



MJC-8 Q400  
PILOT/PRO EDITIONS  
Version 1.3

# Normal Operations System Manual

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## 1. Introduction

The Dash 8-Q400 is a high wing airplane manufactured by Bombardier Canada. It is powered by two 5071 shaft horsepower PW 150A turboprop engines. Each engine drives a six bladed propeller. The Dash 8 is a two pilot transport category airplane approved for instrument flight and operation to a maximum altitude of 25,000 feet.

The airplane has an Active Noise and Vibration Suppression (ANVS) system.

The airplane seats up to 78 passengers and two or three cabin crew members in addition to the pilot, copilot, and flight observer. It has a maximum take-off weight of 65,063 lb (29,574 kg).

## 2. General

The fuselage (Figure 2.1) is constructed in three main parts:

- Forward
- Center
- Aft

The forward section includes the flight deck, which contains the pilot controls, instruments, and indications. Circuit breaker panels are located behind the pilot's and copilot's seats.

There is a forward baggage compartment on the right forward part of the fuselage, and an aft baggage compartment forward of the aft pressure bulkhead. Both baggage doors open outwards and can only be opened from the outside. The passenger compartment doors and one type II/III exit can be opened from either the inside or outside.

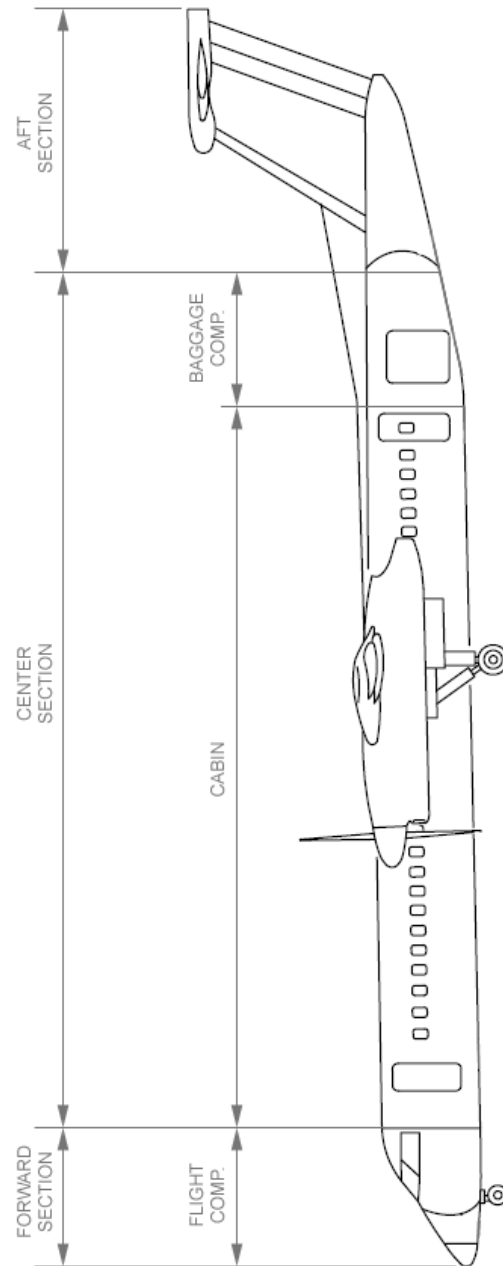


Figure 2.1. Fuselage.

### 3. Cockpit Layout

The cockpit layout of the Dash-8 includes all the controls and indications required for the normal and emergency operation of the airplane. The name and location of the control panels are depicted at the Figure 3.1

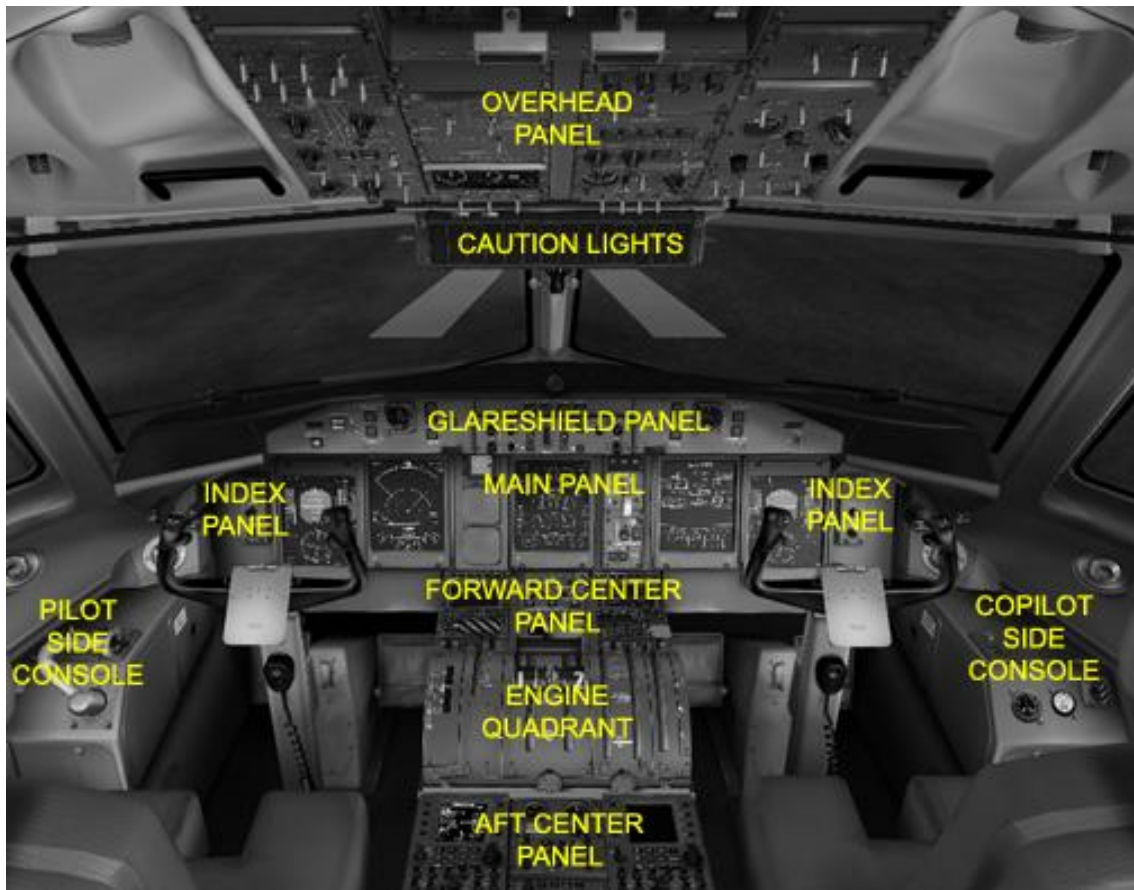


Figure 3.1. Control panels

## 4. Air Conditioning, Bleed Air and Pressurization System

Air Conditioning, Bleed Air and the Pressurization System have the following functions:

- Pressurization of the aircraft's interior
- Providing the pressurized air for the airframe deicing
- Environmental control in the cabin and the cockpit
- Avionics cooling

The controls and indications, pertaining to this system are depicted at the Figure 4.1

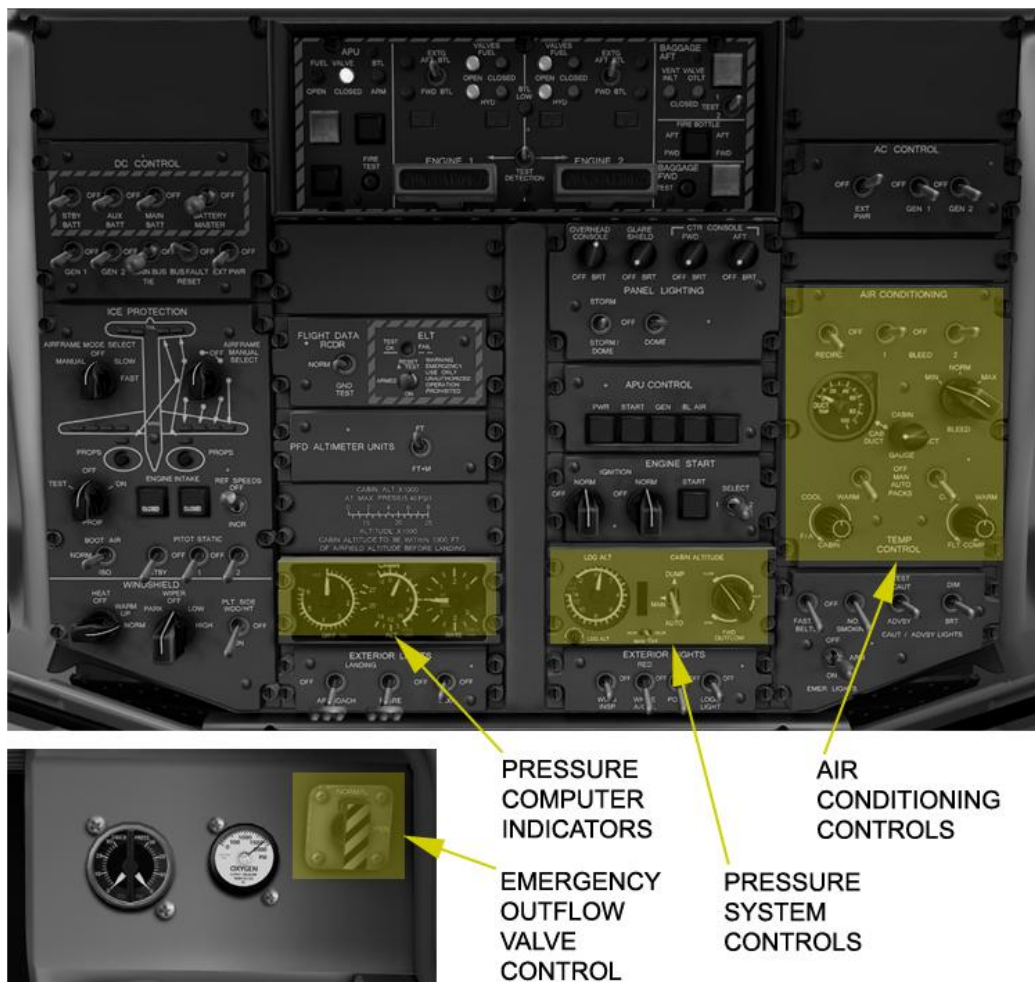


Figure 4.1. Air System Controls and Indicators



## 4.1. Pressurization subsystem

The airplane is pressurized by the engine bleed air supplied and distributed by the air-conditioning system. Pressure is maintained and controlled by the cabin pressure control system which governs the rate of outflow from the pressurized areas of the airplane. An aft outflow valve primarily controls the outflow of air, and is assisted by two safety valves. Figure 4.1.1. shows the pressurized areas in the aircraft.

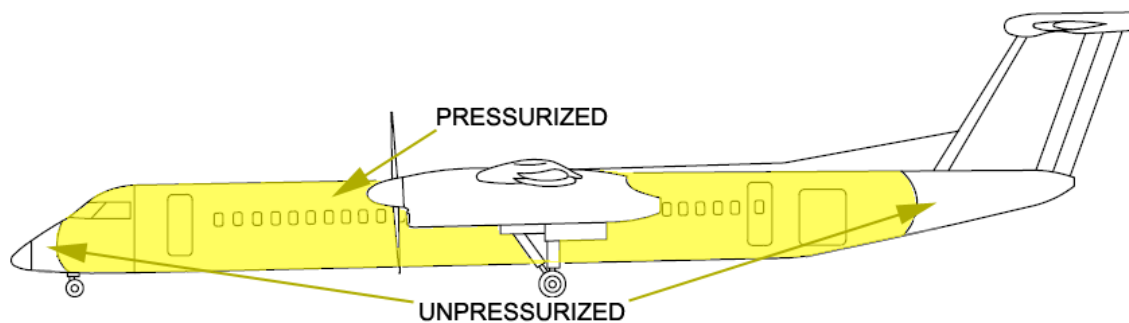


Figure 4.1.1. Pressurized areas

The aft outflow valve is controlled from the Cabin Pressure Control panel on the flight deck Overhead panel. The aft outflow valve and the aft safety valve are located on the aft pressure dome. A forward safety outflow valve is located on the forward pressure bulkhead, and can be controlled from the pressurization panel or the copilot console. Figure 4.1.2 shows the pressurization controls.



Figure 4.1.2. Pressure controls and indications

## **NORMAL OPERATION:**

The pilot is required to pre-set the landing field altitude using the Landing Altitude Selector, while still on the ground or before starting the descend at latest. With the mode selector at Auto, the operation of the system is completely automated in order to achieve the field altitude on landing. Note: Bleeds must be selected ON for the most of the flight for the pressurization system to operate normally. Pressurization of the aircraft using the APU bleed air is not possible.

The required landing field altitude should only be set on the pressurisation panel if landing bleeds on. If the bleed are left ON for landing, +500 ft should be added to the landing field altitude.

Cabin diff has to be below 0.5 before switching to MIN/OFF and has to show 0 before 500ft RA at the latest.

## 4.2. Bleed Air Subsystem

The bleed air subsystem is responsible for supplying the unconditioned bleed air to pressurize the aircraft interior, provide the aircondition and deice the airframe. The Bleed Air is supplied by each engine via Low Pressure (LP) and High pressure ports (HP). When the bleed switches are selected ON, the LP or HP will be operated automatically, based on the available airflow pressure (see Figure 4.3.1).

### **NORMAL OPERATION:**

The bleed switches should be selected OFF if a reduced power takeoff is planned, otherwise the bleeds can be left ON. The Bleed Flow Mode in this case has to be selected to MIN. The bleed should be then selected back to ON after takeoff as soon as practical. Please, note that the bleeds must be ON for the structural antiice to operate. It is a standard practice to keep the bleeds OFF for landing, to increase the engine performance in a case of a possible Go Around.

The Recirculation Fan switch is normally always left in the RECIRC position.

Sudden appearance of the cabin pressure warning light will most likely indicate the bleed selectors have been left OFF, or the system left in the DUMP mode. Correct the problem before continuing the climb.

## 4.3. Air Conditioning Subsystem

The air conditioning system conditions the bleed air to the proper temperature and humidity and delivers it to the air distribution system for environmental control of the cabin and flight deck. The system controls are shown at the Figure 4.3.1.

### **NORMAL OPERATION:**

Operation of the air-condition system is automatic when the packs are selected to Auto. The temperature can be set independently for the flight deck or the cabin using the temperature selectors, and the duct temperature/cabin temperature verified on the temperature indicator by switching the temperature indicator selector to the appropriate position. On the ground with engines off, the air-condition can be utilized with the APU bleed air, in this case however the Bleed switches must be left in the OFF position.

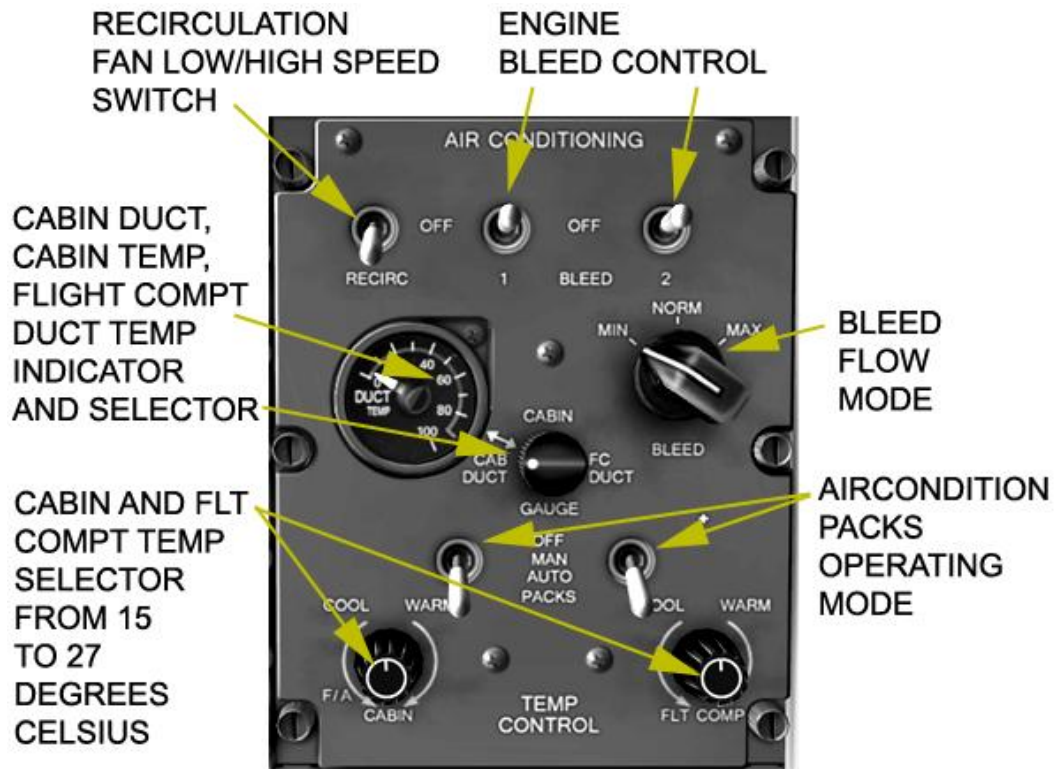


Figure 4.3.1. Air Condition and Bleed Air Controls

## 5. Auto Flight System

The Auto Flight system (or AFCS) is responsible for the automatic operation of the flight director, autopilot, yaw damper and pitch trim

- Flight Director provides the lateral guidance which can be used to fly the aircraft manually or automatically.
- The Autopilot can fly the aircraft based upon the Flight Director guidance.
- Auto Pitch Trim reduces the force on control column by trimming the elevator down during the flaps transit between 15° and 35°.
- The Yaw Damper adjusts the rudder during turns to guarantee the coordinated flight.

The AFCS is designed to provide all weather approach capability up to CATI and CATII limits for ILS. It is also capable for the non-precision VOR approaches, front and back LOC approaches and FMS/GPS overlay approaches.

The AFCS data flow diagram is shown at the figure 5.1.

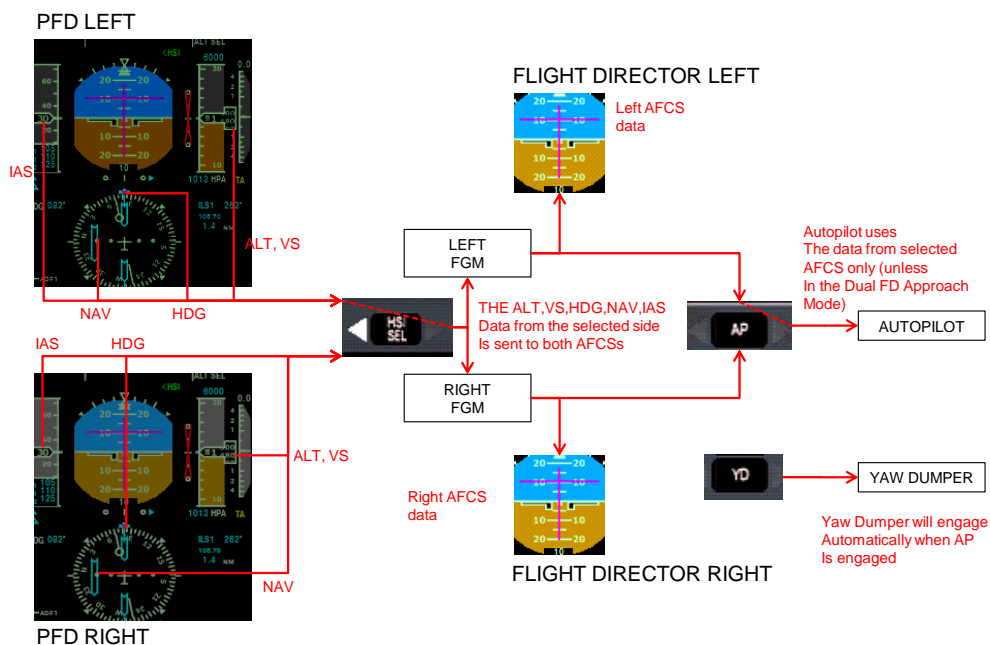


Figure 5.1. AFCS Data Flow Diagram

## 5.1. AFCS Data Flow

The data about the heading, Nav deviation, Airspeed, Altitude and Vertical speed from each PFD is fed to the HSI SEL switch located at the AFCS panel. Depending which side is selected by the pilot, the left or right PFD data is then routed to both left and right side FGM (Flight Guidance Management) computers. Both FGM computers then use the currently selected mode to compute the suggested lateral and vertical guidance, which is visually presented by the related side PFD Flight Director. The pilot can fly the Flight Director commands manually, in which case the data flow ends here. Otherwise, if an automatic flight is desired, autopilot can be engaged by pressing the AP button. The data from one of the FGMs will be used to drive the autopilot servos, unless the Dual Approach mode is active (see AFCS modes below). The Yaw Dumper will automatically engage once the autopilot is engaged.

## 5.2. AFCS Modes

All AFCS modes (lateral or vertical) can be put into 2 categories: *Active* modes and the *Armed* modes. Some modes can switch from active to armed and back when certain condition occurs.

Active mode is the mode which FGM currently shows at the related side flight director. The active mode name is shown in the green text at the top of each PFD.

Armed mode is the mode which was requested, but the condition for which have not been met yet. The armed mode name is shown in the white text under the active mode.

When a mode is requested by pressing one of the mode buttons at the AFCS control panel, it will become active if the condition for this mode is met. For example, if NAV is pressed and the NAV needle on the PFD is fully deflected, the NAV mode will indicate in white (armed), until the needle start to move. On the other hand pressing VS will instantly engage Vertical Speed mode as active, as there are no conditions for this mode that must be met first. During the transition from armed to active, some mode will enter a so called “acquisition” phase, which is indicated by the “\*” sign, next to the mode name. The “\*” sign will be removed from view when the mode stabilizes.

The AFCS modes are controlled from the AFCS panel, shown at the figure 5.2.1.



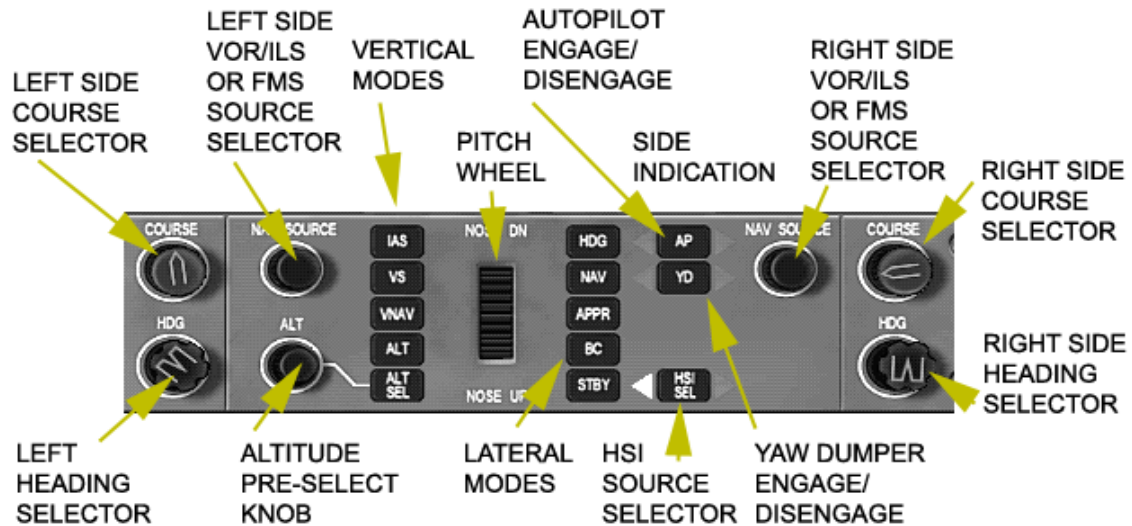


Figure 5.2.1. AFCS Panel

The AFCS panel has 2 columns of buttons; the buttons at the left column are for controlling the vertical modes, and the buttons on the right - the lateral modes. The function of rest of the controls at this panel will change depending on the mode selected.

**Lateral modes:**

**WINGS LEVEL** This mode will become active if AP engages, but no lateral mode was active. In 10 seconds this mode will automatically transition either to ROLL HOLD if the current bank angle is >3 degrees, or HDG HOLD if the bank is less than that value. The WINGS LEVEL mode commands the FD to maintain the wings level.

**ROLL HOLD** This mode will maintain the current bank angle. This mode will automatically transition to WINGS LEVEL, should the bank angle become less than 3 degrees. If required, after the engaging the mode, the goal roll angle can be altered by using the Tactile Control Steering.

**HDG HOLD** Will hold the heading, which the aircraft was flying at the time of transition to this mode. If required, after the engaging the mode, the goal heading can be altered by using the Tactile Control Steering.

**NAV** NAV mode uses the HSI needle to steer the aircraft. For the NAV mode to operate the selected nav source must be

valid, and its needle must be alive (show a less than maximum deviation). The nav source which the AFCS will use for the guidance is the one, shown at the selected PFD (HSI). Available NAV sources can be cycled using the “NAV SOURCE” select knob. If the selected nav source is valid at the time of engaging the mode, and the needle is already alive, the mode will instantly become active, otherwise the HDG SEL will become an active mode, and the heading bug will have to be used to set the desired interception angle. The NAV mode will remain as the armed mode until the needle starts to move, after which it will become an active mode and will commence tracking of the radial. The indication for this mode is “VOR” if the VOR is being received by the nav source, “LOC” for the Localizer, or the “LNAV” for the FMS nav sources. Depending upon the current mode of the FMS operation, the indication can also be “LNAV APPR”, “LNAV HDG SEL” or “LNAV HDG INT”. See the FMS chapter for more information on these modes. Note: *If FGM detects that the aircraft has entered the silence cone of the transmitter, it will enter the VOR OS (VOR Over Station), or LOC OS (Localizer Over Station) mode and will keep flying the current heading until the airplane leaves the silence cone.*

- APPR                      Operation of this mode is similar to the operation of the NAV mode, with the exception that the FMS nav source cannot be used to operate in this mode, and the FGM will apply greater sensitivity to allow for a more precise approach using the selected VOR or LOC nav source. The indication for this mode is “VOR APP” for VOR, or “LOC” for the Localizer.
- BC                              This mode is only applicable to the LOC type of the nav source, and will command the flight director to track the localizer outwards. It is typically used to fly the Back Course Localizer Approaches.
- STBY                        Pressing this button will cancel the current lateral mode and select WING LEVEL mode as active if the Autopilot is currently flying the plane, otherwise the lateral mode will become blank.

#### Vertical modes:

- PITCH HOLD This mode will automatically activate upon engaging the autopilot if no previous vertical mode was selected. In this mode the flight director statically command the pitch, active at the moment of autopilot engaging, or at the time of the Tactile Control Steering disengagement. This is also the mode, FGM will revert to, should any other vertical mode become disengaged either manually or automatically. The indication for this mode is “PITCH HOLD”
- GA GA, or “Go Around” mode is a modification of the pitch mode, which is pre-set to show the pitch of 10 degrees nose up. The GA mode can be selected by pressing the TO/GA button at the sides of the Power Levers. The indication for this mode is “GA”.
- IAS IAS, or “Indicated Airspeed” mode, is an active mode that maintains the airspeed measured at the time of the mode engagement, by altering the plane’s attitude. The goal airspeed that IAS mode maintains can be altered by turning the Pitch Wheel at the AFCS panel, or by using the Tactile Control Steering. The indication for this mode is “IAS”.
- VS VS stands for “Vertical Speed” mode, and will command the flight director attitude to maintain the vertical speed, measured at the time of the mode engagement. The goal vertical speed that this mode maintains can be altered by turning the Pitch Wheel at the AFCS panel, or by using the Tactile Control Steering. The indication for this mode is “VS”.
- GS GS, or Glideslope mode is armed automatically if an APPR mode with the ILS source becomes active (LOC is indicated), and the nav source contains the valid glideslope signal. The mode will be kept armed, until the glideslope will become alive, in which case it will transition to an active mode to intercept the glideslope when on the ILS. Should after that the glideslope needle appear out of range, the mode will transition back to armed. If any of the arm conditions aren’t present, the GS mode will disengage and the FGM will reverse to PITCH HOLD.
- VNAV The VNAV mode is the only vertical mode that is linked to a nav source. When the FMS nav source is selected, the lateral mode is LNAV, and the FMS VNAV guidance is available, pressing VNAV button will activate the VNAV as an armed or active mode, depending upon the deviation

shown by VNAV needle on the PFD. Should any of the conditions listed above suddenly cease to exist, this mode will revert to PITCH HOLD. The indication for this mode is “VNAV”.

**ALT** The ALT mode requires a particular attention, as its operation on this aircraft is different from how it is usually operated on most other aircraft types. In particular, this mode works differently, depending upon how exactly it was engaged. : 1. Manual engagement: Press the ALT button. The FGM will catch the current plane’s altitude as the goal altitude and will command the flight director to maintain it. 2. Use the ALT SEL armed mode (below).

