A350-900

Flight Deck and Systems Briefing for Pilots

Issue 02 - Sept 2011

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A350-900
Flight Deck and Systems Briefing for Pilots

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Statement of offer

The A350 XWB program is currently in development. The description provided in this document including characteristics, features and functions represents the currently best available knowledge. Final description of basic and customization optional features may evolve through the design development process. Airbus reserves the right to change, remove or add features and/or characteristics of the basic aircraft design and of the customization possibilities described in this document. The terms and conditions under which the A350 XWB will be finally offered will be determined in the Purchase Agreement between Airbus and the Buyer relating to the sale and purchase of the A350 XWB aircraft. In the event of any inconsistency between the provisions of this document and the provisions of the Purchase Agreement, the provisions of the Purchase Agreement shall prevail.

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A350 XWB

ATA Chapters

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A350 XWB

Contents

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General

General

The A350 is a twin-engine subsonic aircraft designed for commercial transportation of passengers and cargo.

There are three members in the A350 XWB family:

- The A350-800 (276 passengers in a 2 class cabin arrangement)
- The A350-900 (315 passengers in a 2 class cabin arrangement)
- The A350-1000 (369 passengers in a 2 class cabin arrangement).

When dependant on the aircraft model, this brochure describes the A350-900.

The A350 has two high-bypass turbofan engines mounted underneath the wings. Its cockpit is designed for operation by a crew of two pilots.

All the A350 variants have the same type rating.

The A350 also shares high degree of commonality with other Airbus aircrafts.

Certification Basis

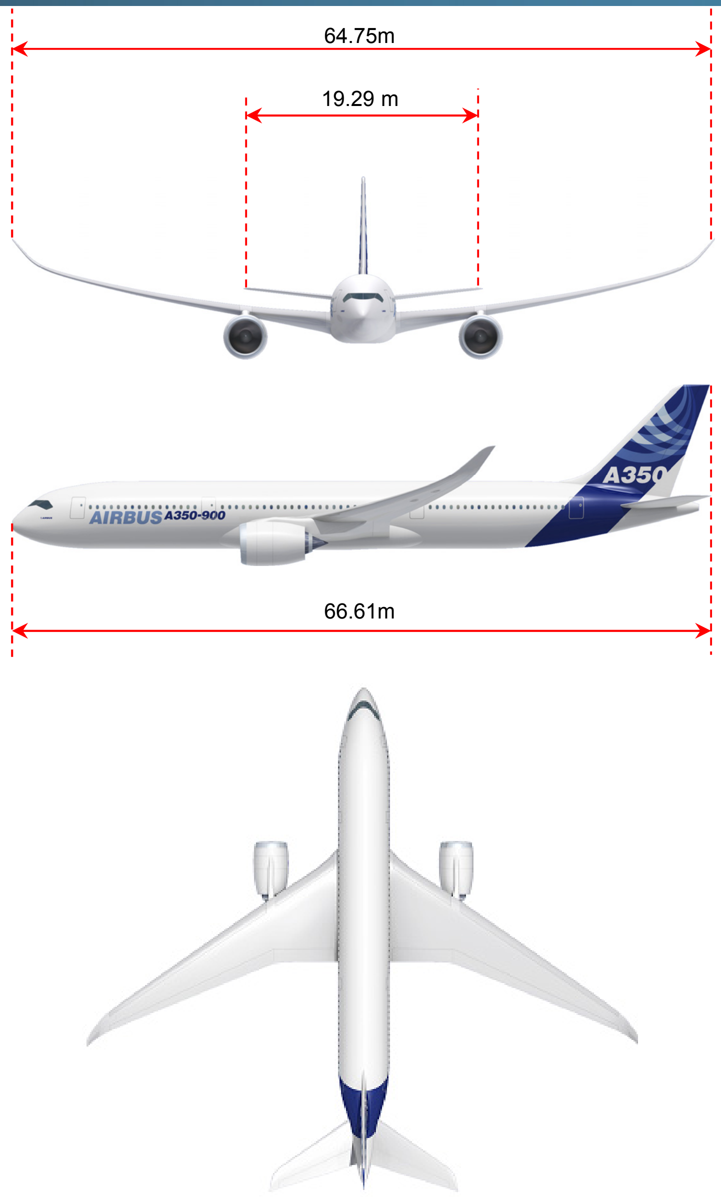
Airbus designs and builds the aircraft according to Airworthiness Requirements from the European Aviation Safety Agency (EASA):

- CS-25 amendment 5
- CS-AWO dated October 2003.

Dimensions

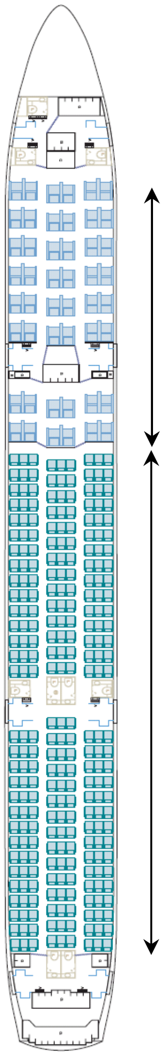
The A350 family presents the current following main dimensions still under review:

	A350-900
Wing span	64.75 m (212 ft 5.2 in)
Wing area	442.9 m² (4767.3 ft²)
Sweep (25% chord, mid-wing)	31.9°
Fuselage length	65.26 m (214 ft 1.3 in)
Fuselage cross-section (constant part)	6.09 m (239 in) height 5.96 m (234 in) width
Horizontal tail plane area	82.7 m² (890.2 ft²)
Horizontal tail plane span	19.29 m (63 ft 3.4 in)
Vertical tail plane area	51 m² (549 ft²)
Overall height	17.05 m (56 ft)

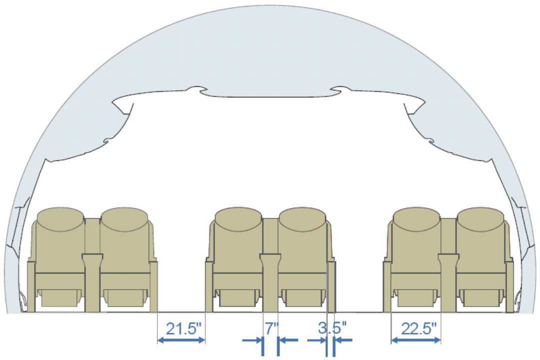


Typical Cabin Layout

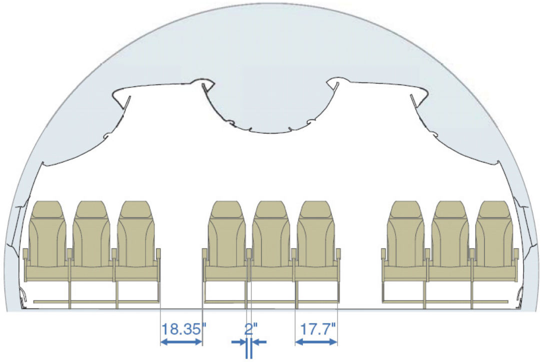
The typical cabin layout is 315 seats. The passenger seating layout may vary according to the Operator's requirements.



Business/First Class



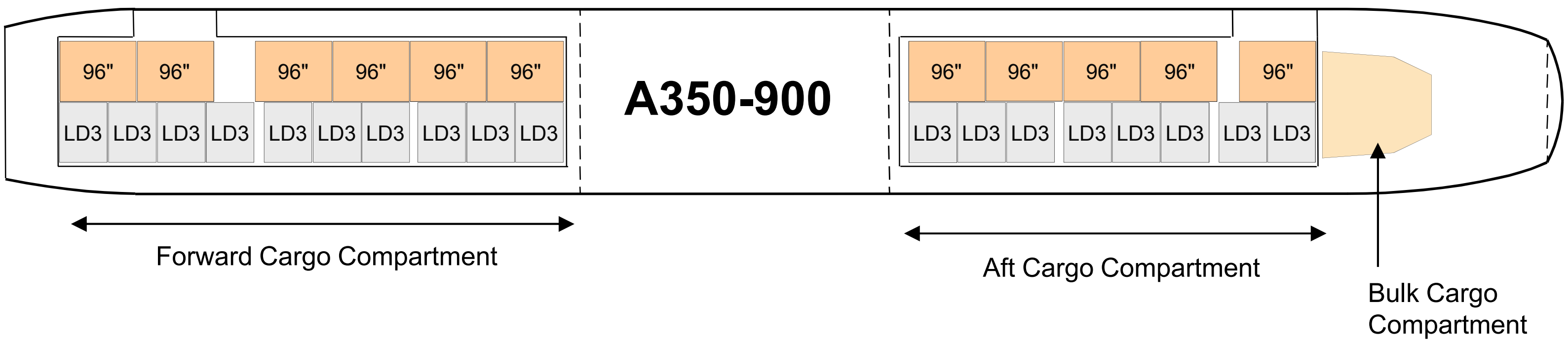
Economy Class



Cargo Hold Capacity

The A350 has the following lower deck cargo compartments:

- Forward cargo compartment (20 LD3 or 6 pallets 96” or 88”)
- Aft cargo compartment (16 LD3 or 5 pallets 96” or 88”)
- Bulk cargo compartment (400 ft^3).



3.Aircraft Design Specifications

1. Design Weights

	A350-900
MTW (taxi)	268 900 kg
MTOW	268 000 kg
MLW	205 000 kg
MZFW	192 000 kg

2. Design Speeds

V_{MO}	340 kt CAS
M_{MO}	0.89
V_D	375 kt CAS
M_D	0.96
V_{LO}	250 kt CAS 250 kt CAS (gravity extension)
V_{LE}	250 kt CAS
M_{LO}	0.55
M_{LE}	0.55

3. Slats and Flaps Design Speed

Lever Pos.	Configuration	Flight Phase	DND(°)	Slats (°)	Flaps (°)	
					Inboard	Outboard
0	Clean	CRZ	0	0	0	0
1	1	HOLD/APP	16.7	18	0	0
	1+F	TO/APP	16.7	18	6 TO / 9 APP	12 TO / 9 APP
2	2	TO/APP	16.7	18	20	20
3	3	TO	16.7	18	26	26
	3+S	APP/LDG	25	27	26	26
Full	Full	LDG	25	27	37.5	37.5

Note: DND stands for Droop Nose Device.

4. Fuel Capacity

		USABLE FUEL (Fuel Specific Density: 0.80 kg/L)			
		Left Wing Tank	Center Tank	Right Wing Tank	TOTAL
VOLUME	Liters	29 619	82 421	29 619	141 659
	US Gal	7 825	21 773	7 825	37 005
WEIGHT	Kg	23 695	65 937	23 695	113 327
	Lbs	52 238	145 366	52 238	249 843

5. Pavement Strength

Main Landing Gear Gear tires (radial)	ACN							
	Flexible Pavement				Rigid Pavement			
	Cat A	Cat B	Cat C	Cat D	Cat A	Cat B	Cat C	Cat D
1400 x 530R23 40PR	56	61	71	95	48	55	65	76

Note: The Nose Landing Gear is equipped with 2 radial 1 270 x 455 x R22 tires.

General

The Rolls Royce Trent XWB engines power the A350-900.

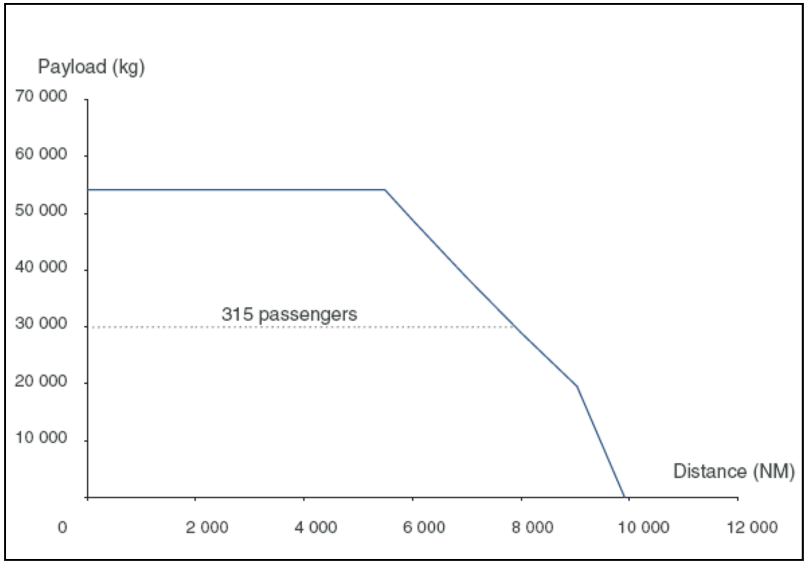
Engine type	Thrust ratings (Maxi takeoff at MSL)
RR Trent XWB - 84	84,000 lbs

Payload / Range calculations

The following payload range calculations have been performed using the A350 family standard layouts presented page 1.6 and Airbus standard operating rules described below:

- Typical international reserves
- Nominal fuel flow
- Standard temperature conditions
- Payload: 95 kg per passenger including luggage
- Fuel density: 0.803 kg/l
- Mach: 0.85.

Payload Range Diagram (RR Trent Engine)



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ETOPS

The A350 family offers a basic ETOPS 180 minutes capability.

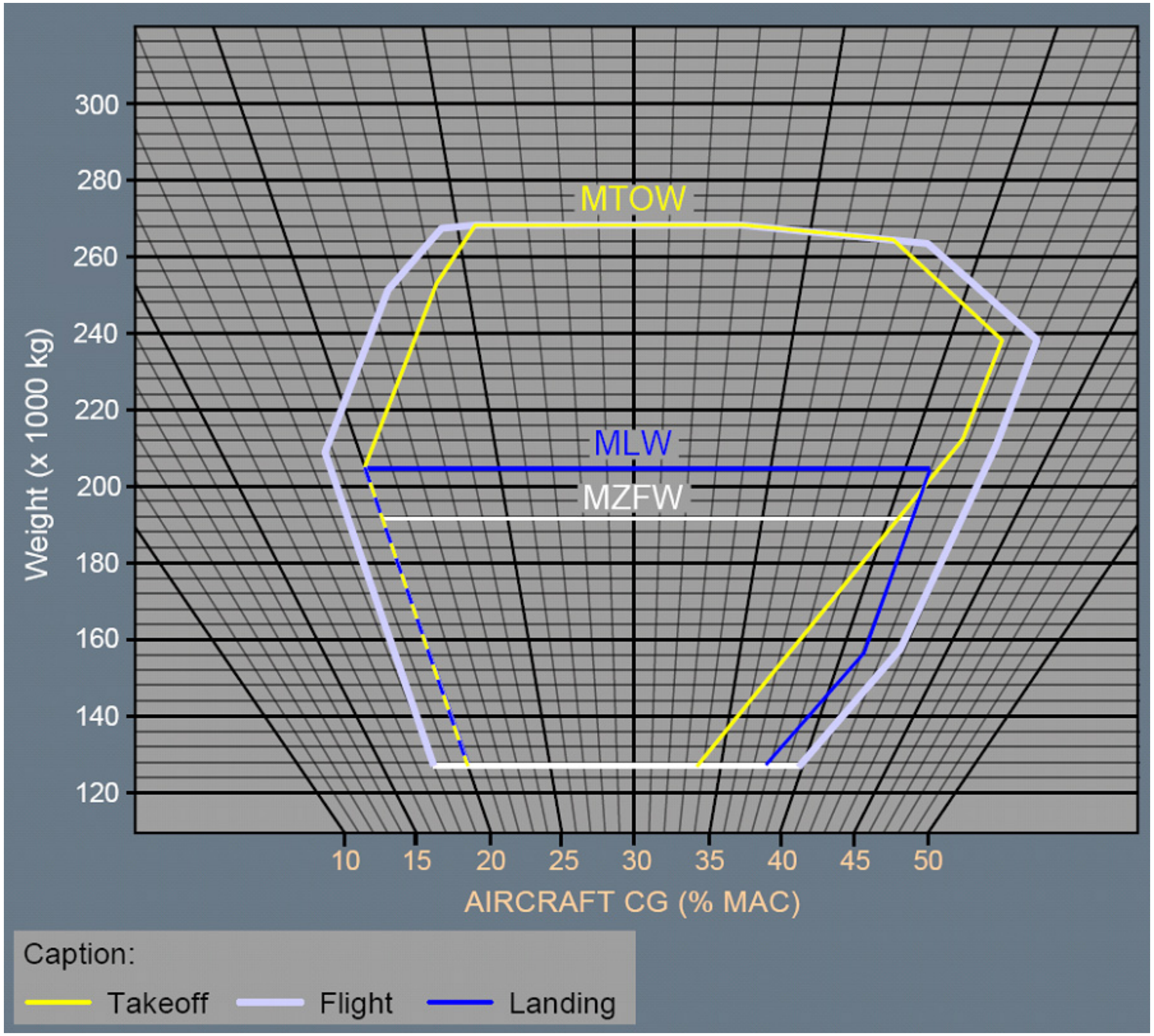
However, the systems of the A350 are designed to sustain up to ETOPS 350 minutes.

Thus, the A350 offers two optional ETOPS capabilities:

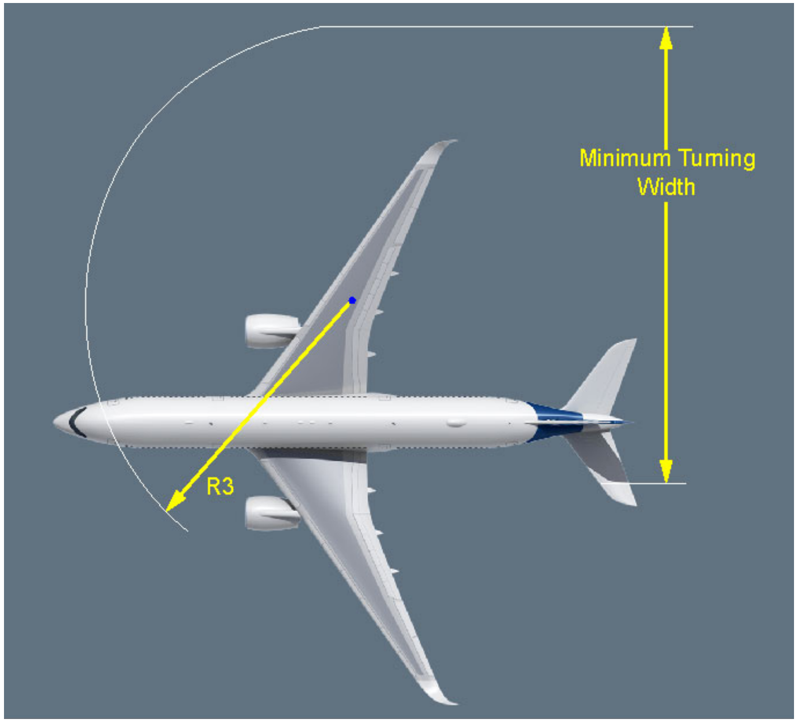
- ETOPS 240 minutes
- ETOPS 350 minutes.

Note: ETOPS revenue flights require both aircraft type design approval, and operational ETOPS approval.

Weight & Balance Graph



Minimum Turning Width



The minimum turning width is 51 meters.

Flight Deck Layout

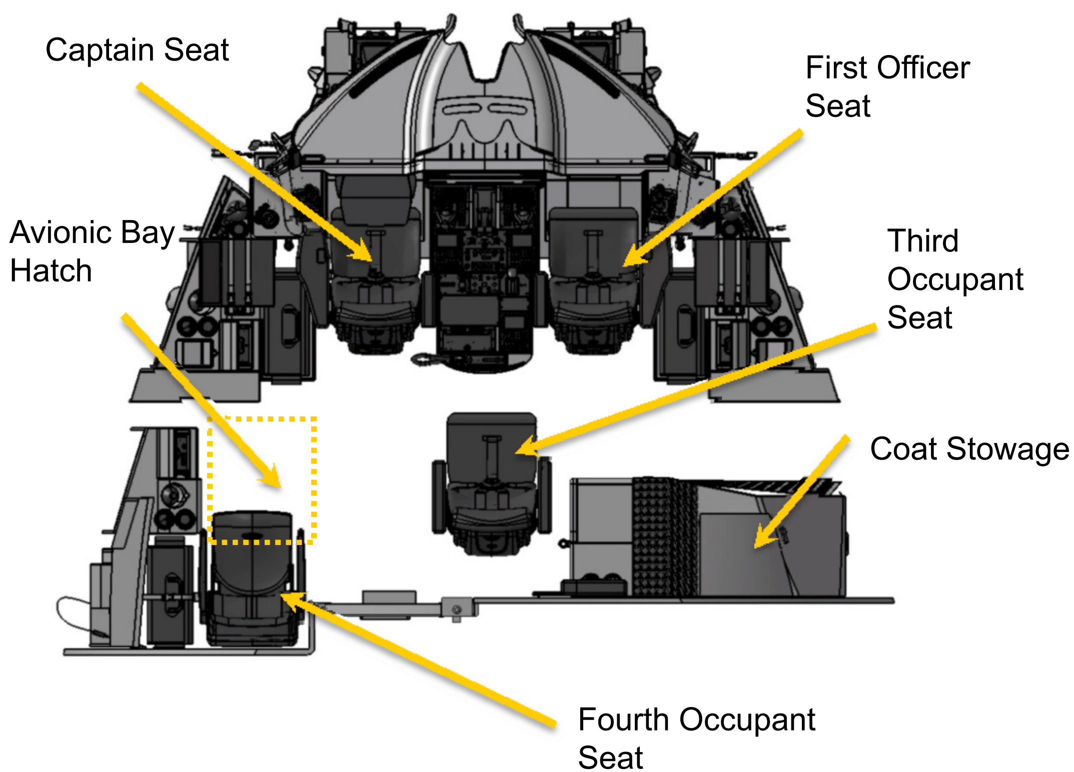
A350 XWB

1. **General**
   - Overview
   - Cockpit Views
   - Flight Crew Seats and Rest Compartment
2. **Instrument Panels**
   - Main Instrument Panel
   - Glareshield
   - Pedestal
   - Overhead Panel
3. **Field of Vision**
   - Flight Crew's Vision Envelope

Overview

The A350 cockpit has:

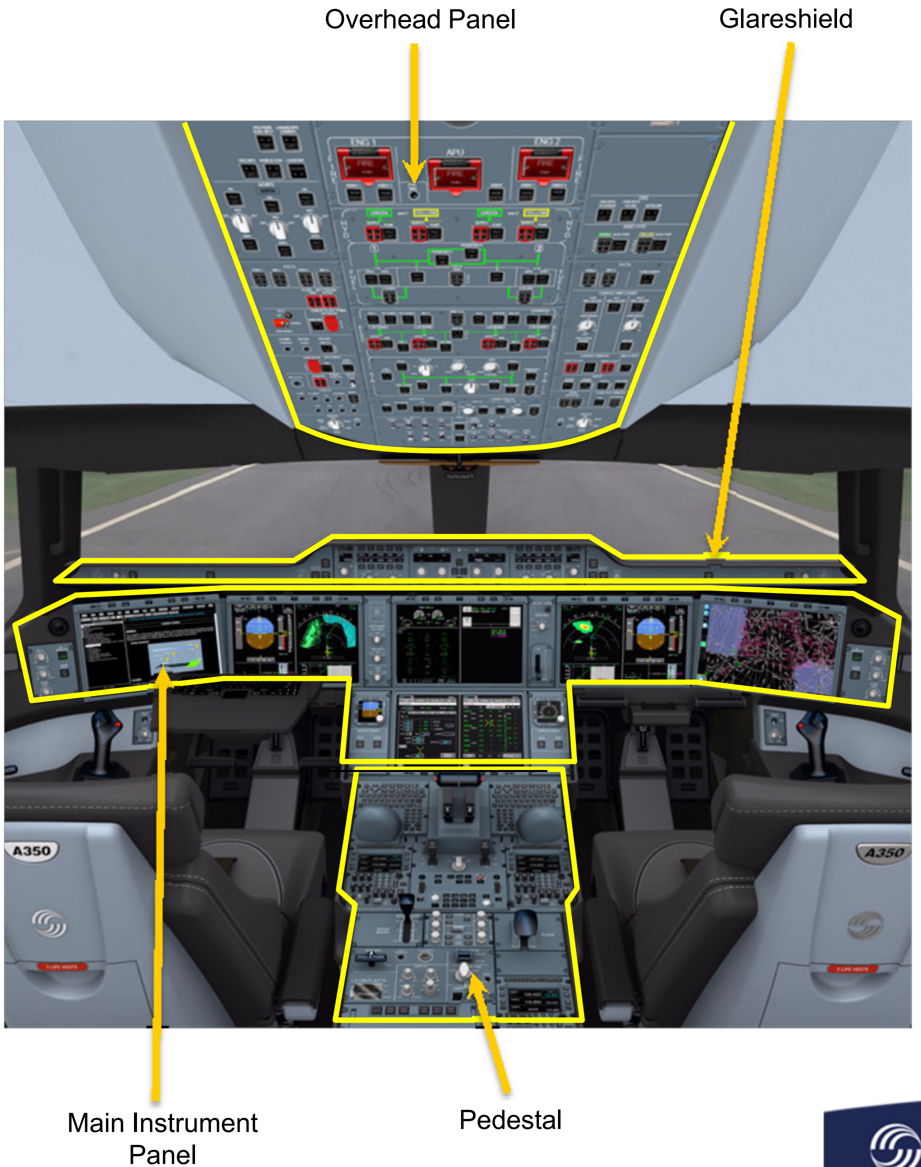
- A captain seat
- A first officer seat
- A third occupant seat
- A fourth occupant seat (optional)



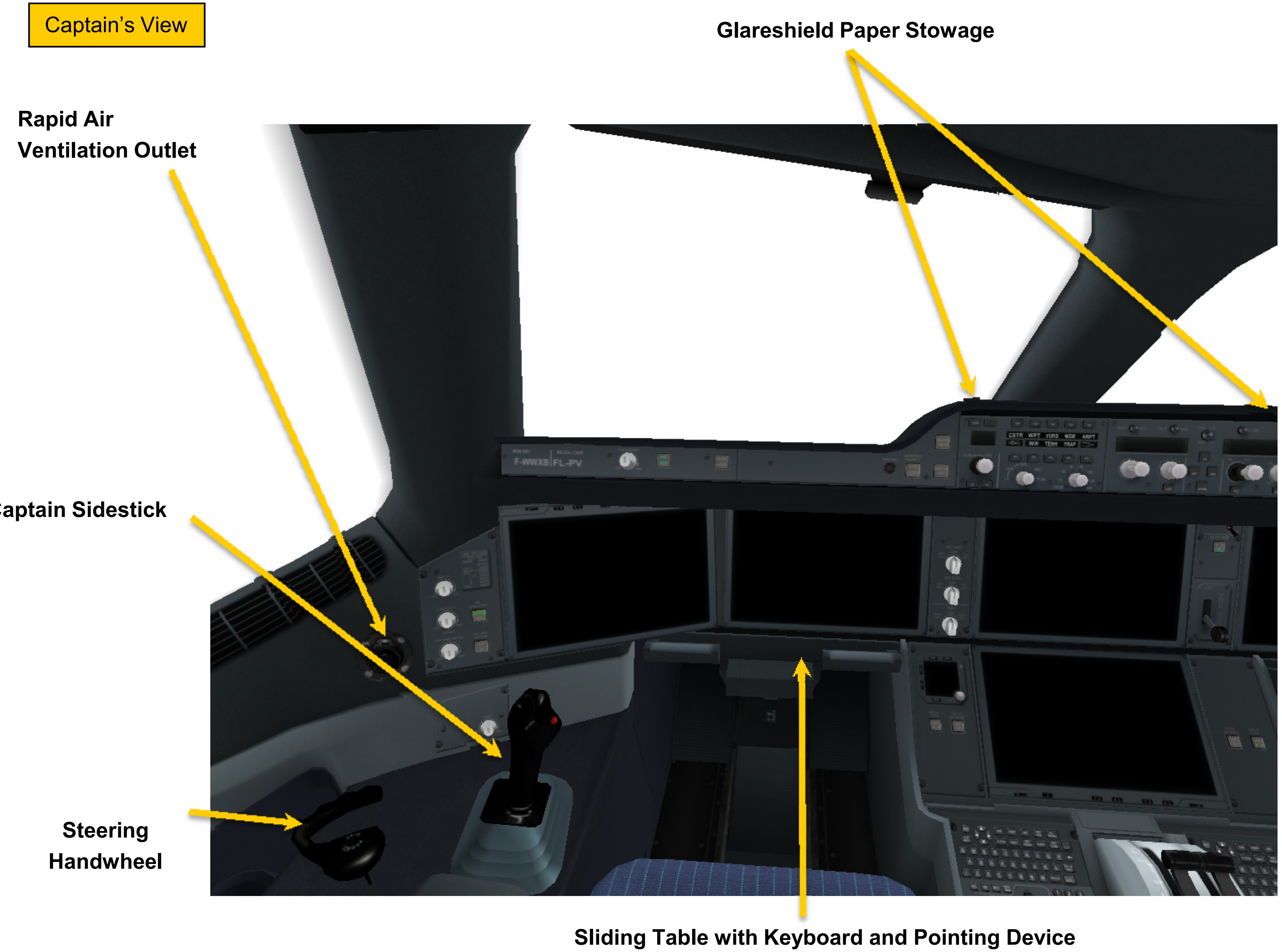
Cockpit Views

The cockpit includes:

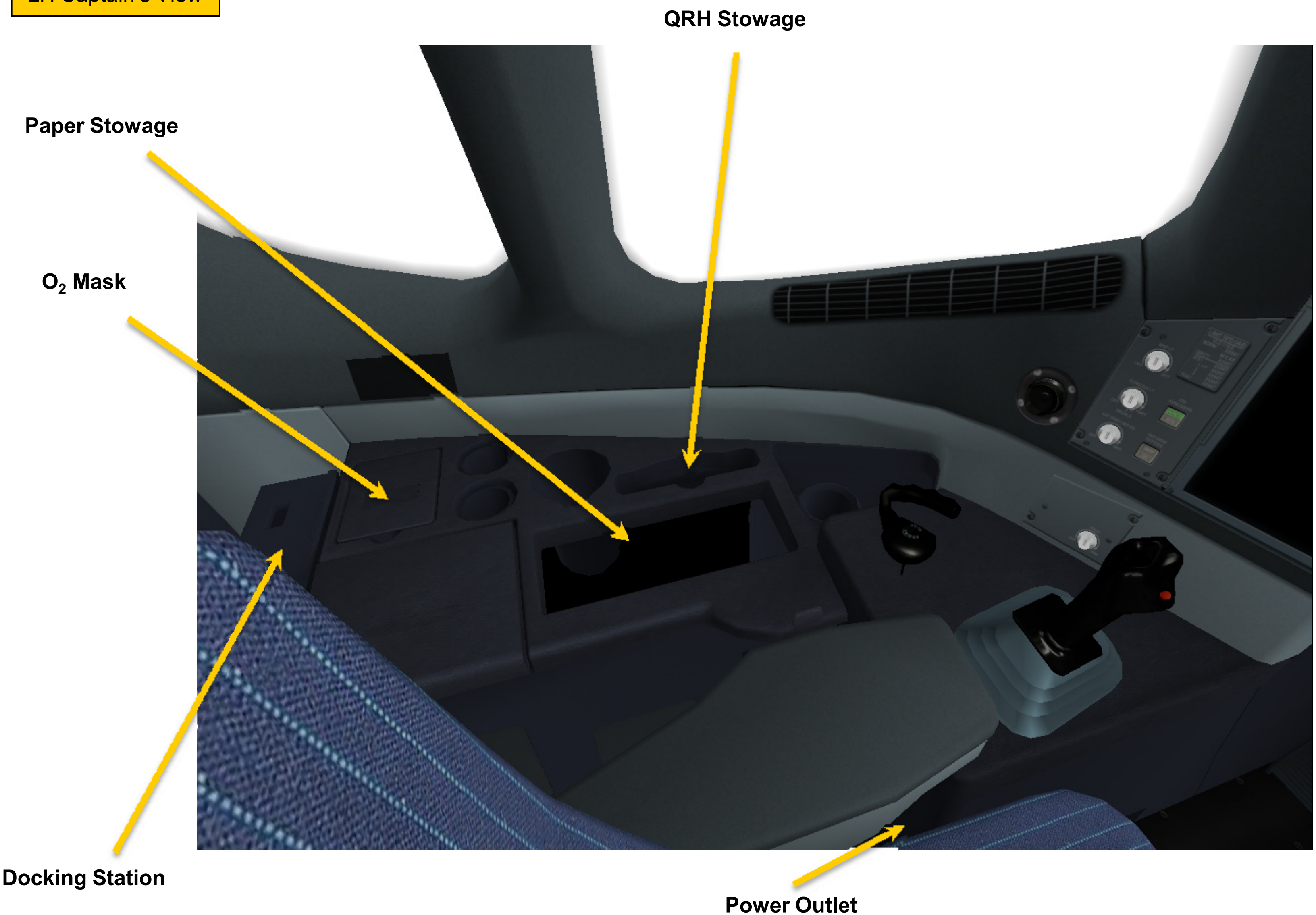
- The following instrument panels:
  - Overhead panel
  - Main instrument panel
  - Glareshield
  - Pedestal
- The captain and first officer lateral consoles that each have:
  - One sidestick
  - One steering handwheel
  - One oxygen mask
  - One stowed laptop
- An Onboard Maintenance Terminal (OMT) for maintenance staff
- A third occupant console with an oxygen mask
- A fourth occupant console with an oxygen mask.



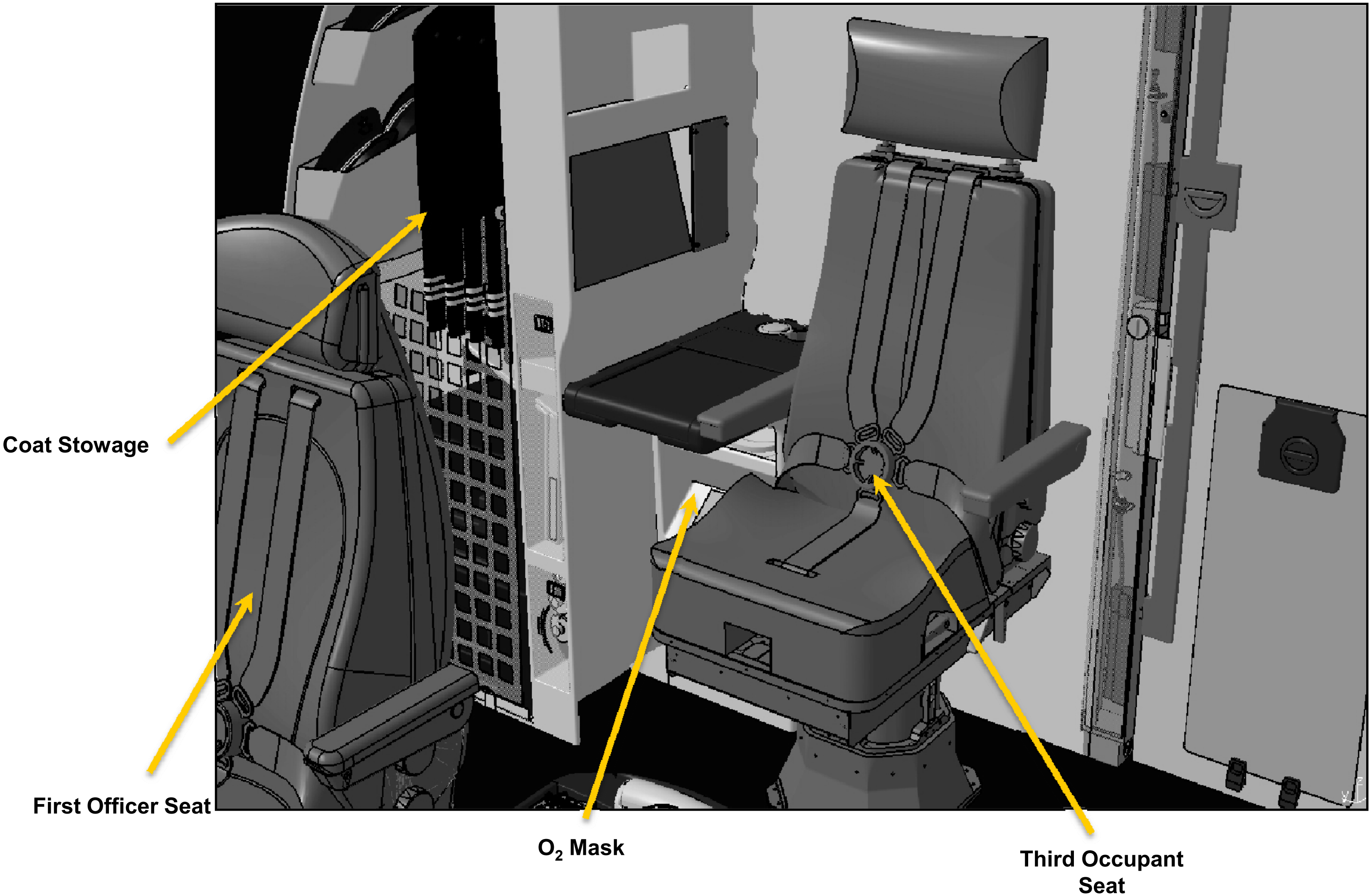
Captain's View



LH Captain's View



RH Aft View

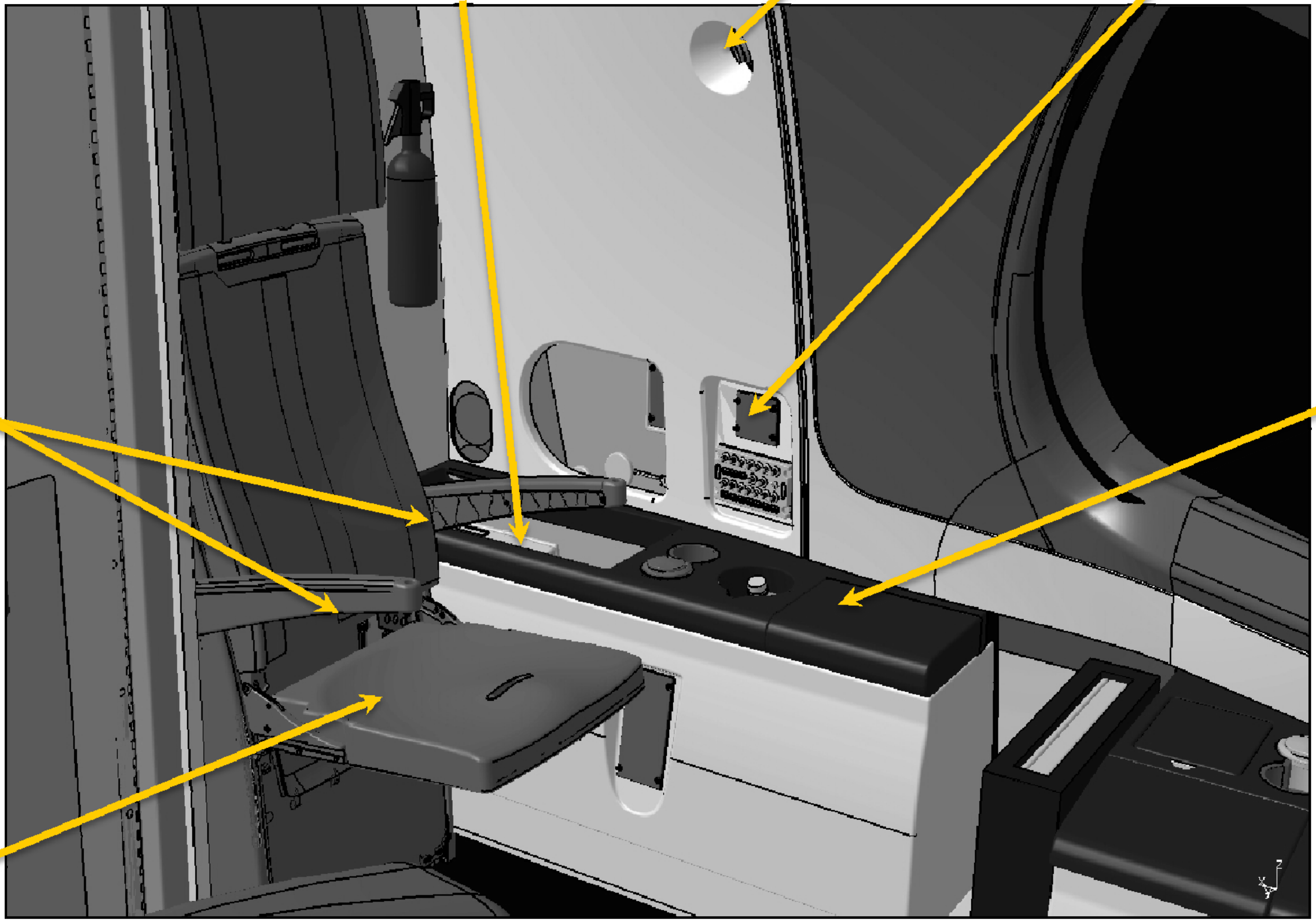


Coat Stowage
First Officer Seat
O_2 Mask
Third Occupant Seat

A350 Flight Deck Layout

1.General

LH Aft View



Flight Crew Seats

Each flight crew seat has:

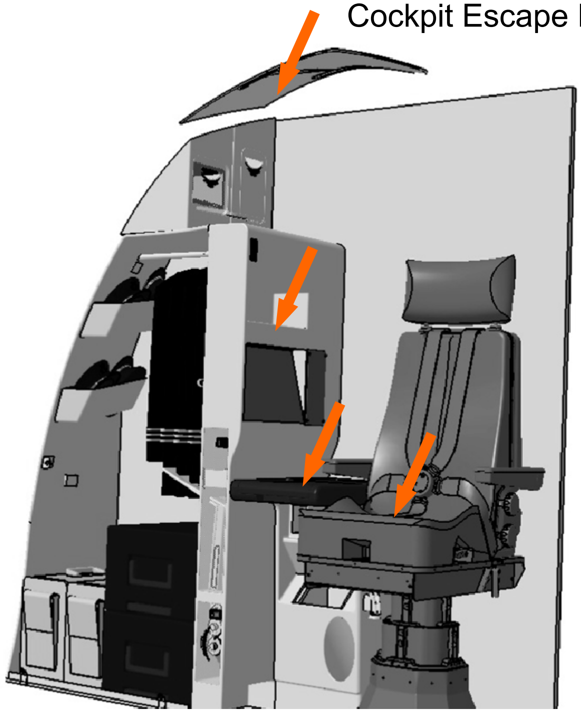
- Folding adjustable armrests
- An adjustable headrest
- A reclining backrest with lumbar adjustment
- A life vest stowage in the back of the seat.

The flight crew can adjust his seat either:

- Electrically, or
- Mechanically in backup.

Cockpit Escape Hatch

The cockpit escape hatch is an emergency exit. This exit is on the ceiling above the coat stowage.



Note: The arrows show the escape pattern

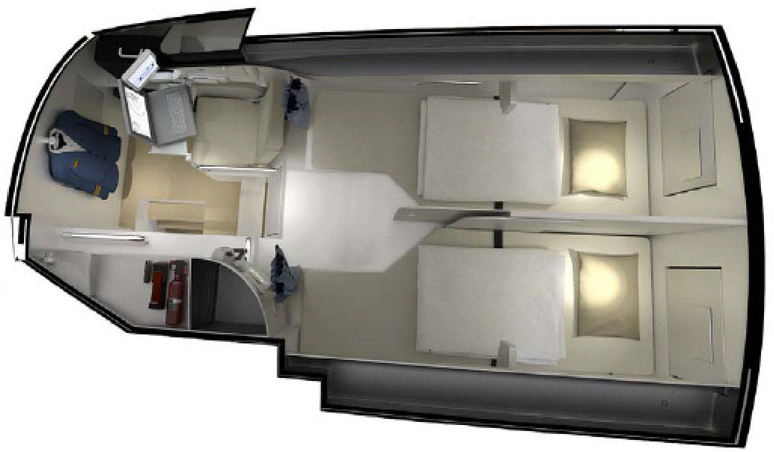
Optional Flight Crew Rest Compartment (FCRC)

The FCRC is in an area above the aircraft forward doors (door 1 RH and door 1 LH), adjacent to the cockpit.

The flight crew can access the FCRC from:

- The RH side of the cockpit corridor or,
- The LH side lavatory.

Example of FCRC arrangement



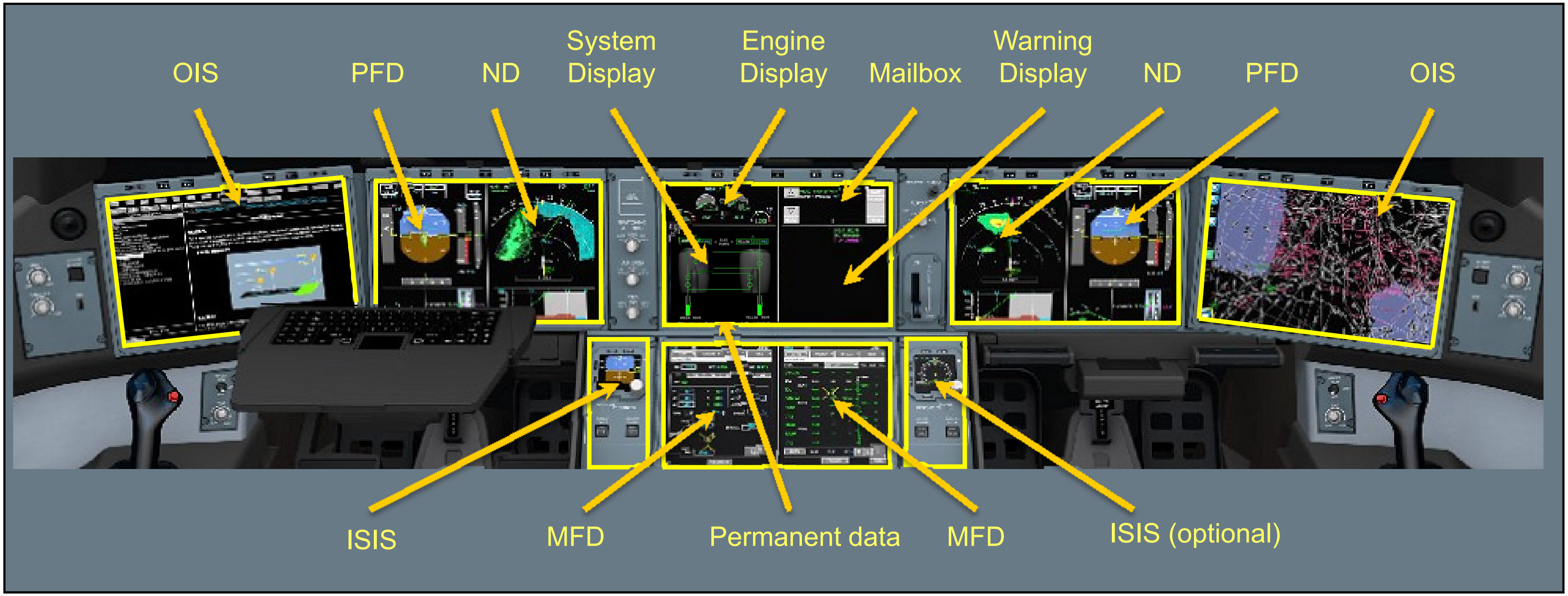
Note: The above picture may contain optional features.

Main Instrument Panel

The Control and Display System (CDS) has:

- **Six identical interchangeable liquid cristal display units**
- **One (optionally two) Integrated Standby Instrument System (ISIS).**

Main Instrument Panel



PFD: Primary Flight Display	**MFD: Multi-Function Display**
ND: Navigation Display	**ISIS: Integrated Standby Instrument System**

Glareshield

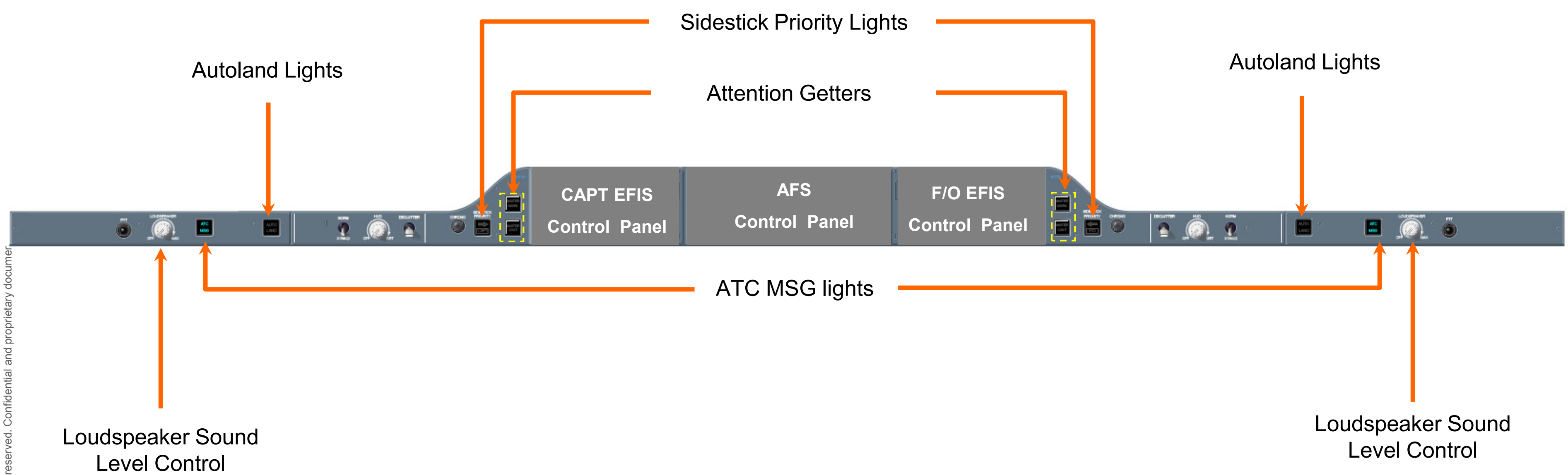
The glareshield has:

- One **Flight Control Unit (FCU)** with:
  - Two **EFIS Control Panels (EFIS CP):**
    Each EFIS CP is used to select the display on the onside PFD and ND and to change the barometer settings
  - One **Auto Flight System Control Panel (AFS CP):**
    The AFS CP is the main interface with the Flight Guidance (FG) system.

- Two panels with:
  - Attention getters: Master warning and master caution lights
  - Sidestick priority lights
  - Autoland lights

- Two panels with:
  - Loudspeaker sound level controls
  - ATC MSG indicators.

GLARESHIELD



Pedestal

The central pedestal includes:

- Two **Keyboard and Cursor Control Units (KCCUs)**
  Each KCCU enables the crew to interface with the MFD, the ND, the Mailbox and the OIS

- Three **Radio Management Panels (RMPs)**
  The RMPs can be used:
  - To tune all radio communications
  - To enter the squawk code
  - As a backup for radio navigation
  - To adjust the volume for communication and NAVAID identification

- One **SURV Control Panel**
  The SURV Control Panel is used to interface with the Surveillance (SURV) functions of the aircraft:
  - Terrain Awareness and Warning System (TAWS)
  - Weather radar (WXR)
  - Traffic Collision Avoidance System (TCAS)

- One **ECAM Control Panel (ECP)**
  The ECP is the interface with the ECAM

- **Thrust levers and engine master levers**

- The following panels for the flight controls:
  - PITCH TRIM and RUDDER TRIM panels
  - SPEED BRAKE and FLAPS panels
  - Parking brake panel

- The CKPT DOOR panel

- The CKPT LT panel

- The following panels for the Landing Gear (L/G)
  - PRK BRK panel
  - The L/G GRVTY EXTN panel

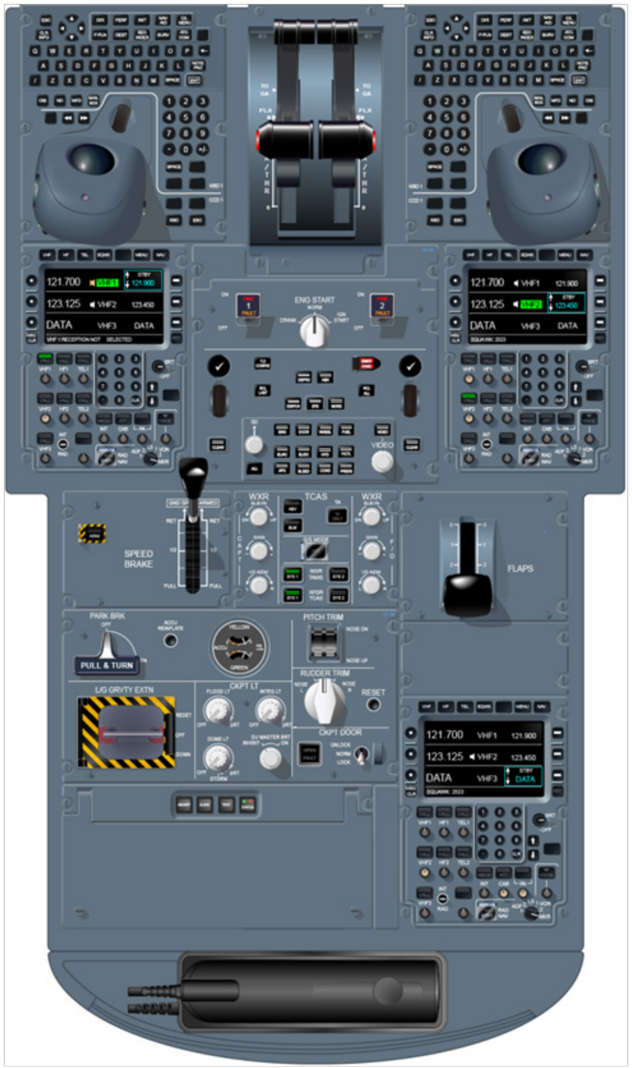
- The printer

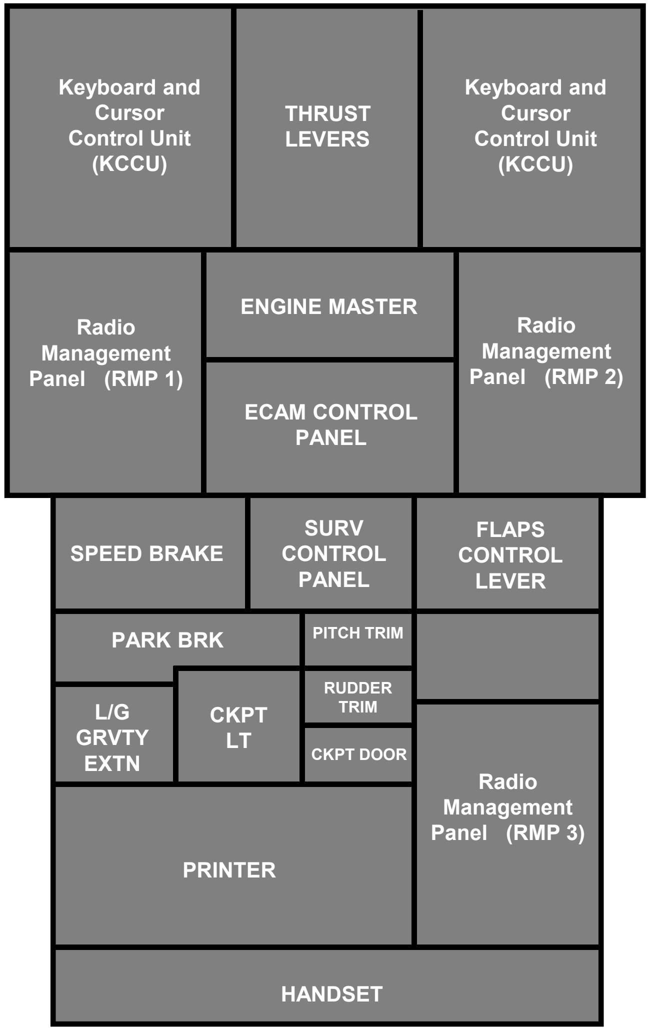
- The handset.

A350 Flight Deck Layout
2.Instrument Panels

A350 XWB

PEDESTAL





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Overhead Panel

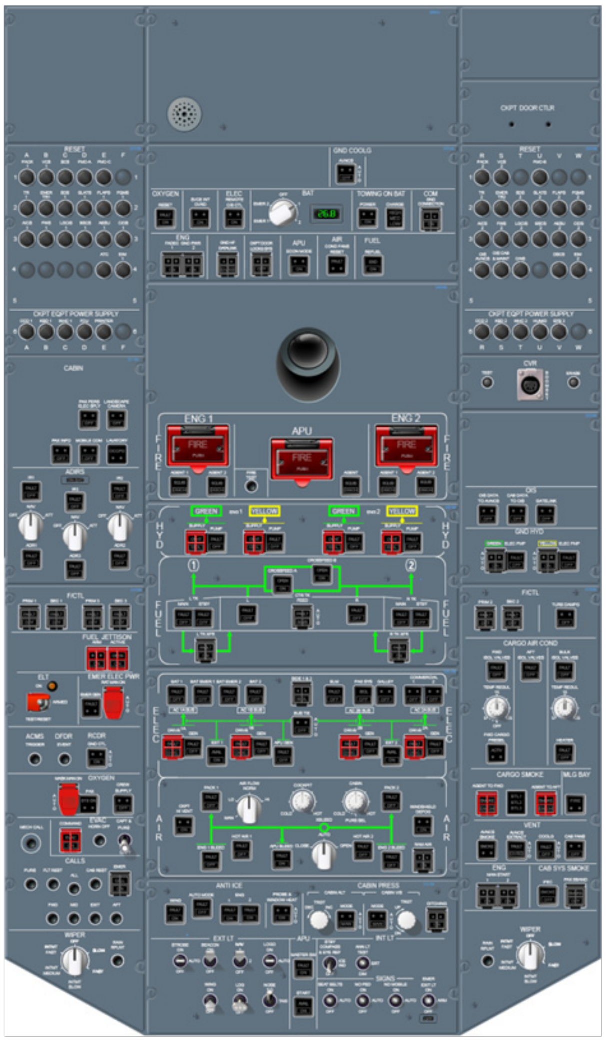
Both pilots can reach all the controls on the overhead panel.

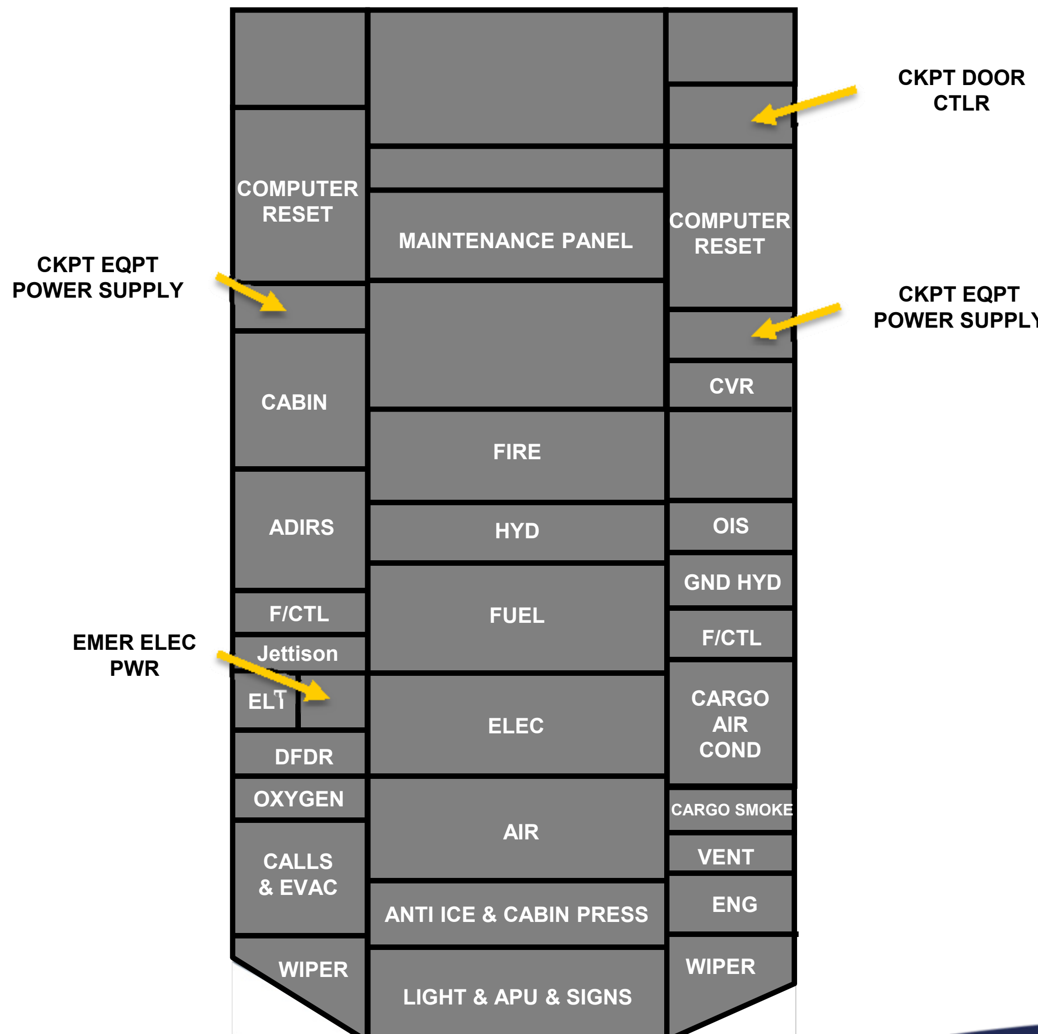
The overhead panel includes the system controls and is organized in three main rows:

- One center row for primary systems organized in a logical way
- Two lateral rows for other systems.

The pushbutton philosophy is identical to previous Airbus aircraft.

OVERHEAD PANEL





Flight Crew’s Vision Envelope

The nose cone, the windshield and the side windows have been designed in order to provide the best outside visibility.

The A350 visibility is greater than the requirements of the Aerospace Standard AS 580B.

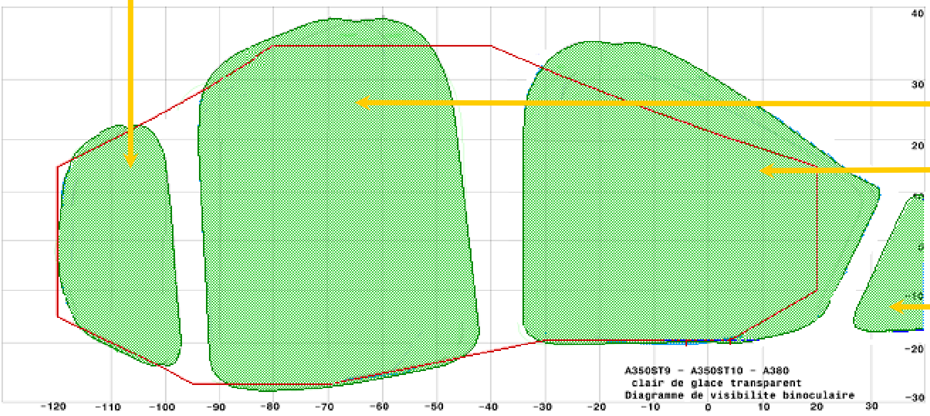
Flight Crew’s Binocular Vision

Captain Aft Lateral Window

Captain Forward Lateral Window

Captain Front Window

First Officer Front Window



A350 Visibility

Requirements

Air Systems

The A350 air system has the following subsystems:

- **Bleed air system:**
  - Engine bleed air system
  - Auxiliary Power Unit (APU) bleed air supply
  - HP ground air supply
  - Leak detection

- **Air conditioning system:**
  - Air generation system
  - Temperature control system
  - Cooling system
  - Conditioned service air system

- **Ventilation control system**

- **Cabin pressure control system.**

Overview

The bleed air system consists of:

- An engine bleed air system
- An Auxiliary Power Unit (APU) bleed air system
- A leak detection system.

The bleed air system supplies air to the following systems:

- Air conditioning and cabin pressurization
- Fuel tank inerting system
- Wing anti-ice and engine anti-ice
- Engine start
- Pack bay ventilation system.

The air sources are:

- The engines
- The APU
- A High Pressure (HP) ground supply source.

In normal conditions, the bleed air system operation is totally automatic.

If necessary, pushbuttons are available on the overhead panel to select the available source and to give the crew the possibility to override the automatic operations.

System Description

Engine Bleed Air System

The engine bleed air system supplies the consumer systems with the required airflow at regulated pressure and temperature levels, in the complete range of aircraft operations and environmental conditions.

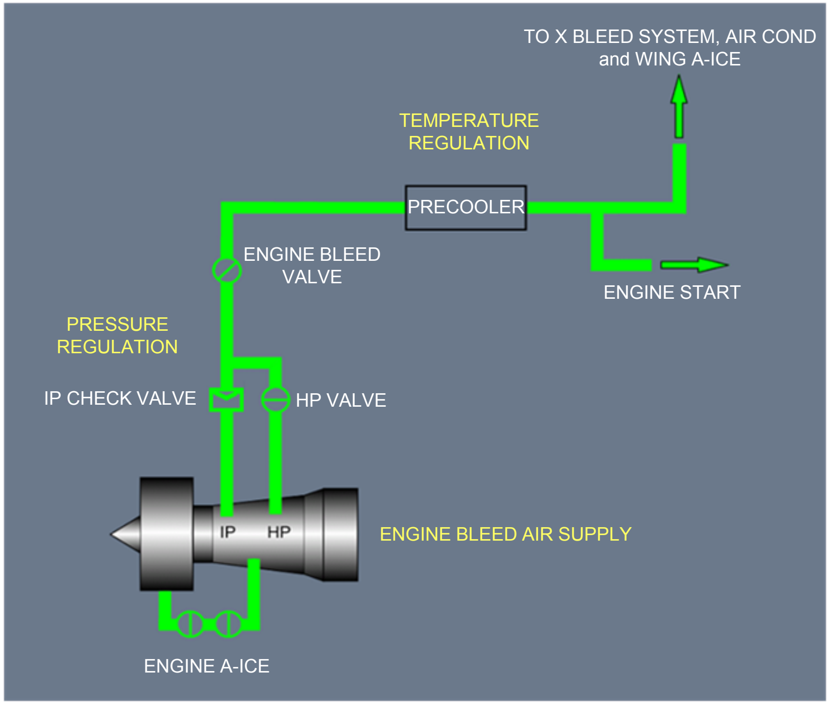
Engine bleed air usually comes from the **Intermediate Pressure (IP)** stage of the engine compressor via the intermediate pressure check valve.

At low engine thrust settings, the pressure of the IP stage is not sufficiently high, thus the **High Pressure (HP) stage** of the compressor provides bleed air via the HP valve.

For each engine:

- The **engine bleed valve** automatically regulates the delivered bleed pressure. This valve can also close and isolate its applicable engine bleed
- A **precooler** regulates the bleed air temperature.

*Note: One **crossbleed valve** interconnects the LH and RH bleed supply systems.*



APU Bleed Air Supply

The APU can supply bleed air to the bleed air system via the APU bleed valve:

- On ground, without any restriction
- In flight, up to 22 500 ft, except for engine start up to 25 000 ft.

Ground Air Supply

There are two **High Pressure (HP) ground connectors.** Thus, two HP ground sources can be connected to the HP ground connectors to supply bleed air to the bleed air system.

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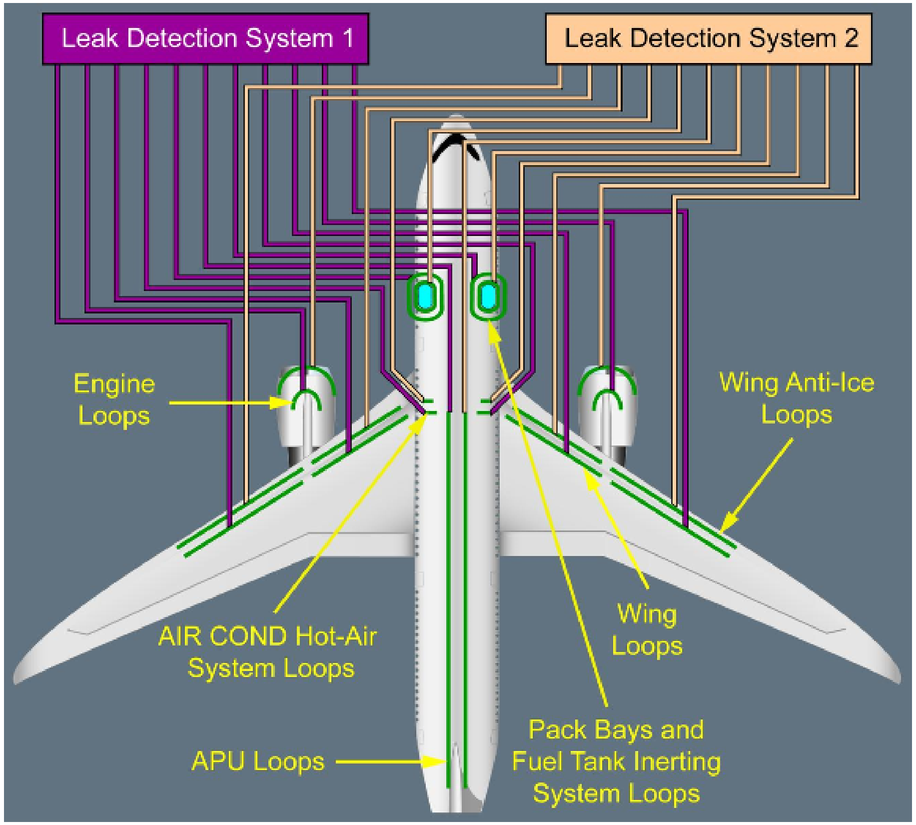
Leak Detection

The leak detection system includes a leak localization function for the **hot air ducts** in the following areas:

- Engines
- Wings and wing anti-ice
- APU
- Pack bays
- Air conditioning hot air system
- Fuel tank inerting system.



When a sensor is exposed to hot air or any overheat condition:

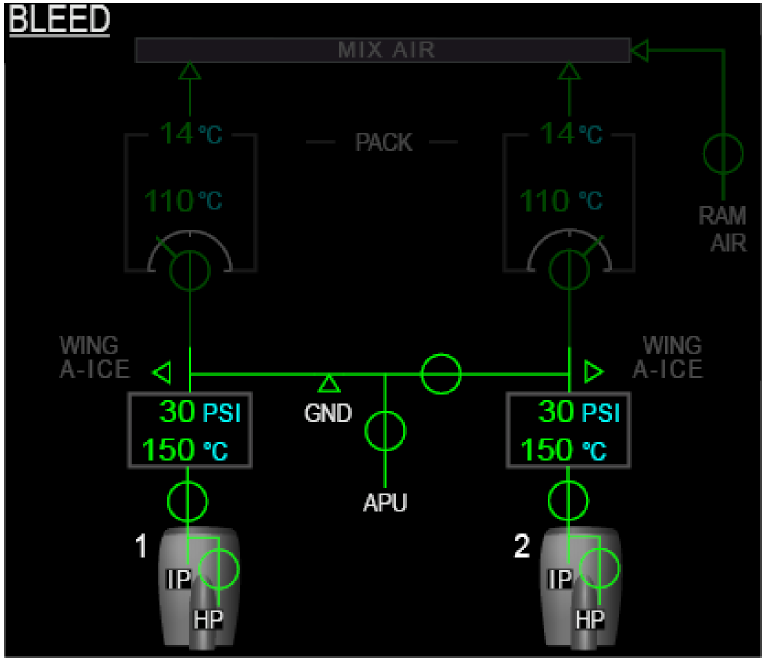
- **A visual and aural overheat alert** is triggered in the cockpit, if the temperature reaches the temperature limit for the corresponding aircraft zone
- The system will **automatically** send closure commands to the affected systems in order to prevent any damage to the aircraft structure and components.

Cockpit View

Controls and Indicators

AIR Panel

BLEED SD Page



Overview

The air conditioning system is fully automatic. This system provides continuous air renewal and maintains a constant selected temperature in the cockpit, cabin zones, and crew rest compartments.

The air conditioning system has:

- An air generation system
- A temperature control system
- A cooling system.

Air from the air conditioning system is also used for cargo ventilation:

- The bulk cargo compartment has a ventilation and a temperature control system (Refer to **Ventilation Control System**)
- The forward lower deck cargo compartment has an optional ventilation and temperature control system (Refer to **Ventilation Control System**)
- The aft lower deck cargo compartments has an optional ventilation system (Refer to **Ventilation Control System**).

System Description

The Air Generation System

The bleed air system supplies two packs, with air coming from the engines, the APU, or the Low Pressure (LP) ground sources. There are four recirculation fans that recycle cabin and cockpit air to the mixer unit via two premixers.

The Packs

The packs provide cold air by cooling hot bleed air. There are two packs which operate automatically and independently from each other.

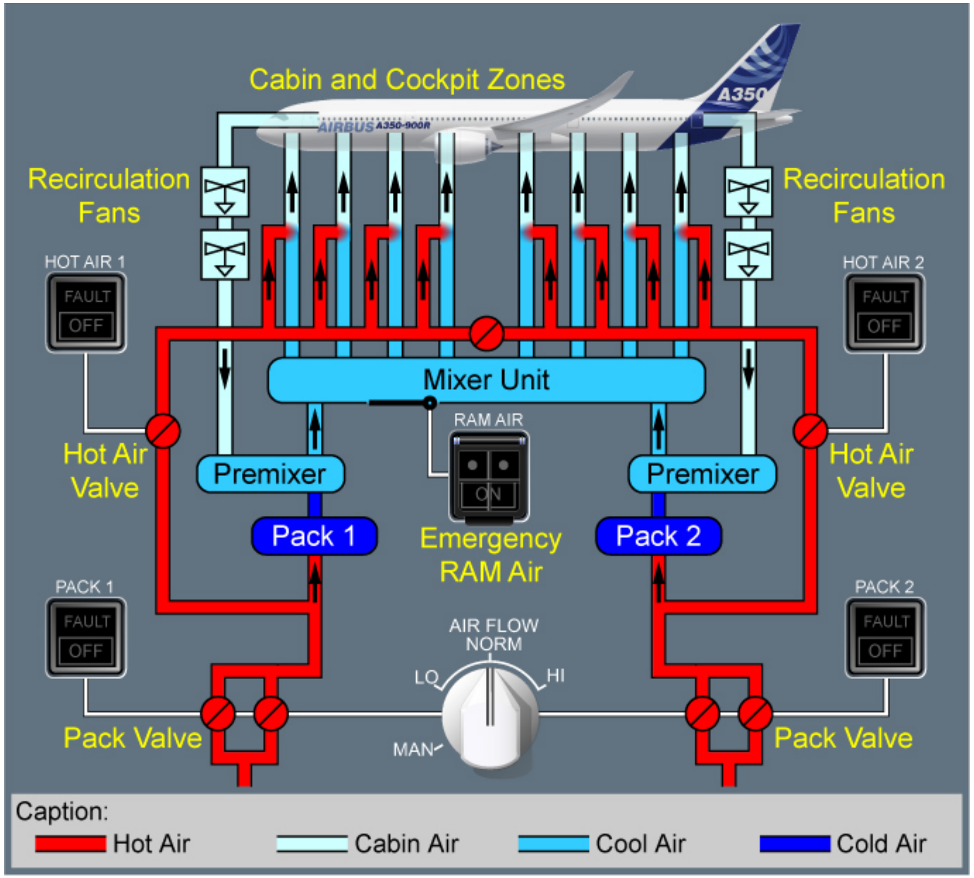
Emergency Ram Air

One emergency ram air inlet ventilate the cockpit and cabin if both packs fail.

The RAM AIR pb on the AIR panel activates the emergency ram air. When set to ON, air from outside the aircraft flows through the emergency ram air inlet directly to the mixer unit.

Ground Air Supply

There are two LP ground connectors directly connected to the mixer unit. Two LP ground sources can be connected to the LP ground connectors to supply conditioned air to the air conditioning system when the packs are off.



Note: Ducts for the bulk, forward cargo and crew rest compartments are not indicated (for clarity reasons).

Temperature Control System (TCS)

The TCS controls the temperature of the different zones within the flight deck and the 7 cabins zones. The system adjusts the temperature according to the demand, by adding hot air from the bleed system to air from the mixer unit. The hot air is added via 2 hot air valves and 8 trim air valves.

The flight crew controls the temperature in the cabin and cockpit. Moreover, the cabin crew can adjust or directly control the temperature in each cabin zone.

Some air from the cabin is recycled into the bulk cargo compartment for ventilation and temperature regulation (temperature regulation is optional for the forward and aft cargo compartments).

If necessary, to obtain the desired temperature:

- An electrical heater can heat the air that flows into the **bulk cargo compartment**
- Air from a trim air pipe can heat the air from the mixer unit that flows into the **forward cargo compartment** (optional).

Supplemental Cooling System

In addition to the air conditioning system, a supplemental cooling system provides cooling capacity for galley trolley compartments and other optional cooling applications.

Conditioned Service Air System

The conditioned service air system is an engine bleed air driven system which has the following objectives:

- To cool down the bleed air supplied by the bleed air system
- To reduce the ozone content via the ozone converter
- To supply the Inert Gas Generation System (IGGS) for fuel tank inerting.

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Cockpit View

AIR Panel

CARGO AIR COND Panel

COND and CRUISE SD Pages

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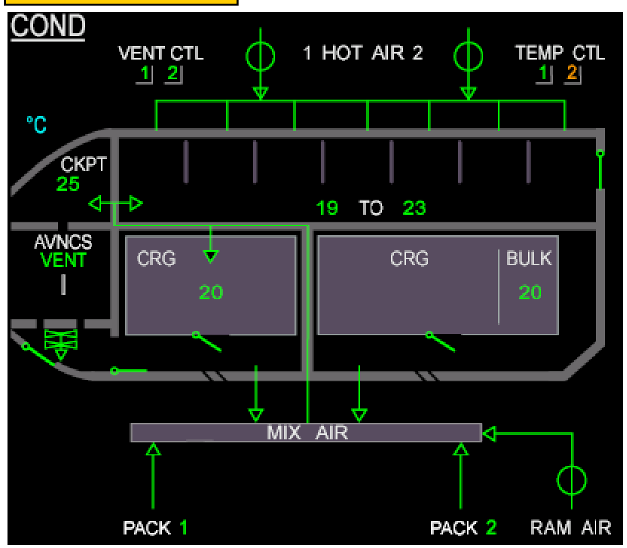
Controls and Indicators

AIR Panel

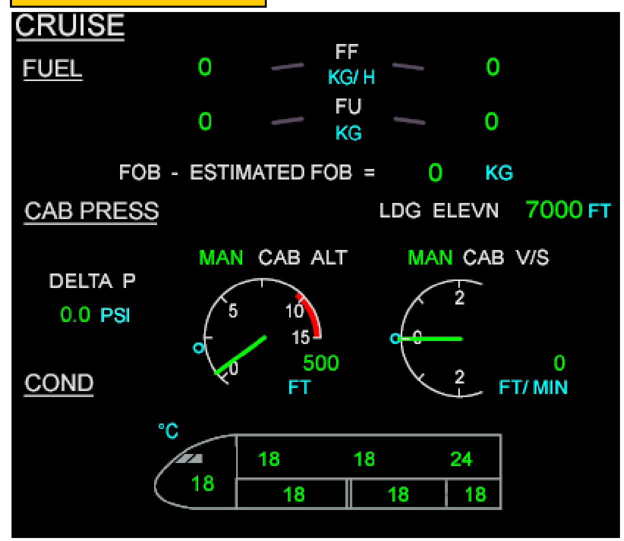
CARGO AIR COND Panel

COND SD Page

(all options active)



CRUISE SD Page



Overview

The aircraft has a fully automatic ventilation system that ventilates:

- The forward avionics compartment
- The cockpit and cabin zones
- The IFE bay
- The pack bays
- The Lower deck bulk cargo compartment.

The ventilation of the forward and aft cargo compartments is optional.

System Description

Forward Avionics Compartment Ventilation

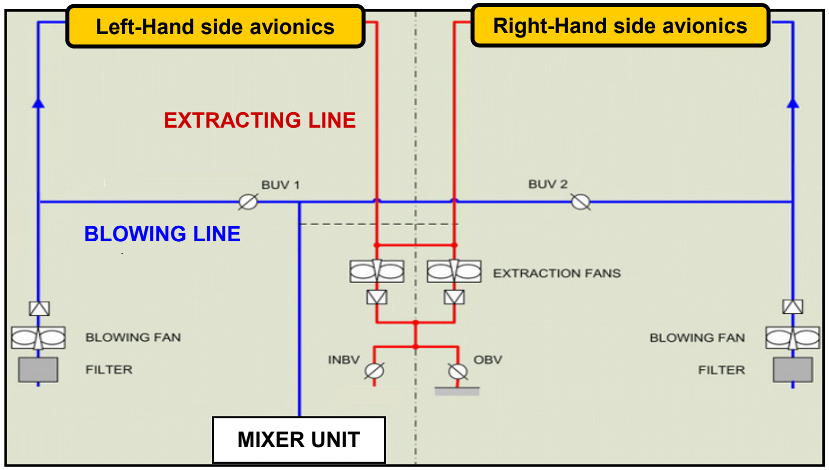
Two independent subsystems ensure the ventilation of the electrical power centers and electrical equipment racks located in the forward avionics compartment:

- A **blowing system** on the left-hand side and right-hand side which has:
  - Two filters
  - Two blowing fans
  - A backup supply from the mixer unit.

  The fans blow cabin air into the various cockpit panels and equipment racks of the forward avionics compartments.

- An **extraction system** based on two extraction fans connected to one inboard valve and one overboard valve. The fans extract and discharge the air from the avionic compartment and cockpit panels, either through the inboard valve or through the overboard valve:
  - **On ground**, when the engines are not running, air is discharged through the overboard valve
  - **In flight**, in normal operations, air is discharged through the inboard valve and outflow valves.

The forward avionics compartment also has a **backup ventilation circuit**. If necessary, air from the mixer unit of the air conditioning system can directly ventilate the avionics compartment, via **two Backup Valves (BUV 1 and BUV 2).**



Cockpit Ventilation

A mix of outside and recirculated air supplies the cockpit. The following air outlets are in the cockpit:

- Windshield air outlets (RH and LH)
- Individual air outlets (CAPT and F/O)
- Foot air outlets (CAPT and F/O)
- Lateral windows air outlet (RH and LH)
- A third individual air outlet
- A fourth individual air outlet.

In addition, there are two ceiling diffusers (RH and LH).

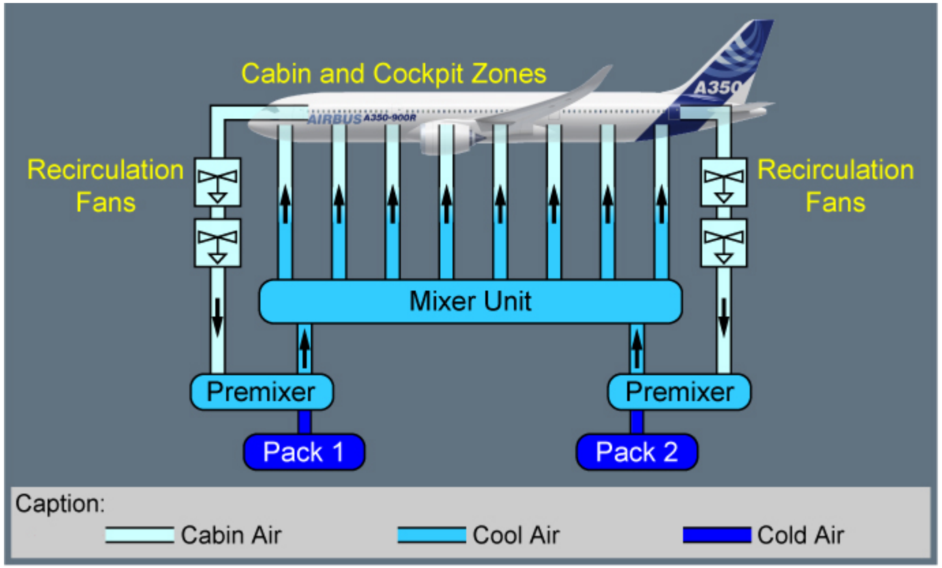
Cabin Ventilation

Fresh air from the air generation system (Pack 1 and 2) is mixed with recirculated air from the cabin into the premixers 1 and 2 and then sent to the mixer unit (refer to Air Generation System).

The recirculated air is supplied through two recirculation circuits (LH and RH) which have each two filters (forward and aft) and two fans.

The mixer unit provides air in the 7 cabin temperature zones.

Cabin Ventilation



In-flight Entertainment Center (IFEC) and Core Rack Ventilation

The IFEC and the core rack have a fully automatic ventilation system that cools their electronic equipment.

Pack Bays Ventilation

Each pack bay is ventilated by a fully automatic ventilation system.

Lower Deck Forward, Aft and Bulk Cargo Compartment Ventilation

All three cargo compartment ventilation systems are based on a suction principle: a fan extracts air from one side of the cargo compartment while air is entering the compartment from the other side. The resulting negative pressure within the cargo compartment assures that no bad odors will enter the cockpit or the cabin from the lower deck compartments.

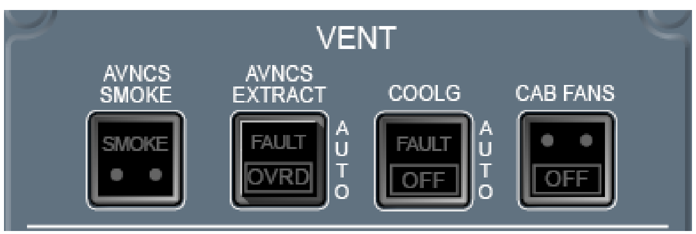
All cargo compartments can be isolated in case of smoke detection. In such a case, all isolation valves are automatically closed and the extraction fan is switched off.

