



Preface

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Chapter P2

Section 0

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767-300

Operations Manual

Volume 2

Delta Air Lines

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Preface**Model Identification****Chapter P2****Section 1****General**

The airplanes listed in the table below are covered in the operations manual. The numbers are used to distinguish data peculiar to one or more, but not all of the airplanes. Where data applies to all airplanes listed, no reference is made to individual airplane numbers.

Use of the table below permits flight crew correlation of configuration differences by number within an operator's fleet for airplanes covered in this manual.

Configuration data reflects the airplane as delivered configuration and is updated for service bulletin incorporations in conformance with the policy stated in the introduction section of this chapter.

Airplane number is supplied by the operator. Registry number is supplied by the national regulatory agency. Serial and tabulation numbers are supplied by Boeing.

The procedures and information contained in this manual also apply to aircraft acquired by Delta Air Lines subsequent to the current revision; however, this document may not address all pertinent information for these airplanes. In such instances, specific operating procedures and systems information can be found in appropriate Differences Chapter(s) and/or Fleet Bulletin(s) prior their incorporation in the next scheduled revision.

Airplane Number	Registry Number	Serial Number	Tabulation Number
121	N121DE	23435	VK036
122	N122DL	23436	VK037
123	N123DN	23437	VK038
124	N124DN	23438	VK039
125	N125DL	24075	VK040
126	N126DL	24076	VK041
127	N127DL	24077	VK042
128	N128DL	24078	VK043
129	N129DL	24079	VK044
130	N130DL	24080	VK045
136	N136DL	25146	VK051

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Airplane Number	Registry Number	Serial Number	Tabulation Number
137	N137DL	25306	VK052
138	N138DL	25409	VK053
139	N139DN	25984	VK054
171	N171DN	24759	VN251
172	N172DN	24775	VN252
174	N174DN	24802	VN254
175	N175DN	24803	VN255
176	N176DN	25061	VN256
177	N177DN	25122	VN257
178	N178DN	25143	VN258
179	N179DN	25144	VN259
180	N180DN	25985	VN260
181	N181DN	25986	VN261
182	N182DN	25987	VN262
183	N183DN	27110	VN263
184	N184DN	27111	VN264
185	N185DN	27961	VN265
186	N186DN	27962	VN266
187	N187DN	27582	VN267
188	N188DN	27583	VN268
189	N189DN	25990	VN269
190	N190DN	28447	VN270
191	N191DN	28448	VN271
192	N192DN	28449	VN272
193	N193DN	28450	VN273
194	N194DN	28451	VN274
195	N195DN	28452	VN275

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Airplane Number	Registry Number	Serial Number	Tabulation Number
196	N196DN	28453	VN276
197	N197DN	28454	VS066
198	N198DN	28455	VS067
199	N199DN	28456	VS068
1200	N1200K	28457	VS069
1201	N1201P	28458	VS070
1401	N140LL	25988	VK055
1402	N1402A	25989	VK056
1403	N143DA	25991	VR4711
1404	N144DA	27584	VR472
1501	N1501P	24983	VN301
1502	N152DL	24984	VN302
1503	N153DL	24985	VN303
1504	N154DL	25241	VN304
1505	N155DL	25269	VN305
1506	N156DL	25354	VN306
1521	N394DL	27394	VL753
1601	N169DZ	29689	VS073
1602	N1602	29694	VS074
1603	N1603	29695	VS075
1604	N1604R	30180	VS076
1605	N1605	30198	VS077
1606	N16065	30199	VS078
1607	N1607B	30388	VS466
1608	N1608	30573	VS467
1609	N1609	30574	VS468
1610	N1610D	30594	VS469



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Airplane Number	Registry Number	Serial Number	Tabulation Number
1611	N1611B	30595	VS470
1612	N1612T	30575	VS471
1613	N1613B	32776	VS472
1701	N171DZ	29690	VS266
1702	N172DZ	29691	VS267
1703	N173DZ	29692	VS268
1704	N174DZ	29693	VS269
1705	N175DZ	29696	VS270
1706	N176DZ	29697	VS271
1707	N177DZ	29698	VS272
1708	N178DZ	30596	VS273
And Subsequent			

Preface
Introduction**Chapter P2**
Section 2

General

The manufacturer has developed normal and non-normal procedures for the 767-300 aircraft. Delta Air Lines, Inc. has modified some of these procedures for simplification and standardization, when appropriate, with other aircraft operated by Delta Air Lines, Inc.

These procedures are intended to be followed during normal ground operations and in flight. Deviations from these procedures should be made only with good cause and based on the safest course of action. The captain's best judgment must be applied if an abnormality occurs that is not covered by these procedures.

Manual Rights

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Corrections to the Manual

Log on to the Delta Flight Operations Portal, <http://deltanet.delta.com> and submit a Publications Change Request (PCR) to correct any errors or discrepancies discovered in this manual, or to submit a suggested change to any Aircraft Operating Manual, Volume 1, Volume 2, Quick Reference Handbook (QRH), Flight Crew Training Manual (FCTM), Normal Checklist, Airway Manual (AM), Flight Operations Manual (FOM), Operating Experience (OE/TOE) Guide, Fleet Bulletin (FB), or All Pilots Bulletin (APB).

There is a link to the PCR form at Deltanet > My Division > Pilot Support > Forms and Reports. Once submitted, the PCR is automatically routed to the applicable Fleet Technical Manager and Technical Writer for that manual.

Organization

The operations manual is organized in the following manner.

Volume 1

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.
- Limitations - Covers operational limitations.
- Normal Procedures - Covers all amplified normal operating procedures and are based on a thorough analysis of crew activity required to operate the aircraft, and reflect the latest knowledge and experience available.
- Normal Operational Information - Contains reference material used to support normal procedures.
- Supplementary Procedures is organized by system and covers:
 - any procedure that is non-routine in nature,
 - any first flight of the day test or other systems test,
 - guidance on lengthy operating procedures, and
 - adverse weather procedures and guidance.
- Differences - Notes differences between aircraft models and variants.

Volume 2

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.
- Contains general aircraft and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

QRH

- Non-normal checklists - Contains checklists used to manage non-normal situations.
- Non-Normal Operational Information - Contains reference material used to support non-normal procedures.
- Non-Normal Checklist Instructions - Contains non-normal checklist instructions and evacuation flow/philosophy.
- Revision Record - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions and a list of effective pages.

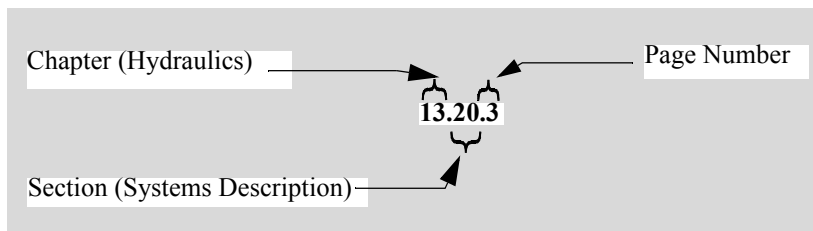
FCTM

- Preface - Contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions, and a list of effective pages.
- Provides information and recommendations on aircraft operations, maneuvers, and techniques, and human factors.

Page Numbering

The operations manual uses a decimal page numbering system. The page number is divided into three fields; chapter, section, and page. An example of a page number for the hydraulics chapter follows: chapter 13, section 20, page 3.

Example Page Number



Warnings, Cautions, and Notes

The following levels of written advisories are used throughout the operations manual and are not to be confused with EICAS messages, which are separately identified in the text.

Warning - A warning is an instruction about a hazard that if ignored could result in injury, loss of aircraft control, or loss of life. A warning will appear prior to the applicable step or item.

WARNING: Do not pressurize any hydraulic or pneumatic system until clearance is obtained from Maintenance.

Caution - A caution is an instruction concerning a hazard that if ignored could result in damage to equipment. A caution will appear prior to the applicable step or item.

CAUTION: Do not set takeoff thrust until oil temperature is above 50°C.

Note - A note provides amplified information, instruction, or emphasis. A note will appear after the applicable step or item.

Note: The checklist must not be modified in any way.

Aircraft Effectivities

Differences in aircraft configuration are shown by use of aircraft effectivities throughout Volumes 1 and 2, QRH, and the FCTM. The following rules are used to express aircraft effectivities:

- Aircraft effectivities are listed by model and/or ship number. A range of aircraft is defined by a dash, e.g. 9901 - 9910. A comma in the effectivity range indicates a break in the range, e.g. 9901 - 9910, 9912 - 9925; aircraft 9911 is excluded from the range. Aircraft introduced to the fleet following manual publication are effective as subsequent ships, e.g. 9901 & Subsequent.
- Aircraft effectivities are listed in bold text throughout the manual, except in the Limitations chapter. In the Limitations chapter, aircraft effectivities are listed in bold when the effectivity applies to the entire section or subsection. When the effectivity applies only to a step within a section, it is listed in normal text.
- Aircraft effectivities apply only to the paragraph, illustration, operational note, procedural step, etc. and to subordinate items (if any). Refer to the examples below.

Example (with subordinate items):

9951 – 9961
CTR TK PUMP (affected).....OFF
 Do not open the WING X FEED valve.
OUTR TK XFR.....ON

In this example, the effectivity 9951 - 9961 applies to the first procedural step (CTR TK PUMP.....) and the further indented/subordinate step (Do not...). The effectivity does not apply to the next equivalently indented step (OUTR TK XFR.....).

Example (without subordinate items):

Using ship number:

9951 – 9961
CTR TK PUMP (affected).....ON
OUTR TK XFR.....OFF

In this example, the effectivity 9951 - 9961 applies to the first procedural step (CTR TK PUMP) only. The effectivity does not apply to the next procedural step (OUTR TK XFR).

Using model number:

767-300
EQUIPMENT COOLING mode selector.....AUTO

In this example, the 767-300 will have the selector in the AUTO position.

When aircraft effectivities are centered immediately below a checklist title, the entire checklist applies to the listed aircraft. In the following example, the FUEL L + R CTR PUMPS LO PR checklist is applicable to 9951-9961 only:

FUEL L + R CTR PUMPS LO PR
9951-9961

Preface

Abbreviations

Chapter P2

Section 3

General

The following abbreviations may be found throughout the manual. Some abbreviations may also appear in lowercase letters. Abbreviations having very limited use are explained in the chapter where they are used. Since this list is compiled across several fleets, there may be some abbreviations that do not apply to this specific fleet.

A	
ABV	Above
AC	Alternating Current or Aircraft
ACARS	Aircraft Communications Addressing and Reporting System
ACE	Actuator Control Electronics
ACP	Audio Control Panel
ACT	Active
ADC	Air Data Computer
ADF	Automatic Direction Finder
ADI	Attitude Director Indicator
ADIRS	Air Data Inertial Reference System
ADIRU	Air Data Inertial Reference Unit
ADM	Air Data Module
AED	Automated External Defibrillator
AFDC	Autopilot Flight Director Computer

AFDS	Autopilot Flight Director System
AFE	Above Field Elevation
AFM	Airplane Flight Manual (FAA approved)
AFM - DPI	Airplane Flight Manual - Digital Performance Information
AFS	Automatic Flight System (Autopilot or Autothrottle)
A/G	Air/Ground
AGL	Above Ground Level
AH	Alert Height
AHRS	Attitude Heading Reference System
AI	Anti-Ice
AIL	Aileron
ALFA	Safe Stall Margin Speed
ALT	Altitude
ALT ACQ	Altitude Acquire
ALT HOLD	Altitude Hold
ALTN	Alternate
AM	Amplitude Modulation

AIMS	Airplane Information Management System
AMI	Airline Modifiable Information
ANP	Actual Navigational Performance
ANT	Antenna
ANU	Aircraft Nose Up
AOA	Angle of Attack
AOC	Airline Operational Communication Data Link
A/P	Autopilot
APL	Airplane
APP	Approach
APU	Auxiliary Power Unit
AR	Authorization Required
ARINC	Aeronautical Radio, Incorporated
ARM	Aircraft Restrictions Manual
ARPT	Airport
ARR	Arrival
ART	Automatic Reserve Thrust
ASA	Autoland Status Annunciator
ASI	Airspeed Indicator
ASR	Airport Surveillance Radar
ASYM	Asymmetry
A/T	Autothrottle
ATA	Actual Time of Arrival

ATC	Air Traffic Control
ATIS	Automated Terminal Information Service
ATM	Assumed Temperature Method
ATT	Attitude
AUTO	Automatic
AUTO-THROT	Autothrottle
AUX	Auxiliary
AVAIL	Available
AWABS	Automated Weight and Balance System
B	
BARO	Barometric
BAT	Battery
B/C or B/CRS or BAC or BCS	Back Course
BFO	Beat Frequency Oscillator
BITE	Built-In Test Equipment
BKR	Breaker
BLD	Bleed
BLW	Below
BRG	Bearing
BRT	Bright
BTL	Bottle
BTL DISCH	Bottle Discharge (fire extinguisher)
BTMS	Brake Temperature Monitoring System

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C	
C	Captain or Celsius or Center or Cool
CAA	Civil Aviation Authority
CADC	Central Air Data Computer
CALSEL	Call Select
CANC/RCL	Cancel/Recall
CANPA	Constant Angle Non-Precision Approach
CAP	Capture
CAPT	Captain
CAWS	Central Aural Warning System
CB	Circuit Breaker
CCD	Cursor Control Device
CDS	Common Display System
CDU	Control Display Unit
CFIT	Controlled Flight Into Terrain
CG	Center of Gravity
CHKL	Checklist
CHR	Chronograph
CKD	Checked
CKT	Circuit
CL	Close
CLB	Climb
CLMP	Computer Lockout Manual Power
CLR	Clear
CMD	Command

CO	Company
COMM	Communication
COMP	Comparator
COMPT	Compartment
CON	Continuous
CONFIG	Configuration
CONT	Control
COOL	Cooling
CRM	Crew Resource Management
CRS	Course
CRT	Cathode Ray Tube
CRZ	Cruise
CTL	Control
CTR	Center
CWS	Control Wheel Steering
D	
DA	Decision Altitude
DA(H)	Decision Altitude (Height)
DC	Direct Current
DCU	Display Concentrator Unit
D/D	Direct Descent
DDA	Derived Decision Altitude (MDA +50 feet)
DDG	Dispatch Deviations Guide
DEL	Delete
DEP	Departure
DEP ARR	Departure Arrival
DEPR	Depressurize

DES	Descent
DEU	Display Electronic Unit
DFCS	Digital Flight Control System
DFGC	Digital Flight Guidance Computer
DFGS	Digital Flight Guidance System
DH	Decision Height
DIFF	Differential
DIR	Direct
DISC	Disconnect
DISCH	Discharge
DK	Deck
DME	Distance Measuring Equipment
DN	Down
DPC	Display Processing Computer
DSP	Display Select Panel
DSPL	Display
DTG	Distance to Go
DTW	Distance to Waypoint
DU	Display Unit
E	
EADI	Electronic Attitude Director Indicator
ECON	Economy
E/D	End of Descent
E/E	Electrical/Electronic
EEC	Electronic Engine Control

EFI	Electronic Flight Instruments
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature
EHSI	Electronic Horizontal Situation Indicator
EICAS	Engine Indication and Crew Alerting System
EIS	Electronic Instrument System
ELEC	Electrical
ELEV	Elevator
ELT	Emergency Locator Transmitter
EMER	Emergency
ENG	Engine
ENG OUT	Engine Out
ENT	Entry
EO or E/O	Engine Out
EOAP	Electronic Overhead Annunciation Panel
EPC	Electrical Power Center
EPR	Engine Pressure Ratio
EQPT or EQUIP	Equipment
ETOPS	Extended Range Operation with Twin Engine Airplanes
ETP	Equal Time Point

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EVAC	Evacuation
EXEC	Execute
EXT	Extend or External
F	
F	Fahrenheit
FAC	Final Approach Course
FAA	Federal Aviation Administration
FACR	Flight Attendant Crew Rest
FADEC	Full Authority Digital Engine Control
FAF	Final Approach Fix
FAR	Federal Aviation Regulation
FCB	Flight Crew Bulletin
FCC	Flight Control Computer
FCTL	Flight Control
FCTM	Flight Crew Training Manual
FD, F/D or FLT DIR	Flight Director
FF	Fuel Flow
FFM	Force Fight Monitor
FGCP	Flight Guidance Control Panel
FGS	Flight Guidance System
FILT	Filter
FIR	Flight Information Region
FL CH or FLCH	Flight Level Change
FLT	Flight

FLT CTRL	Flight Control
FLPRN	Flaperon
FMA	Flight Mode Annunciator
FMC	Flight Management Computer
FMS	Flight Management System
F/O or F O	First Officer
FOM	Flight Operations Manual
FPA	Flight Path Angle
FPM	Feet Per Minute
FPV	Flight Path Vector
FREQ	Frequency
F/S	Fast/Slow
FT	Feet
FWD	Forward
FWSOV	Fire Wall Shut Off Valve
FX	Fix
G	
GA	Go-Around
GEN	Generator
GLS	GNSS Landing System
GMT	Greenwich Mean Time
GND	Ground
GNSS	Global Navigation Satellite System
GP or G/P	Glide Path
GPS	Global Positioning System
GPWS	Ground Proximity Warning System

GS	Ground Speed
G/S	Glide Slope
GW	Gross Weight
H	
HAA	Height Above Airport
HAT	Height Above Touchdown
HDG	Heading or Hydraulic Driven Generator
HDG REF	Heading Reference
HDG SEL	Heading Select
HF	High Frequency
HGS	Head-Up Guidance System (HGS® is a registered trademark of Flight Dynamics)
HI	High
HLD	Hold
HPA	Hectopascals
HPSOV	High Pressure Shut Off Valve
HSI	Horizontal Situation Indicator
HUD	Head-Up Display
HYD	Hydraulic
I	
IAF	Initial Approach Fix
IAN	Integrated Approach Navigation
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization

IDENT	Identification
IDU	Interactive Display Unit
IFE	In-Flight Entertainment System
IFR	Instrument Flight Rules
IGN	Ignition
IGS	Instrument Guidance System
ILS	Instrument Landing System
IM	Inner Marker
IMC	Instrument Meteorological Conditions
IN	Inches
INBD	Inboard
IND	Indicator
IND LTS	Indicator Lights
INOP	Inoperative
INIT	Initialization
INSTR	Instrument
INT or INTPH	Interphone
INTC	Intercept
INTC CRS	Intercept Course
IP	Instructor Pilot
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISDU	Inertial System Display Unit

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ISFD	Intergrated Standby Flight Display
ISLN	Isolation
J	
JAA	Joint Aviation Authority
K	
K or KTS	Knots
KCAS	Knots Calibrated Airspeed
KGS	Kilograms
KIAS	Knots Indicated Airspeed
L	
L	Left
LAT	Latitude
LBS	Pounds
LD	Load
LDA	Localizer-type Directional Aid
LDG	Landing
LDG ALT	Landing Altitude
LE	Leading Edge
LIM	Limit
LIM SPD	Limit Speed
LKD	Locked
L NAV or LNAV	Lateral Navigation
LOC	Localizer
LOC-BC	Localizer Back Course
LOM	Locator Outer Marker
LON	Longitude
LRC	Long Range Cruise

LRU	Line Replaceable Unit
LSK	Line Select Key
LT	Light
LWR CTR	Lower Center
LWR DSPLY or LWR DSPL	Lower Display
M	
M	Mach
MAG	Magnetic
MAHP	Missed Approach Holding Point
MAN	Manual
MAP	Missed Approach Point
MASI	Mach/Airspeed Indicator
MAX	Maximum
MCC	Maintenance Control Center
MCDU	Multi-purpose Control and Display Unit
MCO	Maintenance Carry Over
MCP	Mode Control Panel
MCT	Maximum Continuous Thrust
MDA	Minimum Descent Altitude
MDA(H)	Minimum Descent Altitude (Height)
MDM	Mechanical Dispatch Manual
MEA	Minimum Enroute Altitude
MEL	Minimum Equipment List

MFD	Multifunction Display
MHZ	Megahertz
MIC	Microphone
MIN	Minimum
MKR	Marker
MLS	Microwave Landing System
MM	Middle Marker
MMO	Maximum Mach Operating Speed
MNPS	Minimum Navigation Performance Specification
MOCA	Minimum Obstruction Clearance Altitude
MOD	Modify
MORA	Minimum Off Route Altitude
MSA	Minimum Safe Altitude
MSG	Message
MSGS RCVD	Messages Received
MSL	Mean Sea Level
MTRS	Meters
MUH	Minimum Use Height
N	
N	Normal
NADP	Noise Abatement Departure Procedures
NAR	North American Route
NAV	Navigation
NAV RAD	Navigation Radio
ND	Navigation Display

NLT	No Later Than
NM	Nautical Mile(s)
NNC	Non-Normal Checklists
NNM	Non-Normal Maneuvers
NPS	Navigation Performance Scales
NORM	Normal
N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed (Pratt & Whitney and GE engines) or Intermediate Pressure Rotor Speed (Rolls Royce Engines)
N3	High Pressure Rotor Speed (Rolls Royce Engines)
O	
OAP	Overhead Annunciator Panel (a.k.a. EOAP)
OAT	Outside Air Temperature
OCC	Operations Control Center
ODM	Operational Data Manual
OFST	Offset
OHU	Overhead Unit
OM	Outer Marker
OP	Open
OUTBD DSPL	Outboard Display
OVHD	Overhead
OVHT	Overheat
OVRD	Override

767-300 Operations Manual

OVSPD	Overspeed
OXY or O2	Oxygen
P	
PA	Passenger Address
PAPI	Precision Approach Path Indicator
PAR	Precision Approach Radar
PASS	Passenger
PBE	Protective Breathing Equipment
PCP	Pilot Call Panel
PDC	Pitch Data Computer or Performance Data Computer or Pre-Departure Clearance
PERF	Performance
PERF INIT	Performance Initialization
PES	Pitch Enhancement System
PF	Pilot Flying
PFC	Primary Flight Computer
PFD	Primary Flight Display
PI	Performance Inflight
PIP	Product Improvement Package
PLI	Pitch Limit Indicator
PLLCR	Pilot Lower Lobe Crew Rest
PM	Pilot Monitoring

PMC	Power Management Control
PNL	Panel
POS	Position
POS INIT	Position Initialization
POS REF	Position Reference
PPI	Planned Position Indicator
PPOS	Present Position
PRES or PRESS	Pressure
PREV	Previous
PRI	Primary
PRAIM	Predictive Receiver Autonomous Integrity Monitoring
PROG	Progress
PROX	Proximity
P/RST	Push To Reset
PRV	Pressure Regulating Valve
PSI	Pounds Per Square Inch
PSU	Passenger Service Unit
PTH	Path
PTT	Push To Talk
PTU	Power Transfer Unit
PWR	Power
PWS	Predictive Windshear System
Q	
Q	Quantity
QFE	Local Station Pressure

QNH	Altimeter Setting
QRH	Quick Reference Handbook
QTY	Quantity
R	
R	Right
RA	Radio Altitude or Resolution Advisory
RAD	Radio
RAT	Ram Air Temperature or Ram Air Turbine
RCL	Request for Clearance
RDMI	Radio Distance Magnetic Indicator
REC	Recorder
RECIR or RECIRC	Recirculation
REF	Reference
RET	Retract
REV	Reverse
RF	Radius-to-Fix (RF) Legs or Refill
RMI	Radio Magnetic Indicator
RON	Remain Overnight
RNAV or RNV	Area Navigation
RNP	Required Navigational Performance
RPL	Rudder Pressure Limiter
RPM	Revolutions Per Minute
RPR	Rudder Pressure Reducer

RSEP	Rudder System Enhancement Program
RST	Reset
RSVR	Reservoir
R/T	Radio Transmit
RTE	Route
RTO	Rejected Takeoff
RTP	Radio Tuning Panel
RUD	Rudder
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minimum
S	
SAAAR	Special Aircraft and Aircrew Authorization Required
SAARU	Secondary Attitude Air Data Reference Unit
SAT	Static Air Temperature or Satellite
SB	Service Bulletin
S/B	Speedbrake
S/C	Step Climb
SDF	Simplified Directional Facility
SEI	Standby Engine Indicator
SEL	Select
SELCAL	Selective Calling
SENS	Sensitivity
SERV	Service
SG	Symbol Generator

767-300 Operations Manual

SMGCS	Surface Movement and Guidance Control System
SPD	Speed
SPDBRK	Speedbrake
STA	Station
STAB	Stabilizer
STAT	Status
STBY	Standby
STD	Standard
SYS	System
T	
T or TRU	True
T or TK or TRK	Track (to a Navaid)
TA	Traffic Advisory
TAA	Terminal Arrival Area
TACAN	Tactical Air Navigation
TAC	Thrust Asymmetry Compensation
TAI	Thermal Anti-Ice
TAS	True Airspeed
TAT	Total Air Temperature
T/C	Top of Climb
TCA	Terminal Control Area
TCAS	Traffic Alert and Collision Avoidance System
T/D	Top of Descent
TDZ	Touch Down Zone
TDZE	Touch Down Zone Elevation
TE	Trailing Edge

TEMP	Temperature
TERR	Terrain
TFC	Traffic
TFR	Transfer
THR	Throttle or Thrust
THR HOLD	Throttle Hold
TMC	Thrust Management Computer
TMI	Track Message Identifier
TMSP	Thrust Mode Select Panel
TO or T/O	Takeoff
TOC	Top of Climb
TOD	Top of Descent
TO/GA	Takeoff/Go-Around
TR	Traffic Resolution
TRK	Track
TRP	Thrust Rating Panel
TRU	Transformer Rectifier Unit
TURB	Turbine or Turbulence
U	
UNLKD	Unlocked
UNSCHD or UNSCHED	Unscheduled
UPR DSPL	Upper Display
U.S.	United States
USB	Upper Side Band
UTC	Universal Time Coordinated

UTIL	Utility
V	
VA	Design maneuvering speed
VAL	Valve
VANP	Vertical Actual Navigational Performance
VASI	Visual Approach Slope Indicator
VDP	Visual Descent Point
VEF	Speed at Engine Failure
VERT	Vertical
VFR	Visual Flight Rules
VG	Vertical Gyro
VHF	Very High Frequency
VIB	Vibration
VLV	Valve
VMC	Visual Meteorological Conditions
VMCA	Minimum Control Airspeed or Single Engine Minimum Control Airspeed
VMCG	Minimum Control Groundspeed
VMO	Maximum Operating Speed
V NAV or VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VR	Rotation Speed
VREF	Reference Speed

VRNP	Vertical Required Navigation Performance
V/S	Vertical Speed
VSCF	Variable Speed Constant Frequency
VSD	Vertical Situation Display
VSI	Vertical Speed Indicator
VTK	Vertical Track
V1	Takeoff Decision Speed
V1 (MCG)	Minimum V1 for Control on the Ground
V2	Scheduled Takeoff Target Speed
W	
W	Warm
WATRS	Western Atlantic Route System
WDR	Weight Data Record
WGS-84	World Geodetic System of 1984
WHL	Wheel
WPT	Waypoint
WT	Weight
WXR	Weather Radar
X	
X-FEED	Crossfeed
XPDR or XPDR	Transponder
XTK	Cross Track



Preface
Revision Record

Chapter P2
Section 4

Revision Transmittal Letter

To: All holders of Delta Air Lines, Inc. Operations Manuals.

Subject: Operations Manual Revision.

This revision reflects the most current information available to Delta Air Lines, Inc. through the subject revision date. General information below explains the use of revision bars to identify new or revised information.

Revision Record

No.	Revision Date	Date Filed
0	April 8, 2007	
2	October 23, 2006	
4	August 18, 2011	
6	February 28, 2013	
8	June 16, 2015	

No.	Revision Date	Date Filed
1	October 27, 2003	
3	January 1, 2010	
5	May 24, 2012	
7	December 3, 2013	
9	July 1, 2016	

General

Delta Air Lines, Inc. issues operations manual revisions to provide new or revised procedures and information. Formal revisions also incorporate appropriate information from previously issued operations manual bulletins.

The revision date is the date the revision material is distributed and considered current. EFB revision downloads and/or flight deck distribution should be accomplished as soon as possible, but may take as much as 21 days after the revision date for completion.

Revisions include a Transmittal Letter, Revision Record, Revision Highlights, and a List of Effective Pages. Use the information on the new Revision Record to review the revised operations manual content.

Revision Highlights

Pages containing revised technical and non-technical material have revision bars associated with the changed text or illustration.

Chapter P2 - Preface

Section 2 - Introduction

General

P2.2.1 - Removed sentence about manual being FAA approved; manual is FAA accepted.

Corrections to the Manual

P2.2.2 - Updated for new Deltanet link and location of the PCR form.

Organization

P2.2.3 - Added human factors to list of topics covered in the FCTM.

Section 3 - Abbreviations

P2.3.4 - Added, “ELT - Emergency Locator Transmitter” to table.

P2.3.6 - Added, “IDU - Interactive Display Unit” to table.

Section 4 - Revision Record

P2.4.1 - Removed extraneous sentence.

P2.4.2 - Revised to match the electronic-only methodology.

P2.4.2 - Removed Filing Instructions.

Chapter 1 - Airplane General, Emergency Equipment, Doors, Windows

Section 40 - Systems Description

Portable Protective Breathing Equipment

1.40.9 - Added Portable Protective Breathing Equipment section.

Section 46 - Crew Rest Compartment

Flight Attendant Crew Rest (FACR) Facility

1.46.18 - Added sentence, relocated from the FOM, regarding the gasper vents being the best source for cool air.

Chapter 5 - Communications

Section 10 - Controls and Indicators

Cabin Medical Communication (as installed)

5.10.12 - Added, “headset” to sentence.

Section 30 - Interphone Systems

Cabin Medical Communication (as installed)

5.30.4 - Removed “ and Interphone” from title and updated section.

Crew Rest Facilities Communications (as installed)

5.30.4 - Revised from, “General cabin PAs do not transmit to the FACR facility. It is the responsibility for the Flight Leader/Purser (or designee) to notify resting flight attendants of safety issues when necessary.” to, “General PA is transmitted to the FACR facility, except on A/C 1607-1613. When flying on these aircraft, it is the responsibility for the Flight Leader/Purser (or designee) to notify resting flight attendants of safety issues when necessary.”

Section 35 - Communication System

Satellite Communications (SATCOM)

5.35.1 - Removed Airway Manual reference.

SATCOM Non-Normals

5.35.3 - Removed Airway Manual reference.

Section 40 - Data Link System

Alert Advisory Messages

5.40.4 - Revised FAIL message from, “Internal failure of MU. Refer to POM - COMM/RADAR section - ACARS INOP procedure.” to, “Internal failure of MU. Refer to the ACARS INOP Non-Normal Checklist in the QRH.”

Chapter 6 - Electrical

Section 20 - System Description

Hot Battery Bus

6.20.10 - Revised, “The hot battery bus provides power to items which must be continuously powered, such as the clock’s time reference.” to “The hot battery bus provides power to systems which must be powered continuously, such as the clock’s time reference, fire extinguisher bottles, APU fuel valve, spar fuel valves, and the parking brake valve.” to standardize with Boeing.

Chapter 11 - Flight Management, Navigation

Section 31 - Flight Management System Operation

Lateral Navigation (LNAV)

11.31.12 - Added, “The FMC creates a path allowing the airplane to turn before reaching a fly-by Waypoint. When a waypoint is defined as a fly-over, the FMC directs the airplane to fly directly over the waypoint before turning. The flight path shows on the HSI map using a reduced range.” to standardize with Boeing.

Section 40 - FMC Preflight

Menu Page

11.40.42 - Added number 5, ACMS to graphic.

Chapter 12 - Fuel

Section 20 - System Description

Fuel Tank Capacities

12.20.5 - Separated aircrafts and updated fuel tank capacities.

Chapter 15 - Warning Systems

Section 10 - Controls and Indicators

GPWS with Look-Ahead Display and Alerting

15.10.19 - Updated graphic to standardize with Boeing.

Section 20 - System Description

Resolution Advisories (RA) and Displays

15.20.29 - Added, “TCAS 7.1 replaces several ADJUST VERTICAL SPEED alerts with a LEVEL OFF RA. The level off should be achieved promptly, not at the next flight level.”

Voice Annunciations

15.20.33 - Added row for “LEVEL OFF, LEVEL OFF” incorporating FB 16-03.

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767-300 Operations Manual

Preface

List of Effective Pages

Chapter P2

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* Title Page	July 1, 2016
* Blank	July 1, 2016
* P2.TOC.0.1-2	July 1, 2016
* P2.1.1-4	July 1, 2016
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* P2.3.1-12	July 1, 2016
Revision Record (tab)	
* P2.4.1-6	July 1, 2016
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* P2.5.1-4	July 1, 2016
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* 1.TOC.0.1-4	July 1, 2016
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* 6.10.1-6	July 1, 2016	* 10.10.1-62	July 1, 2016
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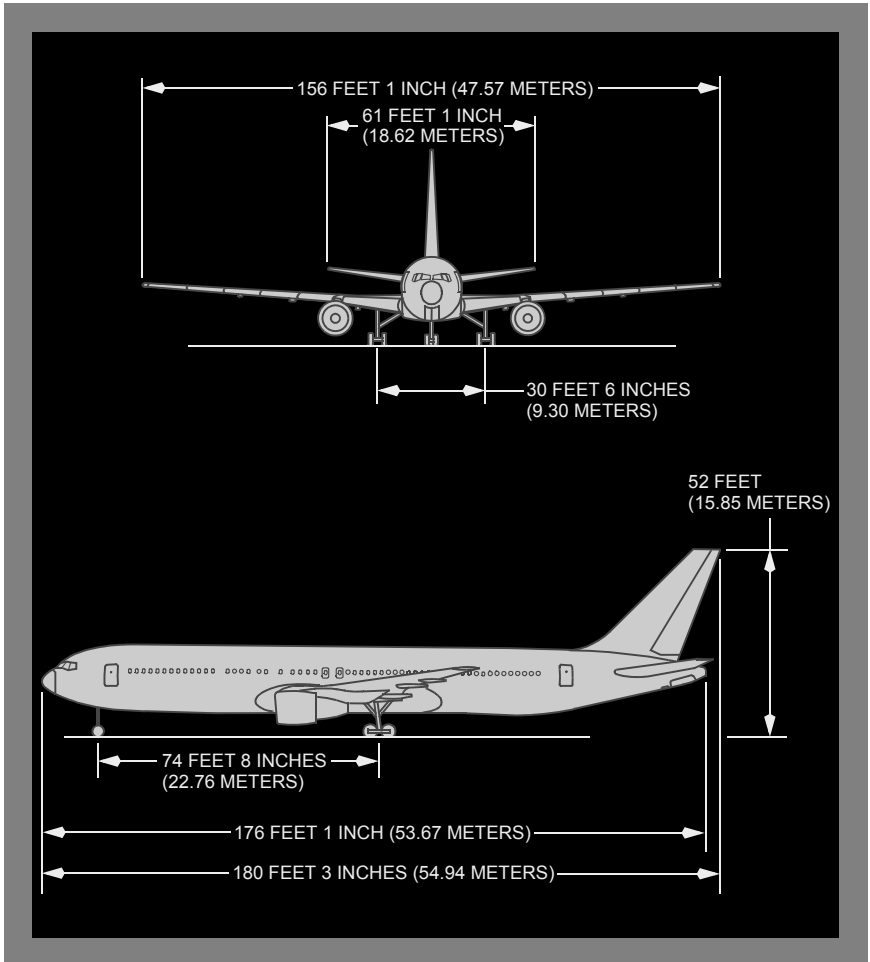
**Airplane General, Emergency
Equipment, Doors, Windows
Dimensions**

Chapter 1

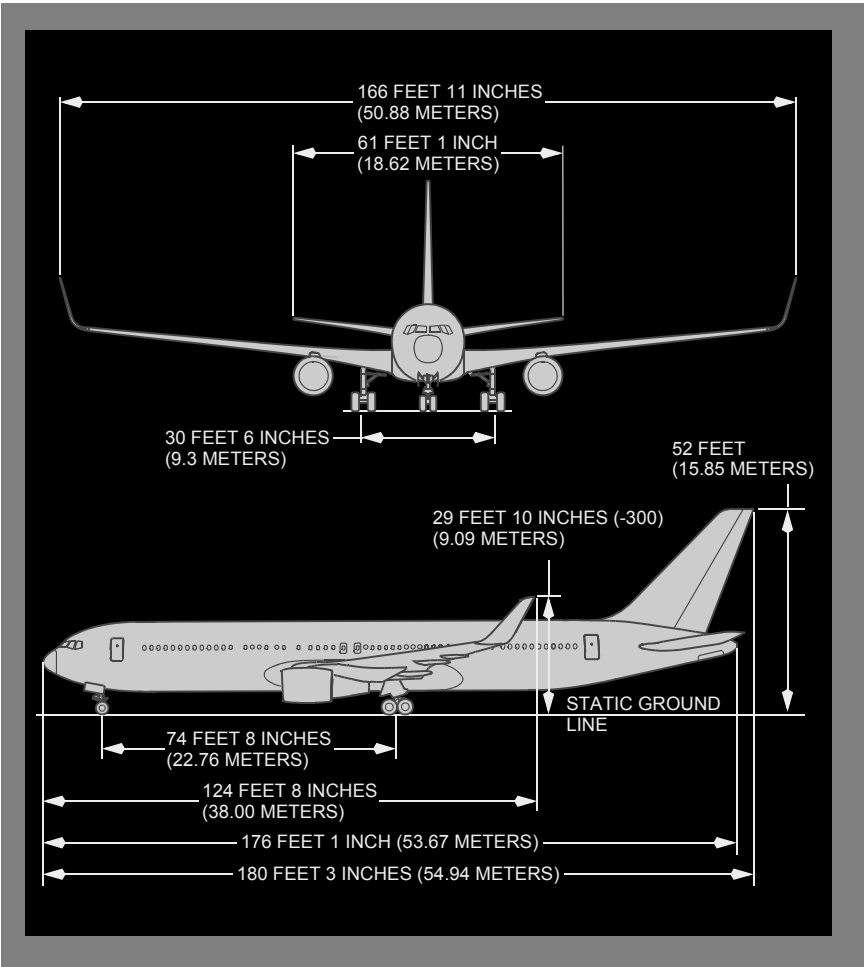
Section 10

Principal Dimensions

767-300 without Blended Winglets



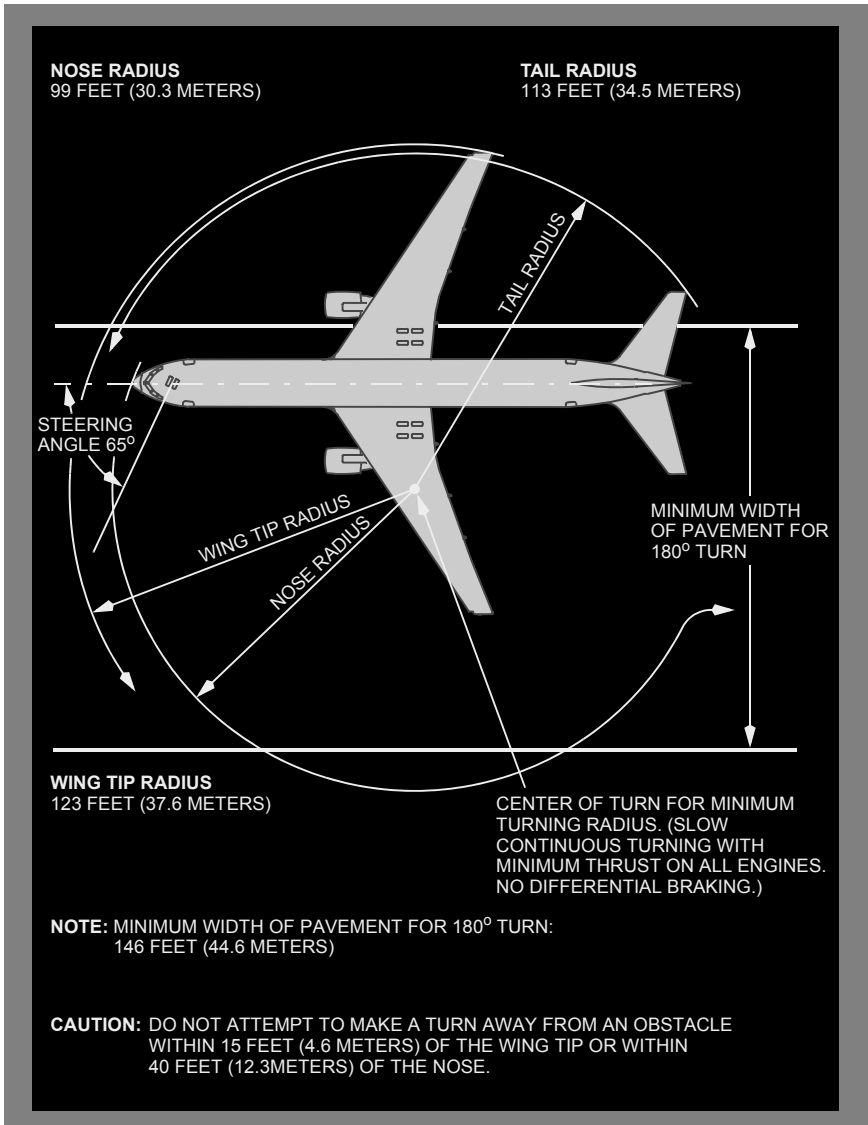
767-300 with Blended Winglets



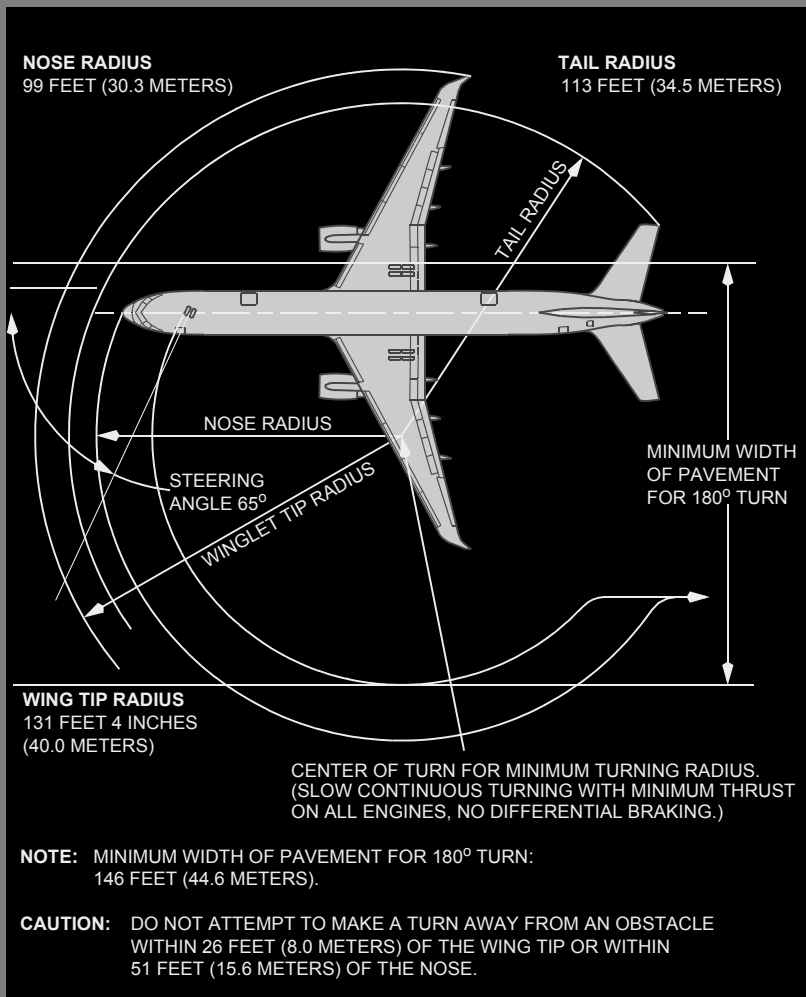
Turning Radius

The wing tip swings the largest arc while turning and determines the minimum obstruction clearance path. All other portions of the airplane structure remain within this arc.

767-300 without Blended Winglets



767-300 with Blended Winglets

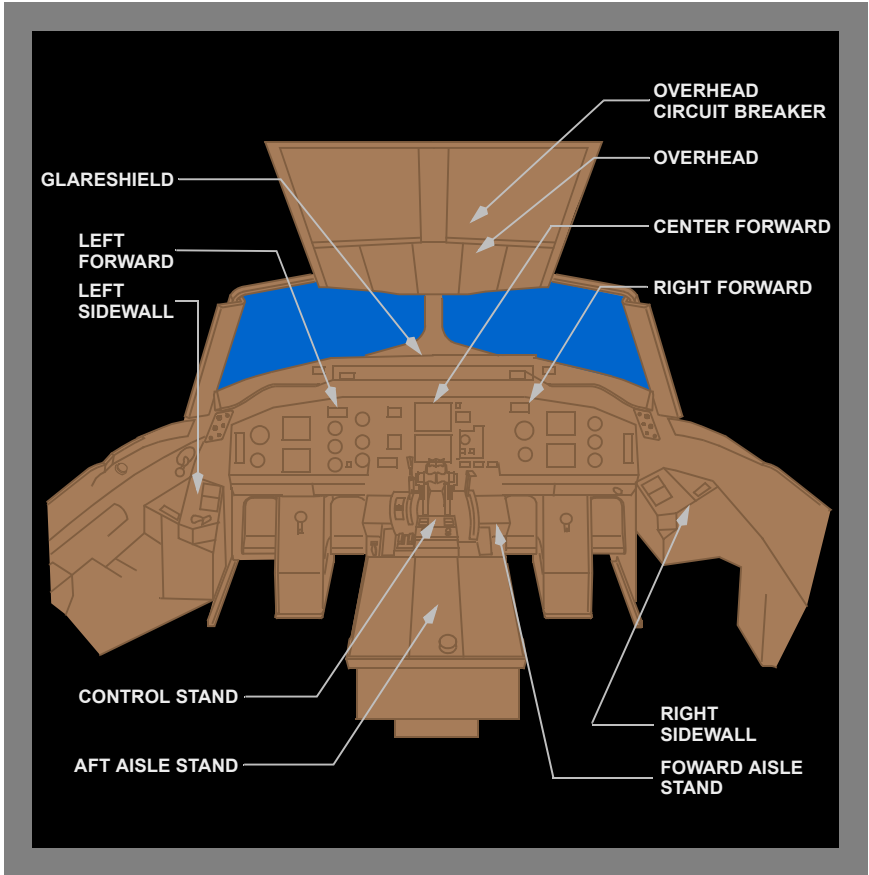


**Airplane General, Emergency
Equipment, Doors, Windows
Instrument Panels**

Chapter 1

Section 20

Flight Deck Panels

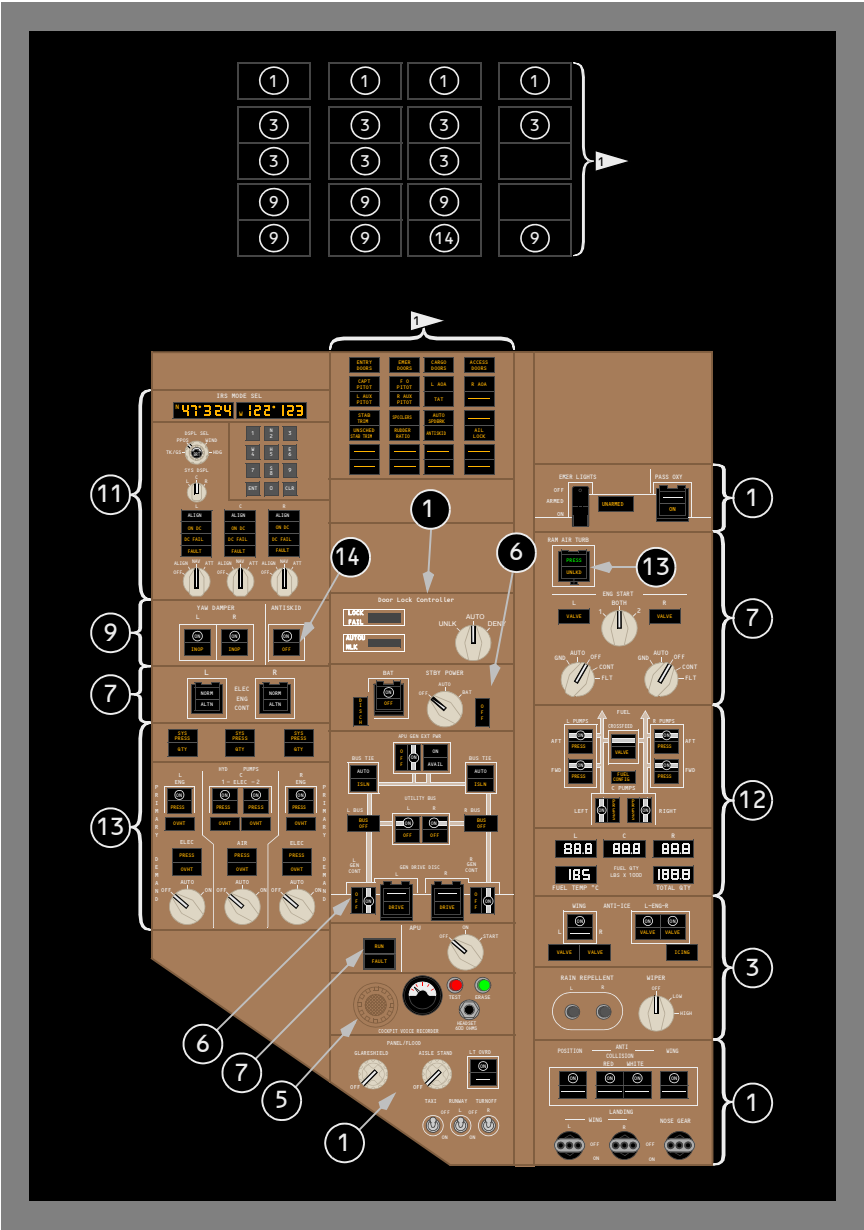


On the following pages, circled numbers refer to chapters where information on the item may be found.

The panels, controls, and indicators shown in this chapter are representative of installed units and may not exactly match the latest configuration. Refer to the appropriate chapter system descriptions for current information.

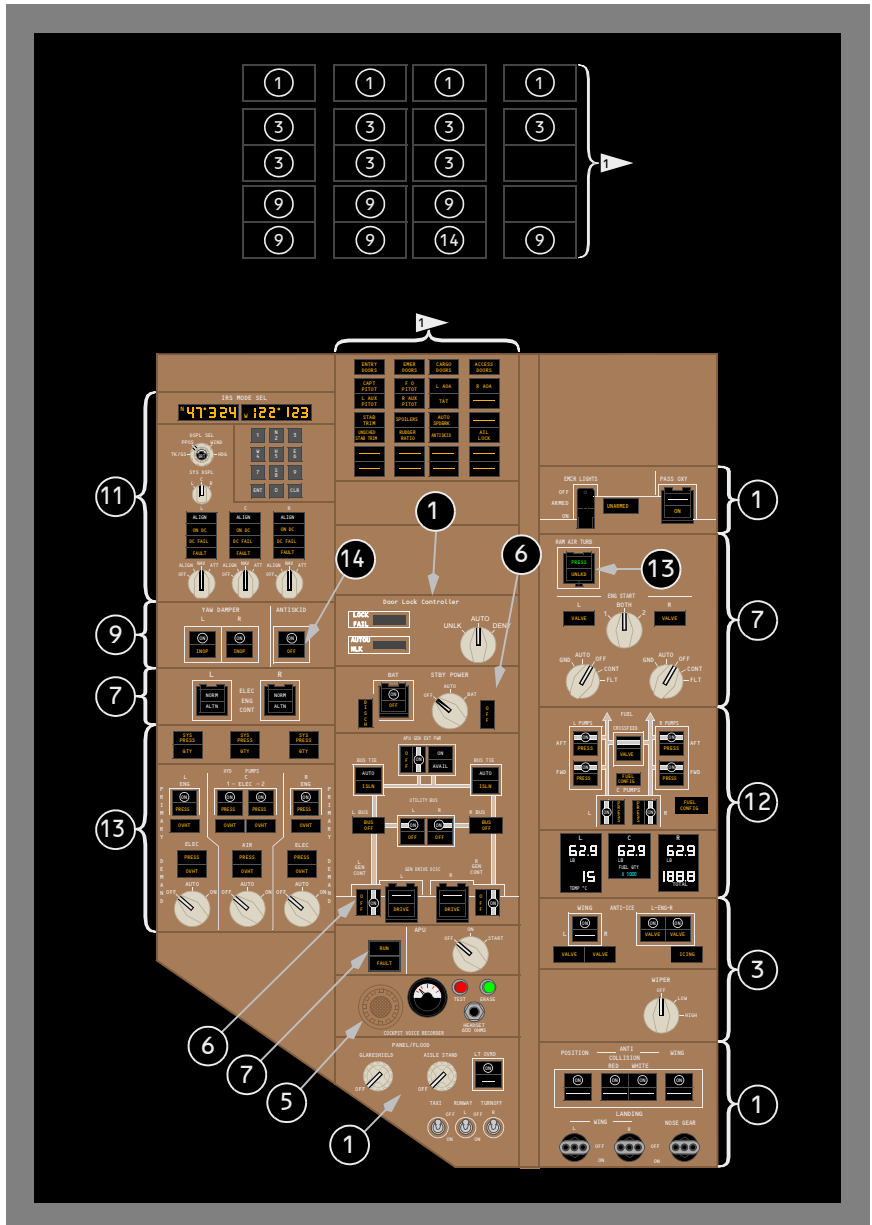
Left Overhead Panel

121-139, 1501-1506, 1521, 1601-1613, 1701-1708

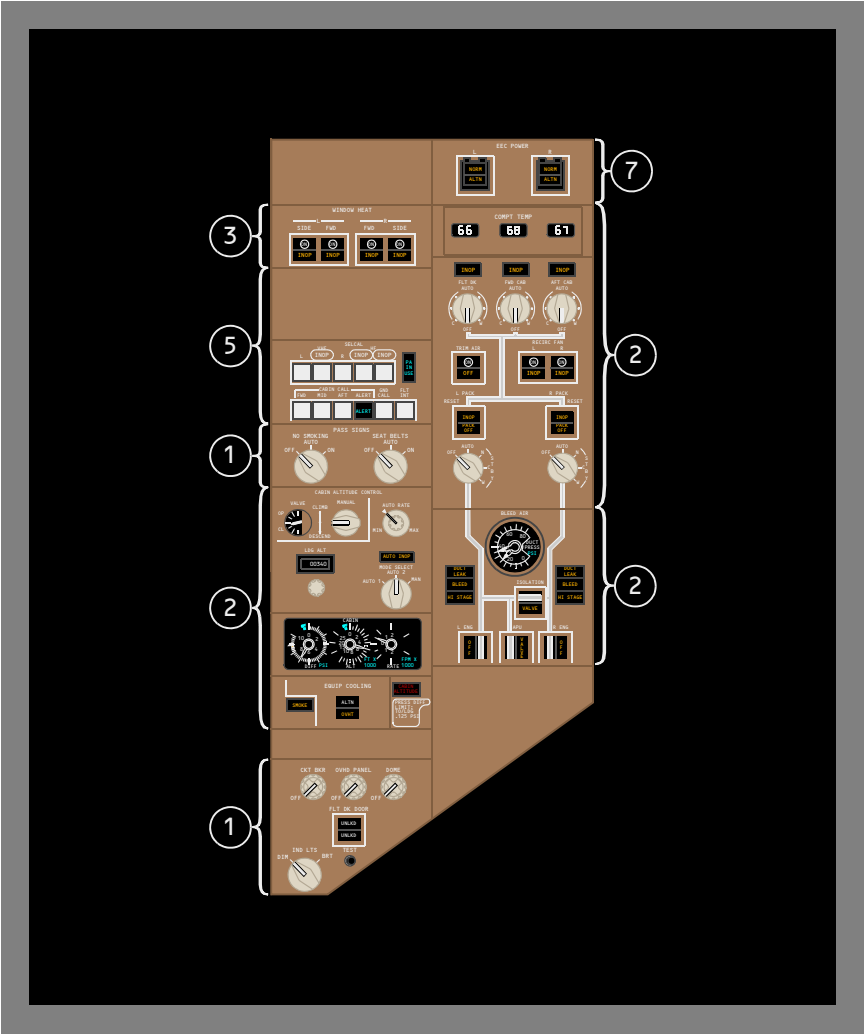


Left Overhead Panel

171-199, 1200-1201, 1401-1404



Right Overhead Panel

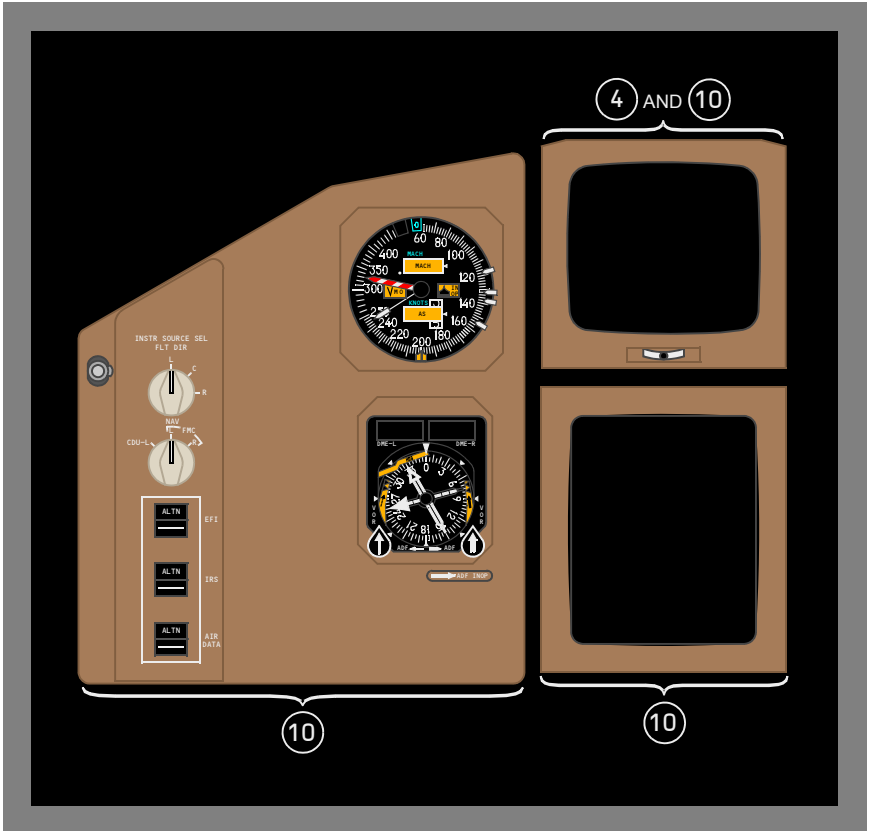


**Airplane General, Emergency
Equipment, Doors, Windows
Instrument Panels**

Chapter 1

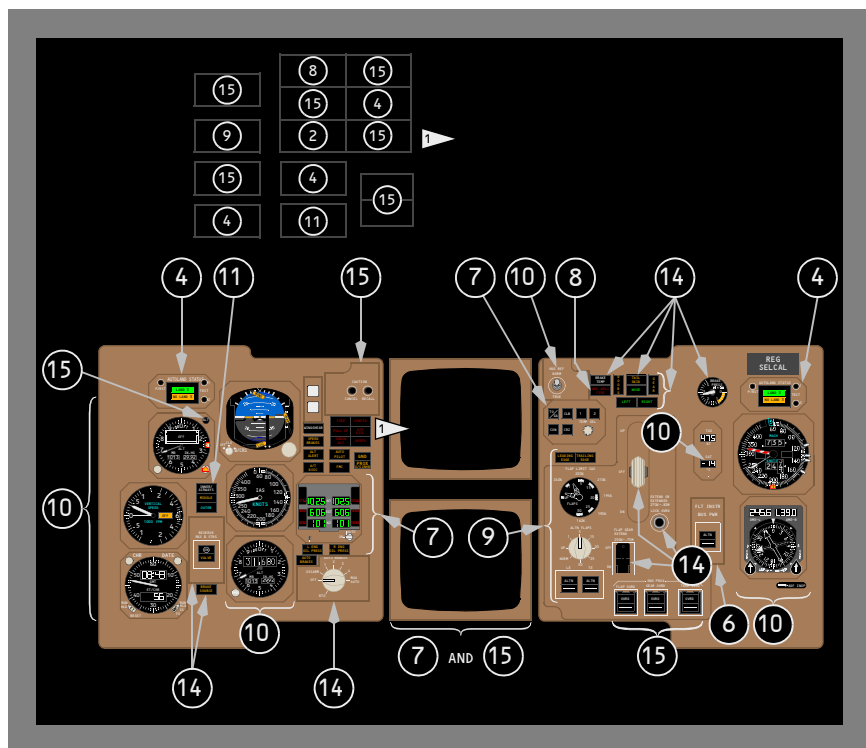
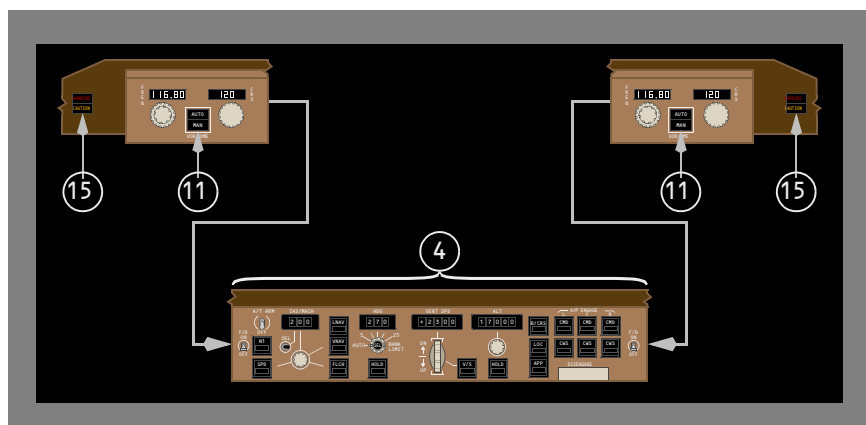
Section 21

Left Forward Panel

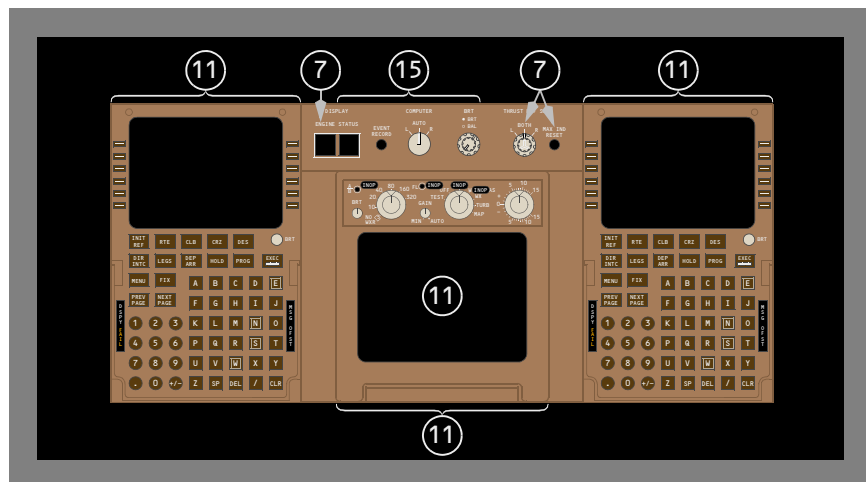


Right Forward Panel





Forward Aisle Stand

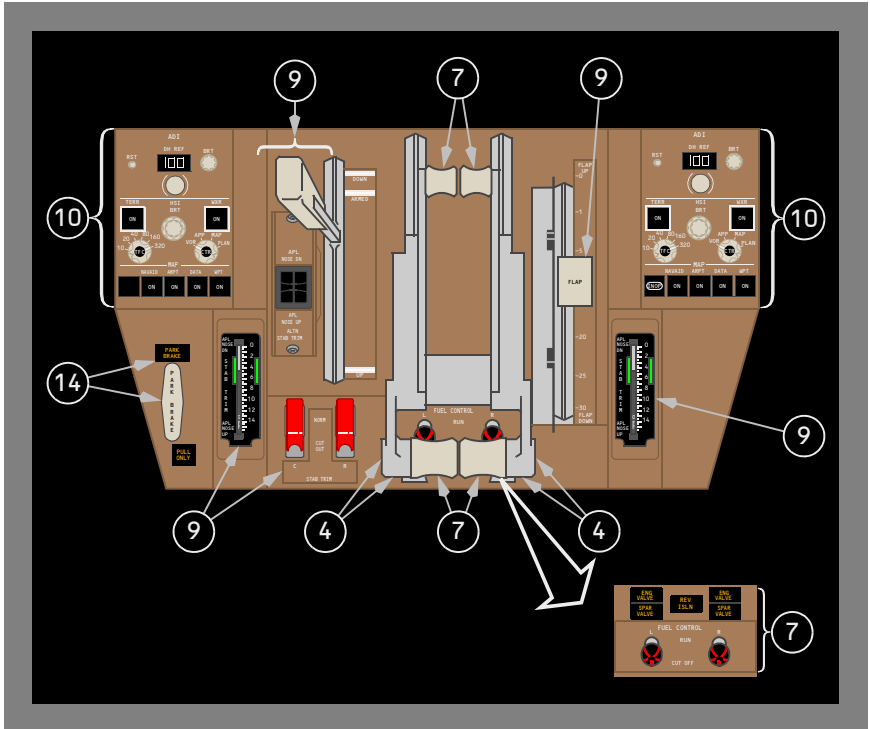


Airplane General, Emergency Equipment, Doors, Windows Instrument Panels

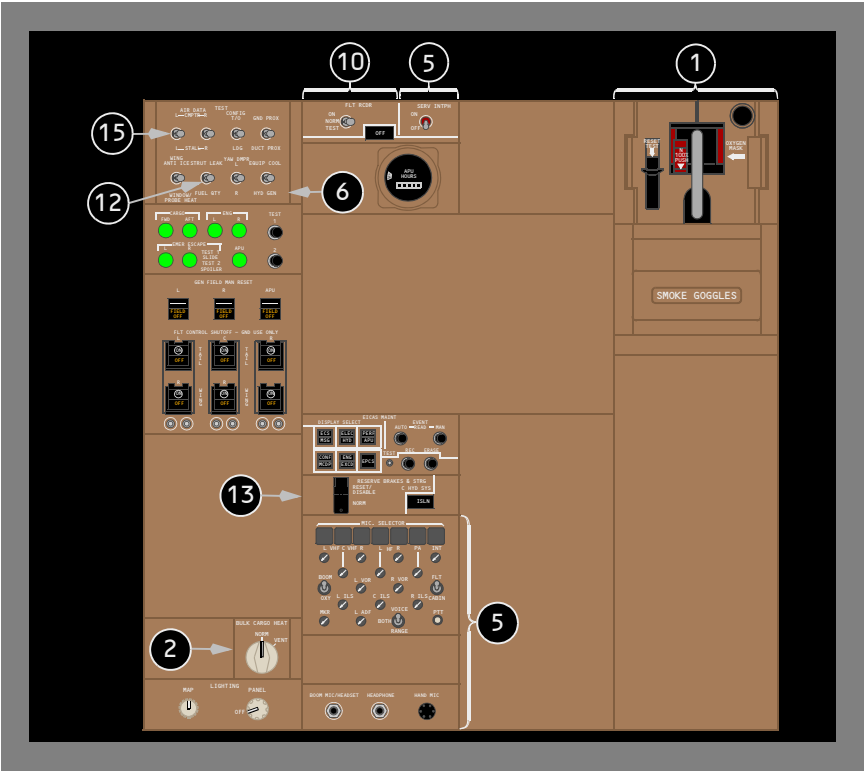
Chapter 1

Section 22

Control Stand

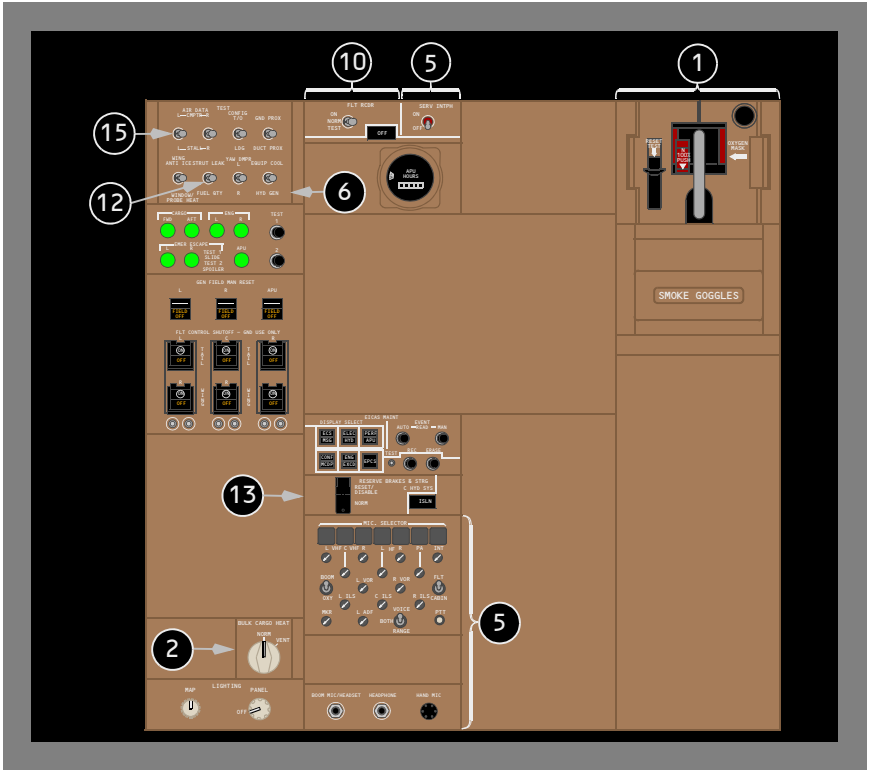


Aft Aisle Stand
120-139, 1401-1404

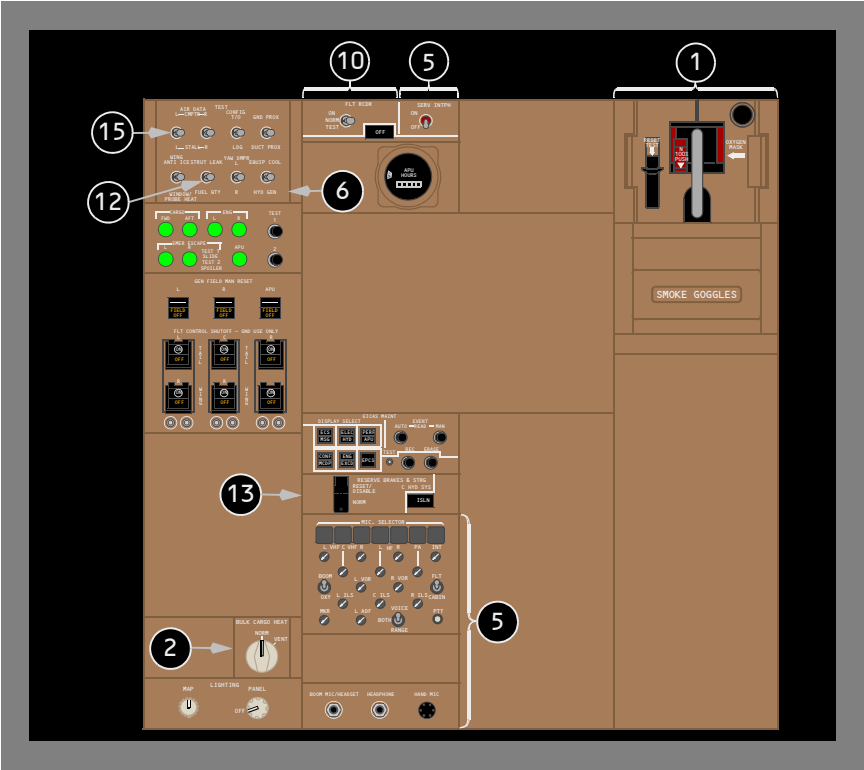


Aft Aisle Stand

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

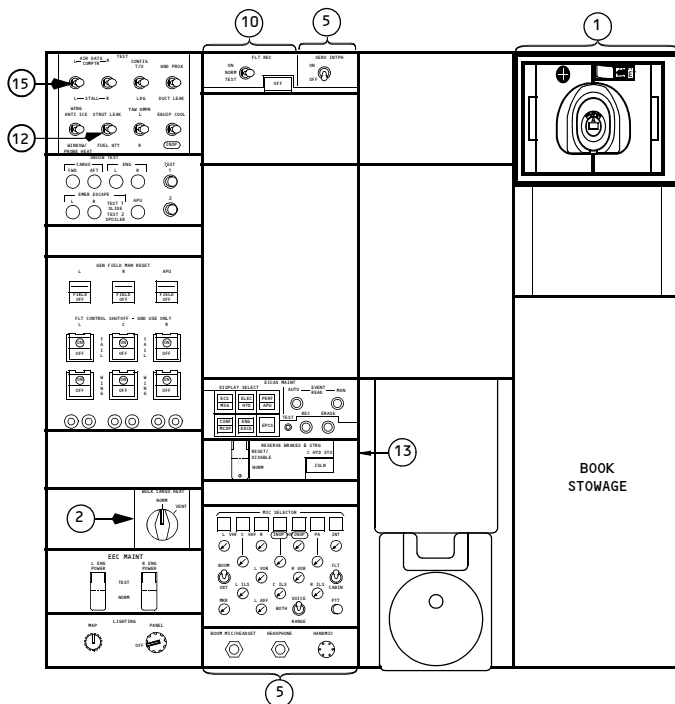


Right Sidewall, Accessory Panel
121-139, 1601-1613, 1501-1506, 1521, 1701-1708

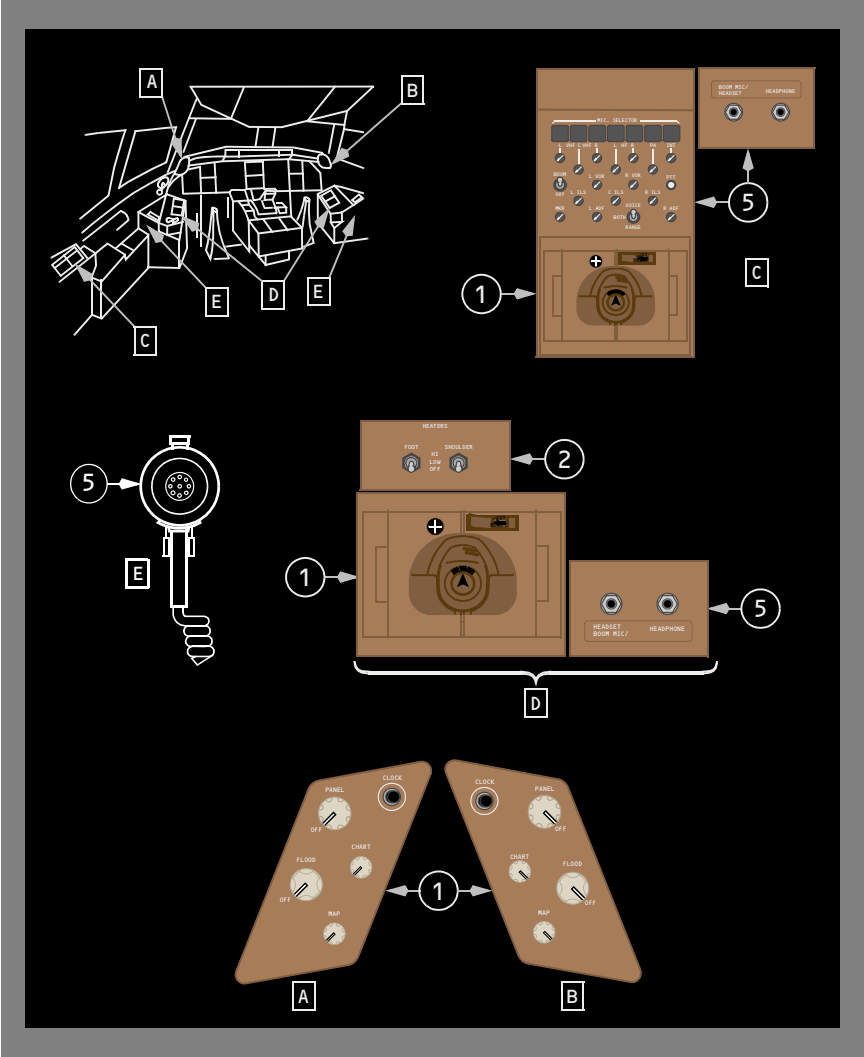


Right Sidewall, Accessory Panel

171-199, 1200-1201, 1401-1404



Left, Right Sidewall, and Observer Panels



Airplane General, Emergency Equipment, Doors, Windows Controls and Indicators

Chapter 1

Section 30

Push–Button Switches

The airplane has two types of push–button switches: alternate action and momentary action. The switch may contain an indicator light that illuminates to indicate system status or faults. A line indicates there is no label for that portion of the switch.

Note: Maintenance personnel should be contacted for all relamping operations. Unintentional system operation can result from improper relamping.

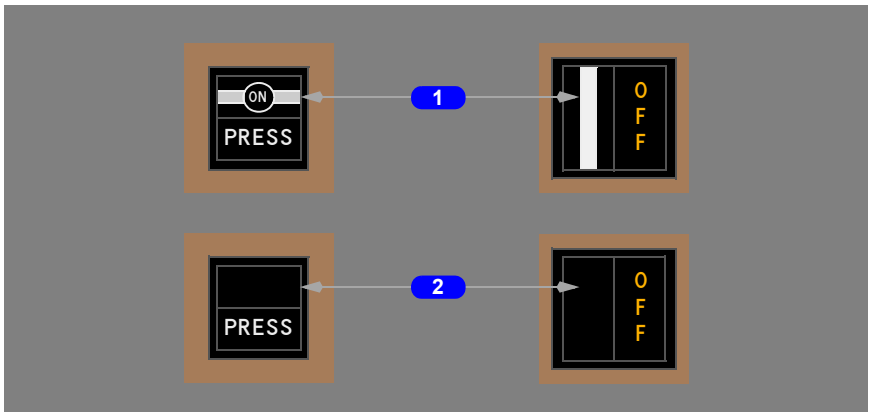
Alternate Action Switches

Alternate action switches have two positions: on and off.

When pushed in and flush with the panel, the switch is on. When the switch is on, a mechanical shutter on one half of the switch opens to show an illuminated legend, such as "ON", "AUTO" or a flow bar.

When pushed out and extended, the switch is off. When the switch is off, the mechanical shutter closes so the legend is not shown.

Additionally, the other half of many switches has a light to indicate system state, such as "PRESS", "FAIL", "INOP" or "OFF".



1 Switch is ON

A mechanical shutter opens and a word, symbol or combination is visible.

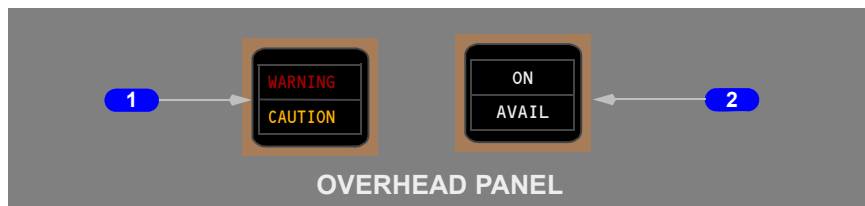
For some switches, system status may be shown in half of the switch.

2 Switch is OFF

A mechanical shutter closes and the ON indication is not visible.

Momentary Action Switches

Momentary action switches are spring loaded to the extended position. They are used to activate or deactivate systems or to reset system logic. The switch display indicates system status.



1 Push to Reset

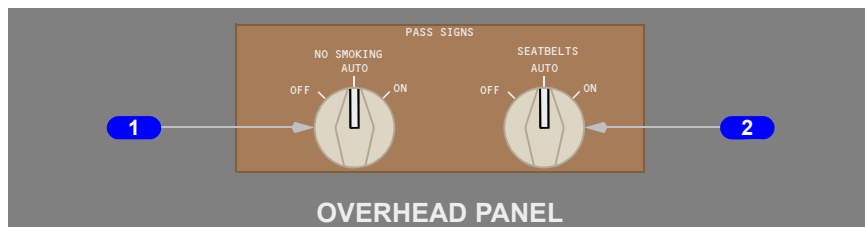
Push – the switch resets the master lights and aural alerts.

2 System Operation

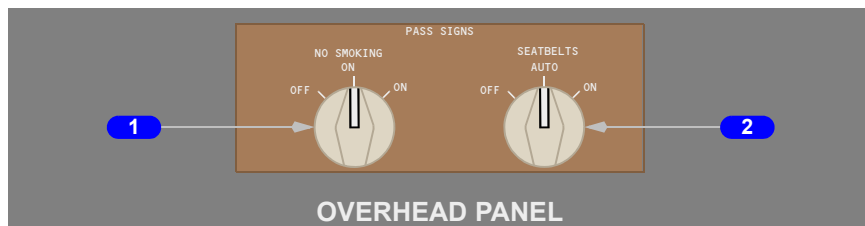
Push – activates or deactivates the system.

Passenger Cabin Signs Passenger Sign Selectors

121-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1606, 1701-1708



1607-1613



1 NO SMOKING Selector

121-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1606, 1701-1708

OFF – the no smoking signs are extinguished.

1601-1606, 1701-1708

AUTO – the no smoking signs illuminate or extinguish with reference to landing gear position (refer to Lighting System Description section).

121-199, 1201-1201, 1401-1404, 1501-1506, 1521

AUTO – the no smoking signs illuminate or extinguish with reference to landing gear position or flaps (refer to Lighting System Description section).

ON – the no smoking signs illuminate.

1 NO SMOKING Selector

1607-1613

OFF – the no smoking signs are extinguished.

ON – (mid position) the no smoking signs illuminate and chime sounds.

ON – (right position) the no smoking signs illuminate but no chime sounds.

2 SEAT BELTS Selector

OFF – the fasten seat belts and return to seats signs are extinguished.

AUTO – the fasten seat belts and return to seats signs illuminate or extinguish with reference to landing gear or flap position (refer to Lighting System Description section).

ON – the fasten seat belts and return to seats signs illuminate.

Note: Any time passenger oxygen is deployed, the cabin signs revert to the following (regardless of selector position):

- No Smoking Illuminated
- Fasten Seat Belts Illuminated

121-186, 1401-1402

Return to seats extinguish if the cabin altitude is above 10,000 ft.

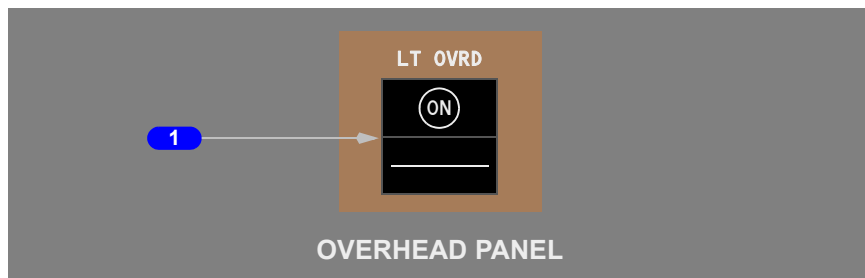
187-1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708

Return to seats extinguish if the cabin altitude is above 10,000 ft. and passenger oxygen is on

Lighting

Flight Deck Lighting

Light Override Switch

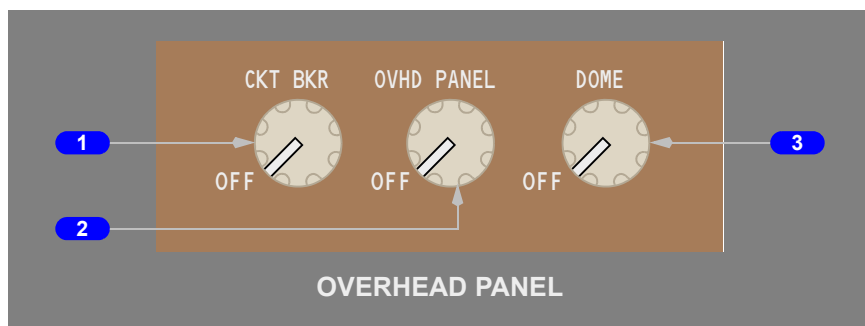


1 Light Override (LT OVRD) Switch

ON – overrides normal controls and illuminates the following lights at maximum brightness:

- forward panel flood lights
- illuminated indicator lights
- glareshield flood lights
- aisle stand flood lights
- dome lights

Circuit Breaker/Overhead Panel and Dome Lights Control



1 Circuit Breaker (CKT BKR) Panel Light Control

Rotate – controls circuit breaker panel light brightness.

2 Overhead (OVHD) Panel Lights Control

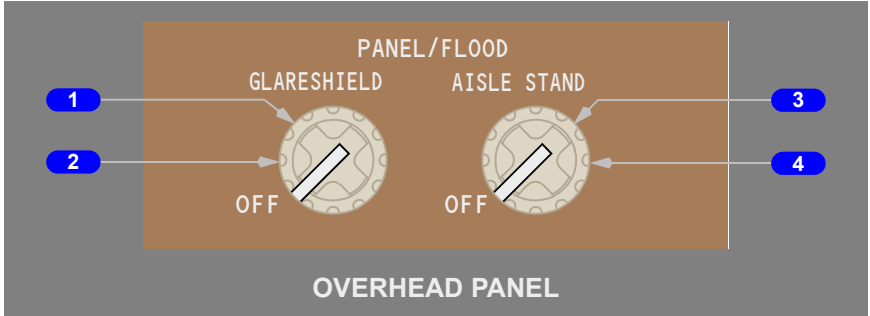
Rotate – controls overhead panel light brightness.

3 DOME Lights Control

Rotate – controls dome light brightness.

Note: Control is overridden with the Light Override Switch in the ON position.

Glareshield Panel/Flood Lights Control



1 GLARESHIELD FLOOD Light Control (inner)

Rotate – controls glareshield flood light brightness.

2 GLARESHIELD PANEL Light Control (outer)

Rotate – controls glareshield panel light brightness.

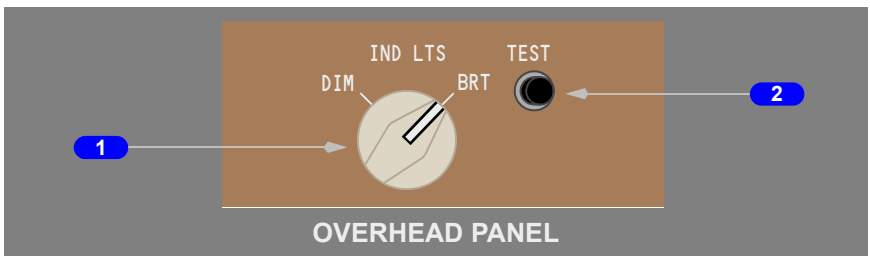
3 AISLE STAND FLOOD Light Control (inner)

Rotate – controls the aisle stand flood light brightness.

4 AISLE STAND PANEL Light Control (outer)

Rotate – controls the aisle stand instrument panel light brightness.

Indicator Lights Switch



1 Indicator Lights (IND LTS) Switch

BRT – sets all illuminated annunciator lights to full brightness.

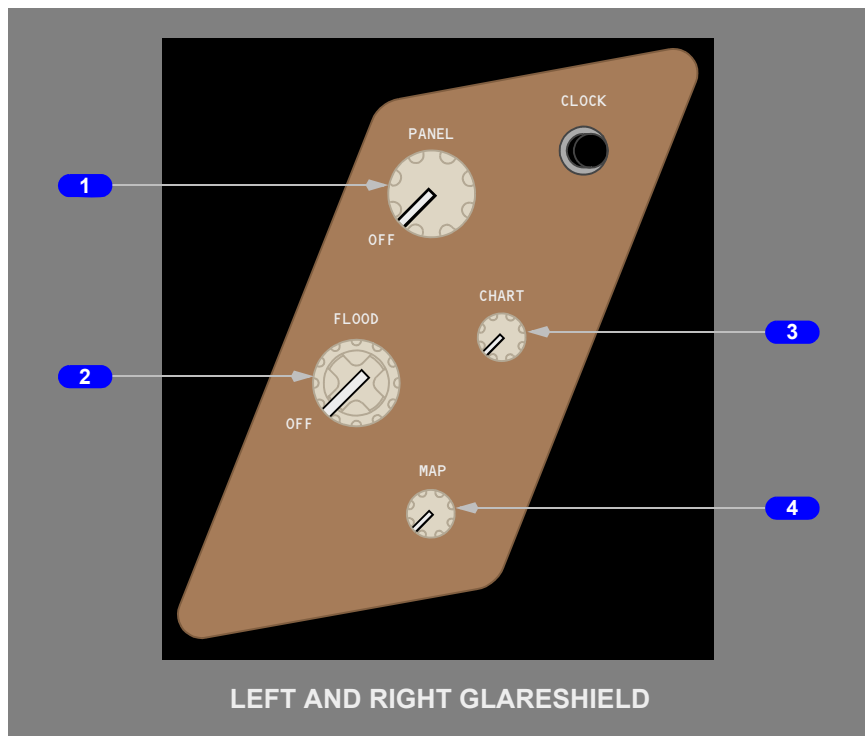
DIM – sets all illuminated annunciator lights to low brightness.

2 Indicator Lights (IND LTS) TEST Switch

Push and hold –

- Initiates an indicator lights test
- Lights illuminate at the intensity selected by the Indicator Lights selector
- Tests the ADI and HSI displays if the airplane is on the ground
- Illuminates the IRS data display characters

Pilot's Lighting Control Panel



1 PANEL Light Control

Rotate –

- left controls left forward and center forward instrument panel lights and standby magnetic compass brightness
- right controls right forward panel lights brightness

2 FLOOD Light Control

Rotate –

- left controls left forward and center forward instrument panel flood lights brightness
- right controls right forward instrument panel flood lights brightness

3 CHART Light Control

Pull – on.

Push – off.

Rotate – adjusts chart light brightness.

4 MAP Light Control

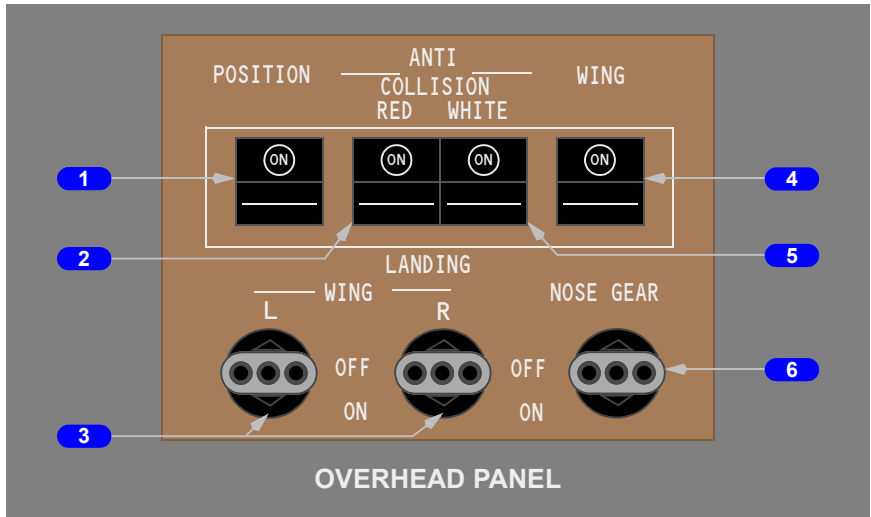
Pull – on.

Push –off.

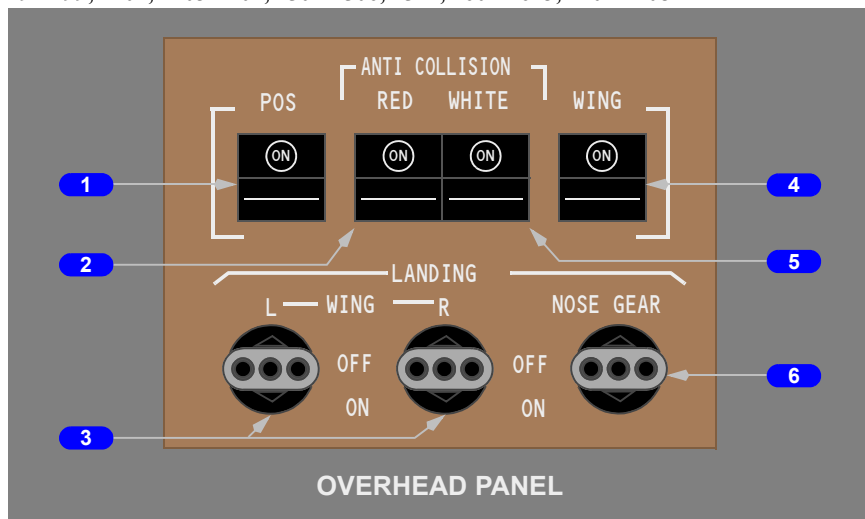
Rotate – adjusts map light brightness.

Exterior Lighting Lighting Control Panel

121-196, 1401-1402



197-199, 1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708



1 POSITION Light Switch

121-196, 1401-1402

ON – the red, green, and white position lights illuminate.

OFF (ON not visible) – the red, green, and white position lights extinguish.

1 Position (POS) Light Switch

197-199, 1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708

ON – the red, green, and white position lights illuminate.

OFF (ON not visible) – the red, green, and white position lights extinguish.

2 ANTI-COLLISION RED Light Switch

ON – the red anti-collision strobe lights on the top and bottom of the fuselage operate.

OFF (ON not visible) – the red anti-collision strobe lights on the top and bottom of the fuselage do not operate.

3 WING LANDING Light Switches

ON – the landing light illuminates.

OFF – the landing light extinguishes.

4 WING Light Switch

ON – the wing leading edge illumination lights illuminate.

OFF – the wing leading edge illumination lights extinguish.

5 ANTI-COLLISION WHITE Light Switch

ON – the white anti-collision strobe lights on tips of each wing operate.

OFF (ON not visible) – the white anti-collision strobe lights on tips of each wing do not operate.

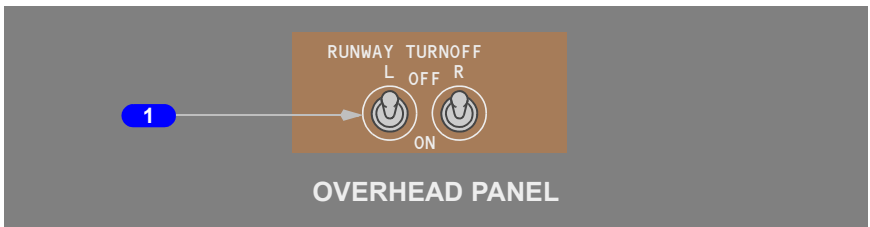
6 NOSE GEAR LANDING Light Switch

ON – the landing lights illuminate.

OFF – the landing lights extinguish.

Note: The nose gear landing lights do not illuminate when the nose landing gear is not down and locked.

Runway Turnoff Light Switches

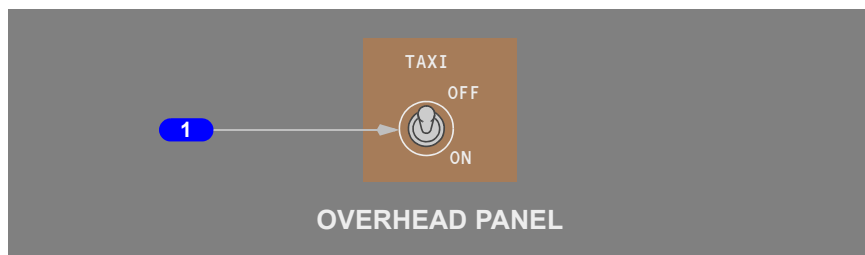


1 RUNWAY TURNOFF Light Switches

ON – the runway turnoff light illuminates.

OFF – the runway turnoff light extinguishes.

Taxi Light Switch



1 TAXI Light Switch

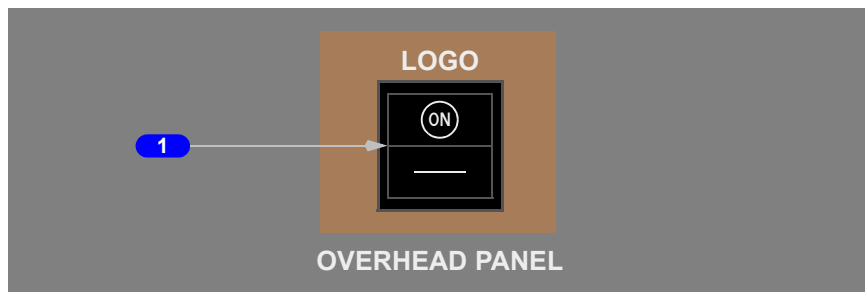
ON – the taxi light illuminates.

OFF – the taxi light extinguishes.

Note: The taxi light does not illuminate when the nose landing gear is not down and locked.

LOGO Lights

171-199, 1200-1201, 1501-1506, 1521, 1601-1708

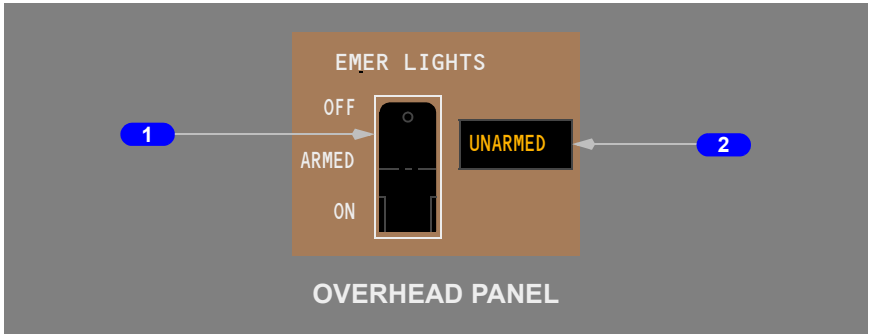


1 LOGO Light Switch

ON – the stabilizer mounted logo lights illuminate the vertical tail surface.

Emergency Lighting Controls

Flight Deck Emergency Lights Switch



1 Emergency (EMER) LIGHTS Switch

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

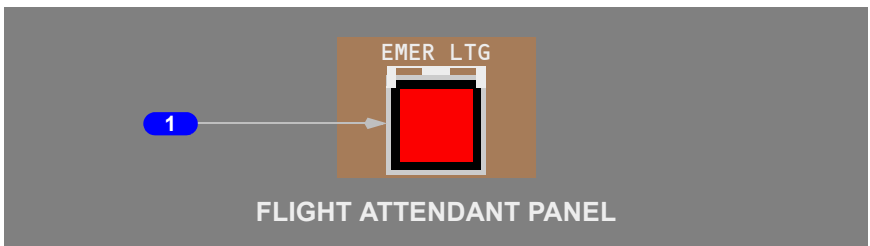
ARMED – all emergency lights illuminate if airplane electrical power fails or is turned off.

ON – all emergency lights illuminate.

2 Emergency Lights UNARMED Light

Illuminated (amber) – the emergency lighting system has been manually actuated or the emergency lights switch is OFF.

Passenger Cabin Emergency Lights Switch



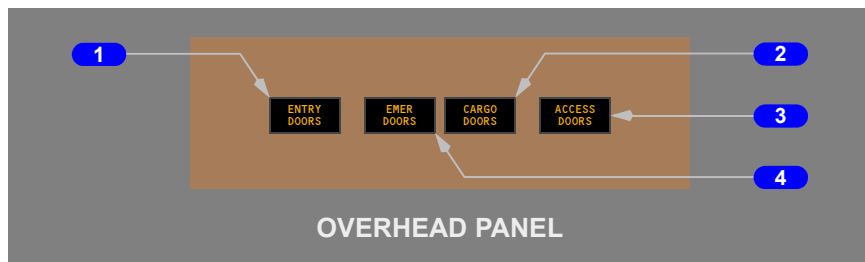
1 Passenger Cabin EMERGENCY LIGHTS Switch

Push –

- Illuminated (red):
 - all passenger cabin and exterior emergency lights illuminate
 - bypasses the flight deck emergency lights switch
- Extinguished: all passenger cabin and exterior emergency lights extinguish

Doors and Windows

Exterior Door Annunciator Lights



1 ENTRY DOORS Light

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

2 CARGO DOORS Light

Illuminated (amber) – the forward, aft, or bulk cargo door is not closed and latched and locked.

3 ACCESS DOORS Light

Illuminated (amber) – the forward equipment bay or the electrical equipment compartment door is not closed and latched and locked.

4 Emergency (EMER) DOORS Light

1501-1506, 1521

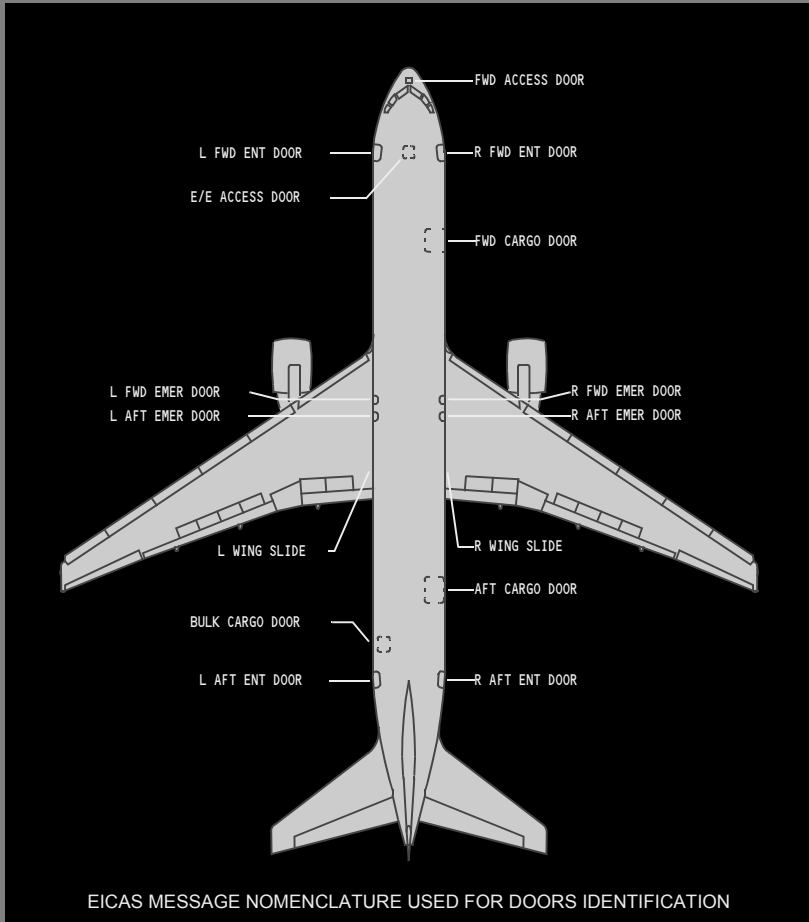
Illuminated (amber) – an overwing emergency exit door, or a wing slide door is not closed and latched and locked.

121-139, 171-199, 1200-1201, 1401-1404, 1601-1708

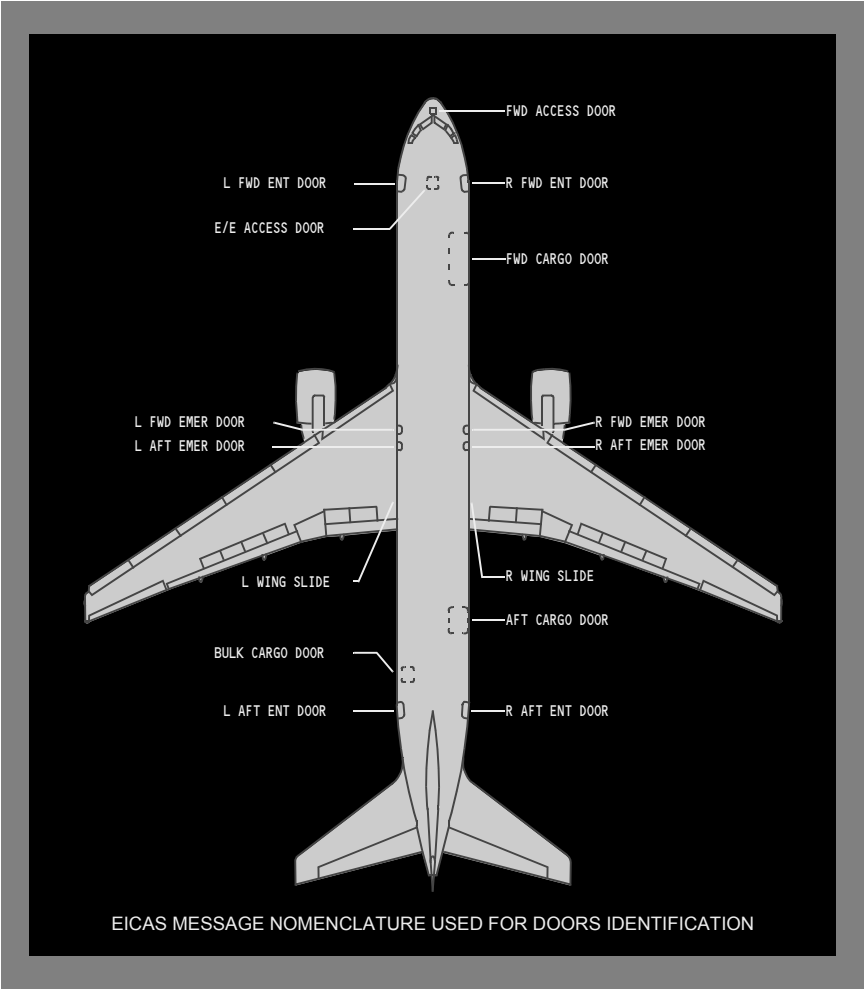
Illuminated (amber) – a forward or aft overwing emergency exit door, or a wing slide door is not closed and latched and locked.

Exterior Door Locations

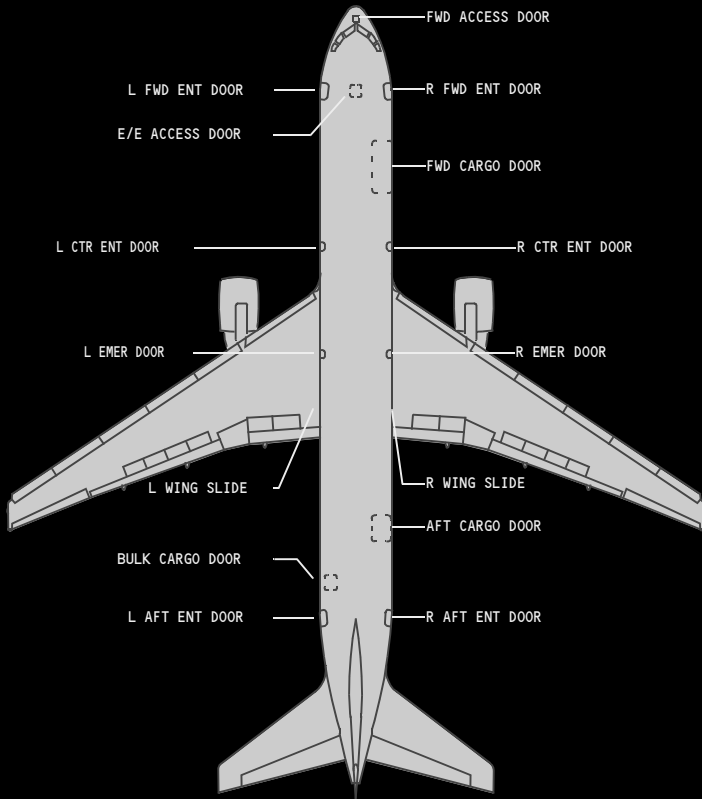
121-139, 1401-1404



171-199, 1200-1201, 1601-1613, 1701-1708

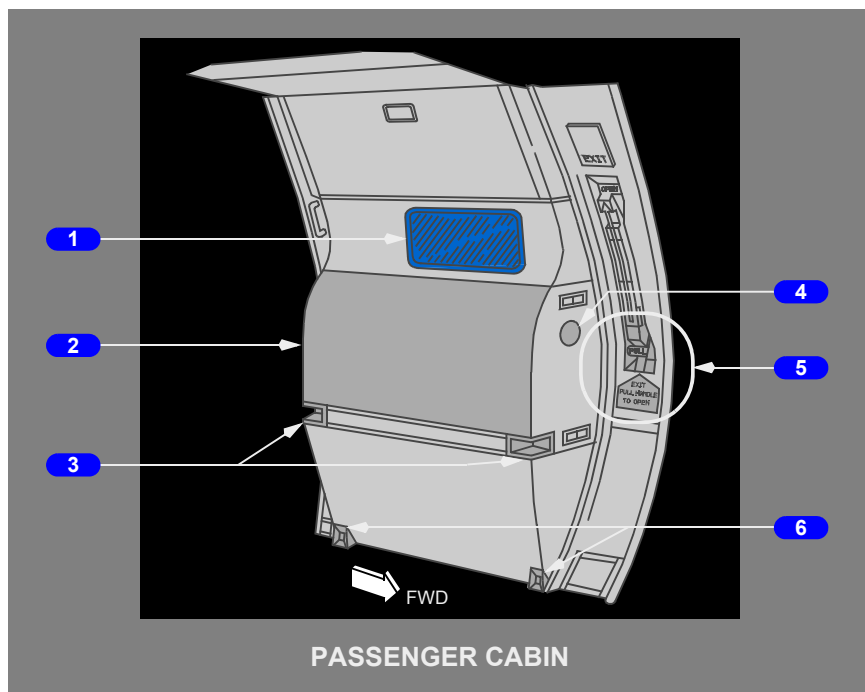


1501-1506, 1521



EICAS MESSAGE NOMENCLATURE USED FOR DOORS IDENTIFICATION

Passenger Entry Doors



1 Viewing Window

Allows observation outside the airplane.

2 Slide

The bustle contains the slide.

Note: The slide is also configured as a raft.

3 Recessed Door Assist Handles

Used to assist in raising/lowering the door.

4 Slide Gas Bottle Pressure Gage

Maintenance use only.

5 Door Control and Mode Select Panel

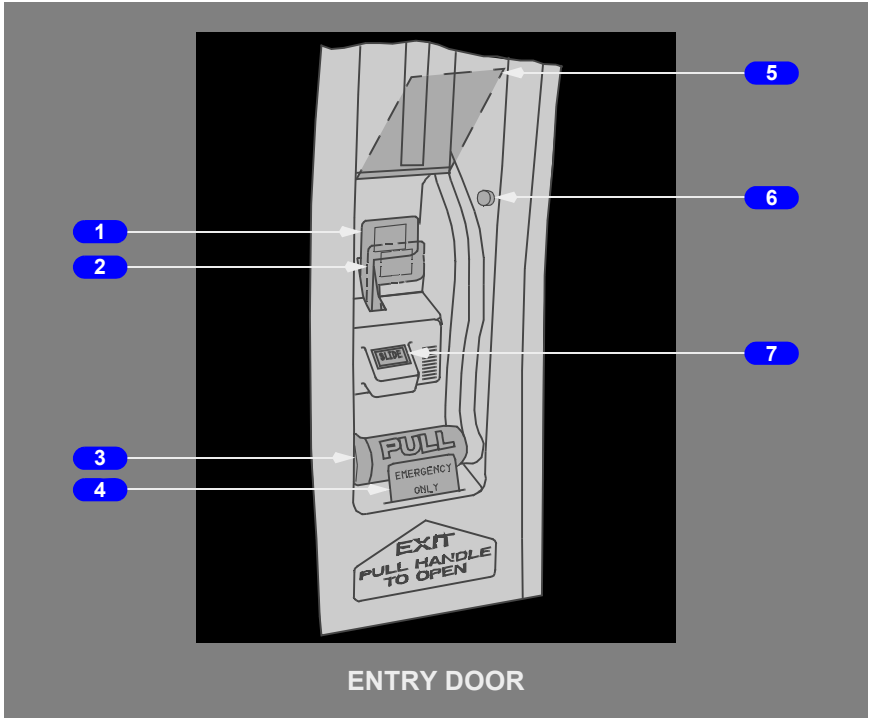
See following illustration.

6 Direct Visual Indication–Girt Bar Lockdown

Indicator in view (yellow) – slide is armed.

Indicator not in view – slide is disarmed.

Passenger Door Control and Mode Select Panel



1 Slide Arming Lever

ARMED – if the door handle is moved to open, the slide deploys.

Note: If the door is opened from the outside, the slide is disarmed.

2 Slide Arming Lever

DISARMED – if the door handle is moved to open, the slide will not deploy.

3 Door Operating Handle

To open the door – pull up in the direction of the arrow.

To close the door– push down in the opposite direction of the arrow.

4 Armed Indicator

In view – slide is armed.

Not in view– slide is disarmed.

5 Slide Arming Lever Cover

Protects against inadvertent movement of the slide arming lever.

6 Slide Arming Lever Release

Push – releases slide arming lever from the slide disarmed position.

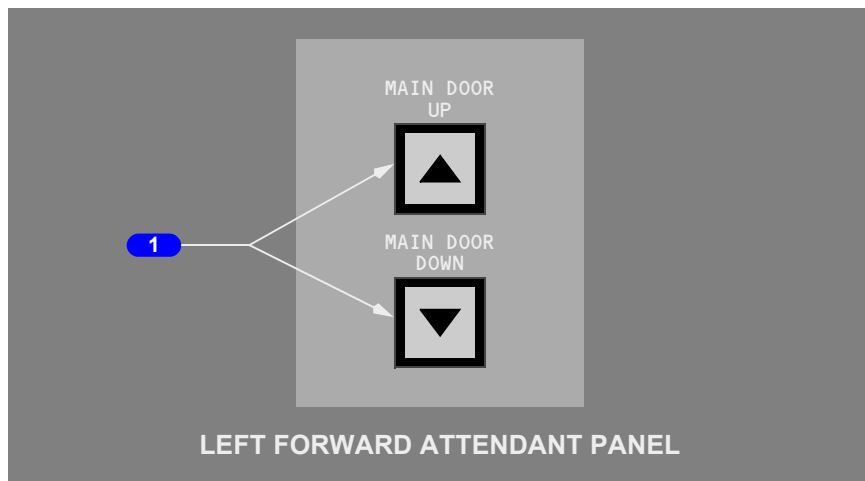
7 Slide Armed Light

Illuminated – slide is armed.

Illuminated, flashing– slide is armed and Door Operating Handle is not in the closed position.

Extinguished– slide is disarmed.

Interior Entry Door Electric Assist Controls



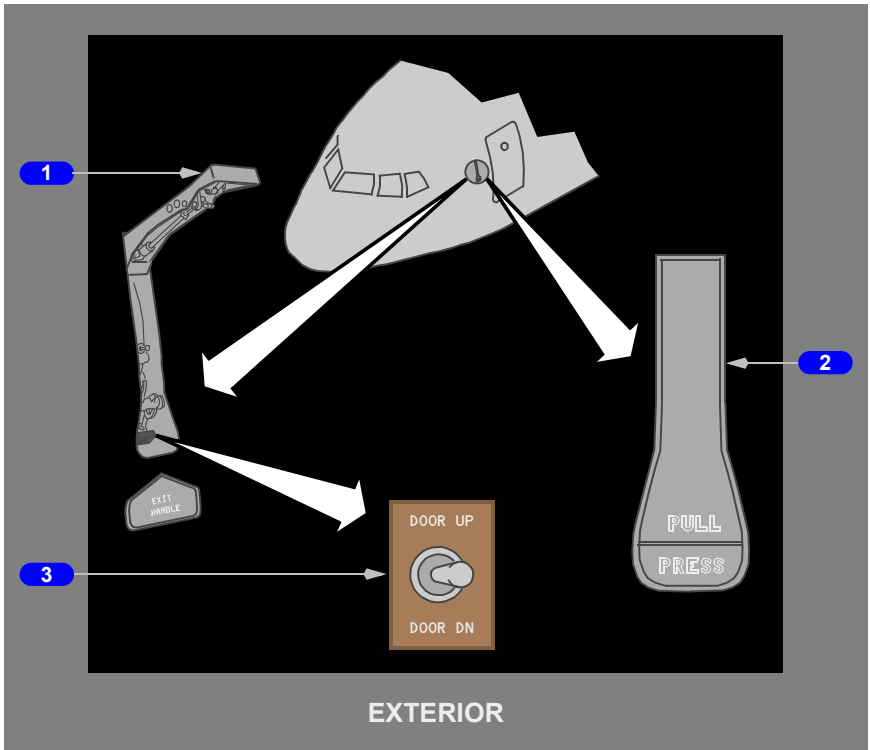
1 Main Door Switch

MAIN DOOR UP – powers electrical assist to raise the entry door.

MAIN DOOR DOWN – powers electrical assist to release the uplatch and lower the entry door.

Note: The switch must be held in position during door operation.

Exterior Entry Door Controls



1 Exterior Door Handle, Open - Door Unlocked

2 Exterior Door Handle, Closed - Door Locked

PRESS – disarms escape slide.

PULL - unlocks door.

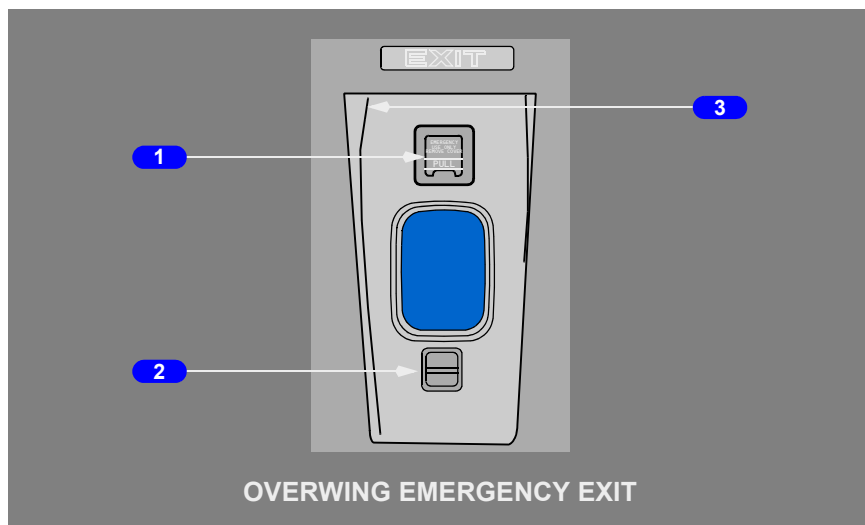
3 Door Switch

DOOR UP – powers electrical assist to raise the entry door.

DOOR DOWN (DN) – powers electrical assist to release the uplatch and lower the entry door.

Note: The switch must be held in position during door operation.

Overwing Emergency Exit Doors



1 Emergency Handle

Note: Cover must be removed to access emergency handle.

To open the door and deploy the ramp slide – pull the handle.

2 Door Assist Handle

Used to assist in removing the door from the opening.

3 Alternate Slide Deployment Handle

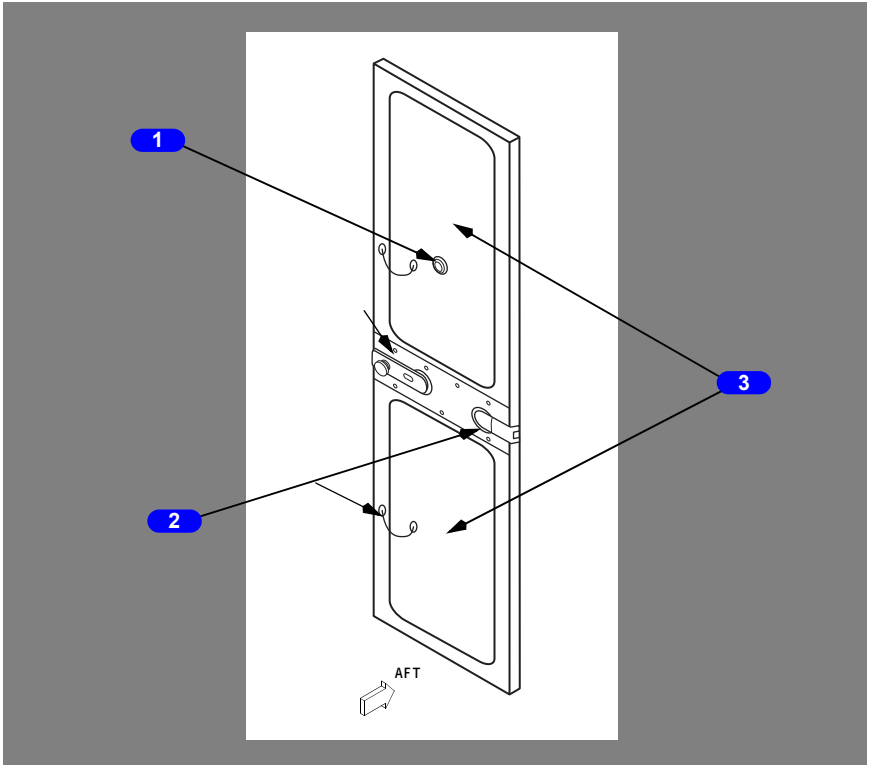
Note: Door must be removed to access.

To manually deploy ramp slide in the event the normal system fails – remove the cover and pull the handle.

Flight Deck Access System

[AFM]

Flight Deck Door



1 Peephole

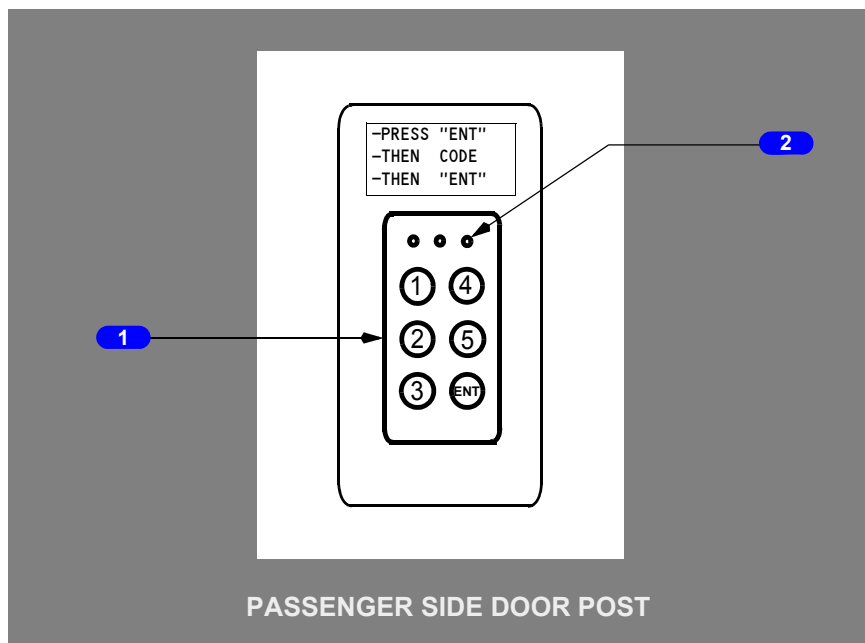
2 Emergency Escape (placard on the door)

- Open cover and push button on right side of door
- Release lanyard from door
- Push hatch into the cabin

3 Decompression Panels

Automatically open during cabin depressurization and provide emergency egress path.

Flight Deck Emergency Access Panel



1 Keypad

Push - enters 3 to 8 digit numeric access code. Entry of correct emergency access code sounds flight deck chime.

2 Access LEDs

Illuminated (red) - entry denied, or incorrect code entered.

Illuminated (amber) - correct emergency access code entered, 30 to 60 second delay in progress.

Illuminated (green) - door unlocked.

Note: Amber and red LED illuminate when incorrect code is entered.

Flight Deck Door Control Panel



1 Control Panel Indicators

LOCK FAIL - Indicates failure of the door locking mechanism (flight deck door is not electronically locked).

AUTO UNLK - Indicates access code has been entered, 30 to 60 second delay has begun, and automatic flight deck door unlock is pending.

2 Door Lock Controller

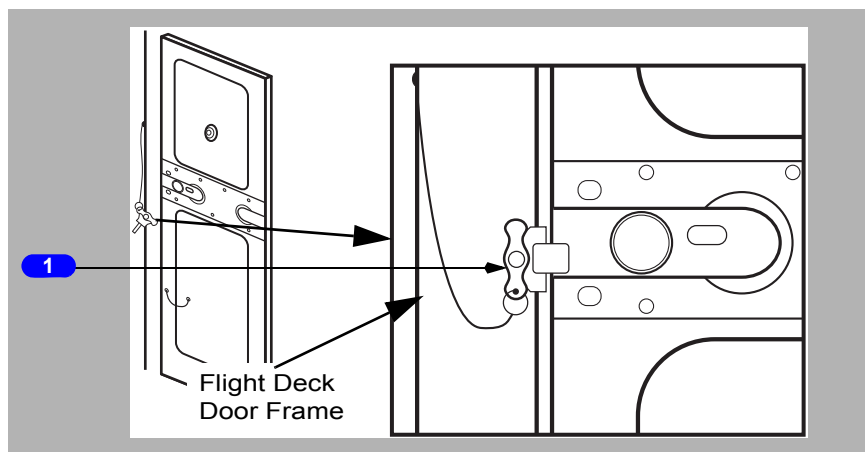
AUTO (Spring-loaded position) - Locks the flight deck door and arms the system for a keypad entry request.

UNLKD (Push and turn to select) - Unlocks flight deck door. Manually overrides **DENY** lock-out period.

DENY (Turn to select) - Cancels keypad entry request.

Note: There will be a five minute lock-out period before the access code can be re-entered, unless **UNLKD** position selected.

Flight Deck Door Mechanical Latch Pin



1 Mechanical Latch Pin

On the ground:

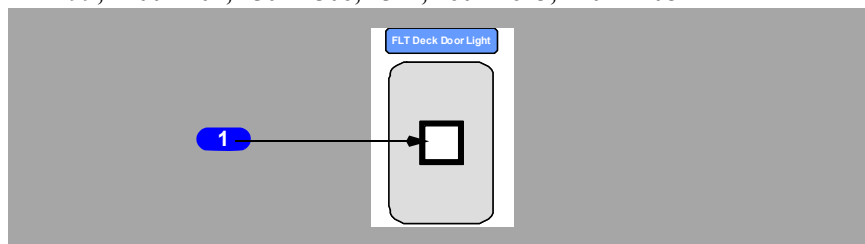
- Install the pin when flight deck door is open to prevent inadvertent closing and locking of the door.
- If the flight deck door automatic locking system is inoperative, install the pin with the door closed to prevent unauthorized flight deck entry.

In flight:

- If the flight deck door automatic locking system is inoperative, install the pin with the door closed to prevent unauthorized flight deck entry.

Flight Deck Security Light

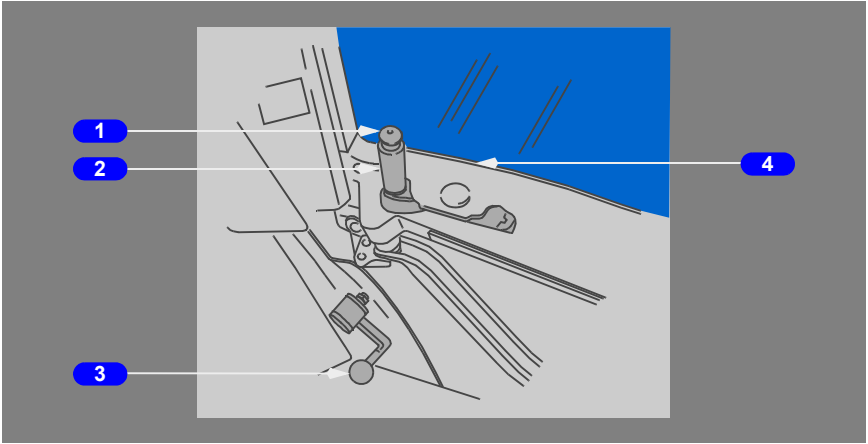
171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708



1 Light Switch

Push - Turns overhead light outside flight deck door on and off.

Flight Deck Number Two Window



1 Window Lock Release Button

Button must be depressed to free the Window Lock Lever from the Forward Position.

2 Window Lock Lever

Forward Position– with the window fully closed (WINDOW NOT CLOSED decal not visible), locks the window.

Aft Position– unlocks the window so it can be cranked open.

3 Window Crank

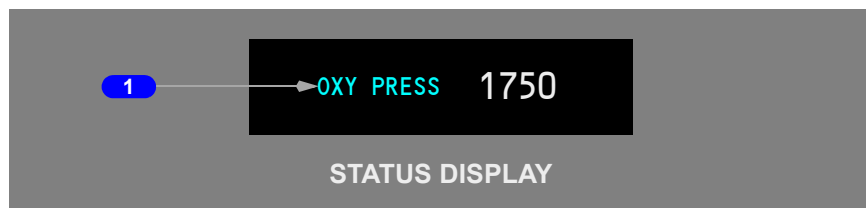
Used to position the window open or closed when the window lock lever is unlocked.

4 WINDOW NOT CLOSED Decal

Visual indication the window is not fully closed.

Oxygen Systems

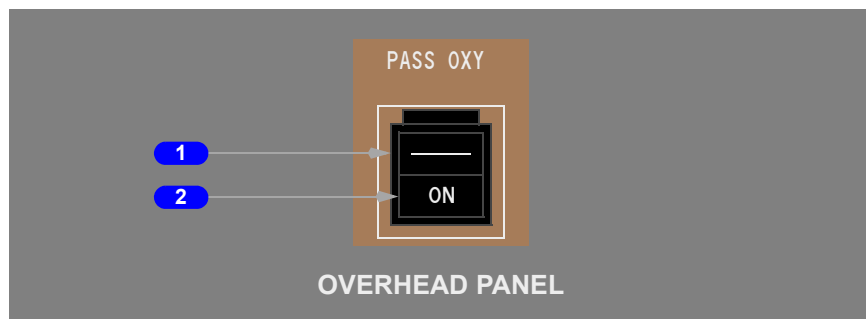
Oxygen Indications



1 Oxygen Pressure (OXY PRESS) Display

Displays crew oxygen cylinder pressure (psi).

Passenger Oxygen Switch



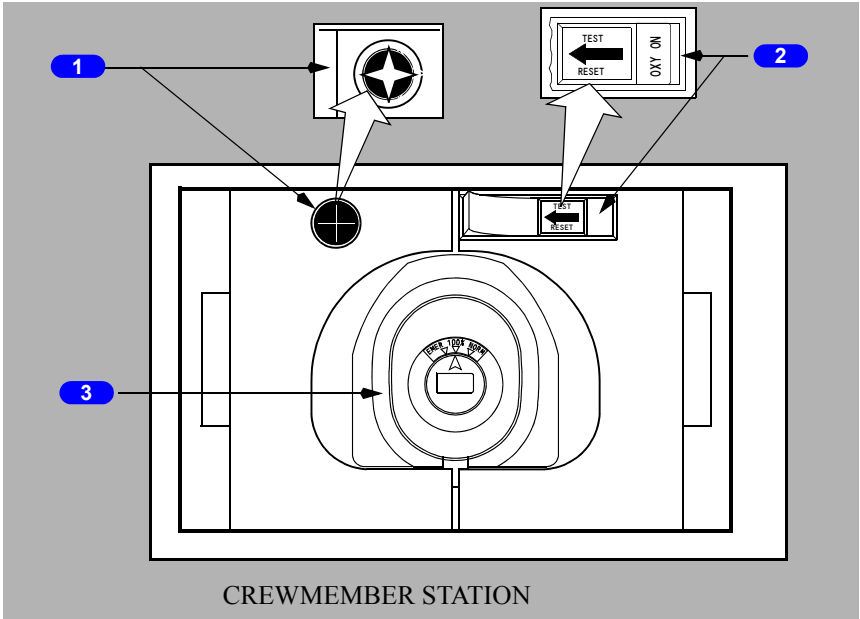
1 Passenger Oxygen (PASS OXY) Switch

Push – the passenger cabin oxygen masks drop.

2 Passenger Oxygen ON Light

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

Oxygen Mask Panel



1 Oxygen Flow Indicator

Shows a yellow cross when oxygen flowing.

2 TEST/RESET Switch

Push –

- if mask is stowed, activates oxygen flow momentarily to test regulator
- if mask is not stowed, regulator keeps box OXY ON flag visible until released.

3 Regulator and Inflation Button (Hidden)

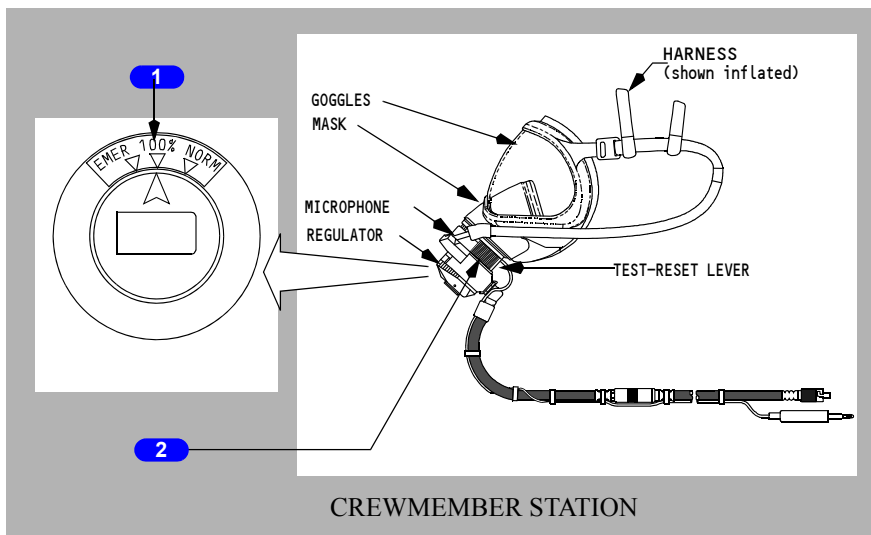
Grasp Regulator and pull up –

- allows mask removal from stowage box
- activates oxygen when stowage box doors open

Squeeze Inflation Button

- inflates harness.

Oxygen Mask and Regulator



1 Regulator Selector (rotary)

Rotate –

- EMER - supplies 100% oxygen under positive pressure at all cabin altitudes
- 100% - supplies 100% oxygen on demand
- NORM - supplies air/oxygen mixture on demand (ratio depends on cabin altitude)

2 Harness Inflation Button

Squeeze (with right stowage box door open) –

- inflates mask harness
- deflates mask harness when lever is released

Airplane General, Emergency Equipment, Doors, Windows Systems Description

Chapter 1

Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- doors and windows
- flight deck seats
- In-flight Entertainment System (IFE)

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- emergency lighting

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- anti-collision
- navigation (position)
- wing leading edge illumination
- taxi

171-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708

- logo

Landing Lights

The landing lights consist of the left, right, and nose gear landing lights. The left and right landing lights are located in the left and right wing root and are optimized for flare and ground roll. The two nose gear-located landing lights are optimized for approach.

The nose gear landing lights are inoperative when the nose landing gear is not down and locked.

Runway Turnoff Lights

Two runway turnoff lights are located in the left and right wing root.

White Anti-collision Lights

The white anti-collision lights are strobe lights located on each wing tip.

(Aircraft with Blended winglets)

White anti-collision strobe lights are located on the outboard tip of each winglet.

Red Anti-collision Lights

The red anti-collision lights are strobe lights located on the top and bottom of the fuselage.

Navigation Lights

The navigation lights are standard red (left forward wingtip), green (right forward wingtip), and white (aft tip of both wings) position lights.

(Aircraft with Blended winglets)

The navigation lights are standard red (left forward winglet), green (right forward winglet), and white (inboard trailing edge of both winglets) position lights.

Wing Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

Taxi Lights

Two taxi lights are installed on the fixed portion of the nose landing gear. The lights are inoperative when the nose landing gear is not down and locked.

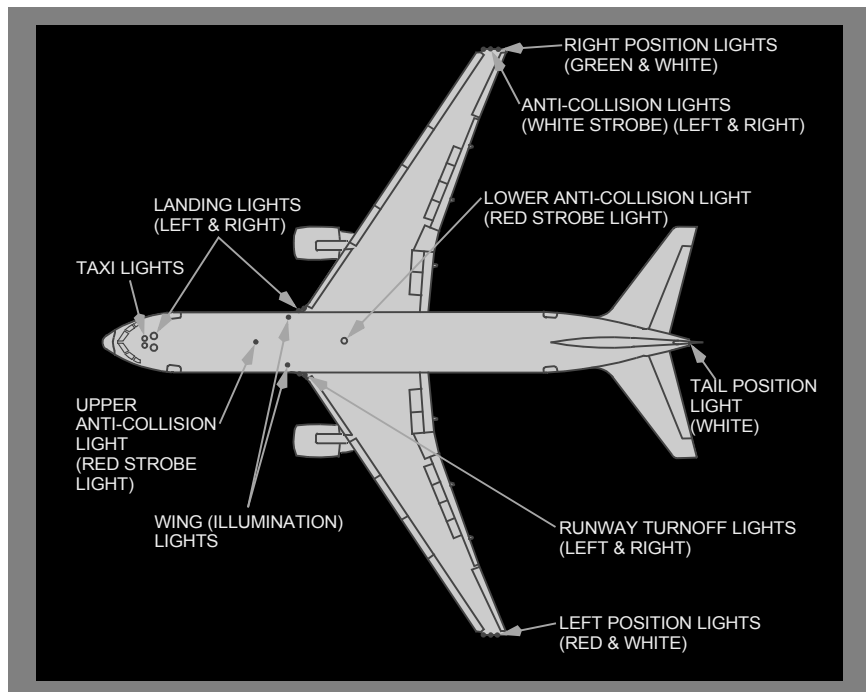
Logo Lights

171-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708

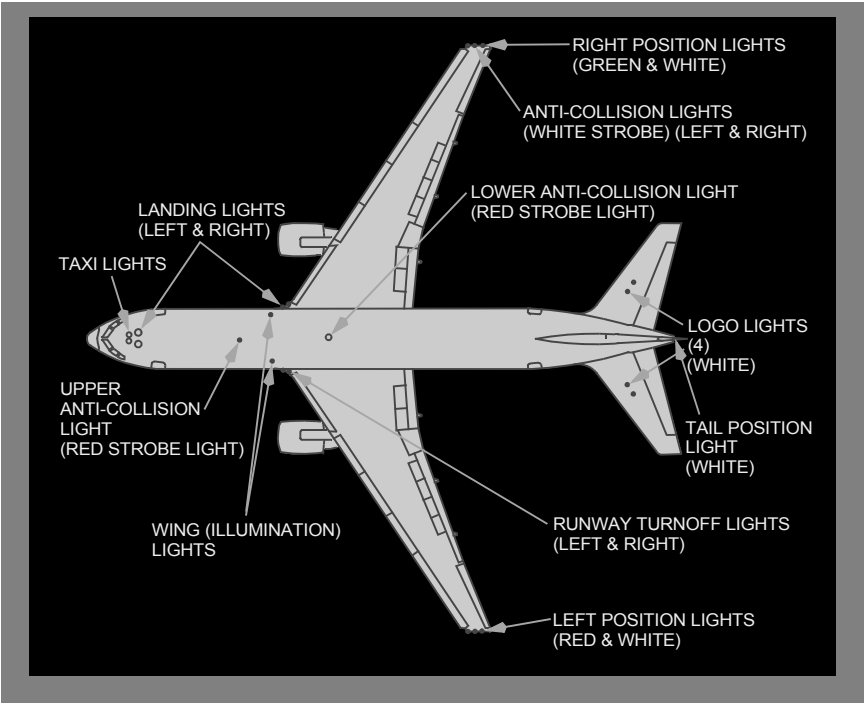
Logo lights are located on the stabilizer to illuminate the logo on the vertical tail surface.

Exterior Lighting Locations

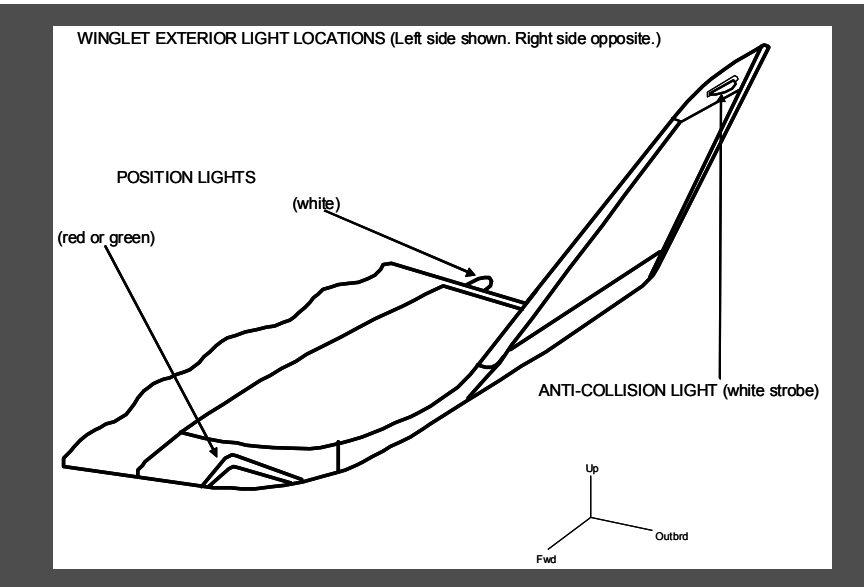
121-139, 1401-1402



171-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1613, 1701-1708



767-300 with Blended Winglets



Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting, and localized illumination. Flood lights and light plates provide panel illumination. Dome lights provide flight deck area lighting. Map lights, chart lights, and utility lights provide localized illumination.

Panel and flood lights illuminate the forward panels, glareshield, and aisle stand panels. When the light override switch is ON, the forward panel flood lights, glareshield flood lights, dome lights, aisle stand flood lights, and all illuminated annunciator lights illuminate at full brightness.

If normal electrical power is lost, the standby magnetic compass light, forward panel flood lights, and integral lights for essential instruments on the left forward, center forward, and overhead panels are automatically switched to the Standby AC bus.

Indicator Lights

Indicator Light brightness can be set to DIM or BRT with the indicator lights selector. The system automatically overrides the DIM position and illuminates the indicator lights full bright if the ambient flight deck light level increases to a preset crossover light value as detected by system sensors located on the center forward panel.

Passenger Cabin Signs

The passenger cabin signs are controlled by overhead panel selectors. The passenger signs illuminate when any of the following conditions are satisfied:

FASTEN SEAT BELTS signs (AUTO selected):

- cabin altitude above 10,000 feet
- landing gear not up and locked
- flap lever not up
- **187-199, 1200-1201, 1403-1404, 1601-1613, 1701-1708**
- passenger oxygen on

121-199, 1401-1404, 1501-1506, 1521, 1601-1606, 1701-1708

NO SMOKING signs (AUTO selected):

- cabin altitude above 10,000 feet
- landing gear not up and locked
- **121-199, 1401-1404**
- flap lever not up
- **187-199, 1403-1404, 1501-1506, 1521, 1601-1606, 1701-1708**
- passenger oxygen on

1607-1613

NO SMOKING signs (any position selected):

- illuminated continuously

121-186, 1401-1402

All passenger signs can be controlled manually by positioning the respective selector to ON or OFF. When the FASTEN SEAT BELTS and NO SMOKING selectors are in the OFF position, and the cabin altitude exceeds 10,000 feet, the FASTEN SEAT BELTS and NO SMOKING signs illuminate.

187-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1606, 1701-1708

All passenger signs can be controlled manually by positioning the respective selector to ON or OFF. When the FASTEN SEAT BELTS and NO SMOKING selectors are in the OFF position, and the cabin altitude exceeds 10,000 feet or passenger oxygen is ON, the FASTEN SEAT BELTS and NO SMOKING signs illuminate.

1607-1613

The FASTEN SEAT BELTS sign can be controlled manually by positioning the selector to ON or OFF. When the FASTEN SEAT BELTS selector is in the OFF position, and the cabin altitude exceeds 10,000 feet or passenger oxygen is on, the FASTEN SEAT BELTS signs illuminate.

121-186, 1401-1402

RETURN TO SEAT signs are illuminated with the FASTEN SEAT BELTS signs and extinguish when cabin altitude exceeds 10,000 feet.

187-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1606, 1701-1708

RETURN TO SEAT signs are illuminated with the FASTEN SEAT BELTS signs and extinguish when the passenger oxygen is on either automatically or manually.

When the passenger signs illuminate or extinguish, a low tone sounds over the PA system.

Emergency Lighting

The emergency lighting consists of:

- passenger cabin interior emergency lights
- passenger exterior emergency lights
- aft flight deck dome light (one bulb only)

These lights are powered by the emergency lighting system. These lights provide illumination for evacuating the airplane. The system is controlled by the emergency lights switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also be controlled by the emergency lights switch on the flight attendant switch panel.

When the emergency lights switch on the flight deck is armed, and the slide arming lever is in the SLIDE ARMED position, moving the door handle to the open position will cause the exterior emergency lights on that side of the airplane to illuminate.

In addition, when the emergency lights switch on the flight deck is armed, moving an overwing emergency exit door handle to the open position will cause the exterior emergency lights on that side of the airplane to illuminate.

The emergency lighting system is powered by remote batteries. Battery charge is maintained by the airplane electrical system. A fully charged battery provides at least 15 minutes of operation.

The UNARMED light illuminates and the EICAS advisory message EMER LIGHTS displays if the emergency lights switch is not in the ARMED position.

Interior Emergency Lighting

Interior emergency lighting consists of door, aisle, escape path, exit lights, and luminescent exit signs.

Escape path lighting consists of floor mounted locator lights spaced at intervals in the aisle and exit indicators by each door.

1607-1613

Escape path lighting consists of lights installed in the arm rest of the center passenger seats, and on the galleys, lavatories, closets and partitions spaced at intervals in the aisles and cross-aisles.

When illuminated, escape path lighting provides visual guidance for emergency evacuation if all sources of lighting more than four feet above the aisle floor are obscured by smoke.

Battery powered exit lights are located at each cabin exit.

Exterior Emergency Lighting

Exterior emergency lights are located at each entry door and overwing emergency exit door. Lights are also installed in each slide to illuminate the ground at the end of the slide.

Oxygen Systems

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders are located throughout the airplane for emergency use.

Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning masks and regulators located at each crew station. Oxygen pressure is displayed on the lower EICAS status display.

Flight crew and observer masks and regulators are installed in oxygen mask stowage boxes near each seat.

Grasp the regulator with the hand nearest the stowage box. Pull upward to expose the entire regulator and inflation lever. Removing the mask from its stowage box (which also opens the stowage box right door):

- initiates oxygen flow to the mask regulator
- momentarily displays the yellow oxygen flow indicator

Squeezing the mask harness inflation lever on the left side of the regulator inflates the mask harness. Releasing the mask harness inflation lever deflates the harness. The mask harness inflation lever is only active when the right door of the stowage box is open, or the door is closed and the OXY ON flag is in view.

Closing the right oxygen panel door and pushing and releasing the test/reset switch shuts off oxygen to the mask. The oxygen flow can be restored by opening the right oxygen panel door.

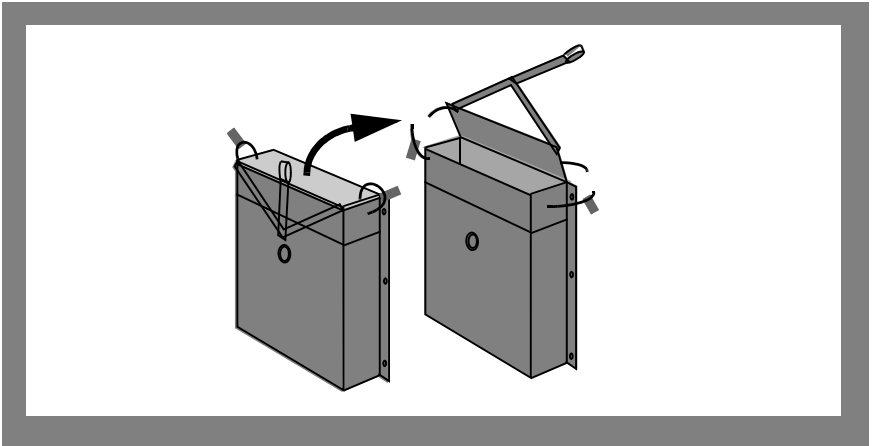
Passenger Oxygen System

The passenger oxygen system is supplied by individual oxygen generators. The oxygen system provides oxygen to the passenger, attendant stations, and lavatory service units. The passenger oxygen masks and oxygen generators are located above the passenger seats in passenger service units (PSUs). Oxygen flows from a PSU generator when any mask hanging from that PSU is pulled. The masks automatically drop from the PSUs if cabin altitude exceeds 14,000 feet. The passenger masks can be manually deployed from the flight deck by pushing the passenger oxygen switch. The passenger oxygen ON light illuminates and EICAS advisory message PASS OXYGEN ON displays when the system is activated.

Portable Protective Breathing Equipment

Protective Breathing Equipment (PBE/Smoke Hood) devices for crew use (for combating fires and/or entering areas of smoke or fume accumulation) may be stowed throughout the airplane; however, they are normally found in the forward and aft sections of the passenger cabin. The device is placed over the head and, when activated, provides approximately 15 to over 20 minutes of oxygen depending upon the device used. Manufacturer's operating instructions are placarded on the container.

The PBE is designed to protect crewmembers from the effects of smoke, heat, carbon dioxide or other harmful gases while combating fires onboard the airplane. The preflight consists of inspecting the red seals and checking that the PBE is intact. If a seal is broken, refer to the MDM for dispatch procedures.



To Operate the PBE

- Remove the pouch from the compartment.
- Open the pouch by pulling the loose ends apart.
- Remove and unfold the hood.
- Position the hood so the clear side is facing downward, with the neck opening positioned towards you.
- Activate the oxygen flow by pulling apart the two oxygen cylinders sharply. One cylinder discharges rapidly to purge the hood of any contaminated air. In order to receive the full benefit of purging, you must get the hood on quickly (within 15 seconds). The second oxygen cylinder releases slowly, lasting 7-8 minutes. After both cylinders have fully discharged, the hood provides an additional 7-8 minutes of breathable air.
- Insert hands, palms together, into the neck opening and spread hands to enlarge opening.
- Slip hood over your head.

- Verify oxygen flow by illumination of the flashing green light.

Special Considerations

Once the hood is activated and donned, be aware of the following:

- A good neck seal is important; push long hair into the hood.
- You may experience light headedness; this is due to the relatively high oxygen content in the hood.
- A flashing red light will turn on after 15 minutes, indicating the oxygen supply is depleted. Leave the area, if possible, and remove the hood.
- You may feel warm inside the hood from the combined warmth of your body temperature, your exhaled breath and chemical process within the hood.
- Normal interphone and face-to-face communication procedures are recommended. Use the hand held mic with both flight deck speaker volumes high.
- Your ears may pop as the hood is pressurized.

Portable Oxygen Bottles

Portable oxygen bottles are stowed in various locations in the passenger cabin. The bottles are fitted with disposable masks and are used for first aid purposes or as walk-around units.

Doors and Windows

121-139, 171-199, 1200-1201, 1401-1404, 1601-1613, 1701-1708

The airplane has four passenger entry doors, four overwing emergency exit doors, one flight deck door (the flight deck/passenger cabin entry), and three cargo doors. It also has electrical equipment and forward equipment bay access doors.

1501-1506, 1521

The airplane has six passenger entry doors, two overwing emergency exit doors, one flight deck door (the flight deck/passenger cabin entry), and three cargo doors. It also has electrical equipment and forward equipment bay access doors.

The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

An EICAS message is displayed when a passenger entry door, overwing emergency exit door, cargo door or access door is not closed and latched, and locked.

Flight Deck Door

The flight deck door meets requirements for resistance to ballistic penetration and intruder entrance. The door opens into the passenger cabin. There is a step between the flight deck and the cabin. When closed, the door locks when electrical power is available and unlocks when electrical power is removed. A viewing lens in the door allows observation of the passenger cabin. The door can be manually opened from the flight deck by turning the door handle.

The flight deck access system consists of an emergency access panel, chime module, three position lock control selector, two indicator lights, and a power cutoff switch. The emergency access panel includes a six button keypad for entering the numeric access code along with red, amber, and green lights. The red light illuminates to indicate entry is denied or the incorrect code is entered. When the correct emergency access code is entered, the amber light illuminates. The green light illuminates to indicate the door is unlocked.

Two indicator lights and a three position lock control selector are located on the overhead panel. Illumination of the amber LOCK FAIL light indicates the door lock has failed.

The emergency access code is used to gain access to the flight deck in case of pilot incapacitation. A flight deck chime and illumination of the amber AUTO UNLK light indicates the correct emergency access code has been entered and the door is programmed to unlock after a time delay. Selecting the DENY position on the door lock control selector denies entry and prevents further keypad entry for several minutes. To allow entry, the selector is turned to the UNLKD position which unlocks the door while held in that position. If the emergency access code is entered and the pilot takes no action, the door unlocks after expiration of the time delay. Before the door unlocks, the chime sounds continuously and the AUTO UNLK light flashes.

By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

The door incorporates two pressure sensors that unlock the decompression panels in the event of flight deck depressurization. These panels open to equalize pressure in the event of cabin depressurization at a pre-determined value. The decompression panels have manual release pins. Pulling the pins frees the panels allowing egress in the event the door is jammed.

Mechanical Latch Pin

A mechanical latch pin is stored in a hole on the door catch sidepost on the flight deck side of the door. The pin is attached to the side post with a lanyard.

The pin is designed to accomplish the following:

- On the ground:
 - prevents inadvertent locking of flight deck door once the door has been opened.
- Inflight (if electrical locking system inoperative):
 - prevents flight deck door being opened from the cabin side

Note: A placard is located below the pin stowage hole. This placard refers to normal operations in which the electrical access is operating normally. Any time the electrical access system is not working, the pin must be used to secure the door in flight.

To lock the door, ensure the door is in the fully closed position. Remove the latch pin from its stowage hole and insert it into the hole on the flight deck side of the door latch mechanism.

The mechanical latch pin will reach to the back surface of the rotatable catch and interfere with the movement (rotation) of the catch so it will be kept locked manually. The pin is designed to allow the door to be opened from inside the flight deck even though the door cannot be opened from outside the flight deck.

Flight Deck Security Light

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

A security light has been installed outside the flight deck door on some aircraft. The purpose of the light is to illuminate the area for identifying person(s) requesting entry. The light switch located on the left door jamb inside the flight deck can be selected to illuminate the entry light.

Flight Deck Number Two Windows

The flight deck number two windows can be opened on the ground or in flight. The flight deck number two windows can be used for emergency evacuation. Pressing the Window Lock Release Button frees the Window Lock Lever. The window lock lever locks or unlocks the window. Rotating the window crank opens and closes the window.

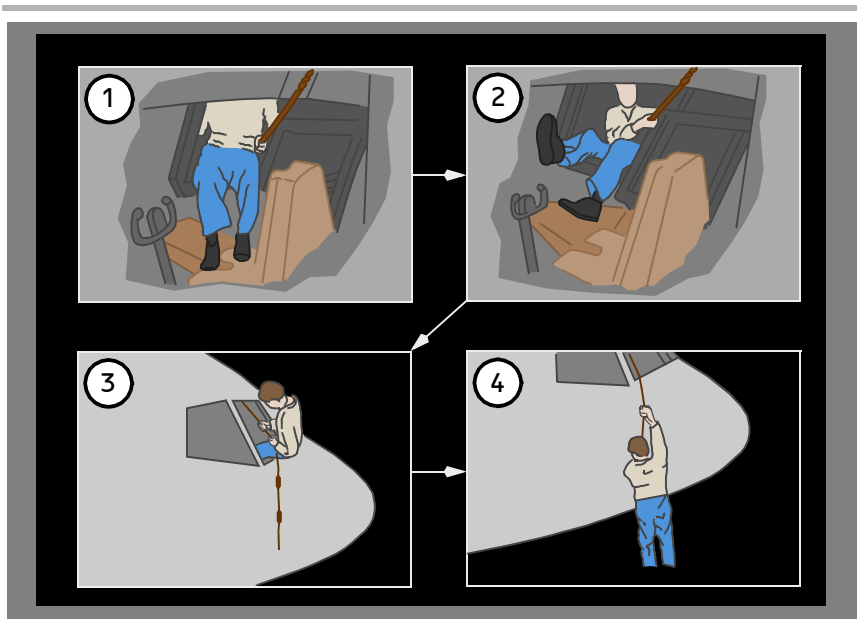
A WINDOW NOT CLOSED placard is visible when the window is open.

The windows can be opened or closed in flight with minor flight deck consequences if the airplane is unpressurized. Because the force required to move the crank increases with airspeed, it is recommended not to exceed VREF 30 + 80 with a window open. It may not be possible to open or close the window at speeds above 250 knots. With the window open, voice, interphone, and radio audio cannot be heard due to high noise levels. Prior communications arrangements with the controlling agency should be established before opening the window. The design provides an area of relatively calm air over the open window. Forward visibility can be maintained by looking out of the open window.

Flight Deck Window Emergency Egress

If the flight deck number two windows must be used for emergency evacuation, exit in accordance with the following illustration.

CAUTION: Ensure the rope is securely fastened to the airplane.



Passenger Entry Doors

The passenger entry doors are used to enter and exit the airplane, and also serve as emergency exits. The passenger entry doors are paired along the airplane fuselage. The doors can be opened or closed manually from inside or outside of the airplane.

Door 1L (1L or 2L for 1501-1506, 1521) may be opened or closed electrically through the electrical control panel located adjacent to the door.

The entry doors are plug-type doors. During opening, the door first moves inward, then upward into the ceiling. The weight of the door is counterbalanced so that very little effort is required for operation. The door is held open by a latch in the upper part of the door frame. In order to close the door it must initially be raised slightly, push and hold the uplatch release button, lower the door approximately 2 inches (5 centimeters). Release button and continue to lower the door.

WARNING: Stand clear of the door handle, the handle may move as the door is lowered.

A window in each door allows observation outside of the airplane.

The ENTRY DOORS light illuminates and the EICAS advisory message L AFT, L FWD, R AFT, (and/or L CTR, R CTR for 1501-1506, 1521) or R FWD ENT DOOR displays when a passenger entry door is not closed and latched and locked. If two doors on the same side of the airplane are not closed and latched and locked, the EICAS advisory message L or R ENTRY DOORS displays.

Passenger Entry Door and Slide Operation

Emergency evacuation slide and door opening systems are provided for each passenger entry door. A cover in the lower face of the door contains the slide.

For normal operations, the slide must be disarmed before opening the door. Moving the arming lever to the SLIDE DISARMED position causes the door girt bar to detach from the floor, the girt bar visual indication window to completely blank, and the yellow armed indicator to be removed from view. Pulling the Door Handle up will unlock and unseat the door.

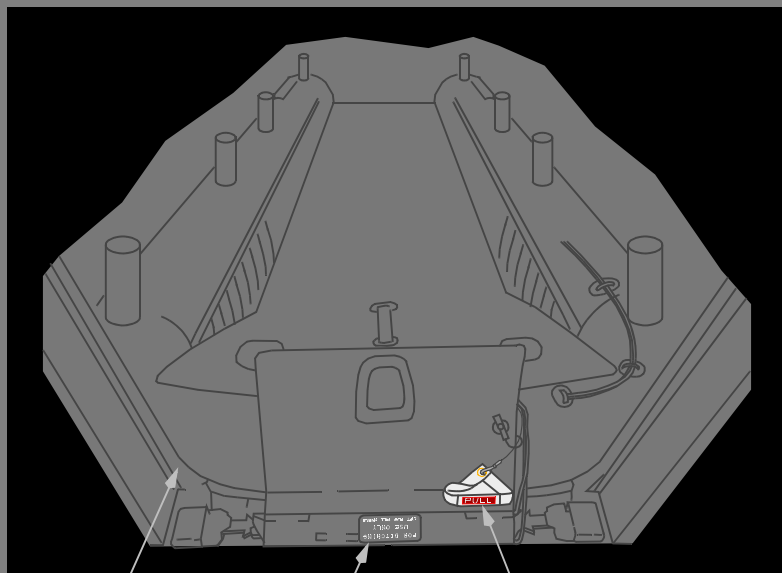
The emergency door opening system is armed by first pressing the arming lever release and then positioning the arming lever to the SLIDE ARMED position. This engages the door girt bar, the girt bar visual indication window will be completely yellow, armed indicator will be in view and armed light illuminates. Once armed, rotating the door handle up to the OPEN position unlocks the door, the slide armed light will flash, and causes the slide to deploy. The door will retract to the full open position, and the slide will inflate automatically.

A manual inflation handle can be pulled if the slide has not automatically inflated.

The emergency door opening system and the slide are automatically disarmed when the door is opened from the outside. If the arming lever is in the ARMED position and the door is opened using the exterior door handle, the arming lever automatically moves to DISARMED and the door opens without slide deployment.

The passenger door evacuation slides are also configured as rafts.

Escape Slide/Raft Deployed



DOOR FRAME

DITCHING INSTRUCTIONS
FOR DITCHING USE ONLY.

MANUAL INFLATION HANDLE
USED TO MANUALLY INFLATE
THE SLIDE IF THE SLIDE
DOES NOT INFLATE AUTOMATICALLY.

TYPICAL INTERIOR VIEW

Overwing Emergency Exit Doors

Overwing emergency exit doors are located over the wing on each side of the airplane. The overwing emergency exit doors are only used as emergency exits. An overwing evacuation ramp and slide assembly is contained within each wing body fairing. A window in the door allows observation outside of the airplane.

