BOEING 737
NEXT GENERATION

MAU VIRTUAL

Course overview

- Airplane General
- Air Systems
- Warning Systems, Communications, Ice & Rain Protection
- Electrical
- Engines, APU, Fuel System
- Hydraulics, Flight Controls, Landing Gear, Brakes
- Flight Instruments, Displays
- Automatic Flight
- Flight Management, Navigation
- Normal Operations

Topics

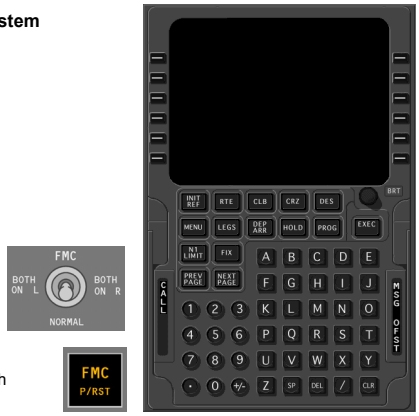
- **Flight Management System (FMS)**
- Controls & indicators
  - Control Display Unit
    - Page components
    - Page coloring
    - Data entry rules
  - FMC Source Select switch
  - FMC Alert light
- System description
- Primary flight deck controls
- Flight Management Computers (FMCs)
- FMS Operation
  - Preflight
  - Takeoff, Climb
  - Cruise
  - Descent
  - Approach
- Thrust management
- **Navigation Systems**
- Flight Management System
- Global Positioning System
- Inertial System
- Radio Navigation Systems
  - Automatic Direction Finder
  - Distance Measuring Equipment
  - Instrument Landing System
  - Navaid Identifiers
  - Marker Beacons
  - VHF Omnidirectional Range
  - VHF NAV Transfer switch
- Transponder
- Weather radar

Flight Management System

Controls & indicators

Control Display Unit

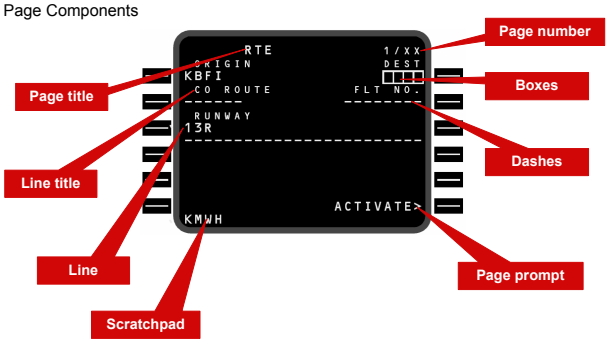
- CDU display
- Line select keys
- Function keys
- Execute key
- Execute light
- Alphanumeric keys
- Misc. keys
- Brightness control
- Message light
- Offset light
- Call light



- FMC Source Select switch
- FMC Alert light

Flight Management System

Control Display Unit
Page Components



Flight Management System

Control Display Unit
Page Coloring

Inactive page title (cyan)

Navaids in use

Active state

Active WP

Flightplan modification
Not yet executed

Flight Management System
Control Display Unit
Data entry rules

Altitude	115 9994 00050	FL115 9990 50	Flight level values Altitudes below transition alt.
Airspeed	.82 220	0.82 M 220 KIAS	Mach number Calibrates airspeed
Data pairs	310/10 220/110	310/10 220/FL110	Wind direction/speed Waypoint airspeed/altitude
Bearings	090 360	090 000	000-360 degrees 3 digits
Positive/negative values	-50		Max. negative altitude: - 1000 feet.

