

**A330**  
**TECHNICAL TRAINING MANUAL**  
**T1+T2 Mechanical and Avionics A330 RR TRENT 700**  
**22-AUTO FLIGHT**



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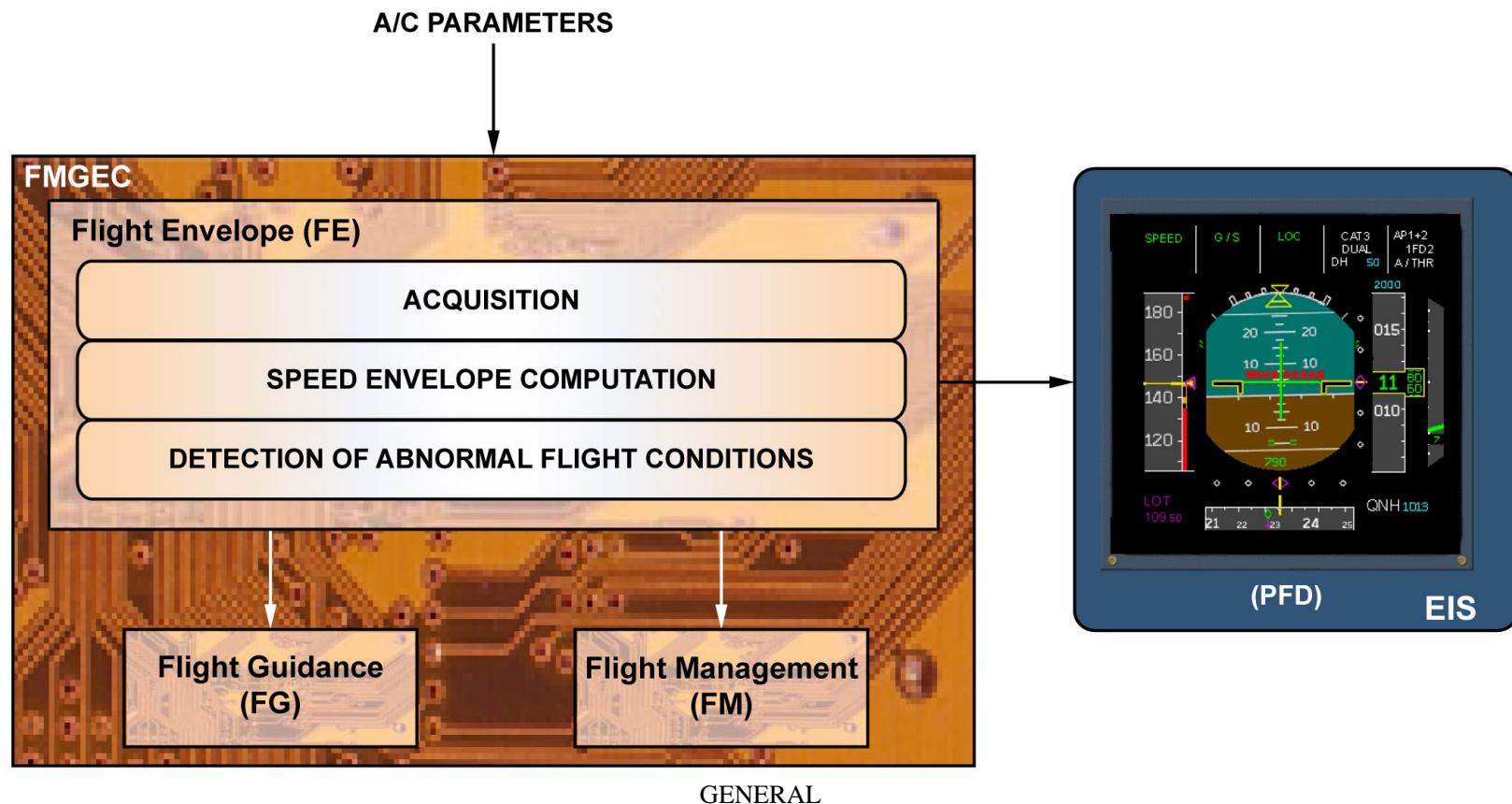
<b>AIRBUS</b> <b>A330</b> TECHNICAL TRAINING MANUAL	<b>T1+T2 Mechanical and Avionics A330 RR TRENT 700</b> <b>22-AUTO FLIGHT</b>	TP REV 4 13/03/2020
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## FLIGHT ENVELOPE GENERAL DESCRIPTION

### GENERAL

In addition to the acquisition of the aircraft parameters used by the Auto Flight System (AFS), the Flight Envelope (FE) function basically consists of the speed envelope computation and the detection of abnormal flight conditions.



## FLIGHT ENVELOPE PROTECTION D/O

### GENERAL

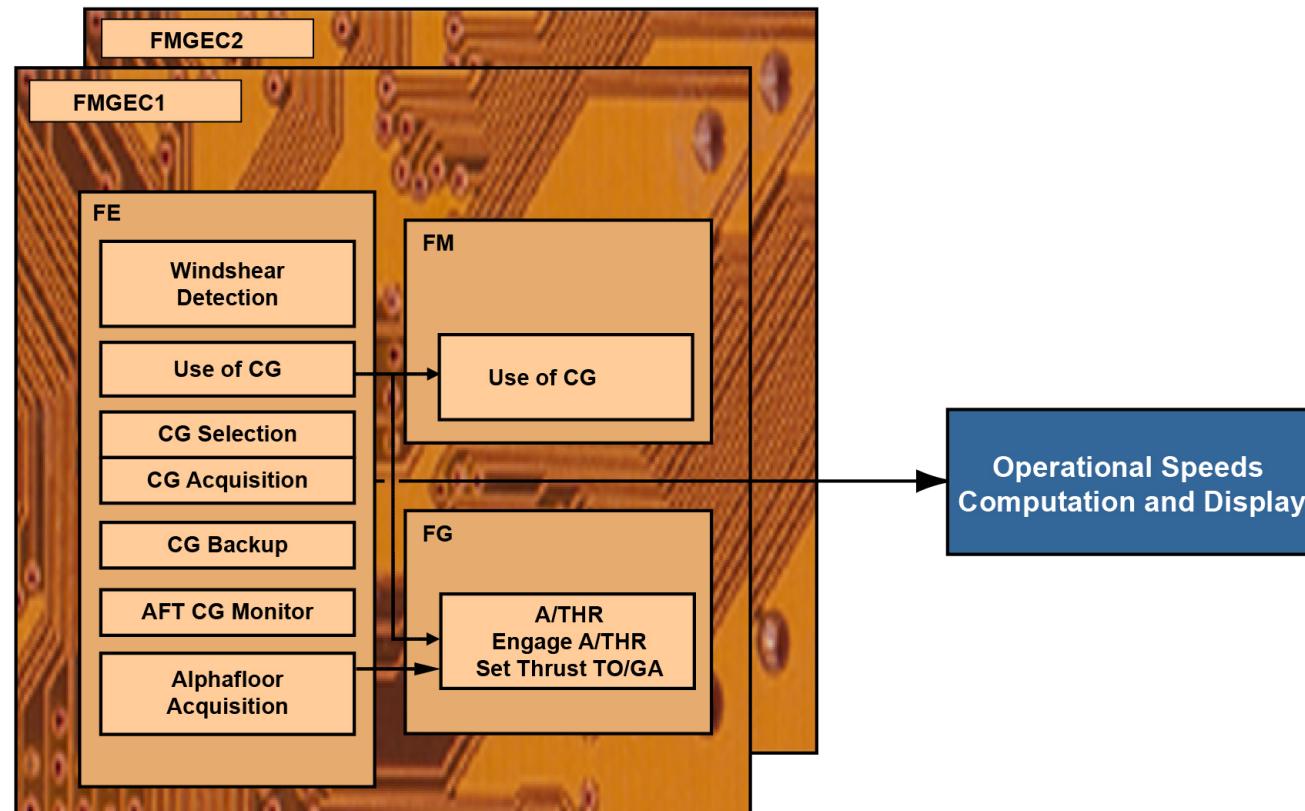
The Flight Envelope (FE) part detects A/C configurations outside the normal flight envelope such as windshear conditions and aft Center of Gravity (CG) out of tolerated limit. The FE part also acquires and transmits the alphafloor signal from the Flight Control Primary Computers (FCPCs) to the Flight Guidance (FG) part.

FE processing is autonomous. A single detection by one of the two Flight Management Guidance and Envelope Computers (FMGECs) is enough to activate one of these three functions.

The FE function computes the limit and manoeuvering speeds which are displayed on the speed scale of the Primary Flight Display (PFD).

### DETECTION AVAILABILITY

Windshear detection, aft CG detection or alphafloor detection depend on flight conditions. Windshear detection is available during 30 seconds after take-off under 250 feet Radio Altimeter (RA) and from 1300 feet RA to 50 feet RA in approach. It is inhibited in clean configuration. AFT CG detection is available in clean configuration and above 20,000 feet. Alphafloor acquisition is available from take-off to a radio altitude of 100 feet before landing.



## GENERAL &amp; DETECTION AVAILABILITY

## FLIGHT ENVELOPE PROTECTION D/O

### WINDSHEAR DETECTION

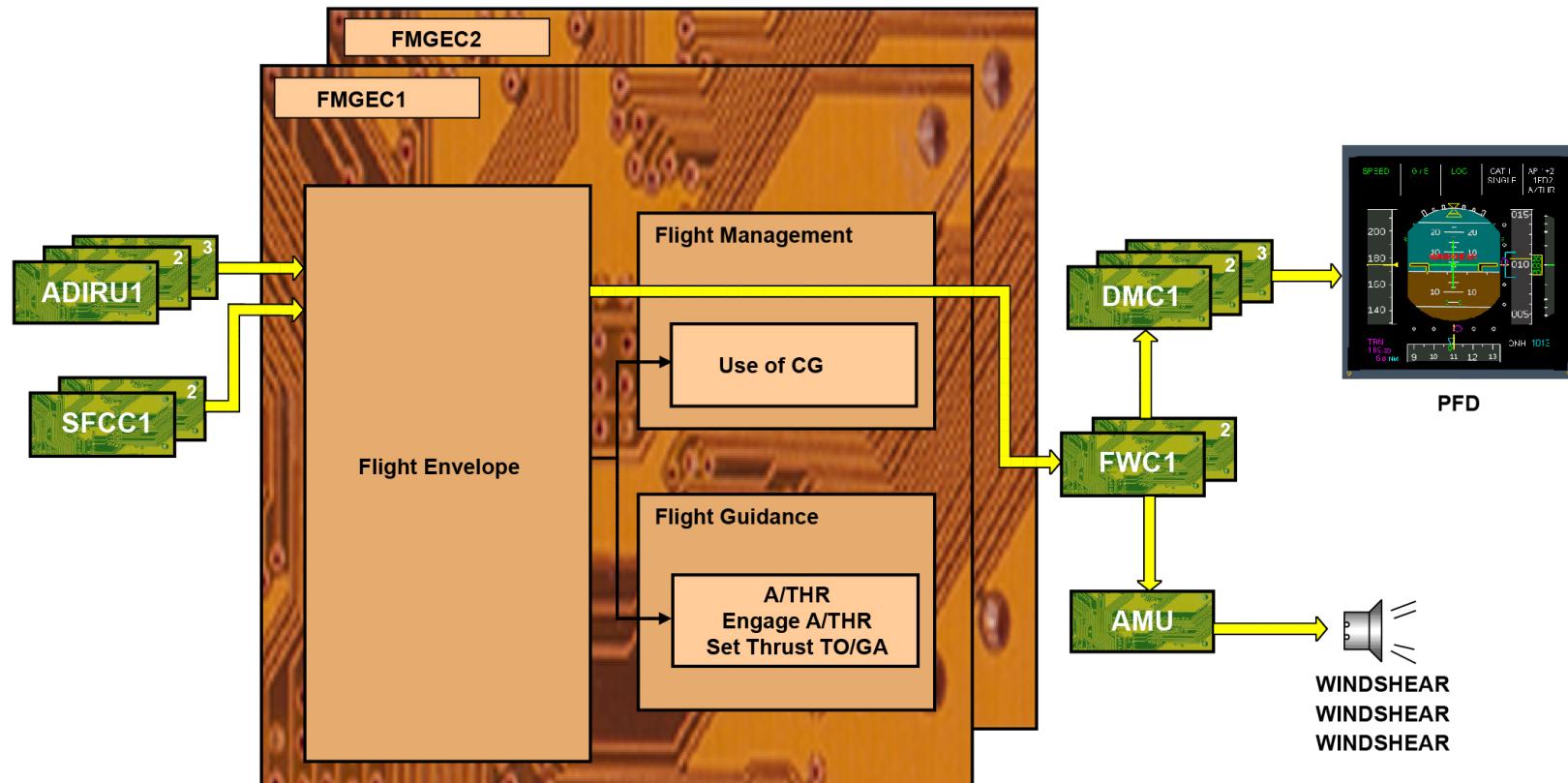
If windshear is detected, the FE function computes a windshear warning.

A visual indication is given on the PFD and an aural warning can be heard from the cockpit loudspeakers. This signal computation is based on an algorithm taking into account longitudinal shears, vertical acceleration, wind components given by the Air Data and Inertial Reference Unit (ADIRU) and slat/flap position given by the Slat Flap Control Computer (SFCC).

### WINDSHEAR WARNING

The warning is triggered depending on the shear intensity and a minimal safe A/C energy (according to speed and flight path).

**NOTE:** Note that if both RAs have failed, the windshear warning is not available. This warning loss is displayed on the ECAM status page.



WINDSHEAR DETECTION - WINDSHEAR WARNING

## FLIGHT ENVELOPE PROTECTION D/O

### AFT CENTER OF GRAVITY DETECTION

In order to improve A/C performance, the Fuel Control and Monitoring Computer (FCMC) controls the CG position by transferring fuel forward. The FE function monitors the non-overshoot of the aft CG limits by a computation fully independent of the FCMC.

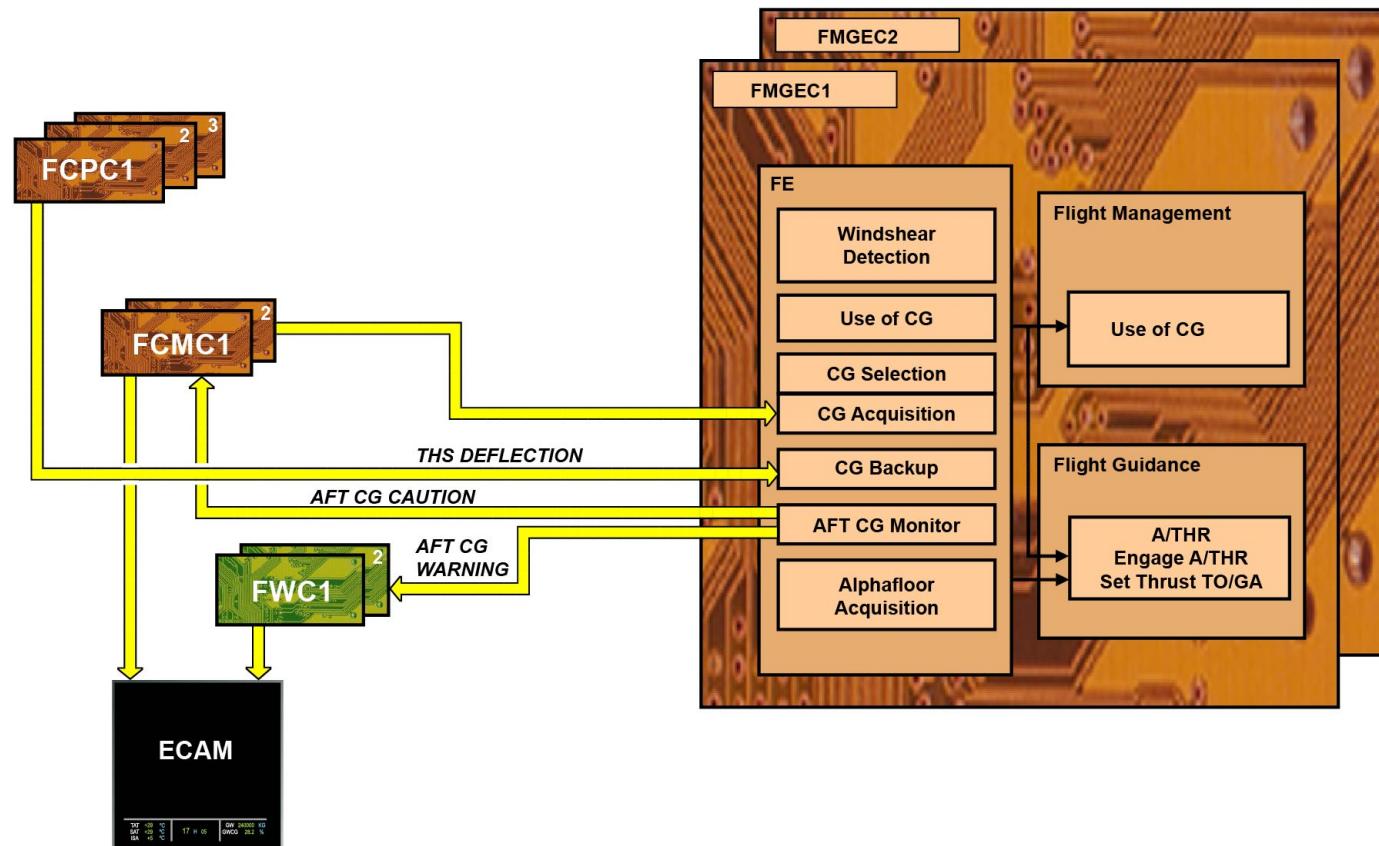
### AFT CG OVERSHOOT

If the FE CG is greater than the aft CG caution limit, the information is transmitted to the FCMC which stops fuel transfer during a time limit.

