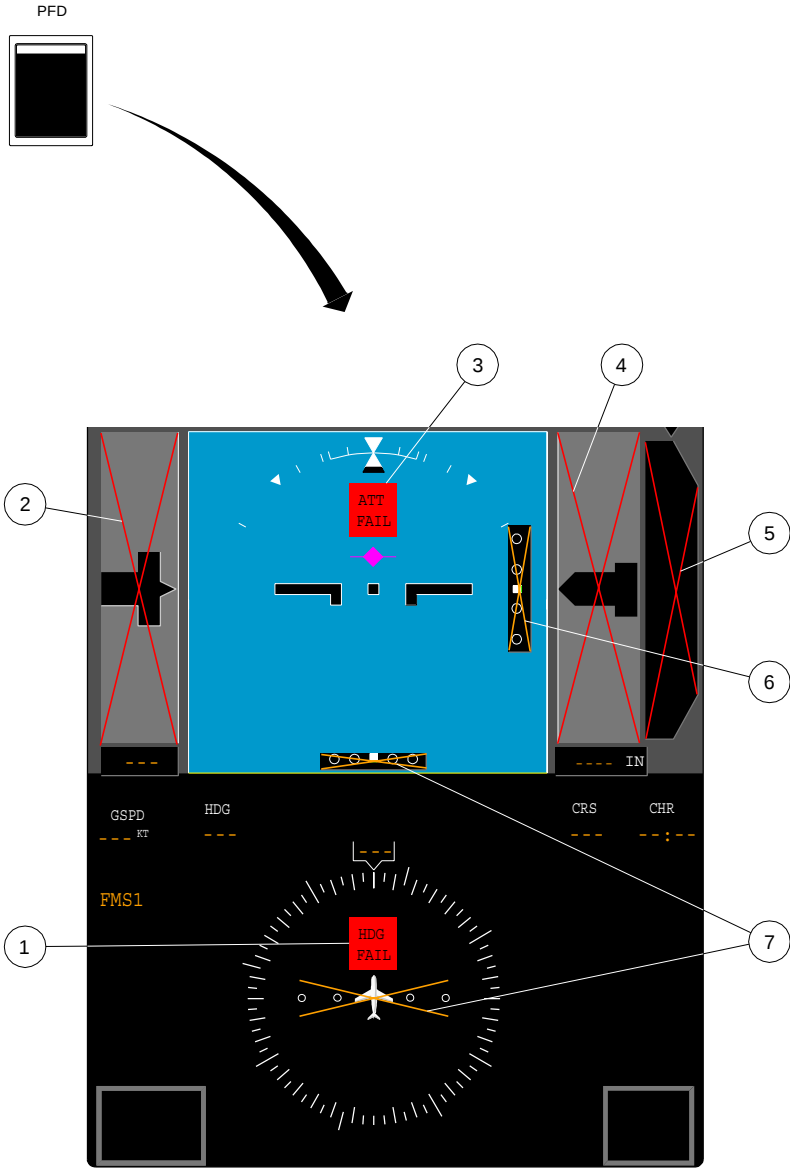
8 – LOC MISCOMPARE ANNUNCIATION

- Displayed whenever localizer miscompare is detected.

9 – CAS MESSAGE MISCOMPARE ANNUNCIATION

- Displayed whenever CAS message list from the two monitor warning (MW 1 and MW 2) do not match.

ADI/HSI FAILS



1 – HDG FAIL

- An 'x' appears whenever HDG indication is lost. It is still possible to revert the HDG source from IRS 1 to IRS 2, in case of a PFD 1 Heading Indication failure, and the opposite in case of HDG 2 failure.

2 – AIRSPEED ANNUNCIATION FAIL

- Airspeed Indication disappears and an 'x' displays.

3 – ATTITUDE INDICATION FAIL

- Attitude indication disappears and a message ATT FAIL displays on PFD.

4 – ALTTITUDE INDICATION FAIL

- Altitude Indication disappears and the message ATT FAIL displays on PFD. The barometric pressure correction appears dashed.

5 – VERTICAL SPEED INDICATION FAIL

- Vertical Indication disappears and an 'x' displays.

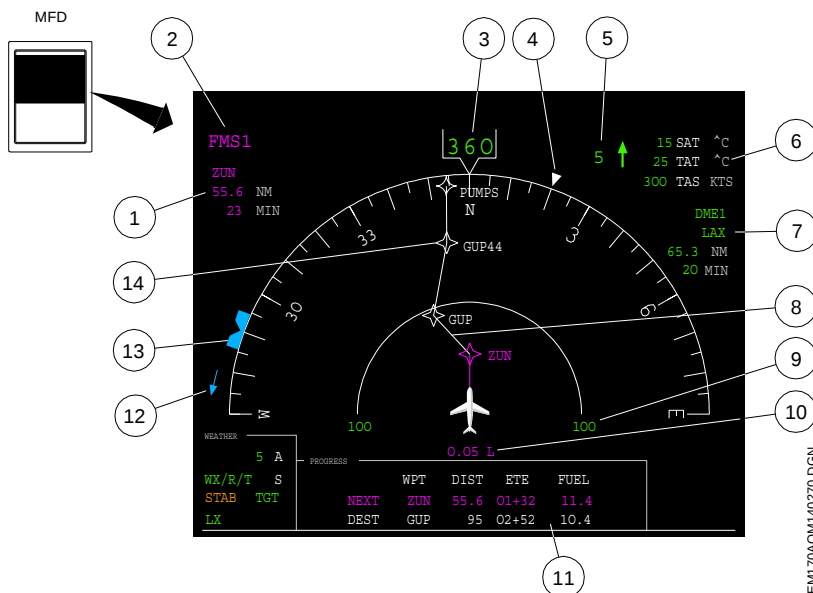
6 – ILS/FMS VERTICAL DEVIATION INDICATION FAIL

- Vertical Deviation indication disappears and an 'x' displays.

7 – LATERAL DEVIATION INDICATION FAIL

- Lateral Deviation Indication disappears and an 'x' displays.

HORIZONTAL PROFILE INDICATIONS



1 – WAYPOINT DATA BLOCK INDICATIONS

- Display the identifier, distance and time to the next waypoint.

2 – FMS SOURCE INDICATION

- Displays the selected FMS source.
MAGENTA: onside FMS is selected.
AMBER: cross-side FMS is selected.

3 – HEADING READOUT

- Displays aircraft's actual heading.
GREEN: valid information.
AMBER DASHES: invalid information.

4 – DRIFT ANGLE BUG

- Displays aircraft's actual ground track. Its offset relative to the top mark is the drift angle, that is, difference between ground track and heading.

5 – WIND DISPLAY

- Indicates wind magnitude and direction of the wind.
- Direction can be displayed as a single arrow (default) or as parallel and perpendicular arrows.

6 – AIR DATA SYSTEM INDICATIONS

- Indicates static air temperature (SAT), total air temperature (TAT) and true air speed (TAS), sourced by the selected Air Data System.
GREEN: all operating ranges.
AMBER DASHED: invalid information or ADS failure, TAT and SAT may be different.

7 – DME DATA BLOCK INDICATIONS

- Display DME source, identifier, distance and time to the selected station.
- H label is displayed whenever the DME is in hold.

8 – HORIZONTAL TRACK LINE

- Connects waypoints.
MAGENTA: connects with next waypoint.
WHITE: connects other waypoints.

9 – RANGE SELECTION

- Displayed when MAP mode is selected, as an outer compass ring and an inner half-range ring. The half-range ring is labeled with the half-range distance.
- The Plan format displays only a half-range ring, which is labeled with the range distance.
- Both range labels are shown with the knob icon, indicating that the range is set and changed by turning the CCD knob.
- The possible values for range are 5 to 1000 NM.

10 – FMS LATERAL DEVIATION INDICATION

- Indicates aircraft's lateral deviation from the desired track.
- R/L label indicates right/left deviation.

11 – FMS PROGRESS WINDOW

- Data contained in the box is arranged in two rows. The upper row lists data for the next waypoint (NEXT) and the lower row lists data for the destination (DEST). The following information is displayed: waypoint name, distance to go, estimated time enroute and fuel remaining at the waypoint.

12 – SELECTED HEADING OUT OF VIEW ARROW

- Displayed when the selected heading is not within the viewable range, and shows which way is shortest to the selected heading.

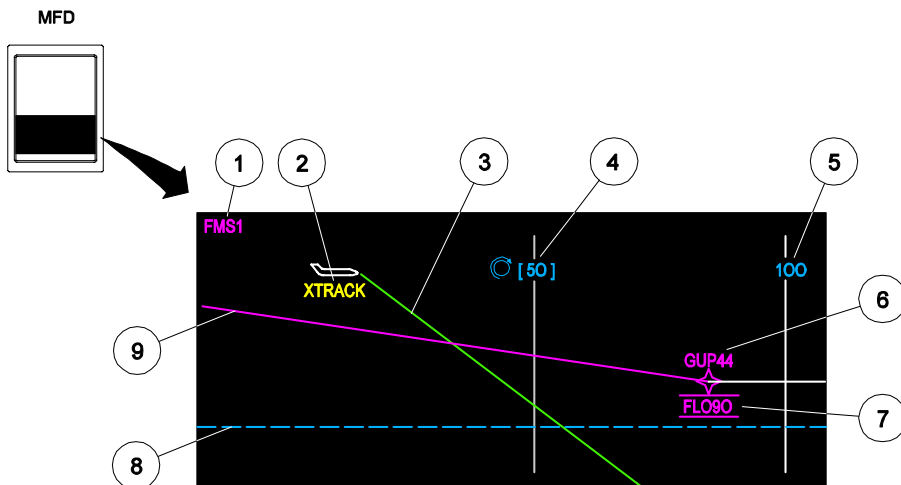
13 – SELECTED HEADING BUG

- Displays the airplane selected heading controlled by the heading select knob on the guidance panel.

14 – WAYPOINT DISPLAY

- Indicates waypoint symbol.
- If selected, also indicates waypoint identifier.
MAGENTA: next waypoint.
WHITE: other waypoints.

VERTICAL PROFILE INDICATIONS



1 – FMS SOURCE INDICATION

- Displays the selected FMS source.
MAGENTA: onside FMS is selected.
AMBER: cross-side FMS is selected.

2 – CROSS TRACK ANNUCIATION

- Indicates a significant deviation from the planned horizontal flight path.
- The vertical track line from the left of the vertical profile window to the next waypoint changes to a dashed amber line.

3 – AIRPLANE TRAJECTORY LINE

- Shows the vector trend of the airplane along the vertical axis, based on the current flight path angle.

4 – HALF/FULL CURL ICON INDICATION

- Can be changed using the CCD outer knob.

5 – HALF/FULL RANGE INDICATIONS

- Show the selected horizontal ranges.

6 – WAYPOINT DISPLAY

- Indicates waypoint symbol.
- If selected, also indicates waypoint identifier with altitude and, if applicable, a HOLD label that indicates a holding pattern.

MAGENTA: next waypoint.

WHITE: other waypoints.

7 – VNAV ALTITUDE CONSTRAINT INDICATION

- Indicates a VNAV waypoint constraint.
- Altitude constraints are displayed as follows:
 - At an altitude: constraint value is displayed without bars.
 - At or above an altitude: a bar is displayed below the constraint value.
 - At or below an altitude: a bar is displayed above the constraint value.
 - Altitude window: the constraint value is displayed between bars.

8 – SELECTED ALTITUDE INDICATION

- Indicates the selected altitude in the guidance panel.

9 – VERTICAL TRACK LINE

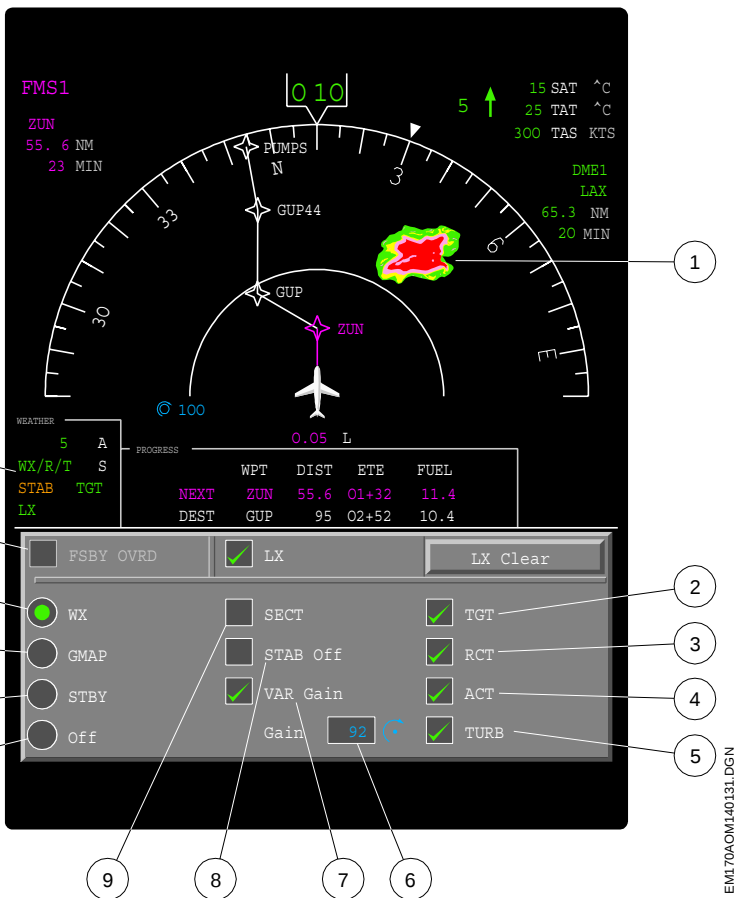
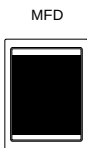
- Connects waypoints.

MAGENTA: connects with next waypoint.

WHITE: connects other waypoints.

DASHED AMBER: airplane has significantly deviated from the planned horizontal flight path.

MFD WEATHER RADAR



EM170AOM140131.DGN

1 – WEATHER RADAR RETURNS

- Displays target in colors.
- WX mode: the color indicates rain intensity. In increasing order of intensity: green, yellow, red and magenta.
- RCT mode: attenuation is too high, hiding possible severe weather areas (cyan).
- GMAP mode: color indicates surface information: black, cyan, yellow and magenta.
- TURB mode (WU880 only): areas of potentially hazardous turbulence (white).

2 – TARGET ALERT CHECKBOX

- Enables and disables the radar target feature. Can only be selected in the WX mode.

3 – RAIN ECHO ATTENUATION COMPENSATION TECHNIQUE CHECKBOX

- Enables REACT function in all modes, except GMAP.

4 – ALTITUDE COMPENSATED TILT CHECKBOX

- Enables automatic adjustment of the antenna tilt in relation to the altitude and selected range.

5 – TURBULENCE DETECTION CHECKBOX

- Enables the turbulence function only in the WX mode and at selected ranges of 50 NM or less.

6 – GAIN INDICATION DISPLAY

- Indicates receiver sensitivity level from 0 to 100.

7 – RECEIVER GAIN CHECKBOX

- Enables manual variation of the receiver sensitivity.

8 – ANTENNA STABILIZATION CHECKBOX

- Enables/disables automatic antenna stabilization.
- An amber STAB label is displayed within the weather box when automatic antenna stabilization is disabled.

9 – SECTOR SCAN CHECKBOX

- Enables the sector scan function for both pilots' displays.

10 – OFF MODE

- Turns off the weather mode, when OFF is selected in both weather radar virtual controllers.
- In flight only, a single virtual controller selected to OFF operates in SLAVE mode.

11 – STANDBY MODE

- Selects the radar system into a standby mode, provided STBY is selected in both weather radar virtual controllers.
- A green FSBY label is displayed within the weather box when forced standby is active, on the ground.

12 – GROUND MAPPING MODE

- Enables ground mapping mode.

13 – RADAR MODE

- In flight, activates the radar mode.

14 – FORCED STANDBY OVERRIDE

- Enables WX on the ground, when selected on both pilots' virtual control panel.

15 – WEATHER RADAR ANNUNCIATIONS

- First line:
 - CCD inner knob icon: tilt angle is modifiable.
 - Tilt angle readout: displays the tilt angle.
GREEN: non-modifiable.
CYAN: modifiable.
 - ACT annunciation: ACT is active.
 - Fault code data (entire line): fault has been detected.
- Second line:
 - Weather radar mode annunciation:
GREEN (WX): normal WX.
GREEN (WX/R): normal WX with RCT.
GREEN (WX/T): normal WX with TURB.
GREEN (WX/R/T): normal WX with RCT and TURB.
GREEN (GMAP): GMAP mode.
GREEN (FSBY): forced standby.
GREEN (TEST): test mode and no faults.
AMBER (WX CTRL): invalid WX control bus.
AMBER (FAIL): failure is detected.
AMBER (OVRNG): MAP range greater than 300 MN.
WHITE (WX OFF): WX is OFF.
WHITE (WAIT): power up.
WHITE (STAB): STAB OFF function selected.
WHITE (STBY): normal standby.
 - Slave annunciation: slave mode is active.
- Third line:
 - Stabilization annunciation: radar stabilization is inhibited.
 - Target and gain mode annunciation.
GREEN (TGT): TGT selected.
FLASHING AMBER (TGT): TGT selected and alert condition.
AMBER (VAR): variable gain selected.

MFD LIGHTNING SENSOR



1 – RATE OF OCCURRENCE SYMBOLS

- Represent the lightning rate of occurrence for the last two minutes in a given location.

RATE 1: represents a single strike.

RATE 2: represents three strikes.

RATE 3: represents six or more strikes.

2 – ALERT SYMBOL

- Displayed for 5 seconds near the outer range arc providing only bearing information.

3 – LIGHTNING MODE

- Enables/disables lightning mode.

4 – LIGHTNING CLEAR FUNCTION

- Clears all past strikes symbols, activating self-test mode after 3 seconds.

5 – LIGHTNING ANNUNCIATIONS

- Lightning mode annunciations displayed on fourth line of the weather data box.

AMBER (LX FAIL): self-test has detected a fault.

GREEN (LX STBY): standby mode.

GREEN (LX CLR): clear mode.

GREEN (LX TST): test mode.

AMBER (LX INHB): transmission inhibition mode.

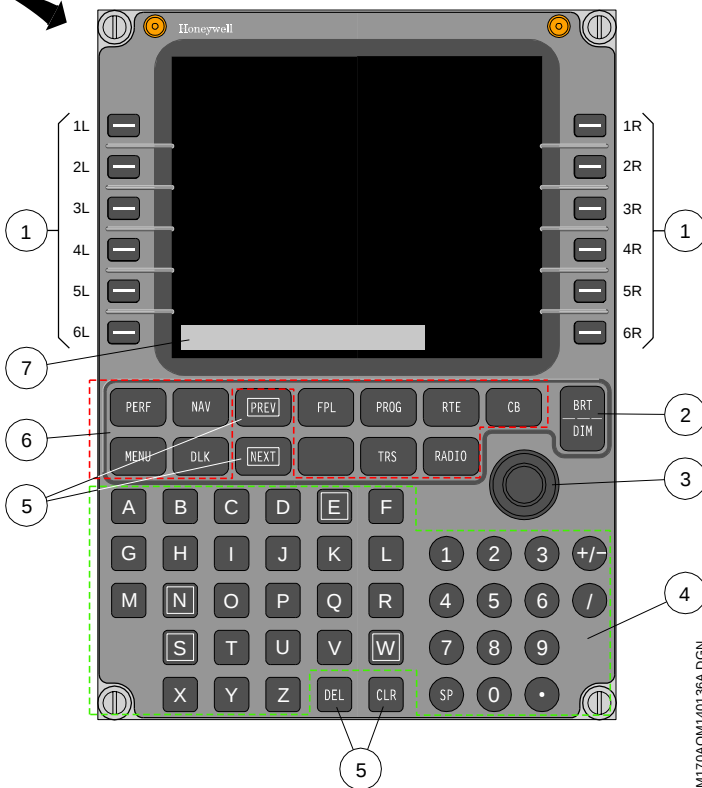
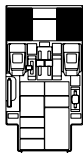
GREEN (LX HDG): lightning-heading input is invalid.

GREEN (LX CAL): self-calibration mode.

GREEN (LX): system is in the normal operating mode.

AMBER (LX): MFD is not receiving data from the LSS processor.

MCDU CONTROLS

 CONTROL
PEDESTAL


1 – LINE SELECT KEYS

- Data is selected to a line from the scratchpad or vice-versa.
- Selects a page if the line shows an index display (arrow).

2 – BRIGHTNESS CONTROL BUTTON

- Controls display brightness.
- A control bar will be displayed on the scratchpad.

3 – TUNING KNOB

- Rotating this knob selects frequencies or other numeric values.

4 – ALPHANUMERIC BUTTONS

- Enter alphanumeric inputs.
- Space key (SP) is used to insert a space.
- A toggle plus/minus key inserts the corresponding signal.

5 – PREV/NEXT AND CLR/DEL BUTTONS

- Previous (PREV): Changes the current page to the previous page.
- Next (NEXT): Changes the current page to the next page.
- Clear (CLR): Clears alphanumeric entries or messages on the scratchpad.
- Delete (DEL): Works together with line select buttons in order to delete waypoints and other displayed items. This button is inhibited when a message is displayed.

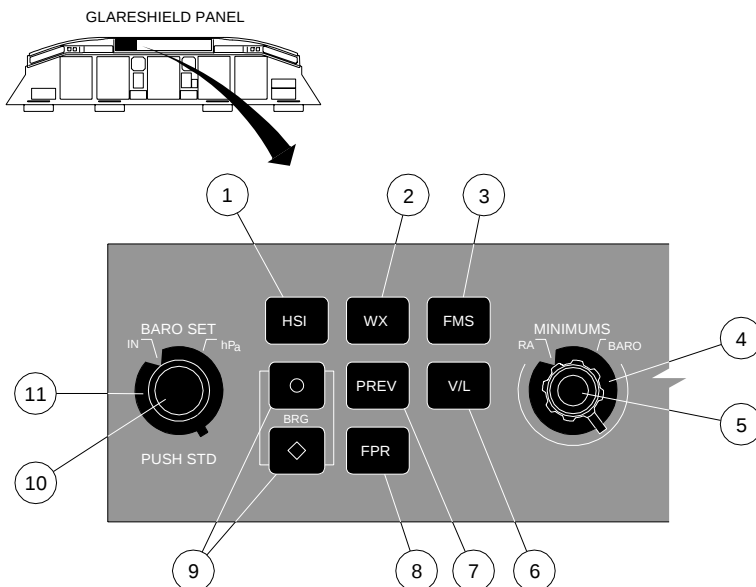
6 – FUNCTION BUTTONS

- Menu (MENU): Displays the menu page.
- Data link (DLK): Displays ACARS main menu page.
- Radio (RADIO): Displays the radio page.
- Circuit breaker (CB): Displays the circuit breaker page.
- Thrust Rating Selection (TRS): Display the engine thrust ratings for various flight phases.
- Performance (PERF): Displays the performance page (FMS function).
- Navigation (NAV): Displays the navigation page (FMS function).
- Flight plan (FPL): Displays the flight plan page (FMS function).
- Progress (PROG): Displays the progress page (FMS function).
- Route (RTE): Display the route page (FMS function).

7 – SCRATCHPAD

- It is the working area, located on the bottom line of the display, where the pilot can enter data and/or verify data before line selecting the data into its proper position.
- Data is retained on the scratchpad throughout all mode and page changes.
- The scratchpad also provides advisory and alerting messages to be displayed.

DISPLAY CONTROLLER PANEL



1 – HORIZONTAL SITUATION INDICATOR (HSI) BUTTON

- Selects between full compass and arc mode for the on side PFD.

2 – WEATHER RADAR (WX) BUTTON

- Displays WX Radar information on PFD.

3 – FMS SELECTION/ FMS SOURCES

- Selects FMS as the primary navigation source for the on-side PFD and toggles between FMS1 and FMS2.

4 – RA OR BARO MINIMUMS SELECTOR KNOB (OUTER)

- **RA:** sets radio altimeter minimums.
- **BARO:** sets barometric minimums.

5 – DECISION HEIGHT OR MINIMUM DESCENT (INNER)

- Selects decision height (DH), decision altitude or minimum descent altitude based on position of RA/BARO selector knob.

6 – VOR/LOC BUTTON (V/L)

- Selects VOR or LOC as the primary navigation source for the on-side PFD.

7 – PREVIEW BUTTON (PREV)

- Selects the preview mode.
- If the FMS is the selected primary navigation source, the course, lateral/vertical deviation can be previewed. The previewed navigation source will automatically transition as the primary navigation source when captured.

8 – FLIGHT PATH REFERENCE (FPR) BUTTON

- Commands the flight path reference line and the flight path digital readout.

9 – BEARING SOURCES (BRG) BUTTONS

- CIRCLE (○): allows VOR1, ADF1 or FMS1 selection for the on-side PFD display.
- DIAMOND (◇): allows VOR2, ADF2 or FMS2 selection for the on-side PFD display.

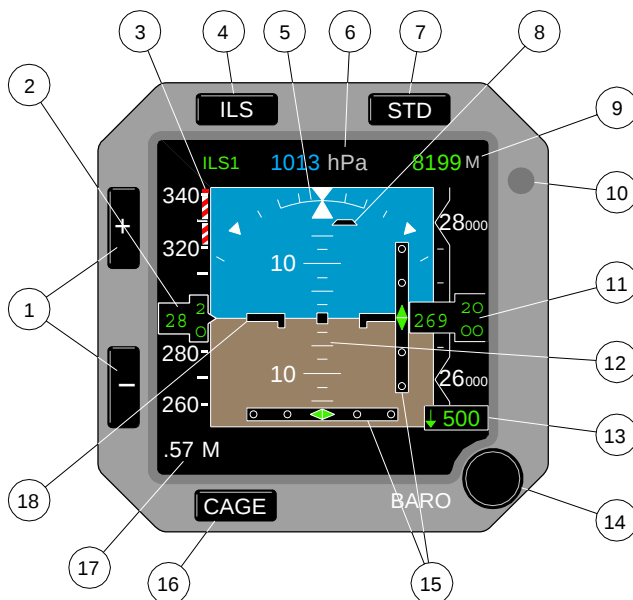
10 – BAROMETRIC CORRECTION CONTROL (INNER)

- Sets barometric altimeter correction.
- Pushing this control knob sets barometric correction to standard.

11 – BAROMETRIC CORRECTION SELECTOR KNOB (OUTER)

- IN: sets barometric correction format to inches of mercury.
- HPA: sets barometric correction format to hectopascals.

INTEGRATED ELECTRONIC STANDBY SYSTEM (IESS)



EM170AOM140124A DGN

1 – BRIGHTNESS ADJUSTMENT BUTTONS

- Adjust brightness.

2 – AIRSPEED ROLLING DIGITS

- Indicates actual calibrated airspeed.
- In case of failure the airspeed tape and the pointer will be removed and replaced by a red cross and an SSEC flag is displayed.

3 – VMO/MMO BARBER POLE

- Displayed when V_{MO}/M_{MO} is within the viewable range, and covers speeds at or above V_{MO}/M_{MO} (red and white).

4 – ILS BUTTON

- Selects the display of ILS 1 deviations and the label LOC 1 is annunciated in the left top corner. In case of failure, a red cross replaces the annunciation.

5 – ROLL INDICATION

- Indicates the bank angle of the airplane.

6 – REFERENCE BAROMETRIC PRESSURE INDICATION

- Indicates the barometric pressure as set by the barometric rotary knob.

7 – STANDARD BUTTON

- Sets the barometric pressure to standard atmospheric pressure.

8 – SLIP/SKID INDICATION

- Indicates slip or skid angle if flight is not coordinated.

9 – METER ALTITUDE INDICATION

- Indicates the actual altitude in meters.
- A green hashed box appears on the left side of the numeric digits when altitude is below 10000 m.
- A minus (–) symbol appears on the left side of the numeric digits when altitude is below sea level.

10 – BRIGHTNESS CELL

- Automatically adjusts the instrument brightness according to the ambient lighting.

11 – ALTITUDE INDICATION

- Indicates actual altitude, with graduated scale of 20 ft.
- A NEG indication is displayed vertically in white in case of negative altitude.
- In case of failure the altitude tape will be removed and replaced by a red cross, and an ALT flag is displayed.
- A green hashed box appears on the left side of the numeric digits when altitude is below 10000 ft.
- A minus (–) symbol appears on the left side of the numeric digits when altitude is below sea level.

12 – PITCH ANGLE SCALE

- Provides a pitch angle indication between the airplane symbol and the horizon line.

13 – VERTICAL SPEED

- Indicates the actual vertical speed in feet per minute (ft/min).
- An arrow indicates climb or descent.
- In case of failure the corresponding pointer and scale will be removed.

14 – BARO ROTARY KNOB

- Allows barometric settings.

15 – ILS DEVIATIONS

- Vertical scale:
- green diamond indicates glide slope position.
- Horizontal scale:
- green diamond indicates localizer position.
- Vertical and horizontal scales are not displayed when ILS is not selected.
- In case of failure, the pointer and the scale are removed from view and replaced by a red cross.

16 – CAGE BUTTON

- Resets attitude to zero, eliminating accumulated drift when the button is pressed for more than two seconds.
- Not operational during the initialization mode and must be used with wings leveled on stabilized flight conditions.
- When pressed, an amber CAGE flag is displayed on the upper right corner of the IESS.

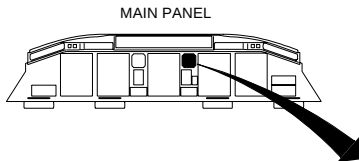
17 – MACH NUMBER INDICATION

- Displayed whenever Mach increases above 0.45 and will be removed when Mach decreases below 0.40.

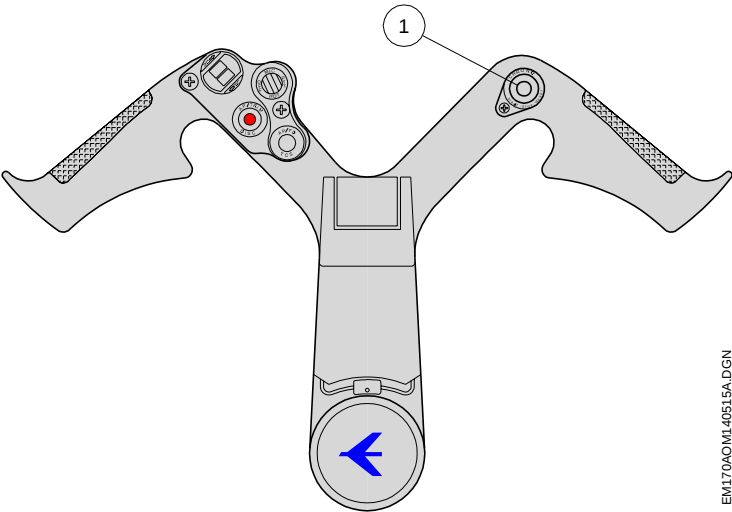
18 – AIRPLANE SYMBOL

- Reference for airplane attitude indication.

CLOCK/CHRONOMETER



MAIN PANEL CHRONOMETER



CONTROL WHEEL CHRONOMETER

1 – DATE/SET KNOB/BUTTON

- Allows time setting when GPS/INT/SET selector is in the SET position. Repeated pressings of the SET button causes the selector to cycle between minute, hour, year, month and day. The desired digit flashes and the setting is obtained by rotating the DATE/SET button clockwise to increase, and counter-clockwise to decrease.
- Selects the date to be displayed on the associated indicator, when GPS/INT/SET selector is in GPS or INT.

2 – RESET BUTTON

- Reset the chronometer to zero if chronometer has stopped.
- LCD display is blanked when the RST button is pressed and the chronometer is running.

3 – CHRONOMETER BUTTON

- Starts/stops the chronometer.

4 – GPS/INT/SET SELECTOR

- GPS: synchronizes with UTC and DATE from GPS.
- INT: displays information from the internal clock.
- SET: sets the clock modes.

5 – ELAPSED TIME SELECTOR

- AUTO: automatically starts the chronometer on liftoff.
- RST (spring loaded): resets the elapsed time if WOW is present.

6 – CLOCK/CHONOMETER DISPLAY

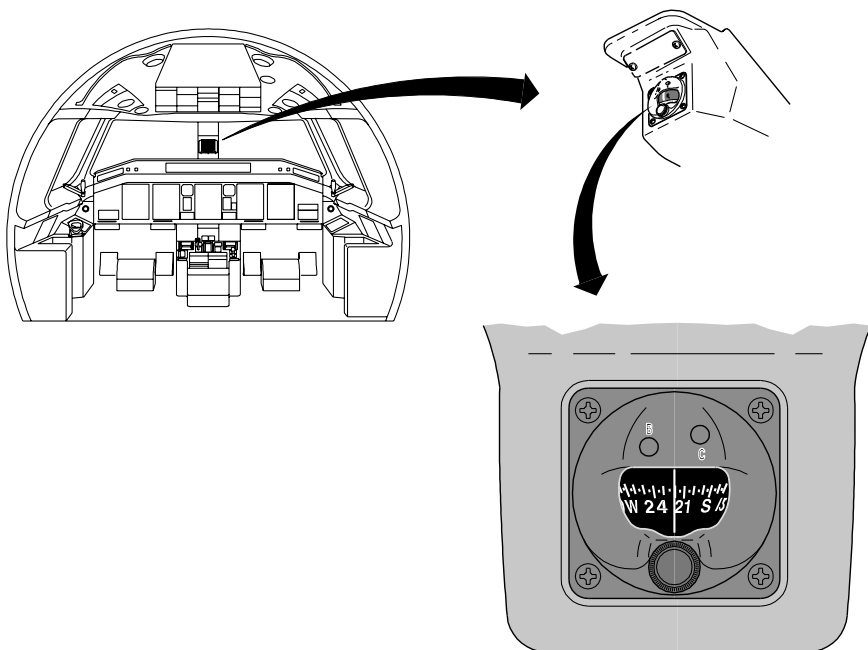
- Displays chronometer, time/date and elapsed time.
- If no GPS signal is detected, the clock will display dashes and only the positions INT and SET on the GPS/INT/SET selector will be available.
- The chronometer display is blanked in the non-operating mode.

CONTROL WHEEL

1 – CHRONOMETER BUTTON

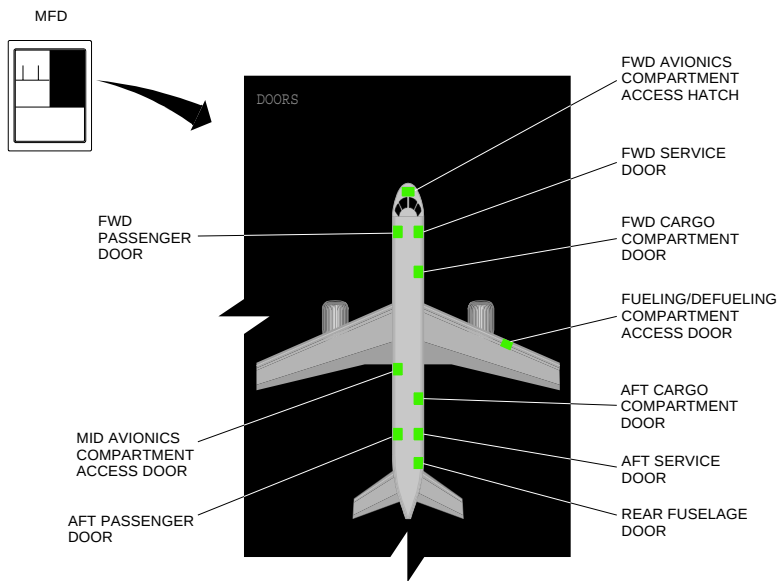
- Starts/stops/resets the chronometer displayed on PFD.
- Independent information/functioning for CPT and FO.

STANDBY MAGNETIC COMPASS



SYNOPTIC PAGE ON MFD

Door information is displayed on the synoptic status page. It can be selected by flight crew on either MFD.

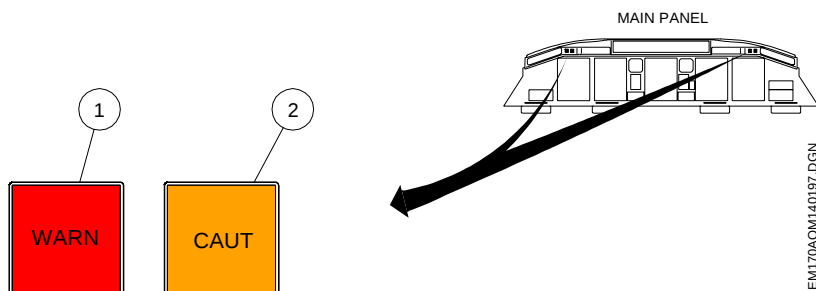


DOOR

- On synoptic page, the door is shown as a colored solid square.
GREEN: the associated door is closed.
RED: the associated passenger, service or cargo door is opened.
AMBER: the associated access door is opened.
AMBER DASHED: the associated door status is undetermined.

NOTE: An annunciation is displayed at the right top of the door status windows whenever the respective door is not properly closed.

GLARESHIELD PANEL



1 – MASTER WARNING PUSHBUTTON

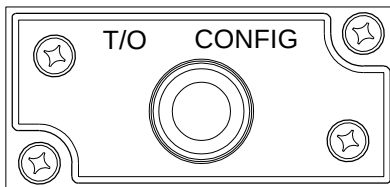
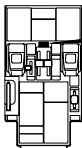
- A red light blinks inside the button when a new warning message is displayed on the EICAS.
- Acknowledges the warning messages and extinguishes the associated blinking.

2 – MASTER CAUTION PUSHBUTTON

- An amber light blinks inside the button when a new caution message is displayed on the EICAS.
- Acknowledges the caution messages and extinguishes the associated blinking.

TAKEOFF CONFIG CHECK BUTTON

CONTROL
PEDESTAL



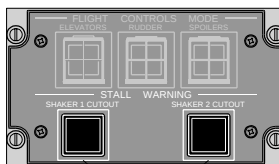
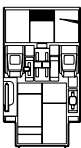
EW170AOM140199.DGN

1 – TAKEOFF CONFIGURATION CHECK BUTTON

- Checks the takeoff configuration.

STALL WARNING PANEL

CONTROL
PEDESTAL



1

EW170AOM140201.DGN

1 – SHAKER CUTOUT BUTTON

- When pushed in, cuts out the associated shaker channel.



VISUAL WARNINGS

Visual warnings are provided through illuminated warning buttons, displays indications and EICAS messages.

WARNING LIGHTS

Master warning and caution lights are installed on the glareshield panel and blink when any warning or caution message shows on the EICAS or is triggered by the Aural Warning Unit. It alerts to conditions that require action or caution related to the operation of the airplane.

MESSAGES ON EICAS

EICAS MESSAGES MNEMONIC

Mnemonic EICAS messages are generally presented in three elements, as shown in the example:

General Header or System	Specific Subsystem or location	Nature of the Problem	EICAS Message Mnemonic
ENGINE	Left side	Fire detected	ENG 1 FIRE
FUEL SOV	Left side	Valve is closed	FUEL SOV CLOSED
ADS	Third system	ADS standby failed	ADS 3 FAIL

- NOTE:** - The above format may not be applicable for all CAS messages. Therefore, although the standard is desirable, it shall be subordinated to a clear statement of the nature of the problem.
- Throughout the manual, number 1 is used to identify the left side, number 2 to identify the right side and number 3 for triple systems (usually for backup and standby systems).

EICAS MESSAGES CATEGORIZATION

There are four message priority levels:

- Warning.
- Caution.
- Advisory.
- Status.

WARNING (red): indicates an operational emergency or airplane system conditions that require immediate corrective or compensatory crew action.

CAUTION (amber): indicates an abnormal operational or airplane system condition that requires immediate crew awareness and a subsequent corrective or compensatory action.

ADVISORY (cyan): indicates operational or airplane conditions that require crew awareness. Subsequent or future crew action may be required.

STATUS (white): indicates information/status messages. The pilot can use the system efficiently when the appropriate action is accomplished.

A fifth level is provided for maintenance and is not available during flight operation. It is accessed only on the ground.

Messages with higher priority precede other messages when shown at the same time. The EICAS displays up to 15 messages at the same time.

The MCDU displays some messages in the event of a failure of both MFD and the EICAS.

EICAS MESSAGES PRESENTATION

The messages are grouped and presented in a chronological order accordingly to its category. The warning category is placed at the top of the EICAS display. Below this category the system presents the Caution, Advisory and Information/Status category, in this order.

When new Warning, Caution and Advisory alert messages are displayed, they are presented flashing in inverse video for crew acknowledgment.

The warning and caution alert messages shall remain flashing in inverse video until manual crew acknowledgment via Master Warning or Caution button (respectively) is pressed. Advisory messages will automatically revert from inverse to normal video 5 seconds after they started to be displayed.

After the acknowledgment, the new message shall remain in steady normal video, at the top of its category on the EICAS display, until a new message belonging to that group appears.

In case of an overflow (exceeding the display capacity – 15 messages), an indication appears, in order to enable the flight crew to scroll the lines, allowing access to all EICAS messages.

The EICAS messages cannot be canceled. They shall remain active as long as its activation condition exists.

The following table presents all EICAS messages. The type column indicates the message priority level:

- (W) Warning.
- (C) Caution.
- (A) Advisory.
- (S) Status.

The INHIBITION column indicates the k-codes.

	TYPE	INHIBITION
	MESSAGE	
W	A-I WING 1 (2) LEAK	K3, K5
	APU FIRE	None
	BATT 1 (2) OVERTEMP	None
	BATT 1-2 OFF	None
	BATT DISCHARGING	None
	CABIN ALTITUDE HI	K1, K2a, K2b, K3, K5
	CRG AFT (FWD) SMOKE	None
	DOOR CRG AFT (FWD) OPEN	K3, K5
	DOOR PAX AFT (FWD) OPEN	K3, K5
	DOOR SERV AFT (FWD) OPEN	K3, K5
	ELEC EMERGENCY	None
	ELEV (RUDDER) (SPOILER) NML MODE FAIL	K1, K2a, K2b, K3, K5
	ENG 1 (2) FIRE	None
	ENG 1 (2) REV DEPLOYED	None
	FUEL 1 (2) LO LEVEL	K1, K2a, K2b, K3, K5
	GROUND SPOILERS FAIL	None
	HYD 1 (2) (3) OVERHEAT	None
	LAV SMOKE	K2, K3, K5
	LG LEVER DISAG	None
	NO TAKEOFF CONFIG	K3, K4, K5
C	AC BUS 1 (2) OFF	K2, K3, K5
	AC ESS BUS OFF	K2, K3, K5
	AC STBY BUS OFF	K2, K3, K5
	ADS 1 (2) FAIL	K3, K5
	ADS 1 (2) HTR FAIL	K5
	ADS 3 (4) HTR FAIL	K2b, K3, K5

	TYPE	INHIBITION
	MESSAGE	
C	ADS 3 FAIL	K2b, K3, K5
	A-I ENG 1 (2) FAIL	K3, K5
	A-I LO CAPACITY	K1, K2a, K2b, K3, K5
	A-I WING FAIL	K3, k5
	A-I WING NO DISPATCH	K2a, K2b, K3, K5
	AMS CTRL FAIL	K2b, K3, K5
	AOM LIMIT FAIL	K2a, K2b
	AP FAIL	K3, K5
	AP PITCH MISTRIM	K3
	AP PITCH TRIM FAIL	K2b, K3, K5
	AP ROLL MISTRIM	K3
	APM FAIL	K2b, K3, K4, K5
	APM MISCOMP	K2b, K3, K4, K5
	APU FAIL	K2a, K2b, K3, K5
	APU FAULT	K2a, K2b, K3, K5
	APU FIRE DET FAIL	K3, K5
	APU FIREX FAIL	K3, K5
	APU FUEL SOV FAIL	K3, K5
	APU GEN OFF BUS	K2, K3, K5
	APU OIL HI TEMP	K2a, K2b, K3, K5
	APU OIL LO PRESS	K2a, K2b, K3, K5
	AT FAIL	K3, K5
	AT NOT IN HOLD	None
	AURAL WRN SYS FAIL	K3, K5
	AUTOBRAKE FAIL	K3
	AVNX ASCB FAULT	K2b, K3, K4, K5
	AVNX MAU 1 (2) (3) A (B) FAIL	K3, K5 and Inhibited from 80 knots to 400 ft by logic.
	AVNX MAU 1 (2) (3) A (B) OVHT	K3, K5 and Inhibited from 80 knots to 400 ft by logic.
	AVNX MAU 1 (2) (3) FAN FAIL	K3, K4, K5 and Inhibited from 80 knots to 400 ft by logic.
	BATT 1 (2) DISCHARGING	None
	BATT 1 (2) OFF	K3, K5
	BATT 1 (2) TEMP SENS FAULT	K2a, K2b, K3, K4, K5
	BLEED 1 (2) FAIL	K2b, K3, K5
	BLEED 1 (2) LEAK	K2b, K3, K5
	BLEED APU LEAK	K2b, K3, K5

	TYPE	INHIBITION
	MESSAGE	
C	BRK OVERHEAT	K3
	BRK RH (LH) FAIL	K3
	CABIN DIFF PRESS FAIL	K3, K5
	CENTER EBAY FANS FAIL	K2a, K2b, K3, K5
	CMS FAIL	K2b, K3, K4, K5
	CREW OXY LO PRESS	K2, K3, K5
	CREW WRN SYS FAULT	K2b, K3, K4, K5
	CRG AFT (FWD) FIRE SYS FAIL	K2a, K2b, K3, K5
	CRG FWD VENT FAIL	K2b, K3, K5
	DC BUS 1 (2) OFF	K3, K5
	DC ESS BUS 1 (2) (3) OFF	K3, K5
	DISPLAY CTRL FAIL	K3, K5.
	DISPLAY CTRL FAULT	K2b, K3, K4, K5
	DOOR CENTER (FWD) EBAY OPEN	K3, K5
	DOOR FUELING OPEN	K3, K5
	DOOR HYD OPEN	K3, K5
	EICAS FAULT	K3, K5
	EICAS OVHT	K3, K5
	ELEV THR COMP FAIL	K3, K5
	ELEVATOR FAULT	K3
	ELEVATOR LH (RH) FAIL	K3
	EMER BRK FAIL	K3
	EMER LT NOT ARMED	K2a, K2b, K3, K5
	EMER LT ON	K2a, K2b, K3, K5
	ENG 1 (2) CONTROL FAULT	K3, K5
	ENG 1 (2) FADEC OVERTEMP	K3, K5
	ENG 1 (2) FAIL	K3
	ENG 1 (2) FIRE DET FAIL	K3, K5
	ENG 1 (2) FUEL IMP BYPASS	K3, K5
	ENG 1 (2) FUEL LO PRESS	K3, K5
	ENG 1 (2) FUEL SOV FAIL	K3, K5
	ENG 1 (2) NO DISPATCH	K3, K4, K5
	ENG 1 (2) OIL LO LEVEL	K3, K4, K5
	ENG 1 (2) OIL LO PRESS	K3, K5
	ENG 1 (2) REV FAIL	K3, K4, K5
	ENG 1 (2) REV PROT FAULT	K3, K4, K5
	ENG 1 (2) REV TLA FAIL	K3, K5

	TYPE	INHIBITION
	MESSAGE	
C	ENG 1 (2) START VLV OPEN	K3, K5
	ENG 1 (2) T2 HEAT FAIL	K3, K5
	ENG 1 (2) TLA FAIL	K3, K5
	ENG EXCEEDANCE	K2b, K3, K4, K5
	ENG NO TAKEOFF DATA	K3, K4, K5
	ENG REF A-I DISAG	K1, K3, K4, K5
	ENG REF ECS DISAG	K3, K4, K5
	ENG THR RATING DISAG	K3, K4, K5
	FD LATERAL MODE OFF	K3
	FD VERT MODE OFF	K3
	FLAP FAIL	K3, K5
	FLT CTRL BIT EXPIRED	K1
	FLT CTRL NO DISPATCH	K3, K4, K5
	FUEL AC 1 (2) PUMP FAIL	K3, K5
	FUEL DC PUMP FAIL	K3, K5
	FUEL IMBALANCE	K3, K5
	FUEL TANK LO TEMP	K3, K5
	FUEL XFEED FAIL	K3, K5
	FWD EBAY FANS FAIL	K2a, K2b, K3, K5
	GND PROX FAIL	K3, K5
	GPU CONNECTED	K3, K4, K5
	HYD 1 (2) (3) HI TEMP	K3, K5
	HYD 1 (2) (3) LO PRESS	Inhibited from 80 knots to 400 ft.
	HYD 1 (2) EDP NOT D-PRESS	K3, K5
	HYD 3 VLV FAIL	K3, K5 and inhibited from 80 knots to 400 ft.
	HYD PTU FAIL	K3, K5
	ICE DETECTOR 1 (2) FAIL	K2b, K3, K5
	IDG 1 (2) OFF BUS	K3, K5
	IDG 1 (2) OIL	K3, K5
	INVERTER FAIL	K2a, K2b, K3, K4, K5
	IRS 1 (2) (3) FAIL	None
	IRS EXCESSIVE MOTION	K2a, K2b, K3, K4, K5
	LAV SMOKE DET FAIL	K2a, K2b, K3, K4, K5
	LG NO DISPATCH	K3, K4, K5
	LG NOSE DOOR OPEN	K3, K5
	LG WOW SYS FAIL	None

	TYPE	INHIBITION
	MESSAGE	
C	MACH TRIM FAIL	K2b, K3, K5
	MCDU 1 (2) OVHT	K2b, K3, K5
	MFD 1 (2) FAULT	K3, K5
	MFD 1 (2) OVHT	K3, K5
	NAV 3 FAIL	K3, K5
	NAVCOM 1 (2) FAIL	K3, K5
	NAVCOM 1 (2) OVHT	K3, K5
	PACK 1 (2) FAIL	K2b, K3, K5
	PACK 1 (2) LEAK	K2b, K3, K5
	PAX OXY NOT DEPLOYED	K2, K3, K5
	PFD 1 (2) FAULT	K3, K5
	PFD 1 (2) OVHT	K3, K5
	PITCH TRIM FAIL	K3, K5
	PRESN AUTO FAIL	K3, K5
	PRESN MAN FAIL	K3, K5
	RAT FAIL	K2a, K2b, K3, K4, K5
	RECIRC SMK DET FAIL	K2, K3, K5
	RECIRC SMOKE	K2, K3, K5
	RUDDER FAIL	K3
	RUDDER FAULT	K3
	RUDDER LIMITER FAIL	K1, K2a, K2b, K3
	SHAKER ANTICIPATED	K3, k5
	SLAT FAIL	K3, K5
	SLAT-FLAP LVR DISAG	K3, K5
	SPOILER FAULT	K2a, K2b, K3
	STAB LOCK FAULT	K3, K5
	STALL PROT FAIL	K3
	STEER FAIL	K3
	SYS CONFIG FAIL	K2a, K2b, K3, K4, K5.
	TERRAIN FAIL	K3, K5
	TRU 1 (2) FAIL	K3, K5
	TRU ESS FAIL	K3, K5
	VALIDATE CONFIG	K2b, K3, K4, K5
	VHF 1 (2) (3) OVHT	K3, K5
	VHF 3 FAIL	K3, K5
	WINDSHEAR FAIL	None
	WINDSHIELD 1 (2) HTR FAIL	K3, K5

	TYPE	INHIBITION
	MESSAGE	
A	ADS 1 (2) HTR FAULT	K3, K4, K5
	ADS 3 SLIPCOMP FAIL	K2b, K3, K5
	AFCS FAULT	K2b, K3, K5
	AFCS PANEL FAIL	K3, K5
	AFCS PANEL FAULT	K2a, K2b, K3, K4, K5
	A-I ENG 1 (2) FAULT	K3, K5
	A-I ENG 1 (2) LEAK	K3, K5
	A-I MODE NOT AUTO	K2, K3, K5
	A-I SWITCH OFF	K3, K5
	AILERON LR (RH) FAIL	K3, K5
	AMS CTRL FAULT	K2a, K2b, K3, K4, K5
	AP FAULT	K2b, K3, K4, K5
	AP PITCH TRIM FAULT	K2b, K3, K4, K5
	APM FAULT	K2b, K3, K4, K5
	APU FIREX BTL DISCH	K3, K5
	AT FAULT	K2a, K2b, K3, K4, K5
	AURAL WRN SYS FAULT	K3, K5
	AUTO CONFIG TRIM FAIL	K3, K5
	AVNX DB MODULE FAIL	K2a, K2b, K3, K4, K5
	AVNX MAU 1 (2) (3) A (B) FAULT	K2b, K3, K4, K5
	AVNX MAU 1 (2) (3) A (B) FAULT	K2b, K3, K4, K5
	BLEED 1 (2) OFF	K2b, K3, K5
	BRK CONTROL FAULT	K3, K5
	BRK PEDL RH (LH) SEAT FAIL	K3
	BRK RH (LH) FAULT	K3
	CCD 1 (2) FAULT	K2b, K3, K5
	CMC FAIL	K2a, K2b, K3, K4, K5
	CMF 1 (2) FAIL	K3, K5
	CMS FAULT	K2b, K3, K4, K5
	CRG FIRE PROT FAULT	K2a, K2b, K3, K4, K5
	CRG FWD (AFT) FIREX HI ARM	K2a, K2b, K3, K5
	CRG FWD (AFT) FIREX LO ARM	K2a, K2b, K3, K5
	DEFUEL SOV OPEN	K3, K4, K5
	EMER BRK FAULT	K3, K4, K5
	EMER LT BATT FAULT	K2a, K2b, K3, K4, K5
	ENG 1 (2) FADEC FAULT	K3, K4, K5
	ENG 1 (2) FIREX BTL A (B) FAIL	K3, K5

	TYPE	INHIBITION
	MESSAGE	
A	ENG 1 (2) FUEL SW FAIL	K3, K5
	ENG 1 (2) OIL IMP BYPASS	K3, K5
	ENG 1 (2) OIL SW FAIL	K3, K4, K5
	ENG 1 (2) SHORT DISPATCH	K3, K4, K5
	ENG FIREXBTL A (B) DISCH	K3, K5
	FD FAIL	K3, K5
	FD FAULT	K2b, K3, K4, K5
	FD VERT MODE MISCMD	K2b, K3, K5
	FLAP LO RATE	K3, K5
	FLT CTRL ADS FAIL	K2b, K3, K4, K5
	FLT CTRL FAULT	K3, K4, K5
	FMS 1 (2) FAIL	K3, K5
	FMS 1 (2) GPS POS DISAG	K1, K2a, K2b, K3
	FMS POS DISAG	K1, K2a, K2b, K3
	FUEL EQUAL-XFEED OPEN	K3, K5
	FUEL FEED 1 (2) FAULT	K3, K5
	FUEL KG-LB MISMATCH	K2a, K2b, K3, K4, K5
	HYD 1 (2) (3) LO QTY	K2a, K2b, K3, K5
	HYD 1 (2) EDP FAIL	K3, K5 and inhibited from 80 knots to 400 ft.
	HYD 1 (2) ELEC PUMP FAIL	K2a, K2b, K3, K5
	HYD 1 (2) SOV FAIL	K3, K5
	HYD 3 PUMP A NOT ON	K3, K5
	HYD PTU NOT AUTO	K3, K5
	HYD PUMP NOT AUTO	K3, K5
	HYD TEMP SENS FAIL	K2a, K2b, K3, K5
	HYD3 ELEC PUMP A FAIL	K3, K5 and inhibited from 80 knots to 400 ft.
	HYD3 ELEC PUMP B FAIL	K2a, K2B, K3, K5
	ICE CONDITION	None.
	IRS 1 (2) (3) NAV MODE FAIL	K1, K2a, K2b, K3, K5
	IRS ALIGNING	K2a, K2b, K3, K4, K5
	IRS PRES POS INVALID	K2a, K2b, K3, K4, K5
	LAND 2 NOT AVAILABLE	K2a, K2b, K3
	LG TEMP EXCEEDANCE	K3, K5
	LOAD SHED	K3, K4, K5
	MACH TRIM FAULT	K2b, K3, K4, K5

	TYPE	INHIBITION
	MESSAGE	
A	OBSERVER OXY LO PRESS	K2a, K2b, K4, K5.
	PACK 1 (2) OFF	K2b, K3, K5
	PAX OXY SW NOT AUTO	K2, K3, K5
	PITCH CONTROL DISC	K3, K5
	PITCH TRIM BKUP FAIL	K3, K5
	PITCH TRIM SW 1 (2) FAIL	K3, K5
	PRESN AUTO FAULT	K3, K5
	RALT 1 (2) (3) FAIL	None
	RAM AIR FAULT	K2a, K2b, K3, K4, K5
	REMOTE CB TRIP	K2a, K2b, K3, K4, K5
	ROLL CONTROL DISC	K3, K5
	SDPBRK LEVER DISAG	K3, K5
	SHAKER 1 (2) FAIL	K3, K5
	SLAT LO RATE	K3, K5
	SPDA FAIL	K3, K5
	STALL PROT FAULT	K2b, K3, K5
	STALL PROT ICE SPEED	K2b, K3, K5
	STEER FAULT	K3, K4, K5
	TAT 1 (2) FAIL	K3, K5
	TCAS FAIL	K3, K5
	TERRAIN NOT AVAILABLE	K3, K5
	XBLEED FAIL	K2, K3, K5
	XBLEED SW OFF	K2, K3, K5
	XPDR 1 (2) FAIL	K3, K5
	YD FAIL	K2b, K3, K5
	YD FAULT	K2b, K3, K4, K5
	YD OFF	None
S	A-I ENG 1 (2) VLV OPEN	None
	A-I WING VLV OPEN	None
	APU FUEL SOV CLOSED	K3, K5
	APU SHUTTING DOWN	K2a, K2b, K3, K5
	BLEED APU VLV OPEN	K2, K3, K5
	CRG FIREX HI (LO) DISCH	K2a, K2b, K3, K5
	ENG 1 (2) FUEL SOV CLOSED	K3, K5
	ENG 1 (2) REV INHIBIT	K3, K4, K5
	ENG 1 (2) TLA NOT IDLE	None
	ENG TDS REF A-I ALL	K3, K4, K5



	TYPE	INHIBITION
	MESSAGE	
S	ENG TDS REF A-I ENG	K3, K4, K5
	FUEL XFEED SOV OPEN	K3, K5
	HYD 1 (2) SOV CLOSED	K3, K5
	PRINTER FAULT	K2a, K2b, K3, K5
	STEER OFF	K3, K4

AURAL WARNING

The electronic display system has two aural warning drivers, which are responsible for generating and prioritizing aural warnings.

Aural warnings sound in a sequence, are never truncated, and are automatically canceled when the alerting situation no longer exists, or when they are reset manually by the pilot. In the event of multiple alerts, the highest priority alerts sound first.

Aural warnings are used when pilots need immediate knowledge of a condition without having to look at a visual display or indicator. Aural warnings are alert tones, bells, horns, clicks, beeps and voice messages.

There are four aural warning priority levels, from the highest to the lowest:

- Emergency (level 3).
- Abnormal (level 2).
- Advisory (level 1).
- Information (level 0).

Emergency: corresponds to a situation that requires the pilot's immediate action. The master warning annunciator is repeated with three-second intervals between alerts until the master warning reset switch is pressed.

Abnormal: corresponds to an abnormal situation such as system malfunction or failures that have no immediate impact on safety. Whenever an abnormal fault occurs, a master caution tone is presented every five seconds until the master caution reset switch is pressed.

Advisory: corresponds to the recognition of a situation such as system malfunction or failures leading to loss of redundancy or degradation of a system. For advisory alerts, a single alert signal, which stops automatically, is presented.

Information: corresponds to an information situation. For information alerts, a single alert signal, which stops automatically, is presented.