**ALT SEL** This mode can only exist as the armed mode. When selected by pushing ALT SEL button, it will keep armed until the aircraft approaches the pre-selected altitude (while flying under any active vertical mode), indicated at the PFD screens just above the altitude tape. At that time, an automatic transition to the ALT mode will occur, and the aircraft will arrive and commence to maintain the pre-selected altitude. The mode will be indicated as “ALT\*” until the altitude is fully acquired. After which any changes to the pre-selected altitude will be ignored. In this case, to change the flight level again, a different vertical active speed mode must be selected, and the ALT SEL reengaged, until it acquires the altitude again. Note: To deselect the ALT SEL mode, push and hold the ALT SEL mode key for 2 seconds or more.

**STBY** Pressing STBY button will revert to the PITCH HOLD mode if the autopilot is currently engaged, or blank the vertical mode completely otherwise.

### **Dual FD Mode:**

The Dual FD mode is a submode of the ILS Approach mode which indicates to the flight crew that the AFCS is in a configuration valid for Category II ILS approaches. In the Dual FD submode, both FGMs independently display FD commands on the PFDs, with left FGM providing the FD commands for the left PFD, and right FGM providing FD commands for the right PFD.

In the Dual FD mode, left side FGM uses Localizer and Glideslope deviations from the left VOR/LOC Receiver, air data from left side ADC, attitude and Vertical Speed data from left side AHRS, and left course data from the FGCP.

Right side FGM uses Localizer and Glideslope deviations from the right VOR/LOC Receiver, air data from right side ADC, attitude and Vertical Speed data from right side AHRS, and right course data from the FGCP.

The flight crew use the Dual FD submode in conjunction with the ILS Approach mode operationally as follows:

- Set the EFIS ADC Source Selection switch to the NORM position.
- Set the EFIS ATT/HDG Source Selection switch to the NORM position.
- Select the VOR/LOC Receiver 1 as the left navigation source.
- Select the VOR/LOC Receiver 2 as the right navigation source.
- Tune both VOR/LOC 1 and 2 Receivers to the same Localizer frequency.
- Select both left and right courses on the FGCP to the desired runway.
- Select the intercept heading target on the FGCP.
- Press the APPR pushbutton on the FGCP to arm the mode.
- Set the left and right Decision Height on the ICP.

This automatically arms the ILS Approach mode, as described earlier. The Dual FD submode is activated if:

- Both FGMs are available.
- Both AHRS are valid for both FGMs.
- The EFIS ATT/HDG Source Selection switch is set to the NORM position.
- Both ADCs are valid for both FGMs.
- The EFIS ADC Source Selection switch is set to the NORM position.
- ILS data from both VOR/LOC Receivers is valid and agree for both FGMs.
- The VOR/LOC 1 is the selected left Nav Source Selection.
- The VOR/LOC 2 is the selected right Nav Source Selection.
- Both VOR/LOC 1 and 2 receivers are tuned to the same Localizer frequency.
- Both left and right courses are the same.
- The lateral and vertical active modes are Localizer Track and Glideslope Track.

- The Radio Altitude is valid and below 1200 feet.
- The left and right side FGMs Flight Director commands agree.
- Tactile Control Steering is not active.

### **Tactile Control Steering mode:**

Tactile Control Steering (or TCS) mode is activated by pressing and holding the TCS button on the yoke. This mode can be used to temporarily disengage the autopilot servos and manually fly the airplane while the autopilot is engaged, and to adjust the parameters for the certain modes (please see the modes description above). Upon releasing the TCS button, the Autopilot will continue flying the airplane (if previously engaged), and the following new parameters will be commanded to the active AFCS modes:

ROLL HOLD	New Bank Angle will be input for the “Roll Hold” mode to hold.
HDG HOLD	New Heading will be input for the “Heading Hold” to maintain.
PITCH HOLD	Will maintain the new pitch.
IAS, VS, ALT	Will maintain the new Airspeed, Vertical speed, or the altitude correspondingly, once the TCS button is released.

Note: TCS function is sometime used in order to program the ALT mode to maintain an altitude, not directly selectable by the Altitude Selector (for example, 2530 feet).

Note: The TCS function is available in our software in the PRO editions and higher.

### **5.3. Pitch Auto Trim for Flaps extension**

There is a provision to automatically pitch the airplane down during the flaps transition from 15° to 35° in flight. This is done in order to lighten the force on the control column during such transition.

#### **NORMAL OPERATION:**

Here we will describe a way how the AFCS is used during a typical flight:

#### **BEFORE TAKEOFF:**

Activate GA mode by pushing the TO/GA button on either Power Lever, pre-set the initial climb altitude using the ALT knob, and press the ALT SEL button. Then, select the runway heading using the heading bug and activate the HDG SEL mode by pushing the HDG button at the AFCS panel. Press YD to activate the Yaw Damper. Alternatively if FMS is set for a departure procedure that already includes the runway heading leg, activate the LNAV mode by pressing

the NAV button. Before takeoff, verify that the lateral active mode is HDG or LNAV (or as required), the vertical active mode is GA and the vertical armed mode is ALT SEL.

#### DURING CLIMB:

After a desired airspeed is established, but not below 500 feet, press IAS to activate Indicated Airspeed mode, verify that your pre-set altitude is not below the current altitude, and that the ALT SEL mode is still armed, then correct the heading or switch to NAV (LNAV) if necessary and press AP to activate the autopilot. The climb is usually performed on the IAS mode, while setting the IAS as per the climb tables using the pitch wheel. The lateral mode is usually by the FMS (LNAV).

#### DURING DESCEND:

Pre-set the desired initial descend altitude, press ALT SEL, and then VS. Select the desired rate of descend using the pitch wheel, keep monitoring the airspeed while descending. If keeping an exact descend speed is not important, the IAS mode can also be used. As a more complex alternative the VNAV mode can be used to descend the aircraft, while the FMS precisely calculates the Vertical Speed, required to meet the published in the procedure or given by the ATC altitude limitations.

#### DURING APPROACH:

If no LNAV approach is used, typically HDG SEL is utilized to intercept the approach leg, with LOC or VOR APR, or LOC + GS are the armed modes, waiting to activate once on the approach track.



## 6. Audio and Radio Management system (ARMS)

The ARMS is using 2 control display units (ARCDUs) to control and monitor the following communication systems:

- Radio Communication (RCOM) and Radio Navigation Management
- Passenger Address (PA) and Communication Interphone System (PACIS)
- Audio Integration System (AIS)

A layout of the ARCDU is shown at the figure 6.1. The Left and Right side modules are similar.

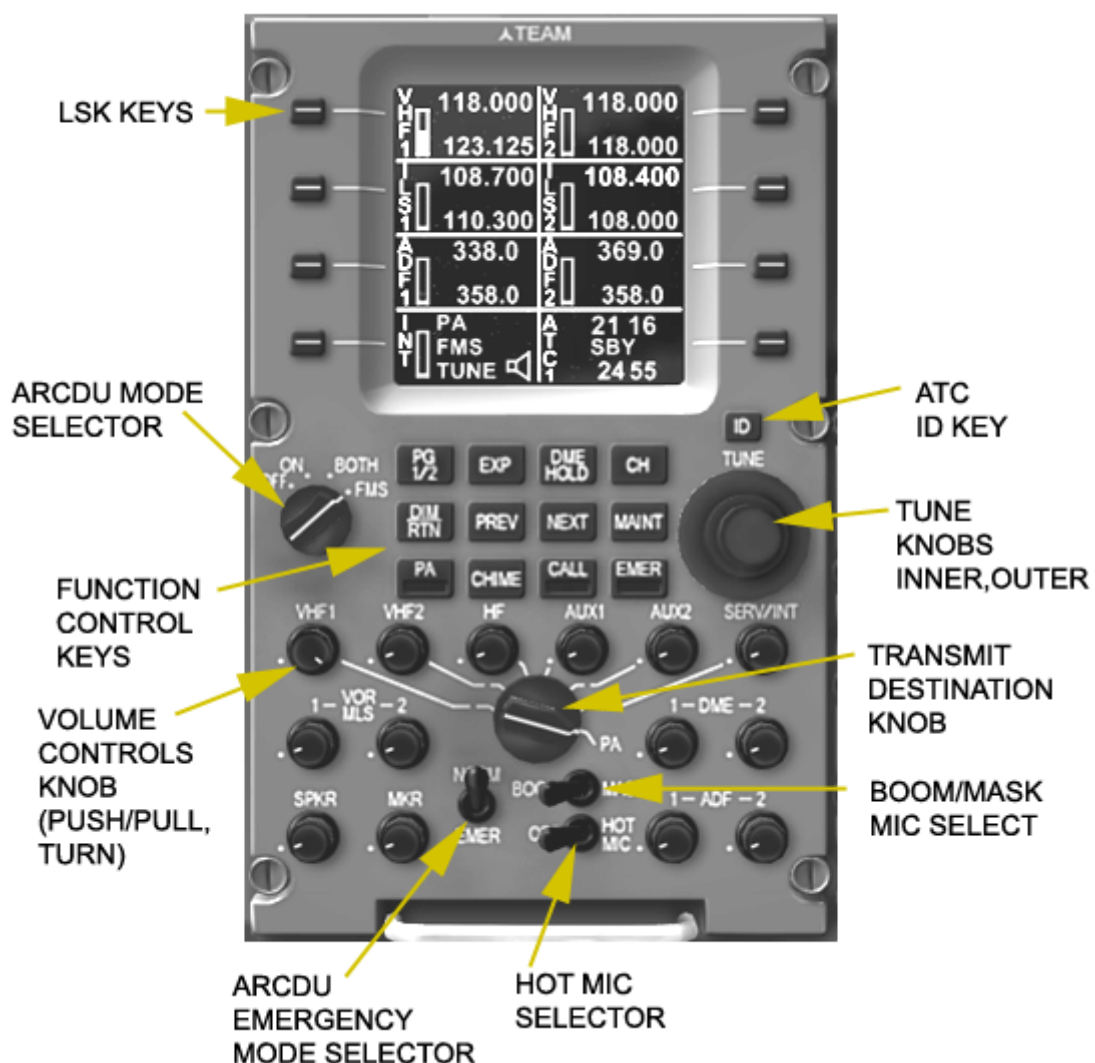


Figure 6.1. ARCDU panel layout

## 6.1. ARCDU pages

The information representing systems, managed by the ARCDU is split into several pages, each of which contains 8 sections, from which 6 upper sections are specific to the particular page, and 2 lower sections are always showing the same information (Intercom on the left, and ATC Transponder on the right side).

The first main page of the ARCDU are shown at the Figure 6.1.1



Figure 6.1.1. ARCDU Main Page 1

The first main page is a summary page, covering the most needed functions for managing most of the radios, the COM system and the active ATC transponder. The 6 radio management sections are uniformly indicate the following information for each radio:

- Radio title - white
- Volume bar - white or green
- Standby frequency - cyan or inverted cyan
- Active frequency - green or inverted green
- Pre-set channel indication - white
- TX and RX flags for the VHF - green

Before a particular radio can be adjusted, it must be selected by pressing it's adjacent side key (LSK). After that the standby frequency will change to inverse, and can be tuned using the ARCDU tuning knobs. When the desired frequency is tuned in, another press of the same LSK will swap standby and active frequencies, and the radio will be tuned to a new frequency.

If pre-set channels are used, turning of the tuning knobs will cycle through the channels, instead of setting the standby frequency directly. The cyan standby

frequency will than indicate the channel pre-set currently selected. The preset channel mode can be turned on and off when a standby frequency for a radio is highlighted.

The volume bar shows in white if the volume is deactivated, or green otherwise. The bar height is proportional to the currently set volume.

Each volume control has 2 functions - activation/deactivation and the volume setting. Activation/deactivation can be controlled by clicking with the mouse at the centers of the volume knobs, and the volume control by using the mouse wheel, or left/right mouse buttons at the sides of the knobs.

The left bottom section is dedicated to the intercom system. It is present on every ARCDU page, and indicates the current transmission destination (as selected with the Microphone selector), and the receive interphone volume level.

The right bottom section is dedicated to the transponders. This aircraft has 2 transponders, only one of which can be active at one time. The top number indicates the transponder code currently active, the bottom number is the standby code, which can be tuned using the tuning knob. The outmost knob will select the first 2 digits, and the inner knob - the last ones. The transponder mode is indicated in small letters between those 2 numbers. The mode can read either SBY, or ON ALT, and will cycle between those 2 states when the adjacent LSK is pressed and held for more than 2 seconds.

The second main page is shown at the Figure 6.1.2.



Figure 6.1.2. ARCDU Main Page 2

This page allows to set the VHF3 radio (which is in the aircraft mostly used by the ACARS). The 3<sup>rd</sup> row represent the summary of all the volumes for all radio sources, they are similar to those shown at the page 1, however smaller in size. The last row shows the intercom and transponder setting, as is on any other page of the ARCDU.

The pages can be cycled through by pressing the PG 1/2 key.

There are a number of expanded pages, available for each radio and the atc transponder. These pages allow the setting of standard for each radio type parameters, such as Squelch for the VHF radios, or a BFO for the ADF radios, and defining up to 8 memory channels for the type of radio. There are also facilities to test some of the radios, and the transponders. We will refer to some of these pages in the subsequent sections of this manual.

The channel page is called by advancing to the Expanded page for the selected section and pressing the LSK adjacent to “CHANNELS”. The layout of this page is shown at the Figure 6.1.3.

VHF1 VOR1/ILS1 ADF1	VHF2 VOR2/ILS2 ADF2
CH1 108.000 CH2 108.000	CH5 108.000 CH6 108.000
CH3 108.000 CH4 108.000	CH7 108.000 CH8 108.000
INT PA FMS TUNE	ATC 1 21 16 SBY 24 55

Figure 6.1.3. Channels page example

This page is used to define up to 8 channels, which can later be utilized to speed up the tuning process, and thus reduce the pilot’s workload during the critical phases of flight.

The top sections of the screen indicate for which radio the channel pre-sets are displayed. In this case the channel frequencies are shown for the VOR/ILS receiver #1.

The next 2 rows allow to edit the frequency for each channel number. Pressing the LSK adjacent to the required section will concurrently highlight each channel in that section, after which the frequency can be modified by using the tuning knobs on the panel.

## 6.2. ARCDU Mode Selector

The ARCDU mode selector (see figure 6.1. above) is used to turn the ARCDU module OFF or ON, to control the ability of the ARCDU to tune the cross side radios and the FMS auto tune functionality.

With ARCDU mode switch in the ON position, the ARCDU is only able to tune it's own side radios, such as ARCDU1 is tuning VHF1, VOR1,ADF1, and ARCDU2 is tuning VHF2, VOR2 and ADF2.

When the BOTH position is selected, any of the radios can be managed from any ARCDU.

In the "FMS" position of the mode switch, the FMS will be allowed to select the radio frequencies automatically (currently used to tune the approach VOR/ILS frequency upon activation of the FMS approach mode).

## 6.3. ATC ID Key

The ATC ID Key is used to supply the ID signal to the ATC. In this addon it is integrated to the Squawkbox3 FSUIPC offset (registered FSUIPC is required) in order to send the ATC the ID signal via the network. This functionality can be utilized with any other virtual flying network software, supporting the SquawkBox offsets (such as the IVAO client).

## 6.4. Tune Knobs

The tune knobs are used to cycle through the allowed values, or tune the digits currently selected by the LSK keys. Generally the outer most knob tunes the major part of the number, and the inner most - the minor part. To utilize the knobs, place the mouse cursor over the outer or the inner knob and use the left/right mouse clicks, or the mouse wheel to tune the desired parameter.

## 6.5. Function keys

"PG 1/2" is used to cycle between the pages when more than 1 page is available

"EXP" will call the expanded page for the radio selected, or the transponder.

- “DME HOLD” will decouple the dme receiver frequency from the vor/ils receiver, such that the currently selected navaid dme is kept receiving, and a new navaid can be selected directly in the upper line of the vor/ils section, using the tuning knobs.
- “CH” will enable/disable the channel mode for a currently selected radio.

## 6.6. Passenger announcement management keys

- “PA” indicates that the passenger announcement is in progress. Can only be selected if the microphone selector is in the PA position. Press the second time to disengage the announcement mode.
- “CHIME” will play a chime sound in the cabin.
- “CALL” initiates a call sound and the audio connection to the flight attendant station.
- “EMER” places the PA system in the emergency mode. This mode places any other selected mode on standby, and engages the red light at the flight attendant station. It initiates a call sound in both cabin and the flight deck, and enables the audio connection to the flight attendant station.

## 6.7. Volume control knobs

Each audible source connected to the communication system, has it's own volume regulator at the ARCDU panels. The regulator has 2 functions:

1. Enable/Disable the sound output - by clicking with the left mouse button directly in the center of the knob
2. Regulate the sound output with left/right mouse buttons at the periphery of the knob, or with the mouse wheel at the entire surface of the knob. When enabled, the volume indicator for a particular source is shown in green, otherwise it remains white.

## 6.8. ARCDU Emergency Mode

ARCDU emergency mode switch (See Figure 6.1.1) alternates between the normal ARCDU mode, and the emergency mode.

When ARCDU is placed in emergency mode, the following will occur:

- Red “EMER” will be displayed in the intercom section of the display

- the microphone/interphone selector is overridden while EMER mode is selected

When selected to the pilot ARCDU:

- The pilot headset and the microphones are directly routed to VHF 1
- the interphone audio side-tone is directly routed to the headset
- audio level can not be set for VHF1 and INT

when selected on copilot's ARCDU:

- the headset and microphones are directly routed to VHF2
- the interphone audio side-tone is directly routed to the headset
- audio level can not be set for VHF2 and INT
- the PTT/INPH must be selected to PTT for access to onsite COMM.
- Interphone function is not available in EMER except for Audio

## 6.9. Standby COM panel

The Standby COM panel can be used to set the COM1 frequency in the case of the ARCDU units failure. This panel is shown at the Figure 6.9.1.



Figure 6.9.1. Standby COM Panel

When the panel is activated by placing the mode selector in the ON position, the main and standby frequencies for the COM1 will be indicated on the display, and ARCDUs will show the “SBY COMM” test instead of the usual VHF1 main frequency entry.

The desired frequency can be set using the Tuning Knobs, and made active by pressing the Exchange Key.

Placing the mode knob in the TEST position allows to test the receiver output by disabling the squash function. Providing the volume for the VHF1 is enabled and set to a non-zero value, a noise will be heard from the headset/speakers.

## 7. Electrical System

The electrical system provides electrical power to all the other aircraft systems. It utilizes the following power sources:

- DC generators #1 and #2
- AC generators #1 and #2
- APU DC generator
- External GPU DC power
- External GPU AC power

The system operation is completely automatic, and is being managed by the Electrical Power Control Unit (EPCU). It provides the automatic reconfiguration and isolation of the faulty busses in the cases of power failures and short circuits.

The system is being controlled by a pilot from the DC and AC electrics control panels located on the overhead panel, and monitored from the electrics page at the MFD.

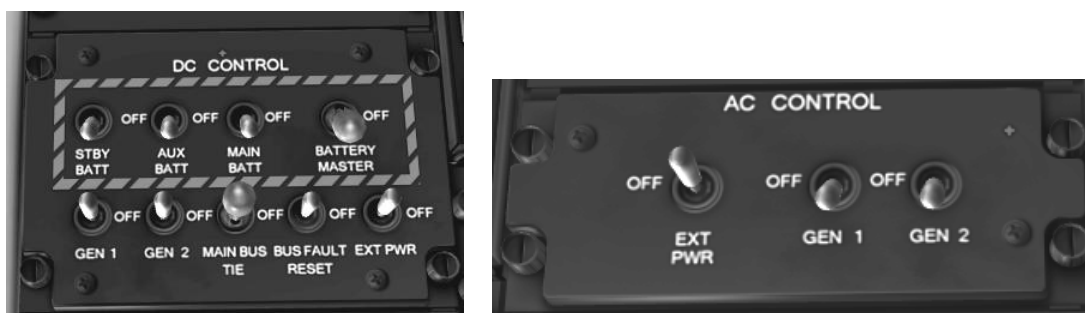


Figure 7.1. Electrical DC and AC Control Panels





Figure 7.2. Electrical System page on the MFD

Electrical system (see figure 7.3.) consists of the AC and DC circuits

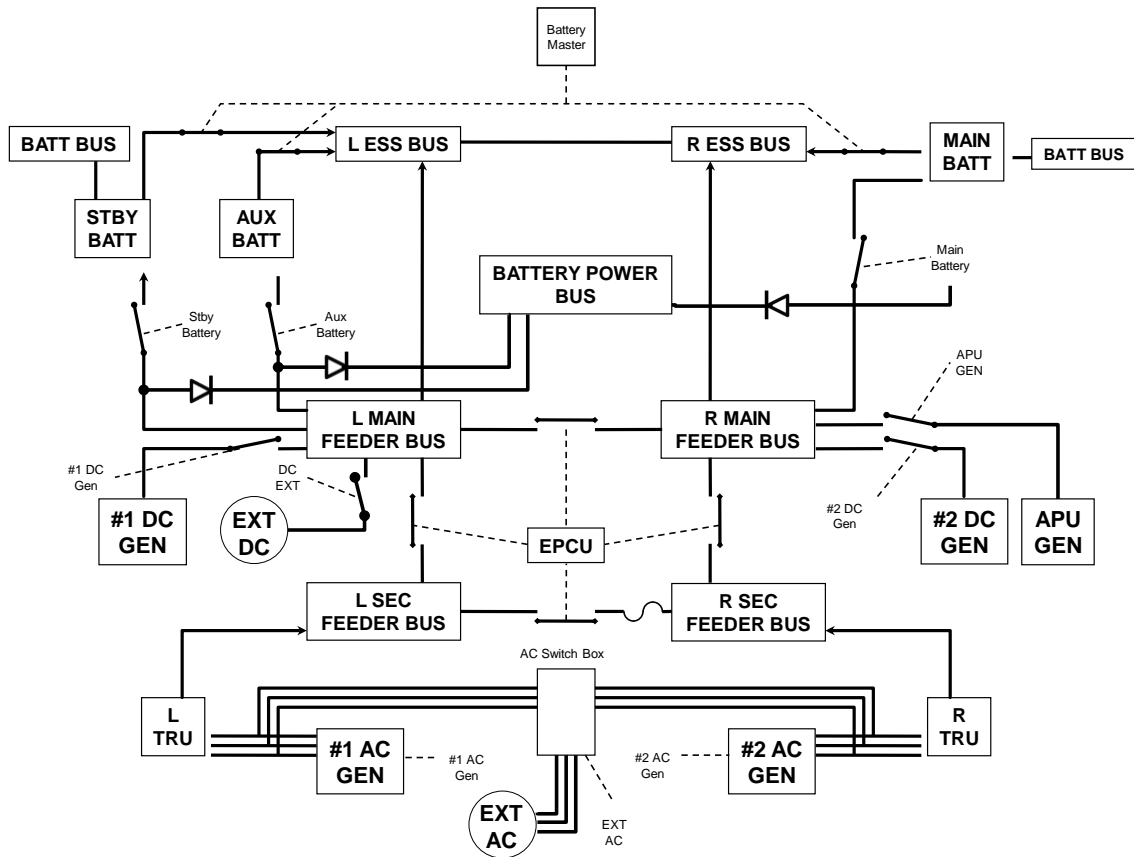


Figure 7.2. Electrical System Diagram

## 7.1. Electrical System Power Sources

### DC Generators

One electrical DC starter-generator is installed in every engine nacelle, and is mechanically linked to the N<sub>h</sub> turbine. Therefore, the DC generators will provide power with propellers both feathered or unfeathered. Actual DC generators load can be checked on the electrics page under the DC GEN 1 and 2 labels.

Should the Electrical Power Control Units suspect a failure in a DC generator, it will be automatically brought offline. The generator faulty status will be indicated at the caution lights panel by the “DC GEN 1” or “DC GEN 2” caution lights. If this happens, it might be possible to bring the generator back online by cycling the respective DC Gen switch OFF and ON. If the light stays after that, and the engine is running, no further attempt should be made to reset the generator, and the flight should be terminated as soon as practical. Please note that the “DC GEN 1 or 2” caution lights also illuminate when the engines are not running. This simply means that the DC Gen is currently offline.

### AC Generators

The AC generators produce the variable frequency AC power during the flight, and are linked to the N<sub>L</sub> turbine. Therefore, the output voltage and frequency of these generators are directly dependent upon the actual propeller rpm. It is important that the AC generators will not come online unless the propellers are unfeathered. The operation status of the AC gens are indicated by the AC GEN #1 and #2 caution lights, as well as by the AC GEN 1 and 2 voltage indication on the electrics system page. In the case of a failure, a reset of AC gens can be attempted, using the same technique as described above for the DC gens.

### DC and AC External Power

When the GPU is available on the ground, both AC and DC buses of the aircraft can be powered by the external power.

The DC power is selected using the DC EXT switch on the DC GEN control panel, and indicated in green at the electrical page. If the DC external power has a compatible voltage, it will become the only power source for the DC system (batteries, APU and DC Gens are disconnected). The batteries can be charged by the DC External power if their respective switches are in the ON position.

The AC power is selected by AC power switch and indicated in green at the electrical page. Enabling the AC Power will automatically disconnect the AC Generators from the electrical system.

### APU Generator

When APU is running on the ground, it's generator can be used to power the DC Electrical system, and used while the main generators are offline. The APU DC Generators is selected using the "GEN" switchlight at the APU Control Panel. The APU generator status is indicated by the green ON light mounted inside the switchlight.

## 7.2. The Auxiliary Power Unit (APU)

The Auxiliary power unit is used on the ground to supply the electrical current and the bleed air for air-conditioning purposes in those cases when no Ground Power Unit is available. The APU is controlled from the APU control panel located on the overhead (Fugure 7.2.1.)

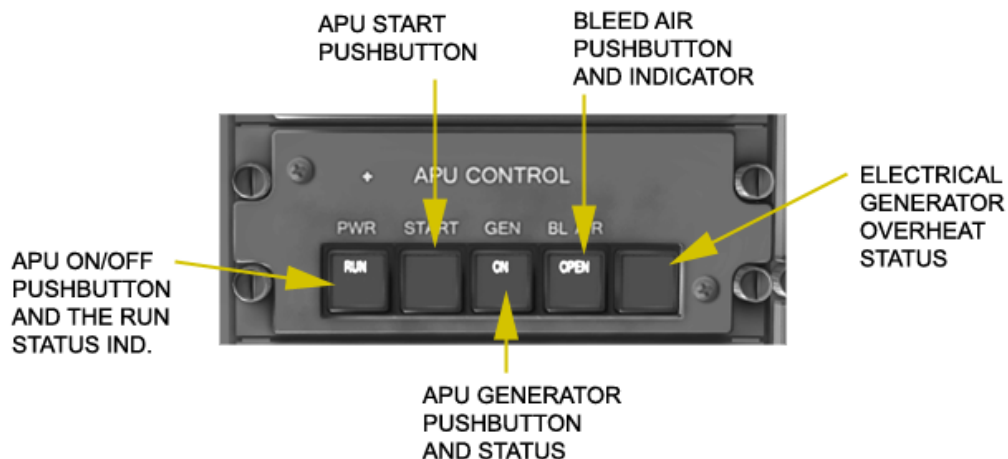


Figure 7.2.1. Auxiliary Power Unit Control Panel

### STOP/START

The APU module is powered by pushing the PWR button. The APU fuel valve (Figure 9.3.1) will open, indicating the APU is ready for start. The START button is then momentarily pressed to begin the automatic startup procedure. When fully started, the green RUN will indicate on the PWR indicator. To stop the APU, de-press the PWR pushbutton

### ELECTRICAL POWER

The APU electrical generator is selected by pressing the GEN button. The generator can power the entire DC electrical system and charge the batteries, providing the DC External power is disconnected.

#### BLEED

The APU bleed air is enabled by pressing the BL AIR button. The APU bleed air can only be used to air-condition the aircraft. For the APU bleed air valve to open, the engine BLEED #1 and #2 switches (Figure 4.3.1.) must be selected to OFF.

Note: The APU can not be used, and will automatically shut down when the airplane is airborne.

## NORMAL OPERATION:

The electrical system operation is generally automatic, providing the following switches configuration is set:

- Master battery, Main, Aux and, Standby battery switches ON
- DC #1 and #2 Gens ON
- AC #1 and #2 buses ON

On the ground,

DC External Power is usually used to power the aircraft (turn DC EXT switch ON, monitor the "DC EXT PWR" indication on the electrical page). In the absence of the Ground Power Unit, an APU can be started, and its DC Generator can power the DC electrical system (GEN switch on the APU panel is ON). Please note, the APU GEN will not come online, until DC EXT power is disconnected. AC part of the system is not normally powered with engines OFF, it is however possible to connect the AC EXT Power, if such application is required.

Engine start,

The No 2 engine is the preferred engine to start first. Once both engines are started and providing DC power to the aircraft the the APU/GPU DC power must be switched off. The Start Select light must be extinguished before switching to the Engine Driven DC Generators. Once this has happened, both engines are taken out of the Start&Feather Condition Lever position.

