
ADIRS and Standby Instruments Presentation
OVRD
APU
AUTO EXTING
TEST
RESET
FADEC GND PWR
HYD
3000
PSI
PTU
ELEC
2
A/SKID &
N/W STRG
ON
OFF

GENERAL SYSTEM

Navigation system groups:

- ADIRS and standby instruments
- Dependent position determining systems and landing aids
- Landing Aids
- Independent position determining systems

The Airbus Single Aisle aircraft family includes several different types of navigation systems, each used for particular functions. The systems will be explained in separate groups based on their functions. These functions are broken down into 4 main groups.

They will be presented in separate modules:
- Air Data/Inertial Reference System (ADIRS) and standby instruments,
- Dependent position determining systems,
- Landing aids,
- Independent position determining systems.

1st group:

- ADIRUs
- Standby
- DDRMI (optionally removed for THALES equipment only)
- ISIS

2nd group: dependent position determining systems:

- GPS
- ATC/TCAS
- DME
- ADF
- VOR

In the same module, 3rd group: landing aids:

- ILS
- Marker receivers

4th group: independent position determining systems:

- EGPWS (Enhanced Ground Proximity Warning System)
- RAs
- WXR and PWS

Air Data/Inertial Reference System (ADIRS) & STANDBY INSTRUMENTS

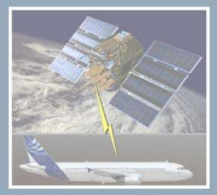
ADIRS & Digital Distance and Radio Magnetic Indicator (DDRMI)

STANDBY INSTRUMENTS

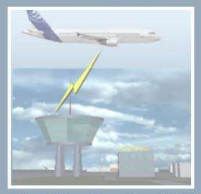
STANDBY INSTRUMENTS

OPTION

DEPENDENT POSITION DETERMINING SYSTEMS

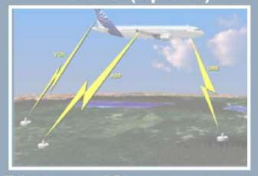


Global Positioning System (GPS)



Air Traffic Control (ATC)

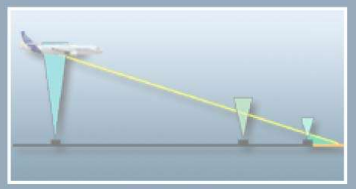
Traffic Collision Avoidance System (TCAS) / T2CAS (option)



Distance Measurement Equipment (DME)
Automatic Direction Finder (ADF)
VHF Omnidirectional Range (VOR)

LANDING AIDS

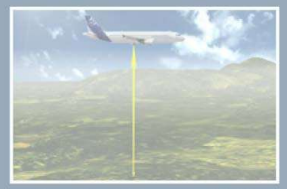
Instrument Landing System (ILS)



MARKER

INDEPENDENT POSITION DETERMINING SYSTEMS

Enhanced Ground Proximity Warning System (EGPWS) / T2CAS (option)



Radio Altimeter (RA)

Weather Radar (WXR) & Predictive Windshear (PWS)

T2CAS: Traffic and Terrain Collision Avoidance System

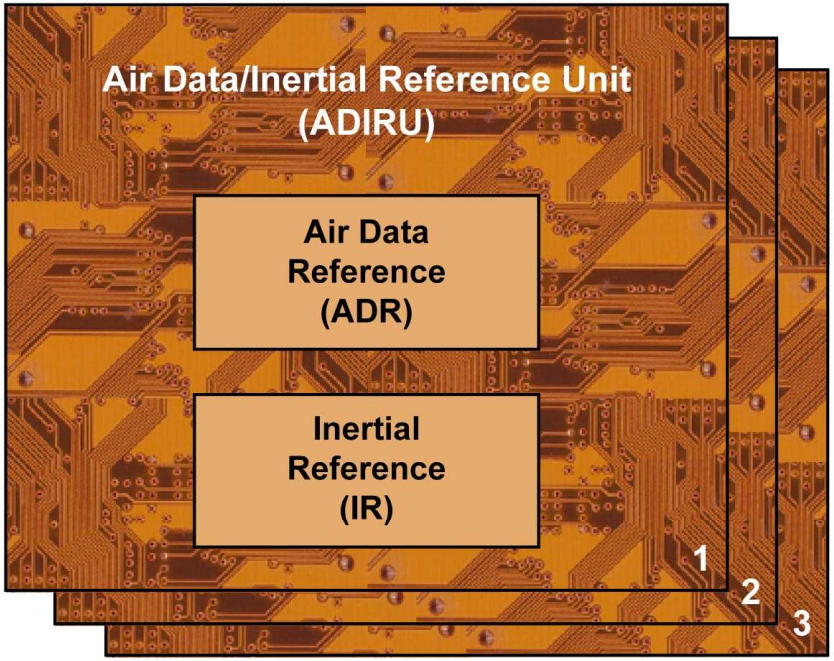
AIR DATA/INERTIAL REFERENCE SYSTEM

3 ADIRUs
The aircraft has three identical and interchangeable ADIRUs.

ADIRU combines:
An ADR
An IR using laser gyros and accelerometers

ADR and IR operate independently
Each ADIRU combines computers that carry out two functions in a single unit with a shared power supply. Those computers are:
- An Air Data Reference (ADR) unit,
- A strapdown Inertial Reference (IR) unit, using laser gyros and accelerometers.

The ADR and IR systems of each ADIRU operate independently, and a failure of one system does not affect the other one.


Air Data/Inertial Reference Unit
(ADIRU)
Air Data
Reference
(ADR)
Inertial
Reference
(IR)
1
2
3

AIR DATA INPUTS

ADR receives information from:

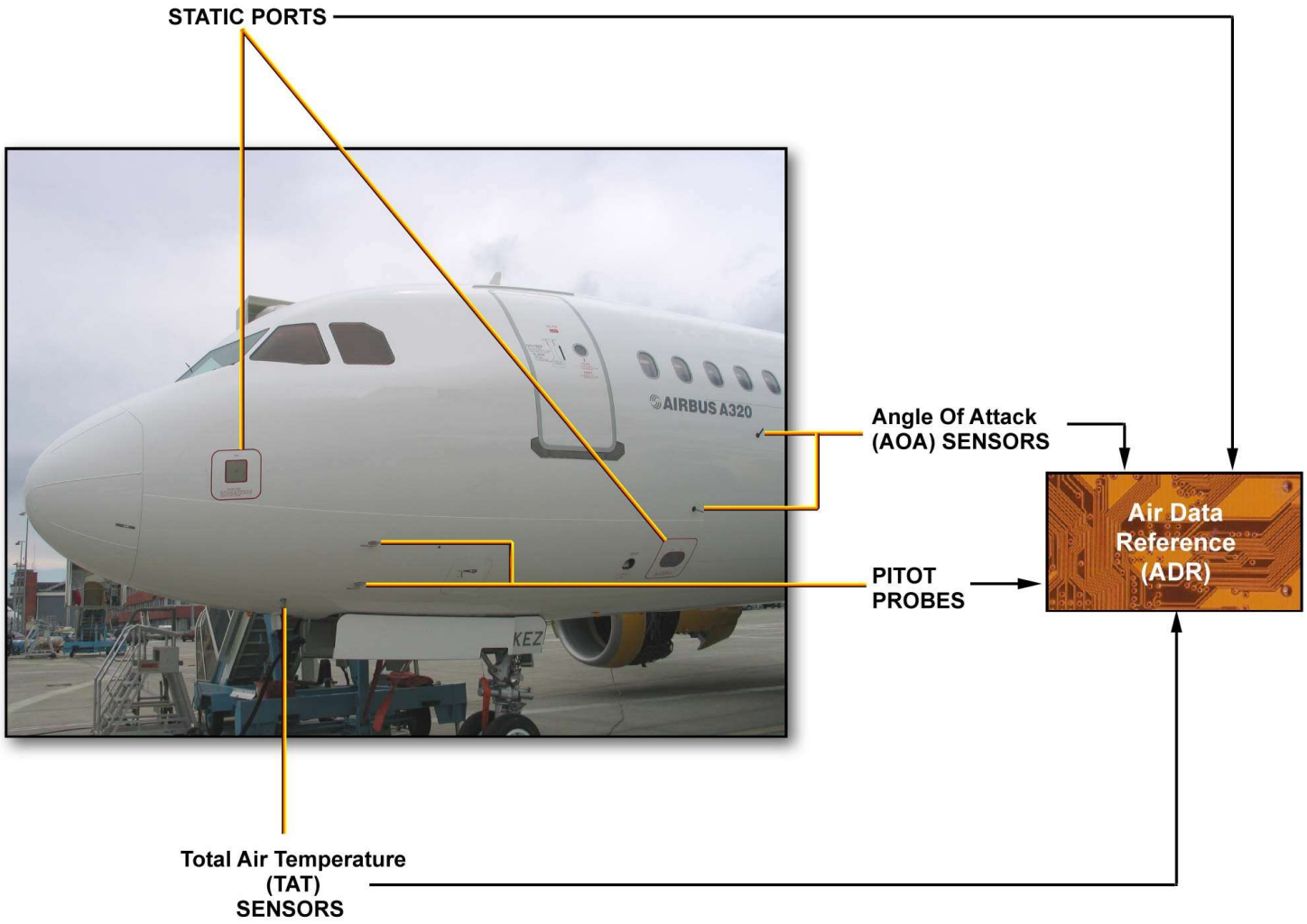
Pitot probes and static ports

AOA and TAT sensors

The ADIRS systems have peripheral components connected to the LRUs. These components are an integral part of the Air Data portion.

The components are:

- Pitot probes,
- Static ports,
- Angle of Attack Sensors (AOA),
- Total Air Temperature Sensor (TAT).


STATIC PORTS
AIRBUS A320
Angle Of Attack
(AOA) SENSORS
PITOT
PROBES
Air Data
Reference
(ADR)
Total Air Temperature
(TAT)
SENSORS

AIR DATA SECTION

ADR supplies:

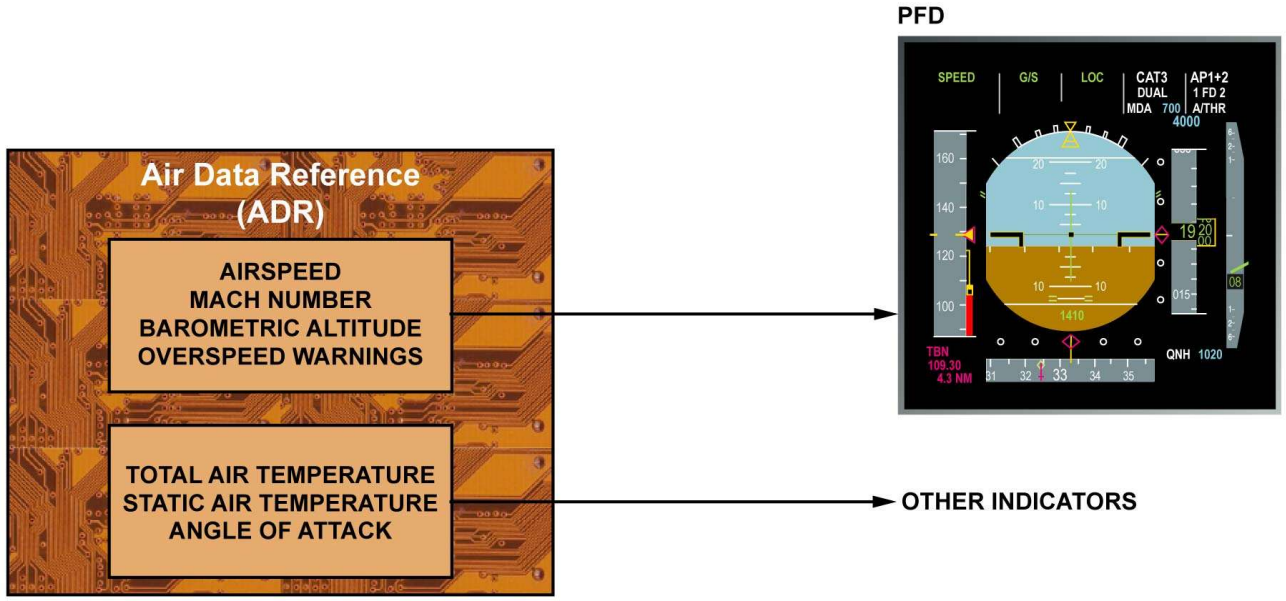
Air data

Airspeed, mach number, barometric altitude to PFD, overspeed warnings to FWC

TAT, SAT, AOA to other indicators

The ADR part supplies various air data parameters to the EFIS instruments and other users:

- Airspeed, mach number, barometric altitude to the PFD and overspeed to the Flight Warning Computer (FWC),
- TAT, Static Air Temperature (SAT) and AOA to other indicators and users.

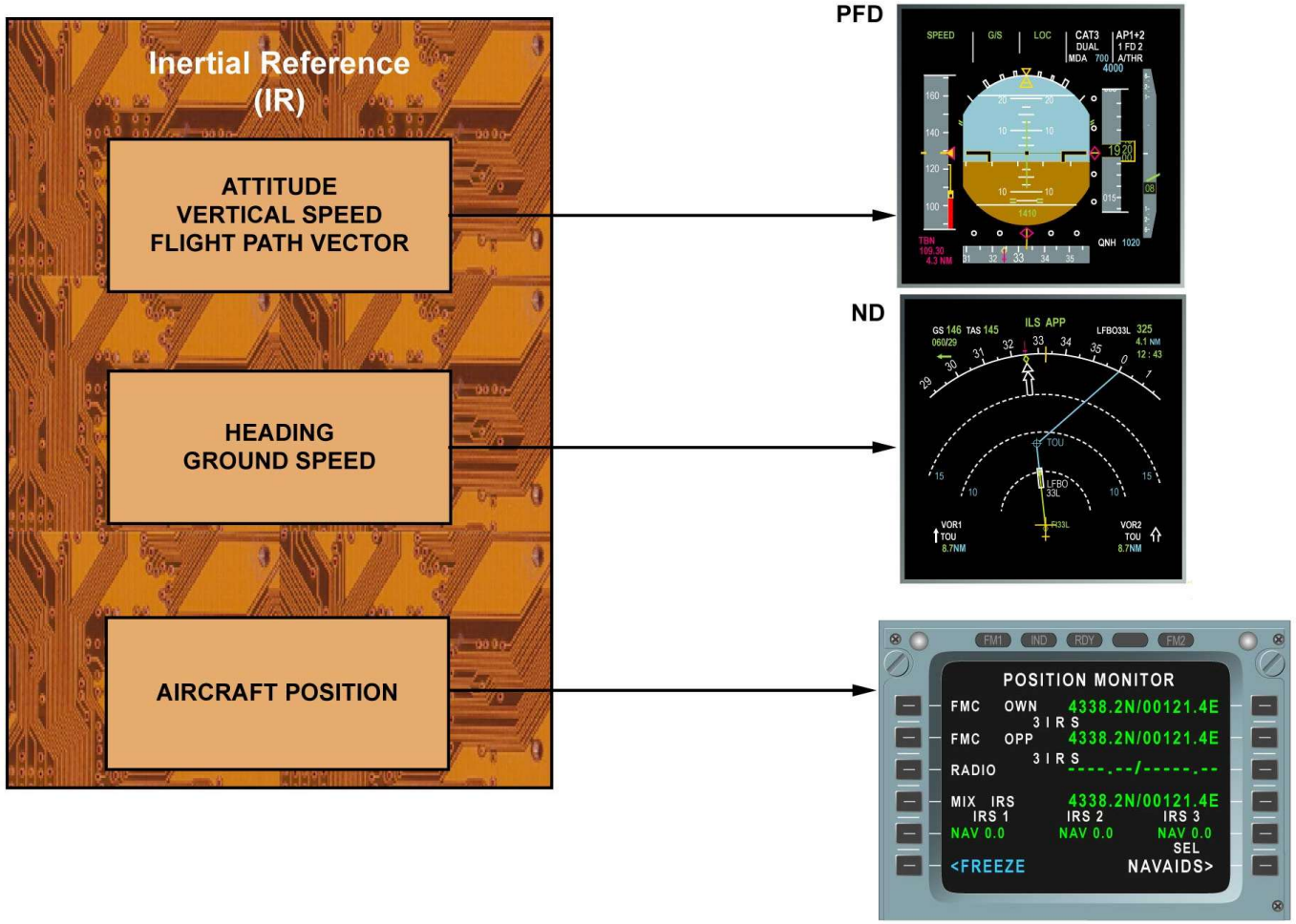

PFD
Air Data Reference
(ADR)
AIRSPEED
MACH NUMBER
BAROMETRIC ALTITUDE
OVERSPEED WARNINGS
TOTAL AIR TEMPERATURE
STATIC AIR TEMPERATURE
ANGLE OF ATTACK
OTHER INDICATORS
SPEED
G/S
LOC
CAT3
DUAL
MDA 700
AP1+2
1 FD 2
A/THR
4000
QNH 1020

INERTIAL REFERENCE SECTION

IR gives data to EFIS, FMGCs, other users:
Attitude, heading, V/S, flight path vector to PFD
Heading, ground speed to ND
IR position to FMGCs for A/C position computation
The IR part of the ADIRU uses laser gyros and accelerometers. They give inertial data to the EFIS, Flight Management and Guidance Computers (FMGCs) and other users. Each ADIRU gives:
- Attitude, heading, Vertical Speed (V/S), flight path vector to the PFD,
- Heading, ground speed to the ND,
- IR position to FMGCs for A/C position computation. This data is available on the MCDU DATA page.

A/C position from the navigation data base, manually adjustable
Action on Align IRS prompt key on the MCDU
Customer option
Auto alignment by GPS position
No operator action

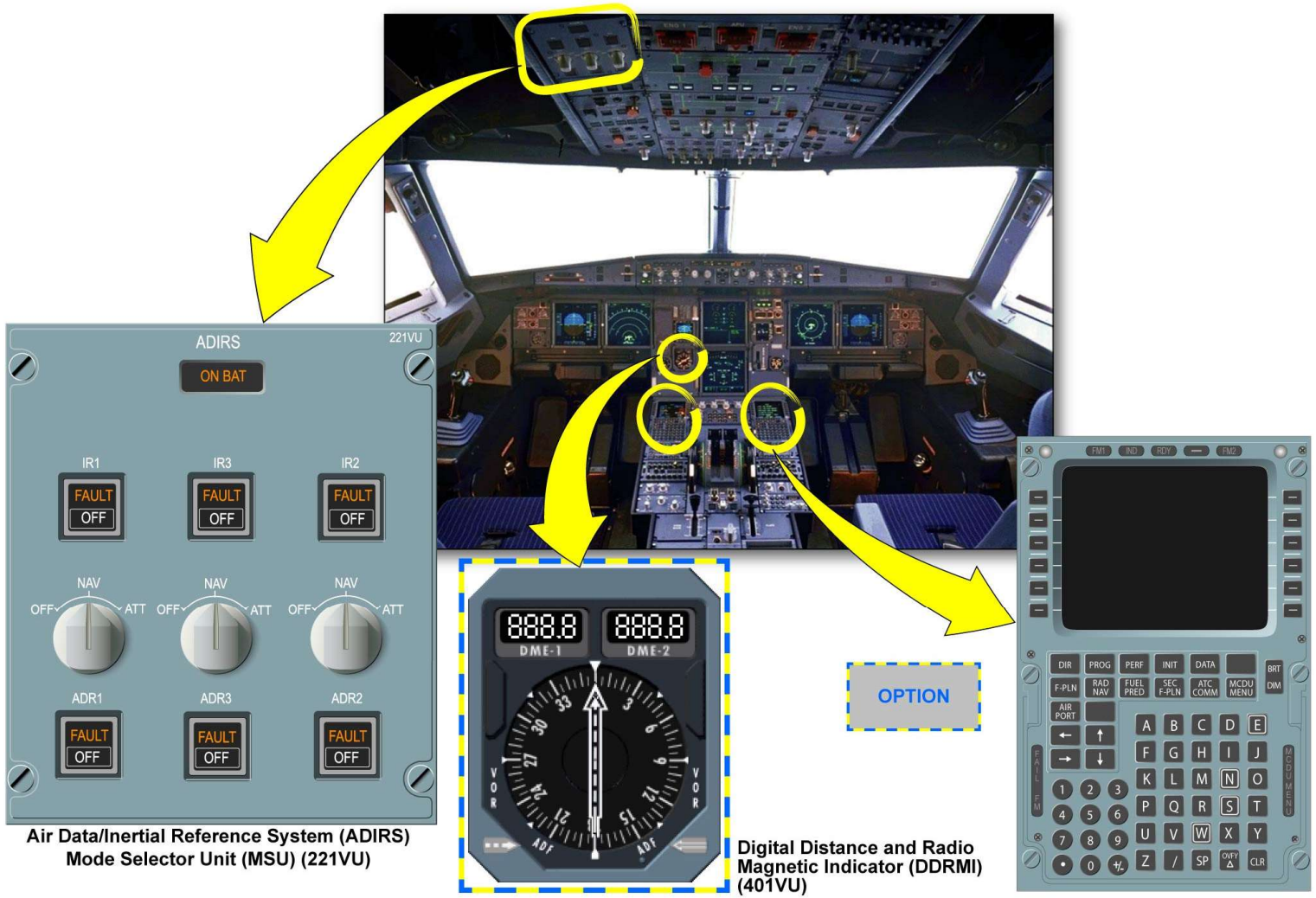
The Flight Management Guidance System (FMGS) uses the reference point coordinates of the departure airport to align the Inertial Reference System (IRS). It automatically gets these coordinates from the database when the operator enters a company route or an origin-destination city pair and pushes the ALIGN IRS key on the MCDU. The operator can manually adjust these coordinates to the gate position.
With the latest ADIRUs, an optional automatic alignment by GPS position is possible. No operator action is necessary for this initialization by GPS.


Inertial Reference
(IR)
ATTITUDE
VERTICAL SPEED
FLIGHT PATH VECTOR
HEADING
GROUND SPEED
AIRCRAFT POSITION
PFD
ND
POSITION MONITOR
FMC OWN 4338.2N/00121.4E
3 I R S
FMC OPP 4338.2N/00121.4E
3 I R S
RADIO ----.--/-----.--
MIX IRS 4338.2N/00121.4E
IRS 1 IRS 2 IRS 3
NAV 0.0 NAV 0.0 NAV 0.0
SEL
<FREEZE NAVAIDS>

ADIRS CONTROL AND INDICATING

ADIRS MSU on overhead panel controls 3 ADIRUs
ADIRUs initialization is normally done through MCDU
The three ADIRUs are controlled through the single ADIRS Mode Selector Unit (MSU) installed on the overhead panel.
The initialization of the ADIRUs is normally done through either one or the two MCDUs installed on the center pedestal.

Optional DDRMI supplies DME information, heading and VOR/ADF bearing information
The Digital Distance Radio Magnetic Indicator (DDRMI) is optionally installed on the main instrument panel below the standby instruments.
It supplies digital DME distance information, as well as heading coming from ADIRS, and VOR/ADF bearing information.



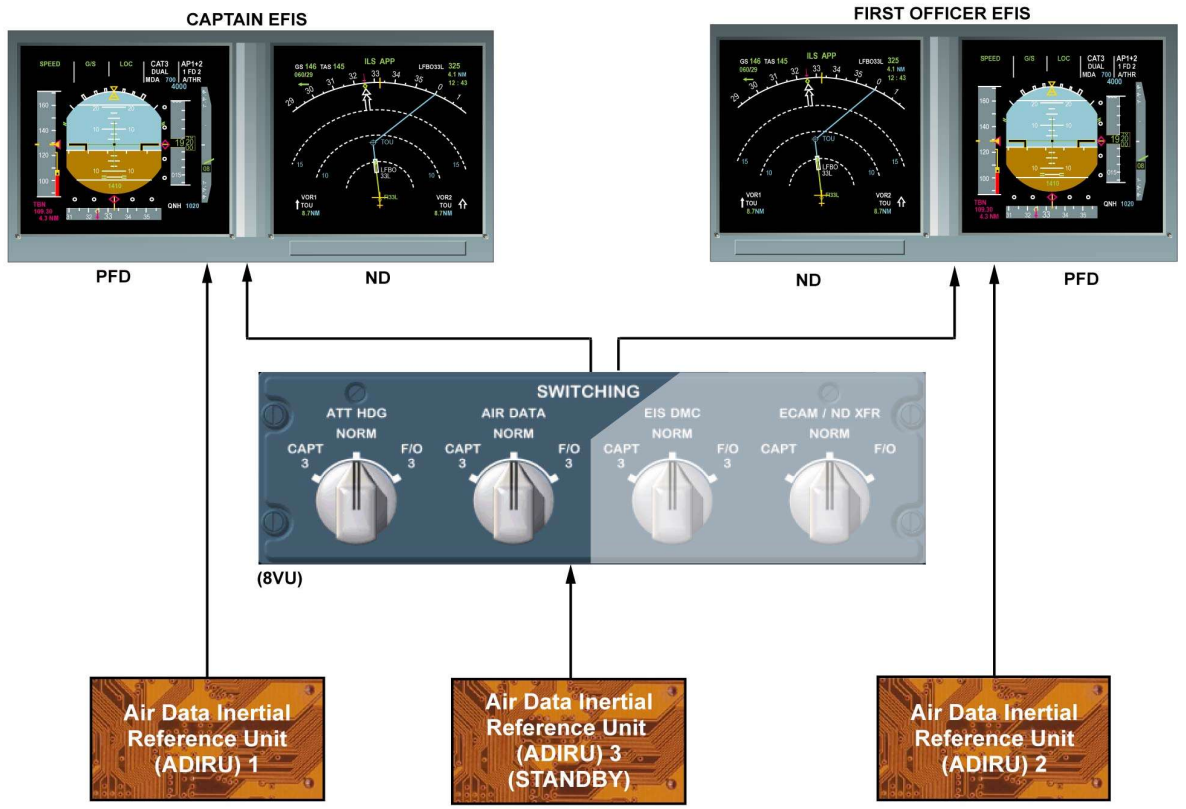
Air Data/Inertial Reference System (ADIRS) Mode Selector Unit (MSU) (221VU)

Digital Distance and Radio Magnetic Indicator (DDRMI) (401VU)

PFD AND ND INDICATING

ADIRU 1 supplies Captain's PFD/ND
ADIRU 2 supplies First Officer's PFD/ND
ADIRU 1 supplies the CAPT PFD and ND, and ADIRU 2 supplies the F/O PFD and ND.

ADIRU 3 is used as a hot spare
ADIRU 3 is used as a hot spare and can be switched via the switching panel to replace ADIRU 1 or ADIRU 2. Each part of the ADIRU (ADR or IR) can be independently switched.



STANDBY INSTRUMENTS (OPTIONAL)

EFIS system failures

3 conventional instruments

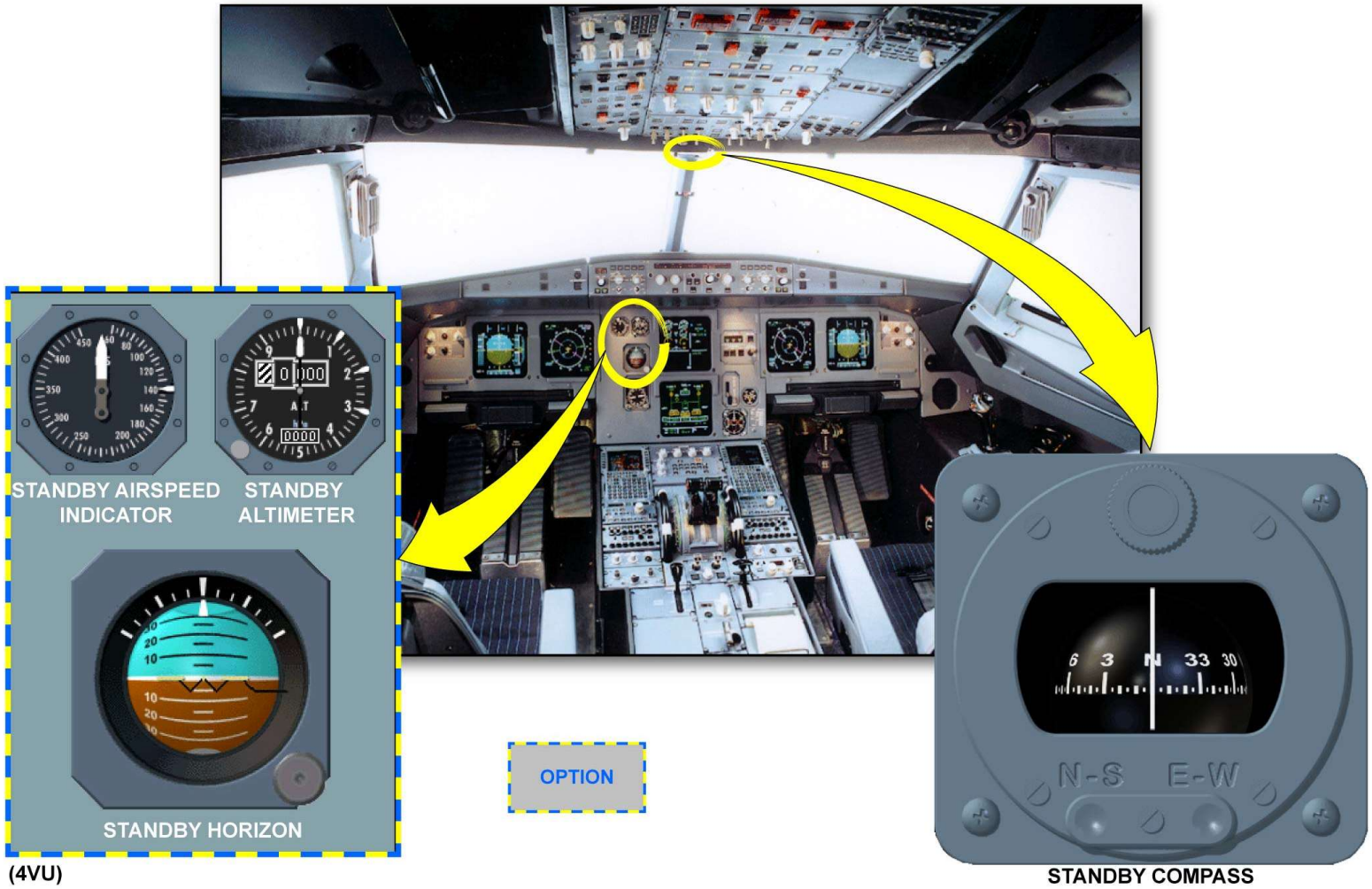
If there is a failure of the EFIS system, the standby instruments can be used.

There are 3 conventional standby instruments, installed on the instrument panel:

- Airspeed indicator,
- Altimeter,
- Horizon.

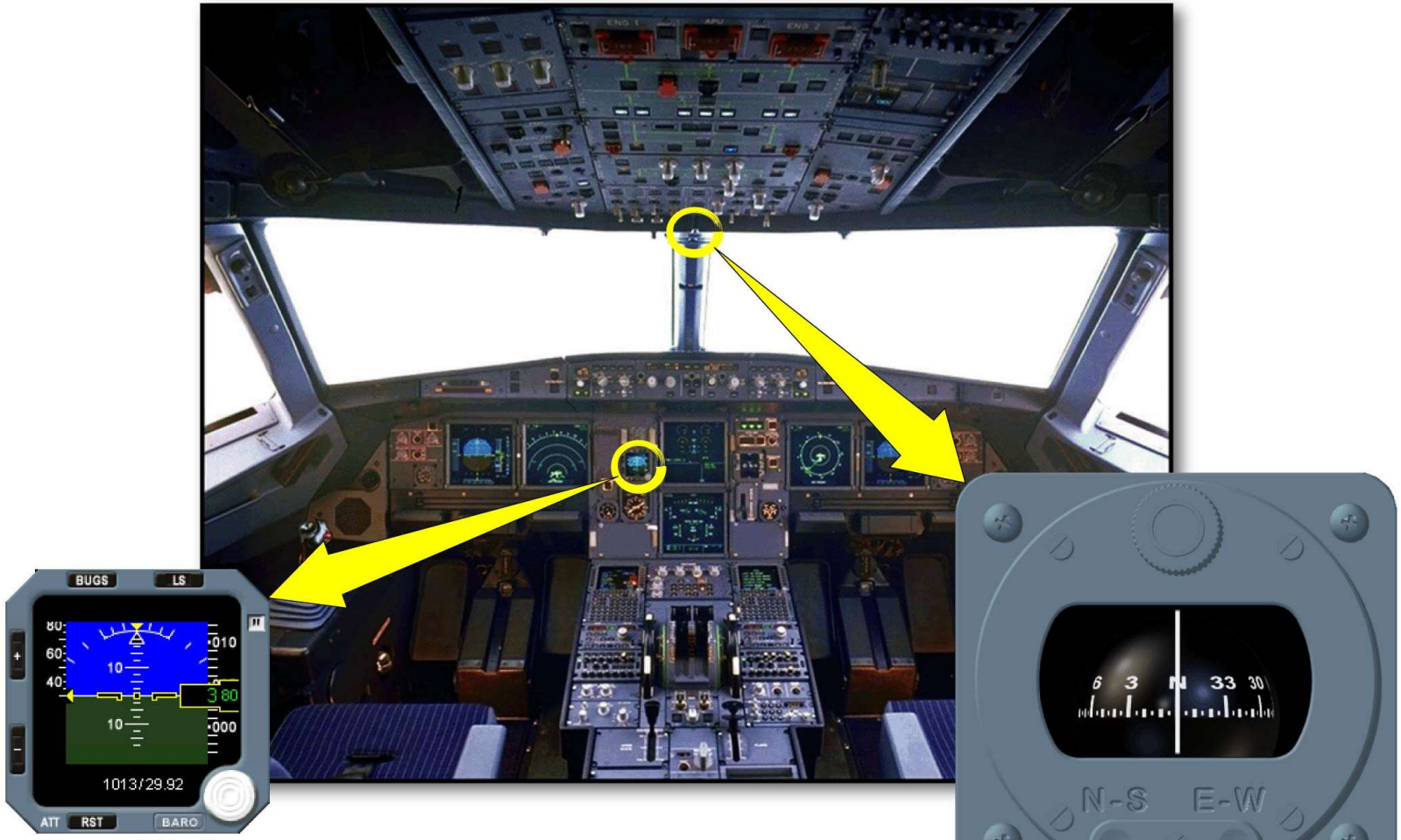
Standby Compass

The standby compass is installed immediately below the overhead panel.


STANDBY AIRSPEED INDICATOR
STANDBY ALTIMETER
STANDBY HORIZON
(4VU)
OPTION
STANDBY COMPASS
N-S
E-W

INTEGRATED STANDBY INSTRUMENT SYSTEM

Enhanced Standby Instruments: ISIS
Replaces 3 conventional instruments
Airspeed indication & altimeter come from air source
Heading and ILS capability
Standby compass
The enhanced standby instrument, called Integrated Standby Instrument System (ISIS), is installed on the instrument panel near the ECAM. It replaces the 3 conventional standby instruments. The inputs to the airspeed indication and the altimeter come directly from the air sources (standby pitot probe and static ports). The standby horizon is self-contained. ISIS can also display heading and ILS data. The standby compass is installed immediately below the overhead panel.

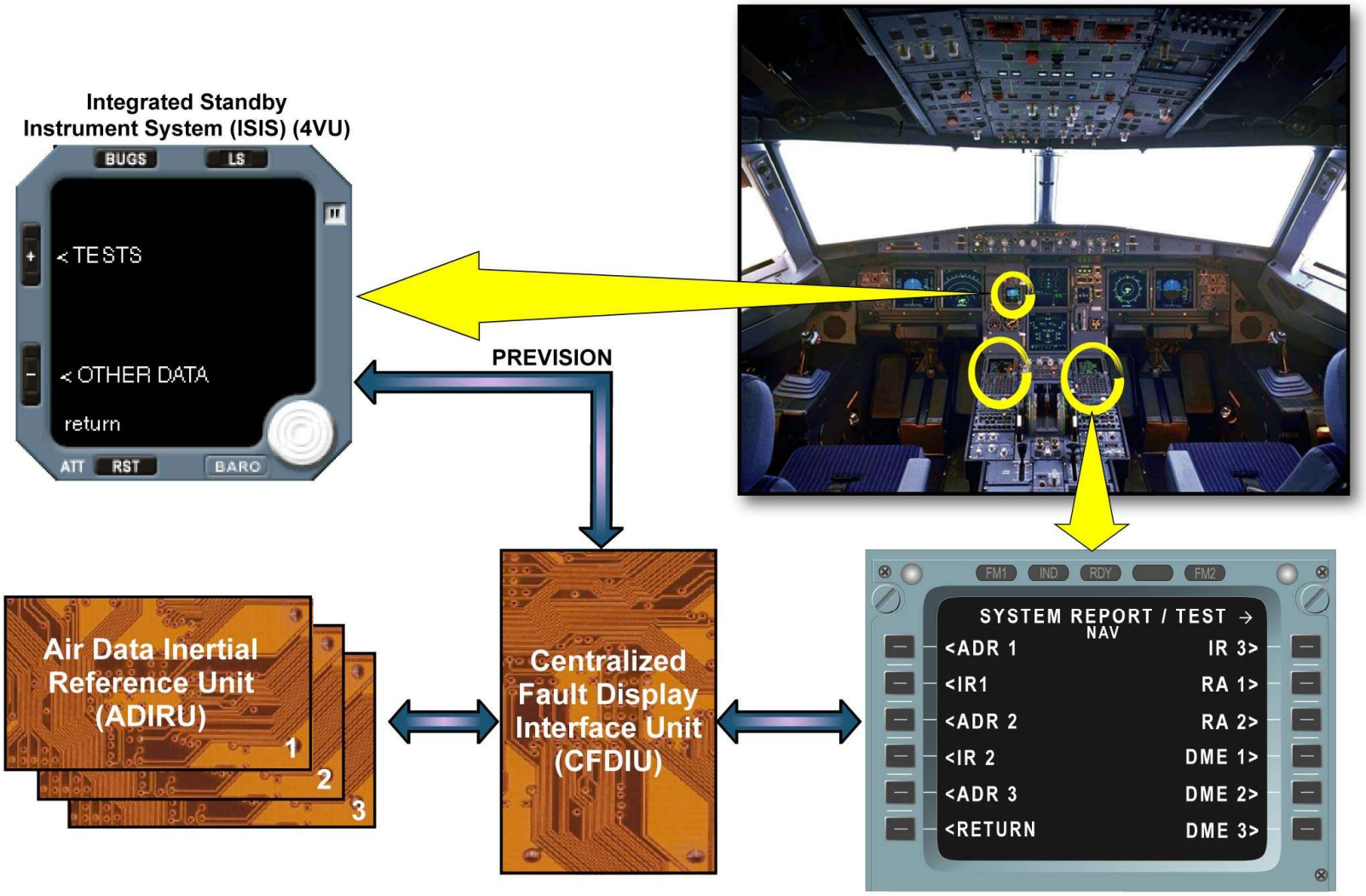


Integrated Standby Instrument System (ISIS) (4VU)

STANDBY COMPASS

MAINTENANCE/TEST FACILITIES

Navigation system tests from MCDUs
Additional Tests from ISIS front face
All the navigation systems can be tested from the MCDUs except the ISIS.
ISIS tests and OTHER DATA are accomplished directly from the unit itself.