The overwing emergency exit door is a plug-type hatch. The emergency PULL handle opens the door. The door can then be removed from the opening. Opening the overwing emergency exit door automatically deploys and inflates the ramp and slide. Simultaneously, on that side of the airplane, the inboard spoiler is retracted and the exterior emergency lights illuminate.

A manual inflation handle can be pulled if the ramp and slide has not automatically inflated.

The overwing emergency exit door ramp and slide is automatically disarmed when the door is opened from the outside.

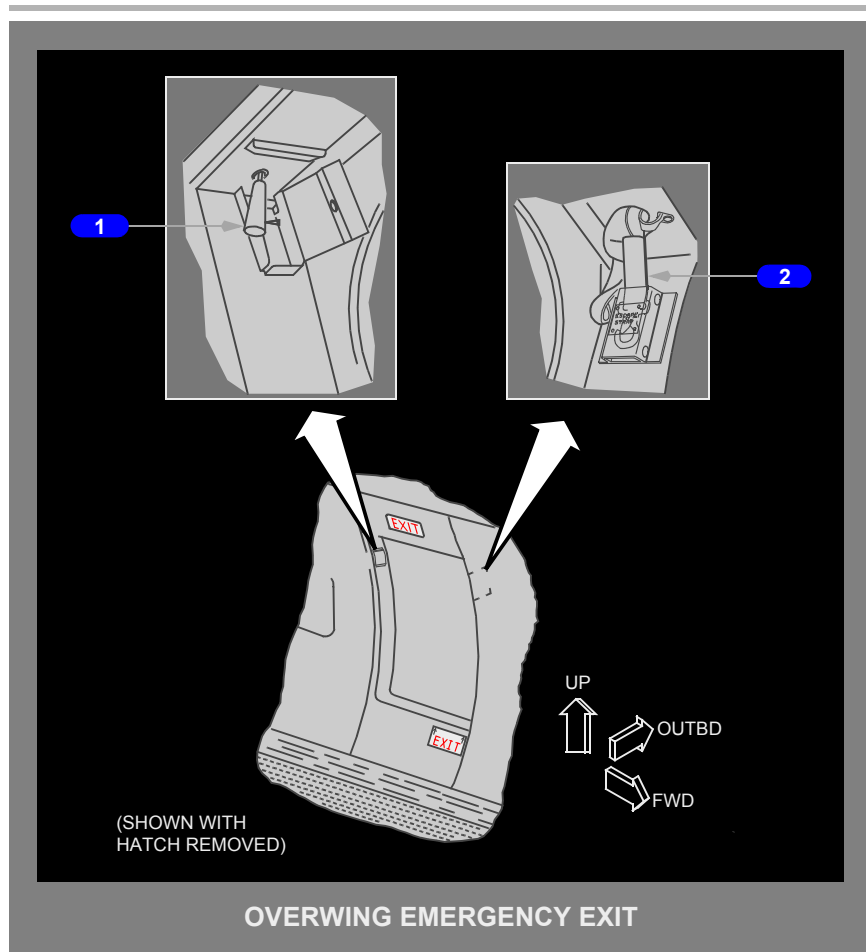
121-139, 171-199, 1200-1201, 1401-1404, 1601-1708

The EMER DOORS light illuminates and the EICAS advisory message L AFT, L FWD, R AFT or R FWD EMER DOOR displays when an overwing emergency exit door is not closed and latched and locked. The EMER DOORS light also illuminates and the EICAS advisory message L or R WING SLIDE displays if the door to the ramp slide stowage compartment is not closed and latched and locked. The EICAS advisory message EMER DOORS displays if two or more, overwing emergency exit doors or wing slide doors are not closed and latched and locked.

1501-1506, 1521

The EMER DOORS light illuminates and the EICAS advisory message L EMER or R EMER DOOR displays when an overwing emergency exit door is not closed and latched and locked. The EMER DOORS light also illuminates and the EICAS advisory message L or R WING SLIDE displays if the door to the ramp slide stowage compartment is not closed and latched and locked. The EICAS advisory message EMER DOORS displays if two or more, overwing emergency exit doors or wing slide doors are not closed and latched and locked.

The overwing emergency exit door ramps and slides are not configured as raft and they may not be used as auxiliary flotation devices.



1 Manual Deployment Handle

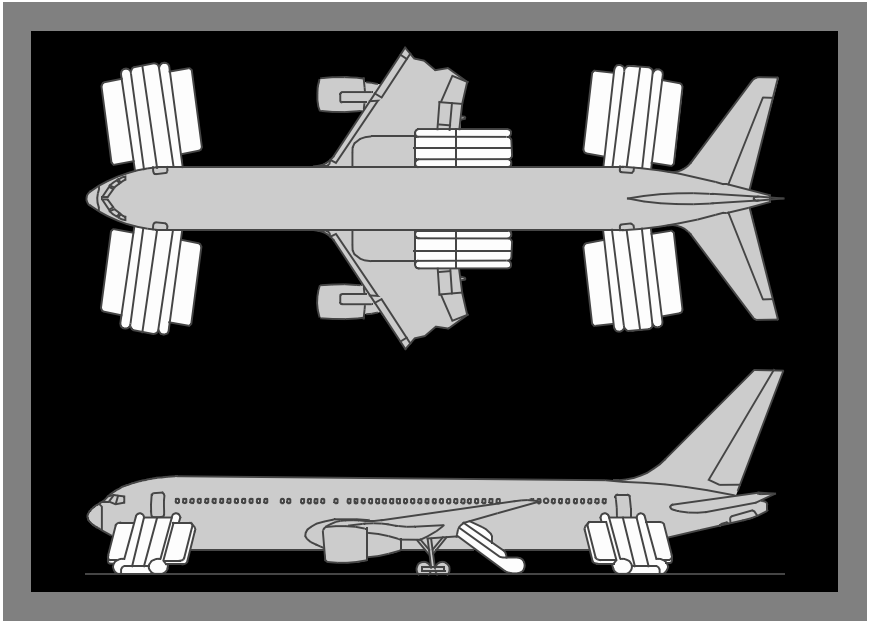
Pull – Deploys ramp slide in the event normal system fails.

- one per exit

2 Escape Strap

Remove Cover – Pull out and attach hook to wing fitting.

Evacuation Slides



Cargo Doors

There are three cargo doors: one AFT, one BULK, and one FWD. The AFT, and FWD doors are located on the right side of the airplane and open upward and outward. The BULK cargo door is on the left side of the airplane.

Both forward and aft cargo doors are normally operated electrically from an exterior or interior fuselage-mounted control panel located with each door. Forward cargo door locking is accomplished manually. If necessary, the forward and aft cargo doors may be operated manually.

CAUTION: Do not operate the cargo doors with winds at the door of more than 40 knots. Do not keep the door open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.

121-139, 1401-1404

The CARGO DOORS light illuminates and the EICAS advisory message AFT, BULK, or FWD CARGO DOOR displays when any cargo door is not closed and latched and locked. The EICAS advisory message CARGO DOORS displays if two or more cargo doors are not closed and latched and locked.

171-199, 1201, 1501-1506, 1521, 1601-1613, 1701-1708

The CARGO DOORS light illuminates. The EICAS caution message FWD CARGO DOOR displays when the forward cargo door is not closed and latched and locked. The EICAS advisory message AFT or BULK CARGO DOOR displays when either cargo door is not closed and latched and locked. The EICAS advisory message CARGO DOORS displays if two or more of these cargo doors are not closed and latched and locked.

Flight Deck Seats

The pilot seats:

- recline
- adjust vertically
- adjust forward and aft
- adjust for thigh support
- adjust for the lumbar region of the back

The seats also have:

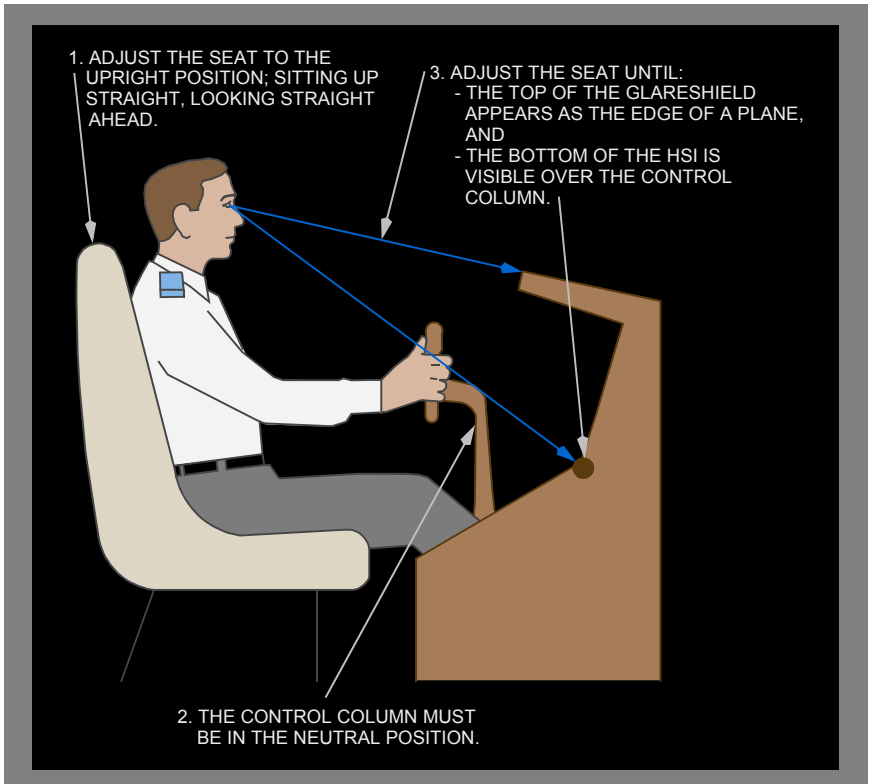
- adjustable armrests
- crotch straps
- inertial–reel shoulder harnesses with manual locks
- lap belts
- adjustable headrests

The seats move outboard during the last four inches of travel. Manual controls provide forward, aft, and vertical adjustment.

Lumbar and thigh pad support can be adjusted using the adjustment hand wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access.

Adjust the seat to obtain the optimum eye position as shown on the following illustration.

Pilot Seat Adjustment



In-Flight Entertainment (IFE) System (as installed) Equipment

The IFE system consists of the following equipment:

- Crew Panel
- LCD monitor in each seat back
- Wall-mounted LCD monitors at bulkhead seats
- Fuselage mounted antenna
- Antenna Control Unit (ACU)
- Multi-region receivers

System Description

System Power and Controls

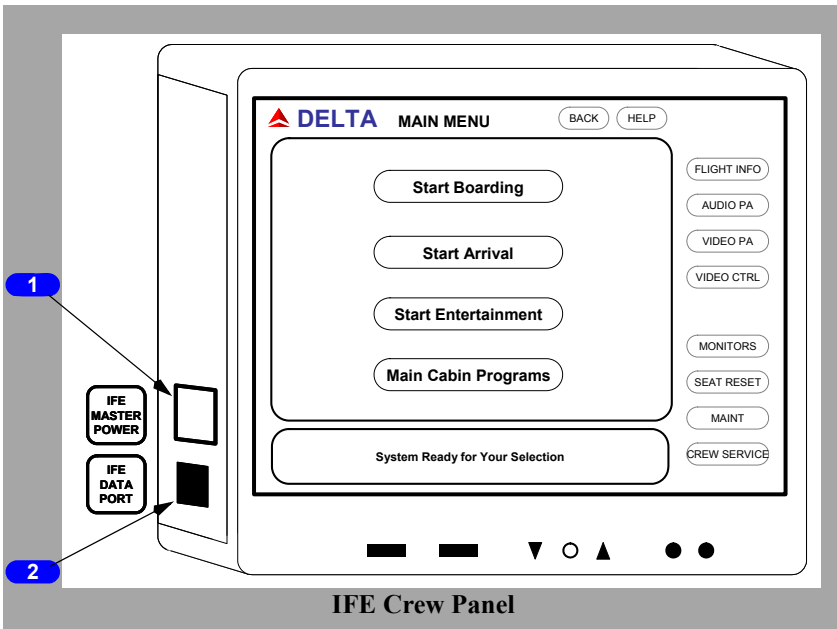
The IFE system is powered from the right utility bus.

Note: The IFE electrical supply will be automatically interrupted in the event of cabin depressurization that results in deployment of the passenger oxygen system.

The following circuit breakers are located on the P11-3 panel on the flight deck:

Function	Identification	Location
ACU and Antenna	ACU	S-1
Cell Modem	Cell Modem	S-2
In-Flight Entertainment System	IFE Cont	S-3

An IFE MASTER POWER switch is located on the side of the IFE Crew Panel at the 1L door area.



1 IFE Master Power switch

2 IFE Data Port

Customer Interface

Flight Attendants will ensure Satellite TV is turned on for all US segments. On segments to destinations outside the 48 contiguous states, the satellite TV signal will be lost 150 miles beyond the US border/coastline. Customers will receive a message on their screens indicating the signal is unavailable. Flight Attendants will make a PA informing customers of other IFE options and then turn off the Satellite TV on the IFE Crew Panel.

Onboard Broadband Wi-Fi Internet

General

The system is powered by the right utility bus. A master power switch, labeled INTERNET, will be located on the flight attendant control panel at the 1L jumpseat. Flight attendants will ensure that this switch is in the ON position.

System operation is automatic as the aircraft ascends and descends through 10,000 feet, and does not require any flight crew action. If required, the system can be switched OFF at any time by using the INTERNET switch on the flight attendant control panel.

A cabin handset can be used to make phone calls to OCC ATL Radio. The handset is installed on the cabin divider partition above the 1L flight attendant jumpseat. This phone will be available for use inside the continental United States above 10,000 feet.

Emergency Procedures

If smoke/fumes/fire are thought to be caused by the Onboard Broadband Wi-Fi Internet System, refer to SMOKE OR FUMES OR FIRE checklist in the QRH.

Note: The Wi-Fi system power is removed when the Right UTILITY BUS SWITCH is OFF.

System Deactivation

If the flight crew determines a need to deactivate the Wi-Fi System, they should:

- Instruct the cabin crew to turn the system off using the INTERNET switch located on the flight attendant control panel at the 1L jumpseat, or
- Pull the INTERNET circuit breaker, located on P11-6, row T.

Seat Belt Airbag System

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

Flatbed seats are equipped with a specially designed airbag seat belt that have their own extensions. The system is specifically designed to improve occupant protection from serious head injury, e.g during a survivable crash

The airbag system is designed with built-in safety features to prevent inadvertent deployment that could result in injury to occupants, crew, or maintenance staff.

The airbag system will recognize and deploy the inflator at a predetermined threshold (G force). The deployment threshold does not allow inadvertent deployment during normal operations such as: hard landing, luggage or food cart strikes on the seat, or random vibration.

Seat Belt Extension Use with the Seat Belt Airbag System

If a seat belt extension is needed, it must be the one specifically designed for the seat belt airbag system. (A regular seat belt extension will not latch into the airbag seat belt.) The approved seat belt extension utilizes a different part number from a non-airbag seat belt extension. Using a seat belt extension deactivates the seat belt airbag system, allowing the restraint to be used with child seats.

Seat Belt Airbag System Operating Procedures

- The airbag system is designed to work with passengers in the brace position. No special safety instructions are necessary.
- If a seat is unoccupied, the seat belt halves should not be buckled together.
- If the system is inoperable, the seat shall be placarded as inoperative.

Intentionally
Blank

Airplane General, Emergency Equipment, Doors, Windows

Emergency Equipment

Chapter 1

Section 45

Introduction

This chapter describes miscellaneous airplane systems, including:

- emergency equipment
- emergency equipment locations

Emergency Equipment

Emergency equipment described in this section includes:

- fire extinguishers
- miscellaneous emergency equipment

Fire Extinguishers

Fire extinguishers are located throughout the aircraft. See emergency equipment diagram for location.

The type of fire extinguishers are as follows:

- Halon (H)
- Water (H₂O)

WARNING: If a fire extinguisher is to be discharged in the flight deck area, all flight crew members must wear oxygen masks and use 100% oxygen with emergency selected.

CAUTION: For electrical fires, remove the power source as soon as possible. Avoid discharging directly on persons due to possibility of suffocating effects. Do not discharge too close to fire as the discharge stream may scatter the fire. As with any fire, keep away from the fuel source. Avoid breathing vapors, fumes, and heated smoke as much as possible.

Halon Fire Extinguishers

Halon fire extinguishers contain a liquefied gas agent under pressure. The extinguisher pressure indicator shows three pressure ranges:

- acceptable
- recharge
- overcharged

A safety pin with a pull ring prevents accidental trigger movement. When released, the liquefied gas agent vaporizes and extinguishes the fire. The extinguisher is effective on all types of fires, but is used primarily on electrical, fuel, and grease fires.

To use the Halon fire extinguisher, hold the extinguisher upright, and remove the ringed safety pin. From a distance of 8 to 10 feet, aim the extinguisher nozzle at the base of the flames and press the top lever.

Water Fire Extinguishers

Water fire extinguishers contain a solution of water mixed with anti-freeze. The container is pressurized by a CO2 cartridge. The extinguisher should be used on fabric, paper or wood fires only.

CAUTION: Do not use on electrical or grease type fires.

To use the Water fire extinguisher, hold the extinguisher upright and rotate the handle fully clockwise. Aim the extinguisher at the base of the flame and pull the trigger.

Miscellaneous Emergency Equipment

Additional equipment is stowed at strategic locations throughout the airplane. This may include a crash axe, megaphones, flashlights and first aid kits. Life vests are stowed at each crew member station and at each passenger seat.

Emergency Locator Transmitters (ELTs)

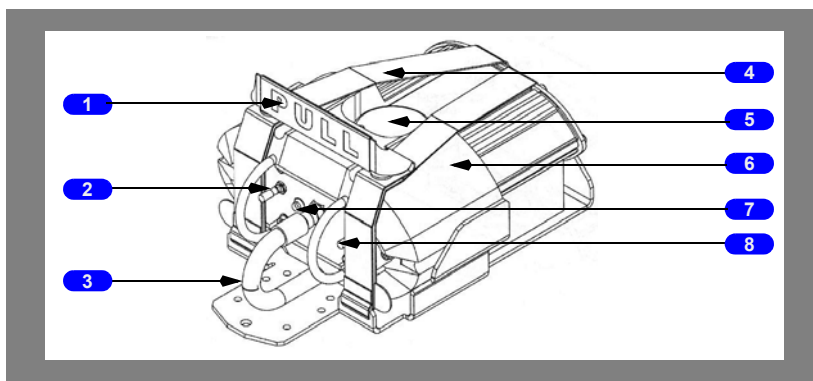
ELTs are installed in slide/raft bustles. The ELTs automatically transmit when submerged in water.

Portable ELTs are installed in the passenger cabin, as shown in the Emergency Equipment Locations diagram.

A Portable ELT is installed on the flight deck, as shown in the Emergency Equipment Locations diagram.

All ELTs transmit distress signals on 121.5 MHz and 406 MHz.

Portable ELT System Description



- 1** Harness Release
- 2** ELT Mode Switch (ARMED/OFF/ON)
- 3** Whip Antenna
- 4** Velcro Harness
- 5** Water Sensor/Identification Assembly
- 6** Float
- 7** Transmit LED
- 8** TEST Push Button

ELT Operation

CAUTION: Use caution when removing ELT from support bracket. Whip antenna release can cause injury.

1. To remove the ELT from the bracket, pull the fabric harness release to unsnap the straps and lift it out by pulling on one of the metal loop shaped handles while holding on to the antenna with the other hand.
2. If the toggle switch is in the ARMED position and the ELT is submerged in water, the water sensor will activate transmission. The ELT can be activated at any time by manually positioning the toggle switch to the ON position.
3. When in use, check regularly that the antenna is vertical. For maximum transmission power, the antenna must be in an unobstructed area far from any metallic objects.

Note: Due to its portability, the ELT can be taken with the crew after a ditching or land evacuation.

Escape Ropes

Escape ropes are attached to the airplane structure above both number two flight deck windows. The ropes are stowed in compartments above the pilot seats. Prior to dropping the rope out of the window, ensure the rope is attached by pulling down.

Life Vests

- **Dual-Cell Life Vests (as installed)**
 - The dual-cell life vests provided for crew (orange) and passengers (yellow) are equipped with two red “T-handles” which, when pulled, activate a CO2 cartridge in each chamber to inflate the vest. Two oral tubes provide a means for backup inflation. The emergency locator light on the vest activates automatically in the water.
- **Single-Cell Life Vests (as installed)**
 - The single-cell life vests provided for crew (orange) and adults (yellow) are equipped with one red “T-handle” which, when pulled, activates a CO2 cartridge to inflate the vest. One oral tube provides a means for backup inflation. The emergency locator light on the vest activates automatically in the water.
- **Infant Life Vests (as installed)**
 - Infant life vests (yellow) are dual-cell type for use by passengers under 35 pounds. The life vests are equipped with two red “T-handles” which, when pulled, activate a CO2 cartridge in each chamber to inflate the vest. Two oral tubes provide a means of backup inflation. The emergency locator light on the vest activates automatically in the water.

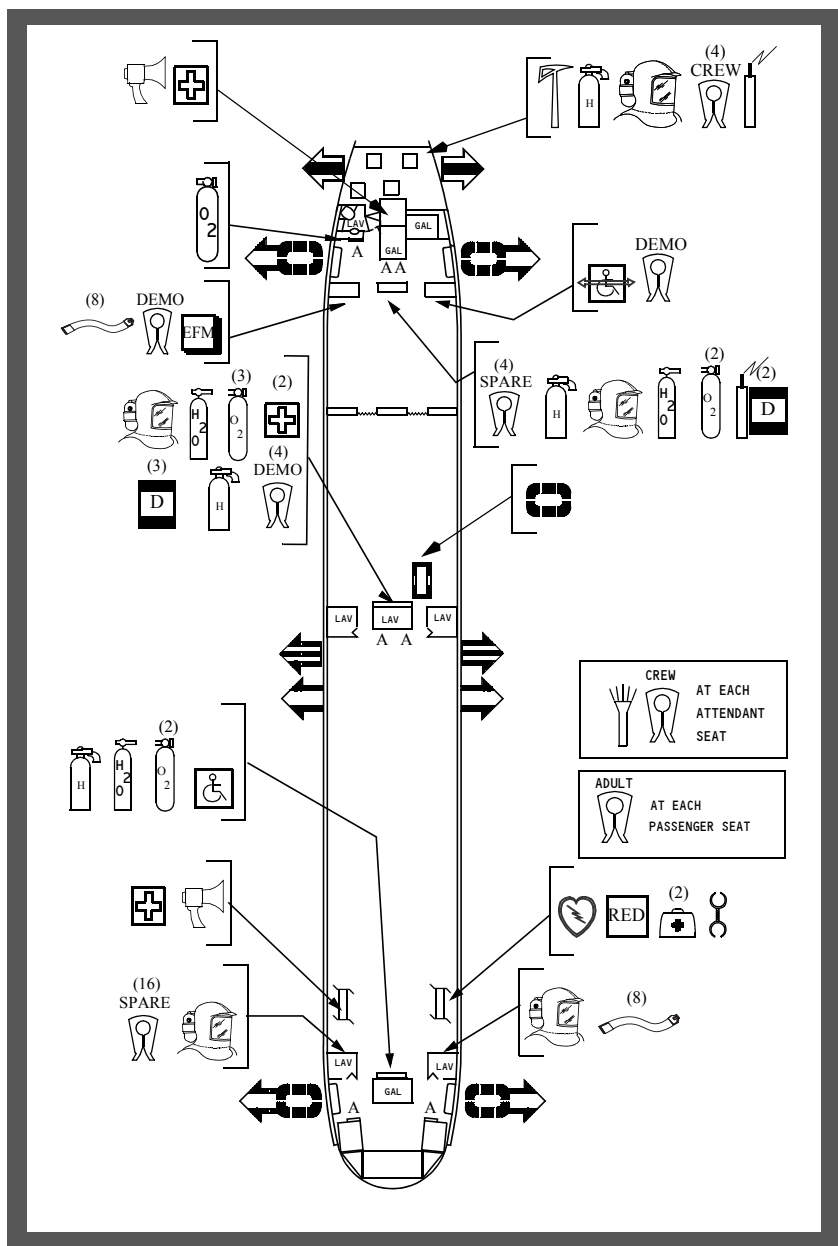
Note: Infant life vests are only installed on aircraft equipped with single-cell adult vests.

Emergency Equipment Symbols

Emergency equipment locations depicted in the following graphics are approximate. For actual locations and quantities, refer to placards located throughout the cabin.

			
PORTABLE OXYGEN BOTTLE	WATER EXTINGUISHER	HALON EXTINGUISHER	PORTABLE BREATHING EQUIPMENT
			
EXIT PATH WITHOUT ESCAPE STRAP	EXIT PATH WITH ESCAPE STRAP	EXIT PATH WITH ESCAPE SLIDE	EXIT PATH WITH ESCAPE SLIDE AND ROPE
			
ESCAPE PATH WITH SLIDE/RAFT	LIFE RAFT	LIFE VEST	EMERGENCY LOCATOR TRANSMITTER
			
MEDICAL ACCESSORY POUCH	AED	ENHANCED EMERGENCY MEDICAL KIT	FIRST AID KIT
			
CRASH AXE	FLASHLIGHT	WHEELCHAIR	WHEELCHAIR RESTRAINING STRAP
			
SECURITY KIT	SLIDE/RAFT SURVIVAL KIT	MEGAPHONE	EQUIPMENT & FURNISHINGS MANUAL
			
BASSINET	CABIN MEDICAL COMMUNICATION HEADSET	DEMO EQUIPMENT	SEATBELT EXTENSION
A = ATTENDANT SEAT G = GALLEY L = LAVATORY C = CLOSET  = CEILING STORAGE  = OVERHEAD STORAGE			

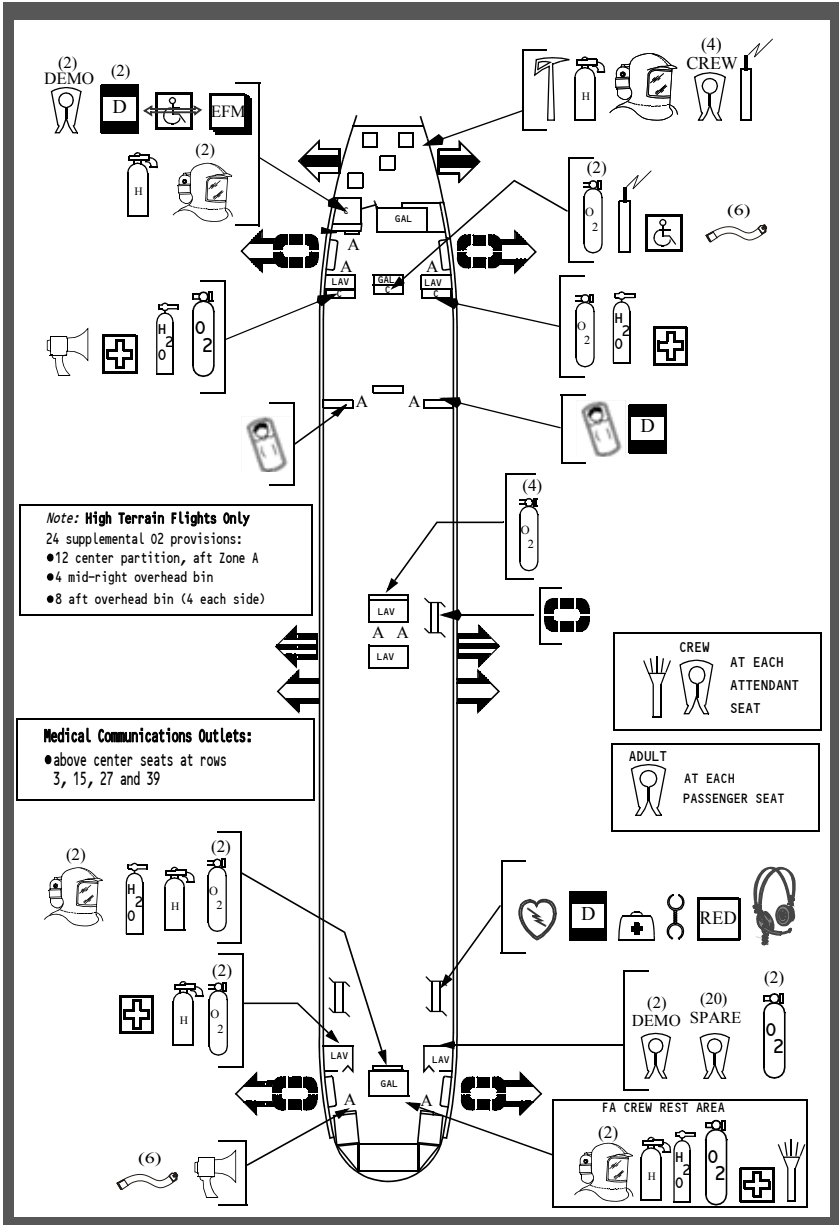
121-139



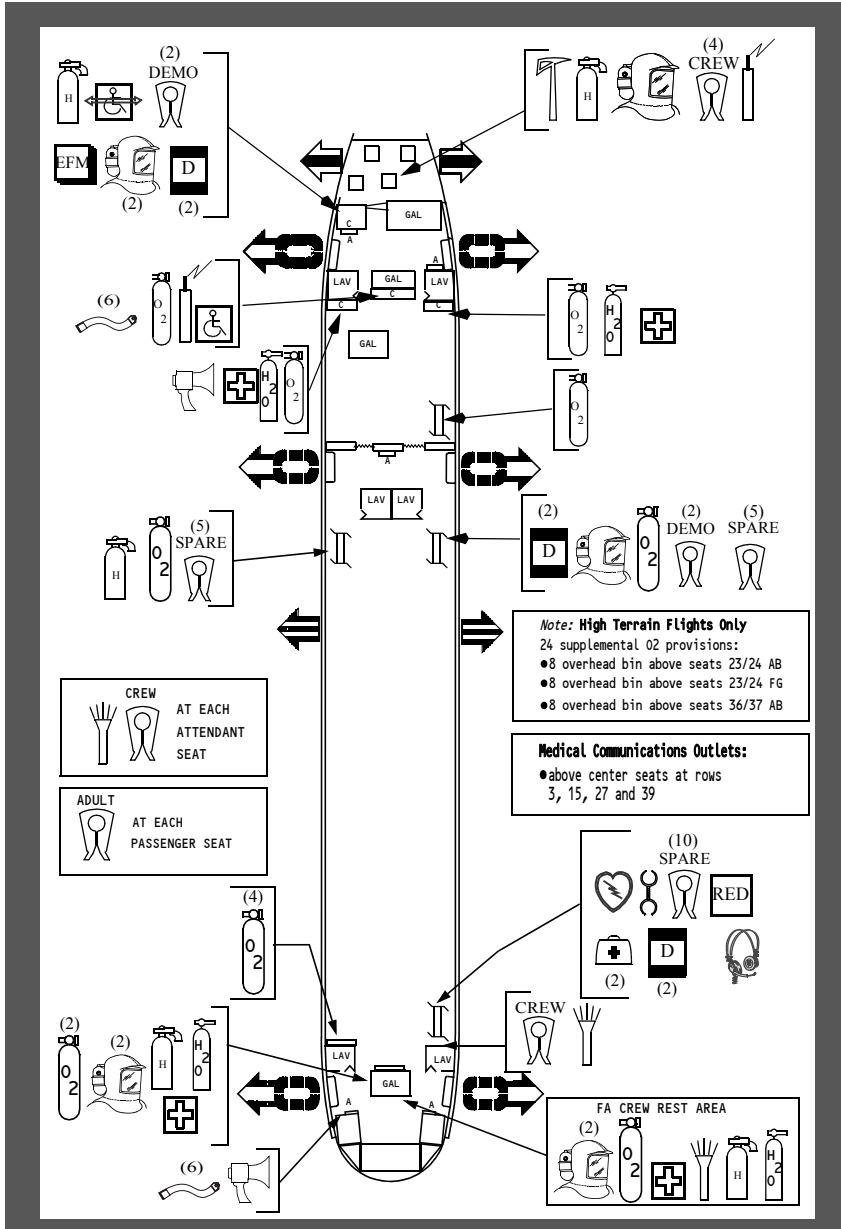
The diagram illustrates the distribution of emergency and medical supplies within an aircraft cabin. Key features include:

- FA CREW REST AREA:** Located at the front of the cabin, containing two crew seats, two oxygen bottles (O2), two first aid kits (FA), and two fire extinguishers (H).
- Medical Communications Outlets:** Located at rows 2, 16, 29, and 40, featuring a heart symbol, a red box (RED), a first aid kit (FA), and a headset.
- High Terrain Flights Only:** A note specifying 24 supplemental O2 provisions: 12 center partition, aft Zone A; 4 mid-right overhead bin; and 8 aft overhead bin (4 each side).
- Legend:**
 - CREW AT EACH ATTENDANT SEAT:** Indicated by a crew seat icon.
 - AT EACH PASSENGER SEAT:** Indicated by a passenger seat icon.
- Equipment Callouts:** Various items are labeled throughout the cabin, including oxygen bottles (O2), first aid kits (FA), fire extinguishers (H), and crew seats (CREW).

180, 181, 187-199



1501-1506, 1521



**Airplane General, Emergency
Equipment, Doors, Windows
Crew Rest Compartment**

Chapter 1

Section 46

Lower Lobe Crew Rest Compartment (as installed)

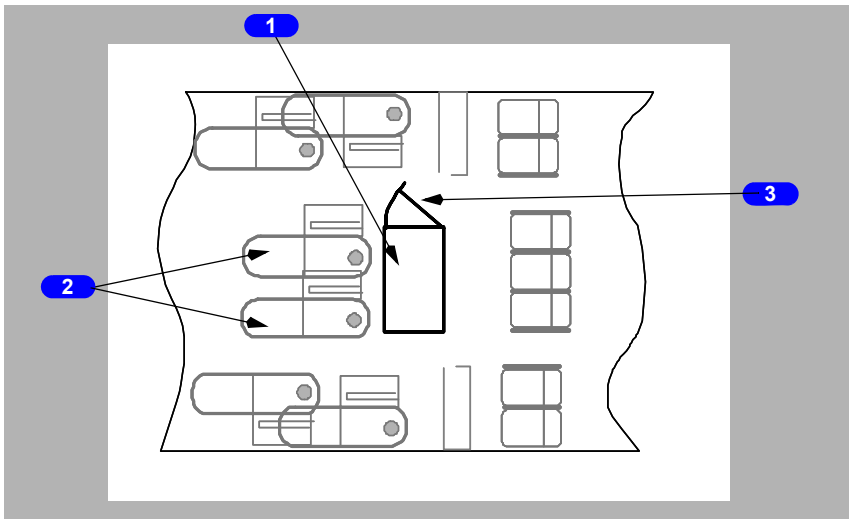
[AFM]

A Pilot Lower Lobe Crew Rest (PLLRCR) compartment is located in the aft section of the fwd cargo compartment. The vestibule for entry to the compartment is located at the mid-galley cross aisle.

Pilot Lower Lobe Crew Rest Overview

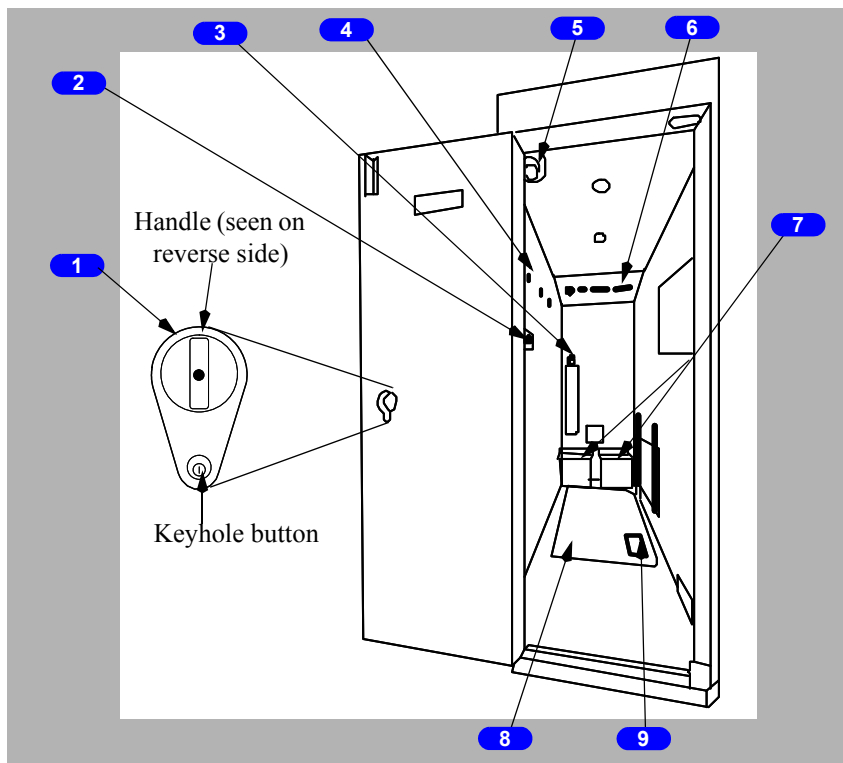
(1607-1613)

The PLLRCR is accessed through an entry door located in the right aisle, aft of BusinessElite section.



- 1 Vestibule for Pilot Lower Lobe Crew Rest Compartment**
- 2 Flat Bed Business Elite Seats**
- 3 Door to Vestibule**

Vestibule



1 Door Entry Latch

To open compartment door, depress keyhole button and turn handle clockwise.

2 Vestibule Switch Panel

3 O2 bottle

4 Coat hooks

5 Smoke alarm

6 Vestibule PSU

7 Shoe bags

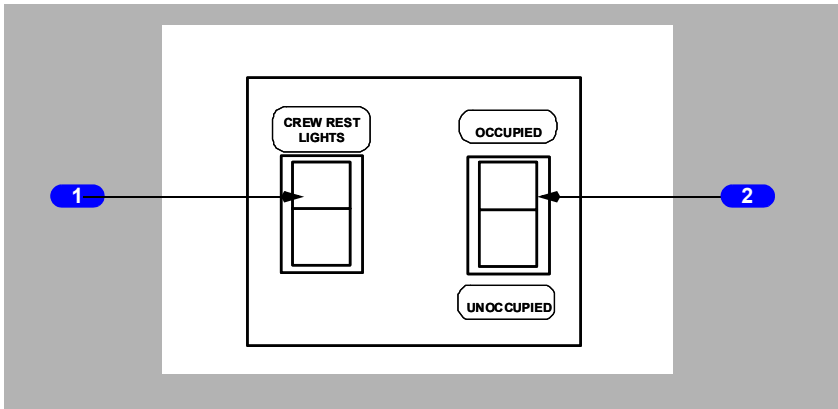
8 Main entry hatch

The main entry hatch to the PLLCR is located inside the vestibule.

CAUTION: The main hatch must be closed when the PLLCR is unoccupied.

9 Pull handle

Vestibule Switch Panel



1 Crew Rest Lights Switch

Crew rest lights are illuminated at all times.

Push

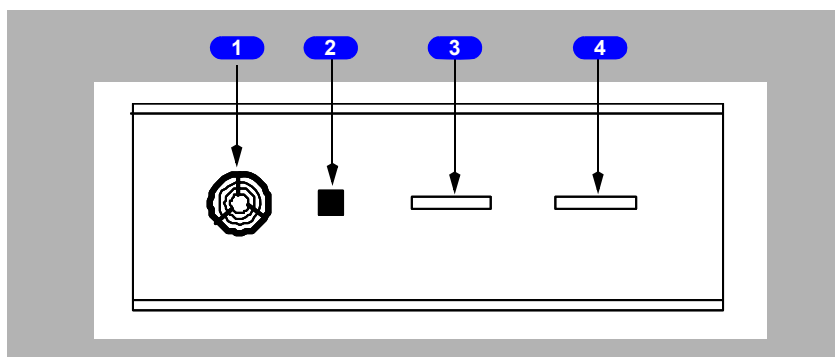
- top switch sets the PLLCR area lights to bright
- bottom switch sets the PLLCR area lights to dim

2 OCCUPIED/UNOCCUPIED Switch

Push

- turns the two (2) amber lights on the forward outside wall of the vestibule on or off

Vestibule PSU



1 Altitude Alert Horn

2 Altitude Alert Reset Switch

Illuminated (blue) when activated

Push

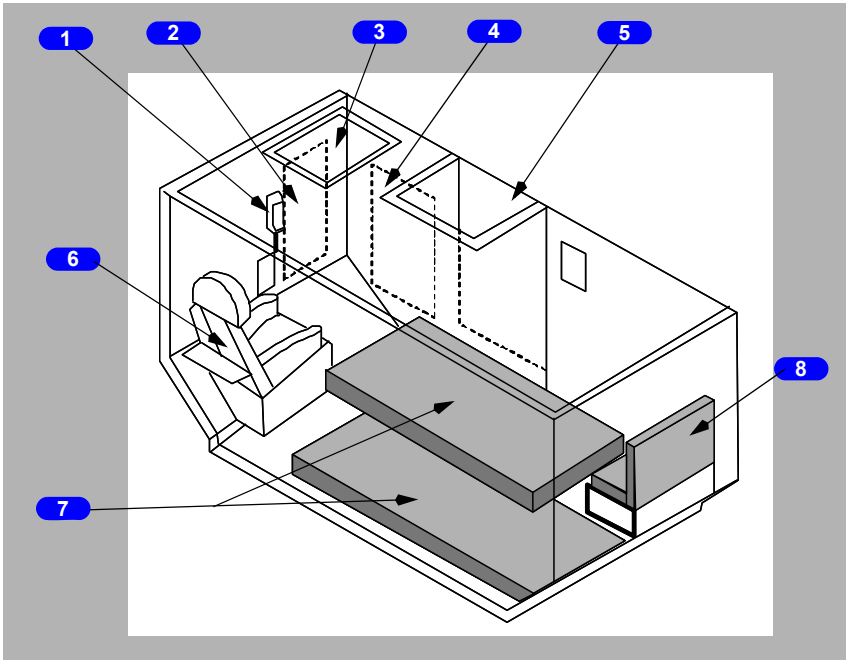
- resets PLLCR Altitude Alert Horn
- resets the switch light
- extinguishes the Don Oxygen Mask sign

3 Don Oxygen Mask Sign

4 Return To Seat Sign

Compartment General

Description of the Crew Rest Compartment



- 1 Handset**
- 2 Auxiliary Panel**
- 3 Emergency Hatch**
- 4 Emergency Equipment**
- 5 Entry Hatch**
- 6 Crew Rest Seat**
- 7 Upper and Lower Bunks**
- 8 Changing Area Seat**

Common Area Amenities

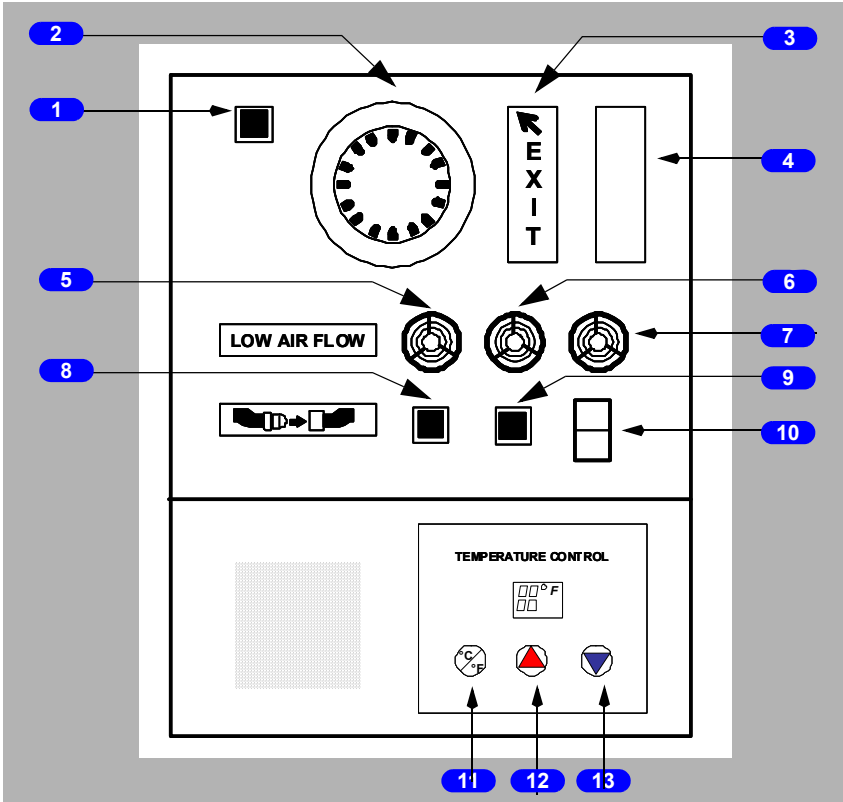
- One comfort rest seat with drop-down table
- One bench seat
- Laptop power supply (2 outlets)
- Two coat hooks
- Adjustable reading light at each seat
- Personal items storage
- Interphone/PA Handset
- Low airflow alert
- Adjustable local light
- Temperature control
- Emergency equipment
- Full-face mirror

Bunk Amenities

- Adjustable reading light
- Individual bunk area lighting
- Emergency oxygen drop, with chemical generator and mask
- Gasper
- Flight Deck call light
- Privacy curtain with valance
- Decompression and smoke alerts
- Personal effects storage pouch
- Personal restraint belt
- Mattress

Auxiliary Panel

The auxiliary panel contains an altitude alert reset switch, an air flow horn reset switch, and a heat controller.



1 LOW AIRFLOW HORN ARM/DISARM switch

Push

- armed, illuminates green and low air flow horn is armed
- disarmed, illuminates red and low air flow horn is disarmed

Note: Low Airflow System must be armed when PLLCR is occupied.

2 Smoke detector

3 Emergency EXIT light

4 Emergency Light

5 LOW AIRFLOW alert

6 ALTITUDE ALERT horn

7 SMOKE DETECTION ALERT horn

8 LOW AIRFLOW ALERT RESET switch

Illuminated (blue) when activated.

Push -

- resets the PLLCR audible horn, if horn was armed
- extinguishes switch illumination

9 ALTITUDE ALERT RESET Switch

Illuminated (blue) when activated.

Push -

- resets audible horn
- extinguishes switch illumination

10 AREA LIGHTS switch

Illuminated (white) at all times.

Push -

- turns the lights located in the PSUs above the seat ON or OFF

Dome lights are illuminated at all times (no switch).

11 Temperature Units Switch

Illuminated (white) at all times, as long as the heat controller is ON.

Push -

- sets the temperature to degrees Celsius (C) or degrees Fahrenheit (F)

12 Temperature Increaser

Illuminated (white) at all times, as long as the heat controller is ON.

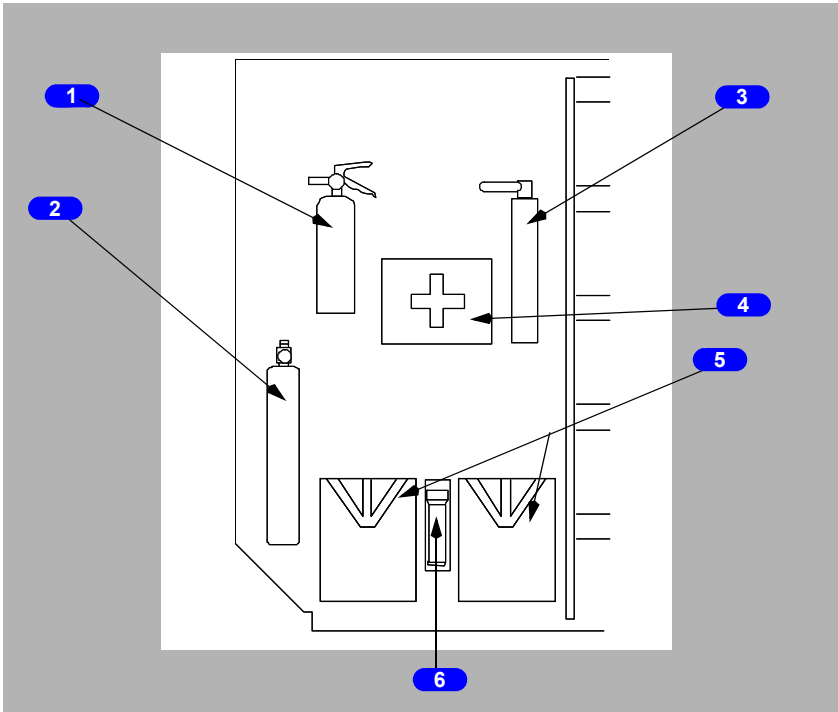
Push - increases temperature in PLLCR. Maximum selectable temperature is 78 degrees F.

13 Temperature Decreaser

Illuminated (white) at all times, as long as the heat controller is ON.

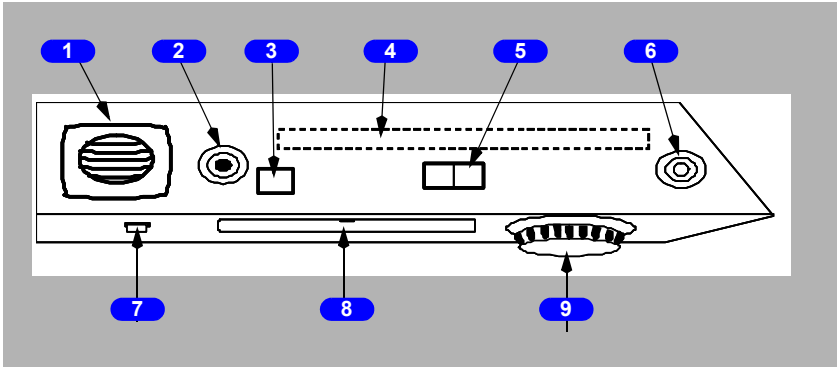
Push - decreases temperature in PLLCR. Minimum selectable temperature is 65 degrees F.

Emergency Equipment



- 1 Halon Fire Extinguisher**
- 2 O2 Bottle**
- 3 Water Fire Extinguisher**
- 4 First Aid Kit**
- 5 PBE (2 ea.)**
- 6 Flashlight**

Bunk PSU



- 1 Air Outlet**
 - 2 Reading Light**
 - 3 Reading Light Switch**
 - 4 Bunk Light**
 - 5 Bunk Light Switch**
 - 6 Gasper Air Outlet**
 - 7 Call Light**
 - 8 Oxygen Mask Compartment**
- The oxygen masks will drop automatically in the event of a decompression and will provide oxygen from a chemical generator for approximately 12 minutes.
- 9 Smoke Detector**

Note: Seat PSU and equipment are similar.

Emergency Lighting

Emergency lights, controlled by the aircraft emergency light system, are installed in the common area, on the auxiliary panel.

Air Systems

The conditioned air system for the Pilot Lower Lobe Crew Rest (PLLCR) is integrated with the cabin conditioned air system. Air is supplied to the PLLCR through the seat and bunk PSU gaspers and vents.

The air supply shutoff valve will close if:

- smoke is detected in the PLLCR,
- the forward cargo fire extinguishing system is armed, or
- the airplane is on the ground and the left pack is on.

Function of the Temperature Control System

Conditioned air is supplied via a duct system with small circulation fans. Air temperature will initially be the same as cabin zone air. The compartment is equipped with a heater system which can only increase the temperature of the air being supplied to the compartment. By adjusting the temperature up or down, the heater will either turn on or off, leading to an increase or decrease of air temperature slowly over time.

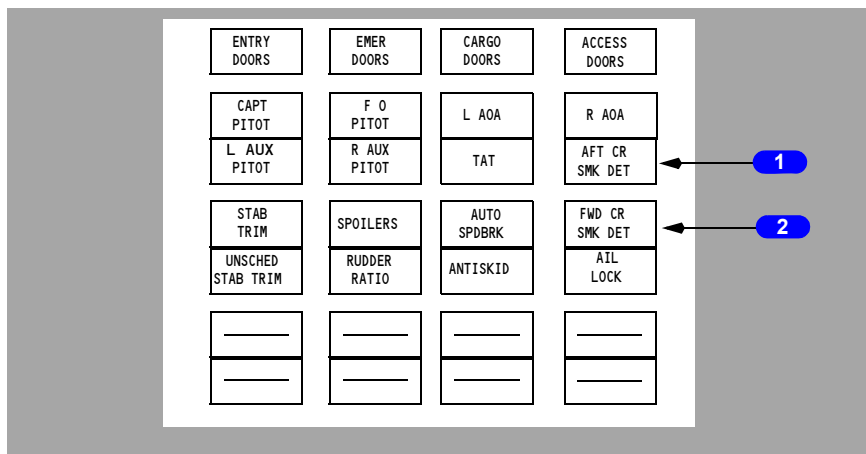
Note: There is no ability to cool the air. If a cooler temperature is desired, select a lower temperature using the Temperature Decreaser selector, which will turn the heater off. The temperature in the compartment will slowly decrease based on the air temperature of the main cabin zone.

Fire Protection

Note: There are no associated EICAS messages for smoke or fire in the lower crew rest compartments.

Overhead Warning Lights Panel

Two new lights are added.



1 Aft Crew Smoke Detection

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

Illuminates (red) when smoke is detected in the aft crew rest compartment Flight Attendant Crew Rest (FACR).

2 Forward Crew Smoke Detection

1607-1613

Illuminates (red) when smoke is detected in the forward crew rest compartment, Pilot Lower Lobe Crew Rest (PLLCLCR)

Fire Detection

The PLLCR and FACR compartments have their own smoke detection system. Smoke detectors are installed in the vestibules and the compartment bunks.

If smoke is detected in either crew rest compartment:

- On the flight deck:
 - illumination of the Red Master WARNING lights
 - the fire bell aural annunciation
 - the FWD or AFT CR SMK DET light illuminates on the overhead warning lights pane

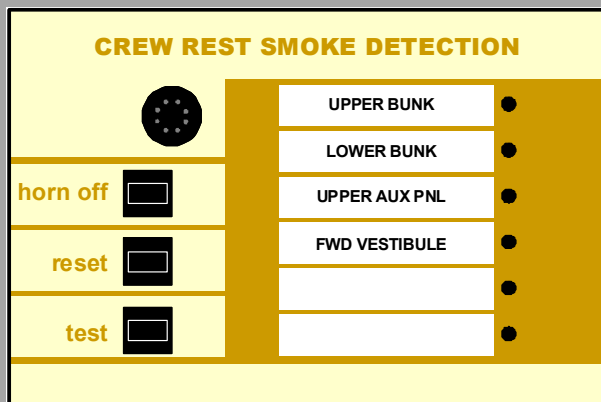
Note: Turn off the fire bell and the Master WARNING Lights by pressing one of the two Master WARNING/CAUTION reset switches.

- In the compartment:
 - a horn on the auxiliary panel will sound.
- In the passenger cabin:
 - a continuous high chime sounds throughout the cabin
 - the cabin attendant master call lights flash
 - an illuminated light on the CREW REST SMOKE DETECTION on the associated panel.

The cabin crew can silence the cabin chime/horn by pressing the HORN OFF button on the associated CREW REST SMOKE DETECTION Panel.

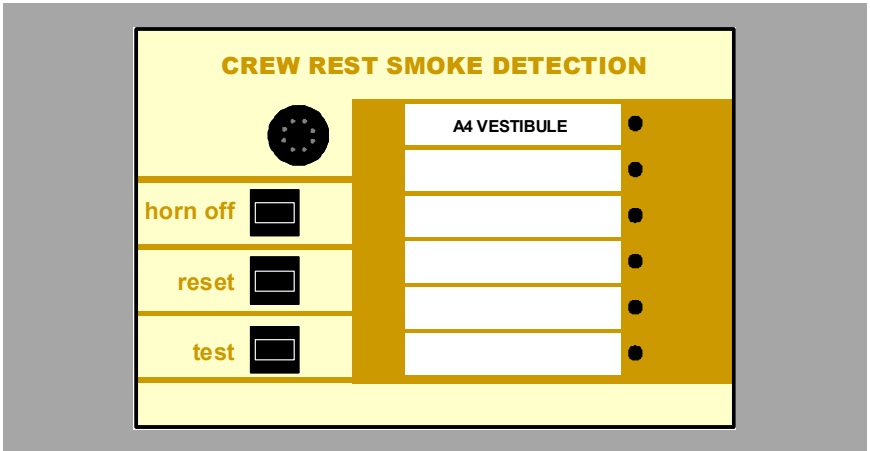
PLLCR - 1L Door Panel

(1607-1613)



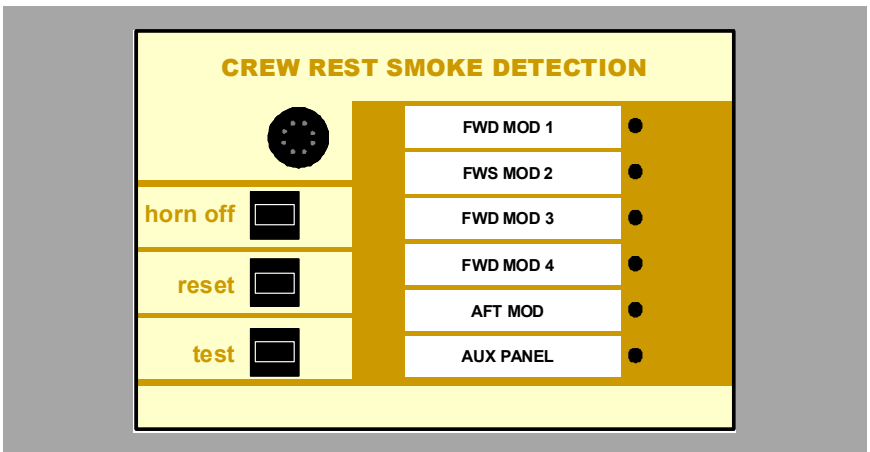
FACR - 2L Door Panel

Note: For aircraft 1501-1506 and 1521, the FACR Smoke Detector Panel is on the 3L Door Panel.



FACR - 2R Door Panel

Note: For aircraft 1501-1506 and 1521, the FACR Smoke Detector Panel is on the 3R Door Panel.

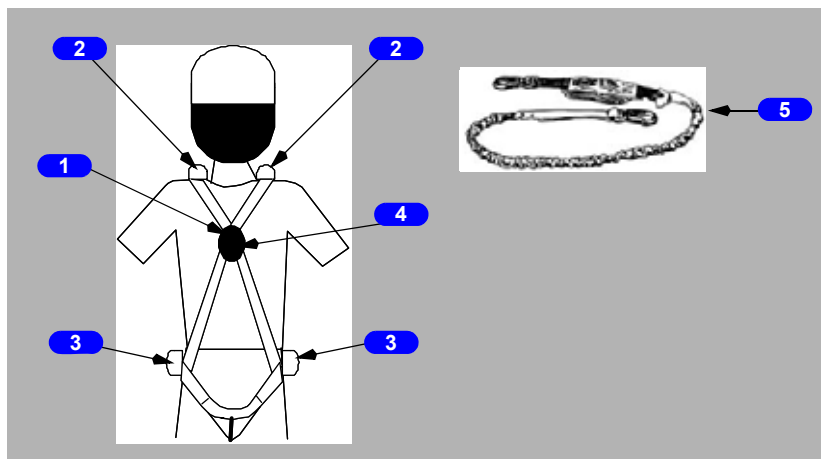


PLLCR Body Harness Operation / Egress

(1607-1613)

Secondary egress is via the Emergency Hatch above the rest seat. Operating instruction are placarded on the Emergency Hatch.

The emergency body harness is stored in a compartment below the comfort seat in the PLLCR.



1 Back D-Ring

For fall arrest.

2 Shoulder D-Ring

For retrieval use.

3 Side D-Ring

For positioning.

4 Warning tags

Position can vary with manufacturer.

5 Harness lanyard

If the body harness is used to remove personnel from either facility, use the following procedure:

- install the body harness on the incapacitated person
 - hold the harness by the back D-ring
 - shake the harness to allow all straps to fall in place
 - slip the straps over the legs
 - slip the straps over shoulders so the D-ring is located in middle of the back between shoulder blades
 - pull the leg strap between legs and connect to the opposite end
 - repeat with the second leg strap and adjust the chest strap (if available)
 - adjust and tighten the harness straps and make sure the fit is snug
 - pass excess strap through the D-ring
 - attach the harness lanyard to the D-ring and ensure its security
- open the emergency hatch
- pass the harness lanyard to personnel in the cabin
- pull on the harness lanyard to ensure it is securely attached
- pull the person through the emergency hatch
- after person is removed from the PLLCR, person can be disengaged from the body harness by loosening the straps and slipping the straps off.

Flight Attendant Crew Rest (FACR) Facility

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

The FACR is located in the aft of the aircraft with entry near the aft galley. The FACR is built into the bulk cargo compartment and is equipped with five full, flat, horizontal bunks (3 upper and 2 lower) and a bench. The single aft right bunk is the Leader bunk. Equipment is similar to the PLLCR. The facility is restricted to operating crewmembers of the flight segment only. The crew rest facility is not approved for occupancy during taxi, takeoff, and landing, and no catering or cabin service items may be stored within the FACR module or vestibule at any time.

The temperature control system inside the facility serves only as a heater; it does not force cool air. The gasper vents are the best source for cool air.

FACR Entry and Exit

The FACR is equipped with a primary and secondary means of entry and exit. Normal entry is through a door and hatch located in the aft galley adjacent to door 2R, 3R for ships 1501-1506 and 1521. Entry and exit is similar to the PLLCR.

Note: Stowage on top of the hatch within crew rest vestibule of any item at any time is not permitted, even if the facility is not in use.

An emergency exit is located in the ceiling of the fwd upper bunk (parallel with the fuselage) and opens up into the right aft cabin floor aisle. A placard with opening instructions is located near the emergency hatch.

FACR Emergency Equipment

The flight attendants are responsible for the preflight of all FACR emergency equipment. The FACR also contains an emergency body harness.

767-300ER Pilot Crew Rest Curtain

The crew rest seat is a Class 2 rest facility at seat 5A or 7A (refer to the FOM, 2.3, for seat locations). The curtain is divided into two halves that are permanently attached to the sidewall. Both curtains slide on a rail that is attached directly above the seat. The curtain must be stowed against the sidewall with the tiebacks during taxi, takeoff and landing.

Airplane General, Emergency Equipment, Doors, Windows

EICAS Messages

Chapter 1

Section 50

Airplane General, Emergency Equipment, Doors, Windows

EICAS Messages

The following EICAS messages may be displayed.

Access Doors

Message	Level	Light	Aural	Condition
ACCESS DOORS	Advisory	ACCESS DOORS		Forward equipment bay and electrical equipment compartment access doors are not closed, latched, and locked.
E/E ACCESS DOOR	Advisory	ACCESS DOORS		Electrical equipment access door is not closed, latched, and locked.
FWD ACCESS DOOR	Advisory	ACCESS DOORS		The forward equipment bay access door is not closed, latched, and locked.

Cargo Doors

Message	Level	Light	Aural	Condition
CARGO DOORS	Advisory	CARGO DOORS		Two or more cargo doors are not closed, latched, and locked.
AFT CARGO DOOR	Advisory	CARGO DOORS		Cargo door is not closed, latched, and locked.
BULK CARGO DOOR	Advisory	CARGO DOORS		Cargo door is not closed, latched, and locked.

Message	Level	Light	Aural	Condition

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

FWD CARGO DOOR	Caution	CARGO DOORS		Cargo door is not closed, latched, and locked.

121-139, 1401-1404

FWD CARGO DOOR	Advisory	CARGO DOORS		Cargo door is not closed, latched, and locked.

Entry Doors

Message	Level	Light	Aural	Condition
L ENTRY DOORS R ENTRY DOORS	Advisory	ENTRY DOORS		Two or more entry doors on the same side are not closed, latched, and locked.
L AFT ENT DOOR R AFT ENT DOOR	Advisory	ENTRY DOORS		Entry door is not closed, latched, and locked.
L FWD ENT DOOR R FWD ENT DOOR	Advisory	ENTRY DOORS		Entry door is not closed, latched, and locked.

1501-1506, 1521

L CTR ENT DOOR R CTR ENT DOOR	Advisory	ENTRY DOORS		Entry door is not closed, latched, and locked.

Overwing Emergency Exit Doors

Message	Level	Light	Aural	Condition
EMER DOORS	Advisory	EMER DOORS		Two or more emergency doors are not closed, latched, and locked (overwing emergency exit door) or (wing slide compartment door).

1501-1506, 1521

L EMER DOOR R EMER DOOR	Advisory	EMER DOORS		Two or more emergency doors are not closed and latched and locked (overwing emergency exit door or wing slide compartment door).

121-199, 1200-1201, 1401-1404, 1601-1613, 1701-1708

L FWD EMER DOOR R FWD EMER DOOR	Advisory	EMER DOORS		An overwing emergency exit door is not closed, latched, and locked.
L AFT EMER DOOR R AFT EMER DOOR	Advisory	EMER DOORS		An overwing emergency exit door is not closed, latched, and locked.

L WING SLIDE R WING SLIDE	Advisory	EMER DOORS		Wing slide compartment door is not closed, latched, and locked.

Emergency Lights

Message	Level	Light	Aural	Condition
EMER LIGHTS	Advisory	UN- ARMED		The emergency lights switch is not in the Armed position.

Oxygen System

Message	Level	Light	Aural	Condition
PASS OXYGEN ON	Advisory	ON		Passenger oxygen system is activated.

Air Systems

Chapter 2

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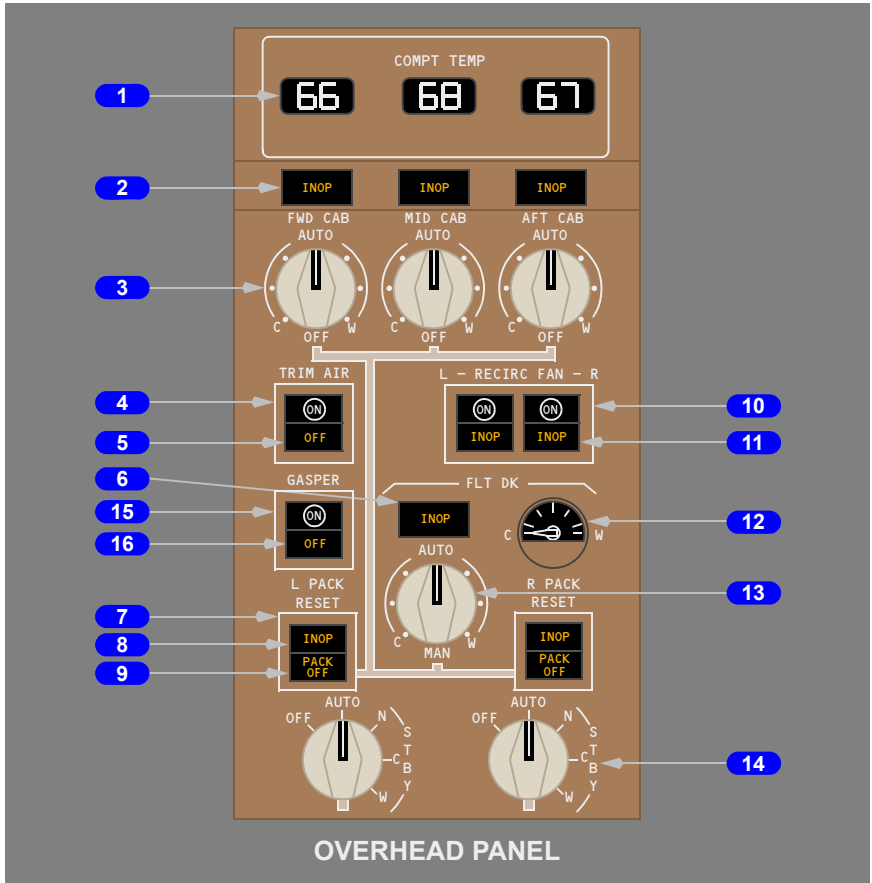
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**Air Systems
Controls and Indicators**

**Chapter 2
Section 10**

**Air Conditioning System
Air Conditioning Control Panel**



1 Compartment Temperature (COMPT TEMP) Indicators

Displays actual temperature sensed in the compartment.

2 Compartment Temperature Inoperative (INOP) Lights

Illuminated (amber) –

- fault in the zone temperature controller
- the Compartment Temperature Control is OFF
- the trim air switch is OFF.

3 Compartment Temperature Controls

AUTO –

- provides automatic compartment temperature control
- rotating the control toward C (cool) or W (warm) sets the desired temperature between 65 degrees F and 85 degrees F.

OFF –

- closes the compartment trim air valve
- the compartment temperature INOP light illuminates.

4 TRIM AIR Switch

ON – the trim air valve is commanded open.

Off (ON not visible) – the trim air valve is commanded closed.

5 Trim Air OFF Light

Illuminated (amber) – the TRIM AIR switch is off.

6 Flight Deck (FLT DK) Temperature Inoperative (INOP) Light

Illuminated (amber) –

- fault in the zone temperature controller.
- the trim air switch is OFF.
- zone supply duct overheat.

7 PACK RESET Switches

Push – resets an overheated pack if the pack has cooled to a temperature below the overheat level.

8 Pack Inoperative (INOP) Light

Illuminated (amber) –

- a pack outlet overheat is detected
- fault in the automatic control system.

9 PACK OFF Lights

Illuminated (amber) – pack valve is closed.

10 Recirculation Fan (RECIRC FAN) Switches

ON – the recirculation fan operates

Off (ON not visible) – the recirculation fan does not operate.

11 Recirculation Fan Inoperative (INOP) Lights

Illuminated (amber) –

- the recirculation fan is failed or is not operating.
- the RECIRC FAN switch is off.

12 Flight Deck Trim Air Valve Position Indicator

C (cool) – valve closed.

W (warm) – valve open.

13 Flight Deck Compartment Temperature Control

AUTO –

- provides automatic flight deck temperature control
- rotating the control toward C (cool) or W (warm) sets the desired temperature between 65 degrees F and 85 degrees F.

MAN –

- provides manual control of compartment trim air valve
- spring loaded to the 6 o'clock position in this sector.

14 PACK Control Selectors

OFF – closes the pack valve.

AUTO – the pack is automatically controlled.

STBY –

- N (normal) – regulates the pack outlet temperature to a constant, moderate temperature.
- C (cool) – sets the pack to full cold operation.
- W (warm) – sets the pack to full warm operation.

15 GASPER Fan Switch (as installed)

121-139, 171-199, 1200-1201, 1401-1404, 1601-1613, 1701-1708

ON – the gasper fan is signaled on

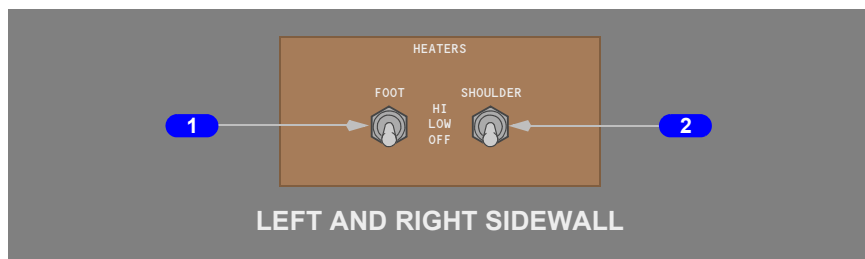
Off (ON not visible) – the gasper fan is signaled off

16 Gasper Fan OFF light

121-139, 171-199, 1200-1201, 1401-1404, 1601-1613, 1701-1708

Illuminated (amber) – the GASPER fan switch is ON but the gasper fan is not operating.

Shoulder and Foot Heaters



1 FOOT HEATERS Switch

HIGH – the electric heater adds heat at high setting to the conditioned air flowing to the rudder pedal area in flight only.

LOW – the electric heater adds heat at low setting to the conditioned air flowing to the rudder pedal area in flight only.

OFF – the electric heater is not operating (no heat added to the conditioned air flowing to the rudder pedal area).

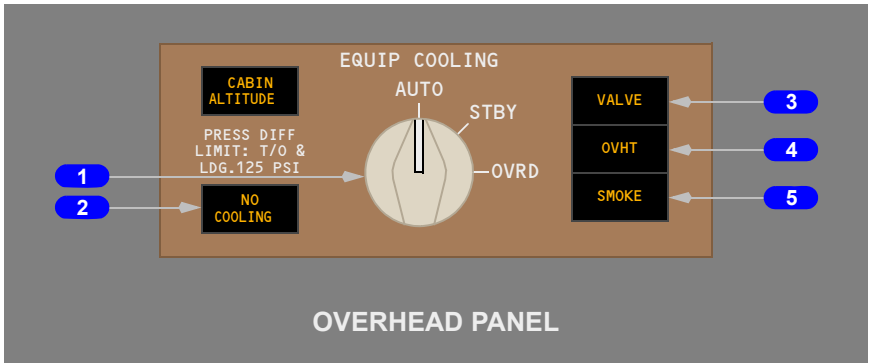
2 SHOULDER HEATERS Switch

HIGH – the electric heater adds heat at high setting to the conditioned air flowing to the side window area in flight only.

LOW – the electric heater adds heat at low setting to the conditioned air flowing to the side window area in flight only.

OFF – the electric heater is not operating (no heat added to the conditioned air flowing to the side window area).

Equipment Cooling Panel



1 Equipment (EQUIP) COOLING Selector

AUTO – automatically controls equipment cooling system.

STBY – positions equipment cooling system for inboard air flow.

OVRD – positions equipment cooling system for reverse air flow.

(As installed)

- shuts down Nitrogen Generation System

2 NO COOLING Light

Illuminated (amber) –

- active in OVRD only
- no reverse air flow through the E/E compartment avionics.

3 VALVE Light

Illuminated (amber) – equipment cooling valves are not in their commanded position.

4 Overheat (OVHT) light

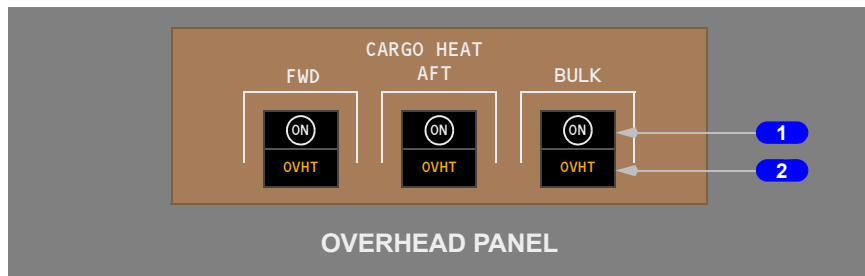
Illuminated (amber) – high temperature or low airflow in the equipment cooling system.

5 SMOKE Light

Illuminated (amber) – smoke in the equipment cooling system.

Cargo Heating

Cargo Heat Panel



1 CARGO HEAT Switches

ON – provides power for heat valves to cycle open and closed for automatic temperature control

Off (ON not visible)– the heat valves are commanded closed.

2 Cargo Heat Overheat (OVHT) Lights

Illuminated (amber) –

- cargo compartment temperature above standard control range
- shutoff valve signaled closed.

Bulk Cargo Heat Panel



1 BULK CARGO HEAT Selector

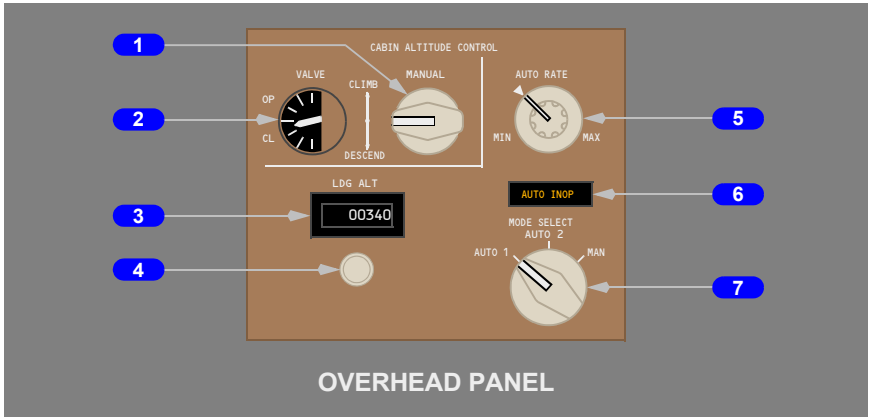
Bulk cargo heat switch must be on

NORM – standard cargo heating range.

VENT –

- requests higher temperature control range than NORM
- turns on ventilating fan for bulk cargo compartment.

Pressurization System Cabin Altitude Controls



1 Cabin Altitude MANUAL Control

Spring – loaded to center.

Controls cabin outflow valve position with the Cabin Altitude Mode Selector in manual (MAN) mode.

CLIMB – moves outflow valve toward open.

DESCEND – moves outflow valve toward closed.

2 Outflow VALVE Position Indicator

OP – Open.

CL – Closed

3 Landing Altitude (LDG ALT) Indicator

Displays selected landing altitude in feet above MSL.

4 Landing Altitude (LDG ALT) Selector

Rotate – sets landing altitude indicator.

5 Cabin Altitude AUTO RATE Control

Rotate –

- sets limit for cabin altitude rate of climb or descent during auto control
- index mark establishes approximately 500 fpm climb and 300 fpm descent.

6 AUTO Inoperative (INOP) Light

Illuminated (amber) –

- AUTO 1 and AUTO 2 cabin altitude control functions are inoperative
- MAN mode is selected.

7 Cabin Altitude MODE SELECTOR

AUTO 1 –

- activates Auto 1 cabin altitude control for automatic operation
- outflow valve positioned automatically.

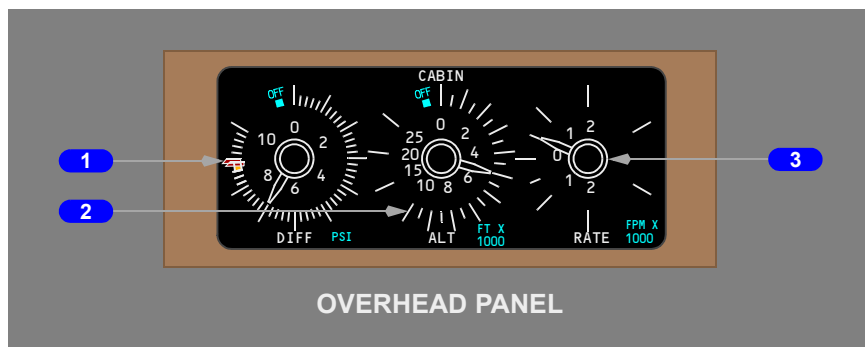
AUTO 2 –

- activates Auto 2 cabin altitude control for automatic operation
- outflow valve positioned automatically.

MAN (Manual) –

- outflow valve position is controlled by the cabin altitude MANUAL control
- AUTO INOP light illuminates.

Cabin Altitude Indicators



1 Cabin Differential Pressure Indicator

Pounds per square inch (psi).

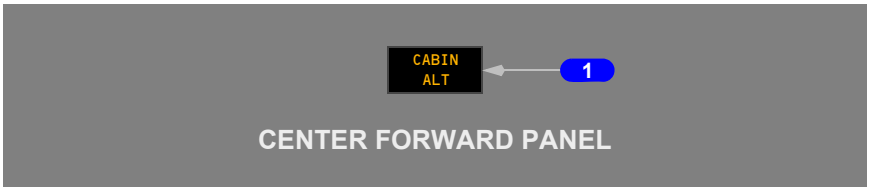
2 Cabin Altitude

Feet x 1,000.

3 Cabin Altitude Rate

Feet per minute (fpm x 1,000).

Cabin Altitude (CABIN ALT) Light

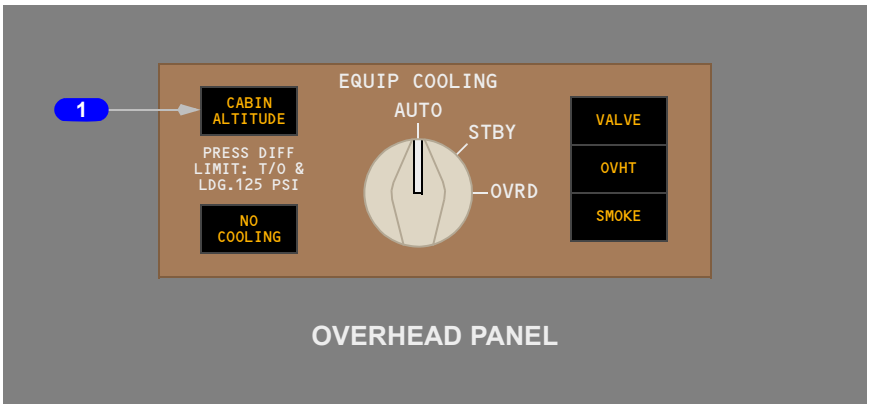


1 Cabin Altitude Light

Illuminated (red) –

- cabin altitude exceeds 10,000 feet
- extinguishes when cabin altitude descends below 8,500 feet.

Cabin Altitude Light



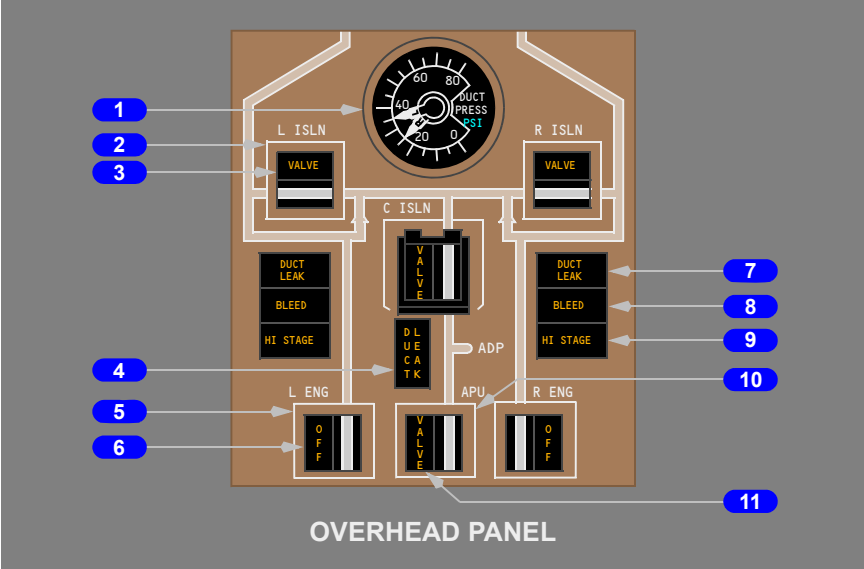
1 Cabin Altitude Light

Illuminated (red) –

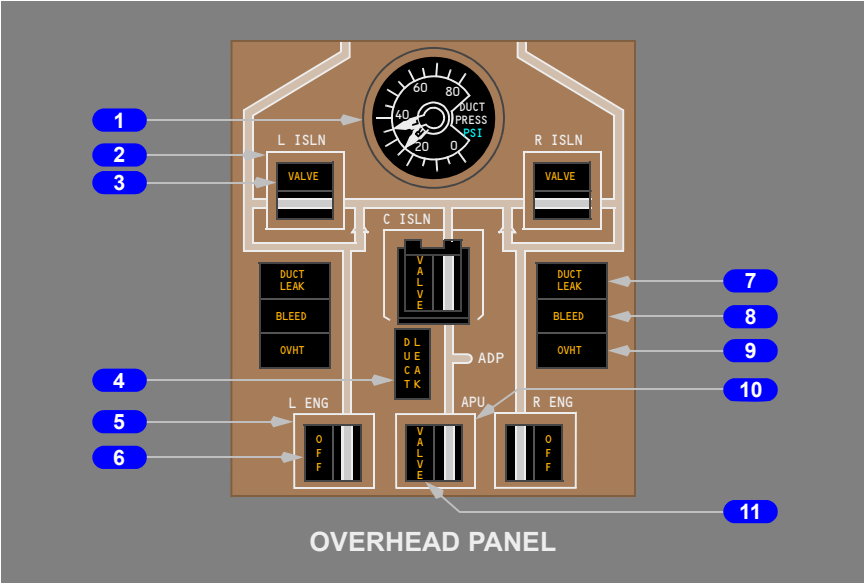
- cabin altitude exceeds 10,000 feet
- extinguishes when cabin altitude descends below 8,500 feet.

Bleed Air System
Bleed Air Control Panel

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1 Duct Pressure (DUCT PRESS) Indicators

Pounds per square inch (PSI).

2 Isolation (ISLN) Switches

On (bar in view) – commands isolation valves to open.

Off (bar not in view) – commands isolation valves to close.

3

Illuminated (amber) – isolation valve position disagrees with commanded position.

4 DUCT LEAK Light

Illuminated (amber) – a high temperature bleed air leak is detected in the center pneumatic duct.

5 Engine (ENG) Bleed Air Switches

On (bar in view) – the engine bleed air valve opens when engine bleed air is available.

Off (bar not in view) – valve is manually commanded closed.

6 Engine Bleed Air OFF Lights

Illuminated (amber) – engine bleed air valve is closed:

- automatically due to a system fault
- the switch is OFF
- the engine is not running.

7 DUCT LEAK Lights

Illuminated (amber) – a high temperature bleed air leak is detected in the left, right, or engine strut pneumatic duct.

8 Engine BLEED Lights

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Illuminated (amber) – the engine high pressure bleed air valve is open when it should be closed.

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Illuminated (amber) – the engine high pressure bleed air valve and/or pressure regulating valves are open when they should be closed.

9 Engine Bleed Air Overheat (OVHT) Lights

171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

Illuminated (amber) –

- engine bleed air overtemp
- engine bleed valves automatically closed.

9 Engine High Stage (HI STAGE) Lights

121-139

Illuminated (amber) –

- engine bleed air overtemp
- engine high pressure bleed valves automatically closed.

10 APU Bleed Air Switch

On (bar in view) – the APU bleed air valve is automatically controlled

Off (bar not in view) – commands APU bleed air valve to close.

11 APU Bleed Air VALVE Light

Illuminated (amber) – APU bleed air valve position disagrees with commanded position.

Air Systems**Chapter 2****Air Conditioning System Description****Section 20**

Introduction

The air conditioning system supplies conditioned bleed air and recirculated cabin air at a controlled temperature throughout the airplane.

The system supplies conditioned air to the flight deck shoulder heaters.

The system supplies ventilation for the cabin:

- lavatories
- galleys

Pack control, zone temperature control, cabin air recirculation, fault detection, and overheat protection are all automatic.

The airplane is divided into four temperature zones: the flight deck and three cabin zones.

Air Conditioning Packs

Two identical air conditioning packs cool bleed air from the engines, APU, or high pressure air from a ground source. Bleed air is precooled before entering the pack. The packs are controlled by two identical pack controllers. Pack output is automatically increased during high pack demand periods to compensate for a failed pack or recirculation fan. This increase in pack output is inhibited during high bleed air demand periods (such as with an engine inoperative).

Air Conditioning Automatic Mode

With the pack selector in the AUTO position, pack output temperature is determined by the left and right cabin temperature controllers:

Air Conditioning Standby Mode

With the pack selector in the standby mode, pack output temperature is determined by the position of the pack selector:

- N (normal) - constant, moderate temperature
- C (cool) - full cold
- W (warm) - full warm.

Ground Conditioned Air Operation

When a ground source of conditioned air is available, it may be used to supply conditioned air directly to the cabin distribution system, eliminating the need for pack operation.

Pack Non–Normal Operation

Pack control, fault detection, and overheat protection are all automatic.

The pack INOP light illuminates and the EICAS advisory message L or R PACK TEMP displays for all pack control system faults or pack outlet overheats.

When an automatic control system fault or a pack outlet overheat is detected, the pack continues to operate in an uncontrolled, degraded condition, requiring crew interaction.

The pack valve closes and the pack is shut down automatically when an internal pack overheat is detected. The PACK OFF light illuminates and the EICAS advisory message L or R PACK OFF displays in addition to the PACK TEMP indications.

If the INOP light remains illuminated after selecting STBY, the fault is a pack overheat. After the pack has cooled, an attempt to restore pack operation may be made by pushing the PACK RESET switch.

Air Distribution

Conditioned air from the packs flows into a mix manifold where it mixes with air from two recirculation fans. Recirculation fans maintain overall cabin air circulation while allowing a reduction of cabin air ventilation, permitting the packs to be operated at a reduced flow. The mixed air is then ducted into the cabin.

The recirculation fans may be turned off for several minutes to provide a more rapid exchange of air.

The recirculation fan INOP light illuminates and the EICAS advisory message L or R RECIR FAN displays whenever a recirculation fan fails or is not operating. A slight increase in fuel consumption occurs for each fan that is OFF.

Temperature Control

The airplane is divided into four temperature control zones:

- flight deck
- forward cabin
- mid cabin
- aft cabin.

The pack controllers regulate the pack output air temperature to satisfy the temperature requirement of the compartment requiring the coolest air. Hot trim air from the bleed air system is added through trim air valves to control the temperature in each of the other compartments. Each temperature control compartment has an associated temperature control.

A compartment INOP light illuminates, and the EICAS advisory message FLT DECK TEMP, FWD CABIN TEMP, MID CABIN TEMP, or AFT CABIN TEMP displays to indicate:

- zone supply duct overheat
- zone temperature controller failure
- trim air switch is OFF (except FLT DECK TEMP)
- compartment temperature control is in the OFF position (FWD, MID, and AFT CAB only).

Temperature Control With Loss of Trim Air System

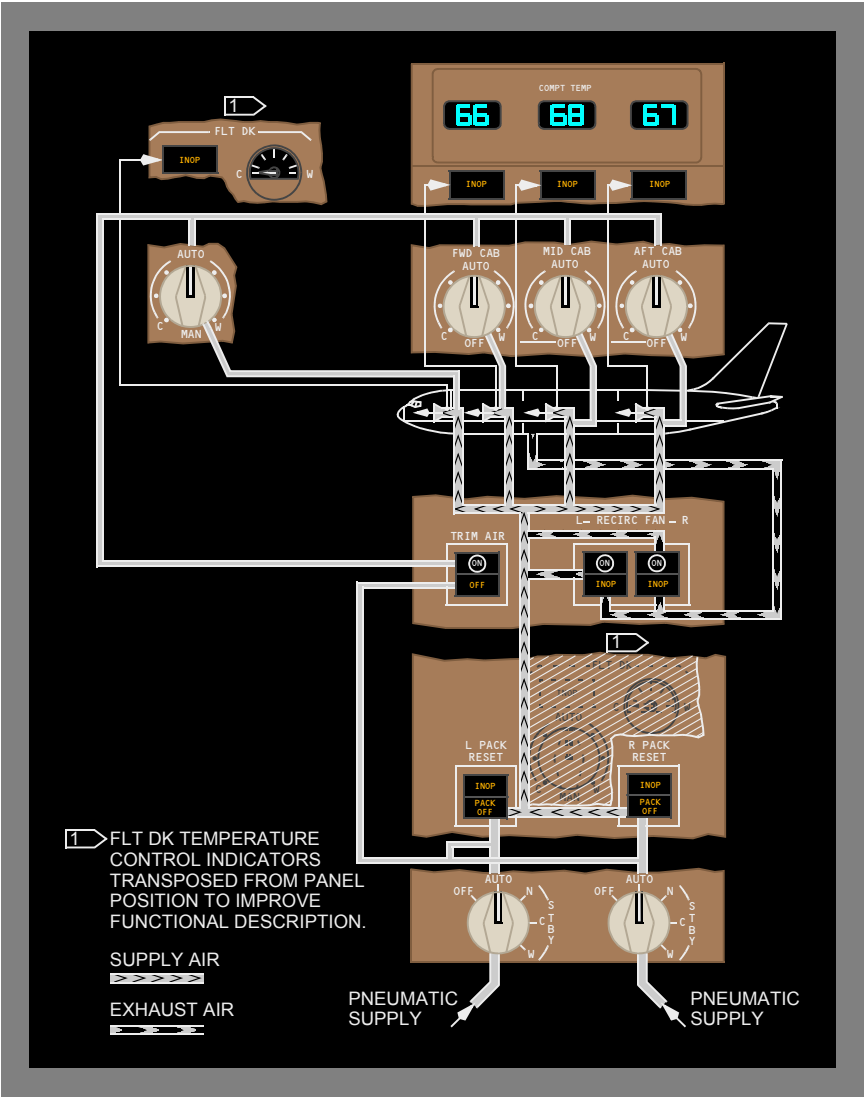
During operation with the trim air system off, the packs attempt to maintain all compartments at an average temperature. The trim air OFF light illuminates and the EICAS advisory message TRIM AIR displays when the TRIM AIR switch is off.

Gasper System

121-139, 171-199, 1200-1201, 1401-1404, 1601-1613, 1701-1708

The gasper system draws air from the forward cabin overhead air conditioning ducts and discharges it from gasper outlets in the passenger service units located above each passenger seat. Gasper air is controlled by the GASPER fan switch.

Air Conditioning System Schematic



Shoulder and Foot Heaters

Flight crew shoulder and foot heat is provided by electric heaters in the ducts that supply conditioned air to the side windows and rudder pedal areas respectively. The heaters operate in flight only.

Equipment Cooling System

Forward Equipment Cooling

The forward equipment cooling system supplies cooling air to equipment in the forward electronic equipment racks and the flight deck avionics.

System operation is automatic with the EQUIP COOLING selector in AUTO.

On the ground, engine operation, pack operation, air/ground logic, airplane skin temperature and ambient temperature are all factors that determine system configuration. A supply fan and an exhaust fan either recirculate the cooling air back through the system, or port it overboard.

In flight, only the exhaust fan operates, and the air is recirculated through the system.

Non-Normal Operation

The VALVE light illuminates and the EICAS advisory message FWD EQPT VAL displays if the system valves fail to reconfigure during automatic operation. Placing the EQUIP COOLING selector in STBY provides an alternate command to reconfigure the system for recirculating the cooling air back through the system,.

The OVHT light illuminates and the EICAS advisory message FWD EQPT OVHT displays if low airflow or high temperature is sensed. Placing the EQUIP COOLING selector in STBY may correct the condition by reconfiguring the system.

The SMOKE light illuminates and the EICAS advisory message FWD EQPT SMOKE displays if smoke is sensed in the forward equipment cooling ducts. Placing the EQUIP COOLING selector in OVRD allows conditioned air to be drawn in reverse through the system by differential pressure and exhausted overboard. The NO COOLING light becomes active after selecting OVRD.

The NO COOLING light illuminates and the EICAS caution message FWD EQPT COOLING displays if no cooling airflow is sensed after selecting OVRD.

Cargo Heat System

The forward, aft, and bulk cargo compartments are provided heat from the bleed air system.

Normal Operation

Separate switches control a shutoff valve and a heat control valve in each compartment. The system automatically maintains compartment temperature above approximately 45°F (7°C).

Bulk Cargo Heat Selector

A BULK CARGO HEAT selector allows a higher temperature to be selected for the bulk compartment. With the selector in the NORM position, the bulk compartment operates the same as the forward and aft compartments. With the selector in the VENT position, the bulk compartment is maintained above approximately 65°F (18°C), and a vent fan draws cabin discharge air into the compartment.

Non-Normal Operation

The cargo heat switch OVHT light illuminates and the EICAS advisory message FWD, AFT or BULK CARGO OVHT displays when the cargo compartment temperature is above the standard control range. The compartment shutoff valve closes automatically if a compartment temperature exceeds approximately 90°F (32°C). When the compartment temperature decreases below the overheat temperature setting, the OVHT light extinguishes, the EICAS message is removed, and the compartment shutoff valve re-opens.

The OVHT light is inhibited any time the heat control valve is in the closed position. This prevents the OVHT light from illuminating when the temperature exceeds 90° F in the cargo compartment and the system is operating normally.

Air Systems**Pressurization System Description****Chapter 2****Section 30**

Introduction

Cabin pressurization is controlled by adjusting the discharge of conditioned cabin air through the outflow valve.

Positive pressure relief valves and negative pressure relief doors protect the fuselage against excessive pressure differential.

The pressurization system has automatic and manual operating modes.

Pressurization System Automatic Operation

The pressurization system is in the automatic mode when the cabin altitude mode selector is set to AUTO 1 or AUTO 2. If the selected auto mode fails, control is automatically switched to the other auto mode.

In the automatic mode, the pressurization system uses ambient pressure data from the air data system in conjunction with the selected cabin auto rate, the takeoff altitude and the indicated landing altitude to calculate the cabin pressurization schedule.

Takeoff

For takeoff, the system supplies a small positive pressurization to cause a smooth cabin altitude transition.

Climb

During climb, cabin altitude increases on a schedule related to the takeoff field elevation, airplane altitude, and the selected auto climb rate limit.

If the maximum cabin pressure differential is reached, cabin climb rate becomes a function of airplane climb rate, while maintaining the maximum differential pressure.

Cruise

Shortly after the airplane levels off, the system enters the cruise mode. The landing altitude and the scheduled cabin altitude are compared and the higher of these two is selected for the cruise cabin altitude. If necessary, the cabin climbs to the cruise cabin altitude at one-half the auto rate or descends to the cruise cabin altitude at the auto rate.

The cruise cabin altitude does not change for minor altitude variations. A significant altitude change causes the system to re-enter the climb mode or to enter the descent mode.

Descent and Landing

During descent, cabin altitude decreases to slightly below the selected landing altitude. This ensures that the airplane lands pressurized. Landing altitude barometric pressure correction comes from the captain's altimeter.

At touchdown, the outflow valve opens to depressurize the airplane.

Non-Normal Indications

If the cabin altitude climbs above 10,000 feet, the CABIN ALT and CABIN ALTITUDE lights illuminate and the EICAS warning message CABIN ALTITUDE displays. The lights extinguish and the EICAS message blanks when the cabin altitude descends below 8,500 feet.

The AUTO INOP light illuminates and the EICAS caution message CABIN AUTO INOP displays when automatic pressurization control fails or when cabin altitude MODE SELECT is MAN. Manual operation is required if the automatic system fails.

Only the automatic mode is equipped with an aneroid switch that automatically closes the outflow valve when the cabin exceeds 11,000 feet. The manual mode has no auto closure feature.

To operate the pressurization system manually:

- set the cabin altitude MODE SELECT to MAN
- hold the cabin altitude MANUAL control to CLIMB to move the outflow valve toward open and cause the cabin altitude to climb
- hold the cabin altitude MANUAL control to DESCEND to move the outflow valve toward closed and cause the cabin altitude to descend.

Air Systems**Chapter 2****Bleed Air System Description****Section 40**

Introduction

Bleed air can be supplied by the engines, APU, or a ground air source.

Bleed air is used for:

- air conditioning
- pressurization
- engine start
- wing and engine anti-ice
- center hydraulic system air driven pump (ADP)
- hydraulic reservoir pressurization

1501-1506, 1521, 1601-1708

- thrust reversers

Engine Bleed Air Supply

Engine bleed air comes from either the high pressure (HP) or the low pressure (LP) engine compressor sections. LP air is used during high power setting operations. HP air is used during descent and other low power setting operations.

The engine bleed air valves are armed when the engine bleed switches are selected ON. The valves are pressure actuated and remain closed until engine bleed air pressure is sufficient to cause forward flow. The valves may close when the APU is starting either engine. The valves may close when ground pneumatic air is connected or during periods of low engine bleed air demand, such as when the air conditioning packs are off.

The engine bleed air OFF light illuminates and the EICAS advisory message L or R ENG BLEED OFF displays when the engine bleed air valve is closed for a system fault.

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The OVHT light illuminates and the EICAS advisory message L or R ENG BLD OVHT displays when the engine bleed air temperature is excessive.

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The HI STAGE light illuminates and the EICAS advisory message L or R ENG HI STAGE displays when the engine bleed air temperature is excessive.

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The BLEED light illuminates and the EICAS caution message L or R ENG BLEED VAL displays when the engine high pressure bleed valve is open when commanded closed.

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The BLEED light illuminates and the EICAS caution message L or R ENG HPSOV displays when the engine high pressure bleed air valve is open when commanded closed.

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The BLEED light illuminates and the EICAS caution message L or R ENG PRV displays when the pressure regulating valve is open when commanded closed.

APU Bleed Air Supply

APU bleed air is used primarily during ground operations for air conditioning pack operation and engine starting. In flight, APU bleed air is available up to approximately 17,000 feet.

The check valve in the APU supply line prevents reverse flow of bleed air from the duct into the APU.

The VALVE light illuminates and the EICAS advisory message APU BLEED VAL displays when the APU bleed valve position disagrees with the commanded position.

Ground Pneumatic Air Supply

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

Check valves prevent reverse flow of bleed air from the bleed air duct to the connectors.

Bleed Air Duct System

The duct pressure indicator displays the pressure in the left and right bleed air ducts.

Isolation valves separate the bleed air ducts into isolated segments. The left and right isolation valves are normally closed except for engine start or single bleed source operation. The center isolation valve normally remains open.

The isolation VALVE lights illuminate and the EICAS advisory message C, L or R BLD ISLN VAL displays when the bleed isolation valve position disagrees with the commanded position.

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The DUCT LEAK light illuminates and the EICAS caution message L or R BLD DUCT LEAK or BODY DUCT LEAK displays when a high temperature bleed air leak is detected.

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The DUCT LEAK light illuminates and the EICAS caution message L or R BLD DUCT LEAK, BODY DUCT LEAK or STRUT DCT LEAK displays when a high temperature bleed air leak is detected.

Bleed Air System Non-normal Operations

121-139

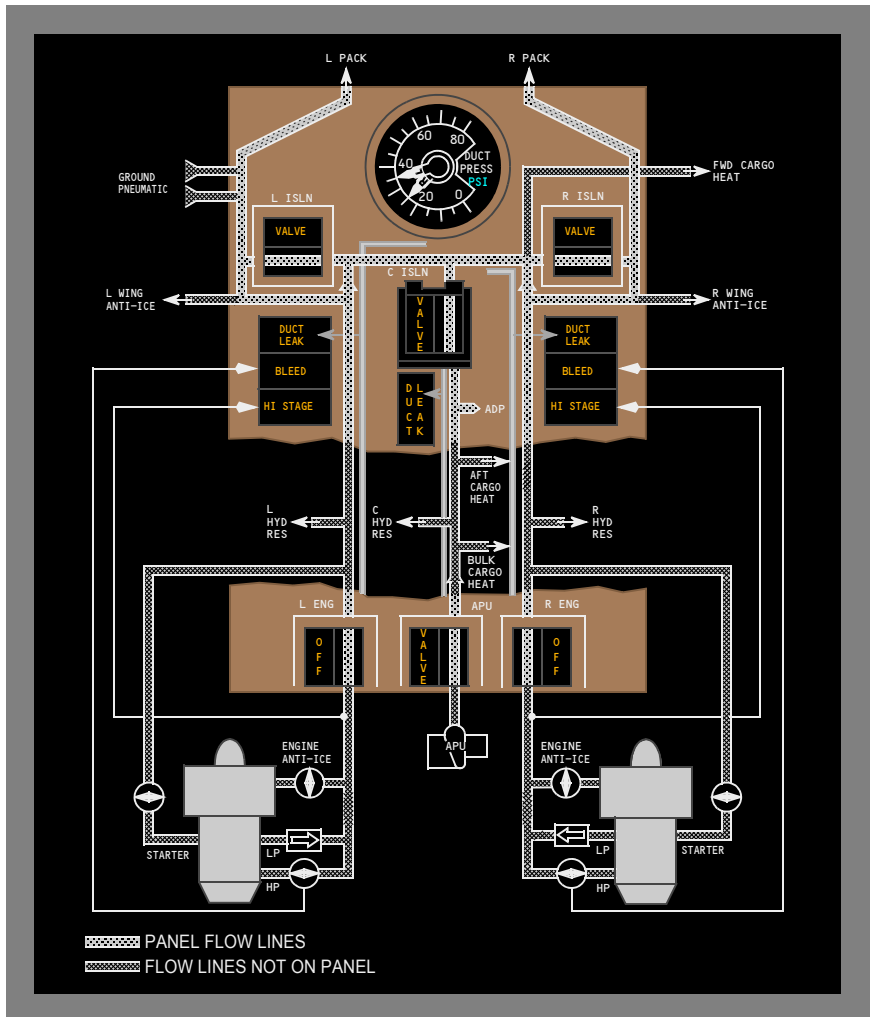
Bleed air overheat protection is provided by a bleed air temperature sensor. A higher than normal temperature causes a L or R HI STAGE advisory message to appear and the engine bleed air HI STAGE light to illuminate. If a bleed overheat occurs, the engine high pressure valve is automatically closed. Low pressure air continues to flow to the affected side to provide engine anti-ice.

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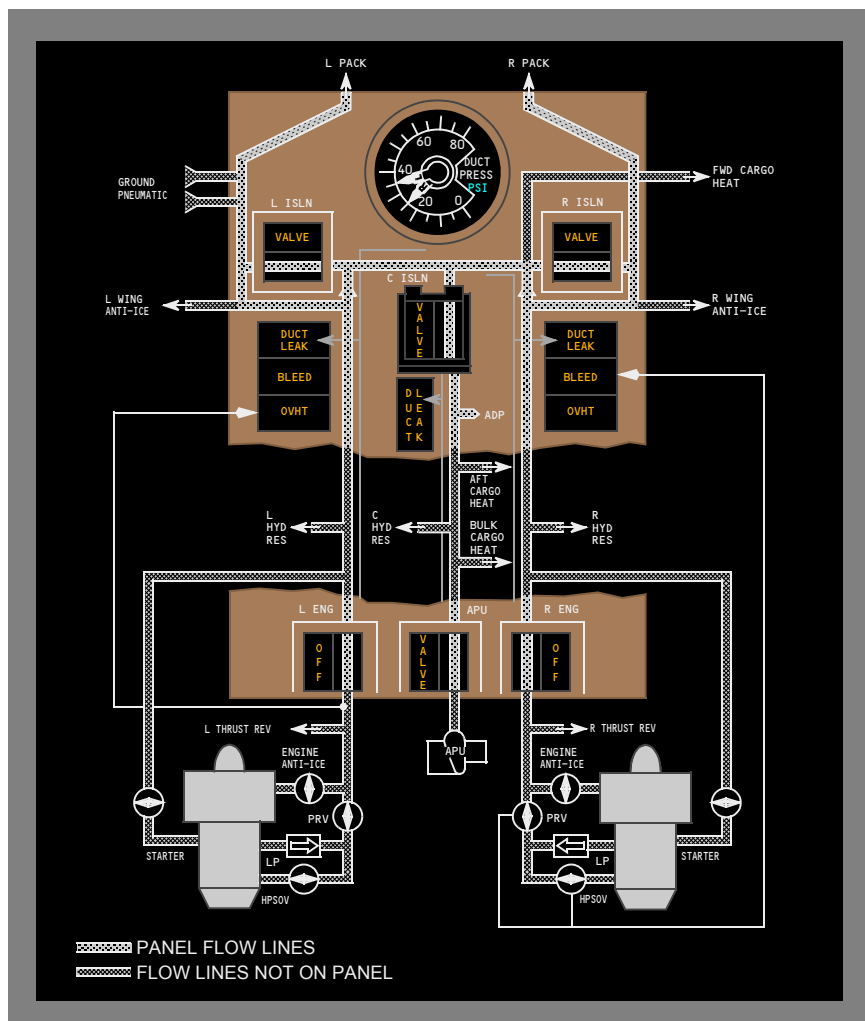
Bleed air overheat protection is provided by a bleed air temperature sensor. A higher than normal temperature causes a L or R ENG BLD OVHT advisory message to appear and the engine bleed air OVHT light to illuminate. If a bleed overheat occurs, the engine bleed air valve is automatically closed. With the engine bleed air valve closed, the HPSOV and PRV are closed. Activation of engine anti-ice will cause the PRV to open to provide cowl anti-ice unless a strut duct leak exists.

Bleed Air System Schematic

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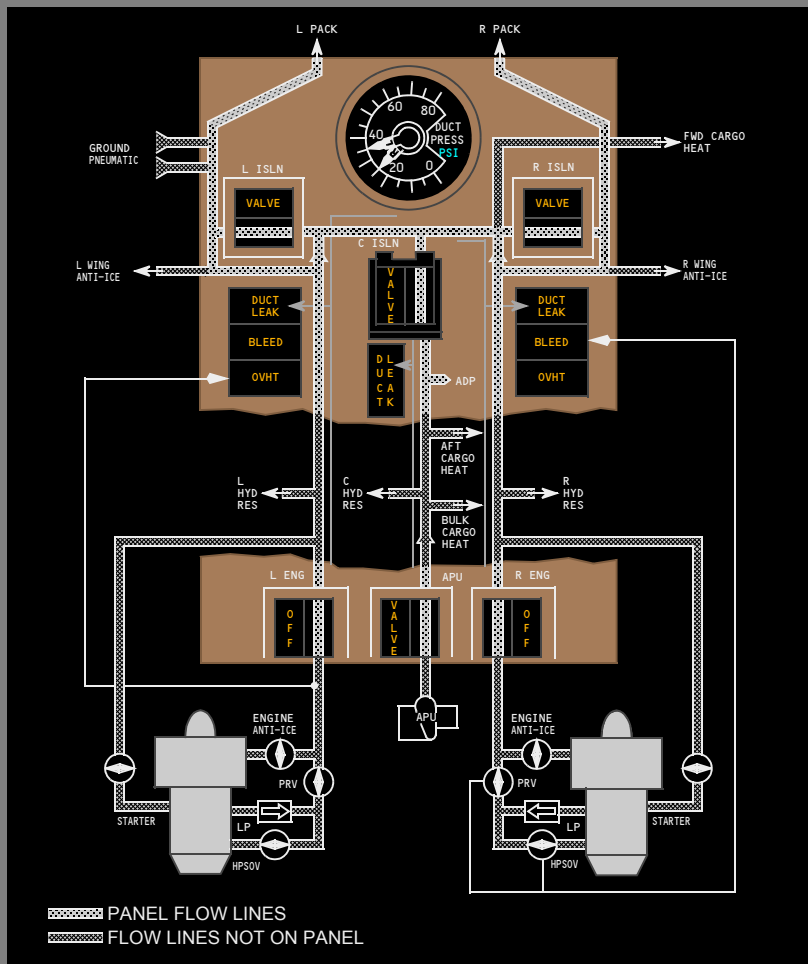
1501-1506, 1521, 1601-1613, 1701-1708



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Air Systems -
Bleed Air System Description

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Air Systems

Air Systems EICAS Messages

Chapter 2

Section 50

Air Systems EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
APU BLEED VAL	Advisory	VALVE		APU bleed valve position disagrees with the commanded position.
L BLD DUCT LEAK R BLD DUCT LEAK BODY DUCT LEAK	Caution	DUCT LEAK	Beeper	A high temperature bleed air leak is detected.
C BLD ISLN VAL L BLD ISLN VAL R BLD ISLN VAL	Advisory	VALVE		Bleed isolation valve position disagrees with the commanded position.
CABIN ALTITUDE	Warning	CABIN ALTITUDE CABIN ALT	Siren	Cabin altitude excessive.
CABIN AUTO INOP	Caution	AUTO INOP	Beeper	Automatic pressurization control has failed or the cabin altitude mode selector is in manual.
AFT CABIN TEMP FWD CABIN TEMP MID CABIN TEMP	Advisory	INOP		A fault in the zone temperature controller, compartment temperature control is in the OFF position, or trim air switch OFF.

Message	Level	Light	Aural	Condition
AFT CARGO OVHT BULK CARGO OVHT FWD CARGO OVHT	Advisory	OVHT		Cargo compartment temperature above standard control range.
L ENG BLEED OFF R ENG BLEED OFF	Advisory	OFF		Engine bleed air valve is closed for a system fault.

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L ENG BLD OVHT R ENG BLD OVHT	Advisory	OVHT		Engine bleed air temperature is excessive.

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L ENG BLEED VAL R ENG BLEED VAL	Caution	BLEED	Beeper	Engine high pressure bleed valve is open when commanded closed.

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L ENG HI STAGE R ENG HI STAGE	Advisory	HI STAGE		Engine bleed air temperature is excessive.

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L ENG HPSOV R ENG HPSOV	Advisory	BLEED		High pressure bleed air valve is open when commanded closed.

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L ENG PRV R ENG PRV	Advisory	BLEED		Pressure regulating valve is open when commanded closed.

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Message	Level	Light	Aural	Condition
FWD EQPT COOLING	Caution	NO COOLING	Beeper	OVRD selected and no reverse airflow detected through the E/E compartment avionics.
FWD EQPT OVHT	Advisory	OVHT	Ground crew call horn on ground	High temperature or low airflow in equipment cooling system.
FWD EQPT SMOKE	Advisory	SMOKE		Smoke detected in the forward equipment cooling ducts.
FWD EQPT VAL	Advisory	VALVE		An equipment cooling valve not in commanded position.
FLT DECK TEMP	Advisory	INOP		A fault in the zone temperature controller or trim air switch OFF.
L PACK OFF R PACK OFF	Advisory	PACK OFF		Pack valve is closed.
L PACK TEMP R PACK TEMP	Advisory	INOP		Automatic control system fault or overheat.
L RECIR FAN R RECIR FAN	Advisory	INOP		Fan is failed or not operating.

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L STRUT DCT LEAK R STRUT DCT LEAK	Caution	DUCT LEAK	Beeper	A high temperature bleed air leak is detected.

TRIM AIR	Advisory	OFF		Trim air switch OFF.

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Anti-Ice, Rain

Chapter 3

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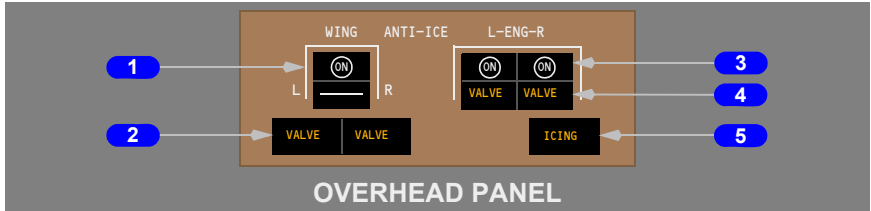
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Anti-Ice, Rain Controls and Indicators

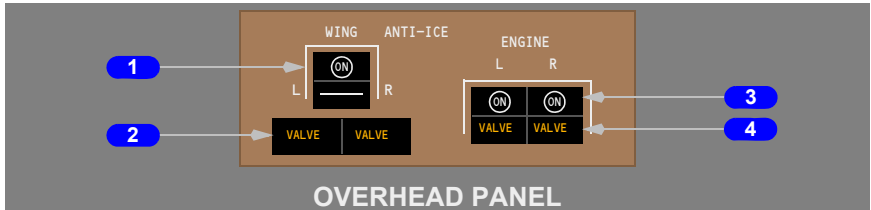
Chapter 3 Section 10

Manual Anti-Ice Panel

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1501-1506, 1521



1 WING ANTI-ICE Switch

ON – in flight, both wing anti-ice valves are commanded open.

Off (ON not visible) – both wing anti-ice valves are commanded closed.

2 Wing Anti-Ice VALVE Lights

Illuminated (amber) – wing anti-ice valve position disagrees with the switch position.

3 ENGINE ANTI-ICE Switches

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

Off (ON not visible) – the engine anti-ice valve is commanded closed.

4 Engine Anti-Ice VALVE Lights

Illuminated (amber) – engine anti-ice valve position disagrees with the switch position.

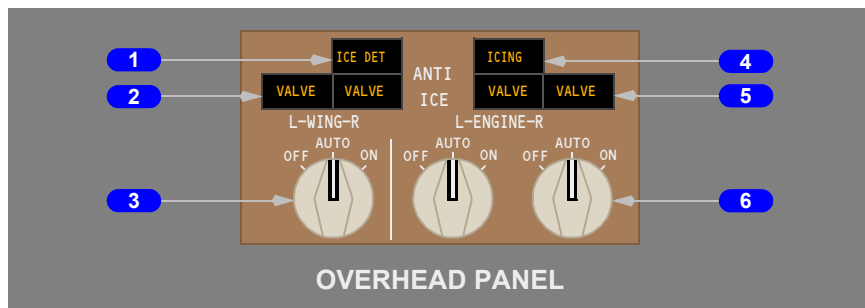
5 ICING Light

121-139, 1401-1404

Illuminated (amber) – ice detection system indicates ice buildup on the airplane.

Automatic Anti-Ice Panel

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1 Ice Detector (ICE DET) Light

Illuminated (amber) – ice detector system is failed.

2 Wing Anti-Ice VALVE Lights

Illuminated (amber) – engine or wing anti-ice is manually selected OFF or an anti-ice valve is closed and engine/wing icing is detected.

3 WING ANTI-ICE Selector

OFF – wing anti-ice commanded off.

AUTO – wing anti-ice automatically commanded on or off as directed by the primary ice detection system.

ON – wing anti-ice commanded on.

4 ICING Light

Illuminated (amber) – engine/wing icing is detected and either engine or wing anti-ice is manually selected OFF or an anti-ice valve is closed.

5 Engine Anti-Ice VALVE Lights

Illuminated (amber) – engine anti-ice valve position disagrees with the commanded position.

6 ENGINE ANTI-ICE Selectors

OFF – engine anti-ice valve is commanded closed.

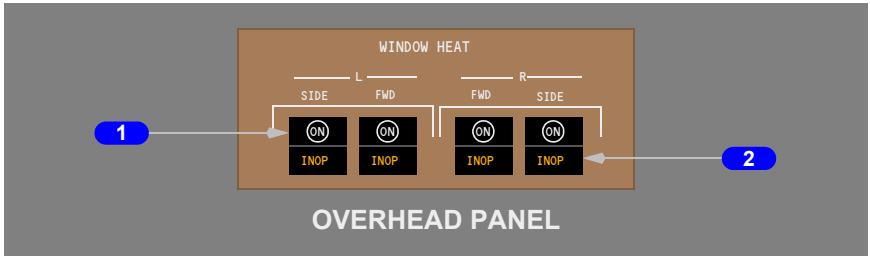
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AUTO – engine anti-ice valve is automatically commanded open or closed as directed by the primary ice detection system.

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

Window Heat and Wiper Panels

Window Heat Panel



1 WINDOW HEAT Switches

ON – window heat is applied to the selected windows.

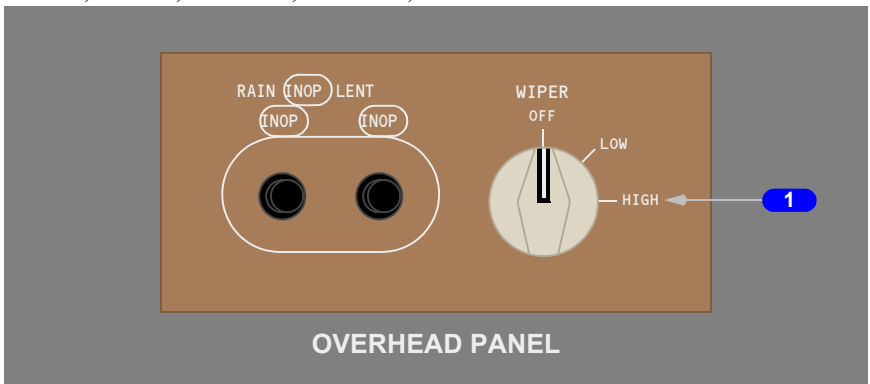
Off (ON not visible) – window heat is removed from the selected windows

2 Window Heat Inoperative (INOP) Lights

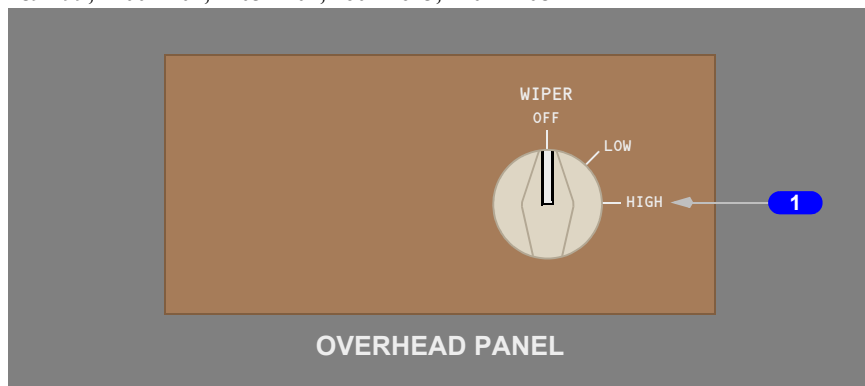
Illuminated (amber) – the window is not being heated.

Wiper Panel

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1 WIPER Selector

OFF – the wipers are stowed at the base of the windows.

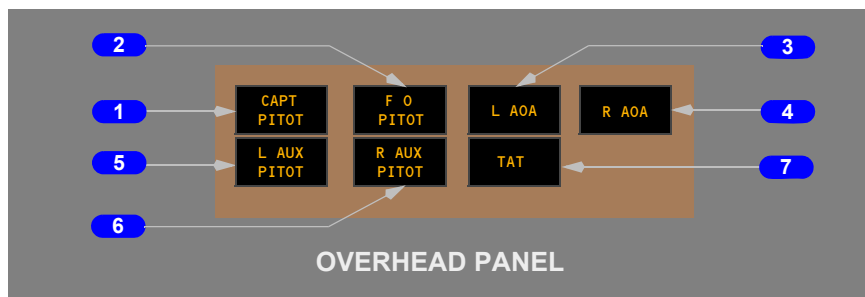
LOW – the wipers operate at low speed.

HIGH – the wipers operate at high speed.

2 RAIN REPELLENT Switches

System is deactivated and the switch is placarded inoperative.

Probe Heat Lights



1 Captain Pitot (CAPT PITOT) Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

2 First Officer Pitot (FO PITOT) Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.



3 Left Angle of Attack (L AOA) Probe Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

4 Right Angle of Attack (R AOA) Probe Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

5 Left Auxiliary Pitot (L AUX PITOT) Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

6 Right Auxiliary Pitot (R AUX PITOT) Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

7 Total Air Temperature (TAT) Probe Light

Illuminated (amber) – probe is not being heated in flight or neither engine is running on the ground.

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Anti-Ice, Rain System Description

Chapter 3 Section 20

Introduction

The anti-ice and rain systems include:

- engine anti-ice
- wing anti-ice
- flight deck window heat
- windshield wipers
- probe heat

Engine Anti-Ice System

The engine anti-ice system uses engine bleed air to provide engine cowl inlet ice protection. Engine anti-ice can be operated in flight or on the ground. The left and right engines have identical, independent anti-ice systems. This allows the remaining system to operate if one engine fails.

171-199, 1200-1201, 1401-1404

The engine thermal anti-ice (TAI) annunciation appears above the EICAS N1 indication when an engine anti-ice switch is on.

121-139, 1501-1506, 1521, 1601-1613, 1701-1708

The engine thermal anti-ice (TAI) annunciation appears below the EICAS N1 indication when an engine anti-ice switch is on.

The VALVE light illuminates and the EICAS advisory message L or R ENG ANTI-ICE displays when the engine anti-ice valve disagrees with the switch position.

Wing Anti-Ice System

The wing anti-ice system provides bleed air to the three outboard leading edge slats on each wing. Wing anti-ice can be operated in flight only. It is inhibited on the ground.

The VALVE light illuminates and the EICAS advisory message L or R WING ANTI-ICE displays if the wing anti-ice valve disagrees with the switch position.

Manual Anti-Ice System Operation

121-139, 1401-1404, 1501-1506, 1521

Engine Anti-Ice Operation

On the ground or in flight, pushing the ENGINE ANTI-ICE switches ON commands the engine anti-ice valves to open, and allows engine bleed air to anti-ice the engine cowl inlets. Pushing the ENGINE ANTI-ICE switches again commands the engine anti-ice valves to close, and stops engine bleed air from anti-icing the engine cowl inlets.

Wing Anti-Ice Operation

In flight, pushing the WING ANTI-ICE switch ON commands the wing anti-ice valve in each wing to open, allowing bleed air to flow from the bleed air manifold to the affected slats. Pushing the WING ANTI-ICE switch again commands the wing anti-ice valve in each wing to close, stopping bleed air from flowing from the bleed air manifold to the affected slats.

Advisory Ice Detection System

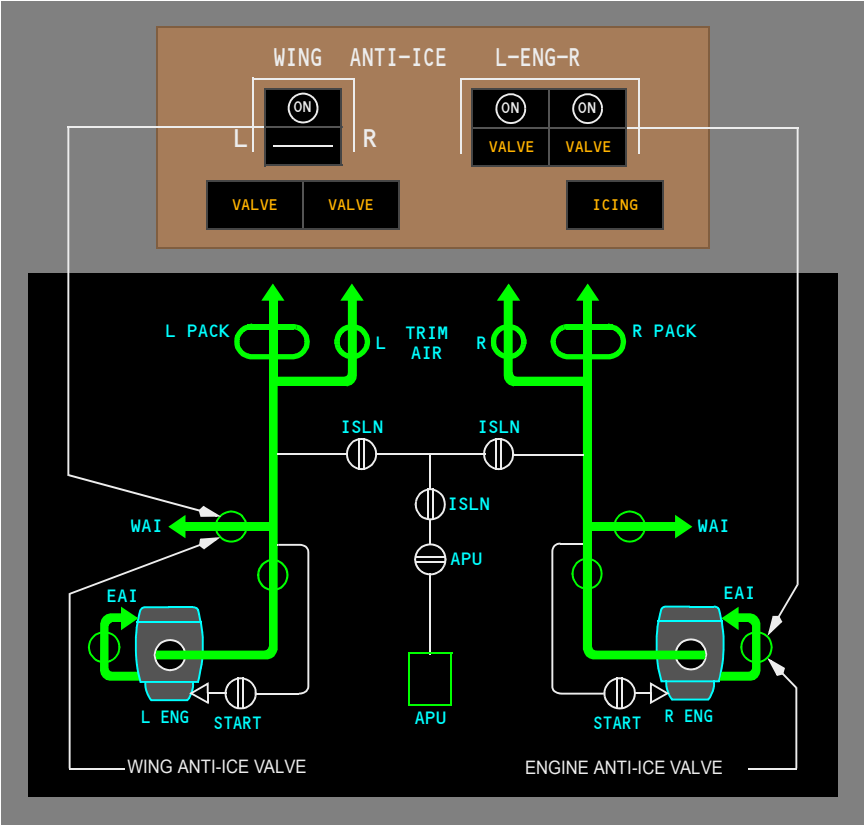
121-139, 1401-1404

An ice detecting sensor is installed on the nose of the airplane. When the sensor detects ice, the amber ICING light illuminates and the EICAS advisory message, ICE DET ON displays. When the sensor no longer detects ice, the ICING light extinguishes and the EICAS message ICE DET OFF displays.

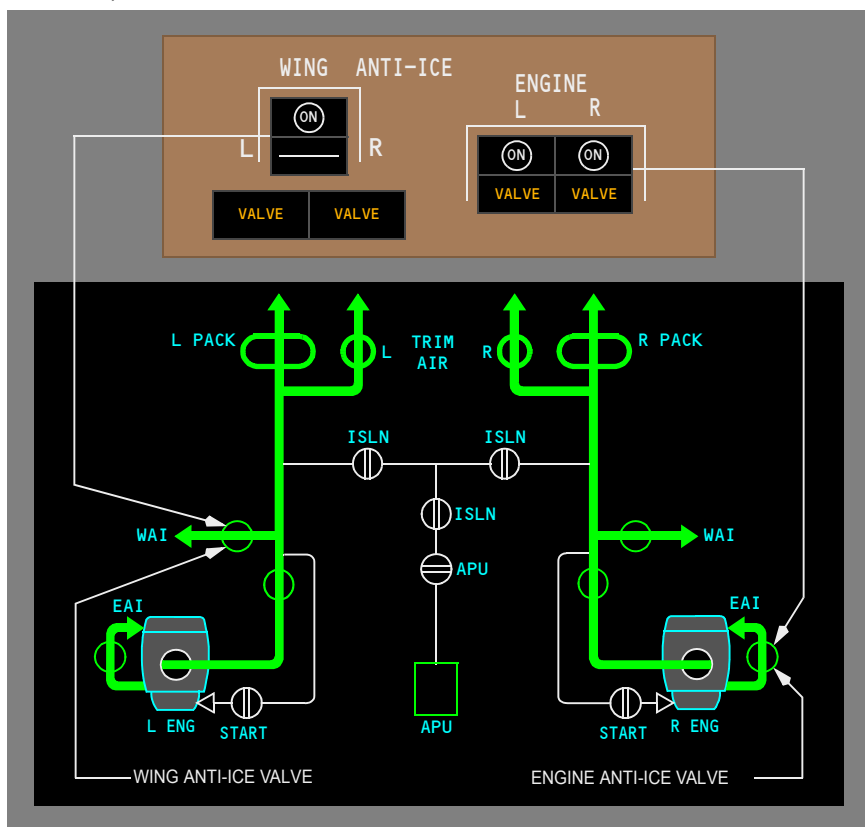
The system operates in an advisory capacity only. Flight crew action is required to activate and deactivate the engine and wing anti-ice systems.

Anti-Ice System Schematic

121-139, 1401-1404



1501-1506, 1521



Automatic Ice Detection System

171-199, 1200-1201, 1601-1613, 1701-1708

The automatic ice detection system detects airplane icing in flight. Automatic ice detection is inhibited on the ground. The system provides signals to control the engine and wing anti-ice system when those systems are in the automatic mode.

The system consists of two ice detector probes, one on each side of the forward fuselage. If the probes detect ice build-up they are automatically de-iced. Each occurrence of ice build-up and subsequent deicing of the probes is accounted for by system logic as a cycle.

When system logic determines that the predetermined number of cycles for engine anti-ice activation have occurred, it activates engine anti-ice. Likewise, when system logic determines that the predetermined number of cycles for wing anti-ice activation have occurred, it activates wing anti-ice.

When icing is no longer detected, system logic deactivates engine anti-ice and wing anti-ice.

The ICE DET light illuminates and the EICAS advisory message ICE DETECTOR displays if the ice detector system is failed.

Engine Anti-Ice

The ICING light illuminates and the EICAS caution message ICING ENGINE displays in flight when the ice detection system detects ice and either the Engine Anti-Ice Selector is OFF or the anti-ice valve is closed.

Engine Anti-Ice Automatic Operation

In flight, when the Engine Anti-Ice Selectors are in AUTO, engine anti-ice system operation is automatic. When system logic determines that engine anti-ice is required, it opens the engine anti-ice valves, and bleed air is automatically supplied to the engine cowl inlets.

When system logic determines that engine anti-ice is no longer required, it closes the engine anti-ice valves, and bleed air is no longer supplied to the engine cowl inlets.

Engine Anti-Ice Manual Operation

On the ground or in flight, placing the Engine Anti-Ice Selectors ON opens the engine anti-ice valves and allows engine bleed air to anti-ice the engine cowl inlets. Placing the Engine Anti-Ice Selector OFF closes the engine anti-ice valves and removes engine bleed air from the engine cowl inlets.

Wing Anti-ice

The ICING light illuminates and the EICAS advisory message ICING WING displays in flight when the ice detection system detects ice and either the Wing Anti-Ice Selector is OFF or the anti-ice valve is closed.

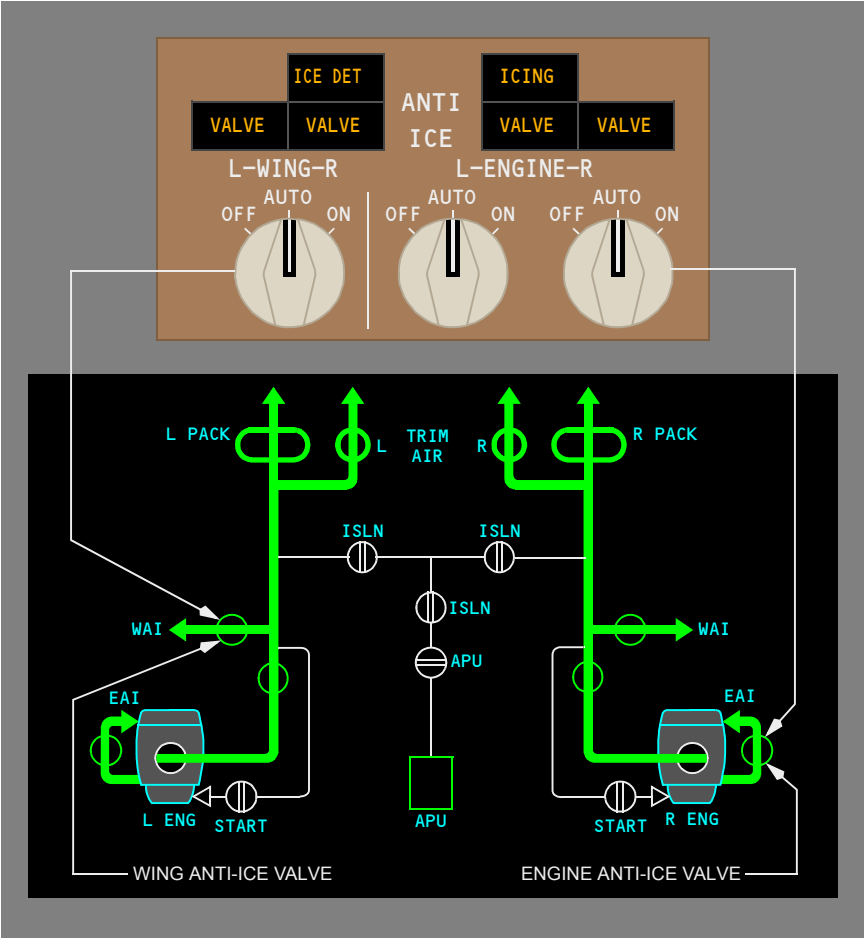
Wing Anti-Ice Automatic Operation

In flight, when the Wing Anti-Ice Selector is in AUTO, wing anti-ice system operation is automatic. When system logic determines that wing anti-ice is required, it opens the wing anti-ice valves, and bleed air is automatically supplied to the affected slats. When system logic determines that wing anti-ice is no longer required, it closes the wing anti-ice valves, and bleed air is no longer supplied to the slats.

Wing Anti-Ice Manual Operation

In flight, placing the Wing Anti-Ice Selector ON opens the wing anti-ice valve in each wing, allowing bleed air to flow from the bleed air manifold to the affected slats. Placing the Wing Anti-Ice Selector OFF closes the wing anti-ice valve in each wing, preventing bleed air from flowing from the bleed air manifold to the slats.

Anti-Ice System Schematic
171-199, 1200-1201, 1601-1613, 1701-1708



Flight Deck Window Heat

All flight deck windows are electrically heated. The forward windows have anti-icing protection and anti-fogging. The side windows have anti-fogging protection only.

The WINDOW HEAT switches control heating for all flight deck windows. With the switches ON, window heat operates as soon as electrical power is established. The windows are protected from thermal shock when the switches are initially placed ON.

In addition to the electric heating, conditioned air is ducted to the top of the forward windows and then flows along the inside surface to provide supplemental anti-fogging. The anti-fogging airflow is continuous and is independent of electric window heat.

One INOP light illuminates and the EICAS advisory message L or R FWD WINDOW or L or R SIDE WINDOW displays to indicate a window is not being heated. If two or more INOP lights illuminate, the EICAS advisory message WINDOW HEAT displays.

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

The WINDOW HEAT EICAS message displays, and electrical power for the aft-most cockpit window heat is load shed when the Fuel Jettison Switch is selected ON. Electrical power is reset, and the WINDOW HEAT EICAS message no longer displays when the Fuel Jettison Switch is selected OFF.

Windshield Wipers

The forward windows are equipped with two-speed wipers. One selector controls both wipers. With the WIPER selector in the OFF position, the wipers are off and stowed.

Probe Heat

Operation of the probe heat system is fully automatic. Power to the electrically heated probes is applied any time an engine is running.

An individual probe heat light illuminates and the associated EICAS advisory message displays when a probe is not being heated. If two or more probe lights illuminate, the EICAS advisory message PROBE HEAT displays.

Anti-Ice, Rain EICAS Messages

Chapter 3 Section 30

Anti-Ice EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
L AOA PROBE R AOA PROBE	Advisory	L AOA R AOA		AOA probe heat is inoperative.
L AUX PITOT R AUX PITOT	Advisory	L AUX PITOT R AUX PITOT		Left aux or right aux pitot heat is inoperative.
CAPT PITOT	Advisory	CAPT PITOT		Captain's pitot probe heat is inoperative.
L ENG ANTI-ICE R ENG ANTI-ICE	Advisory	VALVE		Engine anti-ice valve disagrees with switch position.
F/O PITOT	Advisory	F O PITOT		First officer's pitot probe heat is inoperative.

121-139, 1401-1404

ICE DET OFF	Advisory			Icing is no longer detected.
ICE DET ON	Advisory	ICING		Icing is detected.

171-199, 1200-1201, 1601-1613, 1701-1708

Message	Level	Light	Aural	Condition
ICE DETECTOR	Advisory	ICE DET		Ice detection system is failed.
ICING ENGINE	Caution	ICING	Beeper	Ice detection system detects ice and either Engine Anti-Ice Selector is OFF or anti-ice valve is closed.
ICING WING	Advisory	ICING		Ice detection system detects ice and either Wing Anti-Ice Selector is OFF or anti-ice valve is closed.
PROBE HEAT	Advisory	Two or more PITOT, AOA or TAT		Two or more probe heats are inoperative.
TAT PROBE	Advisory	TAT		TAT probe heat is inoperative.
L FWD WINDOW R FWD WINDOW	Advisory	INOP		Window is not being heated.
L SIDE WINDOW R SIDE WINDOW	Advisory	INOP		Window is not being heated.
WINDOW HEAT	Advisory	Two or more INOP		Two or more windows are not being heated.
L WING ANTI-ICE R WING ANTI-ICE	Advisory	VALVE		Wing anti-ice valve disagrees with switch position.

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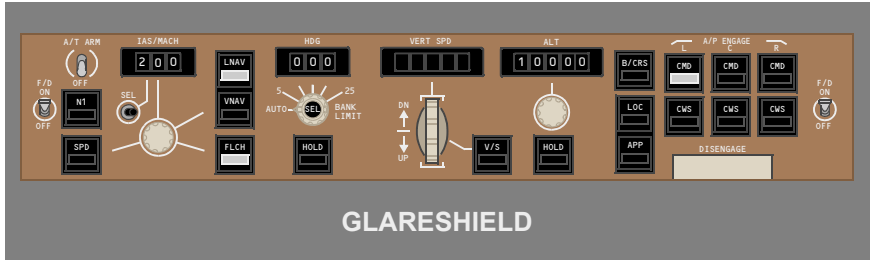
Automatic Flight Controls and Indicators

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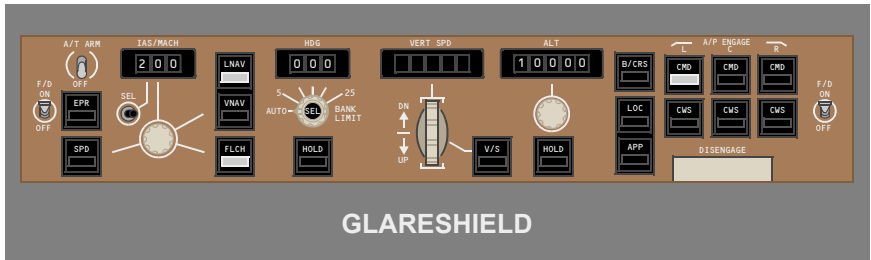
Mode Control Panel (MCP)

Note: Mode control panels are interchangeable and may not match the as delivered configuration depicted in this manual.

121-139, 1501-1506, 1521



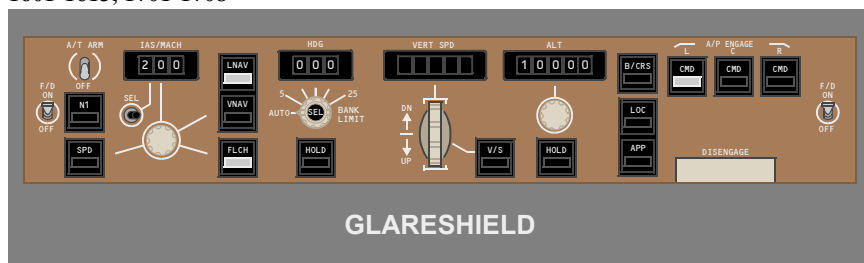
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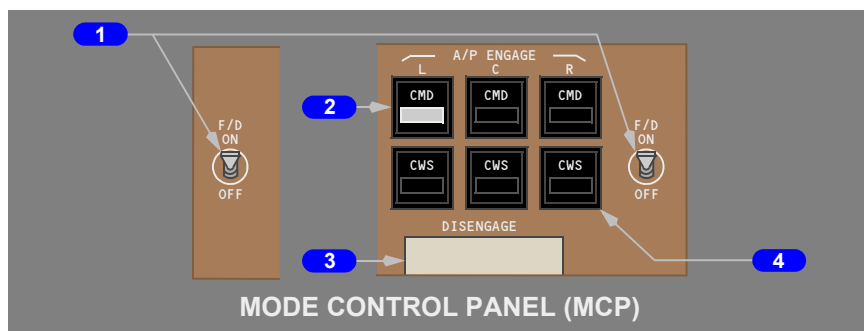
197-199, 1200-1201, 1403-1404



1601-1613, 1701-1708



Autopilot Flight Director System (AFDS) Controls



1 Flight Director (F/D) Switches

The left and right flight director switches activate flight director steering indications on their respective flight mode annunciator (FMA).

ON – respective pilots command bars operate in current AFDS mode.

- On the ground with no autopilot engaged and both F/D switches OFF, the first F/D switch positioned to ON arms the flight director in the takeoff (TO) roll and pitch modes. Positioning the second F/D switch to ON displays the flight director steering indications on the second FMA
- In flight, with the autopilot engaged and both F/D switches OFF, the first F/D switch positioned to ON activates the flight director in the selected autopilot mode(s)
- In flight with the autopilot disengaged and both F/D switches OFF, the first F/D switch positioned to ON engages the flight director in:
 - V/S as the pitch mode and HDG HOLD as the roll mode

OFF –

- flight director steering indications do not display, unless
- the go-around switch is pushed when airspeed is greater than 80 knots with the flaps not retracted

2 Autopilot (A/P) ENGAGE Switches

Push (any switch can engage the autopilot) –

- CMD displays on each FMA
- if either F/D switch is ON, the autopilot engages in the selected flight director mode(s) except TO and GA
- if both F/D switches are OFF, the autopilot engages in:
 - V/S as the pitch mode and HDG HOLD as the roll mode

3 Autopilot DISENGAGE Bar

Push down –

- disengages all three autopilots
- prevents autopilot engagement
- exposes amber stripe

Lift up –

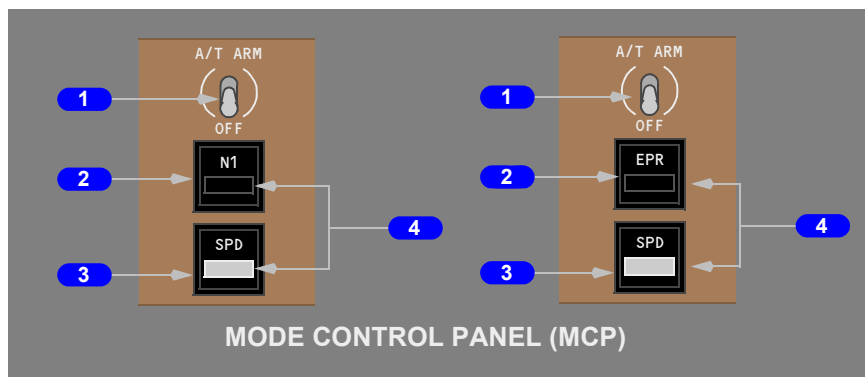
- enables autopilot engagement
- conceals amber stripe

4 Control Wheel Steering (CWS) Switches (as installed)

Push (any switch can engage the control wheel steering) –

- if airplane attitude at engagement exceeds autopilot limits of 30 degrees nose up, 30 degrees nose down or 30 degrees bank, the autopilot returns to these attitude limits
- if control wheel force is released with less than 3 degrees bank (1 degree after LOC capture), autopilot levels wings and holds heading
- with an autopilot in CWS, the flight directors can be operated in command modes
- CWS appears on each FMA
- autopilot pitch and roll are controlled through control wheel and control column pressures

Autothrottle (A/T) System Controls



1 Autothrottle (A/T) ARM Switch

ARM –

- arms autothrottle system for mode selection
- autothrottle operates when N1/EPR, SPD, V NAV, FL CH, or GA switch pushed
- autothrottle operates when SPD switch pushed and pitch mode is ALT HOLD, V/S or G/S

OFF – disconnects autothrottle and prevents autothrottle engagement.

2 N1 Switch/Engine Pressure Ratio EPR Switch

Push –

- selects autothrottle N1/EPR mode
- N1/EPR annunciates on each FMA
- autothrottle holds reference thrust value displayed on EICAS subject to maximum speed limits
- changes thrust reference from TO to CLB if above 400 feet radio altitude
- updates FMC position to takeoff runway threshold position when selected for takeoff only if GPS NAV is OFF (i.e., GPS NAV data not available to the FMC)

3 Speed (SPD) Switch

Push –

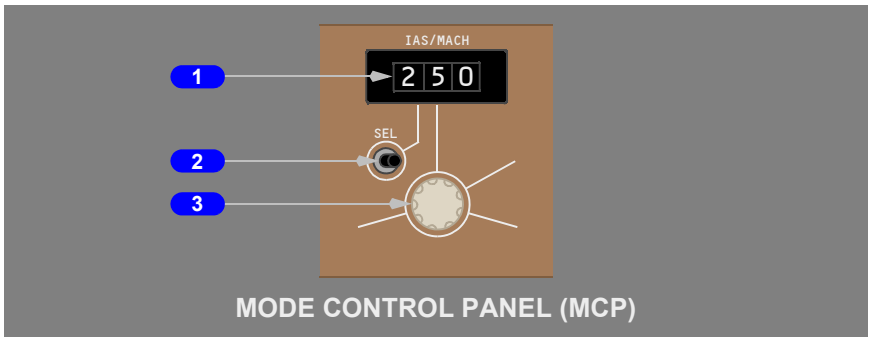
- selects autothrottle SPD mode
- SPD appears on each FMA

- autothrottle controls thrust to maintain IAS or MACH displayed in the speed window subject to minimum and maximum speed limits
- changes thrust reference from TO to CLB if above 400 feet radio altitude

4 MCP Mode Switch Lights

All MCP mode switches contain an annunciator light that illuminates when the mode switch is selected to indicate the mode is either engaged or armed.

Autopilot Flight Director IAS/MACH Controls



1 IAS/MACH Window

Displays selected speed when IAS/MACH selector controls command speed.

Displays 200 knots when power first applied.

Blank when FMC is controlling command airspeed bugs.

Display range:

- 0.40 – 0.95 MACH
- 100 – 399 KIAS

In climb, changes from IAS to MACH at approximately .80 MACH.

In descent, changes from MACH to IAS at approximately 300 KIAS.

2 Select (SEL) Switch

Push – alternately changes the IAS/MACH window between IAS and MACH.

3 IAS/MACH Selector

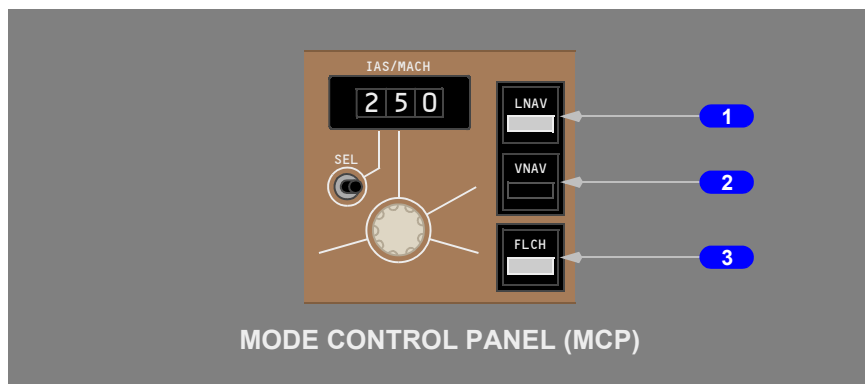
Rotate –

- sets speed in IAS/MACH window and positions command airspeed bugs
- inoperative when IAS/MACH window blank

Push – when VNAV mode is engaged, alternately changes IAS/MACH window between current IAS or MACH and a blank display.

- VNAV active, window opens and speed control transfers from FMC target speed to IAS/MACH selector
- descending in VNAV PTH, pitch mode changes to VNAV SPD. Selected speed maintained by pitch until airplane intercepts an altitude constraint and VNAV PTH reengages. Although, if on approach, pitch mode remains in VNAV PTH and autothrottle controls speed

Autopilot Flight Director Roll and Pitch Controls



1 Lateral Navigation (L NAV) Switch

Push –

Arms, engages or disarms LNAV as the roll mode.

- Displays LNAV in white (armed) on the roll flight mode annunciator when armed. The previous roll mode remains active.
- LNAV engages if the airplane is above 50 feet radio altitude and:
 - within 2.5 NM of the active leg
 - if not within 2.5 NM of the active leg and on an intercept heading to the active leg, remains armed then engages when approaching the active leg
- when engaged, displays LNAV in green on roll flight mode annunciator
- selection of LNAV with the airplane not on a heading which intercepts the active leg, displays NOT ON INTERCEPT HEADING in the CDU scratch pads.
- Selection of LNAV when an active FMC route is not available displays NO ACTIVE ROUTE in the CDU scratchpad.

LNAV maintains current heading when:

- passing the last active route waypoint
- passing the last waypoint prior to a route discontinuity
- passing the last route offset waypoint
- activating the inactive route or activating an airway intercept and not within LNAV engagement criteria

LNAV deactivates:

- by selecting heading hold (HDG HOLD) or heading select (HDG SEL)
- when localizer is captured
- if there is a dual FMC failure (LNAV may be re-engaged if there is an active CDU ALTN NAV route available.
- by pushing LNAV switch a second time when LNAV is armed

2 Vertical Navigation (V NAV) Switch

Push –

- engages AFDS and A/T in VNAV mode
- VNAV PTH or VNAV SPD displays on each FMA
- AFDS and autothrottle follow vertical path and thrust guidance from FMCS
- changes thrust reference from TO to CLB if above 400 feet radio altitude

During climbs or descents, AFDS captures and holds altitude displayed in altitude window or FMC target altitude, whichever is reached first.

With VNAV engaged, pushing IAS/MACH selector permits manual speed selection. FMCs then use manually selected speeds for speed control.

VNAV deactivates:

- by selecting GA, FL CH, SPD or N1/EPR, V/S or ALT HOLD
- by pushing VNAV switch a second time when VNAV is armed
- when glideslope is captured
- in climb or descent, reaching altitude displayed in altitude window prior to reaching FMCs target altitude
- passing top of descent point if the MCP is not set to an altitude below cruise altitude

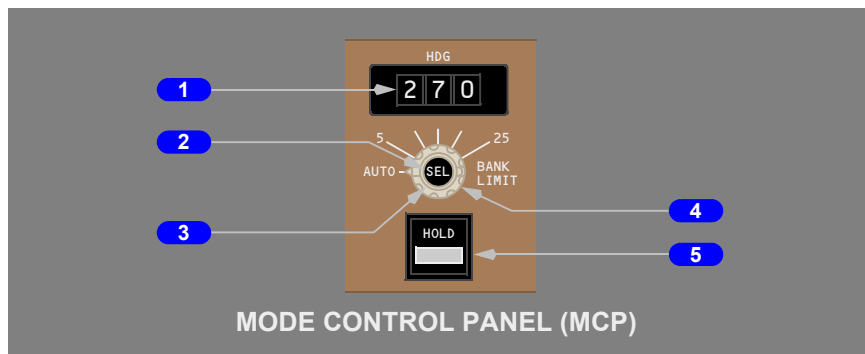
3 Flight Level Change (FL CH) Switch

Push –

- selects FLCH mode and sets IAS/MACH window and command airspeed bugs to current airspeed
- FLCH displays on each FMA

- AFDS pitch holds existing airspeed and A/T sets required thrust, limited by the thrust limit for climb and idle for descent. When selected altitude is reached, pitch mode changes to ALT HOLD and A/T changes to SPD mode
- with FLCH mode displayed, pushing switch resets IAS/MACH window and commands airspeed bugs to current airspeed
- changes thrust reference from TO to CLB if above 400 feet radio altitude

Autopilot Flight Director Heading and Bank Angle Controls



1

Displays selected heading and positions map display selected heading markers. HDG window and map display headings set to 000 when power first applied. Automatically changes to selected ILS front course heading at LOC capture.

2 Heading Select (SEL) Switch

Push –

- engages HDG SEL roll mode
- HDG SEL roll mode displays on each FMA
- AFDS controls roll to acquire and hold heading shown in heading window and on map display heading markers
- bank angle is limited by bank limit selector

3 Heading Selector (inner)

Rotate – sets heading in HDG window and positions selected heading marker on both map displays.

4 BANK LIMIT Selector (outer)

Rotate – sets AFDS commanded bank limit when in HDG SEL roll mode as follows:

AUTO – bank angle varies between 15 – 25 degrees, depending on true airspeed.

- at slower true airspeeds the bank angle limit is 25 degrees
- as true airspeed increases, the bank angle limit decreases

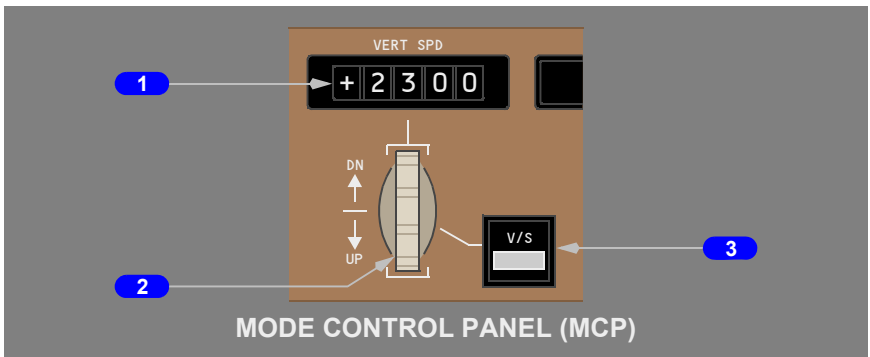
Manually selected – 5, 10, 15, 20, or 25 selected value is maximum regardless of airspeed.

5 Heading HOLD Switch

Push –

- selects HDG HOLD roll mode and displays on each FMA
- AFDS rolls wings level, then holds present heading

Autopilot Flight Director Vertical Speed (V/S) Controls



1 Vertical Speed (VERT SPD) Window

Displays selected vertical speed.

Blank when V/S pitch mode not selected.

Display range is from (–8000 to +6000 fpm) in 100 fpm increments.

2 Vertical Speed Selector (DN/UP)

UP or Down (DN) – sets vertical speed in VERT SPD window.

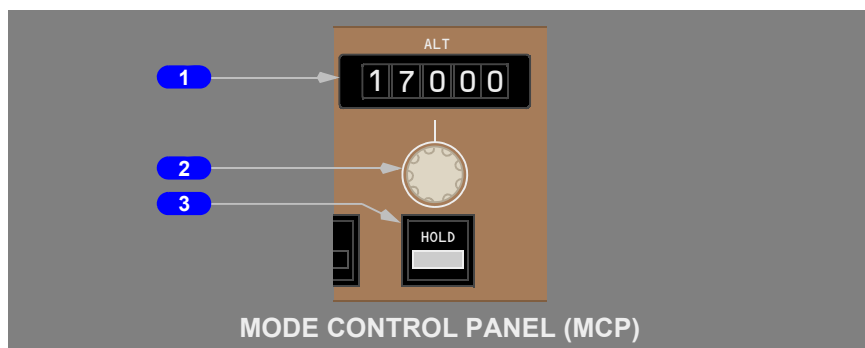
3 Vertical Speed (V/S) Switch

Push –

- selects V/S pitch mode and displays on each FMA
- displays current vertical speed in VERT SPD window

- when selected altitude reached, pitch flight mode annunciation changes to ALT HOLD
- AFDS pitch maintains vertical speed displayed in the VERT SPD window
- if AFDS is engaged in V/S from FLCH or from VNAV, A/T automatically engages in SPD mode if armed

Autopilot Flight Director Altitude Controls



1 Altitude (ALT) Window

Displays selected altitude in 100 feet increments. Range: 0 to 50,000 feet. Displayed altitude is reference altitude, for altitude alerting and level off. ALT window set to 10,000 feet when power is first applied.

2 Altitude Selector

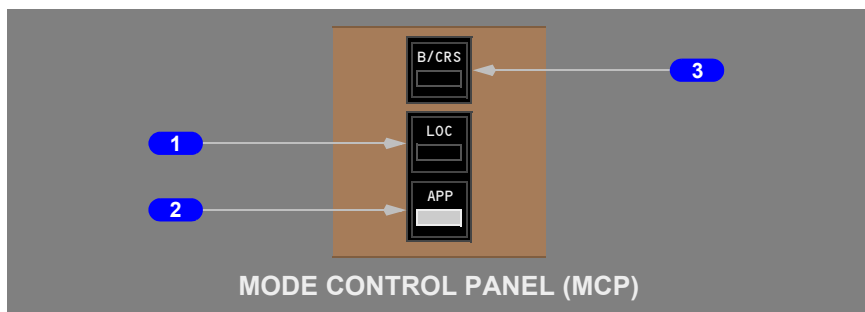
Rotate – sets altitude in ALT window.

3 Altitude HOLD Switch

Push –

- selects altitude ALT HOLD pitch mode
- ALT HOLD pitch mode displays on FMA pitch mode annunciation
- AFDS commands pitch to maintain the altitude when the switch was pushed

Autopilot Flight Director Approach Mode Controls



1 Localizer (LOC) Switch

Push –

- arms, disarms, captures LOC as roll mode
- displays LOC white (armed) on both FMA roll flight mode annunciations before localizer capture; current roll mode LNAV, HDG SEL or HDG HOLD remains active until LOC capture
- displays LOC green (engaged) on FMA roll flight mode annunciations after localizer capture
- arms AFDS to capture and track inbound on front course, capture point varies based on range and intercept angle
- localizer capture can occur when intercept track angle is within 120 degrees of the localizer course

Note: After localizer capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

Localizer mode can be disarmed before localizer capture by:

- pushing localizer switch a second time
- arming LNAV

Localizer mode can be deactivated after localizer capture by:

- pushing a GA switch
- selecting a roll mode other than LNAV
- disengaging the autopilot and turning both F/D switches off

Note: The LOC mode is a single autopilot function only. Multiple autopilots cannot be engaged with this mode.

2 Approach (APP) Switch

Push –

- autopilot systems powered by separate sources with three autopilots engaged
- arms, disarms, or captures LOC as roll mode and glideslope (G/S) as pitch mode
- displays LOC and G/S white (armed) on FMA roll and pitch flight mode annunciations prior to localizer and glideslope capture
- displays LOC and G/S green (engaged) on both FMA roll and pitch flight mode annunciations after each is captured
- localizer captures when intercept track angle is within 120 degrees of localizer course

Note: After localizer capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

- glideslope captures when the intercept track angle is within 80 degrees of localizer course
- AFDS captures and tracks localizer and glideslope upon intercepting the respective localizer and glideslope radio signals
- either localizer or glideslope can be captured first
- arms the other autopilot systems (CMD switch bars in view) for subsequent automatic engagement which occurs when localizer and glideslope are captured, and radio altitude is below 1,500 feet

Approach mode can be disarmed before localizer or glideslope capture by:

- pushing APP switch a second time
- pushing LOC switch (G/S disarms, LOC remains armed)
- pushing LNAV switch and LNAV arms (does not immediately engage)
- pushing VNAV switch and VNAV arms (does not immediately engage)

Approach mode deselects:

- with LOC captured and G/S armed, by selecting another roll mode other than LNAV; selecting LOC mode initiates a localizer approach.
- after LOC and/or G/S are captured, by selecting GA mode or disengage the autopilot and turning both F/D switches off
- with G/S captured and LOC armed, by selecting another pitch mode other than VNAV.

3 Backcourse (B/CRS) Switch (as installed)

Push – (Must be used concurrently with LOC switch), arms or engages AFDS in B/CRS mode as follows:

B/CRS appears on each FMA white (armed) prior to localizer capture.

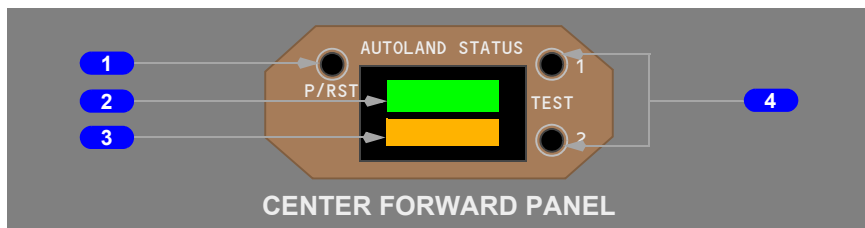
- AFDS is armed to capture and track inbound on backcourse of localizer
- capture point varies based on range and intercept angle
- initial roll modes; LNAV, HDG SEL or HDG HOLD remain engaged until B/CRS capture
- before localizer capture, pushing the LOC switch a second time disarms both the LOC and B/CRS modes. Pushing only the B/CRS switch a second time, disarms the B/CRS mode but the LOC mode remains armed

B/CRS appears on each FMA green (engaged) after localizer capture.

