iFly Jets: The 737NG Operations Manual

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http://www.iflysimsoft.com/

WARNING

This manual is only used for understanding the functionalities of iFly Jets: The 737NG which runs on Microsoft® Flight Simulator 2004™ (A Century of Flight). User must not use iFly Jets: The 737NG and its associated components for real aviation training or other correlative activities!

Introduction

Thanks for using **iFly Jets: The 737NG**!

We have taken two years of development for **iFly Jets: The 737NG**. It is an add-on software for Microsoft® Flight simulator 2004™ (FS9). With our core developer Mr.Jiangwei's hard work, **iFly Jets: The 737NG** is now able to simulate most of system components that are on real Boeing 737NG airplane. They included Air Systems, Automatic Flight Control System, Communication System, Electrical Systems, Fire Protection System, Flight Controls Systems, Flight Instruments, Flight Management Systems, Fuel Systems, Hydraulics Systems, TCAS, GPWS and many more.

Due to the limitation of FS9, some system functionalities couldn't be realized completely. For example, there's no weather radar implementation on **iFly Jets: The 737NG**. Since the overwhelming complexity of 3D 737NG models, only the cockpit has modeled in virtual mode.

Because we took this development seriously and tried to be hardcore enough just like very other fans of Boeing 737NG, this simulator should deserves a comprehensive manual that can fully describe each part of system components. Thus during the time of manual and documents writing, we have referenced the real Boeing 737NG flight manuals in order to provide rich-content documents to the end users. And this is our yet another purpose that while users can fully simulate the cockpit of Boeing 737NG on PCs, they also find commons from flight manuals between real ones and ours.

Bug Reports & suggestions

Contact: support@iflysimsoft.com

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Limitations Operating Limitations

Chapter L Section 10

General

This chapter contains **iFly Jets: The 737NG** limitations and recommended operating limitations.

Airplane General

Operational Limitations

This chapter contains limitations and recommended operating limitations.

Runway slope	+/–2%
Maximum Takeoff and Landing Tailwind Component	15 knots
Maximum speeds	Observe gear and flap placards
Maximum Operating Altitude	41,000 ft

Weight Limitations

[Option - 737-600]

Weights	Pounds / Kilograms
Maximum Taxi Weight	127,500 / 57,832
Maximum Takeoff Weight	127,000 / 57,606
Maximum Landing Weight	120,500 / 54,657
Maximum Zero Fuel Weight	114,000 / 51,709

[Option - 737-700]

Weights	Pounds / Kilograms
Maximum Taxi Weight	133,500 / 60,554
Maximum Takeoff Weight	133,000 / 60,327
Maximum Landing Weight	128,000 / 58,059
Maximum Zero Fuel Weight	120,500 / 54,657

[Option - 737-800]

Weights	Pounds / Kilograms
Maximum Taxi Weight	156,000 / 70,760
Maximum Takeoff Weight	155,500 / 70,533
Maximum Landing Weight	144,000 / 65,317
Maximum Zero Fuel Weight	136,000 / 61,688

[Option - 737-900]

Weights	Pounds / Kilograms
Maximum Taxi Weight	174,700 / 79,242
Maximum Takeoff Weight	174,200 / 79,015
Maximum Landing Weight	146,300 / 66,360
Maximum Zero Fuel Weight	138,300 / 62,731

[Option - BBJ]

Weights	Pounds / Kilograms
Maximum Taxi Weight	171,500 / 77,791
Maximum Takeoff Weight	171,000 / 77,564
Maximum Landing Weight	134,000 / 60,781
Maximum Zero Fuel Weight	126,000 / 57,152

[Option – BBJ2]

Weights	Pounds / Kilograms
Maximum Taxi Weight	174,700 / 79,242
Maximum Takeoff Weight	174,200 / 79,015
Maximum Landing Weight	146,300 / 66,360
Maximum Zero Fuel Weight	138,300 / 62,731

[Option – BBJ3]

Weights	Pounds / Kilograms
Maximum Taxi Weight	188,200 / 85,366
Maximum Takeoff Weight	187,700 / 85,139
Maximum Landing Weight	157,300 / 71,350
Maximum Zero Fuel Weight	149,300 / 67,721

Autopilot/Flight Director System

Use of aileron trim with the autopilot engaged is prohibited.

The autopilot must not be engaged below 400 feet AGL after takeoff.

For single channel operation during approach, the autopilot must be disengaged below 50 feet AGL.

When landing weather minima are predicated on autoland operations the following limits apply:

Headwind	25 knots
Tailwind	15 knots
Crosswind	20 knots

The maximum glideslope angle is 3.25°.

The minimum glideslope angle is 2.5°.

Engines and APU

Reverse Thrust

Intentional selection of reverse thrust in flight is prohibited.

Backing the airplane with use of reverse thrust is prohibited.

APU

APU bleed: max alt 17,000 ft.

APU electrical load: max alt 41,000 ft.

Flight Controls

Avoid rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw.

Max flap extension altitude is 20,000 ft.

Do not deploy the speedbrakes in flight at radio altitudes less than 1,000 feet.

In flight, do not extend the SPEED BRAKE lever beyond the FLIGHT DETENT.

Flight Management, Navigation

ADIRU alignment must not be attempted at latitudes greater than 78 degrees 14.75 minutes.

Fuel System

Fuel Balance

Lateral imbalance between main tanks 1 and 2 must be scheduled to be zero. Random fuel imbalance must not exceed 1000 lbs / 453 kgs.

Fuel Loading

Main tanks 1 and 2 must be scheduled to be full if center tank fuel is loaded more than 1000 lbs / 453 kgs.

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Normal Procedures Introduction

Chapter NP
Section 11

Introduction

This chapter gives:
- an introduction to the normal procedures philosophy and assumptions
- step by step normal procedures

Normal Procedures Philosophy and Assumptions

Normal procedures are done on each flight.

Normal procedures assume:
- all systems operate normally
- the full use of all automated features (LNAV, VNAV, autoland, autopilot, and autothrottle).

Autopilot Flight Director System and Flight Management System Monitoring

When the autopilot, flight director, or autothrottle are in use and a mode change is selected or is scheduled to occur, the annunciation must be verified on the display. Airplane course, vertical path, and speed must always be monitored. In LNAV and VNAV, all airplane course, vertical path, thrust, and speed changes must be verified.

Control Display Unit (CDU) Procedures

CDU manipulations should be accomplished prior to high workload periods such as departure, arrival, or holding. During high workload periods, using autopilot modes such as heading select, flight level change, and the altitude and speed intervention features, may be more efficient than entering complex route modifications into the CDU.

Normal Procedures Amplified Procedures

Chapter NP Section 21

Preliminary Preflight Procedure

The Preliminary Preflight Procedure assumes that the Electrical Power Up supplementary procedure is complete.

A full IRS alignment is recommended before each flight. If time does not allow a full alignment, do the Fast Realignment supplementary procedure.

IRS mode selectors.....OFF, then NAV

Verify that the ON DC lights illuminate then extinguish.

Verify that the ALIGN lights are illuminated.

Verify that the following are sufficient for flight:

- oxygen pressure
- hydraulic quantity
- engine oil quantity

PSEU light.....Verify extinguished

GPS light.....Verify extinguished

ENGINE panel.....Set

Verify that the REVERSER lights are extinguished.

Verify that the ENGINE CONTROL lights are extinguished.

EEC switches – ON

Oxygen panel.....Set

PASSENGER OXYGEN switch - Guard closed

Verify that the PASS OXY ON light is extinguished.

Parking brake .....As needed

CDU Preflight Procedure

Start the CDU Preflight Procedure anytime after the Preliminary Preflight Procedure. The Initial Data and Navigation Data entries must be complete before the flight instrument check during the Preflight Procedure. The Performance Data entries must be complete before the Before Start Checklist.

Initial Data.....Set

IDENT page:

Verify that the MODEL is correct.

Verify that the ENG RATING is correct.

Verify that the navigation data base ACTIVE date range is current.

POS INIT page:

Verify that the time is correct.

Enter the present position on the SET IRS POS line. Use the most accurate latitude and longitude.

Navigation Data.....Set

ROUTE page:

Enter the ORIGIN.

Enter the DEST.

Enter the route.

Enter the FLIGHT NUMBER.

Activate and execute the route.

DEPARTURES page:

Select the runway and departure routing.

Execute the runway and departure routing.

LEGS page:

Verify or enter the correct RNP for the departure.

Verify that the route is correct on the RTE pages. Check the LEGS pages as needed to ensure compliance with the flight plan.

Performance Data.....Set

PERF INIT page:

CAUTION: Do not enter the ZFW into the GW boxes.

Enter the ZFW.

Verify that the FUEL on the CDU and the fuel quantity indicators agree.

Verify that the fuel is sufficient for flight.

Thrust mode display:

Verify that TO shows.

N1 LIMIT page:

Select an assumed temperature, or a fixed derate takeoff, or both as needed.

Select a full or a derated climb thrust as needed.

TAKEOFF REF page:

Make data entries on page 2/2 before page 1/2.

Enter the CG.

Verify that a trim value is shown.

Select or enter the takeoff V speeds.

Verify or enter a thrust reduction altitude.

Verify that the preflight is complete.

Preflight Procedure

Flight control panel.....Check

FLIGHT CONTROL switches – Guards closed

Verify that the flight control LOW PRESSURE lights are illuminated.

Verify that the standby hydraulic LOW QUANTITY light is extinguished.

Verify that the standby hydraulic LOW PRESSURE light is extinguished.

Flight SPOILER switches – Guards closed

YAW DAMPER switch – ON

ALTERNATE FLAPS master switch – Guard closed

ALTERNATE FLAPS position switch – OFF

NAVIGATION panel.....Set

VHF NAV transfer switch – NORMAL

IRS transfer switch – NORMAL

[Option – 800/900/900ER/BBJ/BBJ2/BBJ3]
FMC transfer switch – NORMAL

DISPLAYS panel.....Set

SOURCE selector – AUTO

CONTROL PANEL select switch – NORMAL

Fuel panel.....Set

Verify that the ENG VALVE CLOSED lights are illuminated dim.

Verify that the SPAR VALVE CLOSED lights are illuminated dim.

CROSSFEED selector – Closed

Verify that the VALVE OPEN light is extinguished.

FUEL PUMP switches – OFF

Verify that the center tank fuel pump LOW PRESSURE lights are extinguished.

Verify that the main tank fuel pump LOW PRESSURE lights are illuminated.

Electrical panel.....Set

BATTERY switch – Guard closed

[Option – 800/900/900ER]
CAB/UTIL power switch – ON

[Option – 800/900/900ER]
IFE/PASS SEAT power switch – ON

STANDBY POWER switch – Guard closed

Verify that the STANDBY PWR OFF light is extinguished.

Verify that the BAT DISCHARGE light is extinguished.

Verify that the TR UNIT light is extinguished.

Verify that the ELEC light is extinguished.

Generator drive DISCONNECT switches – Guards closed

Verify that the DRIVE lights are illuminated.

BUS TRANSFER switch – Guard closed

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the SOURCE OFF lights are extinguished.

Verify that the GEN OFF BUS lights are illuminated.

Overheat and fire protection panel.....Check

Do this check if the flight crew did not do the Electrical Power Up supplementary procedure. This check is needed once per flight day.

Verify that the engine No. 1, APU, and engine No. 2 fire switches are in.

Alert ground personnel before the following test is accomplished:

OVERHEAT DETECTOR switches – NORMAL

TEST switch – Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

Verify that the APU DET INOP light is illuminated.

TEST switch – Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and engine No. 2 fire switches stay illuminated.

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Verify that the WHEEL WELL light stays illuminated.

EXTINGUISHER TEST switch – Check

TEST switch – Position to 1.

Verify that the three green extinguisher test lights are illuminated.

Repeat for test position 2.

APU switch (as needed).....START

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches – ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

EQUIPMENT COOLING switches.....NORM

Verify that the OFF lights are extinguished.

EMERGENCY EXIT LIGHTS switch.....Guard closed

Verify that the NOT ARMED light is extinguished.

Passenger signs.....Set

NO SMOKING switch – AUTO or ON

FASTEN BELTS switch – AUTO or ON

WINDOW HEAT switches.....ON

Verify that the OVERHEAT lights are extinguished.

Verify that the ON lights are illuminated.

PROBE HEAT switches.....OFF

Verify that all lights are illuminated.

WING ANTI–ICE switch.....OFF

Verify that the VALVE OPEN lights are extinguished.

ENGINE ANTI–ICE switches.....OFF

Verify that the COWL ANTI–ICE lights are extinguished.

Verify that the COWL VALVE OPEN lights are extinguished.

Hydraulic panel.....Set

ENGINE HYDRAULIC PUMPS switches – ON

Verify that the LOW PRESSURE lights are illuminated.

ELECTRIC HYDRAULIC PUMPS switches – OFF

Verify that the OVERHEAT lights are extinguished.

Verify that the LOW PRESSURE lights are illuminated.

High altitude landing switch.....As needed

Verify that the INOP light is extinguished

Air conditioning panel.....Set

AIR TEMPERATURE source selector – As needed

[Option – 800/900/900ER/BBJ2/BBJ3]
TRIM AIR switch – ON

Temperature selectors – As needed

Verify that the RAM DOOR FULL OPEN lights are illuminated.

[Option – 600/700/700C/700ER/BBJ]
RECIRCULATION FAN switch – AUTO

[Option – 800/900/900ER/BBJ2/BBJ3]
RECIRCULATION FAN switches – AUTO

Air conditioning PACK switches – AUTO or HIGH

ISOLATION VALVE switch – OPEN

Engine BLEED air switches – ON

APU BLEED air switch – ON

Cabin pressurization panel.....Set

FLIGHT ALTITUDE indicator – Cruise altitude

LANDING ALTITUDE indicator – Destination field elevation

Pressurization mode selector – AUTO

Verify that the ALTN light is extinguished.

Verify that the MANUAL light is extinguished.

Lighting panel.....Set

LANDING light switches – RETRACT and OFF

RUNWAY TURNOFF light switches – OFF

TAXI light switch – OFF

Ignition select switch.....IGN L or R

Alternate the ignition select switch position on subsequent starts.

ENGINE START switches.....AUTO

Lighting panel.....Set

LOGO light switch – As needed

POSITION light switch – As needed

ANTI–COLLISION light switch – OFF

WING illumination switch – As needed

Mode control panel.....Set

COURSE(S) – Set

Both FLIGHT DIRECTOR switches – ON

Bank angle selector – As needed

Autopilot DISENGAGE bar – UP

EFIS control panel.....Set

MINIMUMS reference selector – RADIO or BARO

MINIMUMS selector – Set decision height or altitude reference

FLIGHT PATH VECTOR switch – As needed

METERS switch – As needed

BAROMETRIC reference selector – IN or HPA

BAROMETRIC selector – Set local altimeter setting

VOR/ADF switches – As needed

Mode selector – MAP

CENTER switch – As needed

Range selector – As needed

TRAFFIC switch – As needed

Map switches – As needed

Clock.....Set

Display select panel.....Set

MAIN PANEL DISPLAY UNITS selector – NORM

LOWER DISPLAY UNIT selector – NORM

TAKEOFF CONFIG light.....Verify extinguished

CABIN ALTITUDE light.....Verify extinguished

Disengage light TEST switch.....Hold to 1

Verify that the A/P light is illuminated steady amber.

Verify that the A/T light is illuminated steady amber.

Verify that the FMC light is illuminated steady amber.

Disengage light TEST switch.....Hold to 2

Verify that the A/P light is illuminated steady red.

Verify that the A/T light is illuminated steady red.

Verify that the FMC light is illuminated steady amber.

Do the Initial Data and Navigation Data steps from the CDU Preflight Procedure and verify that the IRS alignment is complete before checking the flight instruments.

Flight instruments.....Check

Select the map mode.

Standby instruments.....Check

Standby horizon – Set

Gyro caging control – Pull, then release

Approach mode selector – As needed

Verify that the flight instrument indications are correct.

Verify that no flags are shown.

Standby altimeter – Set

Verify that the flight instrument indications are correct.

Verify that no flags are shown.

Standby RMI.....Set

Select either VOR or ADF.

SPEED BRAKE lever.....DOWN detent

Verify that the SPEED BRAKE ARMED light is extinguished.

Verify that the SPEED BRAKE DO NOT ARM light is extinguished.

Verify that the SPEEDBRAKES EXTENDED light is extinguished.

Reverse thrust levers.....Down

Forward thrust levers.....Closed

FLAP lever.....Set

Set the flap lever to agree with the flap position.

Parking brake.....Set

Verify that the parking brake warning light is illuminated

Engine start levers.....CUTOFF

STABILIZER TRIM cutout switches.....NORMAL

GROUND PROXIMITY panel.....Check

FLAP INHIBIT switch – Guard closed

GEAR INHIBIT switch – Guard closed

TERRAIN INHIBIT switch – Guard closed

Verify that the INOP light is extinguished.

Landing gear panel.....Set

LANDING GEAR lever – DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

AUTO BRAKE selector.....RTO

Verify that the AUTO BRAKE DISARM light is extinguished

Engine display control panel.....Set

N1 SET selector – AUTO

SPEED REFERENCE selector – AUTO

FUEL FLOW switch – RATE

Move switch to RESET, then RATE.

Engine instruments.....Check

Verify that the primary and secondary engine indications show existing conditions.

Verify that the hydraulic quantity indications do not show RF.

CARGO FIRE panel.....Check

This check is needed once per flight day or following a flight crew change.

DETECTOR SELECT switches – NORM

TEST switch – Push

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Master FIRE WARN light – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the FWD and AFT lights stay illuminated.

Verify that the DETECTOR FAULT light stays extinguished.

Verify that the green EXTINGUISHER test lights stay illuminated.

Verify that the DISCH light stays illuminated.

[Option – BBJ/BBJ2/BBJ3]
HUD system.....As needed

[Option – BBJ/BBJ2/BBJ3]
Radio tuning panel.....Set

Verify that the OFF light is extinguished.

[Option – 600/700/700C/700ER/800/900/900ER]

VHF communications radios.....Set

VHF NAVIGATION radios.....Set for departure

Audio control panel.....Set

ADF radios.....Set

Transponder panel.....Set

Before Start Procedure

Do the CDU Preflight Procedure – Performance Data steps before completing this procedure.

CDU display.....Set

N1 bugs.....Check

Verify that the N1 reference bugs are correct.

IAS bugs.....Set

[Option - EFIS/MAP]
Verify that the speed bugs are at V1, VR, V2 + 15, and flaps up maneuvering speed.

MCP.....Set

AUTOTHROTTLE ARM switch – ARM

IAS/MACH selector – Set V2

Arm LNAV as needed

Initial heading – Set

Initial altitude – Set

Taxi and Takeoff briefings.....Complete

Exterior doors.....Verify closed

Fuel panel.....Set

If the center tank fuel quantity exceeds 1,000 pounds/460 kilograms:

LEFT and RIGHT CENTER FUEL PUMPS switches – ON

Verify that the LOW PRESSURE lights extinguish.

AFT and FORWARD FUEL PUMPS switches – ON

Verify that the LOW PRESSURE lights are extinguished.

Hydraulic panel.....Set

Electric HYDRAULIC PUMP switches – ON

Verify that the electric pump LOW PRESSURE lights are extinguished.

ANTI COLLISION light switch.....ON

Trim.....Set

Check each trim for freedom of movement.

Stabilizer trim – ___ UNITS

Set the trim for takeoff.

Verify that the trim is in the green band.

Aileron trim – 0 units

Rudder trim – 0 units

Engine Start Procedure

[Option – Over/Under display]
Select the secondary engine indications.

Air conditioning PACK switches.....OFF

Start sequence.....Announce

Call "START ___ ENGINE"

ENGINE START switch.....GRD

Verify that the N2 RPM increases.

When N1 rotation is seen and N2 is at 23~25%:

Engine start lever.....IDLE

Monitor fuel flow and EGT indications.

At 56% N2, verify that the ENGINE START switch moves to AUTO. If not, move the ENGINE START switch to AUTO.

Verify that the START VALVE OPEN alert extinguishes when the ENGINE START switch moves to AUTO.

Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications while the engine accelerates to a stable idle.

After the engine is stable at idle, start the other engine.

Before Taxi Procedure

GENERATOR 1 and 2 switches.....ON

PROBE HEAT switches.....ON

WING ANTI–ICE switch.....As needed

ENGINE ANTI–ICE switches.....As needed

PACK switches.....AUTO

ISOLATION VALVE switch.....AUTO

APU BLEED air switch.....OFF

APU switch.....OFF

Flap lever.....Set takeoff flaps

Verify that the LE FLAPS EXT green light is illuminated.

Flight controls.....Check

Move the control wheel and the control column to full travel in both directions and verify:

- freedom of movement
- that the controls return to center

Move the rudder pedals to full travel in both directions and verify:

- freedom of movement
- that the rudder pedals return to center

Transponder.....As needed

Recall.....Check

Verify that all system annunciator panel lights illuminate and then extinguish.

Do not accomplish the CONFIG non-normal checklist with less than 5000 pounds/2300 kilograms in the center tank prior to takeoff.

Before Takeoff Procedure

CDU.....Check

Takeoff data - Review

Verify takeoff speeds selected.

When obtain taxi clearance:

Parking brake.....Release

Takeoff Procedure

FIXED LANDING Lights switches.....ON

Transponder Mode selector.....TA/RA

TAKEOFF THRUST.....SET

Advance the thrust levers to approximately 40% N1. After engines stabilize, push the TO/GA switch

Verify correct takeoff thrust is set.

Adjust takeoff thrust before 60 knots as needed.

ENGINE INDICATIONS.....MONITOR

AIRSPEED 80 KNOTS.....Call "80 KNOTS"

AIRSPEED V1.....Call "V1"

AIRSPEED Vr.....Call "ROTATE"

Monitor airspeed and vertical speed.

Verify positive rate of climb

Landing Gear lever.....UP

Flap lever.....SET

Above 400 feet radio altitude

Select or verify the roll mode.

After flaps and slats retraction is complete

Push the VNAV switch.

Set or verify engine bleeds and air conditioning packs are operating

AUTO BRAKE selector – OFF

Landing Gear lever – OFF

Climb Procedure

ENGINE ANTI–ICE switches.....ON

LANDING light switches.....OFF

When at transition altitude:

Barometric Standard Switch.....STD

Cruise Procedure

When established in a level attitude at cruise, if the center tank contains more than 1000 pounds/500 kilograms and the center tank fuel pump switches are OFF, set the center tank fuel pump switches ON again.

Set both center tank fuel pump switches OFF when center tank fuel quantity reaches approximately 1000 pounds/500 kilograms.

Descent Procedure

Prior to top of descent, modify active route as required for arrival and approach.

When cleared to descend, set clearance limit altitude on MCP.

VREF speed.....SET

Verify or enter VREF on the APPROACH REF page.

RADIO or BARO.....SET

AUTOBRAKE selector.....SET

Set or verify the navigation radios and course for the approach.

Approach Procedure

When at transition level, set all altimeters:

Altimeters.....SET

At 10,000 feet, position LANDING light switches ON.

Verify correct arrival and approach procedures selected.

Landing Procedure

Set or verify the navigation radios and course for the approach.

Flap lever.....SET

Transponder selector.....As desired

When on localizer intercept heading:

ILS tuned and identified.....CHECK

Verify that the ILS is tuned and identified

Verify that the LOC and G/S pointers are shown

Verify crossing altitude.

Use HDG SEL to intercept the final approach course as needed.

APP mode.....ARM

Verify that the localizer is captured.

Landing Gear lever.....DN

Verify that the green landing gear indicator lights are illuminated.

Speedbrake lever.....ARM

Verify that the SPEED BRAKE ARMED light is illuminated.

Flap lever.....Landing Position

Set the missed approach altitude on the MCP.

Monitor the approach.

Go-Around Procedure

TO/GA switch.....Push

Verify rotation to go-around attitude and thrust increase.

Verify thrust adequate for go-around; adjust if necessary.

Flap lever.....20

Positive rate of climb.....Established

Landing Gear lever.....UP

When above 400 feet radio altitude:

LNAV or HDG SEL.....As desired

Flap lever.....SET

After flap retraction,

VNAV or FLCH.....As desired

Landing Roll Procedure

Thrust levers.....Closed

Speedbrake lever.....UP

Reverse Thrust levers.....As desired

60 knots.....Call "60 KNOTS"

Reverse Thrust levers.....Down

AUTOBRAKES selector.....DISARM

Manual braking.....As desired

Autopilot.....Disengage

After Landing Procedure

Speedbrake lever.....DN

APU selector.....ON

PROBE HEAT switches.....OFF

LANDING light switches.....OFF

STROBE light switches.....OFF

AUTO BRAKE selector.....OFF

Flap lever.....UP

Transponder mode selector.....STBY

Shutdown Procedure

Start the Shutdown Procedure after taxi is complete.

Parking brake.....Set

Verify that the parking brake warning light is illuminated.

Electrical power.....Set

If APU power is needed:

Verify that the APU GENERATOR OFF BUS light is illuminated.

APU GENERATOR bus switches – ON

Verify that the SOURCE OFF lights are extinguished.

If external power is needed:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch – ON

Verify that the SOURCE OFF lights are extinguished.

Engine start levers.....CUTOFF

FASTEN BELTS switch.....OFF

ANTI COLLISION light switch.....OFF

FUEL PUMP switches.....OFF

[Option – 800/900/900ER]
CAB/UTIL power switch.....As needed

[Option – 800/900/900ER]
IFE/PASS SEAT power switch.....As needed

WING ANTI–ICE switch.....OFF

ENGINE ANTI–ICE switches .....OFF

Hydraulic panel.....Set

ENGINE HYDRAULIC PUMPS switches - OFF

ELECTRIC HYDRAULIC PUMPS switches - OFF

[Option – 600/700/700C/700ER/BBJ]
RECIRCULATION FAN switch.....As needed

[Option – 800/900/900ER/BBJ2/BBJ3]
RECIRCULATION FAN switches.....As needed

Air conditioning PACK switches.....AUTO

ISOLATION VALVE switch.....OPEN

Engine BLEED air switches.....OFF

APU BLEED air switch.....OFF

Exterior lights switches.....As needed

FLIGHT DIRECTOR switches.....OFF

APU switch.....OFF

Secure Procedure

IRS mode selectors.....OFF

EMERGENCY EXIT LIGHTS switch.....OFF

WINDOW HEAT switches.....OFF

Air conditioning PACK switches.....OFF

Intentionally
Blank

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Supplementary Procedures Introduction

Chapter SP
Section 05

General

This chapter contains procedures that are accomplished as required rather than routinely performed on each flight.

Procedures accomplished in flight, or those that are an alternate means of accomplishing normal procedures, are usually accomplished by memory. Infrequently used procedures, not normally accomplished are usually accomplished by reference.

Supplementary Procedures Chapter SP
Air Systems Section 2

Wing–Body Overheat Test

Wing–body OVHT TEST switch.....Push

Both WING–BODY OVERHEAT lights – illuminated

MASTER CAUTION – illuminated

AIR COND system annunciator – illuminated

Wing–body OVHT TEST switch.....Release

Both WING–BODY OVERHEAT lights – extinguished

MASTER CAUTION lights – extinguished

AIR COND system annunciator – extinguished

Pressurization System Manual Mode Test

PACK switches.....OFF

Pressurization mode selector.....MAN

MANUAL light – illuminated.

Outflow valve switch.....CLOSE

Verify outflow valve position indicator moves toward CLOSE.

Outflow valve switch.....OPEN

Verify outflow valve position indicator moves toward OPEN.

Pressurization mode selector.....AUTO

MANUAL light – extinguished.

Manual Mode Operation

Pressurization mode selector.....MAN

MANUAL light – illuminated

CABIN/FLIGHT ALTITUDE placard.....Check

Determine the desired cabin altitude.

If a higher cabin altitude is desired:

Outflow valve switch.....OPEN

Verify the outflow valve position indicator moves right, cabin altitude climbs at the desired rate, and differential pressure decreases.

If a lower cabin altitude is desired:

Outflow valve switch.....CLOSE

Verify the outflow valve position indicator moves left, cabin altitude descends at the desired rate, and differential pressure increases.

Supplementary Procedures Chapter SP
Anti–Ice, Rain Section 3

Anti–Ice Operation

Requirements for use of anti–ice and operational procedures for engine and wing anti–ice are contained in Supplementary Procedures, Adverse Weather Section SP.16.

Window Heat System Tests

Overheat Test

The overheat test simulates an overheat condition to check the overheat warning function of the window heat system.

WINDOW HEAT switches.....ON

WINDOW HEAT TEST switch.....OVHT

OVERHEAT lights – On

ON lights – Extinguish

MASTER CAUTION – On

ANTI–ICE system annunciator – On

WINDOW HEAT switches.....Reset

Position the WINDOW HEAT switches OFF, then ON.

Power Test

The power test verifies operation of the window heat system.

WINDOW HEAT switches.....ON

WINDOW HEAT TEST switch.....PWR

WINDOW HEAT ON lights.....Illuminated

Supplementary Procedures Automatic Flight

Chapter SP Section 4

Level Change Climb/Descent

ALTITUDE selector.....Set desired altitude

LVL CHG switch.....Push

Verify FMA display:

Thrust mode (climb) – N1

Thrust mode (descent) – RETARD then ARM

Pitch mode – MCP SPD

IAS/MACH Selector.....Set desired speed

Vertical Speed (V/S) Climb/Descent

ALTITUDE selector.....Set desired altitude

V/S thumbwheel.....Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH Selector.....Set desired speed

To transition to the vertical speed mode from another engaged climb or descent mode:

V/S mode switch.....Push

V/S climb mode engages at existing V/S.

V/S thumbwheel.....Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH Selector.....Set desired speed

Intervention of FMC Altitude Constraints during VNAV Climb

MCP altitude selector.....Set new altitude

New altitude must be higher than the FMC altitude constraint(s) to be deleted.

ALT INTV switch.....Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Cruise Altitude during VNAV Cruise

MCP altitude selector.....Set

ALT INTV switch.....Push

If a higher altitude is selected, a CRZ climb will be initiated.

If a lower altitude is selected within 50 NM of Top of Descent Point, an early descent will be initiated.

If a lower altitude is selected more than 50 NM of Top of Descent Point, a CRZ descent will be initiated.

Intervention of FMC Altitude Constraints during VNAV Descent

MCP altitude selector.....Set new altitude

New altitude must be lower than the FMC altitude constraint (s) to be deleted.

ALT INTV switch.....Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Airspeed Constraints during VNAV

SPD INTV switch.....Push

MCP IAS/MACH display shows current FMC target speed.

IAS/MACH Selector.....Set desired speed

VNAV remains engaged.

To resume former FMC speed:

SPD INTV switch.....Push

MCP IAS/MACH display blanks and FMC commanded VNAV speed is active.

Altitude Hold

Altitude HOLD switch.....Push

Verify FMA display:

Pitch mode – ALT HOLD

Heading Select

Heading selector.....Set desired heading

Heading select switch.....Push

Verify FMA display:

Roll mode – HDG SEL

VOR Navigation

VHF NAV radio(s).....Tune and Identify

COURSE selector.....Set desired course

When on an intercept heading to the VOR course:

VOR LOC mode switch.....Push

Verify VOR LOC armed mode annunciates.

A/P automatically captures the VOR course.

Verify VOR LOC engaged mode annunciates upon course capture.

Note: If change to a localizer frequency is desired when captured in the VOR mode, disengage VOR LOC mode prior to selection of the localizer. VOR LOC mode can then be reengaged.

Instrument Approach using Vertical Speed (V/S)

Note: Autopilot use is recommended until suitable visual reference is established.

Recommended roll modes: LNAV or HDG SEL.

Ensure appropriate navaids (VOR, LOC or NDB) are tuned and identified prior to commencing approach.

Before descent to MDA(H):

MCP altitude.....Set

Set the first intermediate altitude constraint or the MDA(H).

At descent point:

Desired V/S.....Set

Set desired V/S to descend to MDA(H). Use a V/S that results in no level flight segment at the MDA(H).

Verify V/S mode annunciates.

Approximately 300 feet above MDA(H):

MCP altitude.....Set missed approach altitude

At MDA(H)/missed approach point:

If suitable visual reference is not established, execute a missed approach.

After a suitable visual reference is established:

A/P disengage switch.....Push

Disengage the autopilot before descending below MDA(H).

A/T disengage switch.....Push

Disengage the autothrottle before descending below MDA(H).

Supplementary Procedures Chapter SP
Electrical Section 6

Electrical Power Up

The following procedure is accomplished to permit safe application of electrical power.

BATTERY switch.....Guard closed

STANDBY POWER switch.....Guard closed

ALTERNATE FLAPS master switch.....Guard closed

ELECTRIC HYDRAULIC PUMPS switches.....OFF

LANDING GEAR lever.....DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

If external power is needed:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch.....ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

If APU power is needed:

Verify that the engine No. 1, APU and the engine No. 2 fire switches are in.

OVERHEAT DETECTOR switches……...NORMAL

TEST switch……Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

Verify that the APU DET INOP light is illuminated.

TEST switch……...Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light……Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and the engine No. 2 fire switches stay illuminated.

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Verify that the WHEEL WELL light stays illuminated.

EXTINGUISHER TEST switch…….Check

TEST Switch…….Position to 1

Verify that the three green extinguisher test lights are illuminated.

Repeat for test position 2.

APU……..Start

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches……...ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

Wheel well fire warning system.....Test

Test switch……OVHT/FIRE

Verify fire warning bell sounds, master FIRE WARN lights, MASTER CAUTION lights and OVHT/DET annunciator illuminate.

Fire warning BELL CUTOUT switch……...Push

Verify that the master FIRE WARN lights extinguish.

Verify that the fire warning bell cancels.

Verify that the WHEEL WELL fire warning light is illuminated.

Electrical Power Down

This procedure assumes the Secure Procedure is complete.

APU switch and/or GRD POWER switch.....OFF

BATTERY switch.....OFF

Supplementary Procedures Chapter SP
Flight Management, Navigation Section 11

IRS

Align Light(s) Flashing

IRS.....OFF

Rotate IRS Mode Selector to OFF and verify ALIGN light extinguished.

IRS.....NAV

Rotate IRS Mode Selector to NAV and verify ALIGN light illuminated.

Set IRS position.....Enter present position

Enter present position. If ALIGN light flashes, re-enter same present position over displayed position.

Note: Approximately five to seventeen minutes are required for alignment.

Fast Realignment

Prior to commencing procedure the airplane must be parked and not moved until procedure is complete and ALIGN lights extinguish.

IRS mode selectors.....ALIGN

Observe ALIGN lights illuminate steadily.

CDU.....Set

Enter present position on SET IRS POS line of the POS INIT page.

IRS mode selector.....NAV

Observe ALIGN light extinguished within 10 seconds.

Note: If time permits it is preferable to perform a full alignment of the IRS. A more precise alignment will result.

IRS Entries

Present Position Entry

IRS mode selector.....NAV

ALIGN lights must be illuminated.

IRS display selector.....PPOS

Latitude.....Enter

Key–in latitude in the data display, beginning with N or S.

Longitude.....Enter

Key–in longitude in the data display, beginning with E or W, then press the ENT key (the cue lights extinguish). Observe that proper latitude and longitude are displayed and that the ALIGN light is not flashing.

Heading – Enter through CDU

FMC/CDU POS INIT page.....Select

Enter the correct heading into the CDU scratch pad then press line select key 5R. Verify entered heading appears on line 5R. Select HDG on the IRS display selector and verify that the entered heading is displayed on the navigation displays.

Heading – Enter through ISDU

IRS display selector.....HDG

Press the H key to initiate a heading entry.

Key–in present magnetic heading. Press the ENT key (the cue lights extinguish). Observe proper heading displayed on the navigation displays.

Lateral Navigation (LNAV)

Proceeding Direct to a Waypoint (overwrite)

RTE LEGS page.....Select

On page 1/XX, line 1L, enter desired waypoint over the presently active waypoint.

Correct any ROUTE DISCONTINUITY.

EXEC key.....Push

Observe the MOD RTE LEGS page changes to ACT.

Intercepting a Leg (Course) to a Waypoint

RTE LEGS page.....Select

On page 1/XX, line 1L, enter desired waypoint over presently active waypoint.

Observe INTC CRS prompt displayed in line 6R.

Enter the desired intercept course in the INTC CRS line.

Correct any ROUTE DISCONTINUITY.

EXEC key.....Push

Observe MOD RTE LEGS page changes to ACT.

LNAV may disengage after execution of an intercept leg to a waypoint. If LNAV disengages, turn to a heading to satisfy LNAV capture criteria, as described in Chapter 11, and then engage LNAV.

Route Removal

RTE page.....Select

ORIGIN.....DELETE

Determining ETA and Distance to Cross Radial (Bearing) or Distance from a Fix

FIX INFO page.....Select

Enter the identifier of the reference waypoint (normally an off–route waypoint) onto the FIX line. Enter the desired radial or distance from the FIX on a RAD/DIS line, or line select the ABEAM prompt if the desired radial from the FIX is perpendicular to the present route/course.

Time and distance to go.....Check

Check ETA and DTG, as desired.

Note: If ETA and DTG are not displayed, the fix radial and/or distance do not intersect the route.

Changing Destination

RTE page.....Select

Enter the new destination over the original DEST. Enter desired routing to the new destination using the RTE, RTE LEGS, and ARRIVALS pages, as appropriate. Correct any ROUTE DISCONTINUITY.

EXEC key.....Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT.

Entering Holding Fix Into Route

HOLD key.....Push

(If RTE HOLD page is displayed, observe NEXT HOLD prompt. Line select 6L until (RTE LEGS) HOLD AT page is displayed.)

Observe HOLD AT box prompts and PPOS prompt (if in flight) are displayed. Enter the holding fix in line 6L, or line select PPOS.

If the holding fix is a waypoint in the active route, or PPOS was selected, observe MOD RTE HOLD page displayed. If the holding fix is a waypoint not in the active route, observe message HOLD AT XXXXX displayed in the scratch pad. Enter the holding fix into the route by line selecting in the desired waypoint sequence. Observe the MOD RTE HOLD page displayed. If displayed holding details are incorrect or inadequate, enter correct information on appropriate line(s).

EXEC key.....Push

Observe MOD RTE HOLD page changes to RTE HOLD (ACT RTE HOLD if holding at PPOS).

Exiting Holding Pattern

HOLD key.....Push

Observe EXIT HOLD prompt displayed.

EXIT HOLD line select key.....Push

Observe EXIT HOLD prompt changes to EXIT ARMED.

EXEC key.....Push

Observe EXIT ARMED prompt displayed and LNAV flight returns to the holding fix and resumes the active route.

Entering Created Waypoints on the Route or Route Legs Pages

RTE or RTE LEGS page.....Select

Using any of the following methods, key into the scratch pad the parameters which define the new created waypoint:

- Place bearing/distance (for example, SEA250/40);
- Place bearing/place bearing (for example, SEA180/ELN270);
- Latitude and longitude (for example, N4731.8W12218.3).

Enter into the route by line selecting to the appropriate waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITY.

EXEC key.....Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT (for an inactive route, activate and execute on the RTE or RTE LEGS page).

Entering a Lateral Offset

RTE page.....Select

Observe the OFFSET prompt displayed.

LATERAL OFFSET page.....Select

Observe dash prompts for OFFSET DIST.

OFFSET DIST.....Enter

Enter desired offset distance using format Lxx or Rxx for left or right offset up to 99 nm. Observe dash prompts for START WAYPOINT and END WAYPOINT.

START/END WAYPOINT.....Enter

If no start/end waypoint is entered, offset will begin/end at first/last valid offset leg.

Change SID or Runway

This entire procedure must be accomplished when a SID is used and the runway or SID is changed.

DEPARTURES page.....Select

RUNWAY.....Reselect

SID.....Reselect

TRANSITION (if required).....Reselect

RTE LEGS page.....Select

WAYPOINT SEQUENCE and ALTITUDES.....Check

Modify as necessary to agree with clearance.

EXEC key.....Push

Change STAR or APP

The associated airport must be entered as route origin or destination.

ARRIVAL page.....Select

STAR or PROFILE DESCENT (if required).....Select

TRANSITION (if required).....Select

APPROACH.....Select

APPROACH TRANSITION (if required).....Select

RTE LEGS page.....Select

WAYPOINT SEQUENCE.....CHECK

Modify as necessary to agree with clearance.

EXEC key.....Push

Other Operations

FMC Navigation Check

If the GPS-L INVALID, GPS-R INVALID, VERIFY POSITION, or UNABLE REQD NAV PERF – RNP message is displayed in the scratch pad, or course deviation is suspected, accomplish the following as necessary to ensure navigation accuracy:

Actual position.....Determine and compare with FMC position

Determine actual airplane position using raw data from VHF navigation or ADF radios.

If radio navaids are unavailable:

FMC position.....Compare with the IRS position

Use the POS SHIFT page of the FMC CDU. If the two IRS positions are in agreement and the FMC position is significantly different, the FMC position is probably unreliable.

Actual position.....Confirm with ATC radar or visual reference points.

CAUTION: Navigating in LNAV mode with an unreliable FMC position may result in significant navigation errors.

Inhibiting VOR/DME Use for Position Updating

Note: This procedure inhibits the use of VOR/DME information for FMC position updating. Use DEL key to remove a VOR/DME from inhibit status.

PROG page.....Select

Observe NAV STATUS prompt displayed.

NAV STATUS page.....Select

NAV OPTIONS page.....Select (NEXT/PREV page)

Observe dash prompts for VOR/DME INHIBIT. Enter desired VOR/DME identifier.

Inhibiting GPS Updating

PROG page.....Select

Observe NAV STATUS prompt displayed.

NAV STATUS page.....Select

NAV OPTIONS page.....Select (NEXT/PREV page)

GPS UPDATE.....OFF

Vertical Navigation (VNAV)

Temporary Level Off during Climb or Descent (Not at FMC Cruise Altitude)

MCP altitude selector.....Set desired altitude

Observe VNAV ALT on flight mode annunciator as level off is initiated.

To continue climb/descent:

MCP altitude selector.....Set desired altitude

Observe climb or descent initiated. Mode annunciations appear as initial climb or descent.

Intervention of FMC Altitude Constraints during VNAV Climb

MCP altitude selector.....Set new altitude

New altitude must be higher than the FMC altitude constraint(s) to be deleted.

ALT INTV switch.....Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Cruise Altitude during VNAV Cruise

MCP altitude selector.....Set

ALT INTV switch.....Push

If a higher altitude is selected, a CRZ climb will be initiated.

If a lower altitude is selected within 50 NM of Top of Descent Point, an early descent will be initiated.

If a lower altitude is selected more than 50 NM of Top of Descent Point, a CRZ descent will be initiated.

Intervention of FMC Altitude Constraints during VNAV Descent

MCP altitude selector.....Set new altitude

New altitude must be lower than the FMC altitude constant (s) to be deleted.

ALT INTV switch.....Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Airspeed Constraints during VNAV

SPD INTV switch.....Push

MCP IAS/MACH display shows current FMC target speed.

MCP speed selector.....Set desired speed

VNAV remains engaged.

To resume former FMC speed:

SPD INTV switch.....Push

MCP IAS/MACH display blanks and FMC commanded VNAV speed is active.

Entering Waypoint Speed and Altitude Restriction (On Climb or Descent Legs Only)

RTE LEGS page.....Select

Key–in desired speed and altitude, or speed only (followed by /), or altitude only, into scratch pad.

An altitude followed by A or B signifies a requirement to be “at or above” or “at or below” that altitude at the waypoint (for example, key–in 220A or 240B).

Line select to desired waypoint line.

EXEC key.....Push

Observe MOD RTE LEGS page changes to ACT.

Deleting Waypoint Speed and Altitude Restriction

RTE LEGS page.....Select

Push DEL key to enter DELETE in scratch pad. Line select to appropriate waypoint line.

EXEC key.....Push

Observe MOD RTE LEGS page changes to ACT and restriction is deleted and replaced with an FMC predicted value (small size characters).

Changing Speed and/or Altitude Restriction during Climb or Descent

CLB/DES page..... .....Select

Push DEL key to enter DELETE in the scratch pad, or key–in the desired speed and altitude in the scratch pad. Line select to the SPD REST line.

EXEC key.....Push

Observe the MOD CLB or the MOD DES page changes to ACT and the restriction is changed or deleted.

Changing Climb/Cruise/Descent Speed Schedule

CLB/CRZ/DES page.....Select

Select the prompt for the desired climb/cruise/descent schedule, or key–in the desired speed in the scratch pad and line select to the TGT SPD line.

EXEC key.....Push

Observe the MOD CLB, MOD CRZ, or MOD DES page changes to ACT and new speed schedule is specified.

Early Descent

MCP altitude selector.....Set

Set next level–off altitude.

DES page.....Select

Line select DES NOW prompt.

EXEC key.....Push

Observe MOD DES page changes to ACT. Observe descent is initiated (if VNAV engaged).

Step Climb or Descent from Cruise

MCP altitude selector..... .....Set

Set new level–off altitude.

CRZ page.....Select

Enter new altitude on the CRZ ALT line. The display changes to MOD CRZ CLB or MOD CRZ DES.

If the desired climb/descent speed is different from the displayed cruise speed, manually enter the desired TGT SPD, or use access prompts to select desired CLB/DES page.

EXEC key.....Push

Observe the MOD CRZ CLB/MOD CRZ DES page (or other selected MOD CLB/MOD DES page) changes to ACT. Observe climb/descent is initiated at the TGT SPD (if VNAV engaged).

Performance and Progress Functions

Estimated Wind Entries for Cruise Waypoints

RTE LEGS page.....Select

Observe the DATA prompt displayed.

RTE DATA page.....Select

Enter the estimated true wind direction/speed on the appropriate line(s).

Entering Descent Forecasts

DES page.....Select

Observe FORECAST prompt displayed.

DES FORECASTS page.....Select

Verify the TRANS LVL and revise if required. Enter average ISA DEV forecast for descent. Enter forecast descent WINDs (for up to three different altitudes).

EXEC key.....Push

Observe MOD DES FORECASTS page changes to ACT.

Engine Out

Engine out climb and cruise pages provide advisory information for engine out operation. Refer to section 11.41 and 11.42 for a complete description of ENG OUT CLB and ENG OUT CRZ pages.

Required Time of Arrival (RTA)

Note: An active FMC flight plan complete with all performance data must exist before the required time of arrival (RTA) mode can be used.

Entering an RTA Waypoint and Time

RTA PROGRESS page.....Select

On PROGRESS page 3, line 1L, enter the flight plan waypoint where required time of arrival is applicable. Observe the MOD RTA PROGRESS page displayed with the computed ETA, for the entered waypoint, displayed in line 1R.

RTA.....Enter

Enter required time of arrival into line 1R. Time should be entered in hours, minutes, and seconds (Examples: 174530, 1745, 1745.5). Observe MOD RTA PROGRESS page displayed with pertinent data for complying with entered RTA. Observe EXEC key illuminated.

EXEC key.....Push

Observe ACT RTA PROGRESS page displayed.

Entering Speed Restrictions for RTA Navigation

PERF LIMITS page.....Select

Enter minimum or maximum speed restriction for RTA navigation in lines 2, 3, or 4 depending on phase of flight.

Note: Entered restrictions on line 2, 3, and 4 also restrict other navigation modes such as ECON.

Entering New Time Error Tolerances for RTA Navigation

PERF LIMITS page.....Select

Enter desired time error tolerance (5 to 30 seconds) for the RTA waypoint on line 1L (Example: 25).

Additional CDU Functions

Navigation Display Plan Mode (Center Step Operation)

EFIS Control Panel Mode Selector.....PLAN

RTE LEGS page.....Select

EFIS Control Panel Range Selector.....As required

MAP CTR STEP key.....Push

Each push moves the CTR label to the next geographically fixed waypoint in the route.

EFIS Control Panel Mode Selector.....As required

Supplementary Procedures Chapter SP
Fuel Section 12

Fuel Balancing

If the center tank contains fuel:

Center tank fuel pump switches.....OFF

Fuel CONFIG indication may be displayed with fuel in the center tank.

Crossfeed selector.....Open

Fuel pump switches (low tank).....OFF

When quantities are balanced:

Fuel pump switches (main tank).....ON

Center tank fuel pump switches.....ON

Crossfeed selector.....Close

If the center tank contains no fuel:

Crossfeed selector.....Open

Fuel pump switches (low tank).....OFF

When quantities are balanced:

Fuel pump switches.....ON

Crossfeed selector.....Close

Supplementary Procedures Chapter SP
Adverse Weather Section 16

Introduction

Airplane operation in adverse weather conditions may require additional considerations due to the effects of extreme turbulence. Procedures in this section supplement normal procedures and should be observed when applicable.

Turbulence

During flight in light to moderate turbulence, the autopilot and/or autothrottle may remain engaged unless performance is objectionable. Increased thrust lever activity can be expected when encountering wind, temperature changes and large pressure changes. Short–time airspeed excursions of 10 to 15 knots can be expected.

Passenger signs.....ON

Advise passengers to fasten seat belts prior to entering areas of reported or anticipated turbulence. Instruct flight attendants to check that all passengers' seat belts are fastened.

Severe Turbulence

Yaw Damper.....ON

Autothrottle.....Disengage

AUTOPILOT.....Disengage

Thrust.....Set

Set thrust as needed for the phase of flight.

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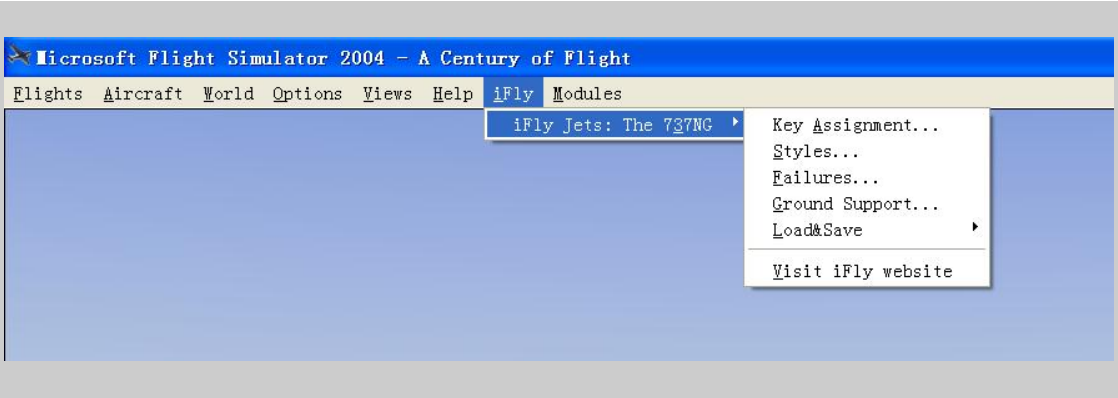
Airplane General iFly Jets: The 737NG OPTION MENU

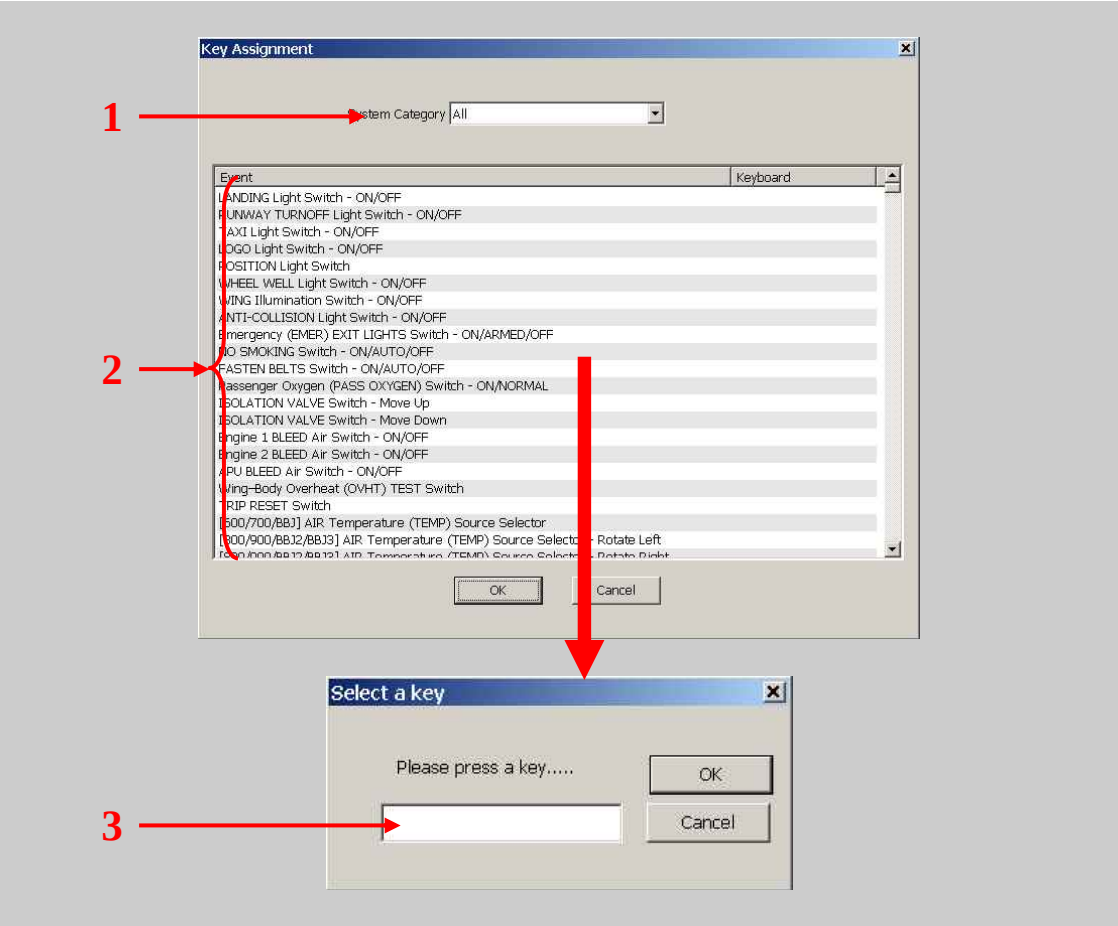
Chapter 1
Section 10

FS MENU



The **iFly Jets: The 737NG**'s option menu can be found from the FS option menu named "iFly". Note, the "**iFly Jets: The 737NG**" menu item is available only when the current selected aircraft is **iFly Jets: The 737NG**, otherwise it is disabled.

Key Assignment



1. System Category

Select the system category for the corresponding list of events.

2. Event

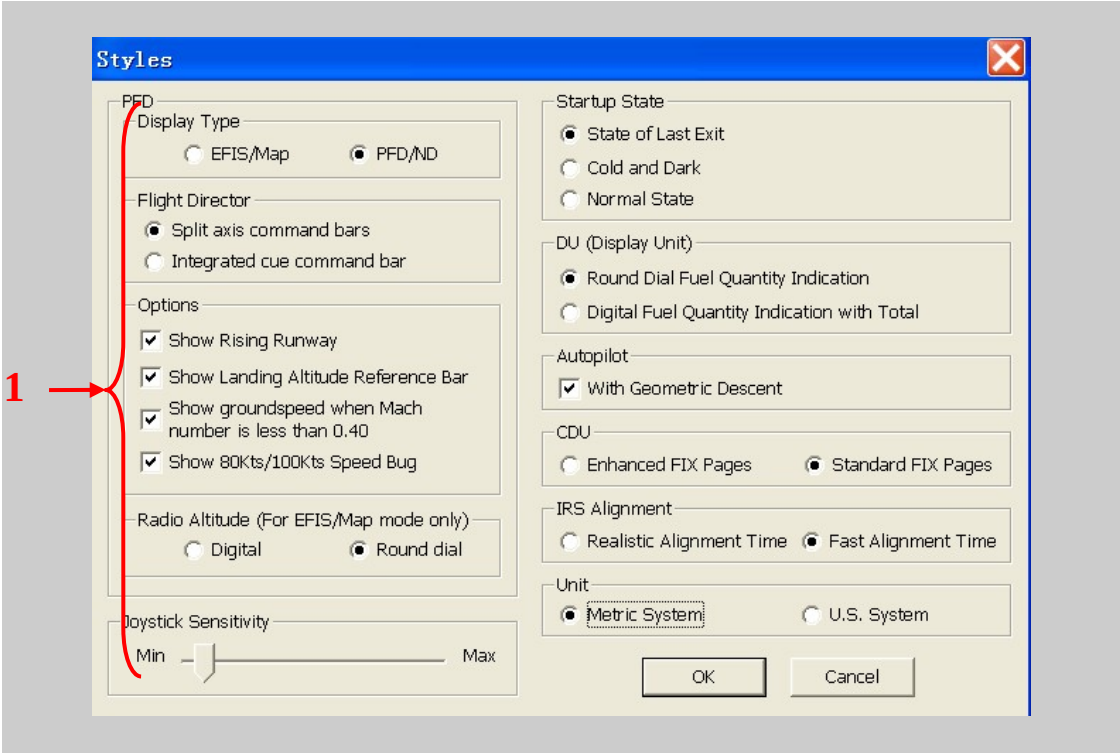
List of available system events for the chosen system category.

Double click - activate “Select a key” dialog for the event.

3. Key assignment

Insert desired key for the chosen event, then click OK to finish the key assignment.

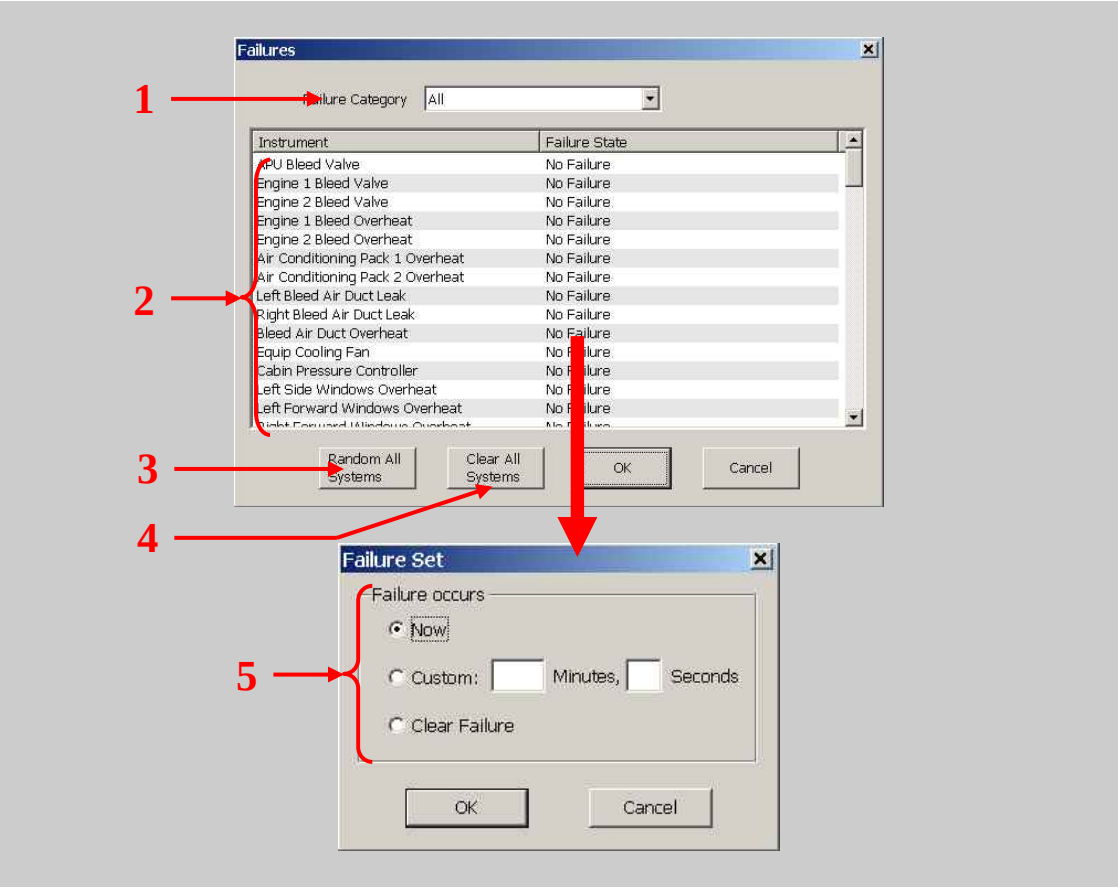
Styles



1. Styles

Select the desired style for the avionic gauges.

Failures



1. Failure Category

Select the system category for the corresponding list of events.

2. Failure list

List of available instrument failures that corresponds to chosen failure category.

Double click - activate “Failure Set” dialog for the event.

3. Random All System

Activate random system failures.

4. Clear All System

Remove all current activated system failures.

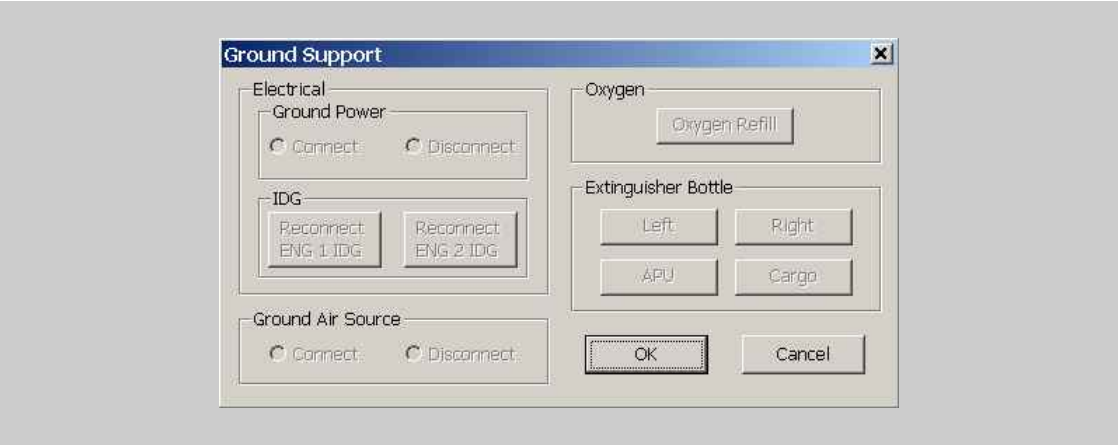
5. Failure occurs

Now – Failure occurs immediately

Custom – Failure will occur at chosen time.

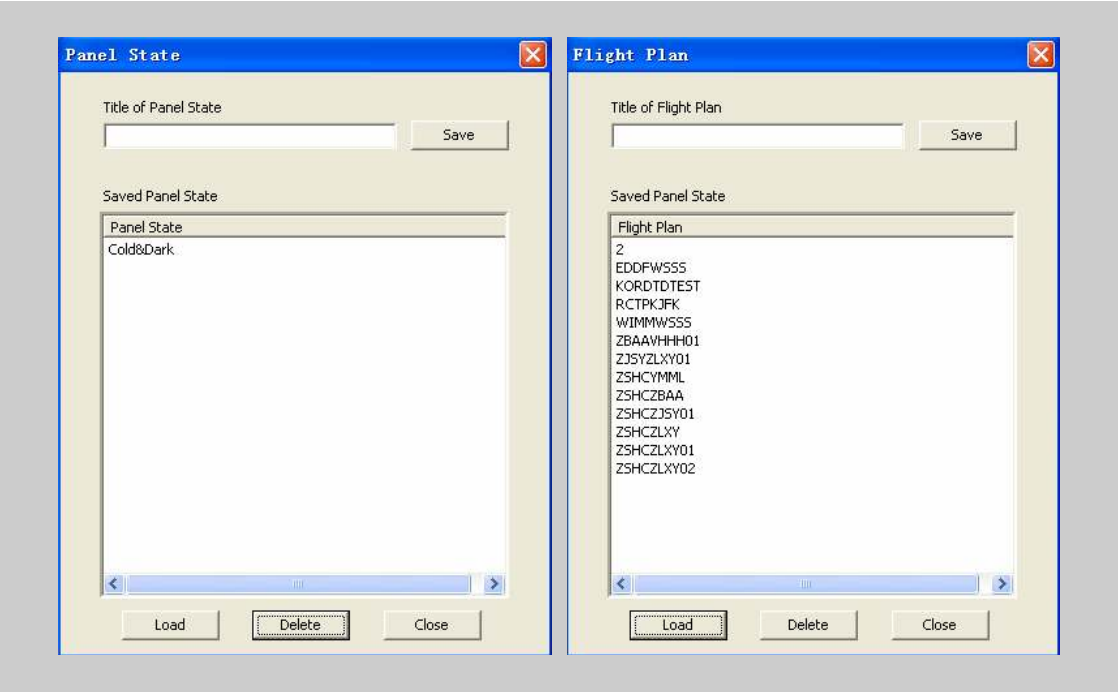
Clear Failure – Remove activated failure.

Ground Support



The ground support menu provides setting for ground services. They are disabled when services are not available.

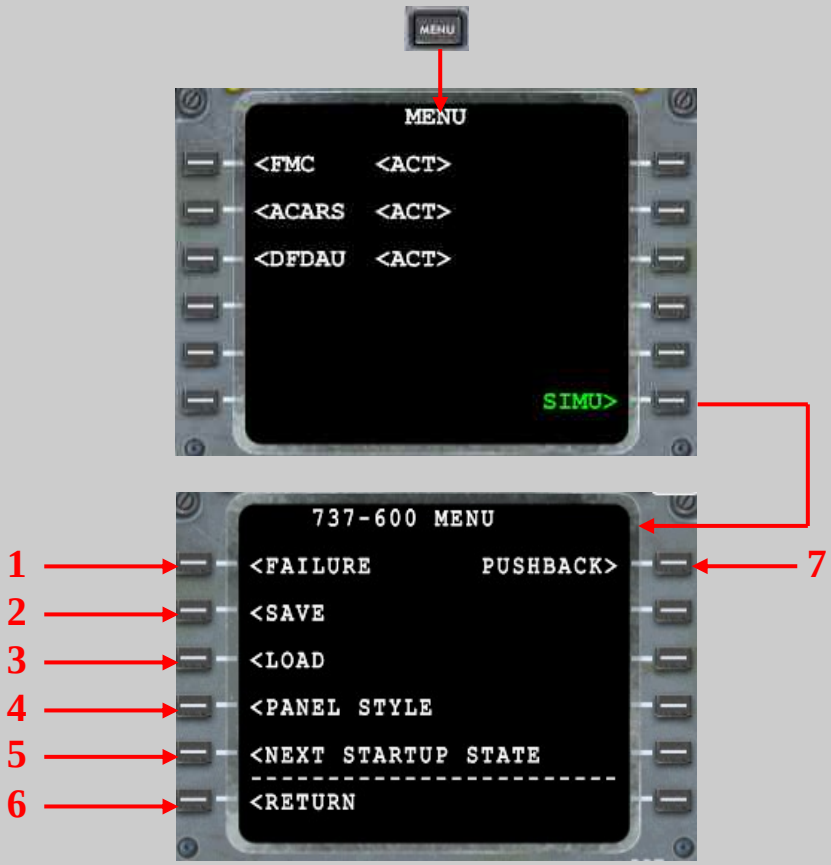
Load&Save



This page provides settings for Panel State and Flight Plan. Through the settings, you can create, load, or delete your desired panel state or flight plan. All saved panel states and flight plans can also be removed manually from the FS installation directory at: \FS\iFly\737NG\navdata\PANEL, and \FS\iFly\737NG\navdata\FLYPLAN.

SIM MENU

SIM MENU is essentially same as settings that are available under the iFly option on the FS menu.



CDU

1. FAILURE

Push – Access to FAILURE page. Refer to chapter 16.

2. SAVE

Push – Access to SAVE page. It is used to save route plans or panel state.

3. LOAD

Push – Access to LOAD page. It is used to load route plans or panel state.

4. PANEL STYLE

Push – Access to PANEL STYLE page. It is used to select the panel style.

5. SELECT NEXT STARTUP STATE

Push – Access to SELECT NEXT STARTUP page. It is used for selecting the state of next startup.

6. RETURN

Push – Return to SIMS page.

7. PUSHBACK

Push – Access to PUSHBACK page.

SAVE

Push left 2 key from SIM MENU page to enter the SAVE AS page. To save route or panel state, first enter the file name by pushing left 1 key, and then pushing the SAVE RTE key or SAVE PANEL STATE key respectively. After that, a file will be created.

CDU

1. FILE NAME

Enter the file name with maximum 12 characters.

2. RETURN

Push – Return to SIM MENU page.

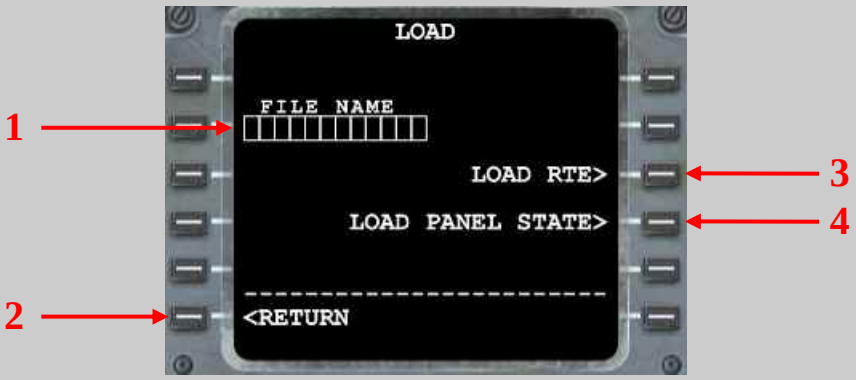
3. SAVE RTE

Push – Save the route if the file name is valid.

4. SAVE PANEL STATE

Push – Save the panel state if the file name is valid.

LOAD



CDU

1. FILE NAME

Enter the file name with maximum 12 characters

2. RETURN

Push – Return to SIM MENU page.

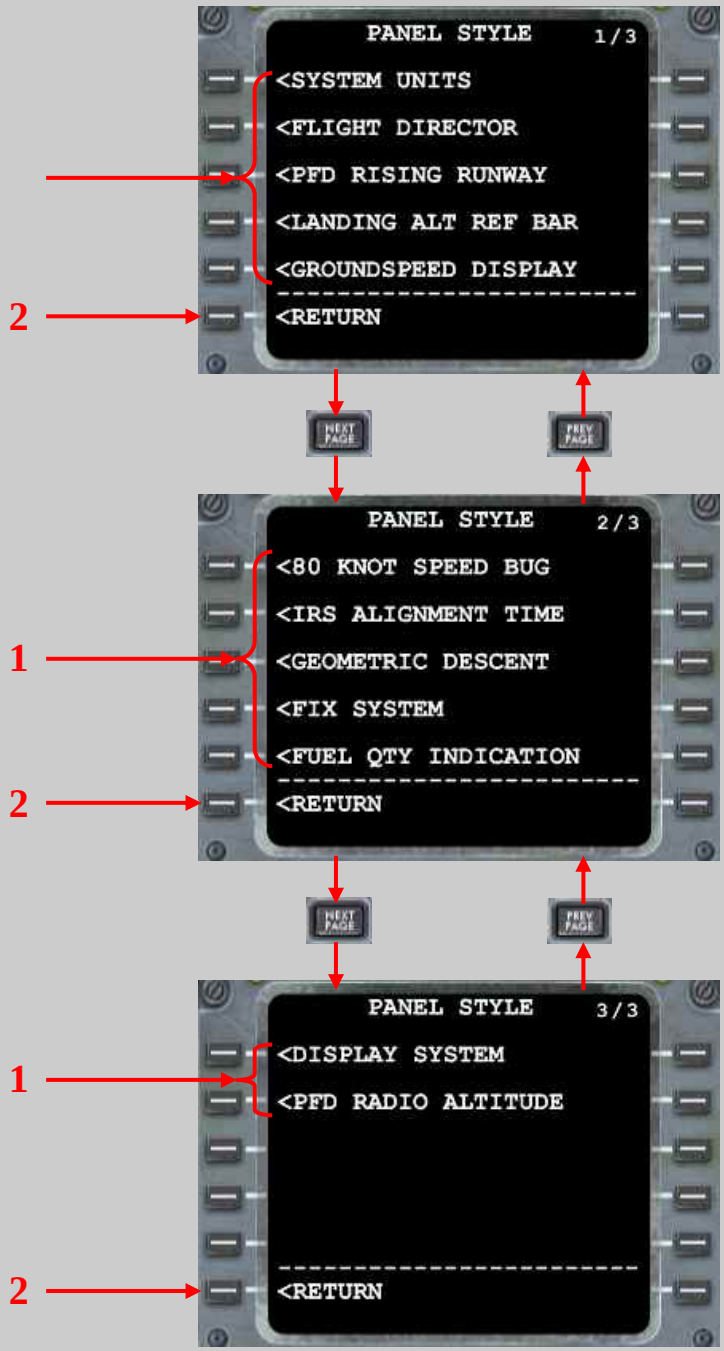
3. LOAD RTE

Push – Load route if the file name is valid.

4. LOAD ANEL STATE

Push – Load the panel state if the file name is valid.

PANEL STYLE



CDU

1. Selection list

Push – Access to the page with specified panel style selection.

2. RETURN

Push – Return to SIMS page.

PANEL STYLE SELECTION PAGE

CDU

1. Selection list

Push –Select particular panel style.

2. RETURN

Push - Return to PANEL STYLE page.

3. <SEL>

Selecting an option displays <SEL> inboard of the option.

SELECT NEXT STARTUP STATE

CDU

1. COLD AND DARK

Push – Cold and dark cockpit state on next gauge startup.

2. NORMAL STATE

Push – Normal cockpit state on next gauge startup

3. STATE OF LAST EXIT

Push – Load up the last cockpit state as for the next gauge startup.

4. RETURN

Push – Return to SIMS page.

Airplane General Flight Deck Panels

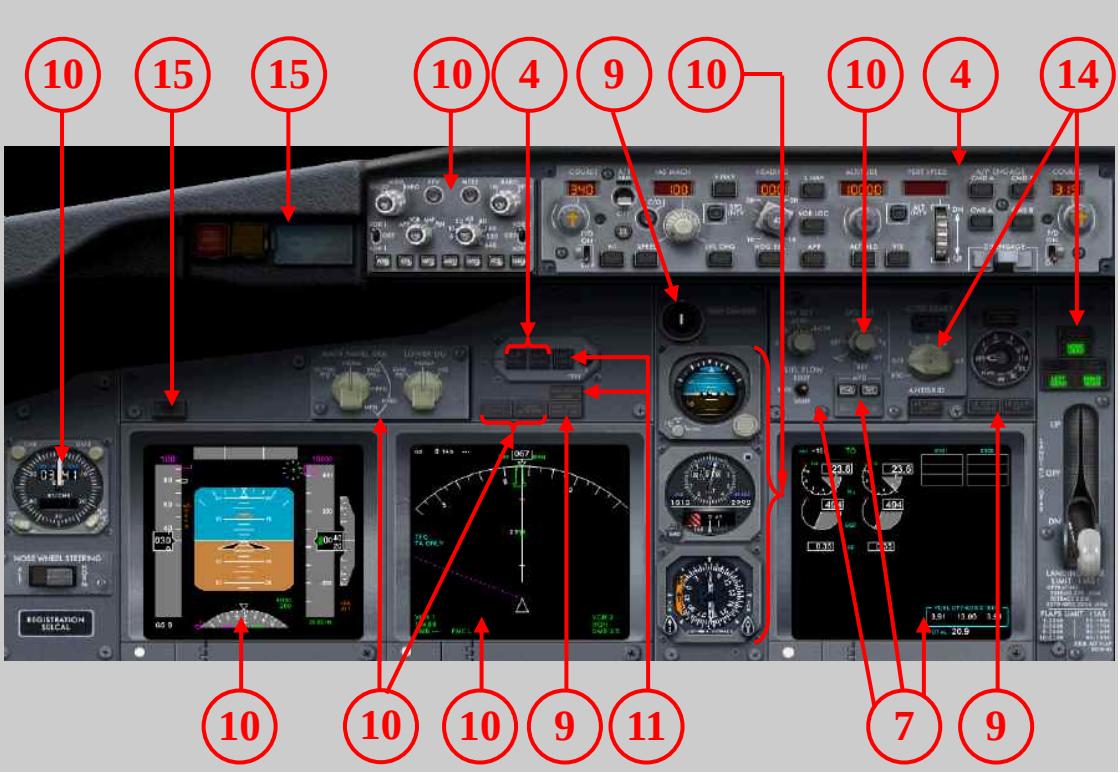
Chapter 1 Section 20

General

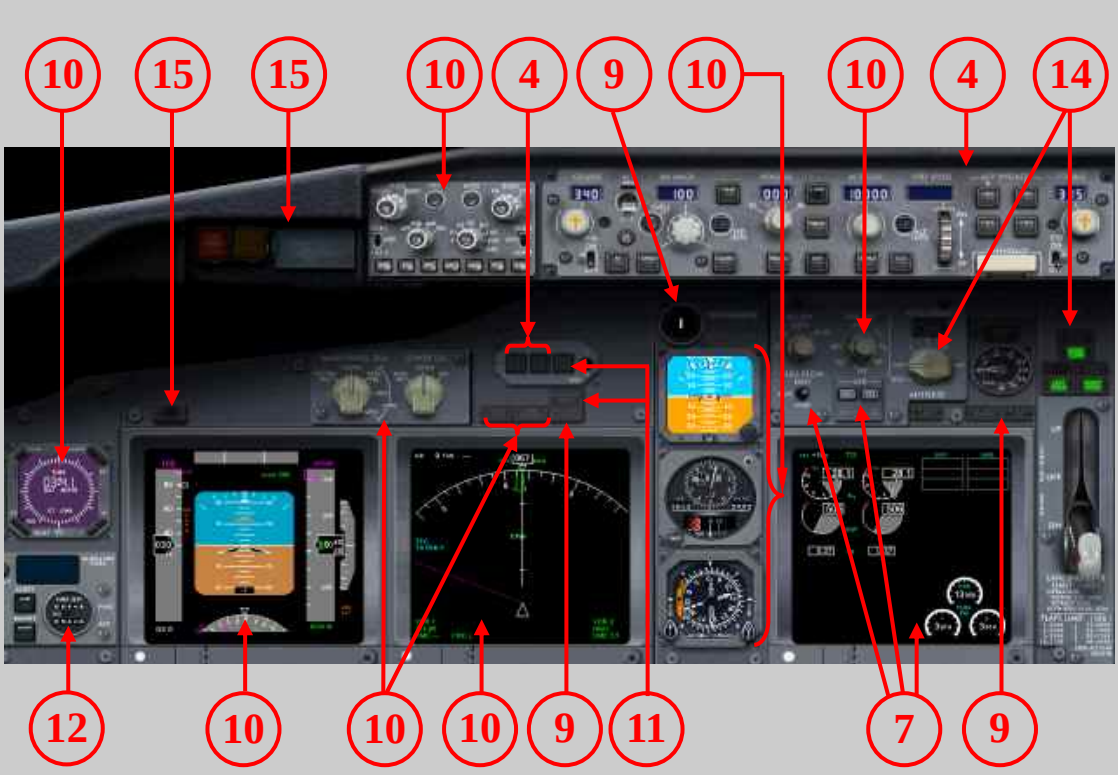
On the following pages, circled numbers refer to chapters where information on each item may be found.

Captain Panel
VFR Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]

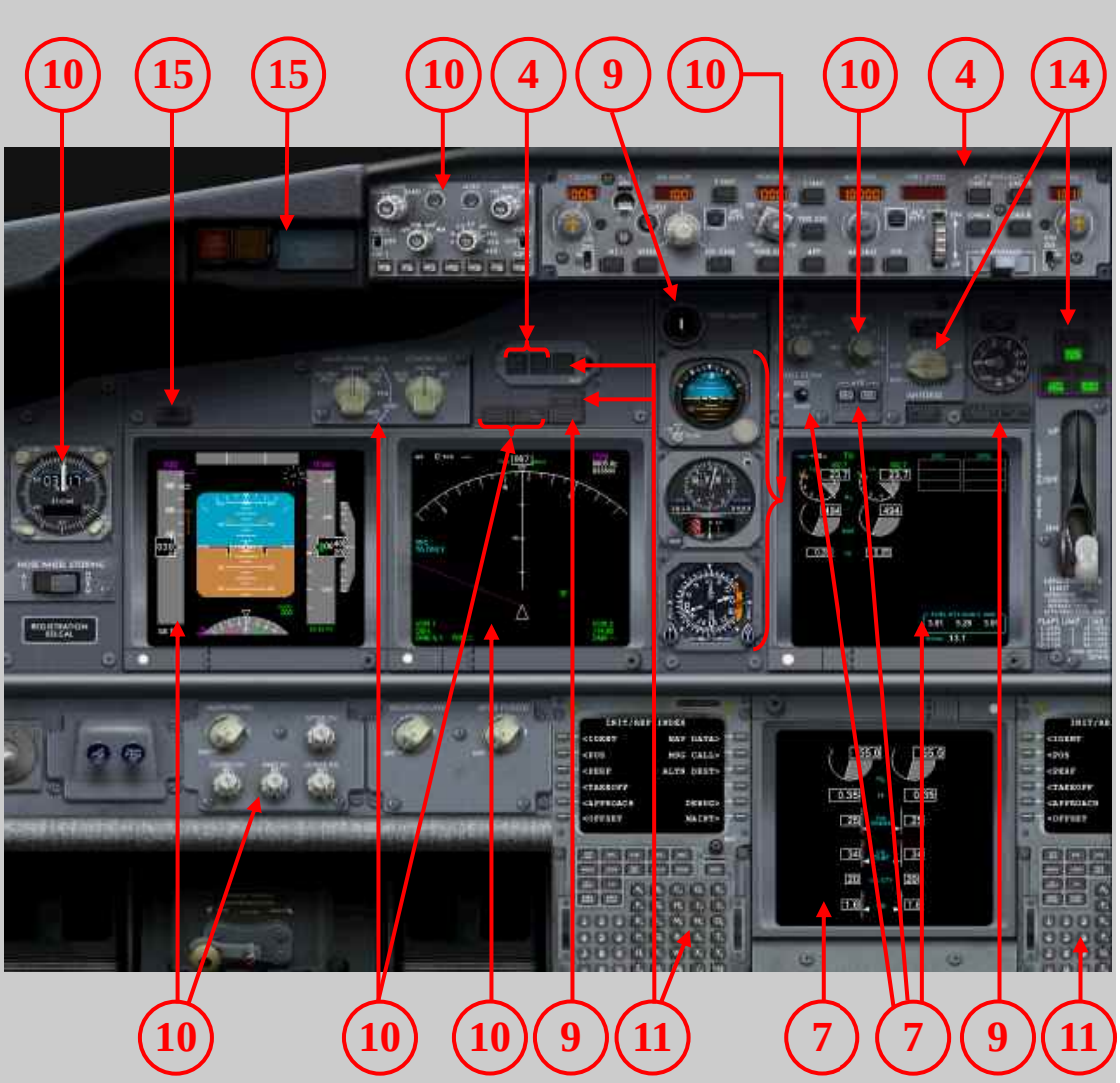


[Option – BBJ/BBJ2/BBJ3]

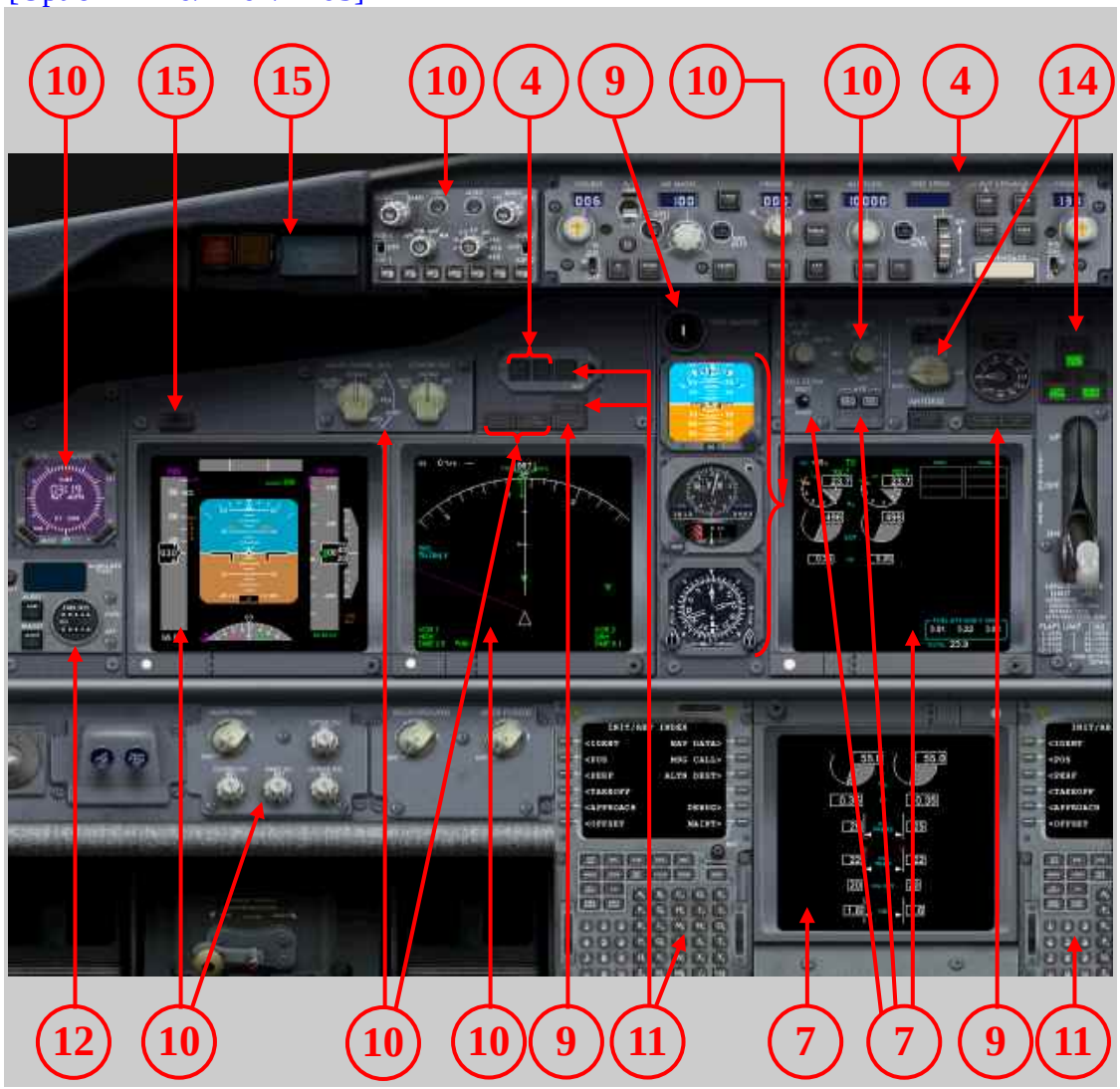


IFR Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]

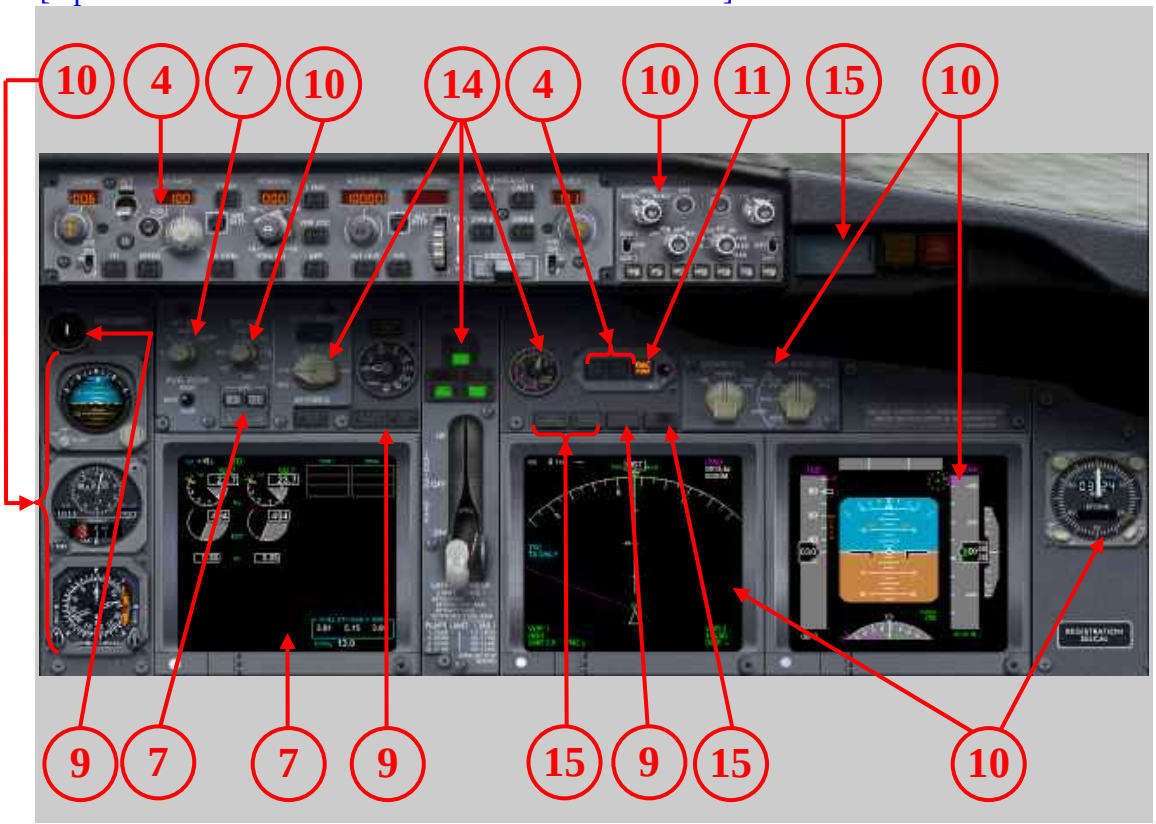


[Option – BBJ/BBJ2/BBJ3]

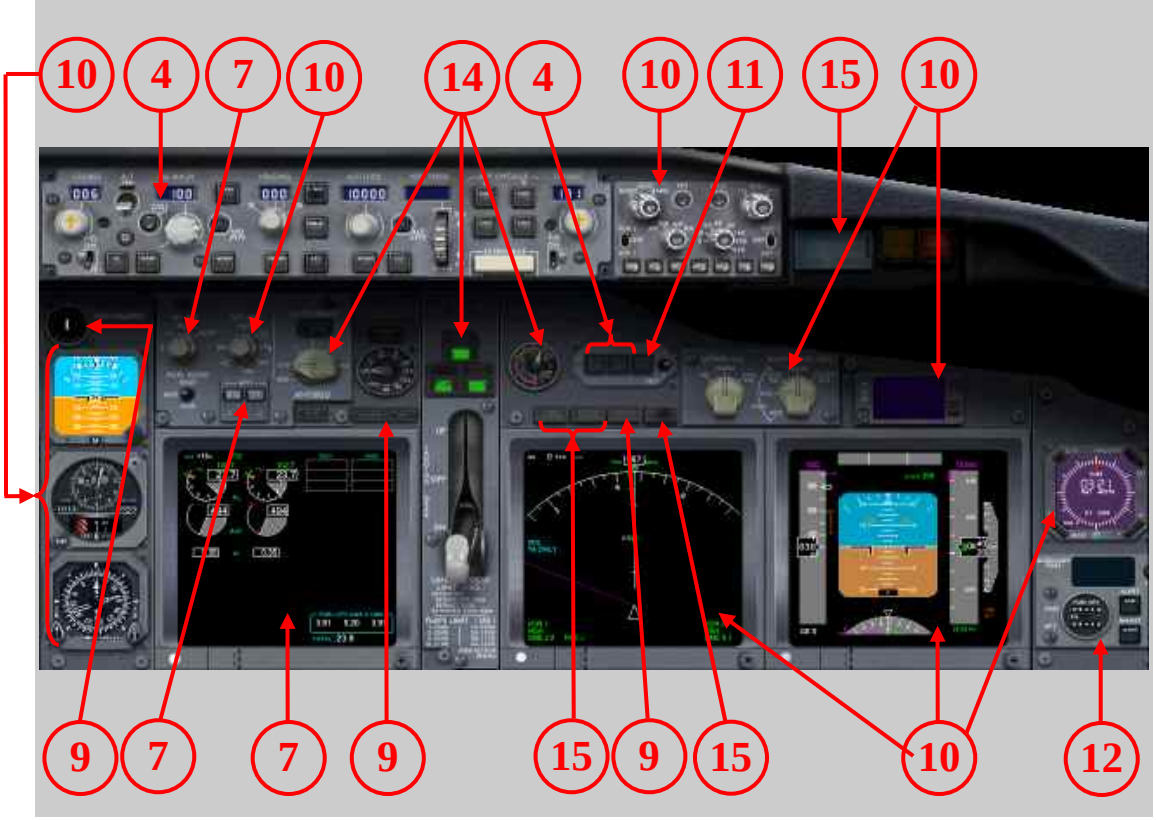


First Officer Panel
VFR Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]

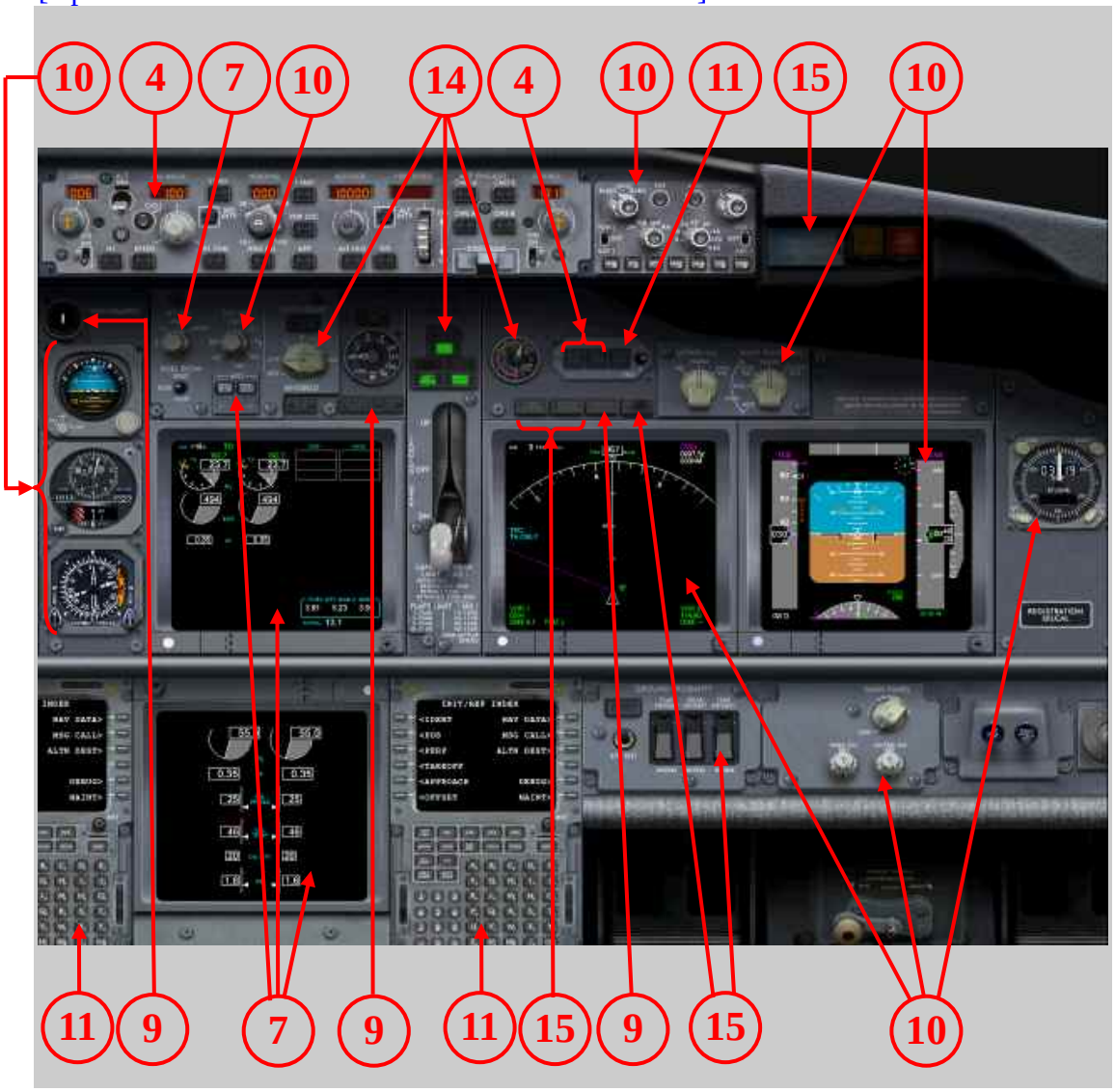


[Option – BBJ/BBJ2/BBJ3]

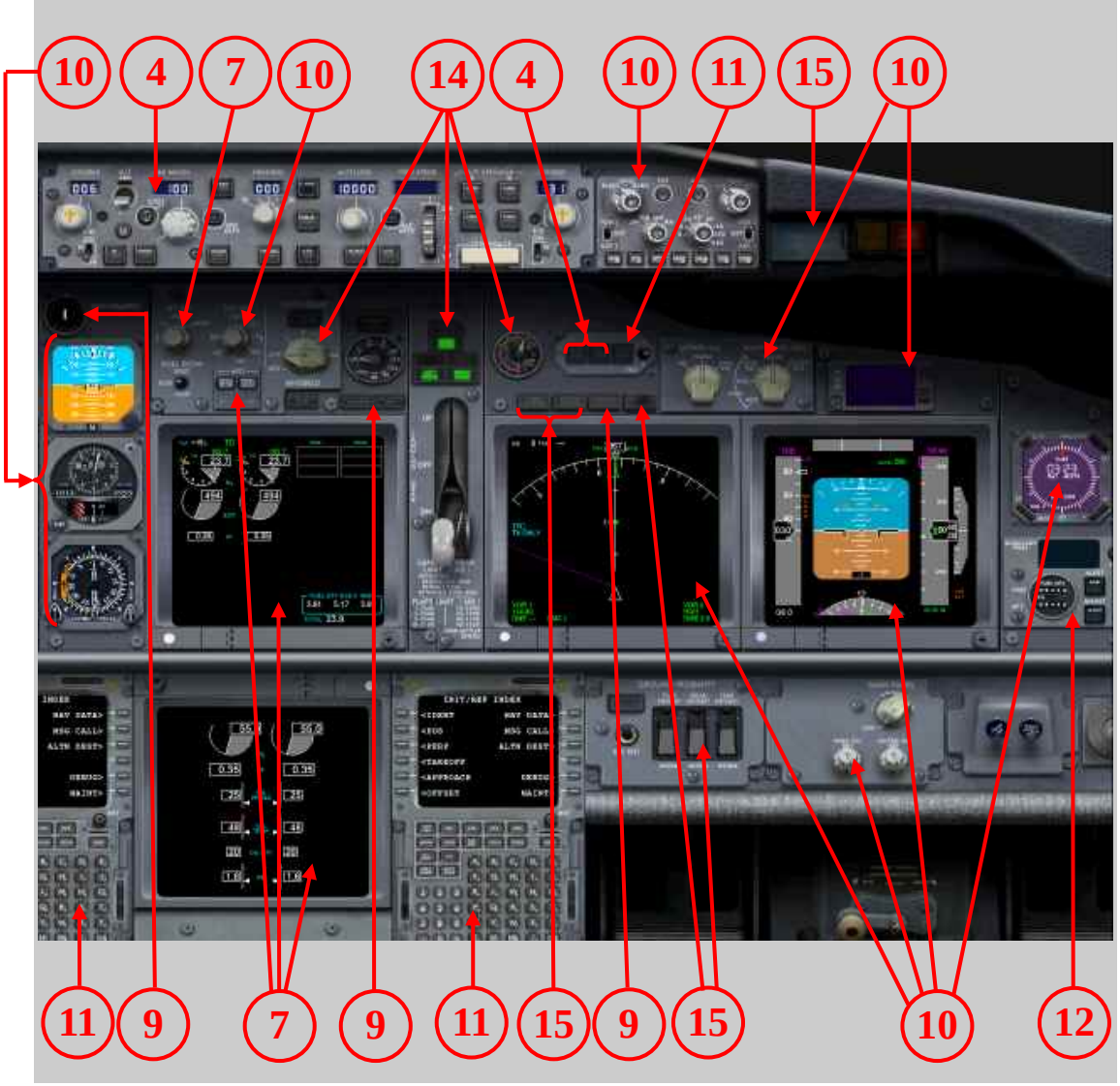


IFR Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]

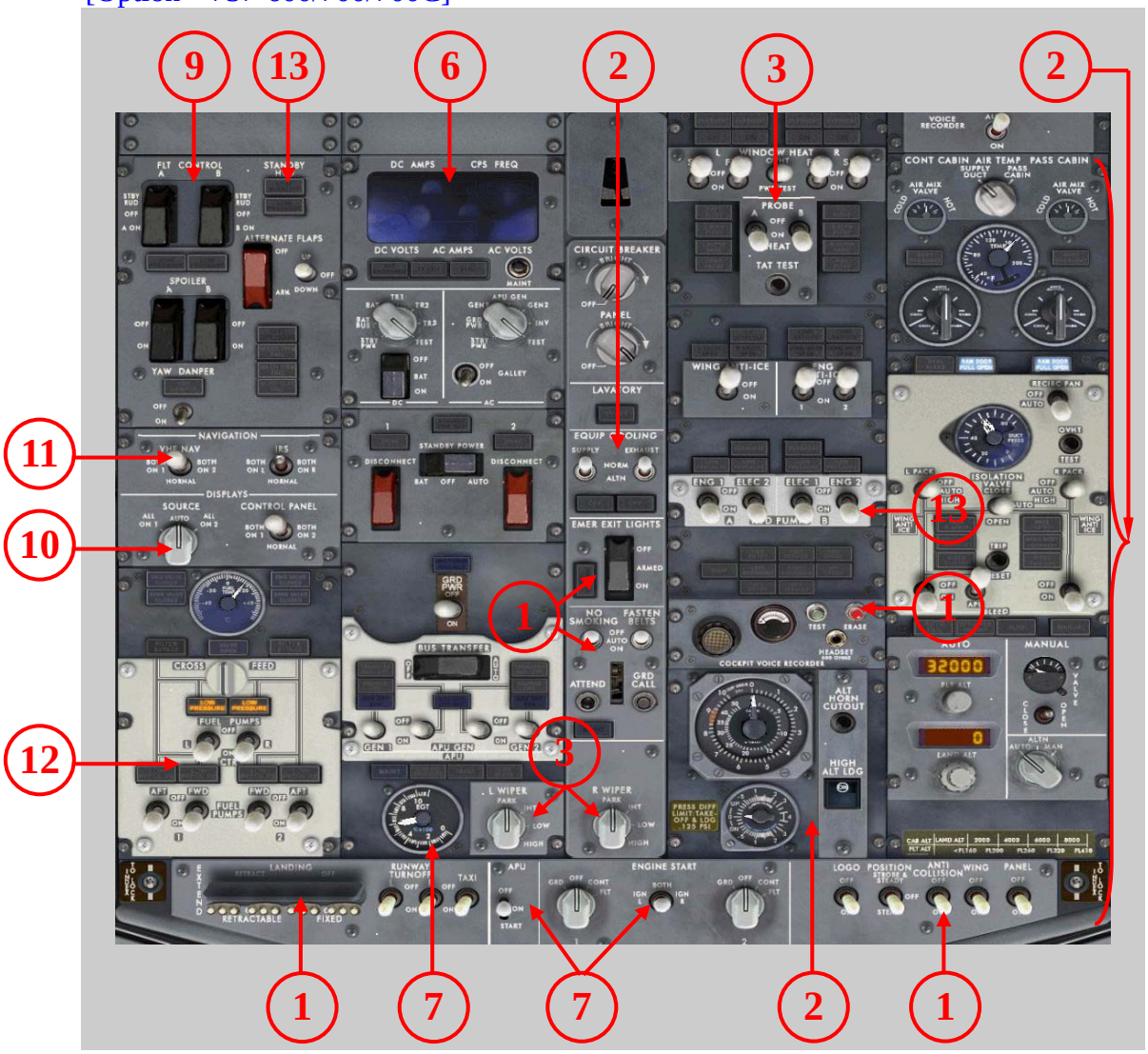


[Option – BBJ/BBJ2/BBJ3]

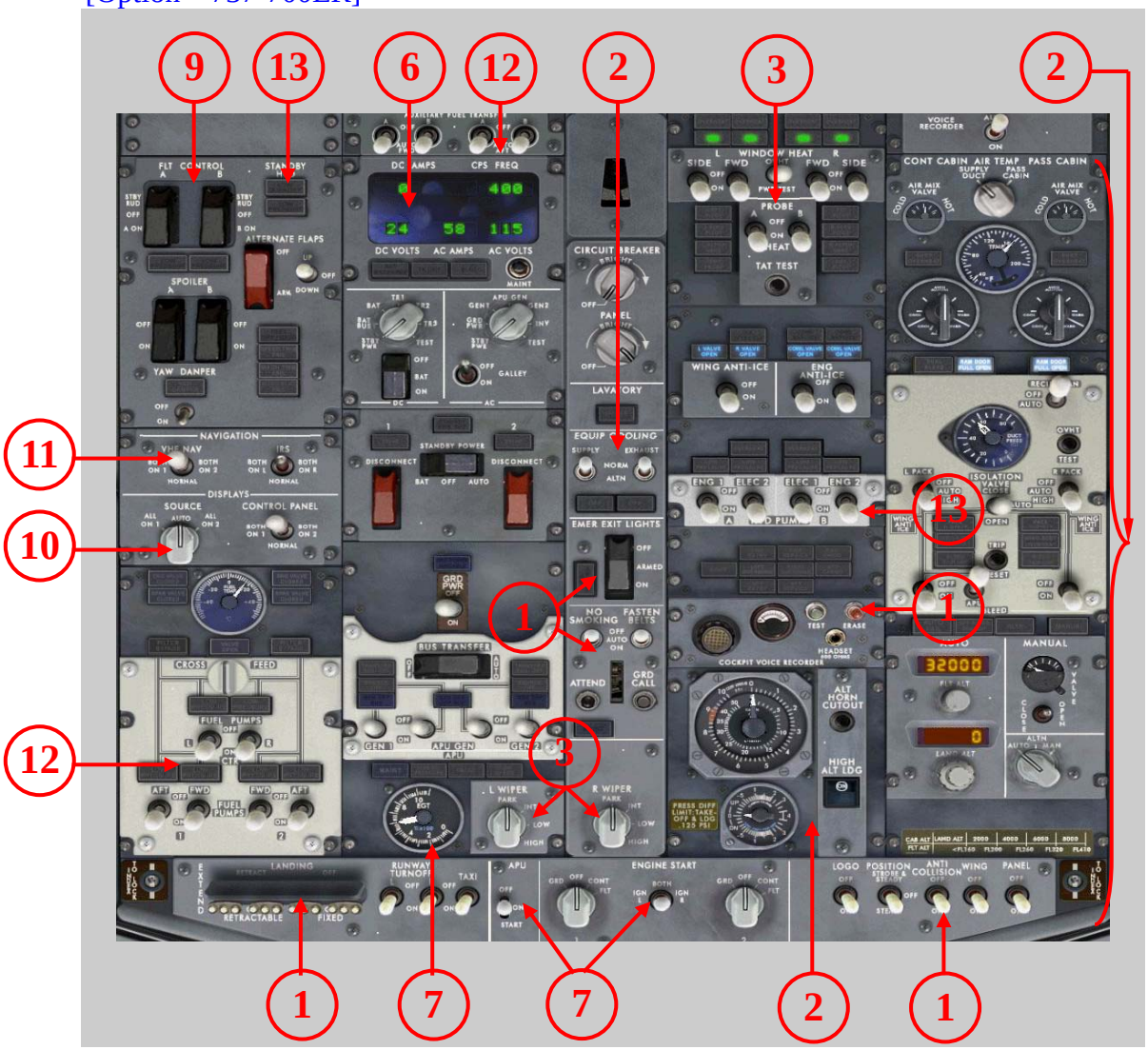


Forward Overhead Panel

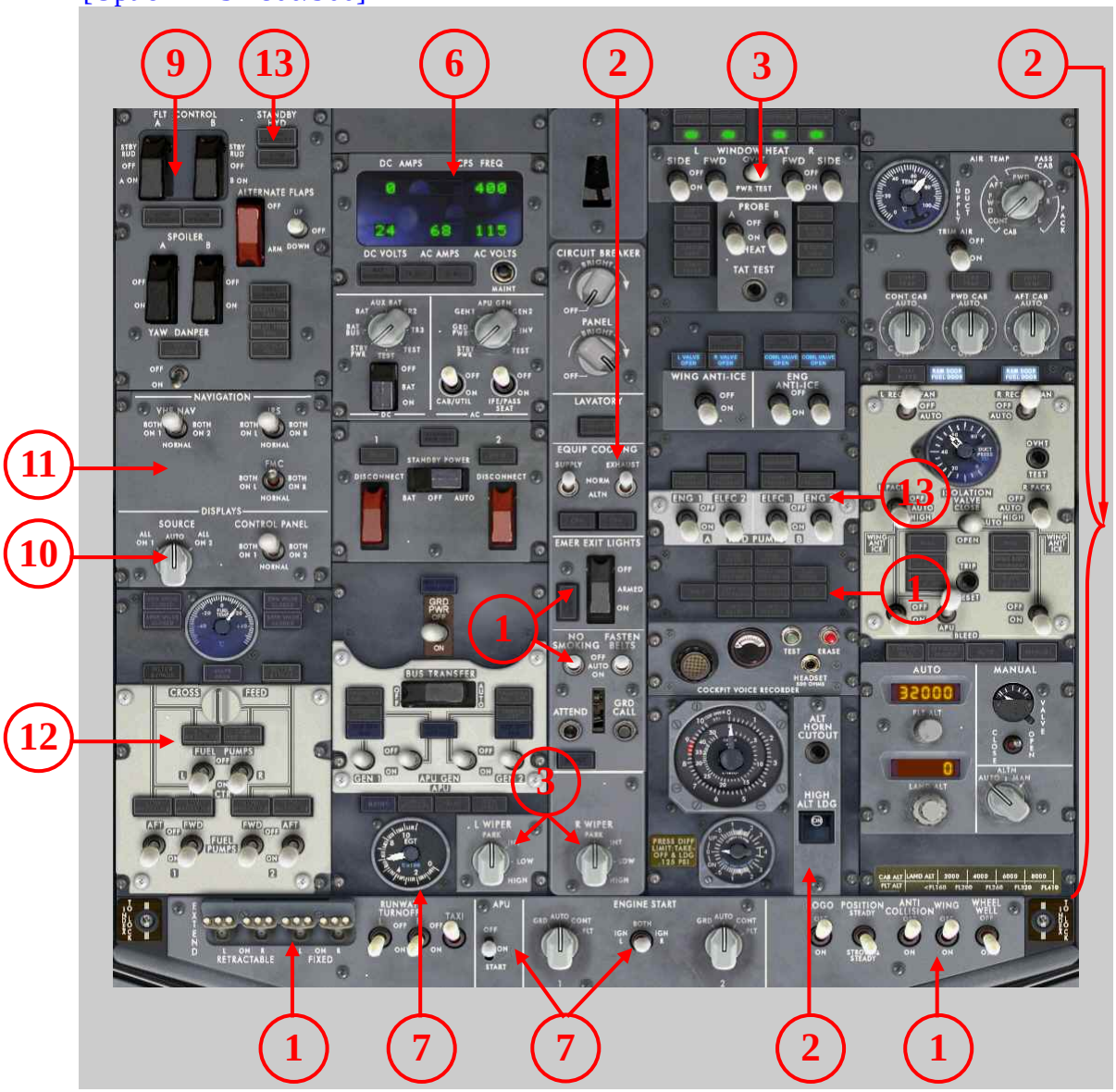
[Option – 737-600/700/700C]



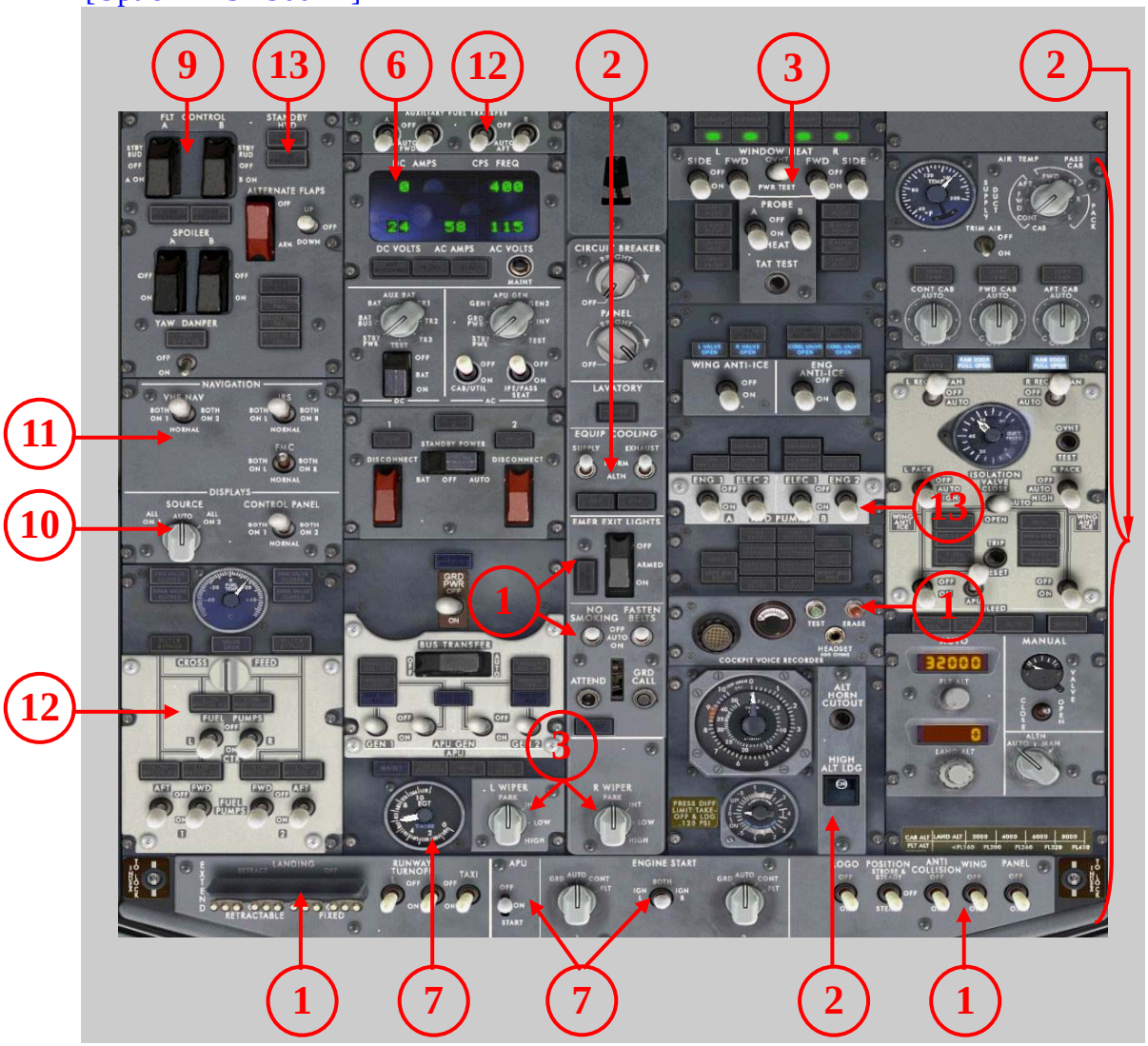
[Option – 737-700ER]