PRIORITY	ALERT	TONE/VOICE MESSAGE
3	EGPWS WARNING	See ATA Chapter 12.34 page 111.
3	TCAS CORRECTIVE ADVISORY	See ATA Chapter 12.34 page 117.
3	TCAS PREVENTIVE ADVISORY	See ATA Chapter 12.34 page 117.
3	FIRE	BELL
3	MASTER WARNING	TRIPLE CHIME
3	OVERSPEED	"HIGH SPEED"
3	LANDING GEAR (With Radar Altitude Valid)	"LANDING GEAR"
3	CABIN ALTITUDE	"CABIN"
3	NO TAKEOFF (slat/flap out of configuration)	"NO TAKEOFF FLAP"
3	NO TAKEOFF (pitch trim out of configuration)	"NO TAKEOFF TRIM"
3	NO TAKEOFF (brakes out of configuration)	"NO TAKEOFF BRAKES"
3	NO TAKEOFF (spoilers out of configuration)	"NO TAKEOFF SPOILER"
3	AUTOPILOT (normal or abnormal)	"AUTOPILOT".
2	MASTER CAUTION	SINGLE CHIME
1	ALTITUDE ALERT (departure)	C CHORD (twice) + "ALTITUDE"
1	ALTITUDE ALERT (capture)	C CHORD
1	AUTOTHROTTLE (normal or abnormal)	"THROTTLE"
0	TAKEOFF CONFIGURATION	"TAKEOFF OK"
0	AURAL WARNING A PIT	"AURAL WARNING TEST A"
0	AURAL WARNING B PIT	"AURAL WARNING TEST B"
0	SELECTIVE CALLING	"SELCAL"
0	TRIM MALFUNCTION	"TRIM" (7 seconds)

VOICE MESSAGES

Voice messages are generated whenever a potentially dangerous condition exists, as determined by the EGPWS, TCAS, and windshear detection system.

Some voice messages may be canceled, but others are only canceled when the cause that activates them stops. When a windshear, TCAS or EGPWS alert condition takes place, a special situation exists. In that case, no other voice messages are presented so that the flight crew can clearly hear the information messages. Only a stall condition takes precedence over windshear, EGPWS and TCAS alerts.

TAKEOFF CONFIGURATION WARNING

A dedicated aural warning indicates that airplane configuration is not in suitable takeoff condition. The aural warning is activated whenever the airplane is on the ground, thrust is applied and at least one of the following conditions is met:

- Flaps are not in takeoff position ("NO TAKEOFF FLAPS").
- Parking brakes are applied ("NO TAKEOFF BRAKES").
- Pitch trim is out of green range ("NO TAKEOFF TRIM").
- Any spoiler panel is deployed ("NO TAKEOFF SPOILER").

More than one warning may be generated if more than one condition is met.

A test button is provided to allow checking the takeoff configuration by simulating power levers in the advanced position. If the airplane is in takeoff configuration, the voice message "TAKEOFF OK" is generated. If the airplane is not set to takeoff configuration, the aural warning referred to the associated takeoff configuration deviation is generated.

MONITOR WARNING FUNCTION (MWF)

The Electronic Display System (EDS) has two MWFs, hosted in two processors modules in different MAUs (MWF 1 in PROC 1 at MAU 1 and MWF 2 in PROC 4 at MAU 2). These operate as priority and non-priority.

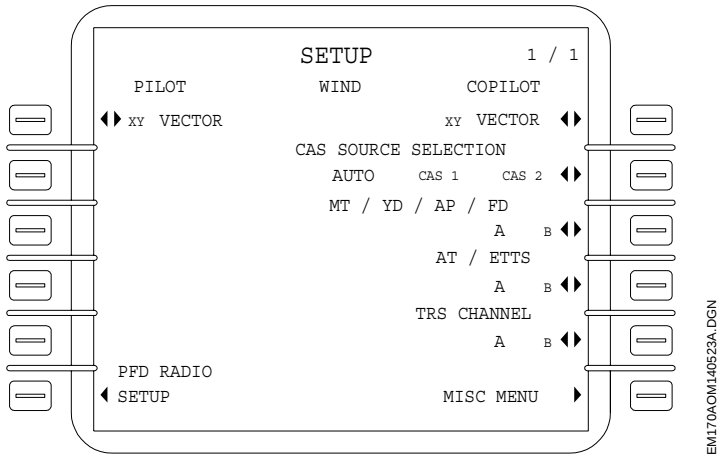
Each MWF receives warning, caution, advisory and status of several aircraft systems. The MWF also integrates aural warning and crew alert functions through two different software applications:

- Monitor warning application: Monitors the display system among several aircraft systems, providing alerts to pilots through the EICAS.
- Aural warning applications: Provides aural warning to pilots, which may be either a tone or a voice.

Both monitor warning applications are active at the same time, and output their status on the ASCB.

A "CAS MSG" miscompare flag is displayed on both PFD whenever the CAS list from MWF 1 is different from MWF 2.

Changing the CAS message source on MCDU avionics SETUP page through LSK 2R from CAS 1 (MWF) to CAS 2 (MWF 2) allows the crew to visualize which CAS message list is being generated by each MWF.



MCDU AVIONICS SETUP PAGE

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AIR CONDITIONING	ATA 21
AUTO FLIGHT	ATA 22
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EQUIPMENT AND FURNISHINGS	ATA 25
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FLIGHT CONTROLS	ATA 27
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ATA CHAPTER 32

LANDING GEAR

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INTRODUCTION

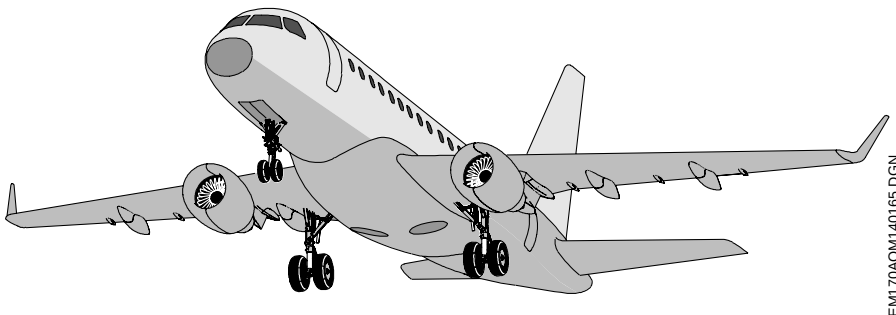
The landing gear system provides ground-rolling capability to the airplane, thus enabling take-off, landing and taxi operations.

The airplane is equipped with a hydraulically operated retractable tricycle landing gear. Each landing gear is a conventional dual wheel unit.

The nose landing gear incorporates a powered steering system, which performs the aircraft directional control on the ground.

The brake system is designed to provide manual or automatic (if applicable) airplane deceleration during ground operations.

The landing gear and brake system parameters and indications are displayed on both MFD synoptic pages. System messages are displayed on EICAS displays.



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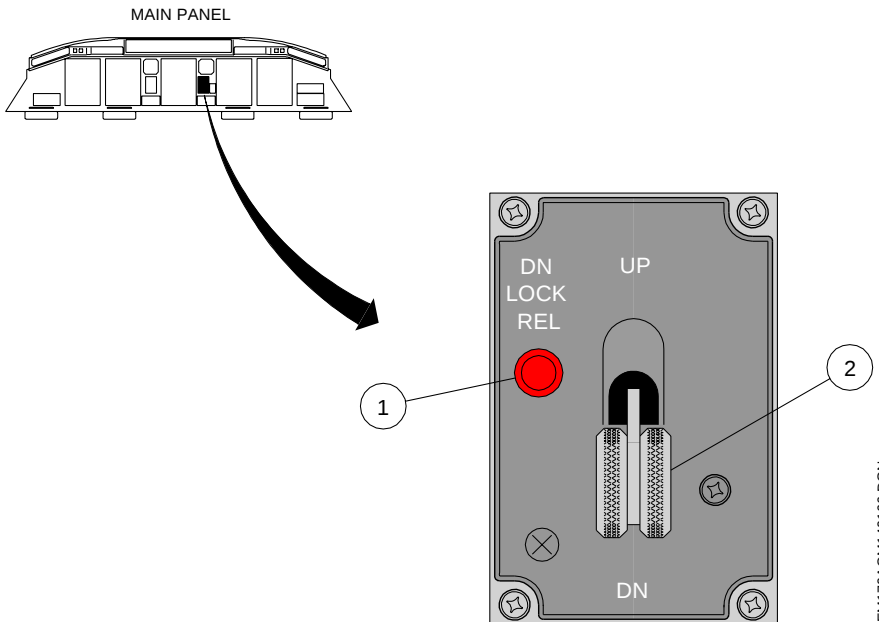
MAIN AND NOSE LANDING GEARS

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CONTROLS AND INDICATIONS

LANDING GEAR

LANDING GEAR CONTROL PANEL



1 – DOWNLOCK RELEASE BUTTON (MOMENTARY ACTION)

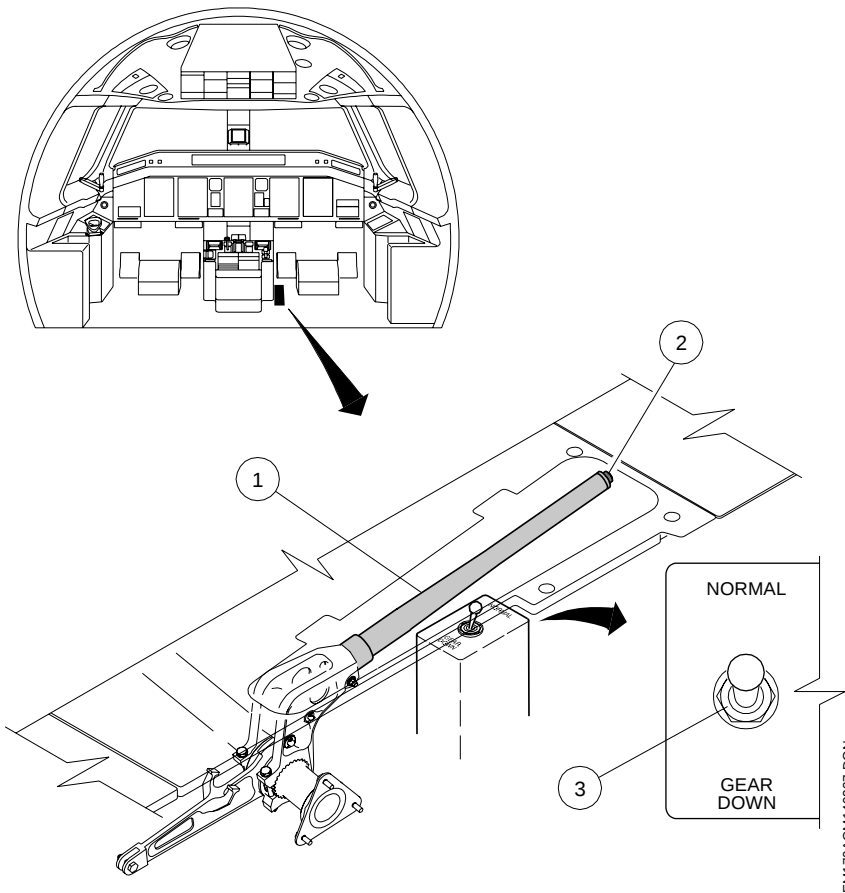
- Mechanically releases the landing gear lever lock.

2 – LANDING GEAR LEVER

UP: retracts the landing gear.

DOWN: extends the landing gear.

ALTERNATE GEAR EXTENSION COMPARTMENT



1 – ALTERNATE GEAR EXTENSION LEVER (TWO-POSITION)

- When pulled, relieves hydraulic pressure in the landing gear lines and releases all landing gear uplocks.

2 – ALTERNATE GEAR EXTENSION LEVER UNLOCK PUSHBUTTON

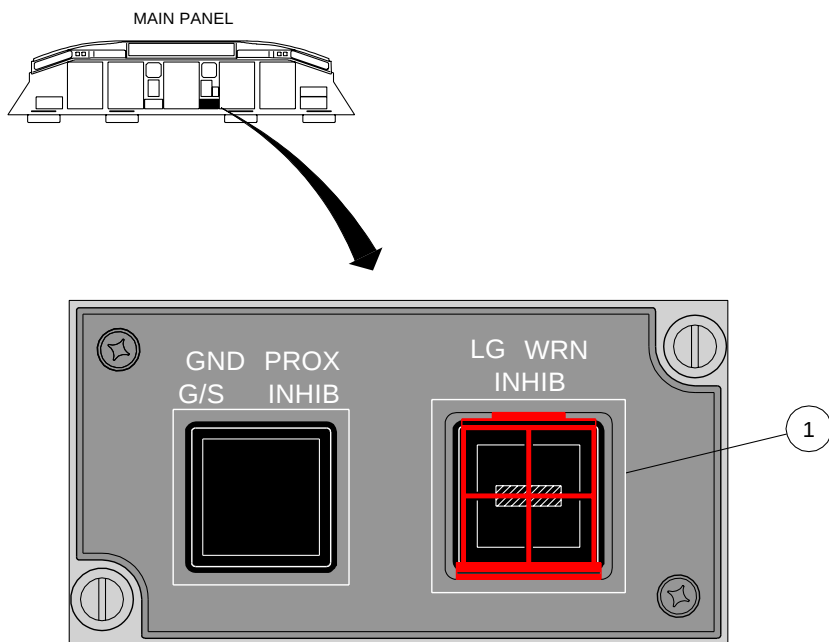
- When pressed, releases the handle from the fully actuated position.

3 – ELECTRICAL OVERRIDE SWITCH

NORMAL: the landing gear lever performs landing gear retraction and extension.

GEAR DOWN: electronically bypasses the PSEM, opens the forward and aft doors and extends the landing gear.

LANDING GEAR WARNING INHIBITION BUTTON



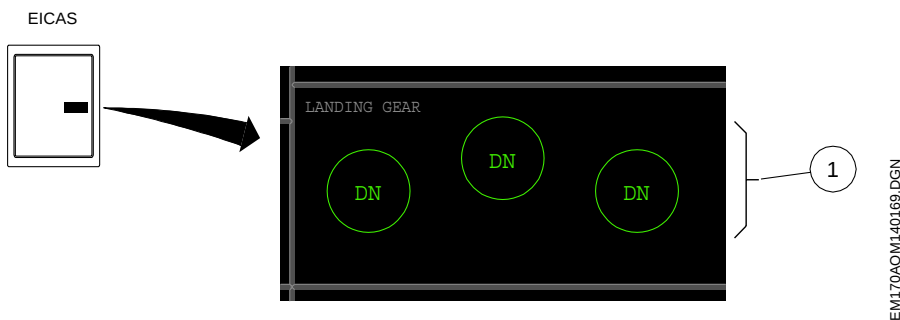
1 – LANDING GEAR WARNING INHIBITION BUTTON (GUARDED-MOMENTARY ACTION)

- Inhibits the landing gear warning in the event of dual radio altimeter failure.
- A white striped bar illuminates on the button, indicating it has been pressed.

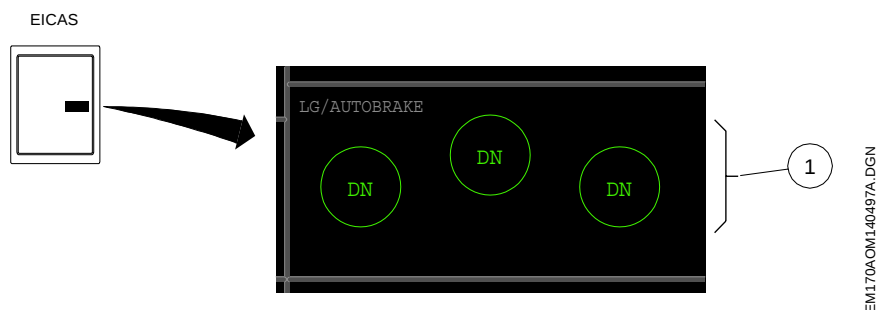
The white striped bar extinguishes, allowing a new warning activation when:

- Thrust levers are advanced beyond 45° thrust lever angle (TLA) for two engines or;
- Thrust levers are advanced beyond 59° TLA for one engine inoperative or;
- The flap selector lever is set to 5 or 6 positions without any landing gear down and locked.

LANDING GEAR POSITION INDICATION



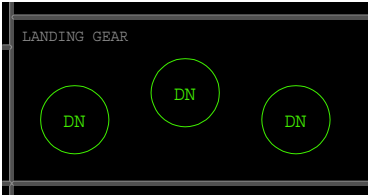
IF INSTALLED



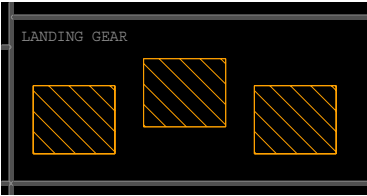
IF INSTALLED

1 – LANDING GEAR POSITION INDICATION

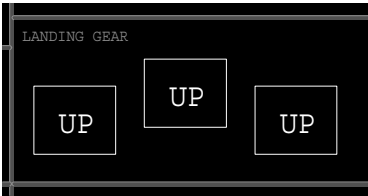
- DOWN:** the green DN label inside a green circle indicates that the respective landing gear is down and locked.
- UP:** the white UP label inside a white box indicates that the respective landing gear is up and locked.
- TRANSIT:** the amber cross-hatched box indicates that the respective landing gear is in transit.
- DISAGREEMENT:** a red icon indicates a discrepancy between landing gear lever position and the respective landing gear position. The indication changes from its previous color to red 20 seconds after the discrepancy is detected.



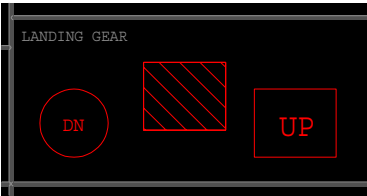
GEAR DOWN



TRANSITION



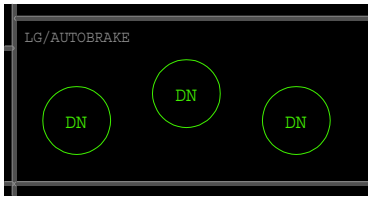
LOCKED UP



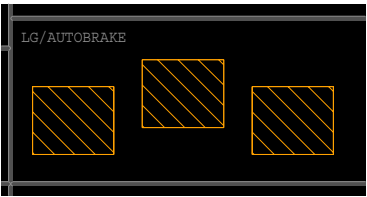
DISAGREE

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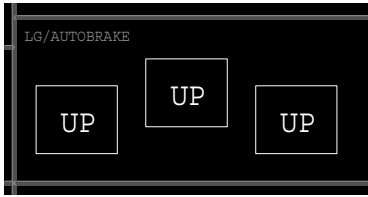
**LANDING GEAR POSITION INDICATION ON EICAS
IF INSTALLED**



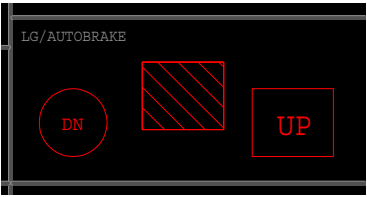
GEAR DOWN



TRANSITION



LOCKED UP



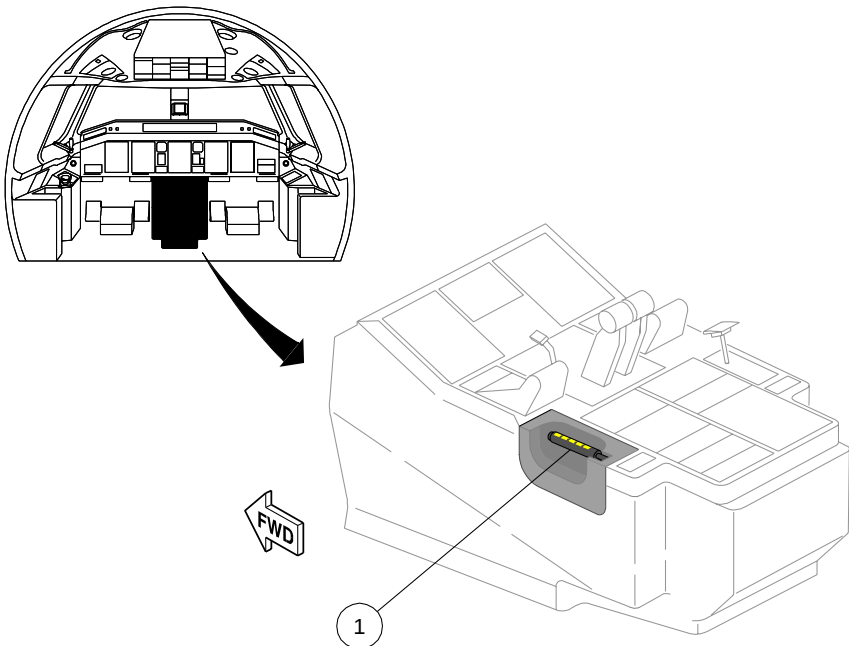
DISAGREE

EM170AOM140249.DGN

**LANDING GEAR POSITION INDICATION ON EICAS
IF INSTALLED**

BRAKES

EMERGENCY PARKING BRAKE HANDLE

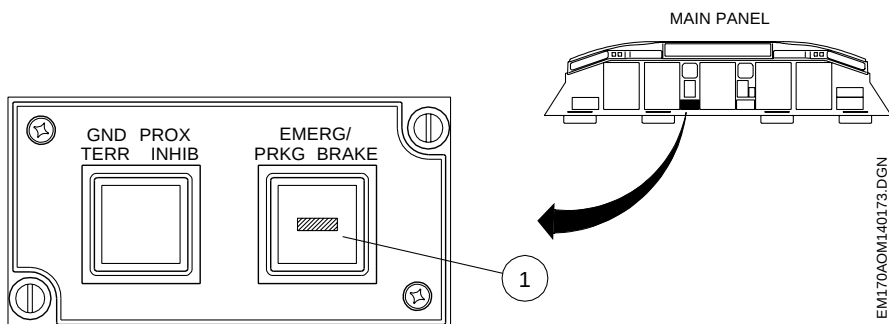


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1 – EMERGENCY/PARKING BRAKE HANDLE

- Actuates the emergency/parking brake.
- The handle will lock when pulled up to the fully actuated position.
- To release the handle from the fully actuated position, the top button must be pressed.

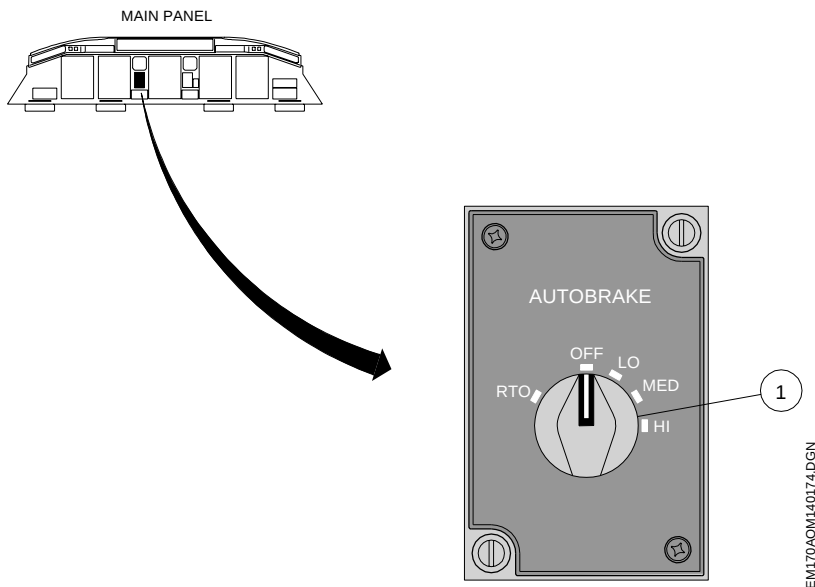
EMERGENCY PARKING BRAKE LIGHT



1 – EMERGENCY/PARKING BRAKE LIGHT

- A striped bar illuminates when the emergency/parking brake is actuated.

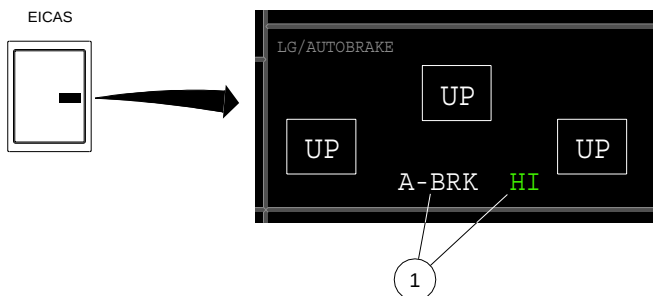
AUTOBRAKE SELECTION (if installed)



1 - AUTOBRAKE SELECTOR KNOB (ROTARY ACTION)

- RTO:** Selects RTO deceleration rate.
- OFF:** Autobrake is deactivated.
- LO:** Selects the low deceleration rate.
- MED:** Selects the medium deceleration rate.
- HI:** Selects the high deceleration rate.

AUTOBRAKE EICAS INDICATION (if installed)

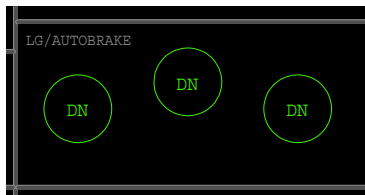


1 -AUTOBRAKE INDICATION

- A-BRK: the white A-BRK label indicates the autobrake is armed.
- RTO, HI, MED or LO: these green labels beside the A-BRK indicate the autobrake mode selected.
- AMBER DASHED: indicates that the data is invalid.



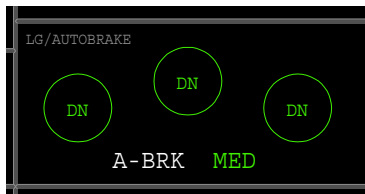
AUTOBRAKE RTO



AUTOBRAKE OFF



AUTOBRAKE LO



AUTOBRAKE MED



AUTOBRAKE HI

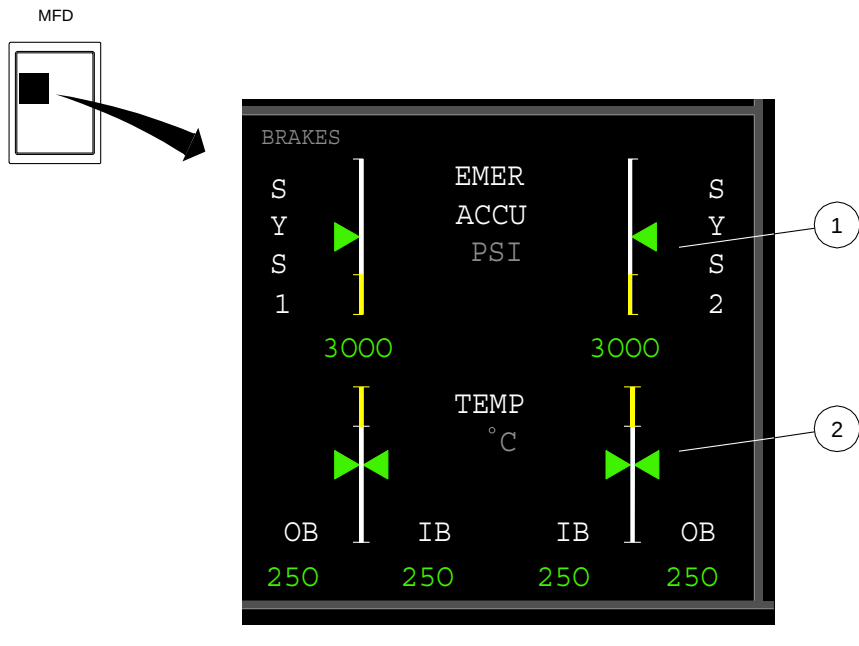


AUTOBRAKE DATA INVALID
OR UNAVAILABLE

EM170AOM140170.DGN

AUTOBRAKE EICAS INDICATION If installed

MFD STATUS PAGE INDICATIONS



1 – EMERGENCY/PARKING BRAKE ACCUMULATOR PRESSURE INDICATION

- Digital Pressure

GREEN: normal operating range.

AMBER: emergency/parking brake effectiveness is degraded.

AMBER DASHED: invalid information or a value out of the valid range.

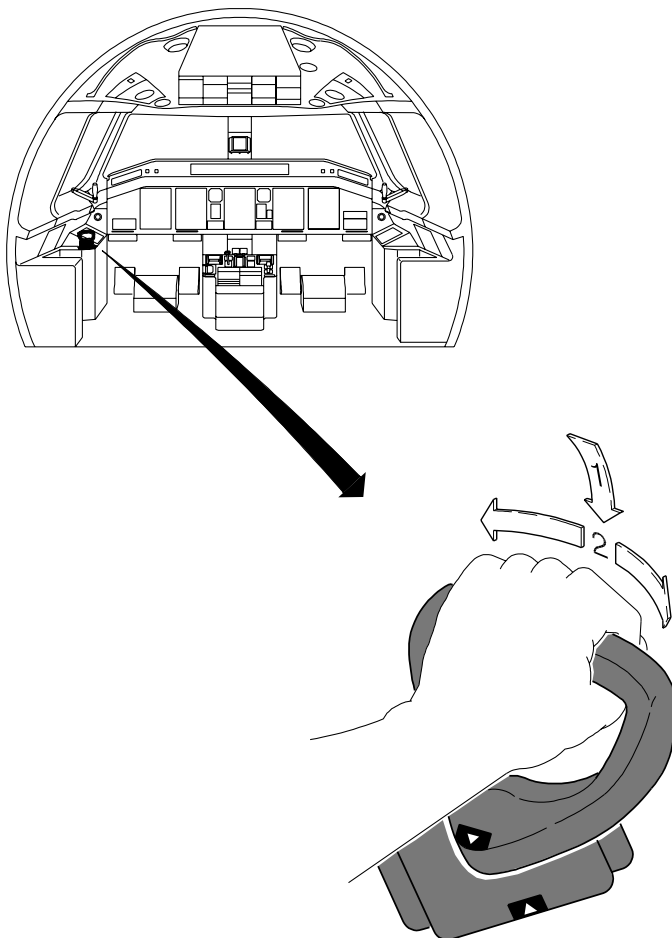
- Pressure Scale/Pointer
 - If the value is invalid, the pointer disappears from the display.
 - Scale:
WHITE: normal operating range.
AMBER: emergency/parking brake effectiveness is degraded.
 - Pointer:
GREEN (hollow): normal operating range.
AMBER (solid): emergency/parking brakes effectiveness is degraded.

2 – BRAKE TEMPERATURE INDICATION

- Digital Temperature
 - Displays brake temperature in degrees Celsius (°C).
GREEN: normal operating range.
AMBER: cautionary operating range.
AMBER DASHED: invalid information or a value out of the valid range.
- Temperature Scale/Pointer
 - If the value is invalid, the pointer will disappear from the display.
 - Scale:
WHITE: normal operating range.
AMBER: cautionary operating range.
 - Pointer:
GREEN (hollow): normal operating range.
AMBER (solid): cautionary operating range.

STEERING

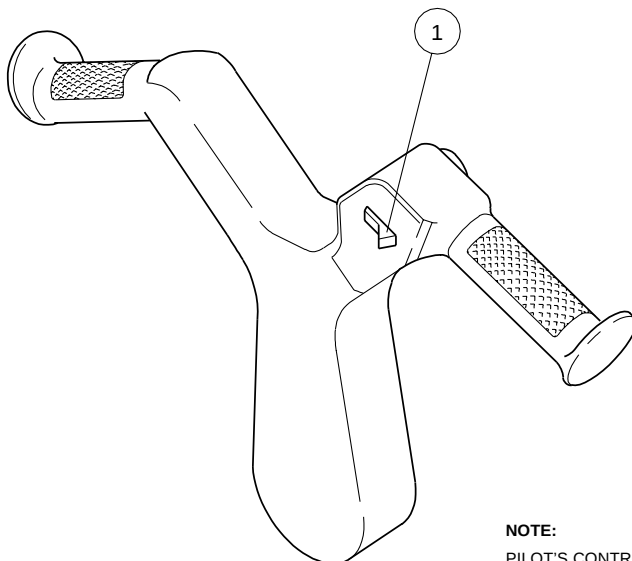
STEERING HANDLE



EM170ACM140178.DGN

- The handle must be pushed down (1) to engage the steering system. Releasing the handle will enable rudder pedals mode, keeping it pressed enables handwheel mode. Rotating the handwheel left or right (2) commands steering.

STEERING DISENGAGE SWITCH

**NOTE:**

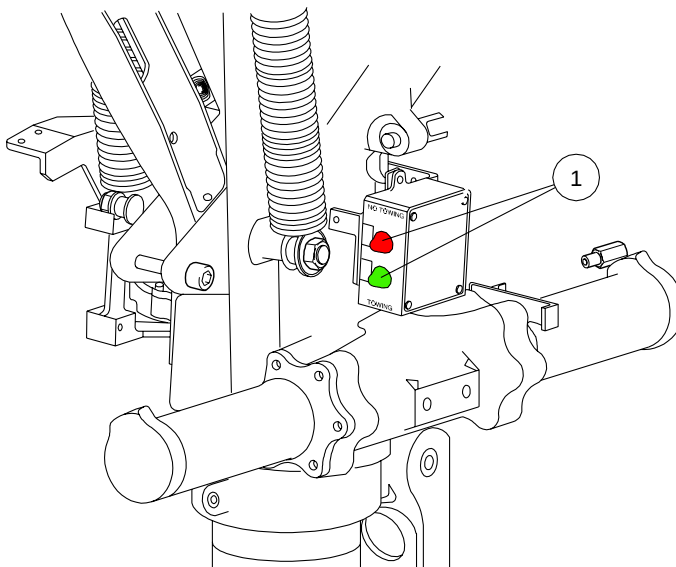
PILOT'S CONTROL WHEEL SHOWN,
VIEWED FROM BEHIND.

EM170AOM140179.DGN

1 - STEERING DISENGAGE SWITCH (MOMENTARY ACTION)

- Disengages the nosewheel steering system.

TOWING LIGHTS



EM170AOM140286.DGN

1 – TOWING LIGHTS

GREEN: Towing is allowed.

RED: Towing is not allowed.

Towing is allowed when:

- Steering is disengaged.
- Parking brakes are not applied.
- Main brakes are not applied.

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AIR/GROUND POSITIONING SYSTEM

The air/ground positioning system includes six weight-on-wheels (WOW) proximity sensors. Two are installed on each main landing gear and two on the nose landing gear.

Two proximity sensor electronic modules (PSEM) process signals from the main landing gear to determine whether the airplane is on ground or in flight.

Each PSEM monitors the six WOW proximity sensors. The inputs are logically combined by the PSEMs, and other airplane systems, to provide the overall airplane air/ground (WOW) indication to those systems.

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LANDING GEAR OPERATION

The LANDING GEAR LEVER, located on the cockpit main instrument panel, controls the normal landing gear operation. The gear lever has two positions:

- Up.
- Down.

DOWN/UP LOCK SENSORS

Each landing gear has two uplock sensors and two downlock sensors.

In the event of a discrepancy between both uplock or downlock sensors of the same landing gear, the sensor in agreement with the landing gear lever position will be considered valid.

LANDING GEAR RETRACTION

Positioning the landing gear lever to the UP position actuates landing gear retraction. Hydraulic pressure releases the nose and main landing gear locks and pressurizes the respective actuators to retract the landing gear.

Automatic wheel braking occurs during landing gear retraction. When retraction is completed, the landing gear is held in place by uplocks and all doors are closed.

The uplock proximity sensors give the uplock signal to the PSEM.

LANDING GEAR EXTENSION

There are three landing gear extension modes:

- Normal extension (electrically-controlled by the PSEM).
- Electrical override extension (electrically-controlled by the override switch).
- Alternate gear extension (mechanically-controlled, by the free-fall system).

NORMAL EXTENSION

Positioning the LANDING GEAR LEVER to the DOWN position actuates landing gear extension. Hydraulic pressure releases the nose and main landing gear uplocks, and extends the retraction actuators, thereby mechanically opening the landing gear doors.

When extension is completed, the landing gear are locked in the fully extended position by the downlock springs.

When the landing gear lever is set to the DOWN position, and the PSEM receive weight-on-wheels WOW logic signals indicating the airplane is on ground, the landing gear lever will be locked in the down position to prevent inadvertent movement to the UP position.

ELECTRICAL OVERRIDE EXTENSION

When the normal extension mode fails, the electrical override system is used to extend the landing gear. The electrical override system bypasses the PSEM, energizing the landing gear selector valve solenoid, and hydraulically releases the nose and main landing gear uplocks, and extends the retraction actuators. The landing gear doors are mechanically actuated.

ALTERNATE GEAR EXTENSION

The alternate gear extension is available in the event of failure of both the electronic and hydraulic system.

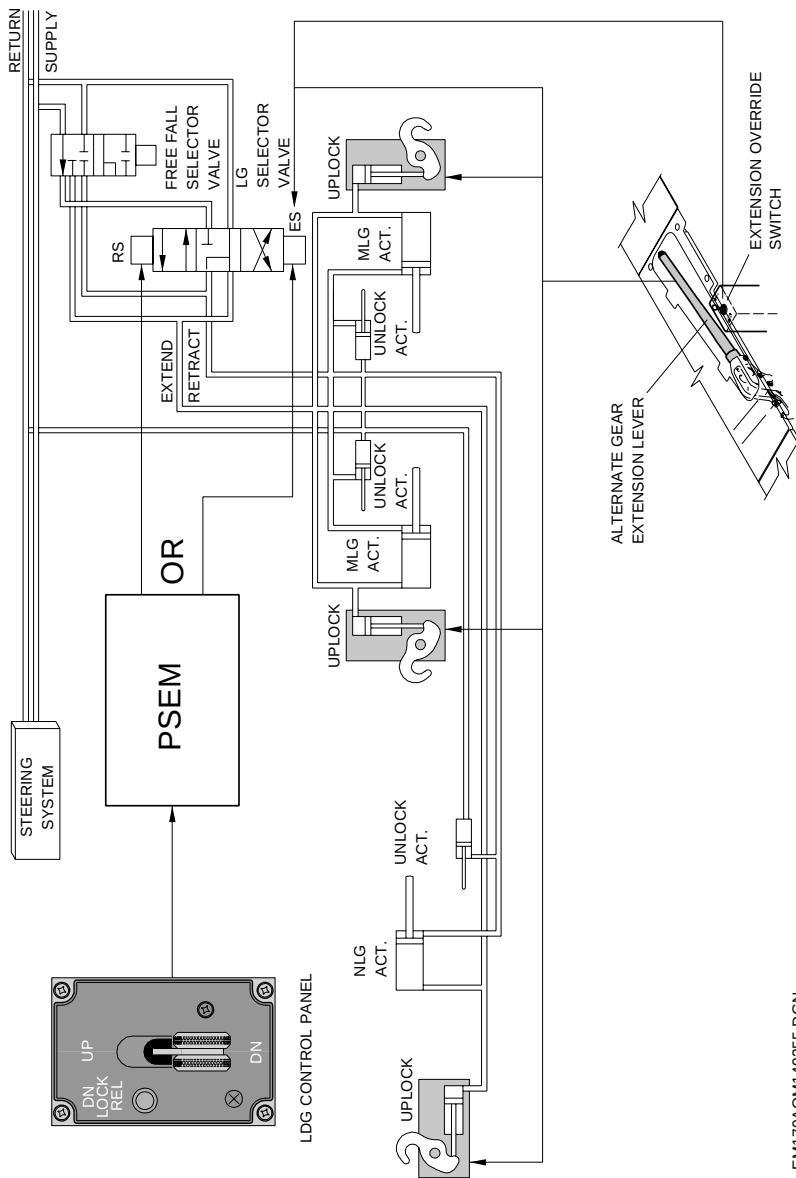
Pulling up the alternate gear lever:

- Activates the free-fall selector valve, releasing all residual hydraulic pressure in the landing gear lines.
- Mechanically releases all landing gear uplocks.

Gravitational and aerodynamic forces extend the landing gear. When alternate extension is completed, the landing gear is locked in the fully extended position by the downlock springs and three green DOWN indications in boxes are displayed on the EICAS, only after the landing gear lever has been moved to the DOWN position.

In the unlikely event that one main gear does not lock down, it may be necessary to slip the airplane using aerodynamic drag to lock the affected leg.

To restore normal landing gear hydraulic operation, the alternate gear extension lever must be stowed in the initial position.



LANDING GEAR OPERATION SCHEMATIC

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LANDING GEAR AURAL WARNING

A landing gear aural warning alerts the crew whenever any landing gear is not down and locked.

The aural warning "LANDING GEAR" is announced in the following situations:

FLAP LEVER IN ANY POSITION

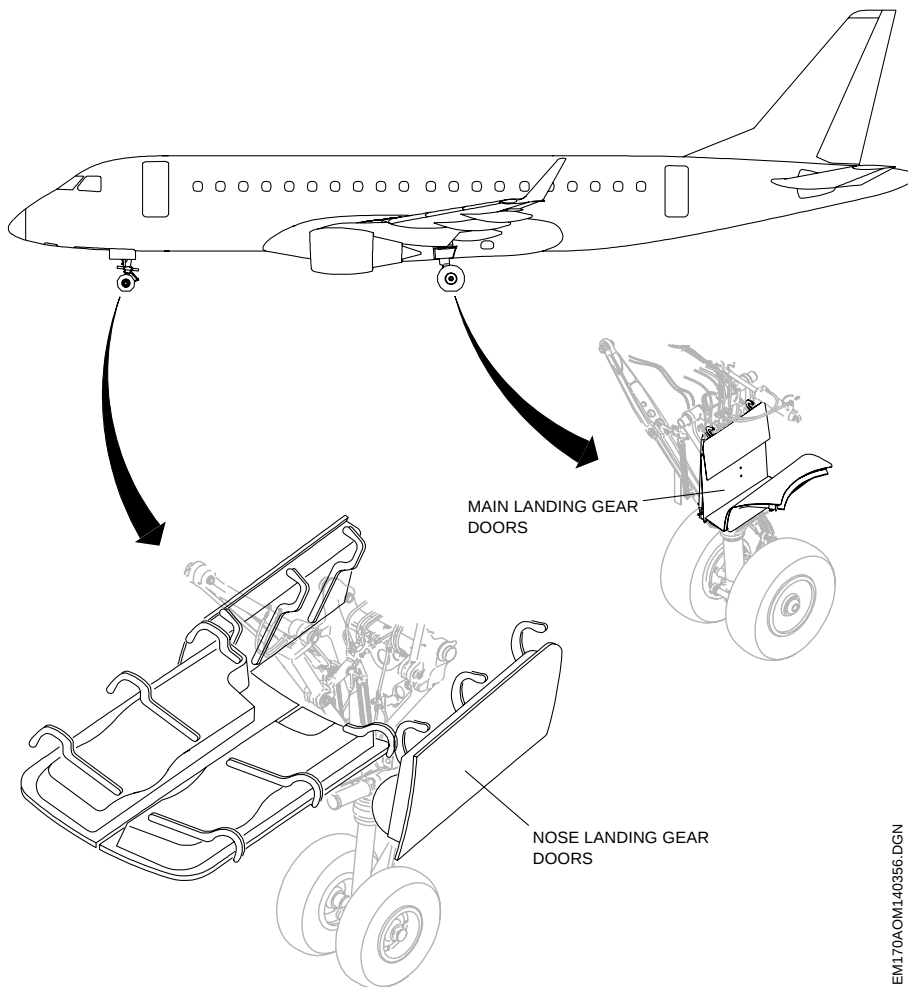
- Radio altitude below 700 ft AGL, and
- Either thrust lever is set below 45° for two operative engines, or
- Thrust lever is set below 59° for a one-engine inoperative condition. In these conditions, the landing gear aural warning cannot be silenced by pushing the landing gear warning inhibition button.

FLAP LEVER IN A LANDING POSITION (5 OR FULL)

- Regardless of thrust lever position and radio altitude, the landing gear aural warning cannot be silenced by pushing the landing gear warning inhibition button.

RADIO ALTIMETER FAIL

In the event of dual radio altimeter failure with flap lever in a position different from 5 or FULL, and either thrust lever is set below 45° (two operative engines) or the single thrust lever is set below 59° (one engine inoperative), the aural warning will be activated and can be silenced by pushing the landing gear warning inhibition button.



LANDING GEAR DOORS

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BRAKES

NORMAL BRAKE SYSTEM

The normal brake employs a brake-by-wire system controlled by either the Captain or First Officer via the rudder pedals. Hydraulic system 1 provides pressure to the outboard brakes and hydraulic system 2 provides pressure to the inboard brakes.

When both hydraulic systems fail, only the Emergency/Parking brake is available and must be used carefully to stop the airplane. The brake system includes:

- Locked wheel protection.
- Antiskid protection.
- Automatic wheel braking.
- Touchdown protection.
- Emergency/parking brake.
- Fusible plugs.
- Brake Wear Pins

The system has two brake control modules (BCM) and one optional auto brake control module (ABM).

- BCM 1 is connected to DC ESS BUS 1 and controls the outboard brakes.
- BCM 2 is connected to DC ESS BUS 2 and controls the inboard brakes.
- ABM is connected to DC BUS 2.

LOCKED WHEEL PROTECTION

Locked wheel protection prevents a main landing gear tire from bursting due to wheel locking.

The system logic compares wheel speed signals between the left and right inboard brakes or between the left and right outboard brakes. If the system measures that a wheel speed is 33% or less of its associated paired wheel speed, the brake control module detects a locked wheel condition and commands zero pressure to the brake of the slower wheel, allowing speed equalization.

When the faster wheel speed is below 30 knots, the locked wheel protection is deactivated.

The 33% tolerance between wheel speeds is provided to permit differential braking, for steering purposes.

ANTISKID PROTECTION

Anti skid protection prevents tire skidding and maximizes brake efficiency according to the runway surface.

The system controls the amount of hydraulic pressure applied to the brakes and, if necessary, reduces the wheel brake pressure in order to recover wheel speed and prevent tire skidding.

For wheel speeds below 10 kts, anti skid protection is deactivated, allowing the pilot to lock and pivot on a wheel.

Anti skid protection is not available for the emergency/parking brake system.

AUTOMATIC WHEEL BRAKING

Automatic wheel braking prevents the main landing gear from being retracted with the wheels spinning.

A dedicated device inside the nose landing gear bay stops the nose landing gear wheels from spinning.

TOUCHDOWN PROTECTION

Touchdown protection prevents the airplane from touching down with the main landing gear brakes applied, and is deactivated three seconds after WOW has sensed the ground or when wheel speed is above 50 kts.

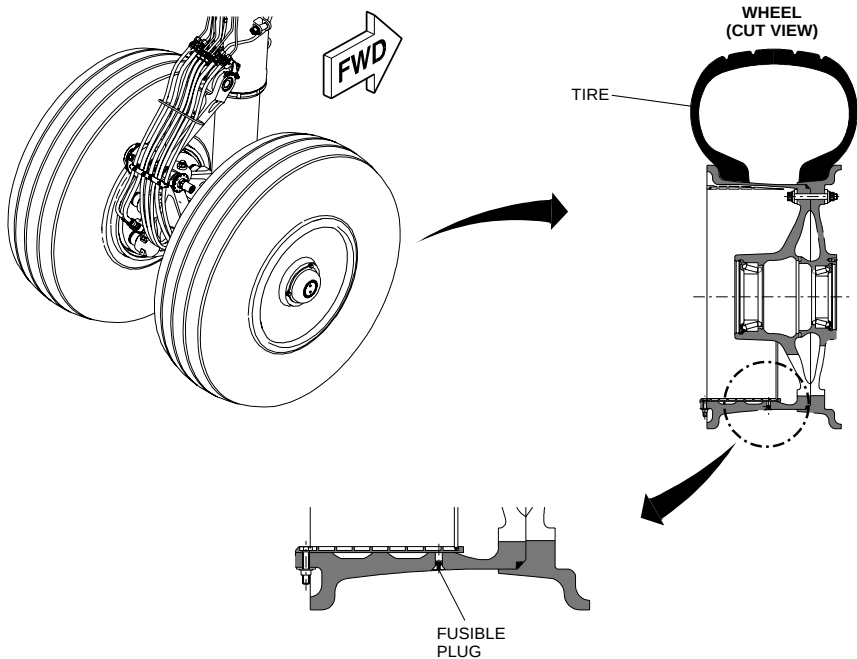
EMERGENCY/PARKING BRAKE

During normal operation, the emergency/parking brake is powered by hydraulic systems 1 and 2. The emergency/parking brake system has pressure accumulators isolated from the normal hydraulic supply by check valves. The accumulators have sufficient pressure to provide six full-brake applications.

The emergency/parking brake handle is set by pulling up, causing hydraulic pressure to activate the brakes.

FUSIBLE PLUGS

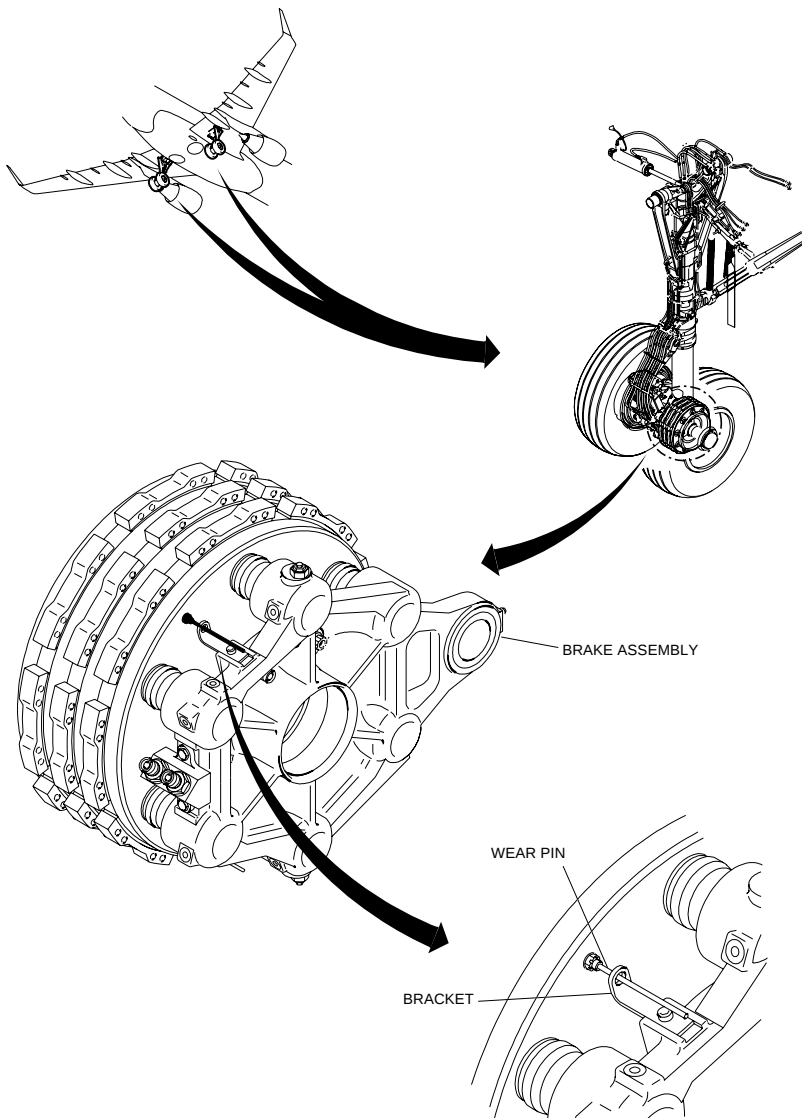
The fusible plugs are pins attached to the wheels, which melt relieving tire pressure in case of a tire overheat.



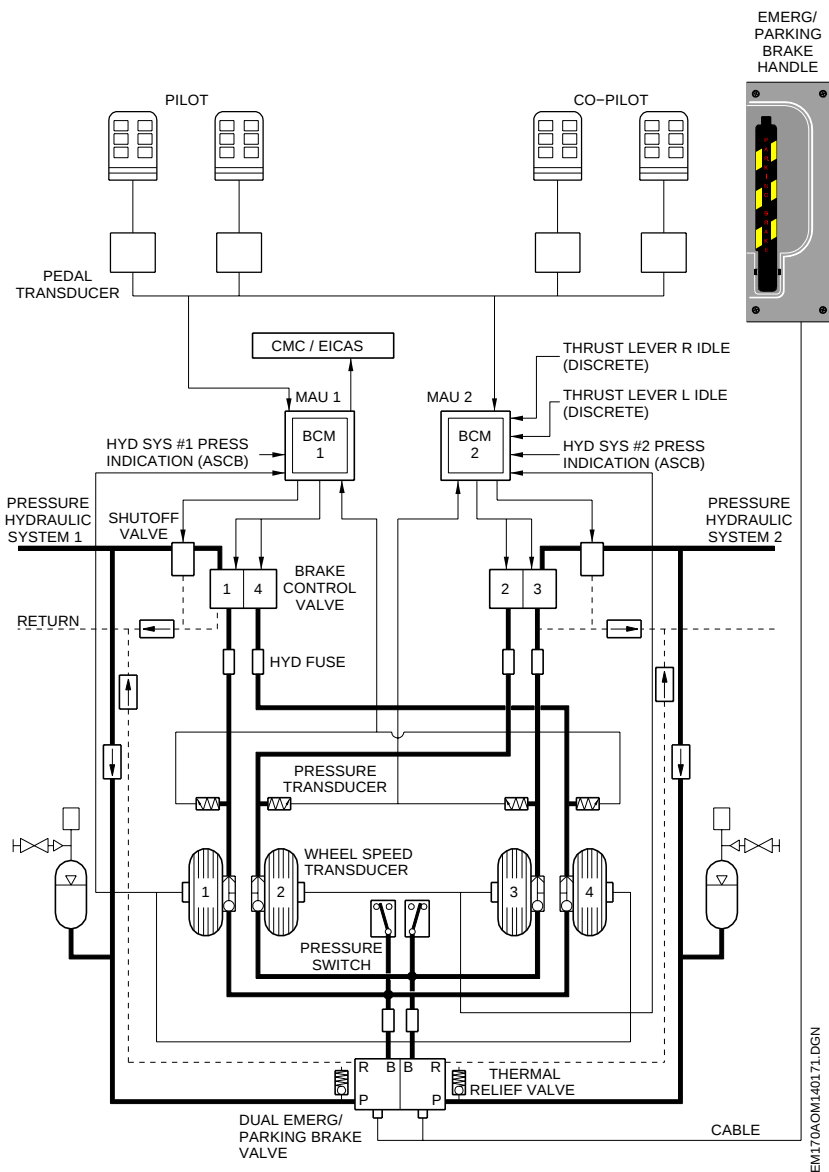
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BRAKE WEAR PINS

During brake operations, Brake Wear Pins are consumed and, when they flush with Brake Bracket Outer Face assembly, indicate brakes need replacement.



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BRAKE SYSTEM SCHEMATIC

AUTOBRAKE (if installed)

The autobrake system provides automatic braking at maximum deceleration rates, which may vary according to runway conditions, for landings and rejected takeoffs. The system modulates hydraulic pressure to the brakes in order to provide a constant deceleration rate corresponding to the level selected. If reverse thrust is actuated, the autobrake system will modulate the brake pressure to maintain the deceleration rate constant.

The autobrake system can only be armed if the normal brake system is functioning. Anti skid, touchdown and locked wheel protections are provided during autobrake operation.

Four autobrake levels of deceleration (RTO, LO, MED, HI) are available via a selector knob on the cockpit main instrument panel.

There are two modes of autobrake control:

- Landing mode (LO, MED, HI).
- Rejected take-off mode (RTO).

NOTE: RTO is the selected takeoff mode with the maximum deceleration rate. This deceleration is equivalent to the maximum manual braking.

The selector knob will always return automatically to the OFF position if the mode is armed and any of the disarming conditions are met.

AUTOBRAKE LANDING AND RTO MODE

Autobrake will be armed if the following conditions are met:

	LANDING MODE	REJECTED TAKEOFF MODE
Selector Knob Position	LO, MED or HI	RTO
WOW Indication	In flight	On the ground
Wheel Speed	Below 60 knots	
Brake Control System	No faults	
Brake Pedal Position	Not pressed	Any
Thrust Levers Position	Any	Idle or below

Autobrake will be applied if the following conditions are met:

	LANDING MODE	REJECTED TAKEOFF MODE
Condition	ARMED	
Selector Knob Position	LO, MED or HI	RTO
WOW Indication	On the ground	
Wheel Speed	Above 60 knots	
Brake Control System	No faults	
Brake Pedal Position	Not pressed	
Thrust Levers Position	Idle or below	

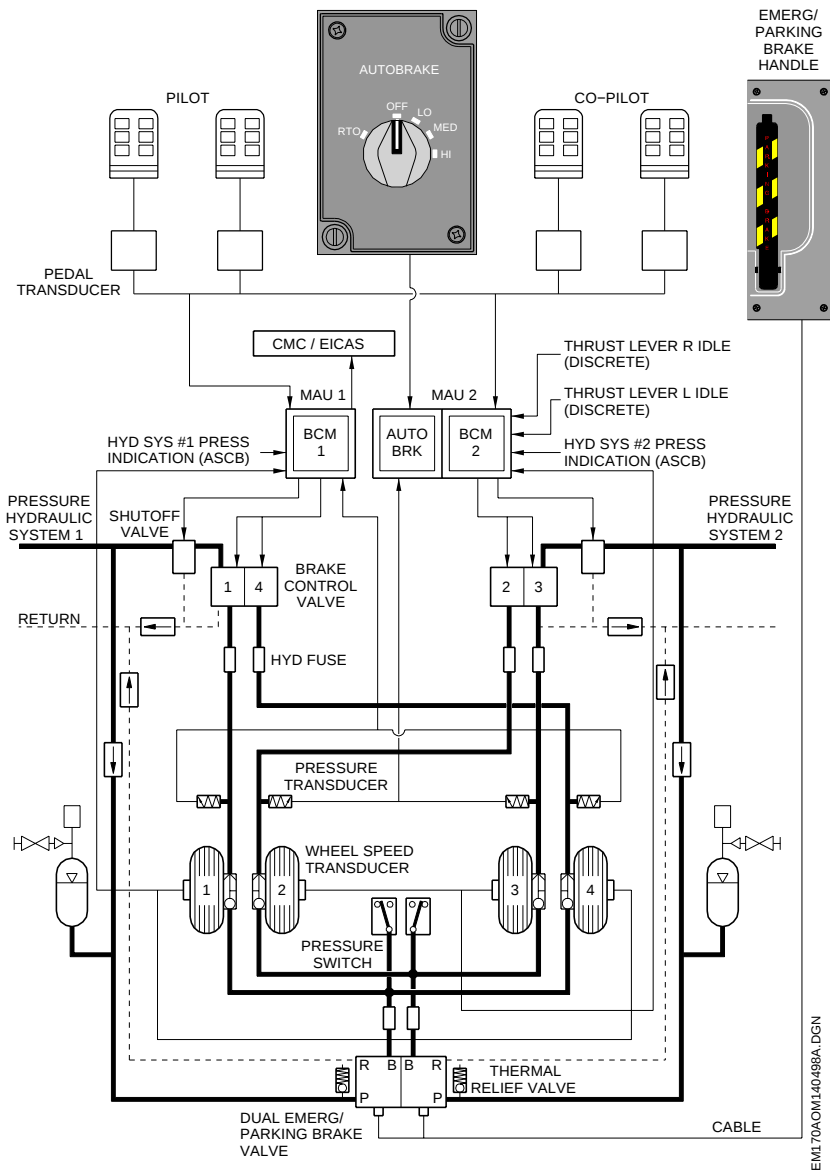
Landing and RTO modes will be disarmed if one of the following conditions occurs:

- The selector switch is set to the OFF position.
- Pedal braking is applied (while wheel speed is above 60 knots if RTO is selected).
- Brake control system failure is detected (while wheel speed is below 60 knots if RTO is selected).
- Either thrust lever is advanced beyond idle during autobrake application.