### AFT CG WARNING

The FE function provides the Flight Warning Computers (FWCs) with a CG monitoring availability signal. If the CG is greater than the limit CG, the FE function sends an aft CG warning signal followed by an ECAM message to the FWCs.

Aft CG warning and caution are computed with CG and weight estimations made by the FE part, mainly by using THS deflection.



AFT CENTER OF GRAVITY DETECTION - AFT CG OVERSHOOT &amp; AFT CG WARNING

## FLIGHT ENVELOPE PROTECTION D/O

### ALPHAFLOOR ACQUISITION

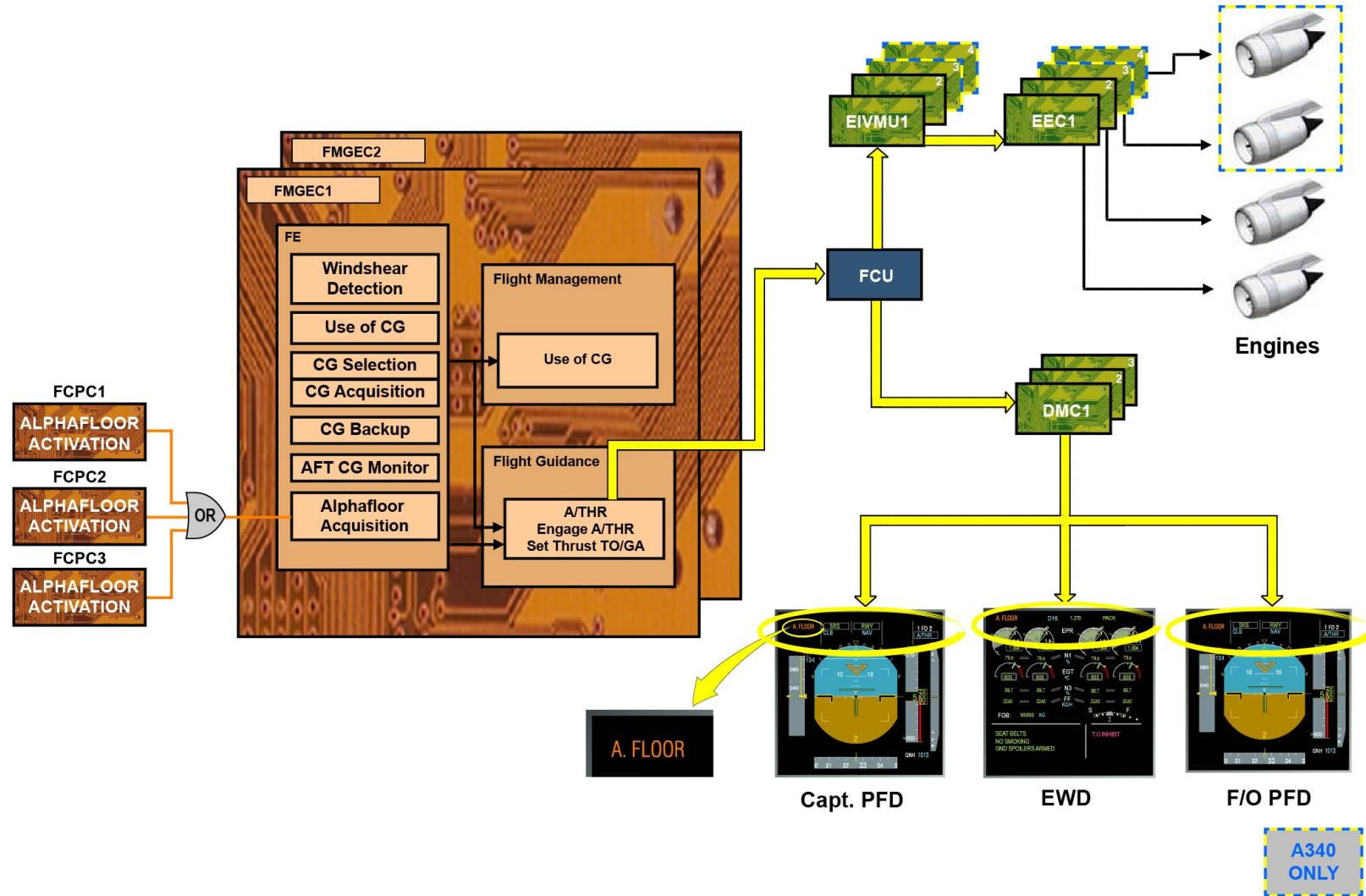
The FE part only acquires the Alphafloor detection/activation signal coming from the FCPC. This creates the Alphafloor condition. The FE part is involved as a letter box between the FCPCs and the FG part. The alphafloor condition is used by the FG part and the opposite FMGEC.

### ALPHAFLOOR PROTECTION OF THE AUTOTHRUST

The alphafloor protection of the autothrust function is active when the detection is performed by at least one of the three FCPCs. The Alphafloor acquisition function has full authority on the autothrust via the FG part. It forces the autothrust to Take-Off/Go-Around (TO/GA) thrust even if the autothrust was not previously engaged.

### ALPHAFLOOR WARNING MESSAGES

Warning messages are displayed on the PFD and on the EWD. The FE function provides the Display Management Computers (DMCs) via the Flight Control Unit (FCU) with a Flight Mode Annunciator (FMA) amber message A. FLOOR in the autothrust zone and an EWD amber message A FLOOR at the top left of the screen.



ALPHA FLOOR ACQUISITION - ALPHA FLOOR PROTECTION OF THE AUTOTHRUST & ALPHA FLOOR WARNING MESSAGES

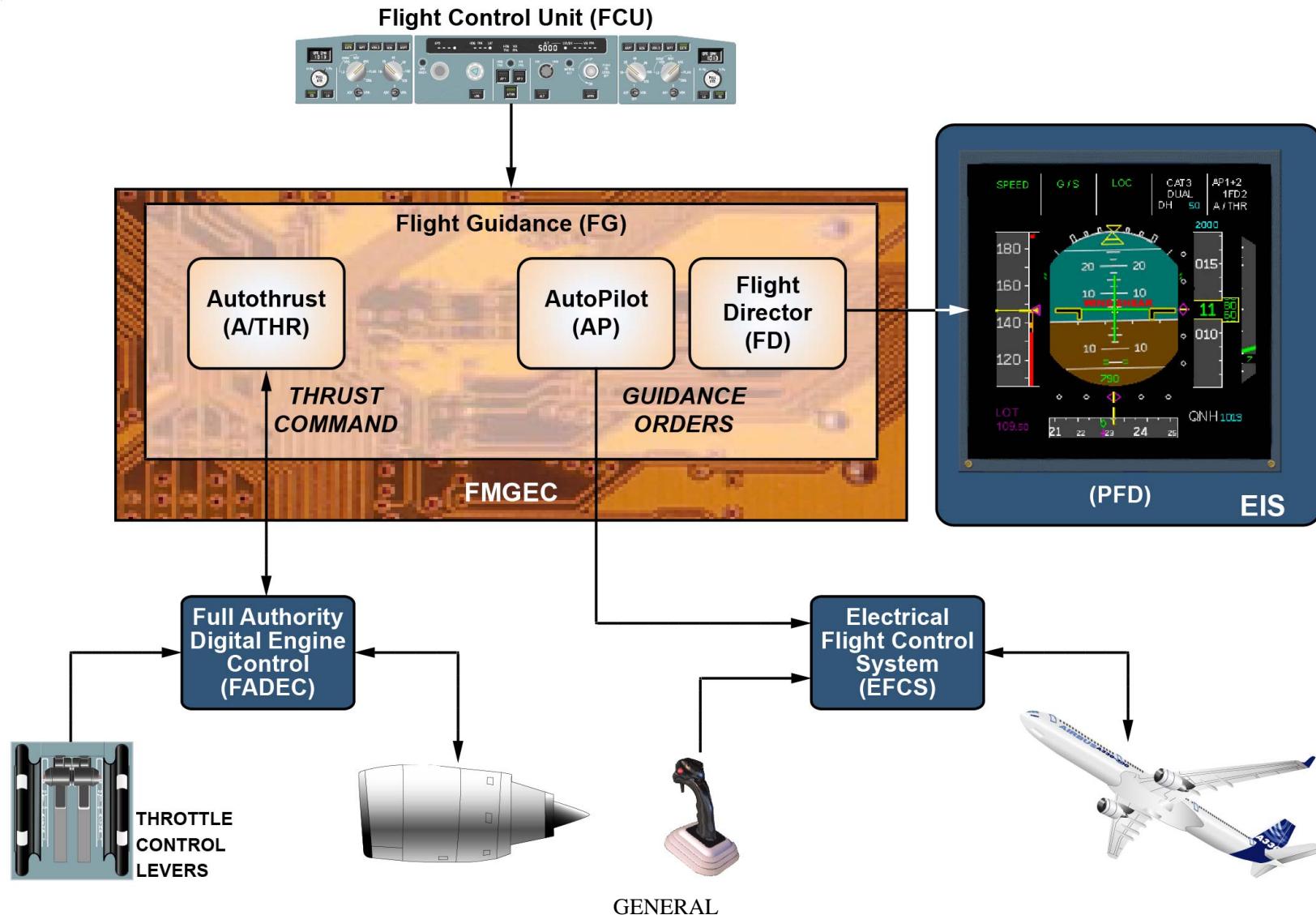
## FLIGHT GUIDANCE GENERAL DESCRIPTION

### GENERAL

The Flight Guidance (FG) functional portion of the Flight Management Envelope and Guidance Computers (FMGECs) performs three functions:

- Autopilot (AP),
- Flight Director (FD),
- Autothrust (A/THR).

The FG part contains the engagement logics, the operational mode logics and the control laws associated to these functions. The control laws provide AP guidance orders, FD orders and a thrust command to stabilize and to guide the aircraft.



## FLIGHT GUIDANCE GENERAL DESCRIPTION

### AUTOPILOT FUNCTION

The autopilot function computes lateral and longitudinal guidance orders used by the Flight Control Primary Computers (FCPCs) for automatic deflection of the flight control surfaces as well as for nose wheel steering through the Braking/Steering Control Unit (BSCU). The autopilot functions are:

- Acquisition and holding of a flight path and stabilization of the aircraft around its Center of Gravity (CG),
- Acquisition and holding of a flight level,
- Acquisition and holding of a speed,
- Automatic landing including roll-out,
- Go around.

The autopilot can also do avoidance maneuvers when the TCAS RA is activated.

### FLIGHT DIRECTOR FUNCTION

When the autopilot is not engaged, the Flight Director (FD) function displays guidance orders to the pilot to apply on the controls to follow the optimum flight path which would be ordered by the autopilot if it was engaged. The FD guidance orders are displayed on the center section of the EFIS PFDs:

- Generally pitch and roll orders,
- A yaw order during take-off and landing.

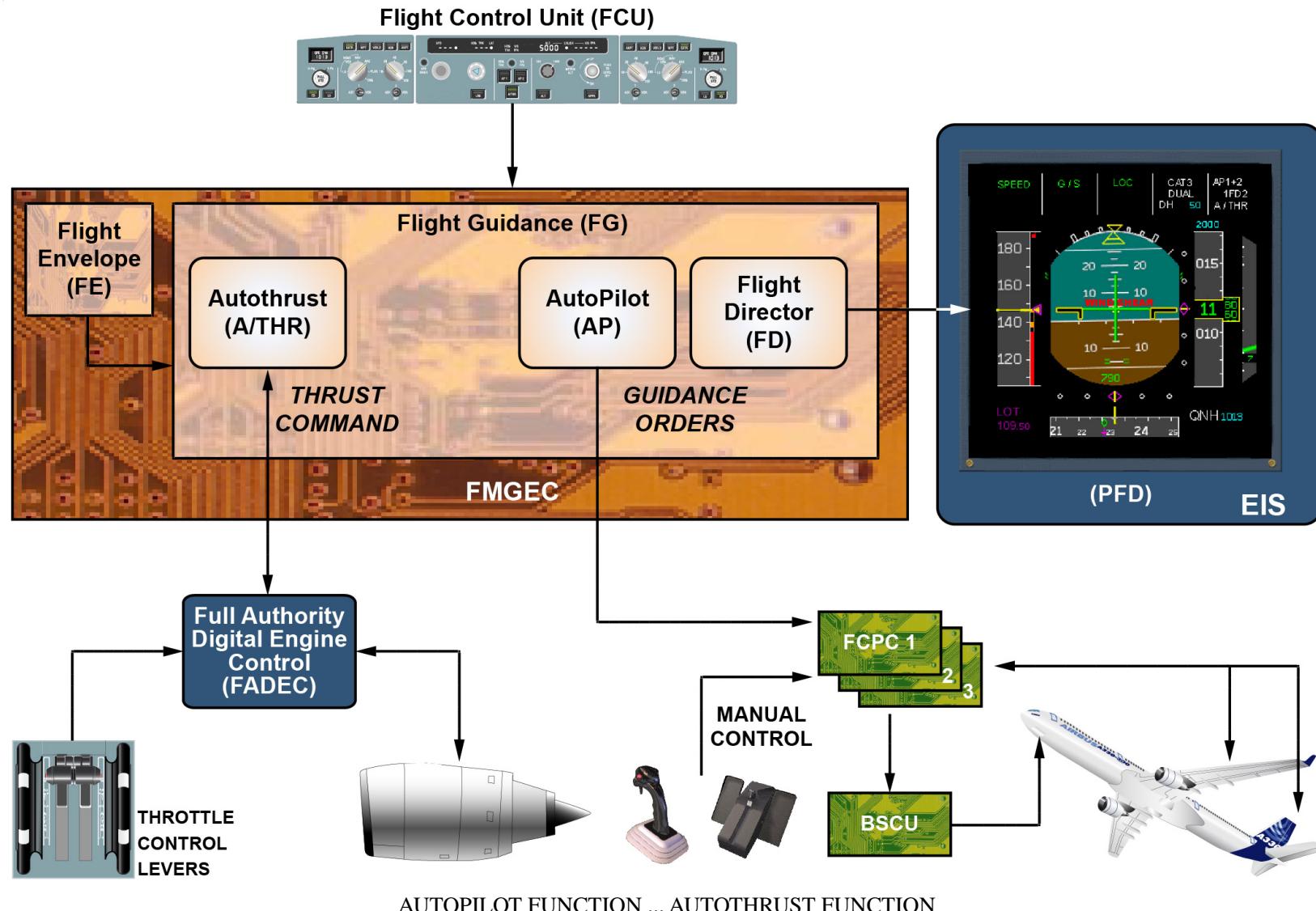
When the autopilot is engaged, the FD function displays the autopilot orders.