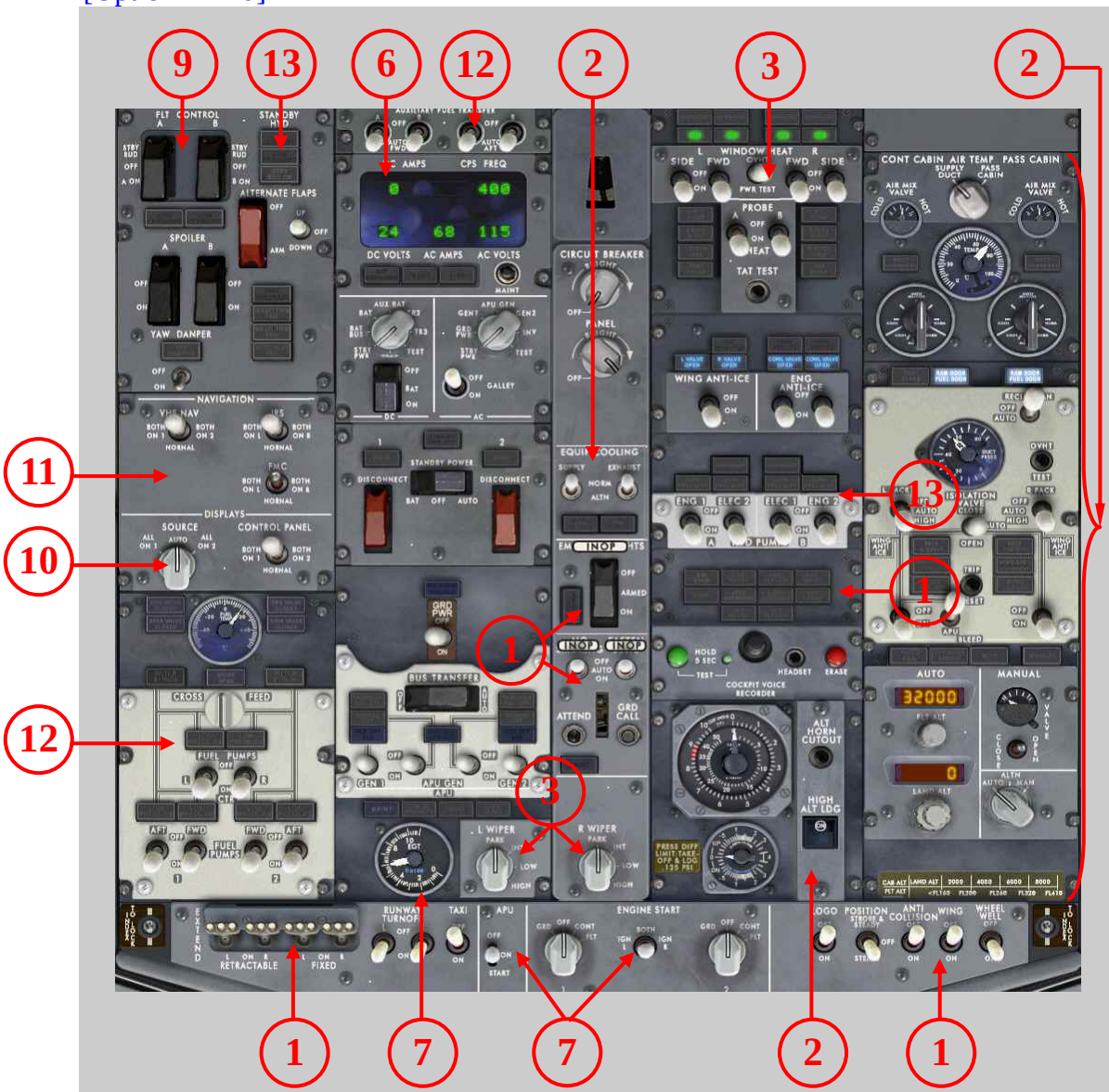
[Option – 737-800/900]



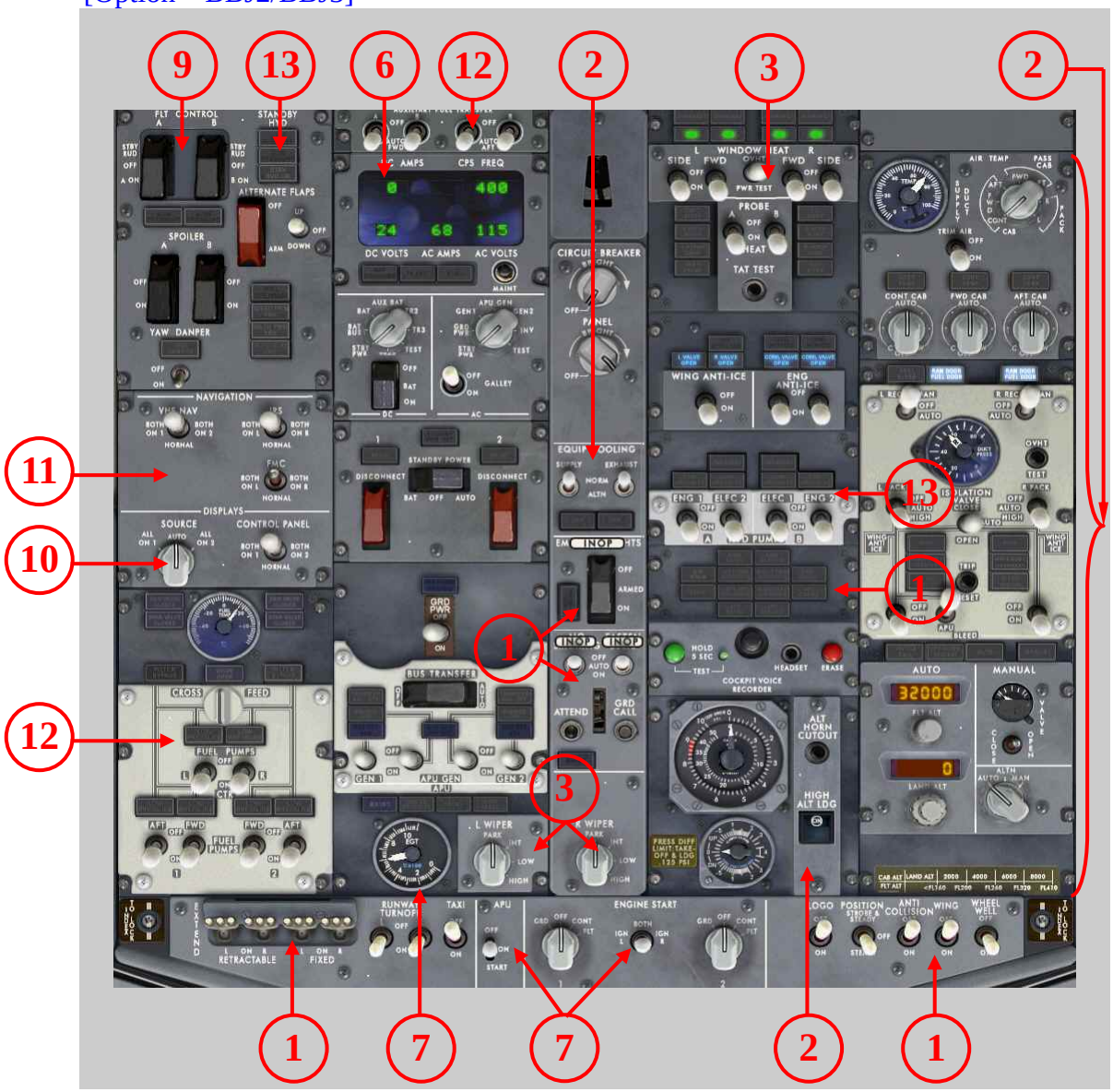
[Option – 737-900ER]



[Option – BBJ]

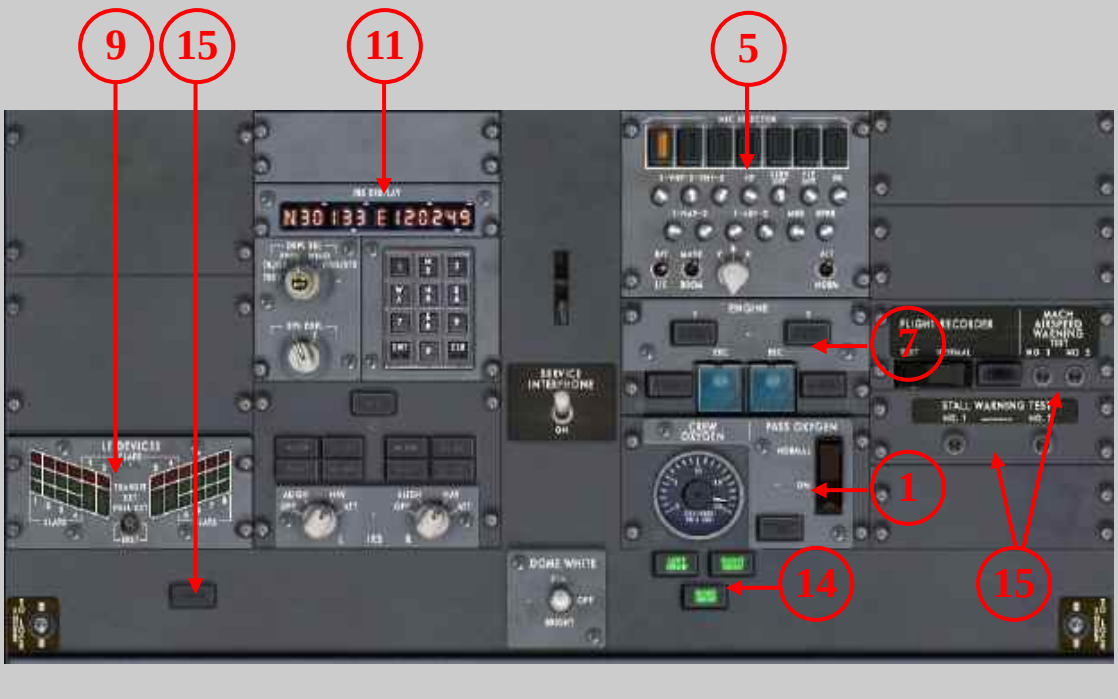


[Option – BBJ2/BBJ3]

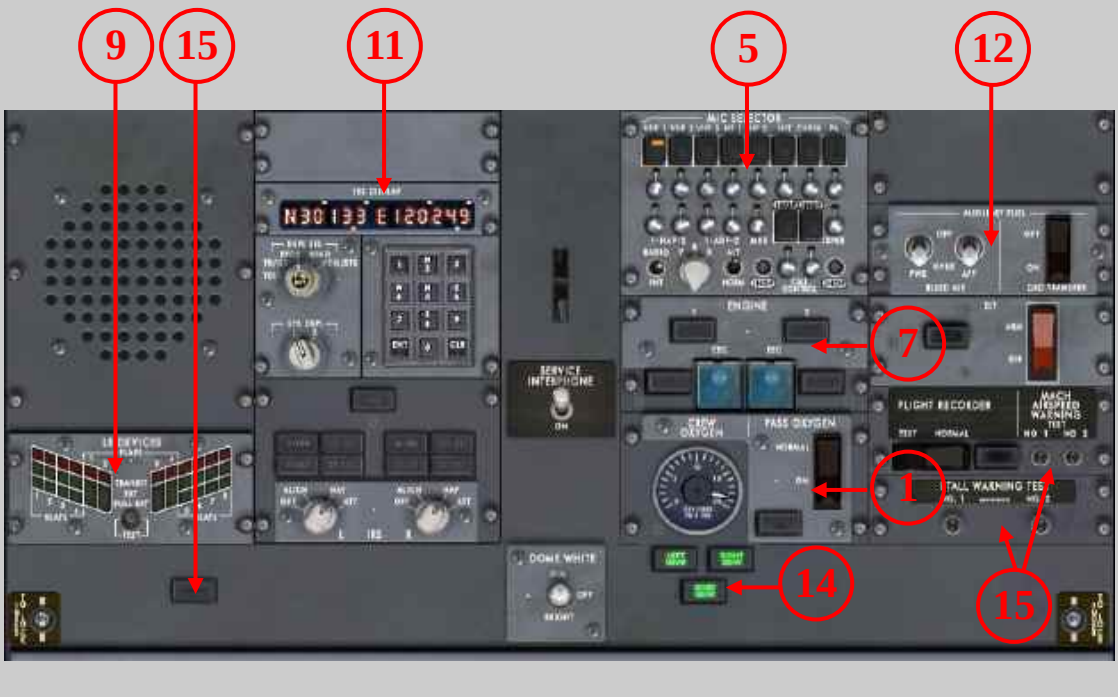


Overhead Panel

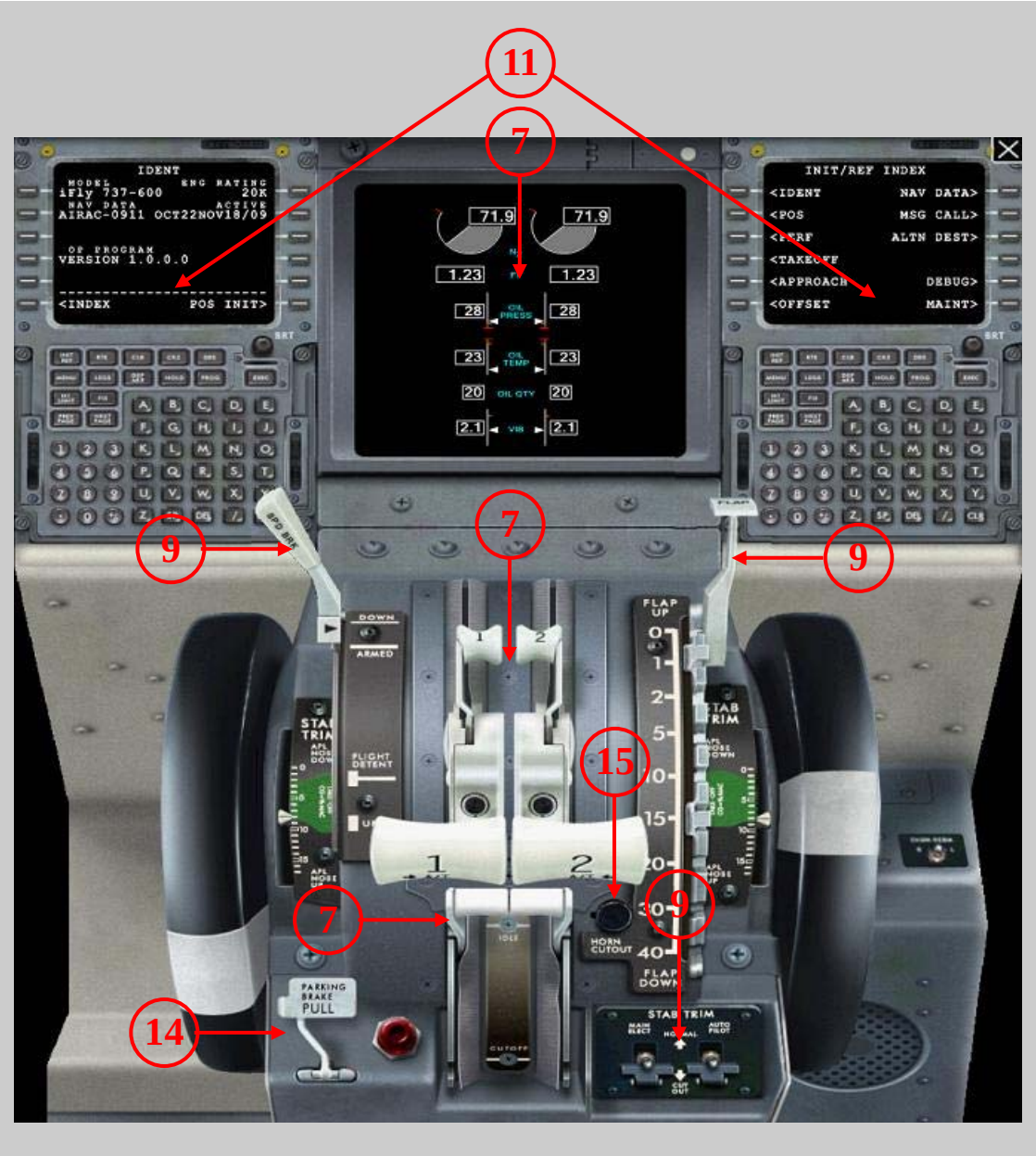
[Option – 737-600/700/700ER/700C/800/900/900ER]



[Option – BBJ/ BBJ2/BBJ3]

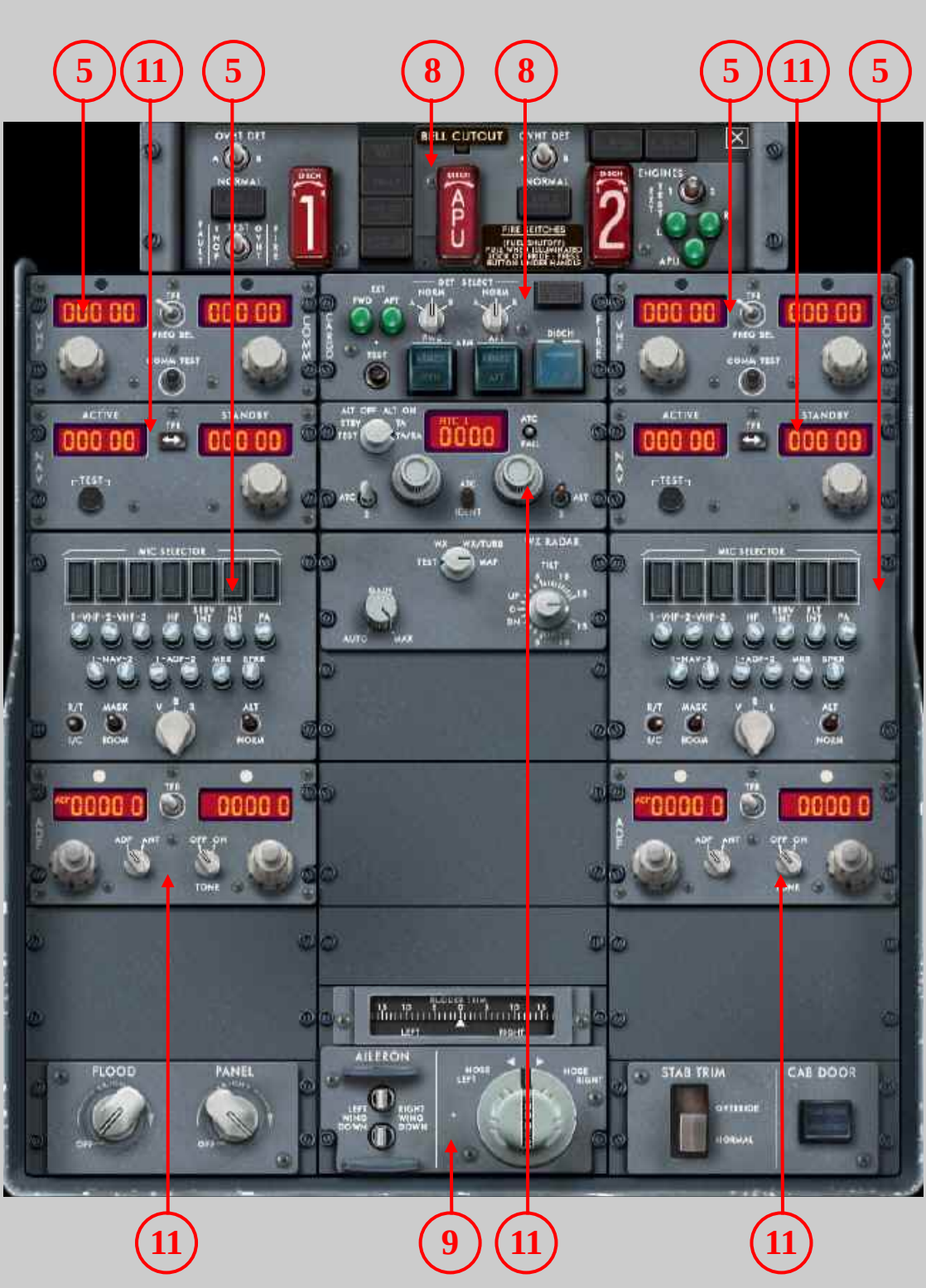


Control Stand

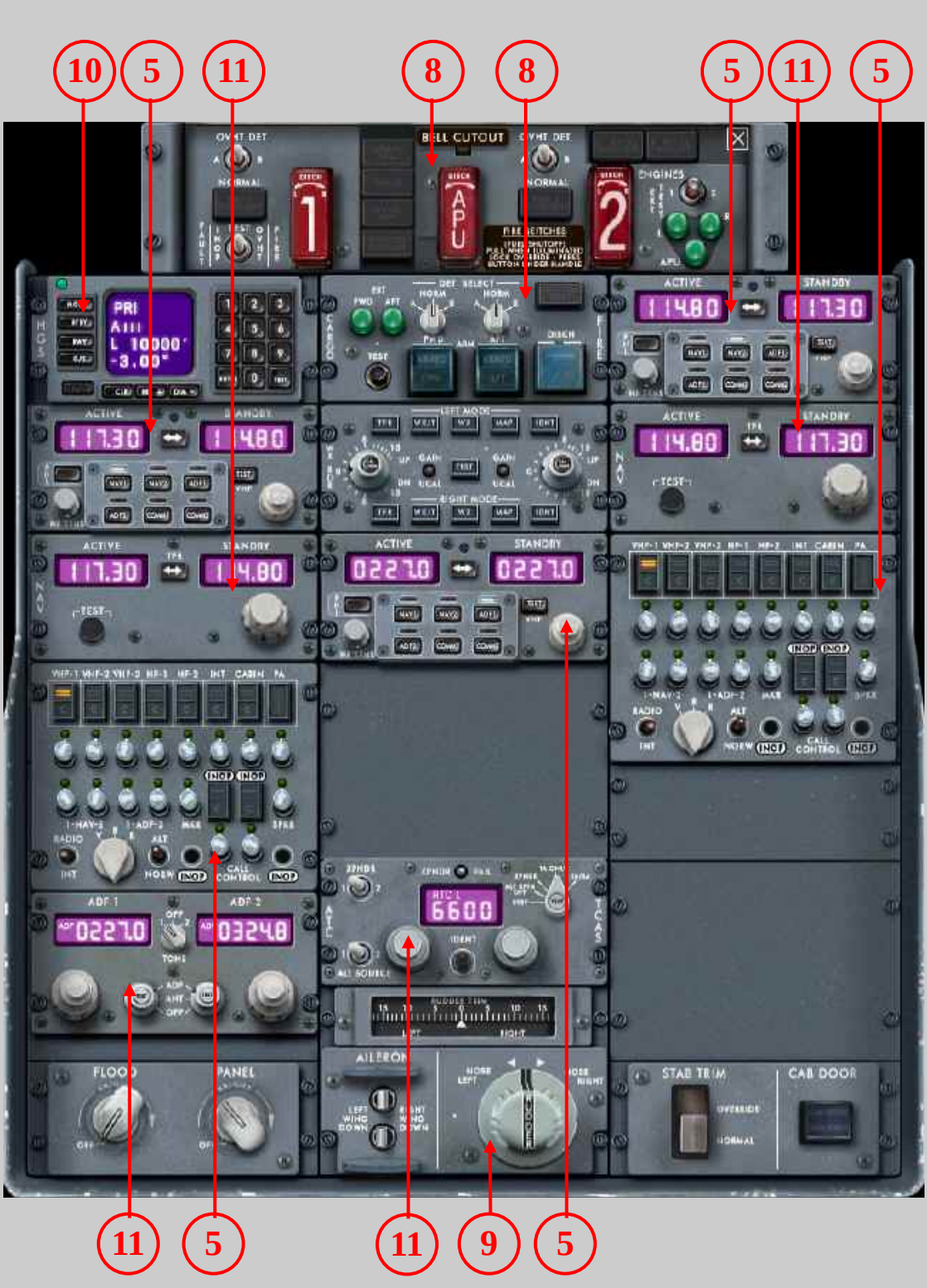


Aft Aisle Stand

[Option – 737-600/700/700C/700ER/800/900/900ER]



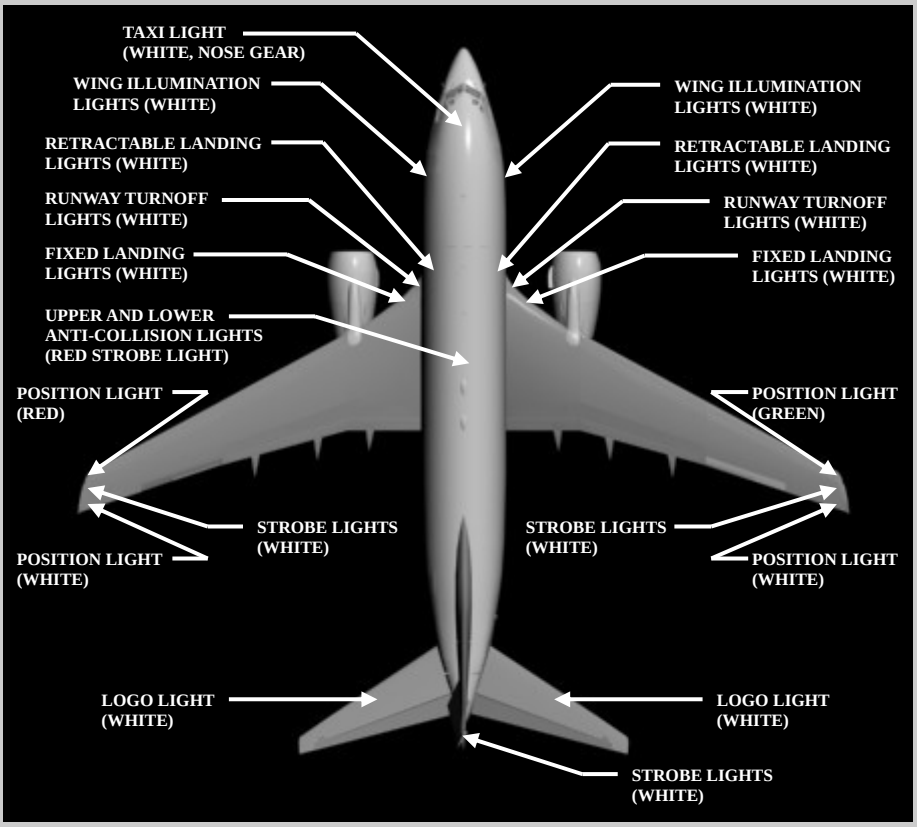
[Option – BBJ/BBJ2/BBJ3]



Airplane General Controls and Indicators

Chapter 1 Section 30

Lighting
Exterior Lighting Locations



Landing, Runway Turnoff and Taxi Lights

FORWARD OVERHEAD PANEL

1. LANDING Light Switch

Controls landing lights. The landing lights help the pilots to see the runway during takeoff and landing.

OFF – landing lights are extinguished.

ON – landing lights are illuminated.

2. RUNWAY TURNOFF Light Switch

Not modeled.

3. TAXI Light Switch

Controls taxi lights. Taxi lights let the pilots see the taxiway or runway during taxi.

OFF – taxi light extinguished.

ON – taxi light illuminated.

Miscellaneous Lights

FORWARD OVERHEAD PANEL

1. LOGO Light Switch

Controls the logo lights. The logo lights help show the airline logo or emblem on the vertical stabilizer.

OFF – logo lights extinguished.

ON – logo lights illuminated.

2. POSITION Light Switch

The position lights show this information to persons in other airplanes or on the ground.

STROBE & STEADY – red and green wing–tip position lights, white trailing edge wing–tip lights and wing–tip and tail strobe lights illuminated.

OFF – red and green wing–tip position lights, white trailing edge wing–tip lights and wing–tip and tail strobe lights extinguished.

STEADY – red and green wing–tip position lights and white trailing edge wing–tip lights illuminated.

3. PANEL Light Switch

OFF – panel light extinguished.

ON – panel light illuminated.

4. WING Illumination Switch

Controls wing leading edge lights. The wing illumination lights supply light to the

leading edge of the wings. At night, this lets the pilots see when ice collects on the on the wing leading edges.

OFF – wing leading edge lights extinguished.

ON – wing leading edge lights illuminated.

5. ANTI–COLLISION Light Switch

Controls red anti-collision strobe lights on top and bottom of fuselage. The anti-collision lights make the airplane easier to see in the air and on the ground.

OFF – red strobe lights extinguished.

ON – red strobe lights illuminated.

Emergency Lighting and Passenger Signs

Flight Deck

FORWARD OVERHEAD PANEL

1. Emergency (EMER) EXIT LIGHTS Switch

OFF – prevents emergency lights system operation if airplane electrical power fails or is turned off.

ARMED – (guarded position) all emergency lights illuminate automatically with the loss of DC power.

ON – all emergency lights illuminate.

2. Emergency (EMER) EXIT LIGHTS NOT ARMED Light

Illuminated (amber) – EMER EXIT LIGHTS switch not in ARMED position.

3. NO SMOKING Switch

OFF – turns off the NO SMOKING signs.

AUTO – the NO SMOKING signs comes on when the landing gear is extended. After takeoff with the landing gear up, the NO SMOKING signs go off. Signs come automatically when cabin altitude exceeds 10,000ft.

ON – turns on the NO SMOKING signs.

4. FASTEN BELTS Switch

OFF – turns off the FASTEN SEAT BELTS signs.

AUTO – the FASTEN SEAT BELTS signs are off with the landing gear and flaps up and the airplane above 10,000ft. During landing when the airplane descends below 10,000ft or when the landing gear or flaps are extended. The FASTEN SEAT BELTS signs come on automatically when cabin altitude exceeds 10,000ft.

ON – turns on the FASTEN SEAT BELTS signs.

Doors
Exterior Door Annunciator Lights

[Option – 737-600/700/700C/700ER]

FORWARD OVERHEAD PANEL

[Option – 737-800/900]

FORWARD OVERHEAD PANEL

[Option – 737-900ER]

FORWARD OVERHEAD PANEL

[Option – BBJ]

FORWARD OVERHEAD PANEL

[Option – BBJ2]

FORWARD OVERHEAD PANEL

[Option – BBJ3]

FORWARD OVERHEAD PANEL

1. Exterior Door Annunciations

The door warning system gives the crew a visual indication when a door is not secure (not latched).

Illuminated (amber) – related door is not closed, latched, and locked.

Oxygen

Oxygen Panel

FORWARD OVERHEAD PANEL

1. Flight CREW OXYGEN Pressure Indicator

Indicates pressure at the crew oxygen cylinder.

2. Passenger Oxygen (PASS OXYGEN) Switch

NORMAL – (guarded position) passenger oxygen system automatically activates when cabin altitude reaches approximately 14,000 feet

ON – activates passenger oxygen distribution system regardless of cabin altitude.

3. Passenger Oxygen On Light

Illuminated (amber) – passenger oxygen system is operating and masks have dropped.

**Intentionally
Blank**

Air Systems Chapter 2
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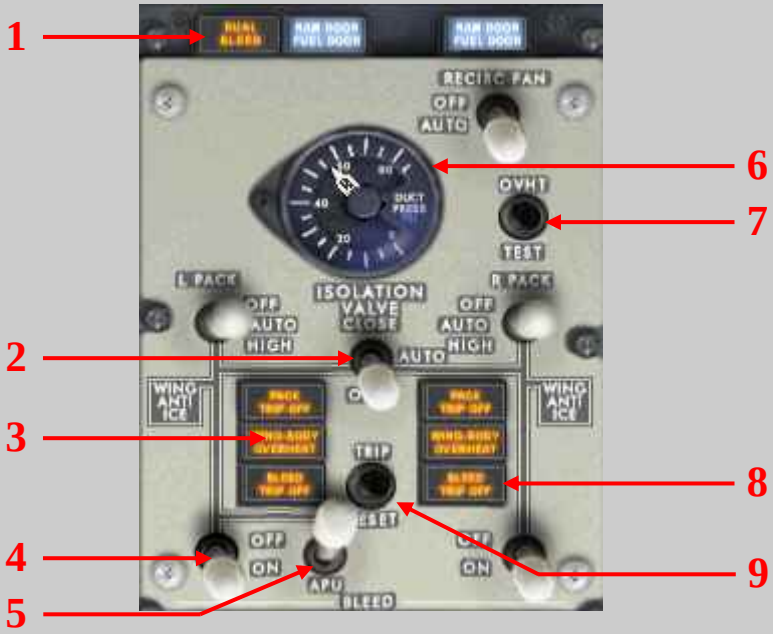
Air Systems Controls and Indicators

Chapter 2 Section 10

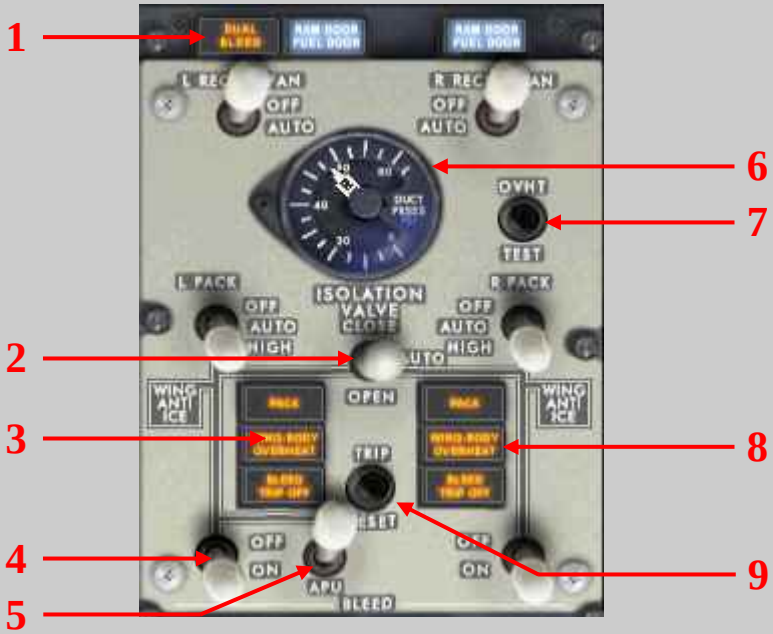
Bleed Air Controls and Indicators

[Option – 600/700/700C /700ER/BBJ]



FORWARD OVERHEAD PANEL

[Option –800/900/900ER/BBJ2/BBJ3]



FORWARD OVERHEAD PANEL

1. DUAL BLEED Light

Illuminated (amber) –
- APU bleed air valve open and engine No. 1 BLEED air switch ON, or
- APU bleed air valve open, engine No. 2 BLEED air switch ON and isolation valve open.

2. ISOLATION VALVE Switch

CLOSE – closes isolation valve, isolates left and right pneumatic manifold

AUTO –the valve opens automatically if any pack or engine bleed switch is put in the OFF position

OPEN – opens isolation valve and connects left and right pneumatic systems.

3. WING–BODY OVERHEAT Lights (left and right)

Illuminated (amber) –
- left light indicates overheat from bleed air duct leak in left engine strut, left air conditioning bay or APU bleed air duct
- right light indicates overheat from bleed air duct leak in right engine strut or right air conditioning bay.

4. Engine BLEED Air Switches (1 and 2)

OFF –engine bleed air valve is closed.

ON –engine bleed air valve is armed to open when bleed air is available.

5. APU BLEED Air Switch

OFF –APU bleed air valve is closed.

ON –APU bleed air valve is armed to open when bleed air is available.

6. Bleed Air DUCT PRESSURE Indicator

Indicates the pressure in the right and left sides of the pneumatic manifold.

7. Wing–Body Overheat (OVHT) TEST Switch

Push – tests wing–body overheat detector circuits

8. BLEED TRIP OFF Lights (left and right)

Illuminated (amber) – excessive engine bleed air temperature or pressure

9. TRIP RESET Switch

[Option – 600/700/700C/700ER/BBJ]
Push (if fault condition is corrected) –
- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- related engine bleed valve opens, or related pack valve opens, or related air mix valve opens
- lights remain illuminated until reset.

9. TRIP RESET Switch

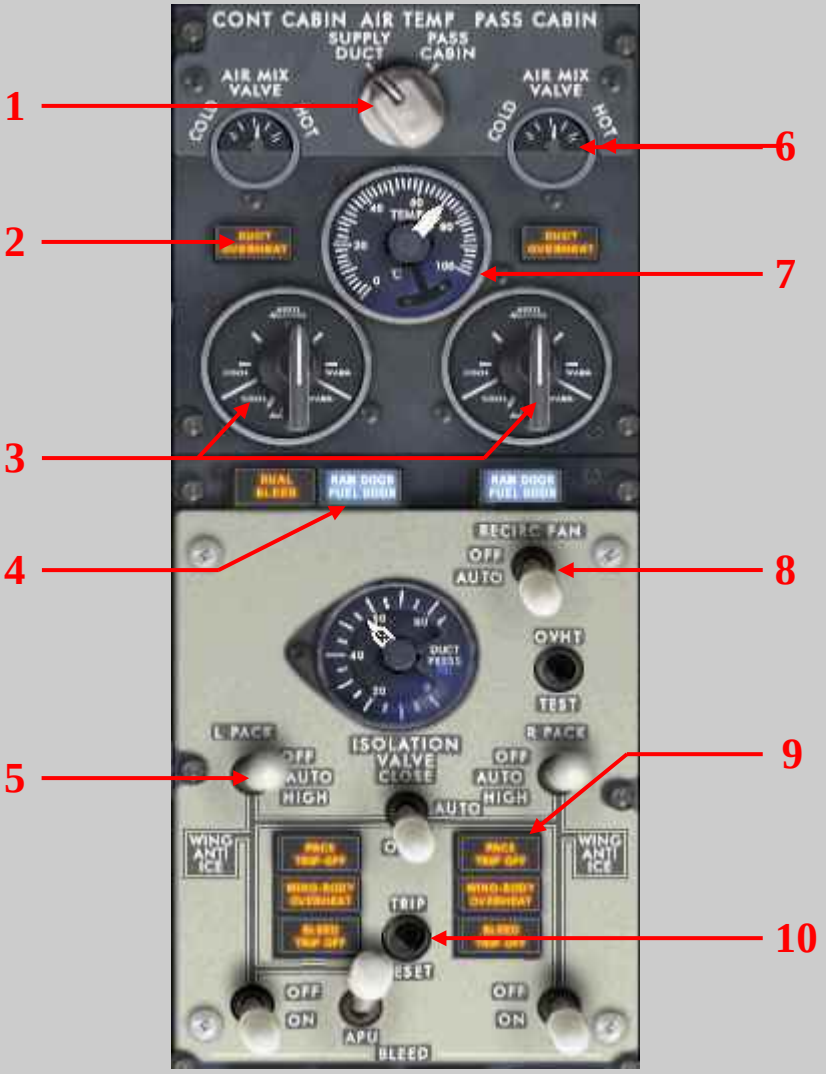
[Option – 800/900/900ER/BBJ2/BBJ3]

Push (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- related engine bleed valve opens, or related pack valve opens, or related air mix valve opens
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators

[Option – 600/700/700C/700ER/BBJ]



FORWARD OVERHEAD PANEL

1. AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects main distribution supply duct sensor for TEMP indicator.

PASS CABIN – selects passenger cabin sensor for TEMP indicator.

2. DUCT OVERHEAT Lights (left and right)

Illuminated (amber) –
- bleed air temperature in related duct exceeds limit
- air mix valves drive full cold

3. Control (CONT) CABIN and Passenger (PASS) CABIN Temperature Selectors (left and right)

AUTO – provides automatic temperature control for the passenger cabin or flight deck temperature.

MANUAL – provides manual control for the passenger cabin or flight deck temperature.

4. RAM DOOR FULL OPEN Lights (left and right)

Illuminated (blue) – indicates ram door in full open position.

5. Air Conditioning PACK Switches (left right)

OFF – pack signaled OFF.

AUTO – pack is automatically controlled. With both packs operating, each pack regulates to low flow

HIGH – pack regulates to high flow

6. AIR MIX VALVE Indicators (left and right)

Indicates position of air mix valves:

7. Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

8. Recirculation (RECIRC) FAN Switch

OFF – recirculation fan off.

AUTO – recirculation fan operates automatically.

9. PACK TRIP OFF Lights (left and right)

Illuminated (amber) – indicates pack temperature has exceeded limits

10. TRIP RESET Switch

Push (if fault condition is corrected) –
- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- related engine bleed air valves open, or related pack valves open, or related air mix valves open
- lights remain illuminated until reset.

[Option – 800/900/900ER/BBJ2/BBJ3]

FORWARD OVERHEAD PANEL

1. Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

2. ZONE TEMP Lights

Illuminated (amber) –

- CONT CAB indicates a duct temperature overheat or failure of the flight deck primary and standby temperature control
- FWD CAB or AFT CAB indicates duct temperature overheat.

During Master Caution light recall:

- CONT CAB indicates failure of the flight deck primary or standby temperature control
- either FWD CAB or AFT CAB indicates failure of the associated zone temperature control

- lights will extinguish when Master Caution is reset.

3. Temperature Selector

AUTO – provides automatic temperature control for the passenger cabin or flight deck temperature.

OFF – closes the associated valve.

4. RAM DOOR FULL OPEN Lights (left and right)

Illuminated (blue) – indicates ram door in full open position.

5. Air Conditioning PACK Switches (left and right)

OFF – pack signaled OFF.

AUTO – pack is automatically controlled. With both packs operating, each pack regulates to low flow

HIGH – pack regulates to high flow

6. AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects appropriate zone supply duct temperature

PASS CAB – selects forward or aft passenger cabin temperature

PACK – selects left or right pack temperatures.

7. TRIM AIR Switch

ON – trim air pressure regulating and shutoff valve signaled open.

OFF – trim air pressure regulating and shutoff valve signaled closed.

8. Recirculation (RECIRC) FAN Switches (left and right)

OFF – recirculation fan off.

AUTO – recirculation fan operates automatically.

9. PACK Lights (left and right)

Illuminated (amber) –
- indicates pack trip off or failure of both primary and standby pack controls
- during Master Caution recall, indicates failure of either primary or standby pack control. Extinguishes when Master Caution is reset

10. TRIP RESET Switch

Push (if fault condition is corrected) –
- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- related engine bleed air valves open, or related pack valves open, or related air mix valves open
- lights remain illuminated until reset.

Equipment Cooling Panel

FORWARD OVERHEAD PANEL

1. Equipment (EQUIP) COOLING SUPPLY Switch

NORM – normal cooling supply fan activated.

ALTN – alternate cooling supply fan activated.

2. Equipment Cooling Supply OFF Light

Illuminated (amber) – no airflow from selected cooling supply fan.

3. Equipment (EQUIP) COOLING EXHAUST Switch

NORM – normal cooling exhaust fan activated.

ALTN – alternate cooling exhaust fan activated.

4. Equipment Cooling Exhaust OFF Light

Illuminated (amber) – no airflow from selected cooling exhaust fan.

Cabin Altitude Panel

FORWARD OVERHEAD PANEL

1. CABIN Altimeter (ALT)/Differential Pressure (DIFF PRESS) Indicator

Inner Scale – indicates cabin altitude in feet.

Outer Scale – indicates differential pressure between cabin and ambient in psi.

2. CABIN Rate of CLIMB Indicator

Indicates cabin rate of climb or descent in feet per minute.

3. Altitude (ALT) HORN CUTOUT Switch

Push – cuts out cabin altitude warning horn

4. High Altitude Landing Switch

ON (white) – reprograms initiation of cabin altitude warning horn from 10,000 to 12,500 feet.

Off – (ON not visible)
- reprograms cabin pressurization from high altitude to normal operation
- extinguishes INOP light

5. High Altitude Landing INOP Light

Illuminated (amber) – indicates high altitude landing system fault.

Cabin Pressurization Panel

FORWARD OVERHEAD PANEL

1. AUTO FAIL Light

Illuminated (amber) – automatic pressurization system failure detected:
- indicates a single controller failure when ALTN light is also illuminated
- indicates a dual controller failure when illuminated alone.

2. OFF Schedule (SCHED) DESCENT Light

Illuminated (amber) – airplane descended before reaching the planned cruise altitude set in the FLT ALT indicator.

3. Flight Altitude (FLT ALT) Indicator

Indicates selected cruise altitude

4. Flight Altitude Selector

Rotate – set planned cruise altitude.(-1,000 ft. to 42,000ft. in increments of 500 feet).

5. Landing Altitude (LAND ALT) Indicator

Indicates altitude of intended landing field

6. Landing Altitude Selector

Rotate – set planned landing field altitude (-1,000ft. to 14,000ft. in increments of 500 feet).

7. MANUAL Light

Illuminated (green) – pressurization system operating in the manual mode.

8. Alternate (ALTN) Light

Illuminated (green) – pressurization system operating in the alternate automatic mode:

- Illumination of both ALTN and AUTO FAIL lights indicates a single controller failure and automatic transfer to ALTN mode
- pressurization mode selector in ALTN position.

9. Outflow VALVE Position Indicator

Indicates position of outflow valve

10. Outflow Valve Switch (spring–loaded to center)

Move the outflow valve toward full open or close when pressurization mode selector in MAN position.

CLOSE – closes outflow valve electrically.

OPEN – opens outflow valve electrically.

11. Pressurization Mode Selector

AUTO – pressurization system controlled automatically.

ALTN – pressurization system controlled automatically using ALTN controller.

MAN – pressurization system controlled manually by outflow valve switch.

Air Systems Chapter 2
Bleed Air System Description Section 20

Introduction

Air for the bleed air system can be supplied by the engines, APU, or an external air source.

Bleed air is used for:
- air conditioning
- pressurization
- wing and engine anti-ice
- engine starting

Engine Bleed System Supply

Engine bleed air comes from either the high stage or the low stage engine sections. After the engine bleed air switches are selected ON, the engine bleed air valves are armed.

Engine Bleed Air Valves

The engine bleed air valve permits engine bleed air to flow to the bleed air duct. The valve closes automatically when the engine is shut down. The engine bleed air valve is DC controlled and pressure operated.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches are ON, and both air conditioning pack switches are AUTO or HIGH, and the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF.

External Bleed System Supply

External connectors are provided to connect a ground source of high pressure air directly to the bleed air duct.

APU Bleed Air Valve

The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. APU bleed air is used primarily during ground operations for air conditioning pack operation and engine starting. In flight, APU bleed air is available below approximately 17,000 ft.

Air Systems Chapter 2
Air Conditioning System Description Section 30

[Option – 600/700/700C/700ER/BBJ]

Introduction

The air conditioning system controls the interior environment of the airplane for flight crew, passengers, and equipment.

Air Conditioning Pack

Each air condition pack is controlled by its own pack valve in order to control the flow of bleed air from the main bleed air duct. Normally the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow”. If one pack is not operating, the other pack automatically switches to “high air flow”.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the ram air system is automatically controlled by the packs through operation of ram air inlet doors. On the ground, or during slow flight with the flaps not fully retracted, the ram air inlet doors move to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. A RAM DOOR FULL OPEN light illuminates whenever a ram door is fully open.

Air Mix Valves

The two air mix valves for each pack control hot and cold air according to the setting of the CONT CABIN or PASS CABIN temperature selector. In the automatic temperature mode, the automatic temperature controller operates the air mix valves.

Air Systems Chapter 2
Air Conditioning System Description Section 31

[Option – 800/900/900ER/BBJ2/BBJ3]

Introduction

The air conditioning system provides temperature controlled air by air conditioning packs.

Air Conditioning Pack

Each air condition pack is controlled by its own pack valve in order to control the flow of bleed air from the main bleed air duct. Normally the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow”. If one pack is not operating, the other pack automatically switches to “high air flow”.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the ram air system is automatically controlled by the packs through operation of ram air inlet doors. On the ground, or during slow flight with the flaps not fully retracted, the ram air inlet doors move to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. A RAM DOOR FULL OPEN light illuminates whenever a ram door is fully open.

Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

Air Systems Chapter 2
Pressurization System Description Section 40

Introduction

Cabin pressurization is controlled by adjusting the discharge of conditioned cabin air through the outflow valves. During all phases of airplane operation, the cabin pressure control system controls the cabin pressurization.

Cabin Pressure Controller

Cabin altitude is normally controlled by the cabin pressure controller. The upper limit is at the cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 41,000 feet. The cabin pressure controller controls cabin pressure in the following modes:

- AUTO – Automatic pressurization control in the normal mode of operation.
- ALTN – Automatic pressurization control in the alternate mode of operation.
- MAN – Manual control of the pressurization system.

Auto Mode Operation

In the AUTO or ALTN mode, the pressurization control panel is used to preset two altitudes into the auto controllers:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

In the air, the auto controller maintains a proportional pressure differential between the airplane and cabin altitude.

An amber AUTO FAIL light illuminates if any of the following conditions occurs:

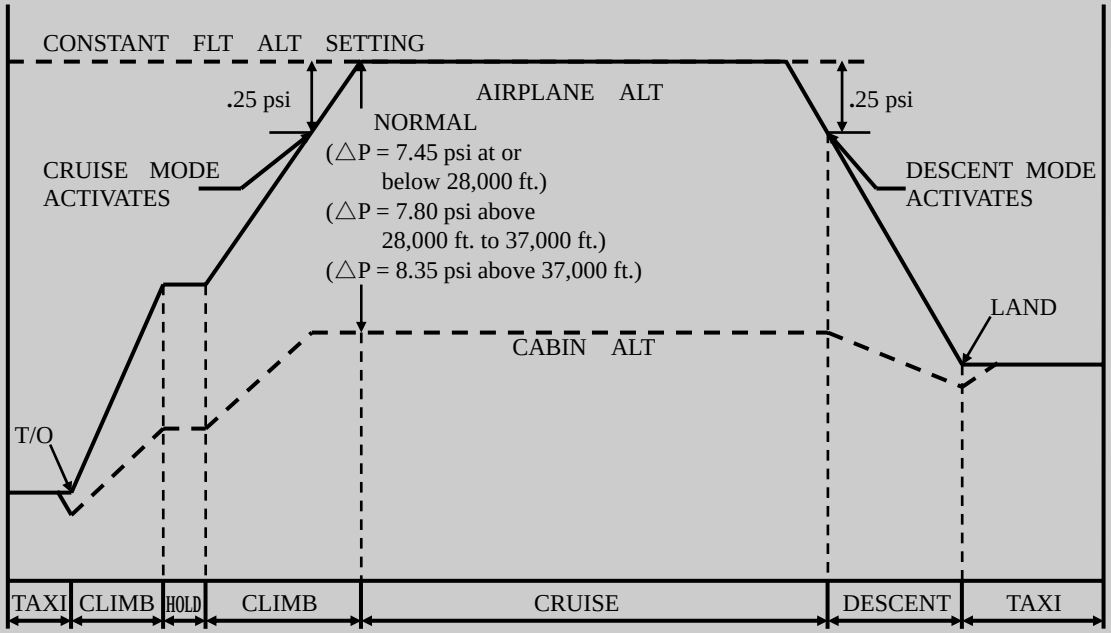
- Loss of DC power
- Controller fault
- Excessive differential pressure (> 8.75 psi)
- Excessive rate of cabin pressure change (±2000 sea level feet/minute)
- High cabin altitude (above 15,800 feet).

Moving the pressurization mode selector to the ALTN position extinguishes the AUTO FAIL light, however the ALTN light remains illuminated to indicate single channel operation.

High Altitude Landing

When the high altitude landing system is engaged and the actual landing altitude is set, the controller brings the cabin altitude to the landing airport elevation when the descent mode is activated. Upon departure from a high altitude airport, the system returns to normal operation as the cabin descends through 8,000 feet.

Flight Path Events – Auto Mode



CABIN ALTITUDE
VS
AIRPLANE ALTITUDE

Manual Mode Operation

A green MANUAL Light illuminates with the pressurization mode selector in the MAN position. In the MAN mode, the outflow valve position switch is used to modulate the outflow valve by monitoring the cabin altitude panel and valve position on the outflow valve position indicator.

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Anti-Ice, Rain Controls and Indicators

Chapter 3 Section 10

Window Heat Panel

FORWARD OVERHEAD PANEL

1. Window OVERHEAT Lights

Illuminated (amber) – overheat condition is detected.

2. Window Heat ON Lights

Illuminated (green) – apply the window heat to selected window(s).

3. WINDOW HEAT Switches

ON – switch on the window heat to selected window(s).

OFF – switch off the window heat.

4. WINDOW HEAT Test Switch (spring–loaded to neutral)

OVHT – provides simulation for an overheat condition.

PWR TEST – provides a confidence test.

Windshield Wiper Selector Panel

FORWARD OVERHEAD PANEL

1. Windshield WIPER Selectors

PARK – wiper is stowed at the base of the window.

INT – wiper operates intermittent.

LOW – wiper operates at low speed.

HIGH – wiper operates at high speed.

Probe Heat Panel

FORWARD OVERHEAD PANEL

1. Probe Heat Lights

Illuminated (amber) – related probe not heated.

2. PROBE HEAT Switches

ON – switch on the power to supply the heat related system.

OFF – switch off the power supply.

3. TAT TEST Switch

Push – the electrical power is applied to TEMP PROBE on the ground.

Engine Anti–Ice Panel

FORWARD OVERHEAD PANEL

1. COWL ANTI–ICE Lights

Illuminated (amber) – indicates an overpressure condition of cowl anti–ice valve.

2. COWL VALVE OPEN Lights

Illuminated (blue) –

- bright – related cowl anti–ice valve is in transit, or, cowl anti–ice valve position different from related ENGINE ANTI–ICE switch position
- dim – related cowl anti–ice valve is open.

Extinguished – related cowl anti–ice valve is closed.

3. ENGINE ANTI–ICE Switches

ON – the engine anti–ice valve is commanded open.

OFF – the engine anti–ice valve is commanded closed.

Thermal Anti–Ice Indication

UPPER DISPLAY UNIT

1. Thermal Anti–Ice Indications

Illuminated –

- Green – cowl anti–ice valve open
- Amber – cowl anti–ice valve is not in commanded position.

Wing Anti–Ice Panel

FORWARD OVERHEAD PANEL

1. Wing Anti–Ice VALVE OPEN Lights

Illuminated (blue) –

- bright – related wing anti–ice control valve is in transit, or, related wing anti–ice control valve position is different from related ENGINE ANTI–ICE switch position
- dim – related wing anti–ice control valve is open.

Extinguished – related wing anti–ice control valve is closed.

2. WING ANTI–ICE Switch

OFF – wing anti–ice control valves are commanded closed.

ON – wing anti–ice control valves are commanded open

3. ICE DETECTOR Light

Not modeled.

Anti-Ice, Rain System Description

Chapter 3
Section 20

Introduction

For ice and rain protection, systems provide the thermal anti-icing (TAI), electrical anti–icing, and windshield wipers.

The anti–ice and rain systems include:

- Flight Deck Window Heat
- Windshield Wipers
- Probe and Sensor Heat
- Engine Anti–Ice System
- Wing Anti–Ice System

Flight Deck Window Heat

All flight deck windows are electrically heated and all heated flight deck windows are controlled by the WINDOW HEAT switches.

Probe and Sensor Heat

Pitot probes and Sensor Heat are all electrically heated. If the standby power is in use, only the Captain's pitot probe is heated, and the CAPT PITOT light does not illuminate for a failure.

Engine Anti–Ice System

Engine anti–ice (EAI) system heats the engine cowl to prevent ice build–up, which could break off and enter the engine. EAI should be used continuously on the ground and in the air in icing conditions. Through ENG ANTI–ICE switches, engine anti–ice operation can be controlled.

Engine Anti–Ice System Operation

The engine anti–ice system operation is automatic when the ENG ANTI–ICE switch is in ON.

Wing Anti–Ice System

The wing anti–ice system provides anti-ice operation for the three inboard leading edge slats on the wings by using bleed air.

Wing Anti–Ice System Operation

In flight, the wing anti–ice system operation is automatic when the WING ANTI–ICE switch is in ON.

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Automatic Flight Controls and Indicators

Chapter 4 Section 10

Mode Control Panel (MCP)

[Option – 737-600/700/700C/700ER/800/900/900ER]

GLARESHIELD

[Option – BBJ/BBJ2/BBJ3]

GLARESHIELD

Speed Controls

[Option – 737-600/700/700C/700ER/800/900/900ER]

GLARESHIELD

[Option – BBJ/BBJ2/BBJ3]

1. Autothrottle (A/T) ARM Switch

ARM –Switch ARM to arm the Auto throttle (A/T). The indicator light illuminates green when A/T ARM switch is in the ARM position. The A/T will be engaged automatically when following AFDS modes are engaged:

- LVL CHG
- ALT ACQ
- V/S
- VNAV
- ALT HOLD
- G/S capture
- TO/GA.

OFF – disarms A/T and prevents A/T engagement.

2. Changeover (C/O) Switch

Push –

- changes IAS/MACH window alternately between IAS and MACH if speed is within indicator range.
- automatic changeover occurs at approximately FL260.

3. MCP Speed Condition Symbols

Display symbolic indication when either over speed or under speed when commanded speed cannot be reached.

The symbols consists of:

- Underspeed limiting (flashing character “A”) – minimum speed
- Overspeed limiting (flashing character “8”) –
  - Vmo or Mmo limit
  - landing gear limit
  - flap limit.

4. IAS/MACH Display

The display shows indicated airspeed (IAS) or the mach number. The IAS shows from 100 to Vmo in one knot increments. The mach shows from 0.60 to Mmo in 0.01 mach increments.

If displayed in blank, it is either when:

- VNAV controls command speed
- A/T engaged in FMC SPD mode
- during 2 engine AFDS go–around

When power is first applied, the display shows 100 knots.

5. N1 Switch

Push – (light not illuminated)
- engages A/T in N1 mode if compatible with AFDS modes already engaged
- illuminates N1 switch light
- annunciates N1 autothrottle mode.

Push – (light illuminated)
- deselects N1 mode and extinguishes switch light
- engages autothrottle in ARM mode.

N1 Mode: A/T maintains thrust at N1 limit selected from FMC CDU. N1 mode engaged manually by pushing N1 switch if N1 mode is compatible with existing AFDS modes. N1 mode engages automatically when:
- engaging LVL CHG in climb
- engaging VNAV in climb.

6. SPEED Switch

Push – (light not illuminated)
- engages A/T in SPEED mode if compatible with engaged AFDS modes
- illuminates SPEED switch light
- annunciates MCP SPD autothrottle mode
- maintains speed in MCP IAS/MACH display.

Push – (light illuminated)
- deselects speed mode and extinguishes switch light
- engages A/T in ARM mode.

Speed Mode: Autothrottle holds speed in IAS/MACH display or a performance or limit speed. Speed mode engaged manually by pushing SPEED switch if speed mode is compatible with existing AFDS modes. Speed mode engages automatically when:
- ALT ACQ engages
- ALT HOLD engages
- V/S engages
- G/S capture occurs.

7. IAS/MACH Selector

When rotate, sets the speed in IAS/MACH window and positions airspeed cursor on PFD. The IAS/MACH selector is not operative when display is blank.

8. Speed Intervention (SPD INTV) Switch

Push (when VNAV engaged) –
- IAS/MACH display alternately shows selected IAS/Mach and blanks
- when IAS/MACH display is not blank, FMC speed intervention is active, FMC target speed is displayed, and IAS/MACH Selector may be used to set desired

speed
- when IAS/MACH display is blank, FMC computed target speed is active and displayed on the airspeed indicator.

Vertical Navigation

[Option – 737-600/700/700C/700ER/800/900/900ER]

[Option – BBJ/BBJ2/BBJ3]

1. VNAV Switch

Push –
- VNAV switch light illuminates
- pitch mode annunciates VNAV SPD, VNAV PTH, or VNAV ALT
- A/T mode annunciates FMC SPD, N1, RETARD, or ARM
- IAS/MACH display blanks and airspeed cursors positioned to FMC commanded airspeed.

VNAV Mode: The FMC commands AFDS pitch and autothrottle to fly vertical profile selected on FMC CDUs. Profile includes climb, cruise, descent, speeds, and can also include waypoint altitude constraints.

Climb –
- autothrottle holds FMC thrust limit
- AFDS holds FMC target speed
- automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
  - MCP constrained altitude annunciates VNAV ALT

- VNAV constrained altitude annunciates VNAV PTH.

Cruise –
- autothrottle holds FMC target speed
- AFDS holds FMC altitude
- selecting a lower MCP altitude arms FMC to automatically begin descent upon arrival at FMC top of descent point.

Descent –
- VNAV SPD descent
  - autothrottle holds idle
  - AFDS holds FMC target speed.
- VNAV PTH descent
  - autothrottle holds idle but can command FMC SPD mode if ground speed becomes too low to maintain FMC vertical path
  - AFDS tracks FMC descent path.
- automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first

Inhibited below 400 ft RA or if performance initialization not complete.

VNAV mode is terminated by any one of the following:
- selecting another pitch mode
- reaching end of LNAV route

2. ALTITUDE Display

This display shows the altitude the flight crew selects. The altitude range is from 0 to 50,000 feet in 100 foot increments.

3. Vertical Speed (VERT SPEED) Display

This display shows the flight crew selected vertical speed. The vertical speed range is from -7,900 fpm to +6,000 fpm.

Displays:
- blank when V/S mode not active
- present vertical speed when V/S switch is pushed to engage V/S mode
- selected V/S when V/S set with thumbwheel

4. Vertical Speed Thumbwheel

To set the vertical speed, turn the vertical speed thumbwheel. Turn the thumbwheel UP to make a nose up change in the value. Turn the thumbwheel DN to make a nose down change in the value. The thumbwheel has increments of 50 feet per minute (fpm) from 0 to 1000 fpm and 100 fpm for more than 1000 fpm

5. Level Change (LVL CHG) Switch

Push –
- LVL CHG switch light illuminates
- pitch mode annunciates MCP SPD for climb or descent

- autothrottle mode annunciates N1 for climb and RETARD followed by ARM for descent
- IAS/MACH display and airspeed cursors display target speed.

LVL CHG Mode: The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds.

A LVL CHG climb or descent is initiated by:
- selecting a new altitude
- pushing LVL CHG switch
- setting desired airspeed.

Climb –
- autothrottle holds limit thrust
- AFDS holds selected airspeed.

Descent –
- autothrottle holds idle thrust
- AFDS holds selected airspeed.

Airspeed –
- if a speed mode is active when LVL CHG is engaged, this speed is retained as target speed
- if a speed mode is not active when LVL CHG is engaged, existing speed becomes target speed
- speed can be changed with MCP IAS/MACH Selector.

The LVL CHG mode is inhibited after glideslope capture.

6. Approach (APP) Switch

(See Lateral Navigation)

7. Altitude Selector (SEL)

The altitude selector sets the reference altitude for the autopilot.

Rotate –
- sets altitude in ALTITUDE display in 100 foot increments
- arms V/S mode if rotated while in ALT HOLD at selected altitude.

8. Altitude Hold (ALT HLD) Switch

Push –
- engages ALT HOLD command mode
- commands pitch to hold barometric altitude at which switch was pressed
- annunciates ALT HOLD pitch mode and illuminates ALT HLD switch light.

Altitude Hold Command Mode: ALT HOLD mode commands pitch to hold either:
- MCP selected altitude
    - pitch mode annunciates ALT HOLD
    - ALT HLD switch light extinguishes.
- barometric altitude at which ALT HLD switch was pressed if not at MCP selected

altitude
  - pitch mode annunciates ALT HOLD
  - ALT HLD switch light illuminates.

When in ALT HOLD at selected MCP altitude:
- selecting a new MCP altitude illuminates the ALT HLD switch light and arms V/S mode
- LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new MCP altitude is selected.

ALT HOLD mode is inhibited after G/S capture.

9. Vertical Speed (V/S) Switch

Push –
- arms or engages V/S command mode
- commands pitch to hold vertical speed
- engages A/T in speed mode to hold selected airspeed
- annunciates V/S pitch mode and illuminates V/S switch light.

Vertical Speed Command Mode: The V/S mode commands pitch to hold selected vertical speed and engages A/T in SPEED mode to hold selected airspeed. V/S mode has both an armed and an engaged state.

Engaged –
- annunciates V/S pitch mode
- vertical speed display changes from blank to present vertical speed
- desired vertical speeds can be selected with vertical speed thumbwheel.

V/S becomes armed if:
- pitch mode is ALT HLD at selected MCP altitude and
- new MCP altitude is selected.

With V/S armed, V/S mode is engaged by moving vertical speed thumbwheel.

Inhibited if:
- ALT HOLD mode is active at selected MCP altitude
- glideslope captured in APP mode.

10. Altitude Intervention (ALT INTV) Switch

Allows manual deletion of next FMC altitude constraint via altitude SEL and ALT INTV switch.

Push – (during VNAV climb)
- lowest FMC altitude constraint below selected MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to resume climb. MCP altitude must be set above current altitude
- for each press of switch, one deletion occurs
- if MCP altitude is set above current FMC altitude, FMC cruise altitude resets to MCP altitude. FMC cruise altitude cannot be decreased using ALT INTV switch.

Push – (during VNAV cruise)

- if MCP altitude is set above current FMC cruise altitude, FMC resets cruise altitude to MCP altitude and initiates a cruise climb
- if MCP altitude is set below current FMC cruise altitude, an early descent is initiated. Lower FMC cruise altitude cannot be entered using ALT INTV switch.

Push – (during VNAV descent)

- the highest FMC altitude constraint above MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to continue descent. MCP altitude must be set below current altitude

Lateral Navigation

[Option – 737-600/700/700C/700ER/800/900/900ER]

GLARESHIELD

[Option – BBJ/BBJ2/BBJ3]

GLARESHIELD

1. COURSE Display

Displays course set by course selector.

Note: Different courses and frequencies on two VHF NAV receivers can cause disagreement between Captain and FO F/D displays and affect A/P operation.

2. Heading Selector

Rotate – changes the flight crew selected heading for the airplane.

3. HEADING Display

The display shows the heading the flight crew selects. The display range is from 000

to 359 degrees.

4. LNAV Switch

Push –
- commands AFDS roll to intercept and track the active FMC route
- annunciates LNAV as roll mode and illuminates LNAV switch light.

LNAV Mode: The FMC controls AFDS roll to intercept and track active FMC route. Active route is entered and modified through FMC CDUs and can include SIDs, STARs, and instrument approaches.

LNAV arming criteria on the ground:
- origin runway in flight plan
- active route entered in FMC
- track of first leg within 5 degrees of runway heading
- LNAV selected prior to TO/GA.
    - LNAV guidance becomes active at 50 feet AGL

LNAV engagement criteria in flight:
- active route entered in FMC
- within 3 NM of active route, LNAV engagement occurs with any airplane heading
- outside of 3 NM, airplane must:
    - be on intercept course of 90 degrees or less
    - intercept route segment before active waypoint.

LNAV automatically disconnects for following reasons:
- reaching end of active route
- reaching a route discontinuity
- intercepting a selected approach course in VOR LOC or APP modes (VOR/LOC armed)
- selecting HDG SEL

5. VOR Localizer (LOC) Switch

Push –
- commands AFDS roll to capture and track selected VOR or LOC course
- annunciates VOR/LOC armed or engaged as roll mode and illuminates VOR LOC switch light.

VOR LOC Mode: Pushing the VOR LOC switch selects VOR mode if a VOR frequency is tuned or selects LOC mode if a localizer frequency is tuned. The VOR mode provides roll commands to track selected VOR course. The LOC mode provides roll commands to track selected localizer course along inbound front course bearing.

The selected course can be intercepted while engaged in:
- LNAV
- HDG SEL
- CWS R if an autopilot is engaged in CMD.

While engaged in VOR or LOC modes:
- A autopilot and Captain’s F/D use information from Captain’s course selector and

No. 1 VHF NAV receiver
- B autopilot and First Officer's F/D use information from First Officer's course selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for two VHF NAV receivers can cause disagreement between the Captain's and First Officer's F/D displays and affect A/P operation.

6. Course Selector

Sets course in COURSE display for related VHF NAV receiver, AFDS and DU. Two course selectors and COURSE displays are located on the MCP.

Rotate Captain's course selector – provides selected course information to:
- No. 1 VHF NAV receiver
- Captain's course pointer and course deviation bar.

Rotate First Officer's course selector – provides selected course information to:
- No. 2 VHF NAV receiver
- First Officer's course pointer and course deviation bar.

7. Bank Angle Selector

Rotate –
- sets maximum allowable bank angle for AFDS operation in HDG SEL or VOR modes
- commanded bank angle can be selected at 10, 15, 20, 25, or 30 degrees.

8. Heading Select (HDG SEL) Switch

Push –
- engages HDG SEL command mode
- commands roll to follow selected heading
- annunciates HDG SEL as FMA roll mode and illuminates HDG SEL switch light.

Heading Select Command Mode: The HDG SEL mode commands roll to turn to and maintain heading shown in HEADING display.

9. Approach (APP) Switch

Push –
- illuminates APP switch light
- arms the AFDS for localizer and glideslope capture
- roll mode annunciates VOR/LOC armed
- pitch mode annunciates G/S armed
- enables engagement of both autopilots.

APP Mode: The approach mode arms AFDS to capture and track localizer and glideslope and can be engaged for dual or single autopilot operation.

One VHF NAV receiver must be tuned to an ILS frequency before approach mode can be engaged. With one VHF NAV receiver tuned, onside AFDS is enabled for guidance and operation.

For dual autopilot operation, both VHF NAV receivers must be tuned to the ILS frequency and both autopilots must be selected in CMD prior to 800 feet RA.

APP mode operation:

- localizer must be captured prior to glideslope
- localizer can be intercepted in HDG SEL, LNAV, or CWS R

[Option – EFIS/MAP]

- 1 CH annunciates in A/P Status Display after localizer capture
  - for single autopilot approach, 1 CH remains annunciated for entire approach
  - for dual autopilot approach, 1 CH annunciation extinguishes when second autopilot engages and FLARE armed is annunciated

[Option – PFD/ND]

- SINGLE CH annunciates in A/P Status Display after localizer capture
  - for single autopilot approach, SINGLE CH remains annunciated for entire approach
- APP switch light extinguishes after localizer and glideslope capture.

After localizer and glideslope capture, APP mode can be disengaged by:

- pushing a TO/GA switch
- disengaging autopilot(s) and turning off both F/D switches
- retuning the VHF NAV receiver.

Note: After localizer and glideslope capture, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

Autopilot / Flight Director

[Option – 737-600/700/700C/700ER/800/900/900ER]

GLARESHIELD

[Option – BBJ/BBJ2/BBJ3]

GLARESHIELD

1. Command Engage (CMD ENGAGE) Switch (A or B):

Push –

- engages A/P
- enables all command modes
- displays CMD in A/P status display
- pushing an engage switch for second A/P, while not in approach mode, engages second A/P and disengages first A/P
- enables CWS operation
- CWS engages if:
  - pitch or roll mode not selected
  - pitch or roll mode deselected
  - pitch or roll mode manually overridden with control column force.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

- CWS engaged displays:
  - CWS P and/or CWS R in A/P status display
  - blank in pitch and/or roll mode FMA
- when approaching a selected altitude in CWS P, the pitch mode engages in ALT ACQ and ALT HOLD when reaching selected altitude
- when approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted
- if pitch is manually overridden while in ALT HOLD and control force is released within 250 feet of selected altitude, A/P pitch mode engages in ALT ACQ and returns to selected altitude in ALT HOLD mode.

2. Control Wheel Steering Engage (CWS ENGAGE) Switch (A or B):

Push –

- engages A/P
- engages pitch and roll modes in CWS. Other pitch and roll modes not enabled
- displays CWS P and CWS R in A/P status display
- CMD not displayed in A/P status display
- F/Ds, if ON, display guidance commands and FD annunciates in A/P status display. A/P does not follow commands while in CWS
- A/P pitch and roll controlled by pilot with control wheel pressure
- when control pressure released, A/P holds existing attitude. If aileron pressure released with 6 degrees or less bank, the A/P rolls wings level and holds existing heading. Heading hold feature inhibited:
  - below 1500 feet RA with gear down
  - after LOC capture in APP mode
  - after VOR capture with TAS 250 knots or less.

3. Autopilot Disengage (DISENGAGE) Bar

Pull down – disengages both A/Ps and prevents engagement of the A/P.

Lift up – allows A/P to be engaged.

4. Master (MA) Flight Director Indicators (white letters)

The master light shows which FCC controls the mode selection. If the master light above the captain F/D switch is on, FCC A controls the mode selection. If the master light above the F/O F/ D switch is on, FCC B controls the mode selection.

5. Flight Director (F/D) Switch

Left F/D switch activates the command bar on the Captain's attitude indicator. Right F/D switch activates the command bar on the First Officer's attitude indicator.

ON –

- in flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- enables command bar display on related attitude indicator
- command bar is displayed if command pitch and roll modes are engaged
- on ground, arms pitch and roll modes for engagement in TO/GA and wings level when TO/GA switch is pushed.

OFF – remove command bars from the related attitude indicator.

Autopilot / Autothrottle Controls

YOKE

[Option – 737-600/700/700C/700ER/800/900/900ER]

GLARESHIELD

[Option – BBJ/BBJ2/BBJ3]

GLARESHIELD

1. Autopilot Disengage Switch

Push –
- disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds
- second push extinguishes disengage lights and silences disengage warning tone
- if autopilot automatically disengages, extinguishes A/P Disengage lights and silences A/P warning tone.

2. Takeoff/Go–Around (TO/GA) Switches

Push – engages AFDS and A/T in takeoff or go–around mode.

Autopilot / Autothrottle Indicators

CAPTAIN PANEL
FIRST OFFICER PANEL

1. Autopilot (A/P) Disengage Light

Illuminated (red) –
- flashes and tone sounds when autopilot has disengaged
- reset by pushing either disengage light or either A/P disengage switch
- steady for any of following conditions:
  - disengage light test switch held in position 2
  - automatic ground system tests fail.

Illuminated (amber) –
- steady – disengage light test switch held in position 1.
- flashing – A/P automatically reverts to CWS pitch or roll while in CMD. Resets by pushing either light or selecting another mode.

2. Autothrottle (A/T) Disengage Light

Illuminated (red) –
- flashing – autothrottle has disengaged
- steady – disengage light test switch held in position 2.

Illuminated (amber) –
- steady – disengage light test switch held in position 1
- flashing – indicates A/T airspeed error under following conditions:
  - inflight
  - flaps not up
  - airspeed differs from commanded value by +10 or -5 knots and is not approaching commanded value.

3. Disengage Light Test (TEST) Switch

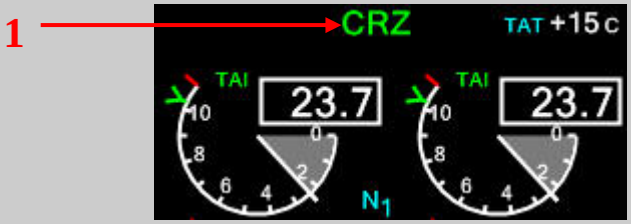
TEST 1 – illuminates autopilot/autothrottle disengage and FMC alert lights steady amber.

TEST 2 – illuminates autopilot/autothrottle disengage lights steady red and FMC alert light steady amber.

Spring – loaded to center position.

Thrust Mode Display

[Option – Side by side display]



UPPER DISPLAY UNIT

[Option – Over/Under display]

UPPER DISPLAY UNIT

1. Thrust Mode Display

N1 limit reference is the active N1 limit for autothrottle and manual thrust control.

N1 limit reference is also displayed by N1 reference bugs with N1 SET control in

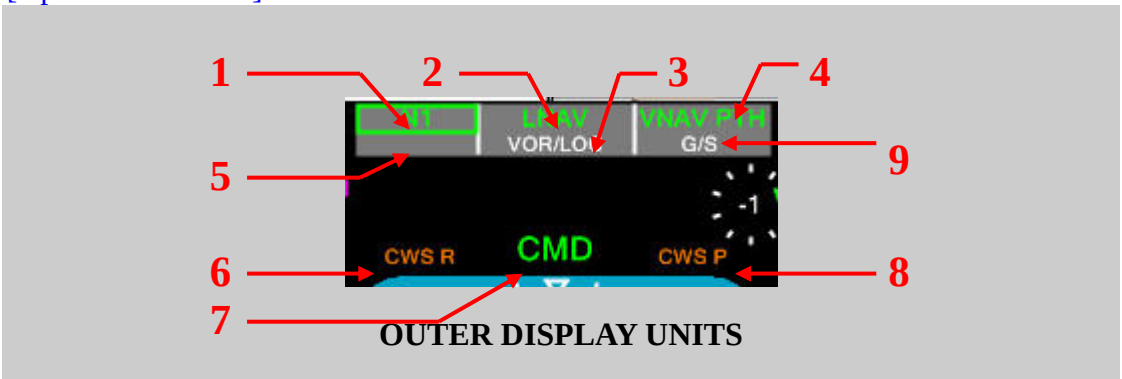
AUTO position.

Thrust mode display annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go–around
- CON – continuous
- —— – FMC not computing thrust limit.

Flight Mode Annunciations (FMAs)

[Option – PFD/ND]



1. Autothrottle (A/T) Engaged Mode

The autothrottle mode annunciation displays in column one of the FMA. One line of annunciation is available. These are the autothrottle modes that may display:

- N1 (green)
- GA (green)
- Retard (green)
- FMC SPD (green)
- MCP SPD (green)
- THR HLD (green)
- ARM (white)

2. Roll Engaged Mode

The roll mode annunciation displays in column two of the FMA. Two lines of annunciation are available. The first line displays the engaged roll mode. The second line displays the armed roll mode.

- HDG SEL (green)
- VOR/LOC (green)
- LNAV (green)

3. Roll Armed Mode

- VOR/LOC (white)

4. Pitch Engaged Mode

The pitch mode annunciation displays in column three of the FMA. Two lines of annunciation are available. The first line displays the engaged pitch mode. The second line displays the armed pitch mode.

- TO/GA (green)
- V/S (green)
- MCP SPD (green)
- ALT/ACQ (green)
- ALT HOLD (green)
- G/S (green)
- FLARE (green)
- VNAV SPD (green)
- VNAV PTH (green)
- VNAV ALT (green)

5. Mode Highlight Change Symbol

A mode change highlight symbol (rectangle) is drawn around each pitch, roll, CWS, A/P status, and thrust engaged mode annunciation for a period of 10 seconds after each engagement.

6. CWS Roll Engaged

- CWS R (amber)

7. Autopilot Status

The autopilot and flight director status displays above the attitude roll indication. These are the indications that may display:

- CMD (green)
- FD (green)

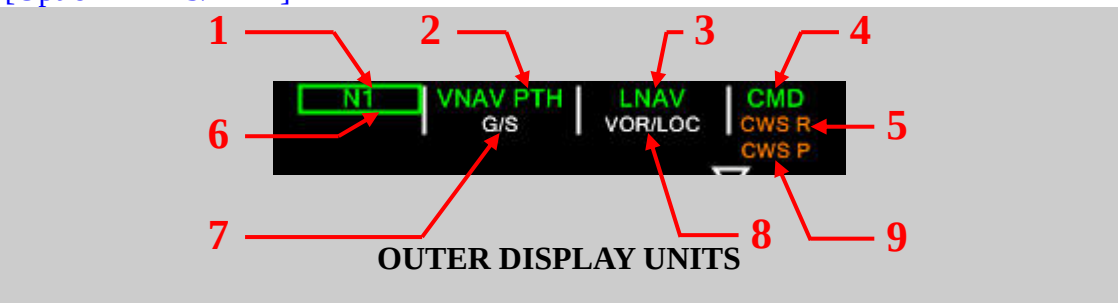
8. CWS Pitch Engaged

- CWS P (amber)

9. Pitch Armed Mode

- G/S (white)
- V/S (white)
- FLARE (white)

[Option – EFIS/MAP]



1. Autothrottle (A/T) Engaged Mode

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- N1 (green)
- GA (green)
- Retard (green)
- FMC SPD (green)
- MCP SPD (green)
- THR HLD (green)
- ARM (white)

2. Pitch Engaged Mode

The pitch mode annunciation displays in column two of the FMA. Two lines of annunciation are available. The first line displays the engaged pitch mode. The second line displays the armed pitch mode.

- TO/GA (green)
- V/S (green)
- MCP SPD (green)
- ALT ACQ (green)
- ALT HOLD (green)
- G/S (green)
- FLARE (green)
- VNAV PTH (green)
- VNAV SPD (green)
- VNAV ALT (green)

3. Roll Engaged Mode

The roll mode annunciation displays in column three of the FMA. Two lines of annunciation are available. The first line displays the engaged roll mode. The second line displays the armed roll mode.

- HDG SEL (green)
- VOR/LOC (green)
- LNAV (green)

4. Autopilot Status

- CMD (green)
- 1 CH (amber)
- FD (green)

5. CWS Pitch Engaged

- CWS P (amber)

6. Mode Highlight Change Symbol

A mode change highlight symbol (rectangle) is drawn around each pitch, roll, CWS, A/P status, and thrust engaged mode annunciation for a period of 10 seconds after each engagement.

7. Pitch Armed Mode

- G/S (white)
- V/S (white)
- FLARE (white)

8. Roll Armed Mode

- VOR/LOC (white)

9. CWS Roll Engaged

- CWS R (amber)

Automatic Flight System Description

Chapter 4
Section 20

General

The automatic flight system (AFS) consists of the autopilot flight director system (AFDS) and the autothrottle (A/T). The flight management computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral and vertical flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's primary display.

Autopilot Flight Director System (AFDS)

The AFDS is a dual system consisting of two individual flight control computers (FCCs) and a single mode control panel.

MCP Mode Selector Switches

The mode selector switches are pushed to select desired command modes for the AFDS and A/T. The switch illuminates to indicate mode selection and that the mode can be deselected by pushing the switch again. When engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect.

Autopilot Engagement Criteria

Each A/P can be engaged by pushing a separate CMD or CWS engage switch. A/P engagement in CMD or CWS is inhibited unless all of following conditions are met:

- no force is being applied to the control wheel
- the STAB TRIM AUTOPILOT cutout switch must be in the NORMAL position.
- the inertial reference data from the ADIRU must be valid
- the IRS transfer switch must be in the NORMAL position to engage the autopilot.

Unless approach (APP) mode is engaged, only one A/P can be engaged at a given time. Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides control through landing flare and touchdown or an automatic go–around.

In single A/P operation, full automatic flare and touchdown capability and A/P go–around capability are not available.

Autopilot Disengagement

The A/P automatically disengages when any of the following occurs:

- pushing either A/P disengage switch
- pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD;
    - below 2000 feet RA or,
    - with flaps not up or,
    - G/S engaged

- pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD above 2000 feet RA with flaps not up or G/S engaged.
- pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- pushing an illuminated A/P ENGAGE switch
- pushing the A/P DISENGAGE bar down
- moving the STAB TRIM AUTOPILOT cutout switch to CUTOUT
- moving the IRS transfer switch to BOTH ON 1 or BOTH ON 2
- either left or right IRS system failure
- loss of electrical power
- loss of respective hydraulic system pressure.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective attitude indicator if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear.

F/D commands operate in the same command modes as the A/P except:

- the takeoff mode is a F/D only mode
- the F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.

AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located above the attitude indicator on the outboard display unit:

- CMD (one or both autopilots are engaged)
- FD (the flight director is ON and the autopilot is either OFF or engaged in CWS)
- CWS P (pitch mode engaged in CWS)
- CWS R (roll mode engaged in CWS)

[Option – EFIS/MAP]

- 1 CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach.).

[Option – PFD/ND]

- SINGLE CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach.).

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed just above the attitude indicator on the outboard display unit. The mode annunciations, from left to right, are:

[Option – EFIS/MAP]

- autothrottle
- pitch
- roll.

[Option – PFD/ND]

- autothrottle
- roll

- pitch.

Engaged or captured modes are shown at the top of the flight mode annunciation boxes in large green letters. Armed modes are shown in smaller white letters at the bottom of the flight mode annunciation boxes.

Autothrottle Modes

- N1 – the autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode display, including full go-around N1 limit
- GA – the autothrottle maintains thrust at reduced go–around setting
- RETARD – displayed while autothrottle moves thrust levers to the aft stop. RETARD mode is followed by ARM mode
- FMC SPD – the autothrottle maintains speed commanded by the FMC. The autothrottle is limited to the N1 value shown on the thrust mode display
- MCP SPD – the autothrottle maintains speed set in the MCP IAS/MACH display. The autothrottle is limited to the N1 value shown on the thrust mode display
- THR HLD – the thrust lever autothrottle servos are inhibited; the pilot can set the thrust levers manually
- ARM – no autothrottle mode engaged. The thrust lever autothrottle servos are inhibited; the pilot can set thrust levers manually. Minimum speed protection is provided

Pitch Modes

- TO/GA – Takeoff

Engaged for takeoff by turning both F/D switches ON and pushing TO/GA switch. Both F/Ds must be ON to engage TO/GA prior to starting takeoff. The AFDS commands pitch attitude in the following order:

  - 10 degrees nose down until 60 knots IAS
  - 15 degrees nose up after 60 knots IAS
  - 15 degrees nose up after lift–off until a sufficient climb rate is acquired. Then, pitch is commanded to maintain MCP speed plus 20 knots.

In takeoff, the flight director commands show automatically even if the flight director switches are in the OFF position. This is the pop-up mode. It occurs when these conditions are true:

  - The pilot pushes a TO/GA switch
  - The airspeed is more than 80 knots.

The F/Ds stay in the pop-up mode for 150 seconds after the airspeed reaches 80 knots.

- TO/GA – Go–around

Engaged for go–around by pushing the TO/GA switch under the following conditions:

  - inflight below 2000 feet radio altitude
  - inflight above 2000 feet radio altitude with flaps not up or G/S captured
  - not in takeoff mode
  - either F/D ON or OFF.

When engaged, the F/Ds command roll to hold the ground track, and 15 degrees nose up pitch.

- VNAV (engaged) – VNAV is engaged by pushing the VNAV switch. With a VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile
  - VNAV SPD – the AFDS maintains the FMC speed displayed on the airspeed indicator and/or the CDU CLIMB or DESCENT pages
  - VNAV PTH – the AFDS maintains FMC altitude or descent path with pitch commands.
  - VNAV ALT – when a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels at the MCP altitude and the pitch flight mode annunciation becomes VNAV ALT. VNAV ALT maintains altitude.
- V/S (armed) – V/S mode can be engaged by moving Vertical Speed thumbwheel
- V/S (engaged) – commands pitch to hold selected vertical speed
- ALT ACQ – transition maneuver entered automatically from a V/S, LVL CHG, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition
- ALT HOLD – commands pitch to hold MCP selected altitude or barometric altitude at which ALT HOLD switch was pushed
- MCP SPD – pitch commands maintain IAS/MACH window airspeed or Mach
- G/S (armed) – the AFDS is armed for G/S capture
- G/S (engaged) – the AFDS follows the ILS glideslope
- FLARE (armed) – during a dual A/P ILS approach, FLARE is displayed after LOC and G/S capture and below 1500 feet RA. The second A/P couples with the flight controls and A/P go–around mode arms
- FLARE (engaged) – during a dual A/P ILS approach, flare engages at 50 feet radio altitude. FLARE accomplishes the autoland flare maneuver.

Roll Modes

- LNAV (engaged) – the AFDS intercepts and tracks the active FMC route. Either of the following capture criteria must be met:
  - on any heading and within 3 NM of the active route segment
  - if outside of 3 NM of active route segment, airplane must be on an intercept course of 90 degrees or less and intercept the route segment before the active waypoint.
- HDG SEL – the airplane is turning to, or is on the heading selected in the MCP Heading Display
- VOR/LOC (armed) – AFDS is armed to capture selected VOR or LOC COURSE
- VOR/LOC (engaged) – AFDS tracks selected VOR course or tracks selected localizer course along the inbound front course bearing.

Autopilot Control Wheel Steering

CWS Engage Switch Selected

Pushing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS P and CWS R on the FMAs.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This feature is inhibited when any of the following conditions exists:

- below 1,500 feet RA with the landing gear down
- after F/D VOR capture with TAS 250 knots or less
- after F/D LOC capture in the APP mode.

Pitch CWS with a CMD Engage Switch Selected

The pitch axis engages in CWS while the roll axis is in CMD when:

- a command pitch mode has not been selected or was deselected
- A/P pitch has been manually overridden with control column force. This manual pitch override is inhibited in the APP mode with both A/Ps engaged.

CWS P is annunciated on the FMAs while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS P with a CMD engage switch selected, CWS P changes to ALT ACQ. When at the selected altitude, ALT HOLD engages.

If pitch is manually overridden while in ALT HOLD at the selected altitude, ALT HOLD changes to CWS P. If control force is released within 250 feet of the selected altitude, CWS P changes to ALT ACQ, the airplane returns to the selected altitude, and ALT HOLD engages. If the elevator force is held until more than 250 feet from the selected altitude, pitch remains in CWS P.

Roll CWS with a CMD Engage Switch Selected

The roll axis engages in CWS while the pitch axis is in CMD when:

- a command roll mode has not been selected or was deselected
- A/P roll has been manually overridden with control wheel force. This manual roll override is inhibited in the APP mode with both A/Ps engaged.

CWS R is annunciated on the FMAs while this mode is engaged.

CWS R with a CMD engage switch illuminated can be used to capture a selected radio course while the VOR/LOC or APP mode is armed. Upon intercepting the radial or localizer, the F/D and A/P annunciations change from CWS R to VOR/LOC engaged, and the A/P tracks the selected course.

Autothrottle System

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach and go–around or landing.

Autothrottle Engagement

Moving the A/T Arm switch to ARM, arms the A/T for engagement in the N1, MCP SPD or FMC SPD mode.

A general summary of A/T mode engagement is as follows:

- A/T SPD or N1 modes automatically engage when AFDS command pitch modes become engaged
- engaging LVL CHG or VNAV climb modes automatically engages the A/T N1

mode
- engaging LVL CHG or VNAV descent modes automatically engages the A/T in RETARD and then ARM when thrust is at idle
- if not in a VNAV mode, engagement of ALT ACQ or ALT HOLD automatically engages the A/T in the MCP SPD mode; otherwise the A/T remains in FMC SPD
- engagement of G/S capture automatically engages the A/T in the MCP SPD mode

Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:
- moving the A/T Arm switch to OFF
- pushing either A/T Disengage switch
- an A/T system fault is detected
- two seconds have elapsed since landing touchdown

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

Automatic Flight Operations

The phases of flight for automatic flight operations are:
- Takeoff and climb
- Enroute
- Approach and landing
- Go–around

Automatic Flight Takeoff and Climb

Takeoff is a flight director only function of the TO/GA mode. Flight director pitch and roll commands are displayed and the autothrottle maintains takeoff N1 thrust limit as selected from the FMC. The autopilot may be engaged after takeoff.

F/D must be ON to engage the takeoff mode prior to starting the takeoff. The F/D takeoff mode is engaged by pushing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and blank for the roll mode.

During takeoff, pushing a TO/GA switch engages the autothrottle in the N1 mode. The A/T annunciation changes from ARM to N1 and thrust levers advance toward takeoff thrust.

The F/D can also be engaged in the takeoff mode with the F/D switches off. If a TO/GA switch is pushed after 80 knots below 2000 feet AGL and prior to 150 seconds after lift–off, the F/D command bars automatically appear for both pilots.

During takeoff, prior to 60 KIAS:
- the pitch command is 10 degrees nose down
- the roll command is wings level
- the autothrottle is engaged in the N1 mode
- the FMAs display N1 for the autothrottle mode, TO/GA for the pitch mode, and blank for the roll mode.

At 60 knots, the F/D pitch commands 15 degrees nose up.

At 84 knots, the A/T mode annunciates THR HLD.

At lift–off:
- the pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots
- if an engine failure occurs during takeoff, the pitch command target speed is:
  - V2, if airspeed is below V2
  - existing speed, if airspeed is between V2 and V2 + 20
  - V2 + 20, if airspeed is above V2 + 20
- the roll command maintains wings level.

After lift–off:
- the A/T remains in THR HLD until 800 feet RA. A/T annunciation then changes from THR HLD to ARM and reduction to climb thrust can be made by pushing the N1 switch
- automatic thrust reduction to climb power occurs when VNAV, ALT ACQ or ALT HOLD is engaged.
- automatic reduction to climb thrust occurs upon reaching the selected thrust reduction altitude which is shown on the FMC CDU TAKEOFF REF page 2/2 during preflight.

To terminate the takeoff mode below 400 feet RA, both F/D switches must be turned OFF. Above 400 feet RA, selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC.

Other roll modes available are:
- VOR course (VOR/LOC)
- heading select (HDG SEL).

Other pitch modes available are:
- altitude hold (ALT HOLD)
- level change (MCP SPD)
- vertical speed (V/S).

Automatic Flight Approach and Landing

The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent may be accomplished using VNAV, LVL CHG, or V/S. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single or dual A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glideslope.

Localizer and Glideslope Armed

After setting the localizer frequency and course, pushing the APP switch selects the APP mode. The APP switch illuminates and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

Glideslope (G/S) capture is inhibited prior to localizer capture.

Localizer Capture

[Option – EFIS/MAP]
The LOC capture point is variable and depends on intercept angle and rate of closure. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

[Option – PFD/ND]
The LOC capture point is variable and depends on intercept angle and rate of closure. Upon LOC capture, VOR/LOC annunciates captured, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glideslope Capture

Glideslope capture is inhibited prior to localizer capture.

The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured
- airplane pitch tracks the G/S
- GA displayed on thrust mode display (N1 thrust limit).

After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pushing a TO/GA switch
- disengaging A/P and turning off both F/D switches
- retuning a VHF NAV receiver.

After LOC and G/S Capture

Shortly after capturing LOC or G/S and below 1500 feet RA:

- the second A/P couples with the flight controls
- FLARE armed is annunciated

[Option – EFIS/MAP]

- the 1 CH annunciation extinguishes

[Option – PFD/ND]

- the SINGLE CH annunciation extinguishes
- A/P go–around mode arms but is not annunciated.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

800 Feet Radio Altitude

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

Flare

The A/P flare maneuver starts at approximately 50 feet RA and is completed at

touchdown:
- FLARE engaged is annunciated and F/D command bars retract.
- the A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. A/T FMA annunciates RETARD.
- the A/T automatically disengages approximately 2 seconds after touchdown.
- the A/P must be manually disengaged after touchdown.

Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD after pushing the APP mode select switch. Single A/P approach operation is the same as dual, with the following exceptions:
- automatic flare is for dual channel approach, however, since it is part of the A/P design, it can function during single channel approaches. The flare mode does not annunciate on the FMA in a single channel approach. The autopilot should be disengaged manually when the airplane reaches the decision height.

[Option – EFIS/MAP]
- A/P status of 1 CH is annunciated for the entire approach after localizer capture

[Option – PFD/ND]
- A/P status of SINGLE CH is annunciated for the entire approach after localizer capture
- an A/P go–around is not available.

Go–Around

Go–Around (GA) mode is engaged by pushing either TO/GA switch. The A/P go–around requires dual A/P operation and is armed when FLARE armed is annunciated. If both A/Ps are not operating, a manual F/D go–around is available.

With the A/T Arm switch at ARM, the A/T go–around mode is armed:
- when descending below 2000 feet RA
- when above 2000 feet RA with flaps not up or G/S captured
- with or without the AFDS engaged.

A/P Go–Around

The A/P GA mode requires dual A/P operation and is available after FLARE armed is annunciated and prior to the A/P sensing touchdown.

With push of either TO/GA switch:
- A/T (if armed) engages in GA and the A/T Engaged Mode annunciation on the FMA indicates GA
- the A/T advances to the full go–around N1 limit.
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- the IAS/Mach display blanks

- the command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

TO/GA mode termination from A/P go–around:
- below 400 feet RA, the AFDS remains in the go–around mode unless both A/Ps and F/Ds are disengaged
- above 400 feet RA, select a different pitch or roll mode.
  - if the roll mode is changed first:
    - the selected mode engages in single A/P roll operation and is controlled by the A/P which was first in CMD
    - pitch remains in dual A/P control in TO/GA mode.
  - if the pitch mode is changed first:
    - the selected mode engages in single A/P pitch operation and is controlled by the A/P which was first in CMD
    - the second A/P disengages
    - the roll mode engages in CWS R.
  - the A/T GA mode is terminated when:
    - another pitch mode is selected
    - ALT ACQ annunciates engaged.

F/D Go–Around

If both A/Ps are not engaged, a manual F/D only go–around is available under the following conditions:
- inflight below 2000 feet RA
- inflight above 2000 feet RA with flaps not up or G/S captured
- not in takeoff mode.

With the first push of either TO/GA switch:
- A/T (if armed) engages in GA and advances thrust toward the full go–around N1 limit. The A/T Engaged Mode annunciation on the FMA indicates GA
- autopilot (if engaged) disengages
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands approach ground track at time of engagement. The Roll Engaged Mode annunciation on the FMA is blank
- the IAS/Mach display blanks
- the command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

TO/GA mode termination from F/D go–around:
- below 400 feet RA, both F/D switches must be turned off.
- above 400 feet RA, select a different pitch or roll mode.
  - if the roll mode is changed first:
    - F/D roll engages in the selected mode
    - F/D pitch mode remains in TO/GA.

- if the pitch mode is changed first:
  - F/D pitch engages in the selected mode.
  - F/D roll mode automatically changes to HDG SEL
- the A/T GA mode (if engaged) is terminated when:
  - another pitch mode is selected
  - ALT ACQ annunciates engaged.

Single Engine F/D Go–Around

With a push of either TO/GA switch:

- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- the F/D target speed is displayed on IAS/Mach display
- the F/D target speed is displayed on the airspeed cursor
- F/D pitch commands 13 degrees nose up. As climb rate increases, F/D pitch commands maintain a target speed.

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Communications Controls and Indicators

Chapter 5
Section 10

VHF Communication Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]

AFT ELECTRONIC PANEL

1. VHF Communications Transfer (TFR) Switch

Selects related frequency as active for transceiver.

2. Active Frequency Light

Illuminated (white) – indicates the related frequency is selected.

3. Frequency Indicator

Indicates frequency selected with associated frequency selector.

4. Frequency Selector

Rotate – selects frequency in related indicator.

5. Communication Test (COMM TEST) Switch

Push – tests VHF Communication system

Radio Tuning Panel

[Option – BBJ/BBJ2/BBJ3]

AFT ELECTRONIC PANEL

1. Frequency Transfer Switch

Push –
- transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency.
- transfers the ACTIVE window frequency to the STANDBY window.

2. Frequency Indicator

ACTIVE – displays the tuned frequency of the selected radio.

STANDBY – displays the preselected or previously tuned frequency of the selected radio. Can be changed by the frequency selectors

3. Radio Tuning Switch

Push –
- selects the radio to be tuned
- the tuned frequency is displayed in the ACTIVE frequency indicator
- the standby frequency is displayed in the STANDBY frequency indicator.

4. Radio Tuning Panel OFF Switch

Push – turns on or off the associated radio tuning panel

Switch illuminates when off.

5. HF Sensitivity Control

Not modeled.

6. Radio Tuning Light

Illuminated (white) – indicates the selected radio.

7. Offside Tuning Light

Illuminated (white) –
- the radio normally associated with this panel is being tuned by another radio tuning panel, or
- the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

8. VHF TEST Switch

Push – tests VHF Communication system

9. Frequency Selector

Rotate – selects STANDBY frequency of the selected radio.

Audio Control Panel (ACP)

[Option – 737-600/700/700C/700ER/800/900/900ER]

AFT ELECTRONIC PANEL

1. Transmitter Selector (MIC SELECTOR) Switches

Not modeled.

2. Receiver Switches

Illuminated (white) – related switch is active

Push– selects related system or receiver.

[Option – BBJ/BBJ2/BBJ3]

AFT ELECTRONIC PANEL

1. Transmitter Selector (MIC SELECTOR) Switches

Not modeled.

2. Receiver Switches

Illuminated (white) – related switch is active

Push – selects related system or receiver.

Communications System Description

Chapter 5
Section 20

Introduction

The communication system includes:

- radio tuning panels
- audio control panels

[Option – 600/700/800/900]

- VHF Communication Panel

Audio Panels

The audio panels control radio and interphone communication systems. Navigation receiver audio can also be monitored.

Radio Tuning Panels

The radio tuning panels tune the radios. The panels are designated left, center, and right, and are normally associated with the related radios.

If a radio-tuning panel fails, the panel can be disconnected from the communication radios using the OFF switch.

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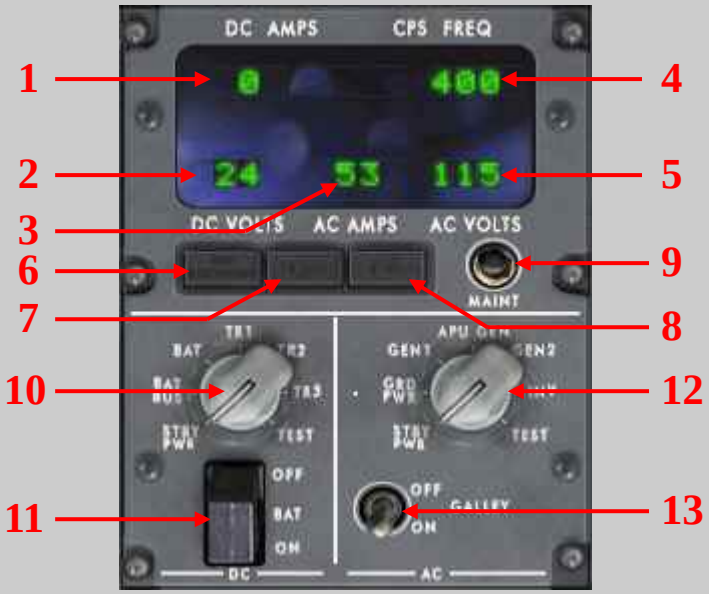
Electrical Controls and Indicators

Chapter 6 Section 10

AC and DC Metering Panel

[Option – 737-600/700/700C/700ER]



FORWARD OVERHEAD PANEL

[Option – 800/900/900ER]

FORWARD OVERHEAD PANEL

[Option – BBJ/BBJ2/BBJ3]

FORWARD OVERHEAD PANEL

1. DC Ammeter

Indicates amperage of source selected by DC meters selector.

2. DC Voltmeter

Indicates voltage of source selected by DC meters selector.

3. AC Ammeter

Indicates amperage of source selected by AC meters selector.

4. Frequency Meter

Indicates frequency of source selected by AC meters selector.

5. AC Voltmeter

Indicates voltage of source selected by AC meters selector.

6. Battery Discharge (BAT DISCHARGE) Light

Illuminated (amber) – the battery discharge discharge with BAT switch ON.

7. TR UNIT Light

The amber TR UNIT light gives indication of transformer rectifier unit (TRU) failure.

Illuminated (amber) –

- on the ground – any TR has failed.
- in flight –
    - TR1 failed; or

- TR2 and TR3 failed.

8. Electrical (ELEC) Light

Illuminated (amber) – a fault exists in DC power system or standby power system.

ELEC light comes on only when the airplane is on the ground.

9. Maintenance Test (MAINT) Switch

Push – tests system. Only operates on the ground.

10. DC Meters Selector

Each position of the DC meter selector, except the TEST position, is related to a DC power source or DC bus. Voltage (DC VOLTS) and load (DC AMPS) show on the alphanumeric display when put the selector in any of the TR positions or any of the BAT positions. Only voltage shows when you put the selector to the BAT BUS or STBY PWR positions.

11. Battery (BAT) Switch

OFF – removes power from battery bus.

ON (guarded position) – enables battery to provide power to battery bus

12. AC Meters Selector

Each position of the AC meter selector, except the TEST position, is related to an AC power source or AC bus. The alphanumeric display shows the following parameters:

- Voltage (AC VOLTS)
- Load (AC AMPS)
- Output frequency (CPS FREQ).

The display shows only voltage and frequency when select one of these:

- STBY PWR
- GRD PWR
- INV.

13. GALLEY Power Switch

[Option – 600/700/700ER/700C/BBJ/BBJ2/BBJ3]
Not modeled.

13. CAB/UTIL Switch

[Option – 800/900/900ER]
Not modeled.

14. IFE/PASS SEAT Switch

[Option – 800/900/900ER]
Not modeled.

Generator Drive and Standby Power Panel

FORWARD OVERHEAD PANEL

1. Generator Drive (DRIVE) Lights

Illuminated (amber) –indicators associated integrated drive generator (IDG) oil pressure is less than the operation limit or when there is an underfrequency condition while the engine operates.

2. Generator Drive Disconnect (DISCONNECT) Switches (guarded)

The generator drive disconnect switch operates the disconnect mechanism for its IDG when the related engine start lever is in the idle position. There is one switch for each IDG. The guard holds the switch in the NORMAL position. IDG cannot be reconnected in the air.

3. STANDBY Power Off (PWR OFF) Light

Illuminated (amber) – indicators either or both standby buses are unpowered.

4. STANDBY POWER Switch

The standby power switch gives manual control of the AC and DC standby power bus sources. The switch is a threeposition switch. The switch is usually in the AUTO position. The guard holds the switch in the AUTO position.

AUTO (guarded position) –

- In flight, or on the ground, and AC transfer busses powered:
  - AC standby bus is powered by AC transfer bus 1
  - DC standby bus is powered by TR1, TR2 and TR3
- In flight, or on the ground, loss of all AC power
  - AC standby bus is powered by battery through static inverter
  - DC standby bus is powered by battery
  - Battery bus is powered by battery.

OFF (center position) –

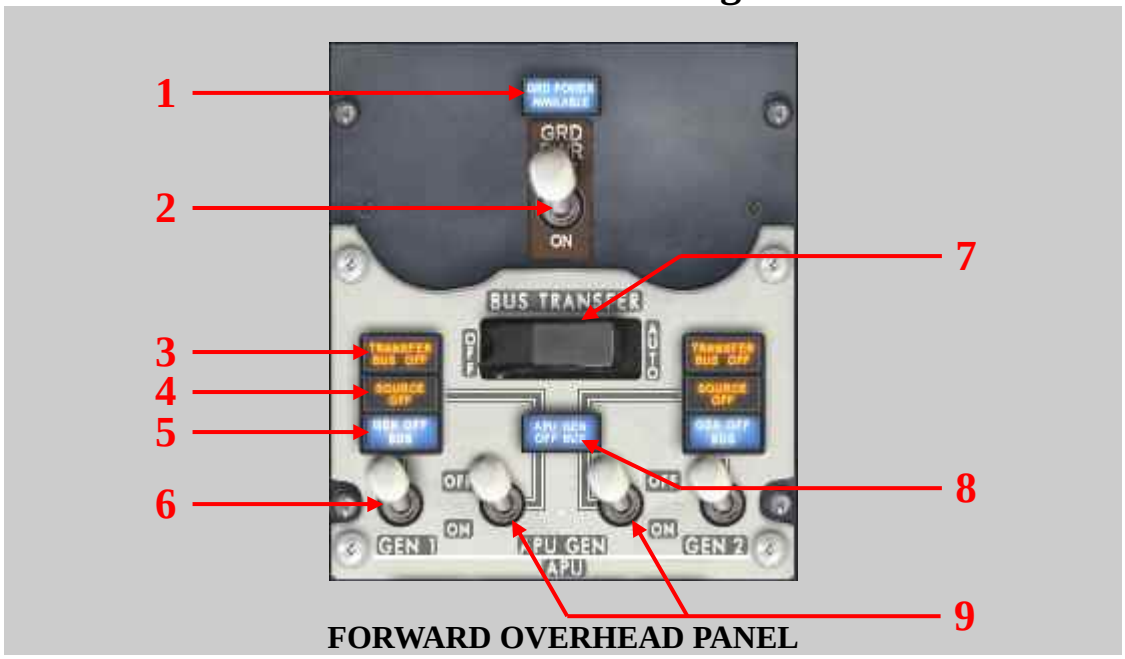
- STANDBY PWR OFF light illuminates
- AC standby bus, static inverter, and DC standby bus are not powered.

BAT (unguarded position) –

- AC standby bus is powered by battery through static inverter

- DC standby bus and battery bus are powered directly by battery.

Ground Power Panel and Bus Switching Panel



1. Ground Power Available (GRD POWER AVAILABLE) Light

Illuminated (blue) – indicators acceptable ground power is plugged.

2. Ground Power (GRD PWR) Switch

Three position switch, spring–loaded to neutral

OFF – removes ground power from the AC transfer busses.

ON – connects ground power to AC transfer busses if ground power is available.

3. TRANSFER BUS OFF Lights

Illuminated (amber) – related transfer bus does not have power.

4. SOURCE OFF Lights

Illuminated (amber) – indicates the associated transfer bus does not have power.

5. Generator Off Bus (GEN OFF BUS) Lights

Illuminated (blue) – IDG is not supplying power to the related transfer bus.

6. Generator (GEN) Switches

The engine generator switches give manual control for IDG power source selection. Each switch is a three-position switch and is spring-loaded to the center (neutral) position. The ON and OFF positions are momentary positions.

OFF – disconnects IDG from related AC transfer bus.

ON – connects IDG to related AC transfer bus.

7. BUS TRANSFER Switch

AUTO (guarded position) – operates automatically to maintain power to AC transfer busses from any operating generator or external power.

OFF – isolates AC transfer bus 1 from AC transfer bus 2.

8. APU Generator Off Bus (GEN OFF BUS) Light

Illuminated (blue) – APU is running but its generator is not a power source in use..

9. APU Generator (GEN) Switches

The APU engine generator switches give manual control for APU generator power source selection. The switches operate like the engine generator switches. Three position switch, spring–loaded to neutral.

OFF – disconnects APU generator from related AC transfer bus.

ON – connects APU generator to related AC transfer bus.

Electrical System Description

Chapter 6 Section 20

Introduction

Single Battery

[Option – 600/700/700C/700ER]
Primary electrical power is provided by two engine integrated drive generators (IDGs). Each IDG supplies its own bus system in normal operation. Transformer rectifier (TR) units supply DC power. The battery also provides backup power for the AC and DC standby system. The APU operates a generator and can supply power to both AC transfer busses on the ground or in flight.

Dual Battery

[Option – 800/900/900ER/BBJ/BBJ2/BBJ3]
Primary electrical power is provided by two engine integrated drive generators (IDGs). Each IDG supplies its own bus system in normal operation. Transformer rectifier (TR) units supply DC power. The main and auxiliary batteries also provide backup power for the AC and DC standby system. The APU operates a generator and can supply power to both AC transfer busses on the ground or in flight.

Principles of operation for the 737 electrical system

- There is no paralleling of the AC sources of power.
- The source of power being connected to a transfer bus automatically disconnects an existing source..

Electrical Power Generation

Engine Generators

Primary power is obtained from two engine IDGs. The IDG maintains a constant generator speed throughout the normal operating range of the engine.

APU Generator

The APU generator can supply power to both AC transfer busses on the ground or in flight.

External Ground Power

An external AC power receptacle allows the use of an external power source. When connected, external power can supply power to both transfer busses.

AC Power System

Each AC power system consists of a transfer bus, a main bus, and two galley busses. Transfer bus 1 also supplies power to the AC standby bus. If the AC source powering either transfer bus fails or is disconnected, the transfer bus can be powered by any available source through the tie bus with the bus tie breakers (BTBs).

Bus Tie System

Either generator or the APU can supply power to both transfer busses. If the BUS TRANS switch is in the AUTO position and the source powering the transfer bus is disconnected or fails, the source powering the opposite transfer bus automatically picks up the unpowered transfer bus through the BTBs.

DC Power System

DC power is supplied by three TR units, which are energized from the AC transfer busses. The battery provides DC power to loads required to be operative when no other source is available.

On the ground, an amber ELEC light comes on to indicate that a fault exists in DC power system or standby power system. The ELEC light is inhibited in flight.

Transformer Rectifier Units

The TRs convert AC to DC, and are identified as TR1, TR2, and TR3.

TR1 receives AC power from transfer bus 1. TR2 receives AC power from transfer bus 2. TR3 normally receives AC power from transfer bus 2 and has a backup source of AC power from transfer bus 1.

Battery Power

Single Battery
[Option – 600/700/700ER/700C]
The battery can supply part of the DC system. Battery charging is automatically controlled. An amber BAT DISCHARGE light comes on when excessive battery discharge is detected.

Dual Battery
[Option – 800/900/900ER/BBJ/BBJ2/BBJ3]
The batteries can supply part of the DC system. The auxiliary battery operates in parallel with the main battery when the battery is powering the standby system. Battery charging is automatically controlled. An amber BAT DISCHARGE light comes on when excessive battery discharge is detected.

Standby Power System

The standby system provides AC and DC power to essential systems in the event of loss of all engines or APU–driven AC power.

During normal operation the guarded standby power switch is in AUTO and the battery switch is ON. This configuration provides alternate power sources in case of partial power loss as well as complete transfer to battery power if all normal power is lost. Under normal conditions the AC standby bus is powered from AC transfer bus 1. The DC standby bus is powered by TR1, TR2, and TR3; the battery bus is powered by TR3.

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Engines, APU Side by Side – Displays

Chapter 7
Section 10

Primary and Secondary Engine Indications

[Option – Side by side display]

UPPER DISPLAY UNIT

[Option – Side by side, total fuel display]

UPPER DISPLAY UNIT

1. Primary Engine Indications

2. Fuel Quantity Indications

Refer to Chapter 12, Fuel.

3. Secondary Engine Indications

4. Hydraulic Indications

Refer to Chapter 13, Hydraulics.

Autothrottle Limit, Thrust Mode Display and Total Air Temperature

UPPER DISPLAY UNIT

1. Thrust Mode Display

Displayed (green) – indicates the mode for which the reference thrust limits are calculated by the FMC.

With N1 Set Outer Knob (on engine display control panel) in AUTO, active N1 limit is displayed by reference N1 bugs.

With N1 Set Outer Knob (on engine display control panel) in either 1, 2 or BOTH, the thrust mode display annunciation is MAN.

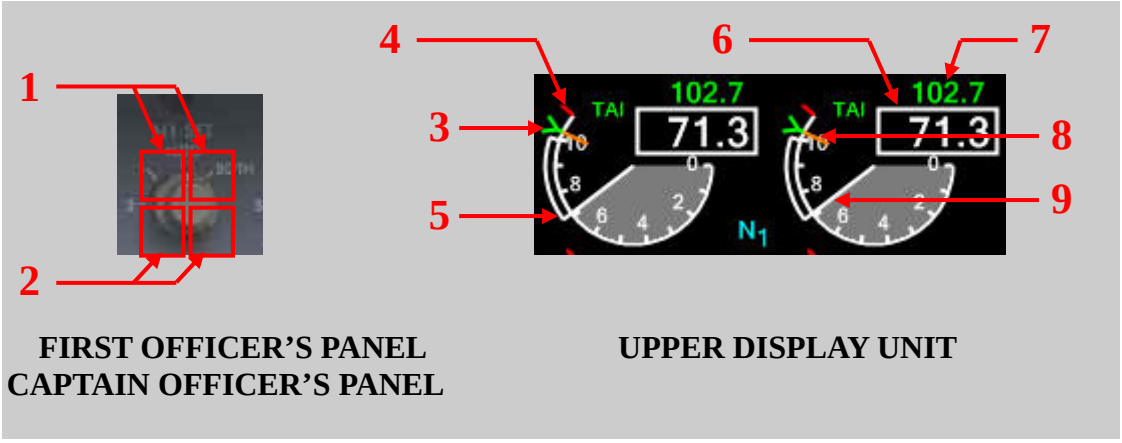
Possible annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go–around
- CON – continuous
- Q-CLB – quiet climb
- —— – FMC not computing thrust limit.