Cockpit View

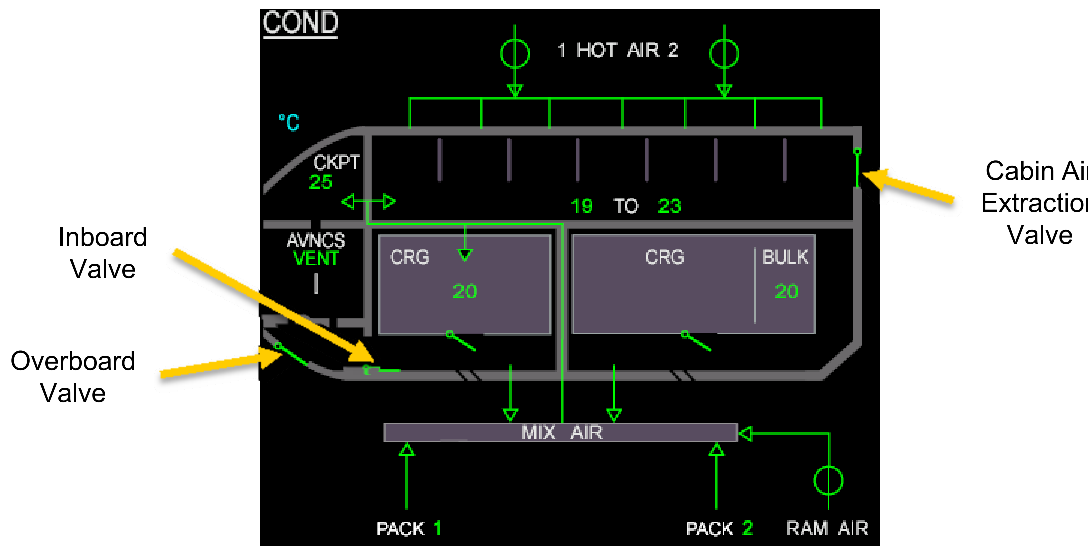
Controls and Indicators

CKPT HI VENT pb-sw on AIR Panel

VENT Panel



COND SD Page



General

In normal operation, the pressurization system is **fully automatic**. The system automatically regulates the cabin air pressure. The maximum cabin pressure will not exceed an equivalent cabin altitude of **6 000 ft** for short range missions and **7 800 ft** for long range missions.

The cabin pressure control system increases or decreases the cabin altitude according to the aircraft operations by adjusting the airflow discharged overboard through the **two outflow valves.** Two electrical motors operate each outflow valve:

- The motor (normal situation)
- The backup motor in the case of a failure.

In addition, **two negative pressure relief valves** and **one overpressure relief valve** are installed to protect the aircraft from structural damage in case of:

- An excessive negative delta pressure
- Over-pressurization.

System Description

The cabin pressure control system has:

- Two electrically actuated **outflow valves** which are in the forward and aft aircraft lower skin
- Two **outflow valve control units,** which control the outflow valves, based on:
  - Measurement of the current cabin pressure
  - Computation of the target cabin pressure
- A separate **Semi Automatic Control Unit** (SACU) which provides a semi automatic pressure control.

The operation of the cabin pressure control system is:

- Fully automatic under normal operating conditions
- Semi-automatic under abnormal operating conditions.

There are two semi-automatic pressurization modes:

- **Cabin altitude manual pressurization mode**:

  The flight crew selects the cabin altitude target. The cabin altitude will change automatically until the cabin altitude target is reached
- **Vertical speed manual pressurization mode**:

  If the cabin vertical speed is selected, the cabin altitude will change in accordance with the selected vertical speed until the cabin altitude target is reached.

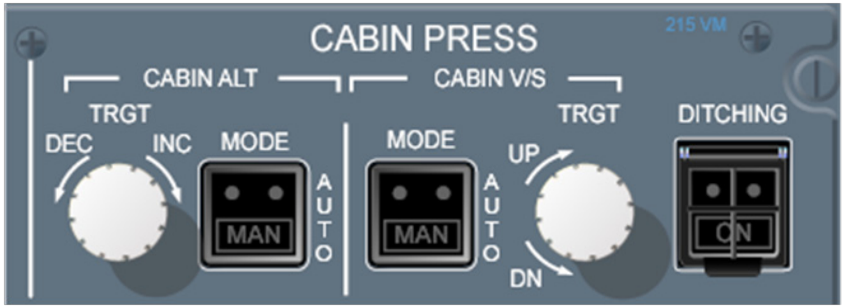
In addition, to protect the aircraft from structural damage, there are:

- One **overpressure relief valve** that provides the positive and negative relief function in the case of excessive positive or negative differential pressure
- Two **negative relief valves** that provide the negative relief function in case of negative differential pressure conditions.

Cockpit View

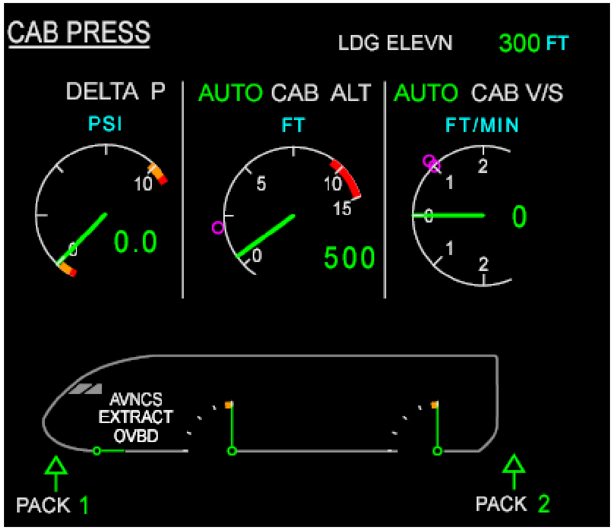
Controls and Indicators

CABIN PRESS Panel

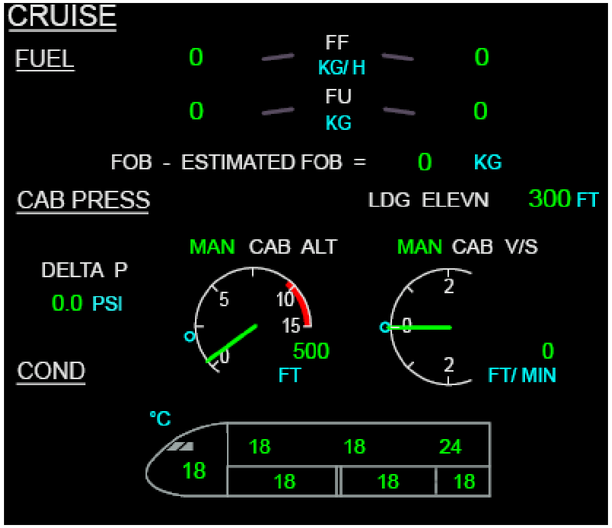


	In automatic mode (digital indicators)	In manual mode (analogical indicators)
Cabin Altitude		
Cabin V/S		

CAB PRESS SD Page



CRUISE SD Page



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Automatic Flight System

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Overview

The Automatic Flight System (AFS) includes:

- **The Flight Guidance (FG)**
  The FG provides guidance in accordance with flight targets which are:
  - Selected by the flight crew, or
  - Managed by the Flight Management System (FMS).

- **The Flight Management System (FMS)**
  The FMS manages the flight plan, defined by the flight crew, and provides flight parameters to the FG accordingly.

- **The Flight Envelope (FE)**
  The FE computes the aircraft normal flight envelope. The FE is used by the FG and by the flight controls to prevent the aircraft from exiting the envelope.

General Architecture

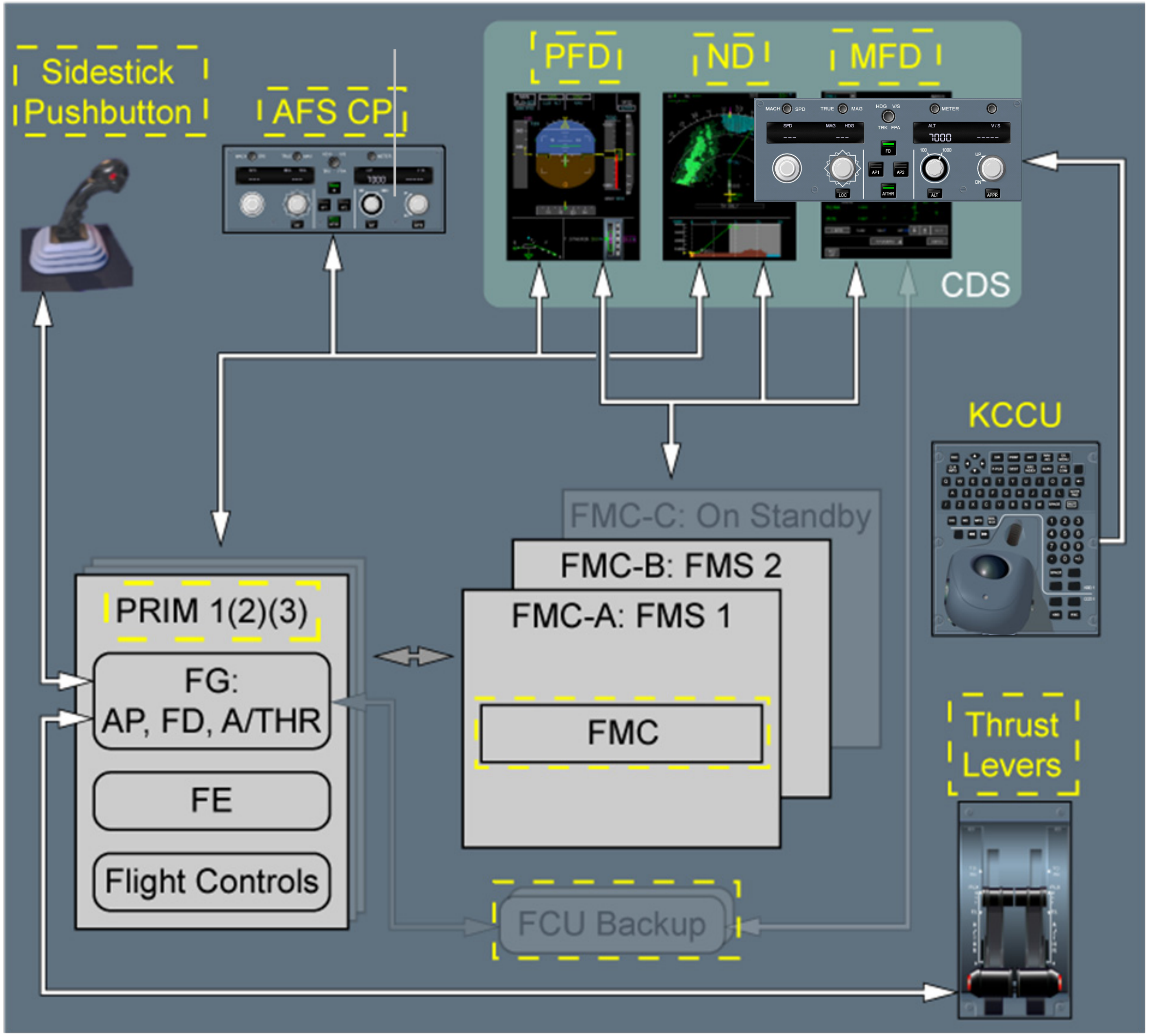
The AFS has:

- Three primary flight control and guidance computers (PRIMs) that control the:
  - Autopilot (AP)
  - Flight Director (FD)
  - Autothrust (A/THR)
- Three Flight Management Computers (FMCs) that operate two Flight Management Systems (FMS).

The flight crew interfaces with the AFS via:

- **One AFS Control Panel** (AFS CP) that is the main interface with the FG. The MFD can be a backup to the AFS CP
- **The Multifunction Displays** (MFD). The MFD is the main interface with the FMS
- **Two Primary Flight Displays** (PFDs) that display:
  - Primary flight parameters
  - Guidance targets (e.g. speed and altitude targets)
  - Armed and engaged modes on the Flight Mode Annunciator (FMA)
  - Flight Director guidance orders
  - Instrument approach information.
- **Two Navigation Displays** (NDs) that display lateral and vertical parts of flight plans, and associated navigation information
- **One sidestick pb** on each sidestick
- **Two thrust levers** and **two A/THR instinctive disconnect pushbuttons.**

AFS Architecture



PRIM Architecture for Flight Guidance

There are three PRIMs. Each PRIM can operate:

- One or both APs
- The two FDs
- The A/THR.

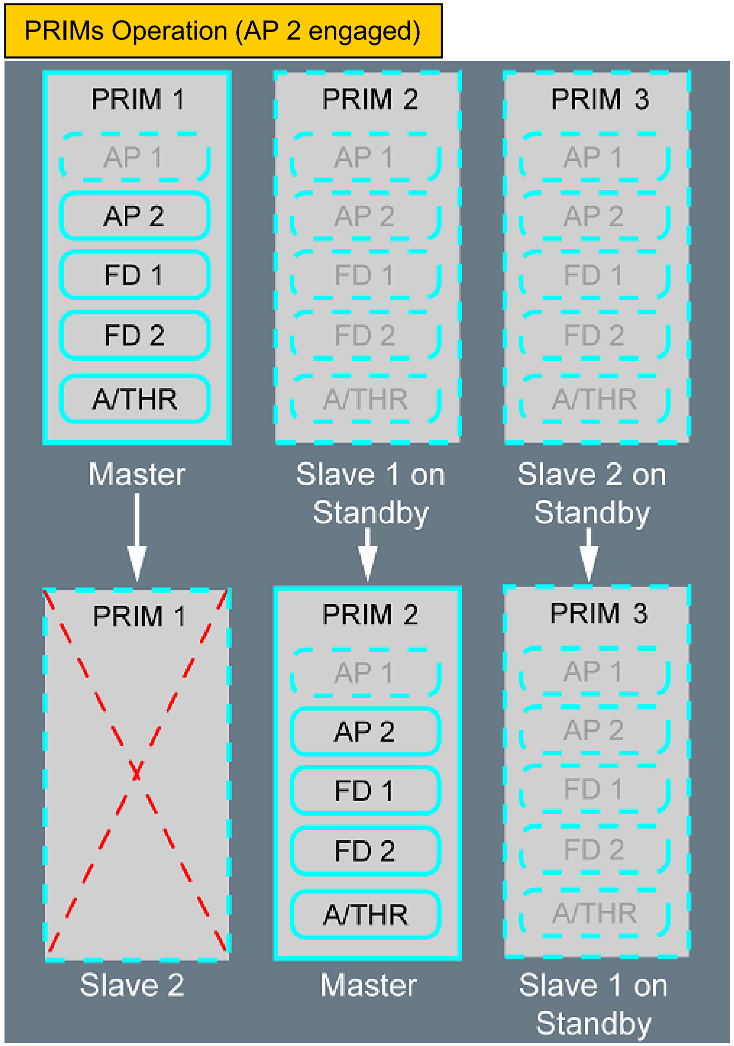
The master PRIM is the PRIM that has the best operational capability. The slave 1 PRIM has the second best operational capability, and the slave 2 PRIM has the third best.

When all the PRIMs have the same capability:

- PRIM 1 is the master PRIM
- PRIM 2 is the slave 1 PRIM
- PRIM 3 is the slave 2 PRIM.

The master PRIM has priority to operate APs, FDs and A/THR.

If the master PRIM loses the best capability, the engaged AP, FDs and A/THR do not disconnect. They are transferred to the slave 1 PRIM.



Autopilot

The Autopilot performs the following functions:

- Stabilization of the aircraft around its center of gravity when the AP is engaged
- Acquisition and hold of a flight path
- Lateral and speed takeoff guidance cues
- Guidance of the aircraft at initial climb by holding runway axis and speed
- Automatic landing
- Automatic go-around
- Automatic TCAS Resolution Advisory (RA).

AP Engagement/Disengagement

The flight crew can:

- Engage the AP via the AP 1 or AP 2 pb on the AFS CP or the backup AFS CP on the MFD
- Disengage the AP via the:
    - Sidestick pb (normal procedure)
    - Sidestick or rudder pedal movement above a given threshold (takeover procedure)
    - AP 1 or AP 2 pb.

Note:

The AP can be engaged 5 seconds after takeoff and can be used for climb, cruise and approach, landing and rollout phase.

Flight Director

The Flight Directors (FD1 and FD2) display guidance orders on the PFDs via pitch, roll and yaw bars. This enables the flight crew to manually fly the aircraft or to monitor the flight guidance orders when the autopilot is engaged.

FD Engagement/Disengagement

The FD is automatically:

- Engaged at power-up and in case of go-around provided sensors and systems are valid
- Engaged in case of a Resolution Advisory (RA) situation
- Disengaged in the case of a failure detection or defined flight protections activation.

When performing an approach with the FD OFF, the FD is automatically re-engaged in the case of a go around procedure.

In addition, the flight crew can manually engage/disengage the FD via the FD pb.

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Autothrust (A/THR)

The Autothrust (A/THR):

- Controls the thrust of the two engines via orders to the Full Authority Digital Engine Control (FADEC)
- Holds selected or managed speed/Mach
- Holds thrust and performs thrust reduction during flare
- Ensures protection against excessive angle-of-attack (alpha floor function).

The A/THR can operate independently or with the AP/FD:

- If the AP/FDs are off, the A/THR still controls the speed or Mach
- If AP and/or FDs are engaged, the A/THR mode and the AP/FD vertical mode are linked.

The A/THR can be active in all phases of flight except during takeoff phase.

<u>A/THR Arming/Activation/Disconnection</u>

The flight crew can arm the A/THR via the A/THR pb on:

- The AFS control panel
- The FCU AFS backup page on the MFD.

The A/THR is armed automatically at takeoff or go-around, and active when thrust levers are in the correct detent (CLB or MCT) whereas in alpha floor, A/THR is directly active whatever the detent position.

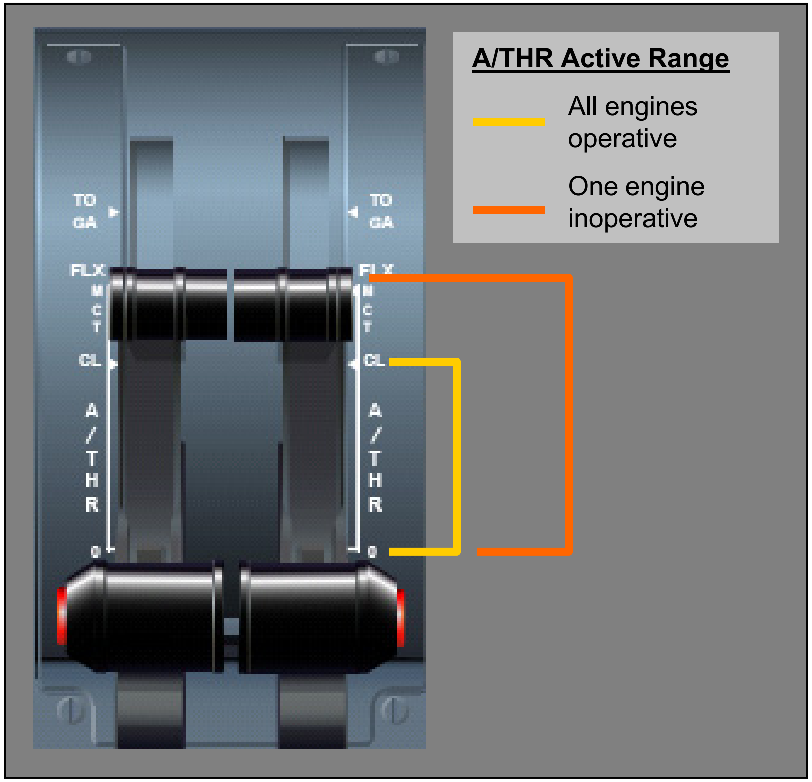
The flight crew can disconnect the A/THR via the:

- Instinctive disconnection pb
- A/THR pb:
  - On the AFS control panel
  - On the FCU AFS backup page on the MFD
- Thrust levers, if the flight crew sets the two levers to idle.

Thrust Levers

The flight crew uses the thrust levers to:

- Manually select the engine thrust
- Activate the Autothrust
- Engage the takeoff and go-around modes.

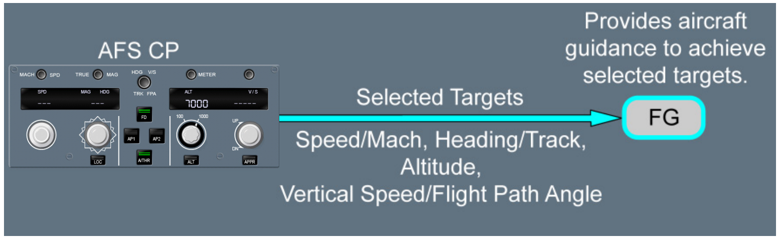


Flight Guidance Objectives

The objective of the **Flight Guidance (FG)** function is to provide short-term and mid-term lateral and vertical guidance, including speed or Mach control, based on defined targets. These targets can be either selected or managed:

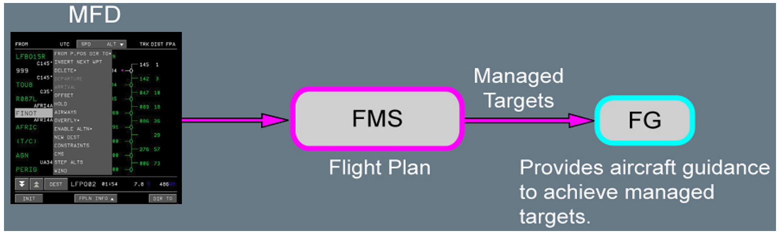
- **Selected Targets**

The flight crew selects targets by using the AFS Control Panel (AFS CP). Then, the FG uses these targets to perform selected guidance.



- **Managed Targets**

The flight crew uses the MFD to prepare the flight plan. The FMS calculates managed targets accordingly. Then, the FG uses these targets to perform managed guidance.



When in managed guidance, the flight crew can take over control at any time, and change to selected guidance.

Lateral guidance and vertical guidance can be selected or managed independently of each other.

However, managed vertical guidance is not possible, when selected lateral guidance is used.

Speed or Mach can be either selected or managed regardless of lateral and vertical guidance.

On the AFS CP, the SPD/MACH, HDG/TRK, V/S / FPA knobs can be turned, pulled, and pushed. This enables the flight crew to:

- Preselect a target: Turn
- Engage a mode that will guide the aircraft to a selected target: Pull
- Arm or engage a mode that will guide the aircraft to a managed target: Push.

In order to achieve its objectives, the FG uses:

- The Autopilots (AP 1 and AP 2)
- The Flight Directors (FD1 and FD2)
- The Autothrust (A/THR)

Flight Guidance Modes

The Flight Guidance (FG) operates by using the following modes:

- **AP/FD lateral modes** that control the lateral trajectory
- **AP/FD vertical modes** that control either:
  - The vertical trajectory, or
  - The speed or Mach
- **A/THR modes** control either:
  - The thrust, or
  - The speed or Mach.

Guidance is either selected or managed. Therefore, the corresponding modes are also referred to as either **selected** or **managed**.

Note:

The FG modes appear on the Flight Mode Annunciator (FMA) of the Primary Flight Displays (PFDs).

FG Selected and Managed Modes

Guidance	Managed Modes	Selected Modes
Lateral	NAV LOC*, LOC LOC B/C*, LOC B/C F-LOC*, F-LOC RWY, RWY TRK GA TRK	HDG, TRACK
Vertical	SRS CLB ALT*, ALT ALT CRZ*, ALT CRZ ALT CST*, ALT CST DES G/S*, G/S F-G/S*, F-G/S TCAS	OP CLB ALT*, ALT ALT CRZ*, ALT CRZ OP DES V/S, FPA
Lateral and Vertical	LAND FLARE ROLL OUT	
Speed or Mach	SPEED, MACH with FMS reference.	SPEED, MACH with AFS CP reference.

Note:
A "star" mode is the capture mode of its corresponding mode.

AP/FD Lateral Modes

Mode	Description
• NAV	• NAV laterally guides the aircraft along the FMS flight plan.
• LOC • LOC B/C	• LOC tracks the localizer beam. • LOC B/C tracks the localizer back course beam.
• HDG/TRACK	• HDG/TRACK laterally guides the aircraft along the AFS CP selected heading/track.

AP/FD Vertical Modes

Mode	Description
Level Changes • CLB/DES • OP CLB/OP DES	• CLB/DES climbs/descends the aircraft along the FMS flight plan to the AFS CP selected altitude, by taking into account all FMS altitude constraints. • OP CLB/OP DES climbs/descends the aircraft to the AFS CP selected altitude (all FMS altitude constraints are disregarded).
Altitude Hold • ALT • ALT CRZ • ALT CSTR • TCAS	• ALT maintains the aircraft at the AFS CP selected altitude. • ALT CRZ acquires and maintains the cruise altitude. • ALT CSTR maintains the aircraft at an FMS altitude constraint. • AP/FD TCAS provides vertical guidance in the case of a Resolution Advisory alert.
• V/S / FPA	• V/S / FPA acquires and maintains the AFS CP selected vertical speed/flight path angle.
• G/S	• G/S tracks the glide slope beam.
• SRS	• SRS ensures the minimum safety speed during takeoff initial climb, and during go-around.

AP/FD Common Modes

Common mode	Vertical mode	Lateral mode	Description
• TAKEOFF	SRS	RWY RWY TRK	• SRS ensures the minimum safety speed during takeoff initial climb, and during go-around. • RWY provides lateral guidance orders during takeoff and initial climb, based on the LOC signal. • RWY TRK maintains the track that the aircraft has at RWY TRK engagement.
• ILS APPROACH • GLS APPROACH (optional) • SLS APPROACH (optional)	G/S	LOC	• G/S tracks the glide slope beam (ILS) or GLS/SLS virtual glide slope beam. • LOC tracks the localizer beam (ILS) or GLS/SLS virtual localizer beam. • LAND tracks the LOC and G/S from 400 ft RA to approximately 60 ft RA. • At landing before touchdown, FLARE aligns the aircraft with the runway centerline, and controls the aircraft rotation for touchdown.
	LAND FLARE ROLLOUT		
• FLS APPROACH	F-G/S	F-LOC	• F-G/S tracks the FLS pseudo glide slope beam. • F-LOC tracks the FLS pseudo localizer beam.
• GO AROUND (GA)	SRS	GA TRK	• SRS ensures the minimum safety speed during takeoff initial climb, and during go-around. • GA TRK maintains the track that the aircraft has at GA TRK engagement.

A/THR Modes

The A/THR modes are:

A/THR Modes	Description
SPEED/MACH	• The A/THR continuously adjusts the thrust in order to acquire and maintain a speed/Mach target. • The AP/FD, if engaged, controls the vertical path.
THRUST MODES THR MCT THR CLB THR LVR THR IDLE THR DCLB NOISE THR DES ALPHA FLOOR	• Thrust hold: The A/THR maintains a constant thrust, based on the engaged THRUST mode. • Thrust reduction: In automatic landing, during flare, the A/THR reduces the thrust.

Interaction between AP/FD and A/THR Modes

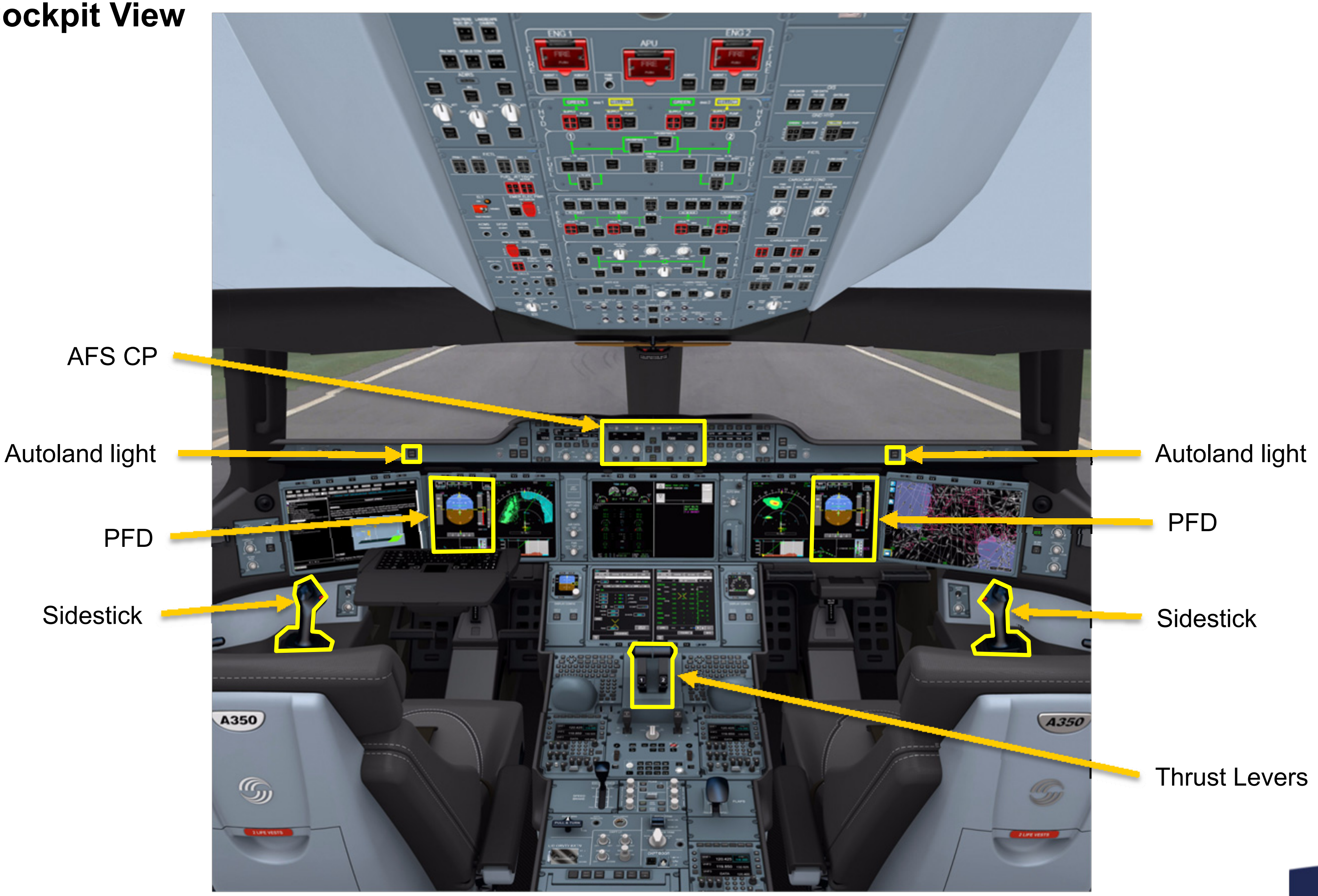
The AP/FD vertical mode determines the associated A/THR mode: :

- When an AP/FD vertical mode controls a speed or Mach target, the A/THR mode controls thrust
- When an AP/FD vertical mode controls the vertical trajectory, the A/THR mode controls a speed or Mach target
- When no AP/FD mode is engaged, A/THR engages in SPEED or MACH mode, in order to control a speed or Mach target.

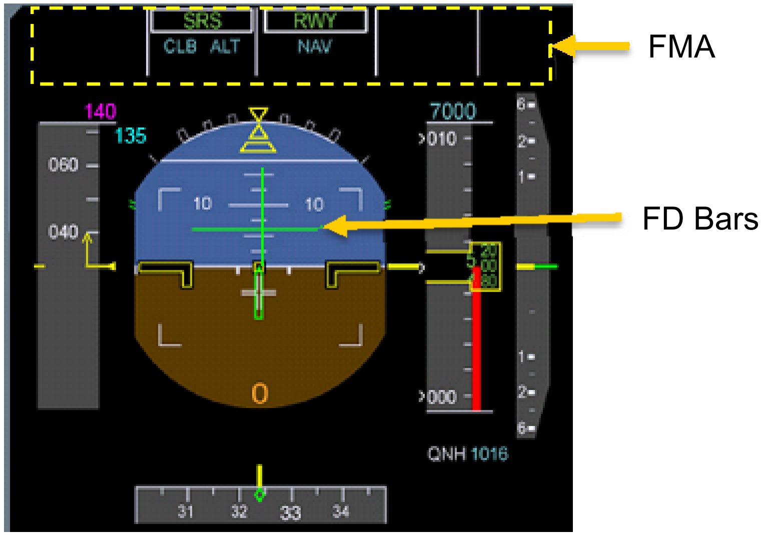
AP/FD Vertical Modes and Associated A/THR Modes

AP/FD		**A/THR**	
Vertical Modes	**Objectives**	**Modes**	**Objectives**
SRS OP CLB CLB OP DES DES in idle path	Control of Speed or Mach Target	THRUST modes	Control of Thrust
V/S / FPA ALT*, ALT ALT CST*, ALT CST ALT CRZ*, ALT CRZ DES in geometric path G/S*, G/S F-G/S* LAND FLARE with no engaged AP	Control of Vertical Trajectory	SPEED/MACH	Control of Speed or Mach Target
FLARE during autoland ROLL OUT common mode	Control of Vertical Trajectory	THRUST modes	Control of Thrust at Idle

Cockpit View

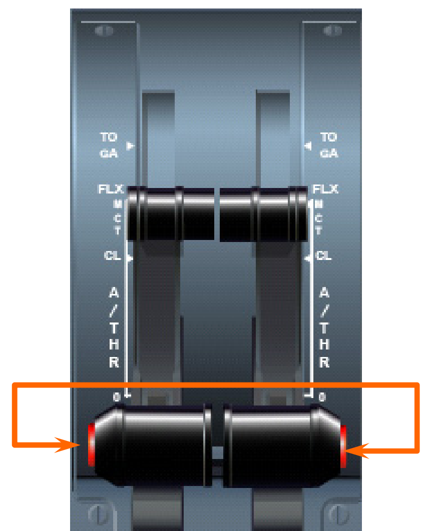


FMA and FD on PFD



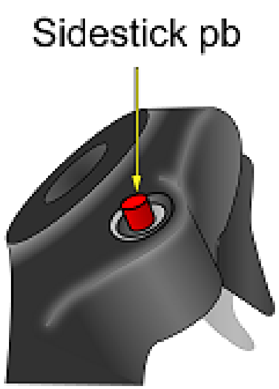
AFS CP

Thrust Levers



A/THR instinctive disconnection pushbuttons

Sidestick



The flight crew uses the sidestick pb to disconnect the Autopilot.

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Flight Management System

Overview

The A350 **Flight Management System (FMS)** provides:

- Navigation functions
  - Radio navigation tuning
  - Polar navigation
  - ATC Datalink
- Flight planning
  - Flight plan creation (lateral and vertical)
  - Flight plan revisions
  - Flight plan predictions
  - Three secondary flight plans (SEC F-PLNs)
  - Required Time of Arrival (RTA)
- Prediction and optimization of performance
- Long-term guidance
- Management of the display units (MFD, ND and PFD)
- Fuel management functions, such as the penalty factor function
- FMS Landing System (FLS)
- Diversion aid functions, such as the WHAT IF function
- A TakeOff Securing (TOS) function
- A TakeOff Monitoring (TOM) function
- A LRC Managed function.

Architecture

There are two Flight Management Systems (FMS):

- FMS 1 on the captain's side
- FMS 2 on the first officer's side.

Each FMS uses a computer, referred to as Flight Management Computer (FMC).

There are three FMCs: FMC-A, FMC-B, and FMC-C.

In normal operation:

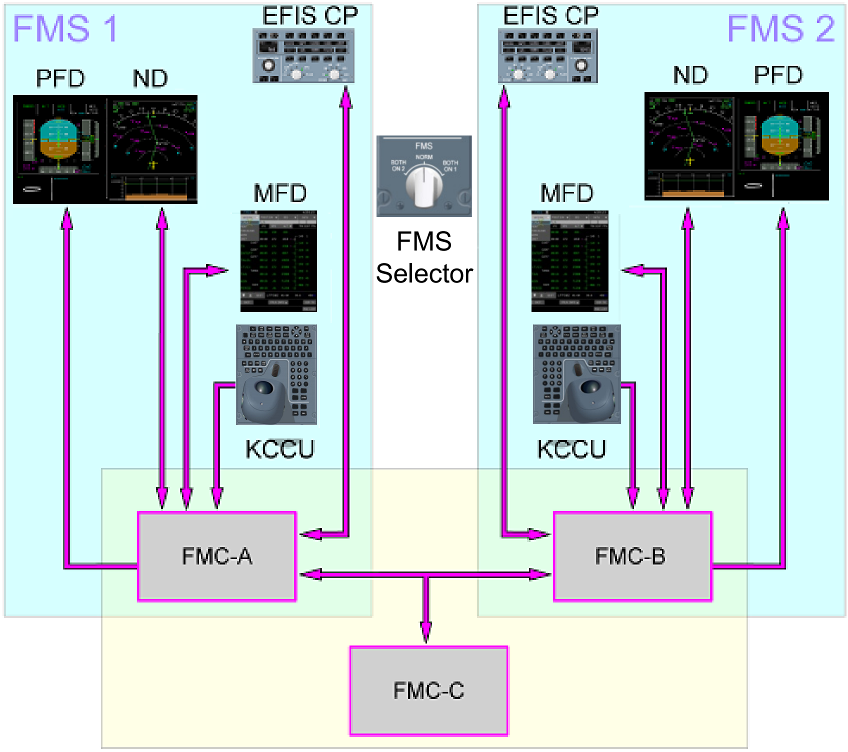
- FMC-A provides data to FMS 1
- FMC-B provides data to FMS 2
- FMC-C is on standby.

Each flight crew member interfaces with their onside FMS via:

- One MFD
- One ND
- One PFD
- One EFIS CP
- One KCCU

In addition, one FMS selector enables one FMC to provide data on both sides.

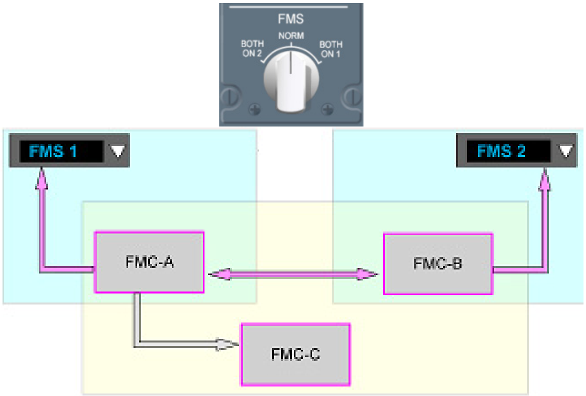
FMS Architecture



Flight Management Computers (FMCs)

There are three different modes of operations: **DUAL**, **INDEPENDENT**, and **SINGLE** mode.

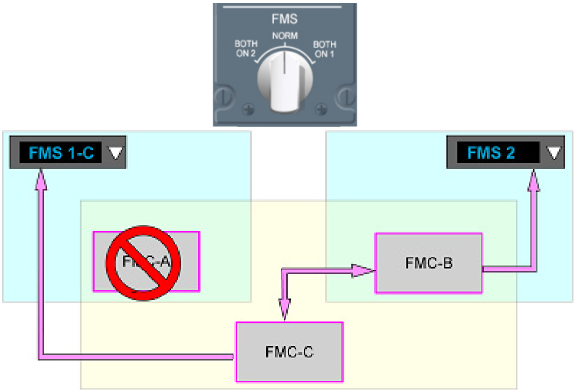
- **DUAL Mode:** FMS 1 and FMS 2 are operative
  Normal Operation



FMC-A provides data to FMS 1, FMC-B provides data to FMS 2 and FMC-C is on standby. One of the two active FMCs is the "master", the other is the "slave". It depends on the AP engagement condition or on the FMS source selector position. The two active FMCs independently compute data. They also exchange, compare, and synchronize this data.

The computer that is on standby does not compute data. The master FMC regularly updates the FMC that is on standby.

Single FMC Failure

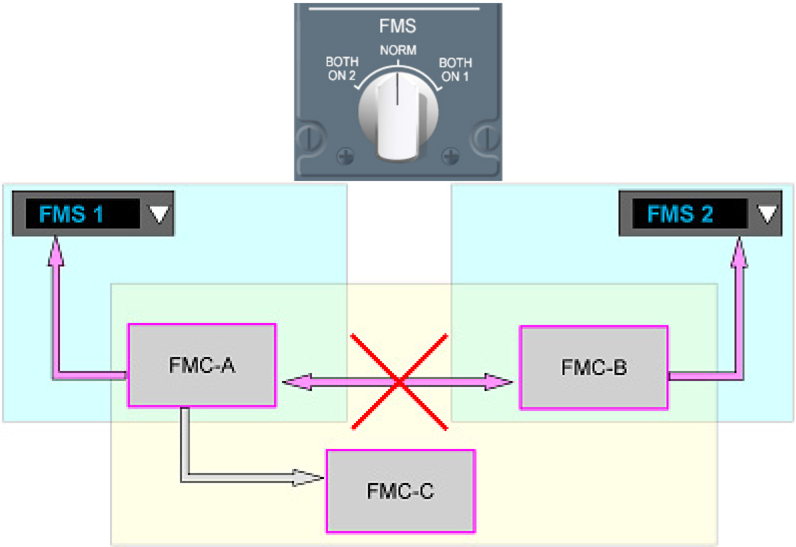


Example: FMC-A failure.

In this case, FMC-C provides data to FMS 1.

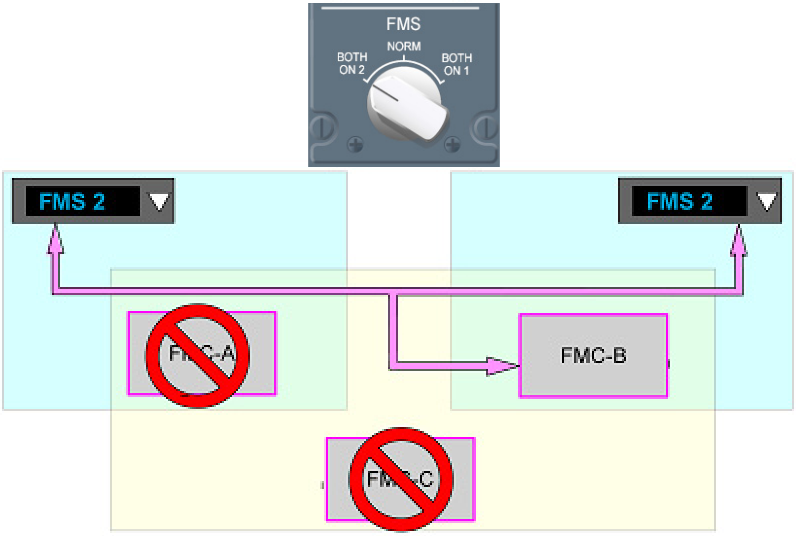
- **INDEPENDENT Mode:**

  FMS 1 and FMS 2 are both operative, but there is no data exchange between them because they disagree on critical data (e.g. aircraft position, gross weight, etc).



- **SINGLE Mode:**

  The loss of two FMCs causes the loss of FMS 1 or FMS 2.
  The flight crew displays the data from the operative FMC on both sides by using the FMS selector.



General

A major purpose of the Flight Management System (FMS) is to help the flight crew to create the flight planning.

The flight crew can enter the **flight plan** in the FMS. This intended flight plan includes the **lateral** and **vertical** trajectories.

When all of the necessary data is entered, the FMS computes and displays the speed, altitude, time, and fuel **predictions** that are associated with the flight plan.

The flight crew can modify the flight plan at any time:

- If the lateral flight plan is modified, the change is called a **lateral revision**
- If the vertical flight plan is modified, the change is called a **vertical revision**.

There are several flight plans:

- One active primary flight plan, and
- Three standby secondary flight plans.

The three secondary flight plans enable the flight crew to prepare different flight plans according to the strategy chosen (e.g. in-flight rerouting, next flight after the stop over, etc…)

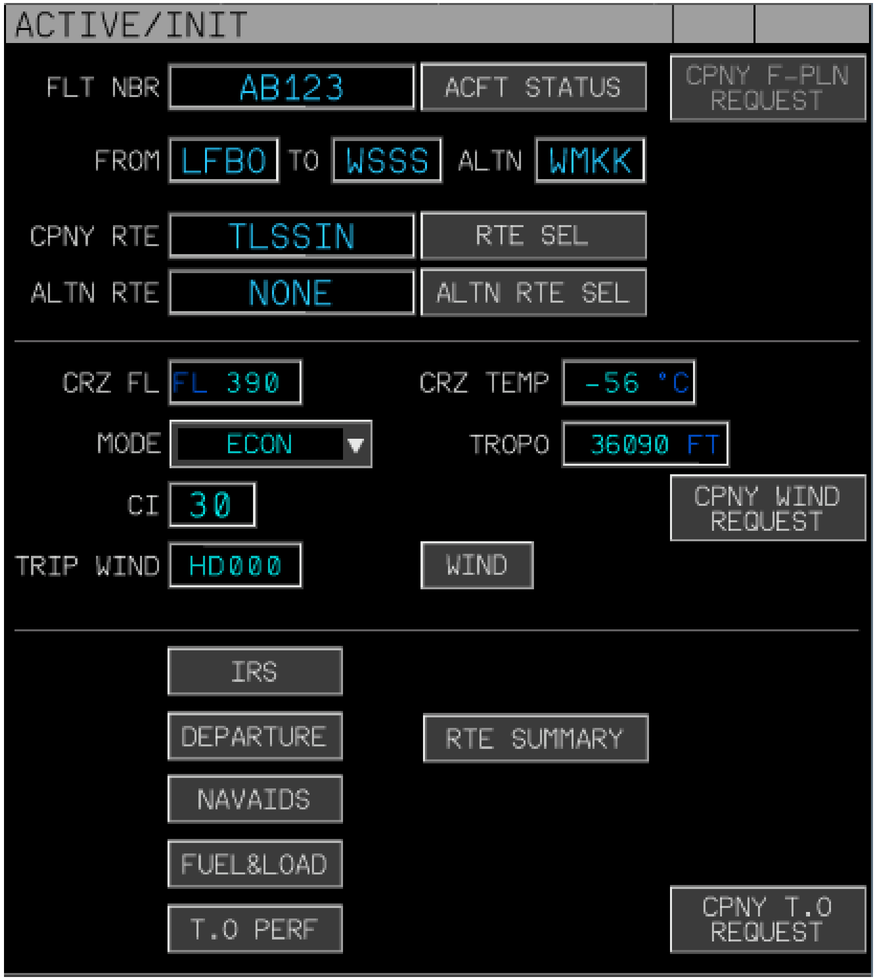
Flight Plan Creation

The lateral flight plan includes the departure, cruise, and arrival. It displays waypoints that are linked with flight legs and transitions between legs.

There are three ways to create a flight plan:

- Insert an origin/destination city-pair, and then manually select the departure, waypoints, airways and arrival
- Insert an airline route stored in the database
- Send a request to the airline on the ground for an active F-PLN uplink.

FMS ACTIVE/INIT Page

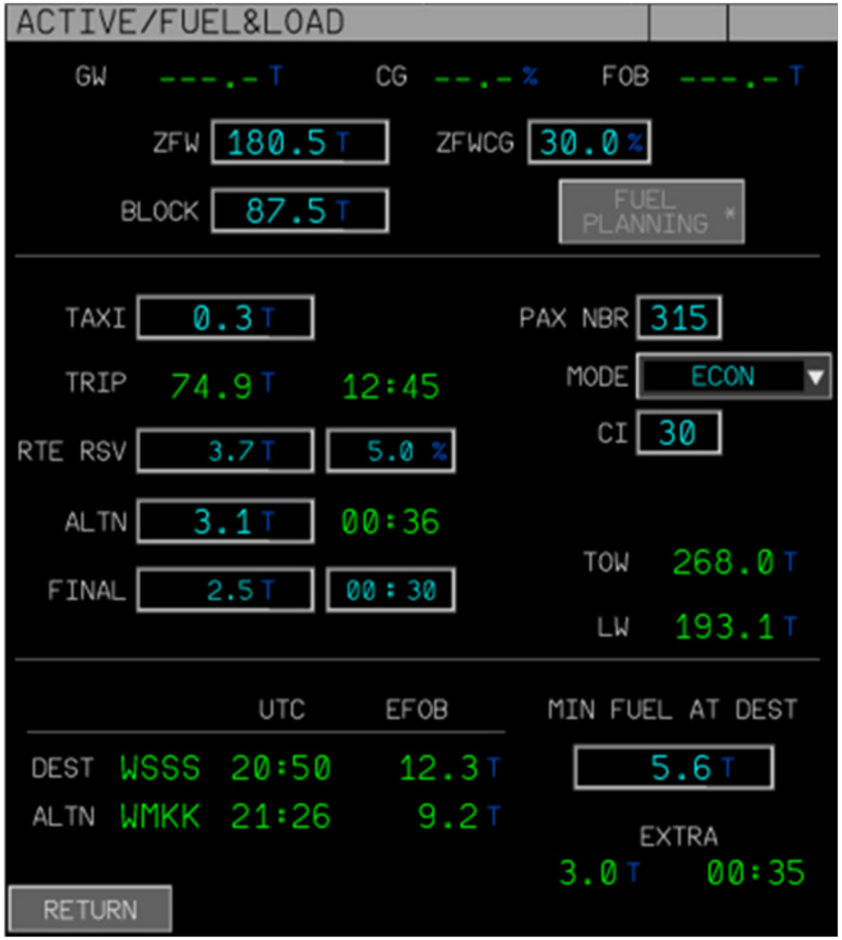


Flight Crew Data Entries

In order to make performance computations and flight plan predictions, the flight crew must enter the following data:

- Zero Fuel Weight (ZFW) and Zero Fuel Weight Center of Gravity (ZFWCG)
- Block fuel
- FMS speed mode (ECON or LRC)
- Flight conditions (CRZ FL, temperature, wind).

FMS ACTIVE/FUEL&LOAD Page



Predictions

The FMS uses the lateral flight plan and the flight crew data entries to compute the following predictions:

- Speed changes
- Pseudo waypoint computation: Top of Climb (T/C), Top of Descent (T/D), etc.
- For each waypoint or pseudo waypoint:
  - Distance
  - Estimated Time of Arrival (ETA)
  - Speed
  - Altitude
  - Estimated Fuel On Board (EFOB)
  - Wind.
- For primary and alternate destinations:
  - ETA
  - Distance to destination
  - EFOB at destination.

These predictions are continually updated depending on:

- Modifications of the lateral and vertical flight plans
- Current wind and temperature
- Current position compared with lateral and vertical flight plans
- Current guidance modes.

Flight Plan Revisions

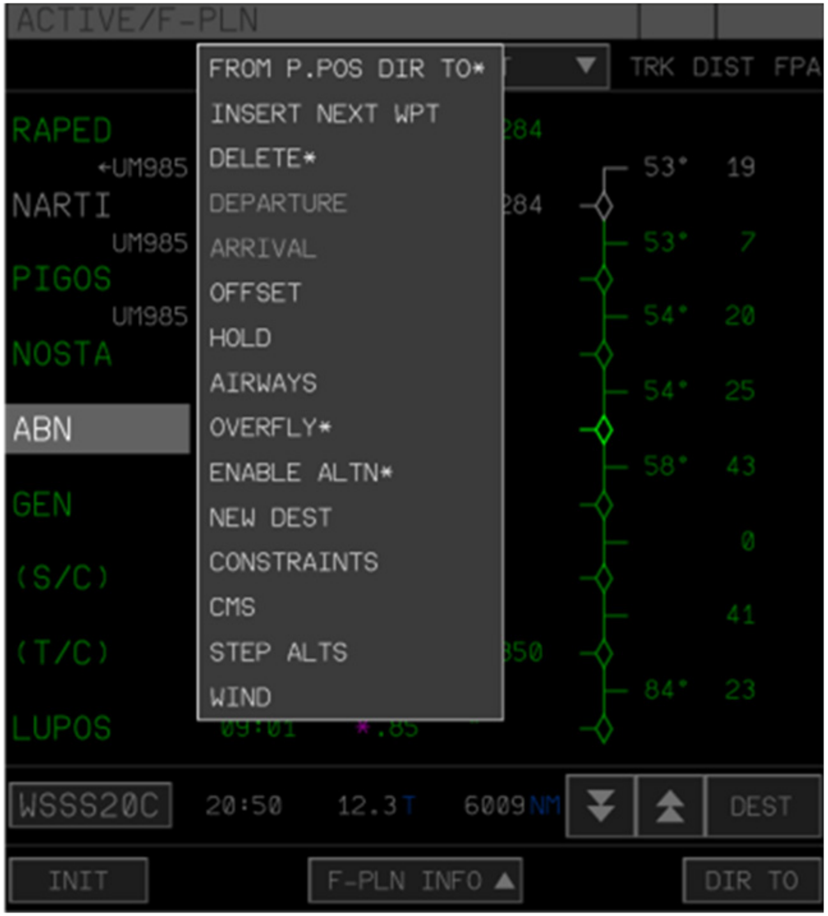
The flight crew can perform the following lateral revisions:

- Delete and insert waypoints
- Departure procedures: Takeoff runway, SID, and transition
- Arrival procedures: Runway, type of approach, STAR, via, transition, etc.
- Airways segments
- Holding patterns
- Alternate airport.

The flight crew can perform the following vertical revisions:

- Time constraints
- Speed constraints
- Constant Mach segments
- Altitude constraints
- Step altitudes
- Wind.

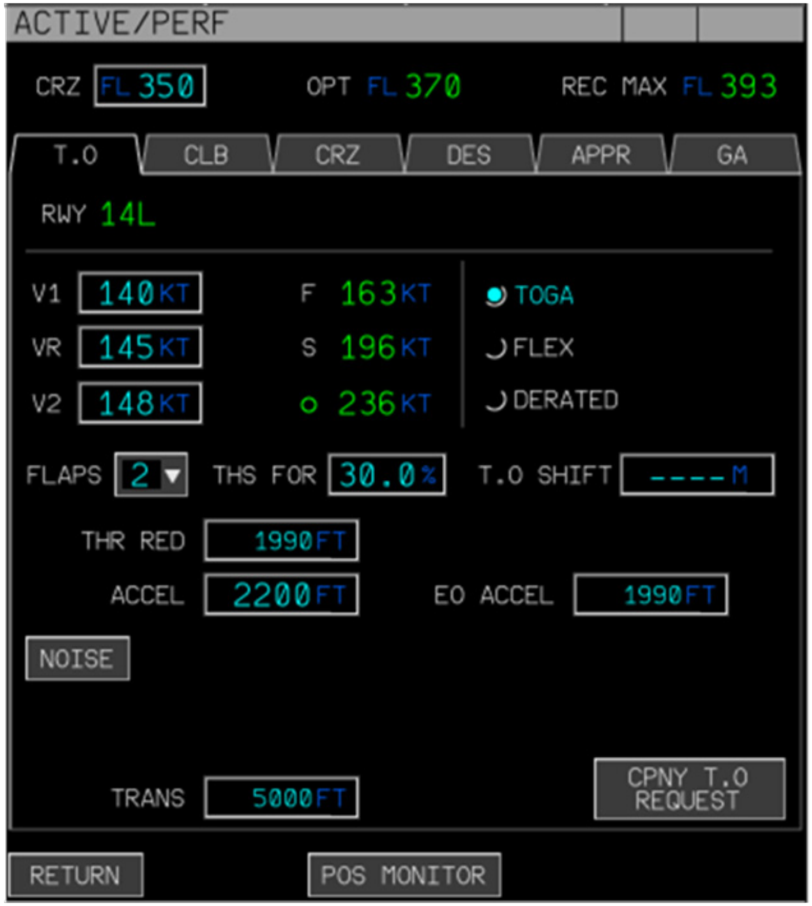
FMS ACTIVE/F-PLN Page



The performance function of the FMS:

- Provides the operating speeds for takeoff, approach, and go-around
- Computes an optimum and recommended maximum flight level
- Computes a speed/Mach profile for the CLIMB, CRUISE, and DESCENT phase, that is based on the cost index
- Computes a descent path from the cruise flight level to the destination airport
- Enables the flight crew to fly a Noise Abatement Departure Procedure (NADP) in managed speed mode.

FMS ACTIVE/PERF Page



The A350 has no longer a conventional clock in the cockpit. The aircraft time reference is managed via the FMS POSITION/TIME page that collects time parameters:

- Clock: time (UTC) and date
- Aircraft clock reference:
  - AUTO (managed by ADIRU), or
  - MANUAL (pilot setting)
- Elapsed times: flight time and block time
- Time markers
- Local time.

Via the FMS POSITION/TIME page, the crew can:

- Set manually a time reference
- Choose a parameter displayed in the ECAM permanent data zone (block time, flight time or date)
- Define up to three time markers
- Visualize local times associated with two airports (including local ETA at DEST)
- Display two elapsed times (block time and flight time).

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Radio Navigation Tuning

The FMS automatically tunes:

- The navaids used for the radio position computation
- The navaids for display on the ND
- The landing system navaids.

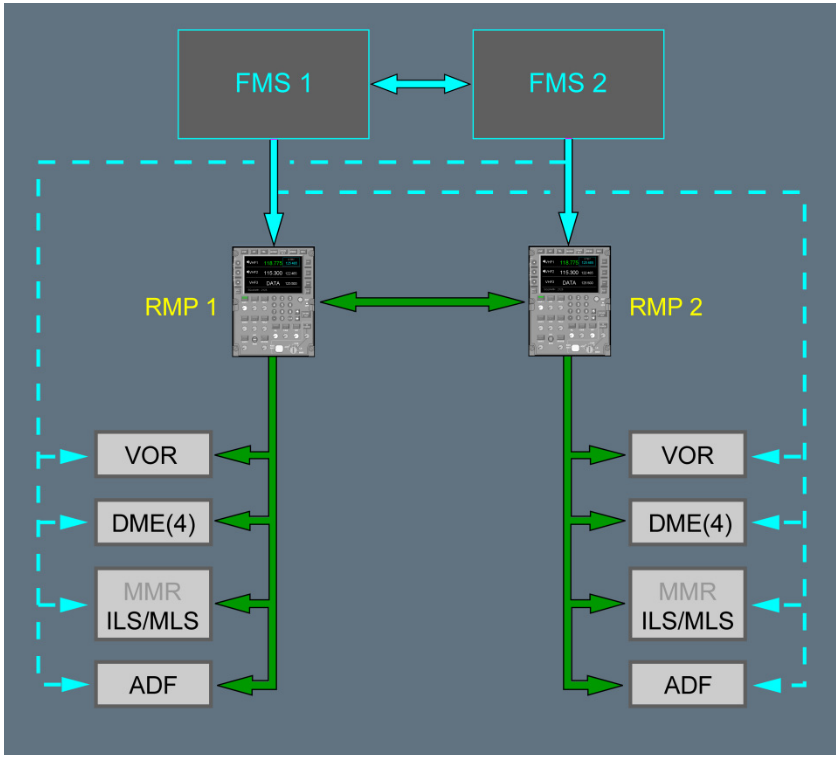
In dual and independent FMS mode, each FMS tunes its onside navaids:

- 1 VOR
- 4 DMEs
- 1 ILS (GLS / SLS optional)
- 1 ADF (optional).

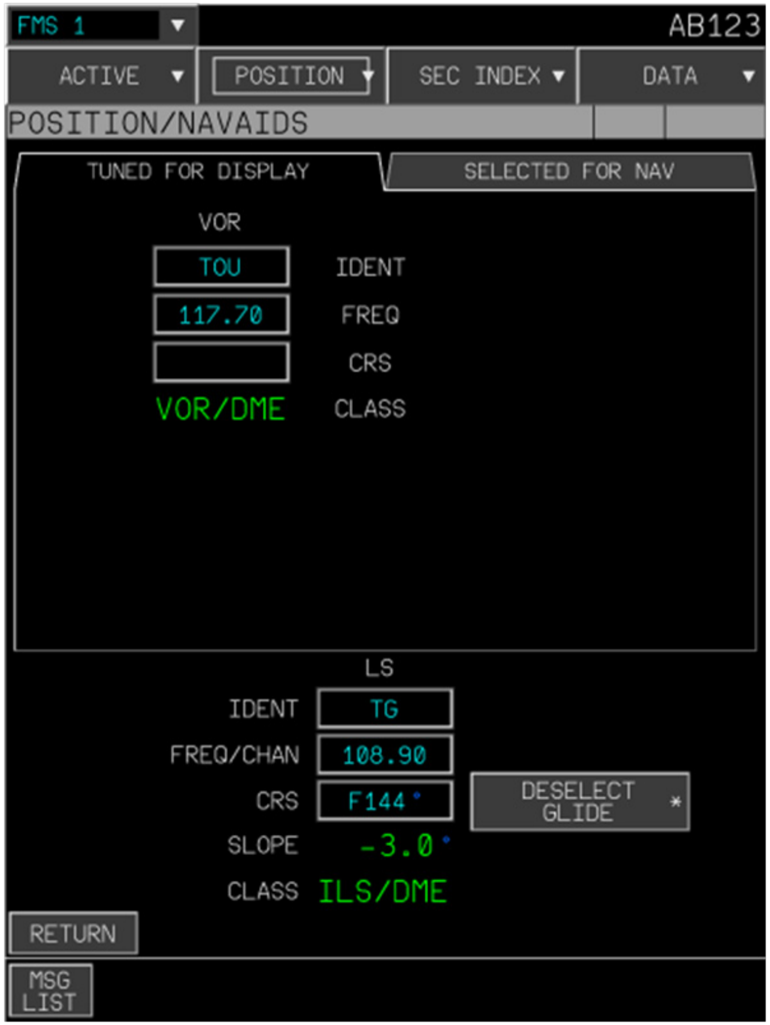
In single FMS mode or in the case of a communication failure between an FMS and its onside RMP, the available FMS will tune the navaids on both sides.

The tuning of the onside navaids is performed through the onside RMP, in order to synchronize the navaids tuning between the FMS and the RMP.

FMS Radio Navigation Tuning



FMS POSITION/NAVAIDS Page



<u>Note</u>:

The navaids that are displayed on the ND and the landing system navaids can also be tuned manually on the FMS POSITION/NAVAIDS page or on the RMP. Manual tuning always has priority over automatic tuning.

ATC Datalink

The FMS manages the FANS A / FANS B during the whole en-route segment (in continental and oceanic areas).

The FMS:

- Provides data about the aircraft status (navigation and Flight Data source) to the ATC Application system (ADS, CPDLC reports, confirm answers)
- Monitors some data for the ATC Application system (reports, confirm, deferred clearances)
- Enables the flight crew to prepare a route request
- Enables the flight crew to directly load an extended set of CPDLC messages into the FMS flight plan.

6.Long-Term Guidance

The FMS contributes to the management of long-term guidance along the lateral and vertical paths. In managed mode, the FMS sends deviations in accordance with the planned trajectory to the flight guidance system. The flight guidance system follows the optimized flight profile and the defined speed, altitude and time constraints.

The FMS sends targets to the FG:

- To guide the aircraft along the inserted flight plan (when AP is engaged)
- To display the FD on the PFDs.

The Fuel Penalty Factor Function

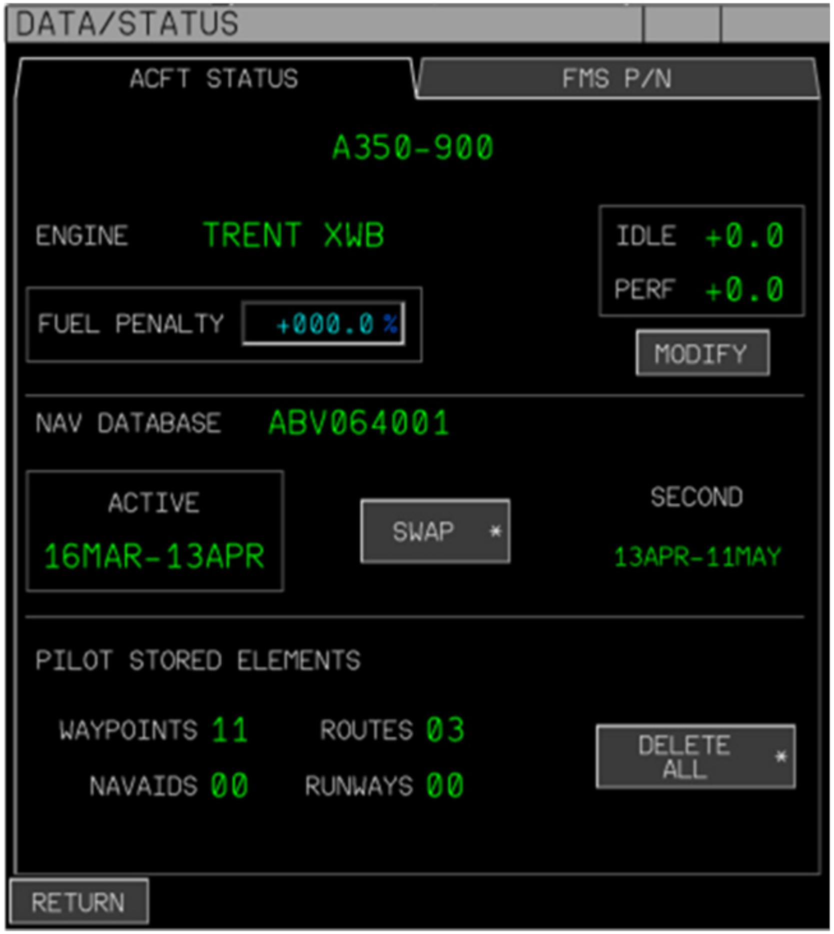
The objective of the fuel penalty factor function is to provide the flight crew with updated fuel predictions taking a non standard configuration into account.

This update is done through the use of a fuel penalty factor in prediction computations in addition to the existing performance factor.

The value of the fuel penalty factor can be provided through the onboard information system according to the detected failure (MEL/CDL items in preflight or any ECAM alerts in-flight).

The flight crew enters the value of the fuel penalty factor on the FMS DATA/STATUS page.

FMS DATA/STATUS Page



The FLS (FMS Landing System) function provides the flight crew with cockpit indications and guidance to fly a VOR, VOR/DME, NDB, NDB/DME, LOC only, LOC B/C, or RNAV approach (including GPS approach) in an ILS look alike display.
The FMS computes a final approach path, called the FLS beam, and sends it to the MMR.

The MMR computes the deviation between the aircraft position (from ADIRS) and the FLS beam.
The MMR sends these pseudo LOC and G/S deviations (now called F-LOC, and F-G/S) to the PRIM for flight guidance, and to the PFD and ND for display.

The WHAT IF function prepares prediction scenarios. The objective of this function is to assist the flight crew to make decisions in the case of a diversion.

The A350 has a TakeOff Securing (TOS) function. The TOS function of the A350 checks the following:

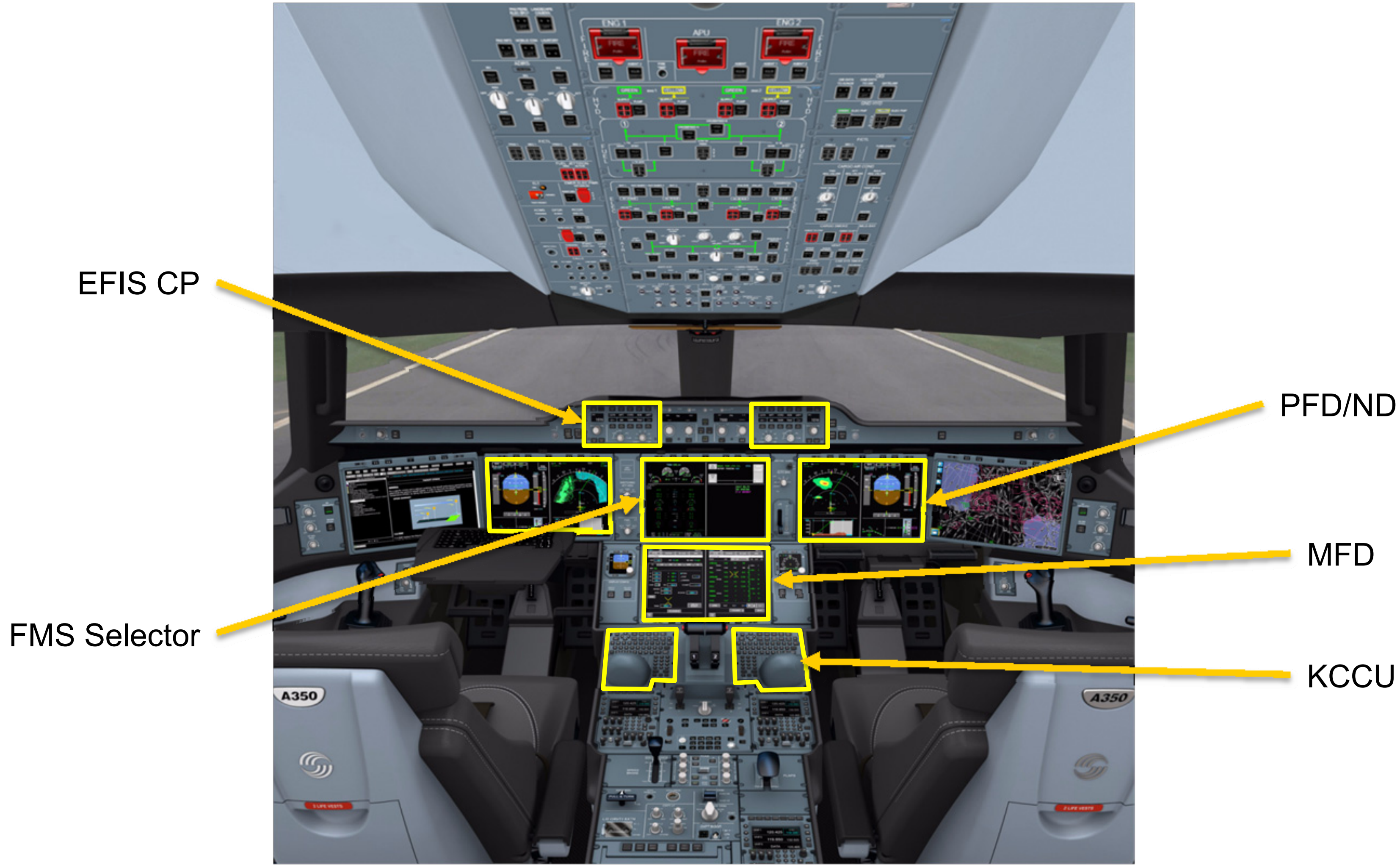
- Takeoff speeds that are inserted in the FMS
- Zero Fuel Weight (ZFW) value
- Aircraft position (checks if the aircraft is on the good runway)
- Runway limitations and available distance
- Flex temperature.

The A350 has a TakeOff Monitoring (TOM) function which monitors the aircraft acceleration during takeoff. If the acceleration is lower than the expected value, the ECAM displays an alert.

The A350 has an LRC Managed function. This function allows flying in Managed mode at the Long Range Cruise speed / Mach with all engines operative.

A350 XWB

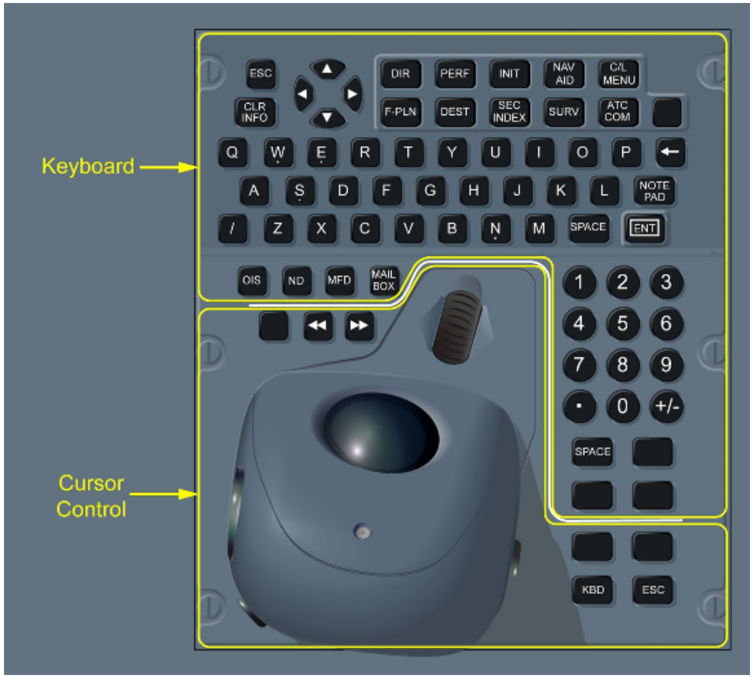
Cockpit View



AIRBUS

Controls

KCCU



EFIS CP

FMS Selector

Indicators

PFD/ND

MFD

Communication

General

The communication system enables:

- **Internal communication** between the:
  - Captain
  - First Officer
  - Third and fourth occupant
  - Cabin crew
  - Ground crew
  - Passengers (for cockpit or cabin announcements).

  Internal communication is possible via the cockpit, cabin and service interphones, and the Passenger Address (PA).

- **External communication** in voice and data mode via the VHF, HF and Satellite Communication (SATCOM) systems.

The aircraft has:

- Three Very High Frequency (VHF) voice and data transceivers with a 8.33 kHz channel spacing
- One High Frequency (HF) transceiver voice and data capable. This transceiver enables to handle long-range communication (that includes polar routes). A second optional transceiver is available
- One SATCOM system
- One SELCAL system.

Radio and Audio Management

The flight crew interfaces with the communication system via:

- **Communication tools**:
  - Four cockpit loudspeakers
  - Three hand microphones
  - Three boomsets
  - One handset
  - Oxygen mask microphones
  - Two sidestick "Push-To-Talk" sw
  - Two glareshield PTT pushbutton (optional).

- **Three Radio Management Panels (RMPs):**
  - RMP 1 (Captain)
  - RMP 2 (First Officer), and
  - RMP 3 (third occupant)

The three RMPs are on the pedestal.

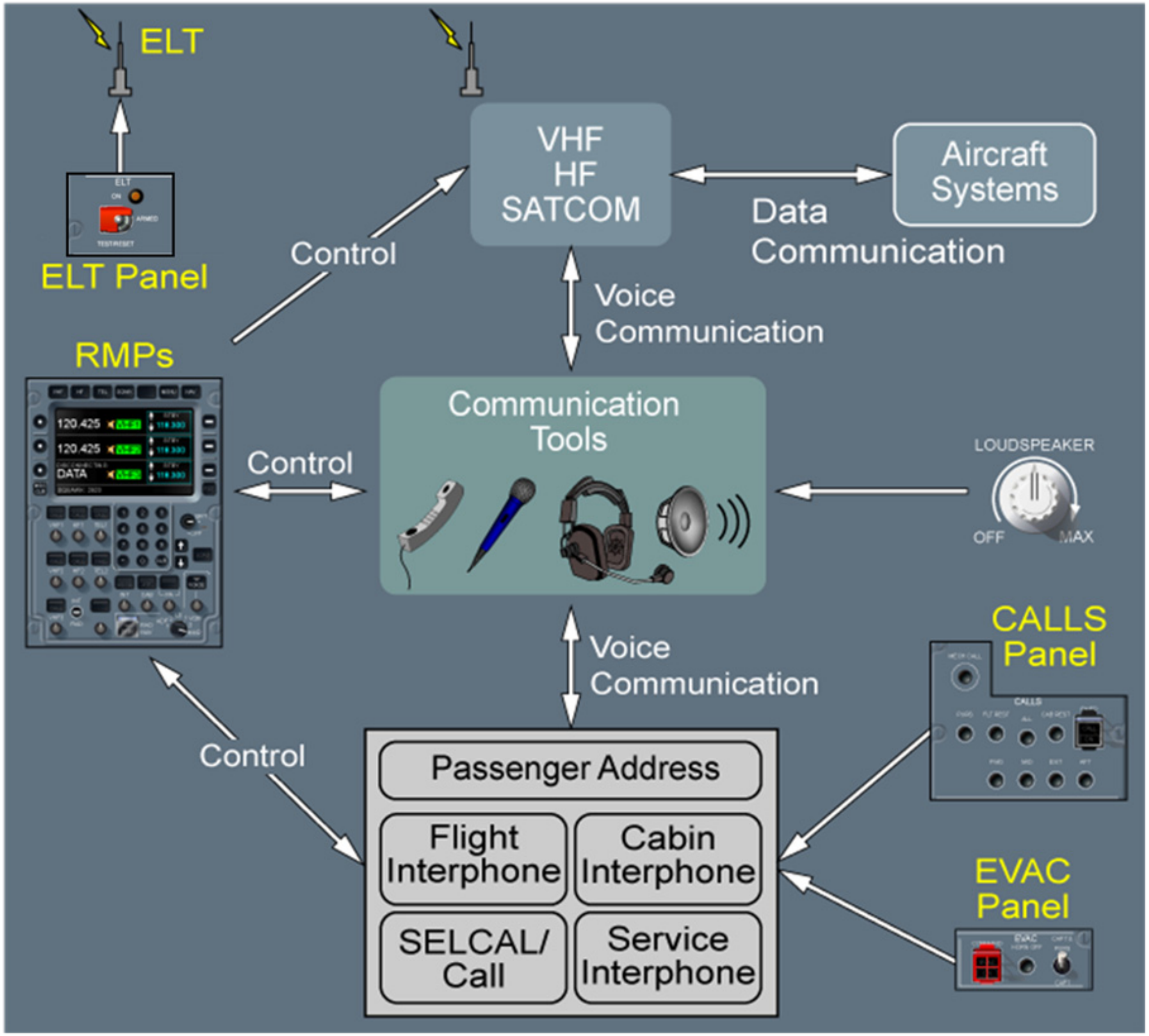
On each RMP the flight crew can:

- Select the type of communication (radio communication, SATCOM, interphones) in transmission and/or reception mode(s)
- Tune HF and VHF frequencies (up to five frequencies in standby)
- Dial SATCOM Telephone (TEL) numbers
- Select voice or data mode
- Monitor and change data
- Enter the squawk (SQWK) code
- Adjust the volume for voice communication and NAVAID identification
- Load the ATCCOM CPDLC frequencies.

- **One CALLS panel** to generate visual and aural call indications
- **One EVAC panel** to initiate evacuation of the aircraft
- **One ELT panel** to activate the Emergency Locator Transmitter.

Communication System Architecture

Communication System Architecture



RMP Architecture

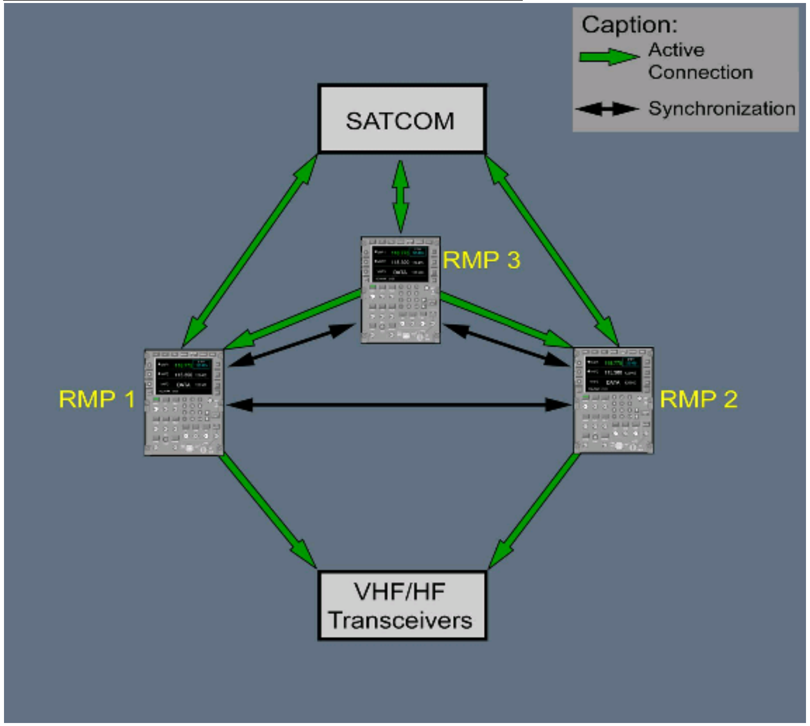
Active Communication
In normal operations:

- The captain controls communication via RMP 1
- The first officer controls communication via RMP 2
- The third occupant controls communication via RMP 3.

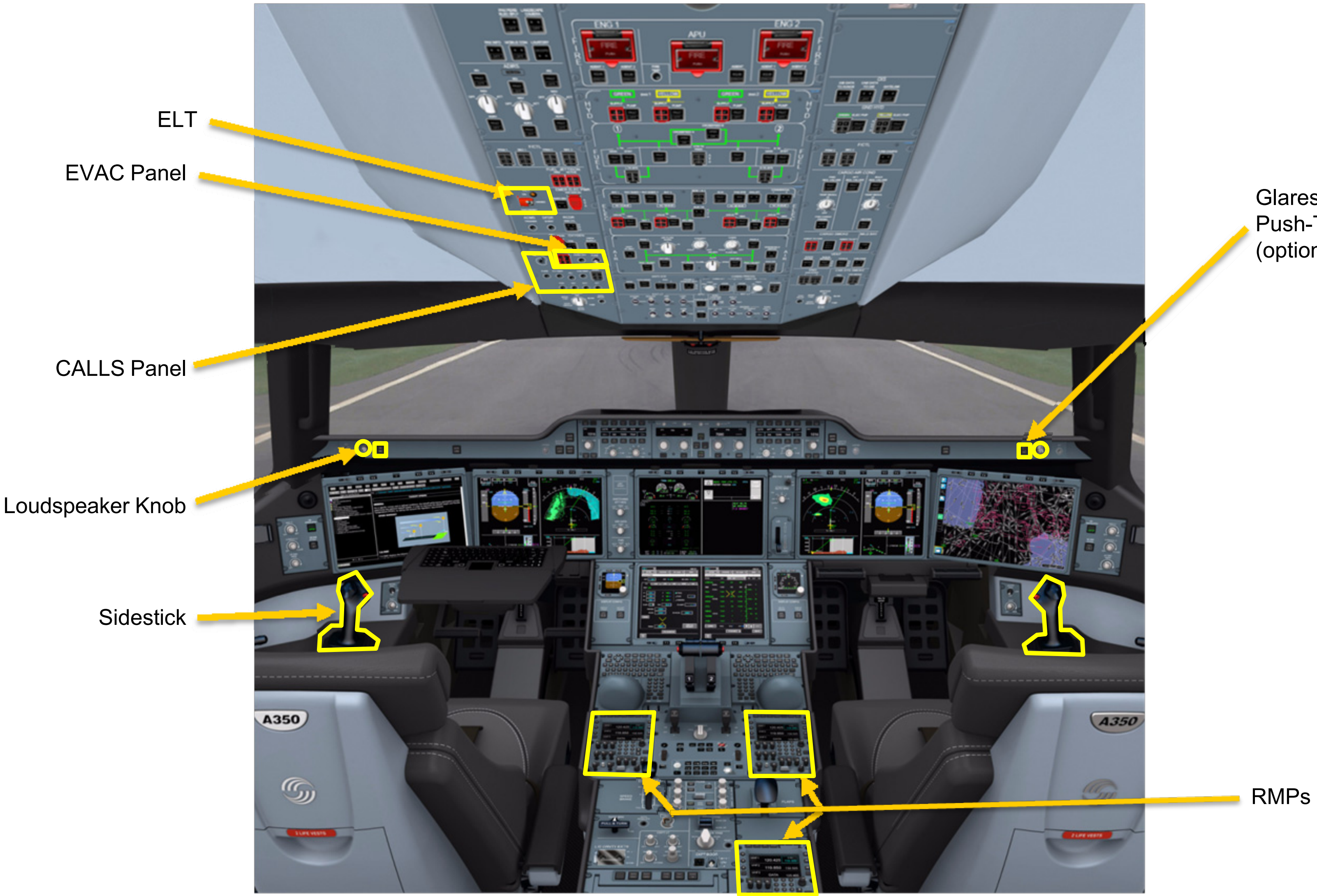
RMP 1 and RMP 2 are directly connected to VHF and HF transceivers.
RMP 3 transmits commands to RMP 1 and RMP 2 via the appropriate control connection. RMP 1 and/or RMP 2 then send these commands to the appropriate transceivers.
All three RMPs are directly connected to the SATCOM system.

Synchronization
The RMPs share selections and inputs, in order to synchronize the main displays and enable control of all radio communication via any RMP. However, it is possible to display a different page on each RMP.
The synchronization of the RMPs enables reconfiguration of the RMPs in the case of a failure of one or more RMPs.

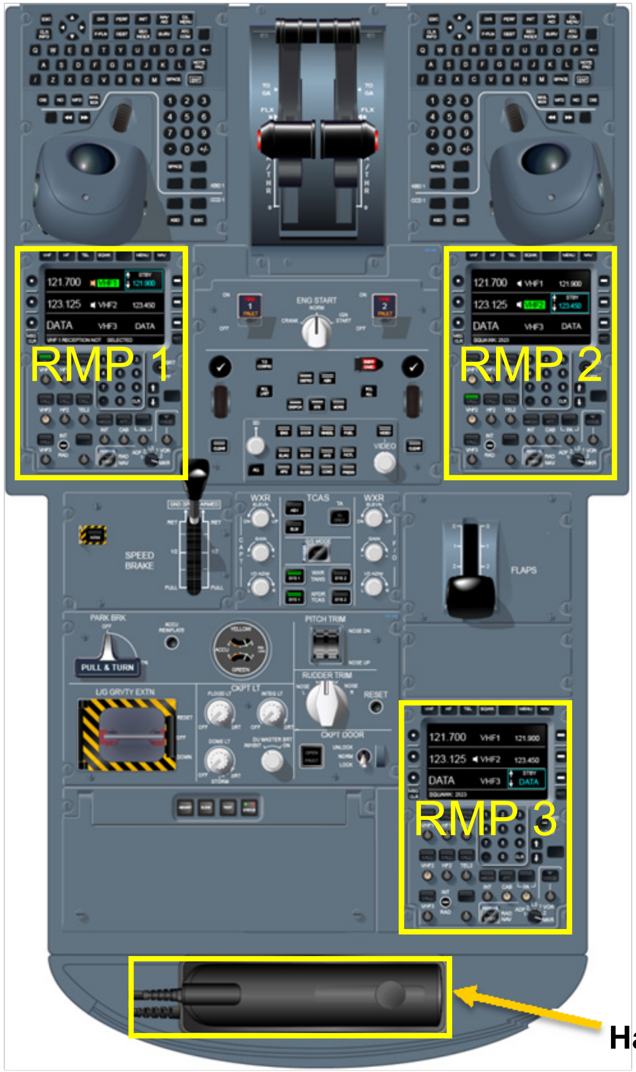
RMP Architecture and Normal Operation



Cockpit View



Pedestal



Handset

RMP

External Communication Controls and Indicators

Reset Key

Brightness/OFF Selector and Indicator

CPDLC frequencies load pb

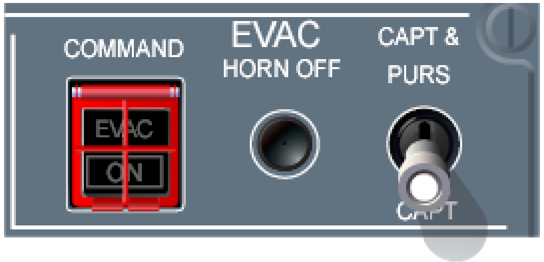
STBY RAD NAV Selector and Indicator

Interphone/PA Transmission Keys and Reception Knobs

INT/RAD PTT sw

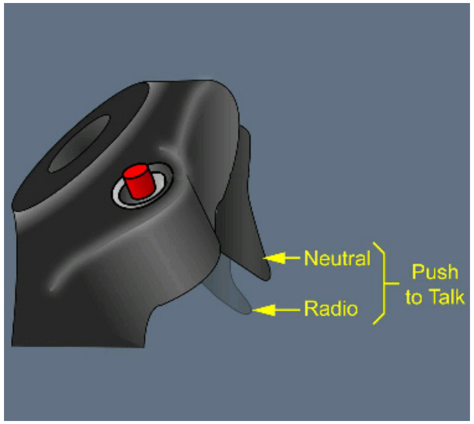
CALLS Panel

EVAC Panel



ELT Panel

Sidestick



Loudspeaker Knob

Glareshield Push-To-Talk pb

Electrical System

Overview

The A350 electrical system has three types of power sources:

- The engine generators (two per engine)
- The APU generator
- The emergency generator driven by the RAT.