- AFDS tracks inbound on backcourse
- if the LOC switch is selected and localizer is captured before B/CRS switch is pushed, AFDS will track the localizer front course (outbound) and B/CRS cannot be selected
- G/S, FLARE and ROLLOUT functions are not available

Note: The B/CRS mode is a single autopilot function only. Multiple autopilots cannot be engaged with this mode.

Autoland Status



1 Push/Reset (P/RST) Switch

Push – resets both pilots annunciators as follows:

Before APP mode selected:

- changes NO AUTOLND or NO LAND 3 to blank,
- if condition is still present when switch release, annunciation returns

After APP mode selected:

- if NO LAND 3 displayed, becomes blank and remains blank until after landing and autopilots disengaged
- if NO AUTOLND displayed, remains displayed until autopilots are disengaged

2 AUTOLAND STATUS Annunciator (Upper)

Normal (blank) –

LAND 3 – (green)

- indicates all three autopilot systems and their associated supporting airplane system inputs are operating normally
- appears below 1500 feet radio altitude with LOC and G/S captured

LAND 2 – (green)

- indicates a minimum of two autopilot systems and their associated supporting airplane system inputs are operating normally
- appears below 1500 feet radio latitude with LOC and G/S captured

3 AUTOLAND STATUS Annunciator (Lower)

Normal (blank) –

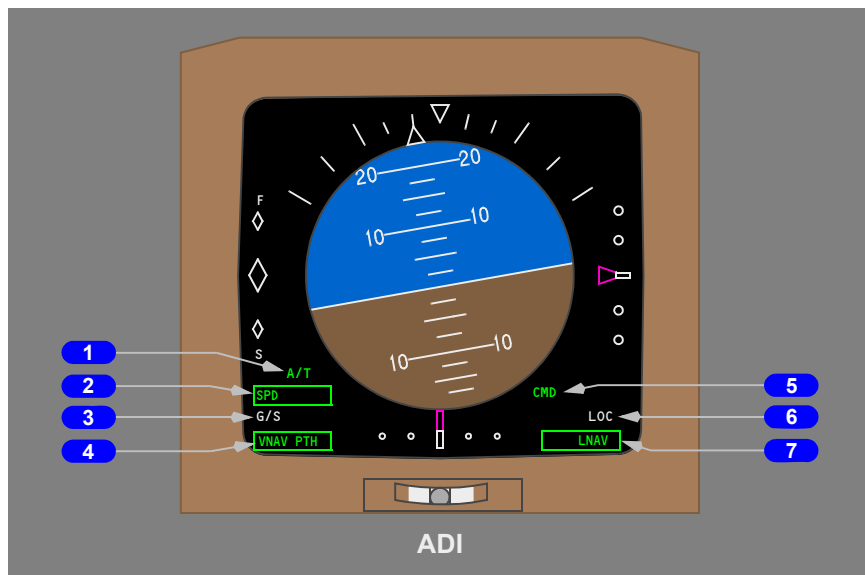
NO AUTOLND (amber) – indicates fault conditions exist which preclude the use of the autopilots for an automatic landing.

NO LAND 3 (amber) – indicates a fault condition exists which results in a LAND 2 condition

4 TEST Switches

Push – activates autoland status annunciator tests.

ADI Flight Mode Annunciations (FMAs)



1 Autothrottle Status

Displayed (green) – ****

- A/T
- F/S

2 Autothrottle Modes (Active)

Displayed (green) – ***

- N1/EPR
- SPD
- FLCH
- GA
- IDLE
- THR HOLD

Autothrottle Limits: displayed (green) – */***

- FLAP LIM
- SPD LIM

3 AFDS Pitch Modes (Armed)

Displayed (white) –

- G/S
- FLARE
- VNAV

4 AFDS Pitch Modes (Active)

Displayed (green) – **/***

- TO
- ALT HOLD
- V/S
- VNAV PTH
- VNAV SPD
- SPD
- G/S
- FLARE
- ALT CAP
- GA

AFDS Pitch Limits: displayed (green) – */***

- FLAP LIM
- SPD LIM

5 AFDS (Active)

Displayed (green) –

- CMD
- FD
- (as installed)**
 - FD CWS
 - CWS

6 AFDS Roll Modes (Armed)

Displayed (white) –

- LOC
- ROLLOUT
- LNAV
- B/CRS

7 AFDS Roll Modes (Active)

Displayed (green) – **/ ***

- HDG HOLD
- HDG SEL
- LNAV
- LOC
- ROLLOUT
- TO
- GA
- B/CRS

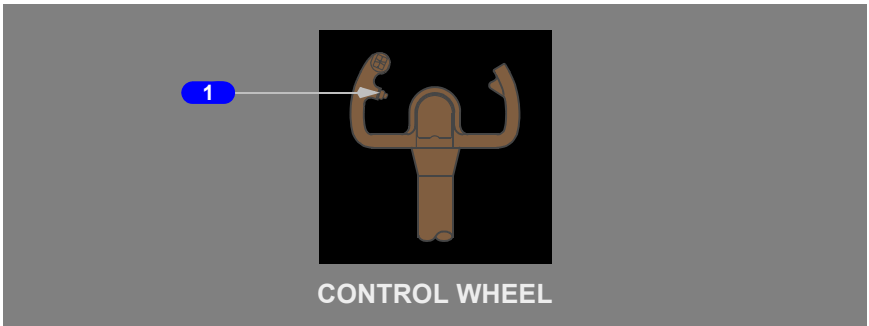
* Mode is operating with angle of attack (alpha) or airspeed limit. Limit mode annunciation replaces engaged mode annunciation.

** An amber horizontal line is drawn through the appropriate autopilot pitch or roll mode annunciation when a flight mode fault is detected.

***AFDS/Autothrottle mode changes are emphasized for 10 seconds by a box (green) drawn around the annunciated mode.

****F/S appears only when autothrottle is disengaged, AFDS is not operating in a speed mode (FLCH or GA) and the present airspeed is approaching either the SPD LIM, ALPHA, or FLAP LIM.

Autopilot Disengage Switch



1 Autopilot Disengage Switches

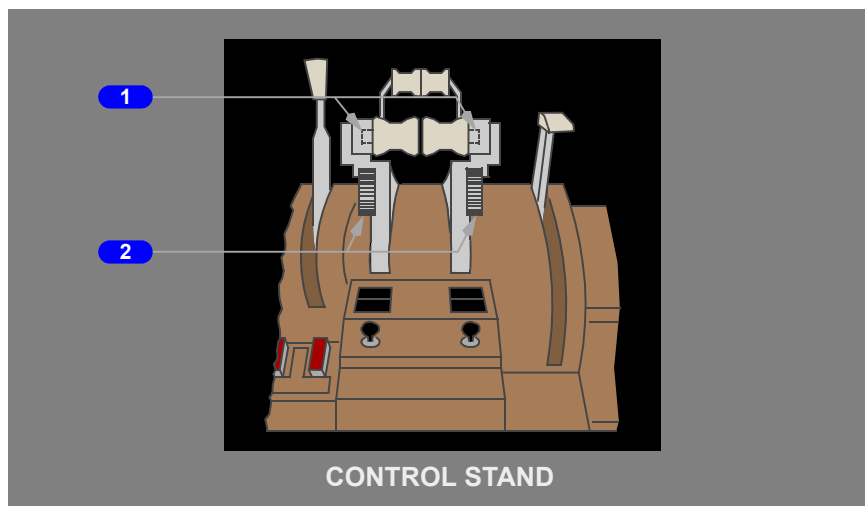
Push (either switch) –

- disconnects the autopilot
- A/P DISC and master warning lights illuminate
- displays the EICAS warning message AUTOPILOT DISC
- sounds an aural warning
- if the autopilot automatically disengages, resets the master warning lights, EICAS warning message, and the aural warning

Second push – resets

- the master warning light
- EICAS warning message
- the aural warning

Autothrottle Disconnect and Go-Around Switches



1 Autothrottle Disconnect Switches

Push (either switch) –

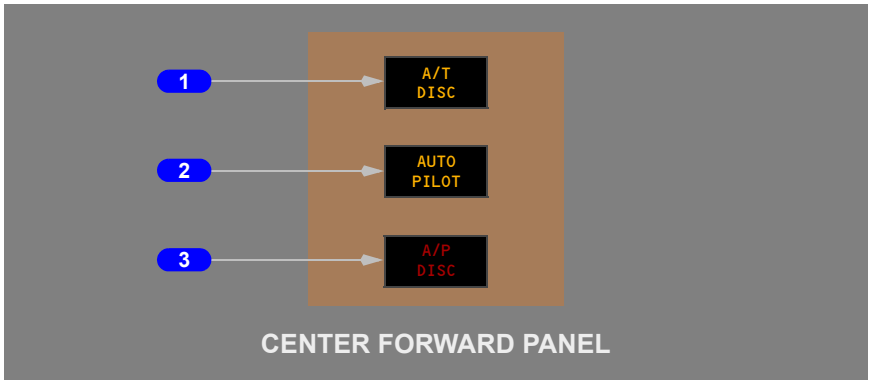
- disconnects autothrottle and A/T DISC light illuminates
- autothrottle remains armed
- subsequent push extinguishes A/T DISC light

2 Go-Around Switches

Push (either switch) –

- automatic arming occurs at glide slope capture or with extension of wing flaps
- engages AFDS and autothrottle in GA mode if previously armed
- provides windshear guidance during GA if windshear detected
- if flight director off, activates flight director in GA mode
- cancels all thrust derates if selected after takeoff

Autoflight Lights



1 Autothrottle Disconnect (A/T DISC) Light

Illuminated (amber) –

- autothrottle has disconnected
- extinguished by pushing either autothrottle disconnect switch

2 Autopilot (AUTO PILOT) Light

Illuminated (amber) –

- a degraded operating condition exists in engaged autopilot
- extinguished when condition is corrected or an alternate autopilot is selected, provided fault is not common to alternate autopilot

3 Autopilot Disconnect (A/P DISC) Light

Illuminated (red) –

- an autopilot has been automatically or manually disconnected
- extinguished by pushing either autopilot disengage switch

Intentionally
Blank

Automatic Flight System Description

Chapter 4 Section 20

Introduction

The automatic flight control system consists of the autopilot flight director system (AFDS) and the autothrottle system (A/T). The mode control panel (MCP) and flight management computer (FMC) control the AFDS and the autothrottle system to perform climb, cruise, descent and approach.

Autopilot Flight Director System

The AFDS consists of three flight control computers (FCCs) and the MCP.

The MCP provides control of the autopilot, flight director, altitude alert, and autothrottle systems. The MCP selects and activates AFDS modes, and establishes altitudes, speeds, and climb/descent profiles.

The three FCCs, left, center, and right, control separate hydraulically powered autopilot control servos to operate flight controls. The autopilot controls ailerons and elevators. Rudder commands are added only during a multiple autopilot approach. Nose wheel steering is also added during rollout from an automatic landing. During an ILS approach with all three autopilots engaged, separate electrical sources power the three FCCs.

The FCCs also provide inputs for AFDS operating mode displays and flight director commands on the FMA.

MCP Switches

MCP switches select automatic flight control and flight director modes. A light in the lower half of the switch illuminates to indicate the mode is armed or active. Respective roll and pitch flight mode annunciations on the FMA will also display. Autothrottle modes are discussed later in this section.

The following modes activate with a single push. These modes include:

- flight level change (FLCH)
- heading hold (HDG HOLD)
- heading select (HDG SEL)
- vertical speed (V/S)
- altitude hold (ALT HLD)

Other modes arm or activate with a single push. These modes are:

- lateral navigation (LNAV)
- vertical navigation (VNAV)
- localizer (LOC)
- approach (APP)
- back course localizer (B/CRS) (as installed)
- control wheel steering (CWS) (as installed)

All modes deactivate by disengaging the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can only be deactivated by disengaging the autopilot and turning both flight directors off or by selecting GA mode.

Desired target values can be selected on the MCP for:

- airspeed
- mach
- heading
- vertical speed
- altitude

All parameters except vertical speed can be preselected before autopilot and/or flight director engagement.

Autopilot Engagement

Autopilot engagement requires at least two FCCs and pushing one of the MCP autopilot engage switches.

Autopilot Disengagement

Normal autopilot disengagement is through either control wheel autopilot disengage switch.

The autopilots can also be disengaged by the MCP autopilot disengage bar.

The A/P DISC light illuminates and the EICAS warning message AUTOPILOT DISC displays when the autopilot has been manually or automatically disconnected.

AFDS Failures

During autopilot operation, failures affecting the active mode annunciate on the FMA. If the failure affects only the active mode:

- the autopilot remains engaged in an attitude stabilizing mode
- an amber line is drawn through the mode annunciation
- the AUTO PILOT light illuminates
- the EICAS caution message AUTOPILOT displays

If unwanted operation is noticed or when an autopilot failure is annunciated, the autopilot should be disconnected and the airplane flown manually.

Failures affecting all autopilot modes result in an autopilot disengagement accompanied by an aural warning. Depending on the system failure, it may be possible to reengage an autopilot by pushing the autopilot engage switch.

Flight Director Display

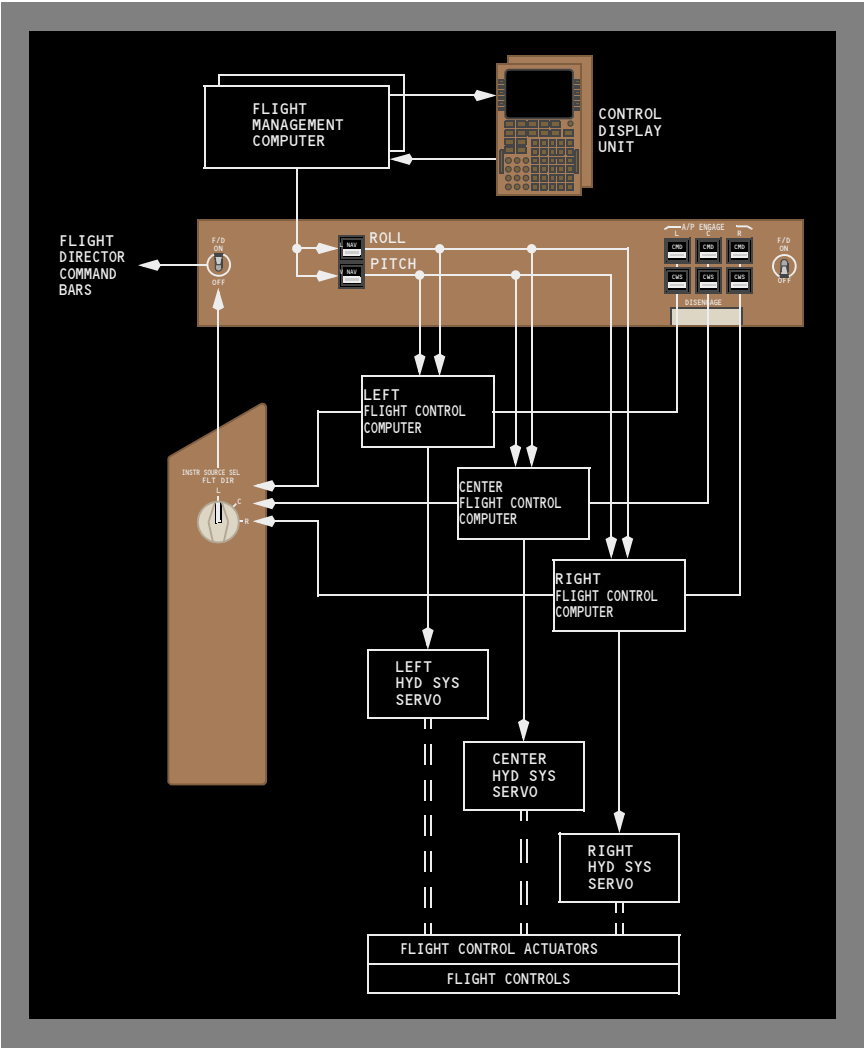
Flight director steering indications normally display any time the related F/D switch is ON.

The steering indications are also displayed when the related flight director switch is OFF and a go-around switch is pushed, if airspeed is greater than 80 knots and the flaps are not retracted. In this case, the flight director display can be removed by cycling the respective flight director switch on and then off.

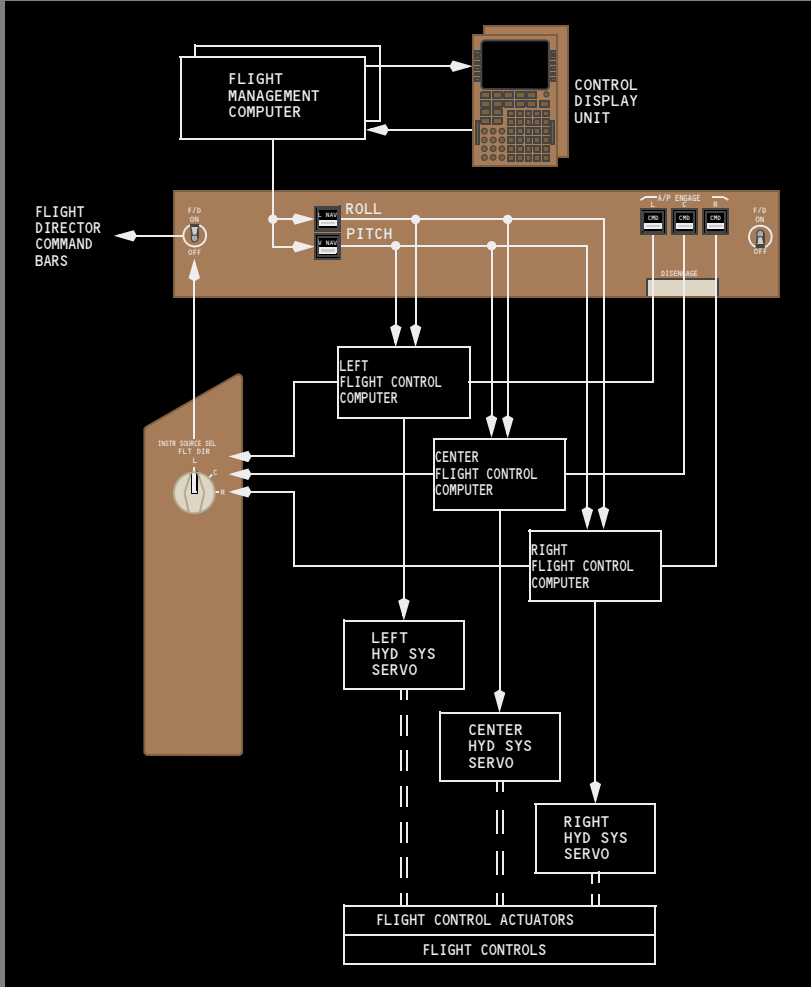
A flight director failure in either pitch or roll, causes the respective steering bars to disappear.

Autopilot Flight Director System Schematic

121-196, 1401-1402, 1501-1506, 1521



197-1201, 1403-1708



Autoland Status Annunciators (ASA)

The following AFDS status annunciations can be displayed:

- LAND 3 – three autopilots engaged and operating normally for an automatic landing
- LAND 2 – AFDS redundancy reduced, in some cases only two autopilots available
- NO LAND 3 – indicates a fault condition exists which results in a LAND 2 condition
- NO AUTOLAND – AFDS unable to make an automatic landing

With a LAND 3 indication, the autopilot system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing (fail operational).

With a LAND 2 indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path (fail passive).

An EICAS message displays for any fault limiting the capability of the automatic landing system. Below 200 feet radio altitude the ASA display cannot change except to indicate a NO AUTOLND condition. Faults not requiring immediate crew action or awareness are annunciated after touchdown.

AFDS Flight Mode Annunciations

Flight mode annunciations are displayed on the ADI. Mode annunciations include:

- autothrottle
- pitch
- roll
- AFDS status

Active modes are displayed in green letters. When a mode changes the new active mode is highlighted with a green rectangle around it for several seconds. Armed modes display in smaller white letters.

Autothrottle Modes

Autothrottle annunciations are:

- SPD – autothrottle controlling thrust to maintain speed selected in IAS/Mach or, if VNAV engaged, the speed as programmed by the FMC
- IDLE – autothrottle is reducing or has reduced thrust to flight idle. It may engage in a VNAV descent. It will, after FLARE is engaged
- THR HOLD – thrust levers remain in existing position or where manually placed
- N1/EPR – autothrottle controlling to the selected N1/EPR reference thrust
- GA – autothrottle controlling to a maximum reference thrust to maintain a climb rate of at least 2000 fpm. If both flight directors and the autopilot are off, autothrottle controls to go-around reference thrust subject to flap and VMO limit speeds

Roll Modes

Roll annunciations are:

LNAV –

Arm LNAV by pushing the L NAV switch. The light illuminates and LNAV annunciates on the FMA roll mode annunciator in white characters above the current roll mode.

- LNAV (armed) – LNAV is armed to activate when parameters are met
- LNAV (active) – LNAV activates when in position to turn onto the active route leg. In flight, selection causes immediate activation if within 2 1/2 NM of the active leg

HDG –

- HDG SEL (active) – airplane turns to or maintains the heading selected in the MCP heading window
- HDG HOLD (active) – AFDS holds present heading. When turning, AFDS holds the heading reached after rolling wings level

LOC –

- LOC (armed) – AFDS captures the localizer when within range and within 120 degrees of the localizer course
- LOC (active) – AFDS follows the localizer course

B/CRS –

- B/CRS (armed) – AFDS is armed to capture and track inbound on backcourse of localizer after localizer capture
- B/CRS (active) – AFDS tracks inbound on backcourse of localizer

TO –

- On the ground, TO annunciates by selecting either F/D switch ON when both flight directors are OFF
- TO roll and pitch guidance become active at lift-off

GA –

- In flight, go-around arms with flaps out of up or at glideslope capture. There is no flight mode annunciation for go-around armed in flight; although the reference thrust limit changes to GA. Go-around is activated in flight by pushing a GA switch. The roll steering indication provides guidance to maintain the ground track present at mode engagement

ROLLOUT –

- ROLLOUT (armed) – displays below 1500 feet radio altitude and activates below 5 feet
- ROLLOUT (active) – after touchdown, AFDS uses rudder and nosewheel steering to steer the airplane on the localizer centerline

Pitch Modes

Pitch annunciations are:

TO –

On the ground, TO annunciates by selecting either F/D switch ON when both flight directors are OFF. The flight director pitch bar indicates an initial pitch of approximately eight degrees up.

After takeoff, the AFDS commands a pitch attitude to maintain:

- pitch command greater of $V_2 + 15$ knots or liftoff speed + 15
- if current airspeed remains above the target speed for 5 seconds, target airspeed resets to current airspeed, to a maximum of $V_2 + 25$ knots
- IAS/MACH window speed if IAS/MACH window speed is changed to a speed greater than the target speed

Note: AFDS uses the speed set in the IAS/MACH window prior to takeoff for V_2 .

GA –

After the reference thrust limit changes from takeoff to climb, GA arms whenever flaps are out of up or at glideslope capture.

When a go-around is initiated, the commanded speed is the MCP IAS/Mach window or current airspeed, whichever is higher. If the airspeed increases and remains above the initial target airspeed for five seconds, target airspeed resets to current airspeed to a maximum of the IAS/MACH window speed plus 25 knots. If airspeed at initiation of go-around is greater than IAS/Mach window plus 25 knots, that speed is maintained. GA displays as the reference thrust limit on the primary EICAS engine display.

VNAV –

Arm VNAV by pushing the V NAV switch. The light illuminates and VNAV annunciates on the FMA pitch mode annunciator in white characters above the current pitch mode.

VNAV provides pitch commands to maintain the FMC computed airspeed/path:

- VNAV SPD (active) – the AFDS maintains the FMC speed displayed on the FMA and/or the CDU CLIMB or DESCENT pages. During speed intervention, use the MCP IAS/MACH selector to manually set the speed
- VNAV PTH (active) – the AFDS maintains FMC altitude or descent path with pitch commands. For a non-entered headwind, thrust may increase to maintain the VNAV descent path. If the MCP altitude window is set to the current cruise altitude as the airplane approaches the top of descent, the CDU scratchpad message RESET MCP ALT displays
- when a VNAV descent is initiated before the top of descent (T/D) and the airplane descent path subsequently intercepts the VNAV descent path, the pitch annunciation changes from VNAV SPD to VNAV PTH

V/S –

Pushing the V/S switch opens the vertical speed window and displays the current vertical speed. It also opens the IAS/MACH window (if blanked). Pitch commands maintain the rate of climb or descent selected in the V/S window.

SPD –

Pushing the SPD switch opens the IAS/MACH window (if blanked). Pitch commands maintain IAS/MACH window airspeed or Mach.

ALT CAP –

A transition maneuver entered automatically from a V/S, FLCH, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition.

ALT HOLD –

Altitude hold mode is activated by:

- pushing the MCP altitude HOLD switch, or
- capturing the selected altitude from a V/S or FLCH climb or descent, or
- During VNAV climb or descent, capturing MCP prior to reaching the active FMC altitude.

G/S –

Autopilot flight director system follows the ILS glideslope.

FLARE –

- FLARE (armed) (white)– during autoland, FLARE displays below 1500 feet radio altitude
- FLARE (active) (green)– during autoland, flare activates at 50 feet radio altitude. FLARE deactivates at touchdown and the nosewheel smoothly lowers to the runway

Autothrottle System

The autothrottle system provides thrust control from takeoff through landing.

Autothrottle mode and speed selection is controlled from the MCP and the thrust mode select panel (TMSP). When in VNAV, the FMC selects autothrottle modes and target thrust values. Refer to Chapter 11, Flight Management, Navigation, for FMS and CDU operation.

With a command speed of VREF + 5 knots and landing flaps, there is sufficient wind and gust protection available with the autothrottle engaged. The autothrottle adjusts thrust quickly when the airspeed decreases below the command speed. The autothrottle decreases thrust slowly when the airspeed is more than the command speed. In turbulence, the result is that the thrust average is higher than necessary to keep the command speed. This causes the speed average to be more than the command speed.

The autothrottle can be operated without using the flight director or the autopilot. The autothrottle can be manually overridden or disconnected by using either A/T disconnect switch.

Thrust Management Computer

The thrust management computer (TMC) controls the autothrottle system through manual inputs from the MCP or automatically from the FMCs while VNAV is engaged. The basic TMC functions are to:

- calculate thrust limits and settings or follow FMC thrust settings
- detect and transmit autothrottle failures
- actuate the thrust levers
- generate fast slow indications for display on the ADIs

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- adjust flight idle with engine anti-ice operation

Thrust Mode Select Panel

The thrust mode select panel (TMSP) provides the following functions:

- selection of reference thrust modes (TO, GA, CLB, CON, CRZ)
- selection of fixed and assumed temperature derated reference thrust values

Autothrottle Thrust Lever Operation

The autothrottle system moves both thrust levers together to control speed or thrust, depending on the engaged mode.

Thrust levers can be manually positioned without disconnecting the autothrottle. After manual positioning and release, the autothrottle repositions thrust levers to comply with the engaged mode. The autothrottle system does not reposition the thrust levers while in THR HOLD mode.

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With the autothrottle in an engaged mode and during icing conditions with anti-icing equipment on, the autothrottle will maintain thrust at or above the thermal anti-ice (TAI) reference bug on EICAS.

Autothrottle Disconnect

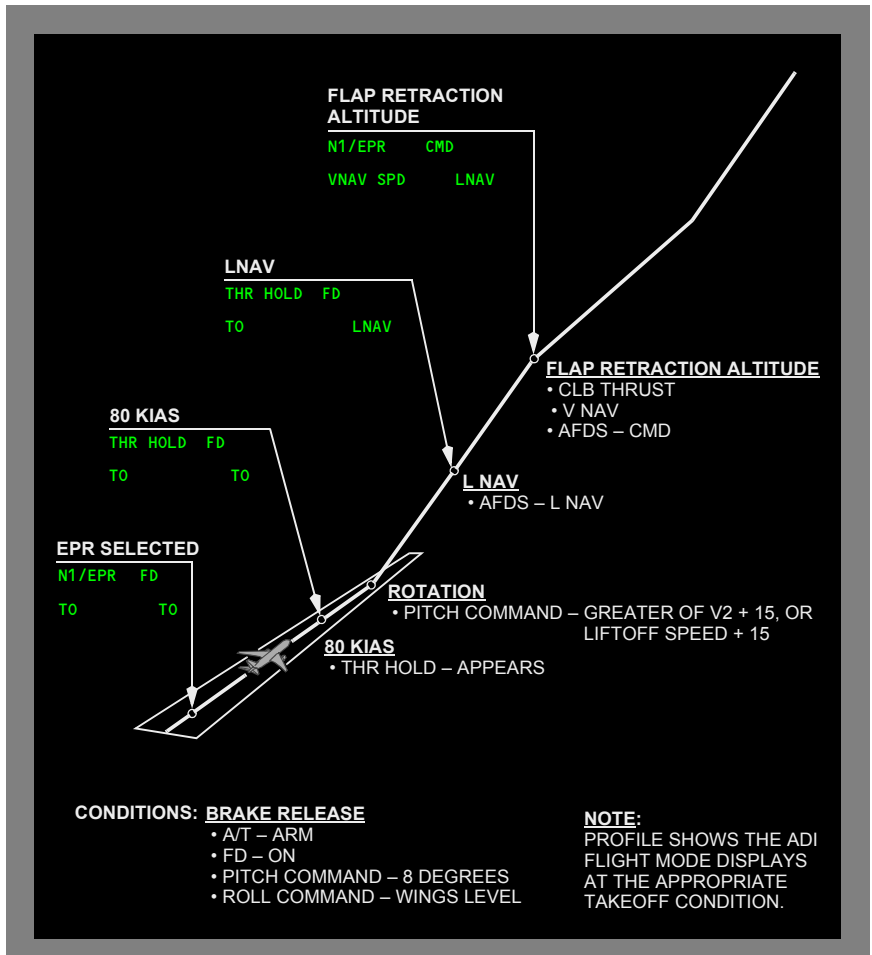
The autothrottle system can be disconnected manually by positioning the A/T arm switch to OFF or by pushing either thrust lever A/T disconnect switch.

Autothrottle disconnect occurs if a fault in the active autothrottle mode is detected, or when a reverse thrust lever is raised to reverse idle.

The A/T DISC light illuminates and the EICAS caution message AUTOTHROT DISC displays.

Automatic Flight Operations

Automatic Flight – Takeoff and Climb Profile



Takeoff is a flight director only function and can only be engaged on the ground. The autopilot is not used during the takeoff roll but may be engaged after liftoff.

During preflight:

- with the autopilot disengaged and both F/D switches OFF, activation of TO roll and pitch mode occurs when the first F/D switch is positioned ON
- FD displays as AFDS status and TO as the pitch and roll flight mode annunciations
- command steering bars come into view

On takeoff, prior to 80 knots IAS:

- pitch command is set to approximately eight degrees up
- roll command is wings level
- autothrottle is engaged by pushing N1/EPR switch, thrust levers advance to selected takeoff power
- FMAs display N1 for autothrottle and TO for both pitch and roll modes

During takeoff prior to lift-off:

- at 80 knots, autothrottle annunciation changes to THR HOLD

At lift-off:

- pitch command greater of $V_2 + 15$ or liftoff speed + 15
- if an engine failure occurs on the ground, the pitch command target speed at lift-off is V_2 or airspeed at lift-off, whichever is greater
- roll command maintains ground track

After lift-off:

- FD TO modes are terminated by engaging an A/P in CMD, or selecting any other pitch or roll mode
- A/T remains in THR HOLD mode at takeoff thrust until a pitch mode, A/T mode, or thrust reference mode switch is pushed. The A/T then sets climb thrust, or the selected reference thrust
- Fast/Slow pointer appears on ADIs following selection of a thrust mode other than TO and a FD mode other than TO

Note: Autopilot elevator authority during a single autopilot operation is limited to reduce the effects of an autopilot malfunction. During altitude capture, there may be insufficient elevator authority and stabilizer trim rate to counteract pitch down, caused by the combination of thrust reduction, flap retraction and aft c.g.

Note: An altitude capture from a climb that includes a significant airspeed increase or thrust reduction may result in the autopilot descending away from the selected altitude in an attempt to increase the airspeed.

Automatic Flight – Cruise

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

Automatic Flight – Approach and Landing

The AFDS provides guidance for multiple autopilot precision approaches. Pushing the APP switch arms localizer in the roll mode and glideslope in the pitch mode. Also, with an autopilot engaged, the remaining two autopilots automatically arm for a multiple autopilot approach.

Either localizer or glideslope can be captured first.

Pushing the LOC switch arms the AFDS for localizer tracking. Descent on the localizer can be accomplished using VNAV, FLCH, or V/S pitch modes. The localizer mode cannot capture if the intercept angle exceeds 120 degrees. All other nonprecision approaches can be flown using LNAV and VNAV modes, or HDG SEL or V/S modes.

Pushing the B/CRS switch in conjunction with the LOC switch will enable localizer backcourse tracking.

Runway Alignment and Asymmetric Thrust Compensation

AFDS controls rudder during multiple autopilot ILS approaches to compensate for engine-out asymmetric thrust conditions during an ILS approach.

With LAND 3 or LAND 2 annunciated, autopilot control of the rudder is active.

The runway align submode is operative during multiple autopilot ILS approach. It reduces the crab angle established during crosswind conditions prior to automatic landing. The submode operates as follows:

- actuated at 500 feet radio altitude with LAND 3 or LAND 2 annunciated
- activation not displayed
- autopilot systems initiate a slip with a maximum bank angle of two degrees when the crab angle exceeds five degrees
- wing leveling from the slip is initiated when the ROLLOUT mode is engaged

If the autopilots are disengaged, manually or automatically, in an asymmetric thrust condition with rudder control active, the rudder moves to the trimmed position. The pilot may need to exert rudder pedal force to maintain a smooth transition to manual flying.

Flare

The flare maneuver brings the airplane to a smooth automatic landing touchdown. The flare submode is a multiple autopilot mode, and is not intended for single autopilot or flight director only operation.

At approximately 50 feet radio altitude, the autopilots start the flare maneuver. FLARE replaces the G/S pitch flight mode annunciation.

Flare arms when LAND 3 or LAND 2 annunciates.

During flare:

- at 15 feet radio altitude the autothrottle retards thrust levers to idle
- IDLE replaces the SPD autothrottle flight mode annunciation
- if slip exists due to runway align submode, wings leveled when ROLLOUT mode engaged
- autopilots start lowering nose wheel to runway at five feet radio altitude plus two seconds with pitch attitude less than two degrees
- at touchdown, the FLARE annunciation no longer displays, and the nose lowers to the runway

Note: During an approach with LAND 2 annunciated and below 100 feet radio altitude an increment of nose up trim is automatically applied for flare. If the autopilots are subsequently disengaged in the approach, a forward control column force of 20–30 pounds may be required to counter the automatic trim condition. If an automatic multi-autopilot go-around is performed, the increment of automatic trim is removed

Rollout

Rollout arms when LAND 3 or LAND 2 annunciates.

At approximately five feet radio altitude, rollout activates. ROLLOUT replaces the LOC roll flight mode annunciation.

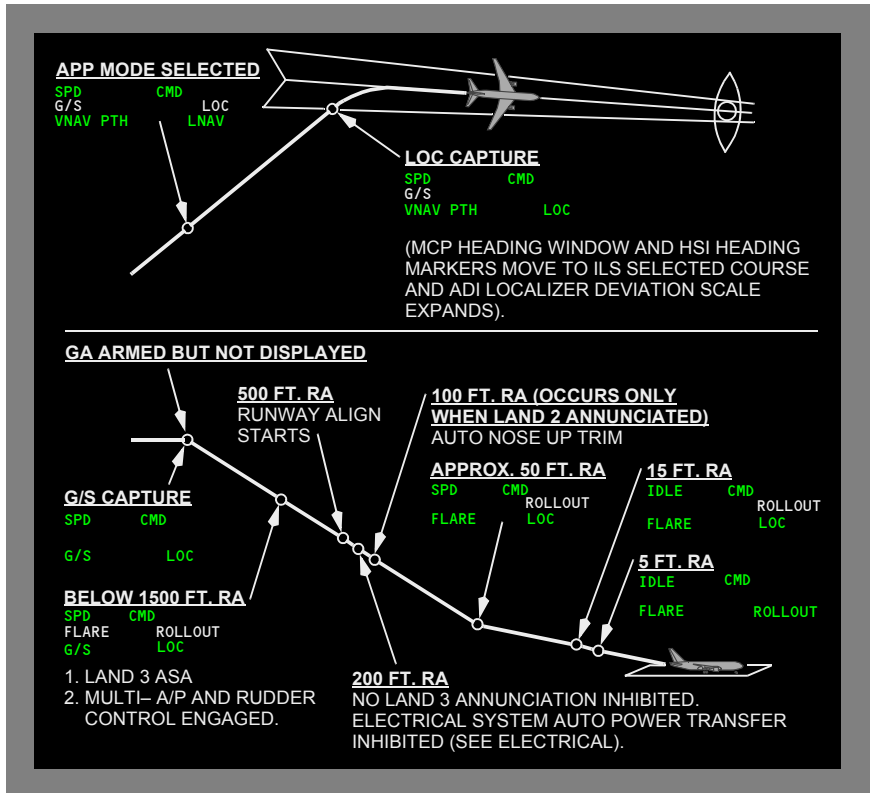
The autopilot controls the rudder and nose wheel steering to keep the airplane on the localizer centerline.

Roll command bar provides directional steering.

Rollout guidance continues until a full stop or until the autopilots are disengaged.

During rollout, autothrottle IDLE mode remains active until the autothrottle disengages. Autothrottle disengagement occurs when either thrust lever is set in reverse thrust position. When selecting reverse thrust the A/T DISC caution light, AUTOTHROT DISC EICAS message and aural warning will not be activated.

Automatic Flight – Approach Profile



Automatic Flight – Go-Around

Pushing either GA switch activates a go-around using multiple autopilot, single autopilot or flight director only.

When the F/D switches are not on, pushing either GA switch displays the flight director bars.

Go-around arms and the reference thrust limit changes to GA when the flaps are out of up or glideslope is captured. Arming is not annunciated. GA remains armed until two seconds after five feet radio altitude. Pushing either GA switch during this period of the approach engages the GA mode. The mode remains active even if the airplane touches down while executing the go-around.

If the airplane is floating within five feet radio altitude for more than two seconds when the GA switch is pushed, the autopilot pitch mode will remain in FLARE and the autothrottle go-around mode will engage.

If the airplane is on the ground but has been below five feet radio altitude for less than two seconds when the GA switch is pushed, the autopilot GA pitch mode will engage but the A/T mode will remain IDLE.

The GA switches are interlocked with the thrust reversers to prevent go-around mode engagement during reverse thrust operation.

Pushing either GA switch:

- roll and pitch activate in GA on the FMA
- autothrottle increases thrust to maintain a climb rate of at least 2,000 fpm
- roll commands bank to maintain ground track
- AFDS increases pitch to hold existing speed or the selected MCP speed, whichever is higher, as thrust increases
- if flap setting is 20 or less, a thrust mode other than go-around can be selected

Note: Autopilot elevator authority during a single autopilot approach is limited to reduce the effects of an autopilot malfunction. If a go-around is initiated during a single autopilot approach, there may be insufficient elevator authority and stabilizer trim rate to counteract pitch up, caused by a rapid application of full go-around thrust. There is sufficient elevator authority to counteract pitchup when the go-around is flown using multiple autopilots, or manually (no autopilot), or when the autothrottle go-around mode is used to set a 2000 FPM climb rate.

GA level-off:

- at the selected altitude, the AFDS pitch flight mode annunciation changes to ALT CAP, then to ALT HOLD and autothrottle mode changes to SPD
- GA remains the active roll mode until another mode is selected
- landing gear and flaps must be operated manually

GA Mode Termination:

Below 400 feet radio altitude –

- if flap setting is 25 or 30, autothrottle remains in GA mode unless disengaged
- disengage autopilot and turn off both flight directors

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Above 400 feet radio altitude –

- select a different roll or pitch mode; all autopilots, except first in CMD, will disengage

Note: If the autopilot systems are compensating for an asymmetric thrust condition when they revert to a single autopilot in CMD configuration, the rudder will return to the trimmed position unless the pilot exerts the rudder pedal force required to maintain the rudder position.

Automatic Flight – Windshear Recovery

The AFDS provides windshear recovery guidance by means of the normal go-around pitch and roll modes. With go-around armed, pushing a GA switch commands a pitch-up of 15 degrees or slightly below the pitch limit, whichever is lower.

When the autopilot is not engaged when go-around is initiated, the pilot must fly the windshear recovery following the flight director commands. If the autothrottle is not armed or engaged, the thrust levers must be advanced manually.

Auto Flight Limit Modes

Autothrottle Limit Modes

- FLAP LIM
- ALPHA
- SPD LIM

Pitch Limit Modes

- FLAP LIM
- SPD LIM

Flap placards speeds, airplane maximum angle of attack and maximum speed limit are automatically monitored by the AFDS and TMC. The appropriate speed limit mode annunciation of FLAP LIM, ALPHA, or SPD LIM is displayed when a speed limit is approached and the MCP selected speed or FMC target speed is set to exceed a limit. When the limit mode is displayed, the limit speed becomes the reference speed for the autothrottle and AFDS.

When the AFDS is engaged in a speed mode (FLCH, GA), the speed limit monitoring is accomplished by the AFDS. When approaching a speed limit, the appropriate limit mode annunciation, replaces the existing pitch mode.

The AFDS will not annunciate ALPHA when approaching maximum angle of attack speed, however, the alpha safe speed will be maintained by AFDS pitch.

When the AFDS is not controlling speed, speed limit monitoring is accomplished by the TMC. When a speed limit is exceeded, the appropriate limit mode annunciation appears at the autothrottle mode position. The speed limit mode annunciations may appear when the autothrottles are engaged or not engaged.

The Fast/Slow pointer changes color to amber and the pointer flashes when a speed limit is exceeded.

**Automatic Flight
EICAS Messages****Chapter 4
Section 30****Automatic Flight EICAS Messages**

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
AUTOPILOT	Caution	AUTO PILOT	Beeper	The engaged autopilot is operating in a degraded mode. Engaged roll and/or pitch mode may have failed.
AUTOPILOT DISC	Warning	A/P DISC	Siren	The autopilot has disconnected.
AUTOTHROT DISC	Caution	A/T DISC	Beeper	The autothrottle has disconnected.

Intentionally
Blank

Communications**Chapter 5****Table of Contents****Section 0**

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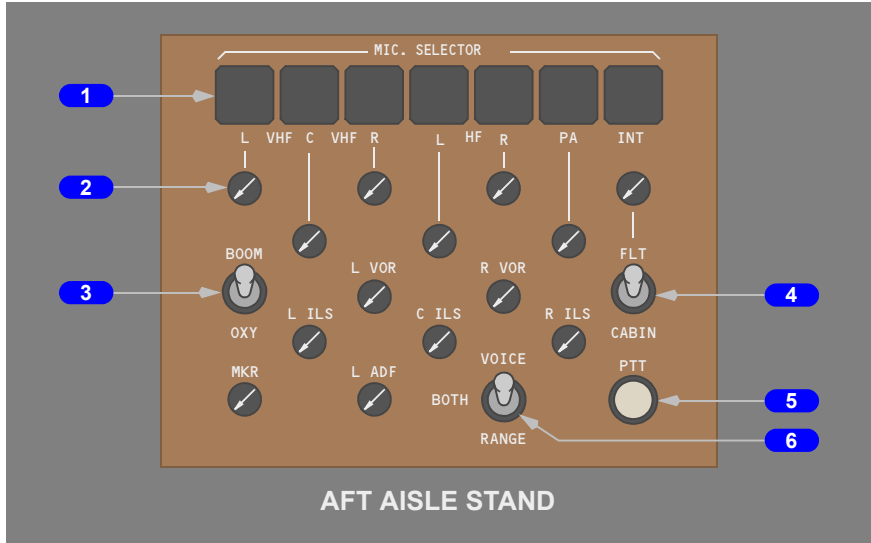
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Audio Control Panel (ACP)

121-139, 1401-1404



1 Microphone Selector Switches/Lights

Push –

- the selected transmitter light illuminates
- the light for any other transmitter extinguishes
- selects the respective transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- selects the receiver audio on, if not already manually selected on

2 Receiver Control

Push – turns respective receiver ON/OFF at any volume setting.

Rotate – varies respective receiver volume.

3 Boom/Oxygen (BOOM/OXY) Switch

BOOM – transmit from the boom microphone or hand held microphone.

OXY – transmit from the oxygen mask microphone.

4 FLIGHT/CABIN Switch

FLT – selects the flight interphone system.

CABIN – selects cabin/service interphone system.

5 Push To Talk (PTT) Switch

Push and hold –

- transmits on selected microphone system
- resets illuminated SELCAL lights

6 Navigation Filter Selector

Filters VOR, ADF, or ILS audio.

VOICE – only voice transmissions can be heard.

BOTH – voice transmissions and station identifiers can be heard.

RANGE – only station identifiers can be heard.

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1 Microphone Selector Switches/Lights

Push –

- the selected transmitter light illuminates
- the light for any other transmitter extinguishes

- selects the respective transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- selects the receiver audio on, if not already manually selected on

2 Receiver Control

Push – turns respective receiver ON/OFF at any volume setting.

Rotate – varies respective receiver volume.

3 Boom/Oxygen (BOOM/OXY) Switch

BOOM – transmit from the boom microphone.

OXY – transmit from the oxygen mask microphone.

4 Push-To-Talk (PTT) Switch

Push and hold – transmits on selected system.

5 Navigation Filter Selector

Filters VOR, ADF, or ILS audio.

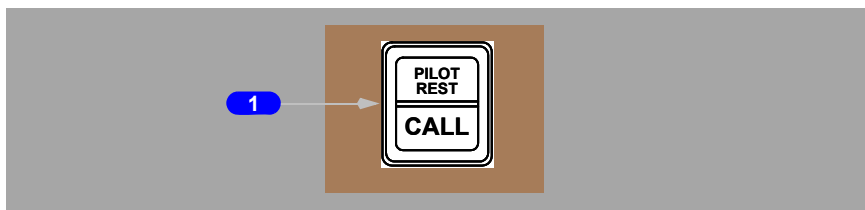
VOICE – only voice transmissions can be heard.

BOTH – voice transmissions and station identifiers can be heard.

RANGE – only station identifiers can be heard.

Pilot Call Panel

(1607-1613)



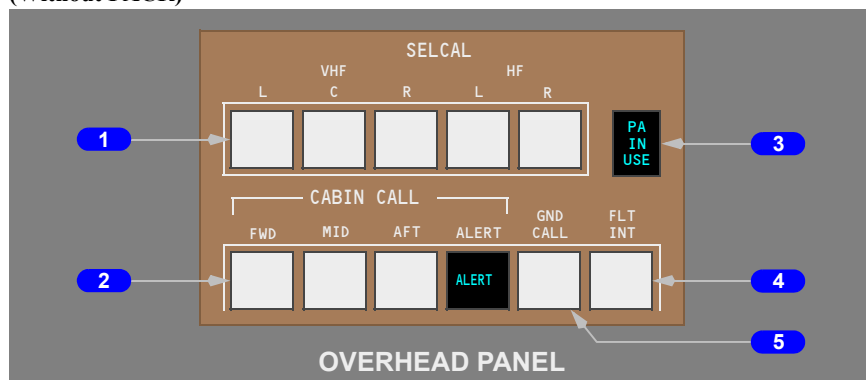
1 Pilot Rest Call switch

Illuminated (blue) - call has been initiated by either flight deck or pilot crew rest facility. Call light will remain illuminated until a call light in the pilot rest facility is pressed.

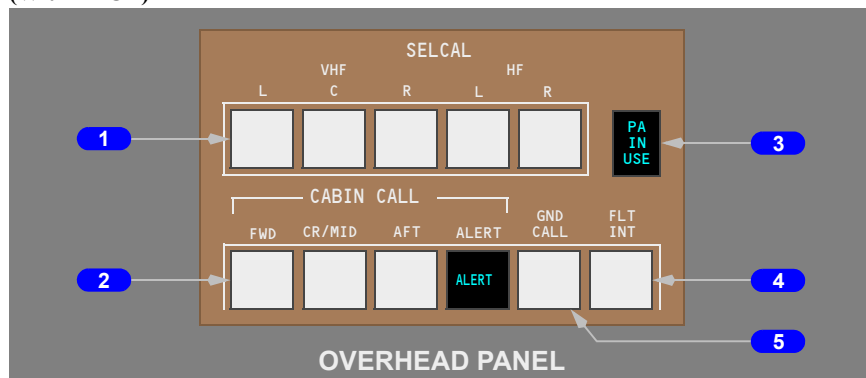
Push

- rings hi/low chime in the pilot rest facility

(Without FACR)



(With FACR)



1 Selective Calling (SELCAL) Switch/Lights

Illuminated – indicates a radio call on SELCAL

- resets when the respective transmitter is keyed or when light is pushed.

2 CABIN CALL Switch/Lights

Illuminated – indicates a flight attendant call.

- resets when call is answered or cancelled

(Without FACR)

- FWD, MID, and AFT also reset when light is pushed

(With FACR)

- FWD, CR/MID, and AFT also reset when light is pushed

Push – calls selected station or ALERT calls all stations.

3 PA IN USE Light

Illuminated – PA system in use.

4 Flight Interphone (FLT INT) Switch/Light

Push – interconnects flight and cabin interphone systems.

Illuminated – flight and cabin interphone systems are connected.

Push again – returns to normal operation – light is extinguished.

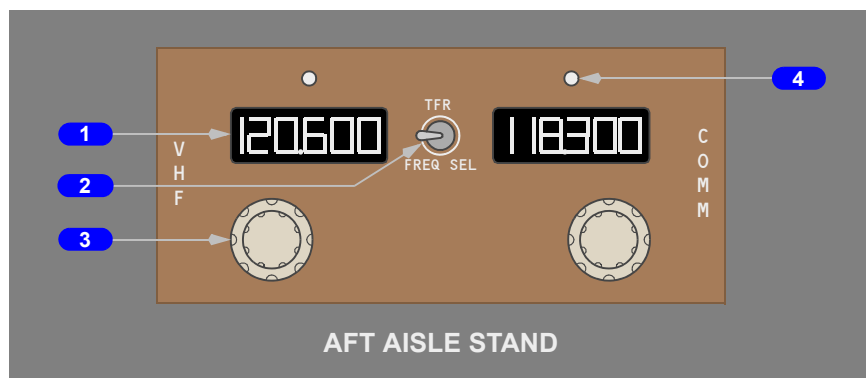
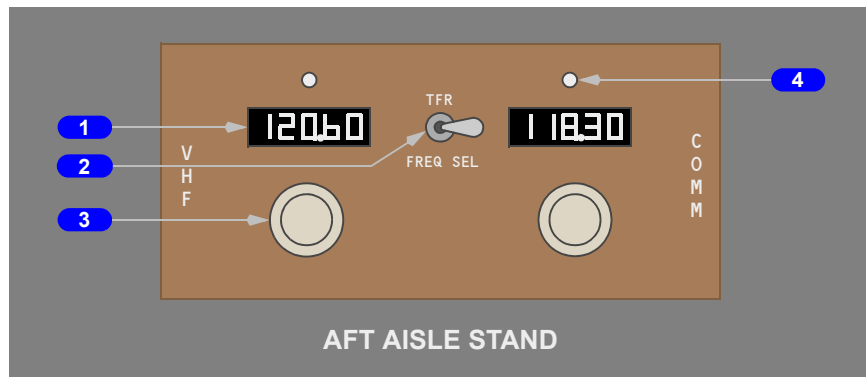
5 Ground Call (GND CALL) Switch/Light

Illuminated – indicates a call from ground personnel

- extinguishes after 30 seconds

Push – calls ground personnel as long as switch is pushed.

Radio System VHF Communication Panel (As installed)



1 Frequency Window

Indicates the selected frequency.

2 Frequency Transfer (TFR) Switch

Selects which frequency is active for the transceiver.

3 Frequency Selector

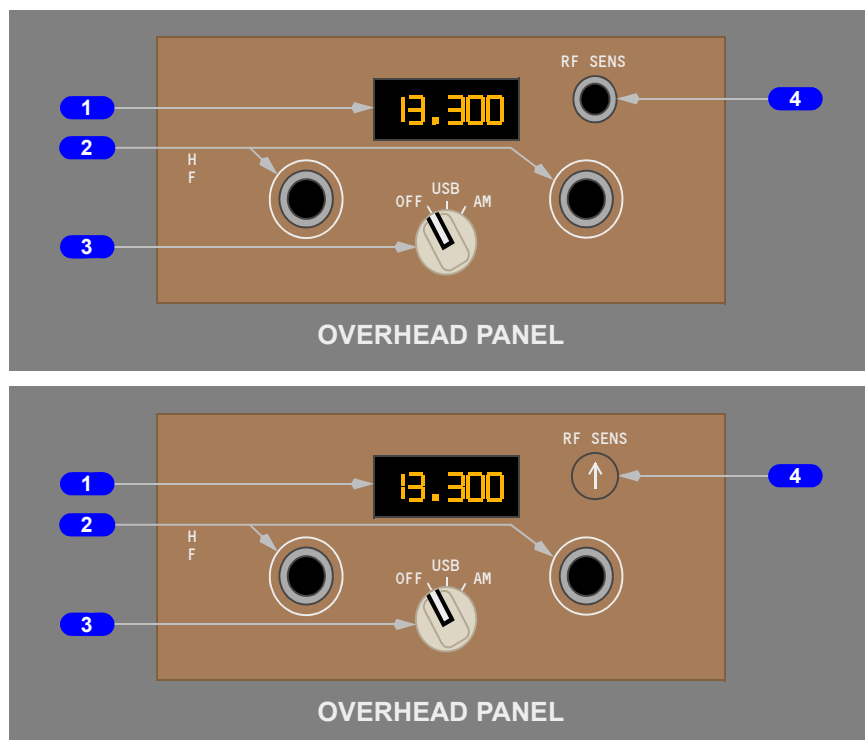
Rotate – changes frequency of related radio:

- outer selector changes digits to the left of the decimal point
- inner selector changes digits to the right of the decimal point

4 Active Frequency Light

Illuminated – indicates which frequency has been selected by the frequency transfer switch.

HF Communication Panel (As installed)



1 Frequency Window

Indicates the selected frequency.

2 Frequency Selectors

Selects the frequency shown in the Frequency Window.

Rotate left knob – changes the digits to the left of the decimal point.

Rotate right knob – changes the digits to the right of the decimal point.

3 Mode Selector

OFF – power removed from unit.

USB – sets the upper side band (U) mode.

AM – sets the amplitude modulation (AM) mode.

4 Radio Frequency Sensitivity (RF SENS) Control

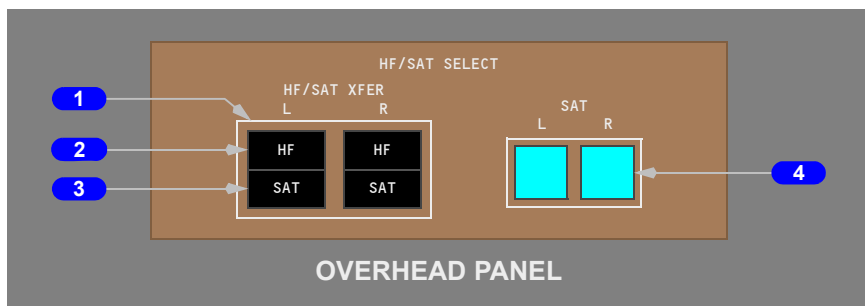
Rotate – adjusts the sensitivity of the HF receiver.

- (clockwise) increases sensitivity for reception of weak or distant stations
- (counter clockwise) decreases sensitivity to reduce noise and static

Note: decreasing sensitivity too far prevents reception, including SELCAL monitoring of HF radio.

HF/SATCOM Select Panel

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1 HF/SATCOM Transfer (HF/SAT XFR) Switch

Push – alternates HF and SATCOM radio transmit/receive control.

Note: INOP placard indicates radio is not installed.

2 HF Transfer Light

Illuminated – indicates associated HF radio is being used to transmit/receive.

3 SATCOM (SAT) Transfer Light

Illuminated – indicates associated SATCOM radio is being used to transmit/receive.

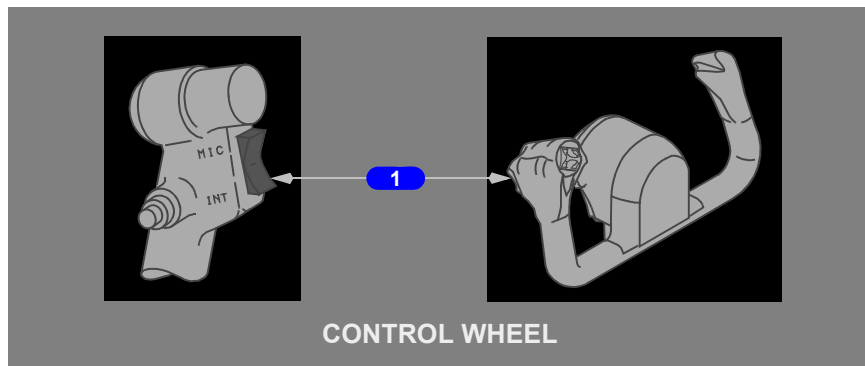
4 SATCOM (SAT) Light

Illuminated – flight crew being called by ground station via SATCOM radio.

Note: INOP placard indicates radio is not installed.

Miscellaneous Communication Controls

Control Wheel Microphone/Interphone Switch



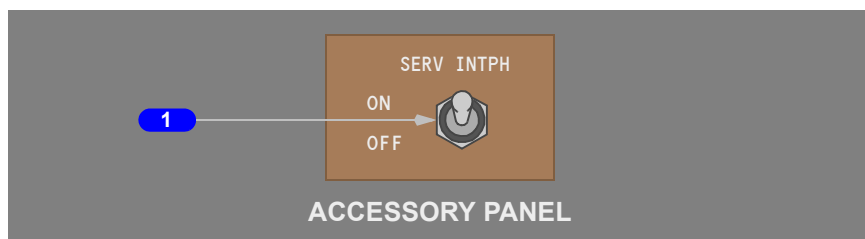
1 Control Wheel Microphone/Interphone (MIC/INT) Switch

Spring loaded to center (off) position.

MIC – allows transmission on the selected transmitter.

INT – allows transmission on the flight interphone system.

Service Interphone Switch



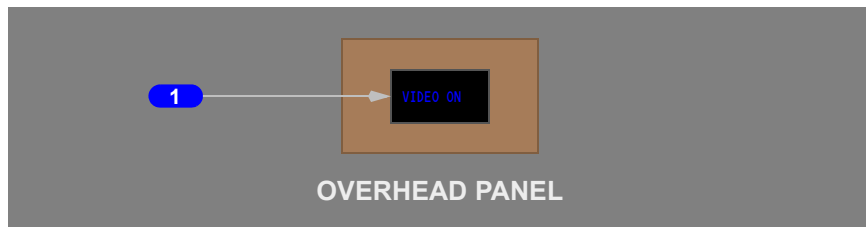
1 Service Interphone (SERV INTPH) Switch

ON – adds external (unpressurized area) headphone jacks to cabin interphone system.

OFF – deactivates external (unpressurized area) headphone jacks, except jack marked FLIGHT at the APU ground control panel.

VIDEO ON Light

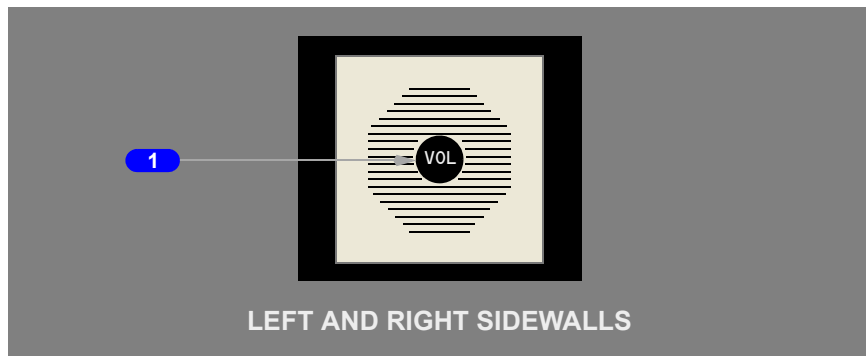
(As installed)



1 VIDEO ON Light

Light has been deactivated for new IFE system.

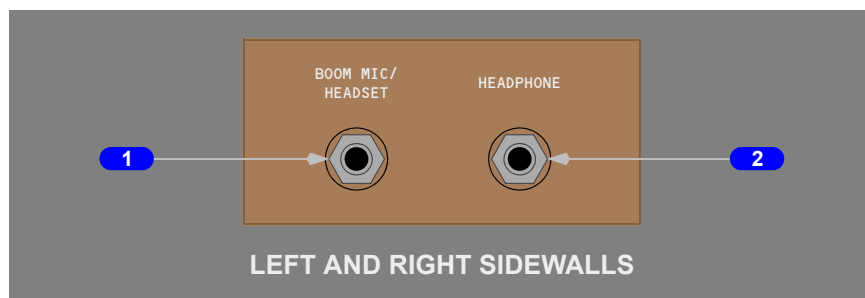
Flight Deck Speaker



1 Flight Deck Speaker Volume Control

Rotate – adjusts speaker volume.

Captain/First Officer Jack Panels



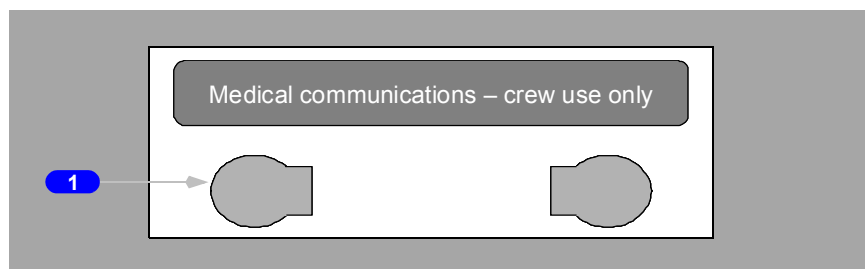
1 BOOM MIC/HEADSET Jack

Accepts a flight crew boom microphone/headset plug.

2 HEADPHONE Jack

Accepts a flight crew headphone plug.

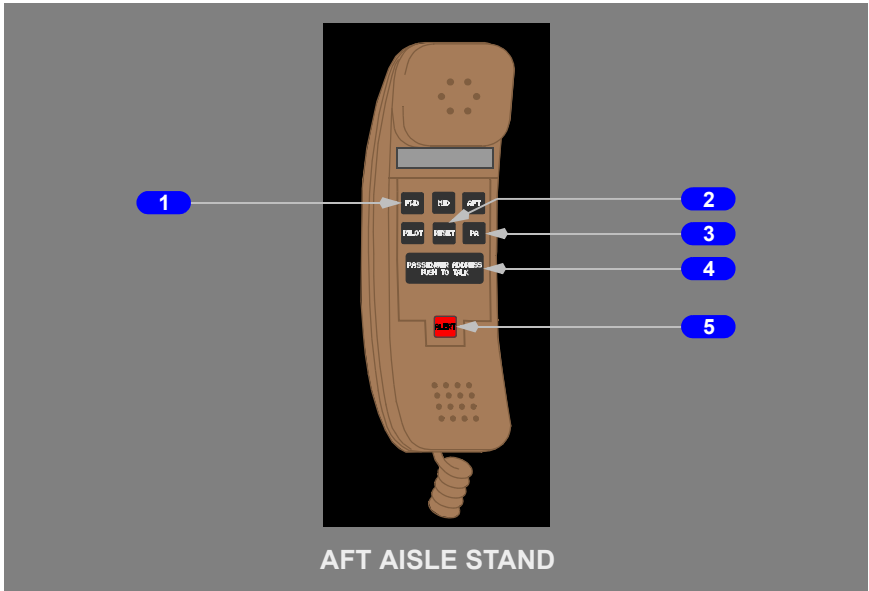
Cabin Medical Communication (as installed)



1 HEADSET Jack

Accepts a flight attendant headset plug. Cabin headset jacks are located above the center seats at select rows.

Handset



1 Cabin Call Switches (FWD, MID, AFT)

121-139, 1401-1404

Push – calls the forward, mid, or aft station.

1 Cabin Call Switches (FWD, CRM/MID, AFT)

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

Push – calls the forward, mid and FACR, or aft station.

2 RESET Switch

Push – cancels a call.

3 PA Call Switch

Push – selects the PA system for subsequent announcement.

4 PASSENGER ADDRESS Switch

Push – calls all stations.

- connects the handset microphone to the PA system
- only used in the PA mode

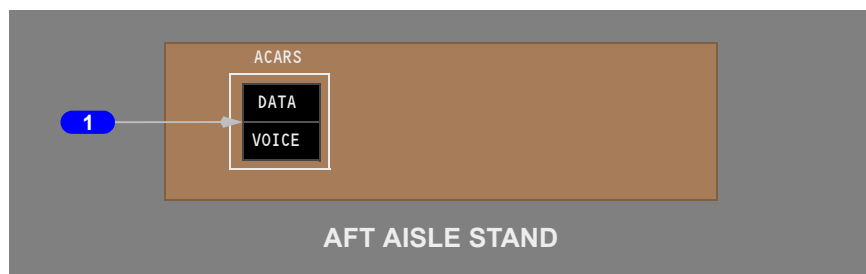
5 ALERT Call Switch

Push – calls all stations.

ACARS Switching Panels

121-199, 1200-1201, 1401-1402, 1601-1613, 1701-1708

ACARS Voice/Data Switch



1 ACARS Mode Switch

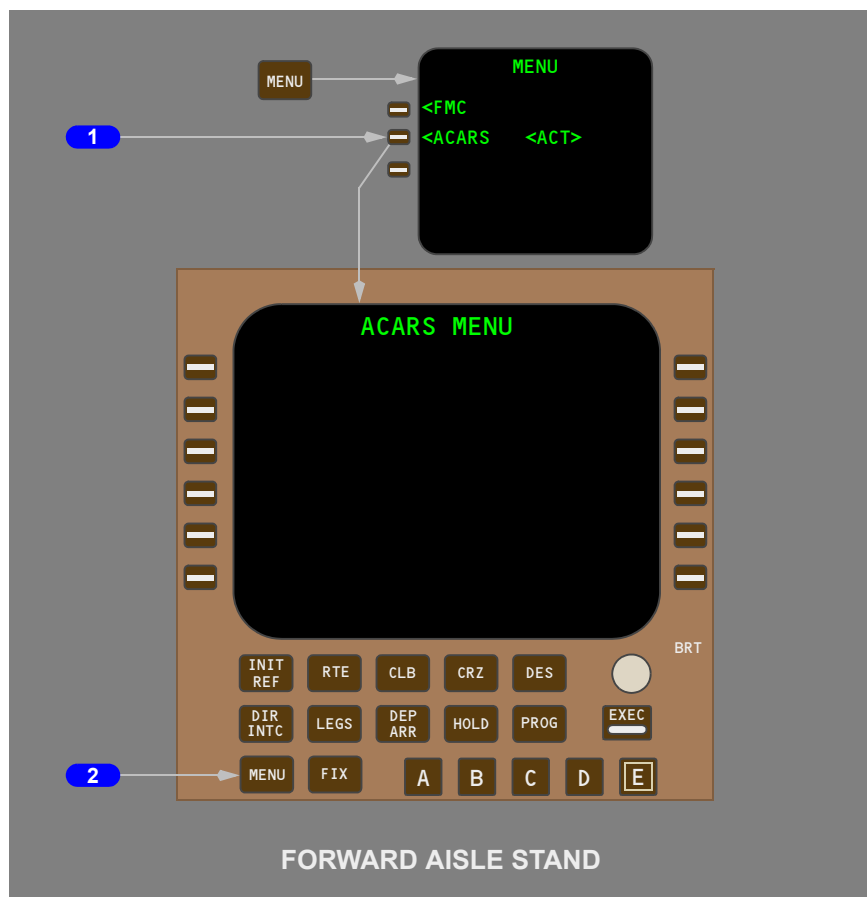
Push – switches center VHF radio (VHF-C) between data and voice mode

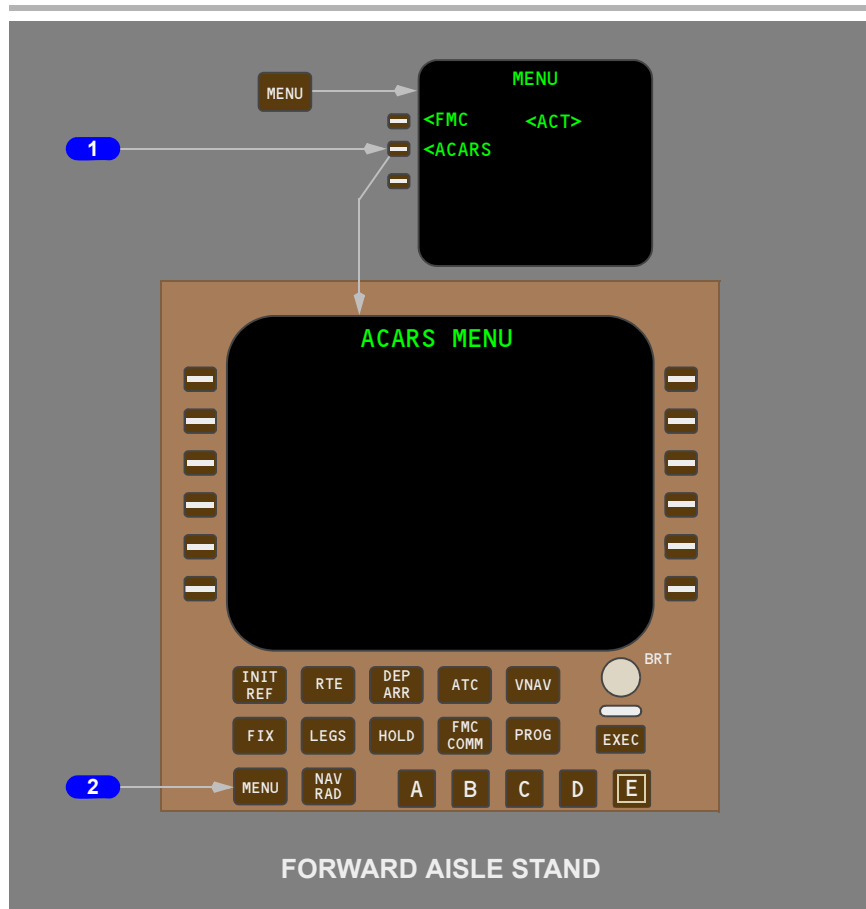
Illuminated –

- DATA - VHF-C is controlled by the ACARS management unit
- VOICE - VHF-C is controlled by the VHF communications panel

ACARS or SATCOM Control

ACARS Access Through Multifunction Control Display Units (MCDU)





1 ACARS Line Select Key

Push – displays ACARS MENU page.

See section 40 of this chapter for description of ACARS operation.

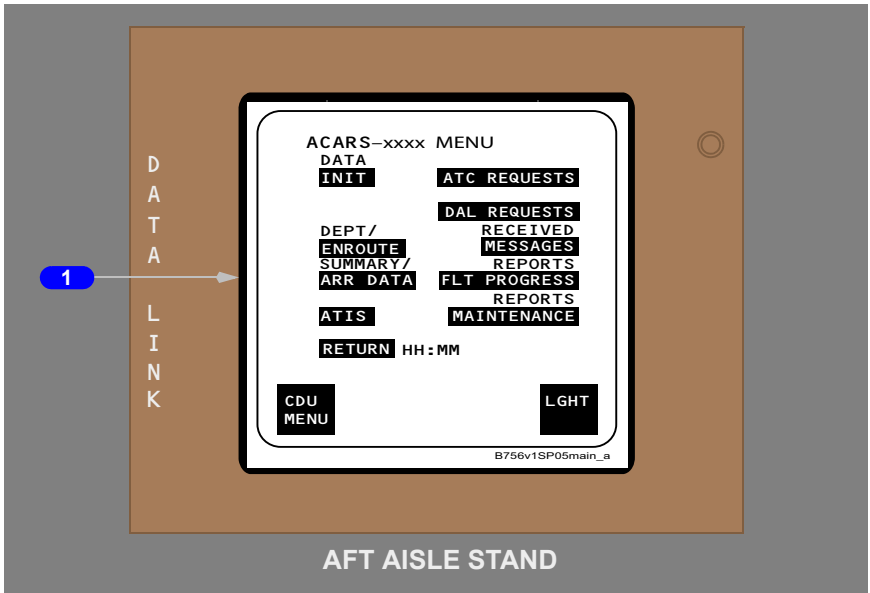
2 MENU KEY

Push – displays MENU page.

See Chapter 11, Flight Management, Navigation for description of the FMC and associated software functions.

Note: ACARS control also available through separate ACARS control panel (IDU) located on the Aft Aisle Stand.

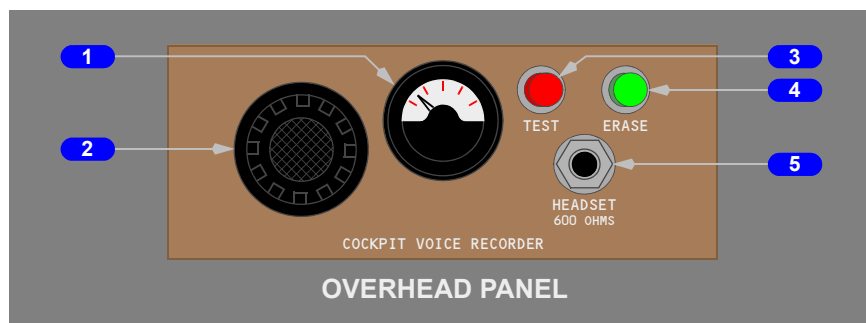
ACARS Interactive Display Units (IDU) Touchscreen



1 Interactive Display Unit (IDU)

Touch screen for entering or receiving information. Information is transferred to or from ground stations through the ACARS management unit. Refer to Volume 1, SP.5 Communications, ACARS.

Cockpit Voice Recorder Panel



1 Monitor

During test, needle displaces to green band if all four channels are operating.

2 Microphone

Area microphone for the voice recorder.

3 TEST Switch

Push and hold – initiates cockpit voice recorder test.

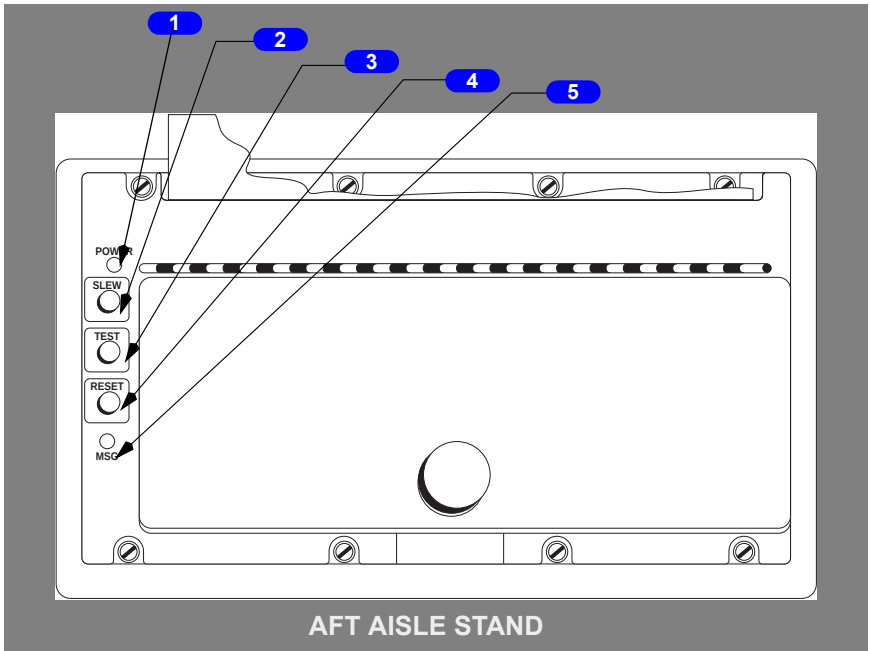
4 ERASE Switch

Push (2 seconds) – erases the voice recorder (if on the ground, AC power on, and the parking brake is set).

5 HEADSET Jack

A headset may be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

ACARS Printer



1 POWER Light

Illuminates when printer is powered.

2 SLEW Button

Push—advances printer paper while the button is held.

3 TEST Button

Push—causes the printer to do a self test and print a test pattern.

4 RESET Button

Push—resets the MSG indicator light.

If the MSG indicator light is extinguished, pushing and holding the button down for 4 seconds clears the printer queue.

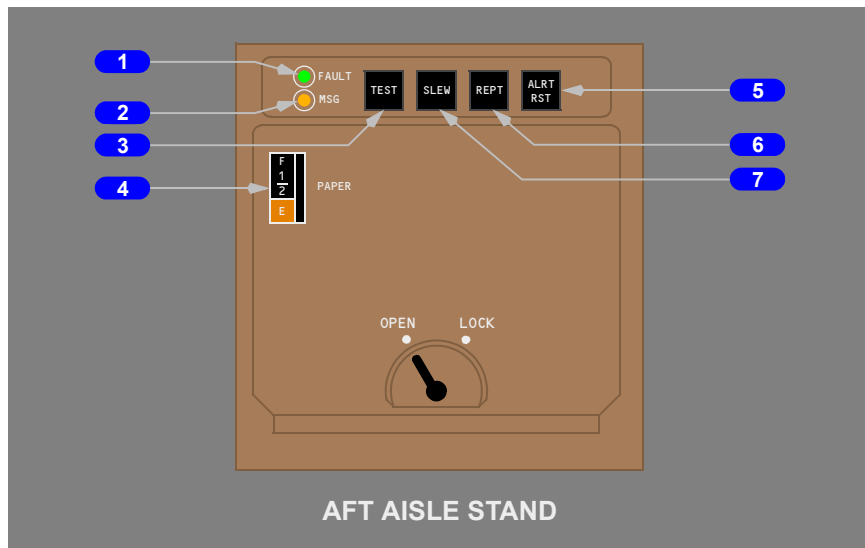
5 MSG Indicator Light

Illuminates whenever a message is received by the printer (including TEST data printout).

Remains illuminated until the RESET button is pushed.

Printer

171-179



1 FAULT Light

Illuminated – indicates any of these situations:

- printer failure
- printer out of paper
- printer door open
- printer test in progress

2 Message (MSG) Light

Illuminated –

- incoming message to printer or test in progress
- remains illuminated until ALRT RST switch pushed or test completed

3 TEST Switch

Push – causes the printer to do a self test and print a test pattern.

4 Paper Quantity Indicator

Indicates quantity of paper remaining.

5 Alert Reset (ALRT RST) Switch

Push – resets printer message (MSG) light.

6 Reprint (REPT) Switch

Push –

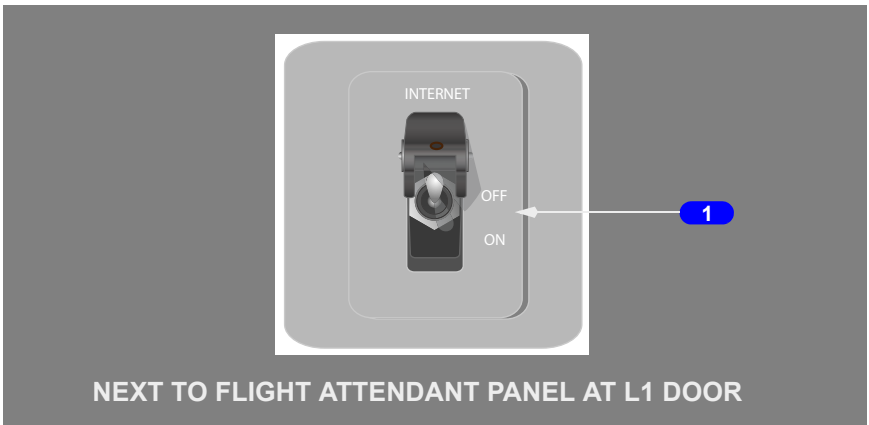
- reprints the last message received
- subsequent pushes provide additional copies

7 SLEW Switch

Push and hold – advances the printer paper.

Wi-Fi

Wi-Fi Master Switch



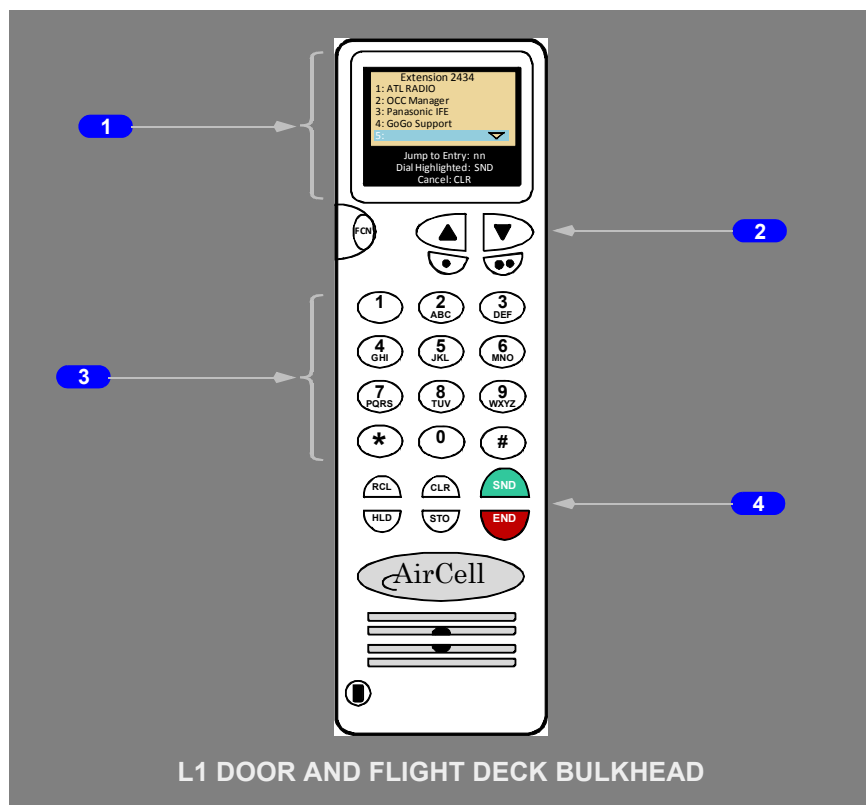
1 Internet Master Switch

ON – provides power to the internet system.

OFF – removes power from the internet system.

Note: The INTERNET switch should not be used to restore service.

Wi-Fi Handset



1 Pre-Programmed Connections

Select pre-programmed connections by using up/down keys. After highlighting selection, select SND.

2 Up/Down Keys to Locate Connections

Push to highlight desired connection.

3 Keypad

4 Function Buttons

Communications System Description

Chapter 5 Section 20

Introduction

The communication systems include:

- radio communication system
- interphone communication system (refer to section 30 of this chapter)
- SELCAL system
- cockpit voice recorder system
- communication crew alerting system
- data communication system (refer to section 40 of this chapter)
- ATC data link system (refer to section 45 of this chapter)

The communication systems are controlled using the:

- audio control panels (ACP)
- pilots call panel (PCP)
- control panels for each communication radio
- control display unit (CDU) for controlling the data link (refer to section 40 of this chapter)
- control panel (IDU) for controlling the data link (refer to section 40 of this chapter)

Audio Control Panels

The audio control panels (ACP) are used to manage the radio and interphone communication systems. Navigation receiver audio can also be monitored.

Systems are monitored using headphones or speakers. Receiver volume is controlled on the ACP by rotating the knob beneath the respective receiver.

Speakers

A speaker volume control is located in the center of the speaker. The flight deck speakers are muted when any transmission is made with the boom mic or the hand mic. Both speakers will be muted when any of the following occur, and will remain muted until the switch or key is released:

- the wheel MIC/INT switch is pressed
- the PPT switch is pressed
- the hand mic is keyed

Speaker volume is not affected when the Audio Control Panel mic switch is in the OXY position. Speaker volume is not affected when using the cabin interphone handset on the aft pedestal.

If a listening watch is required on VHF or HF radios, at least one pilot must have a headset on when the boom mic or hand mic is used for PAs or interphone communication, or if a continuous listening watch on more than one communication radio is required.

Microphones

Microphones are keyed by pushing the desired ACP transmitter select switch and holding in a PTT (push-to-talk) switch. The PTT switches are located on:

- the control wheels
- the glareshield
- any hand microphone

There is a boom microphone on the headset, a microphone in the oxygen mask, and a hand microphone jack at all flight crew member stations.

The oxygen mask microphone is enabled and the boom microphone is disabled when the BOOM/OXY switch on the ACP is in the OXY position. Conversely, the oxygen mask microphone is disabled and the boom microphone is enabled when the BOOM/OXY switch is in the BOOM position.

Radio Communication Systems

The radio communication systems consist of:

- the high frequency (HF) communication system
- the very high frequency (VHF) communication system
- the selective calling (SELCAL) system

HF Communication System (As installed)

Two independent HF communication radios are installed. These are designated HF L (left) and HF R (right). The ACPs are used to control voice transmission and receiver monitoring.

To tune the HF radio, rotate the frequency selectors on the control panel. The left knob changes the digits to the left of the decimal point, and the right knob changes the digits to the right of the decimal point.

The sensitivity is adjusted by rotating the control knob. Rotating clockwise increases the sensitivity to receive weak or distant stations. Rotating counter clockwise decreases the sensitivity to decrease noise and static.

Note: Decreasing sensitivity too far prevents reception, including SELCAL monitoring of the HF radio.

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.

When an HF transmitter is keyed after a frequency change, the antenna tunes. While the antenna is being tuned, a tone can be heard through the audio system (tuning takes a maximum of 15 seconds).

VHF Communication System

Three independent VHF radios are installed, designated VHF L (left), VHF C (center), and VHF R (right).

Tuning is accomplished through communication panels (CP) for each radio.

Each VHF radio allows the tuning of two independent frequencies, an active and a standby frequency. These can be interchanged with the frequency transfer switch. The ACPs are used to control voice transmission and receiver monitoring.

Selective Calling (SELCAL) System

The SELCAL system monitors all of the communication radios. When the system receives a properly encoded call from a ground station, the crew is alerted through the illumination of the corresponding light on the pilot's call panel.

The flight crew is also alerted to an incoming call by an aural chime and the SELCAL communication message on the EICAS display. Refer to section 50 of this chapter for a list of possible messages.

Aircraft Communication Addressing and Reporting System (ACARS)

ACARS data and voice modes provide automatic and manual means to transmit and receive operational, maintenance, and administrative information between the airplane and a ground station. ACARS is operational when electrical power is established. The ACARS systems descriptions provided in this section are limited to manual selection of ACARS radio operating modes. Refer to section 40 of this chapter for additional information about ACARS operation and control.

ACARS communicates incoming and outgoing data and messages through:

- the center VHF radio

ACARS provides for automatic and manual control, including mode selection, of the dedicated ACARS radio through the ACARS management unit. Refer to section 40 of this chapter for description of this function.

1403, 1404

The VHF communication panel for the ACARS dedicated radio does not provide a means to select offline voice mode and ACARS switching panels are not installed. Control of the ACARS dedicated radio may be transferred to the VHF communication panel through menu selection on the CDU/ACARS IDU or depressing the VOICE/VOX mode switch on the ACARS MIDU/CU. Refer to section 40 of this chapter for description of this function.

Manual ACARS Mode Selection

121-199, 1401-1402, 1601-1613, 1701-1708

ACARS also provides for manual selection of the ACARS dedicated radio operating mode through:

- the ACARS voice/data switch

Manual ACARS Override Switches

The ACARS voice/data switch provides for manual override of the ACARS system. Pushing the mode switchlight toggles the center VHF radio between voice and data modes. In VOICE mode, the center VHF transceiver is controlled by the flight crew through the VHF communication panel. In DATA mode, the center VHF radio is controlled by ACARS.

Voice Recorder System

The voice recorder records any transmitted or received flight deck audio transmissions from the flight deck made through the audio control panels. It also records flight deck area conversations using an area microphone.

All inputs are recorded continuously anytime AC power is applied to the airplane.

Communication Crew Alerting System

The communication crew alerting system provides a method of notifying the flight crew about incoming calls from the cabin, ground personnel, or an incoming radio call by displaying messages on the EICAS system.

Crew Communications Messages

The communication crew alerting system provides aural and visual alerts for normal operations requiring crew awareness that may require crew action. Visual alerts are presented as EICAS communication level messages preceded by a white bullet symbol (•). The aural alert is a single chime. The following table shows communication crew alert categories and the respective aural and visual alerts for each category. Refer to section 50 of this chapter for a list of possible messages

Communication Alert Categories

Alert Category	Aural	Visual	Remarks
Medium	Chime	EICAS communication alert. Illumination of appropriate switch/light on the PCP or ACP.	Message awareness required. Crew action may be required.
Low	None	EICAS communication alert.	Crew action may be required.

Crew Communication or Selective Calling (SELCAL) Messages

The communication crew alerting system also provides a supplementary method of notifying the flight crew about incoming calls from the cabin, ground personnel, or an incoming radio call. The •SELCAL message is a medium category alert. The flight crew should respond by establishing interphone communications with the calling station or transmitting on the corresponding radio.

International Wi-Fi Internet

The GoGo International Wi-Fi system is installed on the 767-300ER fleet. The international Wi-Fi system utilizes a Ku-Band satellite antenna mounted under a radome on the fuselage crown skin. Wi-Fi is available while the aircraft is above 10,000 feet. Passengers may experience a 1-4 minute delay in service when the antenna switches satellites. Similar to SATCOM, there is no satellite coverage near the poles. Passengers can expect service interruptions when above 75° latitude and in other global areas that do not have satellite coverage.

System operation is completely automatic and requires no crew action. The Left Inertial Reference Unit provides position and attitude data to the Wi-Fi system. The system is powered by the right utility bus. An INTERNET DC circuit breaker is located on the flight deck. A guarded master power switch, labeled INTERNET, is located above the cabin handset at door 1L. This switch allows the cabin crew to turn the wireless internet on and off.

The Wi-Fi system contains two identical phone handsets. The cabin handset is located next to the forward flight attendant panel at the 1L door, and the flight deck handset is mounted on the aft bulkhead behind the first officer. Operation of the flight deck and cabin handsets is identical. The handsets are available for crew use, but are limited to outgoing calls only using four pre-programmed phone numbers:

- ATL RADIO
- OCC Manager
- Panasonic IFE
- GoGo Support

Using the handset for voice over internet may be considered as a backup if SATCOM is inoperative. Refer to Volume 1, SP.5 for procedures regarding use of the phone handsets for voice communications over internet.

Wi-Fi Non-Normal Procedures

If smoke, fire, or fumes are thought to be caused by the international Wi-Fi internet system, accomplish the Smoke, Fire or Fumes non-normal checklist in the QRH.

Note: Wi-Fi system power is removed when the right UTILITY BUS switch is OFF.

Wi-Fi System Deactivation (not associated with a QRH procedure)

If the flight crew determines a need to deactivate the Wi-Fi system, contact Maintenance for guidance, and:

- Instruct the cabin crew to turn the system off using the INTERNET switch located at door 1L, or
- Pull the INTERNET DC circuit breaker, located on the P11-6 panel, row T-34.

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Communications Interphone Systems

Chapter 5 Section 30

Interphone Communication System

The interphone communication system includes the:

- flight interphone system
- service interphone system
- cabin interphone system
- passenger address (PA) system

The interphone systems allow the flight crew to communicate with the flight attendants, ground personnel, or maintenance technicians. The PA system allows flight attendants or the flight crew to make announcements in the passenger cabin. The flight interphone, service interphone, cabin interphone, and passenger address systems are normally operated through the audio control panel (ACP) in conjunction with the pilot call panel (PCP).

The cabin interphone and passenger address systems may also be operated with the flight deck handset.

Flight Interphone System

The flight interphone system (FIS) permits communication between flight deck crew members and, on the ground, with ground personnel.

The system is used by the following methods:

- pushing the interphone (INT) position of a control wheel mic/interphone switch to transmit
- selecting interphone (INT) transmitter select switch on the ACP and pushing a PTT switch

Ground personnel are able to communicate on the FIS through a jack located on the APU ground control panel mounted on the nose wheel strut.

The pilots are alerted to an incoming call from the ground crew by the following methods:

- an aural chime sounds in the flight deck
- an illuminated GND CALL light on the PCP
- the EICAS communication message GROUND CALL is displayed

The flight crew should respond to the call using the FIS. Any of the PTT switches may be used to communicate.

The flight crew initiates a call to ground personnel by pushing the GND CALL switch. A horn in the nose wheel well activates as long as the switch is pushed. Communication can then take place over the FIS.

Cabin Interphone System

The cabin interphone system (CIS) provides voice communications between the flight deck and the flight attendant stations. Flight deck crew members communicate on the CIS using their ACP and the PCP. The flight crew may use the boom microphones, oxygen mask microphones, or hand microphones to transmit.

Pressing the FLT INT switch on the pilot's call panel (PCP) will connect the flight interphone system to the cabin interphone system and illuminate the FLT INT light. The pilot should then select the destination (FWD, MID, AFT) for the call on the PCP.

The flight crew can also communicate with the flight attendant stations using the flight deck handset. The pilot picks up the handset from the aft aisle stand and presses the button (FWD, MID, AFT or ALERT) to select the destination station.

The pilots are alerted to incoming calls from the cabin by the following methods:

- a light illuminates on the PCP (FWD, MID, AFT, or ALERT)
- an aural chime sounds in the flight deck.
- EICAS communications messages •CABIN ALERT or •CABIN CALL

The ALERT function calls all other interior stations simultaneously. The ALERT is initiated by pressing the ALERT switch on the PCP which will illuminate the call lights and sound the chime at all interior stations except for the originating station. Alert calls automatically override other cabin interphone calls.

The flight crew can also use the handset to call all other stations by pushing the ALERT switch on the handset.

The flight attendants communicate between flight attendant stations or with the flight deck using any of the handsets in the cabin. The system is a party line in that anyone who picks up a handset is automatically connected to the system.

If CIS power is lost, the handsets will automatically be connected to the PA system. Pushing the PTT switch then allows PA announcements.

Flight Deck Handset

The flight crew can also communicate with the flight attendant stations using the flight deck handset. The pilot picks up the handset from the aft aisle stand and presses the button (FWD, MID, AFT or ALERT) to select the destination station.

Service Interphone System

The service interphone system consists of additional internal and external jacks connected to the flight/cabin interphone system for use by maintenance personnel. The flight/cabin interphone system can be connected to the service interphone system by placing the service interphone switch in the ON position. To reduce external noise in the flight/cabin interphone system, the service interphone switch can be left OFF during normal flight operations. This disconnects the microphone jacks at all exterior (unpressurized) service interphone stations except the jack on the nose wheel strut. This switch does not affect the interior flight/cabin interphone stations.

Passenger Address System

The passenger address (PA) system allows flight deck crew members and flight attendants to make announcements throughout the cabin. Flight deck crew members can make announcements with any microphone by pushing the PA transmitter select switch on an audio control panel. Then, pressing any of the PTT switches will key the system for PA announcements.

Flight deck crew members can also use the handset located on the aft aisle stand to make PA announcements. The pilot lifts the handset from the cradle and presses PA button to initialize the system. Pressing the passenger address PTT switch will key the system for announcements. Flight attendants can utilize any of the handsets in the cabin for PA announcements.

(As installed)

The VIDEO ON light is installed on the overhead panel in the flight deck. When this light is illuminated, the pilot is alerted that making a PA announcement would interrupt a video currently being viewed by the passengers. This light has been deactivated on aircraft with the IFE system.

The PA IN USE light is installed on the overhead panel. When this light is illuminated, the pilot is alerted that making an announcement on the PA system would interrupt a current pre-recorded message or announcement being made in the passenger cabin.

The PA system is monitored on the flight deck by pushing the PA receiver volume control on an audio control panel and adjusting the volume. This will adjust the audio volume to the pilot's headset only. It does not adjust the volume of the output broadcast over the PA system.

The cabin PA announcement priorities are:

- flight deck announcements
- cabin announcements made from any flight attendant station
- pre-recorded announcements
- boarding music

PA announcements from any station override all passenger cabin pre-recorded announcements and passenger entertainment outputs.

Cabin Medical Communication (as installed)

The Cabin Medical Communication system connects through the first observer's P61 Audio Control Panel. Headset jacks are located above the center seats at select rows. Two microphone-equipped headsets are located in the overhead bin with the AED and EEMK. Refer to Volume 1, SP.5, Communications for procedures.

Crew Rest Facilities Communications (as installed)

Pilot Crew Rest

Communication with the Pilot Crew Rest facility is initiated by the PILOT REST CALL switch on the P5 Overhead Panel in the Flight Deck. When the switch is pressed the bottom half background illuminates blue and reads CALL. A hi/low chime in the crew rest compartment sounds and the Interphone Call Light/Switch in each bunk illuminates. If there is no response from the compartment, calls can be attempted again after 5-second delays. The PILOT REST CALL switch and both Interphone Call lights will remain illuminated until a call light in the Pilot Crew Rest facility is pressed.

A handset provides 2-way communications between flight deck and Pilot Crew Rest facility. The Pilot Crew Rest facility can call all flight attendant stations, except the mid flight attendant station. The flight attendant stations cannot call the Pilot Crew Rest facility. General cabin PAs do not transmit to the Pilot Crew Rest facility.

Flight Attendant Crew Rest (FACR)

An interphone handset is installed in the FACR facility to allow direct communication with other areas. When calling the FACR facility, a hi/low chime will sound and interphone call light will illuminate above the interphone and also in the Leader bunk. General PAs are transmitted to the FACR facility, except on A/C 1607-1613. When flying on these aircraft, it is the responsibility for the Flight Leader/Purser (or designee) to notify resting flight attendants of safety issues when necessary.

Note: When calling the mid cabin flight attendant station from the flight deck, the FACR Purser handset will ring. Use discretion so as not to disturb the FACR inadvertently.

Communications
Communication System**Chapter 5**
Section 35**Satellite Communications (SATCOM)****171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708**

Flight deck integration has two independent audio channels available at all times and dialing and receiving phone calls will be accomplished through the MCDU. The 3rd channel is used for datalink communication and switching to SATCOM is completely automatic.

SATCOM is to be used only when operationally required and is not for personal use. The primary use for SATCOM is for ACARS data transmission. However, when VHF/HF communication with ATC (including VHF/HF relay) is not possible, it is permissible to contact ATC using SATCOM. The system allows for manual dialing of the phone numbers found on Enroute Charts, Flight Plan Remarks or Delta Bulletins. If this means fails, you may contact the dispatcher through SATCOM to pass information to the appropriate ATC sector.

Other than calls to ATC, operational calls should be routed through ATL Radio for security and transcribing services. All calls to the Dispatcher should be routed through ATL Radio. Do not call Flight Control, Meteorology, Maintenance, etc., directly. For voice reporting, continue using VHF and HF as necessary and copy the company.

In the event SATCOM is inop and the two way communication HF radio check fails on the required HF radio(s), do not enter areas requiring Long Range Communications. For SATCOM dispatch relief, refer to MEL.

Note: With SATCOM operating, the aircraft is capable of FMC Waypoint Position Reporting (WPR). Refer to Volume 1, SP.5, Communications section, for procedures.

System Components

EICAS Display



1 Communications Message

Displays (white) -

- indicates incoming SATCOM call
- Preceded by a white dot

SATCOM Non-Normals

The SATCOM system has built in redundancies and is very reliable. The system has three channels, one is used for ACARS traffic and the other two are for voice operation from the flight deck. If any one channel module fails, ACARS will continue to operate and only one voice channel will be available. If two channels fail, the remaining channel will only be available for ACARS data transmission.

Note: SATCOM will not be available during IRS alignment.

On page 2/2 of the SATCOM Main Menu, BITE OK is displayed unless there is a failure. When one or more channel has failed, an * will be displayed following BITE OK*. This indicates that the SATCOM is still operating but with one or more channels not functioning. Press the line select key next to BITE, and then NEXT PAGE; this will display CHANNELS. Press this line key to determine if a channel has failed.

Non-Normal Procedures

If the SATCOM system fails or in any way interferes with required aircraft systems, contact the Maintenance Control Coordinator for guidance.

The circuit breaker for the SATCOM system is located on the P11-1 circuit breaker panel, Row H, position 8, and is labeled SATCOM. It is powered by the left AC bus.

During a complete SATCOM failure, the SAT prompt should not appear on the MCDU MAIN MENU. If the MCDU is already on a SATCOM page during a complete failure, SAT INOP will display on the SATCOM MAIN MENU page.

For SATCOM dispatch relief, refer to applicable MEL item in the MDM, and the Theater Restrictions.

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Communications

Data Link System

Chapter 5

Section 40

ACARS

The aircraft communications addressing and reporting system (ACARS) is a data link system designed to automatically communicate flight data, performance data, and routine reports between the airplane and a network of ground stations. Manually initiated pilot reports and requests are also be available.

System Information

ACARS consists of the following aircraft components:

- The management unit (MU) which contains system memory, message transmission logic, and a UTC clock. The MU collects, controls, and processes incoming and outgoing data and messages through a dedicated VHF radio or SATCOM.
- An Interactive Display Unit (IDU) (as installed) that provides crew input and control of the system.
- A VHF-3 comm radio which serves as the primary transceiver for ACARS. The ACARS VHF radio is normally in the data mode, allowing automatic transmission of routine reports and engine and performance data.

Note: The flight crew should ensure that the center VHF radio is available to ACARS. If necessary, a voice mode is also available for company voice communications. [AFM]

- Interfaces between the digital flight data acquisition unit (DFDAU) and ACARS through the MU.
- Various sensors located in the airplane.
- A data link panel with annunciators to alert the crew of ACARS message activity.
- A flight deck multiport printer which provides hardcopy capability.
- The MU also interfaces with the flight management computer (FMC) for certain messages which can be loaded into the FMC such as flight plans or wind data. The ACARS interface with the FMC allows the automatic programming of performance parameters and flight plan route into the FMC.

Operational Overview

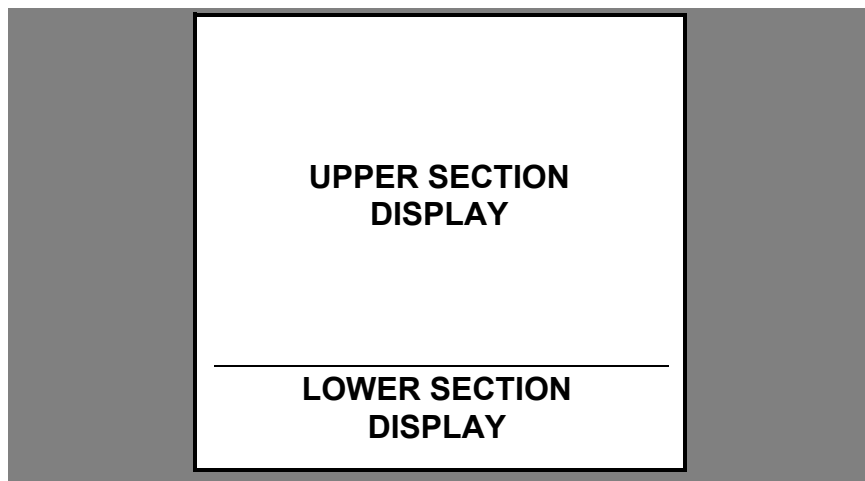
Pilot access to ACARS is either through:

- an interactive display unit (IDU), or
- a multifunction control display unit (MCDU)

Interactive Display Unit (IDU)

The touchscreen interactive display unit (IDU) has a flat display screen activated by objects which break the infrared grid projecting over the screen. As finger tips or pencils touch the screen, the grid calculates the location and expands the displayed selection into an outlined mode. When the finger tip is lifted off the screen, the prompt displaying an outlined mode will be entered in the computer. This allows the crew to slide a finger over the screen to select the desired function without inadvertently entering the wrong selection.

The basic menu and sub-menu page displays are divided into two horizontal sections as shown below:



The upper section can contain the following during normal system operations:

- Menu or sub-menu title.
- Menu items listed in two columns.
 - PRINT prompt - will send pages or messages to the aircraft printer and only appears if printer is operative.
 - SEND prompt - will initiate a downlink from the cockpit. This prompt only appears after all required entries have been completed.

767-300 Operations Manual

- RETURN prompt - will return the system to the previous menu or page.
- Alert advisory messages.
- Informational advisory messages.

The lower section can contain the following selections during normal system operations:

- MENU prompt - returns the system to the MENU page
- INDX prompt - returns the system to the DATA LINK INDEX page
- PREV prompt - returns the system to the previously displayed screen
- NEXT prompt - moves the system to the next display screen
- LGHT prompt - displays the lighting control screen.

Message Indications

Flight crews are notified of incoming messages in one of the following ways:

- The flashing MESSAGE advisory on the IDU.
- The flashing MESSAGE advisory on the IDU, the MSG light on the data link annunciator panel, and chime.
- The EICAS panel will display the message “•ACARS” to alert the crew of ACARS message activity.

Automatic Messages

The system monitors and stores the times of the following events:

- OUT—Anti-collision light ON AND service doors shut
- OFF—takeoff (main gear extended)
- ON—landing (main gear compressed)
- IN— Anti-collision light OFF OR service door open

These events are automatically transmitted at occurrence. The MU automatically tunes the VHF radio to a standard link frequency. ACARS monitors this frequency for messages addressed to that airplane as well as sending messages to the ground.

Pre-flight data such as flight number, fuel on board, and departure/destination station are either entered manually at the gate, or may be received by data uplink.

Crew Generated Messages

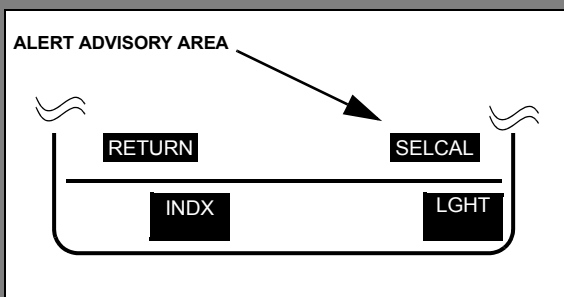
In addition to the automatic messages, ACARS is used to send other messages. Prepared menus and prompts are provided as described in this section. Refer to Volume 1, Supplementary Procedures, Communications for additional information on ACARS messages.

Alert Advisory Messages

The flashing alert advisory messages on the IDU alert the flight crew to abnormal conditions or annunciate the need for necessary crew actions. On menu pages, the alerts appear in the lower right corner above the LGHT prompt. On the keyboards, the alerts appear in the top right-hand corner next to the ENT prompt. Touching the advisory will automatically access the required menu.

The advisories shown below are listed in order from highest to lowest priority

FAIL	Internal failure of MU. Refer to the ACARS INOP Non-Normal Checklist in the QRH.
POWER	Power interruption resulting in loss of initialization data.
SELCAL	SELCAL uplink message received.
ATC MSG	ATC uplink message received.
OCEANCL	ATC oceanic clearance uplink message received.
DEPT CL	ATC predeparture clearance message received.
MESSAGE	Non ATC uplink message received.
INIT	Initialization data incomplete.
DATAMD	Datalink attempted with ACARS in VOICE mode or ACARS in VOICE mode for greater than 3 minutes.
ATIS	ATC ATIS message received and not viewed.
INRANGE	Alert to send the In Range Report.
ARRDLA	Alert to send the Arrival Delay Report.
DEPDLA	Alert to send the Departure Delay Report.
SUMMARY	Summary Report has not been sent.

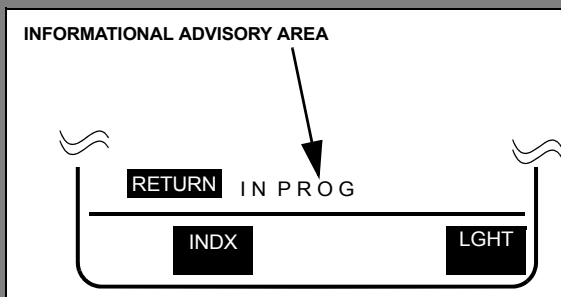


Informational Advisory Messages

Informational advisory messages appear on the IDU indicating system status. The advisories are listed below in order of priority.

IN PROG	Message has been transmitted by aircraft, but not yet acknowledged by ground network.
UTC OK	UTC TIME updated by uplink.
VOICE	C-VHF is in VOICE mode. ACARS data messages will still be transmitted if HF or SATCOM is available. Otherwise, messages will be cued until a ground network access is restored.
NO COMM	No DATA LINK is available.
XMIT	Indicates data being transmitted by ACARS.
VNNN.NN	Indicates the current mode of the VHF Transceiver and the frequency being tuned. The mode is represented by a single character preceding the frequency as shown below: • ‘V’ - VHF is currently being used for voice communication. • ‘D’ - VHF data link to ground has been established on a network base frequency. • ‘A’ - VHF data link to ground has been established on an autotuned frequency. • ‘S’ - No VHF data link has been established and the system is scanning frequencies searching for a ground network service provider. Although this informational advisory message is the lowest priority, it is the most often displayed.

Note: If the DATA LINK Is functioning normally in the DATA mode, there will be no advisory shown.



Touchscreen Keyboards

There are two different categories of input keyboards: data input and free text. The data input keyboards include alphabetical, numeric, and hexadecimal. The free text keyboards include alphabetical, numeric, and symbolic. The appropriate keyboard will automatically appear depending on the prompt that is selected from the displayed page.

Data Entries

Each keyboard has the following functions:

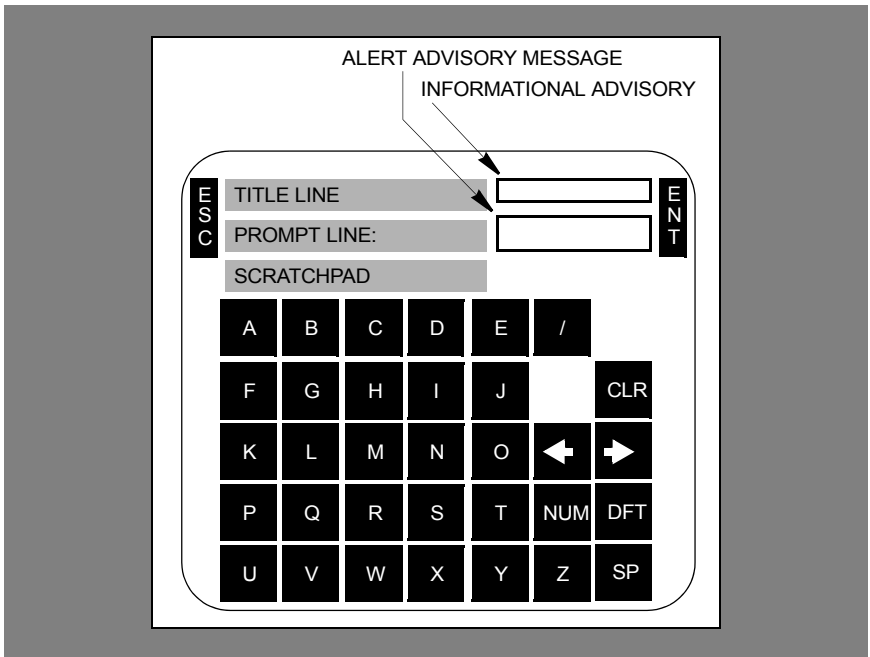
- CLR - Used on data input keyboards. Clears the character under the cursor and all characters to the right of the cursor.
- ESC - For optional fields - aborts current data entry and returns to calling page.
 - - For required (auto-sequence) fields - aborts data entry for current field entry and goes to calling page while retaining data for all previously filled fields of the auto-sequence list.
 - - For free text fields - aborts current free text entry and returns to calling page.
- DEL - Used on free text input keyboards. Deletes the character under the cursor. If the cursor is at the end of the text, deletes the character to the left of the cursor.
- DFT - Used on data input keyboards. Restores the field's default value if one exists. If no default value exists, the field is cleared.
- ENT - For optional fields - accepts entered data and returns to calling page.
 - - For required (auto-sequence) fields - accepts entered data for current field and proceeds to data entry for next field in sequence.
 - - For free text entry - start new line in message.
- SYM - Selects the free text symbolic keyboard.
- NUM - Selects the free text numeric keyboard.
- ALP - Selects the free text alphabetic keyboard.
- Other prompts related to data entry but not shown on actual keyboard include:
 - PREV prompt displays the previous page of a multipage display.
 - NEXT prompt displays the next page of a multipage display.
 - SEND prompt will initiate a downlink from the cockpit. Messages sent while NO COMM is displayed will be queued and transmitted when an air/ground link becomes available or the Flight Summary Report is sent.
 - RET prompt returns the display to the next higher level of the tree associated with the displayed page.

Data Input Keyboards

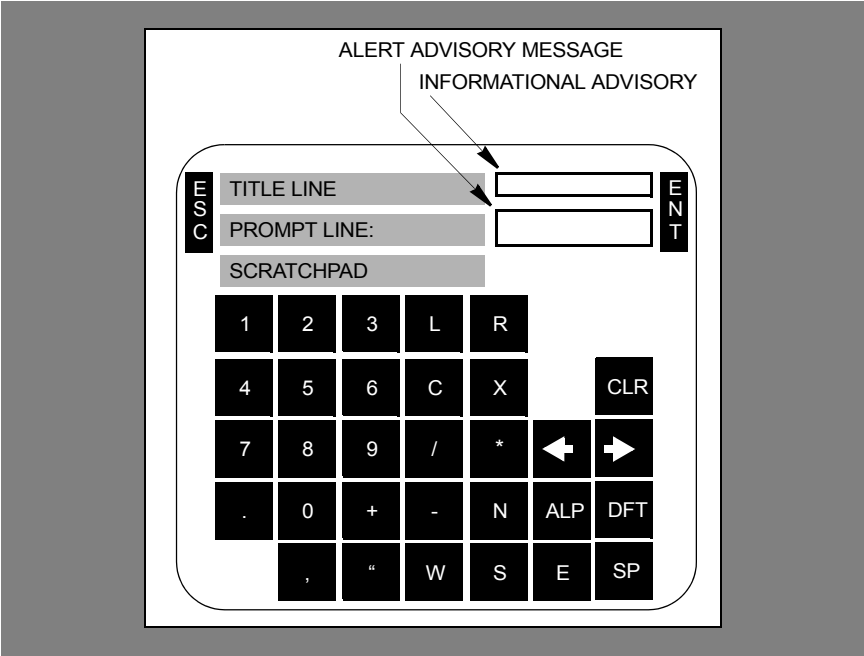
These keyboards include alphabetical, numerical, and hexadecimal.

The area above each keyboard displays three lines: the title of the menu page in use, the prompt selected and the data input line (or scratchpad). Entered data or text appears on the scratchpad with an underscore character to act as an entry cursor and a rectangle character to act as an overwrite cursor. Touching the ENT prompt will enter the data into the message. The left and right arrows allow movement of the cursor across the scratchpad.

Alphabetic Keyboard



Numeric Keyboard



Hexadecimal Keyboard

ALERT ADVISORY MESSAGE
INFORMATIONAL ADVISORY

ESC TITLE LINE **ENT**

PROMPT LINE:

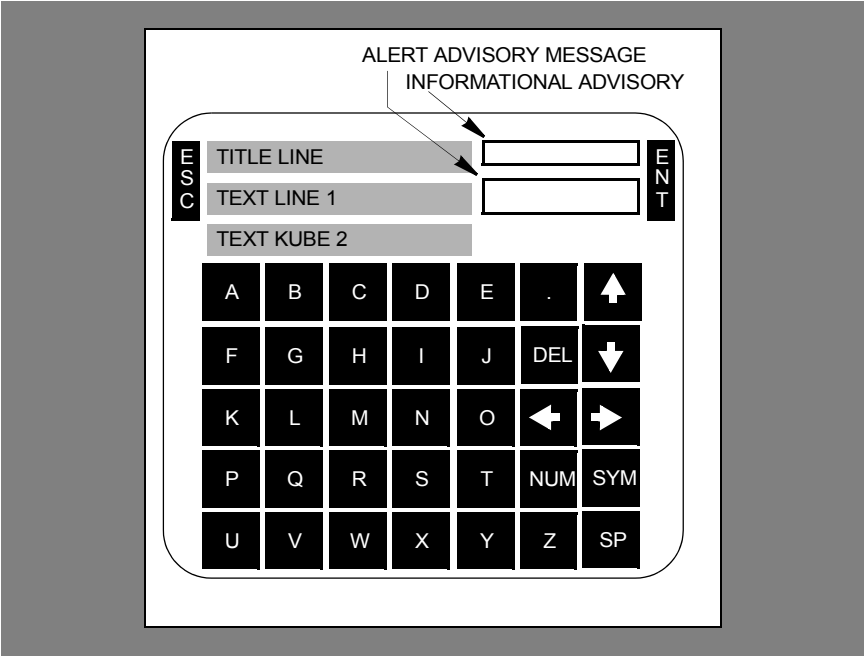
SCRATCHPAD

D	1	2	3	/	
4	5	6	7		CLR
8	9	A	B	←	→
C	D	E	F		DFT

Free Text Keyboards

These keyboards include alphabetical, numeric, and symbolic. The area above each keyboard displays three lines: the title of the menu page in use and two text lines. Up and down arrows are provided to scroll through the text message.

Alphabetic Keyboard



Numeric Keyboard

ALERT ADVISORY MESSAGE
INFORMATIONAL ADVISORY

E
S
C

TITLE LINE

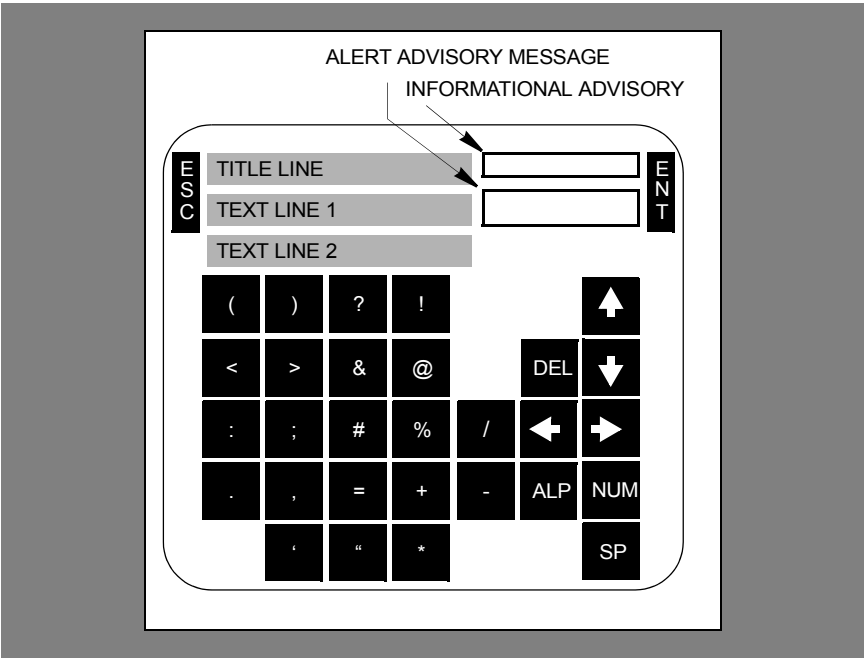
TEXT LINE 1

TEXT LINE 2

E
N
T

1	2	3	⌞	R		⬆
4	5	6	C	X	DEL	⬇
7	8	9	/	*	⬅	➡
.	0	+	-	N	ALP	DFT
'	"	W	S	E	SP	

Symbolic Keyboard



ACARS Control Through an MCDU

Pilot access to ACARS is through a multifunction control display unit (MCDU). In addition to automatic transmission of data by ACARS, the system will allow manual entry of data for transmission to ground stations. Engine parameters, fuel status, and other information can be transmitted by entering values on the appropriate page and pressing the SEND line select key.

ACARS messages can be displayed on the MCDU through the STORED MESSAGES pages. Message titles appear in large characters until displayed. Messages can be sent to the printer by pressing the PRINT line select key.

Data Link Communications Messages

When the system receives a medium-level communications message, an aural chime sounds and the message is presented on EICAS in white letters preceded by a white bullet symbol (•). A low-level communications message is displayed on EICAS but without the chime. During the routine operation of ACARS, several messages may be generated to keep the pilots aware of the status and functioning of the data link. These messages include:

Message	Level	Condition	Crew Action
•ACARS	Medium/ low	A company data link message has been received.	Select ACARS from the MCDU Menu Page and respond to the message.
•PRINTER	Medium/ low	A company data link message has been received and sent to the printer.	Review the printed message and press the reset button on the printer.
•DATALINK AVAIL	Medium	A lost data link connection has been re-established.	Resume use of data link communication.
•VHF DATA OFF	Medium	VHF radio is in voice mode—Data cannot be sent.	Switch radio to DATA to transmit data.

ATC Data Link Communications Message

An ACARS message related to Air Traffic Control (ATC) which may involve clearances, reporting points, climb or descend, or other ATC function will cause the ATC communications message to display on EICAS and the aural chime to sound. Refer to section 5.45 for information on the ATC Data Link.

Message	Level	Condition	Crew Action
• ATC	Medium	An ATC data link message has been received.	Select the ATC mode key on the CDU and respond to the message.

ATC Data Link Advisory Message

Message	Level	Condition	Crew Action
ATCDATALINK LOST	Advisory	An established ATC datalink has been lost.	Notify ATC—resume use of voice communication on the radios.

Data Link Advisory Messages

The following table summarizes the advisory - level EICAS messages related to the data link.

Message	Level	Condition	Crew Action
DATALINK LOST	Advisory	Data link is temporarily lost.	Resume use of voice communication on the radios.
DATALINK SYS	Advisory	Data link system has failed.	Resume use of voice communication on the radios.

FMC Data Link Communications Message

An ACARS communication that is loadable into the FMC, such as winds or route data, will cause the •FMC communication message to display on EICAS and the aural chime to sound. A CDU scratchpad message will provide information on the type of uplink.

Message	Level	Condition	Crew Action
•FMC	Medium	An FMC related data link message has been received.	Select the FMC COMM mode key on the CDU. View the message title in the CDU scratchpad. View the message on the appropriate CDU page.

Communications**Chapter 5****Air Traffic Control Data Link****Section 45**

Air Traffic Control Datalink

Air Traffic Control datalink provides direct communication between the airplane and an air traffic control facility. ATC datalink functions include Air Traffic Services Facilities Notification (AFN), Automatic Dependent Surveillance (ADS), and Air Traffic Control (ATC) Datalink.

ATC datalink communications begins with a logon to the appropriate Air Traffic Control facility. Once the aircraft is logged on, datalink messages can be sent from the ATC facility to the airplane (uplinked) and from the airplane to the ATC facility (downlinked). Also, once the aircraft is logged on, the transfer to adjacent ATC facilities is normally automatic.

The flight crew is alerted by a chime and the EICAS communications message •ATC when an uplink message is received. To display a datalink message which has just been received, press the ATC function key on the MCDU.

The CDU is used to display messages, input data for downlink messages and to respond to uplink messages. Uplink messages which contain route modifications are loaded into the FMC using the LOAD prompts on the ATC pages. Execution of an ATC loaded modification is accomplished using normal FMC modification procedures.

The ATC LOGON/STATUS page provides the capability to establish a downlink connection with a specified ATS facility and to display the ADS, ATC DL, and datalink status.

An uplink delay timer feature allows select ability of maximum uplink delay.

The ATC UPLINK pages display messages uplinked by an ATS facility and provide the capability to respond to uplinked messages and to load clearances which contain loadable data.

The ATC REQUEST pages provide the capability to create downlink requests for altitude, route, and speed changes.

The FMC formats reports in response to requests from an ATS facility. These reports are accessible via the ATC REPORT page and are displayed for review or modification on the VERIFY REPORT page. Some reports can be armed for automatic transmission.

The ATC LOG page provides a list of all uplinks and downlinks stored in the log.

Downlink messages are created by inputting data to the ATC communications pages which provide standard formatting and selectable message elements. The message is sent by selecting a SEND prompt. The status of the message is then indicated as follows:

- displays SENDING while waiting for network acknowledgment
- displays NO ATC COMM if not logged on to ATC

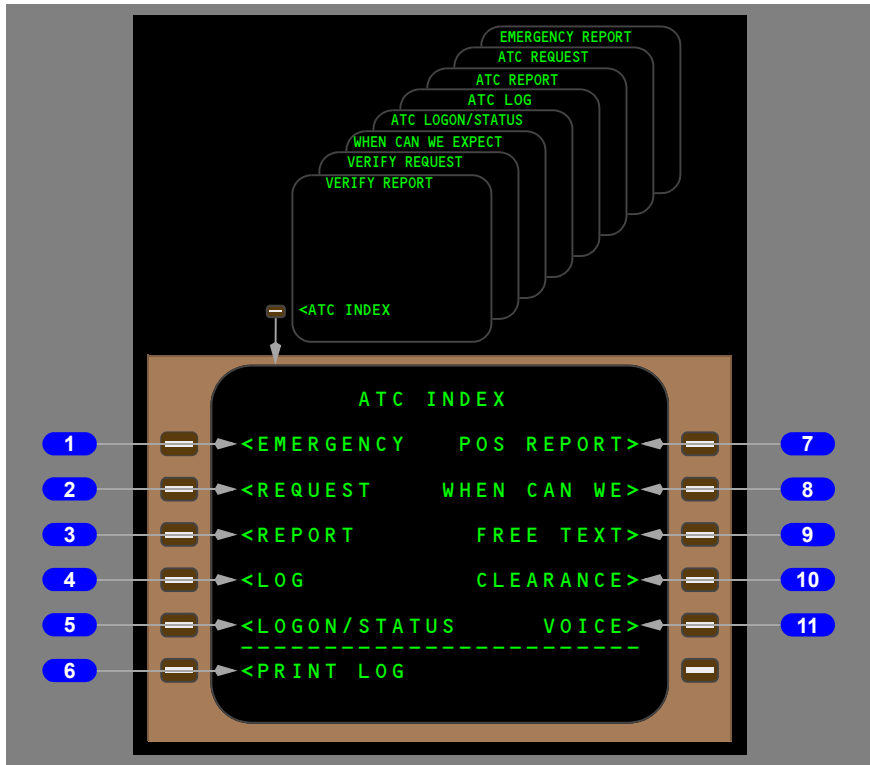
Refer to Volume 1, SP.5 Communications for operating procedures.

ATC Communication Pages

The following graphics show all ATC Communications Pages.

ATC INDEX Page

The ATC INDEX page provides access to pages for ATC data link functions.



1 EMERGENCY

Push – displays EMERGENCY REPORT page.

2 REQUEST

Push – displays ATC REQUEST page.

3 REPORT

Push – displays ATC REPORT page.

4 LOG

Push – displays ATC LOG page.

5 LOGON/STATUS

Push – displays ATC LOGON/STATUS page.

6 PRINT LOG

Push – transmits contents of ATC log to printer.

7 POSITION REPORT

Push – displays POS REPORT page.

8 WHEN CAN WE

Push – displays WHEN CAN WE EXPECT page.

9 FREE TEXT

Push – displays the verify report page with only the free text message element.

10 CLEARANCE

Push – displays VERIFY REQUEST page for clearance request.

11 VOICE

Push – displays VERIFY REQUEST page for voice contact request.

ATC LOGON / STATUS Pages

The ATC LOGON/STATUS pages are used to initiate ATC datalink connection. It displays the status of the datalink system, ATC datalink connection, Automatic Dependent Surveillance (ADS), and crew-entered maximum uplink delay.

The ATC LOGON/STATUS pages are used to initiate ATC data link connection. It displays the status of the data link system, ATC data link connection, Automatic Dependent Surveillance (ADS), and crew-entered maximum uplink delay.



1 LOGON TO

Displays empty character boxes if no ATC COMM connection exists. Dashes display when ATC COMM is established. Valid entry is a four letter ATC center identifier. Entering an identifier and a flight number displays the SEND prompt in the LOGON field (1R) if datalink status is ready.

2 Flight Number (FLT NO)

Displays the flight number entered on the ROUTE page or may be entered directly. The entry is cleared at flight completion. Entering a different flight number during operation terminates ATC COMM connections.

3 Tail Number (TAIL NO)

Automatically loaded when the FMC is powered up. Pilot should verify tail number if it is displayed. The tail number must match the registration number on the SELCAL placard located on the front instrument panel. Displays boxes for pilot input if automatic load is not successful. Entry of a different tail number terminates ATC COMM connections.

4 ATC COMM

Push – terminates A TC datalink connection.

Blank with no active ATC COMM connection.

5 ADS

Push – alternates ADS between OFF and ARM. Status is indicated by large font. (ACT) in the title indicates one or more ADS connection exists. ADS connections are established by the ground and do not require pilot input.

6 ATC INDEX

Push – displays the ATC INDEX page.

7 LOGON

Push – sends logon message to the ATC center listed on the LOGON TO line; Displays SENT. If no network acknowledgment is received, displays RESEND.

After ATC response, displays ACCEPTED or REJECTED.

Display is blank until valid entry in LOGON TO line, then displays SEND.

8 Active (ACT) Center

Displays the four character identifier of the active center.

9 NEXT Center

Displays the four character identifier of the next center if known; otherwise blank.

10 ADS EMERGENCY

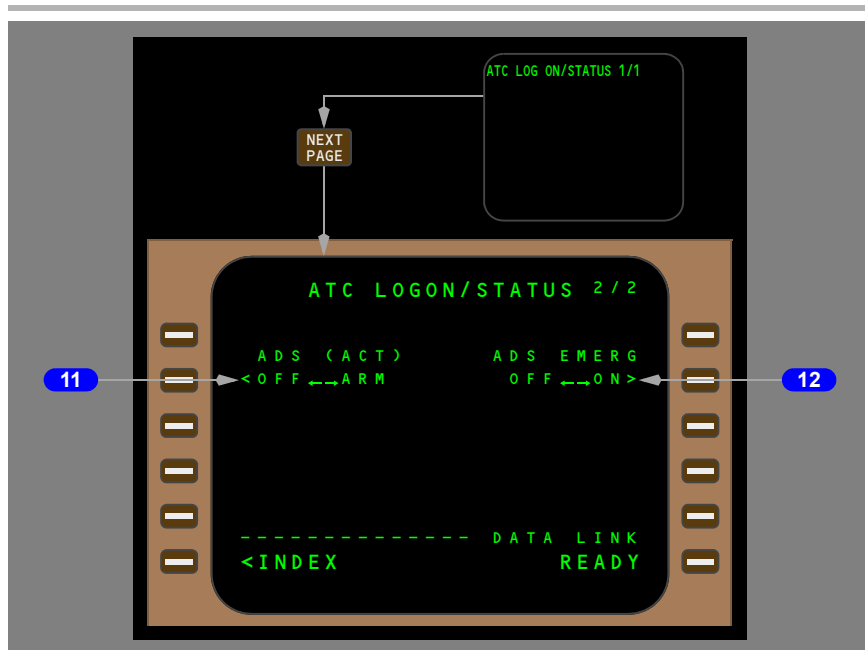
Push – alternately selects ADS EMERGENCY mode ON or OFF; status is indicated by large font. Operates only when ADS is armed or active. Display is blank when ADS is off.

11 DATA LINK Status

Displays status of the datalink system:

- READY
- NOCOMM
- VOICE
- FAIL





1 LOGON TO

Displays empty character boxes if no ATC COMM connection exists. Dashes display when ATC COMM is established. Valid entry is a four letter ATC center identifier. Entering an identifier and a flight number displays the SEND prompt in the LOGON field (1R) if datalink status is ready.

2 Flight Number (FLT NO)

Displays the flight number entered on the ROUTE page or may be entered directly. The entry is cleared at flight completion. Entering a different flight number during operation terminates ATC COMM connections.

3 Tail Number (TAIL NO)

The airplane tail number is automatically loaded when power is applied to the FMC. Display boxes for pilot input appear if automatic load is not successful. Entering a different tail number terminates any active ATC connections.

4 MAX U/L DELAY

Default display is three dashes followed by SEC. Valid entry is a time in seconds between 1 and 999. Entry of an invalid value results in the display of INVALID ENTRY in the scratch pad. Selection of DELETE to the MAX U/L DELAY field (4L) returns the display to dashes.

5 ATC COMM

Push – the SELECT OFF prompt terminates the A TC data link connection.
Blank with no active ATC COMM connection.

6 INDEX

Push – displays the ATC INDEX page.

7 LOGON

Push – sends logon message to the ATC center listed on the LOGON TO line; displays SENT. If no network acknowledgment is received, displays RESEND. After ATC response, displays ACCEPTED or REJECTED.
Display is blank without valid entry in LOGON TO line, then displays SEND.

8 Active Center

Displays the four character identifier of the active center.

9 NEXT Center

Displays the four character identifier of the next center if known; otherwise blank.

10 DATA LINK Status

Displays status of the datalink system:

- READY
- NOCOMM
- VOICE
- FAIL

11 ADS

Push – alternates ADS between OFF and ARM. Status is indicated by large font. (ACT) in the title indicates one or more ADS connection exists.

12 ADS EMERGENCY

Push – alternately selects ADS EMERGENCY mode ON or OFF; status is indicated by large font. Operates only when ADS is armed or active. Display is blank when ADS is off.

ATC UPLINK Page

The ATC UPLINK page displays messages uplinked by ATC and provides the crew the capability to respond to and load clearances into the FMC. The title displays the time the message was received.

ATC UPLINK page 1/X



1 REQUEST

Displays REQUEST when the displayed uplink is in response to a downlink request which is still listed in the ATC log.

Push – displays the corresponding XXXXZ ATC REQUEST page.

Blank if the displayed message is not in response to a downlink request or if the request has been removed from the log.

2 MESSAGE TEXT

Displays the text of the uplink message in lines 2 through 5. If more space is needed additional pages are added.

3 STATUS

Displays the status of the ATC uplink message. The status is also shown on the ATC LOG page.

4 ARM

Displays ARM adjacent to required reports that are armable.

Push –

- arms the report for automatic transmission
- displays ARMED
- deleting ARMED returns the ARM prompt and disarms the report.

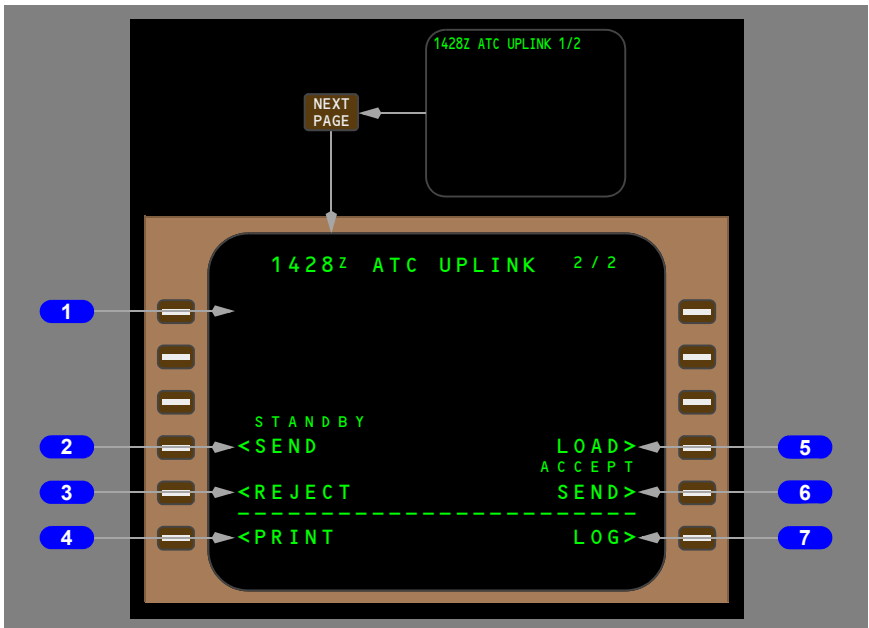
5 LOG, REPORT

Displays REPORT when the uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request. Displays LOG when the uplink message does not contain any of those elements.

Push – displays the ATC LOG or ATC REPORT page as indicated.

ATC UPLINK page X/X

The last ATC UPLINK page continues the text of the uplink message if required. The last page also provides prompts to respond to the message and to load clearances.



1 MESSAGE TEXT (continued)

The first 3 lines of the last page are available to continue the text of the message.

2 STANDBY SEND

Displayed on the last page if a response is required.

Push – sends a STANDBY response to ATC.

3 REJECT

The REJECT prompt is displayed on the last page if UNABLE or NEGATIVE is a valid response.

Push – displays the REJECT DUE TO page.

4 PRINT

Push – prints complete text of displayed uplink message.

5 LOAD

Displays LOAD on the last page only if the message contains loadable data, otherwise the display is blank.

Push – loads data into route.

6 ACCEPT SEND

Displays ACCEPT SEND on the last page when WILCO, ROGER, or AFFIRM is a valid response to the displayed message, otherwise the line is blank.

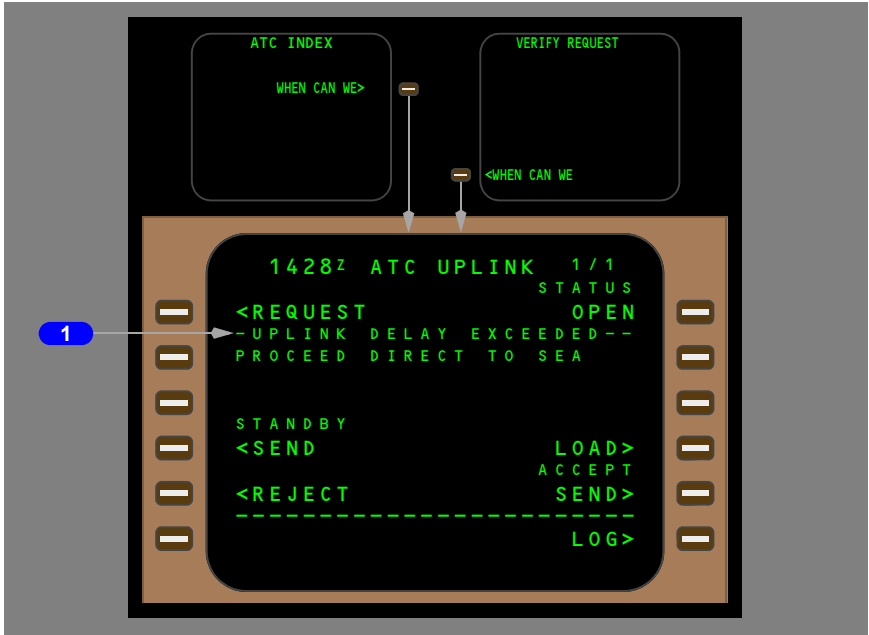
Push – sends a downlink response with WILCO, ROGER, or AFFIRM, as appropriate.

7 LOG, REPORT

Displays REPORT when the uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request. Displays LOG when the uplink message does not contain any of those elements.

Push – displays the ATC LOG or ATC REPORT page as indicated.

Uplink Delay Exceeded message

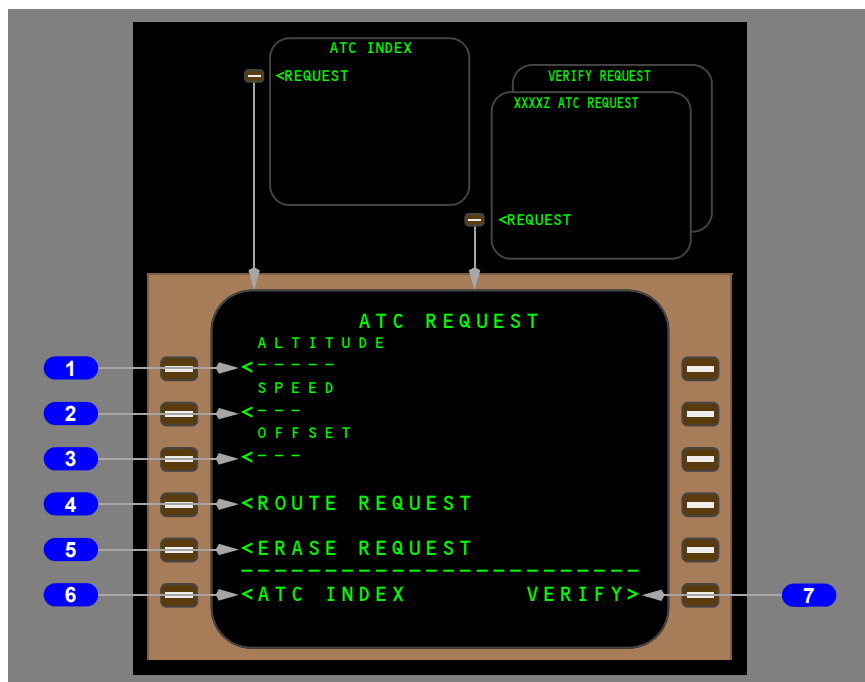


1 UPLINK DELAY EXCEEDED

When a received uplink message exceeds the MAX U/L DELAY time entered on the ATC LOGON/STATUS page, the UPLINK DELAY EXCEEDED message is displayed in the message text.

ATC REQUEST Page

Provides access to various ATC REQUEST pages and allows entry of altitude, speed, and offset information to be requested.



1 ALTITUDE

Push – displays ATC Altitude Request (ALT REQUEST) page.

If selected with valid altitude in the scratch pad, that altitude will be displayed on the ALTITUDE REQUEST page.

Valid entry is XXX (feet), FLXXX, XXXXX (flight level), XXXXXM (meters), XXXXX/XXXXX (block altitude feet), FLXXX/FLXXX (block altitude flight level), or XXXXXM/XXXXXM (block altitude meters).

If selected with dashes displayed and no scratch pad entry, a blank ATC ALT REQUEST page is displayed.

2 SPEED

Push – displays ATC SPEED REQUEST page.

If selected with a valid IAS or Mach number in the scratch pad, that speed will be displayed on the ATC SPEED REQUEST page.

If selected with dashes displayed and no scratch pad entry, a blank ATC SPEED REQUEST page is displayed.

3 OFFSET

Push – displays the ATC OFFSET REQUEST page.

If selected with a valid offset entry in the scratch pad, that offset will display on the ATC OFFSET REQUEST page. Valid entry format denotes offset Left, Right, or Either side and the offset distance: LXX, RXX, or XX for either side. (where XX is any number between 0 and 99 nautical miles).

If selected with dashes displayed and no scratch pad entry, a blank ATC OFFSET REQUEST page is displayed.

4 ROUTE REQUEST

Push – displays ATC ROUTE REQUEST page.

5 ERASE REQUEST

Push – erases all entered or selected data and any of the four ATC REQUEST pages that have data entered.

6 ATC INDEX

Push – displays the ATC INDEX page.

7 VERIFY

Push – displays the VERIFY REQUEST page.

ATC Altitude Request (ALT REQUEST) Page

The ATC ALT (Altitude) REQUEST page is used to create a downlink message requesting an altitude change.



1 ALTITUDE

Initially displays dashes or the altitude entered on the ATC REQUEST page. Entered value may be deleted or modified.

Entering an altitude selects a message requesting a climb or descent based on the current altitude.

2 STEP AT

Allows the optional entry of a position or time. If an entry is made it is included with the altitude request message to specify a step climb or descent at the specified position or time.

Valid STEP AT entries are: fix name, navaid, airport, latitude/longitude, place bearing/distance, or time.

3 At Pilot's Discretion (AT PILOT DISC)

Push – displays AT PILOT DISC in large font and selects it as a message element in the altitude request.

The DELETE key can be used to return the display to small font and remove the message element.

4 REQUEST

Push – displays the ATC REQUEST page.

5 Request Cruise Climb (REQUEST CRZ CLB)

Push – displays CRZ CLB in large font and selects a message element requesting a cruise climb to the entered altitude.

The DELETE key can be used to return the display to small font and remove the message element.

6 MAINTAIN OWN SEPARATION/VMC

Push – displays SEPARATION/VMC prompt in large font and selects the MAINTAIN OWN SEPARATION/VMC message element.

The DELETE key can be used to return the display to small font and remove the message element.

7 DUE TO PERFORMANCE

Push – displays the PERFORMANCE prompt in large font and selects the DUE TO PERFORMANCE message element.

The DELETE key can be used to return the display to small font and remove the message element.

8 DUE TO WEATHER

Push – displays WEATHER in large font and selects the DUE TO WEATHER message element.

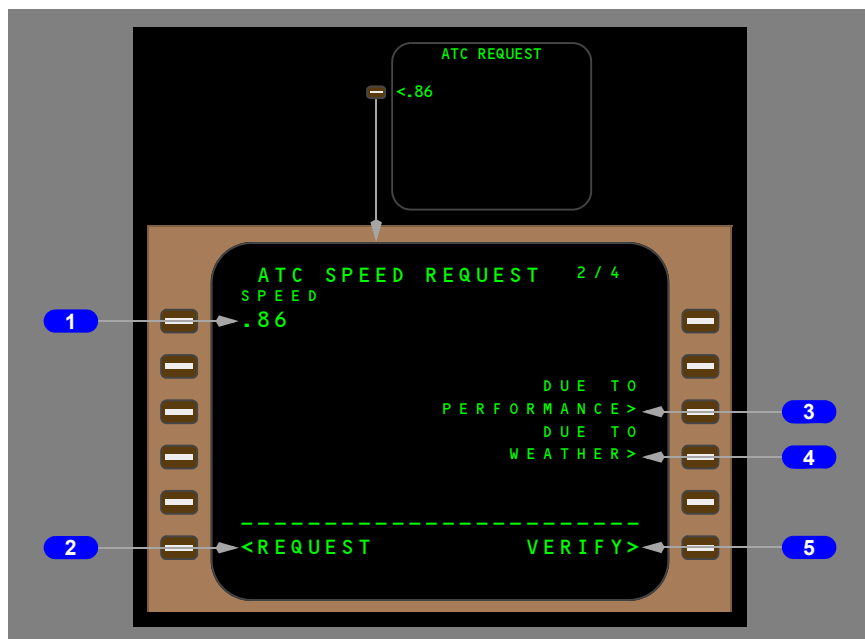
The DELETE key can be used to return the display to small font and remove the message element.

9 VERIFY

Push – displays the VERIFY REQUEST page where all the selected message elements can be confirmed and the message can be sent.

ATC SPEED REQUEST Page

The ATC SPEED REQUEST page is used to create a downlink message requesting a speed change.



1 SPEED

Initially displays dashes or the speed entered on the ATC REQUEST page. Entered value may be deleted or modified.

Entering an IAS or Mach number creates a message requesting that speed.

2 REQUEST

Push – displays the ATC REQUEST page.

3 DUE TO PERFORMANCE

Push – displays the PERFORMANCE prompt in large font and selects the DUE TO PERFORMANCE message element.

The DELETE key can be used to return the display to small font and remove the message element.

4 DUE TO WEATHER

Push – displays WEATHER in large font and selects the DUE TO WEATHER message element.

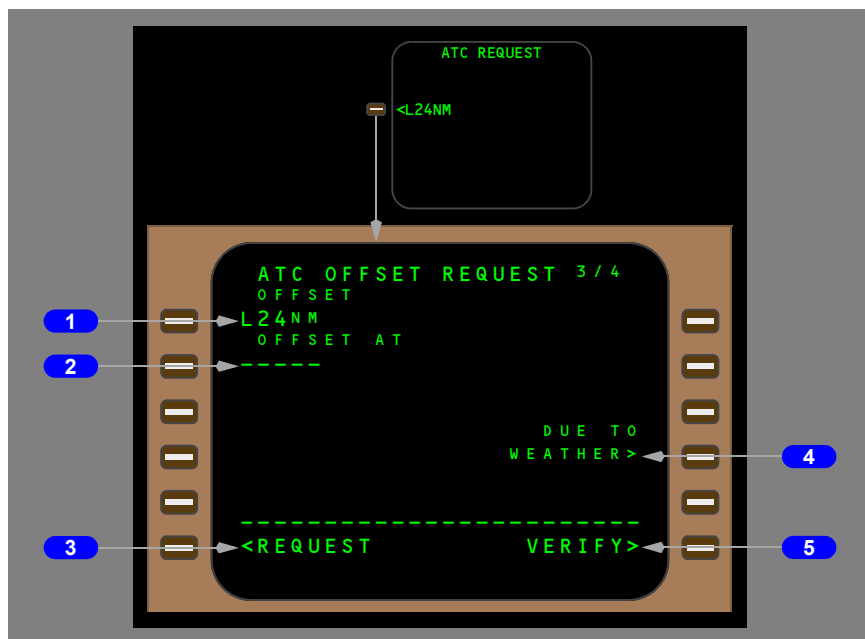
The DELETE key can be used to return the display to small font and remove the message element.

5 VERIFY

Push – displays the VERIFY REQUEST page where all the selected message elements can be confirmed and the message can be sent.

ATC OFFSET REQUEST Page

The ATC OFFSET REQUEST page is used to create a downlink request for an offset.



1 OFFSET

Initially displays dashes or the offset entered on the ATC REQUEST page. Entered value may be deleted or modified.

If selected with a valid offset entry in the scratch pad, that offset will display on the ATC OFFSET REQUEST page. Valid entry format denotes offset left, right, or either side and the offset distance: LXX, RXX, or XX for either side. (where XX is any number between 0 and 99 nautical miles) A valid entry creates a message requesting the offset.

2 OFFSET AT

Allows the optional entry of a position or time. If an entry is made it is included with the offset request message to specify a position to start the offset.

Valid entries are: fix name, navaid, airport, latitude/longitude, place bearing/distance, or time.

3 REQUEST

Push – displays the ATC REQUEST page.

4 DUE TO WEATHER

Push – displays WEATHER in large font and selects the WEATHER DEVIATION message element.

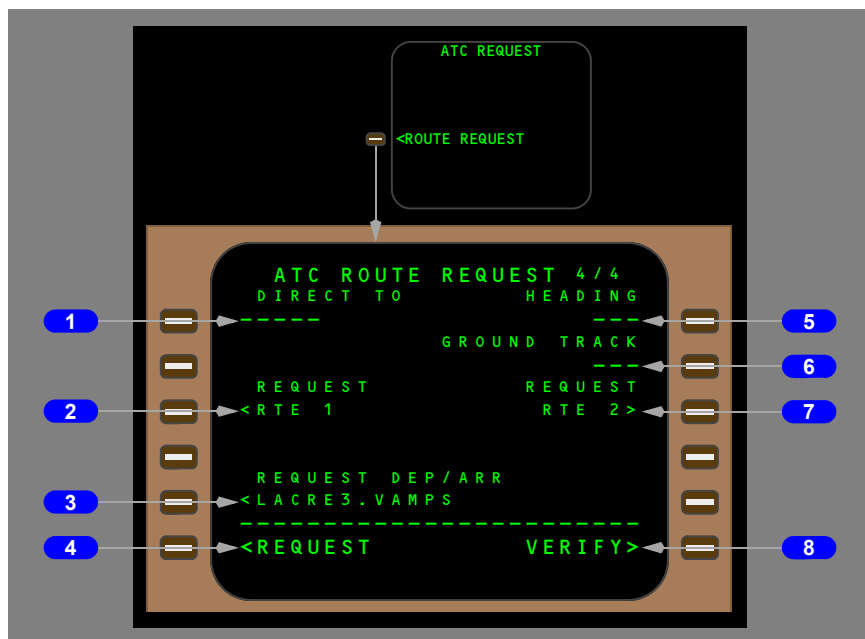
The DELETE key can be used to return the display to small font and remove the message element.

5 VERIFY

Push – displays the VERIFY REQUEST page where all the selected message elements can be confirmed and the message can be sent.

ATC ROUTE REQUEST Page

The ATC ROUTE REQUEST page is used to create a downlink request for a route clearance.



1 DIRECT TO

A position entry creates a message requesting a clearance direct to the specified position. Valid entries are: fix name, navaid, airport, latitude/longitude, or place bearing/distance.

2 REQUEST RTE 1

Push – selects the route stored in RTE 1 for the route request message. If the selected route has a pending modification, the modified route is selected for the route request.

3 REQUEST DEP/ARR

Allows entry of a procedure to be included in the route request. A departure or arrival, or approach and, if applicable, a transition may be entered.

If a procedure has been selected on the DEPARTURES or ARRIVALS page, that procedure will be displayed in small font.

Push – when a procedure is displayed in small font, that procedure changes to large font and is included in the PROCEDURE REQUEST.

If no selection is made on the DEP/ARR page, dashes are displayed. If dashes are displayed, a procedure can be entered into the scratch pad and then line selected to be included as a message element in the request.

4 REQUEST

Push – displays the ATC REQUEST page.

5 HEADING

Entering a heading creates a message requesting the specified heading.

6 GROUND TRACK

Entering a ground track selects a message requesting the specified ground track.

7 REQUEST RTE 2

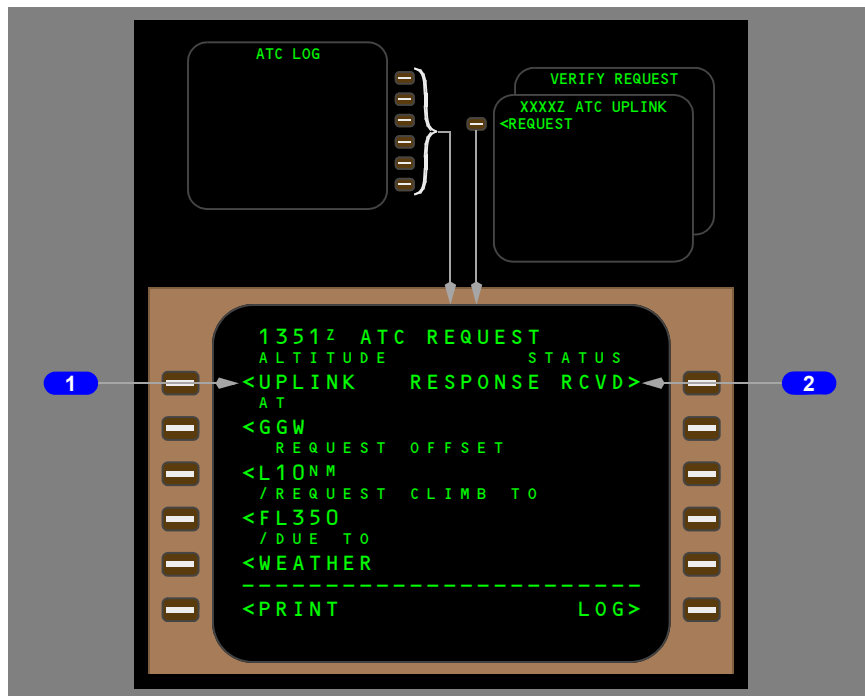
Push – selects the route stored in RTE 2 for the route request message. If the selected route has a pending modification, the modified route is selected for the route request.

8 VERIFY

Push – displays the VERIFY REQUEST page where all the selected message elements can be confirmed and the message can be sent.

XXXXZ ATC Request Page

The ATC REQUEST pages display the transmitted request. XXXXZ is the time request was transmitted.



1 Lines 1- 5

Pages 1/X to X/X display data transmitted to ATC at the time in page title.

Page 1/X line 1 displays UPLINK when ATC response to displayed downlink request exists.

Response time of ATC uplink displays following text.

UPLINK -

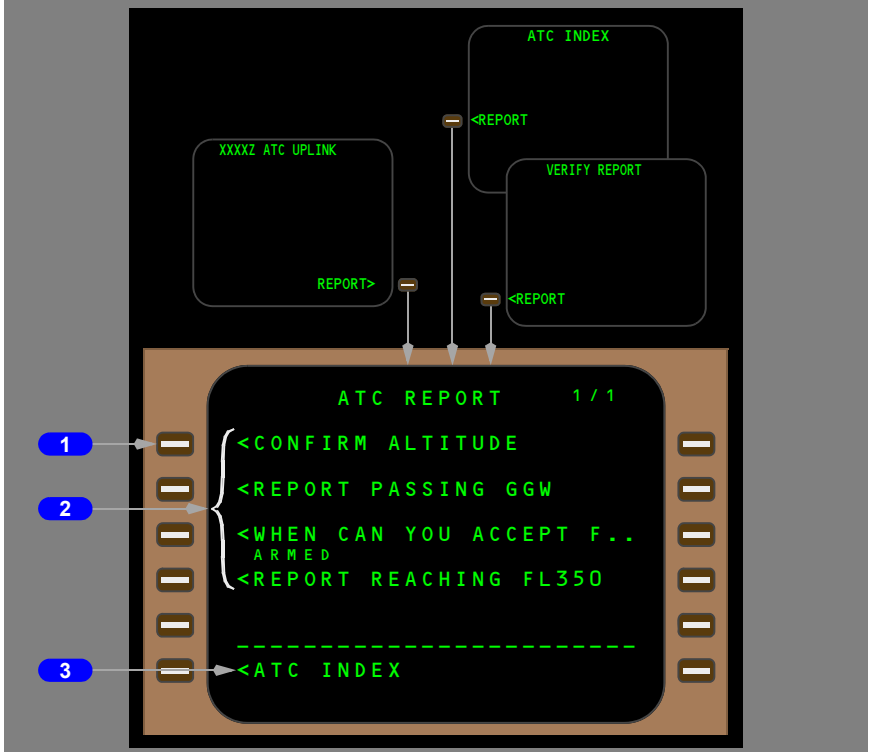
Push - displays the XXXXZ ATC UPLINK 1/X page displaying ATC uplink to displayed request.

2 STATUS

Displays request downlink message status from ATC LOG page.

ATC REPORT Page

The ATC REPORT page lists all (maximum 10) ATC requested reports or confirmations. Provides access to the VERIFY REPORT pages for listed reports.



1 VERIFY REPORT Line Select Keys

Push – displays the VERIFY REPORT page for the report listed. There is a separate page for each report.

2 List of ATC Requested Reports

Lists all reports or confirmations requested by ATC with the most recent request at the bottom of the list. A maximum of 10 report requests can be listed. If a report request is received while the list is full, the ATC REPORT LIST FULL scratch pad message is displayed. Long messages are abbreviated and followed by two periods.

Items are removed from the list when the report has been sent.

ARMED is displayed in the header if the report armed for automatic transmission.

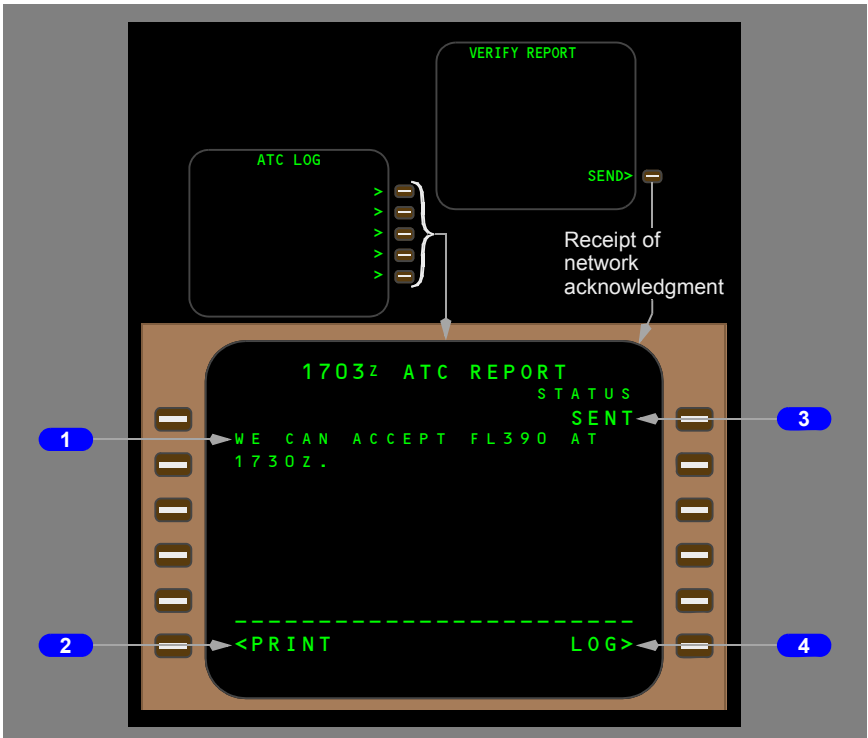
Deleting a line deletes the report.

3 ATC INDEX

Push – selects the ATC INDEX page.

XXXXZ ATC REPORT Page

Displays text of message downlinked to ATC, where XXXXZ is the time the transmission was initiated.



1 Message Text

Displays the message text which was transmitted to ATC at the time indicated in the page title.

2 PRINT

Push – prints the displayed report.

3 MESSAGE STATUS Line

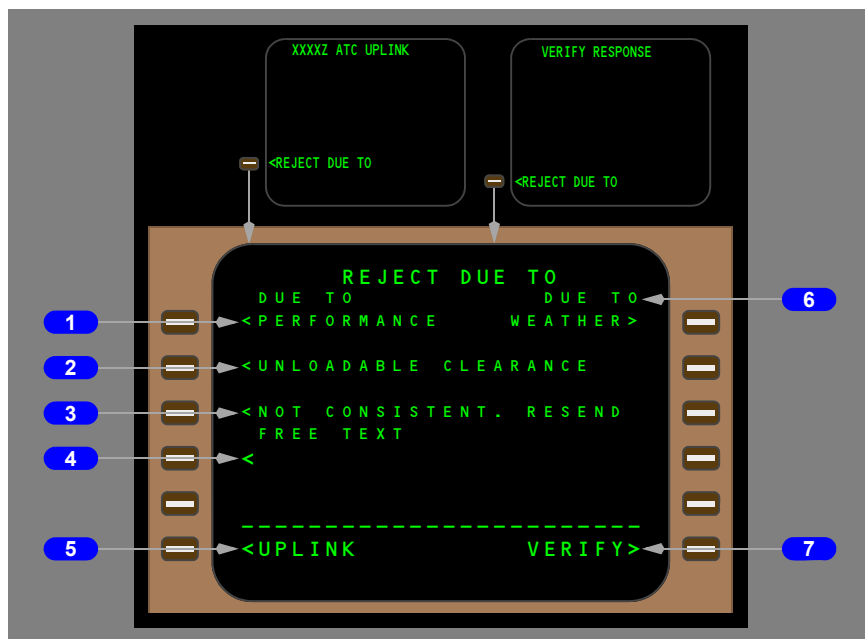
Displays the status of the downlinked message. The status is also displayed on ATC LOG page.