2. Total Air Temperature (TAT) Indication

Displayed (label –cyan, temp – white) – total air temperature (degrees C).

N1 Indications



1. N1 SET Outer Knob

AUTO –
- both reference N1 bugs set by FMC based on N1 limit page and takeoff reference page
- displays reference N1 bugs at active N1 limit for A/T.

BOTH –
- both reference N1 bugs and readouts manually set by turning N1 SET inner knob
- has no effect on A/T operation.

1 or 2 –
- respective N1 reference bug and readout manually set by turning N1 SET inner knob
- has no effect on A/T operation.

2. N1 SET Inner Knob

Rotate – positions reference N1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2.

3. Reference N1 Bugs

Displayed (green) – indicate the N1 reference and valve for the thrust mode.

4. N1 Redlines

Displayed (red) – indicate maximum N1% RPM operating limit

5. N1 Command Sectors

Displayed (white) – display the momentary difference between the commanded thrust and the actual thrust.

6. N1 RPM Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) – operating limit exceeded.

7. Reference N1 Readouts

The reference N1 readout displays above the N1 indication. The reference N1 bug also displays on the N1 analog scale. Crew can set the reference N1 value with the N1 set controls. Not displayed when reverse thrust is selected.

8. N1 Maximum Bug

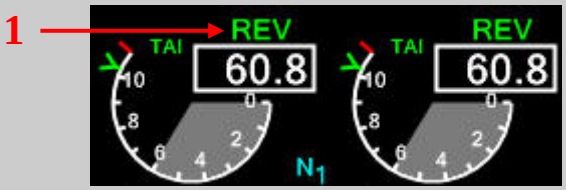
The N1 maximum indication displays as an amber marker in the N1 dial. The EEC calculates the N1 maximum value. Not displayed when reverse thrust is selected.

9. N1 RPM Indications

Displays N1% RPM:

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded

Thrust Reverser Indications



UPPER DISPLAY UNIT

1. Thrust Reverser (REV) Indications

Displayed (amber) – thrust reverser is moved from stowed position.

Displayed (green) – thrust reverser is deployed.

Thermal Anti–Ice Indication

UPPER DISPLAY UNIT

1. Thermal Anti–Ice (TAI) Indications

Displayed (green) – cowl anti–ice valve(s) open.

Displayed (amber) – cowl anti–ice valve is not in position indicated by related engine anti–ice switch.

EGT Indications

UPPER DISPLAY UNIT

1. Exhaust Gas Temperature (EGT) Redlines

The EGT maximum continuous limit is the start of the EGT caution range. Continuous operation of an engine with EGT more than this value could cause damage to the engine.

2. Exhaust Gas Temperature (EGT) Amber Bands

The amber band is the EGT caution range. Continuous operation of an engine with EGT in this range could cause damage to the engine. The amber range shows as an arc between the maximum continuous limit and the EGT redline.

3. Exhaust Gas Temperature (EGT) Start Limit Lines

The EGT start redline is the maximum limit for the EGT during an engine start on the ground. The redline shows only during the ground start. The EGT start redline goes away when the engine goes to idle. This redline does not show in flight.

4. Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – normal operating range (degrees C)

Displayed (amber) – maximum continuous limit exceeded. Color change inhibited for up to 5 minutes during takeoff or go-around

Displayed (red) – maximum takeoff limit or start limit exceeded

5. Exhaust Gas Temperature (EGT) Indications

Displayed (white) – normal operating range.

Displayed (amber) – maximum continuous limit exceeded. Color change inhibited for up to 5 minutes during takeoff or go-around

Displayed (red) – maximum takeoff limit or start limit exceeded.

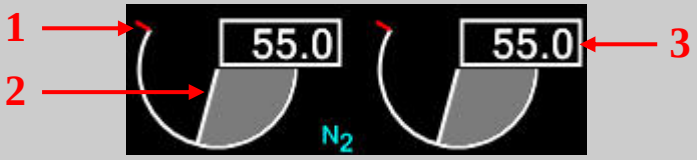
Engine Fail Alert

UPPER DISPLAY UNIT

1. Engine Fail (ENG FAIL) Alert

Displayed (amber) –
- engine N2 below sustainable idle; and
- engine start lever in IDLE position.

N2 Indications



UPPER DISPLAY UNIT

1. N2 Redlines

Displayed (red) – maximum N2 % RPM operating limit.

2. N2 RPM Indications

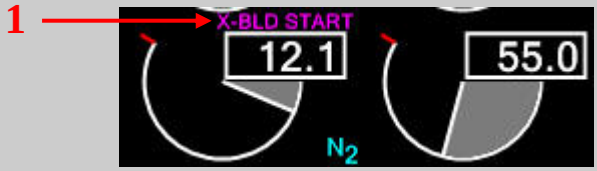
Displays N2 % RPM
- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

3. N2 Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –operating limit exceeded

Crossbleed Start Indication

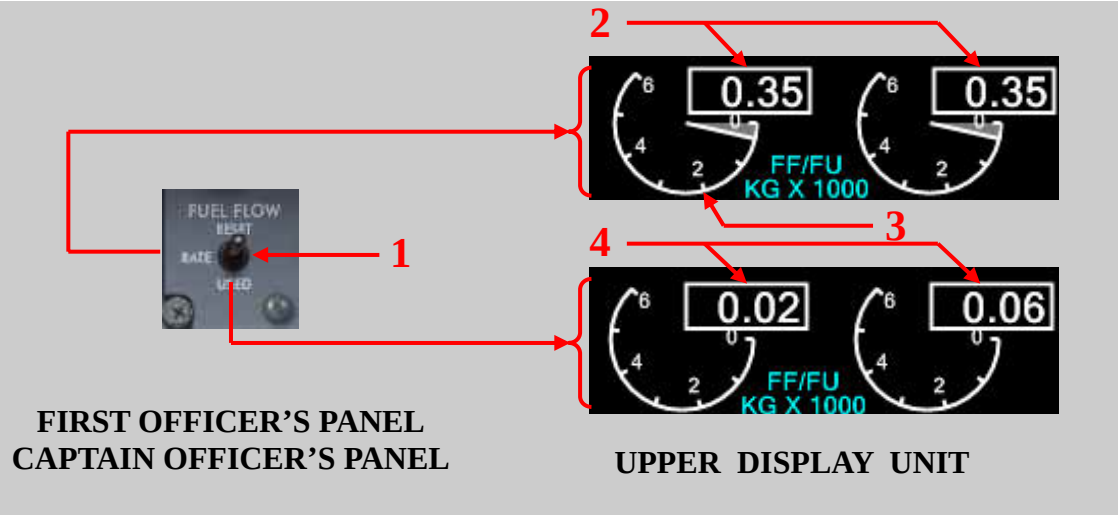


UPPER DISPLAY UNIT

1. Crossbleed (X–BLD) START Indication

Displayed (magenta) – crossbleed air recommended for inflight start.

Fuel Flow/Fuel Used Indications



1. FUEL FLOW Switch (spring-loaded to RATE)

RATE – the RATE position is the usual switch position and shows the fuel flow indication.

USED – the USED position changes from the usual fuel flow indication to the quantity of fuel used since the counter was set to zero. The used indication goes back to the digital and analog rate indication 10 seconds after the indication control switch goes back to RATE.

RESET – the RESET position sets the fuel used display digital counter to zero.

2. Fuel Flow (FF) Readout (digital)

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position.

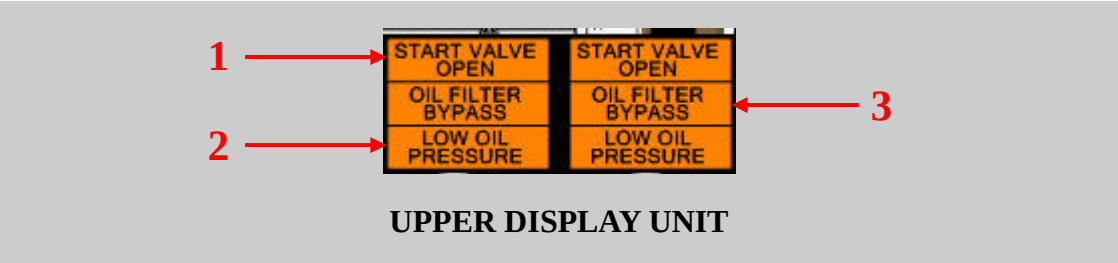
3. Fuel Flow (FF) Dial/ Index Markers & Digits (white)

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position.

4. Fuel Used (FU) Readout (digital)

Displayed (white) – when FUEL FLOW switch moved to USED.

Crew Alerts



1. START VALVE OPEN Alert

Illuminated (amber) – respective engine start valve open.

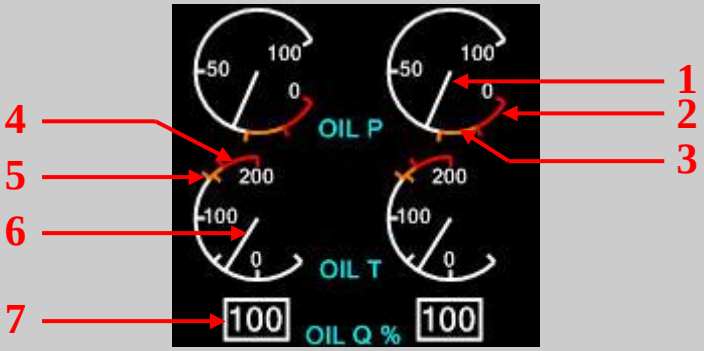
2. LOW OIL PRESSURE Alert

Illuminated (amber) – oil pressure at or below red line.

3. OIL FILTER BYPASS Alert

Not modeled.

Engine Oil Indications



UPPER DISPLAY UNIT

1. Oil Pressure (OIL P) Indication

The oil pressure shows as an analog indication. In the normal operation range, the scale and the pointer are white. When the oil pressure is in the low amber band limit, the scale and the pointer are amber. When the oil pressure is in the low redline limit, the scale and the pointer are red.

2. Low Oil Pressure (OIL P) Redline

Displayed (red) – oil pressure operating limit.

3. Low Oil Pressure (OIL P) Amber Band

Displayed (amber) – low oil pressure caution range.

4. High Oil Temperature (OIL T) Redline

Displayed (red) – oil temperature operating limit.

5. High Oil Temperature (OIL T) Amber Band

Displayed (amber) – oil temperature caution range.

6. Oil Temperature (OIL T) Indication

The oil temperature shows as an analog indication. In the normal operation range, the scale and the pointer are white. When the oil temperature is in the high amber band limit, the scale and the pointer are amber. When the oil temperature is in the high redline limit, the scale and the pointer are red.

7. Oil Quantity (OIL Q)% Readout

Displays oil quantity as a percentage of full quantity.

Engine Oil Indications

UPPER DISPLAY UNIT

1. Vibration (VIB) Pointer

Displayed (white) – indicates the rotor (N1 or N2) with the higher vibration level.

2. High Engine Vibration Indication

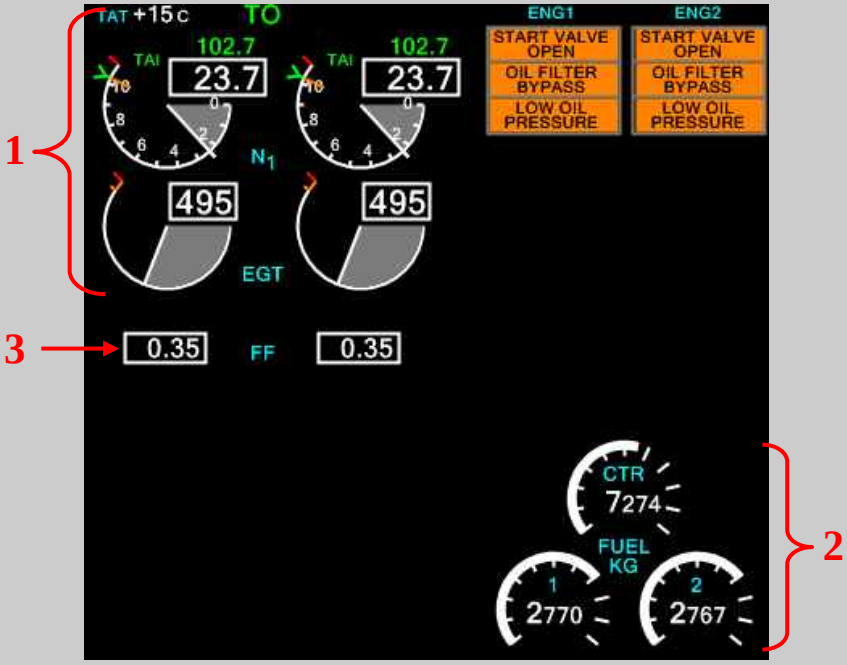
Displayed (white) – When engine vibration level is greater than four units, the portion of the dial arc between 4 units and the pointer, becomes bold.

Engines, APU Over/Under – Displays

Chapter 7 Section 11

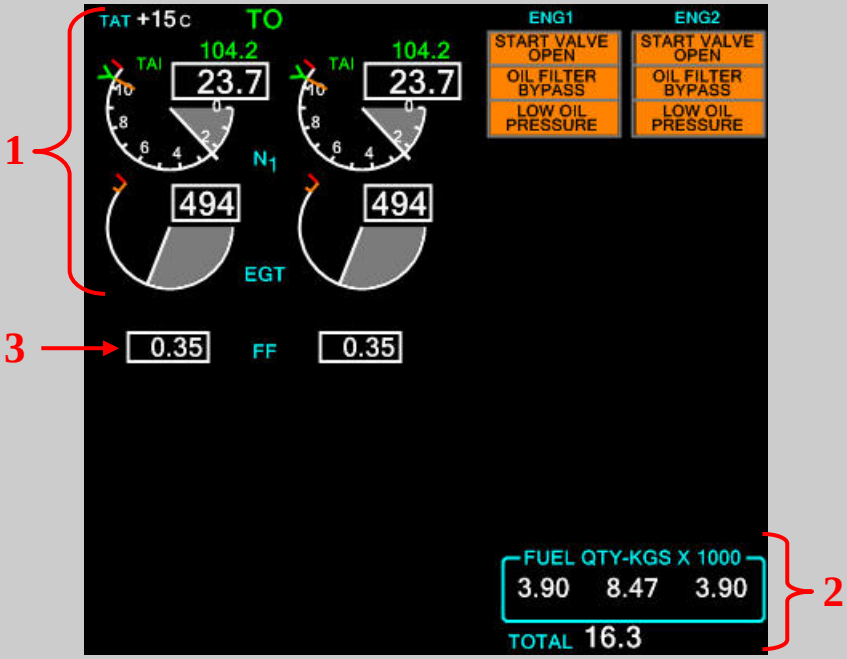
Primary Engine Indications

[Option – Over/Under display]



UPPER DISPLAY UNIT

[Option – Over/Under display, total fuel display]



UPPER DISPLAY UNIT

1. Primary Engine Indications

2. Fuel Quantity Indications

Refer to Chapter 12, Fuel

3. Fuel Flow Indications

Total Air Temperature, Thrust Mode Display, Selected Temperature and Autothrottle Limit

UPPER DISPLAY UNIT

1. Total Air Temperature (TAT) Indication

Displayed (label – cyan, temp – white) – total air temperature (degrees C).

2. Thrust Mode Display

Displayed (green) – indicates the mode for which the reference thrust limits are calculated by the FMC.

With N1 Set Outer Knob (on engine display control panel) in AUTO, active N1 limit is displayed by reference N1 bugs.

With N1 Set Outer Knob (on engine display control panel) in either 1, 2 or BOTH (other than AUTO), the thrust mode display annunciation is MAN.

Thrust mode display annunciations are:

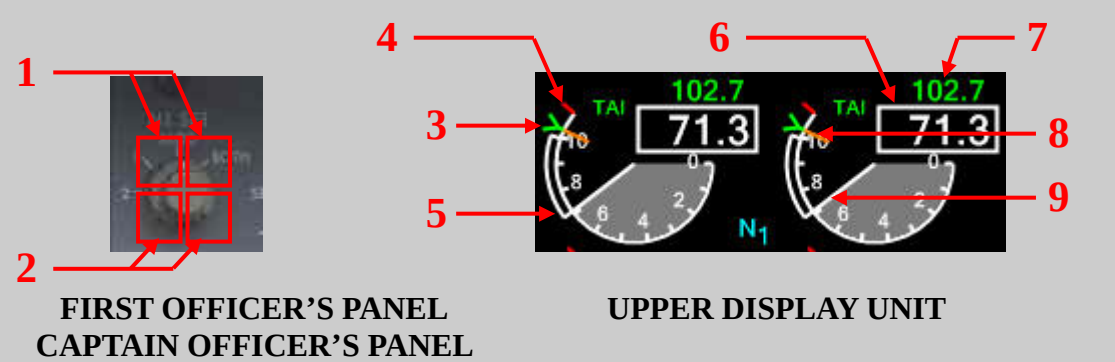
- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go–around
- CON – continuous
- Q-CLB – quiet climb
- —— – FMC not computing thrust limit.

3. Selected Temperature

Displayed (green) – selected assumed temperature (degrees C) for reduced thrust

takeoff N1 that crew set on the FMC CDU takeoff reference page.

N1 Indications



1. N1 SET Outer Knob

AUTO –
- both reference N1 bugs set by FMC based on N1 limit page and takeoff reference page
- displays reference N1 bugs at active N1 limit for A/T.

BOTH –
- both reference N1 bugs and readouts manually set by turning N1 SET inner knob
- has no effect on A/T operation.

1 or 2 –
- respective N1 reference bug and readout manually set by turning N1 SET inner knob
- has no effect on A/T operation.

2. N1 SET Inner Knob (spring-loaded to center)

Rotate – positions reference N1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2.

3. Reference N1 Bugs

Displayed (green) – with N1 SET outer knob in AUTO, 1, 2 or BOTH position.

Position corresponds to digital value on the Reference N1 Readout.

4. N1 Redlines

Displayed (red) – maximum N1% RPM operating limit.

5. N1 Command Sectors

Displayed (white) – display the momentary difference between actual N1 and value commanded by thrust lever position.

6. N1 RPM Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –operating limit exceeded

7. Reference N1 Readouts

Displayed (green) –
- manually set N1% RPM when N1 SET outer knob is in BOTH, 1, or 2 position
- – – – .– when N1 SET outer knob is in AUTO position and FMC source invalid.
- when N1 SET outer knob is in AUTO position, may indicate fixed derate, assumed temperature derate, or a combination of fixed and assumed temperature derate

Not displayed when reverse thrust is selected.

8. N1 Maximum Bug

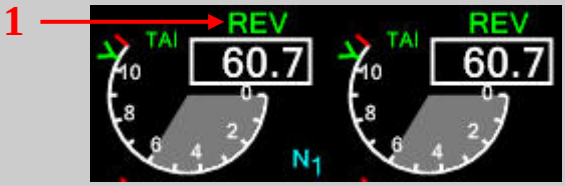
Displayed (amber) –
- N1 value for full rated thrust
- computed by the EEC through all phases of flight.

Not displayed when reverse thrust is selected.

9. N1 RPM Indications

Displays N1% RPM:
- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

Thrust Reverser Indications



UPPER DISPLAY UNIT

1. Thrust Reverser (REV) Indications

Displayed (amber) – thrust reverser is moved from stowed position.

Displayed (green) – thrust reverser is deployed.

Thermal Anti–Ice Indication

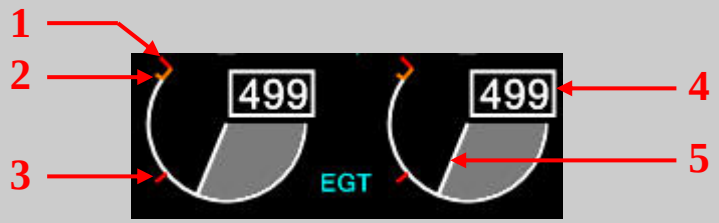
UPPER DISPLAY UNIT

1. Thermal Anti–Ice (TAI) Indications

Displayed (green) – cowl anti–ice valve(s) open.

Displayed (amber) – cowl anti–ice valve is not in position indicated by related engine anti–ice switch.

EGT Indications



UPPER DISPLAY UNIT

1. Exhaust Gas Temperature (EGT) Redlines

The EGT maximum continuous limit is the start of the EGT caution range. Continuous operation of an engine with EGT more than this value could cause damage to the engine.

2. Exhaust Gas Temperature (EGT) Amber Bands

The amber band is the EGT caution range. Continuous operation of an engine with EGT in this range could cause damage to the engine. The amber range shows as an arc between the maximum continuous limit and the EGT redline.

3. Exhaust Gas Temperature (EGT) Start Limit Lines

The EGT start redline is the maximum limit for the EGT during an engine start on the ground. The redline shows only during the ground start. The EGT start redline goes away when the engine goes to idle. This redline does not show in flight.

4. Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – normal operating range (degrees C)

Displayed (amber) – maximum continuous limit exceeded. Color change inhibited for up to 5 minutes during takeoff or go-around

Displayed (red) – maximum takeoff limit or start limit exceeded

5. Exhaust Gas Temperature (EGT) Indications

Displayed (white) – normal operating range.

Displayed (amber) – maximum continuous limit exceeded. Color change inhibited for up to 5 minutes during takeoff or go-around

Displayed (red) – maximum takeoff limit or start limit exceeded.

Engine Fail Alert

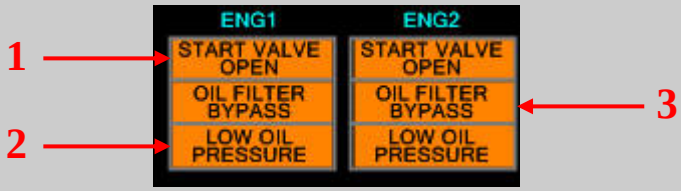
UPPER DISPLAY UNIT

1. Engine Fail (ENG FAIL) Alert

Displayed (amber) –

- engine N2 below sustainable idle; and
- engine start lever in IDLE position.

Crew Alerts



UPPER DISPLAY UNIT

1. START VALVE OPEN Alert

Illuminated (amber) – respective engine start valve open and air is supplied to starter

2. LOW OIL PRESSURE Alert

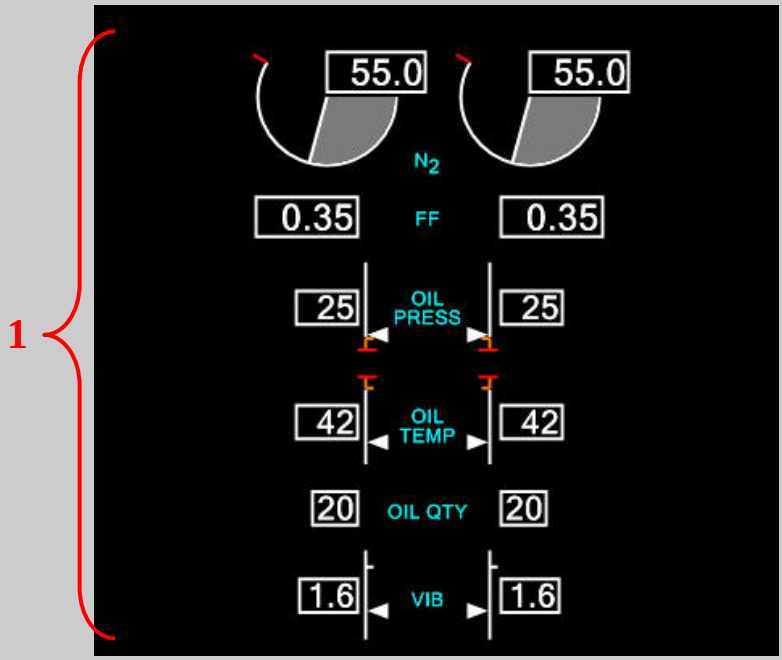
Illuminated (amber) – oil pressure at or below red line

3. OIL FILTER BYPASS Alert

Not modeled.

Secondary Engine Indications

[Option – Over/Under display]



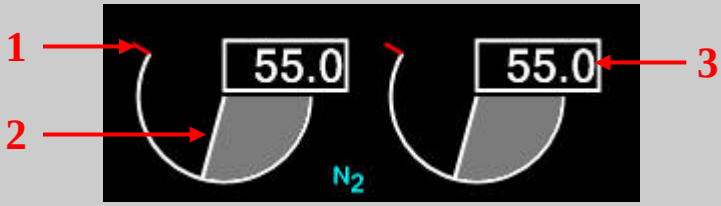
LOWER DISPLAY UNIT

1. Secondary Engine Indications

Secondary engine indications are displayed:

- when initially receives power
- when selected by the Multi-Function Display (MFD)
- in flight when an engine start lever moved to CUTOFF
- in flight when an engine fails
- when a secondary engine parameter exceeds normal operating range.

N2 Indications



LOWER DISPLAY UNIT

1. N2 Redlines

Displayed (red) – maximum N2 % RPM operating limit.

2. N2 RPM Indications

Displays N2 % RPM

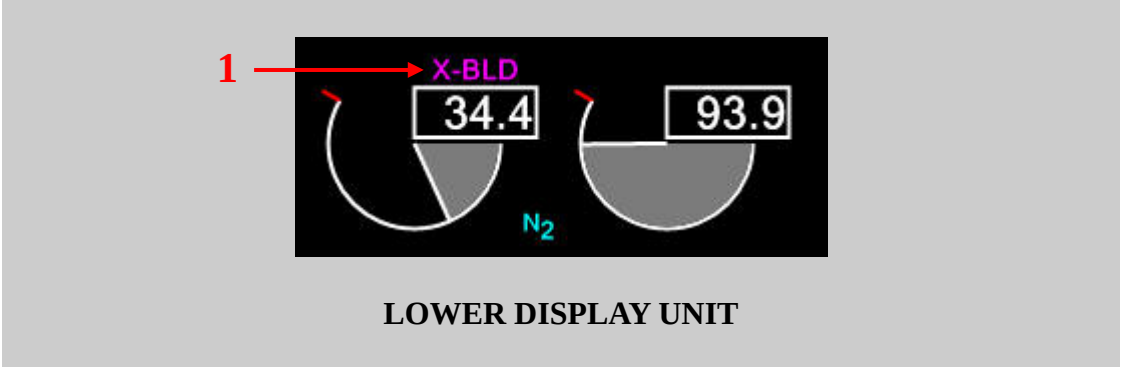
- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

3. N2 Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –operating limit exceeded

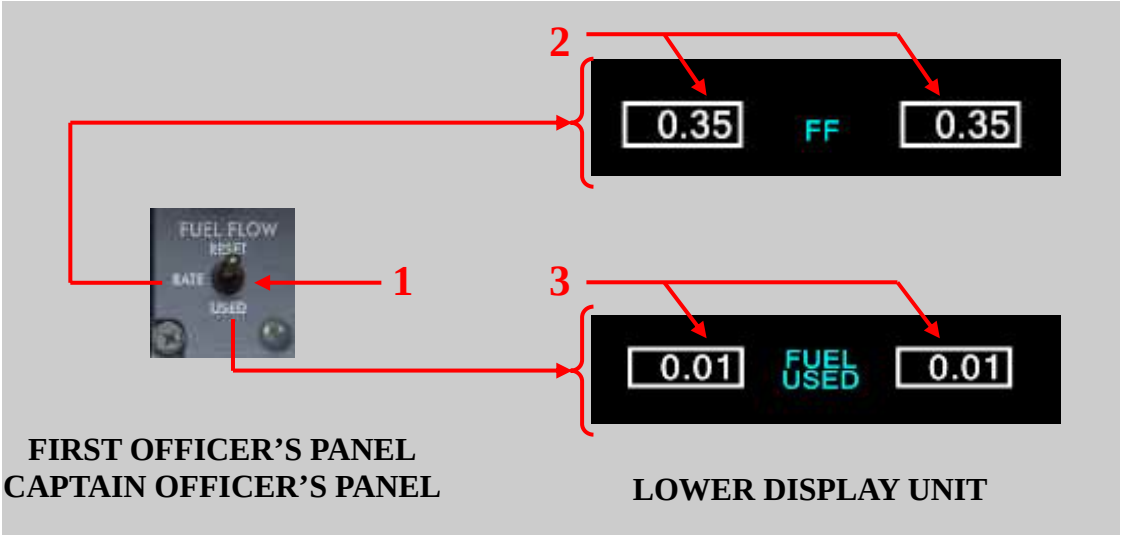
Crossbleed Start Indication



1. Crossbleed Start (X–BLD) Indication

Displayed (magenta) – crossbleed air recommended for inflight start.

Fuel Flow/Fuel Used Indications



1. FUEL FLOW Switch (spring-loaded to RATE)

RATE – the RATE position is the usual switch position and shows the fuel flow indication.

USED – the USED position changes from the usual fuel flow indication to the quantity of fuel used since the counter was set to zero. The used indication goes back to the digital and analog rate indication 10 seconds after the indication control switch goes back to RATE.

RESET – the RESET position sets the fuel used display digital counter to zero.

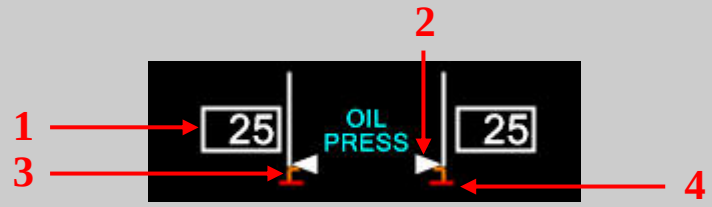
2. Fuel Flow (FF) Readout (digital)

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position

3. Fuel Used Readout (digital)

Displayed (white) – when FUEL FLOW switch moved to USED.

Oil Pressure Indications



LOWER DISPLAY UNIT

1. Oil Pressure (OIL PRESS) Readout

Displays engine oil pressure (psi)
- displayed (white) – normal operating range
- displayed (amber) – caution range
- displayed (red) – operating limit reached.

2. Oil Pressure (OIL PRESS) Pointer

Displays engine oil pressure:
- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

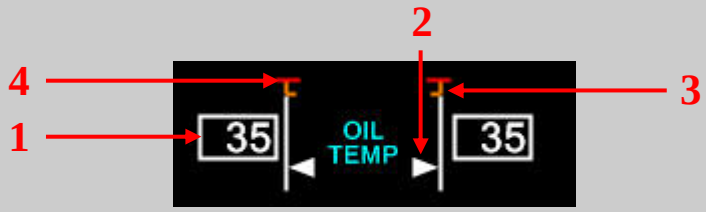
3. Low Oil Pressure (OIL PRESS) Amber Band

Displayed (amber) – low oil pressure caution range.

4. Low Oil Pressure (OIL PRESS) Redline

Displayed (red) – oil pressure operating limit.

Oil Temperature Indications



LOWER DISPLAY UNIT

1. Oil Temperature (OIL TEMP) Readout

Displays oil temperature (degrees C):
- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

2. Oil Temperature (OIL TEMP) Pointer

Displays oil temperature (degrees C):
- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

3. High Oil Temperature (OIL TEMP) Amber Band

Displayed (amber) – oil temperature caution range.

4. High Oil Temperature (OIL TEMP) Redline

Displayed (red) – oil temperature operating limit.

Oil Quantity Indications

LOWER DISPLAY UNIT

1. Oil Quantity (OIL QTY) Readout

Displays oil quantity.

Engine Vibration Indications

LOWER DISPLAY UNIT

1. Vibration (VIB) Readout

Displayed (white) – indicates the rotor (N1 or N2) with the higher vibration level.

2. High Limit

Displays tick mark and thick line.

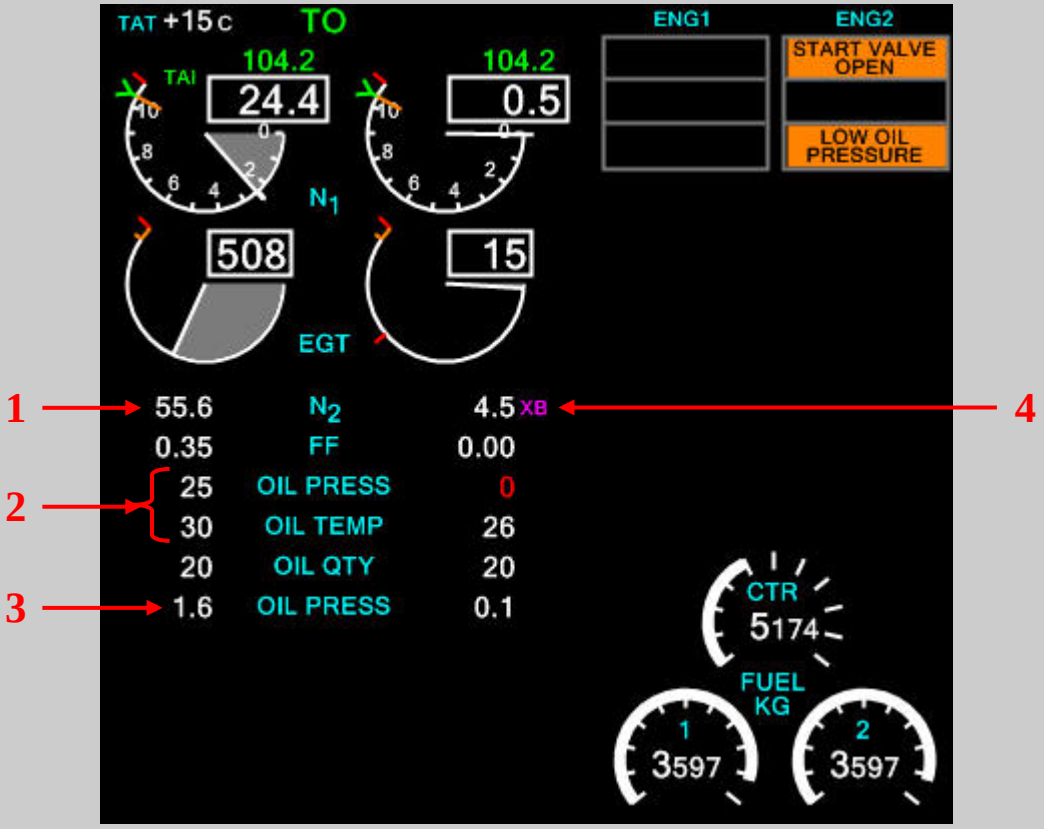
3. Vibration (VIB) Pointer

Displayed (white) – indicates the rotor (N1 or N2) with the higher vibration level.

Compact Engine Displays

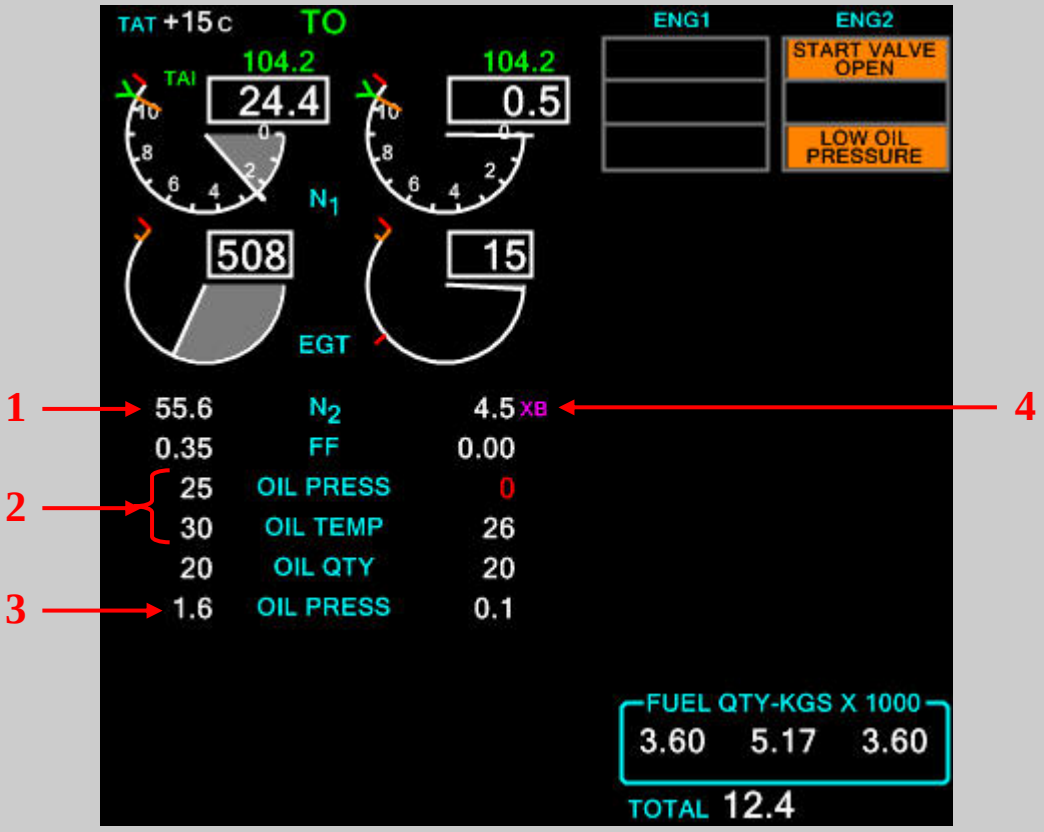
The following changes occur to the secondary engine display in the compact engine displays.

[Option – without total fuel]



UPPER OR LOWER DISPLAY UNIT

[Option – with total fuel]



UPPER OR LOWER DISPLAY UNIT

1. N2 RPM Indications

N2 changes from round dial display to a digital display.

2. OIL PRESS, OIL TEMP Indications

Displayed as digital readouts only. The digital readouts display amber or red if limits are exceeded.

3. Vibration (VIB) Indications

Displayed as digital readout only.

4. Crossbleed Start (XB) Indications

Displayed on the side of N2.

Engines, APU General Controls and Indicators

Chapter 7
Section 15

Engine Start Switches

FORWARD OVERHEAD PANEL

1. ENGINE START Switches

GRD – opens start valve and releases to OFF at start valve cutout.

OFF – closes the start valve and terminates ignition for related engine.

CONT – causes selected ignition system for the related engine to operate continuously with related engine start lever is in IDLE

FLT – bypasses the ignition selector and causes both ignition systems to operate continuously with related engine start lever is in IDLE.

2. Ignition Select Switch

IGN L – selects the left igniter for use on both engines.

BOTH – selects both igniters for use on both engines.

IGN R – selects the right igniter for use on both engines.

Engine Display Control Panel

[Option – Side by side display]

FIRST OFFICER'S PANEL
CAPTAIN OFFICER'S PANEL

[Option – Over/Under display]

FIRST OFFICER'S PANEL
CAPTAIN OFFICER'S PANEL

1. N1 SET Knob

[Option – Side by side display]
Refer to section 10, Side by Side - Displays

[Option – Over/Under display]
Refer to section 11, Over/Under - Displays

2. FUEL FLOW Switch

[Option – Side by side display]
Refer to section 10, Side by Side - Displays

[Option – Over/Under display]
Refer to section 11, Over/Under - Displays

3. Speed Reference Selector

Refer to Chapter 10, Flight Instruments, Displays.

4. MFD Engine (ENG) Switch

[Option – Over/Under display]
Push –

- displays secondary engine indications on lower DU; or if the lower DU is unavailable, on upper or inboard DU based on the position of the display select panel selector
- second push blanks lower DU.

5. MFD System (SYS) Switch

[Option – Over/Under display]
Refer to:

- Chapter 13, Hydraulics
- Chapter 9, Flight Controls

Engine Panel

AFT OVERHEAD PANEL

1. REVERSER Lights

Illuminated (amber) – thrust reverser control valve is not in commanded position

2. ENGINE CONTROL Lights

Illuminated (amber) – faults in system.

3. Electronic Engine Control (EEC) Switches

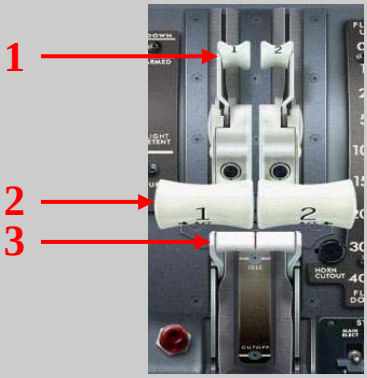
ON – in view (white)

- indicates normal control mode is selected
- when ON is not in view, the EEC has been manually selected to the alternate mode.

ALTN – in view (amber)

- indicated EEC has automatically switched to alternate control mode or it has been selected manually
- EEC provides rated thrust or higher.

Engine Controls



THROTTLE QUADRANT

1. Reverse Thrust Levers

Controls engine reverse thrust

2. Forward Thrust Levers –

- controls engine thrust
- cannot be advanced if the reverse thrust lever is in the deployed position.

3. Engine Start Levers

IDLE –
- energizes ignition system through EEC
- electrically opens spar fuel shutoff valve

CUTOFF –
- closes both spar and engine fuel shutoff valves
- de–energizes ignition system.

APU

FORWARD OVERHEAD PANEL

1. APU Maintenance (MAINT) Light

Not modeled.

2. APU Exhaust Gas Temperature (EGT) Indicator

Displays APU EGT

3. APU OVERSPEED Light

Not modeled.

4. APU FAULT Light

Illuminated (amber) –
- a malfunction exists causing APU to initiate an automatic shutdown
- light is disarmed when APU switch is in OFF position.

5. APU LOW OIL PRESSURE Light

Illuminated (amber) –

- during start until the APU oil pressure is normal
- oil pressure is low causing an automatic shutdown
- light is disarmed when APU switch is in OFF position.

6. APU Switch

OFF – normal position when APU is not running. Positioning switch to OFF with APU running, APU continues to run for a 60 second cooling period

ON – normal position when APU is running.

START (momentary) – positioning APU switch from OFF to START and releasing it to ON, initiates an automatic start sequence.

Engines, APU Engine System Description

Chapter 7
Section 20

Introduction

The airplane is powered by two CFM56–7 engines. A dual–channel electronic engine control (EEC) regulates each engine. The EEC monitors autothrottle and flight crew inputs to automatically set engine thrust.

Engine Indications

[Option – Side by side display]
Engine indications are displayed on the upper display unit (DU). If a failure is detected on the upper DU, the engine indications automatically shift to the lower DU. The engine indications can also be manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel.

Engine Indications

[Option – Over/Under display]
Primary and secondary engine indications are provided. Engine indications are displayed on the upper display unit (DU), lower DU or the Captain's or First Officer's inboard DU.

Primary Engine Indications

N1 and EGT are the primary engine indications. The primary engine indications are normally displayed on the upper DU. If that unit fails, the display automatically moves to the lower DU. The primary engine indications can also be manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel.

Secondary Engine Indications

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are the secondary engine indications. The secondary engine indications, are manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel and the ENG switch on the engine display control panel.

The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power
- in flight when an engine start lever is moved to CUTOFF
- in flight when an engine fails
- a secondary engine parameter is exceeded.

Normal Display Format

N1, EGT, and N2 are displayed as both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and engine vibration indications are both digital

readouts and vertical indication/moving pointers. Fuel flow and oil quantity are digital readouts only.

Compact Display

Primary and secondary engine indications are displayed in compact format on the upper DU when the secondary engine indications are selected for display (manually or automatically) and the lower DU is unavailable.

Electronic Engine Control (EEC)

Each engine has a electronic engine control (EEC). The EEC uses thrust lever inputs to automatically control thrust. N1 is used by the EEC to set thrust in two control modes: normal and alternate. Manual selection of the control mode can be made with the EEC switches on engine panel.

EEC Normal Mode

In the normal mode, the EEC uses sensed flight conditions and bleed air demand to calculate N1 thrust ratings.

EEC Alternate Mode

The EEC can operate in either of two alternate modes, soft or hard. If required signals are not available to operate in the normal mode, the EEC automatically changes to the soft alternate mode. When this occurs, the ALTN switch illuminates and the ON indication remains visible. The soft alternate mode remains until the hard alternate mode is entered by manually selecting ALTN with the EEC switch on the aft overhead panel.

Engine Start System

Starter operation requires pressurized air and electrical power.

In the GRD position, the engine start switch uses battery power to close the engine bleed air valve and open the start valve to allow pressure to rotate the starter. When the start valve opens, an amber START VALVE OPEN alert is provided on the upper display unit. When the engine accelerates to the recommended value, moving the engine start lever to the IDLE position opens the fuel valves on the wing spar and engine.

Inflight Starting

Two methods of starting an engine inflight are available, windmill and crossbleed.

[Option – Side by side display]
If crossbleed starting is required, the X–BLD START indication is displayed above the N2 dial. This indication is based on airplane altitude, airspeed.

[Option – Over/Under display]
If crossbleed starting is required, the X–BLD indication is displayed above the N2 dial. This indication is based on airplane altitude, airspeed.

Engines, APU Chapter 7
APU System Description Section 30

Introduction

The auxiliary power unit (APU) is a self–contained gas turbine engine located in the tail of the airplane.

The APU supplies bleed air for engine starting or air conditioning. An AC electrical generator on the APU provides an auxiliary AC power source.

APU Operation

The APU starts and operates up to the airplane maximum certified altitude.

APU Fuel Supply

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating.

APU Start

The automatic start sequence begins by moving the APU switch momentarily to START. After the APU reaches the proper speed, ignition and fuel are provided.

APU Shutdown

The normal shutdown sequence begins by moving the APU switch to OFF. Shutdown occurs automatically after 60 seconds. At anytime during the cooldown period, the APU may be return to its running condition by moving the APU switch back to START

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Fire Protection Controls and Indicators

Chapter 8
Section 10

Overheat/Fire Protection Panel Switches

AFT ELECTRONIC PANEL

1. Overheat Detector (OVHT DET) Switch

NORMAL – detection loop A and loop B are active.

A – detection loop A is active.

B – detection loop B is active.

2. Fire Warning BELL CUTOUT Switch

Push –
- extinguishes both master FIRE WARN lights
- silences the fire warning bell

3. Extinguisher (EXT) TEST Switch (spring–loaded to center)

1 or 2 – tests bottle discharge systems for all extinguisher bottles.

4. Fault/Inoperative (FAULT/INOP) and Overheat/Fire (OVHT/FIRE) TEST Switch (spring–loaded to center)

FAULT/INOP – tests fault detection systems for both engines and the APU.

OVHT/FIRE – tests overheat and fire detection loops on both engines and APU

5. APU Fire Warning Switch

Illuminated (red) –
- indicates fire in APU
- unlocks APU fire warning switch.

Note: Master FIRE WARN lights illuminate, fire warning bell sounds.

In – normal position, mechanically locked; unlocks automatically for a fire warning.

Up –
- arms the APU extinguisher circuit

- closes APU bleed air valve
- trips generator control relay and breaker
- allows APU fire warning switch to rotate.

Rotate (left or right) – either direction discharges the APU fire extinguisher into the APU compartment.

6. Engine Fire Warning Switch

Illuminated (red) –
- indicates fire in related engine
- unlocks related engine fire warning switch.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

In – normal position, mechanically locked; unlocks automatically for a fire warning.

Up –
- arms engine fire extinguisher
- closes fuel, hydraulic shutoff and engine bleed air valves
- disables thrust reverser
- trips generator control relay and breaker
- deactivates engine driven hydraulic pump LOW PRESSURE light
- allows engine fire warning switch to rotate.

Rotate (left or right) – either direction discharges the selected fire extinguisher into the engine.

Overheat/Fire Protection Panel Lights

AFT ELECTRONIC PANEL

1. Engine (ENG) OVERHEAT Light

Illuminated (amber) – indicates overheat in related engine.

2. FAULT Light

Illuminated – indicates the selected loop for an engine has failed.

3. Engine BOTTLE DISCHARGE Light

Illuminated (amber) – indicates related fire extinguisher bottle has discharged.

4. APU BOTTLE DISCHARGE Light

Illuminated (amber) – indicates APU extinguisher bottle has discharged.

5. Extinguisher Test (EXT TEST) Lights

Illuminated (green) – EXT TEST switch is positioned to 1 or 2 and circuit continuity is normal.

Cargo Fire Panel

AFT ELECTRONIC PANEL

1. Extinguisher (EXT) Test Lights

Illuminated (green) – Cargo Fire TEST switch is pushed.

2. Detector Select (DET SELECT) Switches

NORM - detection loop A and B are active.

A – detection loop A is active.

B – detection loop B is active.

3. Cargo Fire TEST Switch

PUSH – tests circuits for both forward and aft cargo fire detector loops.

4. Cargo Fire ARM Switches

PUSH –

- FWD ARMED – extinguisher armed for the forward cargo compartment
- AFT ARMED – extinguisher armed for the aft cargo compartment.

5. Cargo Fire (FWD/AFT) Warning Lights

Illuminated (red) –

- fire in related cargo compartment, or
- the Cargo Fire TEST switch is pushed

6. Cargo Fire Discharge (DISCH) Switch

PUSH – if system is armed, discharges the extinguisher bottle.

7. Cargo Fire Bottle Discharge (DISCH) Light

Illuminated (amber) – indicates that either extinguisher bottle has discharged.

Master Fire Warning Light

FIRST OFFICER PANEL
CAPTAIN OFFICER PANEL

1. Master Fire Warning (FIRE WARN) Lights

Illuminated (red) – indicates a fire warning (or system test) in engine, APU or cargo compartment

Push –

- extinguishes both master FIRE WARN lights
- silences fire warning bell

Note: Pushing fire warning bell cutout switch on overheat/fire protection panel results in same actions.

Fire Protection System Description

Chapter 8
Section 20

Introduction

There are three detection and extinguishing systems for:
- engines
- APU
- cargo compartments.

Engine Fire Protection

Engine fire protection consists of these systems:
- engine overheat and fire detection
- engine fire extinguishing.

Engine Overheat and Fire Detection

Each engine contains two overheat/fire detector loops. Each loop provides both fire and overheat detection.

The indications of an engine overheat are:
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the related ENG OVERHEAT light illuminates.

The indications of an engine fire are:
- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the related engine fire warning switch illuminates
- all related engine overheat alert indications illuminate.

Engine Fire Extinguishing

The engine fire warning switches are normally locked down. Illumination of an engine fire warning switch or ENG OVERHEAT light unlocks the engine fire warning switch.

When the engine fire warning switch is pulled out, rotating the engine fire warning switch in either direction discharges a single extinguisher bottle into the associated engine. Rotating the engine fire warning switch in the other direction discharges the remaining extinguisher bottle into the same engine.

The L or R BOTTLE DISCHARGE light illuminates a few seconds after the engine fire warning switch is rotated, indicating the bottle has discharged.

APU Fire Protection

APU fire protection consists of these systems:
- APU fire detection system.
- APU fire extinguishing system.

APU Fire Detection

The indications of an APU fire are:
- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the APU fire warning switch illuminates
- the APU automatically shuts down

APU Fire Extinguishing

The APU fire warning switch is normally locked down. Illumination of the APU fire warning switch unlocks the switch.

When the APU fire warning switch is pulled out, rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. The APU BOTTLE DISCHARGE light illuminates after a few seconds, indicating the bottle has discharged.

Cargo Compartment Fire Protection

Cargo fire protection consists of these systems:
- cargo compartment smoke detection
- cargo compartment fire extinguishing.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors in a dual loop configuration.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:
- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the FWD/AFT cargo fire warning light(s) illuminates.

Cargo Compartment Fire Extinguishing

Detection of a fire in either the forward or aft compartment will cause the FWD or AFT cargo fire warning light to illuminate. The extinguishers are armed by pushing the appropriate cargo fire ARMED switch. Once armed, the bottle is discharged by pushing the cargo fire DISCH switch. The cargo fire DISCH light illuminates when a bottle is discharged.

Fire and Overheat System Tests

The fire and overheat detection systems can be tested by pushing the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher can be tested by pushing the EXT TEST switch.

FAULT/INOP Test Detection

The fault detection systems for both the engines and the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP

position.

The indications for the FAULT/INOP test are:
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the FAULT light illuminates
- the APU DET INOP light illuminates.

OVERHEAT/FIRE Test Detection

The overheat and fire detection loops on both engines, and the APU are tested by pushing the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:
- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- both engine fire warning switches illuminate
- the APU fire warning switch illuminates
- both ENG OVERHEAT lights illuminate

Extinguisher Test

When the EXT TEST switch is positioned to 1 or 2, the green EXT TEST lights illuminate.

Cargo Fire System Tests

The cargo fire detection system can be tested by pushing the cargo fire TEST switch.

Cargo Fire TEST

The indications for the Cargo Fire test are:
- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the extinguisher test lights illuminate
- the FWD and AFT cargo fire warning lights illuminate
- the cargo fire bottle DISCH light illuminates

Cargo Fire Extinguisher Test

When the Cargo Fire TEST button is pushed, the green EXT lights illuminate.

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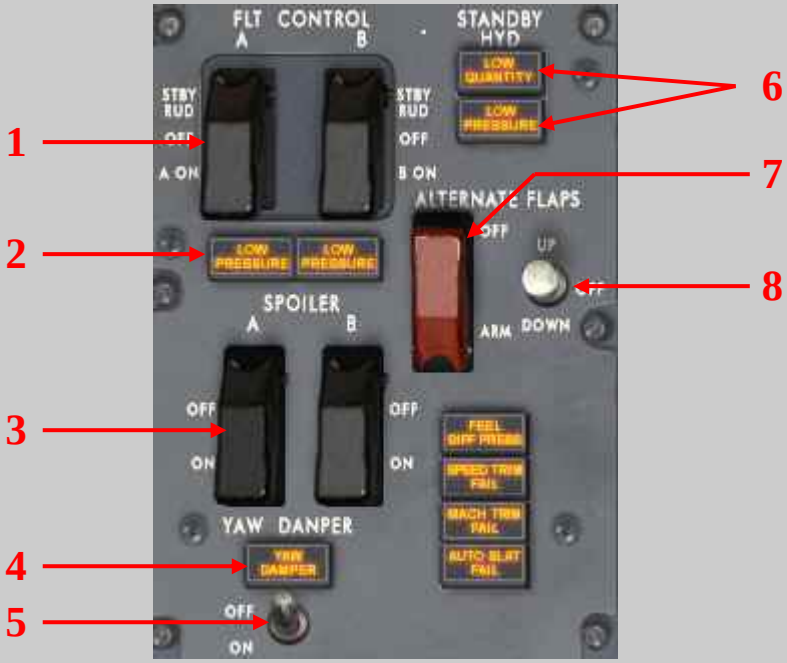
Flight Controls
Controls and Indicators

Chapter 9
Section 10

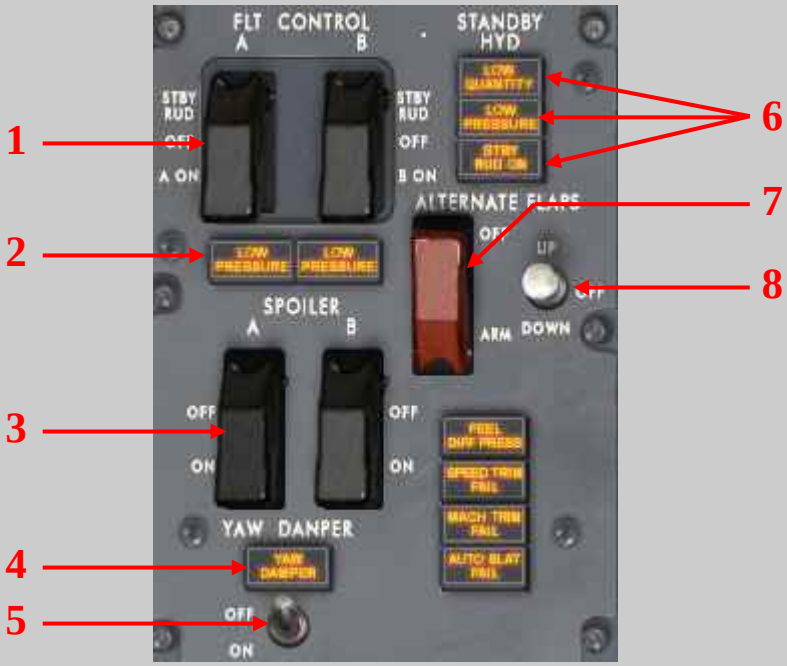
Flight Control Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]



FORWARD OVERHEAD PANEL

[Option – BBJ/BBJ2/BBJ3]



FORWARD OVERHEAD PANEL

1. FLIGHT CONTROL Switches

STBY RUD – turns on the standby pump and pressurizes the standby power control unit.

OFF – removes system pressure from ailerons, elevators, elevator feel computer, and rudder.

ON (guarded position) – system pressure is on to the ailerons, elevators, elevator feel computer, and rudder.

2. Flight Control LOW PRESSURE Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.

3. Flight SPOILER Switches

ON (guarded position) – system pressure is on to the flight spoilers.

OFF – removes system pressure from the flight spoilers.

4. YAW DAMPER Light

Illuminated (amber) – yaw damper is not engaged.

5. YAW DAMPER Switch

OFF – disengages yaw damper.

ON – engages yaw damper

6. STANDBY HYD Lights

STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) – the standby reservoir quantity is low

STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) – the standby system pressure is low.

[Option – BBJ/BBJ2/BBJ3]
STBY RUD ON Light
Illuminated (amber) – indicates the standby rudder system is commanded on to pressurize the standby rudder power control unit.

7. ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – arms the ALTERNATE FLAPS position switch.

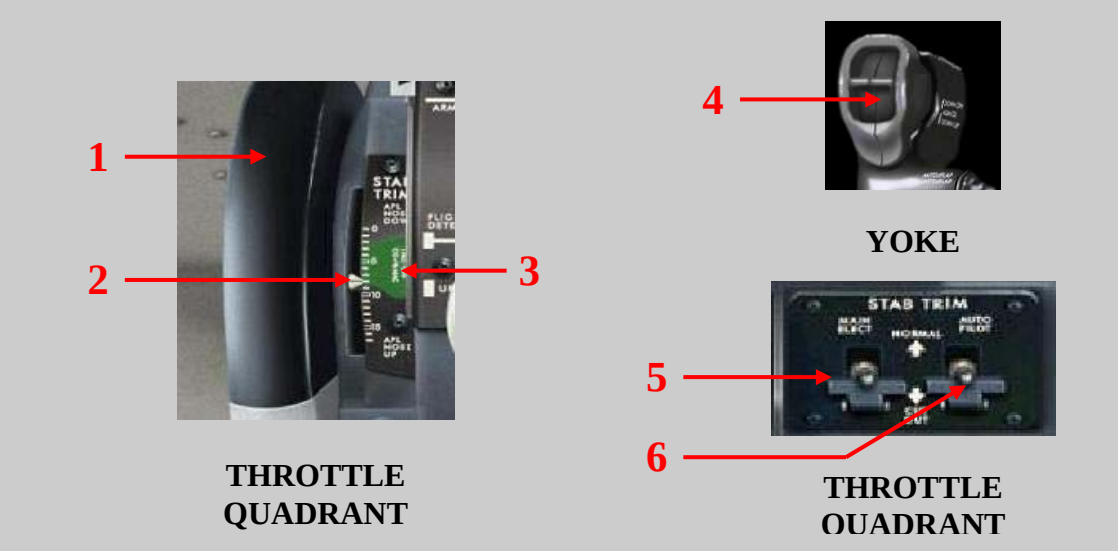
8. ALTERNATE FLAPS Position Switch

UP – electrically retracts TE flaps and LE devices.

OFF – normal operating position.

DOWN – electrically extends TE flaps and LE devices until released.

Stabilizer



1. Stabilizer Trim Wheel

Provides for manual operation of stabilizer

2. Stabilizer Trim Indicator

Indicates units of airplane trim on the adjacent scale.

3. Stabilizer Trim Green Band Range

The green band indicates the allowable takeoff trim range..

4. Stabilizer Trim Switches (spring-loaded to neutral)

Push –

- commands stabilizer trim in desired direction
- autopilot disengages if engaged.

5. Stabilizer Trim Main Electric (MAIN ELECT) Cutout Switch

NORMAL – normal operating position.

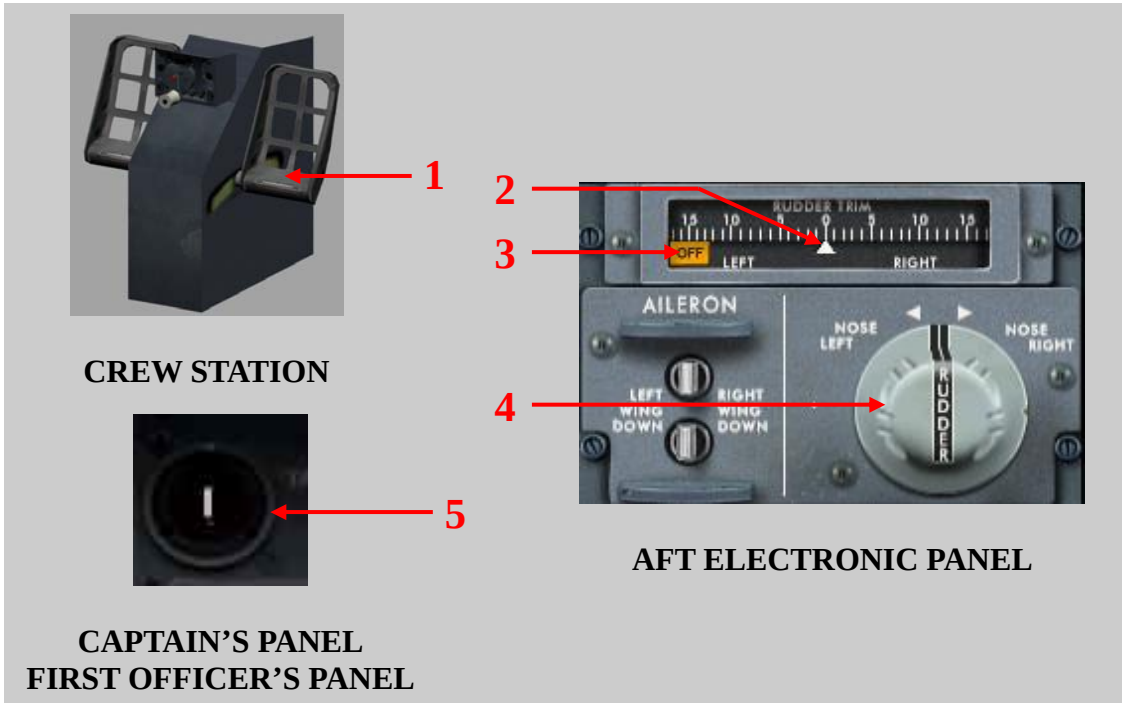
CUTOUT – deactivates stabilizer trim switch operation.

6. Stabilizer Trim AUTOPILOT Cutout Switch

NORMAL – normal operating position.

CUTOUT – deactivates autopilot stabilizer trim operation, autopilot disengages if engaged.

Rudder



1. Rudder Pedals

Push – controls rudder position

2. Rudder Trim Indicator

Indicates units of rudder trim.

3. Rudder Trim OFF Flag

Illuminated (amber) – rudder trim indicator is inoperative.

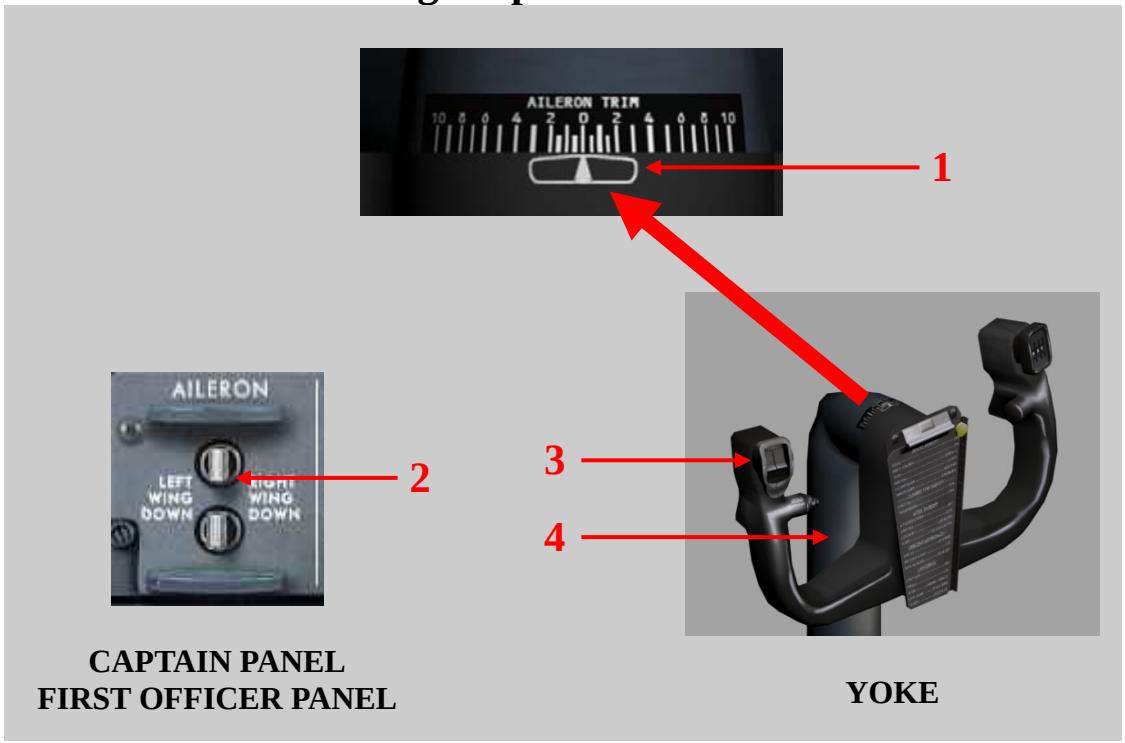
4. Rudder Trim Control (spring-loaded to neutral)

Rotate – electrically trims the rudder in the desired direction.

5. YAW DAMPER Indicator

Indicates yaw damper movement of rudder.

Aileron / Elevator / Flight Spoilers



1. AILERON TRIM Indicator

Indicates units of aileron trim.

2. AILERON Trim Switches (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

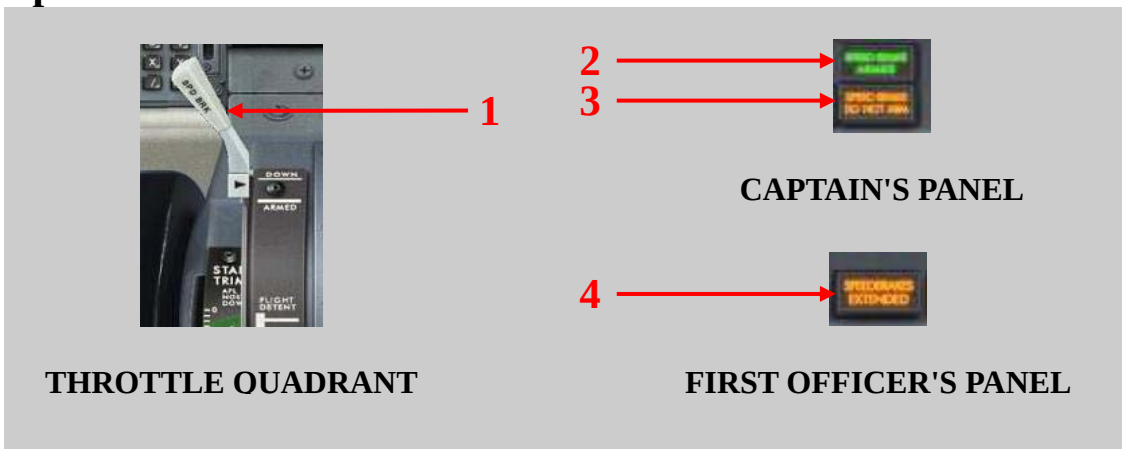
3. Control Wheel

Rotate – operates ailerons and flight spoilers in desired direction.

4. Control Column

Push/Pull – operates elevators in the desired direction.

Speed Brakes



1. SPEED BRAKE Lever

DOWN (detent) – all flight and ground spoiler panels in faired position.

ARMED – upon touchdown, the SPEED BRAKE lever moves to the UP position, and all flight and ground spoilers extend.

FLIGHT DETENT – all flight spoilers are extended to their maximum position for inflight use.

UP – all flight and ground spoilers are extended to their maximum position for ground use.

2. SPEED BRAKE ARMED Light

Illuminated (green) – indicates valid automatic speed brake system inputs.

3. SPEED BRAKE DO NOT ARM Light

Illuminated (amber) – indicates abnormal condition to the automatic speed brake system

4. SPEEDBRAKES EXTENDED Light

Illuminated (amber) –

- in–flight –
  - SPEED BRAKE lever is beyond the ARMED position, and
  - TE flaps extended more than flaps 10, or
  - radio altitude less than 800 feet
- on the ground –
  - ground spoilers are not stowed.

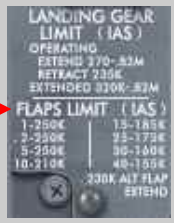
Note: On the ground, the SPEEDBRAKES EXTENDED light does not illuminate when hydraulic system A is available.

Trailing Edge Flaps

1

2

3



THROTTLE QUADRANT

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. FLAP Lever

Selects position of flap

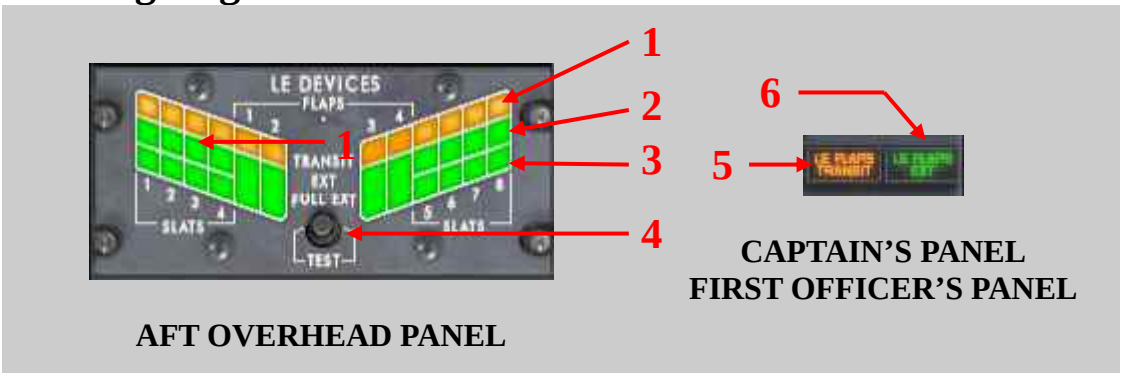
2. Flap Position Indicator

Indicates position of left and right TE flaps

3. FLAPS LIMIT Placard

Indicates maximum speed for each flap setting.

Leading Edge Devices



1. Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related LE device in transit.

2. Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related LE slat in extended (intermediate) position.

3. Leading Edge Devices Full Extended (FULL EXT) Lights

Illuminated (green) – related LE device fully extended.

4. Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

5. Leading Edge Flaps Transit (LE FLAPS TRANSIT) Light

Illuminated (amber) – any LE device in transit

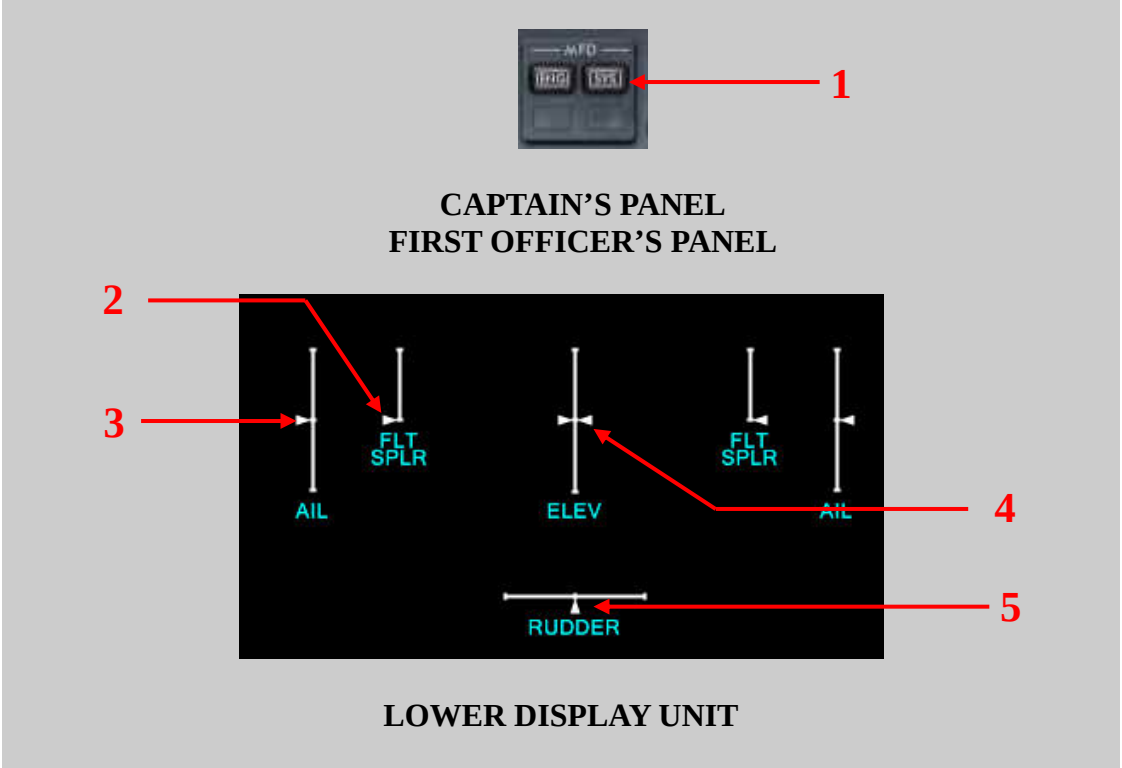
6. Leading Edge Flaps Extended (LE FLAPS EXT) Light

Illuminated (green) –

- all LE flaps extended and all LE slats in extended (intermediate) position (TE flap positions 1, 2 and 5)
- all LE devices fully extended (TE flap positions 10 through 40).

Flight Control Surface Position Indicator

[Option – PFD/ND]



1. MFD System (SYS) Switch

Push – SYS

- displays flight control surface position indications on lower DU; or if the lower DU is unavailable, displays it on upper DU or inboard DU based on the position of the display select panel selector
- second push removes indications on the respective DU.

2. Flight Spoilers (FLT SPLR) (white)

Indicates related (left/right) flight spoilers position:

3. Aileron (AIL) (white)

Indicates related (left/right) aileron position:

4. Elevator (ELEV) (white)

Indicates elevator position:

5. RUDDER (white)

Indicates rudder position

Flight Controls System Description

Chapter 9
Section 20

Introduction

The primary flight control system uses control wheel, column and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces; ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of trailing edge (TE) flaps and leading edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically.

Pilot Controls

The pilot controls consist of:

- control column
- control wheel
- rudder pedal
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

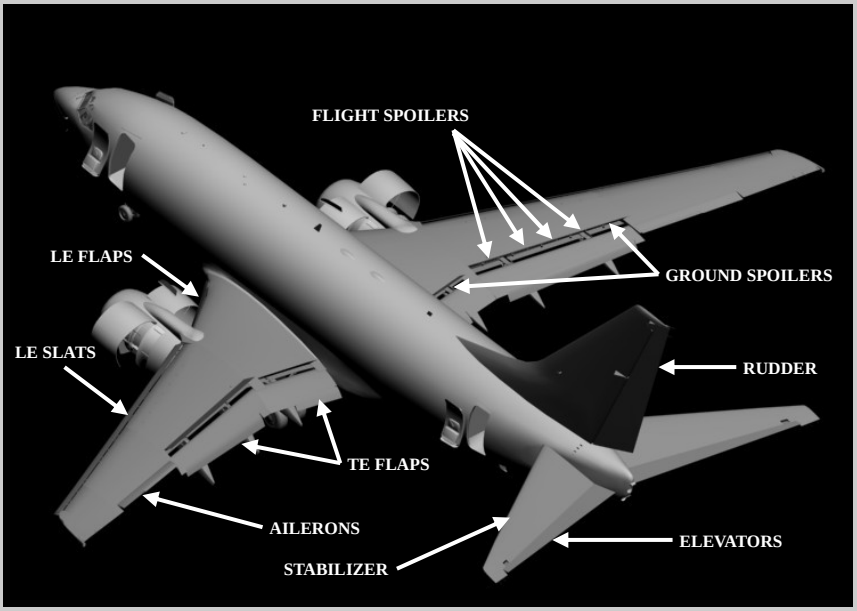
Roll control is provided by:

- two ailerons
- eight flight spoilers.

Yaw control is provided by a single rudder.

TE flaps and LE flaps and slats provide high lift for takeoff, approach and landing.

Flight Control Surfaces Location



Roll Control

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control around the airplane's longitudinal axis. The A and B FLT CONTROL switches control hydraulic shutoff valves. These valves can be used to isolate ailerons, as well as the elevators and rudder, from related hydraulic system pressure.

With total hydraulic power failure the ailerons can be mechanically positioned by rotating the pilots' control wheels.

The aileron trim electrically repositions the aileron centering unit, which causes the control wheel to rotate. The amount of aileron trim is indicated on a scale on the top of each control column.

Flight Spoilers

Four flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoiler pairs to provide isolation operation. Hydraulic pressure shutoff valves are controlled by the two flight SPOILER switches.

Pitch Control

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are controlled by forward or aft movement of the control column. The stabilizer is controlled by autopilot trim or manual trim.

Elevators

The elevators provide pitch control around the airplane's lateral axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the elevators. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns.

Stabilizer

The horizontal stabilizer is positioned through either the stab trim switches on the control wheel or autopilot trim.

Yaw Control

Yaw control is accomplished by a hydraulically powered rudder and a yaw damper system. The rudder is controlled by displacing the rudder pedals.

Rudder

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The RUDDER TRIM indicator displays the rudder trim position in units.

Yaw Damper

When YAW DAMPER switch is positioned to ON, the yaw damper system operate in flight to improve airplane directional stability.

Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all four ground spoilers, two on the upper surface of each wing. The SPEED BRAKE lever controls the spoilers. When the SPEED BRAKE lever is actuated all the spoilers extend when the airplane is on the ground and only the flight spoilers extend when the airplane is in the air.

In-Flight Operation

Operating the SPEED BRAKE lever in flight causes all flight spoiler panels to rise symmetrically to act as speed brakes. Moving the SPEED BRAKE lever beyond the FLIGHT DETENT is prohibited in flight.

Ground Operation

During landing, the auto speed brake system operates when these conditions occur:

- SPEED BRAKE lever is in the ARMED position
- SPEED BRAKE ARMED light is illuminated
- landing gear strut compresses on touchdown
- both thrust levers are retarded to IDLE

The SPEED BRAKE lever automatically moves to the UP position and the spoilers

deploy.

If the SPEED BRAKE lever is in the DOWN position during landing or rejected takeoff, the auto speed brake system operates when these conditions occur:

- both thrust levers are retarded to IDLE
- reverse thrust levers are positioned for reverse thrust.

The SPEED BRAKE lever automatically moves to the UP position and spoilers deploy.

Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and eight slats: two flaps inboard and four slats outboard of each engine. The TE devices consist of double slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flaps 15, 30 and 40 are normal landing flap positions. Flaps 15 is normally limited to airports where approach climb performance is a factor.

Flap and Slat Sequencing

LE devices and TE flaps are normally extended and retracted by hydraulic power from system B. When the FLAP lever is in the UP detent, all flaps and LE devices are commanded to the retracted or up position. Moving the FLAP lever aft allows selection of flap detent positions 1, 2, 5, 10, 15, 25, 30 or 40. The LE devices deployment is sequenced as a function of TE flaps deployment.

When the FLAP lever is moved from the UP position to the 1, 2, or 5 position, the TE flaps extend to the commanded position and the LE:

- flaps extend to the full extended position and
- slats extend to the extend position.

When the FLAP lever is moved beyond the 5 position the TE flaps extend to the commanded position and the LE:

- flaps remain at the full extended position and
- slats extend to the full extended position.

The LE devices sequence is reversed upon retraction.

Flap Load Relief

The flaps/slat electronics unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 10, 15, 25, 30 and flaps 40 positions. The FLAP lever does not move, but the flap position indicator displays flap retraction and re–extension.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 171 knots
- re–extend when airspeed is reduced below 166 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 181 knots

- re–extend when airspeed is reduced below 176 knots.

When the flaps are set at 25, the TE flaps:
- retract to 15 if the airspeed exceeds 196 knots
- re–extend when airspeed is reduced below 191 knots.

When the flaps are set at 15, the TE flaps:
- retract to 10 if the airspeed exceeds 201 knots
- re–extend when airspeed is reduced below 196 knots.

When the flaps are set at 10, the TE flaps:
- retract to 5 if the airspeed exceeds 206 knots
- re–extend when airspeed is reduced below 201 knots.

Autoslats

The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 5 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically begin driving to the full extended position prior to stick shaker activation.

Alternate Extension

In the event that hydraulic system B fails, an alternate method of extending the LE devices and extending and retracting the TE flaps is provided.

The TE flaps can be operated electrically through the use of two alternate flap switches. The guarded ALTERNATE FLAPS master switch closes a flap bypass valve and arms the alternate flaps position switch. The ALTERNATE FLAPS position switch controls an electric motor that extends or retracts the TE flaps.

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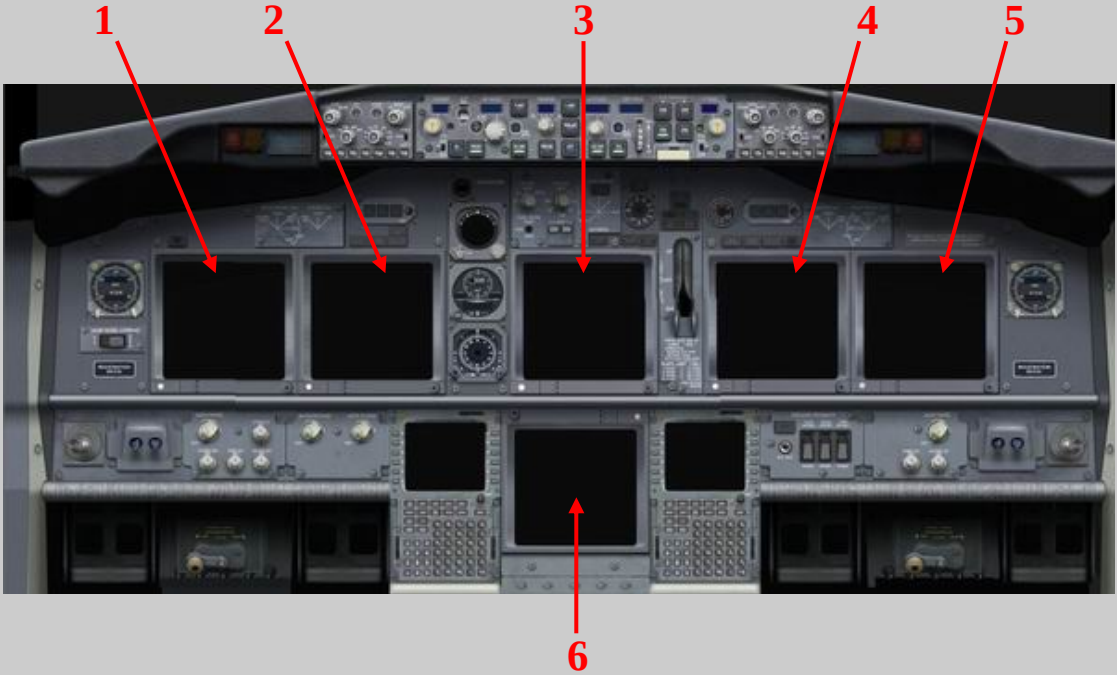
Flight Instruments, Displays EFIS/Map – Controls and Indicators

Chapter 10
Section 10

EFIS/Map Display System – Overview



MAIN PANEL

1. **Captain Outboard Display Unit**
2. **Captain Inboard Display Unit**
3. **Upper Display Unit**
4. **First Officer Inboard Display Unit**
5. **First Officer Outboard Display Unit**
6. **Lower Display Unit**

Captain Outboard Display

CAPTAIN PANEL

1. **Marker Beacon**

2. **Mach/Airspeed Indicator**

3. **Radio Distance Magnetic Indicator**

4. **Flight Mode Annunciations**

Refer to Chapter 4, Automatic Flight

5. **Attitude Indicator**

6. **Horizontal Situation Indicator**

Captain Inboard Display

CAPTAIN'S PANEL

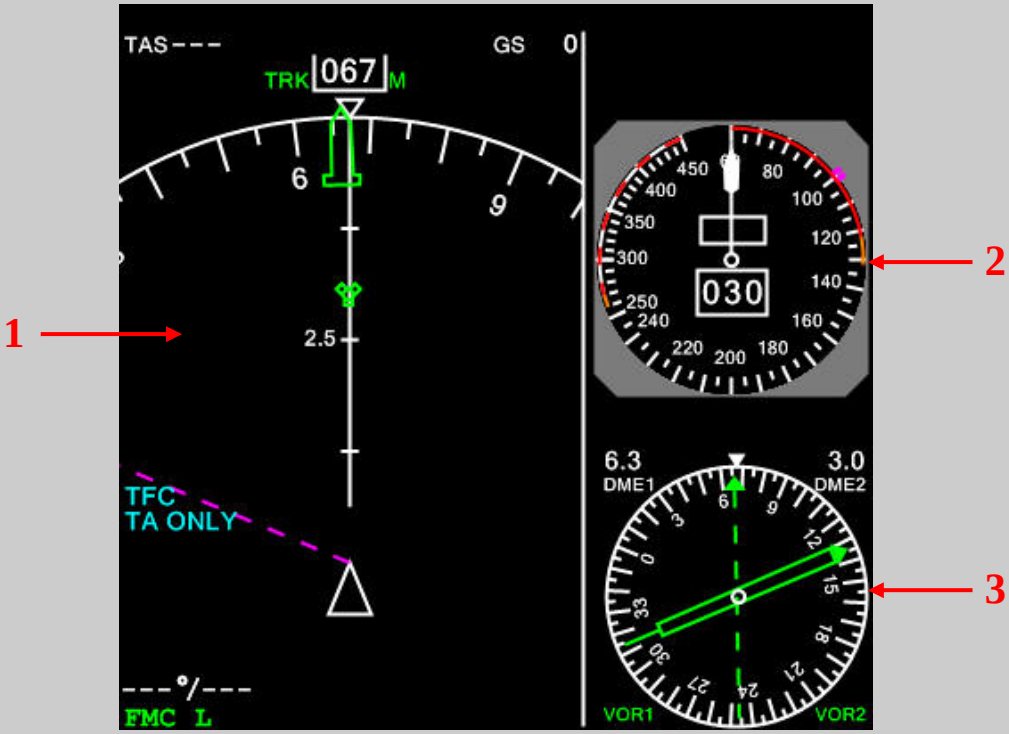
1. Altimeter

2. Vertical Speed Indicator

3. Navigation Display

Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

First Officer Inboard Display



FIRST OFFICER'S PANEL

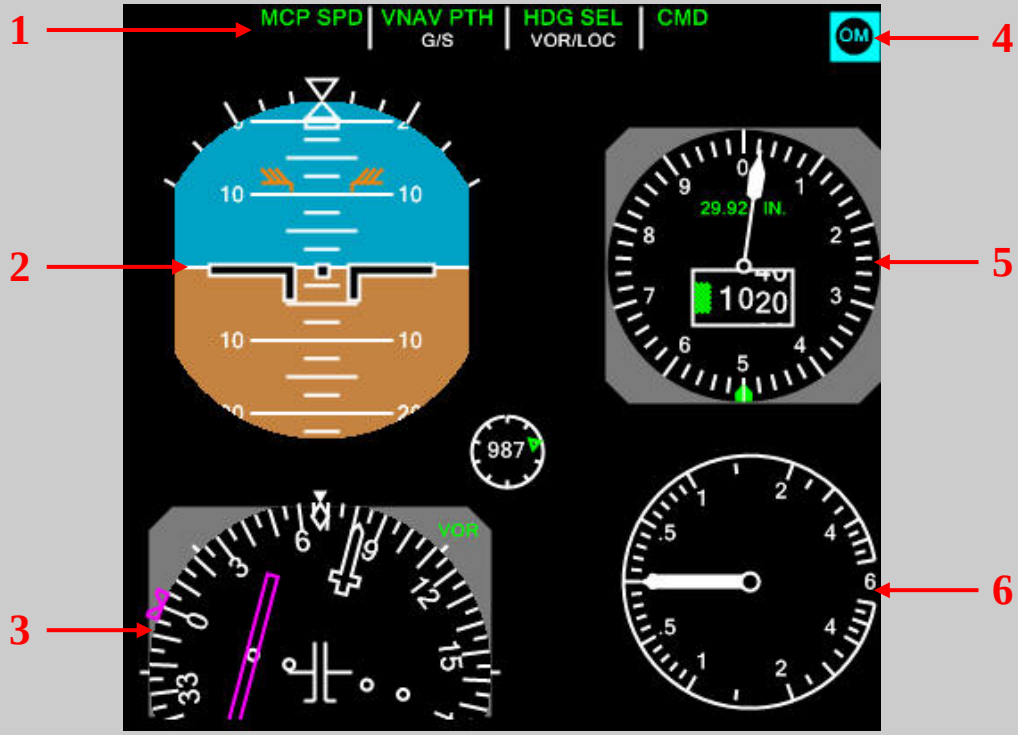
1. Navigation Display

Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

2. Mach/Airspeed Indicator

3. Radio Distance Magnetic Indicator

First Officer Outboard Display



FIRST OFFICER'S PANEL

1. Flight Mode Annunciations

Refer to Chapter 4, Automatic Flight

2. Attitude Indicator

3. Horizontal Situation Indicator

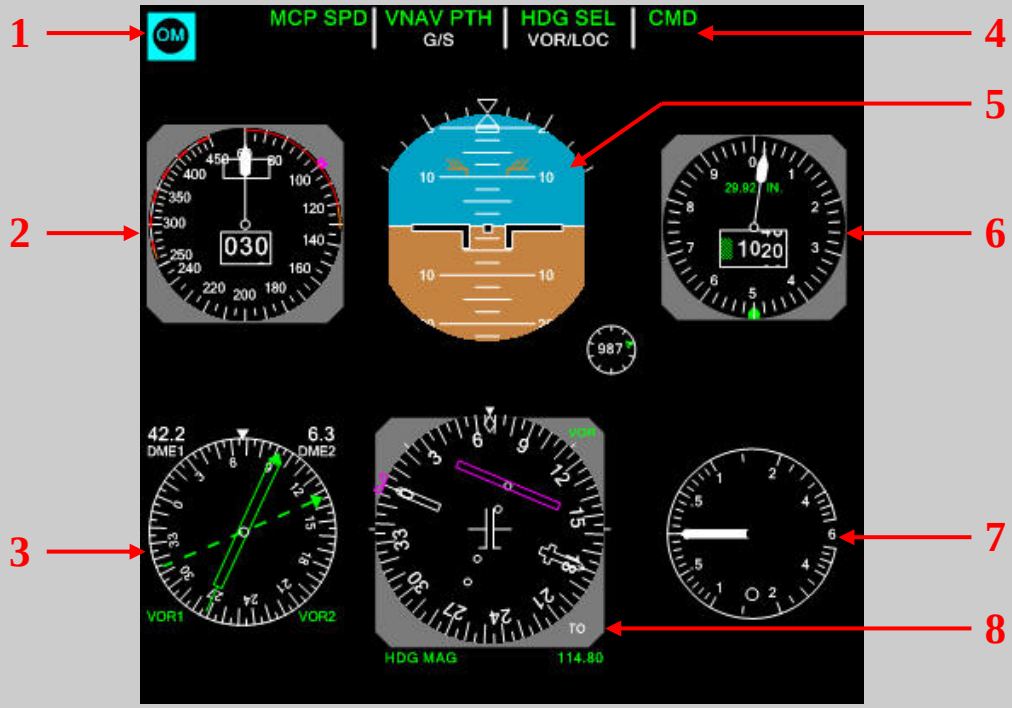
4. Marker Beacon

5. Altimeter

6. Vertical Speed Indicator

Compact EFIS Format

The compact EFIS format is displayed automatically upon failure of either an inboard or an outboard display unit. The compact format can also be selected manually with the MAIN PANEL DUs selectors on the display select panel.

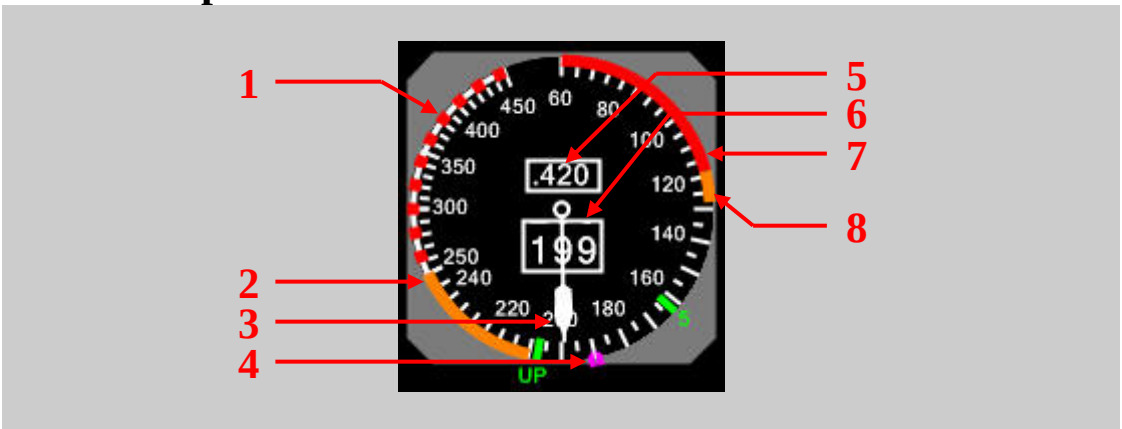


CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. **Marker Beacon**
2. **Mach/Airspeed Indicator**
3. **Radio Distance Magnetic Indicator**
4. **Flight Mode Annunciations**
5. **Attitude Indicator**
6. **Altimeter**
7. **Vertical Speed Indicator**
8. **Horizontal Situation Indicator**

Electronic Flight Instrument System (EFIS) – Mach/Airspeed Indicator (MASI)

Mach/Airspeed Indicator – General



1. Maximum Operating Speed (red and white)

The maximum speed displays as a red and white arc on the airspeed scale. The arc displays from the maximum operating speed up to 450 knots.

2. High Speed Buffet/Flap Extension Speed (amber)

The maximum maneuver speed displays as an amber arc on the airspeed scale. The maximum maneuver speed arc starts at the maximum maneuver speed and extends to the maximum operating speed arc.

3. Airspeed Pointer (white)

Indicates current calibrated airspeed in knots.

4. Airspeed Cursor (magenta)

Displays target airspeed:
- indicates the airspeed manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

5. Mach Digital Counter (white)

The MACH displays above the center point of the MASI indication:
- displays when airspeed increases above 0.40 Mach
- blanks when airspeed decreases below 0.38 Mach.

6. Airspeed Digital Counter (white)

Indicates current calibrated airspeed in knots.

When current airspeed decreases into the minimum maneuver speed amber bar:
- airspeed readout box turns amber and flashes for 10 seconds.
- box returns to white when airspeed is above minimum maneuver speed.

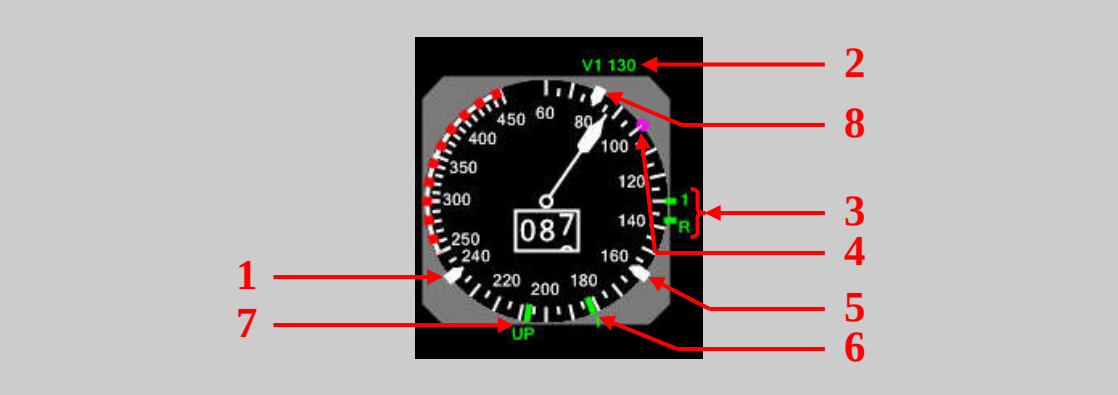
7. Stick Shaker Speed (red)

The stick shaker speed airspeed as a red and white arc on the airspeed scale. The arc displays from the stick shaker speed down to 60 knots.

8. Minimum Maneuver Speed (amber)

The minimum maneuver speed airspeed as an amber arc on the airspeed scale. The minimum maneuver speed arc starts at the minimum maneuver speed and extends to the stick shaker speed arc. Inhibited on takeoff until first flap retraction or valid VREF entered.

Mach/Airspeed Indicator – Takeoff



1. Bug 5 (white)

Displayed if the speed reference selector on the engine display control panel is in the bug 5 position and a value greater than 60 knots has been selected.

2. Speed Reference Display (green)

Displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:

- on the ground, V1, VR, and takeoff gross weight may be selected; if VREF is selected, INVALID ENTRY is displayed
- in flight, VREF and landing gross weight may be selected; if V1 or VR is selected, INVALID ENTRY is displayed
- removed when the speed reference selector is moved to the SET position.

3. Takeoff Reference Speeds (green)

Indicates V1 (decision speed) and VR (rotation speed) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel:

- amber NO VSPD flag is displayed on the ground if V1 or VR is not selected on the CDU or is not set with the speed reference selector
- displayed for takeoff when speed is greater than 80 knots
- removed at lift–off.

4. Airspeed Cursor (magenta)

Set with the speed selector on the mode control panel.

5. V2+15 (white)

Displayed for takeoff.

Removed when either of the following occurs:
- at first flap retraction
- when VREF is entered.

6. Flap Maneuvering Speed (green)

Indicates flap maneuvering speed for the displayed flap position:
- indicates current flap setting speed and next lower flap setting speed when takeoff.
- indicates shows current flap setting speed and next higher flap setting speed when approach.
- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed except for a flaps 1 takeoff
- flap bugs inhibited if less than VREF+4.

7. Flaps Up Airspeed (green)

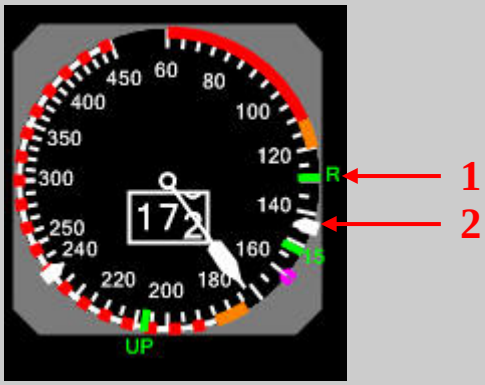
Displayed after zero fuel weight is entered in the CDU and takeoff gross weight is calculated, or after takeoff gross weight is set with the speed reference selector.

Not displayed above approximately 20,000 feet altitude.

8. 80 Knots Airspeed Bug (white)

[Option - 80 knot speed bug]
- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

Mach/Airspeed Indicator – Approach



1. Landing Reference Speed (green)

Indicates VREF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed

reference selector on the engine display control panel.

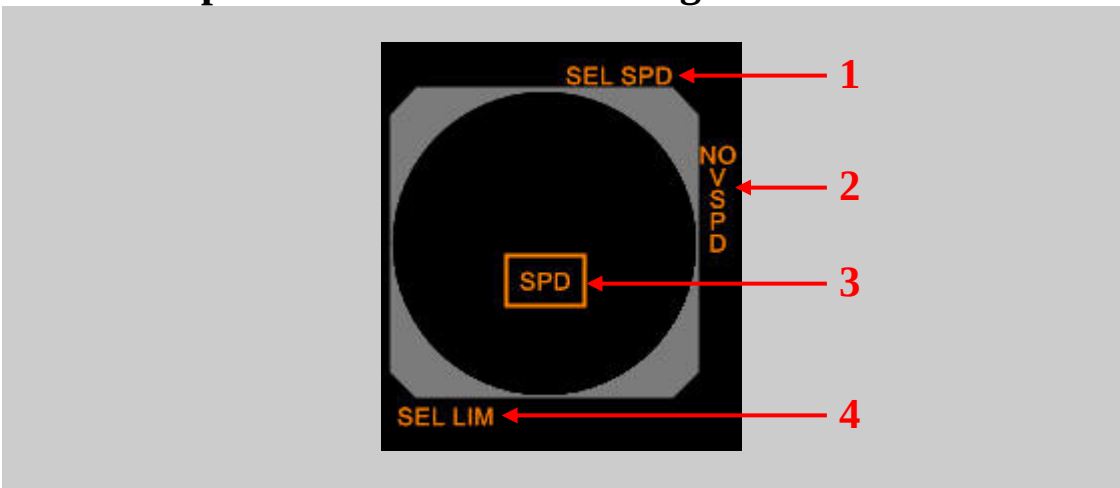
2. VREF+15 (white)

[Option –737-600/700/700C/700ER/BBJ]
Displayed after selection of VREF.

2. VREF+20 (white)

[Option – 800/900/900ER/BBJ2/BBJ3]
Displayed after selection of VREF.

Mach/Airspeed Indicator Failure Flags



1. Selected Speed Flag (amber)

The airspeed cursor is inoperative..

2. No VSPD Flag (amber)

V1 or VR has not been entered or is invalid.

3. Speed Flag (amber)

The Mach/airspeed indicator is inoperative..

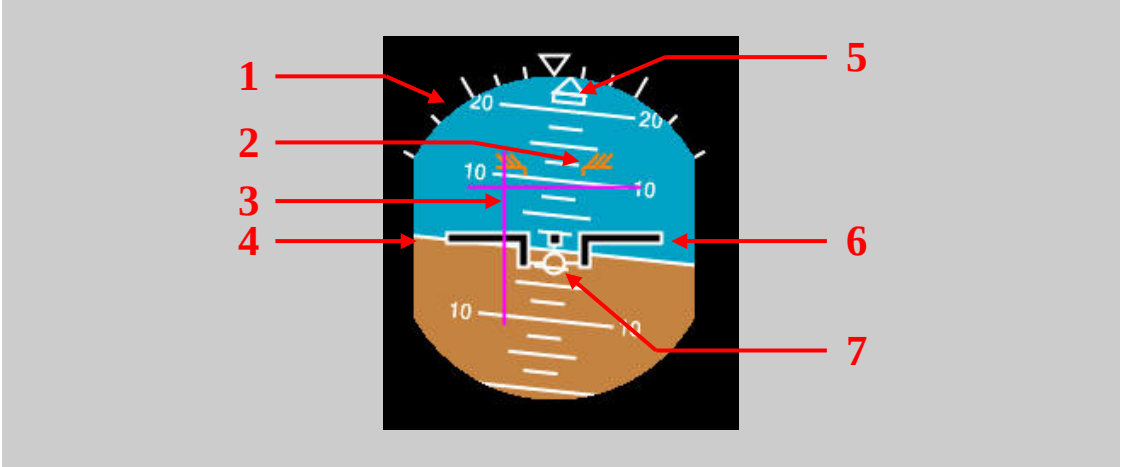
4. Speed Limit Flag (amber)

Displays related with stick shaker or maximum operating speed has failed.

EFIS – Attitude Indicator

Attitude Indicator – General

The attitude indicator displays ADIRS attitude information.



1. Bank Scale (white)

The bank scale is fixed with respect to the airplane symbol. The scale shows +/- 60 degrees of bank. The bank pointer moves on this scale to show the bank angle.

2. Pitch Limit Indicator (amber)

When the flaps are up, the pitch limit indication shows if the airpseed, as it decreases, goes near the stick shaker speed.

3. Flight Director (magenta)

The flight director command shows as a split axis that has a horizontal bar and a vertical bar. The horizontal bar shows the pitch command. The vertical bar shows the roll command. Refer to Chapter 4, Automatic Flight.

4. Horizon Line and Pitch Scale (white)

Indicates the horizon relative to the airplane symbol; pitch scale is in 2.5 degree increments.

5. Bank Pointer

Indicates bank angle in reference to the bank scale, fills and turns amber if bank angle is 35 degrees or more.

6. Airplane Symbol

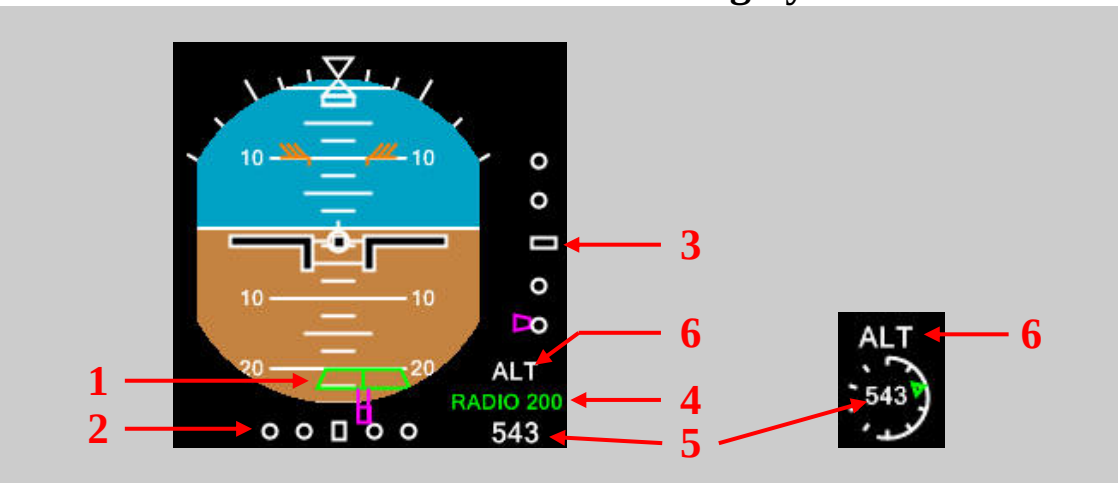
The airplane symbol stays at the center of the attitude director indication (ADI).

7. Flight Path Vector (FPV) Indication (white)

The indication for the flight path vector shows when FPV is set on the EFIS control panel. The indication shows the vector of motion of the airplane relative to the

horizon and the airplane heading.

Attitude Indicator – Instrument Landing System Indications



1. Rising Runway (green)

[Option – Rising runway]
A rising runway symbol shows when the radio altitude is less than 2500 feet and the localizer pointer shows. The stem of the rising runway symbol is the localizer pointer. The stem increases in length and moves the runway symbol up as the radio altitude decreases from 200 feet.

2. Localizer Pointer and Deviation Scale

The pointer indicates localizer position relative to the airplane when the localizer signal is received.

The scale indicates deviation.

At low radio altitudes with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

3. Glide Slope Pointer and Deviation Scale

The pointer indicates glide slope position when the glide slope signal is received.

The scale indicates deviation

At low radio altitudes with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive glide slope deviation.

4. Selected Radio Altitude Approach Minimums (green)

The radio minimum altitude that you select shows above the radio altitude. When the radio altitude height is equal to the radio minimum altitude, the radio minimum altitude and radio altitude indication change to amber. The radio minimums flash for 3 seconds

5. Radio Altitude (display –white, selected radio altitude pointer–green)

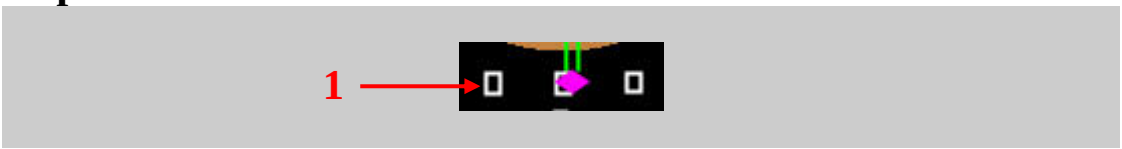
[Option – Digital and round dial]

- displayed below 2500 feet AGL
- digital display from 2500 to 1000 feet AGL
- round dial display below 1000 feet AGL:
  - pointer replaces digital display of selected radio minimum altitude
  - the circumference of the dial depict the airplane's radio altitude
- dial and readout turn amber and dial flashes for 3 seconds when descending through the selected minimum altitude; the dial becomes steady amber after 3 seconds
- changes back to white:
  - when passing through the selected minimum altitude plus 75 feet during go–around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

6. Radio Altitude Height Alert (white)

Displayed when radio altitude is less than or equal to 2500 feet.

Expanded Localizer Indications

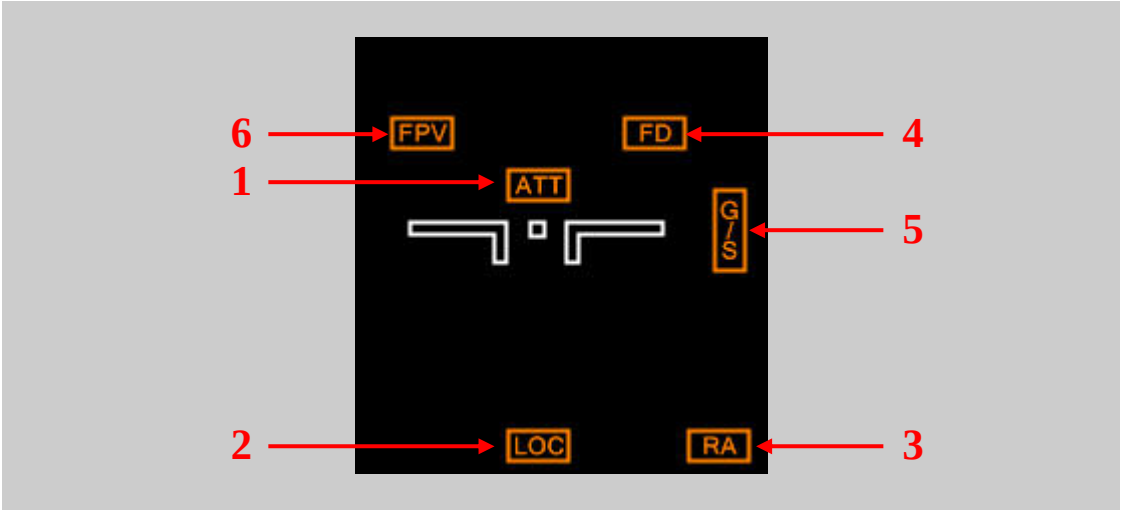


1. Expanded Localizer Scale

Displayed when the autopilot or flight director is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

Attitude Indicator Failure Flags

Flags replace the attitude displays to indicate source system failure or lack of computed information.



1. Attitude Flag (amber)

The attitude display has failed.

2. Localizer Flag (amber)

An ILS system has failed.

3. Radio Altitude Flag (amber)

The radio altitude display has failed.

4. Flight Director Flag (amber)

The flight director has failed.

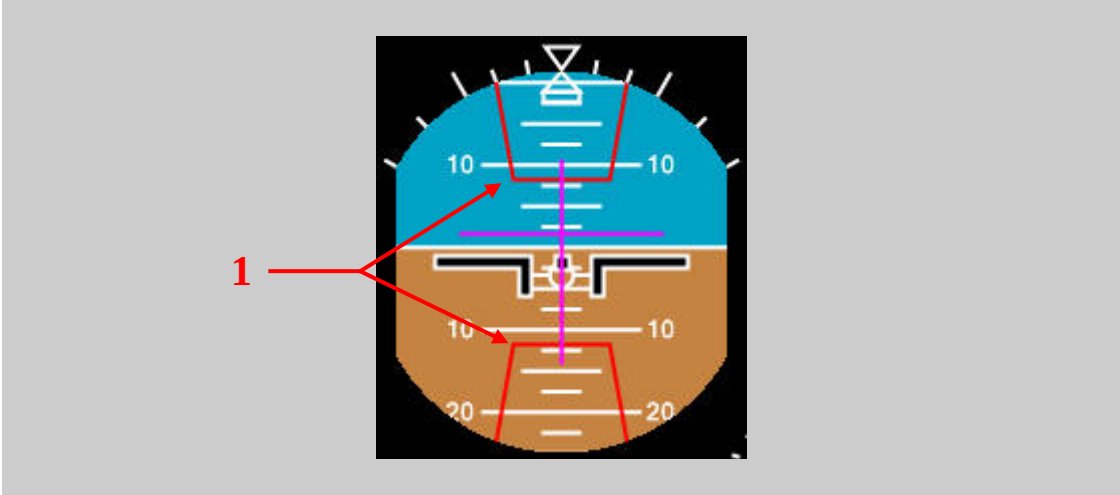
5. Glide Slope Flag (amber)

An ILS frequency is tuned and the ILS glide slope deviation display on the attitude indicator has failed.

6. Flight Path Vector Flag (amber)

FPV is selected on the EFIS control panel, but has failed. De-selection of FPV removes the flag.

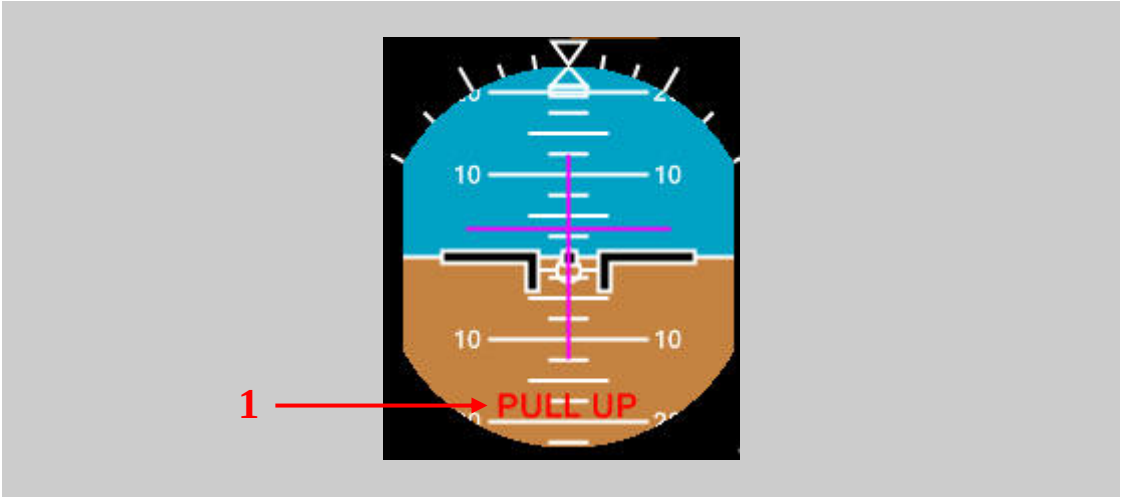
Traffic Alert and Collision Avoidance Indications



1. Traffic Alert and Collision Avoidance System Pitch Command (red)

The traffic alert and collision avoidance system (TCAS) resolution advisories (RAs) show on the ADI. The up RA symbol shows to fly the airplane up and the down RA symbol shows to fly the airplane down. Refer to Chapter 15, Warning Systems.