Integrated Standby
Instrument System (ISIS) (4VU)
BUGS
LS
< TESTS
< OTHER DATA
return
ATT
RST
BARO
PREVISION
Air Data Inertial
Reference Unit
(ADIRU)
1
2
3
Centralized
Fault Display
Interface Unit
(CFDIU)
FM1
IND
RDY
FM2
SYSTEM REPORT / TEST →
NAV
<ADR 1
<IR1
<ADR 2
<IR 2
<ADR 3
<RETURN
IR 3>
RA 1>
RA 2>
DME 1>
DME 2>
DME 3>

SAFETY PRECAUTIONS

Obey AMM procedures to prevent injury or damage

When you do work on the A/C, make sure that you obey all the Aircraft Maintenance Manual (AMM) procedures. This will prevent injury to persons and/or damage to the A/C.

Remove covers before you do a test on the probes

Test less than one minute

Do not touch hot probes (after test)

Before you do the test of the probes, remove the protective covers. Do not continue the test for more than one minute to prevent damage.

Do not touch the probes immediately after the test, they are hot.

CAUTION

BEFORE TESTING PROBES, REMOVE COVERS.
DO NOT CONTINUE THE TEST FOR MORE THAN 1 MINUTE.

WARNING

OBEY ALL THE AMM SAFETY PROCEDURES

WARNING

DO NOT TOUCH PROBES AFTER TEST, THEY ARE HOT


Dependent Position
Determining Systems
& Landing Aids
Presentation

LANDING AIDS

Landing aids systems are:

ILS
Marker

Dependent position determining systems are:

GPS
T/TISS (T3CAS)
DME
ADF
VOR

The navigation systems that require inputs external to the aircraft to operate are: the landing aids systems and the dependent position determining systems. They include:

- ILS,
- marker system,
- GPS,
- Traffic and Terrain Integrated Surveillance System (T/TISS) (T3CAS),
- DME,
- ADF,
- VOR.

Air Data/Inertial Reference System (ADIRS) & STANDBY INSTRUMENTS

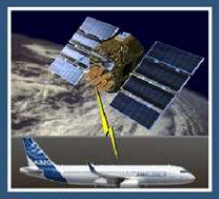
ADIRS & Digital Distance and Radio Magnetic Indicator (DDRMI)

STANDBY INSTRUMENTS

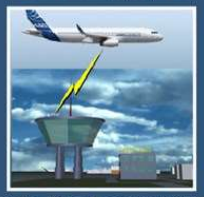
STANDBY INSTRUMENTS

OPTION

DEPENDENT POSITION DETERMINING SYSTEMS

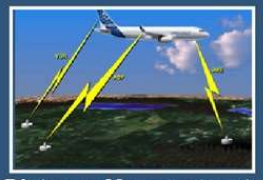


Global Positioning System (GPS)



Air Traffic Control (ATC)

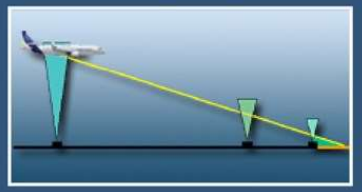
Traffic Collision Avoidance System (T3CAS)



Distance Measurement Equipment (DME)
Automatic Direction Finder (ADF)
VHF Omnidirectional Range (VOR)

LANDING AIDS

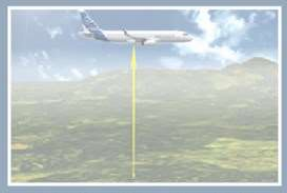
Instrument Landing System (ILS)



MARKER

INDEPENDENT POSITION DETERMINING SYSTEMS

Terrain Awareness and Warning System T3CAS (TAWS)



Radio Altimeter (RA)

Weather Radar (WXR) & Predictive Windshear (PWS)

ILS AND MARKER SYSTEM

ILS sends localizer and G/S signals for optimum descent path for landing

The ILS sends to the flight crew or Autopilot (AP) signals for optimum descent path for landing. The ILS signal reception is done in part by the Multi-Mode Receiver (MMR). The system gives lateral guidance and vertical guidance to the aircraft approaching the runway.

Marker indicates A/C distance to the runway threshold (active in VOR 1 only)

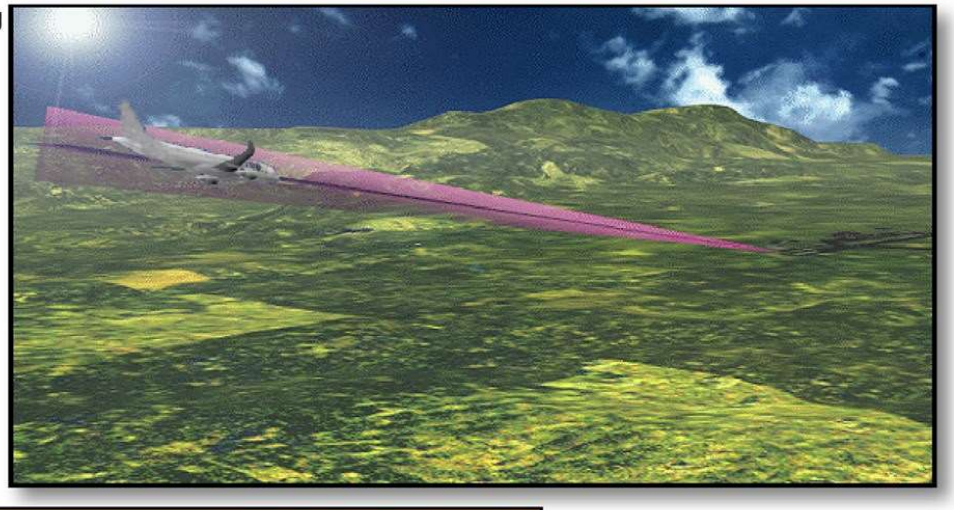
The marker beacon system is a radio navigation aid that, in conjunction with an instrument landing system, indicates the distance between the A/C and the runway threshold. The marker function is done inside the VOR receivers, but it is only active in VOR 1. There are three types of marker beacons:

- the outer marker,
- the middle marker,
- the inner marker.

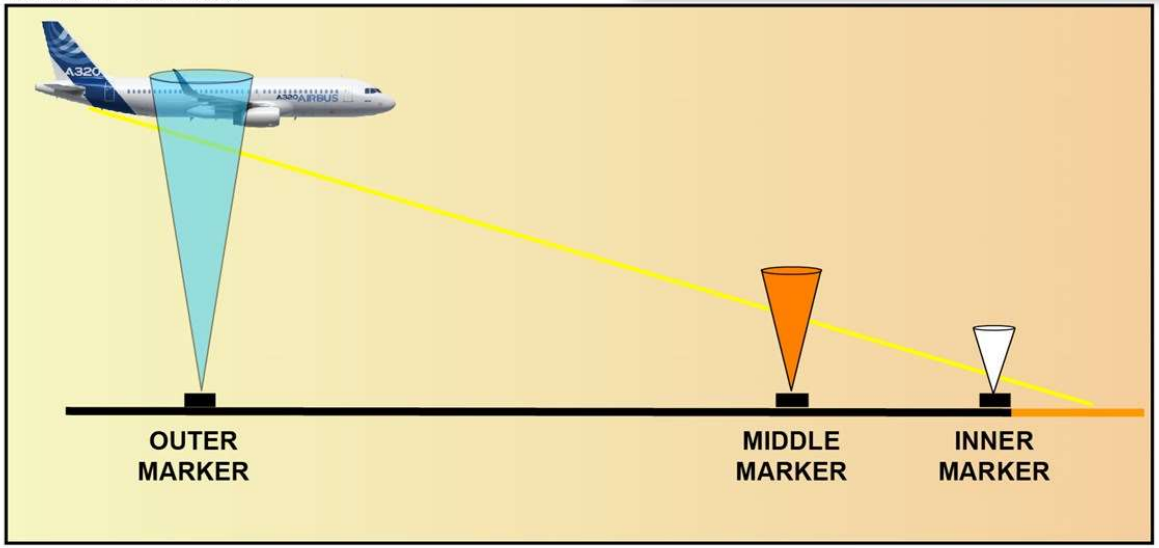
Marker indication on PFD and audio signals when A/C flies over beacon

When the aircraft flies over the beacons, the marker beacon information is displayed flashing on the PFDs, with related audio signals.

Instrument Landing System (ILS)



MARKER BEACONS

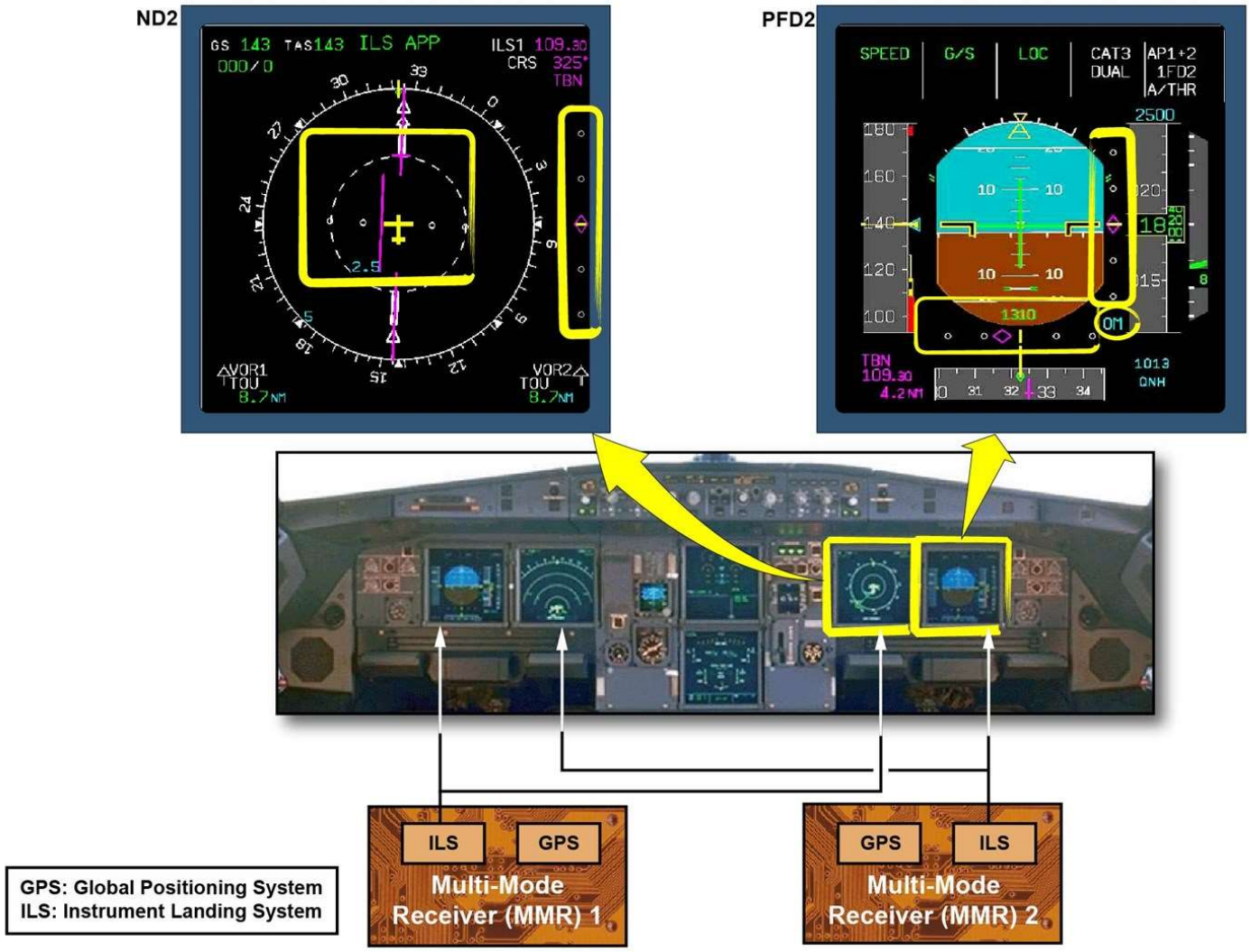


LANDING AIDS CONTROL AND INDICATING

ILS information

The ILS information is displayed on the PFDs as 2 scales. One horizontal scale for the localizer signal and one vertical scale for the Glide Slope (G/S) signal.

ILS 1 displayed on PFD 1 and ND 2
ILS 2 displayed on PFD 2 and ND 1
Note that for redundancy:
- ILS 1 is displayed on PFD 1 and ND 2,
- ILS 2 is displayed on PFD 2 and ND 1.


ND2
GS 143 TAS143 ILS APP
ILS1 109.30
CRS 325°
TBN
VOR1
TOU
8.7 NM
VOR2
TOU
8.7 NM
PFD2
SPEED
G/S
LOC
CAT3
DUAL
AP1+2
1FD2
A/THR
2500
1310
OM
TBN
109.30
4.2 NM
1013
QNH
ILS
GPS
Multi-Mode
Receiver (MMR) 1
GPS
ILS
Multi-Mode
Receiver (MMR) 2
GPS: Global Positioning System
ILS: Instrument Landing System

RADIO NAVIGATION SYSTEM

Radio navigation systems:

2 VOR/markers
2 DMEs
2 MMRs: ILS and GPS
2 ADFs

The A/C has the following equipment installed:
- two VOR/marker receivers,
- two DMEs interrogators,
- two MMRs: ILS and GPS,
- two ADFs receivers.

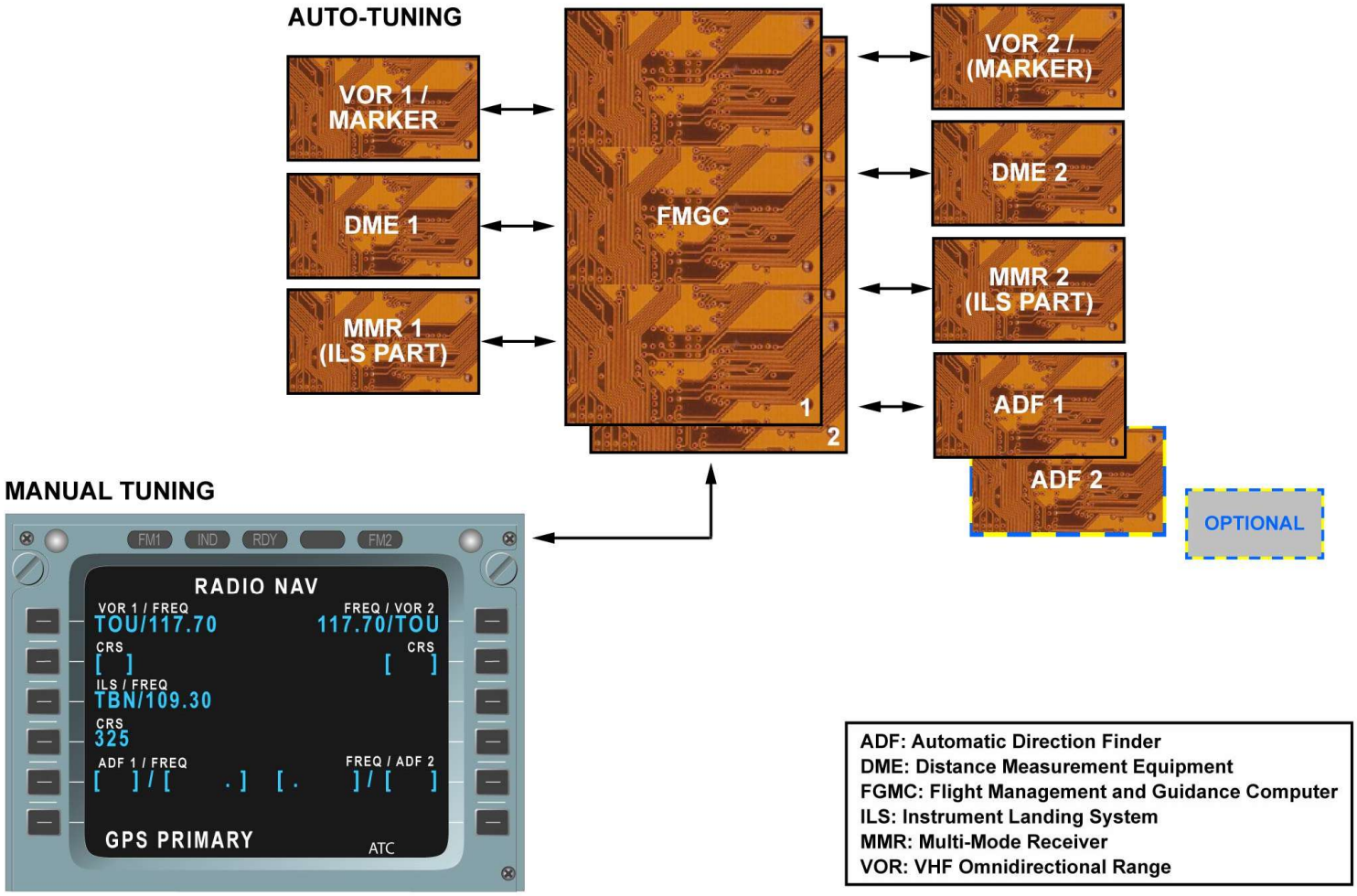
NORMAL TUNING

FMGC auto tuning for display and in background to compute aircraft position

The Flight Management and Guidance Computers (FMGCs) contain the navigation computer function that calculates the aircraft position. The FMGCs tune the radio navigation receivers automatically and use the navigation info from these receivers for display and also in background for A/C position computation. The Jeppesen database is loaded in the FMGCs. This information includes: station identifiers, and specific information (frequency, identification and coordinates) about the station.

MCDU enables manual tuning through FMGCs for display

Access to the MCDU RADIO NAV page lets the crew manually tune the radio navigation receivers, via the FMGCs for display. Manual tuning overrides automatic tuning.



ADF: Automatic Direction Finder
DME: Distance Measurement Equipment
FGMC: Flight Management and Guidance Computer
ILS: Instrument Landing System
MMR: Multi-Mode Receiver
VOR: VHF Omnidirectional Range

BACKUP TUNING

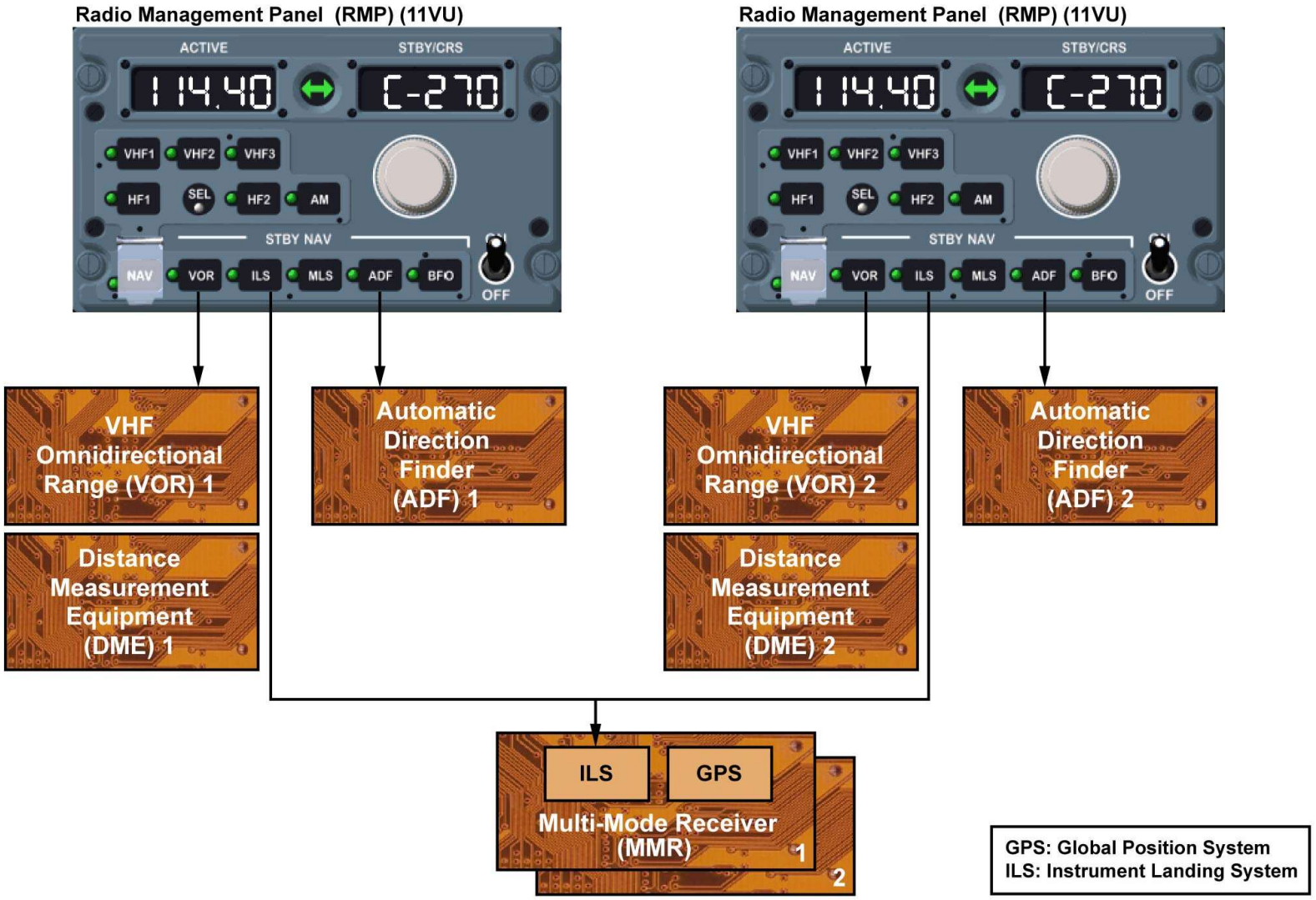
RMP 1 and 2 enable backup tuning in case of:

Both FMGCs failure or

Both MCDUs failure and manual tuning needed

Radio Management Panel (RMP) 1 and 2 are capable of tuning the on side Navigation receivers in backup mode if both FMGCs have failed, or both MCDUs have failed and manual tuning is needed by the crew.

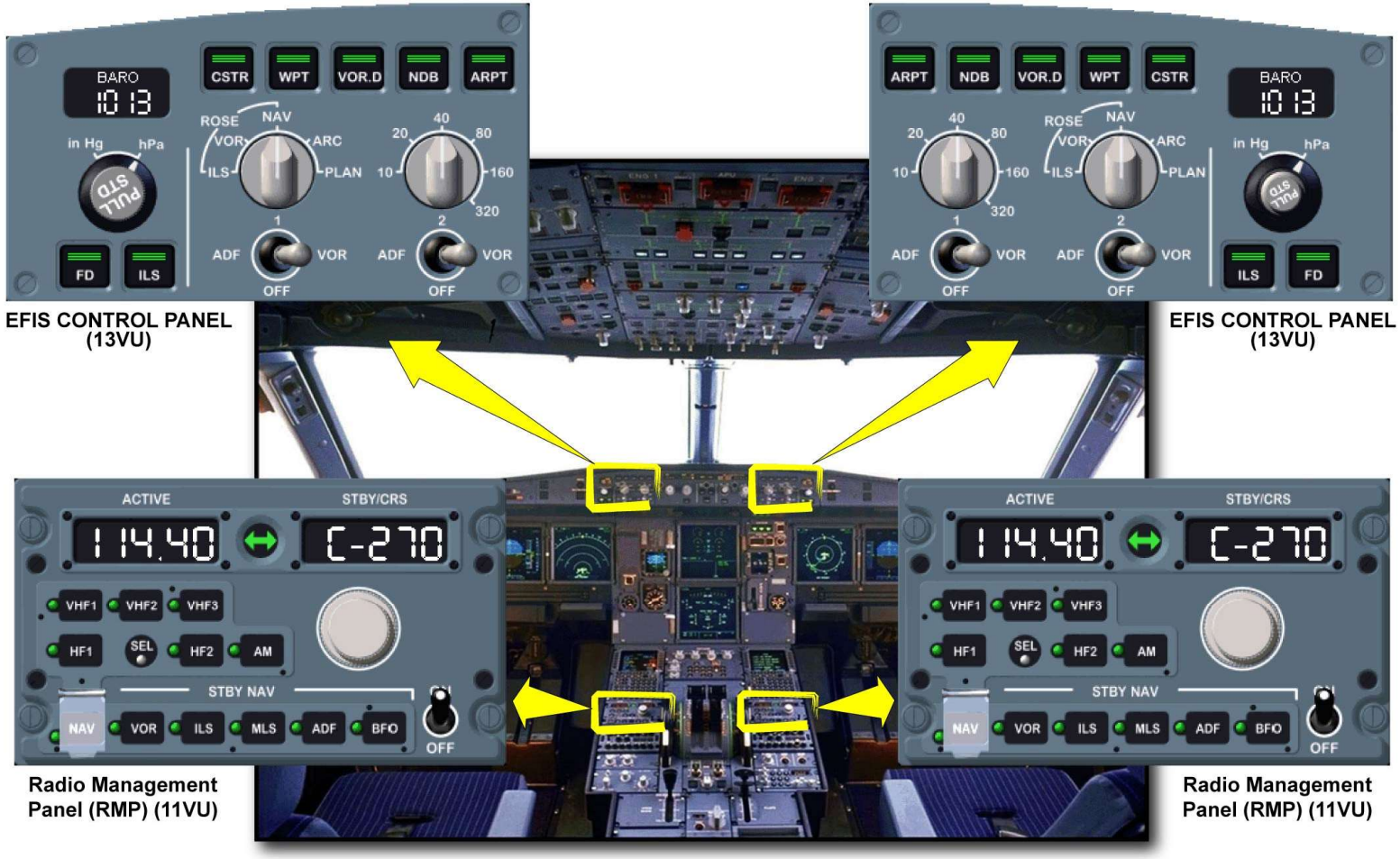
ILS can be tuned from RMP 1 or RMP 2 as no different frequency can be selected for the two MMR/ILS functions.


Radio Management Panel (RMP) (11VU)
ACTIVE
STBY/CRS
114.40
C-270
VHF1
VHF2
VHF3
HF1
SEL
HF2
AM
STBY NAV
NAV
VOR
ILS
MLS
ADF
BFO
OFF
Radio Management Panel (RMP) (11VU)
ACTIVE
STBY/CRS
114.40
C-270
VHF1
VHF2
VHF3
HF1
SEL
HF2
AM
STBY NAV
NAV
VOR
ILS
MLS
ADF
BFO
OFF
VHF Omnidirectional Range (VOR) 1
Automatic Direction Finder (ADF) 1
VHF Omnidirectional Range (VOR) 2
Automatic Direction Finder (ADF) 2
Distance Measurement Equipment (DME) 1
Distance Measurement Equipment (DME) 2
ILS
GPS
Multi-Mode Receiver (MMR)
1
2
GPS: Global Position System
ILS: Instrument Landing System

RADIO NAVIGATION CONTROL and INDICATING

EFIS control panel mode switches

The EFIS control panel mode switches control what type of information is shown to the flight crew on the ND. They are located on both sides of the glareshield. The toggle switches on the EFIS control panel enable the display of the VOR or ILS pointers on the ND. RMPs are located on the center pedestal.


EFIS CONTROL PANEL
(13VU)
EFIS CONTROL PANEL
(13VU)
Radio Management
Panel (RMP) (11VU)
Radio Management
Panel (RMP) (11VU)
BARO
1013
in Hg
hPa
PULL STD
CSTR
WPT
VOR.D
NDB
ARPT
ROSE
NAV
VOR
ARC
ILS
PLAN
20
40
80
10
160
320
1
2
ADF
VOR
OFF
FD
ILS
ACTIVE
STBY/CRS
114.40
C-270
VHF1
VHF2
VHF3
HF1
SEL
HF2
AM
STBY NAV
NAV
VOR
ILS
MLS
ADF
BFO
ON
OFF

ND MODES

5 ND modes

There are five different ND modes that can be selected via the EFIS control panels. These modes are the PLAN, ARC, NAV, VOR, and ILS modes.

PLAN MODE

ARC MODE

ILS MODE

VOR MODE

NAV MODE

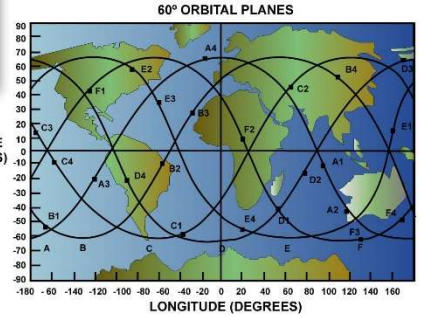
MMR (GPS PART) SYSTEM
GPS receiver uses data from 24 satellites
The GPS receiver uses data sent by 24 satellites.

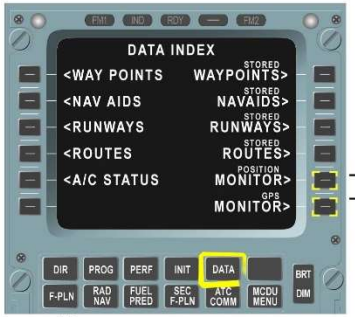
GPS CONTROL AND INDICATING
GPS info on Position Monitor page of MCDU
The GPS data is accessible on the MCDU. Selecting DATA page P/B on the MCDU and then the GPS monitor line select key, will give the information related to the GPS receivers.
16 GPS PRIMARY on ND
GPS when receiving adequate signals to calculate a present position will be annotated at the bottom of the ND. This is displayed as "GPS PRIMARY".

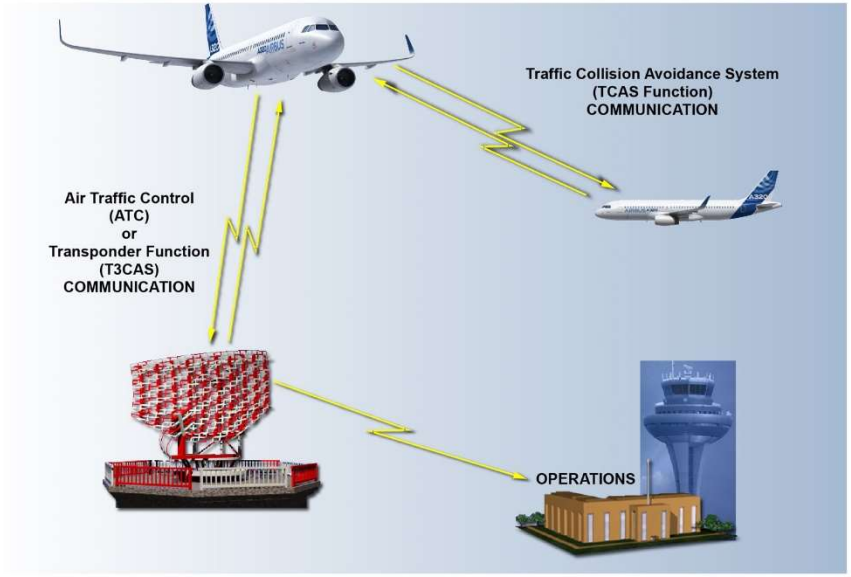
T/TISS (OR T3CAS)
Integrates: TCAS, Transponder and Terrain functions
The Single Aisle (SA) family is equipped with a Surveillance System integrating TCAS, Transponder and Terrain functions (T3CAS).
The Transponder function (ATC) responds to the ATC secondary surveillance radar and TCAS interrogations.

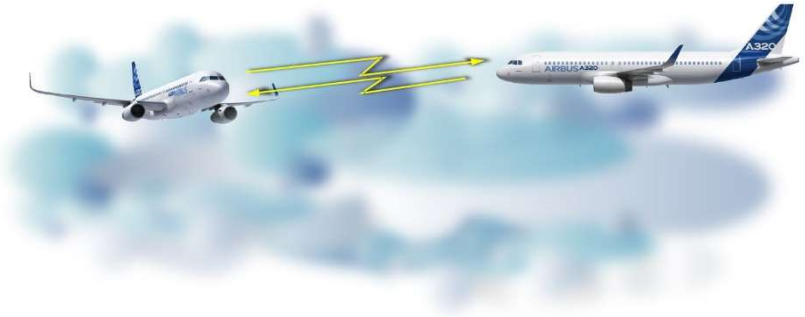
TCAS PRINCIPLE
TCAS function tells about traffic and warnings of potential conflicts with VERTICAL avoidance instructions
TCAS only detects intruders with at least one operative ATC transponder
T/TISS - TCAS function gives traffic information and warnings of potential conflicts to the crew, with vertical avoidance instructions.
TCAS can only detect and indicate intruders that have at least one operative ATC transponder.
NOTE: Only one transponder can operate at one time.

Multi-Mode Receiver (MMR) (GPS PART)







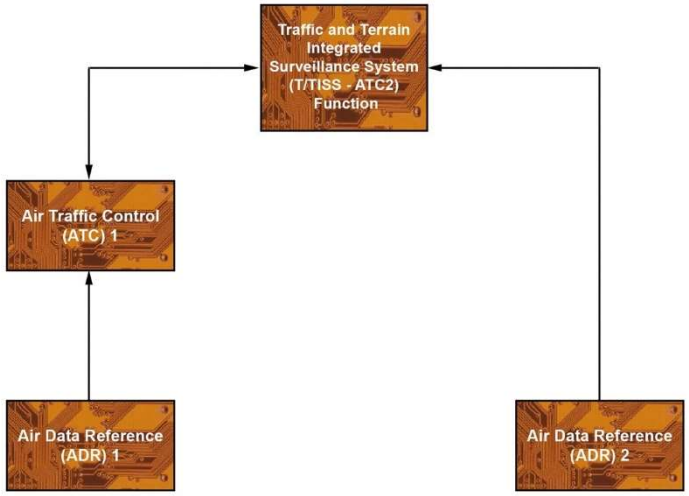


T/TISS combines 3 three functions in a single LRU
The Traffic and Terrain Integrated Surveillance System (T/TISS) (T3CAS) is a combination of three functions in a single Line Replaceable Unit (LRU).

T/TISS - ATC FUNCTION
ADR 1 supplies barometric information to ATC1
ADR 2 supplies barometric information to T/TISS-ATC2
ATC system based on replies provided by airborne transponders
System provides MODE A, MODE C & MODE S to controllers
In normal operation Air Data Reference (ADR) 1 supplies barometric information to ATC 1, and ADR 2 to T/TISS-ATC 2.
The ATC system is based on the replies provided by the airborne transponders in response to interrogations from the ATC Secondary Surveillance Radar.
A/C identification (MODE A), A/C Baro Altitude (MODE C) and Selective calling (MODE S) are provided by the system to the controllers.
This information enables the controller to distinguish the A/C and to maintain effective ground surveillance of the air traffic.

ATC/TCAS FUNCTIONS CONTROL AND INDICATING
T3CAS (ATC/TCAS functions) panel on pedestal
The single control panel on the center pedestal is used for the controls of the T3CAS (ATC/TCAS functions).

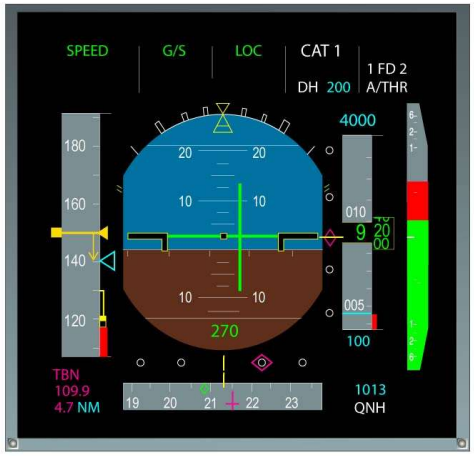
Terrain and Traffic Integrated Surveillance System (T/TISS)
(T3CAS)



TCAS INDICATING

T3CAS - TCAS function indications and audio warnings

Here are the different indications that are given by the T3CAS - TCAS function computer linked to audio warnings.



PFD

FORBIDDEN Vertical Speed (V/S)

"FLY TO" Vertical Speed (V/S)

ND

INTRUDERS

OTHER TRAFFIC

PROXIMATE TRAFFIC

TRAFFIC ADVISORY

RESOLUTION ADVISORY

ON-BOARD AIRPORT NAVIGATION SYSTEM FUNCTION/DESCRIPTION

OANS functions:

Display on ND of airport moving map
Prevents runway incursion & airport navigation errors
Decreases taxiing time

The On-board Airport Navigation System (OANS) is an on-board function which:
- Gives the display of an airport moving map on Navigation Display (ND) units,
- Prevents runway incursions and airport navigation errors and decreases taxiing time.

OANS includes:

Computer (OANC)
Software
Database (ADB)

The OANS includes:
- An On-board Airport Navigation Computer (OANC),
- An OANS software,
- An OANS database, which is a worldwide Airport Database (ADB).

INTERFACE

OANS interfaces with:

ADIRS, MMR and FMS to have A/C data
FWS to give aural and visual alerts

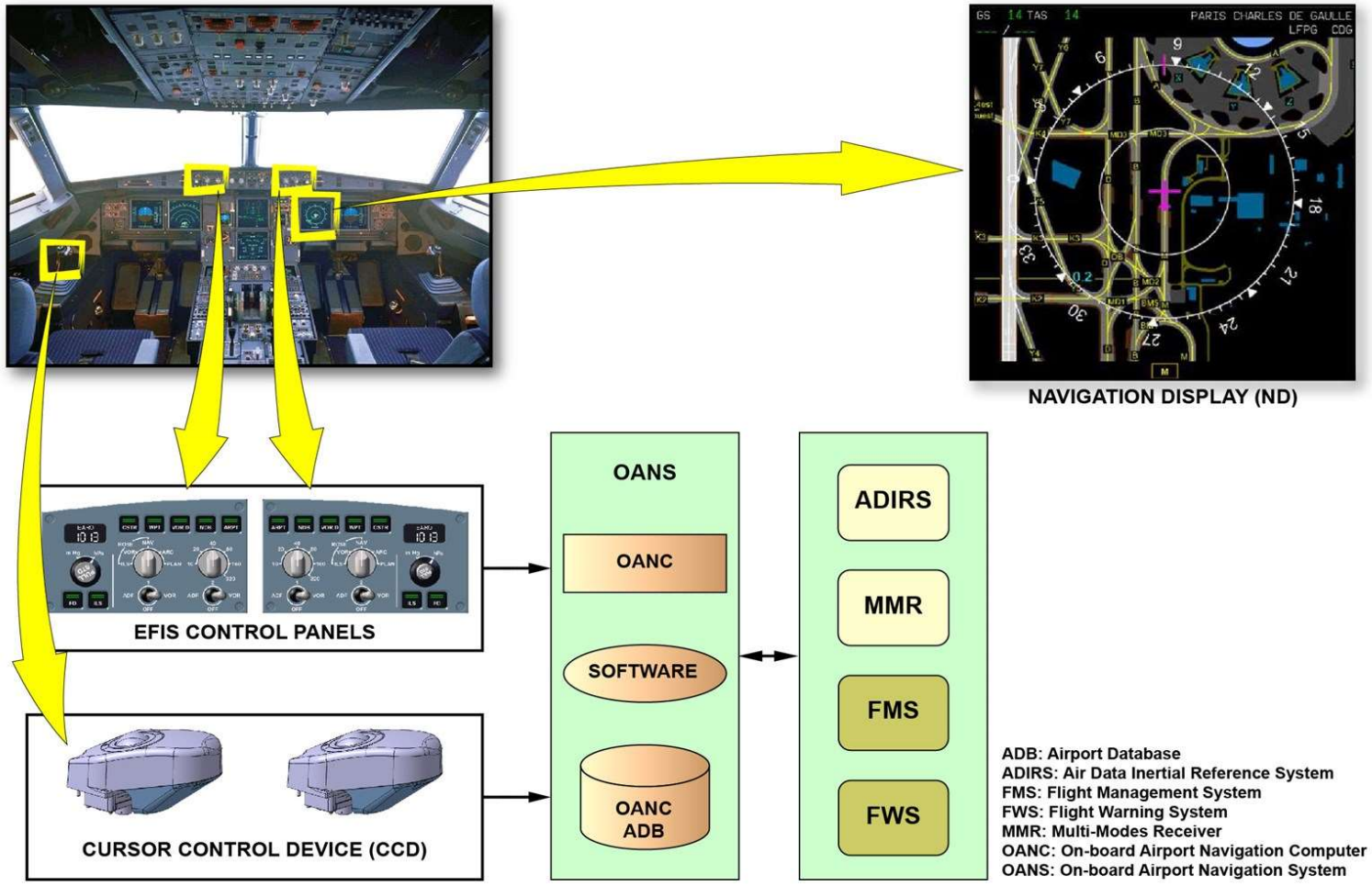
The OANS interfaces with:
- The Air Data Inertial Reference System (ADIRS), the Multi-Modes Receiver (MMR) and the Flight Management System (FMS) to have aircraft data (e.g. aircraft position, aircraft ground speed, selected runway),
- The Flight Warning System (FWS) to give aural and visual alerts.

