

# 09 FLIGHT MANAGEMENT, NAVIGATION



BOEING 737 NEXT GENERATION **737**

### 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

BOEING 737 NEXT GENERATION FLIGHT MANAGEMENT, NAVIGATION **737**

### 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

BOEING 737 NEXT GENERATION FLIGHT MANAGEMENT, NAVIGATION **737**

### 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

BOEING 737 NEXT GENERATION FLIGHT MANAGEMENT, NAVIGATION **737**

### Flight Management System

#### Control Display Unit

#### Page Components

BOEING 737 NEXT GENERATION FLIGHT MANAGEMENT, NAVIGATION **737**

### Flight Management System

#### Control Display Unit

#### Page Coloring

- Inactive page title (cyan)
 

```
RTE
ORIGIN
-----
```
- Nav aids in use
 

```
DME - L
SEA 116.80
EPH 112.80
```
- Active state
 

```
DME UPDATE
<ON/OFF
VOR UPDATE
<ON/OFF
```
- Active WP
 

```
DEG TURN
ELN 270/12
```
- Flightplan modification
 

```
MOD RTE
0.8.8
```

# 09 FLIGHT MANAGEMENT, NAVIGATION

BOEING 737 NEXT GENERATION  
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### 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.

BOEING 737 NEXT GENERATION  
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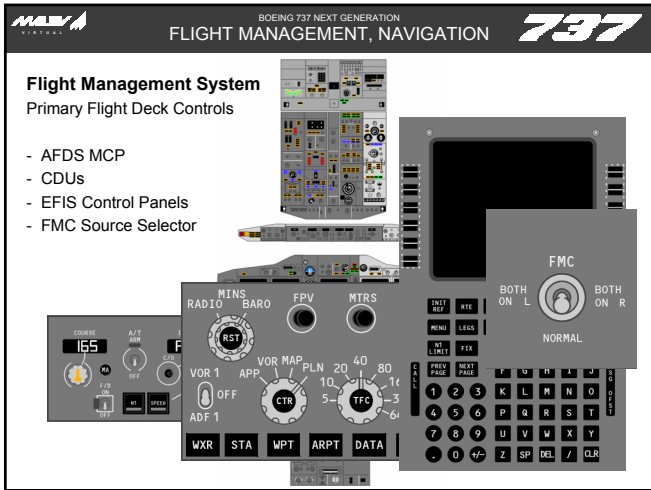
### Flight Management System

#### 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*.



BOEING 737 NEXT GENERATION  
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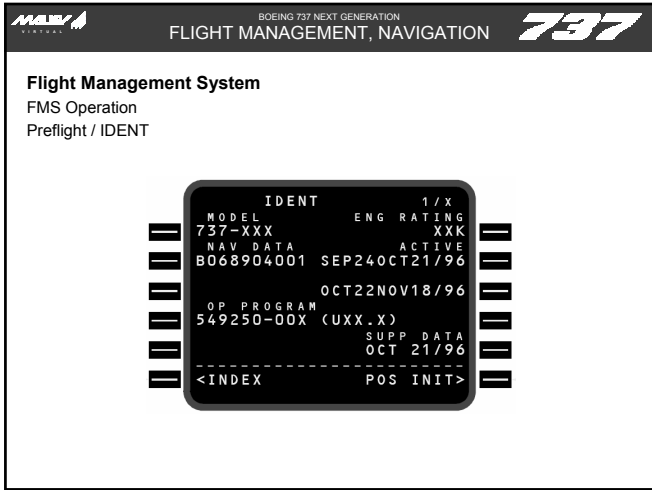
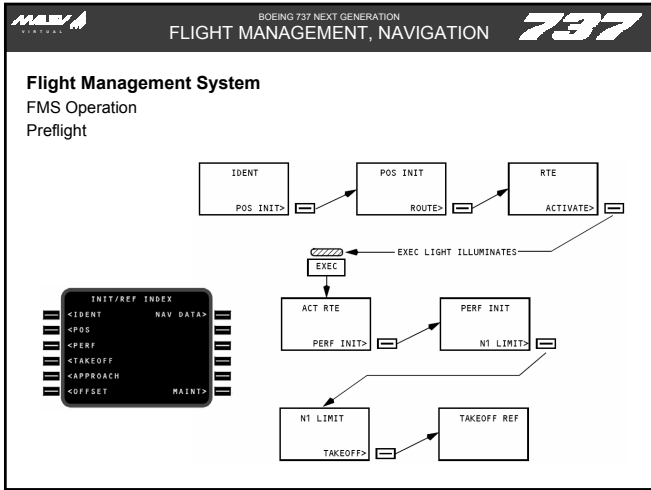
### Flight Management System