Shutdown,

Before shutting down the engines, make sure all non-essential power consumption is turned OFF (pitot heat, taxi/landing lights, other non-essential lights, wipers..). The engines are usually shut down after 30 seconds in Start&Feather (to prevent shock cooling). The battery voltage must be monitored. If the battery levels fall below 24 volts then damage to the batteries could ensue should the batteries are later used to start the APU/Engines.

## 8. Flight Controls

MJC 8 Q400 flight controls system consist of the following channels:

- Yaw
- Roll
- Pitch
- Flaps

The status of all of the control surfaces, except for the ailerons is indicated at the bottom of the left MFD screen, as shown on the Figure 8.1. The Flaps indicator is located at the bottom of the right MFD, at the hydraulics page (Figure 8.2.)

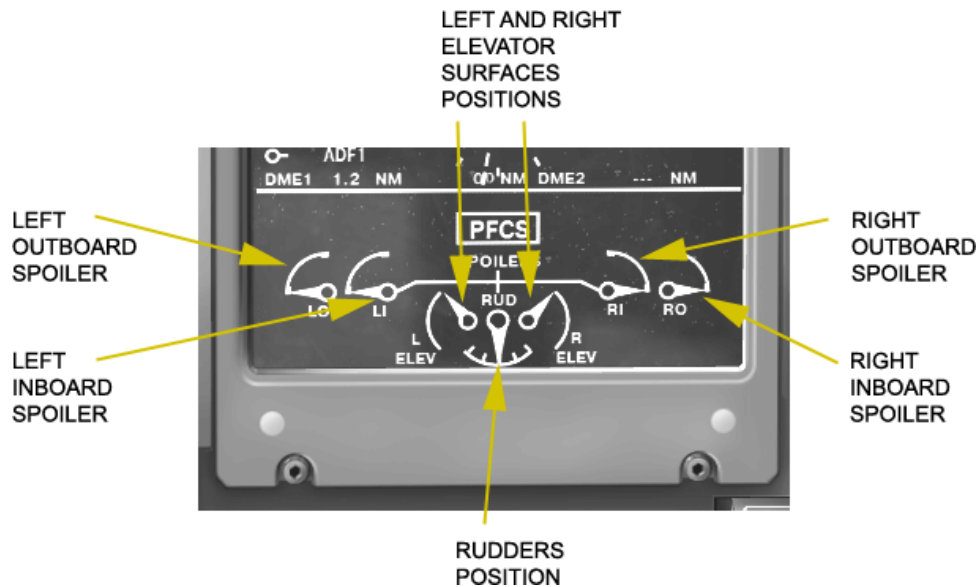


Figure 8.1. Flight Controls indication



Figure 8.1. Flaps position indicator

## 8.1. Yaw channel

The Yaw channel components include 2 sets of rudder pedals, rudder trim, yaw damper servo, autopilot rudder control servo, lower and higher rudder actuators and the rudder control surfaces on the tail fin.

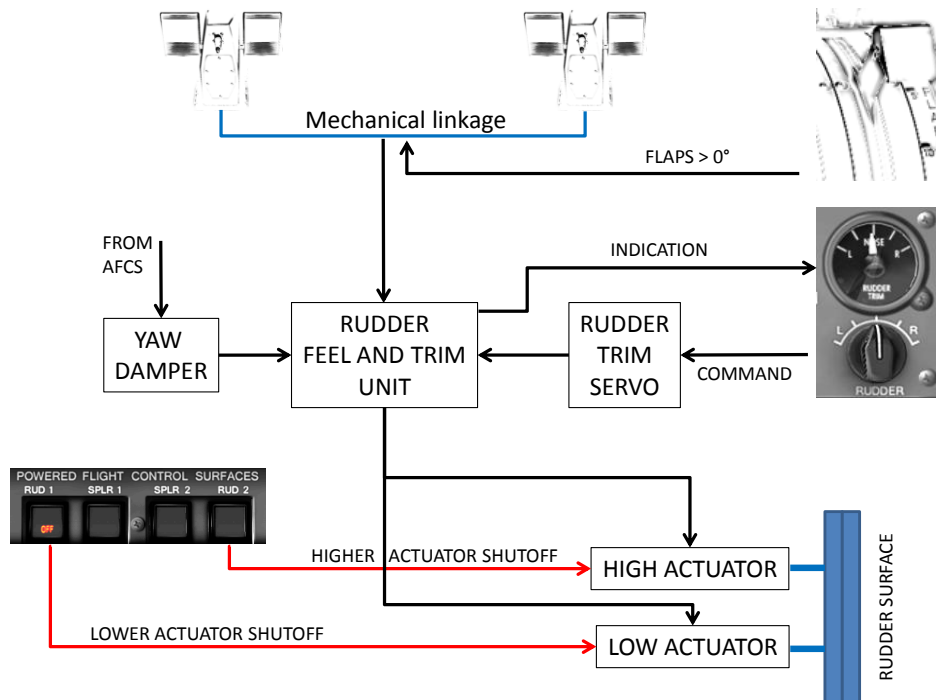


Figure 8.1.2. Yaw channel

Pilots initiate the rudder input by deflecting either of 2 mechanically connected sets of the rudder pedals. The signal proportional to the deflection is measured at the rudder pedals linkage and is fed into the rudder feel and trim unit. Apart from the pilots input, the rudder position can be affected by operating the rudder trim knob on the TRIMS panel, as well as adjusted automatically by the Yaw Damper when YD is activated on the AFCS panel. The sum of all 3 inputs is then mixed by the Rudder Feel and Trim Unit and is sent to 2 rudder actuators, located in the aircraft tail. The actuators also receive inputs from 2 shutoff switchlights, located on the glareshield and marked RUD1 and RUD2. When the switchlight is pressed, the shutoff signal is sent to one of the actuators, forcing it to go offline.

## 8.2. Roll channel

The roll channel provides the roll control from the pilot yokes, aileron trim panel and the autopilot roll control to 2 ailerons one on each wing, and 4 spoilers, 2 on

each wing (please see 8.2.1. for the description of the spoilers subsystem) . The schematic of the roll channel is shown on the figure 8.2.1

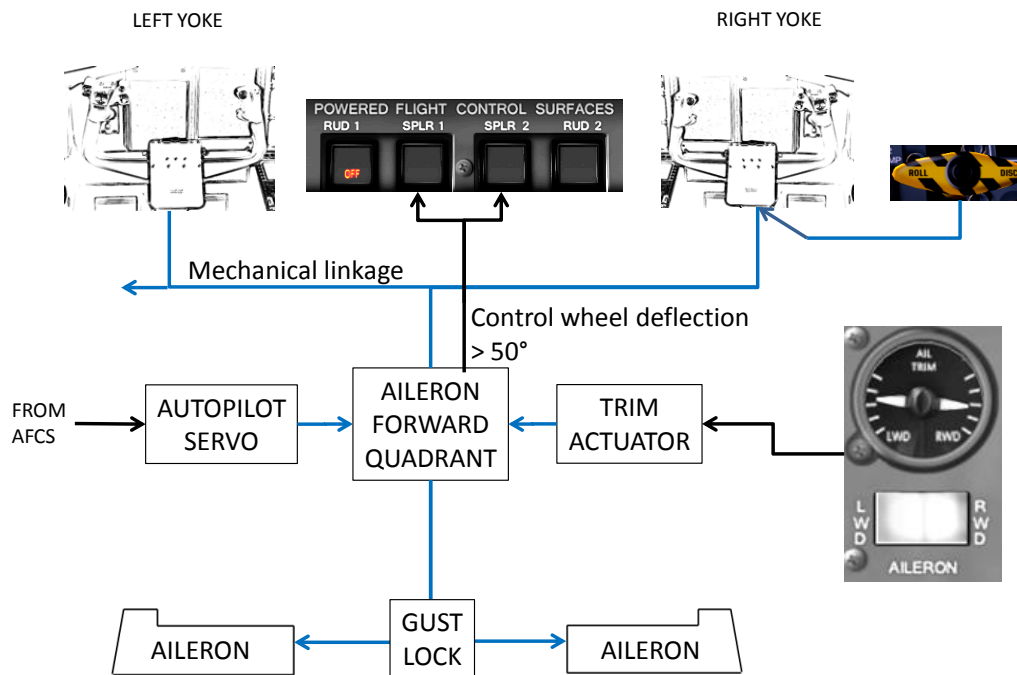


Figure 8.2.1. Roll channel schematic

The pilot control wheels are normally interconnected. Deflecting either wheel sends the deflection command to the spoilers system, and mechanically to the ailerons via the Aileron Forward Quadrant assembly.

The roll can also be commanded by pushing and holding the LWD/RWD buttons on the TRIMS panel, or by the autopilot when it is engaged.

There is an electric connection to the spoiler switchlight, activating the SPLR1 and SPLR2 lights should deflection on the quadrant reach 50 degrees in each direction, as such deflection would normally indicate that there is an un-commanded spoiler deflection which must be stopped by pushing the correspondent switchlight (please see 8.2.1. for the description of the spoilers subsystem).

Should a roll controls jam occur, the left and right control wheels can be disconnected by pulling and turning the Roll Disconnect Handle, shown on the Figure 8.2.1.



When the control wheels are disconnected, the left control wheel will be controlling the roll spoilers deflection and the right control wheel - the ailerons deflection.

## 8.2.1. Spoilers subsystem

2 spoilers are installed on each wing. The spoilers have to functions:

- Augment the roll control in the air
- Augment the deceleration of the aircraft upon the touchdown

The roll spoilers are hydraulically operated by 4 Power Control Units (PCUs). The spoilers are normally controlled by the roll system, unless in the ground mode, where roll system inputs are disconnected, and the spoilers are automatically extended, or manually deactivated on ground, by turning the FLIGHT/TAXI switch to the TAXI position.

Should an un-commanded spoiler deflection occur, the spoilers can be disconnected by pressing the SPLR1 or SPLR2 switchlights. The SPLR1 switchlight deactivate both of the inboard spoilers, and the SPLR2 switchlight, the outboard spoilers.

### FLIGHT MODE

During the flight, the roll control system operates in 2 different modes, depending upon the airspeed. When the airspeed exceeds 170 knots, the Flight Controls Electronic Control Unit (FCECU) will only operate the inboard spoilers to augment the ailerons. When however the speed drops below 165 knots, all the spoilers will be moving with the ailerons.

### GROUND MODE

Upon the touchdown, the spoilers subsystem will enter a ground mode. In particular all the spoilers will fully extend when all of these conditions are true:

- The FLIGHT/TAXI switch, is in the FLIGHT position.
- Both Power Levers are positioned to less than FLIGHT IDLE +12°.
- Weight-On-Wheels (WOW) indicates that the airplane is on the ground.

Upon the touchdown, if all of the above is true, the roll input commands to the spoilers are cancelled, and spoilers are automatically extended. The ground mode extension is indicated in the cockpit by the ROLL INBD and ROLL

OUTBD advisory lights on the glareshield, and by the spoilers position indicator on the right side MFD screen.

### 8.3. Pitch channel

The pitch control of the aircraft is maintained by 2 hydraulically actuated elevators, located at the trailing edge of the horizontal stabilizer.

The pitch channel diagram is shown on the figure 8.3.1.

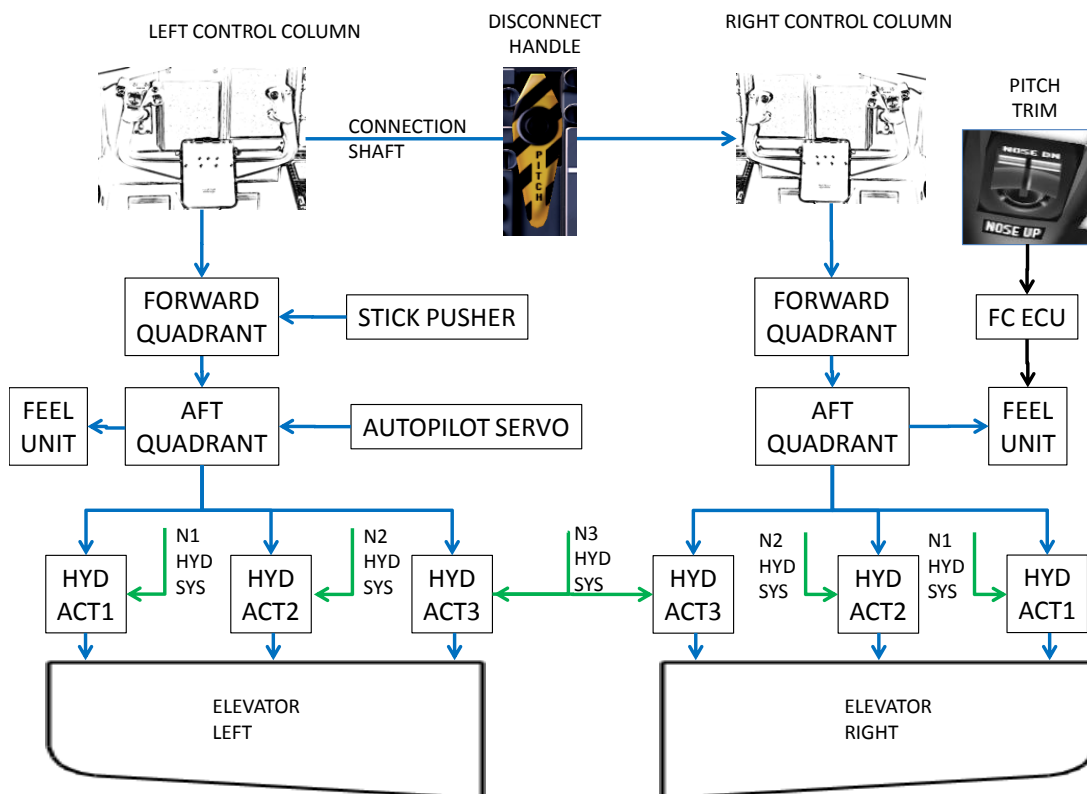


Figure 8.3.1. Pitch channel diagram

The pitch channel consists of 2 completely independent control systems.

Either pilot initiates the control column deflection by pulling or pushing the yoke. The mechanical movement initiated by the yoke is then transferred by the

cables to a FORWARD QUADRANT. The left FORWARD QUADRANT mixes the left control column movement and the stick pusher input, and sends the resulting mechanical reaction further aft of the aircraft to the left AFT QUADRANT. The Right FORWARD QUADRANT simply relays the reaction to the right AFT QUADRANT.

The AFT QUADRANTS then mix the movement they receive from the front of the aircraft and the AUTOPILOT SERVO, and apply the resulting output to 6 hydraulically operated elevator actuators, which are mechanically moving the ELEVATOR surfaces. The AFT QUADRANTS are also connected to 2 FEEL UNITS, which are the module responsible for giving the pilot an impression of the elevator airstream resistance and applying an appropriate pressure on the control column, to maintain the elevator trim - commanded position, processed by the FCECU (Flight Controls Electronic Control Unit).

The HYD ACT1..6 hydraulic actuators are connected to 3 independent aircraft hydraulic systems, in order to make sure an operation of the elevators under most failure conditions.

#### **NORMAL OPERATION:**

Before takeoff, the flight controls have to be un-blocked by releasing the CONTROL LOCK on the Power Quadrant, and the FLIGHT/TAXI switch brought to the FLIGHT position. The Flaps have to be set to the appropriate takeoff setting.

It is also extremely important to make sure the full deflection of all the flight surfaces is available, by fully deflecting the controls and checking that the Elevator position, Rudder position and Spoiler positions are deflecting with it's full range, as shown on the bottom of the right MFD.

After touchdown the roll spoilers will come up automatically, and will remain in the extended position, until the FLIGHT/TAXI switch is set to TAXI, the CONTROL LOCK has to be set to ON, to prevent damage to the flight control surfaces from the wind gusts.

## 9. Fuel System

The Fuel System of this aircraft has the following functions: Storing; Indicating the fuel status; Venting; Feeding and scavenging; refueling/defueling (gravity or pressure); transferring.

There are 2 fuel tanks installed in each wing. The maximum fuel contents is 5862 Lbs or 2664Kg. The fuel type is Jet A1. Each fuel tank is equipped with the quantity gauge.

The left tank supplies the fuel to the left engine and the APU. The right tank supplies the right engine. Each fuel tank is also equipped with a venting system, in order to keep the air pressure in the tanks within the structural limits.

There is a provision for the fuel transfer between the tanks for the balancing and fuel management reasons.

Each fuel tank contains a fuel flow gauge, an engine driven fuel pump (also known as a main fuel pump) and an electrical AC driven auxiliary fuel pump, which can be used in case the engine driven fuel pump fails.

Application of the fuel to the engines and the APU is completely automatic.

### 9.1. Fuel System Controls

The fuel system is controlled by

- Condition levers in the OFF and START&FEATHER
- Fuel panel pump switchlights and the fuel transfer switch
- 2 overhead fire panel Pull Handles

The fuel to the engine is enabled by advancing the Condition Levers to START&FEATHER position. FADEC will however not begin the fuel supply until the engine start parameters reach the point when the fuel can be safely injected into the engine combustion chambers. Therefore, it is ok to select the fuel ON, while simultaneously engaging the engine starter.

The fuel panel (figure 9.1.1) consists of the fuel pump switchlights and the transfer switch.



Figure 9.1.1. Fuel Panel

Each of the TANK AUX PUMP switch lights contains an indicator of the aux pump status. The auxiliary fuel pumps are normally selected ON for the takeoffs, and landings.

The TRANSFER switch is used when the fuel transfer between the fuel tanks is required. Providing the AC power is available, moving the switch left or right will automatically turn on the opposite side fuel pump and begin the transfer. The transfer will stop automatically if the system detects that the source fuel tank is empty or the destination tank is full.

In the case of engine fire, the fuel to the engines can be shut down immediately by pulling the correspondent Pull Handle on the fire panel.

### 9.3. Fuel System Indicators

The status of the fuel system can be viewed on the MFD by pressing the FUEL button on the EFIS MFD controller. The fuel page is shown on the Figure 9.3.1.

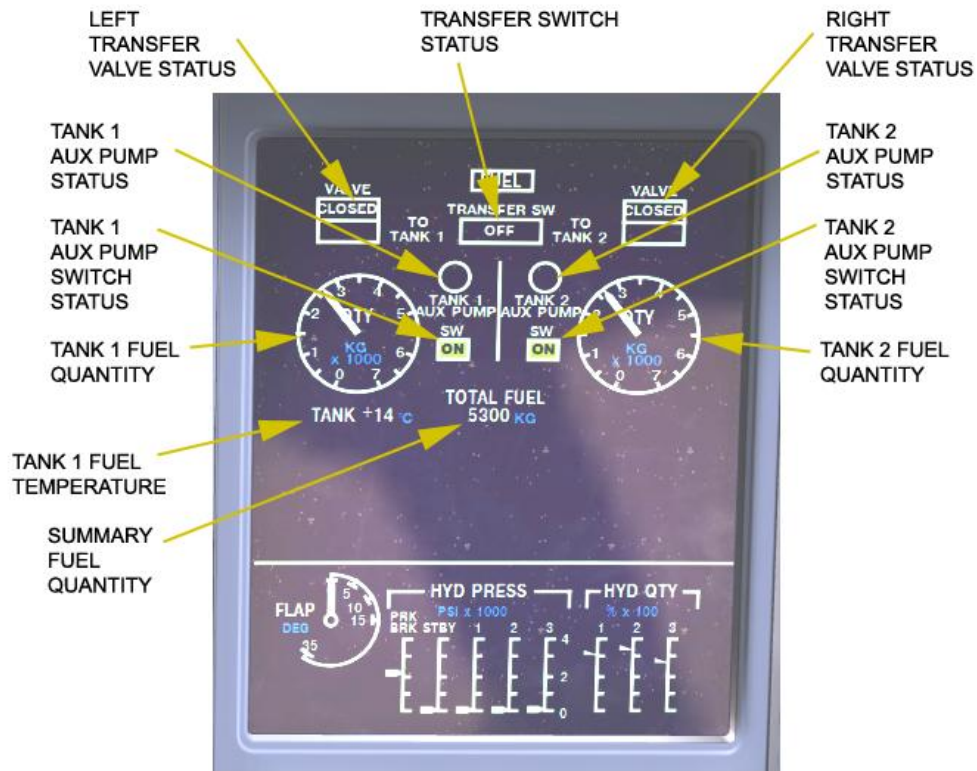


Figure 9.3.1. The Fuel Page

The essential information from the fuel system, such as fuel quantity, fuel flow and the fuel temperature can also be seen on the engine page, shown on the figure 9.3.2.

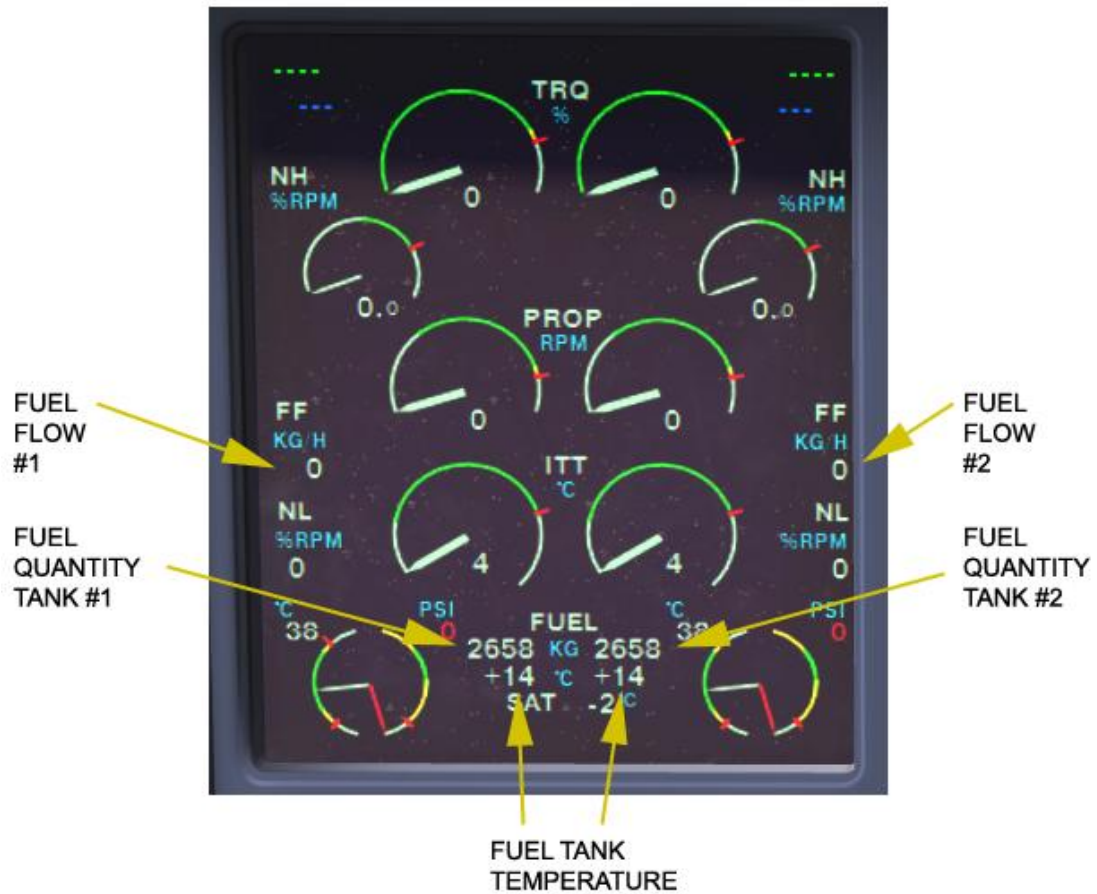


Figure 9.3.3. The Fuel related indication on the engine page.

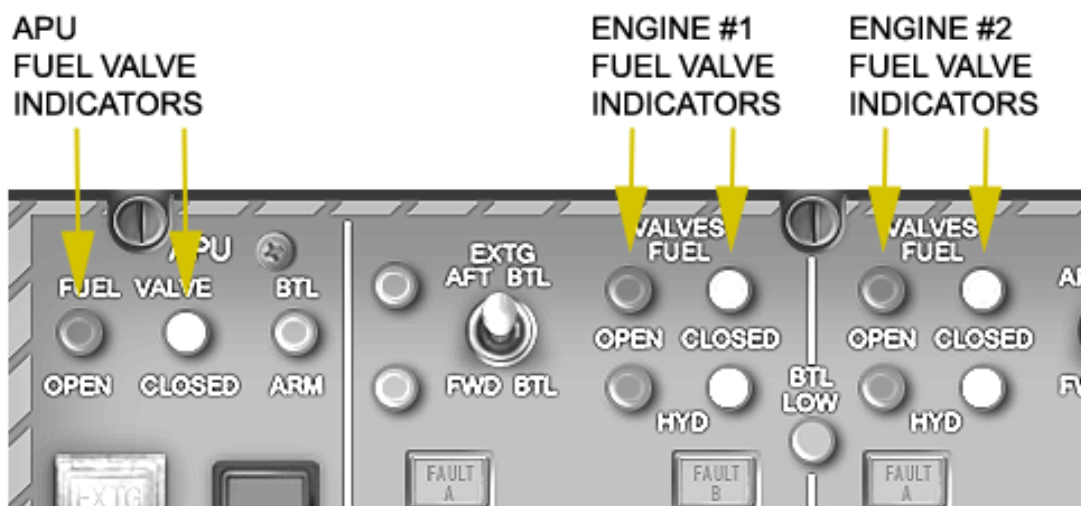


Figure 9.3.4. The Fuel related indication on the overhead fire panel

## **NORMAL OPERATION:**

The Fuel to the engines is being commanded by placing the respective Condition Lever into the START&FUEL position. From this point on, the FADEC will monitor the engine start parameters, and being supplying the fuel to the combustion chamber, when the  $N_h$  reaches a predefined value, and the rest of the parameters are within the allowed limits.

Before takeoff, the auxiliary fuel pumps must be selected ON, to ensure the stable fuel supply to the engines in the case of the main fuel pumps failure. The Auxiliary pumps are then normally turned off until the approach check.

Should it become necessary to transfer the fuel between the tanks, the fuel pumps switches must be first turned off, than the transfer switch selected towards the desired tanks. The appropriate fuel pump will then be activated automatically.

On the ground, the fuel supply to the APU is automatic, when an appropriate APU turbine RPM is reached.



## 10. Hydraulic system

The Hydraulic system of this airplane consists of three main systems and an auxiliary system.

The N1 hydraulic system powers the following components:

- Flaps
- Lower rudder actuator
- Inboard roll spoilers
- Outboard Elevator actuators
- Main wheel brakes

The N2 hydraulic system powers the following components:

- Landing gear
- Nose wheel steering
- Outboard roll spoilers
- Emergency/Parking Brakes
- Rudder upper actuator
- Elevators centre actuators.

The N3 hydraulic system powers the following components:

- Inboard actuators of the Elevators

The emergency hydraulic system powers the following components:

- Alternate landing gear extension system

The status of the hydraulic system is indicated on the bottom part of the right MFD screen, as shown on the Figure 10.1.

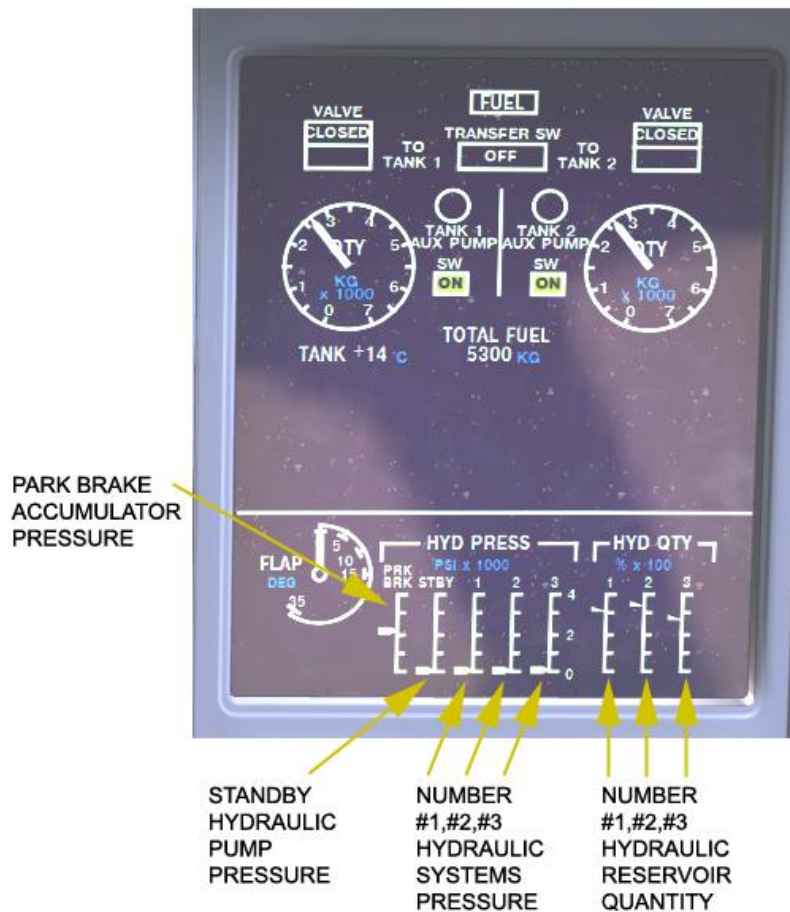


Figure 10.1. Hydraulic system status subpage on the MFD.