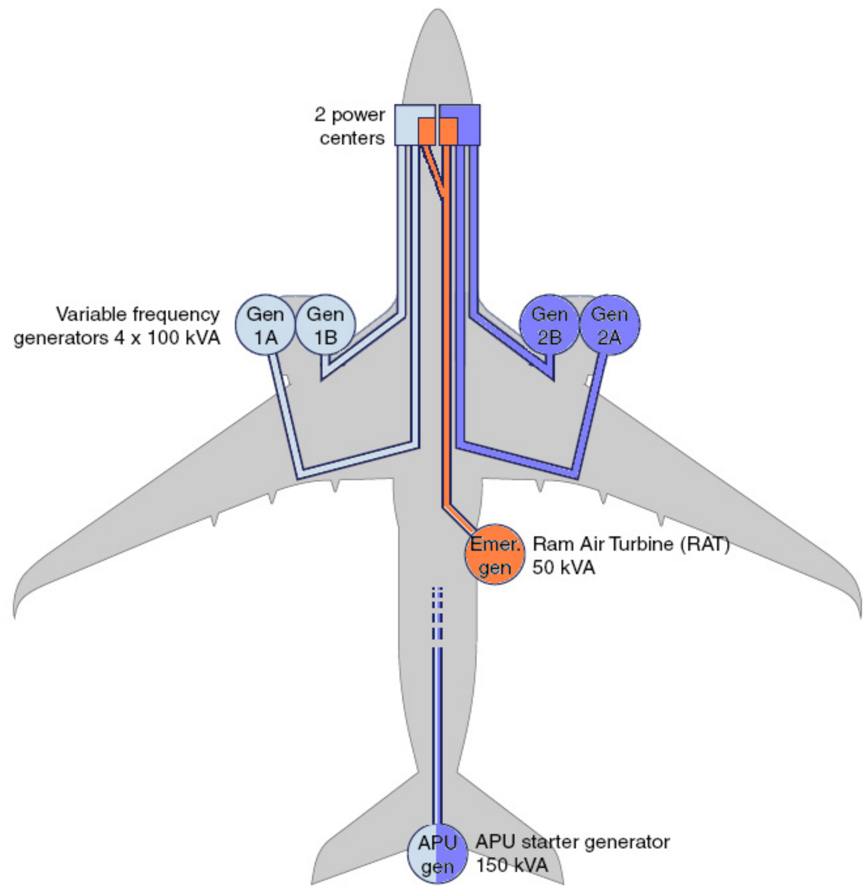
The A350 has three networks:

- 230 V Alternating Current network
- 115 V Alternating Current network
- 28 V Direct Current network

Each network has a normal and an emergency electrical distribution.

Two Electrical Power Distribution Centers manage the power distribution for normal and emergency operations.

The A350 electrical generation and distribution are designed to support ETOPS with diversion time up to **350 minutes.**

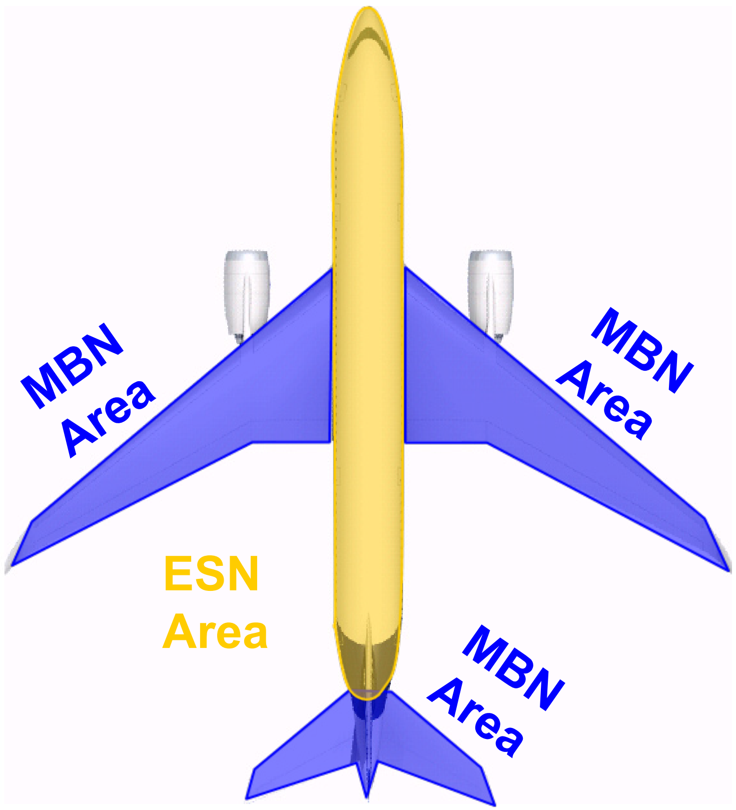


Bonding and Grounding Circuits

The A350 is designed with extensive use of Carbon Fiber Reinforced Plastic (CFRP) for structure, including aircraft skin. On previous aircraft the metallic structure performed a set of functions such as electrical bonding and grounding, voltage reference, etc.
On the A350, two metallic networks ensure this set of functions:

• **Electrical Structure Network (ESN)**
The ESN is implemented in the fuselage. It ensures grounding, bonding, voltage reference and personal protection functions and contributes to direct and indirect lightning protection.

• **Metallic Bonding Network (MBN)**
The MBN is implemented in the non-pressurized zones: wings, fin and tail cone. It ensures bonding, personal protection functions and contributes to direct and indirect lightning protection.



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AC Power Generation

AC Main Generation
Four engine-driven generators are the main generators of AC power. Each engine drives two main generators. Each main generator supplies 230 V AC at a variable frequency and a normal power of 100 kVA to the 230 V AC network. Then the Auto Transfer Units (ATUs) convert the 230 V AC into 115 V AC to supply the 115 V AC network.

AC Auxiliary Generation
The APU drives an auxiliary AC starter generator.
The APU generator supplies 230 V AC at a constant frequency of 400 Hz and a normal power of 150 kVA.
On ground, the APU can power the entire electrical network for normal operations.
In flight if one or more main generators fail, the APU generator can take over the failed main generator(s).

External Power
On ground, it is possible to connect two Ground Power Units (GPU) to the aircraft through two external power connectors (however, one GPU is sufficient to provide electrical power to the aircraft). The GPU supplies 115 V AC and a normal power of 90 kVA.

AC Emergency Generation
A drop out **Ram Air Turbine (RAT)** drives one AC generator to supply essential systems if all generators fail.

DC Power Generation

DC Main Generation
The 230 V AC network supplies the 28 V DC network via four Transformer/Rectifiers Units (TRUs): TR 1, TR 2, TR EMER 1 and TR EMER 2.

Batteries DC Generation
Four identical Lithium-Ion batteries are connected to the 28 V DC network in order to:
- Ensure the No Break Power Transfer (NBPT) function
- Provide standby DC power
- Provide DC power on ground if AC power is not available.

Two out of the four batteries can provide temporary supply in an emergency electrical configuration.

Electrical Power Distribution

The electrical network supplies the aircraft systems with three voltages via the following networks:

230 V AC Network (Normal and Emergency)
This network supplies large power consumers (e.g. fans, compressors, pumps) and has:
• Four AC busbars (AC 1A, AC 1B, AC 2A, and AC 2B)
• Two AC emergency busbars (EMER AC 1 and EMER AC 2).

115 V AC Network (Normal and Emergency)
This network supplies commercial loads such as galley equipment and has:
• Four AC busbars (AC 1A, AC 1B, AC 2A and AC 2B)
• Two AC emergency busbars (EMER AC 1 and EMER AC 2).

28 V DC Network (Normal and Emergency)
This network supplies DC consumers and has:
• Two DC busbars (DC 1 and DC 2)
• Two DC emergency busbars (EMER DC 1 and EMER DC 2).

Auto Transformer Units (ATUs)
The 230 V AC network supplies the 115 V AC network busbars via the Auto Transformer Units.

When the generators and the APU are not operating, the ATU enable to convert the 115 V AC that comes from the GPU into 230 V AC.

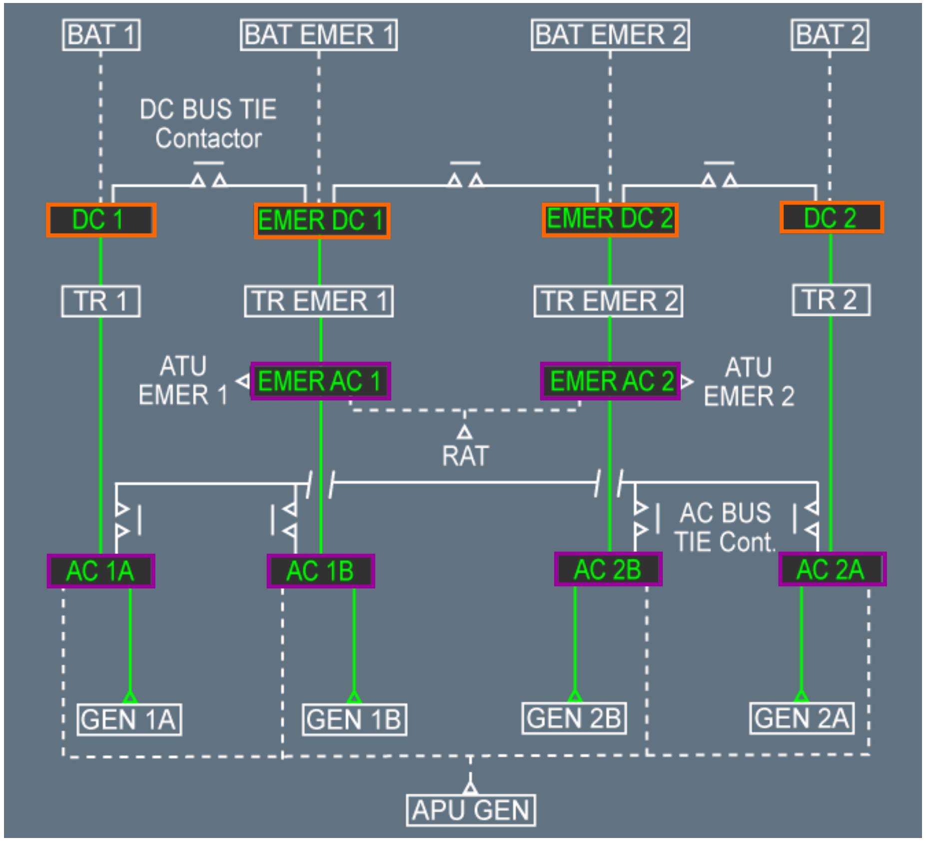
Transformer/Rectifier Units (TRUs)
The 230 V AC network supplies the DC busbars via the Transformer/Rectifier Units.

BUS TIE contactors
The BUS TIE contactors operate automatically to enable any reconfiguration by segregating/connecting:

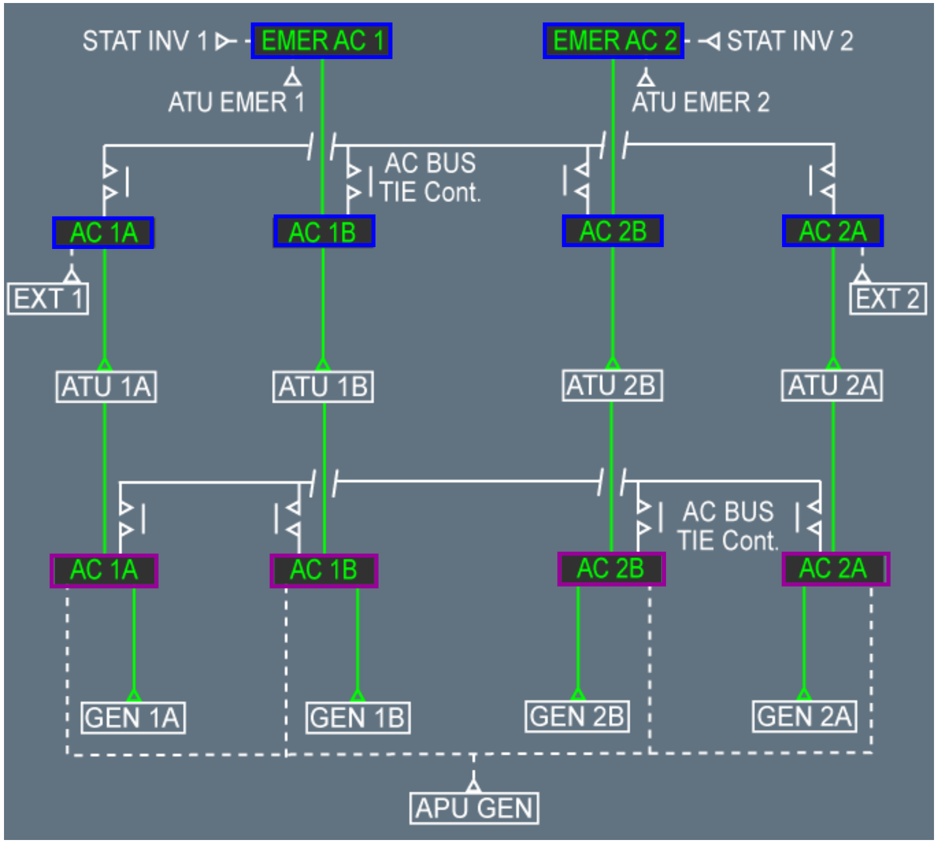
- The AC busbars to/from each other, and
- The DC 1 and DC 2 busbars to/from each other.

Electrical Networks

Electrical Networks (**230 V AC** and **28 V DC**)



Electrical Networks (**230 V AC** and **115 V AC**)



Caption:

230 V AC Network — 115 V AC Network — 28 V DC Network

General

In any abnormal electrical configuration (e.g. failure of one or more engine generators, failure of TRU or busbars), the electrical network automatically reconfigures to ensure that the remaining power sources continue to supply as many busbars as possible.

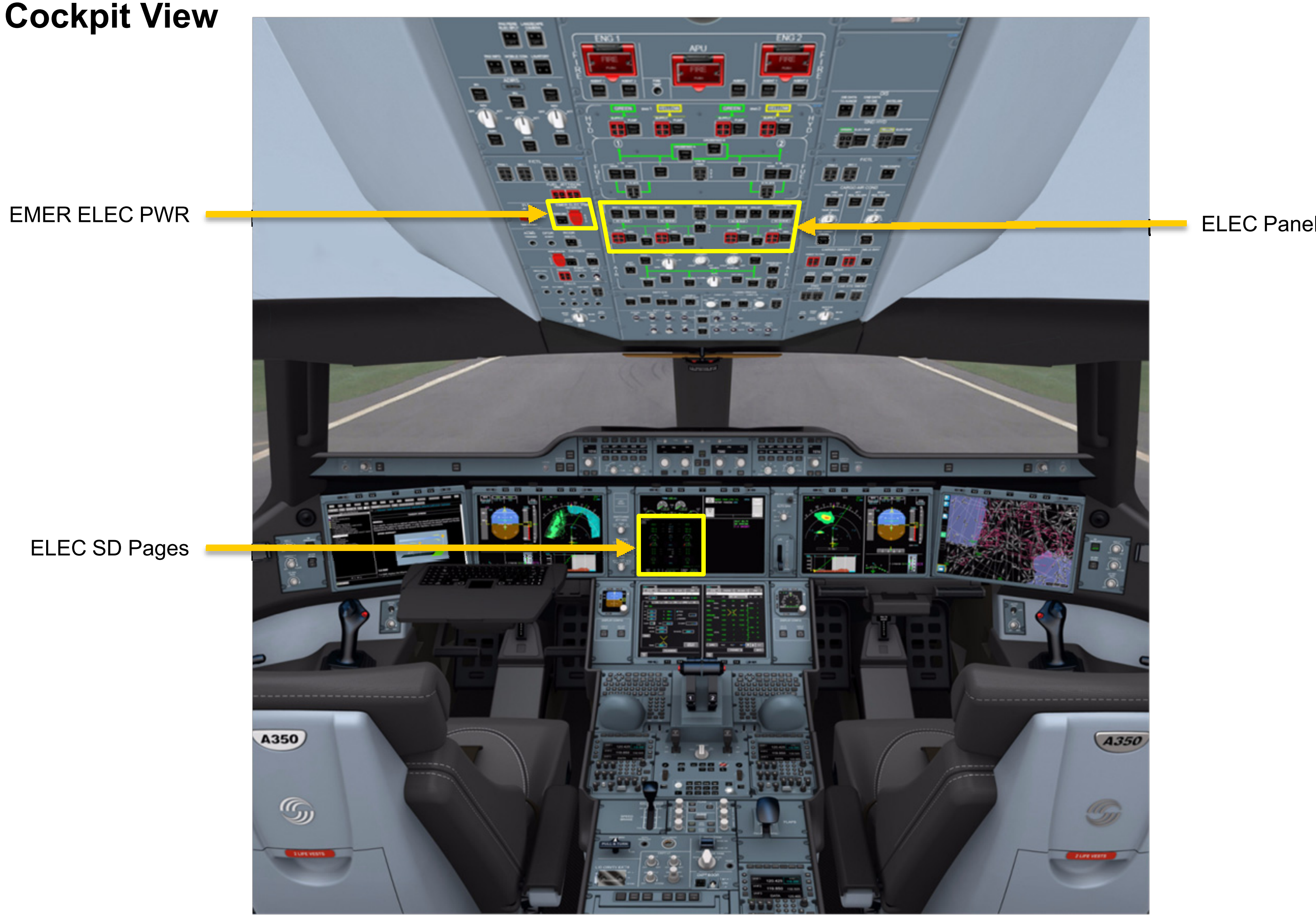
Emergency Generation

If AC 1A, AC 1B, AC 2A, and AC 2B busbars are lost in flight, the **Ram Air Turbine (RAT)** will automatically extend and mechanically drive the RAT generator.

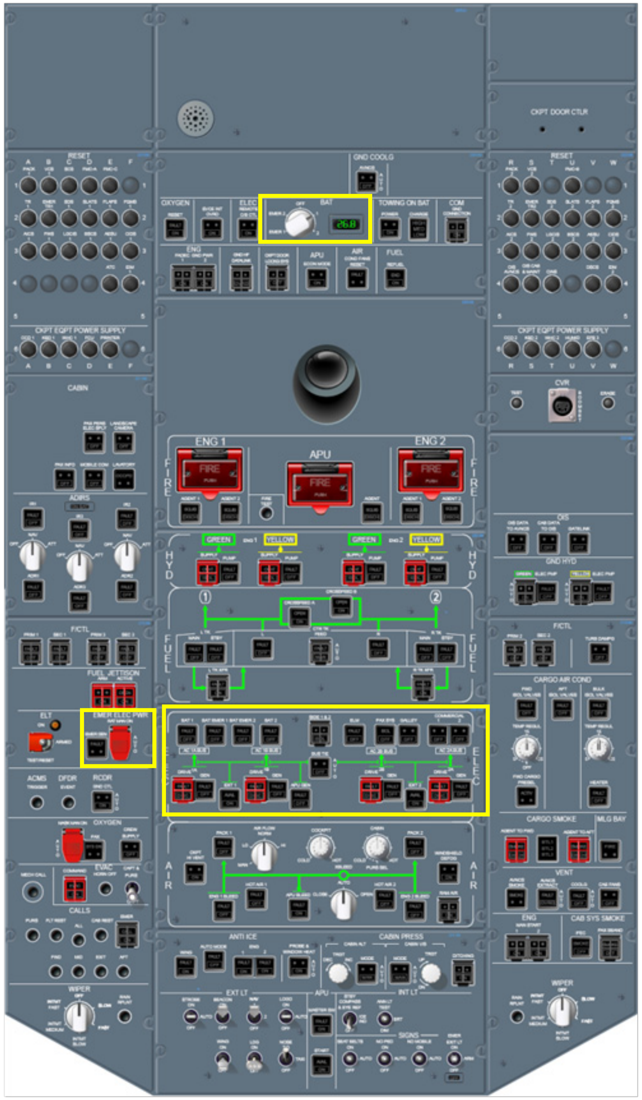
When the aircraft speed is above 140 kt, the RAT generator supplies the EMER AC 1 and EMER AC 2 busbars with 230 V AC and a nominal power of 50 kVA.

If the aircraft speed is below 140 kt (e.g. after landing), the battery supplies the required electrical power through the static inverters (STAT INV 1 and STAT INV 2).

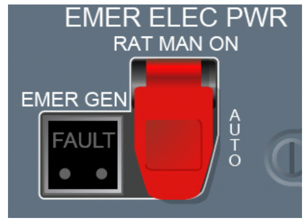
Cockpit View



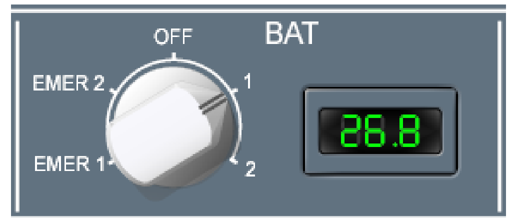
Overhead Panel



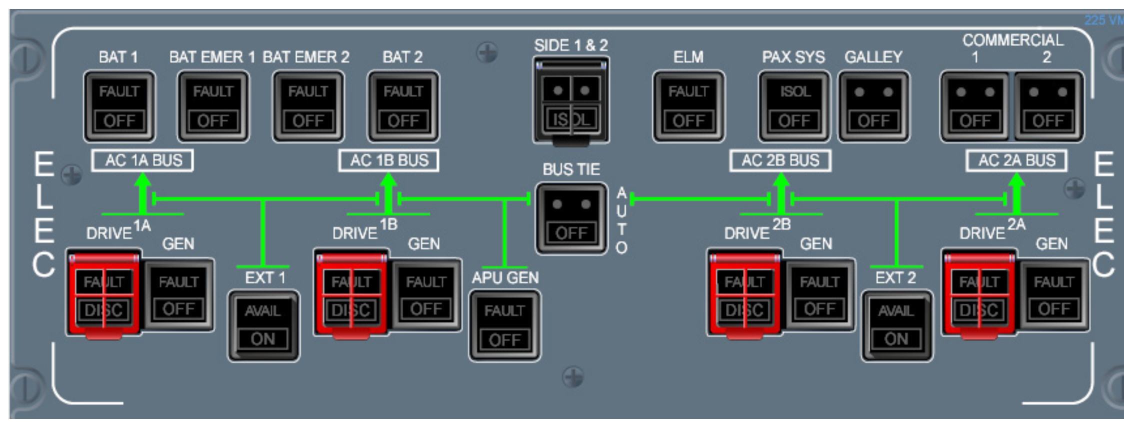
EMER ELEC PWR



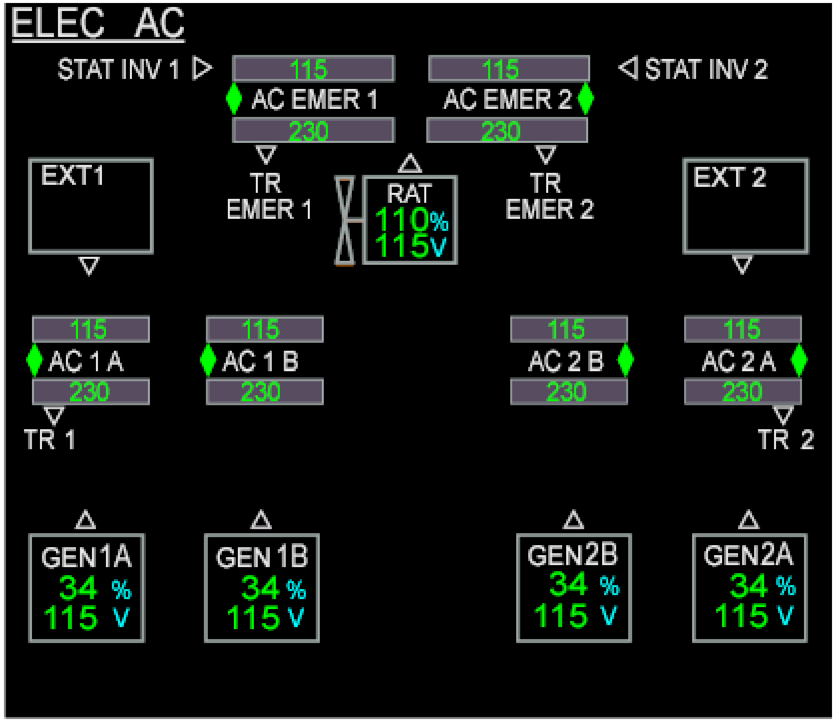
BATT CHECK Panel



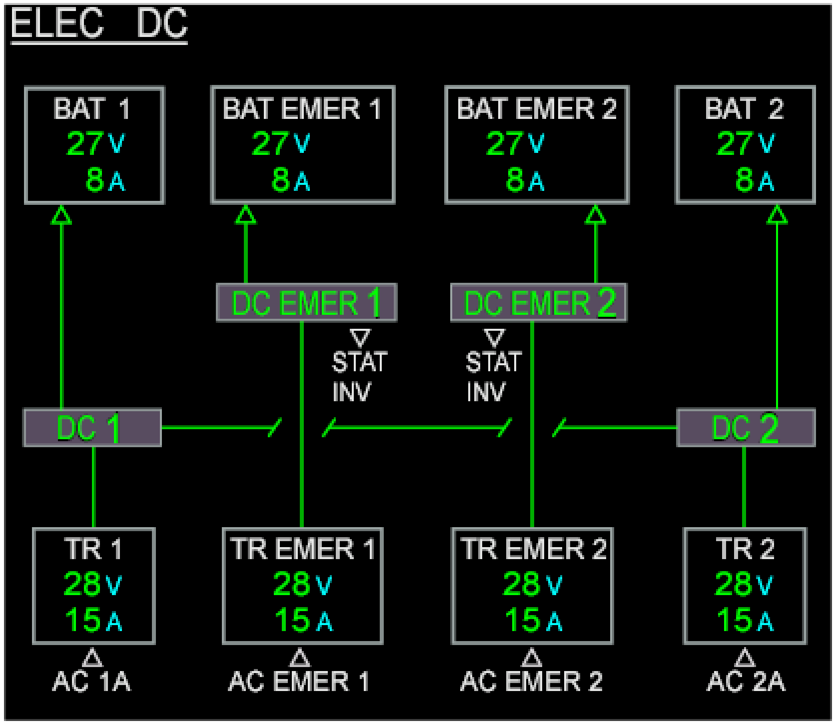
ELEC Panel



ELEC AC SD Page



ELEC DC SD Page



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Fire and Smoke Protection

Overview

The A350 has a:

- **Fire and overheat detection system** for:
  - The engines
  - The APU compartment
  - The Main Landing Gear (MLG) bay

- **Smoke detection system** for:
  - The avionics bay
  - The cargo compartments
  - The lavatories
  - The optional flight crew rest compartment
  - The optional overhead cabin crew rest compartment
  - The optional In-Flight Entertainment center

- **Fire extinguishing system** for:
  - The engines
  - The APU area
  - The cargo compartments
  - The lavatories.

Note:

The fire extinguishing system standard satisfies 180 minutes ETOPS requirements. Additional optional equipment enables up to 350 minutes ETOPS capability.

In addition, the aircraft has portable fire extinguishers in the cockpit and in the cabin areas.

Engine Protection

General

Each engine has:

- A Fire Protection System (FPS) that:
  - Monitors all sensitive zones
  - Provides the flight crew with aural and visual alerts (via the FWS)
- Two extinguisher bottles.

Fire Detection

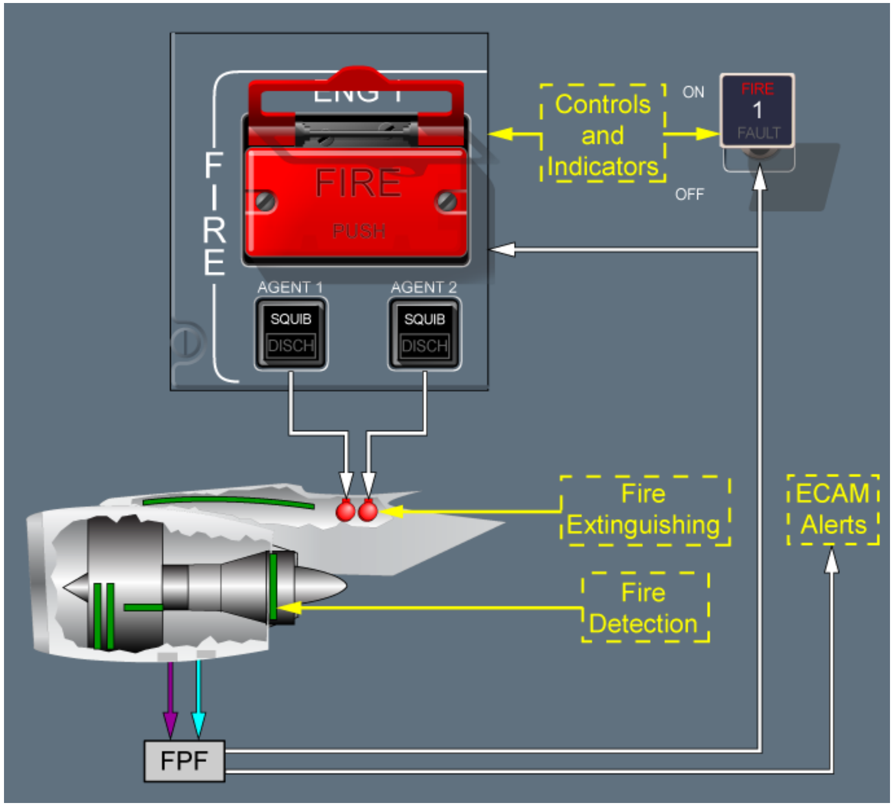
The FPS uses two identical and segregated loops (A and B) to monitor the sensitive zones of the engine. The FWS alerts the flight crew if a fire is detected.

Engine Isolation and Fire Extinguishing

In the case of engine fire, the flight crew can isolate and extinguish the fire from the FIRE panel in the cockpit.

The fire extinguisher agent is discharged in the engine nacelle.

Engine Fire Protection



APU Protection

General

The APU compartment has:

- A Fire Protection System (FPS) that:
  - Monitors all sensitive zones
  - Provides the flight crew with aural and visual alerts (via the FWS)
- One extinguisher bottle.

Fire Detection

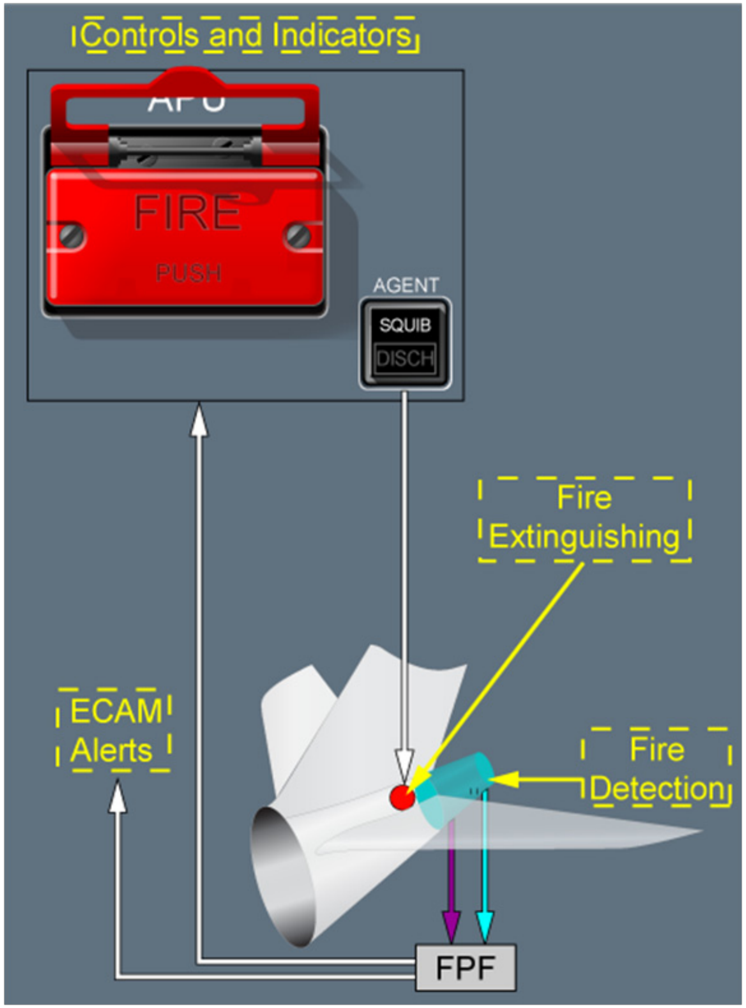
The FPS uses two identical loops (A and B) to monitor sensitive zones of the APU. The FWS alerts the flight crew if a fire is detected.

APU Isolation and Fire Extinguishing

In the case of APU fire, the flight crew can isolate and extinguish the fire from the FIRE panel in the cockpit. The bottle discharge is:

- Manually controlled from the FIRE panel in the cockpit, during the flight, or
- Automatically activated on ground.

APU Fire Protection



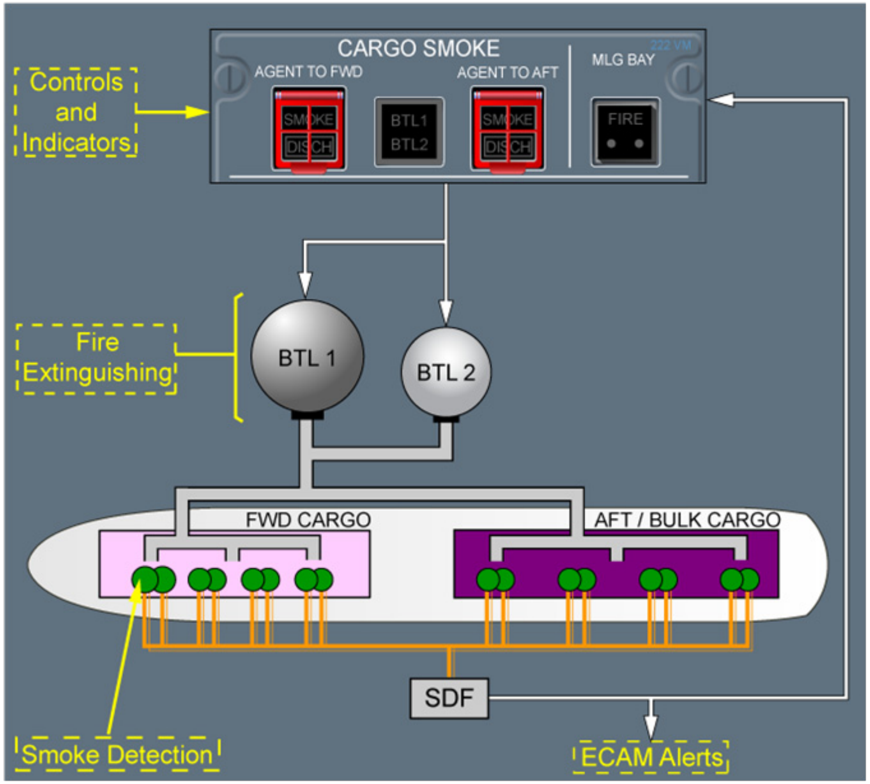
Cargo Compartment Protection

The Smoke Detection System (SDS) monitors the forward and aft/bulk cargo compartments.

In the case of smoke detection in a cargo compartment, the flight crew can extinguish the smoke source using the CARGO SMOKE panel in the cockpit. The system has two extinguisher bottles that discharge an extinguishing agent in any cargo compartment.

If the affected cargo compartment is a ventilated compartment, it is automatically isolated.

Cargo Compartment Protection



Main Landing Gear (MLG) Bay Protection

The MLG bay has an overheat detection system. This system uses two identical and segregated sensing elements (Loops A and B).

Avionics Bay Protection

The smoke detection system monitors the avionics bay.

IFEC Protection

The smoke detection system monitors the optional In Flight Entertainment Center (IFEC).

If an IFEC fire is detected:

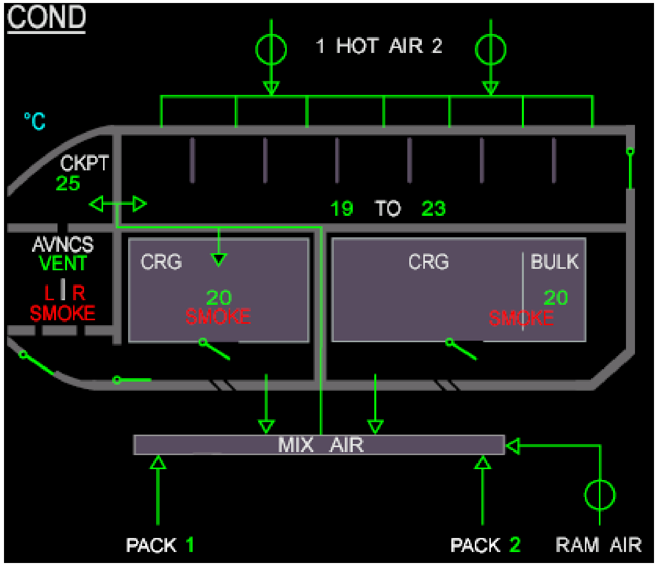
- The FWS alerts the flight crew
- The Flight Attendant Panel (FAP) alerts the cabin crew.

Crew Rest Compartment Protection

An optional flight crew rest compartment and/or an optional overhead cabin crew rest compartment can be installed in the aircraft.

The smoke detection system monitors the:

- The flight crew rest compartment
- The overhead cabin crew rest compartment.



Lavatories Protection

The smoke detection system monitors each lavatory. If smoke is detected, the Flight Attendant Panel (FAP) triggers an alert to the cabin crew.

The waste bin in each lavatory has a built-in automatic fire extinguishing system.

Cockpit View

FIRE Panel

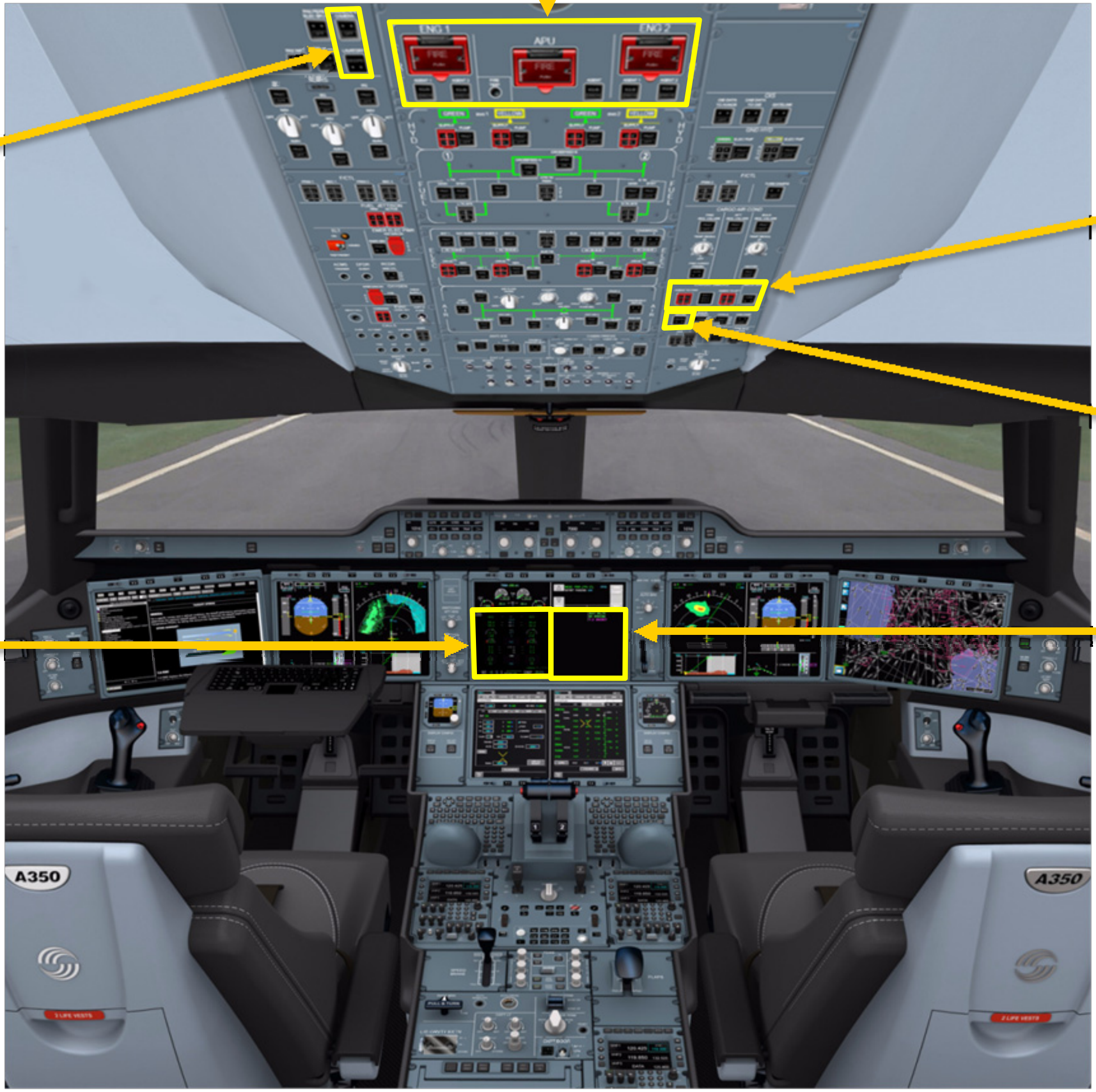
LAVATORY SMOKE Light and IFEC SMOKE Light on CABIN Panel

SMOKE Panel

AVNCS SMOKE Light on VENT Panel

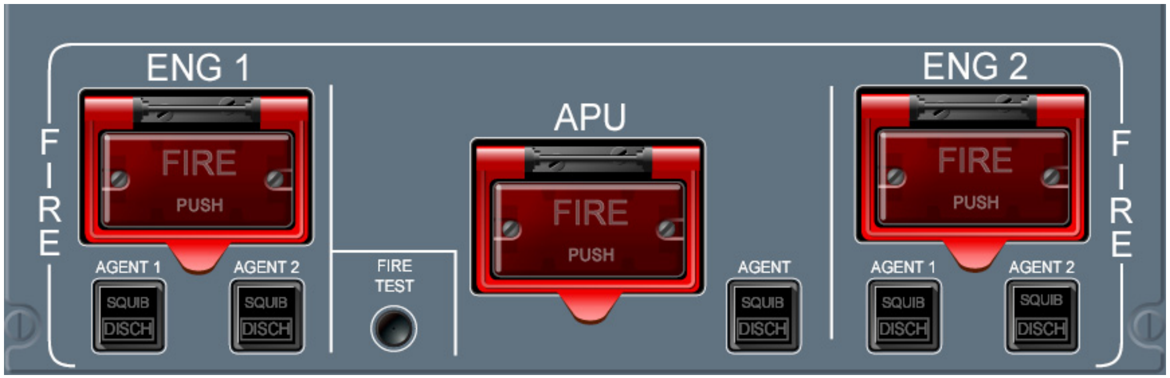
COND SD Page

Warning Display



Controls

FIRE Panel

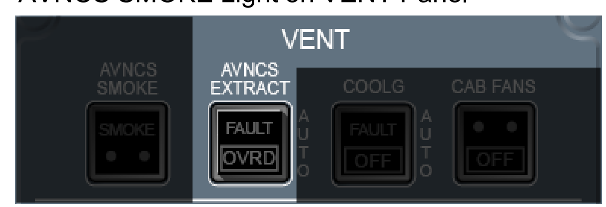


LAVATORY OCCPD Light and IFEC SMOKE Light on CABIN Panel

CARGO SMOKE Panel

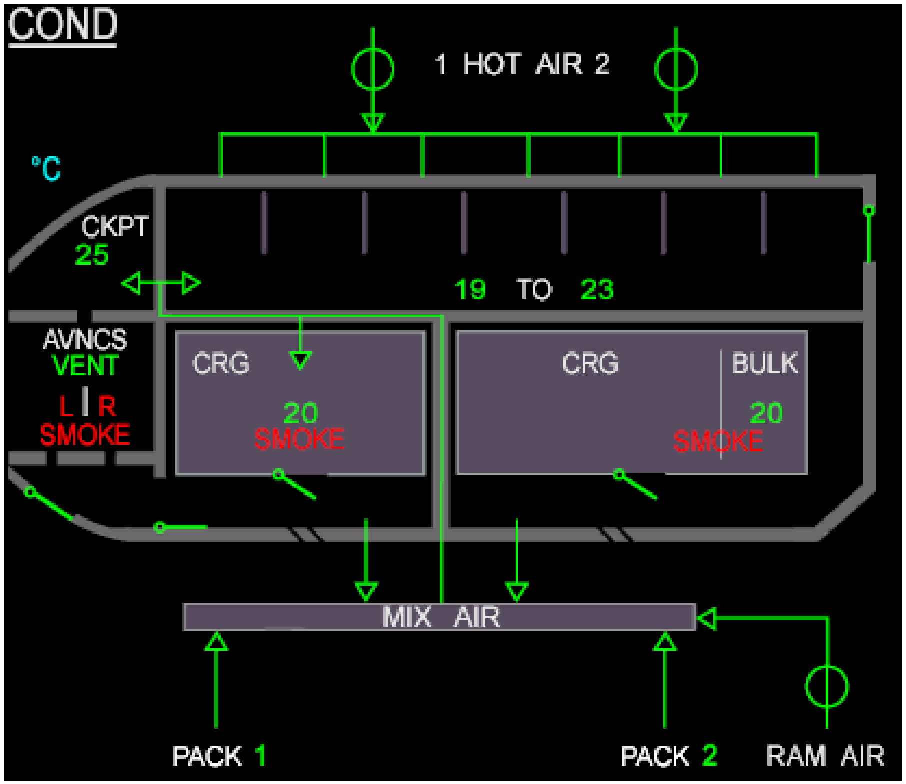
CAB SYS SMOKE Panel

AVNCS SMOKE Light on VENT Panel



Indicators

COND SD Page



Flight Controls

Overview

The A350 has fly-by-wire flight controls.

The flight controls can be divided into two categories:

- The **primary flight controls** which control the aircraft according to the three axes (Roll, Pitch and Yaw) and fulfill the auxiliary functions (speedbrakes, ground spoilers,…)
- The **slats and flaps** which fulfill the high-lift function.

The A350 flight controls system benefits from evolutions introduced on the A380:

- Integration of the Flight Guidance (FG) and Flight Envelope (FE) functions in the Primary Flight Computers (PRIMs)
- Replacement of all mechanical backup controls by electrical backup controls
- Addition of a new pitch trim switch which replaces the trim wheels
- Introduction of active stability for longitudinal and lateral axes
- Introduction of Electro-Hydrostatic Actuators (EHAs) and Electro Backup Hydraulic Actuators (refer to ***Actuators***).

Control Surfaces

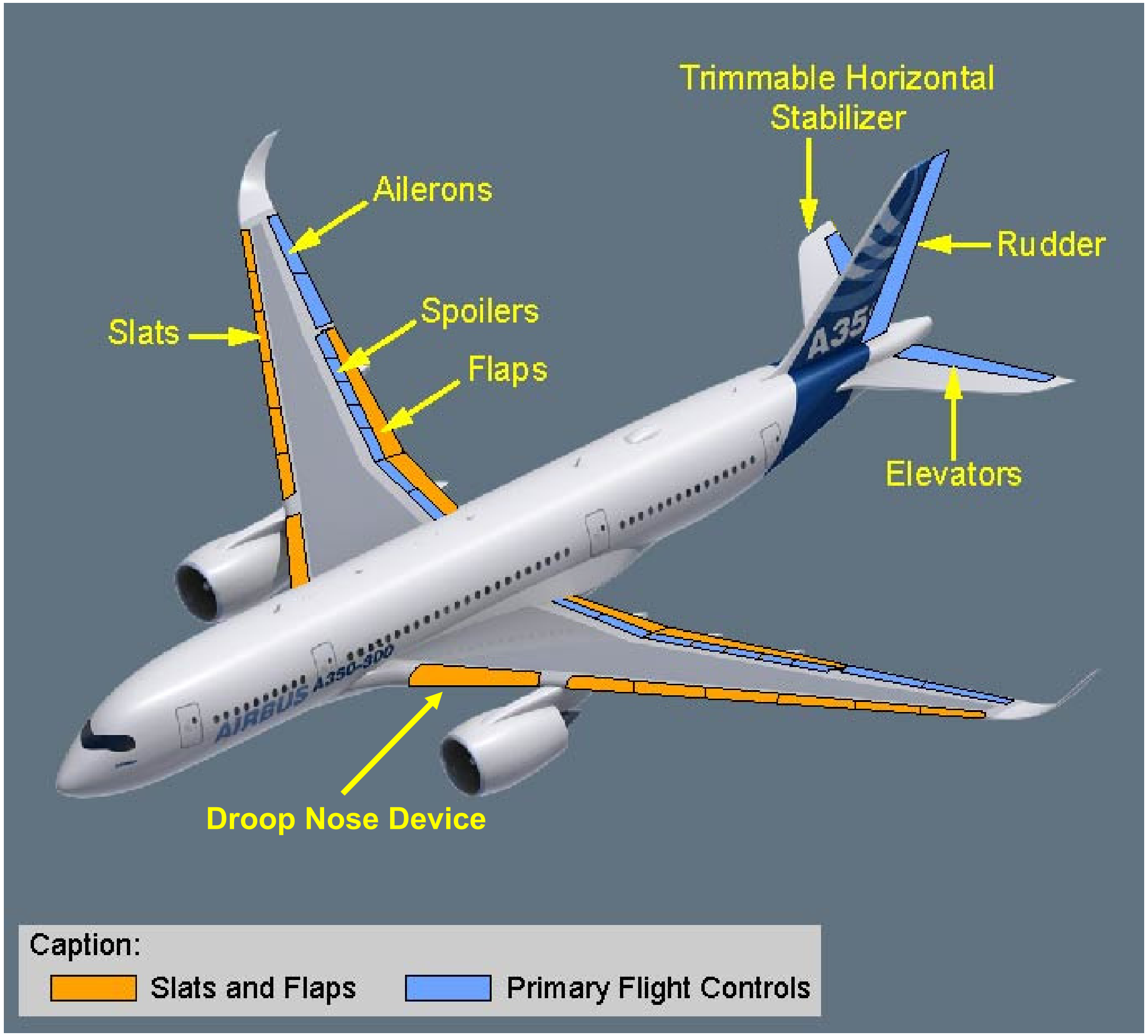
The A350 has:

- 4 ailerons
- 14 spoilers
- 2 elevators and 1 Trimmable Horizontal Stabilizer (THS)
- 1 rudder
- 12 slats, 4 Adaptive Dropped Hinge Flaps and 2 Droop Nose Devices.

The A350 has two independent hydraulic circuits and two independent electrical circuits which power the flight controls surfaces. For more information refer to

Power supply for the Actuators and Control Surfaces

Control Surfaces



System Architecture

The flight controls system has:

- Flight deck controls
  - Sidesticks
  - Rudder pedals
  - Rudder trim selector
  - Pitch trim switch
  - Speed brake lever

  The relation between the flight crew input on the sidestick and the aircraft response is called a Control Law.
  There are three control laws:
  - The normal law
  - The alternate law
  - The direct law.

- Three **Primary Flight Computers (PRIMs)**.
  Each PRIM can provide aircraft control under normal, direct or alternate law. The PRIMs perform the
  - Control of flight controls
  - Flight Guidance (FG), A/THR and AP/FD functions
  - Flight Envelope (FE) function

- Three **Secondary Flight Computers (SECs)**. The SECs can provide complete aircraft control in direct law only.

  The computers receive inputs from the pilot controls or from the Auto Flight System. These inputs are transformed into control surfaces commands which are electrically transmitted to actuators.

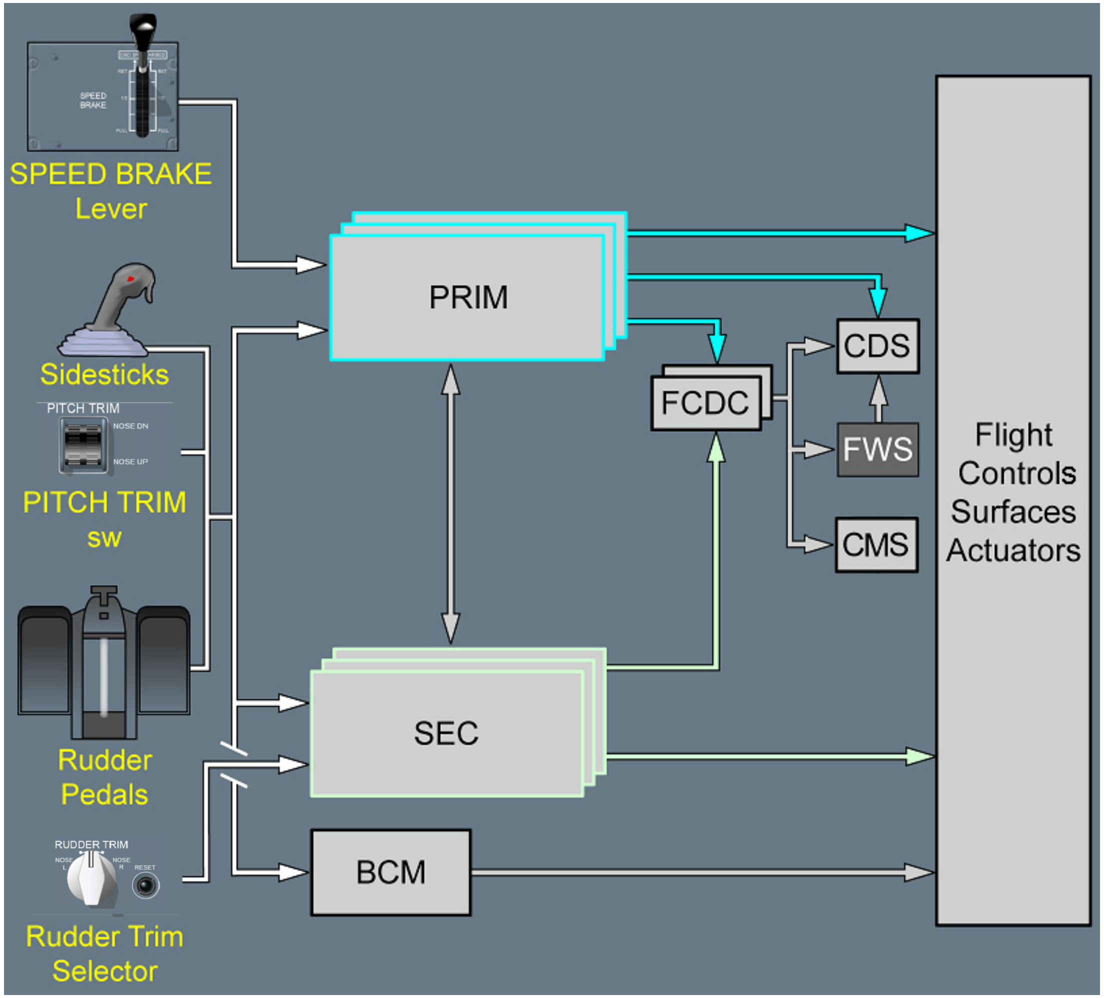
The A350 has:

- Two **Flight Control Data Concentrators (FCDCs)** which acquire data from PRIMs and SECs and send them to the:
  - Control and Display System (CDS)
  - Flight Warning System (FWS)
  - Centralized Maintenance System (CMS)

- An **Electrical Backup System** (Backup Control Module – BCM) that controls the aircraft in the case of failure of all PRIMs and all SECs (For more information, refer to *Backup System*)

- Flight Control Surfaces and Actuators.

Flight Controls Architecture



Operations

The PRIMs and SECs compute the flight controls orders.

Each of these computers can perform two functions:

- The computation function:
  - Converts inputs that come from the flight crew or FG into orders, and computes corresponding surface deflections that are sent to the other computers
  - Compares the aircraft response with the objective to check if its orders are fulfilled.

- The execution function:
  - Commands the surfaces actuation
  - Monitors the surface deflection.

One of the three PRIMs is the master. The master PRIM computes the flight controls orders and transmits them to the other computers. Then, each operative PRIM and SEC activates its respective control surfaces accordingly.

If a malfunction is detected on the master PRIM, the master PRIM transfers the computation function to another PRIM. The master PRIM continues to perform the execution function, depending on the malfunction.

If all the PRIMs are lost, each SEC performs the computation and execution functions. There is no master SEC.

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Actuators

The A350 has three types of actuators:

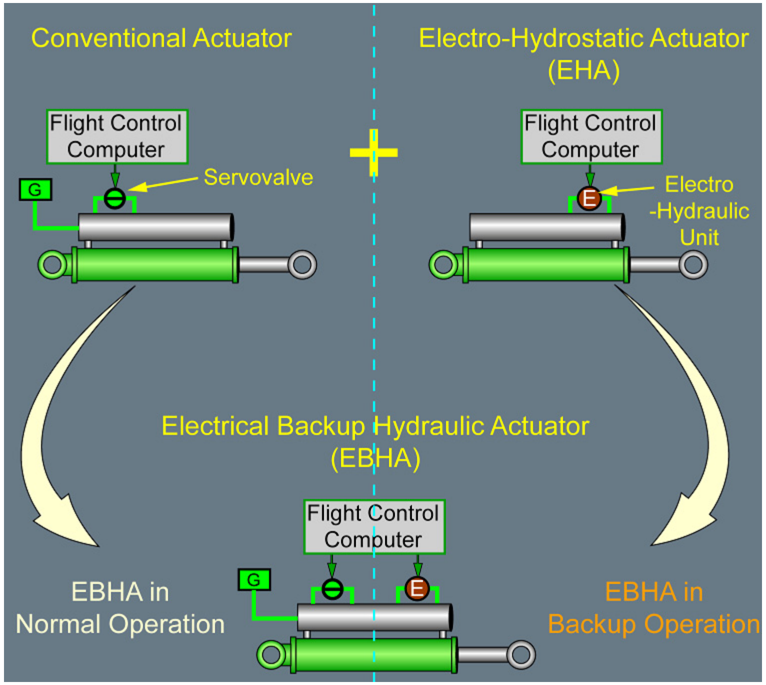
- **Conventional actuators** that include:
    - One actuator
    - One hydraulic block connected to one hydraulic power supply of the aircraft
    - One servovalve that receives orders from the flight controls computers and controls the translation direction of the actuator rod.

  A conventional servocontrol cannot operate if there is no hydraulic supply.

- **Electro-Hydrostatic Actuators (EHAs)** that include:
    - One actuator
    - One hydraulic block
    - One electro-hydraulic generation system that receives orders from the flight controls computers. The rotation direction and the speed of the electro-hydraulic generation system determine the translation direction and speed of the actuator rod.

  In flight, EHAs are fully isolated from the hydraulic power supplies of the aircraft. An EHA can operate when there is no hydraulic supply, but needs an electrical supply.

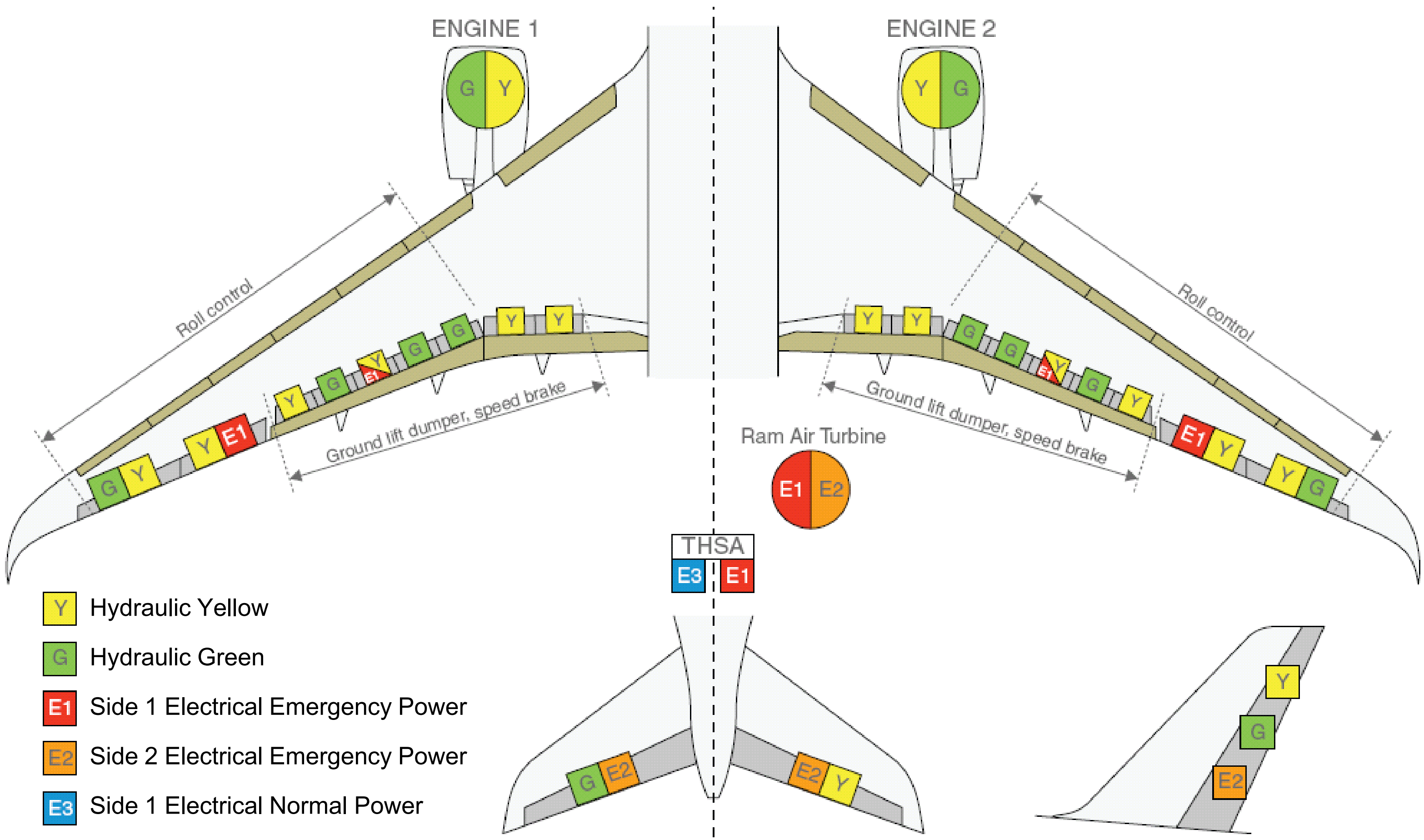
- **Electrical Backup Hydraulic Actuators (EBHAs)** that are a combination of a conventional servocontrol and an EHA.
  In normal mode, they operate as conventional actuators. If there is a hydraulic failure, they operate as EHAs.



*Note: The **YELLOW** or the **GREEN** hydraulic circuit supplies the actuators (refer to next page).*

A350 XWB

Power Supply for the Actuators and Control Surfaces



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Primary Functions

Lateral Control (Roll+Yaw)

The following surfaces provide lateral control:

- The two pairs of ailerons (Inboard and Outboard)
- Spoilers 3 to 7
- The rudder.

Lateral orders are sent by:

- The sidesticks, to the PRIMs and SECs
- The rudder pedals and pedal feel and trim unit, to the PRIMs and SECs
- The rudder trim control panel, to the SECs only
- The autopilot, to the PRIMs only.

Pitch Control

The following surfaces provide pitch control:

- The elevators for short-term actions
- The Trimmable Horizontal Stabilizer (THS) for long-term actions.

Pitch orders are sent by:

- The sidesticks, to the PRIMs and the SECs
- The pitch trim control switches, to the PRIMs and the SECs (only active on ground or in direct law)
- The autopilot, to the PRIMs only.

Auxiliary Functions (1/2)

Speedbrake Function

The objective of the speedbrake function is to increase the drag of the aircraft with an acceptable buffet for passenger comfort.

A speedbrake demand deflects all the spoilers. The roll command has priority over the speedbrake command.

An automatic retraction is provided, when one of the following conditions is fulfilled:

- Angle-of-Attack (AOA) protection is active
- Load factor is lower than 0.3 g in normal or alternate law
- A go-around is initiated.

Spoilers are lost in symmetrical pairs in the case of a failure.

Ground Spoilers Function

The objective of the ground spoiler function is to:

- Stick the aircraft to the ground and reduce the risk of bounce at touchdown
- Increase the efficiency of the brakes
- Decelerate the aircraft.

The ground spoilers function orders the deflection of all the spoilers.

Auxiliary Functions (2/2)

Aileron Droop Function

The objective of the aileron droop function is to increase the high lift function performed by the slats and flaps.

The **inboard ailerons** droop downwards when the flaps are extended. They continue to perform the roll function.

Load Alleviation Function

The objective of the load alleviation function is to reduce structure fatigue and static loads on the wing during manoeuvres, turbulence and gust. This function is available in normal law only.

Differential Flap Setting and Variable Camber

The Differential Flap Setting and Variable Camber enable to optimize the loads and drag on the wings.

Small flaps deflections (4° maximum) either symmetrically or asymmetrically, enable to automatically :

- Optimize the wing camber to reduce wing loads and drag
- Perform an optimized Lateral Trim function.

An **Electrical Backup System** controls the aircraft in the case of the failure of:

- All the PRIMs and all SECs, or
- The electrical power supply of the PRIMs and the SECs.

The electrical backup system is totally segregated from the normal flight controls system and has:

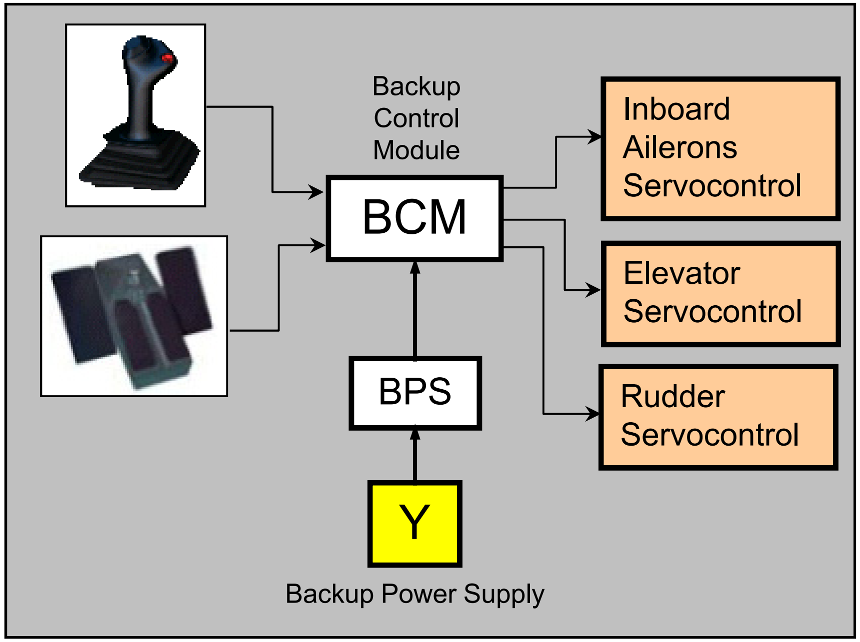
- A Backup Power Supply (BPS)
  The BPS is an electrical generator that is activated in the case of computer or electrical generation failure. The yellow hydraulic circuit supplies the BPS.

- A Backup Control Module (BCM)
  The BCM controls and monitors:
  - The inboard ailerons
  - The elevators
  - The rudder

The direct control laws apply whenever the electrical backup system is active, with the following features:

- Pitch motion damping
- Yaw damping
- Direct roll.

Architecture



General

A **flight controls law** determines the relationship between a flight crew order and the aircraft response.

The main objectives of the normal control law are to:

- Provide instinctive and comfortable handling characteristics
- Provide comfort to the passengers and crew.

Protections prevent the aircraft from leaving the normal flight envelope.

Full pilot authority prevails within the normal flight envelope.

The pilot authority is progressively reduced when exiting the normal flight envelope and entering the peripheral flight envelope.

Progressive control law reconfigurations occur depending on the number and type of failures (computers, sensors and actuator availability). These reconfigurations ensure the best possible performance of the flight controls system.

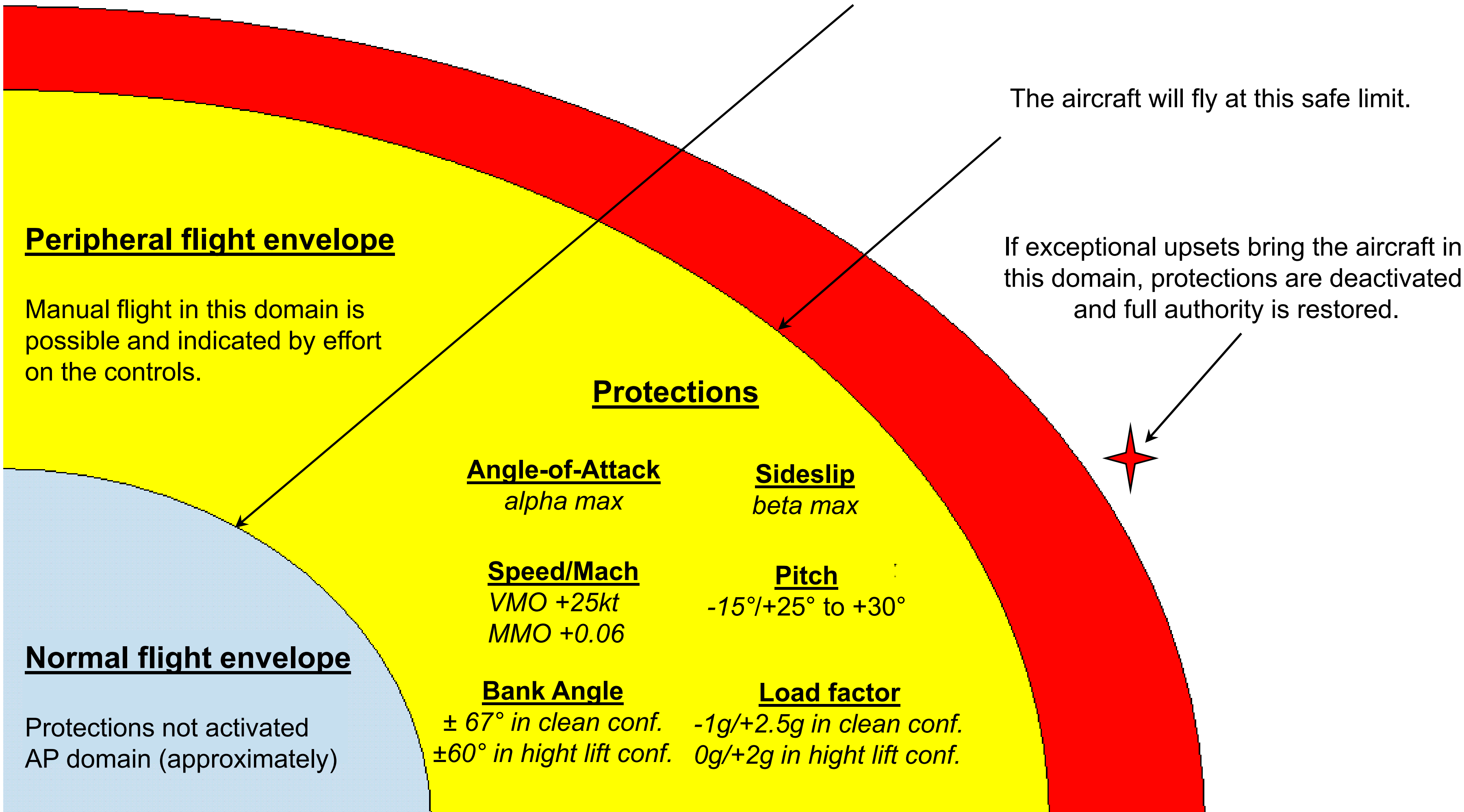
There are different levels of control laws that are a combination of control laws and protections:

- The **normal law**: For normal operations (even after a single failure of sensors, electrical system, hydraulic system or PRIM)
- The **alternate law**
- The **direct law**

Note: A single failure cannot cause the loss of the normal flight controls law.

The control laws and protections that apply to these laws are summarized in the following graph.

Normal/Peripheral Flight Envelope and Protections in Normal Law



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Normal Law

Pitch Control Laws

In order to provide optimum handling characteristics in all flight phases, the normal pitch control law changes, according to the flight phases, and provides the following control laws:

Rotation Law

Objective:

- To provide a homogeneous rotation for all possible weights, Centers of Gravity and configurations
- To minimize the risk of a tail strike.

Features:

- Rotation in direct law
- Damping in case of important pitch rate to prevent tail strike.

A350 XWB

Pitch Normal Law

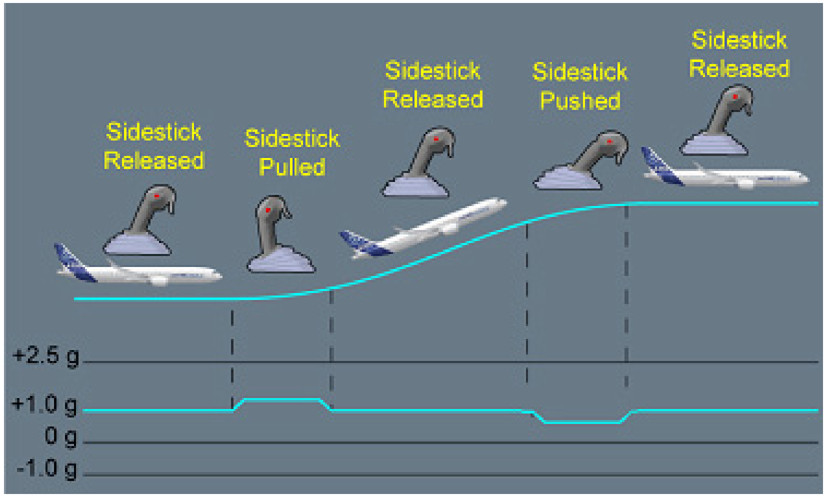
Objective:

- To control the flight path of the aircraft through a load factor demand
- To secure the flight envelope.

Features:

- A sidestick deflection results in a change in vertical load factor and leads to a flight path variation. When the pilot releases the sidestick, the flight path is maintained.
- Load factor limitation to
  - -1 g/+2.5 g in clean configuration
  - 0 g/+2 g when slats or flaps extended
- Autotrim
- Pitch compensation for spoiler deflection, slats and flaps extension or retraction, and thrust variations.

Pitch Normal Law



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Flare Law

Objective:

- To provide an aircraft behavior similar to the one of a conventional aircraft during flare
- To enable a precise control of vertical speed and touchdown point.

Features:

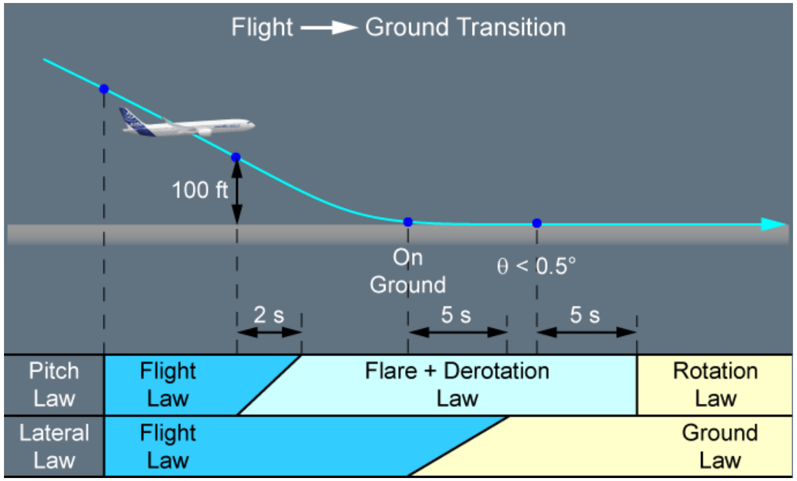
- Flare in direct law (no autotrim).

Derotation Law

Objective:

- To provide a comfortable nosewheel touchdown without interfering with the prompt activation of all the decelerating devices.

Derotation and Flare Laws



Protections

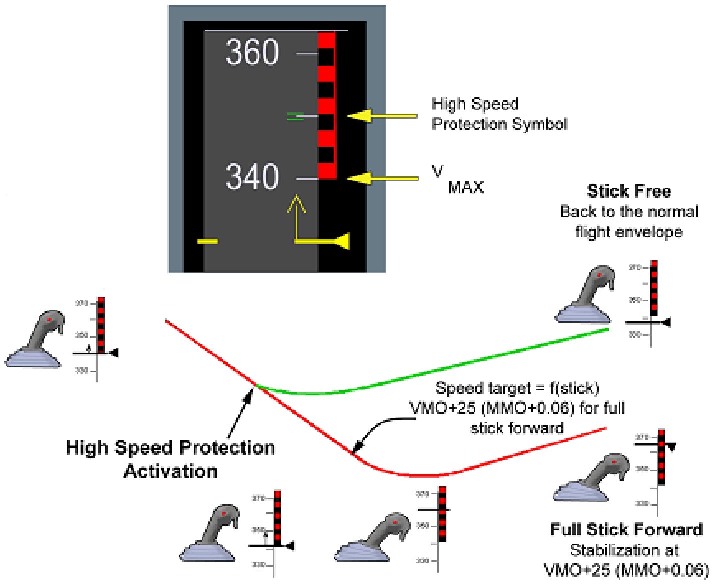
High Speed Protection

Objective:

- To limit the possible speed/Mach excursions beyond VMO/MMO whatever stick input
- To cause no interference with flight at VMO/MMO.

Features:

- Pilot nose down authority is reduced and progressive elevator up is applied to stabilize the aircraft at VMO+25kt (MMO+0.06) if full forward stick is maintained.



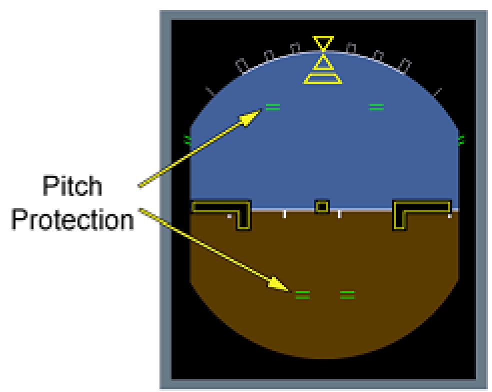
Pitch Attitude Protection

Objective:

- To enhance the effectiveness of the Angle-of-Attack (AOA) and high speed protections in extreme conditions.

Features:

- Pitch limitation to:
  - -15° / +30° at high aircraft speed
  - -15° / +25° at low aircraft speed.



Angle-of-Attack (AOA) Protection

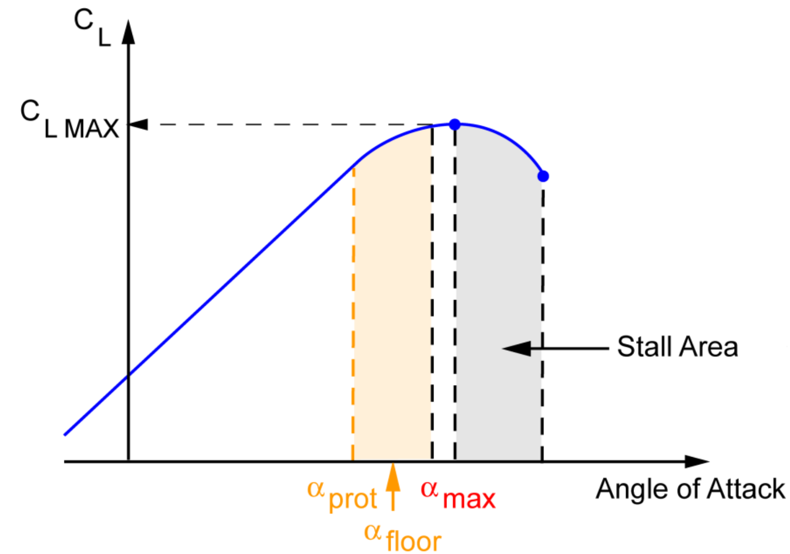
Objective:

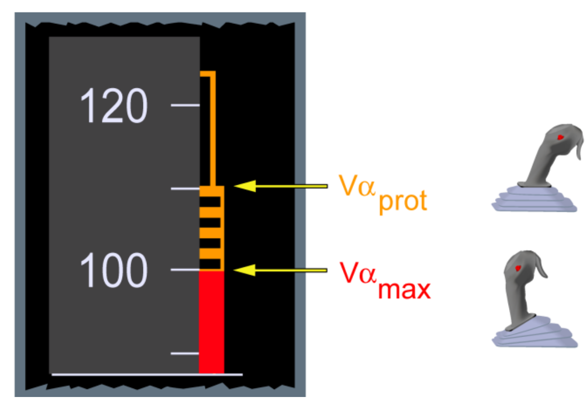
- To protect the aircraft against stall in dynamic maneuvers or gusts
- To ensure safe flight and good handling characteristics at high angle of attack
- To cause no interference with normal operating speeds and maneuvers.

Features:

- The angle of attack is limited to
  - α_{prot} with neutral stick
  - α_{max} with full back stick.

  When reaching α_{floor} ($\alpha_{prot} < \alpha_{floor} < \alpha_{max}$), TOGA thrust is automatically applied.
- Speedbrakes retraction
- Deactivation, as soon as the sidestick deflection commands a smaller angle of attack than α_{prot}.





Normal Law

Lateral Control Laws

Lateral Ground Control Law

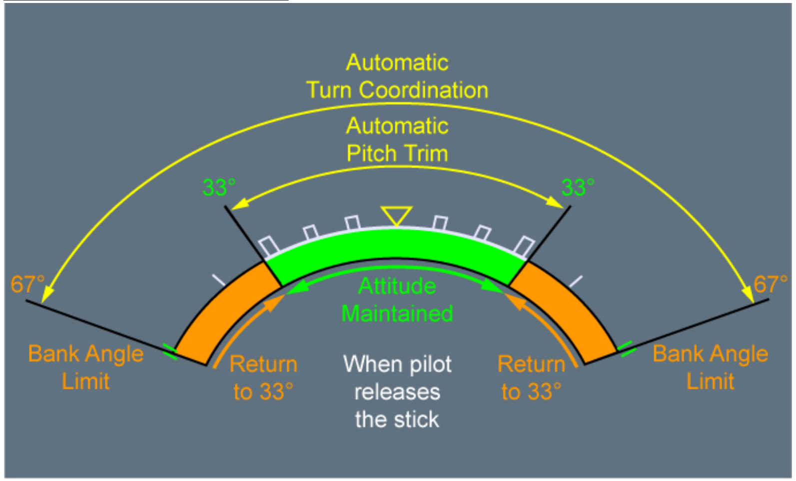
Objective:

- To facilitate aircraft handling on ground.

Features:

- The lateral ground law is a full authority control law in roll and yaw, with some yaw damping. However, for small sidestick deflections, the lateral ground control law helps the pilot to keep a small bank angle using only the ailerons. In particular, when the sidestick is at neutral, the law will aim at keeping the wing level

Lateral Normal Law



Lateral Normal Law

Objective:

- To control the roll and yaw axes of the aircraft through roll rate and sideslip demands.

Features:

- A sidestick deflection results in a roll rate demand with turn coordination.
  Neutral spiral stability up to 33° bank:
  - Automatic pitch trim
  - The bank angle is maintained when the sidestick is at neutral

  Positive spiral stability restored above 33° bank:
  - No automatic pitch trim
  - The bank angle returns to 33° if the sidestick is at neutral
- Bank angle limitation to:
  - 67° in clean configuration
  - 60° in high lift configuration
  - 45° when the high speed or Angle-of-Attack (AOA) protection is active
- A pedal deflection results in a proportional sideslip and bank angle. In the case of an engine failure, the law provides a sideslip and bank angle to indicate the engine failure, as on a conventional aircraft
- Yaw rate feedback for stabilization.

Engine Failure or Aircraft Asymmetry

The flight control laws provide unique handling characteristics in the case of an engine failure. With no corrective action:

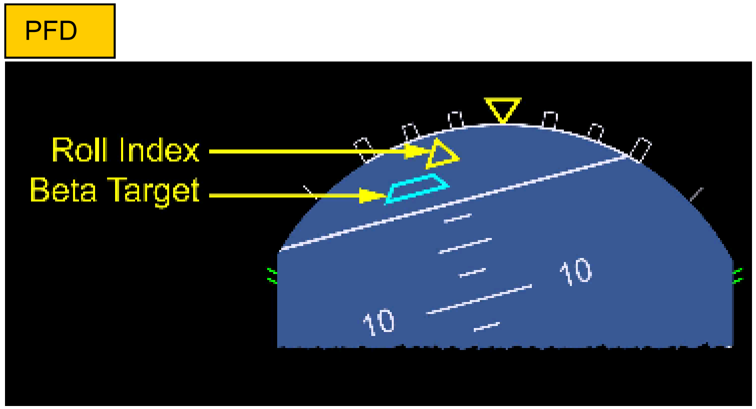
- Stabilized sideslip and bank angle
- Slowly diverging heading
- Safe flight.

The control law computes, at takeoff, the sideslip target that provides optimum trim (optimized roll surfaces deflection so as to minimize spoilers deflection).

The difference between the current sideslip, and the sideslip target, is indicated by a blue symbol on the PFD (only at takeoff).

The short-term recommended actions are to achieve:

- Zero sideslip or sideslip target with pedals
- Then stabilize heading with stick input
- Steady flight with stick free and no pedal force (rudder trim).