If activated, the FD function also displays the orders of TCAS for manual or automatic collision avoidance when the AP is not engaged or engaged.

### AUTOTHRUST FUNCTION

The Autothrust (A/THR) function sends a computed thrust command (thrust target) to the Full Authority Digital Engine Control (FADEC) for automatic engine control. The A/THR functions are:

- Acquisition and holding of a speed or a mach number,
- Acquisition and holding of a thrust,
- Reduction of the thrust to idle during descent and during flare in final approach,
- Protection against excessive angle-of-attack (called alphafloor protection) by ordering a maximum thrust.



## FLIGHT GUIDANCE GENERAL DESCRIPTION

### FLIGHT DIRECTOR ENGAGEMENT

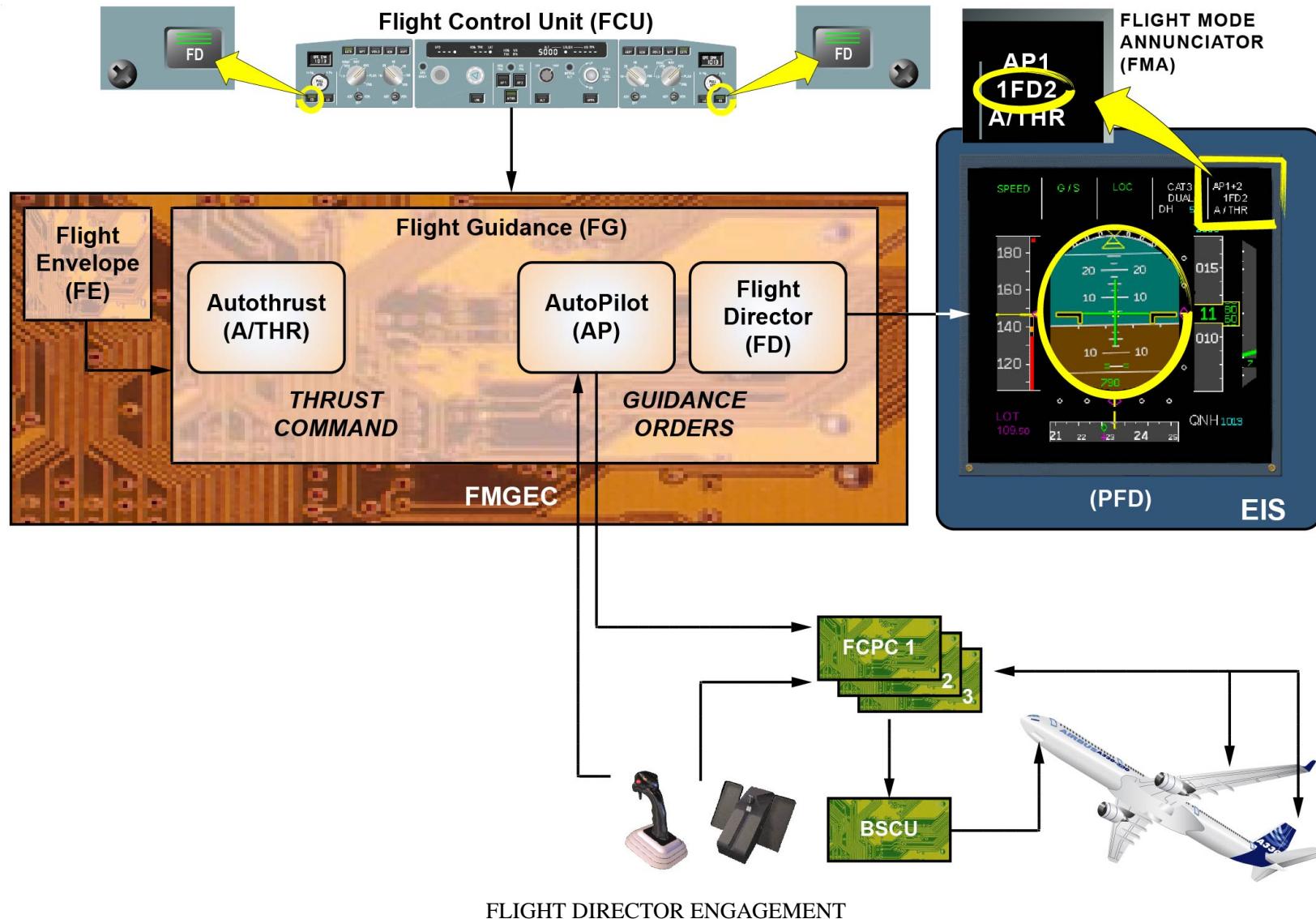
The FD is automatically engaged at FMGEC power-up and the 2 dedicated FCU P/Bs are lit. However, the FD guidance orders will be displayed on the PFDs from take-off only. Then, they can be displayed or not by using the same FCU P/Bs.

The FD is also automatically engaged after engagement of GO-AROUND mode or if AP is lost when ROLL-OUT mode is engaged.

The FD engagement status is displayed on the FMA.

NOTE: : On the A330-800 and A330-900 (NEO), through software adaptation of the FMGECs, the FD is automatically set at Take Off if it was not previously displayed

To engage FD, both hardware and software logics inside FMGEC must be satisfied.



## FLIGHT GUIDANCE GENERAL DESCRIPTION

### AUTOPILOT ENGAGEMENT

Autopilot engagement is always done manually through 2 dedicated Flight Control Unit (FCU) P/Bs. Only one autopilot can normally be engaged at a time. Dual autopilot engagement is possible, but in approach and go around phases (to maximize the autopilot availability during automatic landing). When the autopilot is engaged:

- The associated FCU AP P/B is lit,
- The engagement status is displayed on the Flight Mode Annunciator (FMA) of the PFDs,
- The side sticks are locked and the rudder pedals feel force threshold is increased.

Autopilot disengagement can be done manually or automatically.

Manually, at any time on ground or in flight:

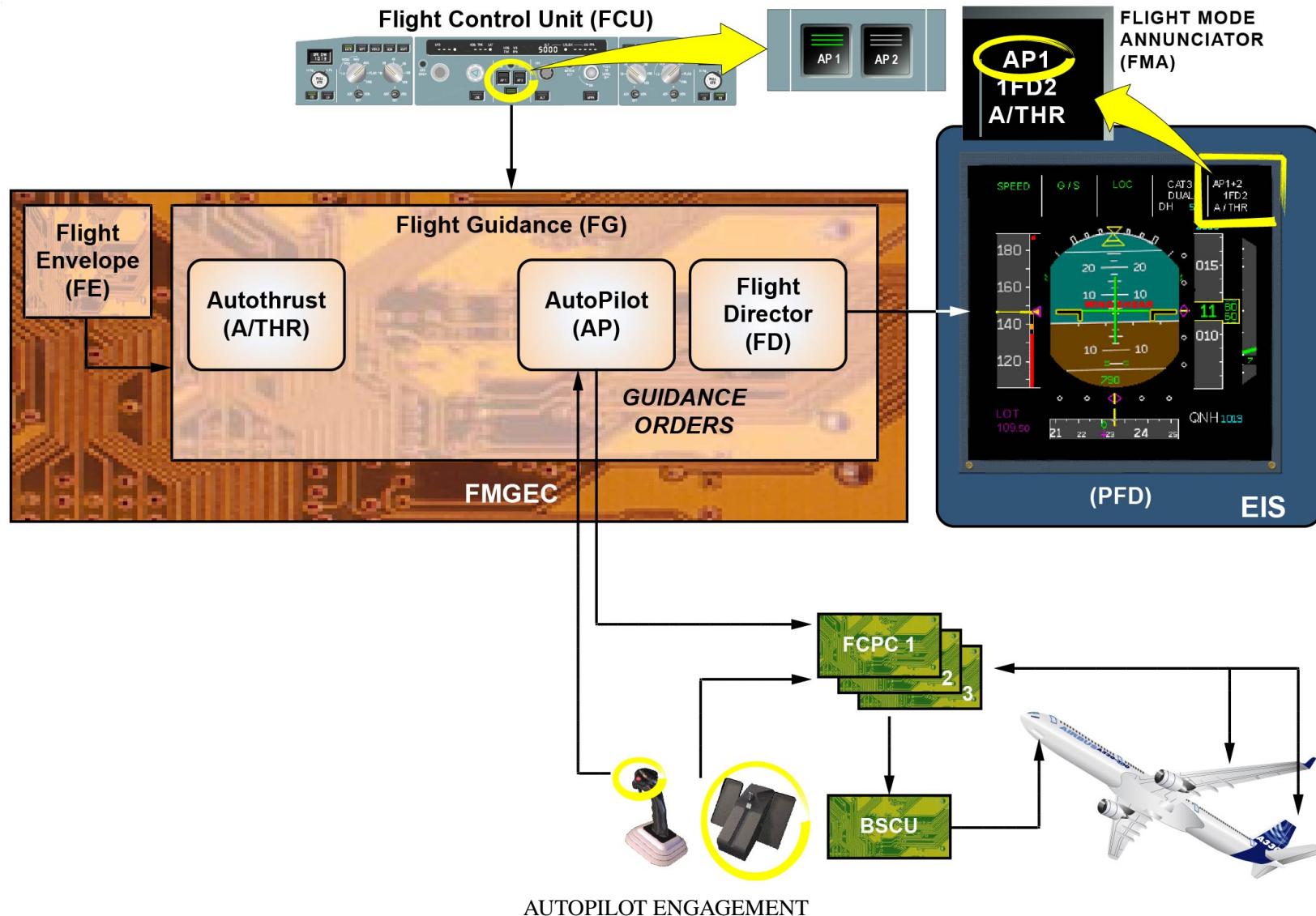
- Either through the associated FCU P/B (AP engagement feedback),
- Or through the side sticks by an unlocking action or by pressing the take-over priority P/BSWs,
- Or through the rudder pedals.

Automatically, in case of failure detection or protection activation (for example, overspeed protection).

To engage or disengage the AP, the corresponding hardware and software conditions must be covered.

On top of the above, the AP engagement has also operational limitations:

- Aircraft speed must be within Lower Selectable Speed (VLS) and Vmax,
- Aircraft pitch angle does not exceed 10 degrees nose down or 22 degrees nose up,
- Bank angle is less than 40 degrees.



## FLIGHT GUIDANCE GENERAL DESCRIPTION

### AUTOTHRUST ENGAGEMENT

The autothrust engagement is done either automatically or manually:

- Automatically when in take-off or go around phases, or when alpha floor protection is activated,
- Manually through a dedicated FCU P/B.

When autothrust is engaged:

- The FCU A/THR pushbutton is lit,
- The engagement status is displayed on the FMA.

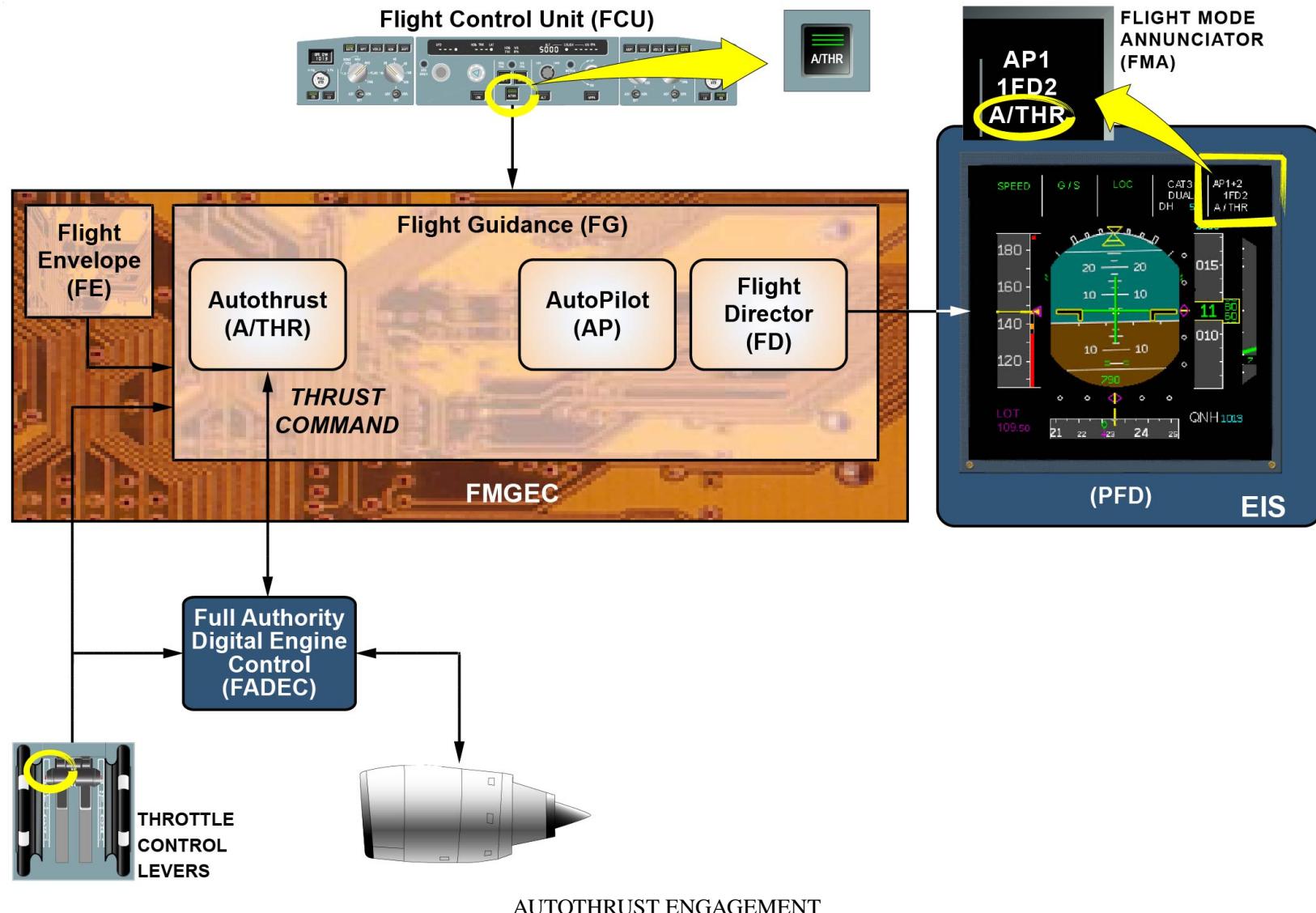
When engaged, the autothrust can be active or not depending on the position of the thrust levers. When engaged and not active, the thrust control is manual. The thrust is commanded according to the position of the thrust levers. When engaged and active, the thrust control is automatic, and the thrust is commanded according to the autothrust computed thrust target.

A/THR disengagement can be done manually:

- By pressing the autothrust instinctive disconnect switch on any thrust lever,
- By setting all thrust levers to idle position,
- Through the dedicated FCU pushbutton.

The A/THR is disengaged automatically in case of failure detection.

The A/THR function can be engaged according to AP, FD and A/THR common conditions and some specific conditions.