On the left side of the screen, the pressures in PSIx1000 are indicated for the following components

- Park brake reservoir
- N1 hydraulic system
- N2 hydraulic system
- N3 hydraulic system

On the right side, the currently measured quantity for 3 hydraulic system reservoirs is shown, as a percentage.

## **NORMAL OPERATION:**

There are 2 hydraulic system components that the pilot is required to operate during the normal operation. The Standby Hydraulic Pump and the Power Transfer Unit. Both are usually selected before takeoff and before the landing. There is a provision for automatic engagement of the standby hydraulic pump when the flaps handle is selected to any position above 0 degrees.

## 11. Ice and Rain protection system

The antiice system allows the airplane to fly into the known icing conditions, and takes care of the following:

- Ice detection
- Airframe de-icing
- Propeller de-icing
- Engine intakes de-icing
- Flight controls de-icing
- Flight instruments probes de-icing
- Cockpit windows de-icing and de-misting
- Windshield rain protection (wipers)

The various components of the system are shown on the Figures 11.2. and 11.3.

The ice detection probes detect the appearance of Ice and show the information at the bottom of the Engine Display, as illustrated on the Figure 11.1

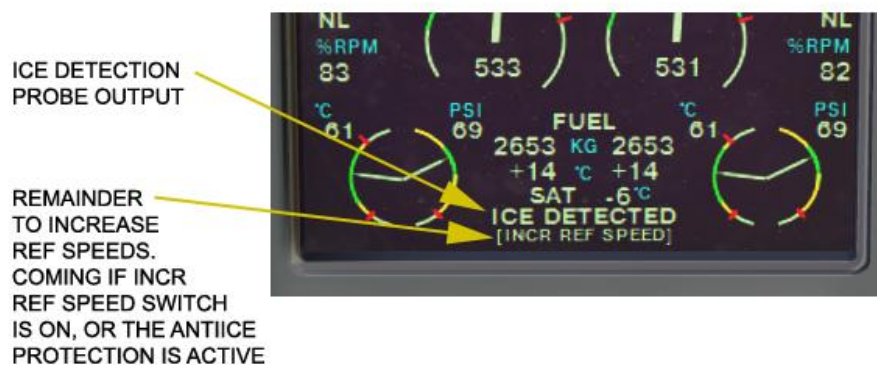


Figure 11.1. Ice detection indication

When the ice is detected by either probe, the ICE DETECTED message comes up on the bottom of the engine display, first in the flashing inverted text for several seconds, then in white on black background if INCR REF SPEED switch is selected, otherwise in yellow on black background.

There is also an [INCR REF SPEED] message that is shown to the pilots when INCR REF SPEED switch is set to ON.

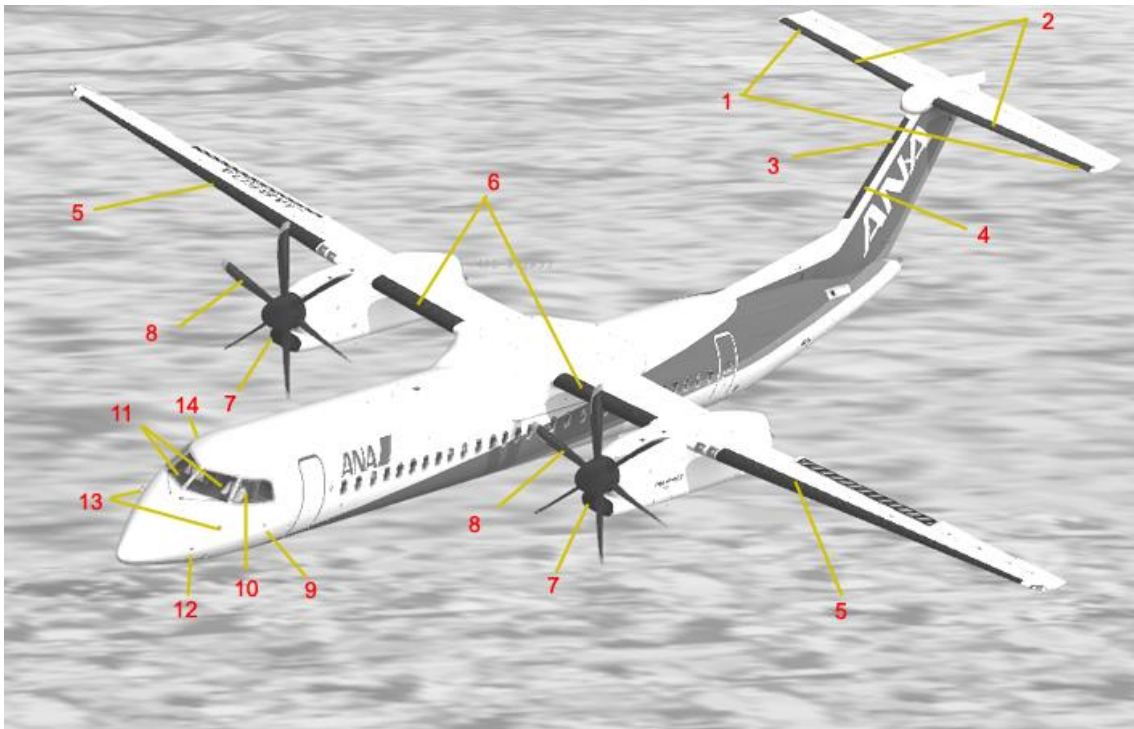


Figure 11.1. Components of the Ice and Rain protection system

1. Outboard Horizontal Stabilizer Boots.
2. Inboard Horizontal Stabilizer Boots.
3. Upper Vertical Stabilizer Boot.
4. Lower Vertical Stabilizer Boot.
5. Extension, outboard and inboard Wing Boots.
6. Centre Wing Boots.
7. Nacelle Inlet Lip heater.
8. Propeller Blade Heaters.
9. Angle of Attack Vane Heaters
10. Pilot's Side Window.
11. Windshield.
12. Ice Detection Probe (Both Sides).
13. Pitot/Static Probes.
14. Copilot's Windshield.

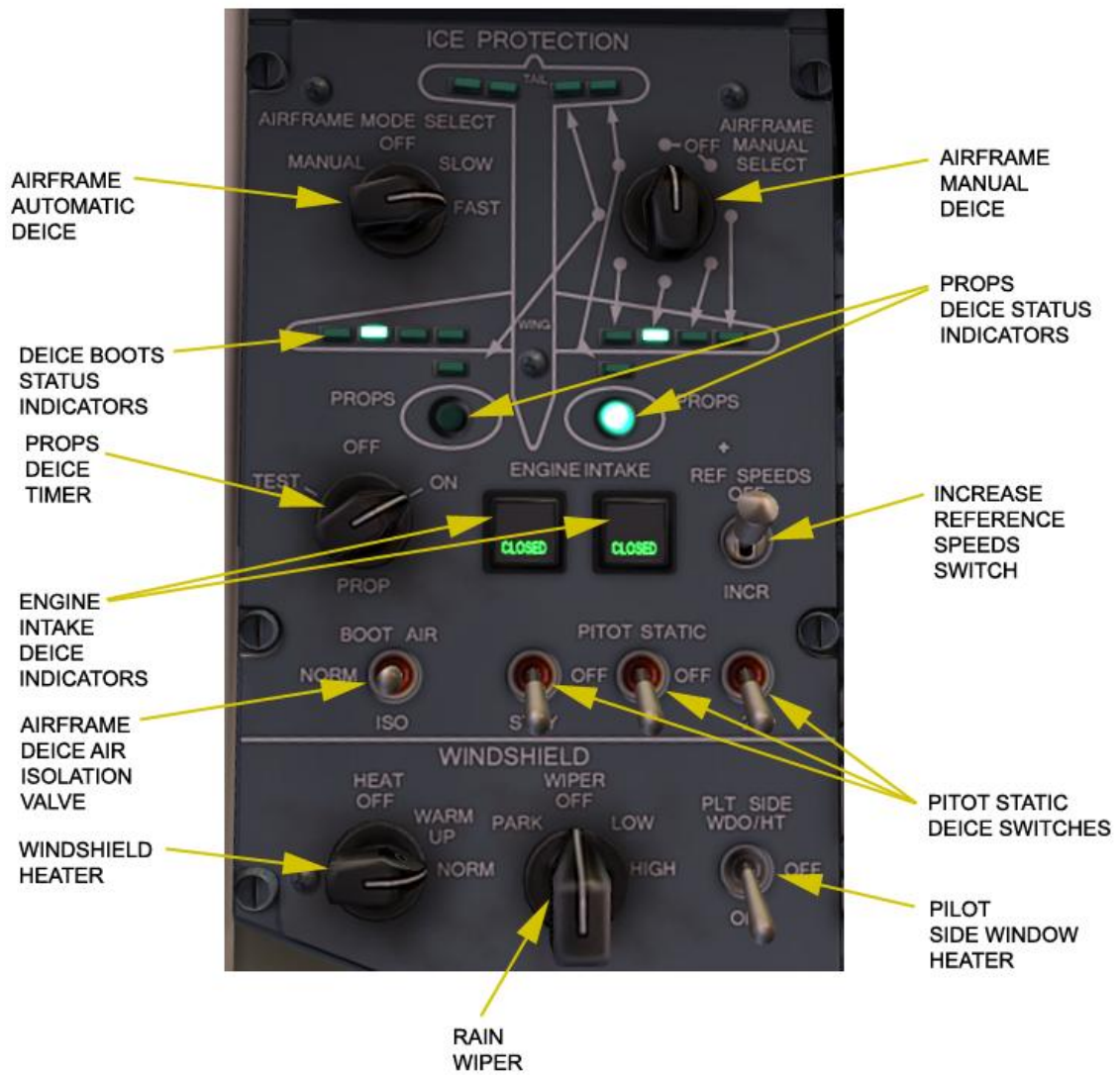


Figure 11.2. Anti-ice Control Panel

## 11.1. Airframe Anti-ice Protection

The Airframe de-icing is achieved by using 14 de-icing boots located on the wings and the forward edge of the vertical tail fin.



Figure 11.1.2. Deice Pressure Indicator

The pressurized air from the bleed air ports is required for the boots to function. There is a provision to mix the air from both ports before forwarding it towards the de-icing boots, by using the isolation valve (Boot Air Switch). The operation of the boots can be either automatic or manual. Automatic de-icing is performed when the “AIRFRAME MODE SELECT” timer knob is set to SLOW or FAST. The boots are inflated with hot air for 6 seconds, 2 at a time on a pre-defined sequence. After the last pair was inflated, the dwell period will be initiated. In the SLOW setting the dwell period equals 144 seconds, and in the FAST setting - 24 seconds.

The boots status indicators will light up green when a particular boot is inflated.

When required, the boots can be de-iced manually by turning the “AIRFRAME MODE SELECT” timer knob to MANUAL and selecting the particular boots using the “AIRFRAME MANUAL DEICE” knob.

Note that the bleed switches on the air condition panel must be selected to ON for the airframe deice to function.

## 11.2. Propeller de-icing

Each propeller blade has an integrated electrical de-icing heater. The propellers are being automatically de-iced using the Variable Frequency AC power when the PROP knob on the antiice control panel is selected to ON. Only one propeller is deiced at one time, in order to minimize the load in AC electrical system. The timing of the de-icing is dependent upon the outside temperature

(OAT). If the temperature exceeds +5 degrees, the propeller de-icing will enter the standby state. Please, also note that the system will not deice a propeller if it's respective rpm is less than 400. The TEST position of the knob can be used to test propeller de-icing (providing the rpm is above 400). In this case, each propeller will be heated for 7 seconds. After the test is concluded an automatic 30 seconds blocking of the test function will be initiated to avoid over-heating the propellers.

### 11.3. Engine intake heaters

Each of the engine intakes includes an electrical heater, which is powered by the Variable AC bus, and can be used to de-ice the intakes when they are in the open position. The heaters will engage automatically, should the outside air temperature drop below +15 degrees Celsius. The heater status is indicated by the "HTR" indicator located on the engine doors switchlights. Please note, that the heaters will not operate while the engines are shut down.

### 11.4. Pitot static and probe heaters.

Each of the pitot/static and AoA vane probs have an integrated heater. The power for the pitot/static heaters is supplied from the DC buses, and can be controlled using 3 "PITOT STATIC" probs. The 2 AOA Vanes are heated unconditionally whenever the AC Variable electrical bus is powered.

### 11.5. Windshield and Pilot side window heaters.

Both sides of the windshield, and the left side window can be heated electrically to provide for de-icing and de-misting. The power is taken from the AC Variable electrical buses, and can be controlled by the "HEAT OFF-WARMUP-NORM" windshield de-icing knob and the "PLT SIDE WDO" switch. There is no provision for the electrical heating of the copilot side window.

### 11.6. Side windows de-misting.

There is a provision to de-mist both side windows using the hot air. The demisting is controlled by the "Side Window De Mist" handles, located just under the respective side windows.



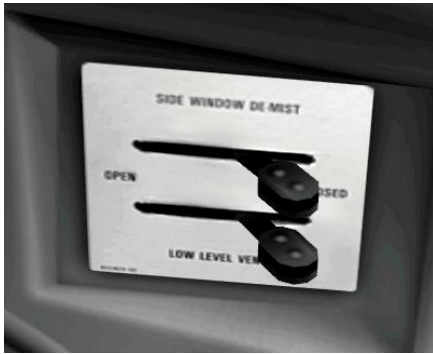


Figure 12.6.1. Side Windows de-misting

## 11.7. Rain protection.

There are 2 wipers installed in front of each front window, to allow for cleaning up the precipitation whenever is required. The wipers are controlled by the “WIPER” knob on the anti-ice panel, and can operate in the SLOW or FAST modes. As soon as the wipers are no longer required, they should be brought to the parking position by selecting and holding the knob in the “PARK” setting.

### **NORMAL OPERATION:**

The pilot/static and AoA Vanes de-ice has to be selected at all times for takeoff, flight and landing.

The propeller and Airframe de-icing is generally selected off for the landing and takeoff to avoid the additional drain on the engine performance due to the consumption of the bleed air and the Variable AC Electrical Power.

The Increase Ref Speeds switch should be ON when flying in the known icing conditions to remind the pilots of the necessity to apply higher speeds during the flight maneuvers.

## 12. Electronic Instruments System

The Electronic Instrument System allows the aircraft to be fully certified for the flights under the day and night conditions.

The Electronic Instruments System (EIS) is connected to the various other aircraft systems and sensors, and presents the integral of these data to the pilots in a convenient way.

The EIS consists of the following components

- Flight Data Processing System (FPDS)
- Primary Flight Displays (PFD1, PFD2)
- Left and Right Index panels
- Left and Right EFIS Control Panels (EFCP1, EFCP2)
- Engine and System Integrated Control Panel (ESCP)
- The PFD Unit Switch on the overhead panel
- Multi Functional Displays (MFD1, MFD2)
- Engine display (ED)
- Electronic Standby Instrument
- 2 Digital Clocks

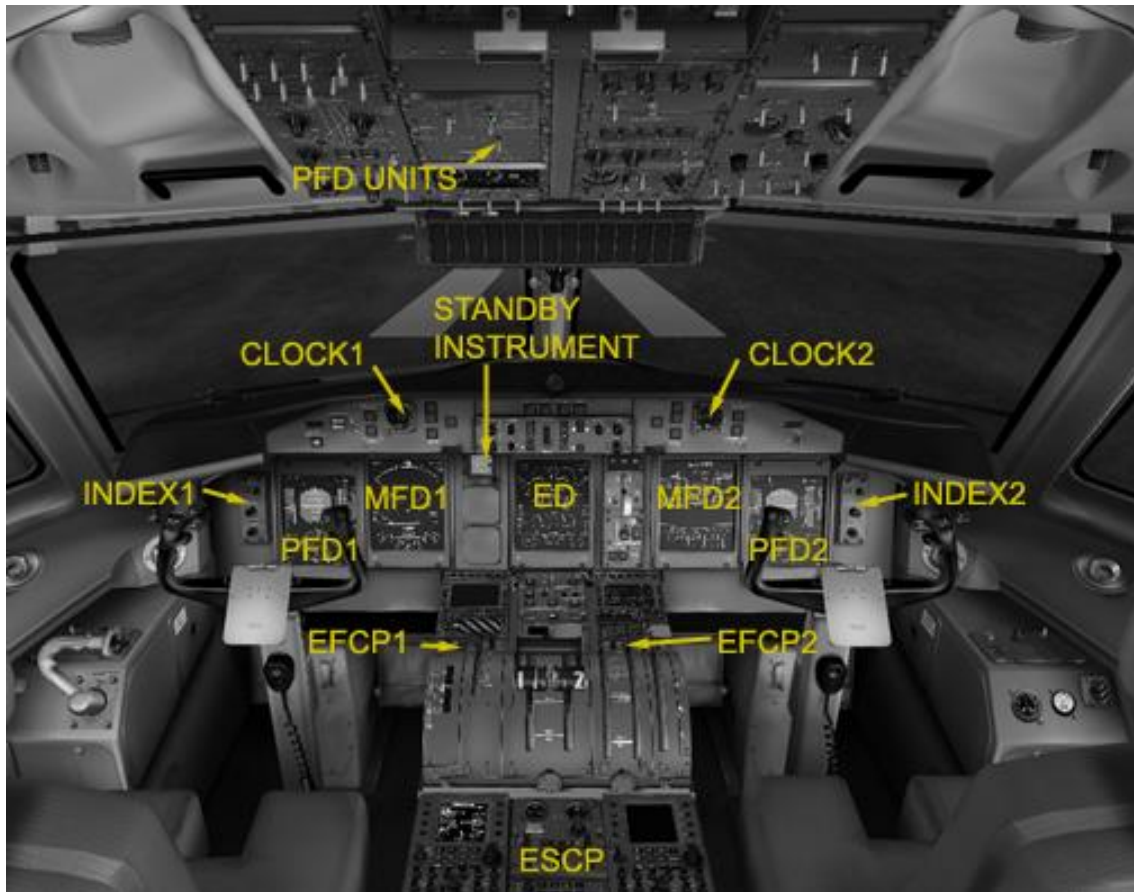


Figure 12.1. EIS Cockpit Components.

## 12.1. EIS Controls

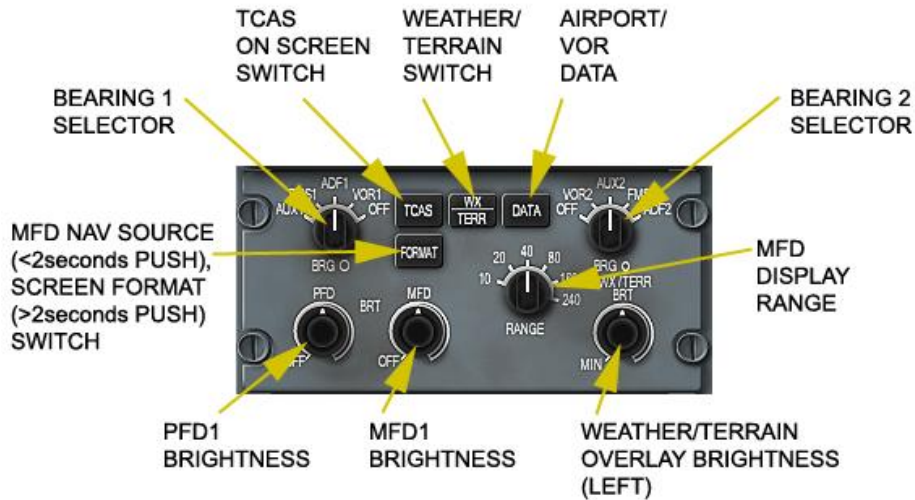


Figure 12.1.1. EFIS Control Panel panel

2 EFIS Control Panels allow each pilot to operate it's respective side PFD and MFD navigational inputs. The designation of the controls is self-describing. However please note that switching the display brightness OFF completely for a particular display will cause the Avionics caution light to come up, and might also cause the other displays reversion mode, depending upon the phase of flight and the EIS configuration.



Figure 12.1.2. Engine and System Integrated Display Control Panel

The Engine and System Control Panel (ESCP), shown on the figure 12.1.2. is controlling the following:

- The display mode of each MFD
- Which system pages are shown on the MFDs
- If the EIS receives the inputs from it's respective side AHRS and ADC computers (see the Navigation chapter), or a particular side computers.
- Engine Display Brightness

The usual display modes of the MFD are NAV and SYS. The PFD display mode is only used if a respective side PFD is failed, and the ENG page when the ED is inoperative.

Pressing the System Page will cause each MFD, which is currently operating the SYS mode, change it's system page. Pressing the ALL button will cycle through each page in sequence, upon each press of the button.

If neither MFD is running in the SYS mode, pressing the page button will bring the respective page on the Engine Display, but only while the system page key is pressed. The ALL page will bring up each page on the ED while it is pressed, even if no power is available to the EFCP panel, as it's power source is different than the EFCP's.

Switch the MFD to any other mode than SYS, and then back to SYS will reset the system page for this MFD to the electrical page.

*Tip: it is possible to bring 2 system pages on 2 MFDs simultaneously if one of the pages is electrical. For this, select one of the MFDs to the SYS mode, and another to NAV mode, select the first MFD desired (non-electrical) page, than switch the second MFD to the SYS mode. This is especially useful on the ground, for example to display the Electrical and Doors page simultaneously.*

Under the normal conditions, each side PFD and MFD receive the data from the respective side Attitude and Heading Reference Computer and Air Data Computer. However, should a failure of one of these computers occur, it is possible for the both side displays to receive the data from a single computer. In this case, the ADC or AHRS knob is turned to the desired side, and the yellow ADC or HDG is indicated on the MFDs and the PFDs.

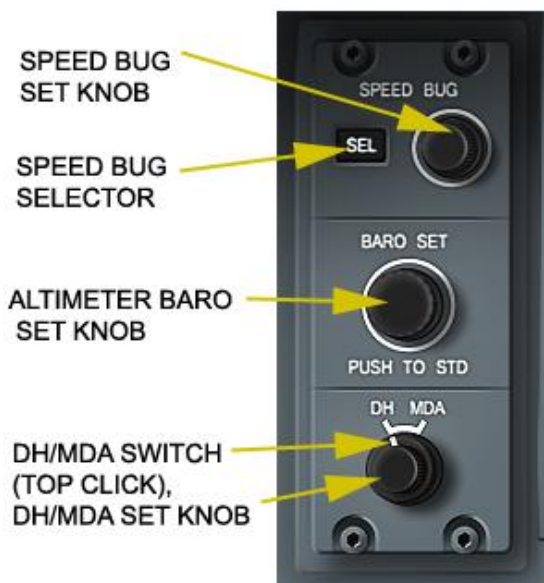


Figure 12.1.3. Index Control Panel

The Index Control panel has 3 functions. It controls the reference speed bugs, the baro-setting for each of the 2 altimeters, and the decision height, or MDA setting.

Pressing the SEL button cycles through V1,Vr,V2,#1 and #2 speed bugs. The V1, V2 and Vr bugs can only be set on the ground. The #1 and #2 reference bugs can be set at any time and used to set an approach speed, or any other required speed (for example, an ATC speed limit). Also see the PFD description below for representation of the speed bugs on the PFD:

The Decision Height or MDA can be set alternatively by switching the DH/MDA outer knob to the respective position. When set, the PFD will inform the pilot of reaching the DH based on the radio altitude, or an MDA based on the pressure altitude. There is also an audio warning for the DH altitude crossing.

## 12.2. Primary Flight Displays

Two Primary Flight Displays combine the essential flight instrument and navigation information.



Figure 12.2.1. Primary Flight Display

The Primary Flight Display indication is generally divided into 5 zones.

The top of the display is dedicated to the AFCS indications and warnings (see the AFCS article for more information on the AFCS indication). First the active and standby AFCS modes are indicated, followed by the standby modes, and the AFCS and AP status messages.

On the above left, is the airspeed related data, which includes the moving tape and the digital indication. The tape also incorporates the airspeed dependant parameters, such as the High Speed Limit, Low Speed Limit and the speed bugs symbolic. The speed bug settings are also indicated under the tape as digital values, however the V1-V2 values are only indicated when the aircraft current airspeed is below the respective settings.

Following the airspeed to the right is the attitude related indication, which includes the attitude ball, attitude marks, slip/skid indicator on the top of the ball, and a flight director whenever the AFCS is in use. There is also a decision Height and Minimum Decision Altitude indication under the attitude ball, when such indication is set using the DH/MDA knob on the respective index panel. Whenever the MKR receiver receives a signal for OM, MM or IM marker, it is indicated in a filled rectangle on the bottom right part of the zone.

The altitude symbolic is located to the right of the attitude zone. The altitude indication consists of the altitude tape, the digital altitude readout and the AFCS pre-selected altitude setting. The Baro reading is located under the altitude tape.

The right most zone, adjacent to the altitude is the IVSI, which includes an analog arrow and the digital IVSI indication, showing the vertical aircraft rate in digits divided by x100. For example, .5 means 500 fpm, and 1.5 means 1500 fpm.

The bottom part of the PFD is for the navigation related data. The following components can be seen in this zone.

- The full compass rose, and the EHSI for the currently selected nav source.
- Currently selected heading on the left of the rose and the selected nav source data on the right side.
- Two bearing designators to the bottom left and right of the rose`
- Two bearing pointers (as selected on the EFCP), one white and white green overlaid over the rose.
- The heading bug in magenta.
- DME1 and DME2 data on the bottom of the screen
- AHRS error in +/- digits on the bottom of the screen

### 12.3. Multi Functional Displays

Each MFD indication is split into 2 zones:

Content of the top zone correspond to the MFD mode as selected on the ESCP.

The bottom zone for the left MFD shows the Flight Controls status, the right MFD shows the Hydraulics status.

In the case of a single MFD failure, and combined hydraulics/flight controls indication will be shown instead on the working side MFD.

The normal modes for the MFD are NAV and SYS. In the SYS mode the desired system page is selected by pressing the corresponding button on the ESCP panel. Please see the respective system article for the explanation on the particular system pages. In the NAV mode the MFD shows the detailed Navigational Information:





Figure 12.3.1. Multifunctional Flight Display in the NAV mode.

The Multifunctional Flight Display includes the following navigational Information

- The Partial or Full compass rose (if in the map mode)
- WXR related indication on the top left
- Currently selected NAV source data on the top right
- Selected AFCS heading on the left
- Drift and heading bugs over the compass rose
- 2 bearing pointers, white and green over the compass rose
- An HSI for the selected VOR/ILS NAV source (removed from view when the FMS is the current NAV source)
- FMS deviation just under the compass rose, when the NAV source is FMS and the LNAV navigation and set
- Weather, TCAS, FMS flight plan and EGPWS data overlay over the compass rose zone
- Current wind indication on the center left
- TAS and GS indication on the center left
- TCAS status indication on the center right
- DME1 and DME2 on the bottom of the NAV zone

## 12.4. Engine Display

The engine display primary function is the engine related information. However it can also be used to display the system information if both MFDs are in the NAV mode, or unavailable.



Figure 12.4.1. The Engine Display

Please, see the Powerplant and Fuel system articles for the detailed description of the Engine Display page.

## 12.5. Electronic Standby Instrument

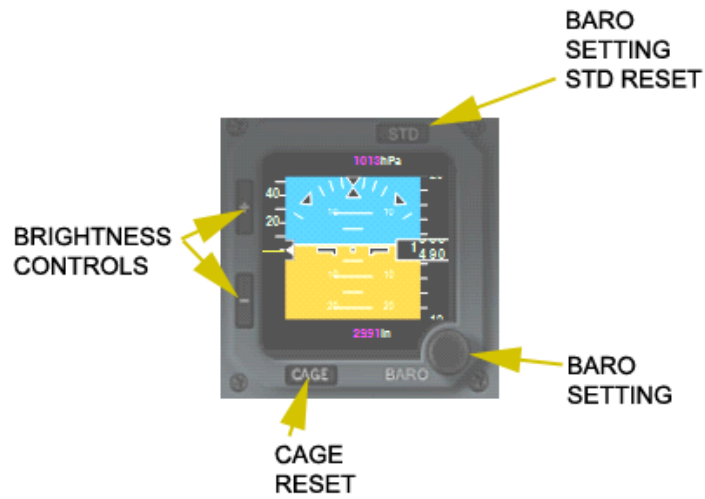


Figure 12.5.1. Electronic Standby Instrument

In the event if only the essential power is available, an electronic standby instrument combines all the necessary indication for flying the aircraft.