Alternate Law

Longitudinal Control Laws

The pitch control is similar to the pitch control in normal law (refer to ***normal law***).

Lateral Control Laws

Depending on the failure:

The roll and yaw control is similar to the roll and yaw control in normal law (refer to ***normal law***), or the roll and yaw control is almost a direct control, similar to the roll and yaw control of a conventional aircraft.

- **Roll Direct Law**
  Features:
  - Linear roll response with respect to roll order
  - Sufficient but not excessive roll order deflections (or authority) to provide adequate efficiency.
- **Yaw Alternate Law**
  Features:
  - Linear yaw response with respect to yaw order
  - Dutch roll damping
  - Turn coordination

Protections

Protections are indicated as lost.

Depending on the failure, some protections may still be available. However, these protections are degraded, and are therefore indicated as lost.

Direct Law

Longitudinal Control Laws

The direct law is the lowest level of flight control computers.

In direct law, there is a direct relationship between the sidestick position and the elevator position.

- **Pitch Direct Law**
  - No autotrim
  - Pitch rate feedback for stabilization
  - Aircraft behavior adequate to perform landing and sufficient authority to compensate airbrake extension/retraction, thrust variation or slats/flaps movements.

Lateral Control Laws

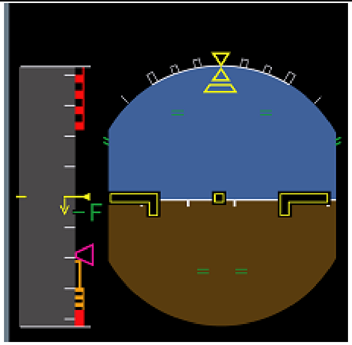
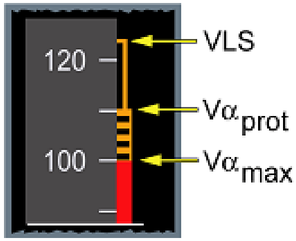
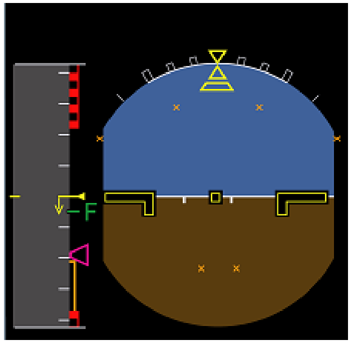
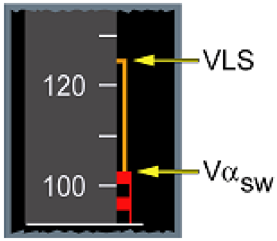
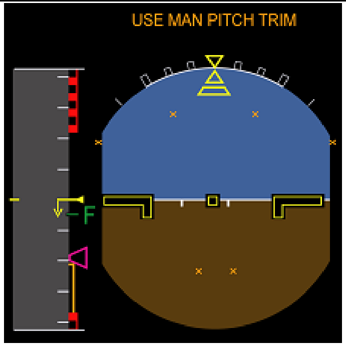
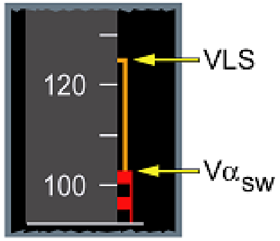
Roll direct law and yaw alternate law.

Protections

All protections are lost.
A conventional aural stall warning ($\alpha > \alpha_{sw}$) and an overspeed warning replace the protections in normal law.

Note: α_{sw} stands for stall warning angle of attack.

Summary of the Different Level of Law

	Normal Law	Alternate Laws	Direct Law
Longitudinal Control Law	Pitch normal law	Pitch normal law	Pitch direct law
Lateral Control Law	Lateral normal law	Lateral normal law **OR** Roll direct law Yaw alternate law	Roll direct law Yaw alternate law
Protections	All protections active	Most protections degraded or lost	No
Autopilot	All modes available	AP available (no Autoland)	No
PFD **Control Law Status Indication**	 	 	 

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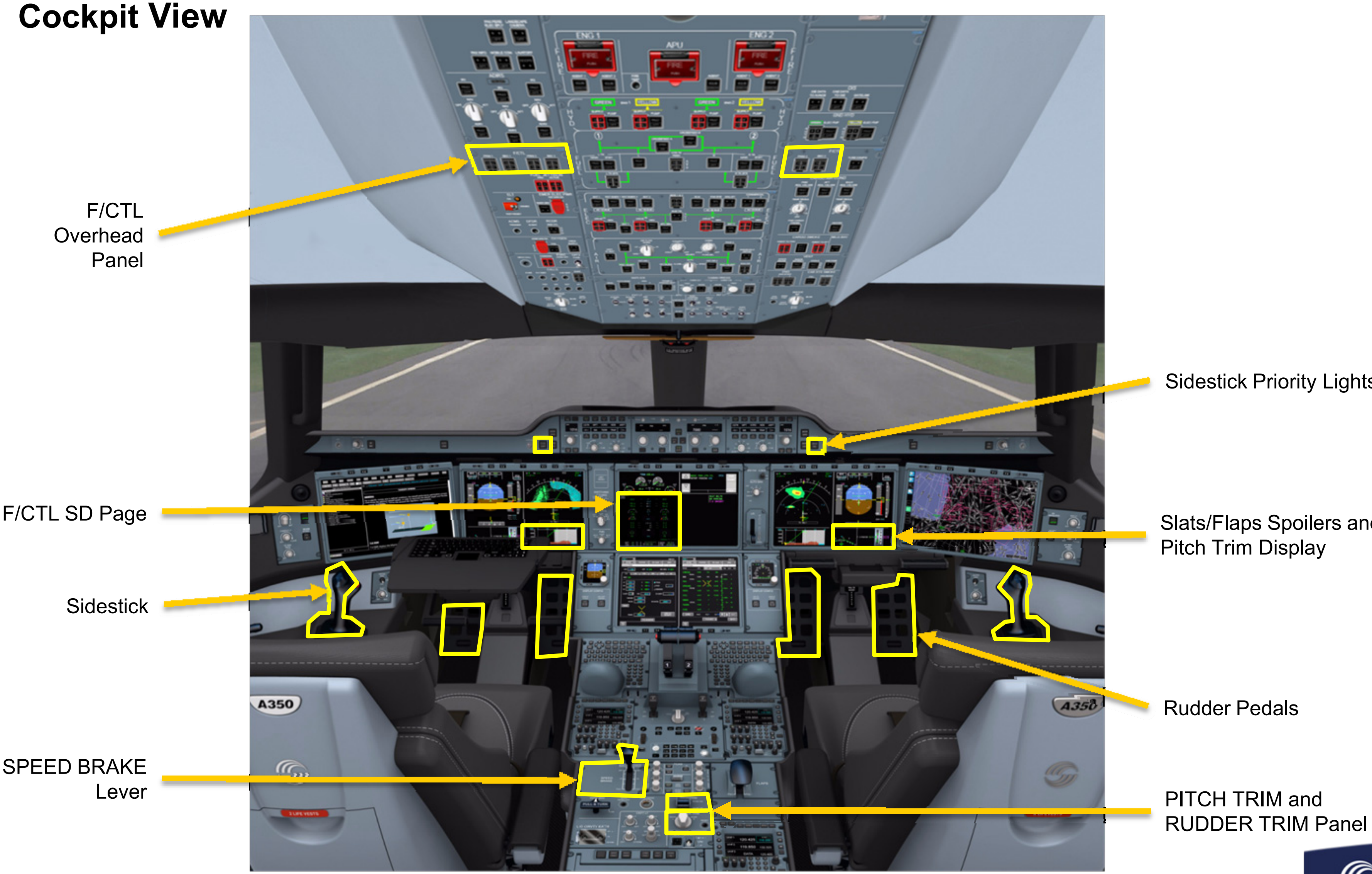
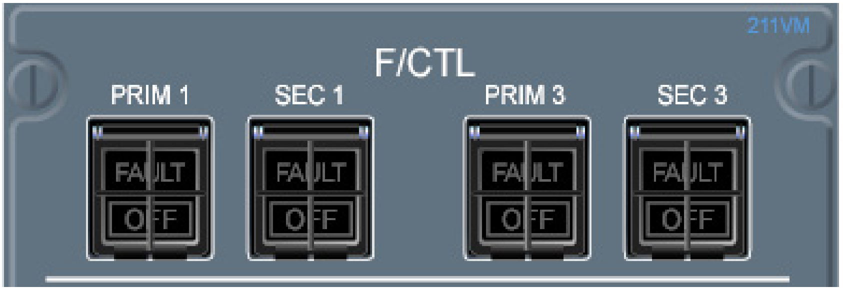
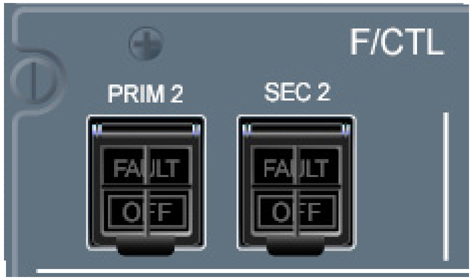
Cockpit View

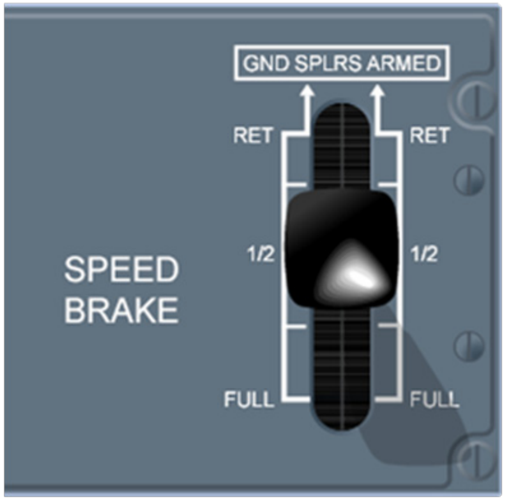


F/CTL Overhead Panels





SPEED BRAKE Lever



PITCH TRIM and RUDDER TRIM Panel

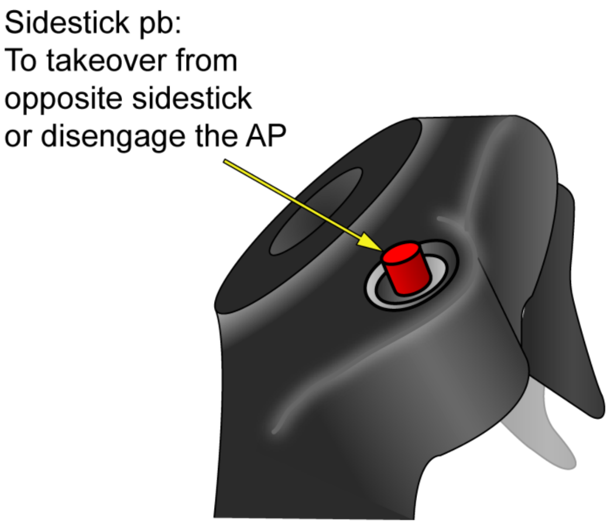
Sidestick and Priority Logic

According to the normal task sharing, one pilot flies at a time.

In case of dual input performed by both pilots, the Pilot Flying (PF) can deactivate the Pilot Not Flying (PNF) sidestick by pressing the priority takeover pushbutton.

If the sidestick pushbutton is pressed for more than 30 seconds, the priority is latched and the other sidestick is maintained deactivated.

At any time, a deactivated sidestick can be reactivated by momentarily pressing the sidestick pushbutton.



Sidestick and Priority Logic

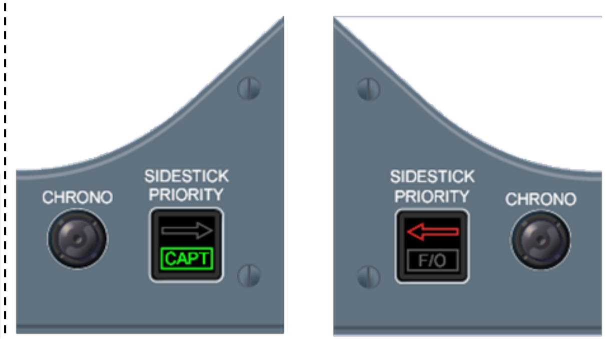
Normal Operation:
Only one sidestick is deflected.

The Captain and First Officer inputs are algebraically summed. The maximum resulting input is limited to a full deflection input of a single sidestick.

\+

« DUAL INPUT »
Aural Message

The Captain presses his sidestick pushbutton, while the First Officer moves his sidestick.
The Captain gains the priority.



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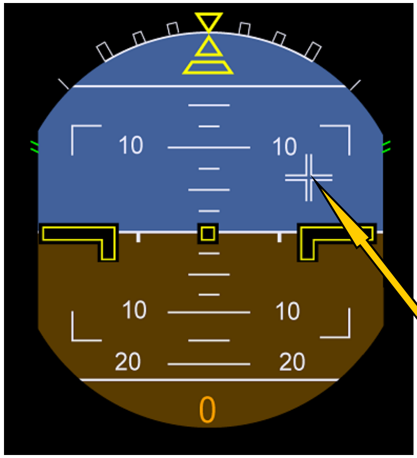
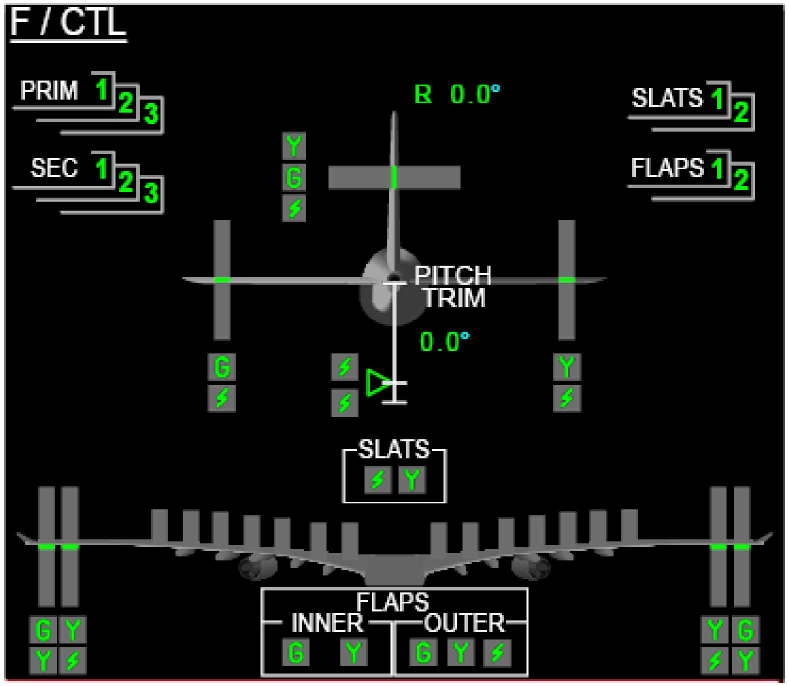
« PRIORITY LEFT »
Aural Message

PFD: Sidestick Indicator



Sidestick Indicator *(displayed on ground only).*

F/CTL SD Page



PFD: Slats/Flaps Spoilers and Pitch Trim Display

Slats and Flaps

A350 XWB

AIRBUS

General

The basic functions of the slats/flaps system are to:

- Control and monitor slats and flaps movement
- Provide status and failure information of the high lift system to other systems and to the flight crew.

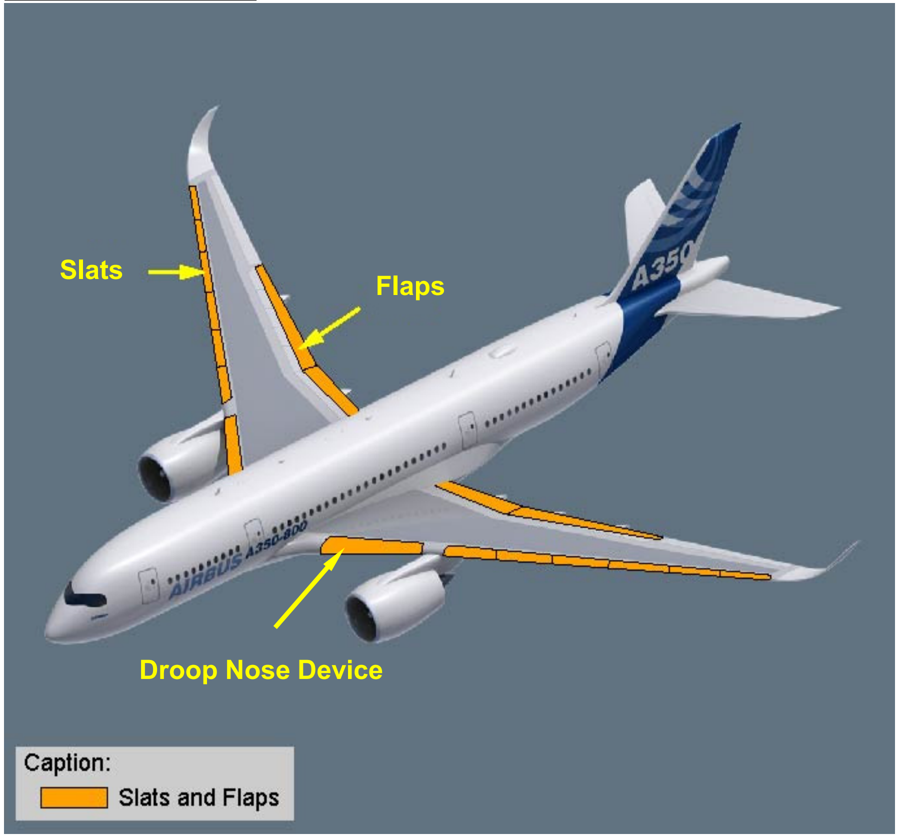
The A350 has the following surfaces that provide lift augmentation :

- 12 slats
- 4 flaps
- 2 droop nose devices.

The Adaptive Dropped Hinge Flaps (ADHF) is a mechanism that combines flaps and spoilers motion to improve the aerodynamic of the wing.

Slats are electrically and hydraulically-actuated.
Flaps are hydraulically-actuated.

High Lift Surfaces



ADHF function

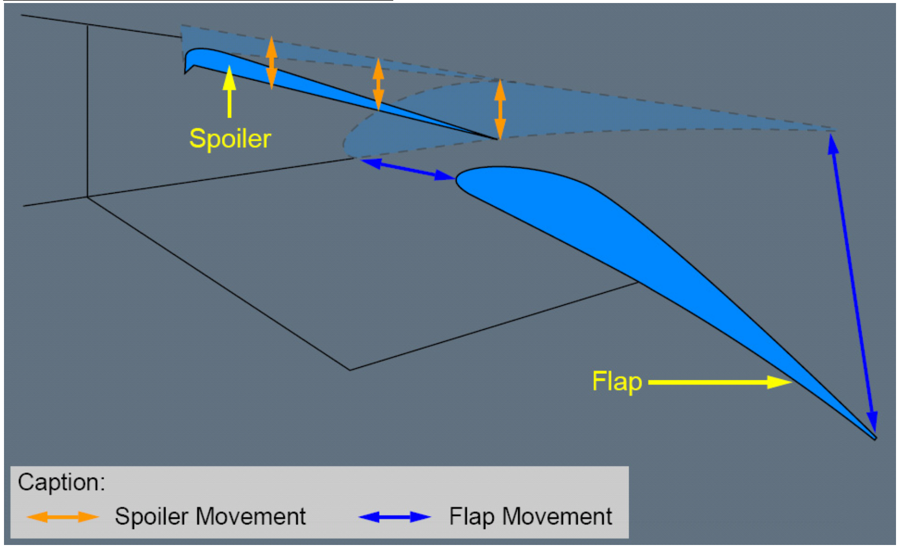
When flaps are extended, the spoiler actuator controls the gap between the spoiler trailing edge and the flap to an optimum value.

This function enables:

- In takeoff configuration to get a permanent optimum Lift over Drag ratio for better climb performance or maximal takeoff weight
- In landing configuration to get a maximum lift (CLmax) for a low approach speed

The ADHF function does not require any pilot action except flap lever selection as usual.

Adaptive Dropped Hinge Flap



Slats/Flaps Control and Motion

Two Slat/Flap Control Computers (SFCCs) control and monitor the High-Lift System. Each SFCC has two independent channels, a SLAT and a FLAP channel:

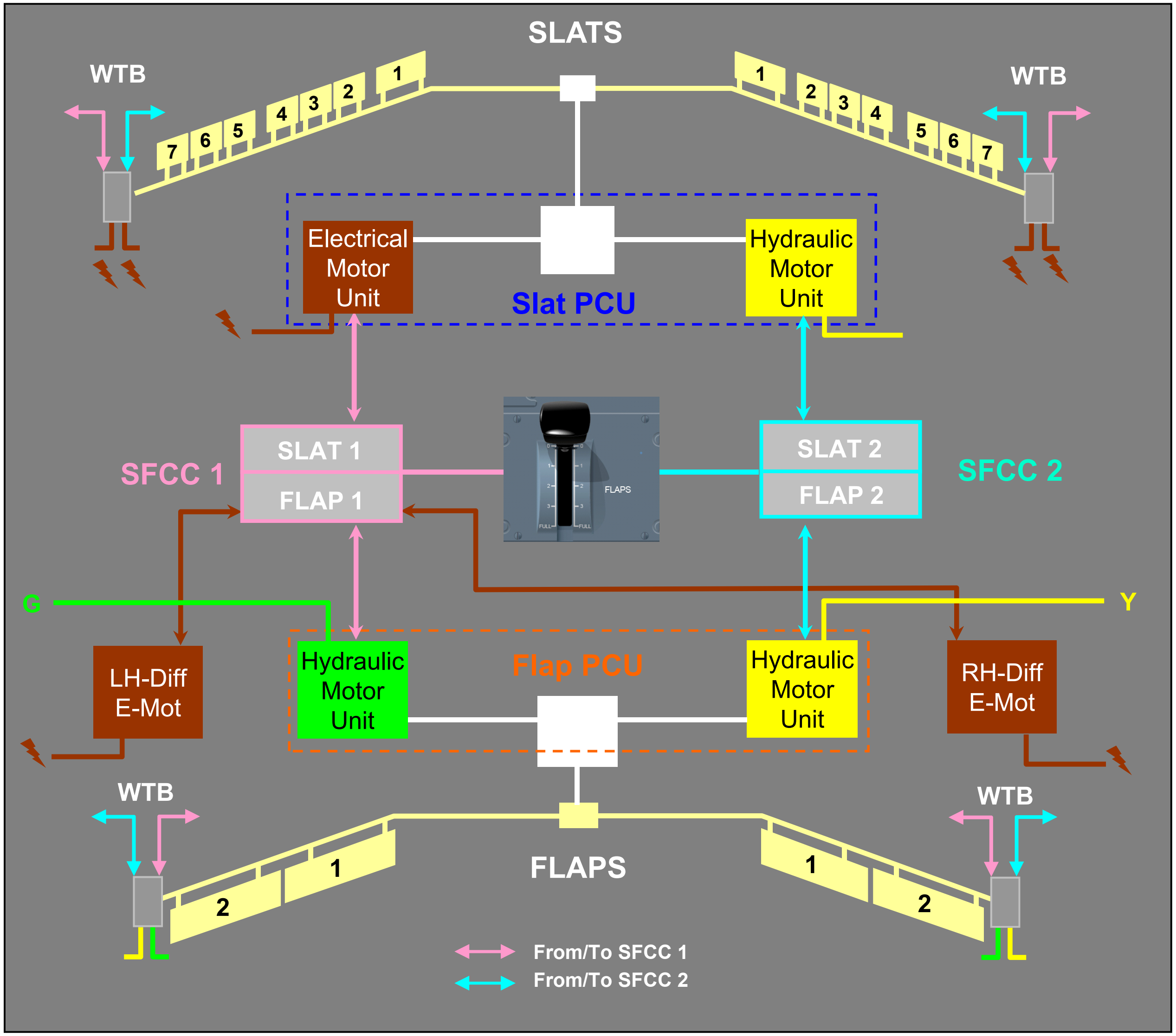
- SFCC 1 (FLAP 1 and SLAT 1 channels)
- SFCC 2 (FLAP 2 and SLAT 2 channels)

Two Power Control Unit (PCUs) power the system:

- **The Flap PCU** which drives the FLAP 1 and 2 systems. This PCU has two identical hydraulic motors:
  - The LH hydraulic motor
  - The RH hydraulic motor

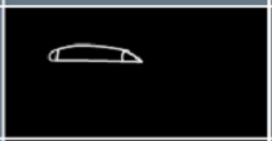
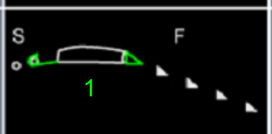
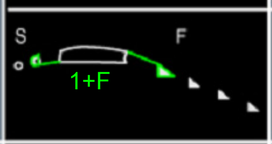
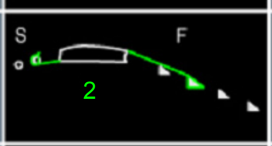
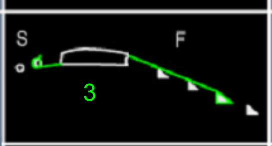
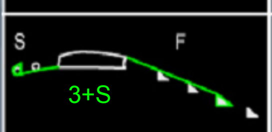
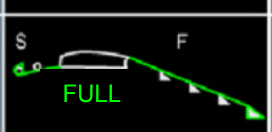
  The **GREEN** hydraulic circuit supply the LH motor and the **YELLOW** hydraulic circuit the RH motor
- **The slat PCU** which drives the SLAT 1 and 2 systems. This PCU has an electric motor and a hydraulic motor:
  - The 230 VAC EMER 1 electrical circuit supplies the electrical motor
  - The **YELLOW** hydraulic circuit supplies the hydraulic motor.

Slats/Flaps System Achitecture



A350 XWB

Slats/Flaps Configurations

FLAPS Lever Position	Configuration on ECAM	Maximum Speed	Flight Phase
0		VMO/MMO	Cruise
1		255 kt	Holding
		220 kt	Takeoff/ Approach
2		212 kt	Takeoff/ Approach
3		195 kt	Takeoff/ Approach/ Landing
		190 kt	Landing
FULL		186 kt	Landing

AIRBUS

Automatic Functions

Flap Load Relief Function

The flaps load relief function retracts the flaps to the next retracted flaps position if the current speed exceeds the VFE. This limits the loads on the flaps. The FLRS is available in position 2, 3, or FULL only.

Slats/Flaps Cruise Balk Function

If the lever is inadvertently moved from 0 to 1 during cruise, the slats/flaps cruise balk function will maintain the slats and flaps in their fully retracted position. This function prevents excessive loads on the flaps.

Nevertheless, if the lever is inadvertently moved to 2, 3 or full during cruise, the slats and flaps will extend.

Slats Speed Balk Function

The slat speed balk function inhibits slats retraction to zero if the speed is too low.

When the speed reaches an appropriate value, the slats retraction inhibition stops.

Slats Alpha Lock Function

The slat alpha lock function inhibits slats retraction to zero if there is an excessive Angle-of-Attack (AOA).

When the AOA reaches an appropriate value, the slats retraction inhibition stops.

Auto Slat Function

The auto slat function enables automatic extension of slats if there is an excessive AOA. The slats return to their initial selected setting as soon a the angle of attack has been restored to a safe level.

Flap Deployment in Cruise Function

A small flap deployment in cruise function enables:

- Wing camber control
- Differential flap setting loads and drag control
- Lateral trim.

The function is active when the flaps lever is in position 0.

Automatic Functions

Differential Flap Setting and Variable Camber

The Differential Flap Setting (DFS) performs small flaps deflections (4° maximum) either symmetrically or differentially.

The Variable Camber (VC) adapts slightly the flaps deflection (in or out) during the cruise.

These two functions enable to:

- Optimize load (mainly wing root bending moment) at high weight
- Minimize drag in cruise
- Perform an optimized Lateral Trim function.

<u>Note</u>:
When the DFS performs a differential deflection, the outer flaps only are deflected differentially.

Wing Tip Brakes (WTB)

The WTBs mechanically lock the slats and flaps, in the case of runaway, overspeed, or asymmetry.
If locked, the WTBs cannot be unlocked in flight.

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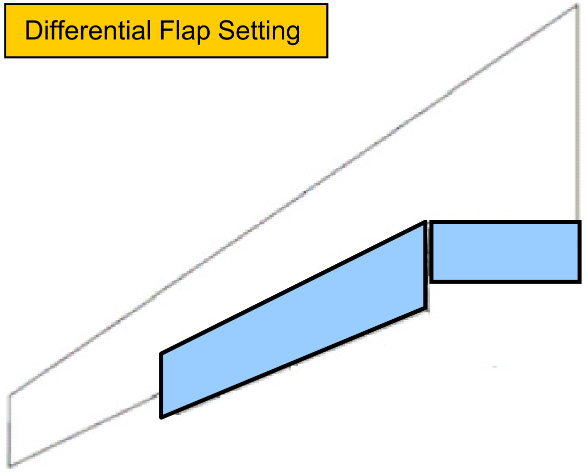
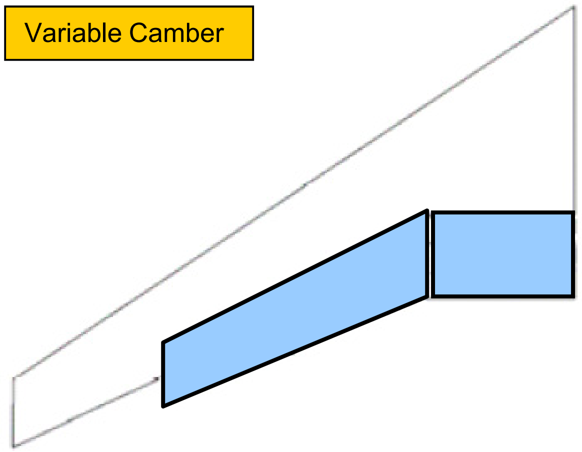
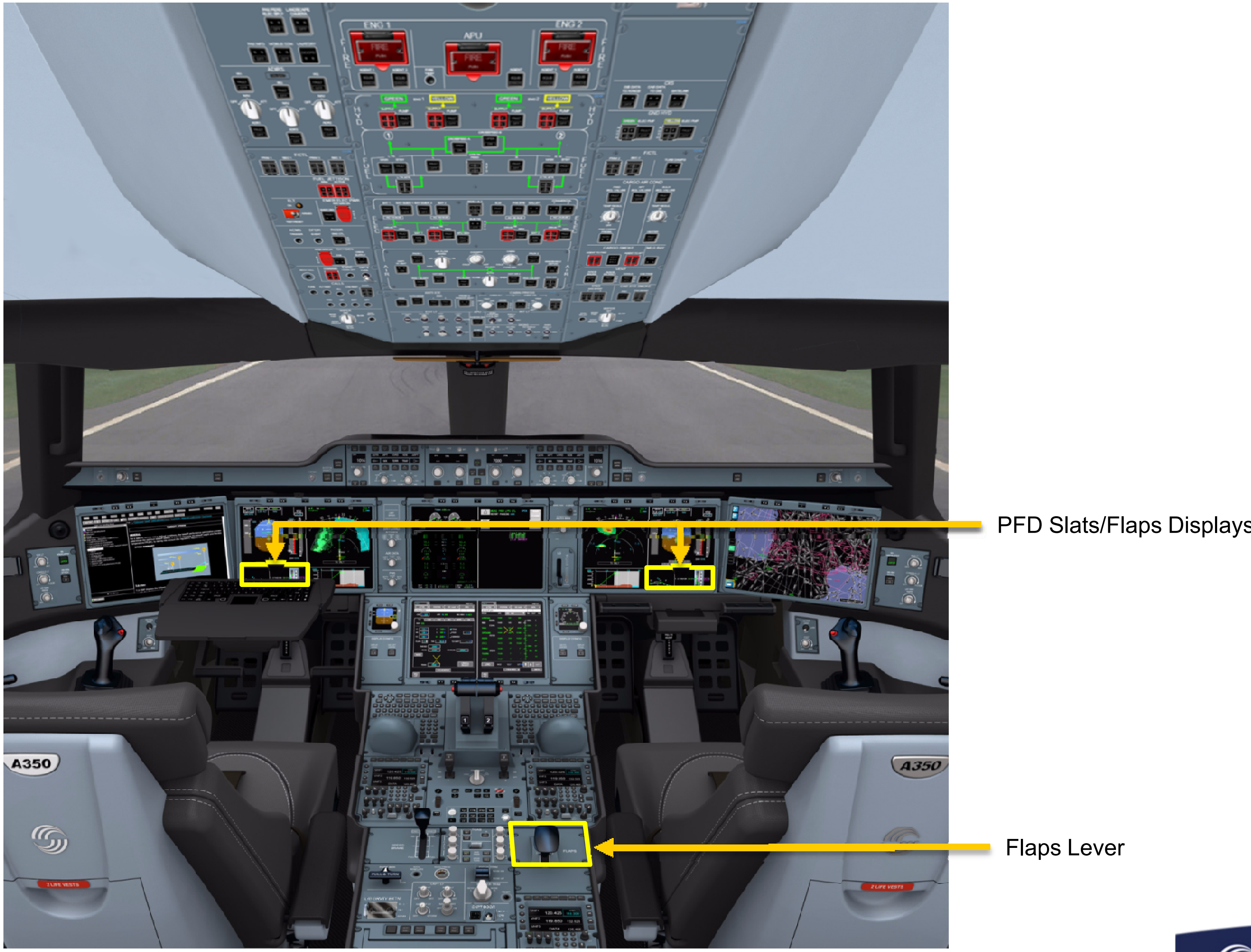




Cockpit View



Flaps Lever

The FLAPS lever controls both the slats and the flaps at the same time. This lever is on the pedestal.

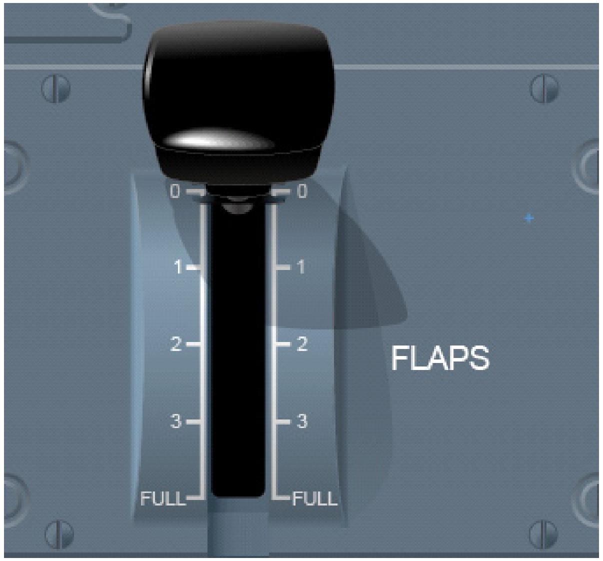
There are five FLAPS lever positions.

Override Mechanism

The FLAPS lever includes an override mechanism that is used if the FLAPS lever is jammed. The override mechanism allows to extend the slats/flaps by one step (e.g. from 0 to 1, from 3 to FULL).

To use the override mechanism, the flight crew moves the lever one step with a strong force, without pulling the lever out of detent.

Flaps Lever



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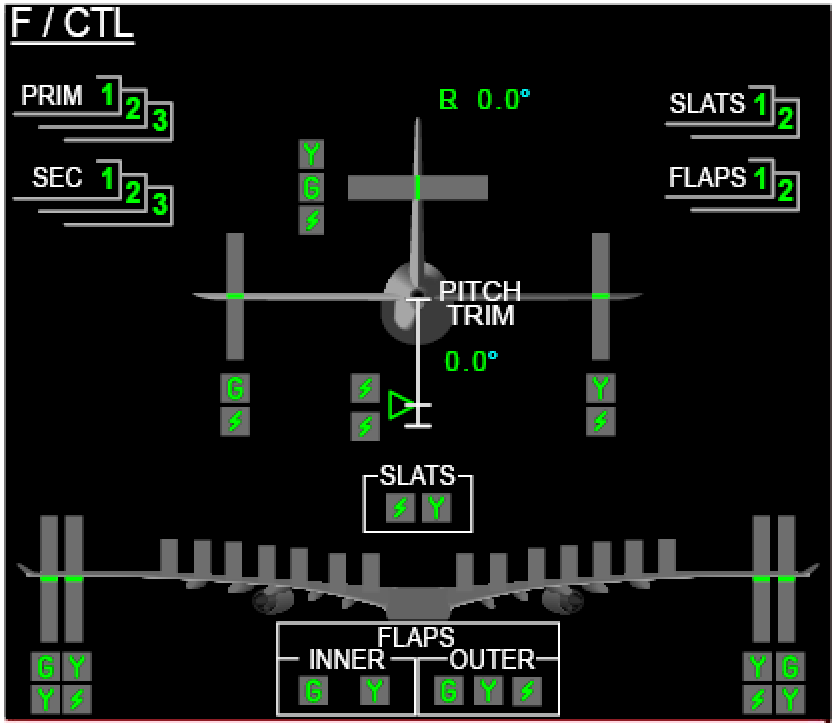
F/CTL SD Page

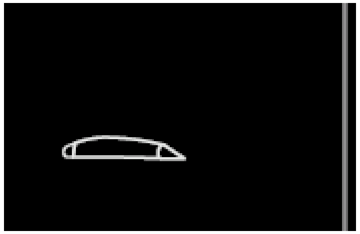


F / CTL
PRIM 1 2 3
SEC 1 2 3
R 0.0°
SLATS 1 2
FLAPS 1 2
Y
G
PITCH
TRIM
0.0°
G
Y
SLATS
Y
G Y
Y
FLAPS
INNER
OUTER
G Y
G Y
Y G
Y

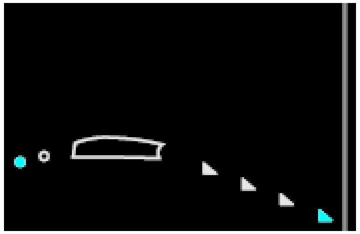
Slats/Flaps Display

The slats/flaps display appears on the bottom left-hand side of the PFD displays.

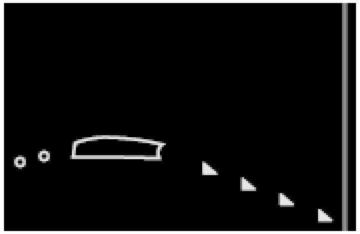
• Slats/Flaps Position Indexes



The slats and flaps are fully retracted.

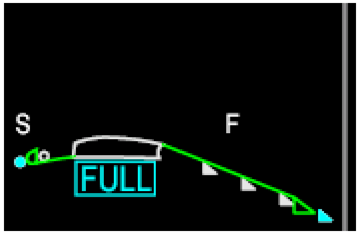


The blue point Indicates the selected slats position. The blue triangle Indicates the selected flaps position.



The dots indicate the slats positions that can be selected.

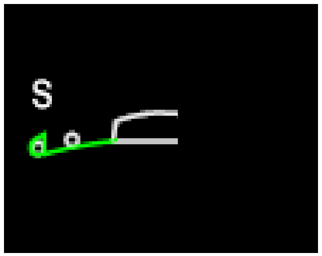
The triangles indicate the flaps positions that can be selected.



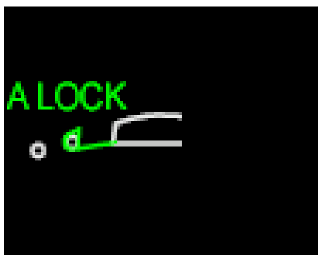
The slats/flaps move to the selected position.

Slats/Flaps Display

• Slats Position and Messages



Position of the slats.

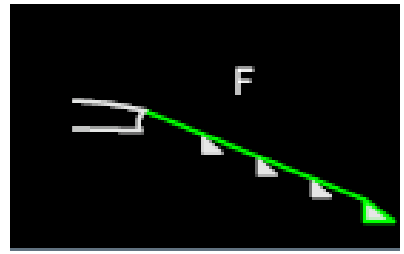


The slat alpha/speed lock function is active. The indication pulses.

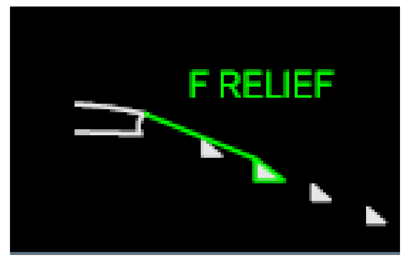
The slats are failed.

Wing-tip brakes are applied to the slats.

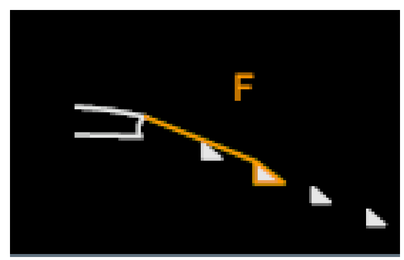
• Flaps Position and Messages



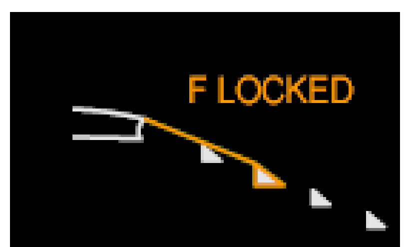
Position of the flaps.



The Flap Load Relief Function is active. The indication pulses.



The flaps are failed.



Wing-tip brakes are applied to the flaps.

Fuel System

A350 XWB

AIRBUS

Overview

The fuel system:

- Stores fuel
- Monitors the quantity and temperature of fuel in the tanks
- Controls fuel transfers, in order to:
  - Supply fuel to the engines and to the Auxiliary Power Unit (APU)
  - Control refueling and defueling
  - Enable fuel jettison (optional), if necessary.

Fuel Tank Arrangement and Quantity

Fuel Tank Arrangement

The fuel is stored in three tanks:

- The left wing tank
- The center tank
- The right wing tank.

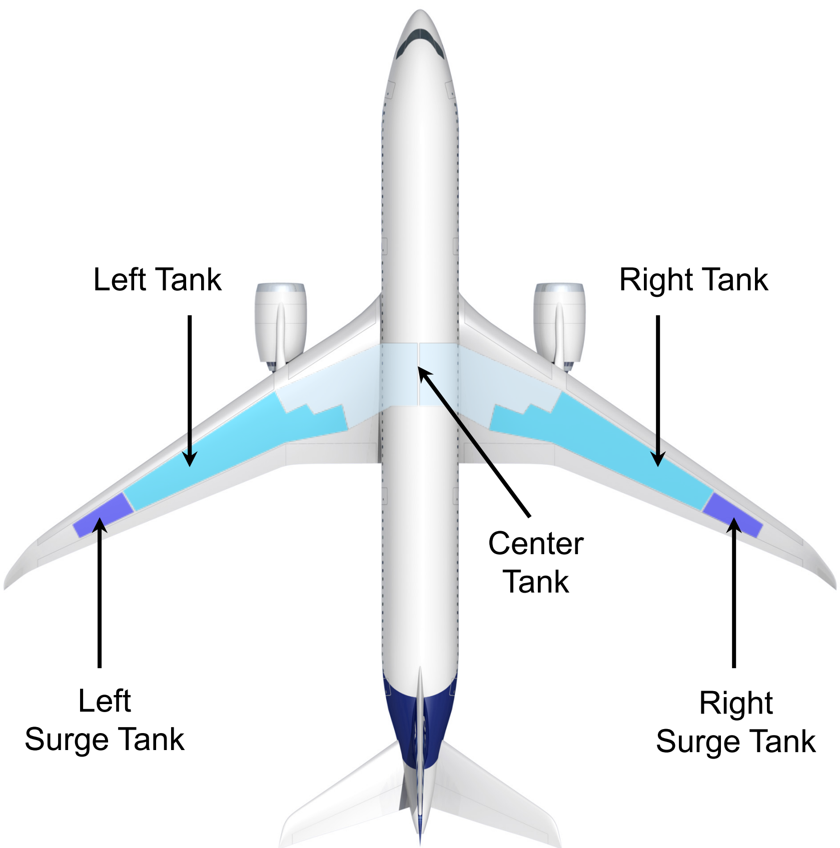
The wing tanks and the center tank directly feed the engines and/or the APU (refer to ***Engine Feed***).

In addition, the A350 has two surge tanks which:

- Connect each tank to the outside atmosphere to:
  - Limit the differential pressure between the tanks and the atmosphere, and
  - Maintain the pressure within structural limits.

- Temporarily collect fuel that may overflow from any fuel tank during operation.

Fuel Tank Arrangement



Fuel Tank Quantity

		USABLE FUEL (Fuel Specific Density: 0.80 kg/L)			
		Left Wing Tank	Center Tank	Right Wing Tank	TOTAL
VOLUME	Liters	29 619	82 421	29 619	141 659
	US Gal	7 825	21 773	7 825	37 005
WEIGHT	Kg	23 695	65 937	23 695	113 327
	Lbs	52 238	145 366	52 238	249 843

System Architecture

The A350 has a feed gallery and the following feed pumps and valves:

• **Wing Tank Pumps and Center Tank Pumps**

Each wing tank has two feed pumps:

- One main wing tank pump
- One standby wing tank pump.

The center tank has two feed pumps:

- The left center tank pump
- The right center tank pump.

Each feed pump is directly connected to its related engine via the feed gallery.

The center tank pumps are designed to produce more pressure than the wing tank pumps, and therefore preferentially supply fuel to the engines.

• **APU Pump**

There is an APU pump at the rear of the center tank. This pump automatically starts to provide pressurised fuel to the APU if the pressure from the engine feed pumps is too low.

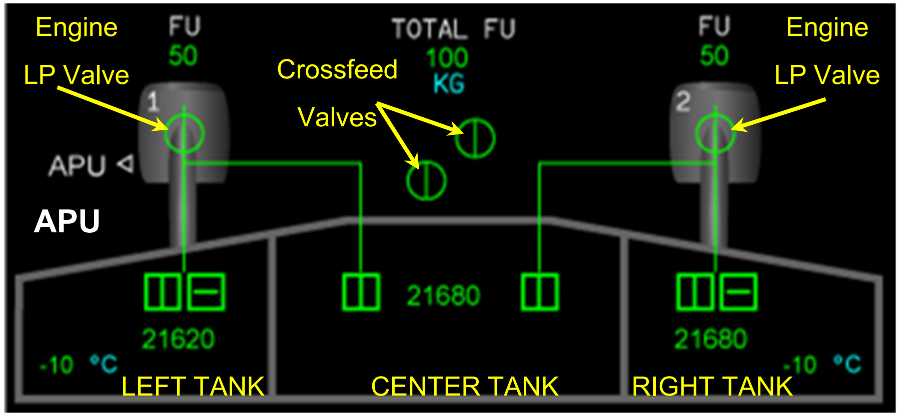
• **Crossfeed Valves**

The two crossfeed valves and the feed gallery enable to feed any engine from any tank. This architecture maximizes fuel availability in case of feed pumps failure and enables correction for any lateral imbalance.

• **Engine Low Pressure Valves**

Each engine has a Low Pressure (LP) valve that can stop the flow of fuel to the engine.

System Architecture



Note: The APU pump is not displayed on this drawing.

Engine and APU Feed

Engine Feed

Normal Operations:

The center tank feeds directly the engines via the feed gallery. When the center tank is empty, the wing tanks feed the engines.

Note: During takeoff, only the wing tanks feed the engines.

The wing tank pumps feed the engine of the same side via the feed gallery. If necessary, the wing tank pumps can feed the engine of the opposite side directly via the crossfeed valves and the feed gallery.

Abnormal Operations:

If a center tank pump fails, the opening of the crossfeed valves enables to maintain fuel supply from the center tank to both engines via the remaining center tank pump. A single center tank pump will maintain sufficient pressure and flow to maintain the fuel supply to both engines.

If both the main and the standby pumps of the same tank fail, gravity feed can supply fuel to the related engine when flying below fuel gravity ceiling.

If fuel is not available from one wing main or standby pump, the wing main or standby pump of the opposite tank will feed both engine via the crossfeed valves.

If a main wing tank pump fails, the corresponding standby wing tank pump automatically takes over.

If one engine has failed, a manual transfer from wing tank to center tank enables to make the fuel available for the remaining engine.

APU Feed

The following pumps can feed the APU:

- Any LH pump (wing tank or center tank pumps)
- Any RH pump (wing tank or center tank pumps) via the crossfeed valves
- The APU feed pump, that automatically starts to provide pressurised fuel to the APU if the pressure from the engine feed pumps is too low.

Fuel Quantity and Management System

Two Fuel Quantity and Management Systems (FQMS) permanently monitor the fuel quantity and temperature. In addition, the FQMS controls:

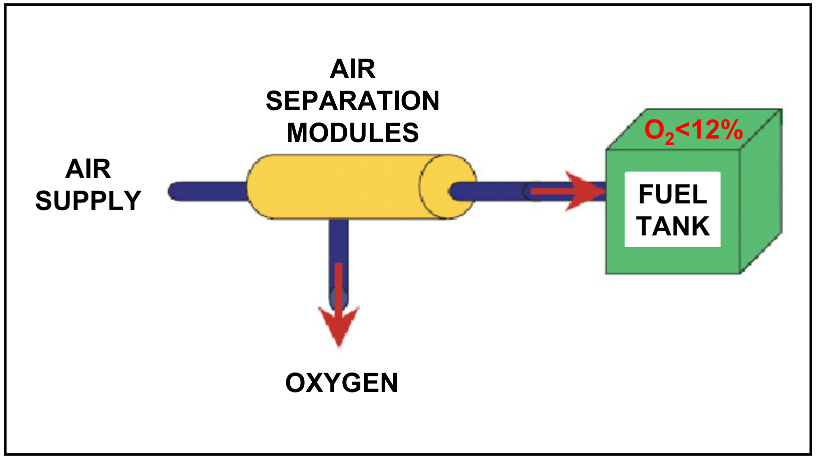
- Ground operations: Refueling and defueling
- Fuel jettison.

Fuel Tank Inerting System

The objective of this system is to feed the fuel tanks with inert air while fuel is consumed in order to provide a full-time flammability protection in the fuel tanks.

Its design does not require any pilot action.

The system consists in passing pressurized conditioned air through a molecular filter. The filter separates the oxygen and safely exhausts it overboard. The remaining oxygen depleted air is fed to the fuel tanks to replace ambient air, making the atmosphere in the fuel tank non-flammable.



Refuel/Defuel

In normal operations, the FQMS fully controls the refueling. This automatic refuel can be initiated from the external refuel panel or from the cockpit (optional).

Manual refuel is also possible from the external refuel panel, if necessary (e.g. failure cases). In this case, an operator controls the refueling.

The aircraft has one refuel coupling and can have a second optional one.

The refuel performance to refuel to the maximum tank capacity is typically:

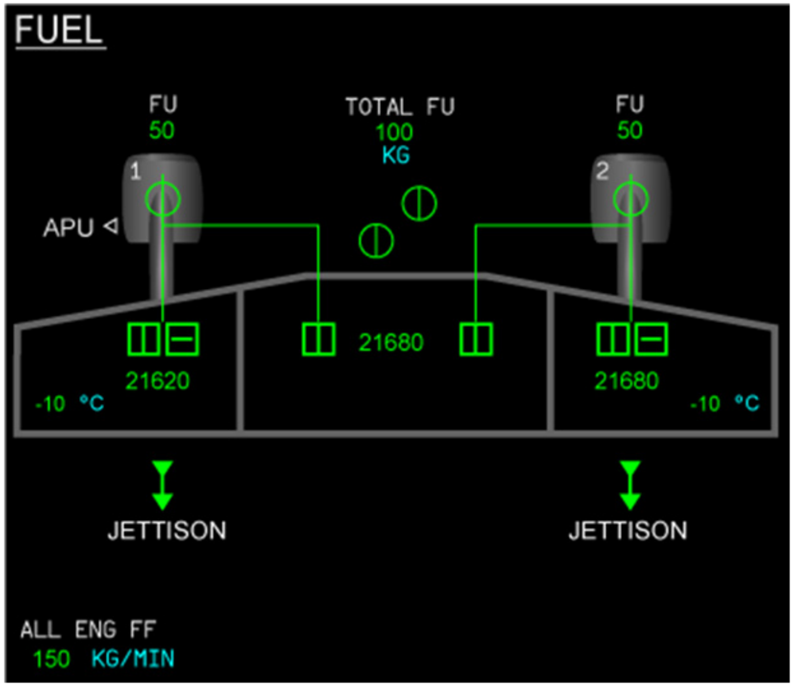
- Approximately 45 minutes, with one refuel coupling
- Approximately 35 minutes, with two fuel couplings.

Defueling may be necessary for maintenance reasons. Defueling is manually controlled via the FQMS, using the external refuel panel. The discharged fuel is collected via the refuel couplings.

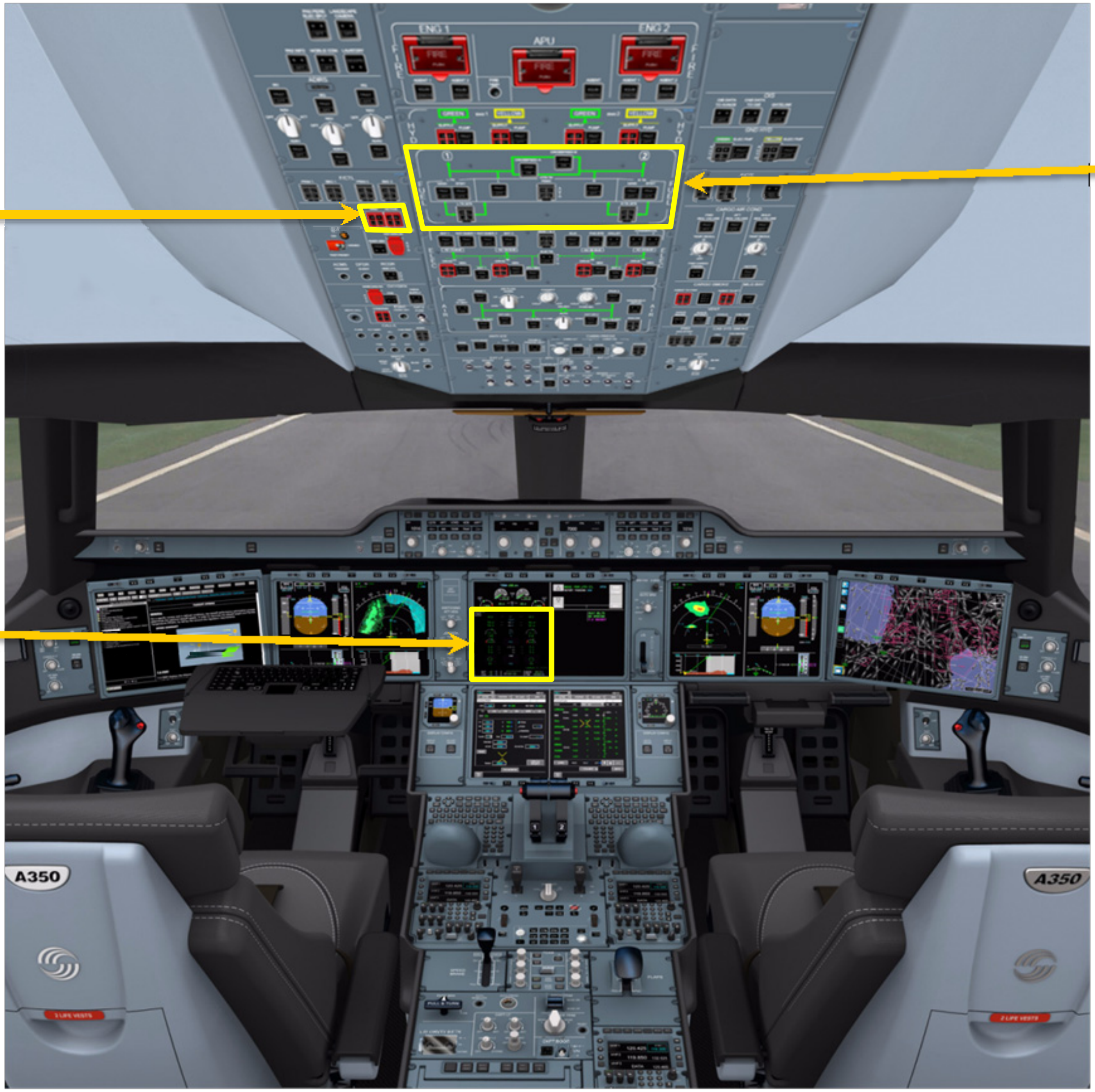
Fuel Jettison (optional)

To rapidly reduce the aircraft gross weight, the jettison system can be used to discharge fuel overboard. The output rate is approximately 60 t (132 400 lbs) per hour.

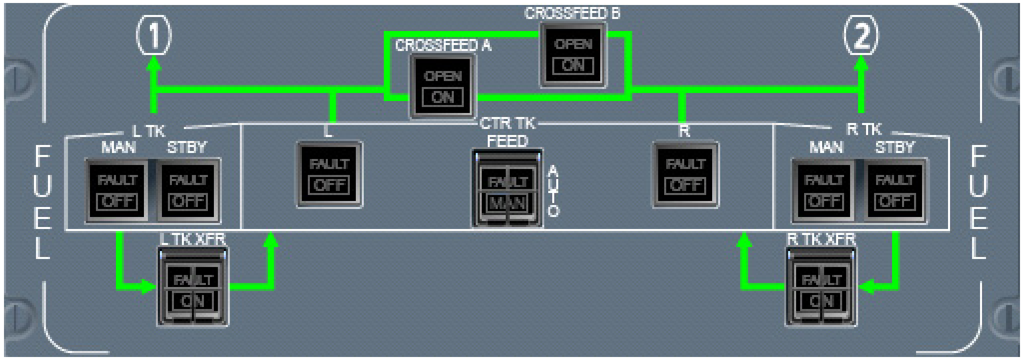
FUEL SD Page



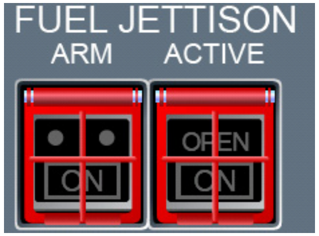
Cockpit View



FUEL Panel

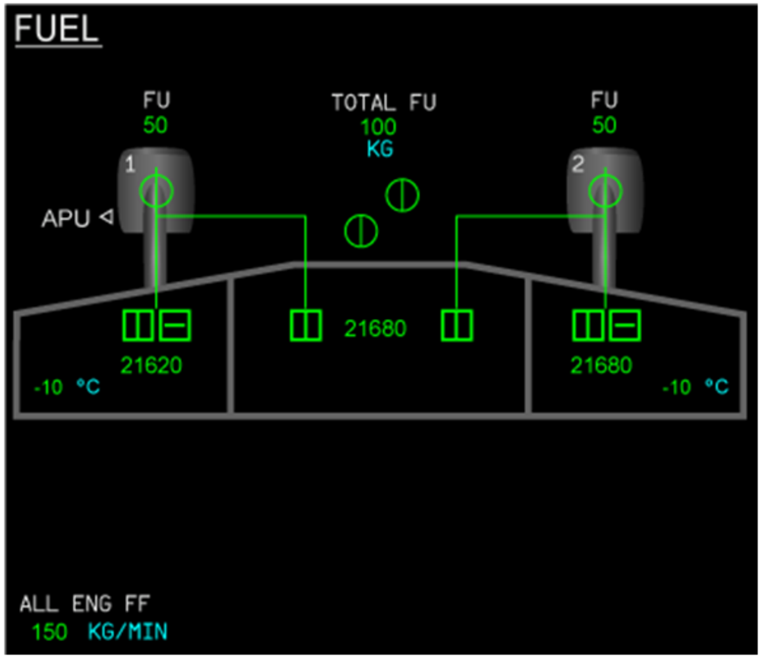


FUEL JETTISON Panel
(optional)



REFUEL Panel
(optional)

FUEL SD Page



CRUISE SD Page

Permanent Data

Hydraulic System

A350 XWB

AIRBUS

General

The A350 hydraulic system has two independent hydraulic circuits:

- The YELLOW hydraulic circuit
- The GREEN hydraulic circuit.

The 2H/2E (two hydraulic circuits/two electrical circuits) architecture provides a redundancy on flight controls (use of Electro-Hydrostatic Actuators (EHA) and Electrical Backup Hydraulic Actuator (EBHA)). Thus, this architecture enables to control the aircraft via the sidestick and pedals without any hydraulic supply.

The two hydraulic systems operate continuously and power the flight controls, the landing gear system and the cargo doors at a nominal pressure of **5000 psi** (like the A380) instead of 3000 psi on previous Airbus aircraft.

If one or both hydraulic systems fail, the following backups remain available:

- For flight controls: the EHAs and EBHAs
- For braking: the independent hydraulic accumulators
- For steering: the Automatic Differential Braking (ADB) and the hydraulic accumulators.

Hydraulic Generation

The hydraulic power generation system provides hydraulic consumers with the required amount of hydraulic flow and pressure to ensure:

- Primary and secondary flight control operation
- Landing gear retraction/extension and associated doors closure/opening
- Wheel brake operation
- Nose wheel steering.

Each circuit has:

- One hydraulic reservoir
- Two Engine Driven Pump (EDPs)
- One Electric Motor Pump (EMP)
- One accumulator
- Two Fire Shutoff Valves (FSOVs)
- One cooling system
- A Hydraulic System Monitoring Unit (HSMU).

Hydraulic Generation

Engine Driven Pumps (EDPs)

Four EDPs pressurize the hydraulic system. On each engine there are two EDPs, one pressurizes the **GREEN** hydraulic circuit and the other pressurizes the **YELLOW** hydraulic circuit. Thus if an engine fails, the remaining engine can still pressurize both hydraulic circuits.

Electric Motor Pump (EMP)

One EMP per hydraulic system can provide hydraulic pressure on ground only, when all engines are shut down. For example, the EMP of the **YELLOW** circuit operates automatically for cargo door actuation.

Fire Shutoff Valves (FSOVs)

There are two fire shutoff valves per engine. The closure of the fire shutoff valves prevents hydraulic fluid from flowing into the pump and thus, to sustain a fire.

Cooling System

Both hydraulic circuits have a cooling system, that prevents overheat and degradation of hydraulic fluid.

This cooling system has two fuel/hydraulic Heat Exchangers (HHX) per circuit (one per EDP). The HHX are submerged in the wing tanks.

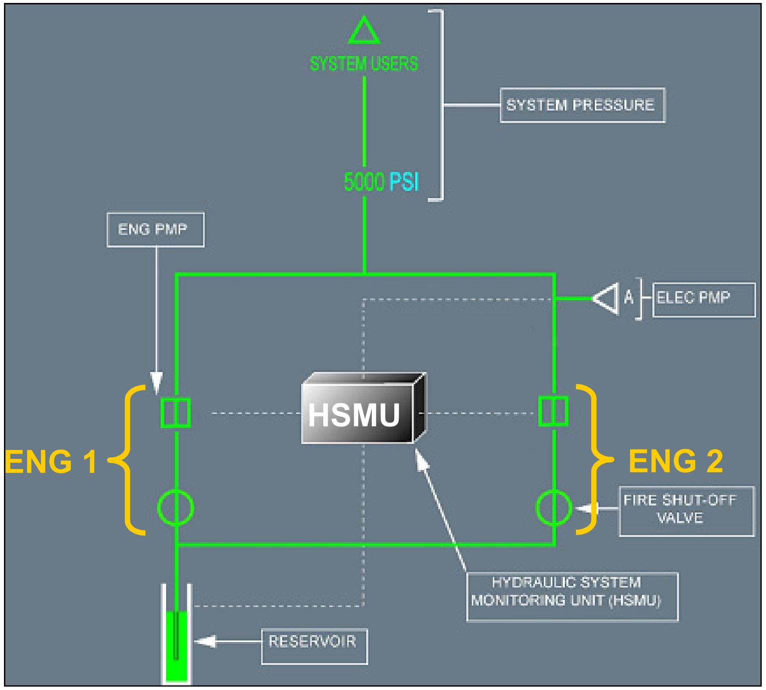
The Hydraulic System Monitoring Unit (HSMU)

The HSMU has the following functions:

- Monitoring functions
  - EDP clutch position, pressure and case drain temperature monitoring
  - EMP status and pressure monitoring
  - System pressure monitoring
  - Filter clogging monitoring
  - Monitoring of pb status (cockpit, GSP)
  - BITE
- Control functions
  - EDP depress control
  - EDP auto depress at fuel low level
  - EMP control and monitoring
  - UERF detection and protection logic
  - FSOV control
  - Manifold isolation valve control
  - Test functions as part of BITE
  - Illumination control of the cockpit pb.

Hydraulic Generation

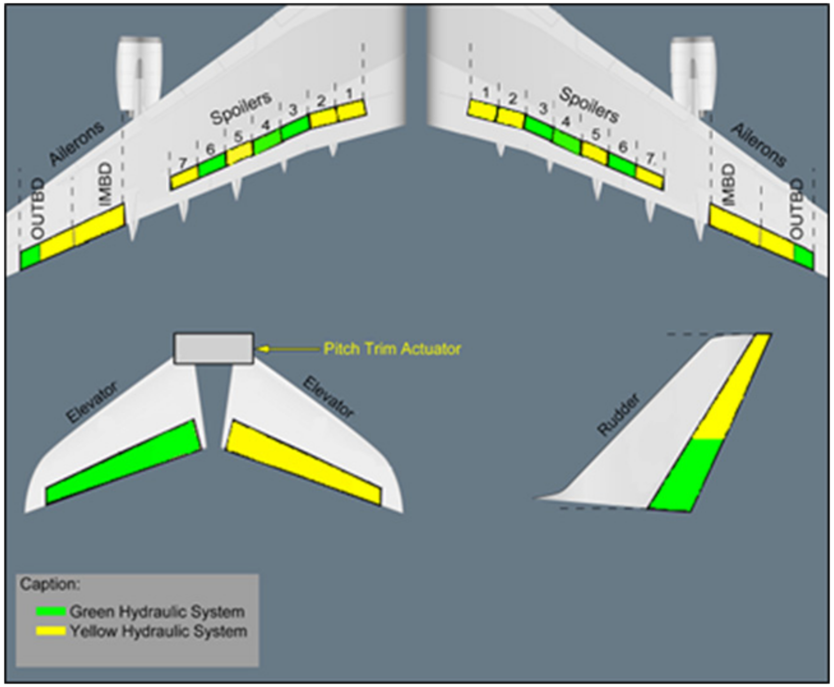
GREEN HYD Circuit Architecture



Note: Similar architecture applies to **YELLOW** hydraulic circuit.

Hydraulic Distribution

Hydraulic Distribution for Flight Controls



Note: For landing gear, brakes and steering hydraulic distribution, refer to ***Landing Gear***.

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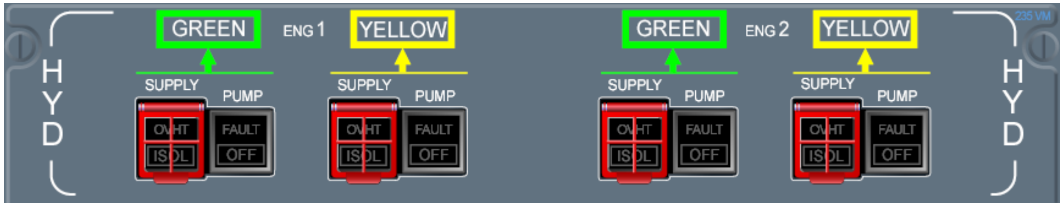
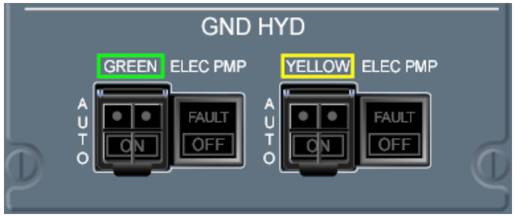
Cockpit View

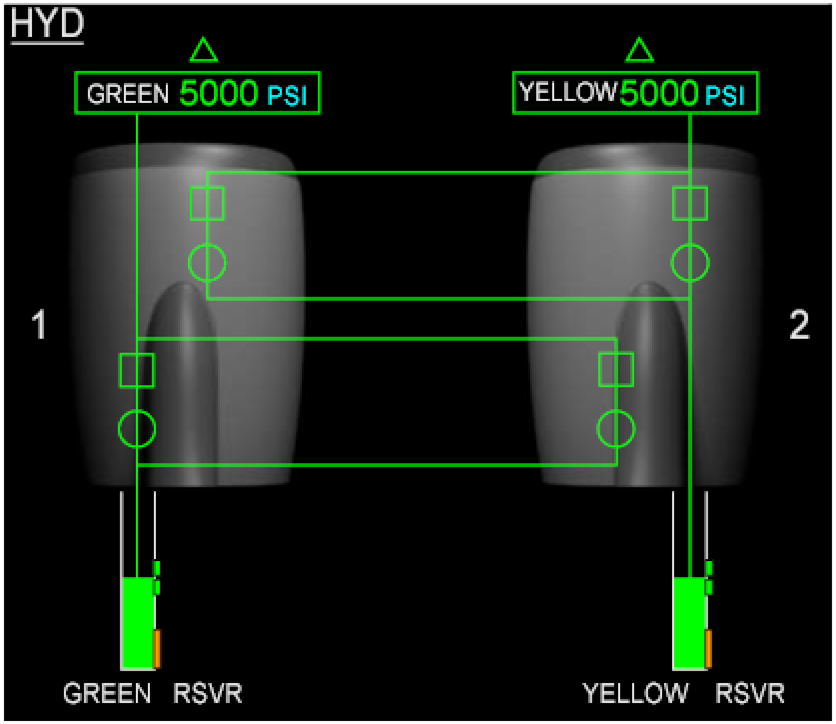
HYD Panel



GND HYD Panel



HYD SD Page



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Ice and Rain Protection

A350 XWB

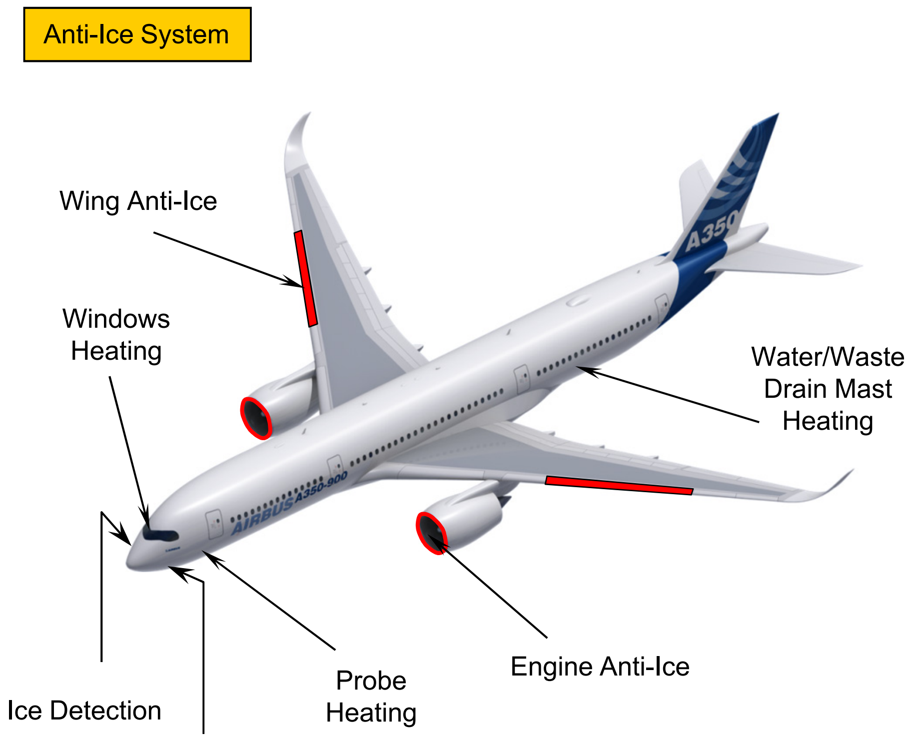
AIRBUS

Overview

The ice protection system enables operation of the aircraft in icing conditions with no restrictions.
The system protects the sensitive areas of the aircraft against ice by the use of:

- **Electrical power for**:
  - Probe heating
  - Cockpit windows heating
  - Water/waste drain mast heating

- **Hot bleed air for**:
  - Engine anti-ice
  - Wing anti-ice.



System Description

Probe Heating

The following probes are electrically heated:

- Static probes
- Multi Function Probes (MFPs)
- Sideslip angle probes
- Standby pitot and static probes.

Engine Anti-Ice

Each engine has its own anti-ice system. Two anti-ice valves on each engine enable the flow of hot air to prevent ice accretion on the nacelle air intake.

Wing Anti-Ice

Hot air from the bleed air system can be used to prevent ice accretion on slats 3, 4, and 5. Wing anti-ice is inhibited on ground and during takeoff until takeoff thrust reduction.

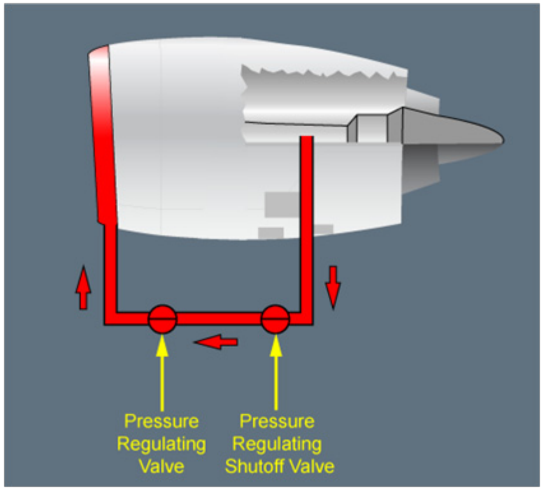
Cockpit Windows heating

The cockpit windows are electrically-heated for icing prevention and for defogging.

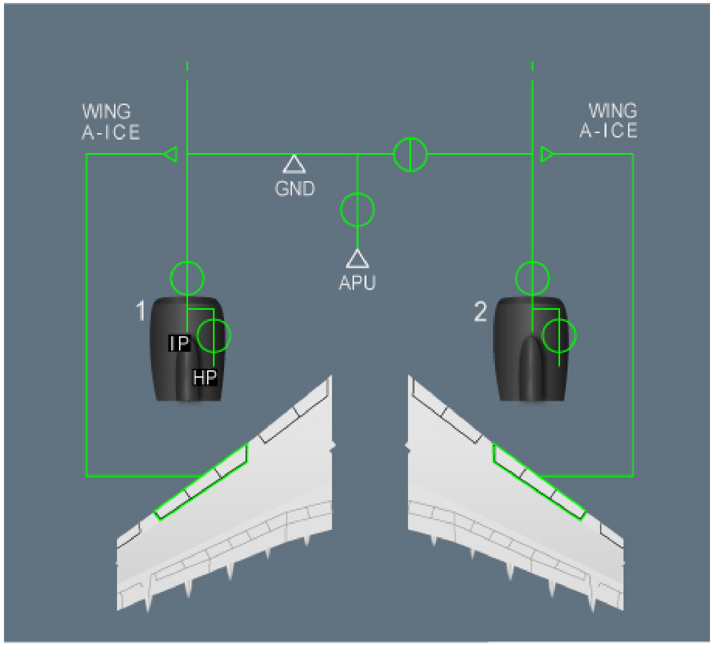
Water/Waste Anti-Ice

The water lines are automatically heated to prevent water from freezing.

Engine Anti-Ice



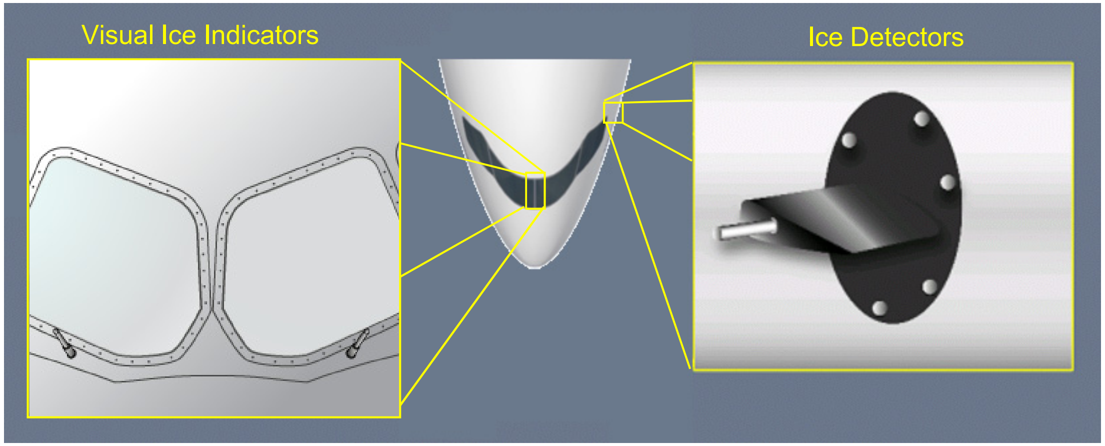
Wing Anti-Ice



Ice Detection

The ice detection system has two ice detectors that measure ice accretion. If icing or severe icing conditions exist, the ice detectors provide this information to the flight crew. There is one ice detector on each side of the fuselage.

Two visual ice indicators provide the flight crew with a visual backup of the ice detection system. These visual indicators can be illuminated.



General

The use of electric windshield wipers and a rain repellent system maintain a clear vision through the front windshields in case of rain.

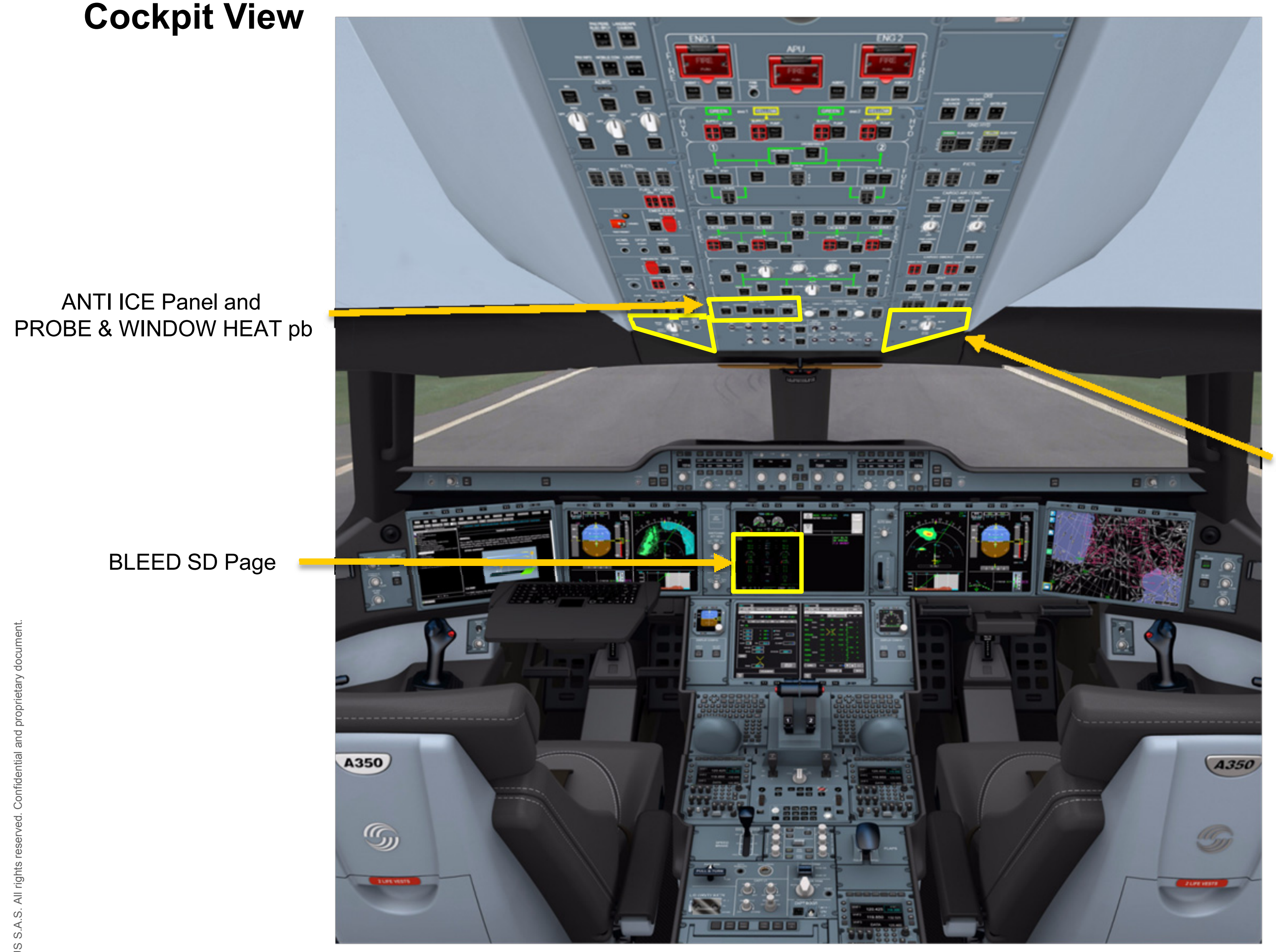
System Description

Wipers
Each windshield has a five-speed electric wiper, including three intermittent speed settings. Each windshield wiper is controlled by its assigned WIPER selector.

The flight crew can use the wipers during taxi, takeoff, holding, approach and landing.

Rain Repellent
A rain repellent fluid can be sprayed on the surface of the windshields to improve visibility in moderate to heavy rain conditions.

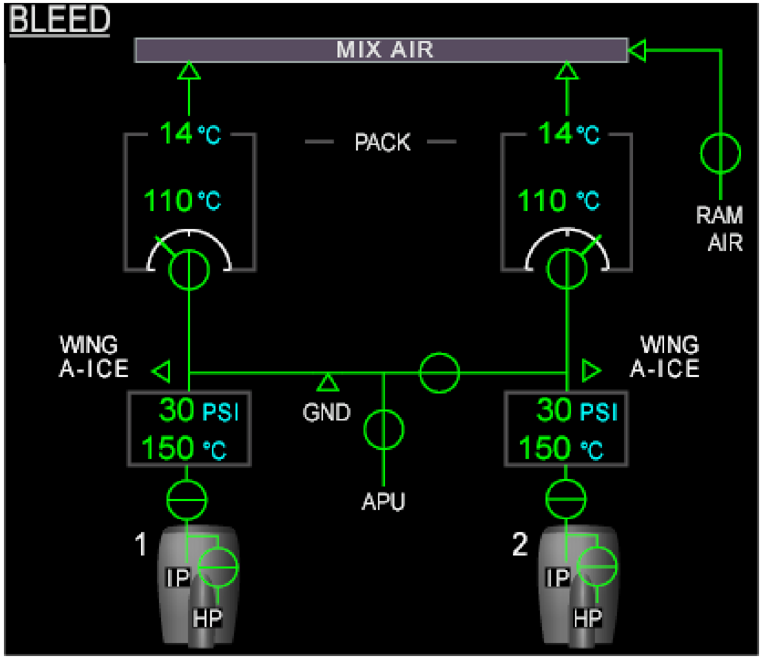
Cockpit View



ANTI ICE Panel and PROBE & WINDOW HEAT pb

WIPER selector and RAIN RPLNT pb

BLEED SD Page



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Control and Display System

A350 XWB

AIRBUS

The Control and Display System (CDS) provides the flight crew with all the necessary information to operate the aircraft.

Therefore the CDS includes:

- **Display Units (DUs)** (refer to ***Display Units***)

  6 Display Units (DUs) provide the following functions:
  - The EFIS displays flight parameters
  - The ECAM assists the flight crew in systems management
  - The MFD provides an interface with various system (e.g. the FMS)
  - The OIS provides an interface with the operational documentation and applications.

- **Head-Up Display (HUD)**

  The optional HUD provides guidance to the flight crew by gathering primary flight display information

  (refer to ***Head-Up Display***).

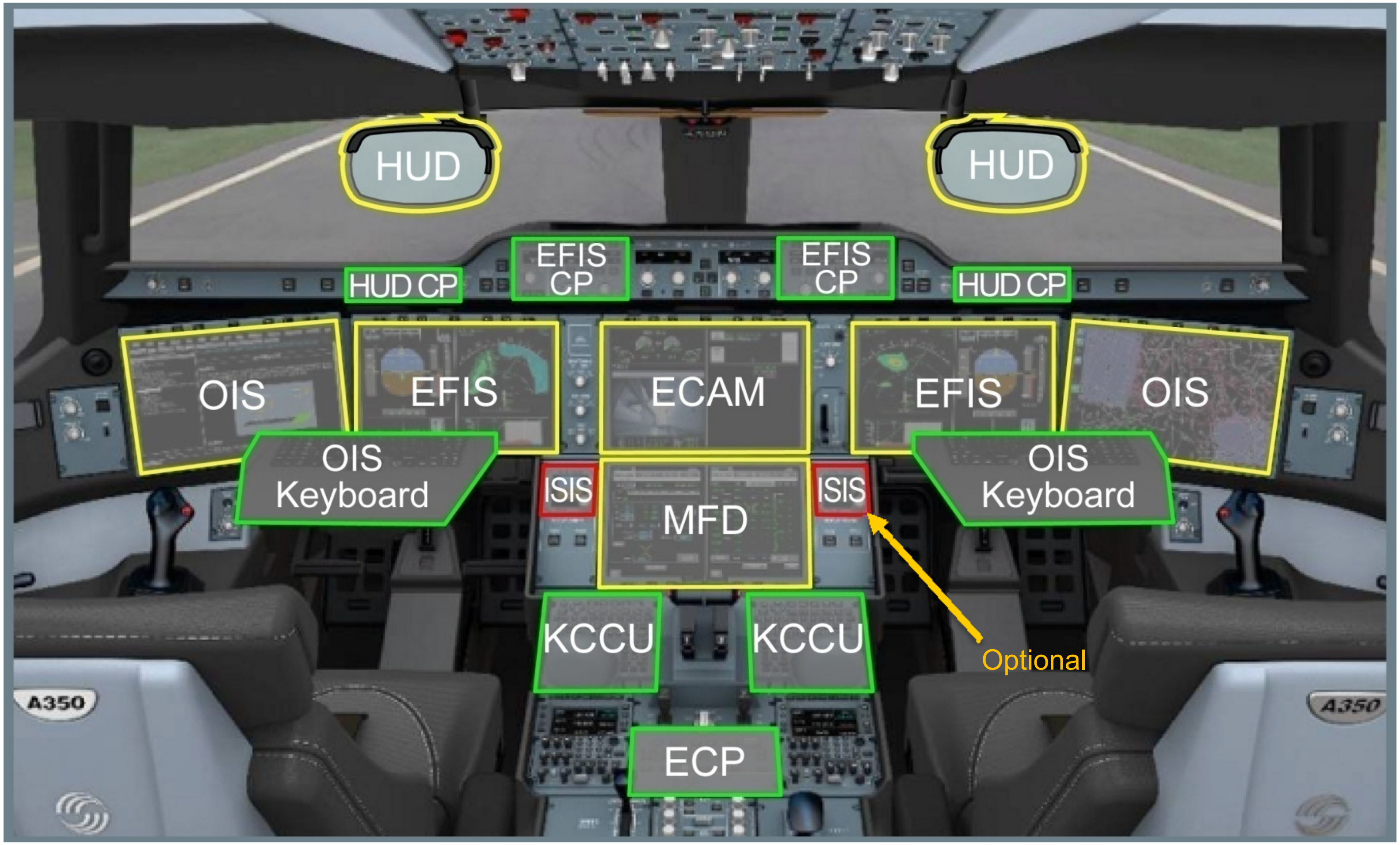
- **Integrated Standby Instrument System (ISIS)**

  The ISIS provides information in case of loss of the EFIS (refer to ***Navigation - ISIS***).