#### 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.



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**Flight Management System**  
FMS Operation  
Preflight / POS INIT

```

    POS INIT      1 / 3
    LAST POS
    N47°32.4 W122°18.6
    REF AIRPORT
    GATE
    SET IRS POS
    GMT-MON/DY   SET IRS HDG
    1432.2z 11 / 20
    <INDEX      ROUTE>
  
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / POS REF

```

    POS REF      2 / 3
    FWC POS      GS
    N47°32.4 W122°18.6 1KT
    IRS L
    N47°32.4 W122°18.7 2KT
    IRS R
    N47°32.4 W122°18.6 3KT
    GPS L
    N47°32.4 W122°18.6
    GPS R
    N47°32.3 W122°18.5
    RADIO
    N47°32.4 W122°18.7
  
```

BOEING 737 NEXT GENERATION  
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**Flight Management System**  
FMS Operation  
Preflight / RTE (ACT = Active, MOD = Modified)

```

    RTE          1 / 2
    ORIGIN      DEST
    CO ROUTE    FLT NO.
    RUNWAY      FLT PLAN
    REQUEST>
  
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / RTE

```

    RTE          1 / 3
    ORIGIN      DEST
    KBFI        KMH
    CO ROUTE    FLT NO.
    BFIMWH      430
    RUNWAY      FLT PLAN
    13R         REQUEST>
    ACTIVATE>

    RTE          2 / 3
    VIA         TO
    LACRE3.VAMPS VAMPS
    V2          ELN
    V336        EPH
    ACTIVATE>
  
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / DEP ARR INDEX

```

    DEP/ARR INDEX 1 / 1
    <DEP  KBFI  ARR>
    KMWH  ARR>
    DEP  OTHER  ARR
    <----->
  
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / DEP ARR

```

    KBFI DEPARTURES
    STDS RUNWAYS
    LACRE3 <SEL> <SEL> 13R
    TRANS
    HUMPP
    ORIGIN
    VAMPS
    <ERASE      ROUTE>
  
```

# 09 FLIGHT MANAGEMENT, NAVIGATION

BOEING 737 NEXT GENERATION  
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**Flight Management System**  
FMS Operation  
Preflight / PERF INIT

```

PERF INIT 1/2
GW/CRZ CG TRIP/CRZ ALT
---/---/ 8.0% FL190/---
PLAN/FUEL CRZ WIND
---/---/34.0 ---/---
ZFW T/C OAT
---*F---*C
RESERVES TRANS ALT
--- 18000
COST INDEX PERF INIT
REQUEST>
<INDEX N1 LIMIT>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / PERF LIMITS

```

PERF LIMITS 2/2
TIME ERROR TOLERANCE
8 SEC AT RTA WPT
MIN SPD --CLB-- MAX SPD
100/.400 --- 340/.820
100/.400 --CRZ-- 340/.820
100/.400 --DES-- 340/.820
PERF LIM PERF LIM
<REPORT REQUEST>
<INDEX RTA>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Preflight / N1 LIMIT

```

N1 LIMIT 1/1
SEL/OAT XXK N1
---/---*c 94.6/ 94.6
XXK
<TO CLB>
XXK DERATE
<TO-1 <ACT> <SEL> CLB-1>
XXK DERATE
<TO-2 CLB-2>
<PERF INIT TAKEOFF>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

```

TAKEOFF REF 1/2
FLAPS V1
--- V1
XXK N1 VR
94.6/ 94.6% ---
CG TRIM V2
22.5% 5.25 ---
TAKEOFF DATA GW / TOW
<REQUEST
INTERSECT
<PERF INIT
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

```

TAKEOFF REF 2/2
RW WIND RW COND
---/--- DRY/WET/SK-R>
RW SLOPE/HDG
---%/130°
TAKEOFF REF
<QFE/QNH
SEL/OAT XXK N1
---/ +15°C 94.6/ 94.6%
THR REDUCTION
CLB . 1500AGL
<INDEX
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Takeoff, Climb / CLB

```

ACT 280KT CLB 1/1
CRZ ALT AT MACEY
FL350 6000A
TGT SPD TO MACEY
280/.720 2004.3z/ 19NM
SPD REST ERR MACEY
250/10000 310L0
CLB-1 N1
<ECON 97.3/ 97.3%
<MAX RATE ENG OUT>
<MAX ANGLE RTA>
    