Autobrake will be disarmed if the following conditions are met:

	LANDING MODE	REJECTED TAKEOFF MODE
Selector Knob Position	OFF or RTO	OFF, LO, MED or HI
WOW Indication	-	In flight
Brake Control System	Faults detected	Faults detected below 60 knots of Wheel Speed
Brake Pedal Position	Pressed	Pressed while Autobrake is being applied
Thrust Levers Position	Above Idle while Autobrake is being applied	

The aural message "AUTOBRAKE" is activated when "armed" condition (LO, MED, HI or RTO) is changed to "disarmed" by autobrake module (ABM) or brake control module (BCM) failure during parking, taxiing, takeoff roll or landing.



BRAKE SYSTEM SCHEMATIC

NOSEWHEEL STEERING SYSTEM

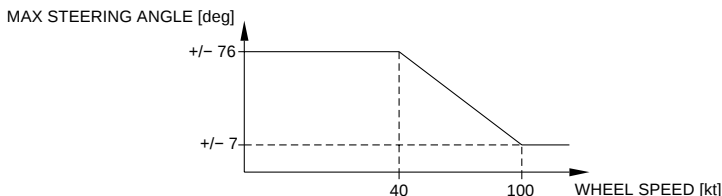
The aircraft nose landing gear has steer-by-wire control powered by hydraulic system 2. Primary steering control is provided by a steering handwheel. Limited steering control is available via the rudder pedals. A free wheel steering mode is also possible, which permits towing operations as well as greater steering angles.

HANDWHEEL STEERING MODE

The handwheel steering mode is used for low speed control. To engage or re-engage the system, the handwheel has to be pressed. Releasing the handwheel will activate the rudder pedal steering mode.

During taxiing, an extended steering range is usually desired, and is provided via the pilot's steering handwheel. Activation of the steering handwheel disengages pedal steering. To transfer the steering from the pedals to the handwheel, steering handle must be kept pressed.

Steering angle varies with wheel speed. The angle is $\pm 76^\circ$ until 40 knots and decreases linearly from $\pm 76^\circ$ at 40 knots to $\pm 7^\circ$ at 100 knots.



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MAXIMUM STEERING ANGLE

RUDDER PEDAL STEERING MODE

The rudder pedal steering mode is used for high speed control. It is activated by pressing and releasing the steering handle. Left/Right seat rudder pedals provide steering command of the airplane via the combination of nose landing gear and rudder deflection.

The maximum allowed steering angle of the rudder pedal steering is +/- 77 d

FREE WHEEL STEERING MODE

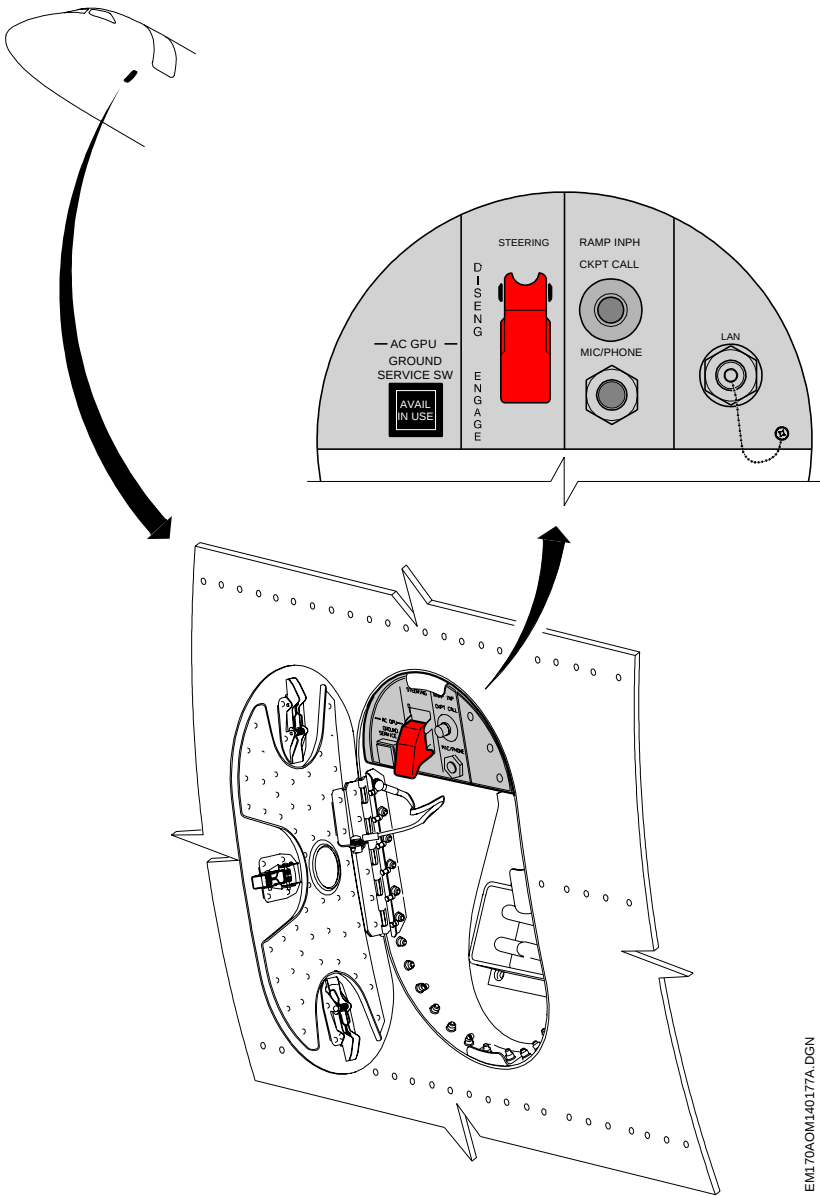
The free wheel steering is used for ground handling. The steer responds to towing and differential braking.

A steering disengage button located on both control wheels allows switching into free wheel steering. In the forward fuselage another disengage button is available for maintenance personnel to activate free wheel steering before performing towing or maintenance.

In the event of a system failure is detected and the free wheel mode is automatically selected, steering can be carried out by use of rudder or differential brake.

The free wheel mode is automatically selected when:

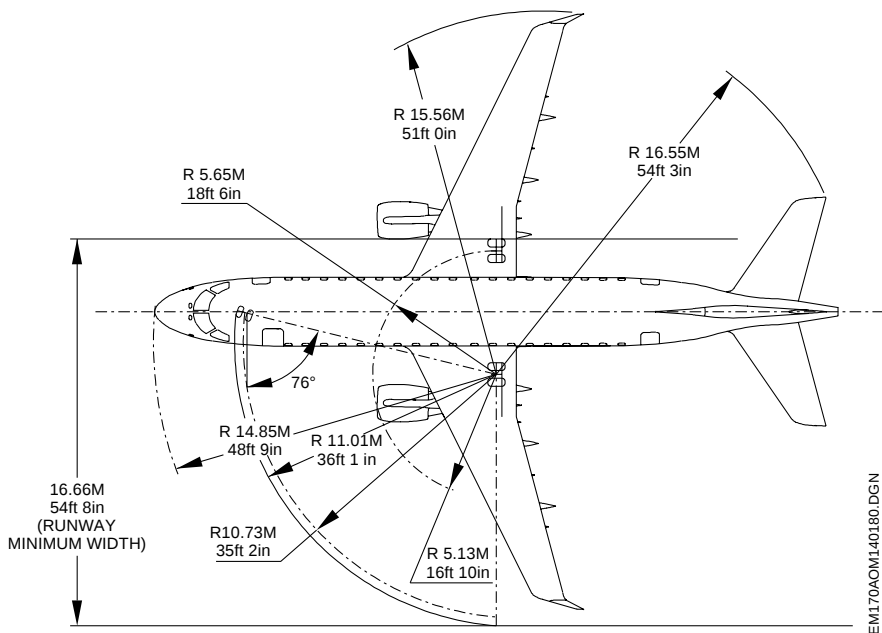
- Air/ground system indicating failure is detected.
- Steering angle is greater than 76°.
- Steering system failure is detected.



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EXTERNAL STEERING DISENGAGEMENT SWITCH

EMBRAER-170 MINIMUM TURNING RADII



EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	LG LEVER DISAG	A discrepancy between the position of the landing gear control lever and at least one landing gear is detected.
CAUTION	AUTOBRAKE FAIL	Autobrake function is no longer available.
	BRK OVERHEAT	Brake temperature has exceeded the normal operating range.
	BRK LH (RH) FAIL	Loss of both wheel brakes (inboard and outboard) of either the left or right landing gear.
	EMER BRK FAIL	Both brake accumulator pressures are low and low pressure of hydraulic systems 1 and 2 is detected.
	LG NO DISPATCH	Landing gear dispatchability is affected.
	LG NOSE DOOR OPEN	Nose landing gear is locked up and nose landing gear door is open.
	LG WOW SYS FAIL	Indicates a failure condition in the WOW indication system.
	STEER FAIL	Indicates a steering system failure condition when the landing gear is down.
ADVISORY	BRK CONTROL FAULT	At least one pressure transducer has failed. Associated wheel operates with degraded braking capability
	BRK LH (RH) FAULT	Loss of one wheel brake (inboard or outboard) of either the left or right landing gear.
	BRK PEDL LH (RH) SEAT FAIL	One pedal of the left or right hand seat has failed.
	EMER BRK FAULT	Pressure on one brake accumulator is low or the inboard and outboard park brake pressures are in disagreement.
	LG TEMP EXCEEDANCE	Indicates non-dispatch condition related to the landing gear after a brake overheat.
	STEER FAULT	Steering system is degraded.
STATUS	STEER OFF	Steering is disconnected.

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ATA CHAPTER 33

LIGHTS

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INTRODUCTION

Lighting system provides lighting to all essential parts located inside and outside of the fuselage to assure a proper and safe operation of the airplane.

The lighting system includes:

- External Lights.
- Cockpit Lights.
- Passenger Cabin Lights.
- Emergency lighting.

The system also provides lighting for baggage and service compartment.

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INTERNAL LIGHTING

COCKPIT LIGHTING

Cockpit lighting consists of:

- Chart lights.
- Dome lights.
- Fluorescent flood/storm light.
- Reading lights.

The system provides lighting for instruments, control panels and buttons.

CHART LIGHTS

Provide variable intensity lights to illuminate chart holders located at the cockpit side windows.

DOME LIGHTS

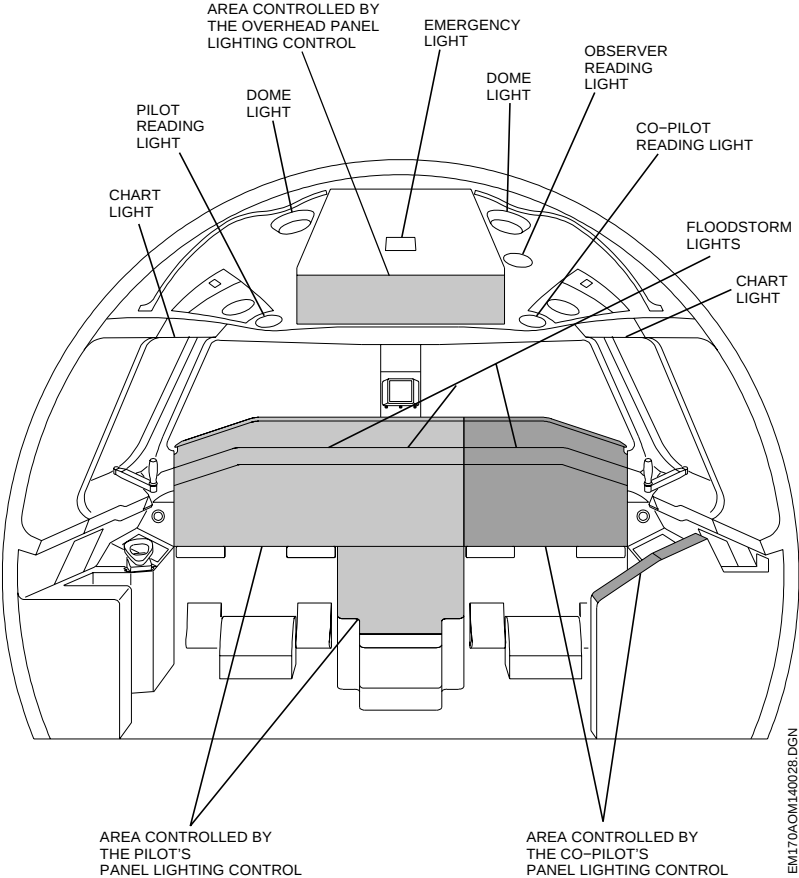
Provide fixed intensity cockpit illumination above Captain and First Officer's seats.

FLUORESCENT FLOOD/STORM LIGHT

Provide high quality illumination to ensure panel readability under high intensity ambient lighting (lightning).

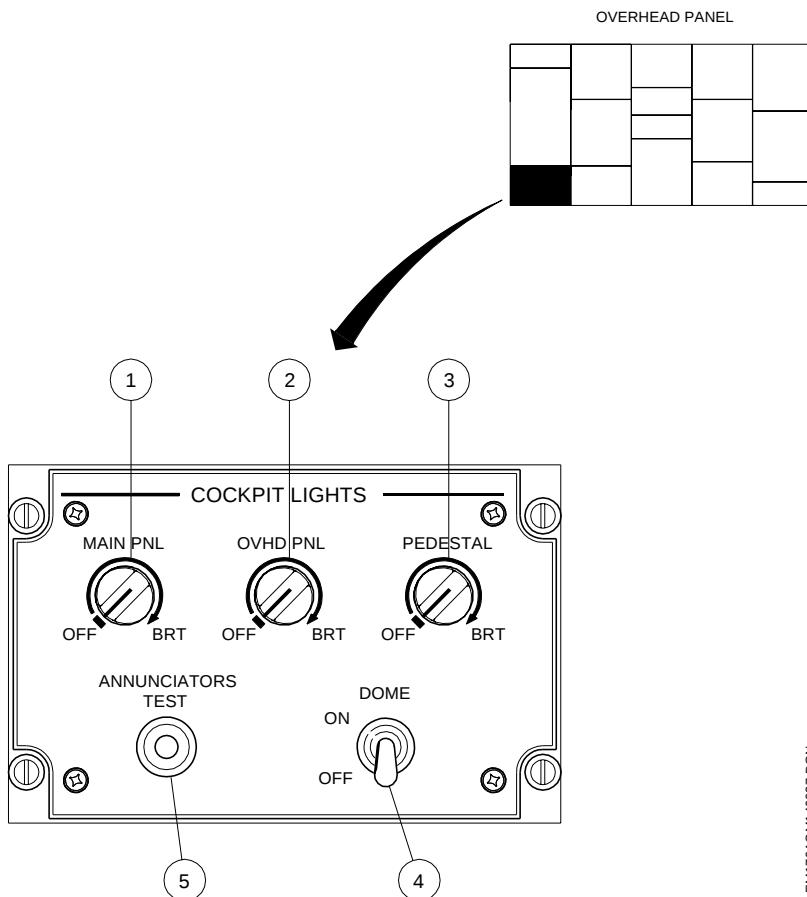
READING LIGHTS

Provide illumination to help the pilots read maps, check lists and manuals.



COCKPIT LIGHTS

COCKPIT LIGHTS CONTROL PANEL



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COCKPIT LIGHTS CONTROL PANEL

1 – MAIN PANEL KNOB

- Turns on/off and regulates the lighting brightness of the main panel.

2 – OVERHEAD PANEL KNOB

- Turns on/off and regulates the brightness of the overhead panel's integral lighting.

3 – PEDESTAL KNOB

- Turns on/off and regulates pedestal lighting brightness.

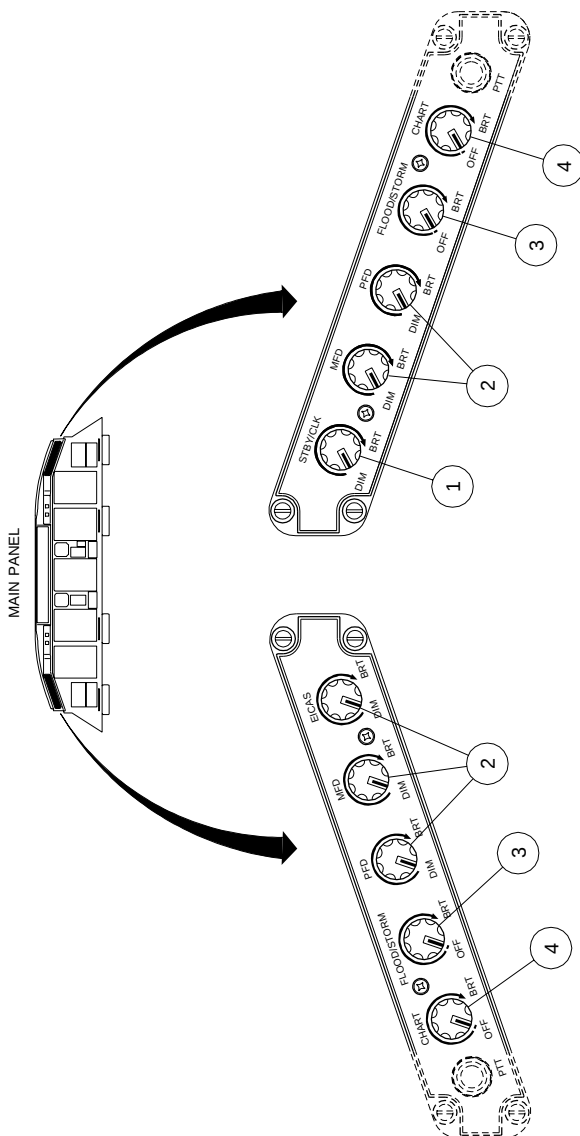
4 – DOME LIGHT SWITCH

- Turns on/off the two cockpit dome lights.

5 – ANNUNCIATORS TEST BUTTON

- When actuated to the TEST position (momentary position) allows checking of the striped bars and caption indications in all pushbuttons located on the main panel, overhead panel, control pedestal, allowing verification of lamp integrity.

GLARESHIELD LIGHTS CONTROL PANEL



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1 – STANDBY/CLOCK CONTROL KNOB

- Regulates the brightness of the standby/clock lighting.

2 – DISPLAY LIGHTING CONTROL KNOB

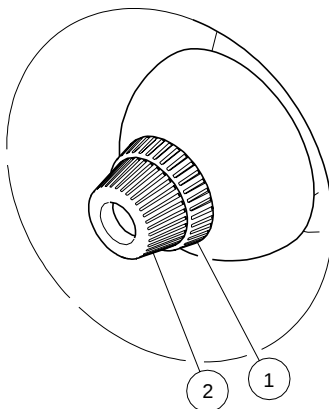
- Regulates the brightness of the associated electronic display.

3 – FLOOD/STORM LIGHTS CONTROL KNOB

- Turns on/off and regulates the brightness of the flood/storm panel lighting.
- Provides maximum brightness for storm conditions at BRT position.

4 – CHART HOLDER LIGHTING CONTROL KNOB

- Turns on/off and regulates the brightness of associated chart holder lighting.

FLIGHT CREW READING LIGHTS

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1 – OUTER RING

- Turn on/off and provides dimming control.

2 – INNER RING

- Adjusts aperture size of light pattern.

PASSENGER CABIN

PASSENGER CABIN LIGHTS

A general passenger cabin illumination, reading lights in the passenger service unit, lavatory lights, galley lights and cabin signs make up the passenger cabin lighting.

passenger cabin signs

Passenger cabin signs provide passengers and flight attendants with signs like:

- NO SMOKING.
- FASTEN SEAT BELTS.
- RETURN TO SEAT.
- LAVATORY OCCUPIED.

The signs are available on every passenger service unit (PSU). An aural signal sounds whenever any passenger sign is turned on or off by the crew. NO SMOKING and FASTEN SEAT BELTS signs are also activated when the oxygen dispensing units are open.

STERILE LIGHTS

Amber sterile light located in the passenger cabin rainbow light indicates that sterile operation is in progress.

COURTESY AND STAIRS LIGHTS

Provide lighting for safe boarding of crewmembers and passengers. Courtesy and stair lights consist of the main door light (entry area), service door light (galley area), stairway lights and cockpit step light.

SERVICE COMPARTMENT LIGHTS

Provide lighting in the service compartments for quick inspection and accomplishment of several tasks. Service lights are installed in the refueling panel, mid and forward electronic bays, APU, tail cone and rear hydraulic compartment.

The lights are controlled by door micro-switch or dedicated standard switches installed in each compartment, which turn on the associated light when the access door is open.

ATTENDANT LIGHTS (RAINBOW LIGHTS)

The attendant lights located on the forward and aft main ceiling panel areas provide a visual indication to attendants when there is a call from the flight crew or passengers. These lights are also called “rainbow lights”.

The passenger call indicator lights consist of orange color indicator for a lavatory call, blue colored for a passenger call in the main cabin area, amber colored for a sterile light call, red colored for a pilot emergency call, and green colored for a pilot’s call.

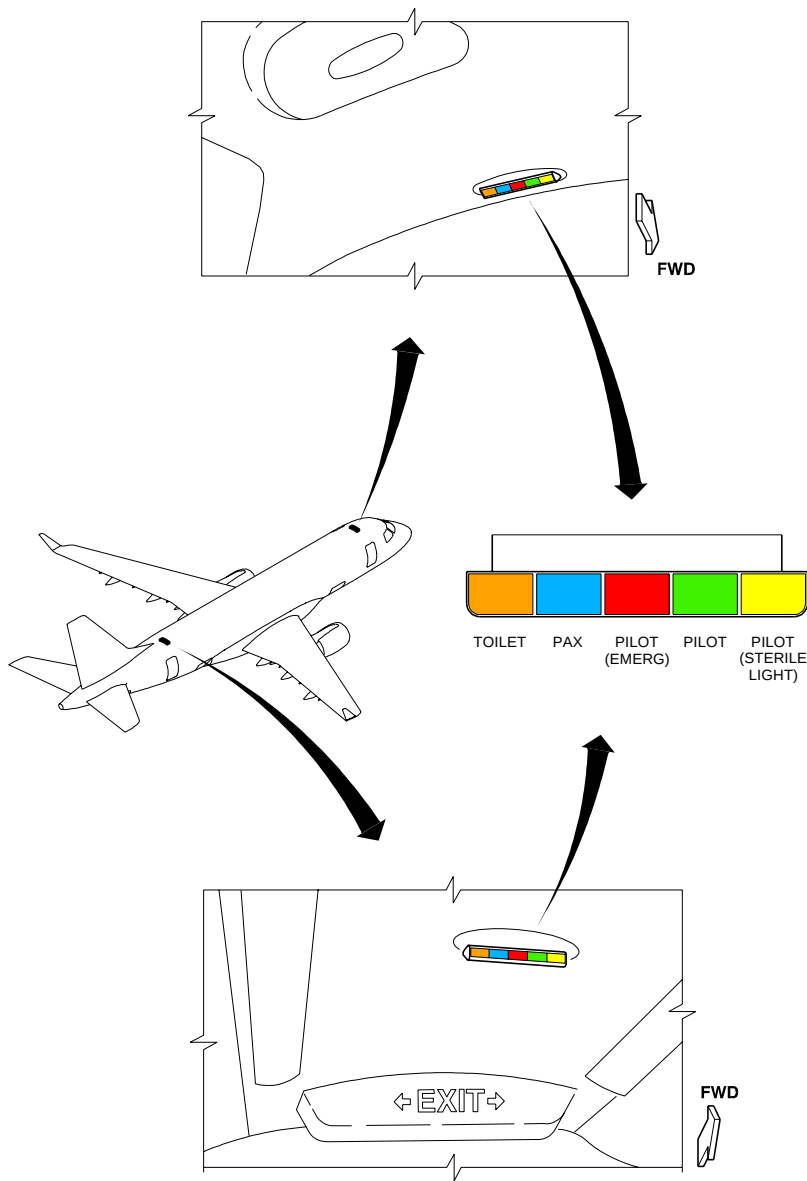
The red indicator illuminates when the pilot makes an emergency call to the flight attendant from the cockpit.

The green indicator illuminates when the pilot calls the flight attendant from the cockpit.

An audible tone is sounded by the passenger address system whenever a passenger presses any attendant call switch located in a PSU or the attendant call switch in the lavatory or pilot call switches.

CALL SYSTEM TABLE

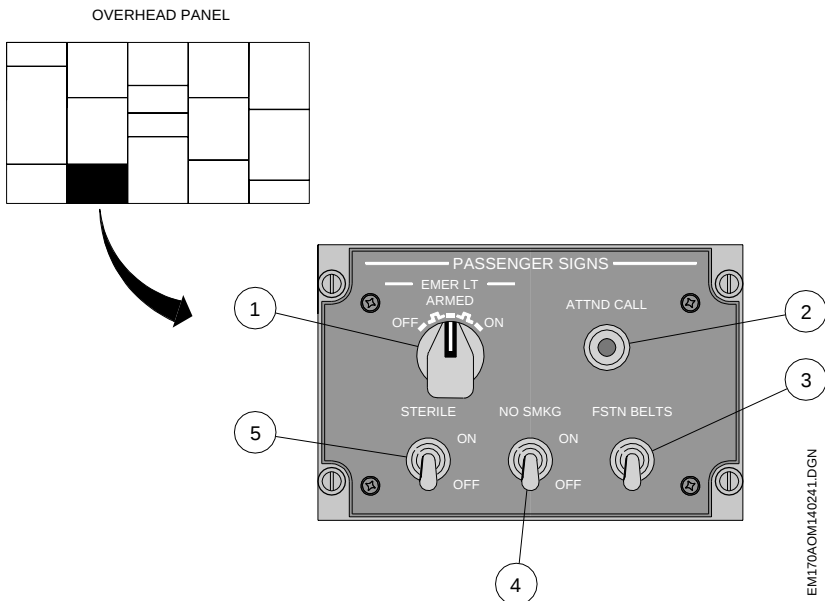
VISUAL INDICATION	AURAL INDICATION	FROM	TO
ORANGE light.	Single hi tone chime.	Respective lavatory call	Attendant station
Flashing ORANGE light	Lavatory fire protection alarm	Respective lavatory smoke detection	Attendant station
BLUE	Single hi tone chime.	Passenger PSU	Attendant station
Flashing RED light.	Triple hi/lo tone chime.	Cockpit	Attendant Station
GREEN light.	Single hi/lo tone chime.	Cockpit	Attendant Station
AMBER sterile cockpit light.	Single hi tone chime.	Cockpit	Attendant station
No smoking or fasten belt signs illuminate/ extinguish.	Single lo tone chime.	Cockpit	Passenger cabin, lavatories and galleys



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ATTENDANT LIGHTS (RAINBOW LIGHTS)

PASSENGER SIGNS CONTROL PANEL



1 – EMERGENCY LIGHT SELECTOR KNOB

OFF: Prevents all emergency lights from illuminating if airplane electrical power is turned off or fails.

ARMED: Automatically illuminates all emergency lights if DC buses lose electrical power or if airplane electrical power is turned off.

ON: Turns on all emergency lights.

2 – ATTENDANT CALL BUTTON

- Pressing this button sounds a single hi/lo tone chime in passenger cabin.

3 – FASTEN SEAT BELTS TOGGLE SWITCH

ON: illuminates the FASTEN SEAT BELTS signs.

OFF: turns off the FASTEN SEAT BELTS signs.

4 – NO SMOKING TOGGLE SWITCH

ON: illuminates the NO SMOKING signs.

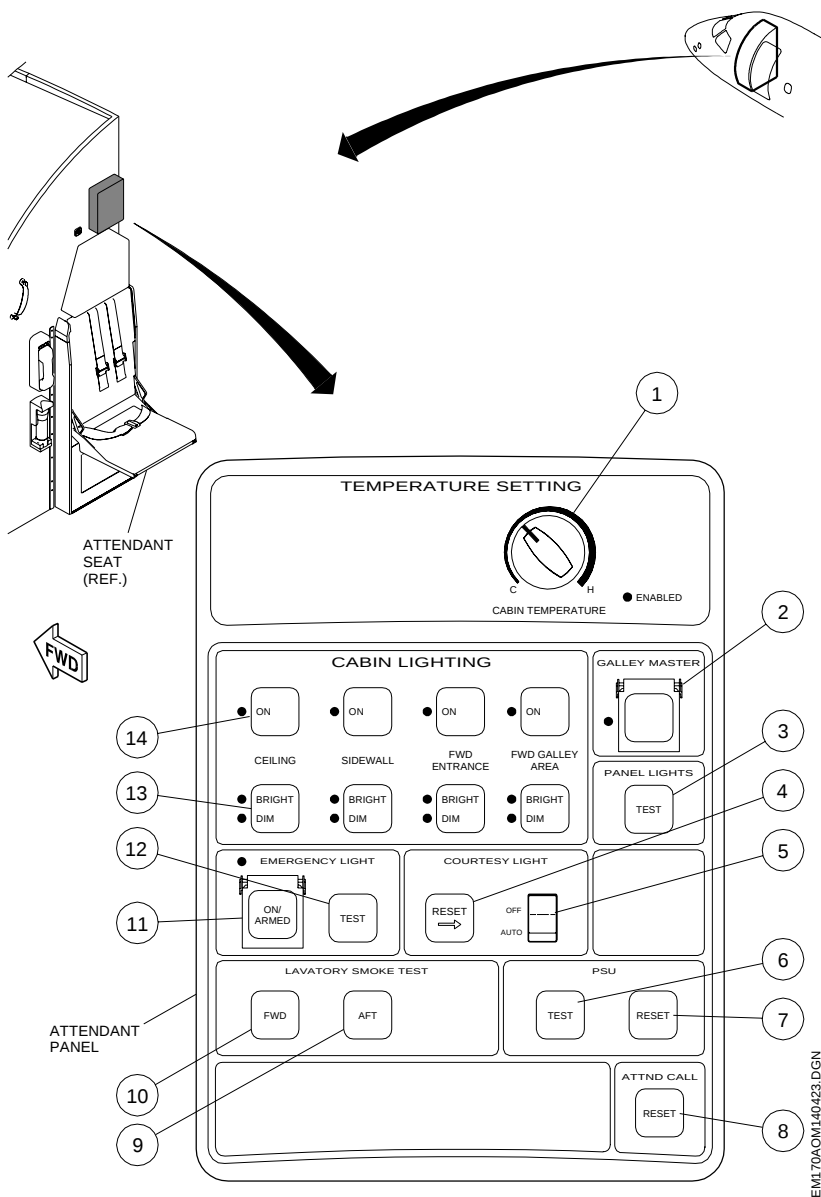
OFF: turns off the NO SMOKING signs.

5 – STERILE TOGGLE SWITCH

ON: illuminates the sterile lights located in the rainbow lights.

OFF: turns off the sterile lights located in the rainbow lights.

FORWARD ATTENDANT CONTROL PANEL



1 – CABIN TEMPERATURE CONTROL

- Controls cabin temperature.
- The “ENABLED” led turns on to indicate the knob controls the cabin temperature. The led turns on only if the Passenger Cabin Temperature Rotating Knob in the cockpit is set to ATTND position (Refer to Section 14-02 – AMS).

2 – GALLEY MASTER SWITCH (GUARDED)

- Turns off all galleys. (AC power of)

3 – PANEL LIGHTS TEST SWITCH

- Provides a test in the attendant panel lights.

4 – COURTESY LIGHT RESET SWITCH

- Turns on all courtesy lights for a 5-minutes period.

5 – COURTESY LIGHT SWITCH

AUTO: turns on or off the courtesy lights according to passenger door position (OPEN or CLOSED).

OFF: turns off the courtesy lights regardless of passenger door position.

6 – PSU TEST SWITCH

- Allows the testing of the following lights:
 - flight attendant reading lights.
 - passenger reading lights.
 - lavatory dome light.
 - lavatory fluorescent light (from DIM to BRT mode).
 - attendant call indicator lights.
 - lavatory occupied signs.

7 – PSU RESET SWITCH

- Turns off the lights previously turned on by the PSU test switch.

8 – ATTND CALL RESET SWITCH

- Turns off the attendant call indicator lights, zonal lights and PSU switch lights, previously turned on due to an attendant call.

9 – AFT LAVATORY SMOKE TEST SWITCH

- Provides a smoke test in the aft lavatory.

10 – FWD LAVATORY SMOKE TEST SWITCH

- Provides a smoke test in the forward lavatory.

11 – EMERGENCY LIGHT ON/ARMED SWITCH (GUARDED)

ON: turns on all emergency lights.

ARMED: automatically illuminates all emergency lights in case of DC bus electrical power loss or if airplane electrical power is turned off.

12 – EMERGENCY LIGHT TEST SWITCH

- Provides a one-minute test of all passenger cabin emergency lights.

13 – CABIN LIGHTING BRIGHT/DIM SWITCH

Momentary press.

BRIGHT: sets the lights of the respective area to full brightness.

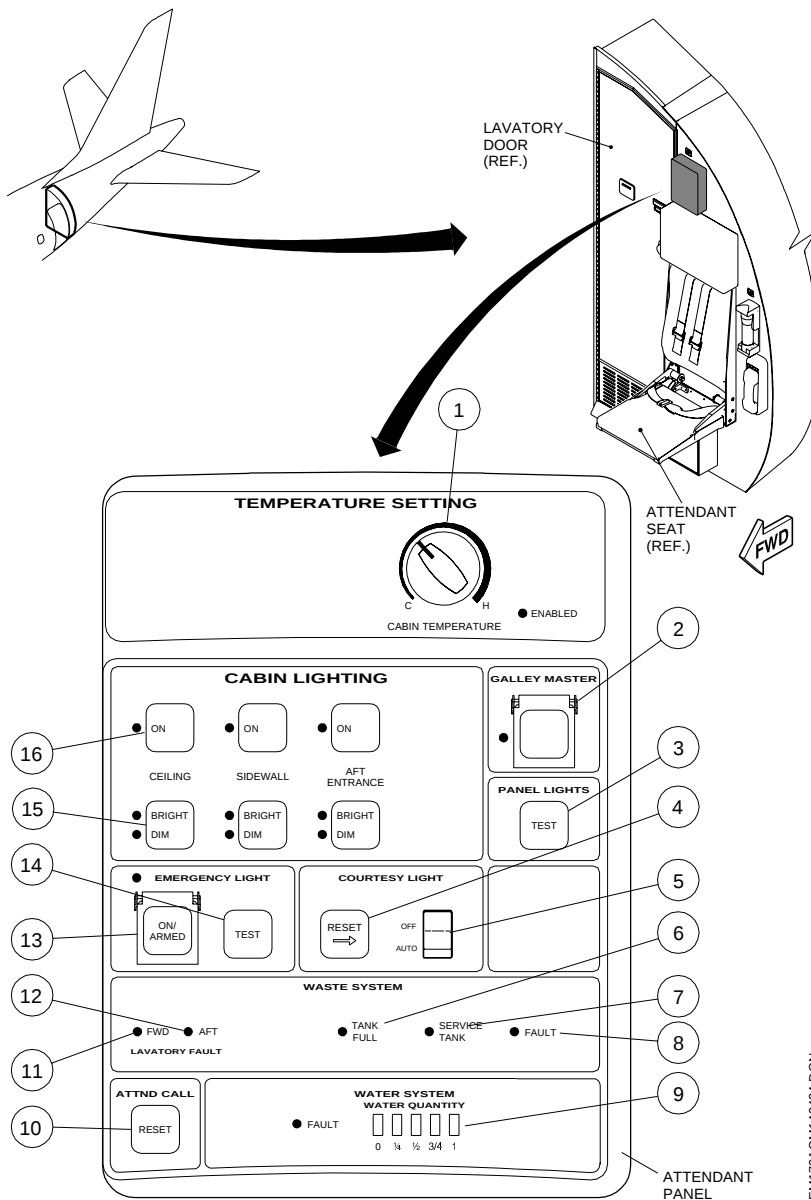
DIM: reduces lights of the respective area brightness.

14 – CABIN LIGHTING ON SWITCH

Momentary press.

- Turns on and off the respective cabin light.

AFT ATTENDANT CONTROL PANEL



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1 – CABIN TEMPERATURE CONTROL

- Controls cabin temperature.
- The “ENABLED” led turns on to indicate the knob controls the cabin temperature. The led turns on when the Passenger Cabin Temperature Rotating Knob in the cockpit is set to ATTND position (Refer to Section 14-02 – AMS).
- Available only for airplanes with dual cabin temperature control.

2 – GALLEY MASTER SWITCH (GUARDED)

- Turns off all galleys (AC power off).

3 – PANEL LIGHTS TEST SWITCH

- Provides a test of the attendant panel lights.

4 – COURTESY LIGHT RESET SWITCH

- Turns on all courtesy lights for a 5-minutes period.

5 – COURTESY LIGHT SWITCH

AUTO: turns on or off the courtesy lights according to passenger door position (OPEN or CLOSED).

OFF: turns off the courtesy lights despite of passenger door position.

6 – TANK FULL INDICATION

- Illuminates to indicate that the waste tank has reached 100% of its capacity.

7 – SERVICE TANK INDICATION

- Illuminates to indicate that the waste tank has reached 75% of its capacity.

8 – FAULT INDICATION

- Illuminates to indicate that a fault in the waste system has been detected.

9 – WATER TANK CAPACITY AND FAULT INDICATION

- Indicates the water tank capacity. The fault light indicates one of the following condition:
 - A fault in the respective (FWD or AFT) drain valve is detected.
 - Water level indication is not available.
 - In-flight drainage is not available due to a fault in the drain valve or in the drain mast heater.

10 – ATTND CALL RESET SWITCH

- Turns off the attendant call indicator lights, zonal lights and PSU switch lights, previously turned on due to an attendant call.

11 – FORWARD LAVATORY FAULT INDICATION

- Illuminates to indicate that the forward lavatory is out of order.

12 – AFT LAVATORY FAULT INDICATION

- Illuminates to indicate that the aft lavatory is out of order.

13 – EMERGENCY LIGHT ON/ARMED SWITCH (GUARDED)

ON: turns on all emergency lights.

ARMED: automatically illuminates all emergency lights in case of DC bus electrical power loss or if airplane electrical power is turned off.

14 – EMERGENCY LIGHT TEST SWITCH

- Provides a one-minute test of all passenger cabin emergency lights.

15 – CABIN LIGHTING BRIGHT/DIM SWITCH

Momentary press.

BRIGHT: sets the lights of the respective area to full brightness.

DIM: reduces light brightness of the respective area.

16 – CABIN LIGHTING SWITCH

- Turns on and off the respective cabin light.

EXTERNAL LIGHTING

The external lights necessary for a proper and safe operation of the airplane are:

- Landing and taxi lights.
- Navigation and anti-collision lights.
- Wing inspection and logotype lights.

LANDING AND TAXI LIGHTS

Landing and taxi lights are fitted to each wing roots behind glazed covers. A third landing light and a third taxi light are mounted on the nose gear structure.

The landing light units provide adequate lighting during final approach, flare out and takeoff. The taxi light provides sufficient intensity and beam spread to aid pilots during all taxi operation phases, covering the runway and adjacent areas.

Different switches for nose and root landing and taxi lights are located at the overhead panel.

NAVIGATION AND ANTI COLLISION LIGHTS

The navigation lights, red on the left and green on the right and white on both wings, are fitted on each wing tip. A switch located at the overhead panel controls the navigation lights.

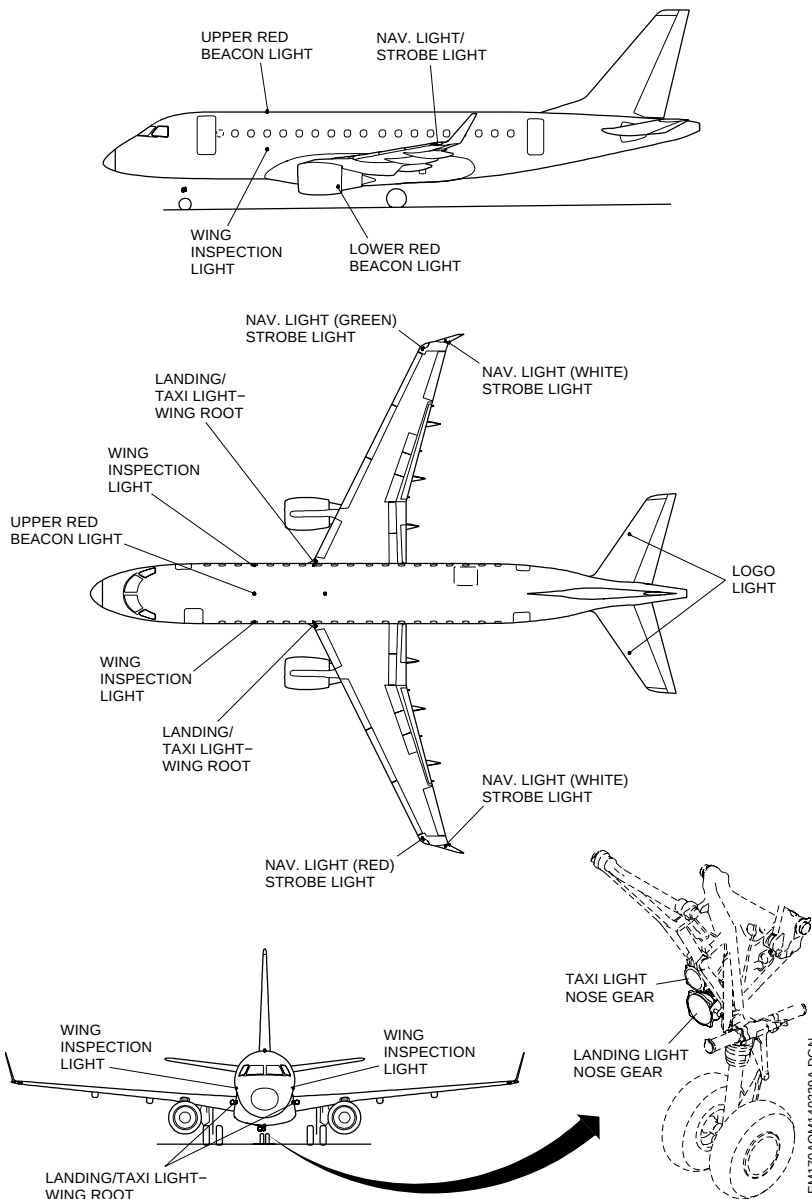
The anti-collision lights two white strobe lights per wing tip and two red beacon lights mounted on the upper and lower fuselage provide illumination for visual recognition and collision avoidance during all flight/taxi operations. Two different switches, one for strobe lights and another for the red beacon lights are located at the overhead panel.

Each navigation light assembly is composed of two lamps while the strobe light assembly is composed of only one lamp. Normally only one navigation lamp is on, while the second lamp is on standby. In case of failure, maintenance personnel through a maintenance panel in the cockpit manually switch navigation lights.

WING INSPECTION AND LOGOTYPE LIGHTS

Provide proper illumination of the engine intake and of the wing leading edges of the wings for Captain and crew to inspect for ice formation. A switch located at the overhead panel controls the engine and wing illumination light system.

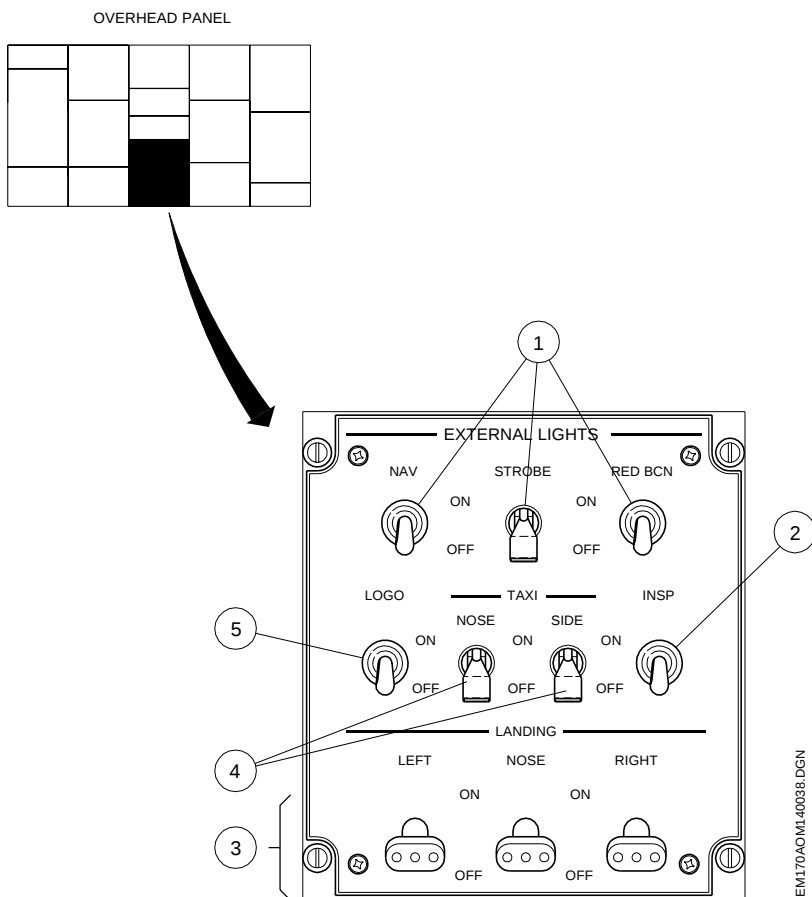
The logo lights are installed in the upper surface of both horizontal stabilizers and are directed to the vertical fin perpendicular to the centerline of the airplane, in order to provide adequate illumination of the airplane's logo during operation on the ground and in flight. A switch located at the overhead panel controls the logotype lights.



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EXTERNAL LIGHTING

EXTERNAL LIGHTS CONTROL PANEL



1 – NAVIGATION, STROBE AND RED BEACON SWITCHES

- Turns on/off the associated light.

2 – INSPECTION LIGHT SWITCH

- Turns on/off the inspection lights.

3 – LANDING LIGHT SWITCHES

- Turns on/off the associated landing light.

4 – TAXI LIGHT SWITCHES

- Turns on/off the taxi lights.

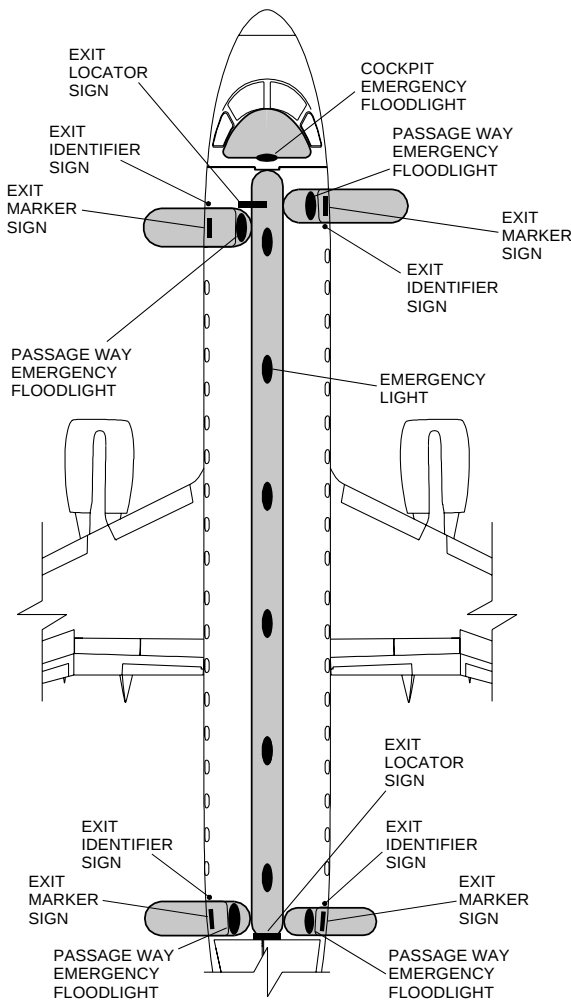
5 – LOGOTYPE LIGHT SWITCH

- Turns on/off the logotype lights.

EMERGENCY LIGHTING

Emergency lighting consists of internal and external lights. The internal emergency lights are powered by four dedicated Emergency Lights Power Units (ELPU) with internal batteries connected to the DC BUS 1. The charge of the batteries is sufficient to supply all emergency lights for approximately 10 minutes. External emergency lighting is provided by each of the escape slides located on each of the four doors of the airplane.

Internal emergency lights comprise the exit locator signs, exit marker signs, exit identifier signs, cabin/cockpit emergency floodlights and passageway emergency exit floodlights. A cockpit light is located at the cockpit ceiling and provides general emergency illumination of the cockpit area.



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EMERGENCY LIGHTING

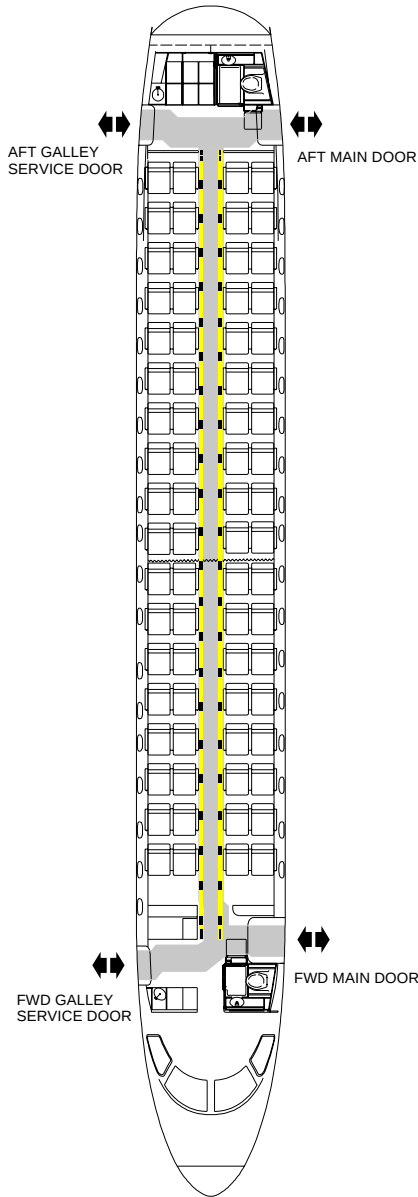
PHOTOLUMINESCENT STRIPS

Photoluminescent strips are installed along the passenger cabin floor to provide means of identifying the emergency escape path even in dense smoke conditions. Double red dots on the strips indicate the end of each exit path.

Photoluminescent escape path strips must be charged prior to the first flight of the day by interior cabin lighting.

For 15 minutes of ceiling and entrance cabin lighting exposure in BRIGHT mode the strip luminescence will be available for 7 hours.

Luminescence time is not limited if during flight either daylight or cabin lighting exist in the cabin.



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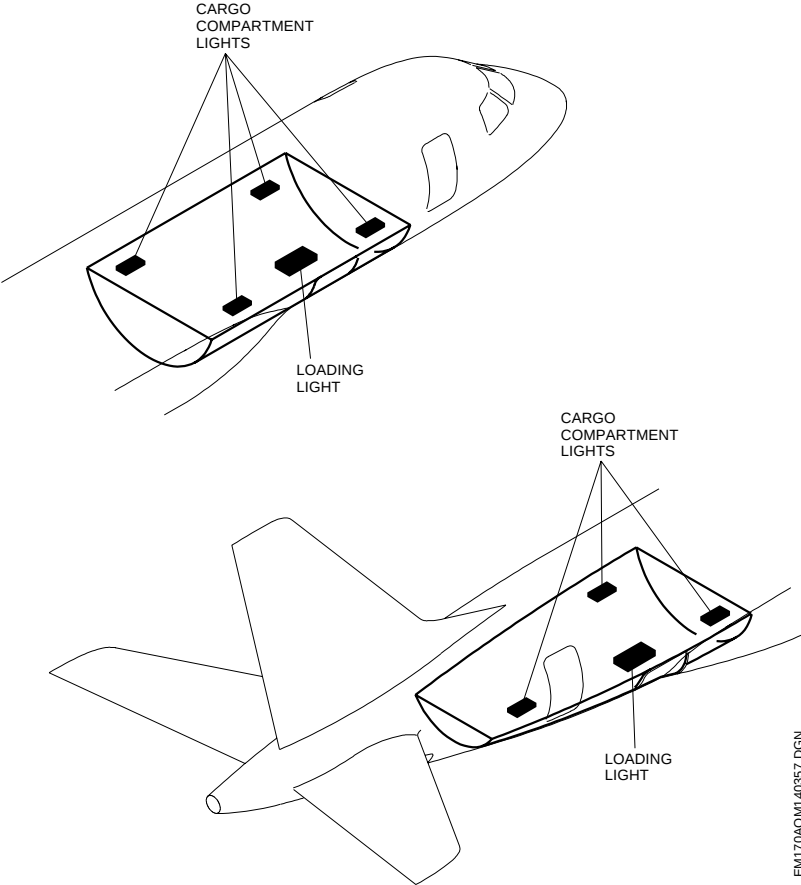
PHOTOLUMINESCENT STRIPS

CARGO COMPARTMENT LIGHTS

The forward cargo bay has 4 cargo lights and 1 loading light and the aft cargo bay have 3 cargo lights and 1 loading light.

There is a manual switch located at each cargo door that gives “AUTO” and “OFF” selections. In “AUTO” mode, the cargo lights come on when the cargo door is opened and turn off when the door is closed. The “OFF” mode turns off the lights regardless of the door position.

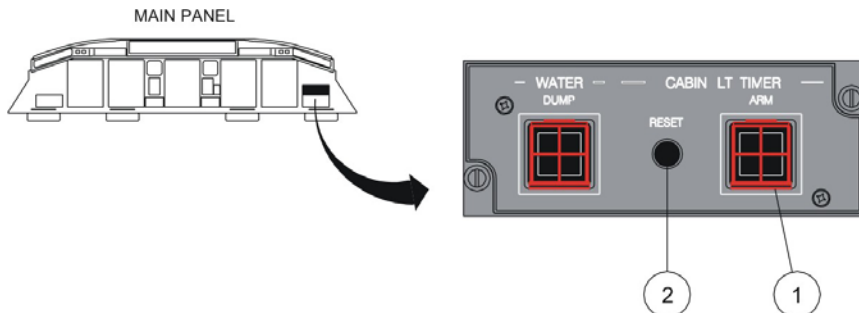
The cargo lights have protective grills installed to protect them against damage from the cargo.



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CARGO COMPARTMENT LIGHTS

CABIN LIGHT TIMER PANEL (-DG and on)



1 – CABIN LT TIMER ARM (GUARDED)

- Turns on the courtesy lights. A five minutes timer turns off the courtesy lights whenever only the batteries energizes the airplane.

2 – RESET BUTTON

- Resets the five minutes timer and turns off the courtesy lights.

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ATA CHAPTER 34

NAVIGATION

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INTRODUCTION

Navigation may be performed using only the navigation radio sensors or Flight Management System (FMS) resources. The FMS uses the standard navigation radio sensors, Global Positioning System (GPS) and Inertial Reference System (IRS), for positioning and navigation.

To aid navigation and approach procedures, an Enhanced Ground Proximity Warning System (EGPWS), Traffic and Collision Avoidance System (TCAS), and a Windshear Detection and Escape Guidance System are also provided.

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FLIGHT INSTRUMENTS

AIR DATA SYSTEM (ADS)

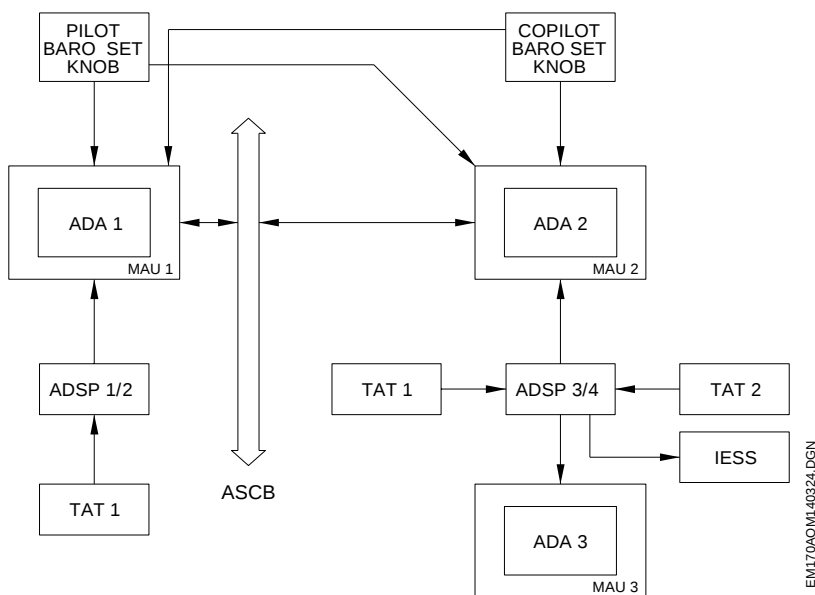
The ADS provides primary air data information to PFDs, flight controls, IESS and other avionics, as required.

Five ADS systems are available:

- ADS 1: TAT 1, ADSP 1/2 and ADA 1.
- ADS 2: TAT 2, ADSP 3/4 and ADA 2.
- ADS 3: TAT 1, ADSP 3/4 and ADA 3.
- ADS 4: TAT 1, ADSP 3/4 and IESS.

The ADS 5 sends information to the flight control system.

All the data that is output by the Air Data Application (ADA) is transmitted via Avionic Standard Communication Bus (ASCB). This interface allows the data from the ADS to be displayed and used by other systems in the airplane.



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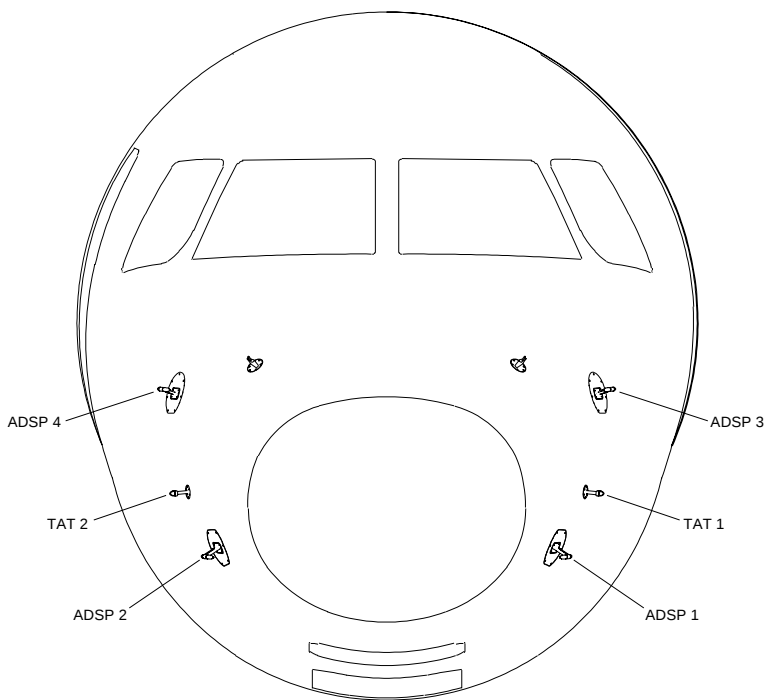


During normal operation, air data readouts on the Captain and First Officer’s PFDs are from ADS 1 and ADS 2, respectively.

Upon failure of either ADS 1 or ADS 2, only the affected side will automatically revert or pilot can source select, using the reversionary panel, one of the remaining two ADS’s for the associated PFD. After manual or automatic reversion, the selected source flag is displayed on the reverted side and the reversion button on the reversionary panel is illuminated.