GPWS Annunciations



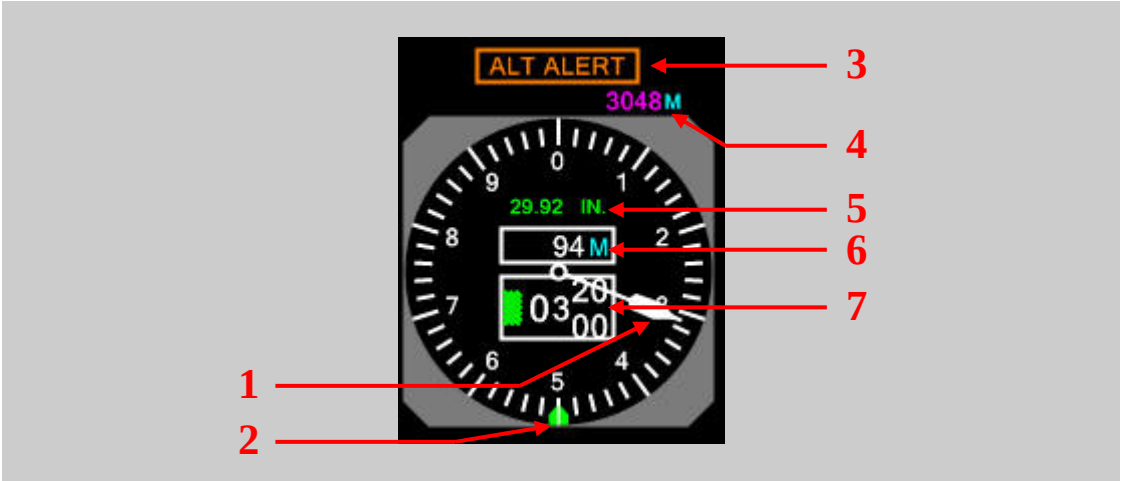
1. GPWS Annunciations (red)

The ground proximity warning system (GPWS) annunciations show in the lower center area of the ADI.Refer to Chapter 15, Warning Systems.

EFIS – Altimeter

Altimeter – General

The altimeter displays ADIRS altitude and other altitude related information.



1. Altitude Pointer

Makes one revolution each one thousand feet.

2. Reference Altitude Marker (green)

The reference altitude marker displays as a bug that moves around the altitude scale. The bug displays the minimum descent altitude. Crew set this with the minimums selector on the EFIS control panel.

3. Altitude Alert Annunciation (amber)

Appears steady for altitude acquisition, flashes during altitude deviation. Refer to Chapter 15, Warning Systems.

4. Metric Selected Altitude Readout (readout–magenta, caption–cyan)

Displays MCP altitude in meters when MTRS is selected on the EFIS control panel.

5. Barometric Setting (green)

The barometric setting readout shows as a digital value. The barometric setting readout is inches or hectopascals. The digital numbers show with IN for inches and HPA for hectopascals.

6. Metric Digital Readout (readout–white, caption–cyan)

Displays current altitude in meters when MTRS is selected on the EFIS control panel.

7. Digital Readout (white)

Displays current altitude in increments of thousands, hundreds and twenty feet:

Altimeter Failure Flag

The failure flag replaces the altitude displays to indicate system failure.

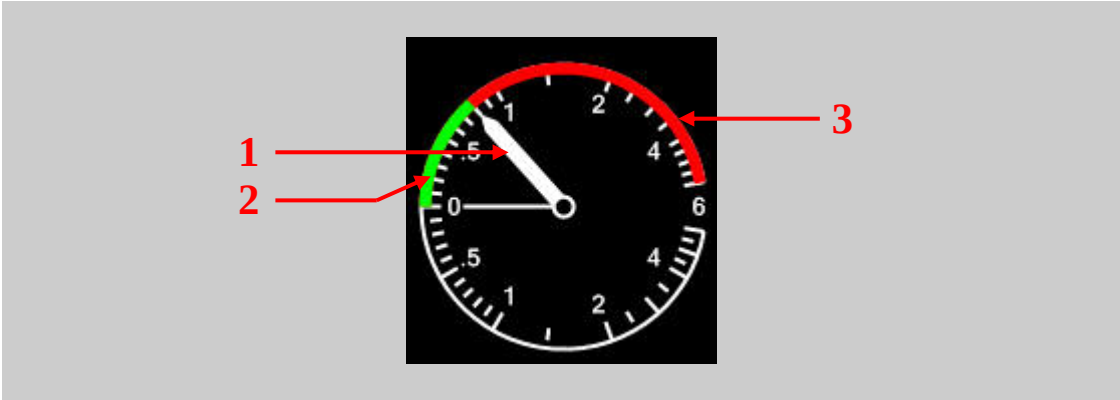
1. Altitude Failure Flag (amber)

The barometric altitude or barometric correction has failed.

EFIS – Vertical Speed Indicator

Vertical Speed Indicator – General

The vertical speed indicator (VSI) displays vertical speed and traffic alert and collision avoidance system data.



1. Vertical Speed Pointer (white)

Depicts rate of climb or descent from 0 to 6000 feet per minute.

2. TCAS Corrective Advisory (green)

Indicates range of recommended vertical speed.

3. TCAS Preventative Advisory (red)

Indicates range of vertical speed to be avoided.

Vertical Speed Indicator Failure Flag

1. TCAS Failure Flag (amber)

TCAS advisory function has failed.

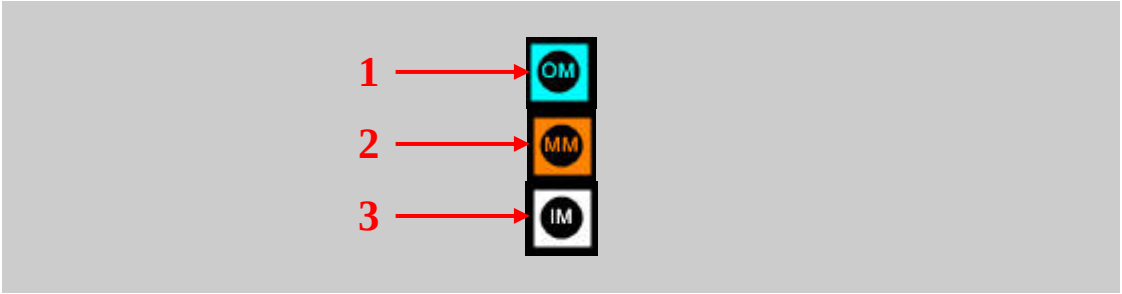
2. VSI Failure Flag (amber)

Vertical speed has failed.

EFIS – Marker Beacon Indications

Marker Beacons Indications

The marker beacon indication flashes when over one of the marker beacon transmitters.



1. Outer Marker (cyan)

Flashes when over an outer marker beacon.

2. Middle Marker (amber)

Flashes when over a middle marker beacon.

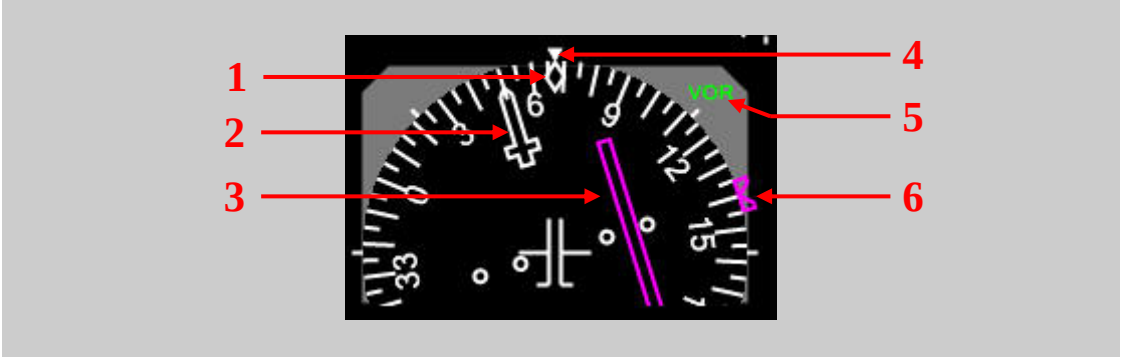
3. Inner Marker (white)

Flashes when over an inner marker beacon.

Navigation Displays – Horizontal Situation Indicator (HSI)

Horizontal Situation Indicator – General

The HSI displays current ADIRS heading, track and other information.



1. Drift Angle Pointer (white)

The drift angle pointer displays as a diamond that moves around the compass rose. The diamond shows the track of the airplane.

2. Selected Course Pointer (white)

Indicates the course set on the mode control panel.

3. Course Deviation Indicator (magenta)

The course deviation data can display for the VOR or the ILS. The course deviation source annunciation displays the source of the deviation. A deviation scale and pointer display the course deviation. The course that crew select on the mode control panel displays as the selected course pointer.

4. Heading Pointer (white)

Indicates current heading.

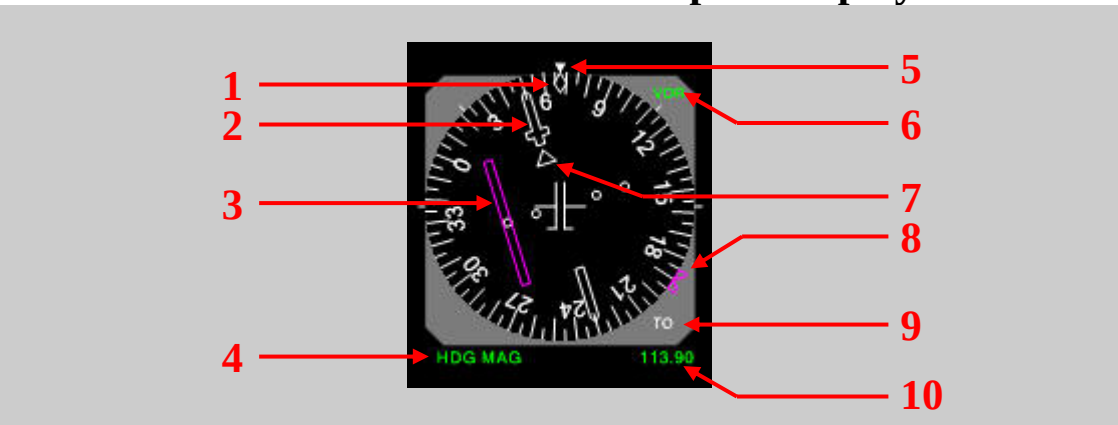
5. Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

6. Selected Heading Bug (magenta)

The selected heading bug displays as a bug that moves around the compass rose. The bug displays the mode control panel (MCP) selected heading.

Horizontal Situation Indicator – Compact Display



1. Drift Angle Pointer (white)

Indicates current drift angle or track.

2. Selected Course Pointer (white)

Indicates the course set on the mode control panel.

3. Course Deviation Indicator (magenta)

Indicates deviation from the selected localizer or VOR course.

4. Magnetic/True Heading Annunciation (green)

Indicates the HSI reference:

- HDG MAG (green) indicates display is oriented relative to magnetic north
- TRU HDG (green) indicates display is oriented relative to true north; a white box is displayed around TRU HDG

5. Heading Pointer (white)

Indicates current heading.

6. Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

7. TO/FROM Pointer (white)

8. Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel.

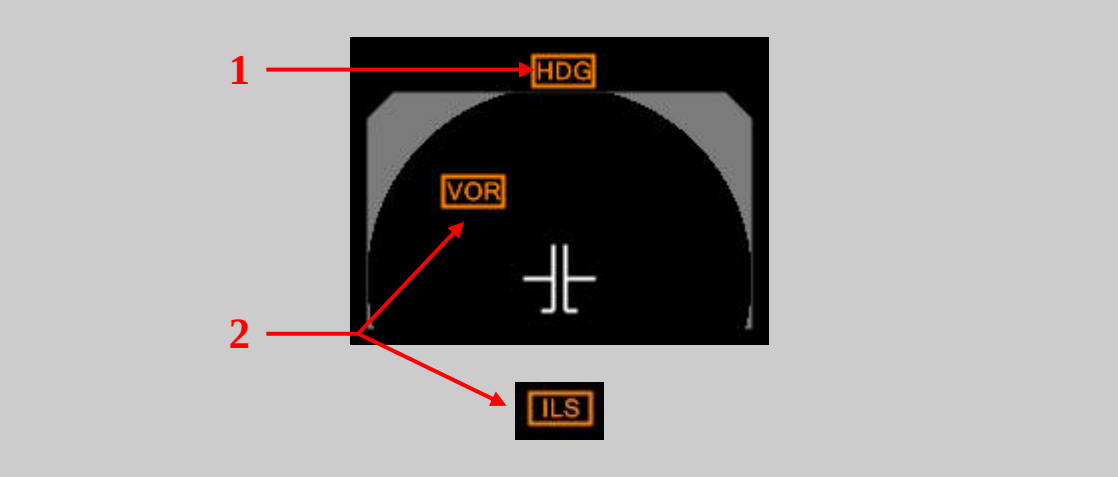
9. TO/FROM Annunciation (white)

10. Frequency Display (green)

Indicates selected navigation radio frequency.

Horizontal Situation Indicator Failure Flags

The flags replace the horizontal situation indicator displays to indicate source system failure or lack of computed data.



1. Heading Failure Flag (amber)

The heading source has failed. The compass rose is removed.

2. VOR/LOC Failure Flag (amber)

The airplane navigation data source has failed.

Navigation Displays – Radio Distance Magnetic Indicator (RDMI)

Radio Distance Magnetic Indicator – General

The RDMI provides the same information as a conventional RDMI.

1. DME Indications (white)

Displayed the DME information.

2. Bearing Pointers (VOR source–green, ADF source–cyan)

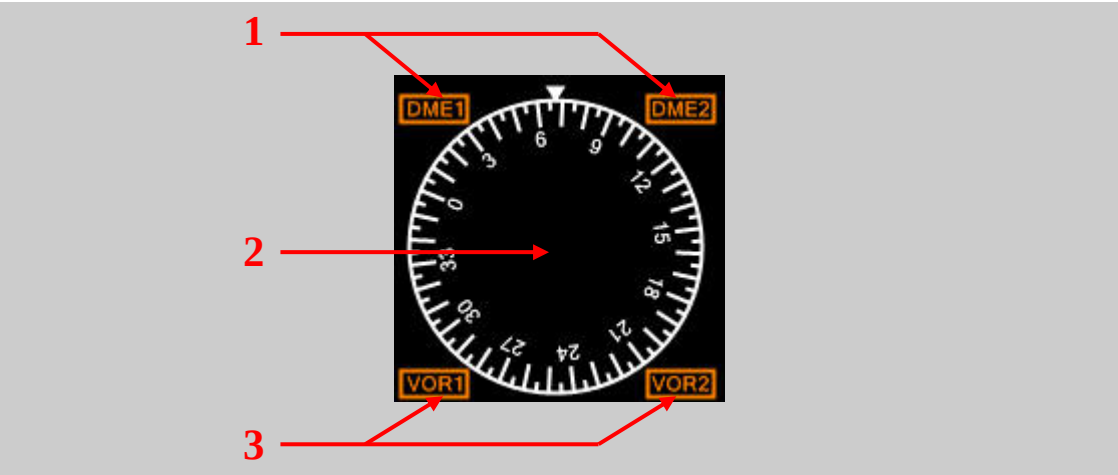
- narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1
- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

3. Bearing Source Indications (VOR source–green, ADF source–cyan)

Indicates “OFF” (white) if related VOR/ADF switch on the EFIS control panel is in the OFF position.

Radio Distance Magnetic Indicator Failure Flags

The flags replace the RDMI displays to indicate source system failure.



1. DME Failure Flags (amber)

The DME system has failed.

2. Heading Failure

The heading display is removed if heading information has failed.

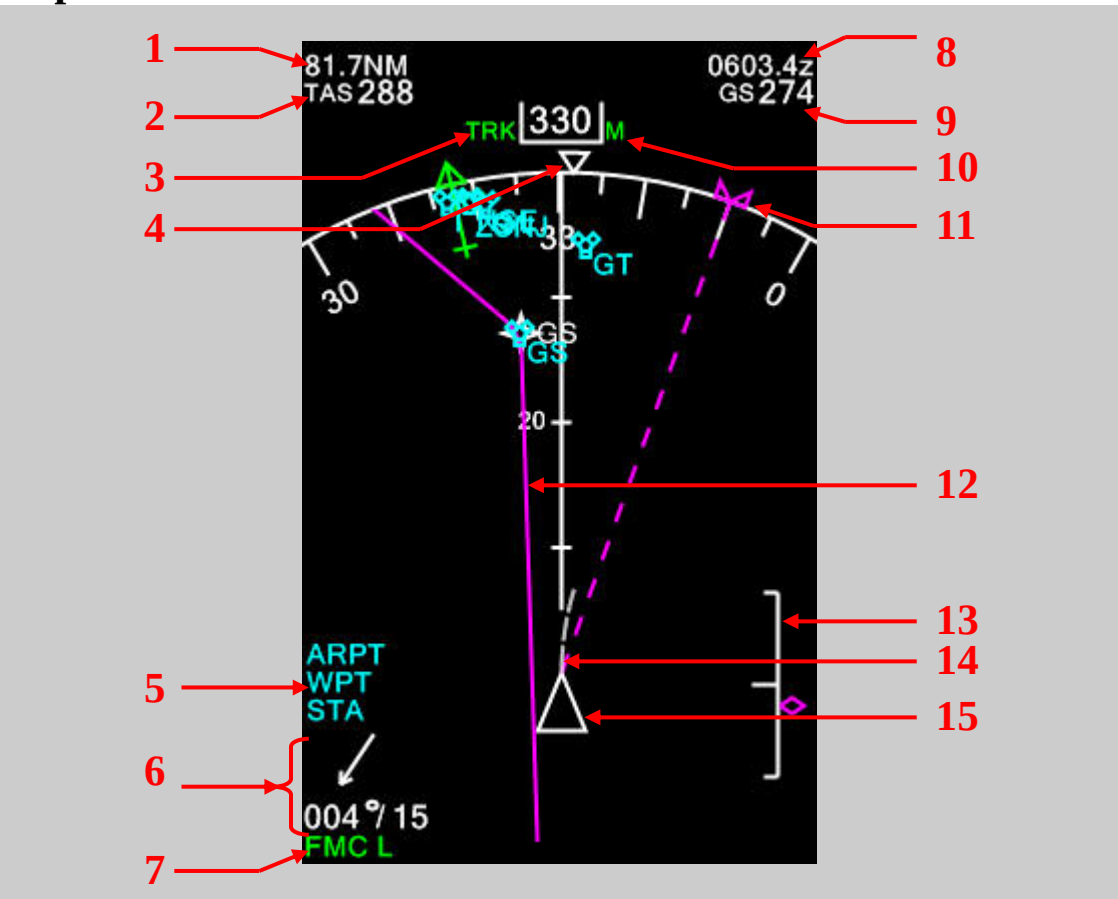
3. VOR, ADF Failure Flags (amber)

The selected VOR or ADF information is invalid.

Navigation Displays – MAP Mode

Note: Refer to section 40 of this chapter for a detailed explanation of the navigation symbology shown on the following pages.

Expanded MAP Mode



1. Distance to Next Active Waypoint

2. True Airspeed

3. Current Track

4. Heading Pointer

5. MAP Options

6. Wind Direction and Speed

7. MAP Source Annunciation

8. **Estimated Time of Arrival at Next Active Waypoint**

9. **Groundspeed**

10. **Magnetic/True Reference**

11. **Selected Heading Bug**

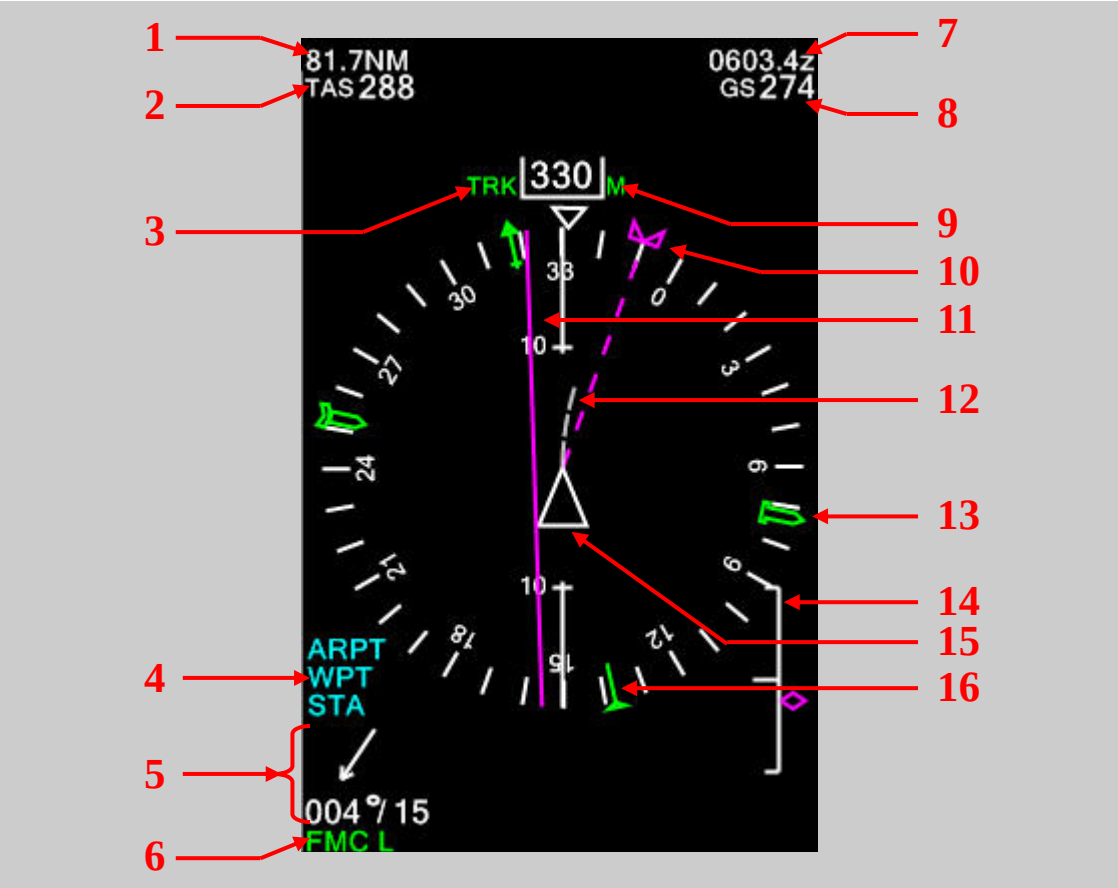
12. **Active LNAV Route**

13. **Vertical Deviation Scale and Pointer**

14. **Position Trend Vector**

15. **Airplane Symbol**

Center MAP Mode



1. **Distance to Next Active Waypoint**

2. **True Airspeed**

3. **Current Track**

4. **MAP Options**

5. **Wind Direction and Speed**

6. **MAP Source Annunciation**

7. **Estimated Time of Arrival at Next Active Waypoint**

8. **Groundspeed**

9. **Magnetic/True Reference**

10. **Selected Heading Bug**

11. **Active Route**

12. **Position Trend Vector**

13. **VOR2/ADF2 Bearing Pointer**

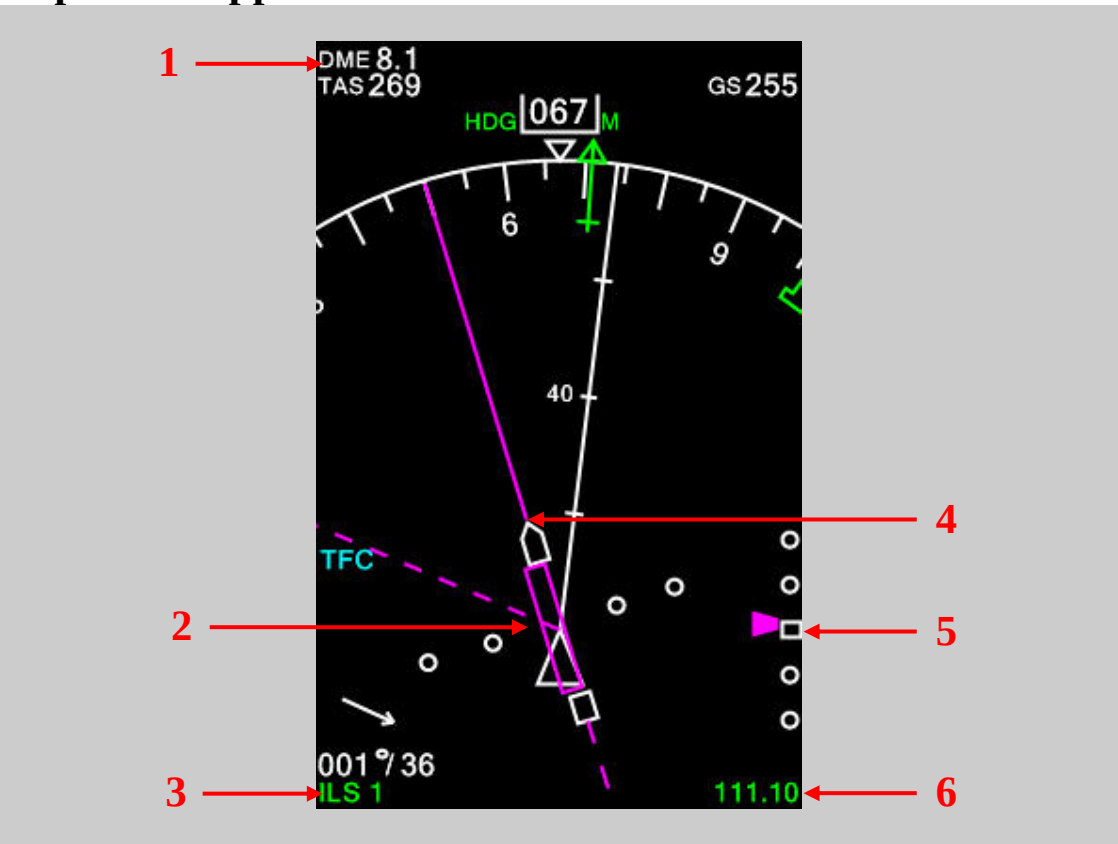
14. **Vertical Deviation Scale and Pointer**

15. **Airplane Symbol**

16. **VOR1/ADF1 Bearing Pointer**

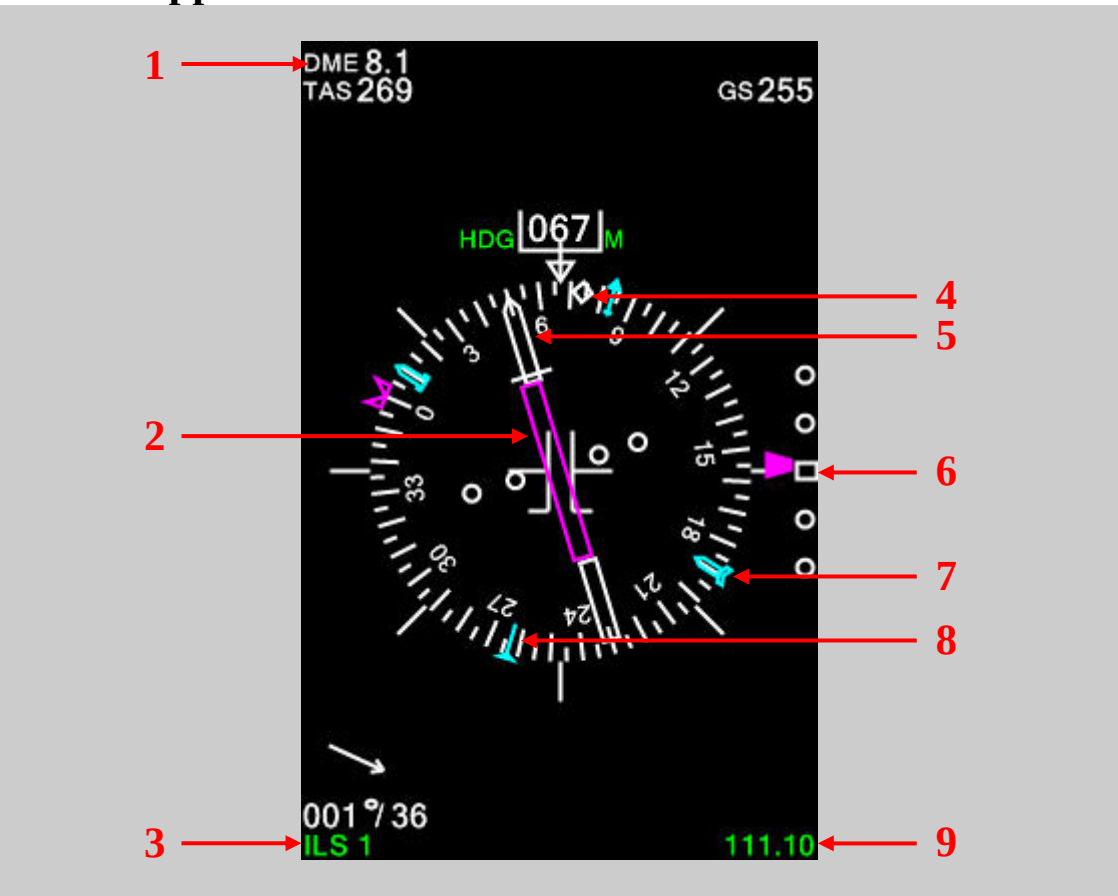
Navigation Displays – Approach Mode

Expanded Approach Mode



1. **Reference ILS DME**
2. **Localizer Deviation Indication and Scale**
3. **Reference ILS Receiver**
4. **Selected Course Pointer**
5. **Glide Slope Pointer and Scale**
6. **Reference ILS Frequency**

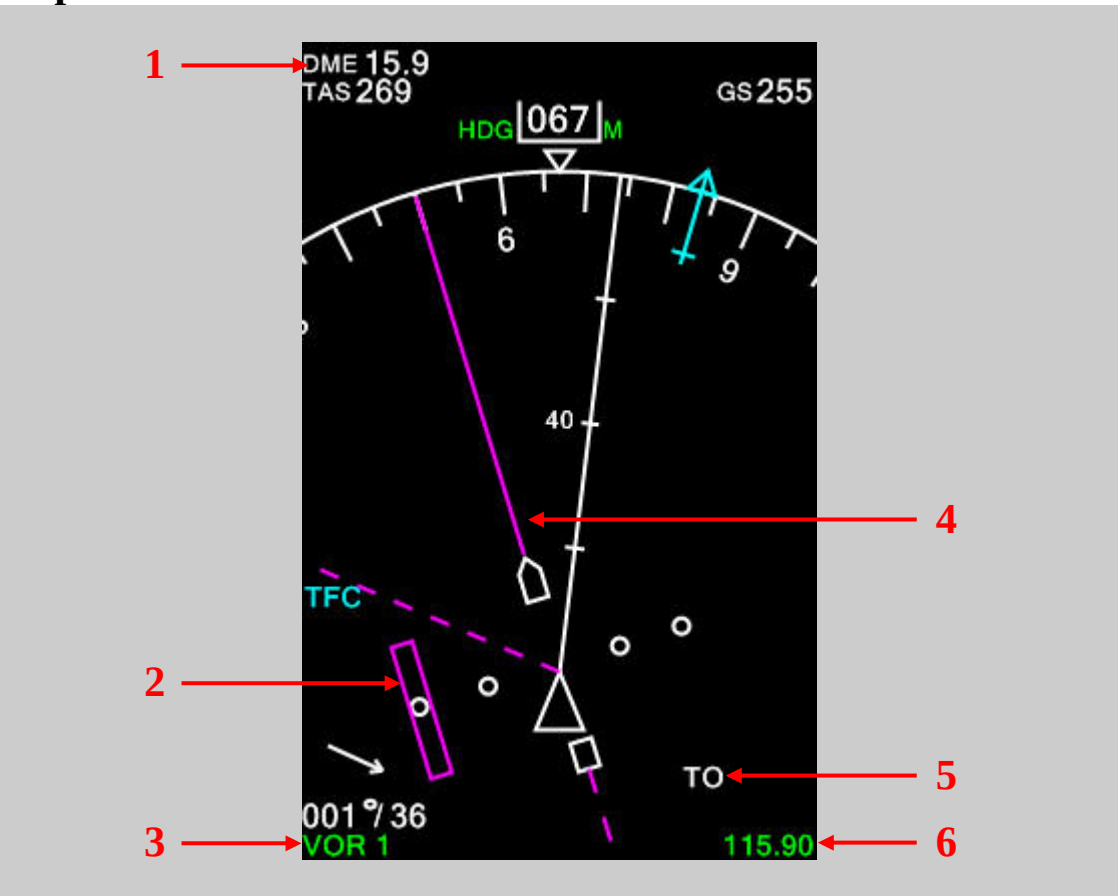
Center Approach Mode



1. **Reference ILS DME**
2. **Localizer Deviation Indication and Scale**
3. **Reference ILS Receiver**
4. **Drift Angle Pointer**
5. **Selected Course Pointer**
6. **Glide Slope Pointer and Scale**
7. **VOR2/ADF2 Bearing Pointer**
8. **VOR1/ADF1 Bearing Pointer**
9. **Reference ILS Frequency**

Navigation Displays – VOR Mode

Expanded VOR Mode



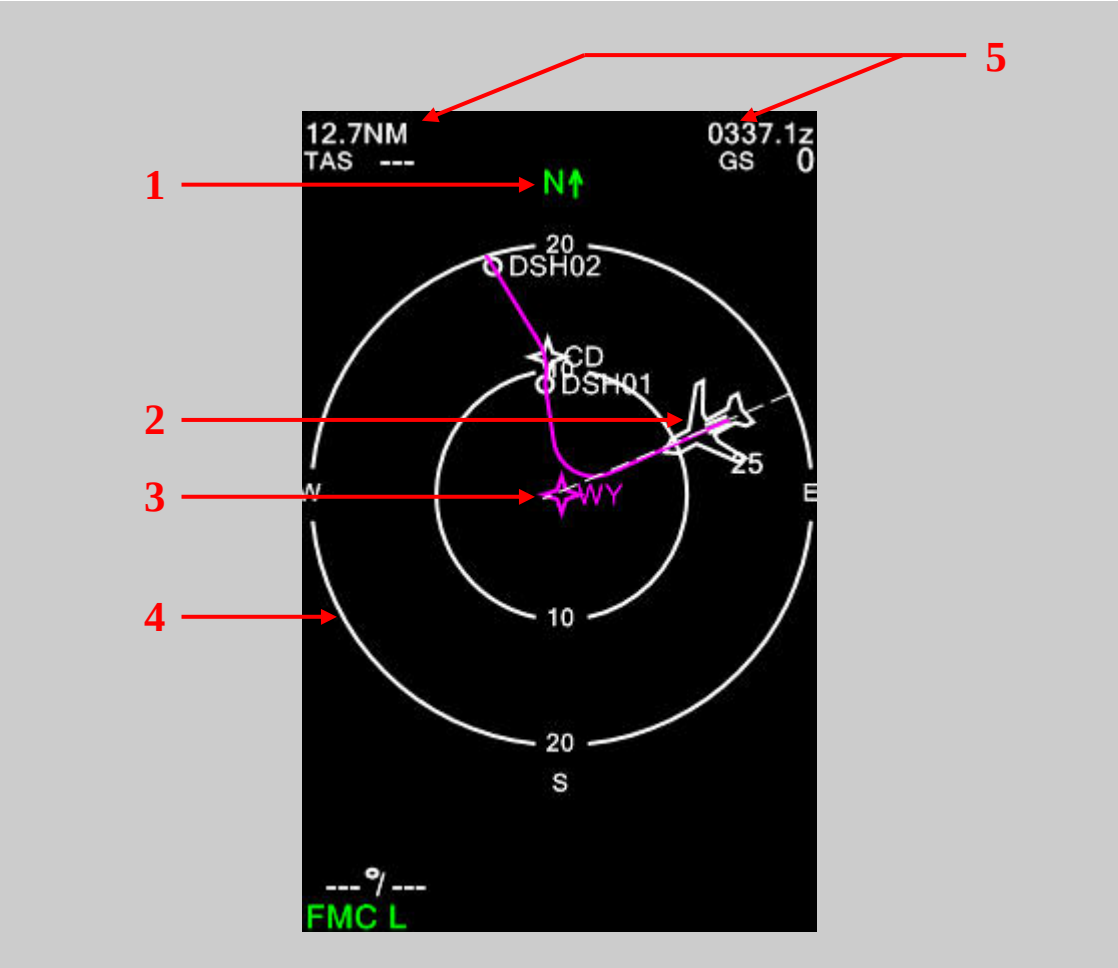
1. **Reference VOR DME**
2. **Lateral Deviation Indication and Scale**
3. **Reference VOR Receiver**
4. **Selected Course Pointer**
5. **TO/FROM Indication**
6. **Reference VOR Frequency**

Center VOR Mode

1. **Reference VOR DME**
2. **TO/FROM Pointer**
3. **Lateral Deviation Indication and Scale**
4. **Reference VOR Receiver**
5. **Drift Angle Pointer**
6. **Selected Course Pointer**
7. **TO/FROM Indication**
8. **Reference VOR Frequency**
9. **VOR2/ADF2 Bearing Pointer**
10. **VOR1/ADF1 Bearing Pointer**

Navigation Displays – Plan Mode

Plan Mode



1. True North Up Arrow

2. Airplane Symbol

Denotes current position and true heading. Symbol does not display north of 82N latitude or south of 82S latitude.

3. Center Waypoint

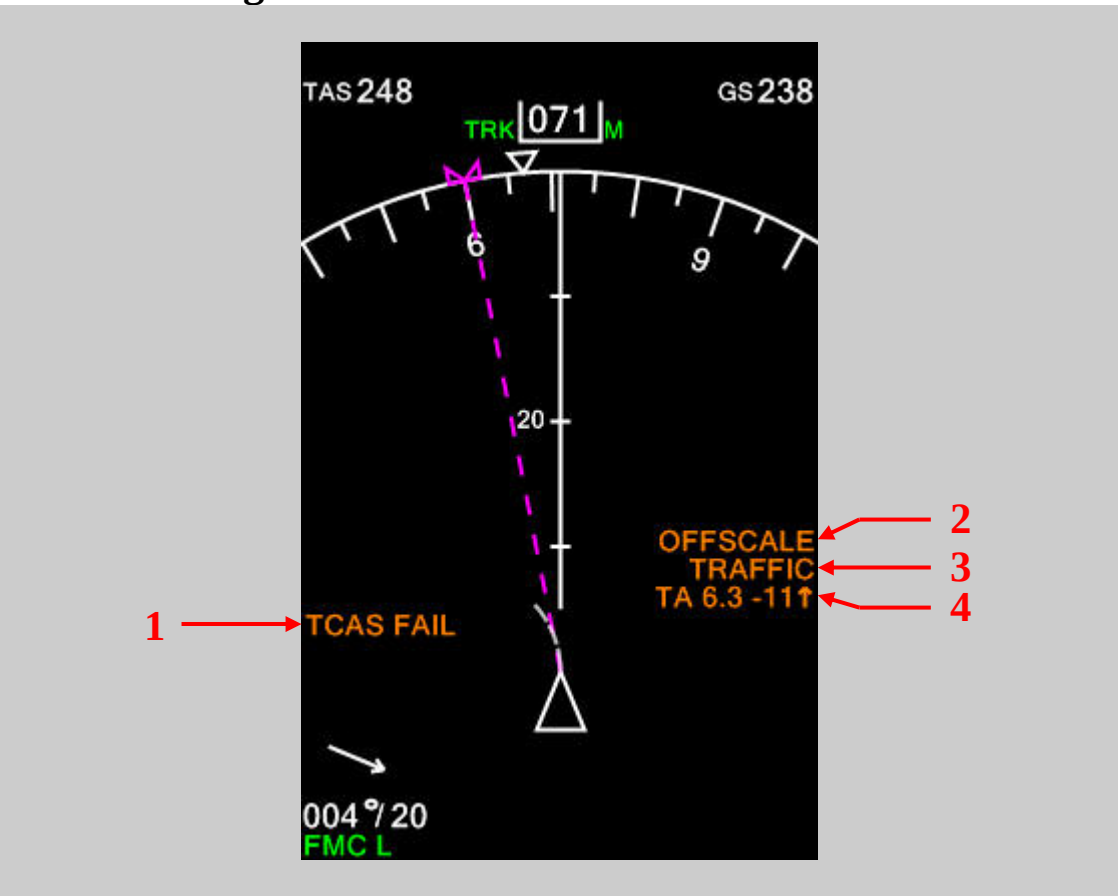
The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

4. Range Circle

5. Active Waypoint Information

Navigation Displays – Advisory Messages

TCAS Messages



1. TCAS Annunciations

TFC (cyan) – TFC selected on the EFIS control panel in Expanded MAP, Center MAP, Expanded APP or Expanded VOR modes.

TCAS TEST (cyan) – TCAS in test mode.

TCAS FAIL (amber) – TCAS has failed.

TA ONLY (cyan) – TCAS TA only mode.

TCAS OFF (amber) – TCAS off.

2. OFFSCALE (red or amber)

TA (amber) or RA (red) is beyond the display range.

3. TRAFFIC (red or amber)

Displayed during a TA (amber) or RA (red) condition.

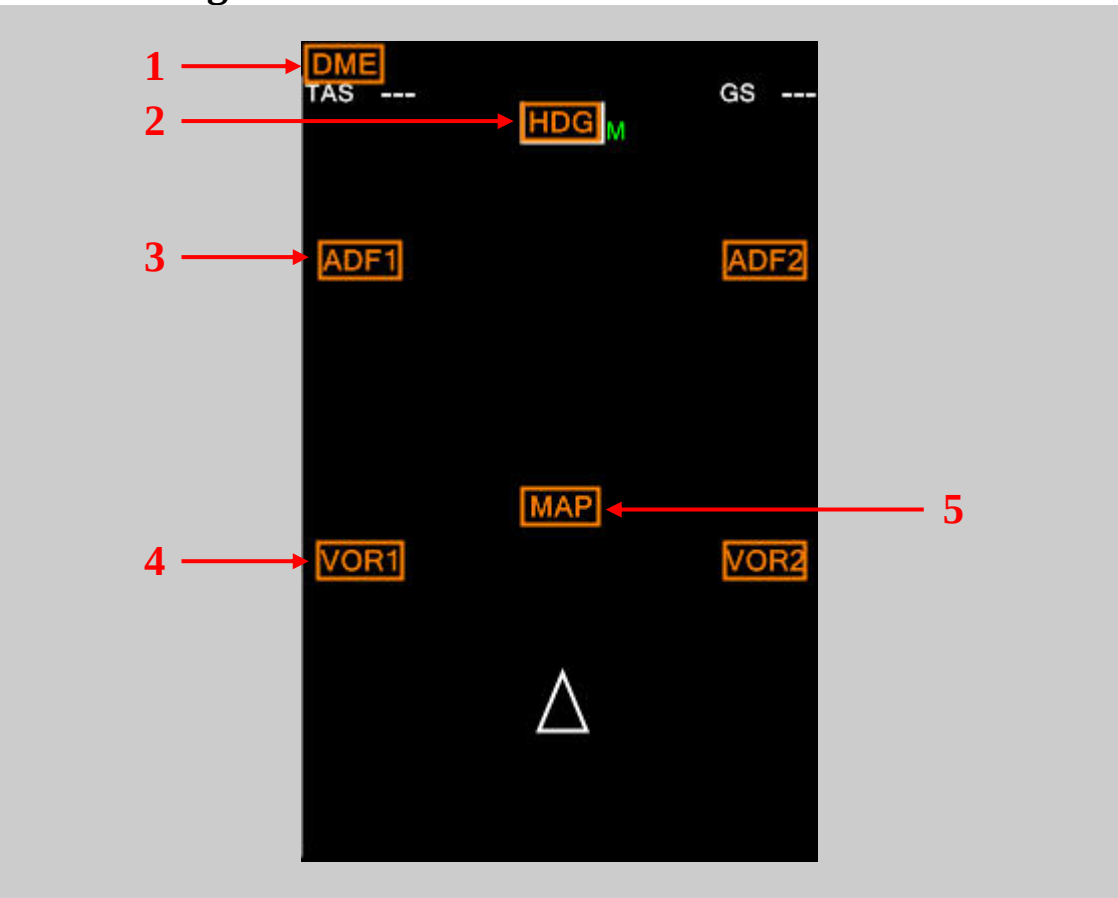
4. No Bearing Message (red or amber)

Displayed when no bearing information is available for traffic.

Navigation Displays – Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

Failure Flags



1. DME Failure Flag (APP and VOR modes)

DME display has failed.

2. Heading Failure Flag (MAP, APP and VOR modes)

Heading display has failed.

3. ADF Failure Flag (MAP, APP and VOR modes)

ADF display has failed.

4. VOR Failure Flag (MAP modes)

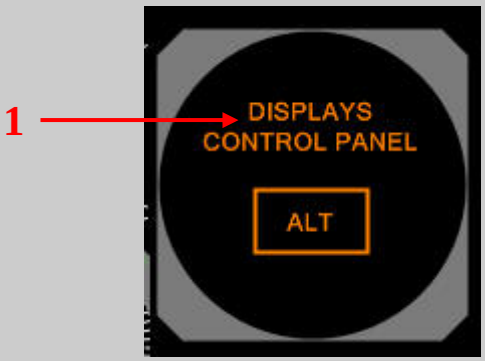
EFIS control panel POS switch selected and VOR display failed.

5. MAP Failure Flag (MAP modes)

The related FMC generated map display has failed.

Additional Flags and Annunciations

Displays Control Panel Annunciation



1. Displays Control Panel Annunciation (amber)

If the EFIS control panel fails, the DISPLAYS CONTROL PANEL flag shows and the ALT flag shows. With the CONTROL PANEL select switch on the overhead panel in:

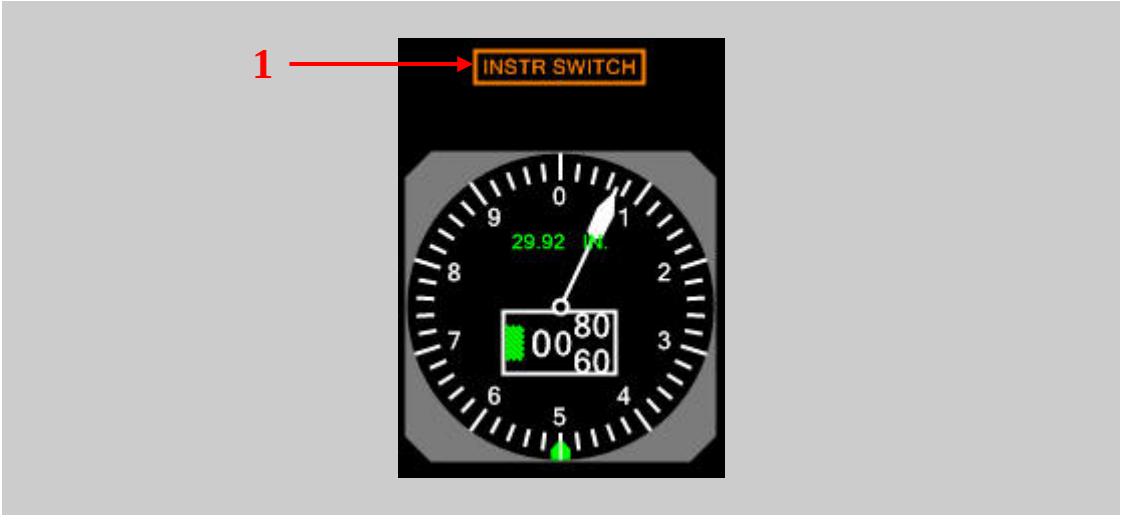
- BOTH ON 1 – left (Capt) EFIS control panel has failed
- NORMAL – corresponding EFIS control panel has failed
- BOTH ON 2 – right (F/O) EFIS control panel has failed.

Display System Annunciations

1. Display System Annunciations

DSPLY SOURCE (amber) – A single DEU has been selected, either manually or automatically, to drive all six display units.

Instrument Switch Annunciation



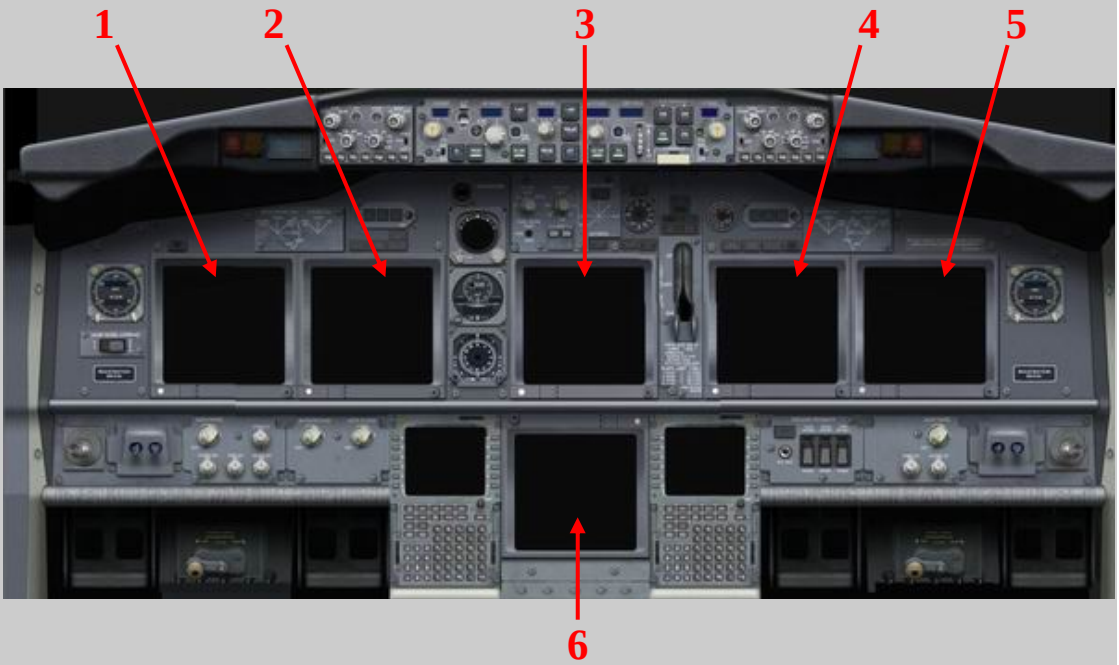
1. INSTR SWITCH Annunciation (amber)

Indicates both the Captain's and First Officer's displays are using the same source of IRU data. Displayed when the IRS switch on the overhead panel is not in the NORMAL position.

Flight Instruments, Displays PFD/ND – Displays

Chapter 10
Section 11

PFD/ND Display System – Overview



MAIN PANEL

1. Captain Outboard Display Unit
2. Captain Inboard Display Unit
3. Upper Display Unit
4. First Officer Inboard Display Unit
5. First Officer Outboard Display Unit
6. Lower Display Unit

Captain Outboard Display

CAPTAIN'S PANEL

1. Flight Mode Annunciator

Refer to Chapter 4, Automatic Flight

2. Airspeed/Mach Indications

3. Attitude Indications

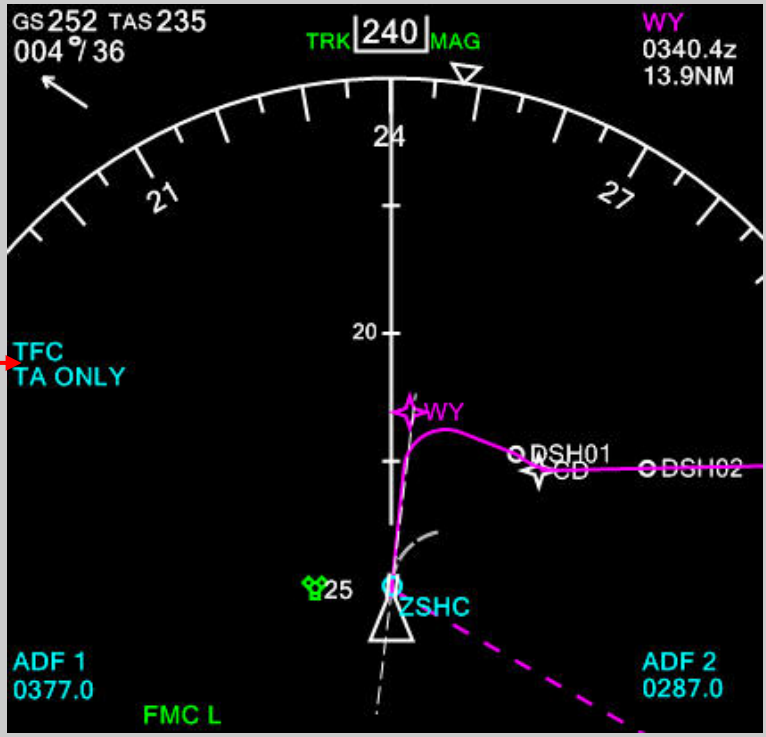
4. Autopilot, Flight Director System Status

5. Altitude Indications

6. Vertical Speed Indications

7. Heading/Track Indications

Captain Inboard Display



CAPTAIN'S PANEL

1. Navigation Display

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

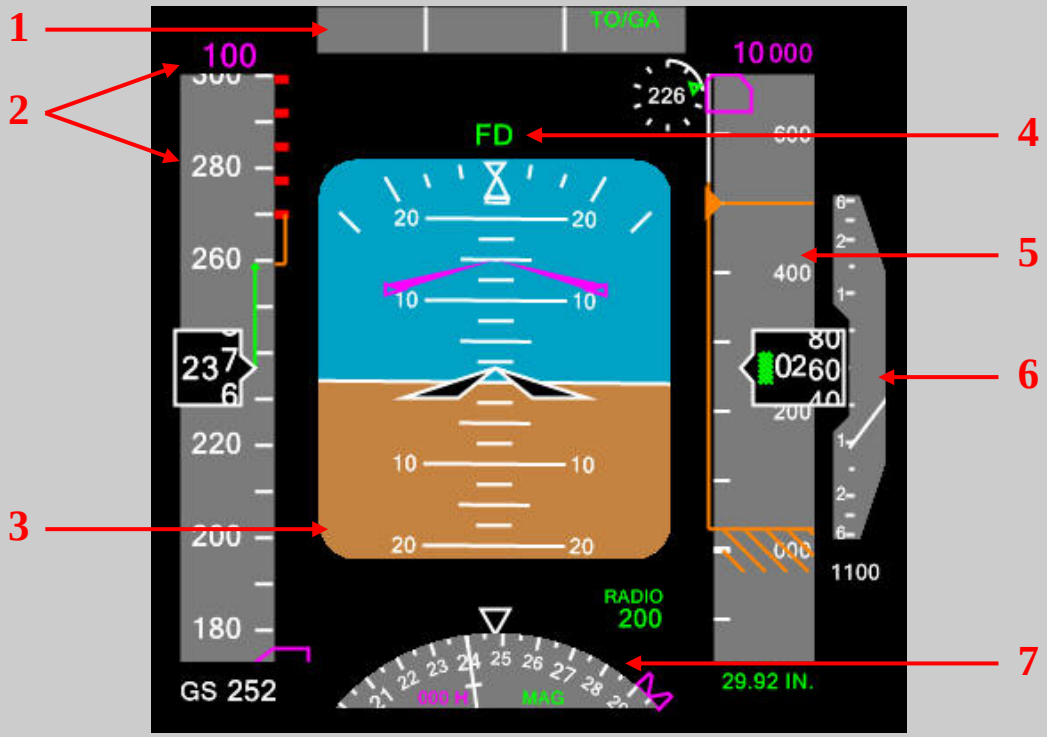
First Officer Inboard Display

FIRST OFFICER'S PANEL

1. Navigation Display

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

First Officer Outboard Display



FIRST OFFICER'S PANEL

1. Flight Mode Annunciator

Refer to Chapter 4, Automatic Flight

2. Airspeed/Mach Indications

3. Attitude Indications

4. Autopilot, Flight Director System Status

5. Altitude Indications

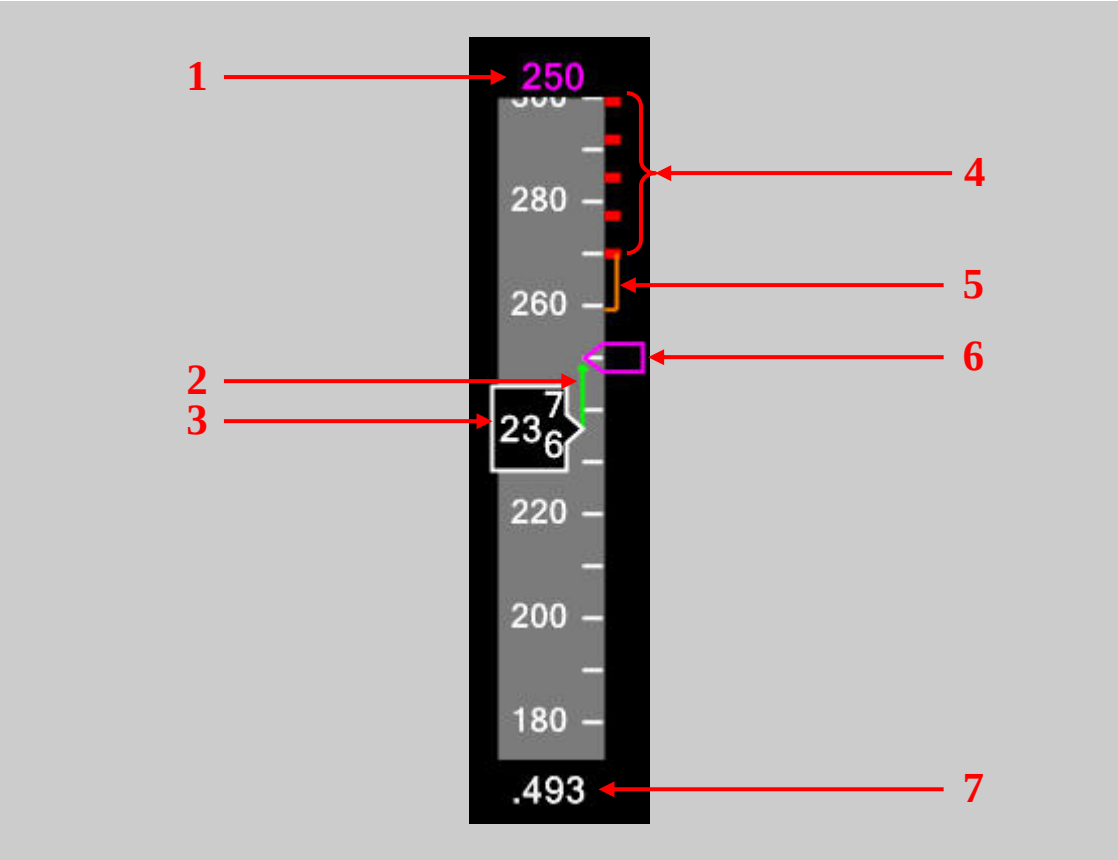
6. Vertical Speed Indications

7. Heading/Track Indications

Primary Flight Display (PFD) – PFD Airspeed Indications

PFD Airspeed Indications – General

The PFD airspeed indication displays air data inertial reference system (ADIRS) airspeed and other airspeed related information.



1. Selected Speed (magenta)

Displays target airspeed:

- indicates the airspeed manually selected in the IAS/MACH window
- indicates the FMC computed airspeed.

2. Speed Trend Vector (green)

The speed trend vector displays the predicted airspeed in 10 seconds based on current acceleration or deceleration.

3. Current Airspeed (white)

Current airspeed displays as a digital readout. The digital readout box points to the value on the speed tape. When the airspeed is below 30 knots, 30 knots shows.

When current airspeed decreases into the minimum maneuver speed amber bar:

- airspeed readout box turns amber and flashes for 10 seconds.
- box returns to white when airspeed is above minimum maneuver speed.

4. Maximum Speed (red and black)

Maximum speed displays as red and black alternate squares. If the maximum speed value is on the speed tape, the maximum speed display starts at the top of the speed tape and goes down to the maximum operating speed.

The maximum speed as limited by the lowest of the following:
- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

5. Maximum Maneuvering Speed (amber)

The maximum maneuver speed displays as a hollow amber bar. It shows the highest speed before the start of the high speed buffet.

6. Speed Bug (magenta)

Points to the airspeed:
- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

When the selected speed or Mach number is off the scale, only half of the bug shows at the top or the bottom of the speed tape.

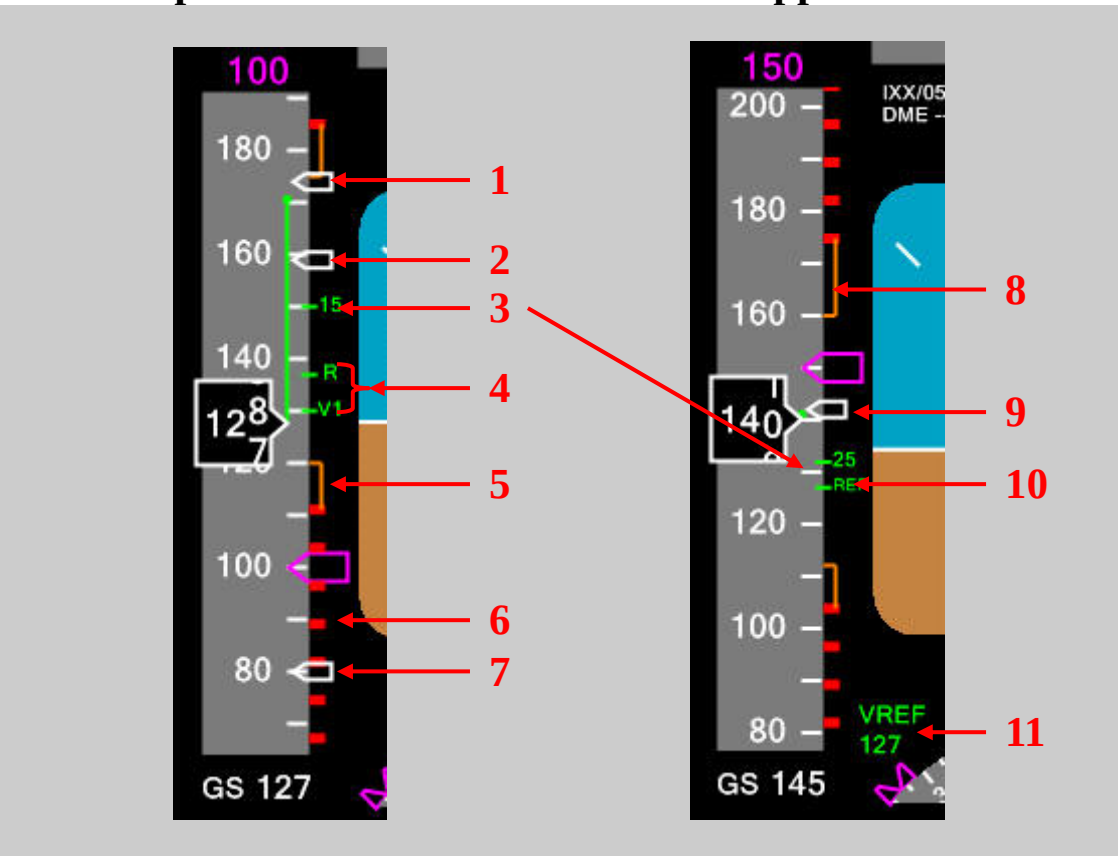
7. Current Mach (white)

[Option – Without groundspeed displayed]
Indicates current Mach number:
- displays when airspeed is 0.40 Mach and above
- blanks when airspeed decreases below 0.40 Mach.

7. Current Mach/Groundspeed (white)

[Option – With groundspeed displayed]
Indicates current Mach or groundspeed:
- displays Mach when airspeed is 0.40 Mach and above
- displays groundspeed when airspeed decreases below 0.40 Mach
- when transitioning from Mach to groundspeed or from groundspeed to Mach, a white box shows for 10 seconds.

PFD Airspeed Indications – Takeoff and Approach



1. Bug 5 (white)

Displayed if speed reference selector on the engine display control panel is in the bug 5 position or SET position and a value greater than 60 knots has been selected.

2. V2+15 (white)

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered in the CDU.

3. Flaps Maneuvering Speeds (green)

Indicates flap maneuvering speed for the displayed flap position:

- indicates current flap setting speed and next lower flap setting speed when takeoff.
- indicates shows current flap setting speed and next higher flap setting speed when approach.
- displayed after gross weight is entered in the CDU or after takeoff gross weight is set with the speed reference selector
- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed, except for flaps 1 takeoff.
- numbered flap maneuvering speed bugs are removed when flap lever is moved to flaps 30 or 40

- flap bugs inhibited if less than VREF +4
- UP bug not displayed above approximately 20,000 feet altitude.

4. Takeoff Reference Speeds (green)

Indicates V1 (decision speed) and VR (rotation speed) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel:

- amber NO VSPD is displayed on the ground if V1 or VR is not selected on the CDU or is not set with the speed reference selector
- displayed for takeoff when speed is greater than 80 knots
- removed at lift–off
- V1 speed is displayed at the top of airspeed indication when selected and value is off scale.

5. Minimum Maneuver Speed (amber)

The minimum maneuver speed displays as a hollow amber bar.

6. Minimum Speed (red and black)

Minimum speed displays as red and black alternate squares. If the minimum speed value is on the speed tape, the minimum speed display starts at the bottom of the speed tape and goes up to the minimum operating speed.

7. 80 Knot Airspeed Bug (white)

Indicates 80 knots:

- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

8. Maximum Maneuvering Speed (amber)

The maximum maneuver speed displays as a hollow amber bar. It shows the highest speed before the start of the high speed buffet.

9. VREF+20 (white)

[Option – 800/900/900ER/BBJ2/BBJ3]
Displayed after selection of VREF.

9. VREF+15 (white)

[Option – 600/700/700ER/700C/BBJ]
Displayed after selection of VREF.

10. Landing Reference Speed (green)

Indicates REF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

11. Speed Reference Display (green)

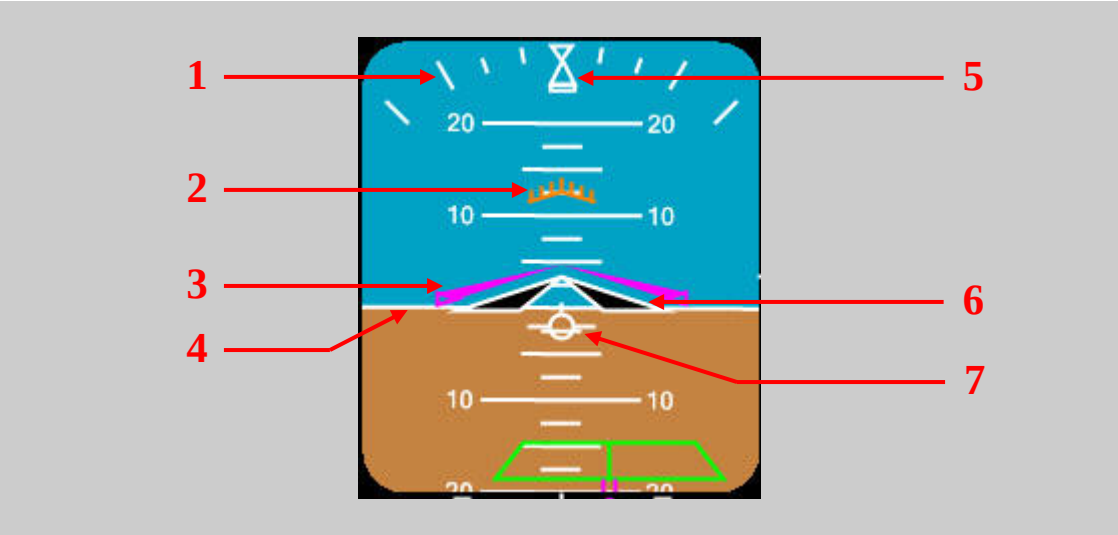
Displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:

- on the ground, V1, VR, and takeoff gross weight may be selected; if VREF is selected, INVALID ENTRY is displayed
- in flight, VREF and landing gross weight may be selected; if V1 or VR is selected, INVALID ENTRY is displayed
- removed when the speed reference selector is moved to the SET position.

PFD – Attitude Indications

Attitude Indications – General

The attitude indication displays ADIRS attitude information.



1. Bank Scale (white)

Fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, and 45 degrees.

2. Pitch Limit Indication (amber)

The pitch limit indication displays the limit that crew can pitch the airplane before the stick shaker starts.

- displayed when the flaps are not up.
- displayed at slow speeds with the flaps up.

3. Flight Director Bar (magenta)

The flight director commands display when the flight director is on. (Refer to Chapter 4, Automatic Flight.)

4. Horizon Line and Pitch Scale (white)

Indicates the horizon relative to the airplane symbol.

5. Bank Pointer

Indicates bank angle; fills and turns amber if bank angle is 35 degrees or more.

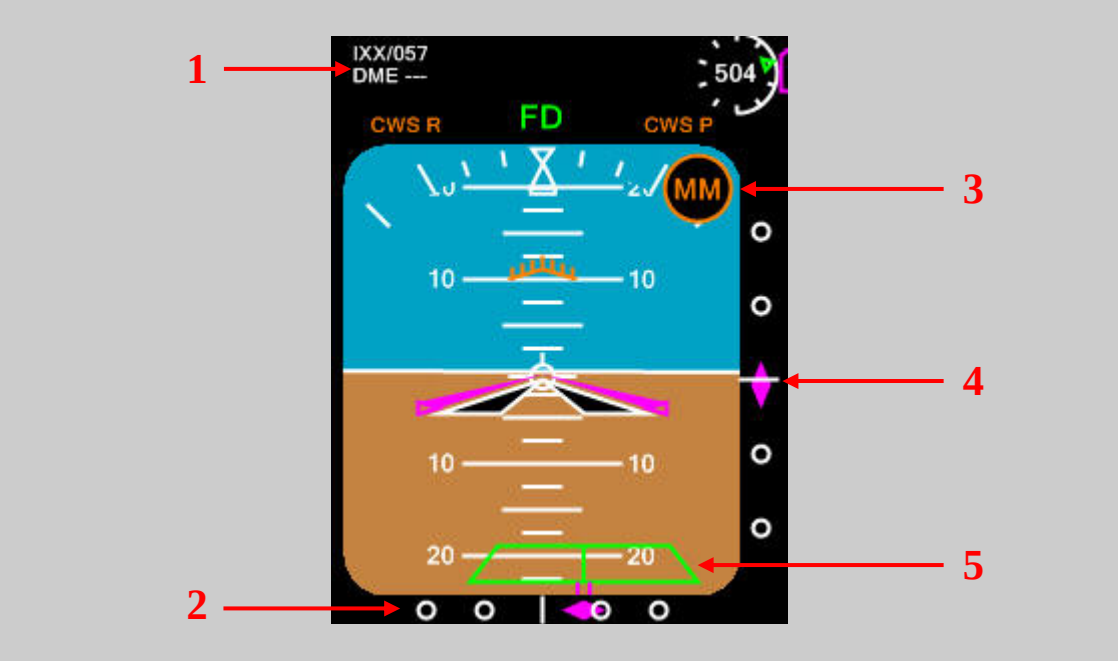
6. Airplane Symbol

Indicates airplane attitude relative to the horizon.

7. Flight Path Vector (FPV) Indication (white)

The flight path vector indication displays when crew select FPV on the EFIS control panel. Flight path angle is displayed relative to the horizon line. Drift angle is represented by the perpendicular distance from the centerline of the pitch scale to the FPV symbol.

PFD Instrument Landing System Indications



1. Approach Reference

The localizer frequency or identifier and the selected runway heading show when crew tune a valid ILS frequency. The localizer identifier normally shows but the frequency shows if the identifier is not available. The runway heading selected on the mode control panel also shows.

The DME distance shows when crew tunes a valid ILS frequency. The indication shows the DME distance to the collocated DME station.

2. Localizer Pointer and Deviation Scale

The pointer:

- indicates localizer position relative to the airplane.
- in view when the localizer signal is receive.
- fills in solid magenta when within 2 1/2 dots from center.

The scale indicates deviation.

At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

3. Marker Beacon symbol

Flashes when over one of the marker beacons:

OM (cyan) – an outer marker beacon

MM (amber) – a middle marker beacon

IM (white) – an inner marker beacon.

4. Glide Slope Pointer and Deviation Scale

The pointer:

- indicates glide slope position.
- in view when the glide slope signal is received.
- fills in solid magenta when within 2 1/2 dots from center.

The scale indicates deviation.

At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive glide slope deviation.

5. Rising Runway (green with magenta stem)

[Option – Rising runway]
The rising runway displays below 2500 feet radio altitude with the localizer pointer in view. Until the airplane descends to 200 feet radio altitude, the rising runway is at the bottom of the PFD display. Below 200 feet radio altitude, the rising runway moves toward the airplane symbol. The indication displays the radio altitude decrease relative to the airplane symbol.

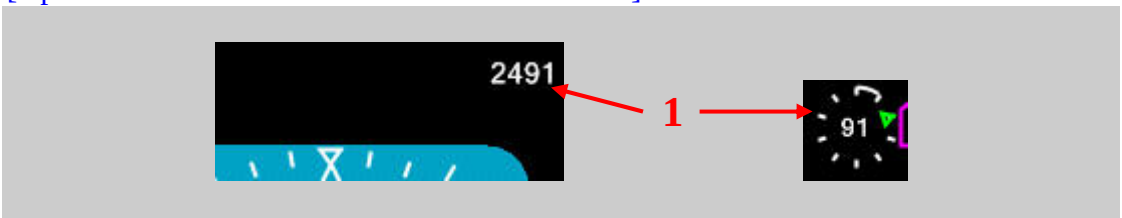
Expanded Localizer Indications

1. Expanded Localizer Scale

Displayed when the autopilot or flight director is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

PFD Radio Altitude Indications

[Option – 600/700/700C/700ER/800/900/900ER]



1. Radio Altitude

Displayed below 2500 feet AGL:

- digital display from 2500 to 1000 feet AGL
- box highlighted white for 10 seconds upon descent below 2500 feet
- round dial displays below 1000 feet AGL
- pointer indicates selected radio altitude minimums
- the circumference of the dial depict the airplane's radio altitude
- the remaining perimeter and pointer turn amber and flash for 3 seconds when below radio altitude minimums, the numeric readout does not flash.

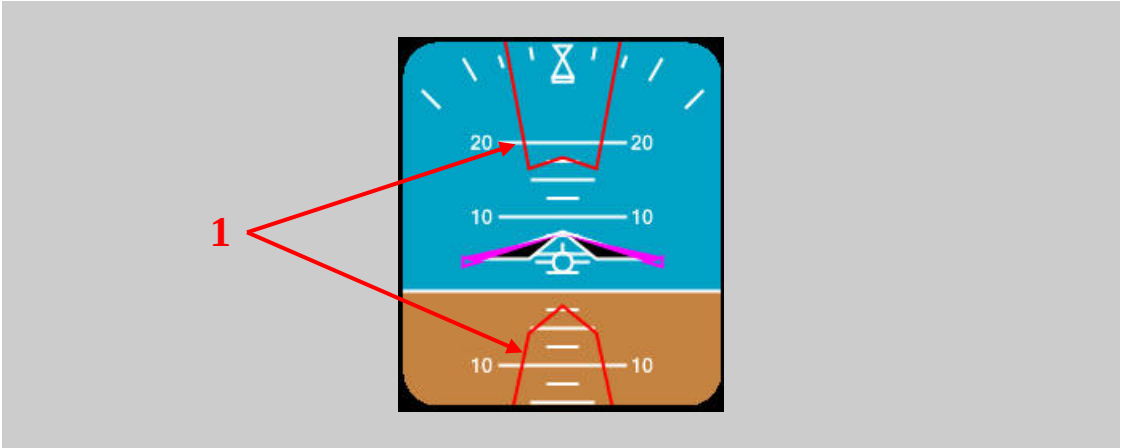
[Option – BBJ/BBJ2/BBJ3]

1. Radio Altitude

Displays current radio altitude:

- displayed below 2500 feet AGL
- box highlighted white for 10 seconds upon descent below 2500 feet
- turns amber when below radio altitude minimums.

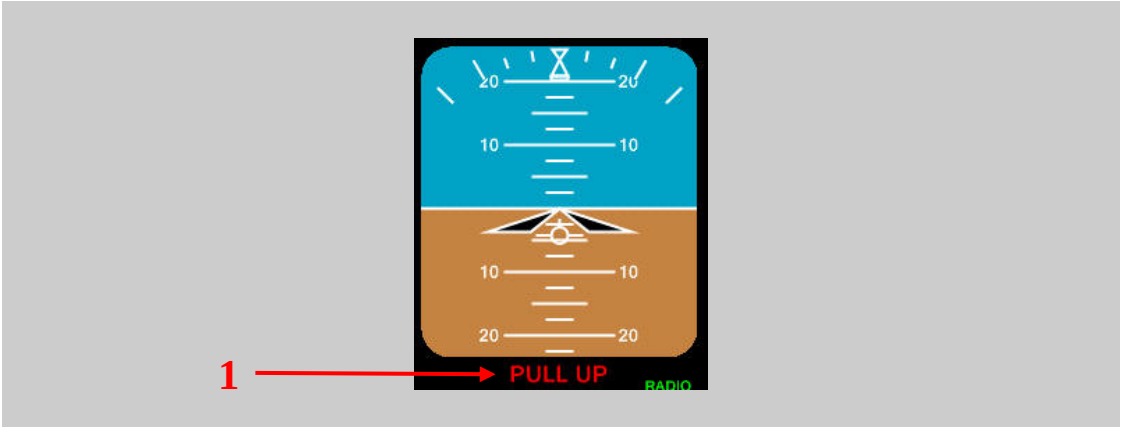
Traffic Alert and Collision Avoidance Indications



1. Traffic Alert and Collision Avoidance System Pitch Command (red)

TCAS resolution advisories display when the TCAS finds that a traffic conflict exists. The red bars show pitch attitudes that the pilots must avoid in a traffic encounter. The airplane symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance. Refer to Chapter 15, Warning Systems.

GPWS Annunciations



1. GPWS Annunciations (red)

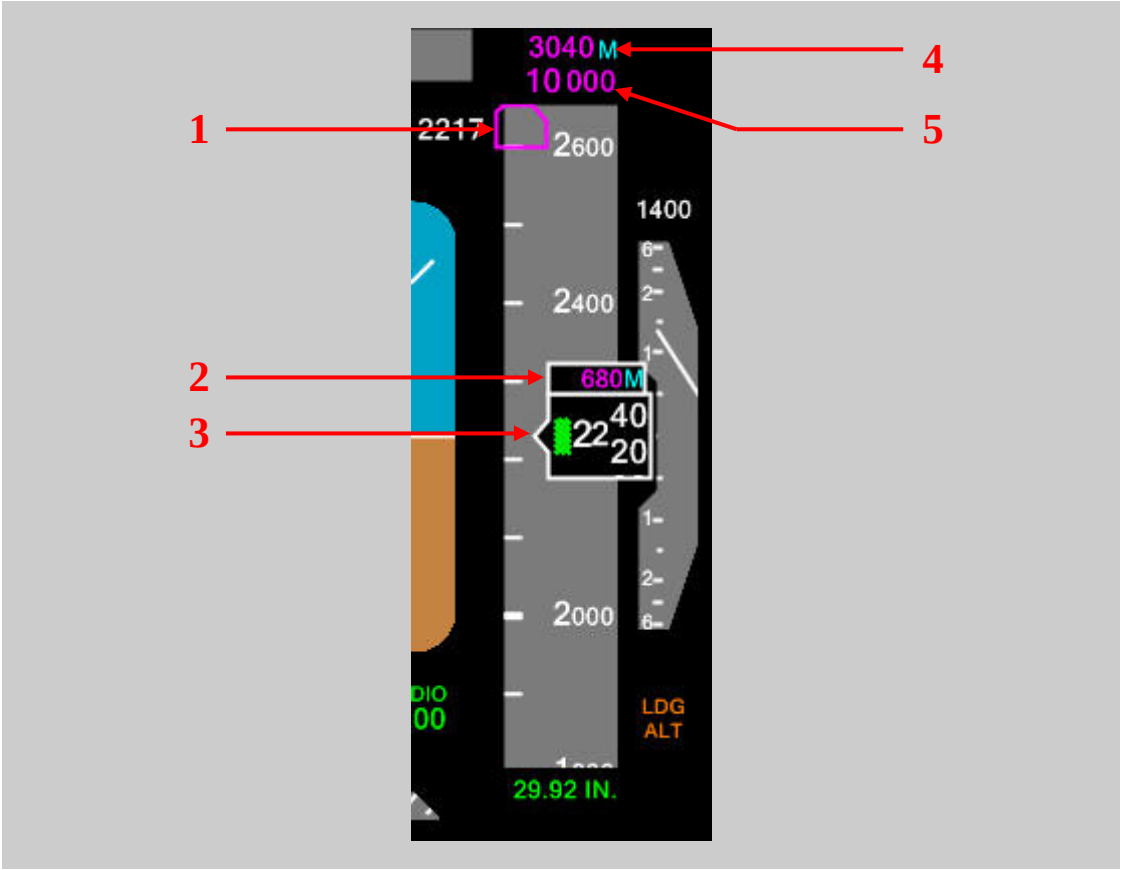
The ground proximity warning system (GPWS) time critical annunciations display below the attitude indication. Only one GPWS annunciations displays at a time. These are the GPWS annunciations:

- WINDSHEAR warning
- PULL UP warning.

PFD – Altitude Indications

Altitude Indications– General

The altitude indication displays ADIRS altitude and other altitude related information.



1. Selected Altitude Bug (magenta)

Indicates the altitude set in the MCP altitude window. When the selected altitude is offscale, only half the bug displays at the top or bottom of the altitude tape.

2. Metric Digital Readout (readout and box–white, metric symbol–cyan)

Displays current altitude in meters when MTRS is selected on the EFIS control panel.

3. Current Altitude

The current altitude displays in a digital readout box. The digital readout box points to the value on the altitude tape.

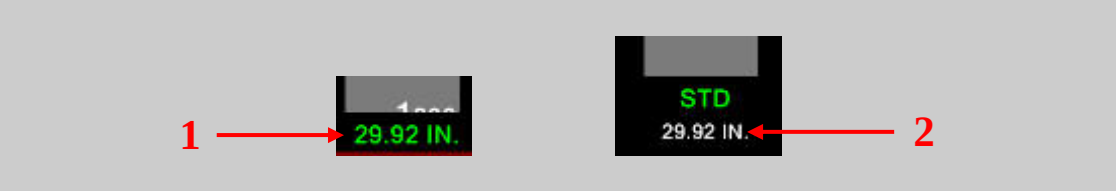
4. Metric Selected Altitude Readout (readout–magenta, metric symbol–cyan)

Displays MCP altitude in meters when MTRS is selected on the EFIS control panel.

5. Selected Altitude (magenta)

Displays the altitude set in the MCP altitude window.

PFD Barometric Indications



1. Barometric Settings (green)

Indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

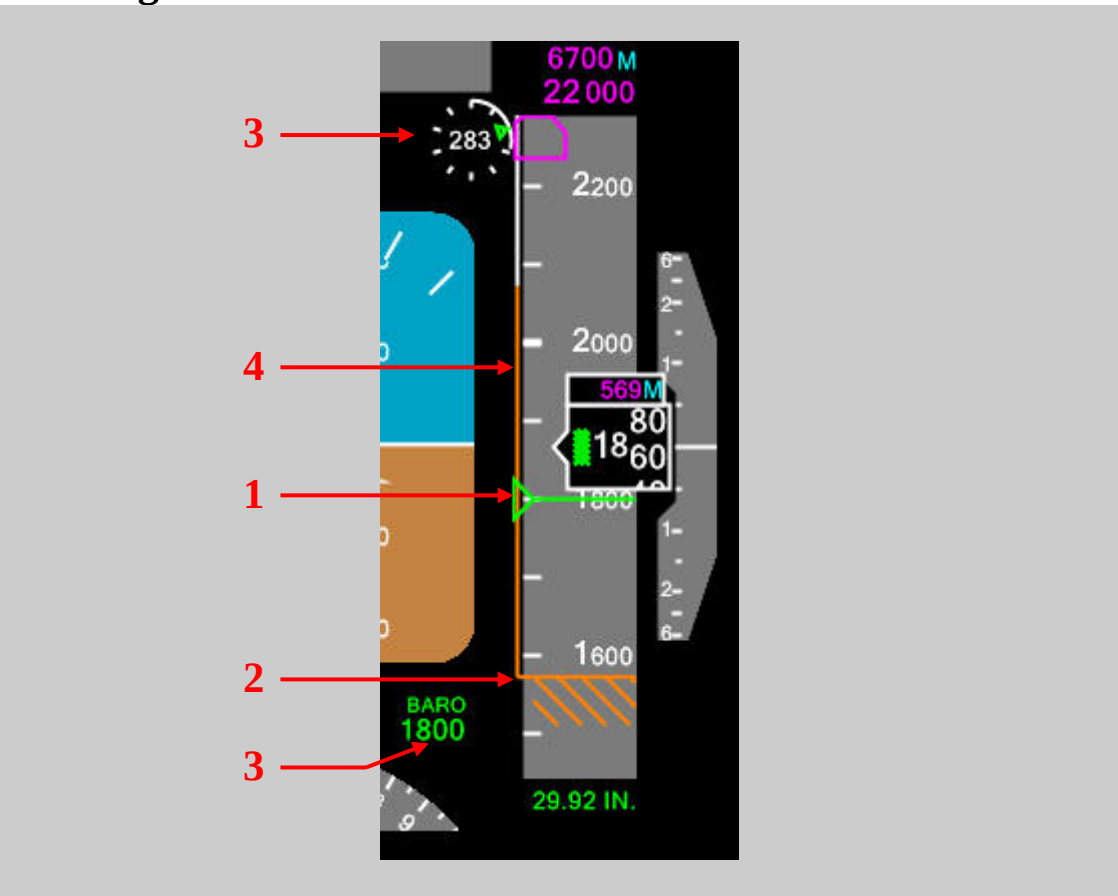
Display is boxed amber if numeric is set and airplane is climbing above transition altitude, or if STD is set and descending below transition flight level.

2. Preselected Barometric Setting (white)

STD is displayed when the Barometric Standard (STD) switch is selected on the EFIS control panel.

When STD is displayed, a barometric setting can be preselected on the EFIS control panel barometric selector and is displayed in small white characters below STD.

Landing Altitude/Minimums Indications



1. BARO Minimums Pointer (green)

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

2. Landing Altitude Indication (amber)

The crosshatched area indicates:

- the FMC landing altitude for the destination runway or airport, or
- the landing altitude for departure runway or airport until 400 NM from departure or one-half the distance to destination.

3. Minimums Reference/Altitude (green)

Displays approach minimum reference and altitude set by the MINS selector on the EFIS control panel:

BARO –

- displayed below ADI when selector is set to BARO, minimums are in feet MSL
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude.
- changes back to green:

- when passing the selected minimum altitude plus 75 feet during go–around
- at touchdown
- after pressing the RST switch on the EFIS control panel.

RADIO –

- displayed above ADI when selector is set to RADIO, minimums are in feet AGL
- blank when an altitude less than 0 feet is selected
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go–around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

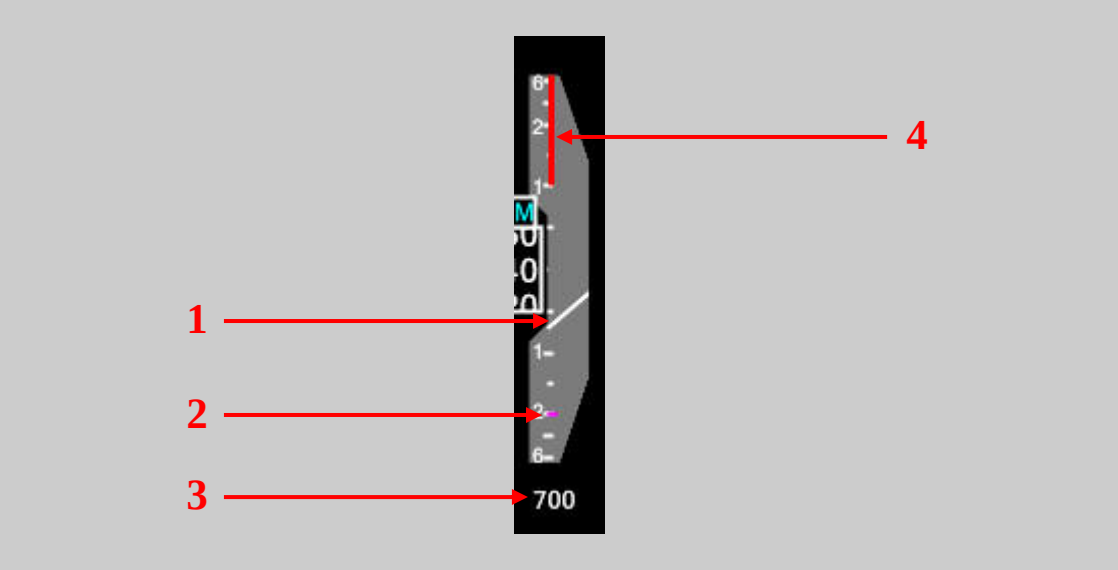
4. Landing Altitude Reference Bar

[Option]
A landing altitude reference bar displays the height above touchdown. From 0 to 500 feet above landing altitude, the bar is amber. From 500 to 1000 feet, the bar is white.

PFD – Vertical Speed Indications

Vertical Speed Indications – General

The vertical speed indication displays ADIRS instantaneous vertical speed.



1. Vertical Speed Pointer (white)

Indicates current vertical speed.

2. Selected Vertical speed Bug (magenta)

Indicates the speed selected in the MCP vertical speed window with V/S pitch mode engaged.

3. Vertical speed (white)

If the vertical speed is more than 400 feet per minute, then vertical speed shows as a digital value. The digital value shows above the vertical speed scale if it is a positive vertical speed. The digital value shows below the vertical speed scale if it is a negative vertical speed.

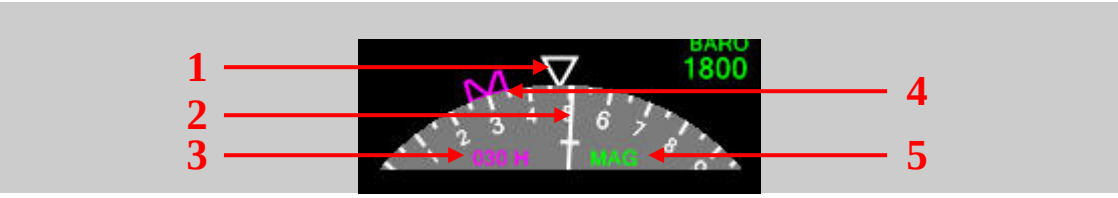
4. TCAS Vertical Speed Tape (red)

Tape turns red to indicate vertical speed values to avoid or exit during a TCAS resolution advisory. Vertical speed pointer is red if it is within the vertical speed tape range.

PFD - Heading and Track Indications

Heading and Track Indications– General

The heading and track indications display current FMC/ADIRS heading, track and other information.



1. Current Heading Pointer (white)

Indicates current heading.

2. Track Pointer (white)

Indicates current track.

3. Selected Heading (magenta)

Digital display of the selected heading bug.

4. Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

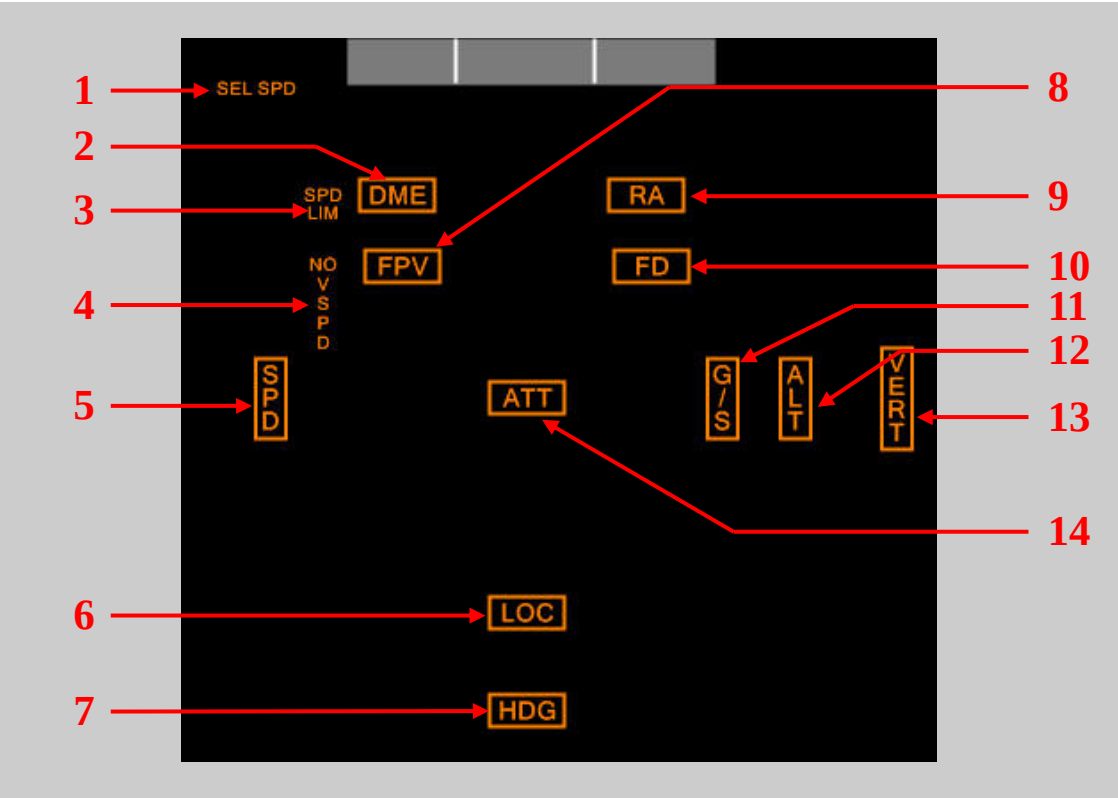
5. Magnetic/True Heading Annunciation (green)

Displays selected heading reference:

- MAG indicates display is oriented relative to magnetic north
- TRU indicates display is oriented relative to true north; a white box is displayed continuously around TRU
- transition from TRU to MAG results in a green box around MAG for 10 seconds

PFD Failure Flags

The flag replaces the appropriate display to indicate source system failure or lack of computed information.



1. Selected Speed (amber)

Invalid data.

2. Distance Measuring Equipment (amber)

The DME system has failed.

3. Speed Limit Flag (amber)

Displays with maximum operating speed has failed.

4. No V Speeds Flag (amber)

V1 (decision speed) or VR (rotation speed) has not been entered or is invalid.

5. Speed Flag (amber)

The speed indication is inoperative. All indication markings are removed.

6. Localizer Flag (amber)

The ILS system has failed.

7. Heading Flag (amber)

Heading information failed.

8. Flight Path Vector Flag (amber)

FPV is selected on the EFIS control panel, but has failed. De–selection of FPV removes the flag.

9. Radio Altitude Flag (amber)

The radio altitude display has failed.

10. Flight Director Flag (amber)

The flight director has failed.

11. Glide Slope Flag (amber)

The ILS system has failed.

12. Altitude Flag (amber)

The attitude display has failed.

13. Vertical Speed Flag (amber)

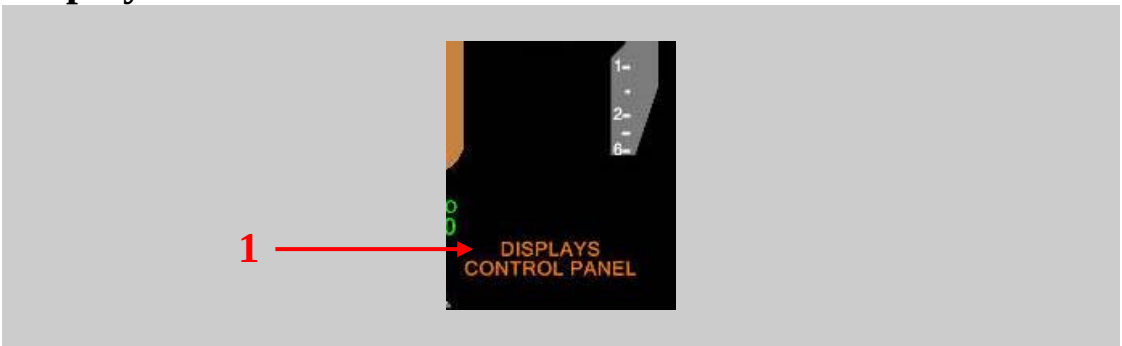
Vertical speed has failed.

14. Attitude Flag (amber)

The attitude display has failed.

Additional Annunciations and Alerts

Displays Control Panel Annunciation

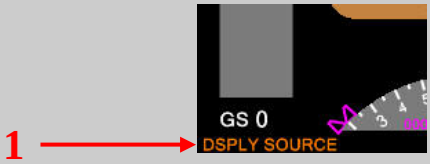


1. Displays Control Panel Annunciation (amber)

With the CONTROL PANEL select switch on the overhead panel in:

- BOTH ON 1 – left (Capt) EFIS control panel has failed
- NORMAL – corresponding EFIS control panel has failed
- BOTH ON 2 – right (F/O) EFIS control panel has failed.

Display System Annunciations



1. INSTR SWITCH Annunciation (amber)

DSPLY SOURCE (amber) – A single DEU has been selected, either manually or automatically, to drive all six display units.

Instrument Switch Annunciation

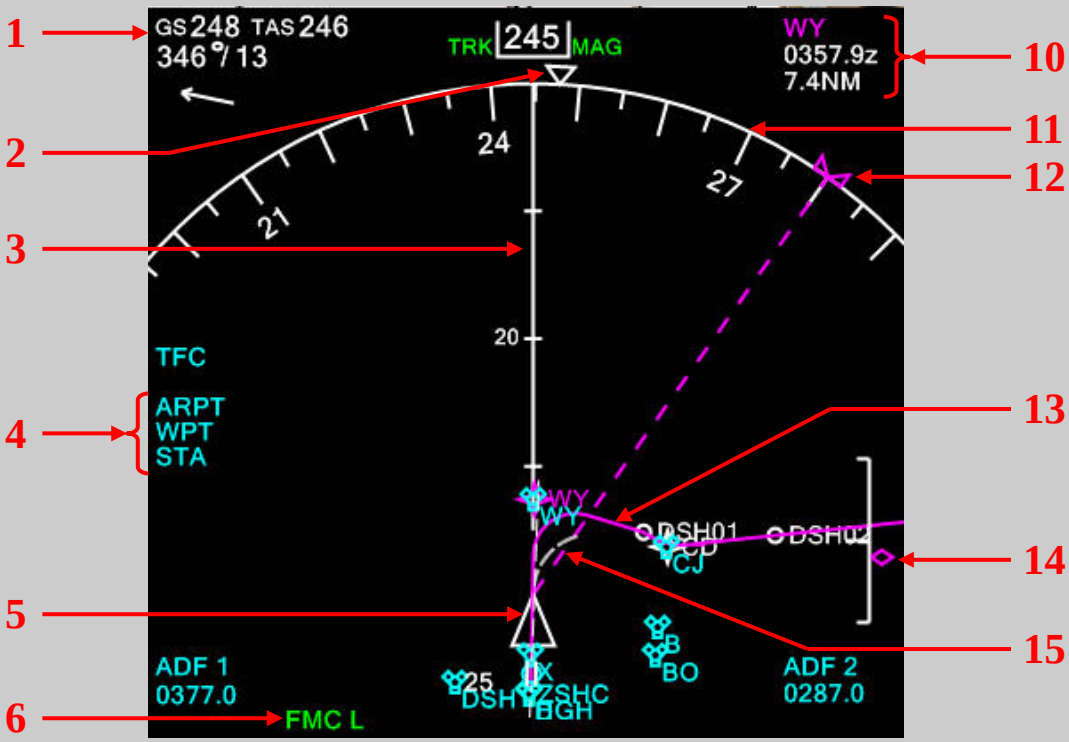
1. INSTR SWITCH Annunciation (amber)

The INSTR SWITCH (instrument switch) annunciation displays below the altitude tape. The annunciation displays when the captain and first officer select the same source of IRU information.

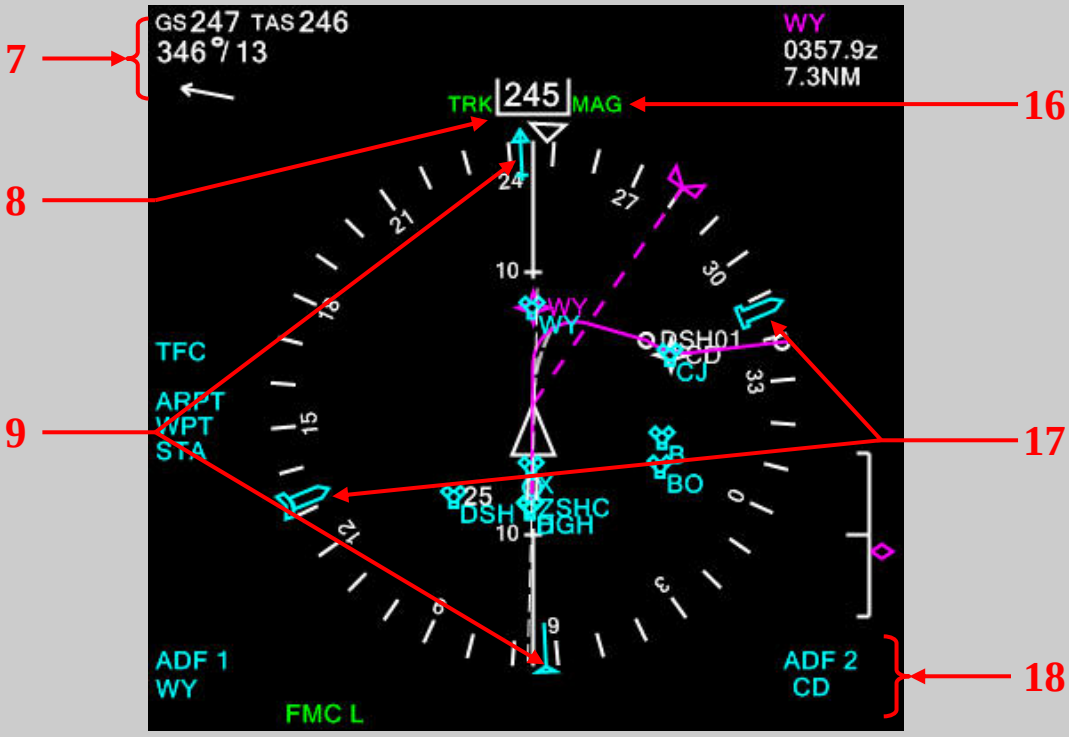
Navigation Displays – MAP Mode

Note: Refer to section 41 of this chapter for a detailed explanation of the navigation symbology shown on the following pages.

Expanded and Center MAP Modes



EXPANDED MAP



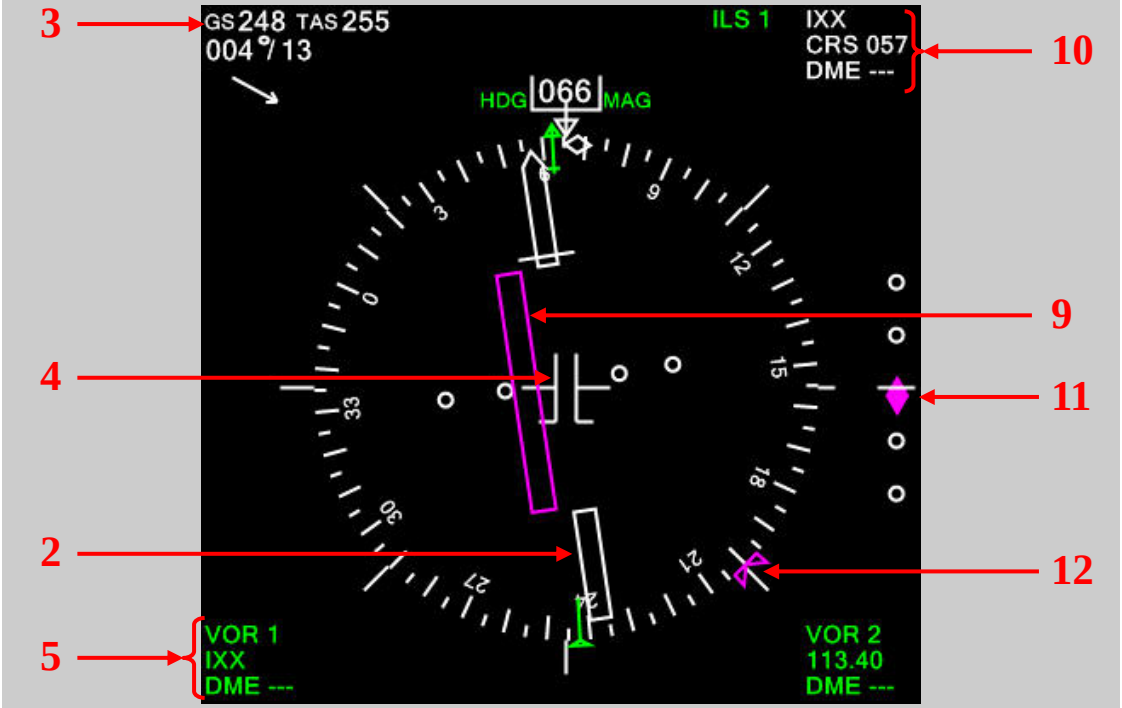
CENTER MAP

1. **Groundspeed/True Airspeed**
2. **Heading Pointer**
3. **Track Line and Range Scale**
4. **Map Options**
5. **Airplane Symbol**
6. **Map Source Annunciation**
7. **Wind Direction/Speed/Arrow**
8. **Current Track**
9. **VOR1/ADF1 Pointer**
10. **Active Waypoint/ETA/Distance–To–Go**
11. **Compass Rose**
12. **Selected Heading Bug**
13. **LNAV Route**
14. **Vertical Deviation Scale and Pointer**
15. **Position Trend Vector**
16. **Magnetic/True Reference**
17. **VOR2/ADF2 Pointer**
18. **VOR/ADF Selection, Ident/Frequency, VOR DME**

Navigation Displays – Approach Mode

Expanded and Center Approach Modes

EXPANDED APPROACH MODE



CENTER APPROACH MODE

1. **Wind Direction/Speed/Arrow**

2. **Selected Course Pointer**

3. **Groundspeed/True Airspeed**

4. **Airplane symbol**

5. **VOR/ADF Selection/Ident or Frequency/VOR DME**

6. **Current Heading**

7. **Magnetic/True Reference**

8. **Track Line**

9. **ILS Localizer Deviation Indication and Scale**

10. **Reference ILS Frequency or Ident/Course/DME**

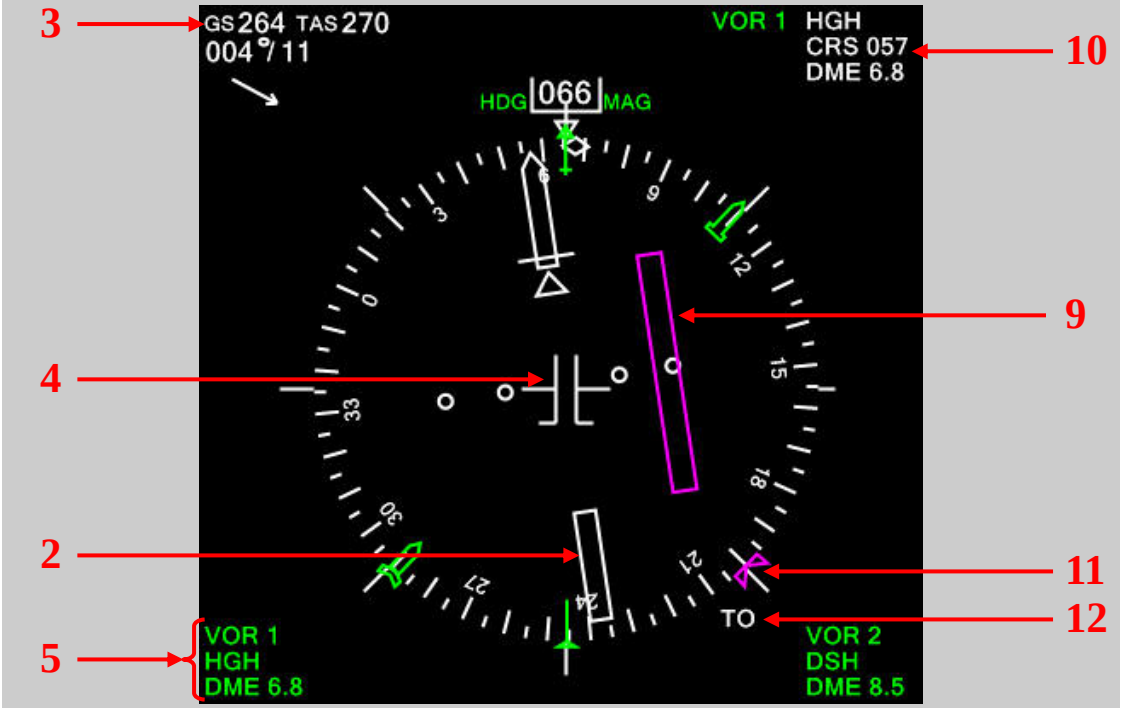
11. **ILS Glideslope Pointer and Scale**

12. **Selected Heading Bug**

Navigation Displays – VOR Mode

Expanded and Center VOR Modes

EXPANDED VOR MODE



CENTER VOR MODE

1. **Wind Direction/Speed/Arrow**

2. **Selected Course Pointer**

3. **Groundspeed/True Airspeed**

4. **Airplane symbol**

5. **VOR/ADF Selection/Ident or Frequency/VOR DME**

6. **Current Heading**

7. **Magnetic/True Reference**

8. **Track Line**

9. **Course Deviation Indication and Scale**

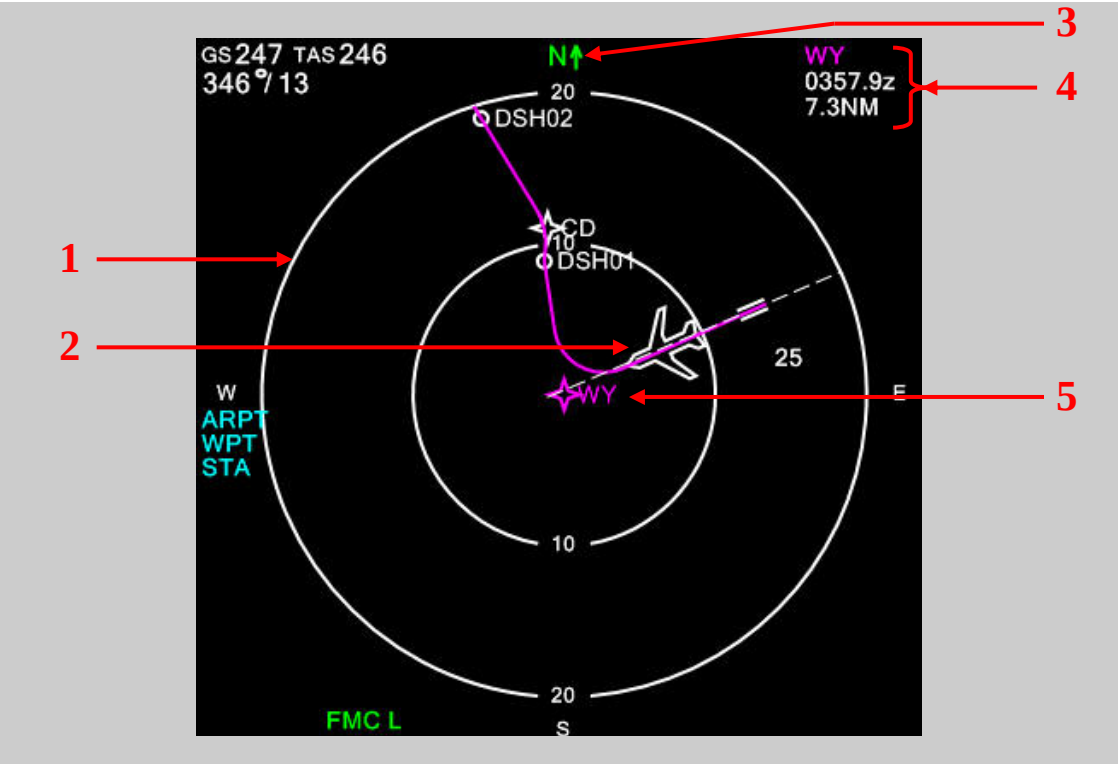
10. **Reference VOR Receiver/Frequency or Ident/Course/DME**

11. **Selected Heading Bug**

12. **TO/FROM Indication and TO pointer**

Navigation Displays – Plan Mode

Plan Mode



1. **Range Circle**

2. **Airplane Symbol**

3. True North Up Arrow

4. Active Waypoint Information

5. Center Waypoint

The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

Navigation Displays – Advisory Messages

TCAS Messages

1. TCAS Traffic Symbols

Indicates position of traffic targets. Refer to section 41 of this chapter for a detailed explanation of the traffic symbology.

2. TCAS Annunciations

TFC (cyan) – Indicates TFC selected on EFIS control panel in expanded MAP, center MAP, expanded APP and expanded VOR.

TCAS TEST (cyan) – TCAS in test mode.

TA ONLY (cyan) – TCAS TA mode only.

TCAS OFF (amber) – TCAS off.

3. Offscale (red or amber)

TA (amber) or RA (red) is beyond the selected display range and TFC is selected on the EFIS control panel.

4. Traffic (red or amber)

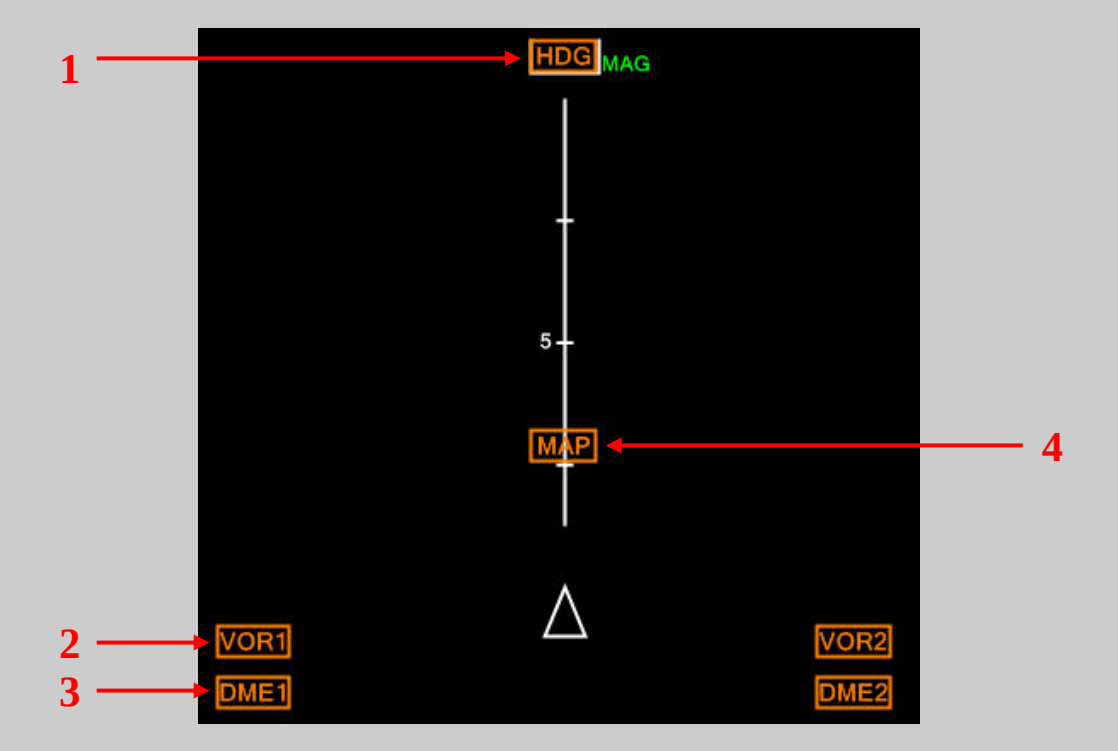
Displayed during a TA (amber) or RA (red) condition whether or not TFC is selected on the EFIS control panel.