```

# 09 FLIGHT MANAGEMENT, NAVIGATION

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FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Takeoff, Climb / RTE LEGS

RTE	LEGS	1/4
129° HDG	3.1NM	166 / 1000A
(1000)		
131°	4.2NM	214 / 2500
LACRE		
128°	1.8NM	250 / 4690
LAC01		
070°	6.9NM	250 / 8000A
VAMPS		
087°	47NM	
RUMOR		
RNP / ACTUAL	.637 / FL190	
1.00 / 0.21NM		ACTIVATE>

ACT RTE	LEGS	1/4
129° HDG	3.1NM	166 / 1000A
(1000)		
131°	4.2NM	214 / 2500
LACRE	<CRZ>	250 / 2500
128°	1.8NM	250 / 4690
LAC01		
070°	6.9NM	250 / 8000A
VAMPS		
087°	47NM	
RUMOR		
RNP / ACTUAL	.637 / FL190	
1.00 / 0.21NM		STEP>

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Takeoff, Climb / PROGRESS

FLT430	PROGRESS	1/4
FROM	ALT	FUEL
CYN	FL186	1349: 35.2
249°	PTS	ETA FUEL
END	61	1359: 32.9
252°		
GVE	192	1411: 31.1
KATL	606	1510: 17.6
1355: / 32NM	FUEL STY	
WIND		34.0
080° / 23kt	NAV STATUS>	

ACT RTE	PROGRESS	3/4
RTA WPT		RTA
EPH		1012:00Z
RTA DEP		TIME ERROR
250 / 633		EARLY 01:30
SPP REST		ENT
250 / 1000		1000:30Z
01ST TO EPH		TALT / ETA
25NM		FL250 / 1010:30Z
1008:23Z		FIRST-RTA WINDOW--LAST
		1010:30Z
		CLIMITS

FLT 430	PROGRESS	2/4
TAILWIND	CROSSWIND	
27kt	R	3kt
WIND	SAT / ISA DEV	
104° / 27	-40°c / 0°c	
TK ERROR	VERT DEV	
L 0.01NM	12HI	
OS-L TRK	TAS	
309°T	426kt	
PRE-FLIGHT	PROGRESS	
<REPORT>	REPORT>	
WEATHER	POSITION	
<REQUEST>	REPORT>	

RNP	PROGRESS	4/4
FF28		6.3NM GP3.0°
RNP / ACTUAL		150 / 2900
0.50 / 0.21NM		
L 0.11NM		VERT DEV
		123HI
		RNP--APPROACH-----
		0.50NM

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Takeoff, Climb / N1 LIMIT

N1 LIMIT	1/1
<AUTO <ACT>	
<GA	91.8 / 91.8
<CON	90.5 / 90.5
<CLB	90.5 / 90.5
<CRZ	86.8 / 86.8
----- REDUCED	CLB-----
<CLB-1 <SEL>	CLB-2>

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

ENG OUT CLB	
CRZ ALT	MAX ALT
FL330	FL185
TGT SPD	CON N1
210KT	92.6%
-----	
<LT ENG OUT	RT ENG OUT>

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

KBFI ARRIVALS	1/2
STARS	APPROACHES
CHNS2 <SEL>	ILS 13R
	RUNWAYS
GLSR3	13R
JWBN5	31L
TRANS	
EPH	
GEG	
<ERASE	ROUTE>

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / RTE LEGS page modifications

MOD RTE	LEGS	1/4
LAC01	2.0NM	250 / 2500
101°	87NM	
THEN		
-----		
ROUTE DISCONTINUITY		
VAMPS	250 / 8000A	
087°	47NM	
RUMOR	.637 / FL190	
<ERASE		RTE DATA>

ACT RTE	LEGS	1/4
129° HDG	1NM	129 / 1000A
LAC01		250 / 4690
070°	7NM	250 / 8000A
VAMPS		250 / 8000A
085°	35NM	
BANDR		.800 / FL190
088°	26NM	
BEEZR		.800 / FL190
088°	19NM	
ELN		.800 / FL190
RNP / ACTUAL		0.50 / 0.21NM
0.50 / 0.21NM		RTE DATA>
		BANDR

ACT RTE	LEGS	1/4
129° HDG	1NM	129 / 1000A
LAC01		250 / 4690
070°	7NM	250 / 8000A
VAMPS		250 / 8000A
085°	35NM	
BANDR		.800 / FL190
088°	26NM	
BEEZR		.800 / FL190
088°	19NM	
ELN		.800 / FL190
RNP / ACTUAL		0.50 / 0.21NM
0.50 / 0.21NM		RTE DATA>
		BANDR

ACT RTE	LEGS	1/4
129° HDG	1NM	129 / 1000A
LAC01		250 / 4690
070°	7NM	250 / 8000A
VAMPS		250 / 8000A
085°	35NM	
BANDR		.800 / FL190
088°	26NM	
BEEZR		.800 / FL190
088°	19NM	
ELN		.800 / FL190
RNP / ACTUAL		0.50 / 0.21NM
0.50 / 0.21NM		RTE DATA>
		DELETE

# 09 FLIGHT MANAGEMENT, NAVIGATION

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / SELECT DESIRED WPT