For ADSs failures, the reversionary logic cycle for the Captain and First Officer PFDs are as follows:

	Reversionary Logic		
	Normal Operation	1 st reversion	2 nd reversion
Captain	ADS 1	ADS 3	ADS 2
First Officer	ADS 2	ADS 3	ADS 1



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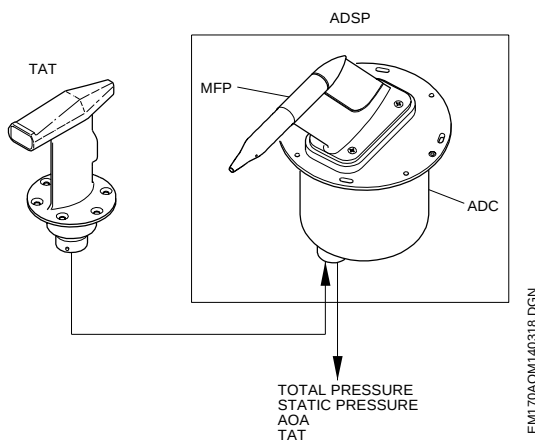
PROBE LOCATION

AIR DATA SMART/TAT PROBES

Four Multi-function Probes (MFP) combine total/static pressures and AOA measurements. The combination of MFP and Air Data Computer (ADC) is called Air Data Smart Probe (ADSP). The ADSP/TAT will sense and transmit static pressure, total pressure, angle of attack and TAT to the Air Data Application (ADA) hosted in the Modular Avionics Units (MAU).

ADSPs interface with each other (1 with 2, 3 with 4) to exchange local static pressure to correct for side-slip effects.

Each of the ADSPs and TATs include resistive heater elements to accomplish de-icing and anti-icing tasks for the probes to provide continued sensor accuracy in icing environments.



TAT AND ADSP

AIR DATA APPLICATION (ADA)

The ADA computes final air data (altitude, airspeed, etc.) and transmits this information to the necessary aircraft systems (PFD, stall protection system, flight controls system, etc).

RADIO ALTIMETER

The radio altimeter system consists of a receiver/transmitter, a configuration module, a receiver antenna and a transmitter antenna and provides accurate altitude above terrain, decision height annunciation and low altitude awareness up to 2500 ft AGL which are displayed on both PFDs.

In a dual system installation, the PFD 1 displays the system 1 radio altitude and the PFD 2 displays the system 2 radio altitude.

The system interfaces with the TCAS, which uses the radio altitude information to inhibit descent resolution advisories. The system also interfaces with the modular avionics unit (MAU), for data distribution and integrity checking. In addition, other interfaces are performed such as with the EGPW system, to determine airplane sink rate variation, with the DVDR system, in order to record mandatory parameters.

RADIO ALTIMETER TEST

This test can be performed during the flight through the MCDU, in the TEST page (MENU -> MISC-> TEST). You can see in the attached picture of this MCDU page, which shows the option for RAD ALT test.

Setting it to ON initiates the self-test of the radio altimeter.

A self-test initiated by the pilot is available on the MCDU for the Radar Altimeter operational check. Under normal operation the self test will generate a radio altitude of 50 +/- 5ft. If 100ft is displayed there is a problem with the systems receiver/transmitter unit; if 200ft is displayed there is a problem with the CM 2000 Configuration Module.



MCDU – RADIO ALTIMETER TEST PAGE

INTEGRATED ELECTRONIC STANDBY SYSTEM (IESS)

The Integrated Electronic Standby System (IESS) permits the computation and the display of the three main functions:

- Attitude (pitch and roll).
- Standard or barometric-corrected altitude and associated barometric pressure.
- Indicated airspeed.

In addition, the IESS provides the following secondary functions or displays:

- Indicated Mach number.
- VMO/MMO.
- Lateral acceleration/slip indication.
- Vertical speed.
- ILS.
- Barometric pressure.
- Altitude in meters.

In case of an electrical emergency, it will continue to operate powered by the ram air turbine (RAT) or by the batteries. The IESS is powered as soon as the airplane batteries are switched to AUTO. Then, the IESS starts its alignment phase, which requires about 90 seconds to be completed and can be identified on the screen by the "INIT 90 s" flag.

NOTE: The airplane must not be moved during the first 90 seconds after power-up, while the IESS is undergoing alignment. Moving the airplane during this period can cause in-flight attitude indication errors that are not noticeable on ground.

In case of failure, attitude display information (e.g. brown and blue background, pitch scale, roll scale and roll pointer) is removed and replaced by a black background and a red cross, and an ATT flag is displayed.

CLOCK

The electronic clock provides the flight crew with universal time coordinated (UTC), date (day/month and year), elapsed time (ET) and chronometer (CHR).

UTC from GPS or internal clock comes on only when the function is initialized. During initialization if the three-position selector is set to GPS and a signal is received, the clock displays its internal time or 00:00:00 (if the internal clock is not yet set), then the clock synchronizes with GPS time after it has completed its setting.

STANDBY MAGNETIC COMPASS

The illuminated magnetic compass has a rotating compass card marked with white legend on black background, with the cardinal points appropriately marked as “N”, “S”, “E”, and “W”. Each 30-degree line, except the cardinals, is identified by numerals representing degrees. Headings are read against a vertical lubber line engraved and filled white on the inside surface of the bowl.



EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	ADS 1 (2) (3) FAIL	Associated ADS has failed.
	ADS 1 (2) (3) (4) HTR FAIL	Associated heater has failed.
	AVNX ASCB FAULT	One or more ASCB buses have failed.
	DISPLAY CTRL FAIL	Display controller is no longer operating.
	DISPLAY CTRL FAULT	Loss of a display controller channel. Maintenance is required.
ADVISORY	ADS 1 (2) HTR FAULT	The electronics in the MFP heater portion of the ADSP has failed.
	ADS 3 (4) SLIPCOMP FAIL	ADS 3 sideslip comparison function has failed.
	FLT CTRL ADS FAIL	The electronics in the ADC portion of the ADSP has failed.
	TAT 1 (2) FAIL	The associated Total Air Temperature measurement system or its heater has failed.
	RALT 1 (2) (3) FAIL	Associated Radio Altimeter has failed.

NAVIGATION SYSTEM DESCRIPTION

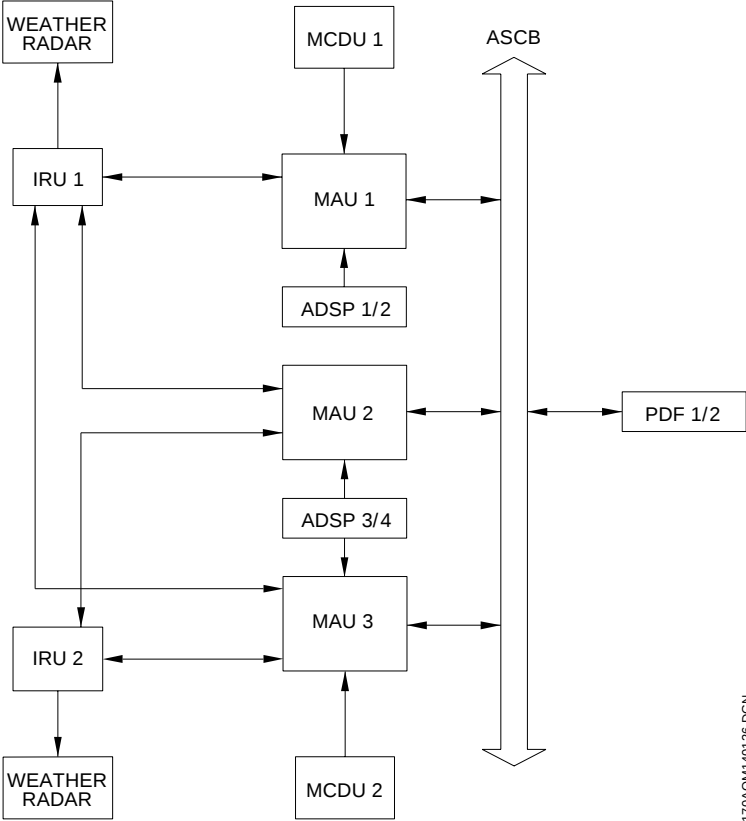
INERTIAL REFERENCE SYSTEM (IRS)

The inertial system computes airplane position, ground speed and attitude.

The main component of the IRS is the Inertial Reference Unit (IRU), which interfaces with the Modular Avionic Unit (MAU), Global Positioning System (GPS), Air Data Computer (ADC). The IRU provides output data to the PFD, weather radar, Multifunction Control Display Unit (MCDU), Flight Management System (FMS) and reversionary panel.

Primary source for the Captain PFD is IRS 1 and for the First Officer PDF is IRS 2. In case of mode failure, power loss or loss of one IRU, the affected station can source select the other side station by means of the IRS reversionary panel button.

An automatic power up (on ground) and alignment is provided. The alignment on ground (up to 17 minutes) must be performed with the airplane not in movement and position entered primarily via MCDU or obtained by the GPS. In flight alignment is also possible to recover navigation capability using data from the GPS.



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IRS SCHEMATIC

The position can be entered on MCDU as follows:

- Press NAV button on the MCDU to go to NAV INDEX page 1/2.

NAV INDEX PAGE 1/2:

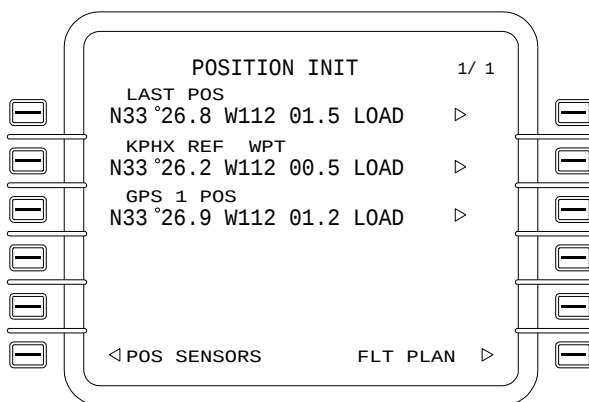
- Press line select key 1L or 4L to go respectively to NAV IDENT or POS SENSORS page 1/1.

NAV IDENT OR POS SENSORS PAGE 1/1:

- Press line select key 6R to go to POSITION INIT page 1/1.

POSITION INIT PAGE 1/1:

- The POSITION INIT page will list positions that can be line-selected for initialization of the FMS using the LOAD line select key. Any of the positions listed can be used for the initialization. The pilot may also enter the appropriate latitude/longitude or reference waypoint using the alphanumeric keys and pressing the line select key 2L.



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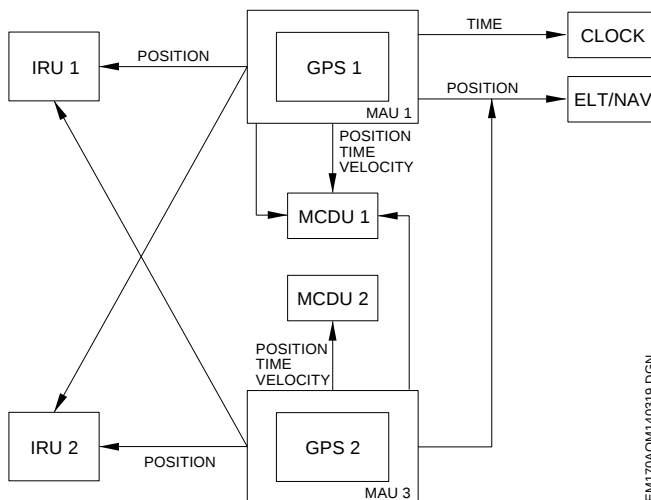
MCDU POSITION INIT PAGE

GLOBAL POSITIONING SYSTEM

The Ground Positioning System (GPS) is a satellite navigation sensor, which receives satellite signals from an active antenna in order to compute airplane position, velocity and time.

The baseline GPS module is contained within MAU 1, in the forward fuselage avionics bay. If the optional second GPS is installed, it is contained in MAU 3.

The GPS module has no direct interface with the flight crew. Any faults within the GPS module will be reported on the FMS multi-function control display unit (MCDU). The FMS produces an alert for the flight crew on the MCDU when the GPS has lost integrity: "GPS RAIM ABOVE LIMITS". Also an alert is generated by the FMS when the integrity will exceed the limit: "RAIM WILL EXCEED LIMIT". A third alert will be generated by the FMS when RAIM is not available: "GPS RAIM UNAVAILABLE".



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GPS SCHEMATIC

RADIO NAVIGATION SYSTEM

The radio navigation is located in the Modular Radio Cabinet (MRC). The interface with the audio is through the audio/microphone bus, and with the MCDU/PFD/MFD through the ASCB. The main components are:

- Very-high-frequency Omni-directional Range (VOR).
- Automatic Direction Finder (ADF).
- Distance Measuring Equipment (DME).
- Instrument Landing System (ILS).
- Transponder System (XPDR).

The MCDU is the primary means for radio tuning while the CCD and PFD are the secondary means. When the RADIO button is selected on the MCDU, two pages are displayed and a detailed page for each radio is available.

The navigation frequency is tuned/activated through the MCDU (primary means) or CCD (PFD).

A tuning backup is available in MCDU 2 in case of loss of both MAUs. As the same way if the audio bus is lost there are audio backups.

VOR/ILS/ADF

The flight crew may tune the navigation frequency on the MCDU as follows:

- Press radio button on the MCDU to go to RADIO page 1/2.

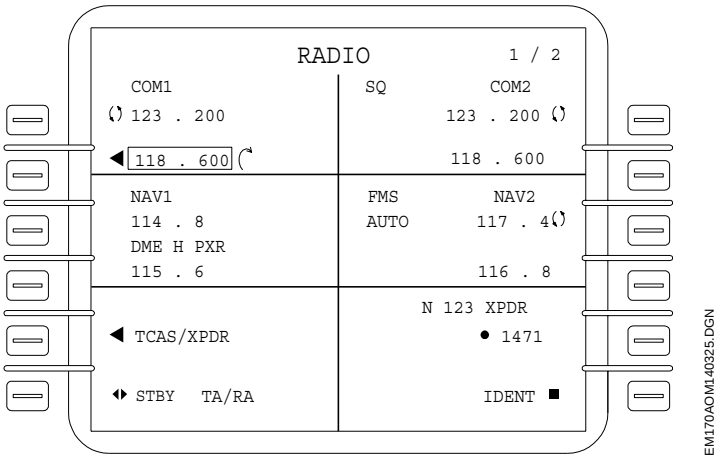
RADIO PAGE 1/2:

- On RADIO page 1/2 it is possible to tune and activate the ILS/VOR frequency. The tuning can be accomplished using the tuning knob or the numeric buttons. If the tuning knob will be used, the standby frequency must be boxed first by pressing its respective line select key. In the case of numeric keys, enter the standby frequency and press the respective line select key. To activate the standby frequency press the respective active frequency.
- Press the respective standby frequency twice if not boxed, otherwise press once, to go to NAV page 1/1.



NAV PAGE 1/1:

- On the NAV page it is possible to capture a frequency tuned in memory. Press 4L to box the memory tuning and use the tuning knob to cycle the stored frequencies. Press the active frequency to capture the selected memory tuning.
- Press 1R to cycle FMS tune enable or disable.
- Press 2R to cycle DME hold on or off.
- Press RADIO PAGE 1/2 and NEXT button on MCDU to go to RADIO page 2/2.



RADIO PAGE 1/2

RADIO PAGE 2/2:

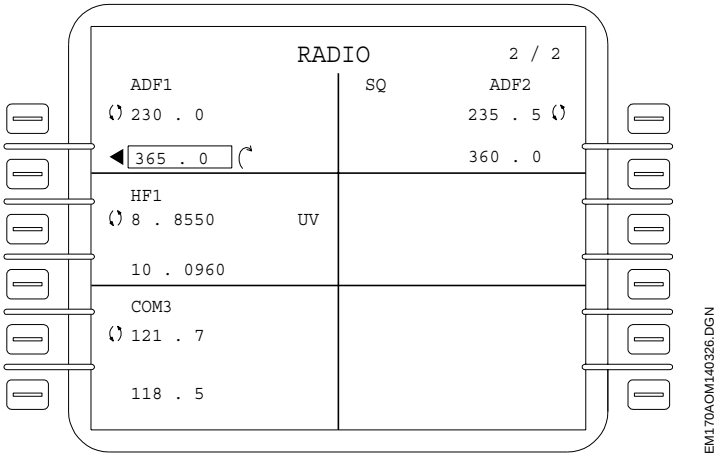
- On RADIO page 2/2 it is possible to tune and activate the ADF frequency. The tuning can be accomplished using the tuning knob or the numeric buttons. If the tuning knob will be used the standby frequency must be boxed first by pressing its respective line select key. In the case of numeric keys, enter the standby frequency and press the respective line select key. To activate the standby frequency press the respective active frequency.
- Press the respective standby frequency twice if it is not boxed, otherwise press once, to go to ADF page 1/1.

ADF PAGE 1/1:

- On the ADF page it is possible to capture a frequency tuned in memory. Press 4L to box the memory tuning and use the tuning knob to cycle the stored frequencies. Press the active frequency to capture the selected memory tuning.
- Press line select key 5R to cycle ADF mode:
 - ADF.
 - ANTENNA.
 - BFO.
 - VOICE.
- Press line select key 6L to go to ADF MEMORY page 1/2.

ADF MEMORY PAGE 1/2:

- On the ADF MEMORY page it is possible to capture a frequency tuned into memory or store a frequency/identification. To capture a frequency press the respective memory frequency to box it and press 1L to activate the frequency. To store a frequency or its identification use the alphanumeric keys and press the respective memory line select key. Additionally the frequency can also be stored pressing the respective memory line select key and rotating the tuning knob.



RADIO PAGE 2/2

The VOR/ILS frequency selection through the CCD is as follows:

- Select the PFD through the CCD. The left and right format location buttons select respectively pilot's and copilot's PFDs.
- Through the touch pad move the cursor to the navigation frequency window.
- Tune the standby frequency through the tuning knob.
- Activate the standby frequency by pressing the enter key.

TRANSPONDER

The transponder is located in the Modular Radio Cabinet (MRC) and the transponder code is entered/activated through the MCDU.

A tuning backup is available in MCDU 2 in case of loss of both MAUs.

The flight crew may enter the transponder code on the MCDU as follows:

- Press radio button on the MCDU to go to RADIO page 1/2.

RADIO PAGE 1/2:

- On RADIO page 1/2 it is possible to enter the transponder code. The entering can be accomplished using the tuning knob or the numeric buttons. If the tuning knob will be used the transponder field must be boxed first by pressing its respective line select key. In the case of numeric keys, enter the transponder code and press the respective line select key.
- Press line select key 6L to cycle the transponder mode between STBY and TA/RA.
- Press line select key 6R to select identification mode.
- Press line select key 5R to go to TCAS/XPDR page 1/2.

TCAS/XPDR PAGE 1/1:

- On TCAS/XPDR page 1/2 it is possible to enter and activate the transponder code. The entering can be accomplished using the tuning knob or the numeric buttons. If the tuning knob will be used, the standby code must be boxed first by pressing its respective line select key. In the case of numeric keys use, enter the standby code and press the respective line select key. To activate the standby code, press the respective active code.
- Press line select key 5L to cycle the transponder selection 1 or 2.
- Press NEXT button to go to TCAS/XPDR page 2/2.

TCAS/XPDR PAGE 2/2:

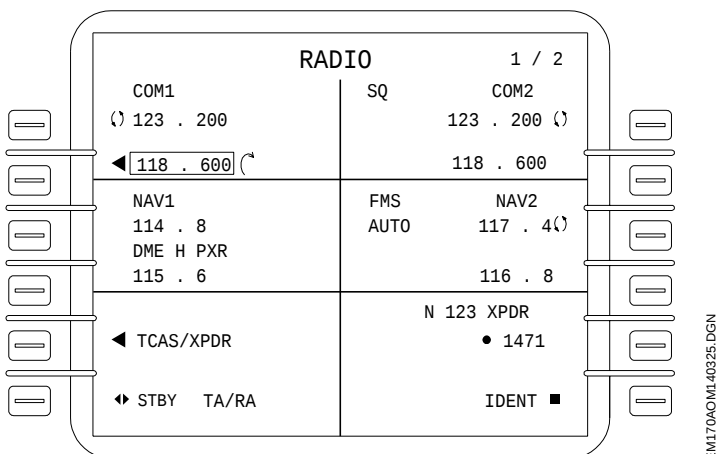
- Press line select key 1L to cycle the transponder mode:

TA/RA.

TA.

ALT-ON.

ALT-OFF.



RADIO PAGE 1/2

MISSED APPROACH PREVIEW

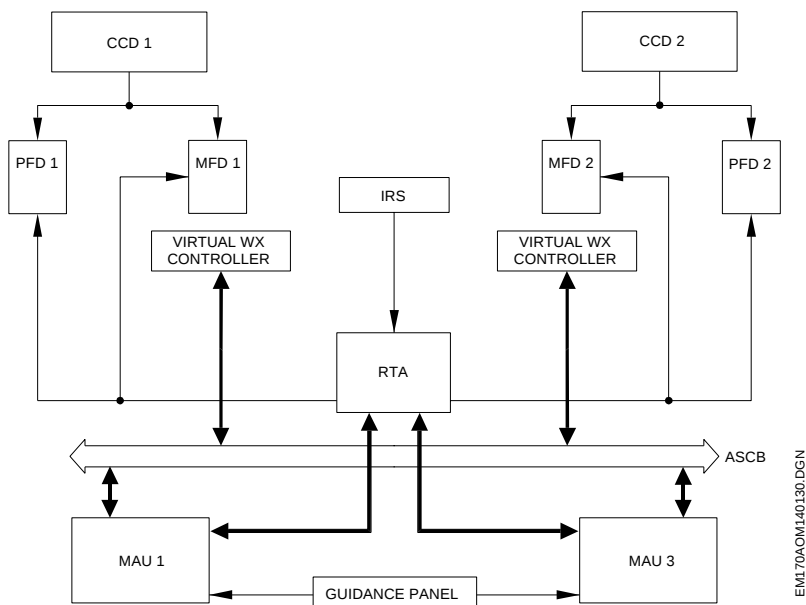
The MFD's MAP menu has the option to select the preview of the Missed Approach procedure on the MFD. The presentation is in cyan and follows the flight plan sequence.

WEATHER RADAR SYSTEM

The airplane can be equipped with WU-660 or WU-880 weather radar system models. The system is designed primarily for detection and analysis of the weather during flight and for ground mapping. The MFD handles the display of radar data and, in addition provides virtual controllers for weather radar control. Weather data is displayed on both MFDs, as well as on the PFDs.

When operating in ground mapping prominent landmarks are displayed which allows identification of coastlines, hilly or mountainous regions, cities or even, large structures.

The weather radar system consists of an integrated Receiver Transmitter Antenna unit (RTA) and two virtual weather radar controllers. The RTA is mounted in the nose of the airplane, whereas the virtual controllers consist of the CCDs and the weather mode information displayed on the MFDs below the weather information.



WEATHER RADAR SCHEMATIC

Displays of weather data are available on the MFDs and PFDs. Selection of weather data display is accomplished via CCD actuating in the MFD using a soft key to select MAP menu. This act will enable weather information and virtual controller on the MFD.

When the weather option is selected on the MAP menu following a cold start, the weather information will be displayed. Weather will initially display in a default OFF mode (OFF is the initial active mode selected on the virtual controller). After 45 seconds, when power up is completed, the pilot can select another available mode using the virtual controller.

Five modes and ten functions are available. Each one will be discussed forward.

RADAR WEATHER DETECTION MODE (WX)

The WX mode is used to detect areas of severe weather. This will allow the pilots to avoid areas of dangerous weather conditions and possible turbulence.

GROUND MAPPING MODE (GMAP)

This mode is used to alert the flight crew about hazards caused by ground targets. This is especially useful in areas of rapidly changing terrain, such as hilly mountainous areas.

The selection of preset gain will generally provide the desired mapping display, however the gain can also be manually operated. It is possible to have one pilot working the GMAP while the other is using the WX mode.



STANDBY (STBY)/FORCED STANDBY (FSBY) MODE

The weather radar remains in a ready state, with the antenna scan motionless and stowed in a tilt-up position. In addition, the transmitter is inhibited and the display memory is erased.

For the system to be completely in standby, both controllers must have the STBY mode selected. The following table shows the RTA modes for each WX radar configuration:

LEFT CONTROLE R	RIGHT CONTROLE R	LEFT SIDE	RIGHT SIDE	RTA MODE
OFF	OFF	OFF	OFF	OFF
OFF	Standby	Slave Standby	Standby	Standby
Standby	OFF	Standby	Slave Standby	Standby
OFF	ON	Slave ON	ON	ON
ON	OFF	ON	Slave ON	ON
Standby	ON	Standby	ON	ON
ON	Standby	ON	Standby	ON
ON	ON	ON	ON	ON
Standby	Standby	Standby	Standby	Standby

STBY mode is relabeled FSBY when the aircraft is on the ground.

OFF MODE

Turns the radar off, provided OFF is selected on both virtual controllers. The system is no longer radiating power and the antenna is stowed.

SLAVE MODE

One controller is in OFF position whereas the other controller is in an operating mode. The operating one is in control of both sweeps.

TURBULENCE DETECTION (TURB) FUNCTION (WU-880 ONLY)

The radar processes return signals in order to determine if a turbulence signature is present. TURB may only be engaged in the WX mode and at selected ranges of 50 NM or less.

NOTE: It may occur that the Turbulence function annunciation in MFD and PFD to remain displayed for ranges above 50 NM even though the function is deactivated.
Range selections of 200 NM or greater always clear Turbulence function annunciation.

ANTENNA STABILIZATION FUNCTION

The antenna is stabilized in pitch and roll using attitude information from the IRU.

RECEIVER GAIN (GAIN) FUNCTION

The GAIN control varies the RTA receiver gain. There are two modes: variable and calibrated. The normal preset is the calibrated mode and is used for weather avoidance. The system will be forced into calibrated gain when RCT or TGT are selected. The variable mode is useful for additional weather analysis and for ground mapping. In WX mode, variable gain can increase receiver sensitivity over the calibrated level to show weak targets or it can be reduced below the calibrated level to eliminate weak returns.

RANGE FUNCTION

The range can be manually set (CCD) to a desirable value (10, 25, 50, 100, 200, 300 NM).

TARGET ALERT (TGT) FUNCTION

Monitors for weather beyond the selected range and 7.5° on each side of the aircraft heading. If such weather is detected within the monitored heading, outside the selected range as far as a range of 200 NM, the TGT annunciation changes from a green-armed condition to an amber alert condition on the MFD.

This annunciation advises the flight crew that potentially hazardous weather lies directly in front and outside of the selected range. When this warning is received, the flight crew should select longer ranges to view the questionable target. Note that TGT is inactive within the selected range.

Selections of this function force the system to preset gain and turns off variable gain mode. Selections of ranges of 200 NM or greater, automatically sets off TGT function and allows variable gain mode. It can only be selected in the WX mode.

NOTE: It may occur that the TGT annunciation on MFD still displays when the ranges are increased to 200 NM or greater, even though the function is deactivated.

In such cases, system's logic follows the TGT function annunciation, gain is automatically preset.

Selection of 1000 NM range always clears TGT annunciation.

SECTOR SCAN (SECT) FUNCTION

The normal radar sweep is ± 60 degrees from the aircraft nose, at a rate of 12 sweeps per minute. Selecting the SECT pushbutton reduces the angle of sweep to ± 30 degrees and increases the sweep rate to 24 sweeps per minute.

TILT FUNCTION

The inner knob on the CCD provides tilt control giving the pilot manual control of the antenna tilt angle. The CCD inner knob is a dedicated tilt knob if VAR Gain is not active. Tilt can be varied between 15 degrees up (clockwise rotation) and 15 degrees down (counterclockwise rotation).

ALTITUDE COMPENSATED TILT (ACT) FUNCTION (WU-880 ONLY)

Automatically adjusts the antenna tilt according to the altitude and selected range. The TILT knob can be used for fixed offset corrections of up to 2.0 degrees.

RAIN ECHO ATTENUATION COMPENSATION TECHNIQUE (REACT) FUNCTION

Automatically adjust sensitivity to compensate for attenuation losses as the radar pulse passes through weather targets on its way to illuminate other targets.

The cyan field indicates areas where further compensation is not possible. This is a warning indicating that attenuation is hiding possible severe weather and should be considered very dangerous.

The REACT compensation is active in all modes except GMAP mode.

TEST FUNCTION

The test function is selected on MCDU avionics test page. The test is used to select a special test pattern to allow verification of system operation.

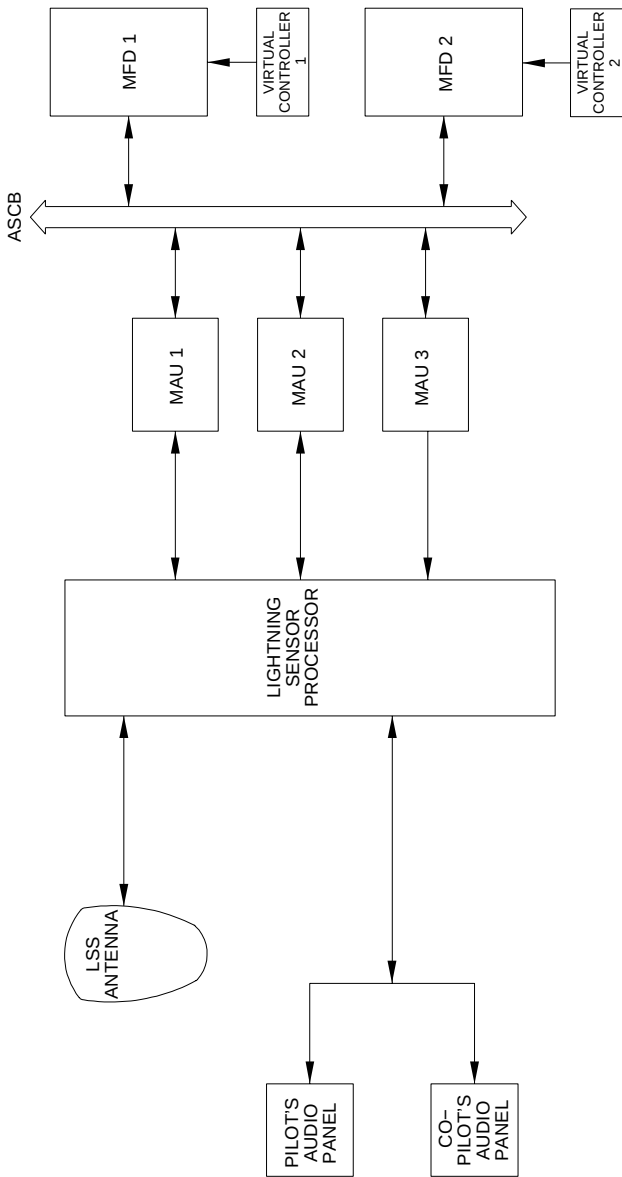
LIGHTNING SENSOR SYSTEM

The Lightning Sensor System (LSS) detects and locates areas of lightning activity in a 200 NM radius around the airplane, displaying lightning rate of occurrence and position relative to the airplane.

The lightning sensor processor is located in the forward electronics bay and interfaces with MAUs sending and receiving information. The antenna is located on the top of the airplane's central fuselage.

A transmit inhibit relay disables the LSS receiver during HF transmissions, preventing false lightning displays caused by interference.

LSS information becomes available in the MFD by selecting "Weather" on the MFD Map menu control and then checking "LX" checkbox on the weather menu.



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LIGHTNING SENSOR SYSTEM SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	IRS EXCESSIVE MOTION	Excessive motion of airplane is disturbing associated IRS aligning sequence.
	IRS 1 (2) (3) FAIL	Associated IRS has failed.
ADVISORY	IRS ALIGNING	Associated IRS is in aligning sequence.
	IRS 1 (2) (3) NAV MODE FAIL	Associated IRS is no longer providing navigation information.
	IRS PRES POS INVALID	Associated IRS did not receive present position or received an invalid one.
	XPDR 1 (2) FAIL	MRC 1 (2) has detected a transponder failure.

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FLIGHT MANAGEMENT SYSTEM

The Flight Management System (FMS) manages navigation sensors to produce the airplane position. The system provides data for the cockpit displays and flight control system. The FMS serves as an aid to flight planning, navigation, performance, database and redundancy management. The system may be installed in a single or dual configuration.

For additional information on functions and operation, refer to the manufacturer's manual.

The FMS 1 and 2 reside respectively in MAU 2 and MAU 3.

The FMS interfaces with the following systems and equipment:

- GPS: the FMS uses inputs from the GPS to calculate aircraft position and perform navigation functions.
- IRS: the FMS uses inputs from the IRS to obtain aircraft position and perform navigation functions.
- MFD and PFD: the FMS provides data for display of navigation guidance on the PFD and navigation map data on the MFD.
- VOR/DME: the FMS uses inputs from the VOR/DME to perform navigation functions.
- MCDU: the Multifunction Control Display Unit, located on the control pedestal, provides control functions management and operating modes for proper FMS operation. It is the interface between the FMS and the flight crew.



PERFORMANCE

The Honeywell Primus Epic FMS provides features to comply with Required Navigation Performance requirements, as described in RTCA DO-283, Minimum Operational Performance Specification for Required Navigation Performance, Rev. - , Oct. 2002.

The FMS has not been demonstrated to comply with the VNAV requirements stated in Appendix H of DO-283. The FMS does not provide the capability to utilize RNP procedures from the navigation database. Fixed radius leg transition capability is not provided. The FMS does not provide constant radius Hold patterns, or RNP Hold entries, as defined in Appendix J of DO-283.

The FMS provides default RNP types for each phase of flight. Each RNP type has a required steering method, which is necessary to maintain containment integrity. The default RNP types and their associated steering methods are as follows:

Flight Phase	RNP Value	Minimum Required Steering Method
Remote/Oceanic	10	Manual CDI
En-route	2	Manual CDI
Terminal	1	Flight Director
Approach	0.3	Auto-pilot

When the FMS is selected as the navigation source on the PFD, the scale of the CDI will be based on the displayed active RNP value. The two-dot full scale deflection will always be equal to the RNP value displayed on the PFD.

The FMS does not provide an indication to the crew of an excessive lateral (cross-track) deviation. Lateral deviation is not considered in the display of the RNP integrity alert. It is the pilot's responsibility to monitor lateral deviation, and take appropriate action to ensure the aircraft follows the flight plan with minimal error.

The steering sources required for each RNP type assume worst case position determination by the FMS. Regardless of the sensors in use, the RNP integrity alert will always be provided at any time the current position determination mode of the FMS does not yield satisfactory accuracy and integrity to satisfy the containment requirements for the active RNP type.

GPS mode is given the highest priority for position determination, when GPS HIL is within limits. If GPS is not available, the FMS will utilize radio modes (DME-DME or VOR-DME) if they provide satisfactory accuracy and integrity. If radio modes are not available, the FMS will use IRS data.

The FMS computes an Estimate of Position Uncertainty (EPU), which is displayed with the current position determination mode on the PROGRESS page on the MCDU. The EPU may be used as an indicator of the margin available to conduct RNP operations.

If the EPU is greater than the active RNP for a set period of time (determined by phase of flight), the FMS will provide an alert (DGRAD on the PFD and UNABLE RNP on the MCDU scratchpad) to notify the crew that the system does not have the necessary accuracy or integrity to maintain RNP operations for the current RNP type. The following table describes the relationship between phase of flight and the time to alarm.

Flight Phase	Time to Alarm (sec)
Remote/Oceanic	54
En-route	24
Terminal	6
Approach	6

Refer to the ABNORMAL PROCEDURES section of this manual for details regarding procedures for degraded navigation.

The FMS also provides annunciations to alert the crew of an inability to meet the RNP for future flight plan legs. Refer to the Honeywell Primus Epic FMS Pilot's Operating Manual for further details regarding system features and annunciations.

FLIGHT PLANNING

In general, flight plans may be divided in four categories: active, stored, lateral or vertical.

ACTIVE FLIGHT PLAN

This is the flight plan currently being flown. The active flight plan can be entered waypoint by waypoint, loaded from an external source, or recalled from storage.

At a minimum, active flight plans must contain a “FROM” waypoint (possibly the origin), a “TO” waypoint, and a destination. A flight plan is considered “closed” when the last waypoint is the destination.

STORED FLIGHT PLAN

The flight plan is stored when it is saved in the computer’s memory and can be recalled later and become an active flight plan.

When entering a flight plan to store, the flight plan must have an origin and destination waypoint, and both must be database waypoints.

When recalling a flight plan, entering the name of the flight plan results in the flight plan becoming active. If the name of the flight plan can not be found, the flight crew can enter the origin and destination. If any are found, the FLIGHT PLN LIST page is displayed to allow selection of a flight plan.

LATERAL FLIGHT PLAN

The lateral flight plan begins at the origin. The default origin in the active flight plan is the nearest airport to the present aircraft position that is within three miles, but it may be changed by the flight crew. The flight plan ends at the destination, which must be entered by the pilot as there is no default destination. The flight plan is built by inserting waypoints or strings of waypoints between the origin and destination. Examples of strings of waypoints are standard instrument departure procedures (SIDs), airways, standard terminal arrival procedures (STARs), and approach transitions.

VERTICAL FLIGHT PLAN (VNAV)

Vertical navigation (VNAV) is a FMS function that calculates a vertical profile, based on performance initialization data, and defines vertical modes to the FGCS.

Once the FMS has generated a vertical profile, VNAV information can be accessed any time via PROG < PROGRESS 2/3 < VNAV DATA. Moreover, FMS VNAV sends inputs for display on the PFD and MFD.

GENERAL RULES FOR VNAV OPERATION

- In order to use the VNAV function, the FMS Performance Initialization must be completed and confirmed.
- VNAV never exceeds the set altitude in the Altitude Selector.
- The airplane climbs whenever the FMS VNAV is in the climb phase, and the altitude set in the Altitude Selector is above the present airplane altitude.
- The airplane descends whenever the FMS VNAV is in the descent phase and the altitude set in the Altitude Selector is below the present airplane altitude.
- A Vertical Track Alert (VTA) is issued 60 seconds before the FMS commands a climb, descent, or 1000 ft before the level off altitude. There is no VTA if leveling-off is based on the altitude set in the Altitude Selector.
- VNAV, whenever existing constraints allows it, defines constant climb or descent paths.

NORMAL OPERATION

Climb: VNAV performs all climb profiles contained in the VFLCH mode. If the FMS levels-off at an altitude constraint defined over a waypoint, it resumes the climb automatically upon sequencing the waypoint. If the FMS levels-off at an altitude set on the Altitude Pre Selector, after setting the Altitude Pre Selector to a higher altitude, the FLCH button must be pressed on the guidance panel in order VNAV transition from VALT to VFLCH.

Cruise: The FMS will transition to cruise phase when reaching the initial cruise altitude set in the PERF INIT page. If the airplane levels at an altitude lower than the initial cruise altitude, the FMS does not transition to cruise.

If the ALT SEL is set to an altitude higher than the FMS cruise altitude, after few seconds, the cruise altitude in the PERF INIT page is reset to match with the ALT SEL selection.

NOTE: To reset the FMS cruise altitude to an altitude lower than the current FMS cruise altitude, it may be necessary to delete the current cruise altitude in the FMS CRUISE PAGE 1/1 prior to insert the new altitude.

To leave cruise level to either climb or descent, the altitude selector must be set to an altitude higher or lower than the present altitude and a vertical DIRECT-TO or VFLCH must be commanded.

When TCS is used to exit a leveled altitude, the command logic is to return to the original altitude when the change is less than 50 ft. For changes greater than 50 ft, the new achieved altitude is maintained.

TOD: The Top of Descent is calculated using the values inserted in the PERF INIT page and is displayed in the VNAV page and on the PFD/MFD.

Descent: One minute prior to the TOD, a vertical track alert is given. When reaching the TOD, the FMS automatically starts the descent in VFLCH or VPATH if the altitude selector is set to a lower altitude.

- **VFLCH Descents** – The descent is in VFLCH mode if there is no altitude constraint down to 1500 ft/10 NM prior to the destination airport. VFLCH also complies with the speed/altitude limit. After an intermediate level-off at the altitude selector altitude, the next descent must be initiated selecting the altitude selector to a lower altitude and pressing FLCH on the FGP.
- **VPATH Descents** – The descent is in VPATH anytime an altitude constraint exists in the descent path and the airplane is within the capture logic of VPATH mode. FMS must be the navigation source and LNAV must be engaged in order the VPATH to become available. When the FMS passes through the last altitude constraint waypoint, it reverts to VFLCH to complete the descent.

During VPTH descents, significant modifications of the flight plan may result the VPTH mode to drop to FPA mode.

Vertical DIRECT-TO: This operation is similar to the lateral DIRECT-TO. It is performed selecting the desired altitude from the scratch pad to the line adjacent to the desired waypoint.

VNAV and HOLDING PATTERNS: The following applies:

- If descending on VFLCH and a holding pattern is entered, the active mode remains VFLCH;
- If a PPOS holding is entered while in VPATH, the active mode changes to VFLCH;
- If a hold is entered while in VPATH descent, the command changes to VALT.

FMS SPEED PLAN

FMS Speed Plan is a function that calculates speeds for a specified navigation based on performance initialization data, and sends speed targets to the FGCS.

Once the performance is initialized and confirmed, FMS speeds can be accessed in the ACTIVE FLT PLAN pages.

SPEED COMMAND FLIGHT PHASES

In order to perform the speed calculations and to define the FGCS targets in automatic mode, the FMS divides the flight in flight phases as follows:

Take Off: The FMS speed control does not provide guidance while in the Take Off mode. However, it sends inputs to the PFD to show the V2, until V2 is reached, then it ramps to V2 + 10 kt until the vertical mode is changed.

Departure: Speed command is the one selected on the DEP/APP speeds page. The default departure speed is 200 kt for 4 NM below 2500 ft.

Climb: Following departure, the command is the speed restriction set on the PERF INIT page 3/3. The default limit is 250 kt below 10000 ft. After clearing the limitation, the FMS commands the lower value between MACH or CAS set on the climb schedule. The default climb schedule is 280 kt/0.73 Mach.

Cruise: When in VALT or ALT and the present altitude is equal to the cruise altitude selected on the PERF INIT, the speed command is the cruise schedule selected. If the airplane levels-off at an altitude lower than the Initial Cruise altitude, the speed command continues on the climb schedule.

Descent: The default descent speed schedule is 290 kt/0.76 Mach/3.0 degrees. Approaching the set limitation in the Speed/Altitude limit of the PERF INIT page 3/3, the FMS commands a speed reduction to comply with any existing speed constraint.

Approach: The transition to approach speeds is at 15 flight plan nautical miles from the destination or 5 NM from the first approach fix. This selection is made on the DEP/APP speeds pages.

When the flaps are set to position 1, the FMS commands speeds for the next flap. These speeds are calculated by the FMS for the actual airplane weight.

Go-around – When the flight director is set to GA the FMS speeds schedule changes for go-around as defined in the PERF INIT.

If a new approach is set while in go-around speed schedule the FMS reverts to approach speeds.

While in go-around, if a new destination is set, the FMS transitions to climb schedule speeds.

Waypoint Speed Constraints – If a speed is set in a flight plan waypoint, the FMS guides the AFCS to comply with this speed.

During a climb, the FMS commands the speed set in the speed constraint waypoint for all previous waypoints. After passing the speed constraint waypoint, the FMS reverts to the speed schedule set in the initialization up to the TOC.

During cruise and descent, the FMS commands the AFCS to cross the waypoint at the selected speed and applies this speed for the subsequent waypoints.

DATA BASE

The FMS has three databases in its memory, a navigation database, a custom database, and an aircraft database.

NAVIGATION DATABASE

This database contains data on NAVAIDS, airports and airways. The information in the navigation database is updated every 28 days. The database contains two effectively consecutive cycles, and the correct database may be automatically or manually selected. Automatic selection occurs upon entry of a valid date. Dates are valid if they are greater than or equal to the expiration date of the current cycle.

CUSTOM DATABASE

The custom database contains information entered by the pilot. This is where the pilot can create and store flight plans and waypoints. This database is not updated on a scheduled basis.

AIRCRAFT DATABASE

The airplane database contains all aircraft-specific performance parameters. The performance learning function within the FMS, known as SmartPerf, has the ability to “learn” performance characteristics based on information gathered on previous flights. This performance learning requires no pilot action. Therefore, all performance data (learned and fixed) is contained in the file.

FUNCTIONS

PERFORMANCE (PERF)

This function gives access to performance related pages including performance initialization, climb, cruise, descent, wind, fuel management and takeoff and landing data. In addition, it permits the initialization of stored flight plans and execution of performance computations.

NAVIGATION (NAV)

This function gives access to the Index providing access to position sensor data, stored flight plans, FIX INFO, selection of waypoints and maintenance pages. In addition, in this page it is possible to perform data loading using a remote terminal or DMU.

FLIGHT PLAN (FPL)

This function provides flight plan data for each leg in the planned (active) flight plan, including course, distance and FPA/altitude constraints. It is also possible to create a flight plan, select a stored flight plan and loading of a flight plan from a disk.

PROGRESS (PROG)

This function summarizes important dynamic flight parameters and the airplane relation to the active flight plan, such as Estimated Time Enroute (ETE), distance to go, fuel information, current NAV mode, number of long range NAVs used, NAVAIDS that are presently tuned, FMS navigation mode, closest NAVAIDS, and air data information (current speed, altitude and temperature).

COMPANY ROUTE (RTE)

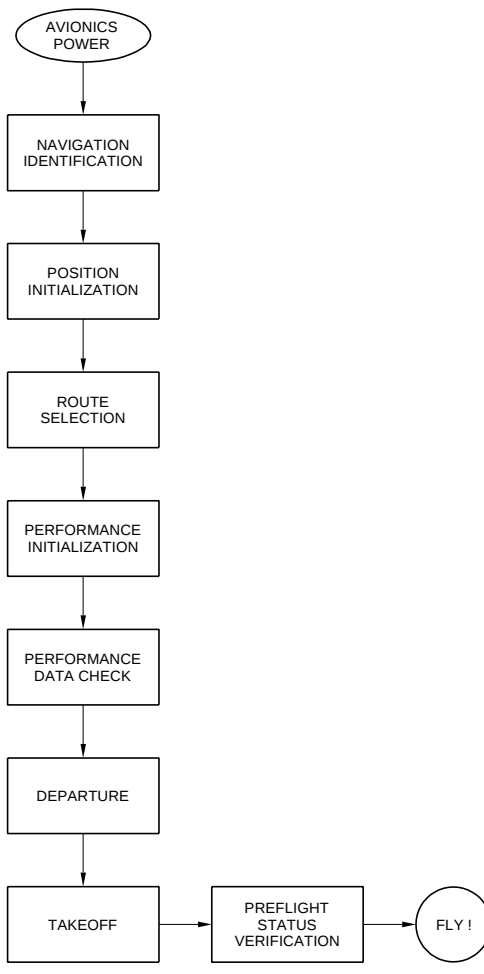
This function displays the active route with origin, destination, runway and company route identifier information.

PREFLIGHT

A preflight procedure for a normal flight can be accomplished on the ground with the following steps:

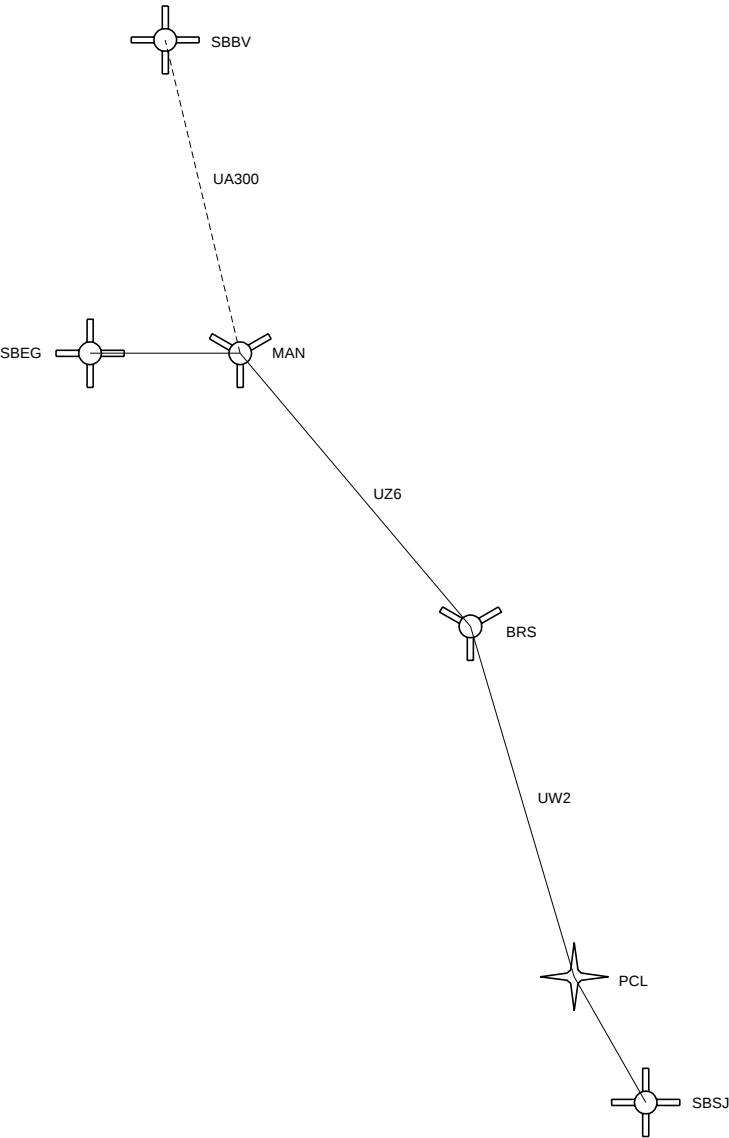
- Navigation identification.
- Position initialization.
- Route selection.
- Departure.
- Performance initialization.
- Performance data check.
- Takeoff.
- Preflight status verification.

In order to clarify the steps required in the preflight procedure a navigation example is considered.



EM170AOM1.40468B.DGN

PREFLIGHT FLOW CHART



EM170AOM140467C.DGN

NAVIGATION EXAMPLE

NAVIGATION IDENTIFICATION AND POSITION INITIALIZATION

After power up the RADIO page will be displayed as default. Press NAV button to enter the NAV INDEX 1/2 page.

Press LSK 1L (NAV IDENT) to go to NAV IDENT 1/1 page. The following items must be checked on NAV IDENT 1/1 page:

- Date and time: This data comes from the GPS. If the GPS is failed or the data is not valid, date and time can be changed.
- Navigation data base: Active data base and alternate period dates.
- Worldwide coverage.

Press LSK 6L (MAINTENANCE) to go to FMS MAINTENANCE 1/3 page. Check if active mode is dual. In case of not operating in dual mode the navigation must be entered in both MCDUs.

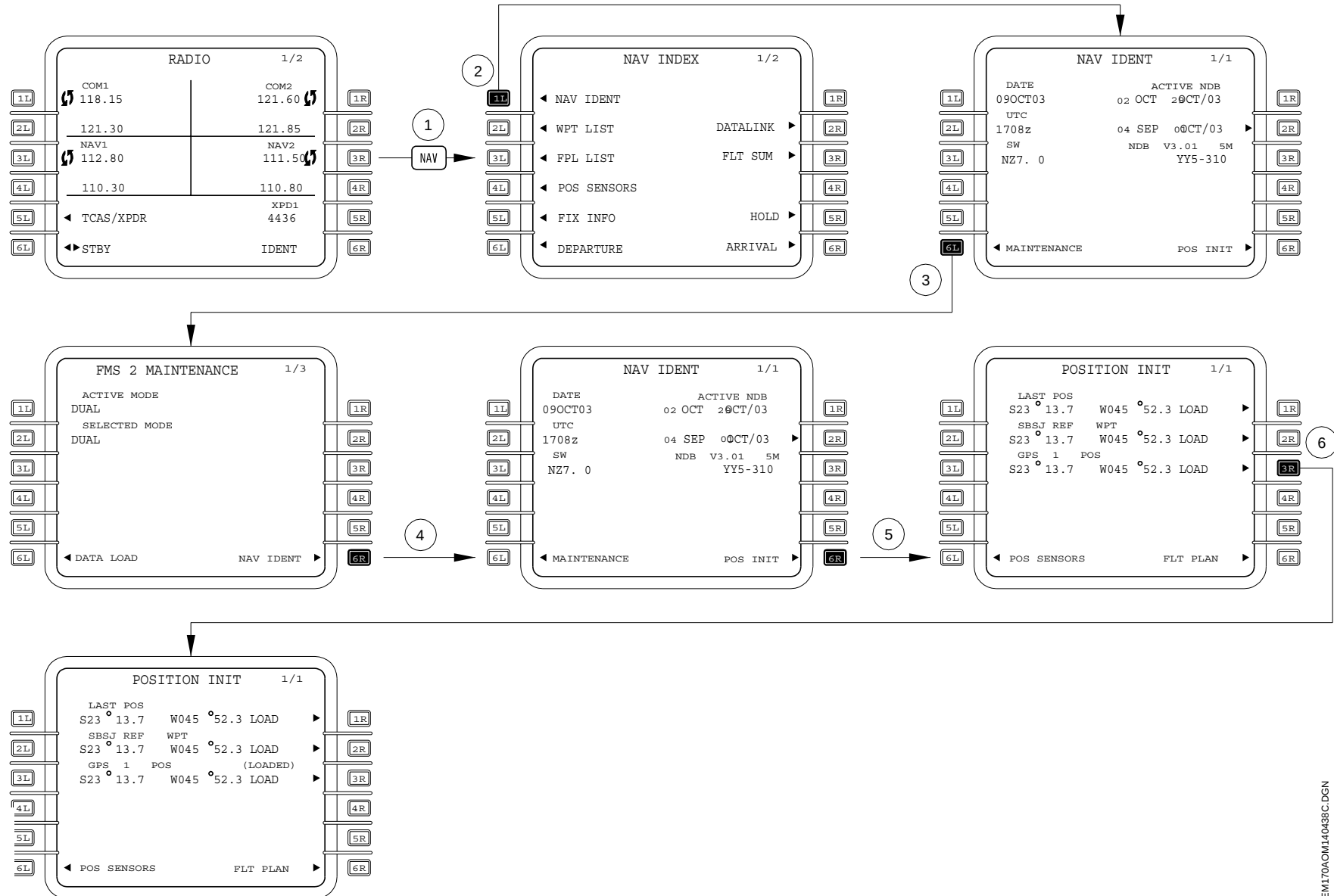
Press LSK 6R to go back to NAV IDENT 1/1 page.

On NAV IDENT 1/1 page press LSK 6R (POS INIT).

The POSITION INIT 1/1 page presents a maximum of 3 options to be loaded as initial position pressing respectively 1R, 2R or 3R:

- Last position: The FMS stores the last position when the airplane is powered down.
- Reference waypoint: Displays the closest ramp x or airport reference point within 3 NM of the last position. Additionally the pilot may type a waypoint or coordinates on the scratchpad thru alphanumeric keys, and enter it pressing LSK 2L.
- GPS position.

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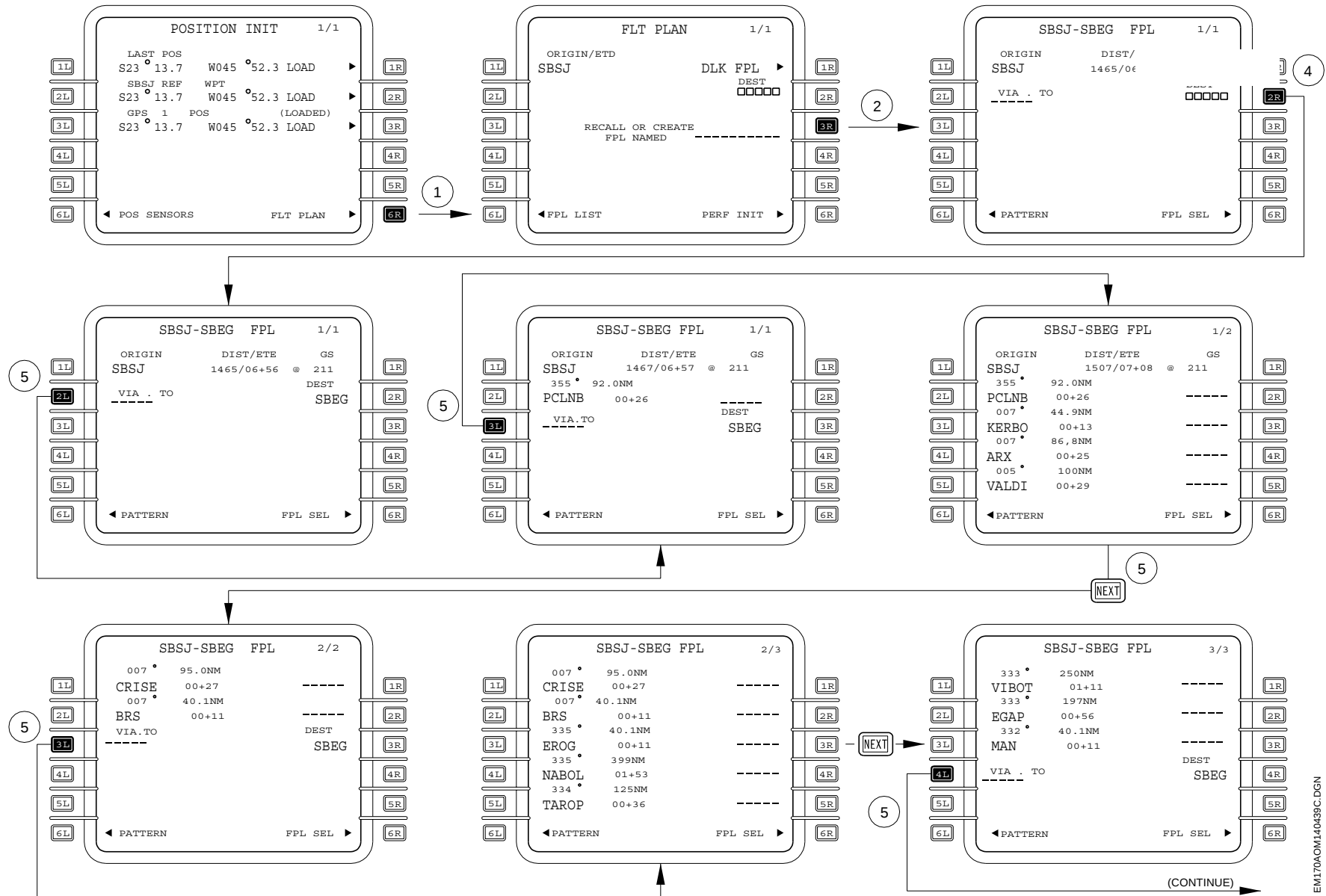


NAVIGATION IDENTIFICATION AND POSITION INITIALIZATION

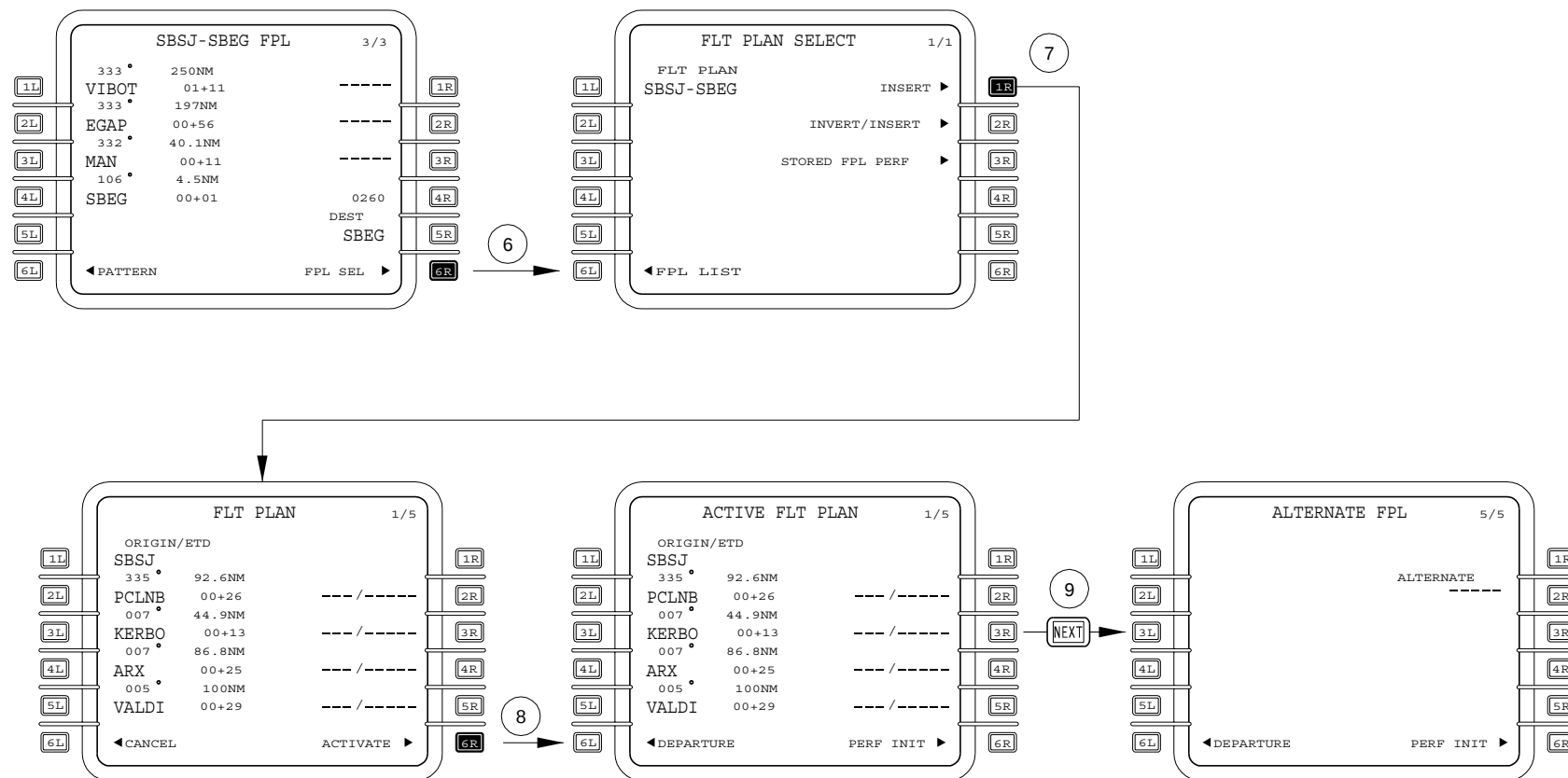
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ROUTE SELECTION - CREATING A FLIGHT PLAN

- 1 On POSITION INIT 1/1 page press LSK 6R (FLT PLAN). On FLT PLAN 1/1 page is possible to create/store a flight plan or load a flight plan from the memory.
- 2 Enter the flight plan name in the scratchpad thru alphanumeric keys and press LSK 3R.
- 3 If the initialization coordinates are within 3 NM of the airport data base the origin airport is already loaded, otherwise enter the origin airport in the scratchpad thru alphanumeric keys and press LSK 1L.
- 4 Enter the destination airport in the scratchpad thru alphanumeric keys and press LSK 2R.
- 5 Enter the waypoints in the scratchpad thru alphanumeric keys and press LSK correspondent to VIA.TO:
 - In case of waypoints entries, enter the airway identifier followed by the last desired waypoint of the airway. Both must be separated by a period.
 - If a waypoint entry corresponds to more than one option in the memory, all options are displayed and selection of the desired one is made by pressing the respective LSK.
 - When entering a waypoint and no VIA.TO is displayed press NEXT button until VIA.TO is displayed.
- 6 When entry of all waypoints is finished, press LSK correspondent to DEST and press LSK correspondent to VIA.TO to close the flight plan. Verify the flight plan created by pressing NEXT button.
Press LSK 6R (FPL SEL) to go to FLT PLAN SELECT 1/1 page.
- 7 Insert the flight plan by pressing LSK 1R (INSERT).
- 8 On FLT PLAN page press LSK 6R (ACTIVATE) to activate the flight plan.
- 9 Access the last page (ALTERNATE FPL) by pressing the NEXT button.



