A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSE - T1+T2 - RR Trent XWB
Indicating/Recording Systems

This document must be used for training purposes only

Under no circumstances should this document be used as a reference

It will not be updated.

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INDICATING/RECORDING SYSTEMS

V1813401 - V01T0M0

COCKPIT CONTROL PANELS DESCRIPTION (3)

General

The control panels used in the A350 cockpit are:
- Integrated Control Panels (ICPs)
Note: the Functional Item Numbers (FINs) are xxxVM. (e.g. 221VM).
- Standard control panels (VUs).
The VUs are installed on:
- The main instrument panel
- The glareshield
- A part of the overhead panel.
The ICPs (VMs) are installed:
- The overhead panel
- The pedestal
- The main instrument panel.

ICP Layout

The ICPs (VMs) are mainly installed on the overhead panel.
Two ICPs are installed on the pedestal.
Two ICPs are installed on the main instrument panel.

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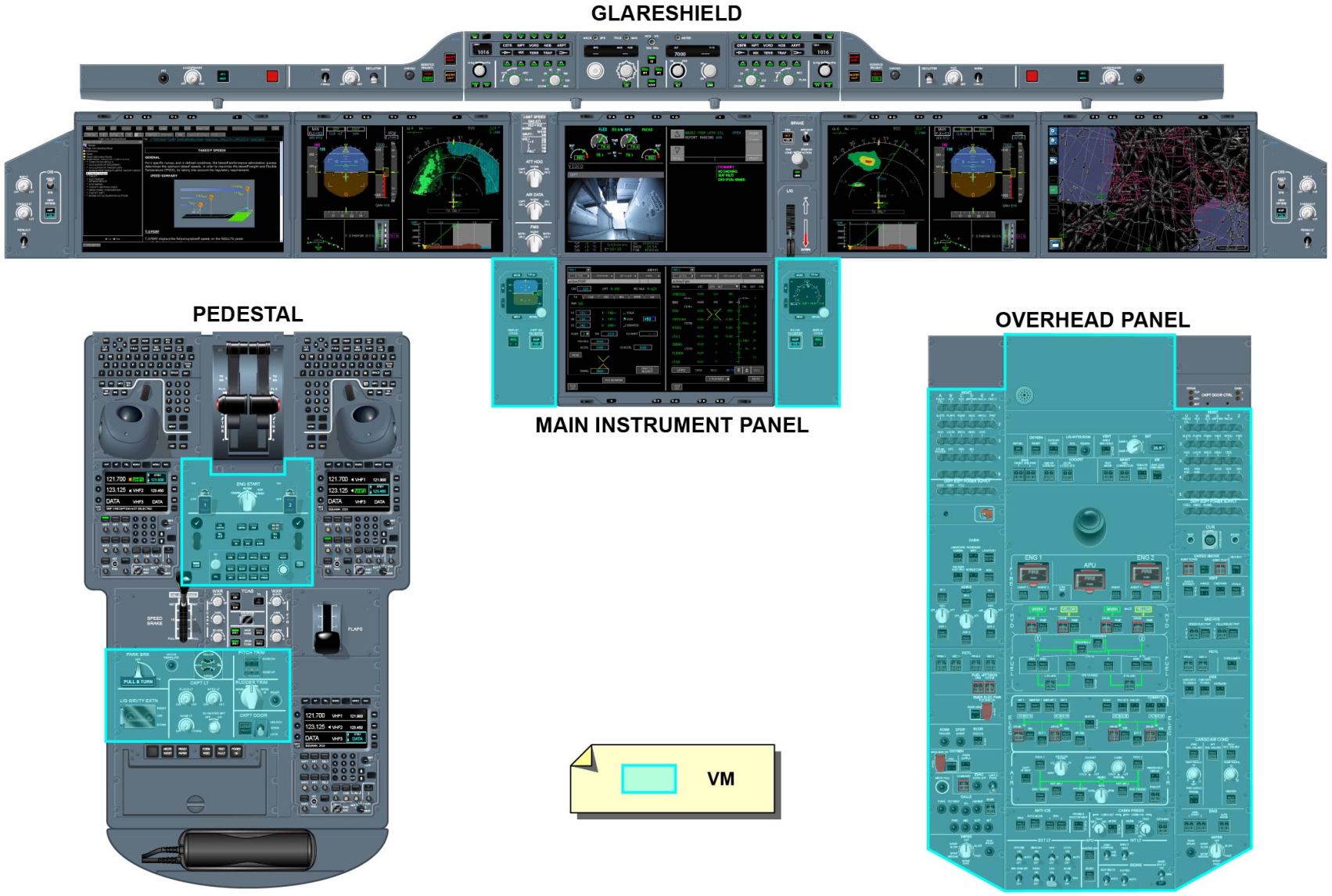


GENERAL & ICP LAYOUT

COCKPIT CONTROL PANELS DESCRIPTION (3)

ICP Layout (continued)

System architecture

The ICPs are:
- Cockpit Human-Machine Interfaces (HMIs) with A/C systems using which use a digital Controller Area Network (CAN) and/or
- Discrete and analog signals.

The ICP system receives data and controls some A/C systems (LRUs and LRMs

The different panels are divided into two classes:
- Digital ICP or CAN ICP, which use discrete, analog and mainly digital interfaces.
- No CAN ICP which only use discrete and analog interfaces.

The CAN ICPs are connected through the CAN network and the CRDCs to the LRUs and LRMs of the A/C systems. The ICPs are also connected to the A/C systems through discrete and analog signals. There is also an exchange of data between these ICPs.

The NO CAN ICPs are connected to the A/C systems (LRUs and LRMs) through analog and discrete signals for the control of very important items such as relays, pumps, valves, etc.

In some special cases (e.g. cabin Pressurization (PRESS)), the CAN bus is directly connected to system components: sensors, relays, valves, without the CRDC mediation.

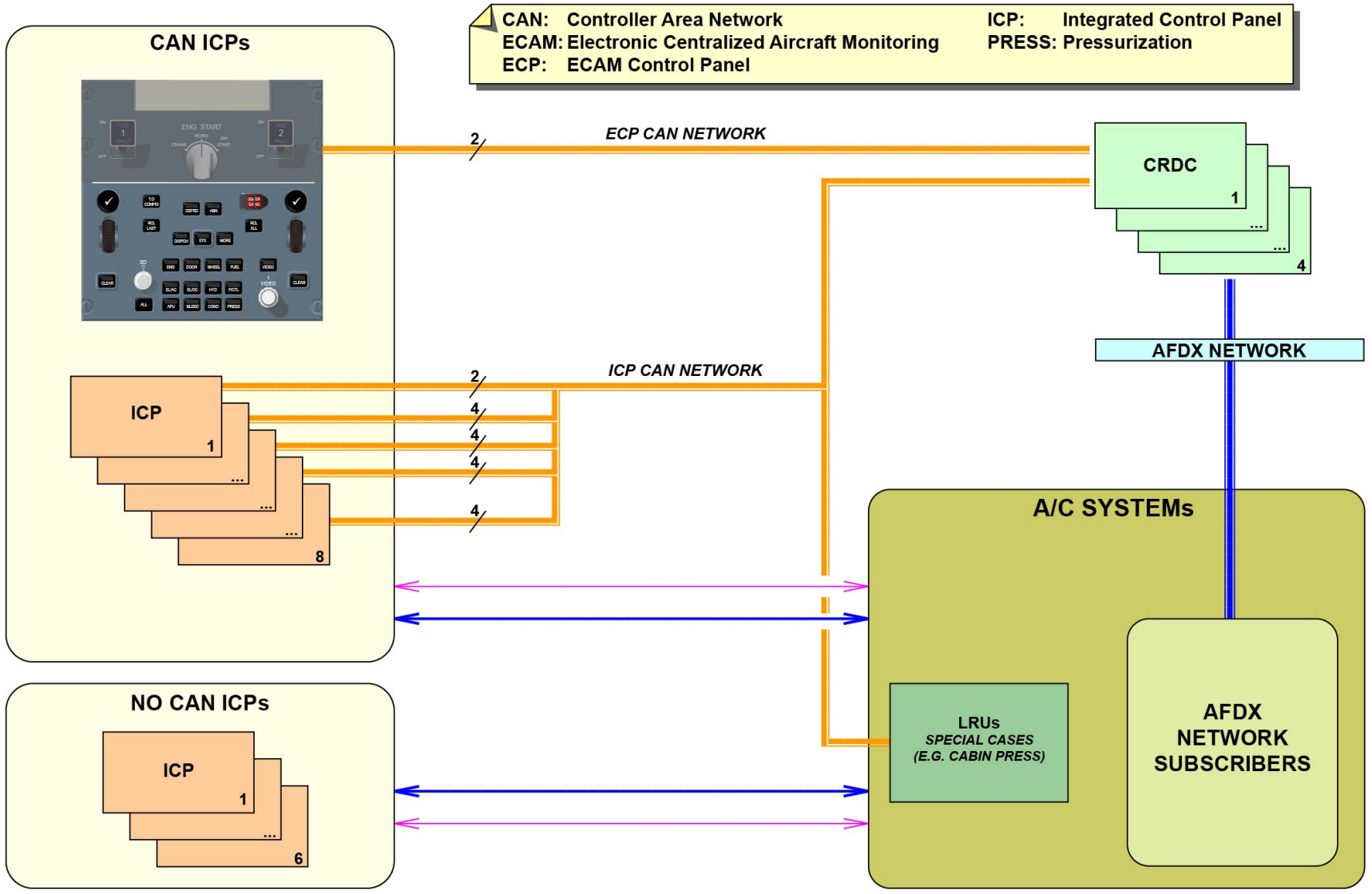
The Electronic Centralized Aircraft Monitoring (ECAM) control panel is connected to the A/C systems (LRUs and LRMs) through the CAN network of the ECAM control panel (ECP) and the CRDCs.

The ECP is also connected to the A/C systems through discrete and analog signals.

CAN network

Each CAN ICP panel can be connected through two or four channels. The ECP is connected to a different CAN network with two segregated channels.

When a pilot pushes a switch (P/BSW, toggle, rotary), this generates the sending of the switch status (e.g. position). In most of the cases, this status is sent to both segregated CAN channels, and then to the destination system through the CRDCs and AFDX network.



ICP LAYOUT - SYSTEM ARCHITECTURE & CAN NETWORK

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CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

CDS Architecture

CDS internal architecture

The Control and Display System (CDS) has:
- Six identical Display Units (DUs)
- Two Keyboard and Cursor Control Units (KCCUs).

The dialog between the DUs is done through the AFDX network. The dialog between the KCCUs and DUs is done through the Controller Area Network (CAN) dedicated to the CDS. There are two CAN buses on each side of the CAN network. The CAN buses of the same side are redundant for reliability.

Each KCCU has two independent parts:
- A Cursor Control Device (CCD)
- A keyboard.

The two parts are fully segregated. Their CAN bus connections operate independently.

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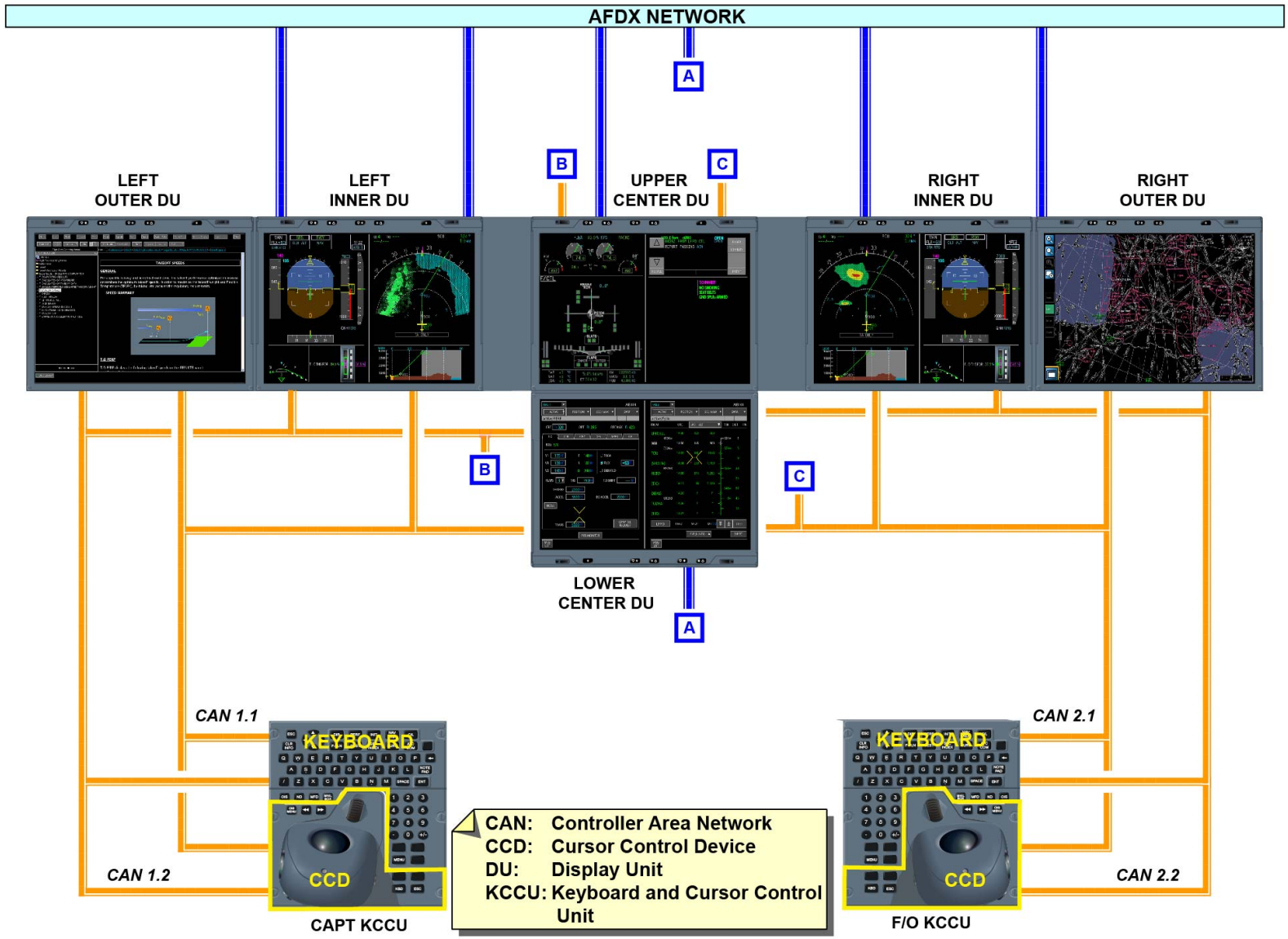

CDS ARCHITECTURE - CDS INTERNAL ARCHITECTURE

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

CDS Architecture (continued)

CDS interfaces with other systems

To manage the applicable display, the CDS gets data from the A/C systems that follow:
- Most of the A/C operational data comes through the AFDX network.
- Some systems also send data to the CDS through the ARINC 429 bus to keep them available if there is a full loss of the AFDX network (e.g.: Air Data/Inertial Reference System (ADIRS), etc.).
- Data transmission through discrete for special signal indication.
- Optical fibers transmit video signals to the CDS for display on the DUs (e.g.: cabin video monitoring, Taxiing Aid Camera System (TACS), etc.).
- Special communications between the CDS inner and outer DUs (through AFDX network), dedicated to the Onboard Airport Navigation System (OANS)/Airport Navigation Function (ANF) (ATA 34), since the inner and outer DUs are necessary to operate this function.

The CDS (upper and lower center DUs) also does the optional Head-Up Display (HUD) computation.

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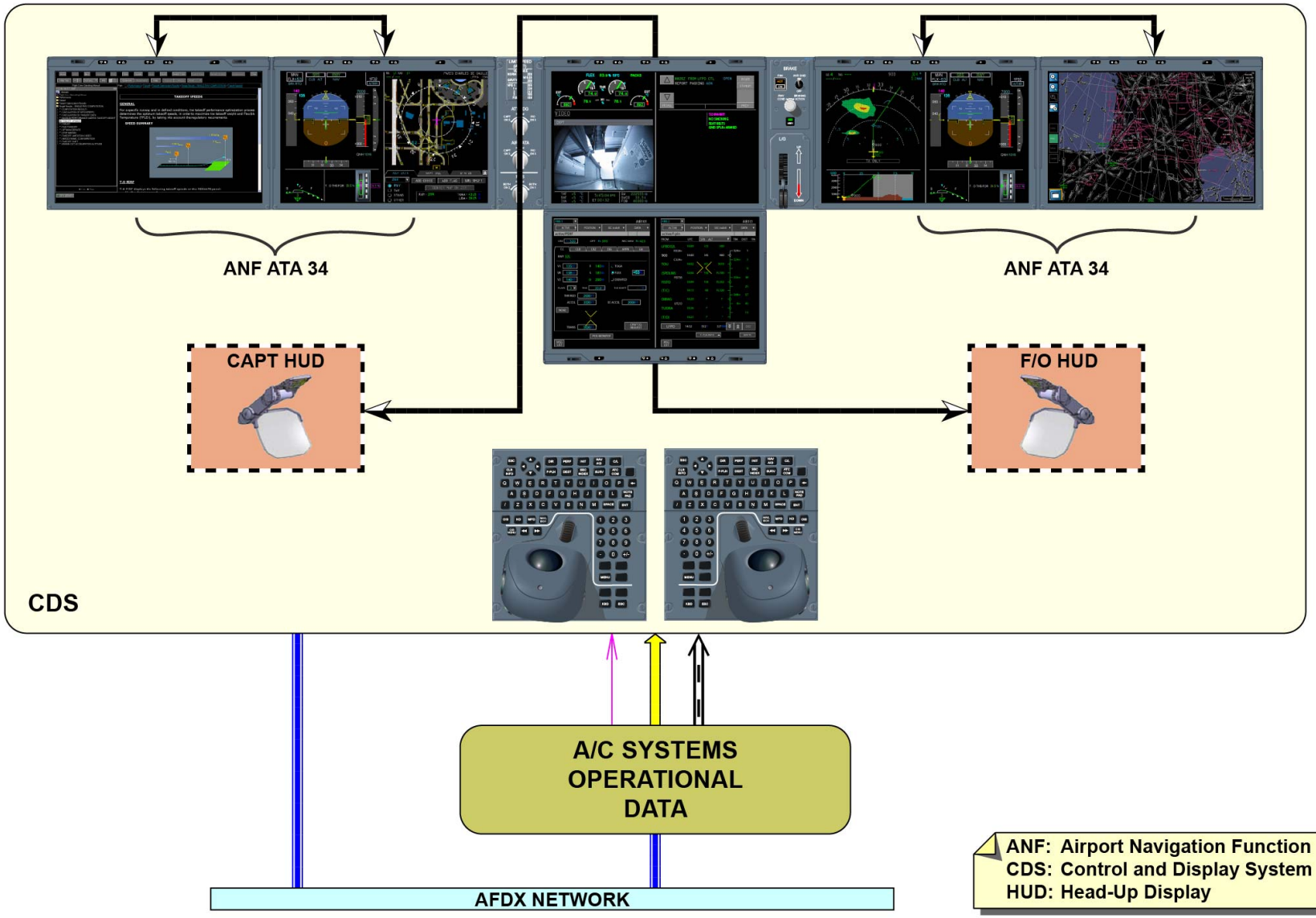


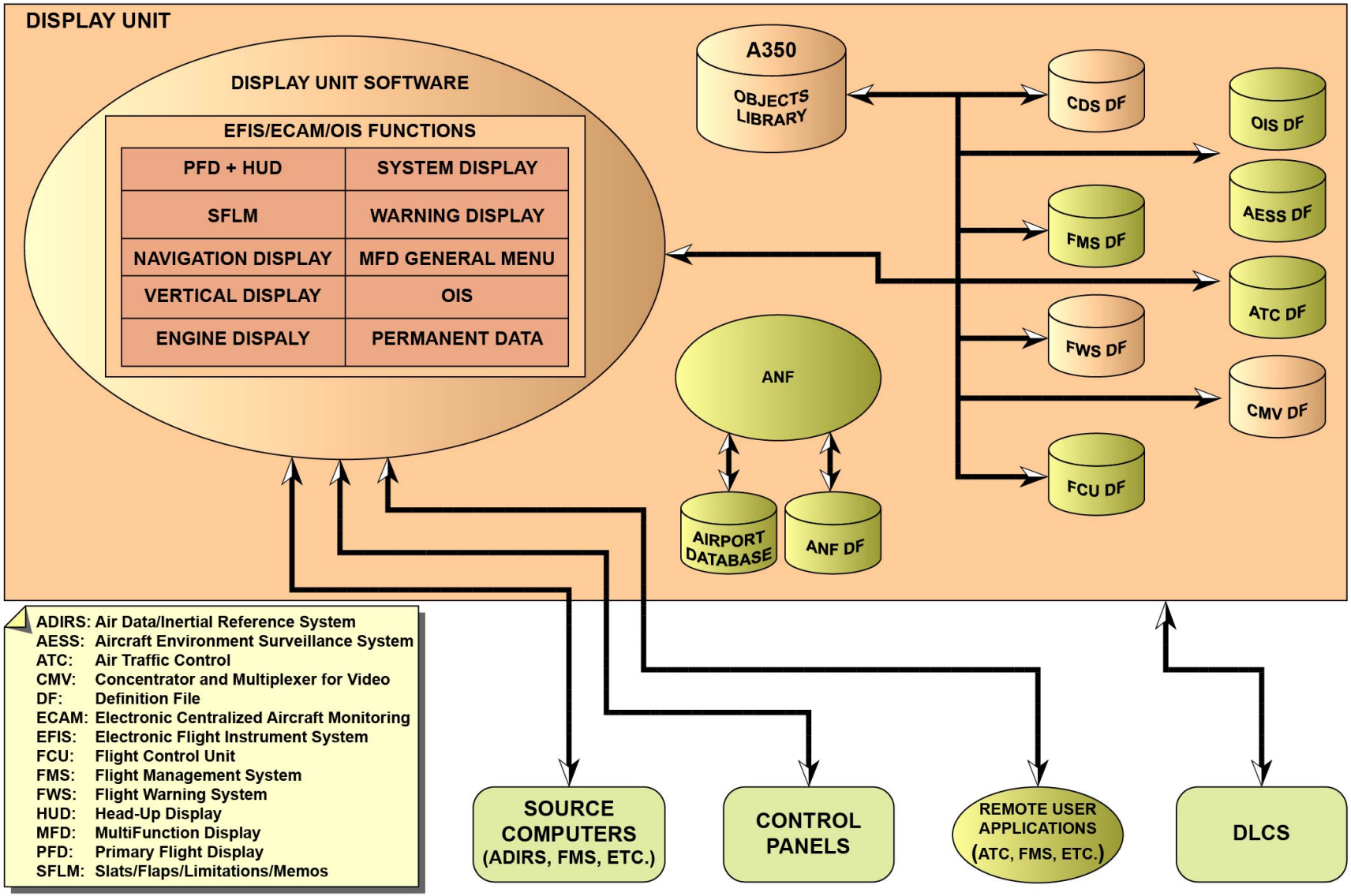
CDS ARCHITECTURE - CDS INTERFACES WITH OTHER SYSTEMS

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

Smart Display Unit Description

Hardware characteristics

The CDS DUs use the Liquid Crystal Display (LCD) technology. They are called smart displays. Each DU includes all resources dedicated to all CDS functions.
The DUs receive and transmit data to the source computers, remote user applications and control panels. All the CDS functions are done in all DUs.
In relation to the DU location in the cockpit, each function is activated or not through pin programming.
Each DU includes the system software and data files that follow:
- System software for system management for DU operations:
- The Electronic Flight Instrument System (EFIS) or the Electronic Centralized Aircraft Monitoring (ECAM) applications that gives all the display functions of the CDS and OIS
- Primary Flight Display (PFD)
- Navigation Display (ND)
- Engine Display (ED)
- System Display (SD)
- Warning Display (WD)
- Vertical Display (VD)
- Mail box
- OIS
- HUD.
- The A350 objects library that includes a set of symbols.
- One CDS definition file for the display definition of the EFIS, ECAM or OIS functions.
- All definition files which are not managed through the CDS for the display definition of remote user applications (Flight Warning System (FWS), Flight Management System (FMS), Flight Control Unit (FCU) backup, Aircraft Environment Surveillance System (AESS), Air Traffic Control (ATC), Concentrator and Multiplexer for Video (CMV) data, OIS and ANF).
These definition files are installed in the DUs but are not part of the CDS. They are as a part of the remote user applications.
(This architecture means that a modification (e.g.: Service Bulletin (SB)) made to a remote user can lead to a new definition file to be loaded in the CDS, etc.).



SMART DISPLAY UNIT DESCRIPTION - HARDWARE CHARACTERISTICS

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

Smart Display Unit Description (continued)

Display unit cooling-system

To control its internal temperature, each DU is connected to the avionics ventilation system. The connection is done at the rear of the equipment.
Each DU has two connections:
- One for the air blowing
- One for air extraction.

The KCCUs are not connected to the ventilation system. The avionics air ventilation system has two Ventilation Control System (VCS) applications hosted in CPIOMs, which control the ventilation system.
The information related to the loss of air cooling capacities is sensed by the cooling effect detectors (too high air temperature or too low blown mass flow). It is sent to the CDS through the AFDX network bus with the VCS application in the CPIOM. This information is used to reduce brightness of the DUs.