CONTROLS

OANS controls are from:

EFIS to get airport moving map on NDs
CCD to interact with airport map

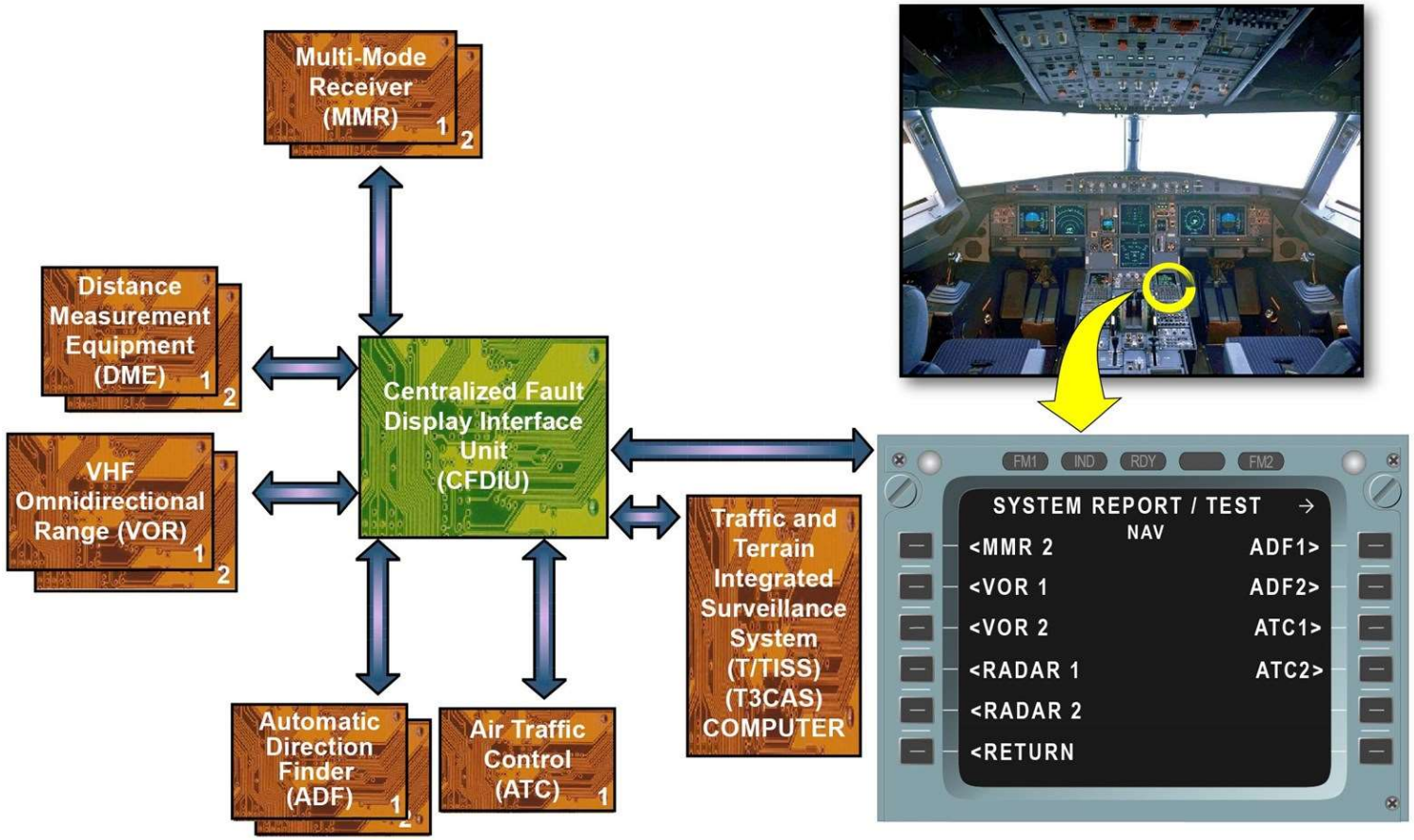
The OANS controls are done from:
- The Electronic Flight Instrument System (EFIS) control panels to get the airport moving map on NDs,
- The Cursor Control Devices (CCD) to interact with airport map.


NAVIGATION DISPLAY (ND)
EFIS CONTROL PANELS
CURSOR CONTROL DEVICE (CCD)
OANS
OANC
SOFTWARE
OANC ADB
ADIRS
MMR
FMS
FWS
ADB: Airport Database
ADIRS: Air Data Inertial Reference System
FMS: Flight Management System
FWS: Flight Warning System
MMR: Multi-Modes Receiver
OANC: On-board Airport Navigation Computer
OANS: On-board Airport Navigation System

MAINTENANCE/TEST FACILITIES

Navigation system tests from MCDUs

All navigation systems can be tested from the MCDUs.




Independent Position
Determining Systems
Presentation
OVRD
G
B
Y
AUTO EXTING
TEST
RESET
1 FADEC GND PWR 2
HYD
PSI
PSI
PTU
ELEC
ELEC
2
A/SKID &
N/W STRG
ON
OFF

GENERAL

Independent position determining systems:

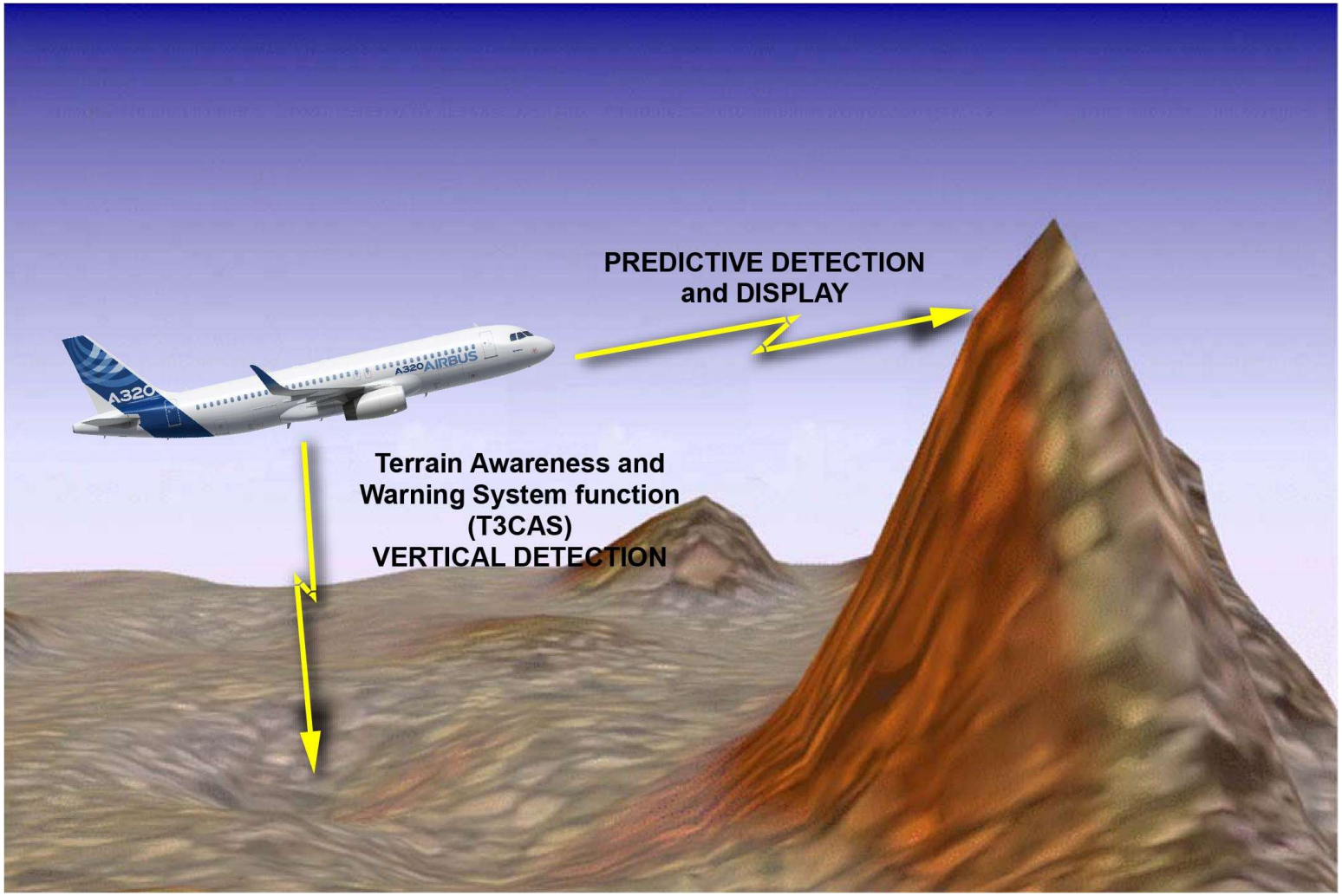
T/TISS/TAWS
RAs
WXR and PWS

The Independent Position determining systems include:
- Traffic/Terrain Integrated Surveillance System (T/TISS or T3CAS), Terrain Awareness and Warning System (TAWS) function,
- Radio Altimeters (RAs),
- Weather Radar (WXR) and Predictive Windshear (PWS).

These systems do not rely on external sources to give to the flight crew the position determination.

T/TISS - TAWS FUNCTION

TAWS generates aural and visual warnings if A/C is closed to ground
T/TISS - TAWS function has 5 basic alerting modes and 2 terrain predictive modes
The function of the TAWS is to launch aural and visual warnings if the A/C adopts a potentially hazardous configuration of Controlled Flight Into Terrain (CFIT).
The T/TISS - TAWS function has:
- 5 basic alerting reactive modes (based on Radio Altitude (RA)),
- 2 Terrain Predictive modes (Obstacle and Awareness Display).

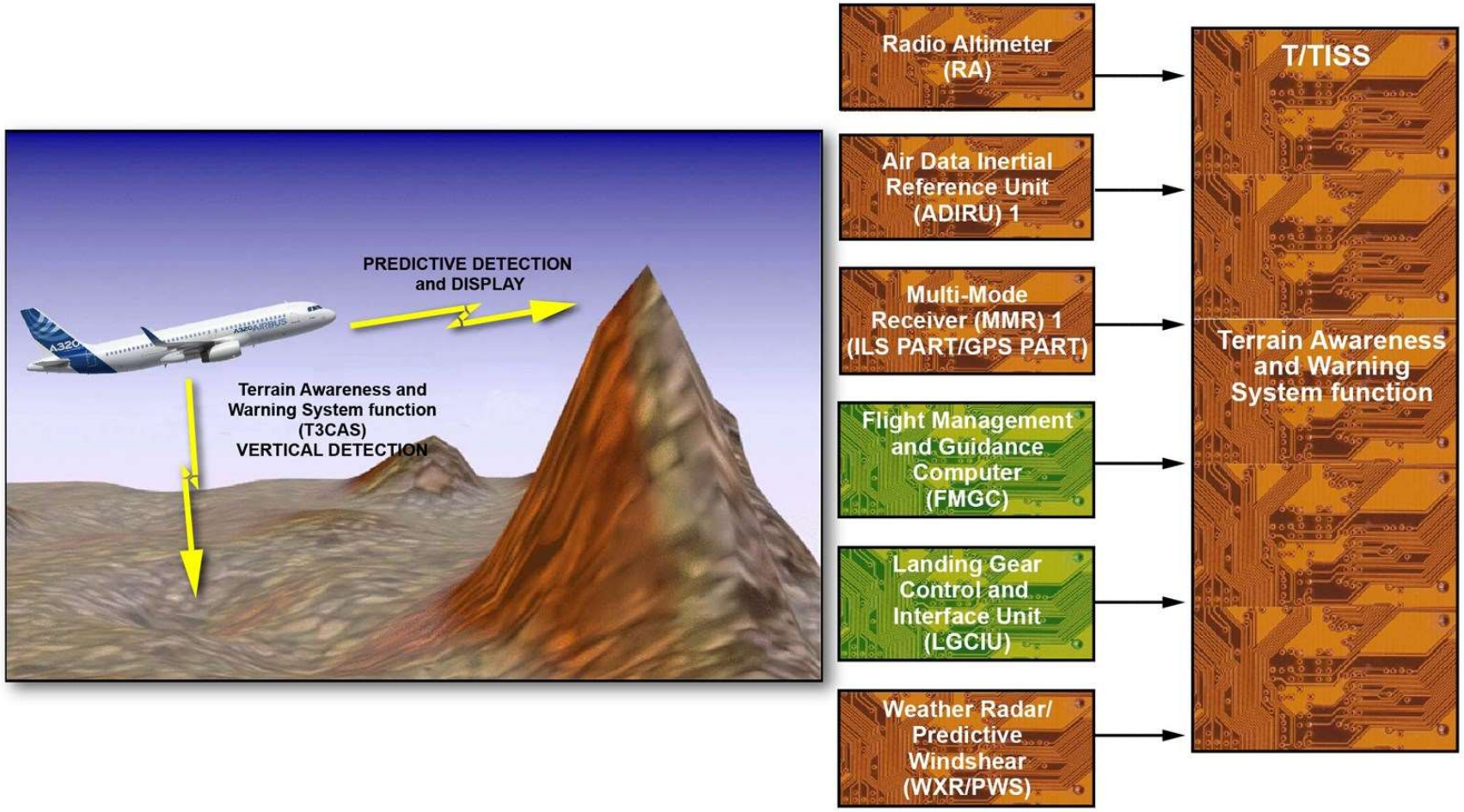

PREDICTIVE DETECTION
and DISPLAY
Terrain Awareness and
Warning System function
(T3CAS)
VERTICAL DETECTION

SYSTEM ARCHITECTURE

TAWS function or T3CAS computer (or T2CAS as option) processes data from:

RA 1 & 2
ADIRU 1
MMR 1 (ILS part & GPS part)
FMGC 1
LGCIU 1
WXR/PWS (for ND image source selection)

The TAWS function or T3CAS computer processes the data from:
- RA 1 and 2,
- Air Data/Inertial Reference Unit (ADIRU) 1,
- Multi-Mode Receiver (MMR) 1 (Instrument Landing System (ILS) part and GPS part),
- Flight Management and Guidance Computer (FMGC) 1,
- Landing Gear Control and Interface Unit (LGCIU) 1,
- WXR/PWS (for ND image source selection between both systems).


PREDICTIVE DETECTION
and DISPLAY
Terrain Awareness and
Warning System function
(T3CAS)
VERTICAL DETECTION
Radio Altimeter
(RA)
Air Data Inertial
Reference Unit
(ADIRU) 1
Multi-Mode
Receiver (MMR) 1
(ILS PART/GPS PART)
Flight Management
and Guidance
Computer
(FMGC)
Landing Gear
Control and
Interface Unit
(LGCIU)
Weather Radar/
Predictive
Windshear
(WXR/PWS)
T/TISS
Terrain Awareness
and Warning
System function

T3CAS (option)
- TAWS part
- TCAS part

TAWS part= EGPWS
- Basic modes based on RA
- Predictive modes: CPA and THD

The Traffic Collision avoidance System (TCAS) part of the T3CAS is the part that carries out the TCAS functions.
The Terrain Awareness and Warning System (TAWS) of the T3CAS carries out the EGPWS functions such as:
- basic TAWS modes based on Radio Altitude (RA),
- predictive TAWS modes: Collision Prediction and Alerting (CPA) function and Terrain Hazard Display (THD) which gives a forward-looking terrain alerting capability.

Traffic and Terrain Integrated Surveillance System (T/TISS) (T3CAS)

Basic TAWS modes based on Radio Altitude (RA)

Predictive TAWS modes:
- Collision Prediction and Alerting (CPA),
- and Terrain Hazard Display (THD).

GPWS PANEL

GPWS/T3CAS panel on overhead panel

Enables deactivation of:

TERRAIN mode

Complete or partial basic TAWS mode

The GPWS/T3CAS control panel is installed on the overhead panel and enables the deactivation of:

- TERRAIN mode,
- complete or partial basic TAWS mode in specific approach configuration.

CONTROL AND INDICATING

System tested pressing GPWS G/S P/Bs

Pressing either of the PULL UP/GPWS P/BSW starts the systems test of the T/TISS - TAWS function.

2 loudspeakers installed on each lower side of main panel

Broadcast aural warnings, even if they are turned off

In addition, two loudspeakers installed on each lower side of the main panel broadcast aural warnings, even if loudspeaker knobs are turned off.

TERR ON ND P/Bs display terrain information on ND except in plan mode

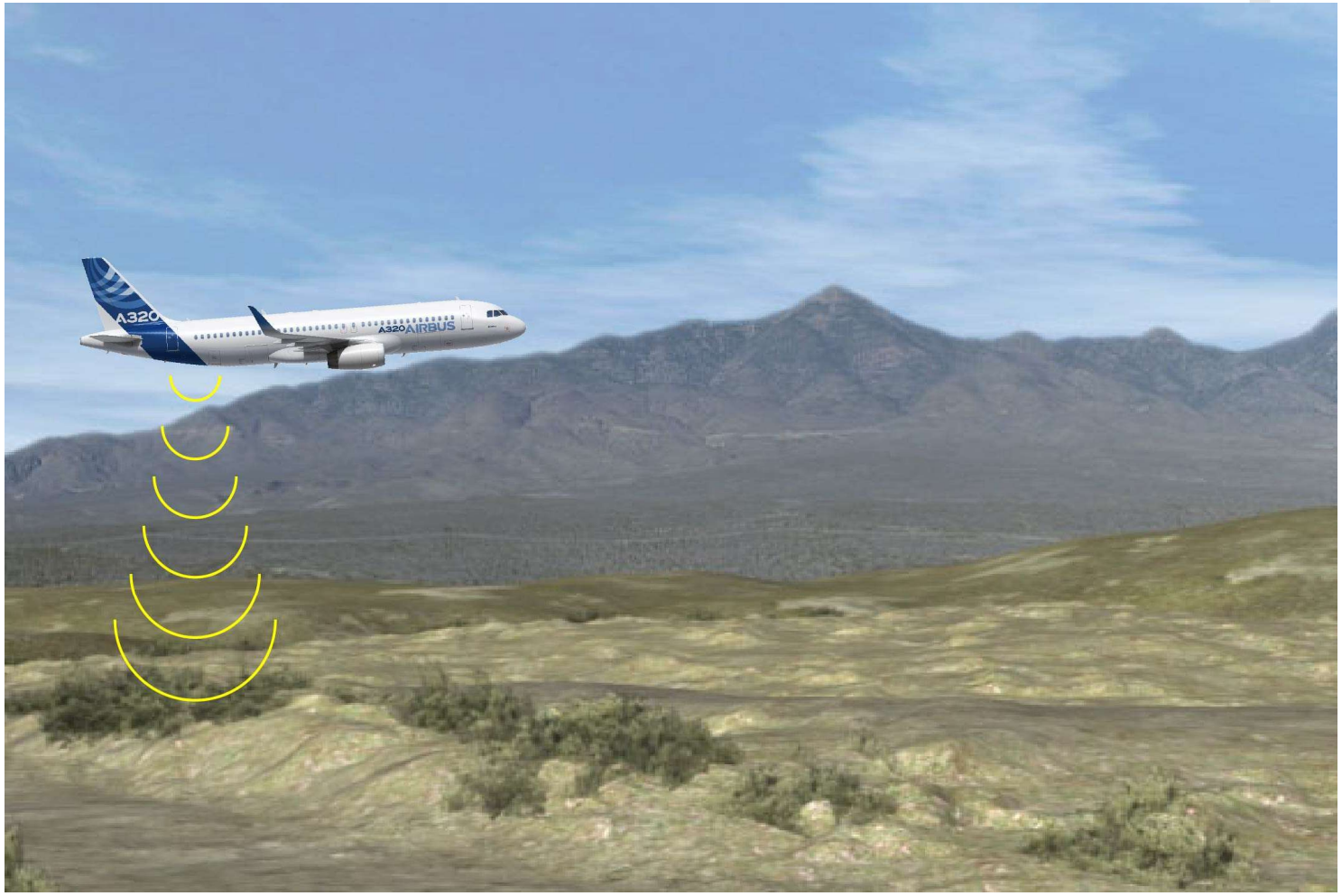
Terrain elevation surrounding A/C is color coded

Terrain information will be automatically displayed on the ND if there is any danger within the proximity of the A/C. The terrain elevation surrounding the A/C is color-coded. The TERRain ON ND P/B is used to display the terrain information on the ND all the time on request.

RADIO ALTIMETER

RAs measure A/C height during climb, landing and approach

The RAs supply accurate measurement of the A/C height above the ground during initial climb, landing and approach phases.



CONTROL AND INDICATING

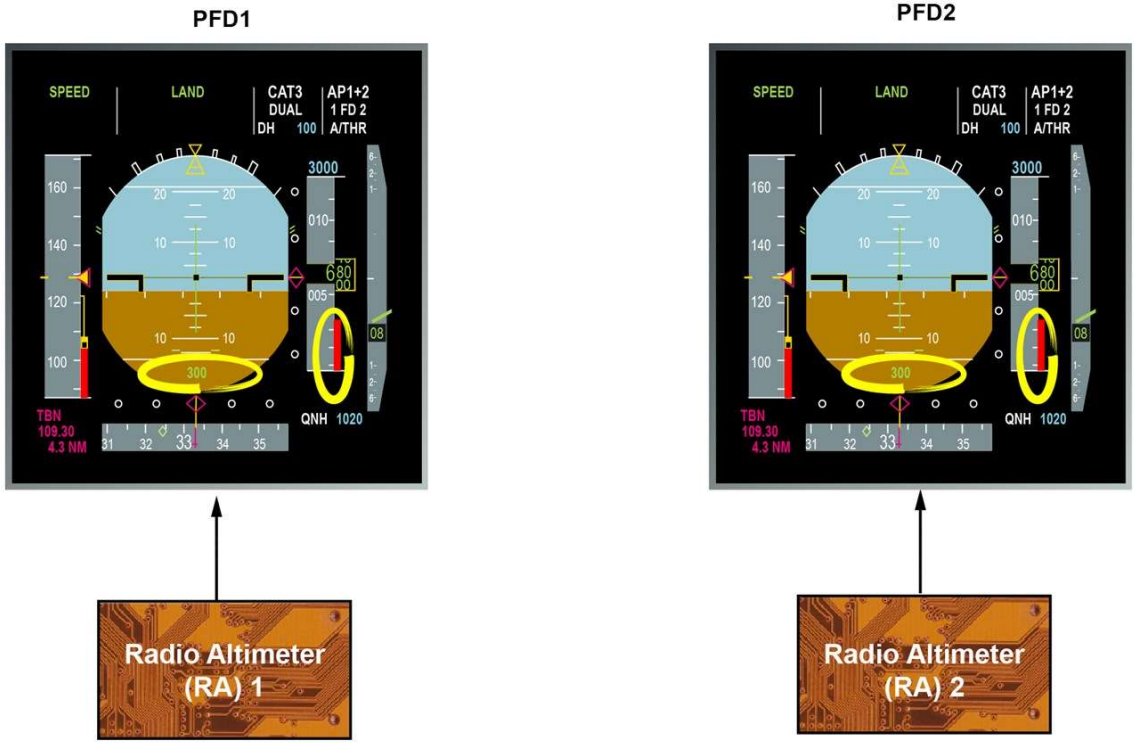
Data is displayed on both PFDs below 2500 feet AGL

RA data is supplied to several users and is displayed on both PFDs at all times below 2500 feet Above Ground Level (AGL).

RA 1 height displayed on CAPT PFD

RA 2 height displayed on F/O PFD

In normal operation, the RA 1 height is displayed on the CAPT PFD and RA 2 height on the F/O PFD.



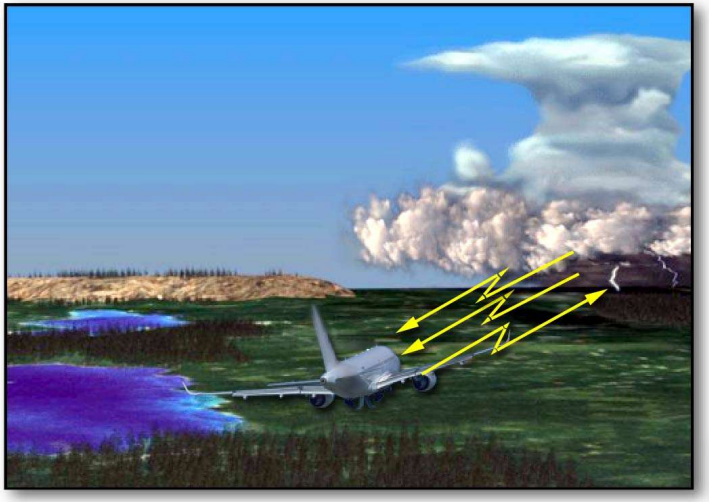
WXR/PWS

Weather radar detects and displays precipitations on ND

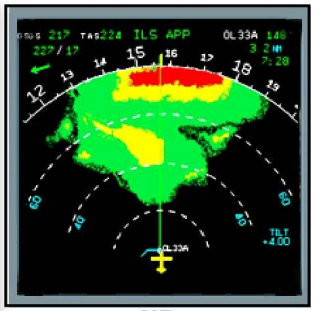
WXR is installed to detect precipitation. The displayed returns are shown on the ND.

PWS detection during take off and landing phases

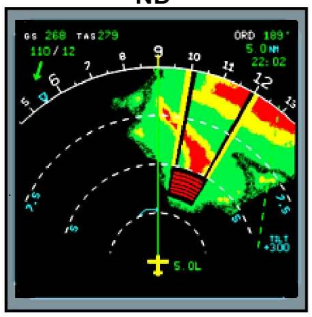
The weather radar supplies PWS detection. A wind shear event is a sudden change of wind speed and/or direction over a short distance with a very dangerous downwards and/or upwards movement of air during take off and approach phases.



WEATHER RADAR

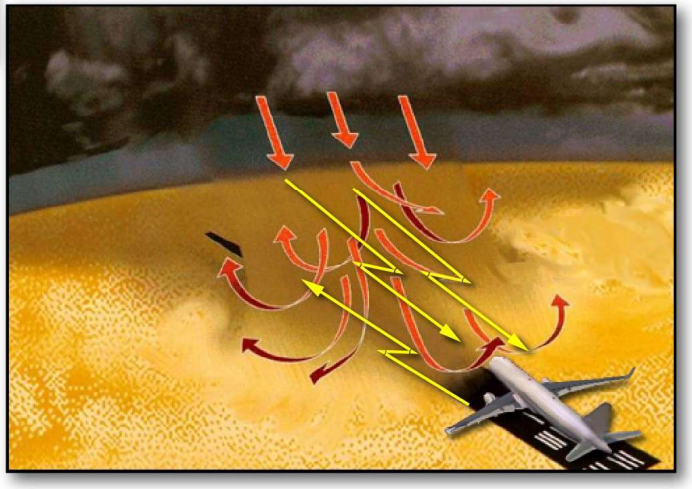


ND



ND

PREDICTIVE WINDSHEAR



WXR/PWS PANEL

WXR control panel on center pedestal

CAUTION: If WXR is ON

Personnel not within 1.5 meters of radome

No metallic obstacle within 5 meters

No refueling within 60 meters

The WXR control panel is installed on the center pedestal. The information is displayed on the CAPT or F/O ND.

WARNING: when the WXR is "ON":

- personnel should not be within 5 meters of the radome,

CAUTION: when the WXR is "ON":

- no metallic obstacle should be within 5 meters,
- no refueling within 60 meters.

MULTISCAN function

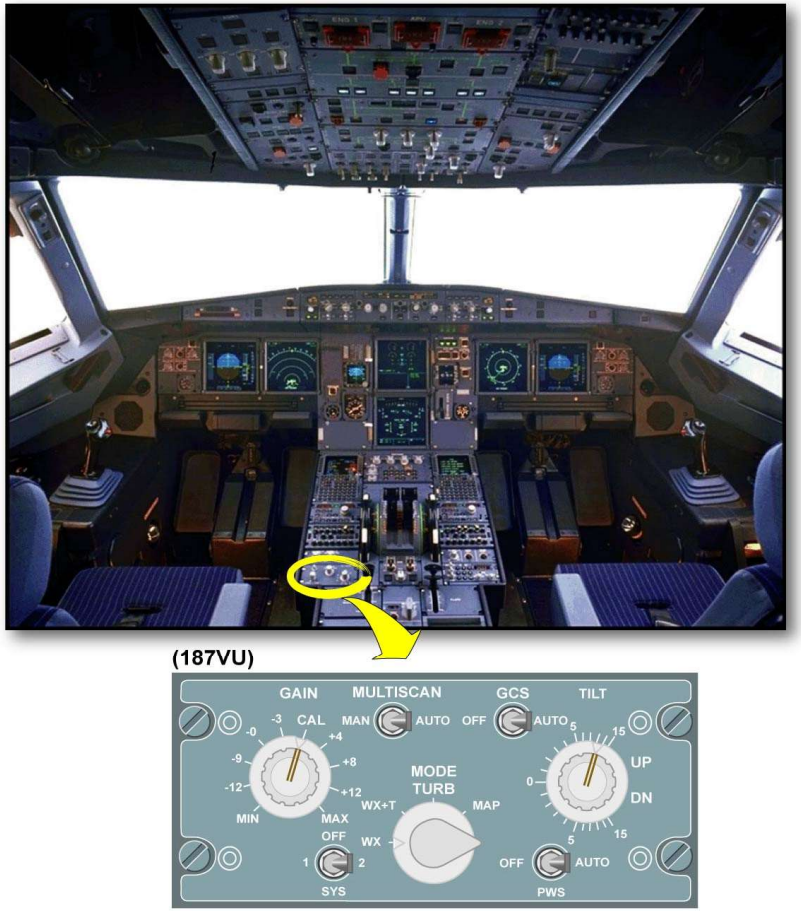
AUTO TILT function as option

The multiscan is a radar function that displays all significant weather at all ranges, at all aircraft altitudes, and at all times on a display that is essentially clutter-free, without the need for pilot to input tilt or gain settings. The multiscan function optimizes weather detection and minimizes ground clutter.

The weather radar can operate in autotilt mode (automatic tilt angle): the use of the automatic tilt function is recommended in WX and TURB modes. The autotilt function uses the terrain altitude information of the EGPWS. Based on the aircraft altitude above the terrain and on terrain conditions in the area, the EGPWS determines the optimum tilt angle for the radar

Automatic tilt is selected by setting the MULTISCAN SW to AUTO on the weather radar control unit.

- switch to AUTO: Tilt setting for weather scans is automatic,
- switch to MAN: Tilt is controlled with the manual tilt control knob.

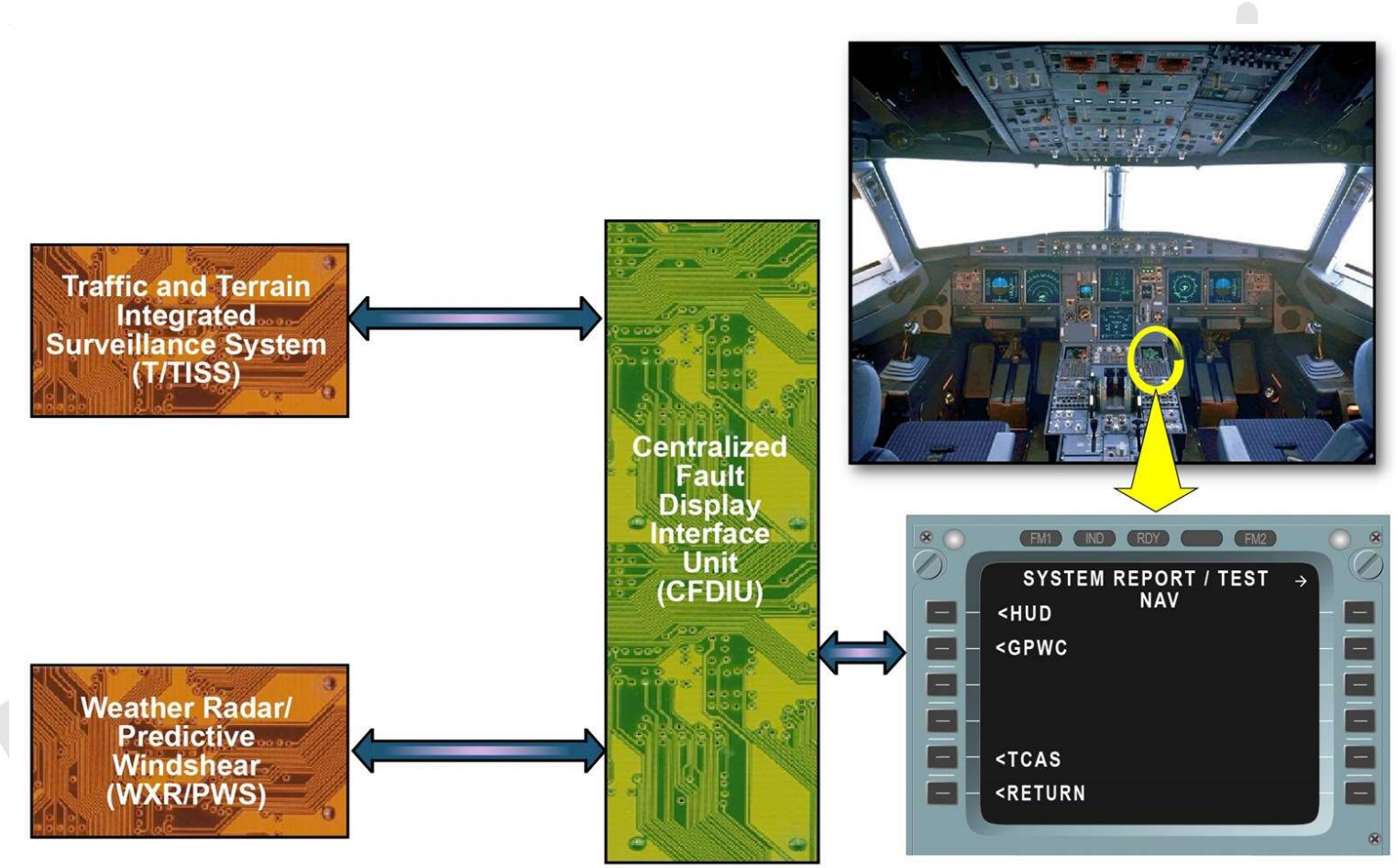


With Predictive Winshear (PWS) and MULTISCAN function

MAINTENANCE/TEST FACILITIES

Navigation system tests from MCDUs

All navigation systems can be tested from the MCDUs.



SAFETY PRECAUTIONS

Obey AMM procedures to prevent injury or damage

When you work on the A/C, make sure that you obey all the Aircraft Maintenance Manual (AMM) procedures. This will prevent injury to persons and/or damage to the A/C.

Make sure

All persons more 5 meters (16.4 feet) from antenna
all objects and obstacles more than 5 meters away from the antenna (arc of 90 degrees on each side of the A/C)
Stop the fuel tanker 60 meters from the A/C nose while the weather radar is operating
Do not operate the fuel tanker/pump while the weather radar is operating
Nobody in an arc of 135 degrees of each side of centerline

Make sure that:

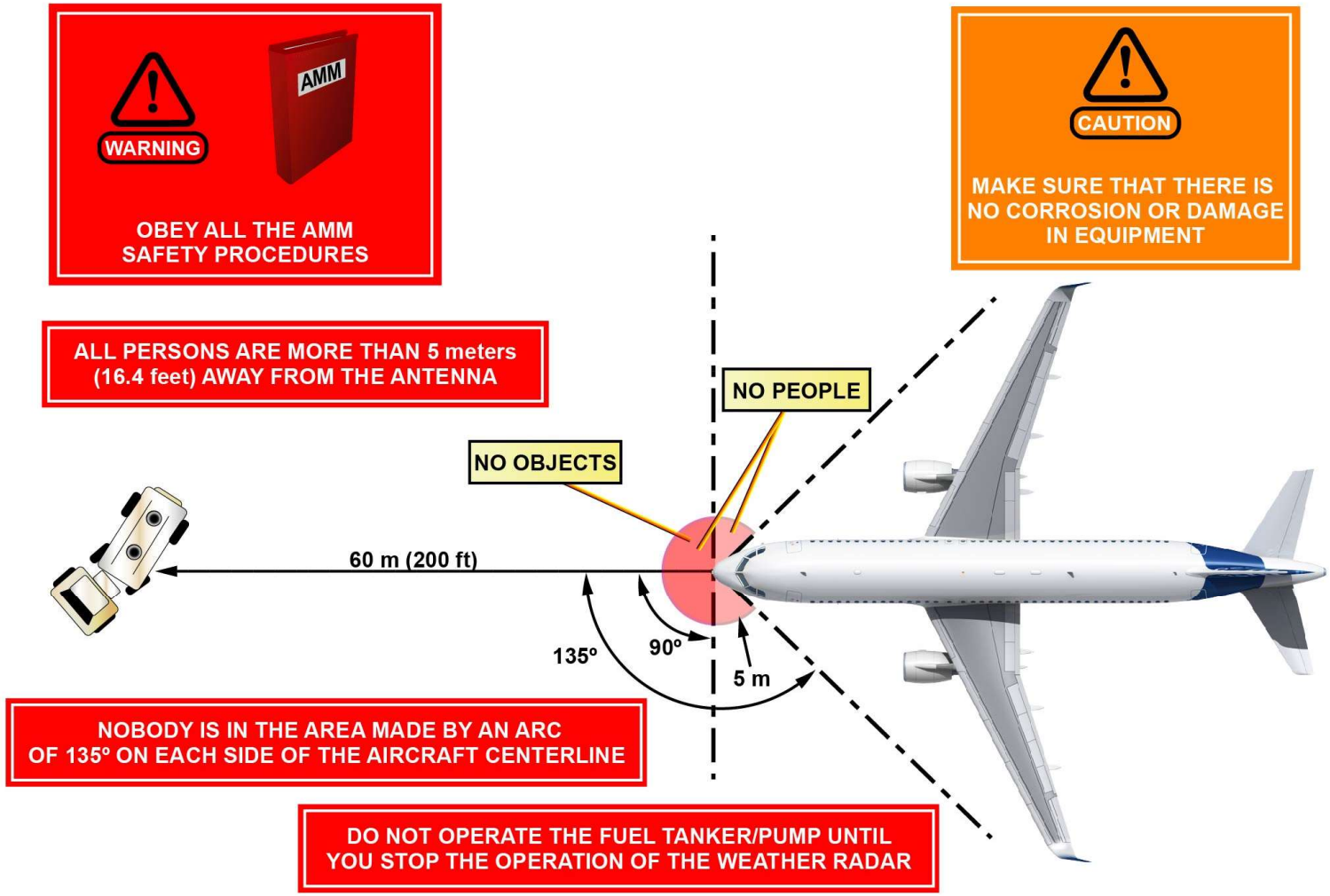
- all persons are more than 5 meters (16.4 feet) away from the antenna,

nobody is in the area made by an arc of 135 degrees on each side of the A/C centerline.