4 LOG

Push – displays the ATC LOG page.

REJECT DUE TO Page

The REJECT DUE TO page allows the crew to include a reason for rejecting an ATC UPLINK message.



1 DUE TO PERFORMANCE

Push – selects the DUE TO AIRCRAFT PERFORMANCE message element to be included in the downlink response. Displays PERFORMANCE in large font after selected.

2 UNLOADABLE CLEARANCE

Push – selects the UNLOADABLE CLEARANCE message element to be included in the downlink response. Displays UNLOADABLE CLEARANCE in large font after selected.

3 NOT CONSISTENT. RESEND

Push – selects the NOT CONSISTENT. RESEND message element to be included in the downlink response. Displays NOT CONSISTENT. RESEND in large font after selected.

4 FREE TEXT

Allows free text to be included in the downlink message.

5 UPLINK

Push – displays the ATC UPLINK page.

6 WEATHER

Push – selects the DUE TO WEATHER message element to be included in downlink response. Displays WEATHER in large font after selected.

7 VERIFY

Push – displays the VERIFY RESPONSE page to review the response message prior to sending.

VERIFY REPORT Page

Displays text of message to be sent to ATC in response to a report request. Allows insertion, modification and review of free text before the report is sent.



1 Message Text

Message text is displayed in line titles and specific data elements are displayed on data lines 1 through 4.

2 Data Line

Displays data elements to be included in message. Empty input boxes or dashes are displayed for pilot entry. Deleting entered data returns boxes or FMC default data.

3 CANNOT ACCEPT Line Select Key

Push – selects a CANNOT ACCEPT message. A selected message may be deleted prior to sending.

Displayed only in response to WHEN CAN YOU ACCEPT uplink messages.

4 FREE TEXT

Allows entering free text to the scratchpad. Every VERIFY REPORT page has at least one line available for free text. If the VERIFY REPORT page is accessed from the FREE TEXT prompt on the ATC INDEX page, all 4 data lines are provided for a free text message.

5 REPORT

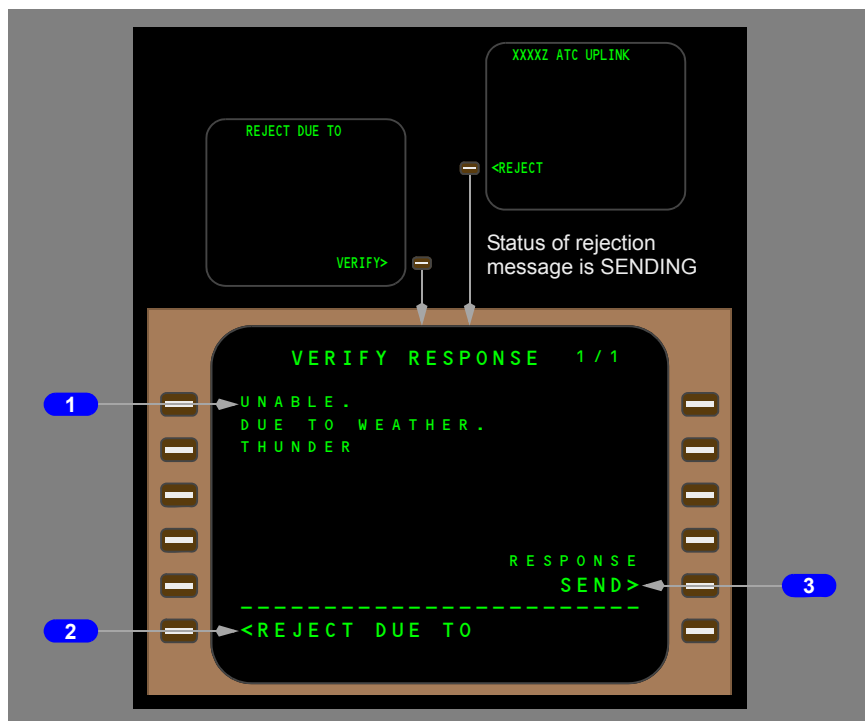
Push – displays the ATC REPORT page.

6 REPORT SEND

Push – transmits ATC REPORT and creates an ATC LOG entry of transmitted message.

VERIFY RESPONSE Page

The VERIFY RESPONSE page allows the crew to create and review a rejection response to an ATC UPLINK message before sending it.



1 UNABLE or NEGATIVE

Displays the message text as selected or entered on the REJECT DUE TO page. Message elements are displayed in the order they were selected. Selected elements are followed by free text.

2 REJECT DUE TO or UPLINK

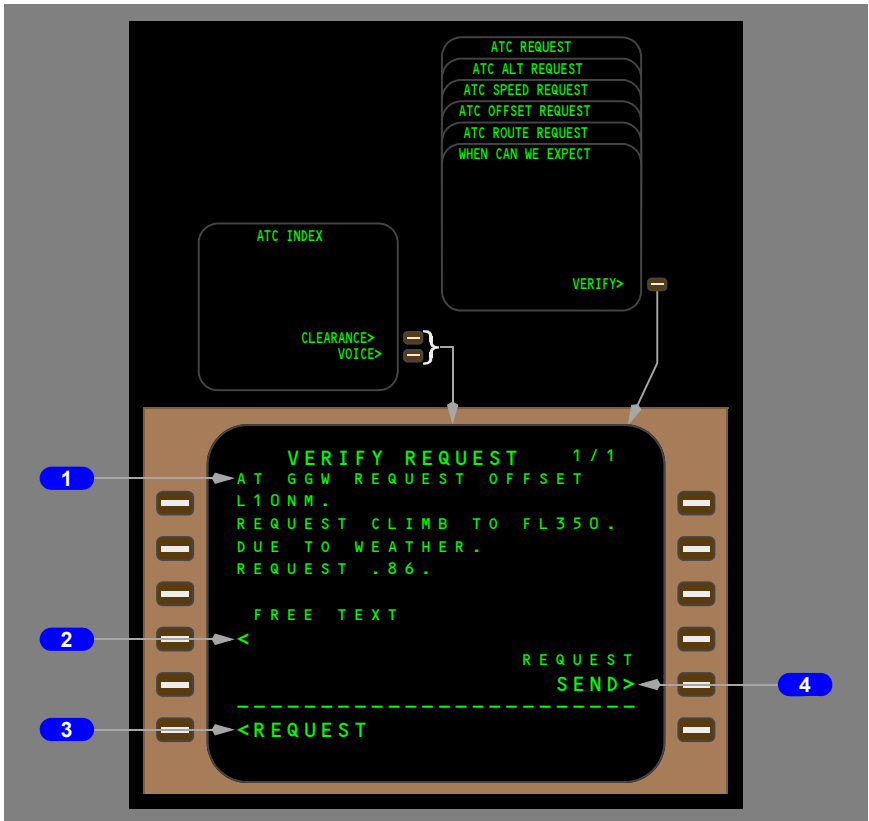
Push – if REJECT DUE TO is displayed, selects the REJECT DUE TO page. If UPLINK is displayed, selects the XXXXZ ATC UPLINK page.

3 RESPONSE SEND

Push – transmits the downlink response.

VERIFY REQUEST Page

The VERIFY REQUEST page is used to confirm the elements included in a downlink request, add free text and send the request.



1 Message Text

Displays the text and data as created on any of the request pages or the WHEN CAN WE EXPECT page. Message elements are listed in the order they were entered.

2 FREE TEXT

At least one line is available for free text entry. Entered text is included in the downlink request. Additional pages are added as required to provide for additional free text.

3 ATC INDEX, REQUEST, WHEN CAN WE

Displays the prompt for the page from which the VERIFY page was selected.

Push – displays the listed page.

4 REQUEST SEND

Push – sends the ATC REQUEST downlink message, creates a log entry of transmitted message and displays standard SEND information.

WHEN CAN WE EXPECT Page

The WHEN CAN WE EXPECT page is used to create a downlink query about the timing of a clearance or request.



1 CRZ CLB TO

Entering an altitude creates a message asking when to expect a cruise climb to the entered altitude. Valid entry is in normal altitude format. The entry may be deleted.

2 CLIMB TO

Entering an altitude creates a message asking when to expect a climb to the entered altitude. Valid entry is in normal altitude format. The entry may be deleted.

3 DESCENT TO

Entering an altitude creates a message asking when to expect a descent to the entered altitude. Valid entry is in normal altitude format. The entry may be deleted.

4 SPEED

Entering a speed creates a message asking when to expect clearance to the entered speed. Valid entry is an IAS or Mach number. The entry may be deleted.

5 ERASE WHEN CAN WE

Push – erases all entered or selected data and returns default values.

6 ATC INDEX

Push – displays the ATC INDEX page.

7 HIGHER ALTITUDE

Push – creates a message asking when to expect a higher altitude. Selection may be deleted.

8 LOWER ALTITUDE

Push – creates a message asking when to expect a lower altitude. Selection may be deleted.

9 BACK ON RTE

Push – creates a message asking when to expect clearance back to the flight plan route. Selection may be deleted.

10 VERIFY

Push – displays the VERIFY REQUEST page where all the selected message elements can be confirmed and the message can be sent.

Position Report (POS REPORT) Page

The XXXXZ POS REPORT page allows review and sending of position report to company and/or ATC. Entered data is sent to ATC only. XXXX is the flight number.

The screenshot shows the POS REPORT page with the following layout and callouts:

- Top Section:** Two boxes labeled "FMC COMM 1/2" and "ATC INDEX", each containing a "POS REPORT>" button.
- Main Display Area:**
 - Header:** "TBC12345 POS REPORT"
 - Left Column (Callouts 1-6):**
 - 1: LAST
 - 2: 4730N110W
 - 3: ALT
 - 4: FL330
 - 5: TO
 - 6: GRF
 - Right Column (Callouts 7-12):**
 - 7: ATA
 - 8: 1436Z
 - 9: SPD
 - 10: .80
 - 11: ETA
 - 12: 1555Z
 - Bottom Section:**
 - Next to "GRF": "NEXT 46N120W"
 - Below "NEXT": "TEMP -52°C"
 - Below "TEMP": "COMPANY-----"
 - Below "COMPANY": "<SEND"
 - Below "TEMP": "290°/70KT"
 - Below "COMPANY": "DEST ETA 1730Z"
 - Below "DEST ETA": "FUEL 91.5"
 - Below "FUEL": "ATC SEND>"

1 LAST Waypoint

Displays waypoint identifier for last sequenced leg.

2 Altitude (ALT)

Displays current altitude.

3 TO Waypoint

Displays waypoint identifier of current leg.

Valid entries are waypoint identifiers in the navigational database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns current leg waypoint.

4 NEXT Waypoint

Displays waypoint identifier of leg following the TO leg.

Valid entries are waypoint identifiers in the navigational database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns default waypoint.

5 Temperature

Displays current static air temperature.

6 WIND

Displays current wind direction and magnitude.

7 Actual Time of Arrival (ATA)

Displays ATA at last sequenced waypoint.

8 Speed (SPD)

Displays current airspeed/Mach.

Valid entry is airspeed or Mach.

Entry overrides displayed airspeed/Mach.

Deletion or page change returns default airspeed/Mach.

9 Estimated Time of Arrival (ETA)

Displays ETA at TO waypoint.

Valid entry is XXXXZ.

Entry overrides displayed time.

Deletion of entry returns default time.

10 Destination Estimated Time of Arrival (DEST ETA)

Displays ETA at destination.

Valid entry is XXXXZ.

Entry overrides displayed time.

Deletion of entry returns default time.

11 Fuel

Displays lesser of calculated or totalizer fuel remaining at LAST waypoint.

12 ATC SEND

Push

- sends downlink position report to ATC
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit.
- displays SEND with network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for data link fault

13 COMPANY SEND

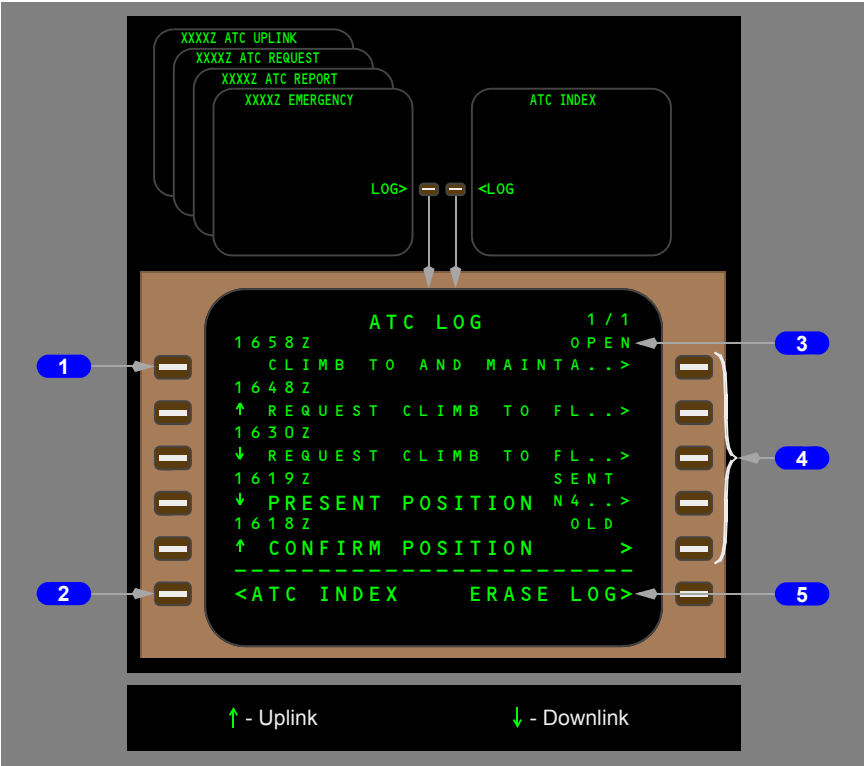
Push

- sends downlink position report to company
- default values are used for TO, NEXT, SPD, and ETA
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays RESEND when no network acknowledgement within time limit.
- displays SEND with network acknowledgement
- displays NO ATC COM when datalink READY and no ATC connection
- displays DATA LINK header and NO COMM, VOICE, or FAIL as appropriate for data link fault

ATC LOG Page X/X

The ATC LOG pages display stored uplinks and downlinks. Log automatically erases after flight completion.

The page becomes active after contact with ATC and more than one new, or no more than one pending uplink.



1 Lines 1 - 5

Display text of uplink and downlink messages. Long messages abbreviated and followed by two periods.

Deleting a line deletes the log entry.

Title displays message receipt (uplink) or transmission (downlink) time.

2 ATC INDEX

Push – displays the ATC INDEX page.

3 Message Status

Title displays one of six possible uplink or seven possible downlink states:

Uplink -

- **NEW** - message not reviewed by crew: message considered pending
- **OLD** - message reviewed by crew and message does not require response;
- **OPEN** - message reviewed by crew, message requires response, crew has not sent response or has sent **STANDBY** or network acknowledgement of response not received; message considered pending
- **ACCEPTED** - message reviewed by crew, message requires response, positive response sent, network acknowledgement of positive response reviewed; message considered non-pending
- **REJECTED** - message reviewed by crew; message requires response; negative response sent; network acknowledgement of negative response received; message considered non-pending
- **ABORTED** - message pending when all terminations terminated or transfer of communications occurred

Downlink -

- **SENDING** - **SEND** prompt selected, network acknowledgement not yet received, message considered pending
- **SENT** - **SEND** prompt selected; network acknowledgement received; message does not require response; message considered non-pending
- **SEND** - **SEND** or **RESEND** prompt selected, network acknowledgement received, message does not require response, message considered non-pending
- **OPEN** - **SEND** prompt selected, network acknowledgement received, message requires response, response not received or **STANDBY** response received, message considered pending
- **DEFERRED** - **SEND** prompt selected, network acknowledgement received, message requires response, **REQUEST DEFERRED** response received; message considered pending
- **RESPONSE RCVD** - **SEND** prompt selected, network acknowledgement received, message requires response, response other than **STANDBY** or **REQUEST DEFERRED** received; message considered non-pending
- **ABORTED** - message pending when all connections terminated or transfer of communications performed

Push - displays **XXXXZ**: **ATC UPLINK**, **ATC REQUEST**, **ATC REPORT**, or **EMERGENCY** page related to line selected.

4 Line 1 – 5 Line Select Keys

Push – displays the corresponding message in its entirety on the associated page. If the message has been ACCEPTED or REJECTED by the flight crew, this page will also show the response and the time that the response was sent.

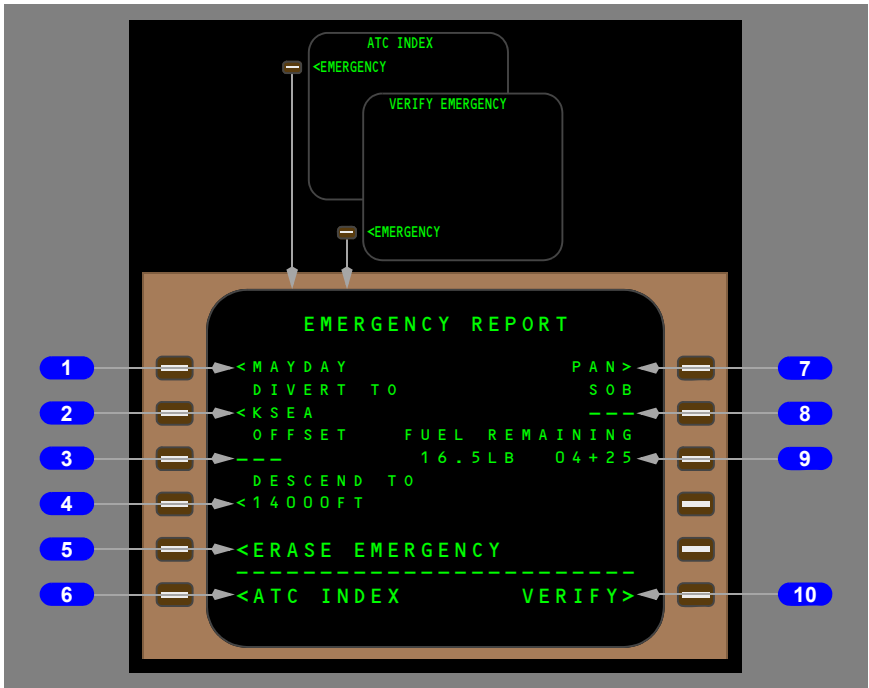
5 ERASE LOG

PUSH -

- arms deletion of all non-pending messages in ATC log.
- Displays CONFIRM.
- Selection of CONFIRM deletes all non-pending messages in ATC log
- Leaving the page without selecting CONFIRM returns ERASE LOG

EMERGENCY REPORT Page

The EMERGENCY REPORT page is used to generate an emergency message to ATC.



1 MAYDAY

Push – selects the MAYDAY MAYDAY MAYDAY message element and displays the VERIFY EMERGENCY page.

If the current altitude is more than 150 feet above the altitude shown in 4L, DESCENDING TO is displayed on the VERIFY EMERGENCY page.

2 DIVERT TO

Default display is the active destination airport.

Valid entries are:

- fix name
- navaid
- airport
- latitude/longitude
- or place bearing/distance

Push – if the default airport is displayed, the remainder of the route is included in the message. If a position other than the destination is entered, the direct route to that position is included in the message.

The entered position may be deleted.

3 OFFSET

121-139, 1401-1404, 1603-1613, 1705-1708

Valid entry format denotes offset left, right, or either side and the offset distance: LXX, RXX, or XX for either side. (where XX is any number between 0 and 99 nautical miles) A valid entry creates a message requesting the offset.

4 DESCEND TO

Default display is the MCP altitude. Valid entry is XXX (feet), FLXXX, XXXXX (flight level), or XXXXXm (meters). Entered altitude is displayed in large font and may be deleted.

Push – inserts message element indicating intention to descend to the displayed altitude.

If the current altitude is more than 150 feet above the altitude shown in the DESCEND TO prompt (4L), then the DESCENDING TO prompt is displayed on the VERIFY EMERGENCY page.

5 ERASE EMERGENCY

Display is blank until a message element is selected. Entry or selection of data on any line causes the ERASE EMERGENCY prompt to be displayed.

After the EMERGENCY REPORT is transmitted the display changes to the CANCEL EMERGENCY prompt.

Push –

- if ERASE EMERGENCY is displayed, erases all emergency data
- if CANCEL EMERGENCY is displayed, generates a CANCEL EMERGENCY message.

The CANCEL EMERGENCY message may be deleted after it is selected.

6 ATC INDEX

Push – displays ATC INDEX page.

7 PAN

Push – selects PAN PAN PAN message and displays the VERIFY EMERGENCY page.

8 Souls On Board (SOB)

Allows entry of the number of people on board. When a number is entered the fuel remaining is displayed and a message element with the number of people on board and the fuel remaining is inserted.

Deleting the entry deselects the message element.

9 FUEL REMAINING

Displays the FMC computed fuel remaining in quantity and time when an number is displayed on the SOB line. Display is blank prior to making the SOB entry.

Valid entry is HH+MM. One or two digits can be entered for hours or minutes.

10 VERIFY

Push – displays the VERIFY EMERGENCY page.

VERIFY EMERGENCY Page

The VERIFY EMERGENCY page is used to verify and transmit an emergency message to ATC after it has been generated on the EMERGENCY REPORT page. It also allows inserting a free text message into the generated message.



1 Message Text

LINES 1 through 5 on all but the last page, and lines 1 through 4 on the last page display the message text. Pages are added as required leaving at least one line for free text on the last page.

The text includes all the elements selected on the EMERGENCY REPORT page.

2 FREE TEXT

At least one line is available for free text on the last page. If the line is filled, an additional page will be generated to provide more space for free text.

Valid entries are:

- fix name
- navaid
- airport
- latitude–longitude
- or place bearing/distance

Push – if the default airport is displayed, the remainder of the route is included in the message. If a position other than the destination is entered, the direct route to that position is included in the message.

The entered position may be deleted.

3 EMERGENCY

Push – displays the EMERGENCY REPORT page.

4 REPORT SEND

Push –

- transmits EMERGENCY REPORT
- creates a log entry of transmitted message and,

if MAYDAY is selected:

- transmits a POSITION REPORT
- activates ADS in emergency mode
- transmits an AOC emergency report

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Communications

EICAS Messages

Chapter 5

Section 50

EICAS Advisory Messages

This section describes the various EICAS advisory messages that can be displayed.

Data Link

Message	Level	Aural	Condition
DATALINK LOST	Advisory		Data link is temporarily lost.
DATALINK SYS	Advisory		Data link system has failed.

EICAS Communication Alert Messages

This section describes the various EICAS communications alert messages that can be displayed.

Crew Communication Messages

Message	Level	Condition	Crew Action/Remarks
• CABIN ALERT	Medium	Pilot alert received over cabin interphone.	Respond to the alert. Message accompanied by aural chime and ALERT cabin call light.
• CABIN CALL	Medium	Pilot call received over cabin interphone.	Respond to the call. Message accompanied by aural chime and FWD/MID/AFT cabin call light.
• GROUND CALL	Medium	Pilot call received from the nose wheel well over the flight interphone.	Respond to the call. Message accompanied by aural chime and GND CALL light.

Selective Calling (SELCAL)

Message	Level	Condition	Crew Action/Remarks
• SELCAL	Medium	SELCAL received on VHF or HF radio.	Determine which radio received call. Respond to the call. Message is accompanied by aural chime and VHF/HF SELCAL light.

Data Link

Message	Level	Condition	Crew Action/Remarks
• ACARS	Medium	A medium level company data link message has been received.	Select ACARS from the CDU menu page and respond to message. Message is accompanied by aural chime.
• ACARS	Low	A low level company data link message has been received.	Select ACARS from the CDU menu page and respond to message.

767-300 Operations Manual

Message	Level	Condition	Crew Action/Remarks
• PRINTER	Medium/ Low	A company data link message has been received and sent to the printer.	Review the printed message and press the reset button on the printer. Message is accompanied by aural chime.
• ATC	Medium	An ATC data link message has been received.	Select the ATC mode key on the CDU and respond to the message. Message is accompanied by aural chime.
• FMC	Medium	An FMC communications related data link message has been received.	Select the FMC COMM mode key on the CDU. View the message title in the CDU scratch pad. View the message on the appropriate CDU page. Message is accompanied by aural chime and a MSG light on the CDU.
• DATALINK AVAIL	Low	A lost data link connection has been re-established.	Resume use of data link communication.
• VHF DATA OFF	Low	VHF radio is in voice mode - Data cannot be sent.	Switch radio to data mode to establish data link communication.

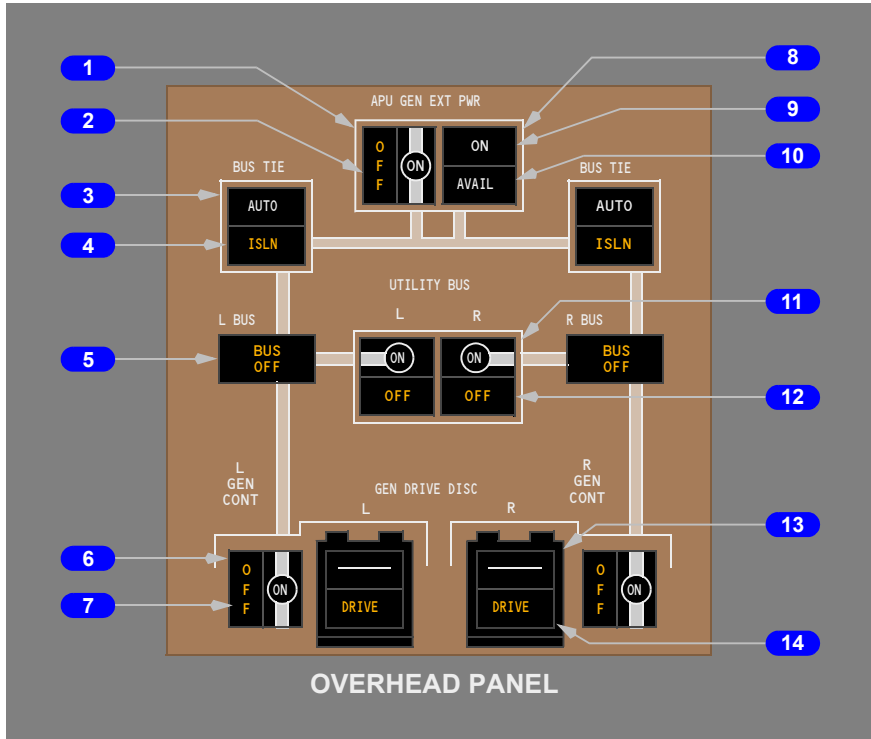
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Electrical Panel



1 APU Generator (APU GEN) Control Switch

ON (bar in view) –

- arms APU generator breaker to automatically close.

OFF (bar not visible) –

- opens APU generator breaker
- resets fault trip circuitry.

2 APU Generator OFF Light

Illuminated (amber) –

- the APU generator breaker is open because of a fault with APU running
- the APU generator control switch is selected OFF.

3 BUS TIE Switches

AUTO –

- arms automatic AC bus tie circuits
- arms automatic DC bus tie circuits
- arms automatic flight instrument transfer bus circuits.

OFF (AUTO not visible) –

- commands the AC bus tie open
- commands the DC bus tie open
- commands the flight instrument bus tie open
- resets fault trip circuitry.

4 AC Bus Isolation (ISLN) Lights

Illuminated (amber) –

- a fault has occurred, automatically opening the AC bus tie breaker
- the BUS TIE switch is OFF.

5 AC BUS OFF Lights

Illuminated (amber) – the AC bus is unpowered.

6 Generator Control (GEN CONT) Switches

ON (bar in view) – arms the generator breaker to close automatically when generator power is available.

OFF (bar not visible)

- opens generator breaker
- resets fault trip circuitry.

7 Generator OFF Lights

Illuminated (amber) – the generator breaker is open.

8 External Power (EXT PWR) Switch

Push – if AVAIL light is illuminated, closes external power contactor

Subsequent push – opens external power contactor.

9 External Power ON Light

Illuminated (white) – external power is powering the bus(es).

10 External Power Available (AVAIL) Light

Illuminated (white) – external power is plugged in and power quality is acceptable.

11 UTILITY BUS Switches

ON (bar in view) – if no load shed signal is present, connects utility and galley busses to main AC bus.

OFF (bar not visible) –

- disconnects utility and galley busses from main AC bus
- resets overload load shed circuitry.

12 Utility Bus OFF Lights

Illuminated (amber) – the utility and galley busses are unpowered.

13 Generator Drive Disconnect (GEN DRIVE DISC) Switches

Push –

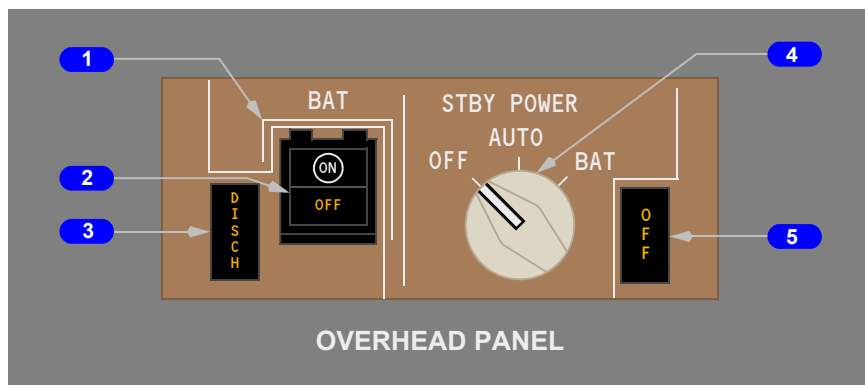
- disconnects generator drive from the engine
- requires maintenance action on the ground to reconnect the generator drive.

14 Generator DRIVE Lights

Illuminated (amber) –

- the generator drive oil temperature is high
- the generator drive oil pressure is low.

Battery/Standby Control Panel



1 Battery (BAT) Switch

ON –

- Unpowered airplane on the ground:
 - a few annunciator lights illuminate
 - allows the APU to be started
- Powered airplane inflight or on the ground when AC power is removed or lost:
 - the standby and battery busses are powered.

OFF (ON not visible) – turns battery power off.

2 Battery OFF Light

Illuminated (amber) – the battery switch is off.

3 Battery Discharge (DISCH) Light

Illuminated (amber) – the main battery is discharging.

4 Standby (STBY) POWER Selector –

OFF – the standby busses are unpowered.

AUTO – the standby busses transfer to battery power if normal AC power is lost.

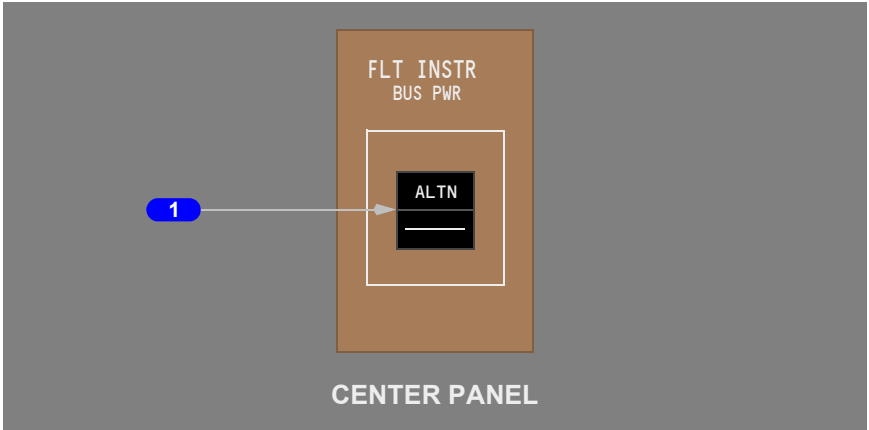
BAT – the standby busses are powered from the main battery.

5 Standby Power Bus OFF Light

Illuminated (amber) – standby AC and/or DC bus not powered.

Flight Instrument Bus Power Switch

Aircraft with HDG installed



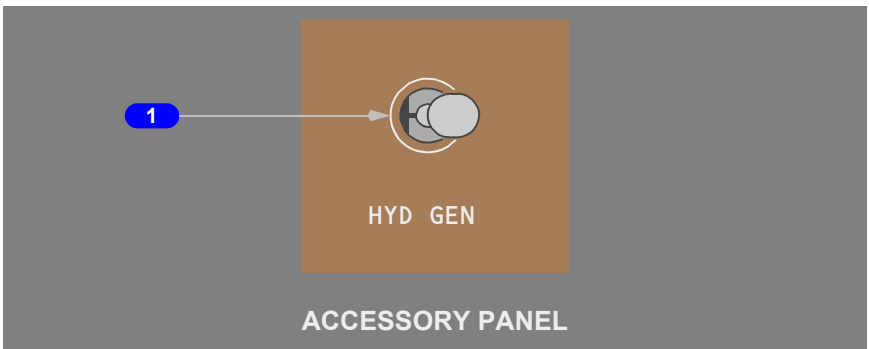
1 Flight Instrument Bus Power Switch

ALTN – allows hydraulic driven generator to power first officer's flight instruments

OFF (ALTN not visible) – allows hydraulic driven generator to power captain's flight instruments

Hydraulic Generator Test Switch

Aircraft with HDG installed



1 Hydraulic Generator Test Switch

Spring-loaded to center.

HYD GEN – initiates hydraulic driven generator system test.

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Electrical System Description

Chapter 6 Section 20

Introduction

Aircraft without HDG installed

The electrical system generates and distributes AC and DC power to other airplane systems, and is comprised of: main AC power, main DC power, and battery/standby power. System operation is automatic. Electrical faults are automatically detected and isolated.

Aircraft with HDG installed

The electrical system generates and distributes AC and DC power to other airplane systems, and is comprised of: main AC power, main DC power, and battery/standby power. Electrical faults are automatically detected and isolated. A Hydraulic Driven Generator (HDG) operates automatically as a backup source of power in the event that both main AC buses become inoperative.

AC Electrical System

The AC electrical system is the main source for airplane electrical power.

AC Electrical System Power Sources

The entire airplane AC electrical load can be supplied by any two main airplane AC power sources.

The main airplane AC electrical power sources are:

- left and right engine integrated drive generators (IDGs)
- APU generator.

The entire airplane AC electrical load also can be supplied by external power.

The power sources operate isolated from one another.

Integrated Drive Generators (IDGs)

Each engine has an IDG. Each IDG has automatic control and system protection functions.

When an engine starts, with the GEN CONT switch selected ON, the IDG automatically powers the respective main bus. The previous power source is disconnected from that bus.

The IDG can be electrically disconnected from the busses by pushing the GEN CONT switch to OFF. The IDG can also be electrically disconnected from its respective bus by selecting external power prior to engine shutdown. (See External Power in this section.) The OFF light in the GEN CONT switch illuminates, and the EICAS Advisory message L or R GEN OFF displays whenever the generator control breaker is open.

The DRIVE light illuminates and the EICAS Advisory message L or R GEN DRIVE displays when low oil pressure or high oil temperature is detected in an IDG. The IDG drive can be disconnected from the engine by pushing the respective DRIVE DISC switch. The IDG cannot be reconnected by the flight crew.

APU Generator

The APU generator is electrically identical to the IDG generators. The APU generator can power either or both main busses, and may be used in flight as a replacement to an IDG source.

If no other power source is available when the APU generator becomes available, the APU generator automatically connects to both main AC busses. If the external source is powering both main busses, the external source continues to power both main busses.

The APU Generator OFF light illuminates, and the EICAS advisory message APU GEN OFF displays when the APU is operating and the APU generator breaker is open because of a fault or the APU GEN switch is selected OFF. When the APU GENERATOR switch is ON and a fault is detected, the APU generator cannot connect to the busses.

External Power

External power can power the left and right main busses. When the power source voltage and frequency are within limits, the external power AVAIL light illuminates.

Pushing the EXT PWR switch ON connects external power to both main busses and removes the IDGs and the APU generator from the busses, if they were powering the busses. When external power is connected to a main bus, the EXTERNAL POWER ON light illuminates.

AC Electrical Power Distribution

AC power is distributed through the left and right main busses and the ground service bus.

AC Main Busses

The right IDG normally powers the right main bus and the left IDG normally powers the left main bus. The APU normally powers both main busses when they are not powered by any other source. External power may also be connected and will also power both main busses.

Bus tie breakers, controlled by BUS TIE switches, are open to isolate the right and left main busses, or closed to power those busses from any available source. When both BUS TIE switches are set to AUTO, the bus tie system operates automatically to maintain power to both main busses.

The AC bus ISLN light illuminates and the EICAS advisory message L or R BUS ISOLATED displays when the bus tie breaker is open because of a fault or the BUS TIE switch is OFF.

The BUS OFF light illuminates and the EICAS caution message L or R AC BUS OFF displays if an AC bus is unpowered.

The source order for powering left and right main busses is the:

- respective IDG
- APU generator
- opposite IDG.

Utility Busses

Left and right utility busses, powered by their respective main AC bus, are controlled by UTILITY BUS switches. Left and right galley busses are powered by their respective utility busses, and have no direct controls or indicators. The utility bus OFF lights illuminate and the EICAS advisory message L or R UTIL BUS OFF displays when a galley and utility bus are unpowered.

Ground Service Bus

The ground service bus is normally powered by the right main bus. Alternate sources of power for the ground service bus, utilizing the GROUND SERVICE switch found on the forward flight attendant panel, are:

- the APU generator
- external power.

The ground service bus powers:

- the main battery charger
- the APU battery charger
- miscellaneous cabin and system loads.

Ground Handling Bus

The ground handling bus can be powered only on the ground and only from the APU generator or from the external power source. It is provided for loads such as cargo handling and equipment energized only during ground operations.

Autoland

During autoland, the busses isolate to allow three independent sources to power the three autopilots:

- the left main system powers the left autopilot and the Captain's flight instrument transfer bus
- the right main system powers the right autopilot and the First Officer's flight instrument transfer bus
- the battery/standby system powers the center autopilot.

Above 200 feet, loss of a generator results in:

- both bus tie breakers closing and the operating generator powers both left and right AC busses
- the left main system powers the center autopilot
- NO LAND 3 appears on the Autoland Status Annunciator.

Below 200 feet, with bus isolation, loss of a generator results in:

- both bus tie breakers remaining open
- the autopilot associated with a failed generator is unpowered
- the flight instruments remain powered through the flight instrument transfer busses
- the autoland continues using the remaining two autopilots.

When the autopilots are disengaged or an autopilot go-around is performed, the electrical system reverts to normal, non-isolated operation.

Flight Instrument Transfer Busses

Normally, the Captain's flight instruments are powered by the left main AC Bus, and the First Officer's flight instruments are powered by the right main AC Bus. If the respective bus tie breakers are in AUTO, the flight instrument transfer busses transfer to the opposite main AC bus in the event power is lost to a main AC Bus.

Aircraft with HDG installed

If power is lost to both main AC busses, either the Captain's or the First Officer's flight instruments are powered by the hydraulic driven generator depending upon the position of the Flight Instrument Bus Power switch. With the switch in the off position, the Captain's flight instruments are powered. With the switch in the ALTN position, the First Officer's flight instruments are powered.

AC Transfer Busses

Aircraft with HDG installed

Left and right AC transfer busses power items considered necessary for ETOPs flights, which are not powered by the battery/standby system. Transfer busses are normally powered by their associated main AC busses, but also can be powered by the Hydraulic Driven Generator when both AC busses are unpowered.

Electrical Load Shedding

Electrical load shedding occurs automatically to ensure power is available to critical and essential equipment.

If the electrical loads exceed the power available, the electrical system automatically sheds AC loads by priority until the loads are within the capacity of the generators. The load shedding is galley power first, then utility busses. Utility busses are followed by individual equipment items powered by the main AC busses. When an additional power source becomes available or the load decreases, the electrical system automatically restores power to the shed systems (in the reverse order).

Examples of load shedding that may be observed in the flight deck or cabin during normal operations include:

- an electric hydraulic pump prior to engine start
- center tank fuel pumps prior to engine start
- utility busses during engine start.

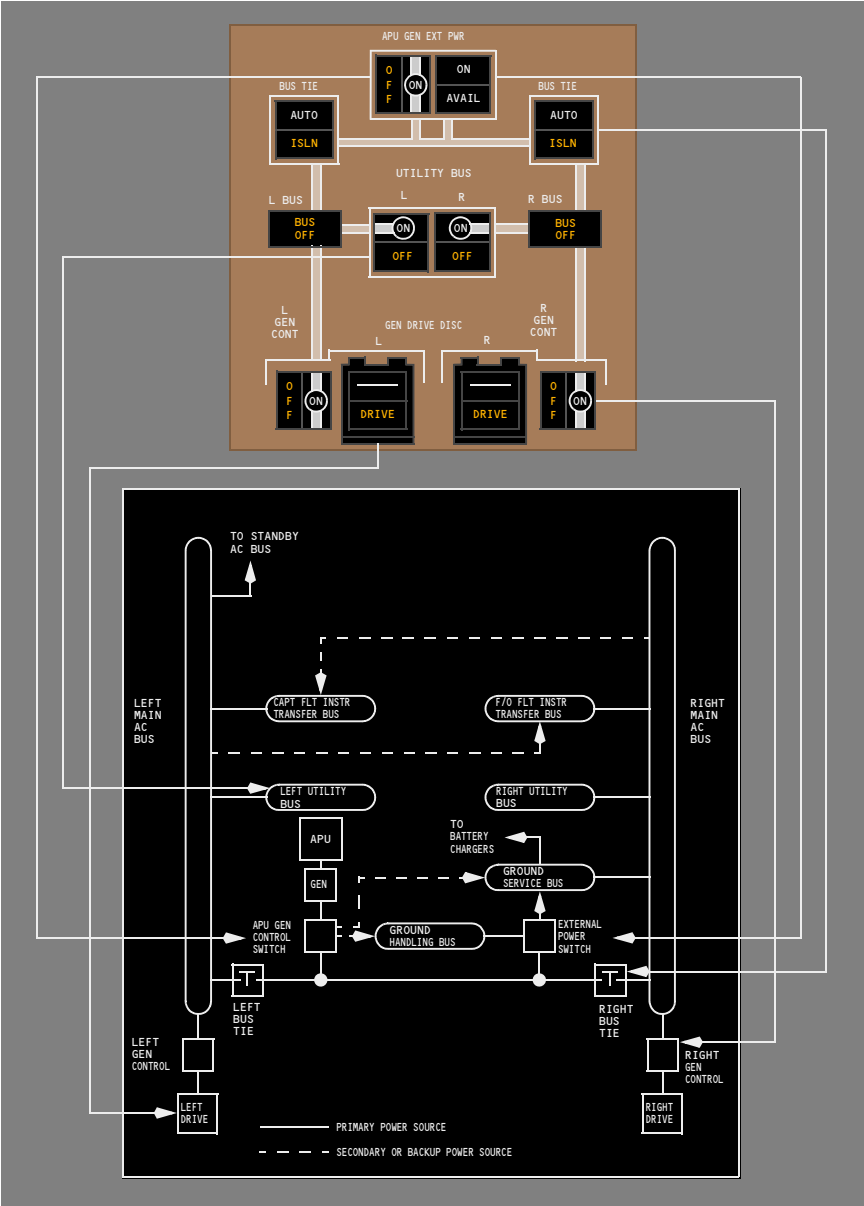
Examples of load shedding that may be observed in the flight deck or cabin during non-normal operations include:

- utility busses after a generator or engine failure
- center tank fuel pump after an engine failure
- cabin ceiling lights after an engine failure.

On the ground, advancing the thrust levers into the takeoff range with the engines shut down may cause inadvertent load shedding of the utility busses to occur.

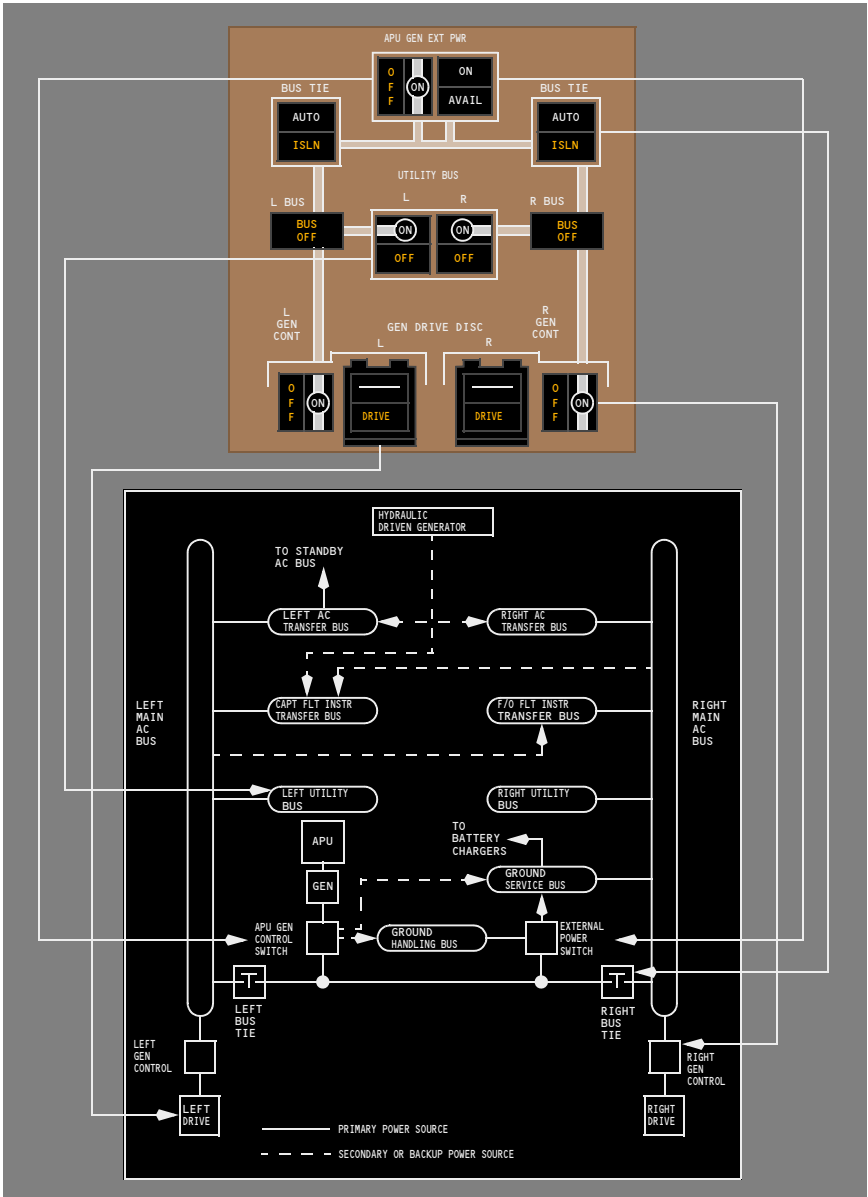
Returning the thrust levers to idle, then pushing the UTILITY BUS switches OFF, then ON will reset this inadvertent load shedding.

AC Electrical System Schematic
Aircraft without HDG installed



AC Electrical System Schematic

Aircraft with HDG installed



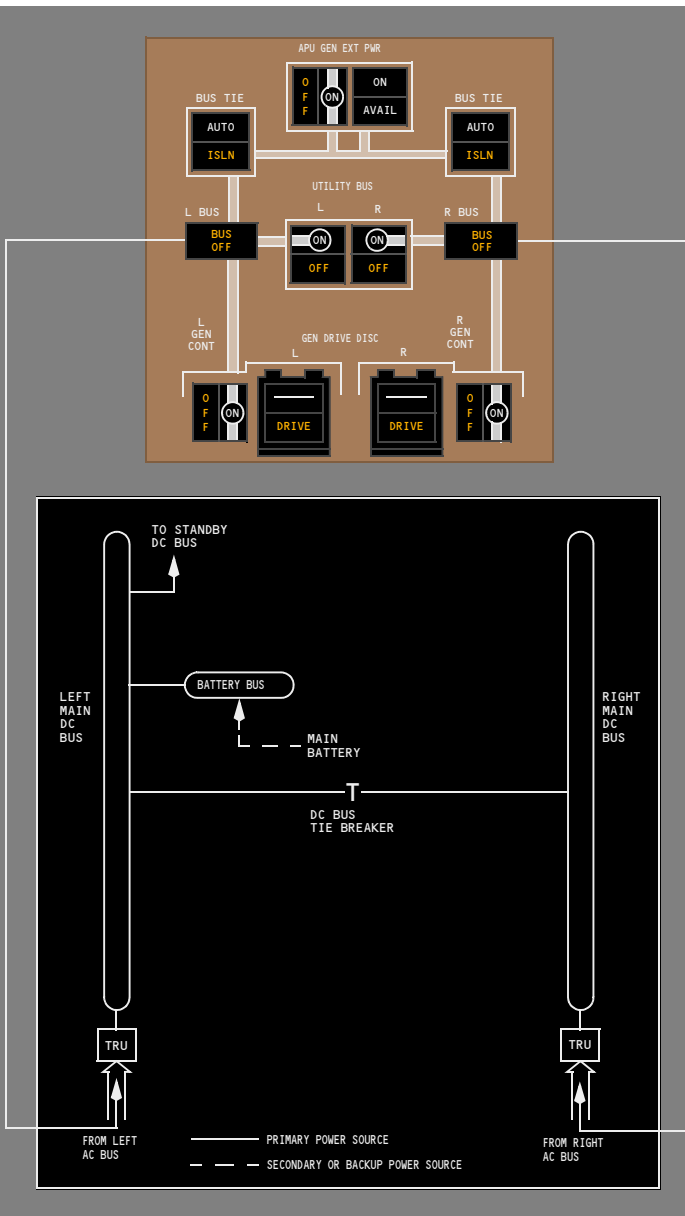
DC Electrical System

The main DC electrical system uses transformer–rectifier units (TRUs) to produce DC power. The TRUs are powered by the main AC busses.

The TRUs operate isolated from one another. If one TRU fails, the DC bus tie breaker closes to keep both DC busses powered. Both BUS TIE switches must be in AUTO for the DC bus tie breaker to close.

There are no flight deck controls for the main DC electrical system.

DC Electrical System Schematic



Battery/Standby Power System

The battery/standby power electrical system can supply DC and AC power to selected flight instruments, communications and navigation systems, and other critical systems, if there are main AC and DC electrical power system failures.

The Battery/Standby Power System consists of the following busses:

- the hot battery bus
- the battery bus
- the standby DC bus
- the standby AC bus

Hot Battery Bus

The hot battery bus provides power to systems which must be powered continuously, such as the clock's time reference, fire extinguisher bottles, APU fuel valve, spar fuel valves, and the parking brake valve.

Prior to establishing electrical power, the main battery powers the hot battery bus.

After establishing electrical power, the main battery charger powers the hot battery bus.

Battery Bus

Prior to establishing electrical power, when the battery switch is ON, the main battery powers the battery bus.

After establishing electrical power, the left DC system powers the battery bus, and the main battery provides a backup source of power.

The Battery DISCH light illuminates when the main battery is discharging. If EICAS is powered, the advisory message MAIN BAT DISCH also displays.

The battery OFF light illuminates and the EICAS advisory message BATTERY OFF displays if the battery switch is OFF after electrical power is established.

Standby DC Bus

The standby DC bus can be powered by several sources. Prior to establishing electrical power, when the battery switch is ON and the standby power selector is in AUTO, the main battery powers the standby DC bus. The Battery DISCH light illuminates when the main battery is discharging. After establishing electrical power, the left DC system powers the standby DC bus and the main battery provides a backup source of power. When the standby power selector is in BAT, the main battery powers the standby DC bus.

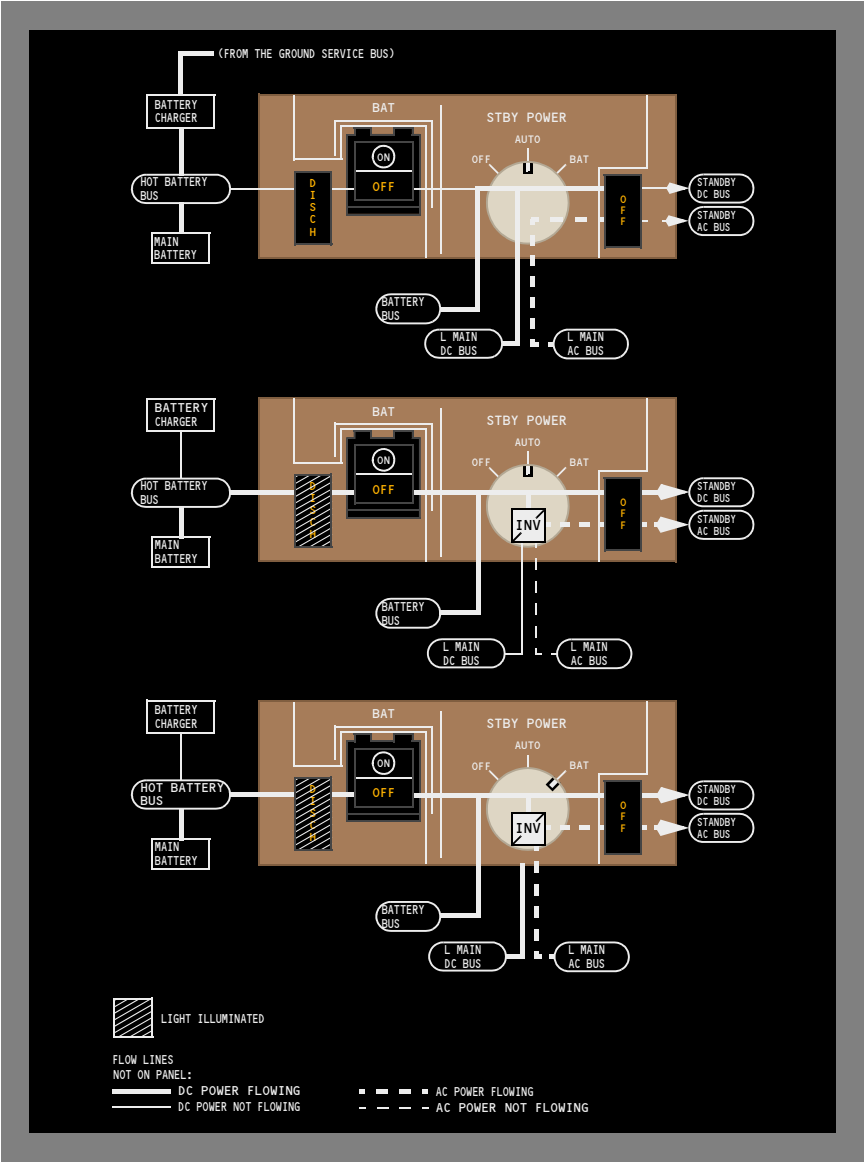
The standby bus OFF light illuminates and the EICAS advisory message STANDBY BUS OFF displays if the standby DC bus is unpowered.

Standby AC Bus

The standby AC bus can be powered by several sources. Prior to establishing electrical power, when the battery switch is ON and the standby power selector is in AUTO, the main battery powers the standby inverter which provides AC power to the standby AC bus. After establishing electrical power, the left AC system powers the standby AC bus and the main battery and standby inverter provide a backup source of power. When the standby power selector is in BAT, the main battery and standby inverter power the standby AC bus.

The standby bus OFF light illuminates and the EICAS advisory message STANDBY BUS OFF displays if the standby AC bus is unpowered.

Battery/Standby System Schematic



Hydraulic Driven Generator

Aircraft with HDG installed

The Hydraulic Driven Generator (HDG) activates automatically when both the left and right main AC busses are unpowered. The Hydraulic Driven Generator (HDG) is powered by the Center Hydraulic System.

The HDG provides AC power to:

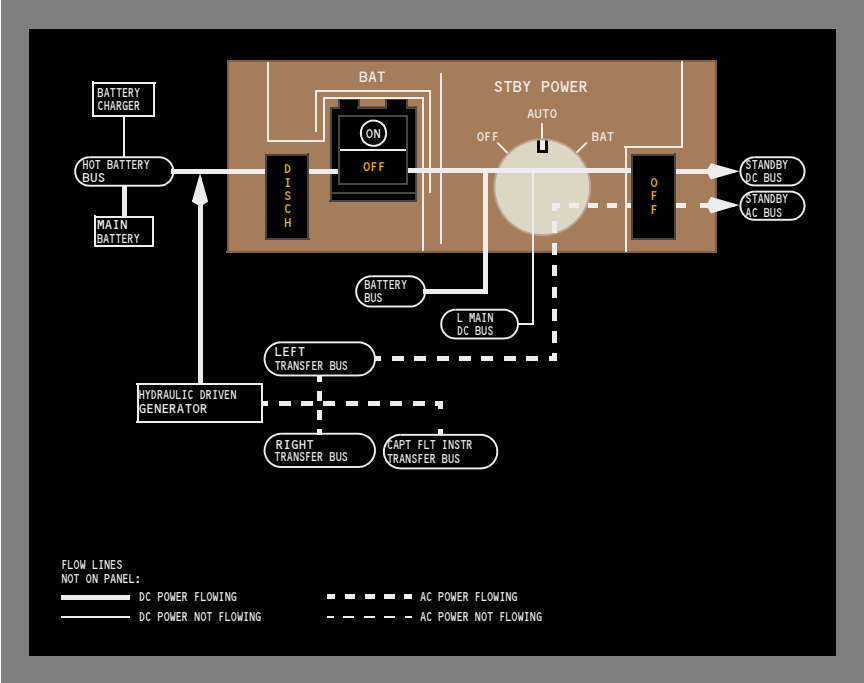
- the left AC transfer bus
- the right AC transfer bus
- the standby AC bus (through the left AC transfer bus)
- either the Captain's or the First Officer's flight instrument transfer bus

The HDG provides DC power to:

- the hot battery bus
- the battery bus
- the standby DC bus.

The amount of DC power produced by the HDG is less than the DC power produced by a fully charged battery. When the HDG first begins to operate, the battery DISCH light may illuminate, until the battery power decreases to the power level produced by the HDG.

**Battery/Standby System Schematic (Hydraulic Driven
Generator Operating)**



Electrical

EICAS Messages

Chapter 6

Section 30

Electrical EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
L AC BUS OFF R AC BUS OFF	Caution	BUS OFF	Beeper	AC Bus is unpowered.
APU GEN OFF	Advisory	OFF		APU generator control breaker is open due to a fault with the APU running.
BATTERY OFF	Advisory	OFF		Battery switch is OFF.
L BUS ISOLATED R BUS ISOLATED	Advisory	ISLN		Bus tie breaker is open due to an AC electrical system fault.
L GEN DRIVE R GEN DRIVE	Advisory	DRIVE		Generator drive oil pressure is low or generator drive oil temperature is high.
L GEN OFF R GEN OFF	Advisory	OFF		Generator control breaker is open.
MAIN BAT DISCH	Advisory	DISCH		Main battery is discharging.
STANDBY BUS OFF	Advisory	OFF		Standby AC or DC bus is unpowered.
L UTIL BUS OFF R UTIL BUS OFF	Advisory	OFF		Galley and utility busses are unpowered.

Intentionally
Blank

Engines, APU

Chapter 7

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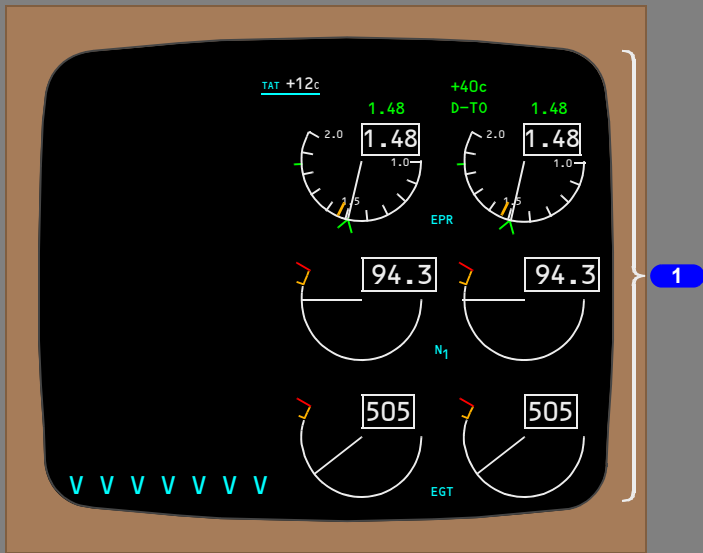
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Engines, APU Controls and Indicators (PW)

Chapter 7 Section 11

This section applies to ships 171-199, 1200-1202, 1401-1404

EICAS Displays Primary Engine Indications [AFM]



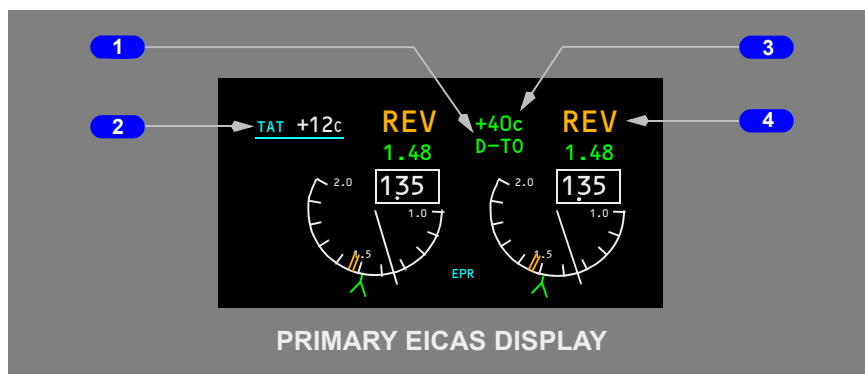
PRIMARY EICAS DISPLAY

1 Primary Engine Indications

Displayed full time on the EICAS display:

- EPR
- N1
- EGT.

Mode Indications



1 Thrust Reference Mode

Displayed (green) – selected FMS thrust reference mode:

Takeoff:

- TO – maximum rated takeoff thrust

1401-1404

- TO 1 – takeoff thrust one, climb one preselected

1401-1404

- TO 2 – takeoff thrust two, climb two preselected

171-199, 1200-1201

- TO 1* – maximum rated takeoff thrust, climb one preselected

171-199, 1200-1201

- TO 2* – maximum rated takeoff thrust, climb two preselected

Assumed Temperature Takeoff:

- D-T0 – assumed temperature derated takeoff thrust

1401 through 1404

- D-T0 1 – assumed temperature derated takeoff thrust one, climb one preselected

1401 through 1404

- D-T0 2 – assumed temperature derated takeoff thrust two, climb two preselected

171-199, 1200-1201

- D-T0 1* – assumed temperature derated takeoff thrust, climb one preselected

171-199, 1200-1201

- D-T0 2* – assumed temperature derated takeoff thrust, climb two preselected

Climb:

- CLB – maximum rated climb thrust
- CLB 1 – climb thrust one
- CLB 2 – climb thrust one

Cruise:

- CRZ – maximum rated cruise thrust
171-199, 1200-1201
- CRZ 1 * – maximum rated cruise thrust, climb one preselected
171-199, 1200-1201
- CRZ 2 * – maximum rated cruise thrust, climb two preselected

Continuous:

- CON – maximum rated continuous thrust
171-199, 1200-1201
- CON 1 * – maximum rated continuous thrust, climb one preselected
171-199, 1200-1201
- CON 2 * – maximum rated continuous thrust, climb two preselected

Go-around and Manual:

- G/A – go-around thrust
- MAN – reference EPR manually selected.

171-199, 1200-1201

Note: * WHITE NUMBER – indicates reduced climb thrust is preselected.

2 Total Air Temperature (TAT)

Displayed (cyan) – "TAT" and underline

Displayed (white) - temperature (degrees C)

3 Assumed Temperature

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

4 Thrust Reverser Indication

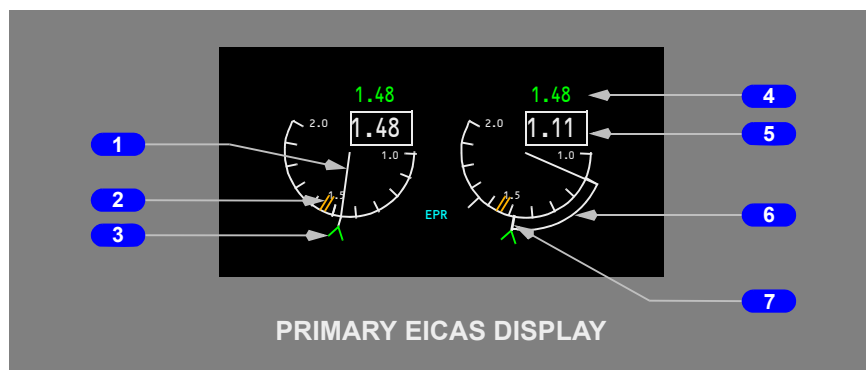
Displayed REV (amber) – reverser in transit.

Displayed REV (green) – reverser fully deployed.

EPR Indications

Note: When reverse thrust is activated, the following indications are not displayed:

- reference/target EPR indication
- thrust reference mode
- reference EPR



1 EPR Pointer

Displayed (white).

2 Maximum EPR Line

Displayed (amber).

3 EPR bug

Displayed (green) – reference EPR limit.

Displayed magenta – target FMC commanded EPR when VNAV is engaged.

4 Reference EPR

Displayed (green).

5 Actual EPR

Displayed (white).

6 Commanded EPR Sector

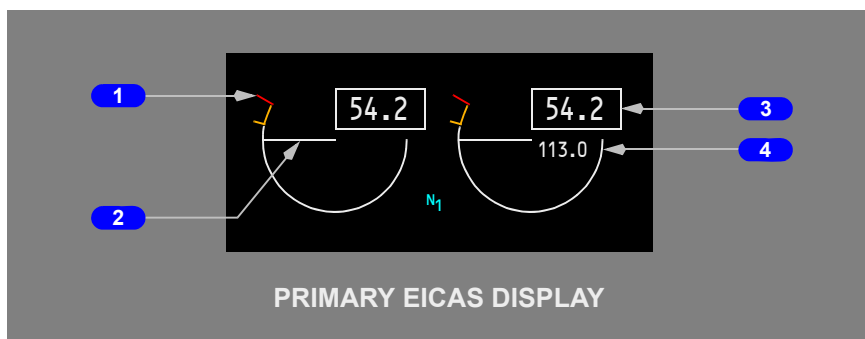
Displays momentary difference between engine EPR and EPR commanded by thrust lever position.

7 Command Thrust Level

Displayed (white):

- end of command sector
- appears as extension of EPR pointer when engine stabilized
- EPR commanded by thrust lever position.

N1 Indications



1 N1 Red Line Limit

Displayed (red) – N1 RPM operating limit.

2 N1 Pointer

- (white) – points at value equal to that shown in the N1 counter
- (red) – operating limit reached or exceeded.

3 N1

N1 RPM (%), displayed:

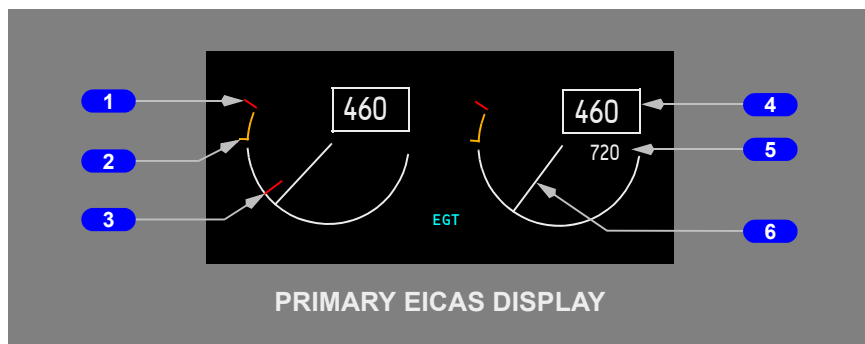
- (white) – normal operating range
- (red) – operating limit reached or exceeded.

4 Maximum Exceedance

Displayed (white):

- red line limit or transient limit is exceeded
- highest value attained.

EGT Indications



1 EGT Red Line

Displayed (red) – maximum takeoff EGT limit.

2 EGT Amber Band

Displayed (amber) – maximum continuous EGT limit.

3 EGT Start Limit Line

Displayed (red) – during start until engine is stabilized at minimum idle RPM.

4 EGT

EGT (degrees C), displayed:

- (white) – normal operating range
- (amber) – maximum continuous limit reached*
- (red) – maximum start or takeoff limit reached.

Note: * Pointer and counter remain white during TO or GA for 5 minutes after amber band is entered.

5 EGT Maximum Exceedance

Displayed (white):

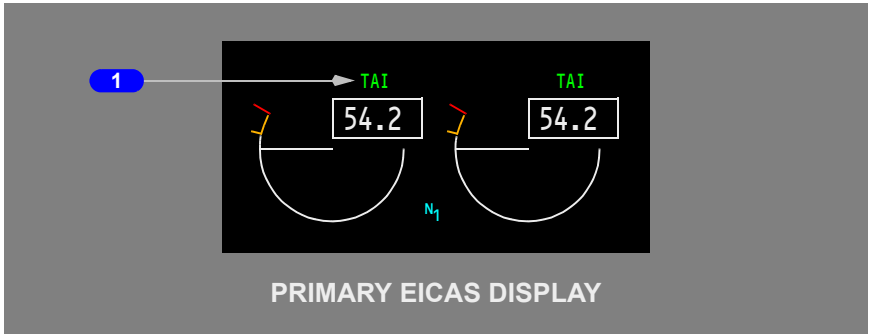
- red line limit, transient limit or start EGT is exceeded
- displays the highest value attained.

6 EGT Pointer

Displayed:

- (white) – normal operating range
- (amber) – maximum continuous limit reached
- (red) – maximum start or takeoff limit reached.

Anti-Ice Indications

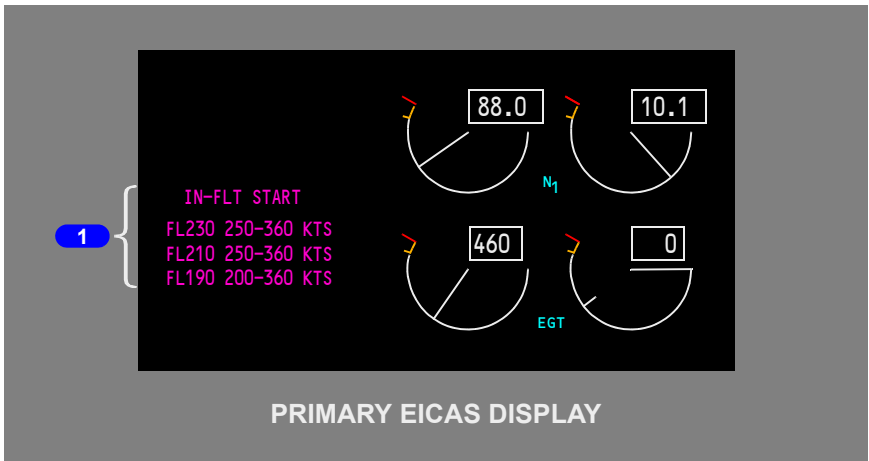


1 Thermal Anti-Ice (TAI) Indication

Displayed (green) –

- engine anti-ice is on

In-Flight Start Envelope



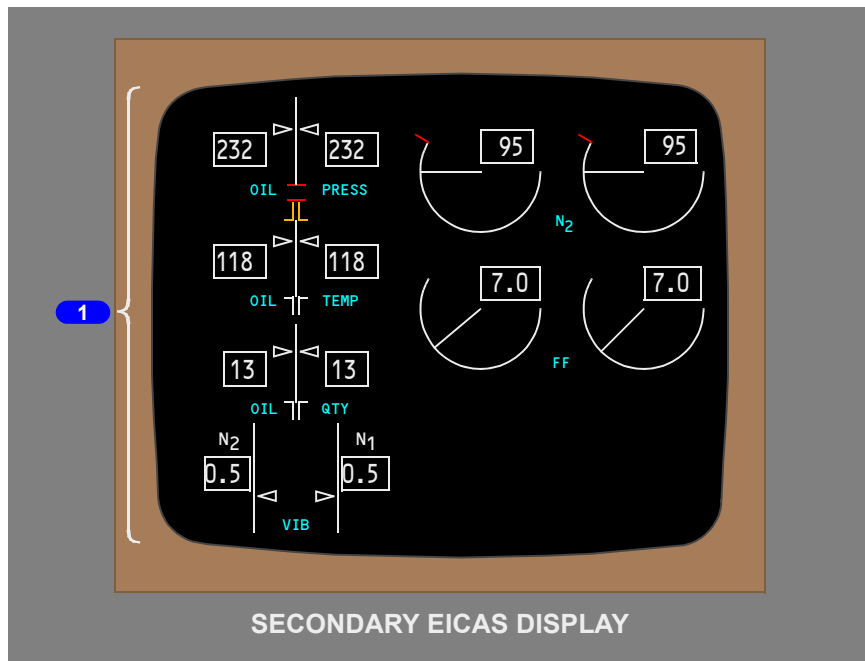
1 In-Flight Start Envelope

Displayed (magenta) – airspeed range for an inflight start for the closest starting flight level and two descending flight levels at two thousand foot intervals when the respective engine fire switch is in and:

- a FUEL CONTROL switch is in CUT OFF, and
- engine N2 RPM is below idle, and
- primary and secondary EICAS displayed.

Secondary Engine Indications

[AFM]

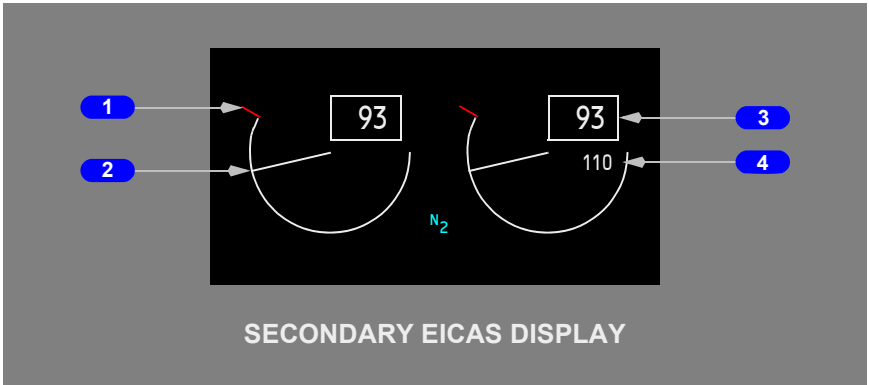


1 Secondary Engine Display

Displays:

- N2 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration.

N2 Indications



1 N2 Red Line

N2 RPM operating limit, displayed (red).

2 N2 Pointer

N2 RPM, displayed:

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

3 N2

N2 RPM (%), displayed:

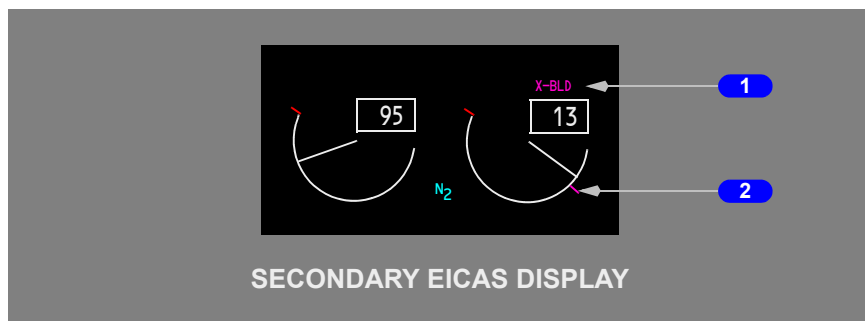
- (white) – normal operating range
- (red) – operating limit reached.

4 Maximum Exceedance

Displayed (white):

- red line limit is exceeded
- highest value attained.

Crossbleed Start Indications



1 Crossbleed Start (X-BLD) Indication

Indicates crossbleed air is recommended for an inflight start.

Displayed (magenta):

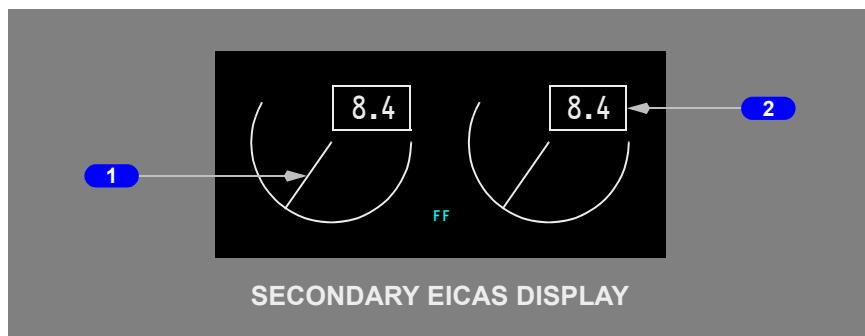
- the inflight start envelope is displayed, and
- airspeed is lower than that for a windmilling start.

2 Fuel On Command Bug

Displayed (magenta):

- engine is shutdown on the ground or inflight when X-BLD is displayed
- minimum fuel on selection point during starter cranking.

Fuel Flow Indications



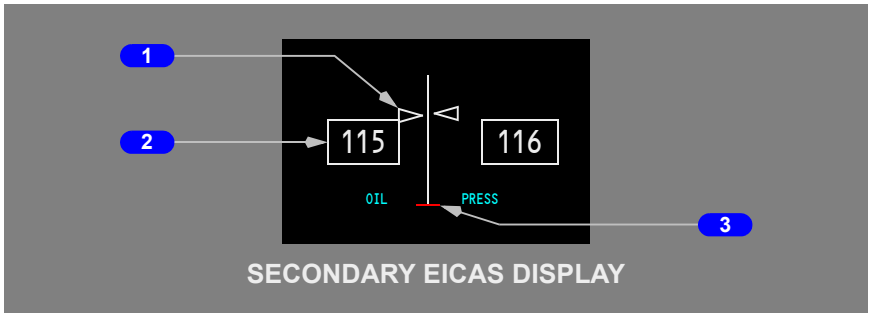
1 Fuel Flow Pointer

Displayed (white) – points at a value equal to that shown in the Fuel Flow.

2 Fuel Flow (FF)

Displayed (white) – fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications



1 Oil Pressure Pointer

Engine oil pressure, displayed:

- (white) – normal operating range
- (red) – operating limit reached.

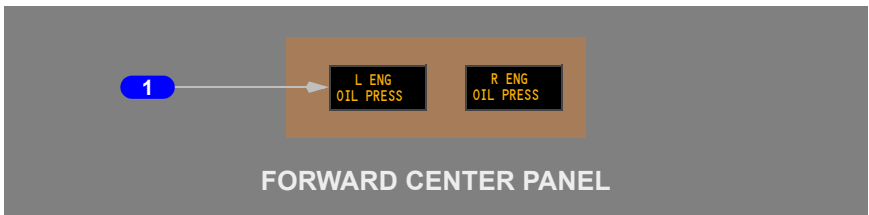
2 Oil Pressure (OIL PRESS)

Engine oil pressure (psi), displayed:

- (white) – normal operating range
- (red) – operating limit reached.

3 Oil Pressure Red Line

Displayed (red) – low oil pressure operating limit.

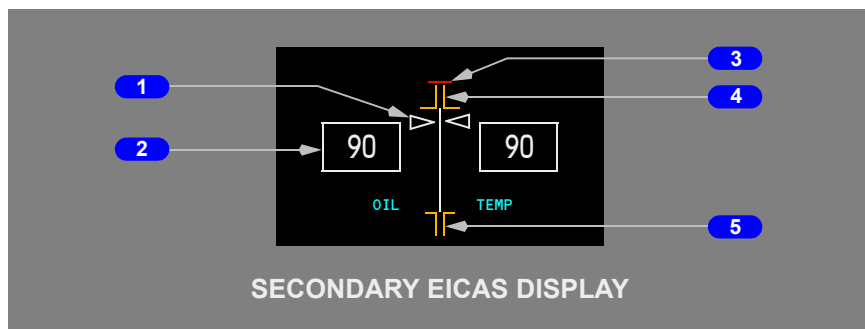


1 Engine Oil Pressure (L or R ENG OIL PRESS) Lights

Illuminated (amber):

- respective engine oil pressure is at or below minimum
- oil pressure switch malfunction.

Oil Temperature Indications



1 Oil Temperature Pointer

Engine oil temperature, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

2 Oil Temperature

Engine oil temperature (degrees C), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

3 Oil Temperature Red Line

Displayed (red) – oil temperature operating limit.

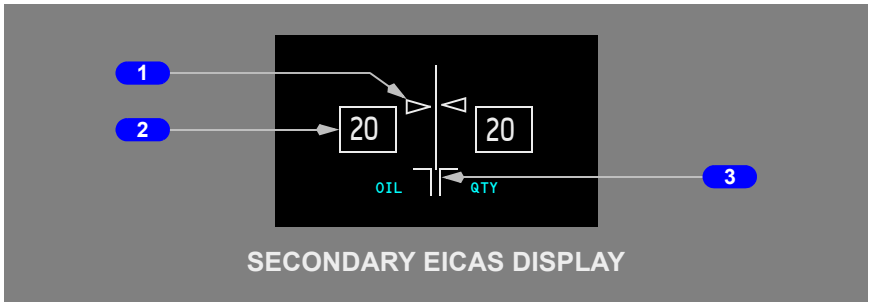
4 Oil Temperature Amber Band

Displayed (amber) – upper oil temperature caution range.

5 Oil Temperature Amber Band

Displayed (amber) – lower oil temperature caution range.

Oil Quantity Indications



1 Oil Quantity Pointer

Displayed (white) – points at a value equal to that shown in the Oil Quantity.

2 Oil Quantity

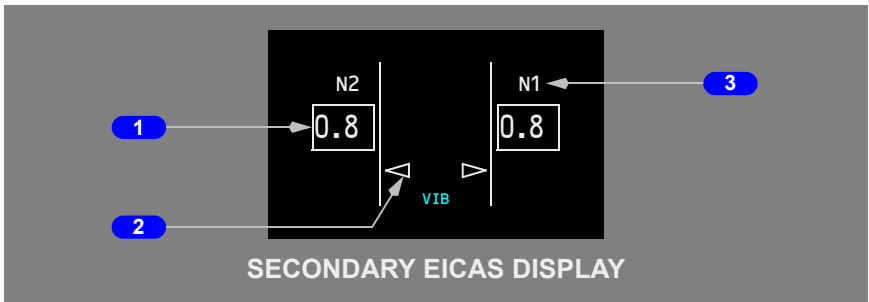
Usable oil quantity (quarts), displayed:

- (white) – normal quantity.

3 Low Oil Quantity Band

Displayed (white) – awareness range for low oil quantity.

Engine Vibration Indications



1 Engine Vibration

Displayed (white) – normal operating range.

2 Engine Vibration Pointer

Displayed (white) – engine vibration.

3 Vibration Source

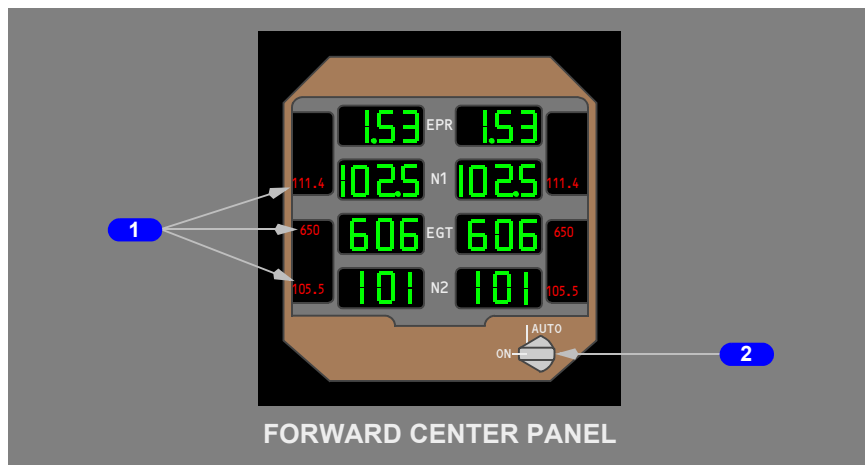
Identifies the vibration source being displayed.

Displayed (white) – vibration source with the highest vibration:

- N1 rotor vibration
- N2 rotor vibration.

If the vibration source BB (broad band vibration) is displayed, the source is unknown and average vibration is displayed.

Standby Engine Indicator (SEI)



1 Maximum Engine Limits

2 Standby Engine Indicator Selector

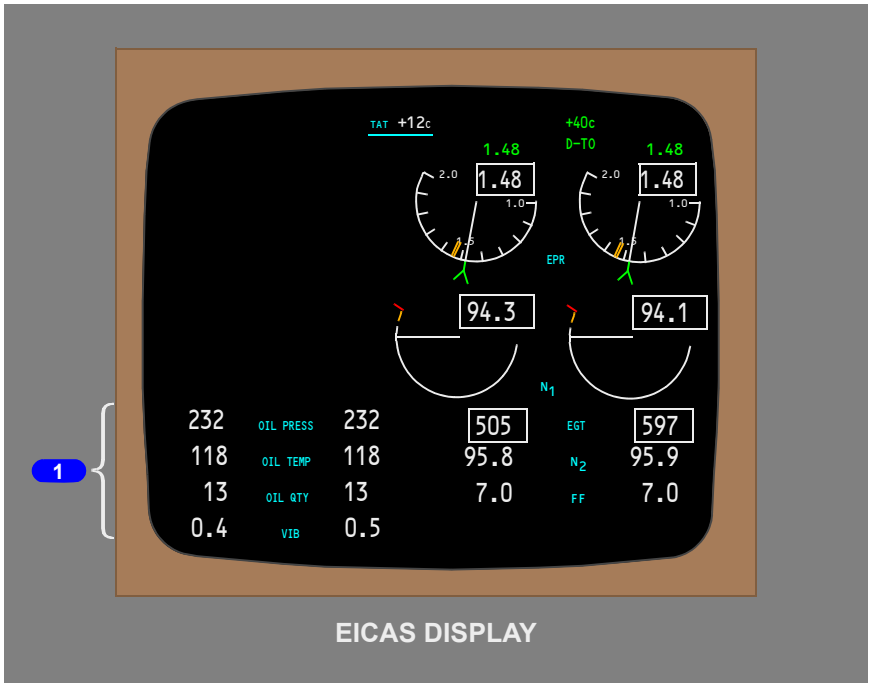
AUTO –

- display is blank with AC power on the airplane and EICAS operative
- standby engine indications in view when:
 - AC power is lost
 - either CRT failed and STATUS selected on the ground
 - EICAS failed.

ON – standby engine indications in view.

Compact Engine Indications

[AFM]



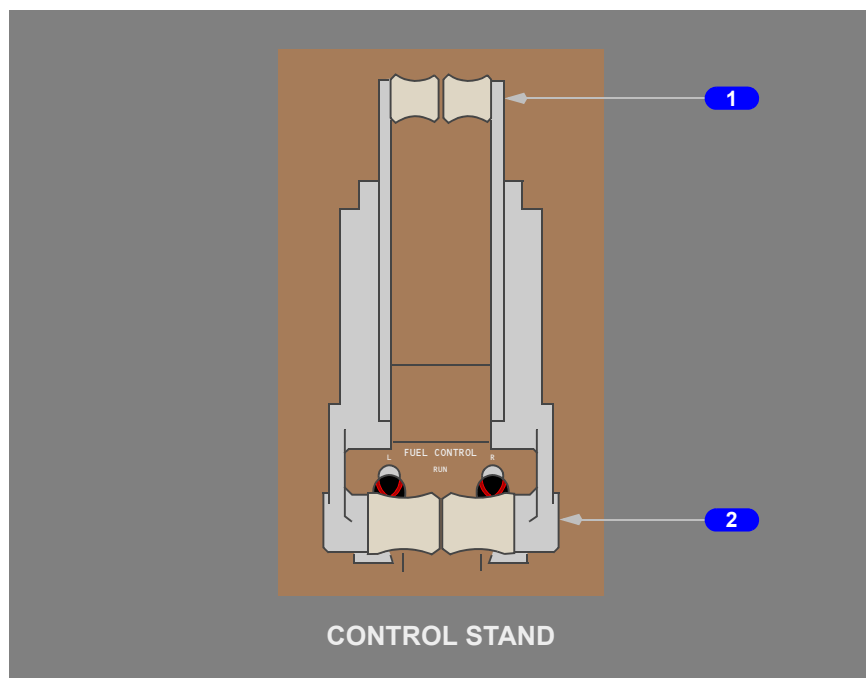
1 Compact Engine Indications

The following changes to EICAS and the normal secondary engine display occur:

- EGT and N2 change from round dial displays to digital displays. The EGT digital display and box turn amber or red if the limit is exceeded. The N2 digital display turns red if the limit is exceeded
- FF, OIL PRESS and OIL TEMP are displayed as digital readouts only. The OIL PRESS and OIL TEMP digital displays turn amber or red if limits are exceeded
- OIL QTY and VIB are displayed as digital readouts only. Low oil quantity and high vibrations are displayed the same as in the normal format.

Engine Controls

Thrust Levers



1 Reverse Thrust Levers

Control engine reverse thrust.

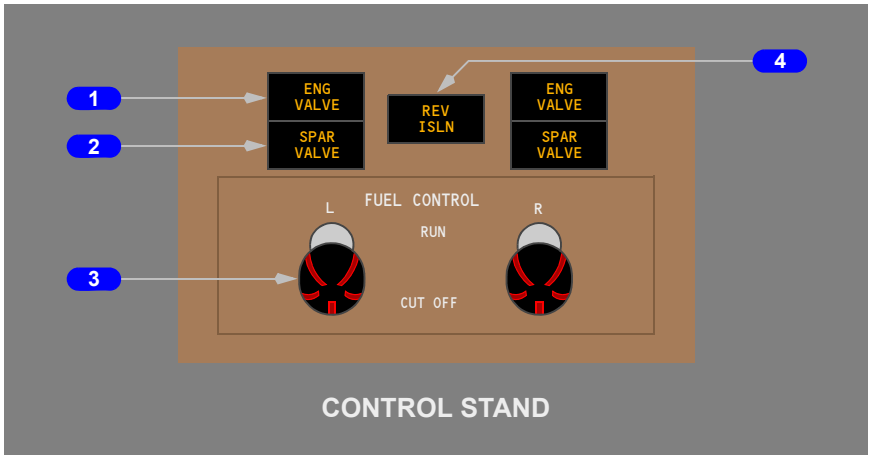
Reverse thrust can only be selected when the forward thrust levers are closed.
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Controls engine forward thrust.

The thrust levers can only be advanced if the reverse thrust levers are down.

Fuel Control Switches



1 Engine Valve (ENG VALVE) Lights

Illuminated (amber) – engine fuel valve is not in commanded position.

2 SPAR VALVE Lights

Illuminated (amber) – spar fuel valve is not in commanded position.

3 FUEL CONTROL Switches

RUN –

- normal position for engine operation
- opens engine and spar fuel valves
- activates selected ignitor(s).

CUT OFF –

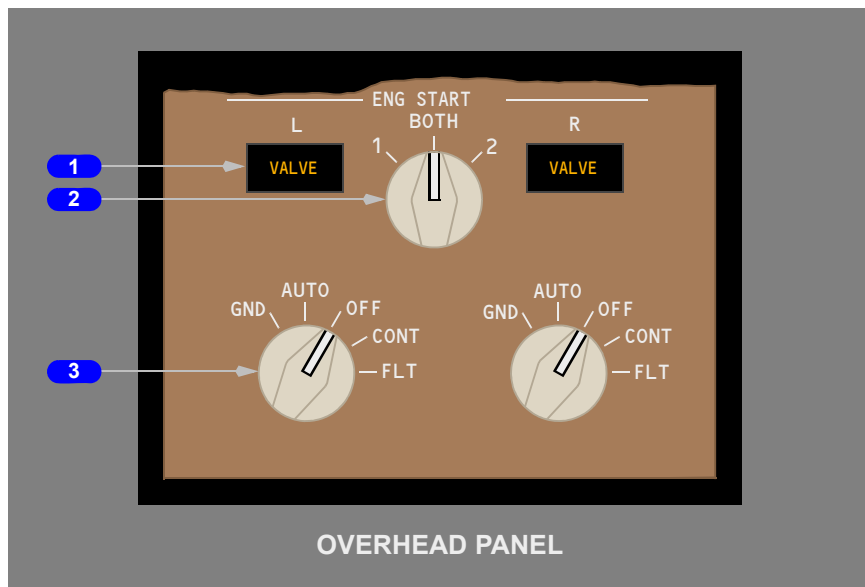
- closes engine and spar fuel valves
- terminates ignition.

4 Reverser Isolation Valve (REV ISLN) Light

Illuminated (amber) – a fault has been detected in the thrust reverser system.

Additional system failures may cause inflight deployment.

Engine Control Panel



1 Engine Start Valve (VALVE) Lights

Illuminated (amber):

- valve is not in commanded position
- N2 RPM exceeds 50% and starter valve open.

2 Ignition Selector

BOTH – both igniters in each engine operate when directed by Engine Start Selector.

1 or 2 – selected igniter in each engine operate when directed by Engine Start Selector.

3 Engine Start Selectors [AFM]

GND (push-in and rotate) –

- opens start valve to supply starter air
- arms selected igniter(s)
- selector magnetically held in GND position until 50% N2 RPM.

AUTO –

- selector releases to AUTO at 50% N2 RPM
- closes start valve and terminates ignition
- selected igniter(s) operate continuously with L.E. slats extended or engine anti-ice on.

OFF – no ignition.

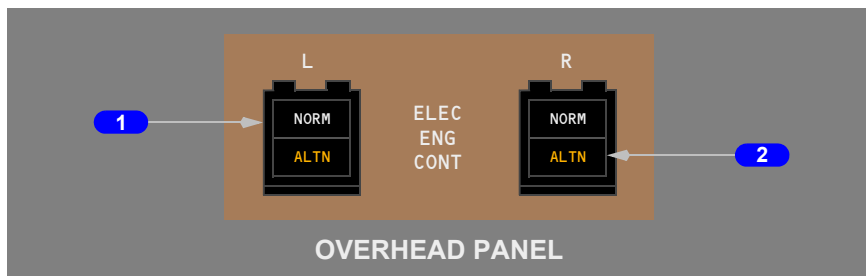
CONT –

- selected igniter(s) operate continuously
- no time limit
- engine operates at a minimum of approach idle.

FLT –

- both igniters operate continuously regardless of ignition selector position
- no time limit.

Electronic Engine Control (EEC)



1 EEC (ELEC ENG CONT) Switches

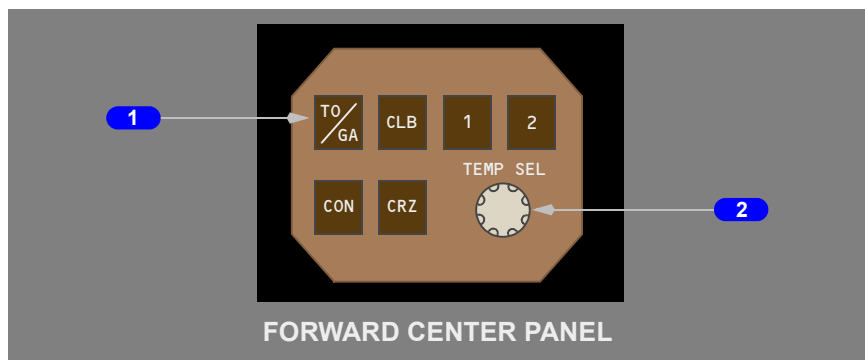
NORM – EEC is operating in normal (EPR) mode.

ALTN (NORM not visible) – EEC is operating in alternate (N1) mode.

2 EEC Alternate Mode (ALTN) Lights

Illuminated (amber) – EEC is operating in alternate (N1) mode.

Thrust Mode Select Panel (TMSP)



1 Thrust Reference Mode Select Switches

Push –

- manually selects desired thrust reference mode
- selected thrust reference mode and reference EPR are displayed

TO/GA –

- selects TO mode on the ground or GA mode inflight
- cancels preselected climb one or two
- cancels selected assumed temperature
- selecting 1 or 2 with TO or D-TO reference mode displayed:
 - preselects CLB 1 or CLB 2 on the ground if autothrottles not engaged
 - subsequent push cancels any preselected 1 or 2
 - cancels selected assumed temperature.

1401 through 1404

- selects TO 1 or TO 2

CLB –

- selects CLB
- selects CLB 1 or CLB 2 if 1 or 2 is preselected
- selecting 1 or 2 with CLB Reference mode displayed:
 - selects CLB 1 or CLB 2
- with CLB 1 or CLB 2 reference mode displayed:
 - subsequent push of active mode switch cancels 1 or 2
- with CLB 2 reference mode displayed:
 - switch 1 selects CLB 1.

CON –

- selects CON mode
- selecting 1 or 2 with CON reference mode displayed:
 - preselects CLB 1 or CLB 2.

CRZ –

- selects CRZ mode
- selecting 1 or 2 with CRZ reference mode displayed:
 - preselects CLB 1 or CLB 2.

2 Assumed Temperature Selector (TEMP SEL)

1401-1404

Functions only with TO, TO 1 or TO 2 mode displayed

171-199, 1200-1201

Functions only with TO, TO 1* or TO 2* mode displayed

Sets assumed temperature.

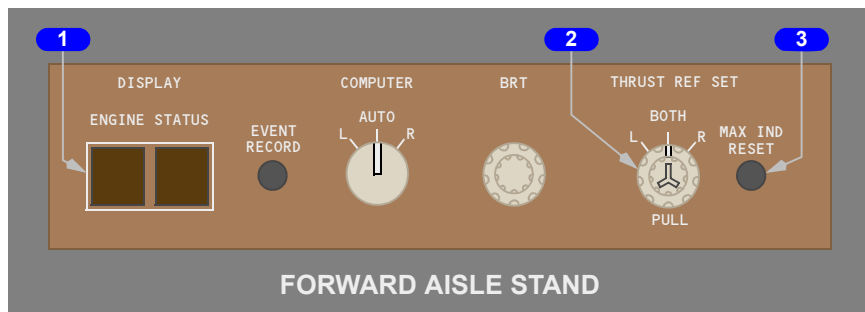
Rotate clockwise –

- assumed temperature appears on EICAS
- one click equals 1 degree centigrade.

171-199, 1200-1201

Note: * WHITE NUMBER - indicates reduced climb thrust is preselected.

EICAS Control Panel



1 ENGINE Display Switch

Push – displays the secondary engine parameters on the lower EICAS CRT.

If secondary engine parameters are already displayed and no limits have been exceeded, the display blanks.

2 Manual Thrust Reference Set (THRUST REF SET) Controls

Outer Knob:

- BOTH – both EPR bugs may be set to the same value
- L or R – only the selected EPR bug may be set to the desired value. Bugs may be set at different values.

Inner Knob:

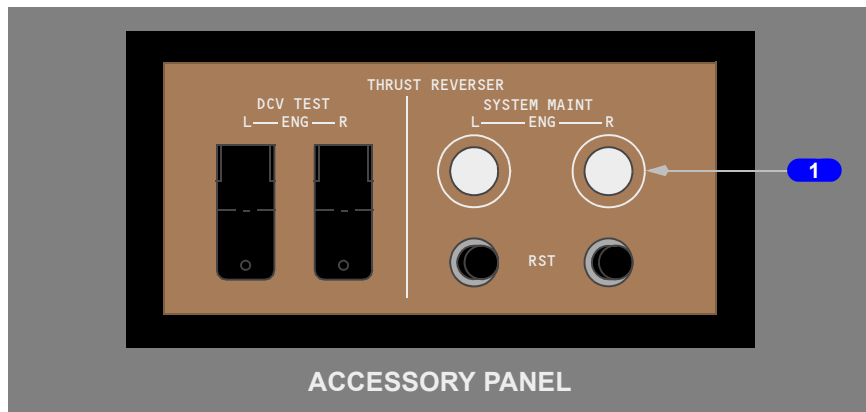
- Push – reference EPR is set automatically
- Pull – reference EPR is set manually. MAN appears in EPR thrust reference mode display and EPR bug moves to 1.55
- Rotate – in manual mode, sets EPR bug and reference EPR to desired value.

3 Maximum Indication Reset (MAX IND RESET) Switch

Push – resets and blanks all maximum exceedance values on EGT, N1 and N2.

Thrust Reverser Maintenance Panel

183-184



1 System Maintenance Lights

Illuminated (white) – fault detected in the respective reverser system

- press to test

Intentionally
Blank

Engines, APU Controls and Indicators (GE)

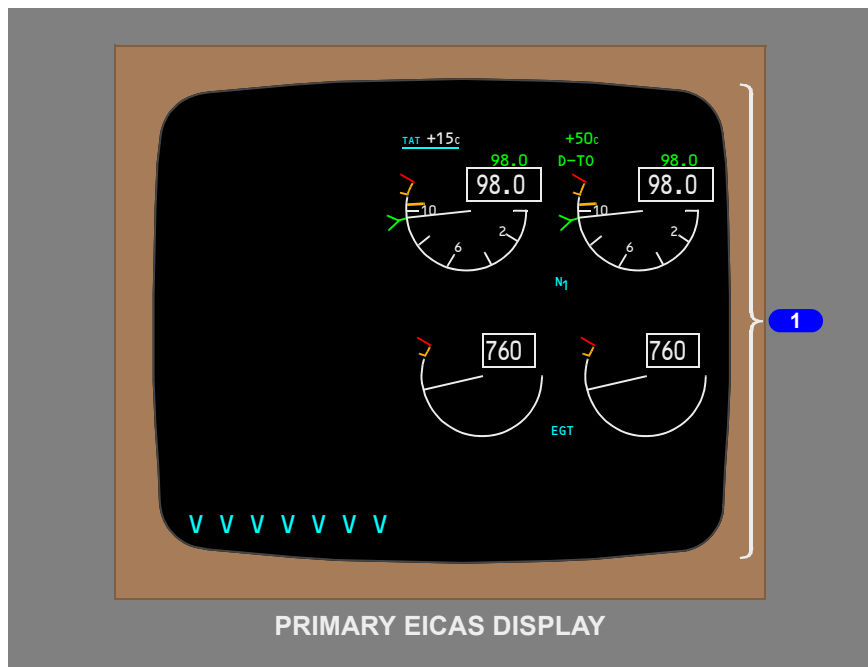
Chapter 7 Section 12

This section applies to ships 121-139, 1501-1506, 1521, 1601-1613, 1701-1708

EICAS Displays

[AFM]

Primary Engine Indications

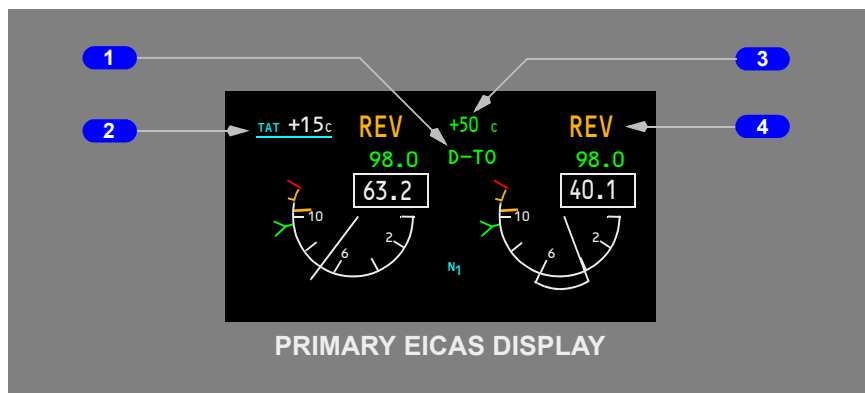


1 Primary Engine Indications

Displayed full time on the EICAS display:

- N1
- EGT.

Mode Indications



1 Thrust Reference Mode

Displayed (green) – selected FMS thrust reference mode:

Takeoff:

- TO – maximum rated takeoff thrust
121-139, 1501-1506, 1521
- TO 1 – takeoff thrust one, climb one preselected
121-139, 1501-1506, 1521
- TO 2 – takeoff thrust two, climb two preselected
1601-1613, 1701-1708
- TO 1* – maximum rated takeoff thrust, climb one preselected
1601-1613, 1701-1708
- TO 2* – maximum rated takeoff thrust, climb two preselected

Assumed Temperature Takeoff:

- D-TO – assumed temperature derated takeoff thrust
121-139, 1501-1506, 1521
- D-TO 1 – assumed temperature derated takeoff thrust one, climb one preselected
121-139, 1501-1506, 1521
- D-TO 2 – assumed temperature derated takeoff thrust two, climb two preselected
1601-1613, 1701-1708
- D-TO 1* – assumed temperature derated takeoff thrust, climb one preselected
1601-1613, 1701-1708
- D-TO 2* – assumed temperature derated takeoff thrust, climb two preselected

Climb:

- CLB – maximum rated climb thrust
- CLB 1 – derate one climb thrust
- CLB 2 – derate two climb thrust

Cruise:

- CRZ – maximum rated cruise thrust
1601-1613, 1701-1708
- CRZ 1 * – maximum rated cruise thrust, climb one preselected
1601-1613, 1701-1708
- CRZ 2 * – maximum rated cruise thrust, climb two preselected

Continuous:

- CON – maximum rated continuous thrust
1601-1613, 1701-1708
- CON 1 * – maximum rated continuous thrust, climb one preselected
1601-1613, 1701-1708
- CON 2 * – maximum rated continuous thrust, climb two preselected

Go-around and Manual:

- G/A – maximum go-around thrust
- MAN – reference N1 manually selected.

1601-1613, 1701-1708

Note: * WHITE NUMBER – indicates reduced climb thrust is preselected.

2 Total Air Temperature (TAT)

Displayed (cyan) – "TAT" and underline

Displayed (white) - temperature (degrees C)

3 Assumed Temperature

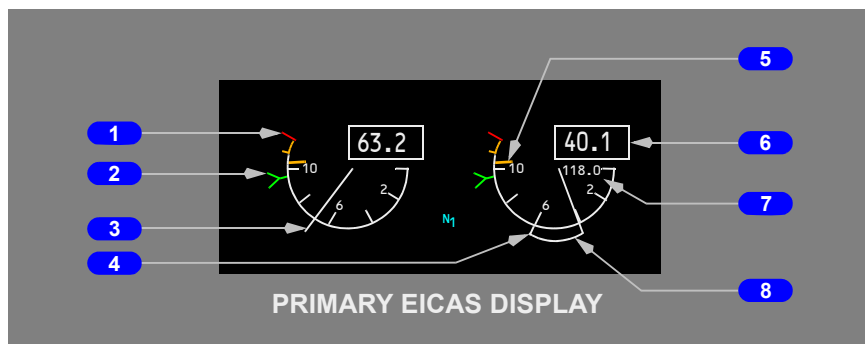
Displayed (green) – selected assumed temperature (degrees C) for reduced thrust takeoff.

4 Thrust Reverser Indication

Displayed:

- REV (amber) – reverser in transit
- REV (green) – reverser fully deployed.

N1 Indications



1 N1 Red Line Limit

Displayed (red) – N1 RPM operating limit.

2 N1 Bug

Displayed (green) – reference N1 for:

- thrust reference mode selected by the FMC
- thrust reference mode selected by the thrust mode select panel
- manual mode selected with thrust reference control.

Displayed (magenta) – target FMC commanded N1 when VNAV is engaged.

3 N1 Pointer

Displayed:

- (white) – points at value equal to that shown in the N1 counter
- (red) – operating limit reached or exceeded.

4 Command Thrust Level

Displayed (white):

- end of command sector
- appears as extension of N1 pointer when engine stabilized
- N1 commanded by thrust lever position

121-139, 1501-1506, 1521

- inhibited when EEC off or inoperative.

5 Limit N1

Displayed (amber) – maximum limit N1.

6 N1

N1 RPM (%), displayed:

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

7 Maximum Exceedance

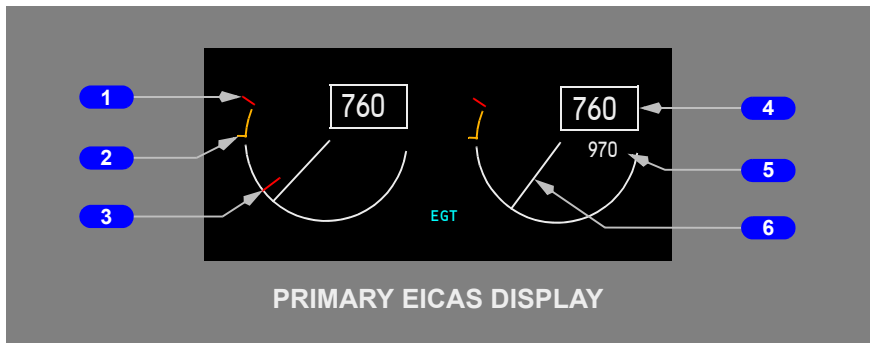
Displayed (white):

- red line limit or transient limit is exceeded
- highest value attained.

8 Command N1 Sector

Displayed (white) – momentary difference between engine N1 and N1 commanded by thrust lever position.

EGT Indications



1 EGT Red Line

Displayed (red) – maximum takeoff EGT limit.

2 EGT Amber Band

Displayed (amber) – maximum continuous EGT limit.

3 EGT Start Limit Line

Displayed (red) – during start until engine is stabilized at minimum idle RPM.

4 EGT

EGT (degrees C), displayed:

- (white) – normal operating range
- (amber) – maximum continuous limit reached*
- (red) – maximum start or takeoff limit reached.

121-139

Note: * Pointer and counter remain white during TO or GA for 5 minutes after amber band is entered.

1501-1506, 1521, 1601-1613, 1701-1708

Note: * Pointer and counter remain white during TO or GA for 5 minutes after amber band is entered. If engine failure occurs during 5 minute amber band inhibit time period then total amber band inhibit time period is extended to 10 minutes.

5 EGT Maximum Exceedance

Displayed (white):

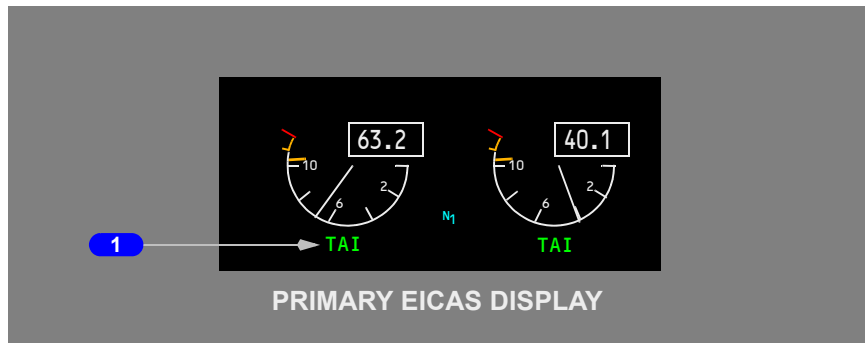
- red line limit, transient limit or start EGT is exceeded
- displays the highest value attained.

6 EGT Pointer

Displayed:

- (white) – normal operating range
- (amber) – maximum continuous limit reached
- (red) – maximum start or takeoff limit reached.

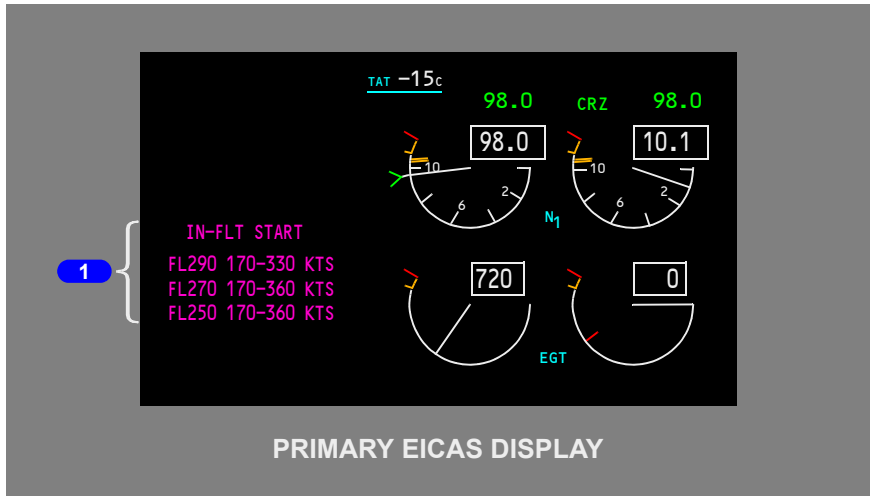
Anti-Ice Indications



1 Thermal Anti-Ice (TAI) Indication

Displayed (green) – engine anti-ice is on.

In-Flight Start Envelope



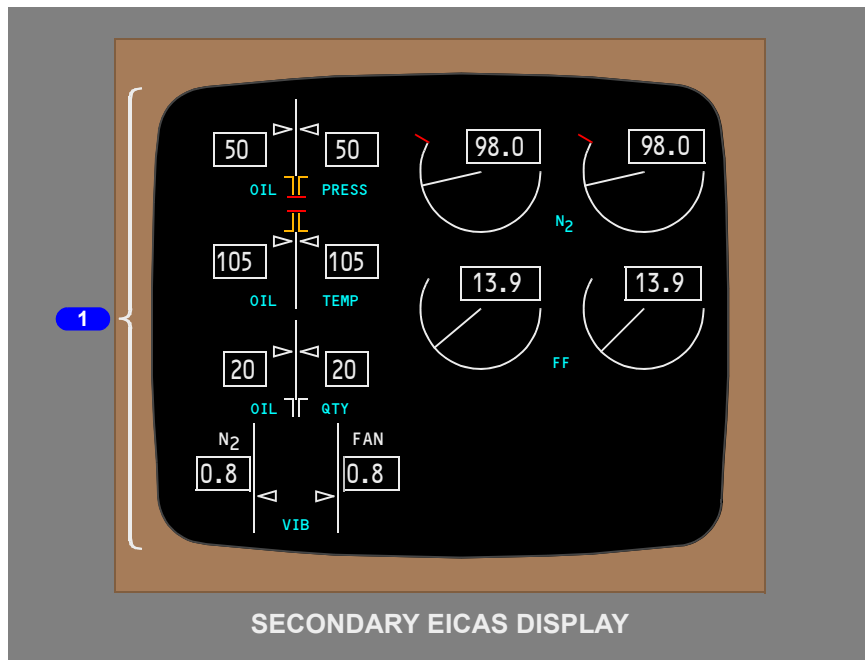
1 In-Flight Start Envelope

Displayed (magenta) – airspeed range for an inflight start for the closest starting flight level and two descending flight levels at two thousand foot intervals when the respective engine fire switch is in and:

- a FUEL CONTROL switch is in CUT OFF, and
- engine N2 RPM is below idle, and
- primary and secondary EICAS displayed.

Secondary Engine Indications

[AFM]

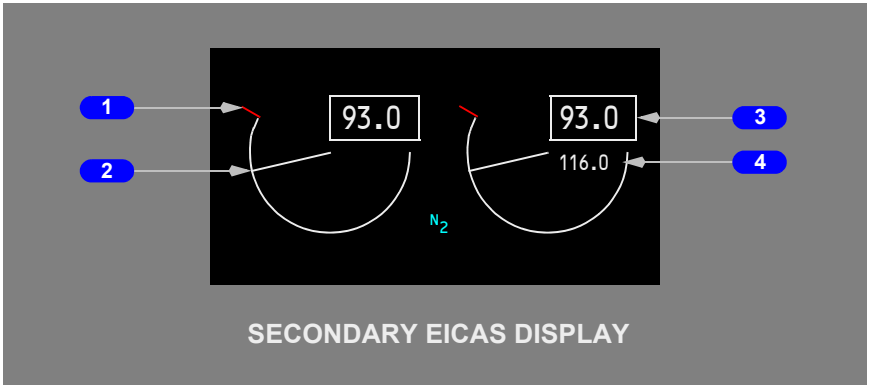


1 Secondary Engine Display

Displays:

- N₂ RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration.

N2 Indications



1 N2 Red Line

N2 RPM operating limit, displayed (red).

2 N2 Pointer

N2 RPM, displayed:

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

3 N2

N2 RPM (%), displayed:

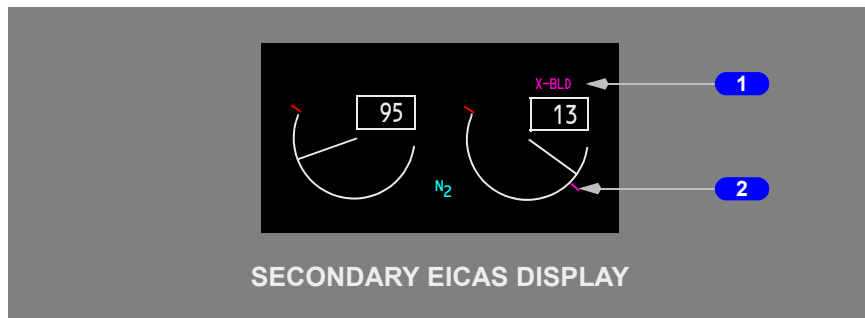
- (white) – normal operating range
- (red) – operating limit reached.

4 Maximum Exceedance

Displayed (white):

- red line limit is exceeded
- highest value attained.

Crossbleed Start Indications



1 Crossbleed Start (X-BLD) Indication

Indicates crossbleed air is recommended for an inflight start.

Displayed (magenta):

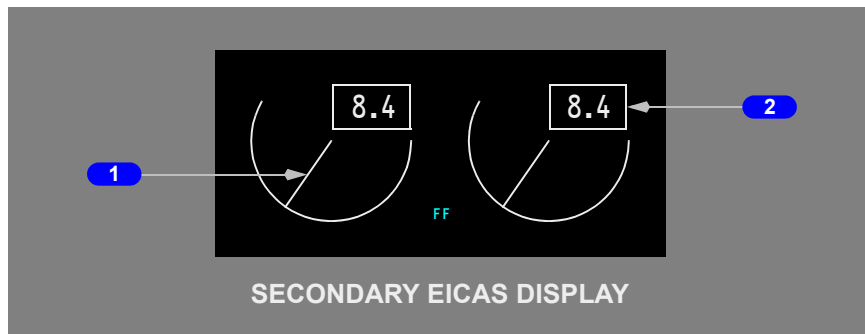
- the inflight start envelope is displayed, and
- airspeed is lower than that for a windmilling start.

2 Fuel On Command Bug

Displayed (magenta):

- engine is shutdown on the ground or inflight when X-BLD is displayed
- minimum fuel on selection point during starter cranking.

Fuel Flow Indications



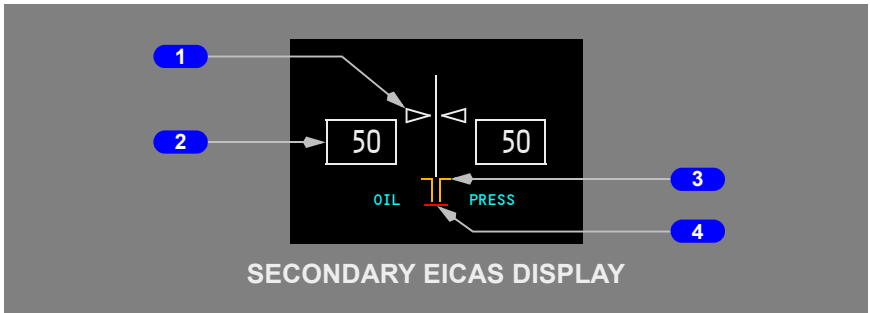
1 Fuel Flow Pointer

Displayed (white) – points at a value equal to that shown in the Fuel Flow.

2 Fuel Flow (FF)

Displayed (white) – fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications



1 Oil Pressure Pointer

Engine oil pressure, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

2 Oil Pressure (OIL PRESS)

Engine oil pressure (psi), displayed:

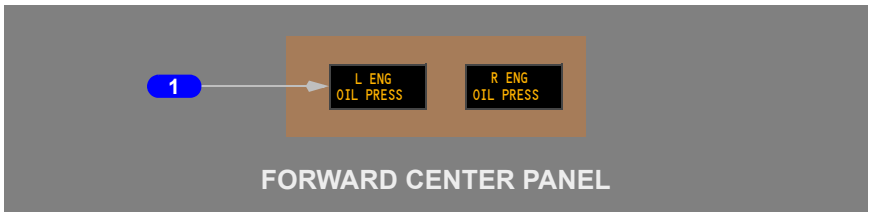
- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

3 Oil Pressure Amber Band

Displayed (amber) – caution range for low oil pressure.

4 Oil Pressure Red Line

Displayed (red) – low (minimum) oil pressure operating limit.

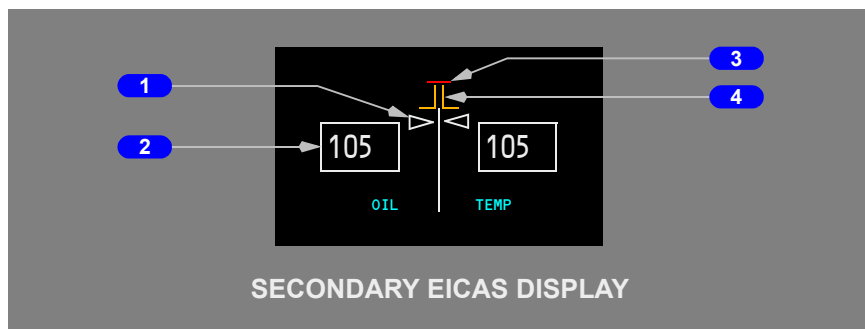


1 Engine Oil Pressure (L or R ENG OIL PRESS) Lights

Illuminated (amber):

- respective engine oil pressure is at or below minimum
- oil pressure switch malfunction.

Oil Temperature Indications



1 Oil Temperature Pointer

Engine oil temperature, displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

2 Oil Temperature

Engine oil temperature (degrees C), displayed:

- (white) – normal operating range
- (amber) – caution range reached
- (red) – operating limit reached.

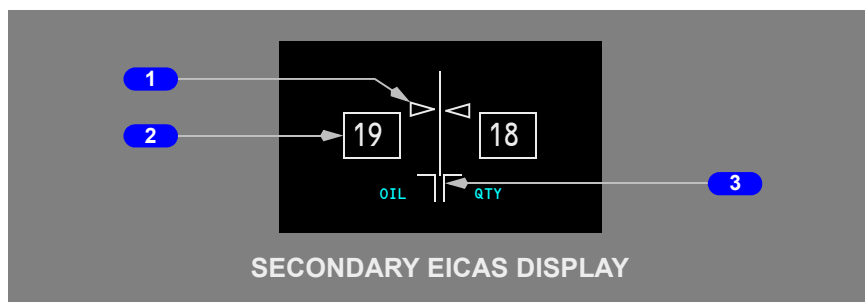
3 Upper Oil Temperature Red Line

Displayed (red) – maximum oil temperature operating limit.

4 Oil Temperature Amber Band

Displayed (amber) – oil temperature caution range.

Oil Quantity Indications



1 Oil Quantity Pointer

Displayed (white) – points at a value equal to that shown in the Oil Quantity.

2 Oil Quantity

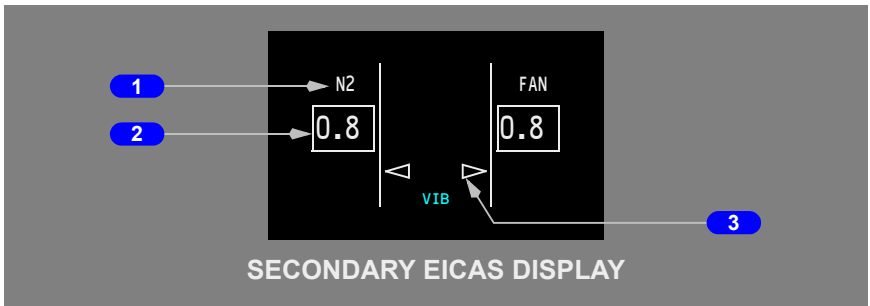
Usable oil quantity (quarts), displayed:

- (white) – normal quantity.

3 Low Oil Quantity Band

Displayed (white) – awareness range for low oil quantity.

Engine Vibration Indications



1 Vibration Source

Identifies the vibration source being displayed.

Displayed (white) – vibration source with the highest vibration:

- FAN – low pressure compressor
- LPT – low pressure turbine
- N2 – high pressure compressor
- BB – broad band engine vibration.

2 Engine Vibration

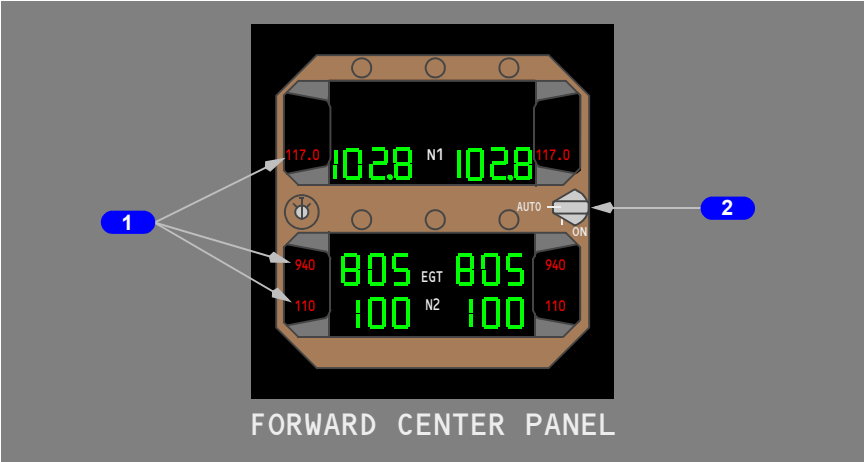
Displayed (white) – display of engine vibration in units.

3 Engine Vibration Pointer

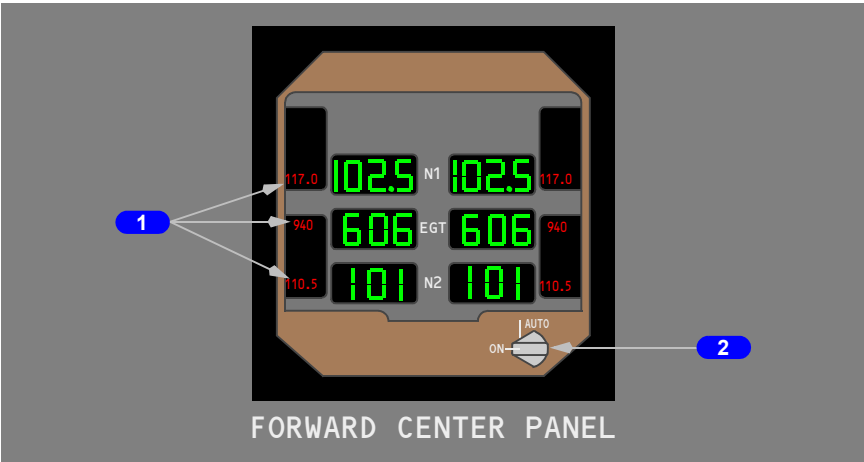
Displayed (white) – engine vibration.

Standby Engine Indicator (SEI)

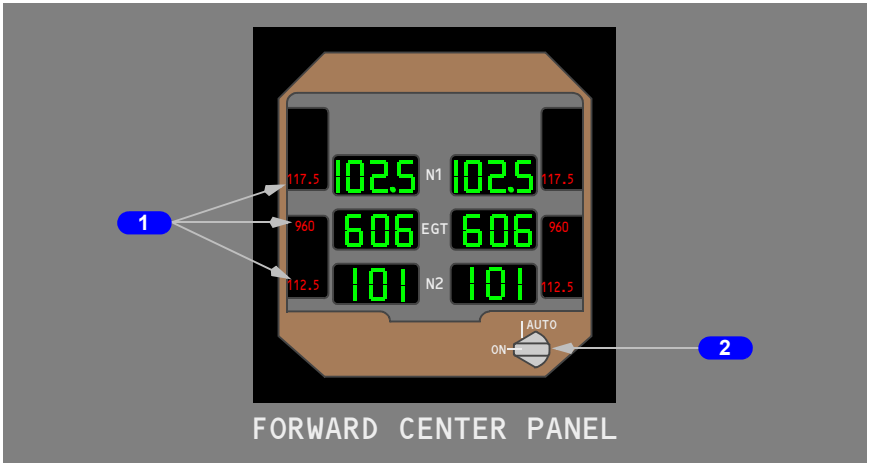
121-128



129-139



1501-1506, 1521, 1601-1613, 1701-1708



1 Maximum Engine Limits

2 Standby Engine Indicator Selector

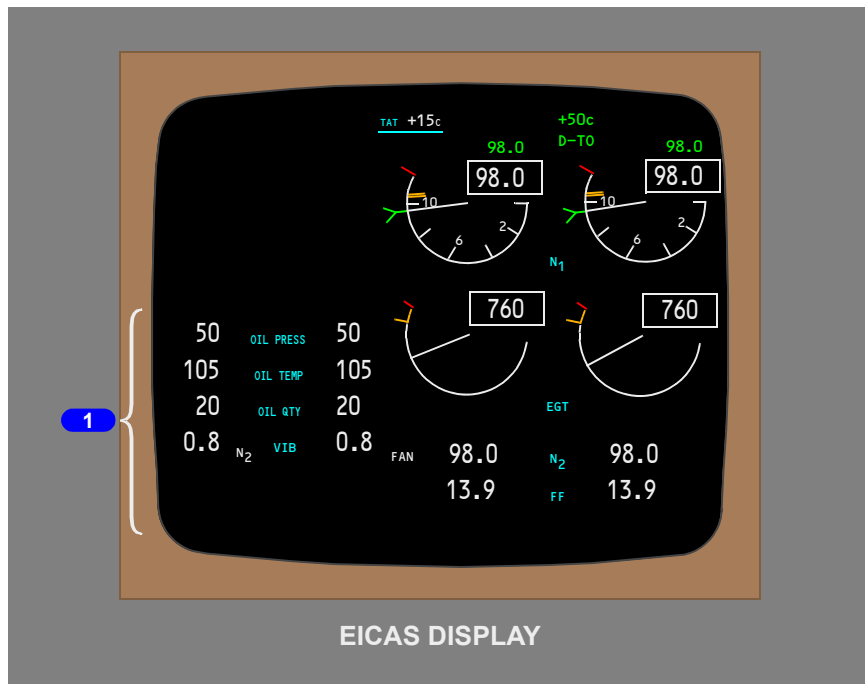
AUTO –

- display is blank with AC power on the airplane and EICAS operative
- standby engine indications in view when:
 - AC power is lost
 - either CRT failed and STATUS selected on the ground
 - EICAS failed.

ON – standby engine indications in view.

Compact Engine Indications

[AFM]

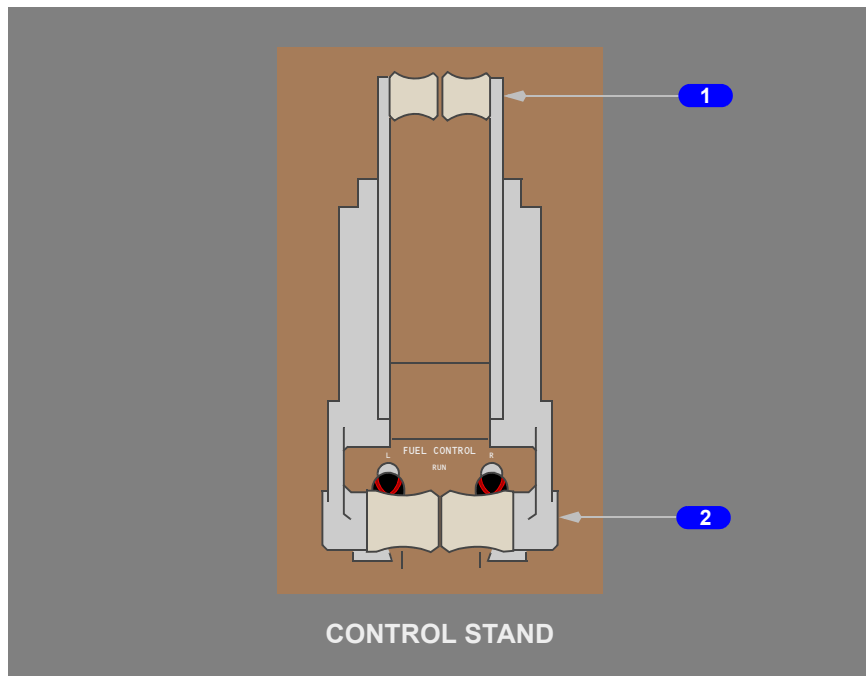


1 Compact Engine Indications

The following changes to EICAS and the normal secondary engine display occur:

- N2 changes from round dial display to digital display. The N2 digital display turns red if the limit is exceeded
- FF, OIL PRESS and OIL TEMP are displayed as digital readouts only. The OIL PRESS and OIL TEMP digital displays turn amber or red if limits are exceeded
- OIL QTY and VIB are displayed as digital readouts only. Low oil quantity and high vibrations are displayed the same as in the normal format.

Engine Controls Thrust Levers



1 Reverse Thrust Levers

Control engine reverse thrust.

Reverse thrust can only be selected when the forward thrust levers are closed.

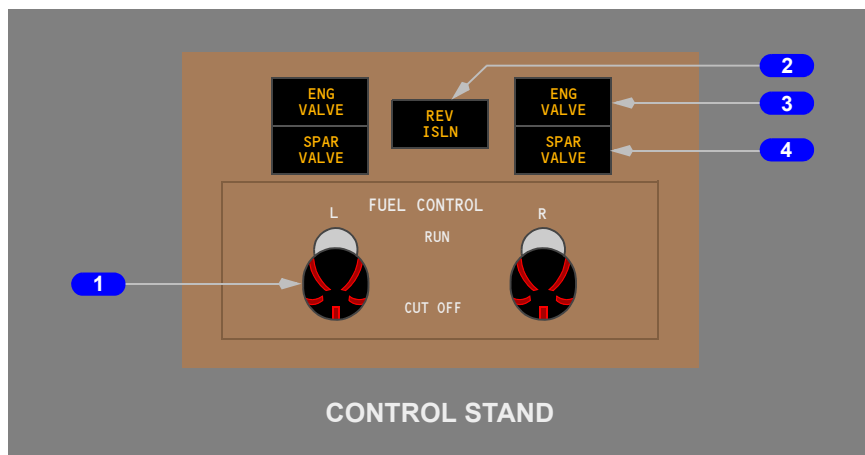
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Controls engine forward thrust.

The thrust levers can only be advanced if the reverse thrust levers are down.

Fuel Control Switches



1 FUEL CONTROL Switches

RUN –

- normal position for flight
- opens engine and spar fuel valves
- activates selected ignitor(s).

CUT OFF –

- closes engine and spar fuel valves
- terminates ignition.

2 Reverser Isolation Valve (REV ISLN) Light

Illuminated (amber) – a fault has been detected in the thrust reverser system.
Additional system failures may cause inflight deployment.

3 Engine Valve (ENG VALVE) Lights

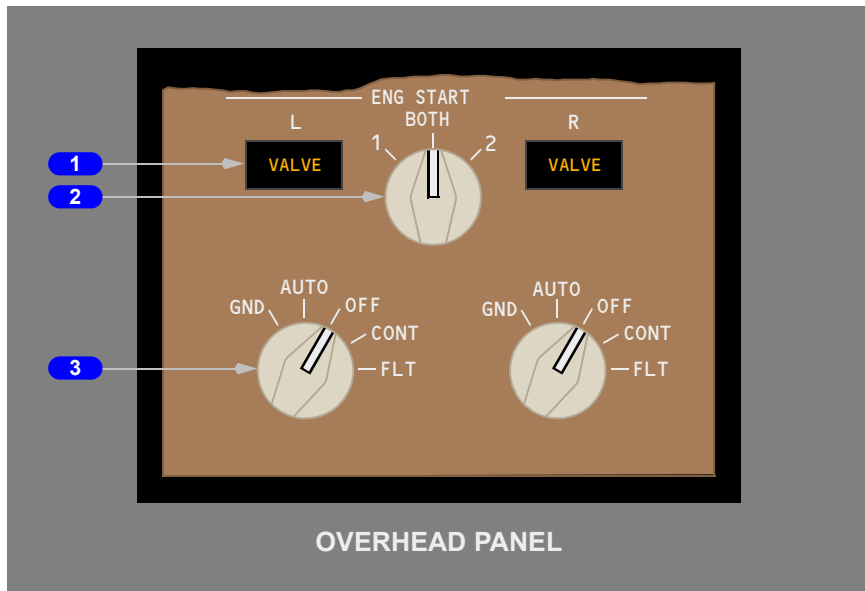
Illuminated (amber) – engine fuel valve is not in commanded position.

4 SPAR VALVE Lights

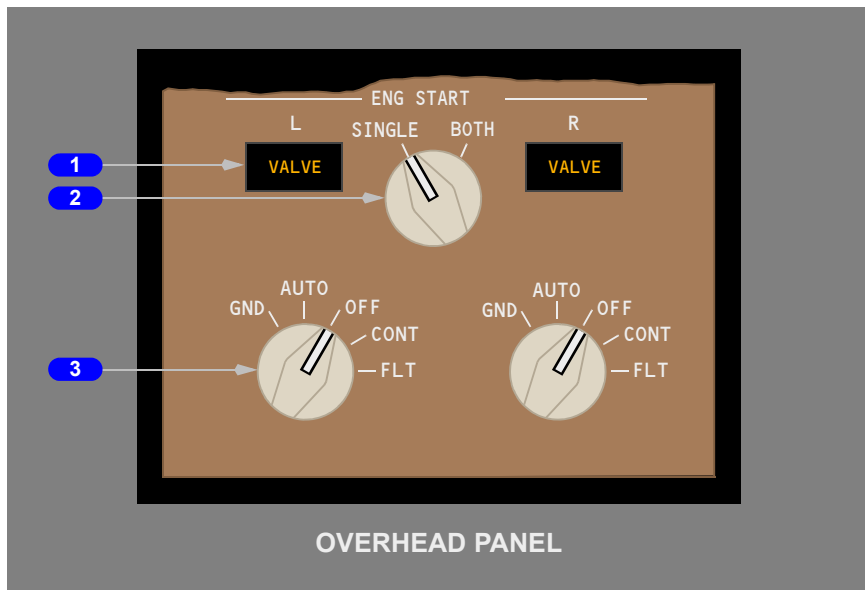
Illuminated (amber) – fuel spar valve is not in commanded position.

Engine Control Panel

121-139, 1501-1506



1521, 1601-1613, 1701-1708



1 Engine Start Valve (VALVE) Lights

Illuminated (amber):

- valve is not in commanded position
- N2 RPM exceeds 50% and starter valve open.

2 Ignition Selector

121-139, 1501-1506

BOTH – both igniters in each engine operate when directed by Engine Start Selector.

1 or 2 – selected igniter in each engine operate when directed by Engine Start Selector.

2 Ignition Selector

1521, 1601-1613, 1701-1708

BOTH – both igniters in each engine operate when directed by Engine Start Selector.

SINGLE – one igniter in each engine operates when directed by Engine Start Selector. The ignitor automatically alternates with each engine start.

Note: Auto relight is enabled regardless of engine start and ignition selector positions. Both ignitors operate when N2 drops below idle speed.

3 Engine Start Selectors [AFM]

GND (push-in and rotate) –

- opens start valve to supply starter air
- arms selected igniter(s)
- selector magnetically held in GND position until 50% N2 RPM.

AUTO –

- selector releases to AUTO at 50% N2 RPM
- closes start valve and terminates ignition
- selected igniter(s) operate continuously with L.E. slats extended or engine anti-ice on.

OFF – no ignition.

CONT –

- selected igniter(s) operate continuously
- no time limit.

1601-1613, 1701-1708

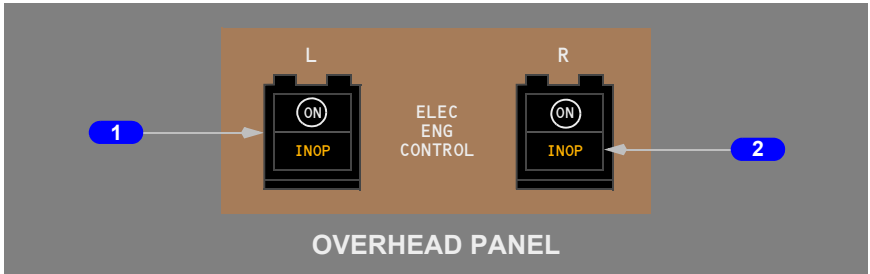
- engine operates at a minimum of approach idle.

FLT –

- both igniters operate continuously regardless of ignition selector position
- no time limit.

Electronic Engine Control (EEC)

121-139, 1501-1506



1 EEC (ELEC ENG CONTROL) Switches

ON – electronic engine control trims fuel flow for limiting N1 RPM when engine is accelerating at or near any thrust mode limit.

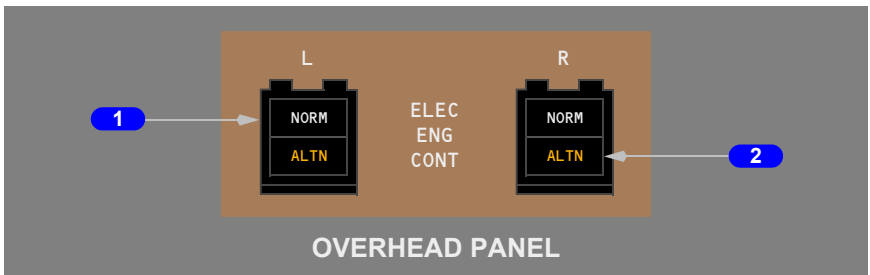
Off (ON not visible) – hydromechanical fuel control is scheduling fuel flow.

2 EEC Inoperative (INOP) Lights

Illuminated (amber) –

- EEC inoperative
- EEC selected off
- inhibited with switch on and engine shutdown.

1521, 1601-1613, 1701-1708



1 EEC (ELEC ENG CONT) Switches

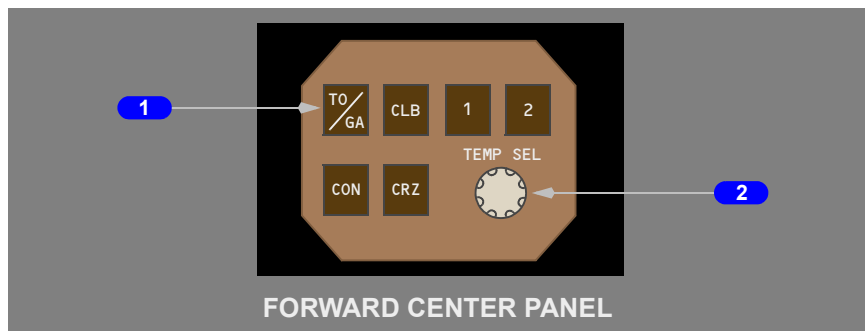
NORM – normal EEC mode is selected.

ALTN (NORM not visible) – alternate EEC mode is selected.

2 EEC Alternate Mode (ALTN) Lights

Illuminated (amber) – EEC is operating in alternate mode.

Thrust Mode Select Panel (TMSP)



1 Thrust Reference Mode Select Switches

Push –

- manually selects desired thrust reference mode
- selected thrust reference mode and reference N1 are displayed

TO/GA –

- selects TO mode on the ground or GA mode inflight
- cancels preselected climb one or two
- cancels selected assumed temperature
- selecting 1 or 2 with TO or D-TO reference mode displayed:
 - preselects CLB 1 or CLB 2 on the ground if autothrottles not engaged
 - subsequent push cancels any preselected 1 or 2
 - cancels selected assumed temperature.

121-139

- selects TO 1 or TO 2

CLB –

- selects CLB
- selects CLB 1 or CLB 2 if 1 or 2 is preselected
- selecting 1 or 2 with CLB Reference mode displayed:
 - selects CLB 1 or CLB 2
- with CLB 1 or CLB 2 reference mode displayed:
 - subsequent push of active mode switch cancels 1 or 2
- with CLB 2 reference mode displayed:
 - switch 1 selects CLB 1.

CON –

- selects CON mode
- selecting 1 or 2 with CON reference mode displayed:
 - preselects CLB 1 or CLB 2.

CRZ –

- selects CRZ mode
- selecting 1 or 2 with CRZ reference mode displayed:
 - preselects CLB 1 or CLB 2.

2 Assumed Temperature Selector (TEMP SEL)

121-139

Functions only with TO, TO 1 or TO 2 mode displayed

1601-1613, 1701-1708

Functions only with TO, TO 1* or TO 2* mode displayed

Sets assumed temperature.

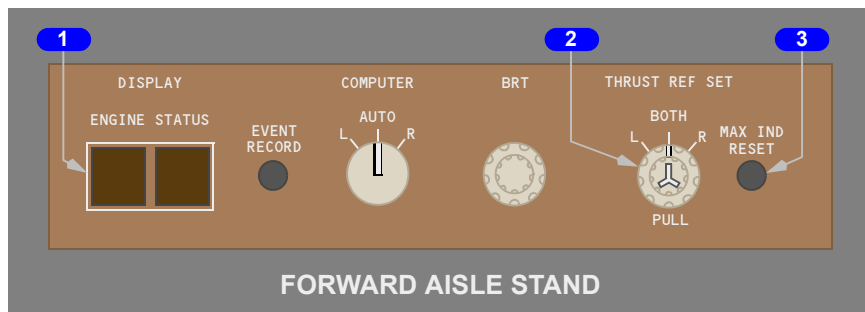
Rotate clockwise –

- assumed temperature appears on EICAS
- one click equals 1 degree centigrade.

1601-1613, 1701-1708

Note: * WHITE NUMBER - indicates reduced climb thrust is preselected.

EICAS Control Panel



1 ENGINE Display Switch

Push – displays the secondary engine parameters on the lower EICAS CRT.

If secondary engine parameters are already displayed and no limits have been exceeded, the display blanks.

2 Manual Thrust Reference Set (THRUST REF SET) Controls

Outer Knob:

- BOTH – both N1 bugs may be set to the same value
- L or R – only the selected N1 bug may be set to the desired value. Bugs may be set at different values.

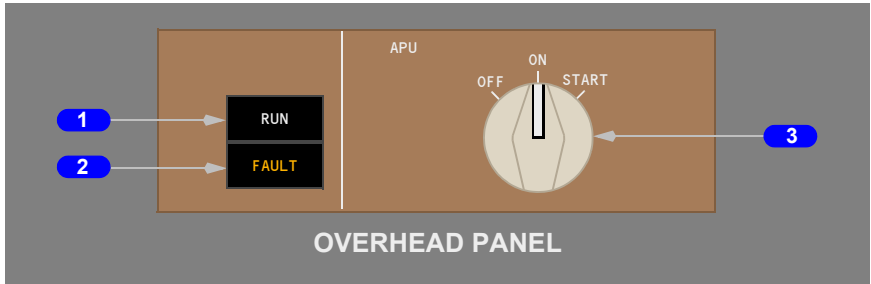
Inner Knob:

- Push – reference N1 is set automatically
- Pull – reference N1 is set manually. MAN appears in N1 thrust reference mode display and N1 bug moves to 104%.
- Rotate – in manual mode, sets N1 bug and reference N1 to desired value.

3 Maximum Indication Reset (MAX IND RESET) Switch

Push – resets and blanks all maximum exceedance values N1, EGT and N2.

Auxiliary Power Unit (APU) APU Controls



1 APU RUN Light

Illuminated (white) - APU is at operating speed.

2 APU FAULT Light

Illuminated (amber):

- the APU has automatically shut down
- the APU fuel valve disagrees with the commanded position.

3 APU Selector

OFF –

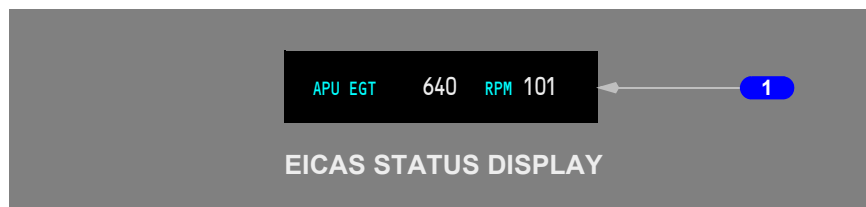
- closes the APU bleed air isolation valve, if open
- initiates APU cooling cycle
- shuts down APU when cooling cycle complete
- resets auto shutdown fault logic.

ON (APU operating position) –

- opens the APU fuel valve and inlet door
- activates AC or DC fuel pump
- powers the APU controller
- permits the APU bleed valve to open if the APU Bleed Switch is on when APU reaches operating speed.

START (momentary position, spring-loaded to ON) – initiates automatic start sequence.

APU Indications



1 APU Status Display

EGT – APU exhaust gas temperature displayed in degrees centigrade.

RPM – APU rotation speed in percent.

Engines, APU

Engine System Description (PW)

Chapter 7

Section 21

This section applies to ships 171-199, 1200-1201, 1401-1404

Introduction

The airplane is powered by two Pratt and Whitney PW4060 engines. The engines are rated at 60,200 pounds of takeoff thrust each.

The engines are two-rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of the fan, a low pressure compressor and turbine section on a common shaft. The N2 rotor consists of a high pressure compressor and turbine section on a common shaft. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine accessory gearbox.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew.

Each engine is controlled by an electronic engine controller (EEC). The EECs monitor autothrottle and flight crew inputs through the thrust levers to automatically control the engines.

Engine indications are displayed on the engine indication and crew alerting system (EICAS) display.

Engine Indications

Primary and secondary engine indications are provided. Engine indications are displayed on the EICAS display. In addition, annunciator lights and a liquid crystal standby engine indicator are provided to monitor engine operation.

Primary Engine Indications

EPR, N1, and EGT are the primary engine indications. The primary engine indications are always displayed on the upper EICAS display.

Secondary Engine Indications

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are secondary engine indications. Secondary engine indications are displayed on the lower EICAS display. The secondary engine indications can be displayed by pushing the Engine Display Switch (the ENGINE switch on the EICAS Control Panel). The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power, or
- a secondary engine parameter is exceeded.

Normal Display Format

Primary engine indications and the N2 and fuel flow indications are 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, oil quantity and vibration indications are both digital readouts and vertical indication/moving pointers. All digital readouts are enclosed by boxes. The dial and vertical indications display the normal operating range, caution range, and operating limits.

Normal operating range is displayed on a dial or vertical indication in white.

The oil temperature vertical indication has caution ranges displayed by amber bands. If oil temperature reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber.

N1, EGT, N2, oil pressure, and oil temperature indications have operating limits indicated by red lines. If one of these indications reaches the red line, the digital readout, box, and pointer change color to red for that indication.

The EGT indication has a maximum continuous limit represented by an amber band. If EGT reaches the maximum continuous limit, the digital indication, box, pointer, and dial all change color to amber. The EGT indication is inhibited from changing to amber during takeoff or go-around for five minutes. The inhibit is extended to ten minutes for single-engine operation. The red line limits for these parameters are not inhibited. The EGT indication has a maximum takeoff limit displayed by a red line. If EGT reaches the maximum takeoff limit, the digital indication, box, pointer and dial, all change color to red.

The maximum EPR limit is indicated by an amber line on the EPR dial. The EPR indication does not change color when maximum EPR is reached. The reference/target EPR indication displays the FMS reference or target EPR. The commanded EPR indication displays the EEC calculated EPR commanded by thrust lever position.

Compact Display Format

In compact format, primary and secondary engine indications are combined on the same display. The EPR and N1 displays are the same as the normal displays. All other indications change to digital readouts only. If an amber or red line parameter for a digital indication is exceeded, the digital indication changes color to amber or red (as does the box that appears around an EGT indication).

Primary and secondary engine indications are displayed on EICAS in compact format whenever a CRT fails.

Engine Secondary Data Cue

A series of blue Vs are visible on the lower left corner of the upper EICAS CRT any time engine data is displayed on the lower EICAS CRT. If for some reason the engine data is not visible, the Status Display Switch may be used to allow the engine data to come up partially compacted on the upper EICAS CRT display.

Engine Pressure Ratio (EPR)

Engine Pressure Ratio is the primary thrust parameter. Annunciations associated with EPR are:

- Maximum EPR
- Thrust Reference Mode
- Reference/Target EPR indication
- Reference EPR
- Assumed Temperature
- Thrust Reverser Indication
- Command Thrust Level
- Commanded EPR Sector.

The maximum EPR is the maximum certified thrust limit for all phases of flight and varies with existing ambient conditions. The maximum EPR is indicated by dual amber radials on the periphery of the EPR indicator. This value is acquired from the EEC or the TMC. With the EEC operating normally, the thrust levers can be moved to the forward stop and the engines will not exceed the displayed maximum EPR.

The command thrust level is a display of thrust lever position and appears as an extension of the EPR pointer when the engine is stabilized. A change in thrust lever position moves the command thrust level and displays the commanded thrust on the EPR indicator. This allows for precise thrust control.

The command sector is a display of the momentary difference between the command thrust level and actual EPR and appears as a white band on the EPR indicator. As the engine accelerates or decelerates to the command thrust level the command sector is erased. This allows for monitoring of engine acceleration and deceleration.

Thrust reverser indication (REV) is displayed above the EPR indicator when the reverser is activated. The annunciation is amber when the reverser is unlocked or in transit. When the reverser is fully deployed, the annunciation changes color to green and the forward thrust reference displays are inhibited.

Thrust Management Computer (TMC)

The thrust management computer calculates a reference EPR based on existing pressure altitude and ambient temperature data from the air data system for the following modes:

- TO – takeoff
 - 1401-1404**
 - TO 1 – takeoff one
 - 1401-1404**
 - TO 2 – takeoff two
 - D-TO – assumed temperature takeoff
 - CLB – climb
 - CLB 1 – climb one
 - CLB 2 – climb two
 - CRZ – cruise
 - CON – continuous
 - GA – go-around.

These modes can be selected with the thrust mode select panel (TMSP). The inner thrust reference set control on the EICAS control panel must be pushed in for the thrust reference modes to be displayed on EICAS. The selected thrust reference mode is displayed above the EPR indicators. The digital reference EPR is displayed adjacent to the mode display. When the EPR bug is green, it is positioned on the EPR scale at the same value as the digital reference EPR.

The thrust mode select switches provide the capability of selecting different thrust modes for each phase of flight. The TO/GA switch is used to select takeoff thrust on the ground and go-around thrust inflight.

1401-1404

The 1 and 2 switches are used to select a reduced takeoff thrust rating or reduced climb thrust. When reduced takeoff thrust rating one or two is selected, this automatically preselects the associated reduced climb one or two. The CLB switch is used to select climb thrust inflight. If reduced climb thrust one or two was preselected, pushing the climb switch inflight selects CLB 1 or CLB 2.

The assumed temperature for a reduced thrust takeoff can be set by:

- using the assumed temperature selector on the TMSP
- entering the assumed temperature into the CDU TAKEOFF REF page
- datalink

171-199, 1200-1201

The 1 and 2 switches are used to select reduced climb thrust. Reduced climb thrust one or two can be preselected in conjunction with takeoff or assumed temperature takeoff thrust prior to takeoff. The CLB switch is used to select climb thrust inflight. If reduced climb thrust one or two was preselected, pushing the climb switch inflight selects CLB 1 or CLB 2.

The CON switch is used to select maximum continuous thrust inflight. The CRZ switch is used to select cruise thrust inflight. The assumed temperature selector or the CDU is used to set assumed temperatures when reduced takeoff thrust is desired.

To manually set Reference EPR values the thrust reference set control is pulled out, MAN appears as the thrust mode annunciation and the EPR bug slews to 1.55. Manual reference EPR values can then be set by rotating the inner control. The outer control of the thrust reference set control is used to select the desired EPR indicator(s) for manual EPR display. The autothrottles do not respond to manually set reference EPR values. When the inner control is pulled out, the autothrottles remain in the active TMC mode. The TMSP remains operable and the autothrottles respond to TMSP mode changes, but selected thrust reference mode displays are inhibited.

When the AFDS VNAV mode is engaged, the EPR bug may be magenta. When the EPR bug is magenta, it is positioned at a nominal target EPR by the FMC, which may not correlate with the digital reference EPR. In VNAV, the FMC controls Thrust mode selection automatically to meet thrust requirements for the active vertical mode of operation. The FMC does not have the capability to select reduced climb thrust values, these values must be selected manually with the 1 or 2 TMSP switches.

The thrust reference mode, reference EPR and EPR bug are not displayed when the reversers are fully deployed.

Reduced Takeoff Thrust

1401-1404

Two levels of reduced takeoff thrust are available with the 1 and 2 mode switches on the Thrust Mode Select Panel. These are lower thrust ratings than takeoff thrust. Takeoff 1 is approximately 90% of takeoff thrust and takeoff 2 is approximately 80% of takeoff thrust. Assumed temperature reduced thrust can be used in conjunction with these lower thrust ratings.

Assumed Temperature Takeoff

The thrust management computer calculates the reference EPR for assumed temperature reduced thrust takeoff. The assumed temperature can be entered manually on the FMC CDU TAKEOFF REF page or selected with the assumed temperature selector on the TMSP. The assumed temperature is displayed above the thrust reference mode.

171-199, 1200-1201

When the assumed temperature selector on the TMSP is initially rotated clockwise, a reference temperature is displayed on EICAS. This temperature also appears on the FMC CDU TAKEOFF REF page as TEMP SEL.

1401-1404

When the assumed temperature selector on the TMSP is initially rotated clockwise, a reference temperature is displayed on EICAS. This temperature also appears on the FMC CDU TAKEOFF REF page as THRUST.

The assumed temperature can be supplied to the FMC and CDU via datalink.

Further clockwise rotation of the selector increases the assumed temperature by 1 degree centigrade per click. The reduced thrust annunciation of D-TO appears when the assumed temperature selected is above ambient. If the ambient temperature is greater than the initially displayed reference temperature, D-TO and reduced thrust occur when the assumed temperature selected exceeds ambient.

Counterclockwise rotation of the selector reduces the assumed temperature by one degree centigrade per click.

Assumed temperature takeoff thrust is limited to a 25% reduction of takeoff thrust or selected climb thrust, whichever is the greater thrust value. When the limit is reached, further adjustment to the assumed temperature by rotating the assumed temperature selector on the TMSP or changing the value entered in the CDU TAKEOFF REF page does not change the displayed assumed temperature or reference thrust value.

Reduced Climb Thrust

1401-1404

Climb one or two is automatically preselected when takeoff one or takeoff two is selected.

Two levels of reduced climb thrust are available with the 1 and 2 mode switches on the thrust mode select panel. Climb 1 is approximately 90% of climb thrust and climb 2 is approximately 80% of climb thrust. Climb one or two can be preselected in conjunction with the TO, D-TO, CON and CRZ thrust reference modes.

Above 10,000 feet, reduced climb thrust gradually changes to reach full climb thrust by 30,000 feet. The 1 or 2 annunciation disappears from the display by 30,500 feet.

Electronic Engine Control (EEC) – PW4000 Series Engine

The thrust system consists of a dual channel, full authority Electronic Engine Control unit without any hydromechanical backup. Each EEC is powered, when the engines are operating, by a dedicated permanent magnet alternator (PMA) independent of airplane electrical power. The EEC commands constant engine output for a given thrust lever position. EPR is the prime thrust setting parameter, N1 is alternate.

The EEC continuously computes the maximum thrust limit which is presented as an amber radial on the EPR display. Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions.

Primary (EPR) Control Mode

Both engines normally operate in the primary mode to control thrust. In primary control mode operation, target EPR for current thrust lever position is computed as a ratio to the full throttle position. During rapid thrust lever movements, the difference between the engines actual EPR and the EEC commanded EPR is displayed as the command sector on the EICAS EPR display.

The EICAS advisory message L or R ENGINE CONTROL displays when faults are detected in the engine control systems. This message is designed to prevent dispatch with these faults.

The dual channel system provides redundancy of inputs to the engine fuel control.

Alternate (N1) Control Mode

If the EEC is unable to maintain EPR control, the EEC will automatically revert to the alternate control mode. The alternate control mode may be manually selected by using the flight deck EEC switches. When operating in alternate control mode, the ALTN light illuminates and the EICAS advisory message L or R ENG EEC MODE displays to indicate the EEC has reverted to the alternate mode.

In the alternate control mode, target N1 for current thrust lever position is computed as a ratio to the full throttle position. Due to changes in thrust produced at constant N1 setting during changes in ambient conditions, alternate control mode operations during climbs and descents require thrust lever adjustment to maintain constant thrust. Thrust is controlled in a manner similar to conventional fuel controls.

The alternate control mode has a dual channel system providing redundancy of inputs to the engine fuel controls. Automatic thrust limit protection is not available. In the alternate mode, the EICAS caution message L or R ENG LIM PROT displays to indicate the commanded N1 exceeds the maximum N1.

Overspeed Protection

In either control mode the EEC also provides N1 and N2 red line overspeed protection. If N1 or N2 approaches overspeed, the EEC commands reduced fuel flow. The EICAS advisory message L or R ENG RPM LIM displays to indicate N1 or N2 is at the red line limit.

The EEC does not provide EGT overtemperature protection.

If engine limit protection is not available, advancing the thrust levers full forward should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent.

Idle Selection

There are two engine idle speeds: minimum idle and approach idle. Minimum idle is a lower thrust than approach idle and selected for ground operation and all phases of flight except approach and landing. Approach idle is selected whenever this higher idle setting is required for proper system operation. The EEC selects these idle speeds automatically.