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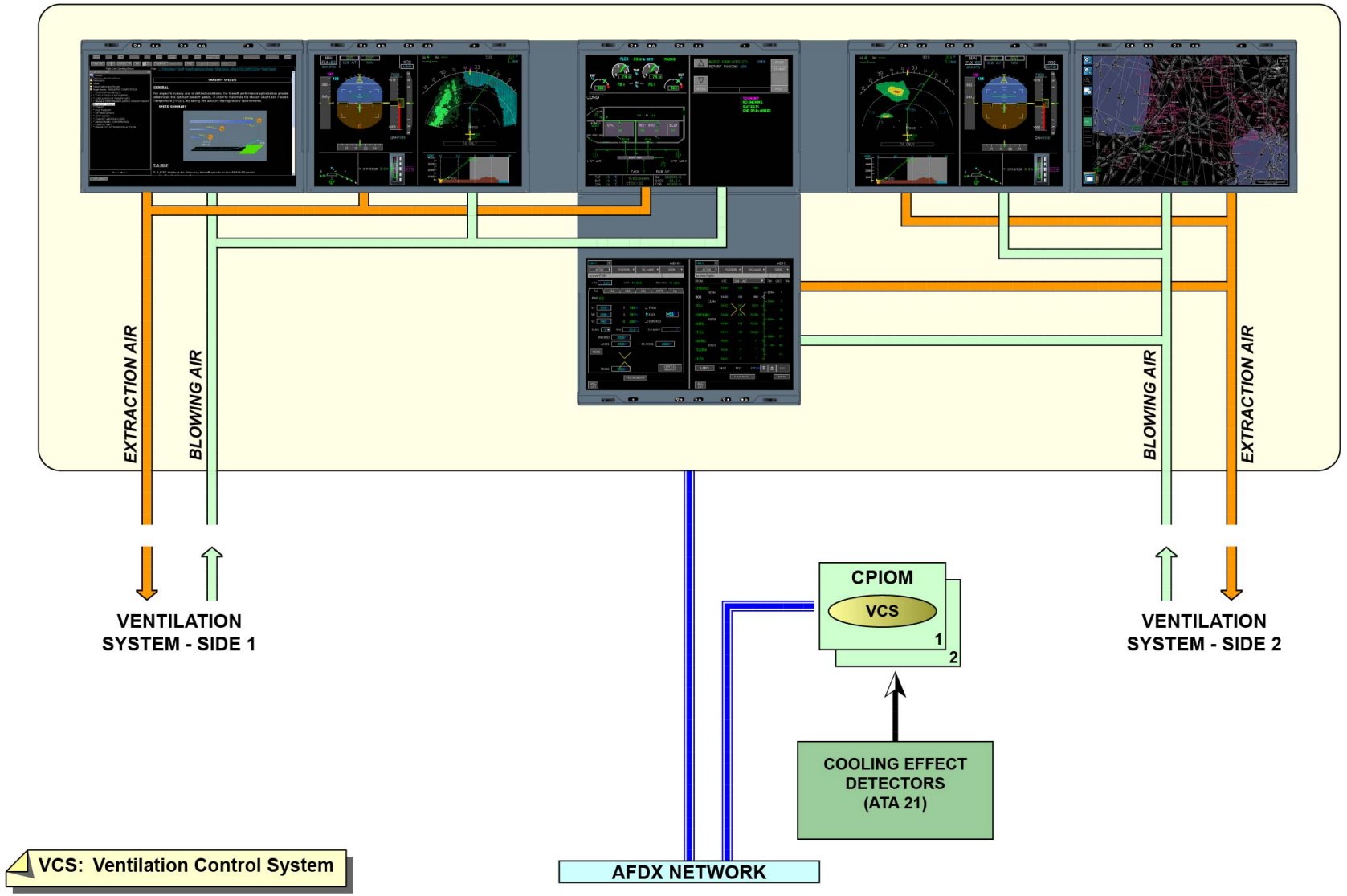


SMART DISPLAY UNIT DESCRIPTION - DISPLAY UNIT COOLING-SYSTEM

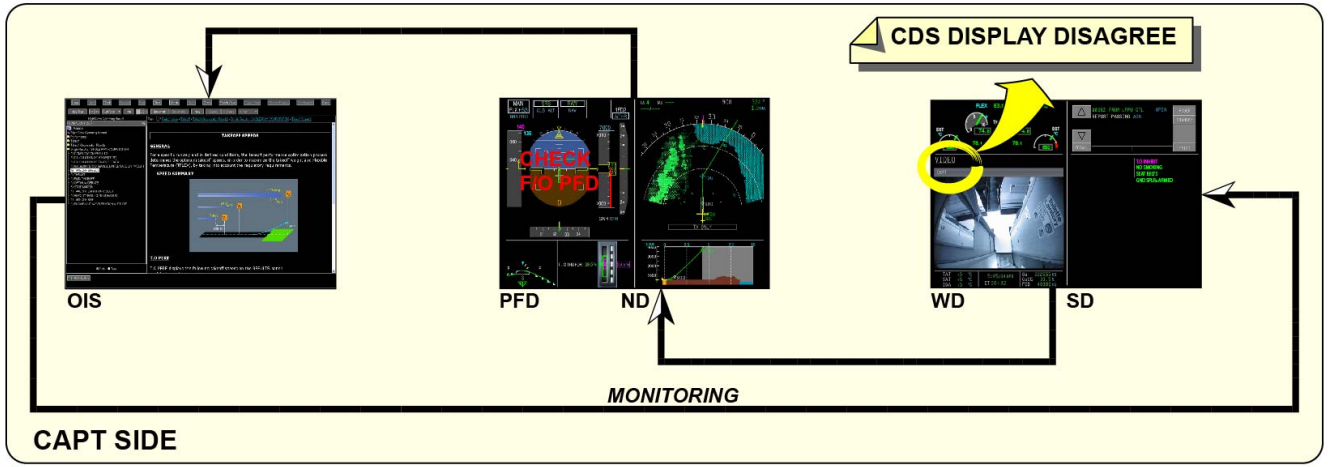
CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

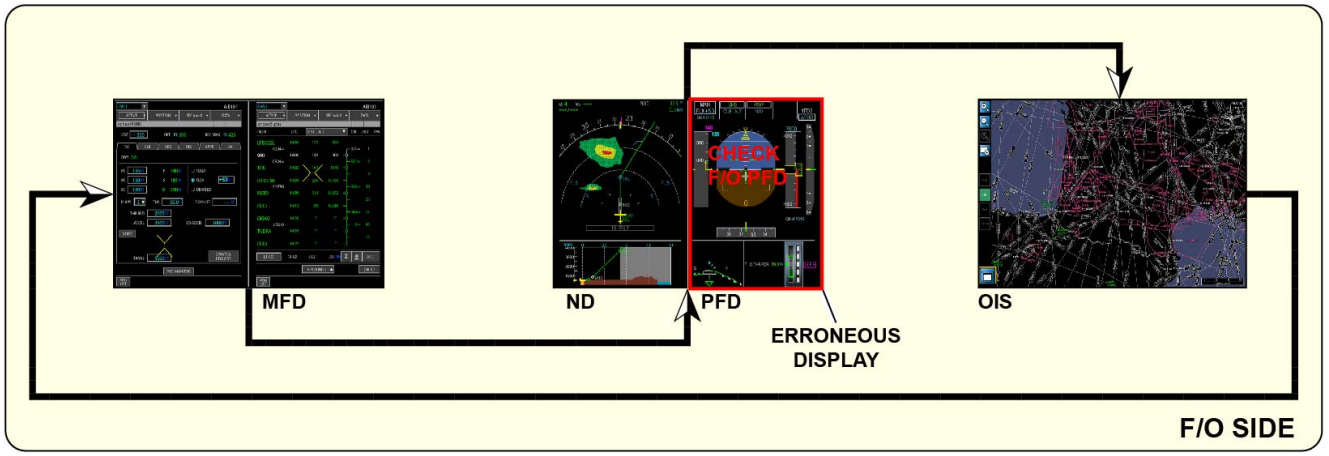
Smart Display Unit Description (continued)

Display unit cross-monitoring

To make sure of a high level of reliability, each DU has monitoring functions. Each DU monitors its control and display functions and its input/output status, with the CDS internal and external equipment.
A DU monitors other DU, which in turn monitors another DU. This makes a feedback monitoring loop. There are two feedback monitoring loops that operate independently, each loop includes three DUs.
The outer CAPT DU monitors the upper center DU. The upper center DU monitors the inner CAPT DU. The inner CAPT DU monitors the outer CAPT DU. If there is a CAPT inner DU failure or a loss of power supply, the two remaining DUs monitor each other and vice versa on the RH side with the lower center DU and the F/O outer DU.
When the monitoring DU finds a difference between the data received and the data shown on the monitored DU, it shows a message to tell the flight crew that the data shown is incorrect. (The monitored DU and the same related DU on the other side show the CHECK DU message (DU = F/O OIS, CAPT OIS, F/O EFIS, etc.).
An alarm, called CDS flag is also sent to the FWS and to the CMS and each one sends a warning and a fault message.

TWO TYPE OF MONITORING:
- DU NORMAL MONITORING (DU SELF-MONITORING)
- DU FEEDBACK MONITORING (WARNING AND FAULT MESSAGE GENERATION IF THERE IS AN ERRONEOUS PARAMETER DISPLAY)





ND: Navigation Display
SD: System Display

SMART DISPLAY UNIT DESCRIPTION - DISPLAY UNIT CROSS-MONITORING

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CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

KCCU Description

The KCCUs installed on the pedestal are new Human-Machine Interface (HMI), that interact with displays (MultiFunction Display (MFD), ND/VD, OIS, ATC mail box, etc.).
A KCCU has two independent parts:
- A CCD that uses the trackball technology
- A keyboard.

If there is a failure of one part of the KCCU (CCD or keyboard) will have no effect on the other one. The KCCUs can control different applications at a given time.
Each keyboard contains a classical keypad with additional keys for special controls:
- Function keys (operational shortcuts to ease the crew control)
- Alphanumeric keys
- Arrow keys
- Etc.

The two CCDs use trackball technology for cursor navigation on the DU screens. They also include some keys to make a selection of objects and to make other special operations:
- A validation knob
- A scrolling wheel
- Right/left navigation keys
- A keyboard key named KBD which is used to show the soft keyboard on the MFD.

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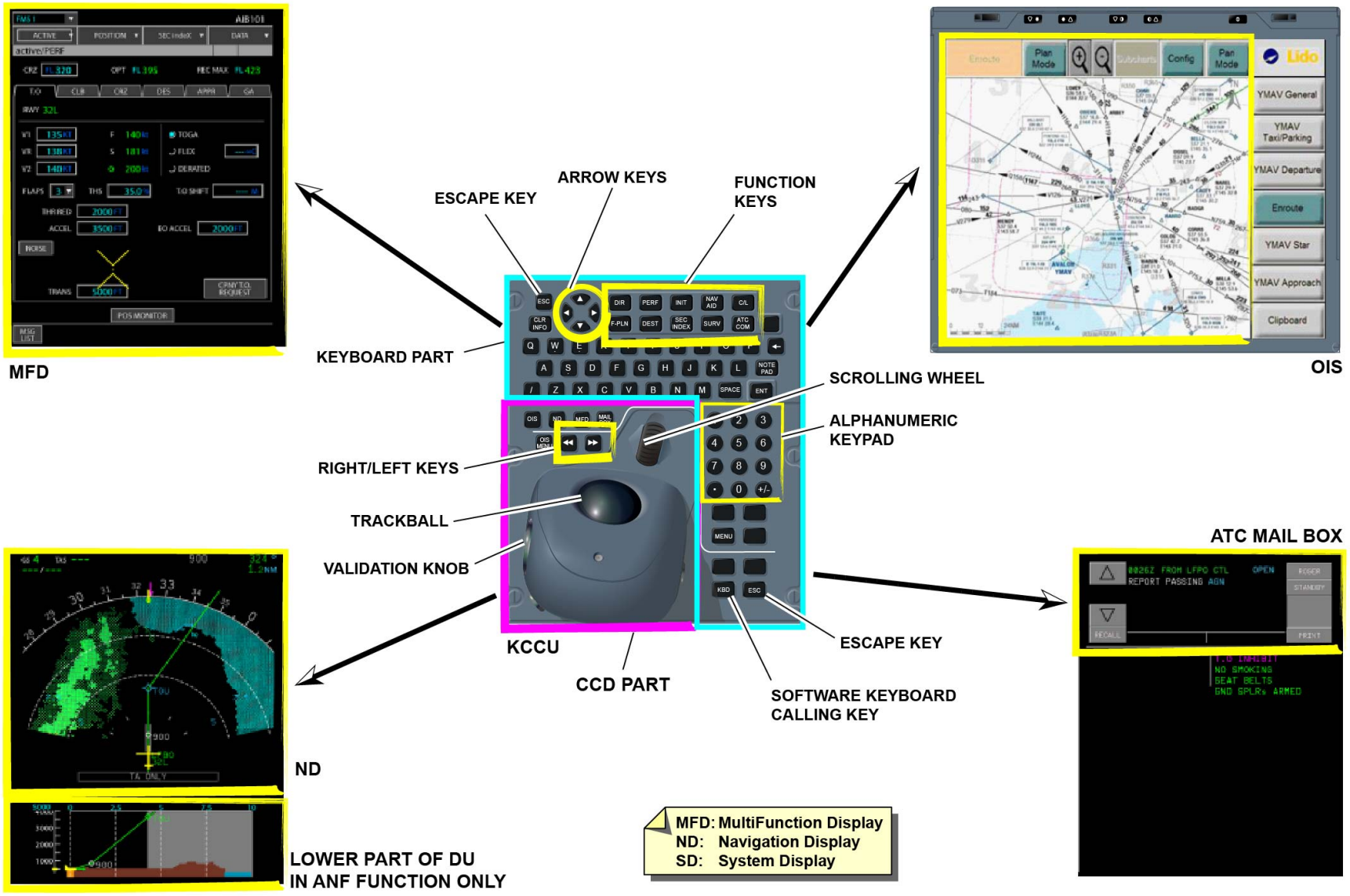


KCCU DESCRIPTION

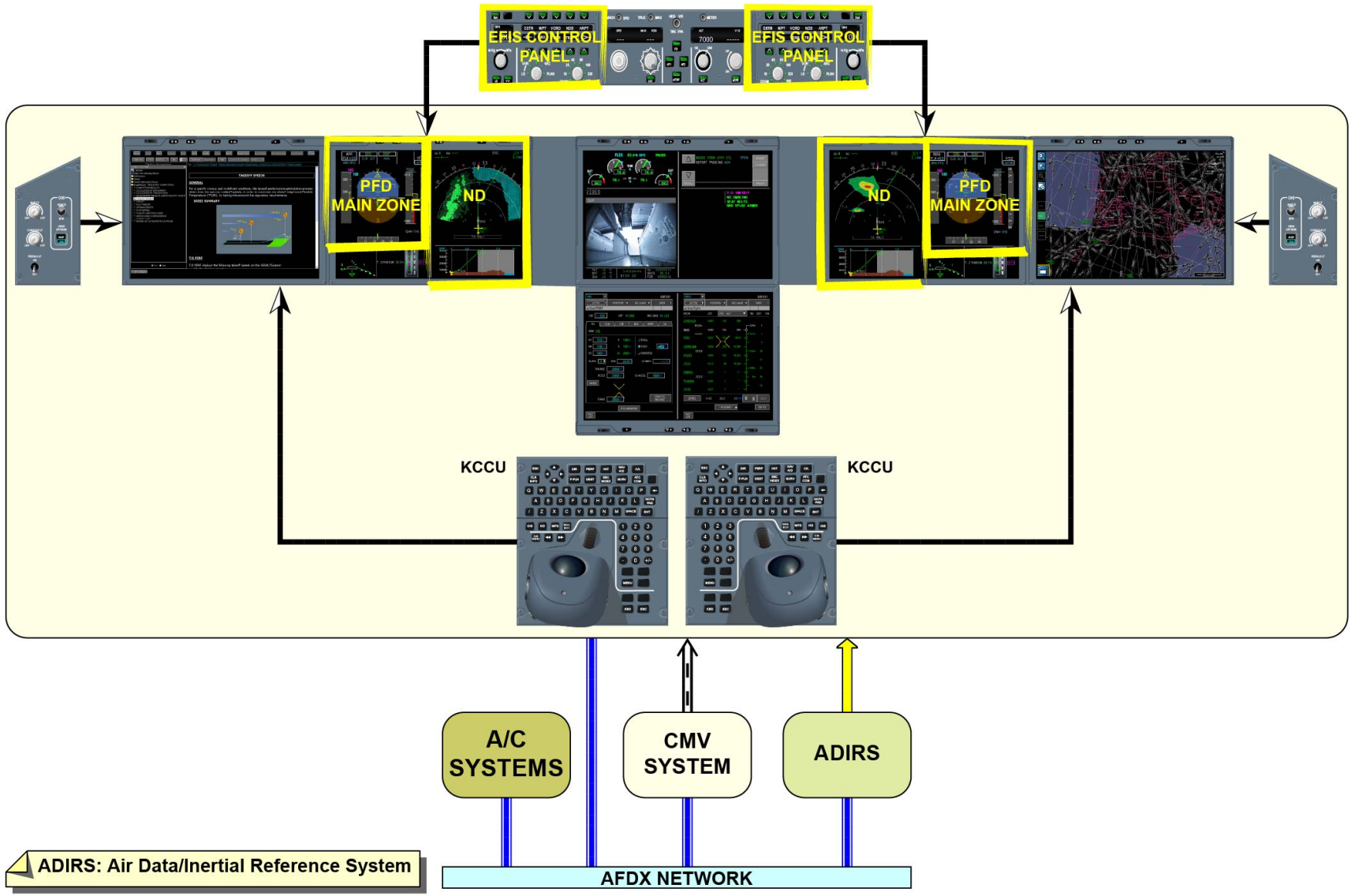
CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

EFIS Description

EFIS function

The EFIS function is to collect and show information related to the aircraft guidance and navigation.
This information is shown in front of each pilot on the PFD and on the ND. The PFD shows, on the inner DU, the flight information necessary for a short-term flight. The ND shows, on the inner DU, the information necessary for the navigation. To show this information, each DU gets data from the A/C systems.
These data include:
- ADIRS data,CMV display request through the AFDX network
- Backup connections, (e.g. ADIRS data) through ARINC 429 bus
- Video data from the CMV through optical fibers
- The aircraft systems such as the FMS, Multi-Mode Receiver (MMR), AESS and Auto Flight System (AFS), for example.

Interactivity with the EFIS is given independently to each pilot, for the display selection and reconfiguration through:
- The CAPT and F/O KCCUs, which are used to select interactive functions on their related DUs through the cursor.
- The CAPT and F/O EFIS control panels which are used to select the display modes and functions.



EFIS DESCRIPTION - EFIS FUNCTION

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

EFIS Description (continued)

EFIS displays

The EFIS information is shown on the PFDs and on the NDs.
Each PFD shows short-term flight information and is divided into two zones.
The PFD shows standard PFD data such as:
- Aircraft attitudes
- Air speed
- Altitude and vertical speed
- Heading
- Flight mode information
- Radio altitude
- Landing system data.

Each ND shows medium or long-term flight information for navigation and is also divided into two different zones.
The top part is called the ND and shows:
- The aircraft location in relation to the flight plan and/or Navigation Aid (NAVAID)
- Weather radar information
- Surveillance information.

The bottom part is called Vertical Display (VD) and shows the vertical information. It manages the vertical selected or managed profile, and gives the crew a better awareness on the A/C vertical situation. It gives a synthetic view of vertical parameters such as:
- Aircraft altitude
- Safe altitude
- Trajectory
- Terrain and weather.

The VD also shows a Flight Management (FM) dialog window on the ND.

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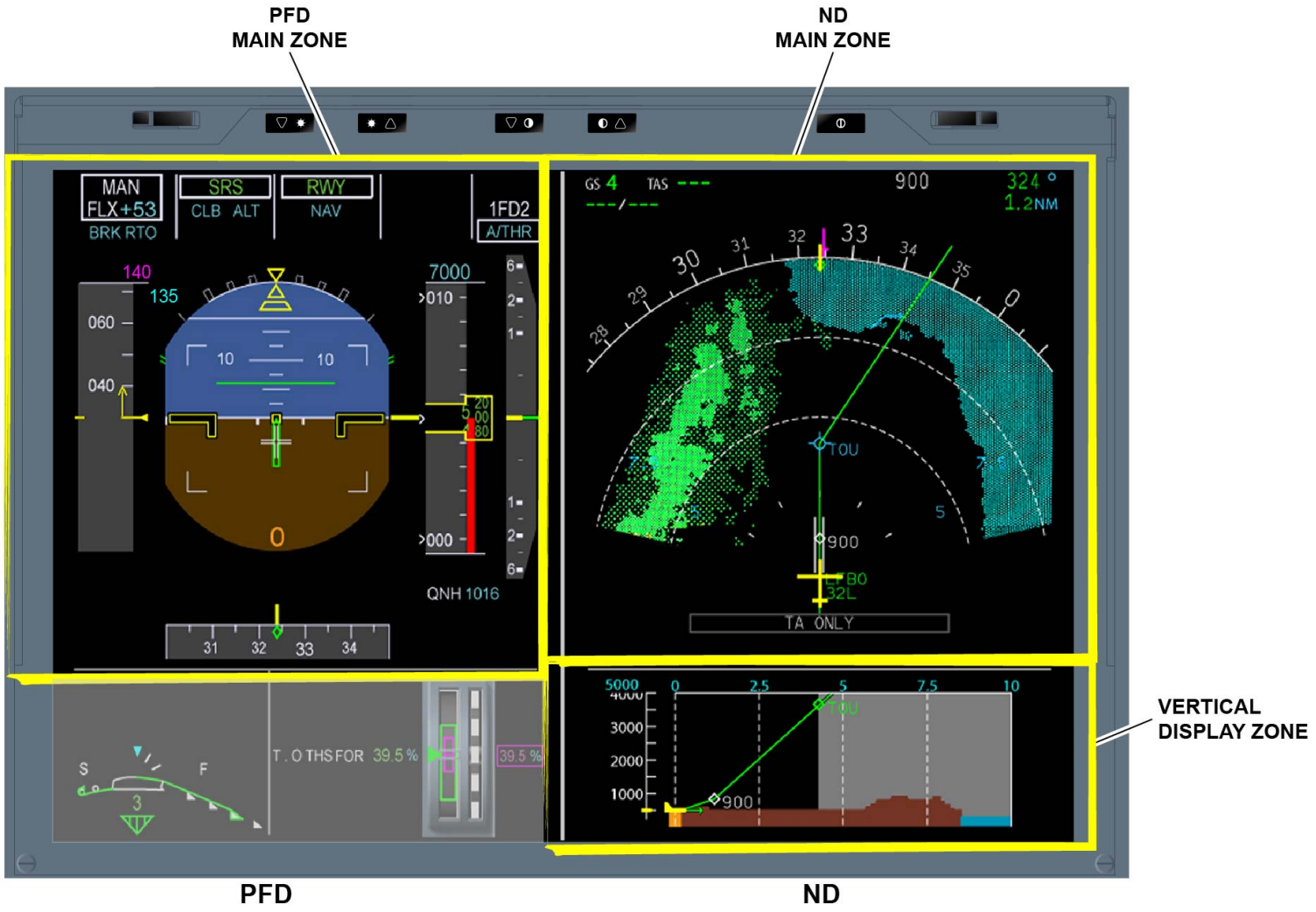


EFIS DESCRIPTION - EFIS DISPLAYS

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

ECAM

ECAM function

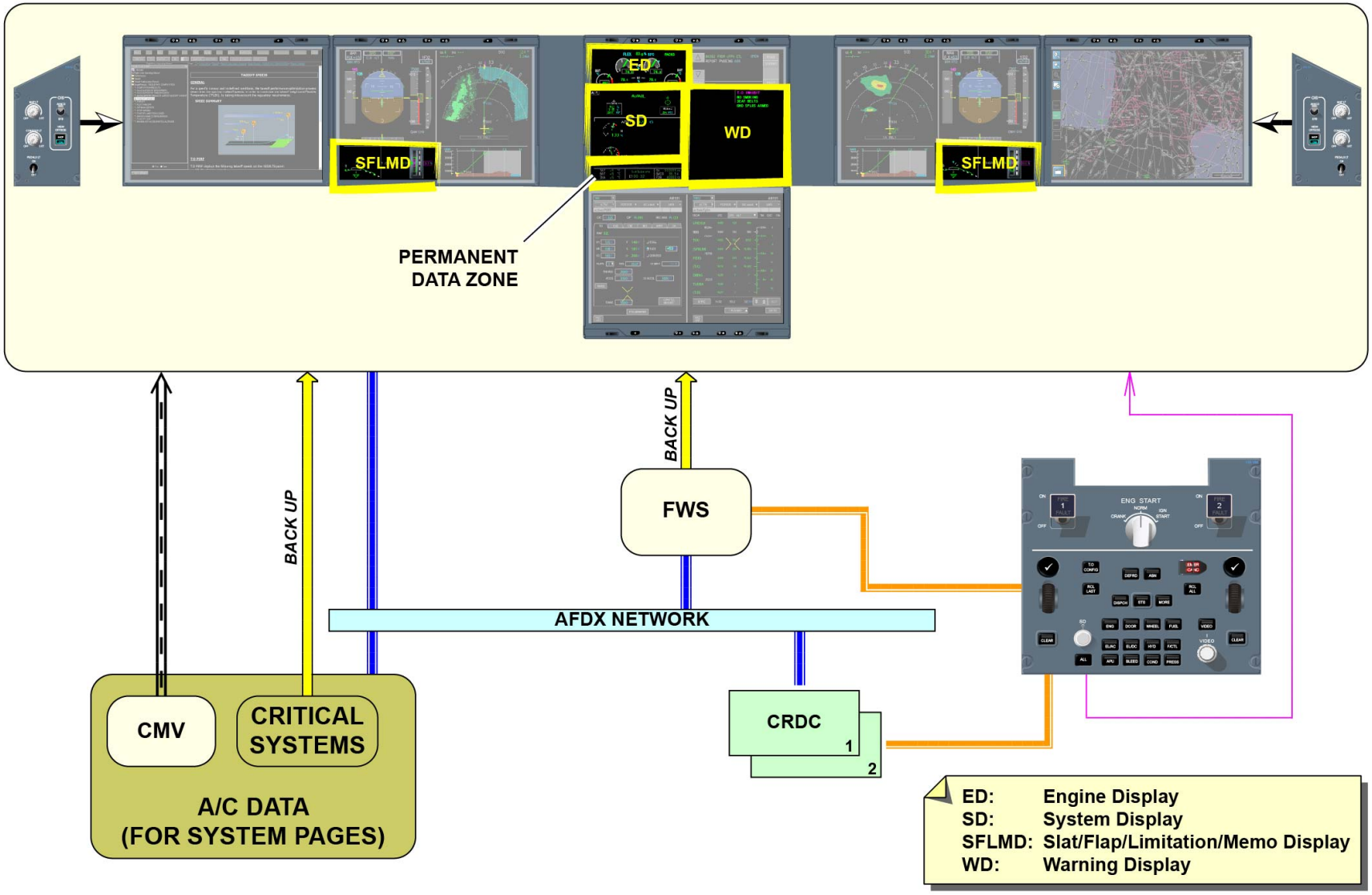
The ECAM gives information to the flight crew about normal and abnormal procedures.
The ECAM system shows A/C system data for monitoring functions and also gives a display support to the FWS.
The ECAM system includes:
- The WD
- The SD
- The ED
- The bottom zone for the display of the permanent data
- The lower part of PFD for the display of the slat flap limitation memos.