- all objects and obstacles are more than 5 meters away from the antenna in the area made by an arc of 90 degrees on each side of the A/C centerline.
- stop the fuel tanker 60 meters from the A/C nose while the weather radar is operating.

Do not operate the fuel tanker/pump until you stop the operation of the weather radar.

Make sure that there is no sign of corrosion or damage and no foreign objects in the test equipment.

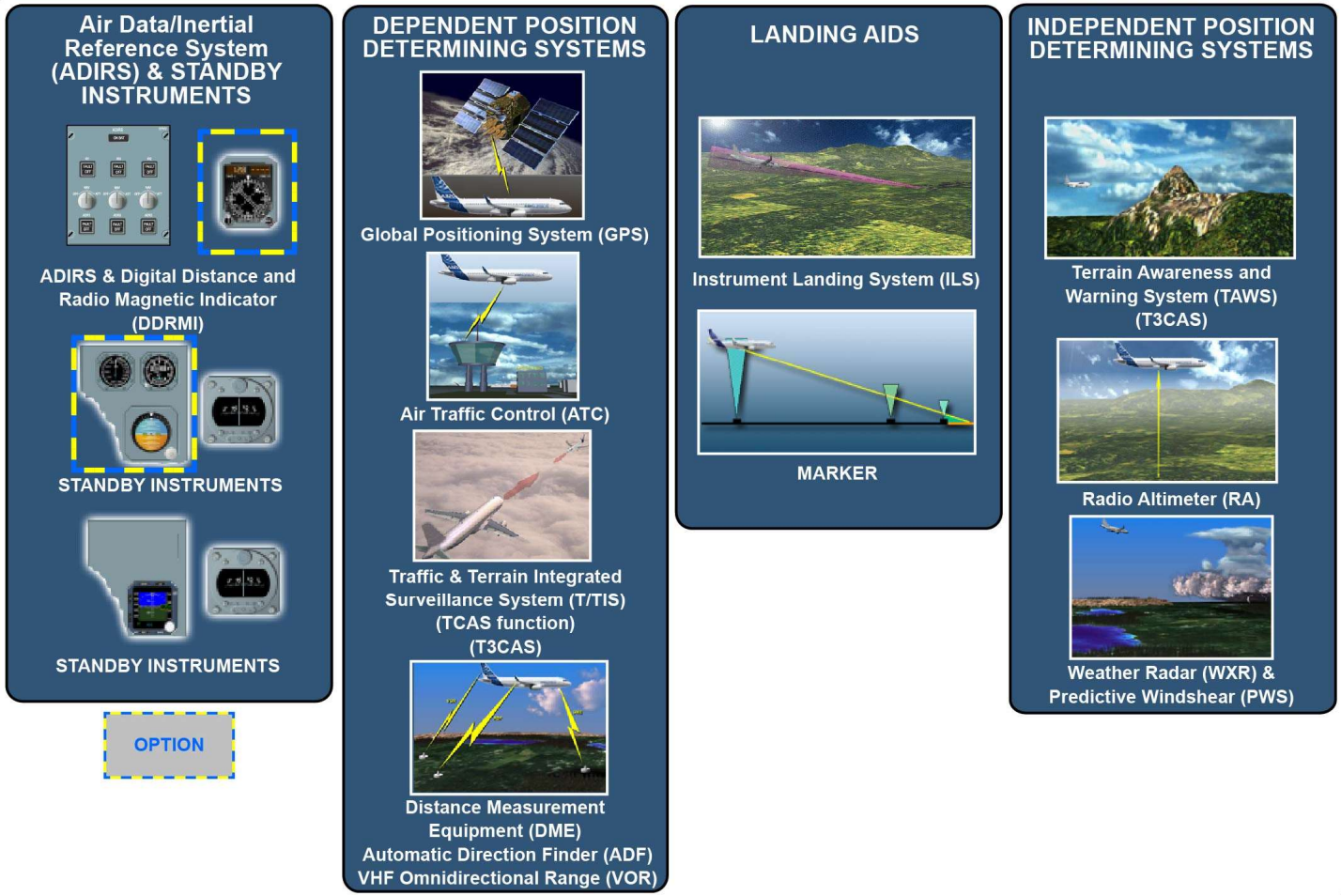

WARNING
AMM
OBEY ALL THE AMM SAFETY PROCEDURES
CAUTION
MAKE SURE THAT THERE IS NO CORROSION OR DAMAGE IN EQUIPMENT
ALL PERSONS ARE MORE THAN 5 meters (16.4 feet) AWAY FROM THE ANTENNA
NO PEOPLE
NO OBJECTS
60 m (200 ft)
135°
90°
5 m
NOBODY IS IN THE AREA MADE BY AN ARC OF 135° ON EACH SIDE OF THE AIRCRAFT CENTERLINE
DO NOT OPERATE THE FUEL TANKER/PUMP UNTIL YOU STOP THE OPERATION OF THE WEATHER RADAR

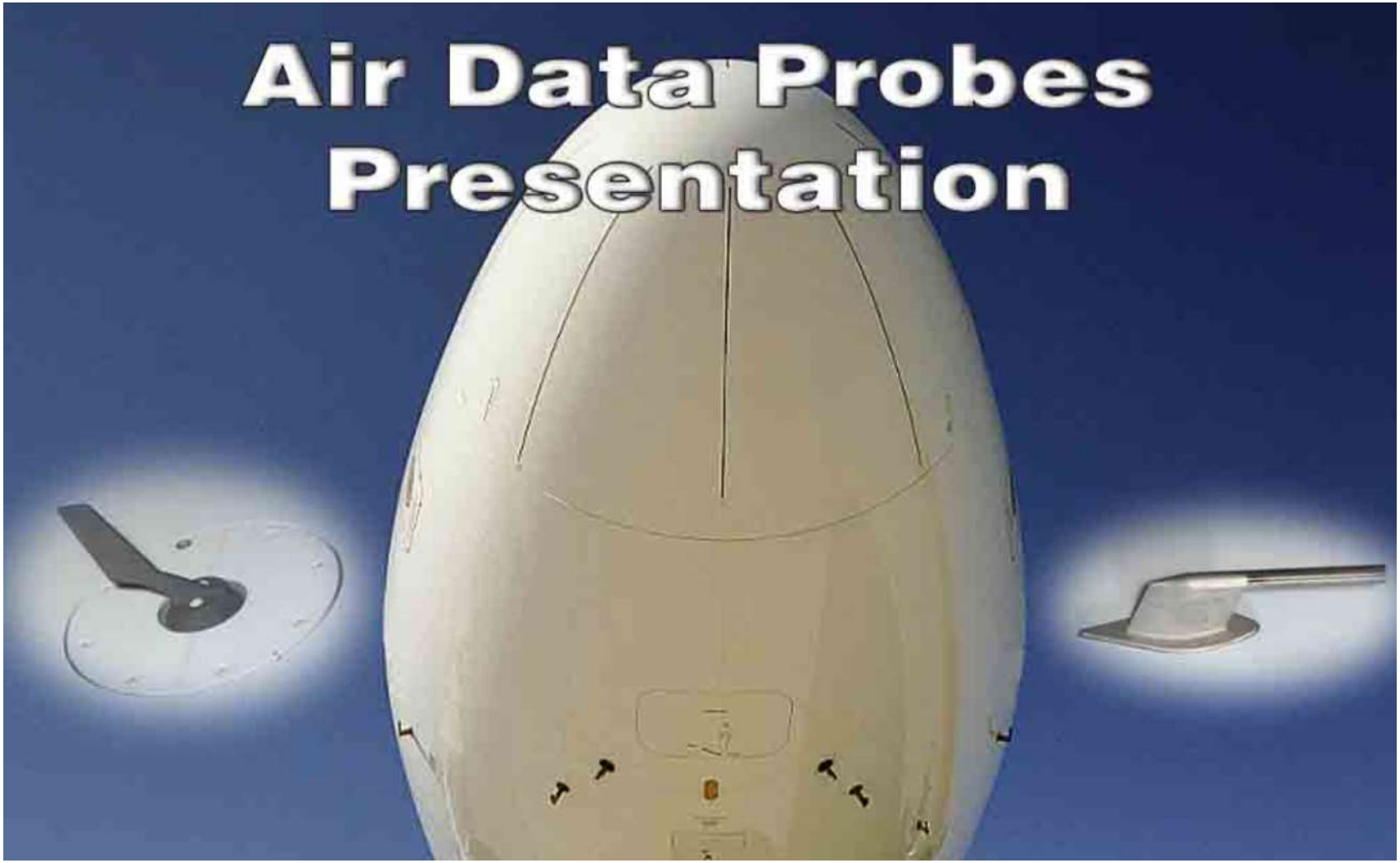
SUMMARY

Navigation systems:

- ADIRS, standby instruments
- Independent position determining systems
- Landing aids
- Dependent position determining systems

This picture lists the navigation systems that are installed on the Single Aisle A/C.




Air Data Probes
Presentation

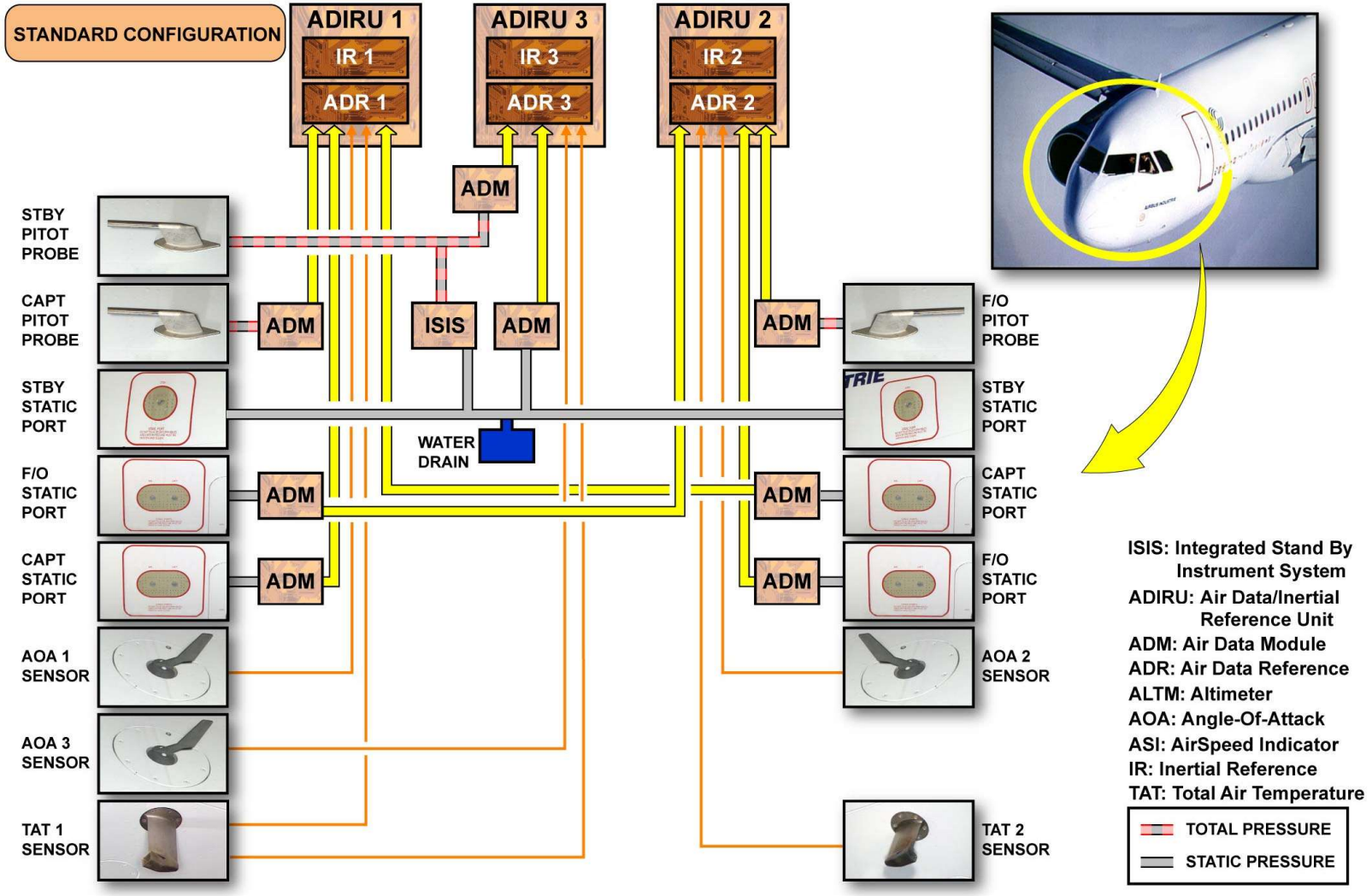
PITOT PROBES
3 probes provide total PRESS to 3 ADMs
Total PRESS:
Converted in ARINC 429 by ADMs
Then sent to ADIRUs
Three Pitot probes provide total pressure to three Air Data Modules (ADMs), which convert this pressure into digital format: ARINC 429. ARINC words are then sent to the corresponding Air Data/Inertial Reference Unit (ADIRU).

STATIC PORTS
6 ports provide static PRESS to 5 ADMs
Static PRESS converted in ARINC 429 by ADMs
2 STBY ports provide average PRESS:
To STBY instruments
To ADR 3 through a single ADM
Six static ports provide static pressure to five ADMs, which convert this pressure into digital format: ARINC 429. The two standby static ports provide an average pressure directly to the standby instruments, and to ADR 3 through a single ADM.

AOA SENSORS
1 AOA sensor per ADIRU
AOA sensors = α probes
Each ADIRU receives Angle-Of-Attack (AOA) information from its corresponding AOA sensor. The AOA sensors are also called Alpha probes.

TAT SENSORS
2 TAT sensors for 3 ADIRUs
The three ADIRUs receive Total Air Temperature (TAT) information from two TAT sensors.
NOTE: The two TAT sensors are composed of two sensing elements. ADIRU 3 receives the TAT from TAT sensor 1 one only.

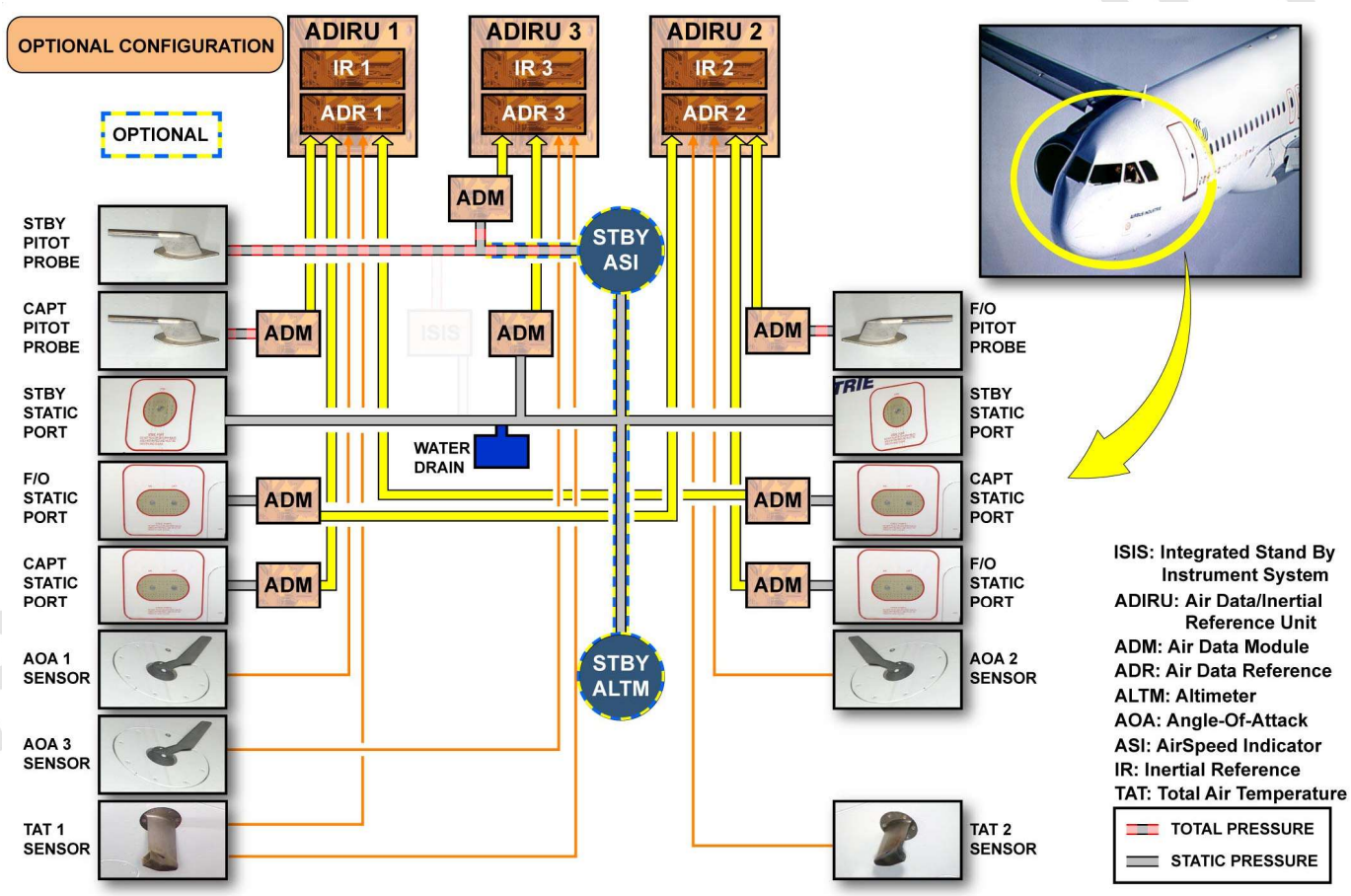
WATER DRAIN
Only for STBY static ports lines
The probes are installed in such a way that their pressure lines do not require a water drain, except for that of the standby static ports.


STANDARD CONFIGURATION
ADIRU 1
IR 1
ADR 1
ADIRU 3
IR 3
ADR 3
ADIRU 2
IR 2
ADR 2
ADM
ADM
ISIS
ADM
ADM
ADM
ADM
ADM
ADM
WATER DRAIN
STBY PITOT PROBE
CAPT PITOT PROBE
STBY STATIC PORT
F/O STATIC PORT
CAPT STATIC PORT
AOA 1 SENSOR
AOA 3 SENSOR
TAT 1 SENSOR
F/O PITOT PROBE
STBY STATIC PORT
CAPT STATIC PORT
F/O STATIC PORT
AOA 2 SENSOR
TAT 2 SENSOR
ISIS: Integrated Stand By Instrument System
ADIRU: Air Data/Inertial Reference Unit
ADM: Air Data Module
ADR: Air Data Reference
ALTM: Altimeter
AOA: Angle-Of-Attack
ASI: AirSpeed Indicator
IR: Inertial Reference
TAT: Total Air Temperature
TOTAL PRESSURE
STATIC PRESSURE

OPTIONAL CONFIGURATION
CLASSIC STANDBY INSTRUMENTS

Classic standby instruments instead of ISIS
STBY probe supplies:
STBY ASI rdiectly
ADR 3 via its related ADM

The classic standby instruments (Altimeter, Air speed indicator and horizon) can be installed instead of ISIS. The standby Pitot probe supplies the standby AirSpeed Indicator (ASI) directly and the Air Data Reference (ADR) 3 through its related ADM.

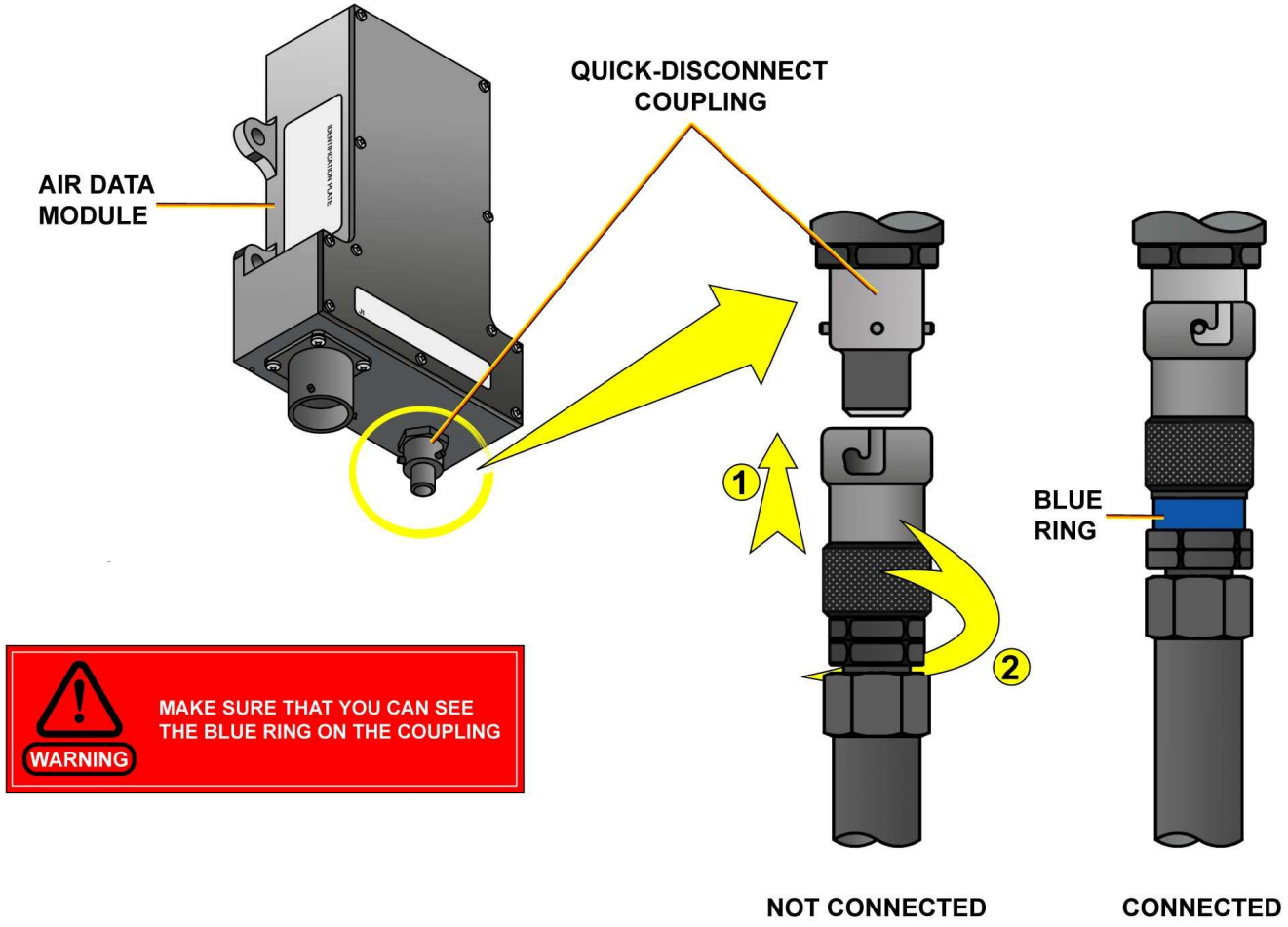


ADM PNEUMATIC CONNECTION

Apply cautions to connect the quick-disconnect coupling

Visible blue ring on the quick-disconnect coupling

To connect the ADM quick-disconnect coupling, make sure that you can see the blue ring on the coupling and pull it to make sure that it is correctly attached.




T/TISS System
Presentation
ACSS

GENERAL ARCHITECTURE

T/TISS integrates 3 functions:

TCAS/ATSAW
TAWS
ATC

Alerts the crew of Collision with Terrain and traffic

The Traffic and Terrain Integrated Surveillance System (T/TISS) is a combination of three functions in a single 6MCU LRU.

These functions are:

- Traffic alert and Collision Avoidance System (TCAS) (with Airborne Traffic Situation Awareness (ATSAW) capability,
- Terrain Awareness and Warning System (TAWS) (former EGPWS),
- Air Traffic Control (ATC) (Mode S Transponder).

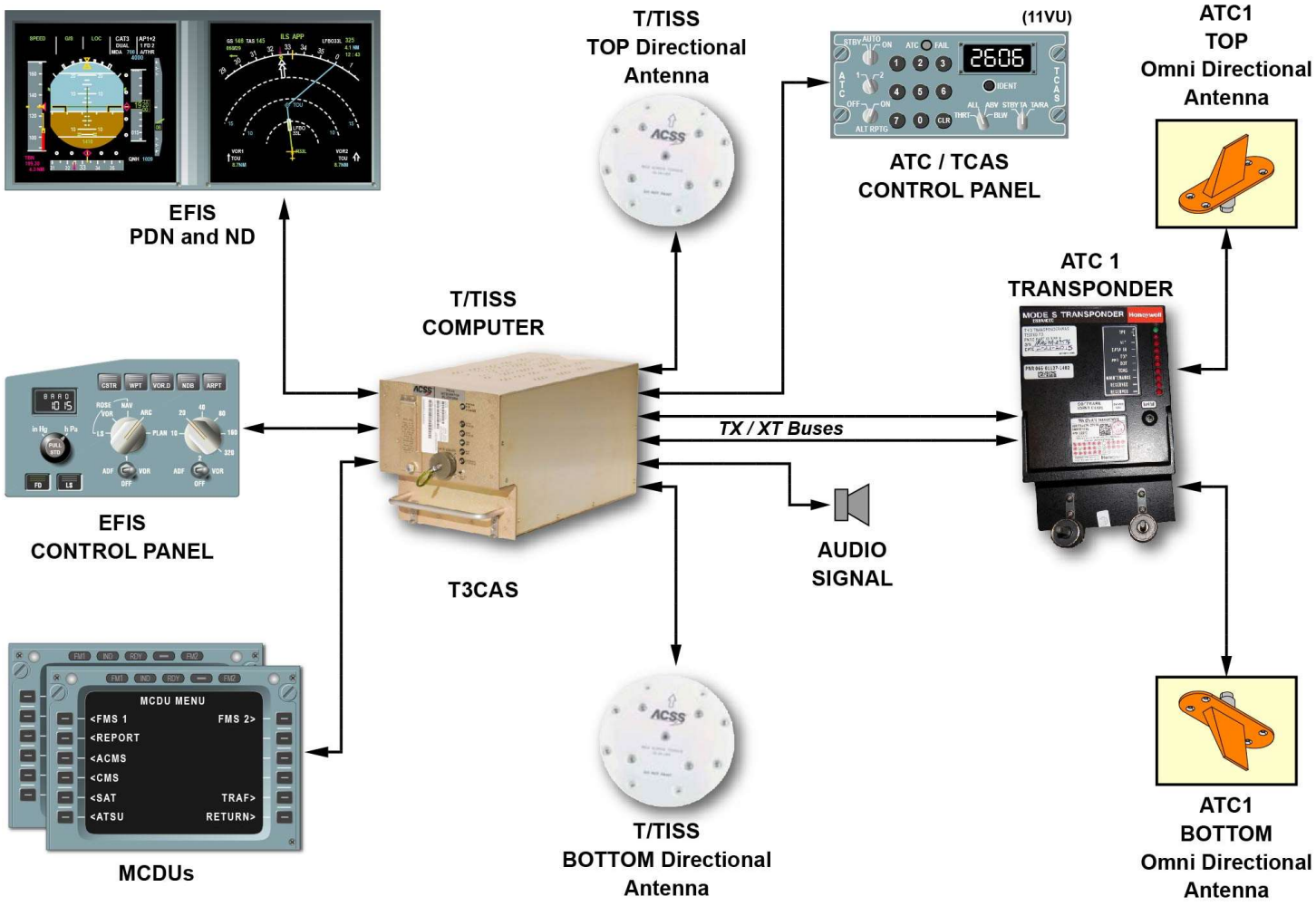
The purpose of the T/TISS is to alert the crew of two kinds of hazards:

- Collision with Terrain,
- Collision with Traffic (other aircraft(s)).

When the hazards are detected, the T/TISS:

- Alerts and informs the crew of the A/C environment,
- Proposes escape maneuvers,
- Provides MODES functions (including Elementary Surveillance (ELS), Enhanced Surveillance (EHS) and Automatic Dependant Surveillance-Broadcast (ADS-B) OUT and IN).

All cockpit hardware interfaces (light P/BSW...) for T/TISS-TAWS function remain identical to the Enhanced Ground Proximity Warning System (EGPWS).


EFIS
PDN and ND
T/TISS
TOP Directional
Antenna
(11VU)
ATC / TCAS
CONTROL PANEL
ATC1
TOP
Omni Directional
Antenna
ATC 1
TRANSPONDER
T/TISS
COMPUTER
EFIS
CONTROL PANEL
TX / XT Buses
AUDIO
SIGNAL
T3CAS
MCDU MENU
<FMS 1
FMS 2>
<REPORT
<ACMS
<CMS
<SAT
TRAF>
<ATSU
RETURN>
MCDUs
T/TISS
BOTTOM Directional
Antenna
ATC1
BOTTOM
Omni Directional
Antenna

T/TISS-ATC XPDR:
- Integral part of ATCRBS
- Interrogated by radar pulses
- Auto replies by series of pulses

Replies enable the controller:
- To distinguish A/C
- To maintain effective GND surveillance

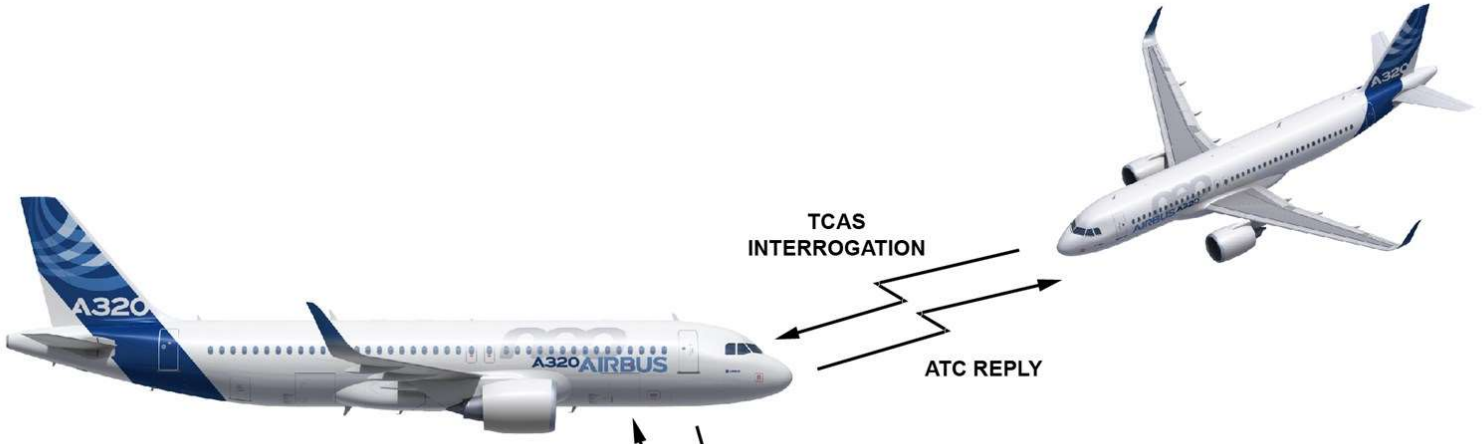
Reply pulses coded to supply:
- A/C Identification (Mode A)
- A/C barometric altitude (Mode C)
- Selective call & flight data + TCAS interrogations (mode S)

New functionalities for ATC Mode S XPDR:
- ELS
- EHS
- ADS-B OUT/IN
- ATSAW (ADS-B IN)

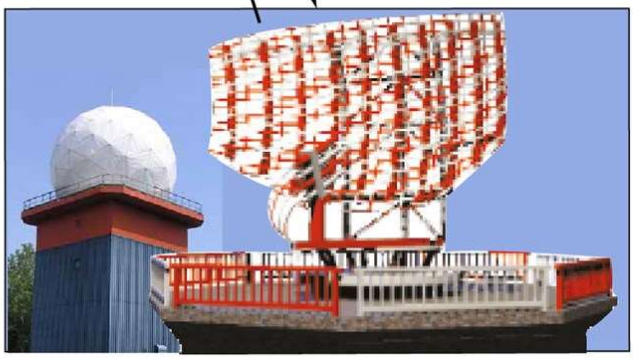
The T/TISS-Air Traffic Control (ATC) 2 function, also called transponder, is an integral part of the Air Traffic Control Radar Beacon (ATCRB) system. The transponder is interrogated by radar pulses received from the ground station. It automatically replies by series of pulses and provides:
- aircraft identification (Mode A),
- aircraft barometric altitude (Mode C),
- selective calling and transmission of aircraft flight data to the ground controller's radar scope.

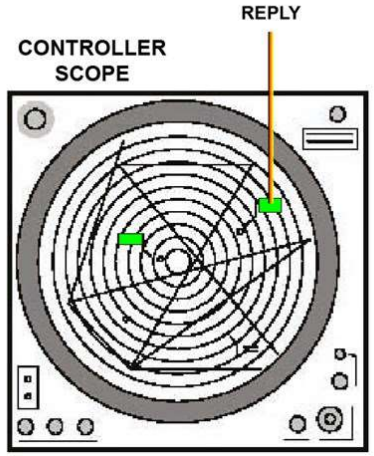
These replies enable the controller to distinguish the aircraft and to maintain effective ground surveillance of the air traffic. The ATC transponder (Mode S) also responds to interrogations from aircraft equipped with a Traffic and Collision Avoidance System (TCAS).

In addition, new functionalities are available for ATC Mode S transponders:
- Elementary Surveillance (ELS),
- Enhanced Surveillance (EHS),
- Automatic Dependent Surveillance Broadcast (ADS-B OUT / ADS-B IN),
- Airborne Traffic Situational Awareness (ATSAW (ADS-B IN)).



ATC MODE	INFORMATION ABOUT THE A/C
A	IDENTIFICATION
C	ALTITUDE
S	SELECTIVE CALL, FLIGHT DATA





T/TISS-TCAS PRINCIPLE

TCAS functions:

Detects & displays A/Cs in immediate vicinity

Provides indications to flight crew

T2CAS (optional) ensures same functions as TCAS

Detects ATC system equipped A/Cs

Maintains surveillance within covered space

Divides space around A/C into 4 volumes

The T/TISS-Traffic and Collision Avoidance System (TCAS) is a function that detects and displays aircrafts in the immediate vicinity and provides the flight crew with indications to avoid these intruders by changing the flight in the vertical axis.

The T/TISS-TCAS periodically interrogates the intruder(s) and maintains surveillance within a range determined by its sensivity and evaluates potential threat of other aircraft(s) classified into 4 categories:

- Other traffic (aircraft) volume,
- Proximate traffic (aircraft) volume,
- Traffic Advisory (TA) volume,
- Resolution Advisory (RA) volume.

OTHER TRAFFIC VOLUME

First volume of detection (No collision threat)

The other traffic volume is the first volume providing the presence and the progress of an intruder. The aircraft detected in this zone does not represent a collision threat.

PROXIMATE TRAFFIC VOLUME

Given volume around TCAS equipped A/C

No collision threat but A/C in vicinity

The proximate traffic volume is defined by a given volume around the TCAS equipped aircraft. The aircraft detected in this zone does not represent a collision threat, but is declared in vicinity (less than 1200 ft and range within 6 NM).

TA VOLUME

Intruder relatively near

No immediate collision threat

TCAS aural & visual information called TA

Messages inhibition depends on higher priority aural messages

When the intruder is relatively near but does not represent an immediate threat, the TCAS provides aural and visual information known as TA for Traffic Advisory. The TCAS aural messages can be inhibited depending on higher priority aural messages.

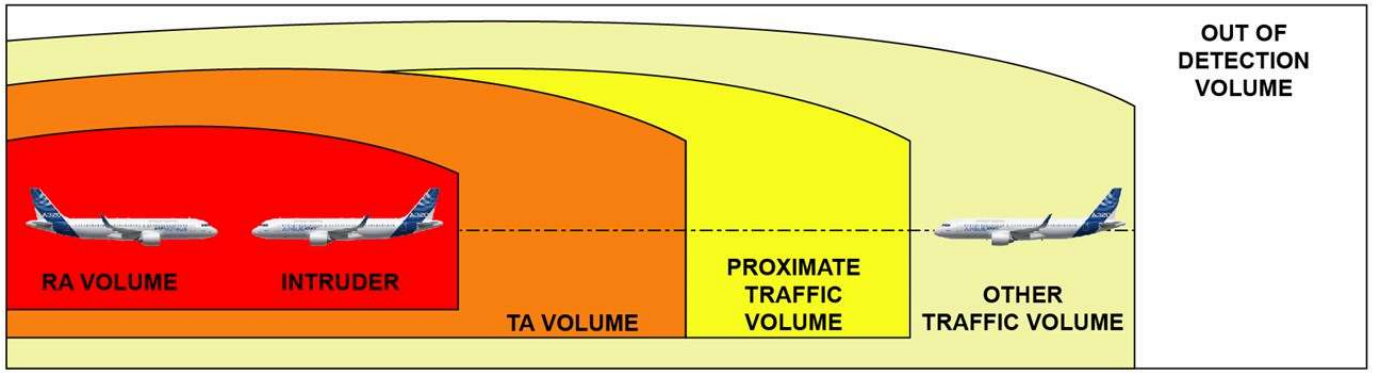
RA VOLUME

Intruder represents real collision threat

TCAS aural & visual information called RA

Crew informed about avoidance maneuvers

When the intruder represents a real collision threat, the TCAS triggers an aural and visual alarm known as RA for Resolution Advisory, which informs the crew about avoidance maneuvers.