## 13. Landing Gear

The landing gear are hydraulically operated. The nose-wheel steering gives directional control during the operation on the ground.

Each main wheel has hydraulically powered anti-skid brakes. There is also an emergency/park brake system.

The main landing gear (MLG) is a retractable dual wheel installation. The main gears retract aft into the nacelles and the nose gear (NLG) retracts forward into the nose section.

A Power Transfer Unit (PTU) supplies back-up hydraulic power to the No. 2 hydraulic system.

Advisory lights show position of gear doors and down-locks. An aural warning sounds if the gear is not extended during certain landing configurations.

A Proximity Sensor Electronics Unit (PSEU) monitors and controls the operation of the landing gear components. The nose-wheel is steerable by a flight deck hand control within the range of 70°, and by the rudder pedals in the range of 8° either side.

The brakes can be controlled by the brake pedals or in the emergency situation by the PARK BRAKE lever.

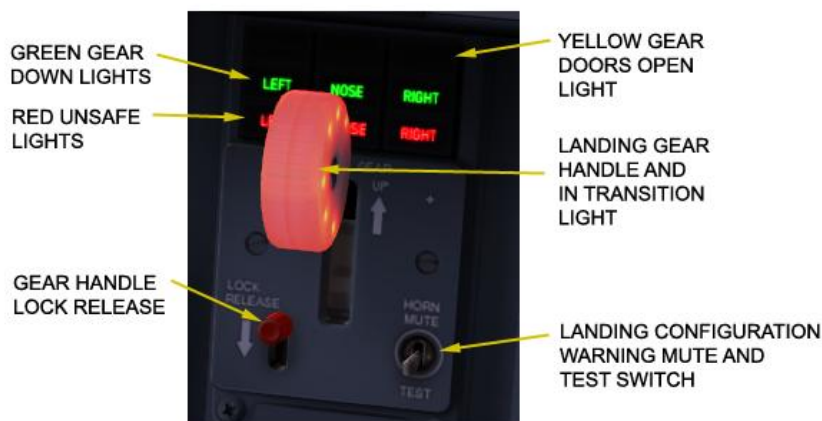


Figure 13.1. Gear Panel

The park brakes hydraulic line is equipped with a pressure accumulator, to allow 4-5 park brake applications in the absence of hydraulic power. The pressure in the park brake accumulator is indicated at the hydraulic subpage (see Figure 10.1.).

## 14. Lights

The aircraft is equipped with exterior and interior lighting.

### 14.1. Exterior lighting

The exterior lighting is controlled from 2 control panels, located on the overhead panel in the cockpit.



Figure 14.1.1. Exterior Light Control Panels

The panel controls the following exterior lights



Figure 14.1.2. Exterior Lights

## **NORMAL OPERATION:**

The operation of the exterior lights is done according to the checklist and the exterior conditions. Certain lights must be operated during certain phases of flight in accordance with the law.

Generally, during the loading/unloading operations at night is accustom to leave the Position (they are also called "NAV lights") lights ON, in order to visually outline the aircraft dimensions to the ground crew. The Position lights must be ON while the aircraft is moving under own power, and are generally maintained ON during all times when the aircraft is powered.

Before the engine start, the red anti-collision light must be selected.

The landing lights should only be turned on before the takeoff and imminent in order to not to blind the landing aircraft. When the takeoff is imminent the landing lights are turned ON and the anticollision lights are switched to White in order to indicate to the rest of the traffic that the aircraft is about to takeoff. The landing lights are generally maintained ON until reaching FL100.

For the flight in the fog/clouds it might be necessary to turn the anti-collision lights to Red until leaving such conditions, in order to prevent the pilot fatigue due to flashing reflections from the surrounding weather.

The Wing Lights can be used at any time to examine the surface of the wings for contamination.

The flare lights are directed steeper down than the landing lights, are selected in addition to the landing lights in order to better highlight the immediate surface in front of the aircraft.

After the runway is vacated, the landing and flare lights must be switched OFF.

The Red or White anti-collision lights must be maintained ON while the engines are operating.

There is also a Logo light which highlights the company logo on the tail fin. The operation of this light is entirely according to the particular company regulations (usually stays ON while landing or taxi lights are ON).

## 14.2. Flight Deck lighting

The Flight Deck is equipped with the following lights:

- Dome lights
- Storm lights
- Panel and Instrument lights
- Pilot's and Copilot's Side Panel lights
- Pilot's and Copilot's Utility lights
- Pilot's and Copilot's Map lights
- Windshield Wiper Ice Detection lights
- Observer's Reading light
- Circuit Breaker Panel lights

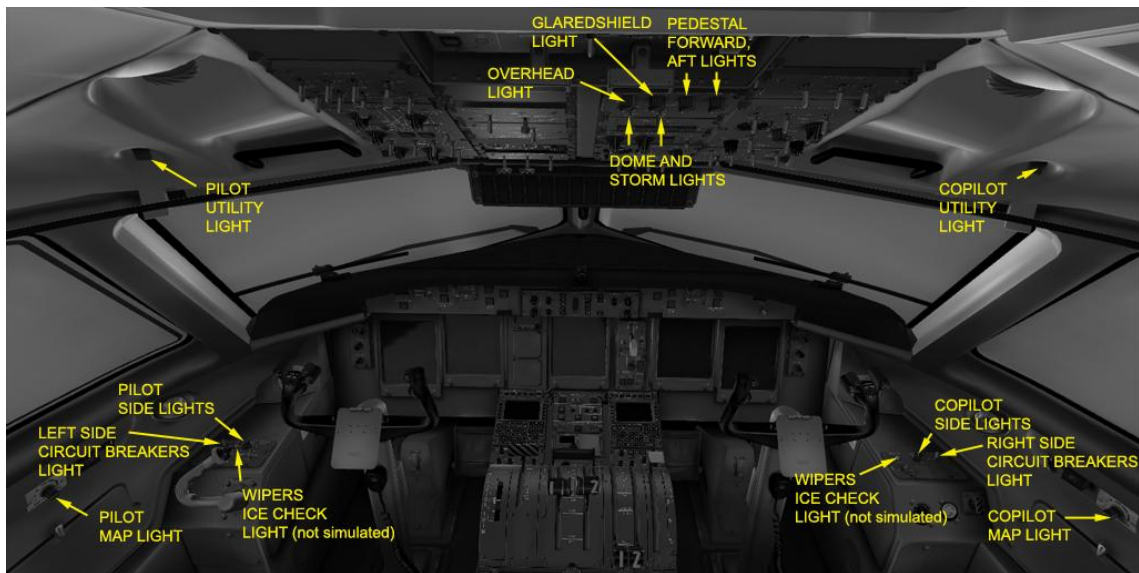


Figure 14.2.1 Flight Deck Lights controls

## **NORMAL OPERATION:**

The lights operation is entirely up to the pilots. The Dome light can be used for boarding the Flight Deck, even if the aircraft is not powered, as it is directly connected to the battery hot bus.

During operation in the stormy conditions with the occurrences of lightning, the Storm light can be used to “stabilize” the cockpit by applying the ambient lighting to the front panel. The Dome and Storm lights are usually OFF for takeoff and landing at night, in order to improve the pilot’s outside awareness.

Each instrument panel has an integrated lighting with variable brightness. The integrated lighting is controlled with 6 lighting knobs, 4 on the overhead, 1 at each pilot-side panels (See Figure 14.2.1.)

Two map lights one on each side are directed from the ceiling down towards the control wheels and can be used to highlight the maps.

Two general purpose utility lights are mounted on the wall beside each seat and are shining downwards.



## 15. The Powerplant system

There are two independent powerplant assemblies, one on each wing. Each powerplant includes:

- Pratt and Whitney PW150A turboprop engine
- Dowty Aerospace R408 Propeller
- Reduction Gearbox
- DC Electrical Generator
- AC Electrical Generator
- Engine Control System
- Propeller Control System
- Engine starting system

### 15.1. The Engine system

Each of the PW150A engines drives its own propeller via a reduction gear box. The engines are rated for 4580 SHP takeoff power, or up to 5071 SHP for a brief period of time, to augment the takeoff thrust in the case of a failure of the opposite engine.

The engine consists of 2 stage (low pressure/high pressure) compressors, each attached to a single stage turbine. A two stage power turbine drives the reduction gearbox, which brings the rotational speed down to match the propeller operating range.

In addition to the propeller operation, the engine drives the AC and DC electrical generators, and provides bleed air to the aircraft systems via two bleed air ports, attached to each compressor stage.

The engine is electronically controlled by a FADEC (Full Authority Digital Engine Computer), with no mechanical control possible. Due to the highly integrated control functions of both engine and a propeller, we will describe the FADEC and propeller controlling functions in the separate article below.

### 15.2. The Propeller system

Two 6 blade variable pitch propellers are attached to the engines via the reduction gearbox. The propeller is hydraulically controlled by utilizing the engine oil pressure, and electrically operated via the Propeller Control Unit (PCU), one on each propeller. Both PCU and the propeller have several levels of protection, in order to feather the propeller in the case of the PCU or hydraulic failure.

## 15.3. The powerplant controls

The powerplants are controlled by

- The condition lever (CL)
- The power lever (PL)
- The engine control panel
- The engine start panel

The powerplants generally operate in four modes:

- Flight constant speed mode
- Flight beta mode
- Ground beta mode
- Reverse mode

In Flight constant speed mode, the propeller speed selected by the pilot via the Condition Lever (CL) is controlled by the PCU using the propeller blade angle, and the FADEC governs the propeller shaft Torque, scheduled for the current position of the Power Lever.

Should the engine thrust become insufficient to maintain the desired RPM during the flight, the PCU enters the Flight Beta Mode, changing the propeller pitch in proportion to the movement of the Power Levers (see the Engine Controls article for more information). The propeller speed control at the same time transfers to the FADEC. This mode provides an instant reaction of the propeller thrust to the movements of Power Levers via the rapid propeller blade beta changes.

In Ground Beta mode, the taxi speed is controlled by changing the propeller beta with the Power Levers via the PCU. The FADEC at the same time maintains 660 RPM.

In Reverse mode, both FADEC and PCU are controlled by the Power Levers, increasing the propeller RPM and the Torque delivered to the propellers, until reaching the maximum reverse torque of 35%.

### 15.3.1. The Condition and Power Levers

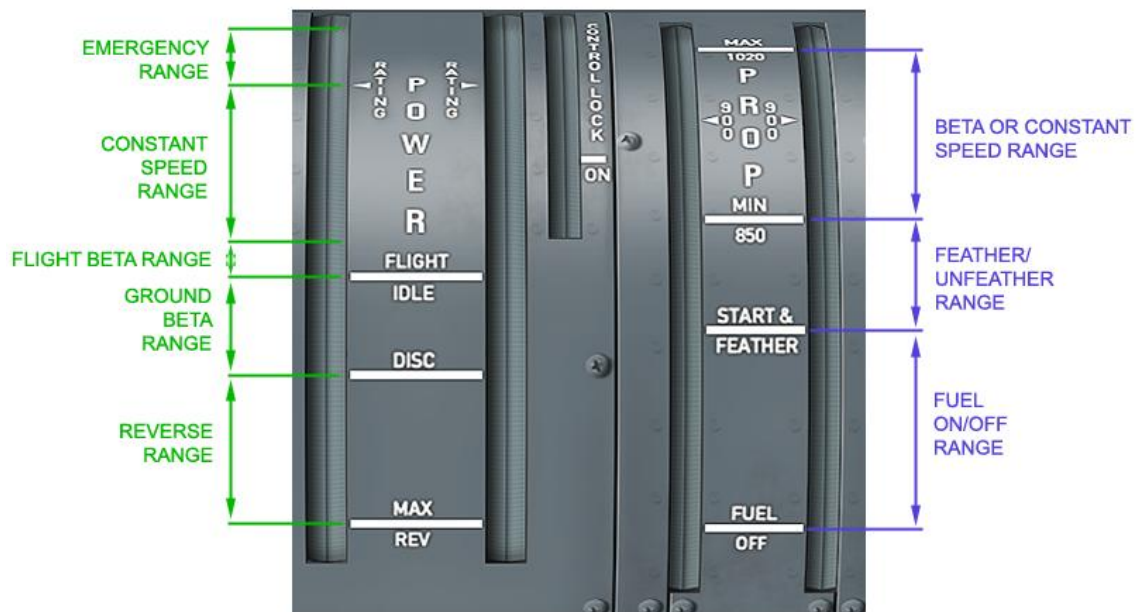


Figure 15.3.1. The Powerplant Controls

The Power Quadrant is the primary control for powerplants, and includes the following controls 2 condition levers one per engine, 2 power levers one per engine, and the Control Lock.

On the ground the control lock is selected ON in order to prevent inadvertent movement of the Power Lever beyond the usual taxi range.

Both Condition and Power levers are essentially the joystick inputs into the electronic control systems. It is these systems that will decide at the end how to operate both the engine and the propeller.

**The Power Lever** is a multifunctional control, meaning it is working differently depending upon the phase of flight and the range where the lever is placed.

The bottom most position, marked MAX REV is for the full reverse. This position is very rarely used, as the DISC position would already provide an acceptable reverse, moving the handle anywhere beyond that will create a discomfort for the passengers.

The range from DISC to FLT IDLE is used on the ground to precisely control the taxi thrust. The DISC position provides a slight negative thrust, similar to the firm braking action. It is therefore usual to taxi the Dash-8 with little, or no brake applications. The FLT IDLE position provides the maximum taxi thrust. This position is usually used to overcome the static friction and get the plane rolling. After that the DISC to half range of FLT IDLE is enough to maintain the desired speed.

The FLT IDLE to RATING positions are for the manual torque control. The control systems will then govern the engine and propellers to maintain the torque, proportional to the lever position. This range is used mainly for descend, approach and low altitude operations.

The RATING position is the detent position. When the lever is set to RATING, the engine and propeller control is automatic. The mode of the control can be set using the Condition Levers, and the engine control panel (see descriptions below). During a typical flight, the Power Levers are set to Detent position for takeoff, and left there until descend.

Maximum Takeoff Power is obtained by placing the Lever above the RATING detent. The engine is capable of providing the emergency power to recover from abnormal situations. The operating in this mode can cause irreparable damage to the engines and propellers, and therefore it should be avoided under the normal conditions.

**The condition lever** primary function is to control the propeller speed. The secondary functions are to control the mode of the powerplant automatic operation, and to give the FUEL ON/OFF commands.

The FUEL OFF to START&FEATHER position is the fuel enabling range. Placing the Condition Lever to START&FEATHER tells the FADEC that the fuel can be introduced into the engine. This should be done while starting the engine using the Engine Start Panel (see the description below). While the Condition Lever is in this position, when appropriate, the FADEC will introduce the fuel for the engine start, and the PCU will command the propeller feathered state.

The MIN/850 position of the lever is used to un-feather the propeller. When on the ground it also switches ON the “quiet taxi mode”, in which the control systems will not allow the propeller rpm increase for the reverse. At the same time, this position commands the Maximum Cruise Rating (MCR), which will standby until the power lever is placed in the detent position. The Propeller will maintain 850 RPM when in Flight.

The 900 position is a Detent, which in conjunction with the power lever Rating position will command the Maximum Climb Rating (MCL) and the propeller RPM of 900.

The MAX/1020 commands 1020 RPM to the propeller, and the Normal Takeoff Power (NTP) or Reduced Takeoff Power is commanded to the powerplant (see the Engine Control Panel description for more on these modes) when the Power Lever is placed in the Detent position. The MAX/1020 position also enables the Full Reverse operation, and is the position that should be used for takeoffs or the short field landings.

### 15.3.2. The Engine Control Panel

The Engine Control panel is located on the forward part of the pedestal, and is used to control the engine rating modes, program the reduced takeoff mode and the Reduced Np landing mode. It can also be used to Mark a particular event in the maintenance memory in order to direct the maintenance crew's attention to an abnormality in any system (*Event marker is not simulated in the PILOT or PRO editions*).



Figure 15.3.2.1. The Engine Control Panel

#### Rating Control:

**MTOp** button commands the Maximum allowed Takeoff Power to the engine. Pressing this button will force the FADEC to provide the maximum power available for the current temperature/altitude (maximum 100% Torque). In the normal situation this mode is used for Go ArounDs. Please note, the Condition Levers must be brought to MAX position first.

**RDC Np LDG** allows the aircraft to land with 850 propeller speed. For this mode to engage, the condition levers must be placed into the desired RPM mode (850), then the RDC Np LDG is pressed, and the condition levers are advanced to the MAX within 60 seconds time. The condition for entering this mode is that either Power Lever is below half travel range. If all set correctly, the PCU will maintain the lower propeller speed until aircraft is landed, or until the power levers are advanced for Go Around. Should this occur, the PCU will instantly command 1020 rpm to the propellers.

**MCL** button is used to override the Condition Lever commanded rating if it is set to 850 RPM position. In this case the MCL rating will be commanded with 850 RPM propeller speed (resulting in a quieter aircraft operation). Moving the Condition lever to any other position, or pressing MCR button will cancel the override.

**MCR** button is used to override the Condition Lever commanded rating if it is set to 900 RPM position. In this case the MCR rating will be commanded with 900 RPM propeller speed (resulting in a slightly higher airspeed). Moving the Condition lever to any other position, or pressing MCL button will cancel the override.

**RDC TOP** buttons are used to set the reduced takeoff power for the more comfortable takeoffs. First the Normal Takeoff Power is set by positioning the Condition Levers to MAX, than the DEC button is used to decrement the Takeoff Goal Torque (as seen on the Engine Display). Each push of the button reduces the torque by 2%. If desired the torque can be reset back to NTP by pressing the RESET button.

### 15.3.3. The Engine Start Panel

The Engine Start panel is used to start the engines and control the igniters.



Figure 15.3.3.1. Engine Start Panel

Each engine contains two pairs of igniters, that are operating alternatively for each next flight. The igniters are enabled by selecting the IGNITION knobs to the NORM position. After that, the desired engine is selected with the SELECT switch and the START switchlight is pressed.

The engine start is always battery-assisted, therefore a sufficient charge must remain in the batteries for the engine start to succeed.

The yellow SELECT will illuminate over the start switchlight when the engine is selected, and the yellow START appears over the bottom part of the button to indicate that the engine start is in progress.

Immediately after the starter indication appears, the fuel can be selected to the engine using the Condition Lever. The timing of the fuel selection is not important, as FADEC will defer the fuel supply to the engine anyway, until  $N_h$  reaches the pre-defined value.

During the engine start, the DC Generator reverses its function and becomes a starter. The starter mode of the DC Generator is maintained while the engine is selected using the Select Switch. At 50% N<sub>H</sub> the switch will trip automatically to neutral, the starter will disengage and the engine will continue spooling up on its own until the engine start cycle is completed. The SELECT light will be removed shortly thereafter, indicating the engine start cycle has completed.

When the battery start is attempted, and the #1 engine has to be started first, the BUS TIE electrical switch must be selected prior to the start. It is recommended that after an engine is started, it is unfeathered in order to augment the electrics for the start of the opposite engine.

### 15.3.4. The Propeller Control Panel

The Propeller Control Panel controls the propeller feathering systems



Figure 15.3.4.1. The Propeller Control Panel

As it is extremely dangerous for a propeller to be left un-feathered in a case of the engine failure, the propeller system incorporates several ways to feather the propellers.

The propeller can be feathered by:

- Manually placing the Condition Lever anywhere below the MIN position
- By the Autofeather, if an engine failure is detected
- By the Alternate Feather in the case of the propeller pitch control failure
- Mechanically, the propeller will enter the feathered state on its own, in the case of a pressure drop in the oil system, that controls the propeller pitch

In the normal conditions, only the Autofeather requires the pilot's attention. When selected by pressing the Autofeather button, the SELECT switch light will indicate the readiness of the autofeather system. During the takeoff, when the TRQ above 50% is registered on both engines, the autofeather will enter the

ARM mode (as indicated on the engine page). From this point on, the autofeather system monitors the Torque on both engines, and will initiate the propeller feathering should it detect that the engine has failed. At the same time a signal to the FADECs will be sent to bring the failed engine into the IDLE mode, and the opposite engine to UPTRIM mode, thus providing the extra power to compensate for the loss of thrust. Such setup will be maintained until the pilot manually disengages the Autofeather by pushing the Autofeather button. Prior for doing so, the condition lever for the affected prop must be placed in the START&FEATHER position to avoid the sudden prop spoolup.

If desired, the engine start can be attempted in the air, after which successful or not, the flight should be terminated as soon as possible.

If it becomes necessary to manually feather the prop, and no oil pressure exists in the main propeller pitch control system to feather the propeller using the condition lever, the Alternate Feather guarded buttons can be used to activate the propeller alternate feather. This system utilizes the extra accumulators (one per propeller) that maintain sufficient oil quantity to feather the propeller several times, until the accumulators become depleted.



## 15.4. The Powerplant indications

The most of the Powerplant related information is indicated on the Engine Display EFIS screen.

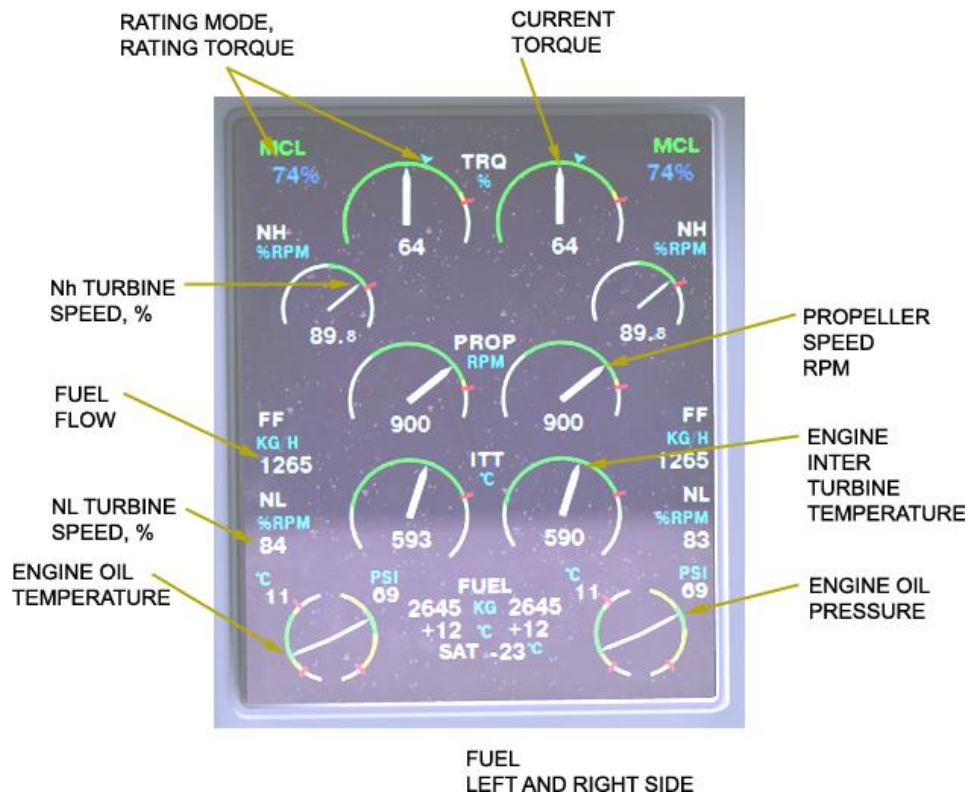


Figure 15.4.1. The Powerplant display

There is also a simplified engine page which can be selected as a system page on each MFD. The indication on the simplified engine page is the same as on the main engine page, except all readout are digital.

## NORMAL OPERATION:

The engine is started by selecting the desired (usually #2) side on the engine start panel, pressing the START switch and selecting the Condition Lever to START&FEATHER position. The Oil Pressure and the ITT should be monitored during the engine start, to ensure the values don't exceed their respective normal ranges. After the SELECT light extinguishes on the start switchlight, the other engine can be started.

Upon the engine start, and before the taxi, the Condition Levers must be advanced to the MIN or MAX positions for the propeller to un-feather. After this the taxi can be initiated.

Before the takeoff, the Condition Levers are selected to the MAX position, and the reduced power mode (also called de-rated mode) can be set for a more comfortable takeoff acceleration, if the runway length and conditions allow for the longer takeoff run. In such case, the bleed switches on the Aircondition panel can be left in the ON position, otherwise if Normal Takeoff Power is used, the bleeds must be switched OFF for the duration of the takeoff. Just prior to the takeoff the Control Lock must be de-selected, and the Power Levers advanced to the RATING detent position.

After the takeoff, and upon passing the safe altitude, the Condition Levers are typically selected to the 900 RPM detent position, switching the Powerplant Control System to the MCL (maximum climb) mode. Also the bleeds are typically enabled at this point, if they were OFF for the takeoff. Upon reaching the cruise altitude, the MCR rating is set by placing the Condition Levers to the MIN position.

*The MCR position does not guarantee that the airplane speed will not exceed the  $V_{ne}$ . It is the responsibility of the pilot to monitor the Airspeed at all times, and manually reduce the Power Levers angle to maintain the safe speed. This is particularly true for the cruise altitudes below FL200-FL220.*

For the approach, a decision should be made if the landing has to be with MAX propeller speed or the Reduced Np Mode. In the last case, the reduced Np mode can be initiated by pushing the Reduced Np button on the control panel while the Power Levers position is below 50% and the propeller speed is less than MAX. After that within 50 seconds the Condition Levers must be advanced to the MAX position. From now on, the Propeller Control System will monitor the Power Levers position, and automatically spool up the propellers to MAX rpm if a position of 50% or more is set by a pilot (which would indicate to the system that there is a possible Go Around in progress).

After the landing, the Control Lock must be selected ON, and the Condition Lever can be set to MIN to initiate the quiet taxi mode. It is also possible to taxi the airplane on a single engine, thus saving some extra fuel.

When on parking, all the non-essential electrical equipment must be switched OFF after which the propellers can be feathered. The propellers are generally remain feathered (providing the limited DC power) until the APU is started, or the GPU becomes available. After the APU or GPU is connected, the engine can be shut down by placing both Condition Levers to the OFF position.

For the rapid operations it is also possible to maintain the #2 engine running in the feathering state, while the passengers disembark, providing the safety precautions are made to prohibit access to the propeller.

## 16. Navigation

This airplane is equipped with sufficient navigation equipment to operate under the VFR and IFR conditions. The navigational equipment includes:

- Two VOR/ILS receivers
- Two DME receivers
- Two ADF receivers
- Two Marker receivers
- Two Mode-S ATC Receivers-Transmitters
- Two Flight Management Systems (FMSs)
- Traffic Collision Avoidance System (TCAS)
- Enhanced Ground Proximity Warning System (EGPWS)
- Weather Radar

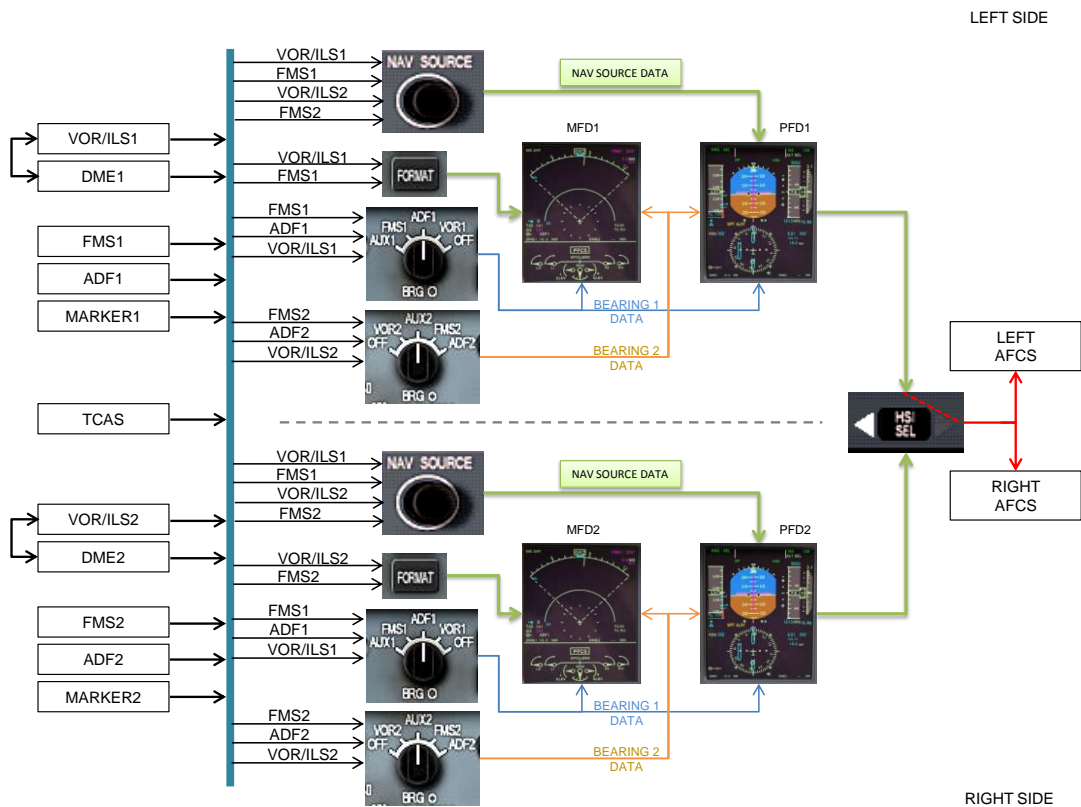


Figure 16.1. Navigation sources switching logic

## 16.1. The Navigational Sources

The Radio Navigation is controlled by the ARCDU units (See the article on ARCDU for more information) and the left and right EFCP panels (described in the Electronic Instruments System article).