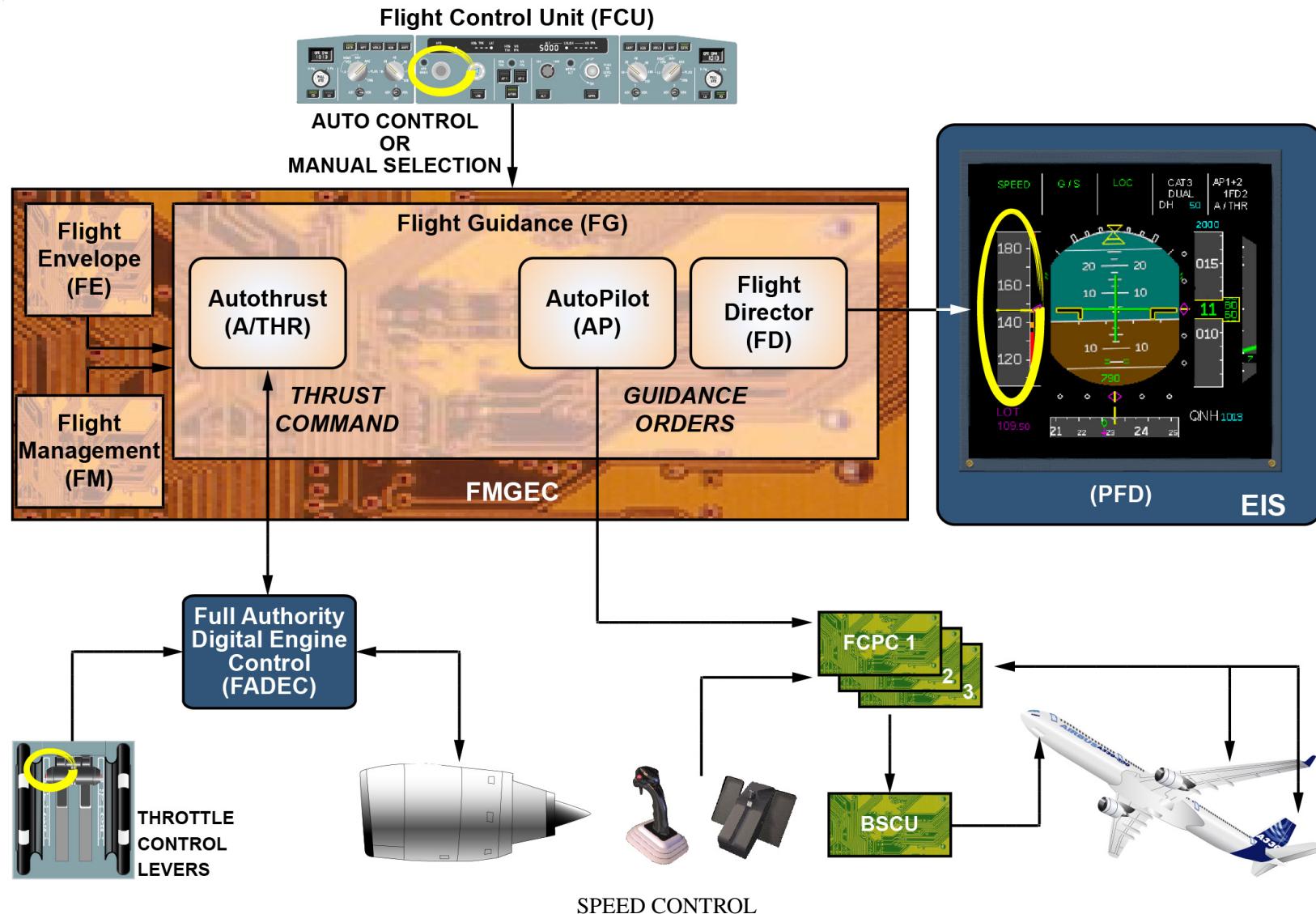


## FLIGHT GUIDANCE GENERAL DESCRIPTION

### SPEED CONTROL

In flight, the speed is a safety parameter used as a reference for the longitudinal guidance. As a consequence, the FG functional part continuously controls the Speed/Mach parameter either by the AP/FD longitudinal guidance or the autothrust. The reference speed is always limited by the Flight Envelope (FE) characteristic speeds computation. It is displayed on the speed scale of the PFDs.

The speed reference is computed by the FM functional part by pushing the FCU knob in, this is called "managed speed". If the speed reference comes from the FCU, by pulling the corresponding knob out, it is called "selected speed".



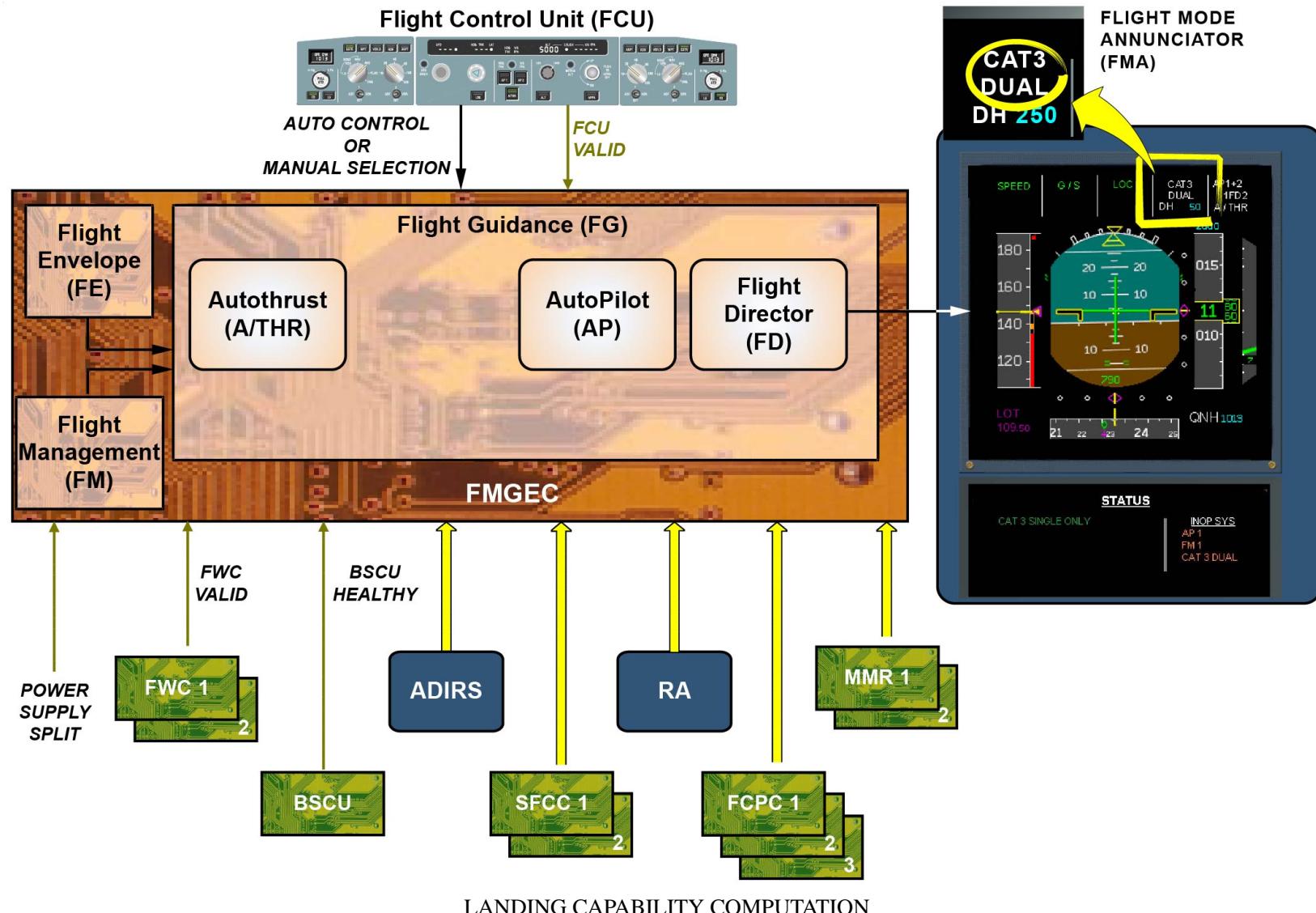
## FLIGHT GUIDANCE GENERAL DESCRIPTION

### LANDING CAPABILITY COMPUTATION

Each FMGEC computes the landing capability (CAT1 / CAT2 / CAT3 / SINGLE/CAT3 DUAL) during the whole flight:

- When the AP and FD are disengaged for one FMGEC, the landing capability corresponds to the category of the available FMGEC.
- When AP and FD are engaged for both FMGECs, the landing capability corresponds to the lowest category sent by the FMGECs.

The computation depends on Auto Flight System (AFS) and peripheral systems availability. The landing capability availability is displayed on the (Electronic Centralized Aircraft Monitoring) ECAM STATUS page and, when in approach, on the fourth column of the FMA. Depending on the availability of peripherals, the landing capability can be downgraded. A triple click aural warning is generated if landing capability is downgraded.



## FLIGHT GUIDANCE AUTOTHRUST D/O

### ENGAGEMENT

#### MANUAL ENGAGEMENT

The engagement of the autothrust function can be manual or automatic.

The autothrust is engaged manually by pressing the A/THR P/B on the Flight Control Unit (FCU). This is inhibited below 100 feet Radio Altimeter (RA), with engines running.

**NOTE:** Note that to effectively have autothrust on engines, the engagement of the autothrust is confirmed by a logic of activation in the Engine Electronic Controller (EEC) for Pratt & Whitney and Rolls Royce Engines and in the Engine Control Unit (ECU) for General Electrics (GE) engines.

#### AUTOMATIC ENGAGEMENT

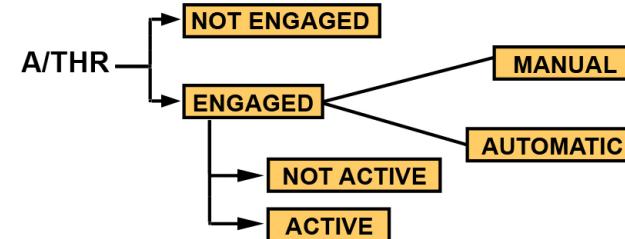
The autothrust is engaged automatically:

- when the Autopilot/Flight Director (AP/FD) modes are engaged at take-off or go-around,
- in flight, when the alphafloor (protection against high angle-of-attack) is activated; this is inhibited below 100 feet RA except during the 15 seconds following the lift-off.

After engagement, the autothrust can be active or not active depending on the thrust lever position.



Flight Control Unit (FCU)

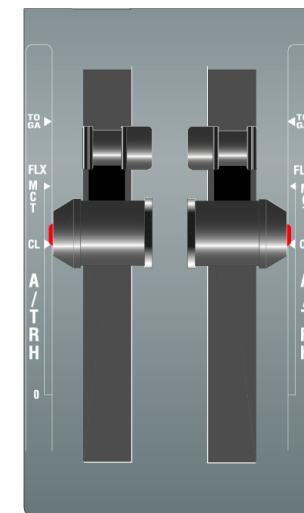


PFD

A/THR

A/THR WHITE WHEN A/THR  
ENGAGED AND ACTIVE

A/THR

A/THR CYAN WHEN A/THR  
ENGAGED AND NOT ACTIVE

ENGAGEMENT - MANUAL ENGAGEMENT &amp; AUTOMATIC ENGAGEMENT

## FLIGHT GUIDANCE AUTOTHRUST D/O

### A/THR LOOP PRINCIPLE

To apply the autothrust function, the master Flight Management Guidance and Envelope Computer (FMGEC) communicates with the Full Authority Digital Engine Control (FADEC) via the FCU and the Engine Interface and Vibration Monitoring Units (EIVMUs).

### A/THR FUNCTION LOGIC

#### A/THR FUNCTION DISENGAGED

When the autothrust function is disengaged:

- the thrust levers control the engines,
- on the FCU, the A/THR P/B light is OFF,
- the Flight Mode Annunciator (FMA) does not display the autothrust engagement status nor the autothrust modes.

#### A/THR FUNCTION ENGAGED

When the autothrust engagement logic conditions are present, the autothrust can be engaged.

Autothrust is active if:

- at least, one thrust lever is between CL detent (included) and 0 stop (included) and, at the most, one thrust lever is between the MCT detent and CL detent, and if there is no engine in FLEX TO mode,
- the alphafloor protection is active.

When the autothrust function is engaged and active:

- the autothrust system controls the engines,
- on the FCU, the A/THR P/B light is ON,
- the FMA displays the autothrust engagement status (in white in the right column) and the autothrust mode in the left column.

A/THR is not active if:

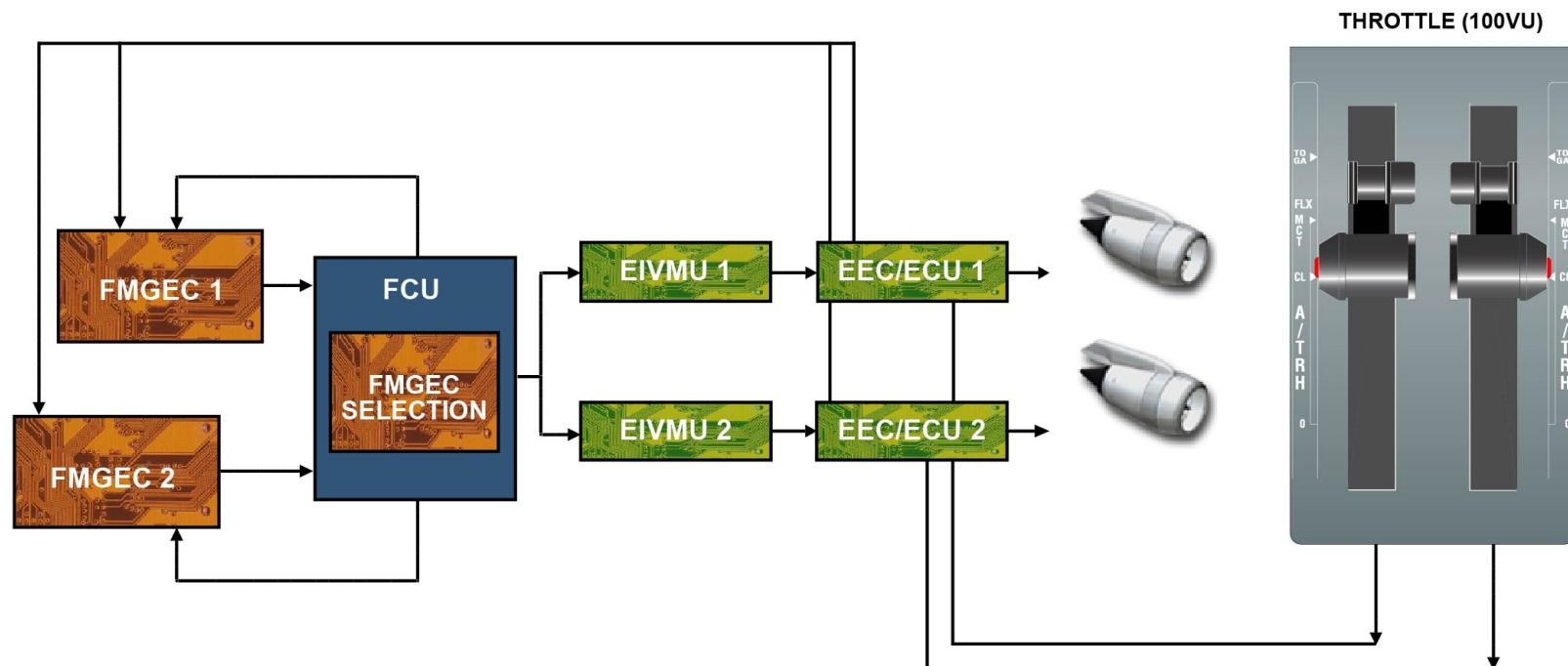
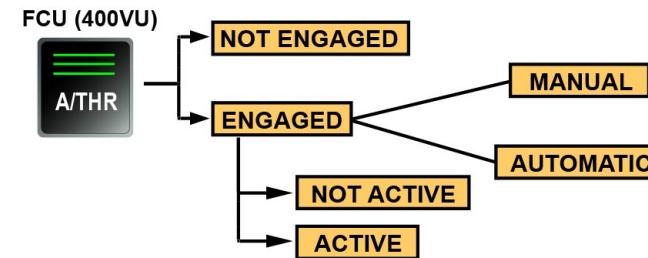
- at least, one thrust lever is above the MCT detent or, all the thrust levers are above the CL detent or, at least one engine is in FLEX TO mode,

- the alphafloor protection is not active.

When the autothrust function is engaged and not active:

- the thrust levers control the engines (as long as a thrust lever is outside the autothrust active area),
- the A/THR P/B light is ON,
- the FMA displays the autothrust engagement status (in cyan in the right column) and the thrust setting in the left column.

**NOTE:** In case of engine failure, the A/THR activation zones become between the MCT and 0 stops.



A/THR LOOP PRINCIPLE &amp; A/THR FUNCTION LOGIC

## FLIGHT GUIDANCE AUTOTHRUST D/O

### MODES

The autothrust function works according to modes and their related reference parameters. The reference parameters can be:

- a SPEED or a MACH NUMBER: in this case, the source is either the FCU (value chosen by the pilots) or the FMGEC itself.
- a THRUST; in that case, the sources are either the EECs / ECUs (which compute the thrust limit) when the thrust limit is needed, or the FMGEC itself.