INTRUDER LOCATION / INTRUDER EQUIPMENT	RESOLUTION ADVISORY (RA) VOLUME	TRAFFIC ADVISORY (TA) VOLUME	PROXIMATE TRAFFIC VOLUME	OTHER TRAFFIC VOLUME	OUT OF DETECTION VOLUME
WITHOUT OPERATIVE ATC	NO DETECTION	NO DETECTION	NO DETECTION	NO DETECTION	NO DETECTION
WITH ATC MODE A	TA WITHOUT INTRUDER RELATIVE ALTITUDE	TA WITHOUT INTRUDER RELATIVE ALTITUDE	TRAFFIC INFORMATION WITHOUT INTRUDER RELATIVE ALTITUDE	TRAFFIC INFORMATION WITHOUT RELATIVE ALTITUDE	
WITH ATC MODE C OR S	RA WITHOUT A/C MANEUVER COORDINATION	TA WITH INTRUDER RELATIVE ALTITUDE	TRAFFIC INFORMATION WITH INTRUDER RELATIVE ALTITUDE	TRAFFIC INFORMATION WITH INTRUDER RELATIVE ALTITUDE	
WITH TCAS	RA WITH A/C MANEUVER COORDINATION				

ATC: Air Traffic Control

TCAS: Traffic alert and Collision Avoidance System

T/TISS-TAWS PRINCIPLE

Prevents hazardous situation ahead of A/C which would result to a CFIT

When boundaries exceeded:

- Aural alert messages
- Visual annunciations & displays

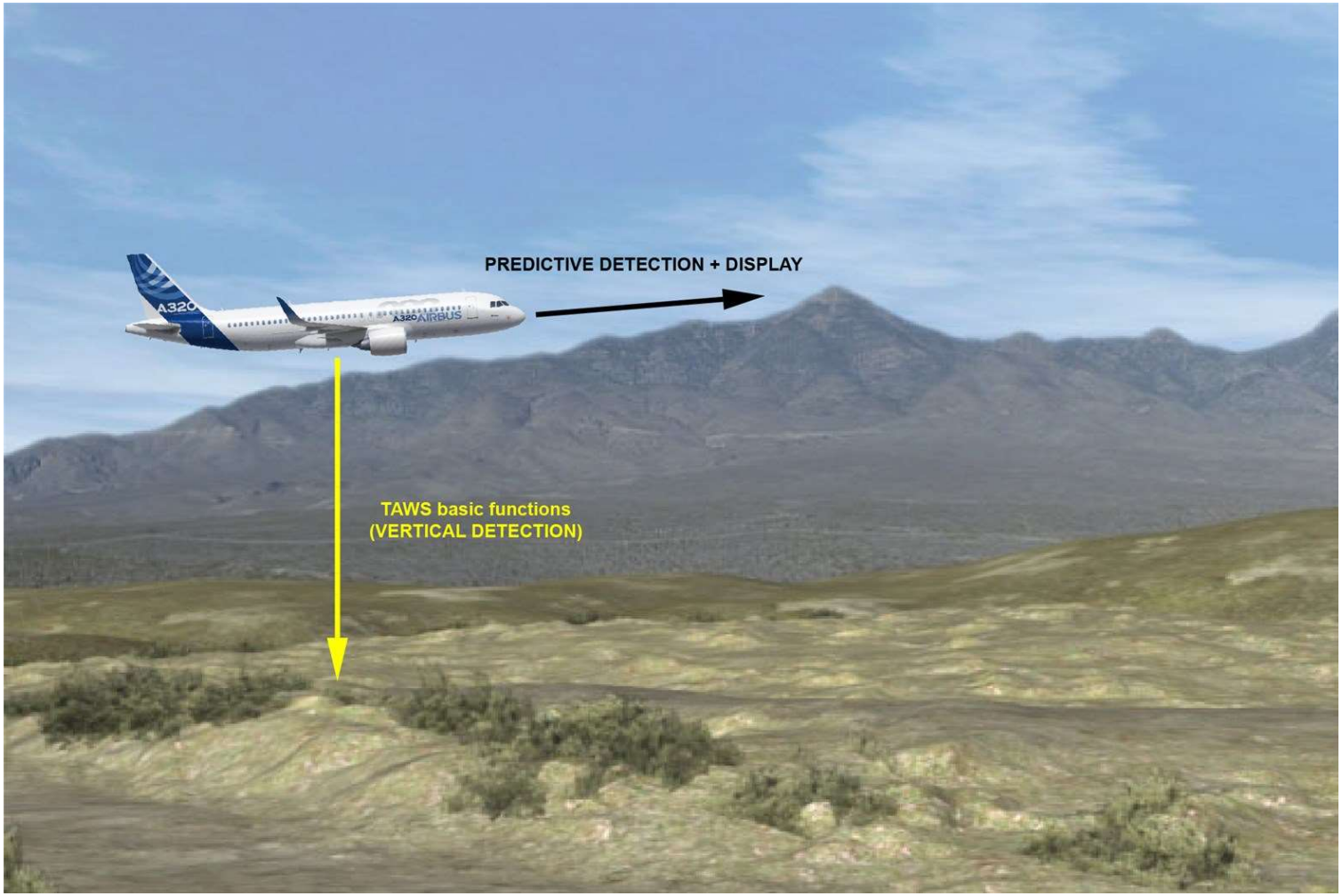
Alerting modes:

- Basic modes
- Predictive modes

The purpose of the T/TISS-Terrain Awareness and Warning System (TAWS) function is to prevent hazardous situation ahead of the A/C which would result to a Controlled Flight Into Terrain (CFIT). When the limits of an alerting envelope are exceeded, aural alert messages, visual annunciations and displays are generated.

The following alerting modes are integrated in the T/TISS-TAWS function:

- Basic TAWS modes: Modes 1 to 5 based on Radio Altitude (RA),
- Predictive modes: providing a forward-looking terrain alerting capability and a horizontal terrain/obstacle depiction relative to terrain/obstacle elevation.


PREDICTIVE DETECTION + DISPLAY
TAWS basic functions
(VERTICAL DETECTION)

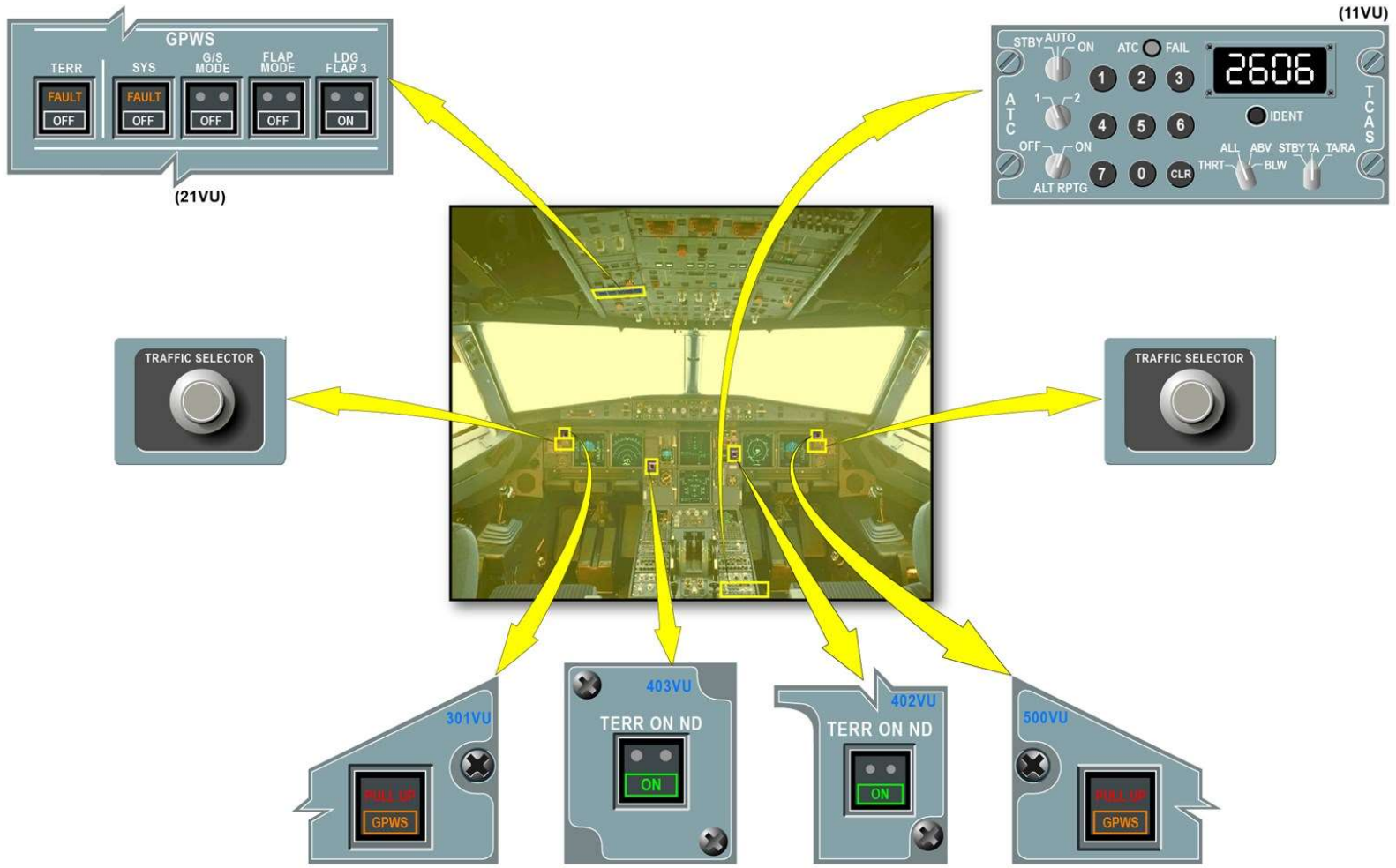
T/TISS-TAWS COMPONENTS

Components in cockpit:

ATC/TCAS control panel
GPWS control panel
2 GPWS/PULL UP warning lights
2 TERRAIN ON ND modes P/BSWs
2 TRAFFIC sel switches

The T/TISS-TAWS components are (in the cockpit):

- the ATC/TCAS control panel,
- the GPWS control panel (TAWS function),
- the 2 GPWS/PULL UP warning lights,
- the 2 TERRAIN ON ND mode P/BSWs,
- the 2 TRAFFIC Selector switches (ATSAW capability).



MAIN INSTRUMENT PANEL

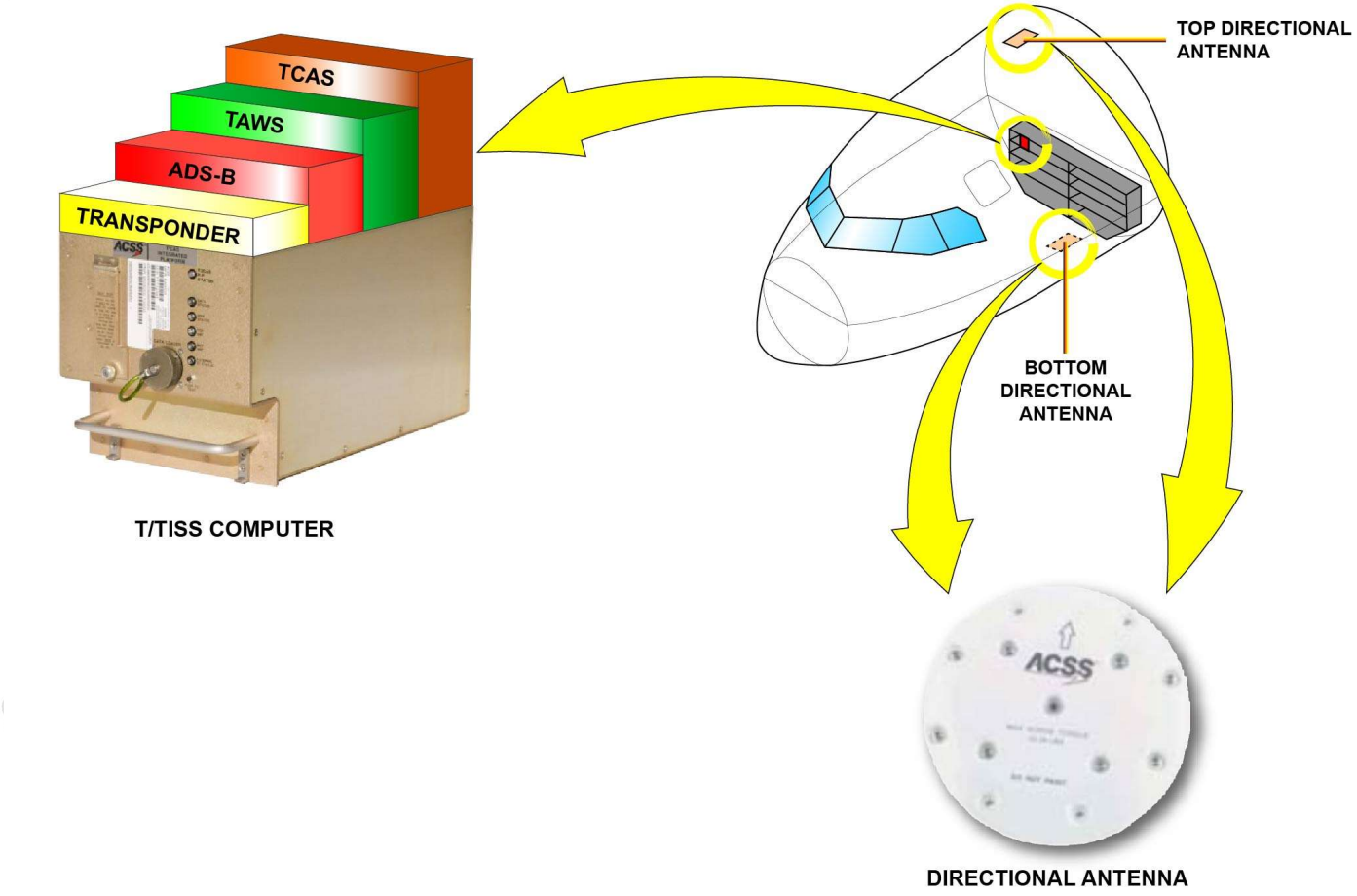
T/TISS-TCAS COMPONENTS

6 MCU T/TISS computer on 82VU

2 directional antennas (top / bottom)

The T/TISS-TCAS is fitted with:

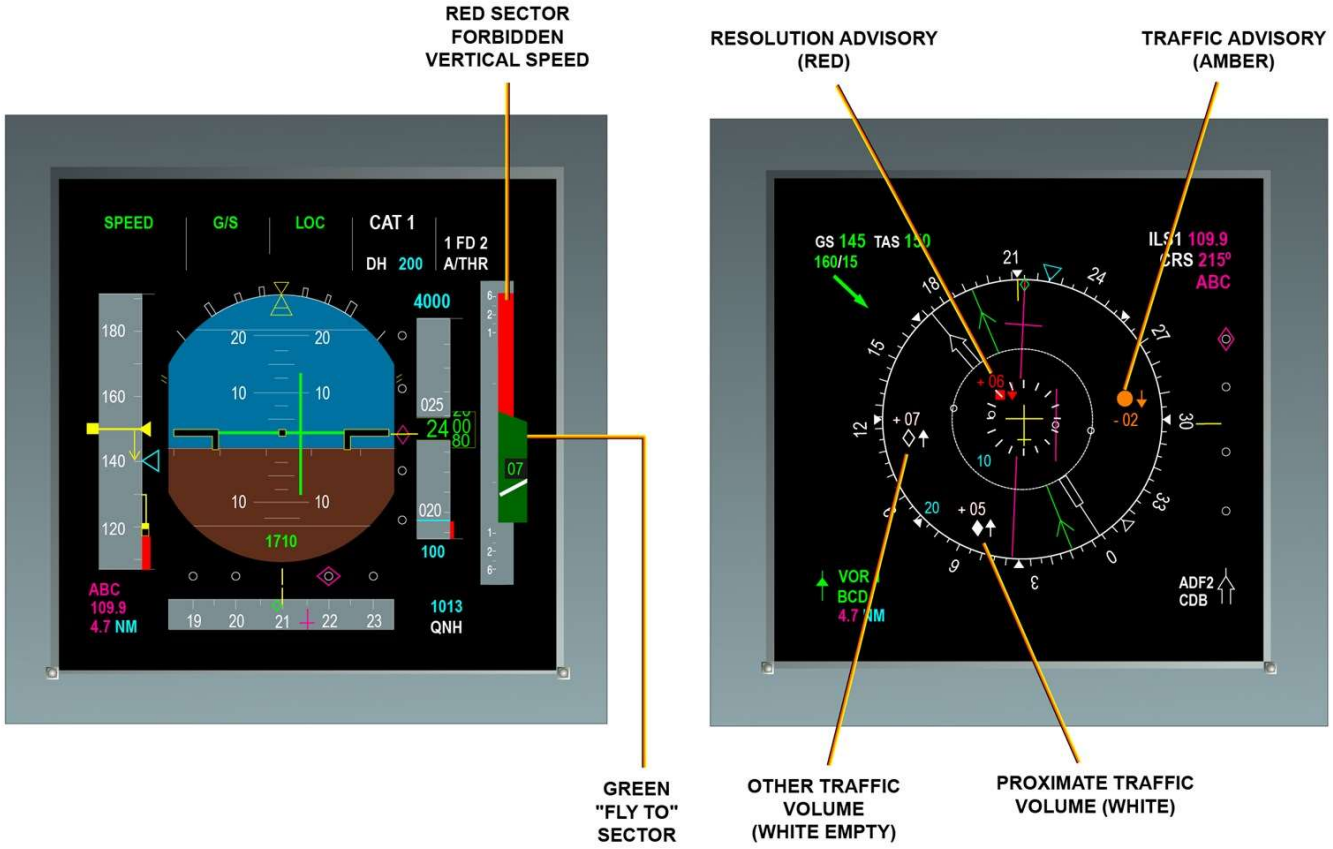
- a 6 MCU T/TISS computer located in the avionics compartment (82VU),
- 2 directional antennas (top and bottom).



T/TISS-TCAS INDICATING

TCAS info on NDs (ARC or ROSE)
RAs also on PFDs V/S scale (red / green sectors)
Aural alerts for TAs and RAs
The TCAS indications are displayed on the NDs in ARC or ROSE mode.
Resolution Advisory (RA) is also represented on the Vertical Speed (V/S) scale of the PFDs by 2 sectors:
- one green sector indicating the fly zone range to avoid the collision,
- one red sector indicating the forbidden fly zone.

Also aural alerts are broadcasted through the loudspeakers for TAs and RAs (e.g. TRAFFIC, TRAFFIC for TA; CLIMB, CLIMB for RA).



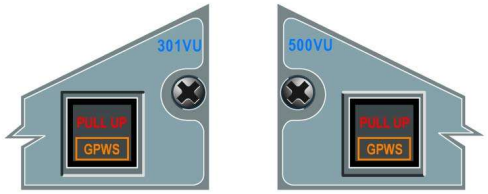
T/TISS-TAWS INDICATING

TAWS visual and aural alerts

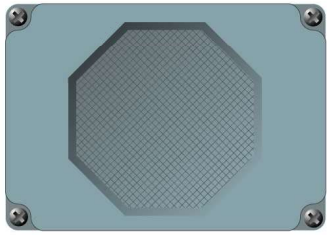
Automatic display of terrain on NDs following TERRAIN or OBSTACLE aural alerts

The basic TAWS generates aural and visual warnings (e.g. SINK RATE and PULL-UP aural alert + PULL-UP P/BSW flashing red).

When TERRAIN or OBSTACLE alerts are triggered a terrain image is automatically displayed on the NDs associated with an aural synthetic voice (e.g. TERRAIN, TERRAIN or OBSTACLE, OBSTACLE).

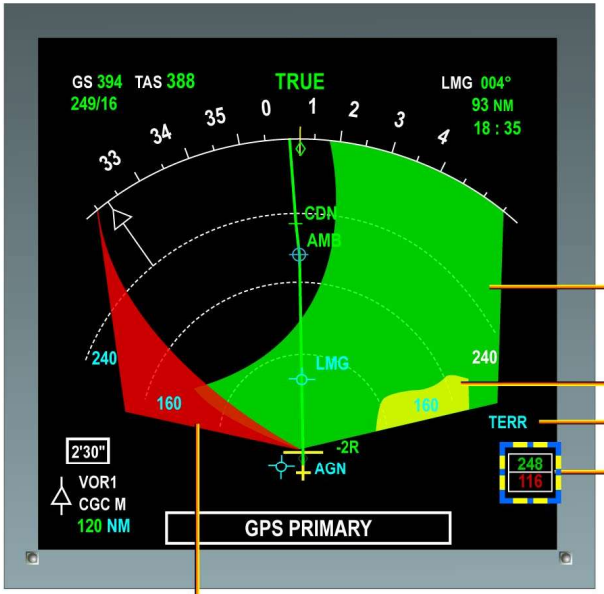


CAPTAIN & F/O
LIGHTING & LOUDSPEAKER
CONTROL PANEL



CAPT & F/O LOUDSPEAKER (2 & 6VU)

NAVIGATION DISPLAY (ND)



TERRAIN ALTITUDE SUFFICIENTLY BELOW THE A/C (GREEN)

CAUTION CRITERIA (YELLOW)

CYAN MESSAGE

HIGHEST AND LOWEST ELEVATIONS

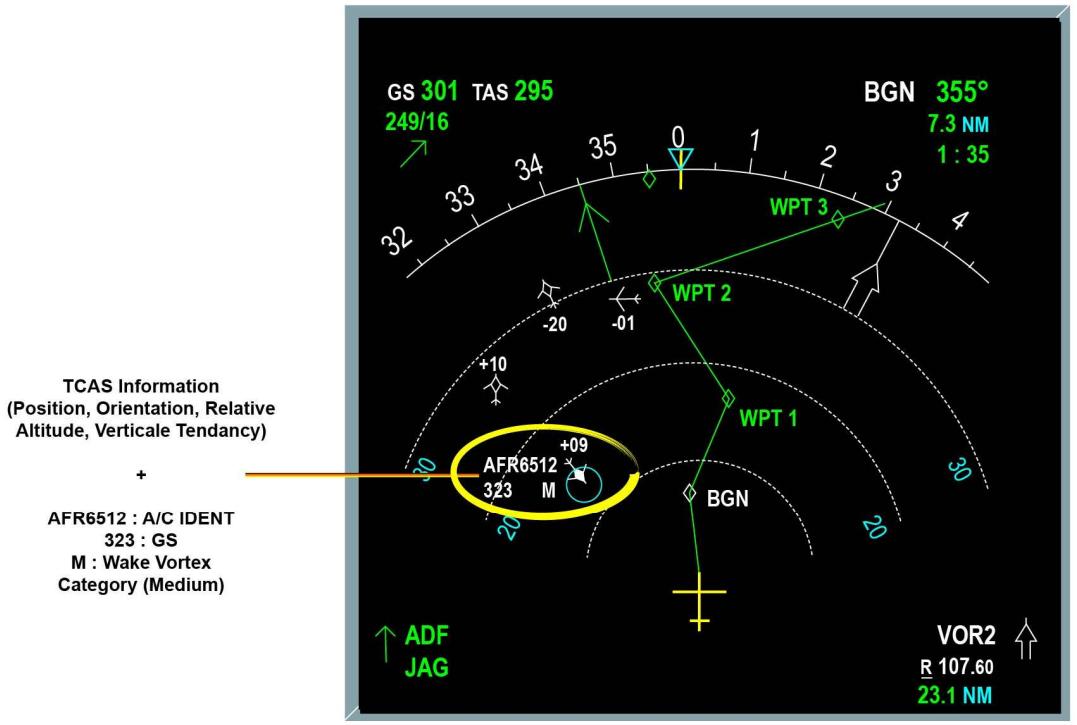
WARNING CRITERIA (RED)

OPTIONAL

T/TISS-ATC2 INDICATING

ATSAW/ADS-B can be implemented in transponder and correlated with TCAS

In order to improve efficiency in the air (flight and approach) and on airport surface, the ATSAW or ADS-B IN can be implemented in the transponder and correlated with TCAS.



T/TISS - TCAS Function Description and Operation

GENERAL

Components:

1 ATC/TCAS CTL PNL
1 T/TISS computer
2 directional antennas

T2CAS as option

The Traffic alert and Collision Avoidance System function (TCAS) includes:

- 1 control unit common with Air Traffic Control (ATC) system,
- 1 T/TISS computer,
- 2 directional antennas (1 top and 1 bottom).

ANTENNA

Provides azimuth information on A/C within surveillance range

Operational range:

1.030 MHz for transmission
1.090 MHz for reception

The TCAS directional antennas provide azimuth information on aircraft located within the TCAS surveillance range. The antennas are in composite and composed of 4 color coded connectors used to coaxially connect the 4 elements to the T/TISS computer (TCAS function). The antennas are used to receive and provide directional information for 1.090 MHz (MODE S replies) and enables omni or directional transmission of 1.030 MHz MODE S interrogations.

SUPPRESSOR

To inhibit the other systems

To prevent simultaneous transmission

The TCAS, ATC, and the Distance Measurement Equipment (DME) operate in the same frequency range. A suppressor signal is transmitted, via a coaxial, by the operating system to inhibit the other systems and to prevent simultaneous transmission.

CONTROL PANEL

Common to ATC system

Transmits information to TCAS computer via ATC XPDR & T/TISS - ATC 2

The operating modes of the TCAS are selected on a common ATC/TCAS control panel. The TCAS information is transmitted to the TCAS function computer via the ATC 1 transponder and the T/TISS - ATC 2.

T/TISS COMPUTER

2 main functions:

Intruder acquisition by transmission/reception
Operation control by processing

ATSAW or ADS-B IN function can also be implemented

The T/TISS-TCAS function ensures two main functions:

- a transmission/reception function for intruder acquisition,
- a processing function for operation control: Digital, discrete and analog types interfaces, intruder trajectory computation and tracking, visual and aural alert commands and avoidance manoeuver coordination.

An Airborne Traffic Situational AWareness (ATSAW) or ADS-B IN function can also be implemented for the flight crews knowledge enhancement of the surrounding traffic situation (in air and on airport surface).

ATC 1 AND T/TISS-ATC2 FUNCTION

Permits COM between TCAS transponder equipped and detected A/C

Coordination messages exchanged through COM link function

Transmits:

- Response to ATC GND station interrogations
- Data to TCAS

Data transmitted to TCAS

- BARO altitude
- TCAS mode from CTL PNL
- TCAS broadcast messages

The operative ATC mode S transponder or function transmits response to ATC ground station interrogations and data to the TCAS: Barometric altitude, TCAS mode from control panel, TCAS broadcast messages. The Mode S transponder permits communication between the TCAS and a TCAS equipped and detected aircraft through the communication link function for exchanging coordination messages.

RADIO ALTIMETER (RA)

Provides radio height

Used as reference to:

- Determine computation sensitivity level
- Trigger inhibit orders

Radio height used in 0 to 2.500 ft range

The RA transceivers provide radio height used as reference to determine the computation sensitivity level and trigger the inhibit orders. The radio height is used in the 0 to 2.500 ft range. RA 1 is used first, if not available RA 2 is used.

ADIRU

Provides TCAS function computer with:

- MAG HDG
- Pitch & roll ATT information

The Inertial Reference (IR) part of the Air Data/Inertial Reference Unit 1 (ADIRU 1) provides the magnetic heading and the pitch and roll attitude information to the TCAS function.

NOTE: The barometric altitude (ADIRU 1) is transmitted via the ATC transponder.

CFDIU

Enables TCAS function tests & trouble-shooting via MCDU

Tests available on GND only

The Centralized Fault Display Interface Unit (CFDIU) allows testing and trouble-shooting of the TCAS function through the MCDU. The tests are only available on ground.

LGCIU

Provides:

- FLT/GND signal for FLT leg counting
- LDG GR extended signal for TCAS operation

The Landing Gear Control and Interface Unit (LGCIU) provides a flight/ground signal used by the BITE module for flight leg counting. It provides also a landing gear extended signal for TCAS function operation.

INDICATING

Visual indications presented on NDs & PFDs
On NDs: Intruders location in traffic area
On PFDs Vertical Speed scale: avoidance maneuver indications
FWCs monitor information validity
Visual indications associated to announcements:
Generated by TCAS function
Broadcasted by loudspeakers
Visual indications are presented on the NDs and PFDs. The NDs present the location of intruders in the traffic area. The PFDs present the avoidance maneuver indications on the vertical speed scale. The Flight Warning Computers (FWCs) monitor the validity of the information. Synthesized voice announcements generated by the TCAS function and broadcast by the loudspeakers accompany the visual indications.
When ATSAW function is implemented (software), the TCAS is able to treat complementary information, coming from ATC transponder, and to provide a unique traffic symbol displayed on the NDs to the flight crew (merge of TCAS and ATSAW information on the same symbol).

INHIBITION

Various discrete signals are used for inhibition
Priorities:
Stall
Windshear
PWS
TAWS
TA mode selected & voice announcements cancelled
Various discrete signals are used for inhibition by equipment with higher priority than the TCAS function.
These priorities are:
- Stall,
- WindShear,
- Predictive WindShear (PWS),
- Terrain Awareness and Warning System (TAWS).

When TCAS is inhibited by a higher priority alert, the TA mode is selected and voice announcement is cancelled.

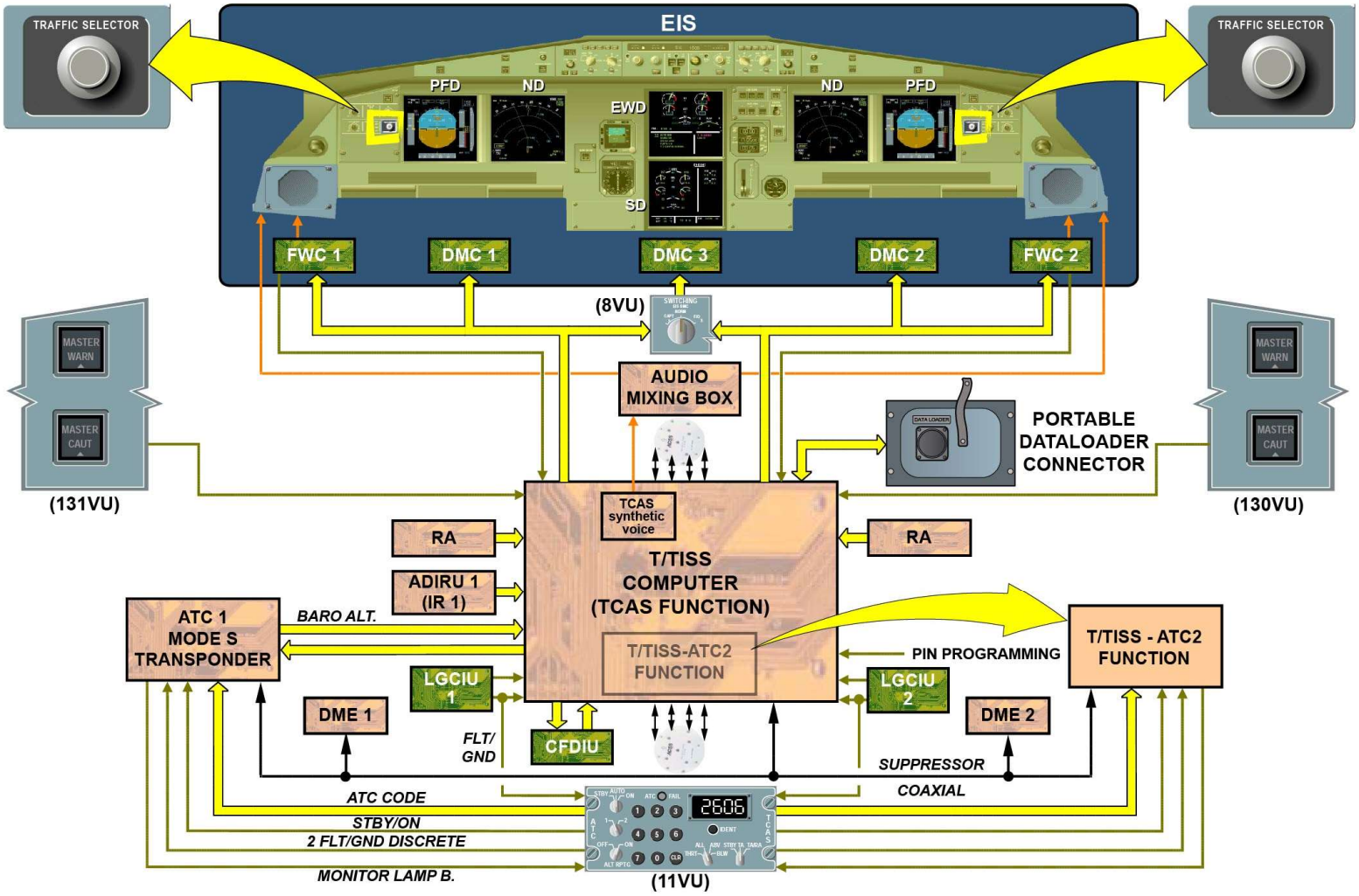
PIN PROGRAMMING

Defines TCAS function operating mode
Operating mode:
Audio level output
All traffic/threat traffic display
GND display mode
Number of intruders
A/C altitude limit
Some pin programs define the operating mode of the TCAS function.
Operating mode:
- audio level output,
- all traffic/threat traffic display,
- ground display mode (TA mode),
- number of intruders displayed,
- aircraft altitude limit (48.000 ft).

CENTRALIZED DATA LOADING CONNECTOR (CDLC-53 PIN CONNECTOR)

Allows software data loading into TCAS function
Remote loading capability linked
- By 2 ARINC 429 LS buses
- To a dedicated A/C connector

An A615A data loader connector allows updating of the T/TISS-TCAS function software (TCAS/ATSAW).
A Flight/Ground discrete signal (LGCIU1) is used to enable the data loading (GND condition).


TRAFFIC SELECTOR
EIS
PFD
ND
EWD
SD
ND
PFD
TRAFFIC SELECTOR
FWC 1
DMC 1
DMC 3
DMC 2
FWC 2
(8VU)
MASTER WARN
MASTER CAUT
(131VU)
AUDIO MIXING BOX
PORTABLE DATALOADER CONNECTOR
MASTER WARN
MASTER CAUT
(130VU)
TCAS synthetic voice
RA
RA
T/TISS COMPUTER (TCAS FUNCTION)
ADIRU 1 (IR 1)
ATC 1 MODE S TRANSPONDER
BARO ALT.
T/TISS-ATC2 FUNCTION
PIN PROGRAMMING
T/TISS - ATC2 FUNCTION
LGCIU 1
LGCIU 2
DME 1
DME 2
FLT/ GND
CFDIU
SUPPRESSOR
COAXIAL
ATC CODE
STBY/ON
2 FLT/GND DISCRETE
MONITOR LAMP B.
(11VU)


T/TISS-TAWS
Description and Operation
HYD
YELLOW
PTU
RAT
ELEC
AUTO EXTING
TEST
RESET
1 FADEC GND PWR 2
A/SKID &
N/W STRG
ON
OFF

GENERAL

TAWS function deliver appropriate cautions and warnings

T/TISS - TAWS function includes:

1 Terrain and Airport database

1 Obstacle database

1 Performance database

The Terrain Awareness and Warning System (TAWS) function is to deliver appropriate cautions and warnings whenever the aircraft is abnormally and hazardously approaching the surrounding terrain.

The Traffic and Terrain Integrated Surveillance System (T/TISS) - TAWS function includes:

- one Terrain and Airport database,
- one Obstacle database,
- one Performance database (A/C climb capability), for alert computation and terrain display.

TAWS CONTROLS

P/BSWs to control TAWS on GPWS panel:

TERR

SYS

G/S MODE

FLAP MODE

LDG FLAP 3

TERR ON ND

PULL UP/GPWS

On the overhead GPWS panel, various P/BSWs permit the crew to control the TAWS modes:

- TERR P/BSW: when depressed, the white OFF legend comes on, the predictive modes Collision Predictive and Alerting (CPA) and Terrain Hazard Display (THD) are inhibited (aural and visual),
- SYS P/BSW: when depressed, the white OFF legend comes on, all visual and aural ground proximity alerts (TAWS modes 1 to 5) are inhibited (no self test possible),
- G/S MODE P/BSW: when depressed, the white OFF legend comes on and inhibits the G/S mode (mode 5),
- FLAP MODE P/BSW: when depressed, the white OFF legend comes on and overrides flap abnormal condition inputs (mode 4) and generates the green "GPWS FLP OFF" memo on the Engine and Warning Display (EWD),
- LDG FLAP 3 P/BSW: when pressed, the white ON legend comes on when landing in flap 3 configuration is intended. The green "GPWS FLAP 3" memo message is displayed on the EWD.
- TERR ON ND P/BSW: on the center main instrument panel, when pressed in, the green ON legend comes on and indicates that the terrain/obstacle data are displayed on the Navigation Displays (NDs) according to the priority (WXR/PWS).
- PULL UP/GPWS P/BSWs: on the main instrument panel, when pushed, have 2 functions:
- to cancel the Glide Slope (G/S) alert or,
- to initiate the self test sequence.

AURAL AND VISUAL WARNINGS

Identify activated mode

EMER CANC key pressed on ECP:

Audio suppression signal sent to T/TISS - TAWS function

TAWS warnings momentarily cancelled

The audio output is used to broadcast aural warning messages, which identify the activated mode. When the EMERgency CANCel key on the ECAM Control Panel (ECP) is pressed, an audio suppression signal is sent to the T/TISS - TAWS function in order to momentarily cancel the TAWS warnings.

T/TISS - TAWS function sends 5 discretes for WARN legends light:

1 for PULL UP legends

1 for GPWS legends

2 for amber FAULT legends on SYS & TERR P/BSWs + EWD messages

1 for terrain mode availability

If FMS low accuracy: Green TERR STBY shown on EWD

In hazardous flight configurations or system failures, the T/TISS - TAWS function sends discretes for the lighting of warning legends:

- one for PULL UP legends, comes on red when Mode 1 is penetrated or when Mode 2, or any CPA or THD alert is activated,
- one for GPWS legends, comes on amber when any other mode is activated.
- two monitor outputs for the amber FAULT legends on the SYS and TERR P/BSWs of the GPWS control panel. These discretes are also sent to the System Data Acquisition Concentrators (SDACs) to generate the amber "GPWS FAULT" and "GPWS TERR DET FAULT" warning messages,
- one monitor output for the availability of the terrain mode. In case of Flight Management System (FMS) low accuracy a green TERR STBY is sent through the SDACs to the right memo area of the EWD.

Inhibits all T/TISS - TAWS function WARNs if stall or windshear alert activated

Receives 2 T/TISS - TAWS function discretes to:

Inhibit auto call out & low speed warnings

Change TCAS mode from RA to TA in case of PULL UP or GPWS alerts

Discretes also used by DFDR

The Flight Warning Computers (FWCs) send a discrete to the T/TISS - TAWS function to inhibit all warnings when a stall or windshear warning is triggered. The T/TISS - TAWS function sends two discretes to the FWCs and the T/TISS - TCAS function in order to inhibit auto call out and low speed warnings and change TCAS mode from Resolution Advisory (RA) to Traffic Advisory (TA) when the PULL UP or GPWS warnings are in progress. These discretes are also used by the Digital Flight Data Recorder (DFDR).

DIGITAL INPUTS AND OUTPUTS

ARINC 429 from NAV sensors

Allow T/TISS - TAWS function to:

Monitor A/C position

Provide audio & visual warnings in hazardous situation

The T/TISS - TAWS function receives ARINC 429 data inputs from the navigation sensors in order to monitor the aircraft position with respect to the terrain and provide audio and visual warnings when in hazardous situation.

ARINC 429 XMTR provides MAINT data used by:

CFDIU

DMU or FDIMU (DMU-part)

An ARINC 429 transmitter provides a maintenance output data bus. This output bus is used by the Centralized Fault Display Interface Unit (CFDIU) for maintenance purposes and by the Aircraft Integrated Data System (AIDS) for the

Data Management Unit (DMU), part of the Flight Data Interface and Management Unit (FDIMU).