Flight Management System
System Description

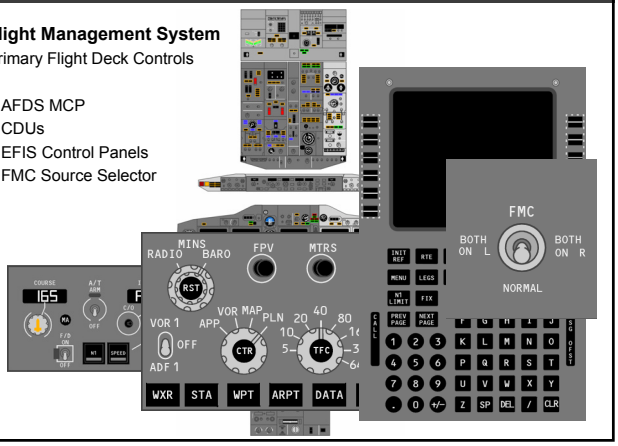
The flight management system (FMS) is comprised of the following components:

- flight management computer system (FMCS)
- autopilot/flight director system (AFDS)
- autothrottle (A/T)
- inertial reference systems (IRS)
- global positioning system (GPS).

Each of these components is an **independent** system, and each can be used independently or in **various combinations**. The term FMS refers to *the concept of joining these independent components together into one integrated system which provides continuous automatic navigation, guidance, and performance management.*

Flight Management System
Primary Flight Deck Controls

- AFDS MCP
- CDUs
- EFIS Control Panels
- FMC Source Selector

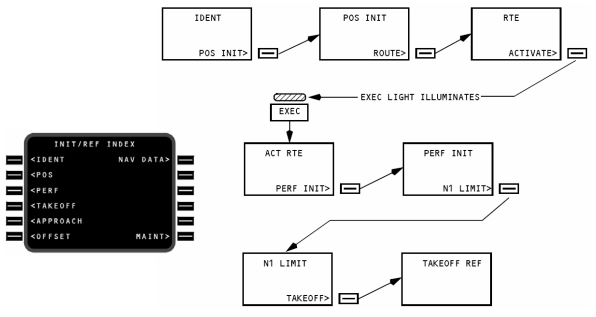


Flight Management System
Flight Management Computer System

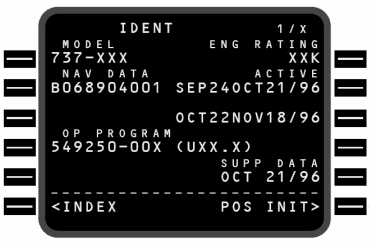
The FMC uses flight crew–entered **flight plan information**, **airplane systems data**, and data from the FMC **navigation database** to calculate airplane *present position, and pitch, roll, and thrust commands* required to fly an optimum flight profile. The FMC sends these commands to the **autothrottle, autopilot, and flight director**. Map and route information are sent to DUs. The EFIS control panels are used to select the desired information for the navigation displays. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes.

Control Display Units (CDUs)
Two identical, independent CDUs provide the means for the flight crew to communicate with the FMC. The crew may enter data into the FMC using either CDU, although simultaneous entries should be avoided. The same FMC data and computations are available on both CDUs; however, each pilot has control over what is displayed on an individual CDU.

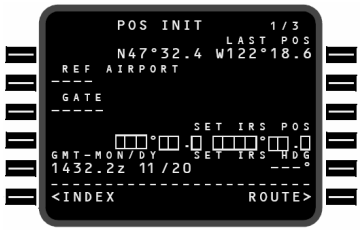
Flight Management System
FMS Operation
Preflight



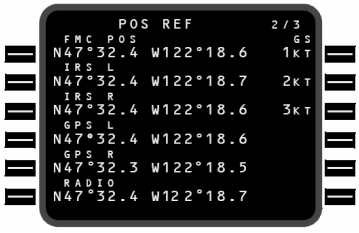
Flight Management System
FMS Operation
Preflight / IDENT



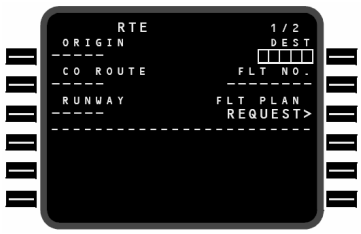
Flight Management System
FMS Operation
Preflight / POS INIT



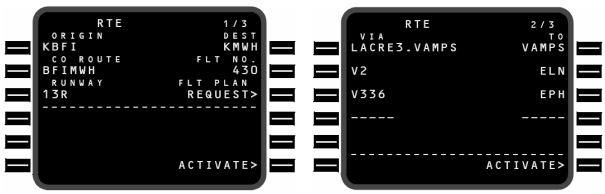
Flight Management System
FMS Operation
Preflight / POS REF