Each ECAM DU gets data from A/C systems to show the ED and the A/C system pages on the SD. It also gets and shows data from the FWS.
In normal system operation, the ECAM function gives the necessary data to help the flight crew to operate and monitor the A/C systems.
These data are shown as follows:
- System pages on the SD
- Memos on the WD, ED and slats/flaps limitation memo from the FWS
- Normal checklists on the MFD, automatically or after the flight crew request. they are also given by the FWS.

In abnormal system operation, the ECAM function helps the flight crew to manage the system failures and aircraft abnormal configurations.
It shows:
- Visual warnings and cautions given by the FWS
- Related procedures, limitations and memos also given by the FWS
- System pages related to the system failure.

To show this information, each DU gets data from the A/C systems such as:
- A/C system data to build the SD system pages from the AFDX network.
- Critical parameters for the system pages in the AFDX and ARINC 429 networks for backup connections.
- FWS data in the AFDX network (ARINC 429 backup) for the warning or caution, memos or limitations and procedures.

Interactivity with the ECAM is given to the two pilots for display the selection and reconfiguration through a single ECAM Control Panel (ECP) for the control and the selection of pages.
The ECAM control panel (ECP) controls the ECAM (CDS) through the AFDX network or directly through discrete signals. The ECP controls the FWS through the CAN bus network.
If there is a failure of the ECP, some orders (CLR, RCL, STS, EMER CANC, VALID keys and SCROLL UP/DOWN device) are directly connected to the FWS through discrete signals to do the primary function of the ECP.
The ALL key is also directly connected to the CDS through a discrete signal if there is a failure of the ECP.



ECAM - ECAM FUNCTION

CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

ECAM (continued)

ECAM mode description

The image shown on the DU, which processes the SD format, is the result of the CDS SD selection logic. It manages the priorities between the different ECAM modes. The ECAM modes are activated in relation to a decreasing priority order:

- Manual mode
- Failure related mode
- Advisory mode
- Normal mode (flight phase related mode).

A manual crew input activates the ECAM manual mode, even if the ECAM failure related mode was active.

Also, if the ECAM is in a manual mode configuration, an incoming warning automatically activates the failure related mode.

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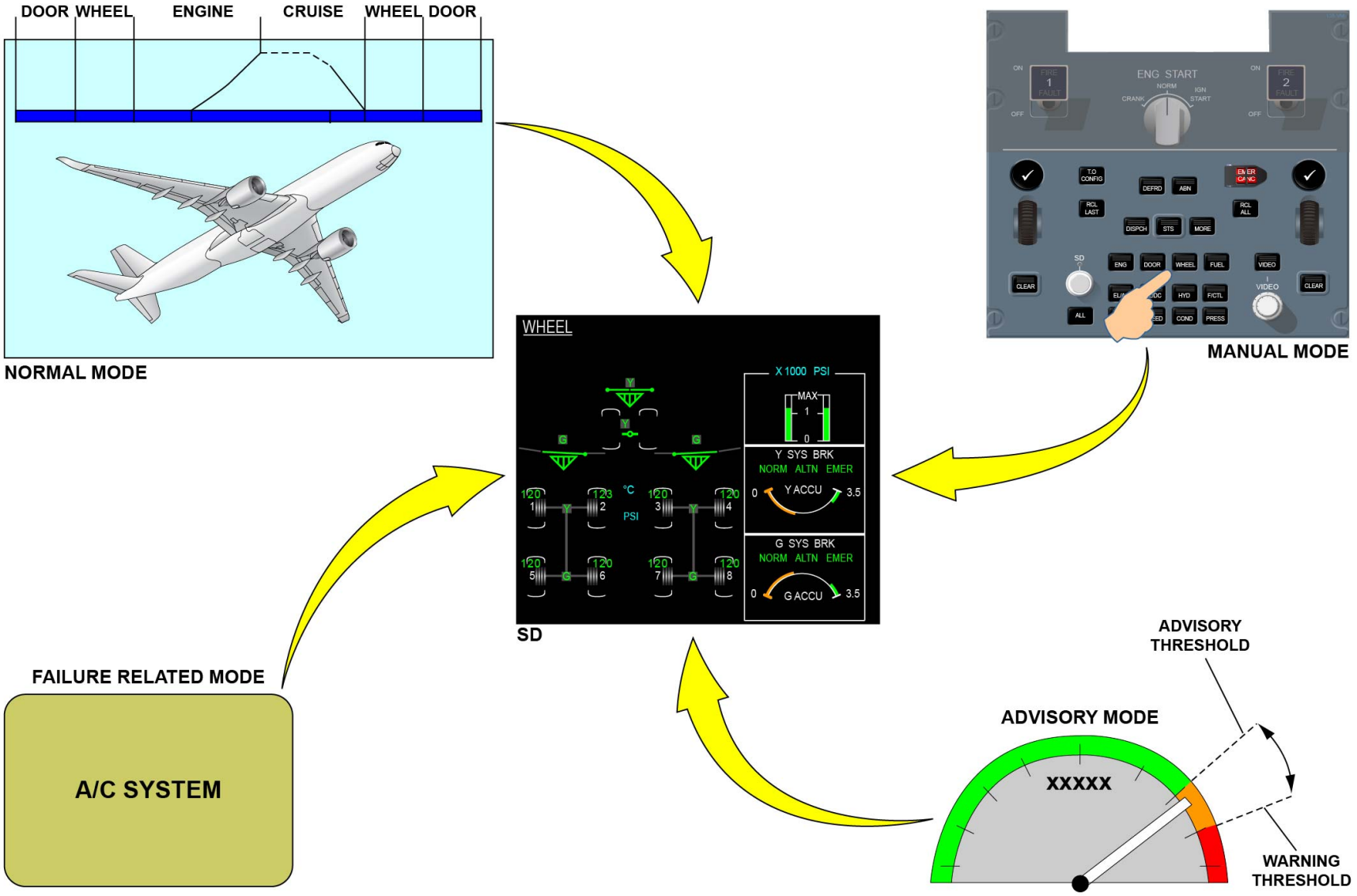

ECAM - ECAM MODE DESCRIPTION

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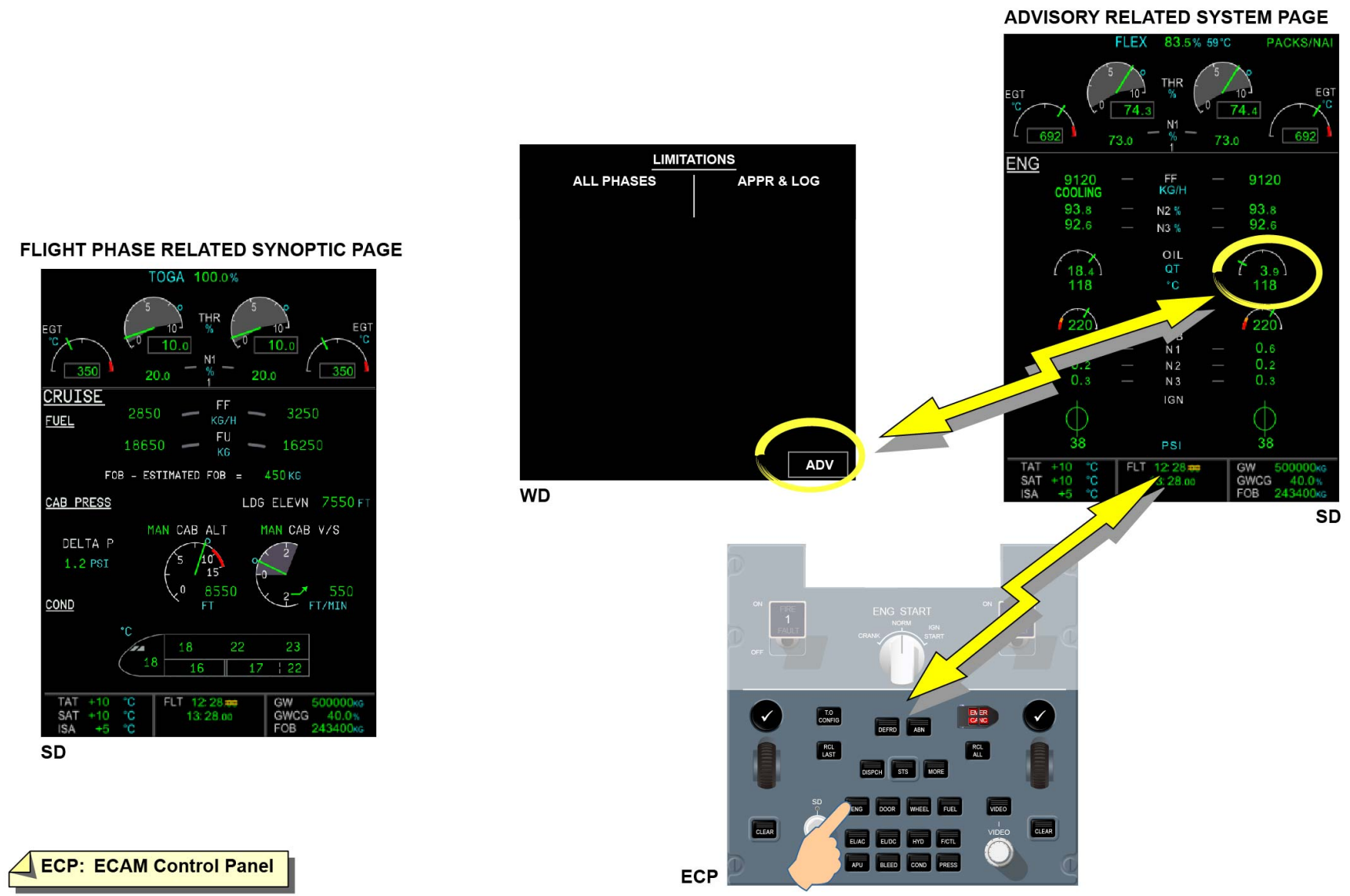
CONTROL AND DISPLAY SYSTEM DESCRIPTION (2/3)

ECAM (continued)

Advisory mode

When a monitored parameter deviates from its specified operational range, an Advisory (ADV) indication comes into view on the bottom line of the WD.
The ADV indication comes into view with the other cockpit indications, in relation to the aircraft configuration:
- The SD shows a flight phase page if there is an ADV condition.
The SD automatically shows the display page of the related system and the white light of the related pushbutton switch on the ECP comes on.
- The SD already shows a system page that follows an ADV occurrence.
If there is another ADV condition, there will be no additional indication, until the first advisory is cleared.
- The SD shows a crew requested-system page.
If there is an ADV condition, the related pushbutton switch on the ECAM control panel flashes. This tells the flight crew to push it.
- If the SD shows a system page that follows an ECAM alert, there will be no more indication on the WD.
The ADV indication goes out of view from the WD when:
- The flight crew pushes the related pushbutton switch on the ECP
- The parameter goes back to its specified operational range.



ECAM - ADVISORY MODE

CONTROL AND DISPLAY SYSTEM CONTROL AND INDICATING (2/3)

CDS controls - Use of ECP (2)

Via the ALL key, SD rotary selector and dedicated SD page key on the ECP, you can access to the different system pages

CDS controls - Use of KCCU (2)

With the KCCUs you can put the KCCU pointer on other DU by using the double arrow keys.
The shortcut keys allow you to access directly to the different DUs:
- OIS,
- ND,
- MFD,
- Mail-box.

CDS Automatic Reconfiguration (3)

The DUs pushbuttons switches are used to set the DUs to ON/OFF.
DUs automatic reconfigurations when DU INNER CAPT or F/O off.
When DU CAPT or F/O button is in off position to simulate failure, the DU CAPT or F/O image appears on the relevant OIS (DU-OUTER CAPT or DU-OUTER F/O).
DUs automatic reconfigurations when DU-UPPER, CENTER off.
When the DU-UPPER CENTER button is selected OFF to simulate a failure, the DU-UPPER CENTER image appears on the DU LOWER CENTER.

CDS Manual Reconfiguration (3)

ON/OFF P/B is used to simulate DU failure.
Set DU-LOWER, CENTER in the OFF position.
You can see there is no automatic reconfiguration.
Now, depress Captain DISPLAY CYCLE button. There is a manual reconfiguration on a remaining display unit to recover the lost display.
Depress Captain DISPLAY CYCLE button until you come back to the initial configuration.
Now, depress F/O DISPLAY CYCLE button. There is a manual reconfiguration on a remaining display unit to recover the lost display.
Depress F/O DISPLAY CYCLE button to come back initial configuration.
Set DU-LOWER, CENTER to ON.

CDS Manual Reconfiguration for OIS (3)

Manual reconfiguration can be initiated.
Push the OIS CENTER button to bring OIS display to the center lower display (Above the MFD).
Push again to return in the original configuration.
Push the VIEW OFFSIDE button to bring a copy of the opposite OIS view. Note that there is no interactivity on the format.
Push again to return in the original configuration.

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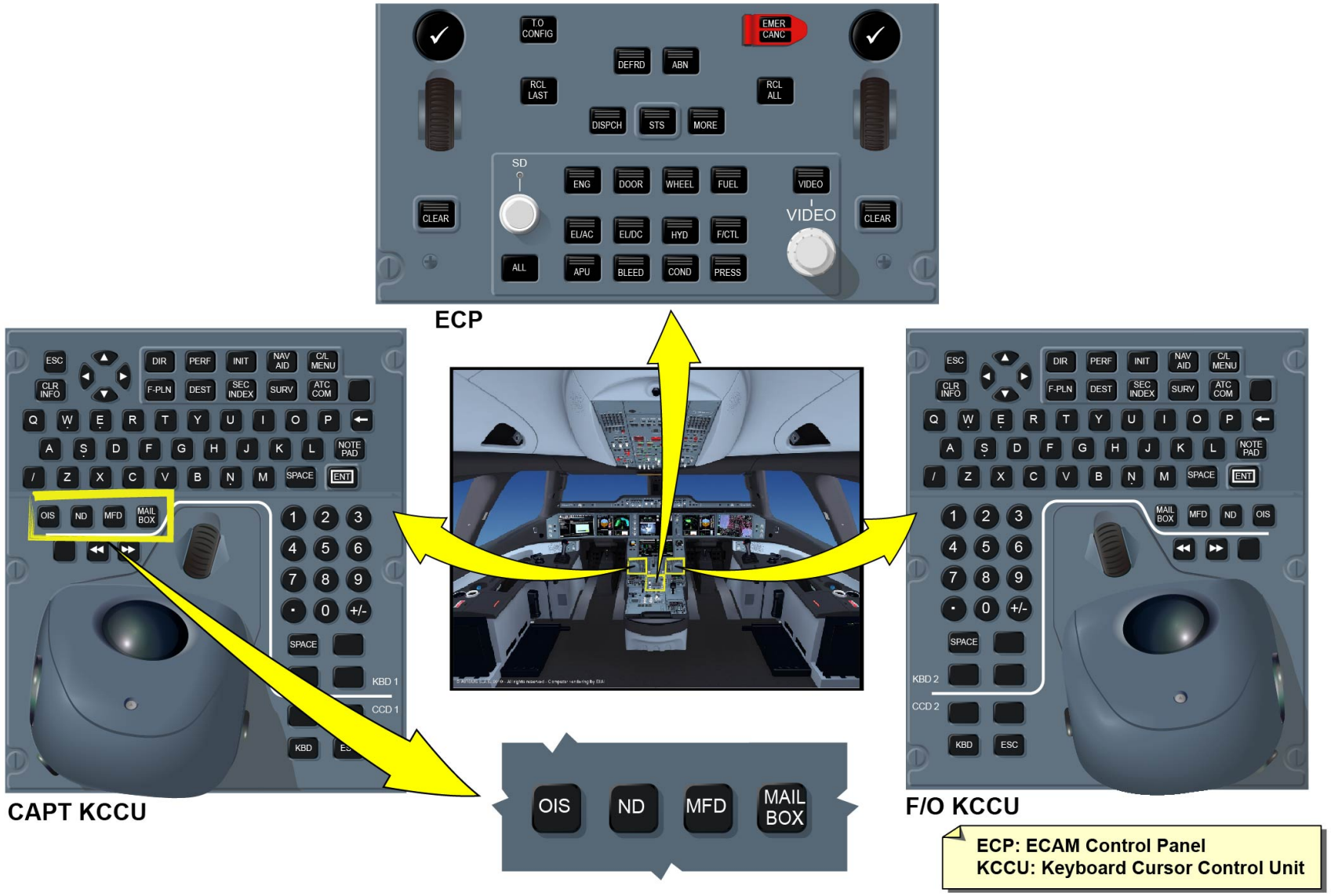

CDS CONTROLS - USE OF ECP (2) ... CDS MANUAL RECONFIGURATION FOR OIS (3)

CDS CONTROLS - USE OF ECP (2) ... CDS MANUAL RECONFIGURATION FOR OIS (3)

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CDS CONTROLS - USE OF ECP (2) ... CDS MANUAL RECONFIGURATION FOR OIS (3)

CDS CONTROLS - USE OF ECP (2) ... CDS MANUAL RECONFIGURATION FOR OIS (3)

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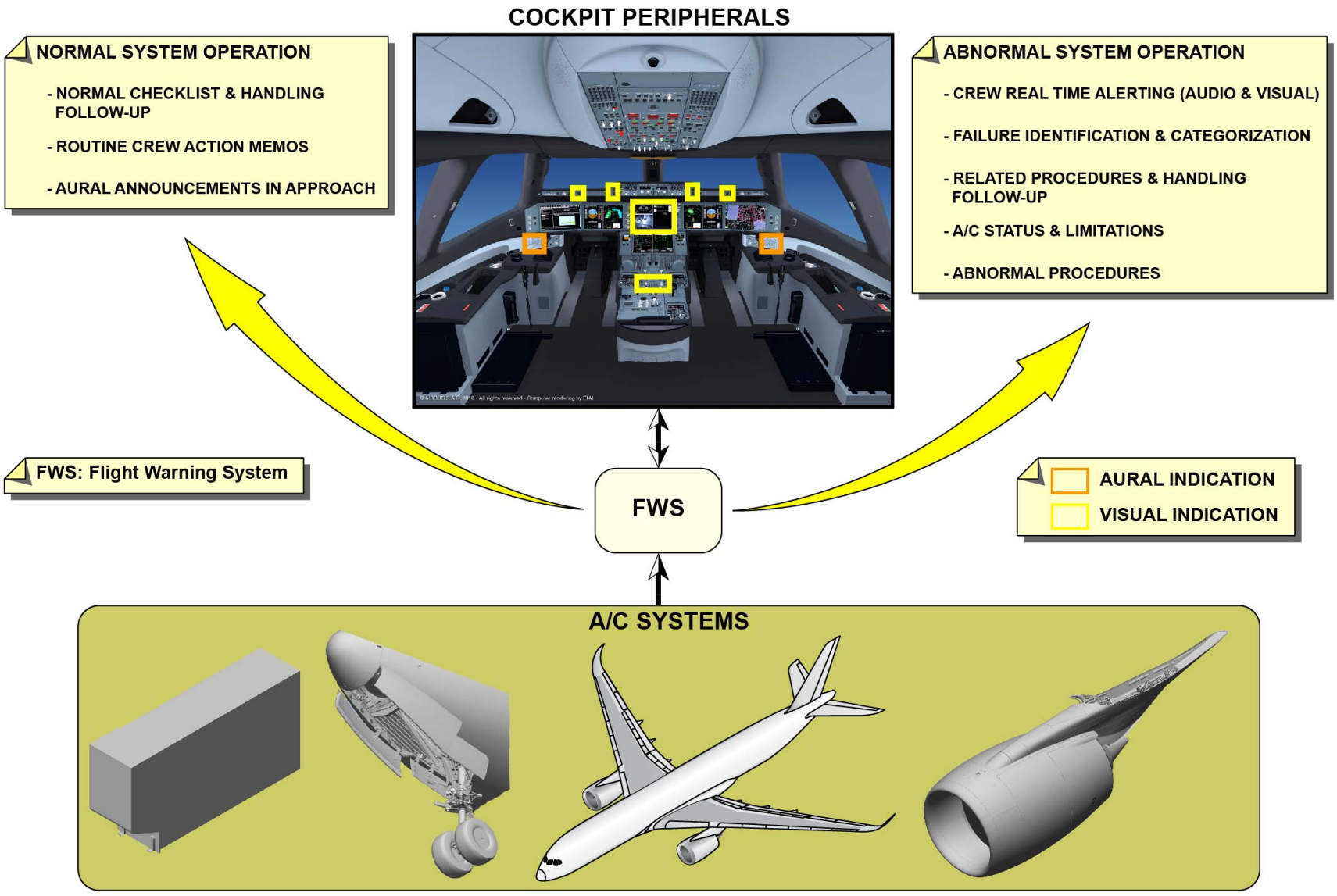
V1813401 - V01T0M0 - VM31I2CDISP3001

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

General

The Flight Warning System (FWS) is a centralized system that lets the crew have a better monitoring in normal and abnormal A/C system operations. If there is a failure of the A/C systems, or if there is an abnormal configuration of the A/C, the FWS:
- Tells the crew in real time about the level of the failure
- Identifies failures and divides them into groups through caution and warning messages
- Helps the pilots to isolate the failure through a related procedure
- Gives failure effects on the A/C status and on flight operations (limitations and dispatch information).

To supply these functions, the FWS:
- Monitors all the A/C systems, identifies and divide failures into categories
- Operates voice and visual alert indications with the cockpit peripheral
- Gives abnormal procedures related to events that cannot be detected
- Helps the crew with the normal checklists, memos and voice announcements in approach in normal operation.


COCKPIT PERIPHERALS
NORMAL SYSTEM OPERATION
- NORMAL CHECKLIST & HANDLING FOLLOW-UP
- ROUTINE CREW ACTION MEMOS
- AURAL ANNOUNCEMENTS IN APPROACH
ABNORMAL SYSTEM OPERATION
- CREW REAL TIME ALERTING (AUDIO & VISUAL)
- FAILURE IDENTIFICATION & CATEGORIZATION
- RELATED PROCEDURES & HANDLING FOLLOW-UP
- A/C STATUS & LIMITATIONS
- ABNORMAL PROCEDURES
FWS: Flight Warning System
FWS
AURAL INDICATION
VISUAL INDICATION
A/C SYSTEMS

GENERAL

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

General (continued)

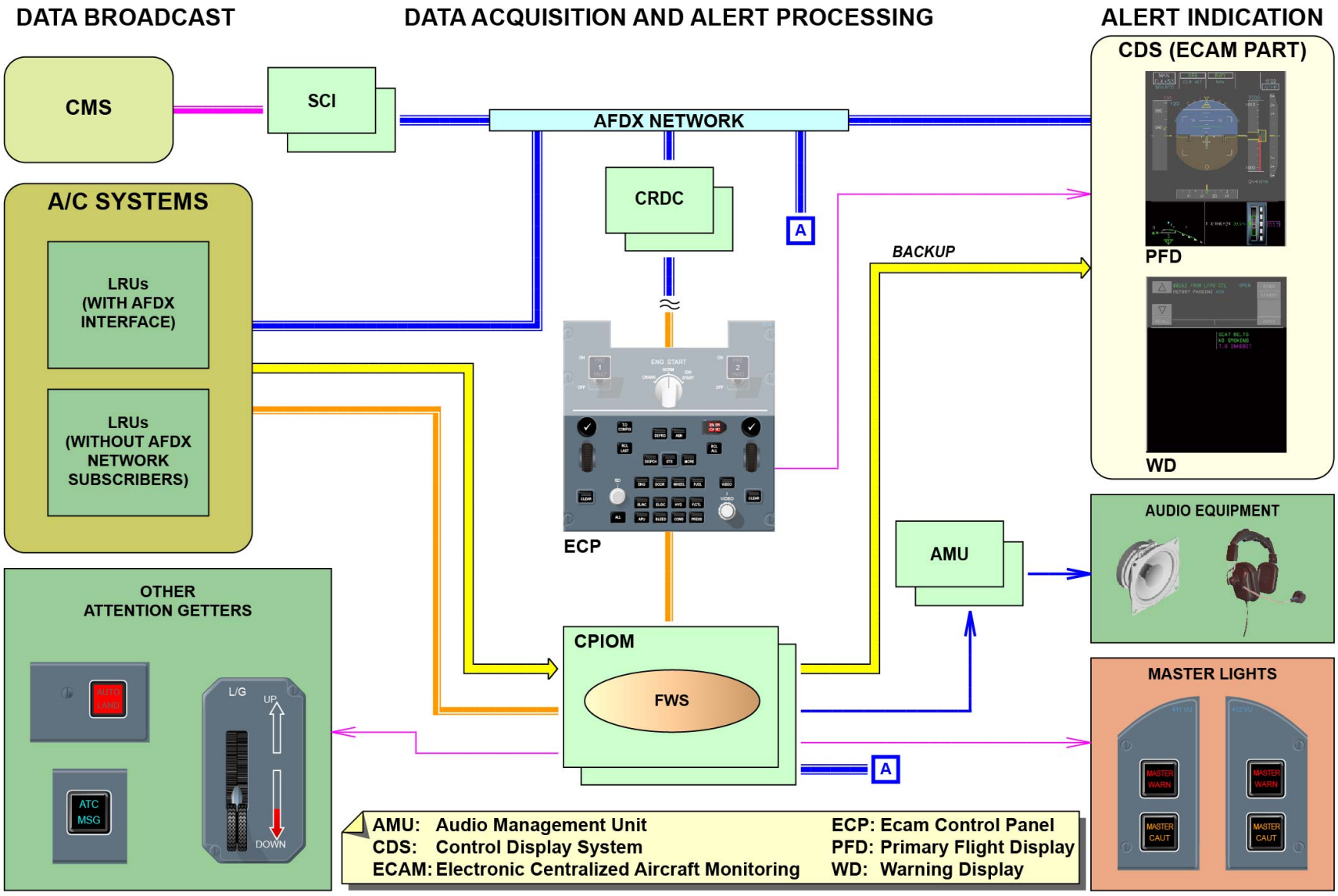
Architecture

The FWS is a central alerting system, which gives the flight crew operational aid for normal and abnormal situations (system failure or abnormal A/C configuration).
The FWS continuously monitors the A/C systems and sensors. It has two fully redundant flight warning applications hosted in two same CPIOMs, which do the same computation in parallel.
These applications acquire data and parameters from the A/C systems through:
- LRMs and LRUs with an AFDX interface through the AFDX network
- ARINC 429 bus for standard LRUs
- Analog and discrete signals, directly, from other standard LRUs.