  The 2nd ISIS is optional.

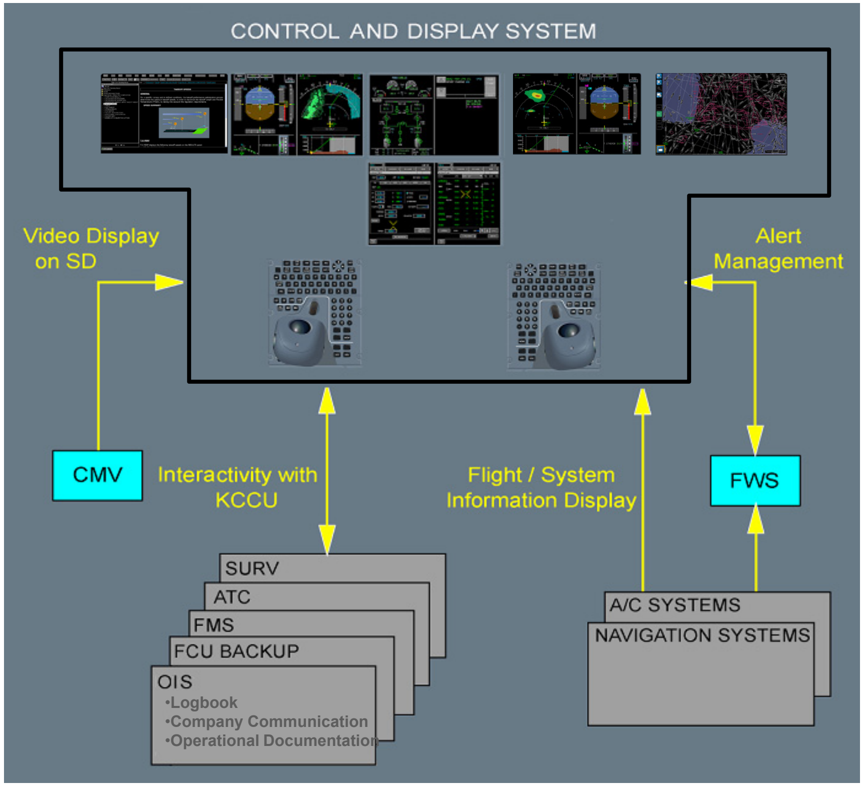
In order to interact with the various displays and functions, the flight crew uses:

- An EFIS Control Panel (EFIS CP)
- An ECAM CP
- A HUD CP
- A Keyboard and Cursor Control Unit (KCCU)
- An OIS Keyboard.


HUD
HUD
EFIS CP
EFIS CP
HUD CP
HUD CP
OIS
EFIS
ECAM
EFIS
OIS
OIS Keyboard
OIS Keyboard
ISIS
MFD
ISIS
KCCU
KCCU
Optional
ECP

Architecture

Each DU has a built-in calculator able to process all the available displays and functions.



The DUs receive flight and system information from:

- Various aircraft systems
- Flight Warning System (FWS)
- Navigation systems
- Concentrator and Multiplexer for Video (CMV)
- Surveillance (SURV)
- Flight Management System (FMS)
- Air Traffic Control (ATC) Communication system
- Full Authority Digital Engine Controls (FADECs)
- Primary flight computers (PRIMs)
- Onboard Information System (OIS): Logbook, Company Communication, Operational Documentation and Applications.

The DUs also provide interface and control through the KCCUs, for the following functions:

- Flight Management System (FMS)
- Air Traffic Control (ATC COM)
- Surveillance (SURV)
- Flight Control Unit (FCU) backup
- Onboard Information System (OIS)

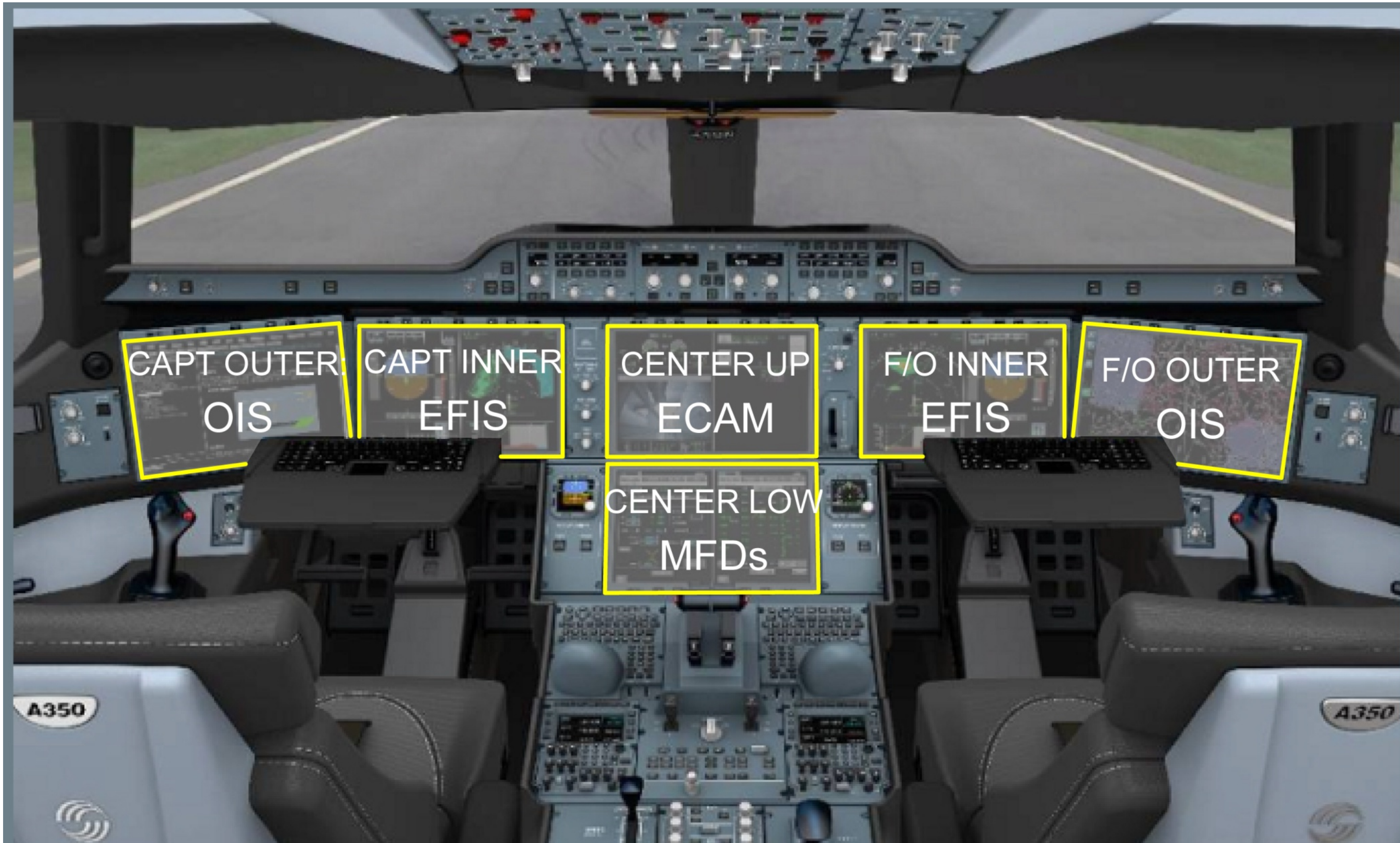
System Description

The CDS has 6 identical interchangeable 30 cm x 20 cm (12” x 8”) Liquid Crystal Display Units (DUs) and associated control panels.

The 6 DUs are referred to as (from left to right):
- Captain Outer DU
- Captain Inner DU
- Center Upper DU
- Center Lower DU
- First Officer Inner DU
- First Officer Outer DU

In normal operation, the configuration is the following:
- The Outer DUs display the OIS
- The Inner DUs display the EFIS
  - PFD
  - ND
- The Center Upper DU displays the ECAM and the mailbox
  - ED
  - SD
  - Permanent data
  - Mailbox
  - WD
- The Center Lower DU displays the MFD

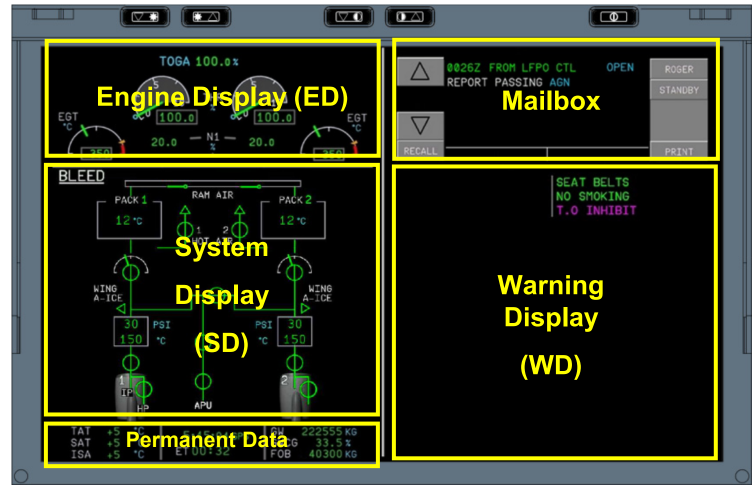
Cockpit View



Controls and Indicators

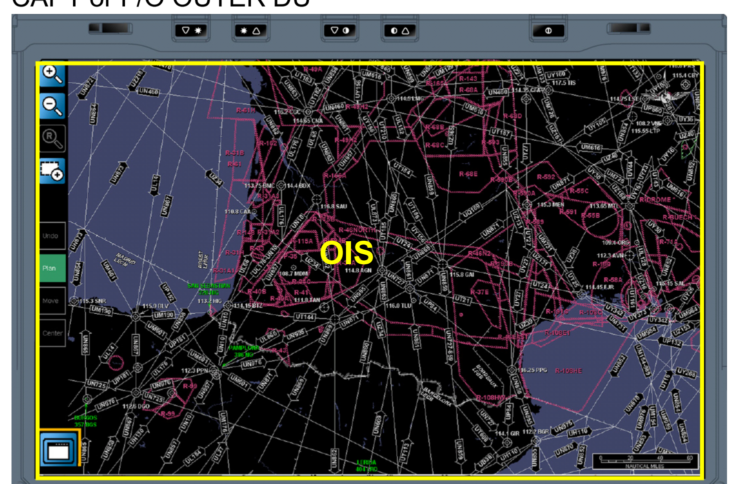
CAPT or F/O INNER DU

CENTER UPPER DU

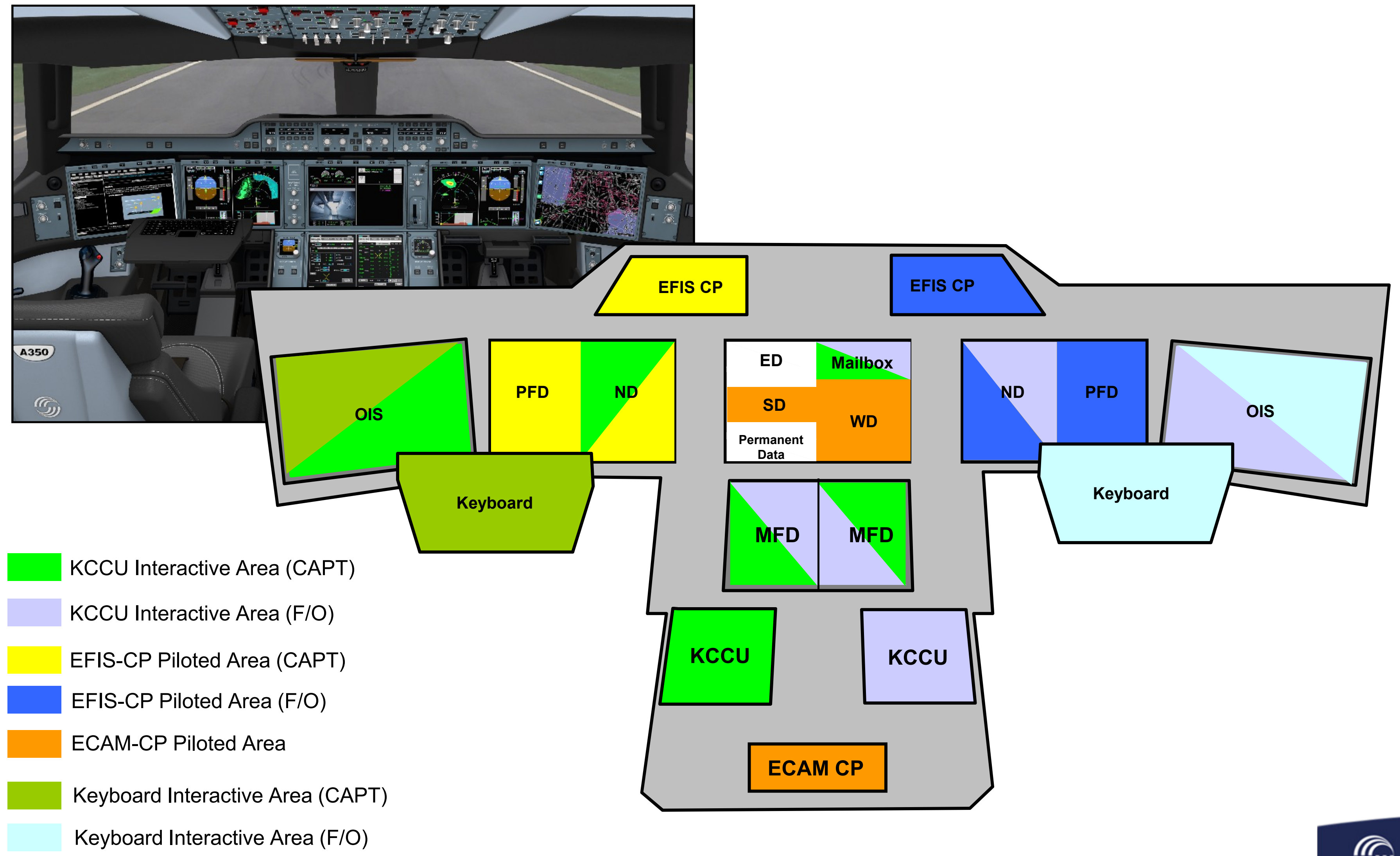


CENTER LOWER DU

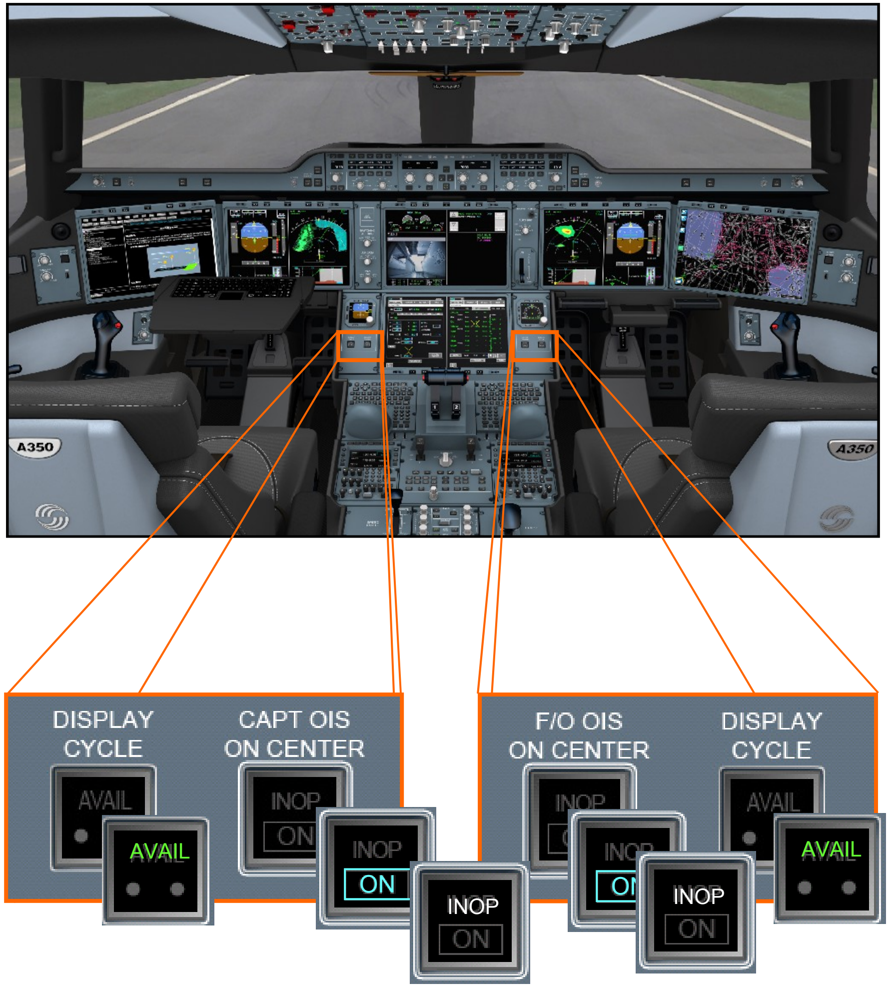
CAPT or F/O OUTER DU



Controls and Display Interactivity



Display Reconfiguration:



Each pushbutton, dedicated to DU reconfiguration, clearly indicates the reconfiguration status and capabilities.

Each DU has a built-in calculator able to process all the available displays and functions:

- EFIS
- ECAM
- Mailbox
- MFD
- OIS.

Therefore, DU reconfigurations enable the flight crew to display the relevant information, either in the case of a DU failure or in normal operations for operational purpose. There are two types of reconfigurations:

- **Automatic reconfiguration**: the CDS reconfigures the display units in order to display, by order of priority, the following formats:
  - ED
  - PFD/ND
  - MFD
  - OIS.-
- **Manual reconfiguration**: the flight crew reconfigures the display according to operational needs in normal operations or in the case of a DU failure.

For manual reconfiguration, the flight crew uses:

• The **CAPT (F/O) OIS ON CENTER pb** to display the OIS on the center lower DU,

• The **DISPLAY CYCLE pb** to choose, through a cyclic process, which display is selected on the remaining DUs.

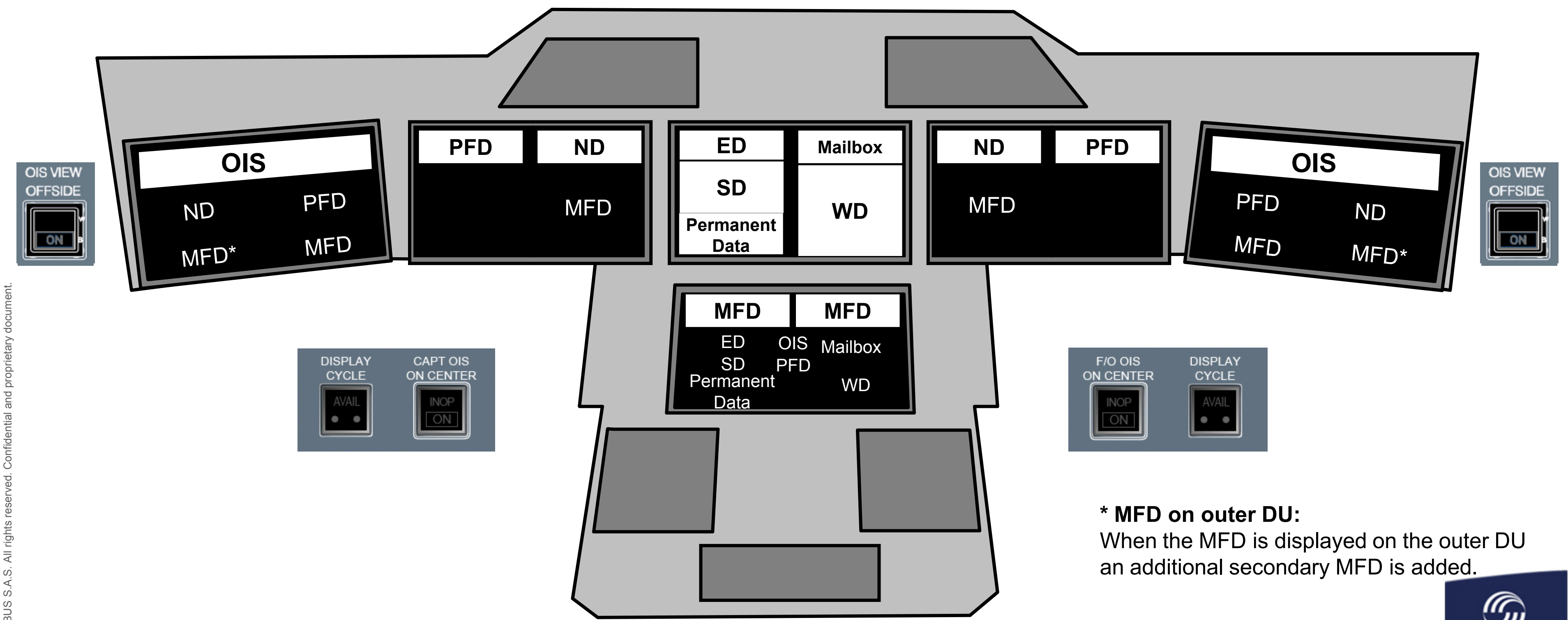
Display Reconfiguration: Display Capabilities

The A350 CDS has been designed to allow the dispatch in the following cases:
- One DU inoperative (regardless of which one)
- The two outer DUs inoperative

Note: There are two laptops available that can be used to display the OIS.

The following illustrates all the display capabilities for each DU:

Caption:
XXX Display in Normal Configuration
XXX Display capabilities for Reconfigurations



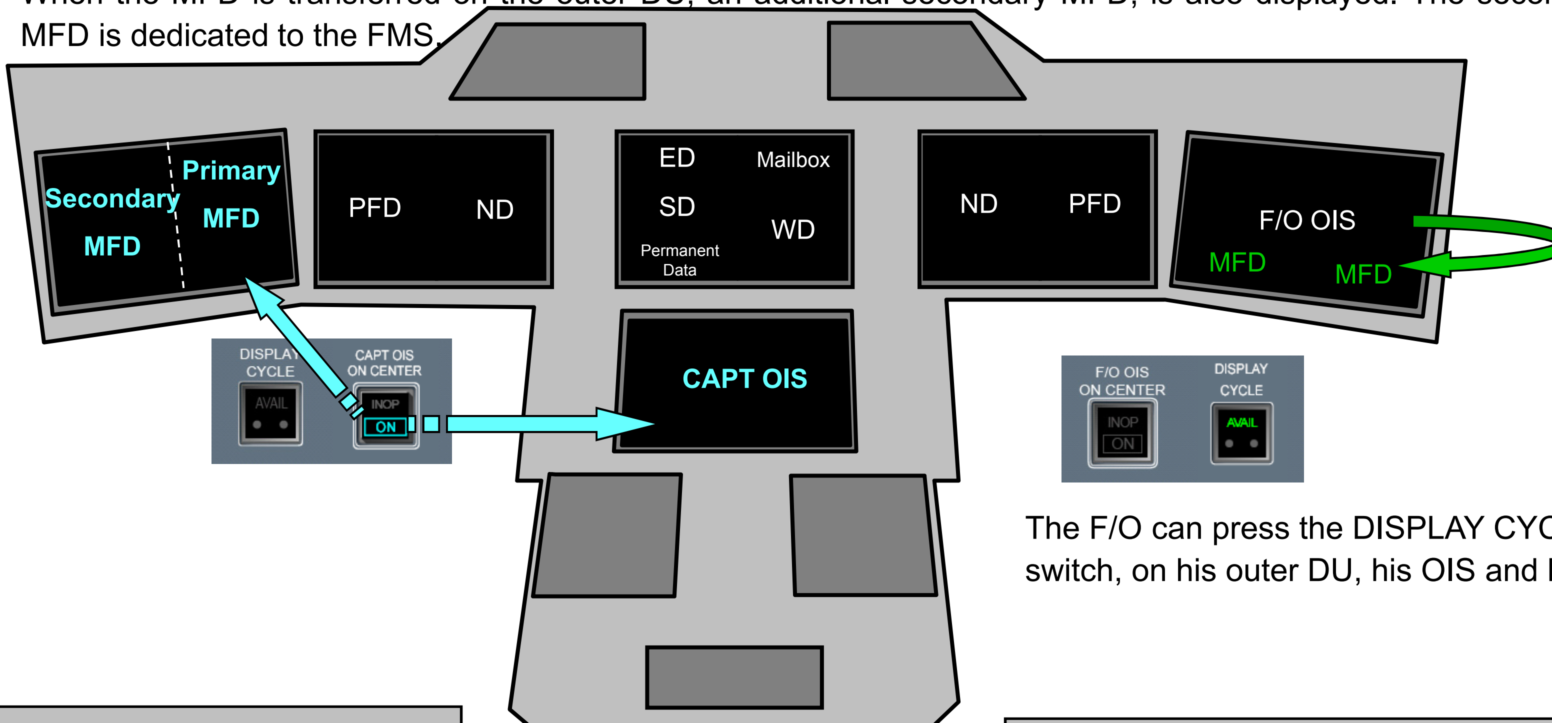
*** MFD on outer DU:**
When the MFD is displayed on the outer DU an additional secondary MFD is added.

Reconfiguration Rules: Manual Reconfiguration in Normal Operation

<u>OIS ON CENTER</u>

For operational needs, the flight crew can manually reconfigure the DUs, thanks to the OIS ON CENTER function.
The CAPT(F/O) OIS ON CENTER pb enables the captain or the F/O to display their OIS on the center lower DU.

When CAPT (F/O) OIS ON CENTER pb is selected ON, the CAPT(F/O) MFD is transferred on the outer DU. When the MFD is transferred on the outer DU, an additional secondary MFD, is also displayed. The secondary MFD is dedicated to the FMS.



The F/O can press the DISPLAY CYCLE pb, to switch, on his outer DU, his OIS and his MFD.

Manual Reconfiguration

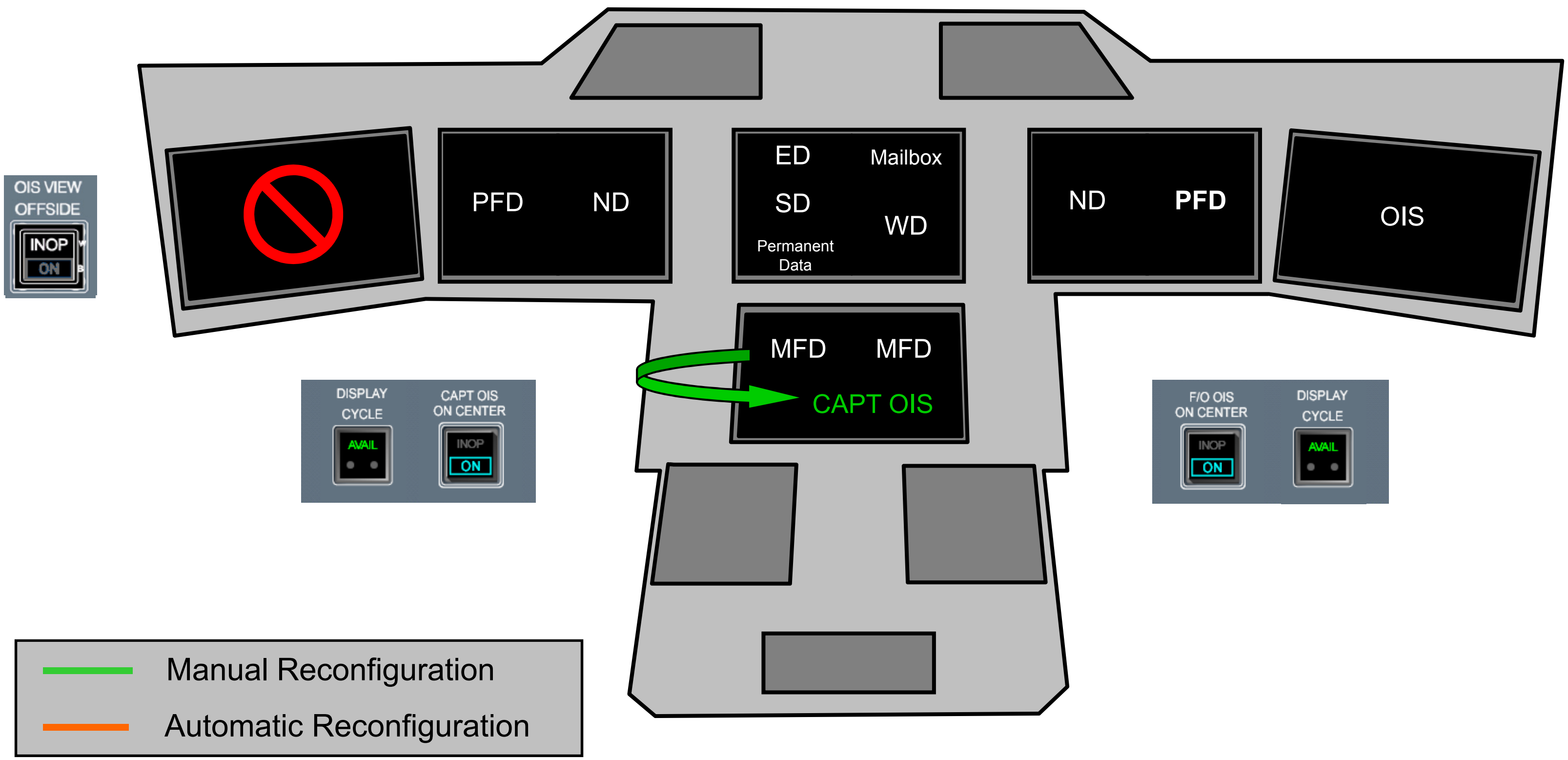
Manual Reconfiguration

Reconfiguration Rules: Captain Outer DU Inoperative

OIS on Center Lower DU

The captain can manually display the OIS on the center lower DU by pressing the CAPT OIS ON CENTER pb.

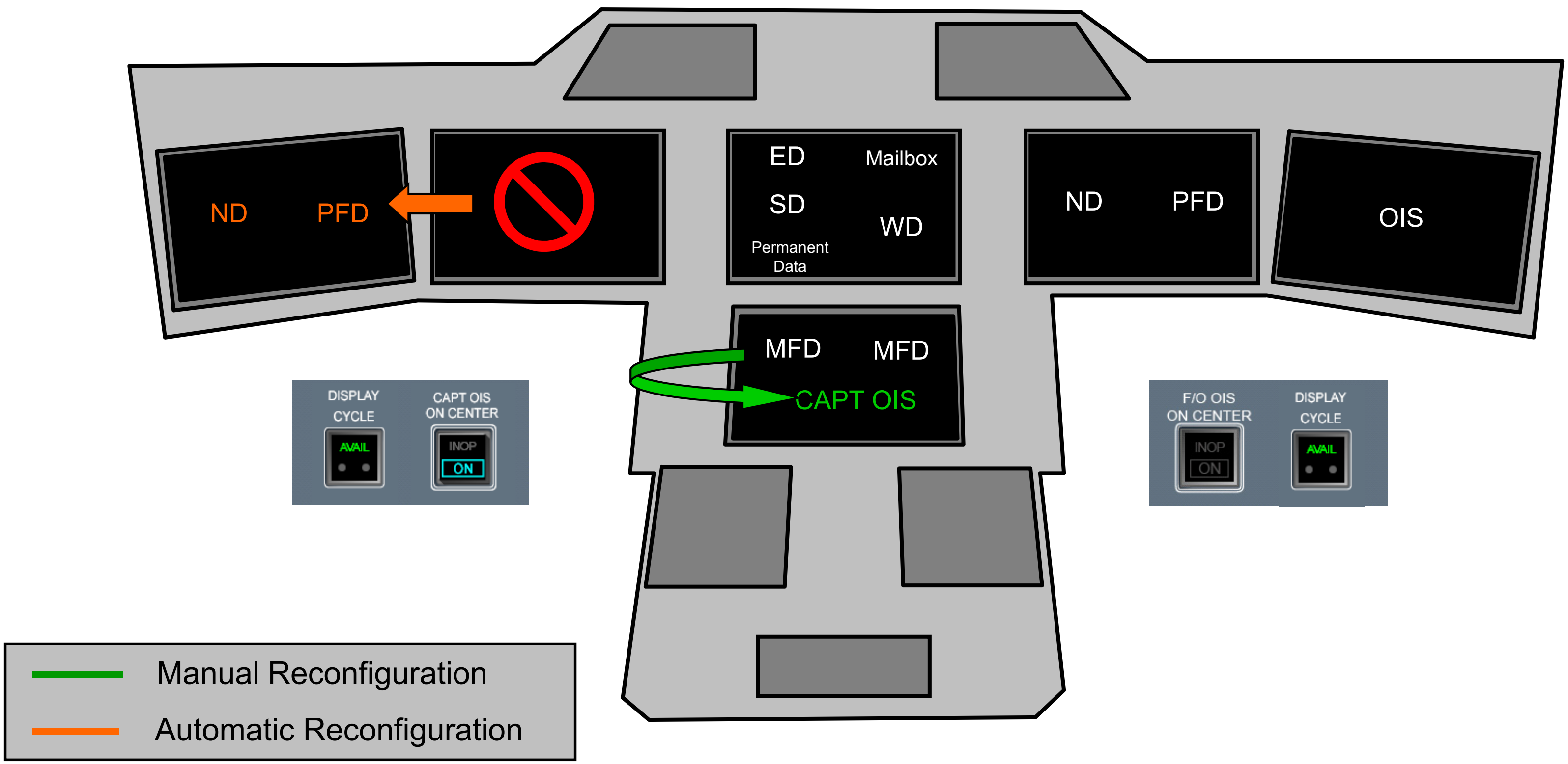
The flight crew can use the DISPLAY CYCLE pb to switch the MFD and the OIS on the center lower DU.



Reconfiguration Rules: Captain Inner DU Inoperative

PFD/ND on Captain Outer DU

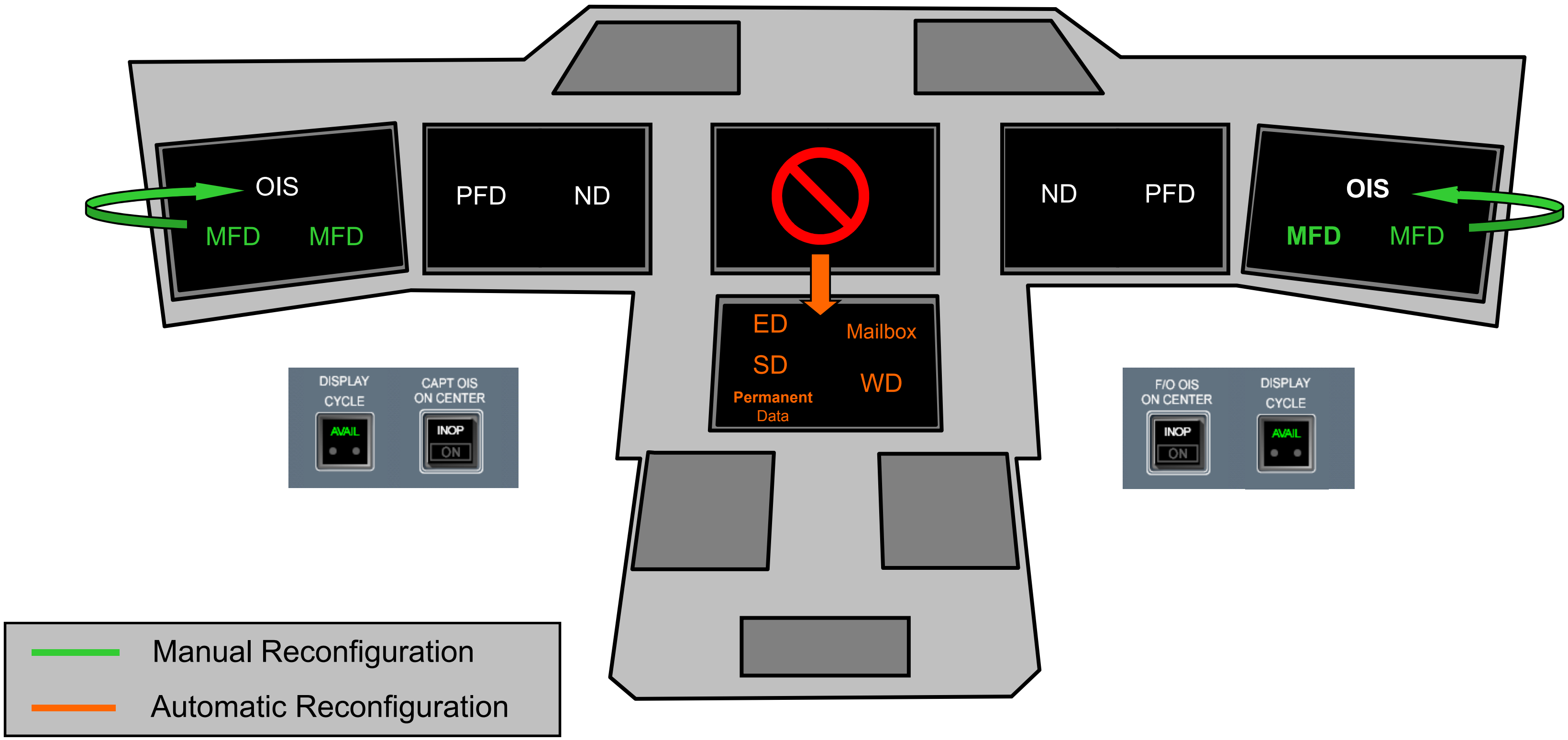
If the CAPT INNER DU fails, it is automatically displayed on the CAPT OUTER DU. To display the OIS on the center lower DU, the captain has to press the CAPT OIS ON CENTER pb.
The flight crew can press the DISPLAY CYCLE pb to switch the MFD and the OIS on the center lower DU.



Reconfiguration Rules : Center Upper DU Inoperative

ED, SD, Permanent Data, Mailbox and WD on Center Lower DU

If the CENTER UPPER DU fails, it is automatically displayed on the CENTER LOWER DU. In this case, the flight crew cannot display the OIS on the center lower DU because the display of the ED has priority. The OIS ON CENTER pushbuttons are inoperative. The flight crew can use the DISPLAY CYCLE pb to switch between the MFD and the OIS on the outer DUs.



General

The **Electronic Flight Instrument System (EFIS)** displays flight parameters and navigation data.
The EFIS is displayed on CAPT and F/O INNER DUs. Each DU displays:

- 1 Primary Flight Display (PFD) for short-term flight information
- 1 Navigation Display (ND) for long-term navigation.

The flight crew interacts with the EFIS displays through the:

- KCCUs
- EFIS control panels.

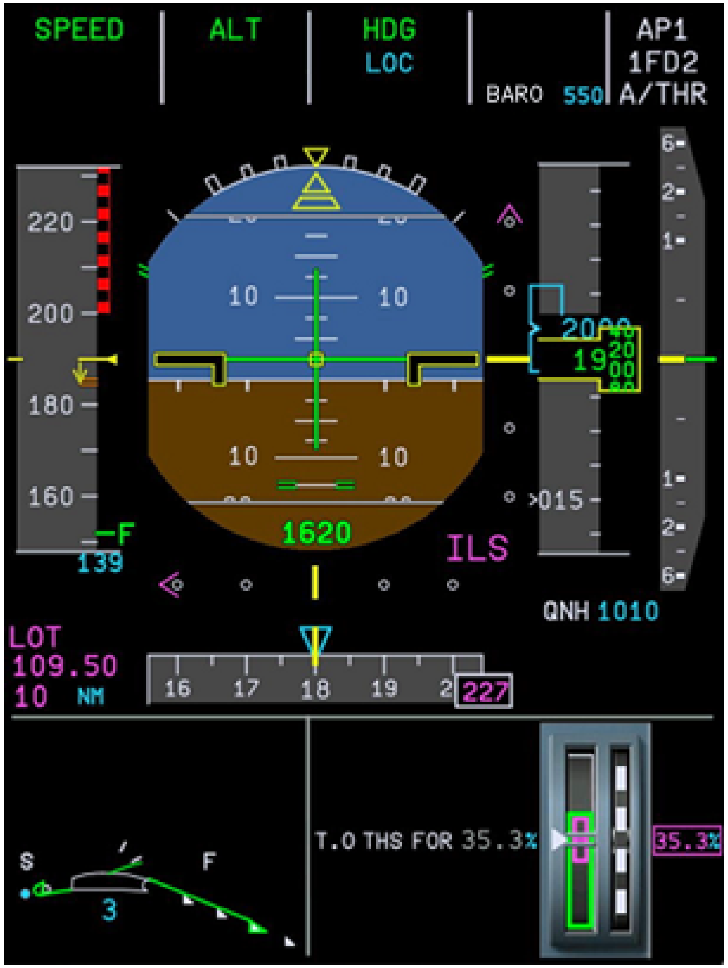
Controls and Indicators

The Primary Flight Display (PFD) has two parts:

- The upper part displays:
  - The Complete Basic T including the:
    - Attitude
    - Airspeed / Mach
    - Altitude / Vertical speed
    - Heading
  - AFS status
  - (X)LS deviation / marker (ILS, FLS, SLS, GLS)
  - Radio altitude

- The lower part displays:
  - Memos and limitations (refer to *ECAM*)
  - Slat/Flap positions
  - Speed brakes and ground spoilers positions
  - Pitch trim indications (on ground only)
  - Landing gear positions (at retraction and extension only).

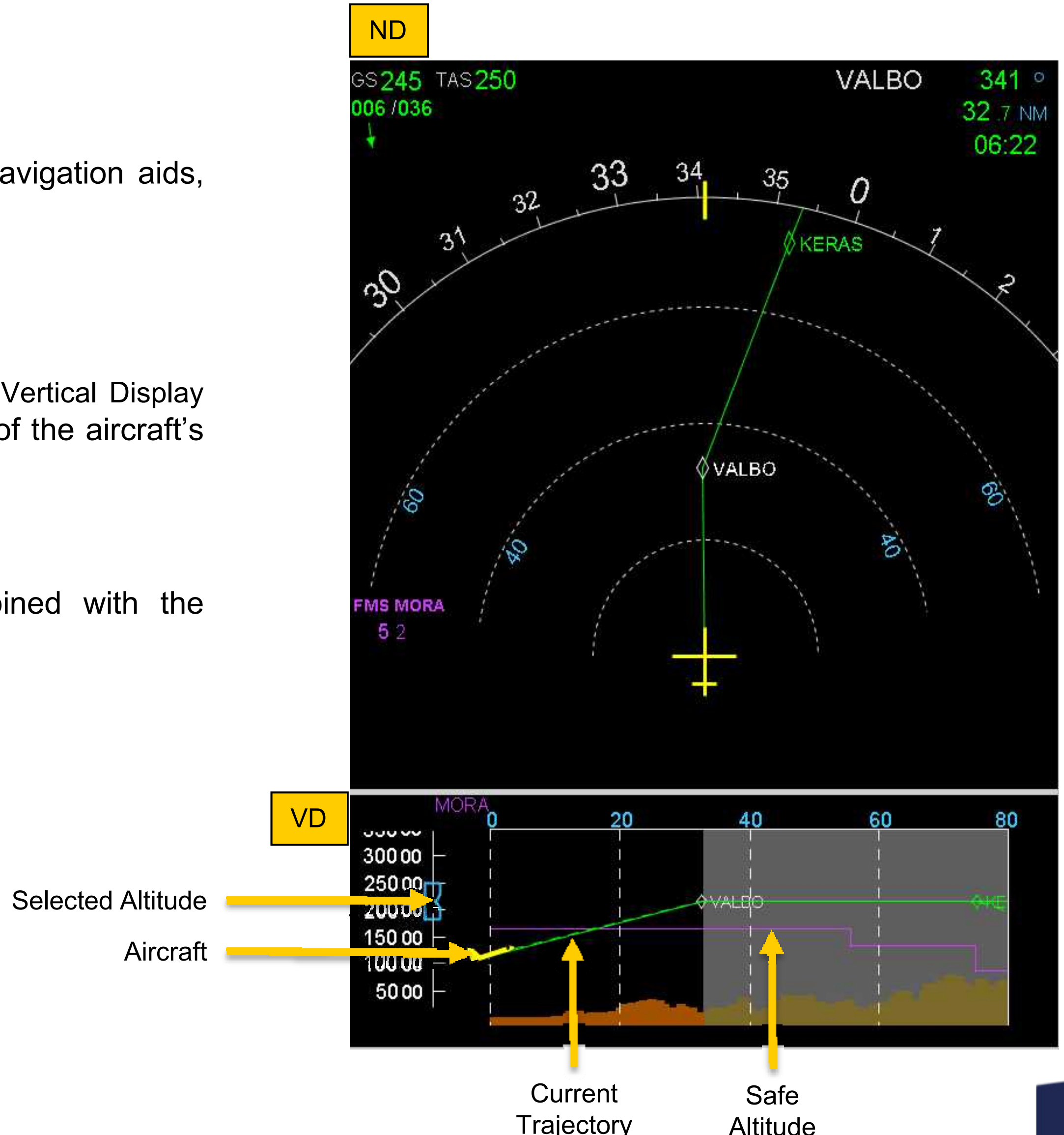
PFD



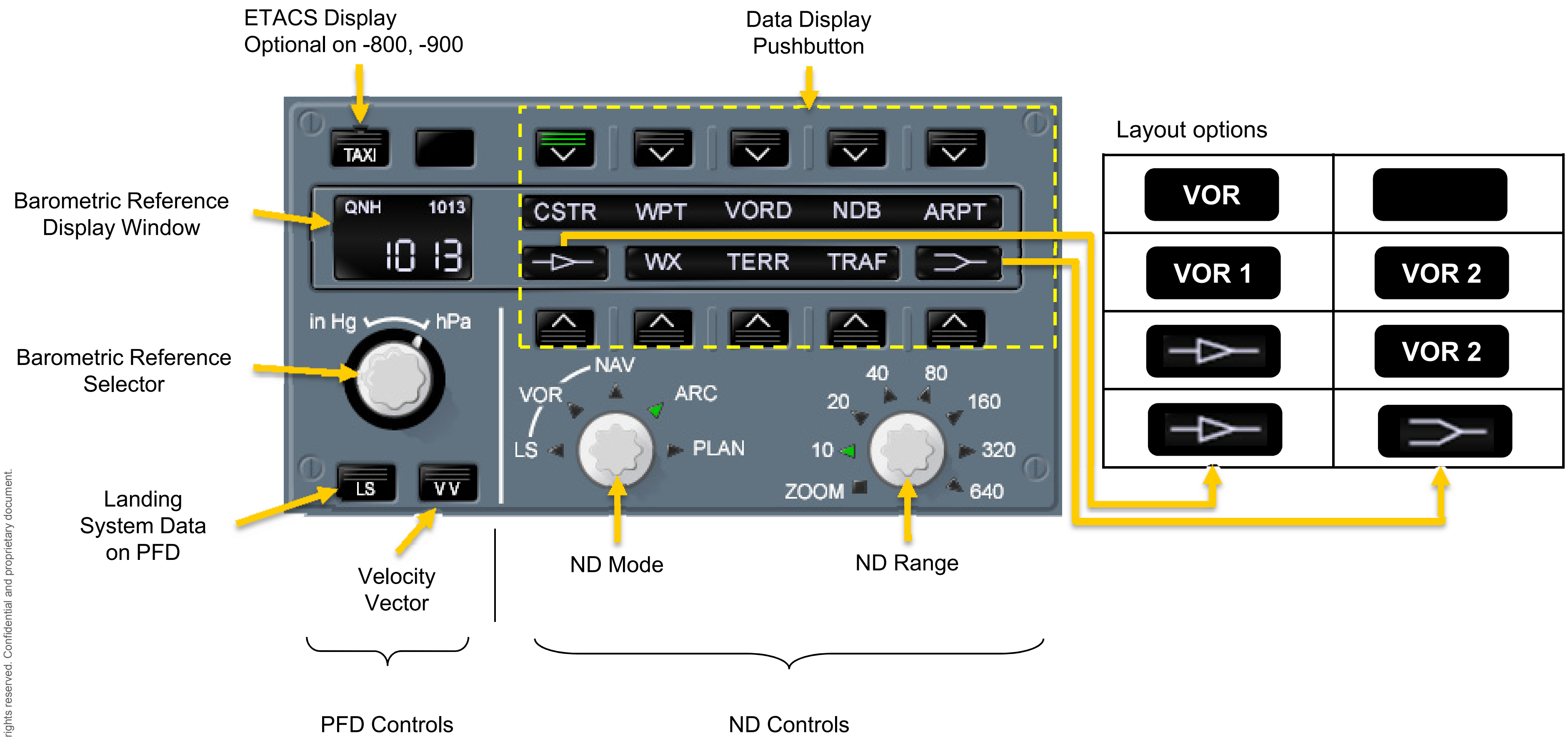
The Navigation Display (ND) has two parts:

- The upper part of the ND displays:
  - Aircraft position with respect to navigation aids, FMS flight plan and map data
  - Weather radar information
  - SURV information.

- The lower part of the ND displays the Vertical Display (VD). The VD provides a synthetic view of the aircraft's vertical situation :
  - Vertical flight profile
  - Weather radar information
  - SURV vertical information combined with the vertical flight profile.



EFIS Control Panel



General

The Head-Up Display (HUD) is proposed, as an option, in two configurations:

- Single HUD
- Dual HUD.

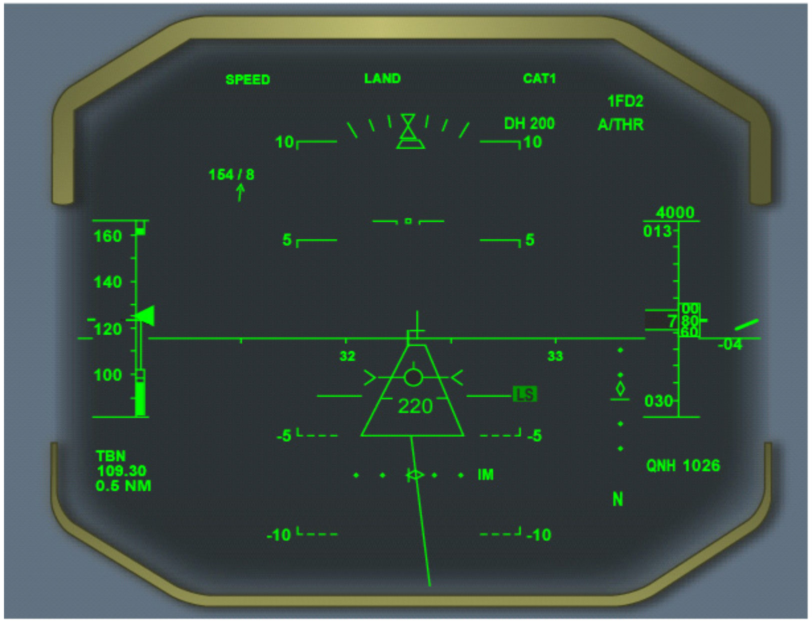
The HUD provides flight data in the flight crew's field of view. The flight data is superimposed to the outside view. This enables the flight crew to adapt the flight trajectory, in relation to external parameters (e.g. terrain, runway surface, clouds, etc.).

The purpose of the HUD is to improve the situational awareness of the flight crew.

The HUD automatically adapts the symbols to the following flight phases :

- Taxi
- Takeoff
- Rollout or rejected takeoff
- Flight.

HUD Display During the Approach Phase in Normal Mode



Architecture

Each HUD includes:

- 1 Display Unit (DU)

  The DU computes and generates the display of the symbols.

  - The Center Upper DU for Left HUD

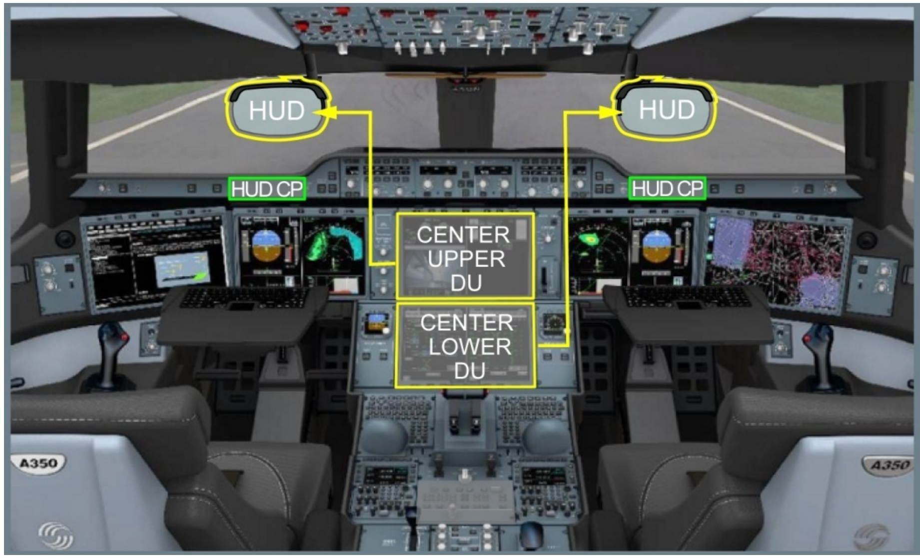
  - The Center Lower DU for Right HUD

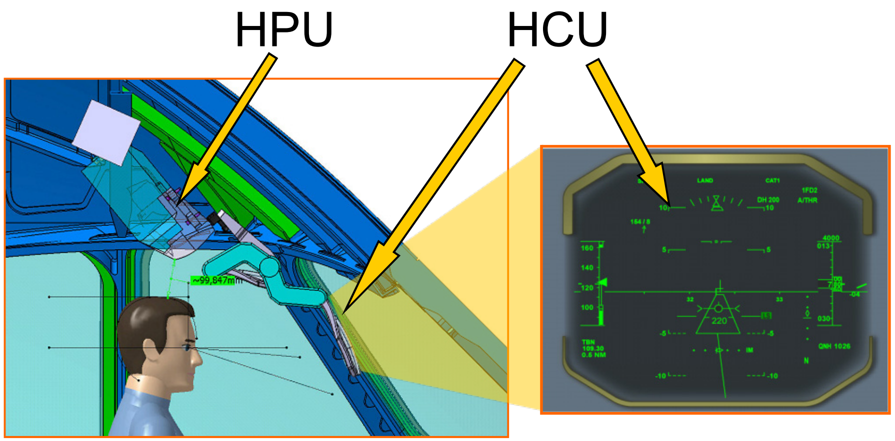
- 1 Head-Up Projection Unit (HPU)

  Each unit is located above the flight crew, and projects the symbols on the Head-Up Combiner Unit (HCU)

- 1 Head-Up Combiner Unit (HCU)

  Each unit is located in the flight crew's field of view, and superimposes the symbols to the outside view.





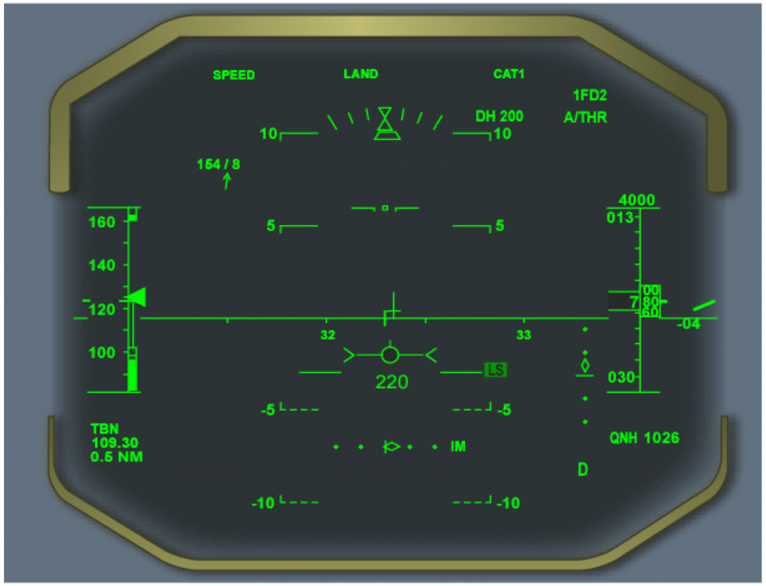
Decluttering modes

The flight crew can reduce the number of information displayed on the HUD by selecting the DECLUTTER pb on the glareshield.

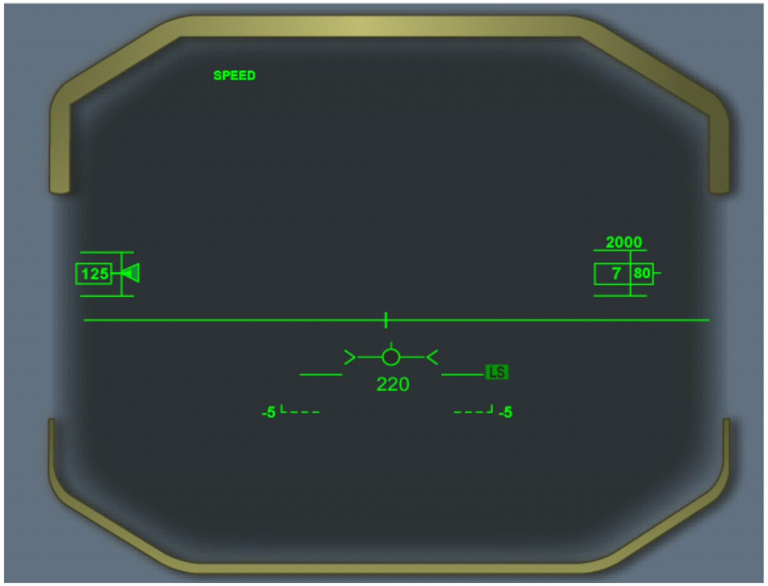
There are two levels of declutter in the approach phase and one in all other flight phases.

HUD display during the Approach phase in:

Declutter 1 mode



Declutter 2 mode



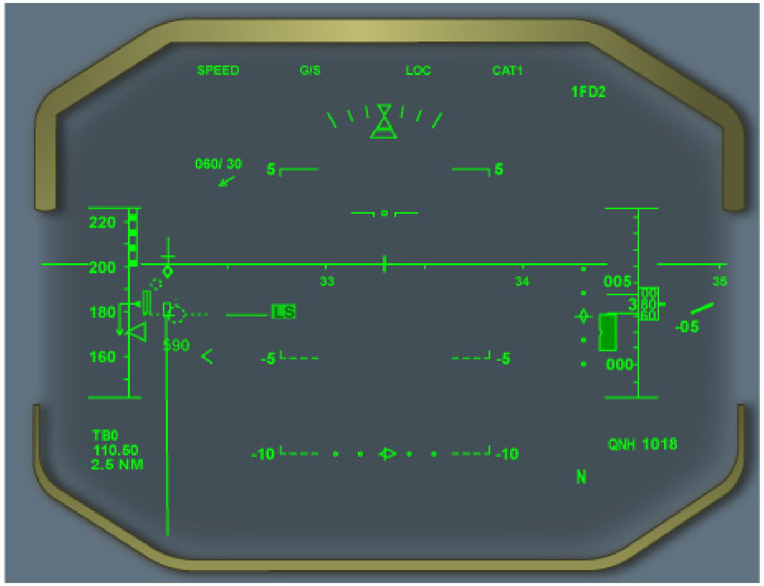
Crosswind

When flying in crosswind conditions, the aircraft trajectory and guidance symbols may reach the border of the display zone.

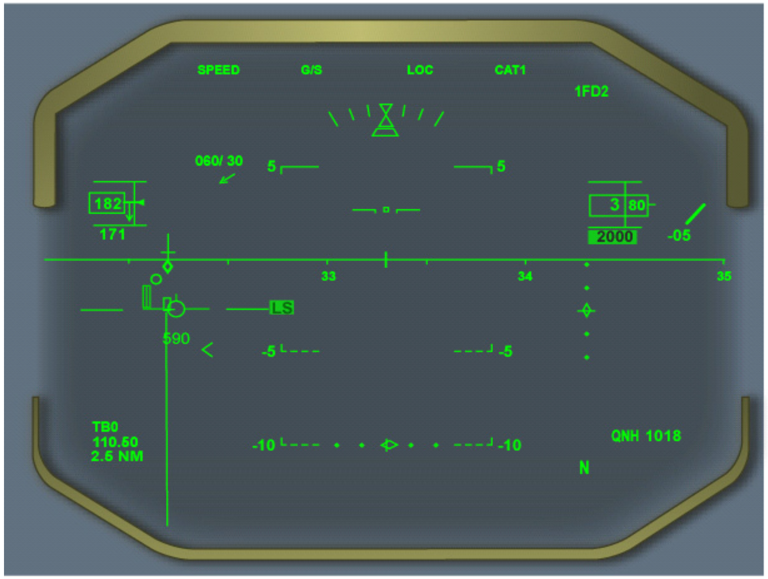
In flight, the flight crew can reduce the speed and altitude scales, by using the X WIND sw on the glareshield, in order to maintain adequate visibility of the symbols.

The X WIND sw has no effect when the aircraft is on ground.

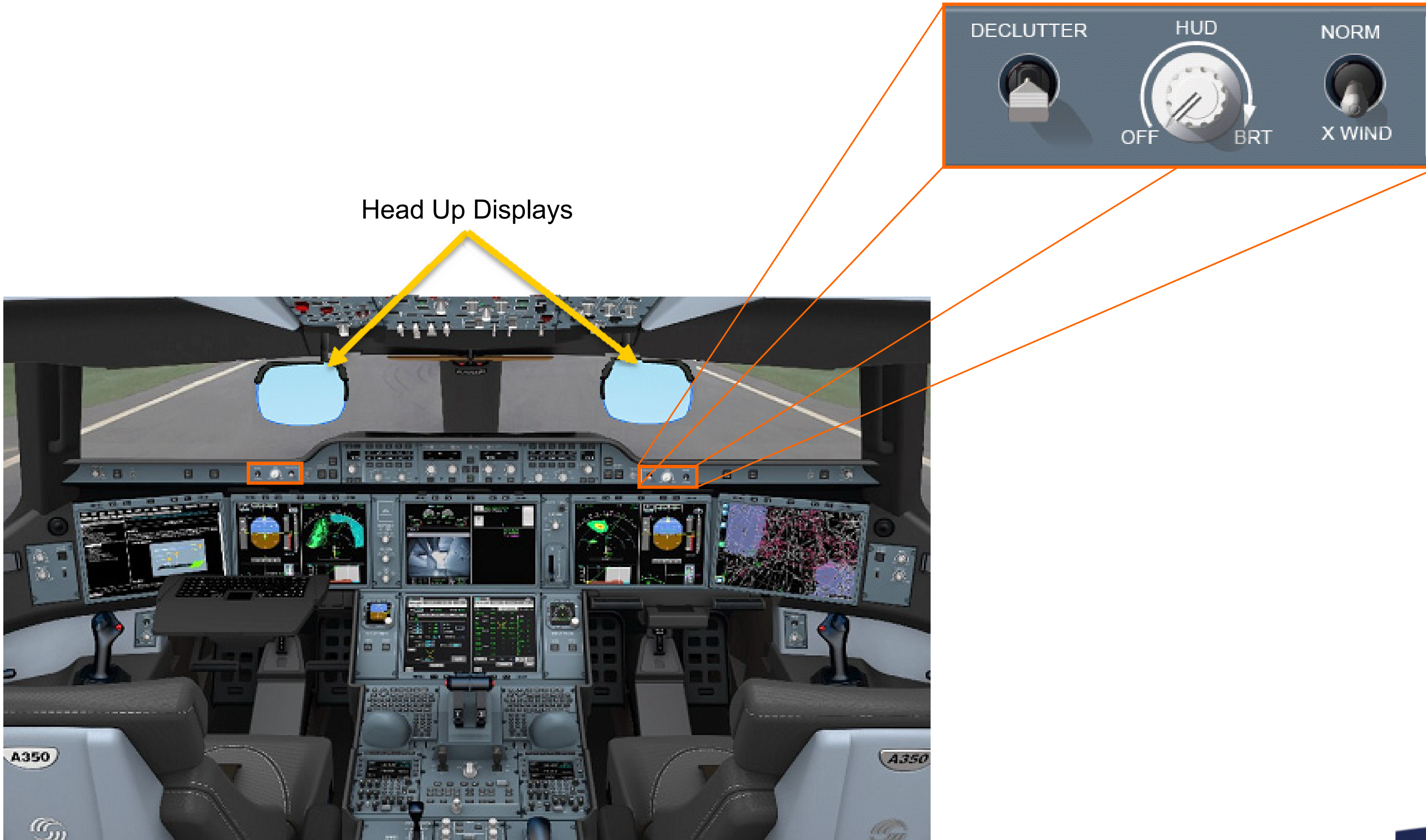
Normal mode



X Wind mode

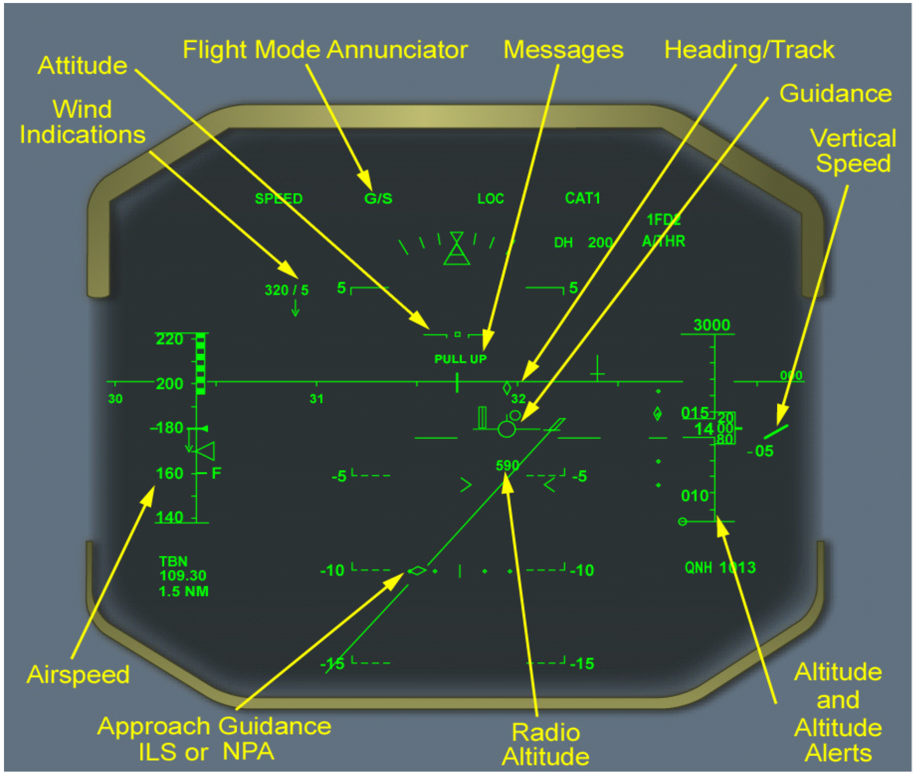


Controls and Indicators

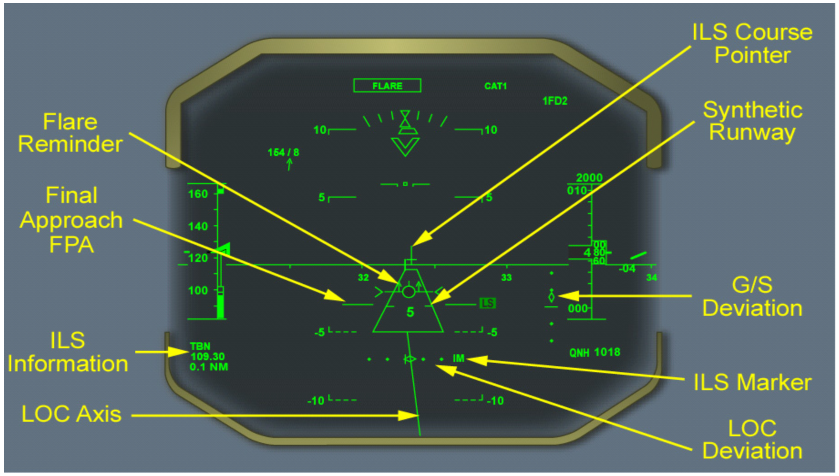


5.Head-Up Display

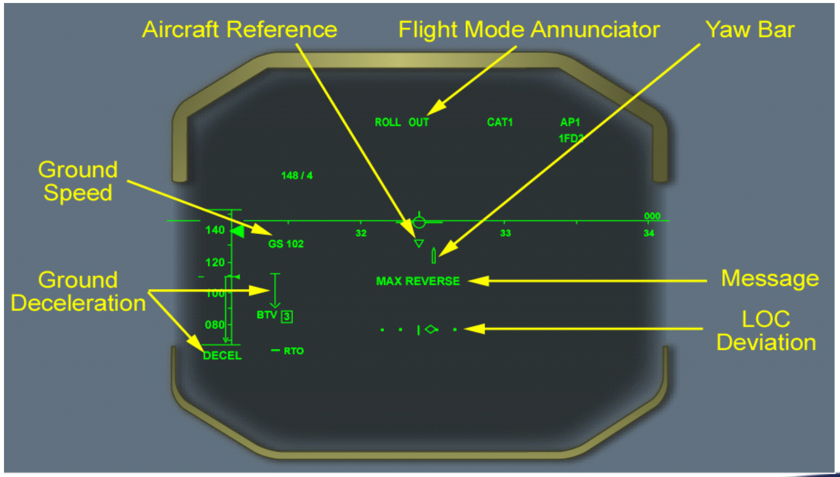
Basic HUD Symbology



Approach Phase (Normal Mode)



Roll Out Mode



General

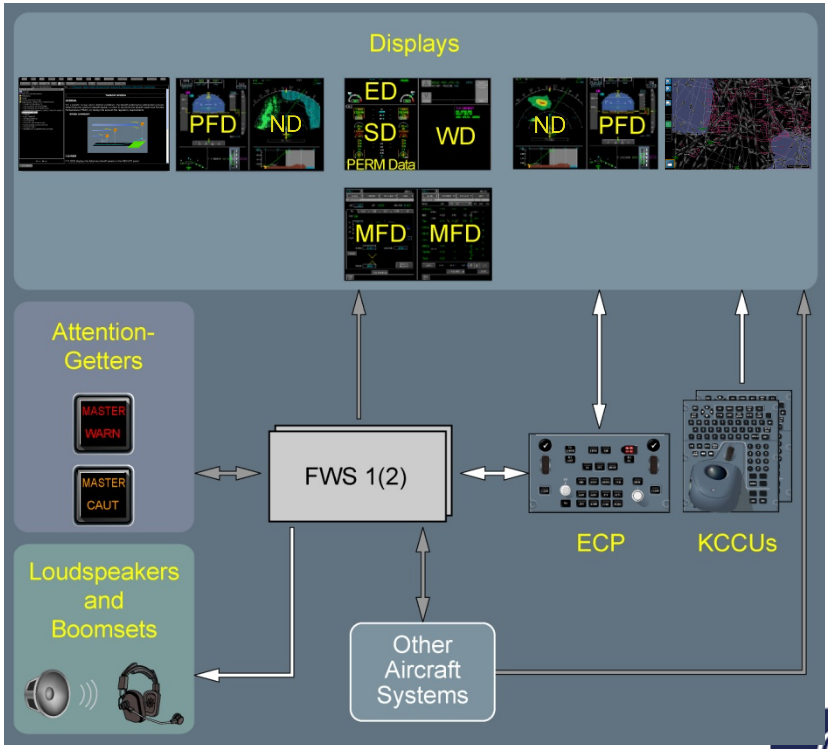
The Electronic Centralized Aircraft Monitoring (ECAM) function assists the flight crew in managing and monitoring the aircraft systems during both normal and abnormal conditions.

The ECAM:
- Displays aircraft system information
- Monitors aircraft systems and triggers alerts
- Indicates required flight crew actions in abnormal and emergency situations
- Provides operational information to the flight crew
- Displays the checklists.

The ECAM has:
- Two Flight Warning Systems (FWS) that compute alerts and manage the display of the ECAM information
- One ECAM Control Panel (ECP)
- Two sets of visual attention-getters
- Four loudspeakers for aural indicators.

The ECAM can display information on the:
- Engine Display (ED)
- System Display (SD)
- Permanent Data
- Warning Display (WD)
- Primary Flight Display (PFD)
- Multi-function Display (MFD)

ECAM Architecture



Operation

In **normal aircraft condition**, the ECAM provides the necessary information to assist the flight crew to operate and monitor the aircraft systems:

- SD pages on the SD: The SD pages are automatically displayed in accordance with the flight phase, but can also be requested manually
- Memos (e.g. SEAT BELTS, ENG A-ICE, T.O and LDG memos) on the WD and PFD
- Normal checklists on the MFD, on flight crew request.

The ECAM also emits:

- Altitude alerts
- Automatic callouts during approach.

Note: The ECAM also computes flight phases to inhibit alerts and memos that can be delayed to a more appropriate time (e.g. inhibition during takeoff).

In **abnormal aircraft condition**, the ECAM helps the flight crew to manage system failures and aircraft abnormal configurations by:

- Producing visual and aural alerts, if failures are detected
- Providing associated sensed procedures and associated limitations and memos, if any
- Displaying the applicable system SD pages
- Providing access to not-sensed abnormal and emergency procedures, and deferred procedures on flight crew request.

Definition:

- A sensed procedure is a procedure that the ECAM automatically activates and displays
- A not-sensed procedure is a procedure that the flight crew manually activates and displays
- In some cases, an emergency or abnormal procedure has complementary actions that the ECAM delays to a more appropriate time, later during the flight. These complementary actions are referred to as deferred procedures.

Automatic Display of System Display Pages in Accordance with the Flight Phase

Condition	SD Page
- Before first engine start, or - During 5 minutes after last engine shutdown	DOOR
- When the APU MASTER sw is set to ON. No longer appears when: - APU is AVAIL for 10 s, or - The APU MASTER sw is set to OFF	APU
- When the ENG START selector is set to IGN/START until the end of the start sequence, or - When at least one engine is in cranking, or - From the setting of takeoff power to thrust reduction altitude or 1 500 ft AGL, whichever occurs first	ENGINE
- During taxi-out, until takeoff thrust is set, or - After landing gear extension, until last engine shutdown	WHEEL
- During F/CTL checks	F/CTL
- At 1 500 ft AGL or at the thrust reduction altitude, whichever occurs first, until landing gear extension in approach	CRUISE

Note:
An SD page manually selected by the flight crew has priority over an SD page that automatically appears depending on the flight phase.

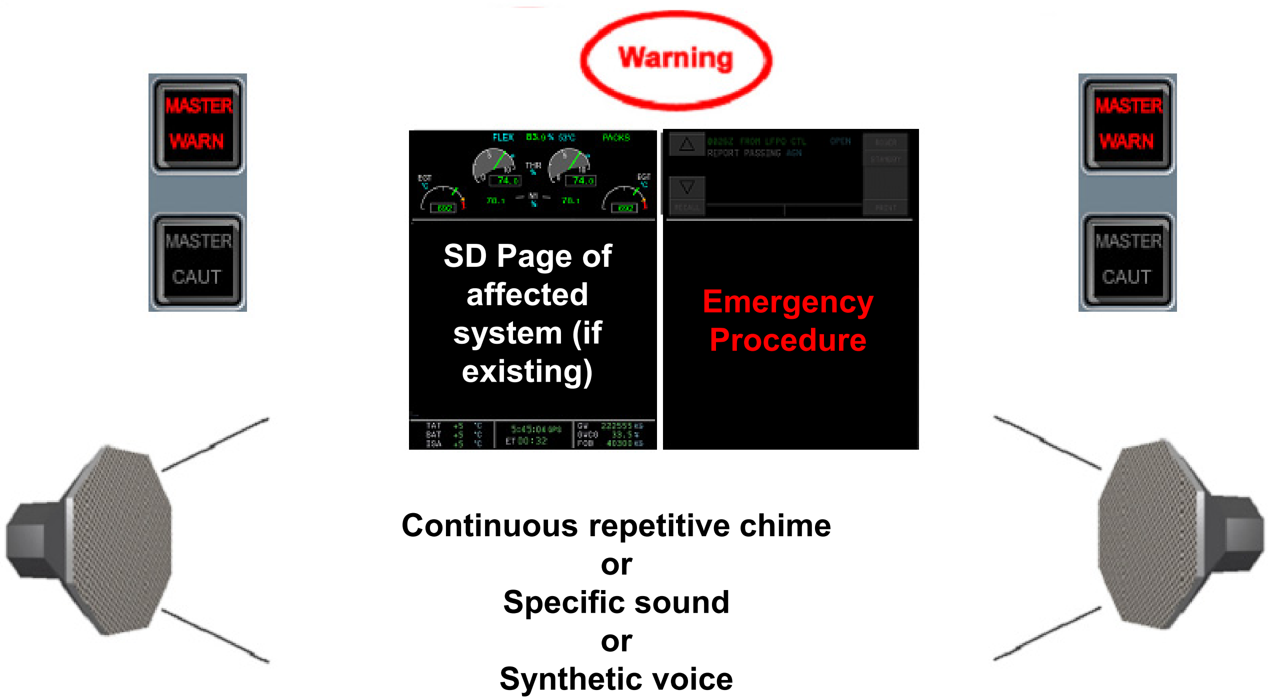
Color Codes

The ECAM displays information in various colors. Each color indicates the importance of the displayed information, or of the failure.

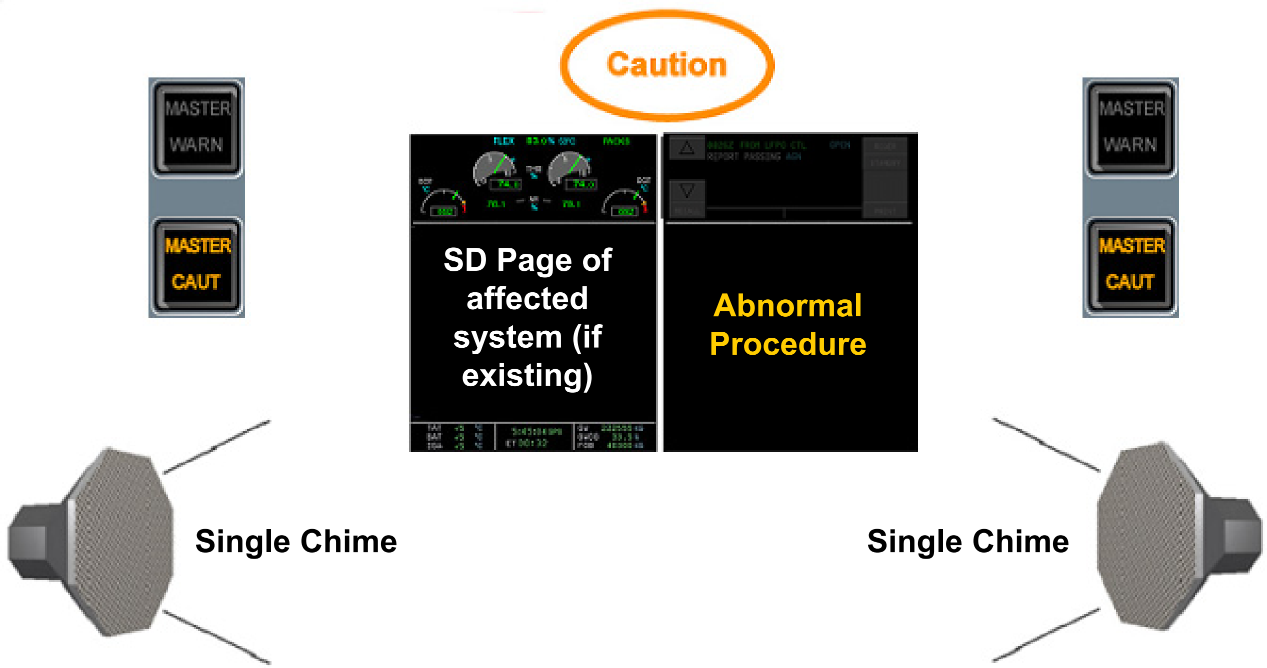
RED	• For configurations or failures requiring immediate action.
AMBER	• For configurations or failures requiring awareness but not immediate action.
GREEN	• For information in procedure, or in the STATUS SD page. • For checklist items completed by the flight crew. • For memo items.
WHITE	• For a procedure completed by the flight crew. • For submenus, condition lines, and titles. • For more information item on the STATUS MORE SD page. • For a completed deferred procedure title in the checklist menu.
BLUE	• For actions to be completed, limitations to be followed, checklist items to be checked, or for not completed checklists in the checklist menu.
MAGENTA	• For a specific memo (e.g. T.O or LDG inhibition).
GRAY	• For checklists completed by the flight crew. • For an action not yet validated by the flight crew (e.g. condition items or a not-sensed procedure that are not activated).

ECAM Alerts

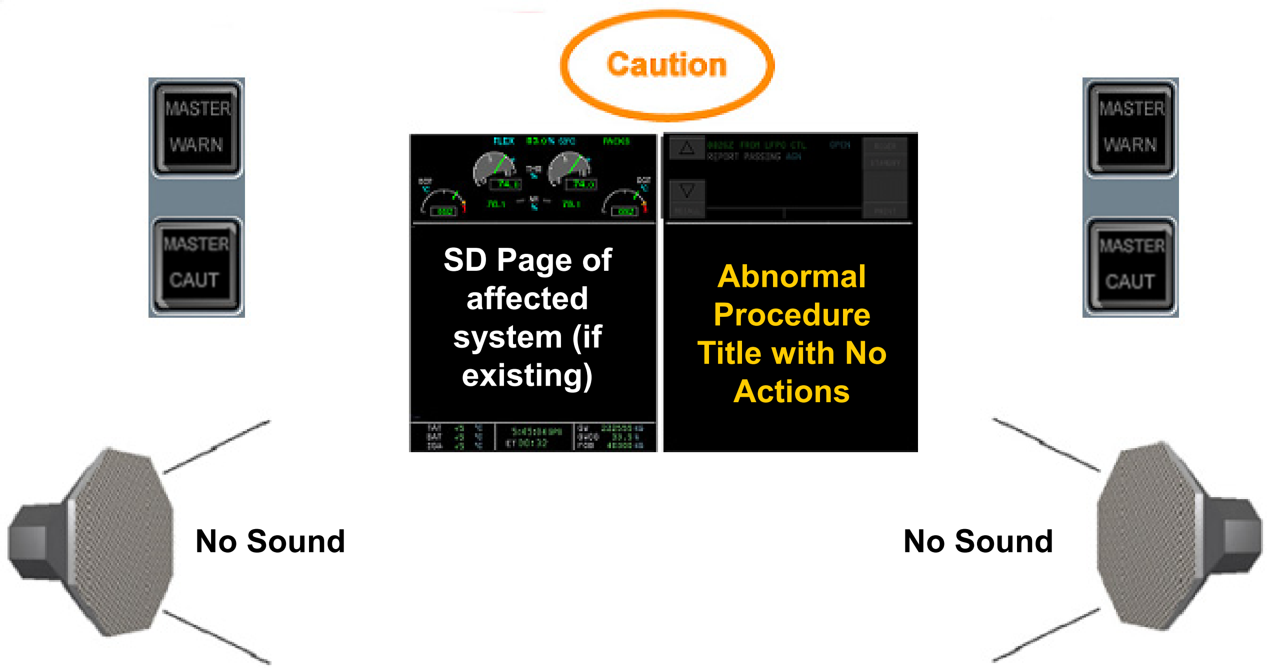
Alert Type	Description
Warning	For an emergency situation that requires immediate crew action: • The aircraft is in a dangerous configuration or in a limiting flight condition (e.g. engine on fire) • Failure of a system that impacts the safety of the flight (e.g. excessive cabin altitude).



Alert Type	Description
Caution	For an abnormal situation requiring awareness but not immediate action: • Failure of a system that does not impact the safety of the flight. However, to prevent any subsequent degradation of the affected system, a crew action is required whenever possible.



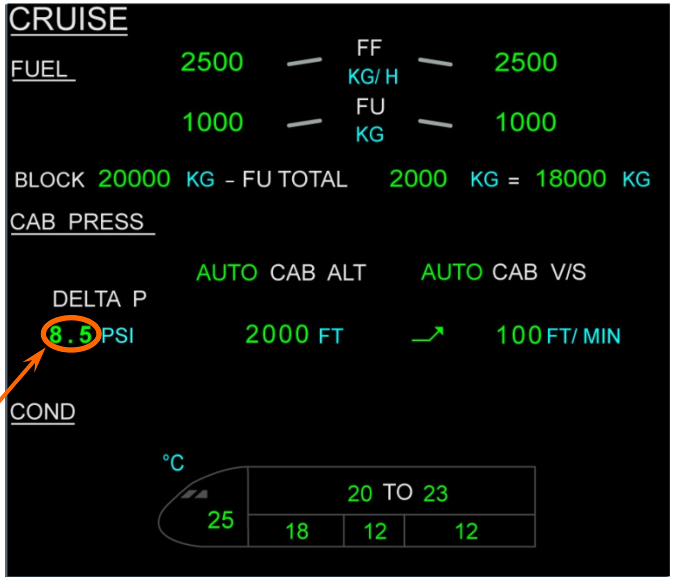
Alert Type	Description
Caution	For a situation that requires the flight crew to be informed (crew awareness), but does not require a flight crew action (e.g. redundancy loss or system degradation).



Advisory	Description
	An advisory indicates that a monitored parameter of a system goes out of its normal operational range, but does not reach a level that triggers an alert.

If there is an advisory condition, the ADV reminder appears on the WD.