All the navigational data in the airplane, (except for the bearings) is presented to the pilots in a form of Navigational Sources (See Figure 16.1.). The Navigational Source may include all or some of the following data (See Figure 16.1.1.):

- Horizontal Deviation (Needle)
- From/To Indicator
- Vertical Deviation (Needle)
- Distance from Source
- OBS Course
- VOR/ILS Frequency

The pilot selects the navigation source for the PFD using the NAV SOURCE knob on the glareshield, and for the MFD in the NAV mode by pressing and holding the FORMAT button on the EFIS control panel.

If desired, the navigational data from the left or right PFD can then be used to drive the Automated Flight Guidance System.

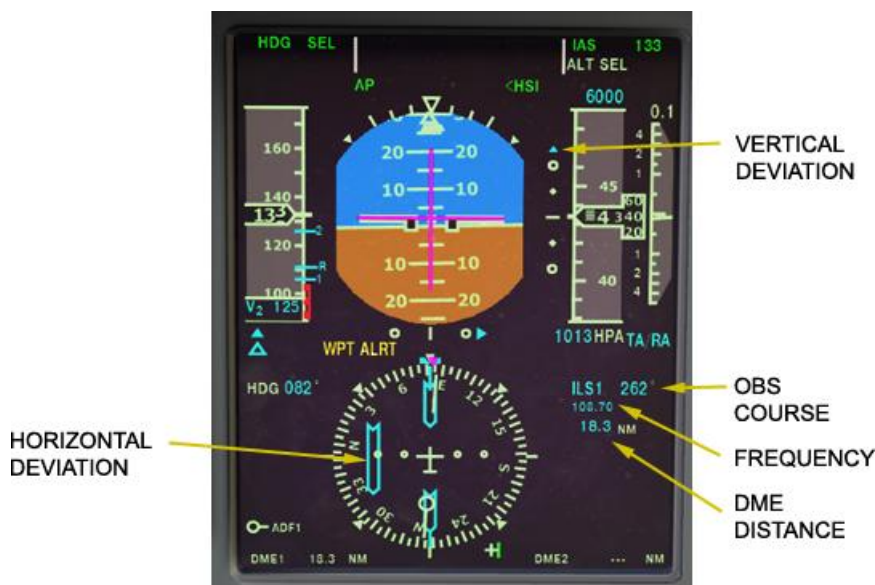


Figure 16.1.1. Representation of a navigation source on the PFD.

## 16.2. VOR/ILS/DME receivers: DME hold function.

The VOR/ILS and the DME receivers are the separate units and when needed, and although they are usually receive on the same frequency (DME1=VOR/ILS1, DME2=VOR2/ILS2), they can work de-coupled if desired. This function is called a DME HOLD function, and is accessible from the ARCDU

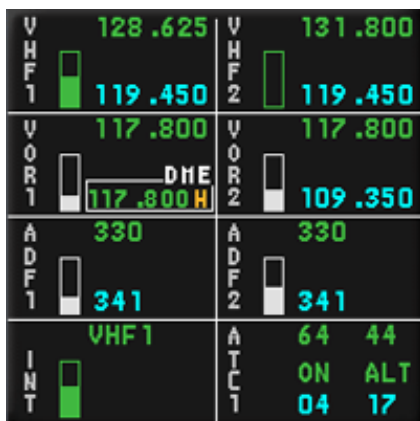


Figure 16.2.1. ARCDU VOR1 entry in the DME HOLD mode

When the desired frequency is tuned into the VOR/ILS receiver, press the DME HOLD button. The ARCDU will draw the rectangle around the current frequency, indicating it is programmed and locked into the DME receiver. After this, the frequency for the VOR will be affect directly by turning the tuning knob, with the DME tuning staying un-changed. The yellow H will indicate on the PFD and MFD DME indication, showing that the DME is de-coupled.

### 16.3. The ADF receivers

Two ADF receiver assemblies are installed on the airplane.

The ADF receivers can be operated from the ADF expanded ARCDU page:



Figure 16.3.1. The ADF expanded page

The ADF receiver can operate in the 0.5 or 1 kHz mode.

If the ANT mode is activated, the bearing information will not be available, however the ADF signal will be heard on a further distance from the NDB than it would in the ADF mode.

The TEST function allows testing of the receiver. During the test watch the ADF bearing (must be selected on the EFCP first) appearing and turning right to a 90° relative bearing, then disappearing as test ends.

The BFO mode allows the pilots to hear the NDBs with non-modulated signals.

## 16.4. The Marker Receivers

The airplane is received with two marker receivers, providing the Outer, Middle and Inner marker signal to the EFIS. The Marker data can be heard if the Marker audio level is active and set to non-zero at the ARCDU, and seen on the PFD.



Figure 16.3.1. The Marker Indication

The Marker Receivers can also be tested from the ARCDU expanded VOR page, by pressing the LSK adjacent to MKR TEST.



Figure 16.3.2. The Marker Test Function on ARCDU

The Marker signal for OM, MM and IM will be simulated, heard and shown on the PFD in sequence.

When required, the MKR SENSE selection allows for increase the sensitivity of the marker receivers. Please note that the LO setting is the standard sensitivity setting.



## 16.5. Mode S ATC receivers/transmitters

The aircraft is equipped with 2 mode S ATC receiver/transmitters, however only one receiver/transmitter can be operated at any given time.

The ATC assemblies are used for two purposes:

- To report the airplane position to the ATC and the surrounding traffic
- To interrogate the surrounding traffic for the Traffic Collision Avoidance (TCAS) purpose. The TCAS system will be described in more details further down in the TCAS section.

TCAS/ATC		TEST
REL		
ABS		
ABOVE		ALT 1
NORM		OFF
BELOW		ALT 2
TA/RA		ATC 1
TA ONLY		SBY
SBY		ATC 2
VHF 1	ATC 1	64 44
INT		ON ALT
		04 17

Figure 16.5.1. The expanded ATC page on the ARCDU

The ATC transponder section is conveniently located in the right bottom corner of all the ARCDU pages (Figure 16.5.1). The transponder code can be set here in the same way, used by setting the receivers frequencies: by first highlighting the standby transponder frequency then selecting the desired code and pressing the LSK R4 once again to make that setting active.

The transponder mode can be controlled with a long press of the LSK R4 button. When the button is pushed and hold for more than 2 seconds, the active transponder will change from ON ALT to STBY mode, and vice versa. Please note, that there is no “Alpha” mode for the transponders.

The active transponder is selected using the R3 LSK. The altitude source (ADC1 or ADC2 computer) can be set in the R2 LSK section in the case of an ADC failure.

The rest of the functions on this page will be described in the TCAS section below.

## 16.6. Traffic Collision Avoidance System (TCAS)

The TCAS system installed on this airplane is compliant with ICAO ACAS II / TCAS II standard, and utilizes for its function the ATC transponders as well as a special computer module, running a custom developed interrogation and thread detection software.

The TCAS system is connected to various other aircraft systems, and communicates its outputs to the MFD and the flight instruments (PFD).

The system serves the following purposes

- To increase the awareness of the crew about the surrounding traffic
- Identify the threatening traffic, and provide the vertical guidance to the pilot in order to avoid the collision

## 16.6.1. The TCAS control page on the ARCDU

The TCAS is controlled from the ARCDU ATC page.

TCAS/ATC		TEST	
REL			
ABS			
ABOVE		ALT 1	
NORM		OFF	
BELOW		ALT 2	
TA/RA		ATC 1	
TA ONLY		SBY	
SBY		ATC 2	
VHF 1		64	44
INT		ON	ALT
		04	17

Figure 16.6.1. ARCDU ATC Page

The REL/ABS changes the way the traffic altitude is presented. Pressing the LSK adjacent to REL/ABS section will change the TCAS mode to Absolute (MSL) altitude indication for roughly 1 minute, after that the system will go back to the REL mode.

The ABOVE/NORM/BELOW defines the vertical range within which the TCAS traffic will be indicated on the MFD. The relative altitude settings are as follows:

ABOVE	between -2700 ft and +8700 ft AMSL
NORM	within +/- 2700 ft AMSL
BELOW	between -8700 and +2700 ft AMSL

TCAS mode can be set with the L3 LSK.

In the Standby mode no traffic interrogation will be performed by the TCAS

In the TA mode, the TCAS system will not issue any resolution advisories, and

In the TA/RA mode both Traffic and Resolution advisories will be given.

Please note, that in the proximity of the ground the TCAS will automatically inhibit the resolution advisory/traffic advisory in order not to distract the pilot during the final approach phase.



Pressing the LSK adjacent to TEST will begin the TCAS system test. During the test 4 different traffic patterns will be observed on the MFD, and a traffic resolution advisory shown on the PFD. There will be no visual warning. After the test is concluded, the test result will be announced audibly as “TCAS TEST OK” or “TCAS TEST FAIL”. Please note, that this test is inhibited in the air.

## 16.6.2. The TCAS related EFIS annunciations

The TCAS has two modes of traffic indication on the MFD

1. Normal mode. This mode is indicated by “TCAS TA/RA”. In this mode the non-threat TCAS traffic is indicated on the MFD whenever the range is set to 40NM or lower.
2. AUTO mode. This mode can be manually enabled by pressing the “TCAS” button on the EFCP panel and will hide the non-threat traffic from view.

In any mode, whenever TCAS generates a Traffic (TA) or Resolution (RA) advisory, the MFD range will automatically be forced to 10NM, and the threatening traffic will be shown to the pilot.

After the TCAS advisory is ceased, the normal MFD range can be restored to its by recycling the MFD range switch.



Figure 16.6.2.1. TCAS related indication on the MFD

The TCAS traffic on the MFD is color coded, and represents:

- Type of traffic
- Relative or Absolute altitude in x100ft units
- Altitude trend of the traffic (Climbing or Descending)

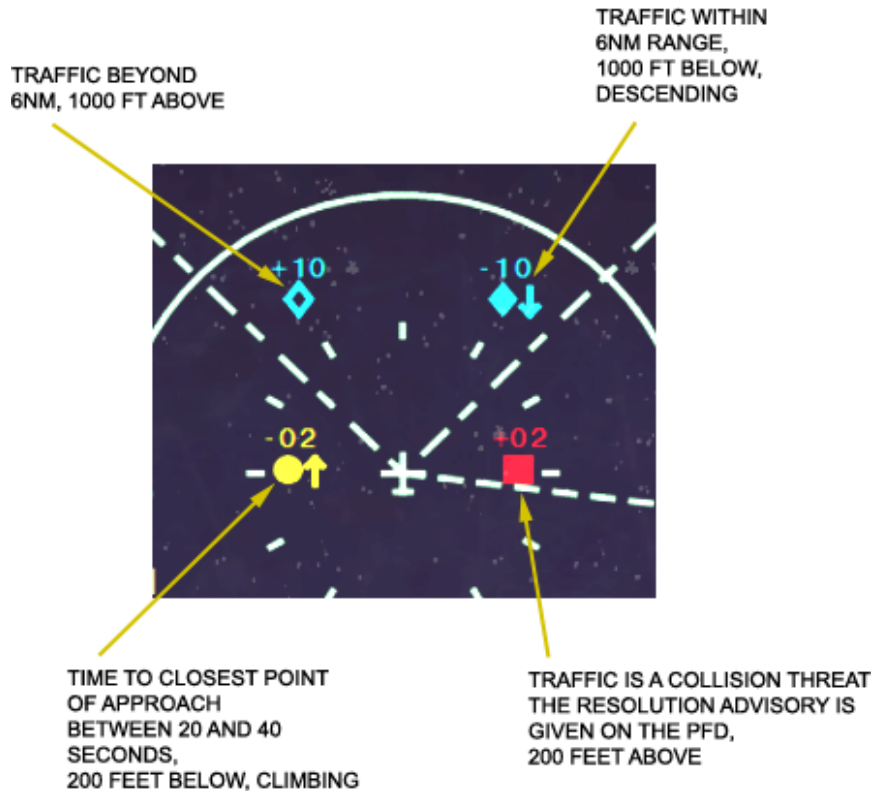


Figure 16.6.2.2. TCAS traffic color coding

During a resolution advisory, the Vertical Speed Tape is used to show the pilot the NO-FLY zones in Red color, as well as the suggested vertical speed in Green, as shown at the picture below. Whenever the vertical speed is in the Red zone, the arrow itself will be presented in Red.



Figure 16.6.2.3. The Resolution Advisory indication on the PFD.

In addition to the VS tape, an audible advisory is given to the pilots. The TCAS will then expect the pilot to start following the advisory within next 40 seconds.

The types of advisories, given by the TCAS:

“TRAFFIC, TRAFFIC”	Monitor the traffic, displayed on the MFD. A Resolution Advisory might follow shortly
“CLIMB, CLIMB”	Climb at rate shown on the green arc of the IVSI / PFD
“DESCEND, DESCEND”	Descend at rate shown on the green arc of the IVSI / PFD
“ADJUST VERTICAL SPEED, ADJUST”	Adjust rate of descent or climb to that shown on IVSI / PFD
“MONITOR VERTICAL SPEED”	Monitor present vertical speed to prevent entering restricted red arc speed
“CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB”	Safe separation will be best achieved by climbing through the intruder’s flight path.
“DESCEND, CROSSING, DESCEND, DESCEND, CROSSING DESCEND”	Safe separation will best be achieved by descending through the intruder’s flight path.
“MAINTAIN VERTICAL SPEED, MAINTAIN”	Maintain present vertical speed to prevent entering restricted red arc speed
“MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN”	Maintain present vertical speed to prevent entering restricted red arc speed. Indicates that own flight path will cross that of intruder.
“CLEAR OF CONFLICT”	Range is increasing and separation is adequate; return to previous ATC assigned altitude.

The advisories announced, if the initial RA did not provide sufficient vertical separation:

“INCREASE CLIMB, INCREASE CLIMB”, (received after “CLIMB” advisory)	Maintain present vertical speed to prevent entering restricted red arc speed. Indicates that own flight path will cross that of intruder
“INCREASE DESCENT, INCREASE DESCENT” (received after “DESCEND” advisory)	Additional descent rate is required
“CLIMB-CLIMB NOW, CLIMB-CLIMB NOW” (received after “DESCEND” advisory)	A reversal from a descent to a climb condition is required to provide adequate vertical separation

## 16.7. Enhanced Ground Proximity Warning System (EGPWS)

The Enhanced Ground Proximity Warning System (in short EGPWS) monitors the flight path of the airplane within the radio altitudes of 50 to 2450 feet. Should an unusual or inconsistent with current airplane configuration flight profile been detected, an audible and visual warnings will be given to the pilot.

The GPWS system has a number of controls associated with it.

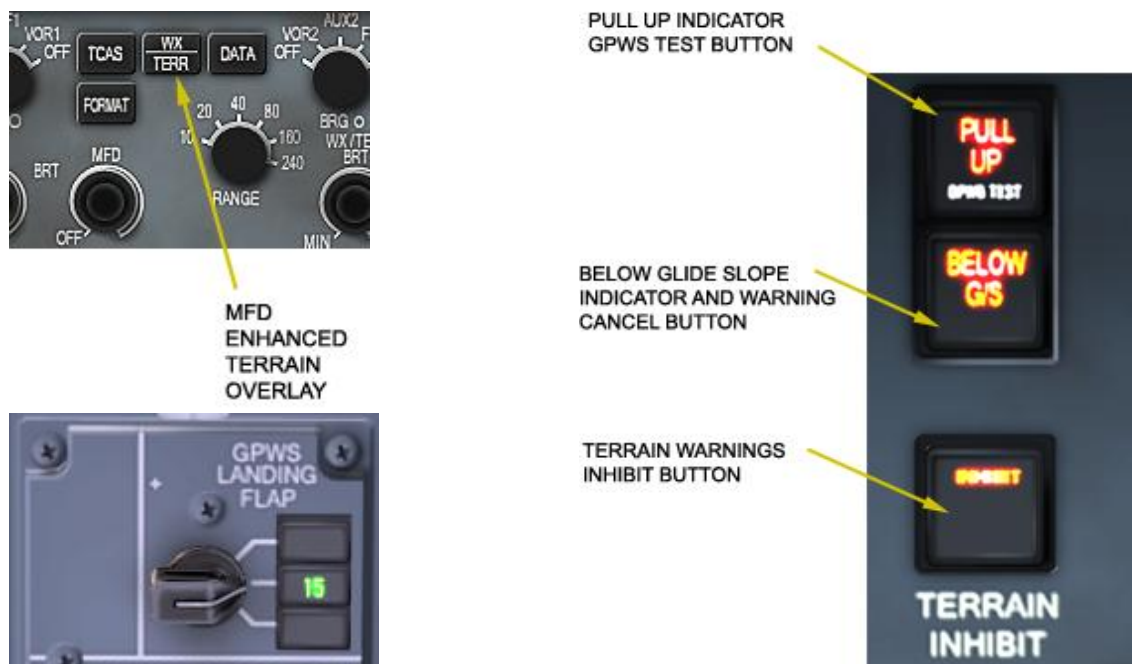


Figure 16.7.1. EGPWS controls

The EGPWS terrain output can be overlaid over the MFD picture by pressing the WX/TERR button on the EFCP. The button alternates between WX and TERRAIN overlays. Pressing and holding the button for 2 or more seconds will remove all overlay output from the respective MFD. The Overlay brightness can be controlled using the WX/TERR BRT knob located on the same panel.

The GPWS LANDING FLAP is used to program the desired landing flap setting into the EGPWS. The system will monitor the approach, and issue a warning should the flaps position in the final approach be not equal to this pre-set.

There are 3 more EGPWS related switchlights located on the glareshield (one set at each pilots side).



The Top button called “GPWS TEST” is used to test the system. The test will flash the lights and issue the number of the audio advisories. The number of advisories and the length of the test differ on the ground and in the air.

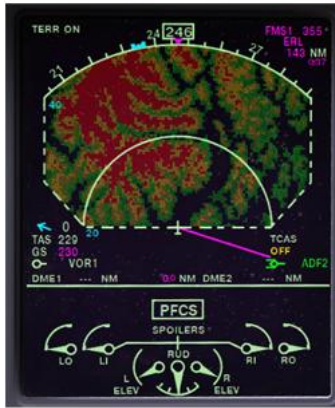
The Below G/S switchlight will indicate should the airplane descend below the glide on the final approach. In certain cases the warning can be cancelled by pressing the switchlight.

Pressing the TERRAIN INHIBIT will remove the EGPWS terrain indication from the MFD, and prevent the system from issuing the terrain-related warnings. INHIBIT light will indicate over the switchlight until the inhibit function is deactivated by the pilot.

### 16.7.1. The EGPWS Terrain overlay

Pressing the WX/TERR button (Figure 16.8.1.9) will bring up the enhanced terrain display on the MFD

NORMAL MODE



PEAK MODE

LOWEST ELEVATION x100 FT  
HIGHEST ELEVATION x100 FT



- SOLID RED** - TERRAIN THREAT AREA - WARNING
- SOLID YELLOW** - TERRAIN THREAT AREA - CAUTION
- 50% RED** - TERRAIN >2000 FT ABOVE A/C ALTITUDE
- 50% YELLOW** - TERRAIN BETWEEN 1000 AND 2000 FT ABOVE A/C ALTITUDE
- 25% YELLOW** - TERRAIN BETWEEN 500 (250 WITH GEAR DOWN) AND 1000 FT ABOVE A/C ALTITUDE
- SOLID GREEN** - HIGHEST TERRAIN NOT WITHIN 500 (250 WITH GEAR DOWN) OF THE A/C ALTITUDE
- 50% GREEN** - TERRAIN BETWEEN 500 (250 WITH GEAR DOWN) AND 1000 FT BELOW A/C ALTITUDE
- 16% GREEN** - TERRAIN BETWEEN 1000 AND 2000 FT BELOW A/C ALTITUDE
- BLACK** - NO SIGNIFICANT TERRAIN
- CYAN** - 0 FEET MSL TERRAIN OR KNOWN WATER BODIES

- SOLID GREEN** - HIGHEST TERRAIN NOT WITHIN 500 (250 WITH GEAR DOWN) OF THE A/C ALTITUDE
- 50% GREEN** - TERRAIN IN THE MIDDLE OF THE ELEVATION RANGE
- BLACK** - NO SIGNIFICANT TERRAIN
- CYAN** - 0 FEET MSL TERRAIN OR KNOWN WATER BODIES

Figure 16.7.1.1. MFD Enhanced Elevation Overlay

There are 2 modes in which the enhanced elevation can be presented. Standard (Normal) and Standard+Peak. In the standard mode, all the elevation levels are relative to the plane altitude. In the Standard+Peak, gradations of green indicate the absolute terrain levels under the aircraft, with the lowest and highest elevation in range digitally shown (right side of the Figure 16.8.1.1.)

## 16.7.2. The EGPWS Warnings

The EGPWS generates audible and visual warnings based on the plane altitude, rate of climb, airspeed, configuration and the relative position to the surrounding elevation.

The following table summarizes the warnings, given by the EGPWS

“SINK RATE”	The sink rate is excessive for the given airplane configuration. Correct the sink rate
“WHOOOP WHOOOP, PULL UP”	A rapid action of the pilot is required to lower the descend rate, or to climb out of the dangerous condition. Pull up on the column
“TERRAIN TERRAIN”, “CAUTION, TERRAIN”	Faster than normal terrain closure. Monitor the level of terrain and prepare to follow the further advisories.
“DON’T SINK”	An abnormal descend is detected after takeoff. Correct the vertical speed
“TOO LOW, GEAR”	The airplane configuration is incomplete; the flight envelope is abnormal with gear retracted. Extend Gear.
“TOO LOW, TERRAIN”	The airspeed is too high, or the altitude is too low for the airplane configuration
“TOO LOW, FLAPS”	The landing configuration is assumed, but the flaps setting is not in the GPWS FLAPS SELECTOR set position. Adjust the flaps or the selector (if set in error).
“GLIDESLOPE”	Airplane is in final approach, and below the glideslope. Adjust the descend rate to re-capture the glide slope.
“BANK ANGLE”	Excessive bank angle is detected.
“MINIMUMS, MINIMUMS”	Airplane has reached the pre-selected Decision Height
Altitude callouts: 2500, 1000, 500, +100 (100 above DH), 50,40,30,20,10	The altitude callouts will only be given if a Decision Height has been selected.

## 16.8. Weather Radar (WXR)

The weather radar system uses microwave beam to detect the thunderstorms and the rain, and provide the weather awareness to the pilots.

Please note, that the weather radar does not detect the clouds directly, rather it judges about the weather ahead by the amount of microwaves, reflected by the water bodies.

The Weather Radar is controlled from the Weather Radar Control panel



Figure 16.8.1. Weather Radar Control Panel

The Weather Radar mode is controlled with the mode knob located on the left top corner. The WXR system can be found in the following modes:

- |             |  |
|-------------|--|
| <b>OFF</b>  | The system is unpowered  |
| <b>STBY</b> | The system is allowed to warm up, but no radiation is emitted  |
| <b>TST</b>  | The WXR assembly and the MFD Overlay is tested, the test pattern showing different weather intensity sectors is presented on the MFD |
| <b>ON</b>   | The radar is operational, the radiation is being emitted.  |

The GAIN knob is used in the Ground Map mode in order to attenuate the ground returns. The TILT knob will change the tilt of the antenna in order to “highlight” the weather higher or lower than that found at the aircraft altitude.

Wx button puts the WXR into the default WX mode. No automated warnings are given in this mode. If alert have been detected, the threatening weather will be flashing on the MFD in magenta once per second.

WxA button allows the WXR to automatically monitor the weather, and give the pilots weather alert (displayed on the top left of the MFD) should the weather in front of the aircraft deteriorate to a pre-defined point.

GND MAP button switches the WXR from weather to the ground mapping.

Please note, that there can still be visible weather returns when WXR is in the ground mode, or the ground returns, when in the Wx (WxA) mode. Although the WXR processor will attempt to filter the undesirable information, there can still be the false returns the pilot should be aware of.

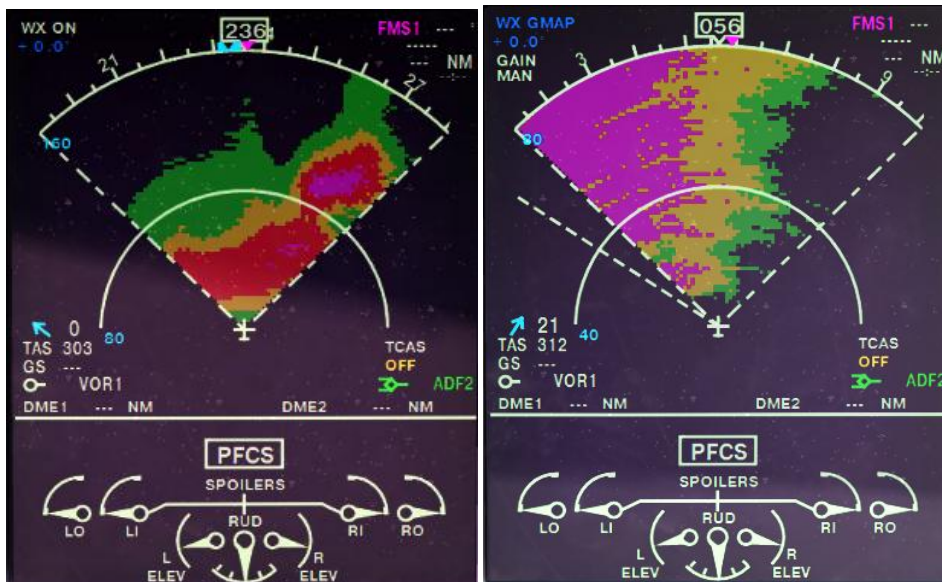


Figure 16.8.2. Weather returns and Ground Map representations

The color representation of the weather returns on the MFD is as follows

- Magenta Most intense, severe weather
- Red Thunderstorms
- Yellow Area of the heavy rain
- Green Area of the mild rain

The ground returns are color coded as follows

- Magenta Highest return
- Yellow Medium return
- Green weakest return

It is the pilots responsibility to interpret the Radar returns by taking in account all of the available weather related information.

## 16.9. Flight Management Systems (FMS)

There are two Flight Management Systems in this airplane. Each system consists of the following components

- Flight Management Computer
- Multifunctional Display Unit (MCDU)
- GPS Receiver
- Interface module

In addition, both Flight management Computers are using the speed data from a single Inertial Reference System (IRS).

The Flight Management System of this addon is programmed after a Universal UNS1E FMS, and can provide the following functionality:

- Vertical and Lateral navigation
- Situation awareness
- Flight planning and Fuel Management
- Control of the environment (Announcements, Music and ground Services)

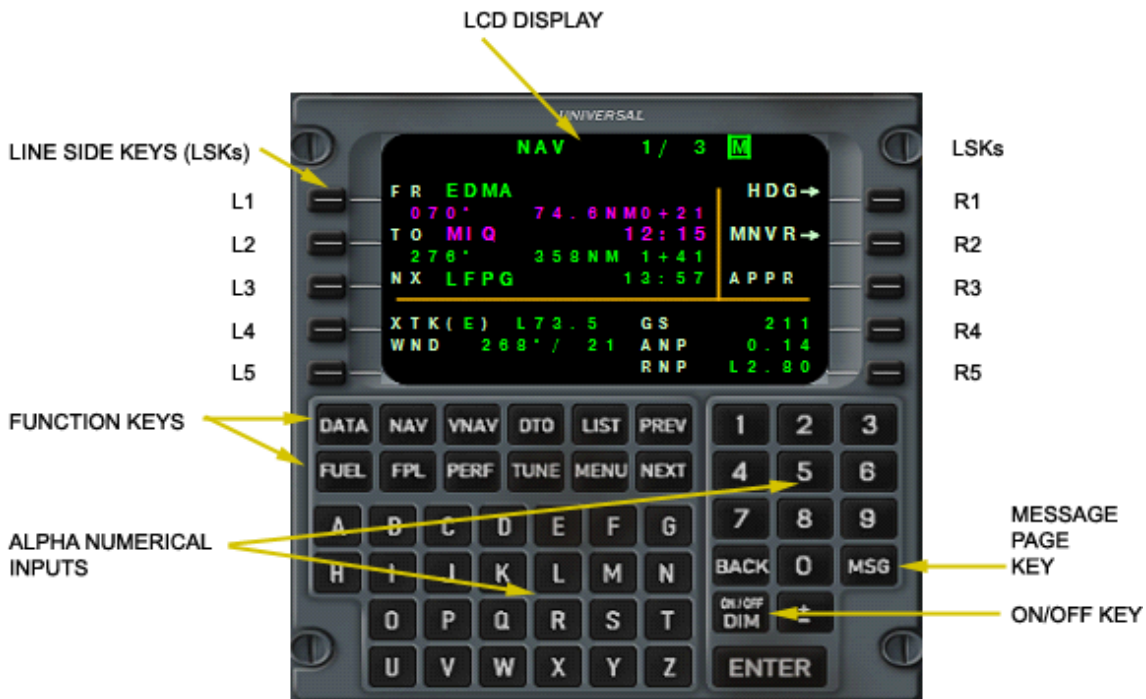


Figure 16.9.1. MCDU Display

## 16.9.1. Sensors and Navigational Performance

This Flight Management System is programmed to operate under the concept of the Required Navigational Performance (RNP)

The RNP based navigation is defined as such that accounts for the minimum navigational performance or accuracy, expressed in the Nautical Miles, required for each of the phase of flight.