Terrain data via ARINC 453 data bus format to DMCs

Terrain data shown on NDs:

Automatically if terrain CAUT or WARN detected

Any time via TERR ON ND P/BSWs

PWS alerts received for priority determination

PWS priority over TAWS modes

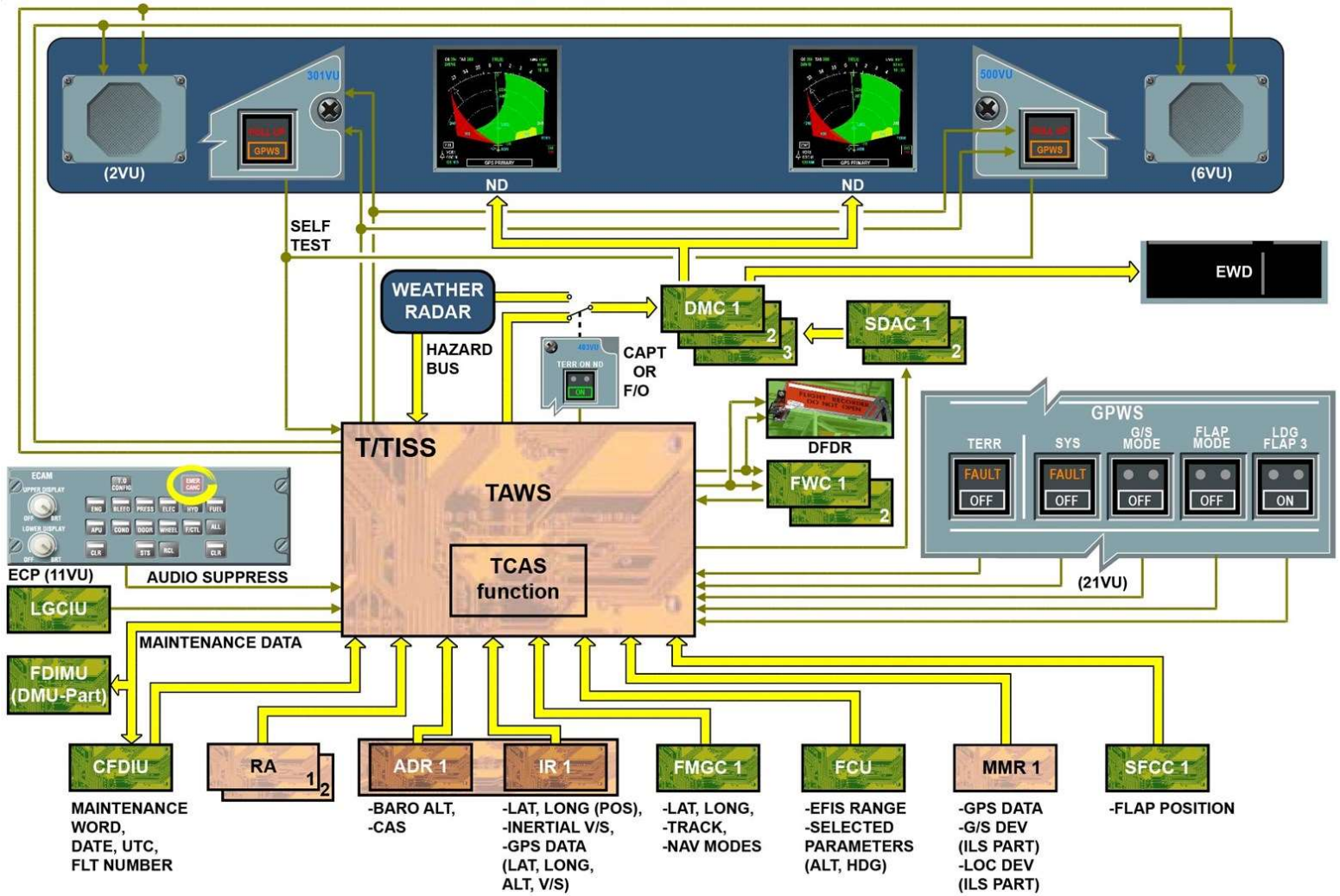
T/TISS - TAWs function uses preferably GPS position, then IR position, then FMS position.

The T/TISS - TAWS function outputs a display of terrain data in ARINC 453 data bus format to the Display Management Computers (DMCs). The terrain data is displayed on the NDs automatically instead of the radar image when a terrain caution or warning is detected or any time by using the TERR ON ND P/BSWs. The T/TISS - TAWS function receives the Predictive WindShear (PWS) alerts from the weather radar hazard bus to determine the priority. The PWS has priority over TAWS modes. The T/TISS - TAWS function uses preferably GPS position, then IRS latitude and longitude data as valid position source and, if these positions are downgraded, then FMS position will be used.

LGCIU

Sends FLT/GND discrete to EGPWC BITE for FLT legs counting

The Landing Gear Control and Interface Unit (LGCIU) sends a flight/ground discrete signal to the T/TISS - TAWS function BITE to count the flight legs.


(2VU)
301VU
ND
ND
500VU
(6VU)
SELF TEST
WEATHER RADAR
HAZARD BUS
CAPT OR F/O
DMC 1
SDAC 1
EWD
DFDR
FWC 1
T/TISS
TAWS
TCAS function
GPWS
TERR
SYS
G/S MODE
FLAP MODE
LDG FLAP 3
FAULT
OFF
ON
(21VU)
ECP (11VU)
AUDIO SUPPRESS
LGCIU
MAINTENANCE DATA
FDIMU (DMU-Part)
CFDIU
MAINTENANCE WORD, DATE, UTC, FLT NUMBER
RA
ADR 1
-BARO ALT, -CAS
IR 1
-LAT, LONG (POS), -INERTIAL V/S, -GPS DATA (LAT, LONG, ALT, V/S)
FMGC 1
-LAT, LONG, -TRACK, -NAV MODES
FCU
-EFIS RANGE -SELECTED PARAMETERS (ALT, HDG)
MMR 1
-GPS DATA -G/S DEV (ILS PART) -LOC DEV (ILS PART)
SFCC 1
-FLAP POSITION

TAWS BASIC MODES

A/C behavior compared with predetermined envelope

The T/TISS - TAWS function computes and compares the aircraft behavior with a predetermined envelope.

WARN envelope penetrated: visual & aural WARNs generated

Aural MSGs broadcast through CKPT loudspeakers

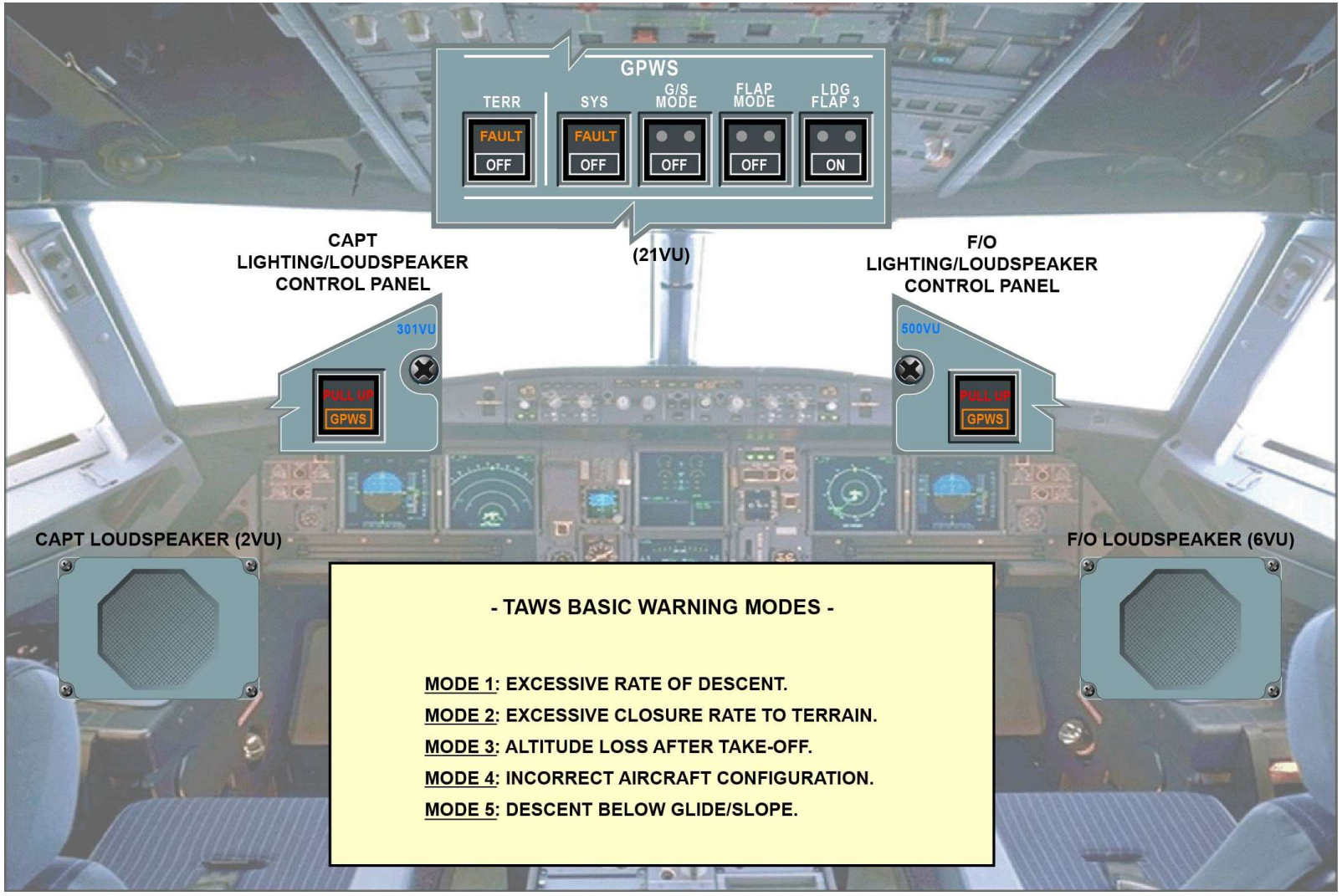
Visual WARNs indicated by: PULL UP GPWS P/BSWs lights

Terrain displayed on NDs

5 basic reactive modes based on RA

When the warning envelope is penetrated, visual and aural warnings are generated. The aural messages are broadcast through the cockpit loudspeakers and visual warnings are indicated by the PULL UP/GPWS P/BSWs lights. A terrain image is displayed on the NDs.

There are 5 basic TAWS reactive modes based on Radio Altitude (RA).


GPWS
TERR
SYS
G/S MODE
FLAP MODE
LDG FLAP 3
FAULT
OFF
FAULT
OFF
OFF
OFF
ON
(21VU)
CAPT LIGHTING/LOUDSPEAKER CONTROL PANEL
F/O LIGHTING/LOUDSPEAKER CONTROL PANEL
301VU
500VU
PULL UP
GPWS
PULL UP
GPWS
CAPT LOUDSPEAKER (2VU)
F/O LOUDSPEAKER (6VU)
- TAWS BASIC WARNING MODES -
MODE 1: EXCESSIVE RATE OF DESCENT.
MODE 2: EXCESSIVE CLOSURE RATE TO TERRAIN.
MODE 3: ALTITUDE LOSS AFTER TAKE-OFF.
MODE 4: INCORRECT AIRCRAFT CONFIGURATION.
MODE 5: DESCENT BELOW GLIDE/SLOPE.

MODE 1: EXCESSIVE RATE OF DESCENT

2 boundaries:

Penetration of 1st boundary = SKIN RATE aural alert + both GPWS lights ON

Penetration of 2nd boundary = PULL UP aural alert + both PULL UP lights ON

Mode 1 provides a warning for high descent rates into terrain and for rapidly increasing sink rates near the runway when landing. Mode 1 has two boundaries. Penetration of the first boundary generates a repeated "SKIN RATE" aural alert and causes both GPWS lights to come on. Penetration of the second boundary generates a repetitive "PULL UP" aural alert and causes both PULL UP lights to come on.

Mode 1 provides a warning when the current flight path is detected with an excessive rate of descent.

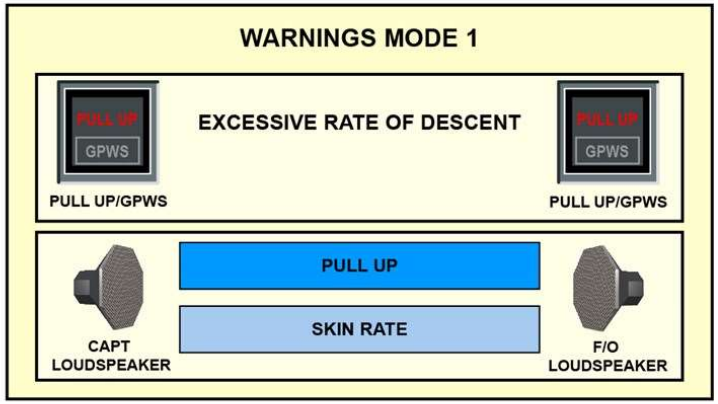
MODE 2: EXCESSIVE CLOSURE RATE TO TERRAIN

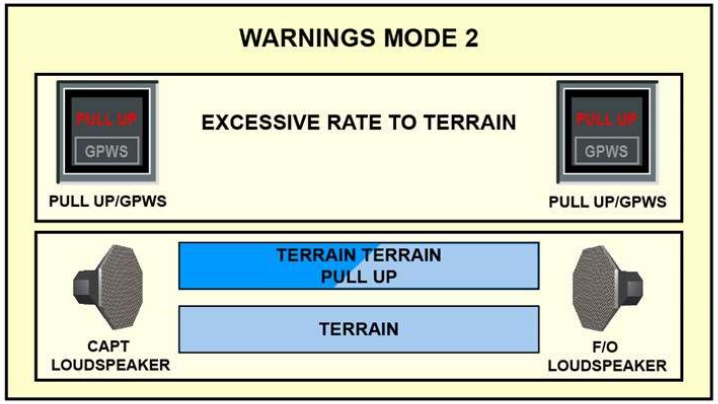
Discrepancy between Terrain database elevation & apparent Terrain elevation

Mode 2 provides a warning when there is a significant discrepancy between Terrain database elevation and apparent Terrain elevation (RA data) according to the flaps position (landing configuration or not).

MODE 1:
EXCESSIVE RATE OF DESCENT

MODE 2:
EXCESSIVE RATE TO TERRAIN





MODE 3: ALTITUDE LOSS AFTER TAKEOFF

Warning when significant loss of altitude

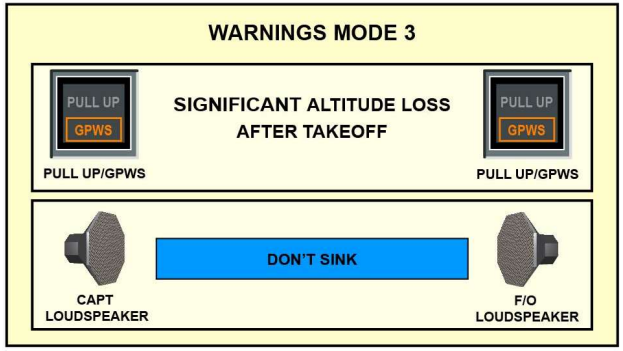
Mode 3 provides a warning for significant altitude loss after takeoff, climb or during go-around.

MODE 4: INCORRECT AIRCRAFT CONFIGURATION

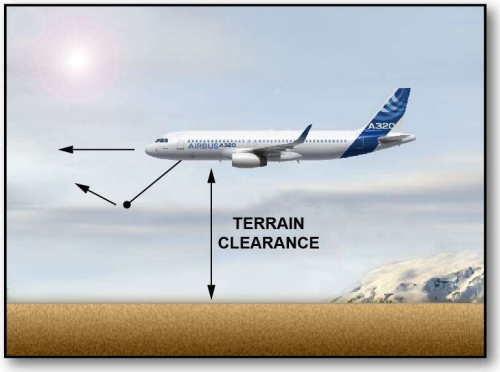
Alert if insufficient terrain clearance

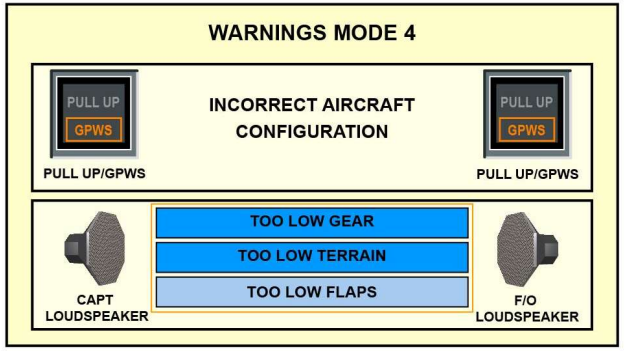
Mode 4 results in the annunciation of an alert in the event of insufficient terrain clearance when the aircraft is not in the correct landing configuration (landing gear/landing flap configuration).

MODE 3:
SIGNIFICANT ALTITUDE LOSS AFTER TAKEOFF



MODE 4:
INCORRECT AIRCRAFT CONFIGURATION



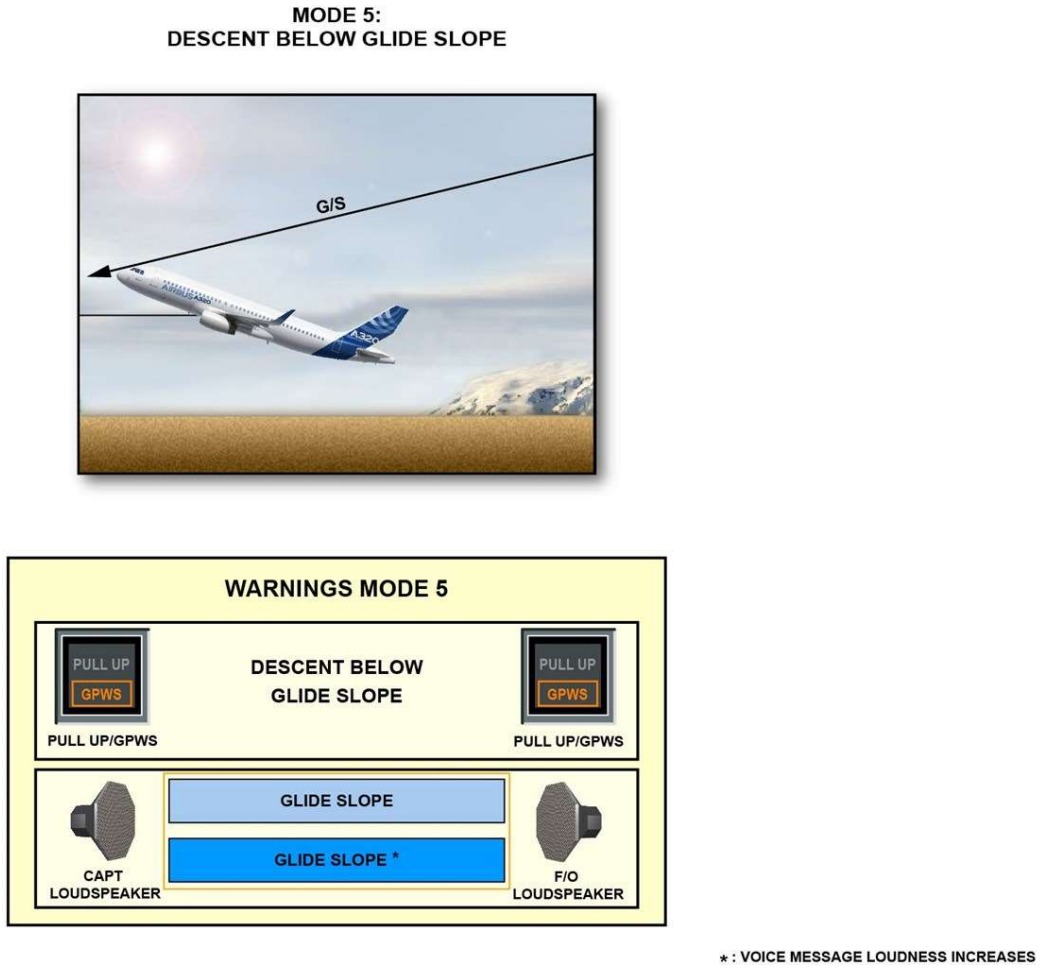


TOO LOW GEAR HAS PRIORITY OVER TOO LOW FLAPS

MODE 5: DESCENT BELOW GLIDE SLOPE

Warnings when A/C flight path descends below G/S beam during ILS approaches

Mode 5 provides warnings when the aircraft flight path descends below the G/S beam during ILS approaches. The loudness of the "GLIDE SLOPE" voice message and the repetition rate are increased when closing to the ground.



TAWS PREDICTIVE MODES

2 predictive modes = CPA & THD:

FWD-looking terrain avoidance function

Premature descent function

The two predictive modes, Collision Prediction and Alerting (CPA) and Terrain Hazard Display (THD), provide a forward-looking terrain avoidance and premature descent alert functions.

COLLISION PREDICTION AND ALERTING (CPA)

Provides alerts when Flight path is hazardous

Depicted image automatically displayed on NDs

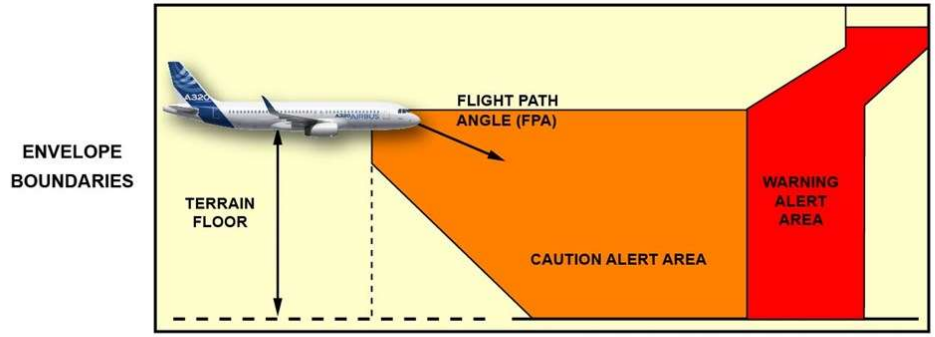
Aural & visual warnings

The CPA function provides to the crew, with respect to the aircraft position and terrain database, alerts that the flight path followed is hazardous due to the presence of terrain or obstacle ahead (this function complements the existing Mode 4). When an alert is triggered, a depicted image of the terrain is automatically displayed on both NDs and aural and visual warnings are generated according to the regulation (Federal Aviation Administration (FAA) or European Aviation Safety Agency (EASA)).

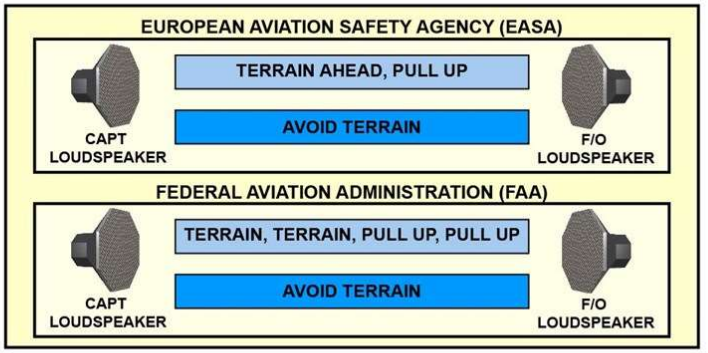
TERRAIN HAZARD DISPLAY (THD)

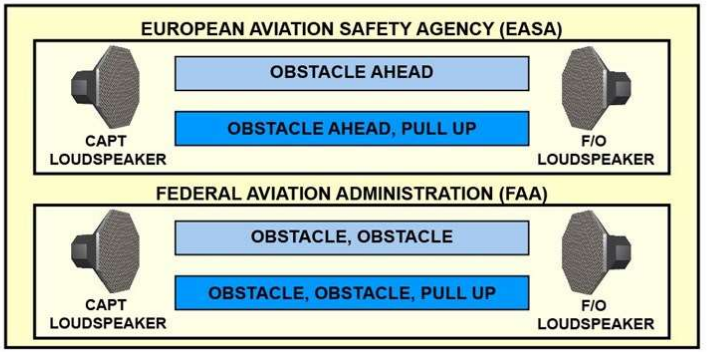
A/C situation with regard to terrain and obstacle:

The THD function provides a representation of the aircraft situation with regard to terrain and obstacle in order to enhance the situational awareness.


ENVELOPE
BOUNDARIES
FLIGHT PATH
ANGLE (FPA)
TERRAIN
FLOOR
WARNING
ALERT
AREA
CAUTION ALERT AREA


PULL UP
GPWS
TERRAIN WARNING ALERT
TERRAIN CAUTION ALERT
PULL UP
GPWS
PULL UP/GPWS
PULL UP/GPWS
EUROPEAN AVIATION SAFETY AGENCY (EASA)
TERRAIN AHEAD
TERRAIN AHEAD, PULL UP
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER
FEDERAL AVIATION ADMINISTRATION (FAA)
TERRAIN, TERRAIN
TERRAIN, TERRAIN, PULL UP, PULL UP
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER

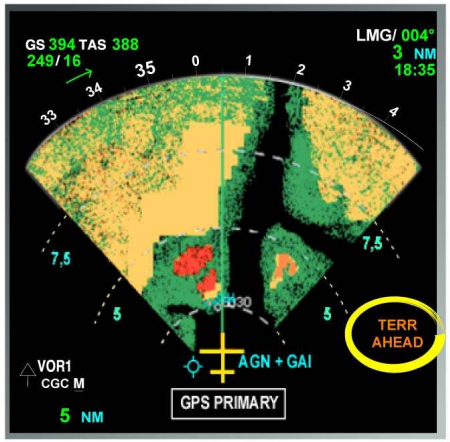

EUROPEAN AVIATION SAFETY AGENCY (EASA)
TERRAIN AHEAD, PULL UP
AVOID TERRAIN
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER
FEDERAL AVIATION ADMINISTRATION (FAA)
TERRAIN, TERRAIN, PULL UP, PULL UP
AVOID TERRAIN
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER


EUROPEAN AVIATION SAFETY AGENCY (EASA)
OBSTACLE AHEAD
OBSTACLE AHEAD, PULL UP
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER
FEDERAL AVIATION ADMINISTRATION (FAA)
OBSTACLE, OBSTACLE
OBSTACLE, OBSTACLE, PULL UP
CAPT
LOUDSPEAKER
F/O
LOUDSPEAKER

TAWS INDICATING

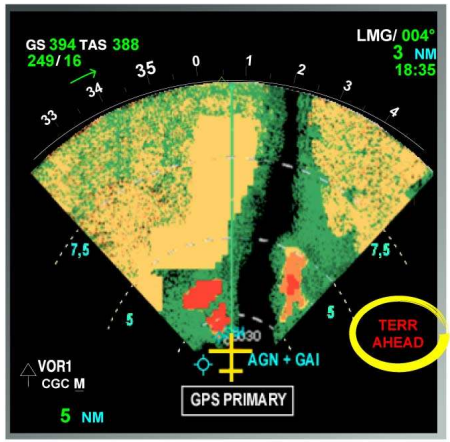
Predictive caution or warning displayed on NDs in place of TILT indication

When a predictive caution or warning alert is triggered, it is also displayed on the bottom right corner of the NDs in place of the TILT indication associated to the terrain depicted color (yellow or red).



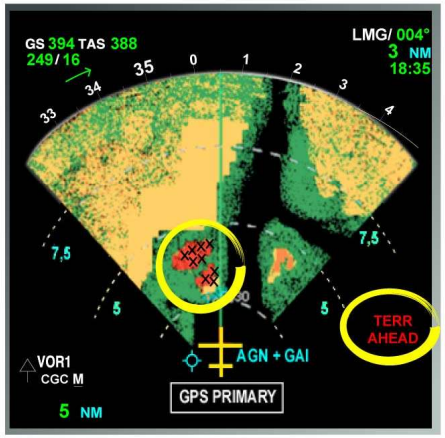
"TERRAIN AHEAD"

CAUTION



"TERRAIN AHEAD, PULL UP"

WARNING



"AVOID TERRAIN"
(PRECEEDED AT LEAST BY "TERRAIN AHEAD, PULL UP")

WARNING

ATC 2 Function Description and Operation

GENERAL

ATC system:

1 ATC/TCAS CTL PNL
1 T/TISS computer
2 directional antennas

The T/TISS - Air Traffic Control (ATC 2) function includes:
- 1 ATC/Traffic Alert and Collision Avoidance System (TCAS) control panel (common to both systems),
- 1 T/TISS computer,
- 2 directional antennas (one top, one bottom).

CONTROL PANEL

Enables system selection
Provides T/TISS - ATC 2 function with code & function data
Receives status data
Converts mode & code data into digital data
Digital data transmitted to XPDR
SDACs connection to monitor XPDR and generate alerts by FWS
LGCIUs provide GND/flight signal:

To ATC XPDR via ATC/TCAS CTL PNL for BITE purposes

A single ATC/TCAS control panel enables system selection. It provides the T/TISS - ATC 2 function with code and function data and, in return, receives status data. The ATC/TCAS control panel converts selected mode and selected code data into digital data and transmits this data in ARINC 429 format to the transponder.

In order to monitor the ATC transponder and generate alerts by the Flight Warning System (FWS), the ATC/TCAS control panel is connected to the System Data Acquisition Concentrators (SDACs) by a discrete connection. The Landing Gear Control and Interface Units (LGCIUs) provide a ground/flight discrete signal to the ATC 2 function via the ATC/TCAS control panel for BITE purposes.
The ATC/TCAS control panel provides a Qualifier (QA2) signal valid when AUTO or ON is selected to the WXR for activation of the PWS function.

T/TISS COMPUTER

Time between interrogation pulses determines operating mode
Mode S function = Surveillance + collision avoidance
Unique address coded in 24 bits to prevent multiple replies
In normal operation, the T/TISS - ATC 2 function operating mode (A, C or S) is determined by the decoding of the time between the interrogation pulses. The main function of the mode S is surveillance. The T/TISS - ATC 2 function has its own and unique address coded on 24 bits so that every interrogation can be directed to a specific aircraft preventing multiple replies. The mode S is also used in collision avoidance (TCAS function).

ANTENNAE
Replies to ATC GND station interrogations
One Top antenna, one bottom antenna
Operation:
Interrogation at 1.030 MHz
Reply at 1.090 MHz
The T/TISS - ATC 2 function antennae (one Top and one Bottom) transmit replies to interrogations from the ATC ground station. The antenna operates with an interrogation frequency of 1.030 MHz and a reply frequency of 1.090 MHz.

SUPPRESSOR
ATC 1, DME & TCAS: Same frequency range
Signal transmitted by operating system via coaxial:
To inhibit other systems
To prevent simultaneous transmission
The ATC 1, the DME and the T/TISS - TCAS and ATC 2 function operate in the same frequency range. A suppressor signal is transmitted, via a coaxial, by the operating system to inhibit the other systems and to prevent simultaneous transmission.

ADIRU
Provide BARO ALT for mode C
Failure: AIR DATA selector switched to ADIRU 3
The ADR, part of the ADIRU 2 provide barometric altitude to the T/TISS - ATC 2 function for mode C. In case of failure of ADIRU 2, the pilot can switch to ADIRU 3 through the AIR DATA selector switch.
The IR part of the ADIRU 2 provides GS, Pitch and Roll, true HDG and A/C position (for Enhanced Surveillance).

FMGC
Provides FLT N & A/C position to ATC GND station
Transmitted after mode S interrogation
The Flight Management and Guidance Computers (FMGCs) provide the flight number and the A/C position (LAT/LONG). This data will be transmitted to an ATC ground station after a mode S interrogation.

CFDIU
Through MCDUs, allows T/TISS - ATC 2 function:
Tests
Trouble shooting
Tests: Only on GND
The Centralized Fault Display Interface Unit (CFDIU) allows testing and trouble-shooting of the T/TISS - ATC 2 function system through the MCDUs (ATC 2 menu). The tests are only available on ground.

T/TISS - TCAS FUNCTION
Individual COMs:
With Transponder equipped A/C via Mode S XPDR
Avoidance maneuvers coordination by acquisition of:
Relative ALT
Separation range
The T/TISS - TCAS function allows individual communications with each TCAS equipped aircraft through the Mode S transponder. This enables a coordination of avoidance maneuvers by acquisition, at regular intervals, of the relative altitude and the separation range.

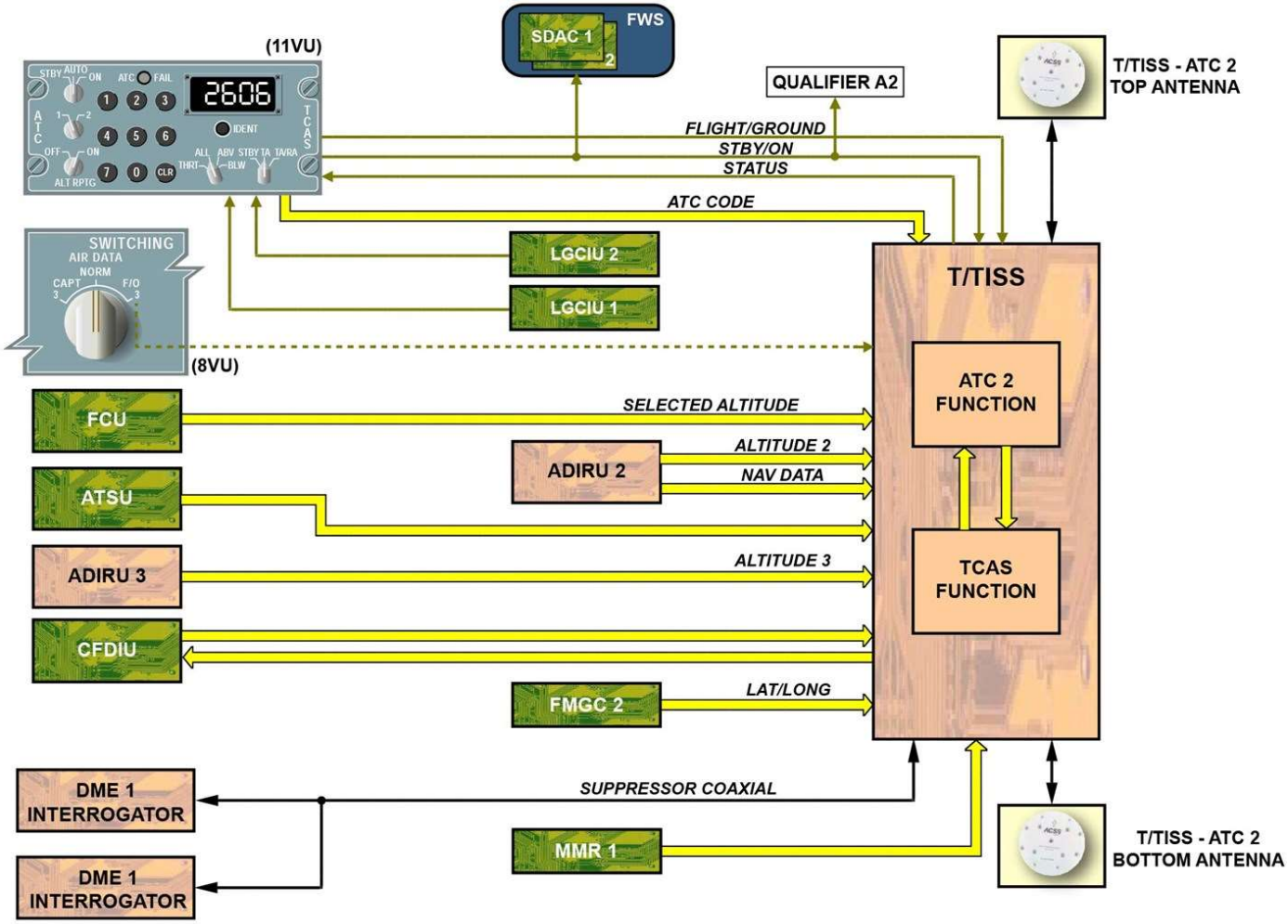
ENHANCED FUNCTIONS

Elementary Surveillance
Enhanced Surveillance
Extended Squitter
Avionics systems connected: ATSU, FCU, MMR1
A/C position sources:
1st: MMR1
2nd: FMGC 2
3rd: ADIRU 2 (IR part)

The T/TISS provides Mode S transponder functions including:
- Elementary Surveillance (ELS) (Flt nbr, ALT, Ground reporting, ...),
- Enhanced Surveillance (EHS) (GS, Baro setting, TAS MAG HDG...),
- Extended Squitter (ES) also called Automatic Dependant Surveillance-Broadcast (ADS-B) OUT (LAT/LONG, HDG SEL, ALT SEL, GPS ALT, Velocity...).

The following avionics systems are connected to the T/TISS - ATC 2 function to fulfill these functions:
- ATSU,
- FCU (ALT SEL, Baro Ref),
- MMR1 (ALT SEL, A/C position, GS...).

The MMR1 is the first source of position for the T/TISS - ATC 2 function, FMGC 2 the second and ADIRU 2 (IR part) the third source.


