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NATIONAL TRANSPORTATION SAFETY BOARD

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Attachment 26 – A300 Flight Management System
(9 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

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Attachment 26 – A300 Flight Management System

OPERATIONAL FACTORS

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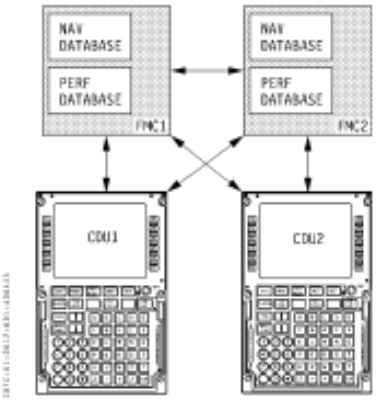
1.0 Flight Manangement System

A300-600 FLIGHT CREW OPERATING MANUAL A/C	SPERRY FLIGHT MANAGEMENT SYSTEM OVERVIEW SYSTEM ARCHITECTURE	1.20.12 PAGE 1 REV 30 SEQ 001

1 - FMS ARCHITECTURE

- The Flight Management System (FMS) consists of :
  - Two Flight Management Computers (FMCs)
  - Two Control Display Units (CDUs). One for each pilot. The CDUs represent the main interface between the flight crew and the FMCs.
- Each FMC works independently but each input entered through a CDU is transmitted to both FMCs.
- The FMCs communicate together through a crosstalk bus.



2 – FMC INTERNAL ORGANIZATION

- Each FMC uses for its computations :
  - the performance database
  and/or
  - the navigation database.

2.1 – PERFORMANCE DATABASE

- The performance database contains :
  - the aircraft aerodynamic data,
  - the engine data.
- It is used for all the performance computations, including aircraft position determination. The airline does not have access to this database.

2.2 – NAVIGATION DATABASE

- The navigation database contains :
  - Ground navigation aids ("navaids") : VOR, VOR/DME, VORTAC, DME, TACAN, ILS.

    Each navaid is defined by its :
    - identifier (4 characters maximum)
    - latitude, longitude,
    - frequency,
    - magnetic variation,
    - class (VOR, VOR/DME...),
    - figure of merit (company defined),
    - elevation (for DME and ILS),
    - course referenced to magnetic North (for LOC),
    - category (for ILS : CAT 1, 2 or 3).
  - Waypoints :

    Each waypoint is defined by its :
    - identifier (5 characters maximum),
    - latitude and longitude,
    - type (en route, terminal, or both).
  - Airways :

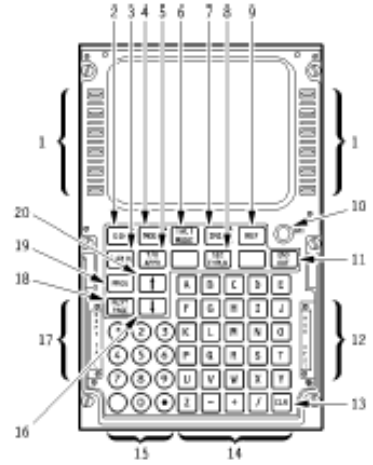
    Each airway is defined by its :
    - identifier (5 characters maximum),
    - list of fixes (waypoints, navaids, or airports that compose the airway).
  - Airports :

    Each airport is defined by its :
    - identifier (ICAO code),
    - latitude and longitude,
    - elevation,
    - association alternate airport (optional).

[1] Source: Airbus A300 Flight Crew Operating Manual (FCOM).

2.0 Control Display Unit

- The CDU keyboard provides a full alphanumeric keyboard combined with mode, function, data entry, slew keys, and advisory annunciators. The keyboard also contains two integral light sensors and a manual knob to control display brightness.



1. LINE SELECT KEYS
2. DIRECT KEY
3. FLIGHT PLAN KEY
4. MODE KEY
5. TAKEOFF/APPROACH KEY
6. TACTICAL MODE KEY
7. INITIALIZATION KEY
8. SECONDARY FLIGHT PLAN KEY
9. REFERENCE INDEX KEY
10. BRIGHTNESS KNOB
11. ENGINE OUT KEY
12. ANNUNCIATOR-MESSAGE, OFFSET
13. CLEAR KEY
14. ALPHA KEYS
15. NUMERIC KEYS
16. SLEW DOWN KEY
17. ANNUNCIATOR-DISPLAY, FAIL
18. NEXT PAGE KEY
19. PROGRESS KEY
20. SLEW UP KEY

1 – SCREEN

- The display screen has 14 lines with 24 characters per line. The page format is partitioned into four areas.