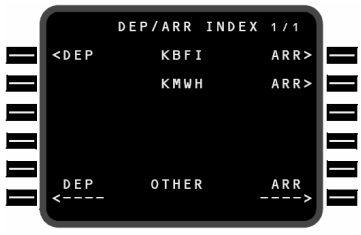
Flight Management System
FMS Operation
Preflight / RTE (ACT = Active, MOD = Modified)



Flight Management System
FMS Operation
Preflight / RTE

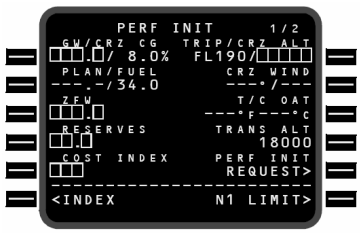


Flight Management System
FMS Operation
Preflight / DEP ARR INDEX

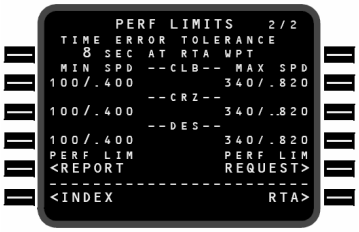


Flight Management System
FMS Operation
Preflight / DEP ARR

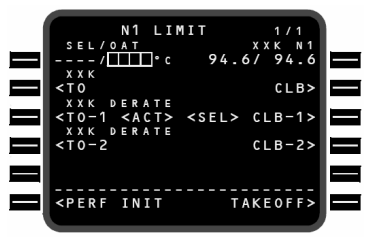
Flight Management System
FMS Operation
Preflight / PERF INIT



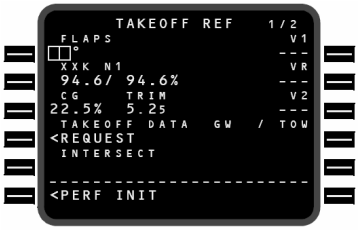
Flight Management System
FMS Operation
Preflight / PERF LIMITS



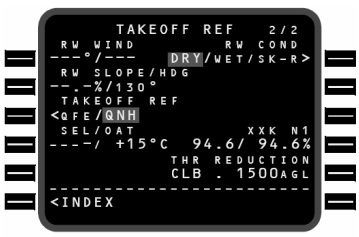
Flight Management System
FMS Operation
Preflight / N1 LIMIT



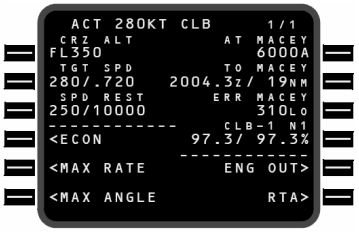
Flight Management System
FMS Operation
Preflight / TAKEOFF REF 1/2



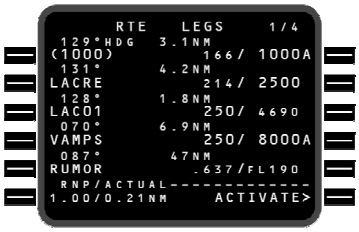
Flight Management System
FMS Operation
Preflight / TAKEOFF REF 2/2



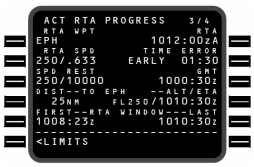
Flight Management System
FMS Operation
Takeoff, Climb / CLB



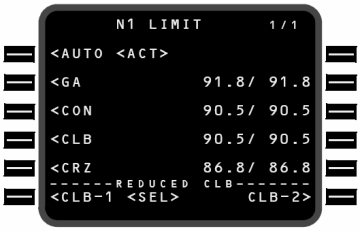
Flight Management System
FMS Operation
Takeoff, Climb / RTE LEGS