(11VU)
SDAC 1
FWS
QUALIFIER A2
T/TISS - ATC 2
TOP ANTENNA
FLIGHT/GROUND
STBY/ON
STATUS
ATC CODE
SWITCHING
AIR DATA
NORM
CAPT
F/O
(8VU)
LGCIU 2
LGCIU 1
T/TISS
ATC 2
FUNCTION
TCAS
FUNCTION
FCU
SELECTED ALTITUDE
ADIRU 2
ALTITUDE 2
NAV DATA
ATSU
ADIRU 3
ALTITUDE 3
CFDIU
FMGC 2
LAT/LONG
DME 1
INTERROGATOR
DME 1
INTERROGATOR
SUPPRESSOR COAXIAL
MMR 1
T/TISS - ATC 2
BOTTOM ANTENNA

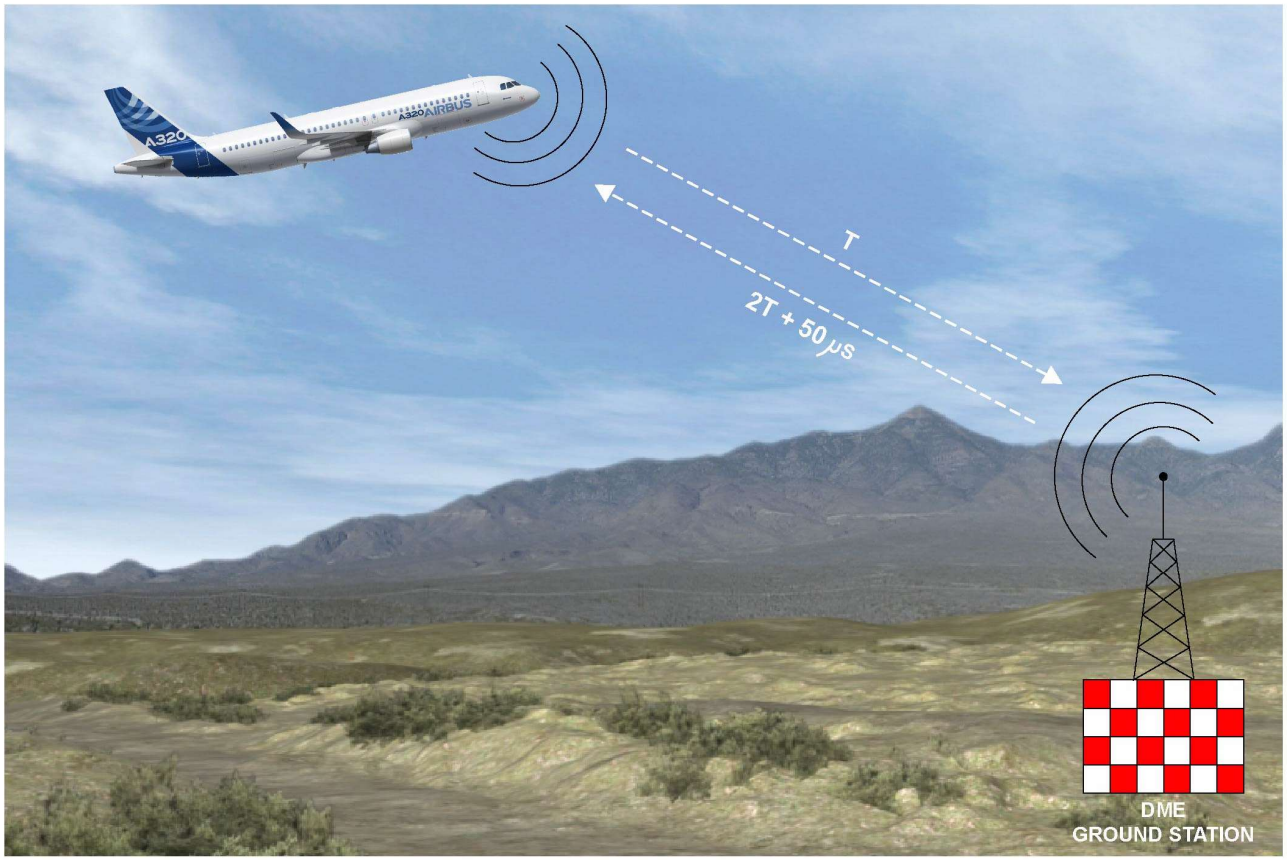

DME System
Presentation
VOR
DME INTERROGATOR

DME:

Slant distance between A/C & GND station
Digital readout

Onboard interrogator:

Generates interrogation pulses to GND station
Receives GND station replies
Determines distance in NM
Detects Morse audio signal for GND station ident



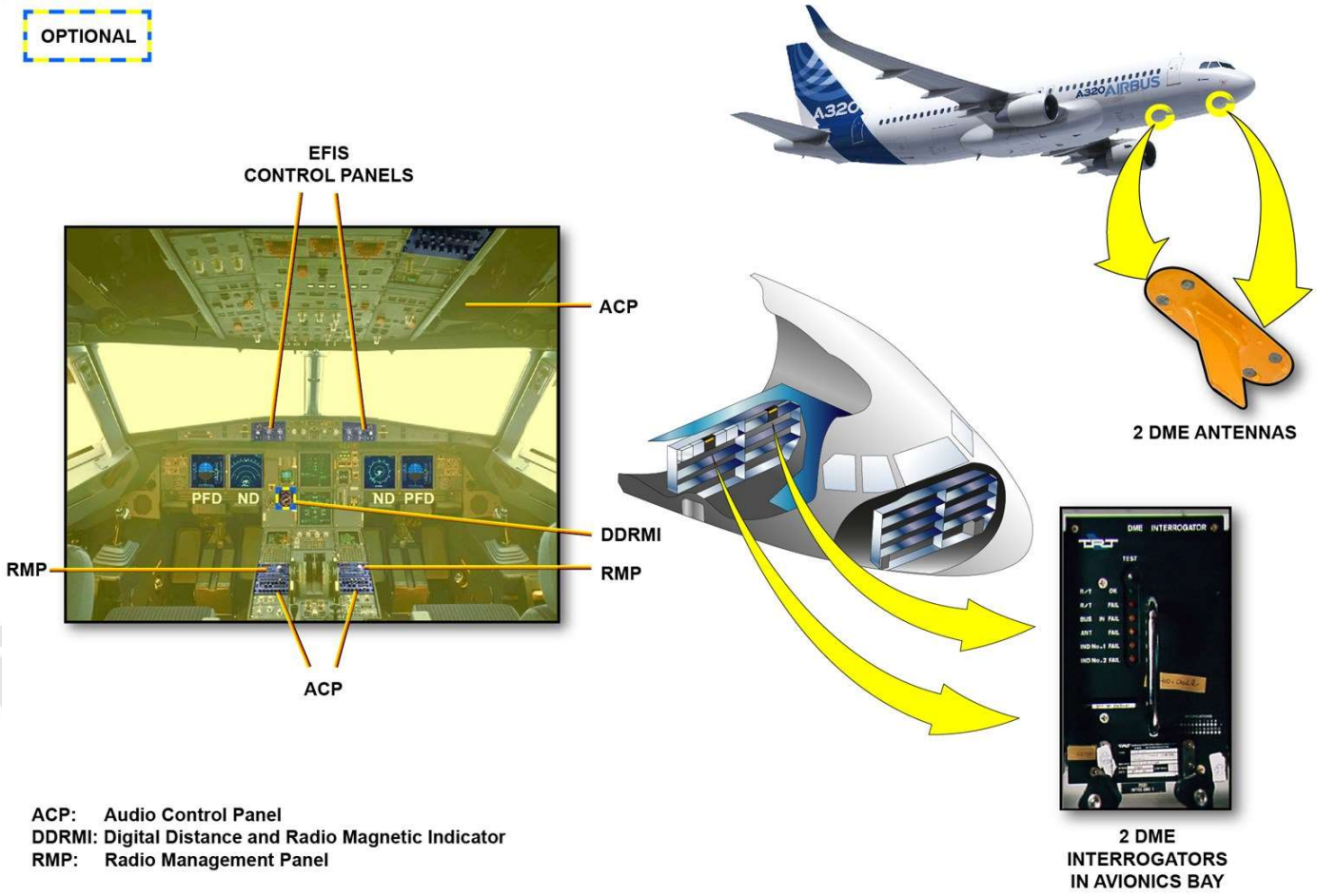
COMPONENT LOCATION

2 antennas on the lower fuselage + 2 interrogators in the avionics bay

DME system connected to:

- PFDs, NDs & DDRMI for display
- EFIS CP for display control
- FMGC for tuning
- CAPT & F/O RMP for back-up tuning
- ACPs for DME audio signal

OPTIONAL



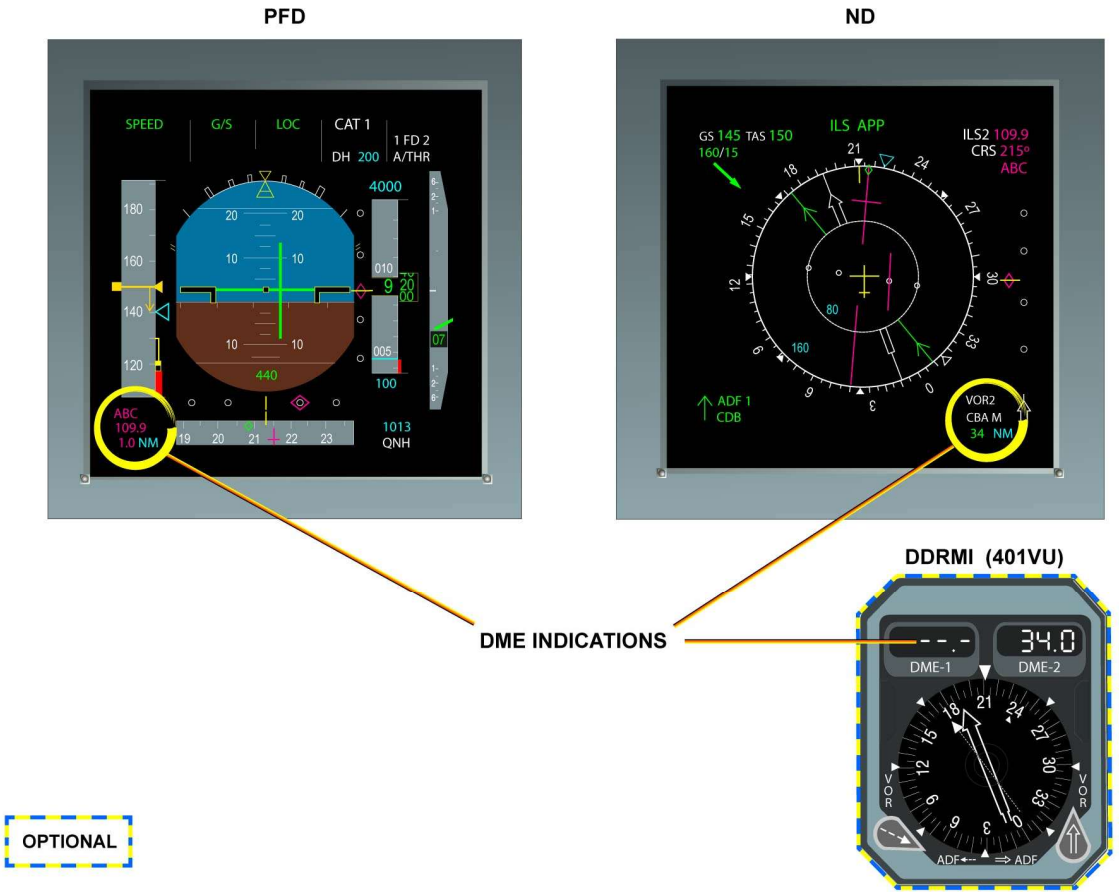
ACP: Audio Control Panel
DDRMI: Digital Distance and Radio Magnetic Indicator
RMP: Radio Management Panel

INDICATING

On:

PFD if ILS display selected
ND if ADF/VOR switched to VOR
OPTIONAL DDRMI windows

The DME distance is shown on the PFD if the ILS display is selected via LS P/B and on the ND if the ADF/VOR selector is set to VOR. The DME distance is also shown on the two windows of the optional DDRMI.




DME
Description and Operation
HYD
GREEN
BLUE
YELLOW
PTU
RAT
ELEC
1
2
AUTO EXTING
TEST
RESET
1 FADEC GND PWR 2
A/SKID &
N/W STRG
ON

GENERAL

DME system:

2 Interrogators

2 antennas

The DME system includes:

- 2 DME interrogators and,
- 2 DME antennas.

AUTO TUNING

FMGC tunes DME interrogator through RMP via port A

One FMGC failure:

DME interrogators controlled by other FMGC

1 DME controlled directly by FMGC, the other via RMP

Discrete signal through RMP to DME to auto select port B

In normal operation each Flight Management and Guidance Computer (FMGC) automatically tunes its ownside DME interrogator through its ownside Radio Management Panel (RMP) via port A. With failure of one FMGC the other FMGC can control the DME interrogators, one directly, the other through its RMP. When the FMGC fails, the DME receives a discrete signal through the RMP to automatically select port B.

.

MANUAL TUNING

From MCDU, DMEs tuned through ownside FMGC

From each MCDU both DMEs can be manually tuned through their ownside FMGC (via port A).

BACK-UP TUNING

Possible via RMP if dual FMGC failure

In case of dual FMGC failure the RMPs enable back-up tuning.

ANTENNA

Transmits DME interrogation

Receives reply from GND station

Operation: 962 MHz < low band < 1213 MHz

The DME antenna transmits the DME interrogation and receives the reply from the selected ground station. The DME antenna operates within the low band from 962 MHz to 1213 MHz (1041 to 1150 MHz for interrogation and 962 to 1213 MHz for reply).

USERS

DME data sent to FMGCs for distance computation

The DME data is sent to the FMGCs for radio distance computation.

SUPPRESSOR

DME, ATC & TCAS: Same frequency range

Suppressor coaxial:

- Between ATC, TCAS & DME
- Prevent simultaneous transmission
- Interrupt other systems reception

The DME, the Air Traffic Control (ATC) and the Traffic Alert and Collision Avoidance System (TCAS) operate in the same frequency range. A suppressor coaxial between the ATC transponders, the TCAS and DME interrogators is necessary to prevent simultaneous transmission and to interrupt reception of the other systems.

AMU

Receives DME audio signals

Dispatches signals to headsets and/or loudspeaker

Volume adjustment of DME GND station by pressing:

- VOR P/B on ACP
- Or LS P/B if ILS/DME collocated

The DME audio signals are transmitted to the Audio Management Unit (AMU) and then dispatched to the headsets and/or loudspeakers. The pilot can adjust the volume of the DME ground station by pressing the VOR P/B on the Audio Control Panel (ACP) or the LS P/B in case of collocated ILS/DME (if LS mode is selected on EFIS control panel).

LGCIU

GND/flight information:

- Sent to DME interrogator by a discrete signal
- Used by receiver BITE to count flight legs

Each Landing Gear Control and Interface Unit (LGCIU) sends a discrete signal to the associated DME interrogator. This is a ground/flight information used by the receiver BITE module to count the flight legs.

INDICATING

DME data sent:

- To EFIS DUs through DMCs
- Directly to optional DDRMI

DME data is sent to the NDs and the PFDs through the Display Management Computers (DMCs) and directly to the optional Digital Distance and Radio Magnetic Indicator (DDRMI).

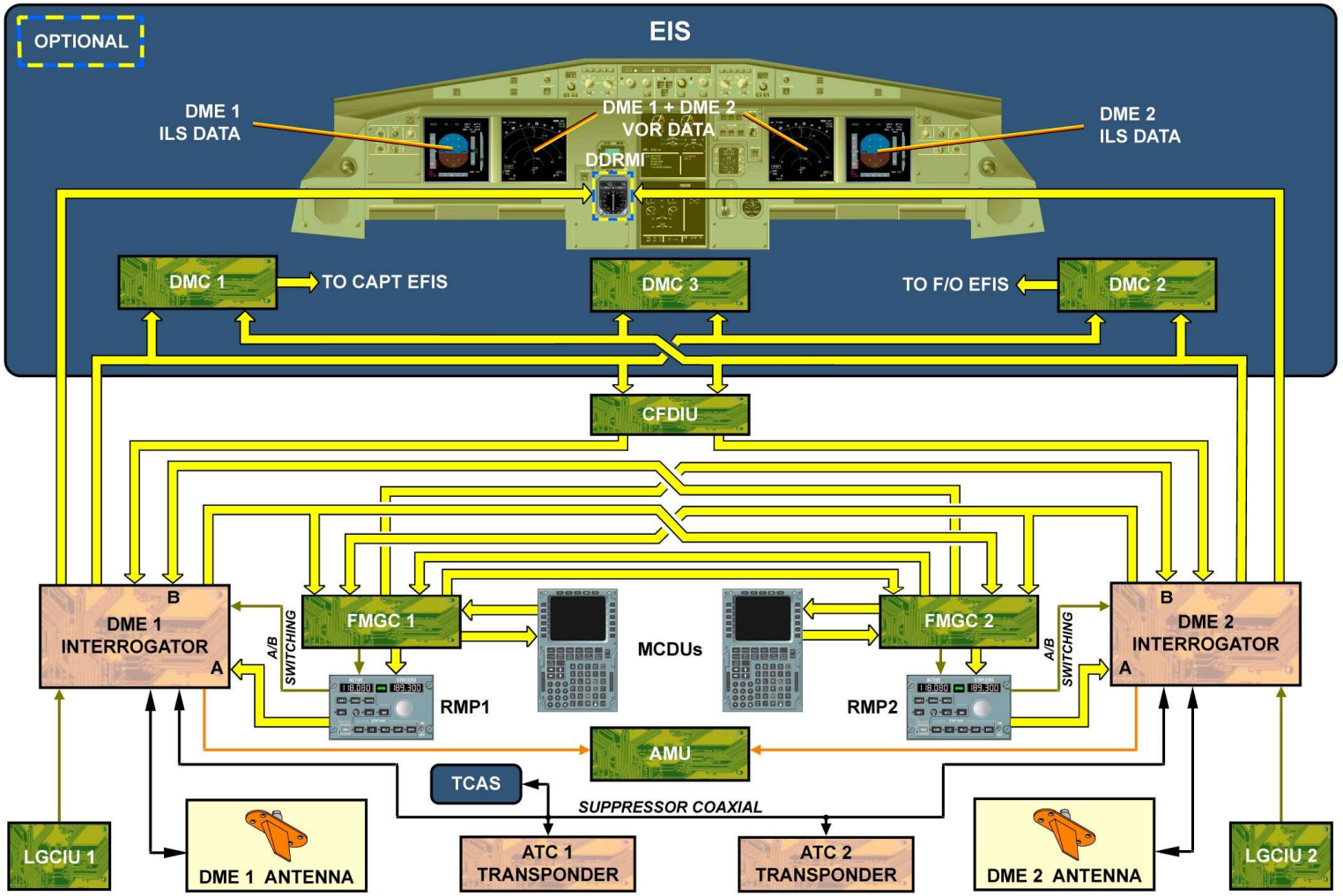
CFDIU

Allows with MCDUs:

- To test systems
- To perform trouble shooting

Tests: Only on GND

The MCDUs allow the systems to be tested and trouble shooting to be performed via the Centralized Fault Display Interface Unit (CFDIU). The tests are only available on ground.


OPTIONAL
EIS
DME 1
ILS DATA
DME 1 + DME 2
VOR DATA
DME 2
ILS DATA
DDRMI
DMC 1
TO CAPT EFIS
DMC 3
TO F/O EFIS
DMC 2
CFDIU
B
DME 1
INTERROGATOR
A
A/B
SWITCHING
FMGC 1
MCDUs
FMGC 2
A/B
SWITCHING
B
DME 2
INTERROGATOR
A
RMP1
RMP2
AMU
TCAS
SUPPRESSOR COAXIAL
LGCIU 1
DME 1 ANTENNA
ATC 1
TRANSPONDER
ATC 2
TRANSPONDER
DME 2 ANTENNA
LGCIU 2


ATC System
Presentation
MODE-S TRANSPONDER
TEST
REPLY
A320
AIRBUS

PRINCIPLE

ATC XPDR:

Integral part of ATCRBS
Interrogated by radar pulses
Auto replies by series of pulses

Replies enable the controller:

To distinguish A/C
To maintain effective GND surveillance

Reply pulses coded to supply:

A/C Identification (Mode A)
Altitude (Mode C)
Selective call & flight data + TCAS interrogations (mode S)

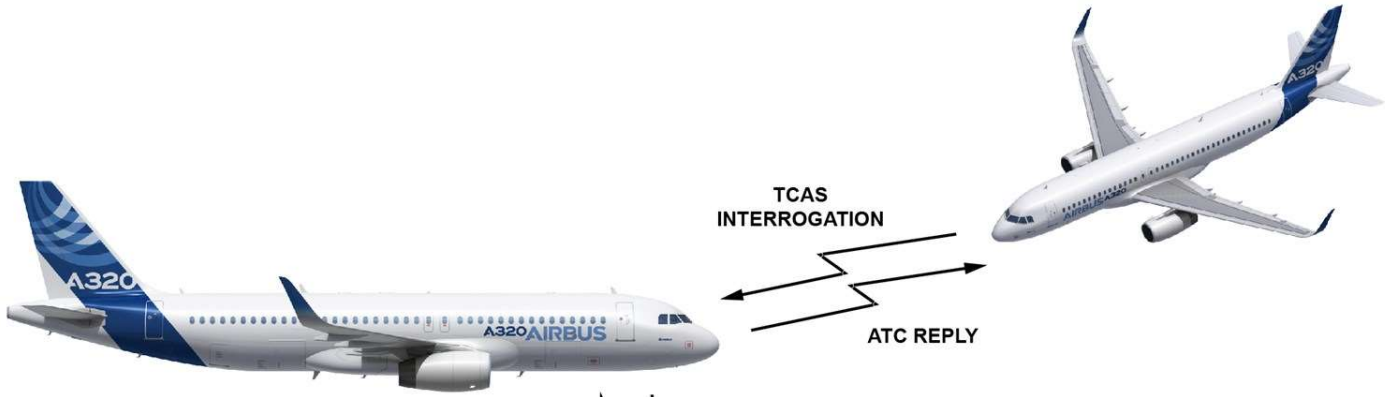
T2CAS can optionally replace the TCAS

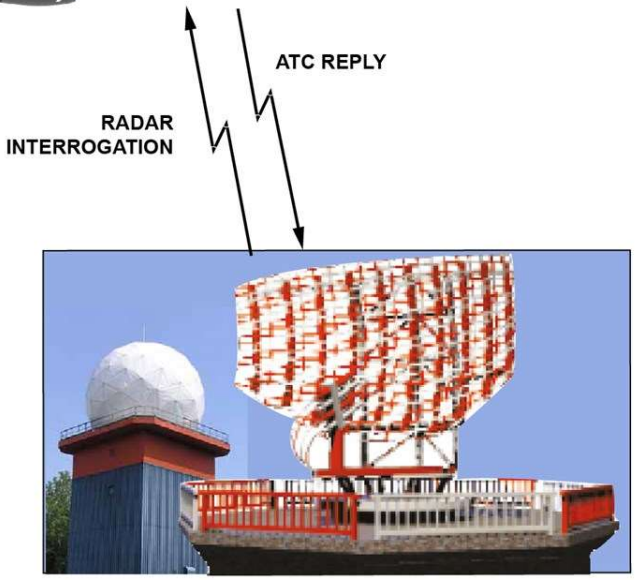
The Air Traffic Control (ATC) transponder is an integral part of the Air Traffic Control Radar Beacon (ATCRB) system. The transponder is interrogated by radar pulses received from the ground station. It automatically replies by a series of pulses. These reply pulses are coded to supply:

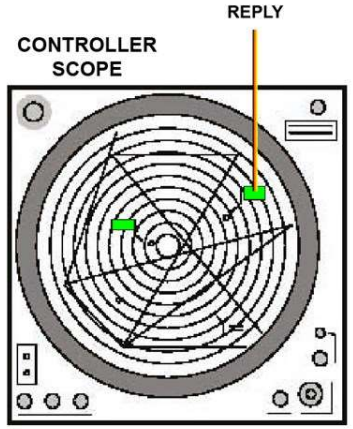
- aircraft identification (Mode A),
- automatic altitude reporting (Mode C) and,
- selective calling and transmission of flight data of the aircraft on the ground controller's radar scope.

These replies enable the controller to distinguish the aircraft and to maintain effective ground surveillance of the air traffic. The ATC transponder (Mode S) also responds to interrogations from aircraft equipped with a Traffic Alert and Collision Avoidance System (TCAS).

NOTE: As an option, the Traffic and Terrain Collision Avoidance System (T2CAS) can replace the TCAS.





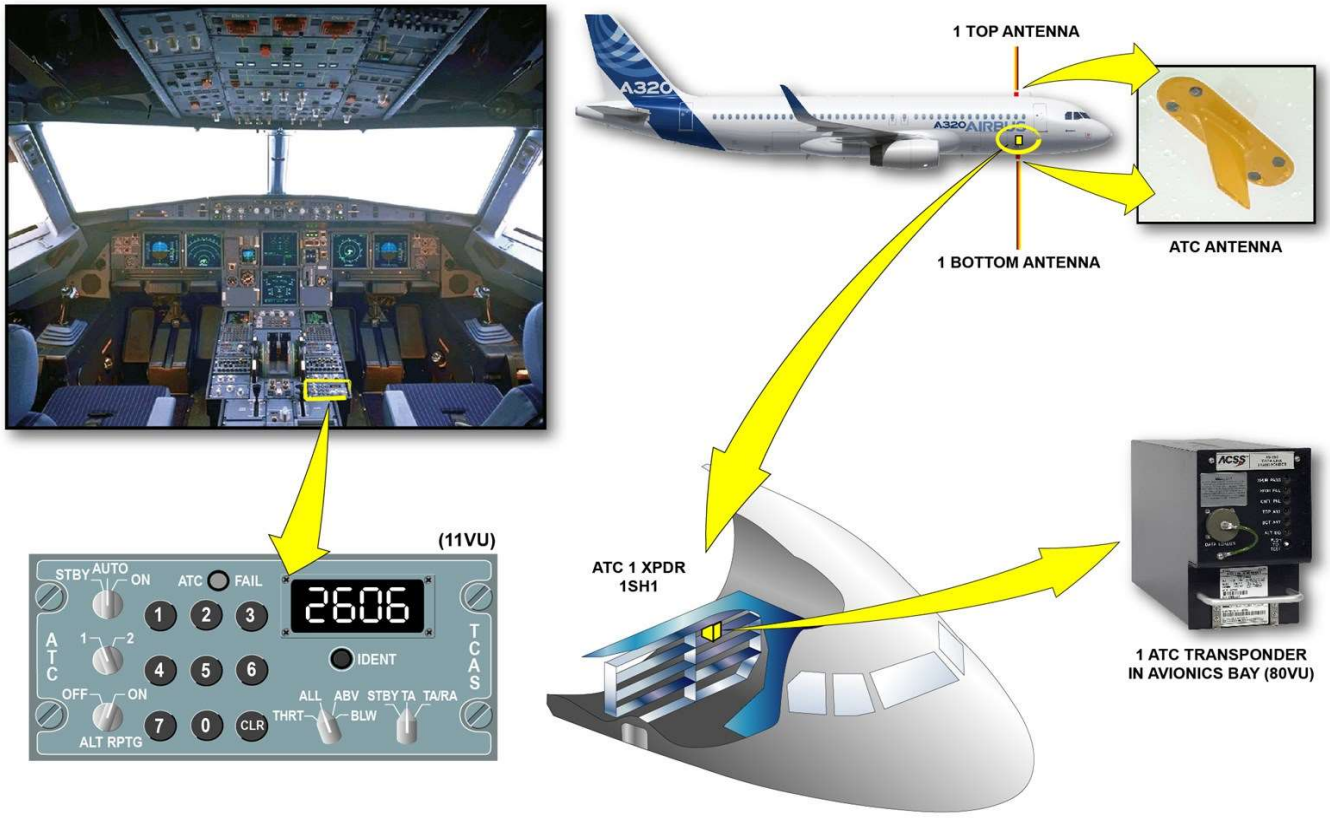


ATC MODE	INFORMATION ABOUT THE A/C
A	IDENTIFICATION
C	ALTITUDE
S	SELECTIVE CALL, FLIGHT DATA

COMPONENT LOCATION

1 ATC XPDR (80VU)
2 antennae
1 ATC/TCAS CP
The components are:
- one ATC transponder in the avionics bay (80VU),
- one top and one bottom ATC antennas,
- one ATC/TCAS control panel.

NOTE: The ATC/TCAS control panel shown here after is given as example. It may differ according to the aircraft configuration.




ATC
Description and Operation
HYD
GREEN
BLUE
YELLOW
PTU
RAT
ELEC
1
2
AUTO EXTING
TEST
RESET
1 FADEC GND PWR 2
A/SKID &
N/W STRG
ON
OFF

GENERAL

ATC system:

1 ATC/TCAS CTL PNL
ATC 1 XPDR
2 ATC antennae

The Air Traffic Control (ATC) system includes:

- 1 ATC/Traffic Alert and Collision Avoidance System (TCAS) control panel (common to both systems),
- ATC 1 transponder,
- 2 ATC antennae.

CONTROL PANEL

Enables system selection
Provides XPDR with code & function data
Receives status data
Converts mode & code data into digital data
Digital data transmitted to XPDR
SDAC connection to monitor XPDR and generate alerts by FWS
LGCIUs provide GND/flight signal:

To ATC XPDR via ATC/TCAS CTL PNL for BITE purposes

QA1 signal, valid when AUTO or ON selected, to WXR for PWS function activation

A single ATC/TCAS control panel enables system selection. It provides the transponder with code and function data and, in return, receives status data. The ATC/TCAS control panel converts selected mode and selected code data into digital data and transmits this data in ARINC 429 format to the transponder. In order to monitor the ATC transponder and generate alerts by the Flight Warning System (FWS), the ATC/TCAS control panel is connected to the System Data Acquisition Concentrator (SDAC) by a discrete connection. The Landing Gear Control and Interface Units (LGCIUs) provide a ground/flight discrete signal to the ATC transponder via the ATC/TCAS control panel for BITE purposes.

The ATC/TCAS Control panel provides a Qualifier signal (QA1), valid when AUTO or ON is selected, to the WXR for activation of the PWS function.

TRANSPONDER
Time between interrogation pulses determines operating mode
Mode S function = Surveillance + collision avoidance
Unique address coded in 24 bits to prevent multiple replies
The ATC transponder operating mode (A, C or S) is determined by the decoding of the time between the interrogation pulses. The main function of the mode S transponder is surveillance. Each transponder has its own and unique address coded on 24 bits so that every interrogation can be directed to a specific aircraft preventing multiple replies. The mode S is also used in collision avoidance (TCAS function).

ANTENNAE
Replies to ATC GND station interrogations
One Top antenna, one Bottom antenna
Antenna operates:
- Interrogation at 1.030 MHz
- Reply at 1.090 MHz

The ATC antennae (one Top and one Bottom) transmit replies to interrogations from the ATC ground station. The antenna operates with an interrogation frequency of 1.030 MHz and a reply frequency of 1.090 MHz.

SUPPRESSOR
ATC, DME & T/TISS-TCAS & ATC 2: Same frequency range
Signal transmitted by operating system via coaxial:
- To inhibit other systems
- To prevent simultaneous transmission

The ATC, the DME and the T/TISS - TCAS and ATC 2 function operate in the same frequency range. A suppressor signal is transmitted, via a coaxial, by the operating system to inhibit the other systems and to prevent simultaneous transmission.

ADIRU
Provide BARO ALT for mode C
Failure: AIR DATA selector switched to ADIRU 3
ADIRU 1 provides:
- GS
- Pitch & Roll parameters
- True HDG
- A/C position

ADIRU 1 (ADR part) provides barometric altitude to the transponder for mode C. In case of failure of ADIRU 1, the pilot can switch to ADIRU 3 through the AIR DATA selector switch.
ADIRU 1 (IR part) provides GS, Pitch, Roll parameters, True HDG and A/C position.

FMGC
Provides FLT N° + A/C position (LAT/LONG) to ATC GND station
Transmitted after mode S interrogation
The Flight Management and Guidance Computers (FMGCs) provide the flight number and A/C position (LAT/LONG). This data will be transmitted to an ATC ground station after a mode S interrogation.

CFDIU
Through MCDUs, allows ATC system:
- Tests
- Trouble shooting

Tests: Only on GND
The Centralized Fault Display Interface Unit (CFDIU) allows testing and trouble-shooting of the ATC system through the MCDUs. The tests are only available on ground.

T/TISS - TCAS
Individual COMs:
- With Transponder equipped A/C via Mode S XPDR

Avoidance maneuvers coordination by acquisition of:
- Relative ALT
- Separation range

The T/TISS - TCAS function allows individual communications with each TCAS equipped aircraft through the Mode S transponder. This enables a coordination of avoidance maneuvers by acquisition, at regular intervals, of the relative altitude and the separation range.
NOTE: As an option, the Traffic and Terrain Collision Avoidance System (T2CAS) can replace the TCAS.

ENHANCED FUNCTIONS

T/TISS Mode S XPDR:

- ELS
- EHS
- ES

Systems connected to ATC XPDR:

- ATSU
- FCU
- MMR1

MMR1 is the 1st source, FMGC is the 2nd source, ADIRU1 is the 3rd source of position for ATC

The T/TISS provides Mode S Transponder functions including:

- Elementary Surveillance (ELS) (Flt N, Alt/ground reporting),
- Enhanced Surveillance (EHS) (GS, baro setting, TAS, MAG, HDG...),
- Extended Squitter (ES) also called Automatic Dependent Surveillance-Broadcast (ADS-B) OUT (LAT/LONG, HDG sel, ALT sel, GPS Alt...).

The following avionics systems are connected to the ATC transponder to fulfill these functions:

- ATSU,
- FCU: sends ALT SEL and BARO Ref parameters,
- MMR1: sends ALT, A/C position, GS.

The MMR1 is the first source of position for the ATC 1, FMGC 1 the second and ADIRU1 (IR part) the third source.

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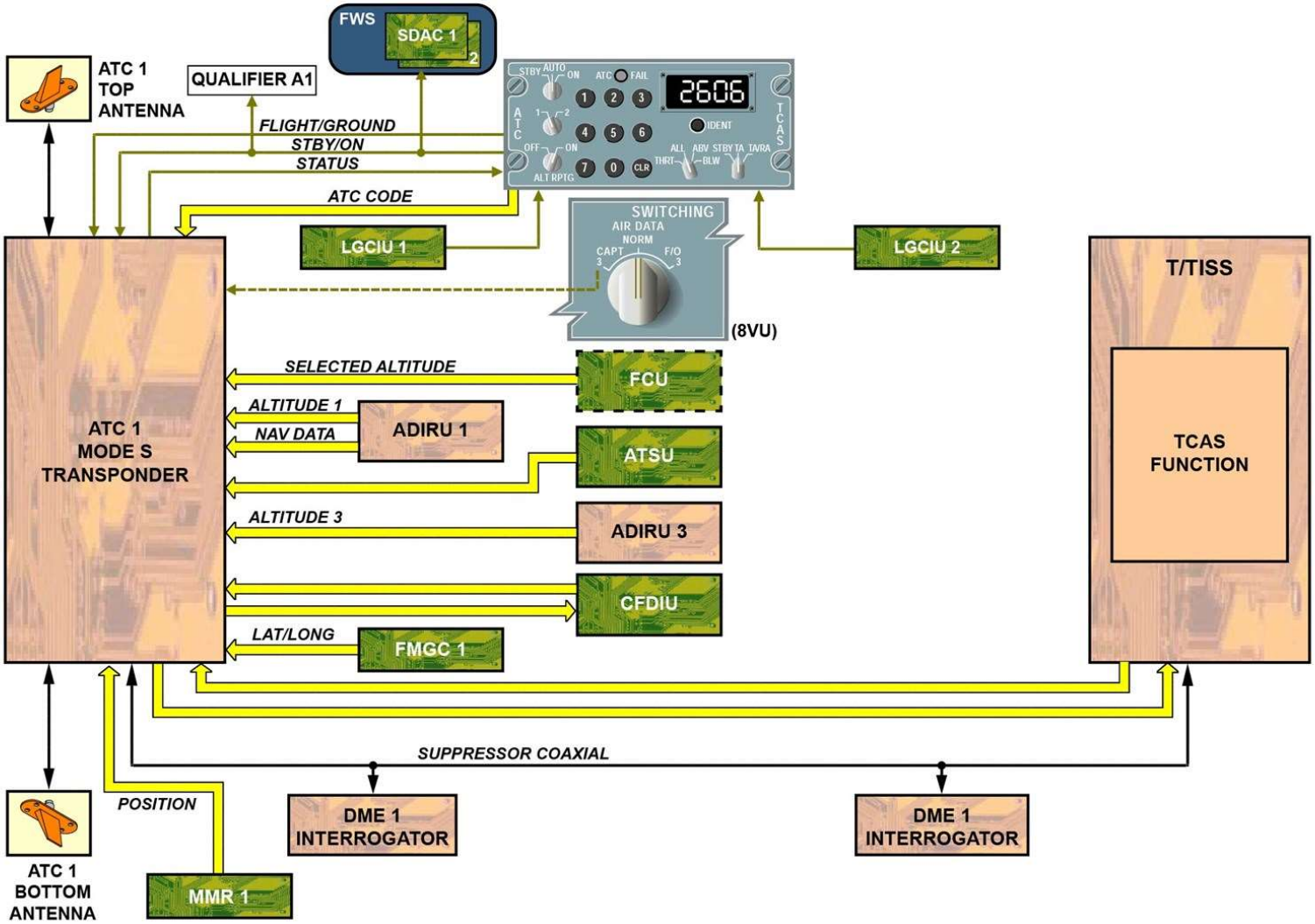

FWS
SDAC 1
2
ATC 1
TOP
ANTENNA
QUALIFIER A1
FLIGHT/GROUND
STBY/ON
STATUS
ATC CODE
2606
IDENT
LGCIU 1
SWITCHING
AIR DATA
NORM
CAPT
F/O
LGCIU 2
(8VU)
T/TISS
TCAS
FUNCTION
SELECTED ALTITUDE
FCU
ALTITUDE 1
NAV DATA
ADIRU 1
ATC 1
MODE S
TRANSPONDER
ATSU
ALTITUDE 3
ADIRU 3
CFDIU
LAT/LONG
FMGC 1
SUPPRESSOR COAXIAL
POSITION
DME 1
INTERROGATOR
DME 1
INTERROGATOR
ATC 1
BOTTOM
ANTENNA
MMR 1


On-Board Airport
Navigation System (OANS)
Description and Operation
HYD
YELLOW
PTU
ELEC
AUTO EXTING
A/SKID &
N/W STRG
ON
OFF

GENERAL

OANS helps flight crew to improve airport surface awareness

OANS objectives:

Help pilots (dangerous errors in airport navigation)
Reduce pilot workload
Reduce taxiing delays

The On-board Airport Navigation System (OANS) is an on-board function which helps the flight crew to improve their airport surface awareness.

The OANS objectives are:

- To help the pilots to prevent dangerous errors in airport navigation such as runway incursion or take-off from a taxiway or from the wrong runway,
- To reduce the pilot workload on complex airports,
- To reduce taxiing delays.

OANS includes:

OANC
Software
Database (ADB)

The OANS includes:

- An On-board Airport Navigation Computer (OANC),
- An OANS software,
- A worldwide Airport Database (ADB).

OANC software gives:

Airport moving-map display
A/C position overlay
Map annotation
Advisory
Airport selection

The OANC software gives:

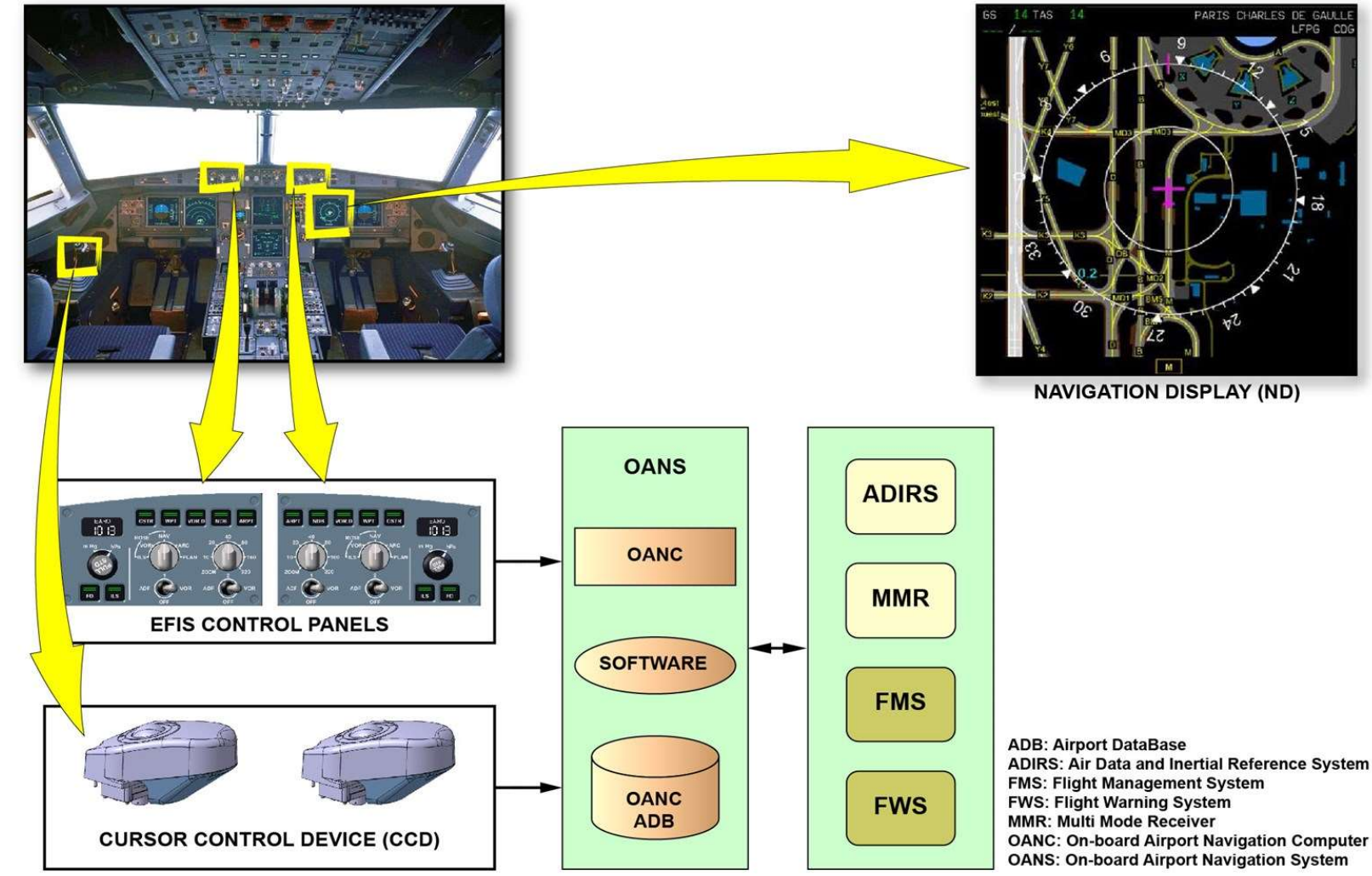
- Airport moving-map display (moving map of the airport surface),
- Aircraft position overlay (display of the aircraft symbol on the airport map),
- Map annotation,
- Advisory (optional runway approach phase),
- Airport selection.