Most LRMs and LRUs with the AFDX network interface are also directly connected to the ARINC 429 buses (backup function). Some of the functions (e.g. primary engine parameters display) use Controller Area Network (CAN) backup interface.
The FWS also includes attention getters and ECAM control panel.
The attention getters include master lights as MASTER CAUT and MASTER WARN (also Air Traffic Control (ATC), AUTO LAND and L/G not down warning lights).
Then, if an A/C system failure or configuration change occurs, or if an A/C abnormal configuration is detected, the FWS generates warning and caution messages that are shown on the CDS (through the AFDX network or ARINC 429 backup). The FWS also generates analog alert signals which are sent to the acoustic equipment (e.g. loudspeakers) through the Audio Management Units (AMUs).
The FWS also controls the visual attention getters through discrete signals. This is the alert processing.
The interface between the flight or maintenance crew and the FWS is made through the ECAM control panel.

The ECP does the functions that follow:
- Controls caution and warning related procedures
- Calls the status page on the System Display (SD)
- Calls and manages the normal checklists and abnormal procedures.

The ECP is connected to the FWS applications hosted in the CPIOMs through CAN buses connections and through the AFDX network. If there is a loss of the AFDX network, discrete connections keep in operation most of its functions.



GENERAL - ARCHITECTURE

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Failure Categorization

There are three types of failures:
- Independent failure
- Primary failure
- Secondary failure.

An independent failure is a failure which only refers to an isolated system or a system component (it does not refer to other system (e.g. main fuel-pump failure)).

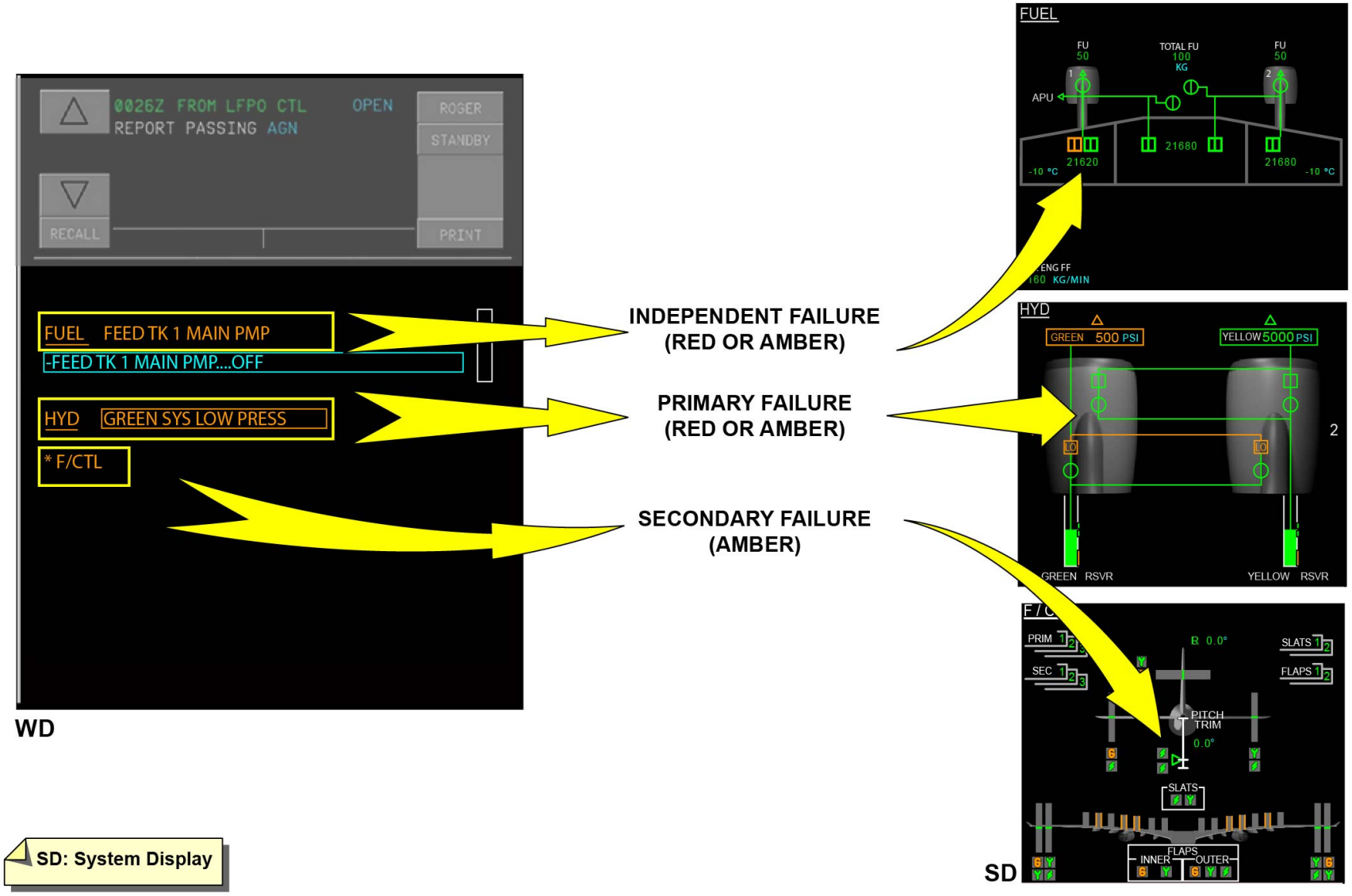
A primary failure is a failure of a system or a system component which causes the loss of other systems or equipment (e.g. green hydraulic-system failure).

A secondary failure is the loss of a system or a system component which is the result of a primary failure (for example: loss of spoilers 2, 4, 6 and 8).

Independent failures are shown as follows:
- Red or amber message
- System indication underlined.

Primary failures are shown as follows:
- Red or amber message
- System indication underlined
- Warning text surrounded.

Secondary failures are shown as follows:
- Amber asterisked message.



FAILURE CATEGORIZATION

V1813401 - V01T0M0 - VM31D3FWRNG3001

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alert Classification

The alerts are divided into four levels, in relation to the importance and the urgency of the crew corrective actions necessary .

Level 3 alert description

A level 3 alert refers to an emergency situation for which an immediate reaction of the crew is necessary.
The warnings include:
- A/C in dangerous configuration or limit flight conditions (e.g. OVERSPEED)
- System failure (e.g. ENGINE/APU FIRE, EXCESS CABIN ALT).

Level 2 alert description

A level 2 alert refers to an abnormal situation of the A/C for which crew awareness and subsequent corrective or compensatory crew actions are necessary.

Level 1 alert description

A level 1 alert refers to a configuration for which the crew monitoring and also crew action can be necessary. This level includes the failures that cause a loss of redundancy or performance degradation of a system (e.g. loss of the left or right main fuel tank pump but not the stand by one).

Level 0 alert description

Level 0 indications refer to operational or A/C system conditions for which a flight deck indication is necessary (e.g.: memos such as ENG A-ICE on, ECAM advisories, dispatch messages, etc.).

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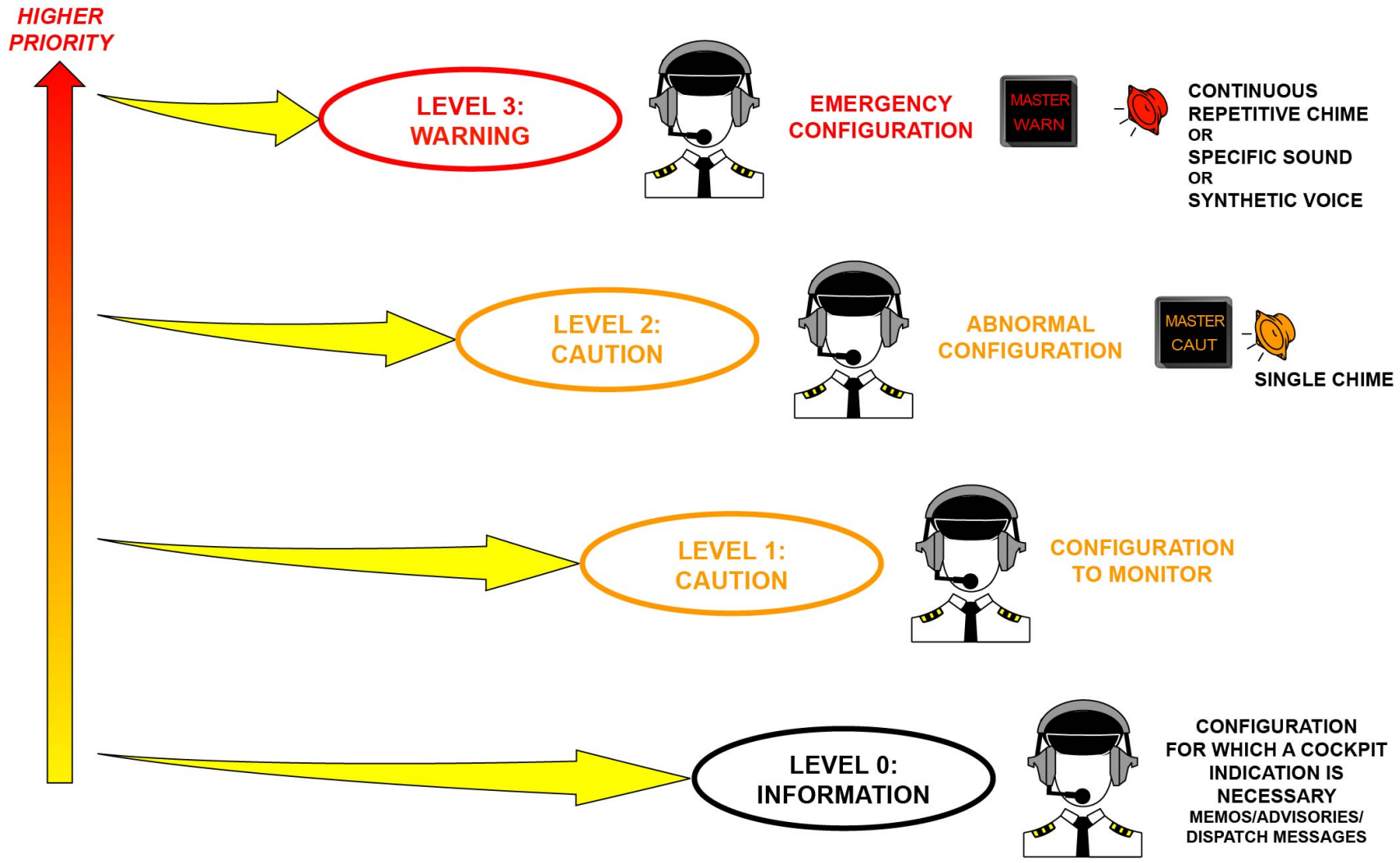

ALERT CLASSIFICATION - LEVEL 3 ALERT DESCRIPTION ... LEVEL 0 ALERT DESCRIPTION

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alert Classification (continued)

Level 3 alert activation

When it is activated, a level 3 causes the alerts that follow in the cockpit:
- An aural alert operated by the Continuous Repetitive Chime (CRC) or a special sound or a synthetic voice broadcast through the cockpit loudspeakers
- A visual alert shown by the two master-warning red-flashing lights
- A red warning message usually shown on the Warning Display (WD)
- The automatic display of the ECAM page (synoptic) of the related SD as applicable.

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ALERT CLASSIFICATION - LEVEL 3 ALERT ACTIVATION

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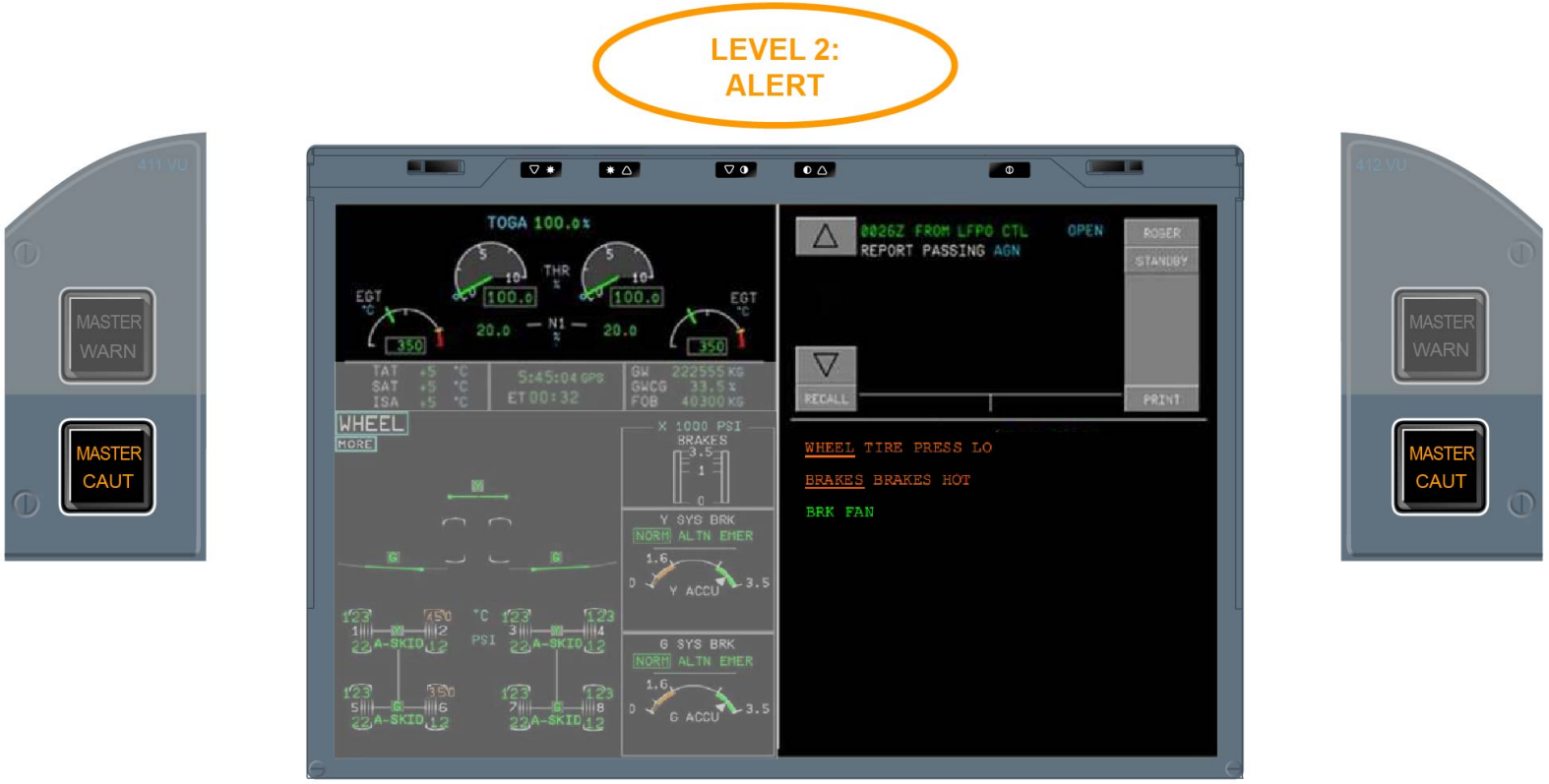
FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

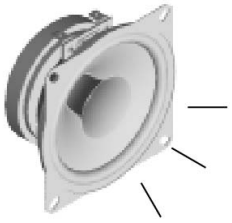
Alert Classification (continued)

Level 2 alert activation

When it is activated, a level 2 causes the alerts that follow in the cockpit:
- An aural alert caused by one chime through the cockpit loudspeakers
- A visual alert shown by the two master caution amber fixed lights
- An amber caution message on the WD
- The automatic display of the related system synoptic-ECAM page on the SD, as applicable.

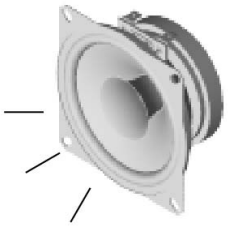


ECAM DISPLAY ZONES



SINGLE CHIME

SINGLE CHIME



ALERT CLASSIFICATION - LEVEL 2 ALERT ACTIVATION

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alert Classification (continued)

Level 1 alert activation

When it is operated, a level 1 alert does not cause visual or aural attention getters but causes:
- An amber caution message on the WD
- The automatic display of the ECAM synoptic-page of the related system on the SD, as applicable.

ECAM DISPLAY (SD & WD ZONES)

NO CHIME

NO CHIME

ALERT CLASSIFICATION - LEVEL 1 ALERT ACTIVATION

V1813401 - V01T0M0 - VM31D3FWRNG3001

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alert Classification (continued)

Level 0 alert activation

The dispatch message is an example of a level 0 alert activation. Each alert which has an effect on the next flight is related to a message shown on the dispatch page.
The dispatch function can identify:
- System failures which have an effect on the flight in progress
- Other system failures related to dispatch (after the flight).

The dispatch function sends dispatch messages in a new dedicated page shown on the SD.
One dispatch message is related to one MMEL item.

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LEVEL 0:
ALERT

ECAM DISPLAY (SD & WD ZONES)

NO CHIME

NO CHIME

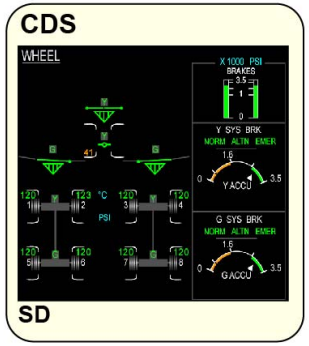
ALERT CLASSIFICATION - LEVEL 0 ALERT ACTIVATION

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alert and Flight Phase Computation

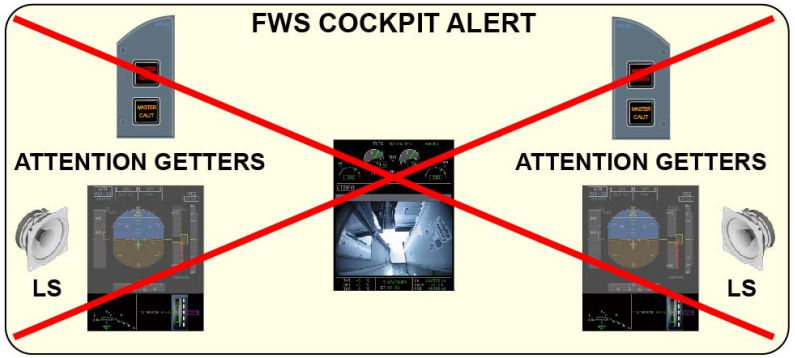
For the FWS, the calculation of flight phases is used to display or inhibit some alerts in relation to the A/C condition when a failure occurs. This prevents to disturb the pilots during high workload phases with useless information (e.g.: TakeOff (T.O) and Landing (LDG) inhibitions).
The FWS calculates the 13 flight phases in relation to A/C parameters.
The different systems use the FWS flight phases for:
- Automatic pop up of CDS normal checklists
- CMS computation of some maintenance flight phases
- BITE function of some systems
- Display of the synoptic pages related to the flight page in progress
- Etc.

In case of flight phase calculation failure, the system will select and show phase 8 by default.



ECAM NORMAL MODE

FLIGHT PHASE
RELATED PAGES

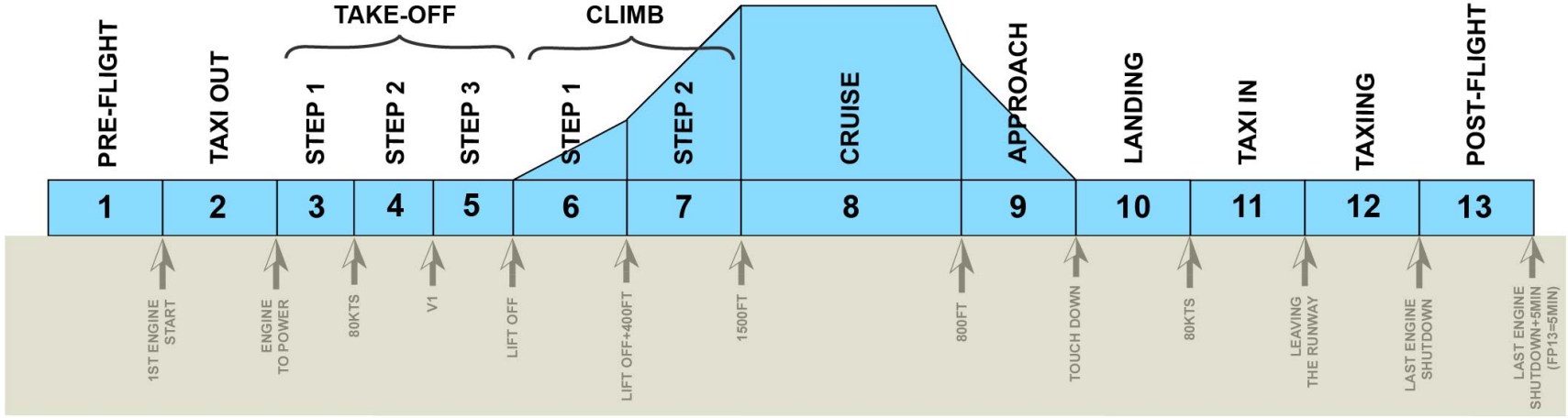


ALERT INHIBITION
(E.G. DURING T.O ON LDG)

CMS

CONTEXTUAL
INFORMATION

LDG: Landing
LS: Loudspeaker



ALERT AND FLIGHT PHASE COMPUTATION

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FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Alerts Computation and Processing

The FWS does the function that follows:
- A/C system data acquisition and computation
- Gives a better situation awareness and decreases the flight crew workload
- Computes data for its own use and other systems
- Sends the flight phases which are necessary to them to other systems (e.g.: CDS, Head-Up Display (HUD) system, CMS, Digital Flight Data Recording System (DFDRS), etc.).
- Alert identification
- Gives the flight crew visual and/or aural alerts and associated recovery procedure (failure/hazard detection, crew alerting function, fault identification, fault isolation)
- Gives the alert context and dispatch messages context in progress to the CMS, optional Electronic Logbook (e-Logbook), Electronic Flight Bag (EFB), etc.
- Alert management
- Gives an automatic call-out announcement
- Gives electronic normal checklists
- Manages aural alerts priorities at cockpit level.
- Automatic alerts display and recording
- Sends memo messages information
- Sends dispatch messages.
- Alerts display on crew input
- Provides A/C operational status
- Provides deferred procedures
- Provides electronic not-sensed abnormal/emergency procedures
- Provides flight crew with HMI controls (ECP, some attention getters).

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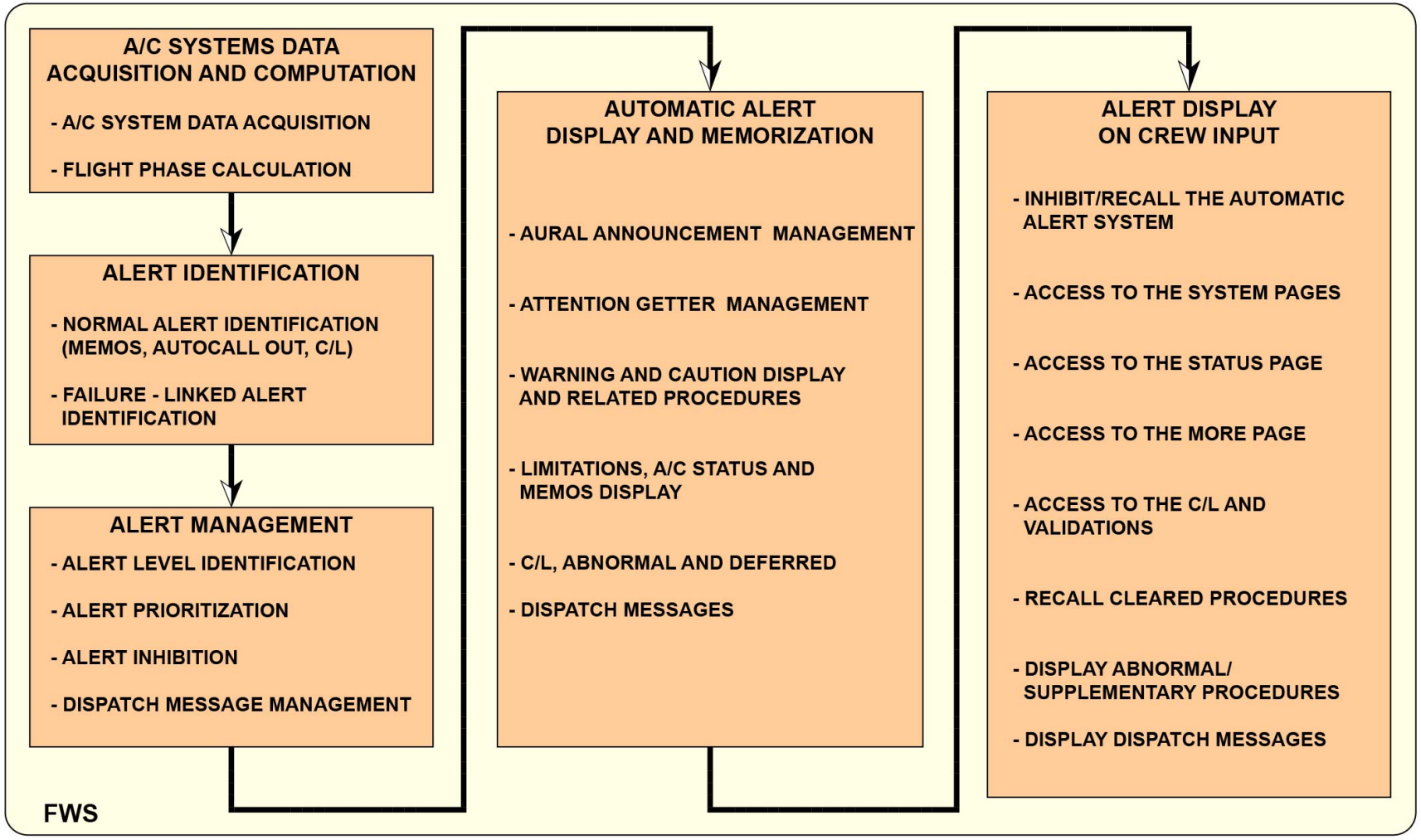


ALERTS COMPUTATION AND PROCESSING

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

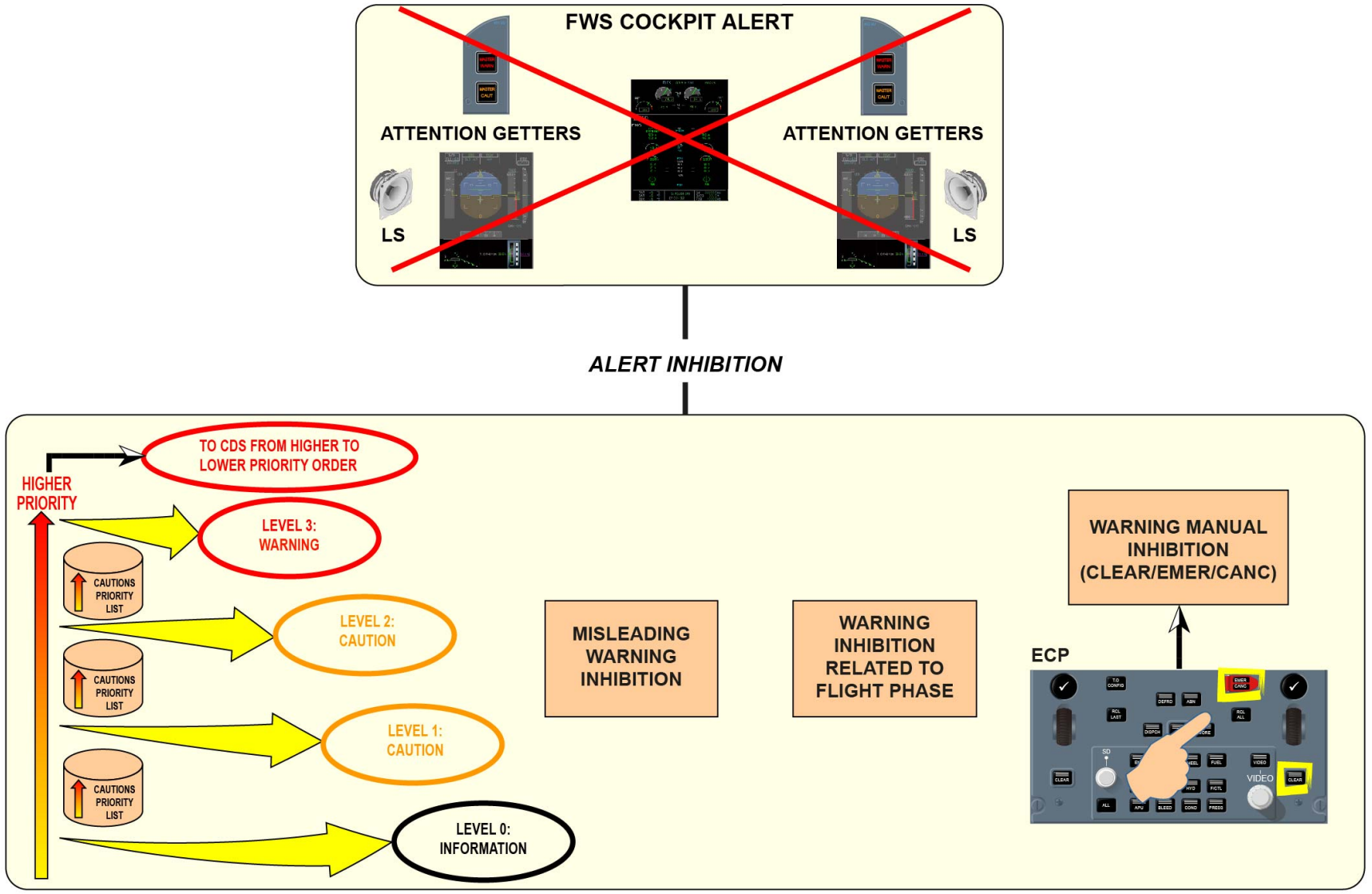
FWS Function in A/C or System Abnormal Configuration

Alert priorities and inhibitions

To control warning or caution messages, attention getter alerts and voice announcements, the FWS uses a priority and inhibition logic.
The alerts are divided into four levels, in the sequence that follows (from the most to the less important):
- Level 3 alert
- Level 2 alert
- Level 1 alert
- Level 0 alert.