CREATING A FLIGHT PLAN 1/2

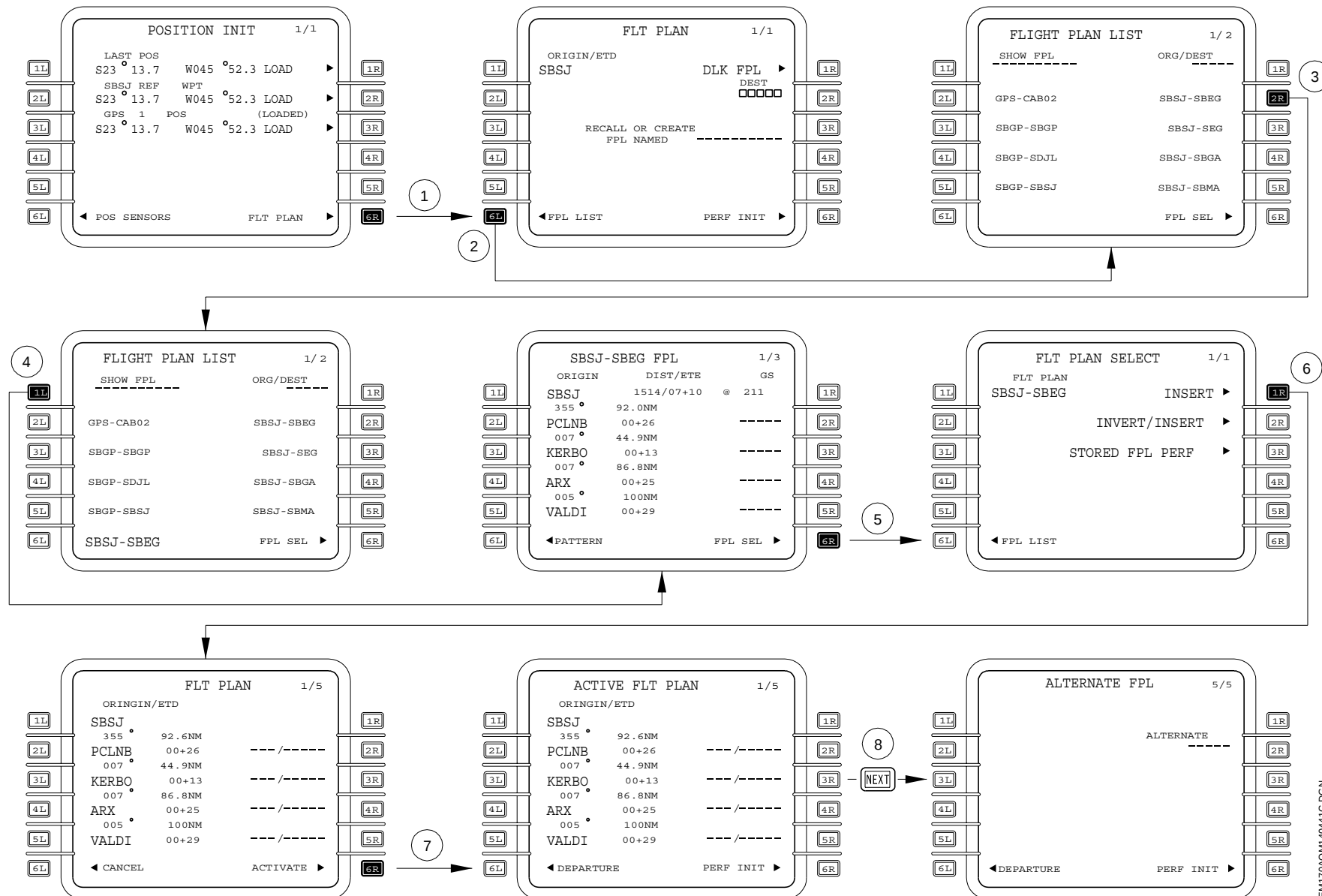


CREATING A FLIGHT PLAN 2/2

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ROUTE SELECTION - LOADING A FLIGHT PLAN

- 1 On POSITION INIT 1/1 page press LSK 6R (FLT PLAN). On FLT PLAN 1/1 page is possible to create/store a flight plan or load a flight plan from the memory.
- 2 Press LSK 6L (FPL LIST) or enter the flight plan name in the scratchpad thru alphanumeric keys to access the FLIGHT PLAN LIST page.
- 3 In the FLIGHT PLAN LIST page, select the desired flight plan by pressing the respective LSK flight plan that appears in the scratch pad.
- 4 Press LSK 1L (SHOW FPL). Verify the loaded flight plan by pressing NEXT button to scroll on the pages.
- 5 Press LSK 6R (FPL SEL) to go to FLIGHT PLAN SELECT 1/1 page.
- 6 On FLIGHT PLAN SELECT 1/1 page press LSK 1R (INSERT) to insert the flight plan.
- 7 On FLT PLAN page press LSK 6R (ACTIVATE) to activate the flight plan.
- 8 Access the last page (ALTERNATE FPL) by pressing the NEXT key.

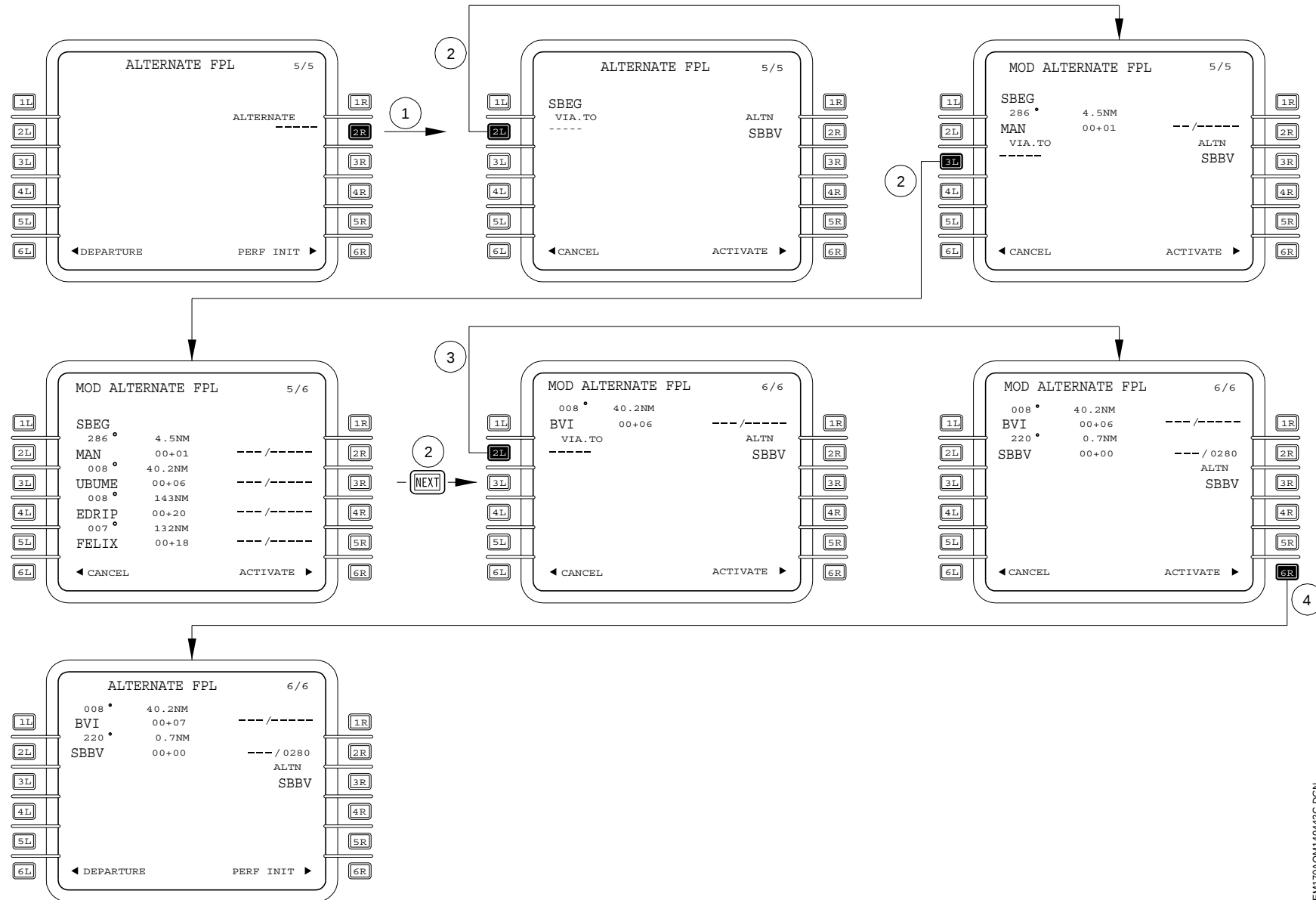


LOADING A FLIGHT PLAN

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CREATING AN ALTERNATE FLIGHT PLAN

- 1 On ALTERNATE FPL page enter the alternate airport in the scratchpad thru alphanumeric keys and press LSK 2R.
- 2 Enter the waypoints in the scratchpad thru alphanumeric keys and press LSK correspondent to VIA.TO:
 - In case of waypoints entries, enter the airway identifier followed by the last desired waypoint of the airway. Both must be separated by a period.
 - If a waypoint entry corresponds to more than one option in the memory, all options are displayed and selection of the desired one is made by pressing the respective LSK.
 - When entering a waypoint and no VIA.TO is displayed press NEXT button until VIA.TO is displayed.
- 3 When entry of all waypoints is finished, press LSK correspondent to DEST and press LSK correspondent to VIA.TO to close the flight plan.
- 4 Activate the alternate flight plan by pressing the LSK 6R (ACTIVATE).



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ALTERNATE FLIGHT PLAN

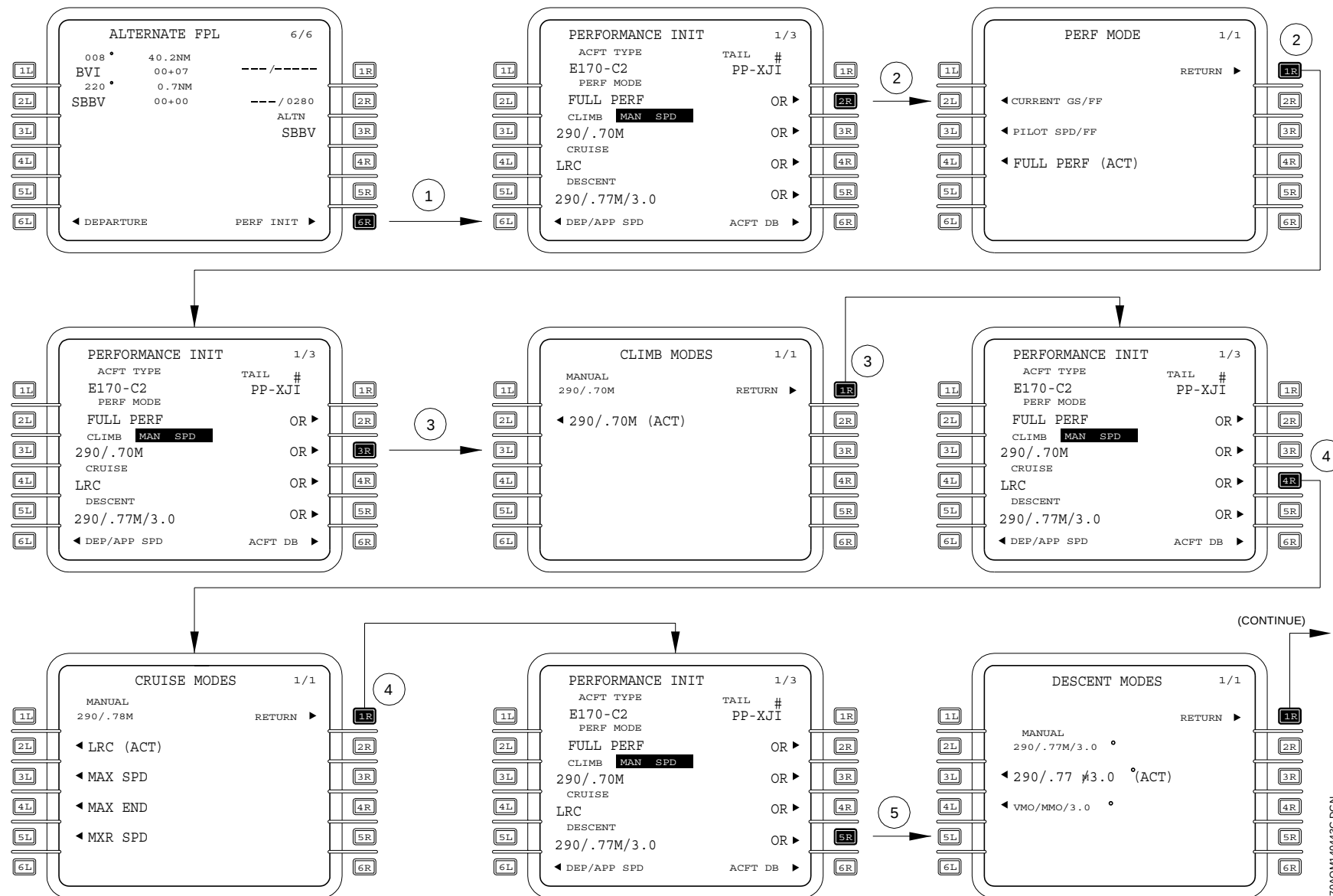
PERFORMANCE INITIALIZATION

- 1 On ALTERNATE FPL page press LSK 6R (PERF INIT) to enter in the PERFORMANCE INIT page. The following items must be checked:
 - Aircraft type.
 - Tail number.
 - 2 Select the performance mode by pressing LSK 2R to enter in the PERF MODE page. Press the respective LSK performance mode and LSK 1R (RETURN). Three modes are available for selection:
 - Full performance: The performance is based according to pilot selections and the learned aircraft performance. This option can not be selected if additional flights are required for the FMS to learn the aircraft performance, in such case the message INSUFFICIENT LEARNED DATA is displayed. The following pages/datas are only available in full performance:
 - PERF DATA pages.
 - CLIMB pages.
 - CRUISE pages.
 - DESCENT pages.
 - Point of no return page.
 - Equal time point page.
 - Optimum and maximum altitude.
 - Cruise speed schedules: long range cruise, maximum speed, maximum endurance and maximum range.
- In order to calculate the performance data the following entries are required:
- Fuel quantity.

- Based on current groundspeed and fuel flow. On the ground a default value for groundspeed is used. When airborne the current value is used. The fuel flow can be overridden entered by the pilot.
 - **Speed schedules and cruise fuel flow:** The performance is based on speed schedules and cruise fuel flow to pilot entered.
- 3 Enter the climb speed in the scratchpad thru alphanumeric keys and press LSK 3L. The entry can be CAS, MACH or both CAS/MACH (separated by a slash). The active speed is the one that provides the lowest TAS. Entering "delete" returns the default values. Selection can also be provided by pressing LSK 3R and entering the CLIMB MODES page. On CLIMB MODES page select the respective LSK climb mode and LSK 1R (RETURN).
- 4 Enter the cruise speed in the scratchpad thru alphanumeric keys and press LSK 4L. The entry can be CAS, MACH or both CAS/MACH (separated by a slash). The active speed is the one that provides the lowest TAS. Entering "delete" returns the default values. Selection can also be provided by pressing LSK 4R and entering the CRUISE MODES page. On CRUISE MODES page select the respective LSK cruise mode and LSK 1R (RETURN). Four cruise mode are available:
- Long range cruise.
 - Maximum speed.
 - Maximum endurance.
 - Maximum range speed.
- If long range cruise or maximum speed is selected, the active speed at high altitudes is MACH and at low altitudes it is CAS. For maximum endurance CAS is always the active speed.
- 5 Enter the descent speed and angle in the scratchpad thru alphanumeric keys and press LSK 3L. The entry can be CAS, MACH, ANGLE, both CAS/MACH or CAS/MACH/ANGLE (separated by slashes). The active speed is the one that provides the lowest TAS. Entering "delete" returns the default values. Selection can also be provided by pressing LSK 5R and entering the DESCENT MODES page. On DESCENT MODES page select the respective LSK climb mode and LSK 1R (RETURN).
- 6 Press the LSK 6L to enter in the DEP/APP SPD pages. On the DEPARTURE SPEED 1/3, it is possible to set the speed restriction during the departure as well as the altitude and the distance where the departure speed limit applies.

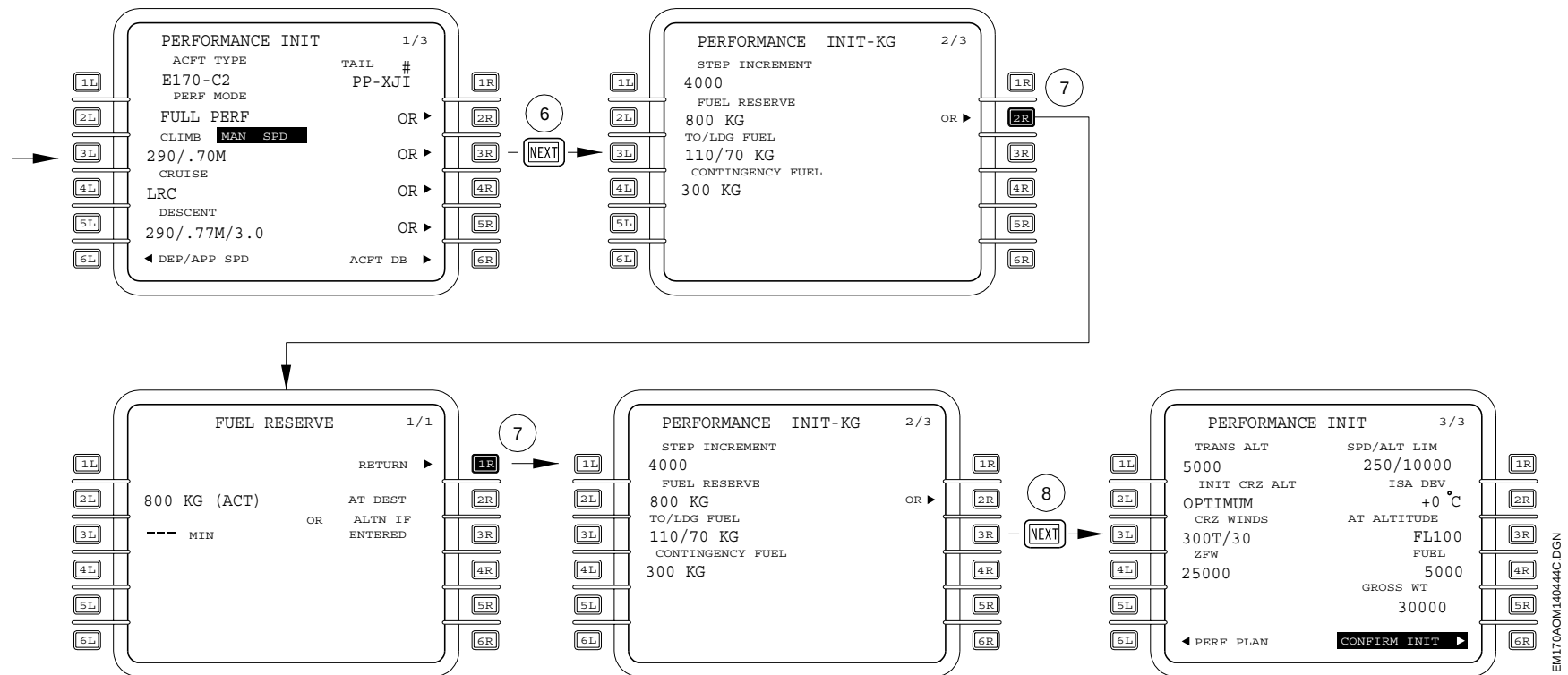
- 7 Press the NEXT button to go to APPROACH SPEEDS 2/3 page. On this page it is possible to enter the approach speeds depending on the flap setting. It is also possible to enter the approach speed limit. The FMS logic is to command the speed for the next flap up to flaps full. In the LSK 4L, it is possible to access the radial distance in nautical miles where FMS begins the approach schedule. In the LSK 5R or 5L it is possible to select if the approach speed schedule is to be initiate at further out distance than the one set in 4L or not.
- 8 Press the NEXT button to go to GO-AROUND SPEEDS page 3/3. On this page it is possible to set go around speeds depending on flap settings. Press the RETURN prompt at 1R to go back to PERFORMANCE INIT 1/3.
- 9 Press NEXT button to go to PERFORMANCE INIT 2/3 page.
- 10 On PERFORMANCE INIT page 2/3 it is possible to enter the data below. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.
 - Step climb increment (unavailable).
 - Fuel reserve. Additionally fuel reserve can also be entered by pressing LSK 2R to access FUEL RESERVE page. On FUEL RESERVE page it is possible to enter the fuel reverse in kilograms or in minutes. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK. Press LSK 1R (RETURN) to go back to PERFORMANCE INIT page. The fuel reverse applies at destination or at the alternate destination if one has been entered.
 - Fuel allowance for takeoff and landing.
 - Contingency fuel.
- 11 Press NEXT button to enter in the PERFORMANCE INIT 3/3 page. On this page it is possible to enter the data below. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.
 - Transition altitude.
 - Initial cruise altitude. Altitudes above the transition altitude are displayed as flight levels and below in feet. The cruise altitude must be equal to or greater than the Altitude Selector, otherwise the message RESET ALT SEL? is displayed. If the full performance mode is selected the initial cruise altitude is displayed as OPTIMUM.
 - Average cruise wind and corresponding altitude.
 - Zero fuel weight.
 - Speed limits associated with altitudes.
 - Temperature deviation.
 - Fuel weight.

If the maximum gross weight is exceeded the message EXCEEDS MAX GROSS WEIGHT is displayed.



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PERFORMANCE INITIALIZATION 1/2



PERFORMANCE INITIALIZATION 2/2

PERFORMANCE DATA CHECK

- 1 On PERFORMANCE INIT 3/3 page press LSK 6R (CONFIRM INIT). On the PERF DATA page the following data displays for destination and alternation:

- Cruise and ceiling altitudes.
- Step increments.
- Estimated time enroute.
- Estimated time arrival.
- Distance.
- Fuel requirement.
- Fuel figure of merit (accuracy of the fuel required).
- Fuel remaining.
- Gross weight.

The cruise altitude and step increments can be changed by entering in the scratchpad thru alphanumeric keys and pressing respectively LSK 1L or LSK 1R.

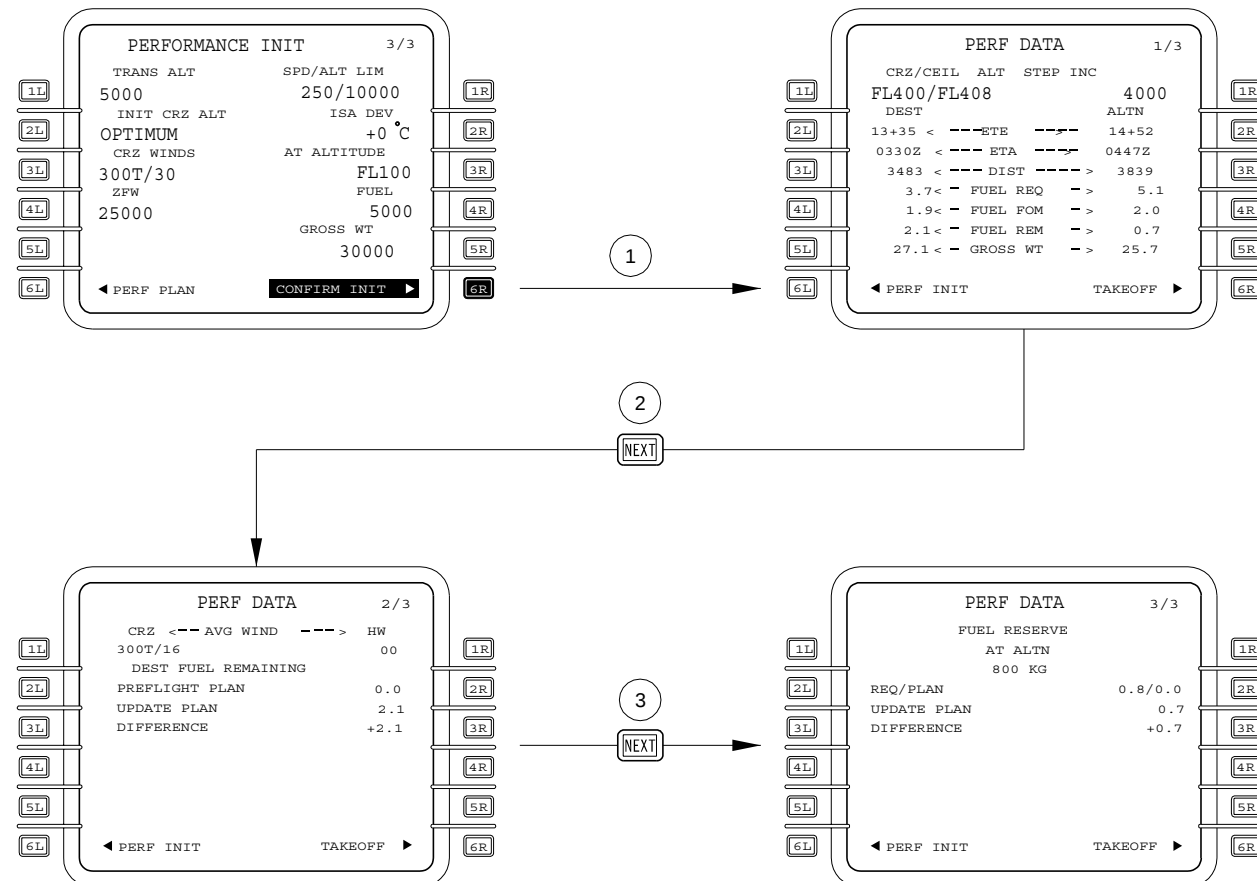
- 2 Press NEXT button to go to PERF DATA 2/3 page. On this page the following information is displayed:

- Average cruise wind.
- Preflight fuel remaining.
- Latest estimated fuel remaining.
- Difference between preflight and estimated fuel remaining.

- 3 Press NEXT button to go PERF DATA 3/3 page. On this page the following information is displayed:

- Required fuel reserve.
- Predicted fuel remaining.
- Updated plan (most recent of the fuel remaining).

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PERFORMANCE DATA CHECK

TAKEOFF

- 1 On PERF DATA page press LSK 6R (TAKEOFF) to enter in the TAKEOFF 1/3 page.
On TAKEOFF 1/3 page the following information is displayed:
 - Runway number and ICAO identifier.
 - Runway heading.
 - Runway length.
 - Outside air temperature.
 - Surface wind.
 - Pressure altitude.
 - Baro settings.
 - Runway elevation.

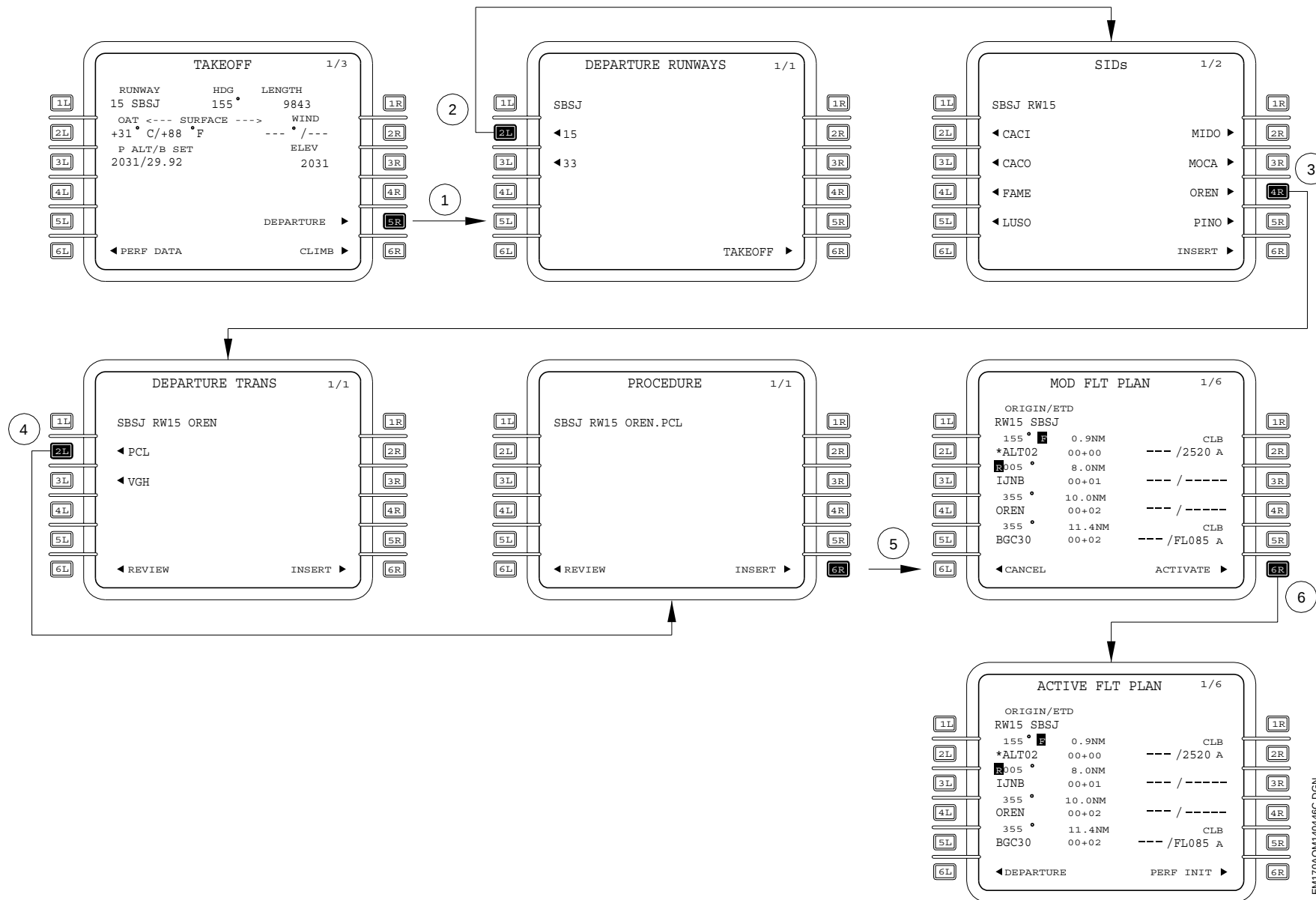
Temperature, surface wind, and baro settings can be entered. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.
- 2 Press NEXT button to go to TAKEOFF 2/3 page. The following information is displayed:
 - Runway slope.
 - Runway threshold.
 - Runway stopway.
 - Headwind/tailwind and crosswind.
 - Density altitude.

With exception of density altitude the others information can be entered. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.
- 3 Press NEXT button to go to TAKEOFF page 3/3. Enter with V1, VR, V2 and VFS. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.



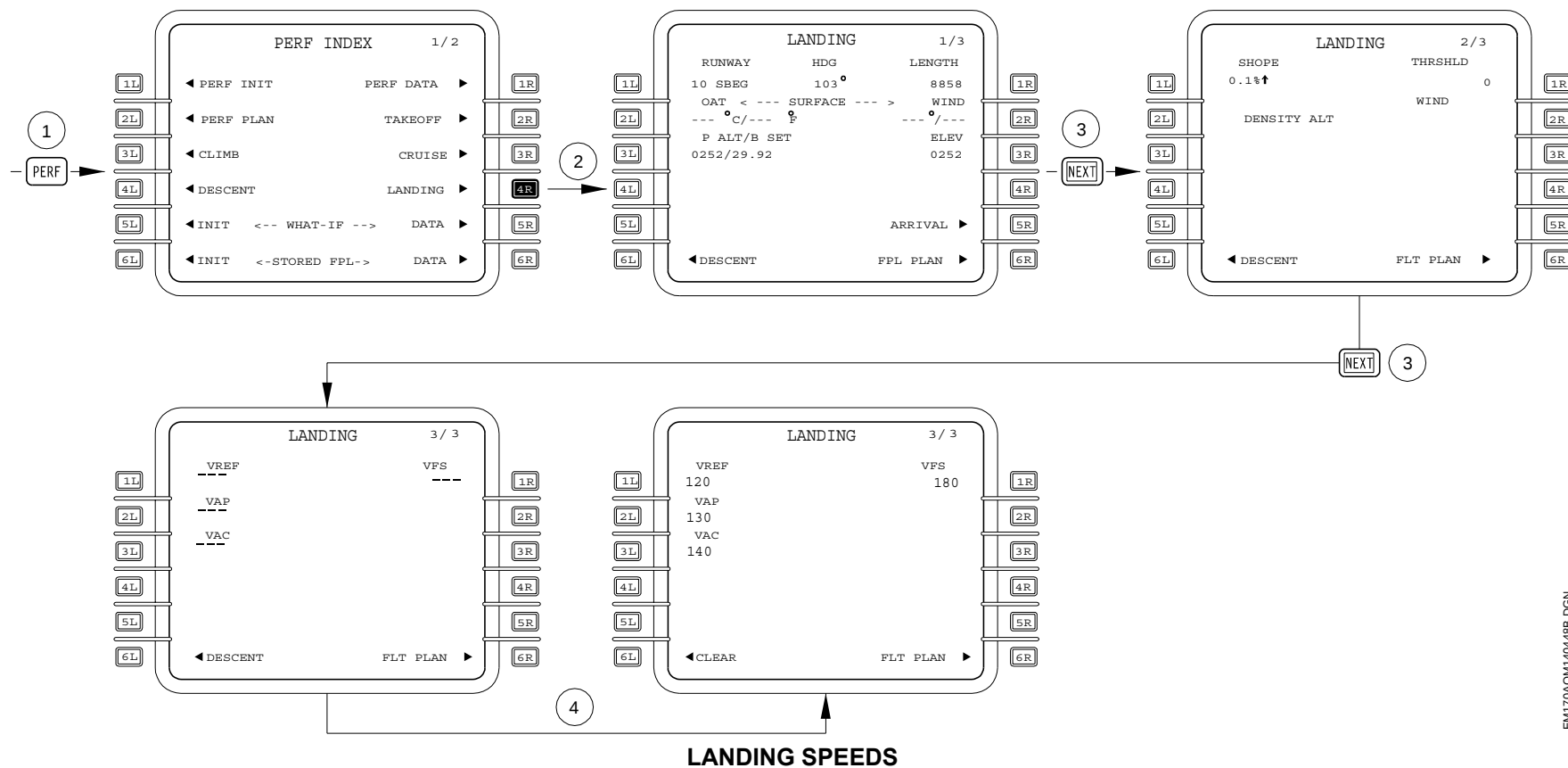
DEPARTURE

- 1 On TAKEOFF 3/3 page press NEXT button to go to TAKEOFF 1/3 page and press LSK 5R (DEPARTURE).
- 2 On the DEPARTURE RUNWAYS page selects the runway by pressing the respective LSK.
- 3 On SIDs page selects the SID by pressing the respective LSK.
- 4 On the DEPARTURE TRANS page selects the departure transition by pressing the respective LSK.
- 5 On PROCEDURE page press LSK 6R (INSERT).
- 6 Activate the flight plan by pressing the LSK 6R (ACTIVATE) on MOD FLT PLAN page. Check if there is no discontinuity between waypoint scrolling with the next button.



LANDING SPEEDS

- 1 Press PERF button to go to PERF INDEX 1/2 page.
- 2 Press LSK 4R (LANDING) to go to LANDING 1/3 page.
- 3 Access the LANDING 3/3 page by pressing the NEXT button twice.
- 4 Enter with VREF, VAP, VAC and VFS for the departure runway. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.



PROGRESS

- 1 Press PROG button to go to PROGRESS 1/3 page. On PROGRESS 1/3 page the following information is displayed for the to, next and destination waypoints:
 - Distance to go.
 - Estimated time enroute.
 - Estimated fuel remaining.
 - Primary navigation source.
 - Required navigation performance (RNP) value.
 - Estimated position uncertainty (EPU) value. If EPU becomes greater than RNP the message UNABLE RNP is displayed.
 - Tuned navigation radios frequencies.

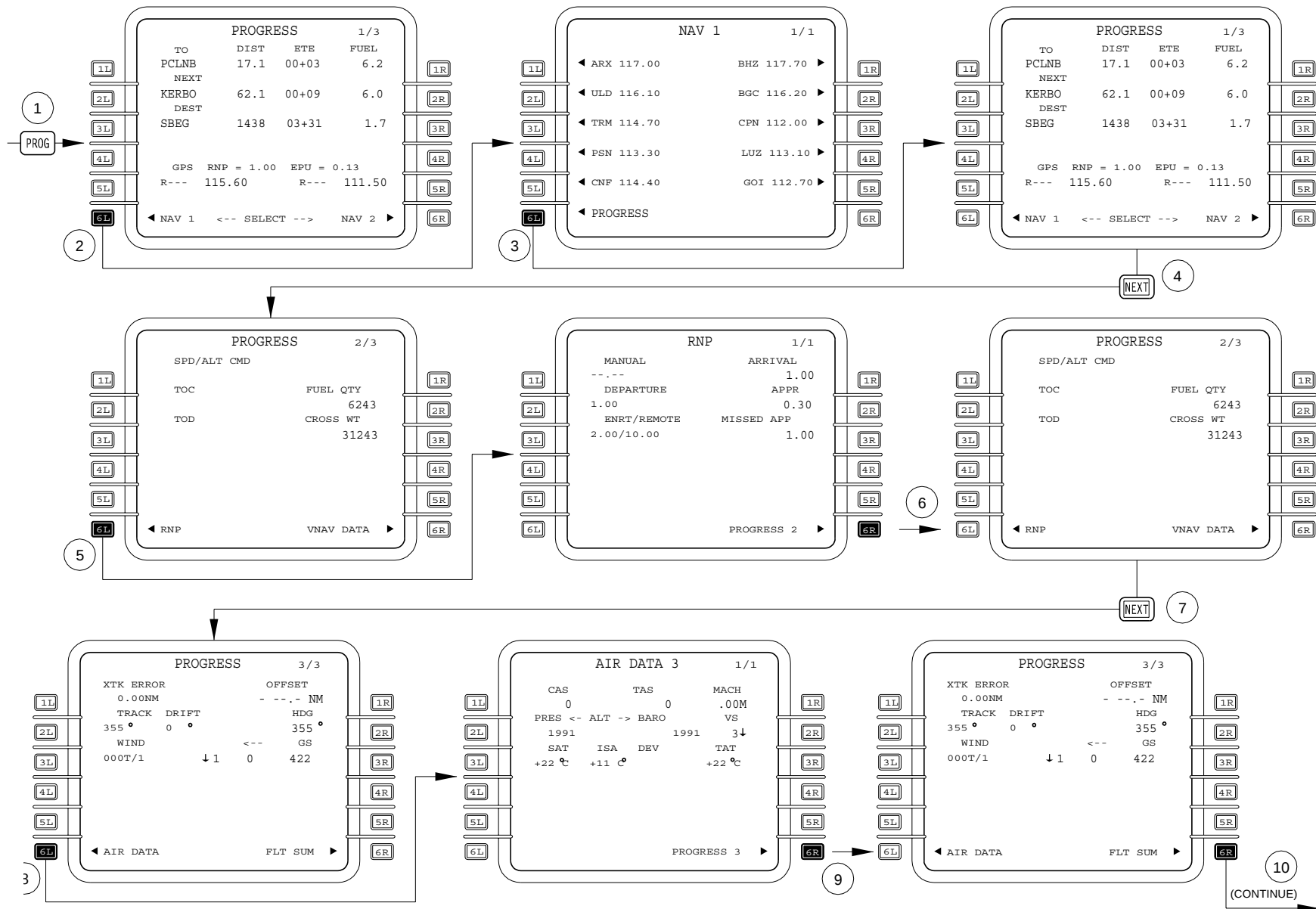
Any active waypoint entry is permitted. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK (1L or 2L).
- 2 Pressing LSK 6L or 6R (NAV 1/NAV 2) enters respectively in the NAV 1 or NAV 2 page.
- 3 A list of 10 closest navigation frequencies is displayed. To tune a frequency press the respective LSK or press LSK 6L (PROGRESS) to return to PROGRESS 1/3 page.
- 4 Press NEXT button to go to PROGRESS 2/3 page. The following information is displayed:
 - Current fuel quantity.
 - Current aircraft Gross weight.

- 5 Pressing LSK 6L (RNP) enters in the RNP 1/1 page. The following information is displayed:
 - Manual override RNP value.
 - Departure RNP value.
 - Approach RNP value.
 - Enroute /remote RNP values.
 - Missed approach RNP value.

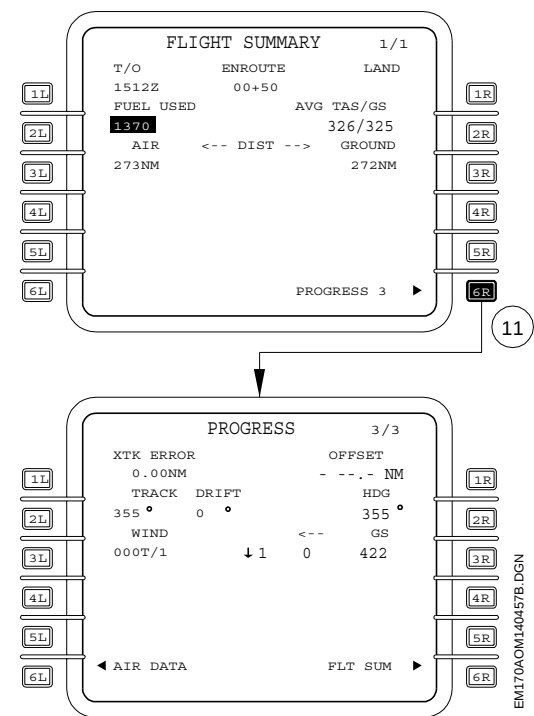
The RNP values can be manually entered. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.

In case of manual override entry a confirm entry prompt is displayed (6L/6R).
- 6 Press LSK 6R (PROGRESS 2) to return to PROGRESS 2/3 page.
- 7 Press the LSK 6R to enter the VNAV DATA page. On this page, the following information displays.
 - VNAV Figure of Merit at LSK 1L.
 - Vertical Deviation at LSK 1R.
 - TOC pseudo waypoint distance/time to go at LSK 2L and TOC altitude at LSK 2R.
 - TOD pseudo waypoint distance/time to go at LSK 3L and TOD altitude at LSK 3R.
 - Bottom of Descent (BOD) pseudo waypoint distance/time to go at LSK 3L and BOD altitude at LSK 3R.
- 8 Press NEXT button to go to PROGRESS 3/3 page. The following information is displayed:
 - Cross track error.
 - Offset entry.
 - Aircraft track.
 - Aircraft drift.
 - Aircraft heading.
 - Wind.
 - Ground speed.

-
- 9 Pressing LSK 6L (AIR DATA) enters in the AIR DATA 1/1 page.
The following information is displayed:
- Pressure altitude.
 - Barometric altitude.
 - Vertical speed.
 - Static air temperature.
 - ISA deviation.
 - Total air temperature.
- 10 Press LSK 6R (PROGRESS 3) to return to PROGRESS 3/3 page.
- 11 Pressing LSK 6R (FLT SUM) enters in the FLIGHT SUMMARY 1/1 page.
The following information is displayed:
- Takeoff time.
 - Enroute time.
 - Landing time.
 - Fuel used.
 - Average true air speed/ground speed.
 - Air distance.
 - Ground distance.
- 12 Press LSK 6R (PROGRESS 3) to return to PROGRESS 3/3 page.



PROGRESS 1/2



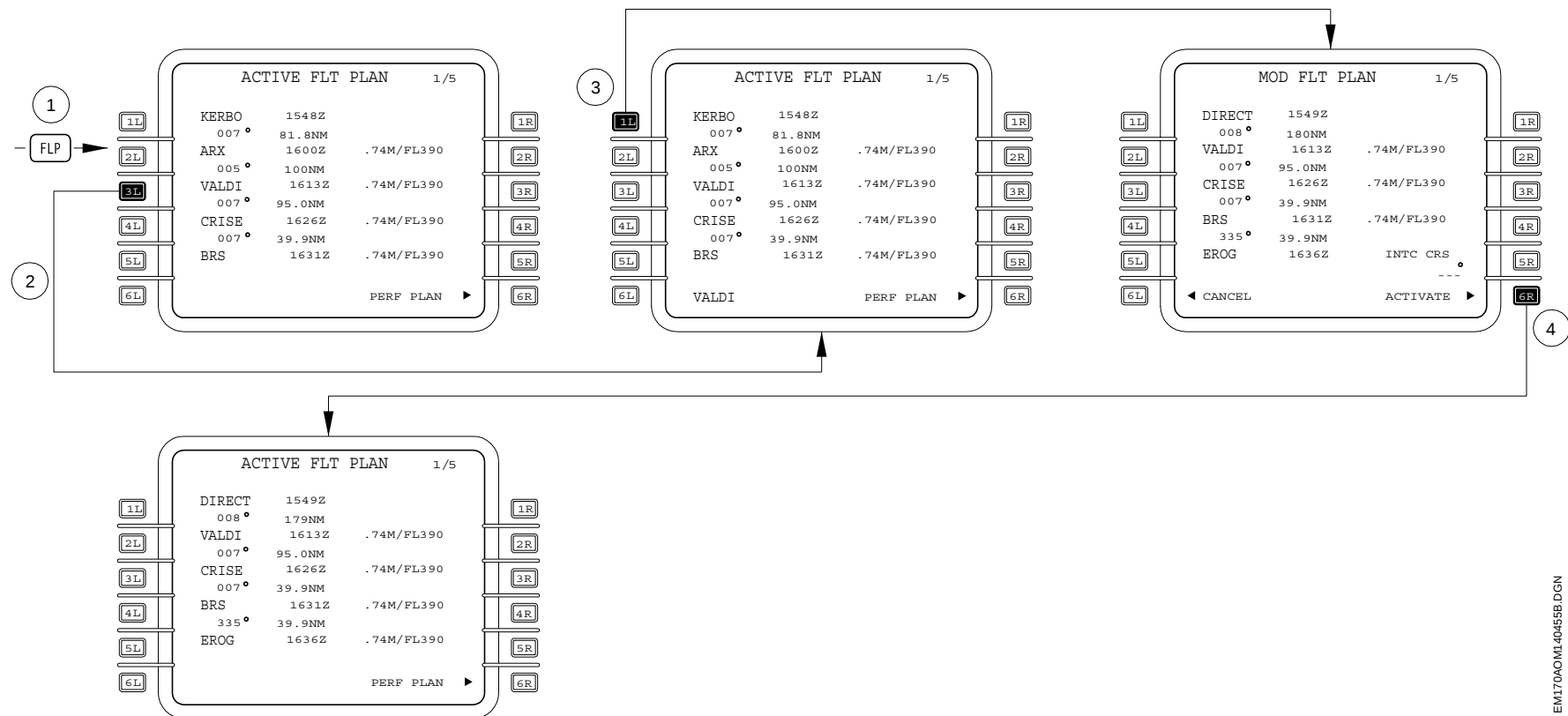
PROGRESS 2/2

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DIRECT-TO

- 1 Press FLP button to go to ACTIVE FLT PLAN page.
- 2 Press the respective LSK correspondent to the desired direct-to waypoint. If the desired direct-to waypoint is not displayed press NEXT button until it appears.
- 3 Press LSK 1L of the first page (previous waypoint).
- 4 Press LSK 6R (ACTIVATE).

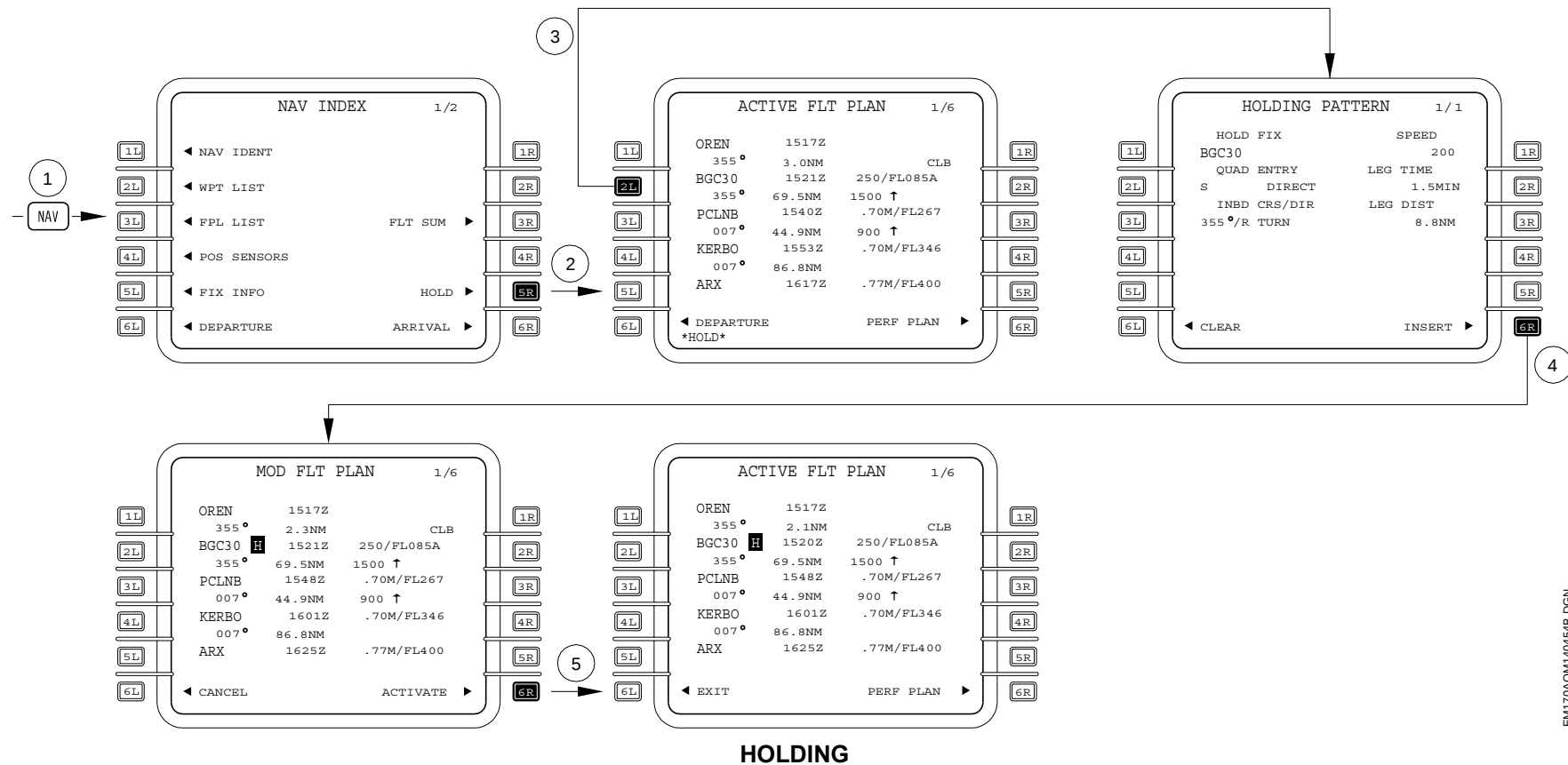


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PATTERNS

HOLDING

- 1 Press NAV button to go to NAV INDEX 1/2 page.
- 2 On NAV INDEX 1/2 page press LSK 5R (HOLD).
- 3 On ACTIVE FLT PLAN page press the respective LSK correspondent to the desired holding waypoint. If the desired hold waypoint is not displayed press NEXT button until it appears.
On the HOLDING PATTERN 1/1 page the following information is displayed:
 - Hold fix name.
 - Speed.
 - Quadrant entry. The possible entries are N, NE, E, SE, S, SW, W or NW.
 - Entry type.
 - Leg time.
 - Inbound course/turn direction. The possible entries are course followed by a slash and then a L (left) or R (right), only the course or only the slash followed by a L (left) or R (right).
 - Leg distance.
- 4 Press LSK 6R (INSERT).
- 5 On MOD FLT PLAN page press LSK 6R (ACTIVATE).

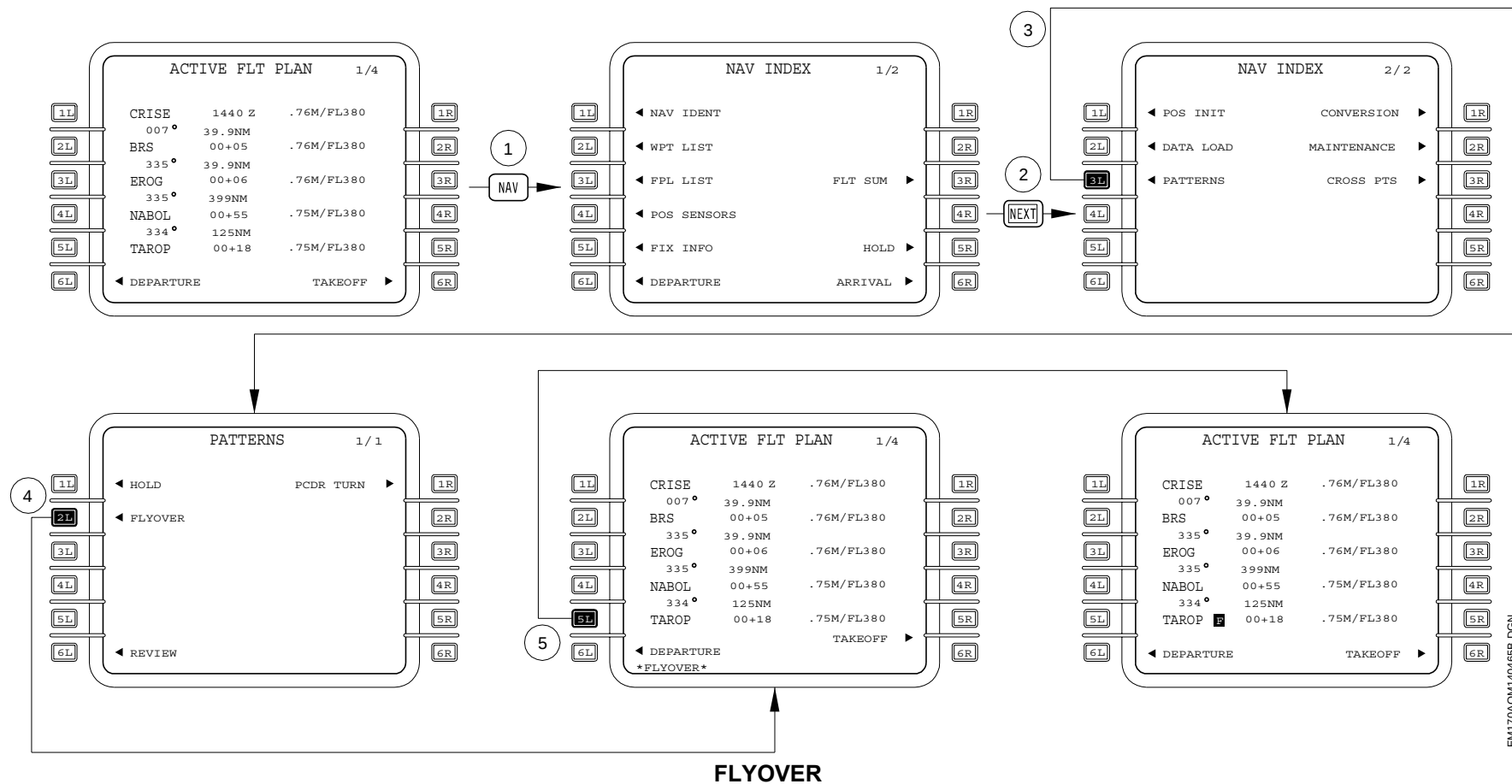


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FLYOVER

The flyover is used to proceed to a waypoint before commencing the turn.