5. No–Bearing Messages (red or amber)

Textual description of TA (amber) or RA (red) traffic with no associated bearing. Message provides traffic type, range in NM, altitude and a vertical motion arrow. TFC selected on the EFIS control panel.

Navigation Displays – Failure Indications and Flags

Failure flags replace symbols or failure messages are displayed, as appropriate.



1. Track Failure Flag

2. ADF 1 and ADF 2 or VOR 1 and VOR 2 Failure Flag

ADF or VOR display has failed.

3. DME 1 and DME 2 Failure Flag

Selected VOR DME display has failed.

4. MAP Failure Flag

The related FMC generated map display has failed.

Flight Instruments, Displays Head-Up Display System – Displays

Chapter 10
Section 12

[Option – BBJ/BBJ2/BBJ3]

HUD Display

The HUD displays symbology and fault indications for the HUD system. Display modes of operation include:

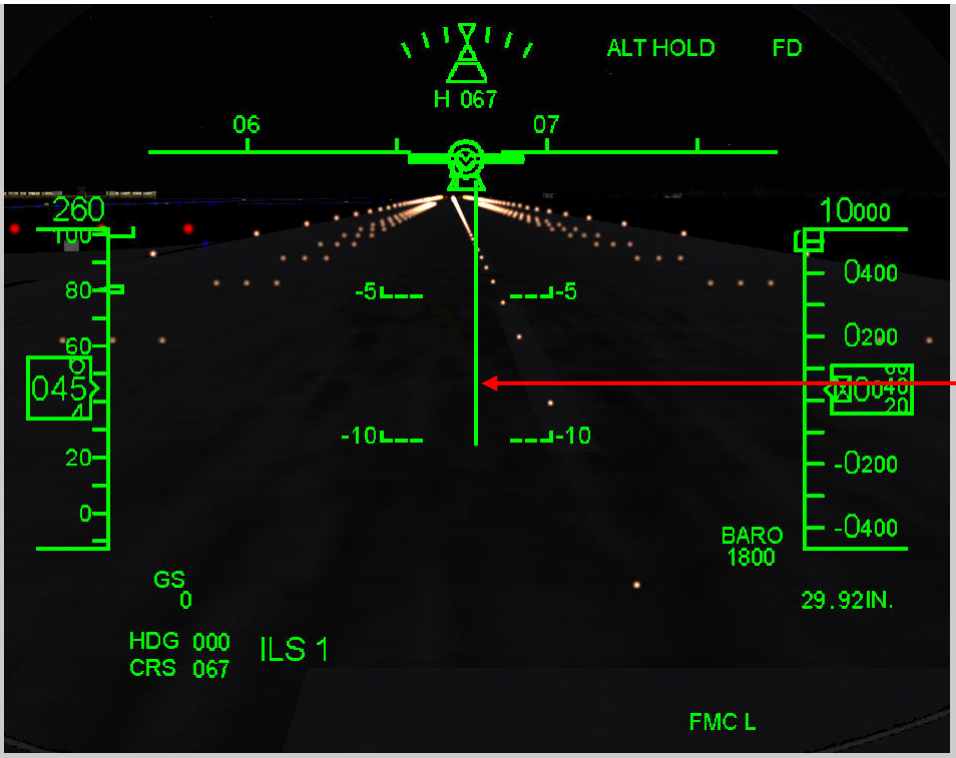
- Primary (PRI)
- AIII approach
- Instrument Meteorological Conditions (IMC) approach
- Visual Meteorological Conditions (VMC) approach

Note: Due to the limitation of FS, some HUD functionalities couldn't be realized completely.

Note: Not all symbols are represented in this section. Refer to Section 10-42, Head-Up Display System, Symbology, for a complete listing of HUD system symbology.

Primary (PRI) Mode Display

PRI (IN FLIGHT) MODE



PRI (TAKEOFF) MODE

1. **Bank Scale and Pointer**

2. **Flight Mode Annunciations (FMAs)**

Refer to Chapter 4, Automatic Flight.

3. **Airspeed Indications**

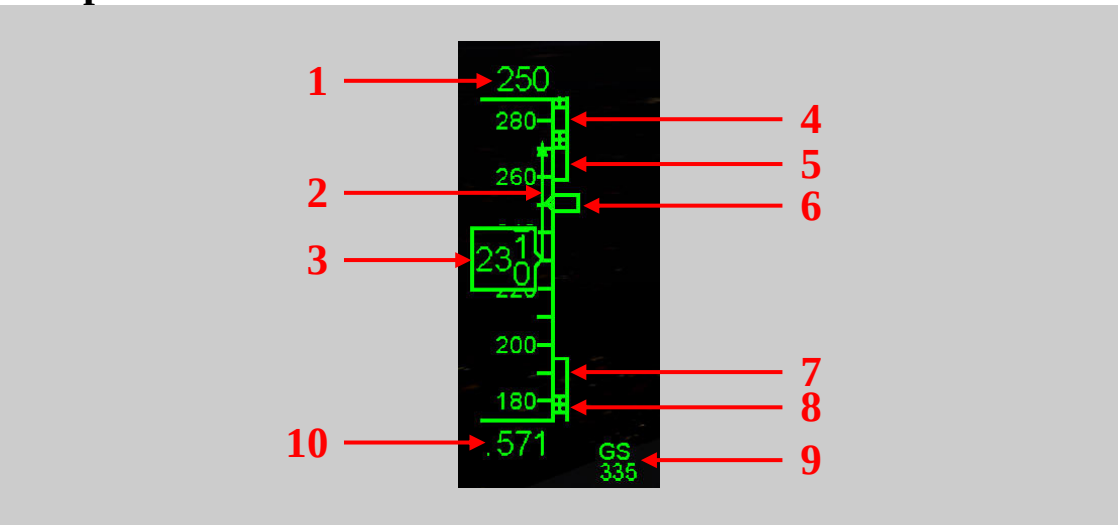
4. **Navigation Indications**

5. **Attitude Indications**

6. **Altitude Indications**

7. **Ground Localizer Line**

Airspeed Indications - General



1. Selected Speed (all modes)

Displays target airspeed:
- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

2. Speed Trend Vector (PRI in flight, PRI ground modes)

Tip of arrow indicates predicted airspeed in the next 10 seconds based on the current airspeed and acceleration.

3. Computed Airspeed (PRI in flight, PRI ground modes)

Indicates current computed airspeed in knots.

4. Maximum Speed (PRI in flight mode)

Bottom of bar indicates the maximum speed as limited by the lowest of the following:
- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

Inhibited on the ground.

5. Maximum Maneuvering Speed (PRI in flight mode)

When displayed, indicates maneuver margin to buffet.

6. Speed Bug (PRI in flight, PRI ground modes)

Points to the airspeed:
- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

7. Minimum Maneuver Speed (PRI in flight, PRI ground modes)

Top of bar indicates minimum maneuver speed.

8. Minimum Speed (PRI in flight mode)

Indicates airspeed where low speed buffet occurs.

Inhibited on the ground.

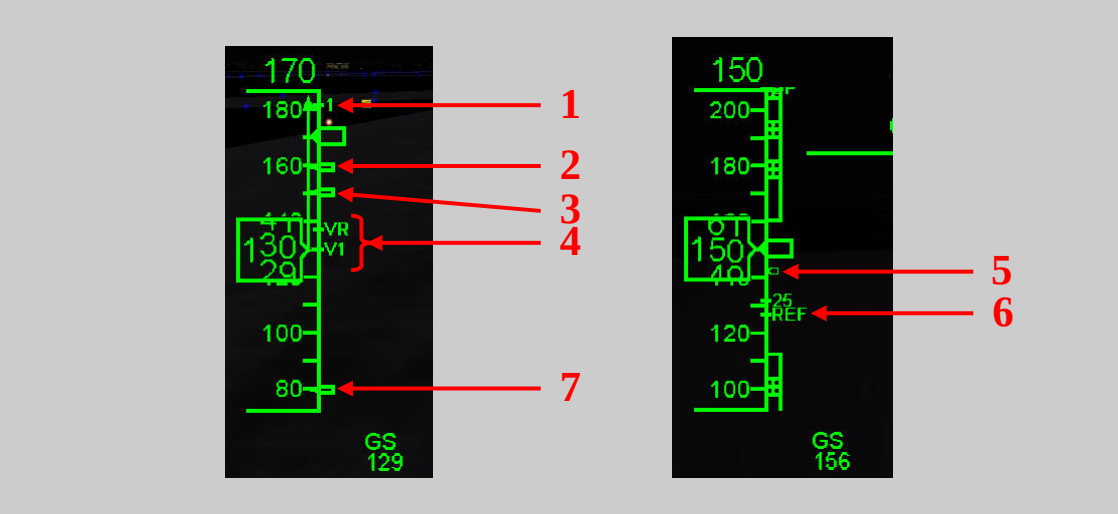
9. Ground Speed (all modes)

Indicates current ground speed in one knot increments.

10. Mach Speed (PRI in flight)

Indicates current mach speed when mach increases above .400 and removed when mach decreases below .380.

Airspeed Indications - Takeoff and Approach



1. Flaps Maneuvering Speeds (PRI in flight mode)

Indicates flap maneuvering speed for the displayed flap position.

2. V2+15 (PRI in flight mode)

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered in the CDU.

3. Bug 5 (PRI in flight, PRI ground modes)

Displayed if speed reference selector on the engine display control panel is in the bug 5 position or SET position and a value greater than 60 knots has been selected. Not available if the speed reference selector is in the AUTO position.

4. Takeoff Reference Speeds (PRI ground mode)

Indicates V1 (decision speed) and VR (rotation speed) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

5. VREF+20 (PRI in flight, PRI ground modes)

[Option – BBJ2]
Displayed after selection of VREF.

5. VREF+15 (PRI in flight, PRI ground modes)

[Option – BBJ]
Displayed after selection of VREF.

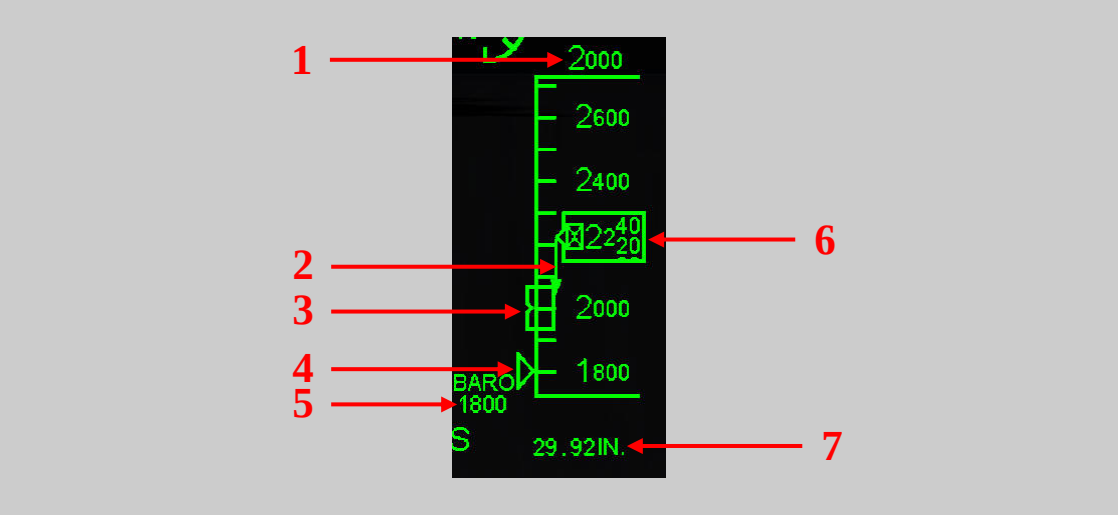
6. Landing Reference Speed (PRI in flight, PRI ground modes)

Indicates REF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation).

7. 80 Knot Airspeed Bug (PRI in flight, PRI ground modes)

Indicates 80 knots:
- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

Altitude Indications



1. Selected Altitude (PRI in flight, PRI ground modes)

Displays the altitude set in the MCP altitude window.

2. Altitude Trend Vector (PRI in flight mode)

Tip of arrow indicates predicted altitude in the next 6 seconds based on the current vertical speed.

3. Selected Altitude Bug (PRI in flight, PRI ground modes)

Points to the altitude set in the MCP altitude window.

4. BARO Minimums Pointer (PRI in flight, PRI ground modes)

Displays the barometric minimums selected on the EFIS control panel.

5. Minimums Reference/Altitude (PRI in flight, PRI ground modes)

Displays approach minimum reference and altitude set by the MINS selector on the EFIS control panel.

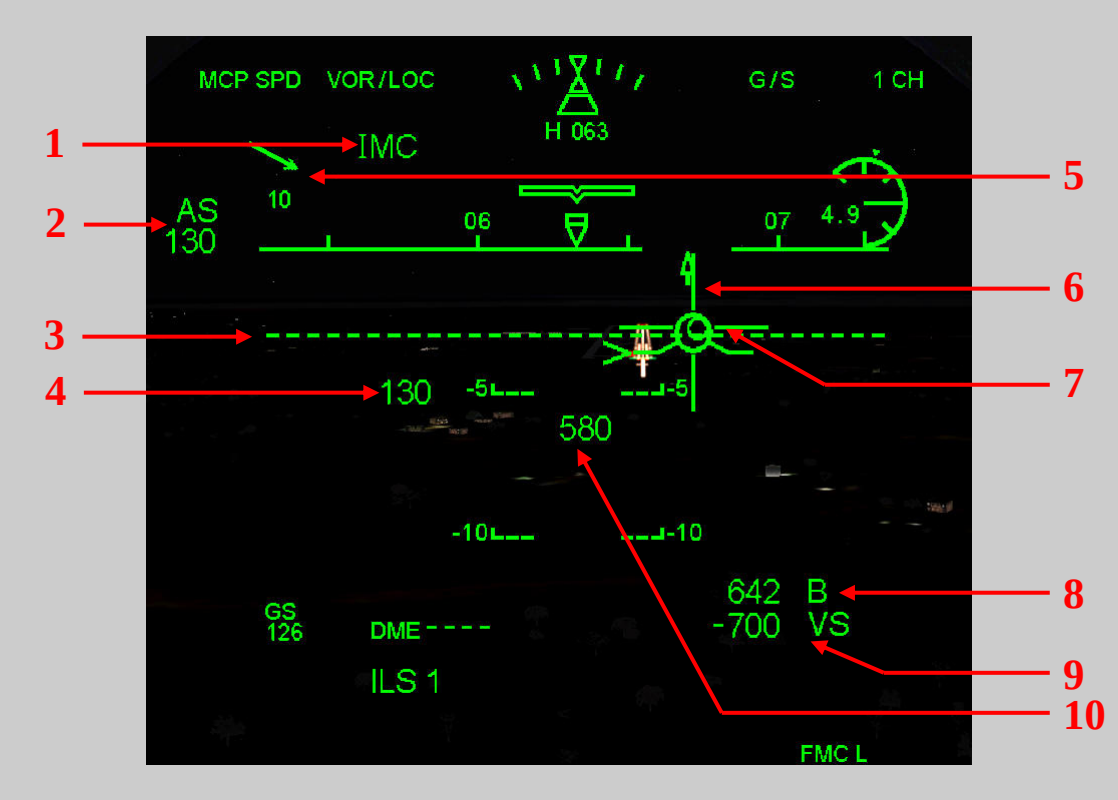
6. Current Altitude (PRI in flight, PRI ground modes)

Displays current altitude in increments of thousands, hundreds and twenty feet.

7. Barometric Setting (PRI in flight, PRI ground modes)

Displays the barometric setting as selected on the EFIS control panel.

Other Mode Display



1. Mode/Status

2. Digital Selected Airspeed

3. Glideslope Reference Line

4. Digital Airspeed

5. Wind Indications

6. Lateral Deviation Line

7. Glideslope Deviation Line

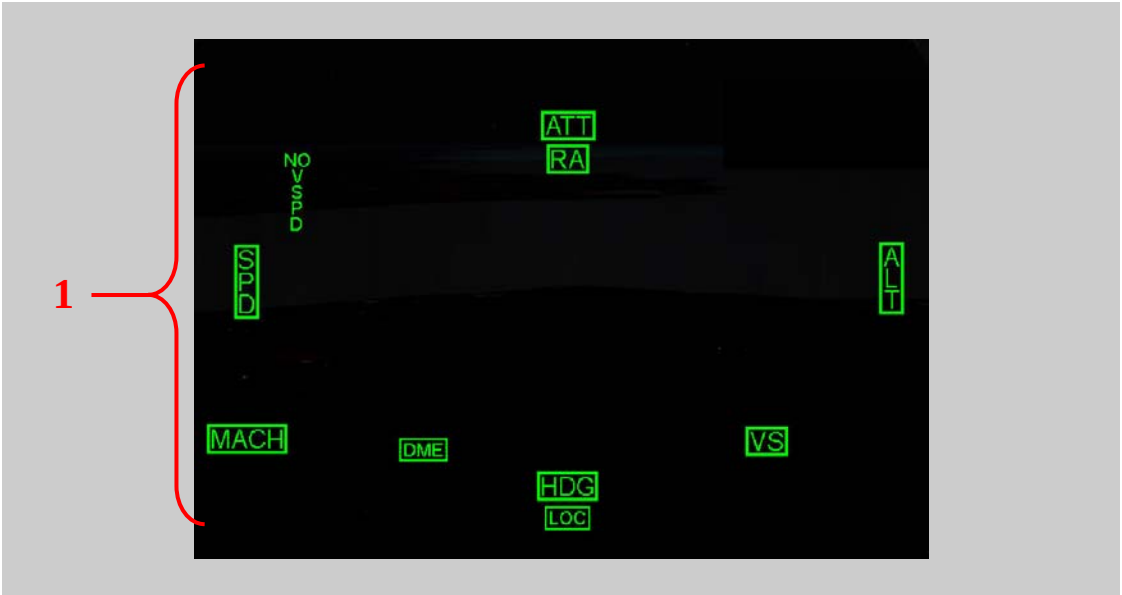
8. Digital Barometric Altitude

9. Digital Vertical Speed

10. Radio Altitude

Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.



1. HUD System Failure Indications and Flags

See section 42 for detailed information on the HUD system failure indications and flags.

Control Panel Display

AFT ELECTRONIC PANEL

1. Control Panel Display Window

Displays selected modes, entered values, system test and system status.

2. Mode Display Line

Displays current mode:
- PRI – primary flight mode
- AIII – Cat III approach mode
- IMC – instrument meteorological conditions approach mode
- VMC – visual meteorological conditions approach mode
- NO AIII – AIII capability lost
- CLR – HUD display cleared.

3. Standby Mode Display Line

Displays standby mode:
- PRI – primary flight mode
- AIII – Cat III approach mode
- IMC – instrument meteorological conditions approach
- VMC – visual meteorological conditions approach.

Automatic AIII arming is indicated by “AIII ARM” displayed as the standby mode. Once all requirements are satisfied for an AIII mode approach, AIII mode is automatically activated.

4. Runway Length Line

Displays runway length. Valid entry is 0 to 99999 feet.

5. Reference Glideslope Line

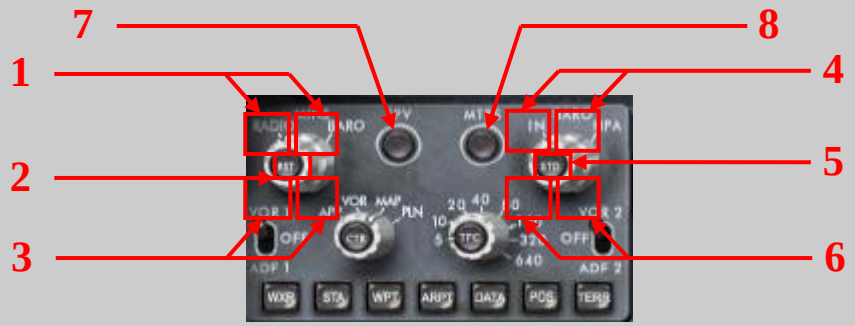
Displays runway glideslope: valid entry is 0.00° to -9.99°.

Flight Instruments, Displays Chapter 10
EFIS Instruments – Controls and Indicators Section 15

EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

EFIS Control Panel Controls – Flight Instrument Displays



GLARESHIELD

1. Minimums (MINS) Reference Selector (outer) (two position)

It selects either radio or barometric as the reference for the minimum altitude.

RADIO – selects radio altitude as the minimums reference.

BARO – selects barometric altitude as the minimums reference.

2. Minimums (MINS) Reset (RST) Switch (inner)

PUSH –
- blanks radio height ALT alert
- resets the radio altitude minimums alert display on the attitude indicator

3. Minimums (MINS) Selector (middle)

ROTATE – adjusts the radio or baro minimums altitude.

4. Barometric (BARO) Reference Selector (outer)

It selects either inches of mercury (IN) or hectopascals (HPA) as the barometric reference.

IN – selects inches of mercury as the barometric altitude reference.

HPA – selects hectopascals as the barometric altitude reference.

5. Barometric (BARO) Standard (STD) Switch (inner)

PUSH – selects the standard barometric setting (29.92 inches Hg or 1013 HPA) for barometric altitude reference.

6. Barometric (BARO) Selector (middle)

ROTATE – adjusts the barometric altitude setting on the altimeter.

7. Flight Path Vector (FPV) Switch

PUSH – displays the flight path vector symbol on the attitude display

8. Meters (MTRS) Switch

PUSH – displays altitude indications in meters.

EFIS Control Panel Controls – Navigation Displays

GLARESHIELD

1. Mode Selector (outer)

The mode control selects the desired mode that shows on the ND. The mode selector is a four position switch.

APP –
- displays localizer and glideslope information in heading–up format
- displays reference ILS receiver, ILS frequency, course and DME
- TCAS is not displayed in center APP mode.

VOR –
- displays VOR navigation information in heading–up format
- displays reference VOR receiver, VOR frequency, course, DME and TO/FROM information
- TCAS is not displayed in center APP mode.

MAP –
- displays FMC generated route and MAP information, airplane position, heading and track
- displays waypoints, including the active waypoint, within the selected range

PLN –
- displays a non–moving, true north up, route depiction
- the airplane symbol represents actual airplane position
- allows route step–through using the CDU LEGS page
- TCAS is not displayed in center APP mode.

2. VOR/ADF Switch (three position)

Displays VOR or ADF information on the respective RDMI.

VOR – displays the selected VOR bearing pointer and VOR bearing pointer source indicator.

OFF – removes the VOR or ADF displays and displays “OFF” in place of the bearing pointer source indicators.

ADF – displays the selected ADF pointer and ADF bearing pointer source indicator.

3. Center (CTR) Switch (inner)

PUSH – displays the full compass rose (center) for APP, VOR and MAP modes

4. Range Selector (outer)

The range selector is an eight position selector. The selector controls the range that shows in the MAP and PLAN modes.

5. MAP Switches

The map switches let ND displays additional map information in the MAP mode. These are the map switches:

WXR (weather radar) – not modeled.

STA (station) –
- displays all FMC data base navigation aids if on map scales 5, 10, 20 or 40 nm.
- displays FMC data base high altitude navigation aids on map scales 80, 160, 320 or 640 nm.

WPT (waypoint) – displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 nm or less.

ARPT (airport) – displays all airports which are stored in the FMC data base and which are within the viewable map area.

DATA – displays altitude constraint, if applicable, and estimated time of arrival for each active route waypoint.

POS (position) – displays VOR and ADF bearing vectors extended from the nose of the airplane symbol to the stations.

TERR (terrain) – not modeled.

6. Traffic (TFC) Switch (inner)

PUSH – displays TCAS information on the display (refer to Chapter 15, Warning Systems).

Displays Source Panel

FORWARD OVERHEAD PANEL

1. DISPLAYS SOURCE Selector

AUTO – DEU 1 controls the Captain outboard, Captain inboard, and the upper display units; DEU 2 controls the First Officer outboard, First Officer inboard, and the lower display units. When a DEU fails, the other DEU controls all display units.

ALL ON 1/ALL ON 2 – provides a means of manually switching to a single DEU as the source of information for all six display units.

2. CONTROL PANEL Select Switch

NORMAL – the left EFIS control panel controls the Captain's displays and the right EFIS control panel controls the First Officer's displays.

BOTH ON 1/BOTH ON 2 – provides a means of manually switching control of the Captain's and First Officer's displays to a single EFIS control panel.

Display Select Panels

[Option – Side by side display]

CAPTAIN'S PANEL

FIRST OFFICER'S PANEL

1. Main Panel Display Units (MAIN PANEL DUs) Selector

Selects what is displayed on the respective outboard and inboard display units:

- Outboard Primary Flight Display (OUTBD PFD) – displays the compact EFIS format on the outboard display unit and blanks the inboard display unit.
- Normal (NORM) – displays normal EFIS and MAP displays on the outboard and inboard display units; provides automatic display switching if a display unit fails.
- Inboard Engine Primary (INBD ENG PRI) – displays the engine display on the inboard display unit and the compact EFIS format on the outboard display unit.
- Inboard Primary Flight Display (INBD PFD) – displays the compact EFIS format on the inboard display unit and blanks the outboard display unit.

2. Lower Display Unit (LOWER DU) Selector

Selects what is displayed on the lower display unit:

- Engine Primary (ENG PRI) – displays the engine display on the lower display unit and blanks the upper display unit.
- Normal (NORM) – displays the engine display on the upper display unit and no display on the lower display unit; provides automatic display switching to the lower display unit if the upper display unit fails.

[Option – Over/Under display]

1. Main Panel Display Units (MAIN PANEL DUs) Selector

Selects what is displayed on the respective outboard and inboard display units:

- Outboard Primary Flight Display (OUTBD PFD) – displays the PFD on the outboard display unit and blanks the inboard display unit
- Normal (NORM) – displays PFD on the outboard display unit and ND on the inboard display unit
- Inboard Engine Primary (INBD ENG PRI) – displays the primary engine instruments on the inboard display unit and the PFD on the outboard display unit
- Inboard Primary Flight Display (INBD PFD) – displays the PFD on the inboard display unit and blanks the outboard display unit
- Inboard Multifunction Display (INBD MFD) – displays PFD on the outboard

display unit and blanks the inboard display unit.

2. Lower Display Unit (LOWER DU) Selector

Selects what is displayed on the lower display unit:

- Engine Primary (ENG PRI) – displays the primary engine instruments on the lower display unit and blanks the upper display unit
- Normal (NORM) – display unit is normally blank or displays MFD format selected on the engine display control panel
- Navigation Display (ND) – displays the navigation display on the lower unit.

Speed Reference Selector

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Speed Reference Selector (outer)

Sets the reference airspeed bugs on the Mach/airspeed indicator:

- AUTO – the FMC supplies the reference airspeeds and gross weight automatically.
- V1 – displays the takeoff decision speed on the ground and displays "INVALID ENTRY" in-flight.
- VR – displays takeoff rotation speed on the ground and displays "INVALID ENTRY" in-flight.
- WT – the crew can set the gross weight manually.
- VREF – displays the landing reference speed (REF) in the air and displays "INVALID ENTRY" on the ground
- Bug 5 – used to manually set the white bug 5 to the desired value
- SET – removes the digital readout above the Mach/airspeed indicator.

2. Speed Reference Selector (inner)

ROTATE –

- manually sets the appropriate reference airspeed or gross weight
- the digital display appears above the Mach/airspeed indicator.

Display Brightness Controls

Captain Brightness Controls

CAPTAIN'S PANEL

1. Outboard Display Unit Brightness (OUTBD DU BRT) Control

ROTATE – adjusts the brightness of the Captain outboard display unit.

2. Inboard Display Unit Brightness (INBD DU BRT) Control

ROTATE – adjusts the brightness of the Captain inboard display unit.

3. Upper Display Unit Brightness (UPPER DU BRT) Control

ROTATE – adjusts the brightness of the upper display unit.

4. Lower Display Unit Brightness (LOWER DU BRT) Control

ROTATE – adjusts the brightness of the lower display unit.

First Officer Brightness Controls

FIRST OFFICER'S PANEL

1. Inboard Display Unit Brightness (INBD DU BRT) Control

ROTATE – adjusts the brightness of the First Officer inboard display unit.

2. Outboard Display Unit Brightness (OUTBD DU BRT) Control

ROTATE – adjusts the brightness of the First Officer outboard display unit.

Standby Flight Instruments

The standby flight instruments include the:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- standby radio magnetic indicator.

Standby Magnetic Compass

CENTER POST ABOVE GLARESHIELD

1. Standby Magnetic Compass

Displays magnetic heading.

Standby Attitude Indicator

[Option – 600/700/700C/700ER/800/900/900ER]

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Bank Indicator and Scale

A bank scale is on the top of the indicator case. The bank indication shows with marks at 0, 10, 20, 30, 45, and 60 degrees.

2. Airplane Symbol

Indicates airplane position.

3. Attitude (GYRO) Flag

Displays when attitude information unreliable.

4. Localizer Indicator

Indicates localizer position relative to the airplane.

5. Glide Slope Indicator

Indicates glide slope position relative to the airplane.

6. Horizon Line and Pitch Scale

Indicates position of horizon relative to the airplane.

7. Caging Control

Pull – levels horizon with airplane symbol.

8. Approach Selector

OFF – no ILS data on indicator.

APP (Approach) – ILS localizer and glideslope data displays.

B/CRS (Back Course) – back course ILS localizer data displays.

[Option – BBJ/BBJ2/BBJ3]

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Bank Pointer

Indicates airplane bank.

2. Airplane Symbol

Indicates airplane position.

3. Bank Scale

Fixed reference for the bank pointer, scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

4. Horizon Line and Pitch Scale

Indicates position of horizon relative to the airplane.

5. Glide Slope Indicator

Indicates glide slope position relative to the airplane.

6. Localizer Indicator

Indicates localizer position relative to the airplane.

Standby Altimeter/Airspeed Indicator

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Standby Altimeter

Receives static pressure from the alternate static ports.

2. Digital Counter

Indicates thousand foot increments of current altitude.

3. Standby Airspeed Indicator

The airspeed indicator displays indicated airspeeds.

4. Barometric Setting Control

ROTATE – adjusts the barometric correction in both barometric windows.

5. Altitude Pointer

Indicates hundred foot increments of current altitude.

6. Barometric Setting Windows

Barometric pressure reference in inches of mercury (in hg) and millibars (mb) displays on the indicator.

Standby Radio Magnetic Indicator

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Heading Warning Flag

Displays when heading signal from the air data inertial reference system is invalid.

2. Bearing Pointers

- narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1
- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

3. Bearing Pointer No. 1 Warning Flag

Displays when ADF 1 or VOR 1 bearing signal unreliable.

4. VOR/ADF Bearing Pointer No. 1 Switch

ROTATE – selects VOR or ADF for the bearing pointer.

5. Bearing Pointer No. 2 Warning Flag

Displays when ADF 2 or VOR 2 bearing signal unreliable.

6. VOR/ADF Bearing Pointer No. 2 Switch

ROTATE – selects VOR or ADF for the bearing pointer.

Clock

[Option – 600/700/700C/700ER/800/900/900ER]

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Chronograph (CHR or CLOCK) Switch

Push – subsequent pushing starts, stops, resets the chronograph.

2. Chronograph Pointer

Indicates chronograph seconds.

3. Elapsed Time (ET) Selector

The elapsed time selector is a three-position rotary switch. Use this selector to control the elapsed time function of the clock. These are the elapsed time selector positions:

RESET – this is a spring-loaded position. Use this position to reset the elapsed time.

HLD – use this position to hold the elapsed time.

RUN – use this position to let the clock start to accumulate elapsed time.

4. DATE Switch

Push –
- displays date (alternates day and month, then year) on GMT display
- subsequent push returns display to time (hours, minutes) on GMT display.

5. GMT Display

Displays time (hours, minutes). Displays date when date switch pushed.

6. Elapsed Time (ET)/Chronograph (CHR) Display

Displays elapsed time (hours, minutes) or chronograph minutes.

7. Clock Set Selector

Sets time and date.

Hours Slew, Day (HS D) –
- advances hours when time selected on time/date selector.
- advances days when date selected on time/date selector Minutes Slew.

Month (MS M) –
- advances minutes when time selected on time/date selector.
- advances months when date selected on time/date selector.

Hold, Year (HLD Y) –
- stops time indicator and sets seconds to zero when time selected on time/date selector.
- advances years when date selected on time/date selector.

RUN – starts time indicator.

[Option – BBJ/BBJ2/BBJ3]

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Chronograph (CHR) Control

The chronograph switch is a pushbutton switch. Use this switch to start, stop, and reset the chronograph function.

2. Chronograph Second Hand

Indicates chronograph seconds

3. Time/Date Indicator

- displays UTC or manual time (hours, minutes) when time is selected with the time/date pushbutton
- alternately displays day–month and year when date is selected with the time/date pushbutton.

4. Elapsed Time (ET) and RESET Pushbutton

The elapsed time pushbutton controls the elapsed time function of the clock. Select the pushbutton once to run the elapsed time. Select the pushbutton again to hold the elapsed time. The word RUN or HLD shows on the lower left part of the LCD display.

5. TIME/DATE Pushbutton

Controls the time/date function:
- select the TIME/DATE pushbutton once to see UTC time
- select the TIME/DATE pushbutton again to see UTC date

6. SET Pushbutton

Controls the setting of time and date:

With time displayed:
- select the SET pushbutton once and the hours flash, use the plus or minus pushbutton to adjust the hours
- select the SET pushbutton again and the minutes flash, use the plus or minus pushbutton to adjust the minutes
- select the SET pushbutton again to run the time.

With date displayed:

- select the SET pushbutton once and the day flashes, use the plus or minus pushbutton to adjust the day
- select the SET pushbutton again and the month flashes, use the plus or minus pushbutton to adjust the month
- select the SET pushbutton again and the year flashes, use the plus or minus pushbutton to adjust the year
- select the SET pushbutton again to run the date.

7. Elapsed Time (ET)/Chronograph Indicator

- displays elapsed time (hours, minutes) or chronograph minutes
- the chronograph display replaces the elapsed time display
- elapsed time continues to run in the background and displays after the chronograph is reset.

8. Plus (+) and Minus (-) Pushbuttons

The plus and minus (+ and -) pushbutton let crew set the manual time and date. Use the time/date pushbutton to select manual time or date. Use the set pushbutton to select what you want to set. Then use the plus or minus pushbutton to increase or decrease the value.

Flight Instruments, Displays Head-Up Display System – Controls

Chapter 10
Section 17

[Option – BBJ/BBJ2/BBJ3]

Head-Up Display Control Panel Controls – Flight Instrument Displays

The HUD control panel controls modes of operation, display values, and system test and status information.

AFT ELECTRONIC PANEL

1. Mode/Function Keys

Push – selects mode or allows data entry:

- MODE – selects desired mode from available modes on the standby display line.
- STBY – selects standby mode.
- RWY – used to enter runway length.
- G/S – used to enter the glideslope angle for the landing runway.

2. Control Panel Display

Displays information entered using the mode/function keys. Refer to Section 12, Head-Up Display System - Displays.

3. FAULT Light

Illuminated (amber) – HUD fault.

4. Clear Key

CLR – used to clear all symbology from the HUD display. Symbology can be re-displayed by selecting CLR again, changing modes, or entering TEST.

5. Numeric Keys

Push –

- 0 through 9 – puts selected number in display
- ENTER – used to enter selected values
- TEST – used for system tests.

HUD Annunciator Panel

FIRST OFFICER'S PANEL

1. HGS Status Annunciations

- AIII (green) – AIII mode is active and all required systems and equipment are valid.
- NO AIII (amber) – loss of AIII capability above 500 feet AGL.
- FLARE (green) – system derived flare guidance is active.
- RO ARM (white) – not used, displayed only during maintenance test.
- RO CTN (amber) – not used, displayed only during maintenance test.
- RO (green) – not used, displayed only during maintenance test.
- TO (green) – not used, displayed only during maintenance test.
- TO CTN (amber) – not used, displayed only during maintenance test.
- TO WARN (red) – not used, displayed only during maintenance test.

2. HGS FAIL Light (red)

Illuminated (red) – indicates HGS failure below 500 ft AGL.

Flight Instruments, Displays EFIS/Map System Description

Chapter 10
Section 20

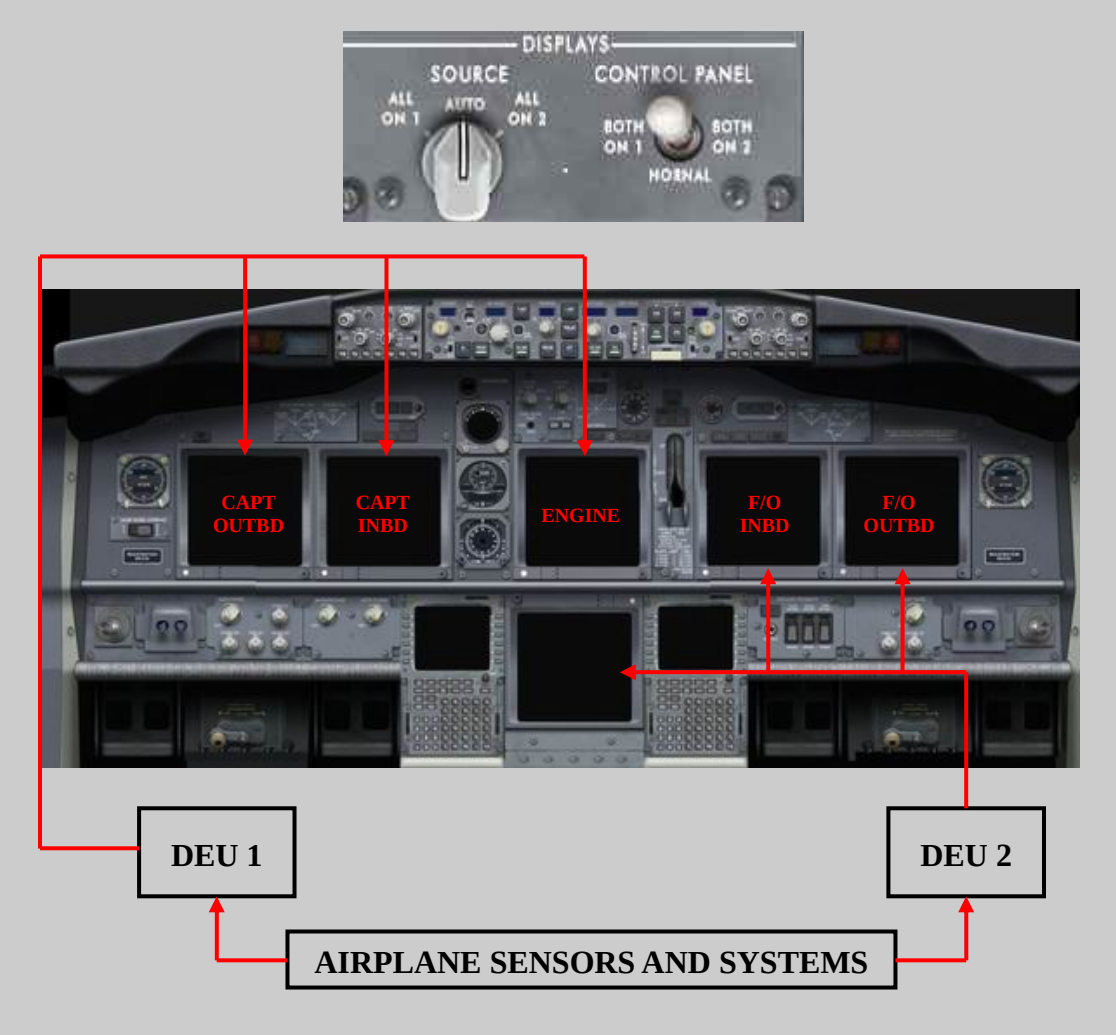
Introduction

The Common Display System (CDS) supplies information to the flight crew on six flat panel liquid crystal display units (DUs). The outboard and inboard display units present all primary flight and navigation information. Engine and system data are normally shown on the upper display unit. The lower display unit serves as a spare.

Detailed information on the following subjects is found in other sections of this chapter:

- Electronic Flight Instrument System (EFIS) – Section 30
- Navigation display – Section 40.

DISPLAYS SOURCE Panel



The DISPLAYS source panel, located on the forward overhead panel, contains source controls for the display electronic units (DEUs) and EFIS control panels.

Two DEUs receive data from sensors and airplane systems and supply data to the DUs. During normal operation, with the display SOURCE selector in the AUTO position, DEU1 supplies data to the Captain outboard, Captain inboard and upper DUs while

DEU2 supplies data to the First Officer outboard, First Officer inboard and lower DUs. If a DEU fails, the remaining DEU automatically supplies data to all six displays. If the displays are automatically or manually switched to a single DEU source, a "DSPLY SOURCE" annunciation illuminates above both pilot's altimeters.

The CONTROL PANEL select switch determines which EFIS control panel controls the pilots' display functions. With the switch positioned to either BOTH ON 1 or BOTH ON 2, the selected EFIS control panel provides inputs for both sets of pilot displays. When in the NORMAL position, a "DISPLAYS CONTROL PANEL" annunciation illuminates on the pilot's altimeters and indicates a failure of the associated EFIS control panel.

EFIS Control Panels

The EFIS control panels, located on the glareshield, control display options, mode, and range for the related pilot's displays. Refer to the EFIS and navigation display sections of this chapter for detailed information.

Display Select Panel

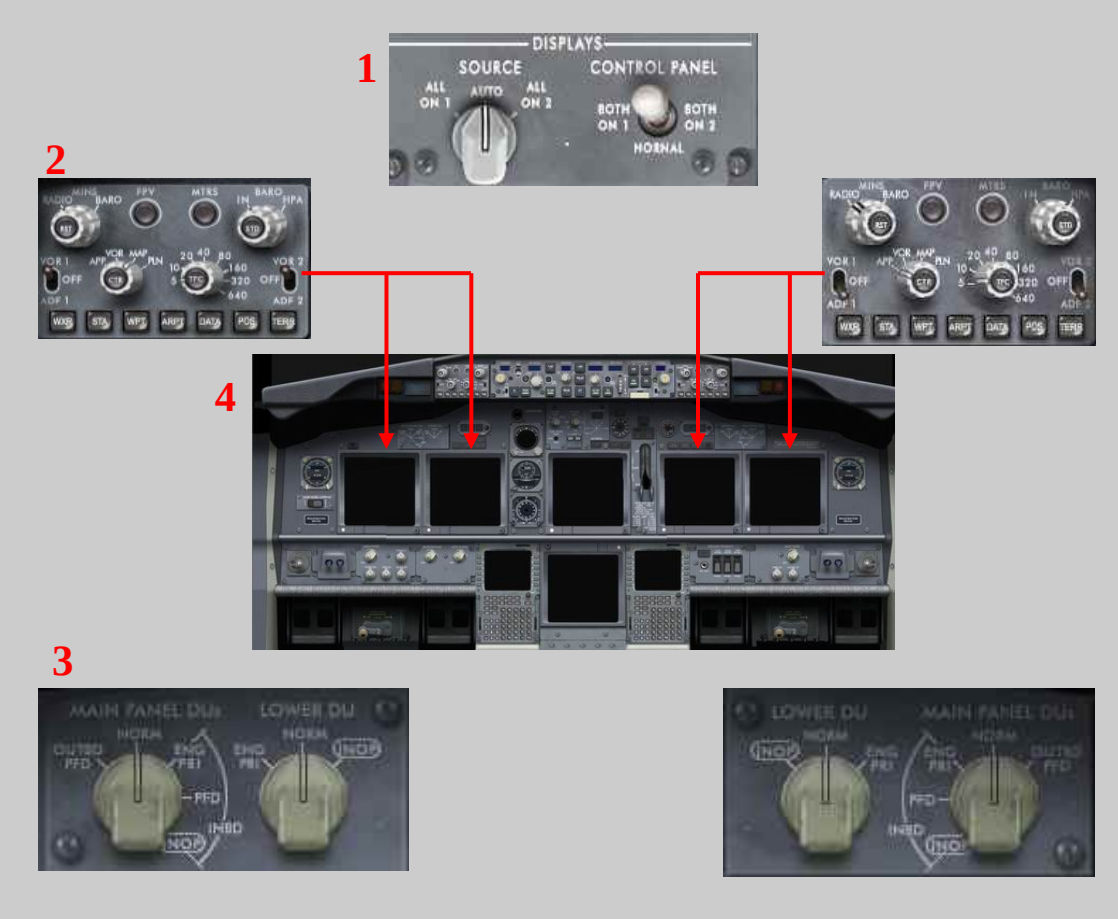
The display select panel, located on the left and right forward panels, controls the displays on the inboard, outboard and lower DUs. Normal operation is all selectors in the NORMAL position. The pilots' outboard and inboard DUs display primary flight and navigation data and the upper DU displays engine data.

If a DU fails, automatic display switching ensures critical information remains available to the pilots at all times. If the system detects an operational failure on an outboard DU, the compact EFIS format automatically moves to the inboard DU and the failed outboard DU blanks. If the system detects a failure on an inboard DU, the compact EFIS format automatically moves to the outboard DU and the failed inboard DU blanks. If the upper DU fails, the engine display automatically moves to the lower DU.

Display Selection and Control Examples

The following examples show display selections.

Normal Display Configuration



1. DISPLAYS Source Panel

The display SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

2. EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

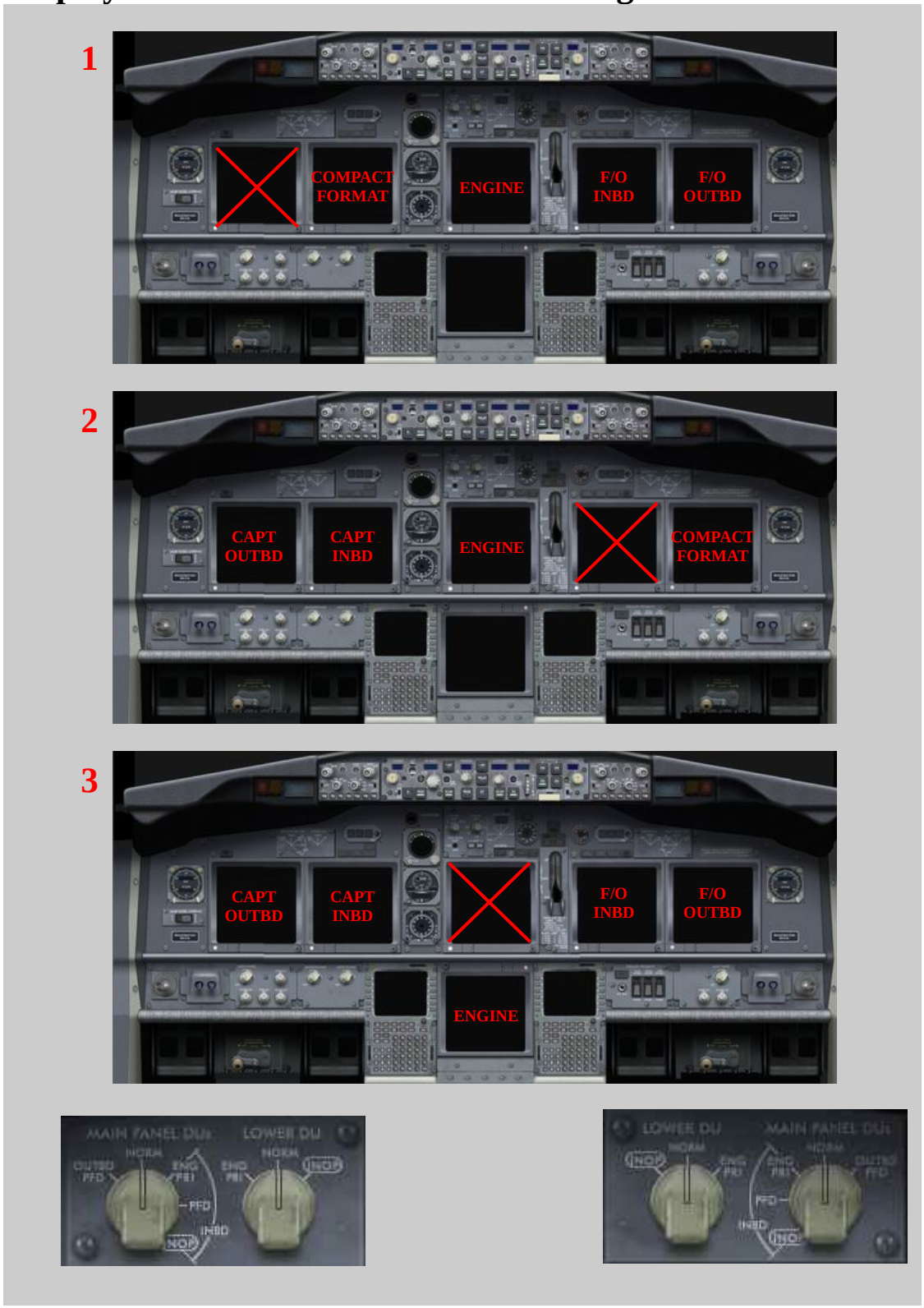
3. Display Select Panel

All selectors are in NORMAL.

4. Display Units

The pilots' outboard and inboard DUs show the normal EFIS/MAP displays.

Display Unit Failure Automatic Switching



1. Outboard Display Unit Fails

If an outboard display unit fails, the compact EFIS format is automatically displayed on the inboard display unit and the outboard display unit blanks.

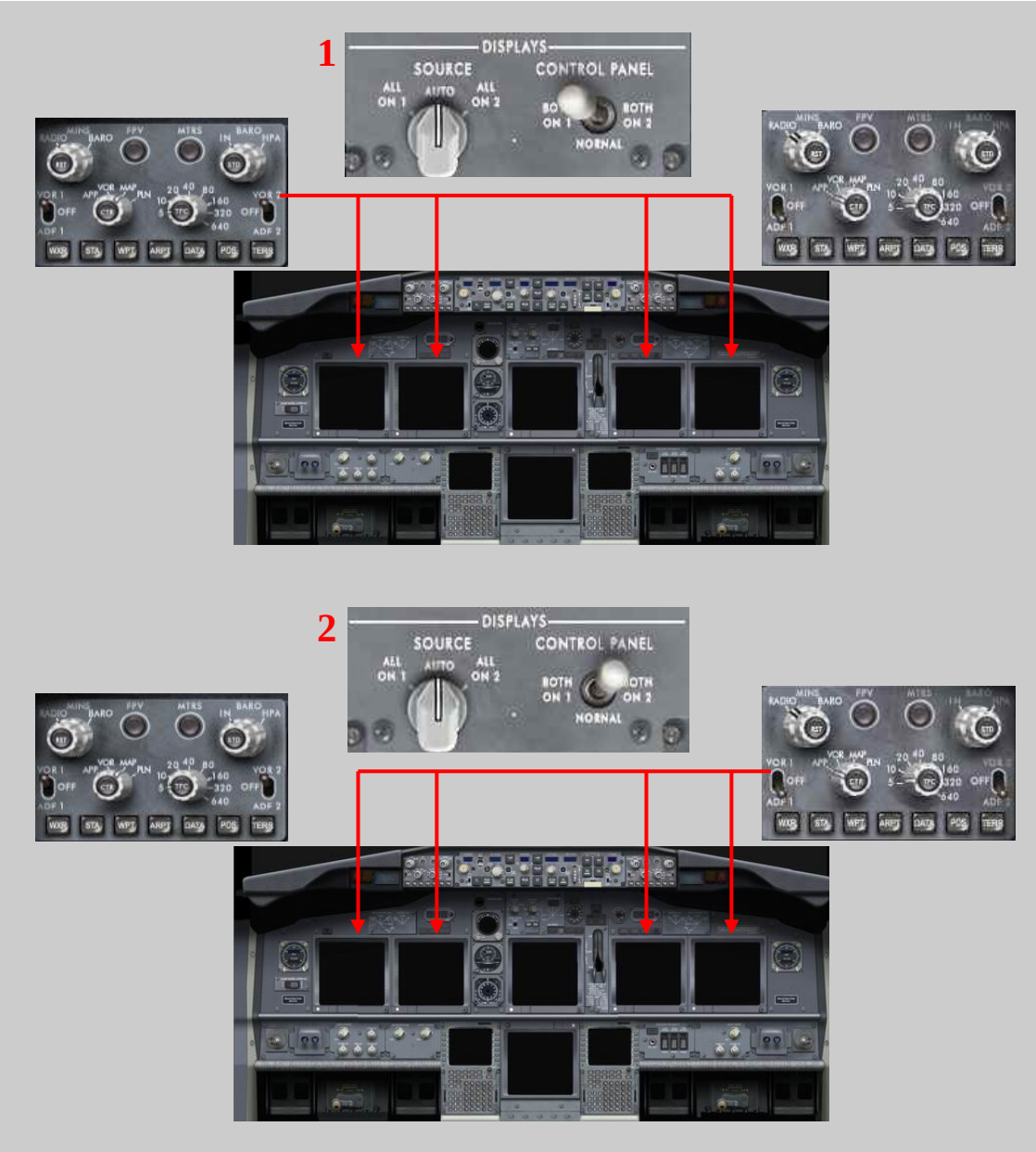
2. Inboard Display Unit Fails

If an inboard display unit fails, the compact EFIS format is automatically displayed on the outboard display unit and the inboard display unit blanks.

3. Upper Display Unit Fails

If the upper display unit fails, the engine display automatically moves to the lower display unit and the upper display unit blanks.

EFIS Control Panel



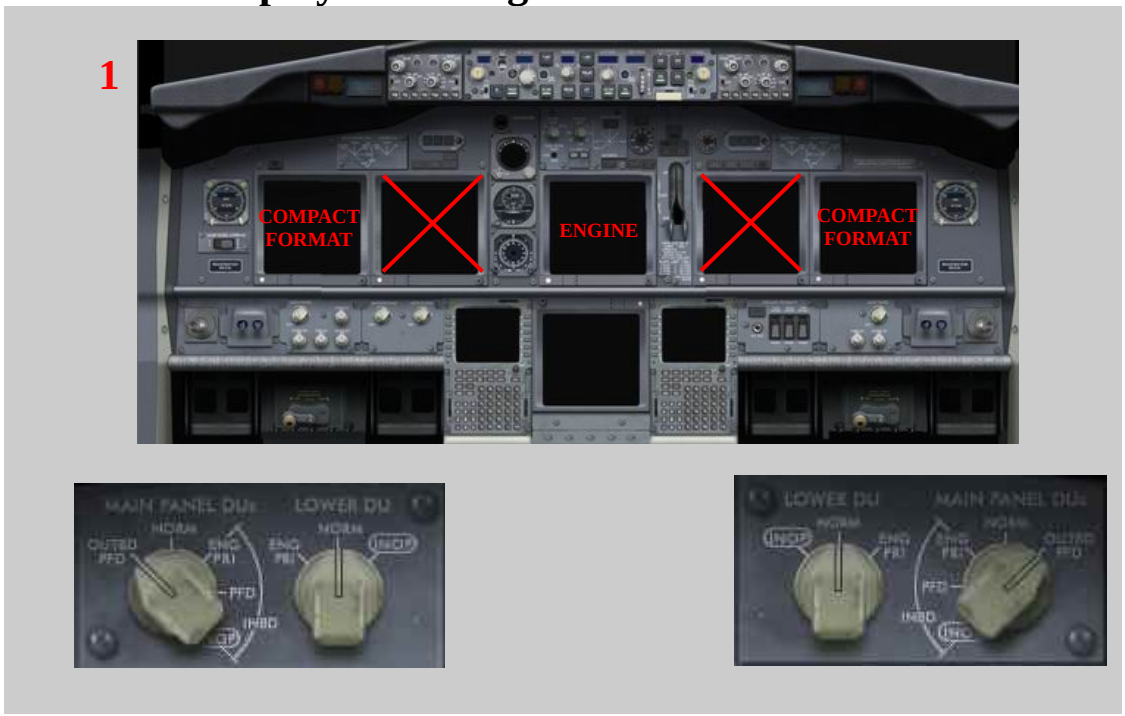
1. CONTROL PANEL Select Switch BOTH ON 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

2. CONTROL PANEL Select Switch BOTH ON 2

The right EFIS control panel controls both pilots' outboard and inboard display units.

Outboard Display Switching

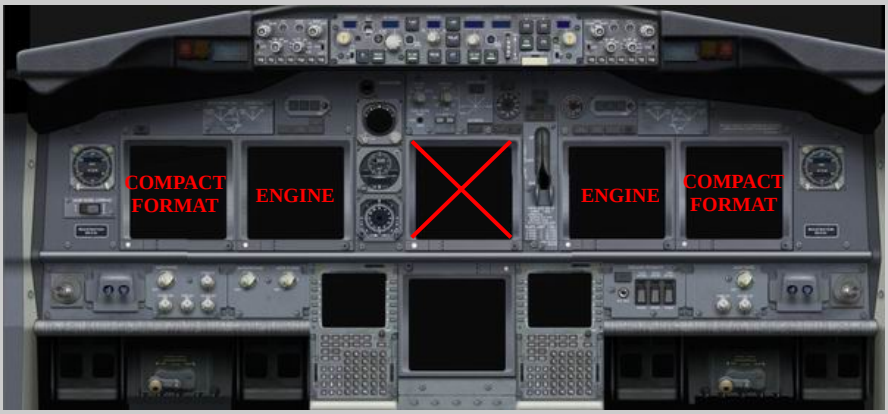


1. MAIN PANEL DUs Switch to OUTBD PFD

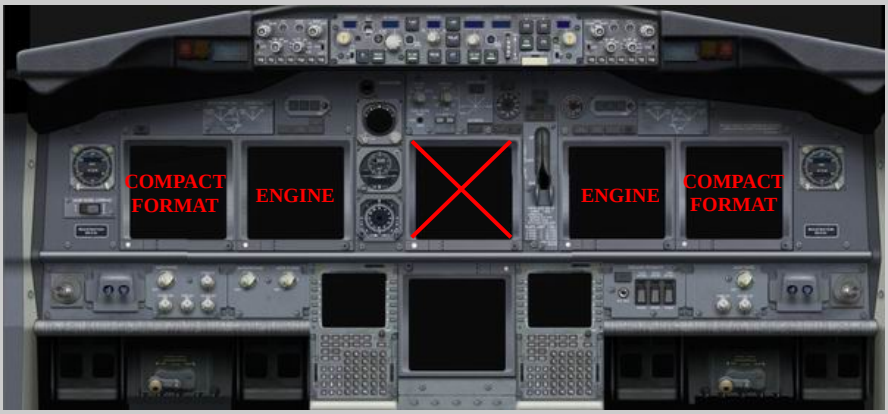
If the MAIN PANEL DUs switch is turned to Outboard Primary Flight Display (OUTBD PFD), the compact EFIS format is displayed on the outboard display unit and the inboard display unit blanks.

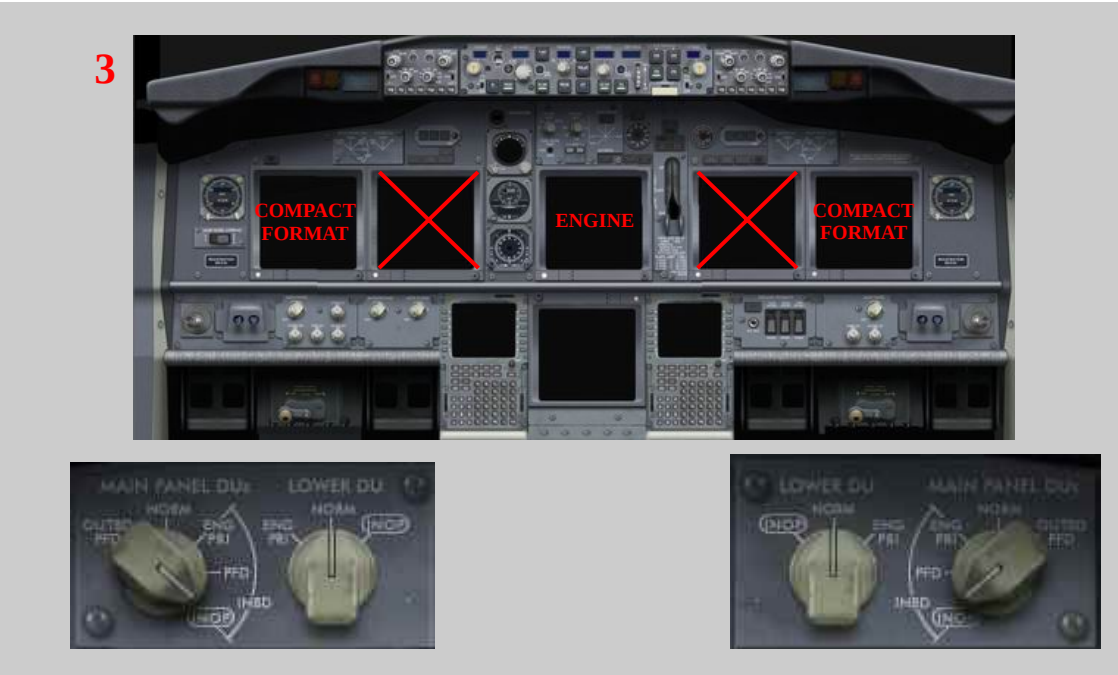
Inboard Display Switching

1



2





1. MAIN PANEL DUs Switch to INBD ENG PRI

If the MAIN PANEL DUs switch is turned to INBD ENG PRI, the engine display moves to the inboard DU, the compact EFIS format is displayed on the outboard DU and the upper DU blanks.

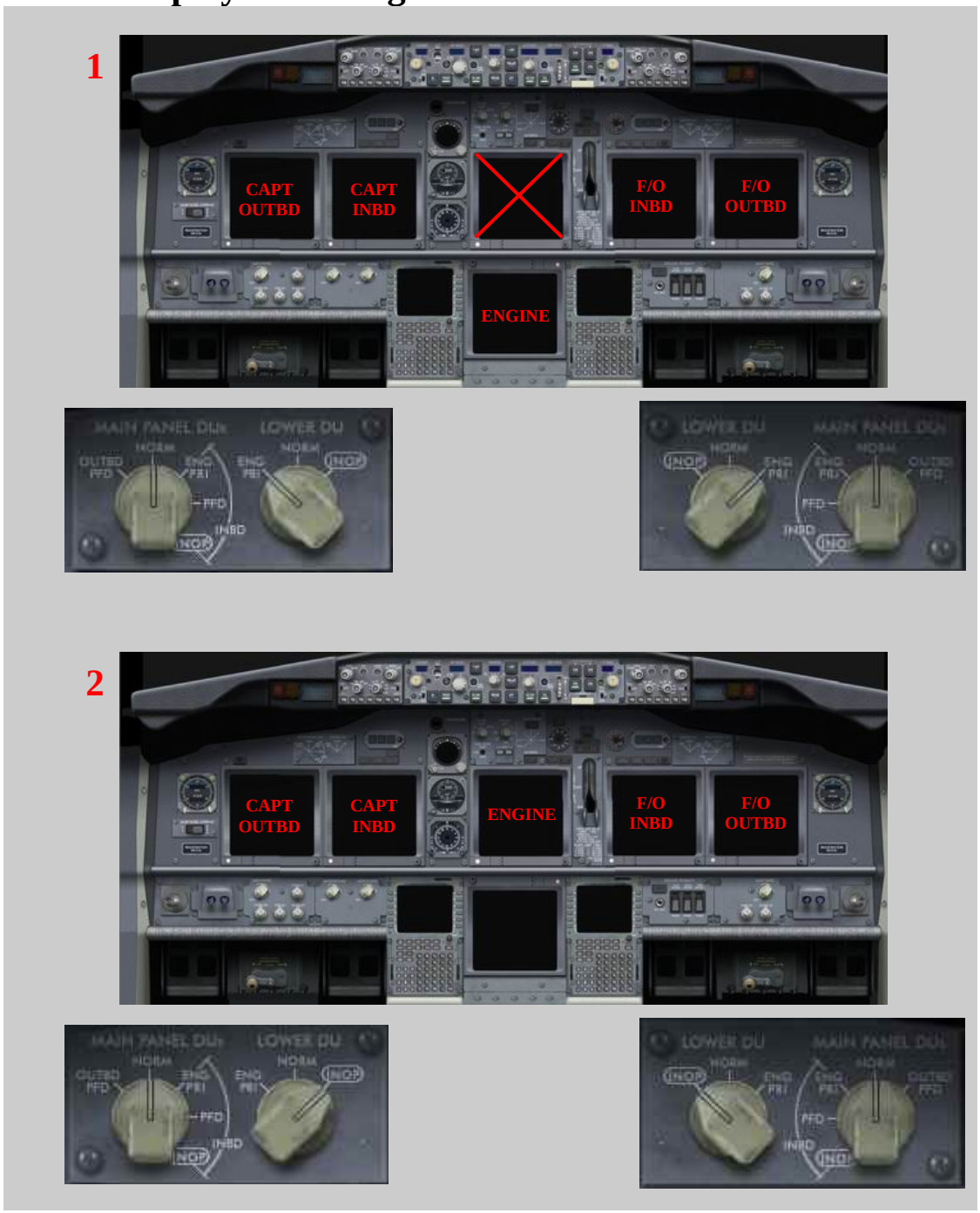
2. MAIN PANEL DUs Switch to INBD PFD

If the MAIN PANEL DUs switch is turned to INBD PFD the compact EFIS format is displayed on the inboard DU and the outboard DU blanks.

3. MAIN PANEL DUs Switch to INOP

If the MAIN PANEL DUs switch is turned to INBD INOP the compact EFIS format is displayed on the outboard DU and the inboard DU blanks.

Lower Display Switching



1. LOWER DU Switch to ENG PRI

If the LOWER DU switch is turned to ENG PRI, the engine display moves to the lower DU and the upper DU blanks.

2. LOWER DU Switch to INOP

If the LOWER DU switch is turned to INOP the engine display is shown on the upper DU and the lower DU blanks.

Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- standby radio magnetic indicator.

Standby Magnetic Compass

A standard magnetic standby compass is provided.

Standby Attitude Indicator

The standby attitude indicator provides attitude information that is independent of the primary attitude displays.

Standby Altimeter/Airspeed Indicator

Standby altitude and airspeed are displayed on a single indicator. The standby airspeed indicator provides current airspeed in knots.

Standby Radio Magnetic Indicator

The standby radio magnetic indicator (RMI) displays magnetic heading and VOR/ADF bearing to the station.

Clocks

Two electronic clocks are installed, with two digital displays on each clock. Either Greenwich Mean Time (GMT) or local time may be set on the upper time display. The lower ET/CHR display is used for either elapsed time or the chronograph. Separate controls are provided for each display.

Flight Instruments, Displays PFD/ND System Description

Chapter 10 Section 21

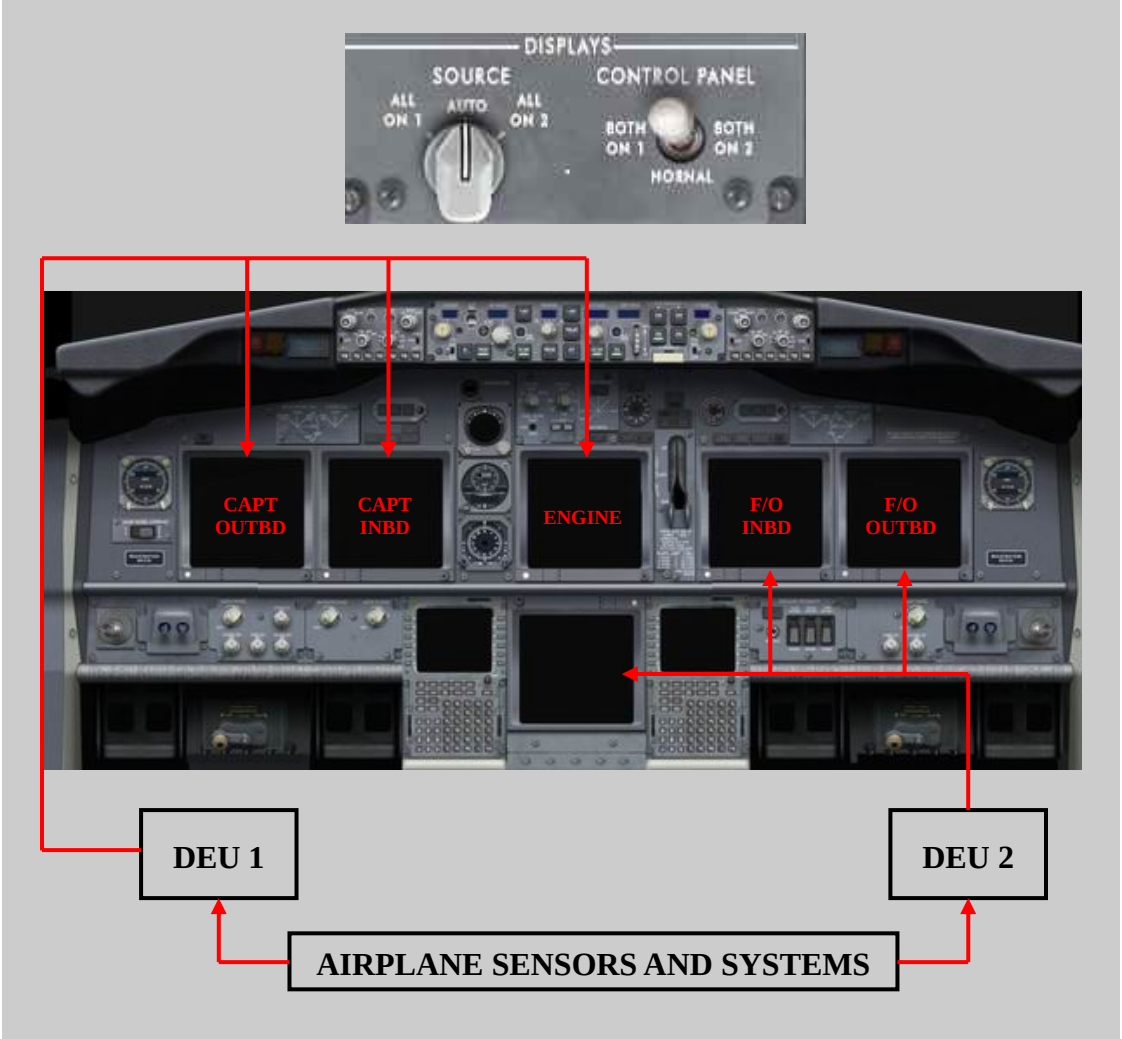
Introduction

The Common Display System (CDS) supplies information to the flight crew on six flat panel liquid crystal display units (DUs). The outboard and inboard display units present all primary flight and navigation information. Primary engine indications are normally displayed on the upper DU. Secondary engine indications or system data are normally displayed on the lower DU.

Detailed information on the following subjects is found in other sections of this chapter:

- Primary Flight Display (PFD)– Section 31
- Navigation display (ND)– Section 41.

DISPLAYS SOURCE Panel



The DISPLAYS source panel, located on the forward overhead panel, contains source controls for the display electronic units (DEUs) and EFIS control panels.

Two DEUs receive data from sensors and airplane systems and supply data to the DUs. During normal operation, with the display SOURCE selector switch in the AUTO

position, DEU1 supplies data to the Captain outboard, Captain inboard and upper DUs while DEU2 supplies data to the First Officer outboard, First Officer inboard and lower DUs. If a DEU fails, the remaining DEU automatically supplies data to all six displays.

The display SOURCE selector allows manual selection of either DEU1 or DEU2 for all six display units. If the displays are automatically or manually switched to a single DEU source, a "DSPLY SOURCE" annunciation illuminates on both pilot's primary flight display.

The CONTROL PANEL select switch determines which EFIS control panel controls the pilots' display functions. With the switch positioned to either BOTH ON 1 or BOTH ON 2, the selected EFIS control panel provides inputs for both sets of pilot displays. When in the NORMAL position, a "DISPLAYS CONTROL PANEL" annunciation illuminates below the altitude indication showing a failure of the associated EFIS control panel.

EFIS Control Panels

The EFIS control panels, located on the glareshield, controls display options, mode, and range for the related pilot's displays. Refer to the PFD and ND sections of this chapter for detailed information.

Display Select Panel

The display select panel, located on the left and right forward panels, controls the displays on the inboard, outboard and lower DUs. Normal operation is all selectors in the NORMAL position. The pilots' outboard and inboard DUs display primary flight and navigation data and the upper DU displays primary engine data and fuel quantity.

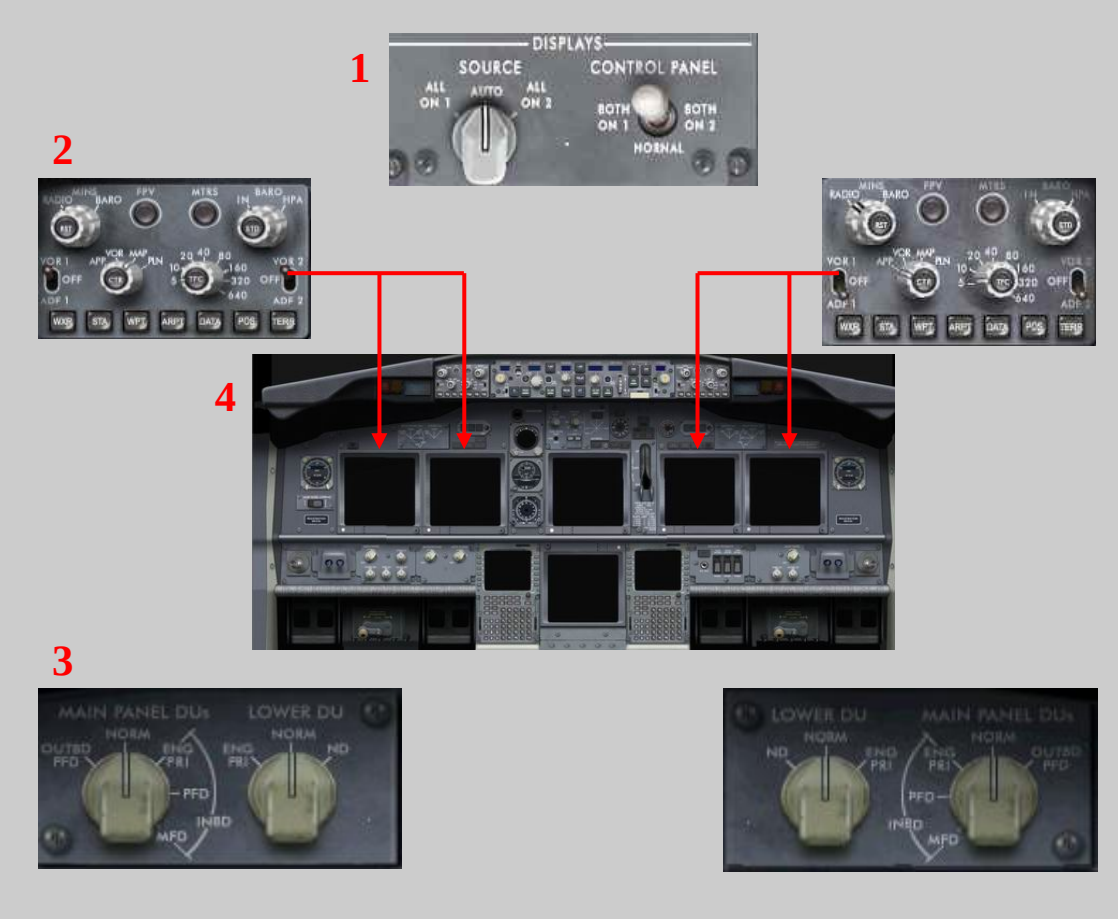
If a DU fails, automatic display switching ensures critical information remains available to the pilots at all times. If the system detects an operational failure on an outboard DU, the primary flight display automatically moves to the inboard DU and the failed outboard DU blanks. If the upper DU fails, the engine display automatically moves to the lower DU.

Manual control of display formats is provided for undetected failures. The outboard rotary switch on the display select panel controls the formats displayed on either the outboard or inboard DUs. The inboard rotary switch controls the display format shown on the lower DU.

Display Selection and Control Examples

The following examples show display selections.

Normal Display Configuration



1. DISPLAYS Source Panel

The display SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

2. EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

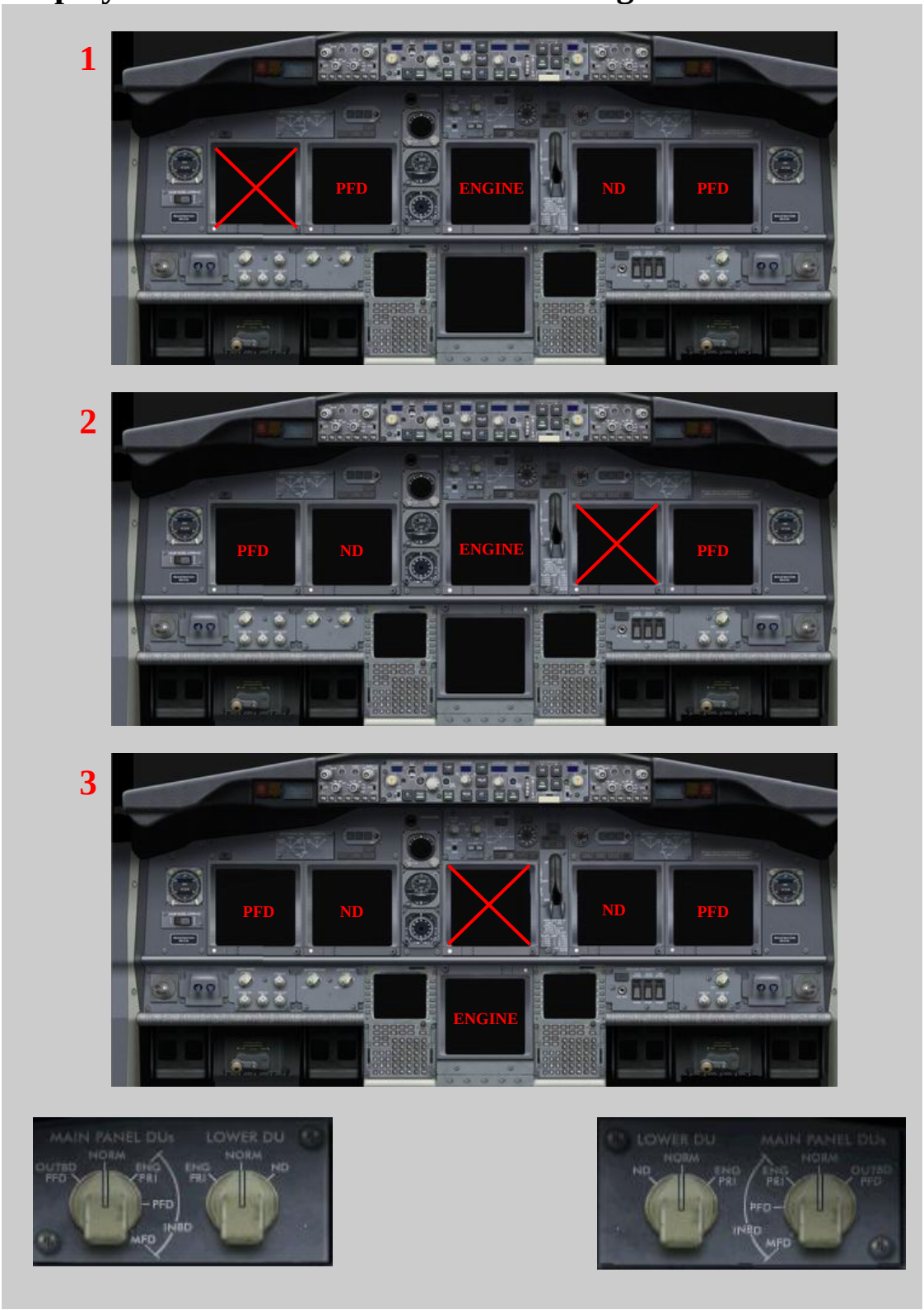
3. Display Select Panel

All selectors are in NORMAL.

4. Display Units

The pilots' outboard and inboard DUs show the normal PFD/ND displays.

Display Unit Failure Automatic Switching



1. Outboard Display Unit Fails

If an outboard display unit fails, the PFD is automatically displayed on the inboard display unit and the outboard display unit blanks.

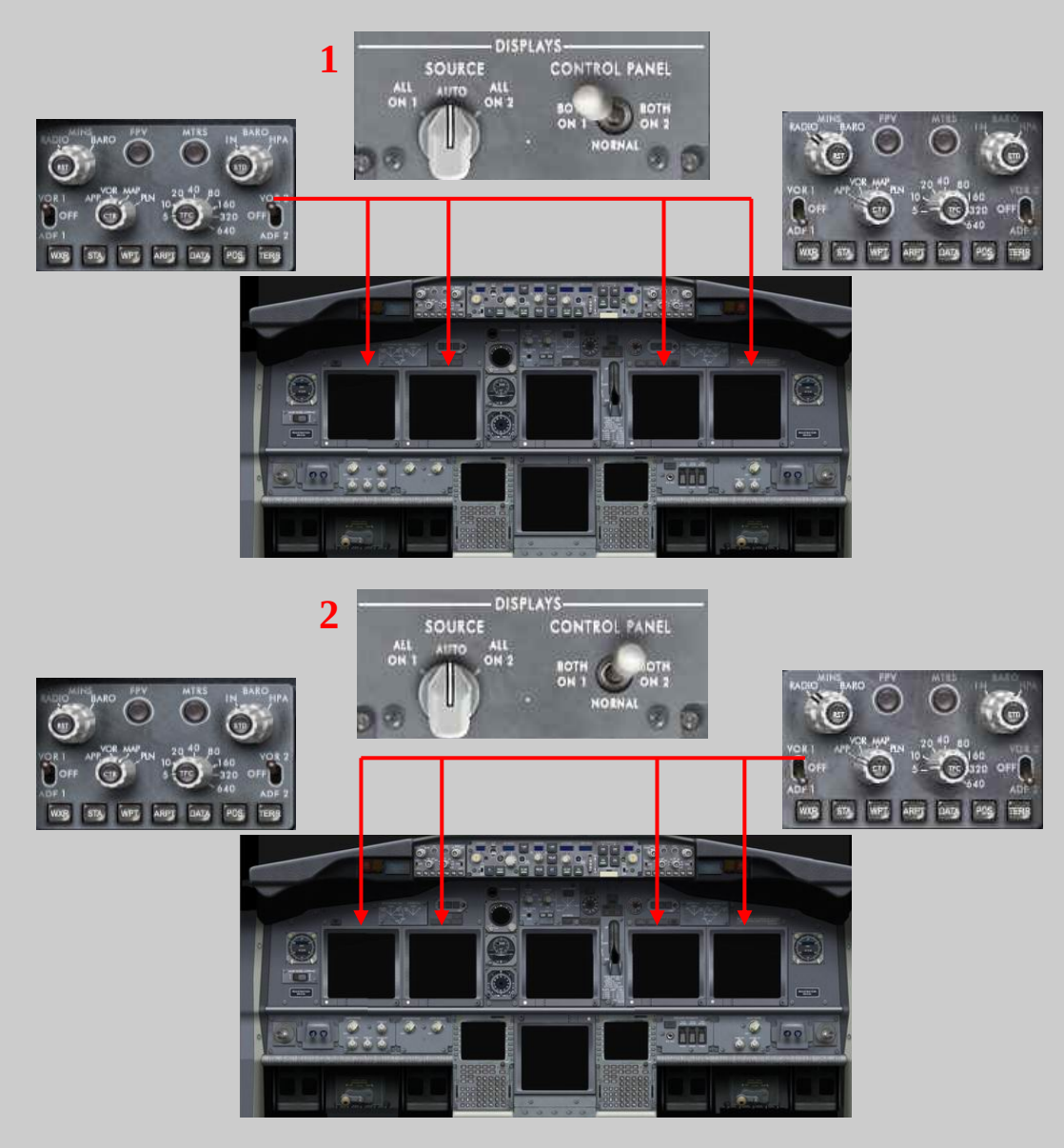
2. Inboard Display Unit Fails

If an inboard display unit fails, the PFD format remains displayed on the outboard display unit and the inboard display unit blanks.

3. Upper Display Unit Fails

If the upper display unit fails, the primary engine display automatically moves to the lower display unit and the upper display unit blanks. If the secondary engine display is already on the lower display unit, a compact engine display is then displayed.

EFIS Control Panel



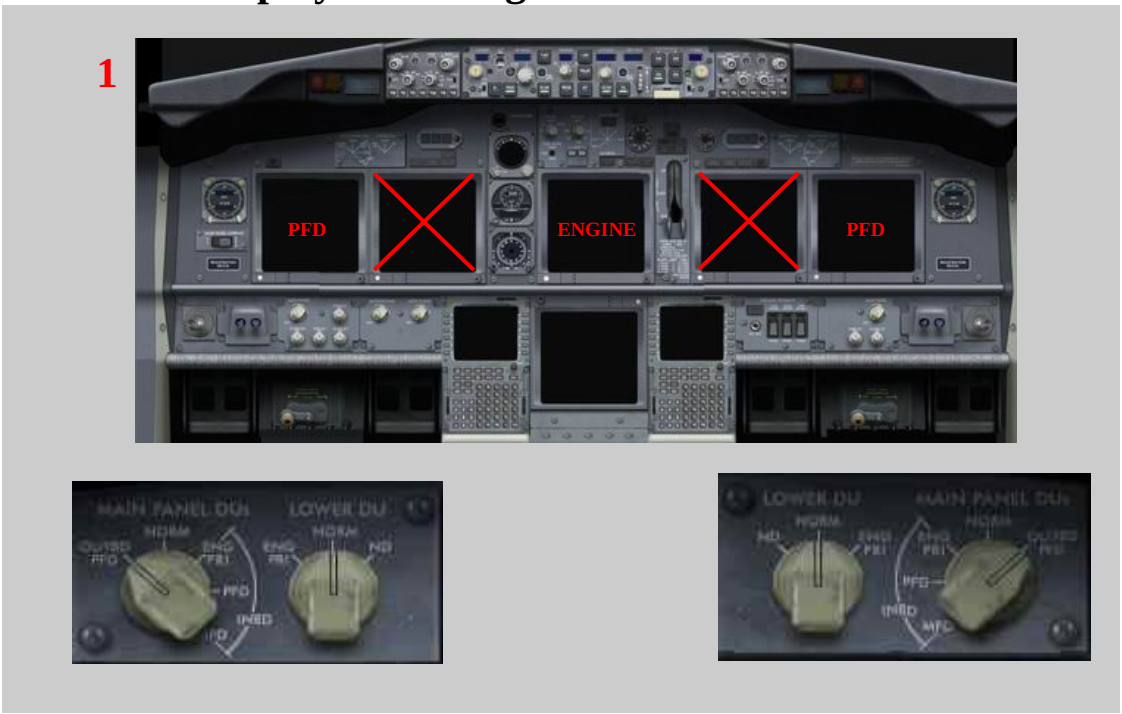
1. CONTROL PANEL Select Switch BOTH ON 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

2. CONTROL PANEL Select Switch BOTH ON 2

The right EFIS control panel controls both pilots' outboard and inboard display units.

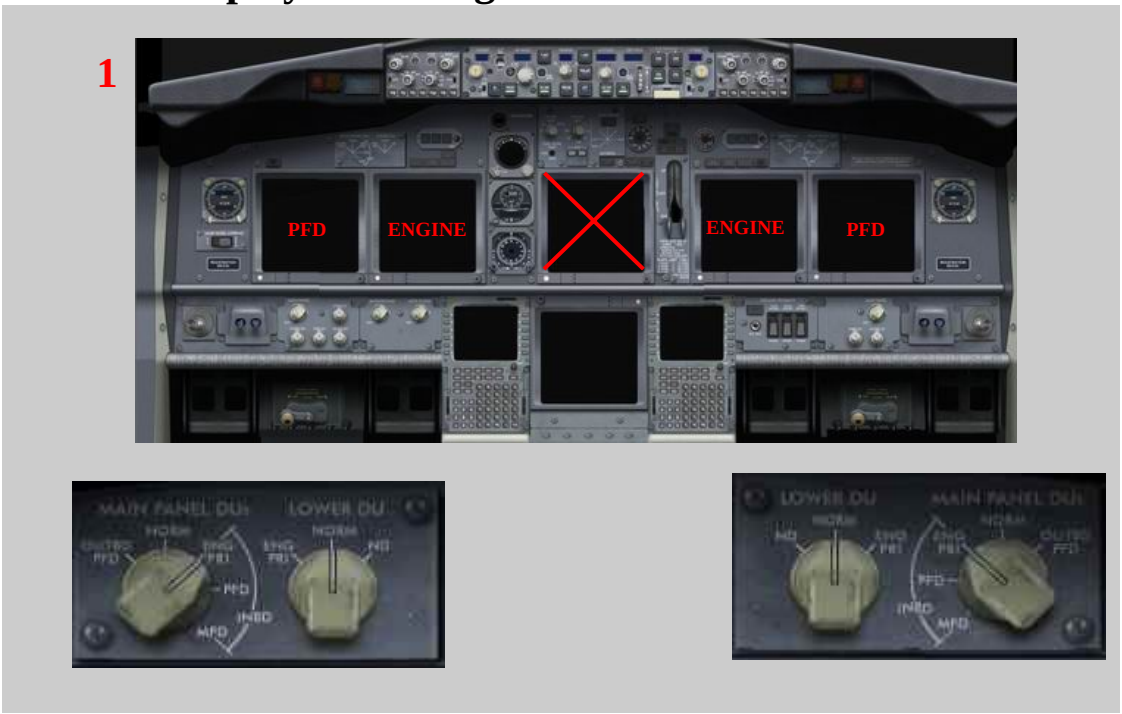
Outboard Display Switching

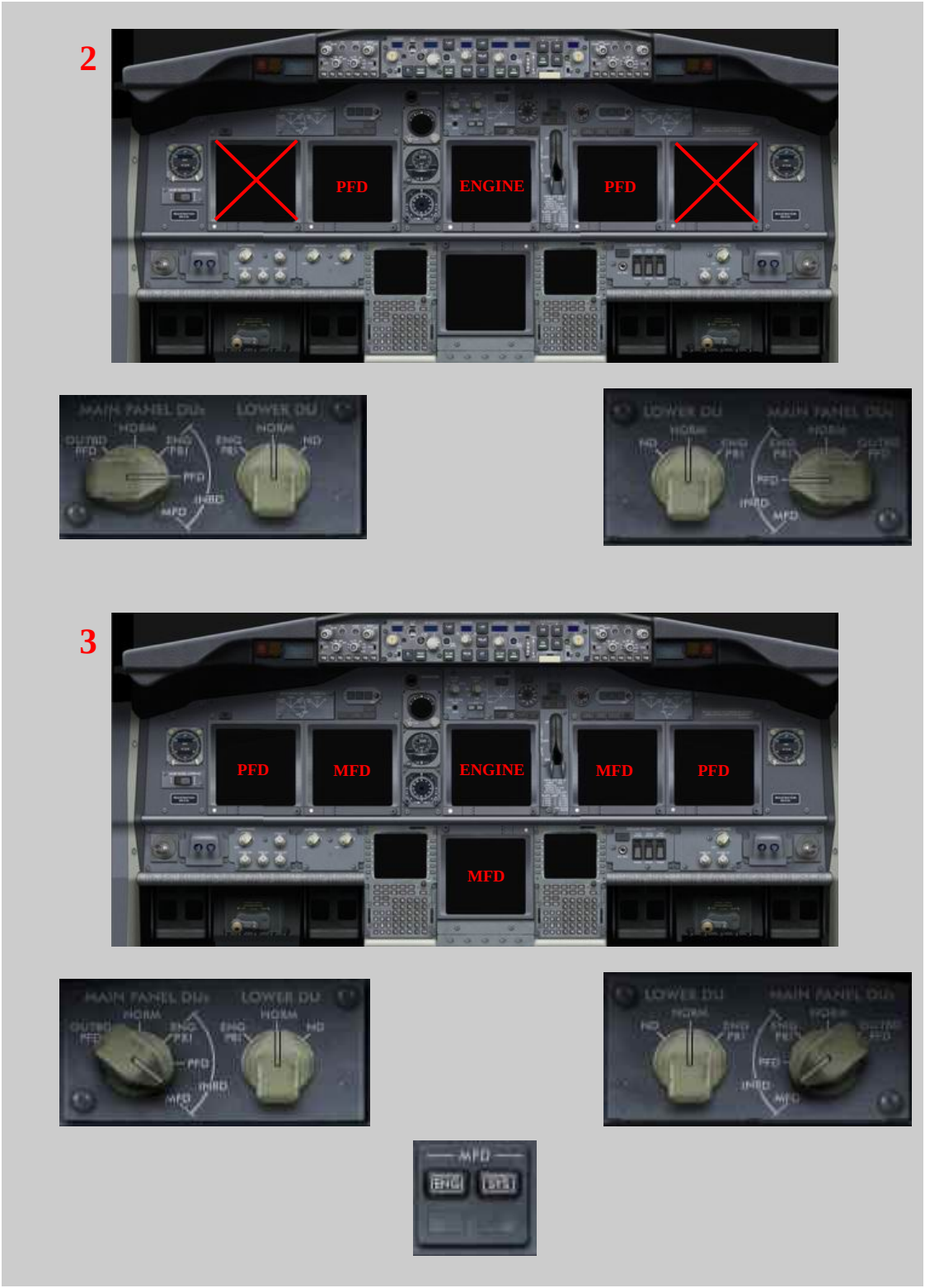


1. MAIN PANEL DUs Switch to OUTBD PFD

If the MAIN PANEL DUs switch is turned to Outboard Primary Flight Display (OUTBD PFD), the PFD format is displayed on the outboard display unit and the inboard display unit blanks.

Inboard Display Switching





1. MAIN PANEL DUs Switch to INBD ENG PRI

If the MAIN PANEL DUs switch is turned to INBD ENG PRI, the primary engine display moves to the inboard DU, the PFD format is displayed on the outboard DU and the upper DU blanks.

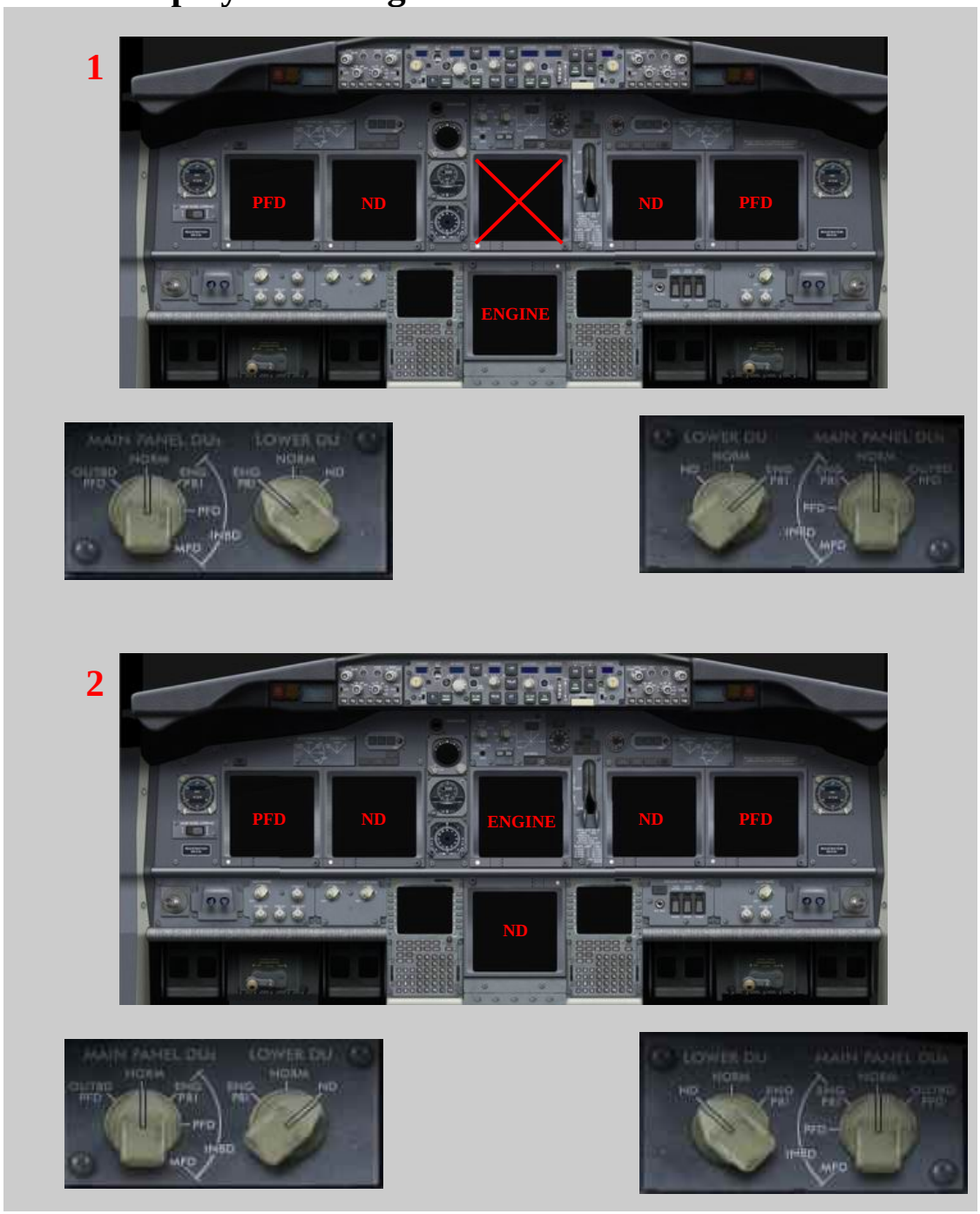
2. MAIN PANEL DUs Switch to INBD PFD

If the MAIN PANEL DUs switch is turned to INBD PFD, the PFD format is displayed on the inboard DU and the outboard DU blanks.

3. MAIN PANEL DUs Switch to MFD

If the MAIN PANEL DUs switch is turned to INBD MFD, the PFD continues to be displayed on the outboard display unit and the inboard display is blank. The system format (SYS) or secondary engine format (ENG) can then be selected to the inboard display unit and lower display unit with the MFD switches on the engine display control unit.

Lower Display Switching



1. LOWER DU Switch to ENG PRI

If the LOWER DU switch is turned to ENG PRI, the engine display moves to the lower DU and the upper DU blanks.

2. LOWER DU Switch to ND

If the LOWER DU switch is turned to ND, the engine display is shown on the upper DU and the navigation display is shown on the lower DU. When the MFD ENG switch is selected, the compact engine display is shown on the upper DU.

Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- standby radio magnetic indicator.

Standby Magnetic Compass

A standard magnetic standby compass is provided.

Standby Attitude Indicator

The standby attitude indicator provides attitude information that is independent of the primary attitude displays.

Standby Altimeter/Airspeed Indicator

Standby altitude and airspeed are displayed on a single indicator. The standby airspeed indicator provides current airspeed in knots.

Standby Radio Magnetic Indicator

The standby radio magnetic indicator (RMI) displays magnetic heading and VOR/ADF bearing to the station.

Clocks

Two electronic clocks are installed, with two digital displays on each clock. Either Greenwich Mean Time (GMT) or local time may be set on the upper time display. The lower ET/CHR display is used for either elapsed time or the chronograph. Separate controls are provided for each display.

Flight Instruments, Displays Head-Up Display System Description

Chapter 10
Section 22

[Option – BBJ/BBJ2]

Introduction

The Head-Up Display (HUD) system uses electronics and optics to calculate and display flight information.

The HUD system can be used during manual flight operations, or with the AFDS engaged during automatic flight operations.

Modes of Operation

The HUD system provides a mode–selectable display on the HUD. The modes are:

- PRI (Primary) – used for most HUD operations
- AIII – primarily used for manually flown CAT II or IIIa ILS approach and landing operations
- IMC – used for AFDS autopilot/flight director approaches
- VMC – used for visual approaches.

Primary (PRI) Mode

The primary mode may be used during all phases of flight from takeoff to landing.

Attitude information is displayed in the form of a horizon line and pitch scales positioned relative to an airplane reference symbol. Airspeed and altitude are displayed in tapes along the left and right edges of the display. A sectored HSI is displayed in flight in the lower center of the display. On the ground, the HSI, flight path and guidance cue are not displayed. These symbols are automatically displayed once the aircraft is in flight.

AIII Approach Mode

The HUD AIII mode is specifically designed for manual ILS approach and landing operations to CAT II or CAT IIIa minimums. Altitude and airspeed tape displays are replaced with digital values. The HSI is also replaced with ILS raw data.

IMC Mode

The IMC mode is an alternate approach mode primarily intended for autopilot approaches. Like the PRI mode, the IMC mode guidance cue utilizes AFDS derived guidance.

VMC Mode

The VMC mode is intended for visual approach operations. No flight director or HUD guidance is displayed. The flight path vector is used to control the approach to the runway.

Flight Instruments, Displays Electronic Flight Instrument System

Chapter 10
Section 30

Introduction

The Electronic Flight Instrument system (EFIS) presents a dynamic color display of the parameters necessary for flight path control. The displays provide the following information:

- flight mode annunciation
- airspeed
- attitude
- steering information
- instrument landing system display
- approach minimums
- radio altitude
- altitude
- vertical speed
- GPWS annunciations
- TCAS indications.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

Airspeed

Airspeed is displayed on a round dial Mach/airspeed indicator, or MASI. Current airspeed is displayed by an airspeed pointer and digital counter. Current Mach number is digitally displayed when the Mach number is greater than 0.40. Target airspeed is shown by the magenta airspeed cursor. Takeoff and landing reference speeds and flap maneuvering speeds are shown along the circumference of the indicator. Maximum and minimum airspeeds are also displayed.

Attitude

The attitude indicator displays pitch and roll attitude referenced to the horizon. Pitch attitude is displayed by an airplane symbol against a pitch scale. Bank angle is represented by the attitude of the airplane symbol against the horizon line and pitch scale.

Steering Indications

The flight director is displayed when the related flight director switch is on. Pitch and roll commands are combined on a single display. The Flight Path Vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the attitude indicator when the EFIS control panel FPV switch is selected on.

Instrument Landing System Indications

The glide slope pointer and scale appear on the right side of the attitude indication when a valid signal is received. The scale and the pointer turn amber to indicate an excessive glide slope deviation.

The localizer pointer and scale appear at the bottom of the attitude indicator when a valid signal is received. At low radio altitudes, with autopilot or flight director engaged, the scale and the pointer turn amber to indicate excessive deviation.

[Option – Rising runway]
Below 2500 feet radio altitude, with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol moves toward the airplane symbol.

Approach Minimums

The selected radio altitude set on the EFIS control panel is displayed near the bottom right of the attitude indicator. The barometric approach minimums is displayed as a marker on the altimeter.

Radio Altitude

[Option – Digital and round dial]
The current radio altitude is displayed near the bottom right of the attitude indicator when radio altitude is below 2,500 feet AGL. When between 1000 feet and 2500 feet AGL, the readout is digital. When below 1000 feet AGL, the readout is displayed in a round dial format. The display turns amber and the circumference flashes for 3 seconds as the radio altitude descends through the selected minimum altitude.

Radio Altitude Alert

The altitude alert is triggered and “ALT” is shown above the radio altitude display when radio altitude is less than or equal to 2500 feet AGL.

Altitude

Altitude is displayed on a round dial altimeter. Current altitude is displayed by an altitude pointer and a digital readout. A green reference altitude marker indicates the barometric minimums set on the EFIS control panel.

When meters is selected on the EFIS control panel, current altitude in meters is shown above the altitude window and the metric altitude equivalent of the selected MCP altitude is displayed above the altimeter. Metric readouts are not available in the compact EFIS mode.

Vertical Speed

Vertical speed is indicted by a vertical speed pointer. The pointer depicts rate of climb or descent from 0 to 6000 feet.

Traffic Alert and Collision Avoidance (TCAS) Indications

TCAS resolution advisories are displayed on the attitude indicator and vertical speed indicator. Refer to Chapter 15, Warning Systems.

GPWS Warnings

GPWS warnings are displayed in large capital letters on the attitude indicator. Refer to Chapter 15, Warning Systems.

Flight Instruments, Displays Primary Flight Display (PFD)

Chapter 10
Section 31

Introduction

The Primary Flight Displays (PFDs) present a dynamic color display of all the parameters necessary for flight path control. The displays provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- TCAS indications
- GPWS annunciations.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

Airspeed

[Option – Without groundspeed displayed]
Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is greater than 0.40. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

[Option – With groundspeed displayed]
Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is 0.40 Mach or above. Ground speed is displayed when airspeed decreases below 0.40 Mach. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the airspeed tape. Maximum and minimum airspeeds are also displayed along the right edge of the airspeed tape.

Attitude

The attitude indicator displays pitch and roll attitude referenced to the horizon. Pitch attitude is displayed by an airplane symbol against a pitch scale. Bank angle is represented by the attitude of the airplane symbol against the horizon line and pitch scale.

Steering Indications

The flight director is displayed when the related flight director switch is on. Pitch and roll commands are combined on a single display. The flight path vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on.

Instrument Landing System Indications

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed. The glide slope pointer and scale appear on the right side of the attitude indication when a valid signal is received. The localizer pointer and scale appear at the bottom of the attitude indication when a valid signal is received. At low radio altitudes with autopilot engaged the scale and the pointer turn amber to indicate excessive deviation.

[Option – Rising runway]
Below 2500 feet radio altitude with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol moves toward the airplane symbol.

Approach Minimums

The selected radio altitude or barometric approach minimums are set on the EFIS control panel. The radio altitude approach minimum is displayed near the top left of the altitude display and the barometric approach minimums is displayed near the bottom left of the altitude display.

Radio Altitude

The current radio altitude is displayed above the upper right corner of the attitude indication area when radio altitude is below 2,500 feet AGL. When between 1000 feet and 2500 feet AGL, the readout is digital. When below 1000 feet AGL, the readout is displayed in a round dial format. The display turns amber when the radio altimeter is below the radio altitude minimums.

Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape. The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and a line when BARO minimums are selected.

[Option – Landing altitude reference bar]
A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

Heading/Track Indications

Heading/track information is displayed in the bottom section of the PFD on a section of the compass rose. Current heading is displayed under a pointer at the top of the compass rose. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

Traffic Alert and Collision Avoidance (TCAS) Indications

TCAS resolution advisories are displayed in the attitude indication and vertical speed indication areas. Refer to Chapter 15, Warning Systems.

GPWS Warnings

GPWS warnings are displayed in large capital letters between the attitude display and the heading/track compass rose. Refer to Chapter 15, Warning Systems.

Flight Instruments, Displays Navigation Displays

Chapter 10
Section 40

Introduction

The navigation displays provide a color display of flight progress. The displays consist of the following:

- horizontal situation indicator
- radio distance magnetic indicator
- navigation display with MAP, APP (approach), VOR, and PLN (plan) modes.

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a center mode with a full compass rose.

Horizontal Situation Indicator (HSI)

The HSI provides heading and track data with VOR navigation or ILS approach information.

Radio Distance Magnetic Indicator (RDMI)

The RDMI provides the same information as a conventional RDMI.

Navigation Display – MAP Mode

The MAP mode is recommended for most phases of flight. This mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display in both the expanded and center MAP modes.

VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or approach information.

Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

Navigation Display Information

Heading

Heading is supplied by air data inertial reference system (ADIRS). The compass rose can be referenced to magnetic north or true north.

Track

Track is supplied by the FMC during normal operation.

Traffic

Traffic information from the TCAS can be displayed on the navigation display when in MAP, Center MAP, APP and VOR modes. TCAS is described in Chapter 15, Warning Systems.

Failure Flags and Messages

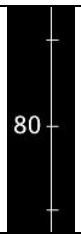
Failure flags are displayed for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

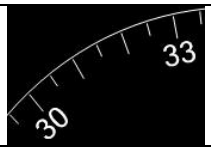
Navigation Display Symbology

The following symbols can be displayed, depending on EFIS control panel switch selections. Colors indicate the following:

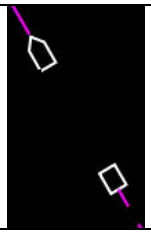
- W (white) – present status, range scales
- G (green) – dynamic conditions
- M (magenta) – command information, pointers, symbols, fly–to condition
- C (cyan) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

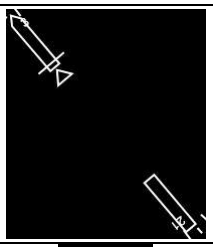
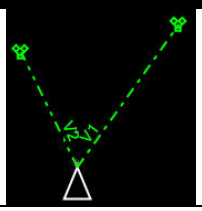
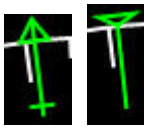
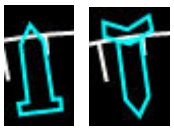
Heading, Track, and Speed

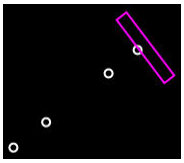
Symbol	Name	ND Mode	Remarks
	Selected heading bug (M)	All except PLN	Displays the MCP–selected heading. A dashed reference line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line).
	Current heading pointer (W)	All except PLN	Points to current heading on the compass rose.
	Track line and range scale (W)	MAP, MAP CTR, APP, VOR	Indicates current track.

	Expanded compass (W)	MAP, APP, VOR	Displays 60 degrees of compass rose.
GS295	Groundspeed (W)	All	Current ground speed.
TAS239	True airspeed (W)	All	Current true airspeed displayed above 100 knots.
340° / 18 ↘	Wind direction/ speed and wind arrow (W)	All	Indicates wind speed and direction, with respect to display orientation and heading/track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots. Blank until TAS is greater than 101 knots. PLN mode displays speed/direction only.
M TRU	Heading/track reference (G), box (W) in TRU, box (A) if TRU displayed in descent	All except PLN	Indicates heading/track is referenced to magnetic north or true north. On transition from TRU to M, a highlight box is displayed around M for 10 seconds. When TRU is the reference, the highlight box is displayed full time (white).

Heading, Track, and Speed

Symbol	Name	ND Mode	Remarks
113.40	ILS/VOR frequency display (G)	APP, APP CTR, VOR, VOR CTR	Displays frequency of manually tuned navaid.
DME 41.7	DME distance (W)	APP, APP CTR, VOR, VOR CTR	Indicates DME distance to the reference navaid.
	Selected course pointer (W) and line (M)	VOR, APP	Displays selected course as set by the related MCP course selector.

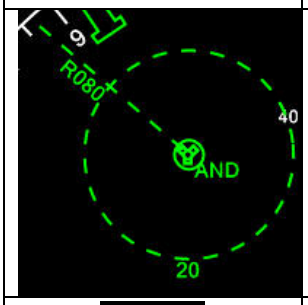
	Selected course pointer (W) TO/FROM pointer (W)	APP CTR, VOR CTR	Displays selected course as set by the related MCP course selector. TO/FROM pointer is displayed when VOR navigation is being used.
	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (C, G)	MAP, MAP CTR	When the EFIS control panel STA map switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 5, 10, 20 or 40 nm. Only high altitude navaids are displayed when the selected range is 80, 160, 320 or 640 nm. Navaids not being used are displayed in cyan. Tuned VHF navaids are displayed in green, regardless of STA map switch selection.
	Manually tuned VOR radials (G)	MAP, MAP CTR	When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR radials (G)	MAP, MAP CTR	When the POS map switch is selected on and a valid VOR signal is received, the station radial is displayed.
	VOR 1 (G) or ADF 1 (C) pointer head and tail	All except PLN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.
	VOR 2 (G) or ADF 2 (C) pointer head and tail		

	ILS localizer or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC or VOR course deviation.
	Glide slope pointer (M) and scale (W)	APP, APP CTR	Displays glide slope position and deviation.

MAP

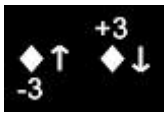
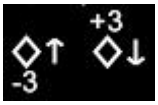
Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	VOR CTR, APP CTR	Current airplane position is at the center of the symbol.
	Airplane symbol (W)	PLN	Indicates actual position and track along the flight plan route. Inhibited north of 82N latitude and south of 82S latitude.
	Airplane symbol (W)	MAP, MAP CTR, VOR, APP	Current airplane position is at the apex of the triangle.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ±400 feet deviation. Digital display is provided when the pointer deviates more than ±400 feet from center.
	Position trend vector (W) (dashed line)	MAP, MAP CTR	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: • > 20 NM, 3 segments • = 20 NM, 2 segments • < 20 NM, 1 segment.
	Active waypoint identifier (M)	MAP, MAP CTR,	Indicates the active flight plan waypoint, the next

		PLN	waypoint on the route of flight.
13.1NM	Active waypoint distance (W)	MAP, MAP CTR, PLN	Distance to the active waypoint.
0420.8z	Active waypoint ETA (W)	MAP, MAP CTR, PLN	Indicates FMS–calculated ETA at the active waypoint.
GS	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
D302L	Off route waypoint (C)	MAP, MAP CTR	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.
N34E112 ZHO HFE	Flight plan route: active (M), modified (W), offset (M)	MAP, MAP CTR, PLN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. An offset route, selected through the FMC, is displayed with a dash line (M) parallel to the active route.
GS FL310 0559z	Route data: active (M), inactive (W)	MAP, MAP CTR, PLN	When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.
N30E120 3070 0540z	Holding pattern: active (M), modified (W), inactive (C)	MAP, MAP CTR, PLN	A holding pattern appears when in the flight plan.
	Altitude range arc (G)	MAP, MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will

			be reached.
	Altitude profile point and identifier (G)	MAP, MAP CTR, PLN	Indicates the approximate map position of the FMC–calculated T/C (top–of–climb), T/D (top–of–descent), S/C (step climb), and E/D (end of descent) points.
	Airport (C)	MAP, MAP CTR	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLN	Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	Selected map options (C)	MAP, MAP CTR, PLN	Displays EFIS control panel selected map options.
	Drift angle pointer (W)	VOR CTR, APP CTR	Indicates airplane's present track. Replaces track line in the center APP and VOR modes.
	MAP source annunciation (G)	MAP, MAP CTR, PLN	Displays source of FMC data used by CDS for data presentation.