For each level, a priority between warnings is also given.
Some warning messages with their related procedures can be shown in the limit of the available area on the WD. They are always shown in the same sequence, which is not in relation to the chronology of the different warnings that occur, but linked to the priority level given in the FWS.
Two different sounds cannot be transmitted at the same time and two different synthetic voices cannot be transmitted at the same time.
But one sound and one synthetic voice can be transmitted together.
The MASTER WARN and MASTER CAUT lights can come on at the same time.
The inhibition logic is used to do the functions that follow:
- Supply the correct alerts only when necessary.

A warning or indication which has no signification on a given configuration is not operated (e.g. hydraulic low-pressure warning is inhibited before the engine starting) (to prevent misleading warnings).
- Prevent alerts which are not important for a flight phase. The inhibition logic selects the display, in relation to the flight phase (during T.O and LDG phases, many warnings and cautions are inhibited to prevent a too important workload for the crew).
- Let the crew cancel alerts when corrective actions are completed:
- An ECP action (CLEAR key function)
- A RCL key long action (>3s!) recalls T.O INHIBIT and LDG INHIBIT memo (data given in magenta in the memo list).
- An EMER/CANC key action on the ECP cancels the related display, the audio signal and the MASTER CAUT light if there are level 1 or level 2 alerts.
- An EMER/CANC key action on the ECP only cancel the audio signal and the MASTER WARN light if there is a level 3 alert.



FWS FUNCTION IN A/C OR SYSTEM ABNORMAL CONFIGURATION - ALERT PRIORITIES AND INHIBITIONS

V1813401 - V01T0M0 - VM31D3FWRNG3001

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Aural Announcements

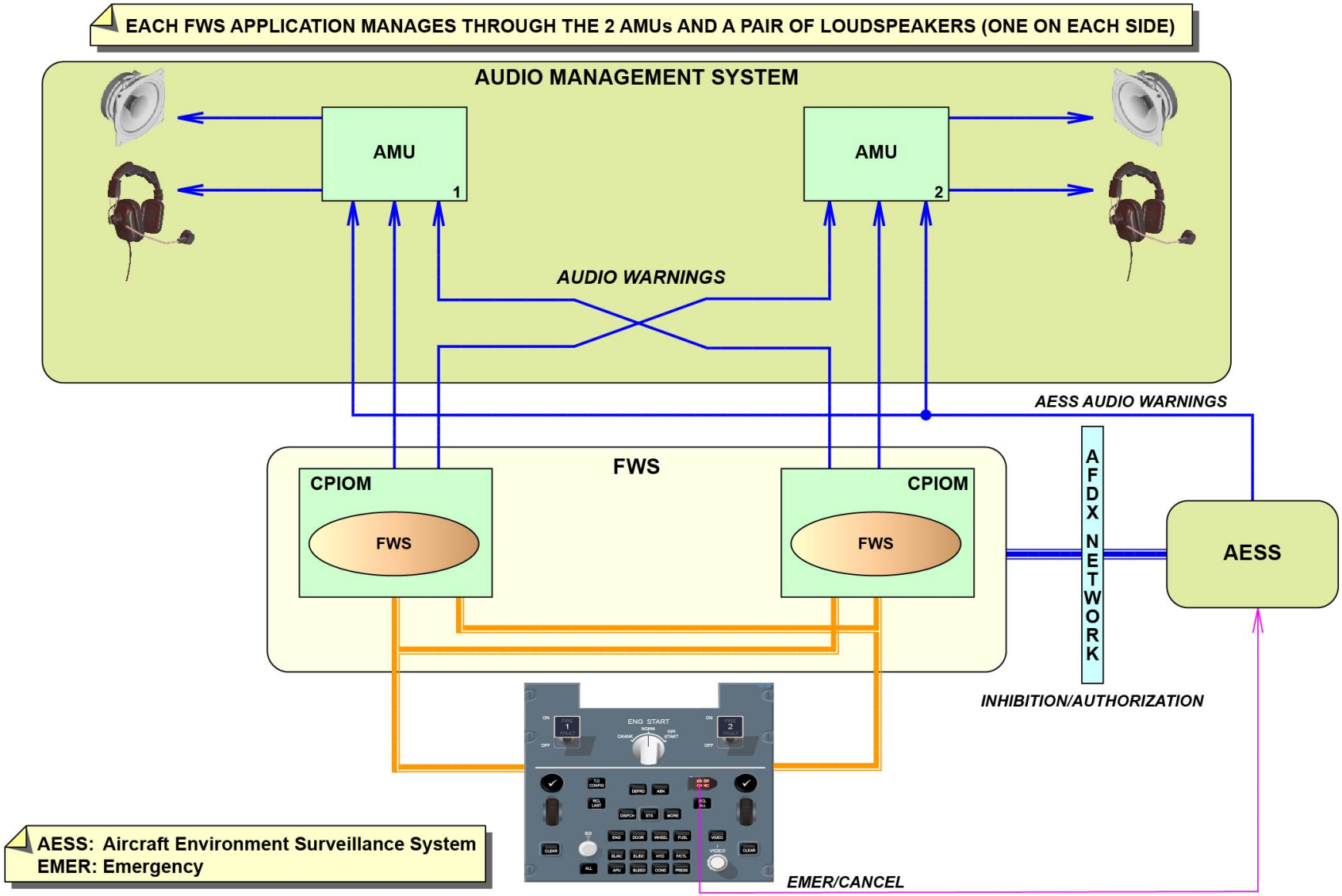
Aural announcement generation architecture

To send aural alerts (audio or voice) to the flight crew, the FWS sends the audio analog signals to the Audio Management System (AMS) for amplification and distribution to the cockpit audio equipment (loudspeakers (4), boomsets, headsets, etc.). The audio warning inputs are sent to each AMU, which are connected to the audio outputs of the FWS.

The audio warning inputs are sent to each AMU, which are connected to the audio outputs of the FWS.

The Aircraft Environment Surveillance System (AESS) sends its own audio signals to the AMS. The FWS manages the aural alert priority at the cockpit level. The FWS sends authorization or inhibition signals to the AESS. This system can interrupt immediately its own aural transmission on the FWS request (because of higher priority alert-incoming), to prevent superimposition. To manage the alert priority, the FWS and AESS have interfaces through the AFDX network.

The EMER/CANCEL key also has interfaces with the AESS (through a discrete signal) to stop the alert in progress generated by the AESS. If there is a communication loss, the default state is an authorization state.



AURAL ANNOUNCEMENTS - AURAL ANNOUNCEMENT GENERATION ARCHITECTURE

FLIGHT WARNING SYSTEM DESCRIPTION (2/3)

Aural Announcements (continued)

List of aural announcements

The FWS supplies different voice announcements in relation to the system status and A/C configuration received from the A/C systems. Then, the FWS transmits these voice announcements to the AMUs for amplification and transmission through the cockpit audio equipment.

These aural announcements can be divided into three groups:

- Sounds
- Synthetic voices
- Hybrid sounds or voice messages.

They are used to let the crew know if warnings or cautions are sent, or for instinctive reaction in relation to special events or configuration.

The general sounds include:

- The Single Chime (SC) related to the cautions
- The Continuous Repetitive Chime (CRC) related to most of the warnings
- The special sounds for instinctive reactions
- The synthetic voices.

The special sounds include:

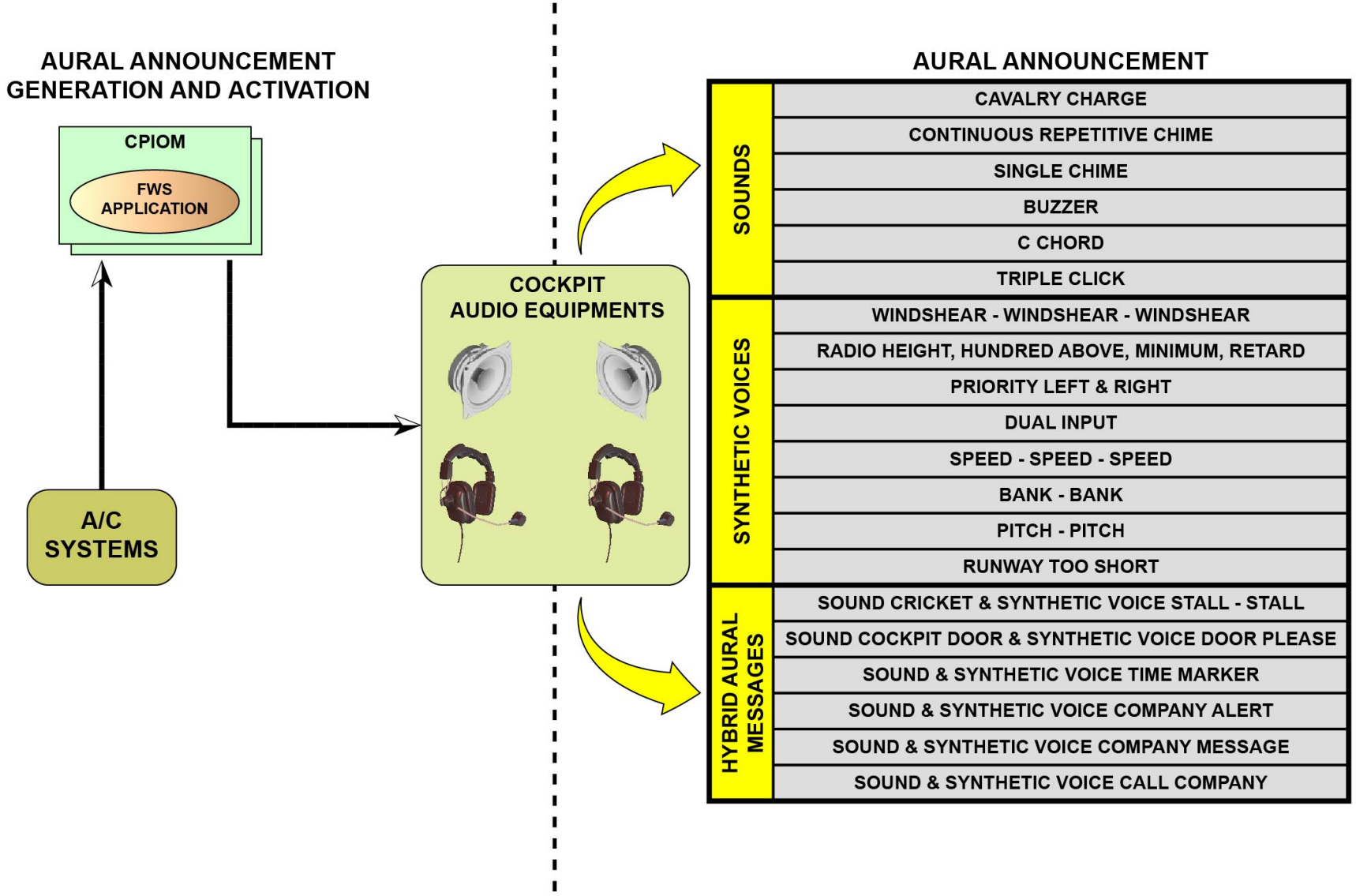
- Cavalry charge for involuntary Autopilot (AP) disconnect
- Cavalry charge for voluntary AP disconnect
- Triple click for landing capability change
- Buzzer for calls and Selective Calling (SELCAL)
- C chord for altitude alert
- Ring for ATC messages.

The synthetic voices are used to tell important radio altitudes. They include:

- HUNDRED ABOVE, MINIMUM and PLUS_HUNDRED for decision height
- WINDSHEAR-WINDSHEAR-WINDSHEAR, SPEED-SPEED-SPEED
- RETARD (only one or continuous), TEN RETARD, TWENTY RETARD
- STICK PRIORITY (PRIORITY LEFT, PRIORITY RIGHT), V_ONE and DUAL INPUT
- PITCH-PITCH for pitch attitude warning
- BANK-BANK for bank angle warning
- RUNWAY TOO SHORT (included in BTV option).

The hybrid voice messages include:

- CRICKET STALL (for stall warning), which includes a synthetic voice STALL-STALL and a CRICKET sound
- COCKPIT DOOR (for cockpit-door emergency opening, which includes a CKPT DOOR sound and a synthetic voice DOOR PLEASE
- TIME MARKER which includes TIME MARKER sound and a synthetic voice TIME MARKER
- COMPANY ALERT, COMPANY MSG and CALL COMPANY. Each one includes a special sound (chime) and a synthetic voice.



AURAL ANNOUNCEMENTS - LIST OF AURAL ANNOUNCEMENTS

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FLIGHT WARNING SYSTEM CONTROL AND INDICATING (3)

Memos, Limitations, Dispatch, Status (3)

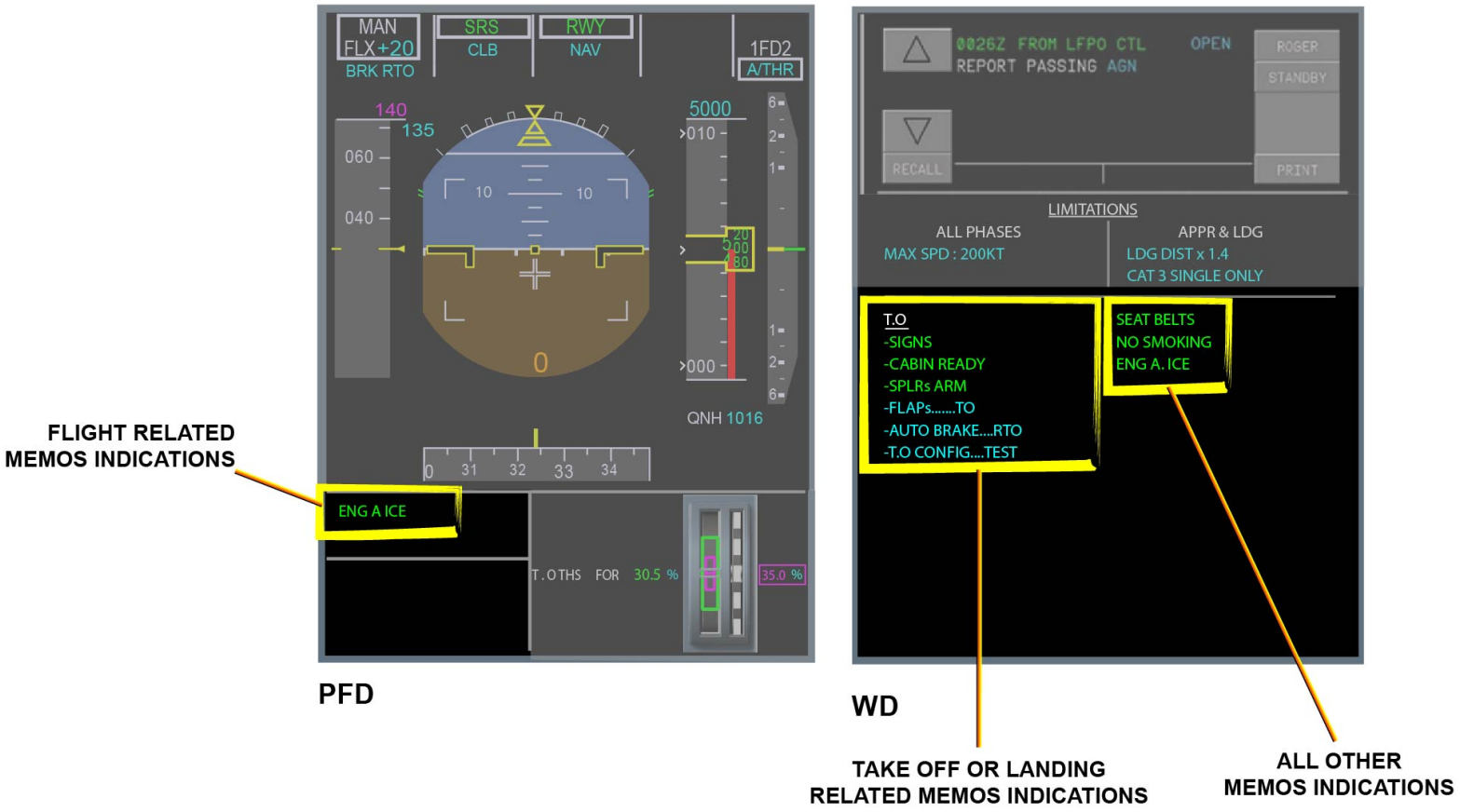
The FWS also supplies all limitation indications, which tell the crew about the A/C flight capabilities.
Limitations are shown on the WD and on the PFD lower zone. All the FWS limitations are shown on the WD. Limitations related to the flight are also shown on the PFD lower zone (for example, speed limitation).
The STATUS page gives the A/C operation status after system failures. It gives the crew limitations and deferred procedures (part of the normal checklist). It also shows the systems that do not operate and other general data. When the MORE indication is selected and shown on the display, more data are available in the STATUS MORE info page.
The DISPATCH page shows maintenance messages impacting the dispatch of the aircraft and is linked to MMEL. The dispatch advisory function differentiates and segregates the operational impacts of failures for the ongoing flight and for the aircraft dispatch at next flight.
The Dispatch page provides the right Dispatch information: one Dispatch Message for a unique condition of Dispatch
As a consequence, there is no more need for troubleshooting to identify the relevant MEL item.
On ground the generic "DISPATCH PAGE UPDATE" alert is triggered in case of new dispatch messages appeared since last take-off.
For systems failures impacting on the ongoing flight:
- Adequate ECAM alert is triggered.
- Dispatch Message is displayed in the DISPATCH page in case of dispatch impact

For systems failures impacting the dispatch only:
- Dispatch Message is displayed in the DISPATCH page only

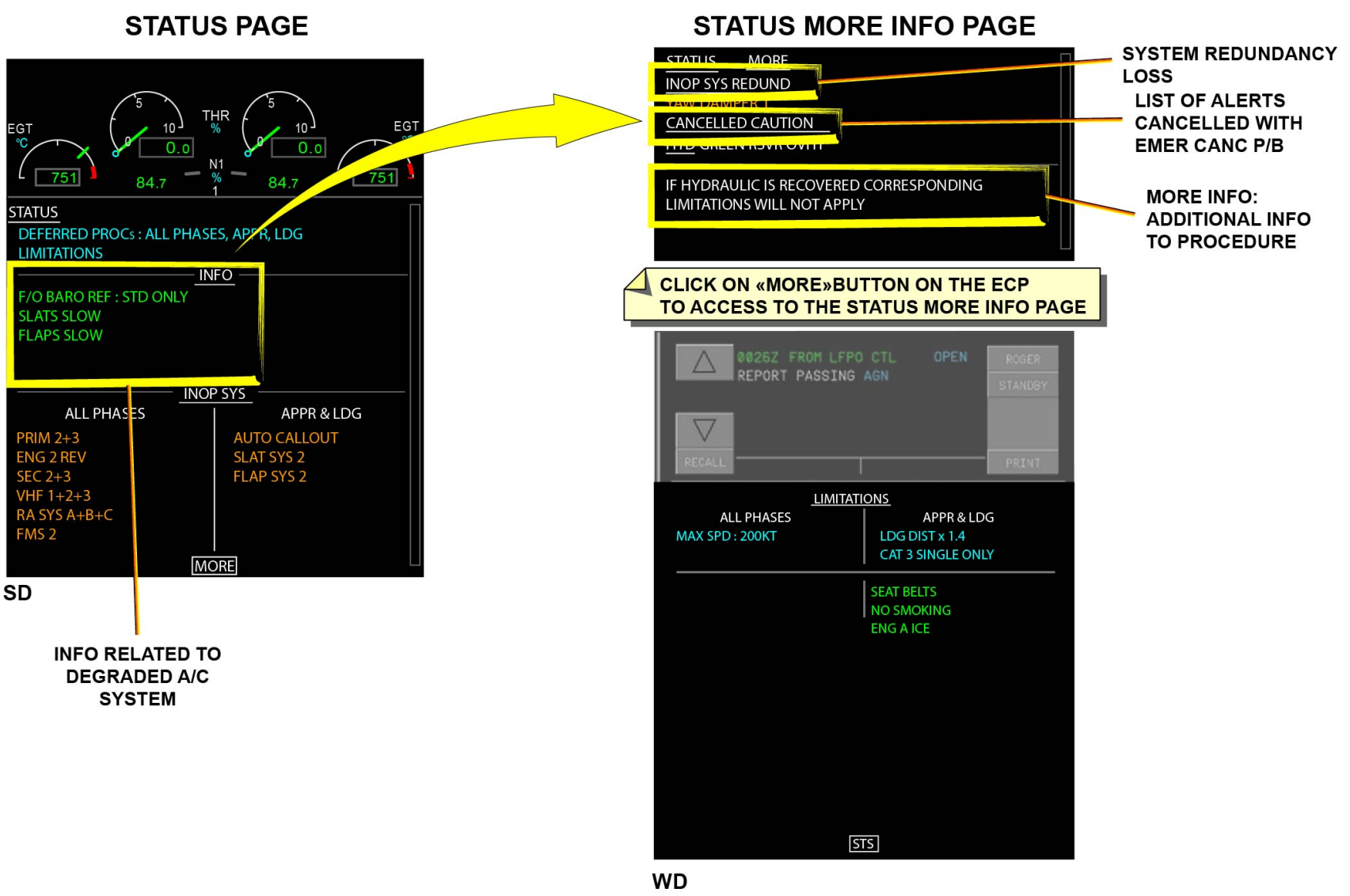
Different way of alerting depending on MEL applicability:
- On ground the generic "DISPATCH PAGE UPDATE" alert is triggered in case of new dispatch messages appeared since last take-off.
- In flight the DISPATCH page is available at any time (as long as failure repair is not confirmed) upon flight crew request only when needed: there is no immediate alerting means. Note that the DISPATCH page content is automatically refreshed after system repair or deactivation

Normal Check Lists, Abnormal Procedures (3)

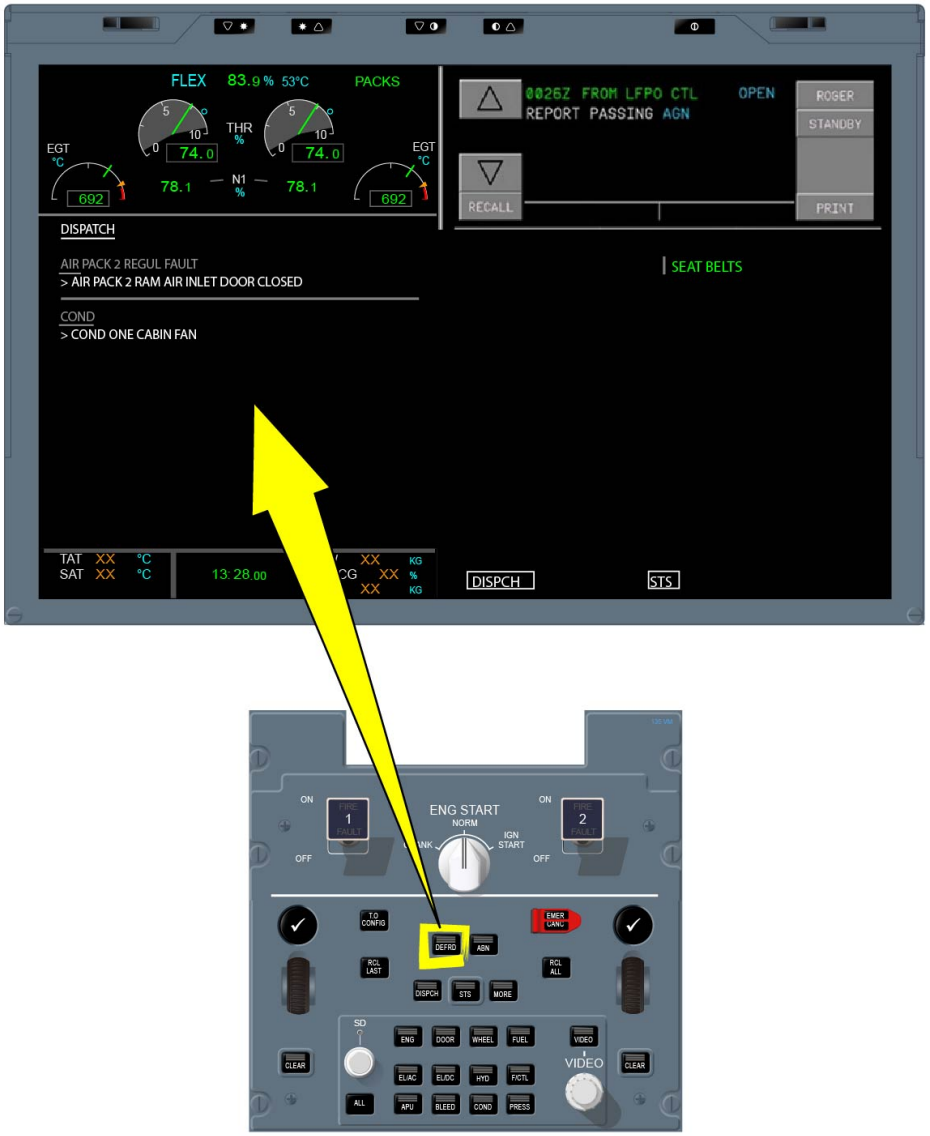
The checklist (CL) menu page is manually called with the C/L MENU pushbutton on the KCCU or automatically activated.
The CL menu page makes a list and identifies the CL that the crew must do during the different flight phases.
The CL menu can be automatically displayed in different cases.
The C/L COMPLETE item is used to manually declare a normal CL full.
When the CL is full, it is automatically stopped and frozen in its state: the CL title changes from cyan to grey in the CL menu and CL items are grayed.
The RESET item makes possible to manually reset all the content of a CL.
The CLEAR pushbutton activated on a normal CL page makes possible go back to the CL menu page.
The crew can manually activate some emergency and abnormal procedures that the systems do not sense (For example, COCKPIT WINDOW CRACKED). On the ECP, the crew can manually push the ABN PROC pushbutton to go to the supplementary abnormal procedures menu-page. This menu has different sub-menus, to get and activate different abnormal procedures. The CLEAR command is used to navigate and go back to the menu level shown before. To activate the line, the crew must push the ACTIVATE line below the heading and title of the selected failure.