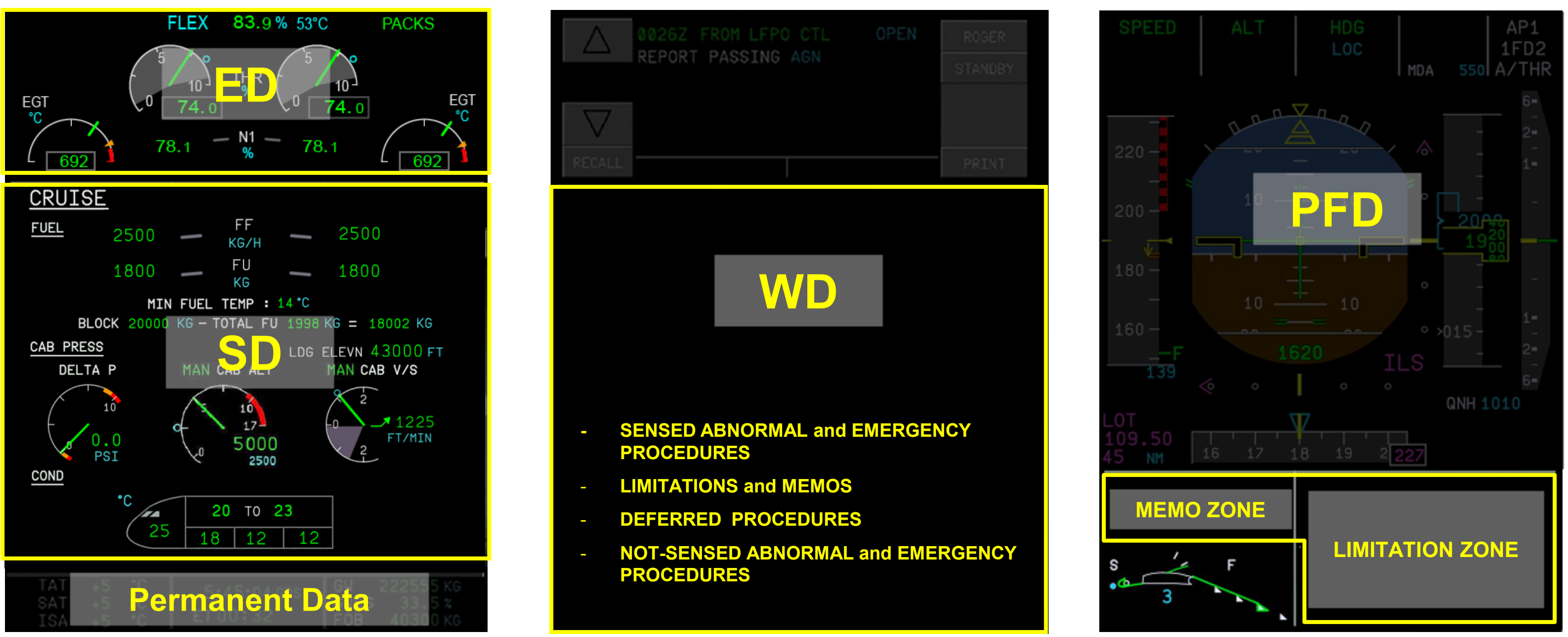
The applicable SD page is automatically displayed. The parameter that deviates from its normal range pulses.



ECAM Displays

The ECAM information appears on the following displays:

- Warning Display (WD)
- Engine Display (ED)
- System Display (SD)
- Permanent Data
- Primary Flight Display (PFD)
- Multi-function Display (MFD) (refer to *Multifunction Display*)



Warning Display (WD)

The WD displays:

- All the memos and limitations
- Sensed abnormal and emergency procedures that automatically appear, if there is an ECAM alert
- Deferred procedures
- Not-sensed abnormal and emergency procedures and associated menus requested by the flight crew
- Advisory Indications, if a monitored parameter deviates from its defined operational range.

Note:

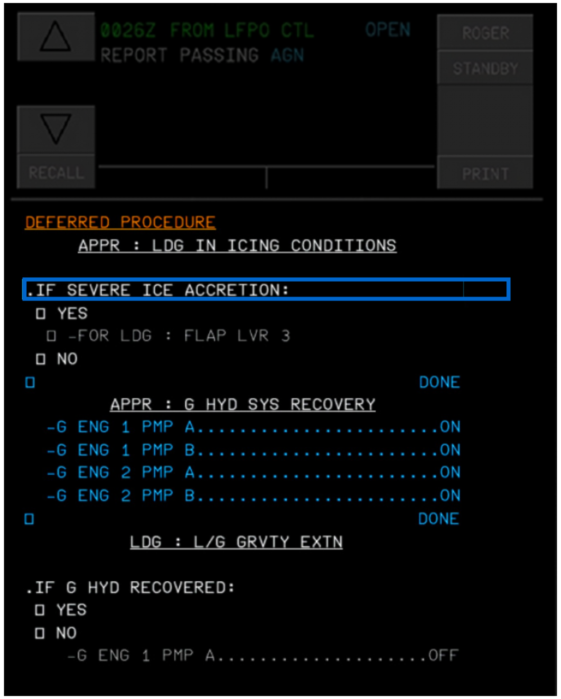
- *If a system fails or if the aircraft is in abnormal configuration, the ECAM may delay some actions to a more appropriate time, later in flight. These actions are called **deferred procedures**.*

- *The **not-sensed abnormal and emergency procedures** are specific procedures which correspond to system failures and some aircraft configuration that the ECAM is unable to detect or that requires airmanship before activation (e.g.: fuel jettison procedure).*

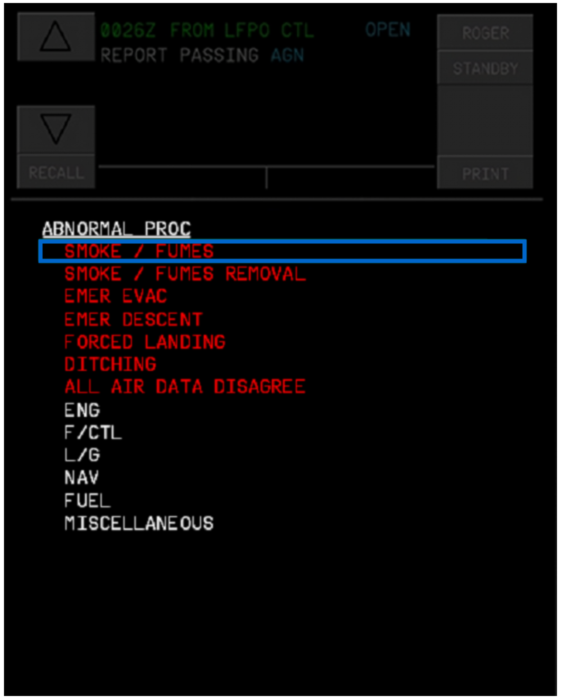
Abnormal and Emergency Procedures

Limitations and Memos

Deferred Procedures



Not-Sensed Procedures Menu



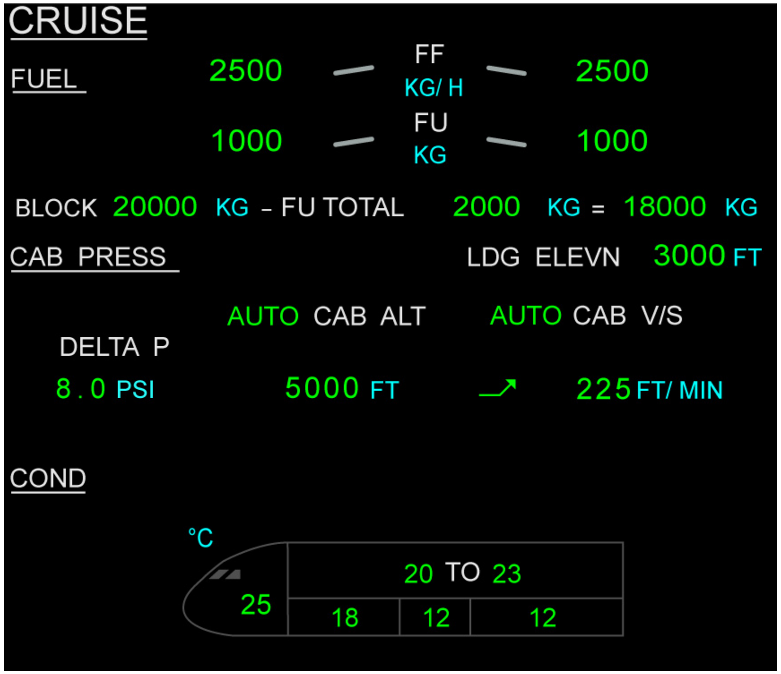
System Display

The SD displays:

- In normal aircraft condition:
  - A manually called SD page or a predefined SD page, depending on ECAM flight phases (refer to ***Automatic display of System Display pages***).

- In abnormal aircraft condition :
  - The SD page of the system related to the ECAM alert
  - The STATUS SD page after the flight crew has cleared the procedure(s) on the WD. The STATUS SD page indicates the aircraft status by displaying limitations and deferred procedures (if any), inoperative systems and general information.

CRUISE SD Page



Permanent Data

When MORE appears next to the STATUS title, or next to the system page title, it indicates that the MORE page is available. The MORE page provides information in addition to the STATUS page, or to a system synoptic page.

The different SD pages are:

- APU for APU status and parameters
- BLEED for bleed parameters
- C/B for that provides a list of the tripped circuit breakers
- CAB PRESS for cabin pressurization status and parameters
- COND for air conditioning status and parameters
- CRUISE with some data from fuel, air conditioning and pressurization systems
- DOOR/OXYGEN for Doors/Oxygen status and parameters
- ELEC AC for AC electrical power status and parameters
- ELEC DC for DC electrical power status and parameters
- ENG for secondary engine parameters
- F/CTL for flight controls status
- FUEL for fuel system status and parameters
- HYD for hydraulic system status and parameters
- WHEEL for landing gear, braking status and parameters.

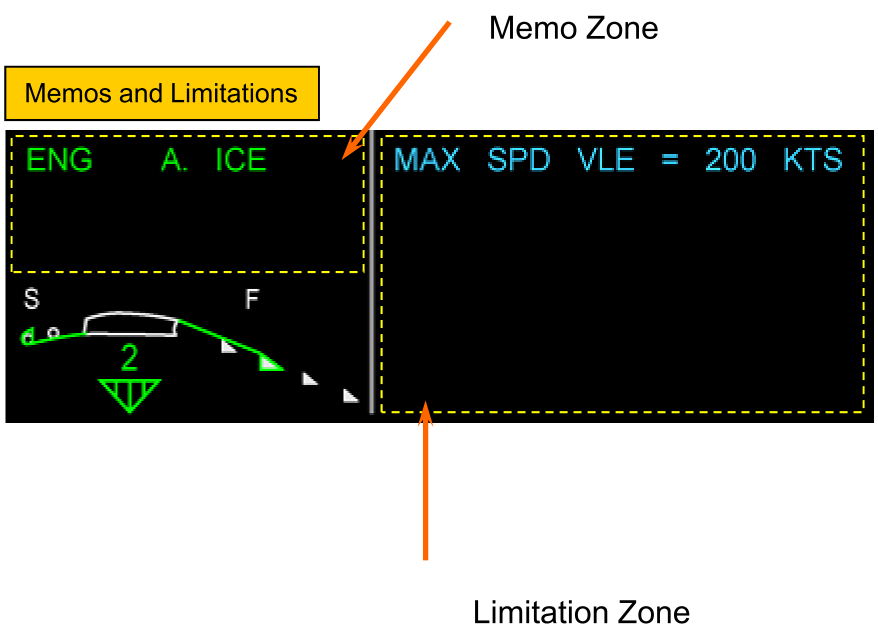
The Permanent Data displays below the SD page. It gives temperature, time and aircraft weight information.

Note: The flight crew interfaces with the time data via the FMS POSITION/TIME page of the MFD.

Primary Flight Display

The ECAM displays limitations and memos on the lower part of the PFD:

- For limitations that have an immediate effect on the flight
- To increase the flight crew awareness on memos.



Controls and Indicators

ECAM Control Panel

Validates, selects or deselects the item that is in the selection box on the WD

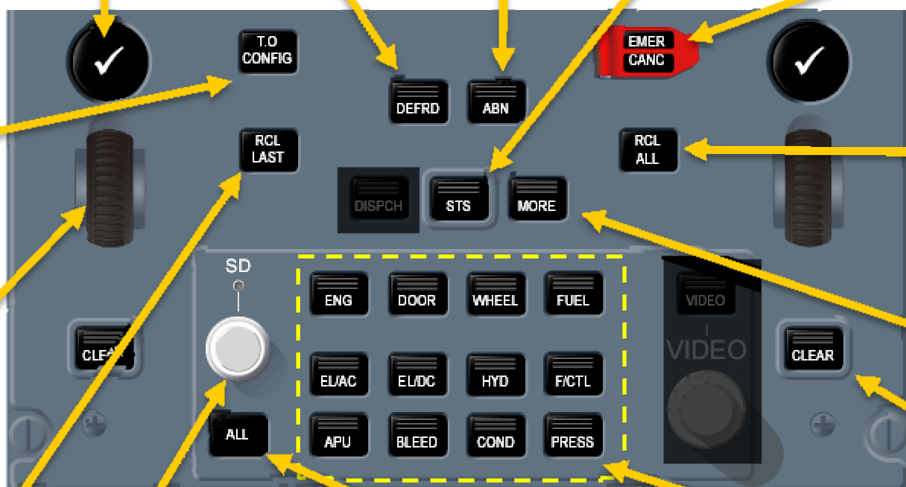
Displays the menu of not-sensed abnormal and emergency procedures

Displays the deferred procedures, if any

Displays the STATUS page

Cancels ECAM alerts, turns off the attention-getters, deactivates the procedures

Initiates a takeoff configuration test



Displays all ECAM procedures that were previously performed and are still active

Scrolls through a procedure or a procedure menu on the WD

Displays the STATUS MORE page

Clears the display

Displays the last ECAM procedure that was previously performed (if still active)

Displays the SD page menu to select a SD page

When pressed and maintained, the SD successively displays all the SD pages at one second intervals

Display the SD pages

Attention-Getters

Overview

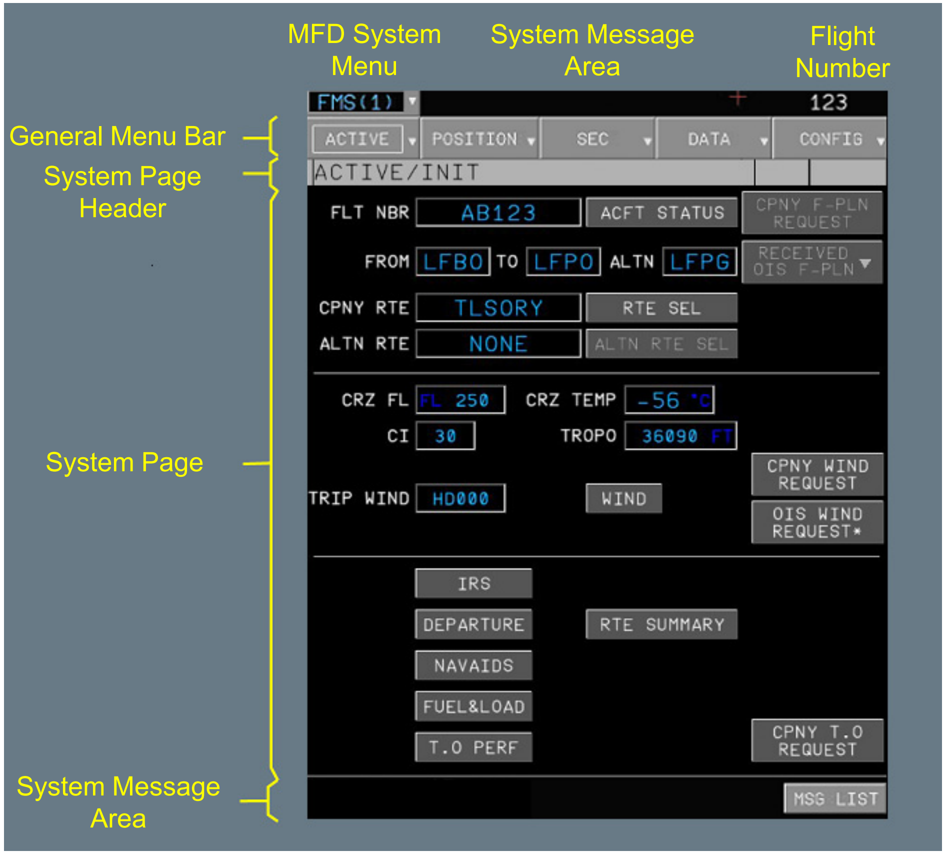
The CDS has two **Multifunction Displays (MFDs).** The MFD is a software interface used to monitor and control systems or specific functions. This software interface designed for long term use provides generally a full set of controls. This software interface can be associated to a hardware interface designed for quick access and with limited functions.

Five systems or functions are accessible through MFD interface:

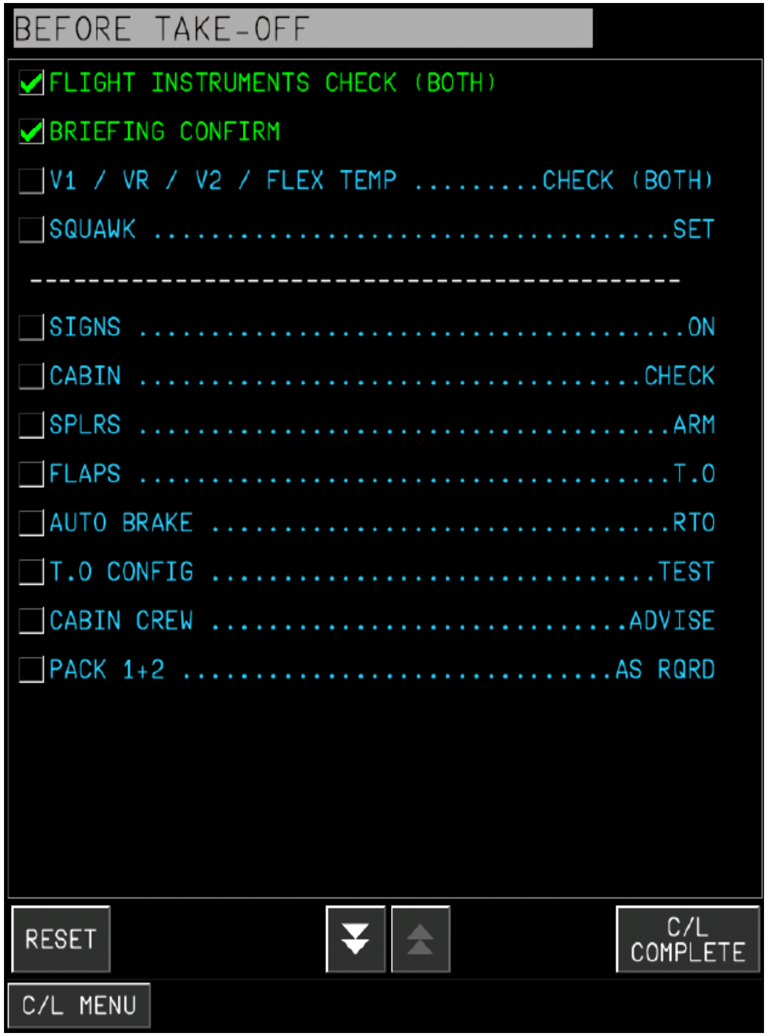
- **Flight Management System (FMS)**
  The MFD displays Flight Management System textual data. There are more than 50 FMS pages that provide information on the flight plan, aircraft position and flight performance
- **Electronic Centralized Aircraft Monitoring (ECAM)**
  The MFD displays the normal check lists (C/L MENU)
- **Air Traffic Control Communication (ATCCOM)**
  The MFD displays the ATCCOM page used for datalink communication.
- **Surveillance (SURV)**
  The MFD displays a backup software version of the SURV panel.
- **Flight Control Unit backup function (FCU BKUP)**
  The MFD displays a backup software version of the AFS CP and of the EFIS CP.

The MFD is interactive: The flight crew can navigate through the pages and can consult, enter or modify the data via the KCCU.

MFD FMS Page

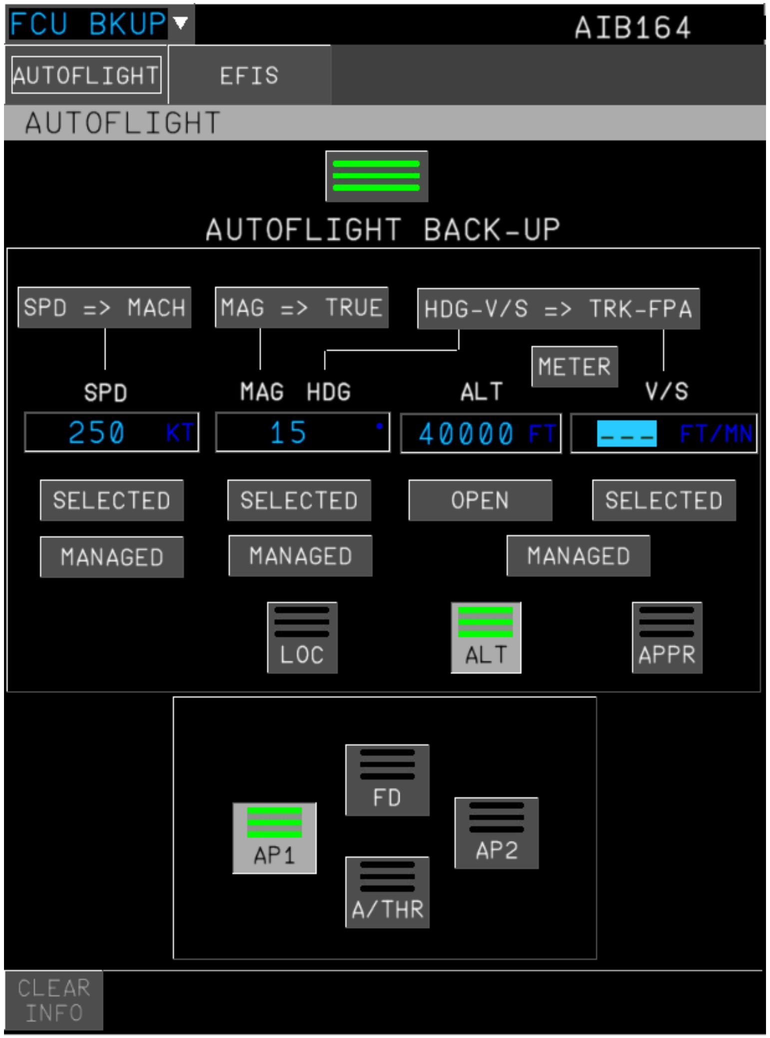


Check List



MFD ATCCOM Page

MFD FCU BKUP Page



MFD SURV Page

The **Onboard Information System (OIS)** is a set of electronic documentation and applications for flight, maintenance and cabin operations. For the flight crew, these applications replace the former paper documentation and charts.
The main objective of the electronic documentation is to provide the flight crew with an attractive documentation viewer, that enables an easy access to the necessary information related to an operational need.

The OIS applications can be divided into:
- Tools for flight operations support
- Tools for maintenance operations support
- Tools for cabin operations support
- Services to the passengers, flight crew and cabin crew.

Overview

The cockpit has two **Keyboard and Cursor Control Units (KCCUs)**. Both are on the center pedestal.

The KCCUs enable the flight crew to directly interact with the onside ND, MFD, OIS and the mailbox section of the SD. Each KCCU displays a different cursor. In addition, the KCCU can also interact with the offside MFD.

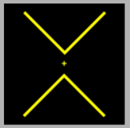
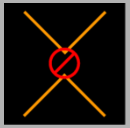
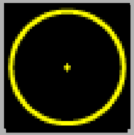
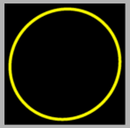
The KCCU has two interfaces:

- A keyboard (KBD)
- A cursor control device (CCD).

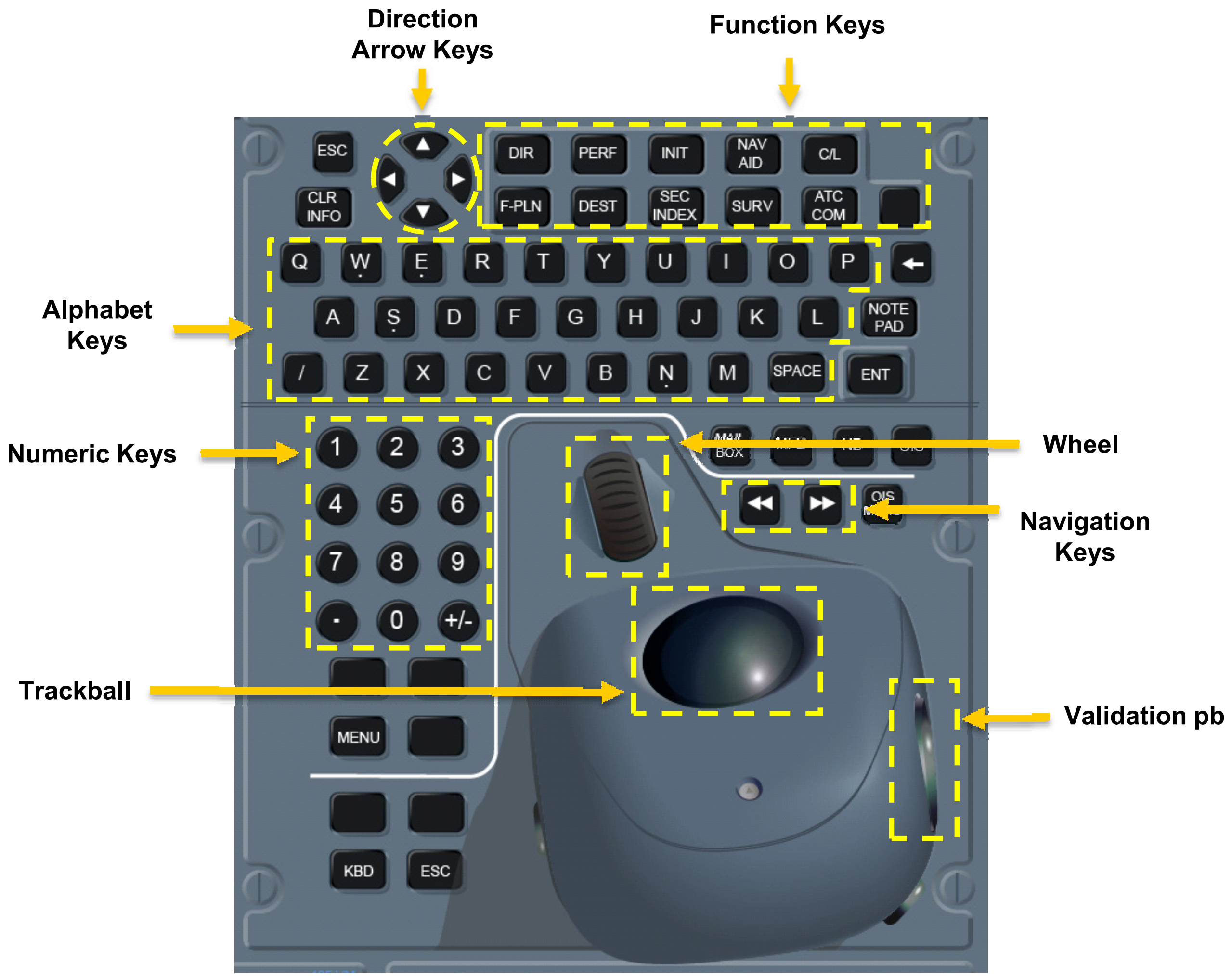
In normal operation the CCD enables the control of the cursor via the trackball of the CCD and the KBD enables to fill in the format fields.

In case of failure of CCD or KBD, the remaining available interface is able to perform both needs thanks to specific backup.

KCCU Cursors

	The Captain's cursor is active.
	The Captain's cursor is not active.
	The First Officer's cursor is active.
	The First Officer's cursor is not active.
	Appears when a cursor is to be displayed but is not yet active.

KCCU


Direction Arrow Keys
Function Keys
ESC
CLR INFO
DIR
PERF
INIT
NAV AID
C/L
F-PLN
DEST
SEC INDEX
SURV
ATC COM
Q W E R T Y U I O P
A S D F G H J K L
NOTE PAD
/ Z X C V B N M
SPACE
ENT
Alphabet Keys
Numeric Keys
1 2 3 4 5 6 7 8 9 . 0 +/-
Wheel
Navigation Keys
Trackball
Validation pb
MENU
KBD
ESC

Overview

The **Concentrator and Multiplexer for Video (CMV)** concentrates and multiplexes video signals coming from several aircraft video sources and transmits these signals to the CDS.

The different video sources are:

- The External and Taxiing Aid Camera System (ETACS), as an option
- Cockpit Door Surveillance System (CDSS) as an option
- Cabin Video Monitoring System (CVMS) as an option.

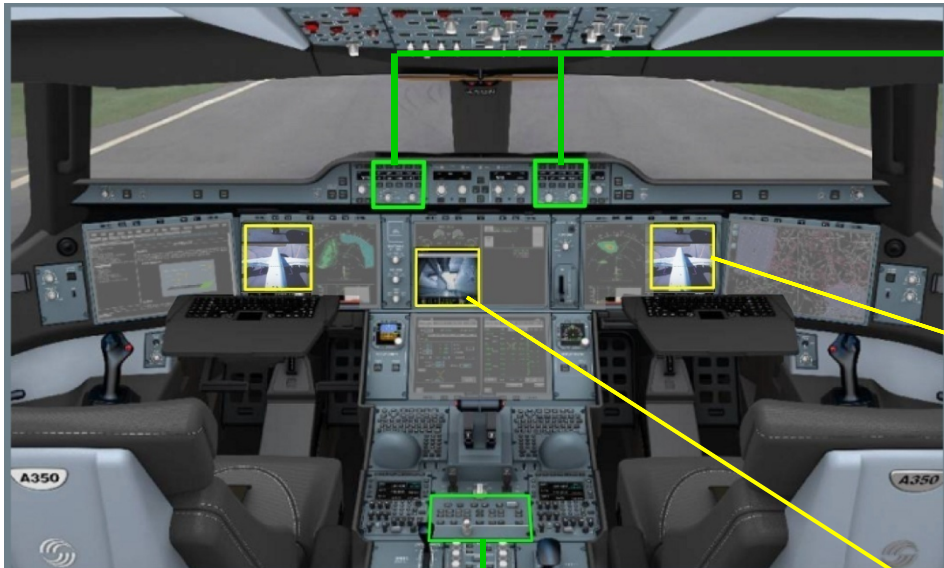
ETACS

CVMS

CDSS

A350 XWB

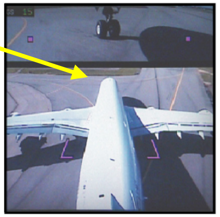
Displays and Control Panels Interactivity



EFIS CP

The TAXI pb displays the ETACS on the PFD

ETACS displayed on PFD



CVMS, CDSS and ETACS displayed on SD

ECAM CP

The VIDEO pb displays the video on the SD

The VIDEO knob enables to select the various videos to be displayed on the SD

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Recording Systems

A350 XWB

AIRBUS

Overview

The A350 has two recording systems:

- **The Flight Data Recording System (FDRS)** that records all mandatory flight data parameters on:
  - The Digital Flight Data Recorder (DFDR)
  - The Virtual Quick Access Recorder (VQAR)

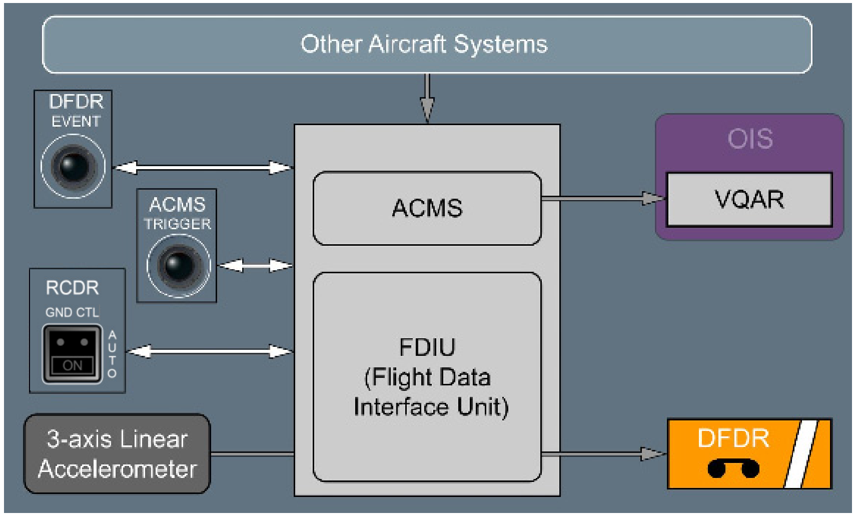
- **The Cockpit Voice Recording System (CVRS)** that records:
  - All voice communications to and from the flight deck between the aircraft and any other station or aircraft
  - All voice communications between cockpit crewmembers
  - All aural warnings
  - The cockpit environment
  - Datalink communication.

The Flight Data Recording System

The Flight Data Recording System (FDRS) has:

- **A Digital Flight Data Recorder (DFDR)**
  The DFDR records flight parameters and data from various aircraft systems
- **A Virtual Quick Access Recorder (VQAR)**
  The VQAR receives a copy of all the data recorded by the DFDR
- **A Linear 3-axis Accelerometer**
  This provides longitudinal, vertical, and lateral aircraft acceleration data to the recorder
- **A DFDR EVENT pb**
  The flight crew can use this pushbutton to flag an event (e.g. turbulence...) that occurred during the flight. This flag can then allow an easier and quicker data analysis by the Flight Operations/Training/Safety team of the airline. This flag is recorded in the VQAR
- **A RCDR GND CTL pb**
  The flight crew uses this pushbutton to manually start and stop the recorder on ground, when all engines are shut down (provided that the aircraft is electrically powered).

Flight Data Recording System Architecture



The Cockpit Voice Recording System

The Cockpit Voice Recorder System (CVRS) has:

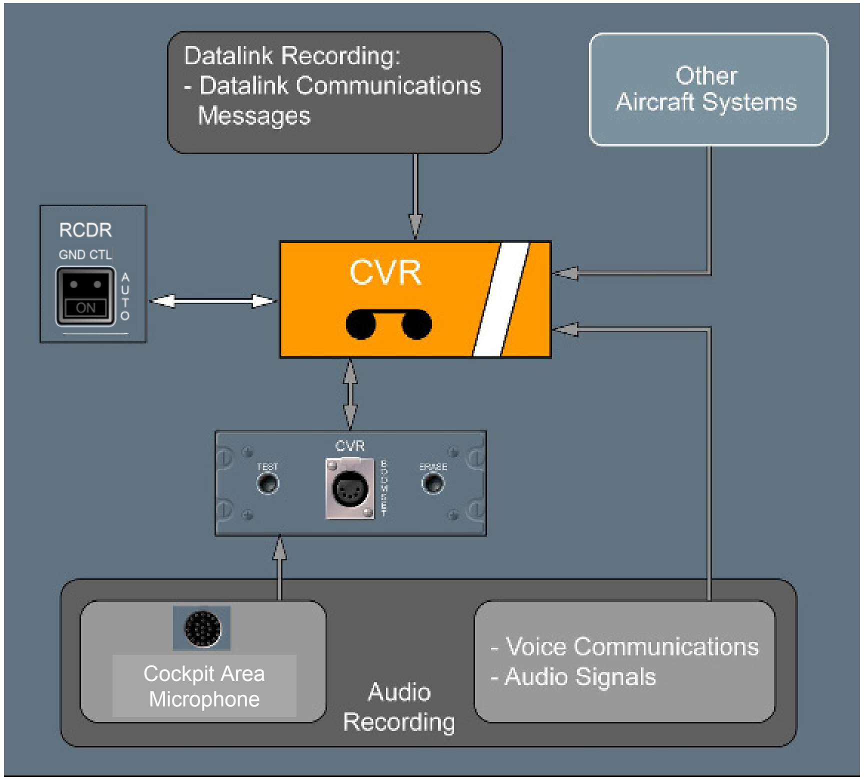
- **A Cockpit Voice Recorder (CVR)**
  The CVR stores all the audio and ATC communications

- **A Cockpit Area Microphone**
  This collects all cockpit sounds such as voice communications, aural warnings and all ambient noises

- **A CVR control panel**
  The flight crew uses this Control Panel to test the CVR, to erase the audio recording and to connect a boomset

- **A RCDR GND CTL pb**
  The flight crew uses this pushbutton to manually start and stop the recorder on ground, when all engines are shut down (provided that the aircraft is electrically powered).

Cockpit Voice Recording System Architecture



The recording system operates automatically:

- On ground
  - During aircraft power-up, the recording system will run for 5 minutes then stop
  - As soon as the first engine is started, the recording system will run and continue to record until 5 minutes after the last engine is shut down.
- In flight, permanently, with or without engines running.

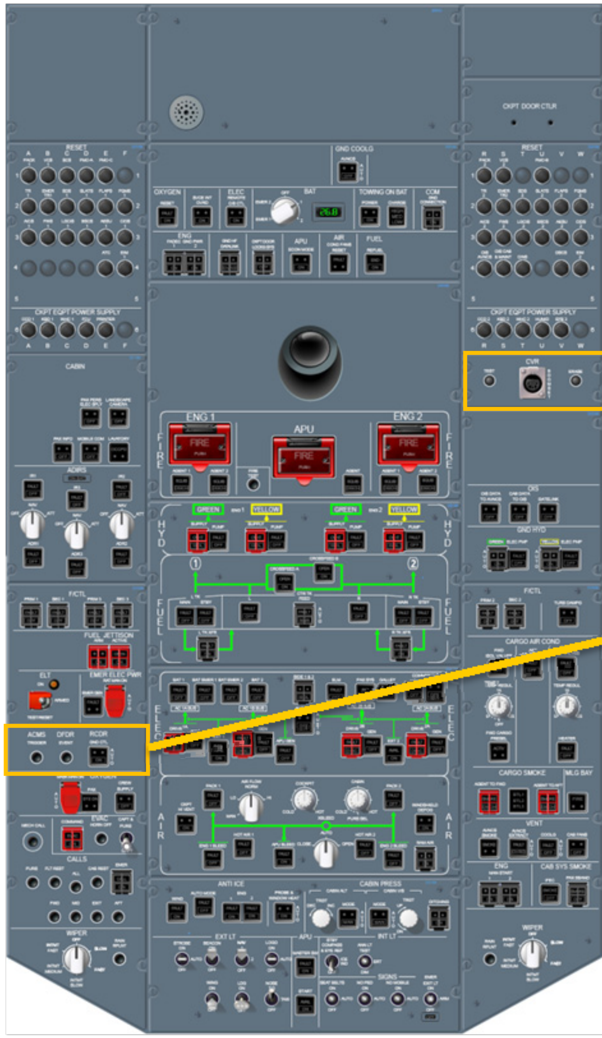
The flight crew can use the RCDR GND CTL pb to start or stop the recorders on ground.

It is not possible to stop the recorders in flight.

Cockpit View

FDRS Panel & RCDR
GND CTL pb

Overhead Panel



CVR Panel

FDRS Panel & RCDR GND CTL pb

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Landing Gear

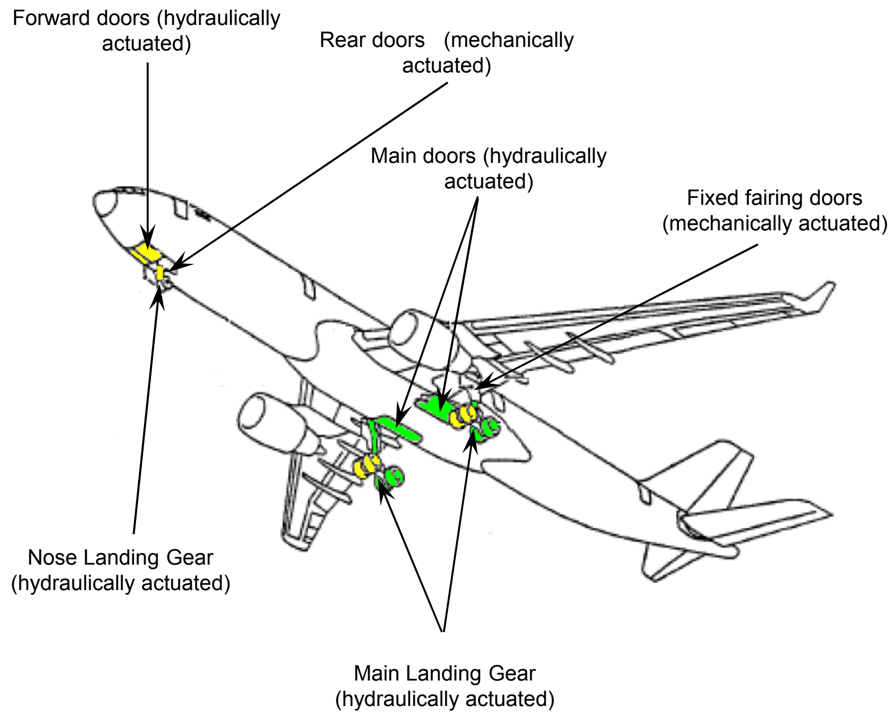
Overview

The A350 has:

- One Nose Landing Gear (NLG)
- Two Main Landing Gears (MLG)

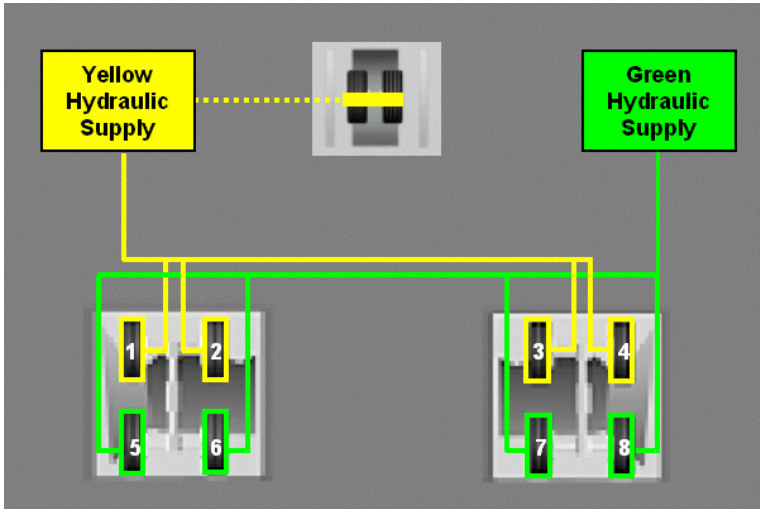
The following systems and functions are associated with the landing gear:

- The Landing Gears Extension and Retraction System
- The Braking System
- Antiskid and Autobrake Systems
- Brake To Vacate (BTV) Function
- Runway Overrun Warning (ROW) and Runway Overrun Protection (ROP)
- The Steering System
- Brake Temperature Monitoring System
- Tire Pressure Indication System
- Brake Cooling Fan Control (optional)

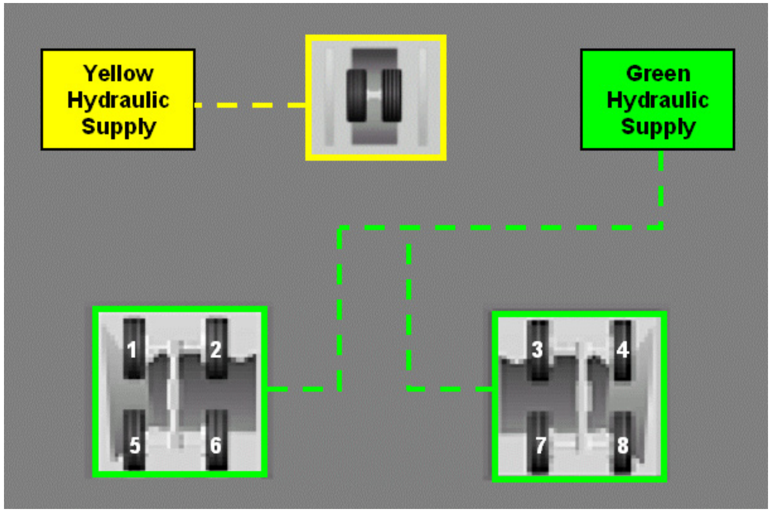


Hydraulic Distribution for Landing Gear, Brakes and Steering

Distribution for Brakes and Steering



Distribution for Landing Gear



Legend:

Brakes Supply

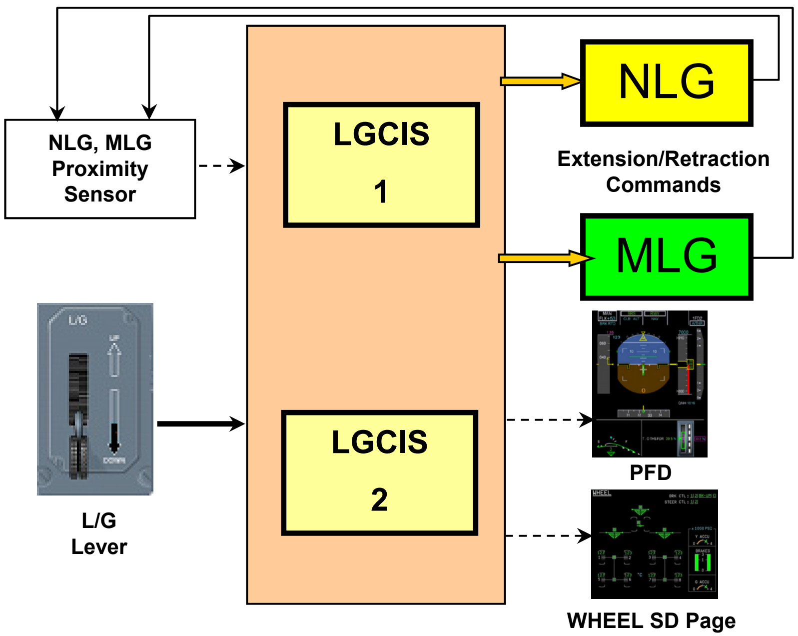
L/G Extension/Retraction Supply

Wheel Steering Supply

Landing Gear Extension and Retraction System

Normal Operation

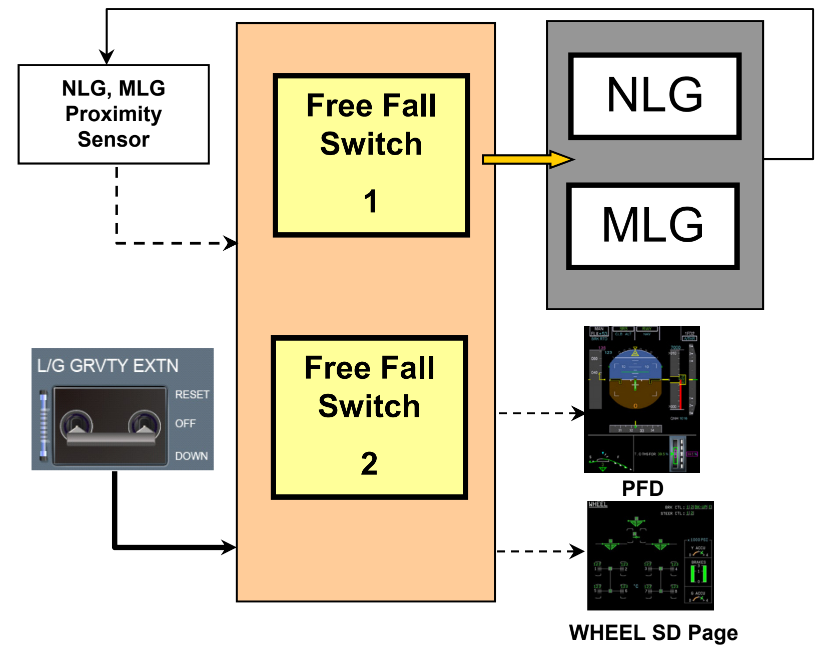
The landing gears hydraulically extend and retract. The **GREEN** hydraulic system powers the MLG and associated doors. The **YELLOW** hydraulic system powers the NLG and associated doors.



There are two Landing Gear Control and Indicating Systems (LGCIS). Only one is active at a time.
The active LGCIS monitors and electrically controls the extension and retraction sequences.
The active LGCIS changes after each landing gear extension.

Landing Gear Gravity Extension

If the normal extension and retraction system is not available, gravity-assisted landing gear extension can be performed using the independent freefall system. **Two free fall switches** monitor and electrically control the extension sequence.



The landing gear gravity extension is activated through the L/G GRVTY EXTN sw.

Braking System

The A350 has 8 carbon brakes. There is one brake on each MLG wheel.

The MLG has two wheel groups:

- The “Front” MLG group (wheels 1,2,3,4). The YELLOW hydraulic circuit supplies the brakes of this group.
- The “Rear” MLG group (wheels 5,6,7,8). The GREEN hydraulic circuit supplies the brakes of this group.

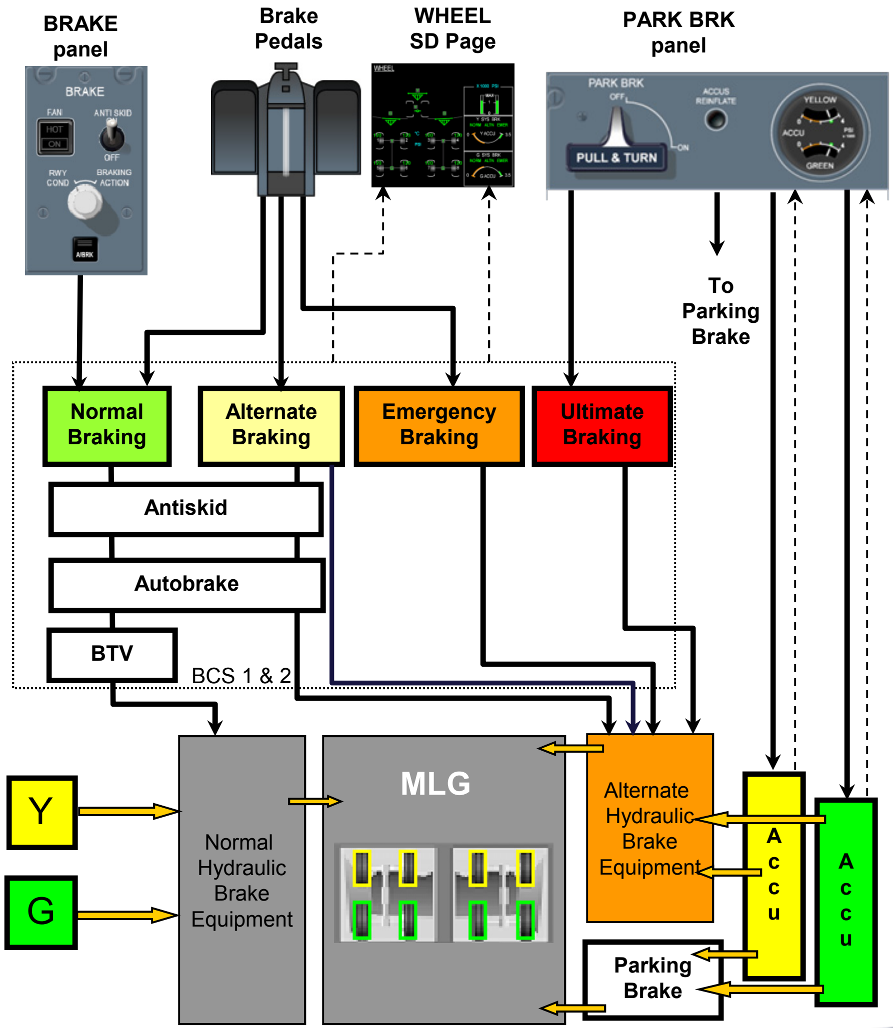
The braking system enables:

- **Manual braking** via flight crew action on:
  - The brake pedals
  - The PARK BRK handle.
- **Automatic braking** via:
  - The Autobrake which includes the Brake To Vacate (BTV) function.

The braking system has **5 braking modes**:

- Normal
- Alternate
- Alternate without antiskid
- Emergency
- Parking/Ultimate

Architecture



A350 Landing Gear
1. System Description

A350 XWB

Braking System Reconfiguration

Braking Modes	Hydraulic Power Supply	Cockpit Interface	Available Functions	Associated ECAM Alert	Braking Performance
NORMAL	GREEN and YELLOW	- Brake pedals - BRAKE Panel	- A-SKID - AUTO BRK - BTV - ROP - Differential braking	No associated alert	Normal performance except if the BRAKES RELEASED alert is displayed → Performance penalties
ALTERNATE WITH A/SKID	Two ACCUs	- Brake pedals - BRAKE Panel	- A-SKID - AUTO BRK - Differential braking	BRAKES NORM BRK FAULT ALL WHEELS	Normal performance except if the BRAKES RELEASED alert is displayed → Performance penalties
ALTERNATE WITHOUT A/SKID	Two ACCUs	- Brake pedals - BRAKE Panel	-Differential braking - Limited brake pressure	BRAKES A-SKID FAULT ALL WHEELS	Degraded performance
EMERGENCY	Two ACCUs	- Brake pedals	- Limited brake pressure	BRAKES A-SKID FAULT ALL WHEELS	Degraded performance
ULTIMATE	Two ACCUs	PARK BRK handle only	- PRK BRK applied on MLG only	BRAKES ALTN + EMER BRK FAULT ON ALL WHEELS	Degraded performance
PARKING	Two ACCUs	PARK BRK handle only	- PRK BRK applied on MLG only	N/A	

Note: Each Wheel Group can be in Normal, Alternate or Emergency mode independently of the other wheel group.

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Antiskid and Autobrake Systems

Antiskid System

The antiskid (A-SKID) optimizes manual and automatic braking performance by preventing any wheel lock.

For manual braking, the flight crew can achieve maximum braking performance by applying maximum deflection on the brake pedals.

For automatic braking, the flight crew can achieve maximum braking performance in Rejected Takeoff (RTO) mode.

The flight crew can switch off the A-SKID from the ANTI SKID selector in the cockpit.

Autobrake System

The autobrake is a function of the Braking Control System (BCS) that automatically decelerates the aircraft during landing, or in the case of a RTO.

Brake To Vacate (BTV) Function

The BTV function that is standard on the A350 brings a major evolution concerning the braking. It can be used on dry, wet, or contaminated runways.

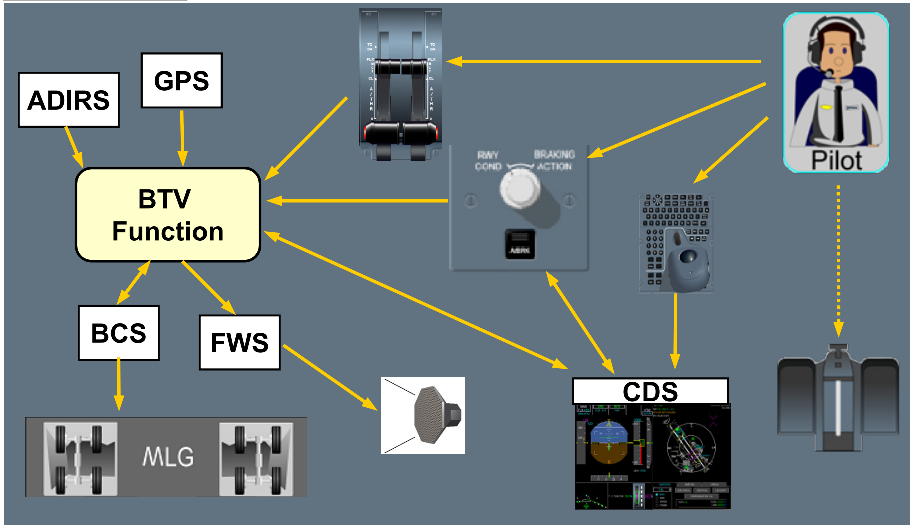
The BTV function is a new autobrake mode. It is hosted in the PRIM.

The BTV function :

- Automatically manages the braking to reach a runway exit pre-selected by the flight crew at a ground speed of 10 kt, 50 meters before that exit
- Improves pilots awareness regarding braking distance before and during the landing
- Optimizes the braking application
- Optimizes runway occupancy time
- Improves passenger comfort.

The flight crew can choose the airport and runway exit using the Onboard Airport Navigation System on the interactive ND, via the KCCU.

Architecture



Runway and Exit Selection

The flight crew selects the runway and the exit in PLAN Mode:

Runway Selection

Runway selection with KCCU

Exit Selection

Exit selection with KCCU

BTV Arming and Activation

BTV Arming

BTV arming with A/BRK pb (below 500 ft)

BTV is displayed in blue on the FMA

FMA

ND

BTV Activation

BTV activation at touchdown

BTV is displayed in green on the FMA

Steering System

The Nose Wheel Steering (NWS) system enables directional control of the aircraft on ground.

The flight crew can steer the aircraft via:

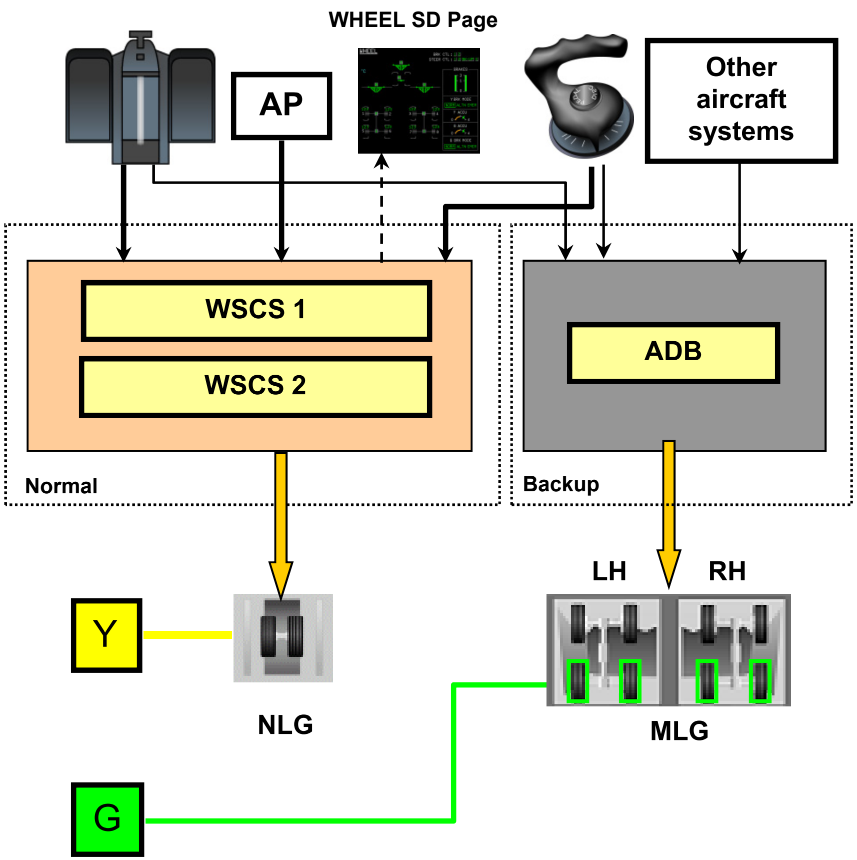
- The rudder pedals, or
- The steering handwheels.

The autopilot can also generate steering commands during an automatic landing.

The steering system has two redundant Wheel Steering Control Systems (WSCS) and two modes:

- In Normal mode, the YELLOW hydraulic circuit powers the NWS
- In Backup mode, the **Automatic Differential Braking (ADB)** provides a limited steering function. In this mode, the GREEN MLG brakes are used only. The flight crew still control the steering via the handwheel.

Architecture



Landing Gear Monitoring Systems

Brake Temperature Monitoring System

The Brake Temperature Monitoring System measures the temperature of each brake. The WHEEL SD Page displays temperature indications in the cockpit. An alert message warns the flight crew in the case of an abnormal situation.

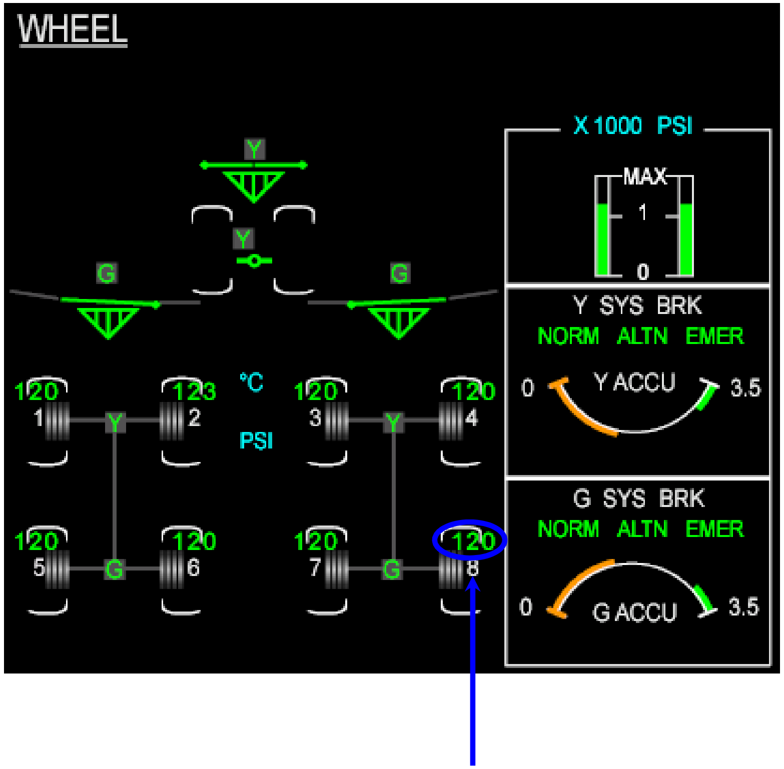
Tire Pressure Indication System

The Tire Pressure Indication System measures the pressure of each tire. The WHEEL SD Page displays pressure indications in the cockpit. An alert message warns the flight crew in the case of an abnormal situation.

Brake Cooling Fan Control (optional)

The A350 can be equipped with optional brake cooling fans on the main landing gears.

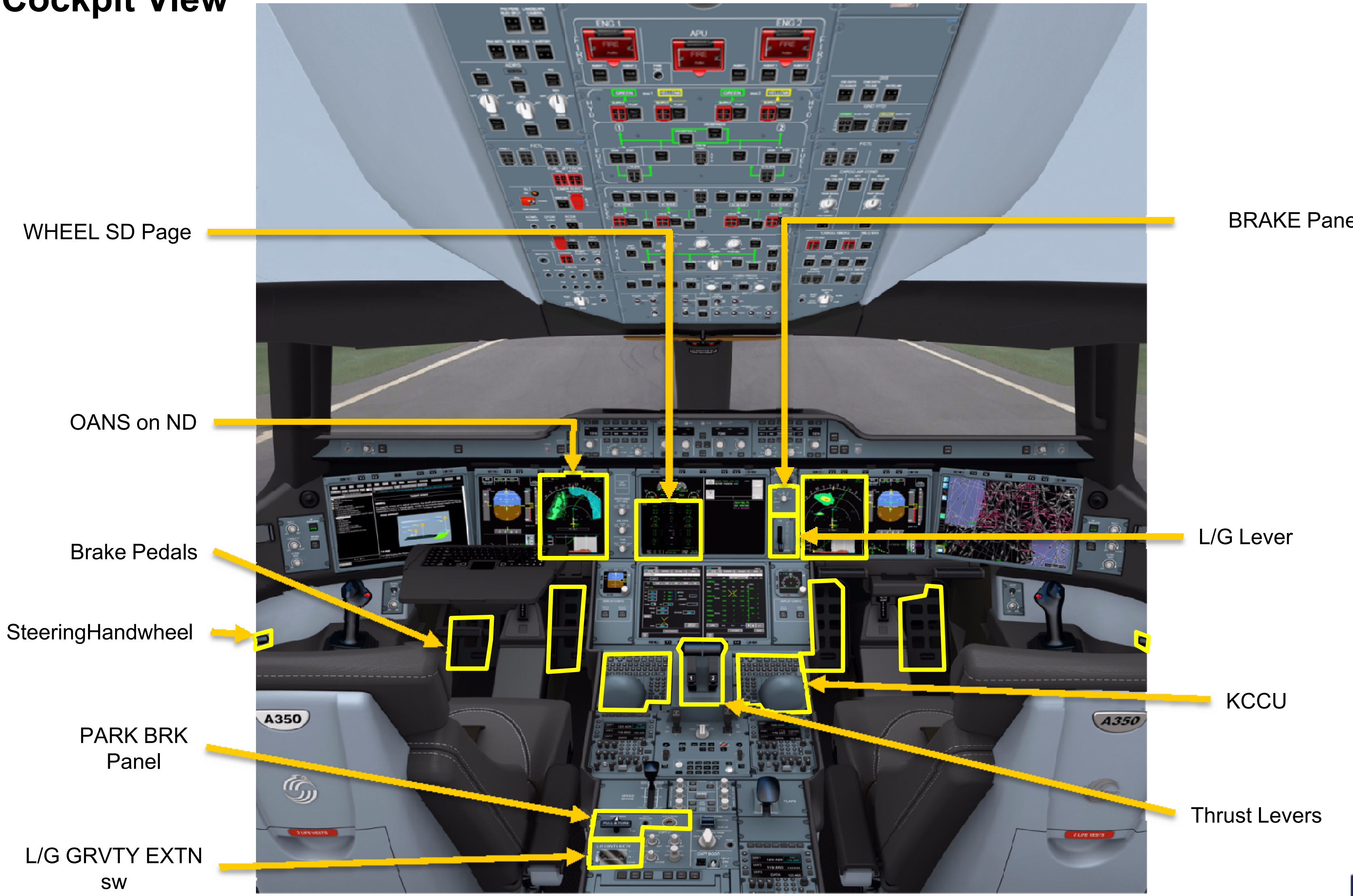
WHEEL SD Page



Temperature (°C)

Note: The pressure is shown only in case of failure.

Cockpit View



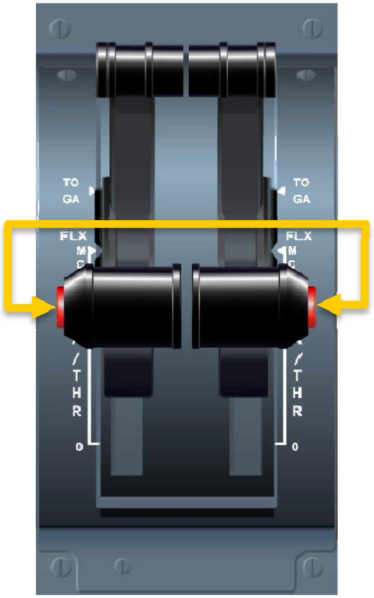
PARK BRK Panel

L/G GRVTY EXTN sw

KCCU

Thrust Levers

A/THR instinctive disconnection buttons

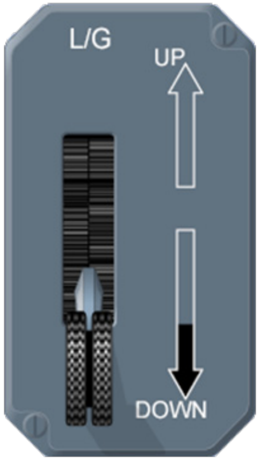


Autobrake and BTV instinctive disconnection using A/THR instinctive disconnection buttons

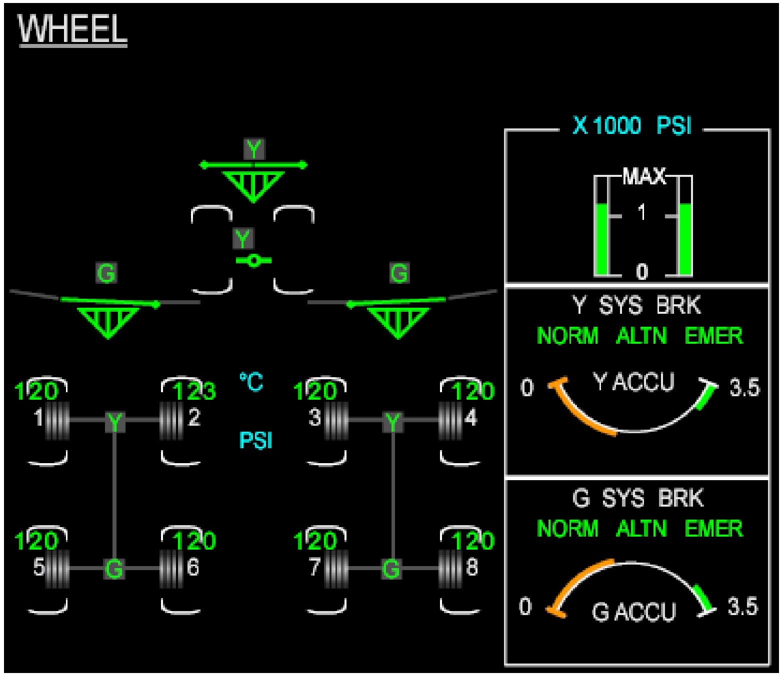
A350 XWB

BRAKE Panel

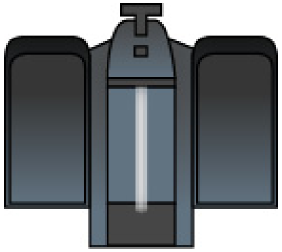
L/G Lever



WHEEL SD Page

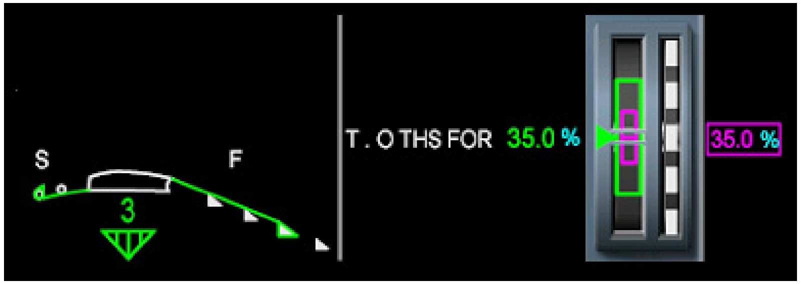


Brake Pedals



Steering Handwheel

L/G Display on PFD



AIRBUS

Autobrake Mode Annunciation on FMA

Autobrake Armed

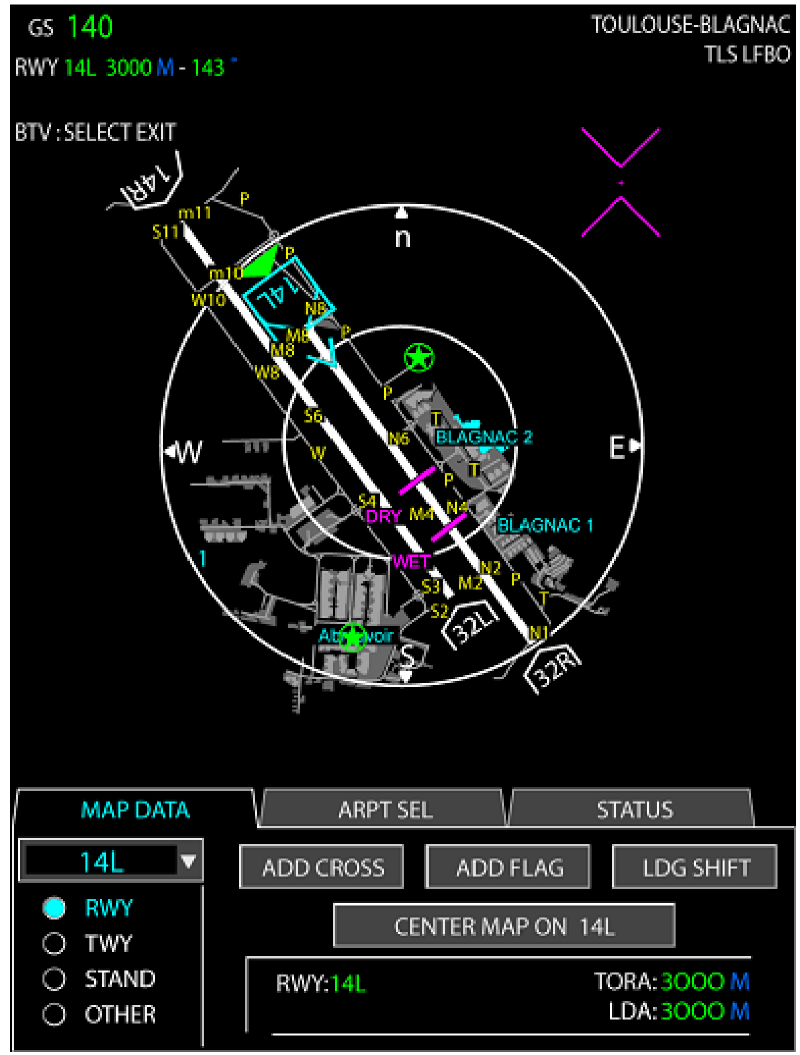
Autobrake Active

BTV Function Annunciation on FMA

BTV Armed

BTV Active

Airport Navigation Page



Lights

Overview

The lighting system provides the required internal and external illumination to perform flight in any day and night conditions.

The lighting system provides the following functions:

- **Internal lighting**
  - Cockpit lighting
  - Emergency lighting

- **External lighting**
  - External visibility (to see outside)
  - External lights (to be seen).

Internal Lighting

Cockpit Lighting

Cockpit lighting provides the flight crew with the most suitable lighting environment, to carry out their mission. All cockpit lights use the Light Emitting Diode (LED) technology.

The cockpit lighting has:

- **Utility lights** to read map and documents
- **Ambient lights** (on the roof of the cockpit) to provide lighting for the various cockpit areas
- **Area and panel lights** to provide lighting for the instrument panels.

The flight crew can dim most of the cockpit lights, if necessary.

The cockpit lights have two different colors:

- A white orangey color, that is restful for human eyes
- A bluish white color, that facilitates reading.

Emergency Lighting

There are emergency lights in the:

- Cockpit
- Cabin.

The flight crew can manually turn on the emergency lighting. However, if electrical power is lost, the emergency lighting comes on automatically in the cockpit and the cabin.

Cockpit Emergency Lighting

Ambient lights and cockpit way light provide emergency lighting in the cockpit.

Cabin Emergency Lighting System

The cabin has an emergency lighting system that provides sufficient lighting in the cabin, in the case of emergency or electrical power loss. The flight crew can manually turn on emergency lights via the emergency exit light (EMER EXIT LT) switch, if necessary.

The emergency lights come automatically on when:

- The flight crew set the EMER EXIT LT switch to “ARM”, and
- The aircraft electrical supply is degraded.

External Lighting

The A350 has the following external lights:

- **Navigation lights**
  The navigation lights provide an external visual indication of the position of the aircraft and its direction of flight.

- **Landing lights**
  The landing lights provide runway illumination during night operations. The landing lights can be used in combination with the takeoff and taxi lights.

- **Taxi lights**
  The taxi lights provide illumination of the taxiways and ground obstructions ahead of the aircraft.

- **Runway turnoff lights**
  The runway turnoff lights provide illumination on either side of the taxi line (approximately 45 degrees) forward of the nose landing gear.

- **Takeoff lights**
  The takeoff lights provide illumination of the runway during taxi, takeoff, approach and landing.

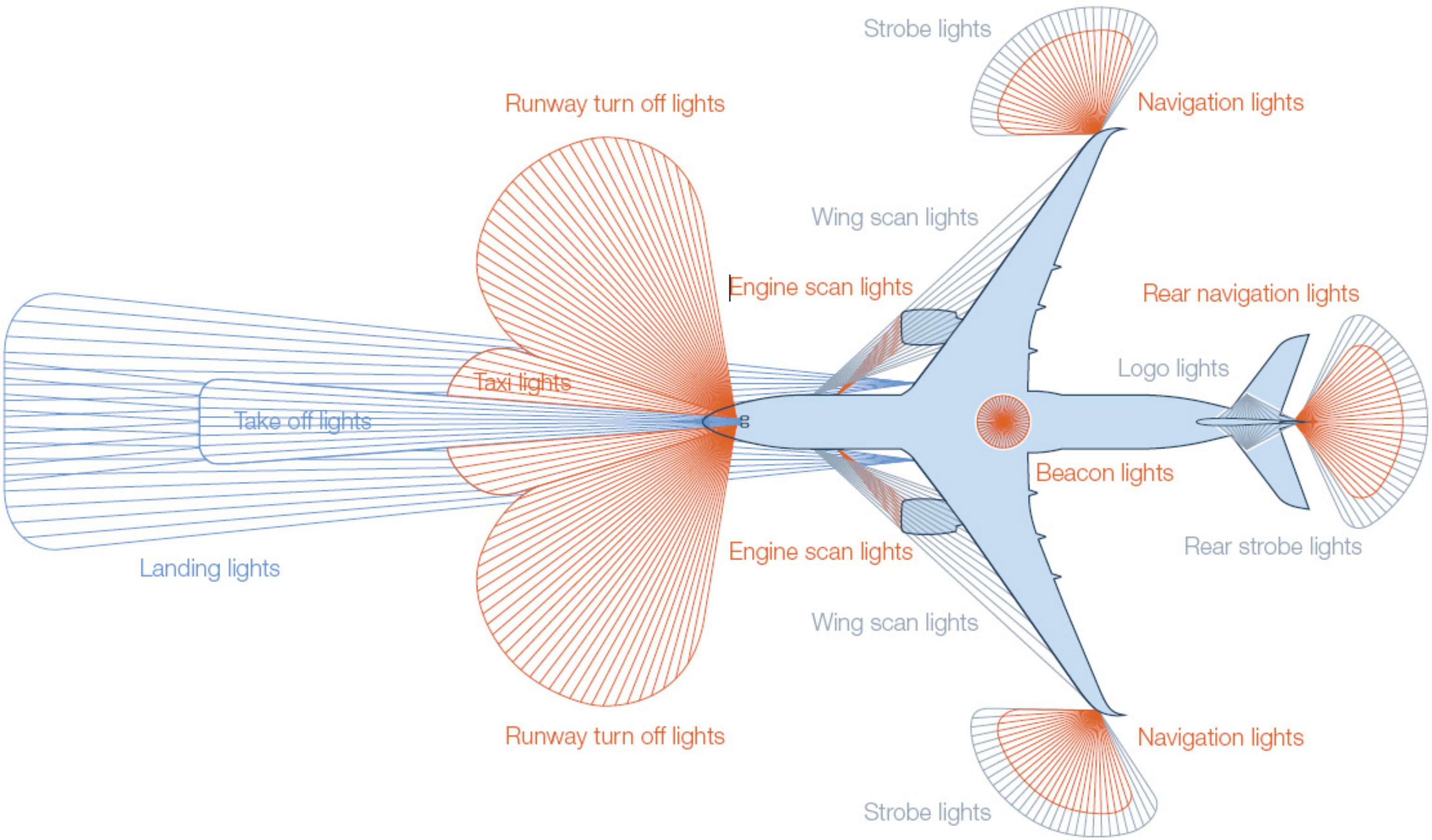
- **Logo lights**
  The logo lights illuminate the logo on the vertical stabilizer.

- **Beacon lights**
  The beacon lights belong to the anti-collision lights system. The beacon lights provide a high-intensity red flashing light.

- **Strobe lights**
  The strobe lights belong to the anti-collision lights system. The strobe lights provide a high-intensity white flashing light.

- **Wing and engine scan lights**
  Wing and engine scan lights are used to illuminate the LH/RH wing tip leading edges and the engines (LH/RH) in order to identify any accumulation of ice.

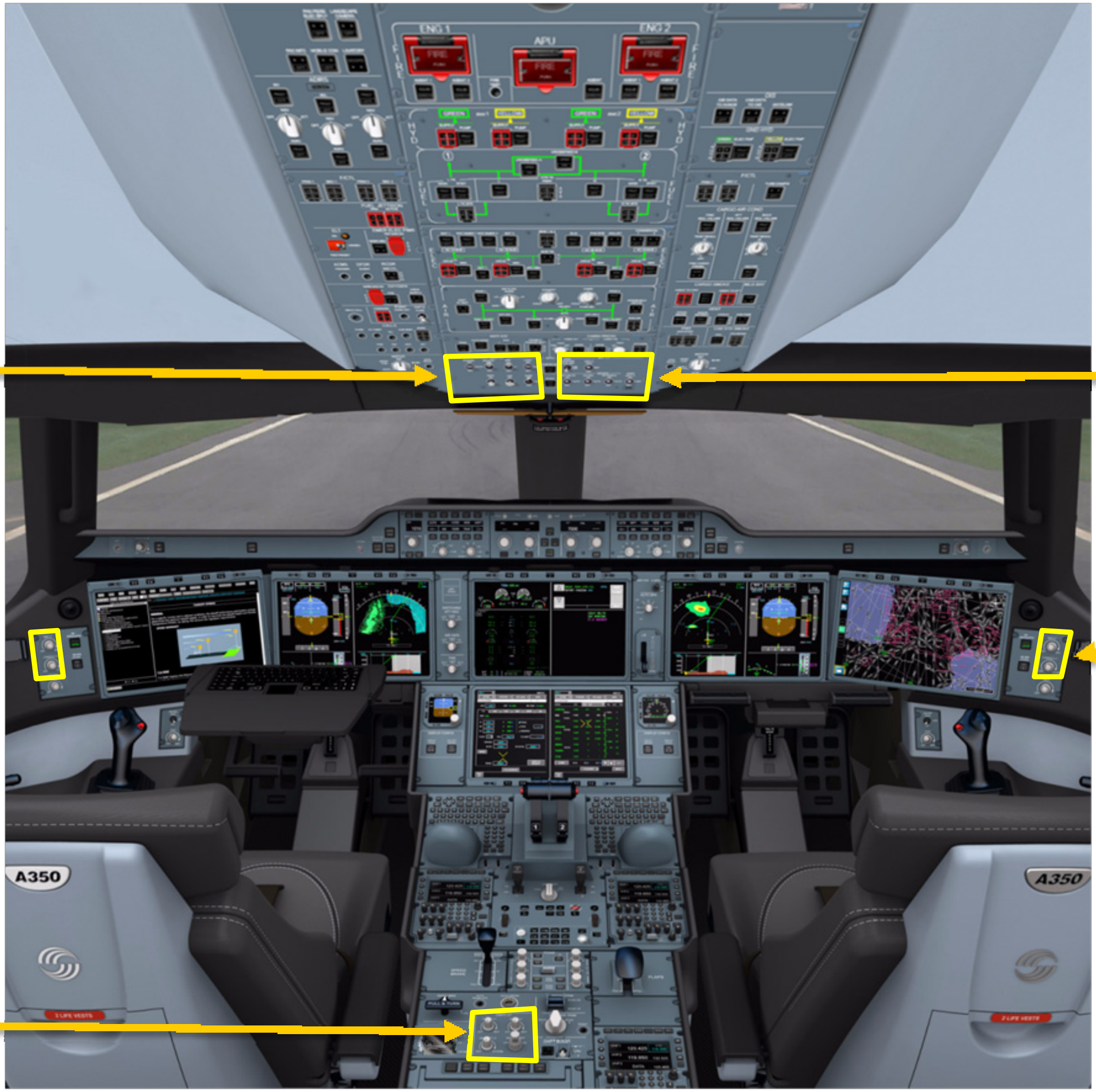
- **Taxi camera lights (optional)**
  The taxi camera lights are used to illuminate the nose landing gear wheels and the Main Landing Gear wheels during taxiways, runway turn-off and any other ground operations that may cause a hazard to the aircraft.


Strobe lights
Navigation lights
Runway turn off lights
Wing scan lights
Engine scan lights
Rear navigation lights
Logo lights
Taxi lights
Take off lights
Beacon lights
Engine scan lights
Rear strobe lights
Landing lights
Wing scan lights
Runway turn off lights
Navigation lights
Strobe lights

Cockpit View

EXT LT Panel

INT LT and SIGNS Panel

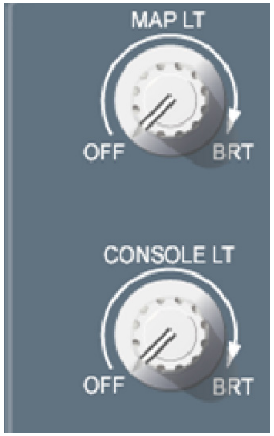


MAP LT and CONSOLE LT Selectors

CKPT LT Panel

EXT LT Panel

MAP LT and CONSOLE LT Selectors



INT LT Panel and SIGNS Panel

CKPT LT Panel

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Navigation

A350 XWB

AIRBUS

The Navigation system provides:

- Flight and navigation parameters
- Navigation aids (NAVAIDS) tuning and reception
- Navigation backup

The systems providing navigation parameters are:

- ADIRS
- Multi-Mode Receivers (MMRs)
- Radio NAVAIDS
- Radio Altimeters (RAs).

The backup navigation system is provided by the Standby Navigation System (SNS) composed of one Integrated Standby Instrument System (ISIS) and one standby magnetic compass. A second ISIS can be installed as an option.

In addition to the navigation functions, the Navigation system provides two additional functions:

- **Surveillance Function**:
  This function protects the aircraft against external environment hazards.

- **Airport Navigation Function**:
  This function helps the flight crew for navigation on airport surfaces.

System Description

The **Air Data and Inertial Reference System (ADIRS)** is the main component of the Navigation system. It provides:

- Flight parameters (air data, attitude, velocities) to ensure the control of the aircraft trajectory
- Navigation parameters (position (lat/long), heading, time) to determine the aircraft position (lat/long) and orientation (N/S/E/W).

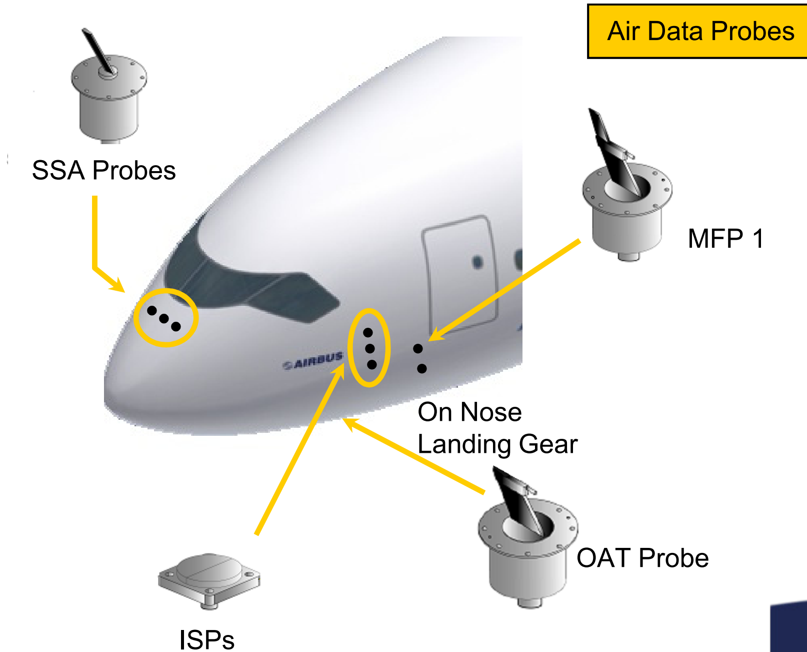
The ADIRS has three Air Data and Inertial Reference Units (ADIRU). Each ADIRU is divided into two parts:

- The ADR (Air Data Reference) part
- The IR (Inertial Reference) part.