The phases of flight are defined as

Phase of flight	RNP	Time to alarm
Enroute	2.0 nm	27 sec
Terminal	1.0 nm	7 sec
Approach	0.3 nm	7 sec
Oceanic	6.0 nm	27 sec

The current navigational performance provided by the FMS is called the “Actual Navigational Performance” or ANP.

Should the ANP for a given phase of flight exceed the RNP, the alarm will be given to the pilot after the “Time to Alarm”, set for the particular phase of flight has elapsed.

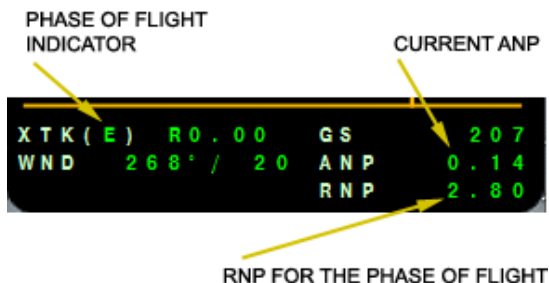


Figure 16.9.1.1. RNP and ANP indication

The Phase of Flight indicated by the FMS as follows (see Figure 16.9.1.1. above)

E: Enroute, T: Terminal, A: Approach, O: Oceanic

The FMS is using the following sensor information to identify the aircraft position:

- GPS data
- VOR and DME data
- IRS speeds

The left FMS is using the GPS1, and the right one - GPS2. In addition, each FMS also receives the opposite side data for comparison.

The GPS constantly monitors its performance (Receiver Autonomous Integrity Monitoring, or RAIM) and will exclude any satellites with non-reliable signals. The degraded performance is then output as the RAIM status, which is directly related to the ANP. The RAIM can change as a result of the weather and terrain factors. The FMS can estimate and show to the pilots the RAIM status preview for the various stages of flight (TRAINING EDITION ONLY).

The Sensors status can be monitored on the Data page 2

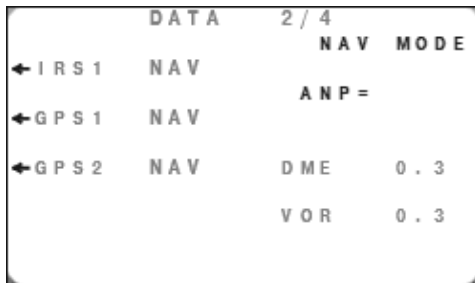


Figure 16.9.1.2. Sensor Status Page

The Inertial Reference System constantly supplies the speeds and is used in a dead reckoning mode by the FMS when no other navigational source is available, or there is a degraded GPS performance.



Figure 16.9.1.3. IRS Panel



The Inertial Reference System control panel is located just behind the left ARCDU on the central console, and allows for the manual re-initialization of the IRS in flight or on the ground.

**IRS operation:**

Usually, no manual output is required to operate the IRS. However if need arises, the system can be re-aligned in the air or on the ground by placing the IRS Mode Switch to OFF for more than 5 seconds, then returning it back to the NAV position.

The re-alignment of the IRS takes 30 seconds in the air, and 10 minutes when on the ground.

## 16.9.2. Direct To Navigation

The easiest way to use the FMS is the direct To function.

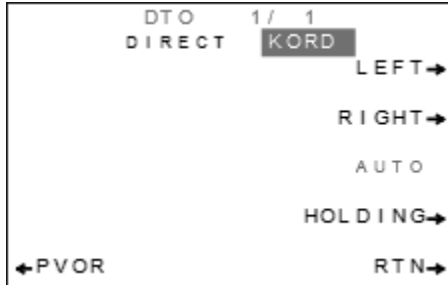


Figure 16.9.2.1. DTO Page

The DTO page is accessed by pressing the DTO function key on the MCDU. The cursor will be positioned adjacent to the DIRECT text, and the manual waypoint entry can be made.

If a particular turn direction towards the waypoint is desired (for example, as a result of the ATC instruction, TURN LEFT/RIGHT TOWARDS XXXX), press the LSK adjacent to LEFT or RIGHT. Provided the Autopilot is already in the LNAV mode, and is engaged, the aircraft will immediately commence the turn towards the waypoint, once it is confirmed.

If more than one waypoint exists in the flight plan, the waypoints will be listed at the Direct To page, and the waypoint can be selected by its reference number. In this case, the aircraft will proceed to the selected waypoint, and the subsequent waypoint (if any) will be automatically linked as Next (See the Flight Plan section for more details)

Another two options that Direct To can be used with, are Direct To PVOR and Direct To HOLDING. These options will be described further in the “Maneuvers” section.

### 16.9.3. NAV Page

Understanding the NAV page is essential in order to utilize the rest of the FMS functionality that is described in the subsequent sections.

NAV 1 / 3				M MSG
FR EDDM				HDG→
327°	72.9NM	+16		
TO MIQ			11:36	MNVR→
269°	18.6NM	+04		
NX WLD			11:40	APPR
<hr/>				
XTK(E)	R24.2	GS		262
WND	357° / 0	ANP		0.14
		RNP		R2.80

Figure 16.9.3.1. NAV Page

The Navigation Page shows what the FMS is actually doing at this moment. The idea is that the Nav function of the FMS, the data for which is shown on this page can take its inputs from multiple other FMS functions (such as Flight Plan or Direct To), but once the data has been copied into the NAV function, its operation is no longer directly dependant on the source for this data. For example, on the page above the FMS flies a Great Circle leg from EDDM to MIQ waypoint, and will take the next waypoint called “WLD” from the flight plan, once it reached the MIQ.

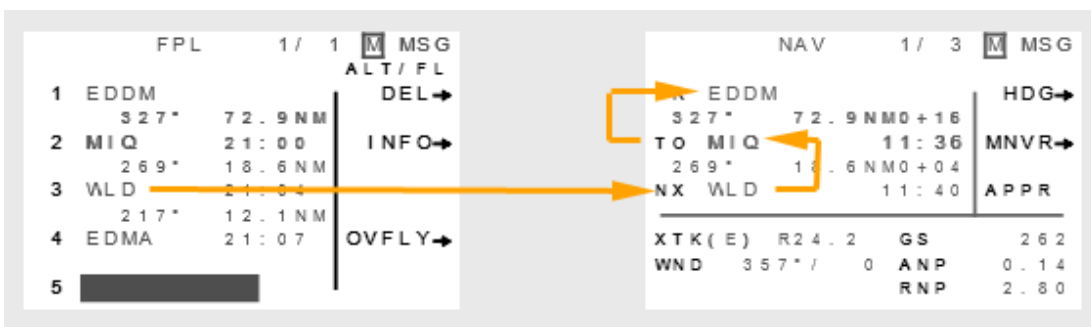


Figure 16.9.3.2. Data flow between Flight Plan and the NAV page

The waypoints FR and TO define the leg the FMS flies at this moment, and can be entered either by:

Directly typing the desired name in, and pressing the <ENTER>, or

By selecting a leg from a flight plan, by typing the leg sequential number.

Once those waypoints were copied from the flight plan, they are no longer dependant on it. For example, would a pilot would erase EDDM or MIQ from the flight plan, they will be left unchanged at the NAV page.

The NX (next) entry is the only link between the Flight Plan and the Nav Function. The waypoint shown here is a link to the Flight Plan, and will disappear if one would erase it from the Flight Plan.

Once however the Next becomes the To waypoint, it also becomes an independent instance of that waypoint, which will stay there regardless of the flight plan changes.

It is important to remember, than after the FROM and TO waypoints are defined, the manual changes made to the flight plan will not affect them. To get the FMS to fly the new/updated flight plan, press the LSKs adjacent to FROM and TO entries on the NAV page, and manually select the appropriate waypoints from the flight plan. Once the waypoints are defined and the correct NEXT waypoint is indicated on the NAV page, the navigation will be linked to the new/updated flight plan.

Once the NAV function runs out of waypoints to fly, the current leg will be extended and the “CURRENT LEG EXTENDED” message will be generated on the Message page.

The page also shows the navigational status as follows:

- **XTK** Cross Track Error, as a nearest distance from the desired course line to the aircraft position
- **E or W** (shown after XTK) Is the code letter for the navigational precision: E for Enroute, T for Terminal, A for Approach
- **WND** Wind in degrees magnetic, knots
- **GS** Ground Speed is knots
- **ANP** Actual Navigational Precision, in nautical miles
- **RNP** Required Navigational Precision, in nautical miles

The following information is indicated on the page 2:

- **TAILWIND/HEADWIND** Wind as tailwind or headwind, knots
- **BRG** Magnetic Bearing to the current To waypoint
- **TKE** Track Course Error in degrees, as a difference between the bearing to the To waypoint and the course to the To waypoint, (L:left or R:right)

The 3<sup>rd</sup> NAV Page can be called to check the status of the sensors.

## 16.9.4. Flight Plan

The FMS has reach capabilities when it comes to managing the flight plans

FPL 1/ 1		M MSG	ALT/ FL
1	EDDM		DEL →
	327° 72.9NM		
2	MIQ	21:00	INFO →
	269° 18.6NM		
3	WLD	21:04	
	217° 12.1NM		
4	EDMA	21:07	OVFLY →
5			

FPL 1/ 2		M	ALT/ FL
1	EDDT		-----
	CRS078°		
2	(600FT)		↑ 600
	DIRECT		
3	DT081	22:09	-----
	←350° 5.0NM		
4	DT084	22:11	-----
	259° 10.7NM		
5	VADUX	22:13	-----

Figure 16.9.4.1. FMS Flightplan

The FMS Flight Plan function is called by pressing the FPL button on the MCDU. The main flight plan pages allow for editing of the flight plan. There are numerous alternative views, which can be called using the Menu function of the flight plan, we will describe them later in this article.

The following information is presented for the flight plan waypoints (whenever available)

- Waypoint designator (for example EDDT)
- Course to the next waypoint (for example CRS078° or simply 078°)
- Estimated UTC time over the waypoint (for example 22:09)
- Distance to the waypoint (for example 5.0NM)
- Altitude restriction in feet or flight level units (for example ↑600 or FL120)

Once the FMS flies the flight plan route, the current TO waypoint will be shown on the FPL page in magenta.

### Flight plan editing

The flight plan can be edited manually by using the cursor.

To enter the new waypoint at the end of the flight plan, position the cursor after the last waypoint, by pressing the appropriate LSK, and type the desired waypoint. After the confirmation this waypoint will become a part of the flight plan, and the course/distance/ETA to this waypoint will be indicated.

If desired, enter the vertical restriction for the waypoint by pressing the LSK on the opposite side. The entry can be in feet (digits only) or in Flight Level units ("FL"+3 digits).

To insert a waypoint between 2 existing waypoints, put the cursor at the waypoint, prior to which the desired waypoint must be inserted, and type the waypoint name.

To pause the FMS navigation after reaching a particular line of a flight plan, a special kind of waypoint by name “GAP” can be used. To insert the GAP, use the list function described below, to select the “GAP” type of a waypoint. Erasing the “GAP” waypoint will allow the FMS to resolve the navigation to the next waypoint, following the “GAP”.

Entering the number “99” as a waypoint name will clear the flight plan.

### Flight plan menu

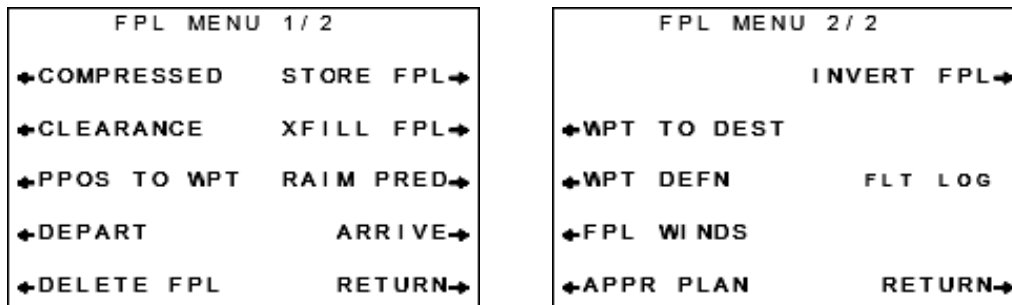


Figure 16.9.4.2. Flight Plan MENU pages

Pressing “MENU” button on the MCDU while the flight plan is displayed will bring up the flight plan menu. There are 2 menu pages available, including the following functions:

- COMPRESSED shows waypoints in a compressed form, one line per waypoint.
- CLEARANCE flight plan in the clearance language, including the names of the procedures, and the ATS routes used (when available).
- PPOS TO WPT shortest distance from current position of the aircraft to the waypoints in the flight plan
- DEPART calls up the departure procedures page. Refer to the procedures section below for more information on this function.
- DELETE FPL deletes the entire flight plan. The 5L LSK has to be pressed twice to perform the deletion.
- STORE FPL store the current flight plan in the FMS memory for the future use
- XFILL FPL pulls the flight plan via the ARINC bus from the opposite side FMS (when available).

- RAIM PRED calls up the GPS RAIM prediction page. TRAINING edition only. Please see the sensors section for more information on this function.
- ARRIVE calls up the arrival and approach procedures page. Refer to the procedures section below for more information on this function.
- RETURN return to the main flight plan pages

\* Please note, that no entries are possible when the flight plan is presented in the alternative view, using the Menu functions.

### Flight plan navigation

Whenever there is an active flight plan, referenced from the NAV page, the FMS will be looking for the best way to join the route.

The general rules the FMS follows are (See the Figure 16.9.4.3. below for an illustration) :

The FMS finds an active segment by checking at which side of the “terminator line” the aircraft is located. If an aircraft location is on the side which is beyond the end of the segment (termination side), the FMS takes the next segment and makes the check, and so on until it finds the terminator which would be “ahead” of the aircraft. The segment behind this terminator becomes then the active segment. The goal behind such a complicated interception is to enable the FMS to correctly join the flight plan from any initial location.

Please note, that the terminator line is located shortly abeam of the segments end. The idea behind this is to transition to the next segment in advance, in order to intercept the next leg smoothly.

\* Please note, there are waypoints where procedure requires that the aircraft overlies the waypoint before proceeding to the next. In such cases the FMS will position the terminator right over the waypoint, and not ahead of it. Such condition is marked as “\*” behind the waypoint name, and can also be set manually by selecting the leg in the flight plan, and the “OVFLY->” prompt on the right side.

Figure 16.9.4.3. below shows an example of a flight plan, with different entry locations and the path the FMS will follow to join the flight plan.

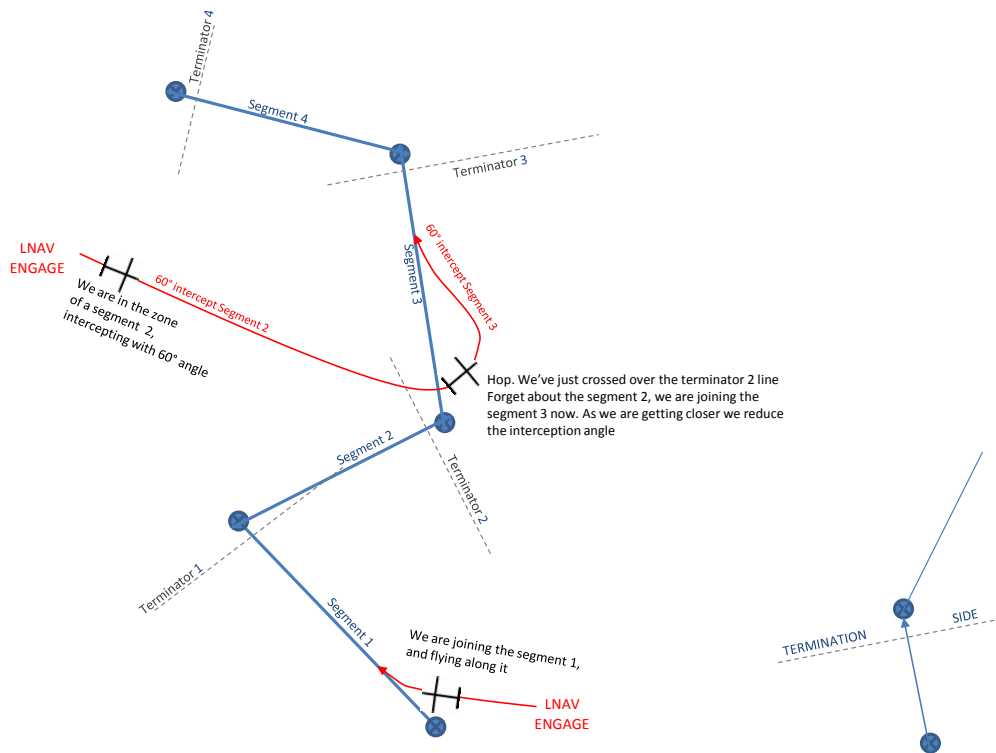


Figure 16.9.4.3. FMS Navigation



## 16.9.5. FPL WIND page

FMS has an option to enter the enroute winds in order to increase the precision in the flight plan times and the fuel management estimations

FPL WIND		1 / 2
1	B IRK	(M)120T / 15
	2.5 NM	
2	> (1000FT)	---T/---
	4.8 NM	
3	RK	018T / 3
	9.4 NM	
4	SA	053T / 11
	27.9 NM	
5	RH	(M)170T / 37

Figure 16.9.5.1. FMS FPL WIND page

The FPL WINDS page is accessible from the FPL MENU, Page 2 by pressing the LSK adjacent to the FPL WIND prompt.

Flight plan waypoint will be presented along with the wind entry prompts on the right side of the screen. The wind can be entered by pressing the appropriate LSK on the right side, and entering the true heading in degrees, and the wind velocity in knots. The letter (M) to the left of the wind entry indicates that the entry is made manually by a pilot. To erase the entry, press the appropriate LSK and push the BACK button.

Whenever possible the FMS will estimate the wind at the missing entries. After takeoff, the wind data for the current TO waypoint will be automatically replaced with the FMS own measured wind data.

FMS then will use the entered and estimated winds in order to estimate the time and fuel values on the PERFORMANCE and the FUEL pages.

## 16.9.6. LIST function

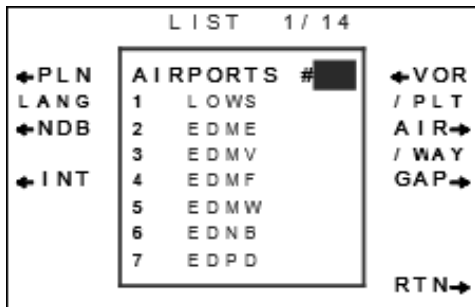


Figure 16.9.6.1 LIST page

The LIST page is used to select the waypoints from the numerous lists, sorted by the waypoint type (intersection, vor, ndb, airway), and allows in addition to the normal waypoint, selection of the airway segments, and the special “GAP” waypoint.

The primary LIST page is shown at the Figure 16.5.5.1. The default list is the AIRPORTS. In addition, the following functions are selectable

- PLN LANG presents the list in the full screen mode, including the full name of the waypoint, whenever available
- NDB lists the nearest NDBs
- INT lists the nearest intersection
- VOR/PLT lists the nearest VORs
- AIRWAY lists the airways, intersecting the waypoint prior to the cursor position. If there is no such waypoint, this prompt will not be shown
- GAP insert the “GAP” into the flight plan. The FMS will not continue navigating after reaching the “GAP” waypoint
- RTN return to the previous page

Please note, that there are 2 additional pages that will be presented in order to select the section of the airway to be inserted into the flight plan, and where the beginning and the end waypoint of the airway can be selected.

## 16.9.7. Procedures

The FMS contains an extensive procedural database containing

Standard Instrumental Departures (SIDs)

Standard Terminal Arrivals (STARs)

Instrumental Approaches (IAPs)

### SIDs

The SIDs can be selecting by calling the FPL MENU page, and selecting the “DEPART” prompt.

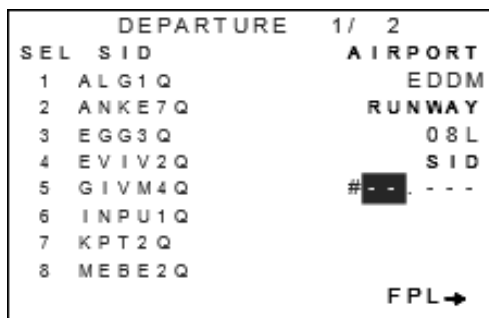


Figure 16.9.7.1. SID page

The AIRPORT field will be pre-filled automatically if the first waypoint of the flight plan is an airport. Otherwise this field can be filled manually

Following the airport selection, the list of the runway for the selected airport will appear. The runway is selected by typing its sequential number. After this, the cursor will move to the SID field

The SID field contains 2 parts : SID.TRANSITION. First the FMS will prompt the pilot to select the SID from the list. If the SID selected contains transition(s) , they will be listed additionally, and the cursor prompt will move to the part of the SID after the dot. However if the SID doesn't have transitions, the part after the dot, and the dot itself will disappear.

After the SID (SID.TRANSITION) is selected, pressing ENTER or selecting 5R LSK will insert the SID into the flight plan. The \*NO LINK\* waypoint will be added at the end of the SID to signify the need for the pilot to manually review the way the procedure links with the rest of the flight plan.

After the SID was properly linked to the flight plan, it might be necessary to review the NAV page, and ensure the airport is selected as PREV and the first waypoint of the SID as TO.

Please note, when a “course To” is the leg type for the first waypoint of the SID, the FMS will take the runway location, and not the airport location as a reference from which the course will be maintained.

## STARs/IAPs

STARs and IAPs are selected on the same page, which is called by selecting the “ARRIVE” prompt on the FPL MENU page.

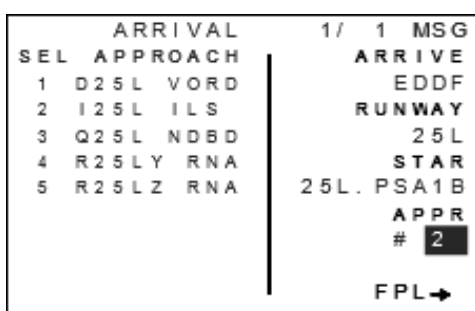


Figure 16.9.7.2. STAR and IAP page

The selection process is similar to the selection of the SID. The ARRIVE field will pre-fill with the last waypoint of the flight plan, if that waypoint is of the airport type. Otherwise, this field must be filled in manually.

After the runway is selected, the cursor will move to the STAR field. The STAR is presented as TRANSITION.STAR. The cursor will first appear at the STAR part, and if any TRANSITION exists for the STAR selected, the transition will be inserted in front of the dot, otherwise the dot will be removed completely, and the cursor will be moved to the APPR field.

If no STAR entry is desired, the cursor can be manually moved to the APPR field, in such case no STAR will be selected into the flight plan.

Same as STAR and SID, an approach can have a transition, which will be separated from the approach name with a dot.

If any STAR/any APPR is selected on this page, pressing FPL or ENTER key will insert these procedures into the flight plan.

\* Please note: The procedure(s) selected on this page will override any procedures previously selected. Because both STARs and IAPs can be selected simultaneously, the FMS will clear all the previous STAR and IAP from the flight plan, prior to adding the newly selected procedures.

After the procedures have been entered, the following discontinuities will be added automatically, to signify that the pilot has to manually ensure the flight plan integrity:

STAR

\*NO LINK\*

IAP (transition)

\*NO LINK\*

IAP

\*NO LINK\*

MISSED APPROACH

\*NO LINK\*

ARRIVAL AIRPORT

The usual procedure is to erase the \*NO LINK\* in front of the STAR after ensuring that it properly links into the flight plan, but leave the \*NO LINK\* ahead of the first approach point (IAP), until the ATC clearance for performing the approach is received.

\* Please note, that the gap in front of the missed approach will be erased automatically by the FMS, if the pilot selects the MISSED APPROACH prompt at the NAV page, or presses the TO/GA button on the Power Levers, while an approach is active. Not every approach contains a missed approach section.

## **Flying the Approach**

When the approach is selected and linked into the FMS, and the aircraft is within the 50nm, the FMS will present on the NAV page a prompt to the pilot to ARM the approach. If the approach is of the ILS or VOR type, the TUNE APPROACH will be shown prior to the ARM APPROACH. Make sure the ARCDU is in the FMS mode, and press the “TUNE APPROACH” LSK. The approach navaid frequency will be tuned automatically, and the FMS will change to the “ARM APPROACH” prompt.

When the approach is armed, the approach can be activated either:

- Automatically, while transitioning to the First Approach Fix (providing the discontinuity ahead of FAF is removed by the pilot)
- Manually, by pressing the LSK adjacent to “ACT APPROACH”

In the case of an automatic activation, FMS will command an intercept course, with 60 degrees intercept angle to the Final Approach Course.

In the case of a manual activation, the normal flight plan navigation will be suspended, and the FMS will enter an FMS Heading mode (FHDG mode), prompting the pilot to enter the heading for the approach interception (manual switch to the NAV page is required). The heading shown will default to the current aircraft heading. When FMS establishes that the aircraft is on the acceptable intercept course to the final approach segment, the INTERCEPT prompt will appear on the NAV page. Pressing the INTERCEPT LSK will enable the FMS to automatically switch to the approach mode, when the aircraft nears the approach path.

### Approach types:

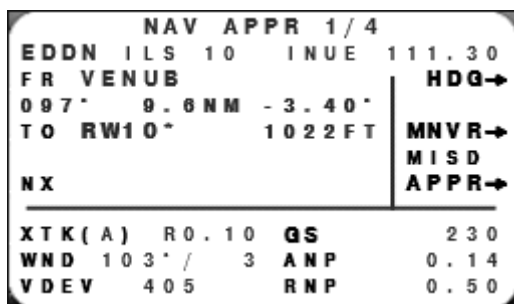
The FMS will fly the following approach types as RNAV overlay approaches:

- RNAV approach
- NDB approach
- NDB-DME approach
- VOR approach
- VOR-DME approach

The FMS will use the navaid data directly for the following approaches

- LOC approach: all types
- ILS approach: all types

### RNP enabled approaches:



NAV APPR 1 / 4			
EDDN ILS 10	INUE	111.30	
FR VENUB			HDG→
097°	9.6NM	-3.40°	
TO RW10°		1022FT	MNVR→
			MISD
			APPR→
NX			
XTK(A)	R0.10	GS	230
WND	103° / 3	ANP	0.14
VDEV	405	RNP	0.50

Figure 16.9.7.3. NAV Approach Page

The RNP enabled RNAV approach can be flown by the FMS, providing the following conditions are met:

- IRS is in the NAV mode
- RNP value from the approach plate is manually entered by the pilot on the NAV page prior or shortly after the approach activation
- Current ANP value is below the entered RNP.

Should the ANP exceed the RNP at any time during the approach, the GPS INTEG announcement will be shown on the PFD, and the approach mode will be invalidated.

Whenever the FMS flies the approach and approach mode is active, the usual NAV page representation changes to reflect the approach data (See figure 16.9.6.3.).

The top line shows the approach airport (EDDN), approach name (ILS 10), ILS id and frequency (INUE 111.30)

The FR is the Initial approach Fix (IAF), and the TO is always the Final Approach Fix (FAF).

When the VNAV coupled approach data is available (see the VNAV approaches article, VNAV section), the path angle, and the VDEV will also be printed (-3.4°), (VDEV 405) . The Vertical Deviation is given in feet and the approach angle in degrees.

### **Missed Approach**

Whenever the FMS is in the approach mode, and the missed approach information is available, the “MISD APPR->” prompt will appear on the NAV page. Pressing the adjacent LSK or the TO/GA button on the Power Levers at any time during the approach will force the FMS to bypass the approach procedure, jump over the “\*NO LINK\*” at the end of approach (if there is one), and begin navigating the missed approach procedure. If VNAV was used for the approach, it will disengage immediately, and revert to the PITCH mode. The RNP will automatically be set to T (Terminal).

### **3D approaches:**

FMS is capable of flying the 3D approaches; refer to the VNAV section for more information on this feature.