TCAS

Symbol	Name	ND Mode	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, VOR, APP	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter

	TCAS traffic advisory (TA), relative altitude (A)		15, Warning Systems. The arrow indicates traffic climbing or descending at a rate >= 500 fpm. At rates < 500 fpm, the arrow is not displayed. The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane. The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane.
	TCAS proximate traffic, relative altitude (W)		
	TCAS other traffic, relative altitude (W)		
TA 6.3 -11↑ RA 5.3 +03↓	TCAS no bearing message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Message provides traffic type, range in NM, altitude and vertical direction. TFC must be selected on.
TRAFFIC	TCAS traffic lert message RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.
OFFSCALE	TCAS off scale message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Displayed only if the EFIS control panel TFC switch is selected on.
TFC	TCAS mode (C)	MAP, MAP CTR, VOR, APP	Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.
TA ONLY	TCAS mode (C)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (C)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (C)	All	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA. Not displayed if TCAS is

			failed.
TCAS FAIL	TCAS mode (C)	All	Indicates TCAS failure, if traffic is selected.

Flight Instruments, Displays PFD/ND Navigation Displays

Chapter 10
Section 41

Introduction

The NDs provide a mode–selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan).

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

Map Mode

The MAP mode is recommended for most phases of flight. This mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display on the ND in both the expanded and center map modes.

VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or approach information.

Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

ND Information

Heading

Heading is supplied by the FMC or air data inertial reference system (ADIRS). The ND compass rose can be referenced to magnetic north or true north.

Track

Track is supplied by the FMC during normal operation.

Traffic

Traffic information from the TCAS can be displayed on the ND. TCAS is described in Chapter 15, Warning Systems.

Failure Flags and Messages

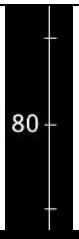
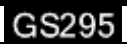
Failure flags are displayed for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

ND Symbology

The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

- W (white) – present status, range scales
- G (green) – dynamic conditions
- M (magenta) – command information, pointers, symbols, fly–to condition
- C (cyan) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

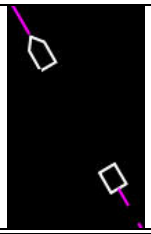
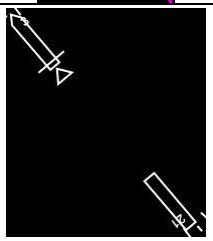
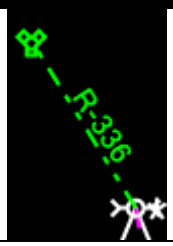
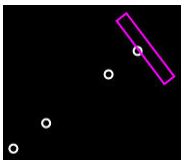
Heading, Track, and Speed

Symbol	Name	ND Mode	Remarks
	Selected heading bug (M)	All except PLN	Displays the MCP–selected heading. A dashed reference line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line). In the MAP mode with LNAV or VORLOC engaged, the dashed line is removed 10 seconds after the selected heading bug is moved.
	Current heading pointer (W)	All except PLN	Points to current heading on the compass rose.
	Track line and range scale (W)	All except PLN	Indicates current track. Number indicates range (VOR CTR and APP CTR do not display range).
	Expanded compass (W)	MAP, APP, VOR	Displays 90 degrees of compass rose.
	Groundspeed	All	Current ground speed.

	(W)		
TAS239	True airspeed (W)	All	Current true airspeed displayed above 100 knots.
340° / 18	Wind direction/ speed and wind arrow (W)	All	Indicates wind speed and direction, with respect to display orientation and heading/track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots. Blank until TAS is greater than 101 knots. PLN mode displays speed/direction only.
TRK 053 MAG	Track orientation (G), current track (W), track reference (G)	MAP, MAP CTR	Displays TRK as the orientation, the current track, and MAG or TRU as the reference, and points to the heading on the compass rose.
HDG 051 MAG	Heading orientation (G), current heading (W), heading reference (G), heading pointer (W)	VOR, VOR CTR, APP, APP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.

Radio Navigation

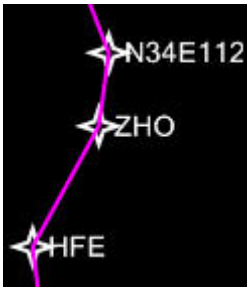
Symbol	Name	ND Mode	Remarks
113.00 HGH	ILS /VOR Reference receiver frequency or identifier display (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency.
CRS 057	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Indicates the VOR course or ILS localizer course.
DME 6.8	Reference VOR or ILS DME (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Indicates DME distance to the reference navaid.
DME 6.8	DME distance (G)	All except PLN	Located lower left or right corner. Indicates DME distance to navaid.

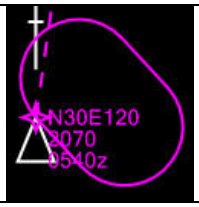
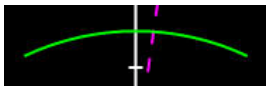
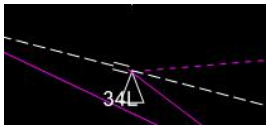
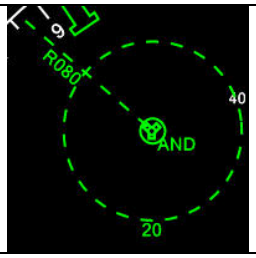
	Selected course pointer (W) and line (M)	VOR, APP	Displays selected course as set by the related MCP course selector.
	Selected course pointer (W) TO/FROM pointer (W)	APP CTR, VOR CTR	Displays selected course as set by the related MCP course selector. TO/FROM pointer is displayed when VOR navigation is being used.
	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	VOR (C, G)	MAP, MAP CTR	When the EFIS control panel STA map switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 5, 10, 20 or 40 nm. Only high altitude navaids are displayed when the selected range is 80, 160, 320 or 640 nm. Navaids not being used are displayed in cyan. Tuned VHF navaids are displayed in green, regardless of STA map switch selection.
	Manually tuned VOR radials (G)	MAP, MAP CTR	When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR/DME raw data radial and distance (G)	MAP, MAP CTR	When the POS map switch is selected on, the station radial extends to the airplane.
	ILS localizer or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC or VOR course deviation.

	ILS Glide slope pointer (M) and scale (W)	APP, APP CTR	Displays glide slope or glide path position and deviation.
113.00 HGH 0572.0 WY	VOR frequency or identifier (G), ADF frequency or identifier (C)	All except PLN	Located lower left or right corner. Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.
VOR 1 VOR 2 ADF 1 ADF 2	VOR (G) or ADF (C) selection	All except PLN	Located lower left or right corner. Represents positions of the EFIS control panel VOR/ADF switches.
	VOR 1 (G) or ADF 1 (C) pointer head and tail	All except PLN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.
	VOR 2 (G) or ADF 2 (C) pointer head and tail		

MAP

Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	VOR CTR, APP CTR	Current airplane position is at the center of the symbol.
	Airplane symbol (W)	PLN	Indicates actual position and track along the flight plan route. Inhibited north of 82N latitude and south of 82S latitude.
	Airplane symbol (W)	MAP, MAP CTR, VOR, APP	Current airplane position is at the apex of the triangle.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ±400 feet deviation. Digital display is provided when the pointer deviates more than ±400 feet from center.

	Position trend vector (W) (dashed line)	MAP, MAP CTR	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: • > 20 NM, 3 segments • = 20 NM, 2 segments • < 20 NM, 1 segment.
	Active waypoint identifier (M)	MAP, MAP CTR, PLN	Indicates the active flight plan waypoint, the next waypoint on the route of flight.
	Active waypoint distance (W)	MAP, MAP CTR, PLN	Distance to the active waypoint.
	Active waypoint ETA (W)	MAP, MAP CTR, PLN	Indicates FMS–calculated ETA at the active waypoint.
	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
	Off route waypoint (C)	MAP, MAP CTR	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.
	Flight plan route: active (M), modified (W), offset (M)	MAP, MAP CTR, PLN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. An offset route, selected through the FMC, is displayed with a dash line (M) parallel to the active route.

	Route data: active (M), inactive (W)	MAP, MAP CTR, PLN	When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.
	Holding pattern: active (M), modified (W), inactive (C)	MAP, MAP CTR, PLN	A holding pattern appears when in the flight plan.
	Altitude range arc (G)	MAP, MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
	Altitude profile point and identifier (G)	MAP, MAP CTR, PLN	Indicates the approximate map position of the FMC–calculated T/C (top–of–climb), T/D (top–of–descent), S/C (step climb), and E/D (end of descent) points.
	Airport (C)	MAP, MAP CTR	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLN	Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	GPS position (W)	MAP, MAP CTR	When the EFIS POS map switch is selected on, indicates GPS position relative to FMC position.
	ADIRU position (W)	MAP, MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMC

			position.
ARPT WPT STA	Selected map options (C)	MAP, MAP CTR, PLN	Displays EFIS control panel selected map options.
FMC L	MAP source annunciation (G)	MAP, MAP CTR, PLN	Displays source of FMC data used by CDS for data presentation.

TCAS

Symbol	Name	ND Mode	Remarks
+3 -3	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, VOR, APP	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems. The arrow indicates traffic climbing or descending at a rate >= 500 fpm. At rates < 500 fpm, the arrow is not displayed. The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane. The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane.
+3 -3	TCAS traffic advisory (TA), relative altitude (A)		
+3 -3	TCAS proximate traffic, relative altitude (W)		
+3 -3	TCAS other traffic, relative altitude (W)		
TA 6.3 -11↑ RA 5.3 +03↓	TCAS no bearing message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Message provides traffic type, range in NM, altitude and vertical direction. TFC must be selected on.
TRAFFIC	TCAS traffic alert message (RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.
OFFSCALE	TCAS off scale message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Displayed only if the EFIS control panel TFC switch is selected on.
TFC	TCAS mode (C)	MAP, MAP CTR, VOR, APP	Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.

TA ONLY	TCAS mode (C)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (C)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (C)	All	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (C)	All	Indicates TCAS failure, if traffic is selected.

Flight Instruments, Displays Head-Up Display System, Symbology

Chapter 10
Section 42

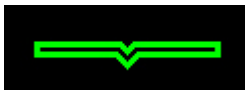
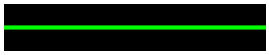
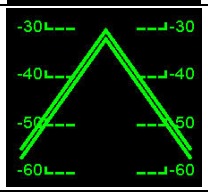
[Option – BBJ/BBJ2]

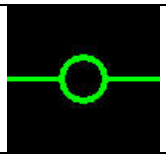
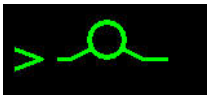
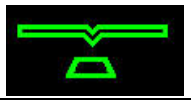
Introduction

HUD symbology consists of green symbols. The PRI mode display symbols are similar to those on the CDS, and can be used for all phases of flight. The approach mode displays (AIII, IMC, VMC) are optimized to enhance aircraft control and situational awareness during final approach, flare, and touchdown.

Head-Up Guidance Display Symbology

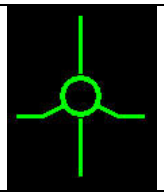
The following symbols can be displayed on the combiner, depending on HUD and EFIS control panel switch selections.

Symbol	Name	Mode	Remarks
	Airplane reference	All	Top center point of the symbol represents airplane projected centerline.
	Horizon Line	All	Indicates the horizon relative to the airplane reference symbol.
	Pitch Scale	PRI in flight, AIII approach, IMC, VMC	Displays airplane pitch in five degree increments between -20° and +25°.
	Compressed pitch scale	PRI in flight, AIII approach, IMC, VMC	Displays airplane pitch in ten degree increments between +/-30° and +/-90°. A chevron appears on the pitch scale at -20° and +30°.
	Bank Scale and Pointer	All	Displays the corresponding roll attitude in ten degree increments between 0° and +/-30°. Tic marks at +/-45° and +/-60° are added when the airplane exceeds +/-35° and +/-50° respectively.
	Horizon heading scale	All	Magnetic heading is displayed in five degree increments on the horizon line. A downward pointing triangle indicates current airplane magnetic heading.

	HSI heading scale	PRI in flight	Displays airplane magnetic heading in a 210° compass rose format.
	Heading pointer	PRI in flight	Indicates current heading.
	Drift angle pointer	PRI in flight	Indicates current drift angle or track.
	Selected heading bug	All	Displays selected heading on the horizon line.
HDG 083	Digital selected heading	All	Displayed full time in PRI mode and for five seconds after selection in the IMC, VMC or AIII modes.
H 077	Digital heading	All	Displays current magnetic heading.
	Ground roll reference	PRI ground	Provides a reference for ground roll guidance during low visibility takeoff operations.
	Flight path symbol	PRI in flight, AIII approach, IMC, VMC	Displays the actual flight path vector of the aircraft.
	Flight path acceleration	All	Positioned left of the flight path vector; indicates sum of all forces affecting the airplane including thrust, drag, and wind. Positioned above flight path vector; airplane is accelerating. Positioned below flight path vector; airplane is decelerating.
  	Additional slip/skid indicators	PRI in flight, AIII approach, MC, VMC	Positioned below the airplane reference and flight path symbols. Displayed during takeoff or low altitude go-around.
	Speed error tape	PRI in flight, AIII approach, IMC, VMC	Displays the difference between indicated airspeed and the reference speed selected on the mode control panel. Tape length equal to the diameter of the flight path circle represents

			approximately 5 knots of error. Maximum tape length is limited to 15 knots of error.
	Bank warning	PRI in flight, AIII approach, IMC, VMC	Displayed if radio altitude is less than 100 feet and airplane roll angle exceeds 5°. Symbol remains until roll angle is less than 3° or radio altitude greater than 100 feet.
	Flight director guidance cue	PRI in flight, IMC	Functions similar to the flight director, but is designed for control of flight path.
	AIII flare command	AIII approach	Initially displayed 2-3° directly below the guidance cue at 105 feet above runway elevation. At an altitude between 45 and 55 feet, the flare command and guidance cue meet and continue rising to command the flare maneuver until touchdown.
	Flare cues	PRI in flight, IMC, VMC	Displayed on each side of the flight path symbol, indicating the flare maneuver must be accomplished.
	Wind speed and direction	PRI in flight, AIII approach, IMC,VMC	Indicates wind speed and direction, with respect to airplane magnetic heading. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots.
	Radio altitude	PRI in flight, AIII approach, IMC, VMC	The value is removed from the display at 1500 feet when ascending and again displayed at 1400 feet when descending. This value is displayed in ten foot increments between 50 and 1500 feet, five foot increments between 10 and 50 feet and one foot increments below 10 feet.
	Decision height	PRI in flight, AIII approach, IMC	Displayed left of radio altitude when selected decision height is reached. When decision height is

			reached, the message flashes for 3 seconds and then remains steady.
OM MM IM	Marker beacon	PRI in flight, AIII approach, IMC	Displayed below the airplane reference symbol for marker beacon passage.
220	Digital airspeed	AIII approach, AIII rollout, IMC, VMC	Displays airspeed.
AS 220	Digital selected airspeed	All	Displays speed selected on the MCP.
GS 249	Digital ground speed	All	Displays digital ground speed.
.409	Digital mach	PRI in flight	Displays mach speed below airspeed scale when mach speed is above .400. Removed when below .380.
.72	Selected mach	All	Displays selected mach speed above airspeed scale.
772 B	Digital barometric altitude	AIII approach, AIII rollout, IMC, VMC	Displays barometric altitude
1350 VS	Digital vertical speed	PRI in flight, AIII approach, IMC, VMC	Displays vertical speed. Value displayed in 50 feet/minute increments.
DME 6.3	DME distance	PRI in flight, AIII approach, IMC, VMC	Indicates DME distance to the reference navaid.
12.8NM	Distance to go	PRI in flight, IMC	Distance to next waypoint.
CRS 227	Selected course (digital)	All	Displayed full time in PRI mode and for five seconds after selection in the IMC, VMC or AIII modes.
25 24	Selected course pointer	All	Displays MCP selected course below the horizon line and on the HSI (PRI mode only). The horizon line pointer is surrounded by a 3 ° gap in the horizon line.

	System source annunciation	PRI in flight, PRI ground, AIII, IMC	Indicates the selected receiver as the display source.
			Indicates source cannot be determined.
	FMC source annunciation	All	Indicates the selected FMC as the system source.
	Glideslope reference line	AIII approach, IMC, VMC	Displays the glideslope value entered on the HUD control panel.
	ILS localizer or VOR deviation indication and scale	PRI in flight	Displays LOC or VOR course deviation on the HSI.
	Glideslope pointer and deviation scale	PRI in flight	Displays glideslope position and deviation during ILS approach.
	Ground localizer pointer and deviation scale	PRI in flight	Displays airplane lateral deviation relative to the runway centerline.
	Vertical deviation pointer and scale	PRI in flight, IMC	Full scale represents 400 feet of vertical deviation. When the deviation is off scale, the pointer is parked at the top or bottom of the tape, and the digital value is displayed at the appropriate end of the scale.
	Lateral deviation line	AIII approach, IMC	Displayed as vertical lines referenced to the selected course.
	Glideslope deviation line	AIII approach, IMC	Displayed as horizontal lines referenced to the glideslope reference line. The line is removed below 70 feet radio altitude.

	VOR1/ADF 1 pointer head and tail	PRI in flight	Indicates bearing to (head) or from (tail) the tuned station.
	VOR2/ADF 2 pointer head and tail		
	Bearing source annunciations	PRI in flight	Indicates pointer source.
	To/from pointer	PRI in flight, PRI ground	A triangle pointing in the same direction as the selected course indicates a “to” condition. Pointing away from the selected course indicates a “from” condition.
	HUD system mode	AIII approach, AIII rollout, IMC, VMC	Indicates current HUD system mode. The PRI mode is not indicated as it is uniquely identifiable by the airspeed and altitude tapes.
	AIII approach status	AIII approach	Indicates AIII mode selection once all AIII approach requirements have been satisfied. If AIII capability is lost, the “NO AIII” status message is displayed.
	Angle of attack scale and indicator	PRI in flight, AIII approach, IMC, VMC	Displays current angle of attack, stick shaker trip point and. Tic marks every 5°.

Failure Flags and Data Source Annunciations

Symbol	Name	Mode	Remarks
	IRS attitude flag	All	IRS pitch or roll attitude has failed.
	Heading flag	All	Heading data has failed.
	Airspeed flag	All	Airspeed information has failed.
	Altitude flag	All	Altitude information has failed.
	Decision speed flag	PRI ground	V1 decision speed or VR rotation speed has not been entered or is invalid.

MACH	Mach flag	PRI in flight, PRI ground	MACH airspeed has failed.
VS	Vertical speed flag	All	Vertical speed has failed.
SEL ALT	Selected altitude flag	PRI in flight, PRI ground	Selected altitude has failed.
SEL SPD	Selected airspeed flag	All	Selected speed has failed.
RA	Radio altitude flag	All	Radio altitude has failed.
ATT2	Right (#2) IRS source	All	All IRS information used or displayed by the HUD is taken from the right (#2) IRS.
LOC	Lateral deviation fault	PRI in flight, PRI ground	ILS has failed.

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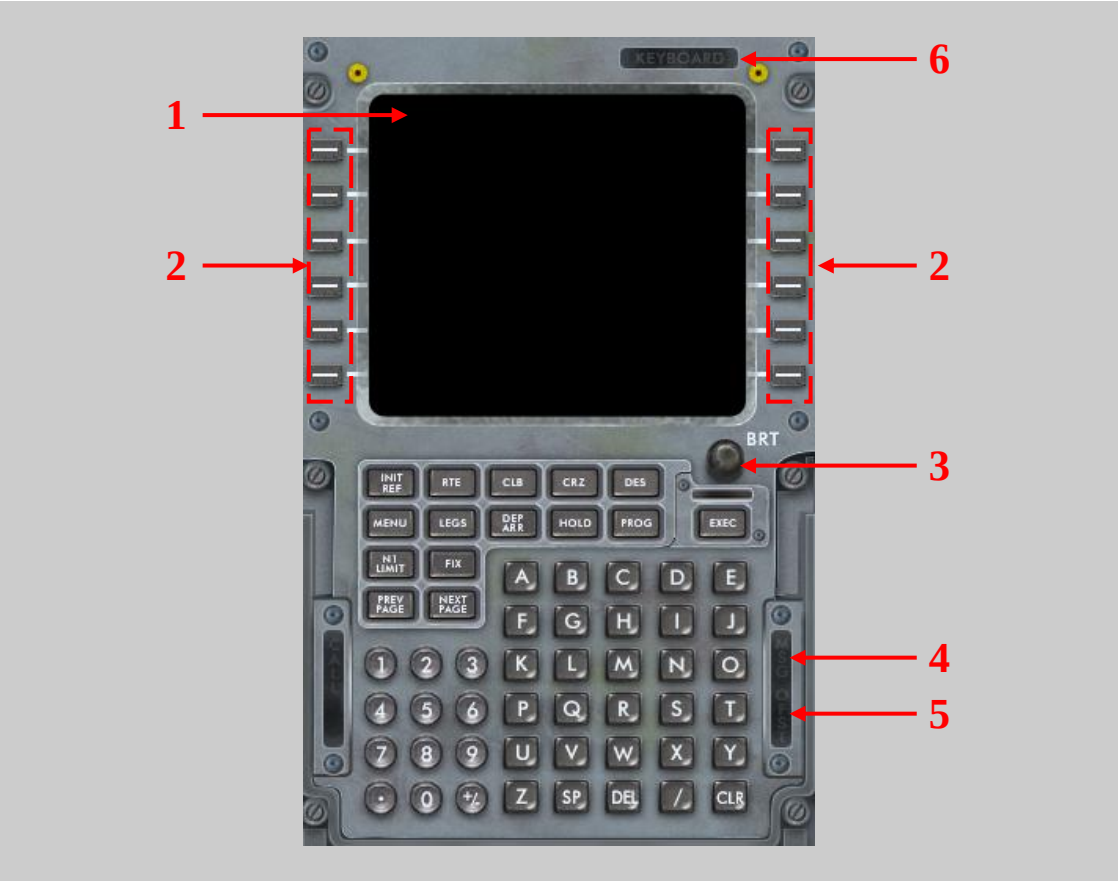
Flight Management, Navigation Controls and Indicators

Chapter 11
Section 10

Flight Management System

Control Display Unit (CDU)



1. Control Display Unit (CDU) Display

Shows FMS data pages.

2. Line Select Keys (LSK)

A momentary push of a LSK affects the adjacent line on the respective side of the CDU for data entry, selection or deletion. Transfer of data from the scratchpad to the line next to the LSK, if acceptable to the FMC, is accomplished by pushing the LSK.

The LSK calls up the first page in a series of pages corresponding to subject on line next to LSK if entry is preceded or followed by a caret (< or >). This LSK can also select procedures or performance mode as identified.

3. Brightness Control

The BRT control knob allows the pilot to manually increase or decrease the light intensity of the CDU display.

4. Message (MSG) Light

Illuminated (white) – indicating to the pilot that an FMC-generated message is displayed on the scratchpad. Pushing the clear (CLR) key extinguishes the light and clears the message from the scratchpad.

5. Offset (OFST) Light

Illuminated (white) – when LNAV is based on a parallel route offset from the active route.

6. KEYBOARD Light

Illuminated (white) – enable directly input character via keyboard.

Function and Execute Keys

1. CDU Function Keys

Push –

- INIT REF – shows the first page of a series of pages used to initialize the position of the FMC and the IRS, plus various pages of reference data.
- RTE – shows the page for entering or changing origin, destination, or route.
- CLB – shows page to view or change climb data
- CRZ – shows page to view or change cruise data
- DES – shows page to view or change descent data
- MENU – shows page to choose subsystems controlled by CDU
- LEGS –
  - shows page to evaluate or modify lateral and vertical details of each route leg.
  - shows page to control the route segment displayed on the associated ND when the ND is in the PLAN mode
- DEP ARR – shows index of series listing all terminal area procedures in the navigation database for departures before traveling 400NM, or for arrivals after 400NM or midpoint, whichever is less. This page allows for entering or changing departure and arrival procedures.
- HOLD – shows page to create holding patterns and show holding pattern data
- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- N1 LIMIT – shows page to view or change N1 thrust limits
- FIX – shows fix information pages. These pages are used for creation of waypoint fixes from intersection of the active route and selected bearing or distance from

stored waypoints.
- PREV PAGE – shows previous page of related pages
- NEXT PAGE – shows next page of related pages.

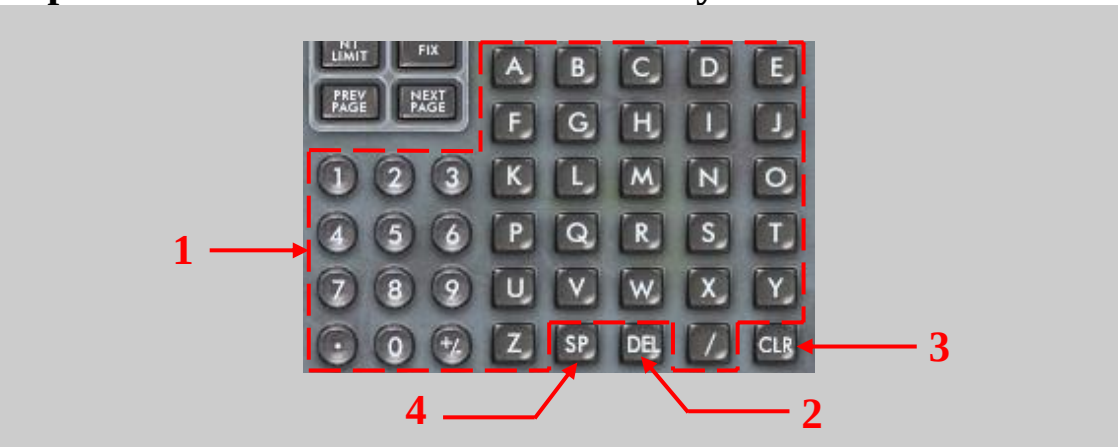
2. Execute Light

Illuminated (white) – active data is modified but not executed.

3. Execute (EXEC) Key

Push –
- makes data modification(s) active
- extinguishes execute light.

Alpha/Numeric and Miscellaneous Keys



1. Alpha/Numeric Keys

Push –
- enters letters and numbers into the scratchpad successively from left to right.
- Slash (/) key – enters "/" into scratchpad. Slash key is used to separate pairs of entries in the same field. For example, airspeed and Mach (280/.730), wind direction and velocity (265/50), bearing and distance (210/25), or airspeed and altitude (250/10000). The trailing entry of an entry pair must be preceded by the slash if it alone is entered. The leading entry may be followed by the slash, but it is not required if the leading entry alone is entered.
- Plus Minus (+/–) key – first push enters "–" into the scratchpad. A second push inserts a "+". Subsequent pushes alternate between "+" and "–".

2. Delete (DEL) Key

Push – inserts the word DELETE into the scratchpad, if the scratchpad is blank. Line selection into an appropriate data field via LSK replaces entered data with blanks, dashes, small font or boxes. Not all information can be deleted.

3. Clear (CLR) Key

Push –
- clears the last scratchpad character.

- clears scratchpad message.

4. Space (SP) Key

Push – inserts a space in scratchpad.

CDU Page Components

1. Page Title

Indicates the subject or title of data displayed on the CDU. ACT or MOD may be displayed to indicate whether the page is Active or Modified.

2. Line Title

Identifies the data displayed on line(s) below it. The line title is displayed in small font.

3. Line

Contains box prompts, dashes, brackets, computer generated data (small font), or crew-entered data (large font).

4. Scratchpad

This is the bottom line of the display area. This line displays alphanumeric data or messages. Data can be entered with the alphanumeric keys or the LSK, or by the FMC.

5. Page Number

The first digit indicates the page number and the second digit indicates total number of related pages. For example, 1/2 identifies page as first series of two pages. This data is in small font.

6. Boxes

Indicates data entry is mandatory. This data entry is performed through the use of the scratchpad and the corresponding LSK. Entry into a box prompt data line is displayed in large font.

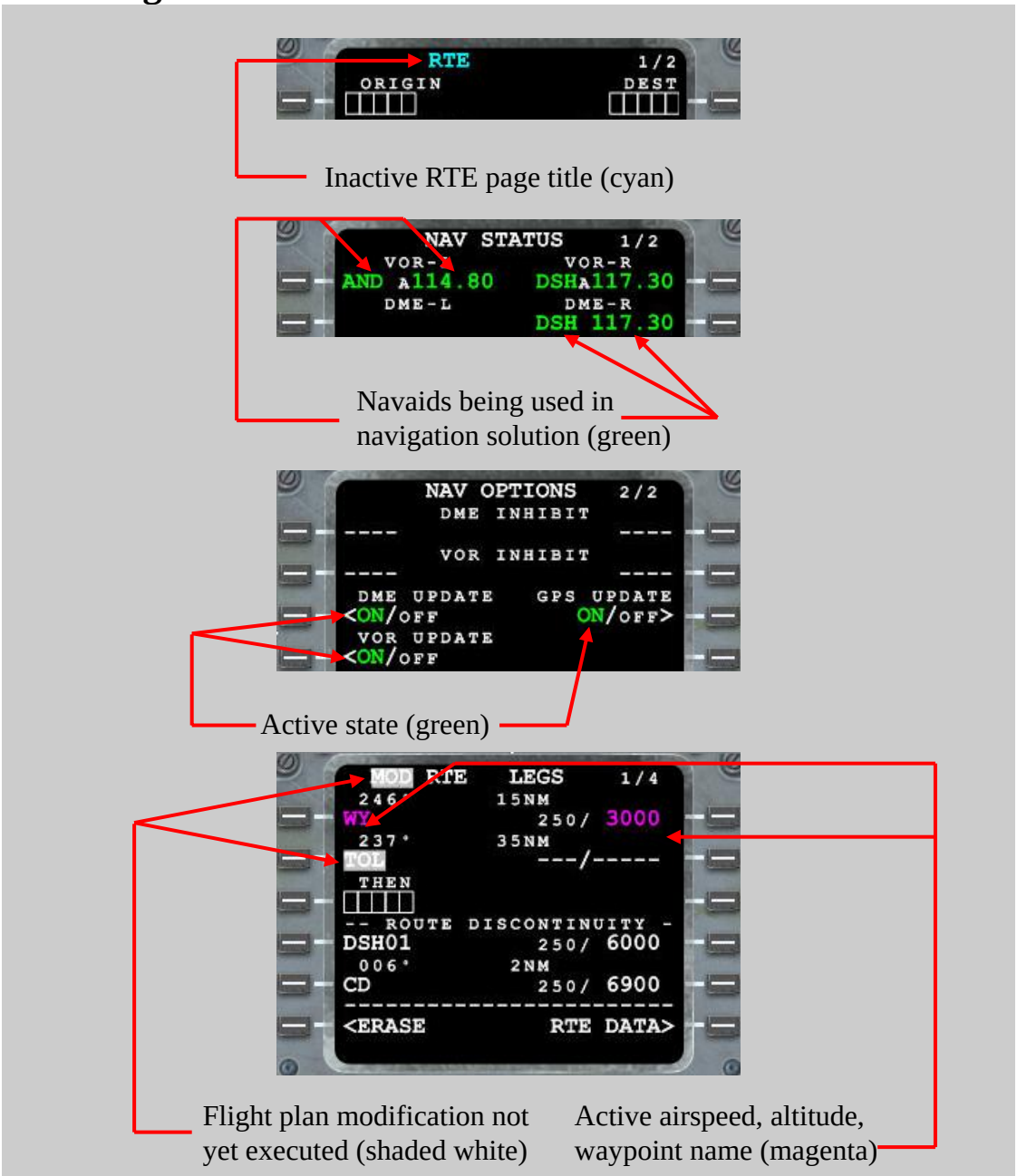
7. Dashes

Indicates data entry is optional, and is performed through the use of the scratchpad and the corresponding LSK.

8. Prompts

Indicates the next logical page or pages in the flight plan progression or pilot-initiated action, such as, an early descent or an engine out climb. Caret “<” or “>” is before or after prompt.

CDU Page Color



Holding pattern inbound course, direction of turn, leg distance or leg time (magenta)

Color is used as follows:

- black – background color of page
- cyan –
  - inactive RTE, RTE LEGS and RTE HOLD page titles
- green –
  - actively tuned VOR, ILS, or DME data (frequency, station ID, course)
  - active state of two–position and three–position selectors.
- magenta – data used by FMC for lateral and vertical flight commands
  - active waypoint
  - active airspeed
  - active altitude
  - holding pattern inbound course, direction of turn, and leg time or leg distance
- shaded white –
  - modifications
  - MOD precedes page titles of modified pages
- white – most data

FMC Source Select Switch

FORWARD OVERHEAD PANEL

1. FMC Source Select Switch

BOTH ON L – selects left FMC for all FMC operations

NORMAL – select left and right FMC for all FMC operations

BOTH ON R – selects right FMC for all FMC operations

Note: Moving the source select switch will cause LNAV and VNAV to disengage.

FMC Alert Light

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. FMC Alert Light

Illuminated (amber) – an alerting message exists for both CDUs, or test switch is in position 1 or 2.

Push – both pilots' FMC alert lights extinguish.

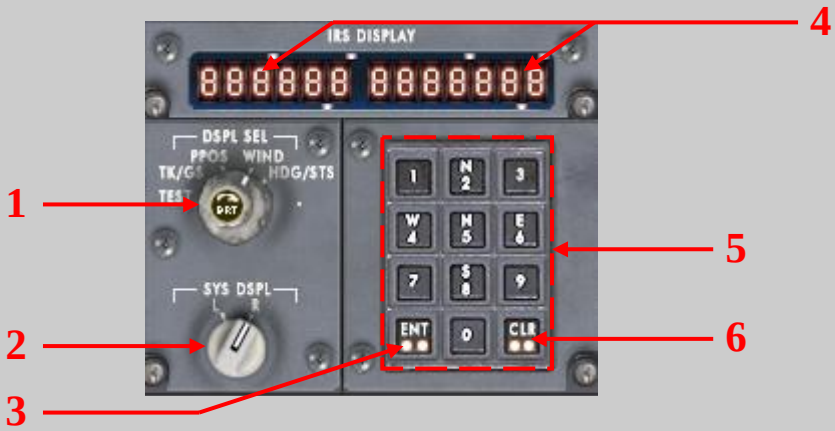
Global Positioning System (GPS) Light

AFT OVERHEAD PANEL

1. Global Positioning System (GPS) Light

Illuminated (amber) – indicates failure of both GPS sensor units.

Inertial System
IRS Display Unit (ISDU)



AFT OVERHEAD PANEL

1. Display Selector (DSPL SEL)

The DSPL SEL switch selects the data to display from the air data inertial reference units (ADIRU). The DSPL SEL switch has these positions:

TEST (spring–loaded to TK/GS) –
- all lights in data displays and on the mode selector unit momentarily illuminate, followed by a 10 second self–test

TK/GS –
- left window displays true track (course)
- right window displays present ground speed (knots).

PPOS –
- left window displays present latitude
- right window displays present longitude.

WIND –
- left window displays present inflight true wind direction
- right window displays present inflight wind speed (knots).

HDG/STS –
- left window displays present true heading
- during alignment, right window displays minutes remaining until alignment is complete.

2. System Display (SYS DSPL) Selector

The SYS DSPL switch selects left or right ADIRU data to display on the IRS display.

L – selects left IRS for the data displays.

R – selects right IRS for the data displays.

3. Enter (ENT) Key

Illuminated (white) – N, S, E, W, or H entries are being keyed.

Push – keyed data is entered into IRS.

4. Data Displays

The IRS display is a 13-character display that can display numbers and the letters N, S, E, and W for the IRS selected with the system display selector

5. Keyboard

Use the keyboard on the panel to enter latitude, longitude and heading data.

Push –
- alpha keys:
  - data displays are controlled by the keyboard when the N, S, E, W (latitude/longitude) or H (heading) keys are pushed
  - pushing an alpha key arms the keyboard for numeric entries.
- numeric keys:
  - permit manual entry of present position when ALIGN light is illuminated

- permit manual entry of magnetic heading when either mode selector is in ATT.

6. Clear (CLR) Key

Illuminated (white) – an ENT attempt has failed (entry not accepted by IRS).

Push – clears data display of any data not yet entered or accepted.

IRS Mode Selector Unit

AFT OVERHEAD PANEL

1. ALIGN Light

Illuminated (white) –
- steady – the related IRS is operating in the ALIGN mode, or the initial ATT mode
- flashing – alignment cannot be completed due to no present position entry.

Extinguished –
- IRS not in ALIGN mode
- with mode selector in NAV, alignment is complete, and all IRS information is available
- with mode selector in ATT, attitude information is available. Heading information is available following entry of initial magnetic heading.

2. FAULT Light

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected.

3. Inertial Reference System (IRS) Mode Selector

OFF – alignment is lost

ALIGN –
- rotating the selector from OFF to ALIGN initiates the alignment cycle
- rotating the selector from NAV to ALIGN automatically updates alignment and zeroes ground speed error.

NAV –
- system enters the NAV mode after completion of the alignment cycle and entry of present position

- in NAV mode, all IRS information is available to airplane systems for normal operations.

ATT – provides only attitude and heading information:

- attitude information is invalid (attitude flag in view) until ALIGN light is extinguished
- heading information is invalid (heading flags in view) until the actual magnetic heading is manually entered after the ALIGN light is extinguished
- position and ground speed information is not available until the IRS is aligned on the ground

4. ON DC Light

Illuminated (amber) –

- the related IRS is operating on DC power from the switched hot battery bus (AC power not normal)
- momentary illumination is normal during alignment self–test.

5. DC FAIL Light

Illuminated (amber) – DC power for the related IRS is not normal

IRS Transfer Switch

FORWARD OVERHEAD PANEL

1. Inertial Reference System (IRS) Transfer Switch

BOTH ON L – switches the flight instruments attitude and heading source to left IRS.

NORMAL – flight instruments attitude and heading source is from default IRS.

BOTH ON R – switches the flight instruments attitude and heading source to right IRS.

Radio Navigation Systems
Automatic Direction Finding (ADF) Control

[Option – 600/700/700C/700ER/800/900/900ER]

AFT ELECTRONIC PANEL

1. Frequency Indicator

Shows the frequency selected with the related frequency selector. As the image shown, click upper area will result ADF code indicator incrementing digits, while click lower area result vice versa.

2. Mode Selector

ADF – ADF bearing sent to the DUs and the standby radio magnetic indicator.

ANT – no ADF bearing data available.

3. Transfer (TFR) Switch

Selects ADF for display.

[Option – BBJ/BBJ2/BBJ3]

AFT ELECTRONIC PANEL

1. Frequency Indicator

Shows the frequency selected with the related frequency selector. Shows if the system is in the ADF or antenna (ANT) mode. As the image shown, click upper area will result ADF code indicator incrementing digits, while click lower area result vice versa.

2. Mode Selector Switch

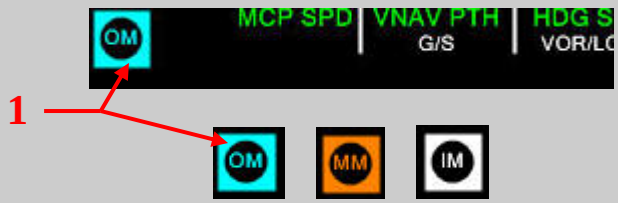
ADF – ADF bearing sent to the DUs and the standby radio magnetic indicator.

ANT – no ADF bearing data available.

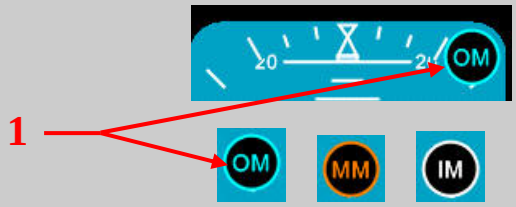
OFF – removes power from selected receiver.

Marker Beacon Annunciations

[Option – EFIS/MAP]



[Option – PFD/ND]



1. Marker Beacon Lights

OM (cyan) – illuminates over an outer marker beacon.

MM (amber) – illuminates over a middle marker beacon.

IM (white) – illuminates over an inner marker beacon.

VHF Navigation Control

AFT ELECTRONIC PANEL

1. Frequency Indicator

Indicates the frequency selected by the frequency selector

2. TEST Switch

Test VHF Navigation system.

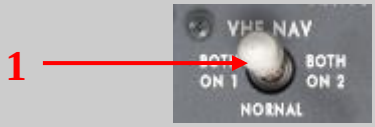
3. Transfer (TFR) Switch

TFR – transfers the frequency in the standby frequency indicator to the active frequency indicator, and the frequency in the active frequency indicator transfers to the standby frequency indicator.

4. Frequency Selector

Rotate – manually selects the standby frequency.

VHF NAV Transfer Switch



FORWARD OVERHEAD PANEL

1. VHF NAV Transfer Switch

The VHF NAV switch on the navigation/displays source select p`anel is a three position switch.

BOTH ON 1 – switches the VHF navigation source to VHF NAV receiver No. 1.

NORMAL – VHF navigation source is from default VHF NAV receiver.

BOTH ON 2 – switches the VHF navigation source to VHF NAV receiver No. 2.

Radio Navigation Systems

[Option – 600/700/700C/700ER/800/900/900ER]

AFT ELECTRONIC PANEL

1. Transponder (ATC) Selector

The transponder select switch is a two-position switch used to select ATC transponder 1 or ATC transponder 2 as the active transponder.

2. Air Traffic Control (ATC) Code Selector

Rotate – You can set transponder code. As the image shown, click upper area will result Transponder code indicator incrementing digits, while click lower area result vice versa.

CAUTION: DO NOT SELECT CODES 7500, 7600 OR 7700. THESE CODES ARE USED ONLY FOR EMERGENCIES.

3. Air Traffic Control (ATC) Code Indicator

Indicates transponder code and operating transponder (1 or 2).

4. Transponder Mode Selector

The transponder mode selector has several positions. These are the functions that the ATC system uses:

TEST – activates ATC transponder functional test.

STBY (standby) – transponder not active.

ALT (altitude reporting) OFF – not modeled.

ALT (altitude reporting) ON – not modeled.

TA(traffic advisory) and TA/RA (resolution advisory) – Refer to Chapter 15, Warning Systems.

5. Transponder (ATC) FAIL Light

Illuminated (amber) – indicates a system failure of the selected transponder.

[Option – BBJ/BBJ2/BBJ3]

AFT ELECTRONIC PANEL

1. Transponder (XPNDR) Selector

The transponder select switch is a two-position switch used to select ATC transponder 1 or ATC transponder 2 as the active transponder.

2. Air Traffic Control (ATC) Code Selector

Rotate – You can set transponder code. As the image shown, click upper area will result Transponder code indicator incrementing digits, while click lower area result vice versa.

CAUTION: DO NOT SELECT CODES 7500, 7600 OR 7700. THESE CODES ARE USED ONLY FOR EMERGENCIES.

3. Air Traffic Control (ATC) Code Indicator

Indicates transponder code and operating transponder (1 or 2).

4. Transponder Mode Selector

The transponder mode selector has several positions. These are the functions that the ATC system uses:

TEST – activates ATC transponder functional test.

STBY (standby) – transponder not active.

ALT RPTG (altitude reporting) OFF – not modeled.

XPNDR (transponder) – not modeled.

TA (traffic advisory) ONLY, and TA/RA (resolution advisory) – Refer to Chapter 15, Warning Systems.

5. Transponder (XPNDR) FAIL Light

Illuminated (amber) – indicates a system failure of the selected transponder.

Flight Management, Navigation Navigation Systems Description

Chapter 11
Section 20

Introduction

Navigation systems include the flight management system (FMS); global positioning system (GPS); air data inertial reference system (ADIRS); radio navigation systems (ADF, ILS, marker beacons, and VOR); and transponder.

Flight Management System

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).

The primary flight deck controls are the AFDS MCP, two control display units (CDU's), two electronic flight instrument system (EFIS) control panels, and an FMC source selector switch. The primary displays are the CDUs, outboard display units, inboard display units, and upper display unit.

Global Positioning System (GPS)

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.

GPS Displays

POS REF page 2/3 shows the left and right GPS latitude and longitude position. POS SHIFT page 3/3 shows the left and right GPS position relative to the FMC position. NAV STATUS page 1/2 shows the GPS currently in use by the FMC for position calculation.

GPS Data

FMC logic selects the position from one of the GPS sensor units as the primary update to the FMC position. The operation of the GPS is completely automatic.

Inertial 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 the air data inertial reference units (ADIRU), an inertial system display unit (ISDU), IRS mode select unit (MSU) and an IRS transfer switch.

Inertial Reference System

Two independent IRSs are installed. The IRSs are the airplane's sole source of attitude

and heading information, except for the standby attitude indicator and standby magnetic compass.

IRS Alignment

An IRS must be aligned and initialized with airplane present position before it can enter the navigation mode. The present position is normally entered through the FMC CDU. If the present position cannot be entered through the FMC CDU, it may be entered through the ISDU keyboard. The airplane must remain stationary during alignment.

Normal alignment between 78 degrees 15 minutes North or South is initiated by rotating the MSU switch from OFF to NAV. The IRS performs a short power test, during which the ON DC light illuminates. When the ON DC light extinguishes and the ALIGN light illuminates, the alignment process begins. Airplane present position should be entered at this time. The alignment time will change between a minimum of 5 minutes at the equator to 17 minutes maximum at 78.25 degrees, north or south latitudes. The alignment time will not be more than 10 minutes if the present position latitude is between 60.0 degrees north or south. The alignment time is fixed at 10 minutes between latitudes of 60.0 and 70.2 degrees north or south. The alignment time is fixed at 17 minutes between latitudes of 70.2 and 78.25 degrees north or south. The ADIRU will not align at latitude more than 78.25 north or south.

If the latitude/longitude position is not within 4 NM of the origin airport, the CDU scratchpad message VERIFY POSITION is displayed. If the entered latitude/longitude position does not pass the IRS internal comparison tests, the scratchpad message ENTER IRS POSITION is displayed.

The flashing ALIGN light alerts the crew that the position entered does not pass the internal comparison tests and should be checked for accuracy. If the test is passed, the IRS will proceed to complete the alignment process and enter NAV mode.

During transit or through–flight stops with brief ground times, a thirty second fast realignment and zeroing of ground speed error may be performed by selecting ALIGN while the airplane is parked. Present position should be simultaneously updated by manually entering latitude and longitude prior to selecting NAV.

Loss of Alignment

If an IRS loses both AC and DC power, the alignment is lost. Alignment can be lost if the MSU switch is moved out of the NAV position.

If alignment is lost in–flight, the navigation mode is inoperative for the remainder of the flight. However, selecting ATT allows the attitude mode to be used to relevel the system and provide an attitude reference. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration stops. The attitude mode can also provide heading information, but crew must manually enter the initial magnetic heading.

Inertial System 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.

Radio Navigation Systems

Automatic Direction Finding (ADF)

Two automatic direction finding (ADF) receivers are installed. The ADF bearing signals are sent to the pointers on the DUs and the standby radio magnetic indicator.

Marker Beacon

[Option – EFIS/MAP]
Marker beacon indications for outer, middle, and inner marker are displayed on the upper outboard corner of the Captain's and First Officer's outboard display units.

[Option – PFD/ND]
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.

Very High Frequency Omni Range (VOR)

Two VOR receivers are installed. Left and right VOR bearings are displayed on the DUs when a valid in–range VOR station is tuned and the respective EFIS control panel VOR/ADF switch is in the VOR position. The DUs also show course deviation.

VHF NAV Transfer Switch

Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.

ATC 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. The TCAS system is described in Chapter 15.

Flight Management, Navigation Chapter 11
Flight Management System Description Section 30

Introduction

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 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, and STARs.

For vertical navigation, computations include items such as fuel data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude restrictions are used to compute VNAV commands.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer (FMC). 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.

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.

Flight Management, Navigation Chapter 11
Flight Management System Operation Section 31

Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and load sheet information are entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the IDENT prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting the appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking the necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase begins at the T/D point. The descent phase extends to the beginning of the approach phase.

Approach

The approach phase begins two miles from the first waypoint of a approach or

approach transition selected from the ARRIVALS page.

Flight Complete

After landing, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

FMC and CDU Terminology

The following information describes the unique terminology which is used to describe the flight crew interaction with the FMC and CDU.

Active – flight plan information that is currently being used to calculate LNAV or VNAV guidance commands. The active waypoint is the point the system is currently navigating toward, and the active performance VNAV mode is the climb, cruise, or descent profile currently being used for pitch and thrust commands. ATC is displayed on the respective page title.

Activate – the process of designating the routes as active. It is a two step process:

- push the ACTIVATE prompt
- push the illuminated execute (EXEC) key.

Altitude restriction – refers to a crossing restriction at a waypoint on the route.

Econ – a speed schedule that is calculated to minimize operating cost of the aircraft. The economy speed is based on a cost index that is entered into FMC during preflight on the PERF INIT page. The cost index is determined by dividing the operating cost of the aircraft by the cost of fuel. If fuel costs are high the number is low A low cost index results in a low cruise speed.

Enter – this is the process of typing or line selecting alphanumeric characters into the CDU scratchpad line and then line selecting the information to the desired location.

Erase – removing of modified LNAV and VNAV path from the system by pushing the LSK adjacent to the word ERASE.

Execute – refers to making entered information part of the active flight plan by pushing the illuminated EXEC key.

Inactive – refers to route, climb, cruise, or descent information that is not currently being used to calculate LNAV or VNAV commands.

Initialize – is the process of entering information into the CDU that is required to make the FMS operative.

Message – refers to information the FMC automatically writes in the scratchpad to inform the flight crew of some condition.

Modify – the changing of active data. When a modification is made to the active route or performance mode, MODE is display in the page title, ERASE appears next to one of the LSK, and the EXEC key illuminates. Pushing the REASE LSK removes the modification. Pushing the EXEC key changes the modified information to active.

Prompt – is something displayed on the CDU page to aid the flight crew in accomplishing a task. It may be boxes, dashes, or a careted (< or >) line to remind the flight crew to enter or validate information on the respective data line.

Select – refers to pushing a key to obtain the desired information or action,

Speed Restriction – refers to an airspeed limit beyond a specified altitude constraint entered by the pilot.

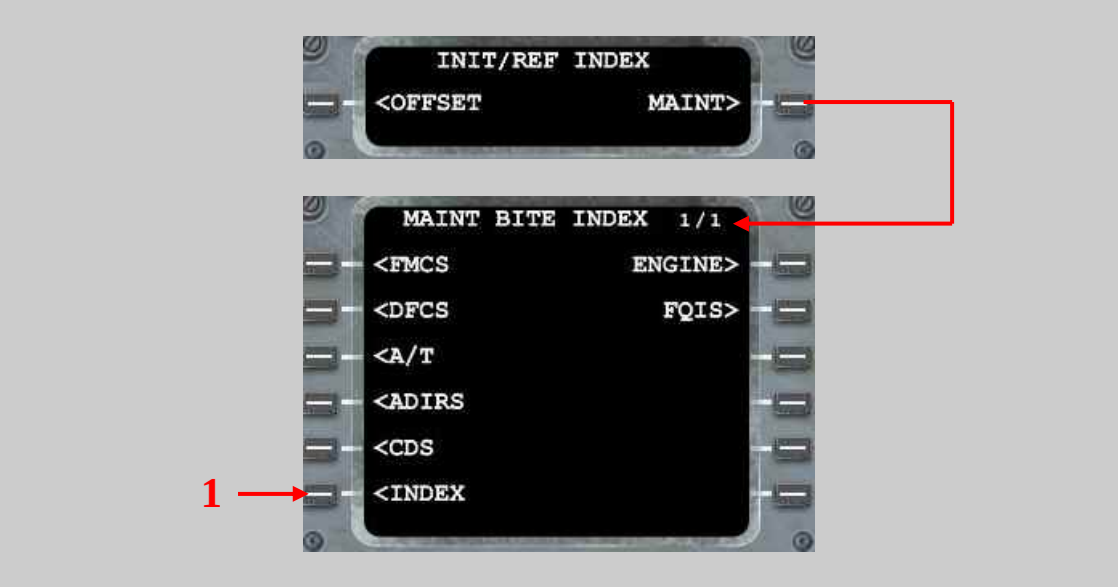
Speed Transition – this is an airspeed limit below a specified altitude which is automatically entered.

Delete – remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Waypoint – refers to a point in the route. It may be a fixed point such as a latitude and longitude, VOR or NDB station, intersection on an airway, or a conditional point. An example of a conditional point is “when reaching 1,000 feet”

Maintenance Index Page

The MAINT BITE INDEX page is available only on the ground.



1. INDEX

Push – displays the INIT/REF INDEX page.

Navigation Position

The FMC determines present position from the IRS, GPS, and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

FMC Position Update

On the ground, the FMC calculates present position based on GPS data. If GPS data is not available, the FMC calculates present position based on IRS data.

In flight, the FMC position is continually updated from the GPS, navigation radios, and IRS. Updating priority is based on the availability of valid data from the supporting systems.

FMC logic selects the GPS position as the primary update to the FMC position. If all GPS data becomes unavailable, the FMC reverts to radio or IRS updating.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint. If selected, LNAV engages when laterally within 3 nautical miles of the active route leg. If outside of 3 nautical miles of the active route leg, LNAV engages if on an intercept heading of 90 degrees or less and the intercept will occur before the active waypoint.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display.

The CDU message NOT IN DATA BASE is displayed if a manually entered waypoint identifier is not stored in the database. The waypoint can still be entered as a latitude/longitude, place–bearing/distance or place–bearing/place–bearing waypoint.

FMC– generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoint Names

VHF and NDB – waypoints located at navaids are identified by the station identifier.

Fix Waypoint Names

Fixes waypoints are identified by the name.

Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure – unnamed fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles, and so forth. Examples:

- GEG006°/20 = D006T.
- EPH145°/24 = D145X

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified as DME station identifier, followed by the radius. Examples:

- CPR338°/29 = CPR29
- GEG079°/30 = GEG30.

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. Examples:

- CPR134°/29 = CP29A
- CPR190° /29 = CP29B
- CPR201°/29 = CP29C.

Conditional Waypoint Names

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Conditional waypoints cannot be manually entered on a route or legs page. These waypoints are events when a condition occurs and are not at a geographically–fixed position. The types of

conditions are:

- passing through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vector to a course or fix.

Conditional waypoints are displayed on the CDU inside (parentheses) marks. A waypoint of “passing through an altitude” is displayed as “(XXX)”, in which XXX is the altitude. For example, “(700)” means to pass the altitude of 700ft. A waypoint of “intercepting a course” is displayed as “(INTC)”; and of “flying a heading to a radial”, as “(ABC123)” where ABC is the navigation station identifier and 123 is the radial. A waypoint of “flying a heading to a DME distance” is displayed as “(ABC-12)” where ABC is the navigation station identifier and the next 2 digits are the DME distance. If exceeds 100NM, the last two digits will be displayed before the navigation station identifier, such as “(23-ABC)”. A waypoint of “heading vector to a course or fix” is displayed as “(VECTOR)”.

Manually Entered Latitude/ Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are displayed in a five–character format. The first three characters are WPT followed by a two digit sequence number. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as WPT01
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displayed as WPT02.

Manually Entered Place–Bearing/Distance or Place–Bearing/Place–Bearing Waypoint Names

Waypoints entered as a place–bearing/distance or place–bearing/place–bearing are identified by the first three characters of the entry followed by a two–digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Restrictions

VNAV controls the path and speed to comply with waypoint crossing restrictions. Waypoint crossing restrictions are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Values entered as part of a procedure and manually entered restrictions are shown in large font. FMC predicted values do not act as restrictions, and are shown in small font.

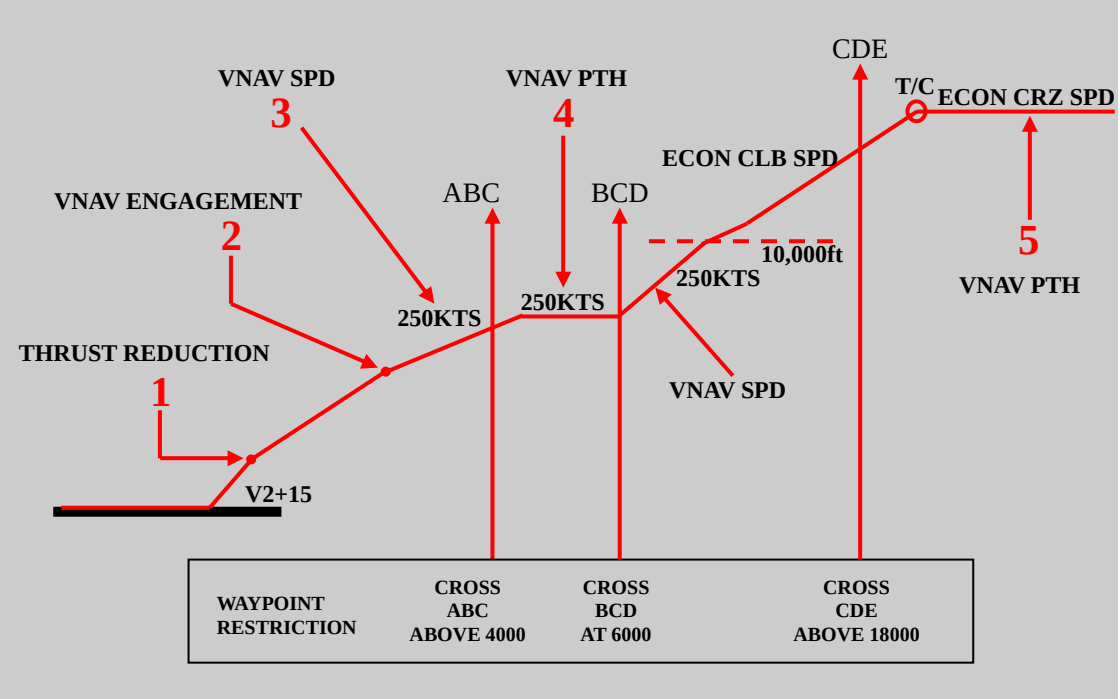
A waypoint restriction is magenta when it is active. The restriction does not have to be in line 1 to be active.

Modified waypoint restrictions are shaded white until they are executed.

At or above altitude restrictions are entered with a suffix letter A (example: 220A). At or below altitude restrictions are entered with a suffix letter B (example: 240B). Mandatory altitude restrictions are entered without any suffix letter (example: 270).

Altitude restrictions that are between two altitudes are displayed with the lower limit first, followed by a suffix letter A, then the upper limit, followed by a suffix letter B (example: 220A240B).

Takeoff and Climb



1. Thrust Reduction

Climb thrust is selected by pushing the N1 switch or automatically upon reaching the thrust reduction altitude.

2. VNAV Engagement

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

3. VNAV Climb

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude restrictions that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

4. Climb Restrictions

VNAV enters the VNAV PTH mode to remain within departure or waypoint restrictions.

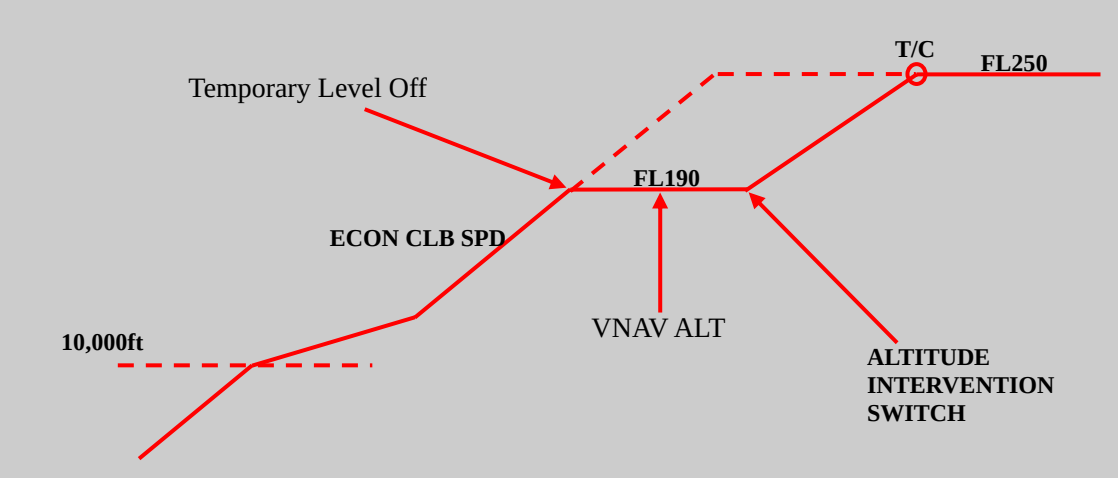
5. Top Of Climb (T/C)

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase.

The T/C point is shown on the map as a green circle with the label T/C.

MCP Altitude Intervention

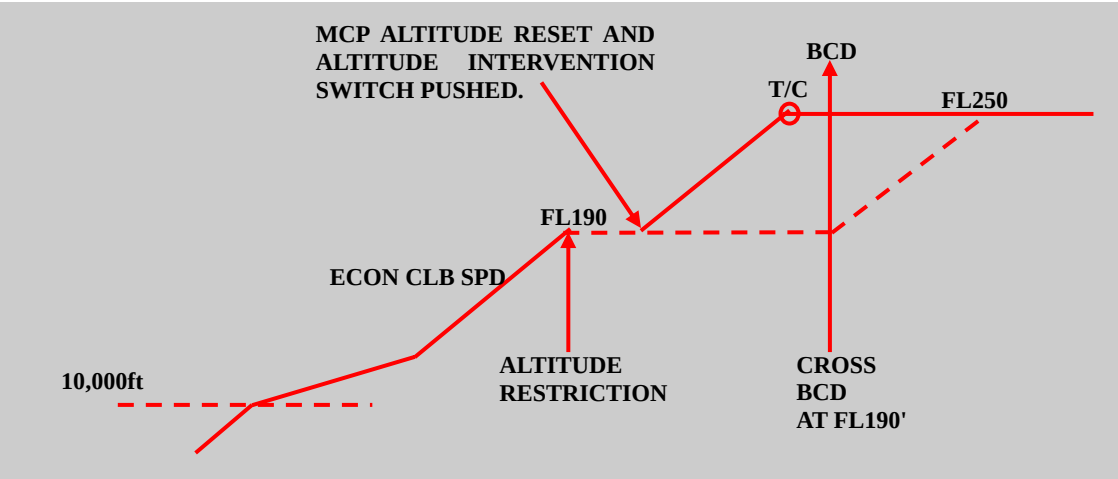
The altitude intervention switch may be used to resume climb after a temporary level off.



Whenever the airplane levels off at an MCP altitude that is not in the FMC, VNAV ALT engages. In the illustration above, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the illustration above, the speed after the temporary level off would be ECON CLB SPEED.

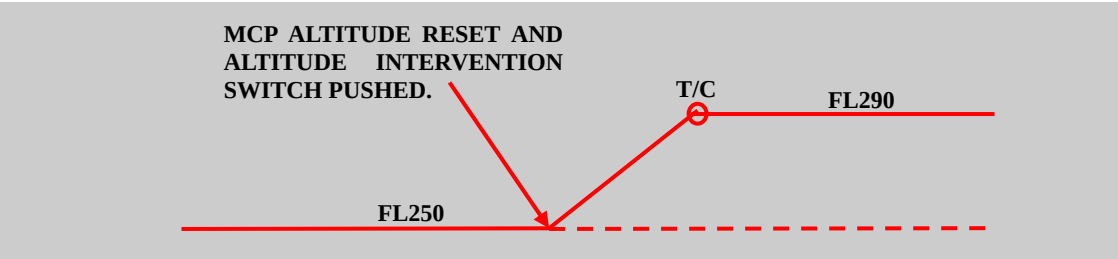
To resume the climb, put the clearance altitude into the MCP altitude window and push the altitude intervention switch. VNAV SPD engages. Pitch maintains FMC speed and thrust increases to the climb limit. In the example, the airplane climbs to FMC CRZ ALT and then levels off in cruise.

The altitude intervention switch may be used during climb or descent to delete altitude restrictions between the current altitude and the MCP altitude. When level at a restriction altitude, and cleared to a higher altitude prior to crossing the restriction waypoint, reset the MCP altitude to the new clearance altitude and push the altitude intervention switch.



In the illustration above, the current altitude restriction is deleted and the airplane continues VNAV climb to the cruise altitude. T/C moves to match the new climb profile.

The altitude intervention switch may be used to increase cruise altitude. When level at a cruise altitude, and then cleared to a higher cruise altitude, reset the MCP altitude to the new cruise altitude and push the altitude intervention switch.



In the illustration above, the cruise altitude is increased and the airplane enters a VNAV cruise climb at the economy cruise speed.

Cruise

At cruise altitude, the FMC sets cruise speed at the default or pilot entered speed until reaching the top–of–descent (T/D) point.

Cruise thrust is set as required to maintain level flight at the target speed, with the autothrottle engaged. The FMC uses maximum range cruise speed if cost index is set to zero.

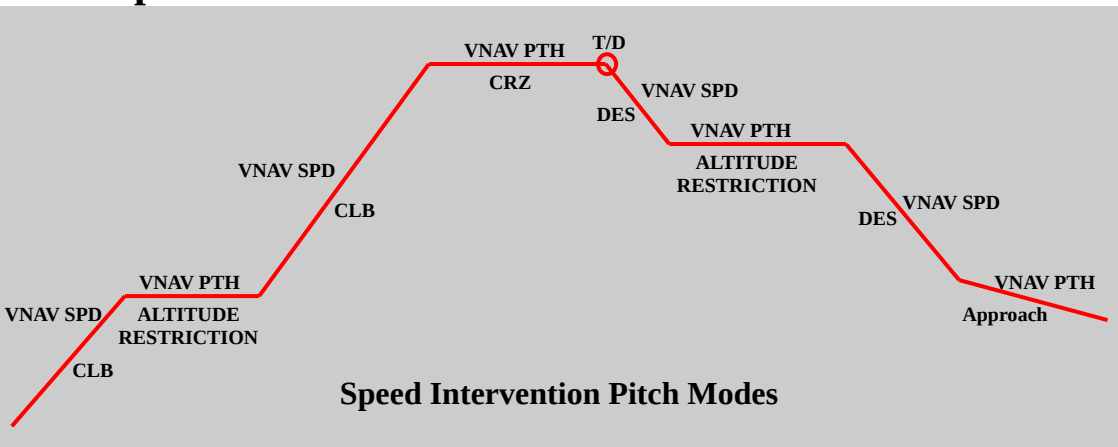
Fuel and ETA predictions are based on a constant altitude cruise unless a step climb altitude is entered.

Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages. The next step point is shown on the map as a green open circle with the label S/C.

MCP Speed Intervention



The above illustration shows VNAV mode for each phase of flight during speed intervention.

With VNAV engaged, pushing the speed intervention switch enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

Descent

VNAV can perform a descent in either of two modes – path descent or speed descent. During a path descent, the FMC uses idle thrust and pitch control to maintain a vertical path, similar to a glideslope in three dimensions. During a speed descent, the FMC uses idle thrust and pitch control to maintain a target descent speed, similar to a level change descent.

Top of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. The T/D point is shown on the map as a green circle with the label T/D. T/D is calculated from an end of descent (E/D) point.

End of Descent (E/D)

The FMC calculates a descent path based on airspeed restrictions, altitude restrictions and the end of descent (E/D) point. The E/D point is shown on the map as a green open circle with the label E/D. VNAV path descent is not available if there is no E/D point.

VNAV Descent and Approach Path

The descent path starts at the calculated top of descent (T/D) point and includes waypoint altitude restrictions. The path is based on:

- idle thrust
- speedbrakes retracted
- descent wind speed decreasing with decreasing altitude
- applicable target speed.

Target speeds are changed by entries on the DESCENT page. Wind and thrust assumptions are changed on the DES FORECASTS page.

During descent, VNAV ALT engages if the airplane levels at an MCP altitude not in the FMC.

VNAV Path Descent

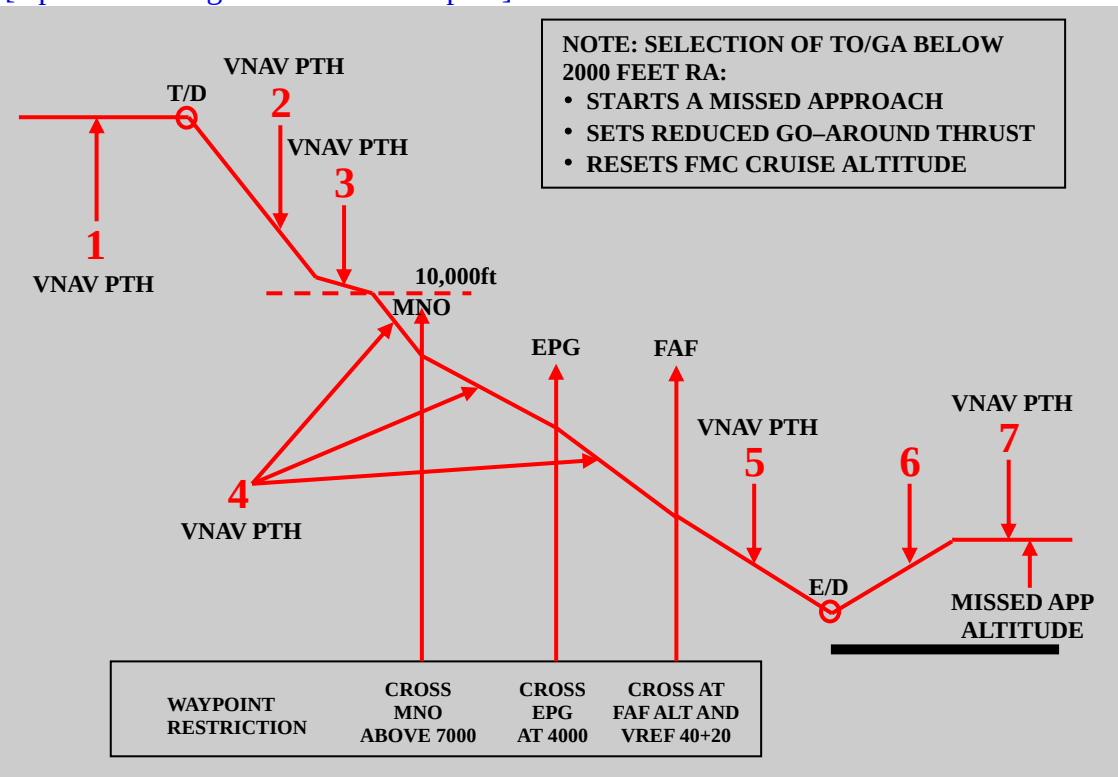
The FMC defaults to the path descent mode for planning purposes. The path descent normally begins automatically at the calculated T/D point. At the T/D, the FMC commands idle thrust and pitch to follow the descent path.

Note: A path descent uses the target speed for planning purposes only. There is no attempt to maintain the target speed during the idle portion of the descent.

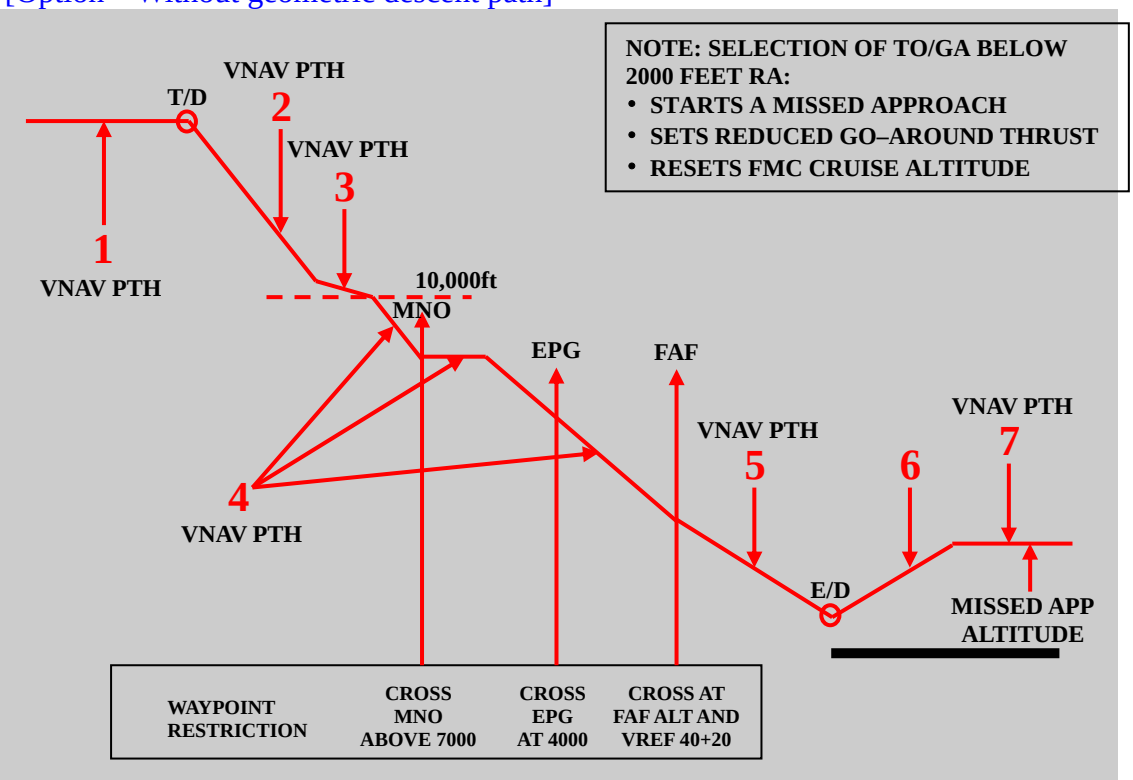
The CDU message DRAG REQUIRED is displayed if an unexpected tailwind results in a significant increase in airspeed to maintain path. VNAV reverts to VNAV SPD if a limit speed will be exceeded.

VNAV Cruise and Path Descent Profile (Instrument Approach using VNAV)

[Option – With geometric descent path]



[Option – Without geometric descent path]



1. Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2. Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV PTH.

3. Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

4. Altitude Restrictions

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF.

[Option – With geometric descent path]
The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. The thrust mode changes to FMC SPD as required to maintain the target speed.

5. Approach

VNAV descends and starts approach in VNAV PTH at the commanded speed.

6. Missed Approach

When TOGA is pushed during approach, VNAV disengages.

When selected during missed approach, VNAV engages in VNAV SPD.

7. Missed Approach Level Off

At missed approach altitude VNAV changes to VNAV PTH.

VNAV Speed Descent

A speed descent may be selected manually by selecting the SPEED prompt on the PATH DES page. With no E/D specified, the speed descent is the only descent mode available.

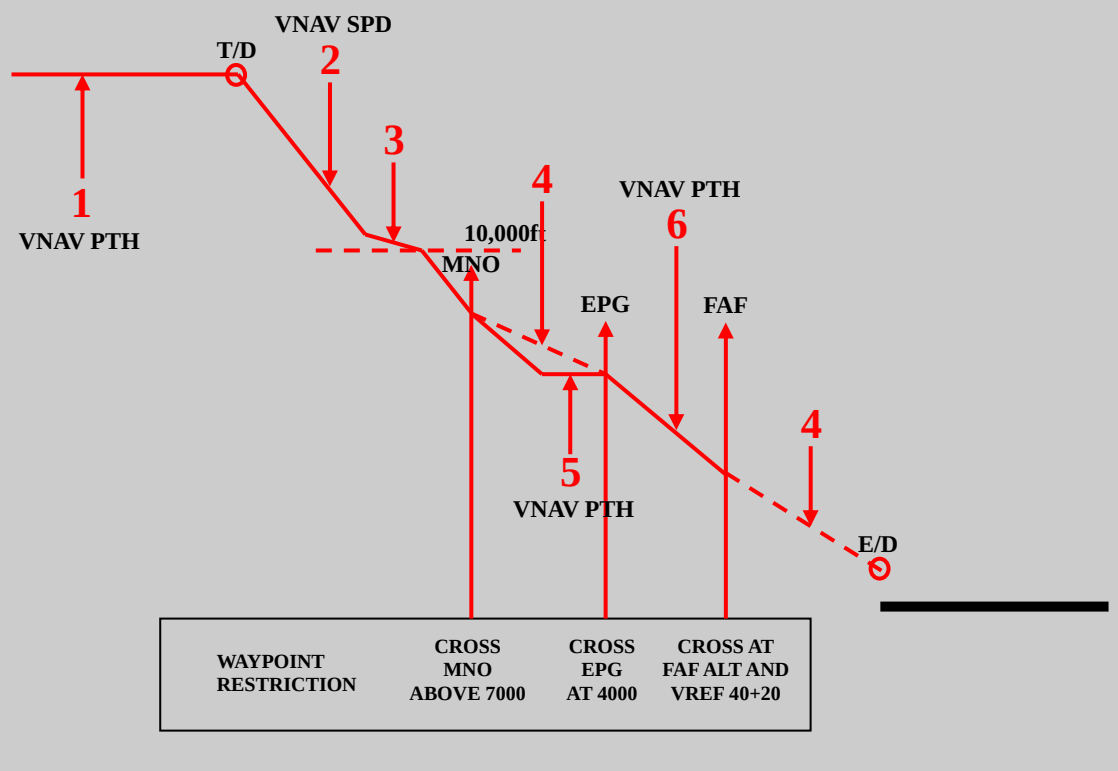
The speed descent maintains the target speed. Normally, the target speed is economy above the airspeed restriction altitude and 240 knots below that altitude. VNAV will not permit descent below the altitude restriction until the airspeed is at or below the restricted value.

The speed descent normally begins automatically at the calculated T/D. At the T/D, the FMC commands pitch to maintain target descent speed.

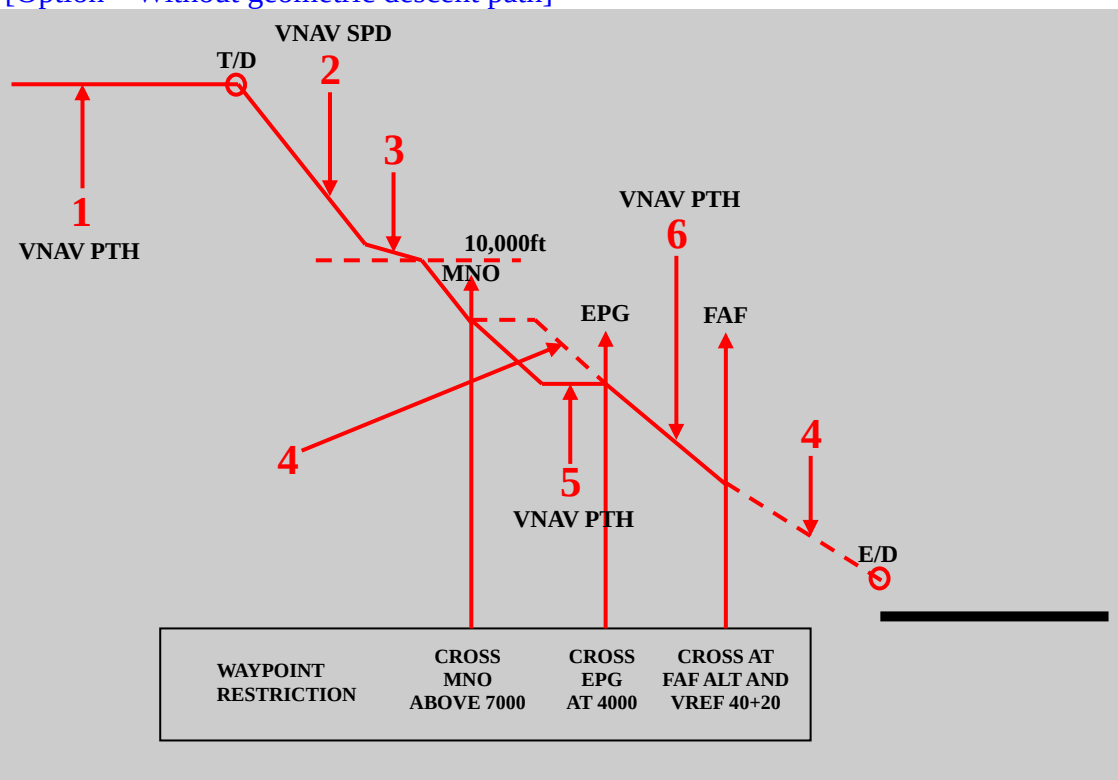
A speed descent cannot automatically revert to a path descent. However, if all required parameters for a path descent are available, a path descent may be manually selected at any time by selecting the PATH prompt on the speed descent page.

VNAV Cruise and Speed Descent Profile

[Option – With geometric descent path]



[Option – Without geometric descent path]



1. Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2. Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV SPD.

3. Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV SPD.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV SPD.

4. VNAV Path

During a speed descent, VNAV may not maintain the FMC computed VNAV path. However, if E/D shows, a VNAV path is available.

5. Altitude Restrictions

VNAV conforms to altitude restrictions at MNO and EPG. After MNO VNAV continues an idle thrust descent using VNAV SPD.

Upon reaching the next altitude restriction, VNAV commands level flight using VNAV PTH. The thrust mode changes to FMC SPD.

6. Descent and Approach

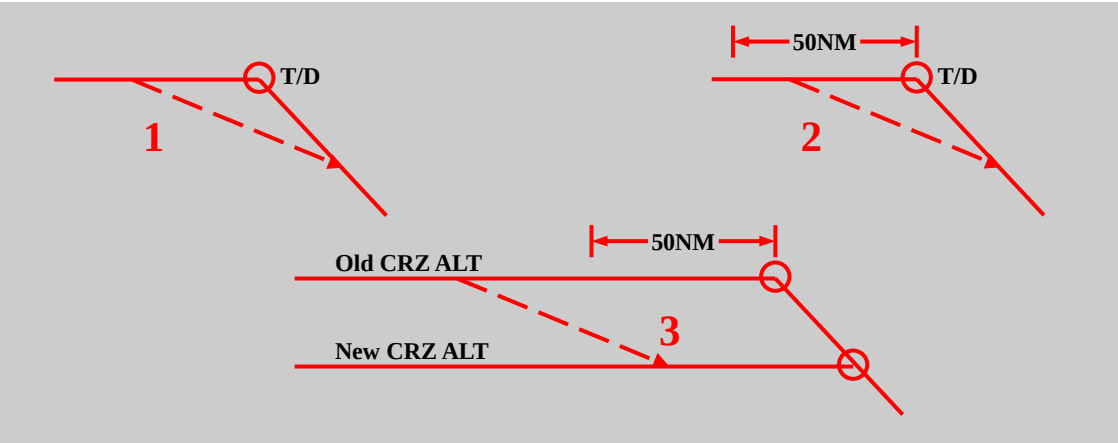
After EPG, VNAV continues the idle thrust descent using VNAV SPD.

Early Descent

A descent in VNAV started before the top of descent point is an early descent. VNAV commands a 1000 fpm descent until the idle descent path is intercepted.

To start an early descent, use DES NOW prompt on the DES page.

An early descent can also be started by pushing the altitude intervention switch.



1. DES NOW

Use the DES NOW prompt on the DES page. VNAV starts an early descent and

captures the idle descent path.

2. Within 50 NM of Top of Descent Point

Use the MCP altitude selector to start an early descent. Within 50 NM of the top of descent point, VNAV starts an early descent and captures the idle descent path.

3. More than 50 NM from Top of Descent Point

Use the MCP altitude selector to start a cruise descent. If the distance from the top of descent is more than 50 NM, VNAV begins a cruise descent to the new cruise altitude.

Approach

The FMC transitions to “on approach” when the airplane is within:

- 2 NM of the first approach waypoint (including approach transitions such as arcs and procedure turns), or
- 2000 feet of airport elevation, whichever occurs first.

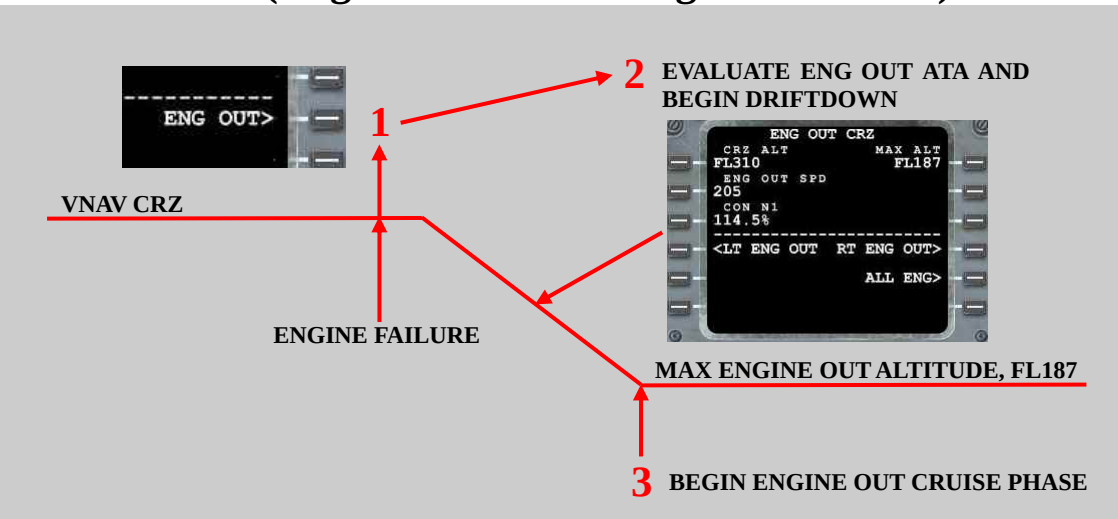
Go-Around

Below 2000 feet radio altitude, the FMC transitions to go-around logic from approach logic when pushing either TO/GA switch.

Once the FMC go-around logic is established:

- the FMC transitions from active descent to active climb
- the thrust limit changes to go-around thrust

VNAV Cruise (Engine Out Above Eng Out Max Alt)



1. Engine Out Modification

Select the ENG OUT prompt on the CRZ page. The ENG OUT page displays the appropriate engine out driftdown performance data to enable the airplane to descend to the engine out maximum altitude.

2. Drift Down Execution

After selecting the left or right ENG OUT mode, perform the driftdown as follows:
- disconnect A/T
- set maximum continuous thrust on operating engine (N1 line)
- set MCP speed to ENG OUT SPD
- set MCP altitude to MAX ALT or lower altitude as required
- select LVL CHG.

The airplane then descends at CON thrust and the driftdown airspeed to the MAX ALT. As the driftdown proceeds and airplane gross weight decreases, the maximum altitude may increase.

3. Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (xxx), four digit (xxxx), five digit (xxxxx), or flight level (FLxxx) numbers. The FMC automatically displays altitude or flight level entries in the proper form based on the transition altitude.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (xxx, FLxxx) entries with transition altitude = 10,000 feet:
- 800 feet is entered as 008 or FL008 and displayed as 800
- 1,500 feet is entered as 015 or FL015 and displayed as 1500
- 11,500 feet is entered as 115 or FL115 and displayed as FL115

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required.

Examples of four digit (xxxx) entries with transition altitude = 18,000 feet:
- 50 feet is entered as 0050 and displayed as 50
- 835 feet is entered as 0835 and displayed as 840
- 1,500 feet is entered as 1500 and displayed as 1500
- 8,500 feet is entered as 8500 and displayed as 8500
- 9,994 feet is entered as 9994 and displayed as 9990.

Five digit entries represent feet, rounded to the nearest ten feet.

Examples of five (xxxxx) digit entries with transition altitude = 4,000 feet:
- 50 feet is entered as 00050 and displayed as 50
- 835 feet is entered as 00835 and displayed as 840
- 1,500 feet is entered as 01500 and displayed as 1500
- 8,500 feet is entered as 08500 and displayed as FL085
- 9,995 feet is entered as 09995 and displayed as FL100
- 11,500 feet is entered as 11500 and displayed as FL115

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed or Mach number. Calibrated airspeeds are entered as three digits (xxx) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash "/." Examples of these pairs include wind direction/speed and waypoint airspeed/altitude restrictions. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line.

Bearing Entry

Entry of a bearing value requires three digits. For example, key 090, not 90. A bearing entry of 360 is displayed as 000.

Plus/Minus Signs

When entering temperature, positive values are assumed by the FMC and + signs are not required. For negative values, key in the – sign.

Flight Management, Navigation Flight Management Computer

Chapter 11
Section 32

FMC Databases

The FMC contains two databases:
- performance database
- navigation database.

The performance database provides the FMC with the information required to calculate pitch and thrust commands. The database includes:
- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

The navigation database includes most information normally determined by referring to navigation charts. The database contains:
- the location of VHF navigation aids
- waypoints
- airports
- runways
- other airline selected information, such as SIDs, STARs, approaches, and company routes.

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 FMC calculates a reference thrust for the following modes:
- takeoff
- derated takeoff
- assumed temperature takeoff
- climb
- reduced climb
- cruise
- continuous
- go–around
- noise abatement (cutback).

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.

The flight crew can specify the thrust reduction height where the transition from takeoff to climb thrust takes place by making an entry on TAKEOFF REF page 2. Allowable entries are 800 feet to 9,999 feet.

With cutback mode selected ON, the flight crew can specify the thrust reduction and restore altitudes on TAKEOFF REF page 2.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Takeoff Derate

Fixed derates can be selected on the N1 LIMIT page. With derated takeoff selected, the thrust setting parameter is considered a limitation for takeoff. Derated takeoff rating can be further reduced by assumed temperature.

Assumed Temperature Thrust Reduction Takeoff

A takeoff thrust less than the full rated thrust may be achieved by using an assumed temperature that is higher than the actual temperature.

Derated Thrust Climb

Two fixed climb thrust derates can be selected on the N1 LIMIT page. CLB–1 provides a climb limit reduced by 10% thrust. CLB–2 provides a climb limit reduced by 20% thrust. The reduced climb setting gradually increases to full rated climb thrust by 15,000 feet. In cruise, the thrust reference automatically changes to CRZ. The reference can be manually selected on the N1 LIMIT page.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity indicating system. Fuel quantity values show on the PERF INIT page and on PROGRESS page 1/4.

The scratchpad message VERIFY GW AND FUEL shows if total fuel quantity data is invalid. The PERF INIT page FUEL line changes to dashes. The flight crew should manually enter estimated fuel weight. Periodic fuel weight update is required for the remainder of the flight to keep gross weight current. The FMC does not update the manual fuel weight entry. The scratchpad message VERIFY GW AND FUEL shows again each 30 minutes if subsequent entries are not performed. The scratchpad message does not show during descent with Vref selected.

The scratchpad message CHECK FMC FUEL QUANTITY shows if the FMC has detected an unexpected drop in fuel quantity.

The FMC continually estimates the amount of fuel that will remain when the destination airport is reached if the active route is flown. The CDU message USING RSV FUEL is displayed if the estimate is less than the fuel reserve value entered on the PERF INIT page. The CDU message INSUFFICIENT FUEL is displayed if predicted fuel at destination will be 2000 lb. (900 kg) or less.

Flight Management, Navigation FMC Preflight

Chapter 11
Section 40

Introduction

Completion of the FMC preflight requires data entry in all minimum required data locations. Completing all required and optional preflight data entries ensures the most accurate performance possible.

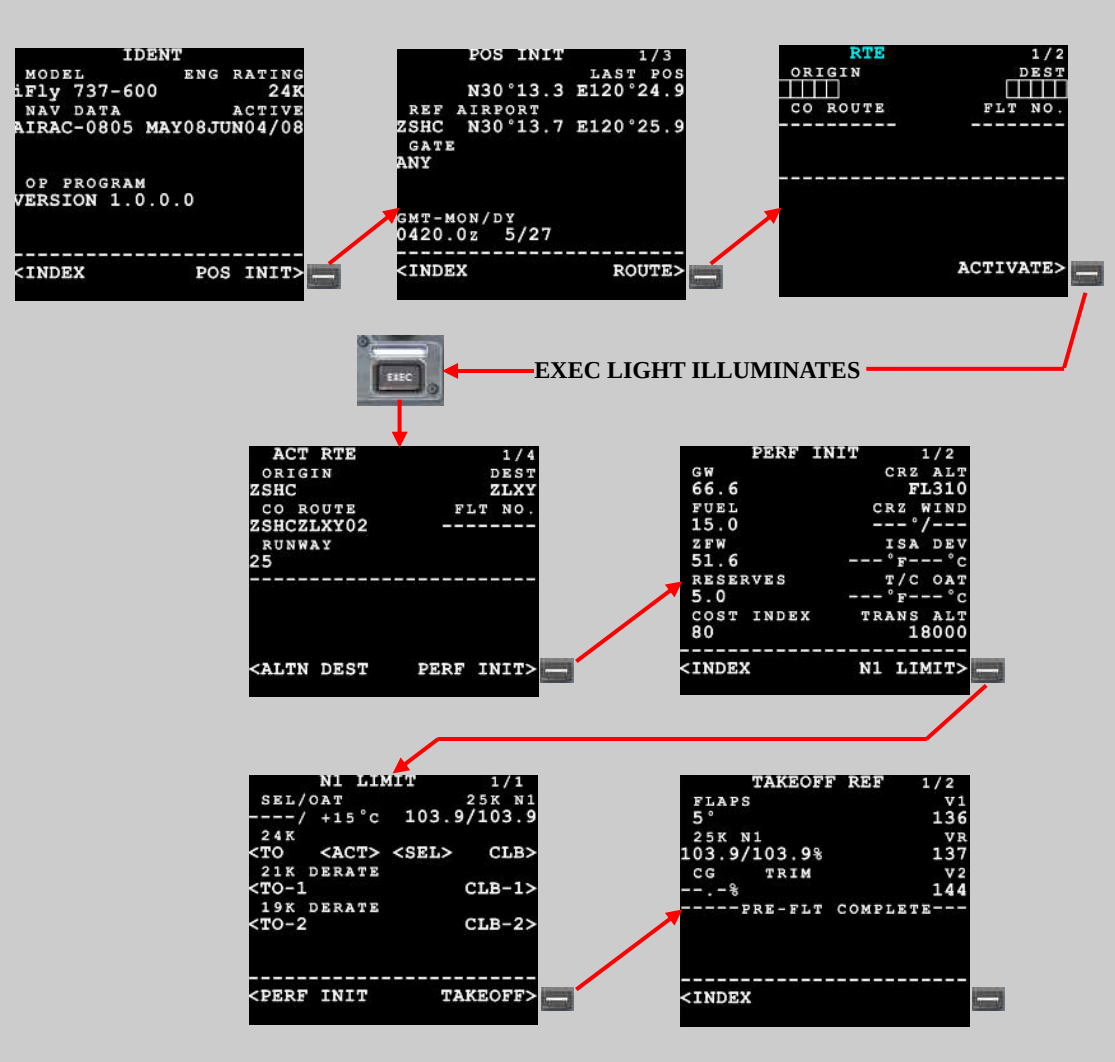
Preflight Page Sequence

The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power–up page is the identification page. Preflight flow continues in this sequence:

- identification page
- position initialization page
- route page
- DEPARTURES page
- performance initialization page
- N1 LIMIT page
- takeoff reference page.

Minimum Preflight Sequence



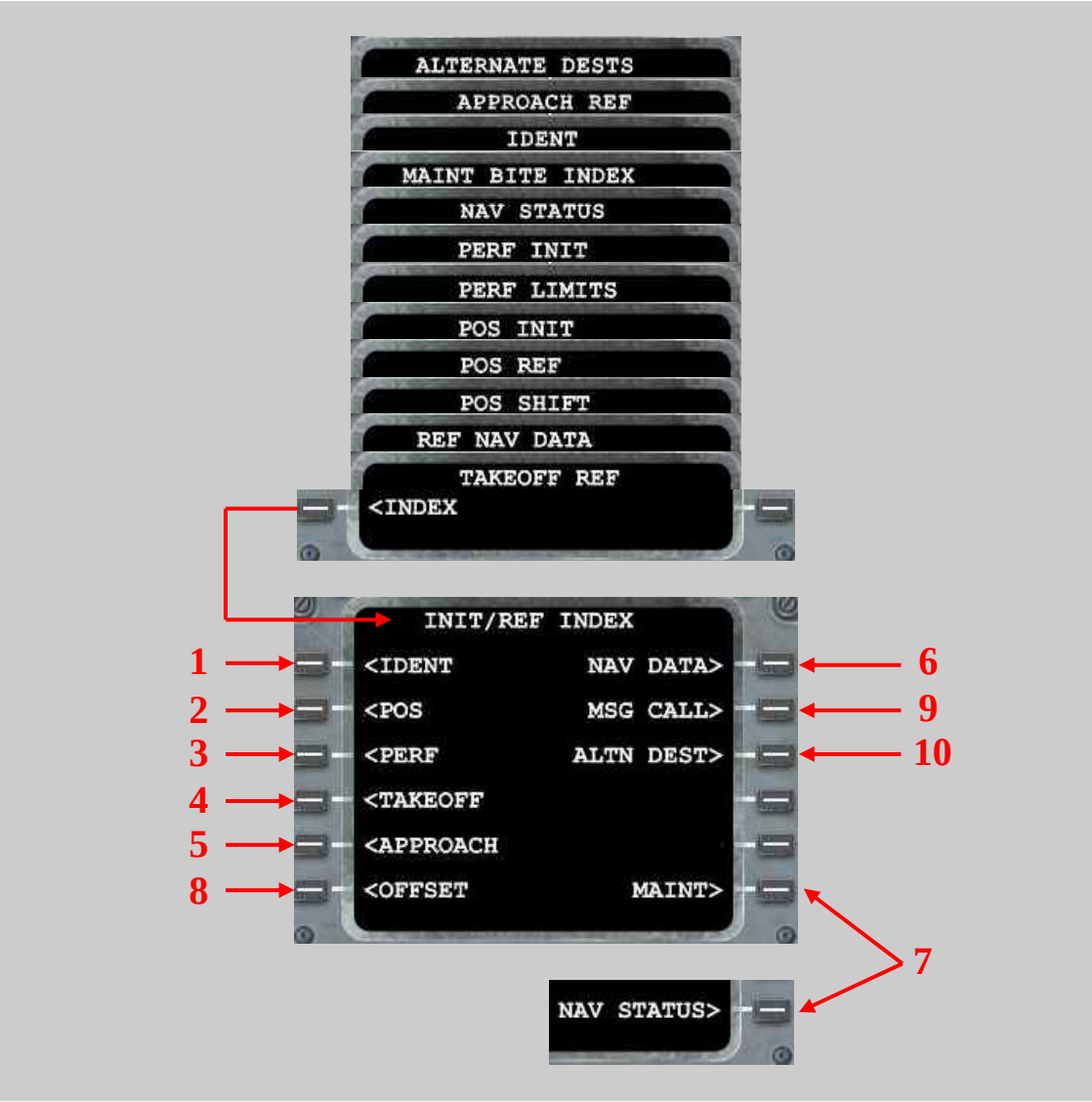
During preflight, a prompt in the lower right of the CDU page automatically directs the crew through the minimum requirements for preflight completion. Pushing the prompt key for the next page in the flow presents new entry requirements. If a required entry is missed, a prompt on the TAKEOFF page leads the crew to the preflight page that is missing data.

Preflight Pages

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The initialization/reference index page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.



1. IDENT

Push – displays the IDENT page.

2. Position Initialization (POS)

Push – displays the POS INIT page used for IRS initialization.

3. Performance Initialization (PERF)

Push – displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

4. Takeoff Reference (TAKEOFF)

Push – displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

5. APPROACH

Push – displays the APPROACH REF page for entry of the approach VREF speed.

6. Navigation Data (NAV DATA)

Push – displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways.

7. Maintenance (MAINT) or Navigation Status (NAV STATUS)

- MAINT – On ground only.
  Push – displays maintenance pages for maintenance use.
- NAV STATUS – Replaces MAINT prompt when in air.
  Push – displays NAV STATUS page which shows status of navigation aids being tuned by the FMC. Replaces MAINT prompt when in air.

8. OFFSET

Push – displays the LATERAL OFFSET page for initiating a lateral offset.

9. Message Recall (MSG RECALL)

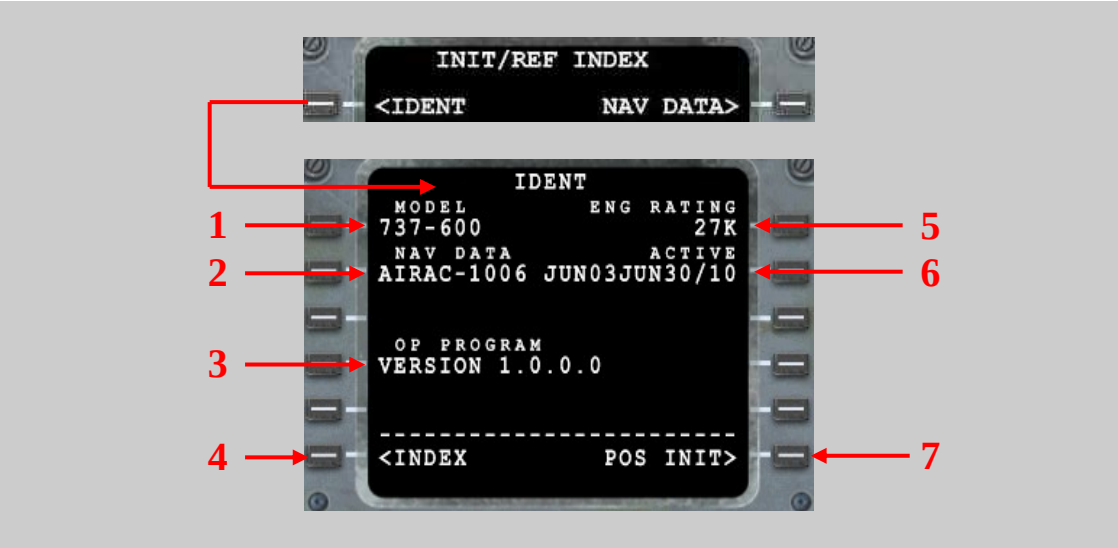
Not modeled.

10. Alternate Destinations (ALTN DEST)

Push – displays the ALTERNATE DESTS page used for alternate airport planning and diversions.

Identification Page

Most of the data on this page is for crew verification. All data on the IDENT page should be reviewed for accuracy and applicability.



1. MODEL

The particular aircraft model contained in the performance database, which in this case, is 737-600.

2. Navigation Data (NAV DATA)

The navigation database identifier is used.

3. Operational Program (OP PROGRAM)

Displays the software version.

4. INDEX

Push – displays the INIT/REF INDEX page.

5. Engine Rating (ENG RATING)

Displays the engine thrust stored in the FMC performance database (e.g., 20K, 22K, 24K, 26K or 27K).

6. ACTIVE Date

Displays the effectively date for the active navigation database.

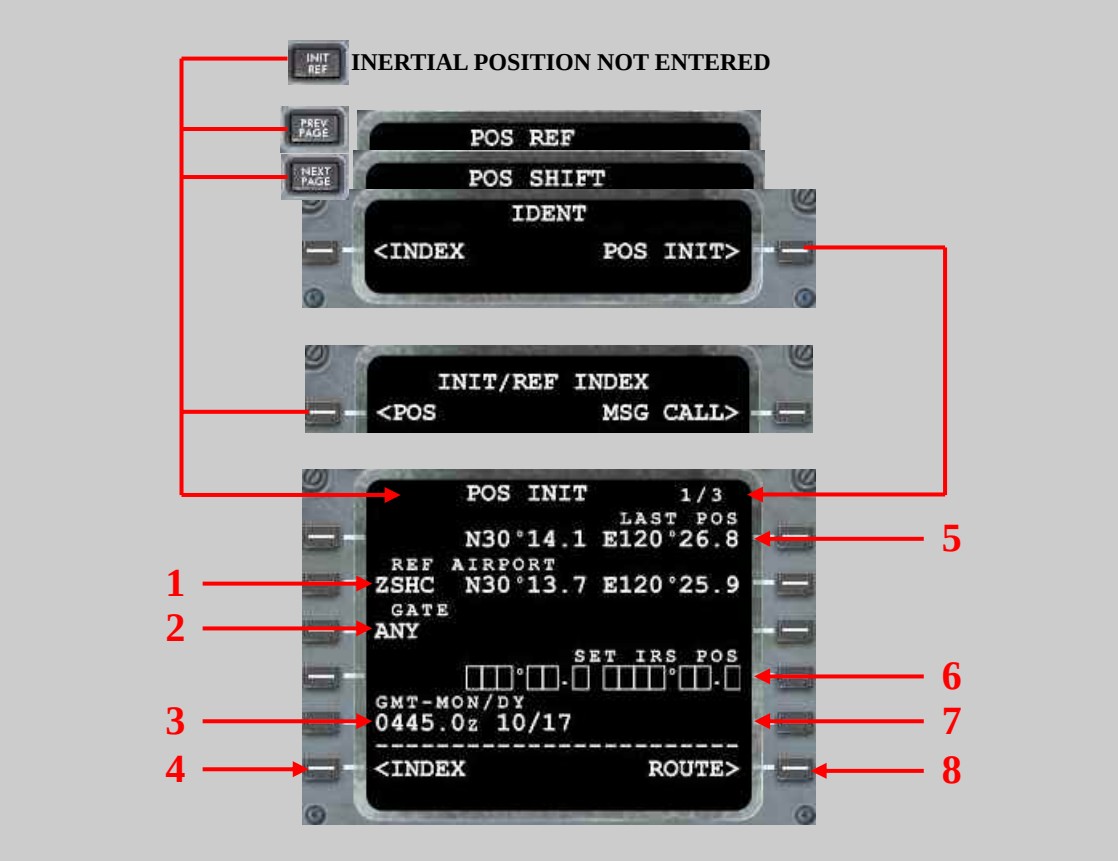
7. Position Initialization (POS INIT)

Push – displays the POS INIT page.

Position Initialization Page 1/3

The position initialization page 1/3 allows the pilot to enter present position into the

IRS during preflight alignment and FMC initialization, enter magnetic heading into IRS during ATT mode operation and check the FMC time reference. Pressing “POS INIT>” LSK on the IDENT page allows access to the POS INIT pages



1. Reference Airport (REF AIRPORT)

The reference airport entry allows entry of the current airport for display of the airport latitude/longitude. Entry is optional. Valid entries are four-character ICAO airport identifiers contained in the navigation database. The REF AIRPORT is cleared once the aircraft is airborne.

2. GATE

Always displays “ANY”.

3. GMT – Month/Day (GMT – MON/DY)

Displays GPS time and date.

4. INDEX

Push – displays the INIT/REF INDEX page.

5. Last Position (LAST POS)

The last latitude/longitude present position is displayed at all times, as calculated by FMC. The data is retained when the aircraft is powered down.

6. Set IRS Position (SET IRS POS)

The boxed prompts are displayed when any IRS is in the ALIGN mode, with the aircraft on the ground, and present position has not yet been entered. The entered data is only displayed until at least one valid IRS enters the NAV mode. Entry into the box prompts can be via the keyboard operation or LSKs at LAST POS or REF AIRPORT. Select the most accurate latitude/longitude for the initialization. Entry of the latitude and longitude sends present position to all inertial reference systems in the ALIGN mode. Blanks when the IRS transitions from the ALIGN mode to the NAV mode.

7. Set IRS Heading (SET IRS HDG)

The data and header lines are blank, except when an IRS is in the ATT mode and then dashes are displayed. Entering heading information resynchronizes the IRS magnetic heading signal for all inertial reference systems in ATT mode.

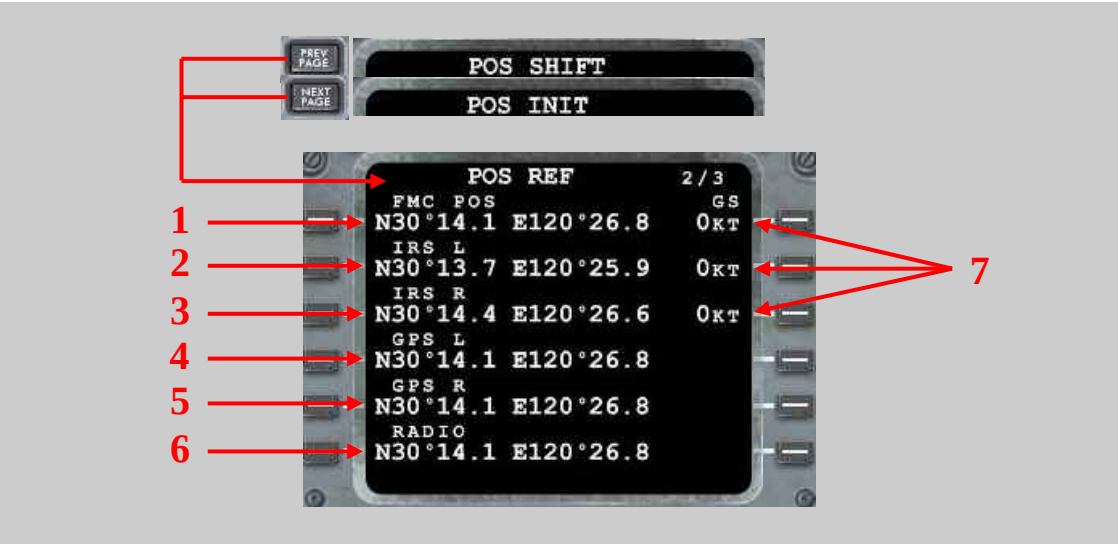
8. ROUTE

Push – displays the ROUTE page.

Position Reference Page 2/3

Position reference page 2/3 displays present position and ground speed as computed in the FMC and each IRS, GPS, and radio navigation receivers.

This page displays latitude/longitude. All position displays are in actual latitude and longitude, as calculated by the respective system. Ground speed is displayed for the FMC and each IRS.



1. FMC Position (FMC POS)

Displays the present FMC computed latitude/longitude. If the FMC position is invalid, blanks are displayed.

2. IRS L

When valid, displays the latitude/longitude position as determined by the left IRS.

When left IRS position is invalid, this line is blank.

3. IRS R

When valid, displays the latitude/longitude position as determined by the right IRS. When right IRS position is invalid, this line is blank.

4. GPS L

Displays the latitude/longitude position as determined by the left GPS. Blank if GPS position is invalid.

5. GPS R

Displays the latitude/longitude position as determined by the right GPS. Blank if GPS position is invalid.

6. RADIO

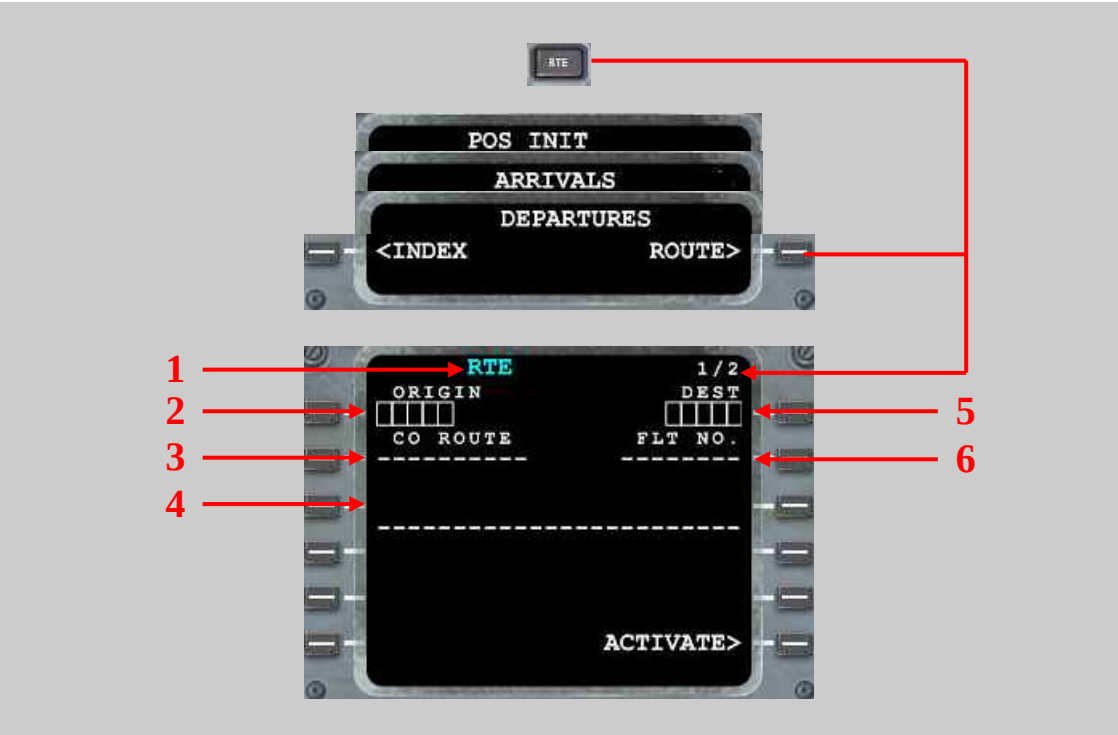
Displays the latitude/longitude position as determined by the navigation radios. Blank if on the ground or if radio position is invalid in flight.

7. Groundspeed (GS)

Displays the ground speed for FMC and IRS. Blank if ground speed of related system is invalid.

Route Page 1/X

The route is entered and displayed in air traffic control format. The first route page displays origin and destination data. Route segments are displayed on subsequent route pages.



1. Page Title

The word ACT appears to the left of the title when the route has been activated and executed. The word MOD appears to the left of the normal title when the route is modified and the change is not executed. Multiple route pages are indicated by the page sequence number to the right of the title.

2. ORIGIN

Allows entry of the origin airport using ICAO identifiers contained in the navigation database. An entry is required for route activation. Valid entries are accepted when the box prompts are displayed. Entry clears any previous route, and allows entry of departure or arrival procedures. Entry is inhibited in flight for the active route. Automatically entered as part of a company route.

3. Company Route (CO ROUTE)

Valid entry is to type the pre-planned route file name into CDU, the maximum length of the file name is 10 letters. If the name is not contained in the NAV database, the scratchpad message NOT IN DATA BASE is displayed.

Inflight entry is inhibited for the active route.

4. RUNWAY

Line title does not display until after entry of origin airport. Valid entries are runway numbers contained in the NAV database for the airport entered into the origin.

5. Destination (DEST)

Enter the ICAO airport identifier for the destination of the route. An entry is required for route activation. Entries must be in the navigation database. New entries on an active route display MOD in the route title. Automatically entered as part of a company route.

6. Flight Number (FLT NO.)

Enter the company flight number. Entry is optional for activation of the route. Limited to 10 characters. Flight number is included in the PROGRESS page title.

Route Pages 1/X and 2/X with Data Entries

1. VIA

VIA column displays the route segment to the waypoint or termination in the TO column. Entry of an airway in the VIA column displays boxes in the TO column.

2. TO

TO column displays the selected end waypoint or termination of the route segment in the VIA column. Dash prompts appear on the first TO waypoint following the end of the route.

3. ACTIVATE

Pushing the ACTIVATE key arms the route for execution as the active route.

After route activation, the ACTIVATE prompt is replaced by:

- PERF INIT, when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete.

Additional Route Page Prompts for an Activated Route

1. ERASE

Push – removes all pending modifications.

Displayed only during modifications.

2. Performance Initialization (PERF INIT)

Push – displays PERF INIT page.

Displayed only on the ground when required entries on the PERF INIT page are incomplete.

3. TAKEOFF

Push – displays TAKEOFF REF page 1/2.

Displayed only on the ground when all required entries on the PERF INIT page are complete.

4. OFFSET

Push – displays LATERAL OFFSET page.

Displayed only in flight.