The ADB and OANS software are uploaded to the OANC through a Portable Data Loader (PDL).

The OANS function is activated when the range selector switch is in the ZOOM position on the EFIS Control Panel (CP). Then, the OANC generates two independent video displays, one for each Navigation Display (ND).

The OANS displays are controlled with the two Cursor Control Devices (CCDs) and the two EFIS CPs.

The selection of the airport moving map can be done manually by the crew or automatically through the Flight Management System (FMS) flight plan.


NAVIGATION DISPLAY (ND)
EFIS CONTROL PANELS
CURSOR CONTROL DEVICE (CCD)
OANS
OANC
SOFTWARE
OANC ADB
ADIRS
MMR
FMS
FWS
ADB: Airport DataBase
ADIRS: Air Data and Inertial Reference System
FMS: Flight Management System
FWS: Flight Warning System
MMR: Multi Mode Receiver
OANC: On-board Airport Navigation Computer
OANS: On-board Airport Navigation System

INTERFACES

CONTROLS

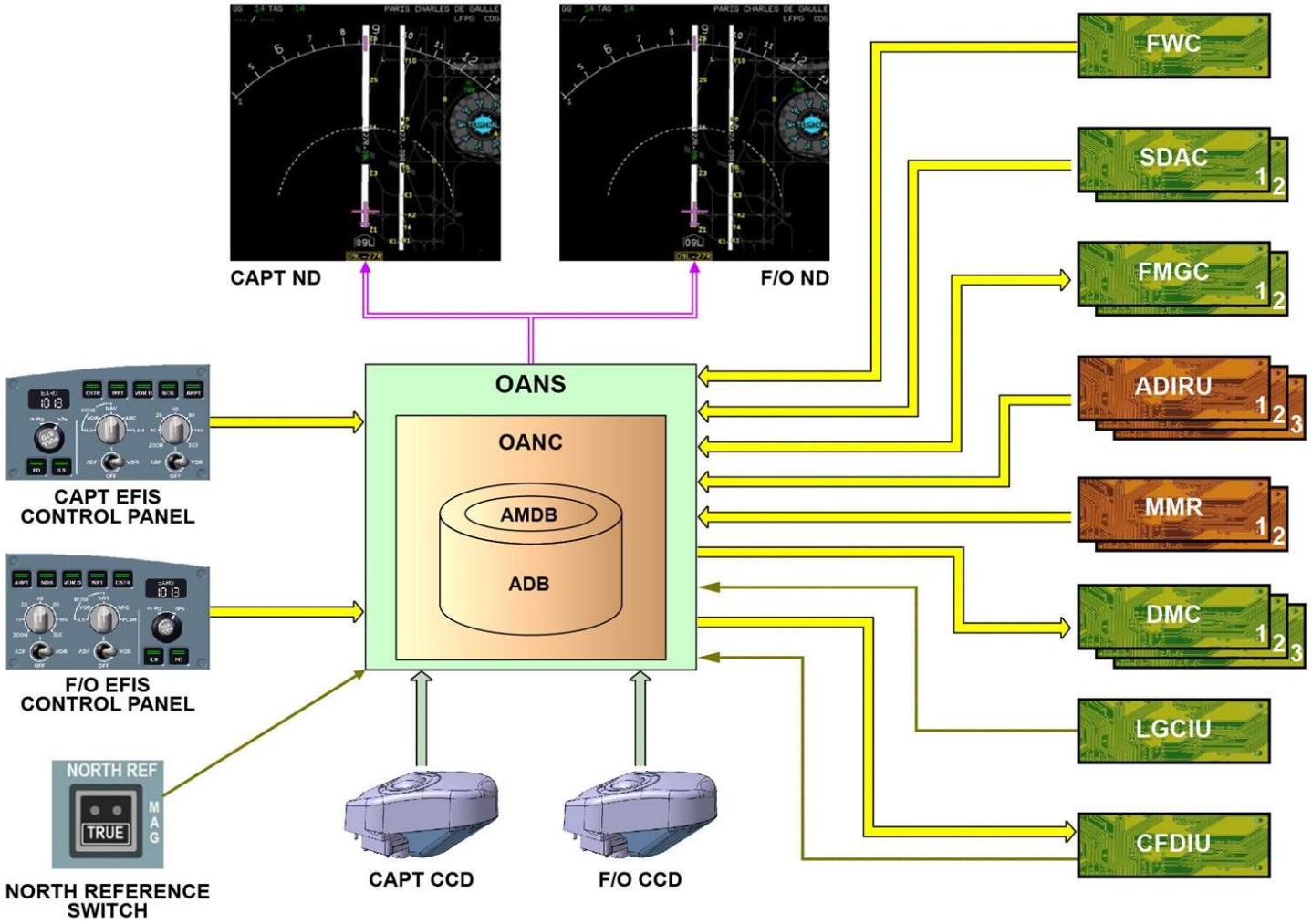
OANS interfaces with:

EFIS control panel
NORTH REF switch
CAPT & F/O CCDs

The OANS interfaces with:

- The EFIS control panel to control the display and the range of the airport moving map transmitted by the OANS (0.2NM, 0.5NM, 1NM, 2NM and 5NM).
- The "NORTH REF" switch (TRUE or MAG) to follow the magnetic reference for displaying the airport map on the ND.
- The CAPT CCD and the F/O CCD to interact with airport map on the related ND.

Note: When the OANS image is not displayed, the OANS inhibits CCD commands.


CAPT ND
F/O ND
FWC
SDAC
FMGC
ADIRU
MMR
DMC
LGCIU
CFDIU
OANS
OANC
AMDB
ADB
CAPT EFIS CONTROL PANEL
F/O EFIS CONTROL PANEL
NORTH REF
TRUE
MAG
NORTH REFERENCE SWITCH
CAPT CCD
F/O CCD

INDICATING

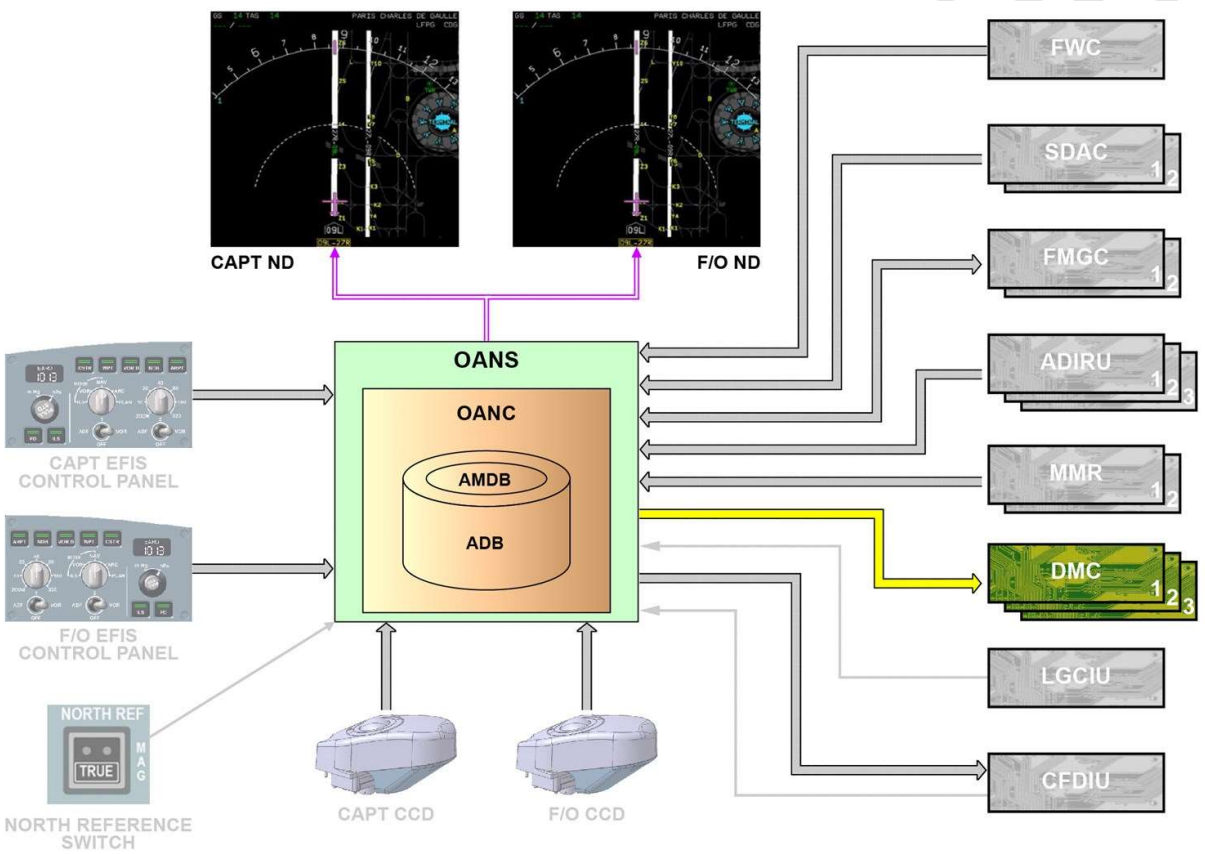
OANS interfaces with:

CAPT & F/O NDs

DMCs

The OANS interfaces with:

- The CAPT and F/O NDs to show the OANS display, the airport moving map and the OANS setting display window.
- DMCs to provide them the necessary information to display the Brake To Vacate (BTV), Runway Overrun Protection (ROP) and Runway Approaching Advisories.



MMR

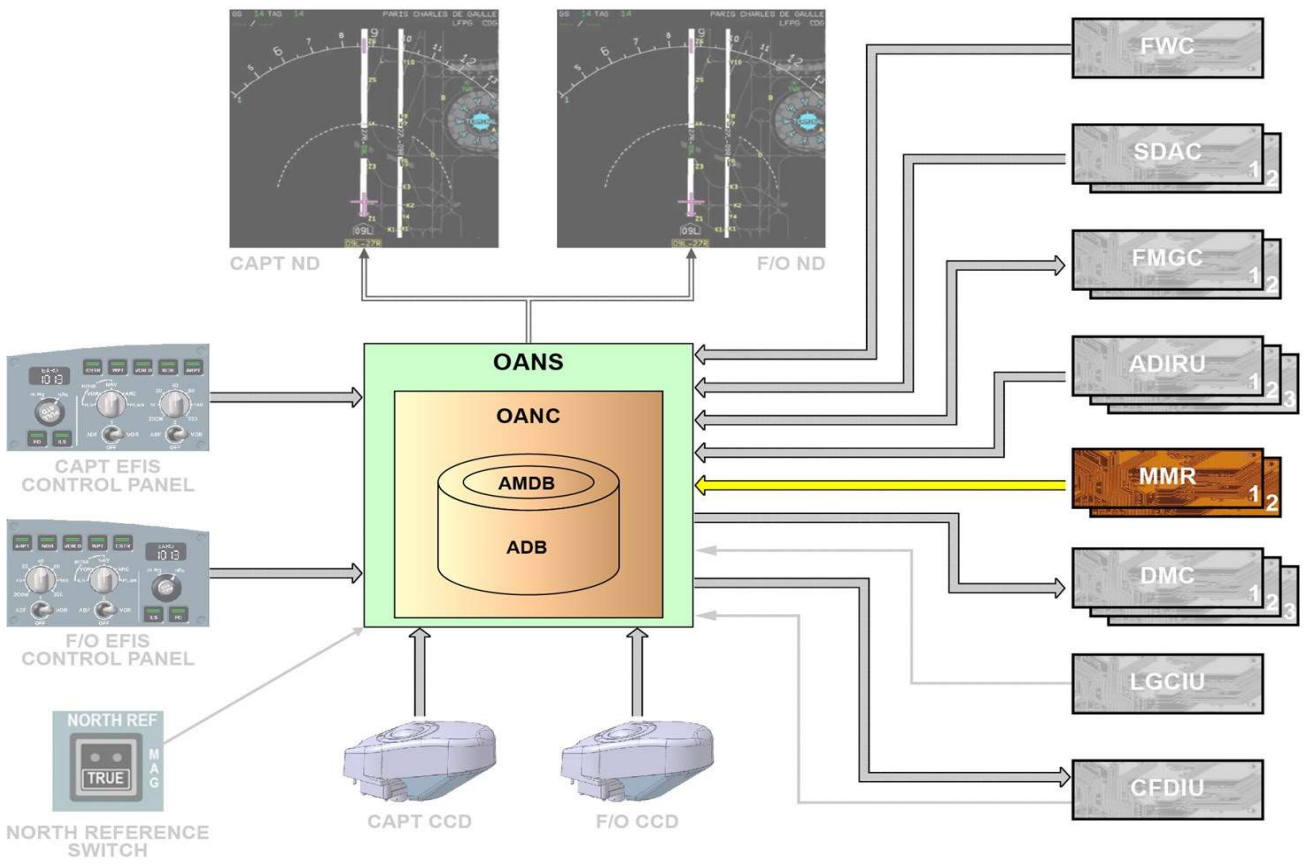
OANS interfaces with both MMRs

OANS receives:

- GPS data from MMRs
- Clock date

The OANS interfaces with both MMRs to compute the aircraft position on the Airport Moving Map.

The OANS receives GPS data from MMRs and the clock date to check if the current date is within the validity date of the active database.



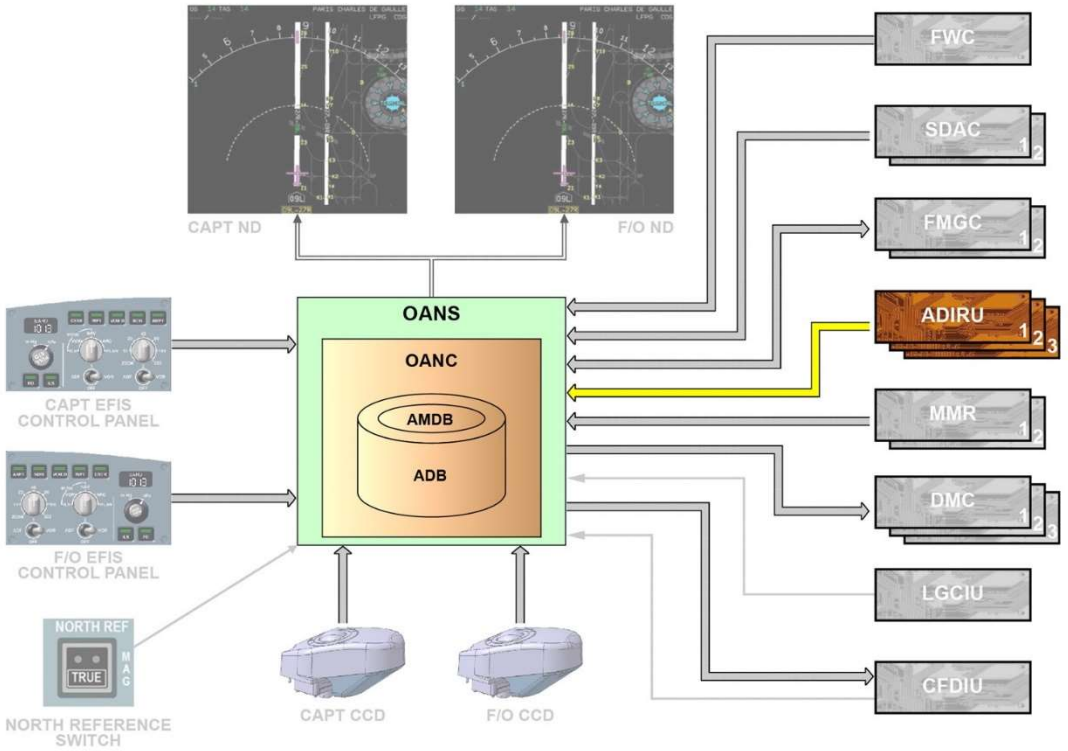
ADIRS

OANC interfaces with ADIRS to show:

- A/C heading
- Ground speed
- Airport selection
- A/C location
- ADR/IR advisories

The OANC interfaces with ADIRS to receive Air Data Reference (ADR)/Inertial Reference (IR) data to show:

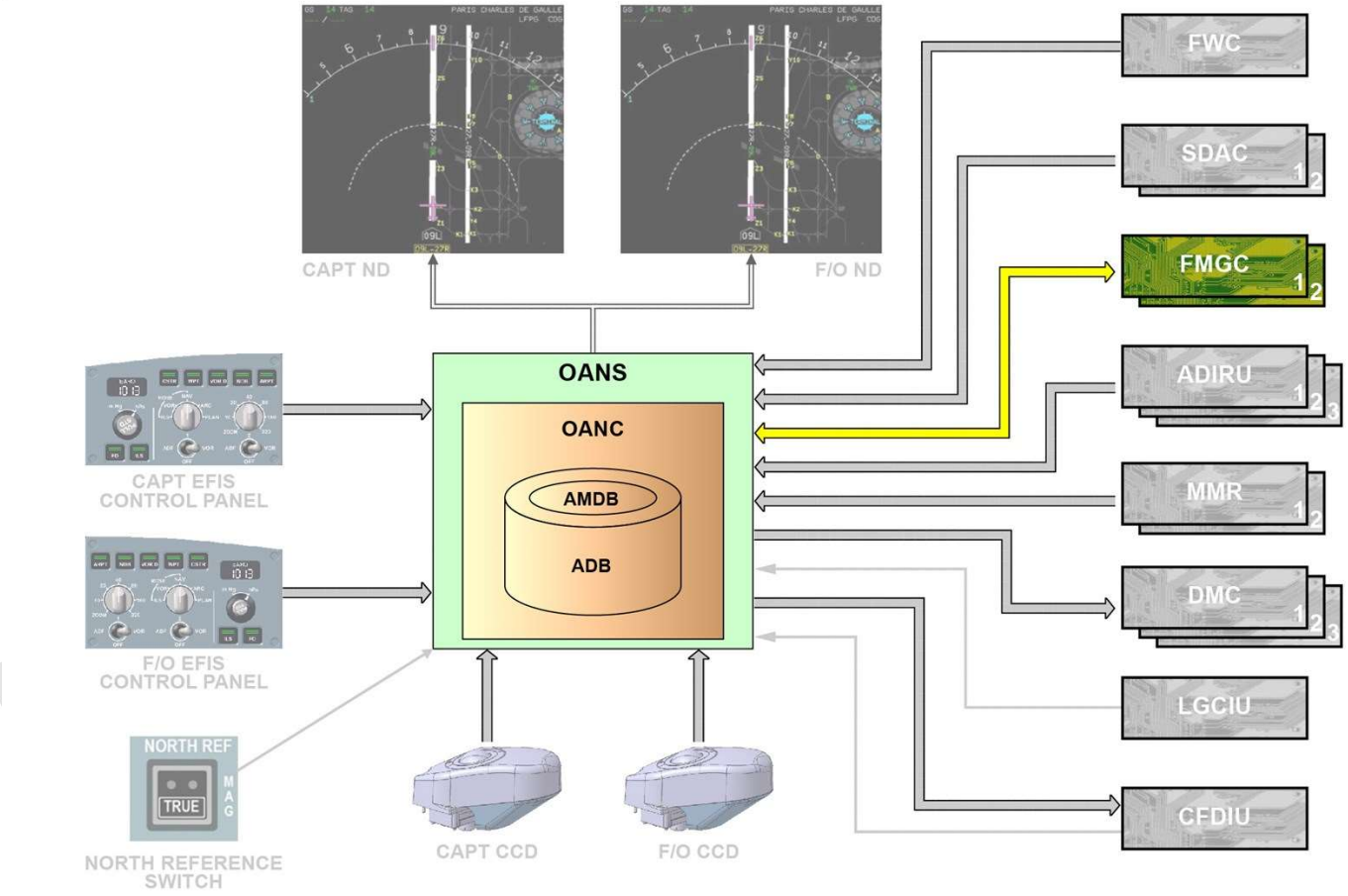
- The aircraft heading,
- The ground speed,
- The airport selection,
- The aircraft location,
- The ADR/IR advisories respectively on the CAPT and F/O NDs



FMS

OANC interfaces with FMGECs

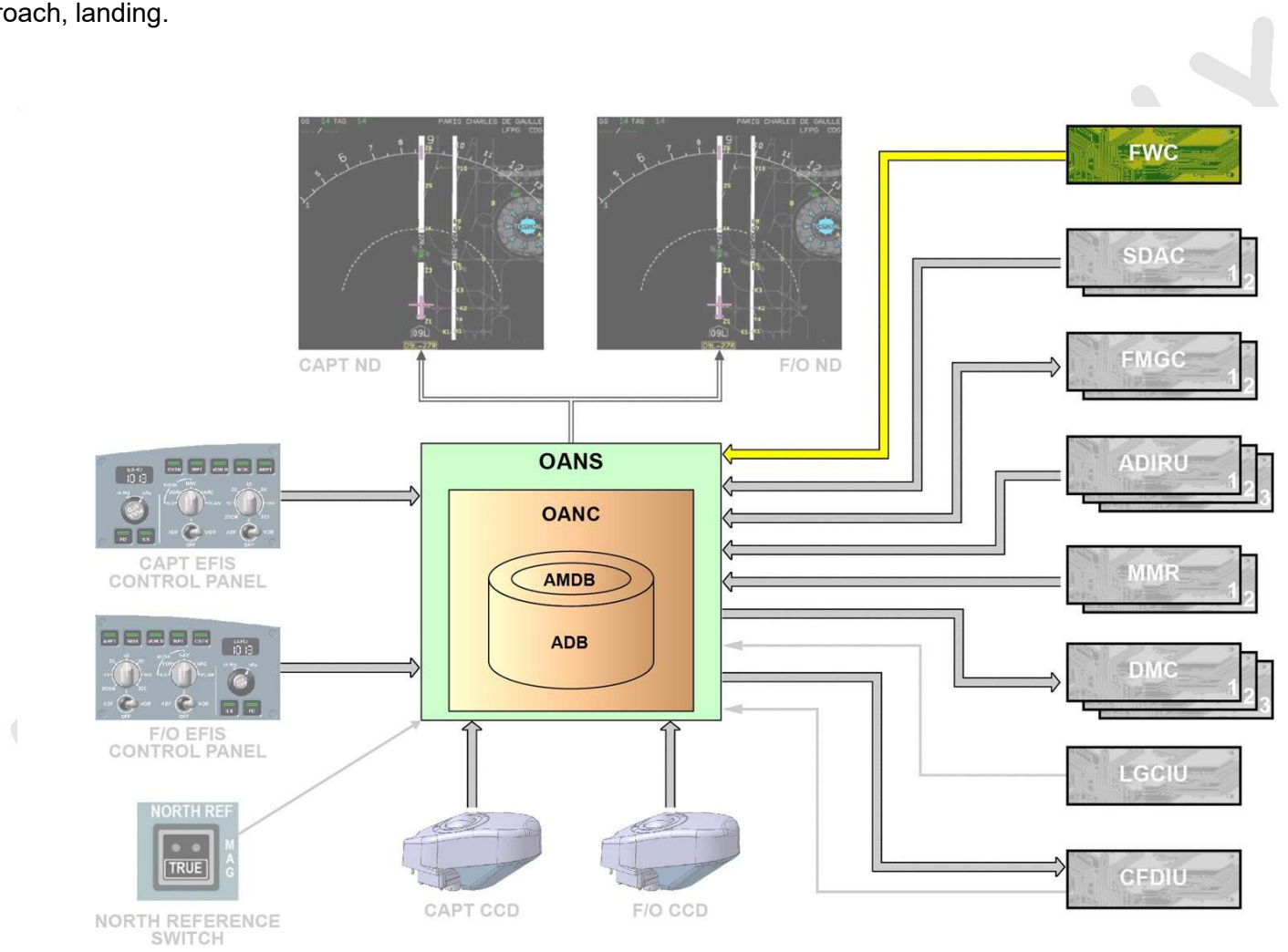
The OANC interfaces with the two FMGECs to receive the departure, the alternate and the destination airports.



FWC

OANC interfaces with FWC

The OANC interfaces with the Flight Warning Computer (FWC) to receive the flight phases information: approach, landing.



LGCIU

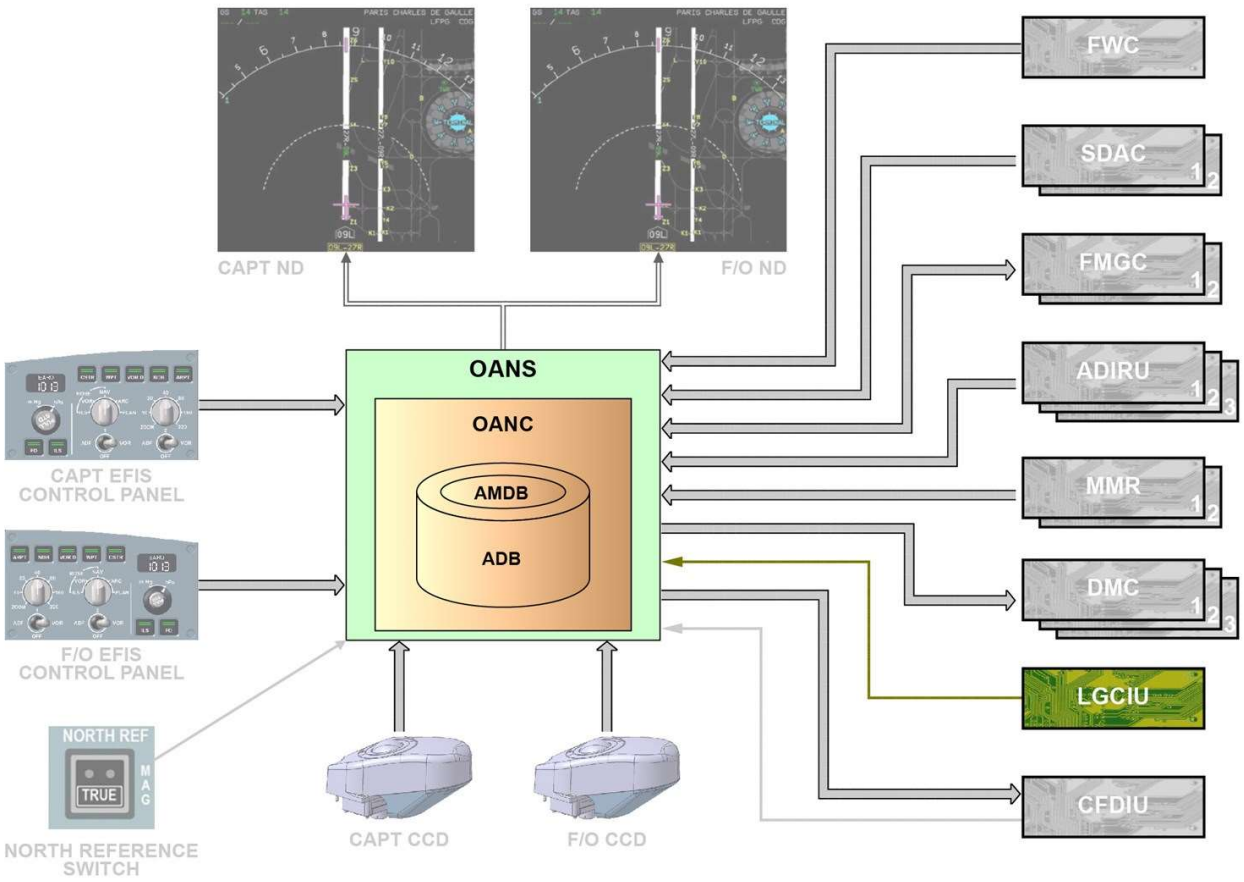
LGCIU transmits "ground signal" to OANC (discrete)

Signal used by:

- Operational software
- BITE
- Power management
- Data loading functions

The LGCIU transmits "ground signal" to the OANC via a discrete signal.

This signal is used by the operational software, BITE, power management and data loading functions.

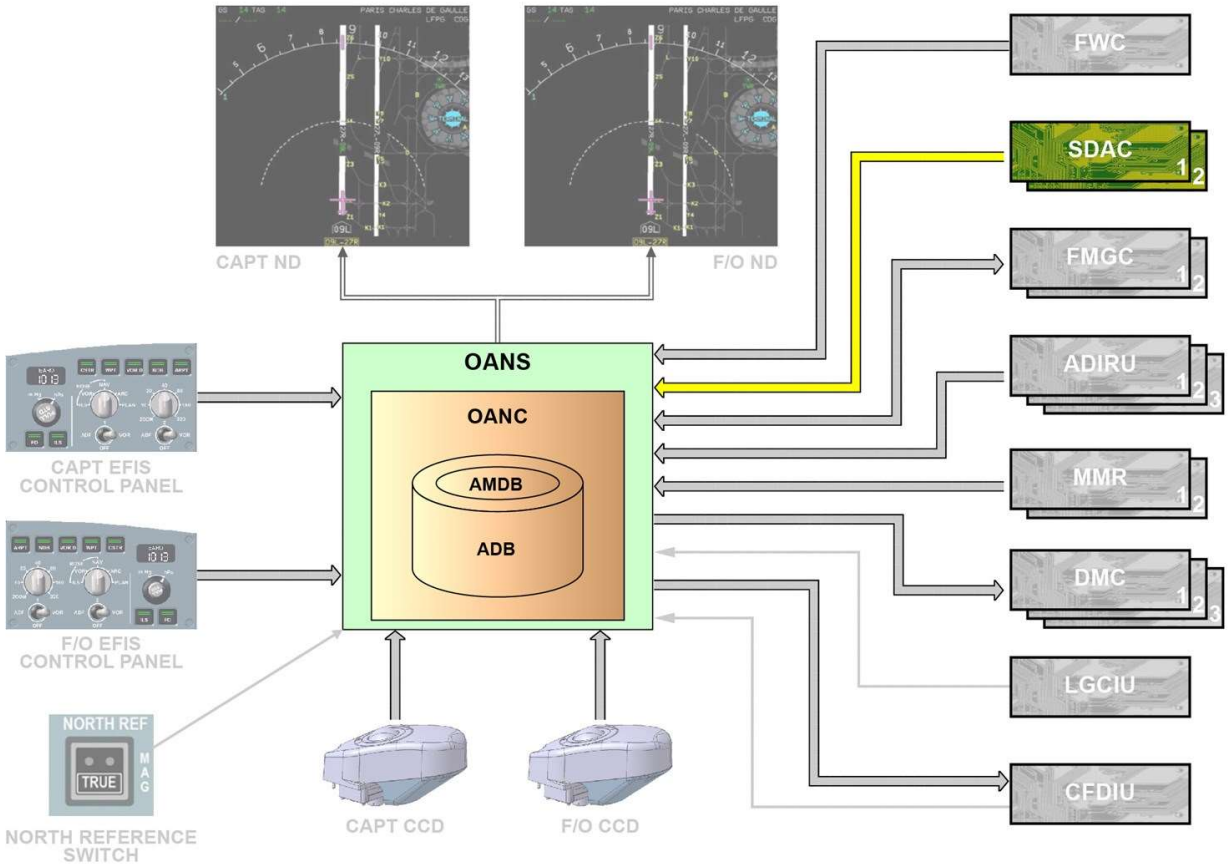


SDAC

OANC interfaces with 2 SDACs for BTV function

The OANC interfaces with the two SDACs for the BTV function.

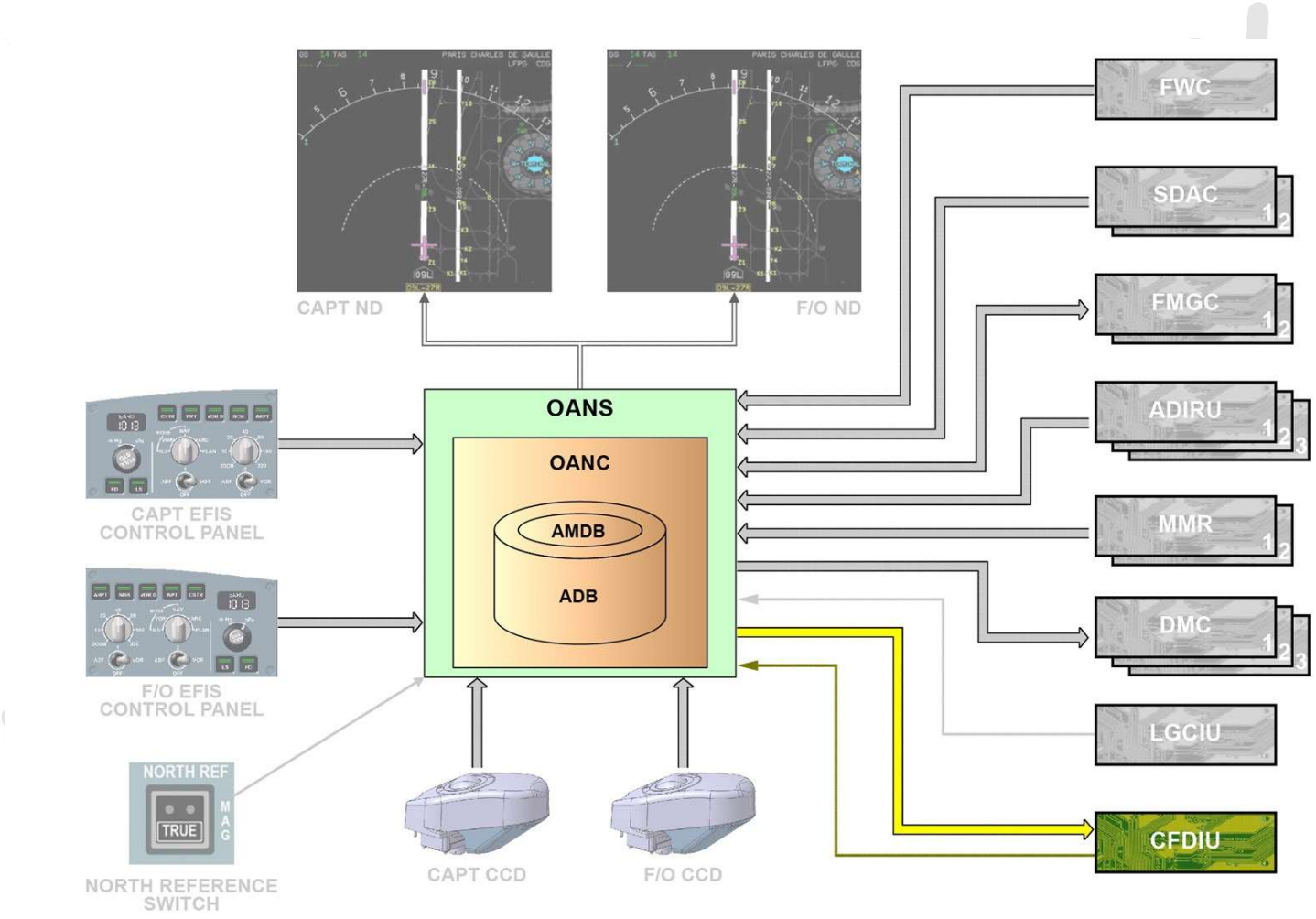
Note: These data are not used by the OANS, but forwarded to the FMGC.



CFDIU

CFDIU allows testing & trouble shooting of OANS through MCDU

The Centralized Fault Display Interface Unit (CFDIU) allows testing and trouble-shooting of the OANS function through the MCDU.



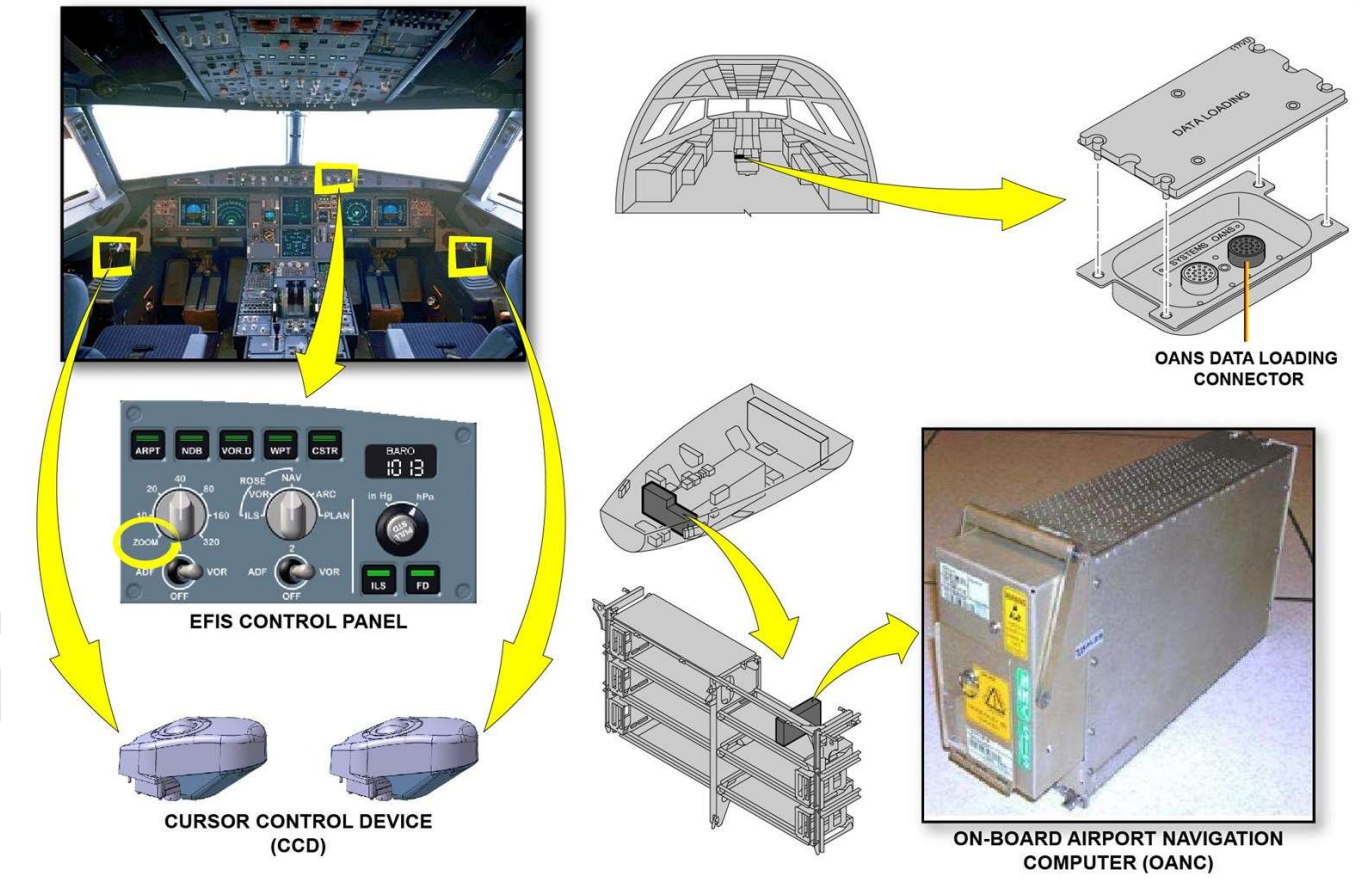
COMPONENTS LOCATION

OANC is located in main avionics compartment

OANS data loading connector is located in the cockpit

The OANC is located in the main avionics compartment.

A dedicated OANS data loading connector is located in the cockpit (e.g. on panel 117VU).



END