- 1 Press NAV button to enter in the NAV INDEX 1/2 page.
- 2 Press NEXT button to go to NAV INDEX 2/2 page.
- 3 Press LSK 3L (PATTERNS) to enter in the PATTERNS 1/1 page.
- 4 Press LSK 2L (FLYOVER).
- 5 On ACTIVE FLT PLAN page press the respective LSK correspondent to the desired flyover waypoint. If the desired flyover waypoint is not displayed press NEXT button until it appears.

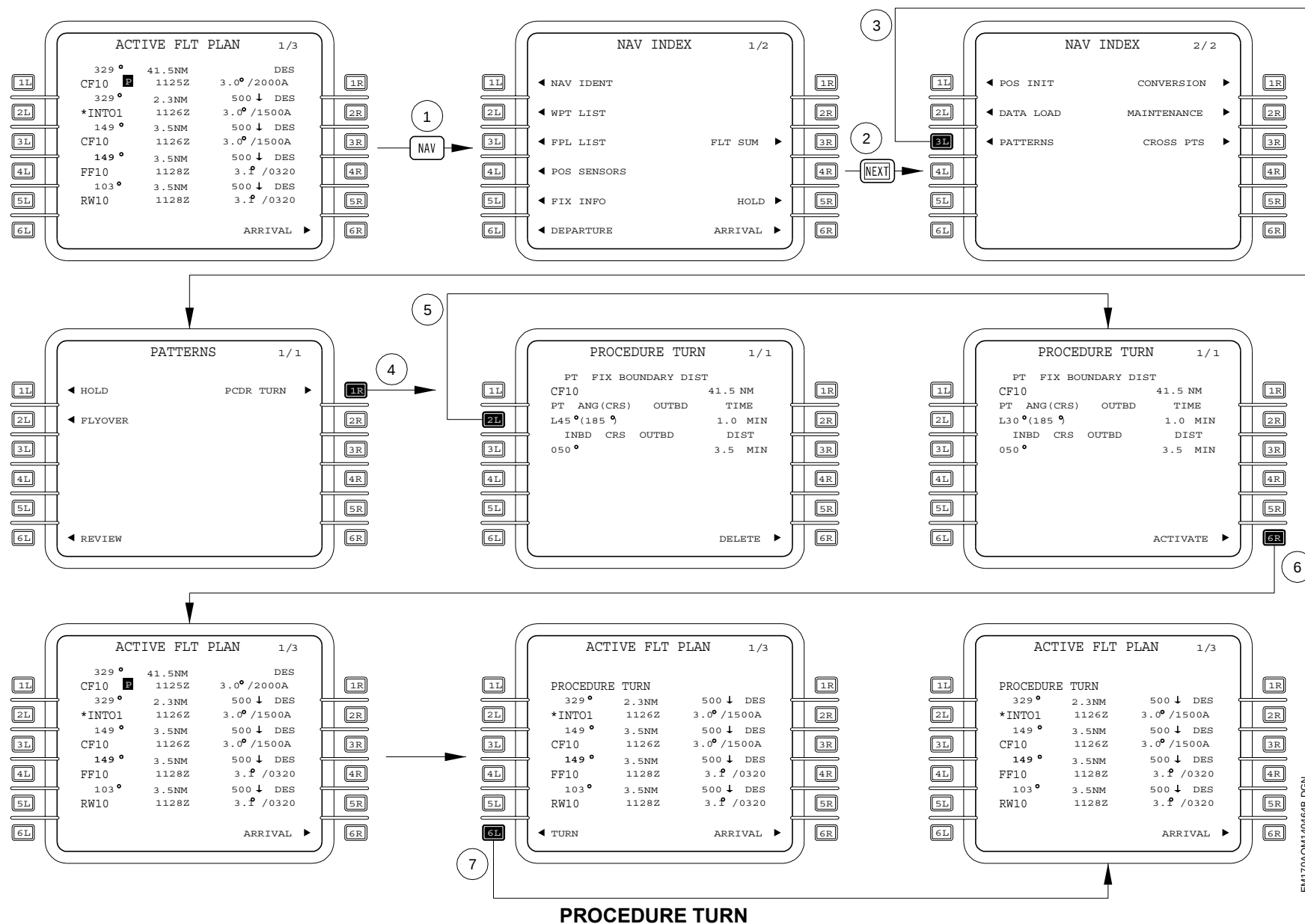


PROCEDURE TURN

The procedure turn is used to reverse the course during an approach. A procedure turn is only available from approaches in the navigation data base.

- 1 Press NAV button to enter in the NAV INDEX 1/2 page.
- 2 Press NEXT button to enter in the NAV INDEX 2/2 page.
- 3 Press LSK 3L (PATTERNS) to go to PATTERNS 1/1 page.
- 4 Press LSK 1R (PCDR TURN) to go to PROCEDURE TURN 1/1 page.
- 5 On the PROCEDURE TURN 1/1 page the following information is displayed:
 - Procedure turn fix.
 - Boundary distance.
 - Procedure turn angle. The entry is L (left) or R (right) followed by the turn angle.
 - Inbound course.
 - Outbound time.
 - Outbound distance.

The outbound time/distance and procedure turn angle can be changed. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK.
- 6 Press LSK 6R (ACTIVATE) to go to ACTIVE FLT PLAN page.
- 7 After passing the procedure turn fix press LSK 6L (TURN).



CROSSING POINTS

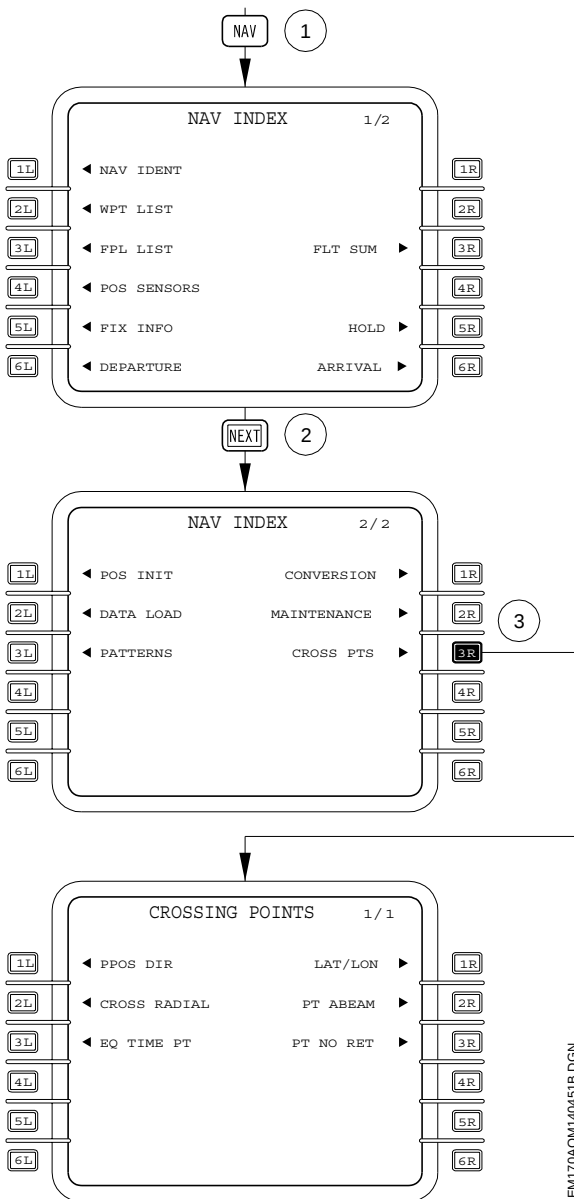
The crossing points are used to determine some information regarding a waypoint relative to the current aircraft position. The following types of crossing points are presented:

- Present position direct to a waypoint from the current airplane position.
- Crossing radial from a waypoint for the current airplane position.
- Equal time point between any two given waypoints. This option is only available when operating in full performance mode.
- Latitude/longitude crossing for the current flight plan.
- Point abeam a waypoint for current flight plan.
- Point of no return from any given waypoint. This option is only available when operating in full performance mode.

- 1 Press NAV button to go to NAV INDEX 1/2 page.
- 2 Press NEXT button to go to NAV INDEX 2/2 page.
- 3 Press LSK 3R (CROSS PTS) to enter in the CROSSING POINTS 1/1 page.

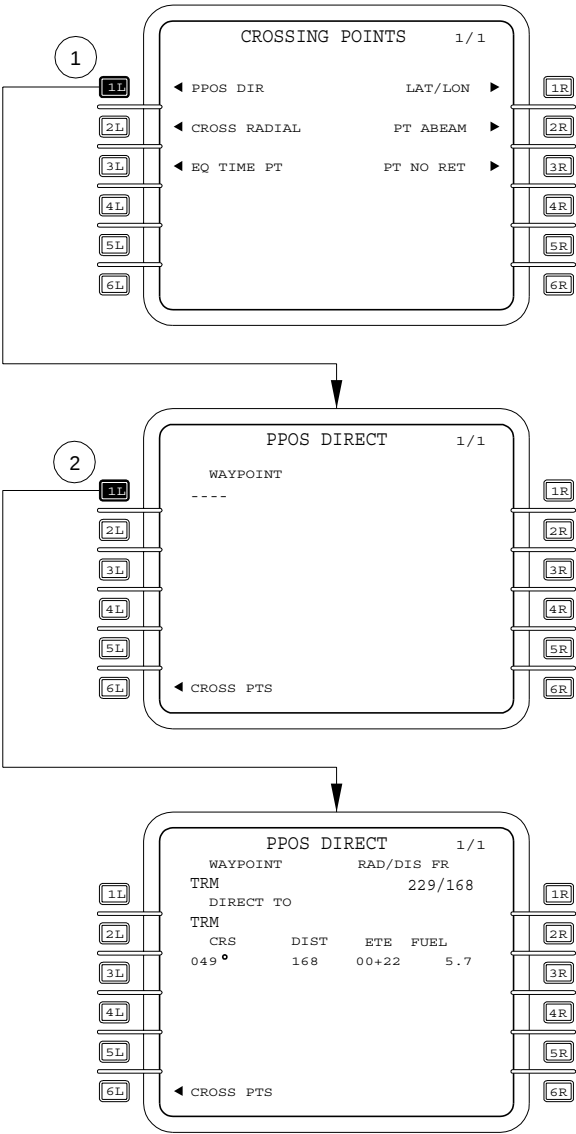
PRESENT POSITION DIRECT

- 1 On CROSSING POINTS 1/1 page press LSK 1L (PPOS DIR) to go to PPOS DIRECT 1/1 page.
- 2 Enter with the waypoint name. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing LSK 1L.
After the entry the following information is displayed:
 - Course to the waypoint.
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel in the waypoint.



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CROSSING POINTS



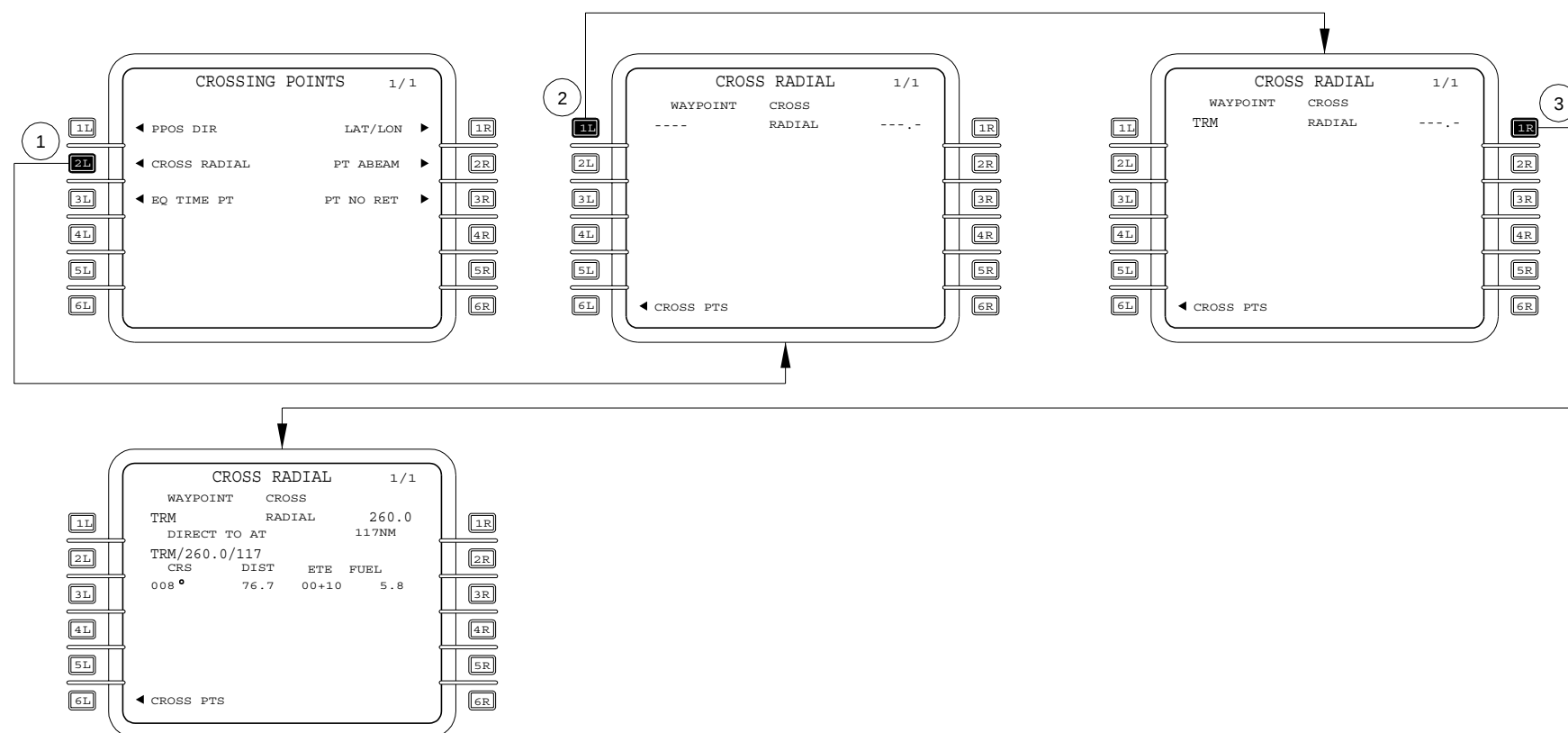
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PRESENT POSITION DIRECT

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CROSSING RADIAL

- 1 On the CROSSING POINTS 1/1 page press LSK 2L (CROSS RADIAL) to go to CROSS RADIAL 1/1 page.
- 2 Enter with the waypoint name. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing LSK 1L.
- 3 Enter with the cross radial. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing LSK 1R.
After the entry the following information is displayed:
 - The distance from the waypoint where the airplane will cross the selected radial.
 - Course to the waypoint.
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel at the waypoint.



CROSSING RADIAL

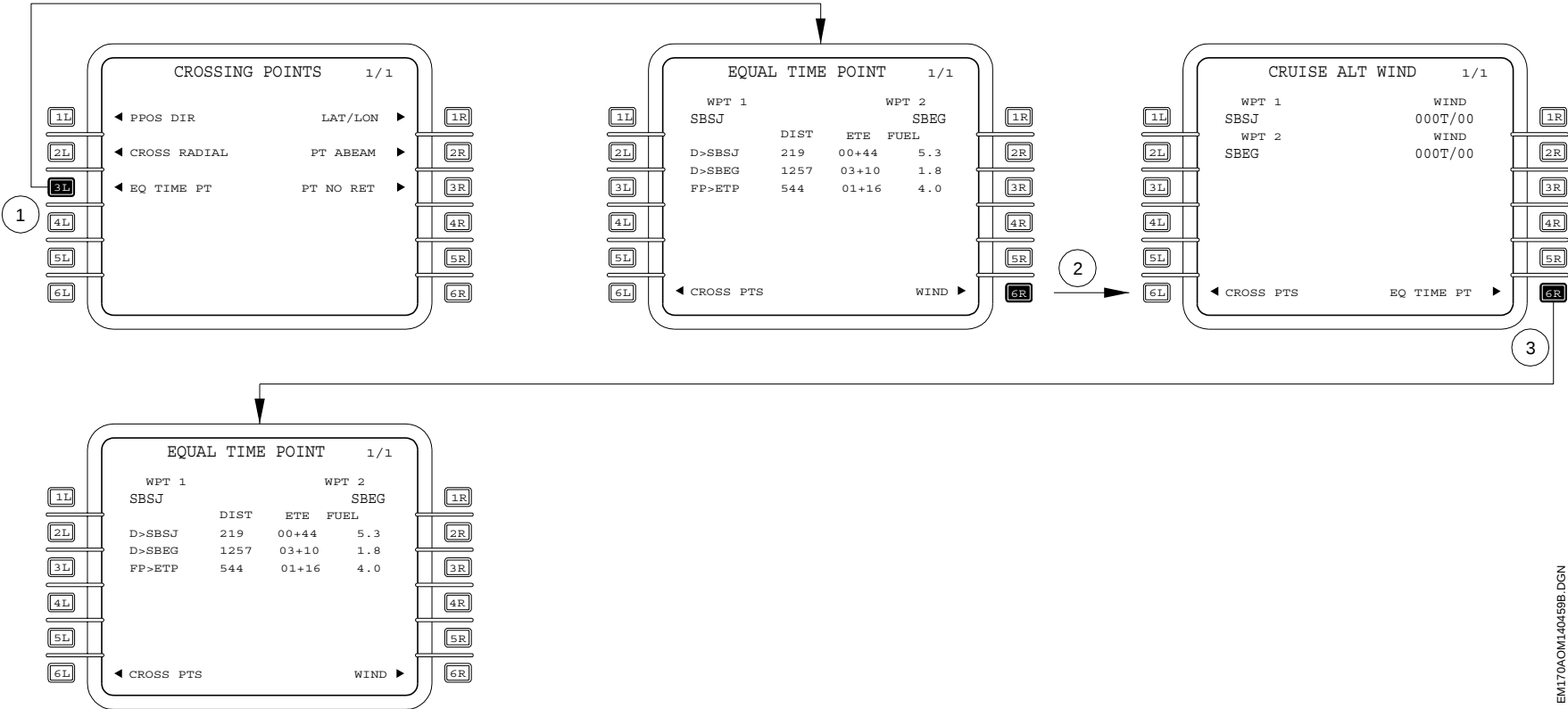
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EQUAL TIME POINT

- 1 On the CROSSING POINTS 1/1 page press LSK 3L (EQ TIME PT) to go to EQUAL TIME POINT 1/1 page.
- 2 On EQUAL TIME POINT 1/1 page the following information is displayed to the waypoints 1/2 and Equal Time Point (ETP):
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel in the waypoint.

The default waypoints are origin and destination. It is possible to enter other waypoints. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing LSK 1L or 1R.

If the airplane has passed the ETP the message PAST is displayed.
- 3 Pressing LSK 6R (WIND) enters in the CRUISE ALT WIND 1/1 page. Cruise wind entry can be done for the selected waypoints. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK (1R or 2R).
- 4 Press LSK 6R (EQ TIME PT) to return to EQUAL TIME POINT 1/1 page.

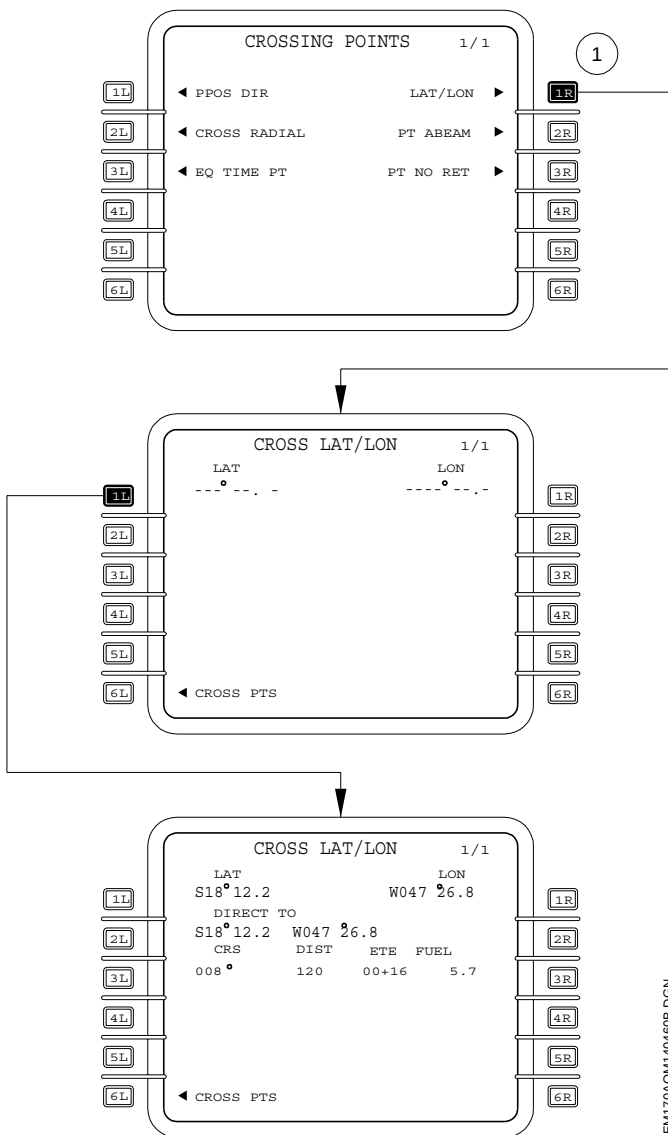


EQUAL TIME POINT

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LATITUDE/LONGITUDE CROSSING

- 1 On the CROSSING POINTS 1/1 page press LSK 1R (LAT/LON) to go to CROSS LAT/LON 1/1 page.
- 2 Enter with the latitude and/or longitude. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing the respective LSK (1L or 1R). After the entry the following information is displayed:
 - Course to the waypoint.
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel in the waypoint.



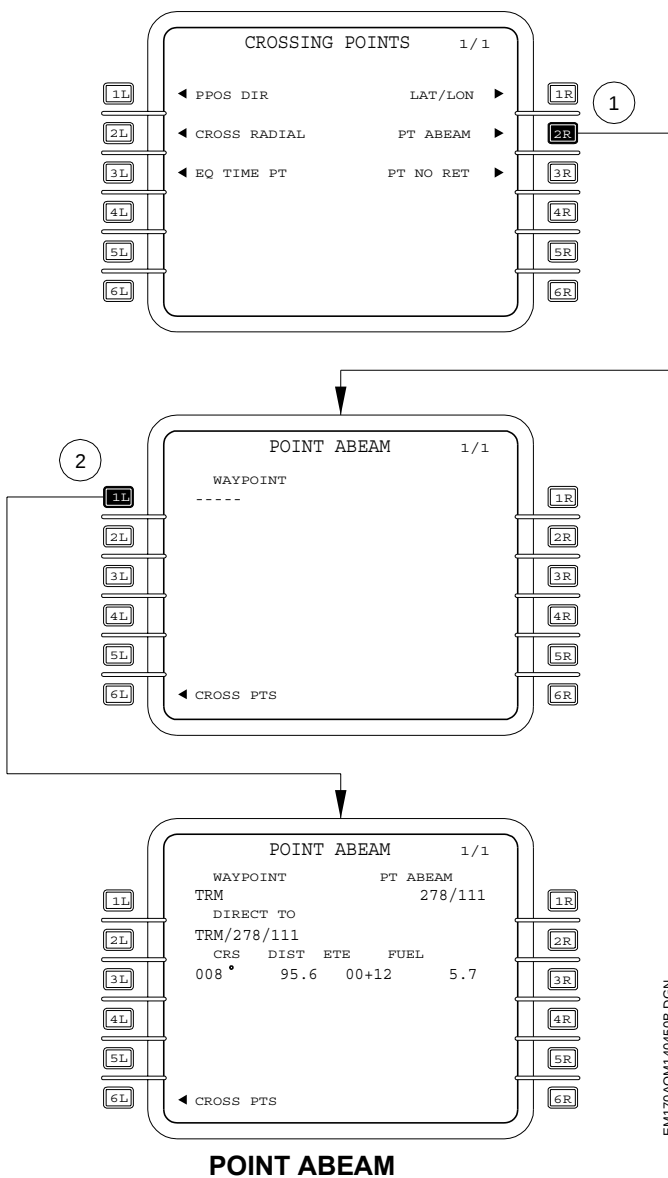
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LATITUDE/LONGITUDE CROSSING

POINT ABEAM

- 1 On the CROSSING POINTS 1/1 page press LSK 2R (PT ABEAM) to go to POINT ABEAM 1/1 page.
- 2 Enter with the waypoint name. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing LSK 1L. After the entry the following information is displayed:
 - The radial and distance from the waypoint where the airplane will cross the point abeam.
 - Course to the waypoint.
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel in the waypoint.

If no point abeam exists for the current flight plan the message NO CROSSING POINT FOUND is displayed.

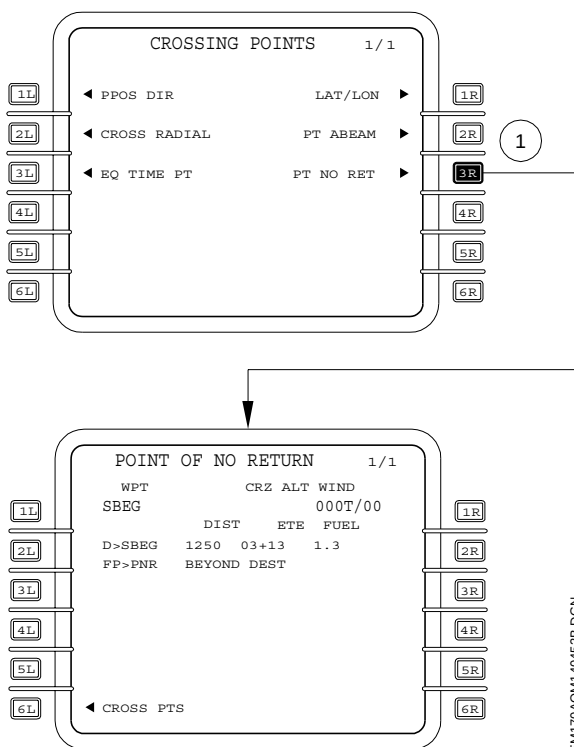


POINT OF NO RETURN

- 1 On the CROSSING POINTS 1/1 page press LSK 3R (PT NO RET) to go to POINT OF NO RETURN 1/1 page.
- 2 On POINT OF NO RETURN 1/1 page the following information is displayed for the selected waypoint and point of no return:
 - Distance to the waypoint.
 - Estimated time enroute.
 - Remaining fuel at the waypoint.

The default waypoint is the origin. It is possible to enter other waypoints and/or cruise wind. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing respectively LSK 1L or 1R. If the airplane has passed the point of no return a message PAST is displayed.

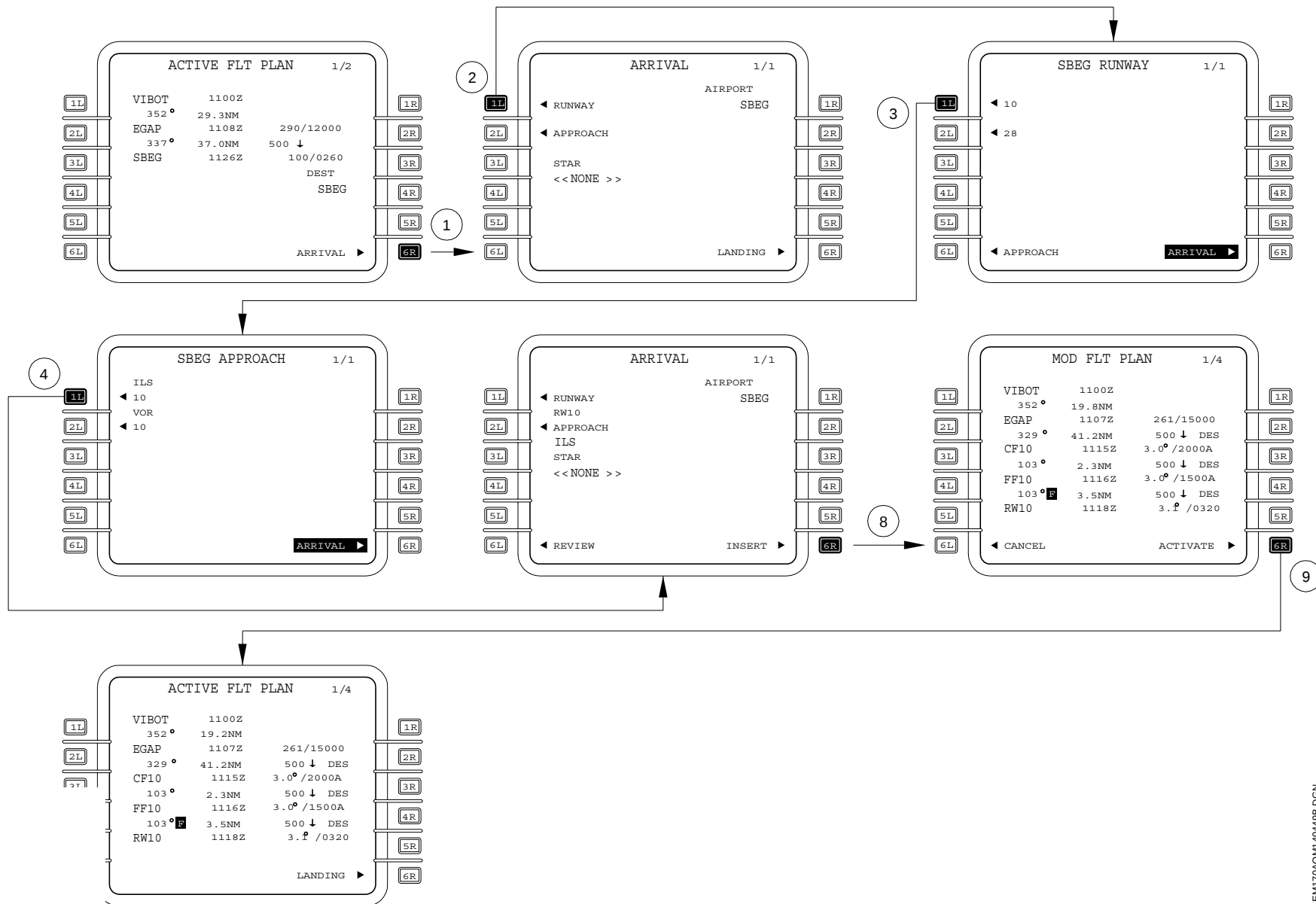
If the point of no return is beyond the destination a message BEYOND DEST is displayed.



POINT OF NO RETURN

ARRIVAL

- 1 When the airplane is within 200 NM to the destination the prompt ARRIVAL appears. Press LSK 6R (ARRIVAL) to enter in the ARRIVAL 1/1 page.
- 2 On ARRIVAL page select LSK 1L (RUNWAY) to go to RUNWAY page.
- 3 On RUNWAY page select the runway by pressing the respective LSK.
- 4 On APPROACH page select approach procedure by pressing the respective LSK.
- 5 On APROACH TRANS page select the approach transition by pressing the respective LSK.
- 6 On STAR page select the STAR by pressing the respective LSK.
- 7 On STAR TRANS page select the STAR transition by pressing the respective LSK.
- 8 Press LSK 6R (INSERT) to insert the arrival.
- 9 On MOD FLT PLAN page press LSK 6R (ACTIVE) to activate the flight plan.



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ARRIVAL

LANDING

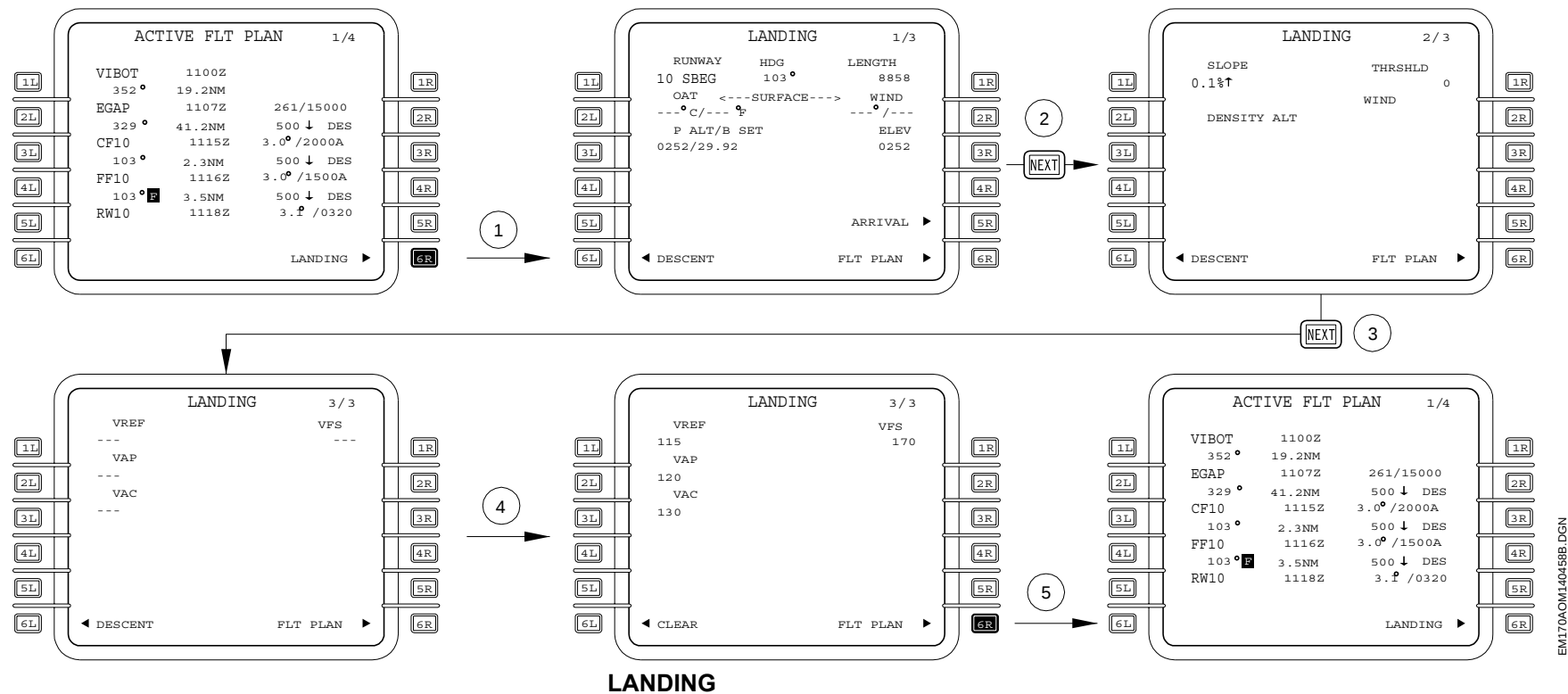
- 1 When the airplane is within 200 NM to the destination the prompt LANDING appears. Press LSK 6R (LANDING) to enter in the LANDING 1/3 page.

On LANDING 1/3 page the following information is displayed:

- Runway heading.
- Runway length.
- Runway outside air temperature.
- Runway wind.
- Runway pressure altitude and barometric setting.
- Runway elevation.

With exception of runway heading and length the other information can be entered. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing respective LSK.

- 2 Press NEXT button to go to LANDING 2/3 page. The following information is displayed:
 - Runway slope.
 - Runway threshold.
 - Runway density altitude.
 - Runway wind.
- 3 Press NEXT button to go to LANDING 3/3 page.
- 4 Enter with VREF, VAP, VAC and VFS. The entry is accomplished in the scratchpad thru alphanumeric keys and pressing respective LSK.
- 5 Press LSK 6R (FLT PLAN) to go to ACTIVE FLT PLAN 1/4 page.



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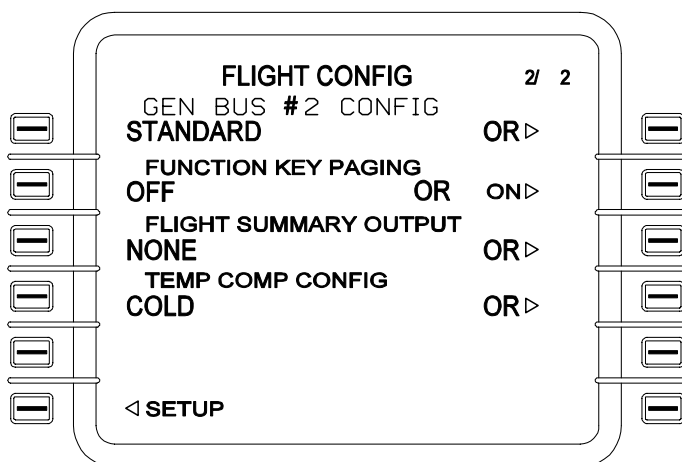
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VNAV TEMPERATURE COMPENSATION

FMS provides the capability to create constant angle vertical paths for the final approach segment of the non-precision approaches and vertical descent profiles for transition to the final approach segment based on the altitude constraints in the navigation database.

These descent profiles are flown by reference to the indicated barometric altitude. However, barometric altimeters are calibrated to indicate true altitude under ISA conditions of temperature and sea level pressure.

The VNAV temperature compensation provides the capability to compensate the altitude constraints for all the waypoints in approach, approach transitions and missed approach segments of the flight plan during non-standard temperature conditions.



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EICAS MESSAGES

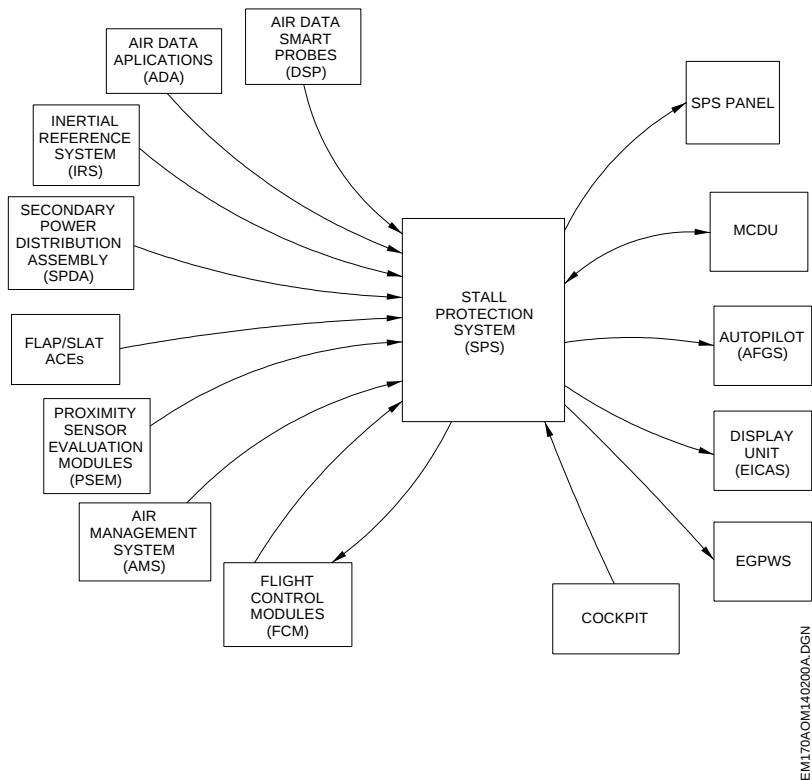
TYPE	MESSAGE	MEANING
CAUTION	FMS POS DISAG	A position disagreement between FMSs was detected.
	FMS 1 (2) GPS POS DISAG	A position disagreement between the associated FMS and GPS was detected.
	MCDU 1 (2) (3) OVHT	Associated MCDU has suffered an overtemperature condition.
ADVISORY	FMS 1 (2) FAIL	Associated FMS has failed.

STALL PROTECTION SYSTEM

The stall protection system provides warning to the pilot when the aircraft's speed is approaching stall speed. It is provided by the Auto Flight Control System (AFCS) by activating the stick shaker motor on the control column. The Flight Control Module (FCM) provides stall protection by means of angle-of-attack (AOA) limiting function.

Once the stick shaker is activated by the AFCS, the AOA limiting function reduces control column authority in the nose up direction gradually until the control column reaches the aft stop, thereby limiting the angle of attack. The FCM computes and AOA limiting command using angle of attack data, control column position and inertial feedback.

If one or more sensors required performing the AOA limiting fail, the function is no longer available, and the respective message is displayed on the EICAS.



STALL PROTECTION SYSTEM SCHEMATIC

ENHANCED GROUND PROXIMITY WARNING SYSTEM (EGPWS)

INTRODUCTION

The EGPWS uses aircraft position information, aircraft configuration information, and terrain database information to provide the flight crew with increased awareness of the terrain along the projected flight path. EGPWS consists of a Forward Looking Terrain, Awareness Function, a Terrain Clearance Floor Function, Ground Proximity Warning Function Modes 1 through 6, and a Terrain Awareness Display.

The system provides the flight crew with sufficient information and alerting to detect a potentially hazardous terrain situation that would permit the flight crew to take effective action to prevent a Controlled Flight Into Terrain (CFIT) event.

The Forward Looking and Terrain Clearance Floor functions of the EGPWS compare the aircraft current position using both lateral and vertical positional information and flight path with the terrain database to determine if there is a potential threat of collision with terrain, as defined by the alerting algorithm. The EGPWS provides appropriate visual and aural discrete signals for alerting. The EGPWS also provides terrain information to be presented on a display system, which depicts the terrain of interest.

The main systems that the EGPWS receives inputs from are the following:

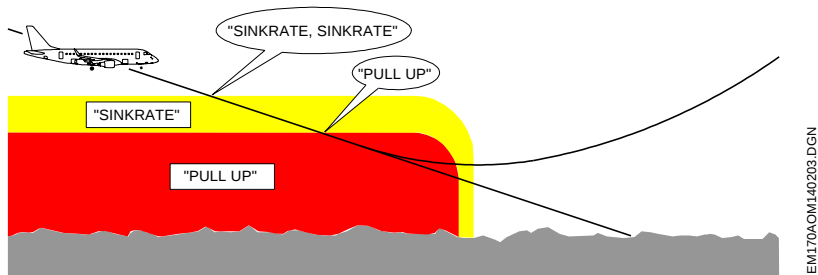
- Air data system (ADS).
- Flight management system (FMS).
- Global positioning system (GPS).
- Inertial reference system (IRS).
- Radar altimeter.
- Slats and flaps control system.

EGPWS MODES

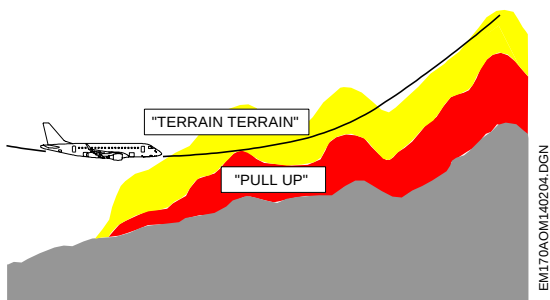
The EGPWS provides alerts associated with the following flight conditions:

- Excessive descent rate.
- Excessive closure rate to terrain.
- Altitude loss after takeoff.
- Unsafe terrain clearance.
- Descent below glideslope.
- Callouts.
- Windshear.
- Excessive bank angle.
- Terrain and obstacles alerts.
- Terrain clearance floor.

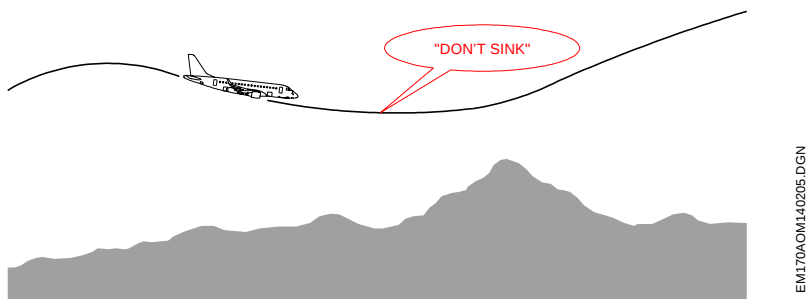
EXCESSIVE DESCENT RATE



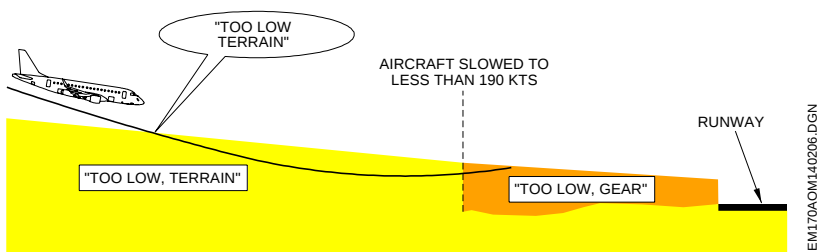
EXCESSIVE CLOSURE TO TERRAIN



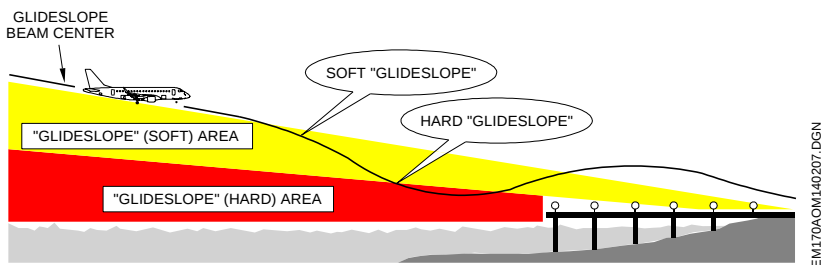
ALTITUDE LOSS AFTER TAKEOFF



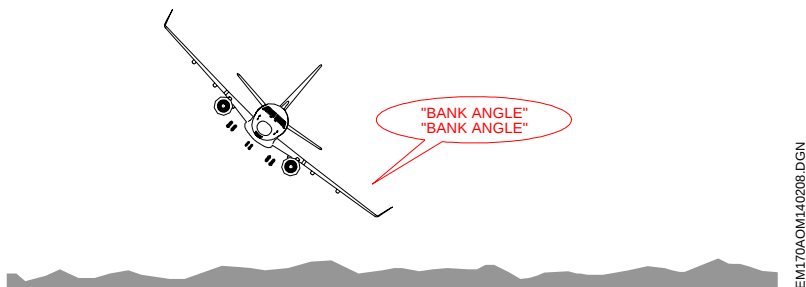
UNSAFE TERRAIN CLEARANCE



DESCENT BELOW GLIDESLOPE



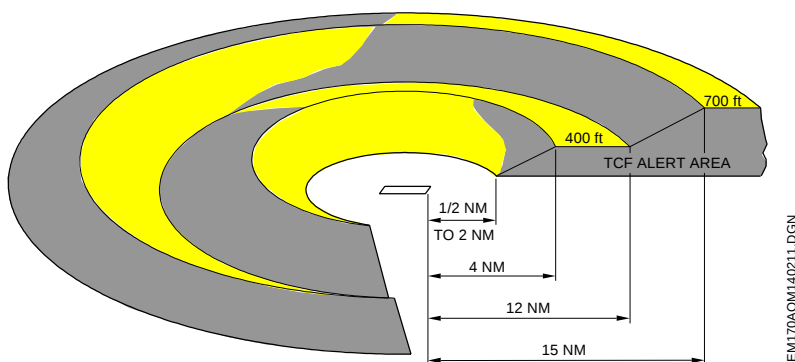
EXCESSIVE BANK ANGLE



TERRAIN CLEARANCE FLOOR

The Terrain Clearance Floor (TCF) provides a circular terrain clearance envelope around the airport runway, alerting the pilot of a premature descent for non-precision approaches. The TCF is active during takeoff, cruise and final approach and is based on airplane present position, nearest runway and radio altitude.

The database consists of all hard surfaces runways greater than 1067 m (3500 ft) in length.



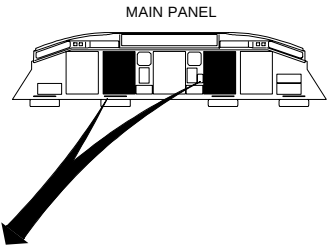
TCF ALERT ENVELOPE

TERRAIN MAPPING SELECTION

Terrain mapping is provided by EGPWS and is displayed on the navigation map of the MFD display when selected. There are two selection modes:

- Display selection through the MFD's MAP menu function.
- EGPWS Auto pop-up request during a terrain/obstacle caution warning.

When an auto pop-up occurs, the MFD range is automatically changed to 10 NM. Terrain mapping is removable from the display via the MFD menu function. EGPWS modes and status are displayed adjacent to the navigation display. Weather radar data is disabled while terrain data is displayed. EGPWS range is controlled with the overall range control in the CCD. The range selections are 5, 10, 25, 50, 100, 200, 300 and 500.



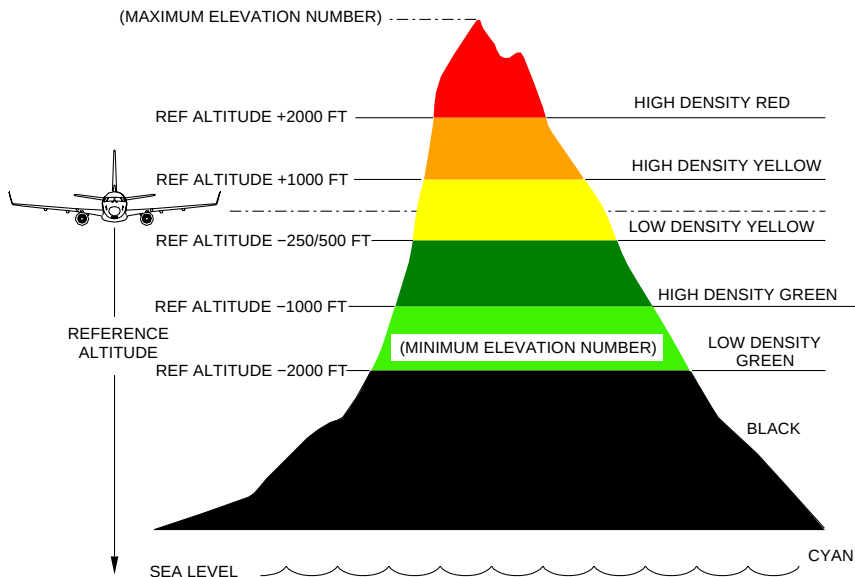
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MFD MAP MENU

TERRAIN AWARENESS DISPLAY

The EGPWS terrain display is designed to increase flight crew awareness of the surrounding terrain in varying density dots patterns of green, yellow and red. These dot patterns represent specific terrain separation from the airplane.

COLOR	MEANING
Solid red	Warning Terrain (Approximately 30 sec from impact).
Solid yellow	Caution Terrain (Approximately 60 sec from impact).
High density red dots	Terrain that is more than 2000 ft above airplane altitude.
High density yellow dots	Terrain that is between 1000 and 2000 ft above airplane altitude.
Low density yellow dots	Terrain that is between 500 ft (250 ft with gear down) below and 1000 ft above airplane altitude.
Solid green	Highest terrain not within 500 (250 ft with gear down) ft of aircraft altitude. May appear with dotted yellow terrain when the aircraft altitude is within 500 ft (250 ft with gear down) of terrain.
High density green dots	Terrain that is the middle elevation band when there is no red or yellow terrain areas within range on the display.
Low density green dots	Terrain that is the lower elevation band when there is no red or yellow terrain areas within range on the display.
Light density cyan dots	Terrain elevation equal to 0 ft MSL.



REFERENCE ALTITUDE IS PROJECT DOWN FROM ACTUAL AIRCRAFT ALTITUDE TO PROVIDE A 30 SECOND ADVANCE DISPLAY 01 TAMA IN WHEN DESCENDING MORE THAN 1000 fpm.

TERRAIN IS NOT SHOWN IF IT IS BELOW THE LOWEST BAND AND/OR IS WITH IN 4000 feet OF THE RUNWAY ELEVATION NEAREST THE AIRCRAFT. SEA LEVEL WATER IS DISPLAYED IF SUPPORTED BY THE DISPLAY.

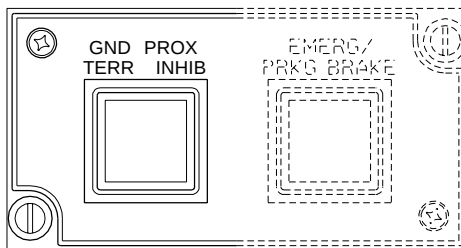
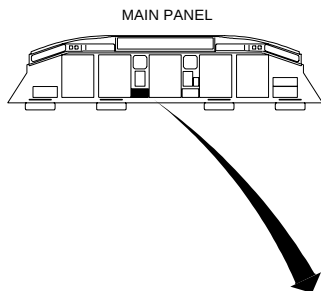
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EGPWS DISPLAY COLOR CODING

CONTROLS AND INDICATORS

GLARESHIELD EGPWS PANEL

EGPWS TERRAIN SYSTEM OVERRIDE

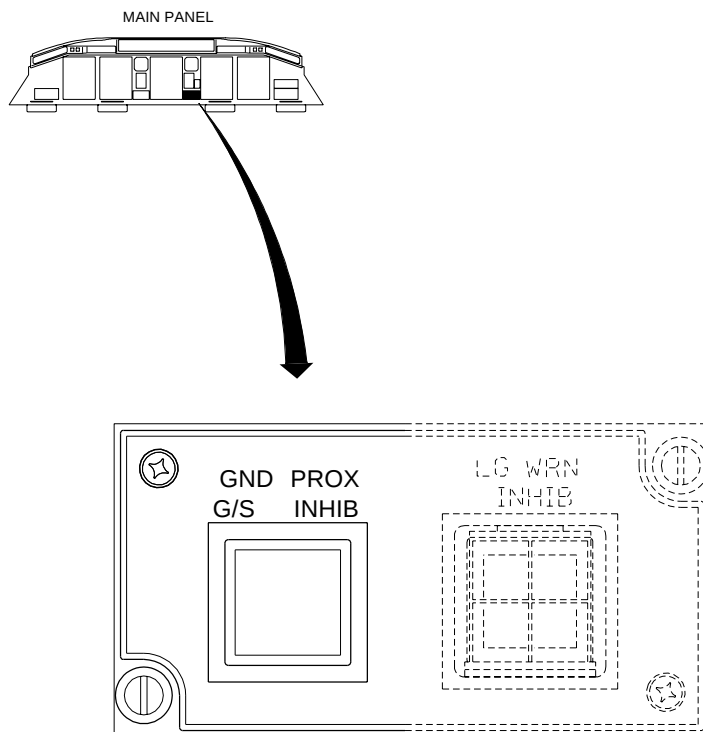


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GROUND PROXIMITY TERRAIN INHIBIT PUSHBUTTON

- When pushed in, inhibits EGPWS and thus avoids unwanted terrain alerts in airports not covered by EGPWS database.

EGPWS GLIDESLOPE CANCELLATION



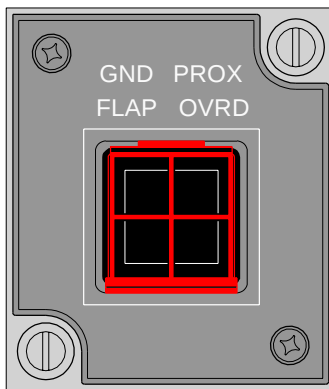
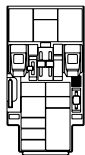
GROUND PROXIMITY GLIDESLOPE INHIBIT

- Momentary pushbutton annunciator used to manually cancel glideslope alerts.
- Illuminates when pressed any time below 2000 ft nominal radar altitude and will be automatically reset (light off) by climbing above 2000 ft nominal or descending below 30 ft.

CONTROL PEDESTAL EGPWS PANEL

FLAP OVERRIDE SWITCH (GUARDED)

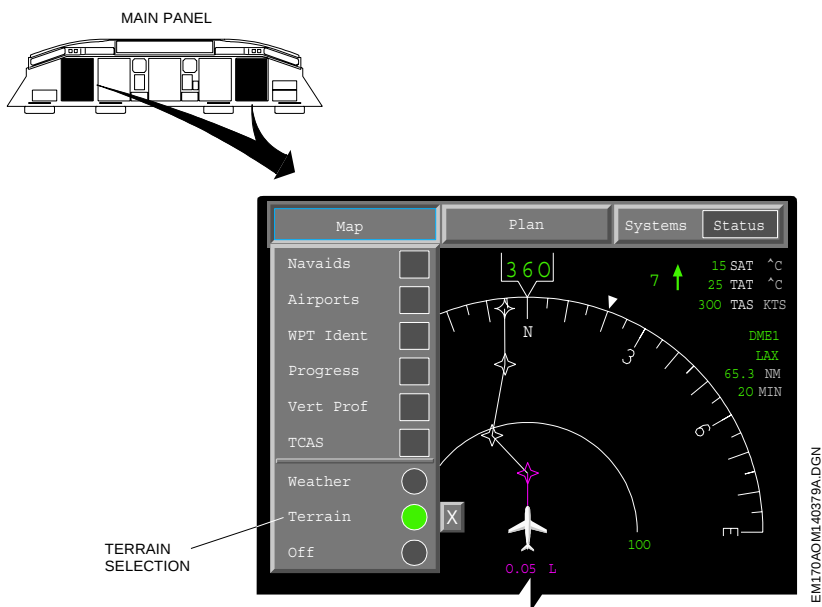
CONTROL
PEDESTAL



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- Inhibits triggering flap alerts in case of landings where flap configuration is different from normal landing flap configuration.

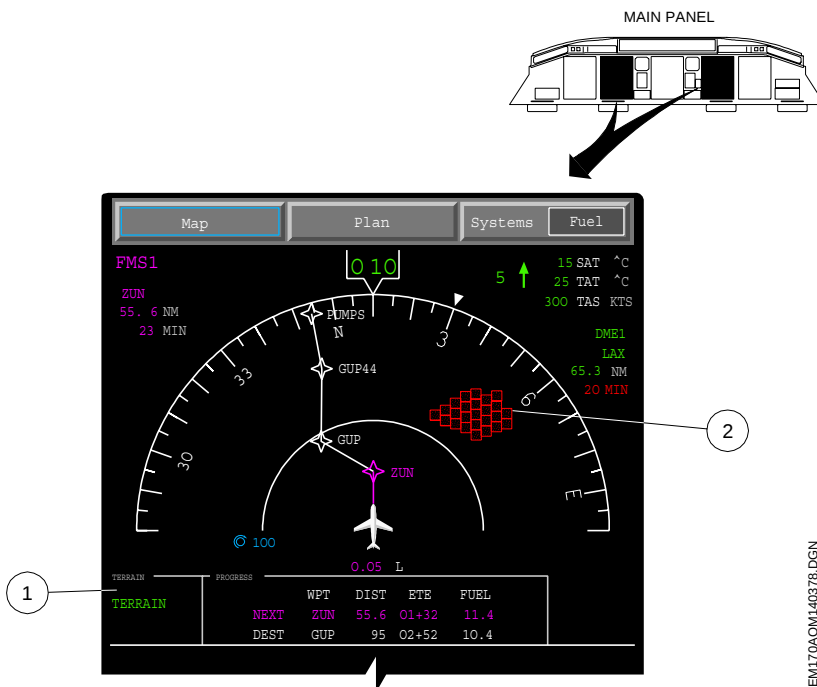
EGPWS SELECTION ON MFD



EGPWS MAP MENU FUNCTION

- The ranges allowed are: 5 NM, 10 NM, 25 NM, 50 NM, 100 NM, 200 NM, 300 NM, 500 NM and 1000 NM.
- When a terrain warning/caution exists and the terrain is not selected on the MFD, the terrain is automatically displayed on the MFD with a range of 10 NM.