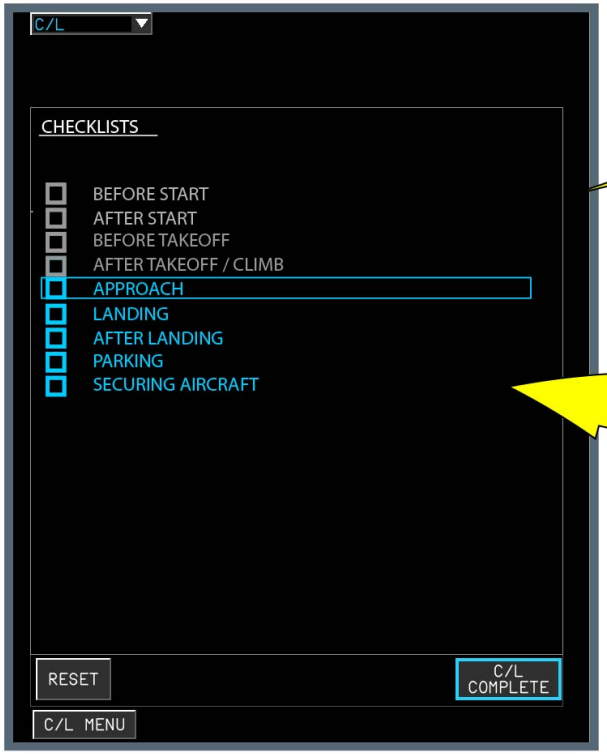
MEMOS, LIMITATIONS, DISPATCH, STATUS (3) & NORMAL CHECK LISTS, ABNORMAL PROCEDURES (3)



MEMOS, LIMITATIONS, DISPATCH, STATUS (3) & NORMAL CHECK LISTS, ABNORMAL PROCEDURES (3)

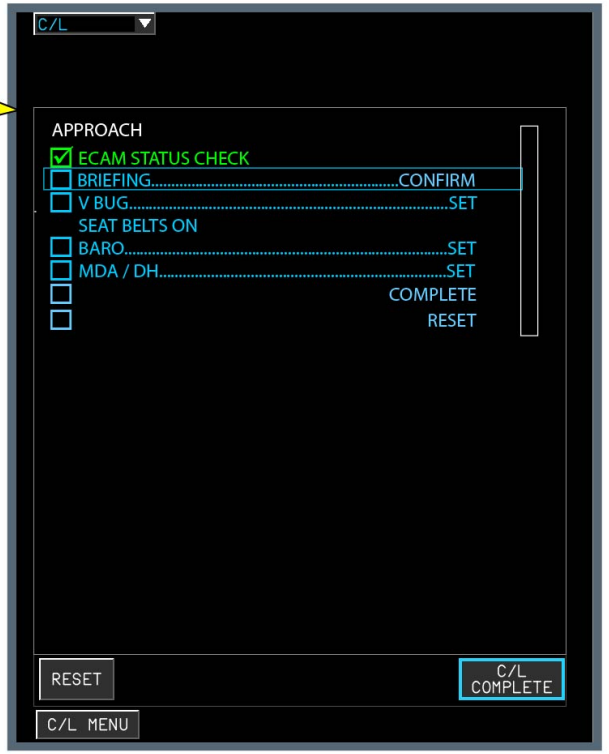


MEMOS, LIMITATIONS, DISPATCH, STATUS (3) & NORMAL CHECK LISTS, ABNORMAL PROCEDURES (3)



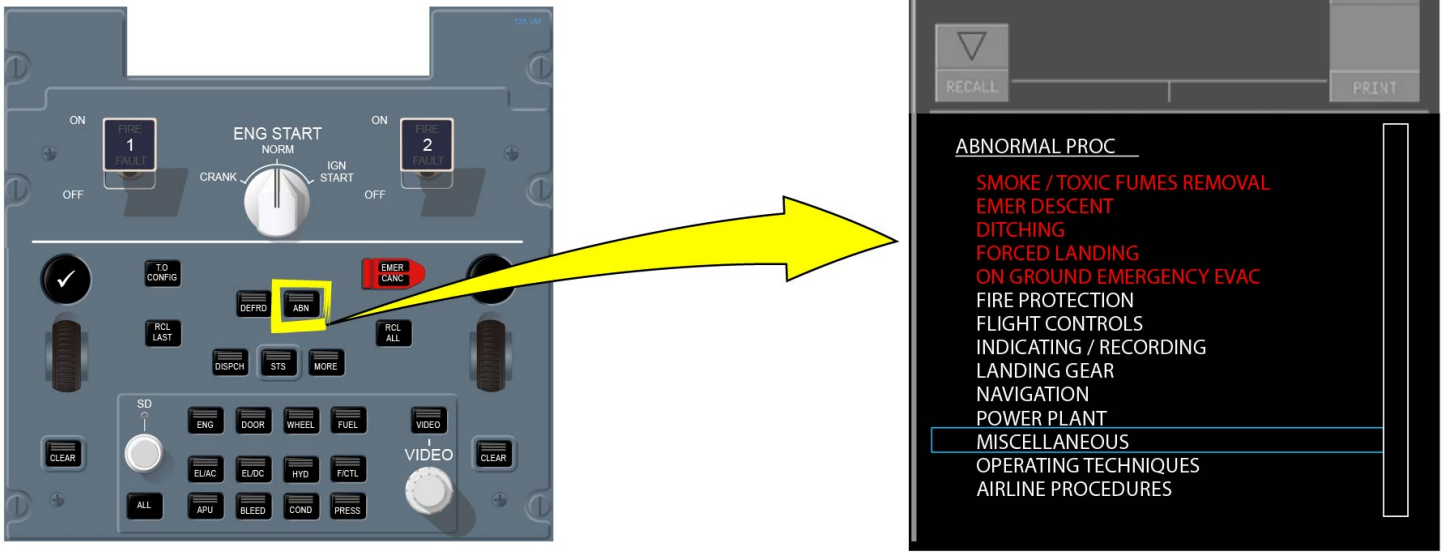
MFD

KCCU



MFD

MEMOS, LIMITATIONS, DISPATCH, STATUS (3) & NORMAL CHECK LISTS, ABNORMAL PROCEDURES (3)



ECP
135VM

WD

MEMOS, LIMITATIONS, DISPATCH, STATUS (3) & NORMAL CHECK LISTS, ABNORMAL PROCEDURES (3)

TAIL STRIKE INDICATION SYSTEM DESCRIPTION (3)

Detection and Warning Display

The primary component of the tail-strike indication system is the tail-strike detection sensor.
The tail-strike detection sensor senses if the rear fuselage hits the ground during TakeOff (T.O) or Landing (LDG). It transmits the tail-strike detection data through discrete connections to the CRDCs.
The CRDCs transmit the related data through the AFDX network to the Flight Warning System (FWS). Then the FWS, in some flight phases, sends the related data through the AFDX network to the Control and Display System (CDS).
The Warning Display (WD) of the Electronic Centralized Aircraft Monitoring (ECAM) and the Primary Flight Display (PFD) show the alert indication.
The tail-strike detection sensor has two closed electrical circuits. In normal operation, the two circuits send a ground signal to the two CRDCs. If the rear fuselage hits the ground during the T.O or LDG phase, one or two discrete signals change their status from the ground status to open during the T.O status (phase 5 or 6) or the LDG status (phase 9 or 10). The CRDCs process this data as a tail strike.
The FWS receives the data from the CRDCs and gives aural and visual messages.

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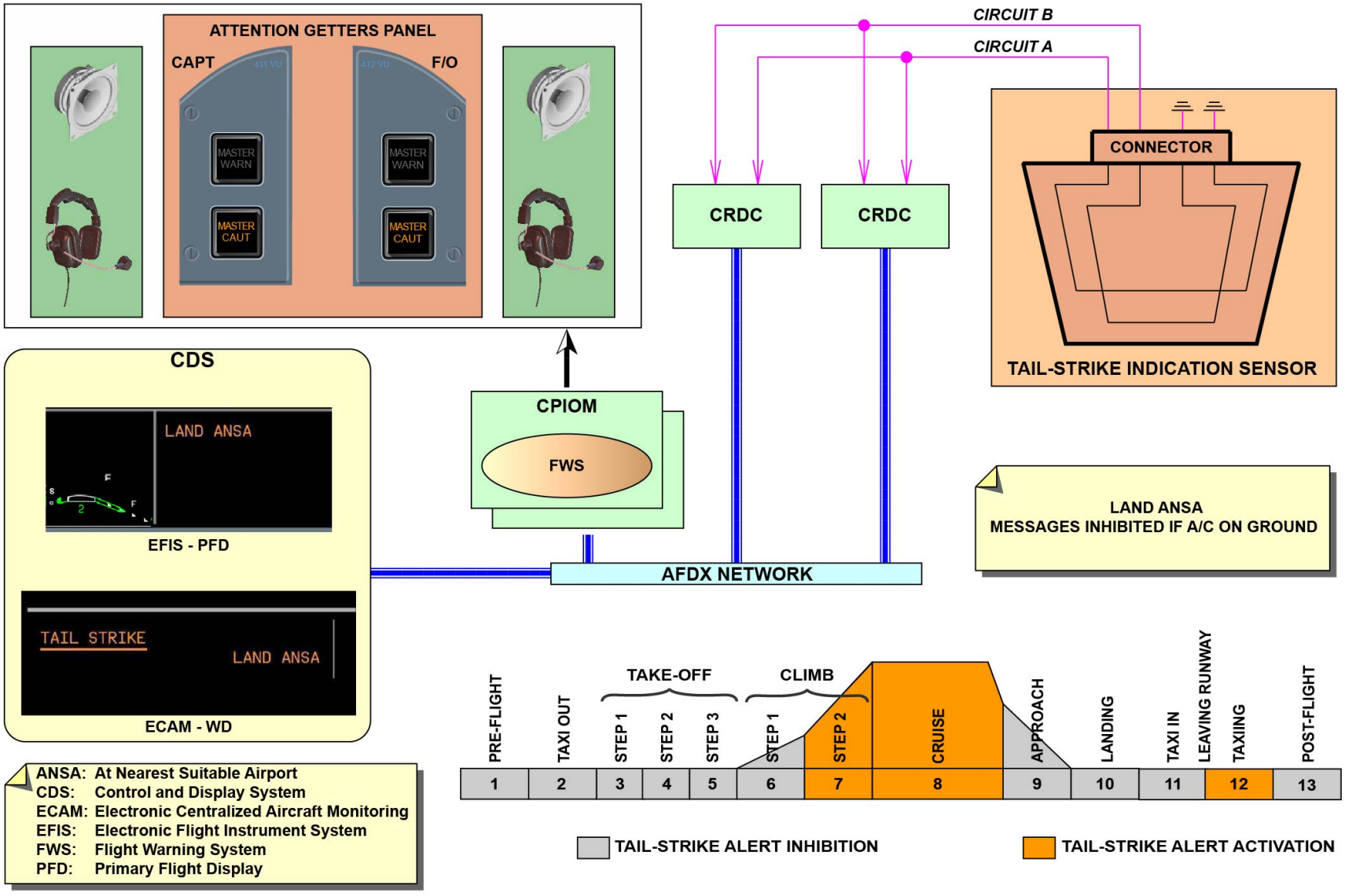

DETECTION AND WARNING DISPLAY

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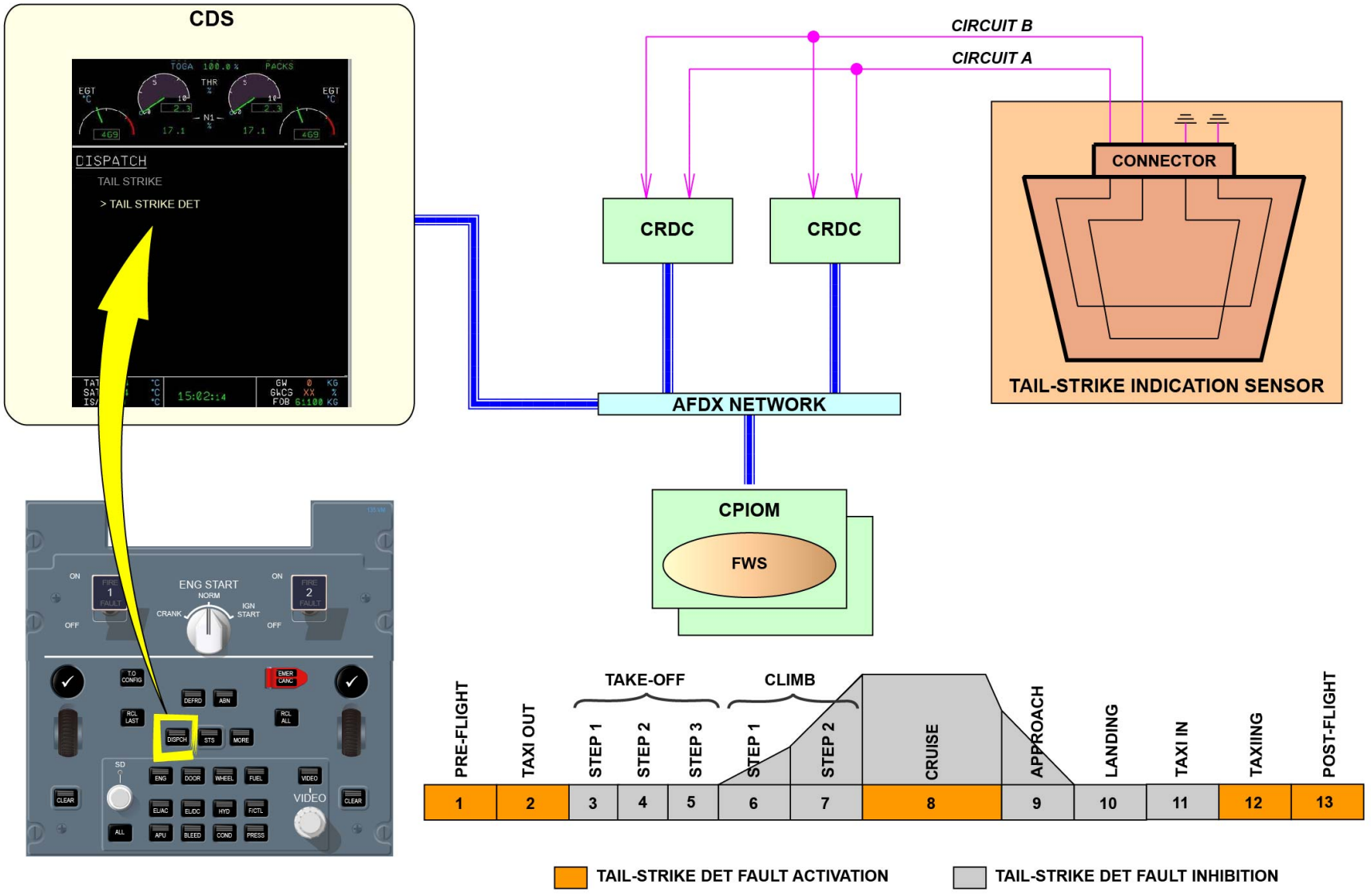
TAIL STRIKE INDICATION SYSTEM DESCRIPTION (3)

Identification of Failure Condition

The detection is memorized. This information is reset when the two detectors go back to the ground state or if the A/C is in flight phase 13. When the alert TAIL STRIKE is reset in flight phase 13, it will not be shown again in flight phase 1 or 2 (because the activation condition is false). But, a DISPACH message will be computed during the next flight to show that the tail strike indication is incorrect (after the reset of a true tail strike event or if there is a detection loop fault).



IDENTIFICATION OF FAILURE CONDITION

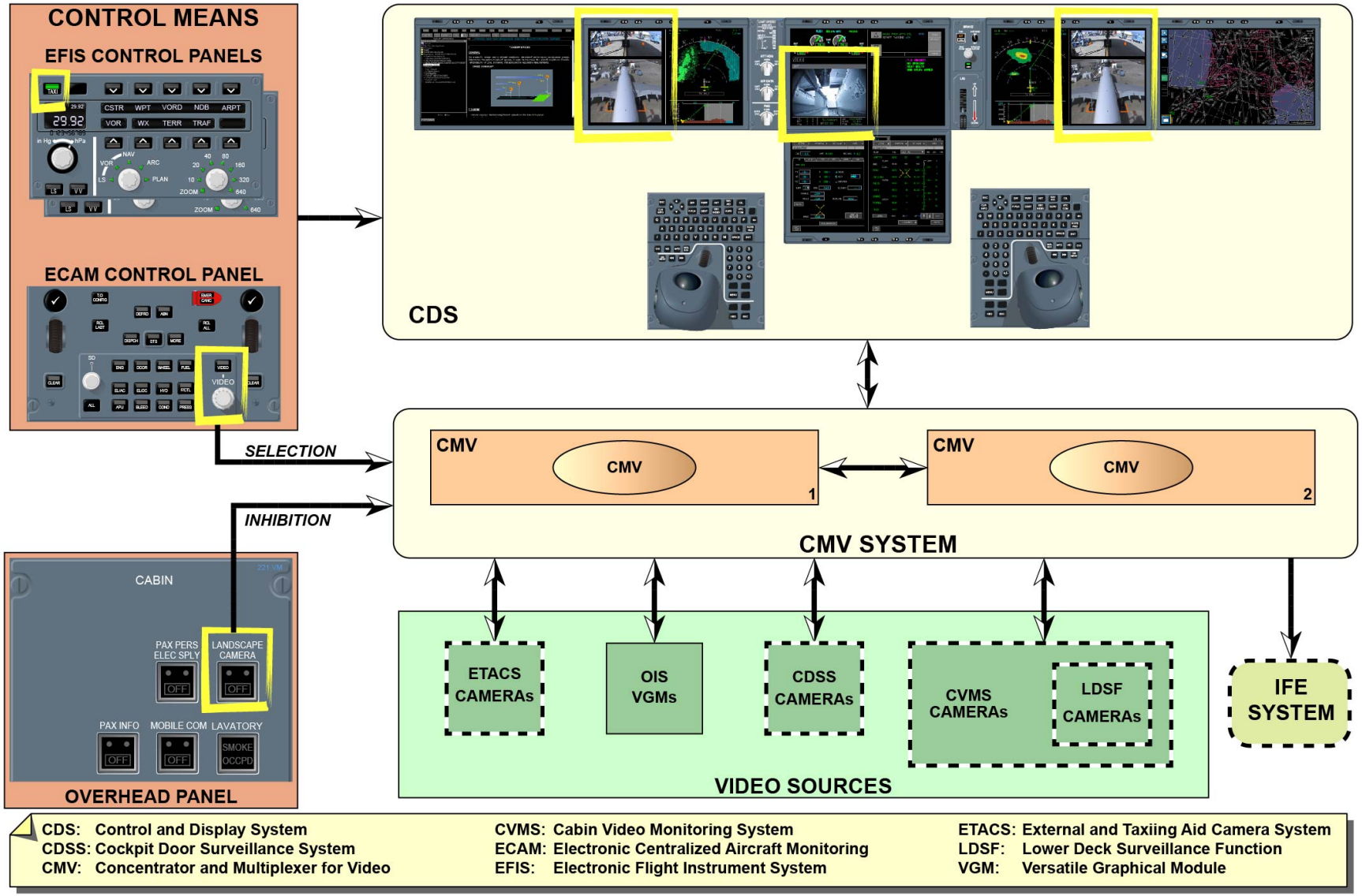
V1813401 - V01T0M0 - VM31D4STRIK3001

INTERFACE FOR VIDEO SYSTEM DESCRIPTION (2/3)

General

The two Concentrators and Multiplexers for Video (CMVs) are core units used to concentrate the video signals from many A/C video sources.
These video sources are:
- The OIS
- The External and Taxiing Aid Camera System (ETACS) (optional)
- The Cockpit Door Surveillance System (CDSS) (optional)
- The Cabin Video Monitoring System (CVMS) (optional), including the Lower Deck Surveillance Function (LDSF).

Different control means give to the crew the capability to do a video source selection. This selection is transmitted in parallel to the Control and Display System (CDS) and to the CMVs, which send it to the different video sources available.
The CMVs process the video source signals in order to make them compatible with the CDS (special video protocol) and transmits them for display to the CDS through direct links (optical fibers).
When the crew activates the TAXI key on the Electronic Flight Instrument System (EFIS) control panel (CAPT or F/O), the CDS requests the Taxiing Aid Cameras (TACs) function on the related Primary Flight Display (PFD) (CAPT or F/O) and the TACs mosaic is shown.
The VIDEO key of the Electronic Centralized Aircraft Monitoring (ECAM) control panel is used to select the video page on System Display (SD). When the video key is selected, the video in ECAM format is necessary to be shown to the CDS.
The LANDSCAPE CAMERA P/BSW, which is on the overhead panel lets the flight crew inhibit the landscape function. If the function is inhibited, the views of the ETACS cameras are no longer sent to the IFE system.


CONTROL MEANS
EFIS CONTROL PANELS
ECAM CONTROL PANEL
VIDEO
CDS
SELECTION
INHIBITION
CMV
CMV
1
CMV
CMV
2
CMV SYSTEM
CABIN
PAX PERS ELEC SPLY
LANDSCAPE CAMERA
OFF
PAX INFO
MOBILE COM
LAVATORY
SMOKE OCCPD
OVERHEAD PANEL
ETACS CAMERAs
OIS VGMs
CDSS CAMERAs
CVMS CAMERAs
LDSF CAMERAs
VIDEO SOURCES
IFE SYSTEM
CDS: Control and Display System
CDSS: Cockpit Door Surveillance System
CMV: Concentrator and Multiplexer for Video
CVMS: Cabin Video Monitoring System
ECAM: Electronic Centralized Aircraft Monitoring
EFIS: Electronic Flight Instrument System
ETACS: External and Taxiing Aid Camera System
LDSF: Lower Deck Surveillance Function
VGM: Versatile Graphical Module

GENERAL

INTERFACE FOR VIDEO SYSTEM DESCRIPTION (2/3)

CMV Description and Interfaces

The CMV system is designed:
- To acquire the different video sources generated through graphical modules (Versatile Graphical Module (VGM) in OIS) and camera sources (ETACS, CDSS, CVMS, LDSF).
- To dispatch them, upon cockpit request, to the related Display Unit (DU) or to the IFE system with the right format.