The possible autothrust modes are SPEED, MACH, THRUST, RETARD and alphafloor protection.

### MODES DESCRIPTION

The choice of the mode is made by the FMGECs according to the AP/FD current longitudinal active mode:

- SPEED or MACH mode, the reference of which is selected on the FCU or managed by the FMGEC,
- THRUST mode, where the reference agrees with the thrust limit computed by the EECs/ECUs (according to the thrust lever position), idle thrust in descent or optimum thrust computed by the FMGEC,
- RETARD mode: the thrust is reduced and maintained at idle during flare,
- ALPHAFLOOR PROTECTION: a TO/GA thrust is activated to protect the A/C against excessive angle-of-attack.

### DEFAULT MODE

When no longitudinal mode is active, the A/THR operates in SPEED/MACH modes except:

- when THRUST mode engages automatically in case of alphafloor protection activation,
- when, autothrust being in RETARD, APs and FDs disengage, the autothrust function remains in RETARD mode.

### ALPHAFLOOR

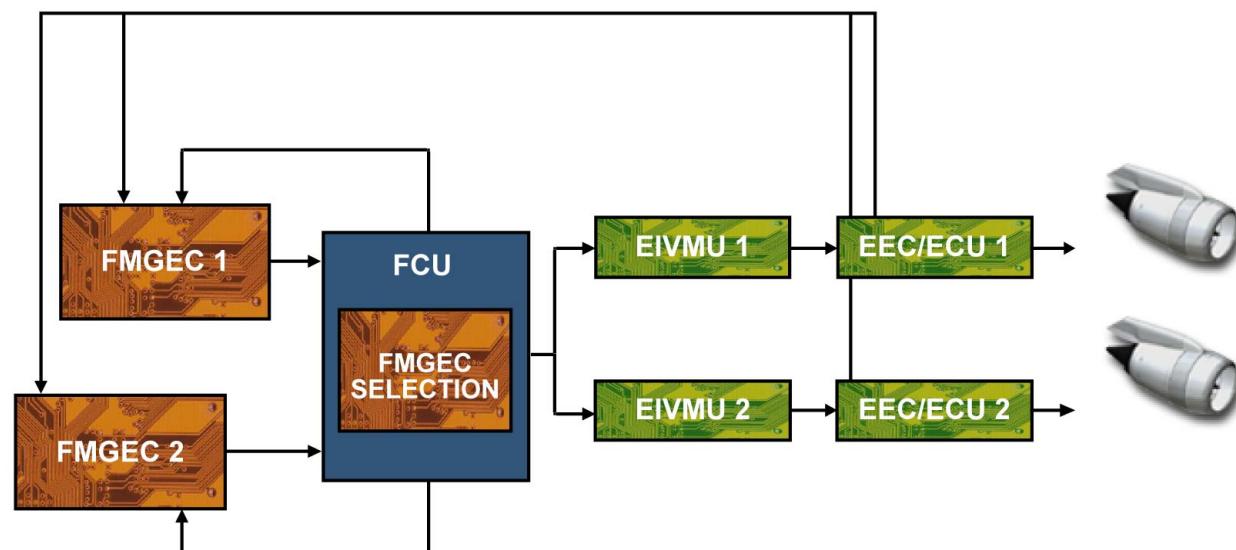
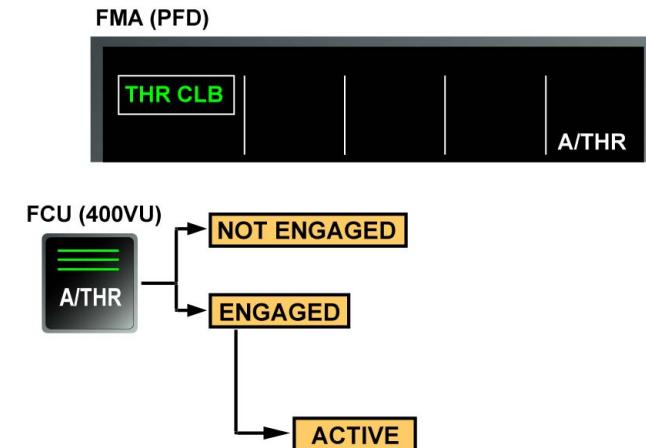
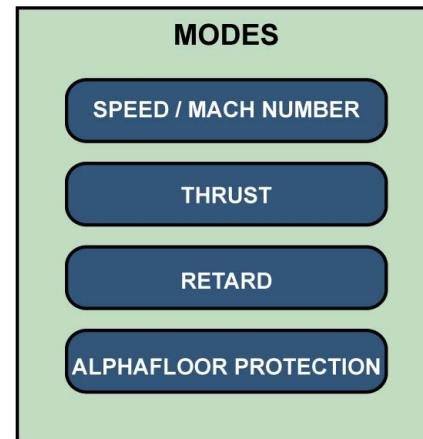
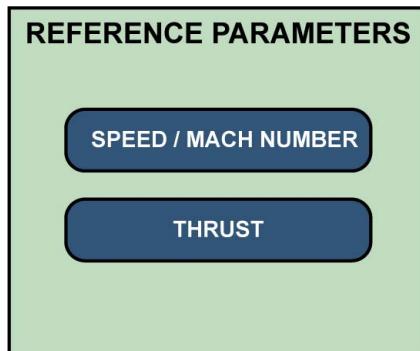
The autothrust function protects against an excessive angle-of-attack. In case of excessive angle-of-attack, the Flight Control Primary Computers (FCPCs) send a detection signal to the FMGECs, which activates the alphafloor protection.

The alphafloor protection automatically engages and activates the autothrust function, whatever the position of the thrust levers and the A/THR engagement status: the engine thrust becomes equal to TO/GA thrust.

Then a green message "A.FLOOR" surrounded by a flashing amber box is displayed on the FMA.

When the alphafloor detection is no longer present in the FCPCs, a green message "TOGALK" (LK for LOCK) surrounded by a flashing amber box is displayed on the FMA.

The "TOGALK" thrust can only be cancelled through the disengagement of the autothrust function, via the A/THR P/B or the autothrust instinctive disconnect switches.



MODES &amp; ALPHA FLOOR

## FLIGHT GUIDANCE AUTOTHRUST D/O

### A/THR OPERATION IN FLIGHT

Let's now see the autothrust operation in flight.

#### TAKE-OFF

The A/C is on ground and ready for take-off, the engines are controlled by the thrust levers and neither AP nor autothrust are engaged. To take off, the pilot sets the thrust levers to the TO/GA stop, or to the FLX/MCT detent provided a flexible temperature was previously selected on the MCDU. This engages the autothrust function (but it is not active).

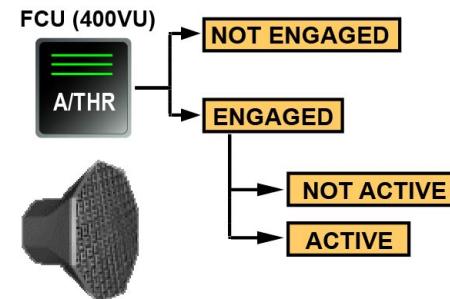
#### THRUST REDUCTION ALTITUDE

At thrust reduction altitude, a message on the FMAs warns the pilots to set the thrust levers in the CL detent. As soon as the thrust levers are in the CL detent, the autothrust is active. If a thrust lever is set into the CL - MCT area, a message on the FMAs warns the pilot to set the thrust lever to the CL detent (LVR CLB). The autothrust remains active. Then, the thrust levers remain in this position until the approach phase.

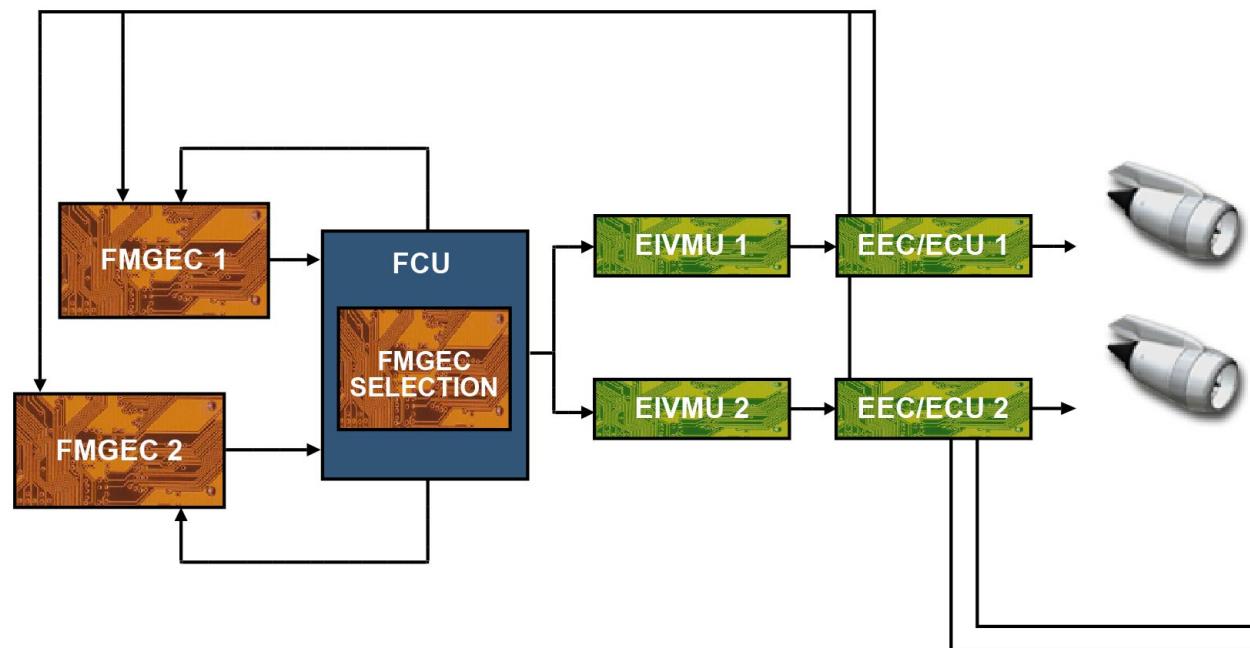
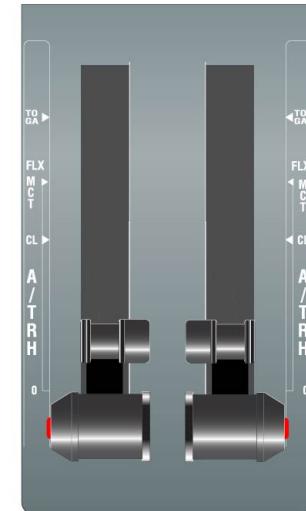
#### AUTOMATIC LANDING

During AUTOMATIC LANDING, before touch-down, an auto call-out, "RETARD", warns the pilot to set the thrust levers to idle. When the pilot put both levers on idle detent, the autothrust disengages. This allows the automatic activation of the ground spoilers if they are in armed condition. Then, on GROUND, the pilot sets the T/R levers to the reverse position.

## FMA (PFD)



## THROTTLE (100VU)



A/THR OPERATION IN FLIGHT - TAKE-OFF ... AUTOMATIC LANDING

## FLIGHT GUIDANCE AUTOTHRUST D/O

### DISCONNECTION

The autothrust can be disengaged in two ways.

- standard disconnection: By pressing at least one of the two red instinctive disconnect switches on the side of thrust levers or setting all thrust levers to IDLE detent.
- non standard disconnection: By pressing the A/THR P/B on the FCU or failure mode affecting one of the engagement condition. When the autothrust function is active, the actual engine thrust does not necessarily agree with the thrust lever position.

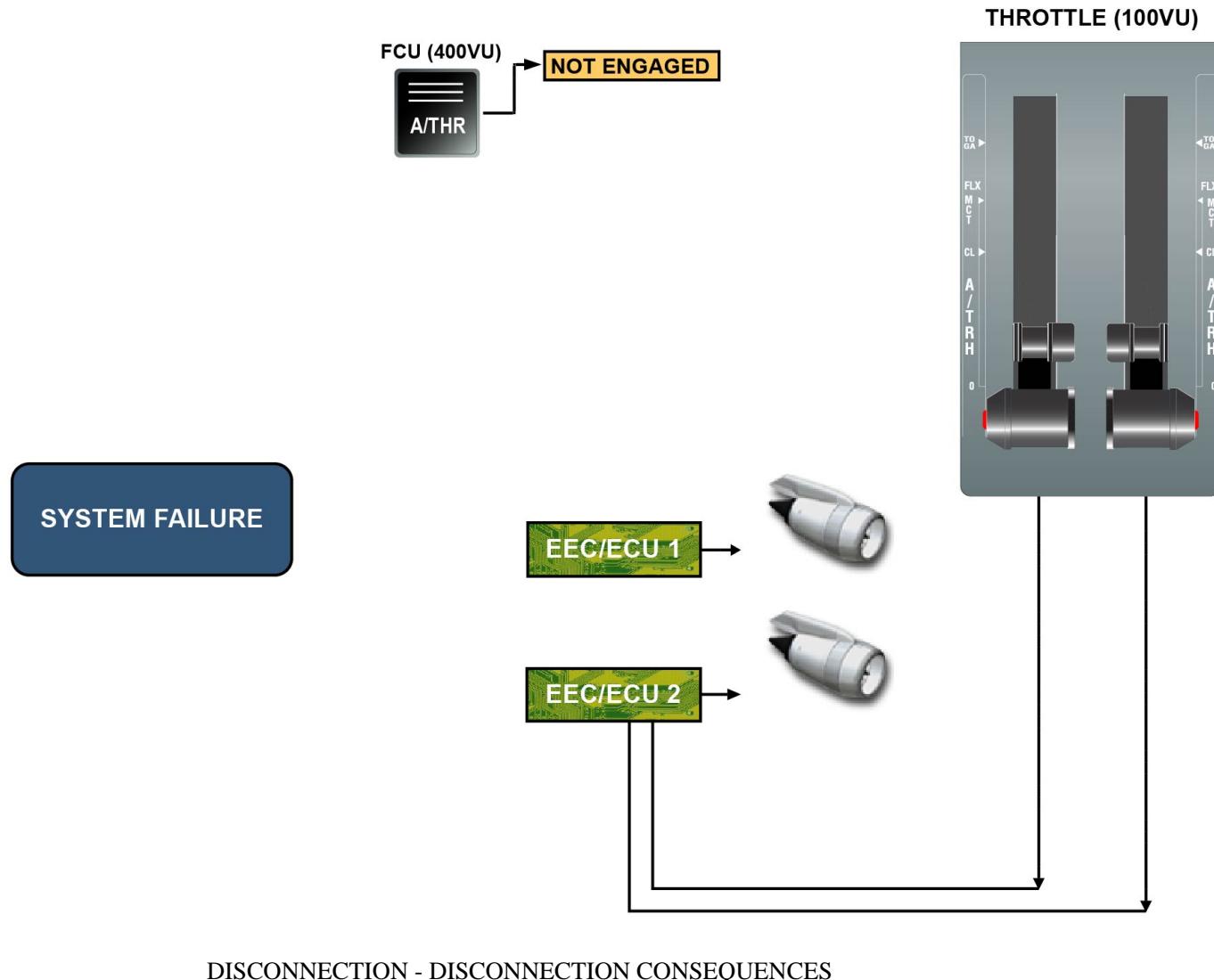
### DISCONNECTION CONSEQUENCES

It is important to know what happens after autothrust disconnection.

When the autothrust function is disengaged through the instinctive disconnect switches, or setting the levers on IDLE, the thrust on the engines is automatically adapted to the related thrust lever position.

When the autothrust function is disengaged through the FCU A/THR P/B or due to a system failure:

- as long as a thrust lever remains in its detent, the thrust on the related engine is frozen at its last value just before the disconnection,
- as soon as a thrust lever is moved from the detent, or if it was not in a detent, the thrust on the related engine is smoothly adapted to the thrust lever position.