Each part (either ADR or IR) can work separately in the case of failure of the other part.

- The **Air Data Reference (ADR)** part computes AIR DATA parameters using data from different probes:
  - One Multi-Function Probe (MFP) per ADIRU provides total pressure (Pt), Total Air Temperature (TAT) and Angle of Attack (AOA) measurements
  - One Side Slip Angle (SSA) probe per ADIRU provides the sideslip angle
  - Two Integrated Static Probes (ISPs) per ADIRU provide the static pressure (Ps)
  - A fourth AOA probe provides additional angle of attack measurements
  - Two Outside Air Temperature (OAT) probes provide Static Air Temperature (SAT) on ground only.

- The **Inertial Reference (IR)** part computes attitude, position (lat/long), heading using data from its internal gyrometers and accelerometers sensors.
  In normal operation, each IR part also receives GPS data from the Multi-Mode Receiver (MMR) for initial alignment and computation of the GPIRS hybrid position.



Aircraft Position Computation

The aircraft position is the result of a selection by the ADIRS of different candidate positions.
In flight, the selection is performed with the following priority:

- The consolidated hybrid solution
- The hybrid solution, called GPIRS
- The mix IRS/Radio solution, copied from the FMS
- The Pure IRS Position

On ground, the ADIRS compute a specific GPIRS hybrid position, with a high level of accuracy, that is used by all other systems, especially the Airport Navigation Function.

The Hybrid Position

The hybrid position is based on a combination of inertial and GPS data (1 IRS/GPS source).

The Consolidated Hybrid Position

The consolidated hybrid position is based on a combination of all hybrid positions (3 IRS/GPS sources).
The main purpose of the Hybridization function is to improve the Integrity, Availability, and Continuity performances of the solutions that come from the GNSS navigation sources.

FMS Position

Each FMS computes its aircraft position and the position accuracy, using three sources:

- Inertial via the ADIRS
- Global Positioning System (GPS) via the MMR
- Radio navigation via NAVAIDS receivers.

The FMS position is a combination of the inertial position and radio position, depending on which equipment provides the most accurate data. This results in three navigation modes, in decreasing order of priority:

- Inertial - DME/DME (IRS/DME/DME)
- Inertial - VOR/DME (IRS/VOR/DME)
- Inertial only (IRS).

Pure IRS Position

The pure IRS position is computed when only the IRS sources are available.

The ADIRS sends the aircraft position to the systems that need this information, including the FMS, which uses the aircraft position for the flight planning and predictions functions.

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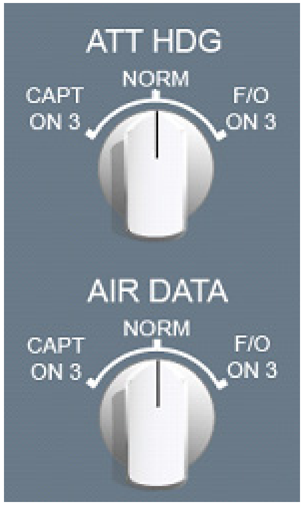
Cockpit View

ADIRS Panel

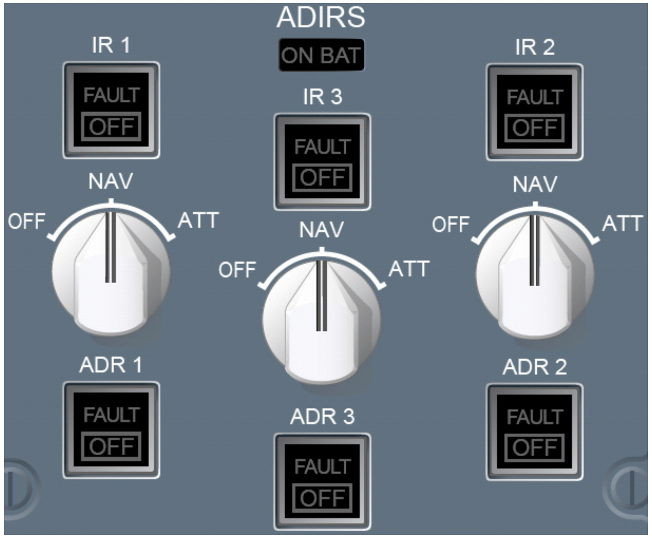
ATT HDG/AIR DATA Switching Selector

Controls

ATT HDG/AIR DATA Switching Selector



ADIRS Panel



General

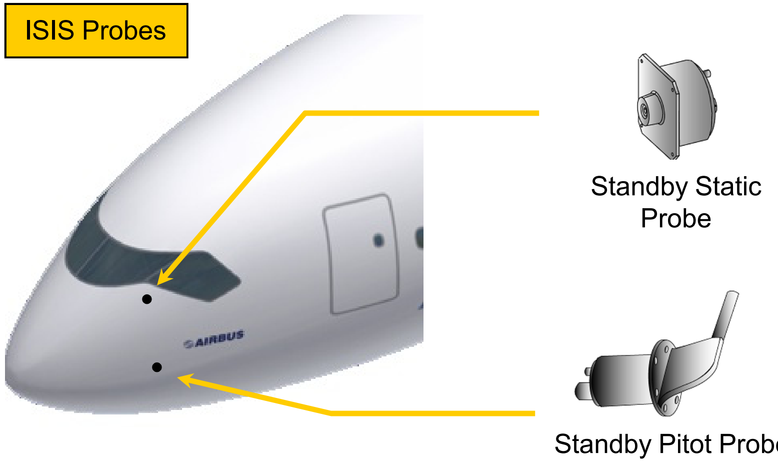
The **Standby Navigation System** provides a navigation backup function. The SNS is composed of one or two Integrated Standby Instrument System (ISIS), one standby pitot probe, two standby static probes, and one standby magnetic compass.

The ISIS can be considered as a small simplified ADIRU coupled with a display unit.

It provides:

- An independent source of computation for attitude information (pitch angle, roll angle), and air data parameters (Computed Air Speed, Altitude, Mach…) in case of all ADIRUs failure
- An independent source of display in case of all DUs failure.

ISIS Probes



System Description

There is one basic ISIS (LH) and one optional ISIS (RH). Each unit can display:

- The **Standby Flight Display (SFD),** or
- The **Standby Navigation Display (SND).**

If only one ISIS is installed, it can only display the SFD. If there are two ISIS, both cannot display the same mode.

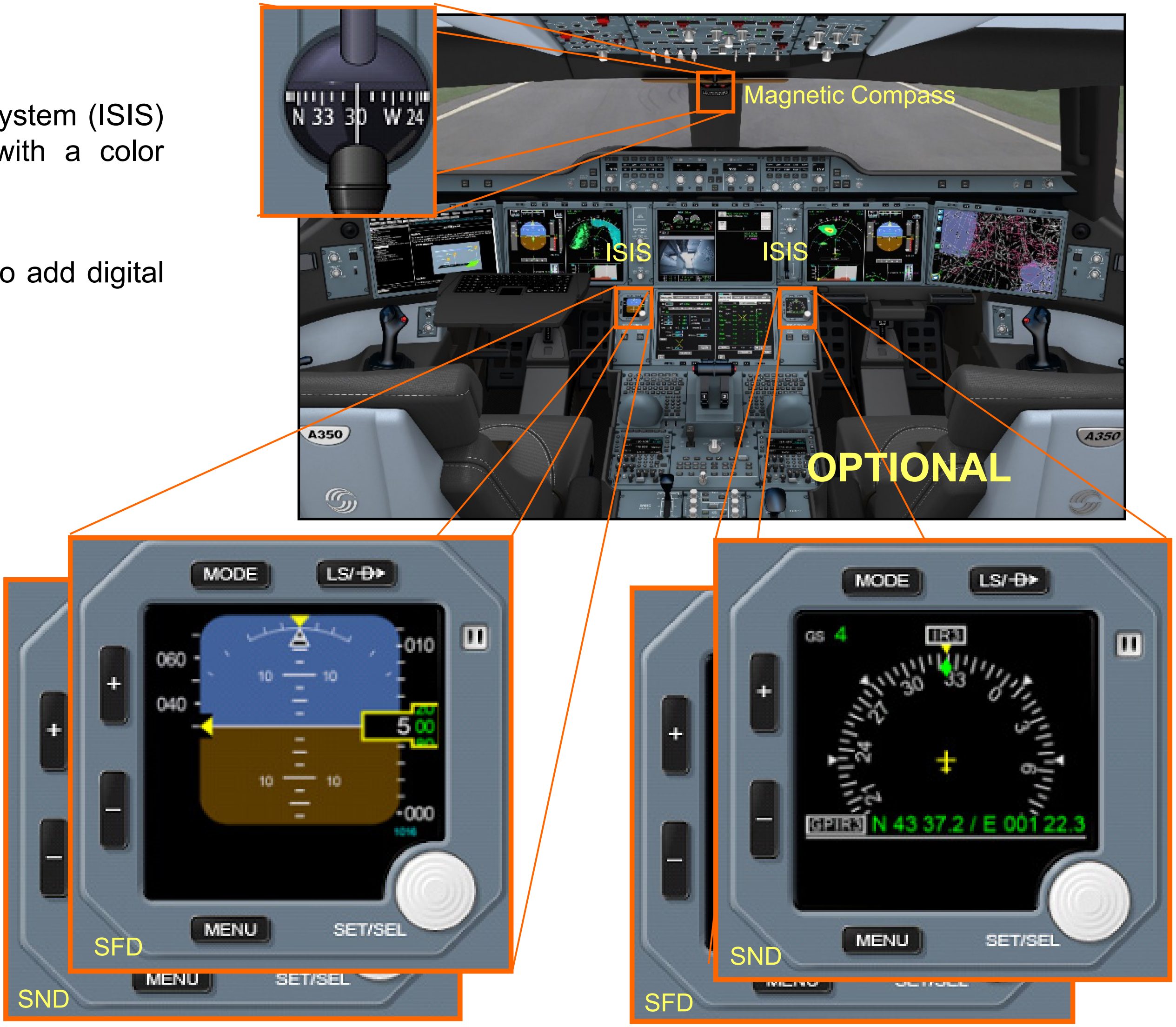
In normal configuration, ISIS computes air data parameters (speed, altitude…) using its independent standby probes. In addition:

- ISIS gyrometers and accelerometers compute attitude information
- ISIS connected to IR 1 or 3 acquires:
  - Heading (magnetic and true)
  - True track (magnetic track is calculated using deviation)
  - Ground speed, latitude, longitude.
- ISIS connected to MMR 1 acquires:
  - LOC & Glide deviations
  - The associated identifier, frequency and the selected course
  - True track
  - The GPS latitude/longitude
  - The ground speed.

Controls and Indicators

The Integrated Standby Instrument System (ISIS) is a combined multi-function unit, with a color liquid crystal display that provides:

- Altitude:
  - Scale in feet with capability to add digital altitude read-out in meters
  - Baro setting - hPa or in Hg
- Airspeed in knots and Mach number
- Attitude situation with pitch and roll
- Landing systems deviation data
- Present position and single fix
- Bugs (speed and altitude)
- Heading and track
- Ground speed.



System Description

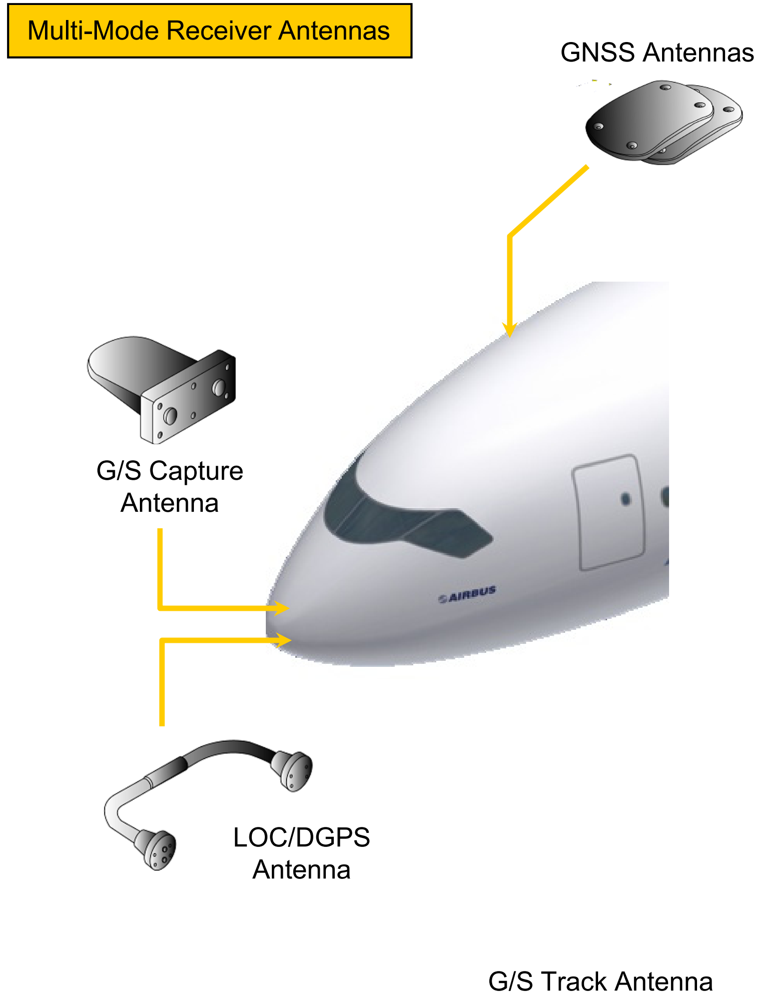
The main function of the **Multi-Mode Receiver (MMR)** is to compute lateral and vertical deviations of the aircraft to the approach and landing trajectory.

The MMR system consists of:

- Two MMR receivers
- Two Global Navigation Satellite System (GNSS) antennas
- One Localizer / Differential Global Positioning System (LOC/DGPS) antenna
- One glide slope capture antenna.

The MMR includes the following functions:

- Landing systems:
  - The Instrument Landing System (ILS) function
  - The FMS Landing System (FLS) function
  - The Ground Based Augmentation System (GBAS) Landing System (GLS) function (optional)
  - The Satellite Landing System (SLS) function (optional).
- Navigation system: Global Navigation Satellite System (GNSS) function.



Overview

The SURV system is an integrated solution that regroups all aircraft surveillance functions into one system. It includes:

- Weather Radar (WXR) with Predictive Windshear (PWS) and Turbulence (TURB) detection functions for atmospheric disturbance hazards
- Traffic Alert and Collision Avoidance System (TCAS) which includes:
  - AP/FD TCAS
  - Air Traffic Situational Awareness (ATSAW)
- Terrain Awareness and Warning System (TAWS)
- ATC mode S Transponder (XPDR).

The SURV system includes two identical surveillance systems (SYS 1 and SYS 2).

Each system can perform all the aircraft environmental surveillance functions, that are grouped in pairs:

- The WXR/TAWS
- The TCAS/XPDR.

The SURV system has the following equipment:

- Two Aircraft Environmental Surveillance Units
- Two Radar Transceiver Units
- One weather radar system
- One SURV control panel
- Four combined TCAS and Mode S antennas.

Weather Radar (WXR)

The weather radar provides:

- A weather (WX) display function
- A predictive windshear (PWS) function (detection and localization)
- A turbulence (TURB) function (detection and localization).

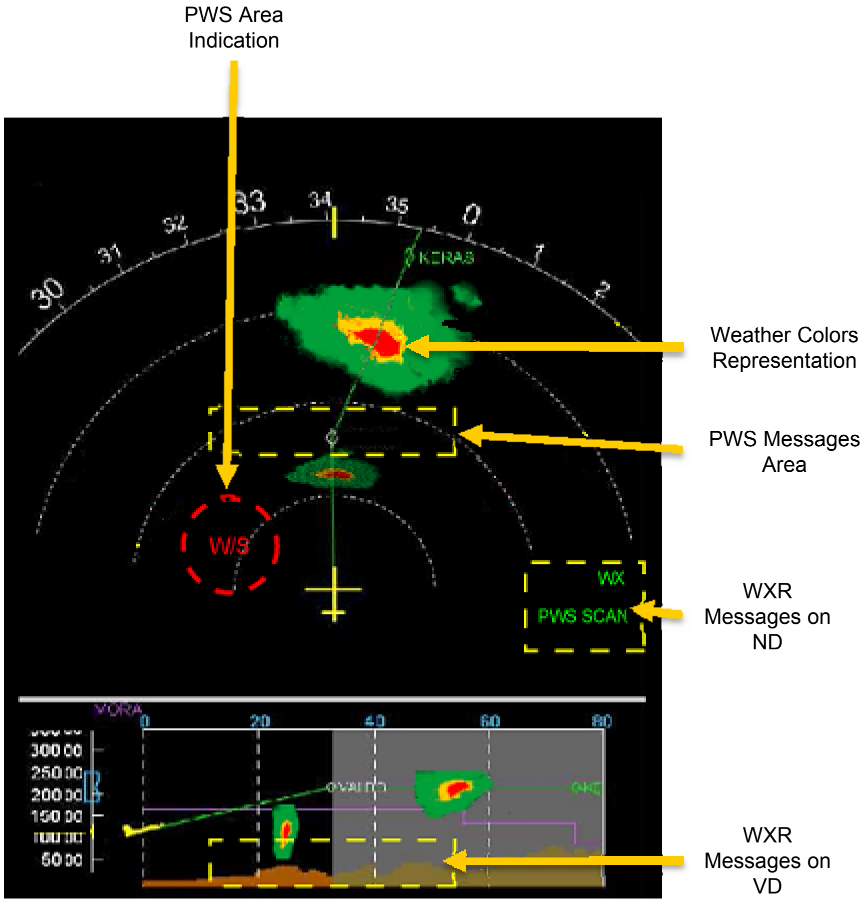
The Navigation Displays (NDs) and the Vertical Displays (VDs) show the weather information, discriminating between relevant and non-relevant weather information in automatic mode.

The weather radar continuously scans a volume of space ahead of the aircraft, and stores this data in a 3D buffer.

The WX display function displays weather data on the:

- ND for views along the:
  - Vertical flight path (in AUTO mode), or
  - Selected altitude (in ELEVN mode), or
  - Selected tilt angle (in TILT mode)

- VD for views along the:
  - Lateral flight path in (AUTO mode), or
  - Selected azimuth (in AZIM mode).



Note: The A350 also has a reactive windshear protection.

Traffic Collision Avoidance System (TCAS)

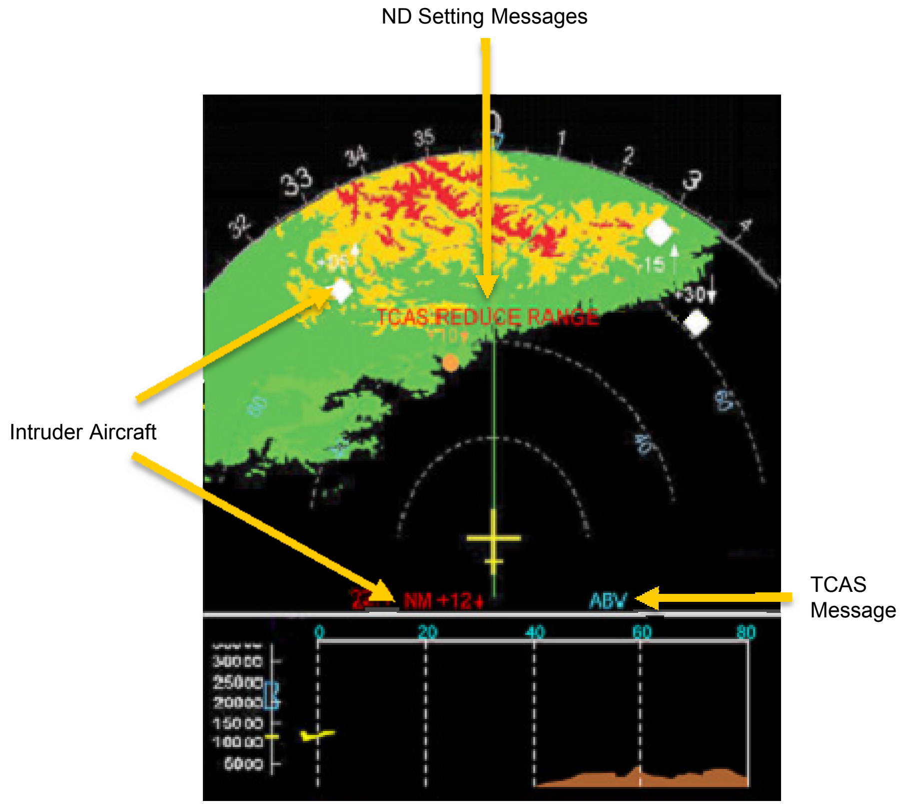
The main TCAS functions are:

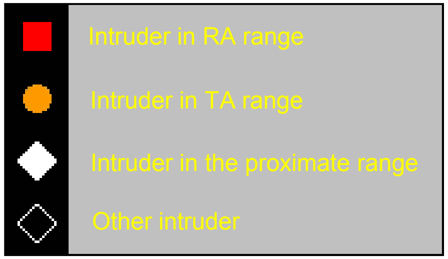
- Traffic active surveillance
- Traffic collision avoidance
- Display of Automatic Dependent Surveillance Broadcast (ADS-B) traffic for improved situational awareness (ATSAW)
- Event recording.

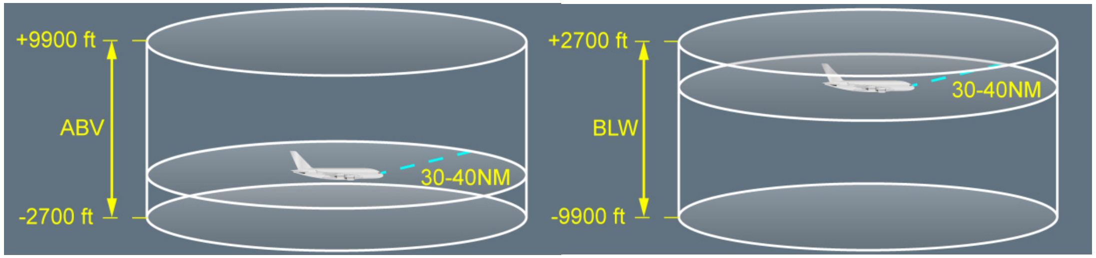
The **Navigation Displays (NDs)** show the TCAS information. The **Primary Flight Displays (PFDs)** show TCAS Resolution Advisory information.

On the ND, the TCAS displays traffic that is within a volume of space around the aircraft:

- In normal selection, the upper and lower boundaries of this volume are set to +2 700 ft and
  -2 700 ft
- In manual selection, the flight crew can choose between two displays: Above (ABV) or Below (BLW).







AP/FD TCAS

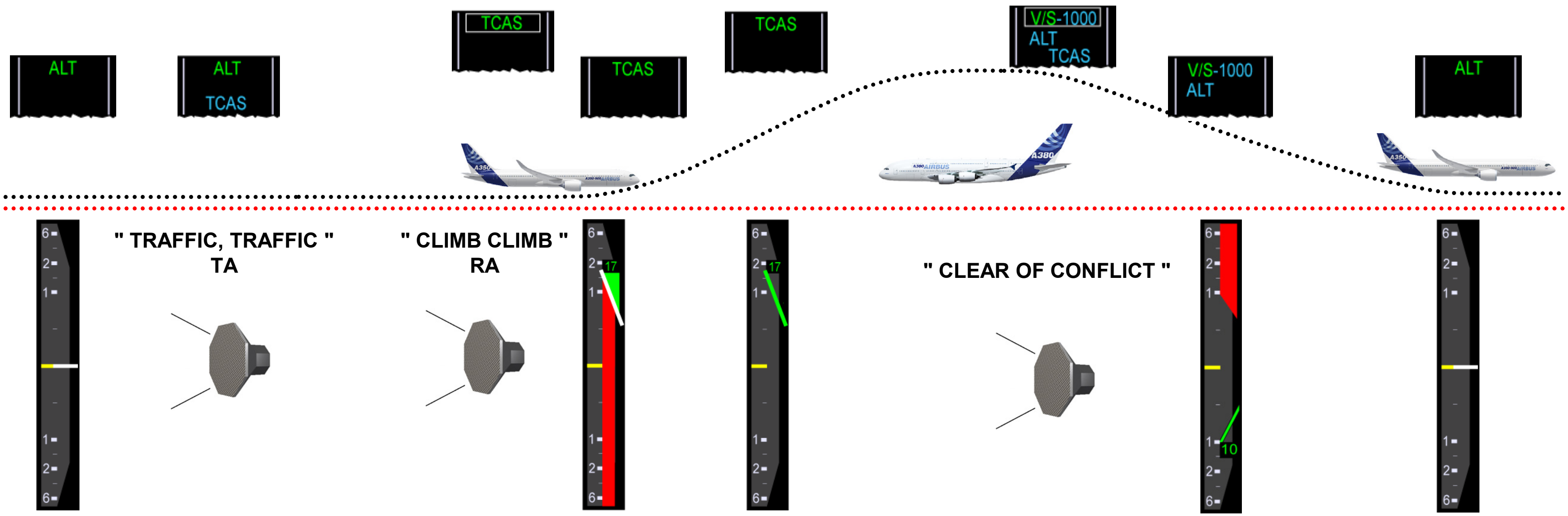
The AP/FD TCAS mode is an AP/FD vertical mode that provides vertical guidance in the case of a TCAS Resolution Advisory alert. This mode:

- Provides the pilot with clear flying orders adapted to each TCAS Resolution Advisory in addition to the TCAS aural and visual alerts
- Avoids the potential opposite or over-reactions to the RA
- Enables to minimize the deviations from the initial ATC clearance during the RA.

The AP/FD TCAS mode automatically arms if a Traffic Advisory is triggered.

When a Resolution Advisory is triggered:

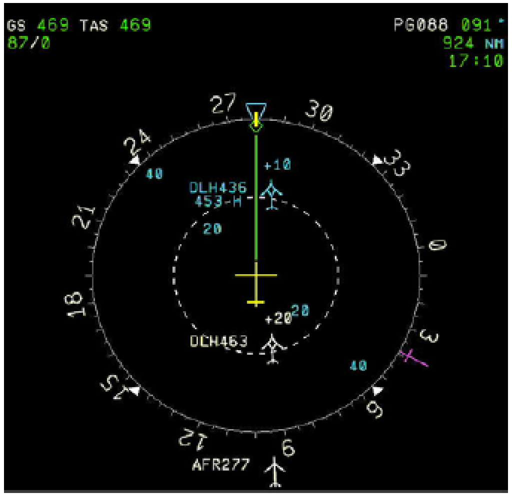
- The AP/FD TCAS **automatically** performs the avoidance manoeuvre if the Auto Pilot is engaged
- In the case both APs and FDs are disengaged, the FDs automatically engage. The flight crew manually executes the avoidance manoeuvre by following the FD bars.



Aircraft Traffic Situation Awareness (ATSAW)

The ATSAW (optional) is based on the display of:

- Traffic information that comes from the ADS-B OUT, and
- Suitable information taking into account the operational context and the different phases of flight, piloting tasks, and flight crew workload.



Four applications use the ATSAW information:

- ATSA-AIRB: to improve situational awareness during airborne operations
- ATSA-VSA: to support visual acquisition and to maintain visual contact and separation with the preceding aircraft during approach
- ATSA-ITP: to enable flying at an optimum flight level, through more frequent altitude changes. The flight crew will be able to detect if an opportunity to climb exists, and thus optimize their flight level. Flying at an optimum flight level brings significant fuel savings
- ATSA-SURF: to improve situational awareness, during surface operations (taxi, takeoff, landing). The application displays on the airport moving map all the traffic and aircraft/vehicles information (future evolution).

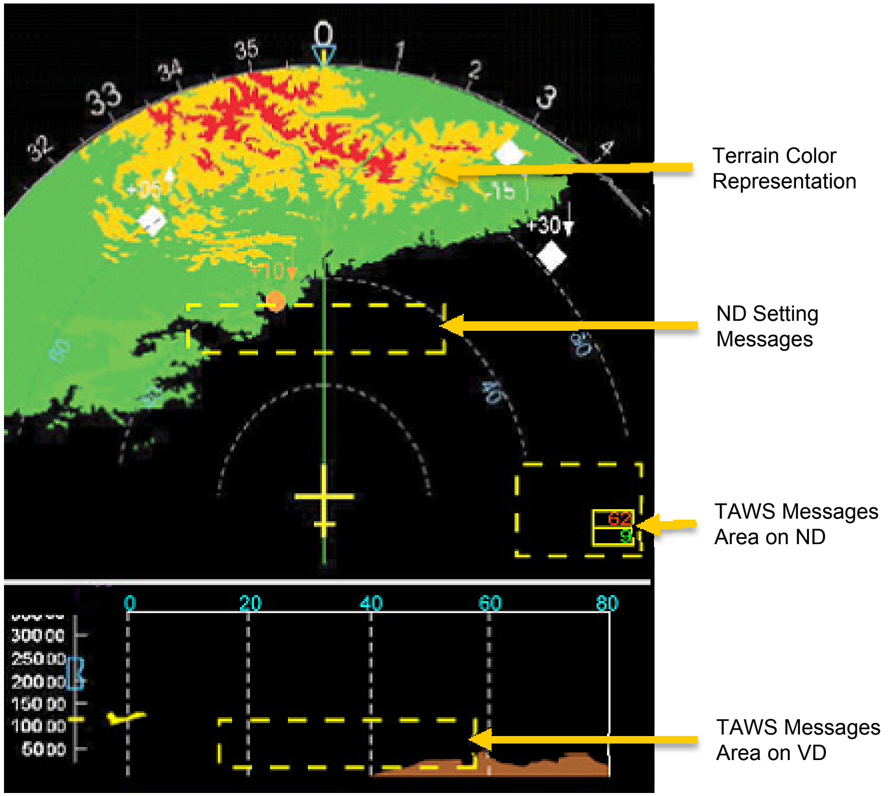
AIRB:	Airborne
VSA:	Visual Separation Approach
ITP:	In Trail Procedure
SURF:	Surface

Terrain Awareness and Warning System (TAWS) and Vertical Display (VD)

The TAWS provides both horizontal and vertical background terrain images respectively on the Navigation Display and the Vertical Display.

The purpose of the TAWS is to:
- Detect terrain collision threats
- Display terrain information
- Trigger applicable aural and visual alerts.

The TAWS provides a:
- Basic ground proximity warning (GPWS Modes 1 to 5)
- Terrain (TERR) and obstacle function awareness, alert and a display function that includes:
  - Horizontal profile terrain displays
  - Vertical profile terrain displays
- Database that includes:
  - A terrain database
  - An obstacle database that can be enriched with man-made obstacles
  - A runway database that contains all hard surface runways worldwide that are at least 3 500 ft long
  - An envelope modulation database which is used to adapt TAWS alert/warning protections to specific areas in the world.



Ground Proximity Warning System (GPWS)

The purpose of the GPWS function is to warn the flight crew of potentially hazardous situations, such as a collision with terrain.

The GPWS function detects terrain collision threats by comparing the geometric altitude of the aircraft and its trajectory with the information provided by the Radio Altimeters (RAs).

The Terrain (TERR) Function

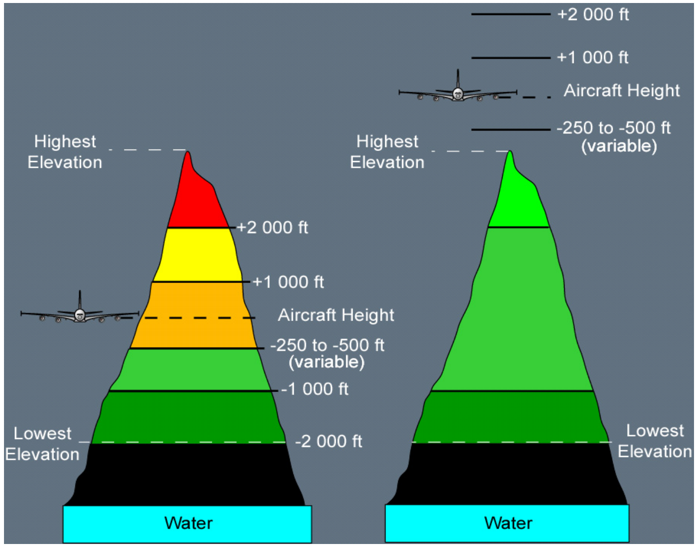
The TERR function provides displays and alerts, based on the comparison between the current aircraft position and a worldwide terrain database. It displays a horizontal and vertical view of the terrain on respectively the Navigation Displays and the Vertical Displays.

The TERR protection features two modes:

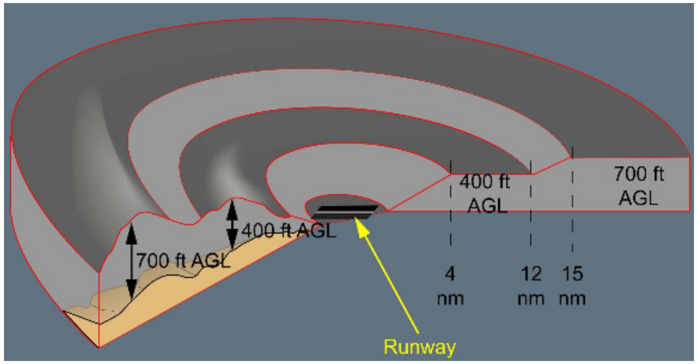
- A Terrain / obstacle Awareness and Display (TAD) that computes a caution and a warning envelope ahead of the aircraft

- The Terrain Clearance Function (TCF) that provides alerts based on insufficient terrain clearance even when in landing configuration.

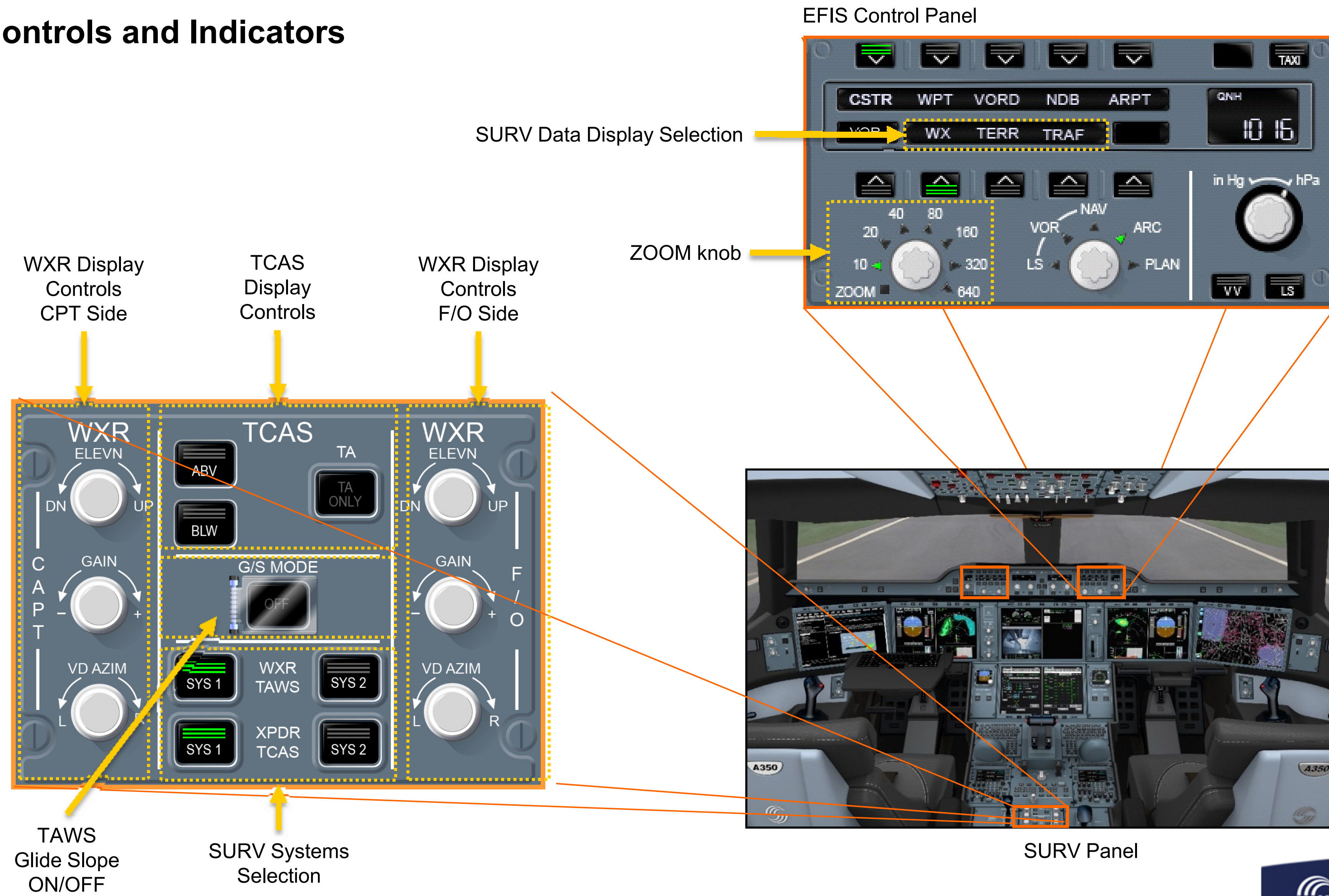
ND Terrain code color



TCF envelope

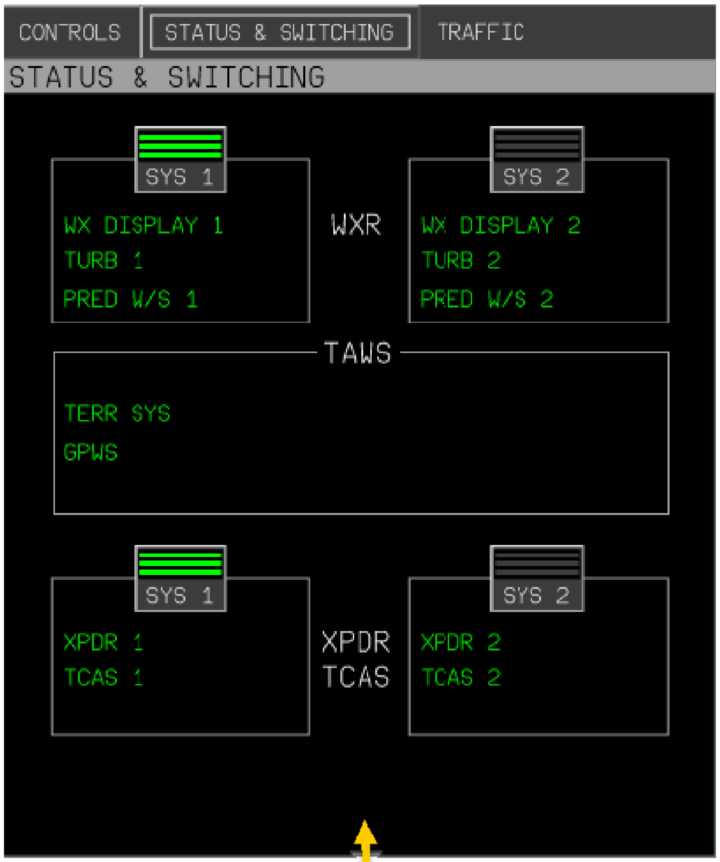


Controls and Indicators



MFD SURV Page

Backup for SURV Control Panel
Additional System Switching Selections

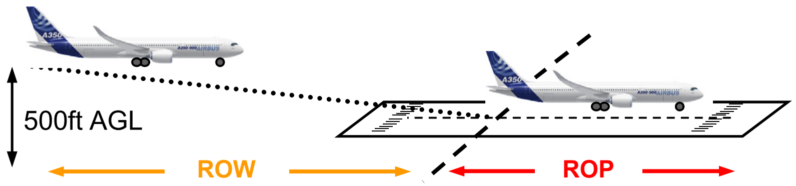


Systems
Selection and Status

Runway Overrun Warning (ROW)
Runway Overrun Protection (ROP)

The objective of the ROW and ROP functions is to minimize the risk of runway overrun at landing. The ROW and ROP are available at landing.

In addition, if the BTV is selected, the Onboard Airport Navigation System displays a line that indicates the stop point. This line moves in real time below 500 ft and turns red if a potential runway end overrun is detected.



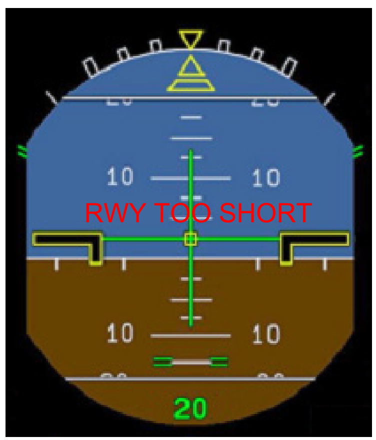
Runway end Overrun Warning (ROW)

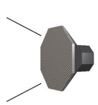
The ROW function computes in real time the required DRY and WET landing distances during the short final.

The objective of the ROW function is to enhance the pilot situation awareness during the approach and to encourage either:

- To perform a Go Around, or
- To correct the flight parameters (speed, V/S…)

If the predicted braking distances overrun the remaining runway length, the here below alerts are triggered.

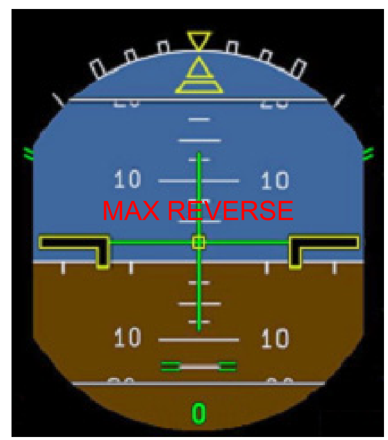


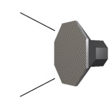
+ 

"RWY TOO SHORT"

Runway end Overrun Protection (ROP)

The ROP function arms as soon as the autobrake is active (e.g. at Nose L/G touchdown or five second after Main L/G touchdown). It can also be armed manually.
If a runway end overrun is detected and confirmed by the system, ROP activates. ROP commands the maximum braking (equivalent to RTO mode). In addition, the "MAX REVERSE" and "KEEP MAX REVERSE" alerts flash on PFD with the associated aural alerts.
If maximum braking is no longer necessary, ROP reverts to the braking level of the selected autobrake mode.



+ 

"MAX REVERSE"
"KEEP MAX REVERSE"

System Description

The Onboard Airport Navigation System (Airport Nav) provides the flight crew with a moving airport map.

The Airport Nav is designed to improve the flight crew awareness of airport surfaces.

The Airport Nav generates the airport navigation image using:

- Airport data stored in the airport database
- Aircraft data mainly from the FMS and the ADIRS
- Flight crew data entries.

The Airport Nav can also be associated with a Runway Proximity Advisory system to further improve the flight crew awareness during taxi phases.

The function displays the aircraft position superimposed on the airport map on the **Navigation Display**.

The Airport Nav can also display traffic of other aircrafts on the airport.

The flight crew uses the Keyboard and Cursor Control Unit (KCCU) to interact with the airport map.

*<u>Note</u>: The ROW and ROP (refer to **Landing Gear**) use the Airport Nav database.*

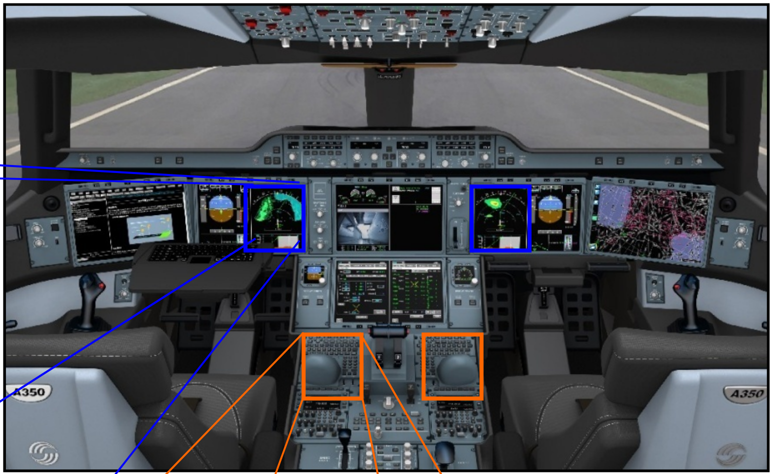
Caption:

Own aircraft

Other traffic

Controls and Indicators

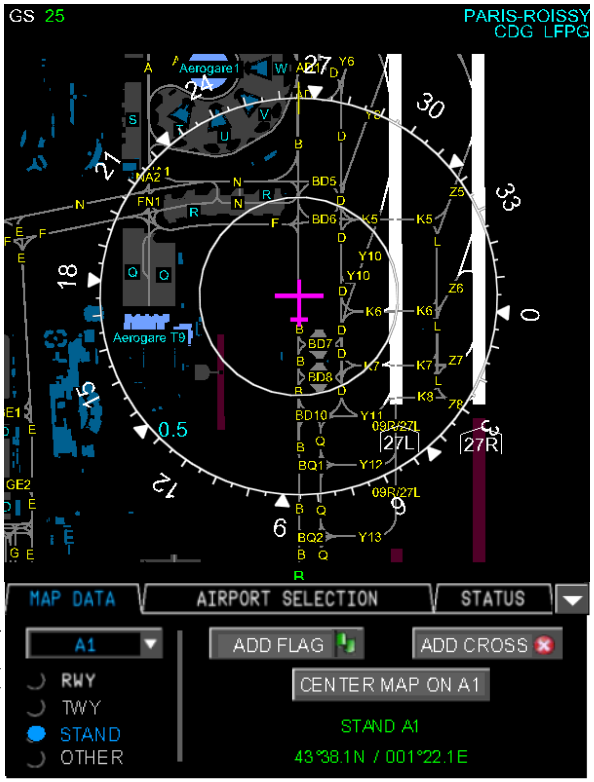
Airport Nav Map on ND (NAV mode)



KCCU

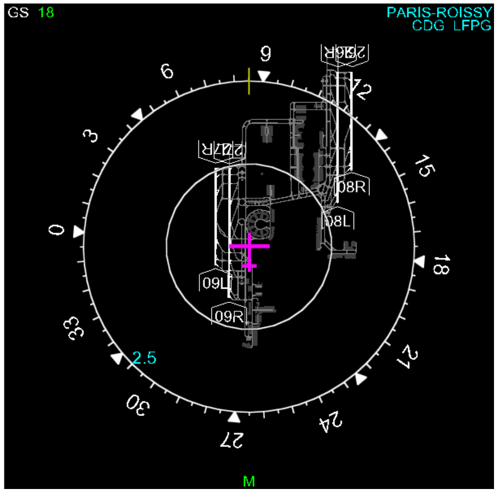
Controls and Indicators

ROSE mode

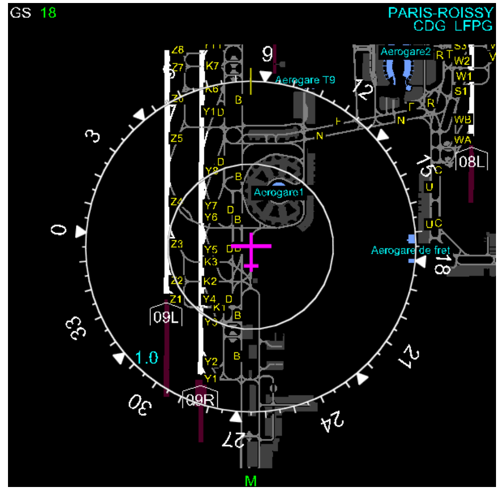


ARC mode

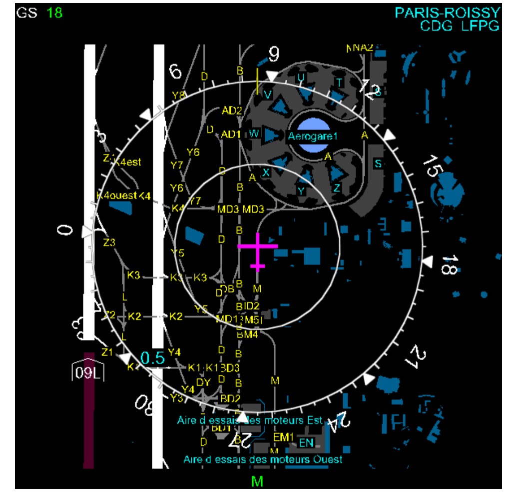
PLAN mode



ROSE 5 NM

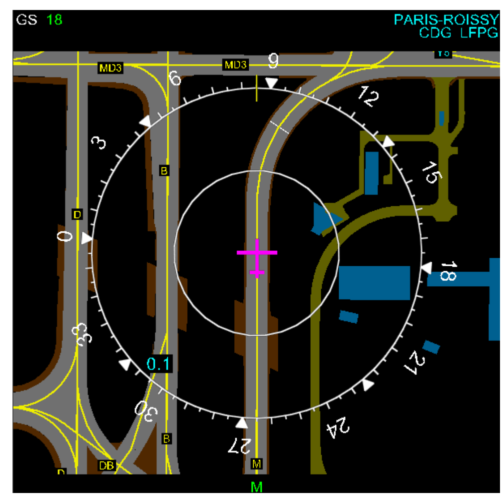


ROSE 2 NM



ROSE 1 NM

ROSE 0.5 NM



ROSE 0.2 NM

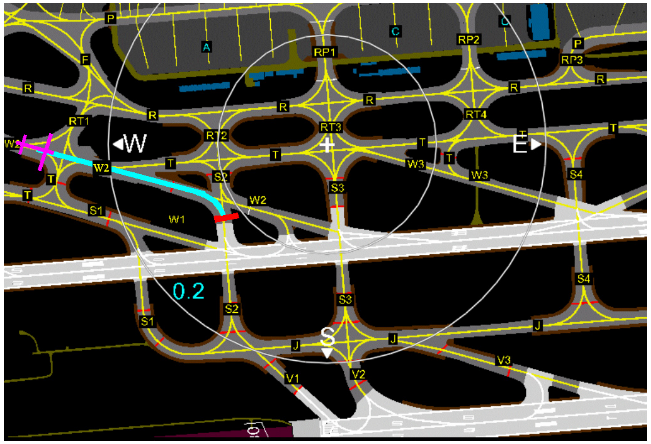
CPDLC (Controller/Pilot Datalink Communication) Ground Clearance on Airport Nav

The combination of the CPDLC Ground Clearance and the Airport Nav provides an assistance to guide the aircraft to taxi:

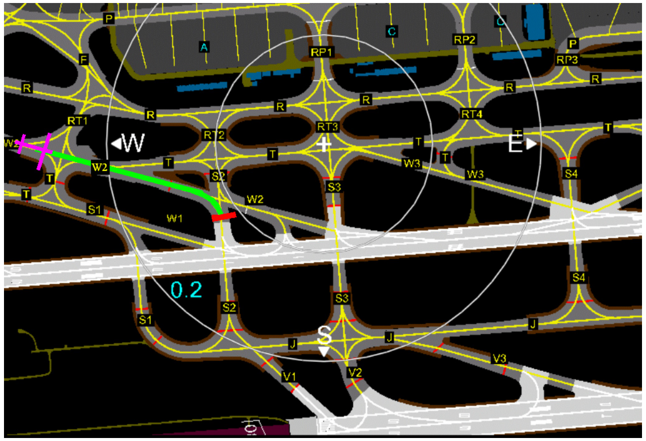
- From the parking stand (gate) to the runway holding point before take-off (TAXI OUT)
- From the runway exit point (after landing) to the parking stand (gate) (TAXI IN).

The CPDLC application enables to construct, send, and receive the ground clearance message.

Before acknowledgement



After acknowledgement



Runway Proximity Advisory (RPA)

The purpose of the RPA is to:

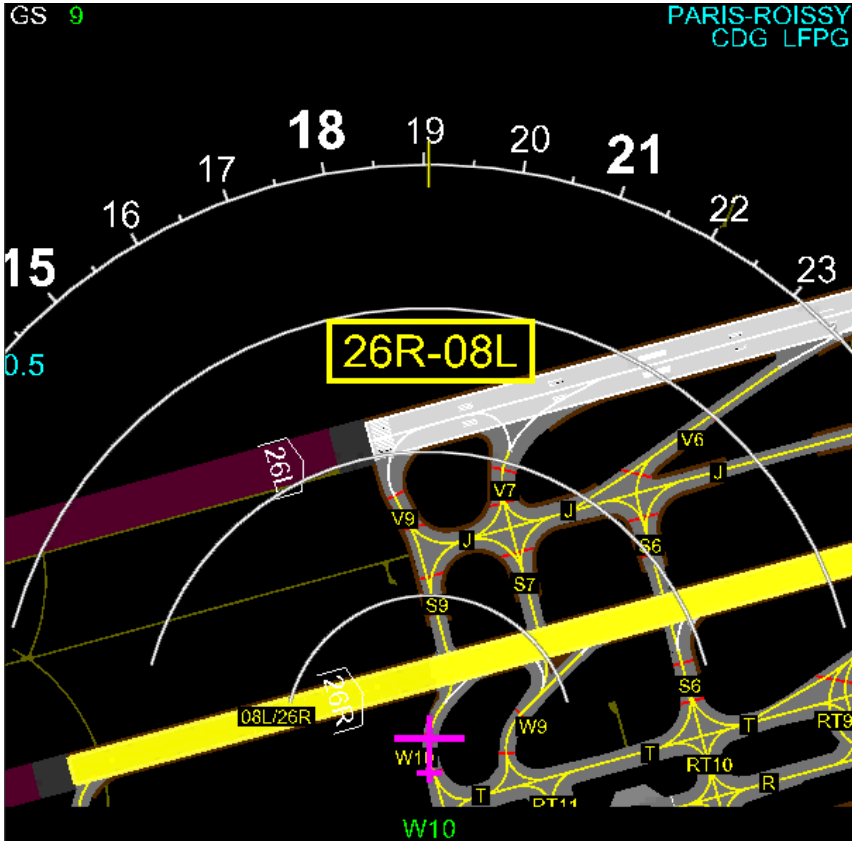
- Reduce the risk of runway incursions and thus, to reduce the risk of ground collision
- Improve runway situational awareness.

In order to reinforce the pilot attention, when the aircraft approaches a runway:

- The runway name pulses
- The runway flashes on the airport map

This visual advisory is triggered **7 seconds before aircraft entry in the runway area** (60 m around the runway in use).

<u>Note</u>: There is no aural advisory but the message is also displayed on the PFD screen and on the ETACS video if it is displayed on the PFD.



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Oxygen System

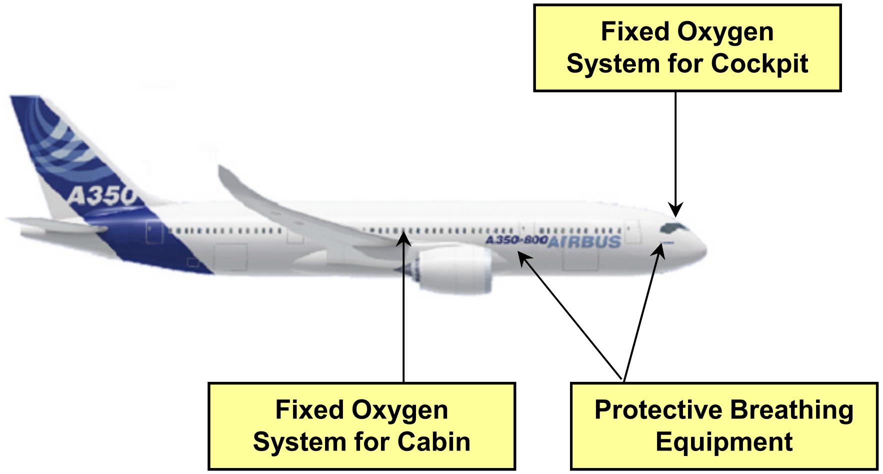
A350 XWB

Overview

The oxygen system is designed to supply oxygen to the flight crew, cabin crew, and passengers, in the case of an emergency (e.g. depressurization, smoke).

The oxygen system has:

- A fixed oxygen system in the cockpit
- A fixed oxygen system in the cabin
- A Protective Breathing Equipment (PBE) for the cockpit and cabin.



AIRBUS

Fixed Oxygen System for Cockpit

The fixed oxygen system for the cockpit provides oxygen for the flight crew and occupants. This system has:

- Four full-face quick-donning masks:
  - Each mask is stowed in its own stowage box
  - The stowage box is next to each flight crew station (Captain, First Officer, third and fourth occupants)

- Two high pressure oxygen bottles:
  - One dedicated to the Captain and fourth occupant
  - One dedicated to the First Officer and third occupant
  - Two extra optional high pressure oxygen bottles

- Two supply valves:

  The valves are normally open. The flight crew can manually close both valves to stop the oxygen supply by using the CREW SUPPLY pb-sw on the OXYGEN overhead panel

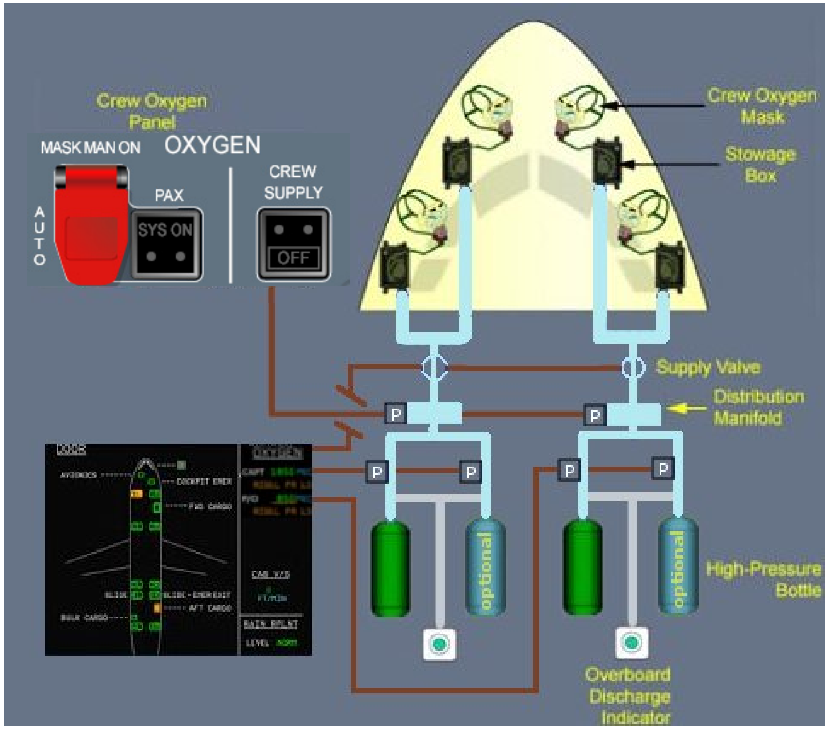
- Two overboard discharge indicators:

  These indicators are normally green. An indicator turns yellow if there is an overpressure in the oxygen system on the associated side.

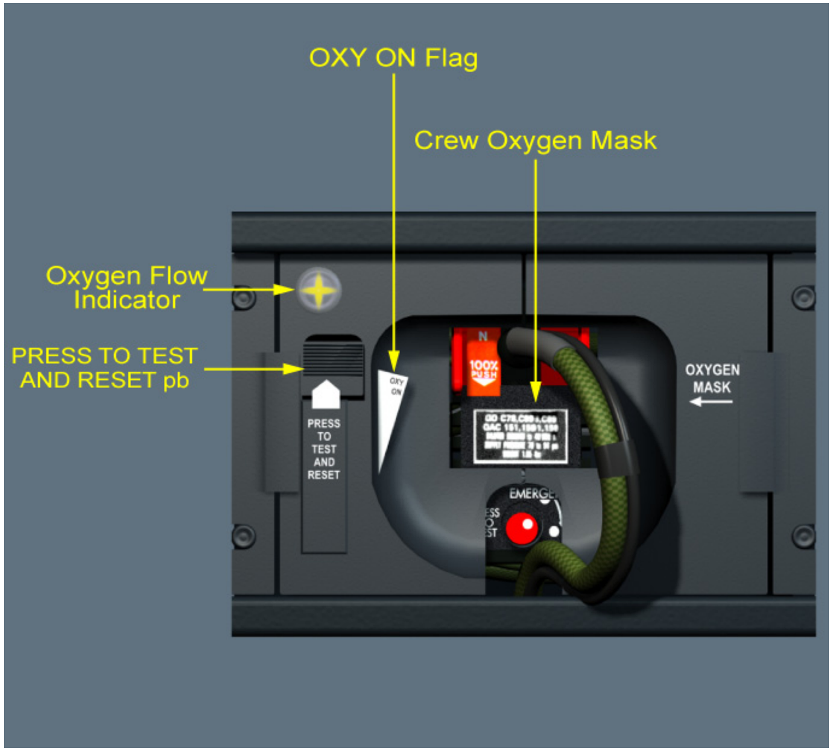
Note: in the case of depressurization the crew must wear the oxygen masks.

A350 XWB

Fixed Cockpit Oxygen System



Cockpit Mask Stowage Box



AIRBUS

Fixed Oxygen for Cabin

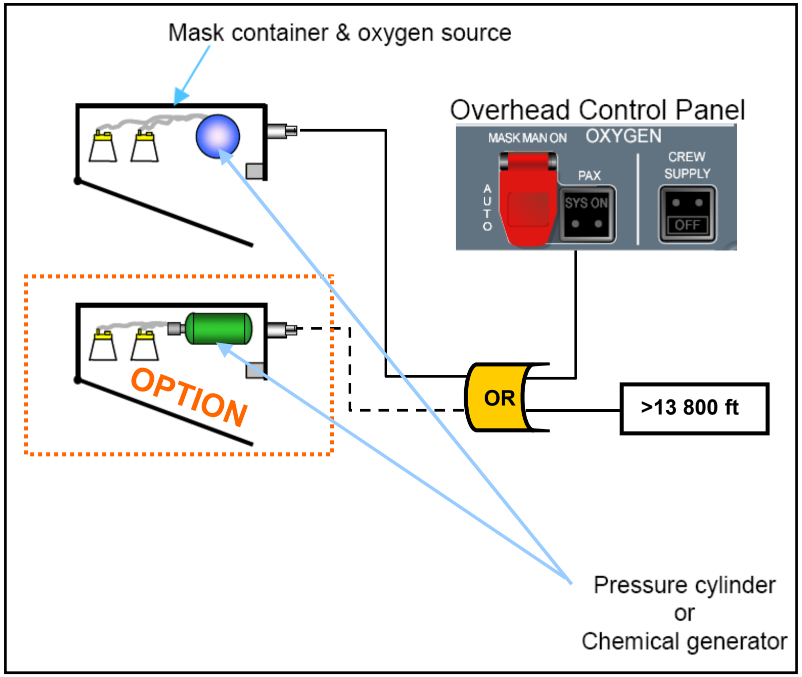
The fixed oxygen system of the cabin provides oxygen to the cabin (passengers and cabin crew) and to the crew rest compartments.

This system has a basic chemical oxygen system that supplies oxygen for a minimum of 15 min to the passengers and cabin crew through continuous flow masks. An optional chemical oxygen system with a capacity of 22 min is also available.

As an option, a decentralized gaseous system (oxygen cylinders stored locally) with a capacity of 45 minutes can replace the chemical system.

Masks that are stowed in containers supply the oxygen to the passengers and the cabin crew. The masks are automatically released when:

- The cabin altitude is above 13 800 ft, or
- The flight crew sets the MASK MAN ON guarded pb to ON.



Protective Breathing Equipment

The Protective Breathing Equipment (PBE) supplies oxygen to the crew in the case of fire, smoke or toxic gases.

The PBE:

- Protects the user's eyes and respiratory system for 15 minutes
- Enables to leave the station.

There is one PBE in the cockpit and eight in the cabin (additional optional PBE in cabin can be provided).

The PBE is a hood contained in a stowage box in a vacuum sealed bag.

Protective Breathing Equipment (PBE)

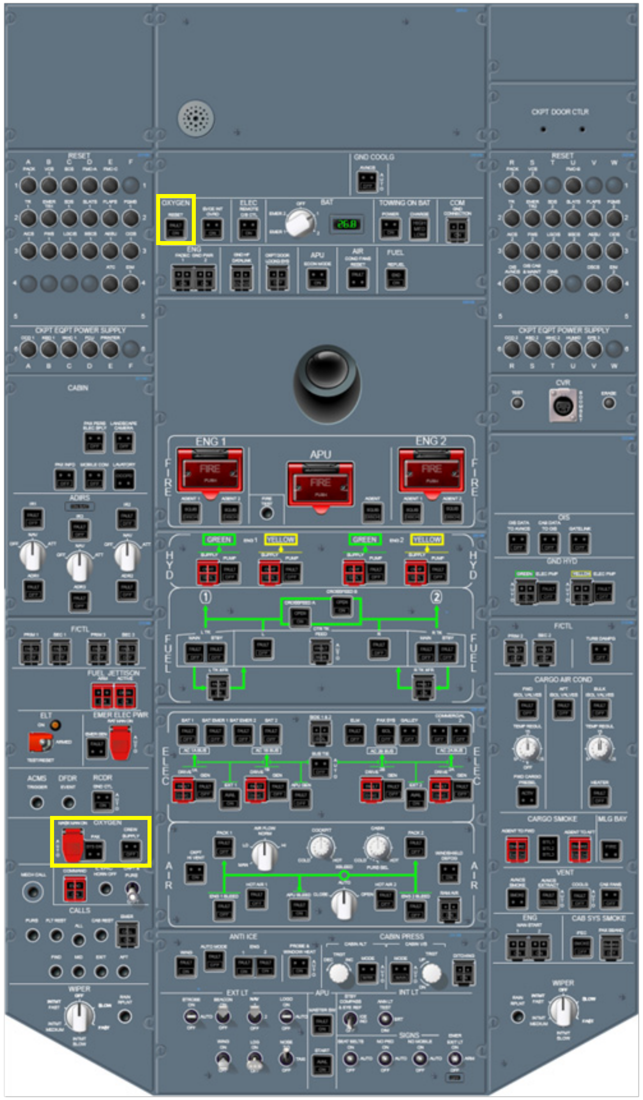
Cockpit View

OXYGEN Panel

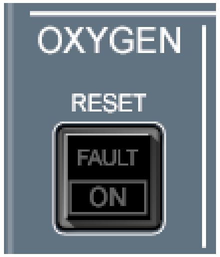
OXYGEN on DOOR SD Page

A350 Oxygen System
2.Controls and Indicators

Overhead Panel



OXYGEN MAINTENANCE Panel



OXYGEN Panel

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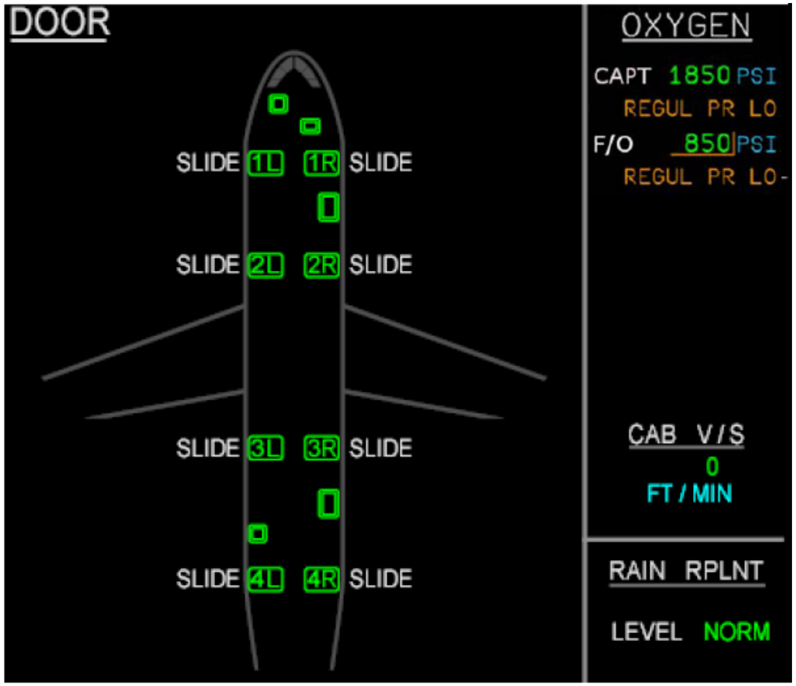
DOOR SD Page


DOOR
SLIDE 1L 1R SLIDE
SLIDE 2L 2R SLIDE
SLIDE 3L 3R SLIDE
SLIDE 4L 4R SLIDE
OXYGEN
CAPT 1850 PSI
REGUL PR LO
F/O 850 PSI
REGUL PR LO
CAB V/S
0
FT / MIN
RAIN RPLNT
LEVEL NORM

Avionics Networks and IMA

A350 XWB

AIRBUS

Overview

All aircraft systems communicate with each other using a redundant Avionics Full DupleX switched (AFDX) network, instead of conventional wiring. This network architecture is based on the Ethernet technology.

The following types of avionics monitor and control aircraft systems:

- **Conventional avionics**, with computers that are assigned to specific systems, or
- **Integrated Modular Avionics (IMA)**, with computers that can monitor and control several systems via several applications.

Integrated Modular Avionics

The principle of Integrated Modular Avionics (IMA) is to provide common or shared resources for computation and communication. This means that the computing functions of several avionics systems may be accommodated in the same common computing hardware platform and that all avionics systems use one common communication network for information.

The IMA has:

- **Core Processing Input/Output Modules (CPIOMs)**

The CPIOMs:

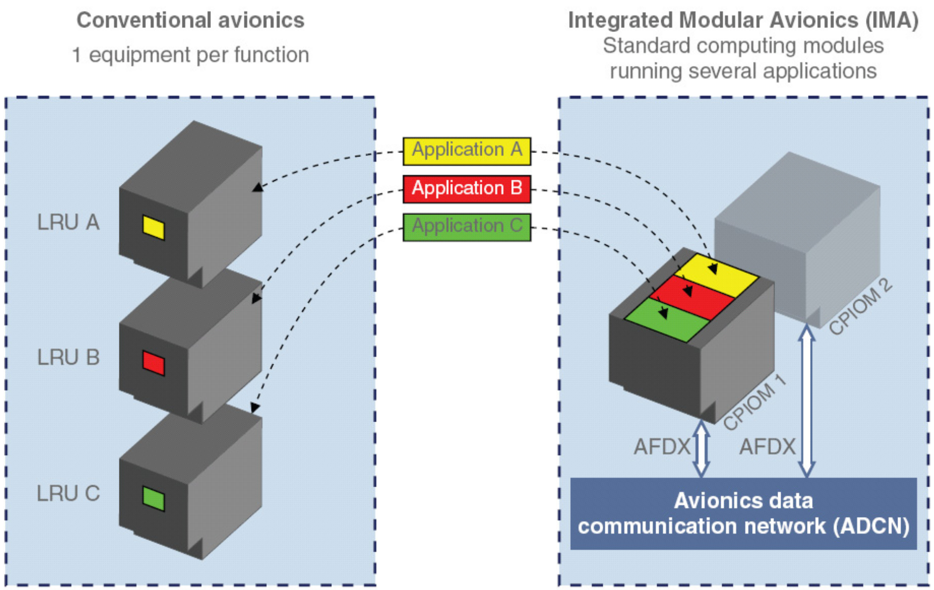
- Are directly connected to the avionics networks
- Host several applications, in order to monitor and control several aircraft systems
- Transmit signals compatible with:
  - The Avionics Networks, and
  - The conventional avionics.

- **Common Remote Data Concentrator (CRDCs)**

The CRDCs:

- Gathers data from sensors and actuators
- Provides this data to all relevant systems via the avionics networks.

Conventional Avionics vs. IMA



Line Replaceable Unit (LRU)

Avionics Full DupleX Switched Ethernet (AFDX)
Core Processing Input / Output Module (CPIOM)

Avionics Networks

There are two independent, identical and redundant avionics networks. The aircraft systems are connected to both of these avionics networks.

The information that comes from the aircraft systems is transmitted to the avionics networks via several transit points, referred to as switches.

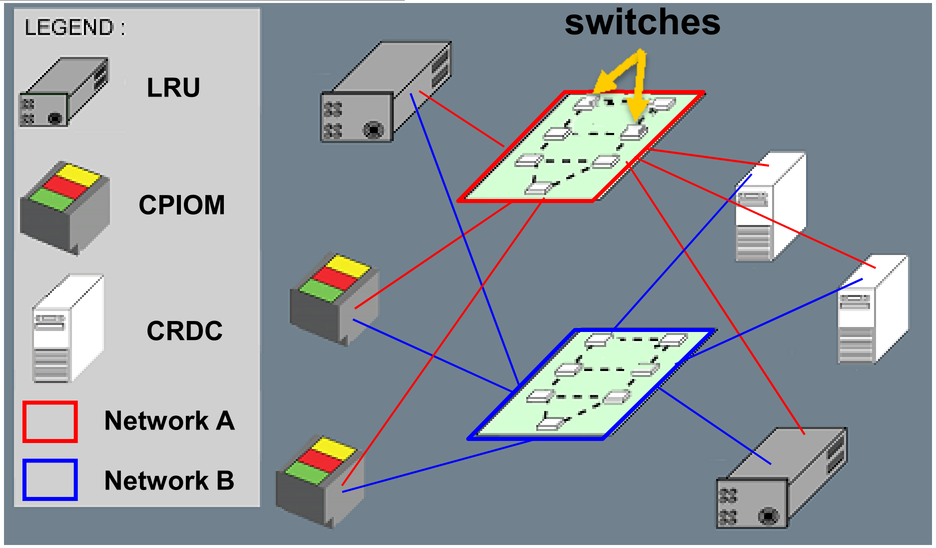
These switches automatically manage the communication between the aircraft systems, through the avionics network:

- They connect the aircraft systems to the network
- They route the information that is exchanged between the applicable systems.

Note:

The critical systems can always communicate with each other via conventional wiring to ensure that communication remains possible, if both avionics networks fail.

Avionics Networks Architecture



Onboard Maintenance System

Overview

The A350 has an Onboard Maintenance System (OMS) which provides support for:

- Aircraft servicing
- Line, schedule and unscheduled maintenance
- Aircraft configuration and reconfiguration monitoring.

The OMS has the following systems and functions:

- The Central Maintenance System which identifies, centralizes and memorizes system failures
- The optional technical logbook (e-Logbook) and the optional cabin logbook (Digital Cabin Logbook)
- The Aircraft Condition Monitoring System that provides support to preventive maintenance and in-depth investigations
- The Data Loading and Configuration Reporting System which manages data loading and equipment configuration.

The maintainer can access maintenance data via the cockpit Onboard Maintenance Terminal (OMT). The maintenance data is also transmitted to flight operations ground centers and service providers during the flight.

Central Maintenance System (CMS)

The CMS has three functions:

- **The diagnostic function** which:
  - Is designed to identify the root cause of a reported defect
  - Provides direct access to all maintenance data needed to correct reported defects.

- **The prognostic function** which provides a mean to:
  - Reduce scheduled maintenance, and
  - Anticipate unscheduled maintenance.

- **The support to maintenance activities**

  In flight (and on ground), the CMS:
  - Centralizes data from the Built-In Test Equipment (BITE) of the various aircraft systems
  - Organizes data and creates standard or customized fault reports.

  These reports are transmitted to the operational ground centers.

  On ground maintenance personnel can consult and download the CMS reports and has directly access to the BITE of the various aircraft systems.

e-Logbook and Maintenance Data Access and Recording Function

This optional function:

- Enables access to the Maintenance Data required to perform any maintenance task via the OMS
- Enables to track the maintenance activities (e-Logbook sub-function)
- Provides the aircraft technical status follow-up and lists all the maintenance actions that have been performed on the aircraft.

Integration of logbook within the OMS ensures that all maintenance related data is appropriately recorded and traced with reduced effort from the maintenance operator.

Aircraft Condition Monitoring System (ACMS)

The ACMS:

- Acquires and processes aircraft operational data in order to reduce scheduled maintenance and support airline in performing preventive maintenance
- Provides operators with performance and trend information about aircraft systems and engines.

The ACMS data can be:

- Transmitted in flight to the ground for real-time monitoring of the aircraft. This real-time monitoring is performed on ground via the AIRMAN™ application
- Downloaded after the flight.

Data Loading and Configuration Reporting System (DLCRS)

The DLCRS has two functions:

- The data loading function
- The configuration reporting function.

The data loading function manages:

- The update of databases and software for various avionics systems
- The downloading of CMS and ACMS reports.

The configuration reporting function:

- Acquires system hardware and software configuration data
- Elaborates and records configuration reports.

The configuration reports can be wirelessly sent to operational ground centers and service providers.

The following devices enables to interface with the OMS:

- **Onboard Maintenance Terminal (OMT)**
  The OMT is the main cockpit terminal to the OMS.

- **Portable Multipurpose Access Terminal (PMAT) - optional**
  During aircraft turn-around or maintenance, the PMAT can be connected to one of the network ports installed on various aircraft locations. The PMAT enables access to the OMS anywhere on the aircraft.

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Information Systems

A350 XWB

AIRBUS

The information systems include the:

- Onboard Information System
- Air Traffic Control Communication (ATCCOM) system
- Airline Operational Control function (optional)
- Cabin Operations

Note: The ATCCOM supports the communication and surveillance functions associated with the Communication Navigation Surveillance/Air Traffic Management environment.

General

The **Onboard Information System (OIS)** is a set of electronic documentation and applications for the flight crew. These applications replace the former paper documentation and charts.
The main objective of the electronic documentation is to provide the flight crew with an attractive documentation viewer, that enables an easy access to the necessary information related to an operational need.

Architecture

The OIS has two servers:

- One avionics server
- One network server.

Each server holds a set of applications.

The flow of data between these two servers is uni-directional, from the avionics server to the network server only. Two airline laptops can connect to the network server. Each laptop has a complete set of flight crew Electronic Flight Bag (EFB) applications.

Flight Operations Applications

The A350 provides several applications for the cockpit operations. These applications include:

- Performance computation tools for:
  - Takeoff
  - In-flight
  - Landing
  - Weight & Balance (W&B).

- Electronic documentation:
  - Flight Crew Operating Manual (FCOM)
  - Airplane Flight Manual (AFM)
  - Configuration Deviation List (CDL)
  - Master Minimum Equipment List (MMEL)
  - Flight Crew Training Manual (FCTM)
  - Cabin Crew Operating Manual (CCOM)
  - Airline documentation.

- Other tools:
  - e-Flight Folder
  - e-Logbook (optional)
  - AOC (optional)
  - e-charts (optional).

Flight Crew Interfaces

The following devices enable the flight crew to interface with the OIS:

- The **two outer DUs** that display the Onboard Information System

- A **KCCU**, for each flight crew, to interact with the applications

- A **keyboard and pointing device**, integrated in the sliding table of the captain and the first officer

- **Server switches**, one on each side, that enable display switching between the avionics server and the network server.

In addition, the captain and the first officer each have a laptop. Each laptop supplies computing and memory resources for the flight operations applications. The laptops are stored in their respective stowage boxes.

A350 XWB

Cockpit View

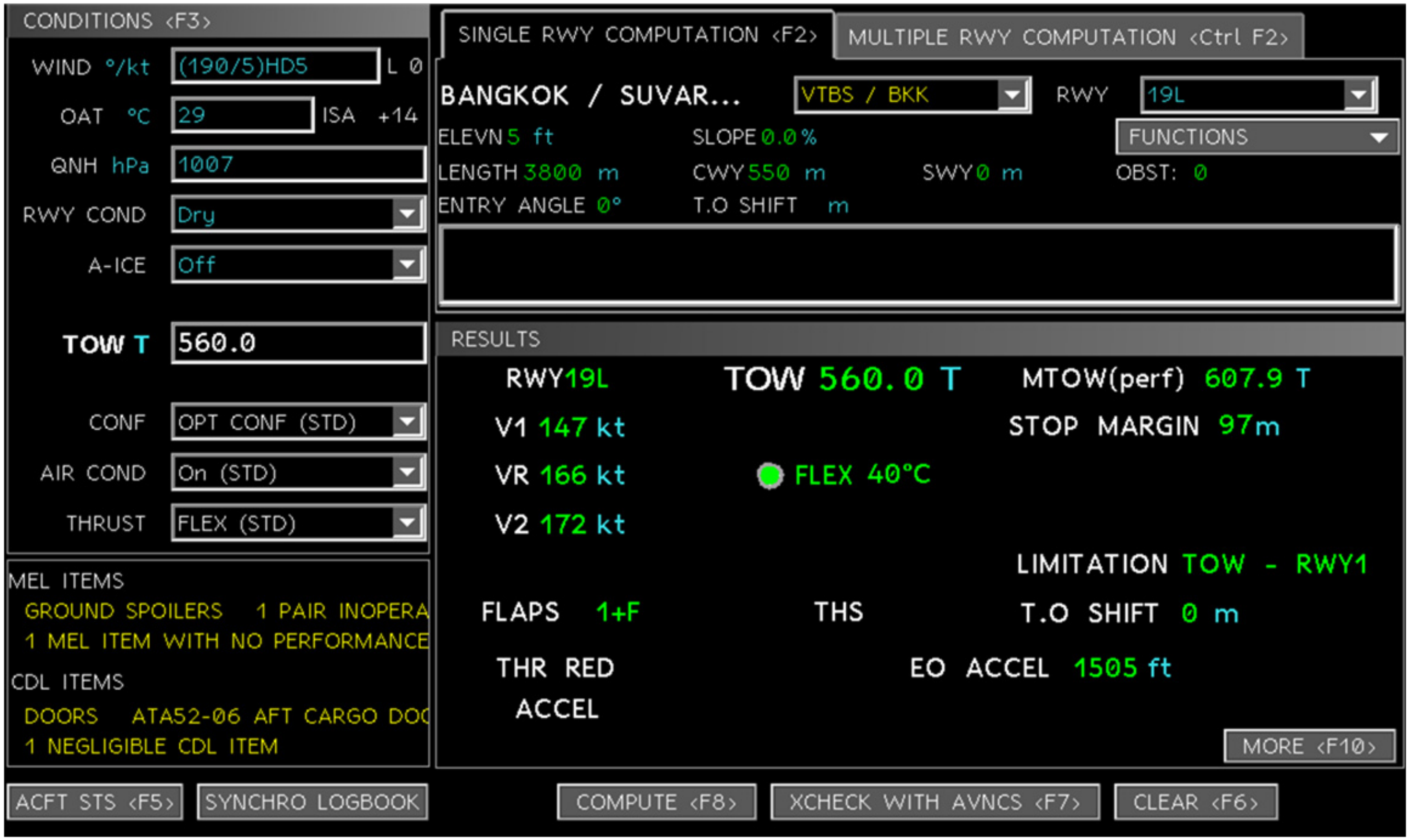
OIS Captain

OIS First Officer

OIS on center

Performance Applications

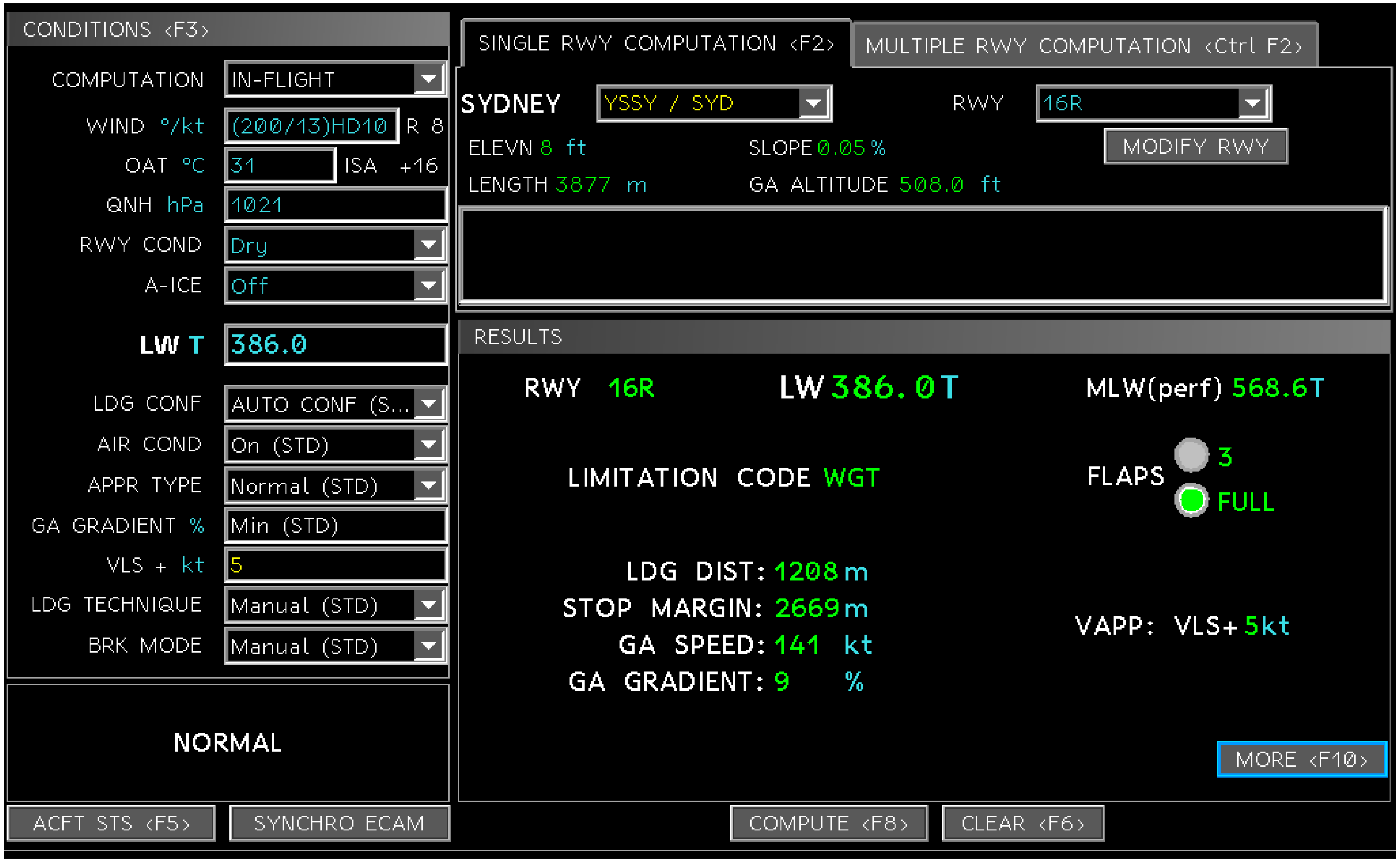
Takeoff



Note: For information only (sources A380).