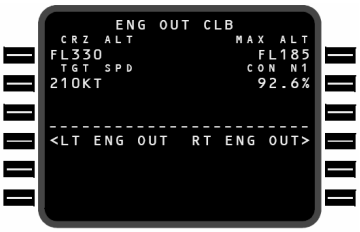
Flight Management System
FMS Operation
Takeoff, Climb / PROGRESS



Flight Management System
FMS Operation
Takeoff, Climb / N1 LIMIT

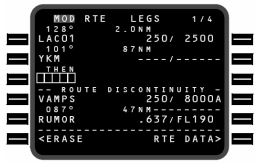


Flight Management System
FMS Operation
Takeoff, Climb / ENG OUT CLB

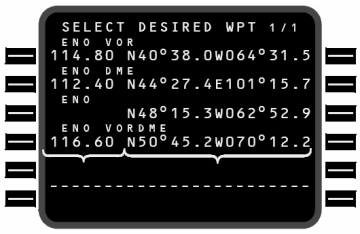


Flight Management System
FMS Operation
Takeoff, Climb / Air turnback / DEP ARR

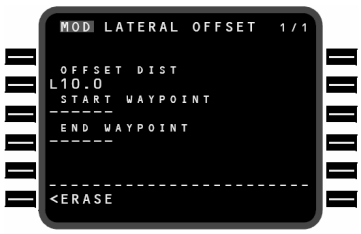
Flight Management System
FMS Operation
Cruise / RTE LEGS page modifications



Flight Management System
FMS Operation
Cruise / SELECT DESIRED WPT

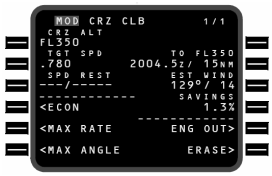


Flight Management System
FMS Operation
Cruise / LATERAL OFFSET

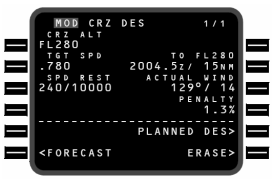


Flight Management System
FMS Operation
Cruise / CRZ

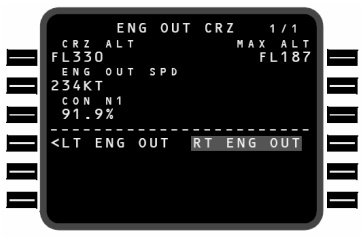
Flight Management System
FMS Operation
Cruise / CRZ CLB



Flight Management System
FMS Operation
Cruise / CRZ DES

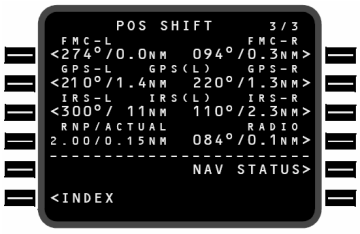


Flight Management System
FMS Operation
Cruise / ENG OUT CRZ

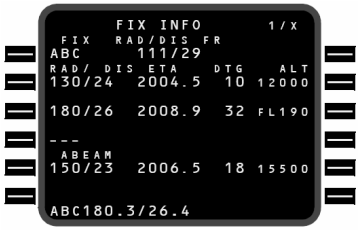


Flight Management System
FMS Operation
Cruise / RTE DATA

Flight Management System
FMS Operation
Cruise / POS SHIFT (POS 3/3)

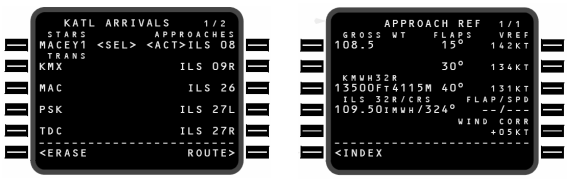


Flight Management System
FMS Operation
Cruise / FIX information page

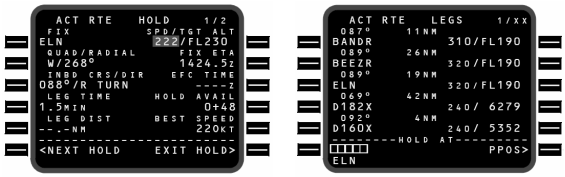


Flight Management System
FMS Operation
Descent, approach / DES

Flight Management System
FMS Operation
Descent, approach / DEP ARR / APP REF



Flight Management System
FMS Operation
Descent, approach / HOLD



Flight Management System

Thrust management

The autothrottle operates in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the N1 LIMIT page. Automatic FMC autothrottle commands are made while VNAV is engaged.