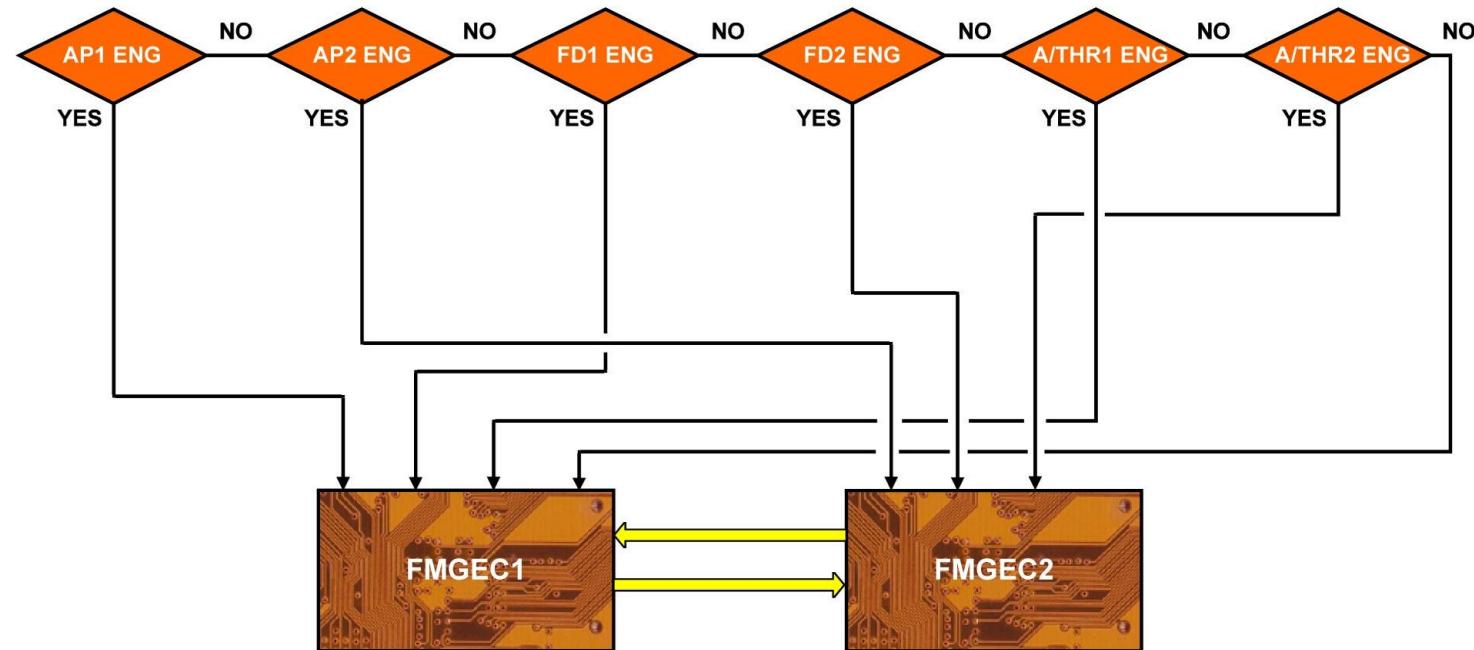


## FLIGHT GUIDANCE PRIORITY LOGIC D/O

### FLIGHT GUIDANCE (FG)

The engagement status of the guidance function works on the MASTER/SLAVE principle. The master Flight Management Guidance and Envelope Computer (FMGEC) imposes all the changes of AP/Flight Director (FD) modes and/or A/THR engagement to the slave FMGEC. Here is an example of a master FMGEC. Look at the flow chart to understand the priority logic. With no AP, no FD1 but FD2 engaged, FMGEC2 is the master because, following the flow chart, the first three answers are "NO", but the fourth one is "YES".

## GUIDANCE FUNCTION: ENGAGEMENT STATUS



- A/THR: AUTOTHROTTLE  
 - AP: AUTO PILOT  
 - FD: FLIGHT DISPLAY  
 - FMGEC: FLIGHT MANAGEMENT GUIDANCE AND ENVELOPE COMPUTER

FLIGHT GUIDANCE (FG)

## AUTO FLIGHT SYSTEM CONTROL AND INDICATING (2/3)

### AUTO FLIGHT SYSTEM

#### FCU Managed and Selected modes

#### AFS software reset switches (FM, FCU, FMGEC)

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## FLIGHT PLANNING D/O

### FLIGHT PLAN

The flight plan is defined by various elements, which indicate the routes the A/C must follow with the limitations along these routes.

The elements are mainly taken from the databases or directly entered by the pilot. The limitations are mainly speed, altitude or time constraints originated by the ATC. The function that integrates these elements and limitations to construct a flight plan is called FLIGHT PLANNING. In addition to this, the Flight Management (FM) part provides the A/C position and the follow-up of the flight plan, this is called NAVIGATION. Everything can be prepared prior to take-off but can also be modified quickly and easily during the flight operation.

### NAVIGATION DATABASE

The navigation database provides all necessary information for flight plan construction and follow-up. The pilot will either select an already assembled flight plan (company route (CO ROUTE)), or will build his own flight plan, using the existing database contents. This database has a worldwide coverage, updated every 28 days. A crossloading facility is available allowing the database loading from either Flight Management Guidance and Envelope Computer (FMGEC) database through an intersystem bus. Besides this, some room is kept to allow manual entry of 20 navaids, 20 waypoints, 5 routes and 10 runways.

The database cannot be erased, except for the manually entered data. Two cycle databases can be inserted, the selection is made automatically using data from the A/C clock.

### NAVIGATION

The navigation process provides the system with current A/C state information consisting of present position, altitude, winds, true airspeed and ground speed. This is achieved using inputs from the Inertial Reference System (IRS), Air Data System (ADS), navigation radios and,

Air Traffic Service Unit (ATSU). Position can be updated manually during the flight or automatically e.g.: on the runway threshold at take-off.

### LATERAL FLIGHT PLAN

The lateral flight plan provides the sequential track changes at each waypoint within 3 main sections. DEPARTURE: In this phase the lateral flight plan provides initial FIX (origin airport), SID (Standard Instrument Departure), etc. EN ROUTE: In this phase the lateral flight plan provides waypoints, navigation aids, etc. ARRIVAL: In this phase the lateral flight plan provides STAR (Standard Terminal Arrival Route), approach, missed approach, go around, etc.

The lateral steering order can be followed by the pilot or the autopilot through the NAV mode selected on the Flight Control Unit (FCU).

### VERTICAL FLIGHT PLAN

The vertical flight plan provides an accurate flight path prediction, which requires a precise knowledge of current and forecast wind, temperature and the lateral flight path to be flown. The vertical flight plan is divided into several flight phases:

- the PREFLIGHT phase in which the vertical flight plan provides fuel, weight and V2 insertions,
- the TAKE-OFF phase in which the vertical flight plan provides speed management, thrust reduction, altitude and acceleration altitude,
- the CLIMB phase in which the vertical flight plan provides speed limit and speed management,
- the CRUISE phase in which the vertical flight plan provides top of climb, cruise altitude and top of descent,
- the DESCENT phase in which the vertical flight plan provides speed management and deceleration,
- the APPROACH/MISSED APPROACH/GO AROUND phase in which the vertical flight plan provides thrust/acceleration altitudes.

<b>AIRBUS</b> <b>A330</b> TECHNICAL TRAINING MANUAL	<b>T1+T2 Mechanical and Avionics A330 RR TRENT 700</b> 22-AUTO FLIGHT	TP REV 4 13/03/2020
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The vertical steering order can be followed by the pilot or the autopilot. Any level change in the vertical profile is initiated after a push action on a level change selector. The crew may send a request for wind data to the ground via the ATSU. In response to this request, or automatically, the ground sends climb, cruise, descent and alternate wind data to the A/C.

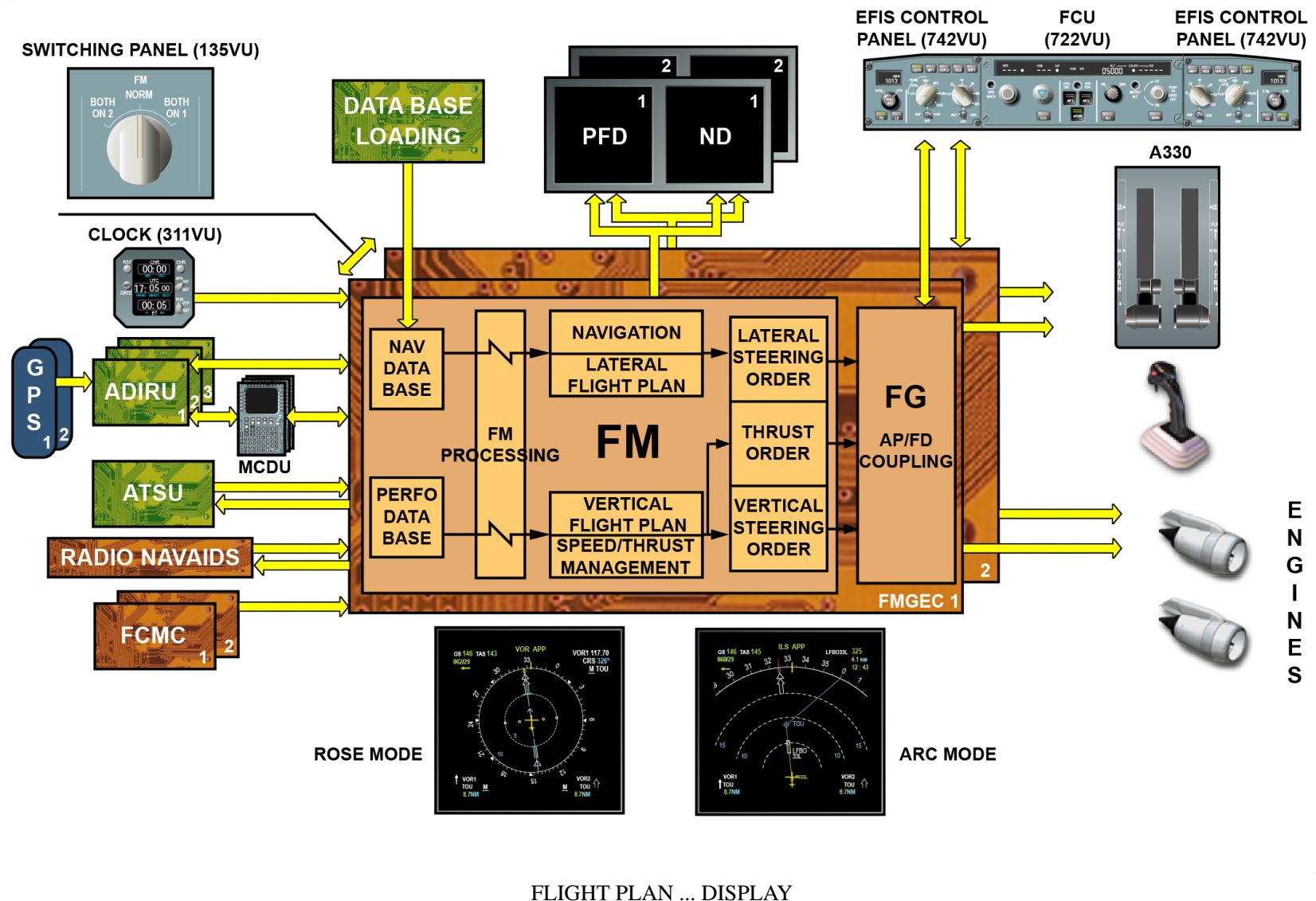
## PERFORMANCE

The performance database contains optimal speed schedules for the expected range of operating conditions. Several performance modes are available to the operator with the primary one being the ECONOMY mode. The ECON mode can be tailored to meet specific airline requirements using a selectable COST INDEX (CI). A CI is defined as the ratio of cost of time to the cost of fuel. The fuel quantity is given by the Fuel Control and Monitoring Computers (FCMCs). The speed and the thrust values associated with a given CI are used to determine the climb and descent profiles. FUEL and TIME are the main "actors" in this particular part of the FM function and direct the airline choice.

## DISPLAY

According to the pilot selection on the FCU, the flight plan is shown in relation to the A/C position on the ROSE-NAV or ARC modes. The A/C model is fixed and the chart moves. The difference between the two modes is that the half range is available when the ND is set to NAV mode as there is only a frontal view when it is set to ARC mode. In PLAN mode, the flight plan is shown, with NORTH at the top of the screen, centered on the TO waypoint (first waypoint to be met).

Depending on the selected range, the A/C may or may not be visualized on this display. The PLAN display can be centered on the waypoint displayed on the second line of the Multipurpose Control and Display Unit (MCDU) screen by scrolling the flight plan on the MCDU. The Primary Flight Display (PFD) shows the FM guidance following engagement of the AP/FD (Autopilot/Flight Director) lateral and longitudinal modes.



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## POWER INTERRUPTIONS AND POWER UP TESTS D/O

### INTERRUPTION < 10 MS

For the Flight Management Guidance and Envelope Computer (FMGEC), Flight Control Unit (FCU) or MCDU, the transparency time may be around 10 ms and these interruptions do not affect the system. [ The only effect is on the MCDU Cathode Ray Tube (CRT) which will momentarily flash.

### 10 MS < INTERRUPTION < 200 MS

If interruption is between 10 ms and 200 ms, the cut-off is a short power fail. [ The FMGEC/FCU/MCDU are recovered after the power interruption. In particular the data displayed on the MCDU and the FCU and the output bus data for all the equipment are recovered after a short power fail without pilot action.

### 200 MS < INTERRUPTION < 5 Sec

When the interruption is between 200 ms and 5 sec, the cut-off is a long power fail. [ A complete initialization of the system is performed, indicating that a long power fail occurred. [ The protection of data stored in the RAMs cannot be longer than 500 ms, except for the FM RAM which is supplied by a 5 V back-up battery (for the FM part, the system status prior to the interruption is stored).

### INTERRUPTION > 5 Sec

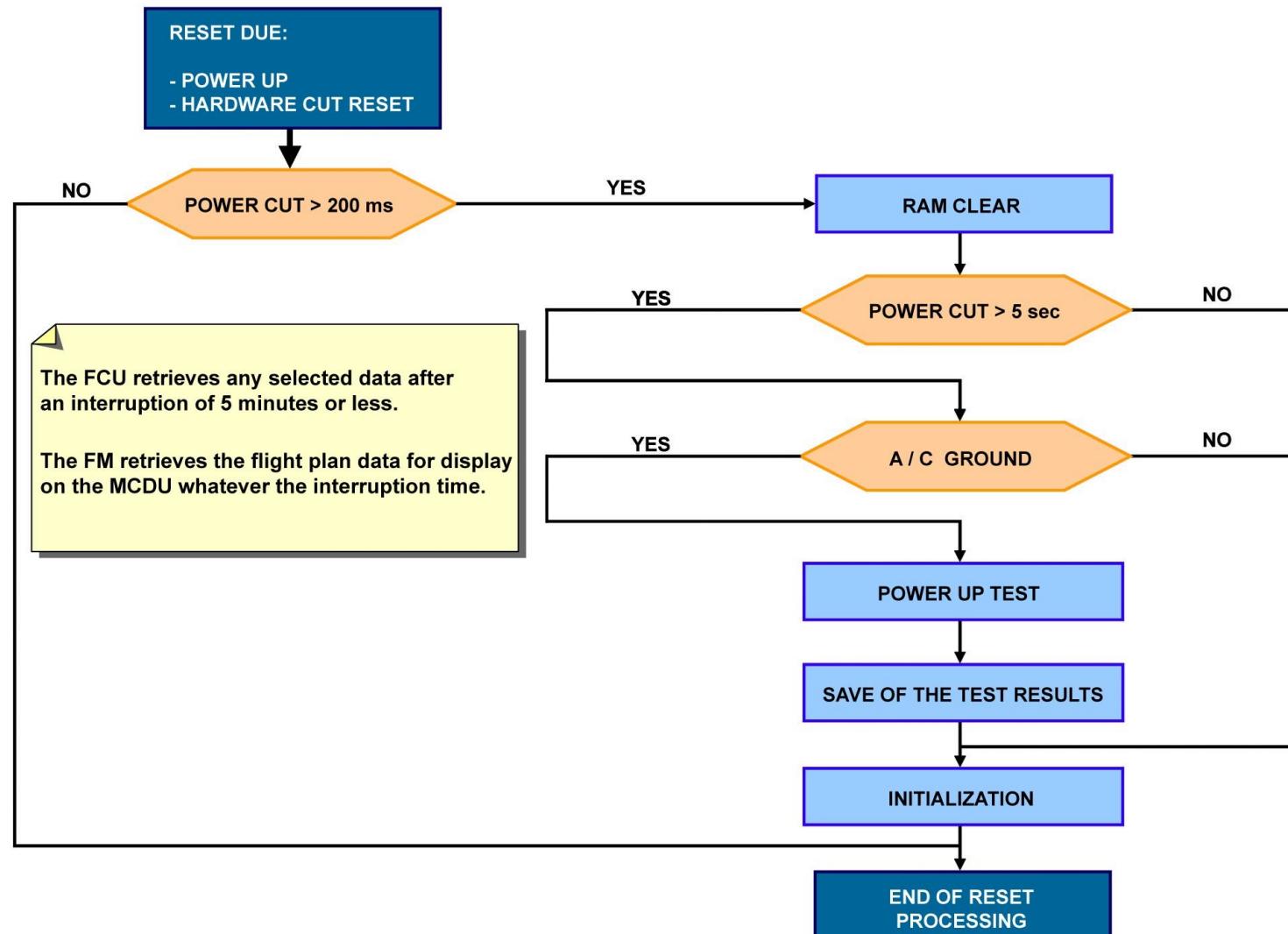
When interruption is longer than 5 seconds the type of cut-off is a very long power fail. [ This leads to an automatic reset where, as long as the reset command is held, the computer behaves as not powered or not active. [ This also leads to safety tests on ground.