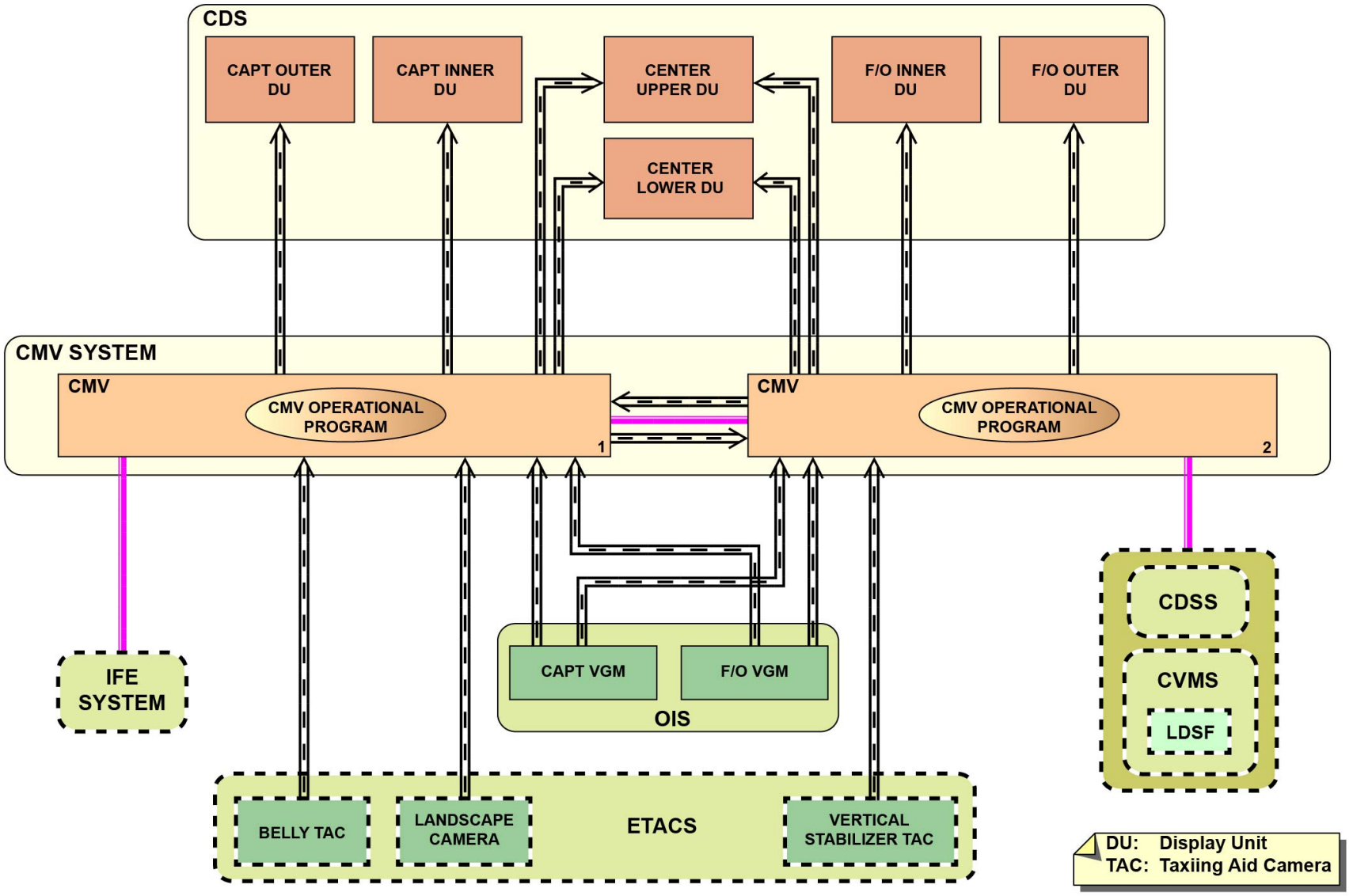
The CMV system has:
- Two CMV LRUs

The OIS video from the OIS is shown on the CDS through the CMV system. To dispach the A/C data, the 2-CMV architecture makes the OIS video available if there is one CMV failure only. If one CMV is lost, the other CMV can manage the two OIS VGM sources.
- An optical cross-link between the 2 CMV LRUs is used to share the external views and the selected CDSS/CVMS/LDSF view for video display on the CDS.
- The Ethernet link is used for the external views to share the video transmission with the IFE system.

The CMV1 encoders are used for:
- The belly TAC
- The landscape camera.

The CMV2 encoders are used for:
- The vertical stabilizer TAC
- The spare input.

The CMV2 encoded views are sent to the CMV1 through the Ethernet crosslink because CMV1 is the only encoder interfaced with the IFE system.



CMV DESCRIPTION AND INTERFACES

INTERFACE FOR VIDEO SYSTEM DESCRIPTION (2/3)

CMV External Interfaces

Video control selectors (EFIS control panel/ECAM Control Panel (ECP))
- The crew uses the EFIS control panel (on the Flight Control Unit (FCU)) for the display of video images on the PFD.
- The crew uses the ECP for the display of video images on the SD.

P/BSW (ICP/VU): manual deactivation of all video displays
- If the function is inhibited, the views of the ETACS cameras are no longer sent to the IFE system.

LGERS automatic deactivation of the ETACS display
- The LGERS application sends the flight/ground status information to the CMV through the AFDX network. This information is used to activate or deactivate the ETACS display on the PFDs.

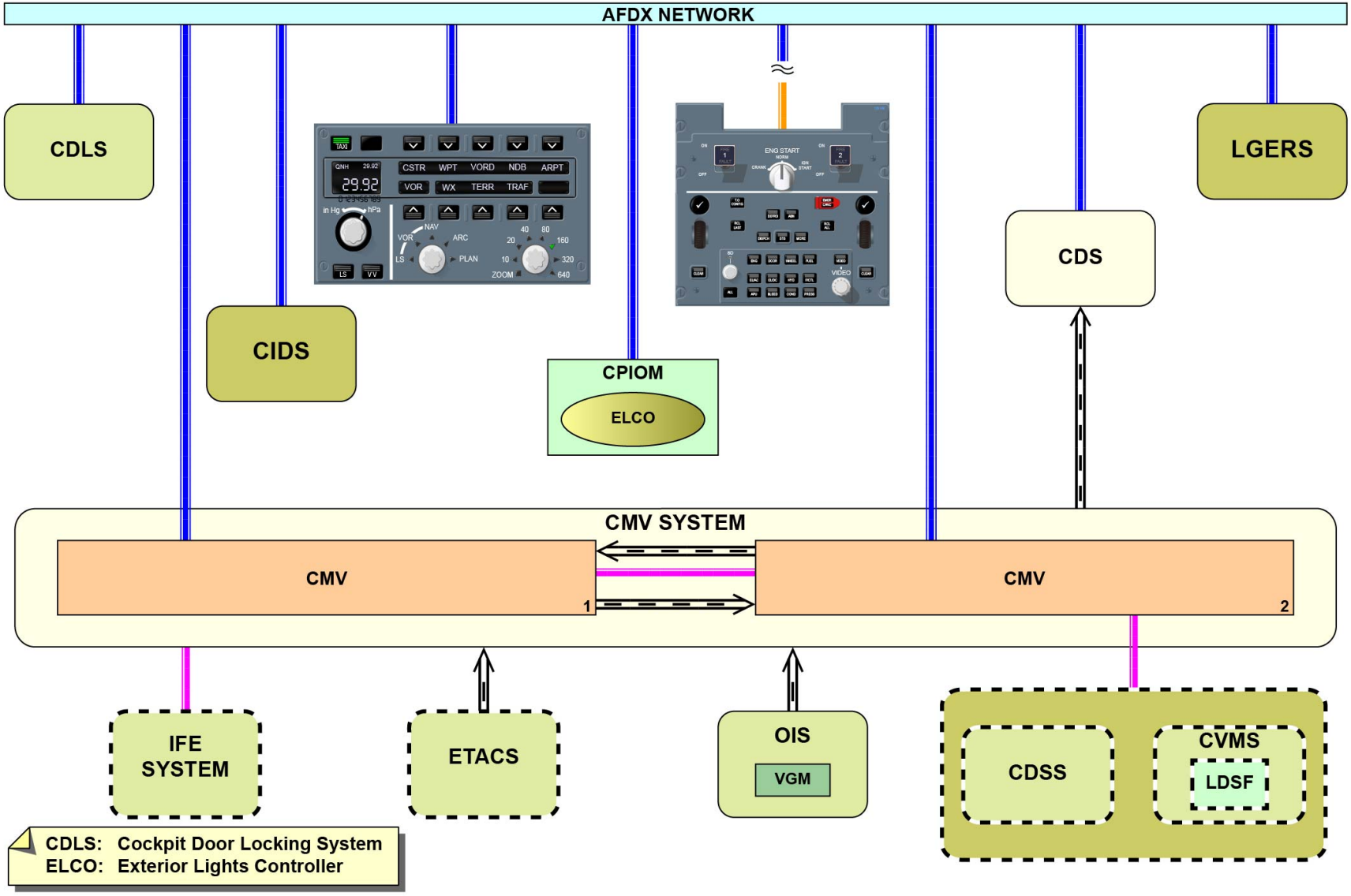
Aircraft Environment Surveillance System (AESS) (option)
- In case of hi-jacking it is possible to deactivate all the video links (no video is shown on the cockpit DUs) through optional CAPT and F/O RATC P/B switches.

GSP SHUT OFF P/BSW (option)
- This P/BSW is used to disable the CMV view (all the video source displays are inhibited) from outside the A/C (discrete to CMV).

OMS
- The OMS has this functions:
- The CMS lets acquire fault messages from the FWS BITE for fault isolation, fault memorization and report generation.
- The DLCS lets check the DLCS configuration and upload the software to the FWS for monitoring and management.

Cockpit Door Locking System (CDLS)
- The CDLS events are reported to the CMV to start the CDSS video to be shown on the SD window.

ELCO
- In order to switch on the TACS lights, the ELCO gives the data that follow:
- A/C on ground
- Runway turn-off lights on
- The TACs system selected on (PFD or SD display format).

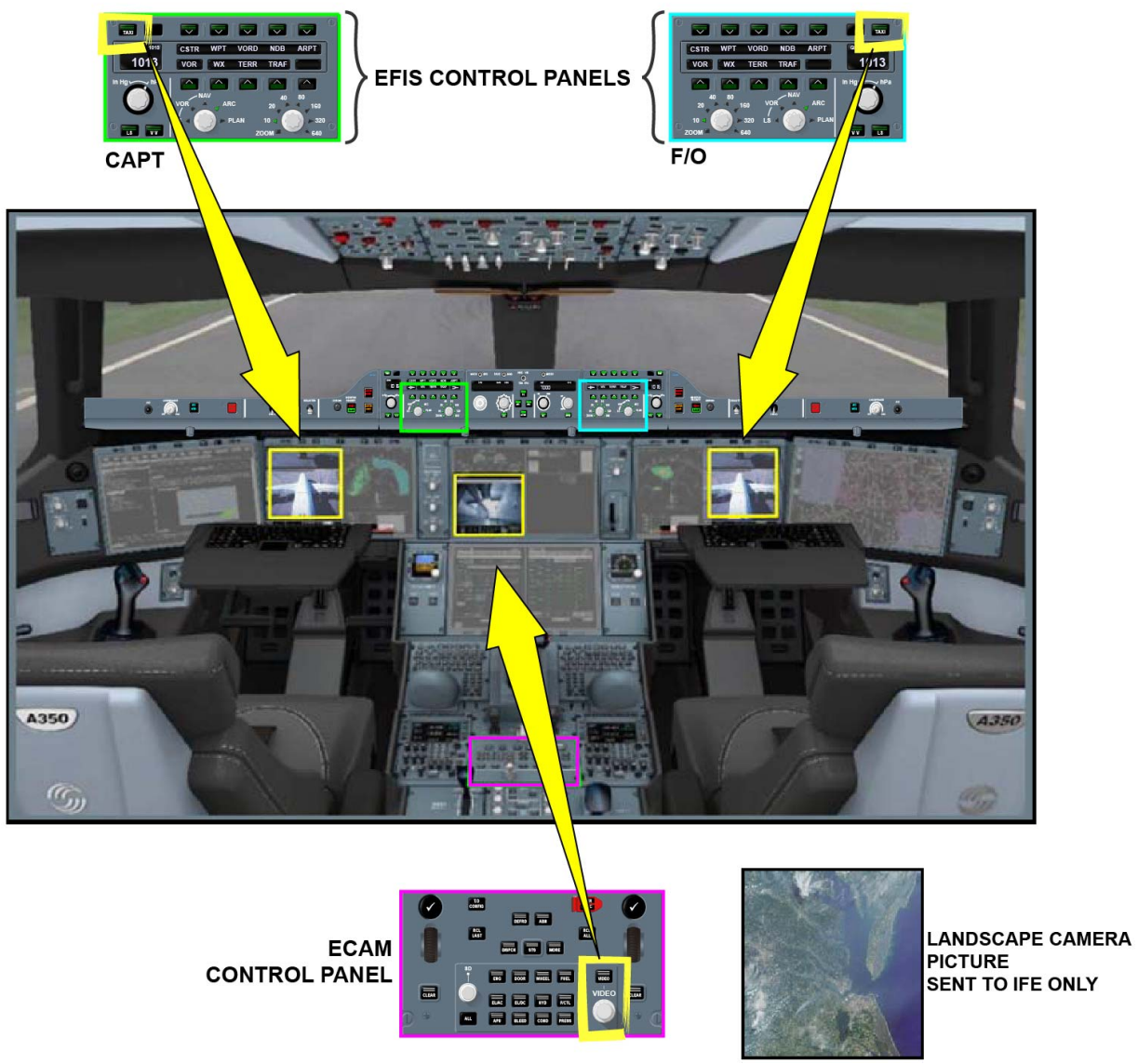


CMV EXTERNAL INTERFACES

INTERFACE FOR VIDEO SYSTEM DESCRIPTION (2/3)

Allocation of the Video Sources to the DUs

The video sources are allocated to the DUs as follow:
- ETACs, CDSS, CVMS, LDSF video views are selected using the ECP and rotating selector
- TACs video view can be displayed on the two PFDs, independently, using the EFIS control panels
- The optional landscape camera view is sent to the IFE system for the passenger entertainment.



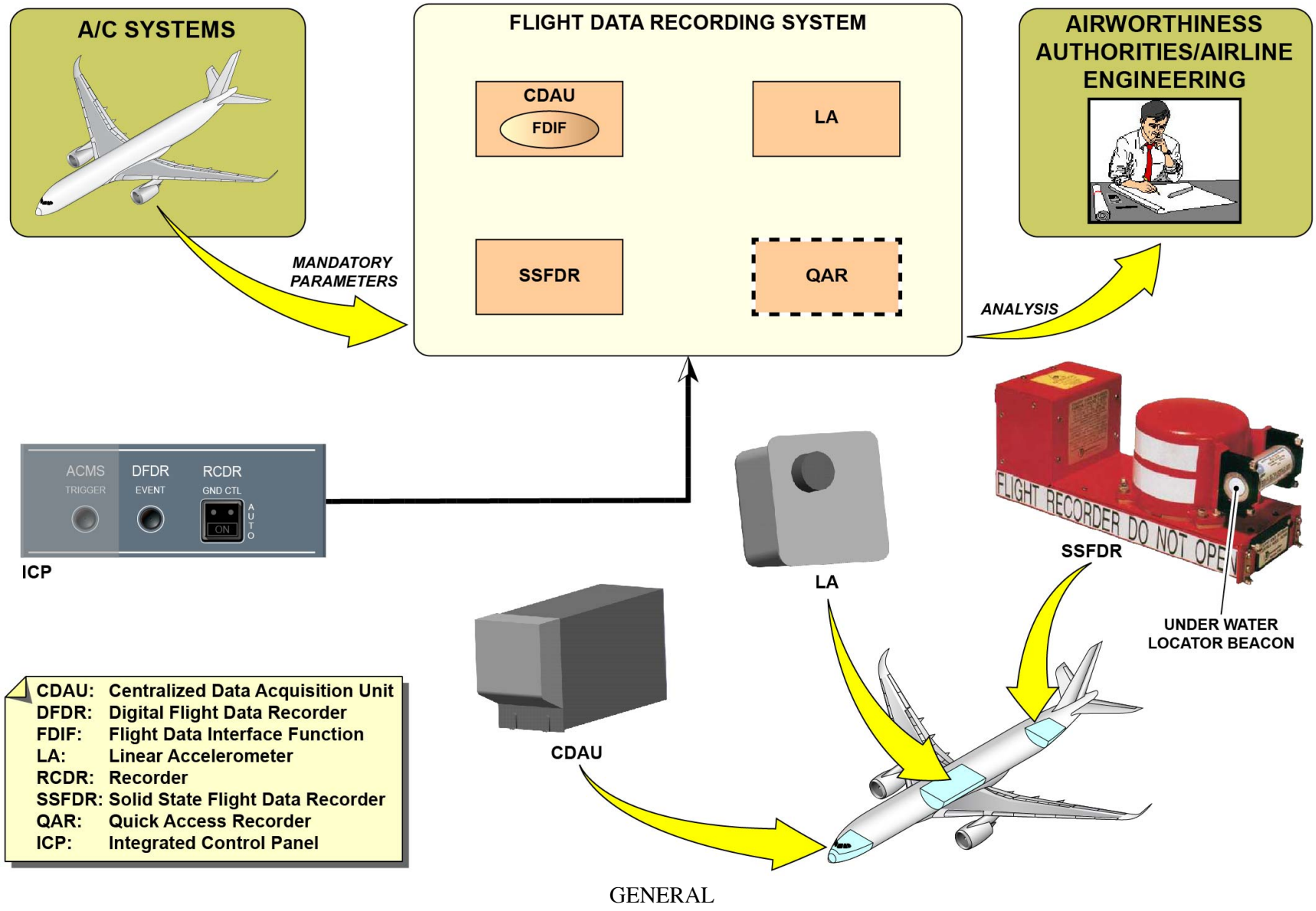
ALLOCATION OF THE VIDEO SOURCES TO THE DUS

FLIGHT DATA RECORDING SYSTEM DESCRIPTION (3)

General

The Flight Data Recording System (FDRS) receives and records mandatory A/C systems and engine parameters. These data can be used by the airworthiness authorities for investigation if there is an incident or accident.
The Solid State Flight Data Recorder (SSFDR) records the mandatory parameters received during the last 25 flight hours.
The Centralized Data Acquisition Unit (CDAU) receives and controls the recorded data of the SSFDR.
The Quick Access Recorder (QAR) (optional equipment) gives an easier access to the recorded data. The airlines can customize the QAR.
The SSFDR has an Underwater Locator Beacon (ULB) to let the authorities locate the recorder if it is fully under the water.
This ULB is supplied with a battery and is activated when it touches the water.
The FDRS has:
- A CDAU with a Flight Data Interface Function (FDIF), in the avionics compartment
- A SSFDR in the aft part of the pressurized area (section 18 of the A/C)
- A Linear Accelerometer (LA) at the A/C Center of Gravity (CG) (section 15 of the A/C).

The Integrated Control Panel (ICP) (211VM) includes the P/BSWs that follow:
- A DFDR EVENT P/BSW which lets the flight crew do a time mark to identify an event.
- A RCDR GND CTL P/BSW which lets the flight crew/maintenance personnel manually trigger the recording of SSFDR, QAR and Cockpit Voice Recorder (CVR) (ATA 23-71-00). This can be used at any time when the A/C is on the ground with all engines stopped (the A/C is supplied with an APU or an external power).



GENERAL

V1813401 - V01T0M0 - VM31D6DFDRS3001

FLIGHT DATA RECORDING SYSTEM DESCRIPTION (3)

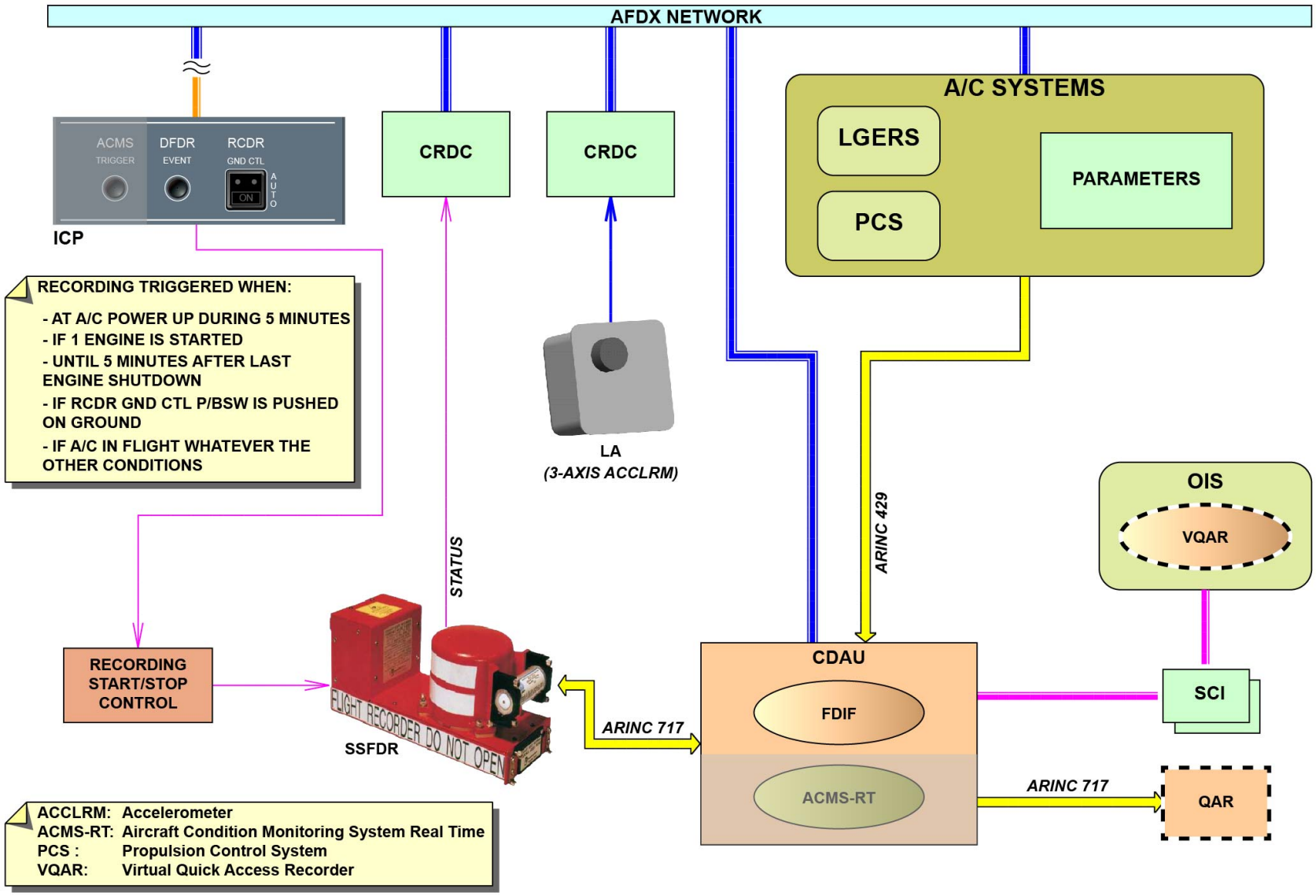
Flight Data Recording and Centralized Data AcquisitionSystem Architecture

The FDIF application hosted in the CDAU receives mandatory data from the A/Ccomponents through the AFDX and the ARINC 429 network as a backup (Flight Control and Guidance System (FCGS) /Flight Warning System (FWS) /Air Data/Inertial Reference System (ADIRS) for example).
The FDIF also receives vertical, lateral and longitudinal accelerations analog the signals from the LA which is near the CG. The information is also sent to the FDIF through the AFDX and CRDC networks.
The FDIF formats the flight data and sends it to these devices:
- The SSFDR through the ARINC 717 data bus
- The optional QAR through the ARINC 717 data bus
- The optional virtual QAR (VQAR).

The QAR and VQAR record the same data as the SSFDR.
The RCDR GND CTR P/BSW is used to supply the SSFDR on ground for test and maintenance, or for pre-flight check.
The recording start/stop control starts or stops the function of the systems which have recording functions.
The SSFDR automatically does the records that follow:
- On ground, for the first five minutes after that the A/C electrical network is energized
- On ground, with a minimum of one engine master switch ON
- Permanently in-flight
- On ground, for five minutes after the last engine shutdown.

The RCDR GND CTR pushbutton switch lets you set the SSFDR in the record mode manually, if:
- The A/C is on ground
- The A/C electrical network is energized
- No engine master switch on.

The DFDR EVENT pushbutton switch let you put a mark on each device with record functions, of the flight data recording and centralized data-acquisition system.



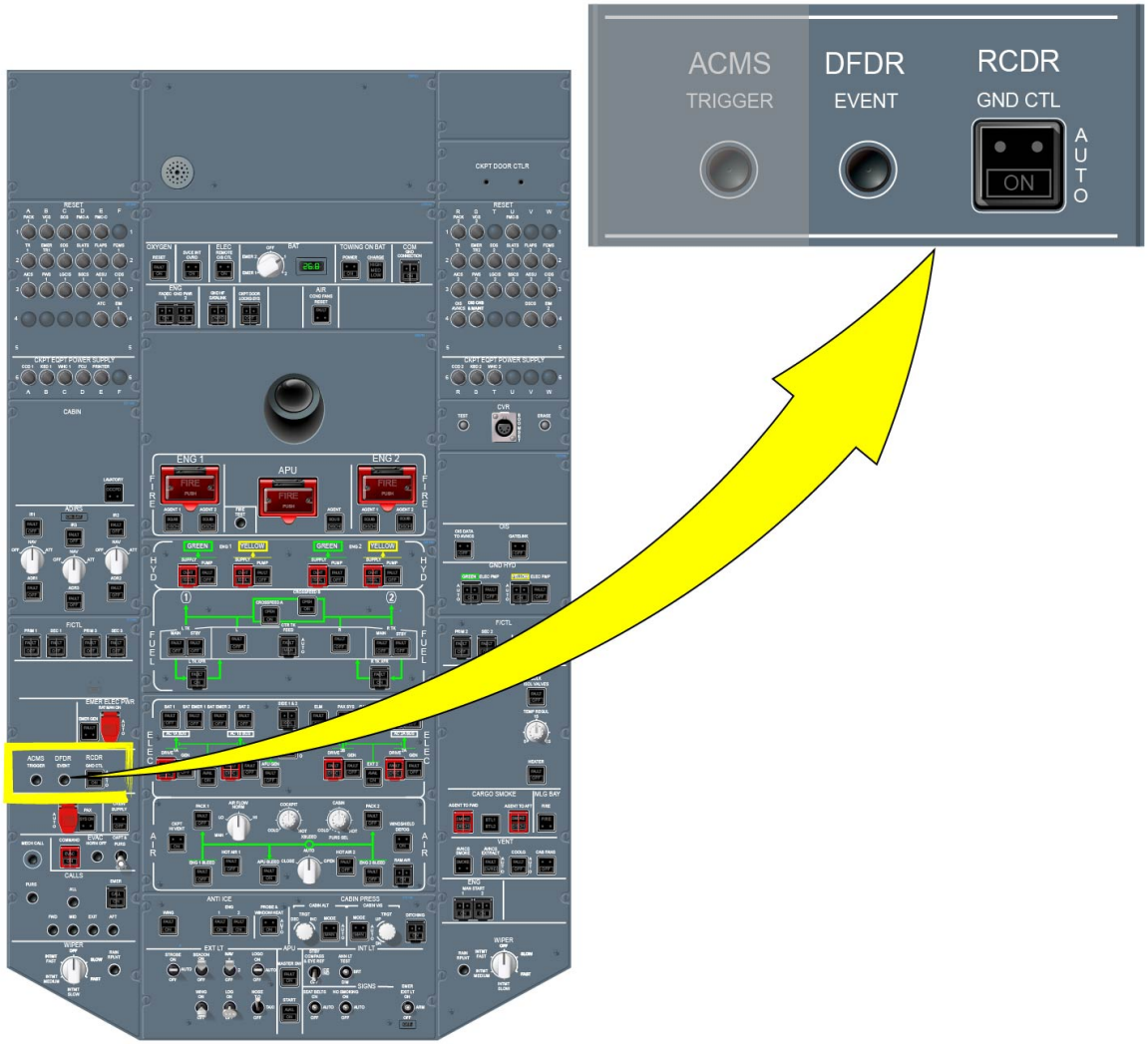
FLIGHT DATA RECORDING AND CENTRALIZED DATA ACQUISITIONSYSTEM ARCHITECTURE

V1813401 - V01T0M0 - VM31D6DFDRS3001

FLIGHT DATA RECORDING SYSTEM CONTROL AND INDICATING (3)

FDRS Manual Control (3)

Five minutes after power up, the recorder stops. With the RCDR GND/CTL button it is possible to force the system to be energized. Consequently, the system is supplied for preflight-checks or for maintenance and test purposes.
A DFDR EVENT button is installed on the center pedestal. The cockpit crew can press it if an event occurs. This shows the time in the recorded data when the event occurred (no visual effect in the cockpit).