1.1 – TITLE FIELD

- This field is the top line of the display. It identifies the page in view and what additional pages of a set are available.

1.2 – LEFT FIELD

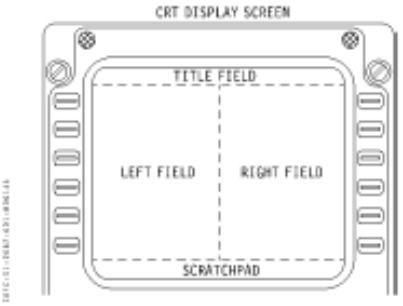
- This field is composed of six pairs of lines, eleven characters per line. It extends from the left side of the screen to the center. The operator has access to one line of each pair through a Line Select key (LS key) on the left side. A line pair comprises a label line and a data line.

1.3 – RIGHT FIELD

- This field is similar to the left field, extending from the center of the screen to the right side. Operator access is available by a LS keys on the right side.

1.4 – SCRATCHPAD

- This field is the bottom line of the screen. Typed alphanumeric characters and FMC generated messages are displayed on this line. The scratchpads for the two CDUs operate independently for data entry. The scratchpad accepts entries up to 22 characters. The last two character spaces are reserved for vertical slew indicators.



2 – LINE SELECT KEYS

- The line select keys (LS key) are twelve keys, six on each side of the screen, aligned with the data fields.
- Pressing a line select key may display a new page or insert data from the scratchpad into selected line and field.

Note : Throughout this chapter, line select keys are denominated as follows :
– LS key 1L for the left upper line select key, then LS key 2L, 3L, 4L, 5L, 6L.
– LS key 1R for the right upper line select key, then LS key 2R, 3R, 4R, 5R, 6R.

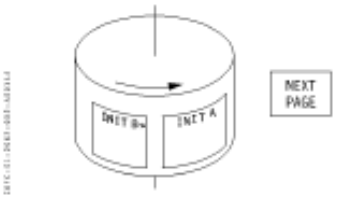
3 – ALPHANUMERIC KEYS

- These keys enable the operator to enter numerals and alphabetic characters into the scratchpad successively from left to right. Alpha and numeric keys may be entered together as required.
- The slash key (/) is included as part of the alpha keys and is used to separate pairs of entries in the same field. For example, airspeed and Mach (280/.720), wind direction and velocity (104/100), or airspeed and altitude (250/10000).
- The trailing entry of a pair is generally preceded by the slash if entered by itself. The leading entry may be followed by the slash but is not required if entered by itself.

4 – FUNCTION KEYS

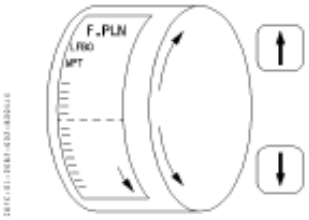
4.1 – NEXT PAGE key

- Provides access to additional pages of a set when another page is required to complete display of data. This capability is indicated by a horizontal arrow on the title line.
- The NEXT PAGE function is closed loop ; that is, it wraps around from the last page to the first page.



4.2 – VERTICAL SLEW keys : ↑ and ↓

- For pages longer than the available space on the screen vertical slewing is used to scroll the display up or down.
- These two keys are also used for incrementing (or decrementing) data (lat/long) in particular data fields.
- Vertical slew capability is indicated by arrows in the last two right hand spaces of the scratchpad. Simultaneous display of up and down arrows indicate upward and downward scroll capability.



4.3 – CLR key

- The CLR key is used to clear messages and data from the scratchpad or an individual data field.

5 – MODE KEYS

5.1 – DIR KEY

- Accesses the DIR TO page and allows the crew to initiate the DIRECT TO function by manual entry of a fixed waypoint, or line selection of a fixed waypoint in the active primary F-PLN only.

5.2 – MODE KEY

- Allows access to the MODE page, which displays the strategic performance modes. Changes made on this page effect performance in all the flight phases.