Rotating the engine start selectors to continuous manually selects approach idle.

The EICAS advisory message L or R ENG LOW IDLE displays to indicate an engine failed to go to approach idle.

The EICAS advisory message IDLE DISAGREE displays to indicate the engines are at different idle settings. Either one engine has failed to go to approach idle when required or one engine has failed to return to minimum idle. Inflight, to ensure that approach idle is available if required, the thrust lever on the engine with the lower RPM should be advanced to match the engine with the higher RPM.

Engine Start and Ignition System

Air from the pneumatic duct is used to power the air driven starter, which is connected to the N2 rotor. The starter air source may be from a ground cart, APU or the other running engine.

The engine start selectors control the start valves. Ignition and fuel flow are controlled through the fuel control switches.

A maximum start limit line (red) is displayed on the EGT indication when the fuel control switch is moved to CUT OFF. It remains displayed after the fuel control switch is moved to RUN until the engine is stabilized at idle. The EGT indication changes color to red if the EGT start limit is reached during starting.

Engine Start

Pushing in and rotating the engine start selector to the GND position, opens the start valve, engages the air driven starter to the N2 rotor and closes the engine bleed air valve if it is open. The VALVE light illuminates and the EICAS advisory message L or R ENG STARTER displays to indicate the start valve failed to open.

As N2 rotation accelerates to maximum motoring RPM, the fuel control switch is positioned to RUN.

Maximum motoring speed is reached when acceleration is less than approximately 1% in 5 seconds. Minimum N2 for selecting RUN is indicated by a magenta fuel on command bug. The fuel control switch opens the spar and engine fuel valves allowing the fuel to flow to the fuel control unit and activates the selected ignition. The ignition selector may be used to select BOTH, or either 1 or 2 ignitor(s). Normally, only one ignitor is used for ground start while both ignitors are used for inflight starts. At approximately 50% N2, the engine start selector automatically moves to the AUTO position. The starter automatically cuts out and the start valve closes stopping the flow of air to the starter. This allows the engine bleed valve to return to a position that agrees with the engine bleed air switch. If the start valve fails to close automatically, the corresponding valve light will illuminate and the EICAS caution message L or R STARTER CUTOFF will display. The engine start selector must be manually moved to the AUTO or OFF position to terminate starter operation.

Starter Operation

Continuous operation of the starter must be limited in accordance with the following starter duty cycles:

Normal Duty Cycle

- Continuous for 5 minutes.
- Cool for 30 seconds per minute of operation.
- After 2 consecutive 5-minute cycles, cool the starter for 10 minutes prior to each subsequent starter duty cycle.

Re-engagement Speed

- 0% N2 Recommended.
- 0–20% N2 Normal.

Re-engagement is not recommended above 20% N2 except in case of fire.

Re-engagement above 30% N2 may result in starter or gearbox damages.

In-Flight Start

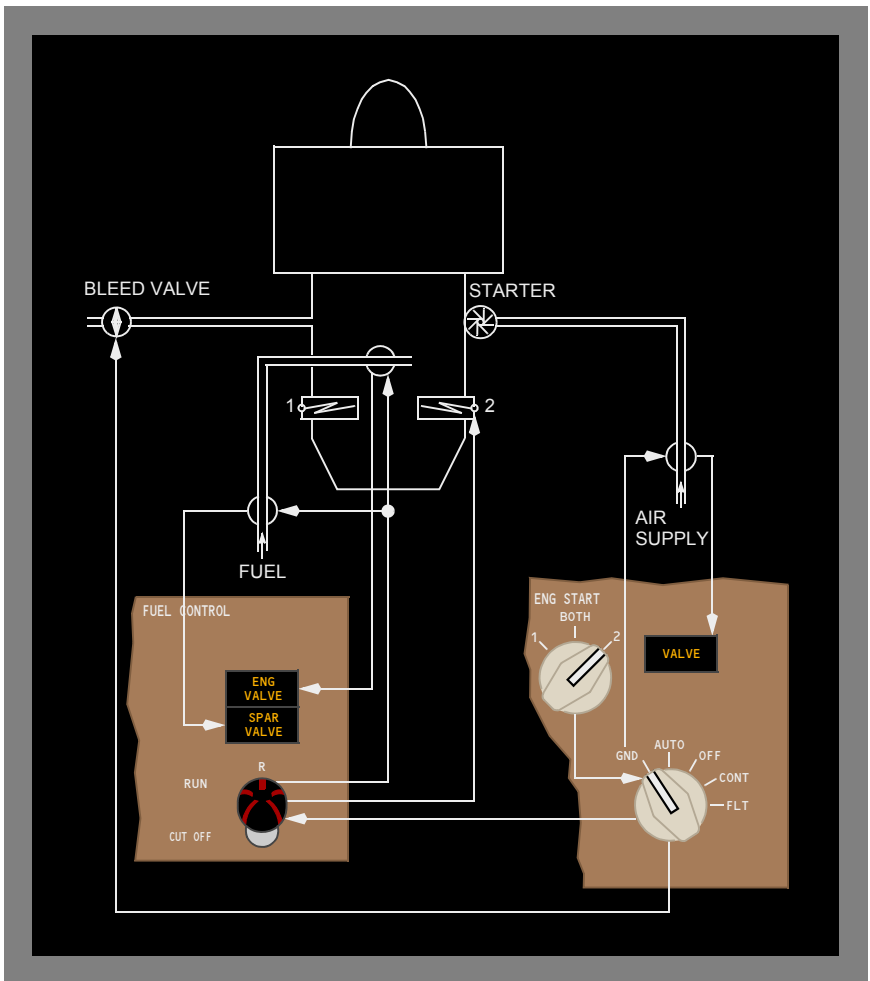
Inflight start envelope information is displayed on the EICAS primary display when an engine is not running in flight, the respective engine fire switch is not pulled and both EICAS primary and secondary displays are selected. The inflight start envelope indicates the airspeed range necessary to ensure an inflight start at the current flight level. If the current flight level is above the maximum start altitude, the maximum start altitude and respective airspeed range are displayed.

A crossbleed start indication (X-BLD) appears above the N2 indication and a fuel on command bug is displayed if airspeed is below that recommended for a windmilling start.

Engine Ignition

Each engine has two ignitors. Dual ignitors are always used for inflight starts. Main AC power is the normal power source for ignition. Standby AC power provides a backup source.

Engine Start and Ignition System Schematic



Engine Fuel System

Fuel is supplied by fuel pumps located in the fuel tanks. The fuel flows through a spar fuel valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added.

The fuel flows through a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants.

A second stage engine fuel pump adds more pressure before the fuel reaches the fuel control unit. The fuel is then controlled to meet the existing thrust requirements. The fuel then flows through the engine fuel valve and fuel flow meter before entering the engine.

Fuel Control Unit

The engine fuel control system incorporates a fuel control unit which operates in conjunction with the EEC. The fuel control system schedules fuel flow to meet engine thrust requirements as dictated by the thrust lever position and the specific engine operating conditions. The EEC controls the metered fuel and prevents engine limits from being exceeded.

Engine and Spar Valves

The spar and engine fuel valves allow fuel flow to the engine when both valves are open. The valves open when the engine fire switch is IN and the fuel control switch is in the RUN position. Both valves close when either the fuel control switch is in CUT OFF or the engine fire switch is OUT.

The ENG VALVE and SPAR VALVE lights illuminate momentarily as the valves open or close. If the valves do not agree with the fuel control switch or the respective fire switch position after allowing for the normal operating time, the lights remain illuminated and the EICAS advisory message L or R FUEL SPAR VAL or L or R ENG FUEL VAL displays.

Fuel Filter

The fuel is filtered by a filter with bypass capabilities. If the filter becomes clogged with contaminants, fuel will bypass the filter allowing contaminated fuel to enter the fuel control unit.

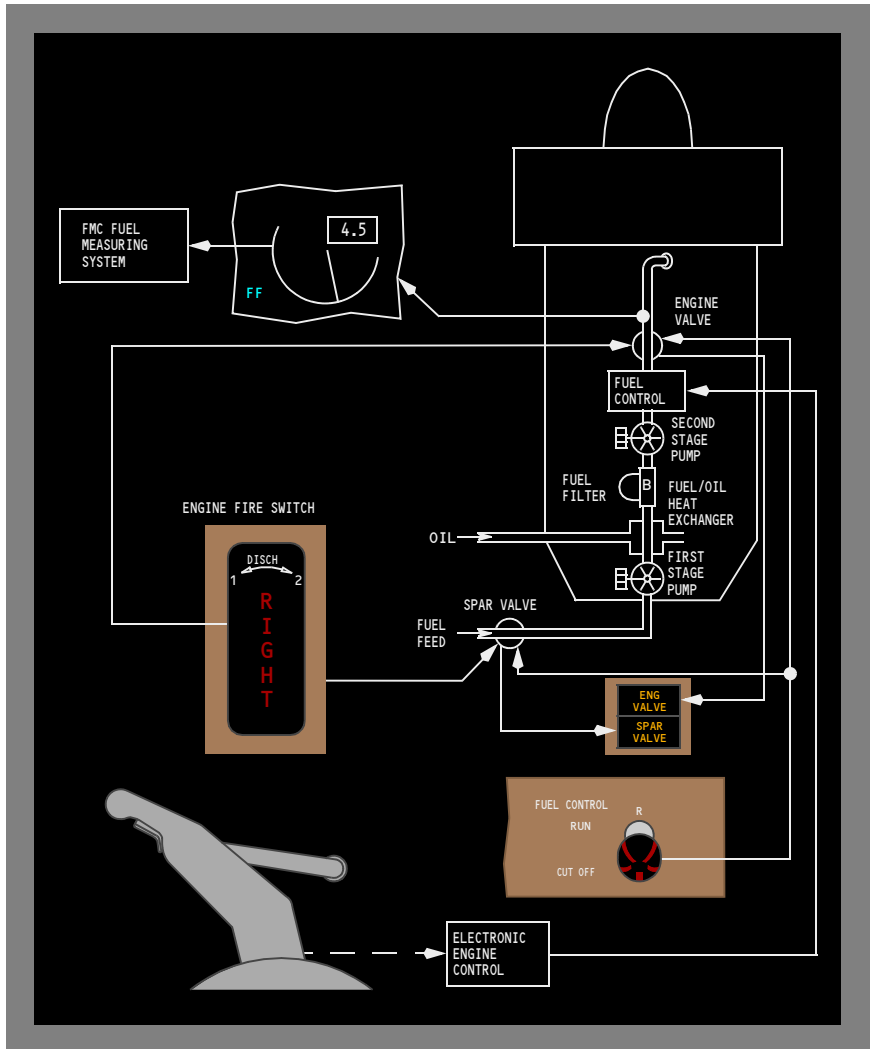
The EICAS advisory message L or R ENG FUEL FILT displays to indicate the affected engine filter is approaching a level sufficient to cause filter bypass.

Erratic engine operation and flameout may occur due to fuel contamination.

Fuel Flow Measurement

Fuel flow is measured after passing through the engine fuel valve. Fuel flow is displayed on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic



Engine Oil System – PW4000 Series Engine

The oil system provides pressurized oil to lubricate and cool the engine main bearings, gears and accessory drives. The oil system also provides automatic fuel heating for fuel system icing protection.

As an engine is started, a quantity of oil will transfer from the oil reservoir to the engine bearing compartments and gearbox. This results in a decrease of indicated oil quantity. During engine shutdown, the indicated oil quantity increases as the oil is returned to the reservoir. In addition, oil temperature will tend to vary with engine RPM such that, as RPM is increased, temperature increases. As RPM is decreased, temperature decreases.

Oil is pressurized by a main (engine-driven) oil pump. From the pump, the oil flows through the oil filter where contaminants are removed. Should the oil filter become saturated with contaminants, oil will automatically bypass the filter. The EICAS advisory message L or R OIL FILTER displays indicating the oil filter is bypassed. The oil flows through the oil coolers where fuel and air are used as the heat sink, and is then delivered to the engine main bearings, gears, and accessory drives. The oil is then returned to the reservoir.

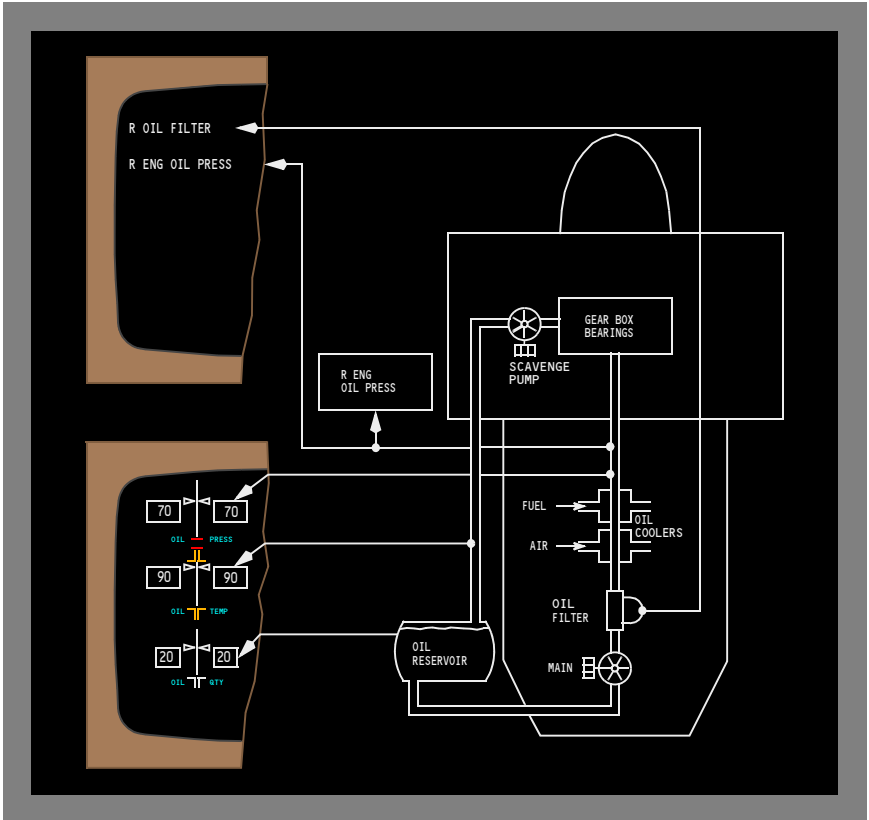
Oil pressure, temperature, and quantity are displayed on the secondary engine display.

Oil pressure is measured prior to entering the engine. The L or R ENG OIL PRESS light illuminates and the L or R ENG OIL PRESS EICAS advisory message displays to indicate the oil pressure is low. When the oil pressure is at or below the minimum limit, the EICAS indication changes to red.

Oil temperature is measured after leaving the scavenge pump, prior to entering the reservoir. When the oil temperature is in the caution range, the EICAS indication changes to amber.

There is no minimum oil quantity limit (no amber or red line limit). There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based solely on a response to low oil quantity.

Engine Oil System Schematic – PW4000 Series Engine



Thrust Reverser System

Each engine has a hydraulically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

The reverse thrust levers can be raised only when the forward thrust levers are in the idle position. An interlock stop limits thrust to idle reverse while the reverser is in transit.

The EECs control thrust limits during reverser operation.

When the reverse thrust levers are pulled aft to the interlock position:

- the autothrottle disengages
- the auto speedbrakes deploy.

When the reverser system is activated:

- reverser isolation valve opens allowing the reverser translating sleeves to hydraulically move aft
- the fan flow blocker doors rotate into place to direct fan air through stationary cascade guide vanes
- the reverser indication (REV) is displayed above each digital EPR indication (REV is displayed in amber when the reverser is in transit).

When the interlock releases:

- the reverse thrust levers can be raised to the maximum reverse thrust position
- the REV indication changes to green when the reverser is fully deployed.

Pushing the reverse thrust levers to the full down position retracts the reversers to the stowed and locked position. While the reverser is in transit, the REV annunciation changes color to amber. The thrust levers cannot be moved forward until the reverse thrust levers are fully down. When the reverser reaches the stowed position, the amber REV annunciation disappears.

Each thrust reverser is automatically protected against unintentional reverse thrust. If an uncommanded thrust reverser movement is sensed, an autostow feature automatically applies hydraulic power to stow the reverser.

The EICAS advisory message L or R REV ISLN VAL is displayed and the REV ISLN light illuminates when a fault exists in the reverser system.

183-184

If the REV ISLN light illuminates in flight, additional system failures may cause inflight deployment. The affected reverser should deploy normally after landing but may not stow when commanded.

171-182, 185-199, 1200-121, 1400-1404

The light and message are inhibited in flight.

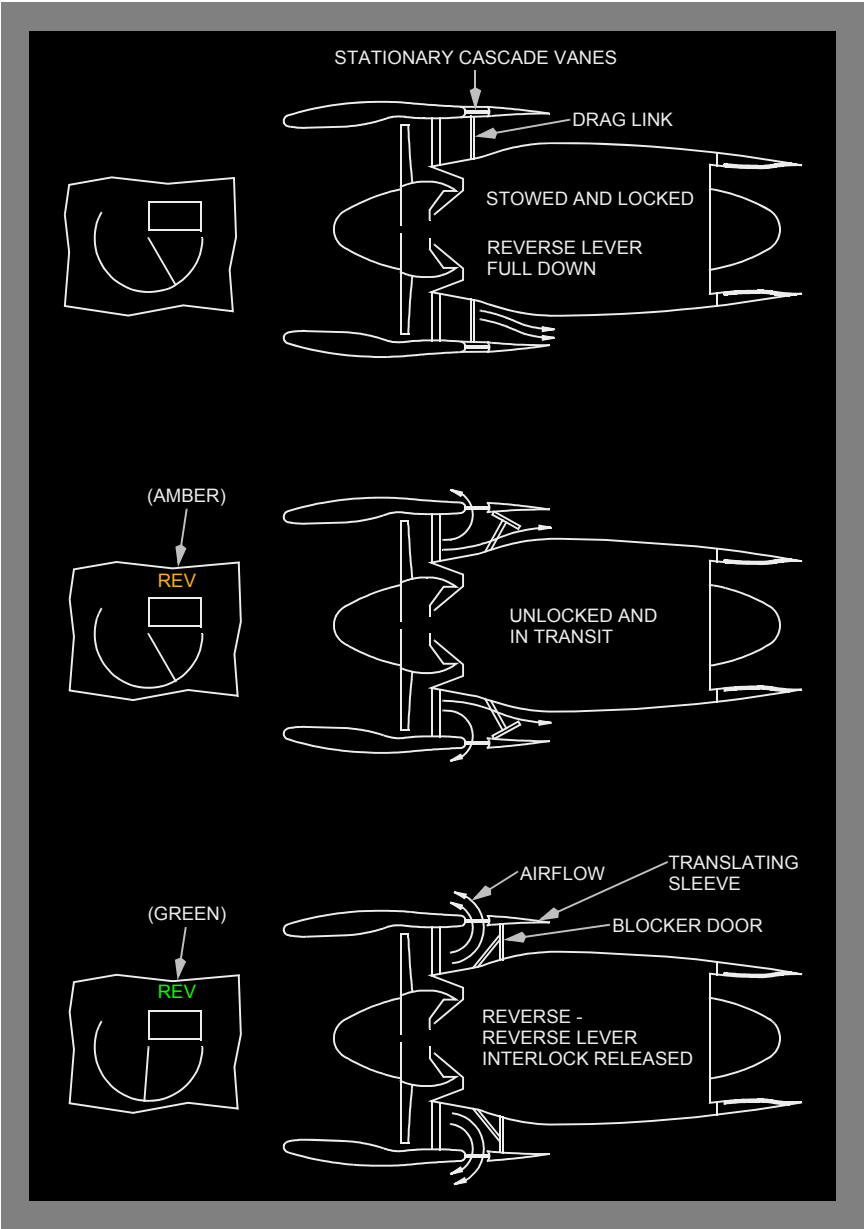
171-182, 185-199, 1200-121, 1400-1404

An electromechanical lock prevents uncommanded reverser deployment in the event of thrust reverser system failures.

183-184

The thrust reverser system maintenance panel light illuminates when a fault has been detected in the thrust reverser system. During ground operations, maintenance action is required prior to dispatch.

Thrust Reverser Schematic



Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications are displayed on the secondary engine display. The vibration source indication is also displayed. If the vibration monitoring system cannot determine the source (N1 or N2), broadband (BB) is displayed for the affected engine. Broadband vibration is the average vibration detected.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

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Engines, APU**Chapter 7****Engine System Description (GE)****Section 22**

This section applies to ships 121-139, 1501-1506, 1521, 1601-1613, 1701-1708

Introduction**121-139**

The airplane is powered by two General Electric CF6-80A2 engines. The engines are rated at 49,200 pounds of takeoff thrust each.

1501-1506

The airplane is powered by two General Electric CF6-80C2B6 engines. The engines are rated at 60,200 pounds of takeoff thrust each.

1521, 1601-1708

The airplane is powered by two General Electric CF6-80C2B6F engines. The engines are rated at 60,200 pounds of takeoff thrust each.

The engines are two-rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of the fan, a low pressure compressor and turbine section on a common shaft. The N2 rotor consists of a high pressure compressor and turbine section on a common shaft. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine accessory gearbox.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. See Chapter 11, Flight Management, Navigation, Section 40, for a description of FMC thrust management functions.

Each engine is controlled by an electronic engine controller (EEC). The EECs monitor autothrottle and flight crew inputs through the thrust levers to automatically control the engines.

Engine indications are displayed on the engine indication and crew alerting system (EICAS) display.

Engine Indications

Primary and secondary engine indications are provided. Engine indications are displayed on the EICAS display. In addition, annunciator lights and a liquid crystal standby engine indicator are provided to monitor engine operation.

Primary Engine Indications

N1 and EGT are the primary engine indications. The primary engine indications are always displayed on the upper EICAS display.

Secondary Engine Indications

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are secondary engine indications. Secondary engine indications are displayed on the lower EICAS display. The secondary engine indications can be displayed by pushing the Engine Display Switch (the ENGINE switch on the EICAS Control Panel).

The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power, or
- a secondary engine parameter is exceeded.

Normal Display Format

Primary engine indications and the N2 and Fuel Flow indications are 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, oil quantity and vibration indications are both digital readouts and vertical indication/moving pointers. All digital readouts are enclosed by boxes. The dial and vertical indications display the normal operating range, caution range, and operating limits (as applicable).

Normal operating range is displayed on a dial or vertical indication in white.

The oil pressure and oil temperature vertical indications have caution ranges displayed by amber bands. If oil pressure or oil temperature reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber.

N1, EGT, N2, oil pressure, and oil temperature indications have operating limits indicated by red lines. If one of these indications reaches the red line, the digital readout, box, and pointer change color to red for that indication.

The EGT indication has a maximum continuous limit represented by an amber band. If EGT reaches the maximum continuous limit, the digital indication, box, pointer, and dial all change color to amber.

121-139

The EGT indication is inhibited from changing to amber during takeoff or go-around for five minutes. The red line limits for these parameters are not inhibited.

1501-1506, 1521, 1601-1613, 1701-1708

The EGT indication is inhibited from changing to amber during takeoff or go-around for five minutes. The inhibit is extended to ten minutes for single-engine operation. The red line limits for these parameters are not inhibited.

The EGT indication has a maximum takeoff limit displayed by a red line. If EGT reaches the maximum takeoff limit, the digital indication, box, pointer and dial, all change color to red.

The maximum N1 limit is indicated by an amber line on the N1 dial. The N1 indication does not change color when maximum N1 is reached. The reference/target N1 indication displays the FMS reference or target N1.

Compact Display Format

In compact format, primary and secondary engine indications are combined on the same display. The N1 and EGT displays are the same as the normal displays. All other indications change to digital readouts only. If an amber or red line parameter for a digital indication is exceeded, the digital indication changes color to amber or red (as does the box that appears around an EGT indication).

Primary and secondary engine indications are displayed on EICAS in compact format whenever a CRT fails.

Engine Secondary Data Cue

A series of blue 'v's are visible on the lower left corner of the upper EICAS CRT any time engine data is displayed on the lower EICAS CRT. If for some reason the engine data is not visible, the Status Display Switch may be used to allow the engine data to come up partially compacted on the upper EICAS CRT display.

N1 RPM

N1 RPM is the primary thrust parameter. Annunciations associated with N1 are:

- Maximum N1
- Thrust Reference Mode
- Reference/Target N1 Indication
- Reference N1
- Assumed Temperature
- Thrust Reverser Indication
- Command Thrust Level
- Command Sector.

The maximum N1 is the maximum certified thrust limit for all phases of flight and varies with existing ambient conditions. The maximum N1 is indicated by dual amber radials on the periphery of the N1 indicator. This value is acquired from the EEC or the TMC. With the EEC operating normally, the thrust levers can be moved to the forward stop and the engines will not exceed the displayed maximum N1.

The command thrust level is a display of thrust lever position and appears as an extension of the N1 pointer when the engine is stabilized. A change in thrust lever position moves the command thrust level and displays the commanded thrust on the N1 indicator. This allows for precise thrust control.

The command sector is a display of the momentary difference between the command thrust level and actual N1 and appears as a white band on the N1 indicator. As the engine accelerates or decelerates to the command thrust level the command sector is erased. This allows for monitoring of engine acceleration and deceleration.

Thrust reverser indication (REV) is displayed above the N1 indicator when the reverser is activated. The annunciation is amber when the reverser is unlocked or in transit. When the reverser is fully deployed, the annunciation changes color to green and the forward thrust reference displays are inhibited.

Thrust Management Computer (TMC)

The thrust management computer calculates a reference N1 based on existing pressure altitude and ambient temperature data from the air data system for the following modes:

- TO – takeoff
- 121-139**
- TO 1 – takeoff one
- 121-139**
- TO 2 – takeoff two
- D-TO – assumed temperature takeoff
- CLB – climb
- CLB 1 – climb one
- CLB 2 – climb two
- CRZ – cruise
- CON – continuous
- GA – go-around.

These modes can be selected with the thrust mode select panel (TMSP). The inner thrust reference set control on the EICAS control panel must be pushed in for the thrust reference modes to be displayed on EICAS. The selected thrust reference mode is displayed above the N1 indicators. The digital reference N1 is displayed adjacent to the mode display. When the N1 bug is green, it is positioned on the N1 scale at the same value as the digital reference N1.

The thrust mode select switches provide the capability of selecting different thrust modes for each phase of flight. The TO/GA switch is used to select takeoff thrust on the ground and go-around thrust inflight.

121-139

The 1 and 2 switches are used to select a reduced takeoff thrust rating or reduced climb thrust. When reduced takeoff thrust rating one or two is selected, this automatically preselects the associated reduced climb one or two. The CLB switch is used to select climb thrust inflight. If reduced climb thrust one or two was preselected, pushing the climb switch inflight selects CLB 1 or CLB 2.

The assumed temperature for a reduced thrust takeoff can be set by:

- using the assumed temperature selector on the TMSP
- entering the assumed temperature into the CDU TAKEOFF REF page

121-139, 1603-1613, 1705-1708

- datalink

1601-1613, 1701-1708

The 1 and 2 switches are used to select reduced climb thrust. Reduced climb thrust one or two can be preselected in conjunction with takeoff or assumed temperature takeoff thrust prior to takeoff. The CLB switch is used to select climb thrust inflight. If reduced climb thrust one or two was preselected, pushing the climb switch inflight selects CLB 1 or CLB 2.

The CON switch is used to select maximum continuous thrust inflight. The CRZ switch is used to select cruise thrust inflight. The assumed temperature selector or the CDU is used to set assumed temperatures when reduced takeoff thrust is desired.

To manually set Reference N1 values the thrust reference set control is pulled out, MAN appears as the thrust mode annunciation and the N1 bug slews to 104%. Manual reference N1 values can then be set by rotating the inner control. The outer control of the thrust reference set control is used to select the desired N1 indicator(s) for manual N1 display. The autothrottles do not respond to manually set reference N1 values. When the inner control is pulled out, the autothrottles remain in the active TMC mode. The TMSP remains operable and the autothrottles respond to TMSP mode changes, but selected thrust reference mode displays are inhibited.

When the AFDS VNAV mode is engaged, the N1 bug may be magenta. When the N1 bug is magenta, it is positioned at a nominal target N1 by the FMC, which may not correlate with the digital reference N1. In VNAV, the FMC controls Thrust mode selection automatically to meet thrust requirements for the active vertical mode of operation. The FMC does not have the capability to select reduced climb thrust values, these values must be selected manually with the 1 or 2 TMSP switches.

The thrust reference mode, reference N1 and N1 bug are not displayed when the reversers are fully deployed.

Reduced Takeoff Thrust

121-139

Two levels of reduced takeoff thrust are available with the 1 and 2 mode switches on the Thrust Mode Select Panel. These are lower thrust ratings than takeoff thrust. Takeoff 1 is approximately 95% of takeoff thrust and takeoff 2 is approximately 85% of takeoff thrust. Assumed temperature reduced thrust can be used in conjunction with these lower thrust ratings.

Assumed Temperature Takeoff

The thrust management computer calculates the reference N1 for assumed temperature reduced thrust takeoff. The assumed temperature can be entered manually on the FMC CDU TAKEOFF REF page or selected with the assumed temperature selector on the TMSP. The assumed temperature is displayed above the thrust reference mode.

1501-1506, 1521, 1601-1602, 1701-1704

When the assumed temperature selector on the TMSP is initially rotated clockwise, a reference temperature is displayed on EICAS. This temperature also appears on the MCDU TAKEOFF REF page as TEMP SEL.

121-139, 1603-1613, 1705-1708

When the assumed temperature selector on the TMSP is initially rotated clockwise, a reference temperature is displayed on EICAS. This temperature also appears on the MCDU TAKEOFF REF page as THRUST.

The assumed temperature may be supplied to the FMC and MCDU via datalink. Further clockwise rotation of the selector increases the assumed temperature by 1 degree centigrade per click. The reduced thrust annunciation of D-TO appears when the assumed temperature selected is above ambient. If the ambient temperature is greater than the initially displayed reference temperature, D-TO and reduced thrust occur when the assumed temperature selected exceeds ambient.

Counterclockwise rotation of the selector reduces the assumed temperature by one degree centigrade per click.

Assumed temperature takeoff thrust is limited to a 25% reduction of takeoff thrust or selected climb thrust, whichever is the greater thrust value. When the limit is reached, further adjustment to the assumed temperature by rotating the assumed temperature selector on the TMSP or changing the value entered in the CDU TAKEOFF REF page does not change the displayed assumed temperature or reference thrust value.

Reduced Climb Thrust

121-139

Climb one or two is automatically preselected when takeoff one or takeoff two is selected.

121-139

Two levels of reduced climb thrust are available with the 1 and 2 mode switches on the thrust mode select panel. Climb 1 is approximately 95% of climb thrust and climb 2 is approximately 85% of climb thrust. Climb one or two can be preselected in conjunction with the TO, D-TO, CON and CRZ thrust reference modes.

1501-1506, 1521, 1601-1708

Two levels of reduced climb thrust are available with the 1 and 2 mode switches on the thrust mode select panel. Climb 1 is approximately 90% of climb thrust and climb 2 is approximately 80% of climb thrust. Climb one or two can be preselected in conjunction with the TO, D-TO, CON and CRZ thrust reference modes.

Above 10,000 feet, reduced climb thrust gradually changes to reach full climb thrust by 30,000 feet. The 1 or 2 annunciation disappears from the display by 30,000 feet.

Electronic Engine Control (EEC)

121-139, 1501-1506

The thrust system consists of a hydromechanical engine fuel control with an EEC unit. The EEC sets thrust by controlling N1 based on thrust lever position. N1 is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew. Both engines may be operated by conventional hydromechanical control by disengaging the EECs. Each engine EEC is powered by dual dedicated generators.

The EEC continuously computes the maximum limits for thrust. Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions. Maximum N1 represents the maximum rated thrust available from the engine. These values are displayed by the position of the amber radial on the N1 display. If the EEC fails or is turned off, these values are computed by the thrust management computer (TMC) and displayed in the same manner. If the TMC fails, the maximum limits are blank.

During normal EEC operation, each EEC provides a trim input to its associated hydromechanical fuel controller to drive the engine to an EEC computed command thrust level. The EEC computes this N1 as a percentage of its maximum limit computation. The percentage is varied with thrust lever position, such that at full throttle, the percentage is 100%. During rapid throttle lever movements, the difference between the engines actual N1 and the EECs commanded N1 is displayed as the command sector on the EICAS N1 display. The engine is controlled by its hydromechanical fuel controls at low power operating conditions.

The EEC INOP light illuminates and the EICAS advisory message L or R EEC OFF displays to indicate the EEC is turned off or a failure is detected in the system. When a failure is detected the EEC trim motor will hold the current trim level until the unit is turned off. When the EEC is turned off and the thrust lever is positioned full forward, a L or R EEC OFF caution message is displayed.

The thrust lever should be retarded to a mid position before turning the EEC off to prevent a possible engine overboost.

Electronic Engine Control (EEC)

1521, 1601-1708

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to automatically control forward thrust and reverse thrust. The EEC has two control modes: normal and alternate. In normal and alternate modes, the EEC uses N1 RPM as the parameter for setting thrust.

EEC Normal Control Mode

In the normal mode, the EEC sets thrust by controlling N1 based on thrust lever position. N1 is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew.

Maximum N1 represents the maximum rated thrust available from the engine. The EEC continuously computes maximum N1.

Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions.

The EICAS advisory message L or R ENG CONTROL and ENGINE CONTROLS displays when faults are detected in the engine control systems.

EEC Alternate Mode

The EEC uses alternate mode as a backup to normal mode. If EEC detects a fault and can no longer control the engine using the normal mode, it transfers control to alternate mode. The L or R ENG EEC MODE advisory message will appear and the ALTN light illuminate. Alternate mode can also be selected manually using the EEC mode switch. If control for either EEC transfers from normal to alternate, the autothrottle disconnects. The autothrottle can be activated after all EECs are manually transferred to alternate mode.

Alternate mode does not provide thrust limiting at maximum N1. Maximum N1 is reached at a thrust lever position less than full forward. The L or R ENG LIM PROT message will appear as the throttle is advanced into the overboost range in this mode. Thrust levers must be adjusted to maintain desired thrust as environmental conditions and bleed requirements change.

The L or R ENG CONTROL or the ENGINE CONTROLS advisory message means that engine control may be unreliable, and the L or R ENG RPM LIM will appear whenever N1 or N2 is at red line limit. Alternate mode provides equal or greater thrust than normal mode for the same thrust lever position. Thrust does not change when EEC transfers control from normal mode to alternate mode. Thrust increases when alternate mode is selected manually. When thrust is greater than idle, the thrust lever should be moved aft prior to manually selecting alternate mode so thrust does not exceed maximum N1.

If the EECs are in the alternate mode, advancing the thrust levers full forward provides some overboost and should be considered only during emergency situations when all other actions have been taken and terrain contact is imminent.

Overspeed Protection

The EEC also provides N1 and N2 red line overspeed protection. If N1 or N2 approaches overspeed, the EEC commands reduced fuel flow.

1521, 1601-1613, 1701-1708

The EICAS advisory message L or R ENG RPM LIM is displayed when N1 or N2 is at the red line limit.

The EEC does not provide EGT overtemperature protection.

If engine limit protection is not available, advancing the thrust levers full forward should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent.

Idle Selection

There are two engine idle speeds: minimum idle and approach idle. Minimum idle is a lower thrust than approach idle and selected for ground operation and all phases of flight except approach and landing. Approach idle is selected whenever this higher idle setting is required for proper system operation. The EEC selects these idle speeds automatically.

1521, 1601-1613, 1701-1708

Rotating the engine start selectors to continuous manually selects approach idle.

1521, 1601-1708

The EICAS advisory message L or R ENG LOW IDLE displays to indicate an engine failed to go to approach idle.

1521, 1601-1613, 1701-1708

The EICAS advisory message IDLE DISAGREE displays to indicate the engines are at different idle settings. Either one engine has failed to go to approach idle when required or one engine has failed to return to minimum idle. Inflight, to ensure that approach idle is available if required, the thrust lever on the engine with the lower RPM should be advanced to match the engine with the higher RPM.

121-139, 1501-1506

The EICAS advisory message IDLE DISAGREE displays to indicate the engines are at different idle settings. One engine has failed to return to minimum idle.

Engine Start and Ignition System

Air from the pneumatic duct is used to power the air driven starter, which is connected to the N2 rotor. The starter air source may be from a ground cart, APU or the other running engine.

The engine start selectors control the start valves. Ignition and fuel flow are controlled through the fuel control switches.

A maximum start limit line (red) is displayed on the EGT indication when the fuel control switch is moved to CUT OFF. It remains displayed after the fuel control switch is moved to RUN until the engine is stabilized at idle. The EGT indication changes color to red if the EGT start limit is reached during starting.

Engine Start

Pushing in and rotating the engine start selector to the GND position, opens the start valve, engages the air driven starter to the N2 rotor and closes the engine bleed air valve if it is open. The VALVE light illuminates and the EICAS advisory message L or R ENG STARTER displays to indicate the start valve failed to open. As N2 rotation accelerates to maximum motoring RPM or 20% N2, the fuel control switch is positioned to RUN. Maximum motoring speed is reached when acceleration is less than approximately 1% in 5 seconds. Minimum N2 for selecting RUN is indicated by a magenta fuel on command bug. The fuel control switch opens the spar and engine fuel valves allowing the fuel to flow to the fuel control unit and activates the selected ignition.

121-139, 1501-1506

The ignition selector may be used to select BOTH, or either 1 or 2 ignitor(s).

1521, 1601-1613, 1701-1708

The ignition selector may be used to select SINGLE or BOTH ignitor(s). With the ignition selector in SINGLE, each EEC channel alternates between the two ignitors on each engine.

Normally, only one ignitor is used for ground start while both ignitors are used for inflight starts. At approximately 50% N2, the engine start selector automatically moves to the AUTO position. The starter automatically cuts out and the start valve closes stopping the flow of air to the starter. This allows the engine bleed valve to return to a position that agrees with the engine bleed air switch. If the start valve fails to close automatically, the corresponding valve light will illuminate and the EICAS caution message L or R STARTER CUTOFF will display. The engine start selector must be manually moved to the AUTO or OFF position to terminate starter operation.

Starter Operation

Continuous operation of the starter must be limited in accordance with the following starter duty cycles:

Normal Duty Cycle

- Continuous for 5 minutes.
- Cool for 30 seconds per minute of operation.
- After 2 consecutive 5-minute cycles, cool the starter for 10 minutes prior to each subsequent starter duty cycle.

Re-engagement Speed

- 0% N2 - recommended.
- 0–20% N2 - normal.

Re-engagement not recommended above 20% except in case of fire.

Re-engagement above 30% N2 may result in starter or gearbox damage.

In-Flight Start

Inflight start envelope information is displayed on the EICAS primary display when an engine is not running in flight, the respective engine fire switch is not pulled and both EICAS primary and secondary displays are selected. The inflight start envelope indicates the airspeed range necessary to ensure an inflight start at the current flight level. If the current flight level is above the maximum start altitude, the maximum start altitude and respective airspeed range are displayed.

A crossbleed start indication (X-BLD) appears above the N2 indication and a fuel on command bug is displayed if airspeed is below that recommended for a windmilling start.

Auto Relight

1521, 1601-1613, 1701-1708

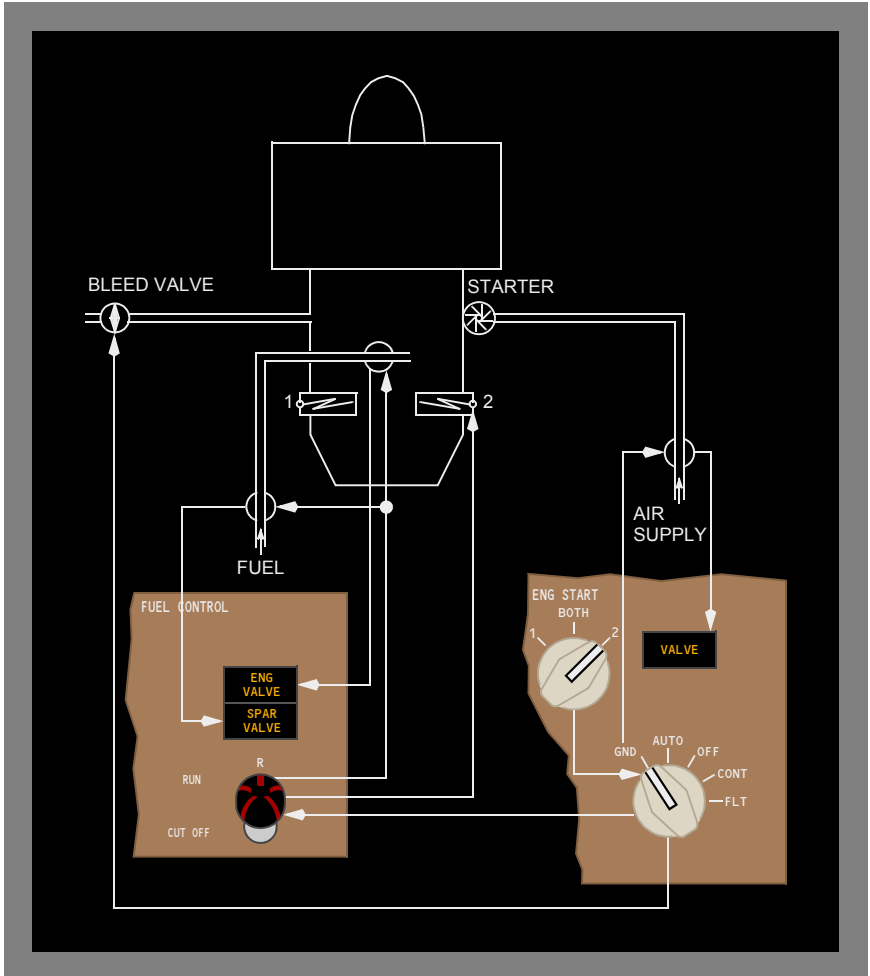
In the air or on the ground, an automatic relight feature is enabled if N2 drops below idle speed. If this occurs, the EEC will energize both ignition systems for the affected engine(s).

Engine Ignition

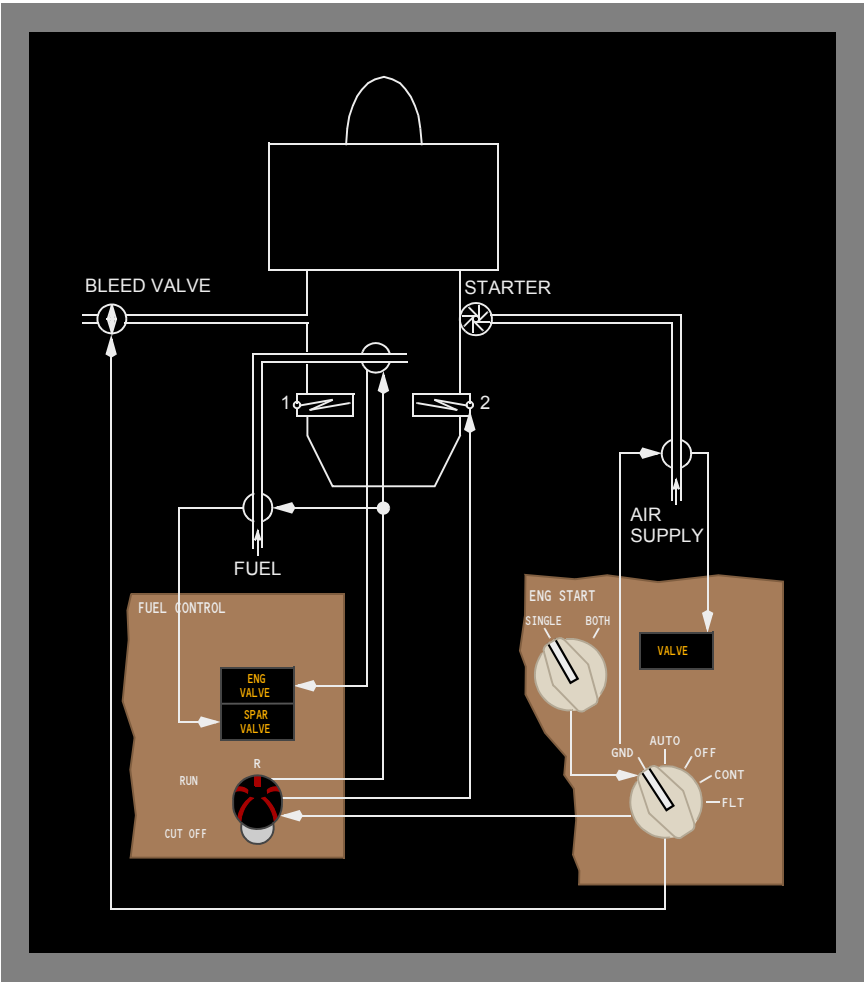
Each engine has two ignitors. Dual ignitors are always used for inflight starts. Main AC power is the normal power source for ignition. Standby AC power provides a backup source.

Engine Start and Ignition System Schematic

121-139, 1501-1506



1521, 1601-1613, 1701-1708



Engine Fuel System

Fuel is supplied by fuel pumps located in the fuel tanks. The fuel flows through a spar fuel valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added. Final pressure is generated by a second stage fuel pump prior to entering a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants. The fuel is then controlled to meet the existing thrust requirements. The fuel then flows through the engine fuel valve and fuel flow meter before entering the engine.

Fuel Control Unit

121-139, 1501-1506

The engine fuel control system incorporates a fuel control unit which operates in conjunction with the EEC. The fuel control system schedules fuel flow to meet engine thrust requirements as dictated by the thrust lever position and the specific engine operating conditions. The EEC controls the metered fuel and prevents engine limits from being exceeded.

Fuel Control Unit

1521, 1601-1613, 1701-1708

The engine fuel control system incorporates a fuel control unit which operates in conjunction with the EEC. The fuel control system schedules fuel flow to meet engine thrust requirements as dictated by the thrust lever position and the specific engine operating conditions. The EEC controls the metered fuel and prevents engine limits from being exceeded.

Engine and Spar Valves

The spar and engine fuel valves allow fuel flow to the engine when both valves are open. The valves open when the engine fire switch is IN and the fuel control switch is in the RUN position. Both valves close when either the fuel control switch is in CUT OFF or the engine fire switch is OUT.

The ENG VALVE and SPAR VALVE lights illuminate momentarily as the valves open or close. If the valves do not agree with the fuel control switch or the respective fire switch position after allowing for the normal operating time, the lights remain illuminated and the EICAS advisory message L or R FUEL SPAR VAL or L or R ENG FUEL VAL displays.

Fuel Filter

The fuel is filtered by a filter with bypass capabilities. If the filter becomes clogged with contaminants, fuel will bypass the filter allowing contaminated fuel to enter the fuel control unit.

The EICAS advisory message L or R ENG FUEL FILT displays to indicate the affected engine filter is approaching a level sufficient to cause filter bypass.

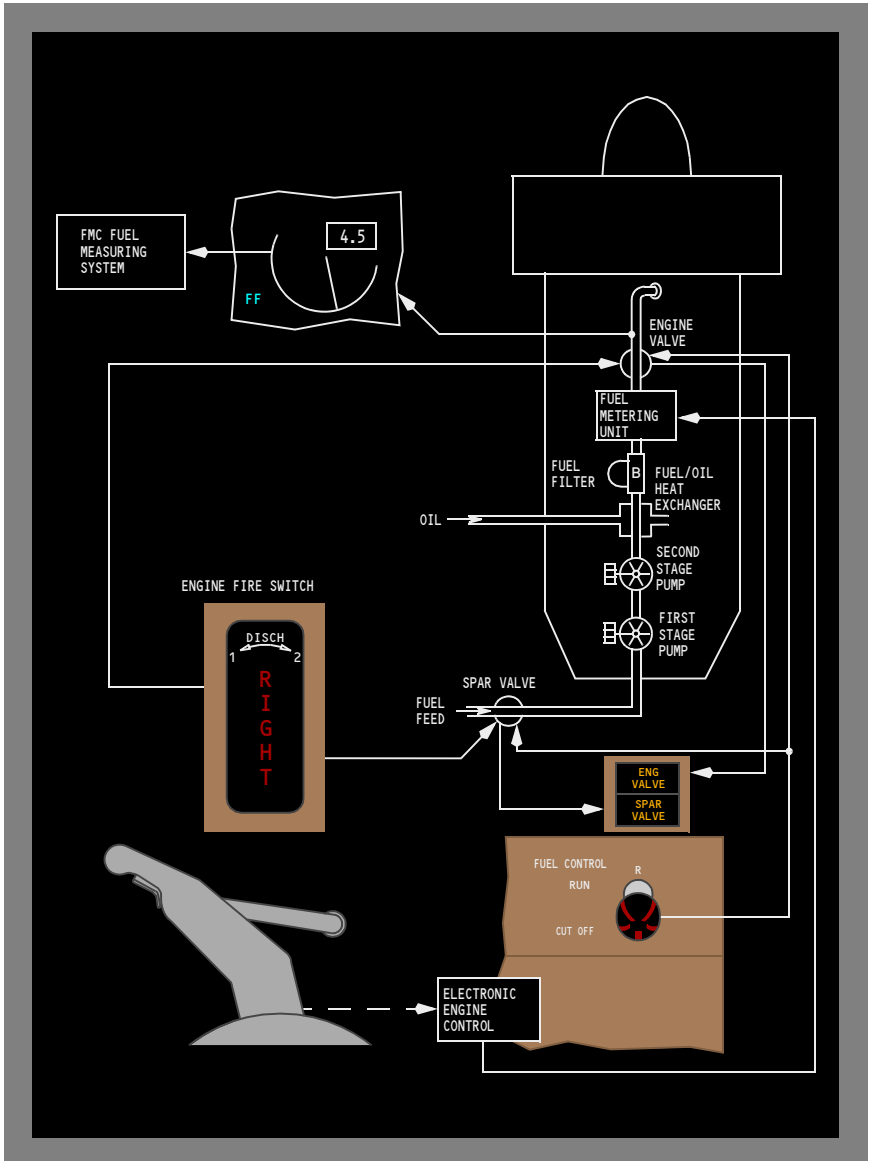
Erratic engine operation and flameout may occur due to fuel contamination.

Fuel Flow Measurement

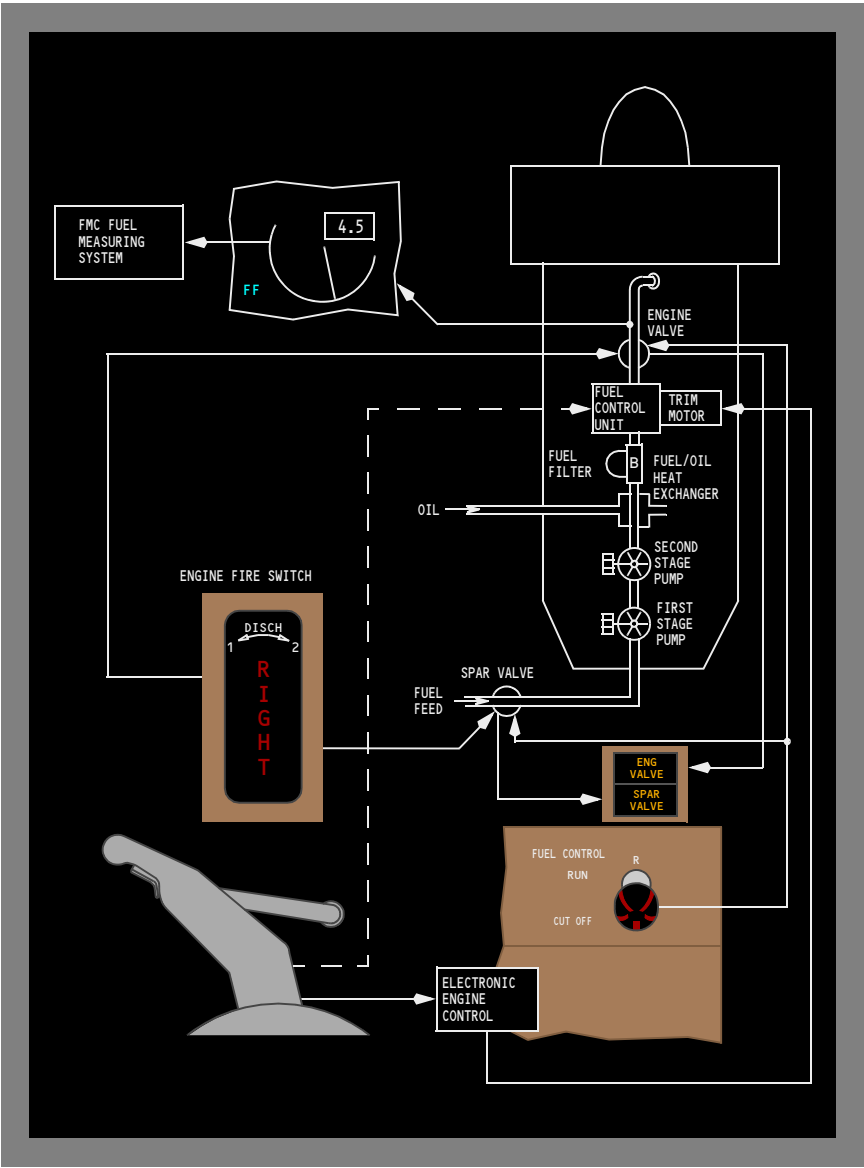
Fuel flow is measured after passing through the engine fuel valve. Fuel flow is displayed on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic

1521, 1601-1613, 1701-1708



121-139, 1501-1506



Engine Oil System

The oil system provides pressurized oil to lubricate and cool the engine main bearings, gears and accessory drives. The oil system also provides automatic fuel heating for fuel system icing protection.

Oil is pressurized by a main (engine-driven) oil pump. From the pump, the oil flows through the oil filter where contaminants are removed and then delivered to the engine main bearings, gears, and accessory drives. The oil is returned by means of a scavenge pump.

121-139

The oil enters a second filter then flows through the fuel/oil heat exchanger where fuel is used as the heat sink before returning to the reservoir.

1501-1506, 1521, 1601-1613, 1701-1708

The oil enters the fuel/oil heat exchanger where fuel is used as the heat sink and then flows through a second filter before returning to the reservoir.

Should an oil filter become saturated with contaminants, oil will automatically bypass the filter. The EICAS advisory message L or R OIL FILTER displays indicating the oil filter is bypassed.

Oil pressure, temperature, and quantity are displayed on the secondary engine display.

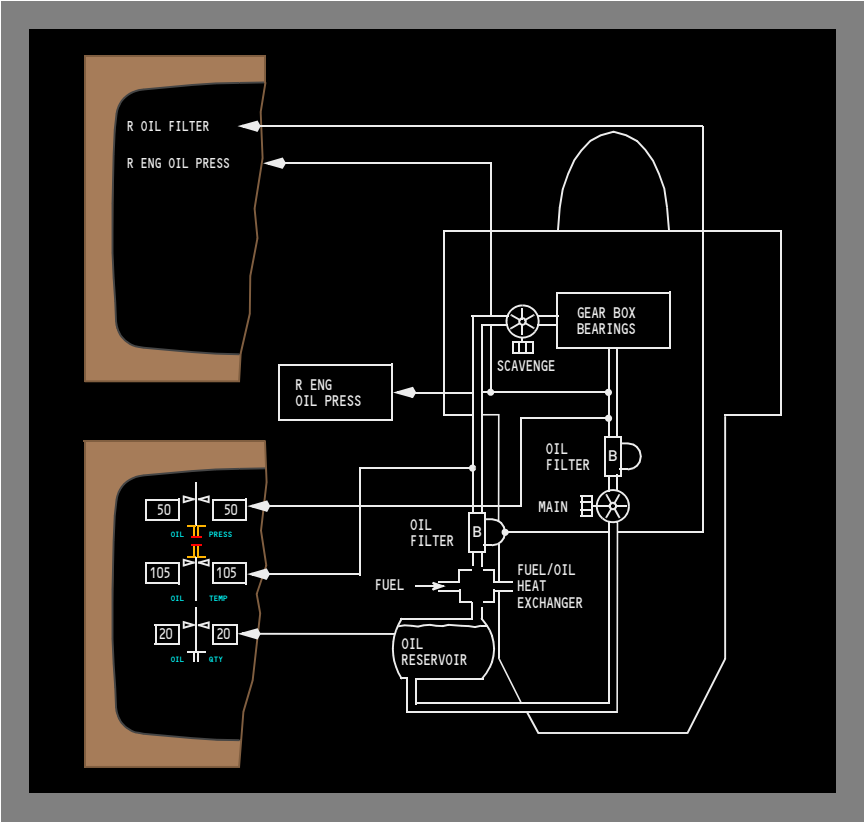
Oil pressure is measured prior to entering the engine. The L or R ENG OIL PRESS light illuminates and the EICAS advisory message L or R ENG OIL PRESS displays to indicate the oil pressure is low. When the oil pressure is at or below the variable limits, the EICAS indication changes to amber.

Oil temperature is measured after leaving the scavenge pump, prior to entering the second filter.

There is no minimum oil quantity limit (no amber or red line limit). There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based solely on a response to low oil quantity.

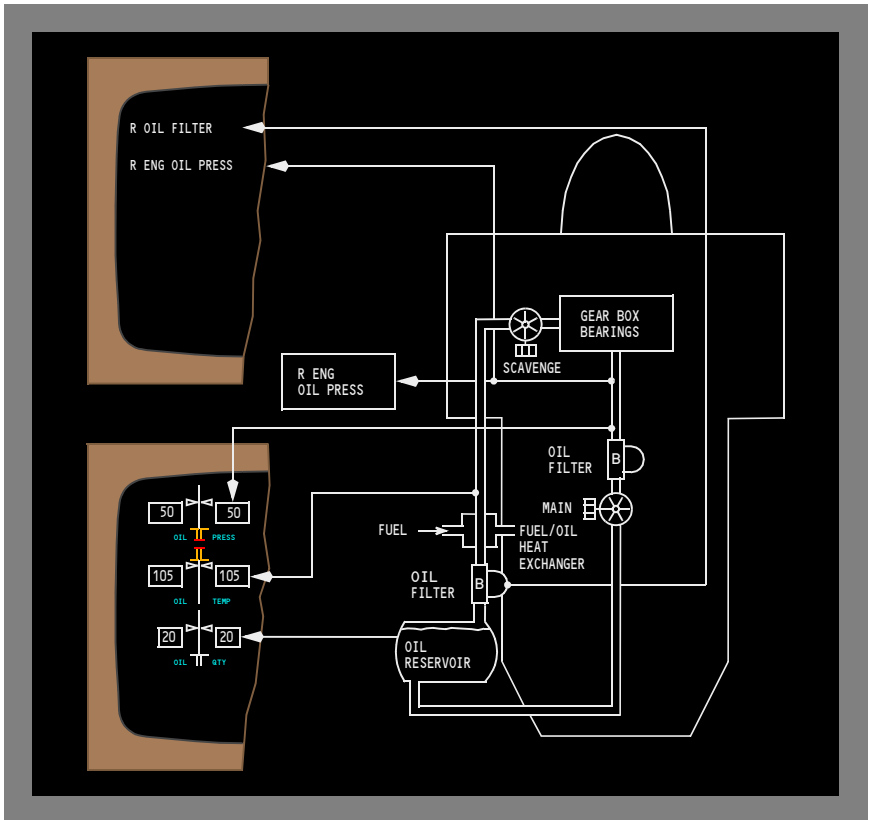
Engine Oil System Schematic

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Thrust Reverser System

121-139

Each engine has a hydraulically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

1501-1506, 1521, 1601-1613, 1701-1708

Each engine has a pneumatically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

The reverse thrust levers can be raised only when the forward thrust levers are in the idle position. An interlock stop limits thrust to idle reverse while the reverser is in transit.

The EECs control thrust limits during reverser operation.

When the reverse thrust levers are pulled aft to the interlock position:

- the autothrottle disengages
- the auto speedbrakes deploy.

When the reverser system is activated:

121-139

- reverser isolation valve opens allowing the reverser translating sleeves to hydraulically move aft

1501-1506, 1521, 1601-1613, 1701-1708

- reverser isolation valve opens allowing the reverser translating sleeves to pneumatically move aft
- the fan flow blocker doors rotate into place to direct fan air through stationary cascade guide vanes
- the reverser indication (REV) is displayed above each digital N1 indication (REV is displayed in amber when the reverser is in transit).

When the interlock releases:

- the reverse thrust levers can be raised to the maximum reverse thrust position
- the REV indication changes to green when the reverser is fully deployed.

Pushing the reverse thrust levers to the full down position retracts the reversers to the stowed and locked position. While the reverser is in transit, the REV annunciation changes color to amber. The thrust levers cannot be moved forward until the reverse thrust levers are fully down. When the reverser reaches the stowed position, the amber REV annunciation disappears.

121-139

Each thrust reverser is automatically protected against unintentional reverse thrust. If an uncommanded thrust reverser unlock is sensed, an autostow feature automatically applies hydraulic power to stow the reverser.

1501-1506, 1521, 1601-1613, 1701-1708

Each thrust reverser is automatically protected against unintentional reverse thrust. If an uncommanded thrust reverser movement is sensed, an autostow feature automatically applies pneumatic pressure to stow the reverser.

The EICAS advisory message L or R REV ISLN VAL is displayed and the REV ISLN light illuminates when a fault exists in the reverser system.

121-138, 1501-1506, 1521, 1601-1613, 1701-1708

The light and message are inhibited in flight.

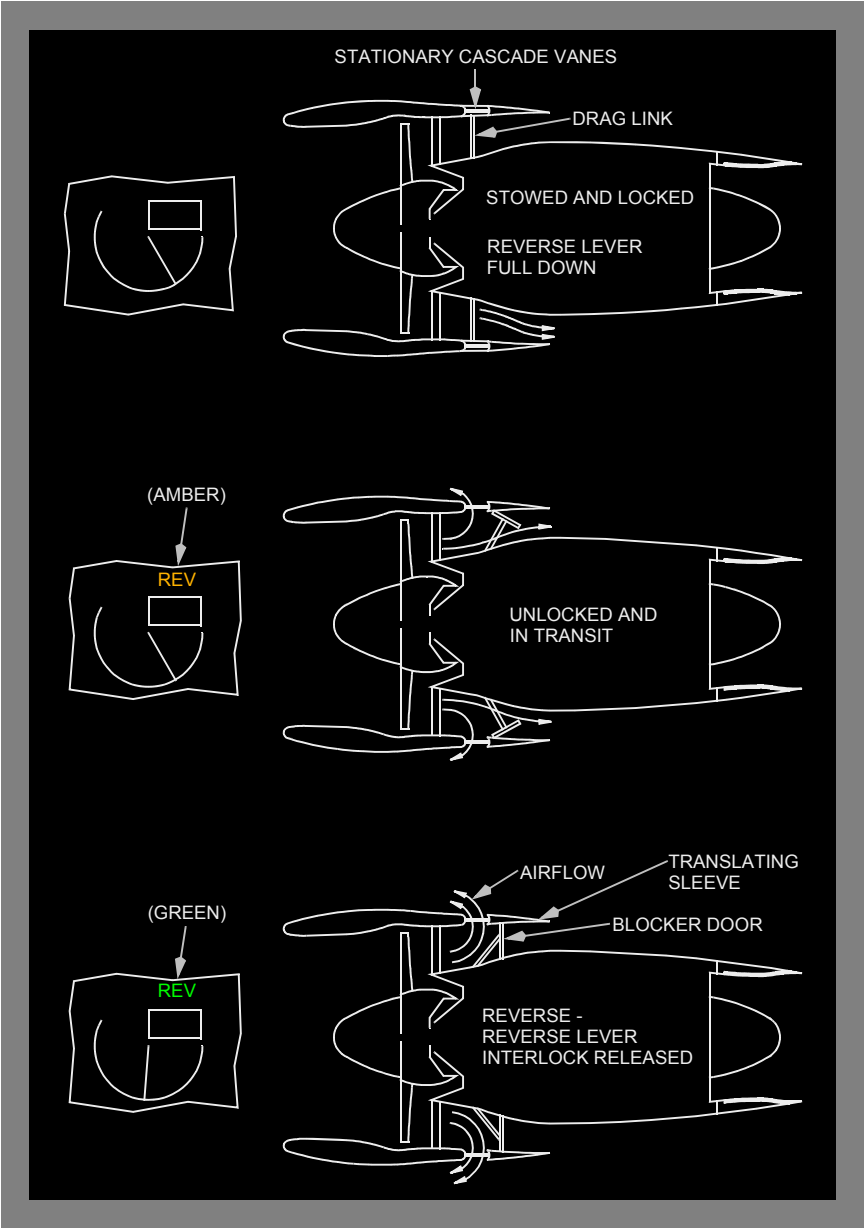
139

If the REV ISLN light illuminates in flight, additional system failures may cause inflight deployment. The affected reverser should deploy normally after landing but may not stow when commanded.

121-138, 1501-1506, 1521, 1601-1613, 1701-1708

An electromechanical lock prevents uncommanded reverser deployment in the event of additional system failures.

Thrust Reverser Schematic



Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications are displayed on the secondary engine display. The vibration source indication is also displayed. If the vibration monitoring system cannot determine the source (FAN, LPT, or N2), broadband (BB) is displayed for the affected engine. Broadband vibration is the average vibration detected.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

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Engines, APU

APU System Description

Chapter 7

Section 30

Introduction

The auxiliary power unit (APU) is a self-contained gas turbine engine located in the airplane tail cone. The APU air inlet door is located between the horizontal and vertical stabilizers on the right side of the airplane.

While the primary purpose of the APU is to supply electrical power and bleed air on the ground before engine start, the APU can also be started inflight, and operated up to the airplane maximum certified altitude.

Electrical power has priority over bleed air. Electrical power is available throughout the airplane operating envelope. Inflight, APU bleed air is available up to approximately 17,000 feet.

Refer to the following chapters for additional information:

- Chapter 2, Air Systems, for a description of APU bleed air operation
- Chapter 6, Electrical, for a description of APU electrical operation
- Chapter 8, Fire Protection, for a description of the APU fire protection system
- Chapter 12, Fuel, for a description of the APU fuel system.

APU Operation

APU Start

APU start requires both the APU battery and the aircraft main battery.

Fuel for the APU is supplied from the left manifold. A dedicated DC fuel pump is energized when the APU Selector is placed in the ON position if no AC power is available. When AC power is available, the left forward AC fuel pump is signaled to operate regardless of its switch position, and the DC fuel pump is signaled off.

Rotating the APU selector to START begins the automatic start sequence. The APU fuel valve opens and at the same time the APU inlet door begins to open. A fuel pump also begins to operate.

When the inlet door is open, the electric starter engages. After the APU reaches the proper speed, ignition and fuel are provided, and the APU accelerates to its normal operating speed.

The starter duty cycle is a maximum of three consecutive starts or attempts within a sixty minute period.

APU Run

When the APU RUN light illuminates, the APU is at normal operating speed and may be used to supply electrical power and bleed air.

APU Shutdown

To protect the unit from thermal shock, the APU control system incorporates a time-delay feature permitting APU cooling before shutdown. If the APU is supplying pneumatic power, rotating the APU selector to OFF begins the shutdown cycle by closing the APU bleed air valve. If the APU bleed valve has been closed for a sufficient length of time when the selector is moved to OFF, the APU shuts down without delay.

If the selector is inadvertently moved to OFF, but the RUN light is still illuminated, momentarily moving the selector to START cancels the shutdown signal.

Protection System

On the ground, placing the Battery Switch OFF also results in an APU shutdown. This is not a recommended procedure however, because while the APU will go through a cooldown cycle, APU fire detection may not be available. In flight, Battery Switch position does not affect APU operation.

An amber FAULT light on the APU control panel illuminates whenever a fault is sensed. In addition, an EICAS advisory message APU FAULT is displayed, and the APU shuts down immediately. Fault detection circuitry is reset by positioning the APU Selector to OFF.

The FAULT light also comes on when the APU fuel valve is not in the commanded position. Therefore, during APU start and shutdown, the light illuminates momentarily. The EICAS advisory APU FUEL VAL appears if the valve fails to reach the commanded position.

With the APU Selector positioned to OFF, both the APU FAULT light and the associated APU FAULT EICAS message are inhibited. Only a failure of the APU fuel valve to close causes the APU FAULT light and the associated APU FUEL VAL message.

Engines, APU

EICAS Messages (PW)

Chapter 7

Section 41

This section applies to ships 171-199, 1200-1201, 1401-1404

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

APU

Message	Level	Light	Aural	Condition
APU FAULT	Advisory	FAULT		The APU has automatically shut down
APU FUEL VAL	Advisory	FAULT		The APU fuel valve position disagrees with the commanded position

Engine Control

Message	Level	Light	Aural	Condition
L ENG EEC MODE R ENG EEC MODE	Advisory	ALTN		The electronic engine control is not receiving adequate inputs and an alternate N1 control mode is being used by the EEC to control thrust
L ENG LIM PROT R ENG LIM PROT	Caution	ALTN	Beeper	The electronic engine control is operating in the ALTN control mode and the commanded N1 exceeds maximum N1
L ENG CONTROL R ENG CONTROL	Advisory			Faults are detected in the engine control system
L ENG LOW IDLE R ENG LOW IDLE	Advisory			An engine has failed to go to approach idle
L ENG RPM LIM R ENG RPM LIM	Advisory			N1 or N2 RPM is at the red line limit

Message	Level	Light	Aural	Condition
L ENG SHUTDOWN R ENG SHUTDOWN	Caution			Engine was shutdown by the fuel control switch or fire switch
IDLE DISAGREE	Advisory			The engines are at different idle settings

Fuel

Message	Level	Light	Aural	Condition
L ENG FUEL FILT R ENG FUEL FILT	Advisory			An impending fuel filter bypass condition exists on the affected engine
L ENG FUEL VAL R ENG FUEL VAL	Advisory	ENG VALVE		The engine fuel valve position disagrees with commanded position
L FUEL SPAR VAL R FUEL SPAR VAL	Advisory	SPAR VALVE		The fuel spar valve position disagrees with commanded position

Oil

Message	Level	Light	Aural	Condition
L ENG OIL PRESS R ENG OIL PRESS	Advisory	L ENG OIL PRESS R ENG OIL PRESS		Engine oil pressure is low
L OIL FILTER R OIL FILTER	Advisory			Affected engine oil filter contamination has been detected

Start

Message	Level	Light	Aural	Condition
L ENG STARTER R ENG STARTER	Advisory	VALVE		Engine starter valve is not in the commanded position

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Message	Level	Light	Aural	Condition
L STARTER CUTOUT R STARTER CUTOUT	Caution	VALVE	Beeper	The engine start valve is open when commanded closed

Thrust Reverser

Message	Level	Light	Aural	Condition
L REV ISLN VAL R REV ISLN VAL	Advisory	REV ISLN		Fault is detected in the affected engine reverser system

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Engines, APU

EICAS Messages (GE)

Chapter 7

Section 42

This section applies to 121-139, 1501-1506, 1521, 1601-1613, 1701-1708

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

APU

Message	Level	Light	Aural	Condition
APU FAULT	Advisory	FAULT		The APU has automatically shut down
APU FUEL VAL	Advisory	FAULT		The APU fuel valve position disagrees with the commanded position

Engine Control

Message	Level	Light	Aural	Condition

1521, 1601-1613, 1701-1708

ENGINE CONTROLS	Advisory			Faults are detected in the engine control system

1521, 1601-1613, 1701-1708

L ENG CONTROL R ENG CONTROL	Advisory			Faults are detected in the engine control system

121-139, 1501-1506

L EEC OFF R EEC OFF	Caution	INOP	Beeper	The electronic engine control switch is OFF and the thrust lever is positioned full forward.

121-139, 1501-1506

L ENG EEC R ENG EEC	Advisory	INOP		The electronic engine control is inoperative

Message	Level	Light	Aural	Condition

1521, 1601-1613, 1701-1708

L ENG EEC MODE R ENG EEC MODE	Advisory	ALTN		The electronic engine control is not receiving adequate inputs and an alternate N1 control mode is being used by the EEC to control thrust

1521, 1601-1613, 1701-1708

L ENG LIM PROT R ENG LIM PROT	Caution	ALTN	Beeper	The electronic engine control is operating in the ALTN control mode and the throttles are advanced into the overboost range

L ENG LOW IDLE R ENG LOW IDLE	Advisory			An engine has failed to go to approach idle

1521, 1601-1613, 1701-1708

L ENG RPM LIM R ENG RPM LIM	Advisory			N1 or N2 RPM is at the red line limit

L ENG SHUTDOWN R ENG SHUTDOWN	Caution			Engine was shutdown by the fuel control switch or fire switch
IDLE DISAGREE	Advisory			The engines are at different idle settings

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Fuel

Message	Level	Light	Aural	Condition
L ENG FUEL FILT R ENG FUEL FILT	Advisory			An impending fuel filter bypass condition exists on the affected engine
L ENG FUEL VAL R ENG FUEL VAL	Advisory	ENG VALVE		The engine fuel valve position disagrees with commanded position
L FUEL SPAR VAL R FUEL SPAR VAL	Advisory	SPAR VALVE		The fuel spar valve position disagrees with commanded position

Oil

Message	Level	Light	Aural	Condition
L ENG OIL PRESS R ENG OIL PRESS	Advisory	L ENG OIL PRESS R ENG OIL PRESS		Engine oil pressure is low
L OIL FILTER R OIL FILTER	Advisory			Affected engine oil filter contamination has been detected

Start

Message	Level	Light	Aural	Condition
L ENG STARTER R ENG STARTER	Advisory	VALVE		Engine starter valve is not in the commanded position
L STARTER CUTOUT R STARTER CUTOUT	Caution	VALVE	Beeper	The engine start valve is open when commanded closed

Thrust Reverser

Message	Level	Light	Aural	Condition
L REV ISLN VAL R REV ISLN VAL	Advisory	REV ISLN		Fault is detected in the affected engine reverser system

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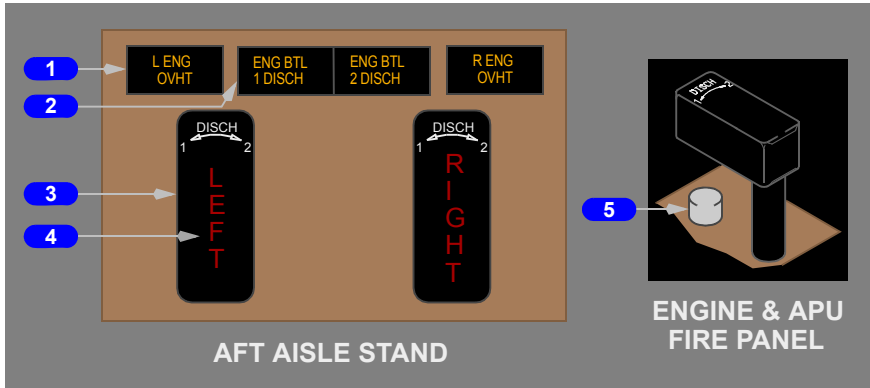


System EICAS Messages	8.30
Fire Protection EICAS Messages	8.30.1

Fire Protection Controls and Indicators

Chapter 8 Section 10

Engine Fire Protection Engine Fire Panel



1 Engine Overheat (L/R ENG OVHT) Lights

Illuminated (amber) – engine overheat is detected.

2 Engine Bottle Discharged (ENG BTL DISCH) Lights

Illuminated (amber) – the extinguisher bottle is discharged or has low pressure.

3 Engine Fire Switches

In – normal position, mechanically locked; unlocks automatically for fire warning.

Out – closes the associated engine and spar fuel valves, and

- closes the associated engine bleed air valves
- trips the associated engine generator off
- shuts off hydraulic fluid to the associated engine-driven hydraulic pump
- arms both engine fire extinguisher bottles
- silences the fire bell.

Rotate to position 1 or 2 – discharges the selected fire extinguisher into the engine nacelle.

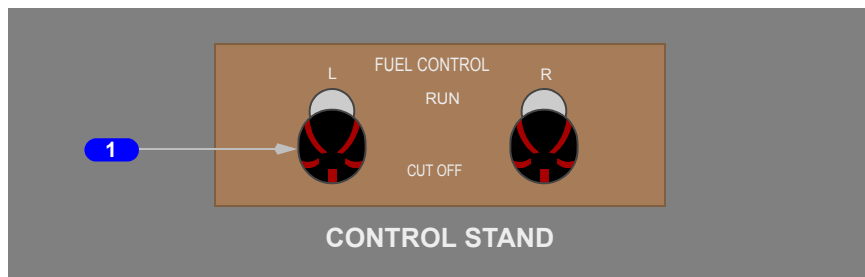
4 Engine Fire Warning Lights

Illuminated (red) – an engine fire is detected.

5 Engine and APU Fire Override Switches

Push – unlocks the respective engine or APU fire switch.

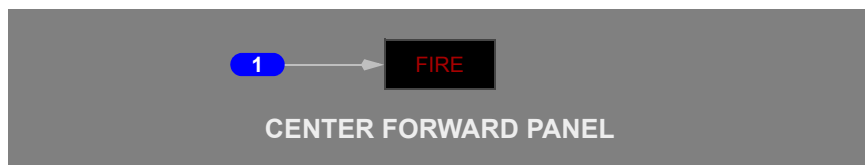
Fuel Control Switches



1 FUEL CONTROL Switch Fire Warning Lights

Illuminated (red) – an associated engine fire is detected.

Fire Warning Light

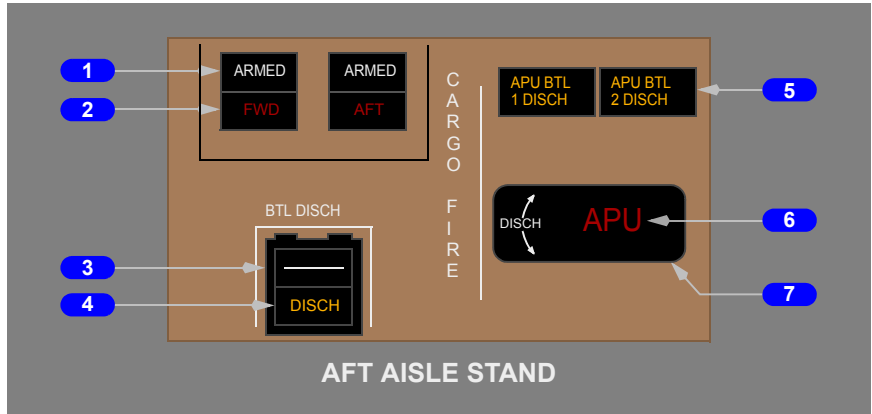


1 FIRE Warning Light

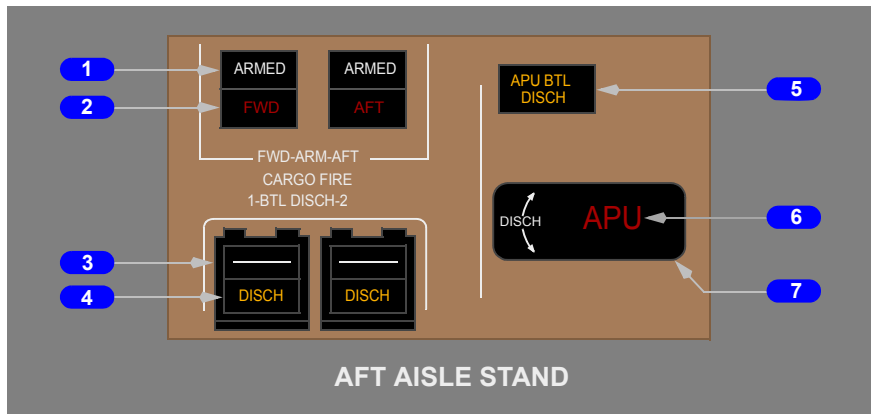
Illuminated (red) – an engine, APU, wheel well, or cargo fire is detected.

Cargo and APU Fire Protection Cargo and APU Fire Panel

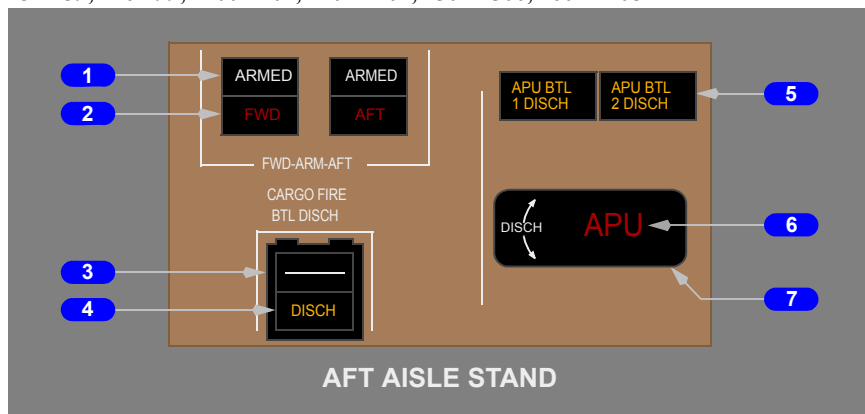
121-130, 171-175



1521



131-139, 176-199, 1200-1201, 1401-1404, 1501-1506, 1601-1708



1 CARGO FIRE ARM Switches and Lights

Push FWD ARMED – Light Illuminates

- arms all cargo fire extinguisher bottles
- turns off both recirculation fans
- shuts down nitrogen generation system

Push AFT ARMED – Light Illuminates

- arms all cargo fire extinguisher bottles
- turns off both the recirculation fans
- inhibits high flow operation of both packs
- shuts down nitrogen generation system

Off – normal position.

2 CARGO FIRE Warning Lights (FWD or AFT)

Illuminated (red) – smoke is detected in associated cargo compartment.

3 CARGO FIRE Bottle Discharge (BTL DISCH) Switch

Push – discharges the fire extinguisher bottles into the ARMED cargo compartment.

4 CARGO FIRE Bottle Discharged (DISCH) Light

Illuminated (amber) – either extinguisher bottle has discharged or has low pressure.

121-199, 1200-1201, 1401-1404, 1501-1506, 1601-1708

5 APU Fire Bottle Discharged (APU BTL DISCH) Light

Illuminated (amber) – the extinguisher bottle is discharged or has low pressure.

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5 APU Fire Bottle Discharged (APU BTL 1 DISCH or APU BTL 2 DISCH) Lights

Illuminated (amber) – the respective extinguisher bottle is discharged or has low pressure.

6 APU Fire Warning Light

Illuminated (red) – an APU fire is detected.

7 APU Fire Switch

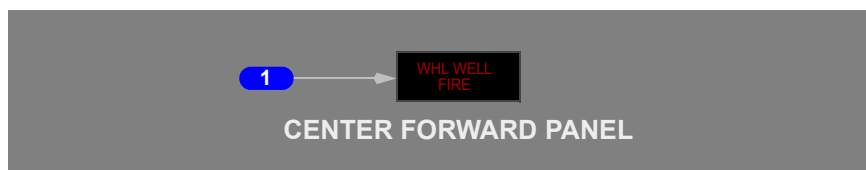
In – normal position, mechanically locked; unlocks automatically if fire warning occurs.

Out – closes the APU fuel valve, and:

- trips the APU generator off
- closes the APU air supply valve
- shuts down the APU
- arms the APU fire extinguisher bottle
- silences the fire bell.

Rotate – either direction discharges one of the APU fire extinguishers into the APU compartment. Rotating in the other direction will discharge the second bottle.

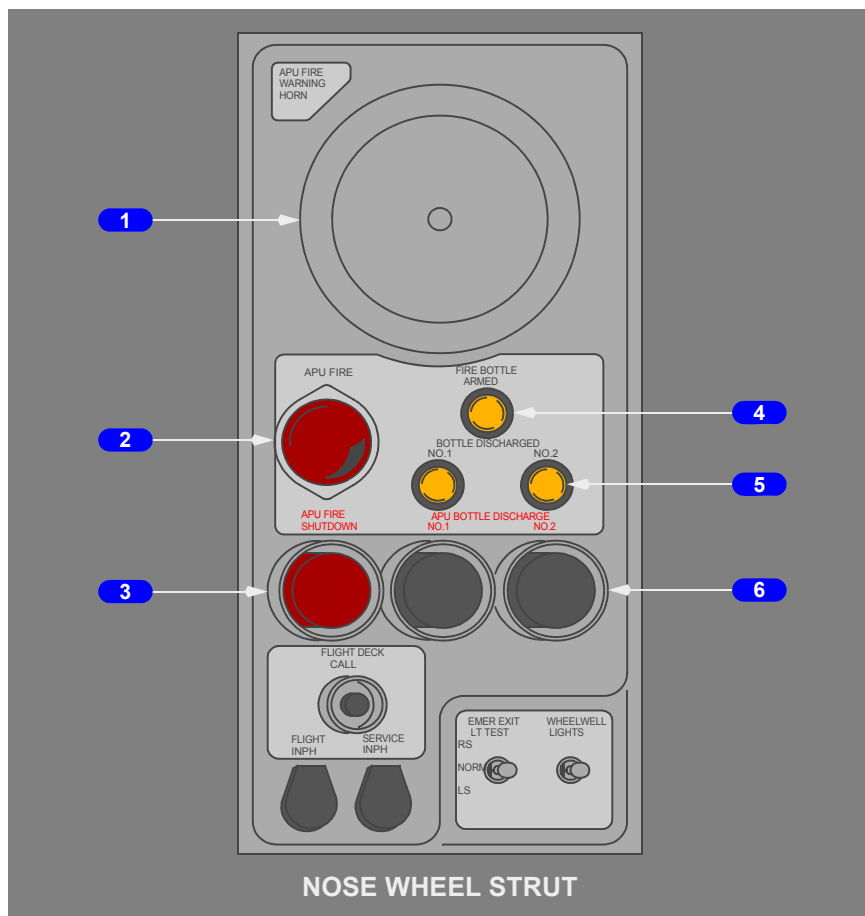
Wheel Well Fire Light



1 Wheel (WHL) WELL FIRE Warning Light

Illuminated (red) – a fire is detected in one or both of the main gear wheel wells.

APU Ground Control Fire Protection Panel



1 APU Fire Warning Horn

Sounds intermittently during ground operation for an APU fire.

2 APU FIRE Light

Illuminated (red) – an APU fire is detected.

The APU automatically shuts down for a detected fire.

3 APU FIRE SHUTDOWN Switch

Push –

- closes the APU fuel valve and trips the APU generator off
- closes the APU air supply valve and shuts down the APU
- arms the APU fire extinguisher bottles.

4 APU FIRE BOTTLE ARMED Light

Illuminated (amber) - the APU fire extinguisher is armed.

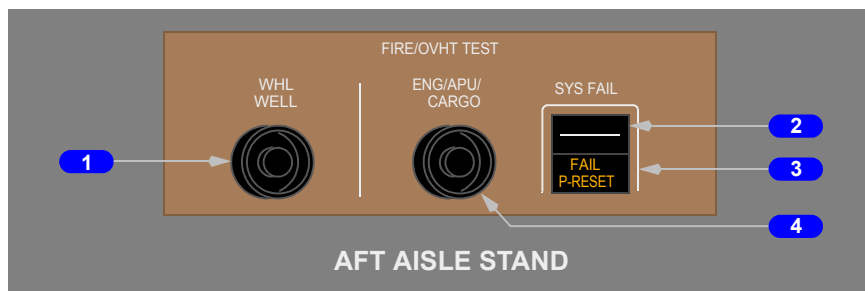
5 APU Fire BOTTLE DISCHARGED Lights

Illuminated (amber) - an APU fire extinguisher bottle is discharged or has low pressure.

6 APU BOTTLE DISCHARGE Switches

Push – discharges one of the APU fire extinguisher bottle(s) into the APU compartment.

Fire/Overheat Test Panel



1 Wheel (WHL) WELL Fire Test Switch

Push and hold – initiates a wheel well fire test.

2 System Fail (FAIL P – RESET) Light

Illuminated (amber) – indicates the failure of the detectors in one of the following systems:

- engine fire
- engine overheat
- APU fire
- cargo fire.

3 System Fail (SYS FAIL) Reset Switch (FAIL P – RESET)

Push – extinguishes the FAIL light and resets the monitor for other systems.

4 ENG/APU/CARGO Test Switch

Push and hold – initiates an engine, APU, and cargo fire/overheat test.

**Fire Protection
System Description****Chapter 8
Section 20**

Introduction

There are fire detection and extinguishing systems for the:

- engines
- APU
- forward and aft cargo compartments
- lavatories

The main gear wheel wells have a fire detection system, but no fire extinguishing system. The system will not detect hot brakes alone, without an associated fire.

Overheat detection systems are installed for both engines, struts, and pneumatic ducts in the wing and body areas.

Refer to Chapter 2, Air Systems, for a description of equipment smoke evacuation, equipment overheat detection and bleed air duct leak.

Engine Fire Protection

Engine fire protection consists of these systems:

- engine fire and overheat detection
- engine fire warning
- engine overheat caution
- engine fire extinguishing.

Engine Fire and Overheat Detection

There are detector loops in each engine nacelle to provide both fire and overheat detection. The SYS FAIL light illuminates and the EICAS advisory message FIRE/OVHT SYS displays to indicate failure of the fire/overheat detection system. The SYS FAIL light and advisory message can be reset to allow monitoring of the remaining systems.

Engine Fire Warning

The indications of an engine fire warning are:

- the fire bell sounds
- the master WARNING lights illuminate
- the engine fire switch LEFT or RIGHT fire warning light illuminates
- the discrete FIRE warning light illuminates
- the engine FUEL CONTROL switch fire warning light illuminates.
- the EICAS warning message L or R ENGINE FIRE displays
- the engine fire switch unlocks

The fire warning lights remain illuminated as long as the fire signal exists. The fire bell may be silenced by any of the following actions.

- extinguishing the fire
- pushing either master warning/caution reset switch
- pulling the appropriate fire switch.

Engine Overheat Caution

The indications of an engine overheat caution are:

- the caution beeper sounds
- the master CAUTION lights illuminate
- the L or R ENG OVHT light illuminates.
- the EICAS caution message L or R ENG OVHT displays.

The overheat lights remain illuminated as long as the overheat condition exists.

Engine Fire Extinguishing

There are two engine fire extinguisher bottles. Either or both bottles can be discharged into either engine.

When an engine fire switch is pulled out, the associated engine:

- fuel is shut off
- bleed valves are closed
- generator is tripped off
- hydraulic fluid is shut off to the engine-driven hydraulic pump
- fire extinguishing bottles are armed
- fire bell is silenced

Rotating the fire switch in either direction discharges a single extinguisher bottle into the associated engine. Rotating the engine fire switch in the other direction discharges the second extinguisher bottle into the same engine.

If an extinguisher bottle is discharged or has low pressure:

- the ENG BTL 1 or 2 DISCH light illuminates
- the EICAS advisory message ENG BTL 1 or 2 displays.

Engine/APU Fire and Override Switches

The engine and APU fire switches are mechanically locked in the down position to avoid inadvertent activation. When a fire is detected, the respective switch is electrically unlocked and may then be pulled out. Manual unlocking of the switch is accomplished by pushing the fire override switch located beneath the fire switch.

APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection
- APU fire warning
- APU fire extinguishing.

APU Fire Detection

There are fire detector loops in the APU compartment. There is no APU overheat detection. The SYS FAIL light illuminates and the EICAS advisory message FIRE/OVHT SYS displays to indicate failure of the APU fire detection system. The SYS FAIL light and advisory message can be reset to allow monitoring of the remaining systems.

APU Fire Warning

The indications of an APU fire warning are:

- the fire bell sounds
- the master WARNING lights illuminate
- the APU fire warning light illuminates
- the discrete FIRE warning light illuminates
- the EICAS warning message APU FIRE displays
- the APU automatically shuts down
- the APU fire switch unlocks.

In addition to the above APU fire warnings, if the airplane is on the ground the horn on the nose gear strut sounds and the fire warning light on the APU ground control panel illuminates.

The fire warning lights remain illuminated as long as the fire signal exists. The fire bell (and horn if APU fire on the ground) may be silenced by any of the following actions:

- extinguishing the fire
- pushing either master warning/caution reset switch
- pulling the APU fire switch
- pushing the APU fire shutdown switch if on the ground.

APU Fire Extinguishing

121-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1601-1708

Rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. Rotating the switch in the opposite direction will discharge the other bottle into the APU compartment. When one of the bottles is discharged or has low pressure:

- the APU BTL 1 or 2 DISCH light illuminates
- the EICAS advisory message APU BTL 1 or 2 displays.

121-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1601-1708

There are two APU fire extinguisher bottles. When the APU fire switch is pulled out, the APU:

- fuel is shut off
- bleed air valve is closed
- generator is tripped off
- fire extinguisher bottles are armed
- fire bell is silenced

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An APU fire on the ground with both engines shut down is automatically extinguished. The fire signal causes discharge of the APU extinguisher system a few seconds after automatic shutdown.

1521

There is one APU fire extinguisher bottle. When the fire switch is pulled out, the fuel is shut off to the APU, the air supply valve is closed, the APU generator is tripped off, the fire extinguisher is armed, and the bell is silenced. Rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. When the bottle is discharged or has low pressure:

- the APU BTL DISCH light illuminates
- the EICAS advisory message APU BTL displays

Main Gear Wheel Well Fire Protection

The main gear wheel well has fire detection and warning only. There is no fire extinguishing system. The nose gear wheel well does not have a fire detection system.

Main Gear Wheel Well Fire Detection

The main wheel well fire detection system consists of a single fire detection loop.

Main Gear Wheel Well Fire Warning

The indications for a main wheel well fire are:

- the fire bell sounds
- the master WARNING lights illuminate
- the WHL WELL FIRE warning light illuminates
- the discrete FIRE warning light illuminates.
- the EICAS warning message WHEEL WELL FIRE displays

The fire warning lights remain illuminated as long as the fire signal exists. The fire bell may be silenced by any of the following actions:

- extinguishing the fire
- pushing either master warning/caution reset switch

Cargo Compartment Fire Protection

Cargo compartment fire protection consists of these systems:

- cargo compartment smoke detection
- cargo compartment fire warning
- cargo compartment fire extinguishing.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors installed.

System monitoring of the cargo smoke detectors is only accomplished when a test of the system is done either manually using the ENG/APU/CARGO test switch or automatically anytime electrical power is applied or transferred from one source to another. During a test, the SYS FAIL light illuminates and the EICAS advisory message FIRE/OVHT SYS displays to indicate failure of the cargo compartment smoke detection system. The SYS FAIL light can be reset to allow monitoring of the remaining systems.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- the fire bell sounds
- the master WARNING lights illuminate
- the FWD or AFT cargo fire warning light illuminates
- the discrete FIRE warning light illuminates.
- the EICAS warning message FWD or AFT CARGO FIRE displays

The fire warning lights remain illuminated as long as the fire signal exists. The fire extinguishing agent may cause the cargo compartment fire warning to remain even after the fire has been extinguished. The fire bell may be silenced by any of the following actions:

- extinguishing the fire and clearing the smoke
- pushing either master warning/caution reset switch
- pushing the illuminated cargo compartment ARMED switch.

Cargo Compartment Fire Extinguishing

Fire extinguisher bottles are installed for cargo compartment fire extinguishing. Pushing the FWD or AFT cargo compartment ARMED switch arms the extinguishers for that compartment.

Pushing the cargo fire bottle discharge switch initiates discharge of the fire bottles. The first bottle discharges immediately into the selected compartment. The CARGO BTL 1 advisory message is displayed on EICAS within a few seconds after pressing the cargo fire bottle DISCH switch. The second fire bottle discharges at a later time at a reduced flow rate into the selected compartment. The CARGO BTL 2 advisory messages is displayed on EICAS within a few seconds after the bottle starts to discharge. The DISCH light illuminates when either bottle discharges.

Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory fire detection and annunciation
- automatic fire extinguishing in the lavatory waste container cabinet

Lavatory Fire Detection and Annunciation

Each lavatory has a single smoke detector. When smoke is detected, aural annunciations sound in the lavatory and in the cabin. Depending on configuration, cabin lavatory smoke detection annunciation will consist of a horn, a chime, a flashing lavatory call light or illumination of the master call light at the associated flight attendant station.

There is no cockpit annunciation of smoke detected in a lavatory.

Lavatory Fire Extinguishing

Each lavatory has a fire extinguisher located in the waste container cabinet, with:

- automatic fire extinguisher operation
- no cockpit annunciations of lavatory fire extinguisher operations

Fire and Overheat Detection System Fault Test

Automatic testing of the engine fire and overheat detectors, APU fire detectors and cargo compartment smoke detectors occurs when electrical power is initially applied. The FIRE/OVHT test panel permits manual testing of the various fire and overheat sensors.

Fire Protection

System EICAS Messages

Chapter 8

Section 30

Fire Protection EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition

121-199, 1200-1201, 1401-1404, 1501-1506, 1601-1708

APU BTL 1 APU BTL 2	Advisory	APU BTL 1 DISCH APU BTL 2 DISCH		APU fire extinguisher bottle1 or bottle 2 pressure is low

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APU BTL	Advisory	APU BTL DISCH		APU fire extinguisher bottle pressure is low

APU FIRE	Warning	APU	Fire Bell	Fire is detected in the APU
CARGO BTL 1 CARGO BTL 2	Advisory	DISCH		Cargo fire extinguisher bottle 1 or bottle 2 pressure is low
AFT CARGO FIRE FWD CARGO FIRE	Warning	AFT FWD	Fire Bell	Smoke is detected in the affected cargo compartment
ENG BTL 1 ENG BTL 2	Advisory	ENG BTL 1 DISCH ENG BTL 2 DISCH		Engine fire extinguisher bottle 1 or bottle 2 pressure is low
L ENGINE FIRE R ENGINE FIRE	Warning	LEFT RIGHT	Fire Bell	Fire is detected in the engine

Message	Level	Light	Aural	Condition
FIRE/OVHT SYS	Advisory	FAIL P-RESET		Fire or overheat detection is inoperative for loops as shown on the status page
L ENG OVHT R ENG OVHT	Caution	L ENG OVHT R ENG OVHT	Beeper	An overheat is detected in the engine
WHEEL WELL FIRE	Warning	WHL WELL FIRE	Fire Bell	Fire is detected in a main wheel well

Flight Controls

Chapter 9

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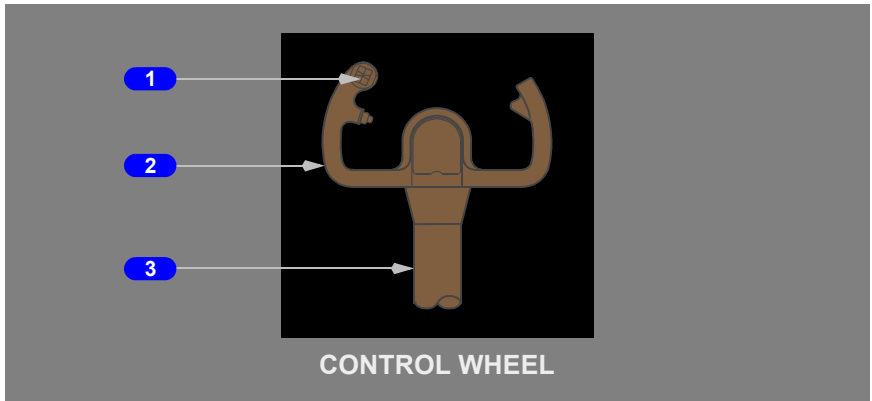
Flight Controls

Controls and Indicators

Chapter 9

Section 10

Pitch and Stabilizer Trim System Control Wheel and Column



1 Pitch Trim Switches

Spring-loaded to neutral.

Push (both switches) – electrically signals stabilizer movement.

2 Control Wheel

Rotate – deflects the ailerons and spoilers in the desired direction.

Moves and remains displaced with aileron trim.

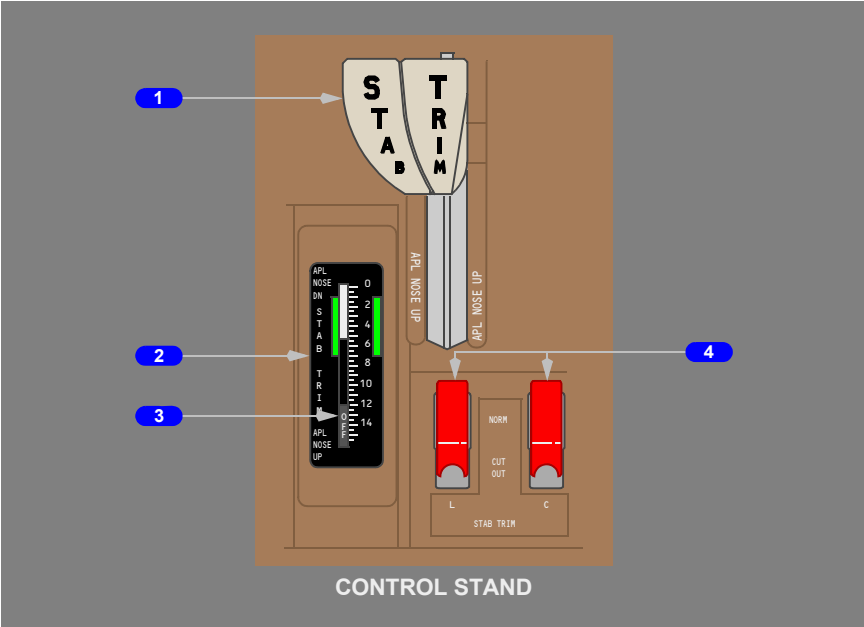
3 Control Column

Push/Pull –

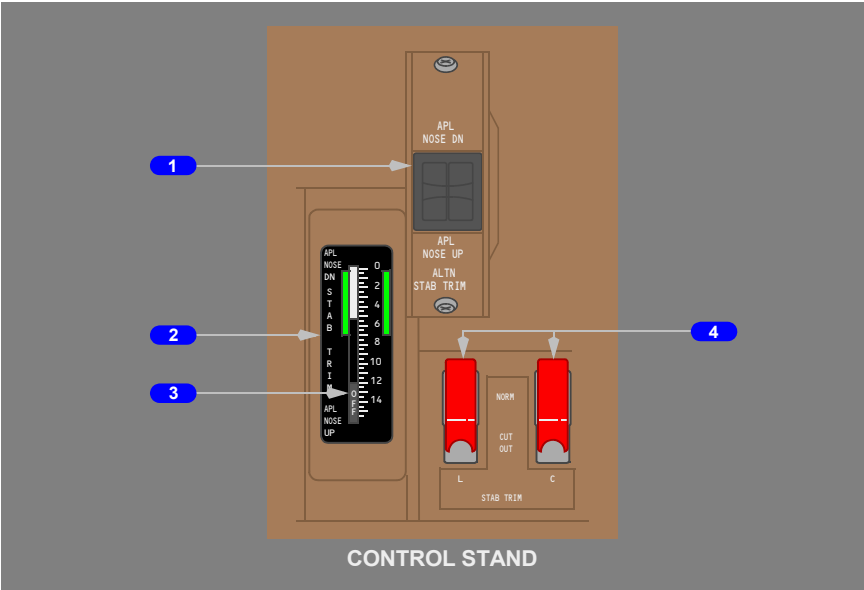
- deflects the elevator
- movement opposing stabilizer trim stops trimming

Stabilizer Trim System

121-130



131-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708



121-130

1 Stabilizer Trim (STAB TRIM) Levers

Spring-loaded to neutral.

Push/pull (both levers) –

- mechanically signals stabilizer movement
- overrides conflicting trim commands

131-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

1 Alternate Stabilizer Trim (ALTN STAB TRIM) Switches

Spring-loaded to neutral.

Push (both switches) –

- electrically signals stabilizer movement
- neutralizes conflicting trim commands

2 Stabilizer Trim (STAB TRIM) Indicator

- indicates stabilizer position in units of trim
- the green bands indicate the allowable takeoff trim range

3 Stabilizer Trim OFF Flag

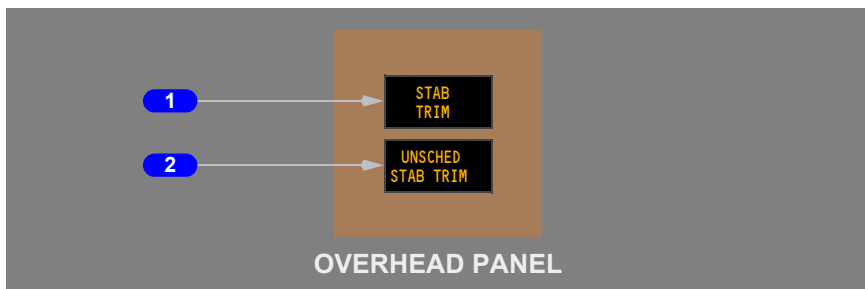
Trim indicator inoperative.

4 Stabilizer (STAB) Cutout Switches

NORM – hydraulic power is supplied to the related stabilizer trim control module.

CUTOFF – shuts off the respective left or center hydraulic system power to the related stabilizer trim control module.

Stabilizer Trim Lights



1 Stabilizer Trim (STAB TRIM) Light

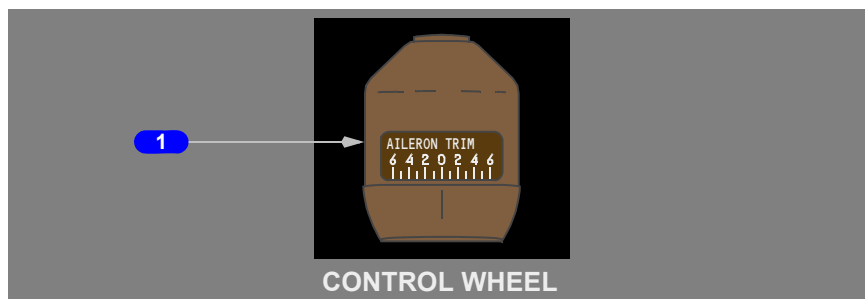
Illuminated (amber) – stabilizer trim rate is one-half the normal control wheel stabilizer trim switch rate.

2 Unscheduled Stabilizer Trim (UNSCHEDED STAB TRIM) Light

Illuminated (amber) – uncommanded stabilizer motion detected.

Aileron and Rudder Trim Controls

Aileron Trim Indicator



1 AILERON TRIM Indicator

Indicates units of aileron trim.

Aileron and Rudder Trim



1 RUDDER TRIM Indicator

Indicates units of rudder trim.

2 AILERON Trim Switches

Spring-loaded to neutral.

Push (both switches) – moves the control wheel, ailerons, and spoilers in the desired direction.

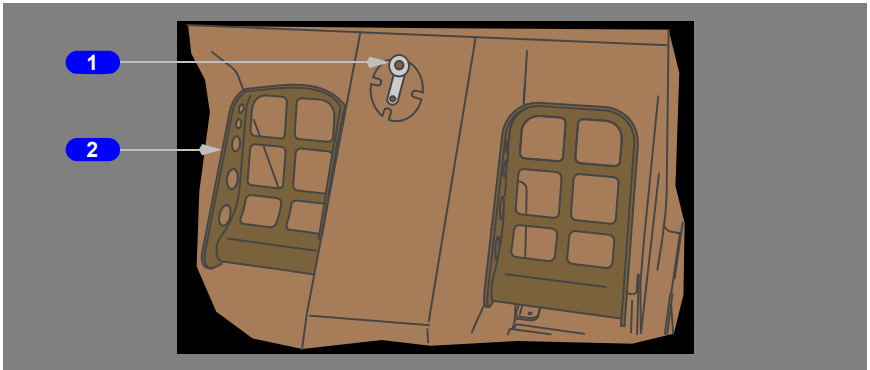
3 RUDDER Trim Control

Spring-loaded to neutral.

Rotate – moves the rudder pedals and rudder in the desired direction.

Rudder System

Rudder/Brake Pedals



1 Rudder Pedals Adjustment Crank

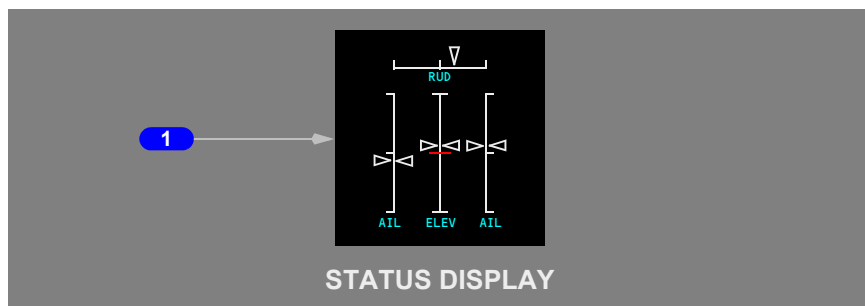
Pull and Rotate – adjusts rudder pedals forward or aft.

2 Rudder Pedals

Push – deflects the rudder in the desired direction.

Refer to Chapter 14, Landing Gear, for brakes and nosewheel steering description.

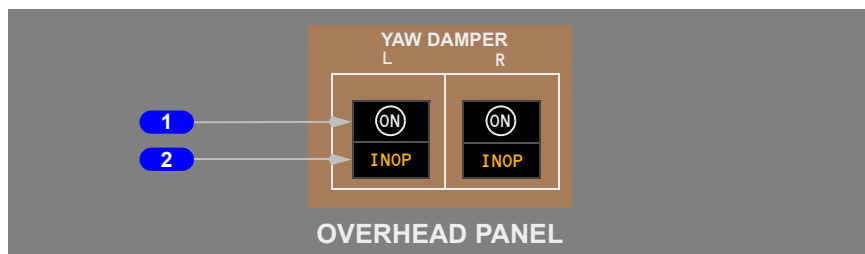
EICAS Status Display



1 Rudder, Aileron, and Elevator (RUD, AIL, ELEV) Position

Indicates rudder, aileron, and elevator flight control surface deflection.

Yaw Damper Switches



1 YAW DAMPER Switches

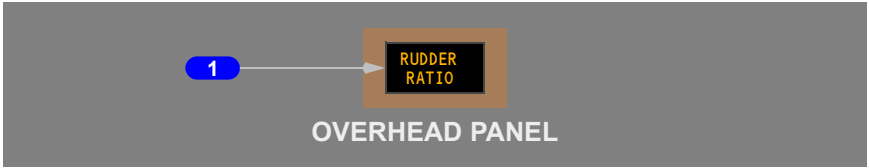
ON – yaw damper is commanded on.

Off (ON not visible) – the yaw damper is commanded off.

2 Yaw Damper Inoperative (INOP) Lights

Illuminated (amber) – the yaw damper is off or inoperative.

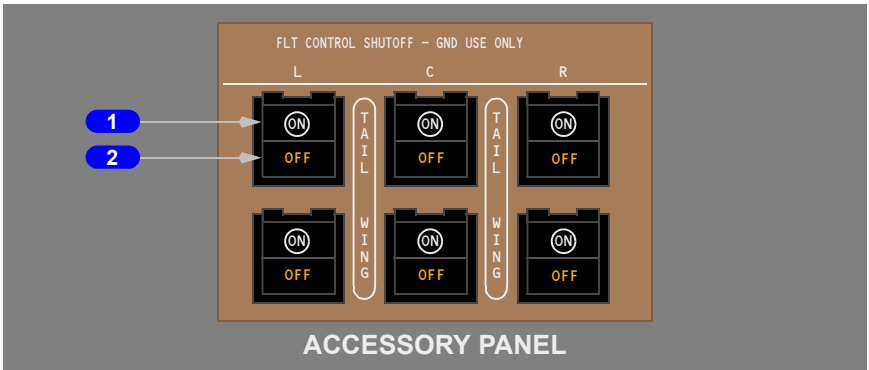
Rudder System Light



1 RUDDER RATIO Light

Illuminated (amber) – the rudder ratio system is failed, or left hydraulic system pressure is not available.

Flight Control Shutoff Switches



1 Flight (FLT) CONTROL SHUTOFF Switches

ON – the flight control valve is commanded open.

Off (ON not visible) – the flight control valve is commanded closed.

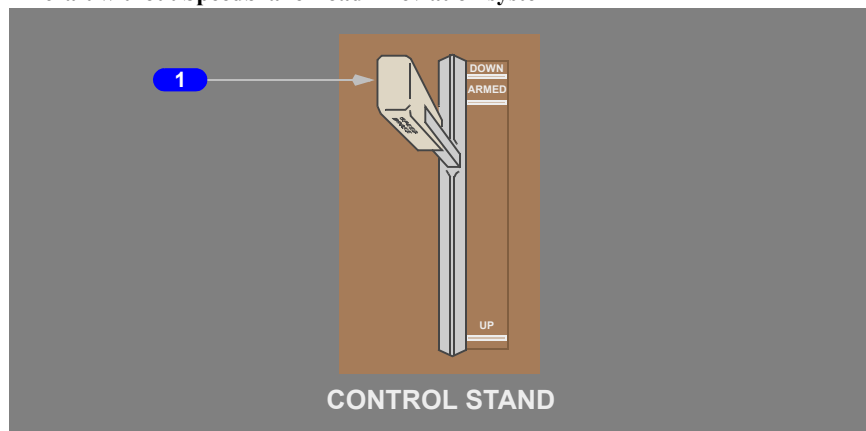
2 Flight Control Shutoff OFF Lights

Illuminated (amber) – the flight control valve is closed.

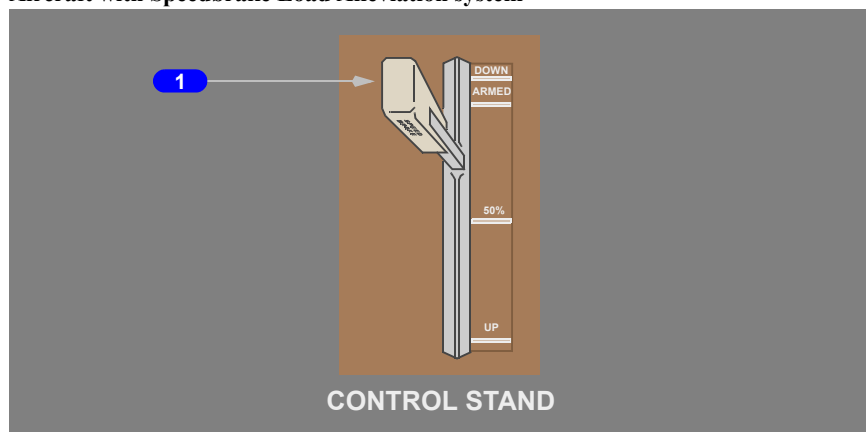
Speedbrakes

Speedbrake Lever

Aircraft without Speedbrake Load Alleviation system



Aircraft with Speedbrake Load Alleviation system



1 SPEEDBRAKE LEVER

DOWN (detent) – all spoiler panels are retracted.

ARMED –

- the auto speedbrake system is armed
- after landing, the speedbrake lever automatically moves to UP and the spoiler panels extend

Aircraft with Speedbrake Load Alleviation System

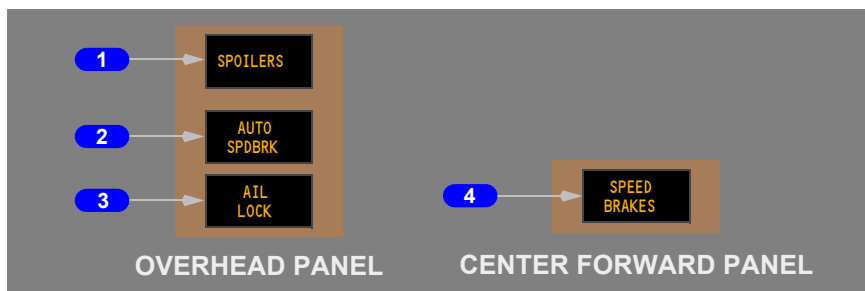
50% – Maximum SPEED BRAKE lever position when Load Alleviation System activates.

UP – the required spoiler panels extend to their maximum in-flight or on-ground positions (intermediate positions can be selected).

On the ground:

- speedbrake lever moves to DOWN and all spoiler panels retract if either thrust lever is advanced to the takeoff thrust position
- the speedbrake lever moves to UP and all spoiler panels extend if either reverse thrust lever is raised to the reverse idle detent

Speedbrake and Aileron Lights



1 SPOILERS Light

Illuminated (amber) – one or more spoiler pairs are not in the signaled position.

2 Auto Speedbrake (AUTO SPDBRK) Light

(Aircraft without Speedbrake Load Alleviation system)

Illuminated (amber) – a fault is detected in the automatic speedbrake system.

(Aircraft with Speedbrake Load Alleviation system)

Illuminated (amber) – a fault in the automatic speedbrake system or load alleviation system is detected.

- If speedbrake lever is ARMED or DOWN, speedbrakes will not extend automatically after landing.
- If speedbrake lever is ARMED, speedbrakes may extend in flight if additional faults occur.
- Do not exceed 320 knots and do not arm automatic speed brakes for landing.
- Use manual speedbrake deployment as required. Increased force may be required to move Speed Brake lever into the UP position.

3 Aileron Lockout (AIL LOCK) Light

Illuminated (amber) – aileron lockout actuator disagrees with the commanded position.

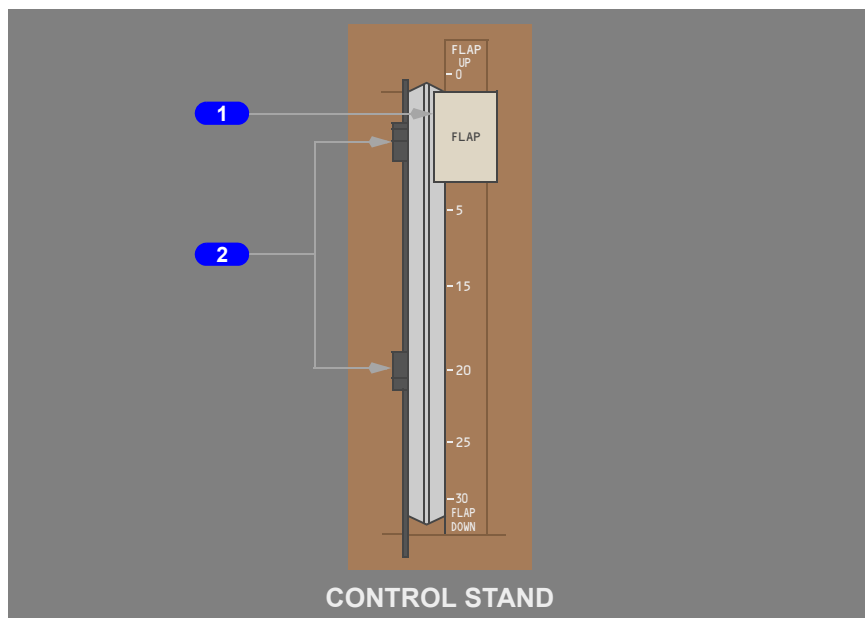
4 SPEED BRAKES Light

Illuminated (amber) – the speedbrakes are extended when:

- radio altitude is 800 feet or below, or
- flaps are in a landing position

Flap System

Flap Controls



1 FLAP Lever

Positions the slats and flaps hydraulically.

Up – the slats and flaps are retracted.

1 –

- the slats extend to the midrange position
- the flaps remain retracted

5, 15, and 20 –

- the slats remain in the midrange position
- the flaps extend to the commanded position
- the inboard ailerons droop in conjunction with flap extension

25 –

- the slats extend to the fully extended position
- the flaps extend to 25

171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

- the flap load relief system arms

30 –

- the slats remain in the fully extended position
- the flaps extend to 30

121-139

- the flap load relief system arms

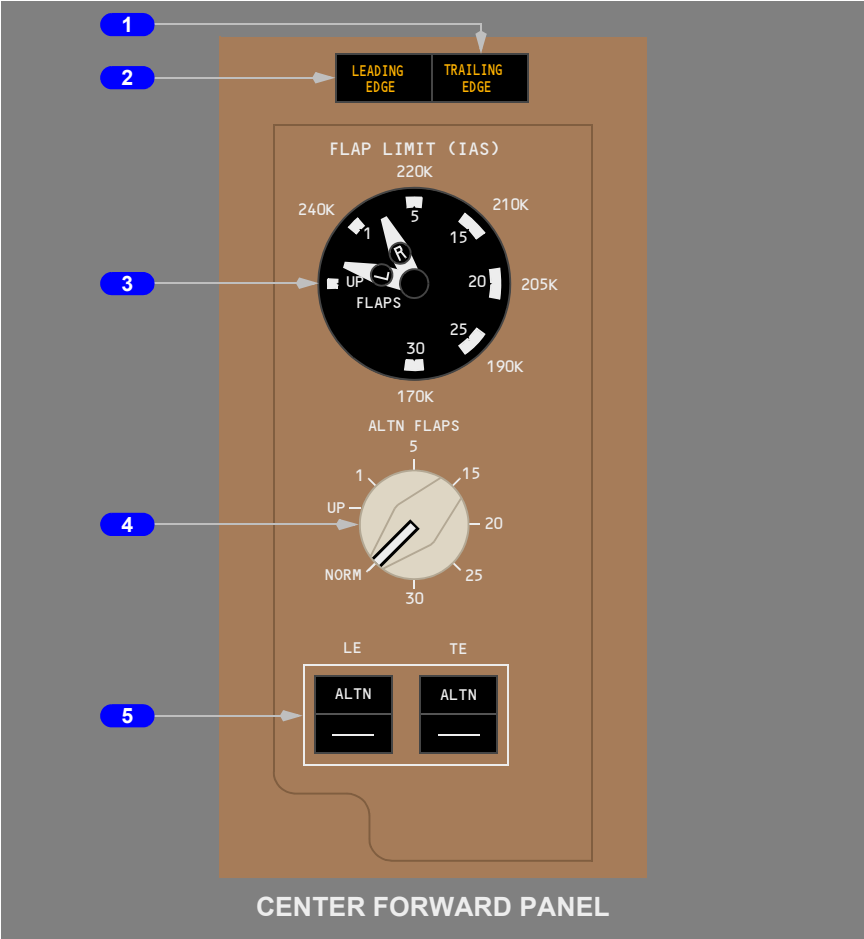
2 Flap Gates

1 – prevents inadvertent retraction of the slats.

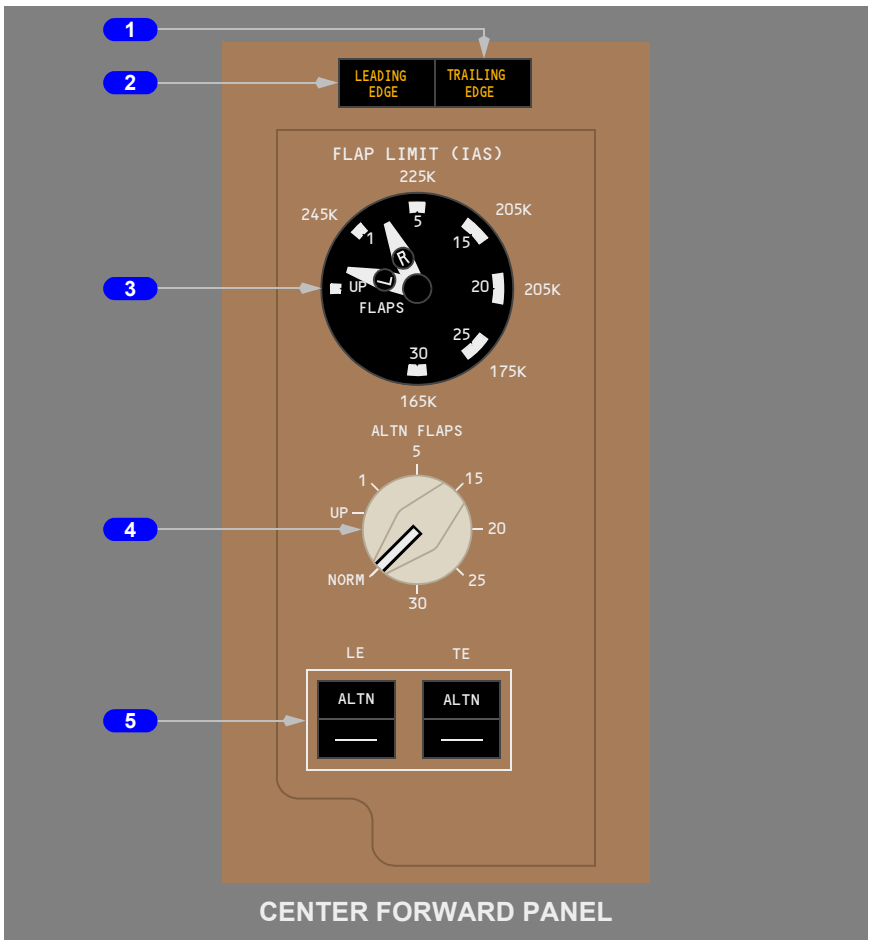
20 – prevents inadvertent retraction of the flaps past the go-around position.

Flap Position Indicator/Alternate Flaps Selector

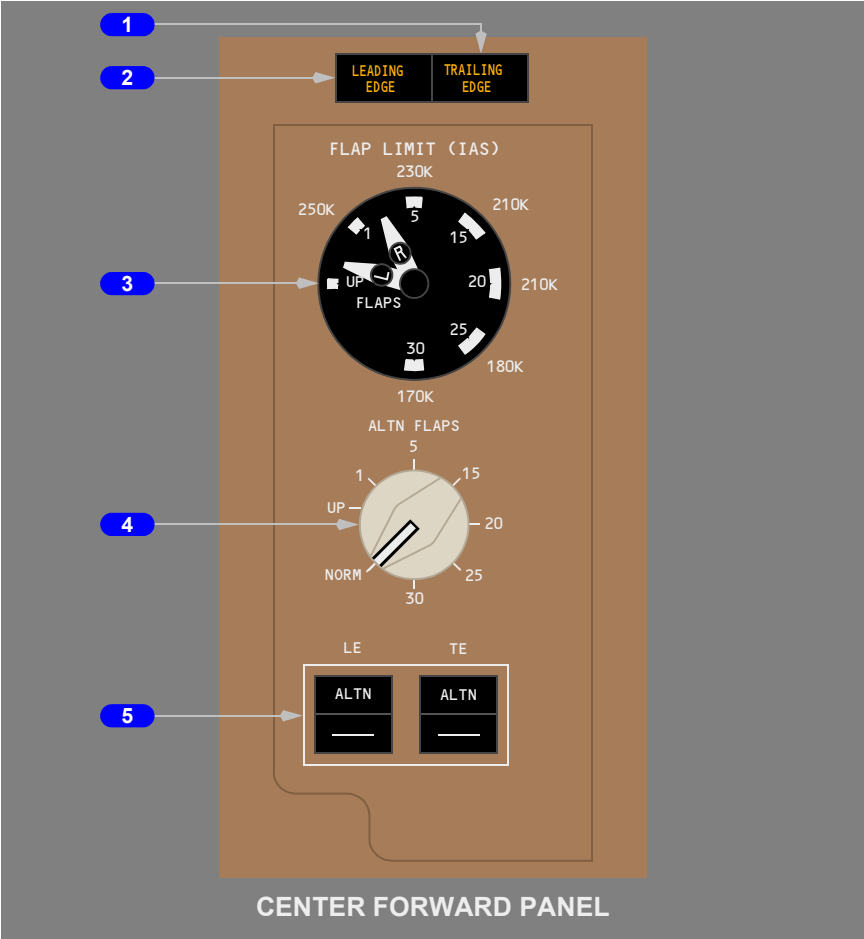
121-139



1401-1404



171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708



1 TRAILING EDGE Light

Illuminated (amber) –

- a flap disagree exists
- a flap asymmetry exists
- the flap load relief system is not operating when required

2 LEADING EDGE Light

Illuminated (amber) –

- a slat disagree exists
- a slat asymmetry exists

3 Flap Position Indicator

Indicates flap position.

UP – the slats and flaps are retracted.

Between UP and 1 – the slats are between the retracted and midrange position.

1 to 30 – the flaps are in the indicated position.

4 Alternate (ALTN FLAPS) Flaps Selector

NORM – normal flap operation, alternate system not in use.

UP – the slats and flaps are retracted.

1 –

- the slats extend to the midrange position
- the flaps remain retracted

5 to 20 –

- the slats remain in the midrange position
- the flaps extend to the commanded position

Alternate flaps switches must be in ALTN for the slats and flaps to move.

5 Alternate (ALTN) Flaps Switches

ALTN –

- arms the selected LE slat or TE flap alternate drive unit
- shuts off hydraulic power to the selected LE slat or TE flap drive system.

Off (ALTN not visible) – alternate flaps and slats command inactive.

Intentionally
Blank

Flight Controls

System Description

Chapter 9

Section 20

Introduction

The primary flight controls are elevators, ailerons, and rudders. The control column, control wheel, and rudder pedals control these flight control surfaces. The primary flight controls are powered by redundant hydraulic systems; there is no manual reversion.

Secondary flight controls include a moveable horizontal stabilizer, spoilers, and leading and trailing edge flaps. Spoilers operate differentially to assist ailerons for roll control and symmetrically as speedbrakes.

There are six guarded flight control shutoff switches that control hydraulic power to the ailerons, spoilers, elevators and rudder. The flight control shutoff OFF light illuminates and the EICAS advisory message L, C, or R WING HYD VAL or L, C, or R TAIL HYD VAL displays when a flight control valve is closed. If two or more OFF lights illuminate the EICAS advisory message FLT CONT VALS displays.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- control wheel stabilizer trim switches
- the speedbrake lever
- the flap lever
- aileron trim switches
- rudder trim switch

121-130

- stabilizer trim levers

131-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

- alternate stabilizer trim switches

The columns and wheels are connected through jam override mechanisms. If a jam occurs in a column or wheel, the pilots can maintain control by applying force to the other column or wheel to overcome the jam. When a restricted portion of the flight controls are bypassed, some control effectiveness may be lost.

The rudder pedals are rigidly connected between the two sides.

The speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer

Roll control is provided by:

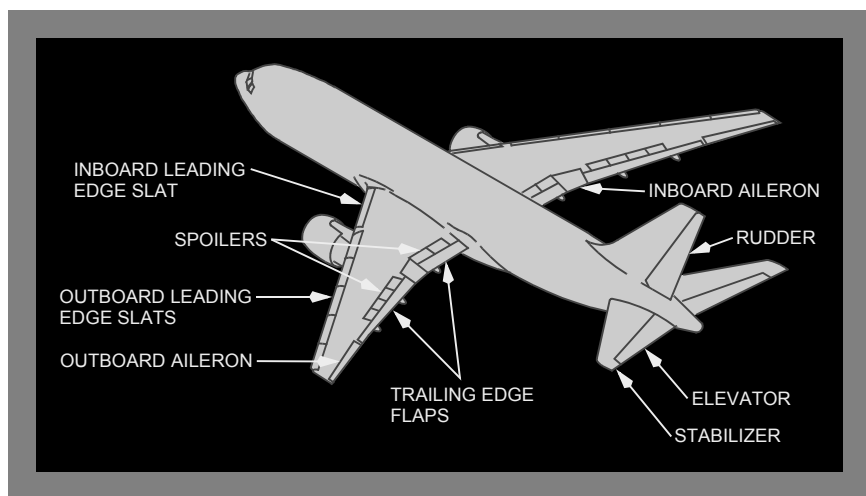
- four ailerons
- twelve spoilers

Yaw control is provided by a single rudder.

Flaps and slats provide high lift for takeoff, approach, and landing.

Symmetric spoilers are used as speedbrakes.

Flight Control Surface Locations



Pitch Control

The pitch control surfaces consist of two elevators and a stabilizer.

Elevator

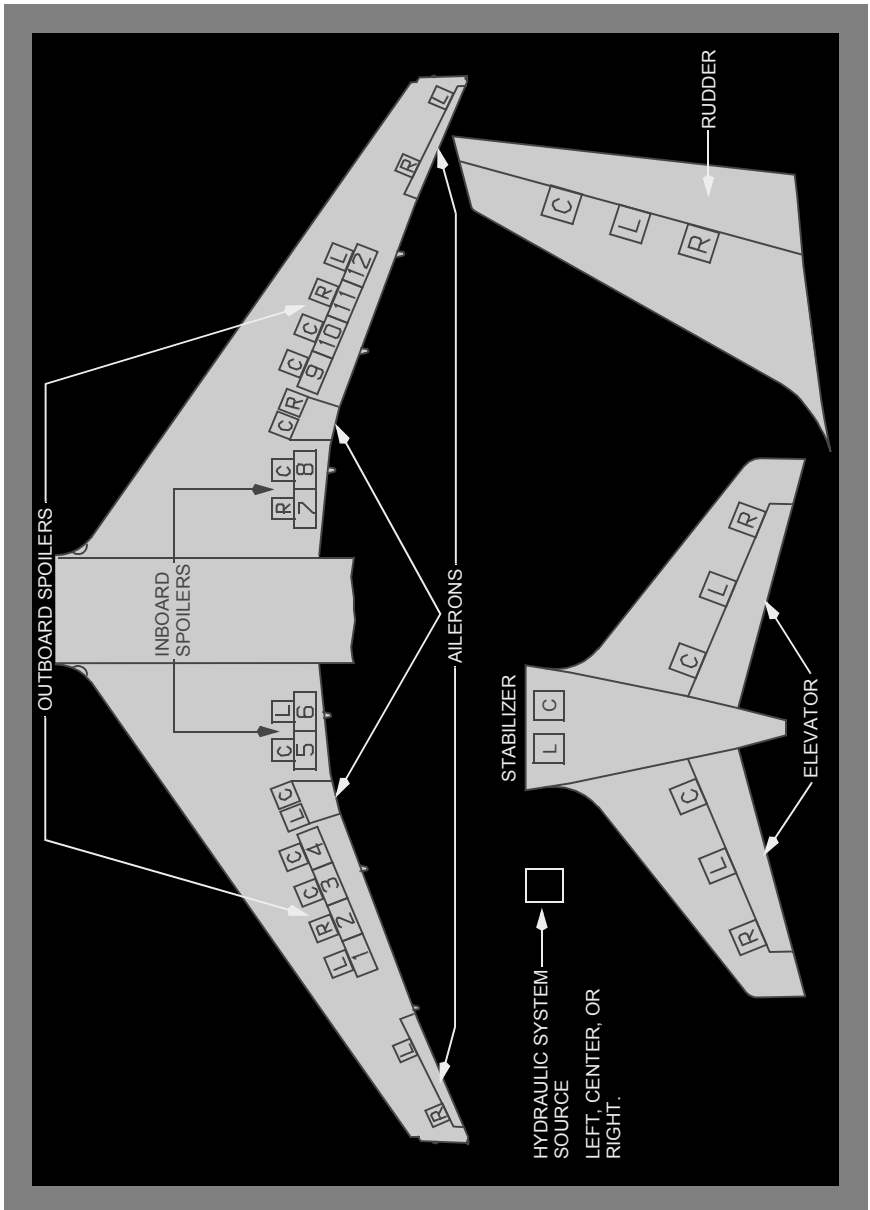
Moving the control column signals hydraulic actuators to move the elevators.

Elevator positions are shown on the EICAS status display. Separate pointers indicate the left and right elevator deflection. A full-scale indication corresponds to the maximum elevator deflection.

If one control column should jam, applying significant forward or aft force to the other causes the two columns to override. Pitch control is then available using the free control column path.

Two elevator feel systems provide artificial feel forces to the pilots control columns. Mechanical springs provide feel following a loss of the left and center hydraulic systems.

Actuator Control Hydraulic Power Distribution



Stabilizer Trim Control

The stabilizer is powered by the left and center and hydraulic systems. Stabilizer position commands are sent to the stabilizer trim control modules, which control hydraulic power to the stabilizer. There are two modules, one for each stabilizer hydraulic source.

Stabilizer position is displayed on two stabilizer position indicators located on the control stand. Green bands indicate the normal trim settings for takeoff.

There are three modes of stabilizer trim control:

- electric
- alternate
- automatic

Electric Trim

Dual electric pitch trim switches located on the control wheel must be pushed simultaneously to command trim changes.

To set Stabilizer Trim less than 1.5 units with flaps up requires use of Alternate Trim system.

Alternate Trim

121-130

Alternate trim control is provided by the stabilizer trim levers on the control stand. Pushing both levers simultaneously commands trim changes and provides an increased range of stabilizer travel. The signals override any other conflicting trim inputs.

131-139, 171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

Alternate trim control is provided by the alternate stabilizer trim switches on the control stand. Pushing both switches simultaneously commands trim changes and provides an increased range of stabilizer travel. The signals neutralize any other conflicting trim inputs.

Automatic Trim

The stabilizer is controlled automatically by the autopilot.

Automatic stabilizer trim uses only one trim control module and trims at one-half the electric or alternate trim rate.

Non-normal Operation

If a single autopilot is engaged, electric trimming causes the autopilot to disengage. If multiple autopilots are engaged, the electric trim switches are inhibited. Alternate trimming does not cause autopilot disengagement.

The UNSCHED STAB TRIM light illuminates and the EICAS caution message UNSCHD STAB TRIM displays when uncommanded stabilizer motion is detected.

The light and message also occur if alternate trim is used with an autopilot engaged.

The left and center stabilizer cutout switches control hydraulic power to the respective stabilizer trim control module. Placing both switches in the CUTOUT position removes all hydraulic power from the stabilizer.

The control column can be used to interrupt stabilizer trim commands. This feature allows the pilot to quickly stop uncommanded trim changes. The stabilizer trim commands are interrupted if the control column is displaced in the opposing direction.

The STAB TRIM light illuminates and the EICAS advisory message STAB TRIM displays when the electric or alternate stabilizer trim rate is one-half the normal control wheel stabilizer trim switch rate.

If the malfunction is unique to the electric trim control, full trim rate is available by using alternate trim.

Pitch Enhancement System (PES)

The Pitch Enhancement System (PES) consists of a hydraulic motor in the right system driving a pump which uses trapped left trim system fluid to operate the stabilizer. It will automatically activate if both the left and center hydraulic systems are lost in flight. Only electric (yoke) trim is available at approximately 1/4 the normal rate. Alternate and automatic trim will be inoperative.

Roll Control

Two ailerons are located on each wing on either side of the outboard trailing edge flap. Aileron surface deflections are proportional to control wheel displacement. Spoilers begin to extend to augment roll control after several degrees of control wheel rotation. Control wheel forces increase as control displacement increases.

The control wheels are connected so that, if one control wheel jams, using significant force causes the control wheels to override. Roll control is then available using the free control wheel.

The inboard ailerons droop in conjunction with trailing edge flap extension.

Ailerons

Aileron positions are shown on the EICAS status display. A full-scale indication corresponds to maximum aileron deflection.

Dual aileron trim switches located on the aft aisle stand must be pushed simultaneously to command trim changes. Hydraulic power from one of the three hydraulic systems is necessary to accurately set aileron trim.

The amount of aileron trim is indicated on a scale on the top of each control column.

Note: If the flight crew inadvertently activates aileron trim while an autopilot is engaged, the repositioning of the aileron neutral point is not apparent to the crew. When the autopilot is disengaged, the control wheels and ailerons move to the new (possibly undesired) neutral point and the airplane will roll proportional to the amount of trim input.

The aileron lockout control system permits full travel of the outboard ailerons at low speeds and locks out the outboard ailerons at high speeds. This provides the required roll authority at low airspeeds and prevents over controlling at high airspeeds.

The AIL LOCK light illuminates and the EICAS advisory message AILERON LOCKOUT displays to indicate aileron lockout actuator disagrees with the commanded position. At high airspeeds it may indicate that one or both of the outboard ailerons failed to lockout. When the message and light appear at low airspeeds it may indicate that one or both of the outboard ailerons failed to unlock.

Yaw Control

Yaw control is provided by a single rudder. Two yaw dampers operate through the rudder control system to improve directional stability.

Rudder

Rudder position is shown on the EICAS status display. On the ground, a full scale indication corresponds to the maximum rudder deflection.

The rudder trim control can be used to command trim changes. The rudder trim indicator shows the units of rudder trim that are commanded.

Rudder Ratio

The control commands from the rudder pedals and trim control are modified by a rudder ratio changer. As airspeed increases the ratio changer desensitizes these inputs from the pilot to reduce the rudder deflection.

The ratio changer receives air data computer airspeed inputs and provides control commands to an actuator powered by the left hydraulic system. The actuator then dampens the pilots inputs to the rudder.

The RUDDER RATIO light illuminates and the EICAS advisory message RUDDER RATIO displays to indicate the rudder ratio system is failed. Rudder structural protection is provided by automatic depressurization of the left hydraulic system actuator which limits rudder displacement at high airspeeds. However, abrupt rudder pedal input should be avoided at high airspeeds. At low airspeeds the two remaining rudder actuators provide sufficient control for full rudder displacement.

If the left hydraulic system is providing normal pressure to the ratio changer, a fault may result in limited displacement of the rudder at all airspeeds. This requires that crosswind and auto land limitations be observed.

Yaw Damping

The yaw damper systems improve turn coordination and dutchroll damping.

The yaw damper INOP light illuminates and the EICAS advisory message L or R YAW DAMPER displays, when a yaw damper is inoperative

Spoilers

There are six spoiler panels located on the upper wing surface of each wing. Spoilers on opposing wings are symmetrically paired.

Spoiler panels are used as speedbrakes to increase drag and reduce lift, both in flight and on the ground. The spoilers also supplement roll control in response to control wheel commands.

Speedbrake Load Alleviation System

(as installed)

Speedbrake load alleviation system operates in flight when these conditions occur at the same time:

- Flaps are UP
- Gross weight is greater than 340,000 lbs
- Indicated airspeed is greater than 320 knots

If the SPEEDBRAKE lever is beyond the 50% position it will automatically move to 50% position. If the SPEEDBRAKE lever is DOWN, an attempt to move it past the 50% position will be restricted. In either case the pilot may override the SPEEDBRAKE lever restriction by applying additional force to the SPEEDBRAKE lever

When gross weight becomes less than 339,000 lbs or airspeed becomes less than 315 knots, the load alleviation system deactivates and the SPEEDBRAKE lever movement is unrestricted.

Spoiler Speedbrake Operation

(aircraft without Speedbrake Load Alleviation System)

The speedbrakes are controlled by the speedbrake lever located on the control stand. The speedbrake lever has three marked positions:

- DOWN
- ARMED
- UP

(aircraft with Speedbrake Load Alleviation System)

The speedbrakes are controlled by the speedbrake lever located on the control stand. The speedbrake lever has four marked positions:

- DOWN
- ARMED
- 50%
- UP

(aircraft without Speedbrake Load Alleviation System)

The speedbrake lever can be placed in intermediate positions between ARMED and UP.

(aircraft with Speedbrake Load Alleviation System)

The speedbrake lever can be placed in intermediate positions between ARMED and UP, however, the speedbrake Load Alleviation System may limit lever placement to 50% or less.

In the ARMED position, when the landing gear is fully on the ground (not tilted) and the thrust levers are at idle, the speedbrake lever is driven aft to the UP position and the spoiler panels are fully extended.

On the ground when either reverse thrust lever is moved to the reverse idle detent, the speedbrake lever is driven to the up position and the spoiler panels are fully extended. The speedbrake lever does not need to be in the ARMED position.

The SPEEDBRAKES light illuminates if speedbrakes are extended when radio altitude is 800 feet or below or the flaps are in landing position.

The EICAS caution message SPEEDBRAKES EXT displays and the master caution lights and beeper activate when the SPEEDBRAKES light illuminates.

The AUTO SPDBRK light illuminates and the EICAS advisory message AUTO SPEEDBRAKE displays to indicate a fault is detected in the automatic speedbrake system which may result in the loss of automatic speedbrake extension.

If the speedbrake lever is armed, the message and light indicate a fault which may result in an inadvertent speedbrake extension in flight. The speedbrake lever should be returned to the DOWN position. The speedbrakes can still be operated manually.

The SPOILERS light illuminates and the EICAS advisory message SPOILERS displays to indicate that one or more spoiler pairs are inoperative.

Flaps and Slats

The trailing edge flaps and leading edge slats are high lift devices that increase wing lift and decrease stall speed during takeoff, approach, and landing.

Flap and slat positions are indicated by two pointers in the flap position indicator. There are L and R pointers for the left and right wing flaps and slats. The right pointer is normally hidden from view by the left pointer.

In the flaps 1 position, only the slats move. Flaps 5, 15, 20 are takeoff flap positions. Flaps 25 and 30 are landing flap positions. Flaps 20 is used for some non-normal landing conditions.

Flap and Slat Sequencing

When the flap lever is in the UP detent, all flaps and slats are commanded retracted and the flap position indicator points to UP. Moving the flap lever aft allows selection of flap detent positions 1, 5, 15, 20, 25, and 30.

Starting from flaps UP, selection of flaps 1 commands the slats to move to the midrange position. The flaps remain retracted. The position indicator pointers move mid-way between UP and 1 when the slats are in transit. The pointers move to the 1 indication when all slats are in the midrange position.

Selection of the flaps 5, 15, or 20 positions commands the flaps to move to the position selected. The inboard ailerons droop in conjunction with flap extension. The slats remain in the midrange position. The position indicator provides only trailing edge flap position indications for all flap settings greater than 1.

Selection of flaps 25 commands both the flaps and slats to move to landing positions.

Selection of flaps 30 commands the flaps to extend to the primary landing position.

During retraction flap and slat sequencing is reversed.

The flap gate at the flaps 20 detent prevents inadvertent retraction of the flaps past the go-around position. The flap gate at flaps 1 prevents inadvertent retraction of the slats.

Flap Load Relief

The flap load relief system protects the flaps from excessive airloads.

121-124

If the flap airspeed placard limit is exceeded with the flaps in the 30 position, the flaps automatically retract to position 25.

125-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

If the flap airspeed placard limit is exceeded with the flaps in the 25 or 30 position, the flaps automatically retract to position 20.

When airspeed is reduced, the flaps automatically re-extend.

Flap/Slat Non-Normal Operation

Alternate Flap Operation

The alternate mode allows direct manual operation of either the flaps and/or slats through electric motors. The alternate flaps switches:

- allow independent selection of either flaps or slats
- disable normal control
- arm the alternate mode
- engage the electric motors
- the flap lever no longer controls the selected flaps and/or slats

The alternate flaps selector extends and retracts the flaps and slats. Alternate mode flap and slat extension is limited procedurally to flaps 20. Flap load relief is not available in the alternate mode.

121-139, 171-199, 1200-1201, 1401-1404, 1601-1610, 1701-1707

Trailing edge flap asymmetry protection is not available in the alternate mode.

1611-1613, 1708

Trailing edge flap asymmetry protection is available in the alternate mode.

Slat and flap operation time in the alternate mode is greatly increased.

Leading Edge Disagreement

The LEADING EDGE light illuminates and the EICAS caution message LE SLAT DISAGREE displays when the leading edge slat positions disagree with commanded position.

The disagree indicates that the slats are not driving toward their new commanded position.

A LE SLAT DISAGREE may also occur if the flap lever is not in a detent for an extended period of time. In this case, the light and message can be removed by moving the flap lever to the desired detent.

Leading Edge Asymmetry

The LEADING EDGE light illuminates and the EICAS caution message LE SLAT ASYM displays when the leading edge slats are not symmetrically extended. Hydraulic power to the slats is automatically shut off.

Trailing edge flaps extension is inhibited until the slats extend to position 1. Therefore, if a slat asymmetry occurs between the UP and 1 positions, the flap indicator may not move until flaps 5 or greater is selected.

Trailing Edge Disagreement

The TRAILING EDGE light illuminates and the EICAS caution message TE FLAP DISAGREE displays when the trailing edge flap positions disagree with commanded position.

The disagree indicates that the flaps are not driving toward their new commanded position.

A TE FLAP DISAGREE may also occur if the flap lever is not in a detent for an extended period of time. In this case, the light and message can be removed by moving the flap lever to the desired detent.

Trailing Edge Asymmetry

The TRAILING EDGE light illuminates and the EICAS caution message TE FLAP ASYM displays when the trailing edge flaps are not symmetrically extended. Hydraulic power to the flaps is automatically shut off.

Load Relief Inoperative

The TRAILING EDGE light illuminates and the EICAS advisory message FLAP LD RELIEF is displayed when the flap load relief system fails to operate when required.

Hydraulic Driven Generator (as installed)

When the hydraulic driven generator is supplying electrical power, hydraulic flow to the slats and flaps is reduced, resulting in increased slat and flap operating time.

Flight Controls

EICAS Messages

Chapter 9

Section 30

Flight Controls EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
AILERON LOCKOUT	Advisory	AIL LOCK		An aileron lockout actuator disagrees with the commanded position.
AUTO SPEEDBRAKE	Advisory	AUTO SPDBRK		A fault is detected in the automatic speedbrake system.
FLAP LD RELIEF	Advisory	TRAILING EDGE		The flap load relief system fails to operate when required.
FLT CONT VALS	Advisory	OFF		Two or more flight control valves are closed.
LE SLAT ASYM	Caution	LEADING EDGE	Beeper	The leading edge slats are not symmetrically extended.
LE SLAT DISAGREE	Caution	LEADING EDGE	Beeper	The leading edge slat positions disagree with the commanded position.
RUDDER RATIO	Advisory	RUDDER RATIO		The rudder ratio system is failed.
SPEEDBRAKES EXT	Caution	SPEED BRAKES	Beeper	The speedbrakes are extended when the flaps are in a landing position, or when radio altitude is 800 feet or below.
SPOILERS	Advisory	SPOILERS		One or more spoiler pairs are inoperative.

Message	Level	Light	Aural	Condition
STAB TRIM	Advisory	STAB TRIM		The stabilizer trim rate is one-half of the normal control wheel stabilizer trim switch rate.
C TAIL HYD VAL L TAIL HYD VAL R TAIL HYD VAL	Advisory	OFF		A tail flight control valve is closed.
TE FLAP ASYM	Caution	TRAILING EDGE	Beeper	The trailing edge flaps are not symmetrically extended.
TE FLAP DISAGREE	Caution	TRAILING EDGE	Beeper	The trailing edge flap positions disagree with the commanded position.
UNSCHD STAB TRIM	Caution	UNSCHED STAB TRIM	Beeper	Uncommanded stabilizer motion is detected.
C WING HYD VAL L WING HYD VAL R WING HYD VAL	Advisory	OFF		A wing flight control valve is closed.
L YAW DAMPER R YAW DAMPER	Advisory	INOP		The yaw damper is inoperative.

Flight Instruments, Displays

Chapter 10

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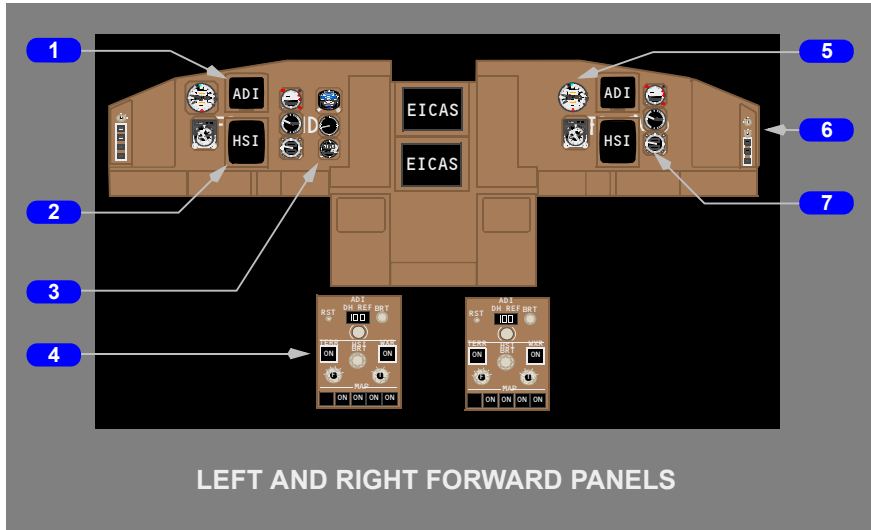
Flight Instruments, Displays

EFIS Controls and Indicators

Chapter 10

Section 10

Flight Instrument Display System - Overview



LEFT AND RIGHT FORWARD PANELS

1 Attitude Director Indicator (ADI)

Displays flight management modes, airspeed, attitude, and radio altitude.

2 Horizontal Situation Indicator (HSI)

Displays map, approach, VOR or plan modes as selected on EFIS CPs.

3 Standby Flight Instruments

4 EFIS Control Panels

Displays controlled via their respective EFIS CP

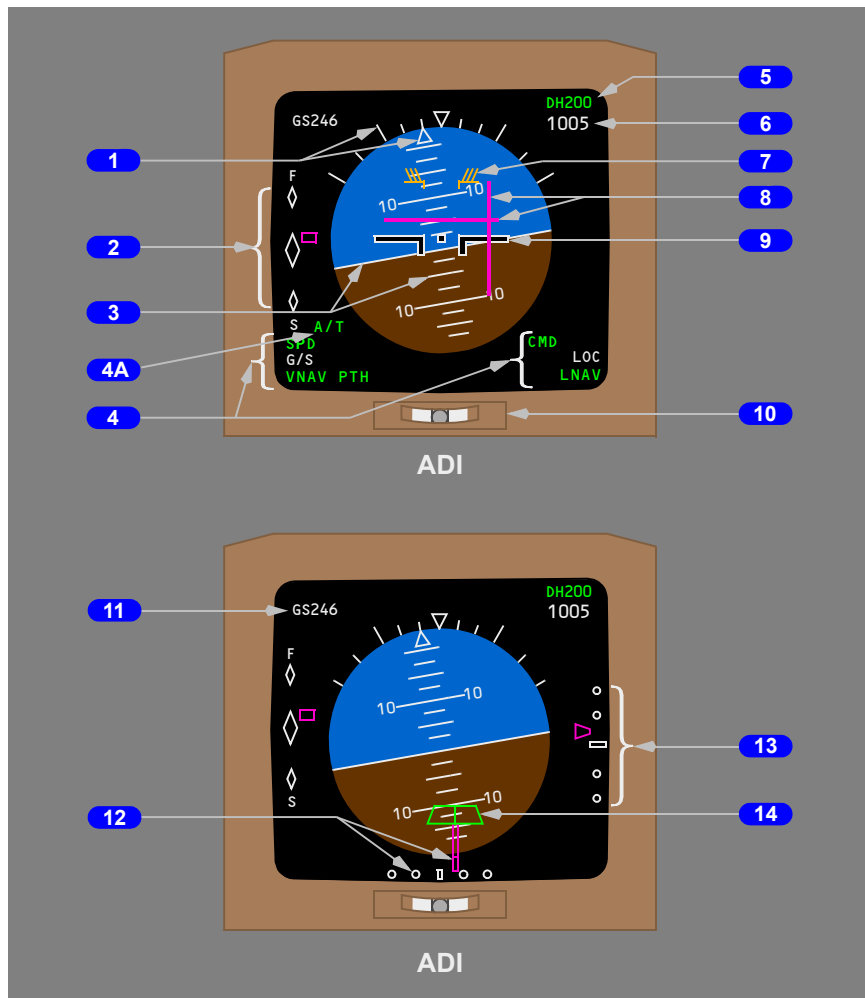
5 Primary Airspeed Indicator (Conventional)

6 Source Selector Panel

Selects sources for respective flight instruments.

7 Primary Flight Instruments (Conventional)

Attitude Director Indicator (ADI) Display



1 Bank Pointer and Scale

Indicates IRS bank in reference to the bank scale.

2 Fast/Slow Indicator

Displays airspeed information.

- indicates deviation from the airspeed selected by the FMC or the IAS/MACH selector, or limit speed
- small diamonds indicate 10 knots fast (F), or slow (S).

3 Horizon Line and Pitch Angle Scale

Indicates the IRS horizon relative to the airplane symbol.

Pitch scale is in 2.5 degree increments.

4 Flight Mode Annunciations

Displays Autopilot Flight Director System (AFDS) mode status. Refer to Automatic Flight, Chapter 4 for description.

4A Autothrottle Annunciation

These airplane(s) have A/T annunciated above the thrust mode.

6 Decision Height

Displays selected decision height.

- blanks when negative decision height is selected
- display changes from green to amber, increases in size and “DH” flashes momentarily when airplane descends below decision height (decision height alerting)
- decision height alert is reset automatically – if airplane climbs 75 feet or more above the selected decision height, or after the airplane lands
- decision height alert is reset manually – if the RST switch is pushed.

7 Radio Altitude

Displays radio altitude.

- blank above 2,500 feet AGL
- changes color from white to amber when below selected decision height on descent
- changes color from amber back to white when airplane climbs 75 feet or more above the selected decision height, or after the airplane lands
- changes color from amber back to white when the RST switch is pushed.

7 Pitch Limit Indicator

Indicates pitch limit (stick shaker activation point for the existing flight conditions).

- displays when flaps are extended.
- displays when flaps are not up, or at slow speeds with the flaps up.

Note: Due to part number interchangeability of Stall Warning Computer, it is possible for a FLAPS-UP PLI to display on only one ADI.

7 Flight Director Command Bars

Indicates flight director pitch and roll steering commands.

- displays when the respective F/D switch is ON and valid command steering is available
- blanks when the respective F/D switch is OFF or when command steering becomes invalid.
- displays when either G/A switch is pushed during a windshear warning regardless of the flight director switch position.

9 Airplane Symbol

Indicates airplane attitude with reference to the IRS horizon.

10 Slip Indicator

Indicates coordinated flight.

11 Ground Speed

Indicates ground speed in knots.

12 Localizer Pointer and Deviation Scale

The localizer pointer indicates position relative to the airplane.

- scale indicates deviation
- pointer not displayed when localizer is unusable
- scale and pointer not displayed when an ILS frequency is not selected
- scale and pointer can display an ILS Deviation Alert.
- a two dot expanded localizer scale (not shown here) displays when LOC is engaged and deviation is slightly more than one half dot on the four dot scale. The expanded scale is more sensitive, with one dot deviation equal to one half dot deviation on the four dot scale

13 Glide Slope Pointer and Deviation Scale

The glideslope pointer indicates glideslope position relative to the airplane.

- scale indicates deviation
- pointer not displayed when glide slope unusable or when track and the front course on the ILS panel differ by more than 90°
- scale and pointer not displayed when an ILS frequency is not selected
- scale and pointer can display an ILS deviation alert.

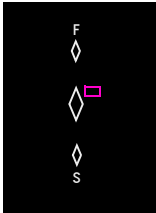
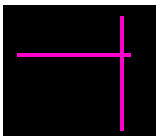
14 Rising Runway

Displays when the localizer pointer is displayed and radio altitude is below 2500 feet.

- rises towards airplane symbol when radio altitude is below 200 feet AGL
- stem can display an ILS deviation alert.

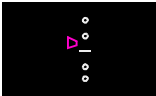
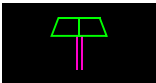
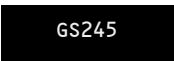
ADI Symbolology

The following symbols can be displayed.

Symbol	Name	Remarks
	Fast/Slow airspeed indicator (white) and pointer (magenta)	Displays airspeed information. - indicates deviation from the airspeed selected by the FMC or the IAS/MACH selector, or limit speed - small diamonds indicate 10 knots fast (F), or slow (S).
	Airplane symbol (black)	Indicates airplane attitude with reference to the IRS horizon.
	Flight director command bars (magenta)	Indicates flight director pitch and roll steering commands. - displays when the respective F/D switch is ON and valid command steering is available - blanks when the respective F/D switch is OFF or when command steering becomes invalid.
	PLI - Pitch Limit Indicator (amber)	Indicates pitch limit (stick shaker activation point for the existing flight conditions). 0121 through 1611, 1701 through 1708 - displays when flaps are extended. 1612, 1613 - displays when flaps are not up, or at slow speeds with the flaps up.

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Symbol	Name	Remarks
	Decision height (green/amber)	Displays selected decision height. - blanks when negative decision height is selected - display changes from green to amber, increases in size and “DH” flashes momentarily when airplane descends below decision height (decision height alerting) - decision height alert is reset automatically – if airplane climbs 75 feet or more above the selected decision height, or after the airplane lands - decision height alert is reset manually – if the RST switch is pushed.
	Radio altitude (white/amber)	Displays radio altitude. - blank above 2500 feet AGL - changes color from white to amber when below selected decision height on descent - changes color from amber back to white when airplane climbs 75 feet or more above the selected decision height, or after the airplane lands - changes color from amber back to white when the RST switch is pushed.

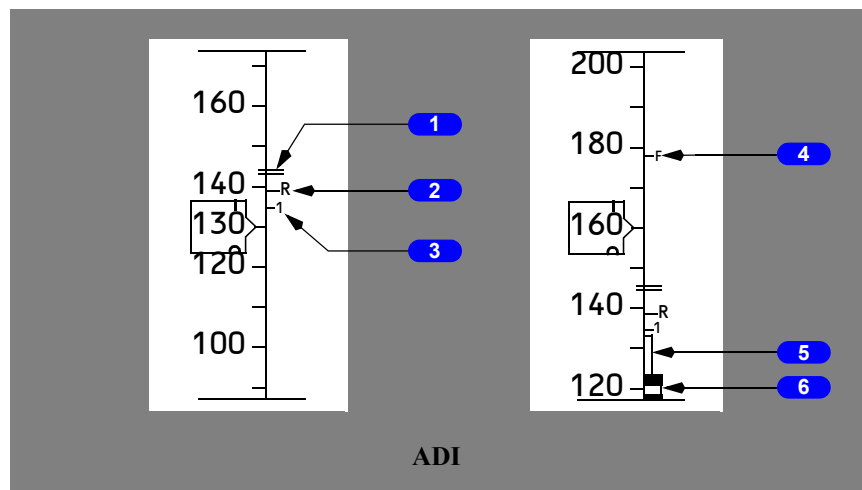
Symbol	Name	Remarks
	Localizer deviation scale (white) and pointer (magenta)	The localizer pointer indicates position relative to the airplane. • scale indicates deviation • pointer not displayed when localizer is unusable • scale and pointer not displayed when an ILS frequency is not selected • scale and pointer can display an ILS Deviation Alert. • a two dot expanded localizer scale (not shown here) displays when LOC is engaged and deviation is slightly more than one half dot on the four dot scale. • expanded scale is more sensitive, with one dot deviation equal to one half dot deviation on the four dot scale
	Glideslope deviation scale (white) and pointer (magenta)	The glideslope pointer indicates glideslope position relative to the airplane. • scale indicates deviation • pointer not displayed when glideslope unusable or when track and the front course on the ILS panel differ by more than 90° • scale and pointer not displayed when an ILS frequency is not selected • scale and pointer can display an ILS deviation alert.
	Rising runway (green)	Displays when the localizer pointer is displayed and radio altitude is below 2500 feet. • rises towards airplane symbol when radio altitude is below 200 feet AGL • stem can display an ILS deviation alert.
	Groundspeed (white)	Indicates groundspeed in knots.