The autothrottle system:

- uses reference thrust limits calculated by the FMC
- commands the thrust levers
- commands thrust equalization through the electronic engine controls.

Thrust limits are expressed as N1 limits.

The FMC calculates a reference thrust for takeoff, derated takeoff, assumed temperature takeoff, climb, reduced climb, cruise, continuous, go-around.

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

Navigation Systems

Flight Management System

The flight management system (FMS) aids the flight crew in managing automatic navigation, in–flight performance optimization, fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers (bugs) on the airspeed and N1 indicators to assist in flying efficient profiles.

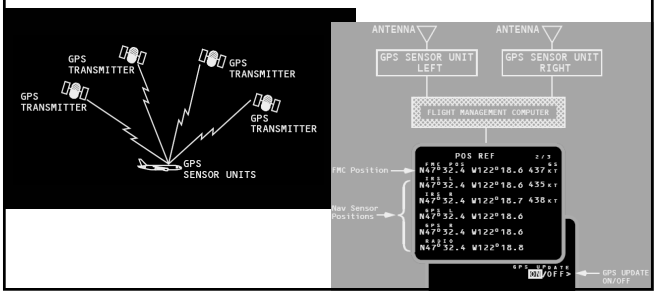
The flight crew enters the desired route and flight data into the CDUs. The FMS then uses its navigation database, airplane position and supporting system data to calculate commands for manual or automatic flight path control.

The FMS can automatically tune the navigation radios and determine LNAV courses. The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Lateral offsets from the programmed route can be calculated and commanded. For vertical navigation, computations include items such as fuel burn data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude restrictions are used to compute VNAV commands. When operating in the Required Time of Arrival (RTA) mode, the computations include required speeds, takeoff times, and enroute progress information.

Navigation Systems

Global Positioning System

Two GPS receivers receive GPS satellite positioning signals. The left and right GPS receivers are independent and each provides an accurate airplane geographical position to the FMC and other aircraft systems. GPS operation is automatic.



Navigation Systems

Intertial System

The inertial system computes airplane position, ground speed, and attitude data for the DUs, flight management system, autoflight system, and other systems. The major components of the inertial system are:

- **air data inertial reference units** (ADIRU)
- an **inertial system display unit** (ISDU)
- **IRS mode select unit** (MSU)
- an **IRS transfer switch**.

The ADIRUs provide inertial position and track data to the FMC, and attitude, altitude, and airspeed data to the CDS. Each ADIRU has an IRS section and an air data section.

Inertial Reference System

Two independent IRSs are installed. Each IRS has three sets of laser gyros and accelerometers. The IRSs are the airplane's sole source of attitude and heading information, except for the standby attitude indicator and standby magnetic compass.

In their normal navigation mode, the IRSs provide **attitude**, **true** and **magnetic heading**, **acceleration**, **vertical speed**, **ground speed**, **track**, **present position**, and **wind** data to appropriate airplane systems. IRS outputs are independent of external navigation aids.

Navigation Systems

Intertial System

Inertial Sys Display Unit (ISDU)

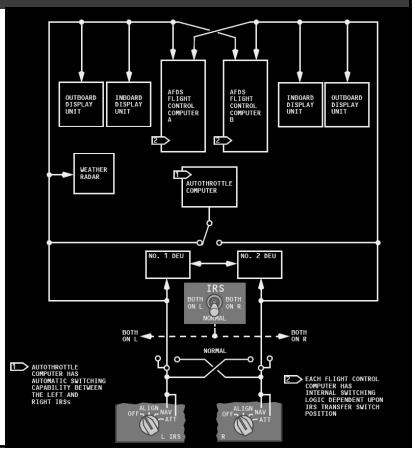
The ISDU is located on the aft overhead panel and displays data according to the position of the display selector and system selector. The ISDU also contains a keyboard for entry of present position and heading.