```

SELECT DESIRED WPT 1/1
ENO VOR
114.80 N40°38.0W064°31.5
ENO DME
112.40 N44°27.4E101°15.7
ENO
N48°15.3W062°52.9
ENO VORDME
116.60 N50°45.2W070°12.2
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / LATERAL OFFSET

```

MOD. LATERAL OFFSET 1/1

OFFSET DIST
L10.0
START WAYPOINT
-----
END WAYPOINT
-----
<ERASE
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / CRZ

```

ACT ECON CRZ 1/1
CRZ ALT OPT/MAX STEP
FL350 FL340/361 -----
TGT SPD TO T/D
780 2004.52/ 100NH
TURB NT ACTUAL WIND
87.3/ 87.3% 129°/ 14
FUEL AT KATL 12.5
-----
ENG OUT>
<LRC RTA>

ACT RTA CRZ 1/1
CRZ ALT OPT/MAX STEP
FL350 FL340/361 -----
TGT SPD TO T/D
780 2004.52/ 100NH
TIME ERROR ACTUAL WIND
EARLY 05:31 129°/ 14
FUEL AT KATL 12.5
-----
ENG OUT>
<LRC RTA>

ACT ECON CRZ 1/1
CRZ ALT OPT/MAX STEP
FL350 FL340/361 FL350
TGT SPD STEP POINT
780 2004.52/ 100NH
TURB NT EST WIND
87.3/ 87.3% 129°/ 14
FUEL AT KATL SAVINGS
W/STEP 12.5 1.3%
-----
ENG OUT>
<LRC RTA>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / CRZ CLB

```

MOD CRZ CLB 1/1
CRZ ALT
FL350 TO FL350
TGT SPD TO FL350
780 2004.52/ 15NH
SPD REST EST WIND
---/----- 129°/ 14
SAVINGS
1.3%
-----
ENG OUT>
<MAX RATE ERASE>

ACT RTA CRZ CLB 1/1
CRZ ALT TIME ERROR
FL350 EARLY 01:22
TGT SPD TO FL370
780 0954.12/ 15NH
SPD REST EST WIND
---/----- 129°/ 14
SAVINGS
1.3%
-----
ENG OUT>
<MAX RATE ERASE>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / CRZ DES

```

MOD CRZ DES 1/1
CRZ ALT
FL280 TO FL280
TGT SPD TO FL280
780 2004.52/ 15NH
SPD REST ACTUAL WIND
240/10000 129°/ 14
PENALTY
1.3%
-----
PLANNED DES>
<FORECAST ERASE>

ACT RTA CRZ DES 1/1
CRZ ALT TIME ERROR
FL280 LATE 10:54
TGT SPD TO FL280
780 2004.52/ 15NH
SPD REST ACTUAL WIND
240/10000 129°/ 14
-----
PLANNED DES>
<FORECAST RTA>
    