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Symbol	Name	Remarks
 A black rectangular box containing the text "A/T" in green.	Autothrottle (green)	These airplane(s) have A/T annunciated above the thrust mode.
 A black rectangular box containing the text "WINDSHEAR" in red.	Windshear annunciation (Red)	Windshear warning active. Refer to Chapter 15, Warning Systems.

ADI Speed Tape (as installed)



1 FMC/MCP Command Airspeed Bug

Displays when the FMC/MCP command airspeed as selected by the FMC or the IAS/MACH selector is in the displayed range.

2 VR (Rotation Speed) Bug

Indicates rotation speed.

- displays after manual entry on the TAKEOFF REF page
- blanks 2 minutes after takeoff.

3 V1 (Decision Speed) Bug

Indicates Decision Speed

- displays after manual entry on the TAKEOFF REF page
- replaces digital V1 display when V1 speed is within the displayed range
- blanks 2 minutes after takeoff.

4 Maneuvering Speed

- displays maneuvering speed for existing flap setting
- displays 10 seconds after takeoff
- blanks above 20,000 feet.

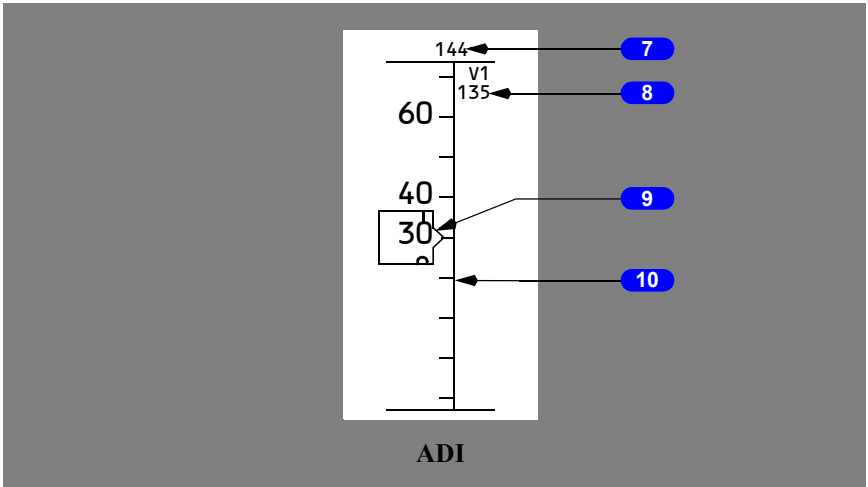
5 Minimum Maneuvering Speed

Top of amber bar indicates speed where 40° bank results in stick shaker.

- displays shortly after takeoff.

6 Minimum Speed

Indicates the airspeed where stick shaker activates.



7 FMC/MCP Command Airspeed

Displays in this location when the FMC/MCP command airspeed bug as selected by the FMC or IAS/MACH selector is above the displayed range.

8 V1 (Decision Speed)

Indicates decision speed.

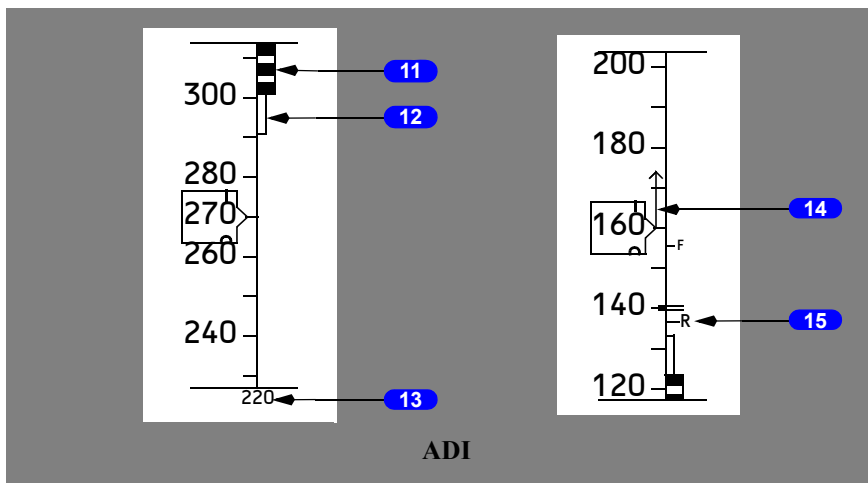
- displays after manual entry on the TAKEOFF REF page
- displays during initial takeoff roll when V1 is above the displayed range.

9 Airspeed Pointer and Digital Display

- indicates current airspeed when above 30 knots

10 Speed Tape Scale

Scrolls up or down in response to airspeed changes.



11 Maximum Speed

Indicates maximum permissible airspeed as limited by the lowest of the following:

- V_{mo}/M_{mo}
- landing gear placard speed
- flap placard speed.

12 Maximum Maneuvering Speed

When displayed, indicates maneuver margin to buffet. May be displayed when operating at high altitude at relatively high gross weights.

13 FMC/MCP Command Airspeed

Displayed in this location when the FMC/MCP command airspeed bug as selected by the FMC or IAS/MACH selector is below the displayed range.

14 Speed Trend Vector

Indicates predicted airspeed in 10 seconds based on current acceleration or deceleration.

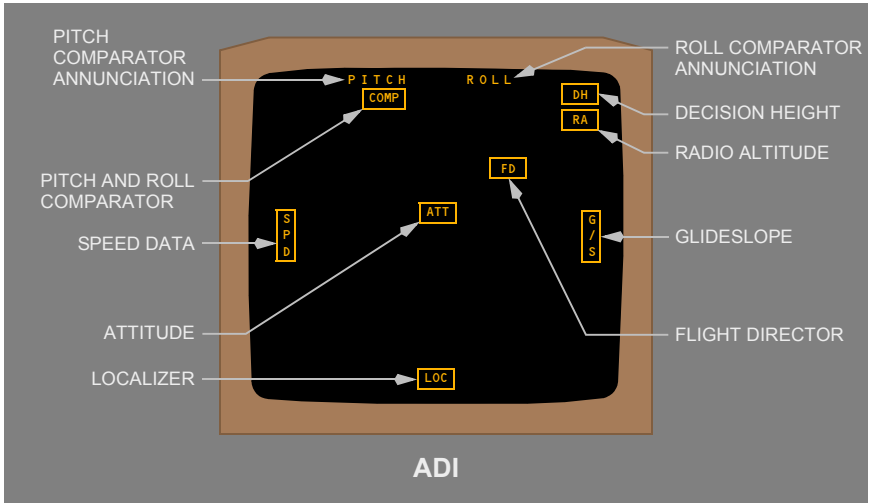
15 Landing Reference Bug

Displays the VREF speed as selected on the APPROACH REF page.

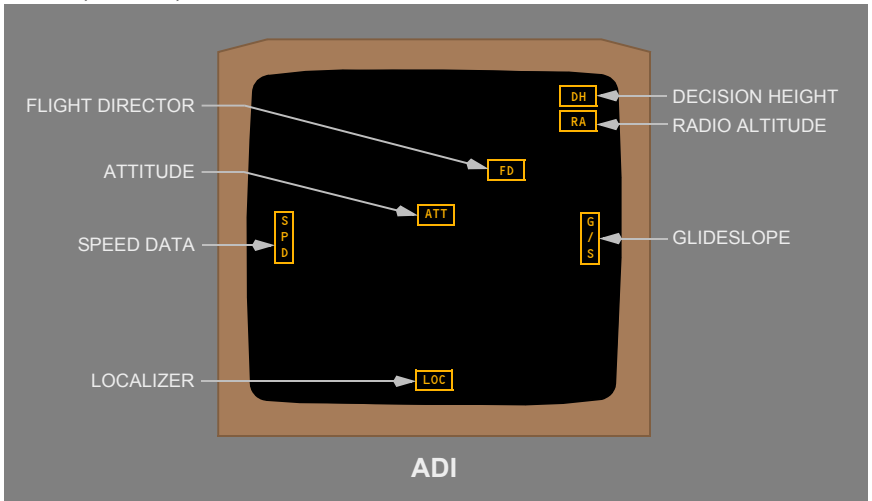
ADI Failure Flags and Annunciations

Note: ADI failure flags replace the appropriate display to indicate source system failure, or lack of computed information.

187-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1708



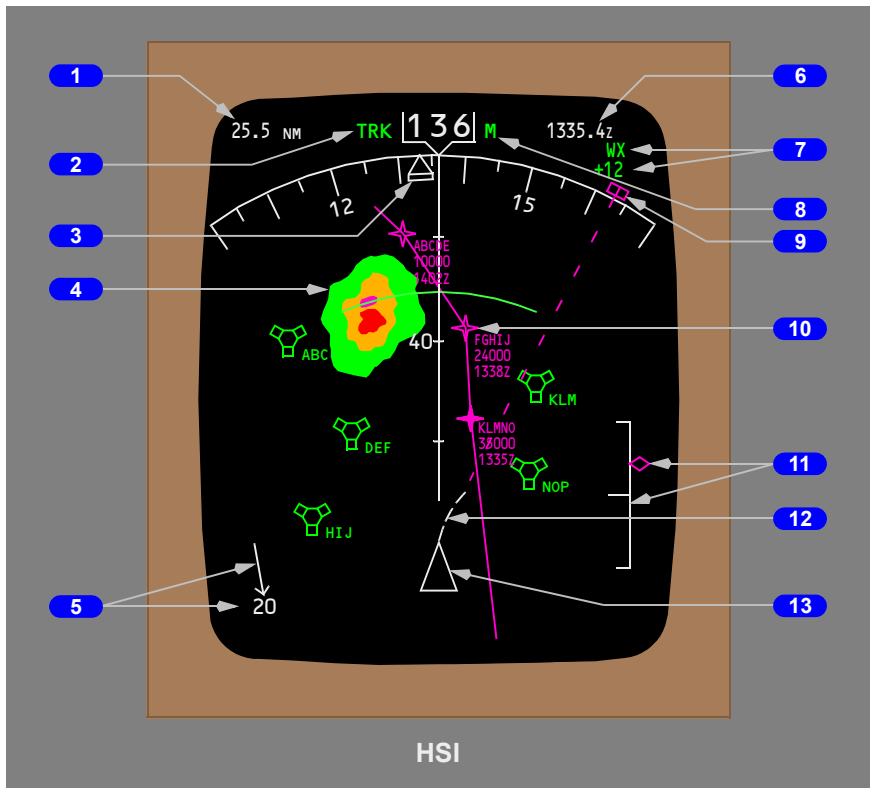
121-139, 171-186, 1401-1402



Intentionally
Blank

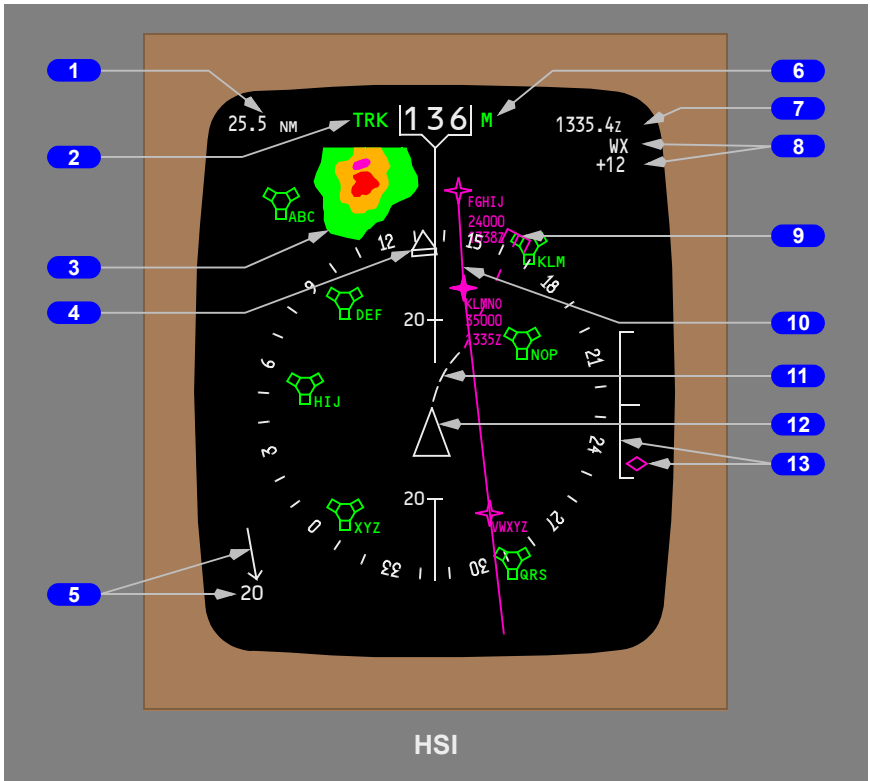
Horizontal Situation Indicator (HSI) Display Modes

MAP Mode



- 1 Distance to the Active Waypoint**
- 2 Current Track**
- 3 Heading Pointer**
- 4 Weather Radar Returns**
- 5 Wind Direction and Speed**
- 6 Estimated Time of Arrival at the Active Waypoint**
- 7 Weather Radar Annunciations**
- 8 Magnetic/True Reference**
- 9 Selected Heading Bug**
- 10 Active LNAV Route**
- 11 Vertical Pointer and Deviation Scale**
- 12 Position Trend Vector**
- 13 Airplane Symbol**

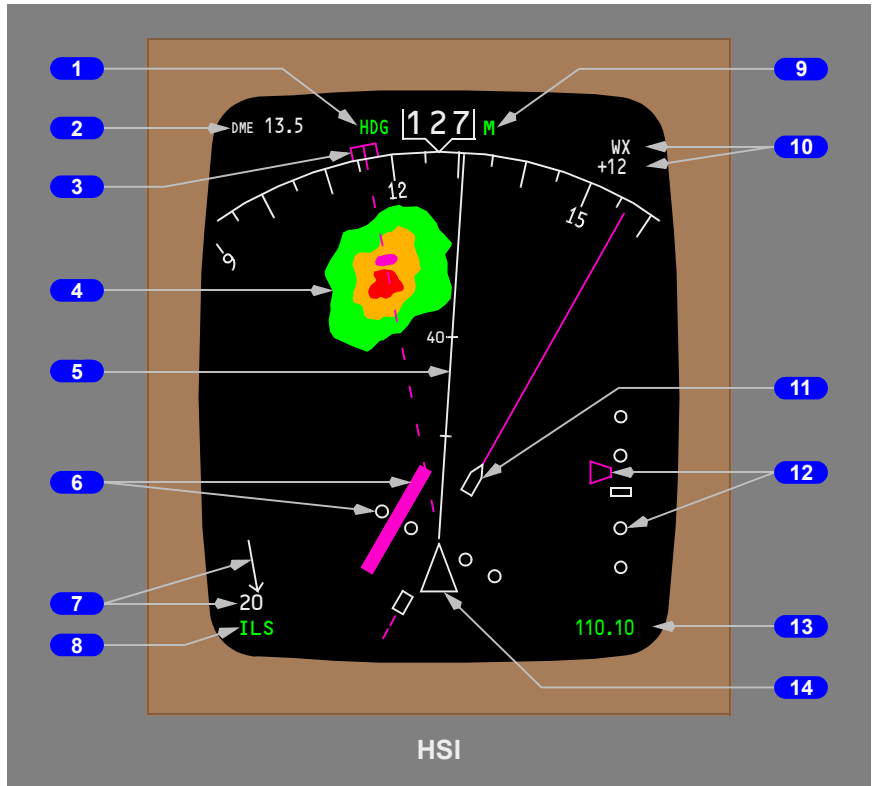
CTR MAP Mode



- 1 Distance to the Active Waypoint**
- 2 Current Track**
- 3 Weather Radar Returns**
- 4 Heading Pointer**
- 5 Wind Direction and Speed**
- 6 Magnetic/True Reference**
- 7 Estimated Time of Arrival at the Active Waypoint**
- 8 Weather Radar Annunciations**
- 9 Selected Heading Bug**
- 10 Active LNAV Route**
- 11 Position Trend Vector**
- 12 Airplane Symbol**
- 13 Vertical Pointer and Deviation Scale**

EXP ILS Mode

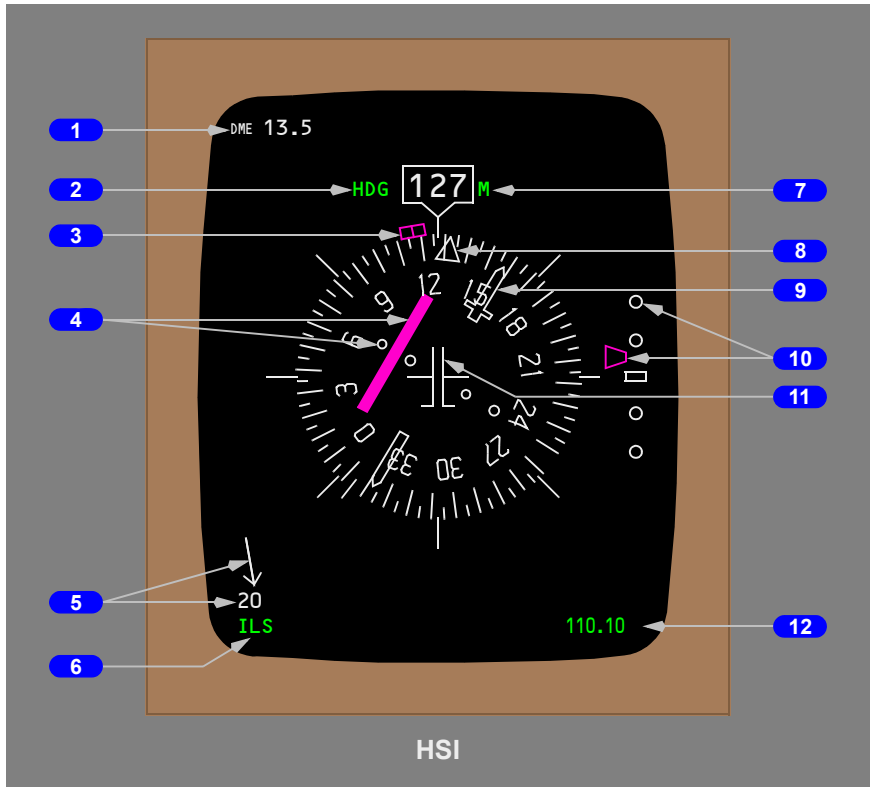
APP Mode



- 1 Current Heading**
- 2 Reference ILS DME**
- 3 Selected Heading Bug**
- 4 Weather Radar Returns**
- 5 Track Line**
- 6 Course Deviation Indicator and Deviation Scale**
- 7 Wind Direction and Speed**
- 8 Reference ILS Receiver**
- 9 Magnetic/True Reference**
- 10 Weather Radar Annunciations**
- 11 Selected Course Pointer**
- 12 Glideslope Pointer and Deviation Scale**
- 13 Reference ILS Frequency**
- 14 Airplane Symbol**

FULL ILS Mode

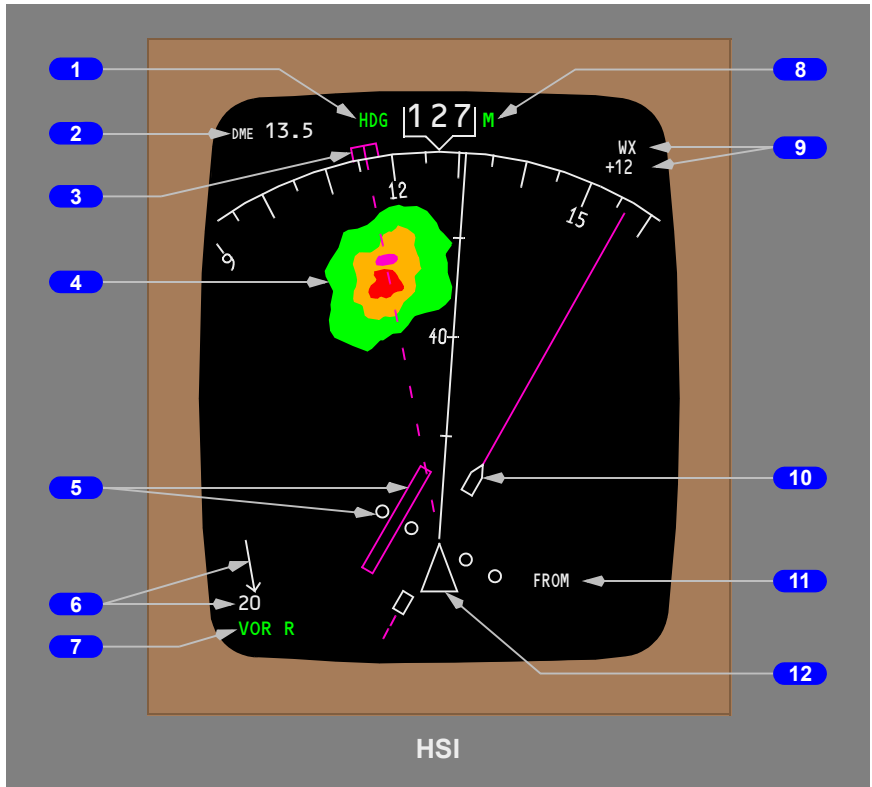
CTR APP Mode



- 1 Reference ILS DME**
- 2 Current Heading**
- 3 Selected Heading Bug**
- 4 Course Deviation Indicator and Deviation Scale**
- 5 Wind Direction and Speed**
- 6 Reference ILS Receiver**
- 7 Magnetic/True Reference**
- 8 Drift Angle Pointer**
- 9 Selected Course Pointer**
- 10 Glideslope Pointer and Deviation Scale**
- 11 Airplane Symbol**
- 12 Reference ILS Frequency**

VOR Mode

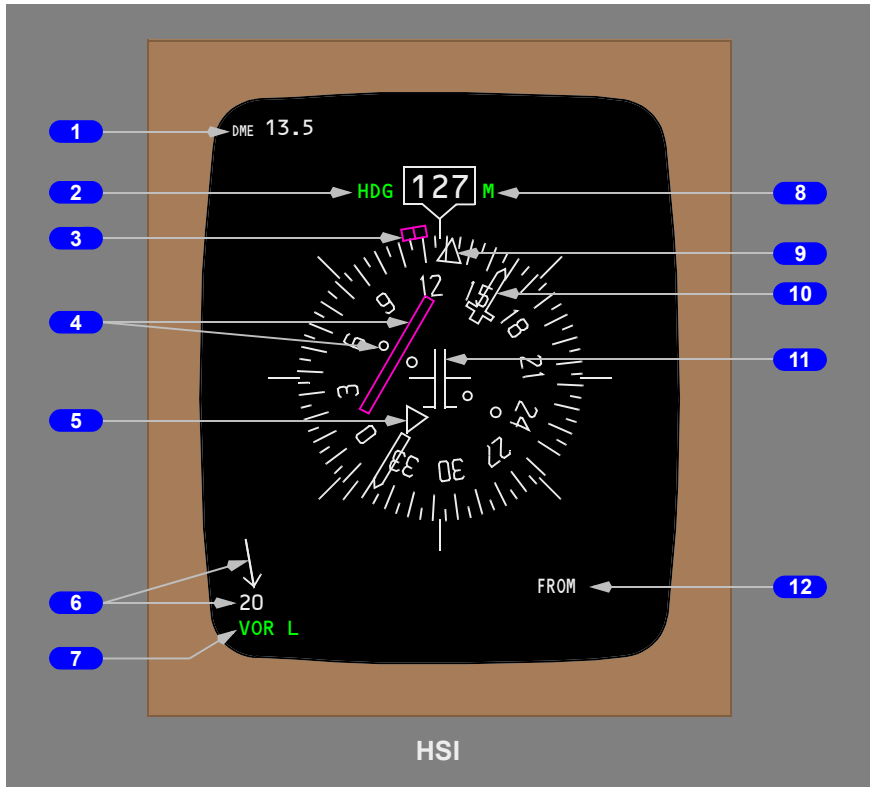
EXP VOR Mode



- 1 Current Heading**
- 2 Reference VOR DME**
- 3 Selected Heading Bug**
- 4 Weather Radar Returns**
- 5 Course Deviation Indicator and Deviation Scale**
- 6 Wind Direction and Speed**
- 7 Reference VOR Receiver**
- 8 Magnetic/True Reference**
- 9 Weather Radar Annunciations**
- 10 Selected Course Pointer**
- 11 TO/FROM Indication**
- 12 Airplane Symbol**

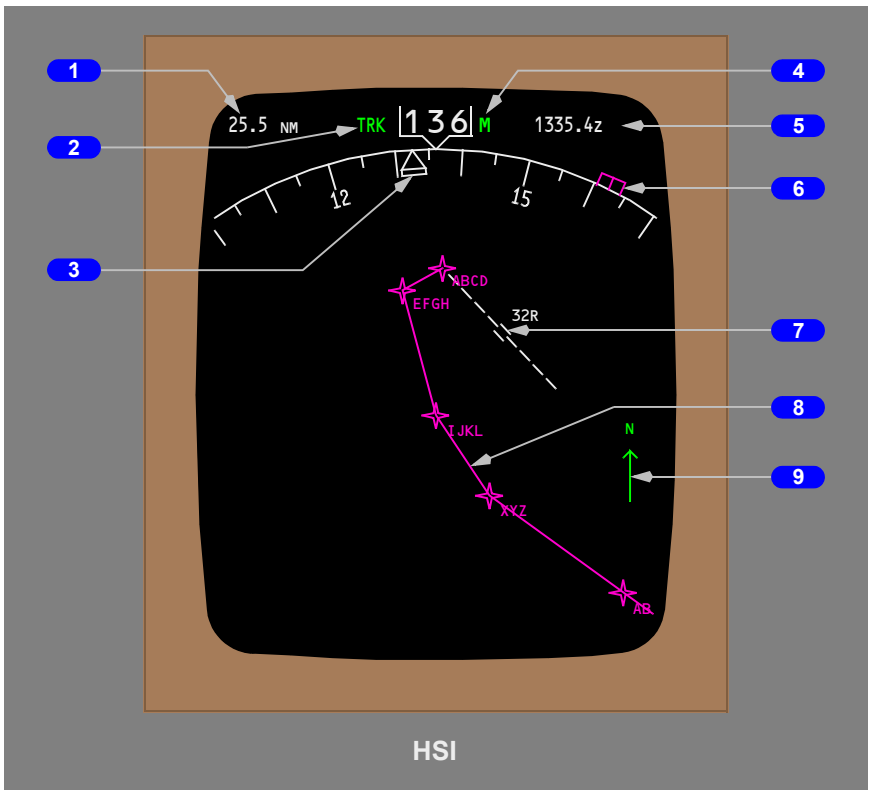
FULL VOR Mode

CTR VOR Mode



- 1 Reference VOR DME**
- 2 Current Heading**
- 3 Selected Heading Bug**
- 4 Course Deviation Indicator and Deviation Scale**
- 5 To/From Pointer**
- 6 Wind Direction and Speed**
- 7 Reference VOR Receiver**
- 8 Magnetic/True Reference**
- 9 Drift Angle Pointer**
- 10 Selected Course Pointer**
- 11 Airplane Symbol**
- 12 TO/FROM Indication**

PLAN Mode



- 1 Distance to the Active Waypoint**
- 2 Current Track**
- 3 Heading Pointer**
- 4 Magnetic/True Reference**
- 5 Estimated Time of Arrival at the Active Waypoint**
- 6 Selected Heading Bug**
- 7 Airport and Runway**
- 8 Active LNAV Route**
- 9 True North Pointer**

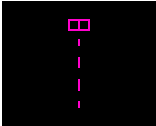
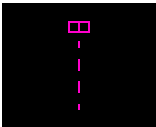
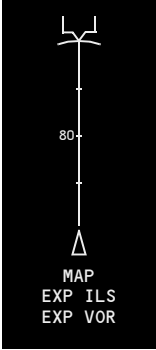
HSI Symbolology

The following symbols can be displayed, depending on EFIS control panel switch selections. Colors indicate the following:

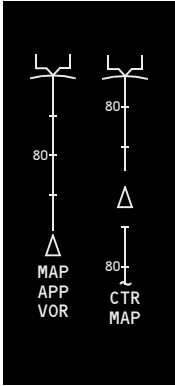
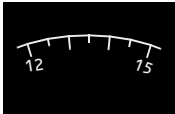
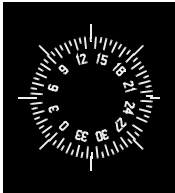
- (W) (white) – present status, range scales
- (G) (green) – active or selected mode and/or dynamic conditions
- (M) (magenta) – command information, pointers, symbols, fly-to condition, weather radar turbulence
- (C) (cyan) – nonactive or background information
- (A) (amber) – cautions, faults, flags
- (R) (red) – warnings
- (B) (black) – blank area, off condition.

Heading, Track, and Wind

Symbol	Name	Applicable Mode(s)	Remarks
	Track orientation (G), current track (W), and track reference (G)	MAP PLAN CTR MAP	Displays track as the display orientation, the current track, and M or TRU as the reference, and points to the heading on the compass rose.
	HDG – Heading orientation (G), current heading and pointer (W), heading reference (G)	EXP VOR FULL VOR EXP ILS FULL ILS VOR CTR VOR APP CTR APP	HDG – Displays heading as the display orientation, current heading, M or TRU as the heading reference, and points to the heading on the compass rose.
	Heading reference (G), box (W) in TRU, box (A) if TRU displayed in descents of 2,000 feet at more than 800 feet per minute.	All	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 (W).

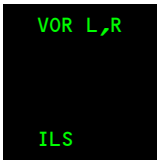
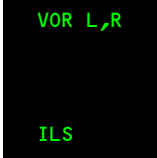
Symbol	Name	Applicable Mode(s)	Remarks
	Selected heading bug (M) and reference line (M)	MAP EXP VOR EXP ILS Bug only FULL VOR FULL ILS PLAN	Displays the heading set in the MCP. A dashed line (M) extends from the bug to the airplane symbol in the MAP and expanded modes.
	Selected heading bug (M) and reference line (M)	MAP, CTR MAP VOR, APP Bug only CTR VOR CTR APP PLAN	Displays the heading set in the MCP. A dashed line (M) extends from the bug to the airplane symbol in the MAP and expanded modes.
	Current heading pointer (W)	MAP PLAN	Points to current heading on the compass rose.
	Track line and range scale (W)	MAP EXP ILS EXP VOR	Displays present ground track based on airplane heading and wind. The displayed range numeric values are one-half the actual selected range. With heading-up orientation (EXP VOR/EXP ILS mode), the track line will be rotated left or right at an angle equal to the drift angle.

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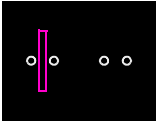
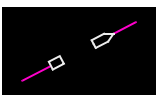
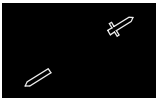
Symbol	Name	Applicable Mode(s)	Remarks
	Track line and range scale (W)	MAP CTR MAP APP VOR	Displays present ground track based on airplane heading and wind. The displayed range numeric values are one-half and one-fourth (CTR MAP) the actual selected range. With heading-up orientation (VOR/APP mode), the track line will be rotated left or right at an angle equal to the drift angle.
	Expanded compass rose (W)	MAP PLAN EXP ILS EXP VOR VOR APP	Displays 70 degrees of compass rose.
	Full compass rose (W) Fixed reference marks (W)	FULL VOR FULL ILS CTR VOR CTR APP	The compass rose rotates through 360 degrees as a function of airplane heading. Fixed reference marks are evenly spaced at 45 degree intervals.
	Center Map full compass rose (W)	CTR MAP	The compass rose rotates through 360 degrees as a function of airplane heading.

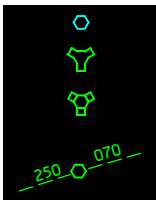
Symbol	Name	Applicable Mode(s)	Remarks
	Wind speed and direction. (W)	All except PLAN	Indicates wind speed and direction, with respect to display orientation and heading reference.

Radio Navigation

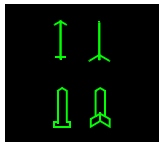
Symbol	Name	Applicable Mode(s)	Remarks
	Airplane symbol (W)	EXP VOR EXP ILS VOR APP	Current airplane position is at the apex of the triangle.
	Airplane symbol (W)	FULL VOR FULL ILS CTR VOR CTR APP	Current airplane position is at the center of the symbol.
	Reference VOR receiver (G)	EXP VOR FULL VOR	Indicates the source of the displayed navigation data.
	Reference ILS receiver (G)	EXP ILS FULL ILS	In the VOR or ILS mode the displayed data source is a function of the tuned frequency (VOR or LOC).
	Reference VOR receiver (G)	VOR CTR VOR	Indicates the source of the displayed navigation data.
	Reference ILS receiver (G)	APP CTR APP	In the VOR or APP mode the displayed data source is a function of the tuned frequency (VOR or LOC).

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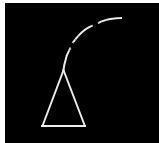
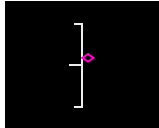
Symbol	Name	Applicable Mode(s)	Remarks
	Reference ILS frequency (G)	EXP ILS FULL ILS APP CTR APP	Displays frequency of manually tuned navaid.
	Reference VOR or ILS DME (W)	EXP VOR FULL VOR EXP ILS FULL ILS VOR CTR VOR APP CTR APP	Indicates DME distance to the reference navaid.
	Course deviation indicator (M) and deviation scale (W)	EXP VOR FULL VOR EXP ILS FULL ILS VOR CTR VOR APP CTR APP	Displays ILS or VOR course deviation.
	Selected course pointer (W) and line (M)	EXP VOR EXP ILS VOR APP	Displays selected course as set by the related VOR or ILS course selector.
	Selected course pointer (W)	FULL VOR FULL ILS CTR VOR CTR APP	Displays selected course as set by the related VOR or ILS course selector.
	Glideslope pointer (M) and deviation scale (W)	EXP ILS FULL ILS APP CTR APP	Displays glideslope position and deviation. Pointer not displayed when track and front course differ by more than 90°.

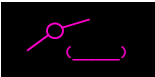
Symbol	Name	Applicable Mode(s)	Remarks
	To/from indication (W)	EXP VOR FULL VOR VOR CTR VOR	Displays VOR TO/FROM indication.
	To/from pointer (W)	FULL VOR CTR VOR	Displays VOR to/from direction.
	VOR (C, G), DME/TACAN (C, G), VORTAC (C, G) Manually tuned VOR radials (G)	MAP CTR MAP	When the EFIS control panel NAV AID switch is OFF, tuned nav aids, excluding NDBs, are displayed (G). When the EFIS control panel NAV AID switch is selected ON, appropriate nav aids are displayed. All nav aids contained in the FMC data base and within the MAP area are displayed when the selected range is 10, 20 or 40 NM. Only high altitude nav aids are displayed when the selected range is 80, 160, 320 NM. Nav aids not being used are displayed in cyan. Tuned VHF nav aids are displayed in green, regardless of switch selection. When a nav aid is manually tuned, the selected course and reciprocal are displayed.

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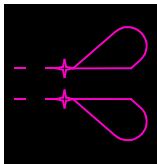
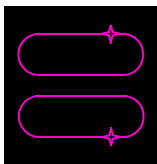
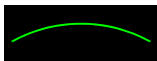
Symbol	Name	Applicable Mode(s)	Remarks
	Left ADF pointer head and tail (G) Right ADF pointer head and tail (G)	All	Indicates bearing to (head) or from (tail) the tuned station.

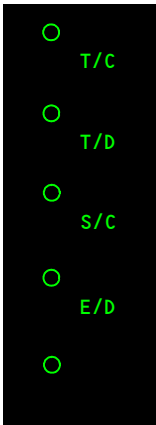
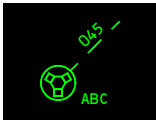
Map

Symbol	Name	Applicable Mode(s)	Remarks
	Position trend vector (W) (dashed line) and airplane symbol (W).	MAP CTR MAP	Predicts position at the end of 30, 60, and 90 second intervals, based on bank angle and ground speed. Each segment represents 30 seconds. Selected range determines the number of segments displayed: - Range > 20 NM, 3 segments - Range = 20 NM, 2 segments - Range = 10 NM, 1 segment
	North Pointer (G)	PLAN	Indicates orientation of map background to true north.
	Vertical pointer (M), and deviation scale (W)	MAP CTR MAP	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates +/- 400 feet deviation.

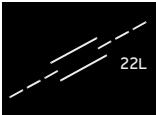
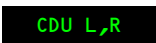
Symbol	Name	Applicable Mode(s)	Remarks
	Off route waypoint (C)	MAP PLAN CTR MAP	When the EFIS control panel WPT switch is selected on, waypoints not on the selected route are displayed, for ranges of 10, 20, or 40 NM. When a range greater than 40NM is selected, only those waypoints associated with NDBs that are within 80NM of the airplane are displayed.
	Conditional Waypoint: active (M), inactive (W)	MAP PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route. Data with parentheses for conditional waypoints indicates type of conditional waypoint (ALTITUDE etc.)

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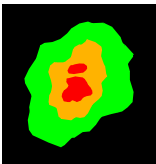
Symbol	Name	Applicable Mode(s)	Remarks
	Procedure turn: active (M), modified (W), inactive (C)	MAP PLAN CTR MAP	A fixed size procedure turn appears when it is part of the displayed FMC route. When the procedure turn waypoint is active and the HSI range is 40 nm or less, the procedure turn changes to the correct scale size. Also used for procedure hold course reversal.
	Holding pattern: active route (M), modified route (W), inactive route (C)	MAP PLAN CTR MAP	A fixed size holding pattern appears when it is part of the displayed FMC route. When the holding waypoint is active and the HSI range is 80 nm or less, the holding pattern changes to the correct scale size. Depicts entry path until entry is completed.
	Altitude range arc (G)	MAP CTR MAP	Based on present vertical speed and ground speed, indicates the approximate map position where the MCP altitude is reached.

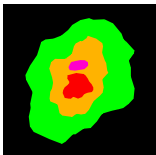
Symbol	Name	Applicable Mode(s)	Remarks
	Energy management circles: clean (C), speedbrake (W)	MAP CTR MAP	Indicates clean and speedbrake energy management circles as defined on OFFPATH DES page.
	Altitude profile point and identifier (G)	MAP PLAN CTR MAP	Indicates the approximate map position of the FMC-calculated T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent) points. Deceleration points have no identifier.
	Selected reference point and bearing information (G)	MAP PLAN CTR MAP	Displays the reference point selected on the CDU FIX page. Bearing from the fix is displayed with dashes (G).
	Selected reference point and distance information (G)	MAP PLAN CTR MAP	Displays the reference point selected on the CDU FIX page. Distance from the fix is displayed with dashes (G).

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Symbol	Name	Applicable Mode(s)	Remarks
	Airport (C)	MAP PLAN CTRMAP	Displayed if the EFIS control panel ARPT switch is selected ON. Origin and destination airports are always displayed, regardless of switch selection.
	Airport and runway (W)		Displayed when selected as the origin or destination and selected range is 80, 160, or 320 NM.
	Airport and runway (W)		Displayed when selected as the origin or destination and selected range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	MAP source annunciation (G)	MAP	Displays HSI source if CDU is selected on respective NAV Source Select Switch.

Radar

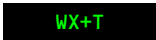
Symbol	Name	Applicable Mode(s)	Remarks
	Weather radar (WXR) returns (R, A, G)	MAP EXP VOR EXP ILS	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green.

Symbol	Name	Applicable Mode(s)	Remarks
	Weather radar (WXR) returns (R, A, G, M)	MAP CTR MAP VOR APP	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.

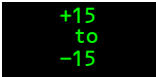
0131 through 0139, 0176 through 1403, 1601, 1602, 1701 through 1704

	WXR precipitation only mode (G)	MAP EXP VOR EXP ILS	Weather radar system is selected on the EFIS control panel. Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).

1404, 1603 through 1613, 1705 through 1708

	WXR and turbulence mode (G)	MAP CTR MAP VOR APP	Weather radar system is selected on the EFIS control panel. Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).

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Symbol	Name	Applicable Mode(s)	Remarks
	WXR receiver gain (G)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather radar system is selected on the EFIS control panel. Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).
	Mode used with down-tilt when ground mapping (G)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather radar system is selected on the EFIS control panel. Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).
	WXR antenna tilt (G)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather radar system is selected on the EFIS control panel. Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).

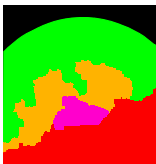
Symbol	Name	Applicable Mode(s)	Remarks
	WXR test mode (C) (G)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather radar mode, gain and tilt is controlled on the weather radar panel(s) (refer to Chapter 11, Flight Management, Navigation).
	WXR calibration fault (A)	MAP EXP VOR EXP ILS	When a degraded condition is present the EFIS will continue to display weather radar information. If any two or all degraded conditions occur simultaneously, the system will display only the highest priority condition as follows: • WEAK • ATT • STAB
	WXR attitude input fault (A)	CTR MAP VOR APP	
	WXR stabilization off (A)		
	WXR display fault (A)	MAP CTR MAP VOR APP	HSI overheat or loss of digital unit cooling air when WXR is selected. Overheat annunciation has display priority over all other degraded conditions. Weather radar information removed after 30 seconds.

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Symbol	Name	Applicable Mode(s)	Remarks
	WXR system failure (A)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather radar system failure is annunciated under any of the following conditions: • receiver transmitter failure • antenna failure • control panel failure
	WXR range status annunciations (A)	MAP EXP VOR EXP ILS CTR MAP VOR APP	Weather output range disagrees with the range selected by the EFIS control panel.
	WXR range status annunciations (A)	MAP CTR MAP	Weather output range and map display output range disagree with selected EFIS control panel range.

Look-Ahead Terrain

1404, 1603 through 1613, 1705 through 1708

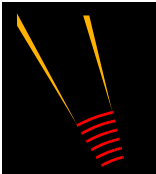
Symbol	Name	Applicable Mode(s)	Remarks
	Terrain display (R, A, G, M)	MAP CTR MAP VOR APP	Displays terrain data from the GPWS terrain data base. The terrain displays as follows: 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude (G), 500 feet (250 feet with gear down) below to 2000 feet above the airplane's current altitude (A), more than 2,000 feet above the airplane's current altitude (R), no terrain data available (M). Color and density vary based on terrain height vs. airplane altitude.
	Terrain alert annunciation (R, A)	All	Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).
	Terrain mode annunciation (C)	MAP CTR MAP VOR APP	Terrain display enabled (manual or automatic display).

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Symbol	Name	Applicable Mode(s)	Remarks
	Terrain status annunciations (A)	MAP CTR MAP VOR APP	Look-ahead terrain alerting and display have failed.
			Look-ahead terrain alerting and display unavailable due to position uncertainty.
			GPWS terrain override switch in OVRD position.
	Terrain test mode annunciation (C)		GPWS operating in self-test mode. This status annunciation is also available in plan mode.
	Terrain range status annunciations (A)	MAP CTR MAP VOR APP	Terrain output range disagrees with selected EFIS control panel range.
	Terrain range status annunciations (A)	MAP CTR MAP	Terrain output range and map display output range disagree with selected EFIS control panel range.

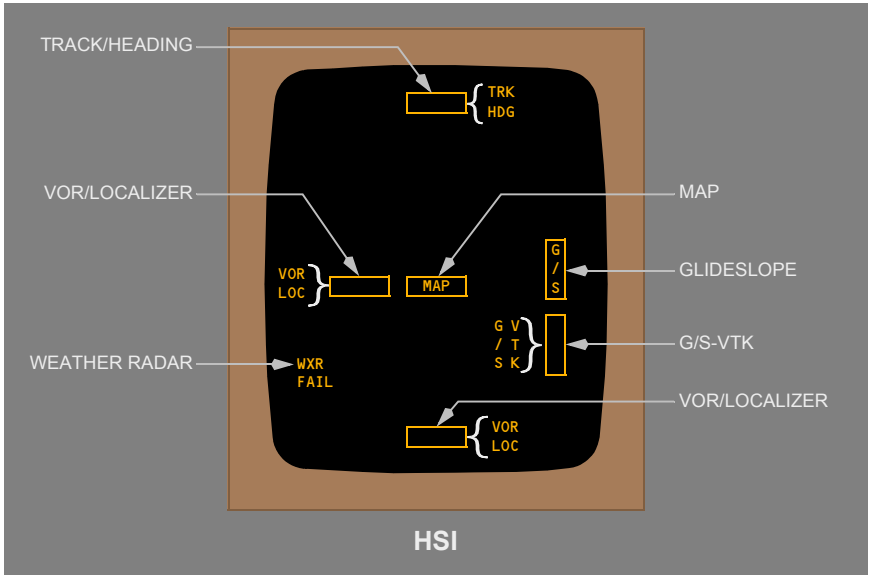
Predictive Windshear

1404, 1603 through 1613, 1705 through 1708

Symbol	Name	Applicable Mode(s)	Remarks
	Predictive windshear symbol (R, B, A)	MAP CTR MAP APP VOR	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).

HSI Failure Flags and Annunciations

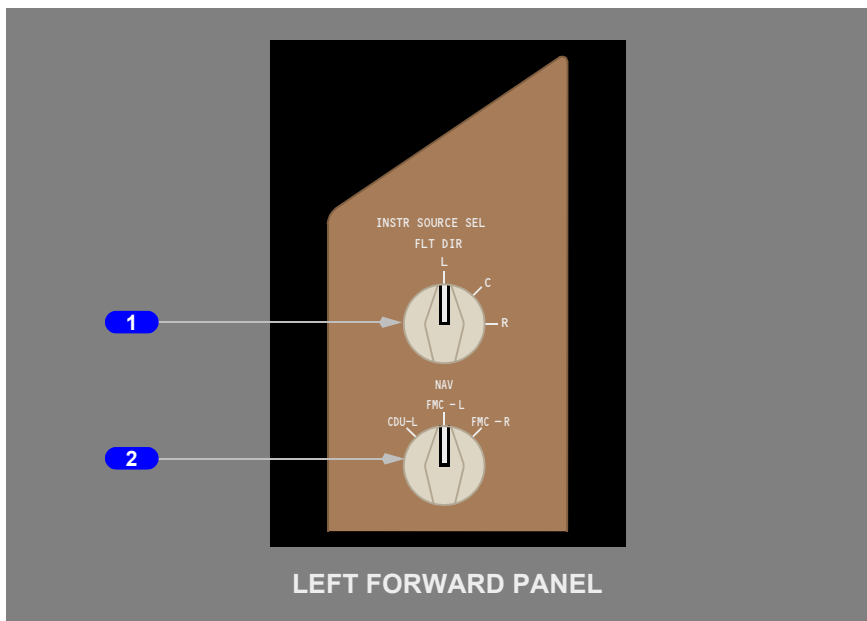
Note: HSI failure flags replace the appropriate display to indicate source system failure, or lack of computed information.



Instrument Switching

Various source selections are available for instrument displays. For other related instrument transfer switching, refer to Chapter 11, Flight Management, Navigation

Left Instrument Source Selector Panel (Upper)



1 Flight Director (FLT DIR) Source Selector

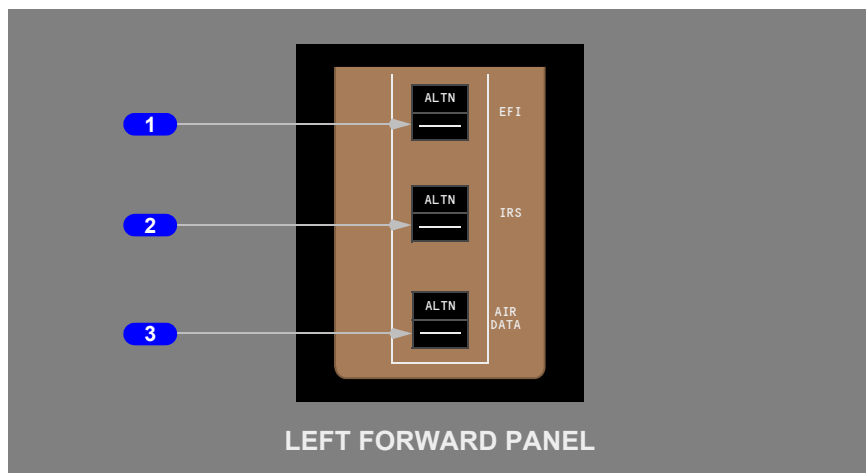
Selects the flight control computer (left, center, or right) used as the source of commands for the captain's flight director display.

2 Nav Instrument (NAV) Source Selector

Selects the source of FMC information used by the left and center EFIS symbol generators and the left and center flight control computers (FCCs).

- FMC L – normal position. The left FMC provides information to the left and center symbol generators, and to the left and center FCCs
- FMC R – alternate position. The right FMC provides information to the left and center symbol generators, and to the left and center FCCs
- CDU L – provides information to the left and center symbol generators. Used for operation of the Alternate Navigation System (refer to Chapter 11, Flight Management, Navigation)

Left Instrument Source Selector Panel (Lower)



1 Electronic Flight Instruments (EFI) Switch

Selects the EFIS symbol generator, ILS receiver, and radio altimeter used as the sources of information for the captains's ADI and HSI displays.

- Blank – normal position. The captains's displays use the left symbol generator, left ILS receiver, and left radio altimeter
- ALTN – alternate position. The captains's displays use the center symbol generator, center ILS receiver, and center radio altimeter

If both pilots select ALTN (both using center sources):

- both pilots' ADI and HSI displays are controlled by the left EFIS control panel
- the EICAS message INSTR SWITCH displays

2 Inertial Reference System (IRS) Switch

Selects the IRS used as the source of information for the left and center symbol generators, the captain's VSI, and the first officers RDMI. Information provided by the IRS includes attitude, heading, and vertical speed

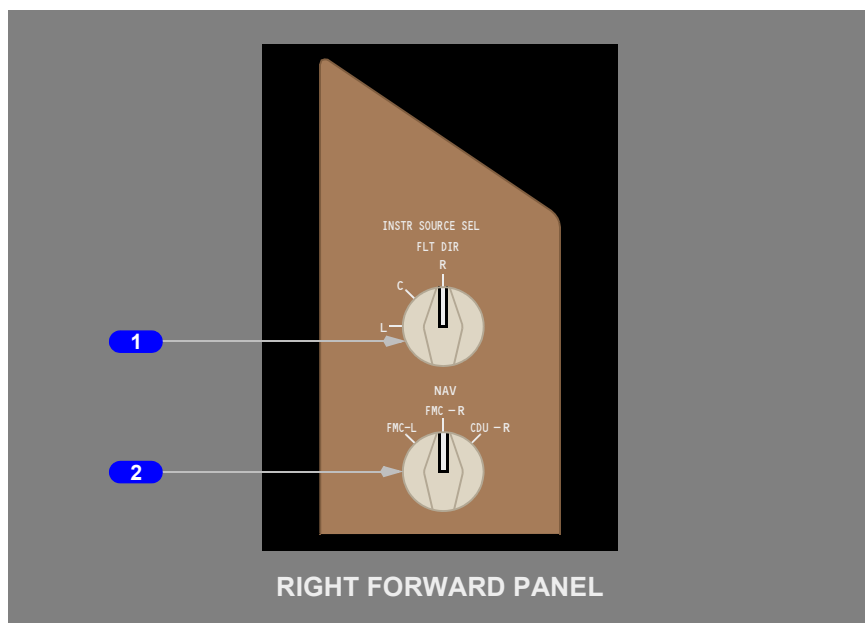
- Blank – normal position. The left IRS is the source for the left and center symbol generators, the captain's VSI, and the first officer's RDMI
- ALTN – alternate position. The center IRS is the source for the left and center symbol generators, the captain's VSI, and the first officer's RDMI

3 AIR DATA Switch

Selects the air data computer used as the source of information for the captain's Mach/airspeed indicator, primary altimeter, and vertical speed indicator (via the selected IRS).

- Blank – normal position. The left air data computer is the source for the captain's air data instruments
- ALTN – alternate position. The right air data computer is the source for the captain's air data instruments.

Right Instrument Source Selector Panel (Upper)



1 Flight Director (FLT DIR) Source Selector

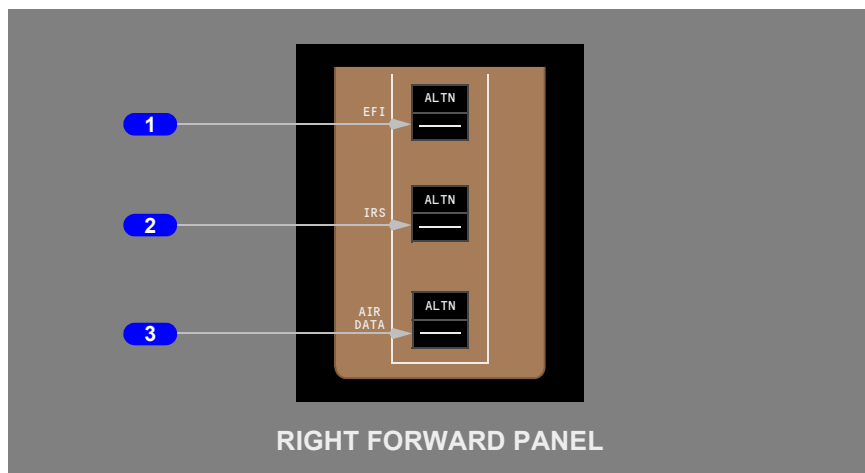
Selects the flight control computer (left, center, or right) used as the source of commands for the first officer's flight director display.

2 Navigation (NAV) Instrument Source Selector

Selects the source of FMC information used by the right EFIS symbol generator and the right flight control computer (FCC).

- FMC R – normal position. The right FMC provides information to the right symbol generator, and to the right FCC
- FMC L – alternate position. The left FMC provides information to the right symbol generator, and to the right FCC
- CDU R – provides information to the right symbol generator. Used for operation of the Alternate Navigation System (refer to Chapter 11, Flight Management, Navigation).

Right Instrument Source Selector Panel (Lower)



1 Electronic Flight Instruments (EFI) Switch

Selects the EFIS symbol generator, ILS receiver, and radio altimeter used as the sources of information for the first officer's ADI and HSI displays.

- Blank – normal position. The first officer's displays use the right symbol generator, right ILS receiver, and right radio altimeter
- ALTN – alternate position. The first officer's displays use the center symbol generator, center ILS receiver, and center radio altimeter

If both pilots select ALTN (both using center sources):

- both pilots' ADI and HSI displays are controlled by the left EFIS control panel
- the EICAS message INSTR SWITCH displays

2 Inertial Reference System (IRS) Switch

Selects the IRS used as the source of information for the right symbol generator, the first officer's VSI, and the captain's RDMI. Information provided by the IRS includes attitude, heading, and vertical speed.

- Blank – normal position. The right IRS is the source for the right symbol generator, the first officer's VSI, and the captain's RDMI
- ALTN – alternate position. The center IRS is the source for the right symbol generator, the first officer's VSI, and the captain's RDMI.

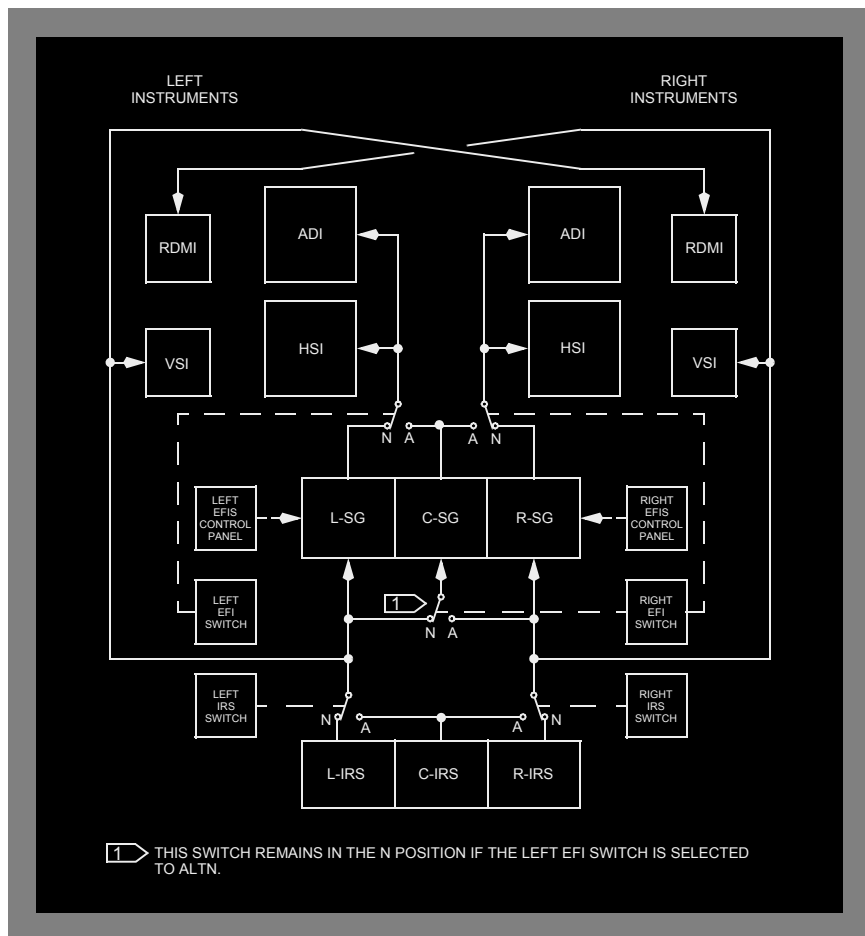
3 AIR DATA Switch

Selects the air data computer used as the source of information for the first officer's Mach/airspeed indicator, primary altimeter, and vertical speed indicator (via the selected IRS).

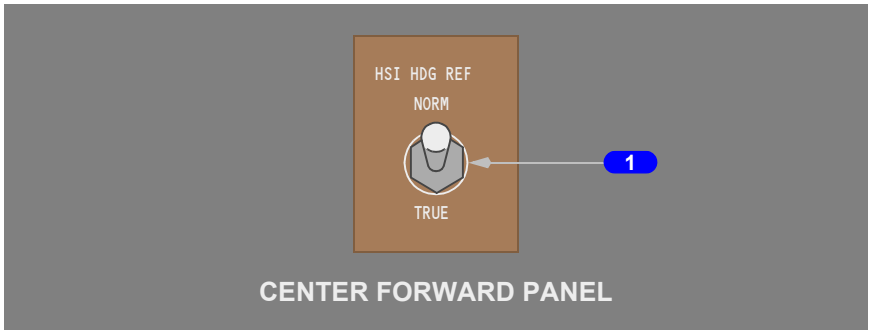
- Blank – normal position. The right air data computer is the source for the first officer's air data instruments
- ALTN – alternate position. The left air data computer is the source for the first officer's air data instruments.

EFI/IRS Interface Diagram

The following diagram shows the normal EFI/IRS interface. EFI switching determines the center symbol generator (C-SG) input and output. Normally, left system instrument sources supply the center symbol generator. When both pilots select ALTN with their EFI switches, the left system instrument sources supply data to the center symbol generator. However, the center symbol generator always uses the center ILS and center radio altimeter. Each EFIS control panel is connected to the symbol generator with the EFI switch. Each IRS switch permits pilot selection of the alternate data source for heading, attitude, and vertical speed.



HSI Heading Reference Switch



1 HSI Heading Reference (HSI HDG REF) Switch

NORM – With NORM selected, the navigation displays and computations are referenced to either magnetic north or true north, depending on current airplane position. Between 60 degrees S and 73 degrees N latitudes, systems are referenced to magnetic north. Above these latitudes, the systems are automatically referenced to true north, except on the RDMI which displays a HDG flag.

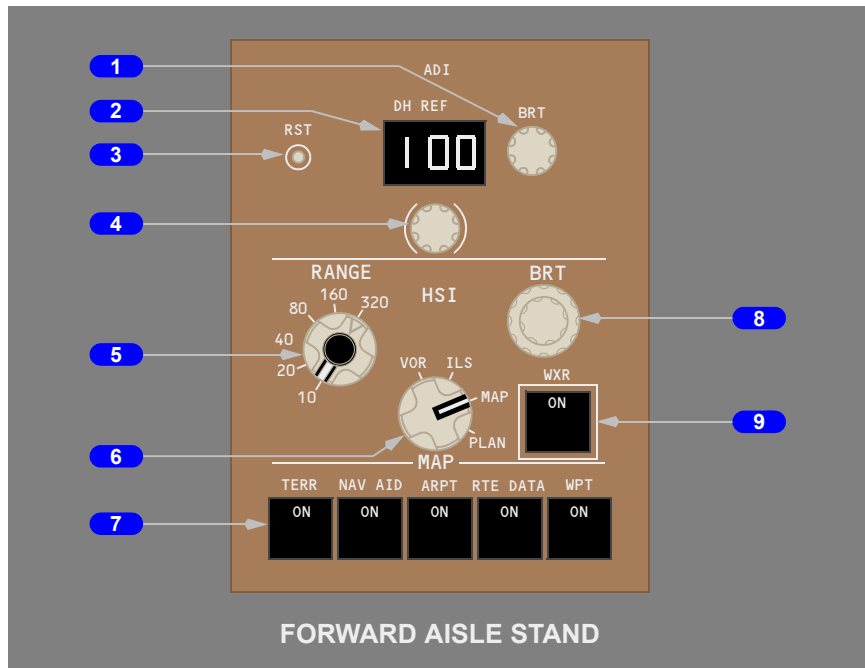
171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

TRUE – With TRUE selected, the navigation system is referenced to true north on both the EHSI's and the RDMI's, regardless of airplane position. No heading flag is displayed on the RDMI in such an event. A bearing flag is displayed when VOR is selected.

EFIS Control Panel

The left EFIS control panel controls the left ADI and HSI. The right EFIS control panel controls the right ADI and HSI.

121, 124-139, 171-199, 1200-1201, 1401-1403, 1501-1506, 1521, 1601-1602, 1701-1704



1 ADI Brightness Control

Rotate – adjusts brightness of ADI display.

2 Decision Height Reference Window

- displays selected decision height
- also displayed on ADI (display on ADI blanks when a negative decision height is selected)

3 Decision Height Reset (RST) Switch

Push –

- resets DH alert on related ADI
- changes RA display from amber to white
- blanks height alert on related ADI

4 Decision Height Selector

Rotate – selects decision height for DH alerting.

5 HSI Range Selector

Rotate –

- selects nautical mile range for MAP and PLAN displays
- when the WXR switch is ON, also selects the desired range for the EXP VOR and EXP ILS mode displays

6 HSI Mode Selector

EXP/FULL VOR –

- displays VOR navigation information
- selects manual VOR and DME tuning on the VOR/DME panel (automatic tuning inhibited)

EXP/FULL ILS –

- displays ILS navigation information
- selects manual VOR and DME tuning on the VOR/DME panel (automatic tuning inhibited)

MAP –

- displays a dynamic map
- allows selection of manual or automatic VOR and DME tuning on the VOR/DME panel
- allows remote manual VOR and DME tuning on the PROGRESS page

PLAN –

- displays static FMC map in true–north–up orientation
- displays heading information in heading–up form
- allows selection of manual or automatic VOR and DME tuning on the VOR/DME panel
- allows remote manual VOR and DME tuning on the PROGRESS page
- activates the MAP CTR STEP prompt on the LEGS page for stepping through the displayed route

7 Map Switches

TERR –

- displays GPWS look-ahead data in VOR, APP, MAP, and CTR MAP modes
- arms GPWS look-ahead data in CTR VOR, CTR APP, and PLAN modes
- deselects the weather radar display regardless of the HSI mode selector position
- second push deselects GPWS look-ahead display

NAV AID –

- displays only high altitude VHF navigation aids when HSI range is 80nm or greater
- displays all VHF navigation aids when HSI range is 40nm or less

Airport (ARPT) –

Displays all airports in the display range.

RTE DATA –

Displays estimated time of arrival and any altitude constraint for each waypoint in the displayed flight path.

Waypoint (WPT) –

- displays all waypoints when HSI range is 40nm or less
- those waypoints associated with NDBs are displayed at any selected range as long as the NDBs are within 80nm of the airplane.

8 HSI Brightness Controls

Rotate –

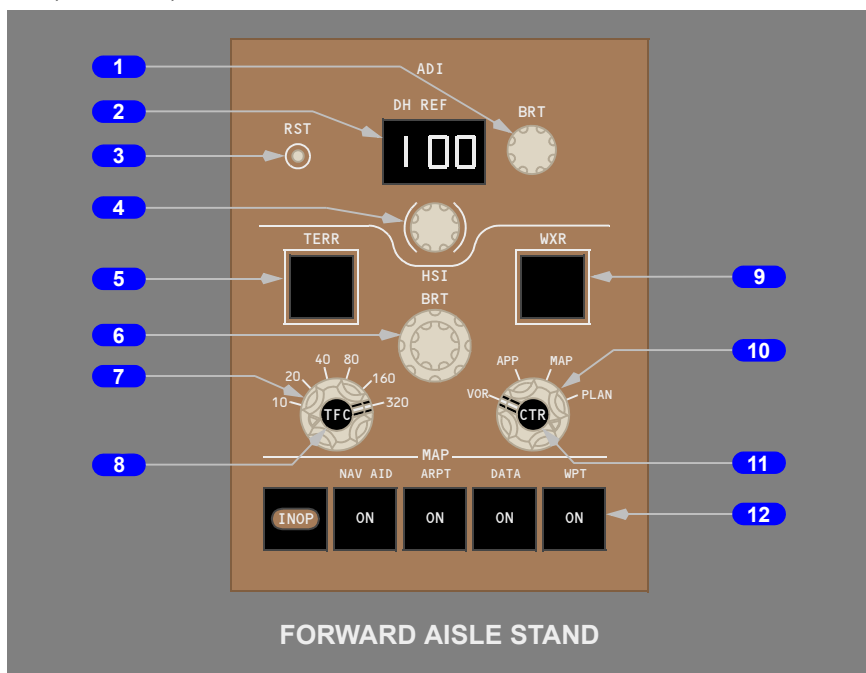
- outer control – adjusts overall brightness of HSI display
- inner control – adjusts brightness of weather radar or terrain display

9 Weather Radar Switch

Push – displays weather radar information (refer to Chapter 11, Flight Management, Navigation).

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1404, 1603-1613, 1705-1708



1 ADI Brightness (BRT) Control

Rotate – adjusts brightness of ADI display.

2 Decision Height Reference (DH REF) Window

- displays selected decision height
- displays on ADI (ADI blanks when a negative decision height is selected)

3 Decision Height Reset (RST) Switch

Push –

- resets DH alert on related ADI
- changes RA display from amber to white
- blanks height alert on related ADI

4 Decision Height Selector

Rotate – selects decision height for DH alerting.

5 Terrain (TERR) Switch

Push –

- displays terrain data on the HSI in MAP, CTR MAP, VOR, and APP
- deselects the weather radar display regardless of the mode selector position

For a description of the ground proximity warning system, refer to Chapter 15, Warning Systems.

6 HSI Brightness (BRT) Control

Rotate –

- outer control – adjusts overall brightness of HSI display
- inner control – adjusts brightness of weather radar or terrain display

7 HSI Range Selector

Rotate –

- selects nautical mile range for MAP, CTR MAP, and PLAN displays
- when the WXR switch or TCAS TFC switch is ON, also selects the desired range for the VOR and APP mode displays

8 Traffic (TFC) Switch

Note: Inoperative.

9 Weather Radar (WXR) Switch

Push – displays weather radar information (refer to Chapter 11, Flight Management, Navigation).

10 HSI Mode Selector

VOR, CTR VOR –

- displays VOR navigation information
- selects manual VOR and DME tuning on the VOR/DME panel (automatic tuning inhibited)

APP, CTR APP –

- displays ILS navigation information
- selects manual VOR and DME tuning on the VOR/DME panel (automatic tuning inhibited)

MAP, CTR MAP –

- displays a dynamic map
- allows selection of manual or automatic VOR and DME tuning on the VOR/DME panel
- allows remote manual VOR and DME tuning on the PROGRESS page

PLAN –

- displays static FMC map in true–north–up orientation
- displays heading information in heading–up form
- allows selection of manual or automatic VOR and DME tuning on the VOR/DME panel
- allows remote manual VOR and DME tuning on the PROGRESS page
- activates the MAP CTR STEP prompt on the LEGS page for stepping through the displayed route

11 Center (CTR) Switch**Push –**

- when the HSI Mode Selector is in the MAP, VOR, or APP positions, toggles between full and expanded rose displays
- does not affect display in PLAN mode

12 Map Switches**NAV AID –**

- displays only high altitude VHF navigation aids when HSI range is 80nm or greater
- displays all VHF navigation aids when HSI range is 40nm or less

Airport (ARPT) –

Displays all airports in the display range.

DATA –

Displays estimated time of arrival and any altitude constraint for each waypoint in the displayed flight path.

Waypoint (WPT) –

- displays all waypoints when HSI range is 40nm or less
- those waypoints associated with NDBs are displayed at any selected range as long as the NDBs are within 80nm of the airplane.

Intentionally
Blank

Flight Instruments, Displays
EFIS System Description**Chapter 10**
Section 20**Introduction**

The electronic flight instrument system (EFIS) consists of three (L, C, R) symbol generators (SGs), two control panels (CPs), two attitude director indicators (ADIs), two horizontal situation indicators (HSIs), and ambient light sensing units. The EFIS uses information provided by a variety of aircraft systems to generate the appropriate visual presentations on the HSI and ADI.

Data relating primarily to navigation is provided by aircraft systems such as the navigation radios, flight management computer (FMC), and the inertial reference systems. Data relating primarily to automatic flight is provided by the flight control computers (FCCs), the autothrottle (A/T), and the FMC. Data which is used to display current aircraft state information is provided by the two air data computers (ADCs) and the three inertial reference systems (IRSs).

Automatic adjustment of the display intensity for each display unit is provided by the ambient light sensing units. Flight crew control of the EFIS displays is accomplished by positioning the various controls on the respective EFIS control panels to the desired settings. For information on EFIS/IRS interface, and instrument switching see Section 10 of this chapter.

EFIS Symbol Generators

Three symbol generators form the heart of the EFIS. The SGs receive inputs from various aircraft systems, then generate the proper visual displays for the related ADI and HSI. Each pilot's ADI and HSI displays are provided from the SG selected with their respective EFI switch. The left SG normally provides the captain's displays, and the right SG normally provides the first officer's displays. The center SG is available as an alternate source for either or both pilots.

EFIS Control Panels

The EFIS control panels control display options, modes, ranges and brightness for the respective ADIs and HSIs.

Attitude Director Indicator

The ADI presents conventional displays for attitude (pitch and roll), flight director commands, localizer deviation and glide slope deviation. In addition, the ADI displays information relating to autoflight system mode annunciations, airplane speed, pitch limit, radio altitude, and decision height. The captain's attitude information is provided by the left IRS and the first officer's information is provided by the right IRS. The center IRS provides that data as an alternate source.

Attitude Display

Airplane attitude data is provided by the IRSs. The IRSs' pitch and roll attitude information is valid throughout 360 degrees of rotation in each axis.

Mode Annunciations

Mode annunciations for the A/T and the AFDS are displayed at the bottom of the ADI displays. For a detailed description of the various autoflight mode annunciations and their meanings, refer to Chapter 4, Automatic Flight.

Flight Director Commands

Flight director guidance commands from the selected FCC are displayed via the flight director symbol on the ADI.

A flight director failure in either axis causes the respective command bar to disappear. If both axes become unreliable, both command bars disappear and the FD flag appears.

Glide Slope and Localizer Deviation Displays

Conventional ILS information is provided from the ILS receiver selected with each pilot's EFI switch. All three ILS receivers are commonly tuned on the ILS panel.

ILS Deviation Warning

ILS localizer and glide slope deviations are monitored when below 500 feet radio altitude with the mode control panel APP switch selected ON. An alert is displayed if a significant deviation from localizer or glide slope occurs: the respective deviation scale changes color from white to amber and the associated pointer flashes. The alert stops when deviation returns to within normal limits. The glide slope alert is inhibited when below 100 feet radio altitude.

If a localizer alert is active, the stem of the rising runway symbol also flashes.

Rising Runway Symbol

The rising runway symbol is an integral part of the LOC deviation display and is positioned at the top of the LOC deviation pointer. The rising runway symbol is displayed in addition to the radio altitude display and gives an additional cue to the flight crew of the aircraft's close proximity to the ground as the airplane descends below 200 feet radio altitude. Full scale, vertical movement of the rising runway represents the last 200 feet of radio altitude. Zero feet radio altitude is indicated as the top of the runway symbol rises to the base of the airplane symbol.

Attitude Comparator

187-199, 1200-1201, 1403-1404, 1501-1506, 1521, 1601-1708

The EICAS caution message ATT DISAGREE displays when a difference of more than 3 degrees between the captain's and first officer's pitch or roll displays is detected. An amber PITCH or ROLL alerting annunciation is displayed on both ADIs for the parameter that is out of tolerance. Attitude comparison monitoring is inhibited when both pilots are using the center symbol generator by selecting ALTN on the EFI switches.

Radio Altitude and Decision Height

When radio altitude is less than 2,500 feet AGL, a digital display is depicted on the ADI. At all other times, the digital radio altitude display is blanked.

When a positive decision height has been selected on the related EFIS control panel, the letters DH and the decision height are displayed just above the digital radio altitude display of the associated ADI.

When descending through the selected decision height, a decision height alert occurs. The display changes from white to amber, increases in size and DH flashes momentarily.

The decision height alert is reset if any one of the following occurs:

- the DH reset switch on the EFIS control panel is pressed
- the radio altitude increases to decision height +75 feet
- the radio altitude is equal to zero feet (i.e. during touchdown).

Pitch Limit Indicator

The position of the pitch limit indicator is a function of the stall warning computer. It is programmed so that stick shaker activation will coincide with a pitch attitude equal to the pitch limit indication.

Ground Speed Display

A digital presentation of the current ground speed is displayed. The ground speed data is received from the FMC or the IRS, with the FMC being the primary source.

Airspeed Display

The Fast/Slow pointer is positioned by the thrust management computer. For additional details see Chapter 4, Automatic Flight.

Horizontal Situation Indicator (HSI)

The HSI presents an electronically generated color display of navigational data. Each HSI is capable of displaying the airplane's progress on a dynamic map display.

Display Orientation

During normal operation, heading reference data is supplied to each HSI from the respective IRS.

Track

Airplane track data is supplied by the FMC during normal operation and by the MCDU when in alternate navigation.

MAP Mode

The MAP mode is recommended for most phases of flight.

Presented track up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- track
- heading
- wind
- routes
- position trend vector
- altitude range arc
- estimated time of arrival
- selected navigation data points programmed in the FMC

VOR Mode

The VOR mode is presented heading up. The VOR mode displays track, heading, and wind speed and direction with VOR navigation information.

ILS Mode

The ILS mode is presented heading up. The ILS mode displays track, heading, and wind speed and direction with ILS approach information.

APP Mode

The APP mode is presented heading up. The APP mode displays track, heading, and wind speed and direction with ILS approach information.

PLAN Mode

The PLAN mode is presented true north up. The active route may be viewed using The STEP prompt on the LEGS pages.

Weather Radar Display

Display of weather radar returns on the HSI is enabled or disabled by the WXR switch on the respective EFIS control panel. The weather radar system is described in Chapter 11, Flight Management, Navigation.

Terrain Display

The HSI can display look ahead terrain alerting. For detailed information, refer to Chapter 15, Warning Systems.

Predictive Windshear

The HSI can display predictive windshear warnings. For detailed information, refer to Chapter 15, Warning Systems.

EFIS Failure Flags and Annunciations

In addition to the normal EFIS displays, various failure annunciations, flags, or indications may be displayed on the ADI or HSI.

The location of the different failure flags and annunciations is depicted in the ADI and HSI Failure Flags and Annunciations figures included in the EFIS Controls and Indicators, section 10 of this chapter.

Not all EFIS displays will be replaced by a failure flag or annunciation if the signal from the sending unit has failed. In these instances, failure is indicated by removal of the data or the affected portions of the display.

During preflight, heading/track data is unavailable until the associated IRS has completed alignment and entered the navigation mode. Heading flags do not appear in this case.

If an FMC FAIL message is observed on a MCDU, a MAP flag will appear on the associated HSI when viewing the MAP mode. Selecting the opposite FMC with the NAV selector will restore the map display. If both FMCs fail, selecting MCDU on the NAV selector will allow the MCDU to provide limited map data to the HSI. For more detailed information on the alternate navigation system, refer to Chapter 11, Flight Management, Navigation.

Various fault messages can also be displayed. For example, a WXR/MAP RANGE DISAGREE message is displayed when the ranges for the FMC and weather radar disagree with the range selected on the HSI control panel.

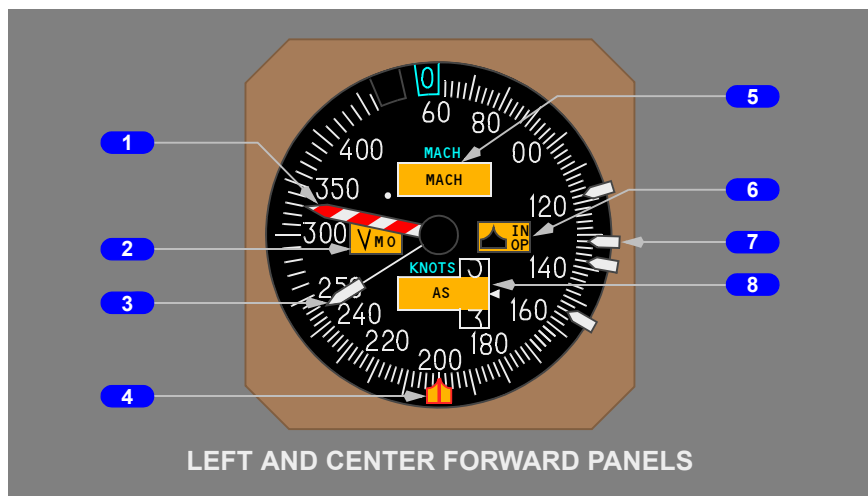
An EXCESS DATA message is displayed if the quantity of information to the display exceeds the HSI's capability to provide a normal display. If in the MAP mode, deselecting the Map switches may correct the condition and remove the message.

Light Sensing and Brightness Control

Ambient light sensors automatically adjust the brightness of the EFIS displays. Once the desired brightness is set, using the EFIS brightness controls, little or no adjustment is needed throughout a wide range of ambient light conditions both outside and inside the flight deck.

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Conventional Flight Instruments Mach/Airspeed Indicator (Electric)



1 Vmo Pointer [AFM]

Indicates the maximum operating airspeed in knots.

2 Vmo Flag

Flag in view – indicates the Vmo pointer is inoperative.

3 Airspeed Pointer

Indicates airspeed in knots.

4 Command Airspeed Bug

Indicates airspeed as manually selected with the IAS/MACH selector.

- positioned by FMC when IAS/MACH window is blank
- removed from view when inoperative.

5 Mach Indicator and Flag

Displays Mach number.

Display range:

- .400 to .999 Mach
- masked below .400 Mach
- flag in view – air data system is inoperative.

6 Command Airspeed Inoperative Flag

Flag in view – command airspeed bug is inoperative.

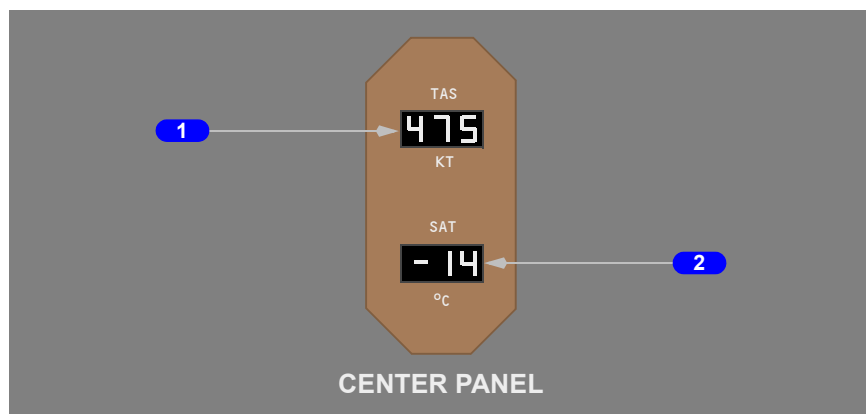
7 Reference Airspeed Bugs

Set at reference airspeeds.

8 Airspeed Indicator and Flag

- displays airspeed when above 30 knots
- flag in view – air data system is inoperative.

True Airspeed/Static Air Temperature Indicator



1 True Airspeed Indicator

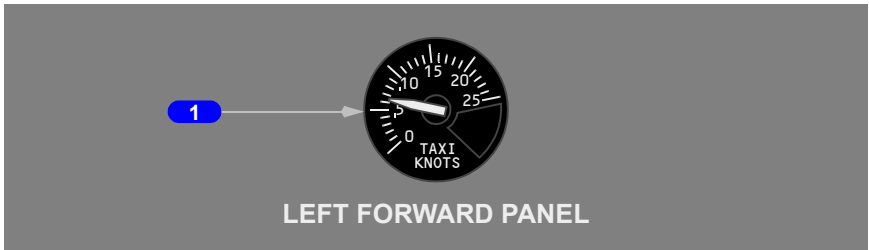
Displays true airspeed.

2 Static Air Temperature Indicator

Displays static air temperature.

Taxi Speed Indicator

121-130



1 Taxi Speed Indicator

Indicates taxi speed.

Primary Altimeter (Electric)



1 Altitude Indicator

Indicates altitude in increments of twenty feet.

OFF flag in view– the altimeter is inoperative

NEG flag in view – displays in the two left-hand windows when altitude below zero feet is displayed.

2 Altitude Pointer

Makes one revolution each one thousand feet.

3 Barometric Setting Control

Rotate – adjusts barometric settings.

4 Altimeter Altitude (ALT) Light

Illuminated (white) –

- between 250 and 750 feet of the altitude selected with the altitude selector.

For detailed information, refer to 15.10, Miscellaneous Lights.

5 Barometric Setting Window

Displays barometric correction (in millibars and inches of mercury) as set by the barometric setting control.

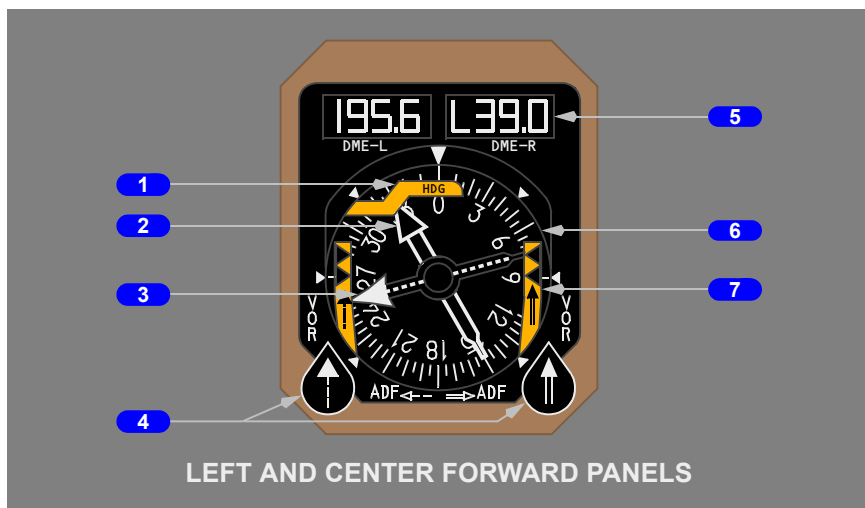
6 Reference Altitude Marker

Manually positioned to the desired reference altitude using the reference altitude marker control.

7 Reference Altitude Marker Control

Used to manually set the reference altitude marker.

Radio Distance Magnetic Indicator



1 Heading (HDG) Flag

Flag in view –

- selected IRS heading source has failed, or no computed data is available
- instrument failure.

121-139, 1401-1404

2 Wide Bearing Pointer

- indicates right VOR magnetic bearing to selected station
- maintains last known bearing on loss of right VOR signal
- right ADF portion placarded inoperative.

171-199, 1200-1201, 1501-1506, 1521, 1601-1708

2 Wide Bearing Pointer

- indicates right ADF/VOR magnetic bearing to selected station
- maintains last known bearing on loss of right ADF/VOR signal.

3 Narrow Bearing Pointer

- indicates left ADF/VOR magnetic bearing to selected station
- maintains last known bearing on loss of left ADF/VOR signal.

4 VOR/ADF Selector (Left/Right)

Rotate – selects related VOR or ADF for the bearing pointer.

121-139, 171-199, 1200-1201, 1401-1403, 1501-1506, 1521, 1601-1602, 1701-1704

5 Left/Right DME (DME –L/R) Indicators

Displays distance to the VOR–tuned station (VORTAC or VOR/DME) in nautical miles, except when ILS is selected on the associated (L or R) EFIS control panel.

- displays distance to the ILS–tuned station when ILS is selected on the associated (L or R) EFIS control panel (L is displayed when valid ILS/DME is available)
- displays dashes when no computed data is available
- displays blank when DME distance is unreliable

1404, 1603-1613, 1705-1708

5 Left/Right DME (DME –L/R) Indicators

Displays distance to the VOR–tuned station (VORTAC or VOR/DME) in nautical miles, except when APP is selected on the associated (L or R) EFIS control panel.

- displays distance to the ILS–tuned station when APP is selected on the associated (L or R) EFIS control panel (L is displayed when valid ILS/DME is available)
- displays dashes when no computed data is available
- displays blank when DME distance is unreliable, or when there are no DME nav aids within range for autotuning

6 Compass Card

Indicates airplane heading under lubber line.

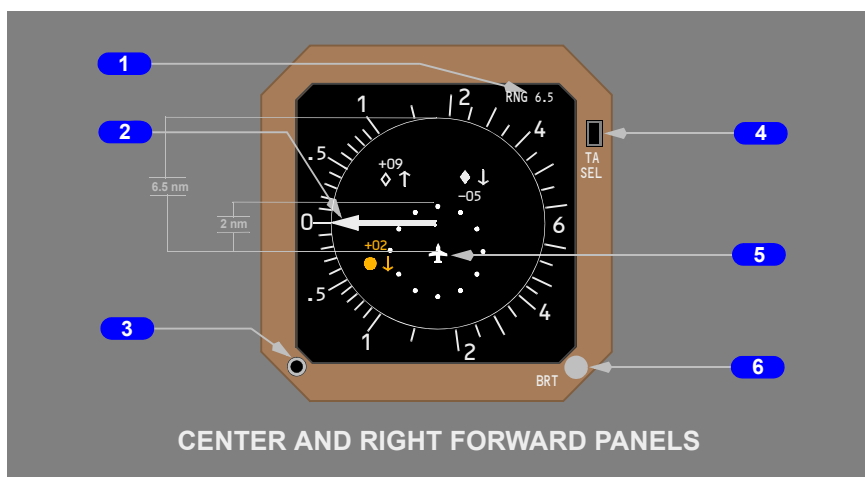
- Captain's heading information as selected by the first officer's IRS switch
- First officer's heading information as selected by the captain's IRS switch

7 Bearing Pointer Failure Flag (Left/Right)

Selected VOR/ADF receiver has failed, or no computed data is available.

- may be in view with heading flag
- instrument failure.

Traffic Advisory/Vertical Speed Indicator (TA/VSI)



1 Range Annunciation

- indicates traffic display - range is fixed to 6.5 nautical miles.
- annunciated when the traffic display is present and during test.

2 Vertical Speed Pointer

- Indicates rate of climb or descent from 0 to 6,000 feet per minute.

3 Ambient Light Sensor

4 Traffic Advisory Selector

- Push-button will add or remove the display of traffic (no effect on radar indicator traffic display).

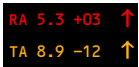
5 Aircraft Symbol

- Fixed in position. Distance can be estimated to other targets, i.e., the one o'clock traffic is approximately 4 miles.

6 Brightness Knob

- Adjustment knob will allow minor adjustment of indicator brightness.

Vertical Speed Indicator TCAS Symbology

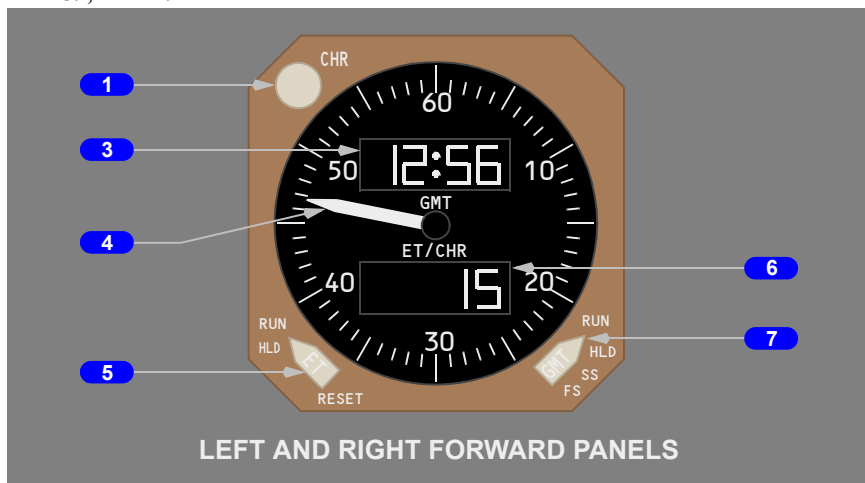
Symbol	Name	Applicable Mode(s)	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	TA/RA	These symbols are displayed when TA or TA/RA is selected with the transponder mode selector. Refer to Chapter 15, Warning Systems.
	TCAS traffic advisory (TA), relative altitude (A)	TA TA/RA	The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed.
	TCAS proximate traffic, relative altitude (W)	TA TA/RA	The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.
	TCAS other traffic, relative altitude (W)	TA TA/RA	The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
	TCAS no bearing message (RA-R, TA-A)	TA TA/RA	Message provides traffic type, range in NM, altitude and vertical direction.

Clock

180-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708



121-139, 171-179



1 Chronograph (CHR) Switch

Push – initiates start, stop and reset functions of the CHR display and second hand
Subsequent pushes –

- overrides any existing ET display
- controls chronograph second hand.

180-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

2 DATE Switch

Push – displays day and month, alternating with year.

Subsequent push – returns display to time.

121-139, 171-179

3 Time Window

Displays time (hours, minutes – 24 hour format) when time is selected with the date switch.

180-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

3 Time/Date Window

Displays time (hours, minutes – 24 hour format) when time is selected with the date switch.

Alternately displays day–month and year when date is selected with the date switch.

4 Chronograph Second Hand

Indicates seconds.

5 Elapsed Time (ET) Selector

Controls the elapsed time function.

RUN – starts the elapsed time display.

HLD – stops the elapsed time display.

RESET – (spring–loaded to HLD) returns ET display to zero.

6 Elapsed Time/Chronograph (ET/CHR) Window

Displays elapsed time in hours and minutes, or chronograph minutes.

- when selected, the chronograph display replaces the elapsed time display
- elapsed time continues to run in the background and displays after the chronograph is reset.

121-139, 171-179

6 GMT Selector

Sets the time.

RUN – starts the time indicator.

HLD (hold) – stops the time indicator and sets the seconds to zero.

SS (slow slew) – advances minutes.

FS (fast slew) – advances hours.

180-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

7 SET Selector

Sets the time and date when the date switch is set to manual

RUN – starts the time indicator.

HLDY (hold, year) –

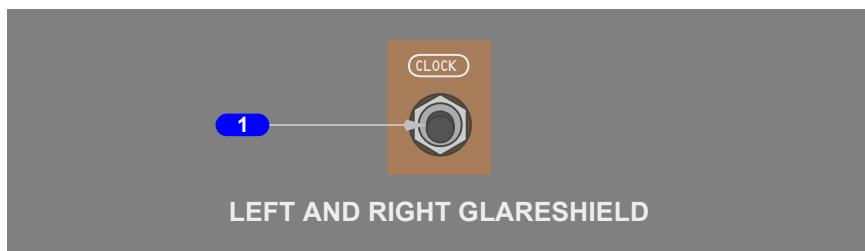
- stops the time indicator and sets the seconds to zero when time is selected with the date switch
- advances years when date is selected with the date switch.

MSM (minute slew, month) –

- advances minutes when time is selected with the date switch
- advances months when date is selected with the date switch.

HSD (hour slew, day) –

- advances hours when time is selected with the date switch
- advances days when date is selected with the date switch

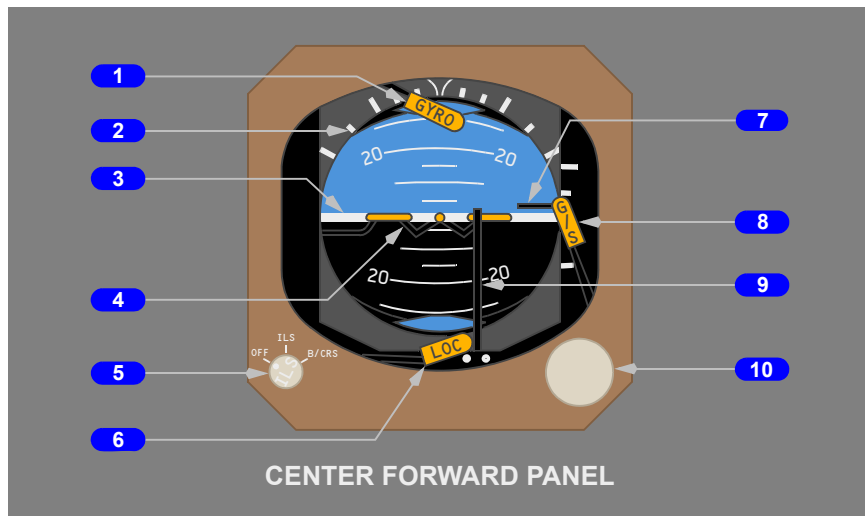


1 CLOCK Switch

Operates the same as the chronograph switch.

Standby Flight Instruments

Standby Attitude Director Indicator (Standby ADI)



1 GYRO Flag

Flag in view – attitude is unreliable.

2 Bank Indicator and Scale

Indicates bank in reference to the bank scale.

3 Horizon Line and Pitch Angle Scale

Indicates horizon relative to the airplane symbol.

Pitch scale is in 5 degree increments.

4 Airplane Symbol

Indicates airplane attitude with reference to the horizon.

5 ILS Selector

OFF – deviation pointers and failure flags retracted from view.

ILS – pointers indicate deviation from localizer and glideslope.

B/CRS – reverses sensing for localizer deviation pointer.

6 Localizer (LOC) Flag

Flag in view – center localizer receiver has failed.

7 Glideslope Pointer and Deviation Scale

The glideslope pointer indicates glideslope position relative to the airplane.

- scale indicates deviation
- pointer is not displayed when ILS selector is OFF or no computed data exists.

8 Glideslope (G/S) Flag

Flag in view – center glideslope receiver has failed.

9 Localizer Pointer and Deviation Scale

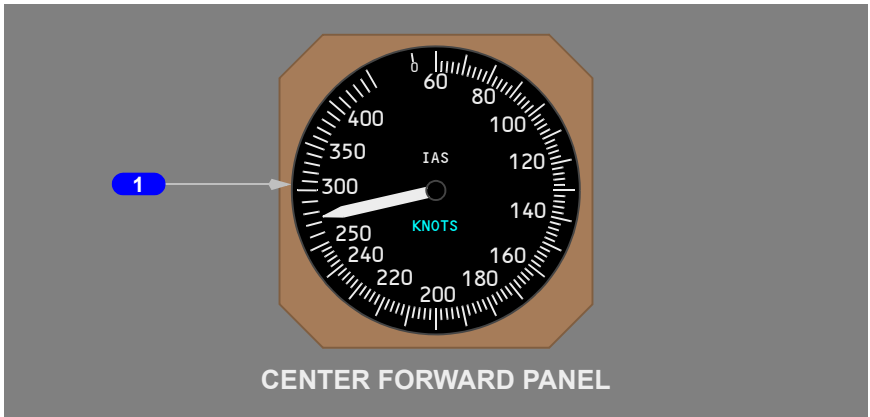
The localizer pointer indicates position relative to the airplane.

- scale indicates localizer deviation
- expanded localizer scale not available
- pointer not displayed when ILS selector is OFF or no computed data exists.

10 Caging Control

Pull – aligns horizon with the airplane symbol.

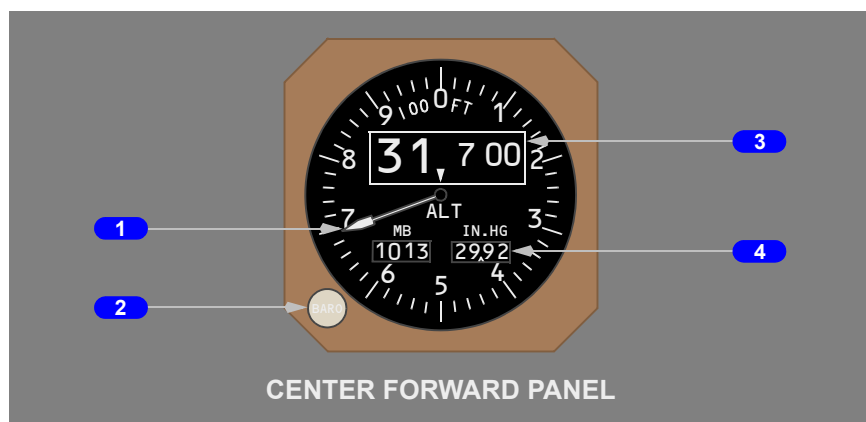
Standby Airspeed Indicator (Pneumatic)



1 Standby Airspeed Indicator [AFM]

Provides alternate airspeed information.

Standby Altimeter (Pneumatic)



1 Altitude Pointer

Makes one revolution each one thousand feet.

2 Barometric Setting Control

Rotate – adjusts barometric settings.

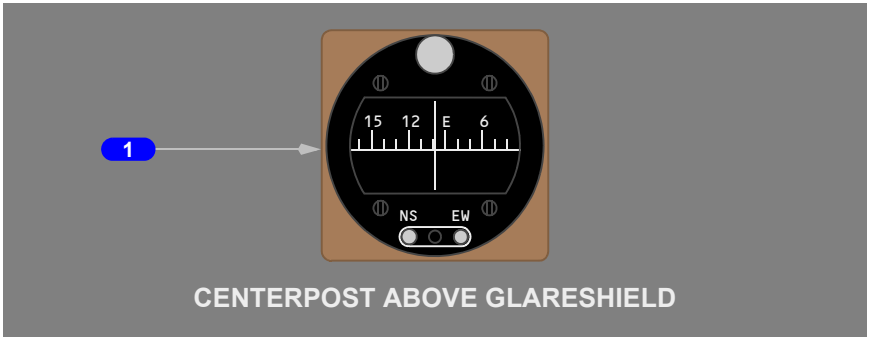
3 Altitude Indicator

Indicates altitude in increments of twenty feet.

4 Barometric Setting Window

Displays barometric correction (in millibars and inches of mercury) as set by the barometric setting control.

Standby Magnetic Compass



1 Standby Magnetic Compass

Displays magnetic heading.

Flight Recorder



1 Flight Recorder (FLT REC) Switch

ON – applies power to the flight recorder.

NORM –

- on the ground – either engine must also be operating.
- in flight – the recorder operates anytime electrical power is available

TEST – (Spring – loaded to NORM) initiates a flight recorder test.

2 Flight Recorder OFF Light

Illuminated (white) – indicates the recorder is not operating or the test is invalid.

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Introduction

The conventional instruments provide information in addition to the EFIS displays to aid pilots in controlling the airplane throughout its flight regime. This section includes a discussion of the primary instruments, standby instruments, and the pitot static system.

Primary Flight Instruments

Mach/Airspeed Indicator

Two electric mach/airspeed indicators display airspeed, mach, and Vmo from the selected air data source. The Vmo pointer indicates the maximum operating airspeed in knots or the equivalent to the maximum operating mach number. The command airspeed bug on each indicator can be automatically positioned from the FMC, or manually from the MCP IAS/MACH Selector.

Primary Altimeter

Two electric altimeters indicate current altitude in feet. An altimeter altitude light is provided. Altitude alerting is described in Chapter 15, Warning Systems.

Radio Distance Magnetic Indicator (RDMI)

Two radio distance magnetic indicators are installed. Each displays magnetic heading, VOR or ADF bearing, and (VOR/ILS/DME, VORTAC) distance. The RDMI receives primary heading signals from the opposite side IRS and alternate heading signals from the C-IRS. The RDMI is inoperative until the associated IRS has completed alignment and entered the navigation mode.

With the HSI heading reference switch in NORM, magnetic heading is displayed if the airplane is outside polar regions. In polar regions, or when the switch is in TRUE a heading flag is in view. For more information on polar regions refer to Chapter 11, Flight Management, Navigation.

Vertical Speed Indicator

Two electrically-driven vertical speed indicators (VSI) are installed. The captain's VSI is connected to the left IRS and ADC, and the first officer's VSI is connected to the right IRS and ADC. The center IRS provides backup vertical speed data for either crew member when ALTN is selected with the respective IRS switch. The opposite ADC provides backup vertical speed data for either crewmember when ALTN is selected with the respective AIR DATA switch.

The VSI is inoperative until the associated IRS has completed alignment and entered the navigation mode.

Clock

Two electronic clocks are installed, with two digital displays on each clock. Either coordinated universal time (UTC) 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.

180-199, 1200-1201, 2502-2502, 1501-1506, 1521, 1601-1613, 1701-1708

In addition to UTC and local time, the date may be set on the upper time display.

Standby Flight Instruments

Standby Attitude Director Indicator (Standby ADI)

A self-contained standby attitude director indicator incorporating an ILS display is installed. In the event that all generator power is lost, the standby ADI will be supplied with electrical power from the standby DC bus. ILS information is provided from the C-ILS receiver.

Standby Airspeed Indicator (Pneumatic)

The standby airspeed indicator provides current airspeed in knots. It is connected directly to the L AUX PITOT and the alternate static ports. (See pitot-static system schematic.)

Standby Altimeter (Pneumatic)

A single indicator is installed for standby reference. Input for the indicator is from the alternate static ports. (See pitot-static system schematic.)

Standby Magnetic Compass

A standard magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Clock

Two electronic clocks are installed, with two digital displays on each clock. Either coordinated universal time (UTC) 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.

180-199, 1200-1201, 2502-2502, 1501-1506, 1521, 1601-1613, 1701-1708

In addition to UTC and local time, the date may be set on the upper time display.

Flight Recorder

The flight recorder provides a permanent record of selected operational systems in a sealed, fire-resistant container. The recorder automatically turns on when either engine is operating or the airplane is in flight.

Air Data System

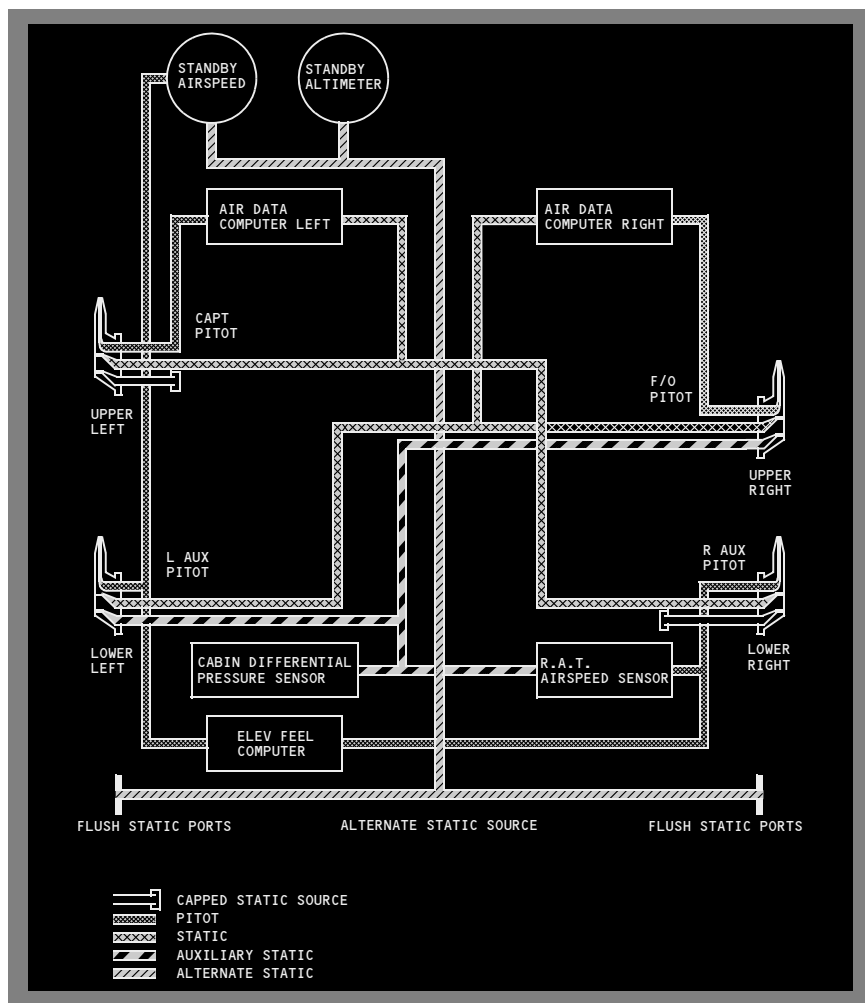
The air data system consists of the pitot-static system, one temperature probe (TAT), two angle of attack probes, two air data computers (ADCs), and electric flight instruments.

The system provides pitot and/or static pressure information to various flight instruments and airplane systems. Standby airspeed and altimeter indicators are also provided. The ADCs use air data information to provide input signals to certain flight instruments (electric mach/airspeed indicator, electric altimeter) and other using systems (AFDS, FMC, etc.). The left instruments use the left ADC and the right instruments use the right ADC. The opposite ADC is available as an alternate air data source.

Warning flags indicate instrument failure or unreliable data. When a malfunction occurs in instruments with failure monitors, warning flags appear.

The EICAS caution messages ALT DISAGREE or IAS DISAGREE display when there is a significant difference between the left and right air data information. These messages are inhibited at low altitude or when both pilots have the same air data source selected.

Pitot-Static System Schematic



Total Air Temperature (TAT)

TAT appears on EICAS above the EPR display and is supplied by a thrust management or air data computer. The TAT indication is comprised of outside air temperature (OAT) plus ram rise. TAT Indication on the ground will approximate OAT.

True Airspeed/Static Air Temperature (TAS/SAT)

True airspeed (TAS) and static air temperature (SAT) are displayed on the PROGRESS page.

**Flight Instruments, Displays
EICAS Messages****Chapter 10
Section 50****Flight Instruments, Displays EICAS Messages**

Note: The OVERSPEED warning and the ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
ALT DISAGREE	Caution		Beeper	Captain's and first officer's altitude indications disagree.
IAS DISAGREE	Caution		Beeper	Captain's and first officer's airspeed indications disagree.
INSTR SWITCH	Caution		Beeper	Both EFI switches are in the ALTN position.

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Flight Management, Navigation

Chapter 11

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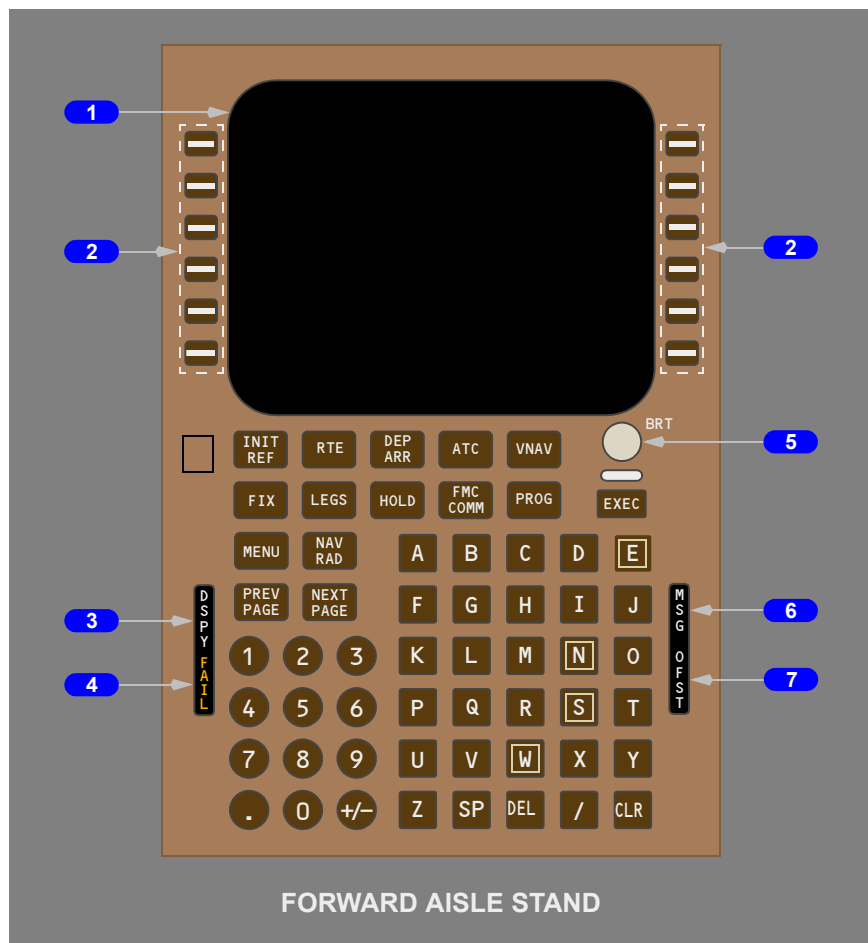
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Flight Management System
Multifunction Control Display Unit (MCDU)



1 Multifunction Control Display Unit (MCDU) Display

Displays FMS data pages.

2 Line Select Keys

Push –

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is displayed in scratchpad.

3 Display (DSPY) Light

Illuminated (white) –

- when RTE page 3 or greater, RTE LEGS page 2 or greater, RTE DATA page 2 or greater is displayed
- when airplane is not in holding pattern displayed on HOLD page
- when modification is in progress, and any RTE, RTE LEGS, RTE DATA, HOLD, or VNAV page is displayed.

4 FAIL Light

Illuminated (amber) – fault detected in related FMC.

5 Brightness Control

Rotate – controls display brightness.

6 Message (MSG) Light

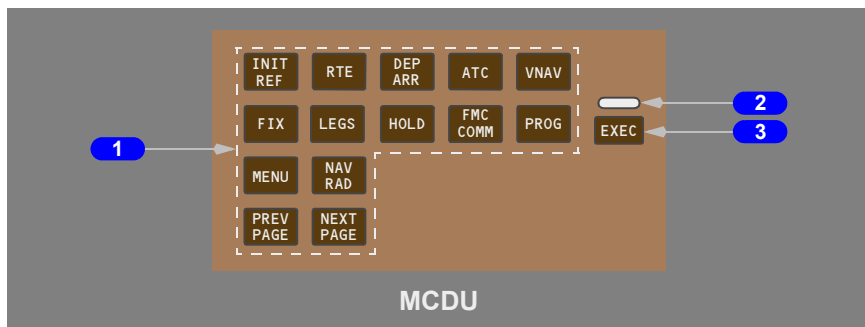
Illuminated (white) – scratchpad message is displayed.

7 Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset.

Function and Execute Keys

MCDU



1 MCDU Function Keys

Push –

- INIT REF – displays page for data initialization or for reference data
- RTE – displays page to input or change origin, destination, or route
- DEP ARR – displays page to input or change departure and arrival procedures
- ATC – displays ATC datalink pages
- VNAV – displays page to view or change vertical navigation path data
- FIX – displays page to create reference points on HSI map
- LEGS –
 - displays page to evaluate or modify lateral and vertical route data
 - displays page to control HSI PLAN mode display
- HOLD – displays page to create holding patterns and show holding pattern data
- FMC COMM – displays FMC data link status page
- PROG – displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU – displays page to choose subsystems controlled by MCDU
- NAV RAD – displays page to monitor or control VOR tuning
- PREV PAGE – displays previous page of related pages (for example, LEGS pages)
- NEXT PAGE – displays next page of related pages.

2 Execute Light

Illuminated (white) – active data is modified but not executed.

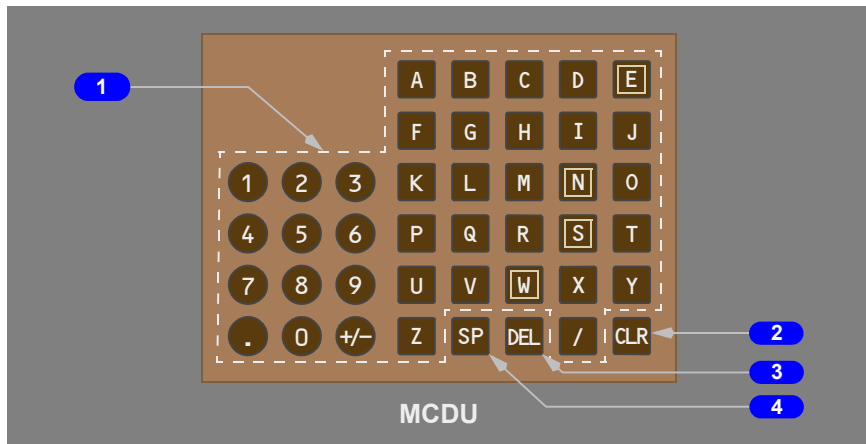
3 Execute (EXEC) Key

Push –

- makes data modification(s) active
- extinguishes execute light.

Alpha/Numeric and Miscellaneous Keys

MCDU



1 Alpha/Numeric Keys

Push –

- puts selected character in scratchpad
- Slash (/) key – puts “/” in scratchpad
- Plus Minus (+/-) key – first push puts “-” in scratchpad. Subsequent pushes alternate between “+” and “-”.

2 Clear (CLR) Key

Push –

- clears last scratchpad character
- clears scratchpad message.

Push and hold – clears all scratchpad data.

3 Delete (DEL) Key

Push – puts “DELETE” in scratchpad.

4 Space (SP) Key

Push –

- puts space in scratchpad

Note: The SP key is normally used when keying in messages for datalink communications. If the SP key is advertently pressed while keying in data for FMC use, it will result in an INVALID ENTRY scratchpad message when attempting to select the data to the appropriate line. Should this occur, clear the scratchpad and begin again.

MCDU Page Components



1 Page Title

Subject or name of data displayed on page.

ACT (active) or MOD (modified) shows whether page contains active or modified data.

2 Line Title

Title of data on line below.

3 Line Data

Displays –

- data
- entry field
- prompts

4 Prompts

Caret “<” or “>” indicates a prompt.

Push – selects indicated information, mode, or page.

5 Page Number

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

6 Boxes

Data input is mandatory.

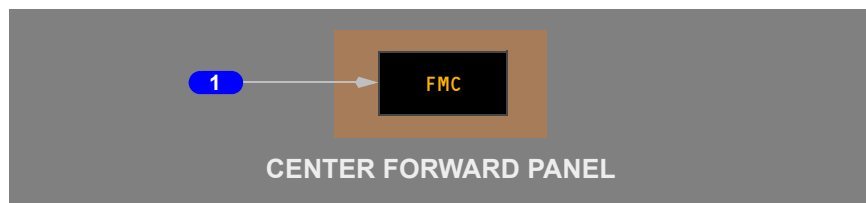
7 Dashes

Data input is optional. The data is not mandatory.

8 Scratchpad

Displays messages, alphanumeric entries or line selected data.

FMC Annunciator Light

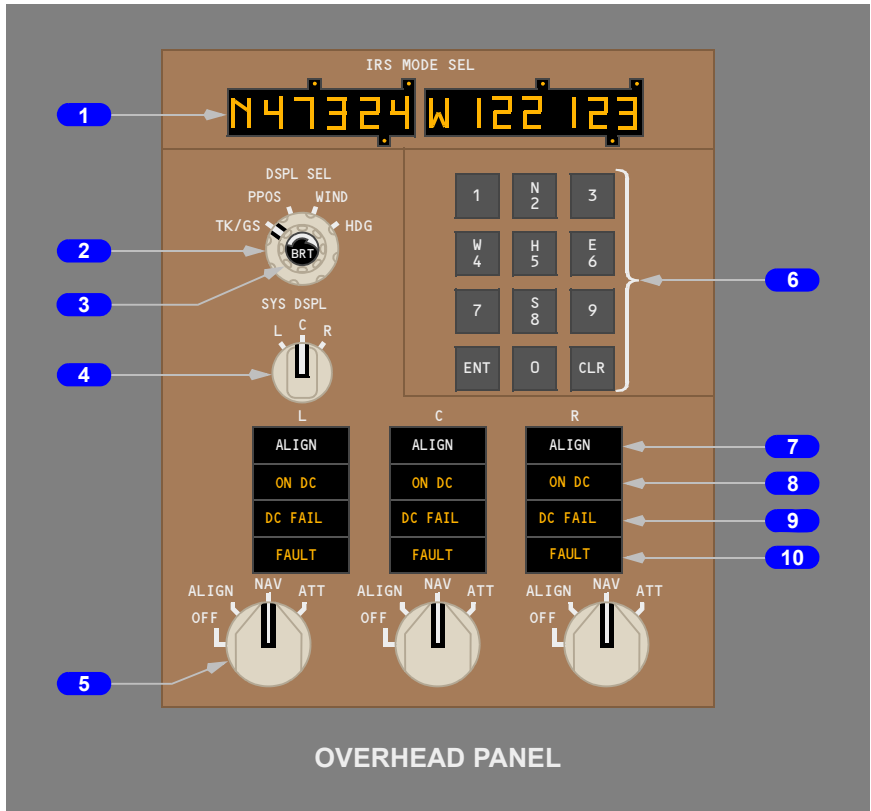


1 FMC Annunciator Light

Illuminated (amber) –

- An operationally significant message is displayed in the scratchpad
- pushing CLR key extinguishes the light and clears the scratchpad message

Inertial System Inertial Reference System



1 IRS DISPLAY

Displays track, groundspeed, present position, wind or heading as controlled by display selectors or keyboard.

2 IRS Display Selector

Selects data for display when keyboard not in control.

- TK/GS – displays present true track and groundspeed
- PPOS – displays present position
- WIND – displays present true wind when inflight
- HDG – displays present true heading.

3 Brightness Control

Rotate – controls intensity of display.

4 IRS System Display Selector

Selects system to display data when keyboard not in control.

5 IRS Mode Selectors

Rotate – controls mode of related IRS.

Must be pulled out to move from NAV position.

OFF –

- alignment is lost
- ALIGN light illuminates for 30 seconds as system goes through a shutdown sequence
- realignment requires about 10 minutes while the airplane is parked and entry of present position (latitude and longitude).

ALIGN –

- initiates alignment when parked
- initiates a quick alignment if selected when the system is in the navigation mode.

NAV –

- normal operational mode
- permits system to enter NAV mode after completing alignment
- initiates a 10 minute alignment if selected from OFF.

ATT –

- provides only attitude and heading information
- position and ground speed information lost until system realigned on ground
- when selected airborne, ALIGN light illuminates for 30 seconds while system senses local level (requires level flight)
- magnetic heading input required to initialize heading output
- the selector must be cycled through OFF to re-enter ALIGN or NAV mode.

6 IRS Keyboard

Push an alpha key to begin entry.

- pushing the N, S, E or W keys changes the IRS display to keyboard control and arms the keyboard for latitude or longitude entry
- pushing H changes the display to keyboard control and arms the keyboard for heading entry.

Enter (ENT) Key – push

- enters data from display into all three IRS systems
- restores display to the display selector setting

Clear (CLR) Key – push

- clears data keyed into display
- restores display to the display selector setting.

7 ALIGN Lights

Illuminated (white) –

- steady – the related IRS is operating in the ALIGN mode, the initial ATT mode, or the shutdown cycle
- flashing – alignment cannot be completed due to IRS detection of:
 - significant difference between previous and entered positions or an unreasonable present position entry
 - no present position entry
 - aircraft movement detected during the alignment process.

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.

8 ON DC Lights

Illuminated (amber) –

- normal AC power for the related IRS has failed and the IRS is operating on DC backup power from the hot battery bus (AC power not normal)
- if on the ground, the ground-call horn in the nose wheel well sounds, providing an alert that a battery drain condition exists
- EICAS advisory message L, C or R IRS ON DC is displayed
- momentary illumination is normal during alignment self-test.

9 DC FAIL Lights

Illuminated (amber) –

- DC backup power for the related IRS has failed
- if the other lights are extinguished, the IRS is operating normally on AC power.
- EICAS advisory message L, C or R IRS DC FAIL is displayed

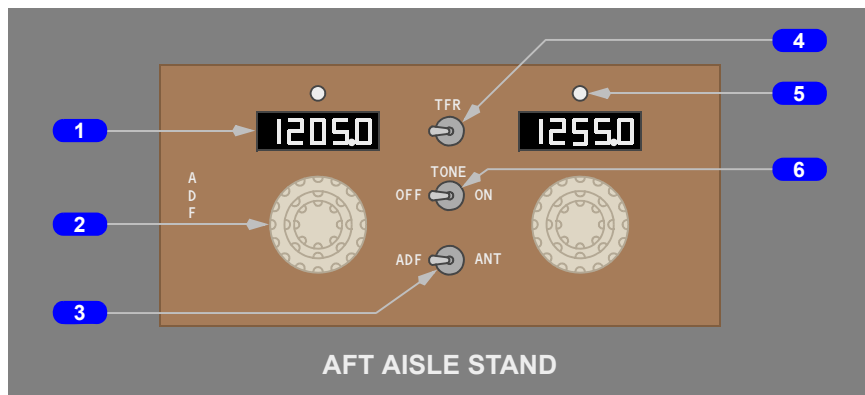
10 FAULT Lights

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected. The EICAS advisory message L, C or R IRS FAULT is also displayed.

Radio Navigation Systems

Automatic Direction Finding (ADF) Control

121-139, 1401-1404



1 Frequency Indicators

Display the frequency selected with the related frequency selector.

2 Frequency Selectors

Rotate –

- outer knob sets the hundreds number
- middle knob sets the tens number
- inner knob sets the tenths and ones number.

3 Mode Selector

ADF –

- audio reception possible
- ADF bearing sent to displays and RDML.

ANT –

- audio reception optimized
- no ADF bearing data available.

4 Transfer (TFR) Switch

Selects which frequency selector controls the ADF.

5 ADF Transfer Lights (white)

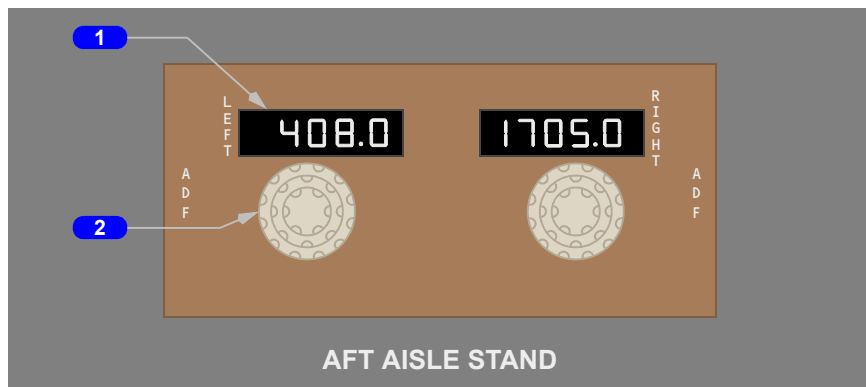
Illuminate to indicate which frequency selector is active.

6 TONE Switch

ON – activates tone generator required for receiving audio from unmodulated stations.

OFF – deactivates tone generator.

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708



1 Frequency Indicators

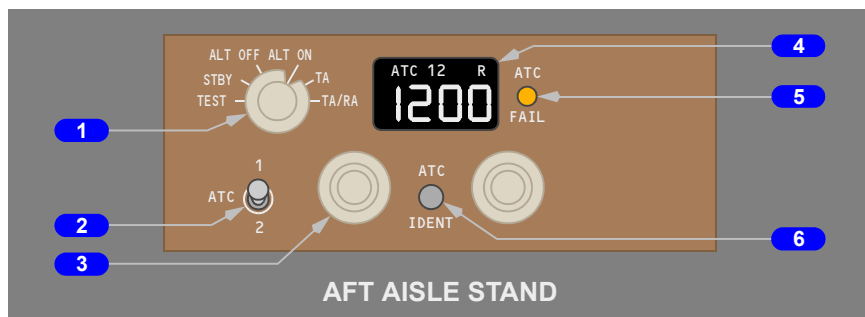
Display the frequency selected with the related frequency selector.

2 Frequency Selectors

Rotate –

- outer knob sets the hundreds number
- middle knob sets the tens number
- inner knob sets the tenths and ones number.

Transponder Panel



1 Transponder Mode Selector

TEST – activates test.

STBY – deactivates transponder.

ALT OFF – activates transponder without altitude reporting if airplane is inflight.

ALT ON – activates transponder with altitude reporting if airplane is inflight.

TA (traffic advisory) – activates TCAS Traffic Advisory (TA) mode and altitude reporting. (refer to Chapter 15, Warning Systems)

TA/RA – activates TCAS TA and Resolution Advisory (RA) modes. (refer to Chapter 15, Warning Systems)

2 Transponder Selector

1 – selects number 1 transponder for operation.

2 – selects number 2 transponder for operation.

3 Transponder Code Selectors

Sets transponder code in ATC indicator and both Transponders. Left selector sets the first two digits, the right selector sets the second two digits.

4 ATC Indicator

Displays transponder code. The heading displays which transponder is selected (ATC 1 or 2) and when a reply is being sent (R).

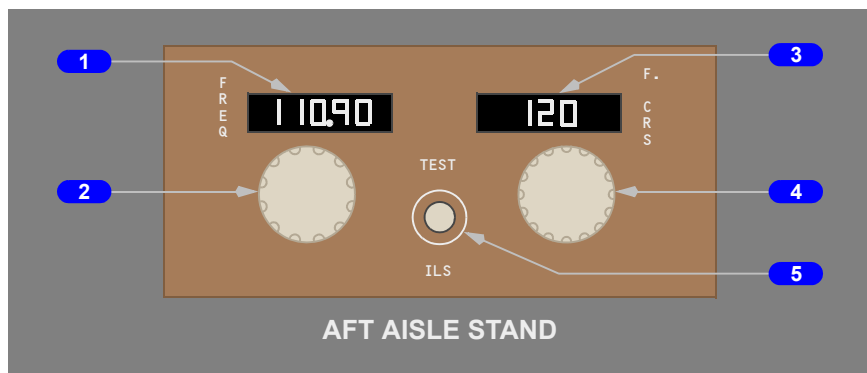
5 ATC FAIL Light

Illuminated (amber) – selected transponder has failed.

6 Identification (IDENT) Switch

Push – transmits an identification signal.

ILS Control Panel



1 ILS Frequency (FREQ) Indicator

Displays frequency tuned in all three ILS receivers or either (----) or (1PK.XX) if the selector is in the standby position. The display is generated by the center ILS receiver.

2 ILS Frequency Selector

Rotate – tunes all ILS receivers.

- tuned frequency displayed in frequency indicator
- received data is displayed on the ADI
- if an ILS mode is selected on the HSI, ILS data is displayed on the related HSI and the associated DME is tuned to the ILS frequency
- VOR frequencies cannot be tuned
- frequency change is inhibited when all three autopilots are armed and either Localizer or Glideslope is captured
- dashes are displayed when turned to the standby position. ILS display symbology is removed from the ADI when dashes are displayed

3 ILS Front Course (F. CRS) Indicator

Displays the selected front course.

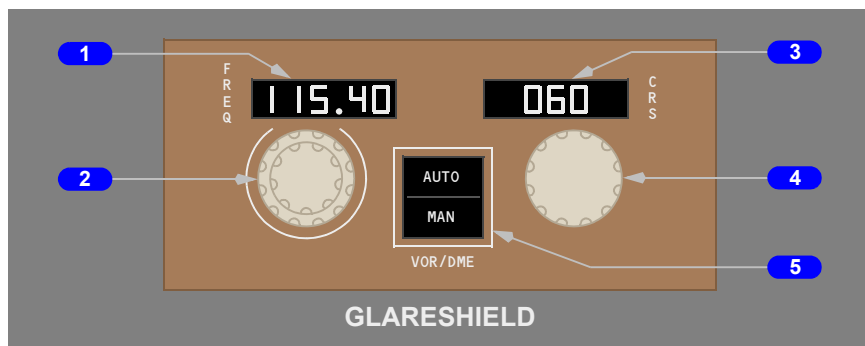
4 ILS Front Course Selector

Rotate – selects the ILS front course.

5 ILS Test Switch

Push – sends a test signal to all ILS receivers except during multiple autopilot approaches after either the localizer or glideslope is captured.

VOR Control Panel



1 VOR Frequency (FREQ) Indicator

Indicates the frequency selected by the frequency selector.

2 VOR Frequency Selector

Rotate –

- when MAN light illuminated, tunes related VOR and also tunes DME if HSI mode selector is not in an ILS position
- ILS frequencies cannot be tuned.

3 VOR Course (CRS) Indicator

Displays course set by VOR course selector.

4 VOR Course Selector

ROTATE – sets course in VOR course indicator and EFIS.

5 VOR/DME Switch

Push –

- alternates VOR and DME tuning between the FMC (AUTO) automatic and VOR frequency selector (MAN) manual when the HSI mode selector is in a MAP or PLAN mode.
- only MAN available when the HSI is not in a MAP or PLAN mode.

AUTO Light illuminated (white) –

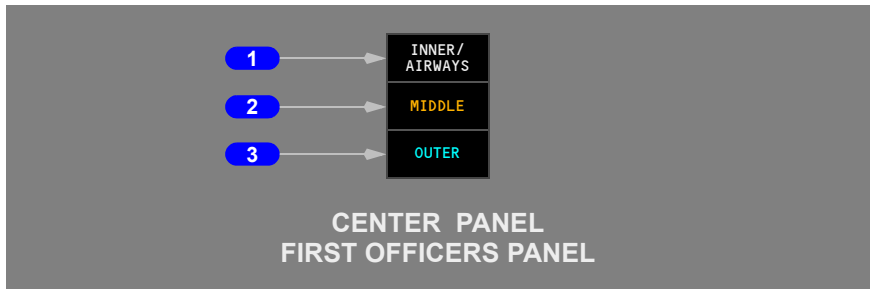
- FMC is tuning related VOR and DME
- HSI selector must be in a MAP or PLAN mode.

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MAN Light illuminated (white) –

- VOR frequency selector is tuning VOR
- if the HSI mode selector is not in an ILS mode, the VOR frequency selector tunes the DME
- if the HSI mode selector is in an ILS mode, the ILS frequency selector tunes the DME.

Marker Beacon Lights



1 INNER/AIRWAYS

Illuminates (white) – over an inner or airways marker beacon.

2 MIDDLE

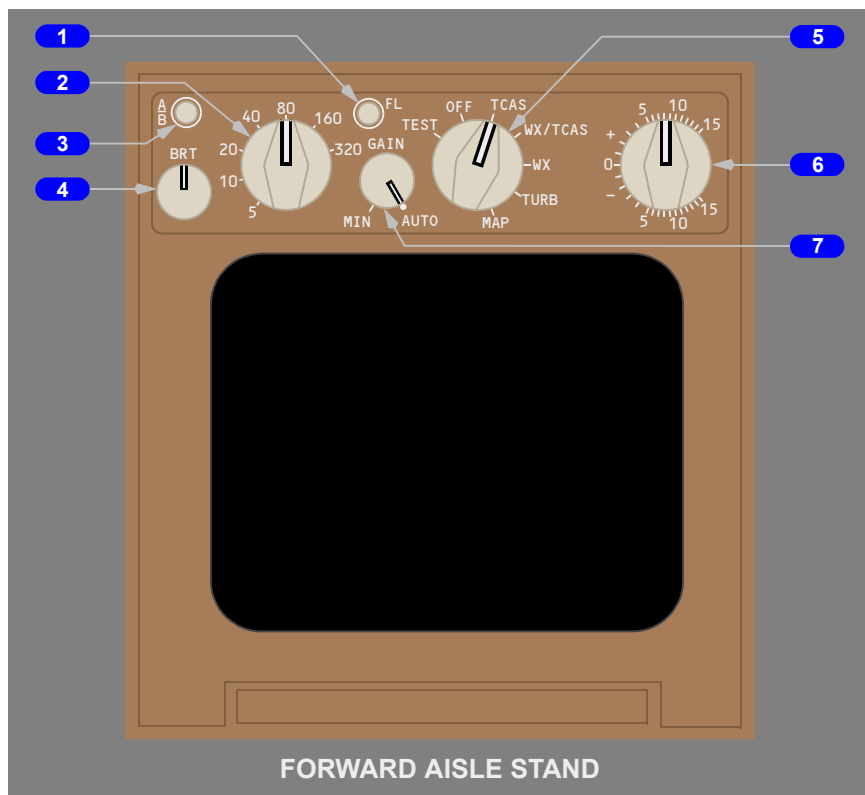
Illuminates (amber) – over a middle marker beacon.

3 OUTER

Illuminates (blue) – over an outer marker beacon.

Weather Radar

Weather Radar Indicator



1 Flight Level (FL) Switch

Controls TCAS traffic altitude display. (refer to Chapter 15, Warning Systems)

2 Range Selector

Selects display range in nautical miles.

3 Above/Below (A/B) Switch

Controls TCAS traffic display. (refer to Chapter 15, Warning Systems)

4 Brightness (BRT) Control

Rotate – adjusts display brightness.

5 Mode Selector

TEST – activates system test.

OFF – deactivates radar and indicator.

TCAS – displays TCAS traffic data. (refer to Chapter 15, Warnings Systems)

WX/TCAS – displays TCAS traffic data and weather radar returns at selected gain level.

WX – displays weather radar returns at selected gain level.

TURB – displays weather radar returns plus turbulence. Turbulence is only shown on display ranges of 40 miles or less.

MAP – displays ground returns.

6 Tilt Control

Rotate clockwise – radar antenna tilts up to selected degrees from horizon.

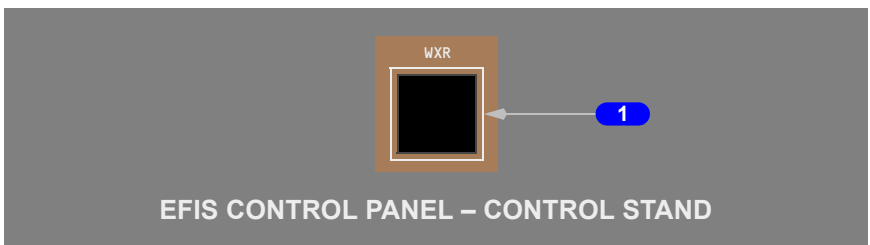
Rotate counterclockwise – radar antenna tilts down to selected degrees from horizon.

7 GAIN Control

AUTO – normal operation, detent position provides automatic gain control calibrated for optimum return.

Rotate – provides manual control of radar gain. Gain increases as control is rotated clockwise.

Weather Radar Switch



1 Weather Radar (WXR) Switch

Push – alternately selects the HSI radar display on and off. The radar transmitter is activated when the radar is displayed on either HSI.

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Flight Management, Navigation Navigation Systems Description

Chapter 11 Section 20

Introduction

Navigation systems include the global positioning system (GPS), inertial reference system (IRS), VOR, DME, ILS, ADF, ATC transponder, weather radar, alternate navigation (as installed), and the flight management system (FMS).

The FMC will provide navigation guidance and MAP display between 87° North and 87° South latitudes.

Navigation Systems Flight Instrument Displays

Refer to Chapter 10, Flight Instruments, Displays for flight instrument display system operations and typical instrument displays.

Inertial Reference System

The inertial reference system (IRS) calculates airplane position, acceleration, track, vertical speed, ground speed, true and magnetic heading, wind speed and direction. It also supplies attitude data for the displays, flight management system, flight controls, engine controls, and other systems.

The IRS consists of three Inertial Reference Units (IRUs) and the IRS mode selector panel.

Inertial Reference System Operation

The Inertial Reference System is controlled by the IRS Mode Control Panel on the overhead panel. When operating in the navigation mode, the IRS provides attitude, acceleration, ground speed, track, true and magnetic heading, present latitude and longitude, and wind speed and direction to other systems. In normal operation, the FMC is used to input data to the IRS and to monitor system operation.

Magnetic heading and track are not available in polar regions. Magnetic reference is provided between N73° and S60° latitude. Above these latitudes only true headings are available.

IRS Alignment

An IRS must be aligned before it can enter the NAV mode. Rotating the IRS mode selector from OFF to NAV begins the IRS alignment. The IRS performs a short power test, during which the ON DC lights illuminate. When the ON DC lights extinguish the ALIGN lights illuminate. Alignment requires approximately ten minutes.

Present position (latitude and longitude) must be entered on the MCDU position initialization page to complete the alignment. If the present position cannot be entered through the MCDU, it may be entered through the IRS mode selector keyboard.

If the latitude/longitude position is not near the origin airport, the 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.

Alignment can be accomplished only when the airplane is parked. Alignment stops if an IRU detects motion during alignment. When the motion stops, some units restart the alignment automatically. Other units flash the ALIGN lights until the alignment is manually restarted.

The IRS is aligned when all IRUs enter the navigation mode. The latitude and longitude display on the SET IRS POS line of the POS INIT page then blanks. Alignment is lost if the selector is moved out of the NAV position.

High Latitude Alignment

High latitude (between 70°12.0' and 78°15.0') alignments requires an extended alignment time. This extended alignment is accomplished by rotating the Mode Selector from OFF to the ALIGN position and allowing the IRS to align for a minimum of 17 minutes. Present position is entered while in the align mode. After the extended alignment, navigation mode is entered by rotating the mode selector to the NAV position.

Fast Alignment

Following operation in the navigation mode and with the airplane parked, performing a fast alignment removes accumulated track, ground speed, and attitude errors, levels the system, and updates present position. This is accomplished by positioning selectors to ALIGN, entering present position, and repositioning selectors to NAV. Fast alignment completes in approximately 30 seconds.

Fast alignment can be accomplished without entering present position. However, greater navigational accuracy is attained by entering present position.

A full alignment must be accomplished when the time from the last full alignment to the completion of the next flight exceeds 18 hours.

IRS Attitude

If alignment is lost in flight, the navigation mode is inoperative for the remainder of the flight. Attitude information can be obtained by moving the selector to the attitude (ATT) position. The IRU enters the Align mode for 30 seconds during which the airplane should stay in straight and level flight. This re-levels the system and provides an attitude reference. Some attitude errors may occur during acceleration. After acceleration, errors are slowly removed.

Heading information can be provided in the ATT Mode if a heading entry is made on the POS INIT page or IRS mode selector panel. Magnetic heading must be updated periodically.

IRS Power

Normally the IRSs operate on AC power from the left and right electrical systems. The main airplane battery is used as an alternate power source. The ON DC light illuminates and the EICAS message IRS ON DC is displayed when AC power is lost and DC power is being used. The DC FAIL light illuminates and the EICAS message IRS DC FAIL is displayed when DC power is lost and AC power is being used. Both lights extinguish if both AC and DC power are on or off.

If all AC power sources are lost the IRSs are powered by the Standby power system.

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Standby power to the left and center IRS is limited to 5 minutes to save battery power.

171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

Standby power to the right IRS is limited to 5 minutes to save battery power.

Radio Navigation Systems

Automatic Direction Finding (ADF)

121-139, 1401-1404

A single ADF system (left) is installed with the control panel located on the aft electronics panel.

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

A dual ADF system is installed with the control panel.

ADF bearings can be selected for display on the RDMIs.

Distance Measuring Equipment (DME)

Two DME systems are installed and each can be automatically tuned by the FMC or manually tuned by the VOR or ILS control panel.

DME Tuning

When an ILS or VOR mode is displayed on the HSI, the related ILS or VOR control panel tunes the DME.

When the HSI selector is in a MAP or PLAN position automatic FMC tuning or manual VOR panel tuning can be selected with the MAN/AUTO switch on the VOR control panel.

The DME can also be remotely tuned on the MCDU by entering a VOR frequency or identifier on the NAV RADIO page, or the PROGRESS page.

The FMC uses two DMEs for position updates. If only one DME is available the FMC can use that DME and the associated VOR for a VOR/DME update.

MCDU

When either or both VORs are being auto tuned by the FMCs the DME receivers are scanned through several frequencies. This provides the FMC with continuous DME-DME updating even when one VOR is being manually tuned or when both VORs are remotely tuned. If both VORs are manually tuned the scanning DME function is disabled.

DME Displays

DME distance is displayed on the RDML. When the DME is tuned by the ILS receiver the distance display is preceded by an L. DME distance is also displayed on the HSI when operating in the VOR or ILS mode.

The identifiers and associated VOR or ILS frequencies of the DME stations used by the FMC for position updates are displayed on the PROGRESS page on the CDU and on the NAV RAD page on the MCDU.

VOR

There are two VOR receivers and two control panels installed. The VORs are normally tuned by the FMC, but can be tuned manually.

VOR Tuning

MCDU

In normal operation the FMC tunes both VORs and the associated DMEs for radio position updates. The HSI must be in a MAP or Plan mode to allow FMC tuning of the VOR. Specific VOR/DME nav aids can be inhibited on the REF NAV DATA page to prevent the FMC from using those nav aids for position updating.

The crew can tune the VORs manually using the control panels, or remotely using the MCDU. If the HSI selector is not in a MAP or PLAN mode, the associated VOR must be manually tuned using the control panel. If the HSI is in a MAP or Plan mode, the AUTO/MAN Switch on the control panel must be selected to MAN to manually tune the VOR.

The tuned VOR frequencies and identifiers are displayed on the NAV RADIO page on airplanes with an MCDU installed and on the PROGRESS page on other airplanes.

VOR Displays

Left and right VOR bearings can be displayed on the RDMLs. When the VOR display is selected on the HSI, the selected course, frequency and course deviation are displayed. If the HSI is in a MAP mode, symbols indicate the position of tuned VORs and the selected course of manually tuned VORs are displayed.

Marker Beacon

Each pilot has a set of marker beacon lights that show outer, middle and inner/airways beacon passage. Both sets are operated by the marker beacon receiver that is part of the left VOR receiver.

Multi–Mode Receiver

Three Multi–Mode Receivers (MMRs) are installed. Each MMR includes an ILS and GPS receiver. The GPS receiver in the center MMR is not used.

Instrument Landing System (ILS)

Three ILS receivers are installed. They are controlled by a single control panel on the aft electronics panel. Frequency changes are inhibited after localizer or glideslope capture if three autopilots are armed for approach. The selected runway front course is locked to prevent changes when the localizer is captured.

ILS Displays

Localizer and glideslope deviation are shown on the ADIs and can be selected on the Standby Attitude Indicator and HSI. The ILS display on the HSI includes the selected front course and frequency in addition to the localizer and glideslope deviation.

Front or back course deviation is determined from airplane heading.

Global Positioning System (GPS)

Left and right GPS receivers are independent and supply very accurate position data to the FMC. The GPS receivers are contained in the left and right Multi-Mode Receivers (MMRs). All GPS tuning is automatic.

GPS Displays

Position Reference, page 3 of 4 (POS REF 3/4) displays the left and right GPS position.

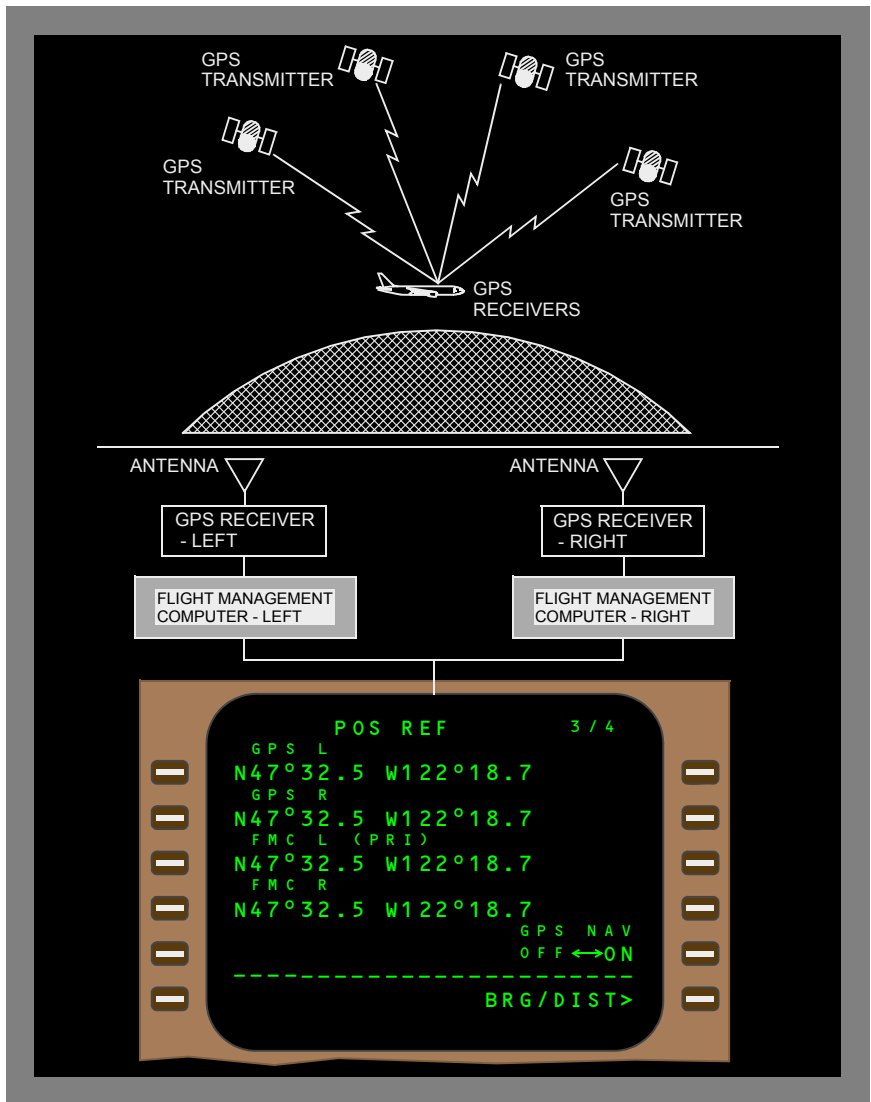
GPS Data

The FMC uses GPS data for position information as long as the GPS is enabled and the GPS data is valid. If GPS data is not available or is unreliable the FMC will use radio position or IRS position data.

The GPS NAV prompt on POS REF page 3/4 can be used to inhibit GPS navigation data. The EICAS message GPS alerts the crew when data from both GPS systems are unavailable or when both systems have failed.

GPS position updates are allowed for all United States National Airspace approach operations. Outside of this region, GPS position updates are allowed during approaches only if the FMC database and approach charts are referenced to the WGS-84 reference datum. GPS updates should be inhibited for all other approach operations unless other appropriate procedures are used.

GPS System Schematic



Transponder

There are two ATC transponders installed. They are controlled by a single control panel and provide normal transponder functions and altitude reporting. The control panel is used to set the ATC code, operating mode, and to select which transponder is active.

The transponder is also capable of providing traffic alert and collision avoidance system (TCAS) indications. Select TA ONLY or TA/RA to enable traffic displays. Refer to Chapter 15, Warning systems, for a description of TCAS.

Failure of a transponder is indicated by the illumination of the amber ATC FAIL light on the control panel and the ATC FAULT advisory message on EICAS.

Weather Radar

The weather radar system consists of a receiver-transmitter, an antenna, and a weather radar indicator. Controls for the system are contained on the indicator.

Radar returns are displayed on the HSI.

The weather radar switch (WXR) on the EFIS control panel selects the weather radar display. The radar display range is set by the range selected on the EFIS control panel.

Weather radar returns can also be displayed on the dedicated radar indicator on the forward aisle stand.

Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Turbulence is displayed in magenta. Clear air turbulence can not be sensed by radar.

1404, 1603-1613, 1705-1708

The predictive windshear alerting system uses the weather radar to sense windshear. To provide windshear alerting the weather radar transmitter is activated on the ground when takeoff power is set and in flight when the airplane is below 2300 feet radio altitude. Weather radar returns are not displayed unless the WXR switch is ON, or a predictive windshear alert occurs. Weather radar returns can only be displayed in VOR, APP, MAP and CTR MAP modes.

Introduction

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

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

The FMS tunes the navigation radios for position updating. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Cruise altitudes and crossing altitude restrictions are used to calculate VNAV commands. Lateral offsets from the programmed route can be calculated and commanded.

Flight Management Computer (FMC)

The heart of the flight management system is the flight management computer. Under normal conditions, one FMC accomplishes the flight management tasks while the other FMC monitors. The second FMC is ready to replace the first FMC if system faults occur.

The FMC uses flight crew-entered flight plan data, airplane systems data, and data from the navigation database to calculate airplane present position and generate the pitch, roll, and thrust commands necessary to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route data are sent to the HSIs. The EFIS control panels are used to select the data to be displayed on the HSIs. The mode control panel selects the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays.

The FMC is certified for area navigation when used with navigation radio and/or GPS updating.

The FMC and MCDU are used for enroute and terminal area navigation, RNAV approaches, and as a supplement to primary navigation means when conducting other types of nonprecision approaches.

Control Display Unit (CDU)/Multifunction Control Display Unit (MCDU)

Two MCDUs are used to control the FMC.

MCDUs also provide alternate navigation capability if both FMCs fail (refer to the Alternate Navigation section of this chapter). MCDUs can also provide control of other systems which are accessed through the menu page.

Flight Management, Navigation
Flight Management System Operation**Chapter 11**
Section 31

Introduction

Many FMS functions change depending on the current phase of flight. When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS changes to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and AWABS data are entered. The flight plan defines the route of flight from the origin to the destination

Required preflight data consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database selection
- route 2
- alternate airport
- SID
- STAR
- wind.

Each required or optional data item is entered on specific preflight pages.

Preflight starts with the IDENT page. If the IDENT page is not displayed, it can be selected with the IDENT prompt on the INIT/REF INDEX page. Visual prompts help the flight crew select necessary preflight pages. Preflight pages can be manually selected in any order.

After the necessary data on each preflight page is entered and checked, the lower right line select key selects the next preflight page. When ACTIVATE is selected on the ROUTE page, the execute (EXEC) light illuminates. Push the EXEC key to make the route active.

Use the departure/arrival (DEP/ARR) page to select a standard instrument departure (SID). Selection of the SID may cause a route discontinuity in the flight plan. The modification can be connected to the existing route and executed. This is accomplished on the ROUTE or LEGS page.

When all required preflight entries are complete, PRE–FLT COMPLETE is displayed on the TAKEOFF REF page.

Takeoff

The takeoff phase starts with engagement of takeoff thrust and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase starts at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C is the position where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase starts 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 starts at the T/D point or when the VNAV descent page becomes active. The descent phase extends to the start of the approach phase.

Approach

The approach phase starts when intercepting the first leg of a published approach selected from the ARRIVALS page.

Flight Complete

Thirty seconds after engine shutdown, 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.

Operational Notes

When operating in the LNAV and VNAV modes, system operation must be monitored for unwanted pitch, roll, or thrust commands. If unwanted operation is noticed, roll and pitch modes other than LNAV and VNAV must be selected.

The system must be carefully monitored for errors following:

- activation of a new data base
- power interruption
- IRS failure.

The FMC will not sequence the active waypoint when more than 21 nm off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO/FROM procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) use the first occurrence of the waypoint even if the second occurrence is selected.

Some SIDs or STARS contain a heading vectors leg. VECTORS waypoints display on the map display as a magenta line without an end point leading away from the airplane symbol. If LNAV is engaged, the DIRECT TO or INTERCEPT COURSE TO procedure can be used to start waypoint sequencing beyond the vectors leg.

When entering airways in a route page, the start and end waypoints must be in the data base. Otherwise, the route segment must be entered as a DIRECT leg.

If the engines remain operating between flights, entering a new cruise altitude before the next flight recalculates the proper vertical profile.

If a climb to cruise altitude is necessary after completing a descent, a new cruise altitude entry must be made. Cruise altitude can be entered on the CLB page.

Direct-to courses are segments of a great circle route. When entering a direct-to waypoint on the LEGS page, the course above the waypoint before execution is the arrival course at the waypoint. However, after execution, the course is the current course to fly to the waypoint. These courses may not be the same.

Terminology

The following paragraphs describe FMS terminology.

Active – flight plan data being used to calculate LNAV or VNAV guidance commands.

Activate – the procedure to change an inactive route to the active route for navigation. It is a two step procedure.

- select the **ACTIVATE** prompt
- push the execute (**EXEC**) key.

Altitude constraint – a crossing restriction at a waypoint.

Delete – using the delete (**DEL**) key to remove FMC data and revert to default values, dash or box prompts, or a blank entry.

Econ – a speed schedule calculated to minimize operating cost. The economy speed is based on the cost index. A low cost index causes a lower cruise speed. Maximum range cruise or the minimum fuel speed schedule may be obtained by entering a cost index of zero. This speed schedule ignores the cost of time.

A low cost index may be used when fuel costs are high compared to operating costs.

A minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds.

Enter – insert data in the scratchpad and line select the data to the applicable location. New characters can be typed or existing data can be line selected to the scratchpad for entry.

Erase – remove entered data, which has resulted in a modification, by selecting the **ERASE** prompt.

Execute – push the **EXEC** key when the light is illuminated to make modified data active.

Inactive – data not being used to calculate LNAV or VNAV commands.

Initialize – entering data required to make the system operational.

Message – FMC information displayed in the scratchpad.

Modify – to change active data. When a modification is made to the active route or performance mode, MOD displays in the page title, ERASE displays next to line select key 6 left, and the EXEC key illuminates.

Prompt – MCDU symbol that aids the flight crew in accomplishing a task.

Prompts can be boxes, dashes, or symbols (< or >) to remind the flight crew to enter or select data.

Reset – a self protection function which causes an FMC to shutdown and restart when an error is detected. Current flight and performance data is automatically re-loaded from the other FMC during the reset.

Select – pushing a key to obtain the necessary data or action, or to copy selected data to the scratchpad.

Speed restriction – an airspeed limit associated with a specified altitude entered by the flight crew.

Speed transition – an airspeed limit associated with a specified altitude entered from the database.

Waypoint – a point on the route or in the navigation database. It can be a fixed point such as a latitude and longitude, VOR or ADF station, or an airway intersection. A conditional waypoint is not associated with a land reference; it is based on a time or altitude requirement. An example of a conditional waypoint is “when reaching 1000 feet”.

Navigation Position

The FMC determines present position from these navigation systems:

- IRS
- navigation radios.
- GPS

The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint. The FMC requires position data from the IRS. All other position sources are validated against the IRS position and are used to refine the FMC position.

FMC Position Update

FMC position may be manually updated to any of the navigation system positions. This update is accomplished on POS REF page 2.

On the ground, the FMC calculates present position based on IRS and/or the GPS data.

If GPS NAV is OFF, the FMC updates position to the takeoff runway threshold when the EPR switch is pushed. The runway data is on the TAKEOFF REF page. When an intersection takeoff is made, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page. If GPS NAV is ON, the THR update is inhibited. GPS NAV is on POS REF page 3/4.

In flight, the FMC position is continually updated from the GPS, navigation radios, and the IRS. Updating priority is based on the availability of valid data from the supporting systems.

The FMC automatically tunes the VOR, DME, and ILS radios for position updates.

FMC position updates from navigation sensor positions follow this priority:

- one LOC and GPS (when on the localizer)
- one LOC and collocated DME (when on the localizer)
- GPS
- two DME stations
- one VOR with a collocated DME
- IRS.

The station identifiers of the tuned radio navigation aids are displayed on the POS REF page 2.

Primary FMC Position Update Source	POS REF page 2/4
GPS	GPS
LOC, GPS valid*	LOC–GPS
LOC, DME DME valid; GPS invalid*	LOC–RADIO
LOC, VOR DME valid; GPS invalid*	LOC–RADIO
LOC valid; GPS, DME, VOR invalid*	LOC
DME DME valid; GPS invalid	RADIO
VOR DME valid; GPS invalid	RADIO
GPS, VOR, DME invalid	IRS
IRS invalid (no navigation capability)	blank
* The FMC changes to LOC updating when: • the tuned localizer is associated with the destination runway • valid localizer signal is being received • the airplane is within the criteria to ensure accurate LOC updating.	

FMC Polar Operations

The FMC automatically starts polar operations when the calculated airplane position enters a polar region. The FMC switches all flight display inputs to reference true north while in these regions.

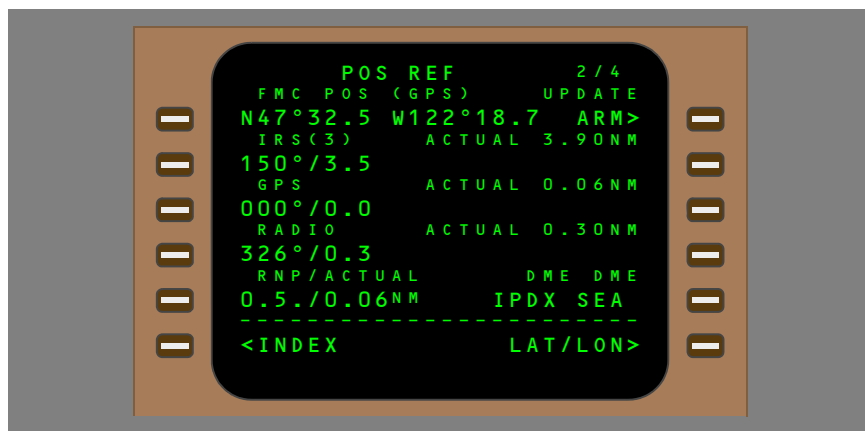
The navigation and display system does not support operations at latitudes greater than 87° North or South.

Automatic switching to a true north reference is annunciated by a flashing white box around the word TRU on the HSI. A TRUE heading reference can be selected with the heading reference switch when outside the polar region. The HSI displays a green box around the word MAG to annunciate the change back to magnetic reference. If the heading reference is TRU in the descent phase, the HSI displays an amber box around the word TRU.

FMC Polar Regions

Polar regions are all areas above 73° North or below 60° South. Magnetic headings are not available in these areas.

Navigation Performance



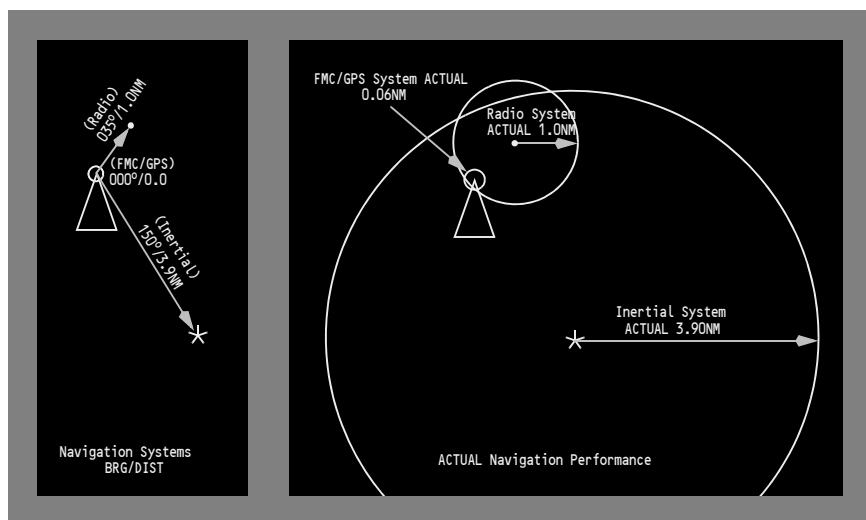
The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position is displayed on line 1 of POS REF page 2. The primary source of update is shown in parentheses above the FMC position. The positions of each of the navigation systems are shown in lines 2 through 4. The flight crew can change the display format from latitude/longitude to bearing/distance format. The bearing/distance is from the FMC position to the individual navigation system position.

Actual Navigation Performance

Actual navigation performance (ANP) is the FMC current computed position accuracy. It is shown on POS REF page 2 (line 5L) titled ACTUAL. ACTUAL navigation performance is expressed in nautical miles. It represents the radius of a circle centered at the FMC position which defines the limit of the potential error in that position. The smaller the ANP the more accurate the FMC position.

ACTUAL navigation performance is also computed for each of the navigation systems and those values are displayed on POS REF page 2 adjacent to the system name. The systems' ACTUAL navigation performance is equivalent to the one calculated for the FMC.

After a manual position update, the ACTUAL navigation performance of the FMC changes to the ACTUAL navigation performance of the selected navigation system. In the example above, a manual position update to the INERTIAL system would change the FMC ACTUAL navigation performance to 3.9 NM. The FMC then updates from the best available navigation system and eventually, the manual update has no effect on position calculation. Some automatic updates can be inhibited: GPS on POS REF page 3 and VOR/DME updates on the REF NAV DATA page. Inertial and DME/DME updates can not be inhibited.