FDRS MANUAL CONTROL (3)

HEAD UP DISPLAY SYSTEM DESCRIPTION (OPTION) (3)

General

The Head-Up Display (HUD) system gives the pilot a better situational awareness and energy management during all the flight phases.
The HUD system prevents the pilot transition from head-down to head-up flying.
All the flight critical information agrees with the view of the outside world. This lets the pilot fly accurate approaches and precise landings on all runways and in different weather conditions.
The HUD system is an optional system and is a flying aid system which gives the pilot an image superimposed on the outside world in his field of view. This aid uses the principle of symbol projection on a combiner, which has mainly a flat sheet of glass.
The objectives of the HUD system are:
- To give guidance information on the ground, at T.O and LDG in low visibility conditions
- To give information to the pilot for visual approach on airfields without the Instrument Landing System (ILS)
- To monitor automatic approach operations.

The HUD system can be installed in a single or dual installation configuration. In a single installation configuration, only the CAPT HUD system is installed.

HUD/PFD REAL RATIO COMPARISON

THE HUD GIVES THE PILOT A BETTER SITUATIONAL AWARENESS AND ENERGY MANAGEMENT DURING ALL THE FLIGHT PHASES (SPEED VECTOR REPRESENTATION).

THE HUD ALSO PREVENTS THE PILOT TRANSITION FROM HEAD-DOWN TO HEAD-UP FLYING.

HUD: Head-Up Display
PFD: Primary Flight Display

GENERAL

V1813401 - V01T0M0 - VM31D7HUDIS3001

HEAD UP DISPLAY SYSTEM DESCRIPTION (OPTION) (3)

System Description

Each HUD system set has:
- One center Display Unit (DU)
- One Head up Projection Unit (HPU)
- One Head up Combiner Unit (HCU)
- One Personalization Memory Module (PMM)
- One HUD system control panel.

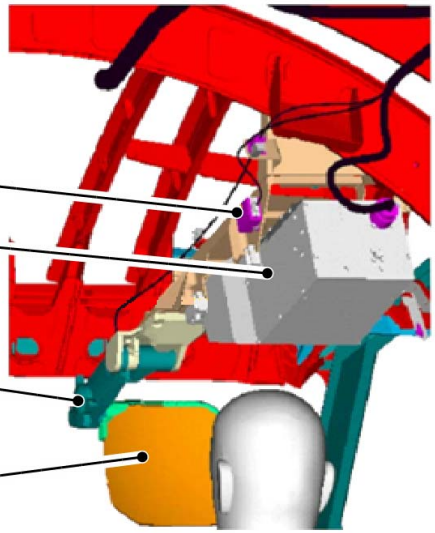
Computerizing: center display units

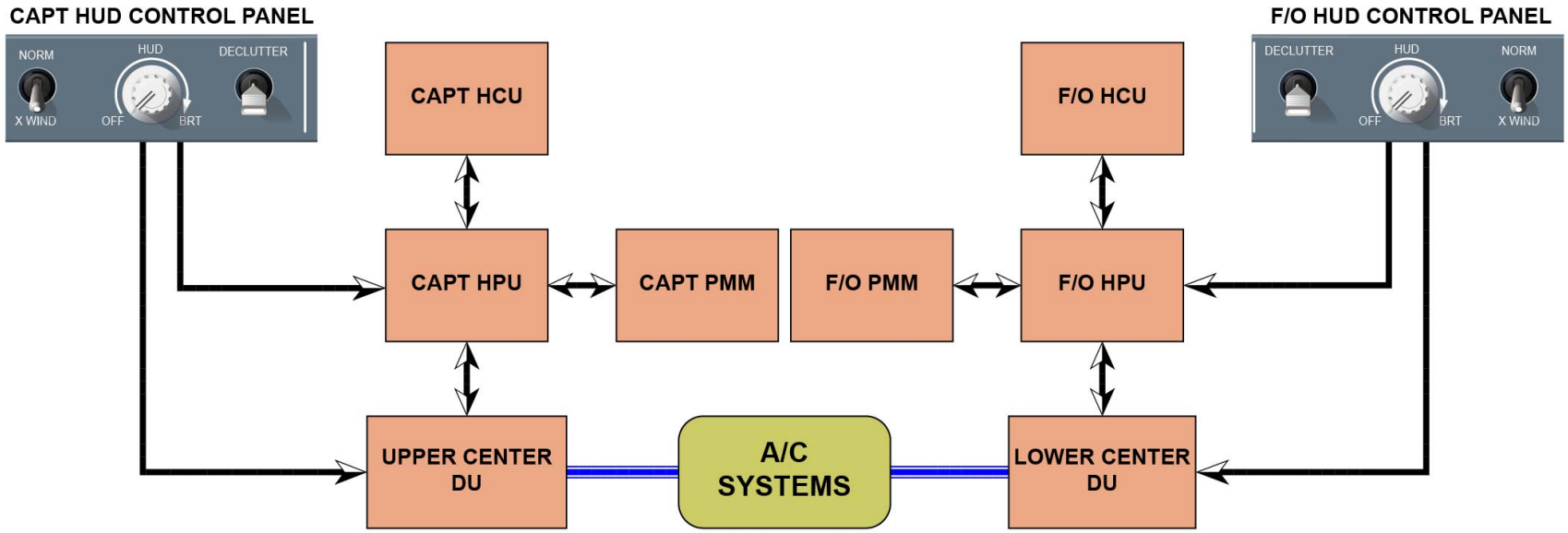
If selected, the HUD system option always includes the CAPT and F/O dual installation.
Each HUD system has the three LRUs that follow:
- One HPU
- One HCU
- One PMM.

The HUD system applicative parts are hosted by the upper center Display Unit (DU) for the CAPT HUD system and by the lower center DU for the F/O HUD system. Thus, all the software of the system and the BITE function are installed in the center DUs. All the data exchange between the HUD system and the other avionics systems are done through the upper center DU for the CAPT HUD system and through the lower center DU for the F/O HUD system.
The HUD system software manages the functions that follow:
- Presentation of symbology in all phases of the flight phases
- Mode management
- Maintenance management
- The HPU management (interface control between DU and HPU, luminosity laws, built-in tests command and results, etc.)
- The HUD system BITE (power-on BITE, continuous BITE, initiated BITE, interactive BITE, system BITE)
- The HUD system input/output data management.

The CMS can start the HUD system interactive tests from the maintenance terminals.

DU: Display Unit
HCU: Head Up Combiner Unit
HPU: Head up Projection Unit
PMM: Personalization Memory Module





SYSTEM DESCRIPTION - COMPUTERIZING: CENTER DISPLAY UNITS

HEAD UP DISPLAY SYSTEM DESCRIPTION (OPTION) (3)

System Description (continued)

Head-up Projection Unit (HPU)

The HPUs are installed inside the cockpit above the CAPT and F/O heads.
Each HPU contains an image generation device which uses the Liquid Crystal Display (LCD) technology and optical lenses.
The HPU has the functions that follow:
- To acquire video from the center DU (through optical fiber)
- To change the video flow into a green image
- To project the image onto the HCU glass (for superimposition on the outside view)
- To adapt the image luminance in relation to orders received from HUD control-panel brightness potentiometers (installed in the front panel)
- To acquire and transfer to the center DU the value of luminance sensors (installed on the HCU)
- To send internal parameters (temperature, status) to the center DU through discrete signals
- To send BITE to the center DU and control functionalities (through the RS422 link).

Head-up Combiner Unit (HCU)

The HCU has:
- A transparent glass (covered with a wavelength selective coating)
- A mechanical subassembly.

The combiner also has sensors for the auto-brightness control.
The HCU send to the HPU some data related to:
- The position of the HCU
- The automatic brightness control function

The HCU has external luminosity sensors that are used to measure the external-world lighting conditions. This measurement is used by the related DU. The DU automatically adjusts the image brightness (in relation to the external luminosity) around the control value adjusted by the pilot. Then, the HPU sends those data to the DU through the RS422 bus.

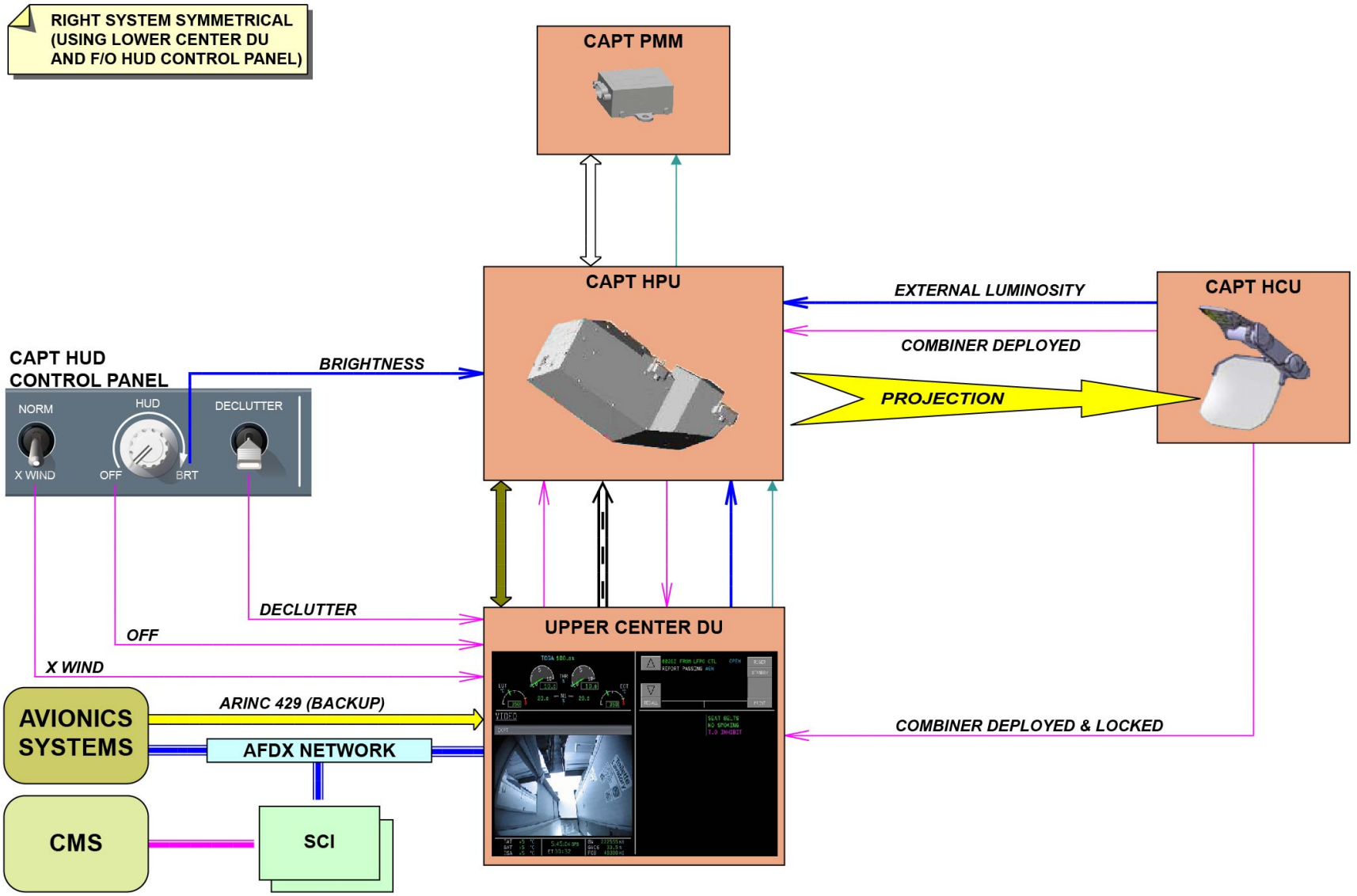
Personalization Memory Module (PMM)

The PMM is a memory module. To get the necessary accuracy for the HUD system installation, two types of adjustment are necessary:
- Mechanical adjustment
- Electronic adjustment (with the PMM).

During the A/C manufacturing, the HCU and HPU are tightly attached to the upper fuselage frames. After error measurement (bore-sighting process), electronic corrections are put into the HUD systems and stored in the PMM to compensate A/C residual errors in X/Y position. Therefore, the PMM is attached to the A/C and is non-interchangeable. It is also specific to CAPT or F/O side.
Adjustments must be as accurate as possible to put the symbols in the correct position.
The electronic bore-sighting process is only done one time at the first HUD system equipment installation on the A/C, and for each side. It is not necessary to do this process again because the electronic corrections are memorized in the PMM equipment.

Head-up Display (HUD) system control panel

The HUD system control panels are in the cockpit on the left side (glareshield/411VU) and on the right side (glareshield/412VU).
The two control panels include:
- An HUD potentiometer, which is used to switch on/off the HUD and to adjust the HUD symbol brightness
- A DECLUTTER switch, momentarily toggle, which is used to change the display format on the HCU from normal mode to the two different levels of de-clutter.
- An X WIND switch used to change the format of the speed and altitude scales (from large scale to small scale).



SYSTEM DESCRIPTION - HEAD-UP PROJECTION UNIT (HPU) ... HEAD-UP DISPLAY (HUD) SYSTEM CONTROL PANEL

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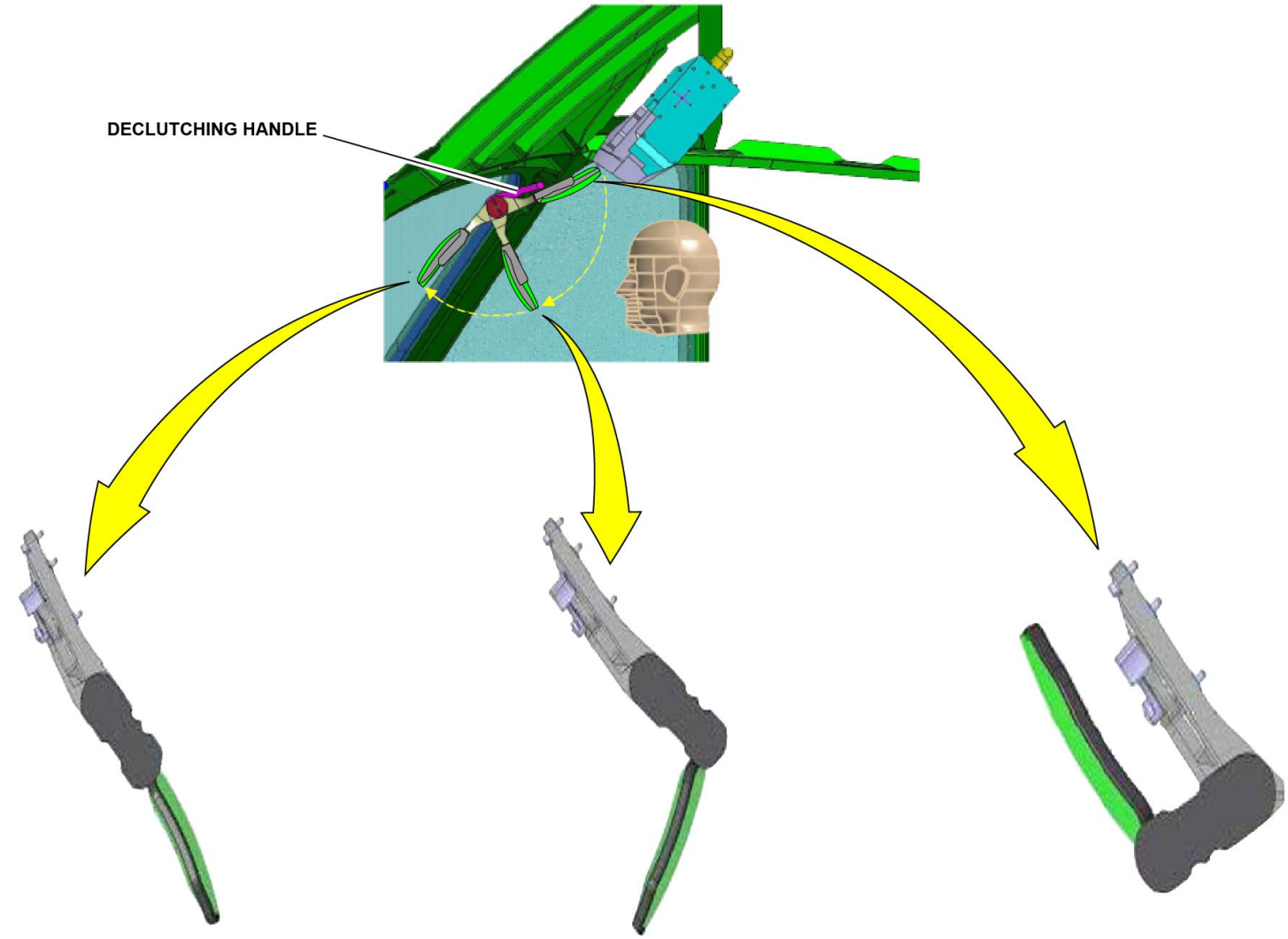
HEAD UP DISPLAY SYSTEM DESCRIPTION (OPTION) (3)

HCU Positions

The HCU has three positions:
- Operational (HCU deployed and locked)
The HCU is in position in front of the pilot with a display of operational symbols.
- Stowed (through a locking mechanism)
The HCU is in up position with a cleared display.
- Breakaway
From the operational position, the HCU will declutch automatically if there is a strong deceleration (of 6-8 g) or upon a shock event.
The declutching handle is used to lock/unlock and deploy/stow the HCU.



HCU POSITIONS

HEAD UP DISPLAY SYSTEM DESCRIPTION (OPTION) (3)

HCU Display

Description

The pilot can have different displays, in relation to the flight configuration.
The HUD system image is divided into different areas, which show almost the same parameters as the PFD:
- Attitude, guidance and Radio Height (RH)
- Heading
- Ground roll information
- Mach/ILS data
- Air speed (AS)
- Flight Mode Annunciator (FMA)
- System messages
- Vertical speed
- Altitude
- Approach trajectory deviation.

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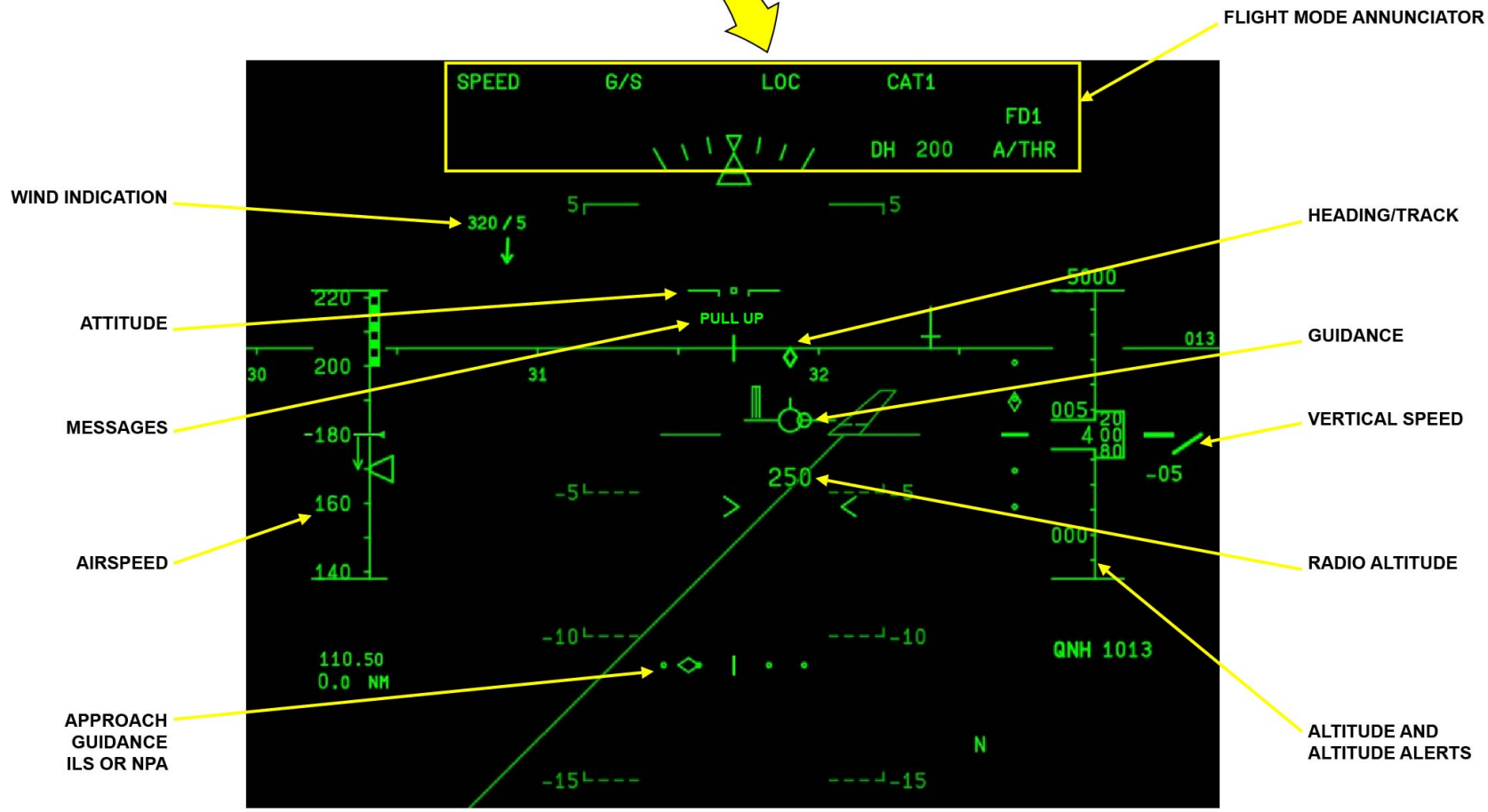
EXAMPLE OF SYMBOLOGY



HCU DISPLAY - DESCRIPTION

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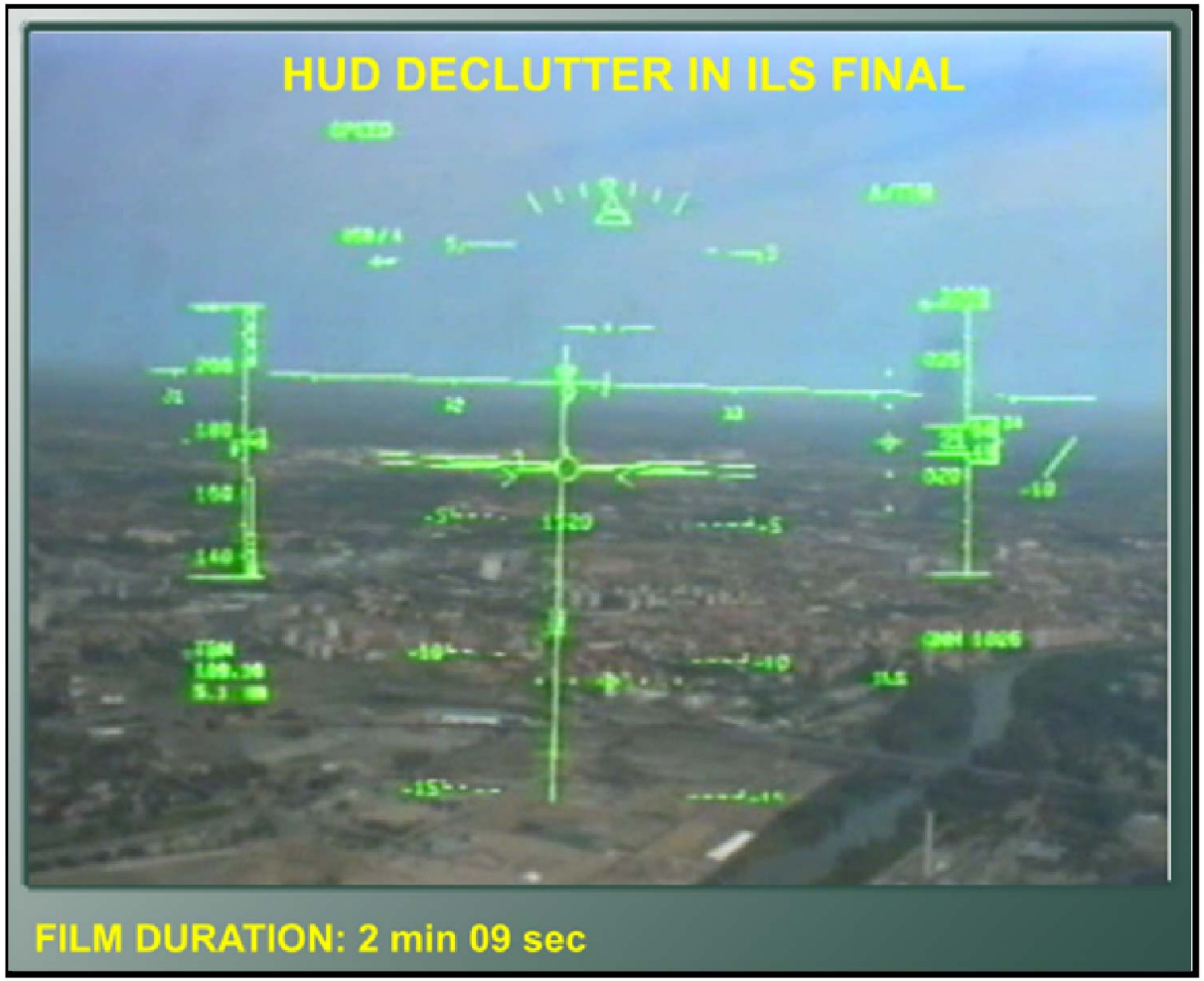

HCU DISPLAY - DESCRIPTION

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