EGPWS DISPLAY ON MFD



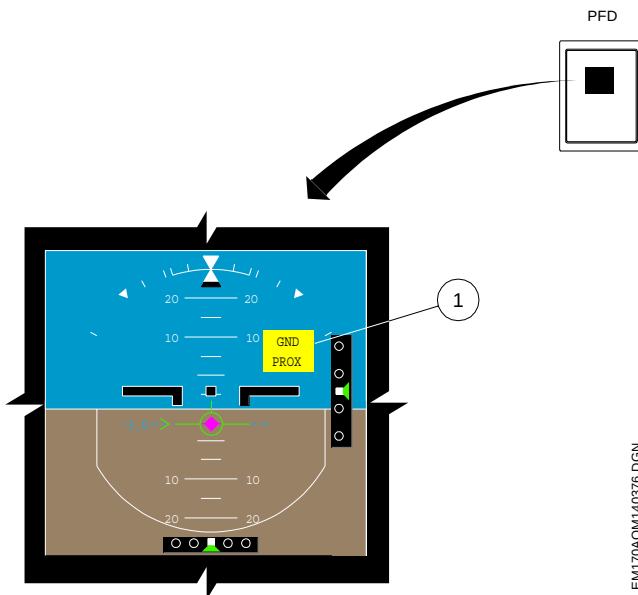
1 – TERRAIN ANNUNCIATION

- Labels and colors:
 - TERRAIN
 - GREEN: EGPWS is scanning the terrain.
 - AMBER: system failure.
 - TERRAIN INHIBIT
 - WHITE: terrain inhibit button is pressed in approach mode.
 - TERRAIN N/A
 - AMBER: terrain awareness not available due to position accuracy degradation.
 - TERRAIN TEST
 - WHITE: self-test activated.

2 – TERRAIN INDICATION

- Displays images of surrounding terrain. Different colors and their intensity represent the terrain elevation.
- Colors:
 - Solid red: warning terrain threat area.
 - Solid yellow: caution terrain threat area.
 - High-density red dots: terrain more than 2000 ft above airplane altitude.
 - High-density yellow dots: terrain between 1000 ft and 2000 ft above airplane altitude.
 - Low-density yellow dots: terrain between 500 ft (250 ft with gear down) below and 1000 ft above airplane altitude.
 - Solid green: the highest terrain is not within 500 ft (250 ft with gear down) of airplane altitude. It may be displayed with dotted yellow when the airplane altitude is near to 500 ft (250 ft with gear down) of terrain.
 - High-density green dots: terrain between 1000 ft and 500 ft below the airplane altitude.
 - Low-density green dots: terrain between 2000 ft and 1000 ft below the airplane altitude.
 - Low density cyan dots: sea level.

EGPWS DISPLAY ON PFD



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1 – GROUND PROXIMITY/PULL UP ANNUNCIATIONS

- Label and colors:
 - GND PROX
 - Color: amber.
 - Ground is getting closer too fast.
 - PULL UP
 - Color: red.
 - Either modes 1 or 2 have been activated in their more critical situation.

EGPWS MESSAGES

The EGPWS provides the following aural and visual messages:

AURAL MESSAGE	VISUAL MESSAGE	MEANING
APPROACHING MINIMUMS	None	Descent below Decision Height (DH) or Minimum Descent Altitude (MDA) setting, plus 80 ft.
BANK ANGLE; BANK ANGLE	None	Excessive roll or bank angle maneuver.
CAUTION OBSTACLE; CAUTION OBSTACLE	GND PROX; Terrain shown in amber on MFD	The projected impact terrain is between 40 and 60 seconds from the airplane. The terrain is shown in amber on the MAP page display.
CAUTION TERRAIN; CAUTION TERRAIN	GND PROX; Terrain shown in amber on MFD	The projected impact terrain is between 40 and 60 seconds from the airplane. The terrain is shown in amber on the MAP page display.
DON'T SINK; DON'T SINK	GND PROX	Excessive loss of altitude after a takeoff or go-around.
FIVE HUNDRED	None	Radio altimeter callout for descent below 500 ft.
GLIDESLOPE	GND PROX	Airplane is below glideslope on ILS approach. Aural warning is annunciated at half-volume.
GLIDESLOPE; GLIDESLOPE	GND PROX	Airplane excessively below from glideslope on ILS approach at low altitudes.
MINIMUMS; MINIMUMS	None	Descent below Decision Height (DH) or Minimum Descent Altitude (MDA) bug setting.
OBSTACLE OBSTACLE, PULL UP	PULL UP; and terrain shown in red on the MAP page display.	Warning proximity to the projected impact terrain. The terrain is shown in red on the MAP page display.
ONE HUNDRED	None	Radio altimeter callout for descent below 100 ft (*). (*) By default this feature is inhibited. Contact maintenance personnel to enable this callout.

AURAL MESSAGE	VISUAL MESSAGE	MEANING
PULL UP; PULL UP; PULL UP	PULL UP	Excessive descent rate becomes severe. Follows the SINKRATE aural annunciation.
PULL UP; PULL UP; PULL UP	PULL UP	Excessive and hazardous terrain closure rate becomes severe. Follows the TERRAIN aural annunciation.
SINKRATE; SINKRATE	GND PROX	Excessive descent rate.
TERRAIN TERRAIN, PULL UP	PULL UP; and terrain shown in red on the MAP page display.	Warning proximity to the projected impact terrain. The terrain is shown in red on the MAP page display.
TERRAIN; TERRAIN	GND PROX	Excessive and hazardous terrain closure rate. Levelled flight or even climb towards obstructing terrain also set the alarm. A continuous TERRAIN aural alert will be annunciated if landing gear and flaps are set to landing configuration.
TOO LOW FLAPS	GND PROX	Unsafe terrain clearance at low speed. Landing gear down, but flaps not in landing configuration.
TOO LOW GEAR	GND PROX	Unsafe terrain clearance at low speed. Flaps and landing not in landing configuration.
TOO LOW TERRAIN	GND PROX	Unsafe terrain clearance at high speed. Flaps and landing gear not in landing configuration.
TOO LOW TERRAIN	GND PROX	Descent below the approach path while too far from the airport in the database.
TWO HUNDRED	None	Radio altimeter callout for descent below 200 ft.
FIFTY	None	Radio altimeter callout for descent below 50 ft.
FORTY	None	Radio altimeter callout for descent below 40 ft.
THIRTY	None	Radio altimeter callout for descent below 30 ft.
TWENTY	None	Radio altimeter callout for descent below 20 ft.
TEN	None	Radio altimeter callout for descent below 10 ft.

NOTE: For decision heights (DH) below 100 ft, the aural “ONE HUNDRED” sounds first than “MINIMUMS, MINIMUMS”. Therefore, a delay for the aural “MINIMUMS, MINIMUMS” is expected.

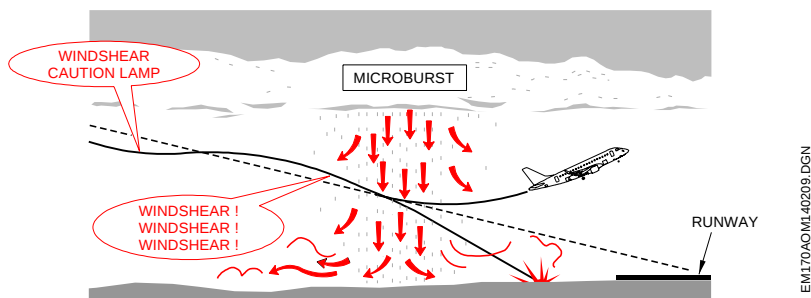
WINDSHEAR DETECTION AND ESCAPE GUIDANCE SYSTEM

WINDSHEAR DETECTION

Windshear detection is activated between 10 and 1500 ft radio altitude during the initial takeoff, go-around and final approach phases of flight.

Increasing headwind and updraft detection cause the annunciation of an amber WSHEAR on PFD and a CAUTION WINDSHEAR voice message.

Decreasing headwind (or increasing tailwind) and down drafts detection cause the annunciation of a warning windshear condition through a red WSHEAR on PFD and a “WINDSHEAR; WINDSHEAR; WINDSHEAR” voice message.



WINDSHEAR DETECTION

WINDSHEAR ESCAPE GUIDANCE MODE

The Windshear Escape Guidance Mode provides a pitch command to recover from a windshear to minimize altitude and airspeed loss during a windshear encounter.

This mode is a flight director mode and it is engaged in the following conditions:

- Manually: pressing the Go Around Button while a windshear condition is detected.
- Automatically: operating in go-around or takeoff mode and a windshear condition is detected.
- Automatically when thrust levers' position is above 70° and a warning windshear condition is detected.

The other flight director modes are canceled and the following modes are inhibited while in a caution or warning windshear condition:

Altitude pre-select, go-around and takeoff modes are canceled while in a caution or warning windshear condition. No lateral mode is inhibited while in windshear mode.

The Windshear Escape Guidance Mode incorporates three control logics:

- Gamma Submode - The airplane has a positive flight path angle. This sub-mode allows the airspeed to build up during an increasing performance windshear in anticipation of a decreasing performance windshear.
- Alpha Submode - The airplane maintains airspeed when approaching stall conditions. The windshear protection control logic keeps the airplane angle of attack below the stick shaker firing angle.
- Speed Target Submode - The airplane manages the airspeed to prevent overspeed. Pitch up is commanded to maintain the calculated airspeed.

Windshear conditions will not be detected if either EGPWS or the Radar Altimeter is unavailable.

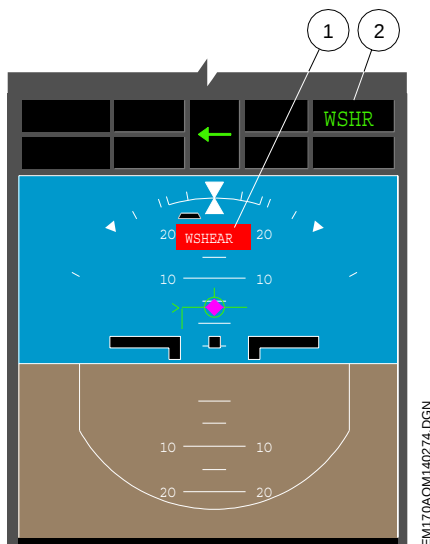
WINDSHEAR SYSTEM TEST

All EGPWS warning functions including the windshear warning function are tested during cockpit self-test prior to takeoff. The self-test is activated using the MCDU test page.

During the test, an amber "WINDSHEAR FAIL" message is displayed on the EICAS. A red "WSHEAR" message is displayed on the PFD and a "WINDSHEAR; WINDSHEAR; WINDSHEAR" aural message is annunciated. If the windshear warning function of the EGPWS is inoperative during the test, a "WINDSHEAR INOP" aural message is annunciated.

CONTROLS AND INDICATORS

WINDSHEAR INDICATION ON PFD



1 – WINDSHEAR INDICATION (WSHEAR)

- Indicates that windshear has been detected.
- Color:

AMBER: caution windshear.

RED: warning windshear.

2 – FLIGHT GUIDANCE ESCAPE MODE ENGAGEMENT

- Indicates the FGCS Windshear Escape Mode engagement.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)

The TCAS detects the nearby airplanes and displays symbols to represent them. The relative or absolute altitude and the vertical motion of the other airplanes is information displayed with each symbol.

The TCAS monitors a potential collision hazard and alerts the flight crew. It interrogates the mode A, mode C and mode S operating transponders in other airplanes and calculates the flight path of the possible intruder airplane.

If the intruder airplane is also equipped with an operating TCAS, the systems will communicate with each other to coordinate and generate guidance for the optimal avoidance maneuver.

NOTE: Intruder airplanes that do not have operating transponders are invisible to the TCAS.

TCAS ANNUNCIATIONS

The TCAS information is displayed on the MFD and PFD. There are six types of TCAS mode annunciations:

- TCAS FAIL – This annunciation is displayed when a TCAS failure is indicated by TCAS data, when TCAS data is invalid or when TCAS data has not been correctly received for 10 seconds.
- TCAS TEST – This annunciation is displayed when the TCAS computer indicates functional test is active.
- TCAS OFF – This annunciation is displayed when TCAS provides a valid indication that the computer is in standby mode.
- TA ONLY – This annunciation indicates that the TCAS is not selected to provide resolution advisories.
- TA/RA – This annunciation is displayed when TCAS provides a valid indication that the computer is in TA/RA mode. This annunciation is only displayed on both TCAS MFD displays.
- TCAS RA FAIL – This annunciation indicates that TCAS is not able to provide resolution advisories. The annunciation is displayed if the resolution advisory data is invalid or not received for 5 seconds or if information required to display the TCAS RA data on the PFD is missing or failed (e.g., if attitude, or groundspeed is failed or missing). This annunciation is only displayed on the PFD.

ANNUNCIATIONS ON MFD

The TCAS map overlay and TCAS zoom format are available on the MFD. The map overlay format displays the TCAS information on the navigation MAP mode, on MFD. The zoom format is displayed in the lower portion of MFD and has a range control. Only one format can be displayed at a time.

NOTE: If neither map overlay nor zoom format is displayed and the range is lower than 50 NM and a TA or RA condition is encountered, the zoom format is automatically displayed.

ANNUNCIATIONS ON PFD

When the TCAS detects an RA condition and a maneuver is recommended to increase the vertical separation (corrective RA), the flight director command bars are removed and one or two red trapezoidal avoidance zones and a green rectangular fly to zone are displayed. For RA condition where certain ranges of vertical speed are not recommended (preventive RA), only one red trapezoidal avoidance zone is displayed.

OPERATING MODES

The altitude range is an altitude region in which targets will be displayed from the present position altitude. There are four different ways to set the TCAS altitude range:

- **NORMAL:** shows targets that are within 2700 ft above or below current airplane altitude.
- **ABOVE:** shows targets that are within 9900 ft above and 2700 ft below current airplane altitude.
- **BELOW:** shows targets that are within 2700 ft above to 9900 ft below current airplane altitude.
- **EXPANDED:** shows targets that are within 9900 ft above or below current airplane altitude.

TCAS IDENTIFICATION

The TCAS provides four types of traffic identification.

- **Traffic Advisory (TA)** is annunciated when another airplane is approximately 35 to 45 seconds from the TCAS collision area. It is represented as an amber solid circle.
- **Resolution Advisory (RA)** is annunciated when another airplane is approximately 20 to 30 seconds from the TCAS collision area. It is represented as a red solid square.
- The proximate traffic is within 6.5 NM and 1200 ft above or below the airplane. It is displayed as a cyan solid diamond.
- Other traffic is beyond 6.5 NM and within 2700 ft above or below the airplane. It is displayed as a cyan hollow diamond.

NOTE: Other traffic is inhibited during TA or RA condition.

TRAFFIC DATA

The traffic data, made up of two or three-digit numbers, a plus (+) or a minus (-) sign, and which may also include an arrow, appears either above or below the intruder aircraft symbol on the MFD

- **RELATIVE ALTITUDE:** two digit numbers, preceded by a plus (+) or a minus (-) sign, represents the altitude in hundreds of feet. The digits are displayed above or below the symbol, according to position of the other airplane.
- **ABSOLUTE ALTITUDE:** the flight level is displayed with three digital numbers above the symbol for airplanes above the reference. For airplanes below the reference, two digits followed by a minus (-) sign are displayed below the symbol.
- **ARROW:** a vertical arrow displayed at the right side of each TA or RA symbol indicates vertical motion information greater than 550 ft/min.

AURAL ANNUNCIATION

For TA conditions, the aural alert “TRAFFIC–TRAFFIC” is annunciated once.

The RA aural messages associated to displayed advisories may be the following:

- “INCREASE CLIMB; INCREASE CLIMB”: Increase immediately the rate of climb.
- “INCREASE DESCENT; INCREASE DESCENT”: Increase immediately the rate of descent.
- “CLIMB, CLIMB NOW!; CLIMB, CLIMB NOW!”: The airplane is descending and a reversal of vertical speed is necessary to provide adequate separation.
- “DESCEND, DESCEND NOW! DESCEND, DESCEND NOW!”: The airplane is climbing and a reversal of vertical speed is necessary to provide adequate separation.
- “CLIMB; CLIMB; CLIMB”: Begin to climb immediately at the indicated rate of climb.
- “DESCEND; DESCEND; DESCEND”: Begin to descent immediately at the indicated rate of descent.
- “ADJUST VERTICAL SPEED, ADJUST; ADJUST VERTICAL SPEED, ADJUST”: Adjust smoothly the vertical speed to the indicated rate.
- “CLIMB, CROSSING CLIMB; CLIMB, CROSSING CLIMB”: Start a climb at indicated rate. The flight path will cross traffic’s altitude.
- “DESCEND, CROSSING DESCEND; DESCEND, CROSSING DESCEND”: Start a descent at indicated rate. The flight path will cross traffic’s altitude.

- “MONITOR VERTICAL; MONITOR VERTICAL”: Certain changes in vertical speed may not be safe.
- “MAINTAIN VERTICAL SPEED, MAINTAIN; MAINTAIN VERTICAL SPEED, MAINTAIN”: Maintain vertical speed rate.
- “MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN; MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN”: Adjust vertical speed to the rate indicated.

When the TCAS confirms no conflict condition and the separation is increasing, a “CLEAR OF CONFLICT” advisory is announced.

WARNING INHIBITS

The INCREASE DESCENT command is inhibited at altitudes below 1450 ft AGL during descent, or below 1650 ft AGL during climb.

The DESCENT command is inhibited at altitudes below 1000 ft AGL during descent, or below 1200 ft AGL during climb.

The TCAS automatically reverts to TA ONLY mode and inhibits RAs for altitudes below 900 ft AGL during descent, or below 1000 ft during climb.

The TAs are inhibited for airplanes at altitudes below 380 ft AGL.

All TCAS aural advisories are inhibited when the present position altitude is below 400 ft AGL during descent, or 600 ft AGL during climb.

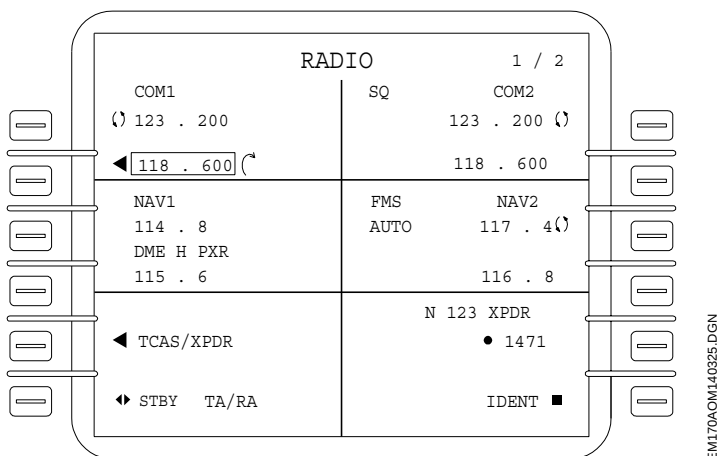
No Climb commands or increased Climb commands are issued at or above 34000 ft MSL. No other inhibits are implemented for the Climb or increased Climb functions.

TCAS OPERATION

The TCAS system can be controlled through the MCDU and on the MFD by the cursor control device (CCD).

Pressing the radio button on the MCDU, the display will show the radio pages. On the lower portion of the radio menu page 1/2 is shown the TCAS/XPDR modes. By pressing the line select key 6L is possible to select the TCAS mode to TA/RA or STBY.

On line select key 4R and 6R are displayed the selected XPDR code and the IDENT request. By pressing line select key 4L the TCAS/XPDR detail page 2 of 2 will be displayed. Beside line select key 1L are shown the TCAS and XPDR modes. To select the desired mode the line select key 1L need to be pressed as many times as needed. The modes are mutually exclusive.



To show TCAS on the Map Overlay is necessary to open the MAP menu on the MFD and then select TCAS TA/RA mode is the normal operation mode providing full TCAS coverage. In this mode, TCAS tracks aircraft in the surrounding airspace and generates traffic advisories or resolution advisories, as the situation requires.

The TA mode provides only surveillance of the surrounding airspace. In this mode, TCAS tracks proximate aircraft and generates traffic advisories; no resolution advisories are issued in this mode.

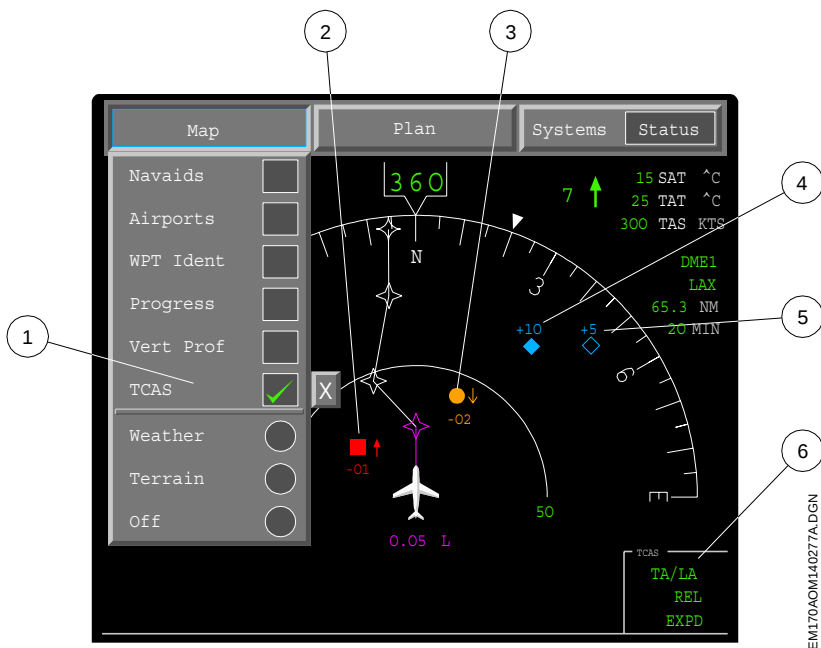
The range is selected using the CCD knob. The ranges selectable are 6, 12, 20, 40, 80 and 120 NM.

Map overlay is displayed selecting TCAS option in the MAP menu on MFD. Zoom display shows up when the Map Overlay is deselected.

Captain and First Officer's TCAS controls on the MFD's are totally independent from each other. That means, each pilot can control the TCAS as desirable independent of the control of the other side.

CONTROLS AND INDICATORS

TCAS MAP OVERLAY FORMAT WINDOW



1 – TCAS SELECTION IN MAP MENU

- Activates the TCAS information to be displayed on the map overlay format window.

2 – RESOLUTION ADVISORY (RA) INDICATION

- Symbol: Solid square.
- Color: Red.

3 – TRAFFIC ADVISORY (TA) INDICATION

- Symbol: Solid circle.
- Color: Amber.

4 – PROXIMATE TRAFFIC INDICATION

- Symbol: Solid diamond.
- Color: Cyan.

5 – OTHER TRAFFIC INDICATION

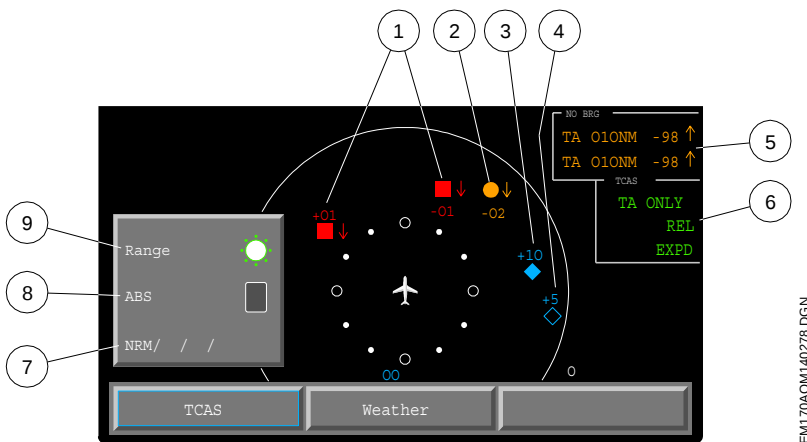
- Symbol: Hollow diamond.
- Color: Cyan.

6 – TCAS MODE

- Annunciates the TCAS operating mode.
- Labels and Colors:
 - TCAS FAIL: amber.
 - TCAS TEST: green.
 - TCAS OFF: amber.
 - TA ONLY: green.
 - TCAS TA/RA: green.

NOTE: The TA ONLY flashes amber when it is the active mode and an RA condition is detected.

TCAS ZOOM FORMAT WINDOW



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1 – RESOLUTION ADVISORY (RA) INDICATION

- Symbol: Solid square.
- Color: Red.

2 – TRAFFIC ADVISORY (TA) INDICATION

- Symbol: Solid circle.
- Color: Amber.

3 – PROXIMATE TRAFFIC INDICATION

- Symbol: Solid diamond.
- Color: Cyan.

4 – OTHER TRAFFIC INDICATION

- Symbol: Hollow diamond.
- Color: Cyan.

5 – NO BEARING INDICATION

- TCAS temporarily unable to determine the bearing of other airplanes when a steep bank angle masks the directional antenna.

6 – TCAS MODE

- Annunciates the TCAS operating mode.
- Labels and Colors:
 - TCAS FAIL: amber.
 - TCAS TEST: green.
 - TCAS OFF: amber.
 - TA ONLY: green.
 - TCAS TA/RA: green.

NOTE: The TA ONLY flashes amber when it is the active mode and an RA condition is detected.

7 – MODE SELECTION

- Selects the vertical mode to be displayed on TCAS.

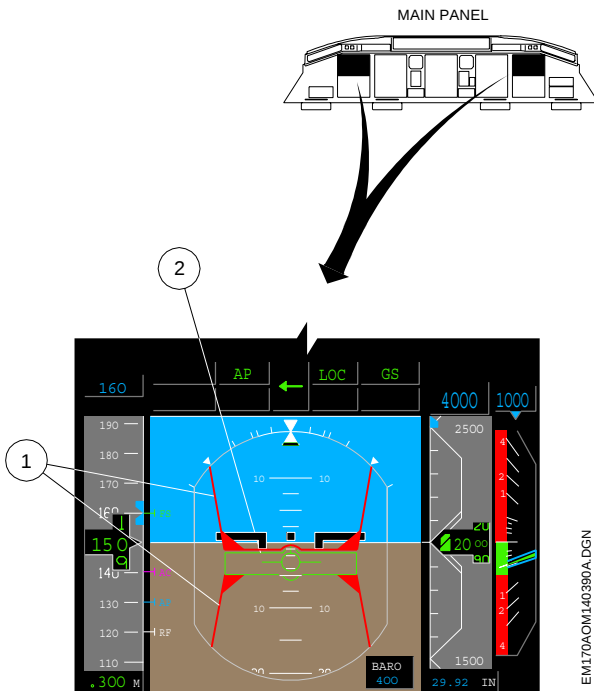
8 – ABS SELECTION

- Selects the absolute altitude mode to be displayed on TCAS. Deselecting this item enables the relative altitude mode.

9 – RANGE SELECTION

- Enables the selection of the range to be displayed. The selection is changed through the selector knob in the CCD.

TCAS INDICATION ON PFD



The commands provide pitch guidance information to the flight crew to recommend or prohibit a maneuver and prevent hazardous encounters with another airplane.

1 – AVOIDANCE ZONE

- Symbol: Trapezoid.
- Color: Red.

2 – FLY-TO ZONE

- Symbol: Rectangle.
- Color: Green.



EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	NO TAKEOFF CONFIG	Airplane is not in a valid takeoff configuration.
CAUTION	AURAL WRN SYS FAIL	Both aural warning channels are failed or off.
	CREW WRN SYS FAULT	Monitor warning A or B has failed.
	GND PROX FAIL	Ground proximity function in EGPWS has failed.
	TERRAIN FAIL	Terrain function in EGPWS has failed.
	WINDSHEAR FAIL	Windshear function in EGPWS has failed.
ADVISORY	AURAL WRN SYS FAULT	One aural warning channel is failed or off.
	AVNX MAU 1 (2) (3) A (B) FAULT	The associated MAU channel suffered failure condition(s) that does not affect its functionality, but may cause loss of redundancy.
	TCAS FAIL	TCAS has failed.
	TERRAIN NOT AVAILABLE	Terrain databases not cover the airplane flying area.

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ATA CHAPTER 35

OXYGEN

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INTRODUCTION

The oxygen system provides oxygen to the flight crew and passengers. The flight crew and passenger oxygen systems operate independently and are supplied by different oxygen sources.

Flight crew oxygen is stored in a rechargeable cylinder and chemical oxygen generators supply the passenger oxygen system. Portable oxygen cylinders are located throughout the airplane for first aid use. Protective breathing equipment is for emergency use only.

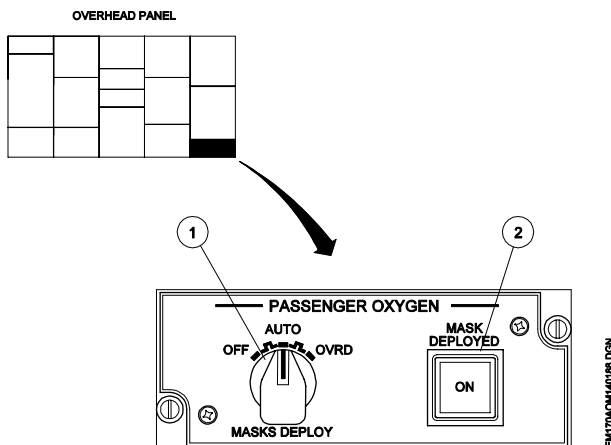
The airplane oxygen system comprises two systems and other oxygen devices, all listed below:

- Flight crew oxygen system.
- Passenger oxygen system.
- Protective breathing equipment (PBE).
- Portable oxygen cylinders.

The oxygen system parameters and indications are displayed on both MFD synoptic pages. System messages are displayed on EICAS displays.

CONTROLS AND INDICATIONS

OXYGEN CONTROL PANEL



1 – MASKS DEPLOY SELECTOR KNOB (ROTARY ACTION)

OFF: disables automatic deployment of passenger oxygen masks.

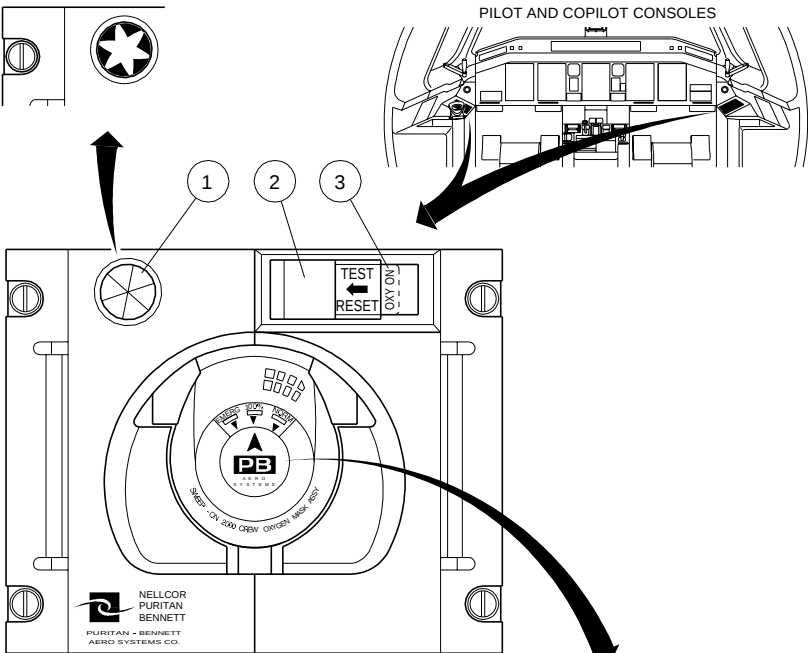
AUTO: enables automatic deployment of passenger oxygen masks when cabin pressure altitude is above 14000 ft.

OVRD: deploys the passenger oxygen masks regardless of cabin altitude.

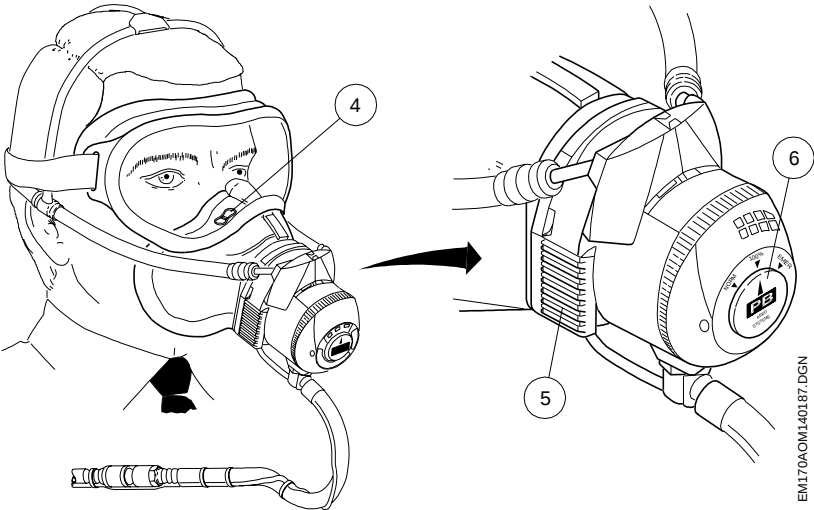
2 – MASK DEPLOYED INDICATOR LIGHT

- An ON light illuminates, indicating that the passenger and flight attendant oxygen masks have been deployed.

MASK STOWAGE BOX AND CREW MASK



MASK STOWAGE BOX



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1 – FLOW INDICATOR

- A bright yellow star illuminates, indicating that oxygen is flowing.

2 – TEST/RESET BUTTON (SPRING LOADED)

- Pressing this button with the mask stowed tests the oxygen mask and activates the microphone. The flow indicator star momentarily illuminates and oxygen flow will be audible through cabin speakers.
- Pressing this button with the mask not stowed shuts off the oxygen flow, turns off mask's microphone and returns the communication from the cabin speakers to the headsets.

3 – OXY ON FLAG

- Appears whenever oxygen is supplied to the mask.

4 – PURGE VALVE

- Allows oxygen flow into the face seal, purging any smoke and fumes.
- Automatically opens when the oxygen supply control knob is rotated to the emergency mode position.

5 – HARNESS INFLATION CONTROL VALVE

- Pressing this valve inflates the harness so that the mask may be donned. Releasing the button deflates the harness to the point that mask is held in place.

6 – OXYGEN SUPPLY CONTROL KNOB (ROTARY ACTION)

- Rotating the knob selects the mode of oxygen supply.

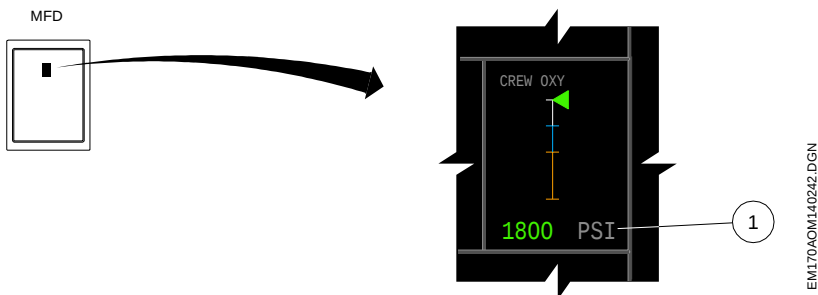
EMERG: supplies pure oxygen under positive pressure.

100%: supplies pure oxygen at all cabin altitudes.

NORM: supplies an oxygen/air mixture on demand (the ratio depends on cabin altitude).

SYNOPTIC PAGE ON MFD

The status synoptic page provides both analog and digital oxygen pressure indication.



1 – COCKPIT OXYGEN PRESSURE INDICATION

- Digital Pressure

GREEN: normal operating range (minimum for three crew members in the cockpit).

CYAN: advisory operating range (minimum for two crew members in the cockpit).

AMBER: cautionary operating range (no dispatch).

AMBER DASHED: invalid information or a value out of the valid range.

- Pressure Scale/Pointer

- The pointer on the scale indicates a value equal to that shown on the digital readout. If the value is invalid the pointer disappears from the display

- Scale:

WHITE: normal operating range.

CYAN: advisory operating range (minimum for two crew members in the cockpit).

AMBER: cautionary operating range (no dispatch).

- Pointer:

GREEN: normal operating range.

CYAN: advisory operating range (minimum for two crew members in the cockpit).

AMBER: cautionary operating range (no dispatch).

FLIGHT CREW OXYGEN SYSTEM

Flight crew oxygen is provided via a conventional, high-pressure, gaseous-type system in which the oxygen is stored in a standard 50-cu.ft., or an optional 77-cu.ft. cylinder, pressurized to 1850 psi at 21°C/70°F. The cylinder is installed in the forward cargo compartment.

A green discharge indicator disc blows out in the event of an overpressure. This indicator disk is located in the fuselage skin, above the oxygen filling port, and to the right of the forward cargo compartment door.

FLIGHT CREW FULL-FACE MASKS

Flight crew and observer full-face, quick donning masks and regulators are stowed in oxygen mask boxes near each seat. Opening the mask's stowage box automatically initiates the oxygen flow. Pressing the harness inflation control valve will inflate the harness, enabling its quick donning. Releasing the button will deflate the harness, firmly attaching it to the head. The oxygen will flow until the stowage box's doors are closed. An oxygen supply control knob is used to set the oxygen flow to normal, 100% or emergency mode.

The mask is also connected to the communications system. Removing it from the stowage box automatically activates mask's microphone and transfers the communications from the headsets to the cabin speakers. Closing the stowage box's doors and pressing the TEST/RESET button will turn off mask's microphone.

Also, the unit can be tested through the TEST/RESET button. With the mask stowed and the regulator knob set to NORMAL, keeping the TEST/RESET button pressed will make the indicator blink, and a sound signal will be audible on the speaker. Releasing the button will terminate the test.

PROTECTIVE BREATHING EQUIPMENT (PBE)

The PBE is vacuum-sealed in a small bag inside a box. The box is equipped with a green "good condition indicator". The unit is for emergency use only, providing the crew with positive pressure oxygen for respiratory and visual protection from fire, smoke and other harmful gases at altitudes up to 25000 ft. The oxygen supply is at least 15 minutes. A radio communication device is also provided.

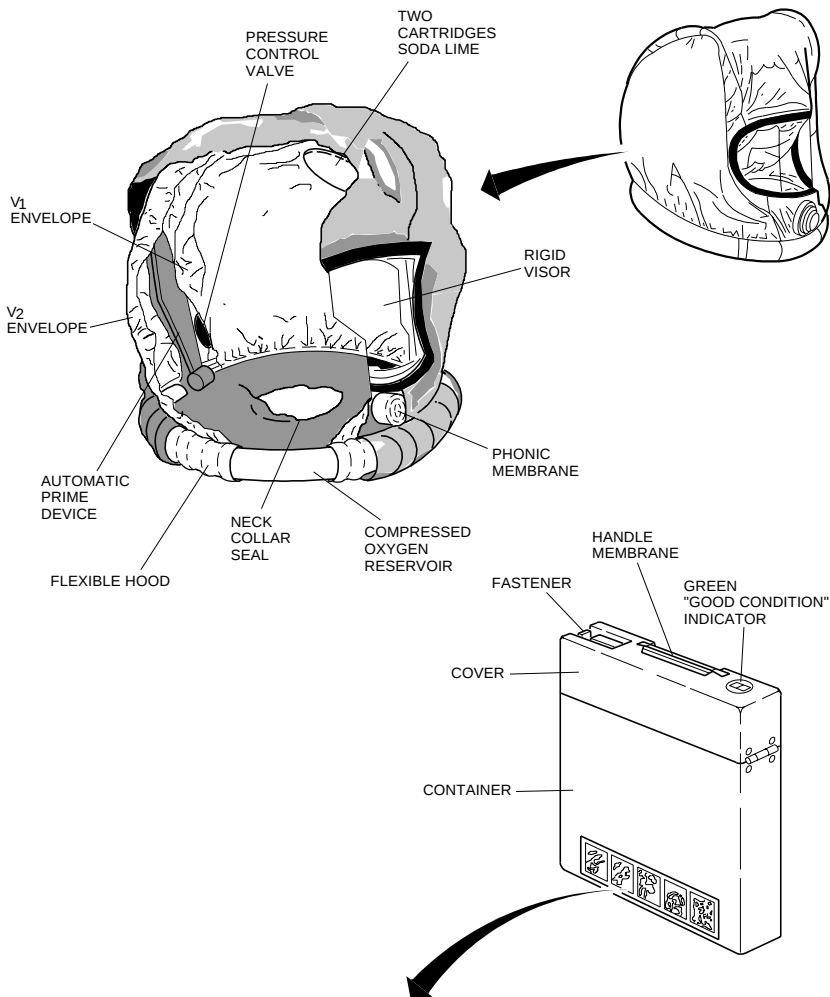
The equipment hood isolates the head from the ambient conditions by means of an elastic neck seal. The oxygen flow starts automatically after donning the hood.

MASK'S OPERATING MODES

Normal Operating Mode: With the regulator set to "NORM" position, it provides an automatic oxygen dilution. At lower cabin altitudes, ambient air is allowed to enter the regulator and mix with the added oxygen during inhalation. As the cabin altitude increases, the proportion of ambient air entering the regulator is reduced until at a preset point the user inhales 100% oxygen. In events such as cabin decompression when the ambient pressure is below the set point, the mask automatically provides pure oxygen to the crew.

100% Operating Mode: 100% Mode provides non-diluted oxygen to the crew regardless of cabin altitude.

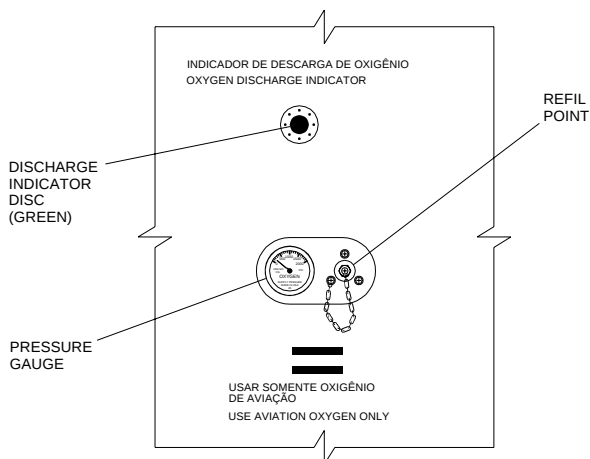
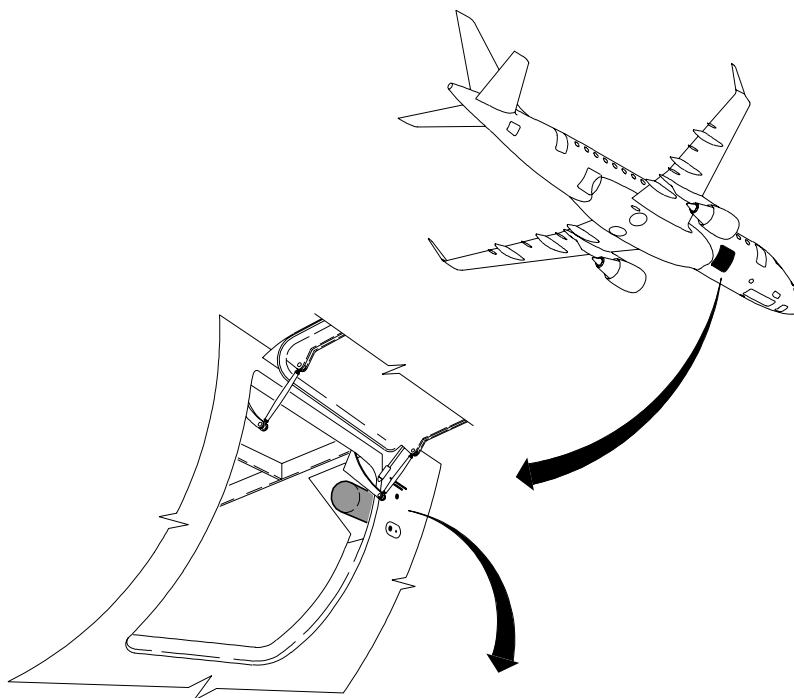
Emergency Operating Mode: The "EMER" setting provides non-diluted oxygen regardless of cabin altitude, with a slightly positive pressure. This positive pressure forms a pressure seal and purges smoke and toxic fumes that may get into the mask.



OPERATION



PROTECTIVE BREATHING EQUIPMENT



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OXYGEN CYLINDER AND REFILL POINT LOCATION

PASSENGER OXYGEN SYSTEM

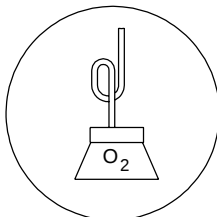
Individual chemical oxygen generators supply the passenger oxygen system during an emergency descent in the event of cabin depressurization. The passenger oxygen system provides oxygen to the following: Passenger Service Unit (PSU), flight attendant stations, lavatories, and galley areas.

The chemical oxygen generators and passenger oxygen masks are located in the dispensing units, above the passenger seats, at the (PSU). Each dispensing unit contains either two or three masks that supply oxygen for approximately 12 minutes. Once the masks start supplying oxygen, they cannot be shut off.

The oxygen masks are held in a mask retainer. The yellow mask must be pulled out of the retainer. Oxygen flows whenever any yellow mask hanging from the dispensing unit is pulled downward. Pulling the oxygen mask downward causes all the masks in that particular unit to drop, with 100% oxygen flow to the masks. A green, in-line flow indicator is visible in the transparent oxygen hose whenever oxygen is flowing to the masks. The point set for automatic mask deployment is 14500 ft. However, due to system's tolerance, the deployment may be commanded at altitudes as low as 14000 ft and up to altitudes as high as 14750 ft. Manual deployment can be performed from the cockpit by positioning the passenger oxygen selector knob to the OVRD position.

A manual release tool located near each flight attendant station can be used in case the command to open the dispensing unit door fails.

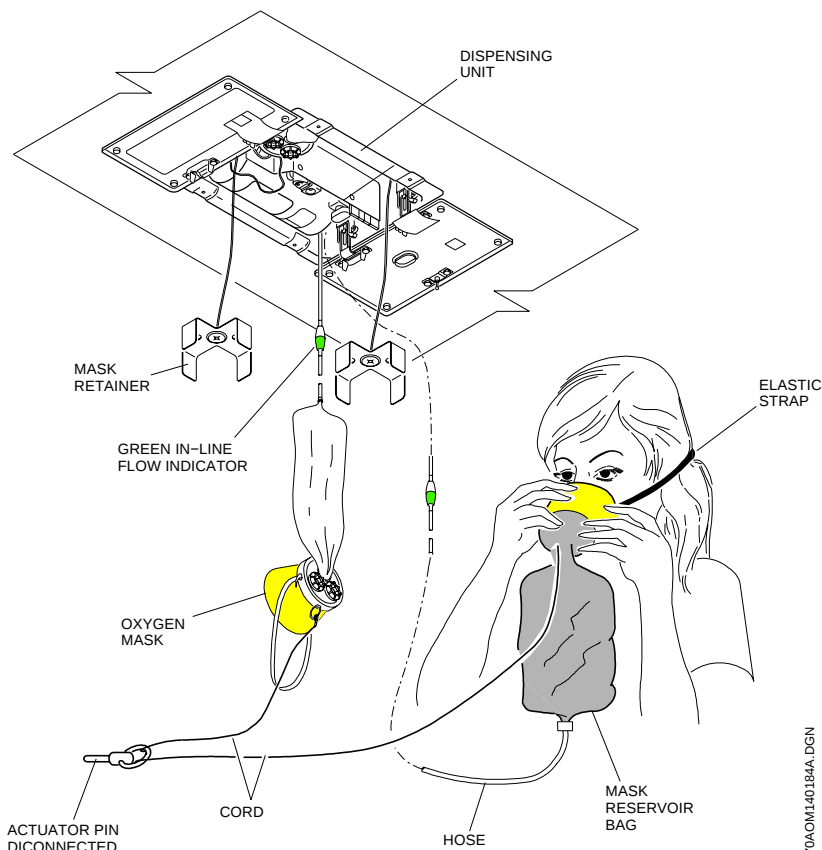
The flight crew monitors the passenger oxygen mask deployment status through EICAS messages and an indicator light on the overhead panel.



ADDITIONAL OXYGEN
MASK INDICATION

NOTE: · DISPENSING UNITS WITH THIS INDICATION
INCLUDE AN ADDITIONAL OXYGEN MASK.

· AIRPLANES EQUIPPED WITH THREE MASKS
IN ALL DISPENSING UNITS LOCATED IN THE
RIGHT OVERHEAD BINS DO NOT HAVE THIS
INDICATION.



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DISPENSING UNITS/PASSENGER MASKS

PORTABLE OXYGEN CYLINDER

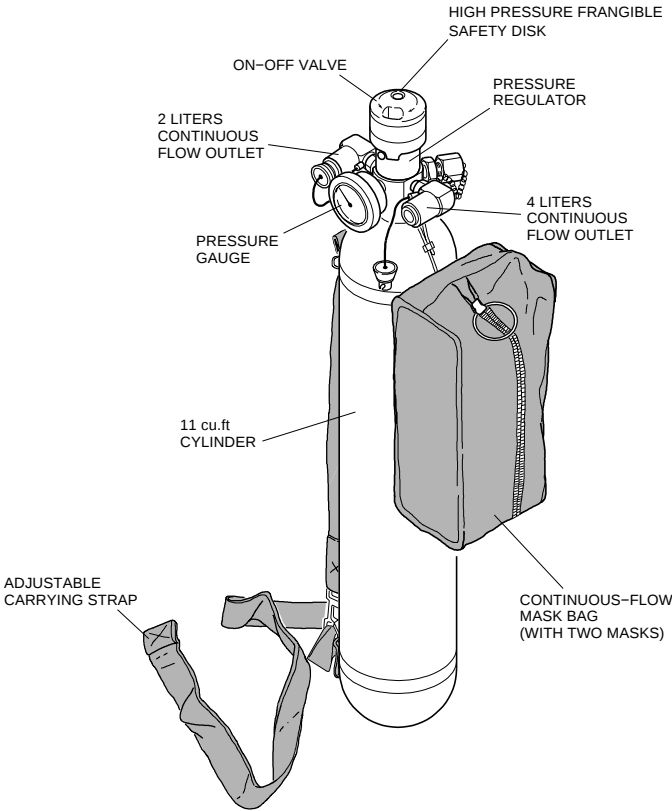
The portable oxygen cylinders are for the use of flight attendants to assist passengers in case of sudden decompression or first aid purposes.

The cylinders are fitted with a pressure gauge, a pressure regulator and an ON/OFF valve.

The cylinders are pressurized to 1800 psi. At this pressure, and at a temperature of 21°C/70°F, the cylinders have a capacity of 312 liters (11 cu.ft.) of free oxygen. Two continuous flow outlets are available; one regulates flow at 2 liters per minute for walk-around use and the second provides flow at 4 liters per minute for first aid use.

A high-pressure frangible safety disk ruptures within cylinder pressure of 2700 to 3000 psi.

For dispatch, the pressure must be at least 1200 psi.



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PORTABLE OXYGEN CYLINDER

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	CREW OXY LO PRESS	Oxygen cylinder pressure is below accepted safety limits, or pressure sensor failure.
	PAX OXY NOT DEPLOYED	Masks not deployed after automatically or manually commanded.
ADVISORY	PAX OXY SW NOT AUTO	Passenger oxygen selector set to the OFF position.
	OBSERVER OXY LO PRESS	Oxygen cylinder pressure is below accepted safety limits for 3 crew members, or pressure sensor failure.

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ATA CHAPTER 36

PNEUMATIC

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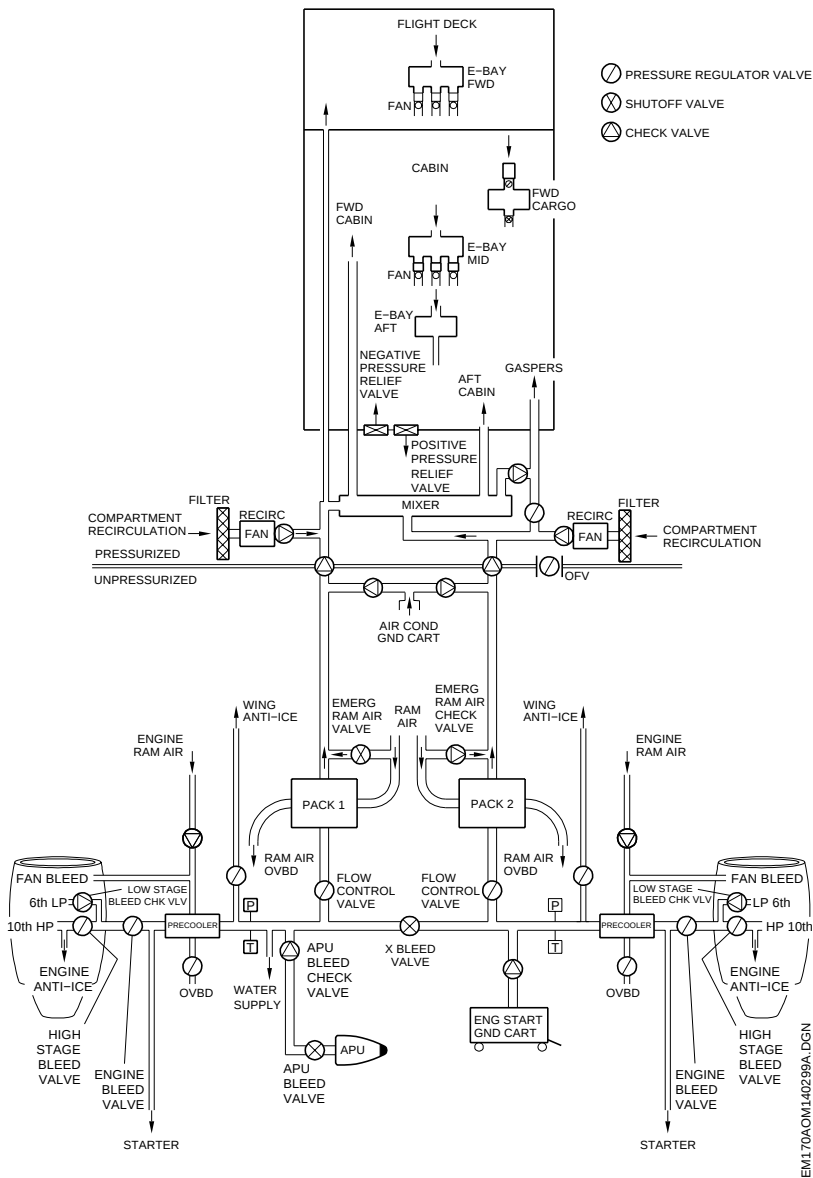
INTRODUCTION

This Chapter contains information on distribution of compressed air from source to using system.

Bleed air is provided by the engines, APU or an external pneumatic source to two different and independent bleed systems. Bleed air is used by:

- Environmental Control System (ECS).
- Engine start.
- Engine and wing anti-ice.
- Water pressurization.

SYSTEM SCHEMATIC



ENGINE BLEED SYSTEM

The engine bleed system is supplied from the low (6th) and the high (10th) stages of the engine.

The bleed system alternately selects between low-pressure and high-pressure bleed sources in order to maintain adequate and safe bleed supply pressure (45 psig) at any engine-operating condition.

This control is established via opening/closing of two bleed pressure regulating valves located in the nacelle:

- High Stage Bleed Valve and
- Engine Bleed Valve (EBV).

The bleed system control functions are effectively integrated with anti-ice and air conditioning functions through the AMS controller.

The temperature is regulated to a predetermined value by a precooler, which cools hot bleed air by a fan air on ground, or ram air or fan air in flight conditions.

APU BLEED

The APU supplies bleed air on the ground or in flight. However, it is used primarily as a ground pneumatic source for air conditioning packs (ECS) and engine starting. The APU Bleed Check Valve prevents engine bleed air from flowing to the APU when the engine is running.

The APU bleed valve controls APU bleed airflow to the pneumatic system.

GROUND CONNECTION

A dedicated high-pressure Engine Start Ground Connection is available for engine starting and a low-pressure Air Conditioned Ground Connection is available for air conditioning.

Both pneumatic ground connection ports are located on the lower section of the fairing area of the airplane.

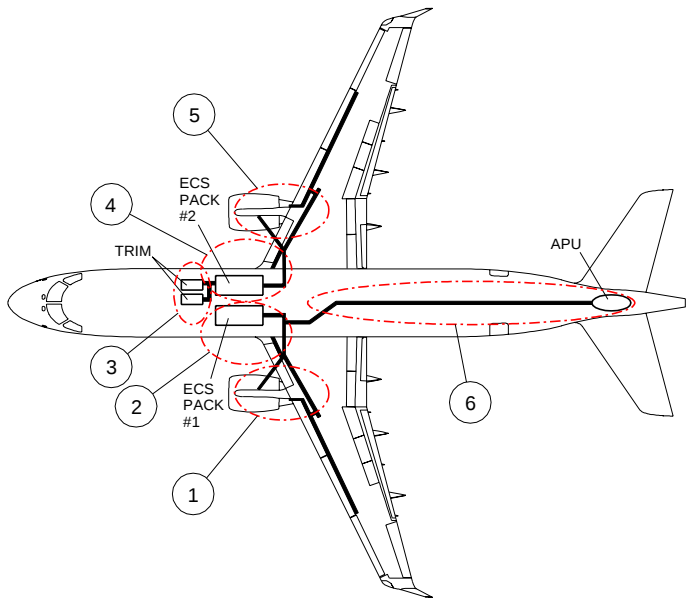
OVERHEAT DETECTION SYSTEM (ODS)

The Overheat Detection System (ODS) is comprised of two main components: overheat sensors and electronic controls. These components provide rapid and reliable overheat and leak detection for the engine bleed, air conditioning ducts, APU bleed air distribution and anti-ice supply ducting.

The overheat sensors use dual loop, and an overheat condition is indicated only when both loops indicate an overheat condition. Each loop consists of dual overheat detection sensor elements. When one loop fails, the remaining loop monitors overheat conditions (single loop operation).

Six sensor loops are used to detect an overheat condition in six zones.

BLEED AIR DISTRIBUTION



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**BLEED AIR DISTRIBUTION AND
OVERHEAT DETECTION ZONES**

OVERHEAT DETECTION ZONES

	ZONE	MONITORED AREA
1	Left Anti-Ice	Left wing anti-ice duct.
2	Left Air Supply	Left bleed system ducts and left air-conditioning ducts.
3	Optional Trim System	Optional trim pressure ducts.
4	Right Air-Supply	Right bleed system ducts and right air conditioning ducts.
5	Right Anti-Ice	Right wing anti-ice duct.
6	APU	APU bleed duct.

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ATA CHAPTER 38

WATER AND WASTE

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INTRODUCTION

Water service is provided to the washbasins for crew member and passenger use.

The waste system consists of a self-contained recirculating flushing toilet.

WATER

A central storage tank holds potable water. Engines and APU bleed air pressurize the potable water system. If engines or APU are not running on the ground, or bleed air pressure is below the optimal range during the flight, an optional air compressor pressurizes the water system.

Pressurized water is supplied to the heaters and faucets in the lavatories and water spigots, and coffee makers in the galleys. Water is also supplied for flushing of the vacuum toilets in the lavatories.

The potable water storage tank's maximum capacity can be configured to 35, 70, 90 or 110 liters. The AFT flight attendant panel indicates the percentage of total water quantity remaining in the tank.

The lavatory faucet has a single cap. Water flow is started by pressing the cap, while rotating it allows water temperature control.

Water from lavatory washbasins and galleys is automatically drained through forward and aft masts. Optional retention tanks are installed to collect water from galleys and washbasins on the ground, thus inhibiting spillage on the tarmac. Drain valves automatically open two minutes after landing gear retraction, allowing overboard drainage of serviced water.