NOTE: Note that the FCU retrieves any selected data after an interruption of 5 minutes or less and due to the 5 V back-up

battery, the FM retrieves the flight plan data for display on the MCDU whatever the interruption time.

### POWER-UP TEST

Power-up tests are performed when the A/C is on the ground, following a power cut longer than 5 seconds. [ The duration of the tests does not exceed 40 seconds in normal cases. The power-up tests carry out an interface test and an analysis (sent to the Central Maintenance System (CMS)).



## POWER INTERRUPTIONS AND POWER UP TESTS D/O

### FM POWER-UP TEST

Following a reset or a transient reset greater than the transparency time of 10 ms, the FM part executes specific internal tests called power-up test. [ It verifies minimum FM hardware integrity and proper initialization. The total execution time of this test is less than 2 seconds.

### FCU POWER-UP TEST

The FCU power-up test has to be performed to confirm system availability and is initiated automatically on the channels concerned (B/power supply 1, C/power supply 2) when the following conditions are met:

- Aircraft On Ground,
- restoration of electrical power after a power cut-off longer than 5 seconds.

The duration of this test is approximately 90 s.

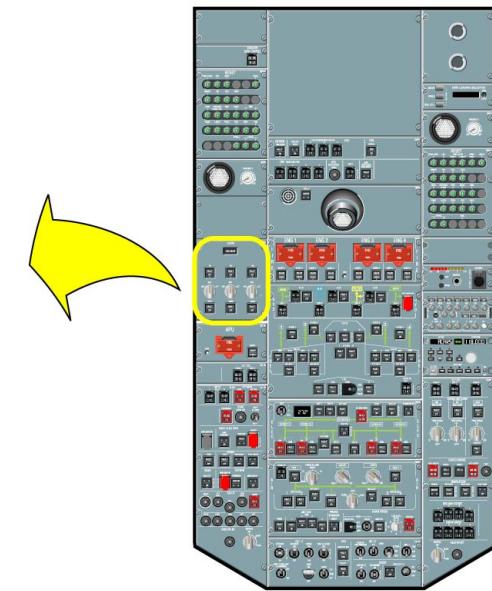
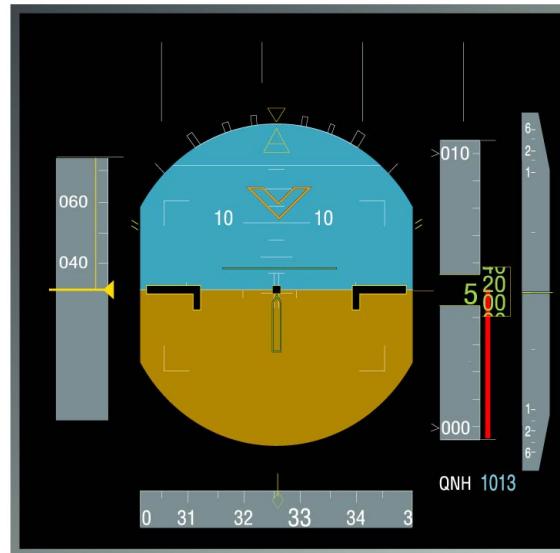
NOTE: Note that at this moment, the Flight Director (FD) P/B lights come on but the FD function is not yet available.

On initialization, the FCU returns to a neutral configuration. [ The flashing of AP1, AP2 and A/THR P/Bs proves the success of the internal tests. [ The FD is finally engaged and the FD red flag removed from the PFDs when the Inertial Reference (IR) system providing the position has been correctly initialized with a delay of 10 minutes and when the present position is entered.

FD status is indicated on the Flight Mode Annunciator (FMA). The altitude, by default 100 feet, is displayed on the FCU. The altitude mode is automatically armed and displayed on the FMA.

NOTE: If FCU fails, FMA data on PFDs are lost and on the Enhanced GPWS panel FAULT light comes on on the SYStem P/B, due to the loss of the QNH barometric reference.

Capt. PFD

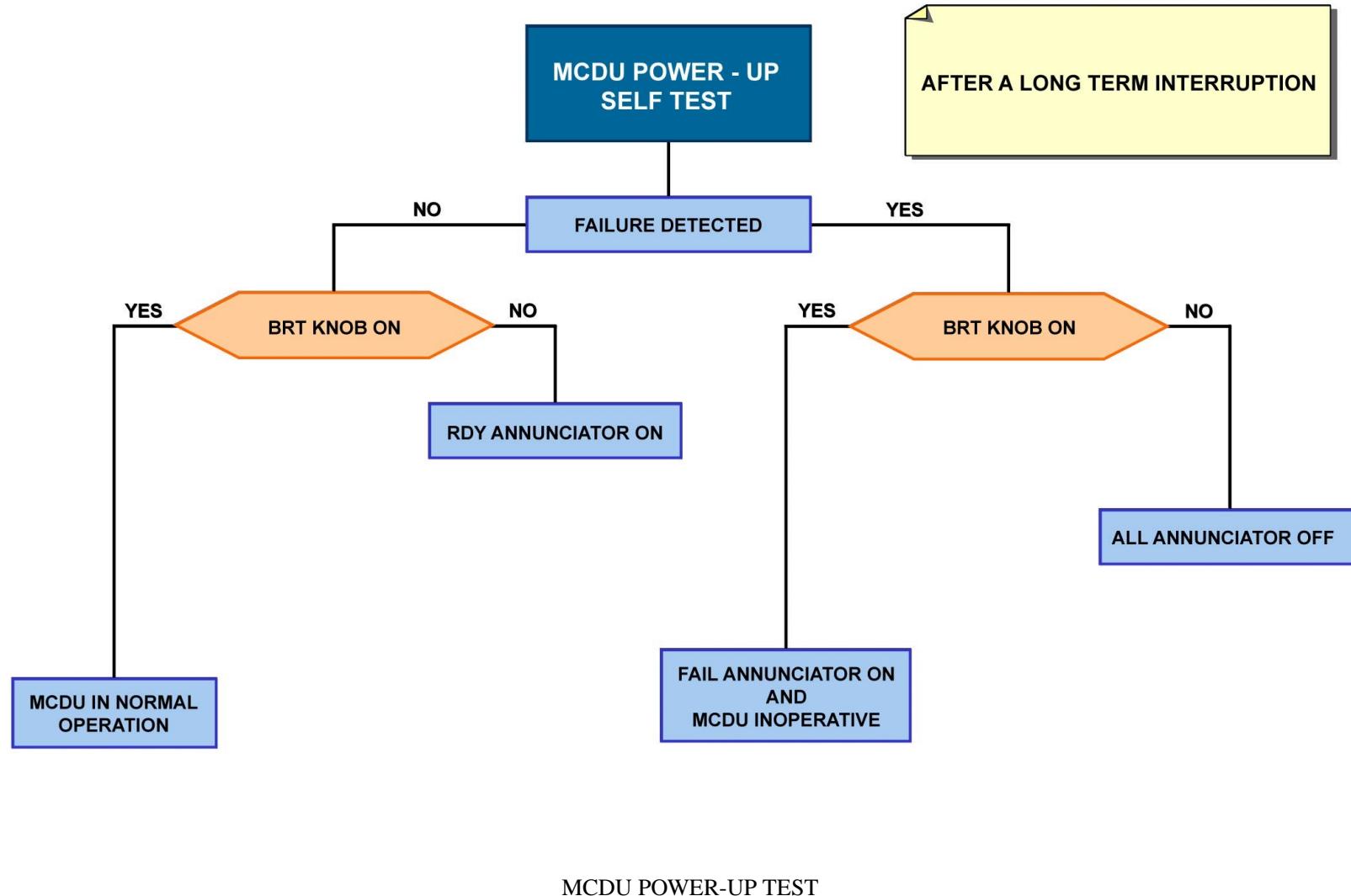
LEFT ECP  
(742VU)FCU  
(722VU)RIGHT ECP  
(742VU)

## FM POWER-UP TEST &amp; FCU POWER-UP TEST

## POWER INTERRUPTIONS AND POWER UP TESTS D/O

### MCDU POWER-UP TEST

After a long-term interruption [ or the movement of the brightness knob from the ON to OFF position, the MCDU extinguishes all annunciations and performs its power-up self test.



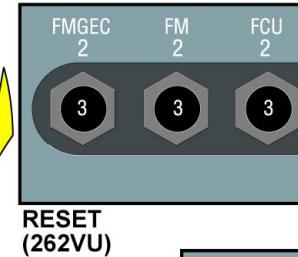
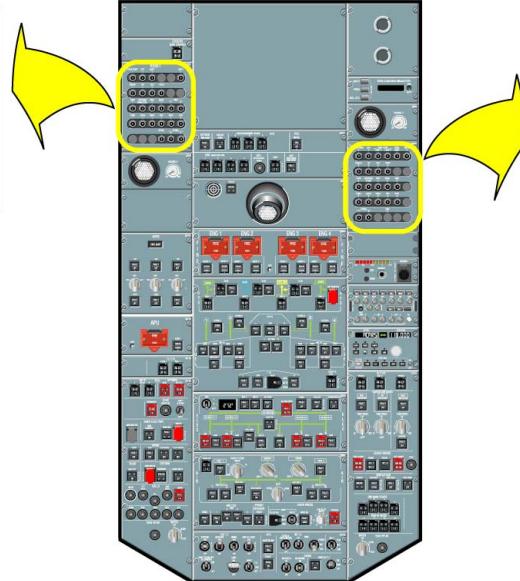
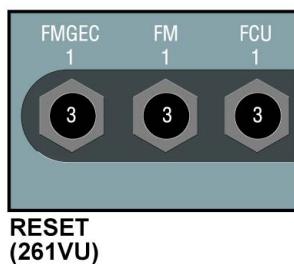
## POWER INTERRUPTIONS AND POWER UP TESTS D/O

### MANUAL RESETS

The reset function is available in the cockpit on the overhead panel. [  
The FM reset SW resets only the FM part. The FMGEC reset SW resets all the FG, FE and FM parts.

Safety test will be run if the aircraft is on ground with engines stopped.  
In flight, the FM or FMGEC reset SW reset leads to the disconnection of the ownside autopilot (if it was engaged) with the resynchronization of both FMs. [  
The MCDUs are reset by the brightness knob (ON/OFF).  
A complete FCU reset is performed by pulling the FCU reset SW longer than 5 min.

The RESET is activated by sending a ground signal to the computer or the function. When the RESET state is confirmed and as long as the RESET command is held, the computer behaves as not powered or not active. The operational functioning of the computer is active when the control signal is back to the NO RESET state.



**Safety test will be run if aircraft is on ground and engines stopped.**

**The RESET is activated by sending a ground signal to the computer or the function.**

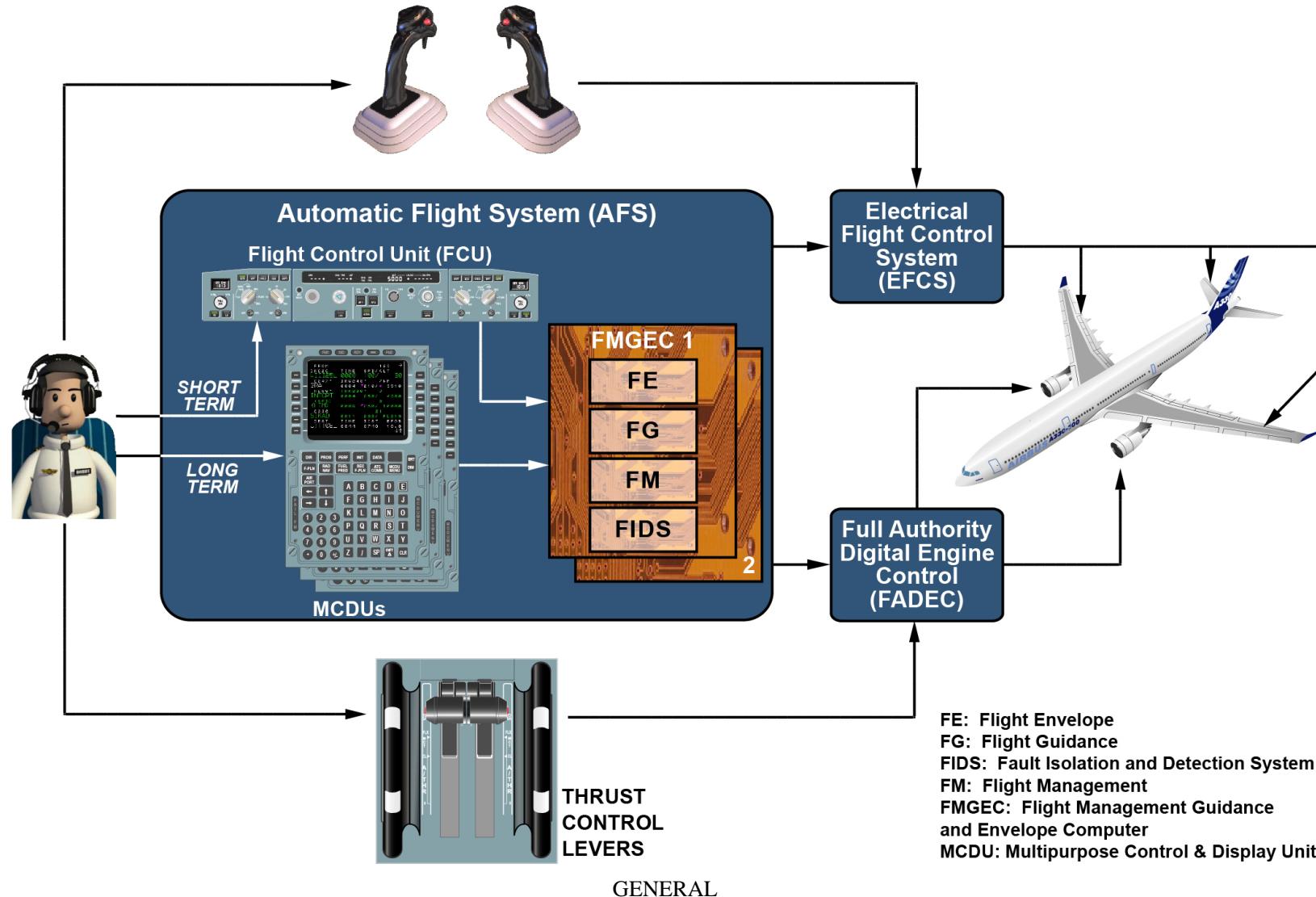
### MANUAL RESETS

## AUTOMATIC FLIGHT SYSTEM COMPONENT LOCATION

### GENERAL

For reliability and redundancy functions, the AFS is made of two Flight Management Guidance and Envelope Computers (FMGECs) which are the same and interchangeable. The AFS does its primary functions through the FMGECs. With the FMGECs, the AFS also has:

- one Flight Control Unit (FCU),
- three Multipurpose Control & Display Units (MCDUs),
- two autopilot instinctive disconnect P/B switches: one on each side stick (these P/B switches are part of ATA27 because they are used for the management of the side stick priority),
- two Autothrust instinctive disconnect P/B switches on each side of the throttle levers,
- one Switching FM selector switch (2CB) on the switching panel which is on the pedestal,
- one North Ref P/B switch (1CB) on the main panel,
- 6 reset switches (FMGEC1 and 2, FCU1 and 2, FM1 and 2).