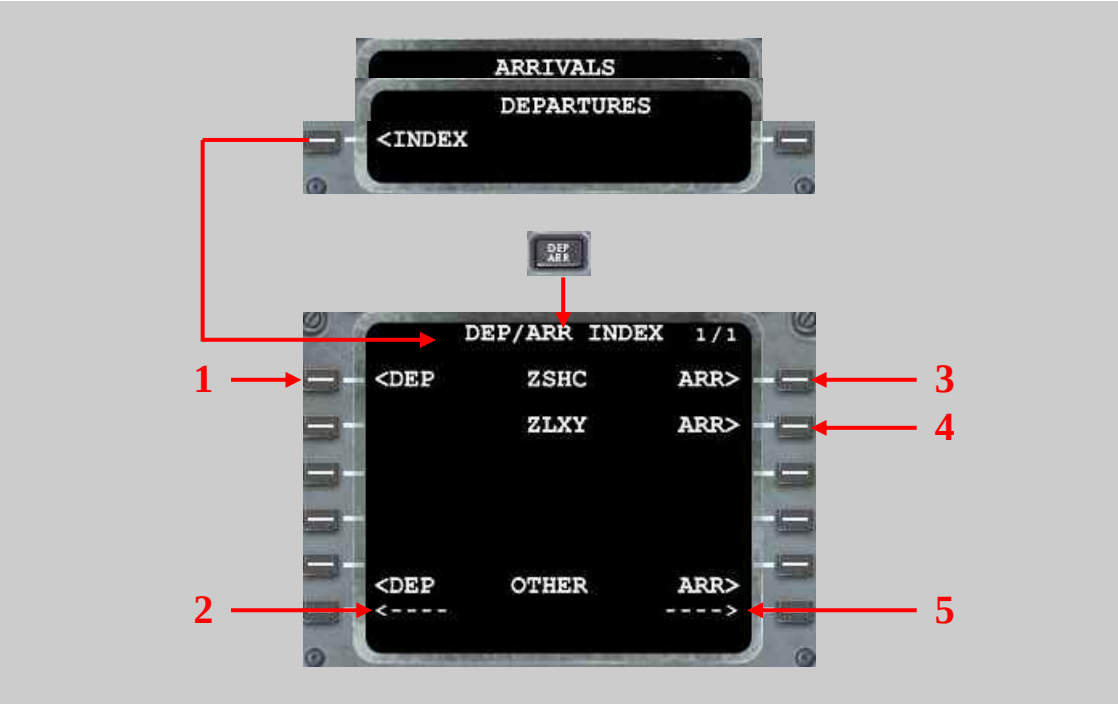
5. Alternate Destination (ALTN DEST)

Push – displays ALTERNATE DESTS page 1/6.

Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival information for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



1. Departure (DEP) – Origin

Push – displays the departure page for origin airport.

2. Departure (DEP) – OTHER

Displays the departure page for the airport entered into this line through the scratchpad. DEP prompt for OTHER allows display of departure information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

3. Arrival (ARR) – Origin

Push – displays the arrival page for origin airport. Origin airport arrivals selection is used during a turn–back situation.

4. Arrival (ARR) – Destination

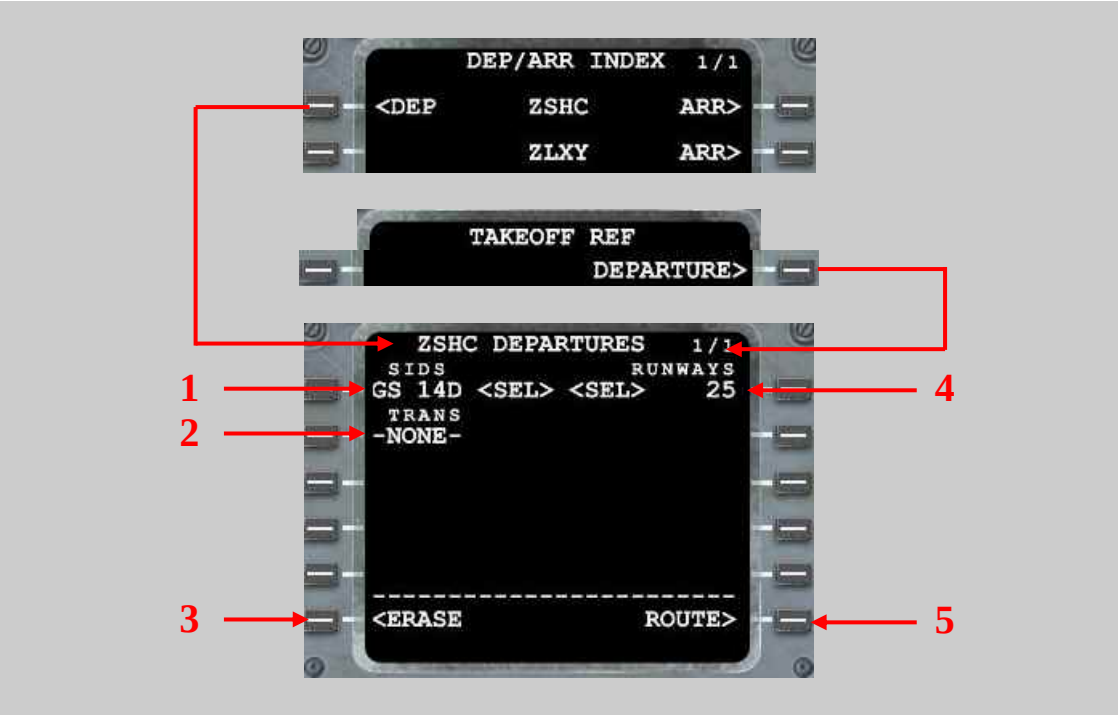
Push – displays the arrival page for destination airport.

5. Arrival (ARR) – OTHER

Displays the arrival page for the airport entered into this line through the scratchpad. ARR prompt for OTHER allows display of arrival information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

Departures Page

The departures page is used to select the departure runway, SID, and transition for the route origin airport.



1. Standard Instrument Departures (SIDS)

Displays SIDS for the airport and runway selections.

2. Transitions (TRANS)

Displays transitions compatible with the selected SID.

3. ERASE/INDEX

ERASE is displayed when a route modification is pending.

Push – removes route modifications that are not executed and restores the original route.

INDEX is displayed when no route modification is pending.

Push – displays the DEP/ARR INDEX page.

4. RUNWAYS

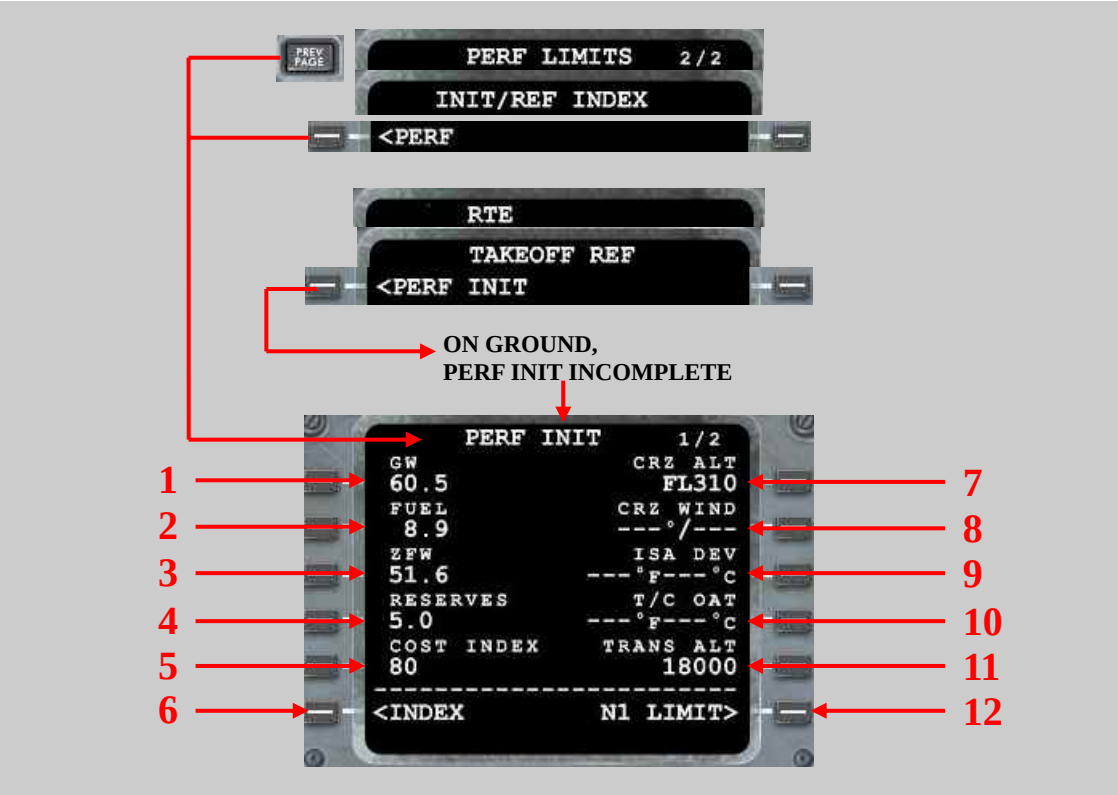
Displays a list of runways for the selected airport.

5. ROUTE

Push – displays the RTE page.

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This information is required for VNAV calculations.



1. Gross Weight

The Gross Weight (GW) is displayed in thousands of pounds or thousands of kilograms. The gross weight is always the sum of the Zero Fuel Weight (ZFW) and the Fuel Weight. If the fuel quantity indicating system is inoperative, the gross weight field is blank until a manual fuel entry is made.

Valid entries for gross weight is xxx, xxx.x, xx or xx.x.

Automatically displays calculated weight when zero fuel weight is entered first.

2. FUEL

Fuel on board is automatically displayed as received from the airplane fuel quantity indication system.

In flight, when the FMC is not receiving the required fuel data, the CDU displays dashes and allows manual entry of fuel weight. After manual entry, MAN (manual) appears next to the fuel weight. Manual entry of fuel weight should continue approximately every 30 minutes for the remainder of the flight to keep gross weight current.

3. Zero Fuel Weight (ZFW)

Zero Fuel Weight (ZFW) is displayed in thousands of pounds or thousands of kilograms. Box prompts are displayed until a valid gross weight and fuel quantity are displayed. Entry results in the calculation and displayed of Gross Weight. Calculated zero fuel weight is automatically displayed if airplane gross weight is entered first and fuel on board is valid.

Valid entries for zero fuel weight is xxx, xxx.x, xx or xx.x.

Enter gross weight or zero fuel weight, but not both. Either entry enables the FMC to calculate the other and display the result in the applicable data field.

4. RESERVES

The fuel reserves weight is displayed in thousands of pounds or thousands of kilograms. The reserves weight is used in determining an insufficient fuel condition, and in calculating performance predictions.

Entry is required to complete the preflight.

Valid entry is xx or xx.x.

5. COST INDEX

The Cost Index line is used to computations of ECON speed values. The cost index is determined by dividing aircraft operating cost ($/hour) by fuel cost (cents/pound). Only those portions of operating costs affected by trip time should be included in the calculation.

Valid entries are 0 to 500. 0 causes the ECON speed to be MAX RANGE; 500 results in a minimum time flight.

6. INDEX

Push – displays the INIT/REF INDEX page.

7. Cruise Altitude (CRZ ALT)

Enter the cruise altitude for the route.

8. Cruise Wind (CRZ WIND)

Cruise wind entry provides input to optimize FMC calculations.If no entry made, the FMC assumes zero wind for preflight predictions.

9. ISA Deviation (ISA DEV)

Enter ISA deviation for top of climb altitude. ISA deviation entry provides input to optimize FMC calculations. Entry causes T/C OAT to be computed and displayed.

10. Top of Climb Outside Air Temperature (T/C OAT)

Enter top of climb OAT. T/C OAT entry provides input to optimize FMC calculations. Entry causes ISA DEV to be computed and displayed.

11. Transition Altitude (TRANS ALT)

Manually change transition altitude. CDU altitude data changes from altitudes to flight levels above the transition altitude.

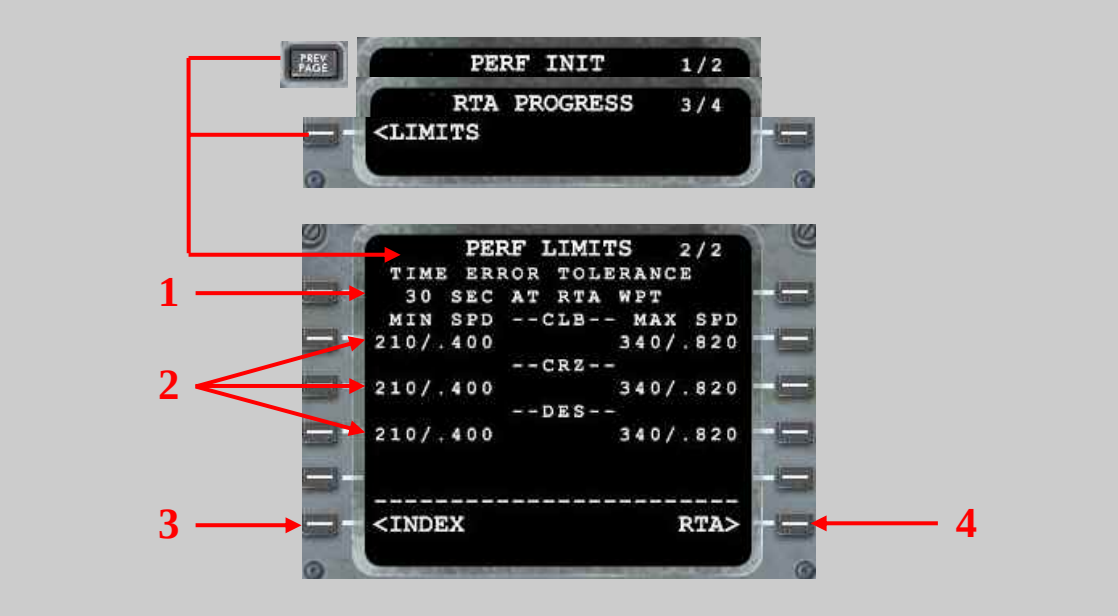
Valid entries are: XXX, XXXX, XXXXX, or FLXXX.

12. N1 LIMIT

Push – displays the N1 LIMIT page.

Performance Limits Page

The performance limits page allows the entry of performance limits affecting RTA and ECON calculations.



1. TIME ERROR TOLERANCE

This shows the time error tolerance at a waypoint which is used by the required time of arrival (RTA) function. The FMC uses this tolerance to calculate the airplane speed. Valid entry range is from 5 to 30 seconds. Default value is 30 seconds and is displayed in small font.

2. Minimum Speed/Maximum Speed (MIN SPD/MAX SPD)

Establishes minimum and maximum speed limits for each phase of flight. Limits both RTA and ECON modes in flight.

Either CAS or Mach can be entered. Default is 100/.400 for lower limit and 340/.820 for upper limit. Default values are displayed in small font and entered values are displayed in large font.

3. INDEX

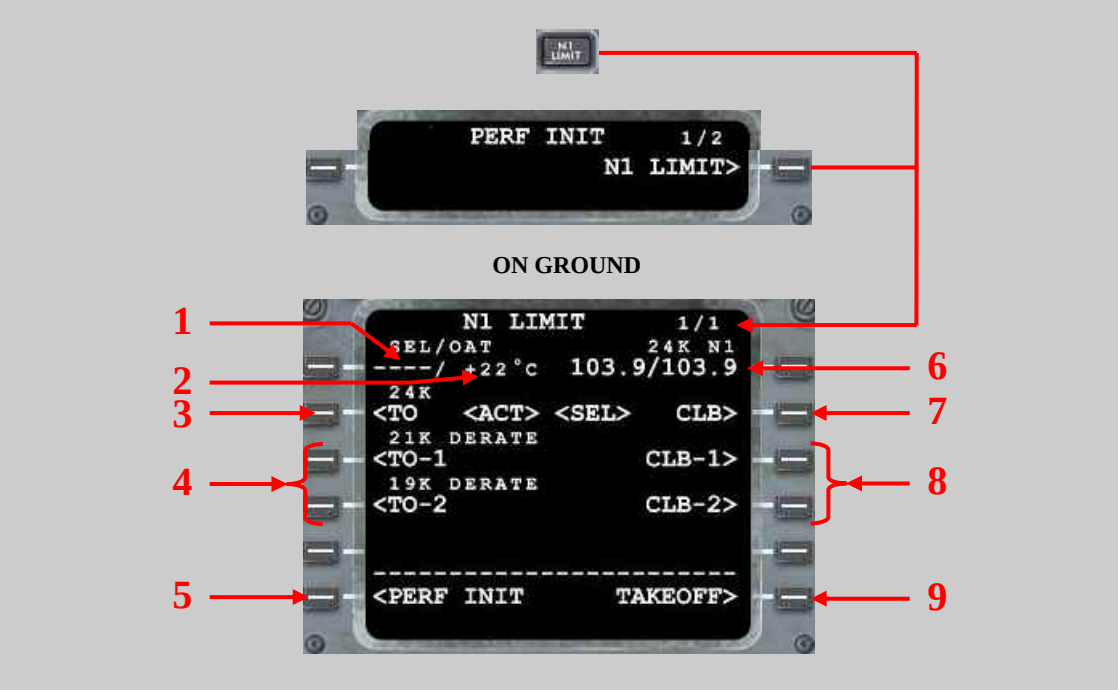
Push – selects INIT /REF INDEX page.

4. Required Time of Arrival (RTA)

Push – selects RTA PROGRESS page.

N1 LIMIT Page - Preflight

This section describes the preflight version of the N1 LIMIT page. See the FMC Takeoff and Climb section for a description of the in–flight version of the N1 LIMIT page.



1. Selected Temperature (SEL)

An assumed temperature (SEL) can be entered for reduced thrust takeoffs. Maximum

allowable entry is 70 degrees C.

2. Outside Air Temperature (OAT)

This data field shows the outside air temperature (OAT) as measured by the aspirated TAT probe or manually entered. Aspirated TAT displays the sensed OAT in small–size characters. Manual entry of actual takeoff OAT is displayed in large–sized characters. Sensed or manually entered OAT is used by the FMC to calculate the takeoff N1 limits.

3. Takeoff Thrust Limit (TO XXK)

Push – selects full rated takeoff thrust limit.

Selection of TO automatically arms CLB thrust. Data line title displays full rated thrust. Typical line titles display as “24K” or “22K”. When a specific takeoff thrust is selected, the <ACT> prompt shows adjacent to the selected thrust. Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

4. Takeoff Derates (TO–1 and TO–2)

Push – selects the associated takeoff thrust limit.

Data line title displays the associated reduced thrust rating. Typical line titles display as “22K DERATE” or “20K DERATE”. Selecting TO–1 automatically arms CLB–1 and selecting TO–2 automatically arms CLB–2. The selected climb thrust shows by the <SEL> prompt in large font adjacent to the selected thrust data field. Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

5. PERF INIT

Push – displays the PERF INIT page.

6. Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff. Data line title displays full rated thrust or selected takeoff derate thrust. This data field displays the active takeoff calculated by the FMC.

7. Climb (CLB)

Push – selects full rated climb thrust limit.

8. Reduced Climb (CLB–1 and CLB–2)

Push – selects the associated reduced thrust climb mode. Manual selection of a climb thrust rating overrides the automatic selection.

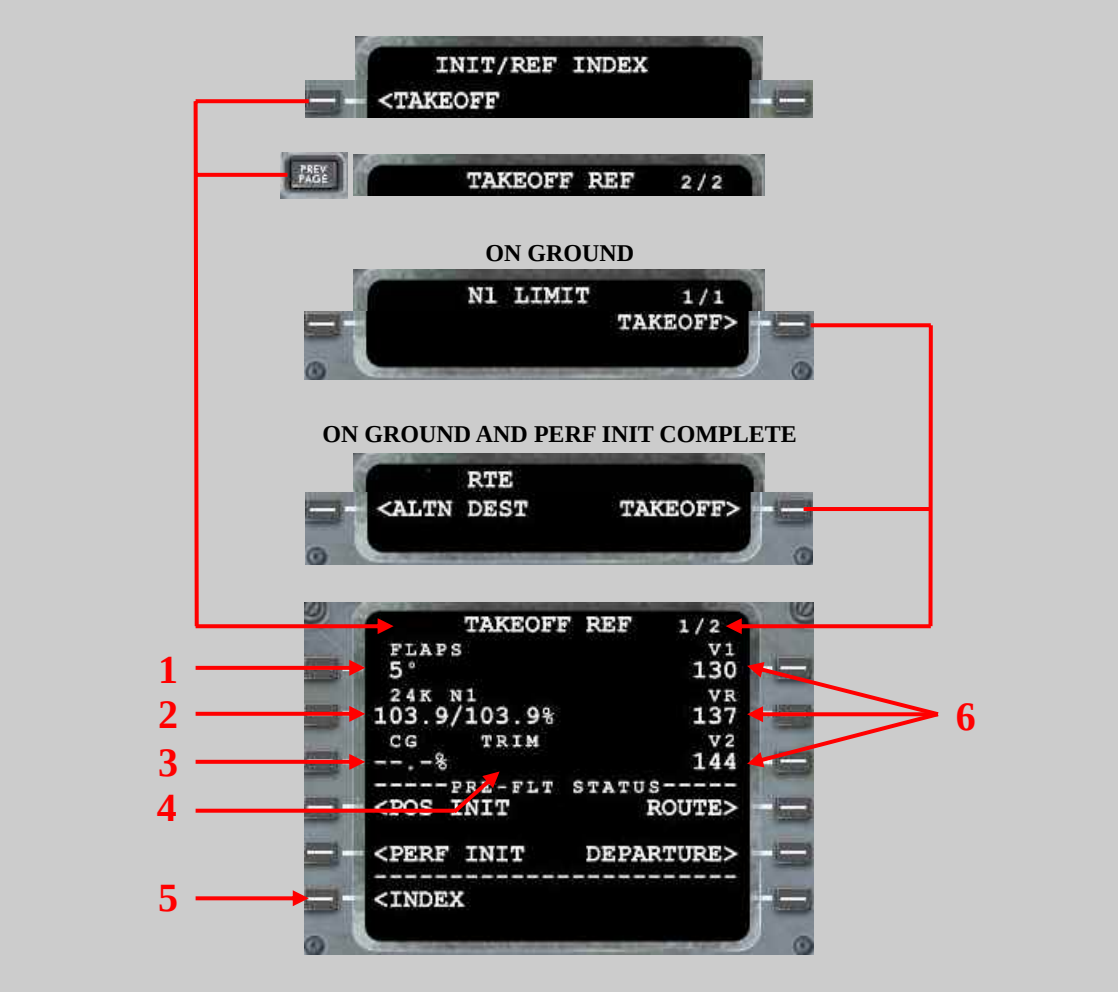
CLB–1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB–2 provides a climb limit reduced by 6% N1 (approximately 20% thrust). The selected climb thrust shows by the <SEL> prompt adjacent to the selected thrust data field.

9. TAKEOFF

Push – displays the TAKEOFF REF page.

Takeoff Reference Page 1/2

The takeoff reference page allows the flight crew to manage FMC calculated takeoff thrusts, crew entered takeoff data, and V speed data.



1. FLAPS

This lets the flight crew enter the takeoff flap setting. Box prompts show before there is a valid entry. Allowable entries are flaps 1, 5, 10, 15, and 25.

2. Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff. Data line title changes to show whether it is one of these:

- Full rated thrust
- Reduced thrust from a SEL (assumed) temperature entry
- First takeoff derate thrust
- Second takeoff derate thrust.

3. Center of Gravity (CG)

Initial display is dashes. After CG is entered, the FMC calculates and displays stabilizer takeoff trim settings.

4. TRIM

Displays stabilizer takeoff trim setting. Display is blank unless CG is entered.

5. INDEX

Push – displays the INIT/REF INDEX page.

6. V Speeds

Crew calculated V speeds may be entered and displayed for reference. The FMC calculated V speeds show in small font. The flight crew accepts the V speed by selection of the appropriate LSK. The V speed will then show in large font under the V speed prompt. Entered V1 and VR will automatically display on the airspeed indication.

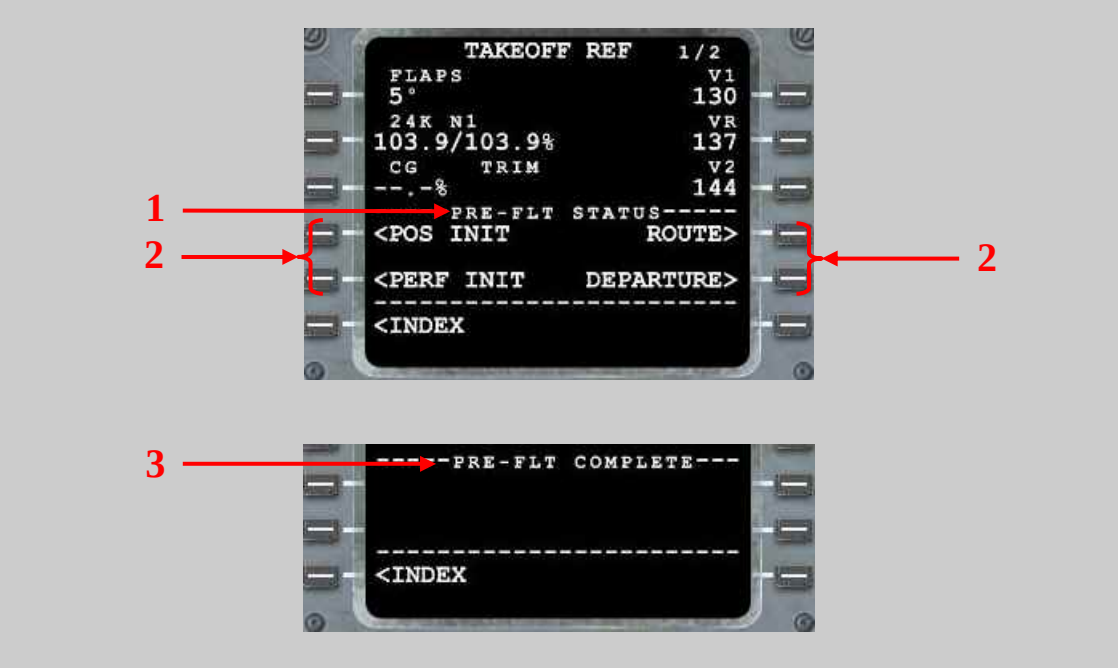
Change of Performance Data After V Speed Entry

V speeds should be entered on the TAKEOFF REF page as a final step of FMC preflight. If V speeds are entered and then performance data is subsequently changed, the FMC automatically removes the previously entered V speeds and the NO VSPD flag shows on the airspeed indication.

In addition, the scratchpad message VERIFY TAKEOFF SPEEDS displays if any of the following items are changed after V speeds have been entered:

- gross weight
- zero fuel weight

Preflight Status



1. Preflight Status (PRE–FLT STATUS)

Displays when required preflight data is not complete.

2. Preflight Incomplete

When required preflight entries are not complete, the related page title displays

- POS INIT – IRS position not entered or invalid
- PERF INIT – required performance data not entered or executed
- ROUTE – required RTE page data not entered
- DEPARTURE – runway or route data not entered on the RTE page.

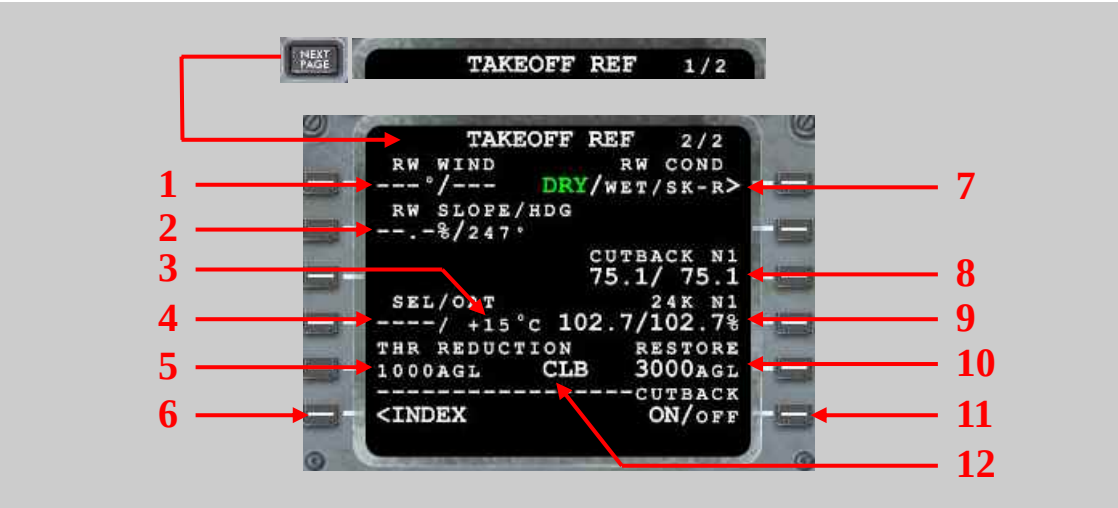
Push – Displays associated page.

3. Preflight Complete (PRE–FLT COMPLETE)

Displayed following completion of required entries on the POS INIT, RTE, and PERF INIT pages.

Takeoff Reference Page 2/2

This page lets the flight crew see the takeoff runway data and takeoff thrusts. It also lets them select a reduced takeoff thrust limit and select the appropriate runway surface condition.



1. Runway Wind (RW WIND)

This lets the flight crew enter the takeoff wind conditions. Entry is optional for preflight completion. The default value is 000/0 and dashes shown before an entry.

2. Runway Slope/Heading (RW SLOPE/HDG)

This lets the flight crew enter the runway slope and the runway heading. It is entered as a percentage either U (+) or D (-) from the runway threshold. If the selected takeoff runway is in the navigation database, the runway heading shows. Otherwise, it must be entered manually.

3. Outside Air Temperature (OAT)

Aspirated TAT displays the sensed OAT in small–size characters. Manual entry of actual takeoff OAT is displayed in large–sized characters.

4. Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1. Maximum allowable entry is 70 degrees C.

5. REDUCTION

With cutback mode OFF, altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

With cutback mode ON, altitude above origin airport elevation at which the transition from takeoff thrust to cutback thrust occurs.

Manual entries allowed on the ground.

6. INDEX

Push – displays the INIT/REF INDEX page.

7. Runway Condition (RWY COND)

Active runway condition is highlighted:
- DRY – Dry runway computations
- WET – Wet runway computations
- SK–R – Skid resistant runway computations

8. CUTBACK N1

FMC calculated cutback N1.

9. Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff. Data line title displays full rated thrust or selected takeoff derate thrust.

10. RESTORE

The altitude at which the normal climb thrust is restored.

11. CUTBACK ON/OFF

Push – selects cutback mode ON/OFF.

Currently selected cutback mode is displayed in large font.

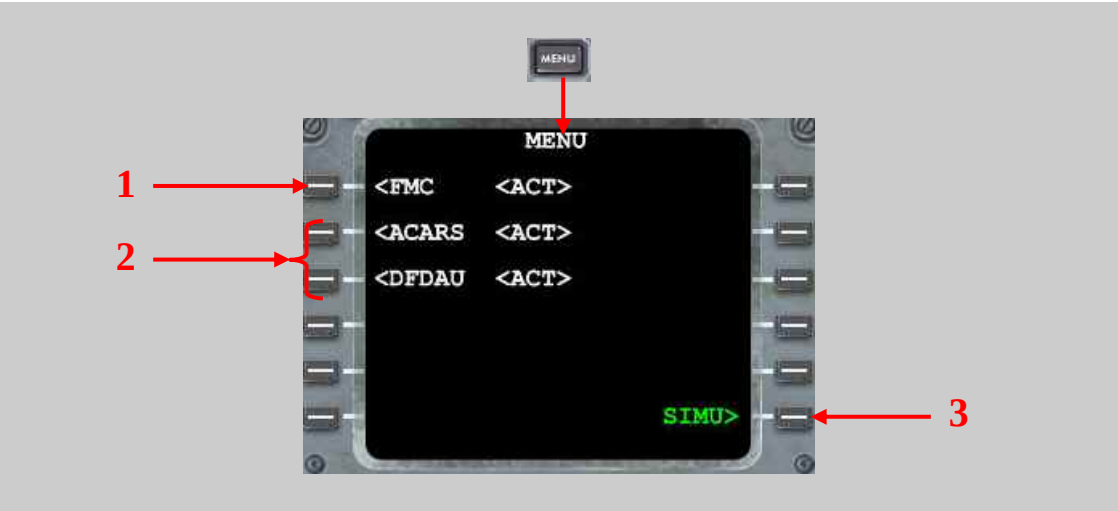
Default is cutback mode OFF.

12. Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

Menu Page

The menu page is selected with the MENU key. The menu consists of a setup page for **iFly Jets: The 737NG**.



1. FMC

Push – displays the IDENT page.

2. Aircraft Subsystems

Not modeled.

3. SIMU

Shows the **iFly Jets: The 737NG**'s menu page.

Flight Management, Navigation Chapter 11
FMC Takeoff and Climb Section 41

Introduction

The FMC takeoff phase begins with the selection of takeoff/go–around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – to make last minute changes to the departure runway
- DEPARTURES page – to make last minute changes to the SID
- CLIMB page – to modify climb parameters and monitor airplane climb performance
- RTE LEGS page – to modify the route and monitor route progress
- PROGRESS page – to monitor the overall progress of the flight
- N1 LIMIT page – to select alternate climb thrust limits
- DEP/ARR INDEX page – to select an approach during a turn–back.

Takeoff Phase

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V2+15 and V2+25 knots.

LNAV can be selected prior to takeoff. Prior to 50 feet radio altitude, roll command is wings level. At 50 feet radio altitude, if within engagement criteria, LNAV engages and provides roll commands to fly the route leg. VNAV may be engaged to control the climb profile.

Note: For LNAV to be engaged on the ground, the departure runway must be selected and the course, to the first waypoint, must be within 5 degrees of the runway heading.

Climb Phase

With VNAV armed during takeoff, VNAV engages at 400 feet and commands acceleration to:

- last MCP speed (V2) + 20 kts until acceleration height
- if an engine failure is detected, target speed will be last MCP speed (V2) + 20 kts if the airplane is at that speed or greater, or the existing speed if the airplane is between V2 and V2 + 20 kts
- the flap placard speed minus 5 kts
- the active target speed
- waypoint speed constraints, or
- the speed restriction, whichever is more restrictive.

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. When cutback mode is selected ON, the FMC calculates and commands a cutback thrust rating at the required cutback altitude. A new N1 is calculated during climb and normal climb thrust is restored at the RESTORE altitude. Passing 10,000 feet, VNAV commands acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority if slower than target speed.

If a CLB 1 or CLB 2 derate is selected, the derate is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust by 15,000 feet.

Climb Page

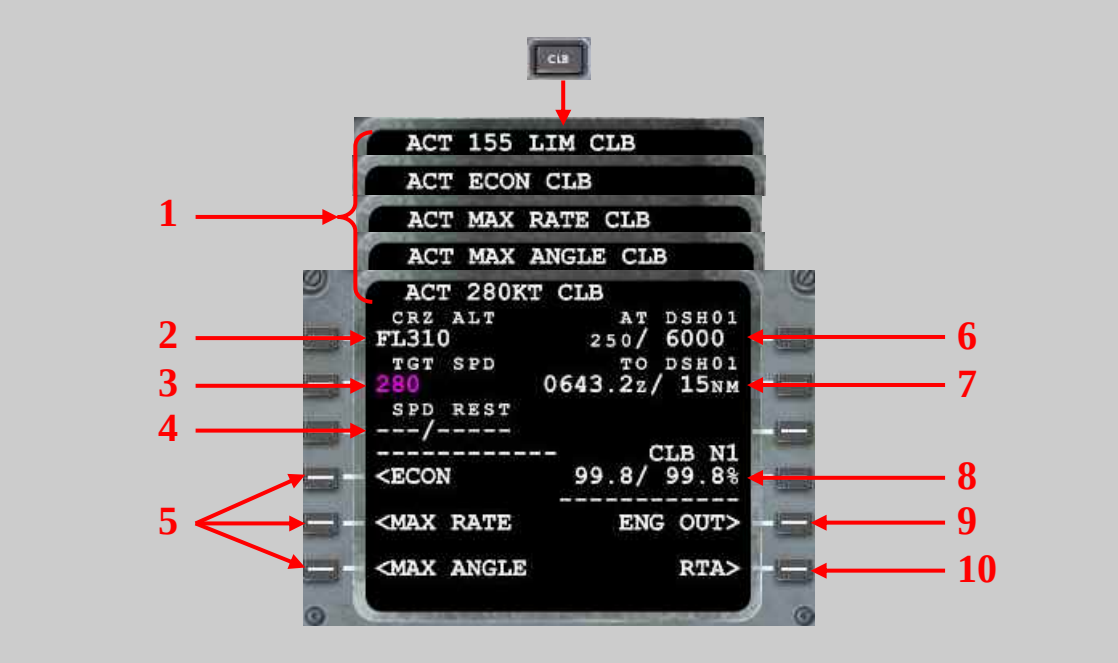
The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages.

The climb page is automatically selected by pushing the CLB function key on the ground and during takeoff and climb. The TAKEOFF REF page automatically transitions to the climb page after takeoff.

The CLB pages let the flight crew review and select one of these climb performance modes:

- Economy climb (ECON CLB)
- Maximum angle climb (MAX ANGLE CLB)
- Manual speed climb (XXX KT CLB)
- Maximum rate of climb (MAX RATE CLB)
- Step climb during cruise (CRZ CLB)
- Required time of arrival (RTA CLB).

Also, there is an ENG OUT page which shows advisory information only (VNAV cannot be engaged in this mode). The default climb mode is the economy (ECON) mode but the other modes may be selected from this page.



1. Page Title

The page title displays the type of climb. Normally, the title displays ECON for the economy climb mode. Fixed speed climbs modify the title.

XXX LIM CLB indicates the limit speed, XXX, is 5 knots below trailing edge flap placard speed

ECON indicates the speed is based on a cost index.

MAX RATE indicates the speed is based on the maximum altitude over the shortest period of time.

MAX ANGLE indicates the speed is based on the maximum altitude over the shortest horizontal distance.

Fixed climb speeds display XXXKT for a fixed CAS climb speed or M.XXX for a fixed Mach climb speed profile.

Displays ACT when the climb phase is active.

2. Cruise Altitude (CRZ ALT)

The cruise altitude entry on the PERF INIT page is propagated to this line. Valid entries to the cruise altitude field are standard altitude entries. The cruise altitude can be changed by two methods:

- a new altitude can be manually entered from the CDU at any time. Changing the altitude in this manner creates a modification.
- Selecting the new altitude on the MCP and pushing the altitude intervention button places the new altitude in the CRZ ALT data line. Entering a new cruise altitude in this manner does not create a modification.

3. Target Speed (TGT SPD)

Displays computed values or manually entered values for the selected mode. Displays XXX/MCP when speed intervention is active and plan is active. In the ECON mode the command speed is a FMC computed value. Pilot-entry of speed and/or Mach results in a change to Selected Speed Climb (SEL SPD).

4. Speed Restriction (SPD REST)

The speed restriction line displays the speed restriction/altitude from one of the following sources:

- a default speed of 250 knots and 10,000
- displays XXX/FLAPS if the active speed restriction is lower than the minimum speed for the selected flap setting

Dashes displayed if no active speed restriction exists.

The speed restriction line allows for entry or deletion of a CAS speed restriction to an altitude less than the cruise altitude. Valid entries for speed restriction consist of a valid speed followed by “/” and a valid altitude. Valid altitude entries are standard altitude format entries that are at or above the current aircraft altitude and below the cruise altitude. FLAPS speed may not be deleted or modified.

5. Climb Page Prompts

Push – selects various CLB pages.

Following line selection, the prompt for that page blanks.

6. AT XXXXX

The waypoint constraint line displays the next waypoint having an altitude constraint. Display is blank if no restriction exists. Constraints are entered on the RTE LEGS page or by departure procedure selection. The constraints can be deleted on this page or the RTE LEGS page. The waypoint may be a HOLD AT point.

7. TO XXXXXX

Displays ETA and distance to go to waypoint on AT XXXXXX line. If no waypoint constraint exists, values are for CRZ ALT.

8. Climb N1 (CUTBACK N1, CLB N1, CLB – X N1)

Displays the computed climb N1 value.

9. Engine Out (ENG OUT)

Push – displays ENG OUT CLB page.

10. Required Time of Arrival (RTA)

Push – displays the RTA PROGRESS page.

ERASE prompt replaces RTA during a page modification.

RTA Climb Page

The RTA climb page is displayed when a required time of arrival is active. The RTA climb page is automatically selected by pushing the CLB function key when RTA is active. Displays on this page are the same as other climb pages except as noted.

1. Target Speed (TGT SPD)

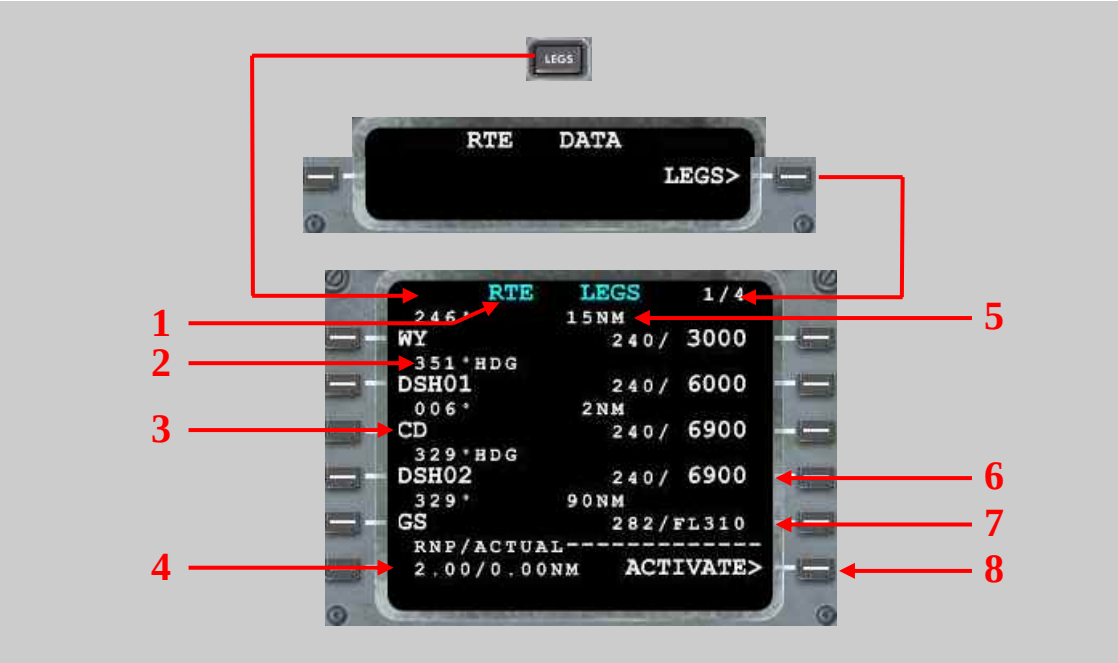
Displays computed speed required to meet entered RTA.

2. TIME ERROR

Displays computed time error at RTA waypoint. Same as RTA PROGRESS page.

RTE LEGS Page

The RTE LEGS pages display a listing of consecutive waypoints and pertinent information about each waypoint of each leg on the route. The first waypoint listed on the LEGS pages is the waypoint toward which the aircraft is navigating, also referred to as the active waypoint.



1. Page Title

An active route legs page title is displayed with ACT as part of the title. A modified page title displays a reverse video MOD.

2. Leg Direction

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°). Heading leg segments to conditional waypoints are displayed as (xxx° HDG).

3. Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE LEGS page. All route waypoints are displayed. Waypoints appear in flight sequence. Waypoints can be entered and moved. This includes:

- adding new waypoints
- removing existing waypoints
- resequencing existing waypoints
- linking route discontinuities.

Displays the waypoint by name or condition. Box prompts are displayed for route discontinuities. Dashes are displayed for the next line beyond the end of the route.

4. Required Navigational Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

5. Distance to Waypoint

Displays the distance from the airplane or the waypoint to the next waypoint. No distance is displayed for conditional waypoints.

6. Specified Waypoint Speed/Altitude

Displays any waypoint speed or altitude constraint in large font. Manual entry is allowed.

7. Calculated Waypoint Speed/Altitude

Displays the calculated speed or altitude at the waypoint in small font.

8. ACTIVATE, RTE DATA

The ACTIVATE prompt is displayed on the legs page when the route is not active.

Push –

- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to RTE DATA
- RTE DATA displays the route data page. The RTE DATA prompt is used to review or modify additional information about the route.

Map Center Step Display

The MAP CTR STEP function is enabled when the PLAN mode has been selected on the EFIS control panel. The MAP CTR STEP prompt replaces ACTIVATE or RTE DATA. It lets the flight crew step through the active flight plan and reviews the data for each waypoint. The selected waypoint will be shown in the center of the navigation display. Pushing the prompt key advances the waypoint that is displayed in the center of the navigation display. The <CTR> prompt shows the selected waypoint on the LEGS page.

1. Map Center Label (<CTR>)

Identifies the waypoint around which the map display is centered. Whenever the EFIS Mode selector is positioned to PLAN, the label is automatically displayed for the first geographically fixed waypoint on the displayed page.

2. STEP

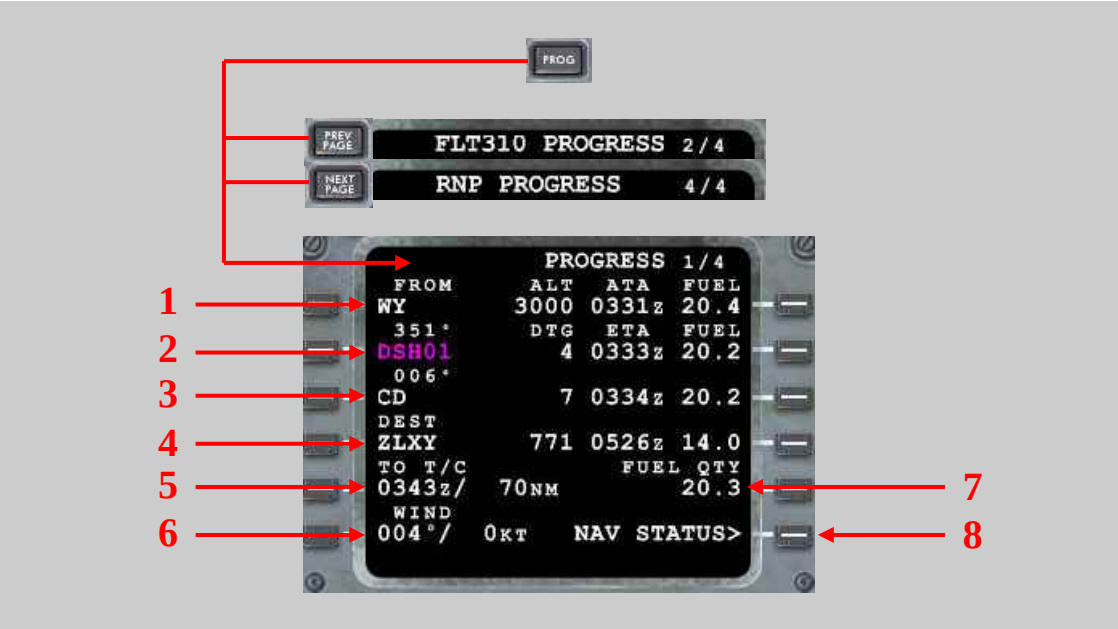
Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the RTE DATA or ACTIVATE prompt.

Push – moves the map center label to the next geographically fixed waypoint in the route.

Progress Page 1/4

The progress page provides general flight progress information along the route of flight such as:

- waypoints (last, active and next)
- waypoint ETA
- waypoint ATA
- distance to go information
- destination information
- altitude change points
- current wind
- fuel quantity



1. FROM

This is the last (FROM) waypoint line and it displays the last waypoint, altitude and fuel remaining when that waypoint was crossed. This line is blanked when no active route is defined, the first leg has not been sequenced or flight completion has occurred.

2. Active Waypoint

The active waypoint line displays the waypoint identifier, distance–to–go (DTG), estimated time of arrival and estimated fuel remaining at the active waypoint.

3. Next Waypoint

The next waypoint line displays the waypoint identifier, distance–to–go, estimated time of arrival, and estimated fuel remaining for the waypoint after the active waypoint.

4. Destination

The destination identifier is displayed on this line. The data on this line; distance–to–go, estimated time of arrival, and estimated fuel remaining, is all relative to the destination which is displayed.

5. Altitude Change Point (TO XXXXX)

Displays ETA and distance to go to the following altitude change points as appropriate to phase of flight:

- TO T/C: to top of climb for the active climb
- TO STEP POINT: to the step point if a STEP TO entry is made on CRZ page
- TO T/D: to top of descent, if no STEP TO entry is made on CRZ page
- TO E/D: to the end of descent waypoint for an active path descent; blank if a path descent is not available.

6. WIND

This line displays the wind speed and direction..

7. Fuel Quantity (FUEL QTY)

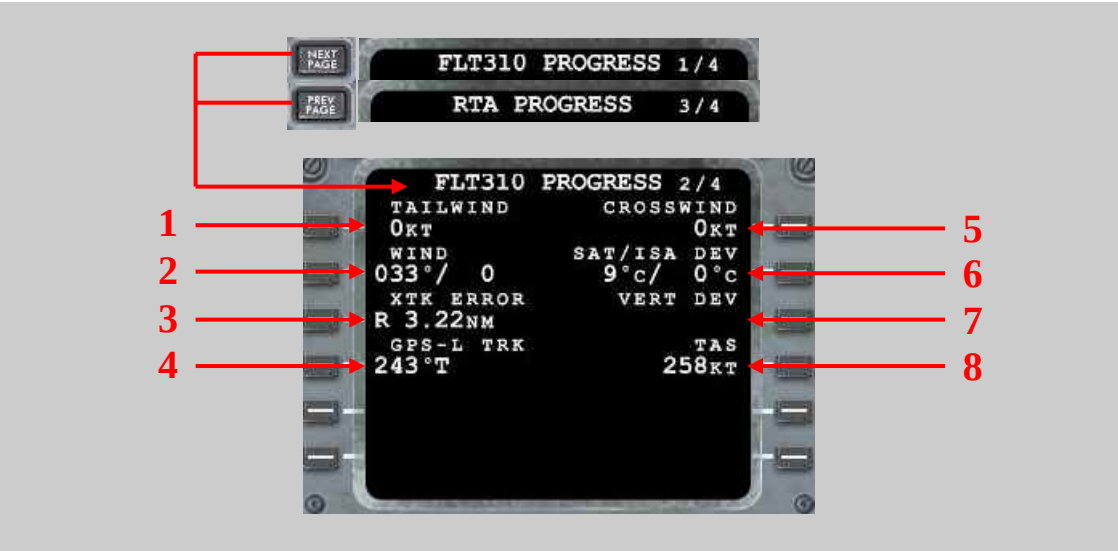
This line displays the current fuel quantity from the fuel quantity indicating system

8. NAV STATUS

Push – displays the navigation status page.

Progress Page 2/4

The progress page 2/4 displays wind, track, path, temperature, and speed data.



1. HEADWIND or TAILWIND

This field displays the present headwind or tailwind component.

2. WIND

This field displays the current wind speed and direction.

3. Crosstrack Error (XTK ERROR)

This field shows the current cross–track error direction and magnitude.

4. GPS–L TRK

Displays GPS track.

5. CROSSWIND

This field displays the current crosswind component direction and speed.

6. Static Air Temperature/ISA Deviation (SAT/ISA DEV)

This field shows the current static air temperature (SAT) and the equivalent international standard atmosphere (ISA) deviation

7. Vertical Descent Path Deviation (VERT DEV)

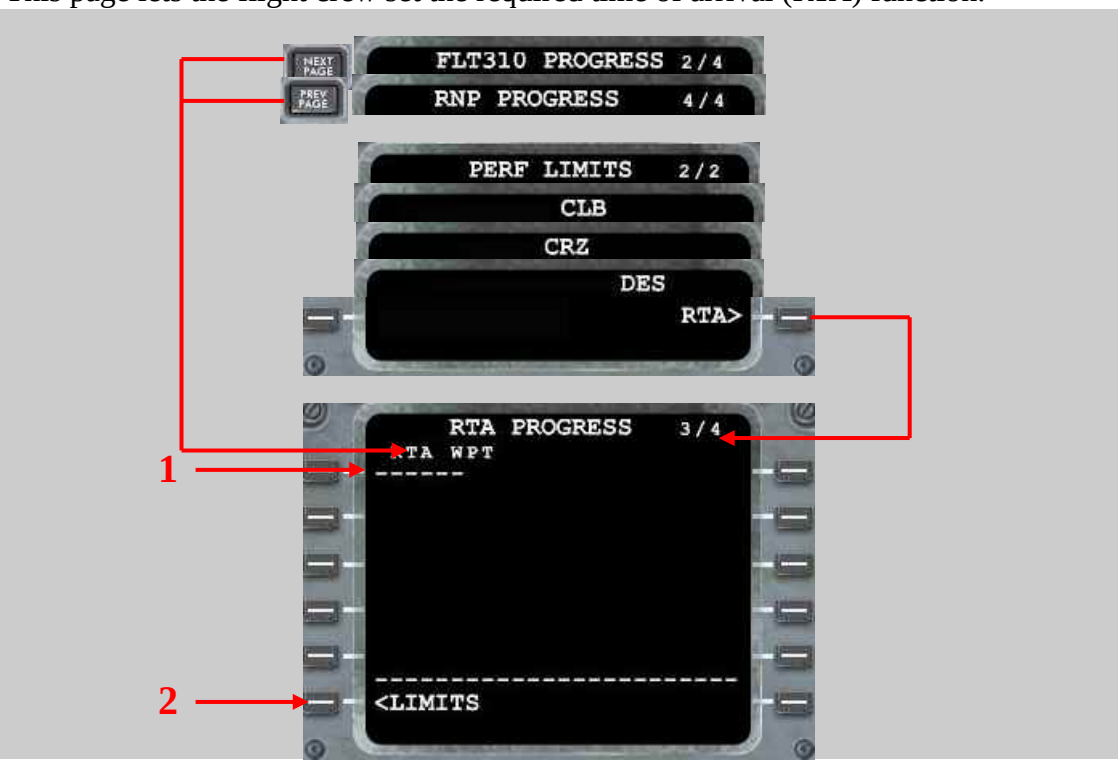
This shows the present vertical deviation (HI or LO) from the calculated vertical guidance path during descent. In climb and cruise, this data field is blank.

8. TAS

This shows the current true airspeed.

Progress Page 3/4

This page lets the flight crew set the required time of arrival (RTA) function.



1. Required Time of Arrival Waypoint (RTA WPT)

Displays dashes when entry allowed.

2. LIMITS

Push – displays the PERF LIMITS page.

RTA Progress on Ground and in Flight

GROUND DISPLAY

IN FLIGHT DISPLAY

1. Required Time of Arrival Waypoint (RTA WPT)

This field lets the flight crew enter the waypoint identifier for the RTA function. Waypoint entry must be in flight plan or the CDU message NOT IN FLIGHT PLAN will be displayed. Entering a valid waypoint will generate a MOD RTA PROGRESS page and illuminate the EXEC light. Deletion of the RTA waypoint will create a MOD RTA PROGRESS page with all data blanked and EXEC light illuminated. Automatically clears the RTA waypoint and exits the RTA waypoint after sequencing the RTA waypoint out of the flight plan. This data field will show dashes if no RTA waypoint is entered and no other data shows on this page.

2. Distance To, Altitude, and ETA at the RTA Waypoint (DIST – – TO XXX – – ALT/ETA)

This line displays the distance from the present position to the RTA waypoint, and the predicted altitude at the RTA waypoint.

3. Arrival Time Window (FIRST – – RTA WINDOW – – – LAST)

This line displays the earliest and latest arrival times at the RTA waypoint. Times based on MIN/MAX speeds on PERF LIMITS page, existing winds, and entered forecast winds.

4. Required Time of Arrival (RTA)

The RTA time is entered in this data field by the flight crew. After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at time of waypoint entry. Desired RTA may be entered by overwriting displayed data.

Entry must be in one of the following forms:

- XXXXXX (hr/min/sec)
- XXXX (hr/min)
- XXXX.X (hr/min/tenths of min).

Entry of “A” after RTA specifies arrival time of at or after. Entry of “B” after RTA specifies arrival time of at or before.

5. TIME ERROR

Displays the time error in minutes and seconds. Displays ON TIME if GMT is within current TIME ERROR TOLERANCE. Displays EARLY or LATE as appropriate if GMT is not within current TIME ERROR TOLERANCE.

6. GMT

This shows actual GMT.

7. Required Time of Arrival Speed (RTA SPD)

This shows the target speed for the current flight phase necessary to meet the RTA. Same as speed displayed on RTA CLB, CRZ, or DES page. Limited by MIN/MAX speeds on the PERF LIMITS page and the SPD REST line.

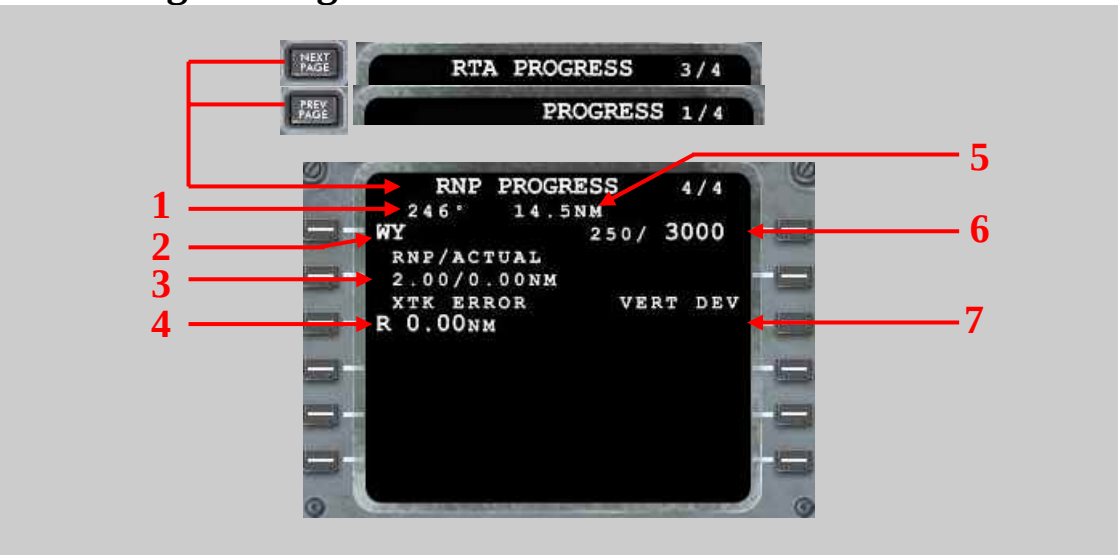
8. Speed Restriction (SPD REST)

This displays the speed restriction.

9. LIMITS

Push – displays PERF LIMITS page.

RNP Progress Page 4/4



1. Leg Direction

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°). Heading leg segments to conditional waypoints are displayed as (xxx° HDG). Display is blank for an undefined course.

2. Waypoint Identifier

Displays the next waypoint. Same as displayed on the RTE LEGS page.

3. Actual RNP

Displays the actual RNP value for lateral navigation. Same as displayed the POS SHIFT page.

4. Crosstrack Error (XTK ERROR)

Displays present cross–track error from the desired LNAV course. L or R indicates left or right of course. Blank if error is greater than 99.9 nm.

5. Distance To Go

Displays the distance remaining to the next waypoint.

6. Waypoint Speed/Altitude

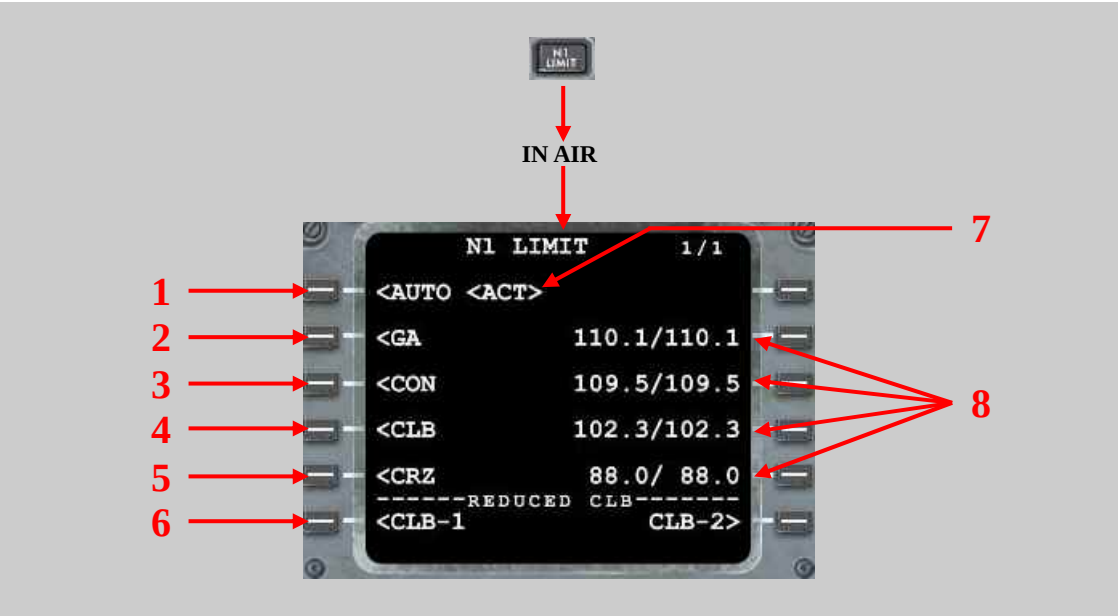
Displays waypoint speed or altitude constraints in large font. Displays FMC predicted values in small font when no restrictions have been specified.

7. Vertical Deviation

Displays present vertical deviation from the FMC computed glidepath.

N1 Limit Page

This section describes the in–flight version of the N1 LIMIT page. See the FMC Preflight section for a description of the preflight version of the N1 LIMIT page. The active thrust limit is used by the autopilot and is displayed on the thrust mode display. Pilot selected mode is automatically replaced by AUTO selection when the autopilot next changes vertical mode.



1. AUTO

Push – selects automatic computation of N1 limits for all phases of flight.

2. Go Around (GA)

Push – selects the go–around thrust limit.

3. Continuous (CON)

Push – selects the maximum continuous thrust limit.

4. Climb (CLB)

Push – changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB–1, or CLB–2.

5. Cruise (CRZ)

Push – selects the cruise thrust limit.

6. Reduced Climb (REDUCED–CLB)

Push – selects either of two reduced climb thrust modes. If either mode is <SEL>, deletion allows return to full rated climb thrust.

Any reduced climb selection is automatically deleted above 15,000 feet.

7. <ACT> STATUS LABEL

Identifies the active N1 thrust limit.

8. N1

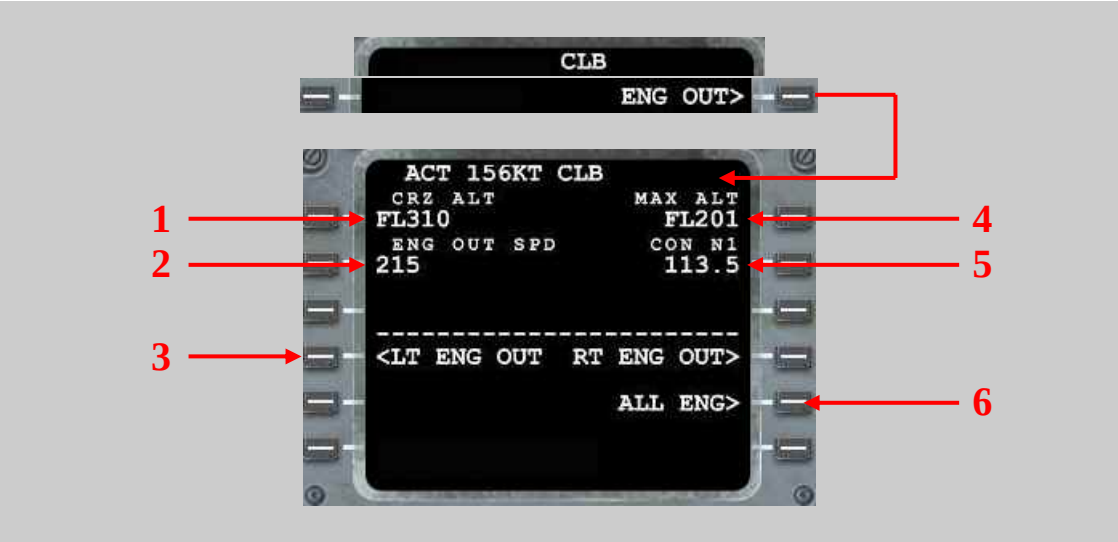
Displays the N1 for individual thrust limits based on present conditions and bleed air configuration.

Engine Out Climb

Engine out climb advisory data is available on the CLB page. Engine out data is also available with both engines operating. The engine out climb phase automatically transitions to the engine out cruise phase when reaching the cruise altitude.

Engine Out Climb Page

Displays advisory information for an engine inoperative condition.



1. Cruise Altitude (CRZ ALT)

Displays the current active cruise altitude.

2. Engine Out Speed (ENG OUT SPD)

Displays the minimum drag engine out climb speed.

3. Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Displayed after selection of ENG OUT prompt.

4. Maximum Altitude (MAX ALT)

Displays the maximum altitude at which company specified rate of climb can be achieved using one engine at maximum continuous thrust.

5. Continuous N1 (CON N1)

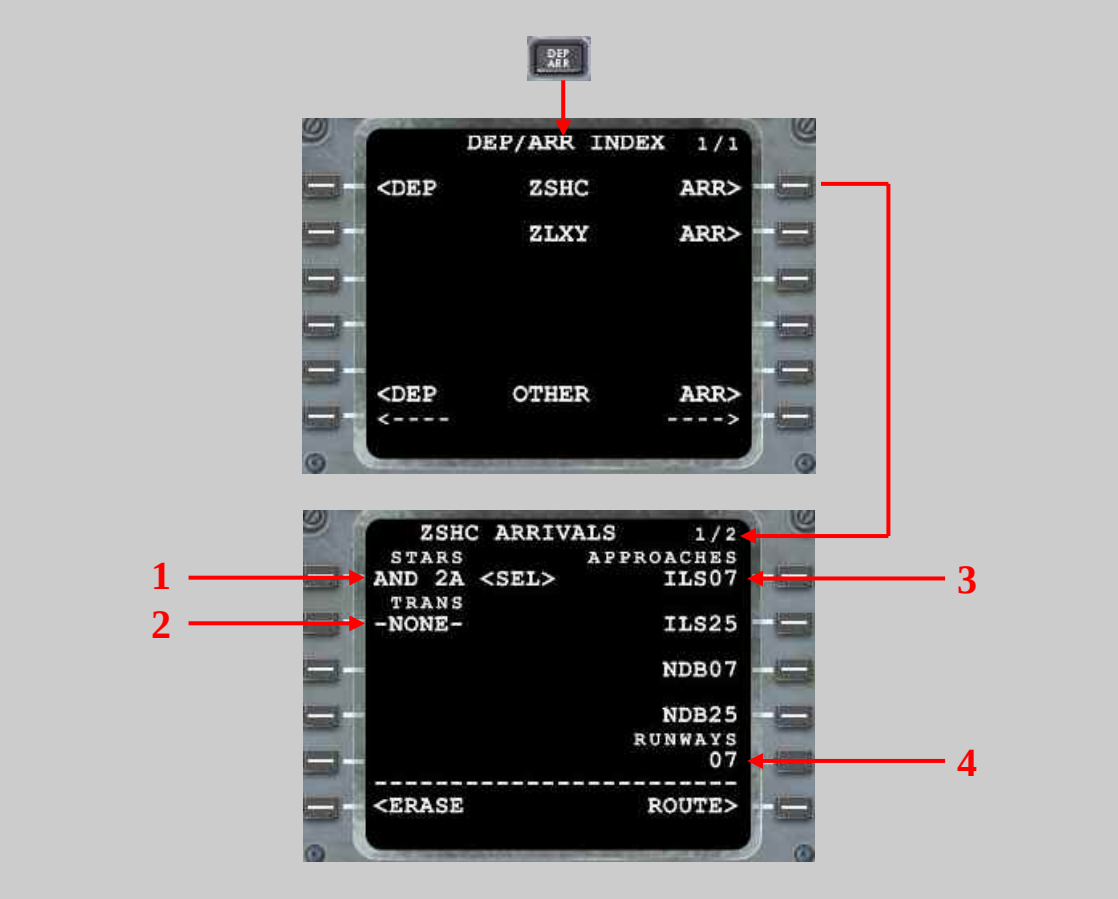
Displays the N1 for maximum continuous thrust.

6. ALL ENG

Push – modifies page to display all engine (ALL ENG) performance data.

Air Turnback Arrivals Page

During a turn–back situation, the crew requires quick access to the arrivals information for the origin airport. The departure/arrivals index and arrivals page provide access without changing the destination on the route page. See Chapter 11, Section 43 for additional information on the arrivals page.



1. Standard Terminal Arrival Routes (STARS)

Displays STARS for the origin airport.

2. Transitions (TRANS)

Displays transitions for the origin airport.

3. APPROACHES

Displays approaches for the origin airport.

4. RUNWAYS

Displays runways for the origin airport.

Flight Management, Navigation FMC Cruise

Chapter 11
Section 42

Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:
- RTE LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:
- POS REF page – verifies the FMC position (refer to Section 40 of this chapter)
- POS SHIFT page – permits selection of preferred position from list of references
- RTE DATA page – displays progress data for each waypoint on the RTE LEGS page. Displays wind data for cruise waypoints.
- REF NAV DATA page – displays information about waypoints, navaids, airports, or runways
- LATERAL OFFSET page – permits selection of a route offset
- FIX INFO page – displays information about waypoints, and can be used to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page – permits selection of the desired waypoint from a list of duplicate named waypoints
- NAV STATUS page – displays information about available navigation aids.

LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:
- adding and deleting waypoints
- resequencing waypoints
- linking discontinuities
- intercepting a course.

Adding Waypoints

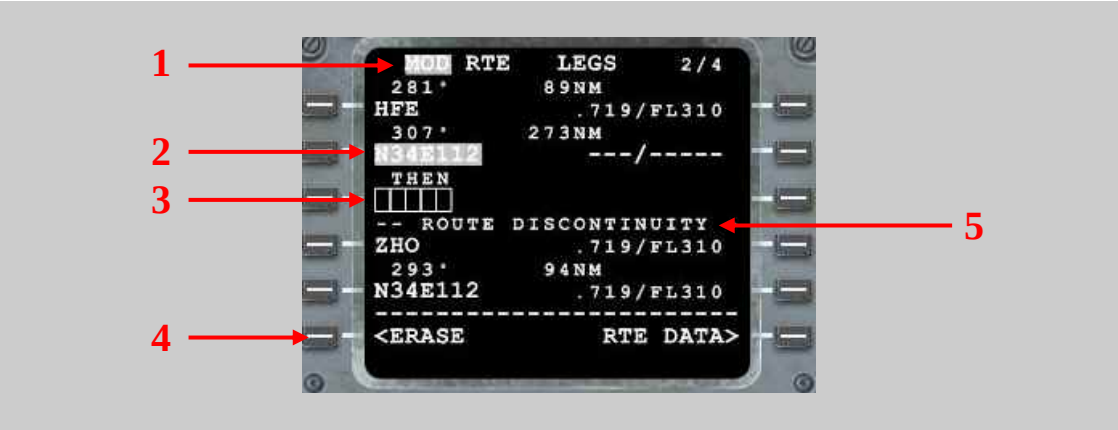
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the LSK adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the LSK adjacent to the desired location for the new waypoint. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints cause a route discontinuity between the new waypoint and the

following waypoint.



1. Page Title

When the page is modified, MOD appears in front of the title. The MOD title also shows that the modifications are not yet executed and can be removed using the ERASE prompt.

2. Modified Waypoint

N34E112 waypoint is entered into the route between HFE and ZHO. This modification creates a route discontinuity.

3. Discontinuity Waypoint

Box prompts indicate the requirement to link the route by entering a route waypoint into the discontinuity waypoint position.

4. ERASE

The ERASE prompt is displayed when the first modification is entered. The prompt remains on the page until the modifications are erased or executed.

Push – removes all modifications and restores all active data.

5. Discontinuity Header

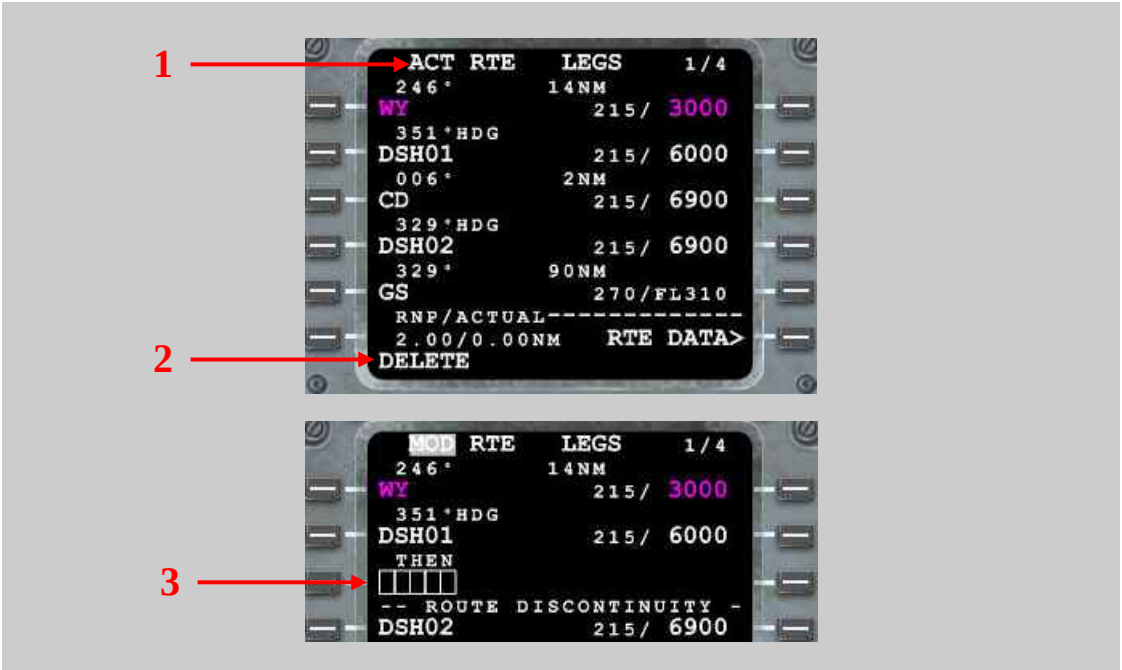
Indicates that the route is not continuous.

Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- delete the waypoint using the DEL function key.
- resequence the route by moving a down–route waypoint up in the sequence and automatically removing all waypoints that are between.

During the deletion process, all of the route prior to the deletion point remains unchanged. Removing a waypoint using the DEL function key causes a route discontinuity to replace the deleted waypoint.



1. Active Route

The existing route shows CD followed by DSH02, and GS.

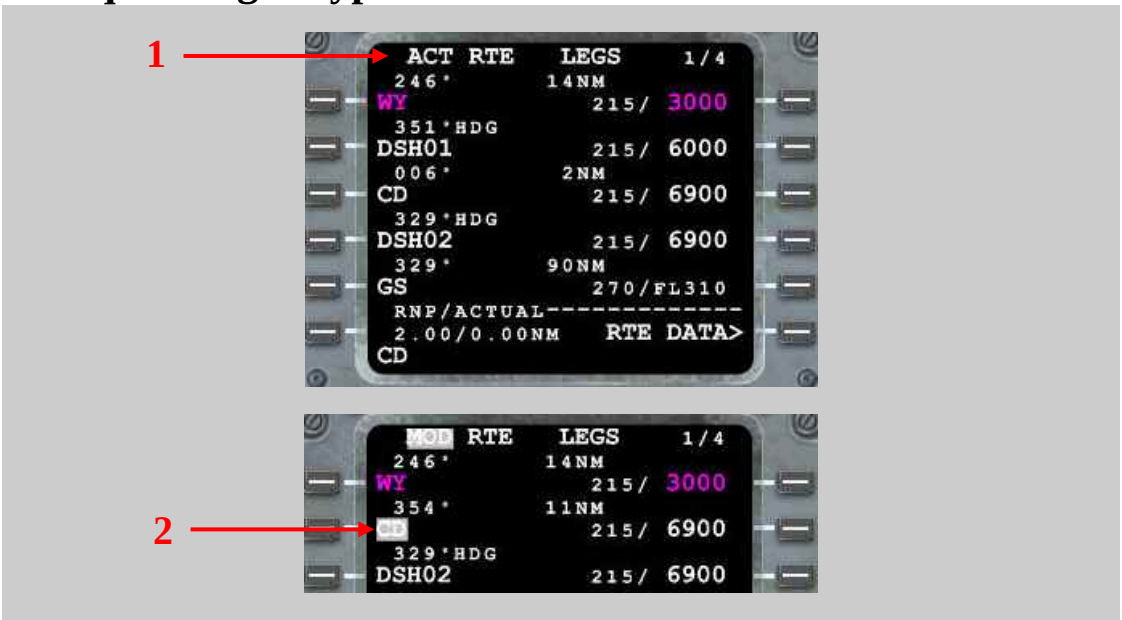
2. DELETE Entry

Push the DEL key to arm the delete function. DELETE is displayed in the scratchpad.

3. Delete CD

With DELETE displayed in the scratchpad, push the line select key left of CD to delete the waypoint. Box prompts replace CD and a route discontinuity follows the box prompts.

Resequencing Waypoints



1. Active Route

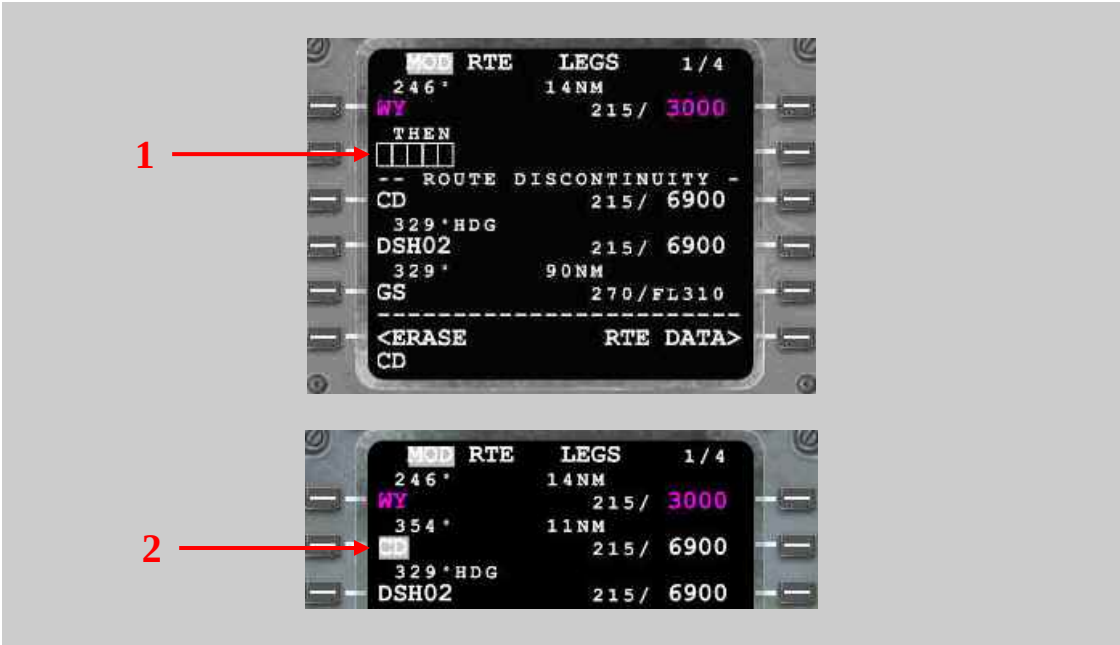
The existing route shows DSH01 followed by CD, DSH02, and GS. The airplane must fly direct from WY to CD. The CD waypoint is copied into the scratchpad.

2. Resequence BANDR

CD is transferred to the waypoint following WY. DSH01 is removed, and the route remains continuous.

Removing Discontinuities

A discontinuity exists when the FMC is unable to determine the route leg following a waypoint. Discontinuities are removed by linking the route segment following the discontinuity to the route segment preceding the discontinuity. The next desired waypoint from the subsequent route is copied into the CDU scratchpad and entered into the discontinuity, just as when adding a waypoint.



1. ROUTE DISCONTINUITY

The active route shows a discontinuity. The airplane must fly direct from WY to CD. The CD waypoint is copied into the scratchpad in preparation to remove the discontinuity. Any waypoint from the route can be copied into the scratchpad to remove the discontinuity.

2. Continuous Route

CD is copied into the box prompts to remove the discontinuity. Entering a waypoint which does not already exist on the route moves the discontinuity one waypoint farther down the route.

Direct To and Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on RTE LEGS page 1 active waypoint line. The INTC CRS prompt displays in line 6R. The example shows the result with WY entered into the active waypoint line.

1. Direct Course

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2. Intercept Course (INTC CRS)

Displayed whenever the active waypoint name is modified.

Valid input is any course from 000 through 360. May be changed until executed.

Push -

- selects entry as intercept course to active waypoint
- displays entry or current route course as course to active waypoint

3. Leg Direction

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

Select Desired Waypoint Page

The SELECT DESIRED WPT page is automatically accessed when an ambiguity occurs in the entry of a navigation database fix, such as multiple waypoints, NDBs and VORs existing with the same identifier. The SELECT DESIRED WPT page is displayed to allow the pilot to select the desired navigation database fix.

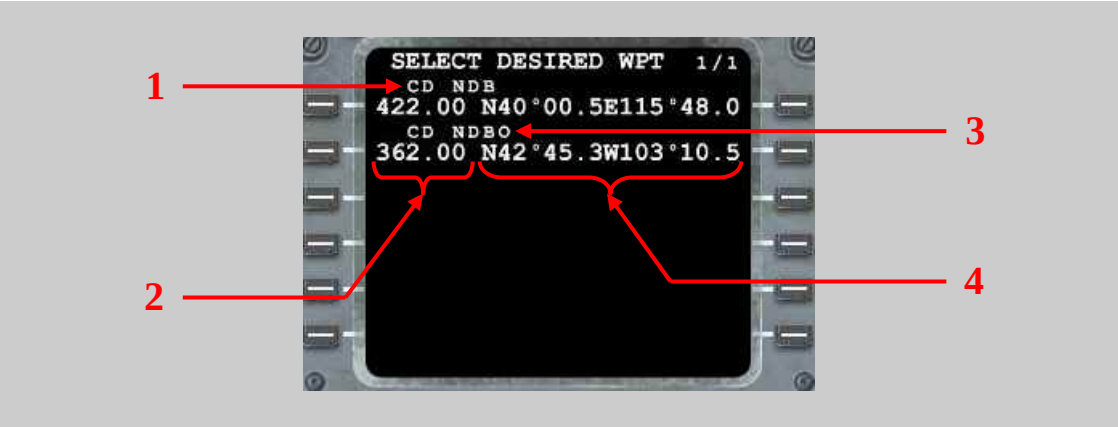
Displayed waypoints are generally displayed by increasing distance from the aircraft. However, if the entry is made on the RTE or RTE LEGS pages, the waypoint are displayed by increasing distance from the fix prior to the entry position.

CAUTION: If the entry is distance ordered from the aircraft and aircraft position is not valid, the waypoints appear in the order they are stored in the Navigation Database.

Selection of a waypoint is made by pushing the adjacent LSK, either left or right. Line selection results in returning to the page from which this page was accessed. The

selected desired waypoint is inserted where the pilot had previously attempted to do so.

CAUTION: Before executing the selection, extreme care should be taken to compare the LAT/LON taken from the Navigation Database against the LAT/LON shown by the chart and check that the proposed routing shown on the map display looks reasonable.



1. Identifier

Displays the identifiers for the duplicate named waypoints. Select the proper waypoint by pushing the appropriate left or right line select key. This page is automatically removed after a waypoint is selected.

2. Frequency

Displays the frequency of the navaid. Blank if the waypoint is not a navaid.

3. Type

Shows type of navaid.

4. Latitude/Longitude

The latitude/longitude is displayed for each duplicate name.

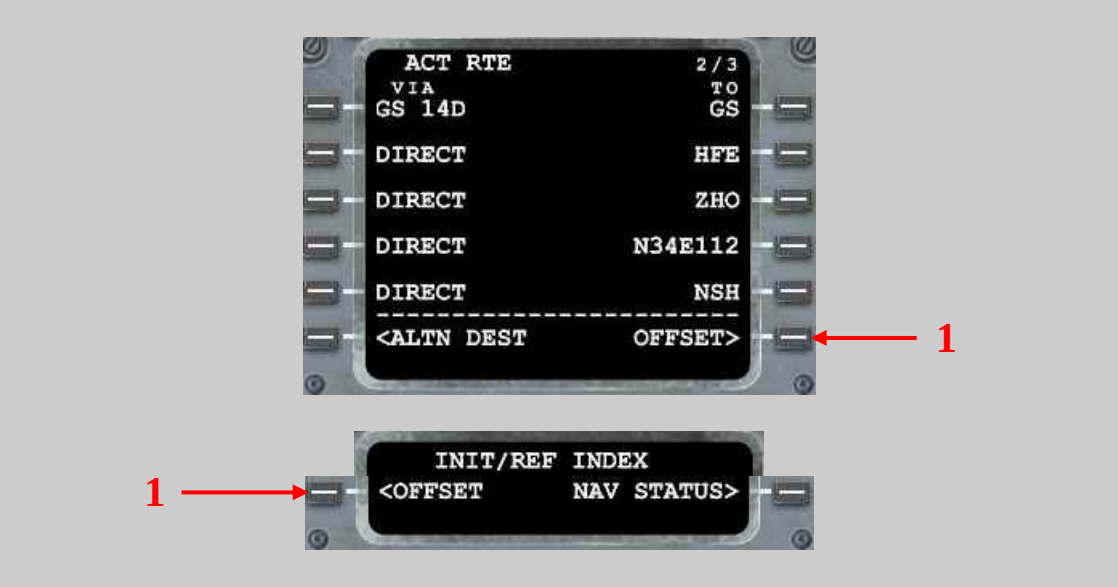
Lateral Offset

The LATERAL OFFSET page lets the flight crew select a lateral offset to the left or the right of the normal route. Offsets are available from 0.1 nautical miles (nm) up to a maximum of 99.9 nm and are set in 0.1 nm increments.

Some legs are invalid for offset. These include:

- End of flight plan waypoint
- Discontinuity
- Beginning of approach transition
- Approach procedure
- Heading leg
- Holding pattern (except PPOS)
- Certain legs containing flyover waypoints

- Course change greater than 135 degrees



1. OFFSET

Push – displays the lateral offset page.

Lateral Offset Page

1. Offset Distance (OFFSET DIST)

The desired lateral offset distance is entered on line 2L. Dashes show initially. Valid entries is Lxx, Lxx.x, xxL, xx.xL, Rxx, Rxx.x, xxR, xx.xR. Entry results in display of start and end waypoint fields.

2. START WAYPOINT

The waypoint at which the offset is to begin may be entered. Dashes are displayed if current leg is valid for offset. Box prompts are displayed if current leg is invalid for offset. Offset will begin at first valid offset leg after the start waypoint. Deletion of start waypoint (or no entry) will result in offset beginning at first valid offset leg in the flight plan.

3. END WAYPOINT

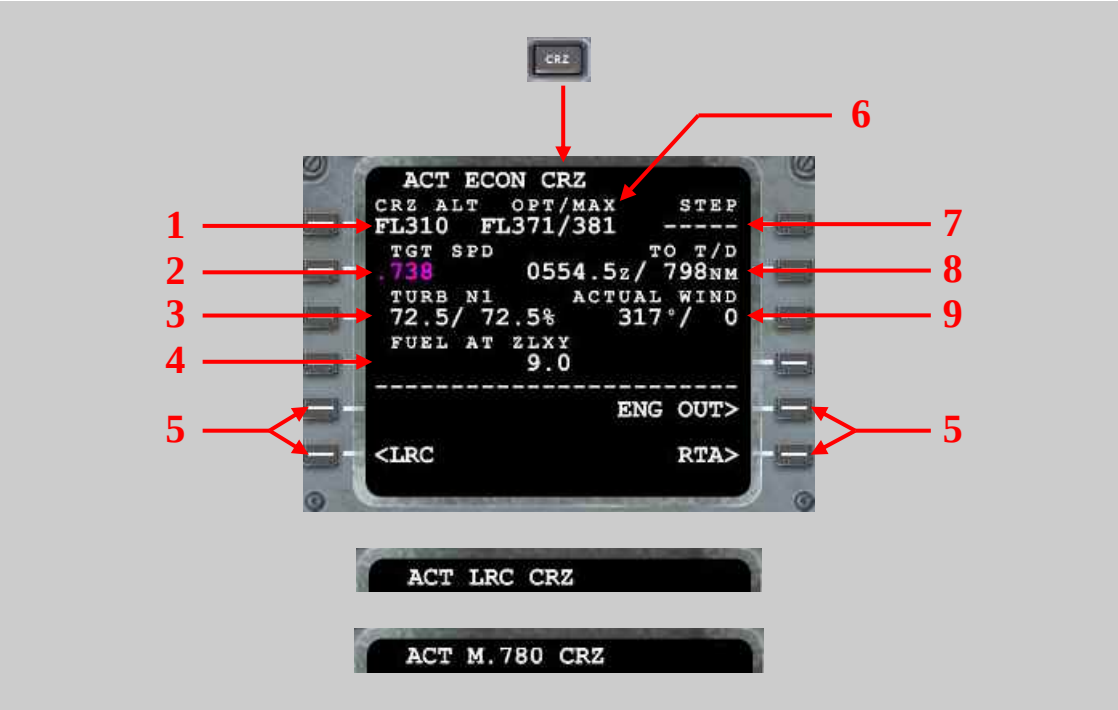
The waypoint at which the offset is to end may be entered. Offset will propagate through flight plan until end waypoint is encountered. Deletion of end waypoint (or no entry) will result in offset propagating until an invalid offset leg is encountered.

VNAV Modifications

Three primary cruise modes are available – economy (ECON) cruise, long range cruise (LRC), and cruise with a manually selected speed. Access to the various cruise pages is obtained by pushing the CRZ mode select key.

Cruise Page

The CRZ page is used by the pilot to evaluate or change cruise altitude, speed and step climb path.



1. Cruise Altitude (CRZ ALT)

Displays present cruise altitude. A cruise altitude entry on the PERF INIT page is propagated to this page. An altitude entry, while the CRZ ALT page is active, changes the page title to MOD CRZ CLB or MOD CRZ DES.

2. Target Speed (TGT SPD)

The computed target speed displays one of the following:

- computed or manually selected value for target airspeed or Mach
- XXX/MCP when speed intervention is active and the plan is active
  - deletion or modification of XXX/MCP is not allowed

3. Turbulence N1 (TURB N1)

Displayed here is the target N1 required to maintain target airspeed at cruise altitude. Value is for reference only. It is not commanded to the autothrottle.

4. Fuel at Destination (FUEL AT XXXX)

Displays the predicted fuel remaining at destination. The value assumes continued flight per the displayed cruise and planned descent modes along the active route. If a step to altitude is entered on line 1R, the computation assumes that the step will occur at the step point.

5. Cruise Page Prompts

Allow line selection of the various cruise pages. The RTA prompt is replaced with ERASE when a MOD page is displayed.

6. Optimum/Maximum Altitude (OPT/MAX)

Displays the computed optimum altitude for the displayed cruise mode. Also displays the maximum possible altitude based on the selected target speed and current gross weight. Values are advisory only. They are provided for crew reference.

7. Step to Altitude Line (STEP)

This line may be used to enter a possible step climb or descent altitude for crew evaluation. The line will be blank when within 100 nm of top of descent or when RTA mode is active.

8. Top of Descent (TO T/D) Line

Displays time of arrival at and distance to top of descent point. The data is always displayed when the distance is less than 100 nm. If the distance is more than 100 nm, the data will be displayed only if a step to altitude has not been entered.

9. ACTUAL WIND

Displays computed true wind for present altitude.

RTA Cruise

If an RTA waypoint has been specified, the cruise page will reflect the RTA data.

1. Target Speed (TGT SPD)

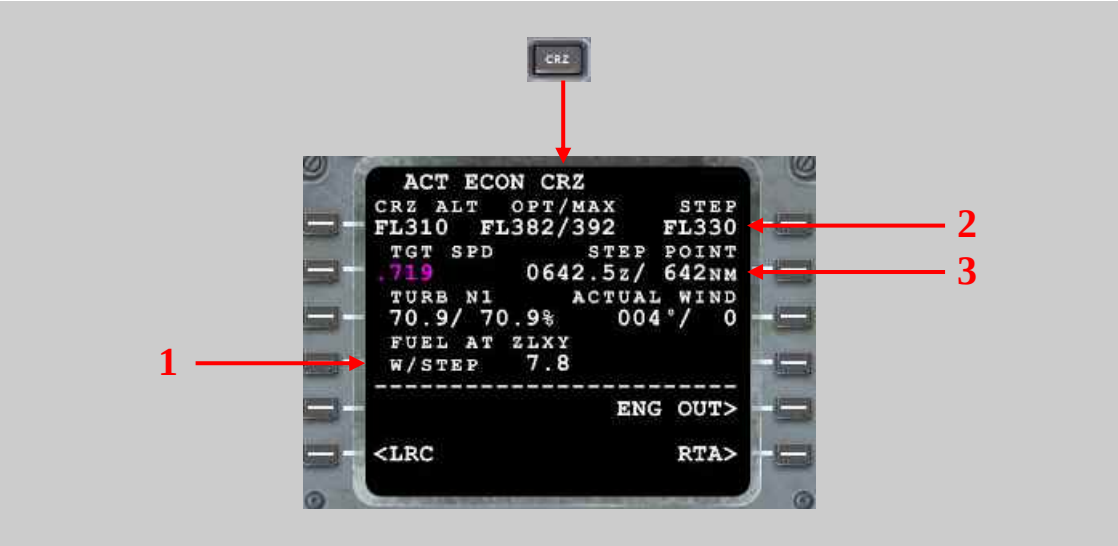
Displays the computed speed required to meet the RTA. When RTA mode is exited by

waypoint sequence or by deletion, this speed becomes the FMC target speed on a manual speed cruise page and the scratchpad message SELECT MODE AFTER RTA is displayed.

2. TIME ERROR

Displays the computed time error at the RTA waypoint. Same as time error on RTA PROGRESS page.

Cruise with Step Climb



1. Fuel at Destination with Step Climb Altitude (FUEL AT XXXX)

The computation assumes the step climb will occur at the STEP point, and the value is prefixed by W/STEP.

2. Step To Altitude (STEP)

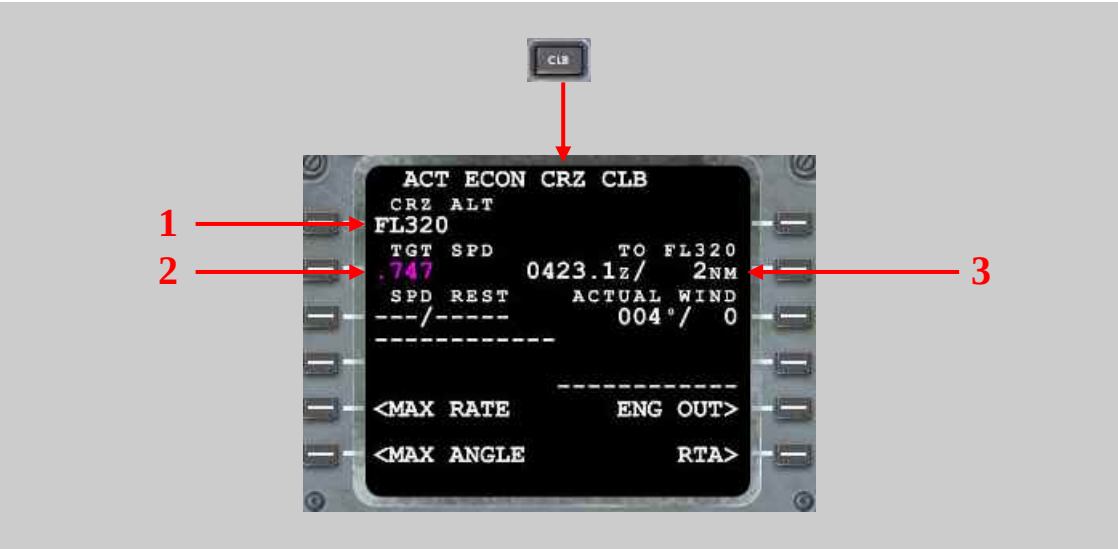
Used to enter step climb or step descent altitudes for crew evaluation. Blank when within 100 nm of top of descent or when RTA mode is active.

3. STEP POINT

Displays the computed ETA at, and distance to, the first possible step climb point based on gross weight.

Cruise Climb

The cruise climb page displays data for a cruise climb to a new altitude. MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page. During VNAV operation, execution initiates a climb at climb thrust and cruise target speed to the new altitude. The VNAV climb mode is active until reaching the selected altitude. The mode then automatically changes back to cruise.



1. Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page. Manual entry may be made.

2. Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude. Manual entry may be made.

3. TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

RTA Cruise Climb

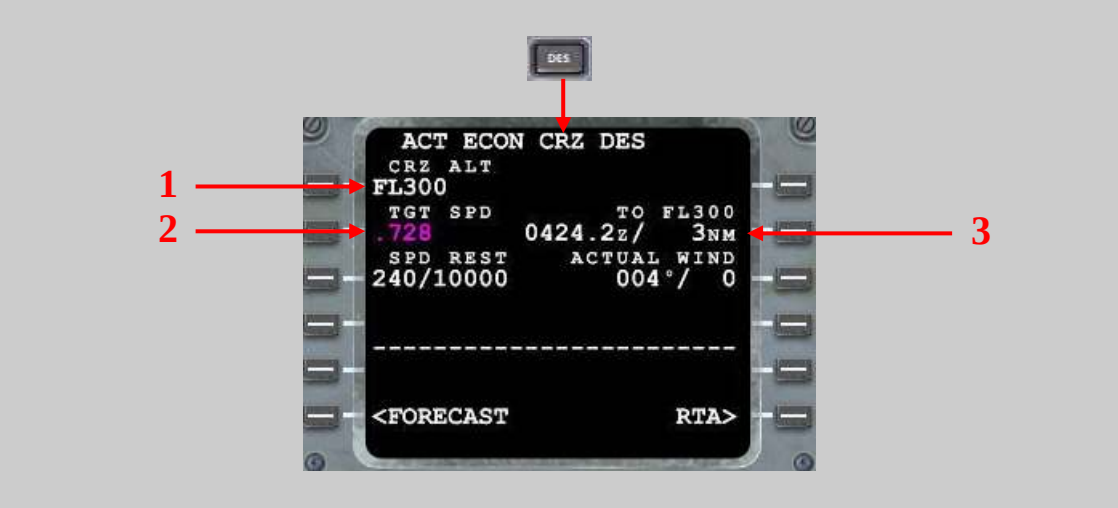
The RTA cruise climb page displays the same data as the cruise climb page except for the TIME ERROR line.

1. TIME ERROR

Displays the computed time error at the RTA waypoint. Same as time error on RTA PROGRESS page.

Cruise Descent

The cruise descent page displays data for a cruise descent to a new altitude. During VNAV operation, execution initiates a descent at 1,000 feet per minute and cruise target speed to the new altitude.



1. Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page. Manual entry may be made.

2. Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude. Manual entry may be made.

3. TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

RTA Cruise Descent

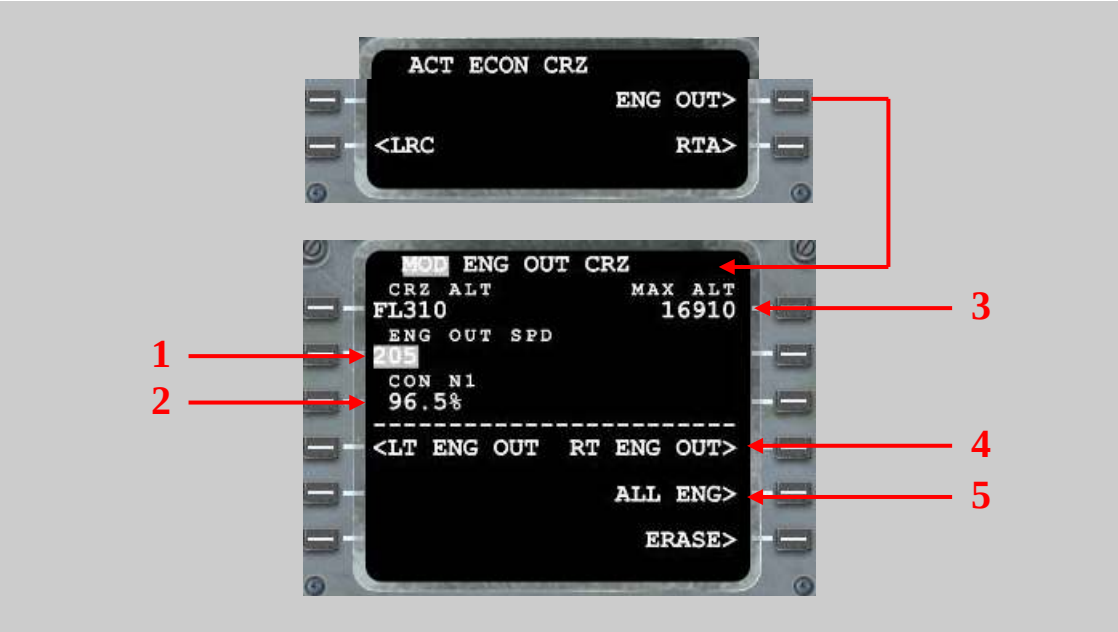
The RTA cruise descent page displays the same data as the cruise descent page except for the TIME ERROR line.

1. TIME ERROR

Displays the computed time error at the RTA waypoint. Same as time error on RTA PROGRESS page.

Engine Out Cruise

The engine out cruise page may be accessed by selecting the ENG OUT prompt on the cruise page. The page displays advisory data for a one engine inoperative condition. Engine out data is also available with both engines operation.



1. Engine Out Speed (ENG OUT SPD)

Displays the optimum speed based on minimum drag. Manual entry is allowed. Valid entry are the same as all engine cruise page.

2. Continuous N1 (CON N1)

Displays N1 for maximum continuous thrust.

3. Maximum Altitude (MAX ALT)

Displays the computed maximum altitude base on:

- current gross weight
- maximum continuous thrust
- disregarding any altitude or speed constrains
- default climb rate is 100 feet per minute

4. LT ENG OUT/RT ENG OUT

Displayed after selection of ENG OUT prompt.

5. ALL ENG

Push – modifies page to display all engine (ALL ENG) performance data.

Early Descent

Early descents are initiated from the DES page. Once an early descent is executed, VNAV transitions to the descent mode and cruise features are no longer available. Once executed, the autothrottle adjusts thrust to maintain 1000 feet per minute until intercepting the descent path.

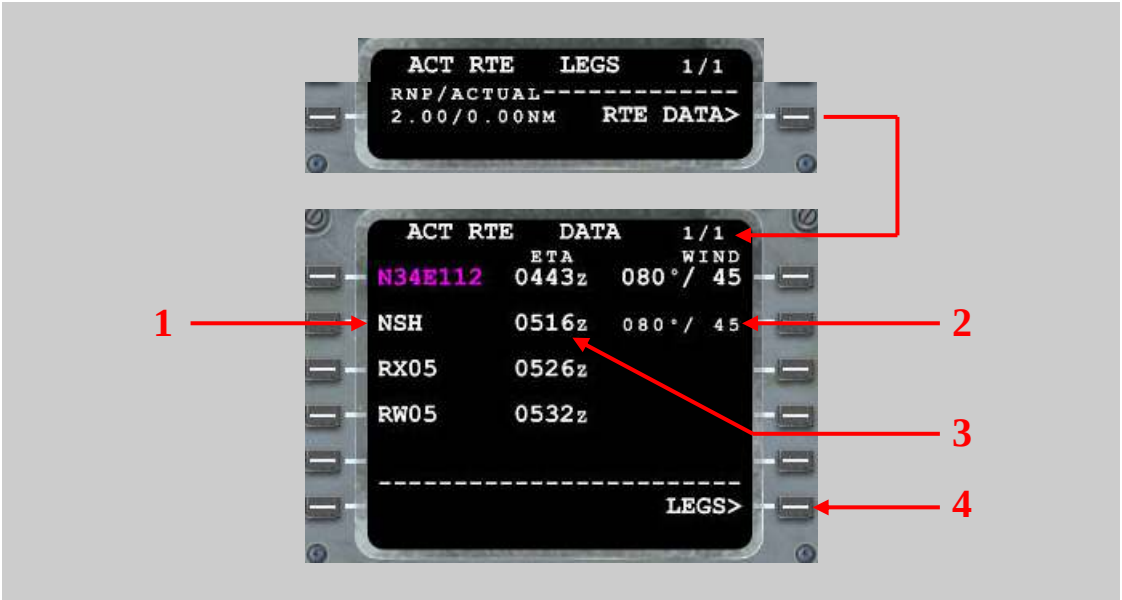
1. Descend Now (DES NOW)

Selecting the DES page when the airplane is within 50 nm of the T/D displays the normal descent page with the prompt DES NOW on the bottom right of the page. Selecting and executing the DES NOW prompt initiates a VNAV descent of 1000 feet per minute at ECON speed. Upon reaching the planned descent path, VNAV transitions to maintain the planned descent path.

Route and Waypoint Data

Route Data (RTE DATA) Page

The purpose of the RTE DATA page is to display additional leg data. This page also displays forecast wind data for cruise waypoints. One page displays data for five waypoints.



1. Waypoint

Displays the identifier for the waypoint from the ACT RTE LEGS page.

2. WIND

Used for entry and/or display of the winds at the cruise waypoint identified on the

same line. Entry may be via the keyboard, or propagated from the CRZ WIND entry on the PERF INIT page. If no CRZ WIND entry was made, the FMC assumes 000°/000. The CRZ WIND value propagates to all cruise waypoints (N34E112 to NSH is the depicted cruise segment). A keyboard entry has priority and propagates to all down path cruise waypoints (an entry of 080°/45 at N34E112 is depicted). Any entries propagated are displayed in small font. Keyboard entries are displayed in large font. Blank for non–cruise waypoints (RX05 and RW05 are depicted), entry is inhibited.

3. Estimated Time of Arrival (ETA)

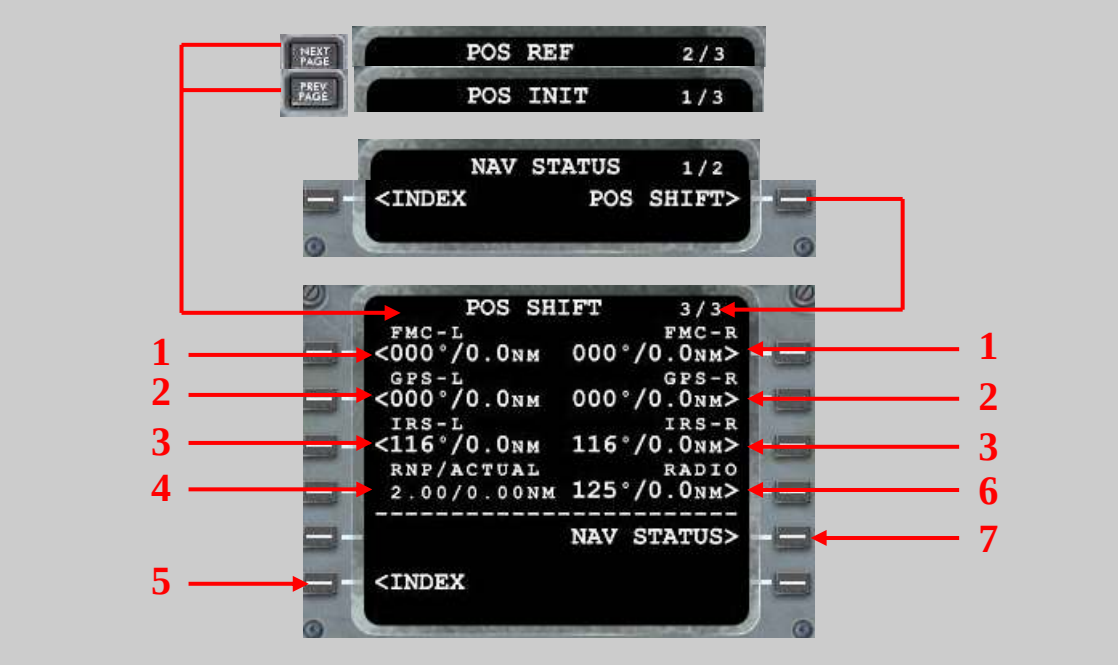
Displays the FMC calculated waypoint ETA.

4. LEGS

Push – displays the RTE LEGS page.

Position Shift Page 3/3

This page shows the bearing and distance between the FMC calculated position shown on the POS REF page and the position of the individual FMCs, ADIRUs, GPS, and radio systems. Data fields are blank when on the ground.



1. FMC Position L/R

Displays left and right FMC position relative to FMC position using current mag/true reference. Blank if FMC position is invalid.

2. GPS Position L/R

Displays left and right GPS position relative to FMC position using current mag/true reference. Blank if GPS position is invalid.

3. IRS Position L/R

Displays left and right IRS position relative to FMC position using current mag/true reference. Blank if IRS position is invalid.

4. Required Navigation Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy. Manual entry is allowed.

5. INDEX

Push – displays the INIT/REF INDEX page.

6. RADIO Position

Displays radio position relative to FMC position using current mag/true reference. Blank if radio position is invalid.

7. Navigation Status (NAV STATUS)

Push – displays the NAV STATUS page.

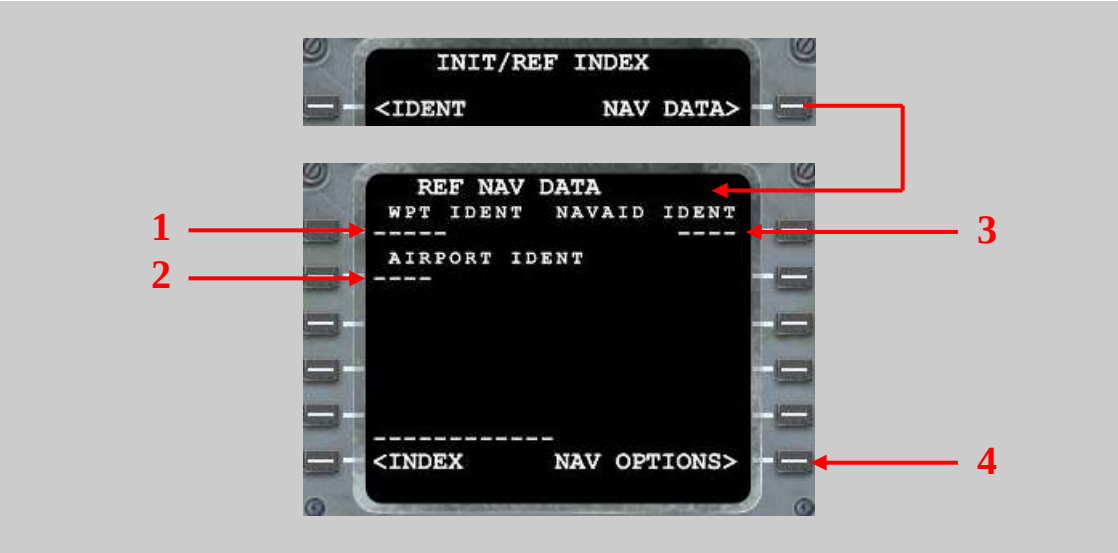
Navigation Data

Reference Navigation Data (REF NAV DATA) Page

The navigation reference data pages let the flight crew review data from the navigation data base for these references:

- Waypoint
- Navaid
- Runway
- Airport

Entering the appropriate identifier initiates the display.



1. Waypoint Identifier (WPT IDENT)

Displays dashes initially. Any waypoint or runway can be entered. Format for runway entry is “RWnna” where “nn” is a one or two digit numeric and “a” is an optional

character L, R, C, or T. In order to access runway data, an airport must be identified.

2. Airport Identifier (AIRPORT IDENT)

Displays dashes initially. The airport identifier is entered here. An invalid airport will result in “NOT IN DATA BASE” displayed in the scratchpad.

3. Navigation Aid Identifier (NAVAID IDENT)

Displays dashes initially. The navaid identifier is entered here.

4. Navigation Options (NAV OPTIONS)

Push – displays NAV OPTIONS page.

Waypoint Data Display

1. Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint. When this entry is complete, the associated data lines are displayed.

2. LATITUDE/LONGITUDE

Displays the latitude and longitude of waypoint.

3. Magnetic Variation (MAG VAR)

Displays the magnetic variation of waypoint.

4. INDEX

Push – displays INIT/REF INDEX page.

Navigation Aid Data Display

1. Frequency (FREQ)

Displays the frequency of the entered navaid.

2. Navigation Aid Identifier (NAVAID IDENT)

Displays or permits entry of navaid identifier (5 characters maximum). Following entry, the associated data lines are displayed.

Airport Data Display

1. Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

2. Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

3. ELEVATION

Displays the elevation of the entered airport.

Runway Data Display

A runway identifier may be entered on the airport data display page. Entry may be in the form of 13R or RW13R. The proper airport identifier must be entered on the runway data display page.

1. Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

2. Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

3. LATITUDE/LONGITUDE

Displays latitude and longitude of entered runway.

4. ELEVATION

Displays elevation (feet above MSL) of the entered runway.

5. Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

Navigation Status Display

The NAV STATUS page displays the current status of the navaids being tuned or in use by the FMC. Access to the NAV STATUS display is from the NAV STATUS prompt on the POS SHIFT page 3/3, the PROGRESS page 1/3, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page 2/2.

1. VOR, ILS and DME Lines

Lines 1L and 1R display the VOR or ILS identifiers and frequencies that are currently tuned on the navigation control panels. If there is no corresponding identifier for the displayed frequency, then the identifier field will be blank and only the frequency will be displayed. The frequency is prefixed by a single character code in small font. This shows the method used to tune the frequency. These codes can show:

- M (manual tuning)
- P (procedural tuning)
- A (auto tuning).

Lines 2L and 2R display the DME data. This shows the status of the DME identifiers of frequencies that are tuned by the FMC. If no DME information is received then the identifier and frequency field is blank.

2. IRS Status Display

Displays the IRS currently selected for use in navigation. “L” or “R” indicates left or right IRS is being used in the FMC position calculation. “2” indicates a dual system with both IRSs used in the FMC position calculation.

3. GPS Status Display

Displays the GPS currently selected for use in navigation. “L” or “R” indicates left or right GPS is being used in the FMC position calculation. “2” indicates dual system with both GPSs used in the FMC position calculation. The display will be blank if GPS is inhibited for use in navigation.

Navigation Options (NAV OPTIONS)

This page lets the flight crew inhibit the use of specific navaids in the FMC navigation sub-function. Access to the NAV OPTIONS page may be gained by selecting the NAV OPTIONS prompt on the REF NAV DATA page or by selecting NEXT or PREV PAGE on the NAV STATUS page.

1. DME/VOR INHIBIT

Enter the identifier of up to two VOR stations that must not be used for FMC position updates.