Required Navigation Performance

Required navigation performance (RNP) values have been created and published for certain areas of operation and procedures. The RNP, expressed in nautical miles, defines the accuracy of the navigation equipment required to fly the route or procedure for which it is published. ACTUAL navigation performance should not exceed RNP. The FMC triggers the EICAS advisory or caution level message UNABLE RNP to alert the flight crew if ANP exceeds RNP. The FMC supplies a default RNP value for takeoff, enroute, oceanic/remote, terminal, and approach phases of flight. RNP is displayed on POS REF page 2. The flight crew may enter an RNP value, if required.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint or the selected route intercept point. When armed on takeoff, LNAV engages at or above 50 feet when laterally within 2.5 nautical miles of the active route leg. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC data base is entered into the active route, the FMC commands a heading, track, or a DME arc to comply with the procedure.

The FMC creates a path allowing the airplane to turn before reaching a fly-by waypoint. When a waypoint is defined as a fly-over, the FMC directs the airplane to fly directly over the waypoint before turning. The flight path shows on the HSI map using a reduced range.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the MCDU and HSI.

The MCDU message NOT IN DATABASE is displayed if a manually entered waypoint identifier is not in the data base. The waypoint can still be entered as a latitude/longitude, place-bearing/distance or a place-bearing/place-bearing waypoint.

FMC-generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoints

VHF – waypoints located at VHF nav aids (VOR/DME/LOC) are identified by one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC – LAX
- Tyndall TACAN – PAM
- Riga Engure, Latvia – AN.

NBD – waypoints located at NDBs are identified by use of the station identifier. Example: FORT NELSON, CAN – YE.

Fix Waypoints

Waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Waypoints with more than five characters are abbreviated using the following rules sequentially until five characters remain. For double letters, one letter is deleted. Example:

- KIMMEL becomes KIMEL.

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Example:

- BAILEY becomes BAILY.

The next rule abbreviates names even further. Apply the previous rule, then delete consonants from right to left. Example:

- BRIDGEPORT becomes BRIDGPRT then BRIDT.

Fixes with multi word names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Waypoints

If an unnamed turn point, intersection, or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID – DISTANCE – IDENT):

- INW – 18 – INW18
- CSN – 106 – 06CSN.

Waypoint located at unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points are identified by the three-letter airspace type identification followed by a two-digit sequence number. Example:

- FRA01

Unnamed oceanic control area reporting points in the northern hemisphere use the letters N and E, while points in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three digit value are used.

Placement of the designator in the five character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

• N50° W040° becomes 5040N	• S52° W075° becomes 5275W
• N75° W170° becomes 75N70	• S07° W120° becomes 07W20
• N50° E020° becomes 5020E	• S50° E020° becomes 5020S
• N06° E110° becomes 06E10	• S06° E110° becomes 06S10.

Procedure Arc Fix Waypoint Names

Unnamed terminal area 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. Example:

- EPH252°/24 = D252X.

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified by the station identifier and the DME radius. Example:

- CPR338°/29 = CPR29.

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.

DME step down fixes are identified by the distance and a “D”.

Examples: 138D, 106D, 56D, 3D.

Procedure Fix Waypoints

Marker beacons are identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21.

Waypoints located at unnamed runway-related fixes are identified by adding a two-letter prefix to the runway number. The following list is used to determine the applicable prefix:

• RX – runway extension fix	• BM – back course marker
• FA – VFR final approach fix	• MD – minimum descent altitude
• CF – final approach course fix	• A – (+ an alpha) step down fix
• FF – final approach fix	• RW – runway threshold
• IF – initial approach fix	• MA – missed approach point other than RW
• OM – outer marker	• TD – touchdown point inboard of RW.
• MM – middle marker	
• IM – inner marker	

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

• C () – final approach course fix	• ()B – backcourse ILS
• F () – final approach fix	• ()D – VOR/DME
• P () – missed approach point	• ()V – VOR only
• I () – initial approach fix	• ()S – VOR with DME points
• D () – minimum descent altitude	• ()N – NDB
• T () – touch down point	• ()Q – NDB with DME points
• R () – runway centerline intercept.	• ()M – MLS
• ()I – ILS	• ()T – Tacan
• ()L – localizer only	• ()R – RNAV.

Examples: CI32R, PV15, FN24L.

Unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page. Airport reference points are identified by the ICAO identifier.

Duplicate Waypoints

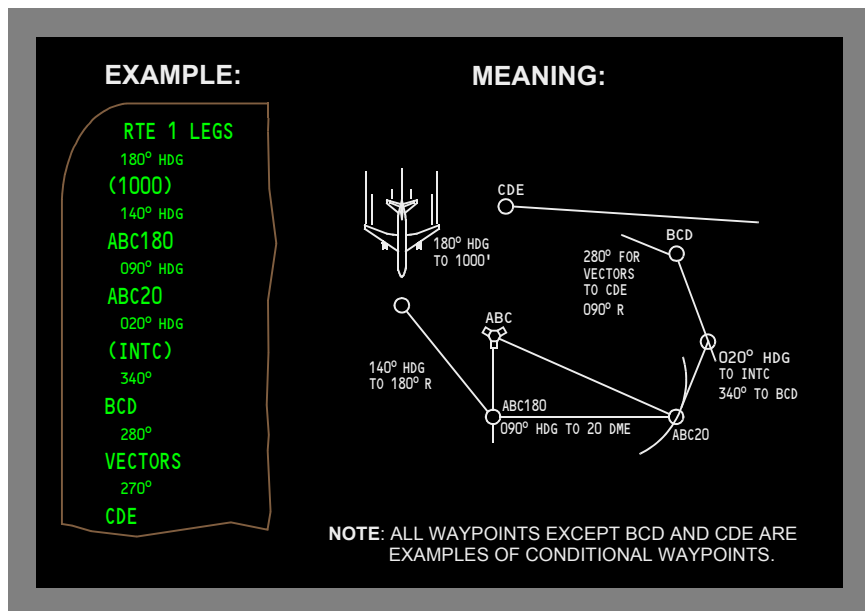
Application of the abbreviation rules may create identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude, longitude, and the type of facility or waypoint of all the waypoints with the same identifier. Select the latitude/longitude of the correct waypoint to enter the correct waypoint on the original page.

Conditional Waypoints

Conditional waypoints may be displayed in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically-fixed position. The types of conditions are:

- climb/descent through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vectors to a course or fix.

Altitude and course intercept conditional waypoints display inside (parenthesis) marks. The diagram below shows conditional waypoints.



Manually Entered Latitude/Longitude Waypoints

Pilot defined waypoints entered as a latitude and longitude are shown in a seven-character format. 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 is displayed as N47W008
- N47° 15.4' W008° 3.4' is entered as N4715.4W00803.4 and is displayed as N47W008.

Manually Entered Place-Bearing/Distance or Place-Bearing/Place-Bearing Waypoints

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.

The two digit sequence numbers reserved for RTE1 are 01 through 49. The two digit sequence numbers reserved for RTE2 are 51 through 99.

Manually Entered Airway Crossing Waypoints

Airway crossing fixes are entered as a five character waypoint name or by entering consecutive airways on the ROUTE page. In the latter case, the display is an X followed by the second airway name. Example: entering J70 on the VIA line of the ROUTE page causes box prompts to display opposite on the same line. Leaving the TO box prompts empty and entering J52 on the next VIA line, directly below J70, causes the FMC to calculate the intersection of the two airways and replace the boxes with the waypoint identifier, XJ52.

Manually Entered Latitude or Longitude Reporting Point Waypoints

Latitude or longitude reporting waypoints are entered as the full latitude or longitude followed by a dash, then the increment chosen for the following multiple waypoints. Example:

- W060-10 adds waypoints starting at W060 in ten degree increments from that point to the destination
- the entry must be made on a LEGS page on any line before the first reporting point
- usually, this entry is made on the active waypoint line and proper sequencing is performed by the FMC.

Manually Entered Along-Track Waypoints

Along-track waypoints are created on the active route and do not cause route discontinuities when they are created.

Along-track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along-track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route and displays as VAM01
- ELN/-30 is 30 miles before ELN on the present route and displays as ELN01.

Engine Out SID

An engine out SID is a procedure developed by an airline for a particular runway to provide unique routing if an engine fails on takeoff. If the database contains an EO SID for the takeoff runway and an engine fails while the flaps are extended, the active route is automatically modified to the engine out route. The modification may be either executed or erased.

Map Displays

The route is displayed on the HSI when a MAP or PLAN mode is selected.

The display color and format represent the following status:

- an inactive route is displayed as a cyan dashed line
- an activated, but not yet executed route, is displayed as a white dashed line
- the active route is displayed in magenta
- modifications to an active route are shown as dashed white lines
- modified waypoints are displayed in white
- executed route offsets are displayed as a dashed magenta line.
- prior to execution entered route offsets are displayed as a dashed white line

The HSI displays the FMC position at the apex of the airplane symbol. All MAP data is displayed relative to this apex.

When adequate GPS or radio updating is not available, the HSI map may display a shift error.

This error results in the displayed position of the airplane, route, waypoints and navigation aids being shifted from their actual position. An undetected, across track map shift may result in the airplane flying a ground track that is offset from the desired track. An undetected, along track map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the map with data from the ILS, VOR, DME, and ADF systems.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Constraints

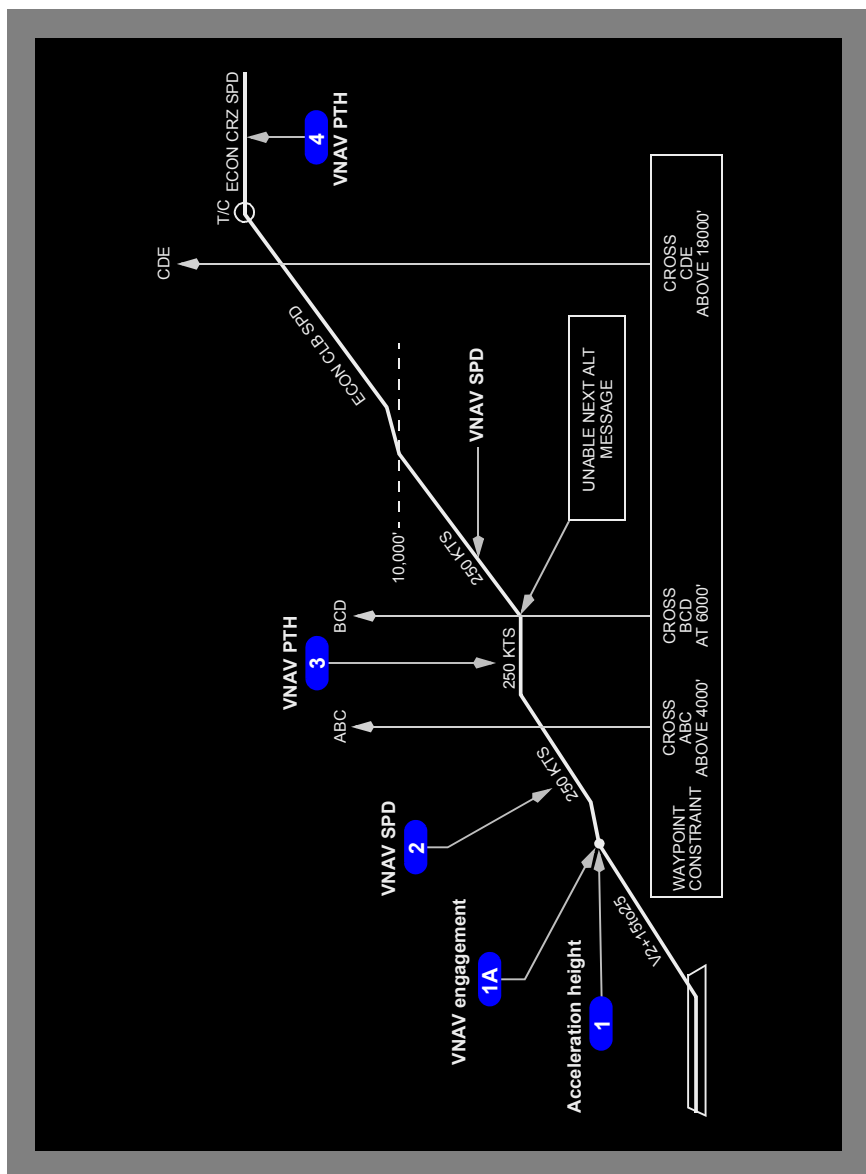
VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the MCDU. Barometric altitude constraints must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and are displayed in small font.

Waypoints can have altitude or airspeed/altitude constraints. Speed constraint entries require an altitude constraint at the same waypoint. All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (example: 220A240B or 240B220A).

Takeoff and Climb



1 Acceleration Height

Height at which acceleration is initiated for flap retraction, normally 1000 feet. Takeoff (TO) pitch mode is used for takeoff and initial climb up to this point.

1A VNAV Engagement

VNAV is normally engaged at acceleration height. Pitch guidance then commands:

- an airspeed increase to 250 knots, or
- the speed transition associated with the origin airport, or
- the takeoff target airspeed (between $V_2 + 15$ and $V_2 + 25$ knots) if the acceleration altitude entered on TAKEOFF REF page 2/2 has not been reached

When VNAV is engaged (above 400 feet) the thrust reference changes to climb.

Initial reduction of flaps after VNAV is engaged also initiates pitch guidance to accelerate to 250 knots.

2 VNAV Climb

The VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed, or pilot selected climb speed to remain within all airspeed and altitude constraints that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

3 Climb Constraints

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed.

If the FMC predicts the airplane will not reach an altitude constraint, the message UNABLE NEXT ALTITUDE is displayed on the MCDU. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb or climb derates can be deleted.

4 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 is displayed any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is displayed on the map as a green open circle with the label T/C.

Cruise

At cruise altitude, the FMC commands economy cruise speed or the pilot entered speed until reaching the top-of-descent (T/D) point. Alternate cruise speed options are:

- long range (LRC)
- engine out (ENG OUT), or
- flight crew entered speed.

If the cost index is set to zero the FMC commands maximum range cruise speed. Cost index modifications are allowed until within ten miles of the top of descent.

Cruise Climb

When VNAV is engaged, resetting the MCP to an altitude within 4000' below or any altitude above the current cruise altitude causes that altitude to be displayed in the scratchpad of the MCDU. The altitude can then be entered on the CRZ ALT line on the cruise page. When the modification is executed the airplane will climb to the new cruise altitude. The CRZ page displays ACT ECON CRZ CLB.

Step Climb

Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise. FMC predicted step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise.

Entry of a step altitude on the CRZ or RTE LEGS page overrides the FMC step climb predictions. Entry of a planned step altitude on the RTE LEGS page overrides a "Step To" entry made on the CRZ page.

Predicted step altitudes display on the RTE LEGS page. The distance and ETA to the next step point (predicted or flight crew entered) display on the CRZ and progress pages. They also display on the map display with a green circle and S/C label.

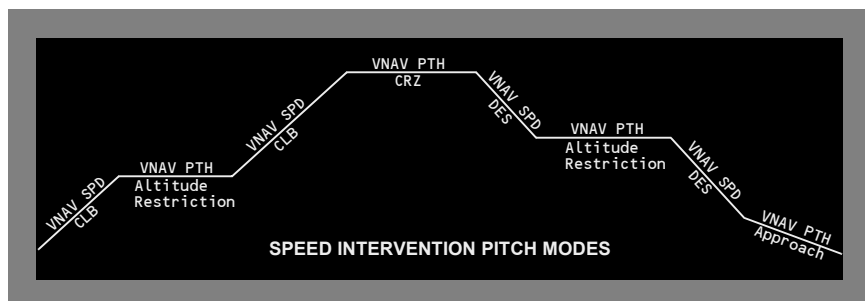
Cruise Descent

Resetting the MCP to an altitude below the current cruise altitude causes the new altitude to be copied to the scratchpad if the altitude change is 4000 feet or less. The new cruise altitude can be entered on the cruise page. When the modification is executed the CRZ page displays ACT ECON CRZ DES. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted and the airplane will maintain cruise speed during the descent.

Note: A cruise descent will not provide speed adjustments to comply with speed restrictions or transition altitude speeds. Transition or speed restrictions must be maintained by flight crew action.

Mode Control Panel Speed Intervention

With VNAV engaged, pushing the IAS/MACH selector enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.



The above illustration shows VNAV mode for each phase of flight during speed intervention.

Note: The FMC does not use the speed set on the MCP for fuel or ETA predictions so FMC predictions are not accurate if speed intervention is used for an extended period.

In VNAV PTH mode, thrust controls speed; in VNAV SPD mode, pitch controls speed.

If speed intervention is selected during a VNAV PTH descent, VNAV PTH pitch mode changes to VNAV SPD and the airplane may depart the FMC calculated descent path. In all other phases of flight, the AFDS captured pitch mode remains unchanged when speed intervention is selected.

In approach phase (see Approach topic this chapter/section), during speed intervention, pitch mode remains in VNAV PTH and the vertical path is maintained regardless of IAS MACH selector changes.

Descent

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point.

An E/D point is created by the FMC when an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan. The E/D point is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point, which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D point is also created when an altitude constraint less than cruise altitude is added to a downstream waypoint on the LEGS page. The E/D point is displayed on the HSI as a green circle with the label E/D.

The FMC calculates the top of descent (T/D) point after the E/D is entered. T/D is the point where the cruise phase changes to the descent phase. The T/D is displayed on the HSI as a green circle with the label T/D. The descent path starts at the T/D and includes any waypoint altitude/airspeed constraints. The path to the first altitude constrained waypoint is based on:

- idle thrust
- speedbrakes retracted
- FMC cruise wind
- wind entries on the DESCENT FORECAST page
- predicted use of anti-ice
- applicable target speed

Descent path segments after the first altitude constrained waypoint are constructed as straight line point-to-point segments from one altitude constraint to the next.

The airspeed used to determine the descent path is the existing VNAV cruise airspeed, normally economy Mach/CAS (based on Cost Index), and any additional descent airspeed constraints. Waypoints with an airspeed constraint must also have an altitude constraint. Airspeed constraints after the first altitude constrained waypoint are treated as speed limits (e.g. at or below the speed constraint).

With the MCP altitude set below the current airplane altitude and at the T/D point, the FMC commands idle thrust and the AFDS pitches down to track the vertical descent path. AFDS pitch maintains the vertical descent path while the angle of the descent path is calculated by the FMC to maintain the descent airspeed (at idle thrust), normally economy descent Mach/CAS.

If the airplane passes the T/D point and the window altitude has not been set lower, or if the airplane levels at an MCP altitude not in the FMC descent profile, ALT HOLD annunciates. To reinstate/continue the descent, the MCP altitude must be reset and VNAV re-engaged.

When a speed transition altitude is included in the descent path (typically 250 knots below 10,000 ft.), the descent path angle shallows temporarily to slow to the transition altitude airspeed. Below the speed transition altitude, the descent path angle increases to maintain a target speed 10 knots below the transition speed (typically 240 knots) to allow for unforecast tailwinds.

Above the speed transition altitude, path and speed are maintained according to the following:

- If airspeed decreases to 15 knots below the VNAV target airspeed, as may be caused by an unforecast headwind (or not entering winds on the DESCENT FORECAST page), the autothrottle changes from IDLE/HOLD to SPD and an appropriate amount of thrust is added to accelerate back to the VNAV target speed. Upon reacquiring the target airspeed, the autothrottle changes back to IDLE/HOLD. If the autothrottle is disengaged, the scratchpad message THRUST REQUIRED displays and it is the flight crew's responsibility to adjust thrust to reacquire the VNAV target airspeed.
- If airspeed increases to 15 knots above the VNAV target airspeed, as may be caused by an unforecast tailwind (or not entering winds on the DESCENT FORECAST page), the scratchpad message DRAG REQUIRED displays. To slow the airspeed back to the target it is the flight crew's responsibility to add an appropriate amount of drag (usually with speedbrakes). Upon reacquiring the target airspeed, the scratchpad DRAG REQUIRED message automatically clears. The DRAG REQUIRED scratchpad message may also appear if the airspeed reaches VMO/MMO minus 16 knots before reaching the airspeed of VNAV target speed + 15 knots.
- If airspeed is allowed to decrease/increase below/above the 15 knot limits and approach an aerodynamic/airframe speed limit (VMO/MMO, minimum maneuvering, flap placard, etc.), VNAV reverts to speed reversion mode. In speed reversion mode, VNAV departs the calculated vertical descent path and pitch changes from VNAV PTH to VNAV SPD. VNAV then pitches to maintain a safe target speed (not the VNAV PTH descent speed) above/below the path as appropriate. If the calculated vertical descent path is reacquired, the target speed returns to the original VNAV PTH descent speed. The scratchpad messages THRUST REQUIRED and DRAG REQUIRED also reappear as appropriate during speed reversion.

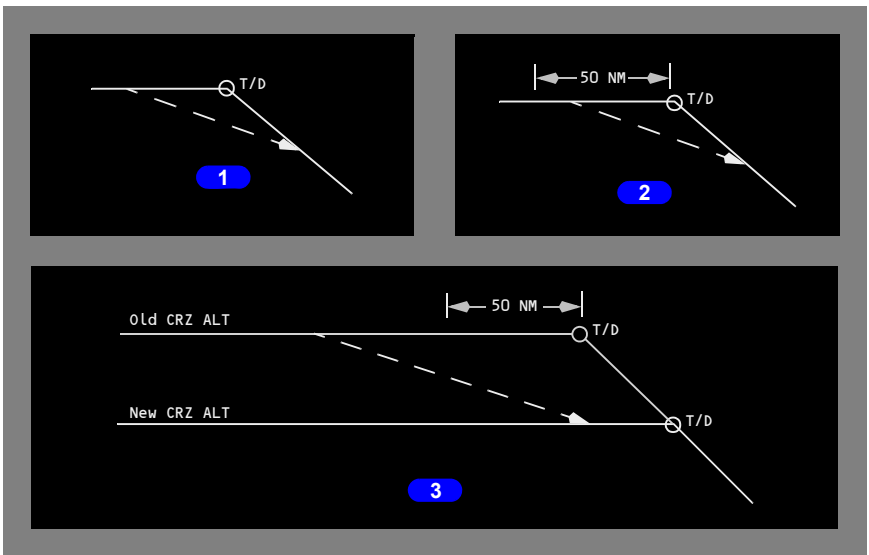
Below the speed transition altitude, path and speed are maintained as described for when above the speed transition altitude, except the airspeed is only allowed to deviate a maximum of 10 knots above/below the VNAV target airspeed before the autothrottle reacts, or the FMC scratchpad messages display.

Final deceleration is commanded to arrive at the final approach fix or the outer marker at 170 kts. It is the flight crew's responsibility to extend flaps as appropriate when the final deceleration segment to 170 kts is initiated by VNAV.

Note: Adding, deleting or revising altitude constraints after VNAV enters the descent mode causes a recalculation of the descent path by the FMC. This may cause VNAV to revert to speed reversion mode (VNAV SPD) if the newly calculated path is above or below the old path far enough so as to prevent the path from remaining captured.

Early Descent

An early descent is initiated by forcing the FMC into the descent phase before reaching the top of descent point. VNAV commands a descent at a reduced descent rate until the idle descent path is intercepted.



1 DES NOW

Use the DES NOW prompt on the DES page. VNAV starts an early descent and captures the idle descent path.

Note: When more than 50 NM from the top of descent point, perform a cruise descent rather than a descend now for descent to intermediate altitudes. During cruise descent the FMC computes a new top of descent for the new cruise altitude and accurate destination fuel predictions. Using DES NOW more than 50 NM from the top of descent point can cause a fuel computation error.

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 and the new T/D is displayed. Monitor the descent profile to ensure the new cruise altitude is reached before T/D.

Approach

For VFR and nonprecision approaches, VNAV will fly the computed descent path to the E/D point altitude if the MCP altitude is set at or below the E/D point altitude. However, it is the responsibility of the flight crew not to descend below the MDA of the approach being flown until adequate visual contact is achieved.

"On Approach" Mode

The FMC transitions to "on approach" mode for any of the following conditions:

- an approach procedure selected into the active route from the destination airport ARRIVALS page becomes the active procedure on page 2 of the active Route Page
- distance to the destination airport is less than 12 nm and the active leg is not part of a procedure
- the MAP (or last waypoint on the approach procedure) is the active waypoint and the distance to that waypoint is less than 25 nm
- flaps extended after VNAV engaged in DES mode

Transition to the "on approach" FMC mode may be delayed if the flight crew manually inserts, bypasses, or deletes an approach waypoint on the LEGS page.

When the FMC is “on approach”, the following features are available:

- the IAS/MACH window can be opened and the command speed can be set while VNAV remains in VNAV PTH descent; VNAV commands the set speed
- the MCP altitude can be set above the airplane altitude for the missed approach. When the MCP altitude setting is at least 300 feet above the current airplane altitude, VNAV continues to command a descent
- VNAV remains in VNAV PTH and follows the descent path unless the airplane accelerates to within 5 knots of the current flap placard and the airplane rises more than 150 feet above the path. In this case, VNAV PTH changes to VNAV SPD

The FMC transitions out of approach under the following conditions:

- the airplane lands
- selecting GA
- the airplane flies beyond the missed approach waypoint

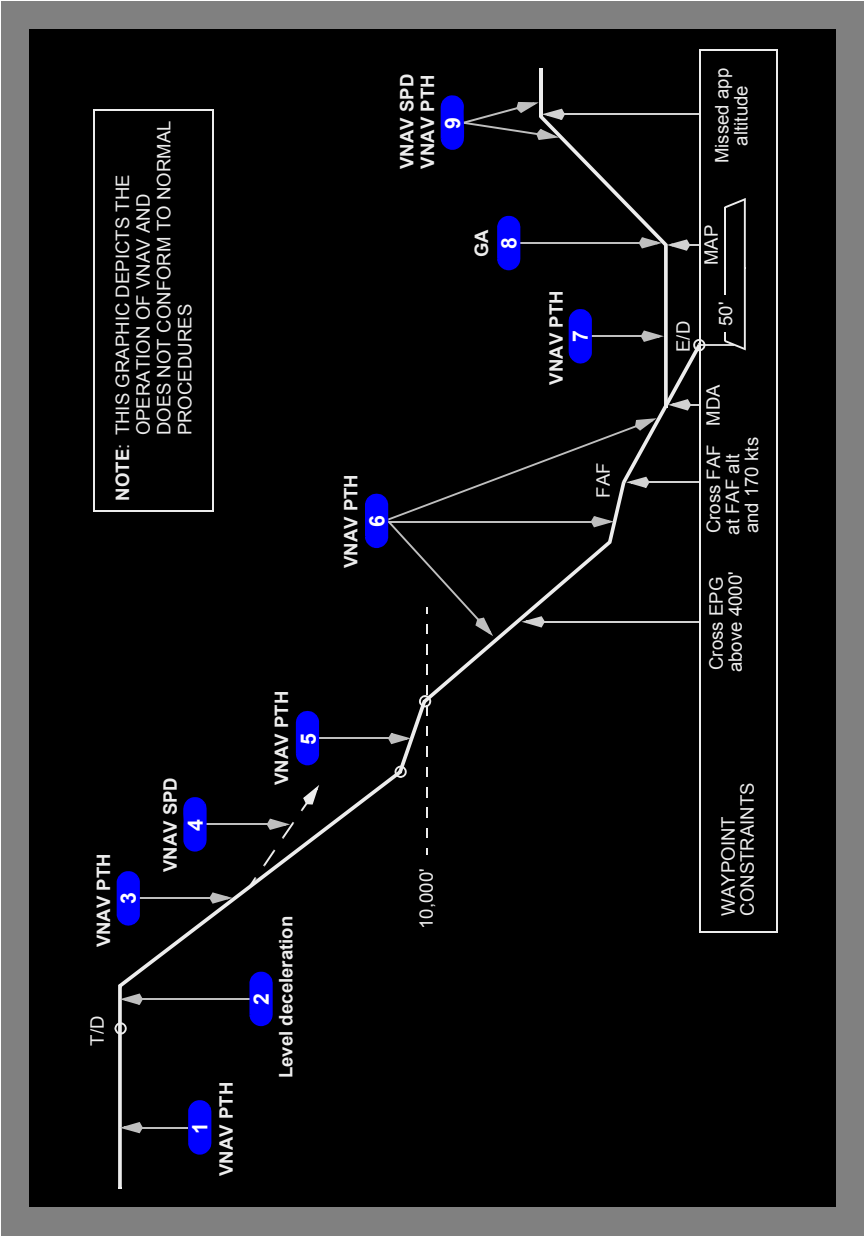
A side step to another approach can be accomplished by selection of a new approach on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the "INTC CRS TO" line on the LEGS page or by selecting the "XXXXX INTC>" prompt on the ARRIVALS page.

Missed Approach

A missed approach is accomplished by selection of either GA switch. The following features are available:

- VNAV (and LNAV) can only be activated when the airplane climbs above 400 feet radio altitude
- all descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan
- the higher of the altitude in the MCP altitude window or the highest altitude in the missed approach procedure becomes the new cruise altitude
- the FMC transitions from active descent to active climb
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected
- when cruise phase is active, the speed target is the most restrictive of 250 knots (below speed transition altitude), best hold speed, or ECON cruise (above speed transition altitude)

Cruise and Descent Profile (Nonprecision Approach)



1 Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2 Level descent phase

After top of descent, FMC is in descent mode, VNAV decreases airspeed to ECON descent speed, maintains altitude in VNAV PTH.

3 Descent

Upon reaching descent speed, VNAV descends in VNAV PTH at ECON descent speed.

4 Speed Limit Protection

If a tailwind which was not entered on the descent forecast page causes the airplane to accelerate, the DRAG REQUIRED scratchpad message will be displayed. If the speedbrakes are not deployed, the pitch mode will change to VNAV SPD and depart the path before the speed reaches the limit.

5 Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

6 Descent and Approach

When at restricted speed, VNAV descends and starts approach in VNAV PTH at commanded speed.

7 Minimum Descent Altitude

When the MDA is reached with VNAV engaged the airplane will maintain the MDA altitude in VNAV PTH.

If the missed approach point is crossed without selecting GA, VNAV will continue to the end of descent point altitude until GA is selected.

8 Go-Around (GA)

The missed approach go-around is commenced by pushing a Go-Around switch.

Pushing a Go-Around switch

- starts a missed approach
- sets go-around thrust
- and deletes altitude constraints between the airplane and the missed approach waypoint.

9 Missed Approach Level Off

If VNAV is selected during missed approach, VNAV engages in VNAV SPD. At the missed approach altitude the pitch mode changes to VNAV PTH.

VNAV Engine Out Operation

The FMC provides single engine performance guidance which is accessed with the ENG OUT prompt on the VNAV pages (CLB, CRZ or DES). After the engine out page is selected the execute key must be pushed to activate the single engine guidance.

The autothrottle system does not have a single engine capability and the autothrottle should be disconnected after an engine failure. VNAV thrust settings and thrust reference modes must be manually set when operating single engine.

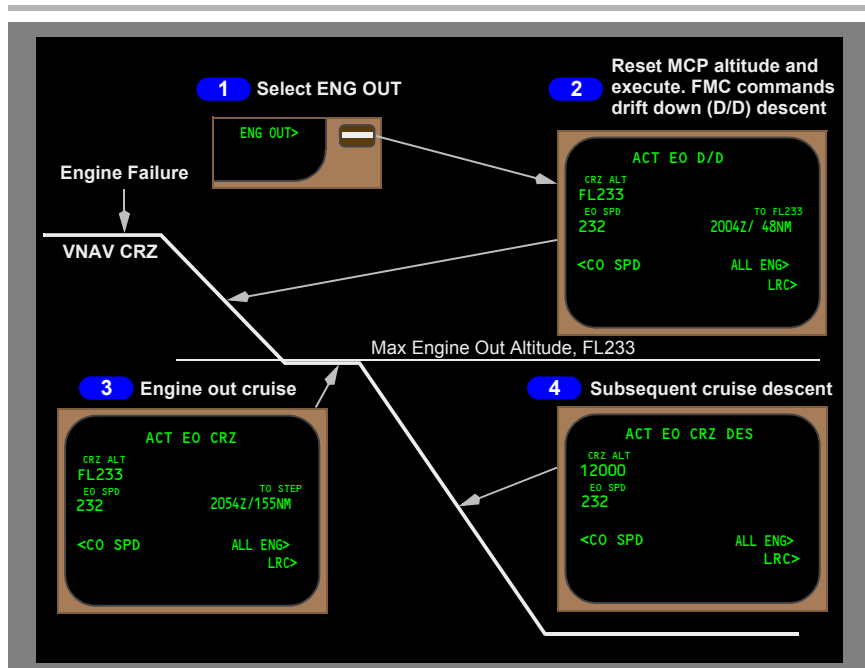
Climb (Engine Out Above Engine Out Max Alt)

When the airplane is above the engine out maximum altitude, selection of the ENG OUT> prompt on the CLB page creates a modification and displays the applicable engine out driftdown (D/D) performance data to enable the airplane to descend to the engine out maximum altitude. Execution of the modification activates the engine out driftdown function.

Cruise (Engine Out Above Engine Out Max Alt)

Selection of ENG OUT> may also be selected on the CRZ page. If the current altitude is above the engine out maximum altitude, the FMC will command a cruise drift down.

Selection of ENG OUT> may also be accomplished on the XXXX ALTN page in conjunction with a diversion modification.



1 Engine Out Modification

Select the ENG OUT> prompt on the VNAV CRZ page. Disconnect the autothrottle and set maximum continuous thrust on the operating engine.

Result: The FMC creates a modification and displays the applicable engine out driftdown (D/D) performance data to enable the airplane to descend to the engine out maximum altitude.

2 Drift Down Execution

Set the MCP altitude at or below EO MAX altitude and execute the FMC modification. This assumes clearance is approved to descend slowly to a non-standard altitude; for example, FL233.

Result: VNAV commands a driftdown at EO SPD, and the EO MAX altitude becomes the cruise altitude at 1L. The descent rate is controlled to a minimum of 300 feet per minute (fpm). Time and distance for the D/D to EO MAX altitude are displayed at 2R.

The initial drift down speed defaults to E/O (minimum drag) speed. Prompts for LRC (long range cruise) and CO SPD (company speed) are displayed or a manual speed entry may be made.

3 Engine Out Cruise

When VNAV captures the engine out maximum altitude, the page changes to the engine out cruise page and the pitch annunciation is VNAV PTH. Predictions for engine out step climb are displayed at 2R.

The VNAV single engine speed can be adjusted to LRC speed, company speed, or a speed entered by the crew. Any change in the single engine speed will change the maximum altitude.

4 Subsequent Cruise Descent

With the FMC in engine out mode more than 50 nm from T/D, set a lower MCP altitude, select the entered altitude from the MCDU scratchpad to the CRZ ALT line on the CRZ page and execute.

Result: VNAV cruise descent at approximately 1,250 fpm at the current speed. When the engine out cruise descent intersects the planned descent profile, descent mode becomes active.

Required Time of Arrival (RTA)

When an RTA is entered for a waypoint on the active route, VNAV controls cruise speed to arrive at the waypoint within ± 30 seconds of the specified time. If the RTA is not achievable, the FMC displays the scratchpad message UNABLE RTA.

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 displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

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; displays as 800
- 1,500 feet is entered as 015 or FL015; displays as 1500
- 11,500 feet is entered as 115 or FL115; displays as FL115
- 25,000 feet is entered as 250 or FL250; displays as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (XXXX) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050; displays as 50
- 835 feet is entered as 0835; displays as 830
- 1,500 feet is entered as 1500; displays as 1500
- 8,500 feet is entered as 8500; displays as 8500
- 9,994 feet is entered as 9994; displays as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet

Examples of five (XXXXX) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050; displays as 50
- 836 feet is entered as 00836; displays as 840
- 1,500 feet is entered as 01500; displays as 1500
- 8,500 feet is entered as 08500; displays as FL085
- 9,996 feet is entered as 09996; displays as FL100
- 11,500 feet is entered as 11500; displays as FL115
- 25,000 feet is entered as 25000; displays as FL250.

Negative altitude entries are allowed to -1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed (CAS) or Mach number (M). CAS is entered as three digits (XXX) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many pages display data in pairs separated by a slash “/.” Examples of these pairs include wind direction/speed and waypoint airspeed/altitude constraints. 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. Omission of the required slash normally results in an INVALID ENTRY message.

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Flight Management, Navigation
Flight Management Computer**Chapter 11**
Section 32

FMC Databases

The FMC contains the following databases:

- performance database
- navigation database
- Airline Modifiable Information (AMI).

The performance database supplies all the necessary performance data to the flight crew. It supplies the FMC with the necessary data to calculate pitch and thrust commands. All necessary data can be shown on the MCDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

The navigation database includes data usually found on navigation charts. The database contains:

- the location of VHF navigation aids
- airways
- airports
- runways
- other airline selected data, such as SIDs, STARs, approaches, and company routes
- transition altitudes.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the usual navigation chart revision cycle. The flight crew selects which set of navigation data is active for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the active data.

The Airline Modifiable Information (AMI) file contains airline specified data. If the FMC senses a conflict in an AMI value after a new AMI data load, the scratchpad shows the message CHECK AIRLINE POLICY.

Thrust Management

The autothrottle is controlled by the thrust management computer. When VNAV is engaged, the FMC controls the autothrottle by setting the command speeds and thrust reference modes on the thrust management computer.

When VNAV is not engaged, the thrust management is controlled by the flight crew through selections made on the TMSP and AFDS.

Fuel Monitoring

The FMC receives fuel quantity data from the fuel quantity system or from manual entries. Fuel quantity values are shown on the PERF INIT page as calculated (CALC), MANUAL, or SENSED. They are shown on PROGRESS page 2 as TOTALIZER and CALCULATED. TOTALIZER and SENSED values are the same data with different names.

The FMC usually uses the calculated value for performance computations. Before engine start, the calculated value is the same as the fuel quantity indicating system totalizer value. When the FMC receives a positive fuel flow signal at engine start, the calculated value is independent of the fuel quantity system and decreases at the fuel flow rate.

The FMC will accept manual entry of the fuel quantity. The line title changes to MANUAL and the manual value is then updated by fuel flow rate. When the fuel quantity calculations are based on a manual entry the FUEL QUANTITY DISAGREE message is inhibited. Deleting the manual entry resets the fuel quantity to the totalizer value and the title returns to CALCULATED.

The calculated value is invalid if fuel flow data is invalid. The FMC uses the fuel quantity indicating system quantity for performance computations. The line title on the PERF INIT page changes to SENSED and is shown as TOTALIZER on PROGRESS page 2. The fuel used by each engine is calculated with its related fuel flow signal.

FUEL USED is also shown on PROGRESS page 2. It is calculated by the FMC from the fuel flow rate beginning at engine start.

Fuel used is reset to zero on the ground after engine shutdown when electrical power is removed or when the FMC receives a positive fuel flow at the next engine start.

The scratchpad shows the message FUEL DISAGREE–PROG 2 (or FUEL DISAGREE–PROG 2/2) if the FMC calculates a large difference between the total fuel value determined by the fuel quantity indicating system and the total fuel value calculated by the FMC. When the fuel disagree message appears, PROGRESS page 2 is used to select one of those two values for use by the FMC for its fuel calculations for the remainder of the flight.

Note: The FUEL DISAGREE message is inhibited if the fuel quantity on the PERF INIT page is entered manually. Deleting a manual entry sets the fuel quantity back to the totalizer value, changes the line title back to CALC and enables the FUEL DISAGREE message.

The FMC continually estimates the fuel at the destination airport if the active route is flown. The MCDU message INSUFFICIENT FUEL is shown if the estimate is less than the fuel reserve value entered on the PERF INIT page.

Note: FMC calculated fuel predictions assume a clean configuration. Flight with gear or flaps extended cause fuel prediction errors. Fuel predictions are accurate after the gear and flaps are retracted if the active route in the FMC is flown.

Loss of FMC Electrical Power

The FMC must have continuous electrical power to operate. When the electrical power is interrupted and returns, the FMC automatically restarts.

After the restart, the performance data shown on the PERF INIT page must be re–entered. The route previously in use is available but must be reactivated.

The flight crew must modify the active waypoint to engage LNAV. Select the applicable active waypoint and proceed direct or intercept a course to the waypoint.

FMC Failure

Single FMC Failure

The scratchpad shows the message SINGLE FMC OPERATION after loss of a single FMC. The EICAS shows the advisory message L (or R) FMC FAIL and the MAP flag is displayed on the side with the failed FMC.

The crew member on the side with the failed FMC selects the opposite FMC with the NAV selector to regain MCDU access to the operating FMC and map displays. LNAV and VNAV, if engaged, stay engaged and all flight plan and performance data is kept.

Note: If the MENU page and the scratchpad message TIMEOUT RESELECT is shown, the FMC is no longer connected to the MCDU. Use the <FMC prompt on the MENU page to connect the MCDU to the FMC.

Dual FMC Failure

In the unlikely event that both FMCs fail, the EICAS advisory messages L FMC FAIL and R FMC FAIL are displayed. LNAV and VNAV are not available.

Selecting CDU-L or CDU-R with the NAV selector on the instrument select panel provides route data to the MAP display. Alternate navigation using the MCDUs is discussed in Section 50 of this chapter.

Note: The MENU page is shown and the <FMC prompt is not shown in line 1. Push the LEGS function key to show the IRS LEGS page or the PROG key to show the IRS PROGRESS page.

FMC Resets

A software reset may occur in dual or single FMC operation. When a software reset occurs, the active route becomes inactive, the performance data is erased, and LNAV and VNAV modes (if engaged) fail. There is not an EICAS message or an FMC scratchpad message to alert the crew of a reset condition. To regain FMC operation, activate and execute the flight plan, reenter the necessary performance data, and reengage LNAV and VNAV.



Air Traffic Control Data Link

Air Traffic Control data link functions are accomplished on the MCDU. The MCDU is used as an input keyboard for downlink message forms. Uplink messages which contain route modifications are loaded into the FMC using the LOAD prompts on the ATC MCDU pages. Execution of an ATC loaded modification is accomplished using normal FMC modification procedures.

Refer to chapter 5, Communications, section 45, Air Traffic Control Datalink, for a description of ATC data link.

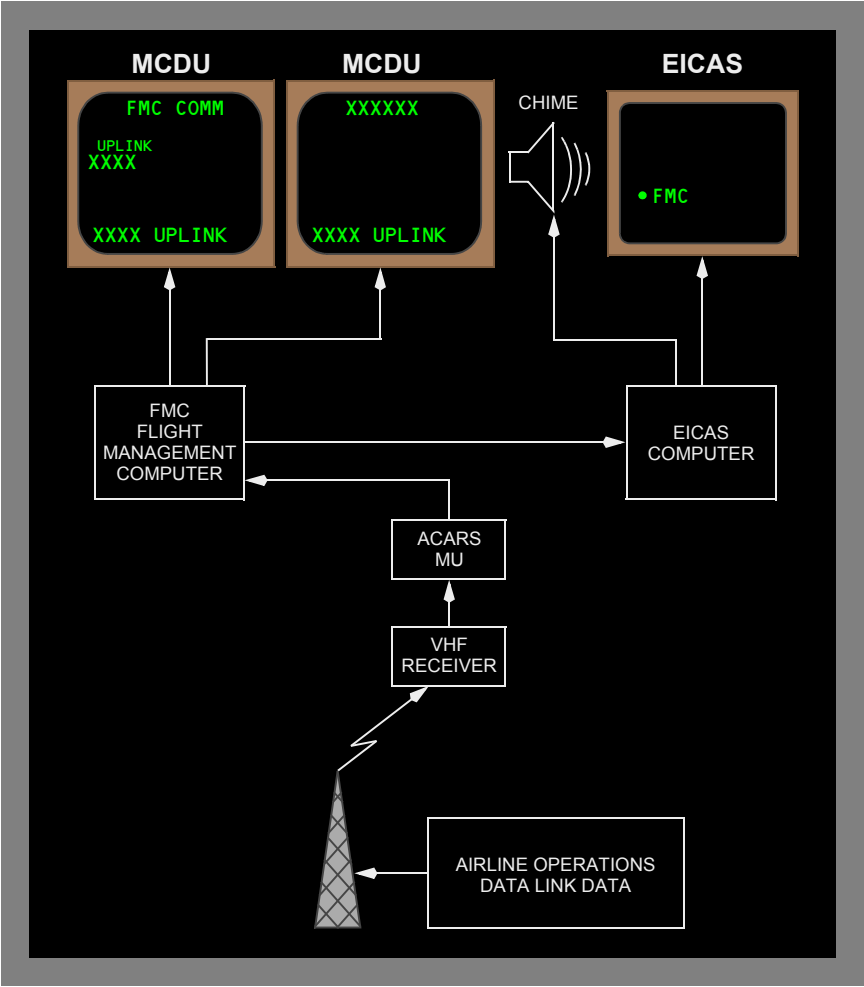
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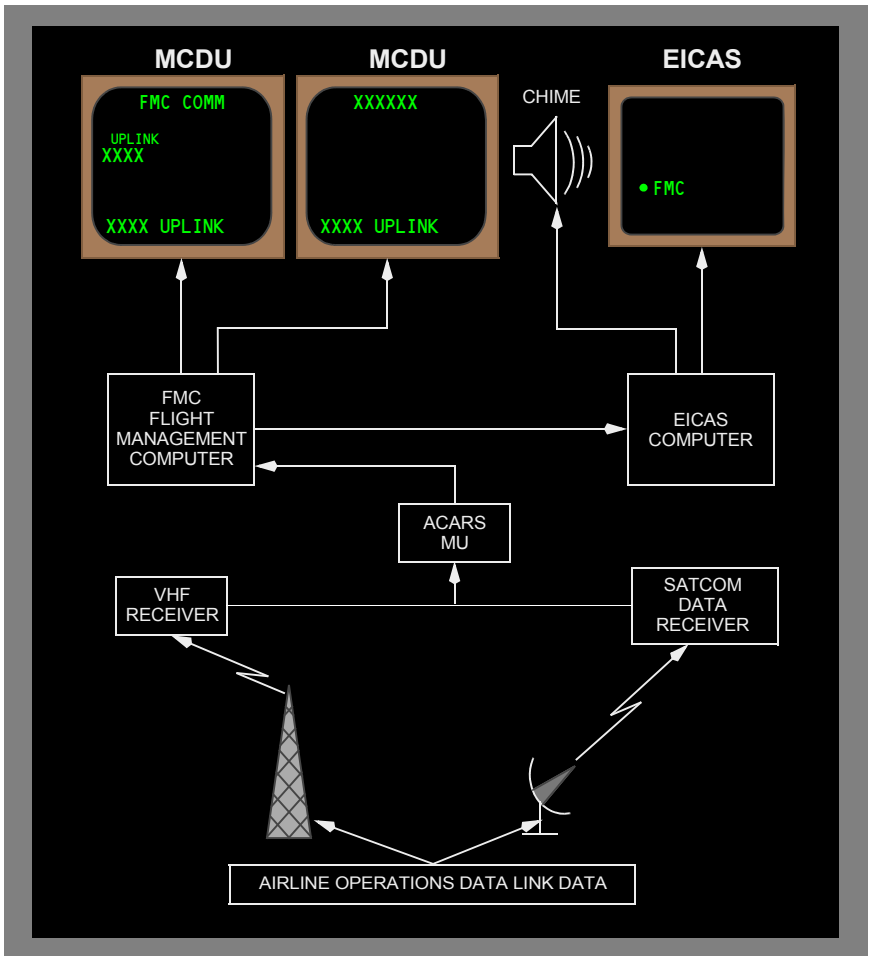
Company Data Link

The airplane communications system enables two-way data link communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMC. Data may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.

Aircraft without SATCOM



Aircraft with SATCOM



Data Link Management

The flight crew should monitor system status of FMC data link.

This is accomplished on various MCDU pages or on the FMC COMM page.

MCDU Data Link Status Displays

Data link operation is verified when the correct prompt is displayed. In the example below, the REQUEST SEND prompt indicates the datalink status is READY.

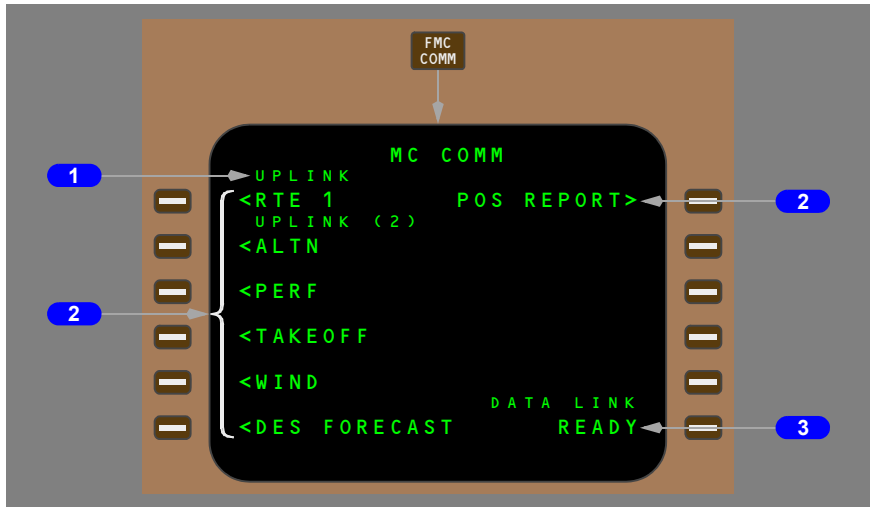


When the data link system is not operating, MCDU page prompts change to NO COMM, VOICE or FAIL and the line titles change to DATA LINK.



FMC Communications Page

General data link status is shown on the FMC COMM page. Page select prompts are shown for each FMC page with access to data link data.



1 Uplink Status

The page line heading shows UPLINK when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks makes sure all of the prerequisite data is available before the uplink message can be selected. Examples of preprocessing include:

- RTE ALTN, ALTN LIST, PERF, TAKEOFF, and WIND uplinks are held until route activation or modifications are complete.
- Subsequent uplinks of the same type are held until previous uplinks are included or discarded by the flight crew.
- TAKEOFF uplink is held until gross weight is entered, a pending PERF uplink is included or discarded, or a takeoff runway is entered.

When both ALTN and ALTN LIST uplinks are pending, (2) is shown to the right of UPLINK in the line heading.

The EICAS message •FMC is shown whenever any UPLINK message is pending.

2 Page Select Prompts

Selection of any of these prompts shows the related page:

- RTE X
- ALTN
- PERF

- TAKEOFF
- WIND
- DES FORECAST
- POS REPORT.

3 DATA LINK

Shows the data link system status.

System status can be:

- READY
- NO COMM
- VOICE
- FAIL

Data Link Messages

Downlinks are data link message transmitted to a ground station. Requests for data and reports of FMC data are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane. Most uplinks require manual selections by the flight crew. Some uplinks are input automatically.

Manual Downlinks

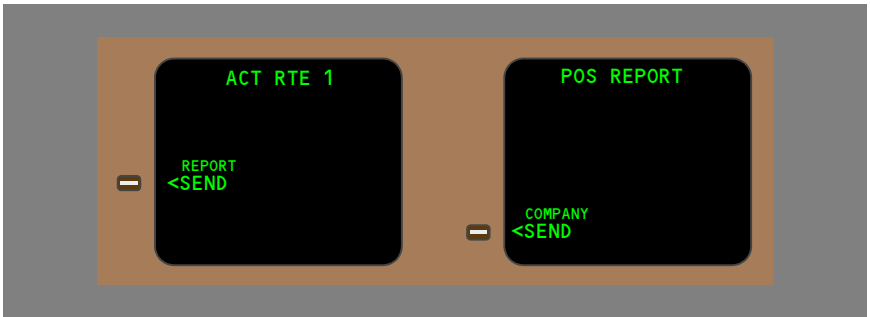
Select a REQUEST SEND prompt to start a downlink request for data. REQUEST SEND prompts are on PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, or RTE DATA pages. Downlink reports of the active route may be accomplished by selection of the REPORT SEND prompt on the RTE page and a position report may be downlinked by selection of the COMPANY SEND prompt on the POS REPORT page.

When the communications function is unable to downlink FMC messages, the words DATALINK FAIL, NO COMM, or VOICE are shown on the CDU pages in place of the REQUEST SEND and REPORT SEND prompts. The data link status is also shown on the FMC COMM page. The status messages are:

- FAIL –
 - the data communications management function is inoperative, or
 - the data radios have failed.
- NO COMM –
 - the radios are operational but not available
- VOICE – all available radios are operating in the VOICE mode.

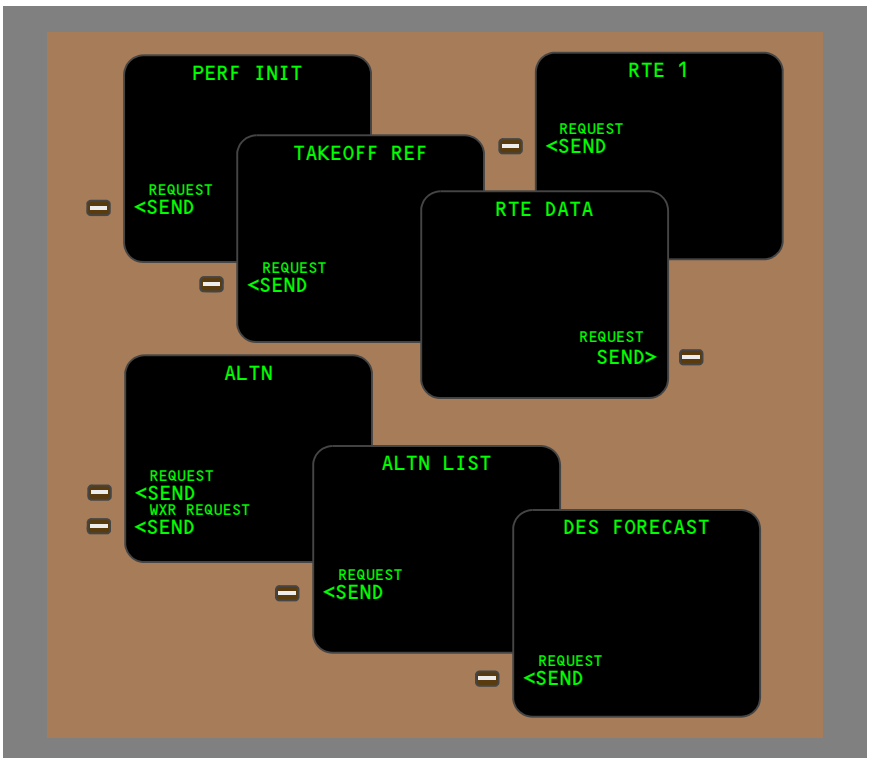
Reports

Selecting the REPORT SEND or COMPANY SEND prompt downlinks a unique report. The pages below contain report prompts.



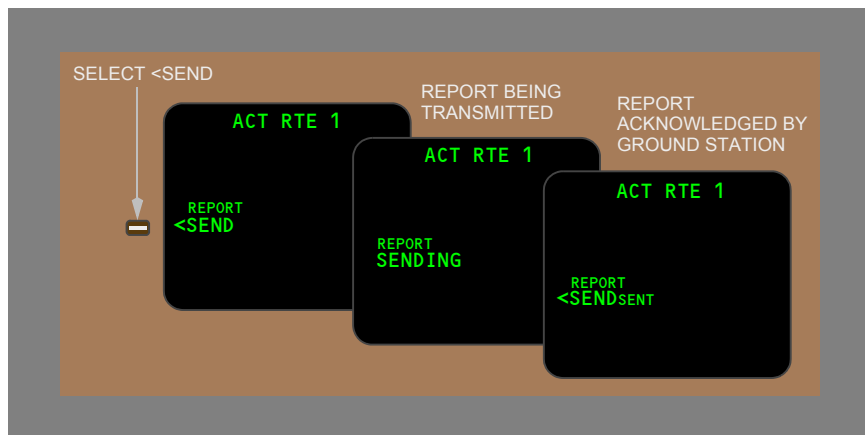
Requests

A REQUEST SEND prompt downlinks a unique request applicable to the displayed page. The pages below contain REQUEST SEND prompts as shown.



Downlink Status

When a SEND prompt is selected the line changes to show the status of the downlink message. Below is a typical sequence of the status display in response to sending a report. The same sequence appears when sending a request.



Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific data requests from the airline dispatcher. The FMC response in these cases is completely automatic and no flight crew action is necessary.

Uplinks

Uplinked data may be loaded automatically or may require flight crew action. Two uplinks automatically load data into the FMC and do not require execution. Uplinked data that waits in system memory for flight crew action are considered to be pending.

A pending uplink is loaded or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with ACCEPT/REJECT or LOAD/PURGE prompts, FMC modification ERASE prompt or EXEC key, or when the page with the uplink is selected.

Data can be uplinked from the airline dispatcher directly to the PERF INIT, TAKEOFF REF, DESCENT FORECAST, RTE, ALTN, ALTN LIST, and WIND pages. The uplinks are annunciated to the crew by the •FMC EICAS communications alert and a chime. The uplink is identified by an MCDU scratchpad message and by the presence of an UPLINK label over the applicable COMM page prompt.

Takeoff uplinks are not annunciated until:

- gross weight is entered on the PERF INIT page
- a route is activated
- the active route has a departure runway (and intersection, if applicable) matching the TAKEOFF uplinks (up to six takeoff records can be uplinked).

If there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the COMM page is not shown.

FMC Data Link Uplinks (Accept/Reject)

ACCEPT and REJECT prompts are shown on the PERF INIT, TAKEOFF 1/2, and ALTN pages after receipt of uplink data.

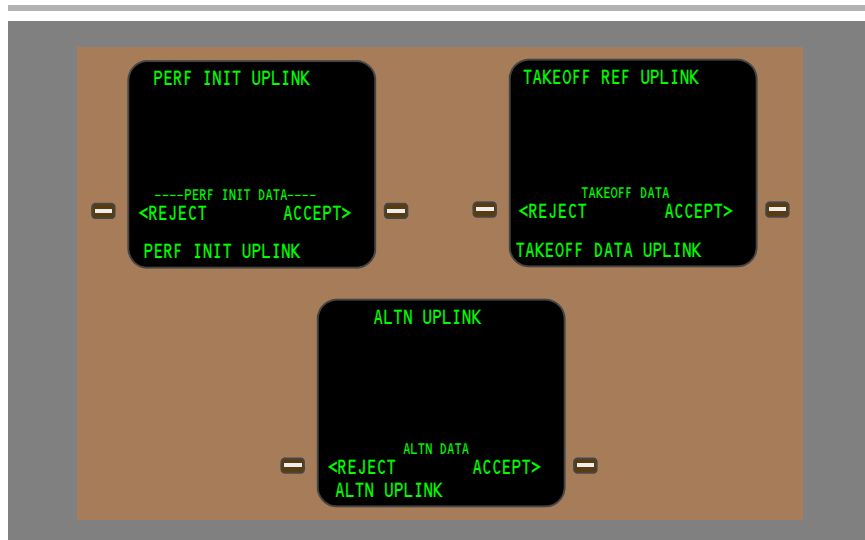
Uplink data is shown initially in small font for preview.

Select ACCEPT prompt:

- shows uplinked data in large font
- replaces previous data with uplinked data
- page changes to pre-uplink format
- clears scratchpad message
- transmits a downlink accept message (if enabled).

Select REJECT prompt:

- replaces uplinked data with previous data
- page changes to pre-uplink format
- clears scratchpad message
- transmits a downlink reject message (if enabled).



FMC Data Link Uplinks (Load/Purge)

LOAD and PURGE are shown on the DESCENT FORECAST page after receipt of uplink data. LOAD and PURGE are shown on the RTE 1 or RTE 2 page when there is an uplink to the inactive route.

Select LOAD prompt:

- loads uplinked data into FMC for viewing
- clears scratchpad message
- replaces previous data with uplinked data
- page changes to pre-uplink format
- transmits a downlink accept message (if enabled).

Select PURGE prompt:

- replaces uplinked data with previous data
- page changes to pre-uplink format
- clears scratchpad message
- transmits a downlink reject message (if enabled).



FMC Data Link Uplinks (Load/Exec-Erase)

LOAD shows on the RTE and WIND pages after receipt of uplink data.

After the uplinked data is loaded, the EXEC light illuminates and the ERASE prompt is shown.

Select LOAD prompt:

- loads uplinked data into FMC
- loaded data can be viewed
- clears scratchpad message
- replaces existing data with modified uplinked data
- page title changes to MOD
- shows ERASE prompt
- illuminates EXEC light.

Push the EXEC key to:

- put modified data in active flight plan
- change page format to pre-uplink format
- transmit a downlink accept message (if enabled).

Select ERASE prompt to:

- remove modified data
- return page display to pre-uplink format
- transmit a downlink reject message (if enabled).



FMC Data Link Uplinks (Automatic)

FLT NO and ALTN LIST data can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page without flight crew action. The list of up to 20 alternates automatically loads into the ALTN LIST page without flight crew action.

The scratchpad messages FLIGHT NUMBER UPLINK or ALTN LIST UPLINK stay in the scratchpad display queue until the applicable MCDU page is selected.



Flight Management, Navigation
FMC Preflight**Chapter 11**
Section 40

Introduction

FMC preflight is required before flight.

Completion of the FMC preflight requires data entry in all minimum required data locations. Additional entry of optional preflight data optimizes FMC accuracy.

Data link can be used to load preflight data from airline ground stations. Using data link reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

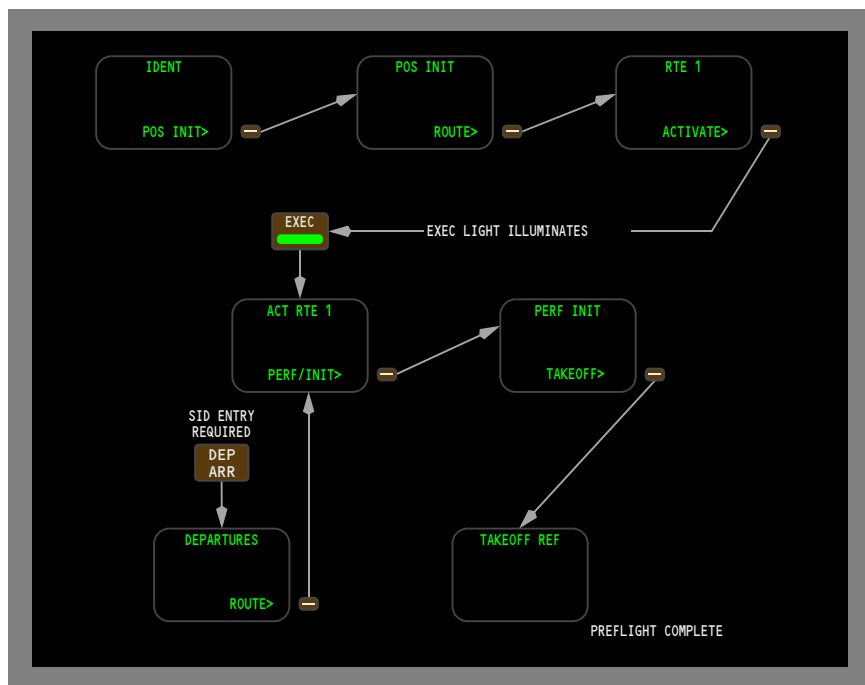
Preflight Page Sequence

The usual FMC power-up page is the identification page. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- ROUTE page
- DEPARTURES page (no automatic prompt)
- performance initialization (PERF INIT) page
- takeoff reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

Minimum Preflight Sequence



During preflight, a prompt in the lower right directs the flight crew through the minimum requirements for preflight completion. Selecting the prompt key displays the next page in the flow. If a required entry is missed, a prompt on the TAKEOFF page leads the flight crew to the preflight page missing data.

Airplane inertial position is necessary for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route data is origin and destination airports, and a route leg.

Performance data including the airplane weight and cruise altitude is required.

Takeoff data requires a flap setting.

Supplementary Pages

Supplementary pages are sometimes required; these pages have no prompts and interrupt the usual sequence. Discussions of each page includes methods to display the page.

When the route includes SIDs and STARs, they can be entered using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed and the route is modified on the ROUTE and RTE LEGS pages. Speed/altitude restrictions are entered and removed on the RTE LEGS page. The RTE LEGS page is described in the FMC Cruise section of this chapter.

Alternate airports are added on the ALTN page. The ALTN page is described in the FMC Descent/Approach section of this chapter.

Waypoint, navaid, airport, and runway data is referenced on the REF NAV DATA page. The REF NAV DATA page is described in the FMC Cruise section of this chapter.

VNAV performance is improved if forecast winds and temperatures are entered during the preflight.

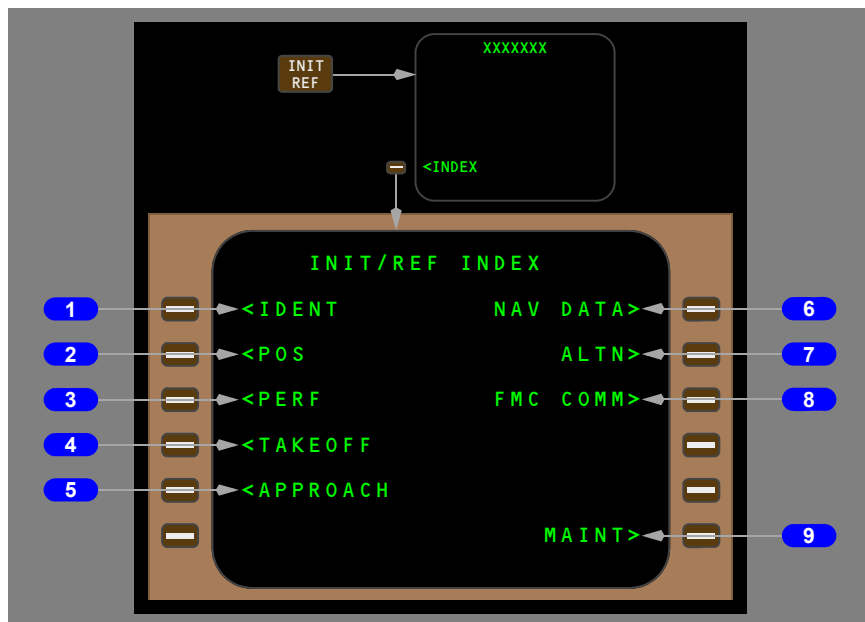
Wind and temperature information for specific waypoints is entered on the WIND page. The WIND page is described in the FMC Cruise section of this chapter.

Preflight Pages - Part 1

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The initialization/reference index page allows manual selection of FMC pages. It gives access to pages used during preflight and not usually used in flight.



1 Identification (IDENT)

The IDENT page is the first page in the preflight sequence.

2 Position (POS)

The POS INIT page is used for input of reference position for inertial alignment.

3 Performance (PERF)

The PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

4 TAKEOFF

The TAKEOFF REF page is used to enter takeoff reference data and V speeds.

5 APPROACH

The APPROACH REF page is used for entry of the approach VREF speed.

6 Navigation (NAV) DATA

The REF NAV DATA page is used to access data on waypoints, nav aids, airports, and runways. The REF NAV DATA page is accessible only from this page.

7 Alternate (ALTN)

The ALTN page is used for alternate airport planning and diversions.

8 FMC COMM – As Installed

The FMC COMM page is used to access other pages from which FMC datalink messages can be accessed or sent.

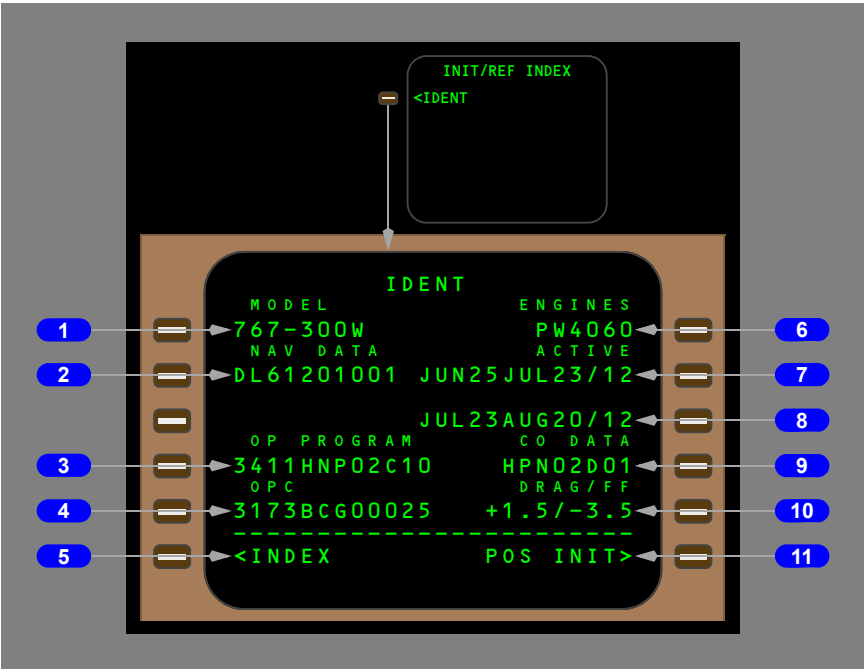
9 Maintenance (MAINT)

For maintenance use only; displays maintenance pages.

Identification Page

Most of the data on this page is for flight crew verification. The active navigation database can be selected.

The flight crew verifies FMC data, selects the current navigation database, and checks drag and fuel flow factors on the identification page.



1 MODEL

Displays the airplane model from the FMC performance database.

2 Navigation (NAV) DATA

Displays the navigation database identifier.

3 Operating (OP) PROGRAM

Displays the operating program identifier.

4 Operational Program Configuration (OPC) PART NUMBER

Displays the Operational Program Configuration part number.

5 INDEX

Push – displays the INIT/REF INDEX page.

6 ENGINES

Displays the engine model (either PW or GE) from the FMC performance database.

7 ACTIVE

Displays the effectivity date range for the active navigation database.

The active navigation database can be replaced with the inactive database while on the ground. Changing the navigation database removes all previously entered route data.

8 Inactive Date Range

Displays range of effective dates for the inactive navigation database. May be line selected to the scratchpad and inserted to the ACTIVE line while on the ground.

9 Company (CO) DATA

Displays the last eight characters of the Airline Modifiable Information (AMI) part number.

10 DRAG/Fuel Flow (FF) Factors

Displays the airplane drag and fuel flow correction factors.

Usually, the default data from the airline policy file displays for flight crew verification. When these values must be changed, enter the word ARM in the scratchpad and transfer it to the DRAG/FF line. This arms the line for actual data and ARM DRAG/FF is displayed.

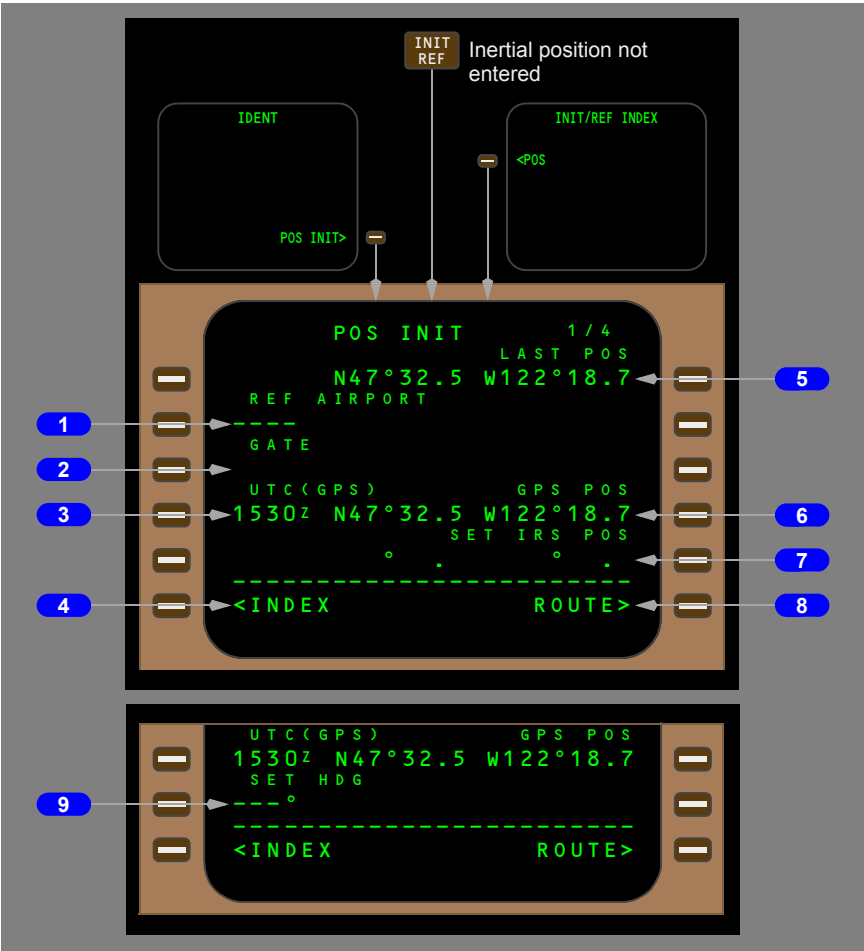
Enter the required drag/fuel flow data in the scratchpad and transfer to the ARM DRAG/FF line. Drag-only entries must be followed by a slash (/). Fuel flow-only entries may optionally be preceded by a slash (/).

11 Position Initialization (POS INIT)

Push – displays the POS INIT page.

Position Initialization Page

The position initialization page allows entry of airplane present position for IRS alignment. This page is also used to enter the heading when an IRS is in the ATT mode.



1 Reference Airport (REF AIRPORT)

Entry of the reference airport displays the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Removes previous GATE entry.

Entry blanks when airborne.

2 GATE

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after reference airport entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate.

Changes to dashes when a new reference airport is entered.

Entry blanks when airborne.

3 Universal Time Coordinated (UTC)

UTC (GPS) – displays time from GPS.

UTC (MAN) –

- displays time from captain's clock when operative; otherwise, displays time from first officer's clock
- hours can be set by entering desired hour reference
- minutes set by resetting appropriate pilot's clock.

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Last Position (LAST POS)

Displays the last FMC calculated position.

6 GPS Position (GPS POS)

Displays the GPS present position. During preflight, the GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

7 Set Inertial Position (SET INERTIAL POS)

The set inertial position entry is required to initialize the IRS. Select the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or a manual entry to initialize the IRS.

If an entry is not made before the IRS completes the initial alignment, the scratchpad message ENTER IRS POSITION is displayed.

If the manually entered position fails the IRS internal check, the scratchpad message ENTER IRS POSITION is displayed.

The manually entered position is also compared with the FMC origin airport position. If the entered position is not within 6 NM of the FMC origin airport position, the scratchpad message IRS POS/ORIGIN DISAGREE is displayed.

Boxes display within one minute of IRS power-up.

Blanks when the IRS changes from the alignment to the navigation mode.

8 ROUTE

Push – displays the ROUTE page.

9 Set Heading (SET HDG)

Dashes display when an IRS selector is placed in the ATT position.

Enter magnetic heading to initialize the IRS in the ATT mode to provide headings. Heading should be updated regularly if extended operation in ATT is necessary.

Valid entry is 0 to 360 (0 or 360 displays as 0°).

Position Reference Pages

Position Reference Page 2/4

Position reference page 2 displays positions calculated by the FMC, IRS, GPS, and radio navigation receivers. The FMC position can be updated to IRS, GPS, or radio position on this page.

Positions are displayed as the latitude/longitude calculated by the individual systems. When BRG/DIST is selected the IRS, GPS, and radio positions are shown as bearing and distance from the FMC position.



1 FMC

The source used by the active FMC for position data is displayed next to the FMC line title. In the example, the FMC uses GPS for position data.

Displays the FMC calculated latitude/longitude.

Identifies the source for calculating the FMC position:

- GPS – position calculated from GPS and inertial position data
- IRS – position calculated from inertial position data only
- RADIO – position calculated from navigation radio and inertial position data
- LOC–GPS – position is calculated from localizer, GPS and inertial data
- LOC–RADIO – position is calculated from localizer, navigation radio and inertial data
- LOC – position is calculated from localizer and inertial data.

2 IRS

Displays latitude/longitude position or the bearing and distance from the FMC position determined by the IRS. If the displayed position is derived from all three IRSs, (3) is displayed. If the position is from a single IRS then (L), (C), or (R) is displayed to indicate which IRS position is displayed.

3 GPS

Displays latitude/longitude position or the bearing and distance from the FMC position determined by the GPS.

4 RADIO

After airborne, displays latitude/longitude position or the bearing and distance from the FMC position determined by navigation radios.

5 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Displays the RNP and actual navigational performance (ACTUAL) of the FMC.

Default RNP is in small font.

Valid RNP entries are in the range 0.01 to 99.9. ACTUAL entry not allowed.

When ACTUAL exceeds RNP, EICAS displays UNABLE RNP message.

Note: The FMC stops GPS updating if GPS data accuracy degrades due to satellite availability or unfavorable geometry. Subsequently, the FMC receives updates from another system.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 UPDATE ARM

Push –

- arms FMC position update function
- changes prompt to ARMED
- adds NOW prompts to right side of INERTIAL, GPS, and RADIO lines.

Push a NOW prompt key to momentarily update FMC position to the selected source. If another source with a smaller ANP exists, the FMC position will correct back to the most accurate position available.

8 ACTUAL

Displays actual navigation performance (ANP) of the IRS, GPS and navigation radios.

9 Radio Update Station(s)/Mode

Displays radio station identifiers.

Position update mode is indicated in the line title:

- DME DME
- VOR DME

Line and title are blank when no radio position is computed.

10 Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)

Push – alternates position data format between bearing/distance or latitude/longitude.

The page illustration is shown in the latitude/longitude display format.

Latitude/longitude format displays are actual position. Bearing/distance display is relative to the FMC position.

Position Reference Page 3/4

On position reference page 3, the flight crew can observe the calculated positions from the left and right GPS receivers and the left and right FMC calculations. This page also allows the flight crew to enable or disable GPS position updates.

This page can display the bearing/distance or latitude/longitude format. The bearing/distance format displays the positions relative to the active FMC position on the POS REF 2/4 page. In the example, both the left and right GPS agree with the left FMC position.



1 GPS Left (L) and GPS Right (R)

Displays the left and right GPS positions.

2 FMC Left (L) and FMC Right (R)

Displays the left and right FMC calculated position.

Primary (PRI) is displayed in the line title of the FMC that is the navigation master.

3 INDEX

Push – displays the INIT/REF INDEX page.

4 GPS NAV

Push – alternately selects GPS NAV ON (enabled) and OFF (disabled).

OFF – GPS position data is not available to the FMC. OFF displays in large letters; ON displays in small letters.

ON – GPS position data is available to the FMC. ON displays in large letters; OFF displays in small letters.

Note: When the engines are shut down after flight GPS NAV is set to ON.

5 Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)

Push – alternately changes the display of position data on POS REF 2/4, 3/4, and 4/4 to latitude/longitude format or bearing/distance format.

The page illustration is shown in the bearing/distance display mode.

Position Reference Page 4/4

On position reference page 4, the calculated positions and ground speeds from the left, center and right IRS are displayed. Positions can be displayed in the bearing/distance or latitude/longitude format.



1 IRS L, C, and R

Displays the position of the Left, Center, and Right IRS. Positions can be displayed in latitude longitude or as bearing and distances from the FMC position.

2 INDEX

Push – displays the INIT/REF INDEX page.

3 Ground Speed (GS)

Displays the ground speed calculated by each IRS. The displayed values are frozen when the engines are shut down after flight until power is removed.

4 Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)

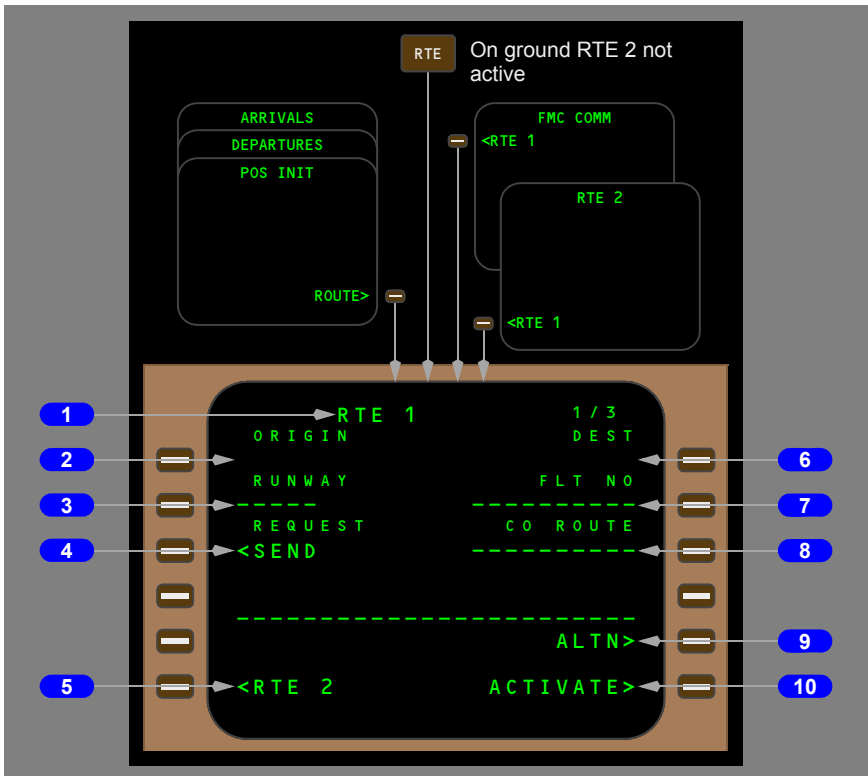
Push – alternately changes the displayed position between latitude/longitude format and bearing/distance format. When the display is in the bearing/distance format the prompt shows LAT/LON>.

Route Page

Two routes (RTE 1 and RTE 2) can be stored and displayed in air traffic control format. The first route page displays origin and destination data. Subsequent route pages display route segments between waypoints or fixes. Having two routes allows management of alternate or future routes while leaving the active route unmodified. RTE 2 has an identical page structure as RTE 1.

Routes can be entered by the flight crew or uplinked through data link.

Route Page 1/X



1 Page Title

Preceded by ACT when the route is active, and by MOD 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. The minimum number of route pages is 2.

2 ORIGIN

Entry:

- must be a valid ICAO identifier in the navigation database
- made automatically when a company route is entered
- enables direct selection of departure and arrival procedures
- required for route activation
- inhibited in-flight for active route.

Entry on the ground deletes existing route.

3 RUNWAY

Enter the applicable runway for the origin airport. Runway must be in the navigation database.

Entry:

- is optional
- causes MOD to display in the title if route is active
- can be selected on the DEPARTURES page
- can be included in company route.

The runway is deleted after the first waypoint is crossed.

4 REQUEST SEND

Push – transmits a data link request for a flight plan route uplink.

Flight crew can optionally fill in origin, destination, runway, flight number, company route name, or route definition to be included in the request.

5 Route (RTE) 2

Push – displays the RTE 2 page 1/x.

Allows access to an inactive route for entry, modification or activation.

Inactive route modifications:

- do not alter the active route
- do not change the inactive RTE page title.

Prompt changes to RTE 1 when RTE 2 is displayed.

6 Destination (DEST)

Entry:

- must be a valid ICAO identifier in the navigation database
- made automatically when a company route is entered

- required for route activation
- displays MOD in page title if entered in an active route.

7 Flight Number (FLT NO)

Enter the company flight number.

Entry:

- optional for activation of the route
- limited to 10 characters
- may be entered by the flight crew or uplinked
- included in the PROGRESS page title
- propagated to RTE 2 page
- deleted at flight completion.

Flight number can also be entered on the ATC LOGON page.

8 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data supplied with a company route can include origin and destination airports, departure runway, SID and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Valid entry is any flight crew entered or uplinked company route name. If the name is not contained in the navigation database, the entry is allowed and the scratchpad message NOT IN DATABASE is displayed.

Entry of a new company route replaces the previous route.

In-flight entry is inhibited for the active route.

9 Alternate (ALTN)

Push – displays the ALTN page.

10 ACTIVATE

Push the ACTIVATE key to arm the route and illuminate the execute light. When the EXEC key is pushed, the route becomes active, ACT is displayed in the title, and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Activation of a route is required for completion of the preflight.

ACTIVATE is always displayed on the inactive route pages.

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.

More Route Page Prompts for an Active Route

Additional prompts are displayed on the route page once it becomes active.



1 REPORT SEND

Push – transmits the active route to the company via data link downlink.

2 PRINT

Push – prints the active route if printer is available.

3 Route Copy (RTE COPY)

Push – copies the entire active route into the inactive route.

Displayed only on the active route page.

Displays COMPLETE after the route is copied.

Route Page After Ground Station Uplink

When a valid route uplink is received, the message ROUTE X UPLINK READY is displayed in the scratchpad.

The EICAS communications message FMC is displayed and a chime sounds.



1 ROUTE UPLINK

Displays ROUTE UPLINK when flight plan uplink received.

2 LOAD

Displays LOAD when an uplinked route received.

Push –

- loads uplinked flight plan
- in flight, when uplinked flight plan applies to active route, EXECUTE light illuminates and ERASE displays at 6L
- when route inactive, blanks PURGE at 4R
- displays scratchpad message ROUTE 1 UPLINK LOADING.

3 PURGE

Displays PURGE when an uplink that applies to an inactive route has been received.

Push – rejects uplinked flight plan data.

Route Page 2/X

The subsequent route pages 2/X through X/X, display route segments in air traffic control format. Route segments are defined as direct routing, airways, or procedures with start and end points such as waypoints, fixes, navaids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.



1 VIA

The VIA column displays the route segment to the waypoint or termination in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and boxes display in the TO column.

Valid entries can also include procedures or DIRECT. Procedures are usually entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is usually entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the previous TO waypoint, or
- intersect the previous VIA route segment.

Dashes change to DIRECT if the TO waypoint is entered first.

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Dashes display for the first VIA beyond the end of the route.

Invalid VIA entries result in the scratchpad message INVALID ENTRY.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways that do not intersect the previous airway
- airways or company routes that are not in the navigation database.

The start and end waypoints determine whether the entered airway is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the start point of the next route segment or a route discontinuity is created between the segments.

Entry of a SID or transition enters the VIA and TO data for the route segments of the SID. A SID links to the next route segment when the final SID waypoint is part of the route segment.

When no SID is used, entering an airway on the first line of page 2 initiates an airway intercept from the runway heading and:

- replaces the airway with dashes in the first line VIA
- shows boxes in the first line TO waypoint
- moves the airway to line 2 after the TO waypoint is entered
- enters the first fix on the airway nearest to being abeam of the departure heading in the airway line TO waypoint.

A route can contain segments formed by the intersection of two airways. Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one segment to the next. The FMC created waypoint intersection (INTC) displays in the first airway segment TO waypoint.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 and V336 are examples of airway entries.

APP TRANS is an example of a STAR selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

2 TO

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway shows DIRECT in the VIA column.

Data input is mandatory when boxes are displayed.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

Valid waypoint entries for airways are waypoints or fixes on the airway.

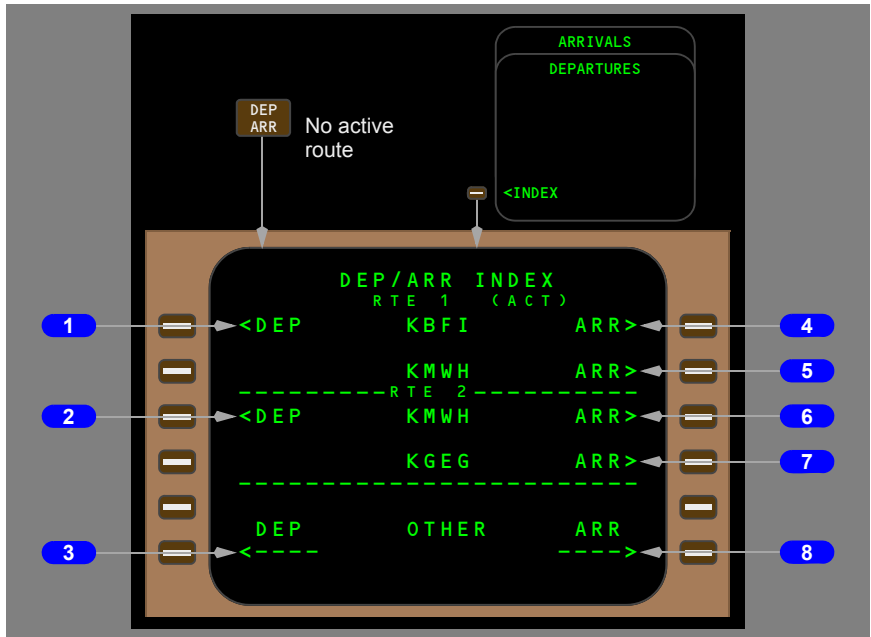
Dashes display on the first TO waypoint after the end of the route.

Preflight Pages – Part 2

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 data 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) – Route 1

Push – displays the departure page for route 1 origin airport.

2 Departure (DEP) – Route 2

Push – displays the departure page for route 2 origin airport.

3 Departure (DEP) – Other

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allow display of departure data about airports that are not the origin or destination for route 1 or 2. The data can be viewed but cannot be selected because the airport is not on the route.

4 Arrival (ARR) – Route 1 Origin

Push – displays the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn-back situation.

5 Arrival (ARR) – Route 1 Destination

Push – displays the arrival page for route 1 destination airport.

6 Arrival (ARR) – Route 2 Origin

Push – displays the arrival page for route 2 origin airport. Origin airport arrivals selection is used during a turn-back situation.

7 Arrival (ARR) – Route 2 Destination

Push – displays the arrival page for route 2 destination airport.

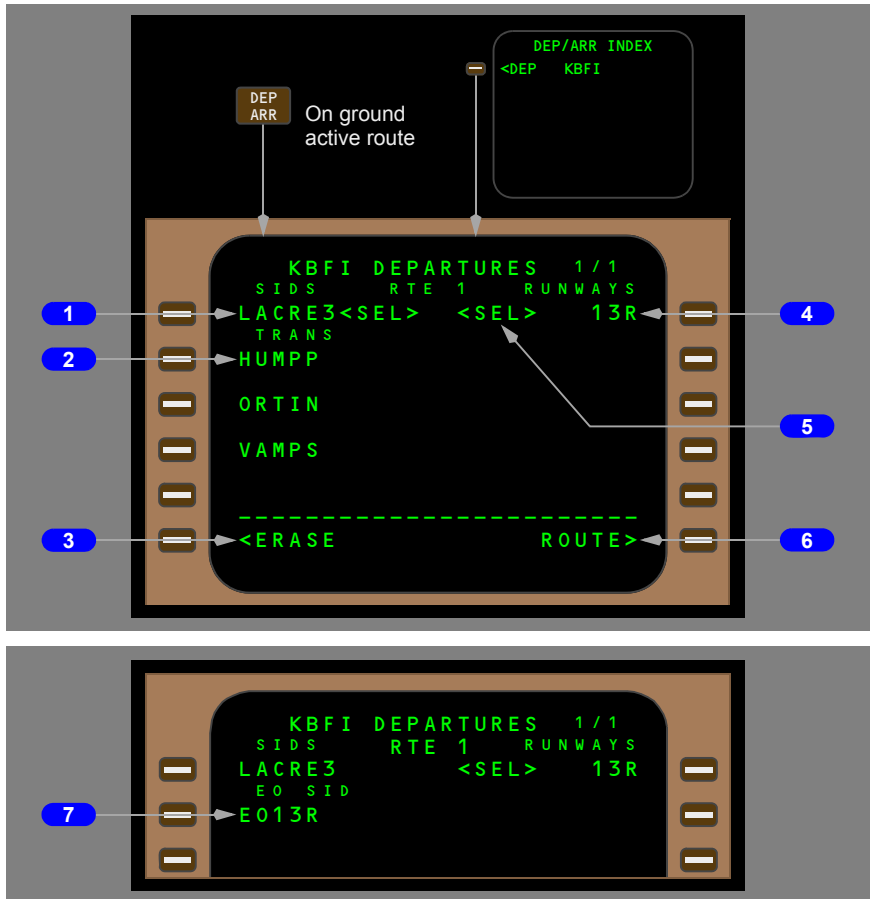
8 Arrival (ARR) – Other

Displays the arrival page for the airport entered in this line through the scratchpad. ARR prompt for OTHER allows display of arrival data about airports that are not the origin or destination for route 1 or 2. The data 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.

The departures page for the inactive route displays when the DEP ARR function key is pushed with an inactive RTE or RTE LEGS page is displayed.



1 Standard Instrument Departures (SIDS)

Displays a list of SIDS for the airport.

Push –

- selects SID for use in the route
- other SIDs are no longer displayed and the transitions for the selected SID are displayed
- runways for selected SID remain and others are no longer displayed.

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

Push –

- selects transition for entry in the route
- other transitions no longer display.

3 ERASE or INDEX

Erase displays when a route modification is pending. INDEX displays when no route modification is pending.

ERASE push – removes route modifications not executed and displays the original route.

INDEX push – displays the DEP/ARR INDEX page.

4 RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE 1/X page displays as <SEL> or <ACT>.

Push –

- selects runway for use in the route. All other runways no longer display
- SIDs associated with selected runway remain, all others no longer display
- subsequent change of a runway deletes departure procedures previously selected.

5 <SEL>, <ACT>

Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>.

Executing a modification or leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

6 ROUTE

Push – displays the related RTE page.

7 Engine Out Standard Instrument Departure (EO SID)

EO SIDs are airline designed procedures for specific runways. When a runway is selected the EO SID is listed after the other SIDs associated with that runway. If no EO SID exists for the selected runway, NONE is displayed.

PUSH – on the ground, selects the EO SID as a route modification for review. The modification should be erased after the review is complete.

If an engine failure occurs after takeoff before the flaps are retracted, the EO SID will be automatically loaded as a route modification to be executed or erased.

Navigation Radio Page

VOR navigation radios are normally autotuned by the FMC. The NAV RADIO page displays the tuned VOR frequencies, identifiers, tuning status and current radial for both VOR receivers. The VORs can be remotely tuned from this page.



1 VOR Frequency and Tune Status

Displays the frequency and identifier of the tuned navaids and allows input of frequencies or identifiers to remote tune the VORs. Dashes are displayed if the VOR is not tuned.

The tuning status is displayed adjacent to left and right VOR frequencies. Entry of a frequency or identifier remotely tunes a VOR. The FMC autotunes VORs and their related DMEs for procedure flying and radio positions. The tuning status displays are:

- A (autotuning) – FMC selects a navaid for best position orientation
- P (procedure autotuning) – FMC selects navaids for approach or departure procedure guidance
- R (remote tuning) – VOR frequency or identifier has been entered by the flight crew on the NAV RADIO page
- M (manual) – VOR is manual-tuned using the VOR control panels on the glareshield. Manual-tuning takes priority over FMC autotuning.

Valid entries:

- VOR, non-ILS DME, or ILS DME identifier
- VOR frequency (XXX.X or XXX.XX).

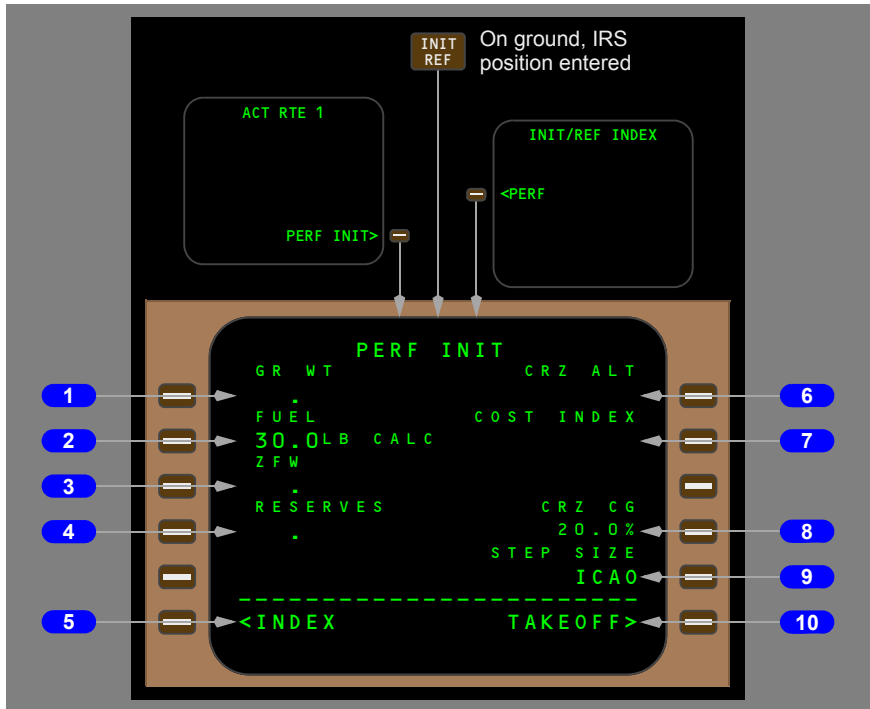
2 RADIAL

Displays the current radial from the left and right VOR stations to the airplane.

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This data is required for VNAV operation.

Performance Initialization Page



1 Gross Weight (GR WT)

Airplane gross weight can be entered by the flight crew or calculated by the FMC after entry of zero fuel weight.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

Entering the zero fuel weight first displays calculated gross weight.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 FUEL

Fuel on board displays when the fuel totalizer calculations are valid. The source for the display is included in the line:

- SENSED – fuel quantity is from the totalizer.
- CALC (calculated) – fuel quantity is from FMC calculations. Manual entry is possible
- MANUAL – fuel quantity has been manually entered. Manual entries blank totalizer on PROGRESS page 2.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

Only manual entries can be deleted. The display returns to the sensed (totalizer) value when a manual entry is deleted.

3 Zero Fuel Weight (ZFW)

Normally, ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Valid entry is thousands of pounds with a decimal (hundreds) optional.

Calculated zero fuel weight displays when airplane gross weight is entered first and fuel on board is valid.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

4 RESERVES

Valid entry is thousands of pounds with a decimal (hundreds) optional.

5 INDEX

Push – displays the INIT/REF INDEX page.

6 Cruise Altitude (CRZ ALT)

Cruise altitude can be entered by the flight crew or from a company route.

Entered value is displayed on the CLB and CRZ pages.

7 COST INDEX

Cost index is used to calculate ECON climb, cruise, and descent speeds. Larger values increase the ECON cruise speed. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route.

Valid entries are 0 to 9999.

8 Cruise Center of Gravity (CRZ CG)

Used by FMC to compute maximum altitude and maneuver margin to buffet.

Displays default center of gravity.

Default value displays in small font.

9 STEP SIZE

Displays the climb altitude increment used for planning the optimum climb profile.

Default value is ICAO which provides a 2000 foot step below FL290 and a 4000 foot step above FL290.

Valid manual entries are 0 to 9000 in 1000 foot increments.

In-flight entries are inhibited. In-flight step size changes are made on the CRZ page.

For a non-zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

10 TAKEOFF

Push – displays the TAKEOFF REF page.

Takeoff Reference Page

The takeoff reference page allows the input of the final performance data required for takeoff. Entries on the takeoff reference page complete the normal FMC preflight. If any required preflight data has been omitted, a prompt is displayed to access the page where data is missing.

Takeoff reference page entries can be made manually or uplinked.

Takeoff Reference Page

Note: Data entered on this page does not change the same data entered on previous preflight pages (i.e. entry of a runway in the RWY/POS line does not change the runway entered on the RTE page). Values entered by the flight crew on this page and downlinked is a request for takeoff data for the entered values.

767-300 Operations Manual

If an assumed temperature value is entered using the thrust management control panel, the entered temperature is displayed here.

When dashes are displayed, it allows entry of an assumed temperature which is used by the TMC. Entries can be made in degrees Celsius or Fahrenheit. Fahrenheit entries must be suffixed with an F. The entered value is displayed on EICAS.

Entry of a value after takeoff speeds are entered removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

3 Center of Gravity (CG), TRIM

Valid entry is CG within the valid range.

After the CG is entered, the FMC calculates and displays the stabilizer trim setting for takeoff.

4 Runway/Position Shift (RWY/POS)

Displays the departure runway from the active RTE page and allows entry of a distance between the departure runway threshold and where the autothrottle will be engaged for takeoff.

If GPS is not enabled (GPS NAV selected OFF), the FMC updates its position to the departure runway threshold when the autothrottle is engaged for takeoff. If a position shift distance is entered, upon autothrottle engagement the FMC updates its position to that entered distance from the departure runway threshold.

If an intersection takeoff is planned, the intersection identifier or a positive distance should be entered. If a displaced threshold takeoff is planned a negative value should be entered.

Valid position shift entries are from 9900 to – 9900 in feet. The last two digits must be zeros.

Entry of a value after takeoff speeds are selected removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

5 Takeoff Data Request (REQUEST SEND)

Push – transmits a data link request for takeoff data uplink.

Flight crew entered data is included with the request.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 V Speeds

Dashes are displayed before speeds are entered and when speeds have been deleted.

Flight crew entered speeds are displayed in large font. V1 and VR are displayed on the ADI speedtape.

If performance or takeoff data is changed after speeds are entered, the speeds are deleted, dashes are displayed, and the scratchpad message TAKEOFF SPEEDS DELETED is displayed.

8 Takeoff Gross Weight (TOGW)

Entry is included with the takeoff datalink request.

9 Gross Weight (GR WT)

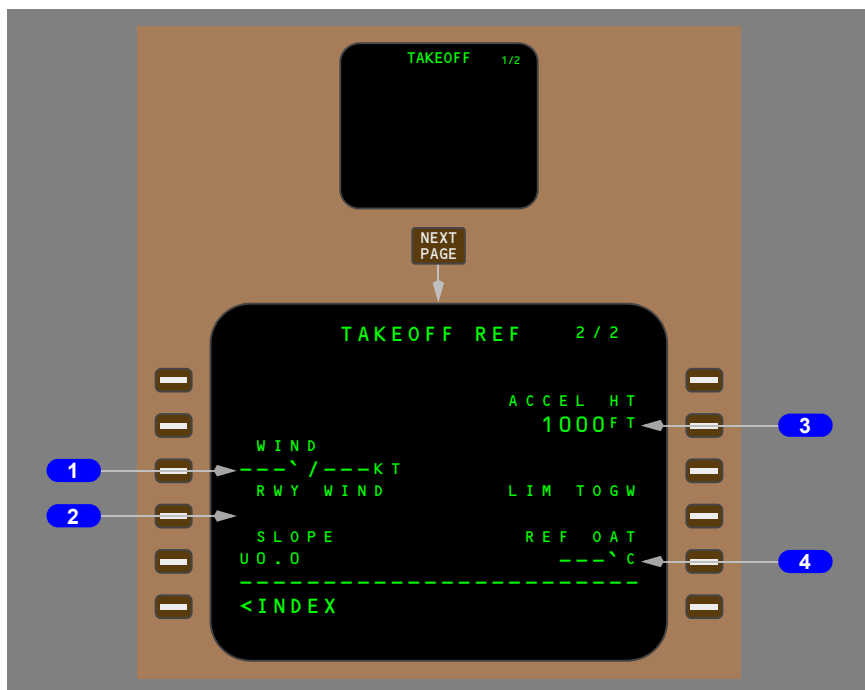
Displays the airplane gross weight value from the PERF INIT page.

10 Pre-Flight (PRE-FLT) Status

Displays COMPLETE if all required pre-flight entries have been made.

Displays a prompt to access a pre-flight page where further entries are required if pre-flight is not complete.

Takeoff Reference Page 2/2



1 WIND

Valid entry is the takeoff wind.

Entry of a value after takeoff speeds are entered removes the speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

2 Runway Wind

Displays the takeoff runway wind components in knots once the wind is entered and a runway is entered on TAKEOFF REF page 1. The headwind is displayed with an H or T and the crosswind is displayed with an L or R.

3 Acceleration Height

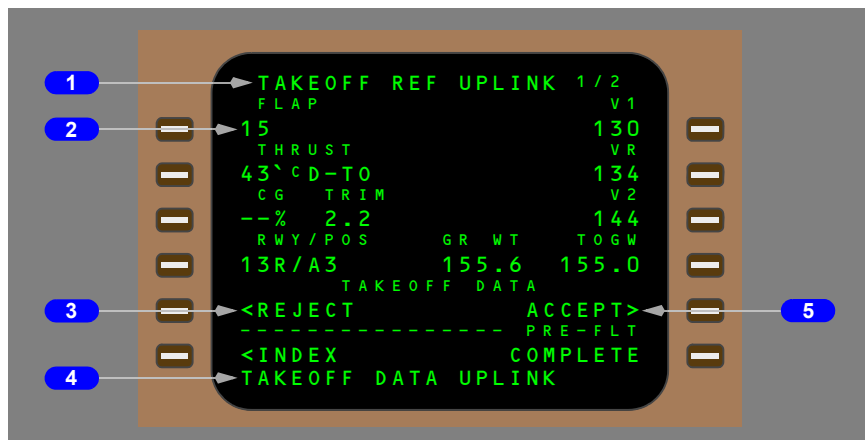
Displays the height that VNAV will begin an acceleration for flap retraction after takeoff. Default value from the navigation database is displayed in small font. Valid entry is 400 to 9999 feet. Pilot entered values are displayed in large font.

4 Reference Outside Air Temperature (REF OAT)

Allows entry of an outside air temperature. Entered value is used in V speed calculations and is included in the takeoff data request downlink.

Entry can be made in degrees Celsius or Fahrenheit. Fahrenheit entries must be include an F.

Takeoff Reference Uplink - As Installed



1 TAKEOFF REF UPLINK

The page title changes to indicate UPLINK data is displayed.

2 Uplinked Data

Uplinked data is displayed in small font until it is accepted.

3 REJECT

Push – deletes uplinked data and returns pre-uplink data to display.

4 Scratchpad Message

The TAKEOFF DATA UPLINK message appears in the scratchpad when the uplink is received. The message is cleared when ACCEPT or REJECT is selected.

5 ACCEPT

Push – loads uplinked data and changes the small font displays to large font.



1 Alternate Takeoff Data

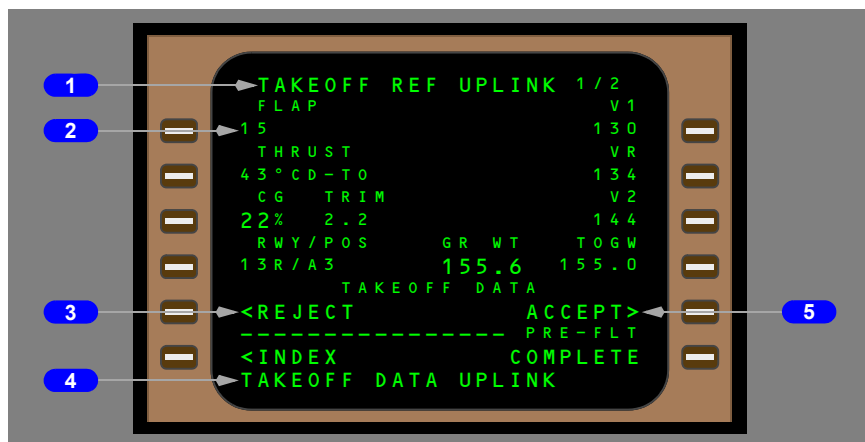
Provides access to alternate takeoff data which is included in the takeoff uplink. Shows the thrust and flap setting used to calculate the alternate data.

Push – selects the alternate takeoff data and replaces all pending (small font) data on page 1 and 2 with the alternate data. The line title changes to STD THR/FLAP and the data line shows the thrust and flap setting used to calculate the standard takeoff uplink data.

2 Standard Limit Takeoff Gross Weight (STD LIM TOGW)

Displays the limit takeoff gross weight used to calculate the standard uplink takeoff data. If alternate data is selected the line title displays ALT LIM TOGW.

Takeoff Reference Uplink



1 TAKEOFF REF UPLINK

The page title changes to indicate UPLINK data is displayed.

2 Uplinked Data

Uplinked data is displayed in small font until it is accepted.

3 REJECT

PUSH – deletes uplinked data and returns pre-uplink data to display.

4 Scratchpad Message

The TAKEOFF DATA UPLINK message appears in the scratchpad when the uplink is received. The message is cleared when ACCEPT or REJECT is selected.

5 ACCEPT

Push – loads uplinked data and changes the small font displays to large font.

Takeoff Reference Uplink Page 2



1 Alternate Takeoff Data (ALTN THR/FLAP)

Provides access to alternate takeoff data which is included in the takeoff uplink. Shows the thrust and flap setting used to calculate the alternate data.

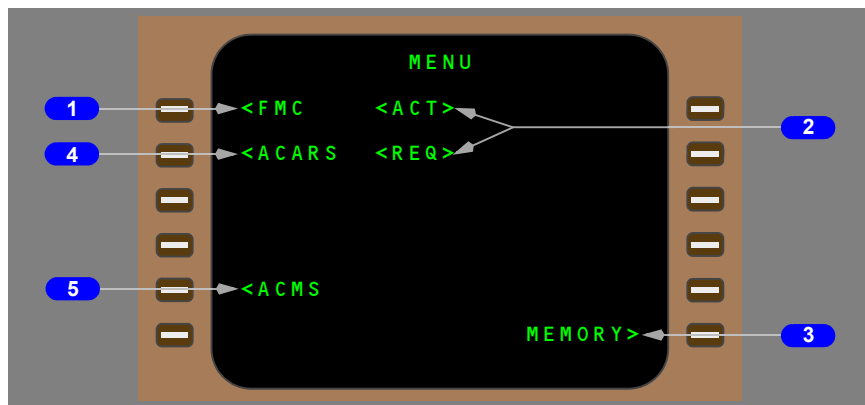
PUSH – selects the alternate takeoff data and replaces all pending (small font) data on page 1 and 2 with the alternate data. The line title changes to STD THR/FLAP and the data line shows the thrust and flap setting used to calculate the standard takeoff uplink data.

2 Standard Limit Takeoff Gross Weight (STD LIM TOGW)

Displays the limit takeoff gross weight used to calculate the standard uplink takeoff data. If alternate data is selected the line title displays ALT LIM TOGW.

Menu Page

The MENU page allows access to other airplane systems which are controlled with the MCDU.



1 FMC

Push – connects FMC to CDU/MCDU

2 MCDU Status

- <ACT> – indicates system currently controlling CDU/MCDU
- <REQ> – indicates inactive CDU/MCDU function requiring pilot action
- blank – indicates function is not selected or requiring action

3 MEMORY (not displayed while airborne)

Push – displays maintenance memory page, providing access to computer memory for maintenance while the airplane is on the ground

4 ACARS (Aircraft Communication Addressing and Reporting System)

Push –

- activates MCDU control of ACARS
- displays ACARS page

See Chapter 5, Communications.

5 ACMS (Airplane Condition Monitoring System)

Push –

- activates MCDU control of ACMS
- displays ACMS page

See Chapter 10, Flight Instruments, Displays.

Flight Management, Navigation
FMC Takeoff and Climb**Chapter 11**
Section 41

Introduction

The takeoff phase of flight starts with the selection of takeoff thrust at the start of the takeoff roll.

If GPS is not available, the FMC position is updated to the takeoff runway position when the autothrottle is engaged for takeoff.

The takeoff mode of the autoflight system provides flight director guidance until LNAV and VNAV are engaged after takeoff. Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase changes to the climb phase when climb thrust and VNAV are engaged. The climb phase continues to the top of climb point, where the cruise phase starts.

Takeoff Phase

When changes are made to the departure runway and SID, the DEPARTURES and TAKEOFF REF pages must be modified to agree. The modified data is entered the same as during preflight.

During takeoff, the autothrottle commands the selected thrust and the autoflight system provides pitch and roll commands through the flight director.

When armed before takeoff, LNAV engages at 50 feet radio altitude. When engaged, FMC roll commands fly the active route leg.

Climb Phase

When climb thrust and VNAV are engaged the FMC provides pitch commands to maintain the climb speed until the acceleration height is reached. At the acceleration height the FMC provides pitch commands to accelerate.

The VNAV commanded speed is limited by the airplane configuration. At acceleration height, VNAV commands a speed 5 knots below the flap placard speed.

Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until reaching the cruise altitude unless the climb profile contains other constraints.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level-off for a crossing altitude restriction is accomplished at the commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC shows the scratchpad message UNABLE NEXT ALT. A different speed profile that gives a steeper climb angle must be manually selected.

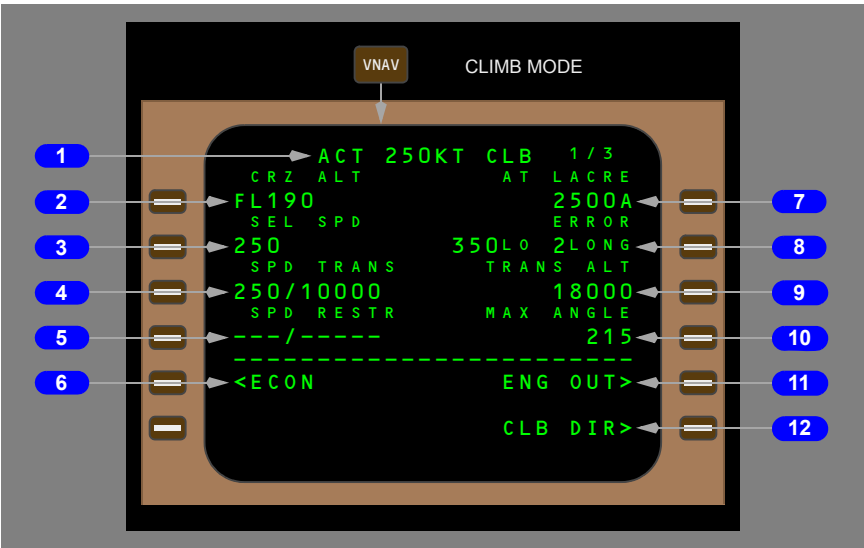
A decrease in airspeed may be observed during VNAV level off to cruise altitude if the rate of climb is high at the level off capture point. VNAV will continue a smooth level off and eventually accelerate to the selected cruise speed. During level off under these conditions, VNAV will not allow the airspeed to decrease below the best hold speed for that altitude, which is above the minimum maneuvering speed.

Climb Page

The climb page is selected by pushing the MCDU VNAV function key while on the ground, during takeoff, or in climb.

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, and from the FMC data bases.

The FMC manages the climb to comply with the active route. The climb mode is indicated by the CLB page title. The mode can be economy, selected speed, or engine out. In each mode, the same type of data is shown on the page.



1 Page Title

ACT is displayed when the climb phase is active.

The page title displays the type of climb:

- ECON – speed based on the cost index
- LIM SPD – speed based on airplane configuration limiting speed
- MCP SPD – MCP speed intervention selected
- EO – engine out mode selected
- XXXKT – fixed CAS climb speed profile
- M.XXX – fixed Mach climb speed profile.

Fixed climb speeds are for:

- climb segment constraints
- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed transition
- a flight crew selected speed.

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on transition altitude.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

ECON SPD

- economy speed based on cost index
- displays CAS and Mach values.

SEL SPD

- displayed when intermediate level off required below an existing speed constraint
- displayed when flight crew enters speed
- CAS or Mach value may be entered.

4 Speed Transition (SPD TRANS)

Displays the transition speed/altitude from one of these sources:

- the navigation database value for the origin airport
- a default speed of 250 knots and 10,000 feet.

Not displayed above the transition altitude.

Can be deleted.

5 Speed Restriction (SPD RESTR)

Speed restrictions not associated with specific waypoints are manually entered on this line.

Displays dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

6 Economy (ECON)

Push – changes climb speed to ECON. Must be executed.

Prompt is shown on line 5L when the climb mode is not ECON.

7 Waypoint Constraint (AT XXXXX)

Displays next airspeed and/or altitude constraint at waypoint XXXXX.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page or are inserted as part of a SID.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

8 ERROR at Waypoint

Displays altitude discrepancy and distance past waypoint where altitude will be reached.

Blank if no error exists.

9 Transition Altitude (TRANS ALT)

Transition altitude for origin airport contained in navigation database. FMC uses 18,000 feet if transition altitude is not available.

Manually change transition altitude here or on DESCENT FORECAST page.

Valid entries are XXX, XXXX, XXXXX, or FLXXX.

Altitude information displayed on the CDU changes from altitudes to flight levels above the transition altitude.

10 Maximum Angle (MAX ANGLE)

Maximum angle of climb speed.

Entry not allowed.

11 Engine Out (ENG OUT)

Push – modifies page to show engine out (ENG OUT) performance data.

12 Climb Direct (CLB DIR)

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Blank if no constraints exist.

Engine Out Climb

Engine out VNAV climb guidance is displayed on the EO CLB page. The EO CLB page must be selected and executed by the flight crew. Engine out data is available with all engines operating. Engine out climb (EO CLB) changes to engine out cruise (EO CRZ) at the top of climb.

Engine Out CLB Page

The modified page displays engine out performance limitations. Manual entries are allowed. After the modification is executed VNAV gives engine out guidance in the climb.



1 Cruise Altitude (CRZ ALT)

Displays cruise altitude if less than MAX ALT.

Displays MAX ALT if less than cruise altitude.

Manual entry is allowed.

2 Speed Line

Displays engine out best gradient climb speed (EO SPD) when page first selected. Any valid speed can be entered.

Valid entry is XXX for CAS.

Valid entry is 0.XXX for Mach. Trailing zeros can be omitted.

A manual entry changes the line heading to SEL SPD and may cause MAX ALT to change.

3 Engine Out Speed (EO SPD)

Push – resets command speed to best gradient speed. Blank when EO SPD is displayed on the speed line.

4 Maximum Altitude (MAX ALT)

Lower of maximum altitude at engine out climb speed or cruise speed.

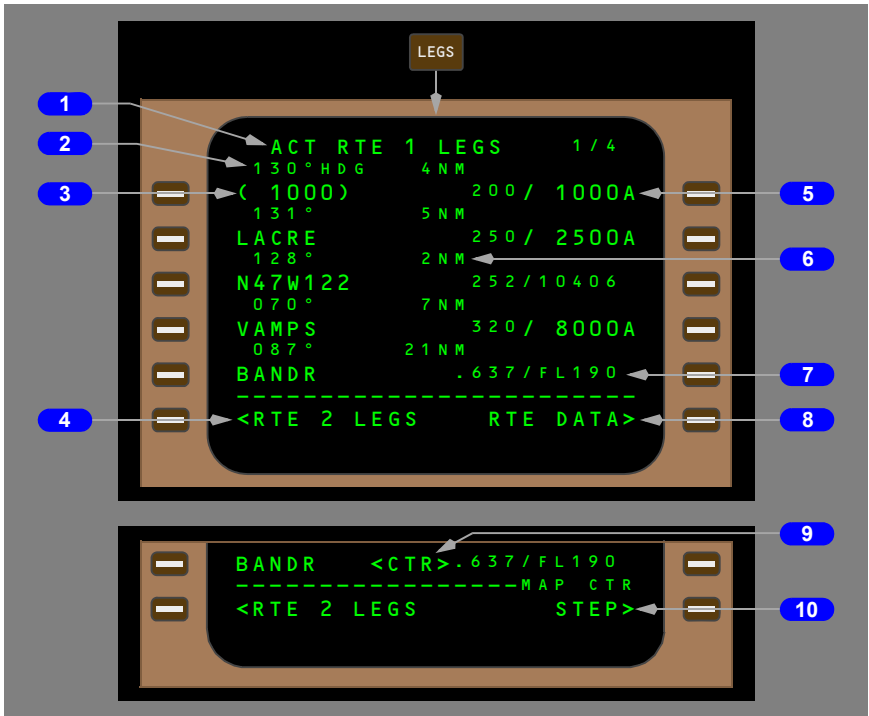
Entry not allowed.

5 All Engine (ALL ENG)

Push – modifies page to display all engine (ALL ENG) performance data.

Route Legs Page

The legs page is used to evaluate and modify the planned route of flight during the climb and to add or delete waypoint constraints to comply with the ATC clearance. The data on the climb page comes from preflight entries made on the route and departure pages, and from the FMC data bases.



1 Page Title

Title format shows route status:

- RTE X LEGS – inactive route
- ACT RTE X LEGS – active route
- MOD RTE X LEGS – modified active route.

2 Leg Direction

Leg segment data in line title:

- courses – magnetic (xxx°) or true (xxx° T)
- arcs – distance in miles, ARC, turn direction (example: 24 ARC L)
- heading leg segments – xxx° HDG

- track leg segments – xxx° TRK
- special procedural instructions from database – HOLD AT, PROC TURN.

Calculated great circle route leg directions may be different than chart values.

Dashes are shown for an undefined course.

3 Waypoint Identifier

Displays waypoints by name or condition.

Active leg is always the first line of the first active RTE X LEGS page.

All route waypoints are shown in flight sequence. Waypoints on an airway are included on the route legs page.

Waypoints can be modified. Examples:

- add waypoints
- delete waypoints
- change waypoint sequence
- connect route discontinuities.

Boxes are shown for route discontinuities.

Dashes are displayed on the line following the last waypoint on the route.

4 Route 2 Legs (RTE 2 LEGS)

Push –

- displays the RTE 2 LEGS
- when RTE 2 LEGS page is shown, prompt changes to RTE 1 LEGS.

5 Waypoint Speed/Altitude Constraints

Waypoint speed or altitude constraint in large font.

Manual entry allowed in climb or descent phase. Entered by FMC when constraints are part of a procedure.

Speed constraint is assumed to be at or below the displayed speed.

Valid entries are:

- speed – airspeed or Mach – requires an altitude constraint at the same waypoint
- altitude in thousands of feet or flight level (19000, 190)
- XXX/XXXXX – airspeed/altitude entered simultaneously
- XXX/ – airspeed only (requires an existing altitude constraint)
- XXXXX or /XXXXX – altitude only.

Altitude constraint suffixes:

- blank – cross at altitude
- A – cross at or above altitude
- B – cross at or below altitude
- both – altitude block. Example: 220A240B
- S – planned step climb (refer to Flight Management, Navigation, Cruise).

6 Distance to Waypoint

Distance from airplane to active waypoint or from waypoint to waypoint.

The first line displays the distance from the airplane to the active waypoint.

7 Waypoint Speed/Altitude Predictions

Waypoint speed and altitude predictions are displayed in small font.

Dashes are displayed in the descent region prior to descent path calculation.

Descent path calculation requires altitude constraint below cruise altitude.

8 ACTIVATE, Route Data (RTE DATA)

Push – three possible prompts

- ACTIVATE – activates inactive flight plan; shows RTE DATA prompt
- RTE DATA (route data) – shows route data page
- CTR – see below

9 Center (<CTR>)

Displayed when PLAN mode selected.

Displayed adjacent to the waypoint around which plan mode is centered.

10 MAP Center (CTR) STEP

Replaces ACTIVATE or RTE DATA when PLAN mode selected.

Push – steps <CTR> to next waypoint. Plan mode recenters.

Engine Out Departure



1 Engine Out Standard Instrument Departure (EO SID)

Engine out SIDs can be created by the airline for specific runways. If there is an EO SID in the database for the departure runway it will be listed on the departures page after the runway is selected.

The FMC puts the EO SID into the route as a modification if:

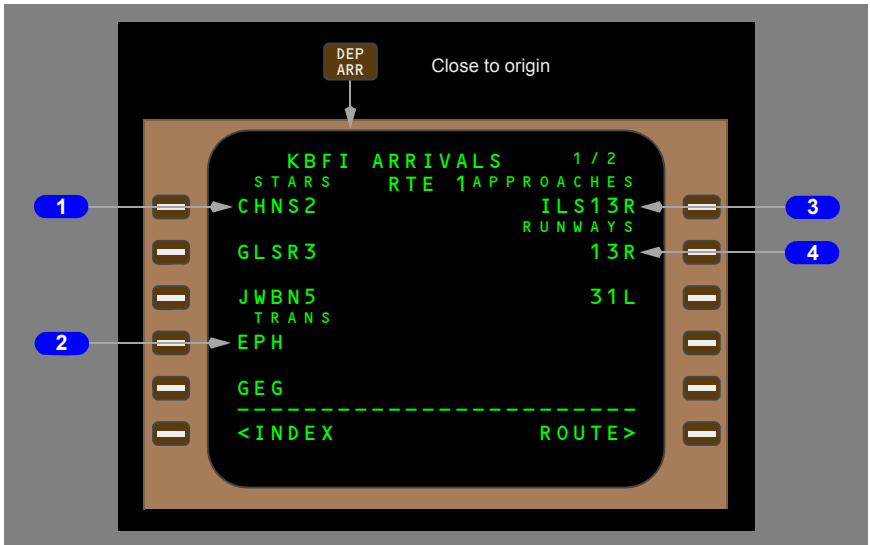
- an engine failure is sensed
- flaps are extended
- and the navigation database has an EO SID for the departure runway.

The modification can be executed or erased.

Air Turnback Arrivals Page

During a turn-back situation, the flight crew requires quick access to the arrivals data for the origin airport. The arrivals page allows access without changing the destination on the route page.

During climb if the airplane is less than 400 miles from the origin and less than half way to the destination, push the DEP ARR key to show the ARRIVALS page for the origin airport.



1 Standard Terminal Arrivals (STARS)

Displays STARS for origin airport.

2 Transitions (TRANS)

Displays transitions for origin airport.

3 APPROACHES

Displays approaches for origin airport.

4 RUNWAYS

Displays runways for origin airport.

Intentionally
Blank

Flight Management, Navigation
FMC Cruise**Chapter 11**
Section 42

Introduction

The cruise phase starts at the top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- CRZ
- PROGRESS.

The RTE LEGS pages are used to modify the route. The CRZ pages display VNAV related data. The PROGRESS pages display flight progress data. During cruise, the specific page listed below is used to:

- POS REF page – verify the FMC position
- RTE DATA page – display progress data for each waypoint on the RTE LEGS page
- REF NAV DATA page – display data about waypoints, nav aids, airports, or runways, and can be used to inhibit nav aids
- RTE X page – select a route offset
- FIX INFO page – display data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page – shows a list of duplicate waypoints from the navigation database. The flight crew selects the correct waypoint from the list
- POS REPORT page – display data for a position report.
- WINDS page – enter forecast wind and temperature

The CLB page changes to CRZ at the top of climb. The CRZ CLB and CRZ DES pages change to CRZ at the new cruise altitude. The CRZ page changes to DES at top of descent.

LNAV Modifications

This section shows typical techniques to modify the route. The modifications include:

- add and delete waypoints
- change waypoint's sequence
- connect discontinuities
- intercept a course.

RTE LEGS Page Modifications

Modifications to the LNAV route are usually made on the RTE LEGS page. When the route is modified, MOD is displayed in the title and the execute light is illuminated.

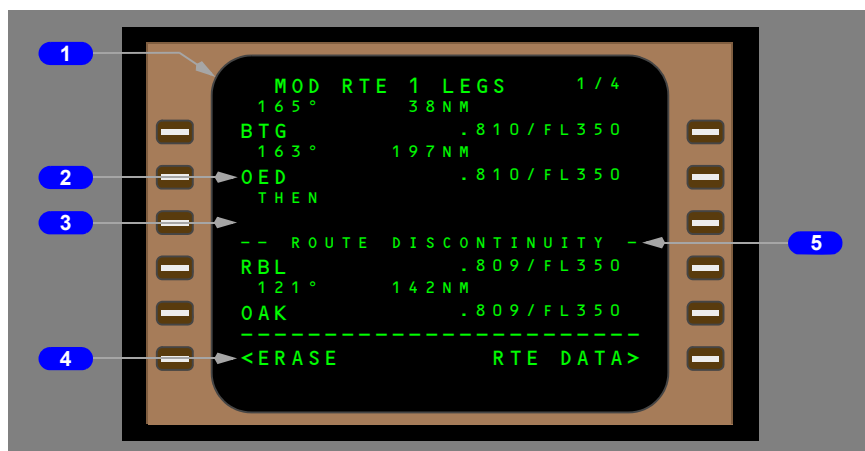
Add Waypoints

Waypoints can be added to the route at any point. Added waypoints are followed by route discontinuities.

First, enter the waypoint name in the scratchpad.

Second, locate the correct line in the flight plan and push the adjacent line select key. The scratchpad waypoint name is put into the selected line. The entered waypoint is connected to the waypoint above it via a direct route. A route discontinuity follows the waypoint.

For example, OED is typed into the scratchpad. Push line select key 2L to put OED into line 2. The FMC assumes BTG direct OED. RBL and the rest of the flight plan are kept but, are put after the route discontinuity.



1 Page Title

MOD – replaces ACT when modification is in progress.

ACT – replaces MOD when ERASE is selected or execute key is pushed.

2 Modified Waypoint

OED waypoint entered into the route after BTG. Modification creates a route discontinuity because OED was not in the active route. The FMC now requires routing beyond OED.

3 Discontinuity Waypoint

Discontinuity is corrected when applicable waypoint is entered in boxes.

4 ERASE

Push – removes all modifications and shows active data.

Displayed when the FMC contains modified data.

Removed when selected or the modifications are executed.

5 ROUTE DISCONTINUITY

Line title separates route segments when there is a discontinuity.

Note: Performance predictions to destination on the PROGRESS page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

Delete Waypoints

Use the RTE LEGS page to remove waypoints from the route. The active waypoint can not be deleted. Two methods to remove a waypoint are:

- delete the waypoint with the DEL function key
- change the waypoint's sequence.

The data in the route before the deleted waypoint does not change. A discontinuity is put in the route when the DEL function key is used to remove a waypoint.



1 Active Route

The active route shows RBL followed by OAK and AVE.

2 DELETE Entry

Pushing the DEL function key arms the delete function and selects DELETE to the scratchpad.

3 Route Discontinuity

With DELETE in the scratchpad, pushing the line select key for RBL deletes the waypoint. Boxes replace RBL and a route discontinuity is displayed.

Change Waypoint Sequence

Waypoints moved from one position in the flight plan to another do not cause route discontinuities.

The waypoint may be manually typed or copied from any of the RTE LEGS pages. To copy the waypoint, push the line select key adjacent to the waypoint.

The example below shows the flight plan being modified to fly from BTG direct OAK. Push the line select key adjacent to OAK to put OAK in the scratchpad. Push the line select key adjacent to RBL. RBL is removed from the flight plan and the routing is direct from BTG to OAK to AVE. The modification does not cause a route discontinuity. Several waypoints can be removed from the flight plan at a time with this method.



1 Active Route

The active route shows RBL followed by OAK and AVE. The clearance is to fly from BTG direct OAK. The OAK waypoint is selected to the scratchpad.

2 Change OAK's Sequence

OAK is selected to the waypoint after BTG. RBL is removed with no discontinuity.

Remove Discontinuities

A discontinuity exists when two waypoints are not connected by a route segment.

To remove a discontinuity, copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity.



1 Route Discontinuity

The active route has a discontinuity after BTG. The example shows how to fly direct from BTG to OAK. Copy OAK to the scratchpad. Any subsequent waypoint in the route can be selected to the scratchpad to remove the discontinuity.

2 Continuous Route

Select OAK to the boxes to remove the discontinuity.

If a waypoint which does not already exist on the route is entered into the boxes the discontinuity moves one waypoint further down the route.

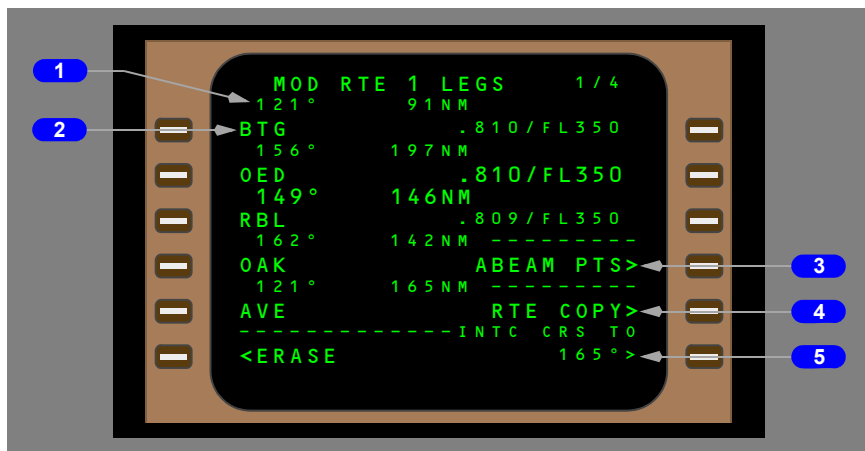
Direct To And Intercept Course To

If the airplane is not on the active leg segment, LNAV may deactivate or it may not activate when armed. This happens after the airplane crosses a discontinuity, or is not on an intercept heading to the active leg segment. Here are three ways to arm or activate LNAV:

- When the airplane is within 2.5 miles of the active leg, push the LNAV switch. LNAV activates and intercepts the active route leg
- When more than 2.5 miles from the active leg, push the LNAV switch when the airplane is on an intercept heading to the active route leg. Initially, LNAV arms and then activates as the airplane approaches the active leg. An intercept heading must intersect the active leg inbound before the active waypoint
- Fly direct to a waypoint or intercept a course to a waypoint. Enter a waypoint in the RTE LEGS page active waypoint line to fly direct. Use the INTC CRS TO prompt in line 6R to create an intercept course to the waypoint. When the modification has been executed, push the LNAV switch and LNAV arms or activates, depending on the distance from the active leg.

Modification of the Active Waypoint

The following example shows a modification to go direct to a waypoint. After vectors off the original route a clearance is received to proceed direct to BTG.



1 Course to Active Waypoint

Prior to execution, displays direct-to inbound course at waypoint; changed by entry in INTC CRS line or by selecting intercept course.

After execution, displays current required track to fly inbound course to waypoint.

2 Active Waypoint

Displays crew entered direct/intercept waypoint. If entered waypoint is not part of the active route it will be followed by a discontinuity.

3 ABEAM Points (PTS)

Push –

- creates abeam points on new route to indicate waypoints bypassed by direct to function
- abeam points are perpendicular to the waypoints bypassed
- line title displays ABEAM PTS, line data displays SELECTED
- subsequent route modifications remove ABEAM PTS prompt.

4 Route (RTE) COPY

Push –

- copies active unmodified route into inactive route
- erases previous inactive route
- line title displays RTE COPY, line data displays COMPLETE
- subsequent route modifications remove RTE COPY prompt.

5 Intercept Course (INTC CRS) TO

Displays boxes if entered waypoint not in the active route.

Displays current route course and prompt caret if the entered waypoint is in the active route. Allows entry of a different inbound course via the scratchpad.

When boxes displayed, valid entry is intercept course from 000 to 360.

Push –

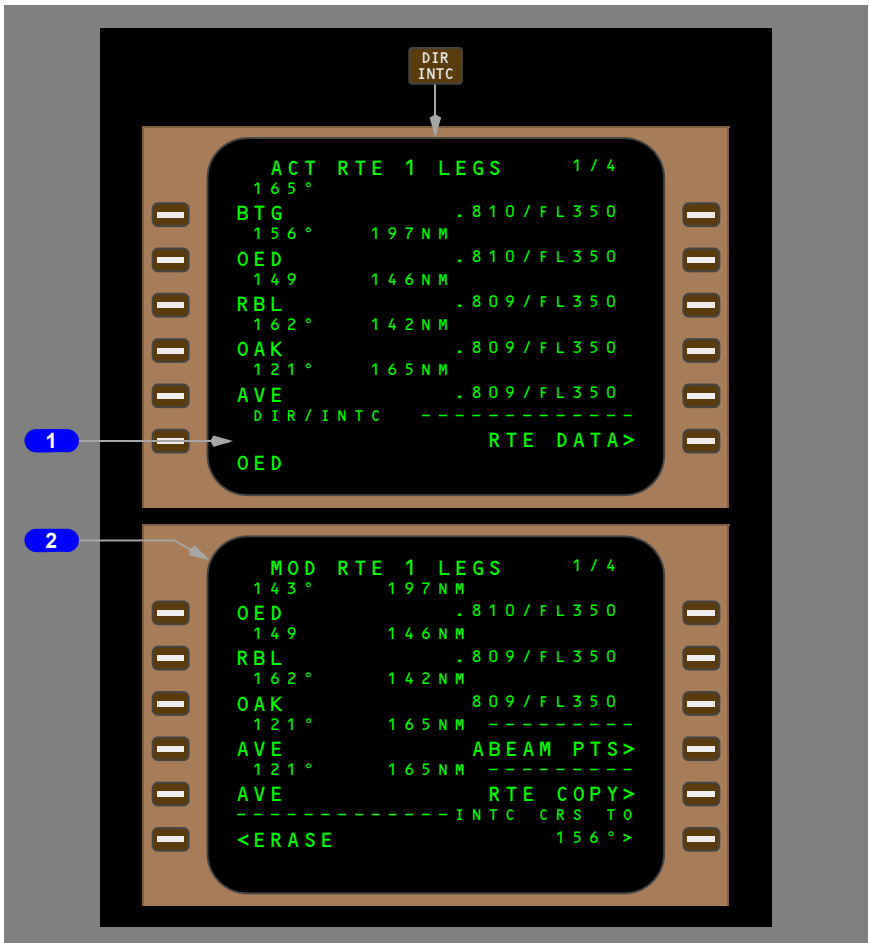
- when course displayed, selects current route course as intercept course to active waypoint
- when course is displayed and a different course has been entered in the scratchpad, the scratchpad value is entered as the intercept course to the active waypoint
- selection or entry is displayed as the course to the active waypoint
- selection or entry removes ABEAM PTS and RTE COPY prompts.

Direct Intercept Page

The active waypoint is modified using the Direct Intercept page which is accessed with the DIR/INTC key. This page shows the RTE LEGS page with boxes at the bottom for selecting a direct route to a waypoint or intercepting a course to a waypoint. If going direct to a waypoint, the waypoint identifier is inserted in the DIRECT TO boxes. If intercepting a course inbound to the waypoint, the waypoint identifier is inserted in the INTC LEG TO boxes and additional boxes are displayed to enter an inbound course.

Direct-To Modification

The active waypoint can also be modified by using the direct intercept page.



1 Direct Intercept (DIR/INTC) Boxes

Select the waypoint to the scratchpad or enter the identifier in the scratchpad using the keypad. Enter the waypoint identifier into the DIR/INTC boxes.

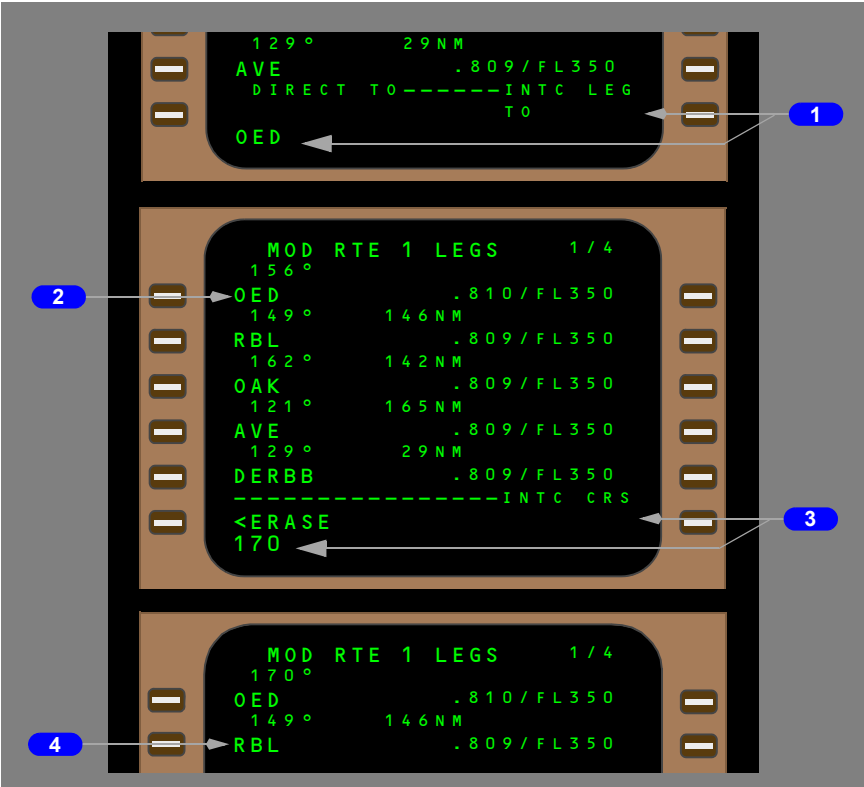
2 Modified Active Waypoint Page

The entered waypoint is displayed as the active waypoint. The course displayed above the waypoint is the direct course from the airplane present position to the waypoint.

If the entered waypoint was not part of the active route it will be followed by a discontinuity.

Intercept–Course–To Modification

The next example shows an intercept course modification. The clearance is to intercept the 170° course inbound to OED.



1 Enter Waypoint in INTC LEG TO Boxes

If the clearance is to intercept a course inbound to the waypoint, the waypoint must be entered in the INTC LEG TO boxes on the right side of the page.

2 Modified Active Waypoint

Displays the crew entered waypoint. If entered waypoint is not part of the active route it will be followed by a discontinuity.

The course displayed above the waypoint is the original inbound course from the active route. If the entered waypoint is not part of the active route the direct course will be displayed.

3 Enter Course in INTC CRS Boxes

INTC CRS Boxes are displayed after the waypoint is entered.

The desired intercept course is entered in the scratchpad and line selected to the boxes.

If the modification is executed without entering a course, the course displayed above the active waypoint becomes the intercept course.

Valid entry is intercept course from 000 to 360.

4 Intercept Course

The entered course is displayed above the active waypoint.

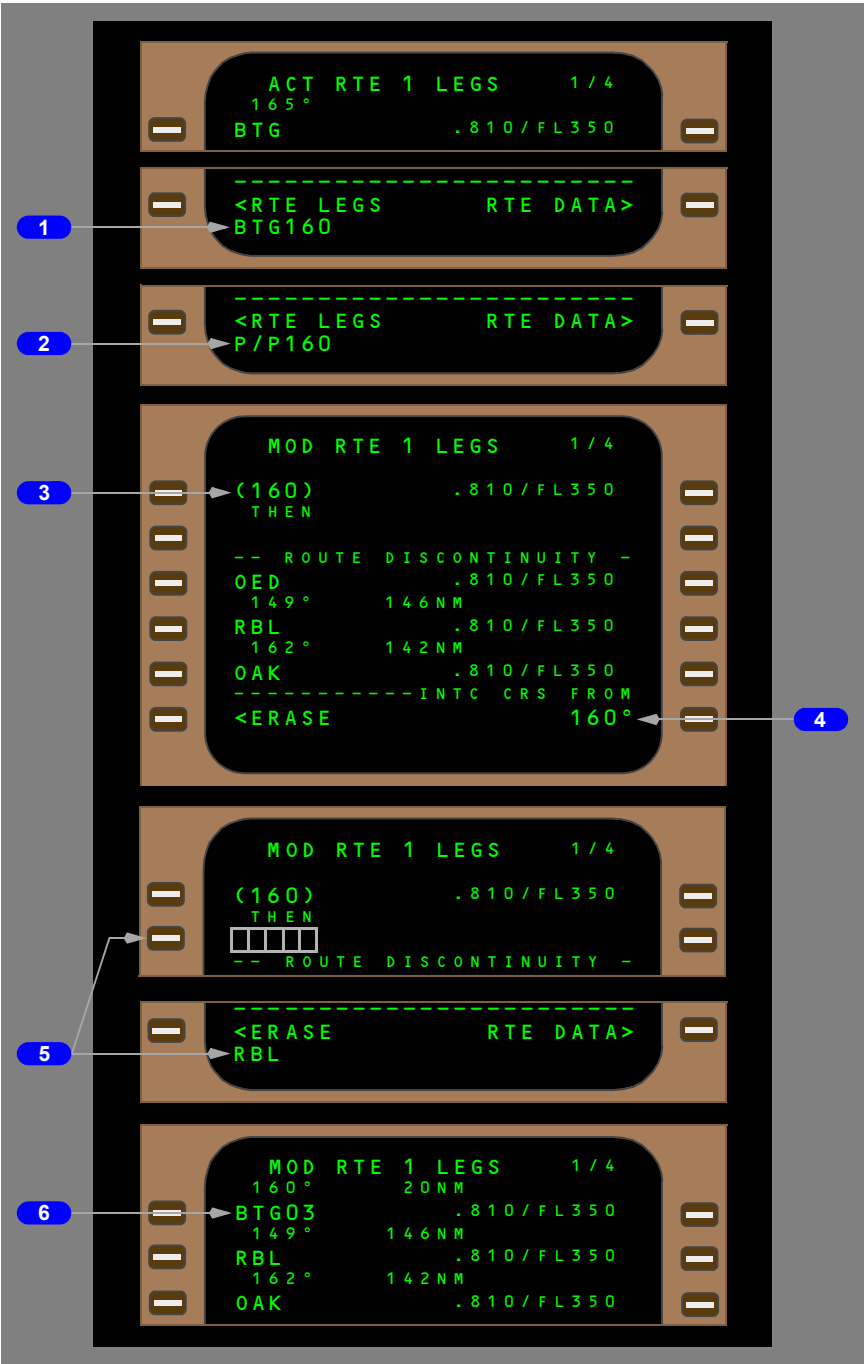
When the modification is executed, LNAV can be armed. If the current airplane heading intercepts the entered course, LNAV will engage when the airplane approaches the inbound course. If the current airplane heading does not intercept the entered course the NOT ON INTERCEPT HEADING scratchpad message is displayed.

Intercept Course From

The steps to create an intercept course from a waypoint are nearly the same as the steps for an intercept course to. The waypoint name in the scratchpad is suffixed with the outbound course.

An intercept course can be created outbound from a waypoint in the navigation data base or from present position. The waypoint does not have to be in the route. Entering a waypoint and course pair in the active waypoint line displays the INTC CRS FROM prompt. The FMC calculates a route leg with the waypoint as the origin of the entered course.

The following example demonstrates entering a 160° course from BTG. BTG160 is entered in the scratchpad. When this entry is line selected to the active waypoint line, the entered course is displayed as a conditional waypoint.



1 Waypoint and Outbound Course

Enter the waypoint name and outbound course in the scratchpad.

2 Present Position and Outbound Course

Enter P/P and outbound course in the scratchpad.

3 Active Outbound Course Entry

After the active waypoint line is selected, the outbound course is displayed. The waypoint name is not used.

For example, BTG160 is entered into the active waypoint line. The FMC calculates a new route leg with BTG as the origin on a outbound course of 160°.

4 Intercept Course From (INTC CRS FROM)

Displays outbound course from the entered waypoint. Allows input of a different outbound course until the modification is executed.

Valid entry is any course from 000° through 360°.

5 Next Waypoint

Enter a down track waypoint into the boxes. To resolve the discontinuity the waypoint must be part of the active route and the inbound course to that waypoint must be intersected by the entered course.

6 Created Waypoint

If the 160° course intercepts the course inbound to the entered waypoint, a new waypoint is created at the intercept point. Line selecting the new waypoint results in a place, bearing, distance format in the scratchpad.

SELECT DESIRED WPT (Waypoint) Page

The SELECT DESIRED WPT page is displayed when a waypoint identifier or name is entered and the navigation database contains more than one location for that name. Selection of a waypoint returns the display to the previous page.



1 Identifier

Displays a list of the waypoints in the navigation database that have the same identifier as entered.

Up to 48 waypoints (8 pages) can be listed.

Waypoints are sorted as follows:

- when page is accessed as a result of a flight plan entry or modification, sort is based on proximity to the waypoint preceding the entered waypoint
- when page is accessed as a result of a DIR/INTC, FIX INFO, or REF NAV DATA entry, sort is based on proximity to current aircraft position.

Select the desired waypoint by pushing either the left or right line select key adjacent to the waypoint. The CDU page where the waypoint identifier was entered is redisplayed with the selected waypoint inserted.

2 Frequency

Displays frequency of the waypoint if it is a navaid. Blank if the waypoint is not a navaid.

3 Type

Displays the type of waypoint for each duplicate name.

4 Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

Airway Intercept

Just as in intercept to, LNAV can be used to intercept an airway. An airway intercept changes the active waypoint on the RTE and LEGS pages.

Enter the airway identifier under VIA on line 1 of the RTE page. Boxes display under TO. Enter the desired airway exit waypoint in the boxes. For this open-ended airway intercept, the FMC selects the waypoint preceding the closest abeam location as the starting waypoint of the airway. This waypoint is displayed on line 1. The entered airway and the desired exit point are displayed on line 2. When the modification is executed the leg inbound to the FMC selected starting waypoint becomes the active leg.

If the clearance heading intercepts the active leg segment, LNAV can be armed and the intercept will occur. In most airway intercept situations, the commanded heading will not intercept the active leg.

If the clearance heading does not intercept the active leg segment, use the intercept-course-to procedure to make the course inbound to the waypoint after the crossing location the active leg segment.

Example

The active route is direct to EPH, then direct to MWH. ATC clears the airplane to:

- turn right heading 110°
- intercept V2 to MWH.

Following the V2 modification to MWH and execution, the LEGS page displays this waypoint sequence:

- BANDR
- BEEZR
- ELN
- PLUSS
- MWH.

Modify the LEGS page using a course intercept to the waypoint after the crossing location. In this case, it would be PLUSS. PLUSS becomes the active waypoint on the V2 airway. The LEGS page now displays:

- PLUSS
- MWH.



1 Active RTE 1 Page

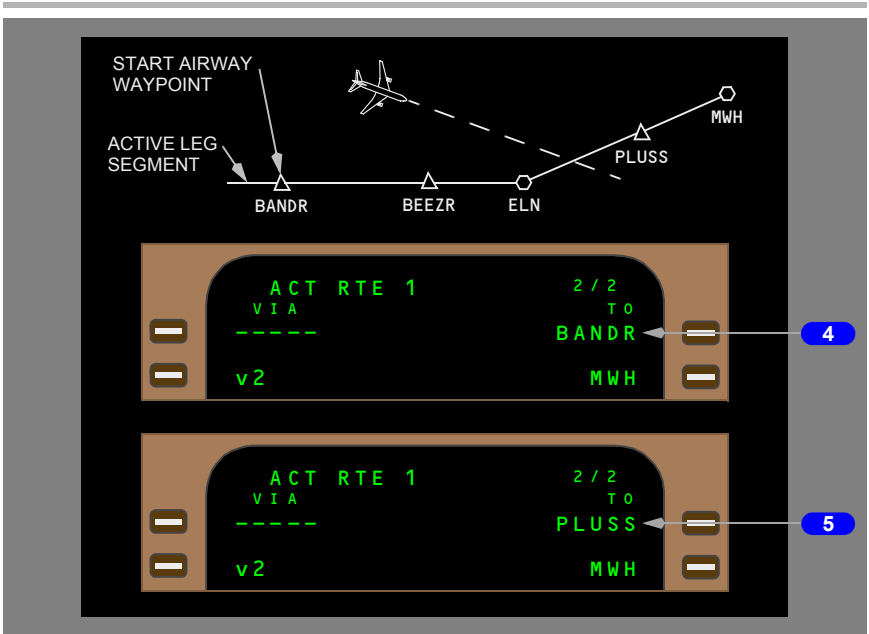
The route page before the ATC clearance.

2 Input Airway

Enter the airway in the first VIA position on the RTE page. Boxes display in the TO position. A route discontinuity follows on the next line.

3 Airway Exit

Enter desired airway exit point in the boxes.



4 Start Airway Waypoint

After entering MWH in the boxes:

- the FMC selects BANDR as the airway start waypoint
- the airway line moves down one line
- dashes are shown in the VIA to the start airway waypoint.

5 New Active Waypoint

Following modification and execution of the course intercept procedure to PLUS, the LEGS page displays PLUS as the active waypoint. LNAV can be armed and the airway intercept can be completed.

Route Offset

Route offsets are selected on the RTE page. The OFFSET prompt is displayed on the RTE page when the airplane is airborne and not on a SID, STAR, or transition. Entering a distance value into the OFFSET dashes creates the selected offset. An offset propagates along the route from the active waypoint until a discontinuity, approach, approach transition, holding pattern, course change of greater than 135°, or end of route is reached. An offset can be removed by deleting the offset, proceeding direct, or entering an offset value of zero.

The offset is shown as a white dashed line on the map display until the offset modification is executed or erased.

After execution, the offset route is shown as a dashed magenta line on the map display. The original route remains a solid magenta line.

If LNAV is engaged when the offset is executed, the airplane turns to an intercept heading and captures the offset course.



1 OFFSET

Enter the necessary offset. When executed, the MCDU offset (OFST) light illuminates.

Valid entries are L (left) or R (right) followed by a distance from 0 to 99 in nautical miles.

Cruise Page

All Engine Cruise

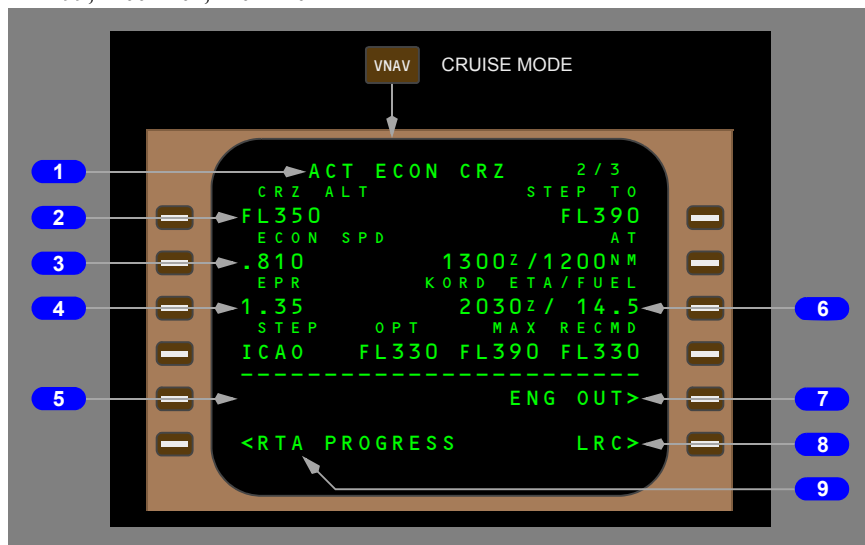
The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually selected or automatically selected with the selection of other VNAV modes. Cruise climbs, cruise descents, and step climbs can be accomplished from the cruise page.

When using the economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in the engine out mode, the data changes to include the airplane capabilities with one engine inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.

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171-199, 1200-1201, 1401-1404



1 Page Title

The page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Fixed speed, engine out, and long range cruise modify the title.

Page titles include:

- CO – engine out mode and company speed selected
- CRZ CLB or CRZ DES – cruise climb or descent
- ECON – speed based on cost index
- EO – engine out mode selected
- EO D/D – engine out drift down displays when EO selected and the airplane altitude is above the maximum altitude for engine out performance
- LIM SPD – based on an airplane configuration limiting speed
- LRC – long range cruise selected
- MCP SPD – speed intervention applied from the MCP
- M.XXX – fixed Mach cruise speed
- XXXKT – fixed CAS cruise speed.

Fixed cruise speeds are for:

- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a flight crew selected speed (SEL SPD).

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, OR FLXXX. Altitude displays in feet or flight level depending on the transition altitude. Changing the MCP altitude enters the new altitude in the scratchpad for entry. Entry creates a modification.

When the modification is executed the page title changes to CRZ CLB or CRZ DES.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Displays target speed or Mach.

Allows entry of any valid speed or mach number. MOD displays in the page title until the modification is erased or executed.

A manually entered speed changes the line title to SEL SPD.

ECON can be replaced with LRC or company speed (CO SPD), depending on the VNAV mode.

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4 N1

Displays N1 necessary for level flight at the target airspeed.

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4 EPR

Displays EPR necessary for level flight at the target airspeed.

5 Economy (ECON)

Push – selects economy cruise speed.

Displayed when speed or Mach is not ECON.

6 Destination ETA/FUEL

Estimated time of arrival and calculated fuel remaining at the destination.

Displays the same data for the alternate airport when a DIVERT NOW modification is selected from the ALTN page.

Calculations are based on optimum step climbs and cruise altitudes.

7 Engine Out (ENG OUT)

Push –

- displays engine out cruise page
- commands engine out performance calculations
- changes CRZ ALT if above maximum engine out altitude
- changes target speed to engine out speed
- upon execution, thrust reference mode changes to CON.

8 Long Range Cruise (LRC)

Push – displays long range cruise page.

9 Required Time Of Arrival (RTA) PROGRESS

Push – displays RTA PROGRESS 3/3.

Engine Out Cruise

Engine out VNAV cruise guidance displays on the EO CRZ page. Engine out data is also available with both engines operating.

The initial page data includes engine out performance limitations. Manual entries are allowed. When above the maximum engine out cruise altitude, VNAV calculates engine out (EO) guidance for drift down (D/D). The EO D/D page changes to the EO CRZ page when reaching the engine out cruise altitude. Subsequent engine out cruise climb or descent is accomplished the same as two engine cruise climb or descent.

As the airplane gross weight decreases, maximum altitude increases. A step climb may be possible under these conditions.

The example is based on a cruise altitude above the maximum engine out altitude. When ENG OUT is first selected, the default speed is EO SPD.



1 Page Title

Displays EO D/D (for this example, airplane is above MAX altitude).

Displays MCP SPD D/D when controlling to a manually entered speed during the driftdown.

Displays EO LRC (long range cruise) D/D when LRC selected during driftdown.

Displays EO LRC when in level cruise flight and the LRC speed is selected.

Displays EO CRZ CLB or EO CRZ DES during engine out cruise climbs or descents and the airplane is below the engine out maximum altitude.

2 Cruise Altitude (CRZ ALT)

Displays altitude from MAX ALT line when current CRZ ALT above MAX ALT.

Manual entry of an altitude above maximum engine out altitude results in the scratchpad message, “MAX ALT FLXXX”.

Valid entries are the same as all engine cruise page.

3 Engine Out Speed (EO SPD)

Displays the target speed or Mach.

Manual entry is allowed.

Valid entries are the same as all engine cruise page.

A manually entered speed changes the line title to SEL SPD.

ECON can be replaced with long range cruise (LRC), company (CO SPD), or engine out (EO SPD) speed using prompts at the bottom of the page.

Selecting any speed shows engine out speed (EO SPD) as a select prompt at 6L.

Manual entries may change MAX altitude.

4 Company Speed (CO SPD)

Push – Modifies the page with company speed, engine out data from the Airline Policy page.

5 Engine Out (EO SPD)

Push – enables execution of engine out minimum drag speed profile.

Display when EO LRC, EO SEL SPD, or CO SPD is the active speed mode.

6 Optimum, Maximum and Recommended Altitude (OPT MAX RECMD)

OPT – displays the most economical altitude based on airplane gross weight.

MAX – displays the maximum cruise altitude based on:

- engine out operation
- selected speed option
- without any altitude or speed constraints, and
- capable of a 100 feet per minute climb rate.L

RECMD – displays the most economical altitude based on airplane performance and winds.

7 ALL Engine (ENG)

Push – displays a MOD XXX CRZ page with performance based on both engines operating.

Selection and execution allows subsequent selection of two engine economy VNAV modes.

8 Long Range Cruise (LRC)

Push – enables execution of engine out long range cruise.

Displayed when EO or SEL SPD is the active mode.

VNAV Modifications

During the cruise phase, VNAV can calculate two types of climbs: cruise and step climbs. Cruise and planned climbs can be entered by the flight crew. Optimum step climbs are calculated by the FMC. In all cases, the new climb altitude must be selected in the MCP altitude window before VNAV commands the climb.

Cruise Climb

To initiate a cruise climb set the higher altitude on the MCP, then enter the altitude in the CRZ ALT line and execute. When the CRZ page is displayed, the new MCP altitude is automatically copied to the scratchpad to be line selected to the CRZ ALT line.



1 During Cruise Climb

VNAV page title displays ACT ECON CRZ CLB in a climb to a new cruise altitude. ECON is replaced by an indication of the selected speed if other than ECON.

2 End of Cruise Climb

VNAV page title displays ECON CRZ after level off at cruise altitude.

Planned Step Climb

When a step climb is planned to start at a waypoint, the data can be entered on the RTE LEGS page. The FMC performance predictions assume the airplane will start the climb at the identified waypoint.

The FMC displays the distance and ETA to the step point on the CRZ and PROGRESS page. The corresponding altitude profile point and identifier are shown on the map display.