In case of water system leakage at either the galley or lavatory, the respective shutoff valve may be actuated to isolate the system.

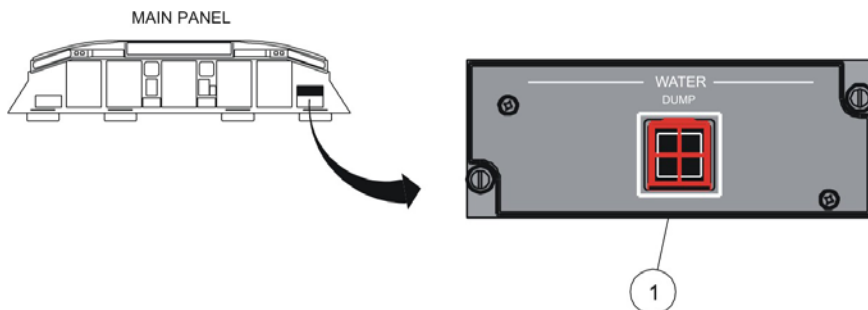
If the auto-drain valve clogs, the flight attendant may manually actuate the remote actuation cable located on the face of the galley. Access to the lavatory valve is through the under sink cabinet door. Pulling up on the ring handle clears the valve.

In-flight drainage is commanded by depressing the water dump pushbutton in the cockpit. Water is drained through aft and forward masts. Pressing the water dump pushbutton discontinues the drainage. Water drainage is automatically interrupted if the landing gear is lowered.

The flight attendant panel indicates a FAULT condition whenever:

- A fault in the respective (FWD or AFT) drain valve is detected;
- Water level indication is not available;
- In-flight drainage is not available due to a fault in the drain valve or in the drain mast heater.

WATER DUMP PANEL



1 – WATER DUMP BUTTON (GUARDED)

- Commands the potable water drainage during flight.

WASTE

The vacuum waste system collects waste from the lavatory toilets to an aft mounted vertical waste tank.

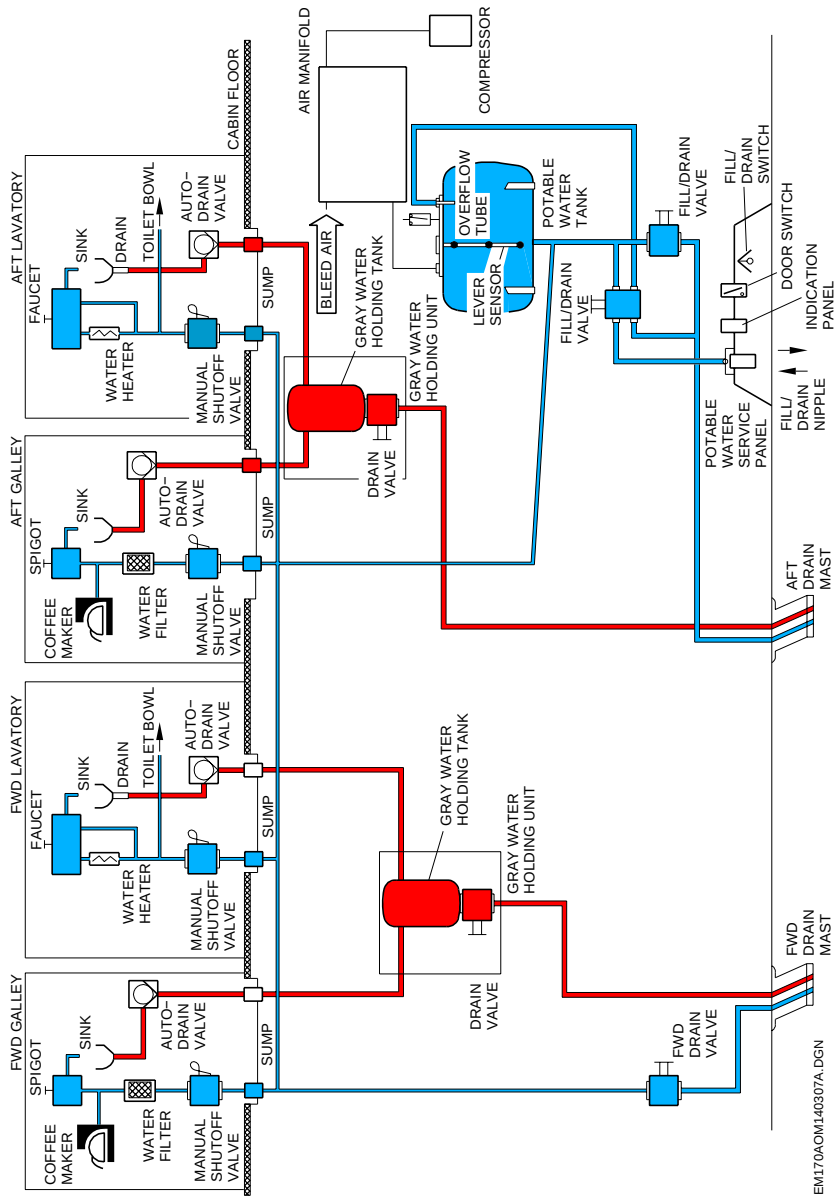
A vacuum generator is used to create differential pressure on the ground or at altitudes below 18000 ft. At higher altitudes, the differential between the airplane's cabin pressure and ambient pressure is sufficient to transport the waste.

Pushing the flushing switch located inside the lavatory initiates toilet-flushing sequence. Water is introduced to rinse the bowl prior to opening of the toilet-flushing valve.

The usable capacity of the waste tank is 95 liters. The Service Tank indication illuminates on the flight attendant's panel when waste tank capacity reaches 75%. When the waste tank's full capacity is reached, the Tank Full indication illuminates and the vacuum toilets are disabled.

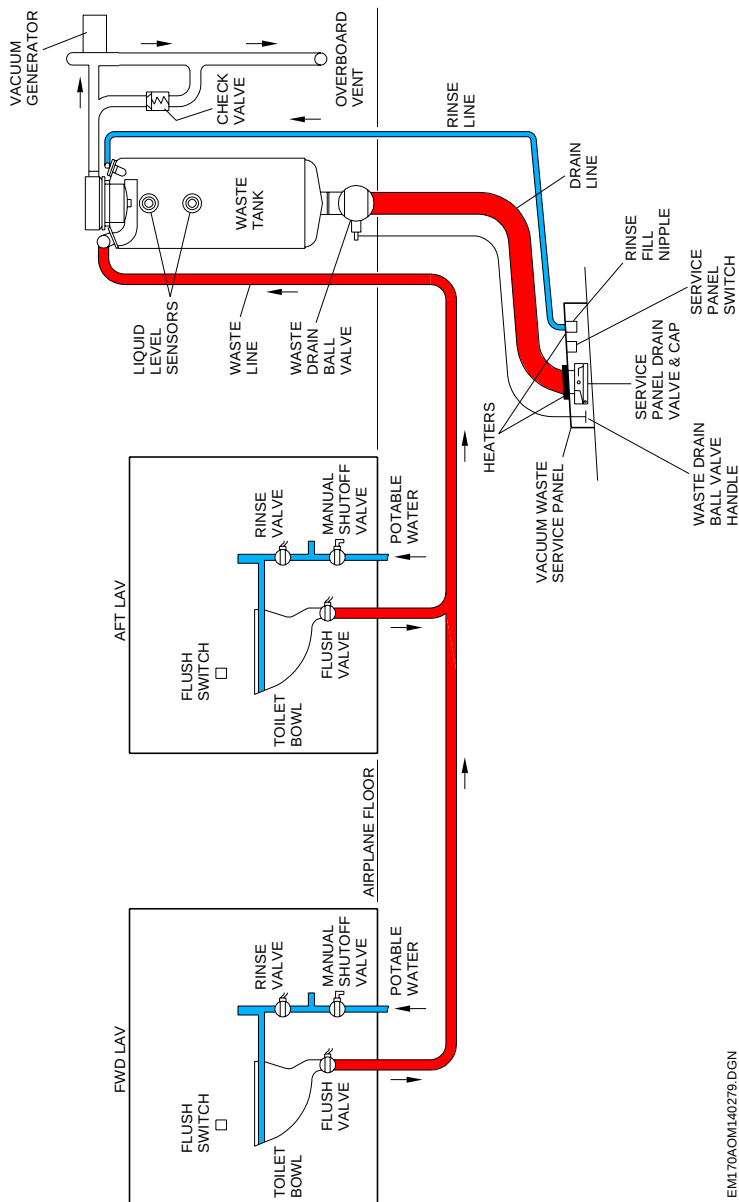
Waste tank draining is performed through the service panel in the aft right-hand side of the fuselage.

POTABLE AND GRAY WATER SCHEMATIC



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WASTE SCHEMATIC



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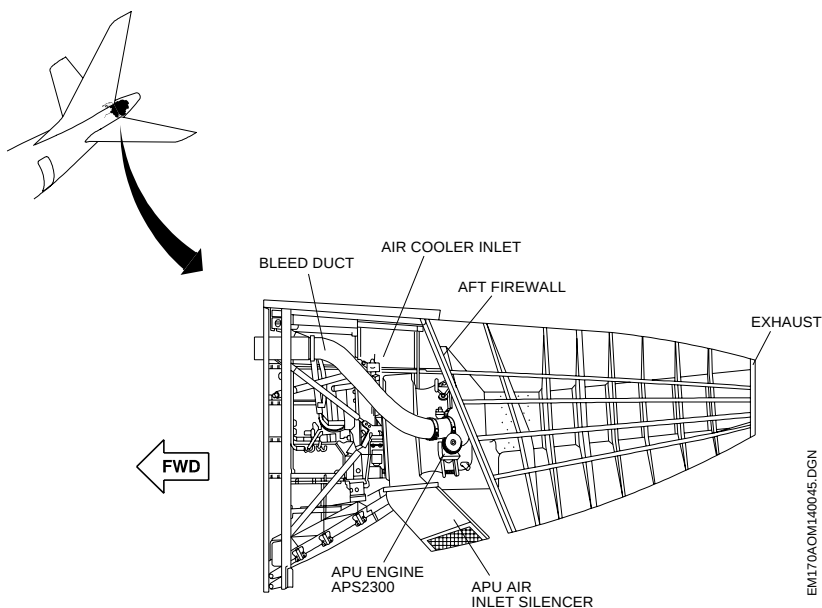
AUXILIARY POWER UNIT

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INTRODUCTION

The Auxiliary Power Unit (APU) is a gas turbine engine located in the airplane tailcone, which provides pneumatic and electrical AC power. The pneumatic power is used for engine starting and to supply bleed air to the air conditioning packs of the Environmental Control System (ECS). An electrical AC generator supplies 115 Volts 40 KVA to the electrical system.

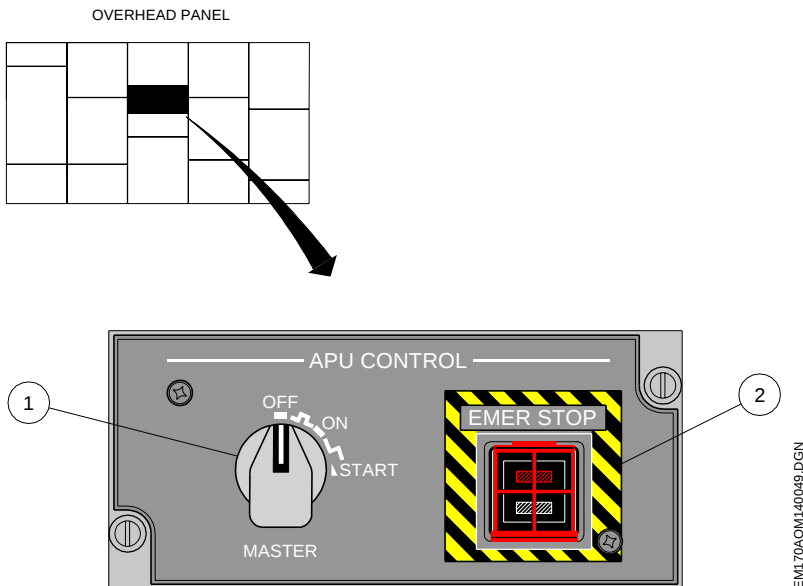
The APU is automatically monitored and controlled through a dedicated Full Authority Digital Electronic Control (FADEC) unit.



APU LOCATION

CONTROLS AND INDICATIONS

APU CONTROL PANEL



1 – APU SELECTOR KNOB (ROTARY ACTION)

OFF: normal position when the APU is not running.

ON: normal position when the APU is running.

START: (momentary action) initiates the APU start cycle.

NOTE: Moving this knob from ON to OFF effects the APU shutdown.

2 – APU EMERGENCY STOP BUTTON (GUARDED)

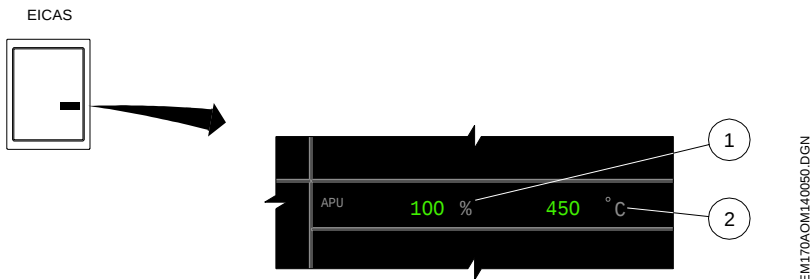
PUSH IN: closes the APU fuel shutoff valve, shutting down the APU with no cooldown period.

PUSH OUT: normal position, with the fuel shut off valve open.

NOTE: - In case of fire, the upper half of the button illuminates red.

- When pushed in, a white striped bar illuminates on the lower half of the button.

EICAS INDICATION



1 – APU RPM INDICATION

- Displays the APU RPM (%).
GREEN: normal operating range.
AMBER: cautionary operating range.
RED: operating limit exceeded.

2 – APU EGT (EXHAUST GAS TEMPERATURE) INDICATION

- Displays the APU temperature in degrees Celsius (°C).
GREEN: normal operating range.
AMBER: cautionary operating range.
RED: operating limit exceeded.

APU FUEL SUPPLY

When DC power is the only electrical power available, the DC fuel pump, located in the right wing tank, feeds the APU. If AC power is available and the engine is not running, fuel feeding will be provided by the AC fuel pump.

When the engine is running, the ejector fuel pump feeds the APU from the right wing tank. However, it is also possible to feed the APU from the left wing tank via a crossfeed valve.

APU BLEED

The Air Management System (AMS) controls the operation of the APU and the engine bleed valves. The engine bleed valve has priority over the APU bleed valve. When the engine starting cycle is in progress, the APU bleed valve opens and the engine pack valves close. After engine starting, the APU bleed valve closes and the engine pack valves open.

APU OPERATION

A Full Authority Digital Electronic Control (FADEC) monitors and controls the start/shutdown sequence, fault detection and APU status. The flight crew controls the APU start/shutdown sequence, using the APU selector knob.

In an abnormal condition, the flight crew can shut down the APU through a dedicated emergency stop button.

The APU is able to supply:

- Electrical AC power up to 33000 ft.
- Bleed air for engine starting up to 21000 ft.
- Bleed air for air conditioning up to 15000 ft.

Maximum altitude for APU start is 30000 ft.

APU START

Rotating the APU master switch to ON powers the FADEC and APU fuel shutoff valve opens.

Rotating the APU selector knob from ON to START (momentary position), initiates the APU automatic starting cycle. In automatic starting cycle the FADEC commands the electronic starter controller to energize the brushless starter generator, initiating APU rotation.

Three seconds after APU speed has reached 95%, electrical and pneumatic loading are available. If the APU does not reach proper speed or acceleration rate within the starting cycle time, the APU will automatically shut down.

GROUND START

The FADEC initiates ignition at approximately 6% RPM and the fuel flow after 0.5 seconds. The battery #2 energizes the electronic starter controller. After a light off occurs, the FADEC commands the starter to cutout at approximately 50% RPM.

IN FLIGHT START

The FADEC initiates ignition at approximately 7% to 17% RPM and the fuel flow after 0.5 seconds. After a light off occurs, the FADEC commands the starter to cutout at approximately 50% RPM.

APU SHUTDOWN

NORMAL APU SHUTDOWN

Rotating the APU selector knob from ON to OFF initiates a normal APU shutdown, which is monitored and controlled by the FADEC. During a normal shutdown sequence, the APU pneumatic and electrical power are removed and a cooldown period of 2 minutes follows.

NOTE: Turning the APU selector knob back to ON position during the shutdown sequence cancels the shutdown.

EMERGENCY APU SHUTDOWN

In the event that the APU emergency stop button has been selected, the APU fuel shutoff valve closes and the APU shuts down without a two-minute cooldown period.

APU PROTECTION

The FADEC provides automatic APU shutdown protection on ground and in flight as follows. The appropriate EICAS message is displayed for each situation.

On the ground	In flight
Overspeed	Overspeed
Underspeed	Underspeed
FADEC critical fault	FADEC critical fault
APU fire	
APU EGT overtemperature	
APU high oil temperature	
APU low oil pressure	
Sensor fail	



EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	APU FAIL	APU automatic shutdown has occurred. APU cannot be restarted, excepted if the automatic shutdown occurred during the starting cycle and according to the restriction defined in the AFM.
	APU FAULT	APU automatic shutdown inhibited in-flight. An anomaly has been detected. Maintenance action is required.
	APU OIL HI TEMP	APU automatic shutdown inhibited in-flight. Oil temperature is above maximum limit.
	APU OIL LO PRESS	APU automatic shutdown inhibited in-flight. Oil pressure is below minimum limit.
STATUS	APU SHUTTING DOWN	A normal APU shutdown has been commanded via the APU selector knob.

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POWERPLANT

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INTRODUCTION

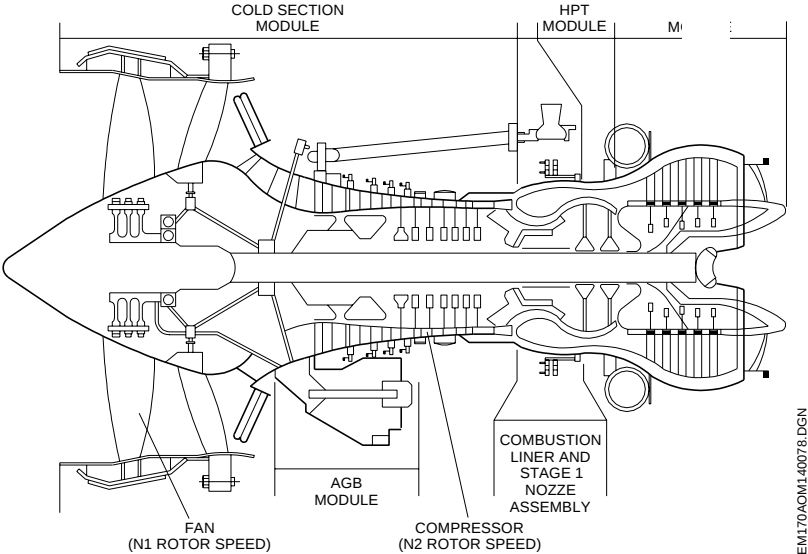
Two wing-mounted General Electric CF34-8E engines produce power to the airplane.

The General Electric CF34-8E is a high-bypass and dual rotor turbofan, fully integrated with a nacelle and thrust reverse.

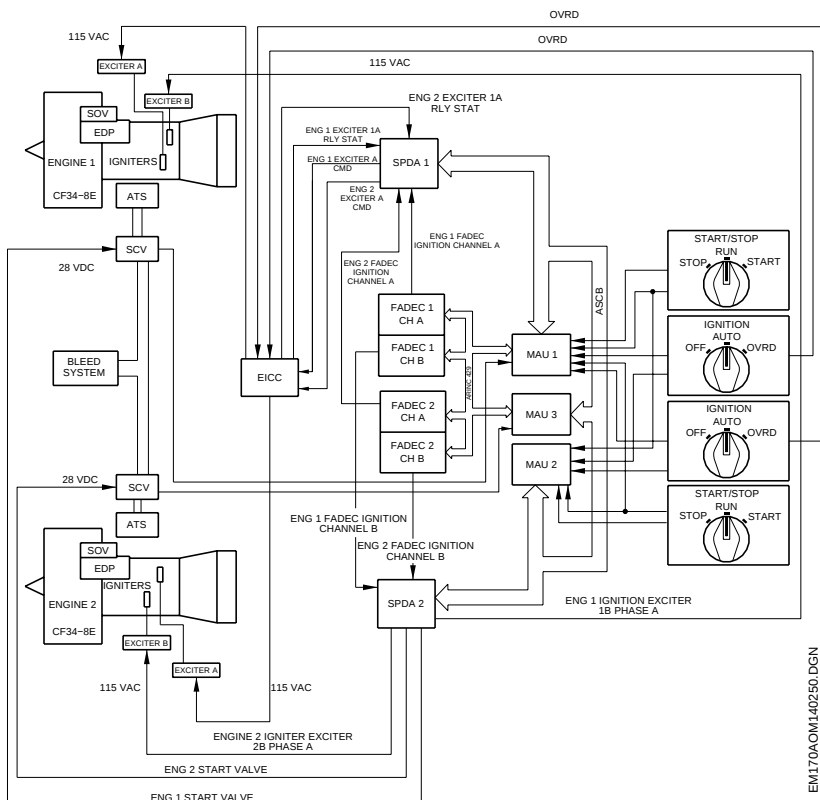
The N1 and N2 rotors are mechanically and independently operated.

The engine is controlled via a dual channel FADEC system providing flexible engine operation and reduced workload.

Engine indications and alerts are displayed on the Engine Indications and Crew Alerting System (EICAS).



CF348E ENGINE

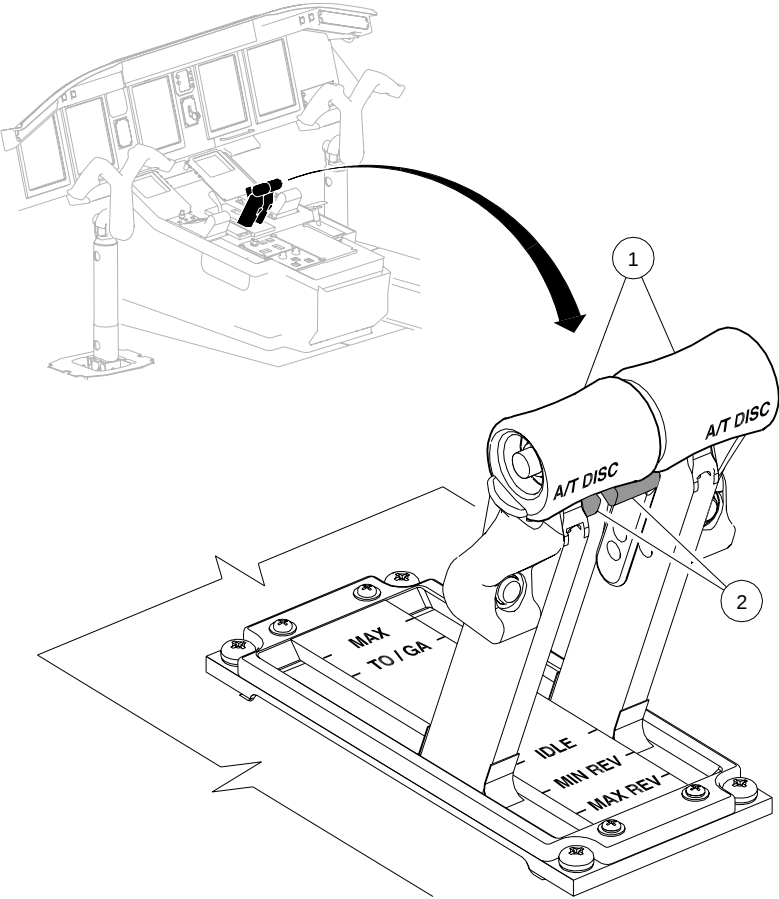


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ENGINE SCHEMATIC

CONTROLS AND INDICATIONS

CONTROL PEDESTAL



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1 – THRUST LEVER DETENTS

MAX: provides the maximum thrust rating available for dual - or single - engine operation.

TO/GA: selects takeoff, maximum continuous, and go-around mode settings.

IDLE: selects flight idle, approach idle, final approach idle and ground idle thrust settings.

MIN REV: provides minimum reverse thrust.

MAX REV: provides maximum reverse thrust. The thrust lever must be pulled against a spring to achieve the MAX REV position. If the thrust lever is released it goes back to MIN REV position.

NOTE: Positioning the thrust lever between the thrust control quadrant detents selects intermediate thrust settings.

2 – THRUST REVERSER TRIGGER

Pulling the thrust reverser trigger, allows commanding of thrust levers from IDLE to MAX REV, thus providing reverser activation on the ground.

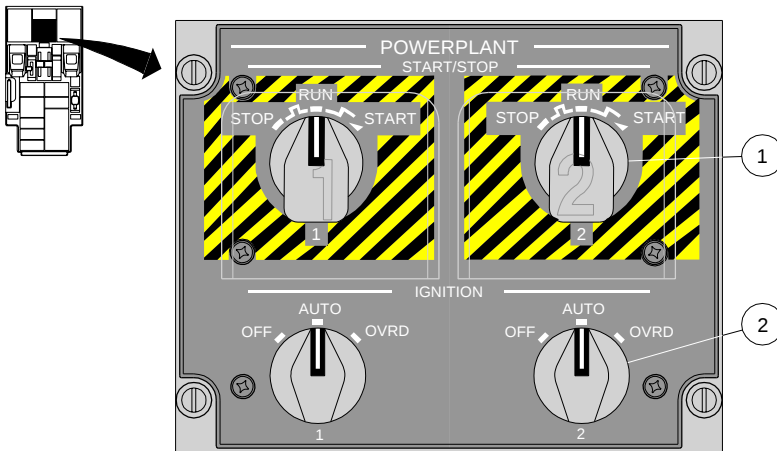
For TO/GA and A/T DISC buttons descriptions, refer to Section 14-03 – Automatic Flight

FIRE HANDLE

The Fire Handle, located on the Fire Protection Control Panel, enables emergency engine shutdown. For further information on fire protection system controls, refer to Section 14-07 – Fire Protection.

ENGINE CONTROL PANEL

CONTROL
PEDESTAL



1 – START/STOP SELECTOR KNOB

STOP: commands the FADEC to shut down the engine, provided the associated thrust lever is in the IDLE position.

RUN: normal position for engine operation.

START: (momentary action): initiates the engine start sequence.

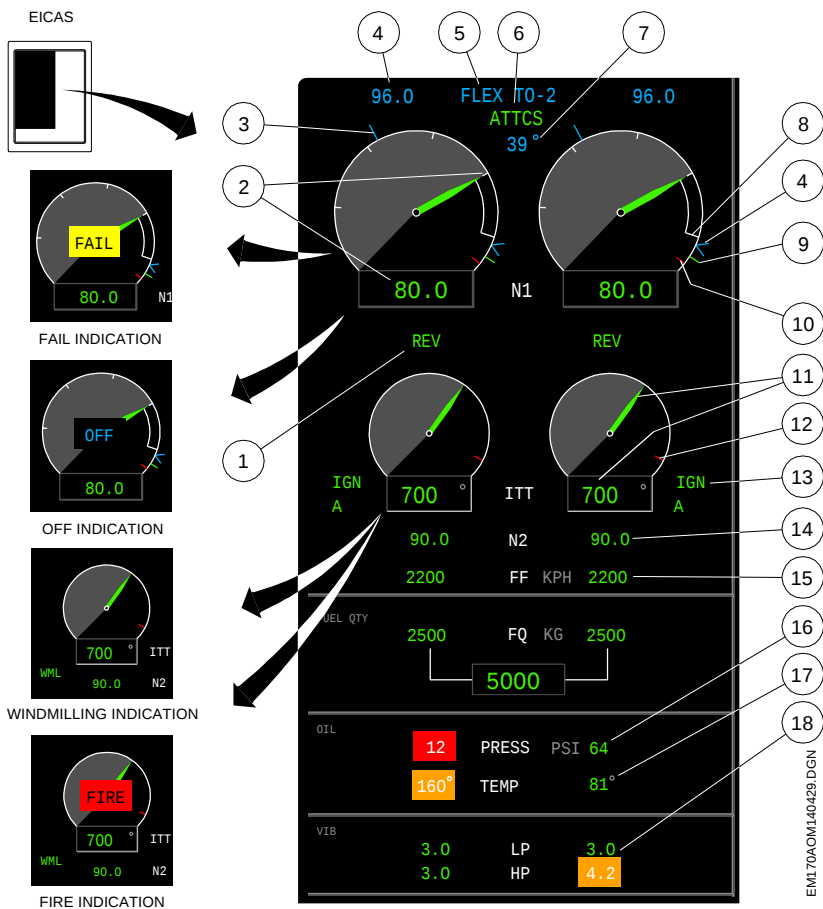
2 – IGNITION SELECTOR KNOB

OFF: deactivates the ignition system. FADEC disregards OFF position in flight.

AUTO: FADEC automatically controls the ignition system, depending on engine requirements.

OVRD: enables FADEC to continuously activate both exciters when the engine is running.

EICAS INDICATION



ENGINE INDICATION - EICAS

1 – THRUST REVERSER INDICATION

- Indicates the thrust reverser position.
- Label: REV

GREEN: fully deployed.

AMBER: in transition.

RED: discrepancy between selected and actual reverser positions.

2 – N1 INDICATION

- Digital Indication.
 - Displays the percentage of N1 RPM.

GREEN: normal operating range.

RED: operating limit exceeded.

AMBER DASHED: invalid information or value out of displayable range.
- Quantity Scale/Pointer.
 - The pointer on the scale indicates a value equal to that shown on the digital readout.
 - Scale:

GREEN: normal operating range.

RED: operating limit exceeded.
- The amber boxed FAIL indication is displayed on the center of the N1 dial when an engine has been flamed out or shut down without pilot action. The cyan OFF indication is displayed when the engine is shut down in flight by pilot action.

3 – N1 WING ANTI-ICE CYAN LINE

- Set only in icing conditions during final approach (radio altimeter below 1200 ft) with landing gear down or flaps extended.
- Indicates the minimum thrust level (N1 value) to meet bleed requirements.

4 – N1 TARGET INDICATION

- Maximum N1 for the engine thrust rating mode indicated on EICAS.
- If the requested value is invalid, the digits will be removed from the display.
- A cyan V-shaped bug represents the N1 target on the dial indicator.
- Digits:

CYAN: normal indication.

AMBER DASHED: invalid information or value out of displayable range.

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- If the requested value is invalid, the digits will be removed from the display.
- A cyan V-shaped bug represents the N1 target on the dial indicator.
- Digits:

CYAN: normal indication.

AMBER DASHED: invalid information or value out of displayable range.

11 – INTERTURBINE TEMPERATURE INDICATION

- Quantity Scale/Pointer.
 - The pointer on the scale indicates a value equal to that shown on the digital readout.
 - Scale:
GREEN: normal operating range.
RED: operating limit exceeded.
- AMBER dashes will display on digital readout when an invalid information or a value out of displayable range is available.
- A red fire warning indication is displayed on the center of ITT dial to indicate engine fire condition.

12 – ITT RED/AMBER LINE

- Maximum allowable ITT.
- Limits thrust, thereby avoiding the maximum allowable ITT to be exceeded.
- The red line will change to amber after the end of the takeoff phase. The red line will be shown in flight if the ITT goes above the CON thrust rating limit.

13 – IGNITION CHANNEL INDICATION

- Indicates the enabled ignition channel.
- Colors:
GREEN: IGN A, IGN B or IGN AB.
CYAN: IGN OFF.
- A WML icon is displayed whenever the FADEC has detected an engine flameout and the autorelight system is actuating to restart the engine. It is also displayed whenever an assisted start is commanded.

14 – N2 INDICATION

- Digital Indication.
- Displays the percentage of N2 RPM.
GREEN: normal operating range.
RED: operating limit exceeded.
AMBER DASHED: invalid information or value out of displayable range.

15 – FUEL FLOW INDICATION

- Indicates fuel flow in kilograms per hour (KPH) or pounds per hour (PPH).
- Color: green.

GREEN: normal indication.

AMBER DASHED: invalid information or value out of displayable range.

16 – OIL PRESSURE INDICATION

- Indicates the engine oil pressure.
- Digit colors:

GREEN: normal operating range.

AMBER: cautionary operating range.

RED: operating limit exceeded.

AMBER DASHED: invalid information or value out of displayable range.

17 – OIL TEMPERATURE INDICATION

- Indicates the engine oil temperature.
- Digit colors:

GREEN: normal operating range.

AMBER: cautionary operating range.

AMBER DASHED: invalid information or value out of displayable range.

18 – ENGINE VIBRATION INDICATION

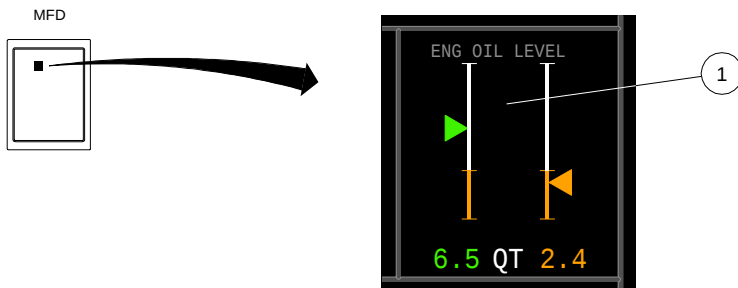
- Indicates low-pressure (LP) and high-pressure (HP) vibration levels for both engines.
- Digit colors:

GREEN: normal operating range (0 to 3.9)

AMBER: cautionary operating range (4.0 to 5.0).

AMBER DASHED: invalid information or value out of displayable range.

STATUS PAGE – MFD



ENGINE OIL LEVEL INDICATION ON MFD

1 – OIL LEVEL INDICATION

GREEN: normal operating range.

AMBER: cautionary operating range.

- AMBER dashes will display on digital readout when an invalid information or a value out of displayable range is available.

ENGINE FUEL SYSTEM

GENERAL

The engine fuel system provides fuel pressurization, filtering, heat exchange and operation of bleed valves and variable geometric actuators.

FUEL PUMP

Fuel supplied by the airplane fuel tanks flows to the engine fuel pumps. Upon exiting the tanks, the fuel flows through the low-pressure pump and then divides into two paths. One flows through the high-pressure fuel pump and returns to the fuel tank as motive flow.

The second flows through the fuel/oil heat exchanger to the fuel filter. Once filtered, the flow leaves the FMU and passes through the high-pressure fuel pump, before returning to the FMU.

FUEL/OIL HEAT EXCHANGER

The fuel-cooled oil cooler (FCOC) maintains the oil temperature within an acceptable range and heats the engine fuel to prevent freezing.

FUEL METERING UNIT (FMU)

The FMU, controlled by the FADEC, meters and distributes the proper amount of fuel for combustion to the injectors under all operating conditions. The FMU controls the shutoff valve used during all normal shutdowns and provides overspeed protection.

FUEL FILTER

The fuel filter removes contaminants from the engine fuel. The impending bypass switch indicates fuel filter blockage and an imminent bypass condition.

VARIABLE GEOMETRY ACTUATOR

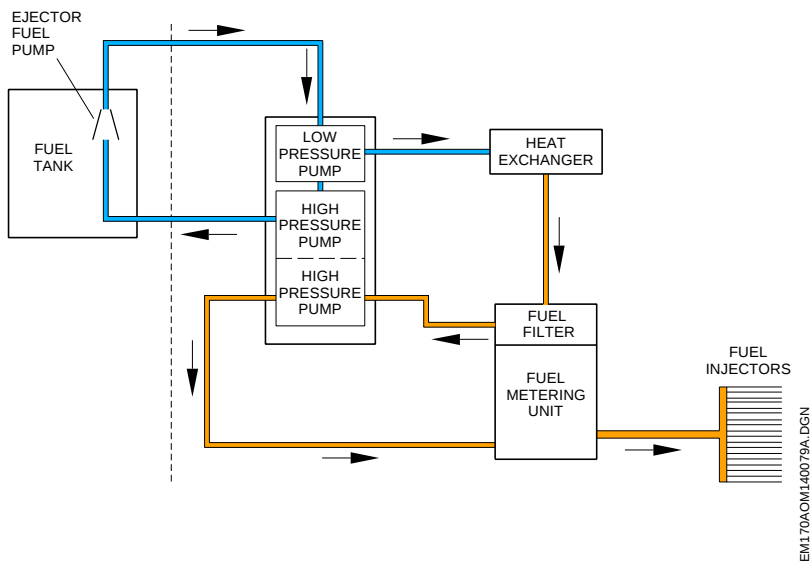
The Variable Geometry Actuator consists of two fuel driven actuators controlled by the FADEC via FMU.

The purpose of the actuators is to optimize the position of the compressor stators as a function of corrected N2 to provide optimum compressor efficiency.

FUEL INJECTORS

The fuel injectors atomize the fuel from the FMU and direct it into the combustion chamber.

FUEL SCHEMATIC



FUEL SYSTEM SCHEMATIC

LUBRICATION SYSTEM

Each engine has an independent lubrication system.

The oil system lubricates and cools the turbine engine main shaft bearings and the accessory gearbox.

Oil is pressurized in the lubrication pump, passes through the filter, passes through the fuel-oil heat exchanger and is then divided into several circuits to lubricate the engine.

OIL TANK

Oil quantity indication is provided for each engine oil tank and is displayed on the MFD.

Sensors in the tank detect low oil quantity and trigger the low oil level caution whenever this occurs.

OIL PUMPS

The pump will provide oil flow any time the core engine is turning.

The pump contains five pumping elements, one supply and four scavenge elements.

The lube and scavenge pumps deliver oil under pressure to the engine bearings and gears, and then recover the oil to the tank for reuse.

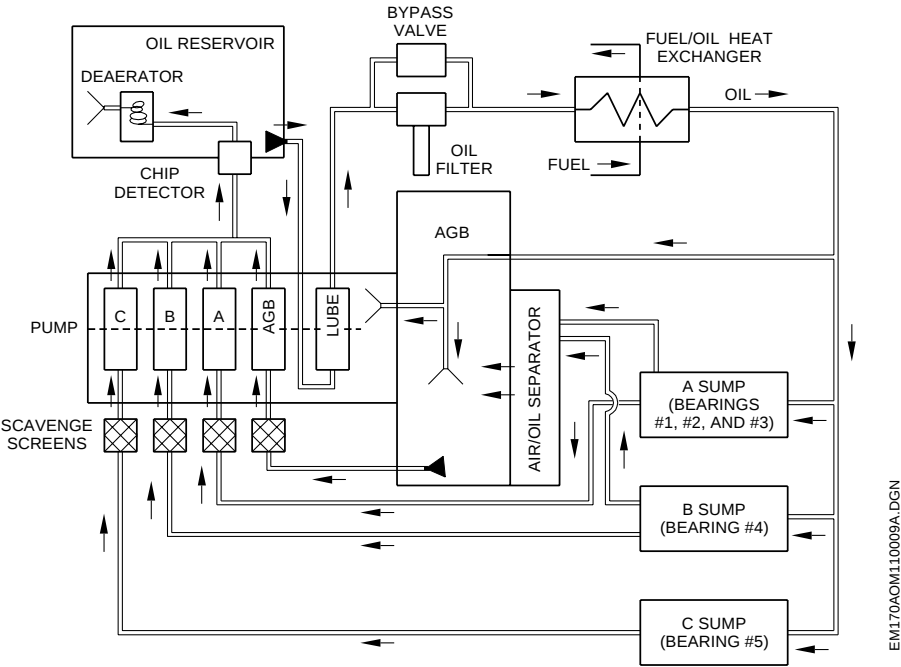
OIL FILTER

Oil filter module incorporates a filter bypass and cold start relief valve.

The oil filter bypass valve permits oil flow if the filter becomes clogged. The filter impending bypass switch monitors the differential pressure at the filter.

The filter module has a relief valve to bypass high viscosity oil during cold start conditions.

LUBRICATION SCHEMATIC



LUBRICATION SYSTEM SCHEMATIC

STARTING AND IGNITION SYSTEMS

STARTING SYSTEM

The engine starting system comprises:

- Air turbine starter (ATS).
- Starter control valve (SCV).

The pneumatic system provides bleed air to increase rotor speed and start the engine cycle.

The FADEC opens the Starter Control Valve (SCV), providing bleed air from the APU, a ground source, or the opposite engine. The Air Turbine Starter (ATS) is a turbine that accelerates the engine to a self-sustaining RPM level.

The FADEC closes the SCV when the starter cutout speed is reached.

IGNITION SYSTEM

The ignition system provides an electrical spark for fuel combustion during on ground engine starts, in flight starts, in flight auto-relights, and when the ignition selector knob is set to OVRD position.

The FADEC energizes one igniter for on ground engine starts and both igniters for in flight engine starts.

Setting the ignition selector knob to OVRD position provides means to keep both igniters energized. Igniters 1B and 2B are connected to SPDA 2. In case of SPDA 2 failure, setting the selector knob to OVRD energizes at least the igniter A.

STARTER OPERATION

The engine starter is controlled via the engine start selector knob on the powerplant control panel. For on ground starts, the SCV opens providing bleed air to increase rotor speed.

GROUND START

The FADEC initiates ignition at approximately 7% N2 and the fuel flow (Metering valve opens) at approximately 20% N2. After a light off occurs, the FADEC commands the starter to cutout at approximately 50% N2, and controls the FMU fuel metering valve to accelerate the engine to ground idle.

IN FLIGHT START

Engine cross-bleed air, APU bleed air, or windmilling can be used for in flight engine starts.

An in flight cross-bleed start is identical to an on ground start, but the FADEC automatically controls fuel flow to begin (Metering valve opens) if N2 has not reached 20% after 15 seconds.

For windmill starting, the SCV configures the pneumatic system. The engine start is controlled by the START/STOP selector knob and the FADEC controls ignition and fuel flow at a minimum of 7.2% N2, or after 15 seconds, whichever occurs first.

The FADEC has no protection for hot starts or hung starts, for in flight engine starts.

AUTO RELIGHT

The FADEC monitors N2 and automatically turns on both igniters and schedules the relight fuel flow in the event of an engine flameout. In addition a WML icon is displayed next to the respective engine N2 and represents an auto relight actuation during the engine auto relight attempts.

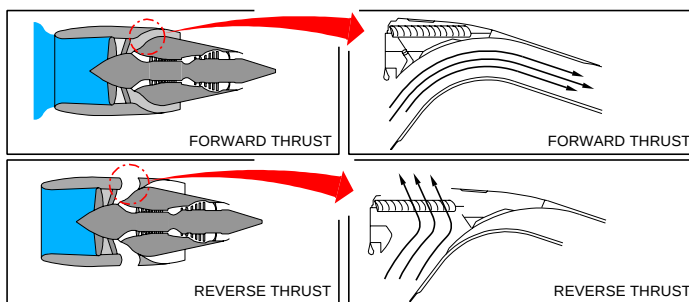
If the engine relight does not occur within 30 seconds or N2 falls below 7.2 %, the automatic relight can be considered unsuccessful and should be manually terminated by moving the START/STOP selector knob to the STOP position.

During ground operations, auto relight attempts are terminated and fuel is shutoff if the engine RPM falls below 52 percent N2.

THRUST REVERSER SYSTEM

The Thrust Reverser System is hydraulically actuated and controlled from the cockpit via the thrust lever.

Thrust reverses 1 & 2 operate independently, and are actuated by the respective hydraulic system.



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THRUST REVERSER ACTUATION

The FADEC provides an interlock function to protect against inadvertent thrust reverser deployment and also to protect against inadvertent thrust reverser stowing.

A locking system consists of two actuator locks and the independent cowl lock. The cowl lock prevents inadvertent deployment of the thrust reverser.

REVERSER OPERATION

Moving the thrust lever to Idle enables the lifting of the Thrust Reverser Trigger. Moving the thrust lever to the reverse position commands thrust reverser deployment.

Thrust reverser deployment occurs only if the airplane is on the ground. The thrust reverser trigger can be lift up to 30 seconds after an engine inoperative condition is detected. After 30 seconds the engine inoperative condition does not release the thrust reverse trigger, so the respective thrust lever cannot be moved to reverse position.

The IDLE REV thrust is commanded until the thrust reverser cowl are not totally deployed, after total deployment the MAX REV is commanded if thrust levers are held in MAX REV position.

The thrust reverser is not designed to operate in flight. Uncommanded thrust reverser deployment limits engine thrust to idle.

ENGINE CONTROL SYSTEM

The engine control system performs engine control and thrust management, providing information to the cockpit, maintenance reporting and engine condition monitoring.

The FADEC manages the engine control system, monitoring the inputs from the airplane and engine. These inputs control the thrust management from the Thrust Lever Angle and Air Data.

The T2 sensor provides engine inlet air temperature for use in FADEC control calculations.

The N1 Fan Speed Sensor provides N1 data for the FADEC and airplane vibration monitoring system.

FULL AUTHORITY DIGITAL ELECTRONIC CONTROL (FADEC)

The FADEC controls the operation, performance and efficiency characteristics of the engine through full authority control over the engine fuel metering unit, variable geometry control, operability bleed valve, T2 sensor heater, thrust reverser actuation, engine starting, ignition and also providing engine limit protection during ground starts.

Fan speed is the parameter used to set engine thrust. The FADEC controls fan speed for the necessary thrust based on pressure altitude, temperature and Mach number.

The FADEC has two identical isolated channels. During operation with two capable FADEC channels, the software logic will alternate the channel in control of each engine start.

One FADEC channel operates as the in-control channel and provides electronic control outputs. The other channel operates as standby and processes all inputs and software, taking control upon a failure of the active channel. Built in test features shutdown of a channel whenever a critical internal components malfunction is detected.

The FADEC is primarily powered by the Permanent Magnet Alternator (PMA) above approximately 50 % N2. Below this value or in case the PMA becomes inoperative, the airplane's electrical system provides the required backup power.

AUTOMATIC TAKEOFF THRUST CONTROL SYSTEM (ATTCS)

The ATTCS, controlled by the FADEC, automatically provides maximum engine thrust reserve (RSV) according to the current rate (TO-1, TO-2, TO-3, FLEX TO-1, FLEX TO-2, FLEX TO-3 and GA) previously selected on the Takeoff Data Set page on the MCDU .

The ATTCS status (ON/OFF) may be selected via MCDU on the Takeoff Data Set page. However, if no selection is made before takeoff the system assumes status ON by default .

Even if ATTCS is selected OFF for takeoff, it will be armed automatically during go-around mode.

The ATTCS automatically commands RSV whenever it is armed, thrust levers are at TOGA position, and one of following conditions occurs:

- Difference between both engine N1 values is greater than 15%;
- One engine failure during takeoff;
- One engine failure during go-around;
- Windshear detection.

Whenever the ATTCS is activated, the green ATTCS indication on the EICAS disappears and the cyan thrust mode will be displayed with an additional "RSV" indication.

ATTCS LOGIC TABLE

Condition	Phase of Flight	ATTCS Status	Thrust Lever Set	Engine Thrust
One Engine Failure	Takeoff	ATTCS ON	TOGA	TO-x RSV
			MAX	TO-x RSV
		ATTCS OFF	TOGA	No Thrust Increase
			MAX	TO-x
	Go-Around	ATTCS ON	TOGA	GA RSV
			MAX	GA RSV
Windshear	Takeoff	ATTCS ON	TOGA	TO-x RSV
			MAX	GA RSV
		ATTCS OFF	TOGA	No Thrust Increase
			MAX	GA RSV
	Go-Around	ATTCS ON	TOGA	GA RSV
			MAX	GA RSV



FLEXIBLE TAKEOFF

Flexible takeoff is a reduced takeoff thrust based on assumed temperature. The assumed temperature is set on the MCDU takeoff page. The FADEC determines flexible takeoff rates for any of three possible takeoff modes, reducing the takeoff thrust based on assumed temperature set on the FMS.

The indication FLEX TO-1, FLEX TO-2 or FLEX TO-3 will be displayed on the EICAS for the respective flexible takeoff thrust.

The flex takeoff reduction is limited to climb thrust. Deselecting the ATTCS on the MCDU does not change the flex reduction limit.

	CF34-8E5A1	CF34-8E5	CF34-8E2
Takeoff Mode	Maximum Flex Reduction		
TO-1	CLB-1	CLB-1	CLB-1
TO-2	CLB-1	CLB-2	-
TO-3	CLB-2	-	-

ENGINE N1

The N1 indicates the engine thrust based on Fan speed.

The N1 “target” is the maximum thrust available in any given mode of operation and is obtained considering fan inlet temperature, pressure, altitude, and engine bleed configuration.

The N1 “Rating” is the maximum N1 value for the current engine thrust mode.

The N1 “Request” is the N1 value requested based on the current TLA position. FADEC may limit the N1 Request value for some conditions, such as during thrust reverser operation.

ENGINE THRUST RATINGS

Engine thrust ratings are controlled by the FADEC, which automatically provides the required thrust rating for engine operation.

The thrust rate modes are the following:

- Takeoff (TO-1, TO-2, TO-3)
- Takeoff Reserve (TO-1 RSV, TO-2 RSV, TO-3 RSV)
- Go-Around (GA)
- Go Around Reserve (GA-RSV)
- Maximum Continuous Thrust (CON)
- Maximum Climb (CLB)
- Maximum Cruise (CRZ)
- Idle

TAKEOFF (TO-1, TO-2, TO-3)

TO-1 is the highest thrust rating available with all engines operating normally considering the thrust levers at TOGA position.

The takeoff modes are designated as TO-1, TO-2 or TO-3.

TO-1, TO-2 and TO-3 are limited to 5 minutes during the takeoff phase.

MAXIMUM TAKEOFF RESERVE (TO-1 RSV, TO-2 RSV, TO-3 RSV)

The maximum takeoff reserve (TO-1 RSV, TO-2 RSV, TO-3 RSV) is the highest thrust rating available according to the TO rate selected. TO-1 RSV, TO-2 RSV and TO-3 RSV are limited to 5 minutes during the takeoff phase.

GO-AROUND (GA)

The GA mode is the highest thrust rating available with all engines operating normally considering the thrust levers at TOGA position during a go-around. The GA mode is limited to 5 minutes during the go-around phase.

GO-AROUND RESERVE (GA-RSV)

The GA-RSV is the highest thrust rating available considering the thrust lever at TOGA, one engine inoperative or windshear detected.

Even with dual engine operation, advancing the thrust levers to the MAX position during go-around mode can also provide GA-RSV. The GA-RSV is limited to 5 minutes during the go-around phase.

MAXIMUM CONTINUOUS RATING (CON)

The maximum continuous rating is the maximum thrust rating available for continuous dual or single engine operation.

MAXIMUM CLIMB RATING (CLB-1, CLB-2)

Maximum Climb rating is the maximum thrust rating for climb operation. Climb modes are designated as CLB-1 and CLB-2.

The Maximum Climb rating does not have a fixed thrust levers position. It is selectable through thrust lever adjustments between the IDLE and TOGA positions, or even manually selecting (CLB-1 or CLB-2) on the MCDU.

MAXIMUM CRUISE RATING (CRZ)

Maximum Cruise is the maximum thrust for cruise operations with all engines operating and is not subject to time-limited operation. The Maximum Cruise (CRZ) thrust ratings does not have a fixed TLA position. It is selectable through thrust lever adjustments between the IDLE and CLB positions.

IDLE

The idle mode selections are the following:

- Flight Idle.
- Approach Idle.
- Final Approach Idle.
- Ground Idle.

Automatic selection between IDLE modes is accomplished by the FADEC based on inputs from the airplane.

FLIGHT IDLE

The engine offers the minimum necessary thrust to provide minimum engine bleed pressure to the airplane. Flight Idle fan speed varies with altitude and can change as a function of ECS bleed, and anti-ice bleed requirements. The flight idle mode is activated as follows:

- Weight off wheels.
- Approach idle not selected.

APPROACH IDLE

Approach Idle is used in flight to enable rapid acceleration to go-around thrust. Approach idle is activated as follows:

- Weight off wheels.
- The approach mode set (flaps 1 or greater or landing gear down and locked).
- Altitude less than 15000 ft.

FINAL APPROACH IDLE

The FADEC sets the Final Approach Idle for altitudes lower than 1200 ft and approach mode configuration. When in Final Approach Idle the FADEC considers anti-ice off, regardless of the actual anti-ice system status.

GROUND IDLE

Ground Idle is the minimum thrust setting. Ground Idle provides a stable and minimum engine thrust level for ground operations.

MINIMUM REVERSE

Min reverse is the minimum reverse thrust available with the thrust lever set in the MIN REVERSE position.

MAX REVERSE

Max reverse is the maximum reverse thrust available with the thrust lever set in the MAX REVERSE position.

THRUST RATINGS TABLE

		CF34-8E5A1		CF34-8E5		CF34-8E2	
Ratings		Thrust (lbf)		Thrust (lbf)		Thrust (lbf)	
Thrust Mode	ATTCS	All Engine Oper.	One Engine Inop.	All Engine Oper.	One Engine Inop.	All Engine Oper.	One Engine Inop.
T/O-1	ON	13800	14200	13000	14200	11700	13000
	OFF	13800	13800	13000	13000	11700	11700
T/O-2	ON	13000	14200	11700	13000	-	-
	OFF	13000	13000	11700	11700	-	-
T/O-3	ON	11700	13000	-	-	-	-
	OFF	11700	11700	-	-	-	-
GA	ON	13000	14200	13000	14200	11700	13000
CON	-	12800	12800	12800	12800	11700	11700
CLB-1	-	12400	-	12400	-	11200	-
CLB-2	-	11200	-	11200	-	-	-
CRZ	-	10400	-	10400	-	10000	-

NOTE: Thrusts values for sea level and ISA conditions.

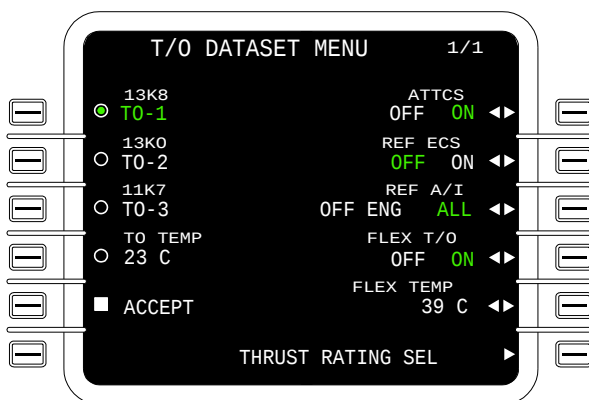
TAKEOFF DATASET

In the T/O DATASET MENU, on the MCDU, the flight crew may set the TO thrust rate mode, the TO temperature, the ATTCS ON or OFF, and assumed temperature for flexible takeoff.

If the FADEC does not receive a FLEX TEMP from the MCDU or receives a value lower than the TO TEMP, the FADEC will not perform a flex takeoff.

The T/O dataset is performed according to the sequence:

- Press MENU (mode button).
- Press MISC (line select key – 1L) on MENU page.
- Press THRUST MGT (line select key – 1R) on MISC MENU page.
- Press TO DATA SET (line select key – 6R) on THRUST RATING SELECT page.



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T/O DATASET MENU ON THE MCDU

TYPE	MESSAGE	MEANING
CAUTION	ENG EXCEEDANCE	In flight engine limit exceedance detected.
	ENG NO TAKEOFF DATA	Takeoff data not entered successfully. Discrepancy between information entered in FMS for engine 1 and 2 detected.
	ENG REF A-I DISAG	Ice protection mode selector knob set to the ON position with OFF or ENG in the take-off data set (TDS) menu.
	ENG REF ECS DISAG	Discrepancy between REF ECS input and actual ECS bleed configuration.
	ENG THR RATING DISAG	Discrepancy between maximum thrust rating of engines 1 and 2. Possible asymmetric engine thrust.
ADVISORY	ENG 1 (2) FADEC FAULT	One FADEC channel no longer sending data.
	ENG 1 (2) FUEL SW FAIL	Fuel pressure switch indicates pressure is not low while all fuel pumps are off.
	ENG 1 (2) OIL IMP BYPASS	Oil filter impending bypass.
	ENG 1 (2) OIL SW FAIL	Oil impending bypass switch or oil pressure switch failure detected.
	ENG 1 (2) SHORT DISPATCH	Short-time dispatch fault condition detected by FADEC.
STATUS	ENG 1 (2) REV INHIBIT	Reverser inhibited by maintenance action.
	ENG 1 (2) TLA NOT IDLE	Thrust Lever Angle not set to idle position during either engine start or engine shutdown.
	ENG TDS REF A-I ALL	REF A-I ALL is selected on take-off data set page on MCDU.
	ENG TDS REF A-I ENG	Ice protection mode selector knob set to the AUTO position and REF A-I ENG is selected on take-off data set page on MCDU.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	ENG 1 (2) OIL LO PRESS	Engine 1 (2) oil pressure is low.
	ENG 1 (2) REV DEPLOYED	Thrust reverser deployed unexpectedly, or not stowed when ordered to stow or thrust reverse position is undetermined.
CAUTION	ENG 1 (2) CONTROL FAULT	Thrust modulate is unenabled. OBV has failed open or engine will respond slowly.
	ENG 1 (2) FADEC OVERTEMP	FADEC overtemperature has been detected.
	ENG 1 (2) FAIL	Engine 1 (2) shutdown has occurred.
	ENG 1 (2) FUEL IMP BYPASS	Fuel filter impending bypass.
	ENG 1 (2) FUEL LO PRESS	Engine 1 (2) Fuel pressure low. Airplane backup fuel pump will be activated.
	ENG 1 (2) NO DISPATCH	No dispatch condition detected by FADEC.
	ENG 1 (2) OIL LO LEVEL	Engine 1 (2) oil level is below minimum.
	ENG 1 (2) REV FAIL	Thrust Reverser is not available.
CAUTION	ENG 1 (2) REV PROT FAULT	Reverser fault detected, operation not inhibited.
	ENG 1 (2) REV TLA FAIL	Respective reverser solenoid protection has failed.
	ENG 1 (2) START VLV OPEN	Start valve not closed while engine running.
	ENG 1 (2) T2 HEAT FAIL	T2 heater failed.
	ENG 1 (2) TLA FAIL	Dual thrust lever angle sensor failure.

TYPE	MESSAGE	MEANING
CAUTION	ENG EXCEEDANCE	In flight engine limit exceedance detected.
	ENG NO TAKEOFF DATA	Takeoff data not entered successfully. Discrepancy between information entered in FMS for engine 1 and 2 detected.
	ENG REF A-I DISAG	Ice protection mode selector knob set to the ON position with OFF or ENG in the take-off data set (TDS) menu.
	ENG REF ECS DISAG	Discrepancy between REF ECS input and actual ECS bleed configuration.
	ENG THR RATING DISAG	Discrepancy between maximum thrust rating of engines 1 and 2. Possible asymmetric engine thrust.
ADVISORY	ENG 1 (2) FADEC FAULT	One FADEC channel no longer sending data.
	ENG 1 (2) FUEL SW FAIL	Fuel pressure switch indicates pressure is not low while all fuel pumps are off.
	ENG 1 (2) OIL IMP BYPASS	Oil filter impending bypass.
	ENG 1 (2) OIL SW FAIL	Oil impending bypass switch or oil pressure switch failure detected.
	ENG 1 (2) SHORT DISPATCH	Short-time dispatch fault condition detected by FADEC.
STATUS	ENG 1 (2) REV INHIBIT	Reverser inhibited by maintenance action.
	ENG 1 (2) TLA NOT IDLE	Thrust Lever Angle not set to idle position during engine start.
	ENG TDS REF A-I ALL	REF A-I ALL is selected on take-off data set page on MCDU.
	ENG TDS REF A-I ENG	Ice protection mode selector knob set to the AUTO position and REF A-I ENG is selected on take-off data set page on MCDU.