## AUTOMATIC FLIGHT SYSTEM COMPONENT LOCATION

### COMPONENT LOCATION

The FGMECs, which are the primary computers of the AFS, are on the main avionics rack 800VU.

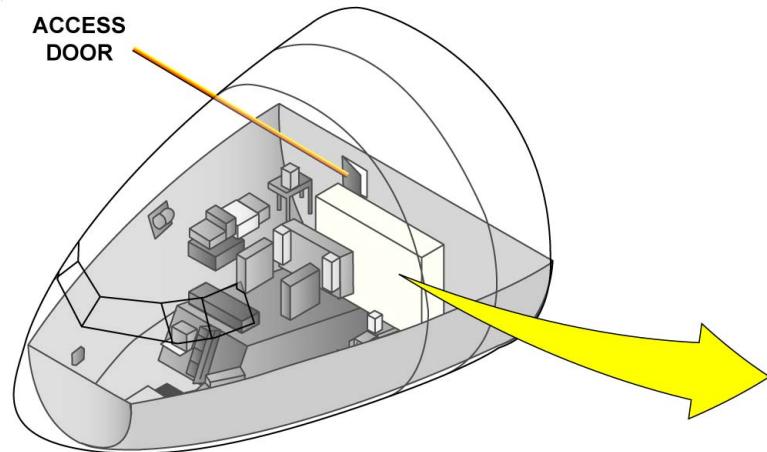
These switches are on the overhead panel (left hand side for system1 / right hand side for system2). They are used to reset the FM, the FMGEC and the related Channel of the FCU.

The Flight Control Unit is on the glareshield.

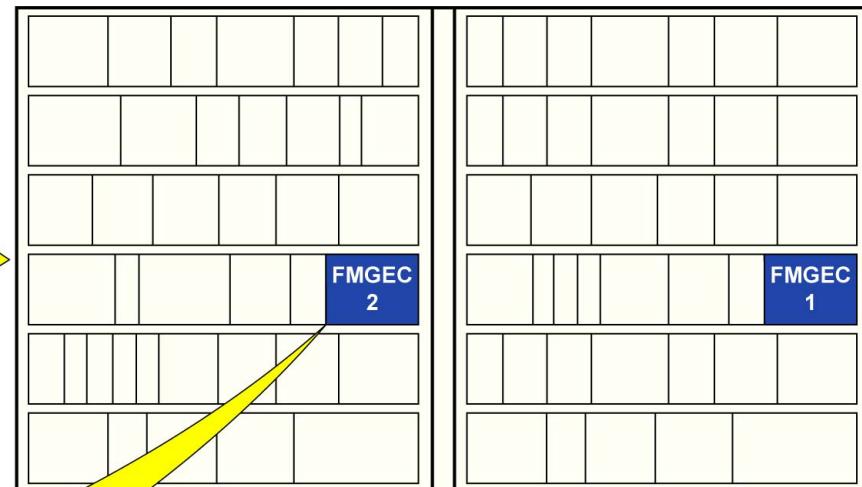
Although the Multipurpose Control and Display Units are used for ATA 45 and for the access to many systems, these components obey the IPC part of ATA 22.

The instinctive disconnect switches are on the side sticks and on the throttles.

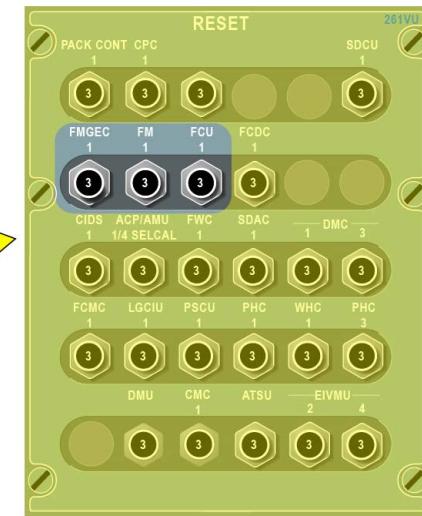
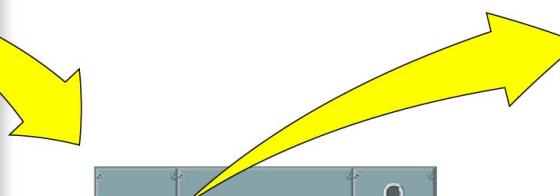
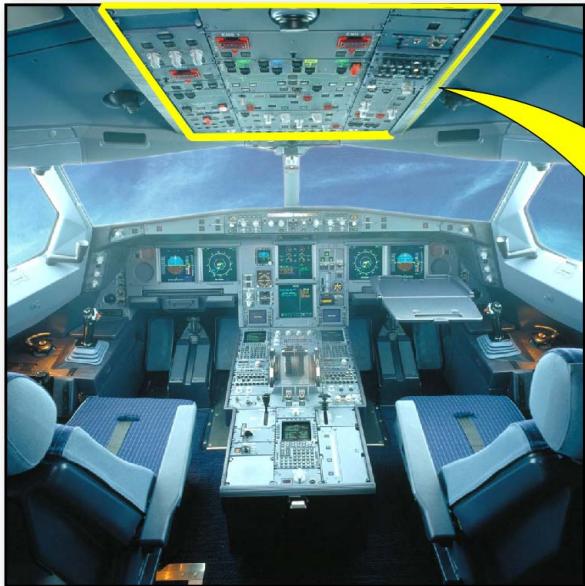
The North Ref P/B is on the main panel and the FM selector is on the pedestal.



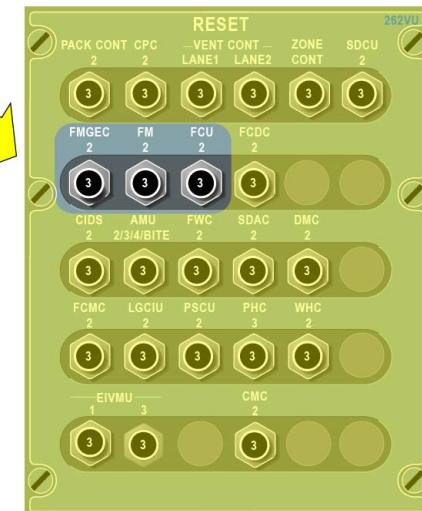
ELECTRONICS RACK (800VU)



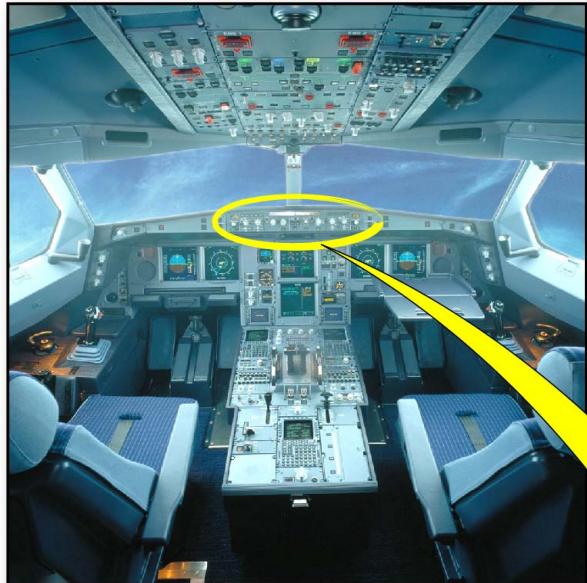
COMPONENT LOCATION



RESET CONTROL PANELS



COMPONENT LOCATION



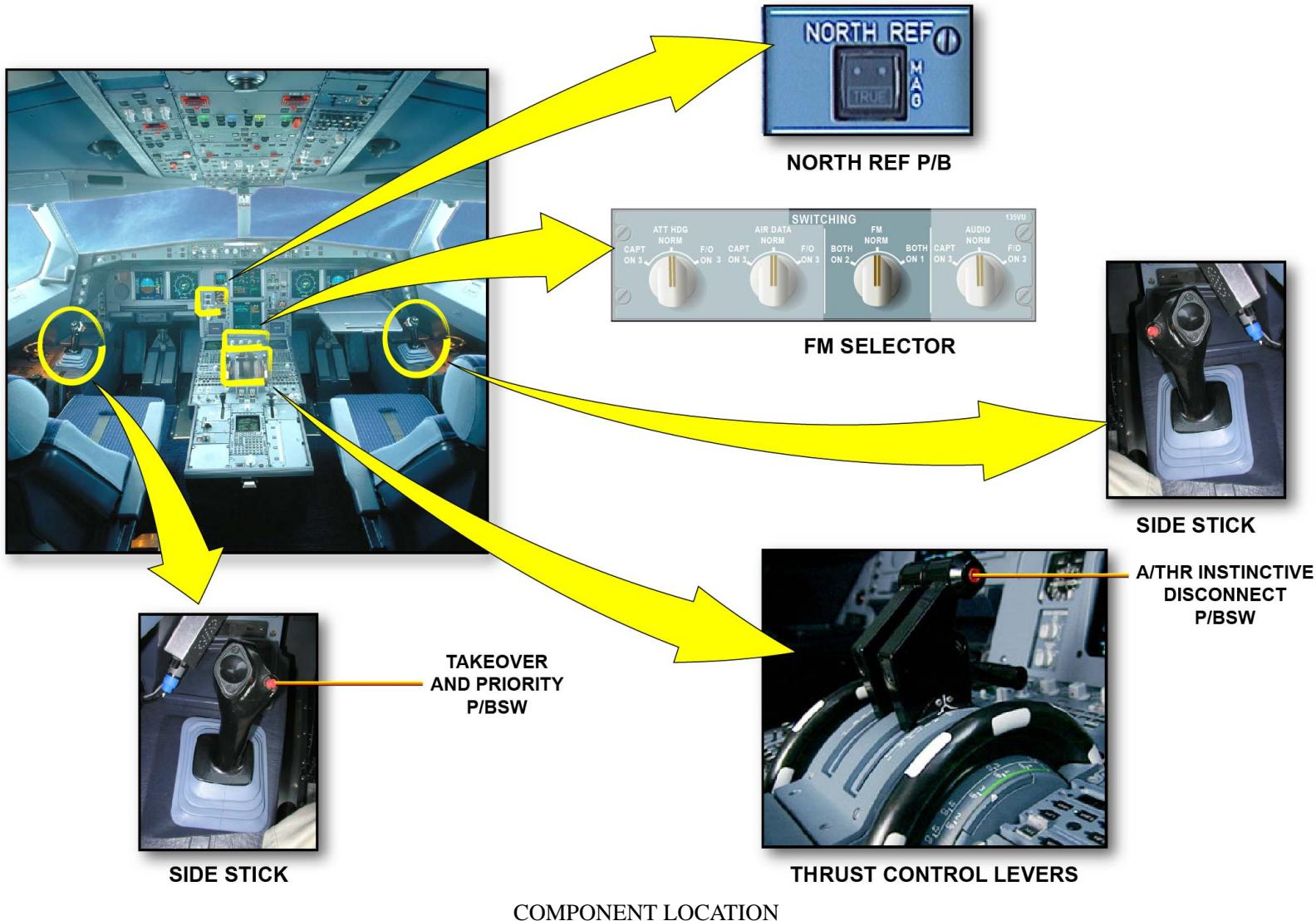
Flight Control Unit (FCU)

## COMPONENT LOCATION



MCDU

COMPONENT LOCATION



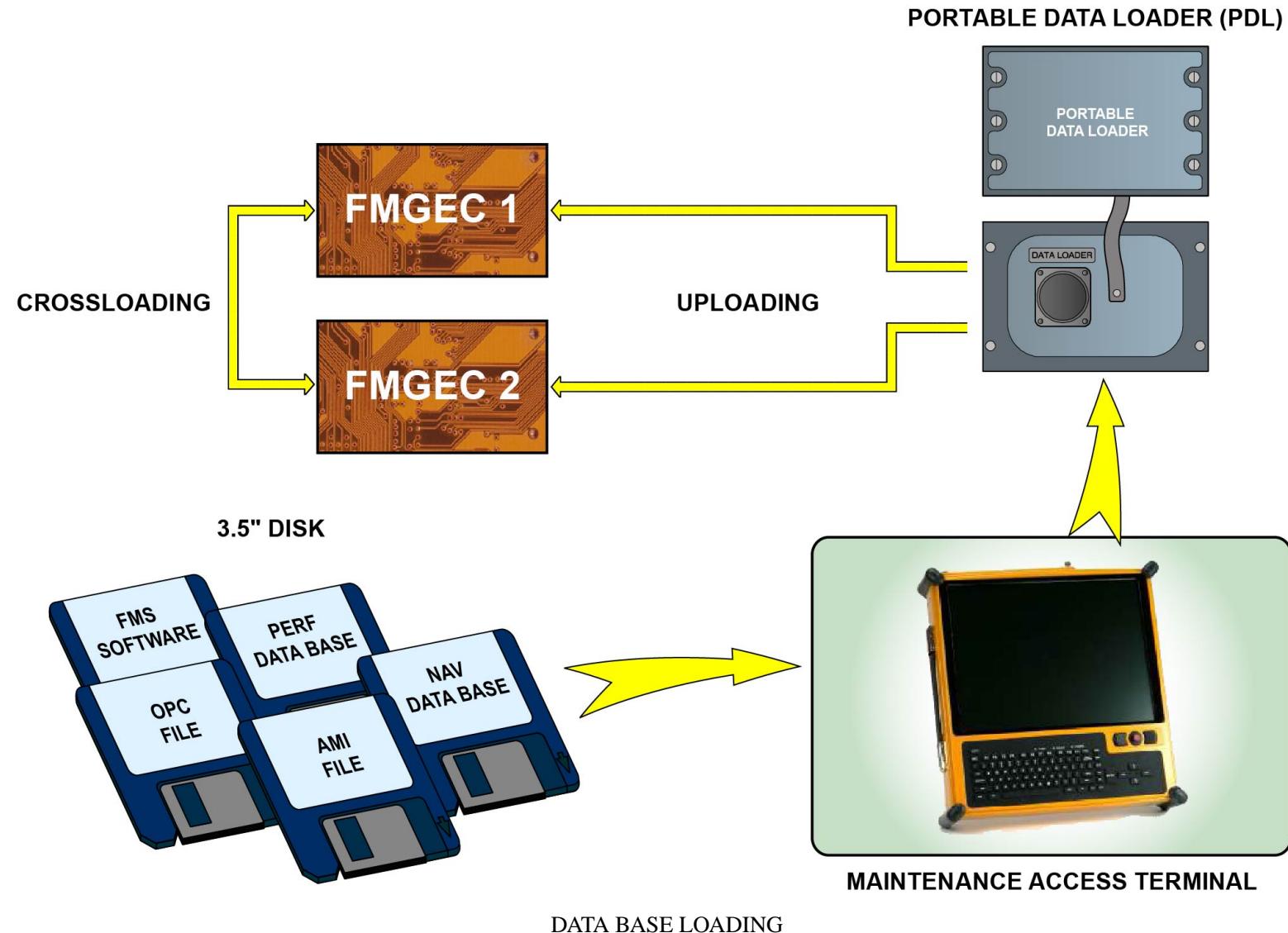
## AUTO FLIGHT SYSTEM LINE MAINTENANCE

### DATA BASE LOADING

The navigation and performance data base must be loaded and updated to keep the system operational. Only the navigation data base is periodically updated (every 28 days). This module gives information related to the uploading and crossloading of the elements of the FM part of the FMGECs. The uploading is done using the Portable Data Loader (PDL).

The FM part of each FMGEC operates thanks to:

- the Flight Management System (FMS) operational software,
- the PERformance and NAVigation data bases aid,
- the OPerational control Configuration (OPC),
- and the Airline Modifiable Information (AMI) configuration files which are mandatory loadable elements.





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