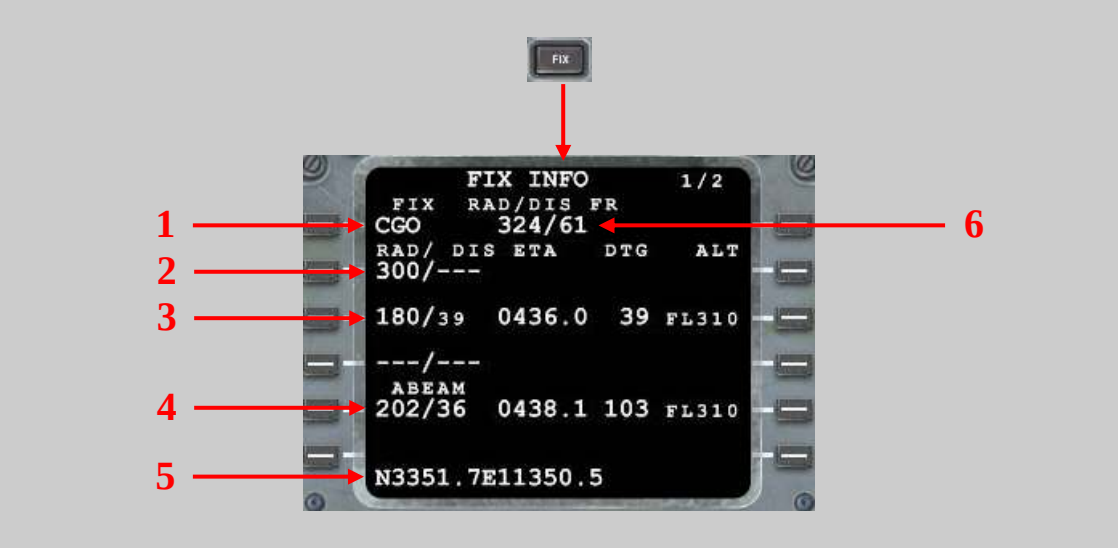
2. DME/VOR/GPS UPDATE

Push – permits switching between ON and OFF modes for updating FMC position. Default mode is ON. The current selected mode shows in large font and the non selected mode shows in small font.

Fix Information Page

[Option – Standard FIX Pages]
Two identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.

[Option – Enhanced FIX Pages]
Four identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.



1. FIX Name

The FIX identifier is entered here by typing the identifier in the scratchpad and line selecting it.

[Option – Standard FIX Pages]
Valid entries are airports, navaids, and waypoints from the navigation database. The selected fix displays on the ND and is highlighted by a green or cyan circle.

[Option – Enhanced FIX Pages]
Valid entries are airports, navaids, place bearing distance, place bearing/place bearing, along track, latitude/longitude, and waypoints from the navigation database. The selected fix displays on the ND and is highlighted by a green circle.

2. Distance Entry (example)

Enter a distance from the fix. Distances from the fix are displayed on the navigation display map mode as a dashed green circle around the fix. When the distance intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed for that intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

[Option – Standard FIX Pages]

- distance is limited to 511 NM or less and may contain 1/10 NM entry

[Option – Enhanced FIX Pages]

- distance is limited to 9999 NM or less and may contain 1/10 NM entry
- leading zeros can be omitted for distance
- decimal values can be omitted
- distance only entries must start with a /.

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

3. Radial Entry (example)

Enter a radial from the fix. Radials are displayed on the navigation display map mode as green dashed lines from the fix. When the radial intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx or xxx/.

4. ABEAM

Displays the abeam point and calculates the ETA, DTG, and ALT information. The fix abeam point ahead of the airplane is displayed by a radial line from the waypoint ending at the nearest perpendicular route leg intersection. If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

5. Route Intersection Point Copied

Pushing the line select key for one of the RAD/DIS entries copies the place definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

6. Radial/Distance From Fix (RAD/DIS FR)

Displays the radial and distance from the fix to the airplane. This information is continually updated as the airplane position changes.

Flight Management, Navigation FMC Descent and Approach

Chapter 11
Section 43

Introduction

The descent phase begins at the top of descent point and continues to the end of descent point. Planning for the descent phase begins during cruise. The approach phase begins at the end of descent point and continues to touchdown or go–around.

Early Descent

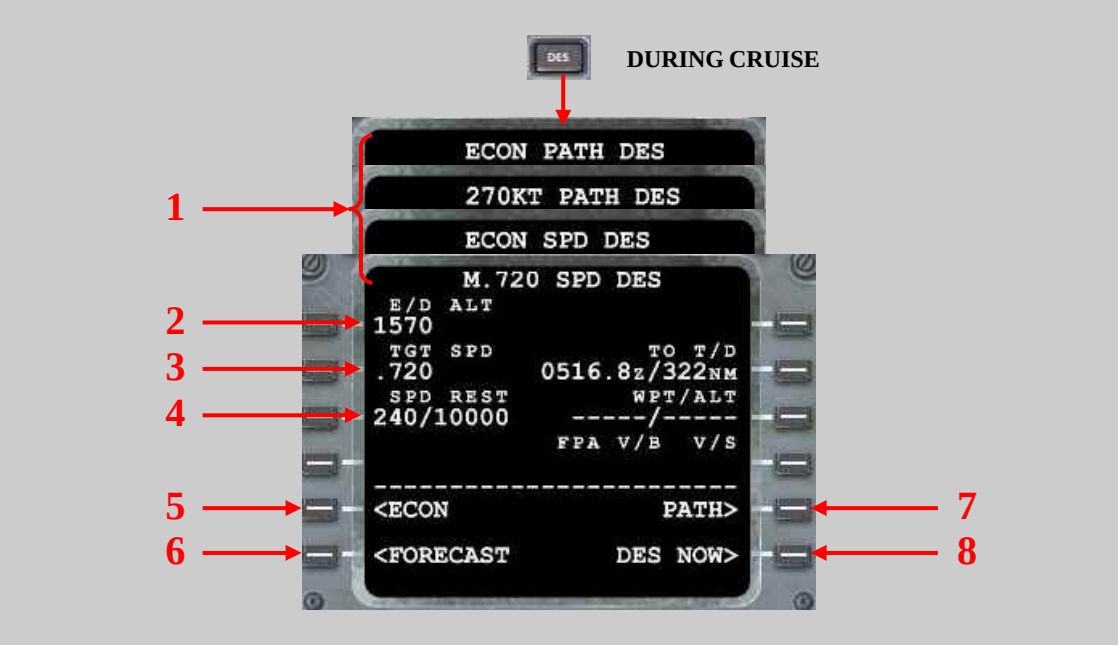
Early descent may be commenced prior to reaching the top of descent by using the DES NOW prompt.

Descent

During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

Descent Page (During Cruise)

The DES page is used by the flight crew to evaluate or revise the descent path. Available speeds are economy and selected speeds. Descent modes are economy (ECON) path or speed and manual path or speed. The default VNAV descent mode is ECON PATH. The page title reflects the VNAV descent mode. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan. The speed mode controls descent at a fixed speed and complies with altitude and speed restrictions in the flight plan.



1. Page Title

The page title identifies the selected mode. When a manual speed is selected, the title

includes XXXKT for fixed CAS or M.XXX for fixed Mach selections. Displays ACT when the descent phase is active.

2. End of Descent Altitude (E/D ALT)

Displays the end of descent altitude.

3. Target Speed (TGT SPD)

Displays the command speed maintained by VNAV. Displays XXX/MCP when speed intervention is active. Manual entries may be made (M.720 SPD DES is depicted).

4. Speed Restriction (SPD REST)

Displays the most restrictive of the following speeds:

- waypoint speed restriction if greater than minimum flaps up maneuvering speed
- minimum flaps up maneuvering speed
- whenever flaps are extended, the, appropriate flap speed shall be displayed as XXX/FLAPS. FLAPS speed may not be deleted or modified.

Dash prompts displayed when there is no active speed restriction. Valid entry is a CAS and altitude (example: 240/10000). Manual crew entries or deletions may be made.

5. Economy (ECON)

Displayed on the manual DES pages.

Push – selects the corresponding ECON SPD DES or ECON PATH DES page.

6. Descent Forecasts (FORECAST)

Push – selects the DES FORECASTS page.

7. PATH

Displayed on the SPD DES pages if a path descent is available.

Push – selects the corresponding PATH DES page.

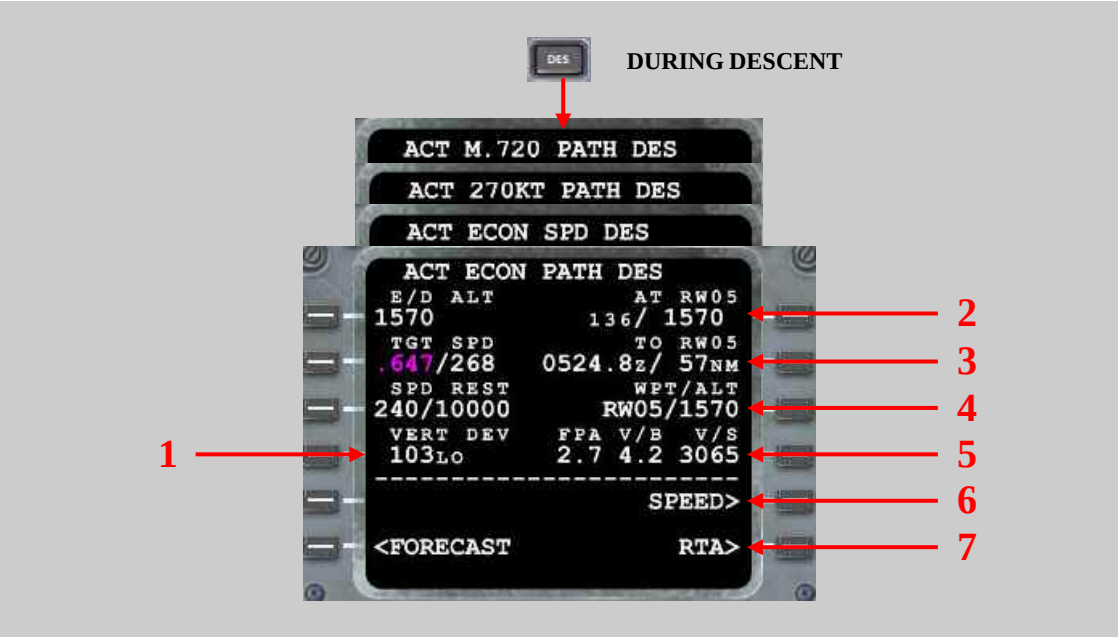
8. Descend Now (DES NOW)

Displayed on the standard DES pages whenever descent is not ACT or MOD.

Push – arms the DES NOW function and illuminates the EXEC light. Execution allows early initiation of PATH descent at 1000 fpm until intercepting the computed path.

Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



1. Vertical Deviation (VERT DEV)

Displays present deviation (feet HI or LO) from the computed vertical path. Blank if a path is not available. Displays when the descent phase is active.

2. Altitude Restriction (AT XXXXX)

This is the waypoint constraint line that displays the next descent waypoint constraint from the RTE LEGS page. The constraint is speed/altitude.

3. To Waypoint (TO XXXXX)

Displays computed ETA and distance to go to T/D.

4. Waypoint/Altitude (WPT/ALT)

Displays the waypoint and altitude that serves as the basis for the vertical bearing (V/B) display on line 4R.

5. Vertical Path Parameters (FPA V/B V/S)

Displays the following parameters related to the present vertical path:

- FPA – the present vertical bearing being flown.
- V/B – that is, the flight path angle required if flying direct to the waypoint and altitude on the WPT/ALT line.
- V/S – the required vertical speed (in fpm, based on present ground speed) to fly the displayed V/B.

6. SPEED

Displayed on PATH DES pages.

Push – selects the related SPD DES page.

7. RTA

Displayed when DES NOW or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

RTA Descent Page

RTA Descent pages are displayed when an RTA mode is active. Displays are the same as on other descent pages except as noted.

1. Target Speed (TGT SPD)

Displays computed RTA target speed.

Changes to FMC target speed if the RTA mode is exited.

2. TIME ERROR

Displays computed time error at the RTA waypoint.

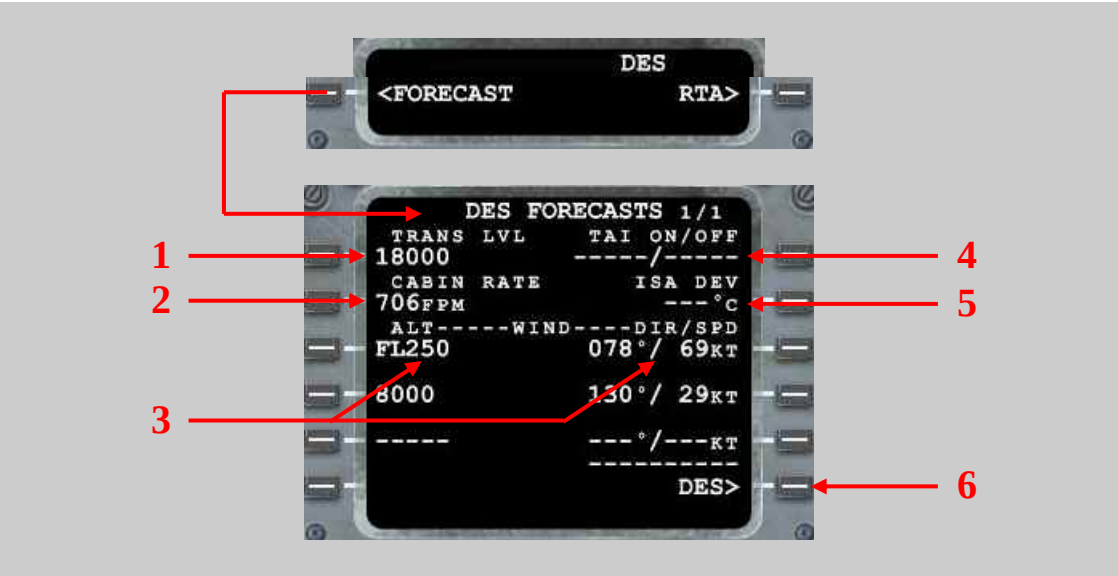
Same as time error line on RTA PROGRESS page.

3. RTA

Push – selects the RTA PROGRESS page.

Descent Forecast Page

The descent forecast page is used to enter forecast winds and the altitude there thermal anti-icing is turned on to more accurately define the descent path.



1. Transition Level (TRANS LVL)

The transition level for the descent phase of flight defaults to FL180. The value may be changed by pilot-entry.

2. CABIN RATE

Displays the predicted cabin rate of descent required by the flight plan descent profile.

3. Descent Wind (ALT – – – – – WIND – – – – DIR/SPD)

Allows entry of altitude and wind direction/speed for up to three forecast wind values. Entries may be made in any altitude sequence and will be automatically ordered by altitude from highest to lowest.

4. Thermal Anti–Ice On/Off (TAI ON/OFF)

Enter the altitudes in flight level or feet at which anti–ice is expected to be turned on and off.

5. ISA Deviation (DEV)

Enter the average ISA deviation for descent.

6. Descent (DES)

Push – displays the DES page.

Engine Out Descent

There are no specific engine out pages for descent. Use the normal descent planning

features and pages.

Approach

During approach, LNAV and VNAV guidance normally transitions to the approach guidance provided by navigation radios.

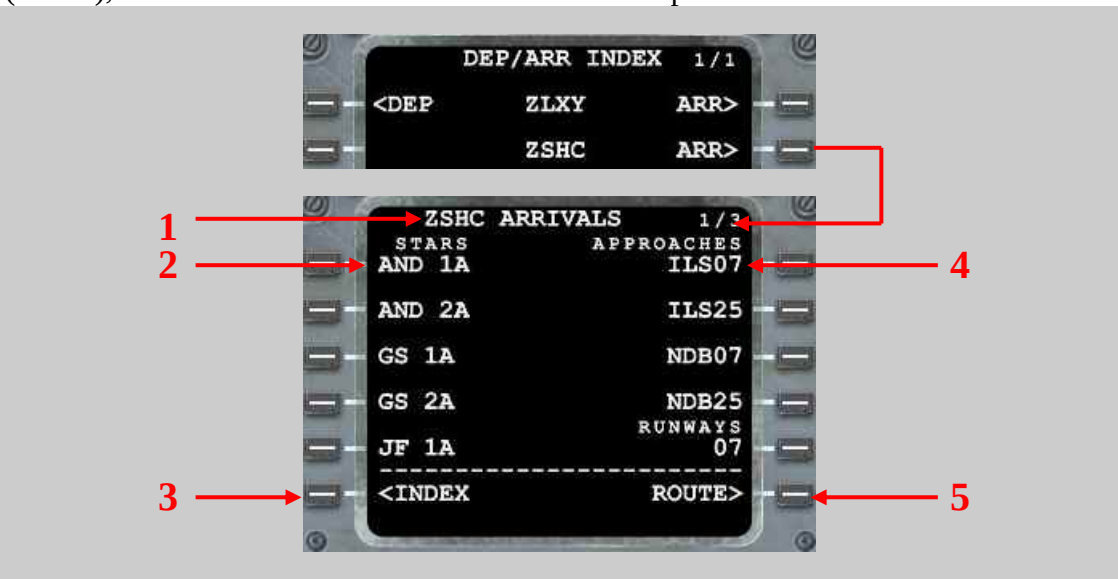
The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

Arrivals Page – IFR Approaches

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and arrival transitions to the destination airport.



1. Page Title

The destination airport identifier is displayed in the title.

2. Standard Terminal Arrival Routes (STARS)

Upon initial selection, an alphabetical listing of all STARS and profile descents is displayed. Selection of the desired STAR deletes all other STARs and non–applicable approaches/runways, and displays a listing of any arrival transitions applicable to that STAR.

3. INDEX

Push – displays the DEP/ARR INDEX page.

4. Approaches and Runways (APPROACHES)

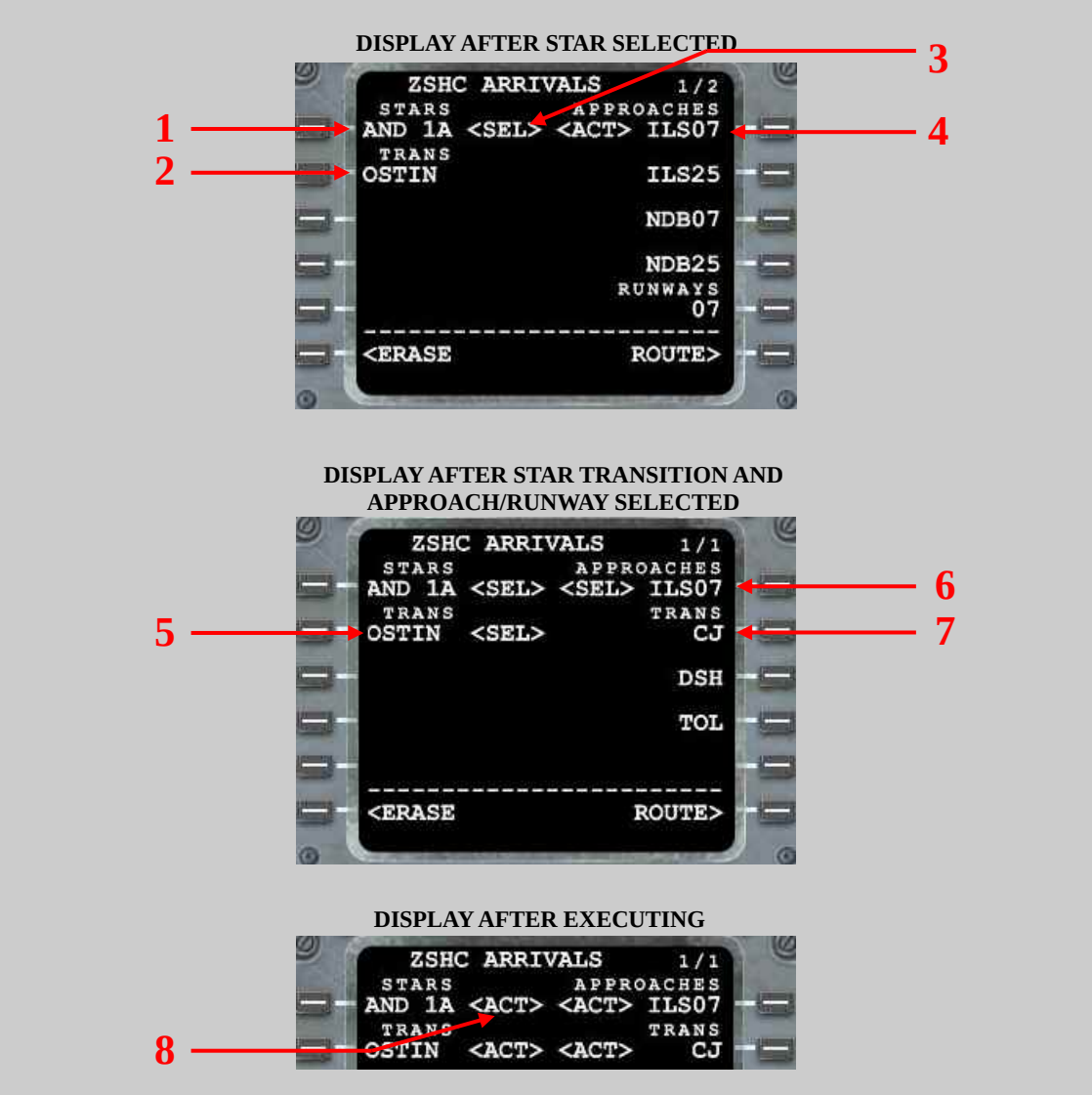
Upon initial page display, an alphabetical listing of all approaches for the airport,

followed by a numerical listing of all runways, is displayed. Selection of the desired approach or runway deletes all other approaches/runways.

5. ROUTE

Push – displays the RTE page.

Arrivals Page during approach selection



1. STARS

Displays the selected STAR.

2. Arrival Transitions (TRANS)

Displays all arrival transitions related to the selected STAR.

3. Selected Status Label (<SEL>)

Identifies arrival/approach procedures or a runway which has been selected for entry into the route, but not executed.

4. Approach and Runway (APPROACHES, RUNWAYS)

Displays all approaches related to the selected STAR, followed by all related runways.

5. Arrival Transition (TRANS)

Displays the selected arrival transition.

6. APPROACHES

Displays selected approach/runway.

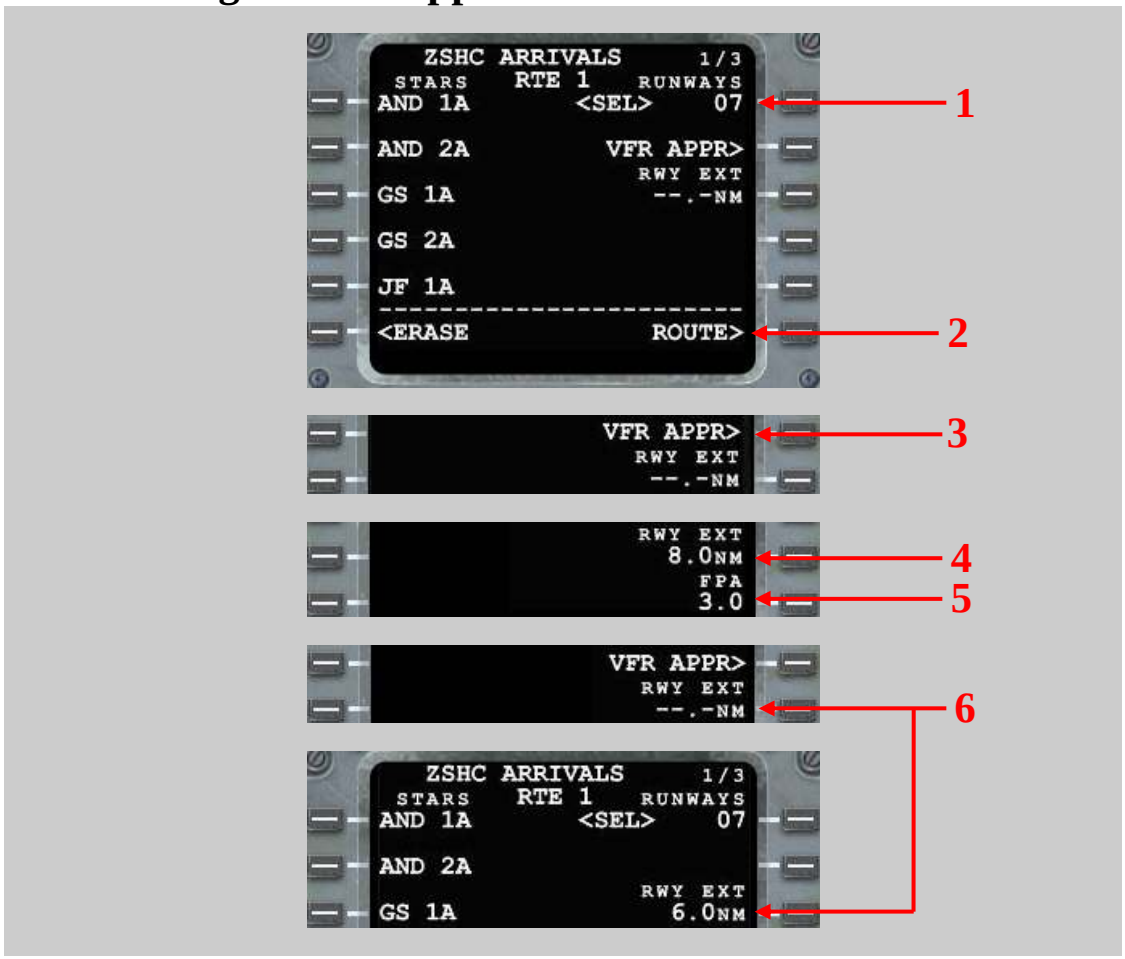
7. Approach Transition (TRANS)

Displays all approach transitions related to the selected approach.

8. Active Status Labels (<ACT>)

Following execution of the selected entries, the arrival/approach procedures and runway are identified as active.

Arrivals Page – VFR Approaches



1. RUNWAYS

Displays a list of runways for destination airport.

Push –
- selects runway for entry into the route
- deletes previously selected approach
- allows selection of VFR approach or entry of RWY EXT data
- deletes all other runways and approaches

2. ROUTE

Push – displays the active route page 2/X.

3. VFR Approach (VFR APPR)

Push – makes a transition waypoint, FAXXX at 8 NM and 2000 feet above the runway. LNAV and VNAV guidance to the runway is available. VNAV programs arrival at the FAF at 170 knots.

4. Runway Extension (RWY EXT)

After VFR APPR selected, displays RWY EXT 8.0; RWY EXT can not be modified.

5. Flight Path Angle (FPA)

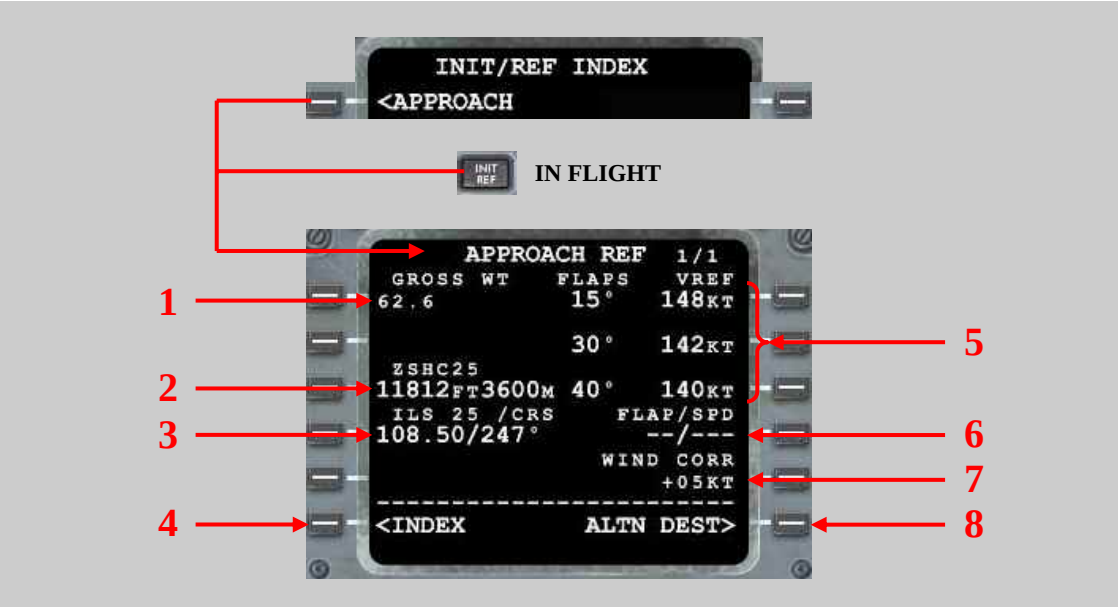
Displays flight path angle after VFR APPR is selected. Default is 3.0 degrees. Valid entries are from 2.4 to 3.7 degrees.

6. Runway Extension (RWY EXT)

Valid entries are from 1.0 to 25.0 miles from the runway threshold. Entry allowed if VFR APPR is not selected. Entry removes VFR APPR prompt. Makes waypoint RXYYY, where YYY is the runway; example: RX32R.

Approach Reference Page

The APPROACH REF page lets the flight crew review performance data related to the approach profile.



1. Airplane Gross Weight (GROSS WT)

The gross weight line displays FMC instantaneous computed aircraft gross weight, or a pilot-entered gross weight value. Manually entered gross weight is replaced by instantaneous computed gross weight upon leaving the page. Pilot-entered gross weight is for approach reference speed computation only and dies not affect the airplane gross weight or the values displayed on the PERF INIT page.

2. Runway Length

Displays the runway length for the destination runway in feet and meters.

3. Approach Information

Displays the runway number, associated ILS frequency and approach identifier for the ILS in the active flight plan.

4. INDEX

Push – selects the INIT/REF INDEX page.

5. Vref (FLAPS – – – VREF)

These display the calculated VREF speeds for the three flap settings. Push the applicable line select key to select the correct VREF speed. The three VREF speeds are based on landing flap setting. Displays the calculated reference speed for flaps 15°, 30°, and 40°. The display is blank until a gross weight is displayed.

6. Flap/Speed (FLAP/SPD)

Displays selected approach reference flap and speed setting. Valid entry format is FF/SSS, SSS, /SSS, FF/ or F/, where F or FF is a flap setting of 0, 1, 2, 5, 10, 15, 25, 30, 40 and SSS is a speed.

7. Wind Correction (WIND CORR)

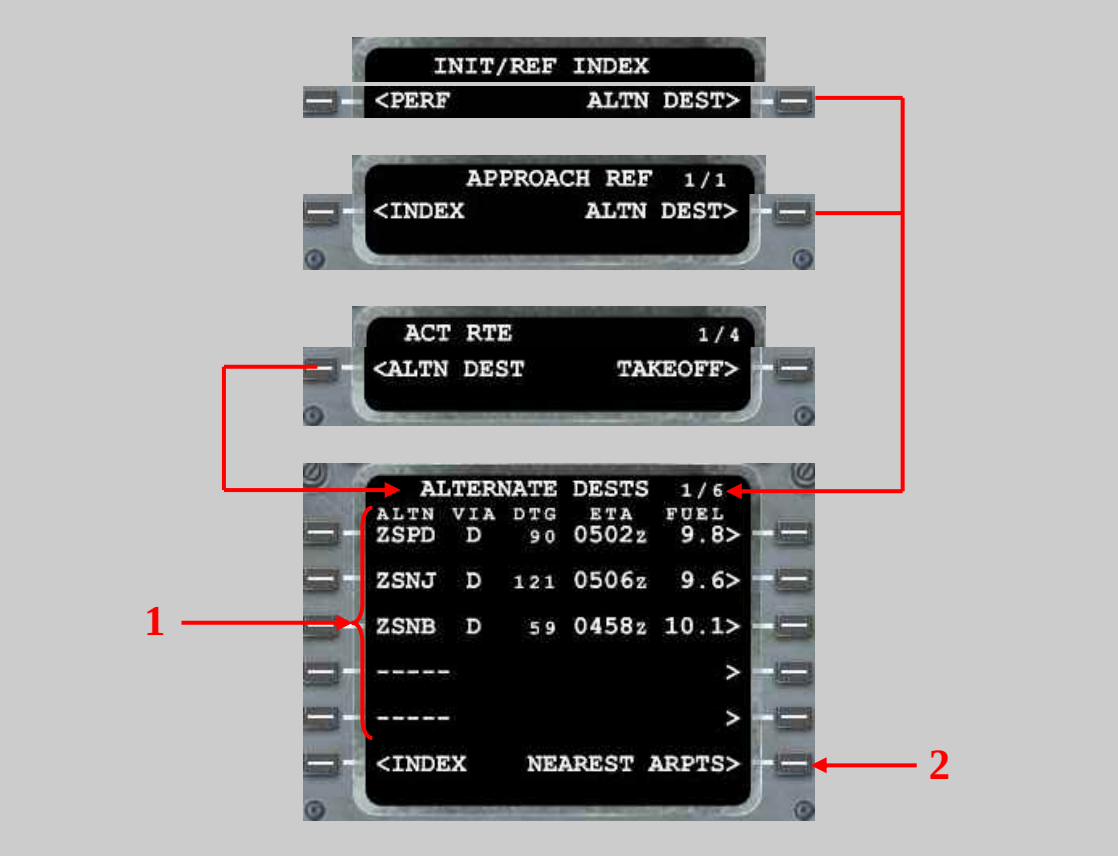
Displays current wind correction for approach. The default value is +05 knots and the allowable entry range is 0 to 20 knots.

8. Alternate Destination (ALTN DEST)

Push – selects alternate Destination page.

Alternate Airport Diversions
Alternate Dests Page 1/X

The alternate destinations pages allow the selection of alternate airports and the display of data about the alternates. The ALTERNATE DESTS page 1/X allows entry and display of up to five alternate airports. Pages 2 through 6 allow entry and display of data related only to the selected alternate.



1. Alternate Airports (ALTN)

These data fields let the flight crew enter alternate destination identifiers. Valid entries are airports, navaids, or waypoints. The identifiers must be 5 characters or less.

Push – selects page 2/X–6/X for data on selected alternate. The DELETE function key can be used to remove manually entered alternates.

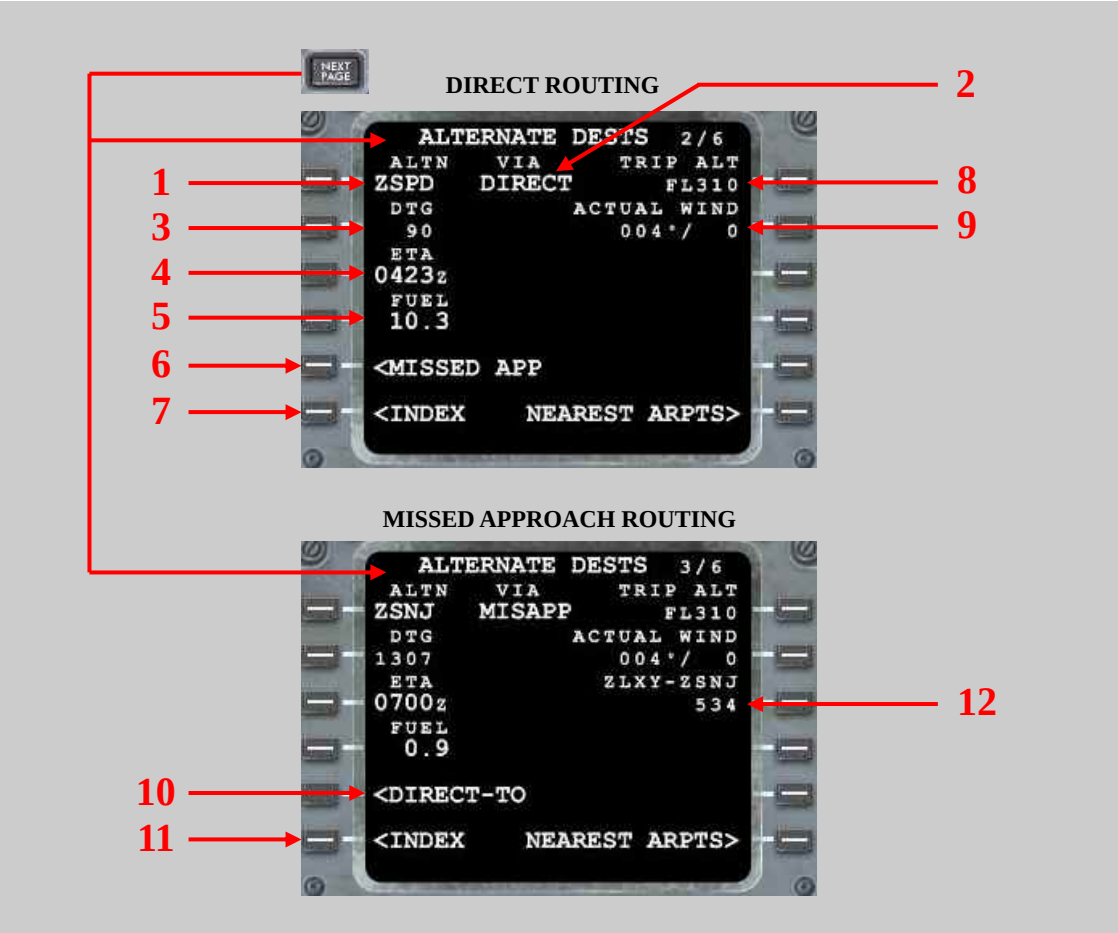
2. Nearest Airport (NEAREST ARPTS)

Push – commands FMC to search navigation database for the five airports nearest to the airplane's present position. The following actions occur:

- any alternates already entered are saved
- page title changes to NEAREST ARPTS
- the five nearest airports are displayed on lines 1L to 5L
- the NEAREST ARPTS prompt is replaced with PREVIOUS prompt
    - selection of the PREVIOUS prompt returns the display to the ALTERNATE DESTS page.

Alternate Dests Page X/X

This page lets the flight crew enter or review an alternate destination.



1. Alternate (ALTN)

Displays the alternate destination.

2. VIA

Displays routing method used for alternate predictions, either DIRECT or MISAPP.

3. Distance To Go (DTG)

Displays distance to go to alternate.

4. Estimated Time of Arrival (ETA)

Displays estimated time of arrival at alternate.

5. FUEL

Displays fuel remaining at alternate.

6. Missed Approach (MISSED APP)

Push – changes routing method to missed approach for alternate predictions.

Two routes to the airport can be selected:
- DIRECT–TO
- MISSED APP

7. INDEX

Push – displays ALTERNATE DESTS Page 1/X.

8. Trip Altitude (TRIP ALT)

Displays cruise altitude.

9. ACTUAL WIND

Displays current wind direction and velocity.

10. Distance To Go (DTG)

Displays distance to go.

11. DIRECT–TO

Push – changes routing method to direct to for alternate predictions.

Two routes to the airport can be selected:
- DIRECT–TO
- MISSED APP

12. Destination–Alternate

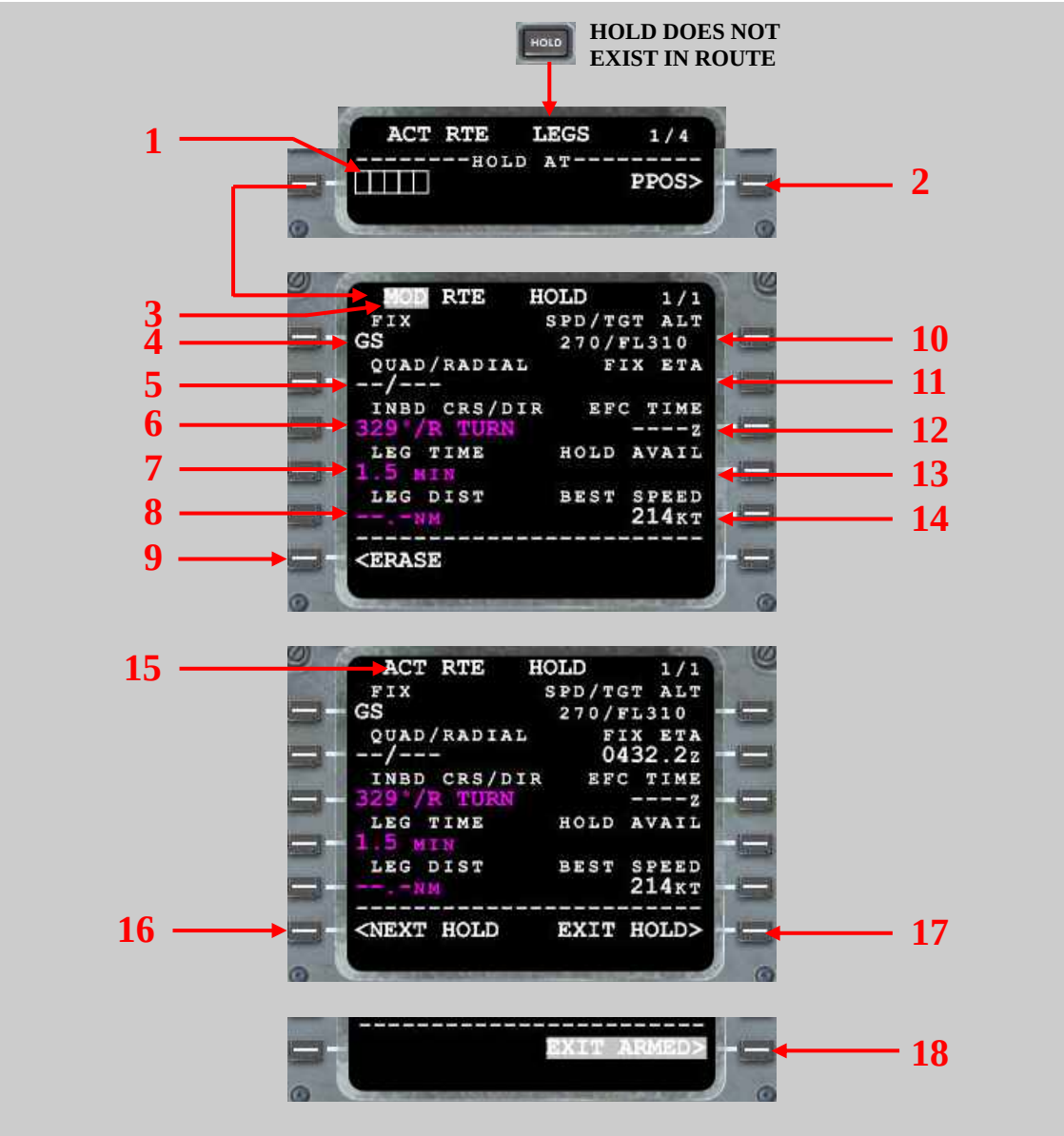
Displays computed distance from destination to alternate only when missed approach mode is selected.

Holding

The FMC computes holding patterns with constant radius turns based on current winds and FMC commanded airspeed. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle.

HOLD Page

The hold page is used to enter a holding pattern into the route. When the flight plan does not have a holding pattern, push the HOLD function key to show the LEGS page with the HOLD AT line. The holding page displays actual or default data about the holding pattern. Entries make route modifications, which can be erased or executed.



1. HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the LEGS page shows prompts to enter the holding fix. Enter the holding fix to show the RTE HOLD page.

2. HOLD AT Present Position (PPOS)

Selecting the airplane present position as the holding fix.

3. Modified Route Hold Status

MOD indicates that the holding fix has not been executed.

4. FIX

The fix line displays the holding fix as defined on the HOLD AT page. The holding fix may not be changed or deleted on the HOLD page but maybe deleted on the RTE LEGS page.

5. Quadrant/Radial (QUAD/RADIAL)

The quadrant and radial are displayed on this line. Normally this line displays dashes. Valid entry is XXX (radial) or XX/XXX (quadrant/radial). Valid quadrant entry is N, NE, E, SE, S, SW, W, or NW. Example: NW/330.

6. Inbound Course/Direction (INBD CRS/DIR)

This data field displays the inbound course and the direction of the holding pattern. Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction). Magenta when the holding fix is the active waypoint. Default value is inbound course to the holding fix on the preceding leg with right turns.

7. LEG TIME

This data field displays holding pattern leg time. Valid entry is X, X.X, or .X. The default times are 1.5 minutes above 14,000 feet and 1.0 minutes at or below 14,000 feet. If a LEG DIST is manually entered, then dashes will be displayed.

8. Leg Distance (LEG DIST)

This data field lets the flight crew enter the leg distance for the holding pattern. Dash prompts are normally displayed. Entry displays dashed on LEG TIME line. Valid entry is XX.X or X.X.

9. ERASE

Displayed only while modification is in progress.

Push – Erases all FMC modifications.

10. Speed/Target Altitude (SPD/TGT ALT)

The SPD/TGT ALT line displays the fix target speed/altitude as displayed on the LEGS page.

11. Fix Estimated Time of Arrival (FIX ETA)

This data field displays the next time the holding fix is passed.

12. Expect Further Clearance Time (EFC TIME)

This data field displays the time at which the holding pattern is exited. Entry of the EFC time will help optimize FMC performance computations.

13. Hold Available (HOLD AVAIL)

This data field displays the holding time available before exit is necessary to reach the destination with the necessary fuel reserves.

14. BEST SPEED

This data field displays the best holding speed for the current altitude and conditions.

15. Active Route Hold Status

ACT indicates that the airplane has entered the holding pattern.

16. NEXT HOLD

Push – displays a new hold page for a new holding pattern entry.

17. EXIT HOLD

Push –

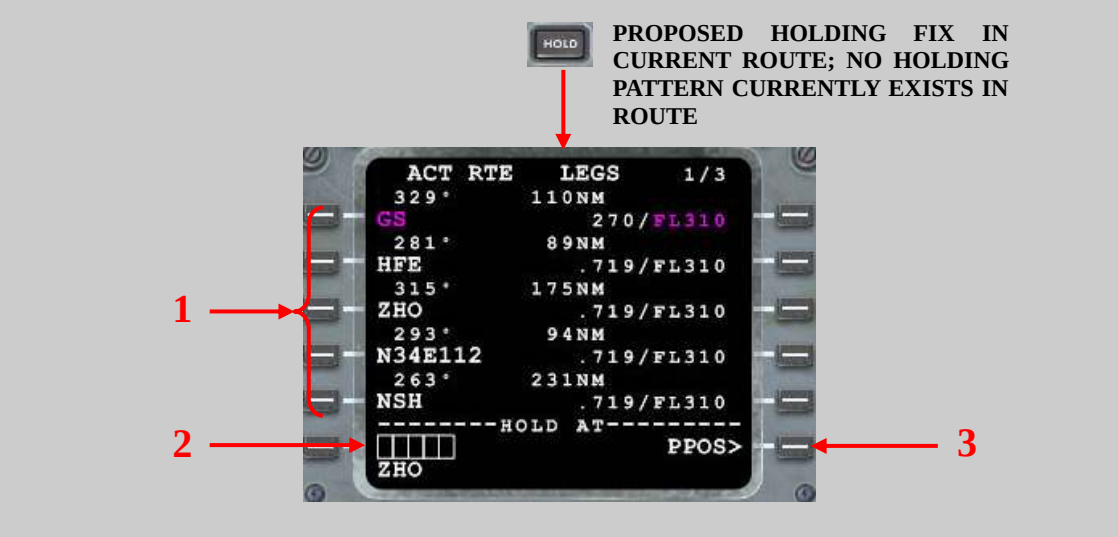
- arms a holding pattern exit
- EXIT ARMED displays in shaded white; when executed, airplane returns to the holding fix via the inbound course and continued flight along the active route.

18. EXIT ARMED

Displayed on the holding page when in the holding pattern and after line selection of EXIT HOLD prompt. Execution activates LNAV flight back to the holding fix via a holding pattern, and continued flight along the active route.

RTE LEGS HOLD AT (Fix in Route)

Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.



AFTER EXECUTING ROUTE HOLD AT DOWNTRACK WAYPOINT

1. Data Lines

Display same data as the corresponding RTE LEGS page.

2. HOLD AT

Used to enter any waypoint identifier, which then defines a holding fix. Entry may be via keyboard, or by transfer of any downpath waypoint which is in the existing route (the example depicts ZHO line selected into the scratch pad). Following line selection of the desired waypoint into the box prompts, the MOD RTE HOLD page appears and the execute key illuminates.

3. Present Position (PPOS)

Push – selects holding fix at present position. The MOD RTE HOLD page appears and the execute key illuminates.

Displayed only in flight.

4. Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

RTE LEGS HOLD AT (Fix not in Route)

AFTER LINE SELECTING THE DESIRED LEGS PAGE SEQUENCE AND EXECUTING THE OFF ROUTE HOLD

1. Hold at Waypoint (HOLD AT XXXX)

Displayed in the scratchpad whenever the entry in the HOLD AT line is not a waypoint in the existing route (the example above depicts entry of WY). Route position of the holding fix is defined by line selecting to the desired LEGS page sequence.

2. Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Flight Management, Navigation FMC Messages

Chapter 11
Section 60

Introduction

The FMC shows alerting or advisory messages when there is a condition that degrades the system. The FMCS also shows entry error.

FMC messages show in the CDU scratchpad. The messages are categorized as:

- alerting messages
- entry error messages
- advisory messages.

The FMC messages are shown according to their level of importance. Alerting messages are most important, followed by entry error messages. Advisory messages are least important. If multiple messages exist, a less important message replaces another message in the scratchpad when the CLR key is pushed or the condition is corrected.

The amber FMC alert light on each pilot's instrument panel illuminates when there is an FMC alerting message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

FMC Alerting Messages

Alerting messages show an FMC condition that must be shown to the flight crew and corrected before further FMC operation is advisable or possible.

FMC alerting messages:

- are shown in the CDU scratchpad
- cause the amber FMC alert light on each pilot's instrument panel to illuminate
- illuminate the message light (MSG) of the CDU

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CHECK ALT TGT	VNAV disengages while airplane is between MCP and FMC altitudes or VNAV button pressed while airplane is between MCP and FMC altitudes.	Clear the message.
DISCONTINUITY	Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.	Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage

		LNAV.
END OF OFFSET	Two minutes prior to passing offset leg termination.	Confirm clearance.
END OF ROUTE	LNAV engaged and passing the last waypoint in the route (LNAV disengages).	Select the RTE LEGS page. Enter the desired active waypoint into the dash prompts and EXECute. Reengage LNAV.
ENTER IRS POSITION	IRS in the alignment mode needs present position to complete alignment.	Enter IRS present position into the scratchpad pad and line select 4R on the POS INIT page of the CDU. If necessary, enter present position directly into the IRS control /display unit.
GPS-L INVALID GPS-R INVALID	FMC is no longer receiving information from the displayed GPS system.	Refer to FMC Navigation Check supplementary procedure.
INSUFFICIENT FUEL	A change in conditions or flight plan route causes predicted fuel at destination to be 900 kilograms/2000 lbs or less.	Modify the route plan or cruising altitude, or divert for additional fuel.
IRS MOTION	IRS has automatically restarted the alignment due to detection of excessive motion.	Clear message and attempt to reduce airplane movement, if practicable.
OVERSPEED DISCONNECT	During path descent, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots.	Manually reduce speed and reengage VNAV.
RESET MCP ALT	During the FMC cruise phase with VNAV engaged, when within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP.	Select lower MCP altitude values as clearances permit.
RTA UNACHIEVABLE	The RTA is not in the computed RTA window under current parameters.	Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to

		meet the RTA.
RW/APP CRS ERROR	During approach, MCP selected course does not match front course for the approach in the active flight plan.	Clear the message and select correct MCP course.
SELECT MODE AFTER RTA	RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.	Select alternate performance mode. (ECON, manual speed, etc.)
TAKEOFF SPEEDS DELETED	A change to runway, runway data, takeoff thrust selection or performance data is made after the V speeds have been selected, or entered V speeds fail to meet relative value check.	Reselect new V speeds and clear message.
THRUST REQUIRED	Airplane is in an underspeed condition.	Clear the message. Increase airspeed to within 15 knots of speed target.
UNABLE NEXT ALTITUDE	Unable to meet the next flight plan altitude constraint in a VNAV climb or descent. The message appears only with VNAV engaged.	Clear the message and review the prediction. For undershoot condition during climb, consider selection of MAX RATE CLB or MAX ANGLE CLB, or a different N1 limit as appropriate.
UNABLE REQD NAV PERF–RNP	When entering an RNP the underlying RNP value is smaller than the manually entered value or the ANP is greater than the manually entered RNP.	Change or delete the manually entered RNP.
VERIFY GW AND FUEL	Fuel data becomes invalid, PERF INIT fuel value is replaced with dashes. FMC uses last valid fuel quantity for performance predictions until manual entry is made. Shows if 30 minutes have elapsed since last manual entry.	Enter fuel weight on PERF INIT page 1/2. Periodic update of fuel weight is required to keep gross weight value current.

	Does not show in descent with Vref selected.	
VERIFY POSITION	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY TAKEOFF SPEEDS	A PERF INIT change has been made after takeoff speeds were specified.	On TAKEOFF REF page 1, accept previous V speeds, or reject previous V speeds and enter new V speeds.
VNAV DISCONNECT	The criteria for VNAV engagement is not satisfied (VNAV disengages). On approach, with VNAV engaged, the FCC has switched to LVL CHG.	Manually control the vertical path.

FMC Entry Error Messages

These messages relate to incorrect scratchpad entries. FMC entry error messages:

- are shown in the CDU scratchpad
- illuminate the message light (MSG) of the CDU
- temporarily overwrite data in the scratchpad.

Use the CLR key or key in new data to remove the message. If the CLR key is used to remove the message, the data previously entered is once again displayed. If new data is keyed in over the message, the message and the data previously entered are removed.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID DELETE	DEL key operation was attempted for a data line to which it was not applicable.	Clear the message and select the proper line after the DEL key is pressed.
INVALID ENTRY	Attempted data entry has incorrect format, range, etc. for the selected data line.	Clear the message and scratchpad entry, and repeat the entry with the correct data.
INVALID QUAD	Attempted HOLD page QUAD entry has incorrect format or range.	Clear the message and revise the QUAD entry.
NO OFFSET AT LEG XXXXX (waypoint)	Attempted entry of a lateral offset start or end waypoint XXXXX that is not offsetable.	Clear the message and amend the route.

NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry.
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset start/end waypoint entry is not in active flight plan.	Clear the message and amend the entry.

FMC Advisory Messages

These messages relate to FMC status. FMC advisory messages:

- are shown in the CDU scratchpad
- illuminate the message light (MSG) of the CDU

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The airplane is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
APPRCH VREF NOT SELECTED	Airplane has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel quantity indications for correctness.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Mmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the airplane within 5 kts of FMC target speed.
INVALID OFFSET	Desired offset does not meet FMC offset criteria.	Clear the message and amend the entry.
MAX ALT FLXXX (flight level value)	Altitude entry on any page is above the maximum altitude for current selected performance margins.	Clear the message or amend the data entry.
NOT ON INTERCEPT HEADING	Airplane is not within the LNAV capture criteria for the active leg (LNAV disengages).	Manually place the airplane on an intercept heading and reengage LNAV.

OFFSET DELETED	The entered start waypoint has been deleted from the flight plan.	Clear the message and amend the route.
POS SHIFT OVER 50NM	FMC position shift excess 50nm.	Clear the message.
RUNWAY N/A FOR SID	The selected runway is not applicable to the selected departure procedure.	Clear the message and check selections on the DEPARTURES page. Modify as required.
UNABLE CRZ ALT	FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection.
UNABLE MACH .XXX	The entered cruise Mach is unattainable based on present gross weight.	Select a smaller Mach number or wait until gross weight is reduced sufficiently.
USING RSV FUEL	Predicted fuel remaining at DEST is less than the RESERVES entry on the PERF INIT page.	Clear the message and change routing if required.

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Fuel Controls and Indicators

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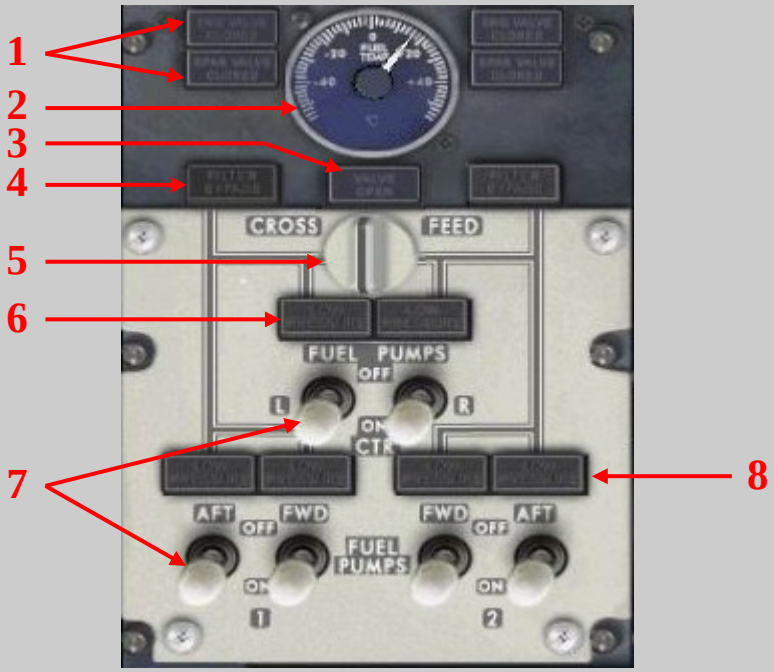
Fuel Control Panel



FORWARD OVERHEAD PANEL

1. Engine Valve Closed (ENG VALVE CLOSED) and SPAR VALVE CLOSED Lights

Extinguished – related engine or spar fuel shutoff valve is open.

Illuminated (blue) –

- bright – related engine or spar fuel shutoff valve is in transit, or valve position and engine start lever disagree.
- dim – related engine or spar fuel shutoff valve is closed.

2. FUEL Temperature (TEMP) Indicator

Indicates fuel temperature.

3. Crossfeed VALVE OPEN Light

Extinguished – crossfeed valve is closed.

Illuminated (blue) –

- bright – crossfeed valve is in transit, or valve position and CROSSFEED selector disagree.
- dim – crossfeed valve is open.

4. FILTER BYPASS Lights

Not modeled.

5. CROSSFEED Selector

Controls fuel crossfeed valve.

6. Center Tank FUEL PUMP LOW PRESSURE Lights

Illuminated (amber) – fuel pump pressure is low and FUEL PUMP switch is ON.

Extinguished – fuel pump pressure is normal, or FUEL PUMP switch is OFF.

7. FUEL PUMP Switches

ON – activates fuel pump.

OFF – deactivates fuel pump.

8. Main Tank FUEL PUMP LOW PRESSURE Lights

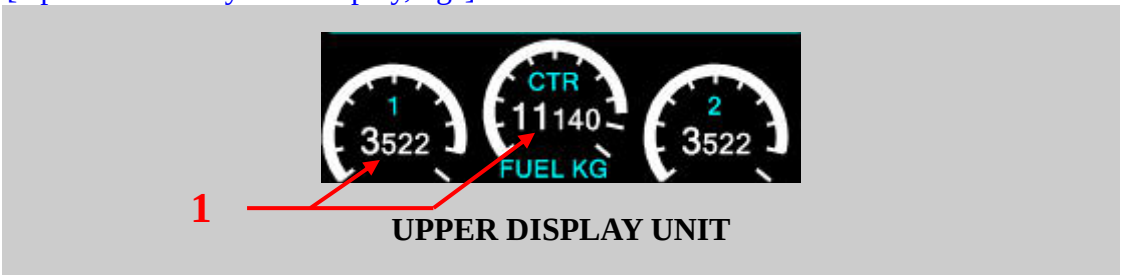
Illuminated (amber) – fuel pump pressure is low, or FUEL PUMP switch is OFF.

Extinguished – fuel pump pressure is normal.

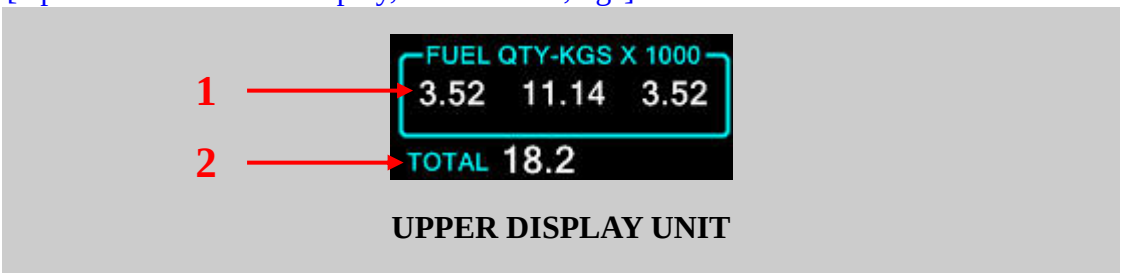
Fuel Quantity Indications

The fuel quantity indicating system (FQIS) shows fuel weight of the main tanks and the center tank on the common display system (CDS).

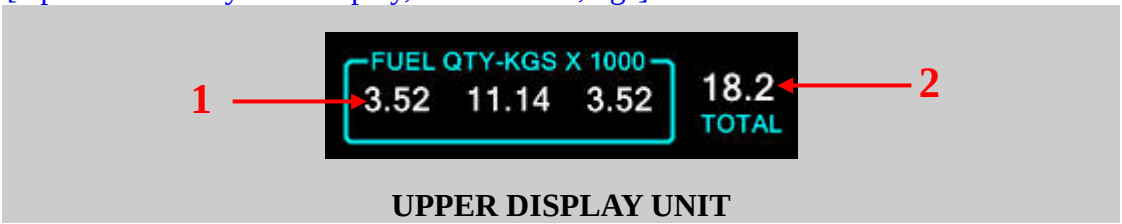
[Option – Side By Side display, kgs]



[Option – Over/Under display, TOTAL fuel, kgs]



[Option – Side By Side display, TOTAL fuel, kgs]



1. FUEL Quantity Indicators

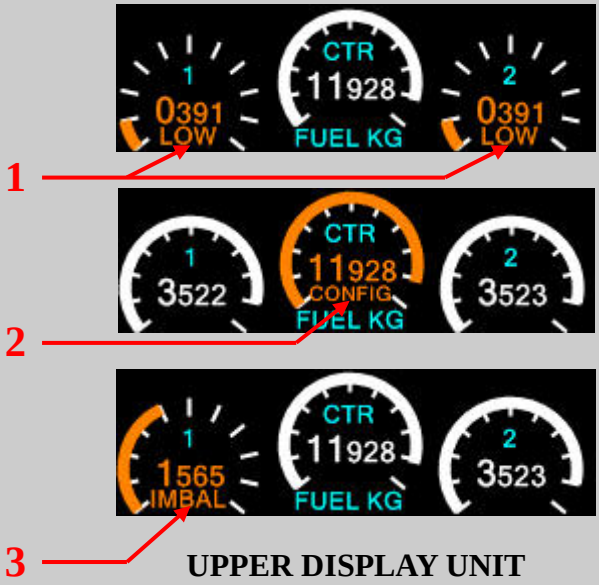
Displayed (white) – indicates usable fuel in related tank.

2. Total Fuel Quantity Indicator

Displayed (white) - indicates total usable fuel.

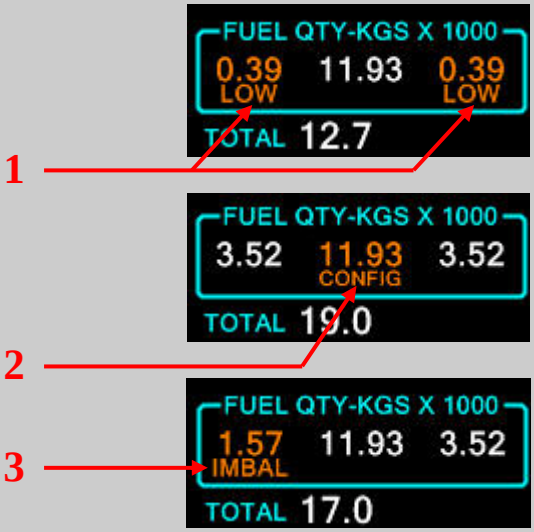
Fuel Alert Indications

[Option – Side By Side display, kgs]



UPPER DISPLAY UNIT

[Option – Over/Under display, TOTAL fuel, kgs]



UPPER DISPLAY UNIT

1. Fuel LOW Alert

Displayed (amber) – either main tank 1 or main tank 2 has less than 2,000 lb (907 kg) of fuel. This message goes away when there is more than 2,500 lb (1133 kg) of fuel in that tank. The low fuel condition must exist for 30 seconds before the LOW message shows.

2. Fuel Configuration (CONFIG) Alert

Displayed (amber) –
- either engine is in operation
- 1,600 lb (725 kg) or more of fuel in the center tank; and
- both center fuel tank pump switches positioned OFF

The quantity digits on the center tank fuel quantity indicator turn amber.

Display remains until –
- both engines are not in operation
- 800 lb (360 kg) or less of fuel in the center tank
- one center fuel tank pump switch ON

The quantity digits on the center tank fuel quantity indicator return to normal.

3. Fuel Imbalance (IMBAL) Alert

Displayed (amber) –
- there is a difference of 1,000 lb (453 kg) between main tank 1 and main tank 2
- displays below main tank with lower fuel quantity
- only displays when the airplane is in the air.
- does not displays when the LOW message shows
- displays until the difference between tanks is 200 lb (90 kg) or less
- the imbalance condition must exist for 60 seconds before the IMBAL message shows.

The fuel quantity digits on tank with lower fuel quantity turn amber.

Auxiliary Fuel Control Panels

[Option – BBJ/BBJ2]

Auxiliary Fuel Cockpit Display Panel

[Option – BBJ/BBJ2]

CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Auxiliary FUEL Quantity Indicators (FWD and AFT)

Indicate usable fuel in related auxiliary fuel tank.

Auxiliary Fuel Transfer Panel

[Option – BBJ/BBJ2]

FORWARD OVERHEAD PANEL

1. FWD AUXILIARY FUEL TRANSFER Valve Switches (A and B)

OFF - closes forward auxiliary fuel transfer valves.

AUTO - arms forward auxiliary fuel transfer valves to begin fuel transfer.

2. AFT AUXILIARY FUEL TRANSFER Valve Switches (A and B)

OFF - closes aft auxiliary fuel transfer valves.

AUTO - arms aft auxiliary fuel transfer valve to begin fuel transfer.

Auxiliary Fuel Bleed Air Panel

[Option – BBJ/BBJ2]

AFT OVERHEAD PANEL

1. AUXILIARY FUEL BLEED AIR Switches (FWD and AFT)

OFF - closes auxiliary fuel bleed air valve.

OVRD- allows bleed air valve to operate if A or B auxiliary fuel transfer valve is open and auxiliary fuel tank pressure is low.

2. AUXILIARY FUEL Ground (GRD) TRANSFER Switch

OFF (Guarded Position) - prevents fuel transfer from auxiliary tanks while airplane is on the ground.

ON - disables air/ground logic and arms auxiliary fuel bleed air valves, allowing bleed air to pressurize auxiliary fuel tanks for fuel transfer while airplane is on the ground.

Fuel System Description

Chapter 12
Section 20

Introduction

The fuel system supplies fuel to the engines and the APU. Fuel is contained in three tanks located within the wings and wing center section.

[Option – BBJ/BBJ2]
Auxiliary fuel tanks are located in the forward and aft cargo compartments.

Fuel Feed

Both engines are normally pressure fed from the center tank until the center tank quantity decreases to near zero. The engines are normally then pressure fed from their respective main tanks.

Fuel Pumps

Each fuel tank uses two AC powered fuel pumps. Center tank pumps produce higher pressure than main tank pumps. This ensures that center tank fuel is used before main tank fuel, even though all fuel pumps are operating.

Fuel Crossfeed

The engine fuel manifolds are interconnected by use of the crossfeed valve. The valve is DC motor operated from the battery bus.

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve.

Fuel Temperature

The FUEL TEMP indicator located on the fuel control panel displays fuel temperature. A sensor in main tank No. 1 allows monitoring of fuel temperature. The temperature indicating system uses AC electrical power.

APU Fuel Feed

When AC fuel pumps are operating, fuel for the APU is supplied from the left side of the fuel manifold. If the AC fuel pumps are not operating, fuel is suction fed from main tank No. 1.

Fuel Quantity Indication

The fuel quantity indication system calculates the usable fuel quantity in each tank. The fuel quantity in each tank is displayed on the upper display unit and on the fueling station panel.

Auxiliary Fuel System

[Option – BBJ/BBJ2]
The Auxiliary Fuel System provides for extended range operations. Auxiliary fuel

tanks are located in the cargo compartments. Controls for the auxiliary fuel system are located on the Forward Overhead Panel. Auxiliary fuel quantities are displayed on the Auxiliary Fuel Cockpit Display Panels. Auxiliary fuel quantity is included in the airplane total fuel quantity sent to the FMC for fuel computations.

Auxiliary Fuel System Operation

During normal operation, fuel is transferred from the auxiliary fuel tanks into the center fuel tank. This transfer is accomplished using pressurized air from the cabin. If the cabin pressure is not adequate for fuel transfer, bleed air can be selected for fuel transfer. The bleed air valves cycle open and closed to regulate the bleed air pressure to the auxiliary fuel tanks.

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Hydraulics Controls and Indicators

Chapter 13
Section 10

Hydraulic Panel

FORWARD OVERHEAD PANEL

1. Electric Hydraulic Pump OVERHEAT Lights

Illuminated (amber) – Hydraulic fluid has overheated or the electric motor–driven pump has overheated.

2. Hydraulic Pump LOW PRESSURE Lights

Illuminated (amber) – output pressure of associated pump is low than normal.

3. ELECTRIC HYDRAULIC PUMPS Switches

ON – turn on associated electric motor–driven pump.

OFF – turn off associated electric motor–driven pump.

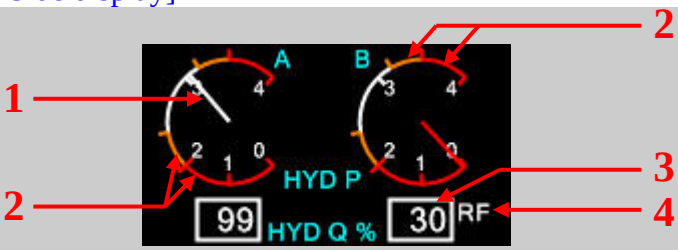
4. ENGINE HYDRAULIC PUMPS Switches

ON – turn on the engine–driven hydraulic pump.

OFF – turn off the engine–driven hydraulic pump.

Hydraulic Indications

[Option – Side by Side display]



UPPER DISPLAY UNIT

1. HYDRAULIC System PRESSURE Indications

The hydraulic pressure shows as an analog indication. In the normal operation range, the scale and the pointer are white. When the hydraulic pressure is in the low or high amber band range, the scale and the pointer are amber. When the hydraulic pressure gets to the low or high redline limit, the scale and the pointer are red.

2. Hydraulic Pressure Amber Bands/Redlines

Displayed (amber) – low/high hydraulic pressure caution range.

Displayed (red) – low/high hydraulic pressure operating limit.

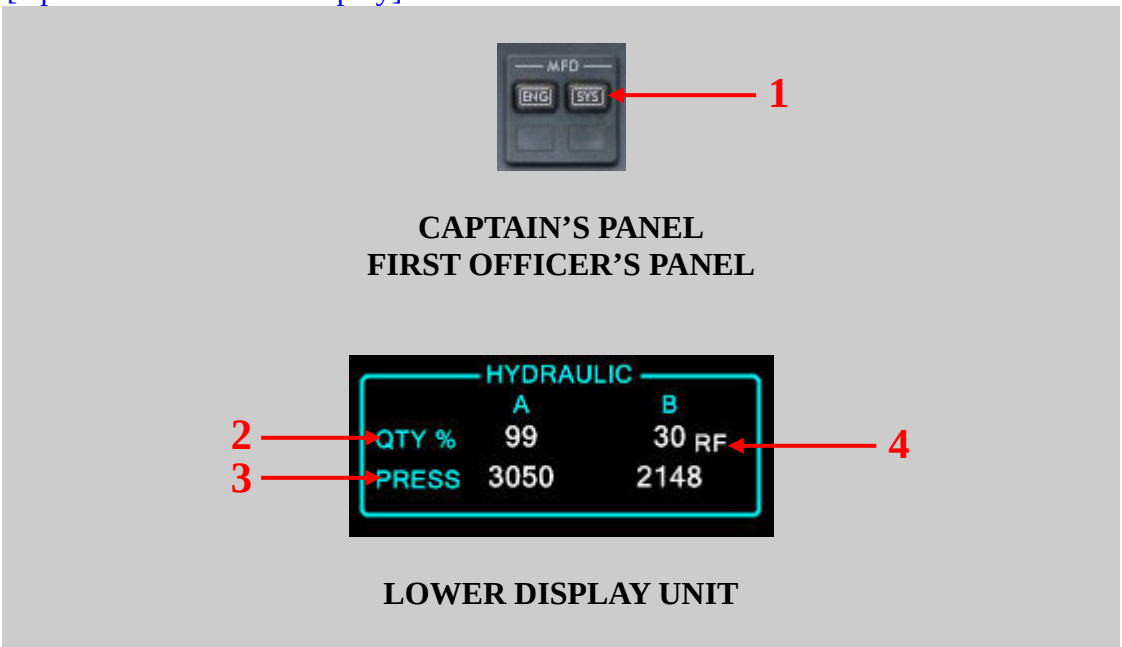
3. HYDRAULIC System QUANTITY Indications

The hydraulic quantity shows as a digital indication. The hydraulic quantity and the box are white.

4. REFILL Indication (RF) (white)

Illuminated (white) – hydraulic quantity below 76%.

[Option – Over/Under display]



1. MFD System (SYS) Switch

Push – SYS

- displays hydraulic indications on lower DU; or if the lower DU is unavailable, displays it on upper DU or inboard DU based on the position of the display select panel selector
- second push blanks lower DU.

2. HYDRAULIC System QUANTITY Indications (white)

Indicates digital percentage (0% to 106%) of hydraulic quantity.

3. HYDRAULIC System PRESSURE Indications (white)

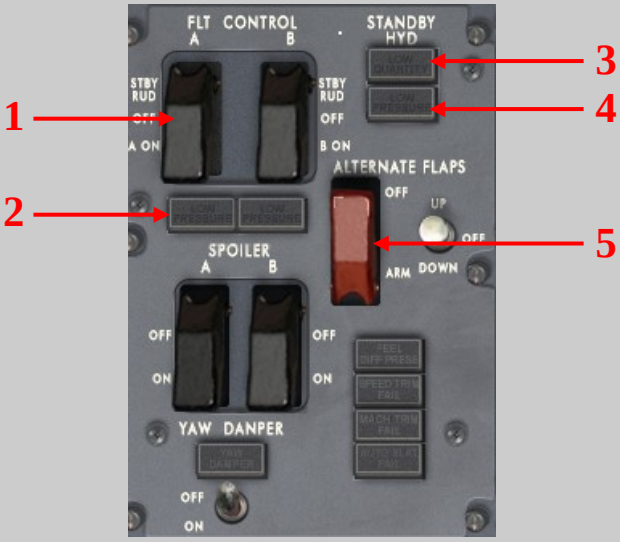
Indicates system pressure.

4. REFILL Indication (RF) (white)

Illuminated (white) – hydraulic quantity below 76%.

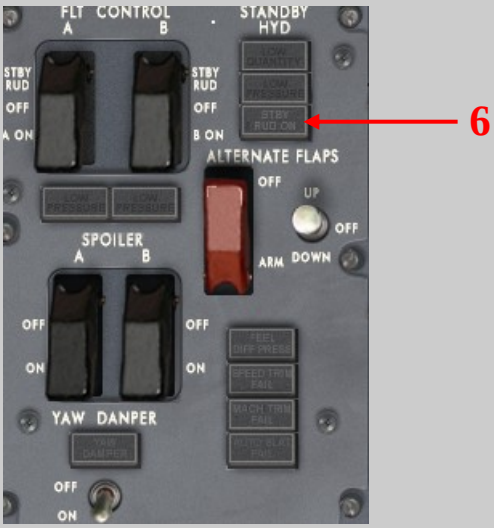
Flight Control Panel

[Option – 737-600/700/700C/700ER/800/900/900ER]



FORWARD OVERHEAD PANEL

[Option – BBJ/BBJ2/BBJ3]



FORWARD OVERHEAD PANEL

1. FLIGHT CONTROL Switches

STBY RUD – turns on the standby pump and pressurizes the standby power control

unit.

OFF – removes system pressure from ailerons, elevators, elevator feel computer, and rudder.

ON (guarded position) – system pressure is on to the ailerons, elevators, elevator feel computer, and rudder.

2. Flight Control LOW PRESSURE Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD.

3. STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) – indicates low quantity in standby hydraulic reservoir

4. STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) – indicates output pressure of standby pump is low

5. ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes TE flap bypass valve, activates standby pump, and arms the ALTERNATE FLAPS position switch.

6. STBY RUD ON Light

Illuminated (amber) – indicates the standby rudder system is commanded on to pressurize the standby rudder power control unit.

Hydraulics System Description

Chapter 13
Section 20

Introduction

The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots.

Either A or B hydraulic system can power all flight controls.

A and B Hydraulic Systems

Components powered by hydraulic systems A and B are:

System A

- ailerons
- rudder
- elevator
- flight spoilers (two on each wing)
- ground spoilers
- alternate brakes
- No. 1 thrust reverser
- autopilot A
- nose wheel steering
- landing gear

System B

- ailerons
- rudder
- elevator
- flight spoilers (two on each wing)
- leading edge flaps and slats
- normal brakes
- No. 2 thrust reverser
- autopilot B
- nose wheel steering
- landing gear.
- yaw damper
- trailing edge flaps.

A and B Hydraulic System Pumps

Both A and B hydraulic systems have an engine–driven pump and an AC electric motor–driven pump. The system A engine–driven pump is powered by the No. 1 engine and the system B engine–driven pump is powered by the No. 2 engine.

Standby Hydraulic System

The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. The standby system can be activated manually or automatically and uses a single electric motor–driven pump to power:

- thrust reversers
- rudder
- leading edge flaps and slats
- standby yaw damper.

Manual Operation

Positioning either FLT CONTROL switch to STBY RUD:

- activates the standby electric motor–driven pump
- shuts off the related hydraulic system pressure to ailerons, elevators and rudder by closing the flight control shutoff valve
- opens the standby rudder shutoff valve
- deactivates the related flight control LOW PRESSURE light when the standby rudder shutoff valve opens
- allows the standby system to power the rudder and thrust reversers.

Positioning the ALTERNATE FLAPS master switch to ARM, (refer to Chapter 9, Flight Controls for a more complete explanation):

- activates the standby electric motor–driven pump
- closes the trailing edge flap bypass valve
- arms the ALTERNATE FLAPS position switch
- allows the standby system to power the leading edge flaps and slats and thrust reversers.

Automatic Operation

Automatic operation is initiated when the following conditions exist:

- loss of system A or B, and
- flaps extended, and
- airborne, or wheel speed greater than 60 kts, and
- FLT CONTROL switch A or B Hydraulic System ON

Automatic operation:

- activates the standby electric motor–driven pump
- opens the standby rudder shutoff valve
- allows the standby system to power the rudder and thrust reversers.

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Landing Gear Controls and Indicators

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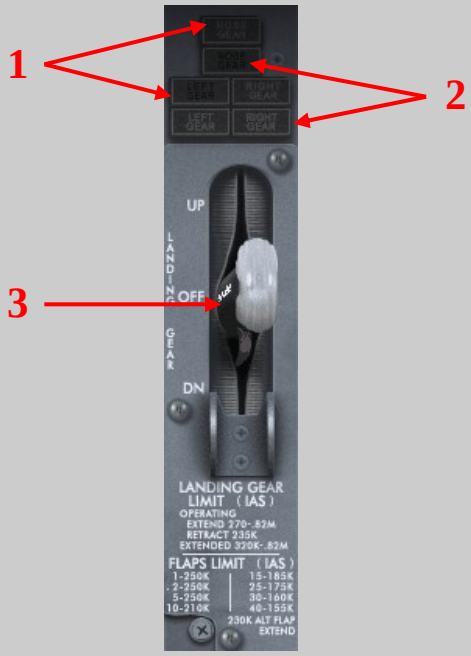
Section 10

Landing Gear Panel



CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. Landing Gear Indicator Lights (top)

Illuminated (red) –

- indicate related landing gear is not down and locked.
- related landing gear is in disagreement with LANDING GEAR lever position.

2. Landing Gear Indicator Lights (bottom)

Illuminated (green) – indicate related landing gear is down and locked.

3. LANDING GEAR Lever

UP – retracts landing gear.

OFF – removes hydraulic pressure to the landing gear system.

DN – extends landing gear.

Landing Gear Indicator Lights

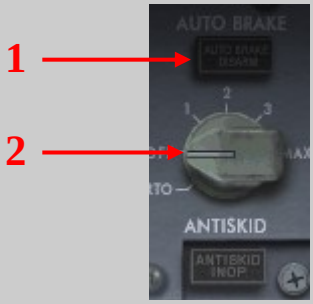
AFT OVERHEAD PANEL

1. Landing Gear Indicator Lights (overhead)

Illuminated (green) – indicate related landing gear is down and locked.

Extinguished – indicate related landing gear is not down and locked.

Autobrake and Antiskid Controls



CAPTAIN'S PANEL
FIRST OFFICER'S PANEL

1. AUTO BRAKE DISARM Light

Illuminated (amber) –
- RTO mode selected on ground
  - illuminates for one to two seconds then extinguishes
- a malfunction exists in automatic braking system.

Extinguished –
- AUTO BRAKE select switch set to OFF
- autobrakes armed.

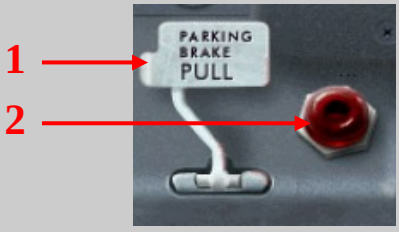
2. AUTO BRAKE Select Switch

OFF – removes power from autobrake system.

1, 2, 3, or MAX – selects desired airplane deceleration rate and arms autobrake system for automatic braking upon landing

RTO – arms the autobrake system to provide maximum braking for rejected takeoff when both throttles are retarded to idle above 80 knots.

Parking Brake



CONTROL STAND

1. PARKING BRAKE Lever

Forward – parking brakes released.

Aft – sets parking brakes.

2. Parking Brake Warning Light

Illuminated (red) – parking brake is set.

Extinguished – parking brake is released.

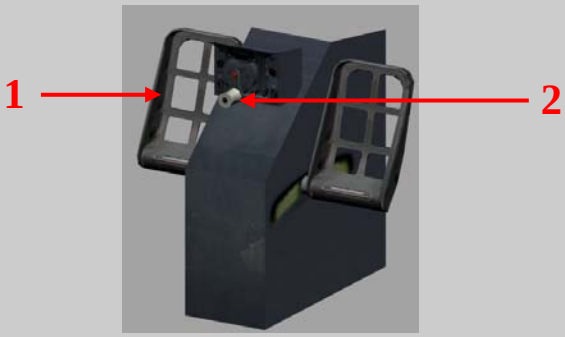
Hydraulic Brake Pressure Indicator

FIRST OFFICER'S PANEL

1. Hydraulic Brake Pressure (HYD BRAKE PRESS) Indicator

Indicates brake accumulator pressure.

Rudder/Brake Pedals



CREW STATION

1. Rudder/Brake Pedals

Push full pedal – turns rudder and nose wheel.

Push top of pedal only – activates wheel brakes.

Refer to Chapter 9 Flight Controls for rudder description.

2. RUDDER PEDAL ADJUSTMENT Crank

AFT (counter–clockwise) – adjusts rudder pedals aft.

FWD (clockwise) – adjusts rudder pedals forward.

Landing Gear System Description

Chapter 14
Section 20

Introduction

The airplane has two main landing gears and a single nose gear. Each main gear is a conventional two–wheel landing gear unit. The nose gear is a conventional steerable two–wheel unit.

Landing Gear Operation

The landing gears are controlled by the LANDING GEAR lever. On the ground, the landing gear lever is locked, prevents the LANDING GEAR lever from moving to the up position.

Landing Gear Retraction

When the LANDING GEAR lever is moved to UP, the landing gear begins to retract.

Hydraulic pressure is removed from the landing gear system with the LANDING GEAR lever in the OFF position.

Landing Gear Extension

When the LANDING GEAR lever is moved to DN, hydraulic system A pressure is used to release the uplocks. The landing gear extends by hydraulic pressure.

Brake System

Each main gear wheel has a multi–disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
- alternate brake system
- brake accumulator
- autobrake system
- parking brake

Normal Brake System

The normal brake system is powered by hydraulic system B.

Alternate Brake System

The alternate brake system is powered by hydraulic system A. If hydraulic system B is low or fails, hydraulic system A automatically supplies pressure to the alternate brake system.

Brake Accumulator

The brake accumulator is pressurized by hydraulic system B. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

Autobrake System

The autobrake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning.

Parking Brake

The parking brake can be set with either A or B hydraulic systems pressurized. If A and B hydraulic systems are not pressurized, parking brake pressure is maintained by the brake accumulator. Accumulator pressure is shown on the HYD BRAKE PRESS indicator.

The TAKEOFF CONFIG lights illuminate and the takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.

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Warning Systems Controls and Indicators

Chapter 15
Section 10

Landing Gear Panel

CAPTAIN'S PANEL

FIRST OFFICER'S PANEL

1. Master Fire Warning (FIRE WARN) Lights

Illuminated (red) – indicates a fire warning (or system test) in engine, cargo, or APU.

Push – extinguishes both master FIRE WARN lights and silences fire warning bell

2. MASTER CAUTION Lights

Illuminated (amber) – a system annunciator light has illuminated.

Push – extinguishes both MASTER CAUTION lights and system annunciator light(s) extinguish

3. System Annunciator Panel

Illuminated (amber) – an amber light, relating to illuminated system annunciator, has illuminated on forward overhead, aft overhead or overheat/fire protection panel.

To extinguish – push either MASTER CAUTION light.

To recall – push either system annunciator panel.

Takeoff Configuration and Cabin Altitude Warning Lights

CAPTAIN'S PANEL

FIRST OFFICER'S PANEL

1. Takeoff Configuration Warning Light

Illuminated (red) – activates on the ground as the throttles are advanced if the airplane is not configured correctly for takeoff

2. Cabin Altitude Warning Light

Illuminated (red) – illuminates at 10,000 feet if the cabin has not been pressurized

Landing Gear Warning Cutout Switch

CONTROL STAND

1. Landing Gear Warning Cutout Switch

Push – silences landing gear configuration warning aural indication at flaps up through 10 and above 200 feet RA.

Altitude Alert

[Option – EFIS/MAP]

ABOVE EACH PILOT'S ALTIMETER

1. Altitude Alert (ALT ALERT) Annunciation

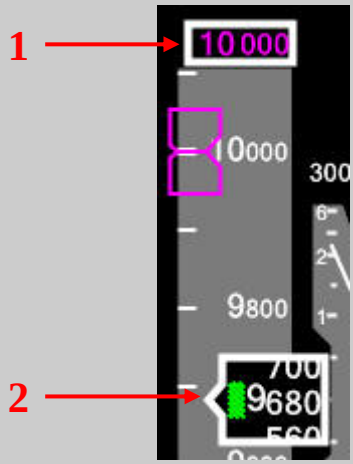
One on each pilot's primary display above altimeter.

Displayed (amber):

- steady –
  - 900 feet from MCP selected altitude

  - momentary tone also sounds
  - 300 feet from MCP selected altitude, ALT ALERT annunciation no longer shows.
- flashing –
  - deviation more than 300 feet from MCP selected altitude
  - momentary tone also sounds
  - flashing continues until:
    - altitude deviation less than 300 feet, or
    - altitude deviation more than 900 feet, or
    - new MCP altitude selected.

[Option – PFD/ND]



CAPTAIN'S PFD
FIRST OFFICER'S PFD

1. Selected Altitude Alert

A white box shows around the selected altitude display between 900 feet and 300 feet before reaching the selected altitude.

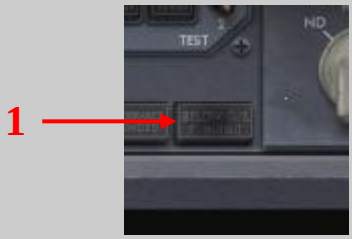
2. Current Altitude Alert

The white box around the current altitude display becomes bold between 900 feet and 300 feet before reaching the selected altitude.

The box turns amber and flashes for 300 feet to 900 feet deviation from the selected altitude.

Ground Proximity Warning System (GPWS)
GPWS Controls

CAPTAIN'S PANEL



FIRST OFFICER'S PANEL

FIRST OFFICER'S PANEL

1. BELOW Glide Slope (G/S) light

Illuminated (amber) – below glide slope alert is active.

Push – inhibits GLIDE SLOPE alert.

2. Inoperative (INOP) light

Illuminated (amber) –there is a failure of the GPWS computer. The INOP light also comes on during GPWS self test, the INOP light comes on.

3. Ground Proximity System Test (SYS TEST) Switch

Push – start GPWS system test

System test inhibited in-flight.

4. Ground Proximity FLAP INHIBIT Switch

FLAP INHIBIT – inhibits the mode 4 warning TOO LOW FLAPS alert.

NORM (guarded position) – the mode 4 warning TOO LOW FLAPS alert active.

5. Ground Proximity GEAR INHIBIT Switch

GEAR INHIBIT – inhibits the mode 4 warning TOO LOW GEAR alert.

NORM (guarded position) – the mode 4 warning TOO LOW GEAR alert active.

6. Ground Proximity Terrain Inhibit (TERR INHIBIT) Switch

Not modeled.

TCAS Controls (Transponder Panel)

[Option – 600/700/800/900]

AFT ELECTRONIC PANEL

[Option – BBJ/BBJ2]

AFT ELECTRONIC PANEL

1. Transponder Mode Selector

TA (traffic advisory) – enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

Warning Systems
System Description

Chapter 15
Section 20

Introduction

Aural and visual warning signals alert the flight crew to conditions requiring action or caution in the operation of the airplane.

Conditions which require the immediate attention of the flight crew are indicated by red warning lights. These lights indicate engine, cargo, or APU fires; autopilot, autothrottle disconnects; and landing gear unsafe conditions.

Conditions which require the timely attention of the flight crew are indicated by amber caution lights.

Blue lights inform the flight crew of electrical power availability, valve position, and equipment status. Blue lights are for information and do not require immediate flight crew attention.

Green lights indicate a fully extended configuration, e.g., landing gear and leading edge devices.

Generally, aurals automatically silence when the associated non–normal condition no longer exists.

Master Fire Warning Lights

Two master FIRE WARN lights illuminate when any fire warning condition occurs. The lights remain illuminated as long as the condition exists. Pushing either master FIRE WARN light or fire warning bell cutout switch extinguishes both lights, silences the fire warning bell. Further information appears in the Fire Protection chapter.

Master Caution Lights

Two MASTER CAUTION lights illuminate when any caution occurs. The lights remain illuminated as long as the caution condition exists, or until the crew resets the system. Pushing either MASTER CAUTION light extinguishes both lights. Pushing either annunciator light panel recalls all existing fault annunciations.

System Annunciator Lights

Two system annunciator light panels are located on the glare shield. The annunciator light panels include only those systems located on the forward overhead, aft overhead, and fire control panels. If a caution condition exists, the appropriate system annunciator(s) and MASTER CAUTION lights illuminate.

Warning Systems
Intermittent Cabin Altitude/Configuration Warning

The takeoff configuration warning is armed when the airplane is on the ground and either or both forward thrust levers are advanced for takeoff. An intermittent warning horn sounds if:

- trailing edge flaps are not in the flaps 1 through 25 takeoff range, or

- speed brake lever is not in the DOWN position, or
- parking brake is set, or.
- stabilizer trim not set in the takeoff range.

The Cabin Altitude Warning Horn activates when cabin altitude exceeds 10,000 feet. An intermittent warning horn is heard. The Cabin Altitude Warning Horn may be silenced by momentarily pressing the ALT HORN CUTOUT switch on the Cabin Altitude Panel.

Landing Gear Configuration Warnings

Visual indications and aural warnings of landing gear position are provided by the landing gear indicator lights and landing gear warning horn.

Visual Indications

The landing gear indication lights are activated by signals from each gear, the LANDING GEAR lever, and the forward thrust lever position as follows:

Green light illuminated – landing gear is down and locked.

Red light illuminated –
- landing gear is not down and locked.
- landing gear is in disagreement with LANDING GEAR lever position.

All lights extinguished – landing gear is up and locked with the LANDING GEAR lever UP or OFF.

Aural Indications

A steady warning horn is provided to alert the flight crew whenever a landing is attempted and any gear is not down and locked.

Mach/Airspeed Warning System

The Mach/airspeed warning system provides a distinct aural warning, a clacker, any time the maximum operating airspeed of Vmo/Mmo is exceeded. The warning clackers can be silenced only by reducing airspeed below Vmo/Mmo.

Altitude Alerting System

[Option – EFIS/MAP]

Altitude alerting occurs when approaching or departing the MCP–selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

Acquisition Alerting

900 feet before reaching the selected altitude, both ALT ALERT annunciations show and a momentary tone sounds. At 300 feet from selected altitude, the ALT ALERT annunciations no longer show.

Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the ALT ALERT annunciations flash. Flashing continues until:
- altitude deviation becomes less than 300 feet

- altitude deviation becomes more than 900 feet
- a new altitude is selected.

Altitude Alerting System

[Option – PFD/ND]

Altitude alerting occurs when approaching or departing the MCP–selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

Acquisition Alerting

900 feet before reaching the selected altitude, a white box shows around the selected altitude display and the box around the current altitude becomes bold. A momentary tone sounds. At 300 feet from selected altitude, the selected altitude box no longer shows.

Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the current altitude box turns amber and begins to flash. The amber flashing continues until:

- altitude deviation becomes less than 300 feet
- altitude deviation becomes more than 900 feet
- a new altitude is selected.

Ground Proximity Warning System

The GPWS gives the pilots aural and visual warnings of unsafe conditions. The warnings continue until the pilots correct the condition. The system operates when the airplane is less than 2450 feet above the ground.

These are the GPWS modes:

- Mode 1 – Large descent rates
- Mode 2 – Too much of a closure rate when approaching terrain that is rising
- Mode 3 – Too much altitude loss during climb phase when the airplane is not in the landing configuration
- Mode 4 – Not enough terrain clearance
- Mode 5 – Too much deviation below the glideslope
- Mode 6 – Aural callouts when the airplane descends through selected radio
- Mode 7 – Warning for windshear conditions.

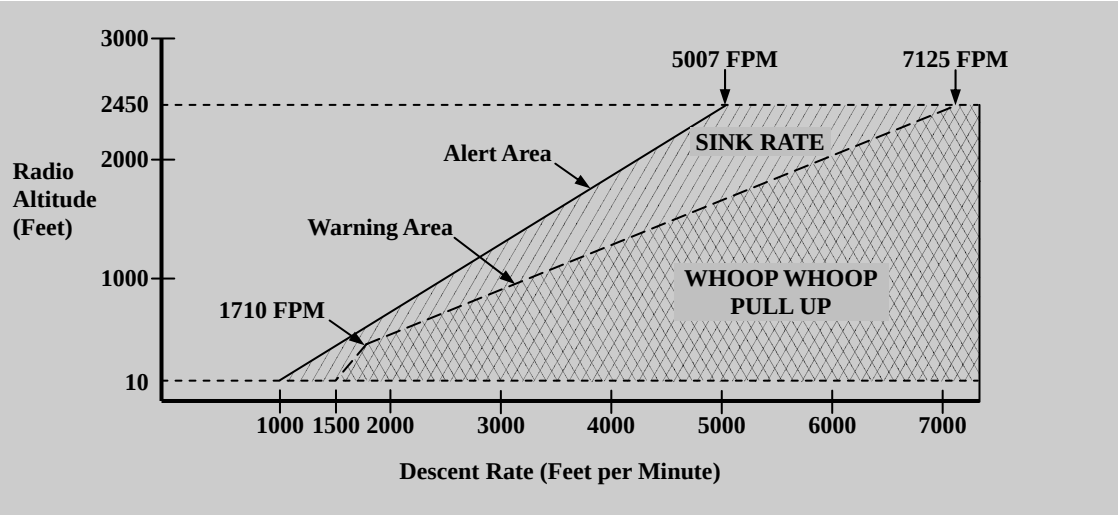
Mode 1

Mode 1 alert conditions and warning conditions can occur between 2450 feet and 10 feet radio altitude. The type of annunciation depends on the rate of descent and the radio altitude. The first annunciation is a caution. If the rate of descent does not decrease, the annunciation changes to a warning.

The alert condition gives the aural message, SINK RATE and makes the PULL UP display on the attitude indication. If the descent rate does not decrease, the alert condition changes to a warning condition.

The warning condition makes the red PULL UP warning on the attitude indication and

gives the aural message, WHOOP WHOOP PULL UP.



Mode 2

Mode 2 supplies alerts and warnings when the closure rate to the terrain is too large. Mode 2 has two submodes, mode 2A and mode 2B.

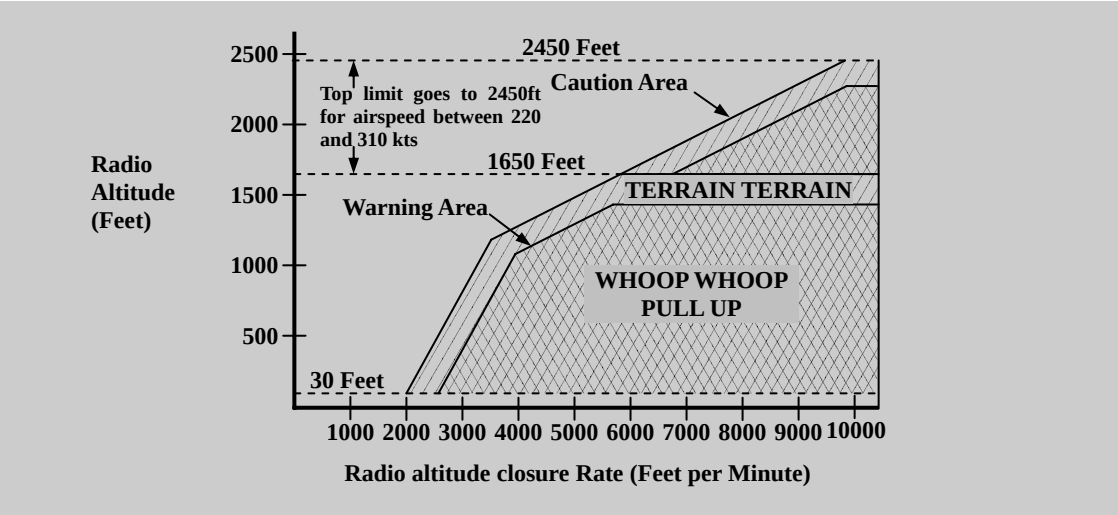
Mode 2A

Mode 2A occurs for a large closure rate if the flaps are not in the landing configuration and glideslope deviation is more than 2 dots. Flaps 30 or more is a landing configuration. Mode 2A can have two alert levels, a caution condition or a warning condition.

Mode 2A annunciations occur between 1650 feet radio altitude and 30 feet radio altitude for airspeed less than 220 knots. The top limit increases to 2450 feet radio altitude for airspeed between 220 knots and 310 knots.

If the terrain closure is too large, the GPWS gives the TERRAIN aural caution message twice and PULL UP shows on the primary flight display (PFD).

If the condition is not corrected, the caution aural message changes to the warning WHOOP WHOOP PULL UP message and PULL UP still shows on the PFD.

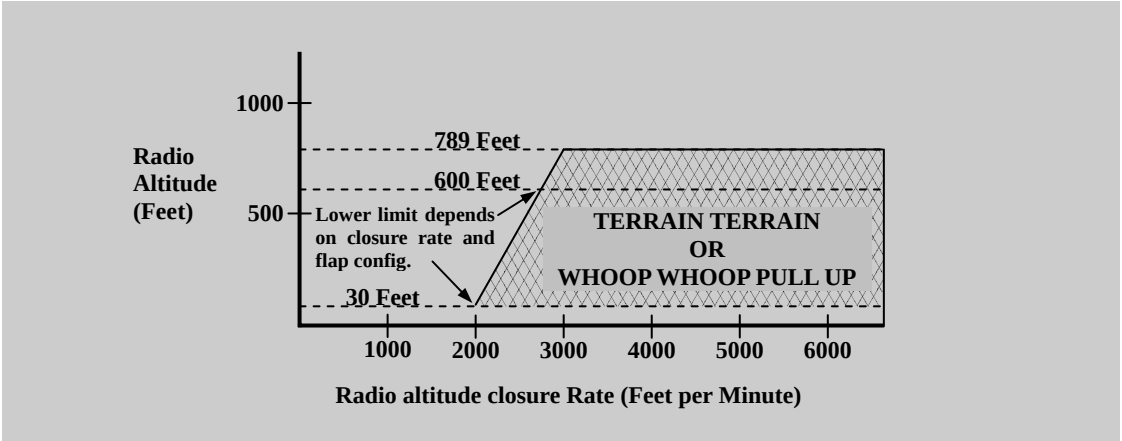


Mode 2B

Mode 2B gives alerts for a large closure rate if the flaps are in the landing configuration (flaps 30 or more). Mode 2B can have a caution condition or a warning condition.

Mode 2B annunciations can occur between 789 feet radio altitude and 30 feet radio altitude. The lower limit is between 30 feet and 600 feet radio altitude. The GPWS uses flap configuration and altitude descent rate to calculate the lower limit.

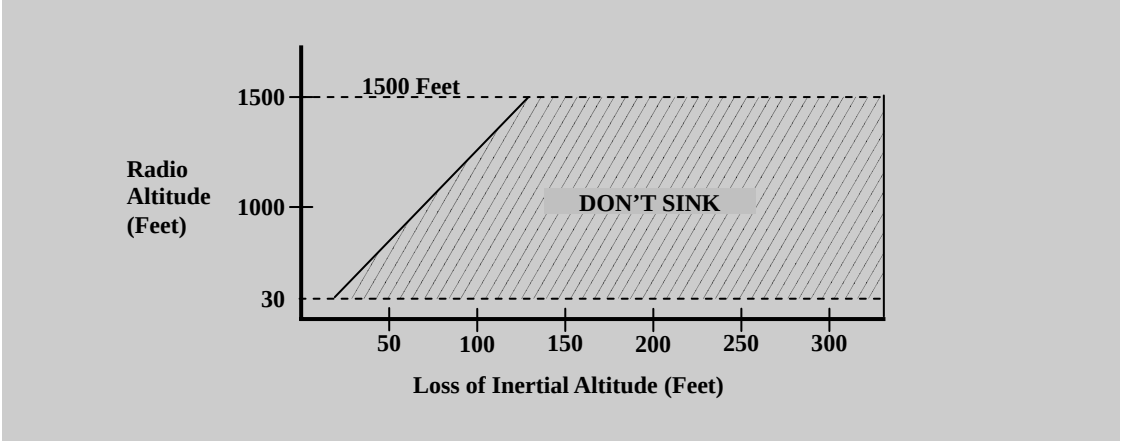
If the terrain closure is excessive, the GPWS gives the TERRAIN aural caution message repeatedly. If this condition lasts for more than 1.6 seconds, the GPWS gives the WHOOP WHOOP PULL UP aural warning message and a PULL UP annunciation on the PFD. If the terrain closure is excessive and the landing gear is extended, the PULL UP aural warning message is replaced with the TERRAIN aural caution message.



Mode 3

Mode 3 supplies alerts for a large altitude loss during takeoff or during a missed approach with the flaps not in the landing configuration (landing configuration for the flaps is 30 units or more) or landing gear not down.

When there is a GPWS mode 3 alert, the GPWS gives the aural message, DONT SINK. The PFD shows the message, PULL UP.



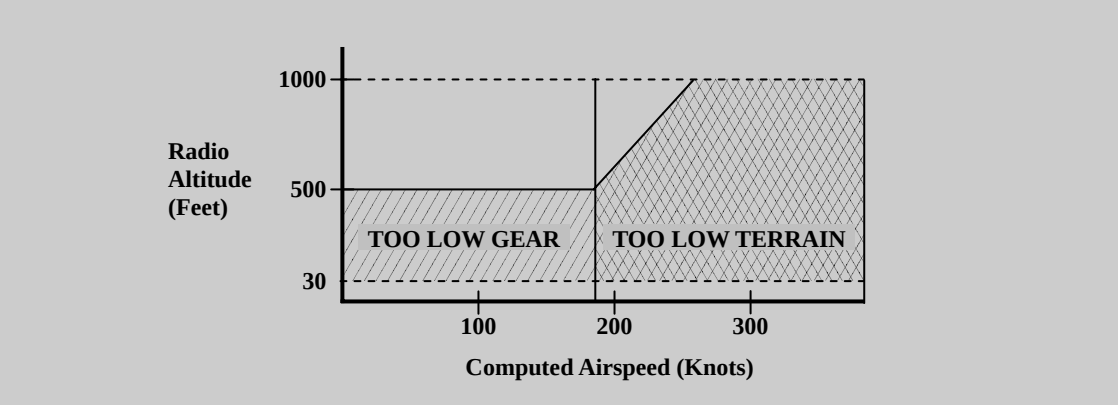
Mode 4

Mode 4 supplies alerts when the airplane is too close to the terrain and the landing

gear or flaps are not in the landing configuration. Mode 4 alerts occur between 1000 feet and 30 feet. The altitude limits for mode 4A and mode 4B are lower at low airspeed. Mode 4 has two submodes (4A and 4B).

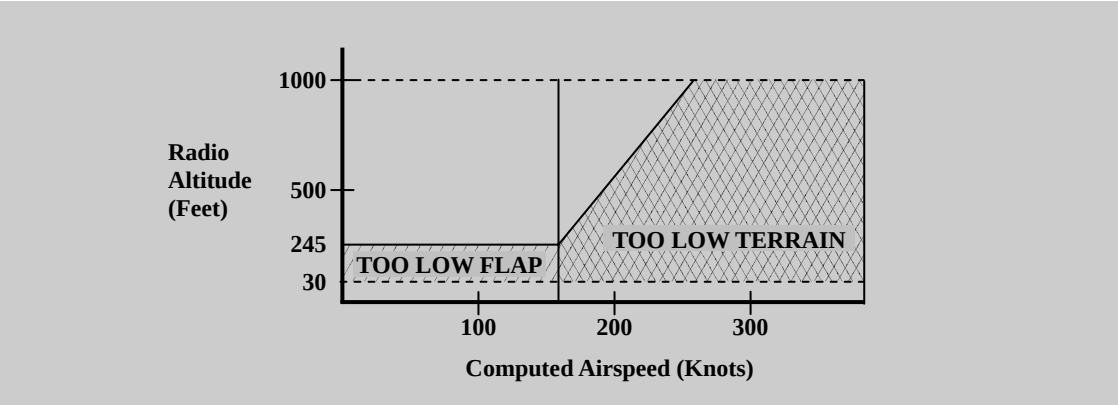
Mode 4A

The Mode 4A alert occurs if the landing gear is not down below the altitude limit. The mode 4A altitude limit is 500 feet when the airspeed is less than 190 knots and it is 1000 feet at high airspeed. The mode 4A aural message TOO LOW GEAR changes to the aural message TOO LOW TERRAIN when the airspeed is more than 190 knots.



Mode 4B

The Mode 4B alert occurs if the landing gear is down and the flaps are not in a landing configuration below the altitude limit. The Mode 4B altitude limit is 245 feet when the airspeed is less than 159 knots and it is 1000 feet at high airspeed. The mode 4B aural message TOO LOW FLAPS changes to the aural message TOO LOW TERRAIN when the airspeed is more than 159 knots.



Mode 5

The GPWS gives a mode 5 alert when the airplane goes below the glideslope during approach if the landing gear is down.

Mode 5 alerts can occur between 1000 and 30 feet radio altitude. The interval between aural messages depends on altitude and glideslope deviation. Low volume audio occurs below 1000 feet down to 30 feet when the deviation is more than 1.3 dots. Normal volume audio occurs below 300 feet when the deviation is more than 2 dots.

Mode 6

The GPWS mode 6 supplies aural callouts when the airplane descends through set altitudes with the landing gear down. These are the options available for mode 6:

- Altitude callouts
- Minimums callout
- Approaching minimums callout
- Bank angle (roll alert) callout.

Altitude callouts start at 2500 feet. At 2500 feet, the GPWS gives the TWENTY FIVE HUNDRED aural callout.

The minimums callout gives an aural callout when the airplane descends through the decision height altitude set on the EFIS control panels. The GPWS can give aural callout MINIMUMS for decision height.

There is also an approaching minimums callout that tells the pilots when the airplane is near the decision height set on the EFIS control panel. The callout normally comes on when the airplane altitude is 80 feet above the decision height. The aural callout for this option is APPROACHING MINIMUMS.

Mode 6 bank angle callouts occur when the airplane bank angle is more than 10 degrees between 30 feet and 130 feet altitude. Above 130 feet, the callout occurs at 35 degrees, 40 degrees, and 45 degrees. The aural message is BANK ANGLE, BANK ANGLE.

Mode 7

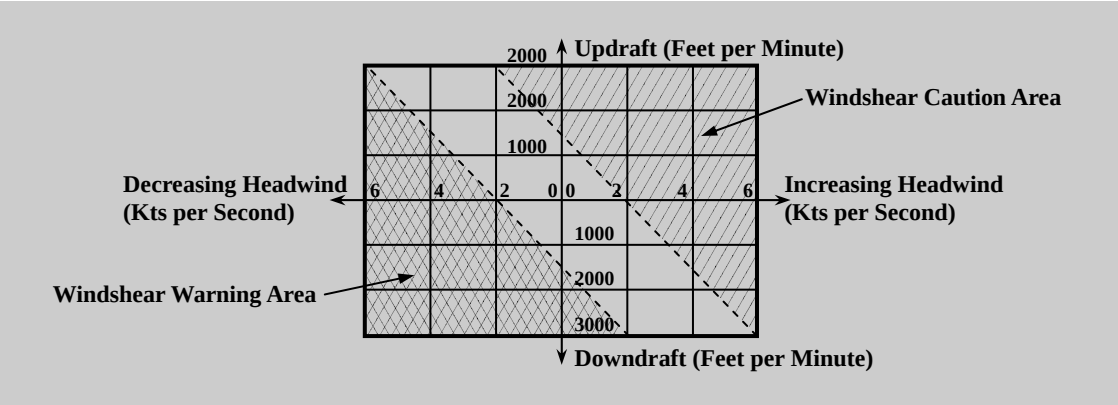
The GPWS gives mode 7 warnings when there are horizontal and vertical windshear conditions during approach or takeoff.

Windshear is the effect of large volumes of air that change direction rapidly. The most dangerous type of windshear is the microburst. When the airplane is near the terrain, a downward microburst gives the pilots very little time to react to the windshear effects.

The initial effects on an airplane when it encounters the microburst are an increase in airspeed and lift. Because of the increased lift, the airplane increases altitude.

As the airplane continues through the microburst, the effects rapidly change to a loss in airspeed and lift. The airplane altitude now rapidly decreases.

For mode 7 warnings, the GPWS gives the aural message WINDSHEAR WINDSHEAR WINDSHEAR with a siren. The red WINDSHEAR message show on the primary flight displays. Mode 7 warnings have the highest priority.



Traffic Alert and Collision Avoidance System (TCAS)

The traffic alert and collision avoidance system (TCAS) helps the flight crew maintain safe air traffic separation from other ATC transponder equipped airplanes. TCAS is an airborne system and operates independently of the ground-based ATC system.

A traffic advisory (TA) is generated when the other airplane is approximately 40 seconds from the point of closest approach. If the other airplane continues to close, a resolution advisory (RA) is generated when the other airplane is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.

Advisories and Displays

Annunciations associated with TCAS and the traffic displays are discussed further in Chapter 10.

TAs are indicated by the aural “TRAFFIC, TRAFFIC” which sounds once. The TRAFFIC annunciation appears on the navigation display. The TA symbol appears at the proper range and relative bearing of the other airplane. Altitude and vertical motion are included with the symbol.

RAs are indicated by one or more aural listed in the RA aural table. The TRAFFIC annunciation and RA symbol which depicts the traffic’s relative bearing, range, altitude, and vertical motion are on the navigation display similar to the TA symbol.

Additional symbols are proximate traffic and other traffic. Proximate traffic is within six miles and 1200 feet vertically, but is not expected to cause a TA or RA alert. Other traffic is beyond the six mile and 1200 feet vertical criteria.

If the range of the navigation display does not permit the display of a TA or RA an OFFSCALE annunciation appears on the navigation display.

Vertical motion information is indicated by an arrow depicting a climb or descent if a change of greater than 500 feet per minute is detected.

TCAS display automatically shows when:

- the transponder mode selector is in TA ONLY or TA/RA, and
- a TCAS TA or RA occurs, and
- neither pilot has the TCAS (TFC) display selected, and
- in MAP, center MAP, VOR, or APP modes.

Inhibits

INCREASE DESCENT RAs are inhibited below approximately 1,500 feet radio altitude.

DESCEND RAs are inhibited below approximately 1,100 feet radio altitude.

RAs are inhibited below approximately 1,000 feet radio altitude. Below 1,000 feet when the TA/RA mode is selected on the transponder panel, TA only mode is enabled automatically and the TCAS message TA ONLY displays on the ND.

All TCAS voice annunciations are inhibited below approximately 500 feet radio altitude.

Mode Control

The TCAS operating mode is controlled from the TCAS/ATC transponder panel. TCAS is normally operated in the TA/RA mode.

Resolution Advisory Aurals

The following table identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

AURAL ALERTS	VERTICAL RESTRICTIONS/MANEUVER
MONITOR VERTICAL SPEED	Present pitch attitude is outside the RA pitch command area. Keep pitch attitude away from red area.
MAINTAIN VERTICAL SPEED, MAINTAIN	
MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	
CLIMB, CLIMB	The flight crew must climb at a rate to avoid the preventive up advisory.
DESCEND, DESCEND	The flight crew must descend at a rate to avoid the preventive down advisories.
ADJUST VERTICAL SPEED, ADJUST	The flight crew must reduce the rate of climb to avoid the preventive down advisory, or reduce the rate of descent to avoid the preventive up advisory.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	The flight crew must climb at a rate to avoid the preventive up advisory. The flight path crosses through the flight path of the threat.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	The flight crew must descend at a rate to avoid the preventive down advisory. The flight path crosses through the flight path of the threat.
INCREASE CLIMB, INCREASE CLIMB	This follows the CLIMB advisory. The range of advised climb rates shifts to tell the flight crew to increase the climb rate.
INCREASE DESCENT, INCREASE DESCENT	This follows the DESCEND advisory. The range of advised descent rates shifts to tell the flight crew to increase the descent rate.
CLIMB – CLIMB NOW, CLIMB – CLIMB NOW	This follows the DESCEND advisory. A climb is now necessary to give safe vertical separation.
DESCEND – DESCEND NOW, DESCEND – DESCEND NOW	This follows the CLIMB advisory. A descent is now necessary to give safe vertical separation.
CLEAR OF CONFLICT	RA encounter terminated. Maneuver guidance no longer displayed.