Performance Applications

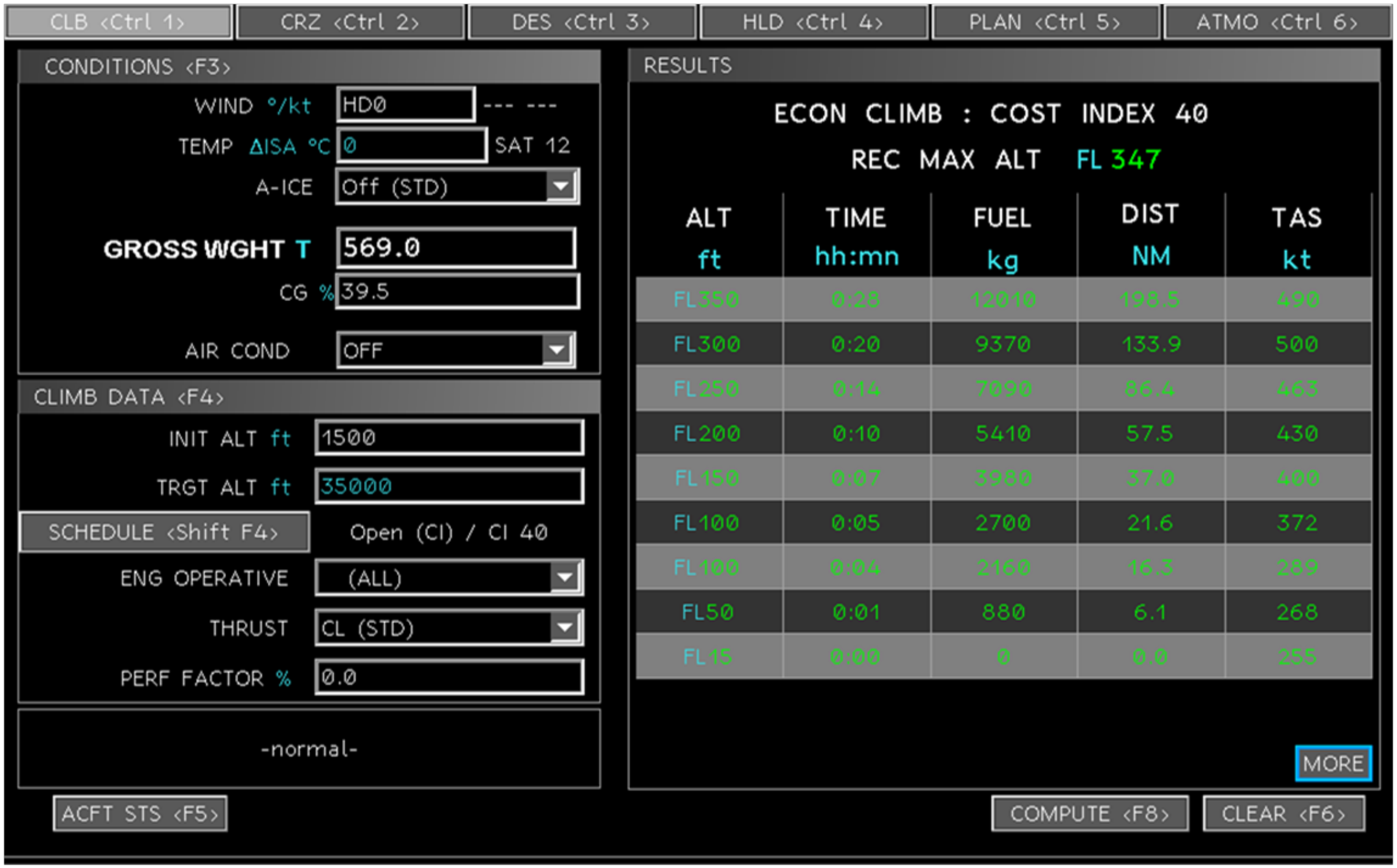
Landing



Note: For information only (sources A380).

Performance Applications

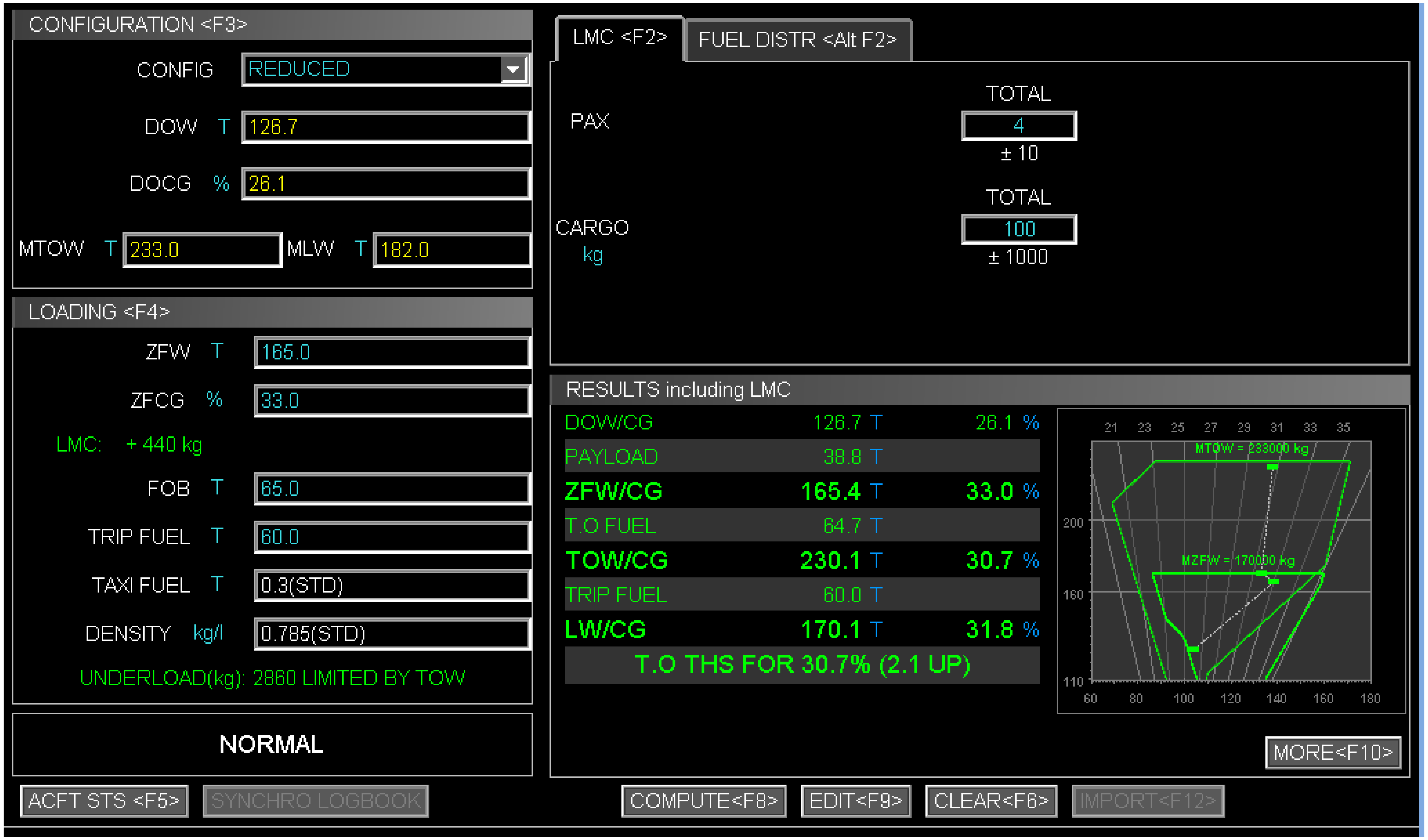
In-flight



Note: For information only (sources A380).

Performance Applications

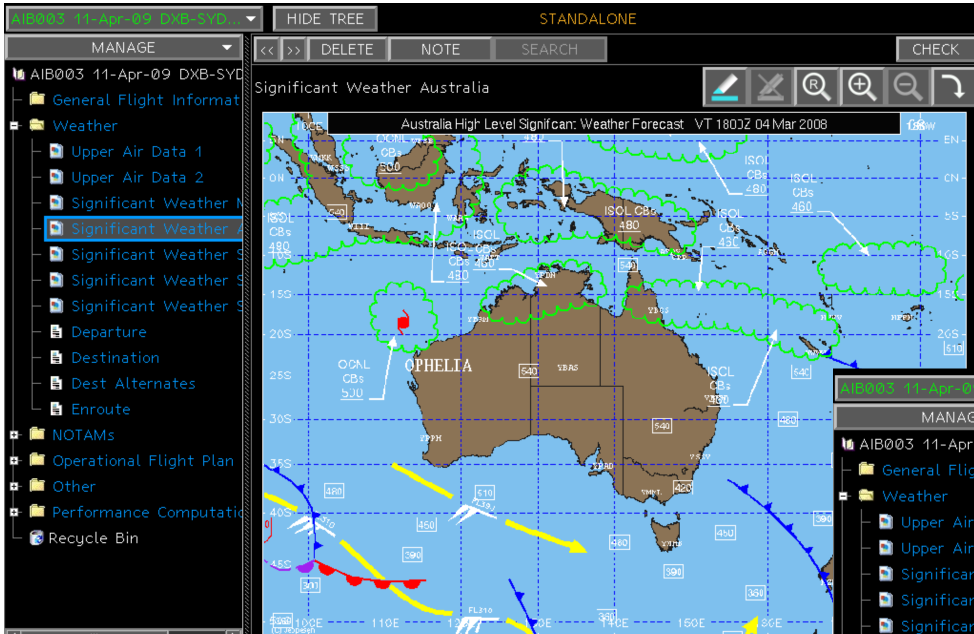
Weight & Balance

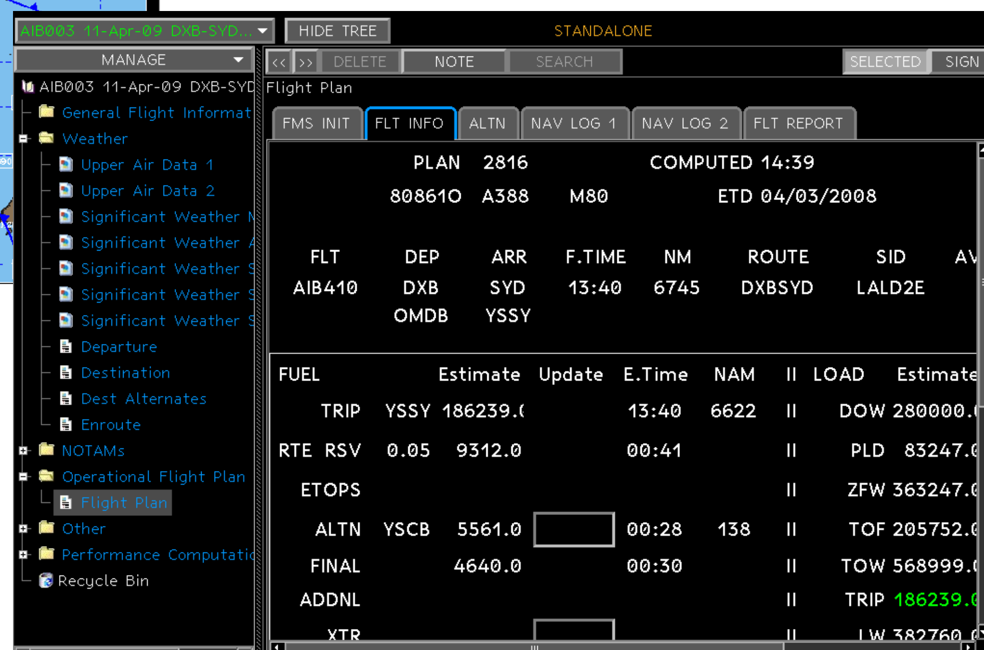


<u>Note</u>: For information only (sources A330).

e-Flight Folder

Graphics display (e.g. weather)

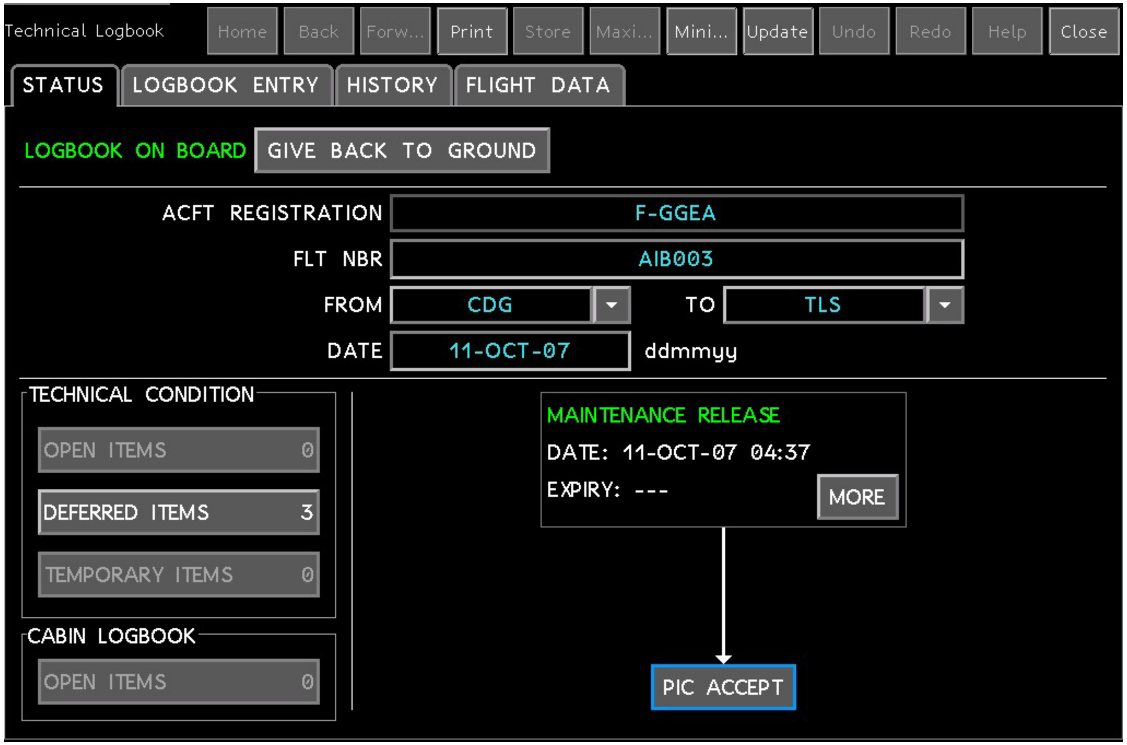




Electronic flight folder contains information on:

- Weather
- ATC flight plan
- Computer flight plan
- Flight info
- …

e-Logbook



The electronic logbook gives the technical status of the aircraft. It provides the possibility for the flight crew and maintenance personnel to follow the technical status of the aircraft.

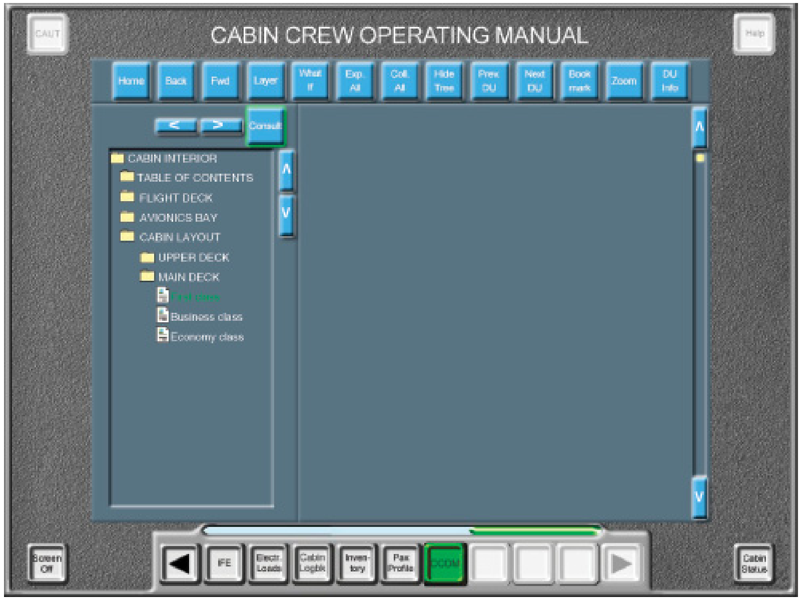
Cabin Operations

The A350 provides a **Flight Attendant Panel** (**FAP)** that enables access to the following applications:

- Digital Cabin Logbook (DCL)
- Cabin Crew Operating Manual (CCOM) viewer
- Cabin Intercommunication Data System (CIDS).

The cabin crew uses the FAP for cabin operations.

FAP



Overview

The flight crew and the company ground stations use the Airline Operational Control (AOC) application to exchange messages related to aircraft operations and/or management.
The AOC application uses the ACARS messaging system, to transmit AOC messages and performs the following functions:
- Message management function
- Out-Off-On-In (OOOI) function.

Note: The AOC is an optional application.

AOC Application

The AOC application enables Operators to:
- Manage flight operations:
  - Data initialization
  - Flight log
  - Flight summary
  - Free text
  - Estimated Time of Arrival (ETA)
  - Ramp service requests
- Check the weather status:
  - TAF
  - METAR
  - SIGMET
- Manage delays related to: Departure, takeoff, flight, and gates
- Manage flight parameters.

The onboard application has:
- Associated software
- An AOC database, that can be a:
  - Generic database, with the basic AOC functions, or
  - Customized database.

AOC Functions

The Message Management Function

The AOC application either warns, or advises, the flight crew that an AOC message is received, depending on the message priority.

The AOC can automatically:

- Print specific types of messages
- Send specific types of messages
- Delete all messages from the mailbox at the end of each flight
- Store all messages in the appropriate directory (sent, inbox, or outbox)
- Perform additional functions, as applicable, depending on AOC customization.

The AOC enables the flight crew to manually:

- Print messages
- Edit messages
- Zoom messages
- Store messages, as applicable, depending on AOC customization
- Send pre-defined messages to the company ground station with an associated free text.

The Out-Off-On-In (OOOI) Function

The AOC application computes and sends automatic reports (also called OOOI reports) to provide the Operators with applicable details about aircraft and flight status, progress, and/or delays.

The AOC automatically sends the message at a pre-defined time during the flight (e.g. when the doors are closed, when the parking brake is off, when the landing gear is up (down), etc).

Operators can customize the triggering conditions of these messages.

Air Traffic Control Communication System

A350 XWB

AIRBUS

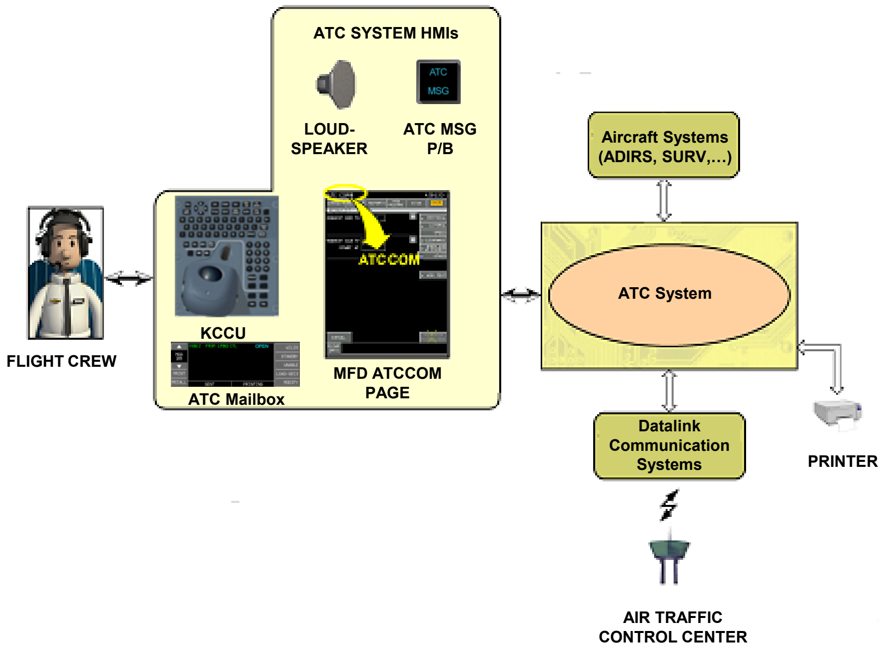
Overview

The Air Traffic Control Communication (ATCCOM) system provides datalink communication between the aircraft and the ATC centers.
The ATC datalink system has several functions that the flight crew uses to communicate with the ATC center. These functions enable the air traffic controller to monitor aircraft navigation, and manage air traffic.
The datalink communication between the aircraft and the ground network is made via the HF, VHF or SATCOM communication systems.

Onboard the A350, the ATC system provides the following datalink capabilities:
- ATC datalink
- ARINC 623 services.

The ATC communication enables to perform the following operations in oceanic/remote and continental airspace:
- Notification to ATC centers
- Communication between flight crew and controllers
- Automatic Dependant Surveillance-Contract (ADS-C)
- Request and reception of Oceanic and Departure Clearances (OCL/DCL)
- Reception of D-ATIS information.

ATCCOM System Architecture



ATC Datalink

The Future Air Navigation System (FANS) aims at upgrading Communication and Navigation systems and Surveillance (CNS) in order to enable the introduction of efficient Air Traffic Management (ATM) to:

- Increase airspace capacity in order to cope with air traffic growth
- Enhance operational flexibility
- Enable improved air traffic control
- Contribute to continued safety of air traffic.

There are two types of datalink:

- FANS A that uses the ACARS datalink network to communicate with ATC in oceanic or remote areas
- FANS B that uses the Aeronautical Telecommunication Network (ATN) to communicate with ATC in continental area.

The FANS A and FANS B provide the following functions:

- **Notification Function**

The ATS Facilities Notification (AFN in FANS A), or the Context Management (in FANS B) establishes a datalink connection between the aircraft and the ATC center by sending aircraft identity information (e.g. aircraft registration number and flight number).

- **Controller-Pilot Datalink Communications (CPDLC)**

A datalink communication function enables the flight crew to:

  - Send requests
  - Send reports: Position reports and others
  - Read uplink messages
  - Answer uplink messages.

- **Automatic Dependent Surveillance-Contract (ADS-C)**

This function provides information reports, without any flight crew action, to one or more ATC centers or AOC centers.

The reports include data such as the aircraft position and speed.

Note:

The ATC communication system will be integrated in the A350 cockpit as a single unified crew interface. This unified interface will enable operators to have both FANS A and FANS B operative on the same airplane with a single set of flight crew procedures.

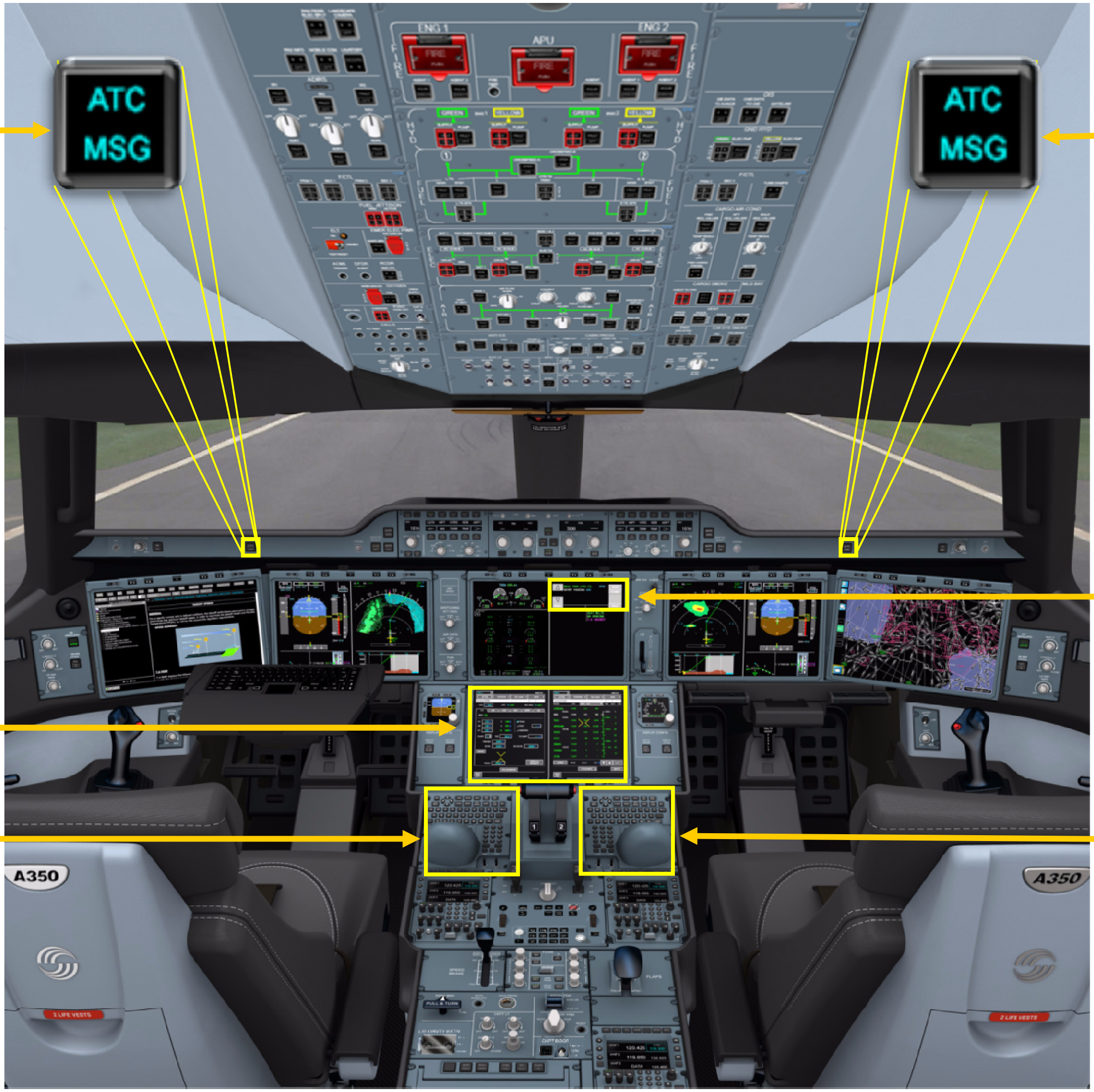
ARINC 623 Services

The ARINC 623 services include:

- A **clearance function** that enables the flight crew to request and obtain Oceanic and Departure Clearances (OCL/DCL). The ATC mailbox displays the clearances.

- A **Digital-Automatic Terminal Information Service (D-ATIS)** that enables the flight crew to request and obtain digital ATIS information for departure, destination, and alternate airports (if available).

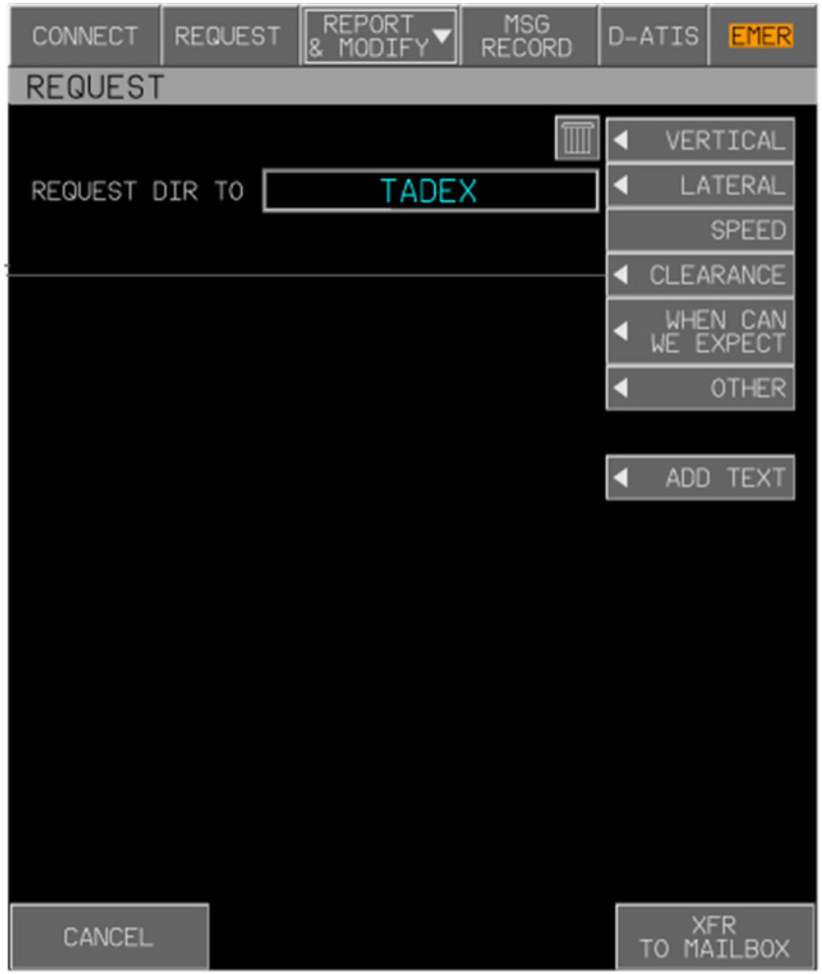
Cockpit View



The flight crew uses the following interfaces:

- An MFD ATCCOM page on the CENTER LOWER display on which the flight crew creates requests, manages connection, checks history files and D-ATIS reports and modifies answers
- An ATC mailbox on the CENTER UPPER display to display ATCCOM system messages exchanged between the flight crew and the ATC centers
- The CAPT and F/O ATC MSG pb and loudspeakers that indicate the arrival of an ATC message
- The KCCU, which provides an interface with the MFD ATCCOM page, and which has a shorcut that provides a quick access to the ATC mailbox
- The flight crew can print any message exchanged with the ATC center.

MFD ATCCOM Pages



ATC Mailbox

Auxiliary Power Unit

General

The Auxiliary Power Unit (APU) is a single shaft gas turbine that enables the aircraft to be autonomous regarding:

- Electrical power (230 VAC 150 kVA)
- Bleed air.

The APU can provide:

- On ground:
  - Bleed air for engine start and for air conditioning
  - Electrical power via a starter/generator system

- During takeoff:
  - Bleed air for air conditioning, when needed
  - Electrical power

- In flight:
  - For the entire flight envelope:
    - A backup for electrical power

  - Up to 25 000 ft:
    - Bleed air for engine start

  - Up to 22 500 ft:
    - Backup for air conditioning.

Electrical and pneumatic power can be provided to the aircraft separately or in combination. However, electrical generation has priority over bleed air generation.

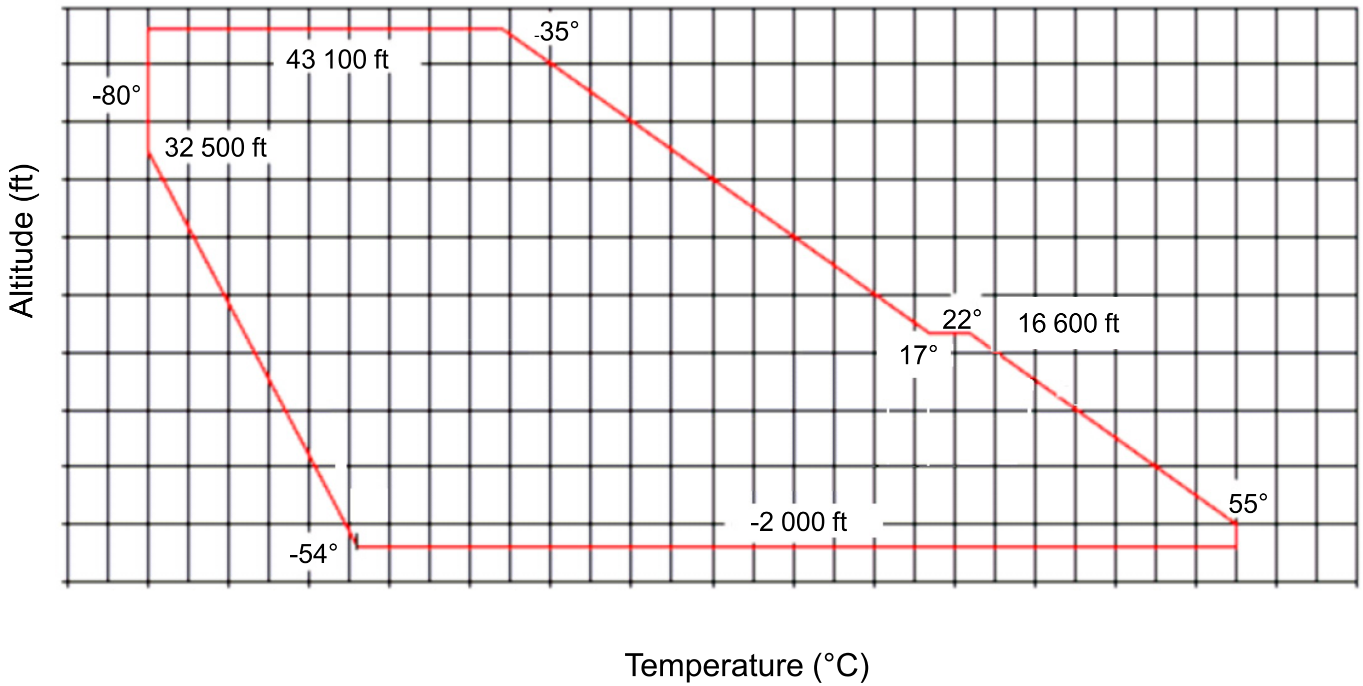
The APU system has:

- One Electronic Control Box (ECB) which permanently monitors and controls all APU functions
- One starter/generator system.

The following power sources can start the APU:

- The aircraft batteries
- External power (GPU)
- The normal electrical network of the aircraft.

APU Flight Envelope



Note:

- *The APU operating envelope and aircraft flight envelope are identical*
- *The APU can be started up to a flight altitude of 43 100 ft.*

System Architecture

APU Engine

The APU has a:

- Load compressor which provides power for bleed air and electrical generation
- Two-stage engine compressor
- Three-stage engine turbine.

Electronic Control Box (ECB)

The ECB:

- Sequences and monitors the APU start
- Sequences and monitors the manual, automatic, and emergency APU shutdown
- Monitors the APU bleed air
- Monitors the operating parameters of the APU
  - Controls the rotation speed
  - Protects the APU from overtemperature or other malfunctions (e.g. overspeed)
  - Avoids load compressor surge
  - Supplies fault information for APU failure and engine trend monitoring
  - Commands directly the opening and closure of the air intake flap actuator
  - Displays the applicable information on the ECAM.

APU Starter/Generator System

The APU drives a starter/generator System which can either:

- Start the APU (in STARTER mode)
- Generate electrical power (in GENERATOR mode).

APU Bleed Air

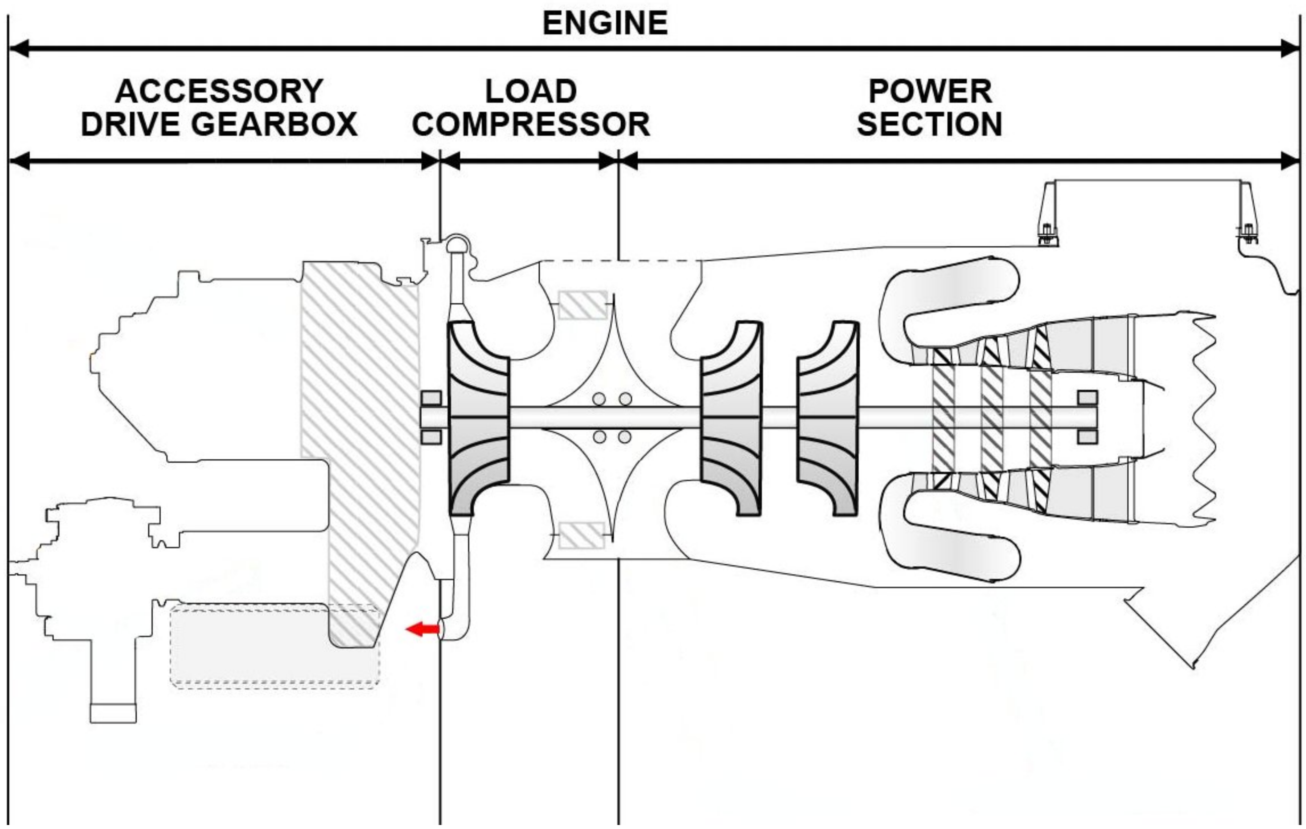
The APU can provide bleed air to the bleed system, via the APU bleed valve.

APU Air Intake System

The APU air intake system has an:

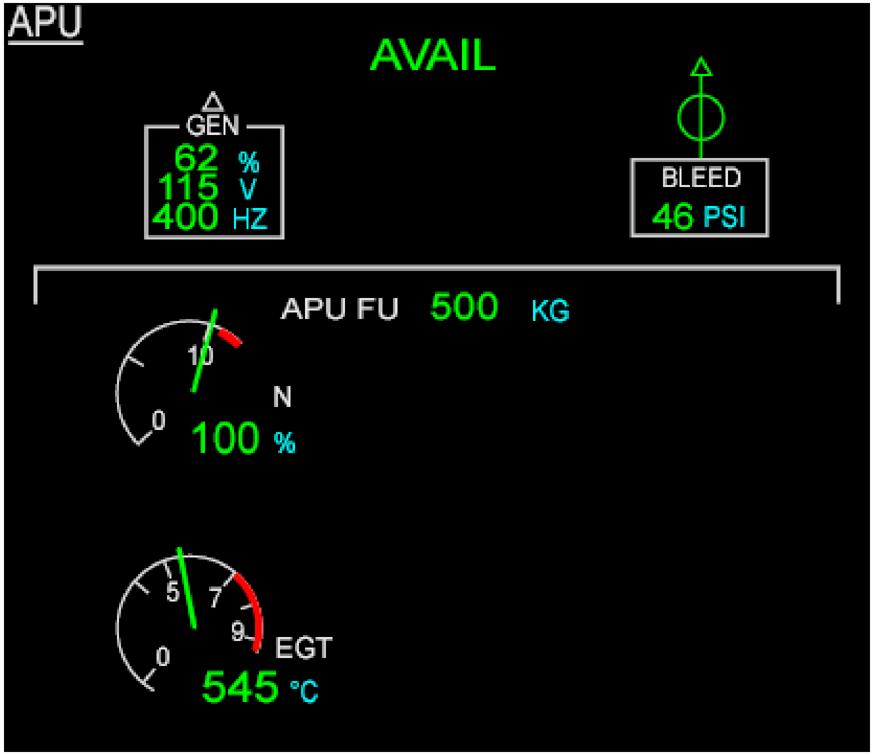
- Air intake flap. External air flows into the APU via this flap
- Ice protection.

APU Architecture



Cockpit View

APU SD Page



APU Panel

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Doors

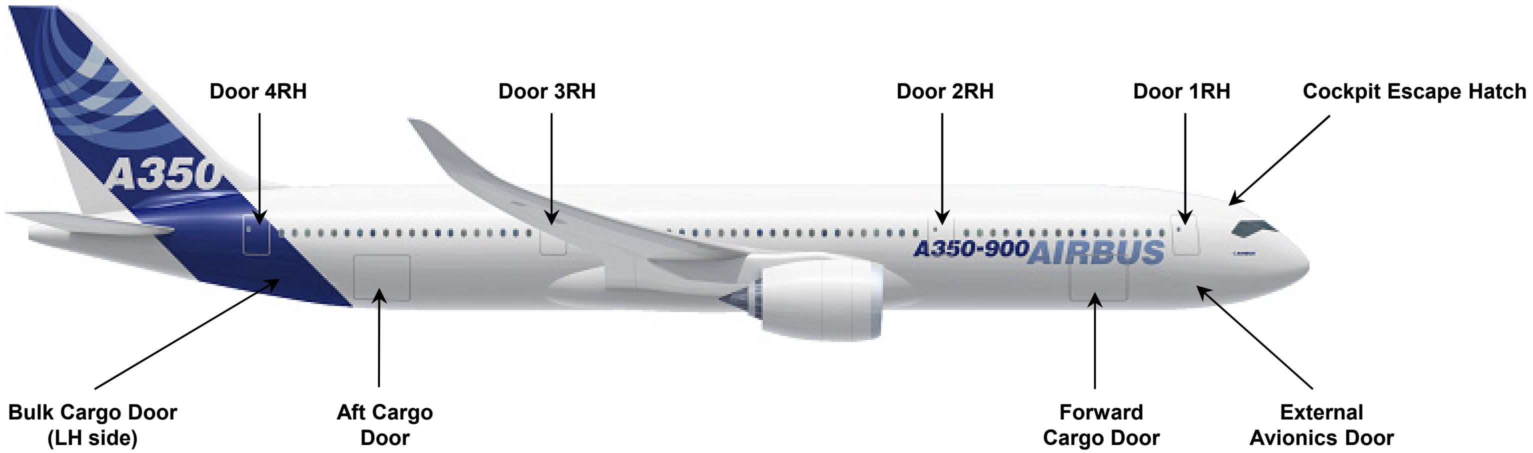
A350 XWB

AIRBUS

Overview

The A350-900 has:

- 8 passenger doors
- 3 lower deck cargo doors (forward, aft and bulk)
- External and internal avionics access doors
- A cockpit escape hatch
- A cockpit door between the cockpit and the cabin
- A cockpit door surveillance system (CDSS), optional.



Passenger Doors

The A350 has eight passenger doors which can be operated from inside and outside the aircraft.

Each door has :

- A hold open device
- One damper and inflatable escape slide raft for emergencies
- Residual pressure indication
- Optional slide status indication.

Lower Deck Cargo Compartment Doors

There are two doors for cargo loading on the lower right side of the fuselage:

- One for the forward compartment
- One for the aft compartment.

The door for the bulk compartment is on the lower left hand side of the fuselage.

Cockpit Door

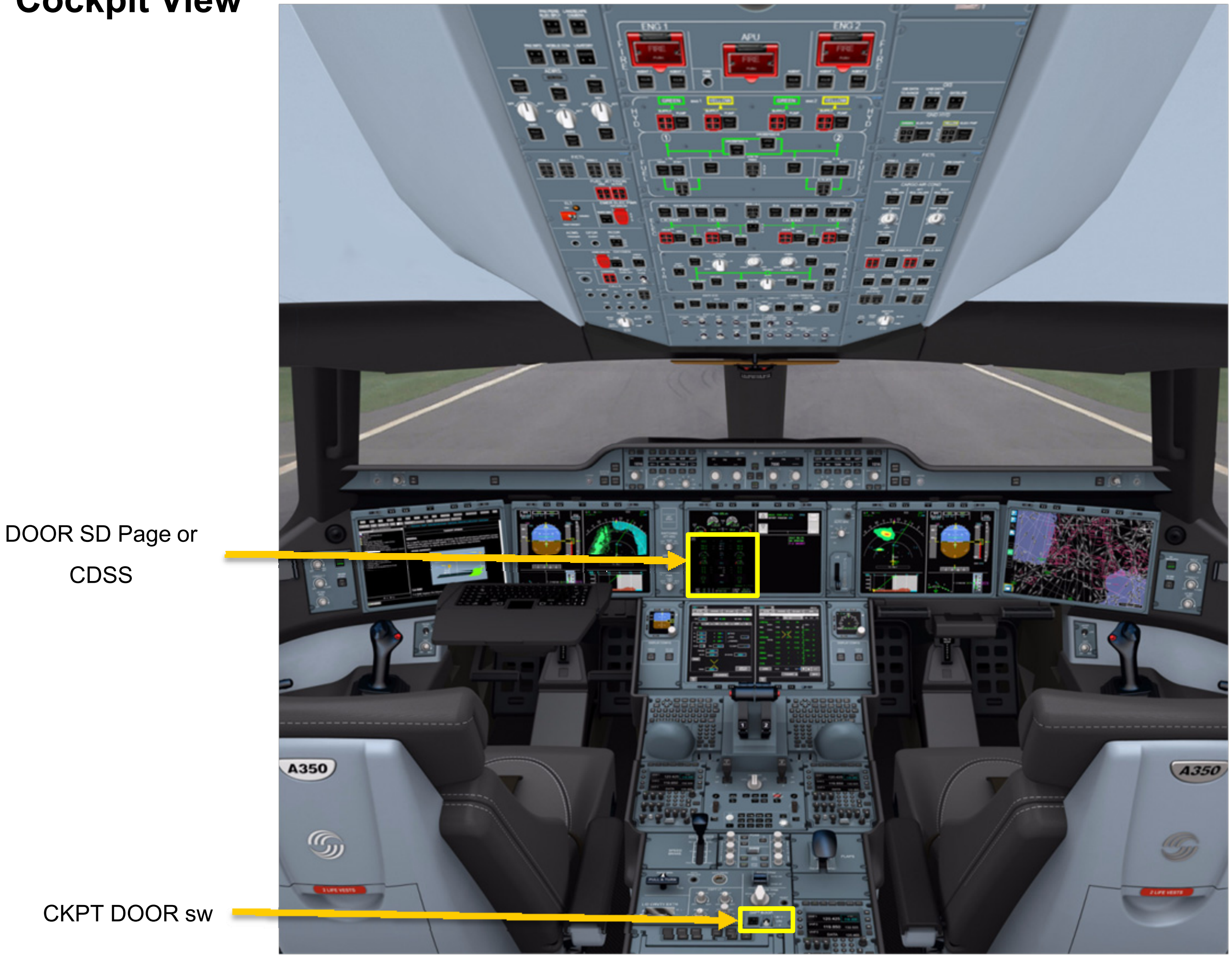
The door between the cockpit and the cabin is intrusion and penetration resistant. This door is electrically controlled and has a mechanical opening device.

Cockpit Door Surveillance System (CDSS)

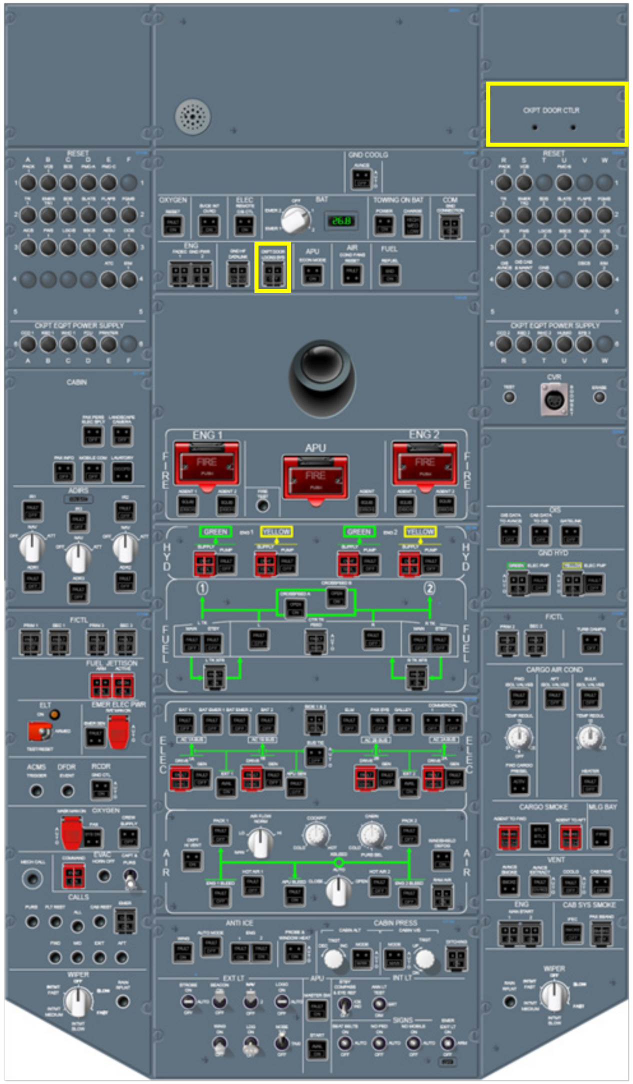
This system enables the flight crew to monitor the cabin area in front of the cockpit door and the door 1 cross aisle.

This system has three cameras which display video on the dedicated VIDEO SD page.

Cockpit View

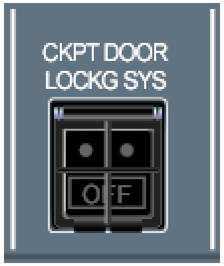


Overhead Panel

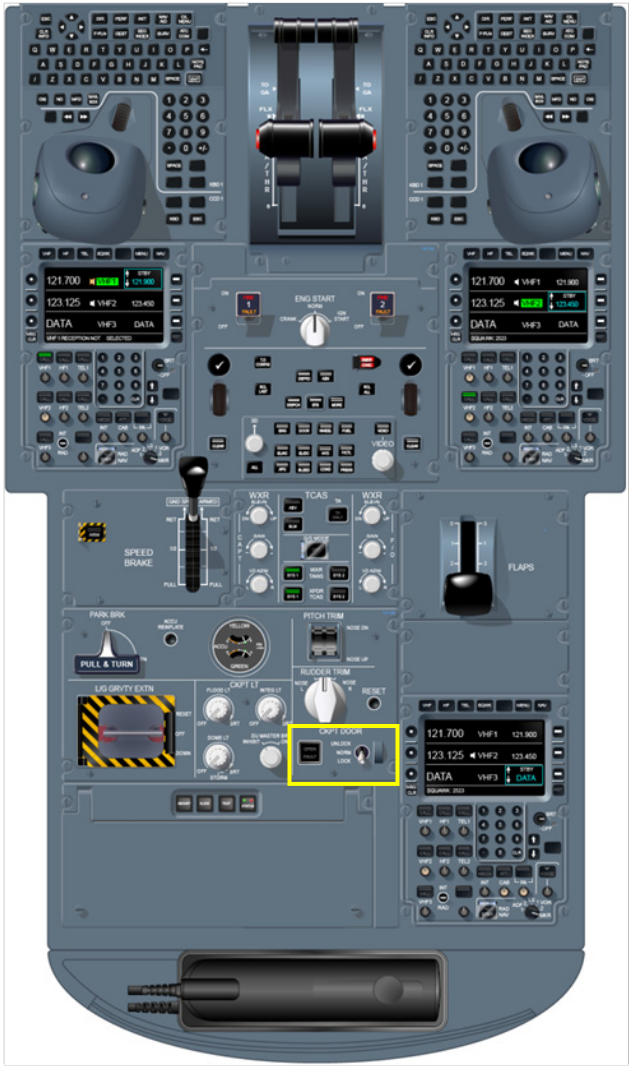


CKPT DOOR CTRL Panel

CKPT DOOR LOCKG
SYS guarded pb

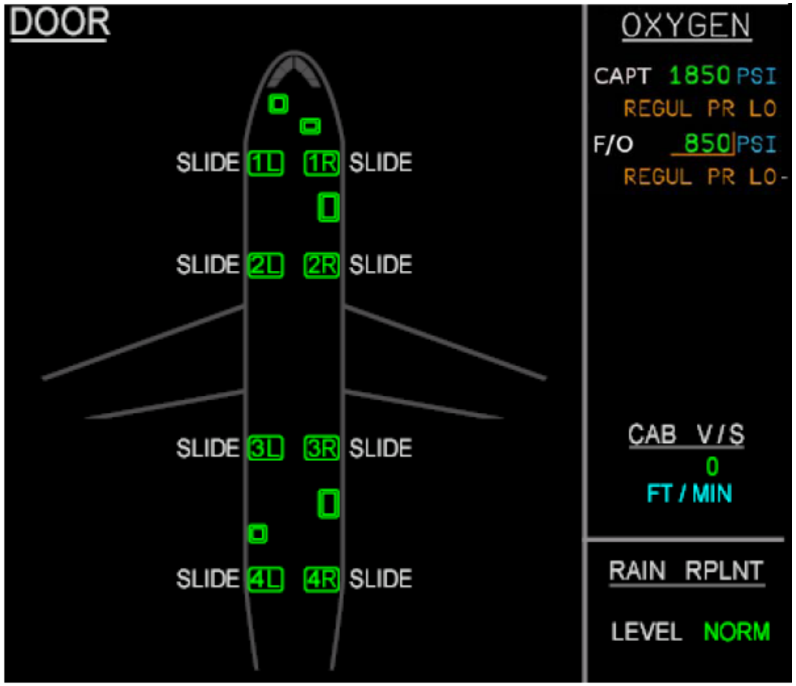


Pedestal



CKPT DOOR sw

DOOR SD Page



Cockpit Door System Surveillance

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Engines

A350 XWB

1. **System Description**
   - General
   - Full Authority Digital Engine Control
   - Engine Start
   - Thrust Control
   - Thrust Reverser
2. **Controls and Indicators**

AIRBUS

General

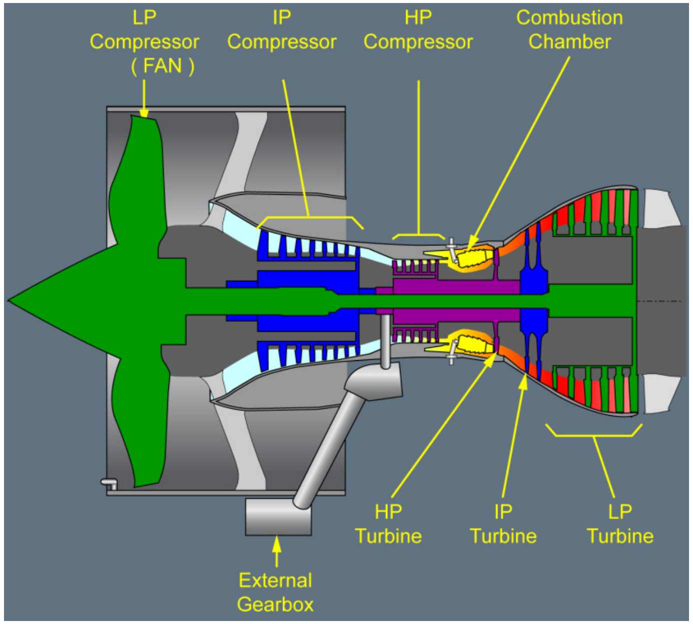
The Rolls-Royce TRENT XWB engine powers the A350 aircraft.

It is a high bypass ratio turbofan engine and is offered at different thrust levels to support all variants of the A350 family.

Nominal Static Thrust of A350-900 Engines

Engine type	Thrust ratings (Maxi takeoff at MSL)
RR Trent XWB - 84	84,000 lbs

Rolls-Royce TRENT XWB



Full Authority Digital Engine Control

Each engine has one Full Authority Digital Engine Control (FADEC). Each FADEC has two fully redundant channels that perform:

- Ignition and starting:
  - Automatic engine start monitoring, start abort and re-start when necessary
  - Automatic relight and quick relight functions
  - Manual engine start passive monitoring with fault annunciation

- Engine power management:
  - Thrust rating and thrust limit computation
  - Idle settings

- Engine protection in the entire aircraft envelope and weather conditions:
  - N1, N2, N3 and EGT overlimit protection
  - LP shaft breakage protection
  - Overthrust detection
  - Adverse weather management
  - Fan instability protection
  - Stall protection

- Engine parameters monitoring and display,including the Airbus Cockpit Universal Thrust Emulator (ACUTE):
  - The FADEC transmits engine parameters to the Engine Display (ED) and the System Display (SD) and engine monitoring information to the Flight Warning System (FWS).

Engine Start

The engine has a pneumatic air turbine starter. This starter is supplied with air either from:

- The Auxiliary Power Unit (APU)
- The other engine
- An external ground air supply.

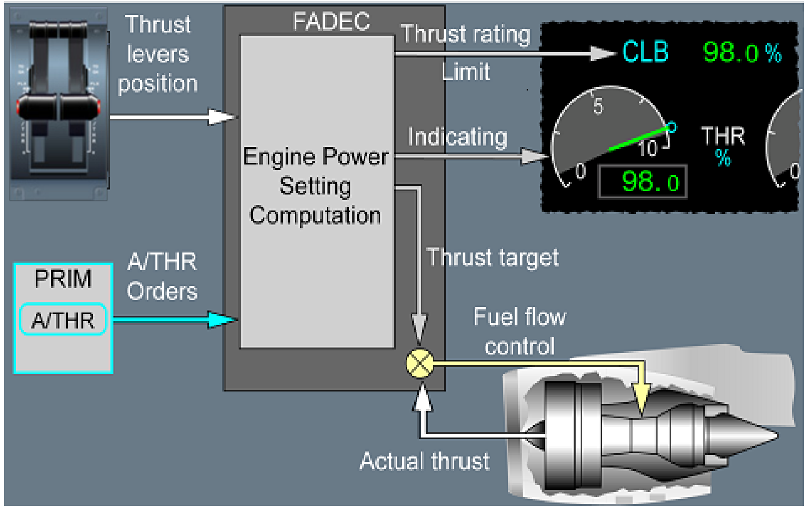
Thrust Control

The FADEC provides engine thrust control. The FADEC controls the thrust either in:

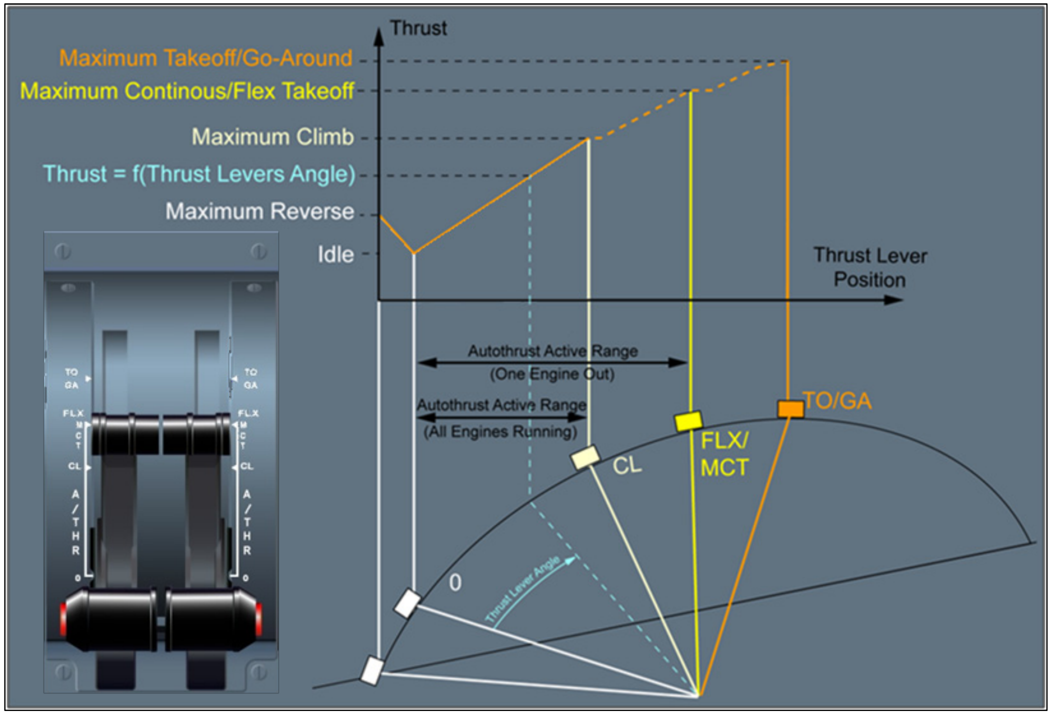
- **Manual mode** according to the thrust lever position, or
- **Automatic mode** (Autothrust) according to thrust targets coming from the Flight Guidance (FG) part of the PRIMs.

When the Autothrust (A/THR) is engaged, the thrust control levers are not moving according to the thrust rating commanded by the A/THR system.

Thrust Control Architecture



Thrust Levers Detents/Angle and Corresponding Thrust



There are **four detents** on the thrust levers:

- **TOGA**: Maximum Takeoff/Go-Around thrust
- **FLX MCT**: Maximum continuous thrust (or FLX at takeoff, in accordance with the FLX/TO temperature setting on the T.O panel of the FMS ACTIVE/PERF page on the MFD)
- **CL**: Maximum climb thrust
- **0**: Idle thrust.

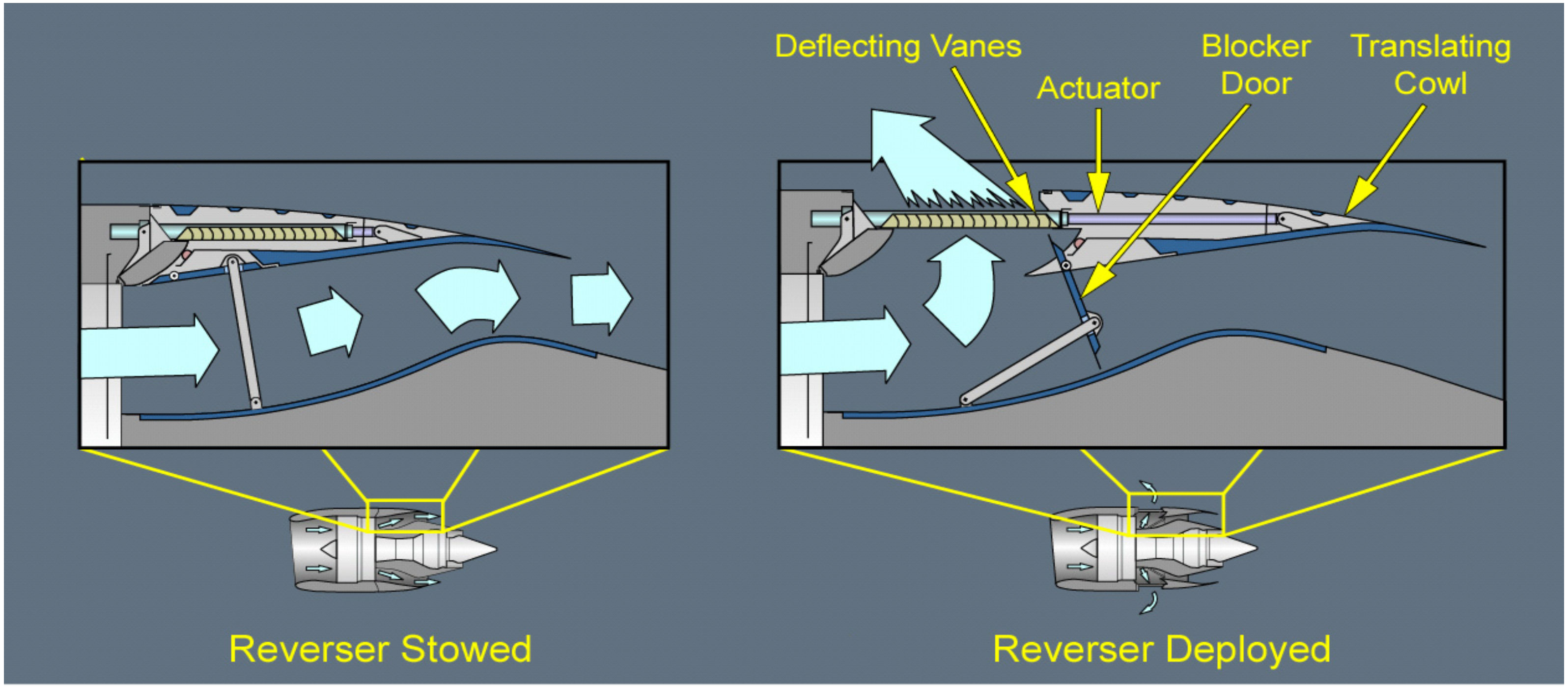
Thrust Reverser

There are two thrust reversers: one on each engine.
The thrust reversers are electrically actuated.

The thrust reverser system has several segregated lines of defense to protect the aircraft against deployment in flight.

These lines of defense are based on the following elements:

- Thrust lever positions
- Radio altimeter altitude
- Aircraft-on-ground confirmation
- Reverse levers positions.



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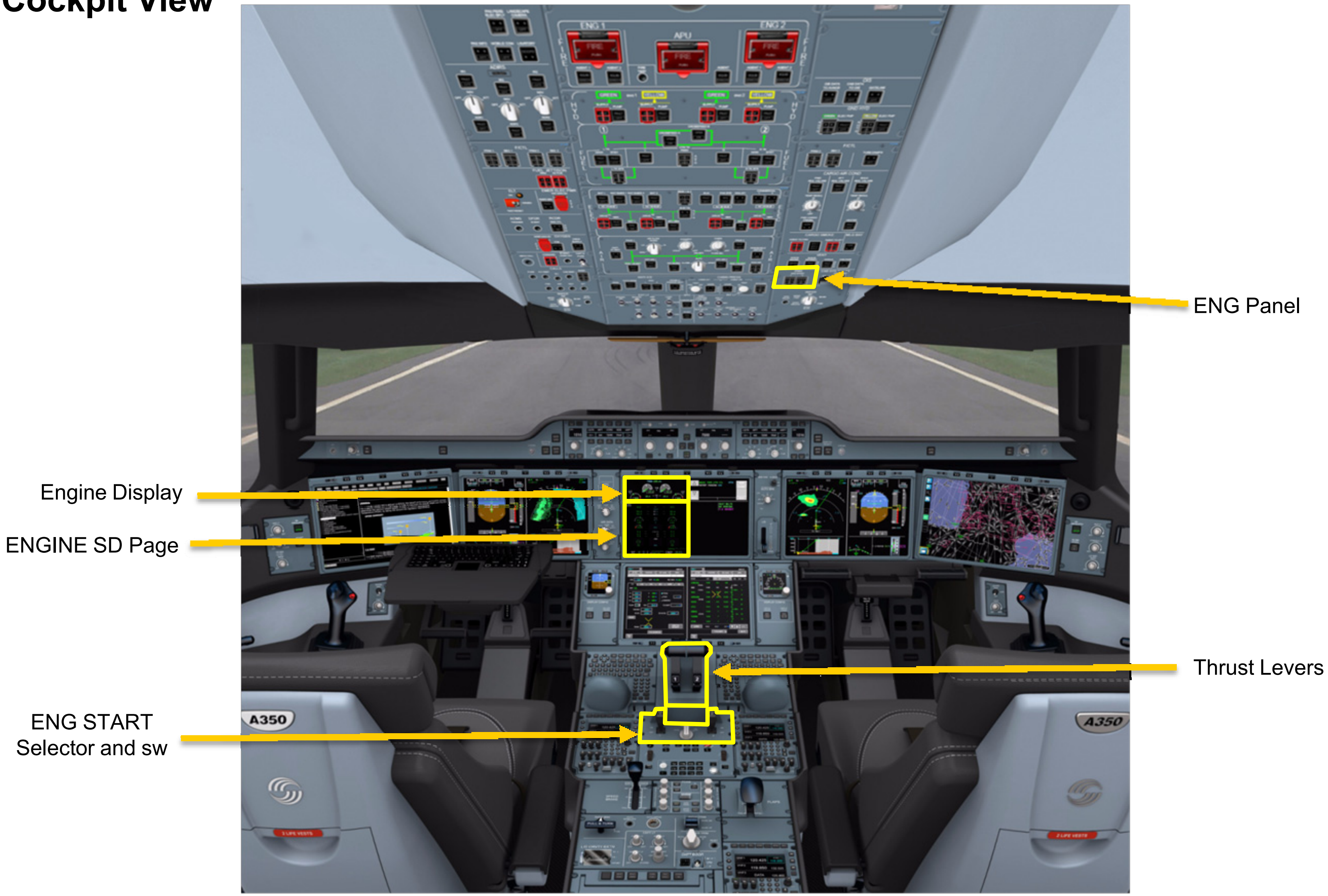
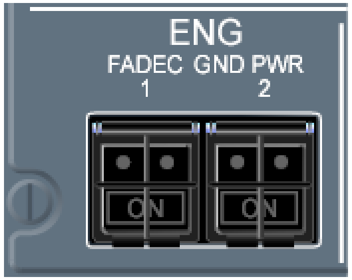
Cockpit View

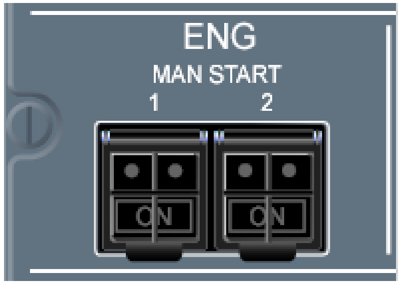


Controls

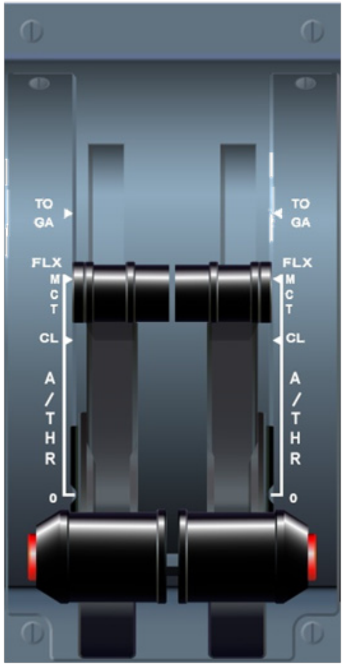
ENG MAINTENANCE Panel



ENG Panel



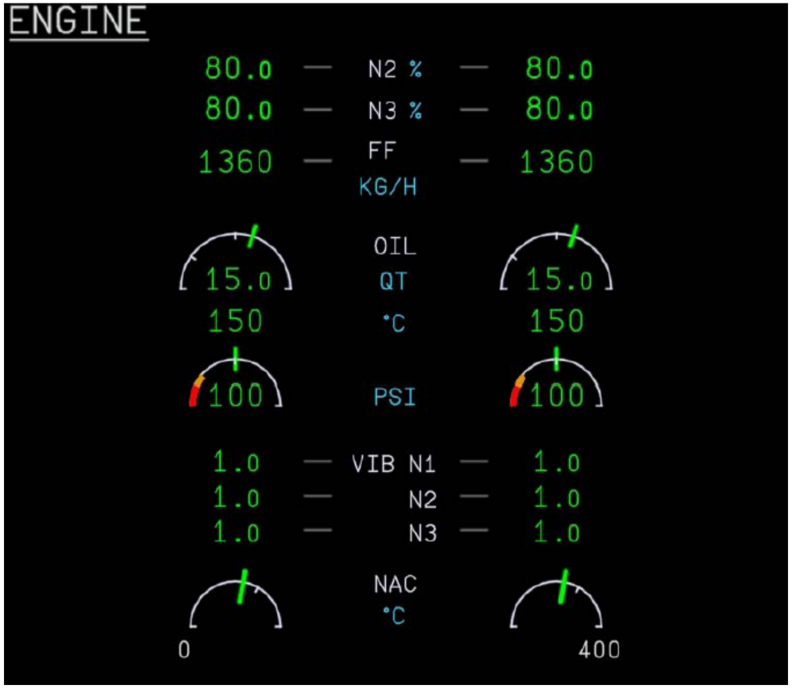
Thrust Levers



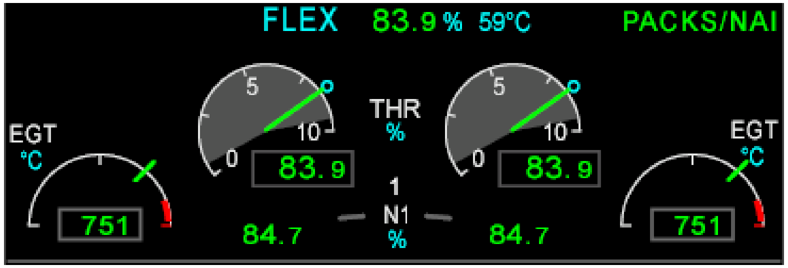
ENG START Selector and sw

Indicators

ENGINE SD Page



Engine Display (ED)



ACUTE

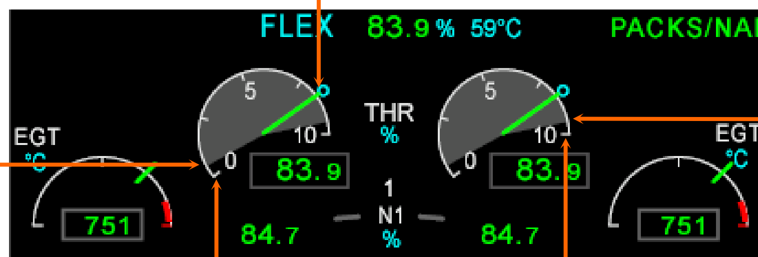
The **Airbus Cockpit Universal Thrust Emulator (ACUTE)** converts the engine control parameter into a common Thrust parameter (THR) for all engine types.

The thrust parameter varies between 0% and 100% in all flight conditions and is defined as follows:

ED: Forward Thrust

THR_{REF} : Thrust corresponding to the thrust lever position

THR_{IDLE} : Thrust produced when the engine is operating at IDLE

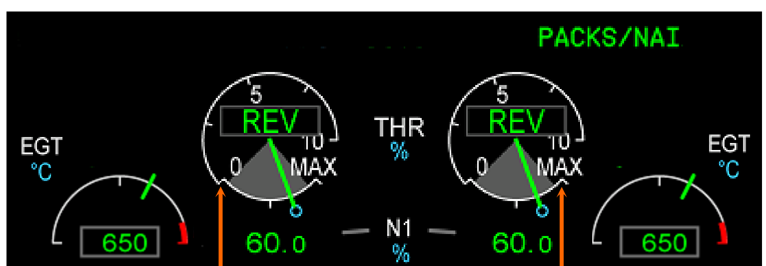


THR_{MAX} : Thrust produced when thrust levers are at TOGA detent, taking into account the air bleed effect

THR_{WML} : Thrust produced when the engine is windmilling

THR_{MAX} : Thrust produced when thrust levers are at TOGA detent and bleed off

ED: Reverse Thrust



$THR_{IDLE\ REV}$

$THR_{MAX\ REV}$

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List of Abbreviations

A

- **A/THR** Autothrust
- **ABV** Above
- **AC** Alternating Current
- **ACMS** Aircraft Condition Monitoring System
- **ACUTE** Airbus Cockpit Universal Thrust Emulator
- **ADC** Air Data Computer
- **ADIRS** Air Data and Inertial Reference System
- **ADIRU** Air Data and Inertial Reference Unit
- **ADHF** Adaptive Dropped Hinge Flaps
- **ADR** Air Data Reference
- **ADS** Automatic Dependent Surveillance
- **ADV** Advisory
- **AES** Auto Extension System
- **AFDX** Avionics Full Duplex switched
- **AFM** Aircraft Flight Manual
- **AFS** Automatic Flight System
- **AFS CP** AFS Control Panel
- **AGL** Above Ground Level
- **AGS** Air Generation System
- **A-ICE** Anti-Ice
- **ALT** Altitude
- **AOA** Angle-of-Attack
- **AOC** Airline Operations Communications
- **AP** Autopilot
- **APPR** Approach
- **APU** Auxiliary Power Unit
- **ARS** Auto Retraction System
- **ATC** Air Traffic Control
- **ATM** Air Traffic Management
- **ATSAW** Air Traffic Situational Awareness
- **ATU** Automatic Transfer Unit
- **AVNCS** Avionics

B

- **BAT** Battery
- **BPS** Backup Power Supply
- **BCM** Backup Control Module
- **BCS** Brake Control System
- **BITE** Built-In Test Equipment
- **BKUP** Backup
- **BLW** Below

C

- **C/B** Circuit Breaker
- **C/L** Checklist
- **CAPT** Captain
- **CCOM** Cabin Crew Operating Manual
- **CDL** Configuration Deviation List
- **CDS** Control and Display System
- **CDSS** Cockpit Door Surveillance System
- **CG** Center of Gravity
- **CI** Cost Index
- **CIDS** Cabin Intercommunication Data System

List of Abbreviations

- **CL** Climb
- **CMS** Central Maintenance System
- **CMV** Concentrator and Multiplexer for Video
- **CNS** Communication and Navigation systems and Surveillance
- **CP** Control Panel
- **CPCS** Cabin Pressure Controller System
- **CPDLC** Controller/Pilot Datalink Communication
- **CPIOM** Core Processing Input/Output Module
- **CRDC** Common Remote Data Concentrator
- **CRZ** Cruise
- **CST** Constraint
- **CVMS** Cabin Video Monitoring System
- **CVR** Cockpit Voice Recorder

D

- **D-ATIS** Digital Automatic Terminal Information Service
- **DC** Direct Current
- **DCL** Digital Cabin Logbook, Departure Clearance
- **DES** Descent
- **DFDR** Digital Flight Data Recorder
- **DFS** Differential Flap Setting
- **DGPS** Differential Global Positioning System
- **DIR TO** Direct to
- **DLCRS** Data Load and Configuration Reporting System
- **DME** Distance Measuring Equipment
- **DU** Display Unit

E

- **EBHA** Electrical Backup Hydraulic Actuator
- **ECAM** Electronic Centralized Aircraft Monitoring
- **ECB** Electronic Control Box
- **ECP** ECAM Control Panel
- **ECS** Environmental Control System
- **ED** Engine Display
- **EDP** Engine Driven Pump
- **EFB** Electronic Flight Bag
- **EFF** Electronic Flight Folder
- **EFIS** Electronic Flight Instrument System
- **EFOB** Estimated Fuel On Board
- **EHA** Electro-Hydrostatic Actuator
- **EIS** Entry Into Service
- **e-Logbook** Electronic Logbook
- **ELT** Emergency Locator Transmitter
- **EMP** Electric Motor Pump
- **EPU** Estimated Position Uncertainty
- **ETA** Estimated Time of Arrival
- **ETACS** External and Taxiing Aid Camera System
- **EVAC** Evacuation
- **EXT** External

List of Abbreviations

A350 XWB

F

- **F/CTL** Flight Controls
- **F-PLN** Flight Plan
- **F/O** First Officer
- **FADEC** Full Authority Digital Engine Control
- **FAP** Flight Attendant Panel
- **FCDC** Flight Control Data Concentrator
- **FCOM** Flight Crew Operating Manual
- **FCRC** Flight Crew Rest Compartment
- **FCTM** Flight Crew Training Manual
- **FCU** Flight Control Unit
- **FD** Flight Director
- **FDIU** Flight Data Interface Unit
- **FDRS** Flight Data Recording System
- **FE** Flight Envelope
- **FFCM** Free Fall Contol Module
- **FG** Flight Guidance
- **FL** Flight Level
- **FLRS** Flap Load Relief Function
- **FLS** FMS Landing System
- **FMA** Flight Mode Annunciator
- **FMC** Flight Management Computer
- **FMS** Flight Management System
- **FPA** Flight Path Angle
- **FPS** Fire Protection System
- **FPV** Flight Path Vector
- **FQMS** Fuel Quantity and Management System
- **FSOV** Fire Shutoff Valve
- **FWD** Forward
- **FWS** Flight Warning System

G

- **G/S** Glide Slope
- **GA** Go-Around
- **GEN** Generator
- **GLS** GPS Landing System
- **GNSS** Global Navigation Satellite System
- **GPS** Global Positioning System
- **GPU** Ground Power Unit
- **GPWS** Ground Proximity Warning System

H

- **HCU** Head-up Combiner Unit
- **HDG** Heading
- **HF** High Frequency
- **HHX** Hydraulic Heat Exchanger
- **HMI** Human Machine Interface
- **HP** High Pressure
- **HPU** Head-Up Projection Unit
- **HSMU** Hydraulic System Monitoring Unit
- **HUD** Head-Up Display

List of Abbreviations

A350 XWB

I

- **IFEC** In-Flight Entertainment Center
- **IGGS** Inert Gas Generation System
- **ILS** Instrument Landing System
- **IMA** Integrated Modular Avionics
- **IP** Intermediate Pressure
- **IRS** Inertial Reference System
- **ISA** International Standard Atmosphere
- **ISIS** Integrated Standby Instrument System
- **ISP** Integrated Static Probe

K

- **KCCU** Keyboard and Cursor Control Unit

L

- **LAF** Load Alleviation Function
- **LCD** Liquid Crystal Display
- **LDG** Landing
- **LGCIS** Landing Gear Control and Indicating System
- **LGERS** Landing Gear Extension and Retraction System
- **LL Xing** Latitude/Longitude Crossing
- **LOC** Localizer
- **LP** Low Pressure
- **LRC** Long Range Cruise
- **LRU** Line Replaceable Unit
- **LVL** Level

M

- **MCT** Maximum Continuous Thrust
- **MEL** Minimum Equipment List
- **MFD** Multifunction Display
- **MFP** Multifunction Probe
- **MLG** Main Landing Gears
- **MLS** Microwave Landing System
- **MLW** Maximum Landing Weight
- **MMO** Maximum Mach in Operation
- **MMR** Multi-Mode Receiver
- **MSG** Message
- **MTOW** Maximum Takeoff Weight
- **MTW** Maximum Taxi Weight
- **MZFW** Maximum Zero Fuel Weight

N

- **NADP** Noise Abatement Departure Procedure
- **NAV** Navigation
- **NAVAID** Navigation Aid
- **ND** Navigation Display
- **NLG** Nose Landing Gear
- **NSS** Network Server System
- **NWS** Nose Wheel Steering

AIRBUS

List of Abbreviations

A350 XWB

O
- **OANS** Onboard Airport Navigation System
- **OCL** Oceanic Clearance
- **OIS** Onboard Information System
- **OMS** Onboard Maintenance System
- **OMT** Onboard Maintenance Terminal
- **OOOI** Out-Off-On-In

P
- **pb** Pushbutton
- **PBE** Protective Breathing Equipment
- **PCU** Power Control Unit
- **PFD** Primary Flight Display
- **PMAT** Portable Multipurpose Access Terminal
- **PRIM** Primary Flight Control Computer
- **Ps** Static Pressure
- **Pt** Total Pressure
- **PTT** Push-To-Talk
- **PWS** Predictive Windshear

Q
- **QRH** Quick Reference Handbook

R
- **RA** Radio Altimeter/Altitude, Resolution Advisory
- **RAT** Ram Air Turbine
- **RMP** Radio Management Panel
- **RNP** Required Navigation Performance
- **ROP** Runway Overrun Protection
- **ROW** Runway Overrun Warning
- **RPA** Runway Proximity Advisory
- **RTA** Required Time of Arrival
- **RTO** Rejected Takeoff
- **RVR** Runway Visual Range
- **RWY** Runway

S
- **SACU** Semi Automatic Control Unit
- **SATCOM** Satellite Communication
- **SD** System Display
- **SDS** Smoke Detection System
- **SEC** Secondary Flight Control Computer
- **SFD** Standby Flight Display
- **SID** Standard Instrument Departure
- **SLS** Satellite Landing System
- **SND** Standby Navigation Display
- **SQWK** Squawk
- **SRS** Speed Reference System
- **SSA** Side Slip Angle
- **STAR** Standard Terminal Arrival Route
- **STBY** Standby
- **SURV** Surveillance system
- **Sw** Switch

List of Abbreviations

A350 XWB

T

- **T/C** Top of Climb
- **T/D** Top of Descent
- **TA** Traffic Advisory
- **TAD** Terrain Awareness and Display
- **TAT** Total Air Temperature
- **TAWS** Terrain Awareness and Warning System
- **TCAS** Traffic Collision Avoidance System
- **TCS** Temperature Control System
- **TCF** Terrain Clearance Function
- **TEMP** Temperature
- **TERR** Terrain
- **THR** Thrust
- **THS** Trimmable Horizontal Stabilizer
- **T.O** Takeoff
- **TOM** Takeoff Monitoring
- **TOS** Takeoff Securing
- **TRU** Transformer Rectifier Unit
- **TRANS** Transition
- **TRK** Track

V

- **V/S** Vertical Speed
- **VAPP** Final Approach Speed
- **VC** Variable Camber
- **VD** Vertical Display
- **VENT** Ventilation
- **VFE** Maximum Flap Extended Speed
- **VHF** Very High Frequency
- **VLE** Maximum Landing Gear Extended Speed
- **VLO** Maximum Landing Gear Operating Speed
- **VLS** Lowest Selectable Speed
- **VMO** Maximum Operating Speed
- **VOR** VHF Omnidirectional Range
- **VQAR** Virtual Quick Access Recorder
- **VV** Velocity Vector

W

- **W&B** Weight and Balance
- **WLAN** Wireless Local Area Network
- **WPT** Waypoint
- **WSCS** Wheel Steering Control System
- **WTB** Wing Tip Brakes
- **WXR** Weather Radar

X

- **X-FEED** Crossfeed
- **XFR** Transfer
- **XPDR** Transponder

Z

- **ZFW** Zero Fuel Weight
- **ZFWCG** Zero Fuel Weight Center of Gravity

AIRBUS

AN EADS COMPANY