## 16.9.8. Maneuvers

There are 3 kinds of maneuvers, supported by this rendition of the FMS



Figure 16.9.8.1 MANEUVER page

### Heading mode

The heading mode, also called FHDG (FMS Heading) can be used to force the aircraft to fly a particular heading without having to disengage the LNAV mode of the Autopilot.

Selecting the HDG-> prompt will bring up the NAV page of the FMS, with left side showing a part of the NAV1/3 page, and the right part - the heading mode information and data entries:

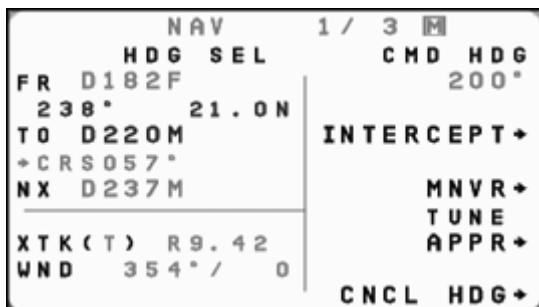


Figure 16.9.8.2 Heading subpage

When the heading subpage first becomes visible, the input cursor will be placed over the heading input field (CMD HDG). Entering a value here and confirming it with the “ENTER” key will result in FMS switching to “FHDG” mode and the aircraft turning to a selected heading (providing the LNAV autopilot mode is active), with PFD showing “LNAV HDG SEL” mode.

Note, that it is possible to specify the turn direction towards the desired heading, by pressing +/- key of the FMS when the cursor is placed over the heading field.



Should the FMS have an active NAV leg, and the selected heading is believed by the FMS to intercept that leg, the “INTERCEPT->” prompt will be shown under the heading field. If selected, the FMS will indicate “INTERCEPT” on the left top of the page, and LNAV HDG INT will appear on the PFD



Figure 16.9.8.3. Heading mode with intercept

Upon intercepting the active NAV leg, the FMS will cancel the FHDG mode automatically, and return to the normal NAV leg navigation.

*Please note, that the FHDG/Intercept option will also become active if an approach mode is manually activated via “ACT APPR->” prompt, thus allowing the pilot to intercept the final approach course from an arbitrary aircraft position.*

### PVOR mode

A special P(seudo) VOR mode is provided when a VOR-like navigation is required while using a non-VOR waypoint or an intersection as a reference.

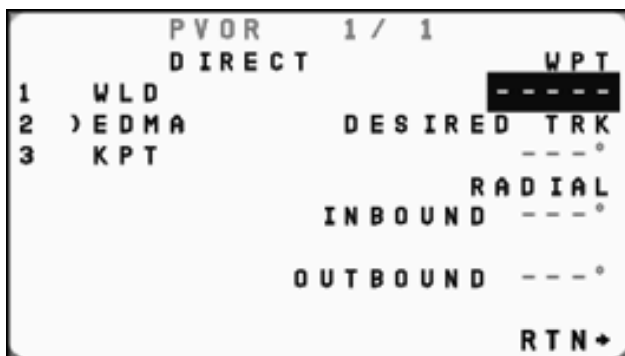
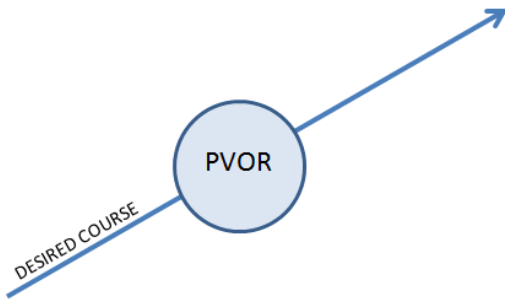


Figure 16.9.8.4. PVOR page

The page is called by selecting the PVOR-> prompt from the maneuver page. An existing waypoint from the flight plan, or an arbitrary waypoint can be entered as a PVOR reference point (WPT).

DESIRED COURSE NAVIGATION



RADIAL NAVIGATION

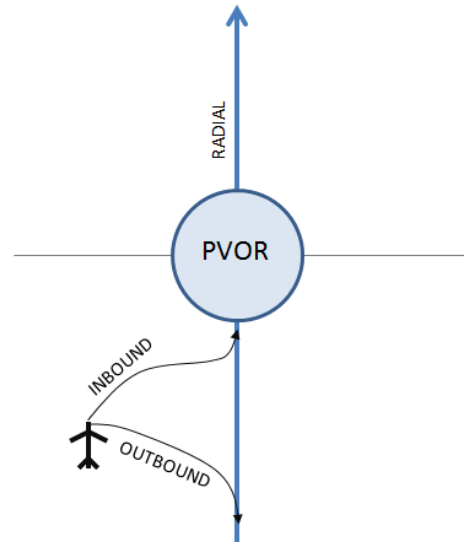


Figure 16.9.8.5. PVOR navigation illustration

PVOR can be navigated as a desired track, or a radial – inbound or outbound. The navigation is similar to that of a conventional VOR navigation, except the aircraft can still fly in the LNAV mode.



Figure 16.9.8.6. PVOR operation illustration

Once the PVOR mode was activated by selecting the “ACCEPT->” prompt on the PVOR page, the desired PVOR radial or a course will be shown by the magenta dashed line on the ND. Please note, that there are no provisions to terminate the PVOR mode automatically. PVOR mode should be cancelled by going to MANEUVER page and selecting the “CNCL PVOR->” prompt.

### Cross Track (SXTK) mode

The Cross Track mode of the FMS is used to enable the aircraft to fly parallel to the active FMS flight plan.



Figure 16.9.8.7. SXTK mode illustration

Upon selecting SXTK-> prompt on the MNVR page, the NAV 1/3 page will be shown on the FMS display, with the cursor placed over the SXTK field. Upon entering the desired side distance to the FMS track, the FMS will command the aircraft parallel to the course.

In addition, an XTK indicator will be visible on lower right part of the PFD, thus reminding the pilot that a cross track mode is in operation.

Please note, that only the regular flight plan (point to point) legs can be flown in the XTK mode. The mode should be cancelled prior to transition to a terminal (SID/STAR) or an approach procedure.

## 16.9.9. VNAV function

The vertical navigation function allows 3 dimension FMS navigation, with lateral and vertical flight profiles commanded by the FMS. The vertical information is taken from a flight plan, but can be overridden by the pilot.

The crew will use the existing flight plan waypoints to define the vertical profile. When a waypoint specified as vertical waypoint, VNAV will use an existing altitude restriction provided for that waypoint. If there is no altitude restriction, the altitude must be entered manually, either directly in the Flight Plan, or at the VNAV page. When the altitude information is entered, the VNAV function will calculate the vertical path to that waypoint, based on the vertical speed entered by the pilot. Any subsequent flight plan waypoints will then be imported into the vertical flight plan, as vertical waypoints. The altitude restriction for those waypoints will also be taken from the flight plan if they exist. If not, they will be automatically pre-filled from the previous waypoints which had such restriction. It is also possible to specify the distance, in nautical miles, from the waypoint in order to intercept the goal altitude ahead of the waypoint, or behind it.

The FMS VNAV function is programmed by specifying the existing lateral waypoints as vertical waypoints. There are 2 ways to use the FMS VNAV function.

### 1. VNAV TO

This is the easiest option to use, when an immediate VNAV application is required. The pre-condition for this function is that the waypoint must exist in the flight plan, along with an altitude restriction. Otherwise, the altitude has to be entered manually on the flight plan page, before engaging a VNAV TO the waypoint.

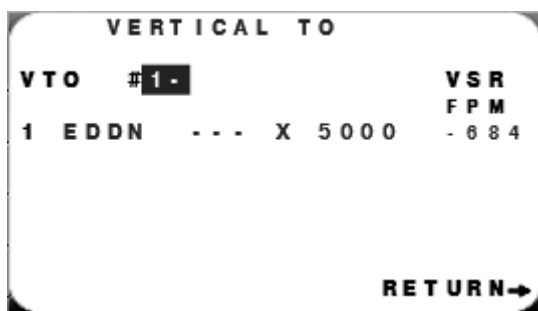


Figure 16.9.9.1. Vertical To Page

To enable the VNAV TO, click the VNAV key, then the “VTO” LSK. Enter the sequential number for the desired waypoint, press ENTER. Providing the FMS is the active NAV source and the LNAV mode is the current mode, the VNAV function will activate and provide a vertical path direct to the waypoint. Press VNAV on the AFCS panel to activate the mode. After passing the Vertical To Waypoint, the VNAV will attempt to provide the vertical path for the rest of a flight plan.

## 2. VNAV enroute

The VNAV enroute is the main VNAV function. The VNAV enroute is designed to defer the descend until the aircraft arrives at such location, that the descend to a programmed waypoint will result in the pre-defined vertical speed. Such location is commonly called “TOP OF DESCEND”, or “T.O.D.”.

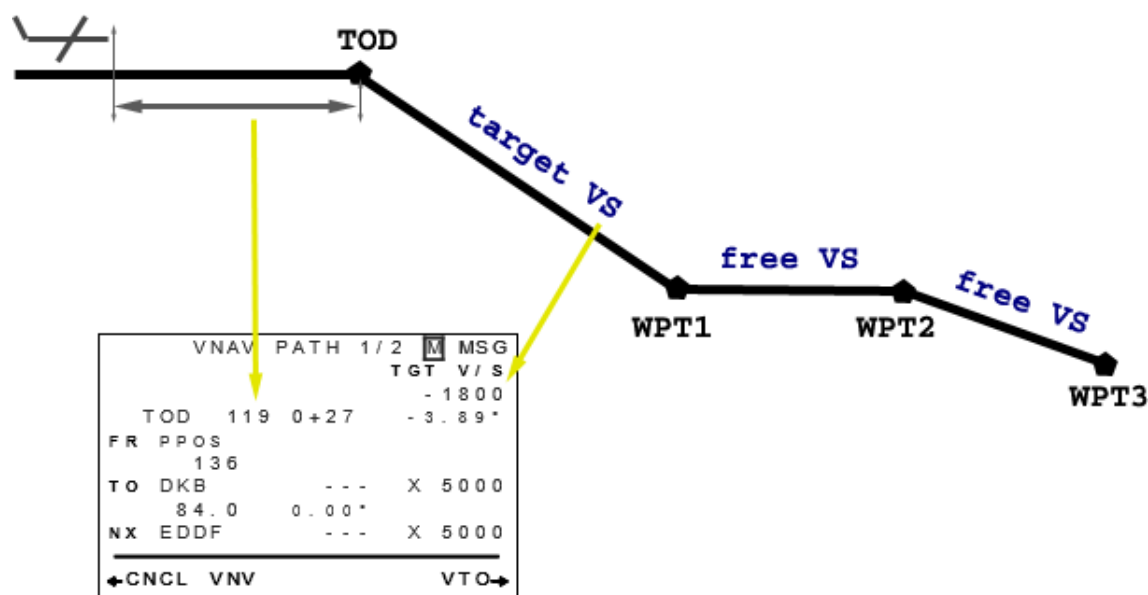


Figure 16.9.9.2. Enroute descend

To activate the enroute descend, click VNAV, in TO position enter the sequential number of a waypoint, then the offset distance (if required), or ENTER, the cursor will advance to the altitude field, press ENTER if an altitude is pre-filled from a flight plan, and is acceptable otherwise, enter a different altitude, press ENTER. The cursor will then advance to the TGT V/S field. Enter the desired descend Vertical Speed, and press ENTER. Providing the parameters are acceptable for an actual aircraft location and speed, the VNAV enroute will activate, and be placed in standby.

When entering the 2 minutes flight time range from a Top Of Descend, as shown at the VNAV PATH page, the VNAV pointer will appear on the PFD. Put the AFCS VNAV mode in the armed state, by pressing the VNAV key on the AFCS panel. Shortly prior to reaching the T.O.D. point the VNAV pointer will become alive, and the VNAV mode of the AFCS will become active. The aircraft

will be flying a VNAV defined path for as long as the vertical information exists in the flight plan, or can be approximated from it.

### VNAV Approach

The VNAV function has a special provision in order to enable flying the approaches in a coupled mode. What this means, is that it is possible for the FMS to combine all the navigation information available (IRS/GPS, and the ILS inputs), to generate and automatically fly the glide and lateral slope for the approach.

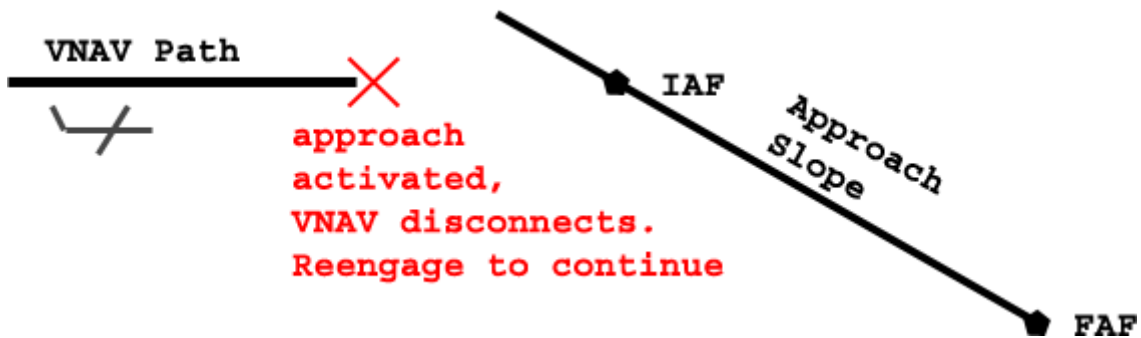


Figure 16.9.9.3. VNAV Approach

On successful approach activation, and provided the VNAV was active at a time, the VNAV approach mode will be engaged automatically. Prior to engaging the VNAV mode, a disconnect will occur and the AFCS will revert to the PITCH mode. Should the crew decide to utilize the VNAV Approach to descend on the glide, the VNAV can be re-engaged, after which it will be intercepted by the AFCS.

Engaging the missed approach will cancel the VNAV approach with a disconnect (as VNAV is prohibited from commanding a climb to the AFCS).

### VNAV Limitations

To operate the VNAV function safely, it is necessary to be aware of the numerous limitations. The most important of them are:

- Only the leg types with clearly defined terminators can be flown by the VNAV function. Such leg types as heading to altitude, course to intercept, or course to DME distance are not the valid VNAV legs. For some of them however the VNAV function will still provide the vertical guidance in the form of a suggested vertical speed and the path angle, shown on the VNAV page, but no

AFCS guidance will be provided, until the FMS arrives at a leg type which is acceptable for the vertical navigation, in which case the vertical signal to AFCS will be restored.

- Please keep in mind, that whenever the VNAV disengages by the pilot action, or otherwise, the AFCS will enter the pitch mode. Should the VNAV function restore the guidance to AFCS, it will be necessary for a pilot to re-engage the VNAV manually.
- Due to the fact, that the aircraft doesn't in fact have a speed autothrottle, changes in the vertical speed by the VNAV should be monitored closely by the pilots, and the appropriate power adjustments must be made to maintain the desired airspeed. Failure to do so may very quickly result in the aircraft flying dangerously slow, or fast.
- The VNAV is prohibited from sending an aircraft into the climb mode, therefore should a climb-resulted altitude profile emerge, the VNAV will disconnect and will not allow the re-engaging until such condition clears.

## 16.9.10. ETP/PNR Pages (PRO/TRAINING editions only)

**ETP** or **Equal Time Point** is a point along the flight plan where flying to the destination will take as long as flying back to the point of departure under the present wind conditions

**PNR** or **Point of No Return** is the point along the flight plan, beginning from which the aircraft can no longer return to the point of departure under the present wind conditions.

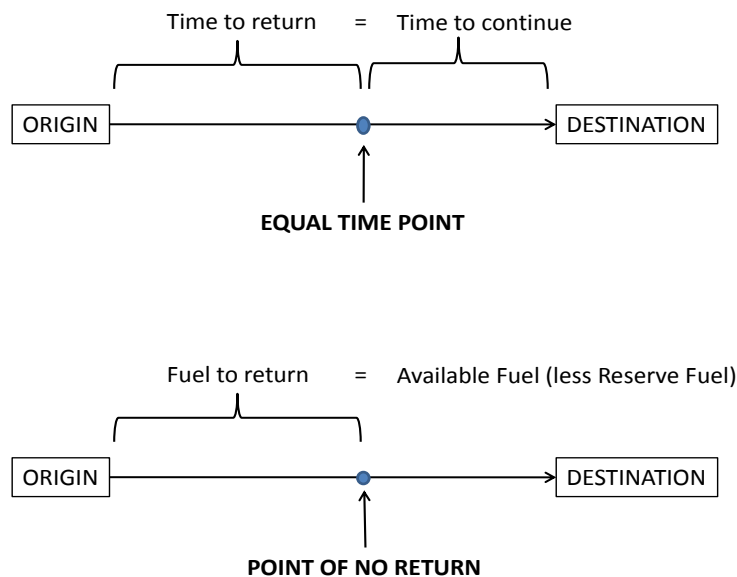


Figure 16.9.10.1. Equal Time Point and Point of No Return

The ETP and PNR pages can be accessed via the PERFORMANCE page, pressing the MENU button, and the LSK adjacent to ETP/PNR prompt.

Below we will describe all 4 pages of the ETP/PNR functionality.



ETP/PNR 1/4 M			
	DTO	DTO	FUEL
	TIME	DIST	OVHD
ARPT1		MM	LBS
BIRK	0+00	3	-----
ARPT2			
EGLC	4+03	1019	-----
ARPT3			
EGKK	4+06	1032	-----
ARPT4			
----	---+	-----	-----

Figure 16.9.10.2. ETP/PNR Page 1

The first page of ETP/PNR is used to define up to 4 airports which can be later selected for calculating ETP/PNR. The page will indicate the ETE in Direct To mode, Direct distance and the overhead fuel, if fuel information was previously entered on the FUEL pages.

ETP/PNR 2/4 M	
NORMAL	
COAST OUT	WINDS OUT
BIRK	(M) 240T/015
COAST IN	WINDS IN
EGLC	(M) 280T/035
FPL WINDS	(LBS/HR) FF
180T/000	1759
FOB (LBS)	TAS
9998	281

Figure 16.9.10.3. ETP/PNR Page 2

The second page defines 2 airports as Origin and Destination points, as well as the winds on altitude for both origin and the destination. FPL WINDS is filled by the FMS automatically with the ambient wind data. This will create a better estimate of the ETP/PNR points when arriving in the proximity of these points. If however the ambient wind information is not available, a pilot may enter the wind direction and speed manually, which will be indicated by the letter (M) to the right of the wind entry field. **Please note that ETP/PNR does not use the FMS Flight Plan or the Flight Plan winds data of the FMS.**

ETP/PNR 3/4 M		
ENG OUT	PRESSURE	LOSS
BIRK	WINDS	BIRK
240T/015 (M)	(M) 240T/015	
EGLC	WINDS	EGLC
270T/035 (M)	(M) 270T/035	
FF (LBS/HR)	(LBS/HR)	FF
3075		3075
TAS		TAS
279		279

Figure 16.9.10.4. ETP/PNR Page 3

The 3rd page of the ETP/PNR is read only, and demonstrates the ability of the aircraft to reach the destination under the abnormal scenarios of the depressurization and the loss of a single engine. The wind information from the Page 2 is used for calculation. The page calculation is based on a wind triangle.

ETP/PNR 4/4 M			
ETP/PNR TYPE			
NORMAL			
		DTG	
		FUEL OVHD	
COAST OUT	BIRK	9964LBS	
COAST IN	EGLC	-975LBS	
	DTG	ETE	ETA
ETP	NM	1+42	14:15
PNR	NM	1+34	14:06

Figure 16.9.10.5. ETP/PNR Page 4

The page 4 contains the actual data for ETP/PNR, indicating for which scenario the data is calculated (pressing LSK1 allows switching between NORMAL/ENGINE OUT/PRESSURE LOSS scenarios). The fuel overhead and the ETE to reach the ETP and PNR points will be shown, as well as the times of arrival.

## 16.9.11. DEFINE WPT (PRO/TRAINING editions only)

In the PRO and above editions of the Q400, there is a possibility to add new waypoints to the FMS database.

### Creating a pilot waypoint

In order to create the new waypoint, enter a unique 5 characters long waypoint name from the FPL page. DEFINE WPT page will be presented by the FMS

```

DEFINE WPT
REF WPT      WPT
-----      SNN02
N  --- --
W  --- --
RADIAL / DIST  W  --- --
----- / -----  GPS POS
WPT / RADIAL    FMS1 POS
----- / -----
RETURN+

```

Figure 16.9.11.1. DEFINE WPT page

This page allows a pilot to define the waypoint using one of the 3 methods:

1. Direct entry of the lat/lon coordinates. Press LSK7, and type the desired coordinates. As an alternative, the current FMS position can be selected by pressing LSK8 or LSK9. Press ACCEPT to finalize the creation of the new waypoint
2. Waypoint by a radial and a distance from another fix. Enter a known fix into REF WPT field, or enter a reference fix coordinates by pressing LSK2. Enter a radial and a distance (4 digits each) as prompted by the FMS. If necessary verify the resulting coordinates as shown on the right side of the screen. Press ACCEPT
3. Waypoint by intersection of 2 radials. Enter the first reference fix into REF WPT, or enter the reference fix coordinates by pressing LSK2, enter the first radial as prompted by the FMS, after that select LSK4 and input the second reference waypoint and the second radial, press ENTER. . If necessary verify the resulting coordinates as shown on the right side of the screen. Press ACCEPT.

## Editing the pilot waypoints

Go to DATA page of the FMS, select <-PILOT DATA prompt, select WAYPOINT.

PILOT WPTS page will be presented with a list of all the PILOT waypoints. Select the desired waypoint by sequential number or by name, and press ENTER. Waypoint information screen will appear with the prompts to DELETE, MODIFY or RETURN. Press DELETE to erase the waypoint from the database, MODIFY to change the parameters of the waypoint, or RETURN to select another waypoint for modification.

Note: Since the PILOT waypoints are saved into the EPROM memory of the FMS where they were originally created, the other side FMS will not have access to these waypoints. Note also that it is possible to crossfill a flightplan with the pilot waypoint from one FMS to another FMS, due to the fact that the flight plan waypoints are self-contained (do not rely on the database), however no additional information (such as reference fixes, distance or radials) will be shown for such waypoints.

## 16.9.12. FMS related MFD and PFD indications.

In addition to the information, supplied with a nav source, such as the course, distance and bearing, the FMS shows a great deal of additional information to the pilots.

### PFD indication

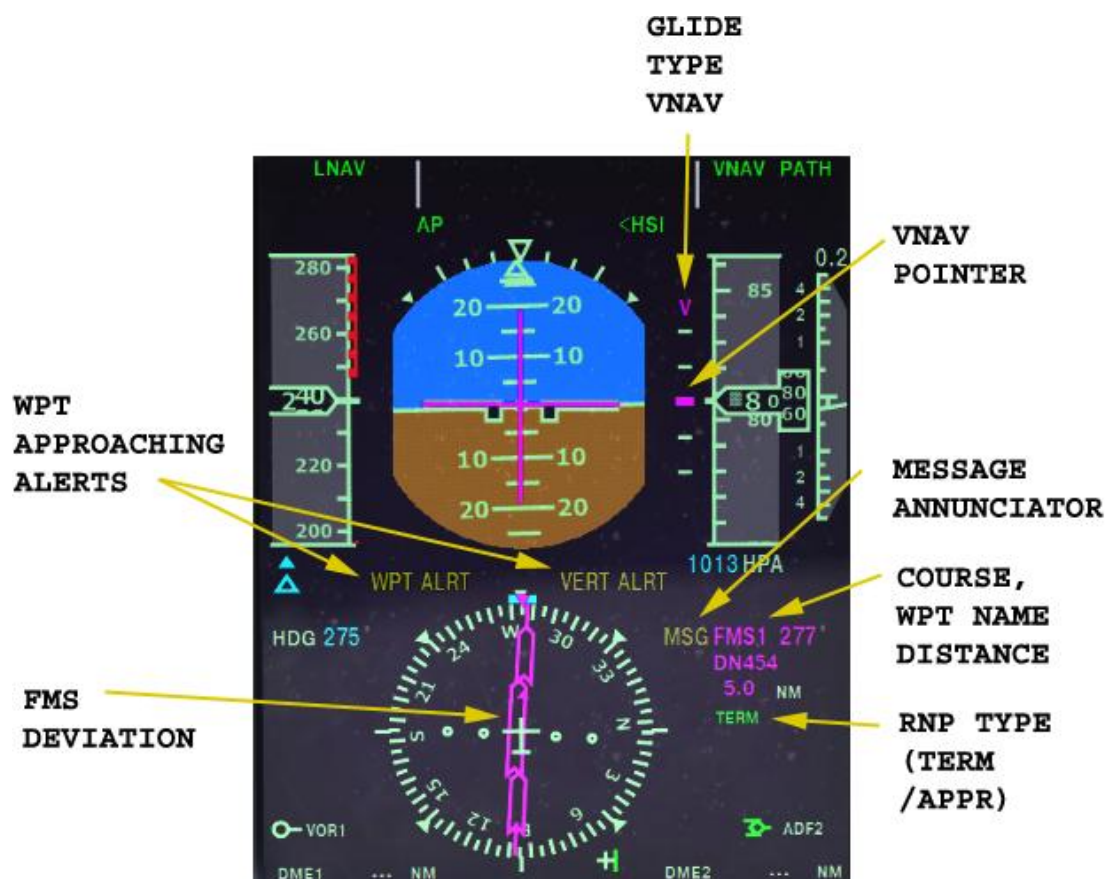


Figure 16.9.12.1. FMS specific indications on the PFD

The following FMS -related information is shown on the PFD:

- HSI deviation from the FMS course
- Distance to go, and ID of the current waypoint or a leg
- RNP accuracy, such as TERM or APPR. The accuracy is Enroute whenever this field is empty
- Lateral and Vertical waypoint Alerts (WPT ALRT, VERT ALRT) are shown shortly before then aircraft arrives at a waypoint
- Vertical deviation, and the “V” identifier, whenever VNAV is enabled

## MFD indication

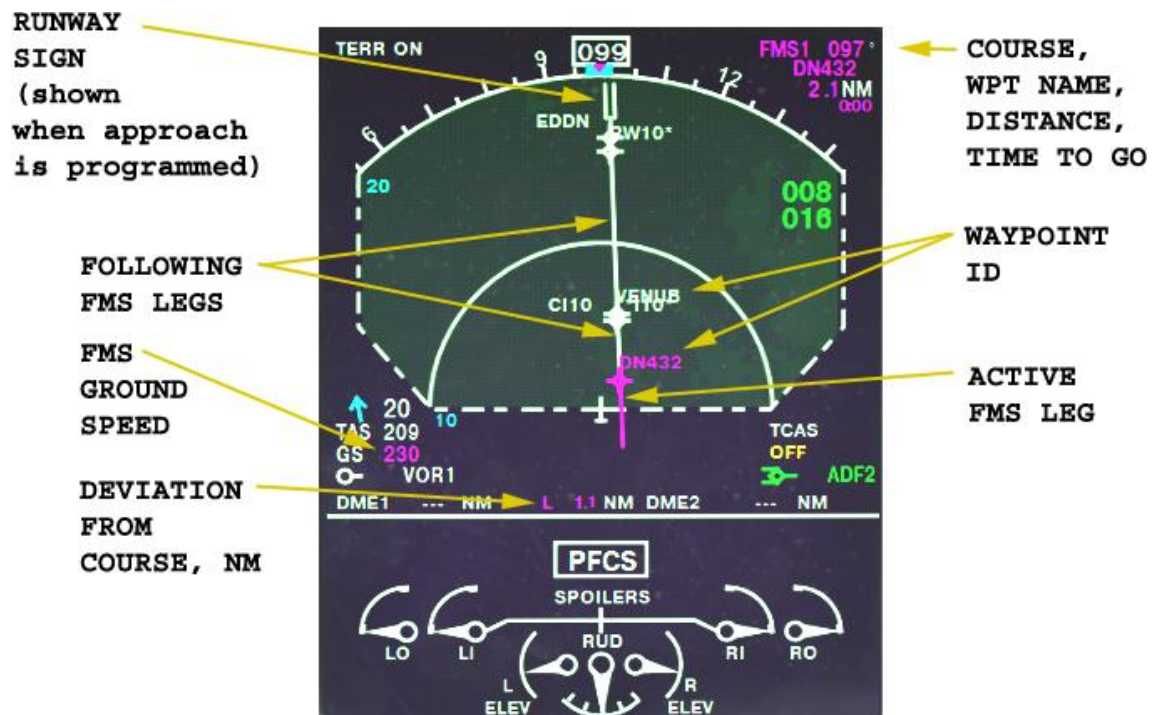


Figure 16.9.12.2. FMS specific indications on the MFD

The following FMS -related information is shown on the MFD:

- Deviation from the FMS course in NM
- Ground Speed, calculated by the FMS, in knots
- Current and following legs
- Waypoint and leg identifiers
- (For approaches only) Runway sign