Mode Select Unit (MSU)

The MSU is located on the aft overhead panel and is used to select the operating mode for each IRS. Indicator lights on the MSU show status of each IRS.

IRS Transfer Switch

Should either IRS fail, the IRS transfer switch is used to switch all associated systems to the functioning IRS.



Navigation Systems

Radio Navigation Systems

Automatic Direction Finding (ADF)

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

One ADF receiver is installed. The ADF bearing signal is sent to the pointer on the DUs and the standby radio magnetic indicator. The audio is heard by using the ADF receiver control on the audio selector panel.

If heading or track information is lost or invalid, ADF bearing pointers on the DUs will be removed, and ADF bearing pointers on the standby radio magnetic indicator will not display correct magnetic bearing. Relative bearings indicated by pointers may be correct if the receiver is operating.

Navigation Systems

Radio Navigation Systems

Distance Measuring Equipment (DME)

Two frequency scanning DME systems are installed.

The FMC autotunes DME receivers as necessary for position updating. During normal operations, two different DME signals or a signal from a collocated VOR/DME pair provide an accurate radio geographical position to the FMC.

The flight crew must manually tune the DME on the VHF navigation control panel and the respective EFIS control panel VOR/ADF switch must be in the VOR position for DME to be displayed on the CDS. DME distance is also displayed on the CDS when the ILS receivers are tuned to a collocated DME and localizer facility.

Very High Frequency Omni Range (VOR)

Two VOR receivers are installed.

The flight crew must manually tune the VOR on the navigation control panel for display on the DUs and the standby radio magnetic indicator. VOR–DME radio updating is available if the crew manually tunes a valid in–range VOR station.

Navigation Systems

Radio Navigation Systems

Instrument Landing System (ILS)

Two ILS receivers are installed.

The ILS receivers are tuned manually on the VHF navigation control panel. The flight crew must manually tune the ILS for display on CDS. The ILS localizer and glideslope can also be displayed on the standby attitude indicator.

LOC updating of the FMC occurs only after the ILS is manually tuned.The tuned ILS frequency is displayed on the navigation display in the APP modes.

Marker Beacon

Marker beacon indications for outer, middle and inner marker are displayed on the upper right hand corner of the attitude display located on the Captain's and First Officer's Primary Flight Display (PFD) units.

Navaid Identifier Decoding

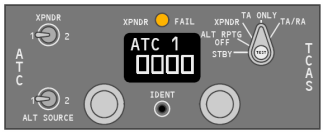
The Morse code identifier of a tuned VOR, ILS, or ADF can be converted to alpha characters. The decoded identifier is then shown on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC database.

Navigation Systems

Transponder

Two ATC transponders are installed and controlled by a single control panel. The ATC transponder system transmits a coded radio signal when interrogated by ATC ground radar. Altitude reporting capability is provided.

Transmissions are automatically enabled when the air/ground system indicates air mode.



Transponders may also transmit information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Airport equipment monitors airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). TCAS modes should not be used on the ground for ground tracking.

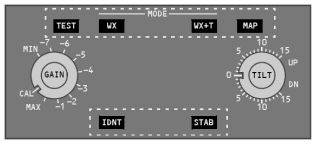
Navigation Systems

Weather Radar

The radar indicates a cloud's rainfall intensity by displaying colors contrasted against a black background. Areas of heaviest rainfall appear in red, the next level of rainfall in yellow, and the least rainfall in green.

In map mode, the radar displays surfaces in red, yellow, and green (most reflective to least reflective). These displays enable identification of coastlines, hilly or mountainous regions, cities, or large structures. Ground mapping mode can be useful in areas where ground–based navigation aids are limited.

The radar system performs only the functions of weather detection and ground mapping. It should not be used or relied upon for proximity warning or anticollision protection.



Köszönöm a figyelmet!

Elérhetőségek:
Internet: **http://www.b737.virtualairlines.hu**
E-mail: **training@virtualairlines.hu**
Előadó: **Hegedüs Zoltán**