```

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / ENG OUT CRZ

```

ENG OUT CRZ 1/1
CRZ ALT MAX ALT
FL330 FL187
ENG OUT SPD
234KT
CON N1
91.9%
-----
<LT ENG OUT RT ENG OUT
    
```

# 09 FLIGHT MANAGEMENT, NAVIGATION

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / RTE DATA

ACT RTE	DATA	1/2	WIND
VERNO	1315z	070° / 40	
ABC	1328z	075° / 45	
DEF	1333z	080° / 140	
GHI	1338z	080° / 140	
JKL	1341z		
<LEGS		--- WINDS REQUEST>	

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

POS SHIFT		3/3
FMC-L	094° / 0.3NM	FMC-R
<274° / 0.0NM		>
GPS-L	220° / 1.3NM	GPS-R
<210° / 1.4NM		>
IRS-L	110° / 2.3NM	IRS-R
<300° / 11NM		>
RNP/ACTUAL	084° / 0.1NM	RADIO
2.00 / 0.15NM		
		NAV STATUS>
<INDEX		

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Cruise / FIX information page

FIX	RAD/DIS FR	1/X
ABC	111/29	
RAD / DIS	ETA	DTG
130/24	2004.5	10 12000
180/26	2008.9	32 FL190
---		
ABEAM		
150/23	2006.5	18 15500
ABC180.3/26.4		

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Descent, approach / DES

M.720 SPD DES	1/1
E/D ALT	AT MACEY
2015	230/6000A
TGT SPD	TO T/D
.720/280	2004.3z / 46NM
SPD REST	MPT ALT
240/10000	---
FPA V/B V/S	
---	
<ECON PATH>	
<FORECAST DES NOW>	

ACT RTA PATH DES	1/1
E/D ALT	AT BARON
2015	230/6000A
TGT SPD	ON TIME
.704/260	
SPD REST	DP/ALT
240/10000	BARON/6000
VERT DEV FPA V/B V/S	
24HI 3.8 6.2 2360	
---	
<ECON SPEED>	
<FORECAST RTA>	

ACT ECON PATH DES	1/1
E/D ALT	AT MACEY
2015	230/6000A
TGT SPD	TO MACEY
.720/280	2004.3z / 19NM
SPD REST	MPT/ALT
240/10000	MACEY/6000
VERT DEV FPA V/B V/S	
25 HI 3.8 6.2 2360	
---	
<ECON SPEED>	
<FORECAST RTA>	

MOD DES FORECASTS	1/1
TRANS LVL	TAI ON/OFF
FL180	---
CABIN RATE	154 DV/NNH
480FPM	---FC/---
ALT	---DIR/SPD
FL210	078° / 69kt
---	
5000	130° / 29kt
---	
DES WINDS	
---°/---KT	
<REQUEST ERASE>	

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

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

KATL ARRIVALS	1/2
STARS	APPROACHES
MACEY1 <SEL>	<ACT>ILS 08
TRANS	
KMX	ILS 09R
MAC	ILS 26
PSK	ILS 27L
TDC	ILS 27R
--- WINDS REQUEST>	
<ERASE ROUTE>	

APPROACH REF	1/1
58035 WT	FLAPS 130°
108.5	142KT
---	
30°	134KT
KMHV32R	
13500ft/4115M	40° 131KT
ILS 32R/CRS	FLAP/SPD
109.501NMW/324°	---/---
WIND CORR +05KT	
---	
<INDEX	

BOEING 737 NEXT GENERATION  
FLIGHT MANAGEMENT, NAVIGATION **737**

**Flight Management System**  
FMS Operation  
Descent, approach / HOLD

ACT RTE	HOLD	1/2
FIX	SPD/TGT	ALT
ELN	222	FL230
QUAD/RADIAL	FIX	ETA
W/268°	1424.5z	
IRSD CRS/DIR	EFC TIME	
088°/R TURN	---	
LEG TIME HOLD AVAIL		
IL-SWEN 0448		
LEG DIST BEST SPEED		
---NM 220KT		
---		
<NEXT HOLD EXIT HOLD>		

ACT RTE	LEGS	1/XX
087°	11NM	310/FL190
BANDR	26NM	
089°		
BEEZR	19NM	320/FL190
089°		
ELN	42NM	320/FL190
069°		
D182X	4NM	240/ 6279
095°		
D160X	240/ 5352	
---		
HOLD AT		
PPOS>		

# 09 FLIGHT MANAGEMENT, NAVIGATION

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### 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.

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### 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.

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### 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.

The diagram shows GPS transmitters and sensor units connected to the Flight Management Computer (FMC). The FMC displays the following data:

```

POS REF 773
N478 32.4 W122 10.6 439 x1
N478 32.4 W122 10.7 438 x1
N478 32.4 W122 10.6
N478 32.4 W122 10.6
N478 32.4 W122 10.6
N478 32.4 W122 10.6
  
```

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### Navigation Systems

Inertial System

The inertial system computes airplane position, ground speed, and altitude 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.

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### Navigation Systems

Inertial 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.

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### 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.




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## 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.

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## 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.

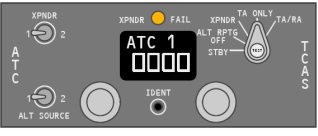
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## Navigation Systems

### 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.

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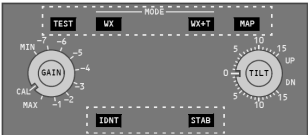
## Navigation Systems

### 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.



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## Köszönöm a figyelmet!

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