5.3 – TACT MODE KEY

- Allows access to the current flight phase page (climb, cruise, etc.). Changes made to the strategic modes on this page effect performance only in the current flight phase.

5.4 – INIT KEY

- Pressing this key will bring the INIT A page to the display on the ground only. The crew can define various initialization parameters including active F-PLN data and IRS alignment.

5.5 – REF KEY

- Accesses the REFERENCE INDEX page, which allows further access to reference pages concerning to aircraft configuration, stored and defined waypoints, navaids, maintenance, and other user systems.

5.6 – FPLN KEY

- Provides access to a leg by leg description of the active route. The data includes a listing of real and pseudo waypoints, estimated times of arrival, air speed/altitude constraints, distances between legs, and magnetic courses between legs.

5.7 – TO/APPR KEY

- Accesses the TAKEOFF or APPROACH page, as appropriate, on which takeoff or approach parameters are displayed and/or inserted depending on the flight phase.

5.8 – SEC FPLN KEY

- When pressed, displays the SEC INDEX page. The SEC INDEX page allows access to, and functions related to, the secondary flight plan. These functions include copying into, deleting, and activating the secondary flight plan. The SEC INIT pages and all secondary performance pages are accessible from this page.

5.9 – ENG OUT KEY

- Has no specific page associated with it however, pressing it can cause display of an EOSID, if available, or display of the MODE page with EO prompts.

5.10 – PROG KEY

- Pressing the PROG key displays dynamic flight information about the active flight plan including : CRZ FL, present position, distance to destination, etc.

6 – BRIGHTNESS KNOB

- The brightness knob allows the operator to manually increase or decrease the brightness of the CDU display. The back lighted key illumination is controlled by a remote flight deck control. Annunciators are controlled by the master bright-dim-test system.

7 – ANNUNCIATORS

- There are four annunciators, two on each side.

7.1 – DSPY (TOP LEFT)

- Illuminates when the flight plan has been slewed and/or the display does not indicate the active situation in the FMC.

7.2 – FAIL (BOTTOM LEFT)

- Indicates the CDU has failed. The screen is blank, except for the message FMC FAIL.

7.3 – MSG (TOP RIGHT)

- Illuminates when a scratchpad message is being displayed or when a message is waiting in the queue.

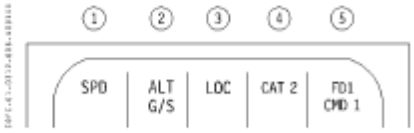
7.4 – OFST (BOTTOM RIGHT)

- Illuminates when a parallel offset is active.

3.0 Flight Mode Annunciator

FLIGHT MODE ANNUNCIATOR (FMA)

FMA design principle and display :



- The FMA is the main interface between the flight crew and the AFS in order to :
  - confirm the engagement of the selected A/THR and AP/FD modes (together with the illumination of the corresponding pushbutton switch on the FCU),
  - confirm, at any time, the status of the A/THR and AP/FD modes (e.g. in order to identify and callout any mode transition or reversion).
- Together with the FCU, the FMA provides feedback to the flight crew regarding the AFS operation :
  - flight crew **inputs** to AFS : **FCU** (and FMS CDU when in PROFILE / NAV mode),
  - AFS **feedback** to flight crew : **FMA** (together with other **PFD** and **ND** data).
- The FMA is divided into 5 separate columns :
  - column 1 : **ATS modes,**
  - column 2 : **AP/FD vertical modes,**
  - column 3 : **AP/FD lateral modes,**
  - column 4 : **Category of the landing capability:**
    CAT1 / CAT2 / CAT3
  - column 5 : **FD engagement status :**
    FD1 / FD2 (first line)
    AP mode engagement status :
    CMD1 / CMD2 / DUAL / CWS1 / CWS2 (Second line).
  - AP/FD **combined modes** are displayed in columns 2 and 3, used as a single column.

FMA colour codes :

- The following colour codes are used to indicate the status of the AP/FD and A/THR modes, on the FMA :

In column 1, second line, blue is used for THR and A/THR and amber is used for MAN THR.

In column 5, second line, white is used for CMD1 / CMD2 / DUAL and amber for CWS1 / CWS 2.