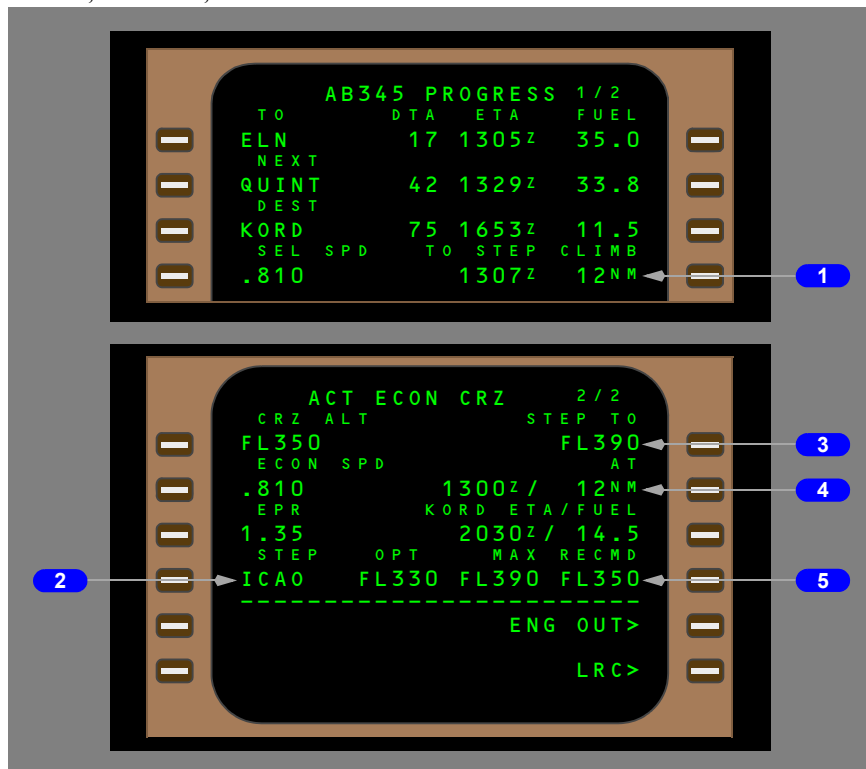
1 Step Climb Altitude

Enter the cruise altitude as an altitude constraint and the letter S. The FMC assumes the step climb starts at the waypoint. Accomplish the step climb at the waypoint with the steps described in cruise climb.

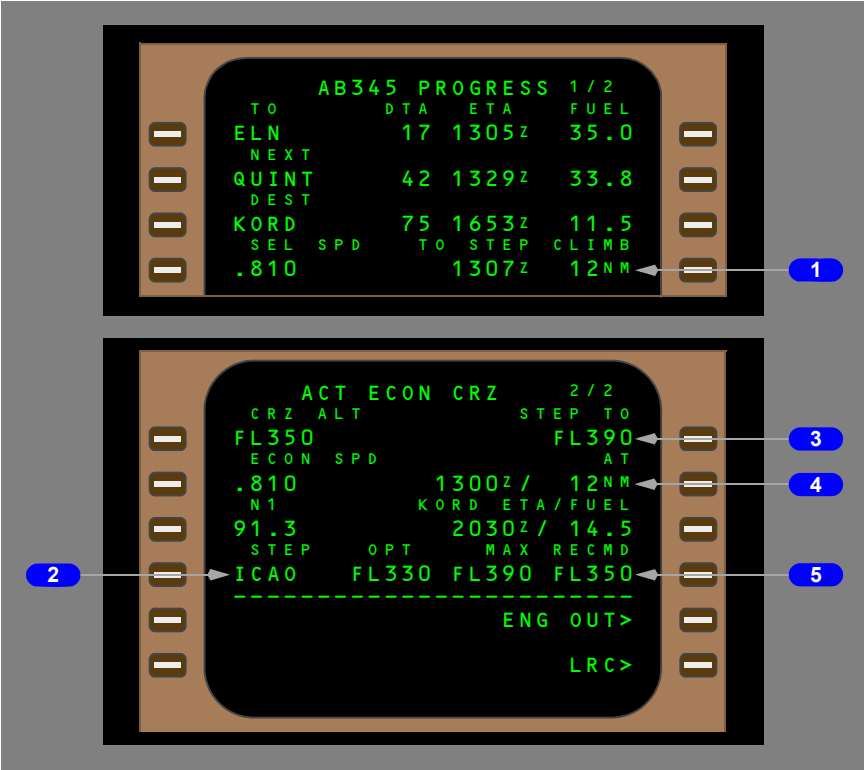
Calculated Step Climb

When a non-zero value is entered into the STEP SIZE line on the PERF INIT or CRZ page, the FMC calculates optimum points for step climbs as the airplane performance permits. The climb altitude is determined by the value in STEP SIZE. Multiple step climbs are possible based on performance and route length. VNAV commands the step climbs, if the MCP altitude and the FMC CRZ ALT are set to the new altitude.

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1 TO STEP CLIMB

When the step climb start point is the next VNAV event, the line title changes to TO STEP CLIMB.

Displays the ETA and DTG to the point where the step climb starts.

If the airplane passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word NOW.

When the FMC calculates that a step climb is not advised, the ETA and DTG are replaced with the word NONE.

2 STEP SIZE

Displays the default step climb size of ICAO.

Valid entries are altitudes from 0 to 9000 in 1000 foot increments.

Used for calculation of optimum step point and step climb predictions.

Deletion of a manual entry defaults back to ICAO.

3 STEP TO

An altitude can be entered for a step climb evaluation. The FMC calculates the predicted step climb data and displays the results on this page and the PROGRESS page.

Entering a zero value for STEP SIZE causes the FMC to calculate performance based on a constant altitude flight at the CRZ ALT. Entering a valid, non-zero increment or ICAO step size causes the FMC to calculate performance based on accomplishing step climbs at calculated step climb points.

Step climb altitudes entered on the RTE LEGS page can be higher or lower than the CRZ ALT. These step climb altitudes cannot be overwritten on the CRZ page.

When using the ICAO step size, the STEP TO altitude is the next higher altitude above the OPT altitude corresponding to the direction of flight, based on the CRZ ALT entered before takeoff. Changes to CRZ ALT while in flight do not affect calculation of STEP TO altitudes using ICAO step sizes. However, if an alternate route (for example, Route 2) is activated in flight, the hemispheric altitude will be calculated using the current CRZ ALT.

When using an altitude increment step size, the STEP TO altitude is the next higher altitude above OPT calculated by adding the STEP SIZE increment to the FMC CRZ ALT.

When entering a cruise altitude above maximum altitude, the scratchpad message MAX ALT FLXXX is displayed.

Displays:

- the STEP TO altitude from the RTE LEGS page
- a calculated step climb altitude based on the step size.

Manual entry is allowed.

Blank when:

- there is no active flight plan
- less than 200 NM from the T/D point
- less than 500NM from the destination
- the step size is zero
- in the EO D/D phase.

4 AT

Displays the ETA and DTG to the step climb point.

Displays NOW when past the calculated step climb point.

Line title changes to AVAIL AT when the climb is restricted by thrust or buffet.

Line title displays AT XXXXX where XXXXX is the waypoint where a planned step climb has been entered on the RTE LEGS page.

Line title changes to TO T/D when within 200 NM of the top of descent point.

ETA and DTG are relative to the T/D point.

The data is the same as displayed on the PROGRESS page.

5 Optimum, Maximum and Recommended Altitude (OPT MAX RECMD)

OPT – displays the most economical altitude based on gross weight and the active cruise speed.

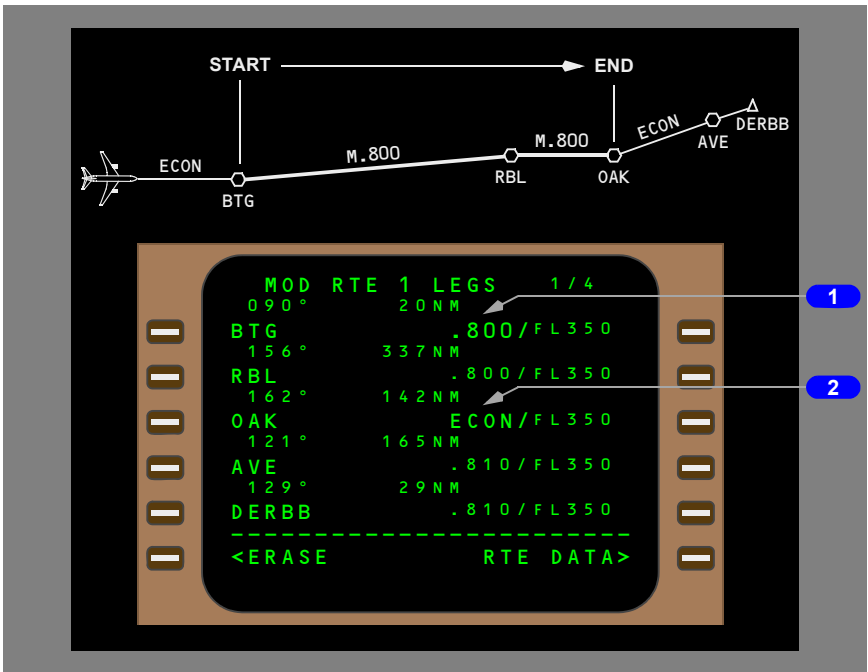
MAX – displays the two engine maximum altitude based on gross weight, climb and cruise speeds within the speed envelope, and sufficient excess thrust to provide a specified residual rate of climb capability.

RECMD – displays the most economical altitude based on winds and airplane performance.

Constant Speed Cruise

A speed for a cruise segment can be specified. A cruise segment has a start waypoint and an end waypoint. The airplane maintains a constant speed between the two waypoints. The waypoints must be in the cruise phase. The FMC controls the speed after the end waypoint or top of descent.

Modification must be executed.



1 Start Waypoint for Constant Speed Cruise

The constant speed cruise starts at BTG at .800 Mach. Entry is in Mach.

2 End Waypoint for Constant Speed Cruise

The constant speed cruise ends at OAK then ECON speed is used.

Entry can be a Mach number, ECON/ or E/, LRC/ or L/.

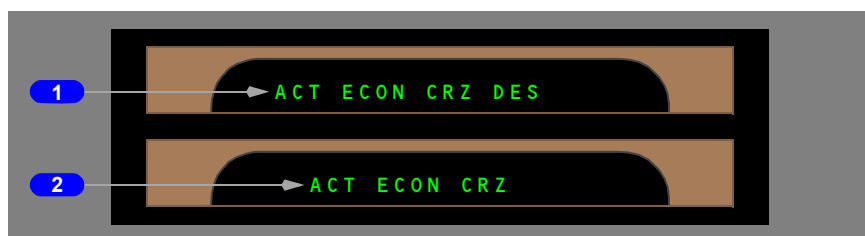
If no end waypoint is specified, the constant speed terminates at top of descent.

Cruise Descent

Cruise descents can be started in the cruise phase when more than 50 miles from the T/D point.

A cruise descent can be started by selecting a lower altitude on the MCP, entering the new altitude in the CRZ ALT line and executing. A VNAV cruise descent is commanded at the current cruise speed and approximately 1250 feet per minute rate of descent.

The autothrottles adjust thrust to maintain the target descent rate; pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.



1 During Cruise Descent

VNAV page title shows cruise phase in a descent to a new cruise altitude.

2 End of Cruise Descent

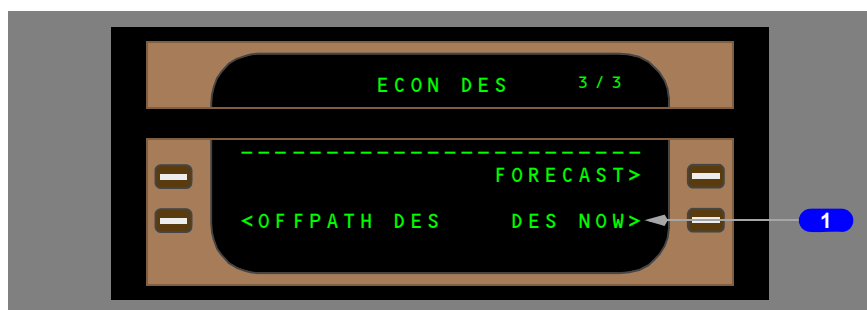
VNAV page title shows cruise phase after level off at new cruise altitude.

Early Descent

An early descent starts when the descent for landing is commenced prior to the top of descent point. Early descents should not be started when the distance to the top of descent point is greater than 50 nautical miles. When further from the top of descent point, the cruise descent function should be used.

Early descents are started on the DES page. Once an early descent is started, VNAV changes to the descent phase and cruise features are no longer available.

The autothrottle adjusts thrust to maintain the target descent rate; pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.



1 Descend Now (DES NOW)

The DES NOW prompt is shown on the descent page when the cruise phase is active. Reset the MCP altitude and select the DES NOW prompt and execute to start an early descent. The descent page becomes active and the airplane starts a VNAV ECON descent of approximately 1250 feet per minute at ECON descent speed.

Once the descent is established the autothrottle mode changes to THR HLD to allow the pilot to adjust the rate of descent with power changes.

Upon reaching the planned descent path, VNAV commands pitch to maintain the planned descent path and ECON speed.

Navigation Data

Reference Navigation Data Page

The reference navigation data page displays data about waypoints, navaids, airports, and runways. Use this page to inhibit FMC position updates from radio navaids.



1 Identification (IDENT)

Valid entries are any waypoint, navaid, airport, or runway from the navigation database. Only runways at the destination airport can be entered.

Entry changes to dashes when the page is exited and then reselected.

2 LATITUDE

Displays latitude of entered identifier. When the identifier is a runway the latitude displayed is for the threshold of the runway.

3 Magnetic Variation (MAG VAR), LENGTH

MAG VAR - displays magnetic variation when entered identifier is a navaid.

LENGTH - displays runway length when entered identifier is a runway.

4 NAVAID INHIBIT

When a navigation radio is known to provide erroneous position information, the FMC must be inhibited from automatically tuning that navaid.

Enter the identifier of up to two VOR, VOR/DME, VORTAC, or DME stations that must not be used for FMC position updates.

Entries are blanked at flight completion. Deleting or overwriting removes a previous inhibit.

5 VOR ONLY INHIBIT

Use this line when only the VOR portion of a VOR/DME or VORTAC navaid must be inhibited. ALL is displayed if the VOR/DME NAV prompt is selected to OFF.

Enter the identifier of up to two VORs that must not be used for FMC position updates. Only the VOR portion of the navaid is inhibited, the FMC will still tune the DME for DME-DME updating.

Entries are blanked at flight completion. Deleting or overwriting removes a previous inhibit.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 Frequency (FREQ)

Displays frequency of entered identifier when it is a navaid.

8 LONGITUDE

Displays longitude of entered identifier. When the identifier is a runway the longitude displayed is for the threshold of the runway.

9 ELEVATION

Displays elevation of entered identifier when it is a navaid, airport, or runway.

10 VOR/DME NAV

Alternately switches VOR/DME NAV updating between OFF and ON

Push – when ON is displayed in large font

- changes OFF to large font and ON to small font
- inhibits VOR/DME updates to the FMC by inhibiting all VORs. DME-DME updating is not inhibited.
- displays ALL in both locations of the VOR ONLY INHIBIT line.

Push – when OFF is displayed in large font

- changes ON to large font and OFF to small font
- enables VOR/DME updating to the FMC
- deletes the ALL from the VOR ONLY INHIBIT line.

Fix Information Page

Two identical fix information pages are used to create waypoint fixes and waypoints for the map display. Some of the created waypoints can be copied into the route.

The bearing information is presented in magnetic or true depending on the position of the heading reference switch or airplane location. Refer to FMC Polar Operations, Flight Management Navigation, section 31.

FIX

FIX INFO 1 / 2

FIX BRG/DIS FR

BRG/DIS ETA DTG ALT

PRED ETA-ALT

ABC

FIX INFO 1 / 2

FIX BRG/DIS FR

ABC 111/29

BRG/DIS ETA DTG ALT

130/24 2004Z 10 12000

180/26 2008Z 32 FL190

---/---

ABEAM

150/23 2006Z 18 15500

PRED ETA-ALT

<ERASE FIX 112NM 2016Z

ABC180.0/026.4

1: FIX button

2: ABC

3: 111/29

4: 130/24

5: 2004Z

6: 10

7: 12000

8: 180/26

1 FIX

Before entry of a name or identifier, boxes displayed and most data lines are blank. Valid entries are airports, nav aids, and waypoints from the navigation database. The selected fix appears on the map display and is highlighted by a green circle.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT

Valid entries are XXX/YYY.Y:

- decimal values can be omitted
- leading zeros can be omitted for distance entries
- distance only entries must start with a slash (/).

Distances from the fix appear on the HSI as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the intersection display for the closest of the two intersections.

Bearings from the fix appear on the map display as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA – displays the estimated time if arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

Push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

4 Bearing/Distance (BRG/DIS) – Dashes

Enter a bearing, distance, or both bearing and distance from the fix. A bearing and distance from the fix appear on the map display as a waypoint fix point. ETA, DTG, and predicted do not display.

4 ABEAM

Displays ABEAM prompt.

Push - displays bearing and distance from the fix perpendicular to the nearest segment of the flight plan path, and ETA, DTG, and altitude at the intersection point.

Second push - copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

5 ERASE FIX

Push – removes all fix data from the page and the map display.

6 Route Intersection Point Copied

Pushing the line select key for one of the BRG/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

7 Bearing/Distance From (BRG/DIS FR)

Displays the bearing and distance of the airplane from the fix.

8 Predicted Distance to ETA or Altitude (PRED ETA-ALT)

Valid entry is altitude, flight level, or time. Time entry must be followed by “Z”.

Entering an altitude or flight level displays the predicted along track distance and altitude or flight level on this line. The predicted airplane position appears on the map as a green circle with the entered altitude/flight level or time.

In-Flight Position Update

FMC position update can be accomplished on the POS REF 2/4 page in flight.



1 UPDATE ARMED

Pushing the ARM prompt arms the position update function. ARM changes to ARMED. Each of the position update sources have a NOW prompt.

2 NOW

Push – to update the FMC position from the desired source. The FMC position is momentarily changed to the position of the selected system. If a valid source with a more accurate position (smaller ACTUAL) exists, the FMC position will quickly return to the most accurate position source.

Route and Waypoint Data

Route Data Page

The route data page displays progress data for each waypoint on the ACT RTE X LEGS page. This page is available only for the active route.

The ETA and calculated fuel remaining at the waypoint display for each waypoint. Manual entry is not possible. This page also allows access to the WIND page.

One page shows data for five waypoints.



1 Waypoint (WPT)

Displays identifier for waypoint.

2 ETA

Displays ETA for waypoint.

3 LEGS

Push – displays RTE LEGS page.

4 FUEL

Displays the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

5 WIND Page Prompt

Push – selects WIND page for the selected waypoint.

A “W” next to the prompt indicates that wind data has been entered on the wind page for that waypoint.

6 WIND DATA REQUEST

Push – transmits a data link request for wind and descent forecast data.

Flight crew may enter up to four altitudes on any wind page to qualify the request.

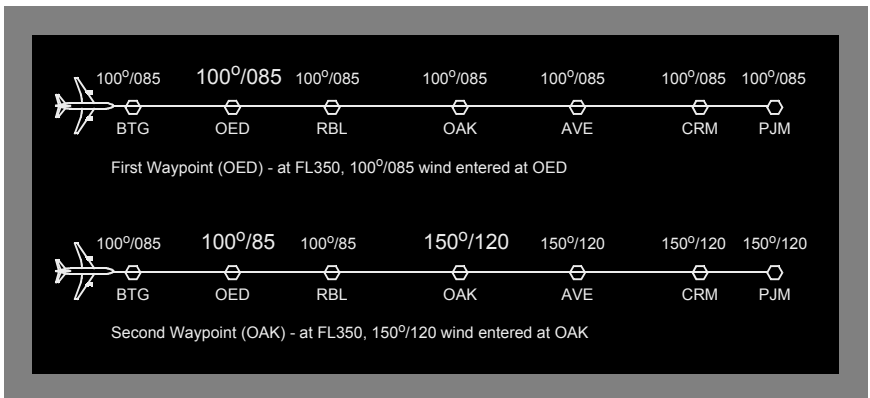
Wind Data

The FMC uses wind data to improve performance prediction accuracy.

The FMC applies the first entered wind data to all waypoints in the flight plan. Wind data includes altitude and direction/speed.

Wind data entered at another waypoint (at the same altitude) changes wind data down track from the second entered waypoint either to the end of the track, or to the next entered wind. The wind data before the second entered waypoint does not change. Therefore, enter wind data for waypoints closest to the airplane, then enter wind data for waypoints down track from the airplane.

For example: at FL 350, 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK and through the end of the route.



Entered wind data are mixed with sensed wind data for performance predictions. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. The FMC mixes these winds for predictions in between.

Sensed winds are displayed on the HSI and on progress page 2.

Wind Page

The wind page is used to enter forecast winds and temperatures at specific altitudes for specific waypoints to enhance VNAV performance. The FMC calculates step climb points based on the wind effect.

The wind page displays waypoint wind data for one to four altitudes per waypoint. This data can be uplinked or manually entered.

The altitudes are entered first. The altitudes can be entered in any order and are sorted and displayed in ascending order.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any one altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.



1 Page Title

Displays ACT XXXXX WIND, where XXXXX is the waypoint for which the wind page was selected.

When a route is being modified, MOD is shown in the page title. If ACT is displayed when the wind page is first accessed, entry of wind data caused MOD to be displayed. Wind entries must be executed.

2 Altitude (ALT)

Enter altitude or flight level for wind entries. Altitude data entry is possible only on line 1L.

After altitude entry, data is sorted in ascending order in lines 1 through 4. Dashes display on right side of line for wind direction and speed entry.

When all four lines have data, one must be deleted before new data can be entered.

Entered altitudes are propagated to all wind pages.

3 Altitude/Flight Level Data

Displays the altitude or flight level for wind entries. Data entered on 1L is displayed on lines 1 through 4 in ascending order. Altitude entry is not possible in lines 2L through 4L.

Calculated OAT based on standard lapse rate from the entry made on the ALT/OAT line are display in small font.

4 ERASE

Push – removes modified data.

5 Direction and Speed (DIR/SPD)

Displays dashes after altitude/flight level entry in the ALT line. Enter predicted wind direction and speed for the altitude.

Values propagate to other waypoint winds. Propagated values display in small font.

Manual entries display in large font.

6 Altitude/Outside Air Temperature (ALT/OAT)

Enter altitude and OAT. The altitude for OAT does not have to be one of the wind altitudes. The FMC uses standard lapse rate to calculate the temperature at the other altitudes.

Entries must be executed.

7 Route Data (RTE DATA)

Push – displays the RTE DATA page.

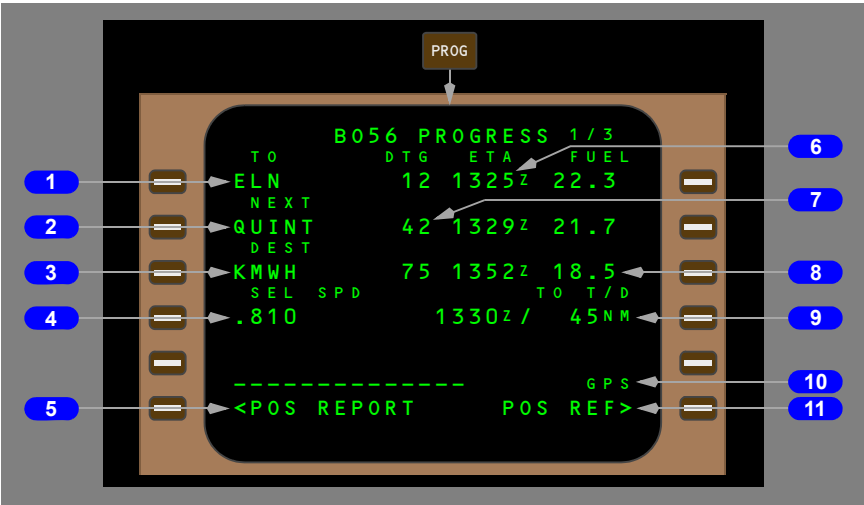
Progress Pages

The progress page displays general flight progress data.
The position report page is accessed from the progress page.

Progress Page 1

The page title displays the company flight number entered on the RTE page.
Page one of the progress pages displays general data about:

- waypoints (active and next)
- destination
- FMC speed
- next VNAV profile point.



1 TO

Active waypoint is displayed.
Can not be modified.

2 NEXT

Waypoint after TO waypoint is displayed.
Can not be modified

3 Destination (DEST)

When the page is selected the active route destination is displayed. Any waypoint or airport in navigation database can be entered over the destination.

The line titles are:

- DEST – performance predictions to destination. Default display.
- DIR TO FIX – when entered waypoint is not in flight plan. Data is based on flying present position direct to the waypoint.
- EN ROUTE WPT – when entered waypoint is in flight plan. Line data are based on flying the flight plan route to the waypoint.
- MOD – a modification has been made on another page. Performance predictions include modification.

Entries do not modify the active route and are deleted when all CDUs are changed to a different page.

4 Selected Speed (SEL SPD)

Displays the FMC active command speed.

The active speed mode is the same as on the performance page, unless changed by the MCP or a limit. The speed modes are:

• LRC SPD – long range cruise speed	• MCP SPD – MCP speed entered on the MCP IAS/MACH indicator
• ECON SPD – economy speed	• EO SPD – engine out speed
• SEL SPD – selected speed manually entered on the CDU	• CO SPD – engine out operations at airline specified engine out company speed
• LIM SPD – speed is limited by VMO, MMO, flap limit, or buffet limit	

5 Position Report (POS REPORT)

Push – displays the POS REPORT page.

6 ETA

Estimated time of arrival at waypoint or destination.

7 Distance To Go (DTG)

Distance to go to waypoint or destination.

8 FUEL

Estimated fuel remaining at waypoint or destination.

9 TO Top Of Descent (T/D)

ETA and DTG to next VNAV profile point.

The line title and data change for other phases of flight. Other line titles:

- TO T/C – top of climb data
- TO STEP CLIMB – step climb data
- TO E/D – end of descent data
- LEVEL AT – time and distance to level off in engine out mode.

10 Navigation Updating Mode

Displays the current FMC position updating source. Possible displays are:

- GPS
- RADIO
- IRS
- LOC–GPS
- LOC–RADIO
- LOC

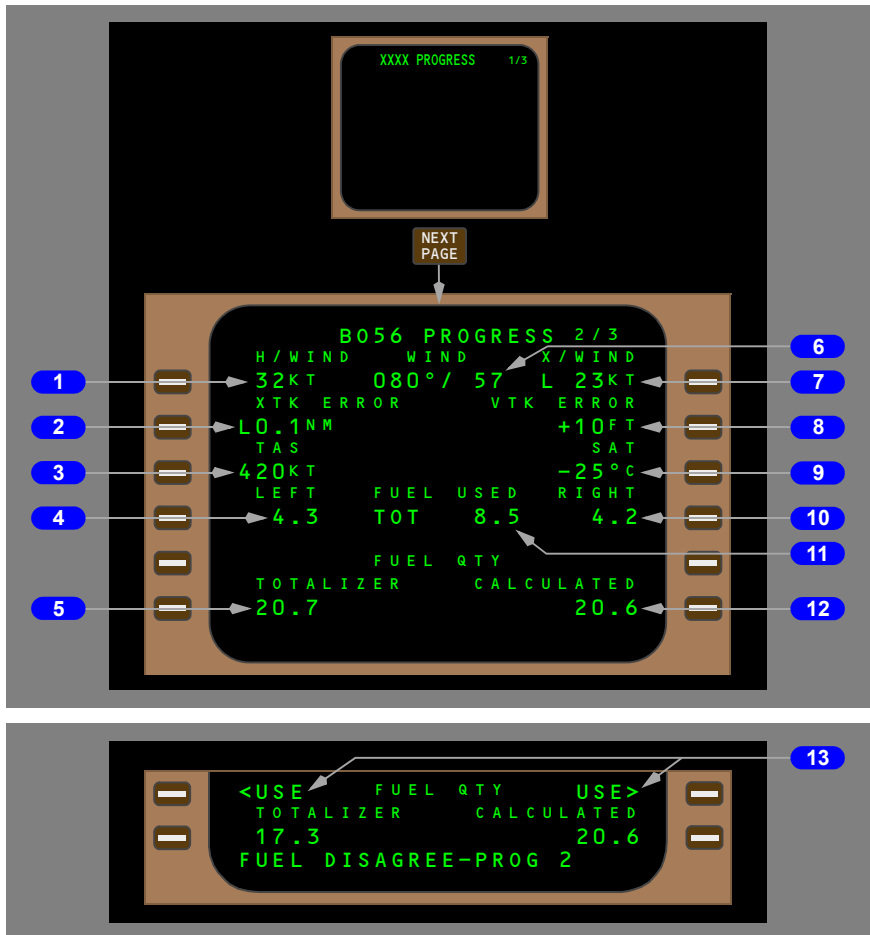
11 Position Reference (POS REF)

Push – displays position reference page.

Progress Page 2

Progress page two contains:

- wind data
- true airspeed
- fuel data
- track error data.
- static air temperature



1 Headwind (H/WIND), Tailwind (T/WIND)

Displays headwind (H/WIND) or tailwind (T/WIND) component relative to the airplane heading.

2 Crosstrack Error (XTK ERROR)

Displays crosstrack (XTK) error in nautical miles left or right of the active route.

3 TAS

Displays airplane true airspeed.

4 LEFT FUEL USED

Displays fuel used by left engine sensed by fuel flow meters.

5 Fuel Quantity (TOTALIZER)

Displays total fuel quantity from the fuel system quantity processor.

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations.

6 WIND

Displays current wind direction and speed referenced to true north.

7 Crosswind (X/WIND)

Displays left (L) or right (R) crosswind component relative to airplane heading.

8 Vertical Track Error (VTK ERROR)

Displays vertical path (VTK) error above (+) or below (-) vertical path.

9 Static Air Temperature (SAT)

Displays outside static air temperature.

10 RIGHT FUEL USED

Displays fuel used by right engine sensed by fuel flow meters.

11 FUEL USED Total (TOT)

Displays sum of the LEFT and RIGHT fuel used values.

12 FUEL Quantity (QTY) CALCULATED

Displays fuel remaining as calculated by the FMC with these methods:

- before engine start, fuel quantity calculated by fuel quantity system totalizer
- after engine start, fuel quantity at engine start decreased by EICAS engine fuel flow rate
- after fuel dump or after erasing a manually entered fuel quantity, resets to fuel quantity system totalizer
- after all engines are shut down, resets to fuel quantity system totalizer.

The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations.

13 USE

USE prompts display when TOTALIZER and CALCULATED values disagree by a significant amount. The scratchpad message FUEL DISAGREE-PROG 2 is also displayed.

On older FMCs the scratchpad message reads FUEL QTY ERROR-PROG 2/2.

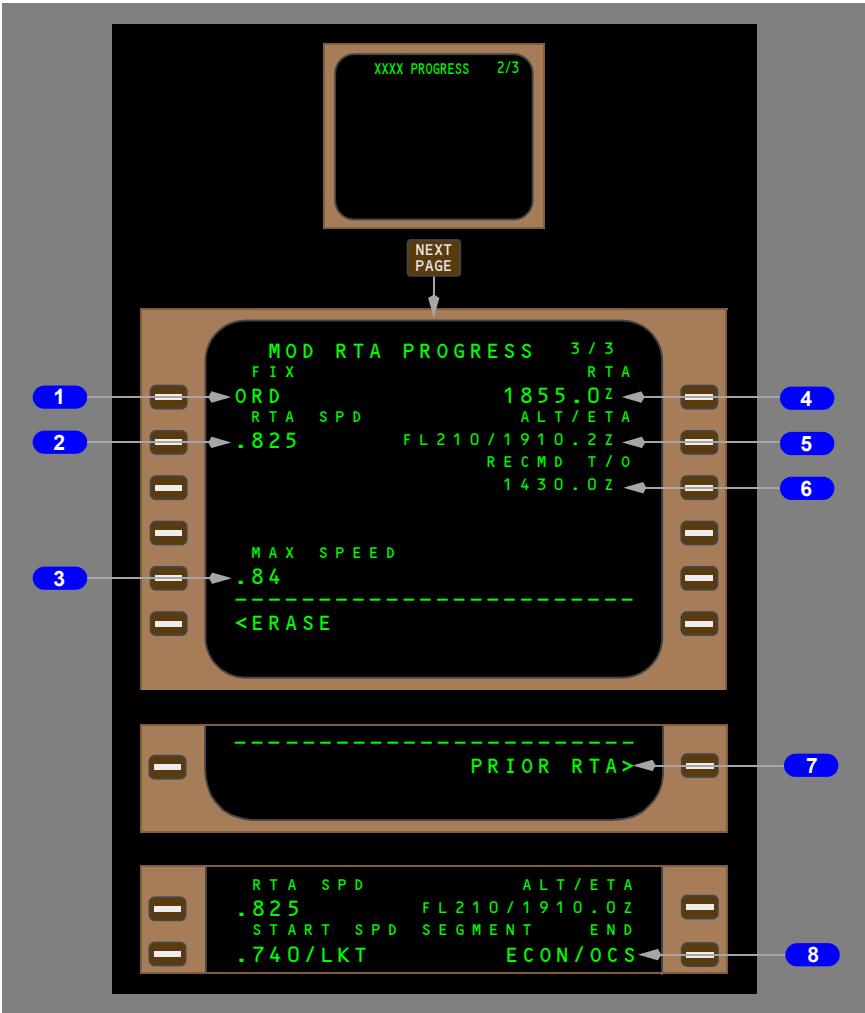
Push – selects method to calculate fuel quantity, either TOTALIZER or CALCULATED.

When one is selected:

- it is used for remainder of flight
- the other fuel calculation method blanks
- scratchpad clears.

RTA Progress Page 3

Progress page three is used to enter data for required time of arrival (RTA). RTA can be entered or changed during preflight or in flight. Creating an RTA changes PROGRESS and CRZ page titles to include RTA. RTA operations only impact speeds in the cruise phase.



1 FIX

Displays boxes prior to RTA fix entry. Displays is blank when an engine-out mode is active or there is no active or pending active route.

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Valid entry is a waypoint in the active or pending active route. Waypoints defined by coordinates must be down selected to the scratchpad, then selected to the FIX line.

Entry by flight crew or data link.

ALT/ETA is displayed in line 2R after a valid FIX is entered.

When RTA is active, deletion of FIX terminates RTA and resumes ECON. Display returns to boxes.

When RTA not is active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

2 Required Time Of Arrival Speed (RTA SPD)

Displays FMC computed cruise speed to accomplish RTA.

Blank if no RTA fix or time entered, or with descent active.

3 Maximum Speed (MAX SPD)

Displays the maximum speed used for RTA calculation.

Valid entry is Mach .100M to .990M.

Deletion of entered value displays default Mach.

Default Mach .84M displays in small font.

4 Required Time Of Arrival (RTA)

Boxes display after entry of RTA FIX in 1L.

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

Suffix to RTA indicates:

- no suffix – arrive at entered time
- A – arrive at or after entered time
- B – arrive at or before entered time.

Entry shows recommended T/O time.

Deletion terminates RTA and returns ECON as cruise mode.

5 Altitude/ETA (ALT/ETA)

Displays predicted altitude and ETA at RTA fix after entry of FIX in 1L.

Blank until performance data is entered.

6 Recommended Takeoff (RECMD T/O)

Displays recommended takeoff time to meet RTA at ECON speed.

Dashes until FIX is entered.

Blanks in flight.

Valid entry is time from 0000.0 to 2359.9. Decimal entry of .0 is optional.

Manual entry recalculates all flight plan time predictions.

Changes to NOW after recommended takeoff time.

When unable to meet the RTA based on a manual takeoff time entry the scratchpad message UNABLE RTA is displayed.

7 PRIOR RTA

Displays when RTA is not active but RTA fix and time previously entered and activated.

Push -

- displays previously active RTA fix and time
- initiates RTA modification.

8 Constant Speed Cruise

Displays constant speed cruise start and end waypoint

Position Report Page

The position report page displays current flight data formatted as a position report. The page contains reference data only. Manual entries are inhibited.

A data linked position report can be initiated from the page.



1 Position (POS)

Waypoint used to report position. This is the previous active waypoint.

The actual time of arrival (ATA) and altitude (ALT) at the waypoint follow the waypoint name.

2 Estimate (EST)

The active waypoint is displayed with the ETA to that waypoint.

3 NEXT

The waypoint following the active waypoint.

4 Temperature and Wind (TEMP WIND)

TEMP displays the OAT in degrees C.

WIND displays the wind direction and speed. Wind direction is shown in degrees true.

5 Destination ETA (DEST ETA)

The FMC calculated ETA for the destination is displayed.

6 Speed (SPD)

Displays the target FMC speed.

7 Position Fuel (POS FUEL)

Displays the fuel on board at the POS waypoint.

8 SEND Prompts

Push – sends a position report via datalink to the company or ATC.

Flight Management, Navigation

FMC Descent and Approach

Chapter 11

Section 43

Introduction

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for the descent phase starts during cruise.

The approach phase starts at the end of descent point and continues to touchdown or go-around. When a go-around is accomplished, the FMC enters a modified cruise or approach phase, depending on the route and cruise conditions.

Alternates can be selected at any time. Alternates are available from preflight through all phases of flight and can be updated at any time. Diversion to an alternate can be accomplished during cruise, descent, or approach.

As the airplane passes the top of descent point with VNAV engaged, the descent page becomes active and the CDU automatically changes from the cruise page to the descent page.

Early Descent

Descent for the approach and landing may be commenced before reaching the top of descent point. The description of early descent options and functions is in Section 42, FMC Cruise.

Descent

During descent, LNAV is managed using the RTE LEGS page, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

Other pages which support descent are:

- DESCENT FORECAST page – to enter forecast wind data to aid descent planning
- OFFPATH DES page – to analyze descent performance with and without the use of speedbrakes

Descent Page

The descent page is used to monitor and revise the descent path. Descent speed modes are economy (ECON) and fixed speed (SEL). The default VNAV descent mode is ECON. A fixed speed descent is flown when speed intervention is used or a speed is entered on the DES page. The descent page is no longer available after the end of descent.

The page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a lower speed restriction. The fixed speed mode controls descent speed until a lower speed restriction is reached.



1 Page Title

The title usually shows ECON during descent. Fixed speed descents modify the title.

The page title shows the type of descent:

- ECON – speed based on a cost index
- LIM SPD – speed based on airplane configuration limiting speed
- MCP SPD – MCP speed intervention is selected
- XXXKT – fixed CAS descent speed profile
- M.XXX – fixed Mach descent speed profile
- ACT – prefix shown when descent phase is active
- MOD – prefix shown when descent phase is active and the flight plan is modified.

Reasons for fixed descent speeds are:

- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed transition
- a flight crew entered selected speed (SEL SPD).

2 End Of Descent At (E/D AT)

Shows the end of descent altitude and waypoint.

The end of descent point is a waypoint in the descent phase with the lowest altitude constraint.

Blank if no E/D point exists.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Shows the current target descent speed.

ECON SPD –

- economy speed based on cost index
- shows CAS or Mach.

SEL SPD –

- shows when intermediate level off required below an existing speed constraint
- shows when flight crew enters speed
- CAS or Mach value may be entered.
- page title changes to ACT XXXKT DES or ACT M.XXX DES
- <ECON prompt appears at line 5L to allow selection of economy descent speed

4 Speed Transition (SPD TRANS)

The transition speed is usually 10 knots less than the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 240 knots is shown. The transition altitude is the point that the transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet is shown.

Blanks when the transition has occurred.

Can be deleted.

5 Speed Restriction (SPD RESTR)

Speed restrictions not associated with specific waypoints are manually entered on this line.

Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

An entry creates a modification.

6 Off Path Descent (OFFPATH DES)

Push – shows the OFFPATH DES page.

7 AT XXXXX

Shows the next waypoint constraint from the RTE LEGS page.

Line title shows:

AT XXXXX (the waypoint identifier)

- HOLD AT XXXXX
- AT VECTORS
- AT (INTC).

The constraint is speed/altitude. Blank when no constraint exists.

Can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

8 FORECAST

Push – shows the DESCENT FORECAST page.

9 Descend Direct (DES DIR)

Push – deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Shown in descent phase with altitude constraint between airplane and E/D.

10 Descend Now (DES NOW)

Shown when the descent phase is not active.

Push –

- starts a 1250 feet per minute descent schedule until intercepting the planned descent path
- activates the FMC descent phase.

Descent Forecast Page

The descent forecast page is used to enter wind data for descent, and the altitude at which anti-ice use is anticipated for more accurate descent path calculation.

The primary entries are wind direction and speed for up to four descent altitudes, and the altitude that anti-ice is turned on.

DESCENT FORECAST	
TRANS LVL	WIND DIR/SPD
FL180	090°/105KT
FL290	078°/69KT
FL210	130°/29KT
5000	
REQUEST	DES>

1 Transition Level (TRANS LVL)

Shows the transition level.

The transition level can be specified by the arrival procedure. The default transition level is FL 180.

Above transition level, altitudes are in flight levels. Below transition level, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

2 Altitude (ALT)

Enter altitude of forecast wind data.

Altitudes and flight levels can be entered in any order. Entries are not sorted.

Execute not necessary.

3 REQUEST SEND

Push – transmits a data link request for descent wind data.

4 Thermal Anti-Ice On Altitude (TAI/ON ALT)

Enter the altitude where anti-ice is first turned on during the descent. The FMC calculates the descent profile based on the higher thrust caused by thermal anti-ice operation below this altitude.

5 Wind Direction/Speed (WIND DIR/SPD)

Enter the wind direction/speed for the specified altitude. Initial entry must have wind direction and speed, subsequent entries may have one or the other.

Execute not necessary.

6 Descent (DES)

Push – shows the DES page.

Offpath Descent Page

The offpath descent page allows the analysis of descent performance off the present route of flight, direct to a selected waypoint. Data entered on the page shows clean and drag descent ranges on the page and on the map display. The ranges are based on an entered waypoint and altitude constraint. The range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC puts the last descent waypoint with an altitude constraint into DES TO. The ECON SPD, SPD TRANS, SPD RESTR, and DES data are the same as the DES page.



1 Descend To (DES TO)

The waypoint for a direct-to descent. Usually, this is the E/D waypoint from the active route. Manual entry of waypoints on or off of the route are allowed. The DTG calculations are for a descent direct to the selected waypoint.

When within 150 feet of the DES TO altitude for a waypoint other than the E/D waypoint, the display automatically changes the DES TO waypoint to the E/D waypoint from the DES page.

A waypoint is entered for direct-to analysis.

2 Distance To Go (DTG)

Shows the straight line distance to the entered waypoint.

3 Speed/Altitude (SPD/ALT)

Shows the speed/altitude constraint for the entered waypoint.

A manual waypoint entry shows boxes for manual speed and altitude entry.

4 TO CLEAN

Distance to the clean descent circle. The distance is negative when a clean descent is no longer possible.

A clean circle assumes no drag devices are used for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the clean circle. The clean circle is shown on the map display when the DISPLAY prompt is ON.

5 TO DRAG

Distance to the drag descent circle. The distance is negative when a drag descent is no longer possible.

A drag circle assumes speedbrakes are UP for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the drag circle. The drag circle is shown on the map display when the DISPLAY prompt is ON and the airplane is inside the clean circle.

6 DISPLAY

Push – alternates between ON and OFF. The current condition of the display is indicated by the large font.

ON – when ON is displayed in large font, shows the clean and drag circles on the HSI. The drag circle is not shown until the airplane position is inside the clean circle.

OFF – when OFF is displayed in large font, removes the clean and drag circles from the HSI.

Automatically changes to OFF within 150 feet of the waypoint constraint altitude.

Engine Out Descent

There are no specific engine out pages for descent. Use the two engine descent planning features and pages.

Approach

During approach, roll and pitch modes usually change to the approach guidance supplied by navigation radios. The FMC continues to calculate and show present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and DESCENT pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- ARRIVALS page – to select arrival and approach procedures
- HOLD page – to manage holding patterns.
- APPROACH REF page – to access the FMC calculated approach VREF speed

Holding is described in this section but it can be used during any phase of flight.

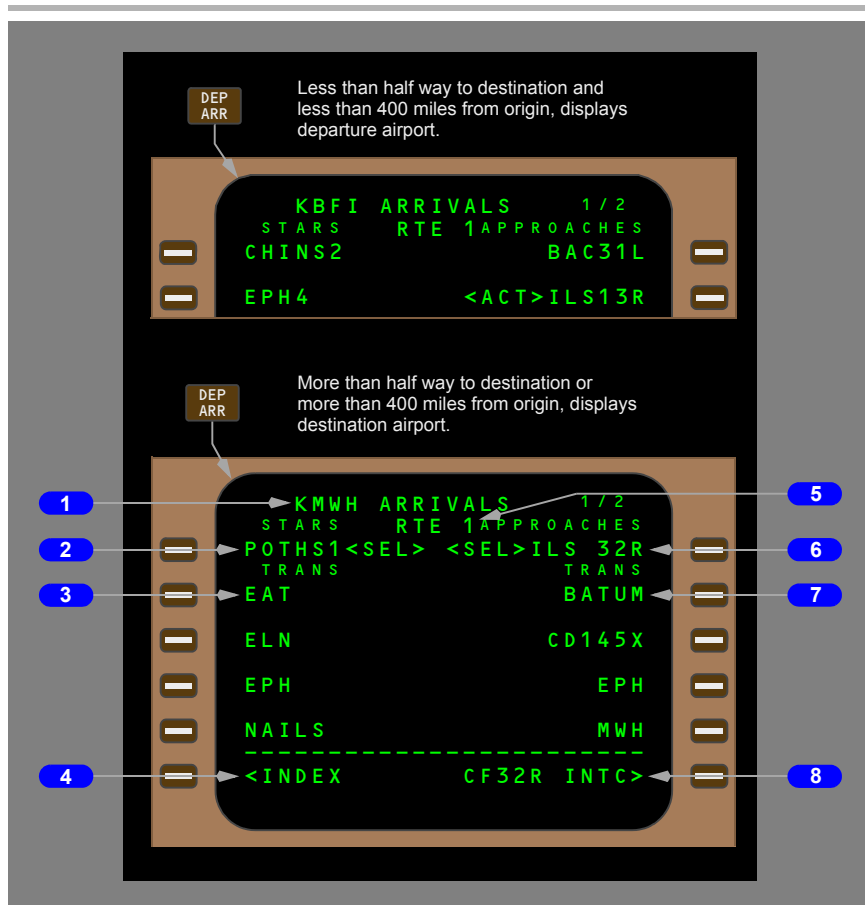
Arrivals Page – IFR Approaches

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and an arrival transition to the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and Route 2 have separate arrival pages.

The approaches, STARS/profile descents, and transitions are shown and selected on this page.

Selecting Options

Selecting a runway, approach, approach transition, STAR/profile descent, or descent transition option shows <SEL> inboard of the selection, and makes a route modification. The other options within the same category are removed from the list. When the modification is executed, <SEL> changes to <ACT>. Select another page and return to ARRIVALS to show all options; the applicable <SEL> or <ACT> prompts are shown.



1 Page Title

The destination airport identifier is shown in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

2 Standard Terminal Arrivals (STARs)

Lists the STARs and PROFILE DESCENTS for the airport.

STARs are shown first in a list under the STAR line title. Profile descents are listed after the STARs under the PROF DES line title.

When a selection is made the procedures not selected are removed from the page. The selected procedure is listed with <SEL> and a list of compatible transitions is shown.

3 Standard Terminal Arrivals Transitions (STARS TRANS)

Lists all the transitions for the selected STAR.

When a selection is made the transitions not selected are removed from the page. The selected transition is listed and marked <SEL>.

4 INDEX

Push – shows the DEP/ARR INDEX page.

5 Route 1 (RTE 1)

Shows the active route number (RTE 1 or RTE 2).

6 APPROACHES

Lists all approaches and runways for the destination airport.

When a selection is made, other approaches and runways are removed from the page and compatible transitions are listed. The list of STARS and profile descents is reduced to those compatible with the selected approach.

7 Approach Transitions (APPROACHES TRANS)

Transitions are listed when an approach is selected. Shows a list of available transitions to the selected approach.

Approach transitions include:

- IAF
- feeder fix
- fixes which define routing to the FAF.

Selecting an approach without a transition makes a straight-in approach which starts at:

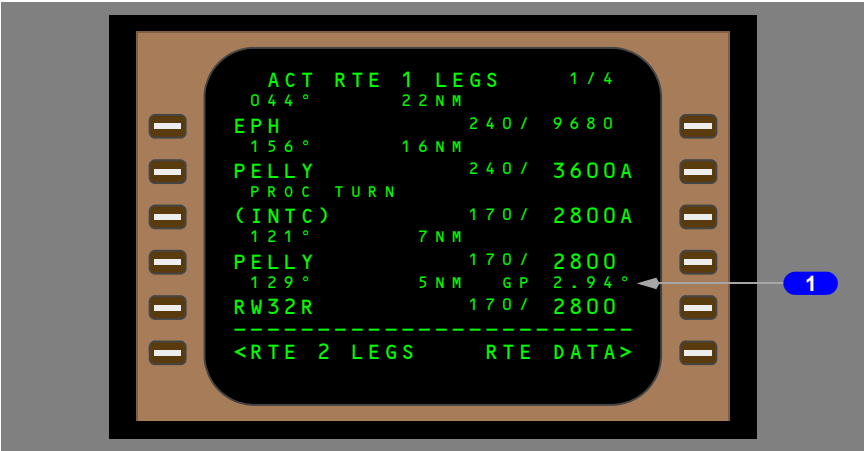
- a charted fix or CFXXX, where XXX is the runway number
- a waypoint 4–8 miles outside the final approach fix.

8 Final Approach Fix Intercept (XXXXX INTC)

Selecting the prompt shows a modified RTE LEGS page with an intercept course to the approach transition fix (usually the IAF) for the selected approach.

Vertical Angle Display on the Route Legs Page

When a runway is selected as part of the active route the vertical angle of the flight path approaching the runway is displayed on the RTE LEGS page.

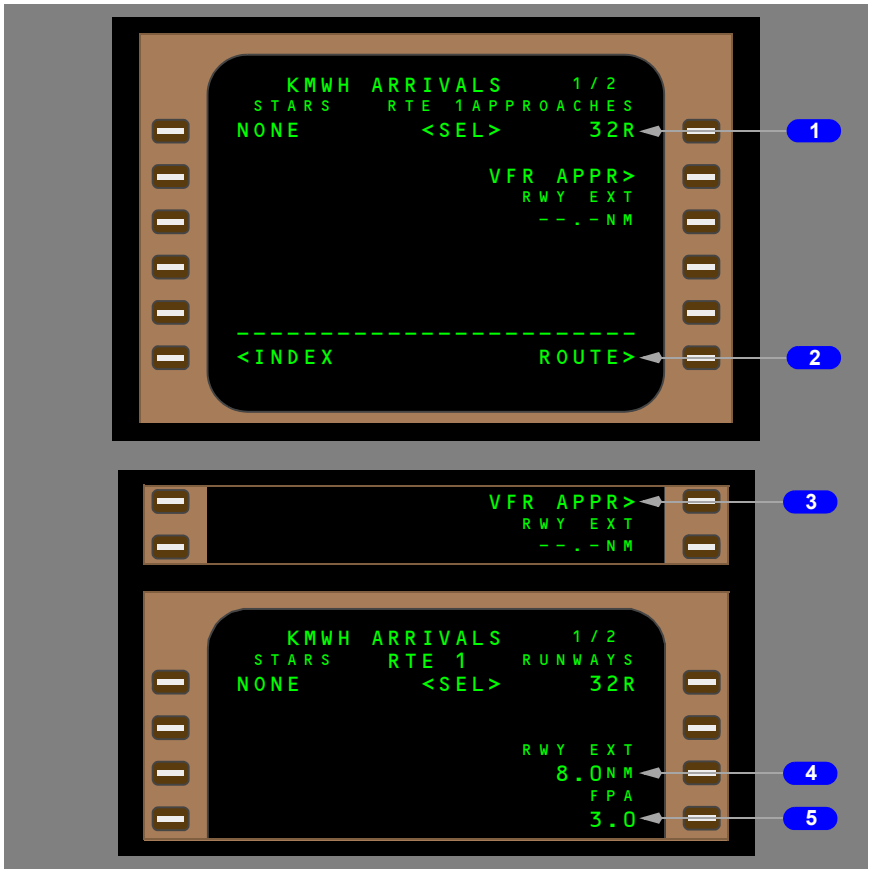


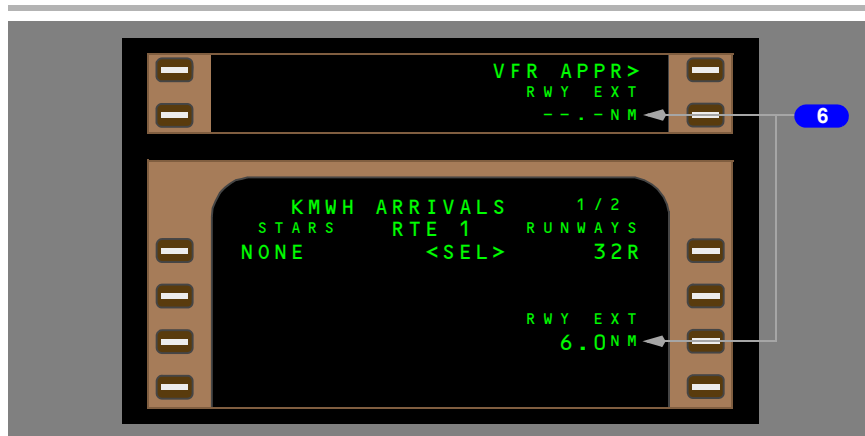
1 Glide Path (GP) Angle

Displays the vertical angle for use by VNAV on the final approach to the runway. If the runway was selected as part of a published approach, the displayed angle will be close to the published glide path angle but may differ slightly.

Arrivals Page – VFR Approaches

The arrivals page also allows selection of a VFR approach if the navigation database contains a VFR approach for the selected runway.





1 RUNWAYS

Push – removes approach list and other runways. Displays RWY EXT prompt and VFR APPR prompt in line 2 if a VFR approach is in the navigation database.

The RUNWAYS list for other runways is shown if a runway is not selected. Example shows runway 32R selected. Change to another page and return to the ARRIVALS page to show all arrival procedures.

2 ROUTE

Push – shows the active route page 2/X.

3 VFR Approach (VFR APPR)

Push – makes a transition waypoint, FXXXX at 8 NM and 2000 feet above the runway.

Shown when a VFR approach is in navigation data base for selected runway.

LNAV and VNAV guidance to the runway is available.

4 Runway Extension (RWY EXT)

After VFR APPR is selected, RWY EXT can not be modified.

5 Flight Path Angle (FPA)

Shows flight path angle. Shown only after VFR APPR is selected.

Default is 3.0 degrees. Valid entries are from 2.4 to 3.7 degrees.

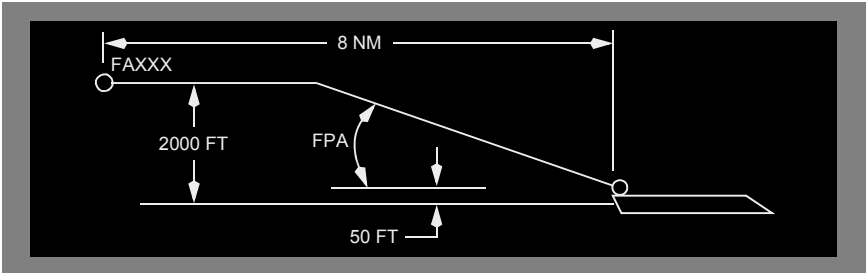
6 Runway Extension (RWY EXT)

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. Example shows 6 NM entered.

Makes waypoint RXXXX, where YYY is the runway; example: RX32R. Makes a route discontinuity before and after the waypoint.

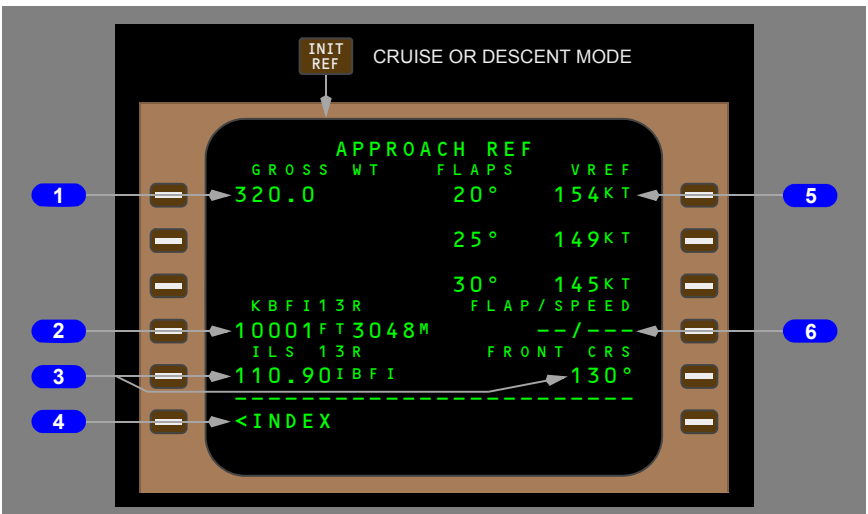
VFR Approach Path



The VFR approach is a level path until the FPA is intercepted. The FPA goes from the FAXXX waypoint altitude to the runway threshold at 50 feet and 170 knots. Default values are shown in RWY EXT and FPA.

Approach Reference Page

The approach reference page shows approach planning data and approach reference speed (VREF) selection.



1 Gross Weight (GROSS WT)

FMC calculated airplane gross weight is usually shown.

Manual entry is allowed in case the FMC calculated gross weight is unavailable or invalid, or to allow previewing recommended approach speeds at other than the calculated FMC gross weight. The manually entered gross weight is for reference only and is deleted when a different page is selected. Permanent changes to gross weight may only be made on the PERF INIT page.

Shows boxes when gross weight is not available from the FMC.

Valid entry is XXX.X.

2 Runway Length

The shown runway reference changes based on route progress. The destination runway is the reference when the present position is more than halfway to the destination or more than 400 NM from the origin airport. The origin airport runway is the reference when less than halfway or less than 400 NM from the origin airport.

3 ILS Frequency and FRONT Course (CRS)

Display is blank prior to entering a destination runway in the active route.

Displays the runway, corresponding ILS frequency, facility identifier and FRONT CRS from the navigation database for the runway shown.

4 INDEX

Push – shows the INT/REF INDEX page.

5 FLAPS VREF

A gross weight is necessary for VREF speed calculation. Push the applicable line select key to select the correct VREF speed. The three VREF speeds are based on landing flap setting.

Shows the calculated reference speed for flaps 20°, 25°, and 30°.

The display is blank until a gross weight is shown.

6 FLAP/SPEED

The flap position and VREF speed is entered for landing.

Alternate Airport Diversions

The ALTN helps the flight crew find the best alternate airport. The page has four airports shown in an ETA sequence. There is a prompt for each airport on the list to select the ALTN XXXX page which has more information and routing options for the airport. (XXXX is the identifier for the airport).

There are three uplinks messages that provide alternate airport data. The Company Preferred Alternates Uplink provides up to 4 alternate airports that are listed on the ALTN page 1/2. The Alternates Flight List Uplink provides a list of up to twenty alternate airports that are listed on ALTN page 2/2. And the Alternates Inhibit Uplink provides up to two alternate airports that are listed on the inhibit lines of ALTN page 1/2.

Alternate Page 1/2

The first alternate page displays alternate airport data. An alternate airport can be selected to change the flight plan destination.

The page displays a list of up to four alternate airports sorted in order of the ETA to the airport while airborne. The source of alternate airports can be:

- an uplink directly to this page
- automatic selection from the ALTN LIST page
- automatic selection from the navigation database
- manual entry.

Alternate airports automatically selected from the alternate list or the navigation database are shown in a small font. The presently selected alternate airport is shown on the map display in normal airport symbology. All four alternate airports are shown on the plan mode.



1 Alternate Airports

Displays the identifier of the four alternate airports in ETA order when airborne. Displays the identifier of the four alternate airports in distance order when on the ground.

Valid manual entry is an airport from the navigation database. A manual entry replaces the alternate where the entry is made and is shown in large font. After entry, the four airports are resequenced according to ETA.

The DELETE function key can be used to remove manually entered alternate airports from the ALTN page.

2 Selected (<SEL>), Automatically Selected (<A>)

<SEL> indicates a manually selected alternate airport.

A manual selection of an alternate airport is made by pushing the line select key left of the airport identifier with nothing in the scratchpad.

When there is no manually selected alternate the FMC automatically selects the alternate airport with the earliest ETA. Automatically selected alternates are indicated by <A> next to the airport identifier.

The selected alternate identifier is shown in the line title of the DIVERT NOW prompt.

Entering a new airport into the list deletes the overwritten airport but does not select the new airport. After entry, the airports are rearranged in ETA sequence. Manually entered airports are shown in large font and can be removed using the DELETE function.

Use the DELETE function to remove the <SEL> from a manually selected alternate. The automatic selection function selects a new alternate.

3 Alternate Request (REQUEST SEND)

Push – transmits a data link request for company preferred alternates (up to four).

Uplinked airports are shown in ETA order but are assigned a preference number by the transmitting site. The scratchpad displays the message ALTN UPLINK when the alternate airport data arrives.

4 Weather Request (WXR REQUEST SEND)

Push – transmits a data link request for alternate airport weather data.

Uplinked weather is sent to the flight deck printer.

5 ETA

Displays the alternate airport ETA.

ETA is calculated based on the routing, altitude, and speed shown on the XXXX ALTN page. ETA is blank when the airplane is on the ground.

6 FUEL

Displays the alternate airport predicted arrival fuel.

Predicted arrival fuel is calculated based on the routing, altitude, and speed shown on the XXXX ALTN page. The message UNABLE FUEL is shown in the FUEL column if the predicted arrival fuel is less than zero.

Fuel values are blank when the airplane is on the ground.

7 Alternate Select

Selects the XXXX ALTN page, which contains more data about the specific airport.

8 Alternate Inhibit (ALTN INHIBIT)

An airport will not be one of the four alternate airports if entered into the alternate inhibit line.

One or two airports can be entered.

Alternate inhibits can be manually entered or uplinked. The inhibited airports may be uplinked with the ALTN UPLINK or separately. If uplinked separately, the scratchpad displays the message ALTN INHIBIT UPLINK.

Valid entries are airports from the navigation database.

9 DIVERT NOW

The DIVERT NOW selection modifies the route to go from the present position to the selected alternate using the route shown on the XXXX ALTN page.

Push –

- makes an LNAV route modification for a divert to the selected alternate
- automatically displays the MOD XXXX ALTN page for the selected alternate
- displays SELECTED in this position on the CDUs/MCDUs not involved with the modification
- blank on ground
- blank in the air when a diversion is not permitted.

The DIVERT NOW selection changes the display to the XXXX ALTN page for the diversion airport. The details of the route can be confirmed or modified before the diversion is executed.

Execution of the diversion:

- changes the route destination airport
- includes the route modification into the active flight plan
- deletes all parts of the original route that are not part of the diversion
- if a descent path exists, deletes all descent constraints (the scratchpad message DESCENT PATH DELETED is shown when DIVERT NOW is selected).

After a divert is executed the XXXX ALTN page is not updated until all CDUs/MCDUs are selected off of the XXXX ALTN page.

Alternate List Page 2/2

The second alternate page displays a list of previously uplinked alternate airports. The alternates shown on the ALTN 1/2 page are automatically selected from this list, or from the navigation database when a list does not exist.



1 Alternate Airports List

The four lines contain up to 20 airports from which the alternates shown on the ALTN page 1/2 are automatically selected.

The alternates shown on the ALTN 1/2 page are selected by the FMC from this list when manually selected and preferred uplinked airports do not use all four selections.

The list is uplinked directly to this page. No manual entry is allowed. Manual airport entries are accomplished on the ALTN 1/2 page.

2 Alternate List Request (REQUEST SEND)

Push – transmits a data link request for an alternate airport list uplink.

3 INDEX

Push – displays the INIT/REF INDEX page.

4 Alternate List Purge/Confirm (ALTN LIST PURGE/CONFIRM)

The entire alternate list can be deleted. A new list must be uplinked after a purge. When no list exists, the alternate airports are automatically selected from the navigation database.

Selecting PURGE arms the purge function and displays the CONFIRM prompt.

Selecting CONFIRM permanently deletes all airports from the alternate airport list.

XXXX Alternate Page

Each of the four alternate airports shown on the ALTN page 1/2 have a related XXXX ALTN page. The XXXX ALTN pages show specific data about alternate airports, the route used for a diversion, and the conditions upon which the ETA and fuel calculations are based. All data on the page is related to the alternate airport shown in the page title.

Three route options to the airport can be selected:

- DIRECT TO – direct to alternate
- OFFSET – flight plan route with an offset
- OVERHEAD – flight plan route to a waypoint then direct to alternate.

The selected route option is identified by <SEL>. ETA and fuel remaining are calculated based on the selected option. Selection of a route option for one alternate selects the same route option for the other three alternates.



1 VIA DIRECT TO

Push – selects present position DIRECT TO alternate route option.

All flight plan waypoints are deleted.

2 VIA OFFSET

Push –

- with scratchpad empty, selects OFFSET route option
- with offset data in scratchpad, enters offset data. Does not select option.

Entry and exit to the offset is the same as for the RTE page offset. All flight plan waypoints are kept.

3 VIA OVERHEAD

Push –

- with scratchpad empty, selects OVERHEAD option
- with overhead data in scratchpad, enters overhead data. Does not select route option.

Displays active waypoint in flight plan.

The waypoints up to the selected or entered overhead waypoint are kept, then routing is direct to the alternate airport. All waypoints after overhead waypoint are deleted.

Enter any waypoint in the active or modified route.

4 Engine Out (ENG OUT)

This prompt performs the same function as described on the cruise page in the FMC Cruise section. It can be selected before or after the diversion is selected.

5 Alternate (ALTN)

Push – displays the ALTN 1/2 page.

6 Altitude (ALT)

Entry of any valid altitude or flight level into this line causes a recomputation of ETA and arrival fuel. Altitude entries do not become part of the diversion modification. Altitude entries apply to all four alternates.

Displays the altitude for which ETA and arrival fuel are calculated.

The scratchpad displays the message UNABLE ALT, if the entry is above maximum altitude or the top of climb point for divert is after top of descent point for divert.

7 Speed (SPD)

Entry of speed or Mach number into this line causes a recomputation of ETA and arrival fuel. Speed entries do not become part of the diversion modification. Speed entries apply to all four alternates.

Speed modes available are:

- ECON (economy)
- LRC (long range cruise)
- EO (engine out)
- EO LRC (engine out long range cruise)
- CO (company speed)
- any CAS or Mach.

8 WIND

Entry of data into these lines causes a recomputation of ETA and arrival fuel. A separate wind entry may be made for each of the four alternates.

Displays the estimated average wind for the divert route.

Valid entry is a direction in degrees/speed in knots from 1 to 999.

9 Altitude/Outside Air Temperature (ALT/OAT)

Entry of data into these lines causes a recomputation of ETA and arrival fuel. A separate ALT/OAT entry may be made for each of the four alternates.

Displays the OAT for a specific altitude.

Valid entry is an altitude/temperature in degrees C.

10 Alternate Airport ETA/Fuel (XXXX ETA/FUEL)

Displays the calculated airport ETA and arrival fuel based on the selected route, altitude, and speed shown on this page.

11 XXXX DIVERT NOW

This prompt performs the same function as described on the ALTN 1/2 page.

Note: After a divert is executed, the XXXX ALTN page data is not updated until all CDUs/MCDUs change to a page other than the XXXX ALTN page.

Holding

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

Entry to a holding pattern is via the parallel, teardrop, or direct entry methods, dependant upon the airplane's track to the hold fix. However, to make efficient use of the holding airspace, the airplane may begin the initial turn to the holding entry maneuver, parallel, teardrop or direct, just prior to crossing the hold fix ("fly-by"). In all entry maneuvers the airplane will "fly-over" or "fly-by" the holding fix as appropriate to remain on the holding side of the inbound hold course. Teardrop and parallel entry flight maneuvers are flown within the confines of the holding pattern as displayed on the HSI. Direct entry maneuvers may extend slightly beyond the end of the hold pattern.

Note: The holding pattern entry flight path is displayed on the HSI with an HSI selected range of 40 NM or less, and after the holding fix becomes the active waypoint.

HOLD Page (First Hold)

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 RTE X LEGS page with the HOLD AT line.

Two versions of the hold page are possible:

- an airway or procedure holding pattern
- a flight crew-entered holding pattern.

The holding page displays actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the HSI.



1 HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the RTE LEGS page displays prompts to enter the holding fix. Enter the holding fix to show the RTE X HOLD page.

Normally a route waypoint is entered as the holding fix. If a waypoint that is not part of the active route is entered the scratchpad message HOLD AT XXX appears where XXX is the entered waypoint. The holding fix can then be inserted in the route in the proper sequence.

2 HOLD AT Present Position (PPOS)

Selects the airplane present position as the holding fix.

3 Holding FIX

Displays the holding fix.

4 Quadrant/Radial (QUAD/RADIAL)

The holding quadrant and radial are entered.

Valid entry is X/XXX, XX/XXX, or /XXX (example NE/040).

Automatically changes INBD CRS/DIR to agree.

5 Inbound Course/Direction (INBD CRS/DIR)

Displays the holding inbound course and turn direction.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Automatically changes QUAD/RADIAL to agree.

6 LEG TIME

Default display is 1.0 MIN (minute) at or below 14,000 feet or 1.5 MIN above 14,000 feet.

Displays — if a LEG DIST is entered.

Valid entry is X, X.X, or .X in minutes from 0.1 to 9.9.

When climbing/descending through 14,000 feet with VNAV engaged and the SPD/TGT ALT values are displayed in large font, the FMC adjusts leg time (1.0 MIN at or below 14, 000 feet; 1.5 MIN above 14, 000 feet).

7 Leg Distance (LEG DIST)

Default display is — NM if no leg distance has been entered or if a LEG TIME is entered

Valid entry is X.X, XX.X, or .X.

8 ERASE

Erases all FMC modifications.

9 Speed/Target Altitude (SPD/TGT ALT)

Waypoint holding fix speed/altitude constraint from the RTE LEGS page.

Manual entries are in large font.

During cruise, an altitude entry below cruise altitude activates the descent page, unless a new cruise altitude is entered. Altitude entry must be at or below cruise altitude.

A speed entry requires an altitude constraint.

10 FIX ETA

Displays the ETA to the next passing of the holding fix.

11 Expect Further Clearance Time (EFC TIME)

Enter the expect further clearance time to enable accurate fuel and ETA predictions after the hold.

12 Hold Available (HOLD AVAIL)

Displays calculated holding time available before requiring reserve fuel to reach the destination.

13 BEST SPEED

Displays the best holding speed for the airplane gross weight, altitude, and flap setting.

Note: May exceed ICAO limit speed.

HOLD Page (Existing Hold)

When one or more holding patterns are already in the route, push the HOLD key to show the hold page for the first holding pattern. Holding parameters can be monitored and changed on this page. New holding patterns are added using the NEXT HOLD prompt.



1 NEXT HOLD

Push – displays a new hold page for a new holding pattern entry.

2 EXIT HOLD

Push –

- arms a return to the holding fix via the inbound course for holding pattern exit
- EXIT ARMED displayed
- EXEC light illuminated.

When the EXEC key is pushed, the airplane will cross the holding fix and exit holding. If executed when outbound in the holding pattern the airplane will immediately turn inbound and exit holding when the fix is crossed.

Exit from the hold will be initiated prior to crossing the hold fix ("fly-by") if the course to the next route waypoint is not closely aligned with the holding inbound course. Acute angles between the inbound hold course and the course to the next waypoint may result in a substantial distance from the airplane to the hold fix during the exit hold maneuver. However, flight is maintained at all times within FAA or ICAO protected holding airspace. The exit flight path is displayed on the HSI.

Note: If a turn (course change) of 110°- 135° is required to exit the hold toward the next flight plan waypoint, the exit flight path on the HSI may display as a zigzag line, typically in the shape of a Z. However, in all instances LNAV provides appropriate guidance via a smooth turn to intercept the active leg to the next route waypoint. There is no indication on the FMC CDU LEGS page if the exit flight path displayed on the HSI is irregular.

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Introduction

The MCDUs can be used as an alternate navigation system if both FMCs fail. The MCDUs perform lateral navigation computations. LNAV and VNAV are not available.

During normal FMC operation, all system capabilities are contained within the FMCs. During alternate navigation operation, the MCDUs use their own internal memory and computing capability.

Each MCDU performs its calculations based on inputs from its own IRS and provides information for display independent of the other MCDU. Each MCDU can display its route on its respective HSI in the map mode without database symbology.

Alternate Navigation Waypoints

The MCDUs do not have a performance or navigation database. The MCDUs continuously load the active route from the FMC. If both FMCs fail, the MCDUs keep flight plan waypoints except for conditional waypoints, offsets, and holding patterns. Waypoints which are part of the route when the FMCs fail can be referenced by either their identifier, or latitude and longitude.

New waypoints can only be entered as latitude and longitude. This includes waypoints the flight crew has deleted from the MCDU. Complete departure or arrival/approach procedures cannot be manually entered.

Waypoint Operations

Waypoint operations include:

- add new waypoints (latitude/longitude entry only)
- remove existing waypoints
- change the sequence of existing waypoints
- connect discontinuities.

Alternate Lateral Navigation

All MCDU calculations are based on a great-circle course between waypoints.

Route Changes

Route changes are made on IRS LEGS page in almost the same manner as normal FMC operations. All courses between waypoints are direct routes. When the active waypoint is modified, the only navigational choice is present position direct to the modified active waypoint.

The two MCDUs operate independently. A route change to one MCDU does not change the other one. The route entered in the left MCDU can be displayed on the captain's HSI using his NAV source select switch. The route entered in the right MCDU can be displayed on the first officer's HSI using his NAV source select switch.

Course Reference

Each MCDU uses its associated IRS for navigation data. The IRS supplies magnetic variation only for the present position. Therefore only the active waypoint course can be referenced to magnetic north. All subsequent courses are referenced to true north.

Alternate Navigation MCDU Pages

The alternate navigation system provides two MCDU pages:

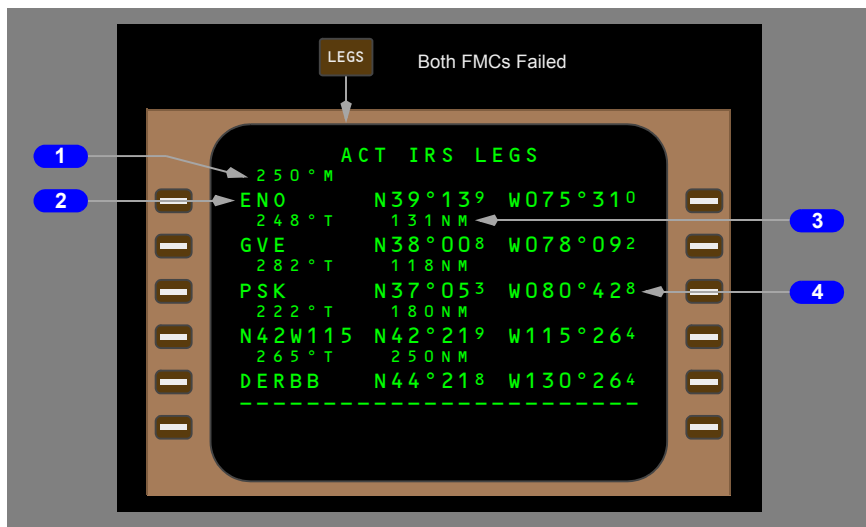
- IRS LEGS
- IRS PROGRESS

Failure of a single FMC causes the related MCDU to display the MENU page. Selecting the operable FMC on the NAV selector switch restores the MCDU displays to normal.

If the other FMC fails, the IRS LEGS and IRS PROGRESS pages are available on either MCDU via the LEGS and PROG mode select keys. Selecting MCDU on the NAV source selectors provides a MCDU generated map on the HSI.

Alternate Navigation Legs Page

This page displays data about each leg of the route. The route can be modified. Waypoint speed and altitude restrictions are not displayed because performance data is not available.



1 Leg Direction

Displays course to the waypoint.

Course reference is M for magnetic, T for true.

Active waypoint leg direction can be magnetic or true. Subsequent waypoint leg directions are true.

2 Waypoint Identifier

Displays the waypoint by name or latitude/longitude.

Valid entries are waypoint names that were in the route when the FMCs failed, or latitude/longitude for new waypoints.

3 Distance to Waypoint

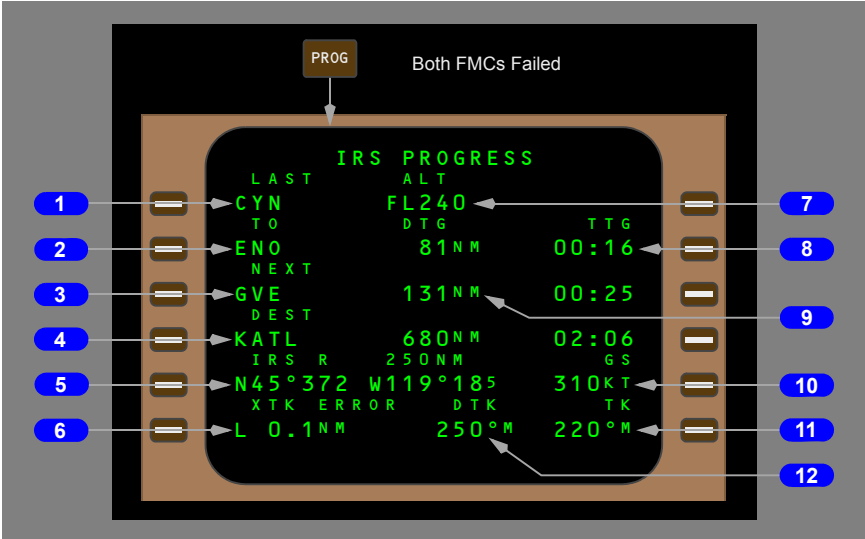
Displays the great circle distance between waypoints.

4 Waypoint Coordinates

Displays the waypoint coordinates.

Alternate Navigation Progress Page

This page shows general data about flight progress.



1 LAST

Displays the identifier of the last waypoint.

2 TO

Displays the active waypoint.

3 NEXT

Displays the waypoint after the TO waypoint.

4 Destination (DEST)

Displays identifier for route destination waypoint or airport. Any waypoint on or off the route can be entered. Time and distance data temporarily displays for that waypoint.

Display options:

- destination airport identifier; distance and time to go along track to the destination airport
- entry of an existing flight plan waypoint (identifier or latitude/longitude) causes the line title to change to ENROUTE WPT. Time and distance to go are from the present position direct to the new waypoint
- entry of a waypoint not in the flight plan causes the line title to change to DIR TO ALTERNATE. Time and distance to go are from the present position direct to the new waypoint.

5 Inertial Position (INERTIAL POS)

Displays IRU present position.

Line title displays IRU source for position.

6 Cross Track Error (XTK ERROR)

Displays airplane left or right cross-track error in nautical miles from the active route track.

7 Altitude (ALT)

Displays airplane altitude when the LAST waypoint was crossed.

8 Time to Go (TTG)

Displays time to go to waypoint or destination.

9 Distance to Go (DTG)

Displays distance to go to waypoint or destination.

10 Ground Speed (GS)

Displays IRU groundspeed.

11 Track (TK)

Displays airplane track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

12 Desired Track (DTK)

Displays desired track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

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Flight Management, Navigation

EICAS Messages

Chapter 11

Section 60

EICAS and MCDU Messages

The following EICAS messages can be displayed to alert the flight crew to navigation system faults and failures.

Message	Level	Light	Aural	Condition
ATC FAULT	Advisory	ATC FAIL		Selected transponder has failed.
L FMC FAIL R FMC FAIL	Advisory	FAIL		FMC has failed.
FMC MESSAGE	Advisory	FMC		A message is in the FMC scratchpad.
L GPS R GPS	Advisory			Indicated GPS has failed.
GPS	Advisory			GPS system has failed.
L IRS DC FAIL C IRS DC FAIL R IRS DC FAIL	Advisory	DC FAIL		IRS DC backup power has failed and the IRS AC normal power is being used.
L IRS FAULT C IRS FAULT R IRS FAULT	Advisory	FAULT		An IRS fault is detected.
L IRS ON DC C IRS ON DC R IRS ON DC	Advisory	ON DC		Indicated IRS AC normal power has failed and the IRS DC backup power is being used.

Message	Level	Light	Aural	Condition
UNABLE RNP	Caution Advisory		Beeper	Navigation performance not meeting required accuracy. Message is a caution if fault occurs when the airplane is in "on approach" mode. Message is an advisory if fault occurs when the airplane is not in "on approach" mode.

FMC Messages

FMC messages alert the flight crew to conditions that could degrade the system operation and advise the crew of input errors.

FMC messages also alert the flight crew to FMC datalink communications.

The messages are categorized as:

- alerting messages
- advisory messages
- communications messages

The scratchpad messages display according to their level of importance. A less important message replaces another message in the scratchpad when the CLEAR key is pushed or the condition is corrected.

The FMC light illuminates and the EICAS advisory message FMC MESSAGE displays when there is an FMC alerting message.

The EICAS displays the white communications message •FMC when there is an FMC communications message.

Scratchpad advisory messages appear in the scratchpad without an EICAS message or FMC light. All FMC messages illuminate the MCDU message (MSG) light. Clear the message or correct the condition to cancel the message.

Keying data into the scratchpad that contains an FMC message temporarily removes the message from the scratchpad. The message reappears in the scratchpad when the data is line selected into a display or cleared from the scratchpad. On other FMCs the scratchpad must be cleared of any FMC messages before manual entries are possible.

FMC Alerting Messages

FMC alerting messages:

- display in the MCDU scratchpad
- illuminate the amber FMC light on the center instrument panel
- cause the EICAS advisory message FMC MESSAGE to display
- illuminate the MCDU message light (MSG).

Use the CLEAR key or correct the condition responsible for the message to remove the message.

ATC COMM ESTABLISHED – the active ATC data link connection is successfully established following initial AFN logon or a successful transfer.

ATC COMM TERMINATED – the active ATC data link connection is terminated without transfer.

ATC REPORT LIST FULL – an uplink message which includes an ATC REPORT or CONFIRM request is received and the ATC report list contains 10 reports.

CHECK AIRLINE POLICY – after loading a new airline modifiable information file, the FMC determines a parameter is invalid. The FMC uses the default value. This is a maintenance function.

CHECK ALT TGT – VNAV active and the airplane is between the MCP and FMC altitudes. VNAV maintains level flight.

CYCLE IRS OFF – NAV – With the airplane on the ground any IRS has detected a condition that requires cycling inertial power off and back to NAV.

DESCENT PATH DELETED – VNAV active and all waypoint altitude constraints defining the descent profile deleted.

Note: This message displays before execution of the modification which deletes the descent path.

DISCONTINUITY – LNAV active and the route is not defined after the waypoint (except when the waypoint is before a manually terminated leg, such as a VECTORS legs).

DRAG REQUIRED – VNAV active and additional drag required or autothrottle off and less thrust required to maintain the VNAV descent path.

END OF OFFSET – LNAV active and two minutes prior to end of active route offset. AFDS maintains last heading if active route offset overflowed.

END OF ROUTE – LNAV active and end of active route overflowed. AFDS maintains last heading.

ENTER IRS POSITION – the flight crew–entered present position did not pass one of the IRS comparison checks, or the IRS is ready to change to navigate mode and has not received a present position entry. Use the CLEAR key to remove this message.

FMC L (or R) OUTPUT LOSS – data output or discreet signals from indicated FMC are lost.

FUEL DISAGREE–PROG 2 – totalizer (TOTL) fuel quantity and FMC calculated (CALC) fuel quantity disagree by a significant amount.

FUEL QTY ERROR – PROG 2 – totalizer fuel quantity and FMC calculated fuel quantity disagree by a significant amount. This message is replaced by the FUEL DISAGREE message on later FMCs.

INSUFFICIENT FUEL – estimated fuel at destination less than entered RESERVES value.

INVALID ATC UPLINK – an ATC uplink message received by the FMC contains errors.

IRS MOTION – an IRS has detected motion while in ALIGN.

IRS NAV ONLY – the FMC has been without radio or GPS updating for a predetermined time.

IRS POS/ORIGIN DISAGREE – valid inertial position differs from active origin airport.

LIMIT ALT FLXXX – the flight crew– or FMC–selected altitude is greater than the VNAV limit altitude.

NAV DATA OUT OF DATE – the clock calendar date is after the active navigation database valid calendar cycle.

NAV INVALID–TUNE XXXX – RNAV or VOR approach procedures must have a specific navaid tuned. It is either not tuned or a valid signal is not being received.

NO ACTIVE ROUTE – LNAV selected and no active route activated.

PARTIAL CLEARANCE LOADED – the FMC was able to load only a portion of the data contained in an ATC uplink clearance.

PERF/VNAV UNAVAILABLE – VNAV selected and gross weight, cost index, or cruise altitude are not entered.

PURGE UPDATES – POS 2 – multiple navaids rejected by the FMC due to a position error.

RE-LOGON TO ATC COMM – one of the following conditions requires the flight crew to re-initiate ATC logon procedures.

- an invalid END SERVICE message is received
- an ATC LOGON message was transmitted and
 - no valid response received in the allotted time
 - the flight number is changed via the MCDU
 - the tail number is changed via the MCDU
 - the addressed ATC center sends a negative response.

RESET MCP ALT – 2 minutes prior to the top of descent point with VNAV active and MCP not set to altitude below cruise altitude.

RESPOND TO ATC UPLINKS – an ATC uplink is received which causes the pending uplink storage to be full.

RESYNC FAIL – SINGLE FMC – resynchronization attempt failed and one FMC is shut down.

RESYNCING OTHER FMC – offside FMC has just powered up or failed comparison data check and is being resynchronized to onside FMC.

RW/ILS CRS ERROR – LOC mode armed and the selected ILS course is incorrect for the active route runway.

RW/ILS FREQ ERROR – the selected ILS frequency does not match frequency for runway in active route.

SET CLOCK TO UTC TIME – the UTC time from the GPS disagrees with the Captain's clock by more than 12 seconds.

SET THRUST MODE – TO X – uplinked takeoff data is accepted and the thrust mode in the accepted data is different than currently set on the TMC.

SINGLE FMC L (or R) OPERATION – one FMC has failed, only the indicated FMC is operational.

SINGLE FMC OPERATION – one FMC has failed.

SPLIT IRS OPERATION – a fault exists on an IRS making only two IRSs available for navigation.

TAKEOFF SPEEDS DELETED – selected V speeds have been deleted due to changes in takeoff performance or configuration data.

THRUST REQUIRED – VNAV active, autothrottle disconnected, and additional thrust required to track VNAV descent path and maintain speed.

UNABLE FLXXX AT RTA FIX – predicted crossing altitude at RTA fix less than FLXXX, but predicted ETA within tolerance.

UNABLE NEXT ALT – VNAV active and climb not sufficient to comply with waypoint altitude constraint.

UNABLE RTA – RTA not achievable within applicable arrival time tolerance.

UNABLE TO LOAD CLEARANCE – the FMC is unable to load any of the data contained in a loadable ATC uplink clearance/

UNABLE TO SEND MSG – FMC is unable to send a message after a manual initiation of a downlink.

VERIFY POSITION – the difference between the FMC position and other position data exceeds a comparison threshold. The possible conflicts are:

- the left FMC position differs from the right FMC position
- the radio position, with radio updating, differs from the FMC position
- the GPS position, with GPS updating, differs from the FMC position

VERIFY RNP – POS REF 2 – the default RNP has changed due to a change in flight phase and the flight crew entered RNP value exceeds the new default RNP value.

VIA OFFSET INVALID – flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.

FMC Communications Messages

FMC communications messages:

- display in the MCDU scratchpad
- cause the EICAS communications message •FMC to display
- illuminate the MCDU message light (MSG)
- cause the communications aural high–low chime to sound.

ALTN UPLINK – Up to four company–preferred alternate airports and associated data has been received and is available for preview on the ALTN page.

ALTN INHIBIT UPLINK – uplink contains two airports for the ALTN page 1/2 ALTN INHIB line.

ALTN LIST UPLINK – a company list of up to 20 alternate airports has been received and is available on the ALTN LIST page.

DES FORECAST UPLINK READY – descent forecast data has been received and is available for loading on the DESCENT FORECAST page.

FLT NUMBER UPLINK – a new flight number has been received and is available on the RTE page 1/X.

INVALID TAKEOFF XXX/YYY – takeoff data for up to six runways or runway intersection pairs has been received but some data for one runway or runway intersection pair (RWXXX/YYY) is invalid.

PARTIAL ROUTE X UPLINK – a new route has been uplinked to the FMC but a portion of the route could not be loaded.

PERF INIT UPLINK – performance initialization data has been received and is available for preview on the PERF INIT page.

ROUTE X UPLINK READY – a new route or route modification has been received and is available for loading on the RTE X page.

TAKEOFF DATA LOADED – An uplink containing takeoff data matching the runway/position entry on the takeoff page is available for preview (only displays after an initial takeoff uplink has been received) or alternate thrust and/or flaps have been selected.

TAKEOFF DATA UPLINK – an uplink containing takeoff data matching the runway on the takeoff page is available for preview.

WIND DATA UPLINK READY – wind data has been received and is available for loading into the active route.

FMC Advisory Messages

FMC advisory messages are displayed on the MCDU scratchpad and illuminate the CDU message light (MSG). There are no EICAS messages associated with these messages and they do not cause the FMC light to illuminate.

Those messages which are caused by an entry error must be cleared before the entry can continue.

ARR N/A FOR RUNWAY – the runway/approach selected is not compatible with arrival selected.

CRS REVERSAL AT FA FIX – a conflict exists between the default final approach (FA) waypoint (result of a runway or VFR approach selection) and the flight plan before it.

DELETE – DELETE key pushed.

ENG OUT SID MOD – an engine failure is sensed after takeoff before the flaps are fully retracted; the FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.

HOLD AT XXXX – a waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, after selection of the HOLD function key. Selection of HOLD AT XXXX into a RTE LEGS page waypoint line makes a holding fix at the XXXX waypoint.

INVALID DELETE – deletion of selected data is not allowed.

INVALID ENTRY – entry format or range is incorrect for the selected field or the entered airway or TO waypoint does not coincide with the navigation database.

INVALID TUNE REQUEST – attempt to remotely tune a VOR is not valid.

KEY/FUNCTION INOP – selected mode key is inoperative.

MANUALLY TUNED – attempt to remotely tune a VOR that is manually tuned.

MAX ALT FLXXX – the altitude entry on any MCDU page is above the performance calculated maximum altitude.

NO ACTIVE ROUTE – DIR/INTC button pressed without an active route.

NOT IN DATABASE – data is not in the route or the navigation database.

NOT ON INTERCEPT HEADING – LNAV selected and the airplane is outside active capture criteria and the present heading will not intercept the active leg.

RE-ENTER IRS POSITION – the flight crew-entered SET IRS POS disagrees with data in the IRS. This message has been replaced by the ENTER IRS POSITION on later FMCs.

ROUTE FULL – the route is filled to the allowable capacity.

RUNWAY N/A FOR SID – selected runway not compatible with SID.

RW/ILS FREQ ERROR – the selected ILS frequency does not match frequency for runway in active route.

STANDBY ONE – the FMC requires more than 4 seconds to display data.

TAKEOFF SPEEDS DELETED – selected V speeds have been deleted due to changes in takeoff performance or configuration data.

TIMEOUT-RESELECT – communication between the FMC and the MCDU has failed. The flight crew must reselect FMC on the CDU MENU page.

UNABLE CRZ ALT – performance predicts a zero cruise time at the entered cruise altitude.

VERIFY RNP ENTRY – the entered RNP value is greater than the default RNP value for the present flight phase or, less than the present Actual Navigation Performance.

VOR AAA INVALID – signal is lost from remotely tuned VOR. AAA is the identifier for the VOR.

XXXXXX – altitude set in the MCP window when VNAV is engaged, the CLB or CRZ page is displayed, and the altitude is above, within 4000 feet below, and not equal to the CRZ ALT.

FMC Datalink Advisory Messages

FMC datalink advisory messages are displayed the same as other FMC advisory messages but are associated with datalink operations.

INVALID ALTN UPLINK – a company-preferred list of alternate airports and associated alternate data has been received but the data is not valid and can not be displayed.

INVALID ALTN LIST UPLINK – a company list of up to 20 alternate airports has been received but the data is not valid and cannot be displayed.

INVALID FLT NO UPLINK – a new flight number has been received but the data is not valid and cannot be displayed.

INVALID FORECAST UPLINK – descent forecast data has been received but the data is not valid and cannot be displayed.

INVALID PERF INIT UPLINK – performance initialization data has been received but the data is not valid and cannot be displayed.

INVALID ROUTE UPLINK – a new flight plan route or modification to the active flight plan route has been received but the data is not valid and cannot be displayed.

INVALID TAKEOFF UPLINK – takeoff data for up to six runways or runway-intersection pairs has been received but the data is not valid and cannot be displayed.

INVALID WIND DATA UPLINK – en route wind data has been received but the data is not valid and cannot be displayed.

ROUTE X UPLINK LOADING – a new flight plan route or modification to the active flight plan route has been received and is being loaded after flight crew selection of the LOAD prompt.

MCDU Annunciator Lights

These annunciator lights illuminate when certain conditions exist.

DSPY – a flight plan modification is pending and the RTE, RTE LEGS, RTE DATA, or RTE HOLD page not containing the active leg or route segment is displayed, or a VNAV page (CLB, CRZ, or DES) not corresponding to the active VNAV mode is displayed.

OFST – an offset path has been entered and executed.

MSG – an FMC message is waiting to display or is displayed.

FAIL – the associated FMC has failed.

Fuel

Chapter 12

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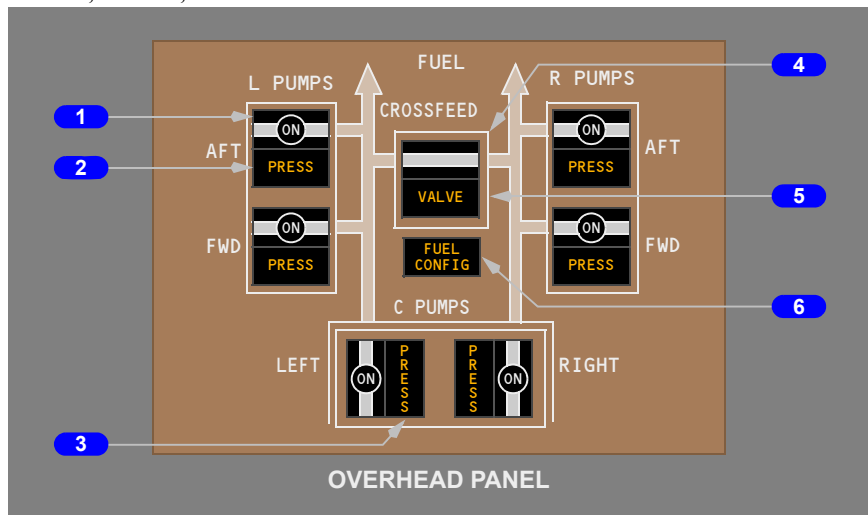
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Fuel Controls and Indicators

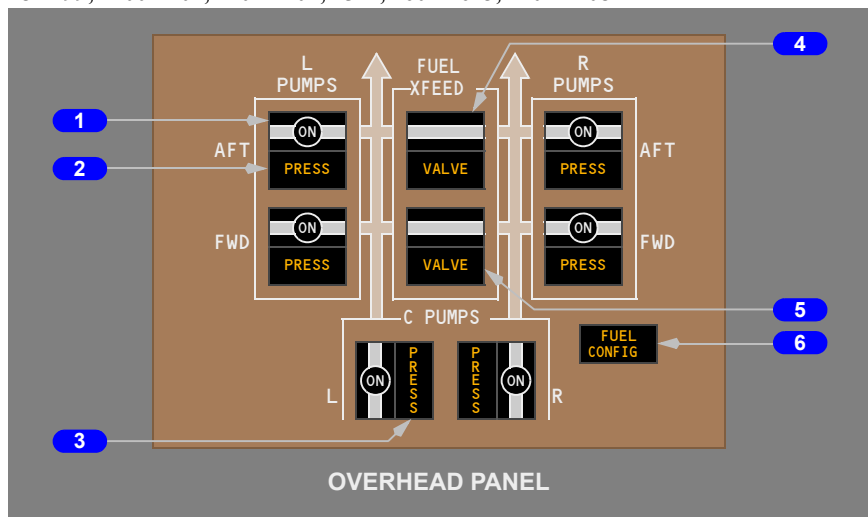
Chapter 12 Section 10

Fuel System

121-139, 171-180, 1501-1506



181-199, 1200-1201, 1401-1404, 1521, 1601-1613, 1701-1708



1 Left/Center/Right (L/C/R PUMPS) Switches

ON – the fuel pump is selected ON.

Off (ON not visible) – the fuel pump is selected off.

2 Left/Right Pump Pressure (PRESS) Lights

Illuminated (amber) – fuel pump output pressure is low.

3 Center Pump Pressure (PRESS) Lights

Illuminated (amber) –

- fuel pump output pressure is low with the pump selected ON
- associated N2 below 50% with pump switch ON.

Note: Illumination is inhibited when the center tank fuel pump switch is selected OFF.

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4 Fuel Crossfeed (CROSSFEED) Switch

On (bar visible) – the crossfeed valve is selected open.

Off (bar not visible) – the crossfeed valve is selected closed.

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4 Fuel Crossfeed (FUEL XFEED) Switches

On (bar visible) – the crossfeed valve is selected open.

Off (bar not visible) – the crossfeed valve is selected closed.

5 Crossfeed VALVE Light

Illuminated (amber) – the crossfeed valve is not in the selected position.

6 Fuel Configuration (FUEL CONFIG) Light

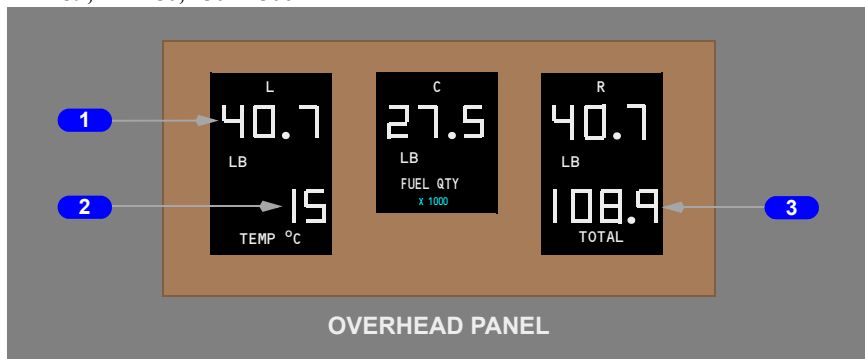
Illuminated (amber) –

- less than 2200 pounds of fuel in either main tank
- imbalance of approximately 2000 pounds between left and right main tanks
- center tank fuel pumps off with more than 1200 pounds of fuel in center tanks.

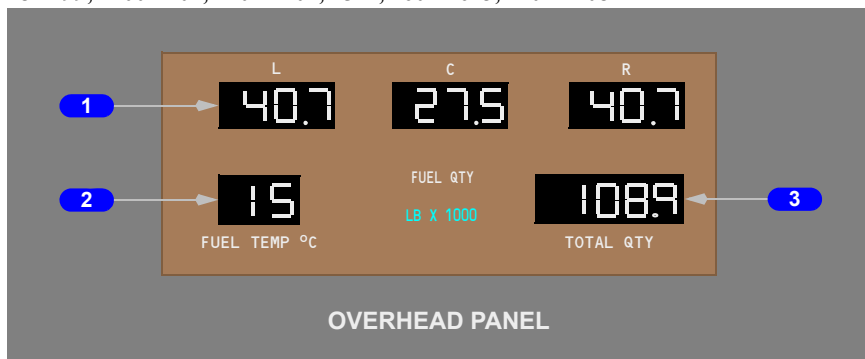
Fuel Indications

Fuel Quantity Indicator

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1 Fuel Quantity (L/C/R FUEL QTY) Indication

Displays usable fuel quantity in the left main, center, and right main tank (pounds x 1000).

2 Fuel Temperature (TEMP) Indication

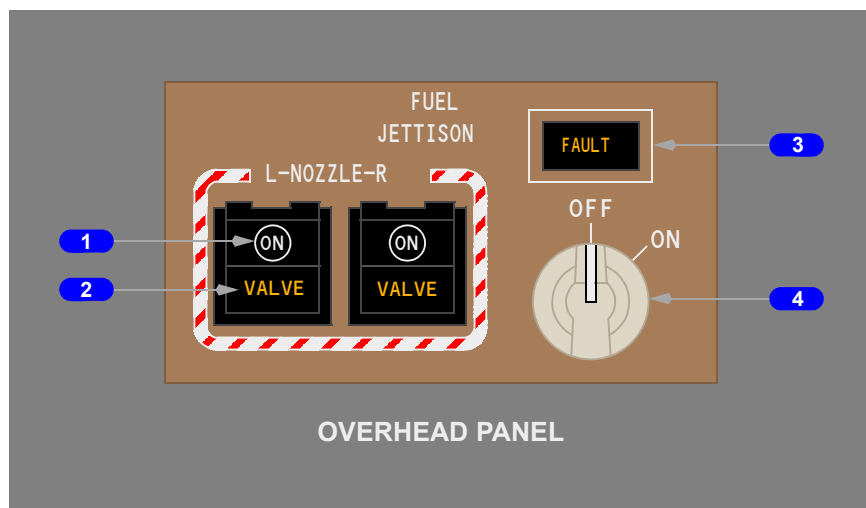
Displays temperature of fuel in the left main tank (degrees celsius).

3 TOTAL Fuel Quantity Indication

Displays total usable fuel quantity in all tanks (pounds x 1000).

Fuel Jettison

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1 Fuel Jettison Nozzle Switches (L-NOZZLE-R)

ON – opens respective jettison nozzle.

Off (ON not visible) – closes respective jettison nozzle.

2 Fuel Jettison Nozzle VALVE Lights

Illuminated (amber) – the jettison nozzle valve is not in the selected position.

3 FAULT Light

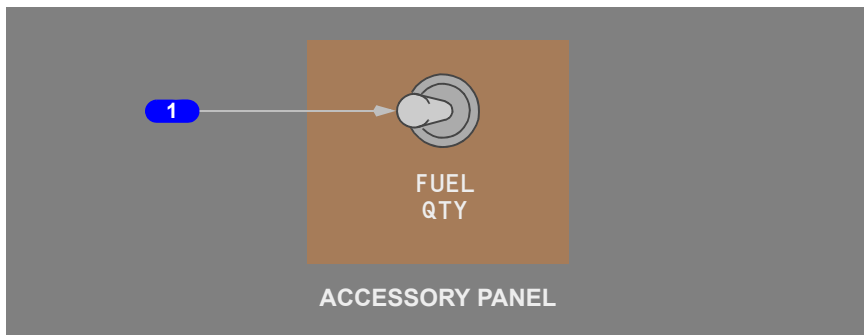
Illuminated (amber) – transfer valve(s) disagree with jettison switch position.

4 Fuel Jettison Selector

OFF – closes both jettison transfer valves.

ON – opens both jettison transfer valves.

Fuel Quantity Test



1 Fuel Quantity (FUEL QTY) Test Switch

Spring-loaded to center.

Initiates fuel quantity test.

Intentionally
Blank

Fuel System Description

Chapter 12 Section 20

Introduction

The fuel system supplies fuel to the engines and the APU. The fuel is contained in a center tank, and left and right main tanks.

Refer to Chapter 7, Engines, APU, for an additional description of the engine and APU fuel systems.

Fuel Quantity

Fuel quantity data, measured by probes in each tank, is fed to the fuel quantity processor where it is corrected for density then displayed on a fuel quantity indicator for each tank. Total fuel quantity, from a separate calculation, is shown on the total fuel quantity indicator and is also provided to the FMC.

When total usable fuel in either left or right main tank drops below approximately 2200 pounds, the FUEL CONFIG light illuminates and the LOW FUEL caution message is displayed.

Fuel Temperature

Temperature of the fuel in the left main tank is displayed on the fuel temperature indicator.

Fuel Pumps

Each fuel tank contains two AC-powered fuel pumps. A single pump can supply sufficient fuel to operate one engine under all conditions.

The two center tank fuel pumps have approximately twice the output pressure of the left and right main tank fuel pumps. When all six pumps are operating, the center tank pumps override the left and right main tank pumps so that center tank fuel is used before left or right main tank fuel.

If any pump has low output pressure, the appropriate switch PRESS light illuminates and the pump pressure EICAS message is displayed. If the main tank pump switches are OFF, the low pressure lights are illuminated and EICAS messages for the pumps are displayed. When the center pump switches are OFF, the low pressure lights and EICAS messages for the center pumps are inhibited.

To reduce electrical loads, the center tank pumps are inhibited when the associated N2 is less than 50% RPM. Thus both center tank pumps are inhibited when the engines are shutdown. As an engine is started and N2 RPM increases above 50%, the inhibit is removed for the associated center tank pump.

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The EICAS caution messages, L or R FUEL SYS PRESS, displays when all fuel pumps have low output pressure or all fuel pumps on one side have low output pressure and the crossfeed switch is off.

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The EICAS caution messages, L or R FUEL SYS PRESS, displays when all fuel pumps have low output pressure or all fuel pumps on one side have low output pressure and the crossfeed switches are off.

The fuel pump low pressure messages are inhibited by the corresponding L or R FUEL SYS PRESS messages.

During normal operation, the EICAS advisory messages CTR L FUEL PUMP and CTR R FUEL PUMP display to indicate depletion of center tank fuel.

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With either message displayed, a small amount of center tank fuel may be indicated (as much as 1000 pounds). A scavenge system will operate automatically to transfer any remaining center tank fuel to the main tanks. Fuel scavenge begins when the main tanks are approximately half empty.

An automatic center tank fuel pump shutoff system is installed on each center tank fuel pump. Several seconds after display of the CTR L FUEL PUMP or CTR R FUEL PUMP message on EICAS, power is automatically removed from the respective pump. Operation of the automatic shutoff system is transparent to the flight crew and is installed to ensure continued center tank fuel pump operation is terminated. Reselecting a center tank fuel pump switch on will reset power to the respective pump.

The left main tank contains a DC-powered fuel pump. It has no controls or indicators. The DC pump operates automatically to provide fuel to the APU when AC power is not available and the APU selector is ON.

Fuel Crossfeed

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The fuel manifolds are arranged so that any fuel tank pump can supply either engine. A crossfeed valve isolates the left fuel manifold from the right. This valve is normally closed providing fuel feed from tank to engine. The valve may be opened any time it becomes necessary to feed an engine from an opposite fuel tank. The valve disagreement light illuminates and the EICAS advisory message FUEL CROSSFEED displays if the valve position does not agree with its switch position. The L or R FUEL SYS PRESS messages are inhibited with the crossfeed valve open.

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The fuel manifolds are arranged so that any fuel tank pump can supply either engine. Two crossfeed valves isolate the left fuel manifold from the right. These valves are normally closed providing fuel feed from tank to engine. Both valves are opened any time it becomes necessary to feed an engine from an opposite fuel tank. Only one open crossfeed valve is required for successful crossfeed operation. A valve disagreement light illuminates and the EICAS advisory message FWD FUEL X-FEED or AFT FUEL X-FEED displays if a valve position does not agree with its switch position. The L or R FUEL SYS PRESS messages are inhibited with either crossfeed valve open.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the airplane climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

(With single fuel crossfeed switch.)

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve. Continued crossfeed use will result in a progressive fuel imbalance.

(With dual fuel crossfeed switches.)

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valves. Continued crossfeed use will result in a progressive fuel imbalance.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine may be capable of suction feed operation at cruise power.

Fuel Configuration Light

When the fuel quantity in left and right main tanks differ by 2000 pounds (plus or minus 500 pounds) or center fuel pump switches are OFF with more than 1200 pounds in the center tank, the FUEL CONFIG light illuminates and the EICAS advisory message FUEL CONFIG is displayed.

The FUEL CONFIG light also illuminates when the EICAS caution message LOW FUEL is displayed.

Fuel Imbalance

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Fuel balancing is accomplished by opening the crossfeed valve and turning off the fuel pump switches for the left or right main fuel tank that has the lowest quantity. Fuel balancing may be done in any phase of flight.

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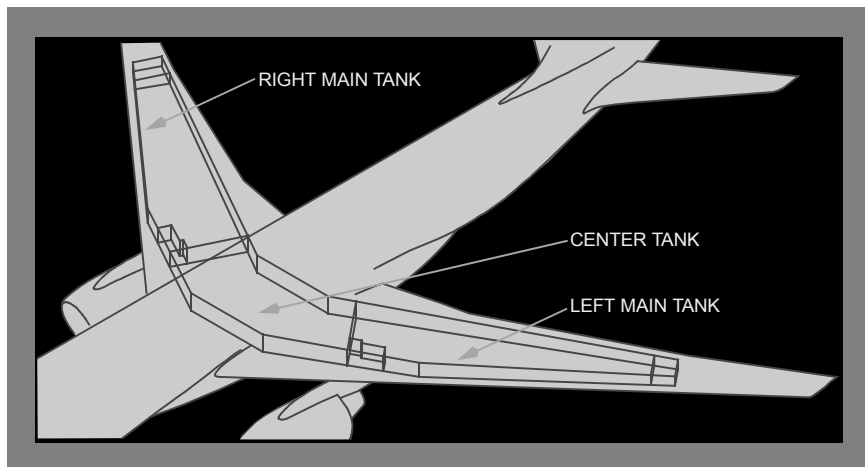
Fuel balancing is accomplished by opening the crossfeed valves and turning off the fuel pump switches for the left or right main fuel tank that has the lowest quantity. Fuel balancing may be done in any phase of flight.

Nitrogen Generation System (NGS)

The NGS converts bleed air to nitrogen-enriched air (NEA) during all phases of flight. The NEA is delivered to the center fuel tank to reduce flammability of the tank. The operation of the NGS is transparent to the flight crew; it does not require any flight crew action to operate the system, nor are there any flight deck indications. The NGS automatically starts operating after take-off and runs continuously through climb, cruise, descent, landing and during taxi for a short period of time. The NGS shuts down after a specified period of time or when bleed pressure is no longer available.

Fuel Tank Locations and Capacities

Fuel Tank Locations



Fuel Tank Capacities

[AFM]

121-139

Tank	U.S. Gallons	Pounds *
Left main	6,070	40,600
Right main	6,070	40,600
Center	4,560	30,600
Total	16,700	111,800
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

171, 173

Tank	U.S. Gallons	Pounds *
Left main	6,070	40,600
Right main	6,070	40,600
Center	12,000	80,400
Total	24,140	161,600
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

172, 174-180

Tank	U.S. Gallons	Pounds *
Left main	6,053	40,500
Right main	6,053	40,500
Center	12,000	80,400
Total	24,106	161,400
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

183-184, 188-190

Tank	U.S. Gallons	Pounds *
Left main	6,010	40,200
Right main	6,010	40,200
Center	11,900	79,700
Total	23,920	160,100
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

181-182, 185-187, 191-199

Tank	U.S. Gallons	Pounds *
Left main	5,993	40,100
Right main	5,993	40,100
Center	11,900	79,700
Total	23,886	159,900
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1401-1404

Tank	U.S. Gallons	Pounds *
Left main	6,010	40,200
Right main	6,010	40,200
Center	11,900	30,500
Total	23,920	110,900
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1501-1506

Tank	U.S. Gallons	Pounds *
Left main	6,070	40,700
Right main	6,070	40,700
Center	12,000	80,400
Total	24,140	161,800
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1521

Tank	U.S. Gallons	Pounds *
Left main	6,010	40,300
Right main	6,010	40,300
Center	11,900	80,100
Total	16,716	160,700
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1601-1611

Tank	U.S. Gallons	Pounds *
Left main	5,993	40,100
Right main	5,993	40,100
Center	11,900	79,700
Total	23,886	159,900
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1612-1613

Tank	U.S. Gallons	Pounds *
Left main	5,993	40,100
Right main	5,993	40,100
Center	11,900	80,100
Total	23,886	160,300
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1706, 1708

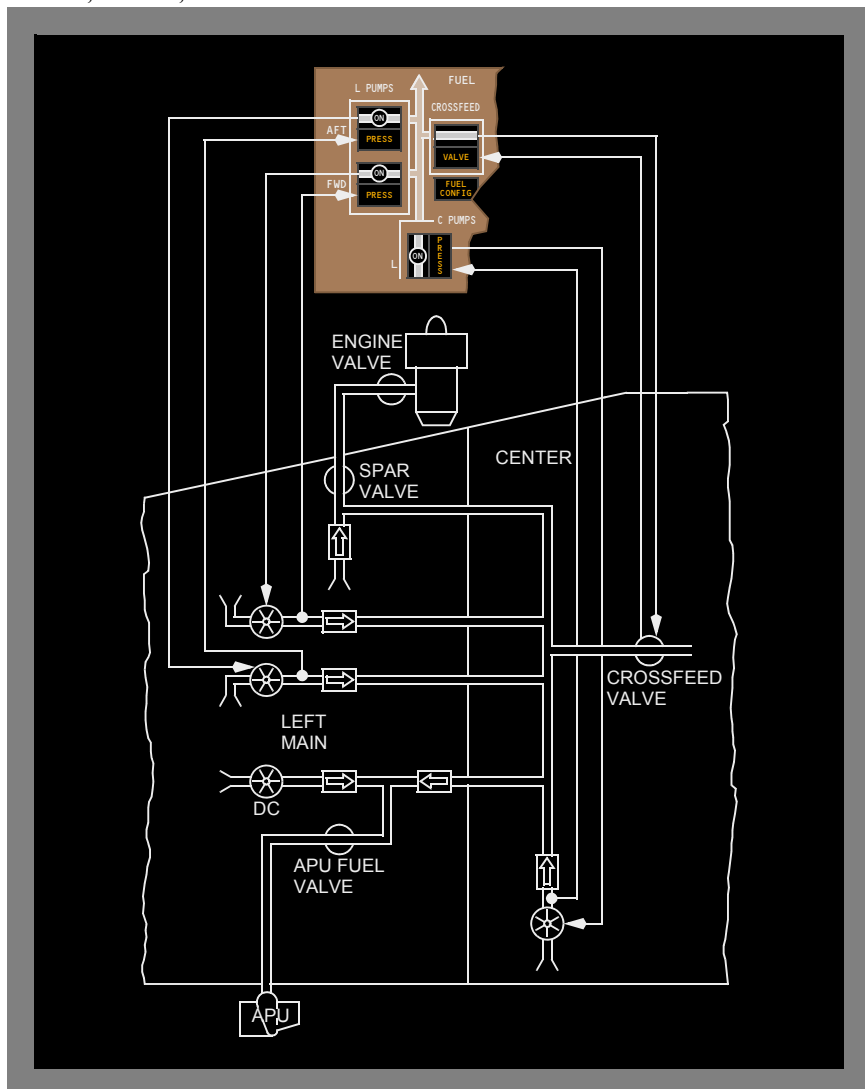
Tank	U.S. Gallons	Pounds *
Left main	6,010	40,200
Right main	6,010	40,200
Center	11,900	79,700
Total	23,920	160,100
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

1701-1705, 1707

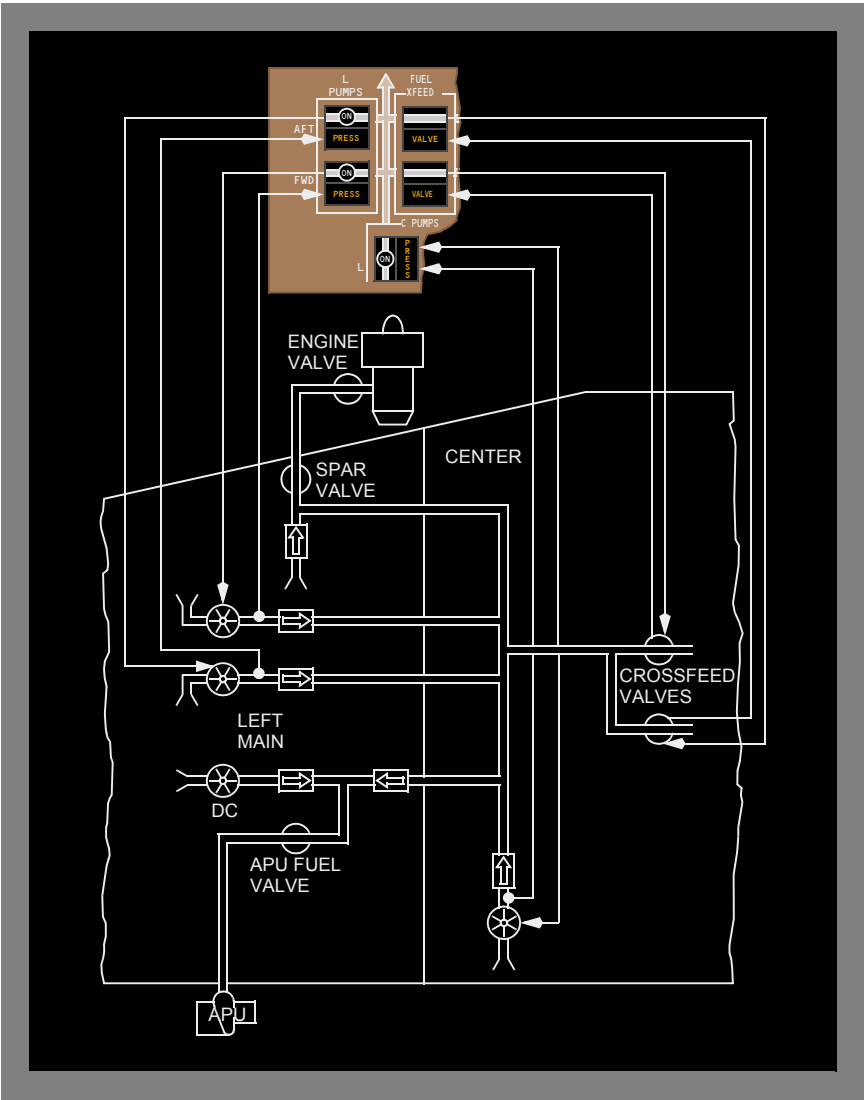
Tank	U.S. Gallons	Pounds *
Left main	5,993	40,100
Right main	5,993	40,100
Center	11,900	79,700
Total	23,886	159,900
* Usable fuel at level attitude, fuel density = 6.7 LB/U.S. per Gallon		

Fuel System Schematic

121-139, 171-180, 1501-1506



181-199, 1200-1201, 1401-1404, 1521, 1601-1613, 1701-1708



APU Fuel Feed

APU fuel is supplied from the left fuel manifold. APU fuel can be provided by any AC fuel pump supplying fuel to the left fuel manifold or by the left main tank DC fuel pump.

On the ground, with the APU selector ON and no AC power available, the DC pump runs automatically. With AC power available, the left forward AC fuel pump operates automatically, regardless of fuel pump switch position, and the DC fuel pump turns off.

Fuel Jettison

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

The fuel jettison system allows jettison from the center fuel tank. Fuel is jettisoned through nozzles inboard of each outboard aileron. The common fuel manifold allows pumps in the center tank to pump fuel overboard. This system is not inhibited on the ground.

The two center tank fuel pumps provide a jettison rate of approximately 1300 pounds per minute.

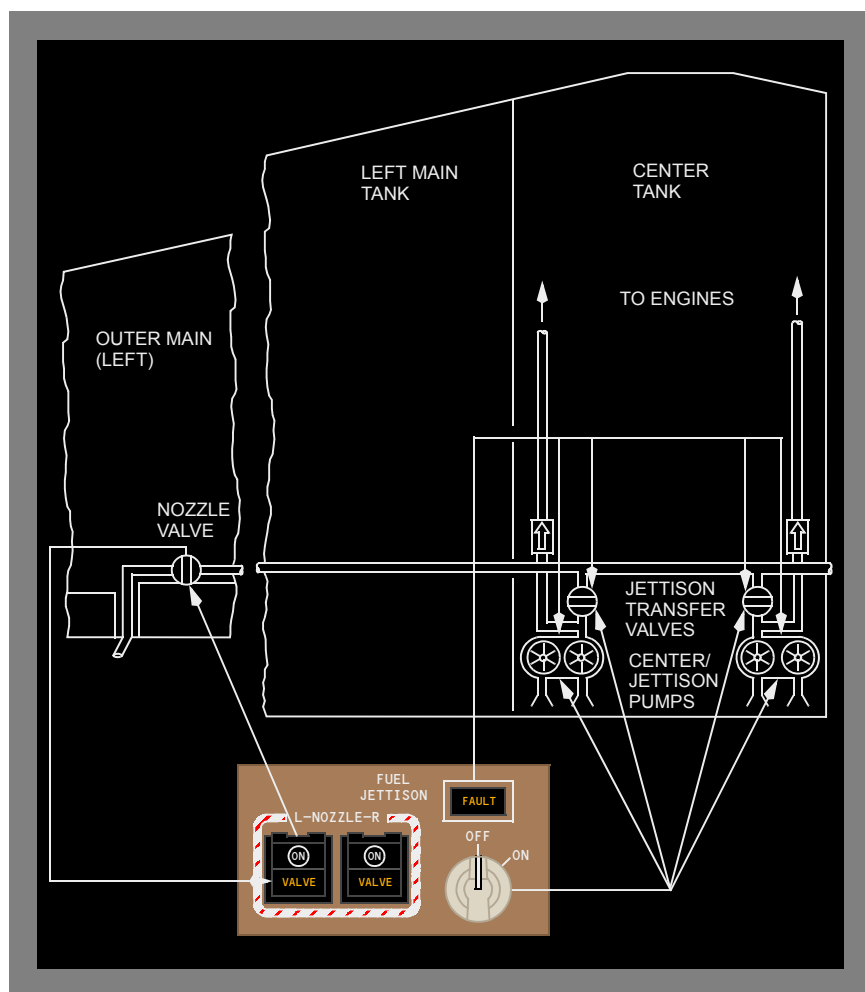
Fuel jettison begins when:

- the FUEL JETTISON selector is selected ON
- the jettison transfer valves open
- the FUEL JETTISON NOZZLE switches are selected ON
- the nozzle valves open, and
- the center tank fuel pumps are operating.

The FMC discontinues fuel value calculations and the totalizer value is used during fuel jettison operation. After fuel jettison is complete, the calculated value will reset using the same value as the totalizer value.

The fuel disagree message is not displayed during fuel jettison operation.

Fuel Jettison Schematic



Note: Center fuel tank jettison pumps are deactivated.

Fuel System FMS MCDU Messages

The CDU/MCDU can display the following messages.

INSUFFICIENT FUEL – Predicted fuel at destination is less than the FMC reserves.

FUEL DISAGREE-PROG 2 – The fuel totalizer and calculated fuel quantity disagree.

Fuel

EICAS Messages

Chapter 12

Section 30

Fuel System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
FUEL CONFIG	Advisory	FUEL CONFIG		Both center pump switches are OFF with fuel in the center tank or a fuel imbalance between main tanks, or fuel quantity is low in either main tank.

121-139, 171-180, 1501-1506

FUEL CROSSFEED	Advisory	VALVE		The crossfeed valve position disagrees with the commanded position

171-199, 1200-1201, 1521, 1601-1613, 1701-1708

AFT FUEL X-FEED FWD FUEL X-FEED	Advisory	VALVE		The crossfeed valve position disagrees with the commanded position

171-199, 1200-1201, 1501-1506, 1521, 1601-1613, 1701-1708

FUEL JET NOZ	Advisory	VALVE		In flight, the nozzle valve position disagrees with the commanded position On the ground indicates one or both fuel nozzle valves are open

Message	Level	Light	Aural	Condition
L JET XFER VALVE R JET XFER VALVE	Advisory	FAULT		The associated fuel jettison transfer valve is not in the commanded position
CTR L FUEL PUMP CTR R FUEL PUMP L AFT FUEL PUMP R AFT FUEL PUMP L FWD FUEL PUMP R FWD FUEL PUMP	Advisory	PRESS		Fuel pump output pressure is low
L FUEL SYS PRESS R FUEL SYS PRESS	Caution		Beeper	All fuel pumps have low output pressure or all fuel pumps on one side have low output pressure and the crossfeed switches are off
LOW FUEL	Caution	FUEL CONFIG	Beeper	Fuel quantity is low in either left or right main tank

Hydraulics

Chapter 13

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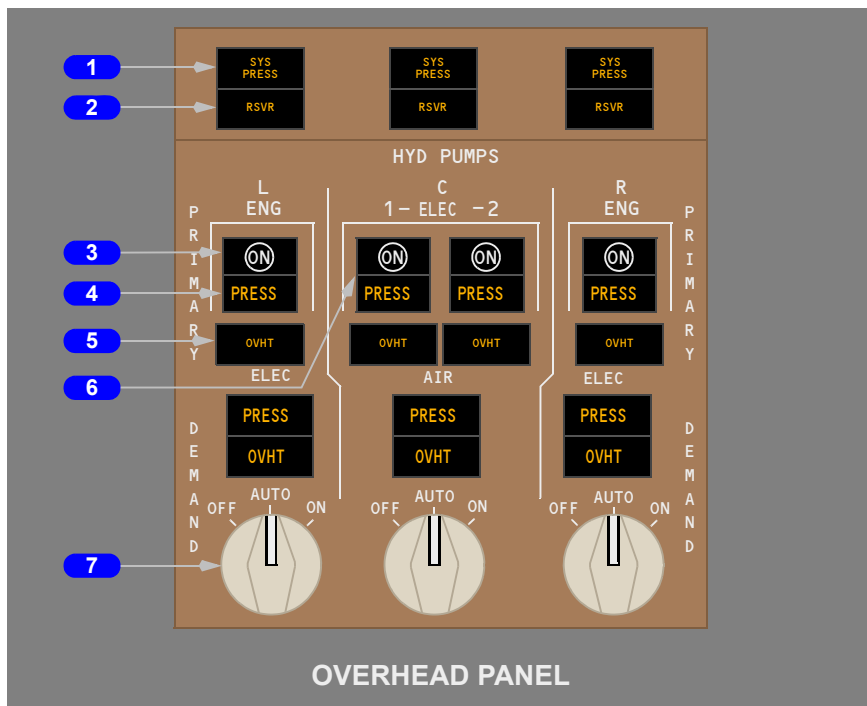
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Hydraulics Controls and Indicators

Chapter 13 Section 10

Hydraulic Panel



1 System Pressure (SYS PRESS) Lights

Illuminated (amber) – system pressure is low.

2 Reservoir Low Quantity (RSVR) Lights

Illuminated (amber) – reservoir quantity is low.

3 Left/Right Engine (L/R ENG) Primary Pump Switches

ON – the engine-driven hydraulic pump pressurizes when engine rotates.

Off (ON not visible) – the engine-driven hydraulic pump is turned off and depressurized.

4 Pump Pressure (PRESS) Lights

Illuminated (amber) – pump output pressure is low.

5 Pump Overheat (OVHT) Lights

Illuminated (amber) – pump temperature is high.

6 Center 1/2 Electric (C1/2 ELEC) Primary Pump Switches

ON – the electric motor–driven pump pressurizes the center hydraulic system.

OFF (ON not visible) – the electric motor–driven hydraulic pump is turned off.

7 Left/Right Electric and Center Air (L/R ELEC and C AIR) Demand Pump Selectors

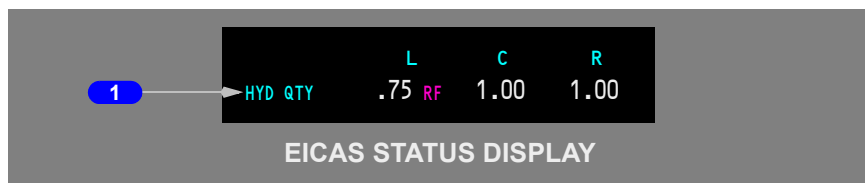
ON – continuous operation.

AUTO –

- left/right electric pumps operate when engine pump pressure is low
- center air demand pump operates when either or both center electric pump pressures are low, or left center pump is isolated
- center air demand pump operates when heavy load items are selected

OFF – pump off.

Status Display

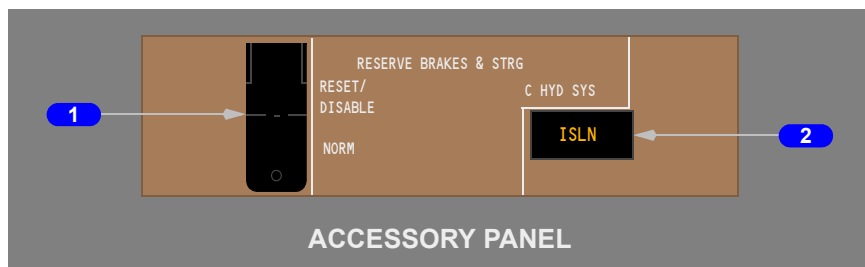


1 Hydraulic Fluid Quantities (HYD QTY)

- displays system reservoir quantity (1.00 is the normal service level)
- RF (magenta) – displayed when the reservoir requires refilling

Miscellaneous Hydraulic System Controls

Reserve Brakes and Steering Reset/Disable Switch



1 Reset/Disable Switch

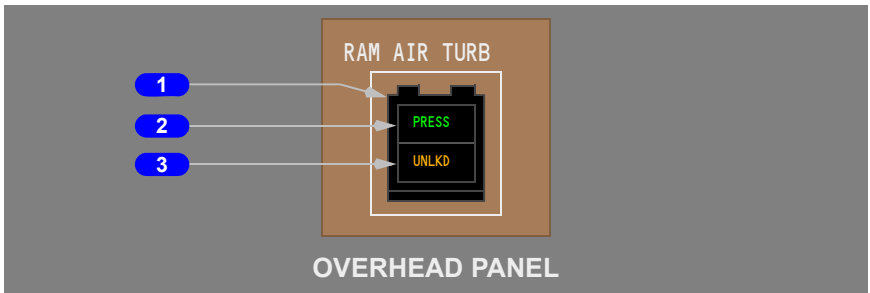
RESET/DISABLE – resets or disables the automatic isolation feature of the center hydraulic system.

NORM – the isolation feature is armed for automatic operation.

2 Isolation (ISLN) Light

Illuminated (white) – the center number one electric primary hydraulic pump is isolated to provide hydraulic pressure to the reserve brakes and steering system.

Ram Air Turbine



1 RAM AIR Turbine (TURB) Switch

Push – deploys the RAT.

2 Ram Air Turbine Pressure (PRESS) Light

Illuminated (green) –

- the RAT is deployed
- the RAT is producing hydraulic pressure

3 Ram Air Turbine Unlocked (UNLKD) Light

Illuminated (amber) – the RAT is not stowed and locked.

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Hydraulics

System Description

Chapter 13

Section 20

Introduction

The airplane has three independent hydraulic systems: left, right, and center. The hydraulic systems power the:

- flight controls
- leading edge slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- autopilot servos

121-139, 171-199, 1200-1201, 1401-1404

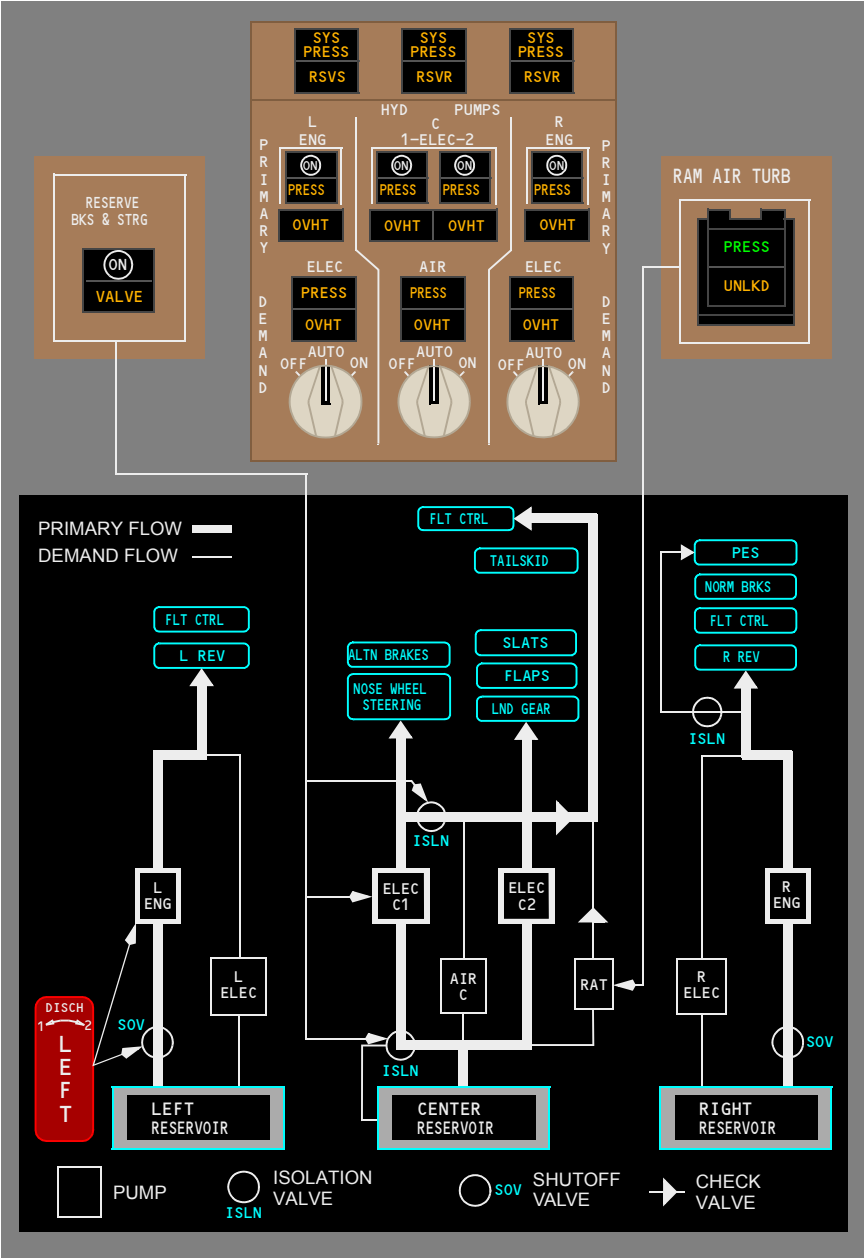
- thrust reversers
- tailskid

Flight control system components are distributed so that any one hydraulic system can provide adequate airplane controllability.

Hydraulic fluid is supplied to each hydraulic pump from the associated system reservoir. The reservoirs are pressurized by the bleed air system.

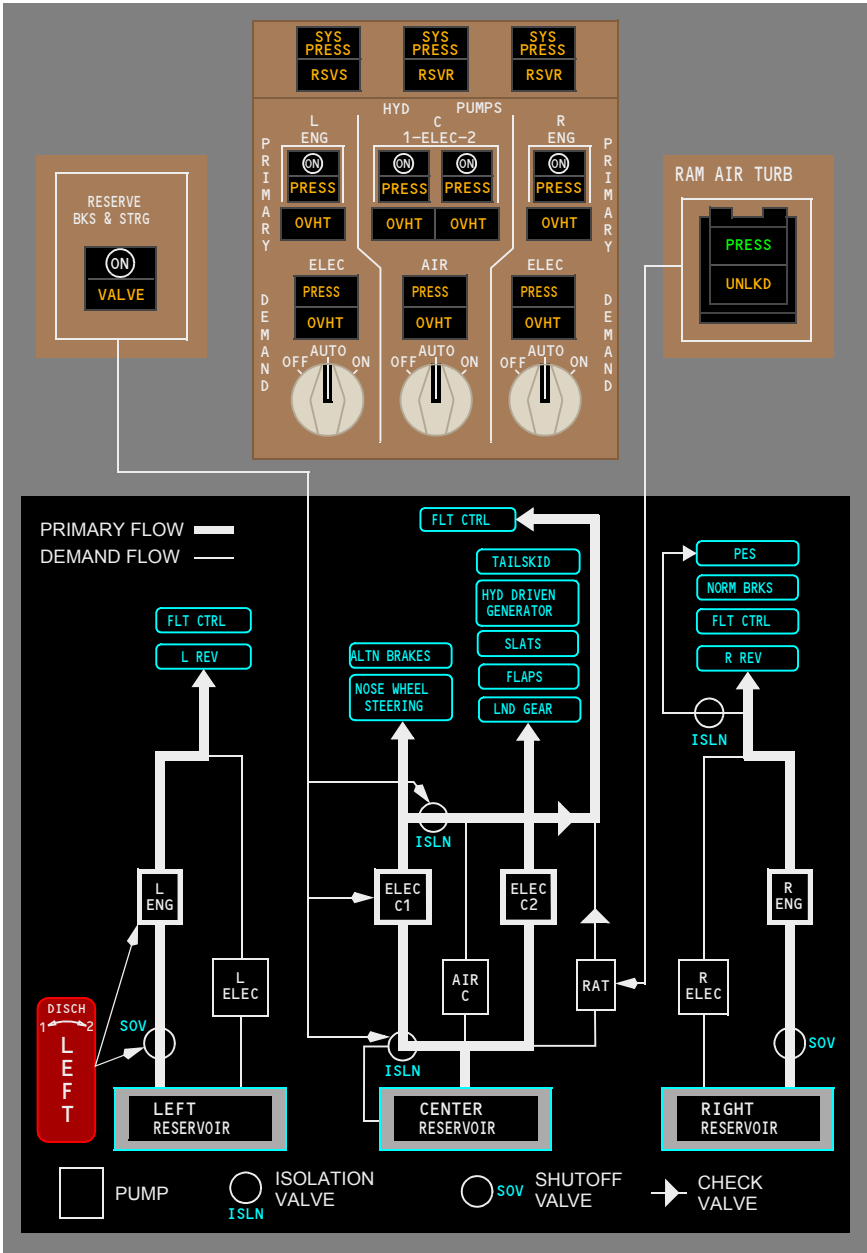
Hydraulic Systems Schematic

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767-300 Operations Manual

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Left Hydraulic System

The left hydraulic system powers:

- flight controls
- 121-139, 171-199, 1200-1201, 1401-1404
- left engine thrust reverser

The system consists of a reservoir, engine-driven primary pump, and an electric motor-driven demand pump.

Fluid Supply

Hydraulic fluid is supplied to each hydraulic pump from a reservoir. The reservoir is pressurized by the bleed air system. A quantity measuring system provides information to the EICAS status display. RF displays on the EICAS status page when a reservoir requires refilling prior to dispatch.

The RSVR light illuminates and the EICAS advisory message L HYD QTY displays when the reservoir quantity is low.

Fluid for the engine-driven pump flows through a shutoff valve controlled by the engine fire switch. Pulling the fire switch shuts off the flow of fluid to the engine pump and depressurizes the pump.

Engine-driven Primary Pump

The primary hydraulic system pump is an engine-driven pump.

The primary pump PRESS light illuminates and the EICAS advisory message L HYD PRIM PUMP displays when the pump output pressure is low. The pump OVHT light illuminates and the EICAS advisory message L PRIM HYD OVHT displays when the pump temperature is high.

Electric Motor–driven Demand Pump

An electric motor–driven demand pump provides additional hydraulic power either on demand or continuously for periods of high system demand. The demand pump also provides a backup hydraulic power source for the engine–driven primary pump.

The pump PRESS light illuminates and the EICAS advisory message L HYD DEM PUMP displays when the pump has been signaled to run and the output pressure is low. The pump OVHT light illuminates and the EICAS advisory message L DEM HYD OVHT displays when the pump temperature is high.

To reduce electrical load, the left electric demand pump is inhibited on the ground during engine start of either engine, when only one electrical generator is operating. The left demand pump PRESS and SYS PRESS lights may illuminate when starting engines on the ground.

System Pressure Indications

The SYS PRESS light illuminates and the EICAS caution message L HYD SYS PRESS displays when the hydraulic system pressure is low.

Right Hydraulic System

The right hydraulic system is similar to the left system. The right system powers:

- flight controls
- normal brakes
- pitch enhancement system
- **121-139, 171-199, 1200-1201, 1401-1404**
- right engine thrust reverser

The system consists of a reservoir, engine-driven primary pump, and an electric motor-driven demand pump.

Fluid Supply

The right reservoir is similar to the left system. The associated EICAS message for low reservoir quantity is R HYD QTY.

Engine-driven Primary Pump

The right engine-driven primary pump is identical to the left system. The associated EICAS messages for low pump output pressure or high pump temperature are R HYD PRIM PUMP and R PRIM HYD OVHT.

Electric Motor-driven Demand Pump

The right electric motor-driven demand pump is identical to the left system. The associated EICAS messages for low pump output pressure or high pump temperature are R HYD DEM PUMP and R DEM HYD OVHT.

System Pressure Indications

The right system pressure indications are similar to the left system. The associated message for low system pressure is R HYD SYS PRESS.

Center Hydraulic System

The center system powers:

- flight controls
- nose wheel steering
- flaps and slats
- alternate brakes
- RAT pump
- landing gear

171-199, 1200-1201, 1401-1404, 1501-1506, 1521, 1601-1613, 1701-1708

- hydraulic driven generator
- tailskid

The system consists of a reservoir, two electric motor-driven pumps, an air-driven demand pump, and a ram air turbine (RAT) pump.

Fluid Supply

The center reservoir is similar to the left system. The associated EICAS messages for low reservoir quantity is C HYD QTY.

The reservoir maintains reserve hydraulic fluid for use by the brakes and steering in the event of a center system hydraulic leak.

Electric Motor-driven Primary Pumps

The two center electric motor-driven primary pumps are identical to the left and right system electric motor-driven pumps. The C2 pump may be load shed automatically to reduce electrical loads. The associated EICAS messages for low pump output pressure or high pump temperature are C HYD PRIM 1, C HYD PRIM 2, C HYD 1 OVHT, and C HYD 2 OVHT.

Air-driven Demand Pump

An air-driven demand pump provides additional hydraulic power either on demand or continuously for periods of high system demand. The demand pump also provides a backup hydraulic power source for the electric motor-driven primary pumps.

The pump PRESS light illuminates and the EICAS advisory message C HYD DEM PUMP displays when the pump has been signaled to run and the output pressure is low. The pump OVHT light illuminates and the EICAS advisory message C DEM HYD OVHT displays when the pump temperature is high.

System Pressure Indications

The center system pressure indications are similar to the left system. The associated message for low system pressure is C HYD SYS PRESS.

Reserve Brakes and Steering Isolation

The center number one electric primary hydraulic pump is automatically isolated, if system quantity is sensed low, to provide hydraulic pressure to the reserve brakes and steering system.

Hydraulic Driven Generator (As installed)

A hydraulic driven generator is automatically powered by the center hydraulic system when electrical power is lost from both main AC busses. The center air demand pump will then operate continuously to ensure sufficient hydraulic pressure to drive the generator.

Ram Air Turbine (RAT) Pump

When deployed, the RAT, provides hydraulic power to the flight controls portion of the center hydraulic system. The RAT provides adequate hydraulic power at speeds above 130 knots. In flight, the RAT deploys automatically when both engines fail. The RAT is inhibited from auto deployment on the ground.

The RAT can be deployed manually by pushing the RAM AIR TURB switch. The UNLKD light illuminates and the EICAS advisory message RAT UNLOCKED displays when the RAT is not stowed and locked. Once the RAT is producing pressure the ram air turbine PRESS light illuminates. The SYS PRESS light remains illuminated if the RAT is the only source of center system pressure. Once deployed, the RAT cannot be stowed in flight.

Hydraulics

EICAS Messages

Chapter 13

Section 30

Hydraulics EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Light	Aural	Condition
C DEM HYD OVHT L DEM HYD OVHT R DEM HYD OVHT C HYD 1 OVHT C HYD 2 OVHT L PRIM HYD OVHT R PRIM HYD OVHT	Advisory	OVHT		Pump temperature is high.
C HYD DEM PUMP L HYD DEM PUMP R HYD DEM PUMP L HYD PRIM PUMP R HYD PRIM PUMP C HYD PRIM 1 C HYD PRIM 2	Advisory	PRESS		Pump output pressure is low.
C HYD QTY L HYD QTY R HYD QTY	Advisory	RSVR		Hydraulic quantity is low.
C HYD SYS PRESS L HYD SYS PRESS R HYD SYS PRESS	Caution	SYS PRESS	Beeper	Hydraulic system pressure is low.
RAT UNLOCKED	Advisory	UNLKD		The ram air turbine is not stowed and locked.

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Landing Gear

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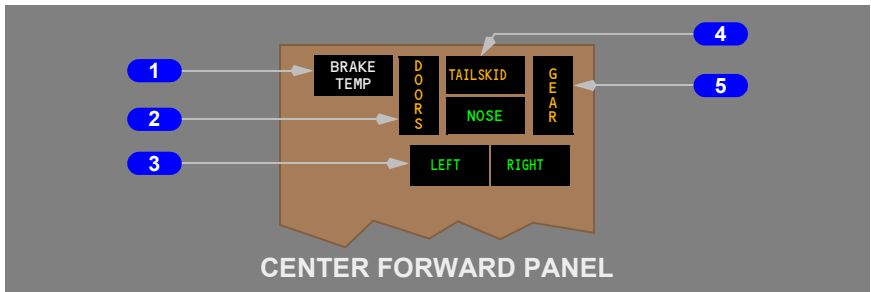


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Landing Gear Controls and Indicators

Chapter 14 Section 10

Landing Gear Panel



1 Brake Temperature (BRAKE TEMP) Light

Illuminated (white) – a wheel brake temperature is in high range (a value of 5 or above on the status page).

2 DOORS Light

Illuminated (amber) – a door is not closed.

3 Landing Gear Down Lights (NOSE, LEFT, and RIGHT)

Illuminated (green) – the associated landing gear is down and locked.

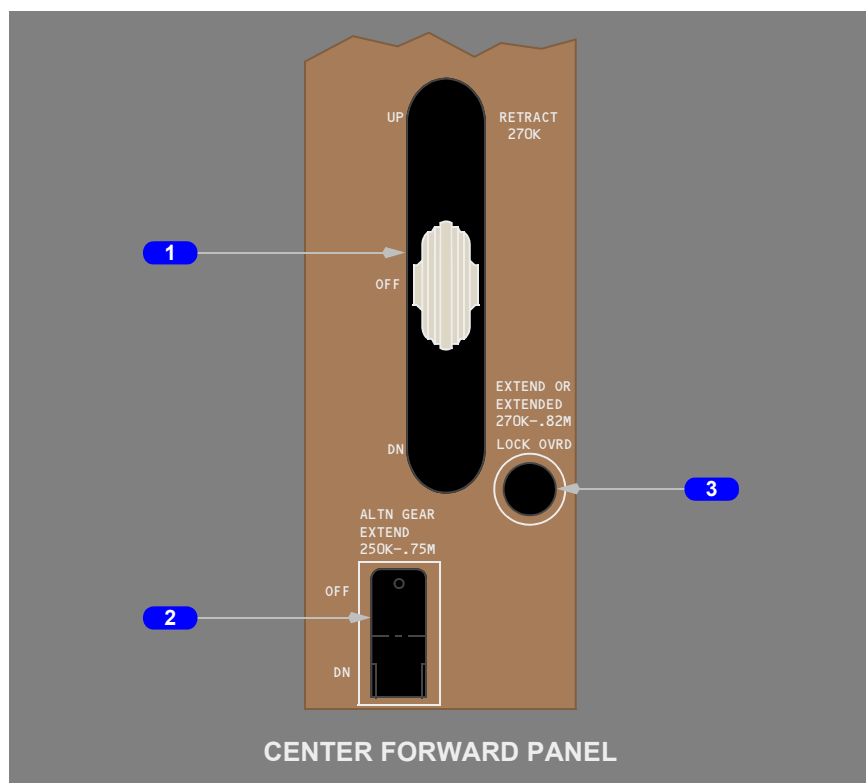
4 TAILSKID Light

Illuminated (amber) – the tailskid position disagrees with the landing gear lever position.

5 Landing GEAR Disagree Light

Illuminated (amber) –the gear position disagrees with the lever position.

Gear Extension/Retraction



1 Landing Gear Lever

UP – the landing gear retracts.

OFF – hydraulic pressure is removed from landing gear system.

DN – the landing gear extends.

2 Alternate Gear Extend (ALTN GEAR EXTEND) Switch

OFF – the landing gear lever operates normally.

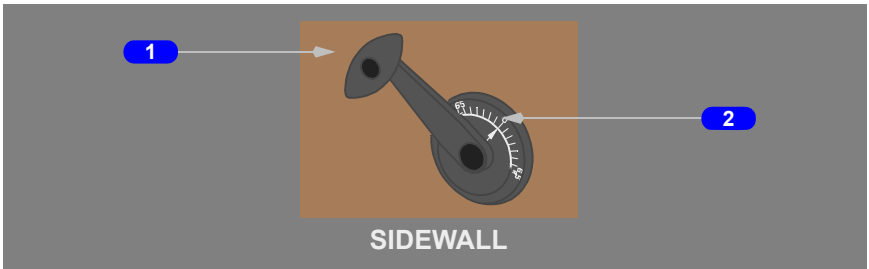
DN (down) – the landing gear extends by the alternate extension system.

3 Landing Gear Lever Lock Override (LOCK OVRD) Switch

Push – releases the landing gear lever lock.

Nose Wheel Steering Tiller

A nose wheel steering tiller is installed on the left sidewall.



1 Nose Wheel Steering Tiller

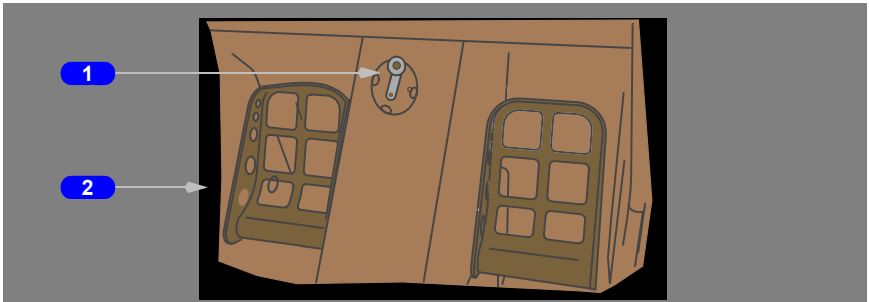
Rotate –

- turns the nose wheels up to 65 degrees in either direction
- overrides rudder pedal steering

2 Tiller Position Indicator

Shows tiller displacement from the straight-ahead, neutral position.

Brake System Rudder/Brake Pedals



1 Rudder Pedal Adjust Crank

Pull and Rotate – adjusts the rudder pedals forward or aft.

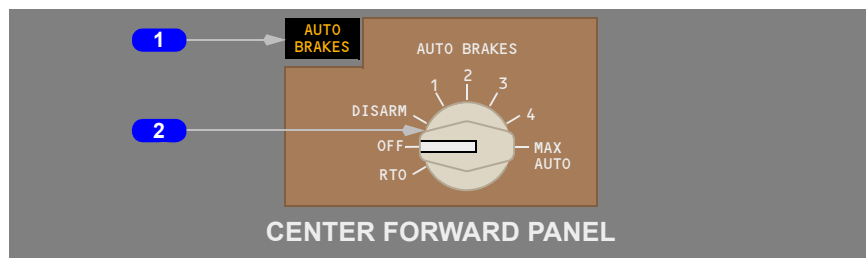
2 Rudder/Brake Pedals

Push the full pedal –turns the nose wheel up to seven degrees in either direction.

Push the top of the pedals – actuates the wheel brakes.

Refer to Chapter 9, Flight Controls for the description of rudder operation.

Auto Brakes Selector



1 AUTO BRAKES Light

Illuminated (amber) – the auto brakes are disarmed or inoperative.

2 AUTO BRAKES Selector

OFF – deactivates the autobrake system.

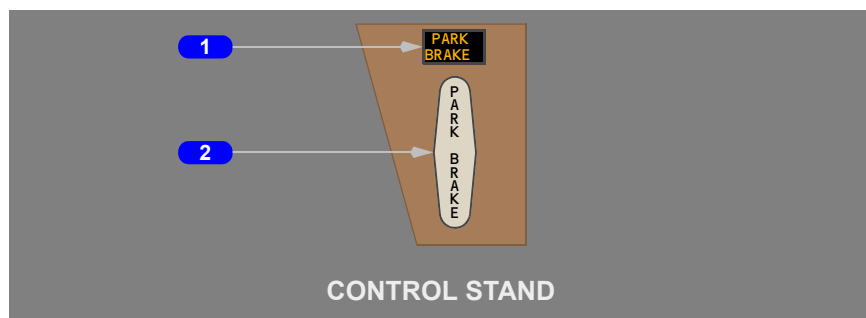
DISARM –

- disengages the auto brake system
- releases brake pressure

1,2,3,4, MAX AUTO – selects the desired deceleration rate.

RTO – automatically applies maximum brake pressure when the thrust levers are retarded to idle above 85 knots.

Parking Brake Handle



1 Parking Brake (PARK BRAKE) Light

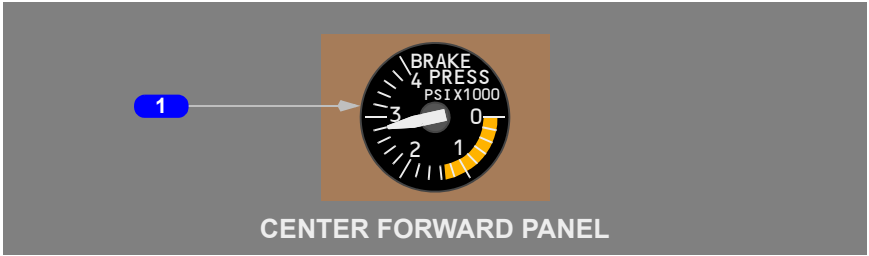
Illuminated (amber) – the parking brake is set.

2 Parking Brake (PARK BRAKE) Handle

Pull – sets the parking brake when both brake pedals are simultaneously depressed.

Release – simultaneously depress both brake pedals.

Brake Accumulator Pressure Indicator

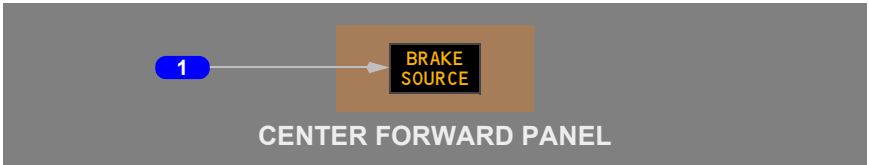


1 Brake Accumulator Pressure (BRAKE PRESS) Indicator

Indicates brake accumulator pressure (psi x1000).

The amber band represents accumulator pre-charge only. No brake pressure is available in this range.

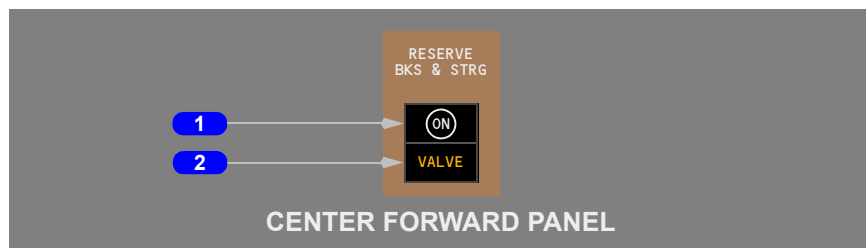
Brake Source Light



1 BRAKE SOURCE Light

Illuminated (amber) – both normal and alternate brake system pressures are low.

Reserve Brakes and Steering Switch



1 RESERVE Brakes and Steering (BKS & STRG) Switch

ON – provides pressure to alternate brake system and nose wheel steering system.

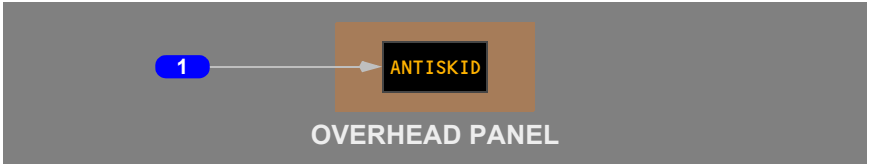
Off – (ON not visible) – the reserve brakes and steering system is commanded off.

2 Reserve Brakes and Steering VALVE Light

Illuminated (amber) –

- switch OFF – valve(s) disagree with commanded position from automatic isolation feature
- switch ON – valve(s) disagree with manually selected switch position

Antiskid Light

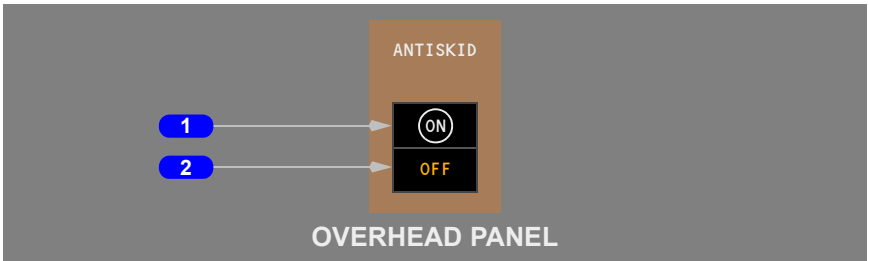


1 ANTISKID Light

Illuminated (amber) – a fault is detected in the antiskid system.

Antiskid Switch

121-139, 171-199, 1200-1201, 1401-1402, 1601



1 Antiskid Switch

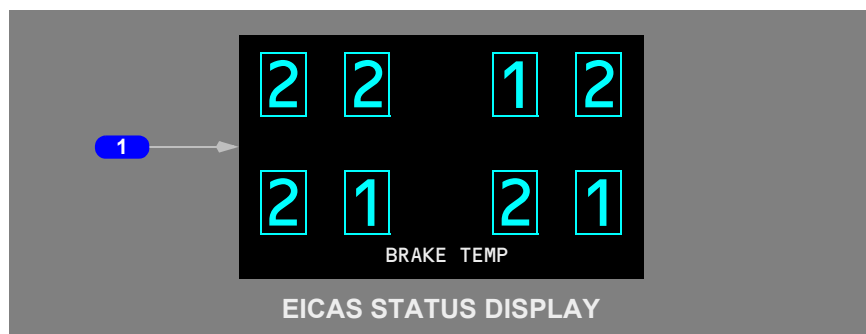
ON – the antiskid system is commanded on.

OFF – (ON not visible) – the antiskid system is commanded off.

2 Antiskid OFF Light

Illuminated (amber) – the antiskid switch is OFF.

Brake Temperature



1 Brake Temperature (BRAKE TEMP)

Indicates a relative value of wheel brake temperature.

- values range from 0 to 9
- 0 to 2 – initial range, box and number are cyan
- 3 to 4 – normal range, box is white for the first brake per truck that exceeds a value of 2 and number is cyan
- 5 to 9 – high range, box and number are white for each brake with a value of 5 or above

Landing Gear System Description

Chapter 14 Section 20

Introduction

The airplane has two main landing gear and a single nose gear. The nose gear is a conventional steerable two-wheel unit. Each main gear has four wheels in tandem pairs.

Hydraulic power for retraction, extension, and steering is supplied by the center hydraulic system. An alternate extension system is also provided.

The normal brake hydraulic system is powered by the right hydraulic system. The alternate brake hydraulic system is powered by the center hydraulic system. Antiskid protection is provided with both systems, but the autobrake system is available only through the normal system.

A brake temperature monitor system displays each brake temperature on the EICAS status display.

Air/Ground Sensing System

In-flight and ground operation of various airplane systems are controlled by the air/ground sensing system and the nose air/ground sensing system.

The air/ground sensing system receives air/ground logic signals from tilt sensors located on each main landing gear. These signals are used to configure the airplane systems to the appropriate air or ground status.

A nose air/ground sensing system receives air/ground logic signals from nose gear strut compression sensors. These signals are for controlling stall warning and portions of the caution and warning system.

An EICAS advisory message AIR/GND SYS or NOSE A/G SYS indicates that some portion of the sensing system failed. Affected equipment and systems will not operate normally and therefore takeoff is not allowed.

Landing Gear Operation

The landing gear are normally controlled by the landing gear lever. On the ground, the lever is prevented from moving to the UP position by an automatic lever lock controlled by the main gear tilt sensors. When the gear is not tilted (aircraft on the ground) the lock is engaged. The lever lock can be manually overridden by pushing and holding the landing gear lever LOCK OVRD switch. In flight, the lever lock is automatically released through air/ground sensing of main gear tilt sensor.

Landing Gear Retraction

When the landing gear lever is positioned to UP, the tilted landing gear begins to retract. The landing gear doors open and the gear retracts to up position. Automatic wheel braking occurs during gear retraction.

The GEAR and DOORS lights illuminate as the landing gear retracts into the wheel wells. After retraction, the nose gear is held up by uplocks and the main gear is held up by the door structure. The GEAR and DOORS lights extinguish. The landing gear lever is placed in the OFF position to depressurize the landing gear system. The GEAR light remains illuminated and the EICAS caution message GEAR DISAGREE displays if any gear is not up and locked up after the normal transit time. The affected gear's Gear Down Light, remains illuminated if the gear never unlocked from the down position. The DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays if any hydraulically actuated main gear door is not closed after normal transit time.

Landing Gear Extension

When the landing gear lever is moved to DN, the landing gear doors open, the gear are unlocked, and the GEAR and DOORS lights illuminate.

The gear are hydraulically powered to the down and locked position. The downlocks are powered to the locked position, all hydraulically actuated gear doors close, and the main gear trucks hydraulically tilt to the flight position. When all gear are down and locked, the Gear Down Lights illuminate and the GEAR and DOORS lights extinguish.

The amber GEAR light remains illuminated and the EICAS caution messages GEAR DISAGREE, L or R SIDE BRACE, L or R DRAG BRACE displays if any gear is not locked down after the normal transit time. The extinguished green gear down light indicates the affected gear. The DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays if any hydraulically actuated door is not closed after the normal transit time.

Landing Gear Alternate Extension

The alternate landing gear extension system uses an electric motor to trip the locking mechanism for each gear. Selecting DN on the ALTN GEAR EXTEND switch releases all door and gear uplocks. The landing gear free-fall to the down and locked position.

When all gear are down and locked, the gear down lights illuminate and the GEAR light extinguishes. During alternate extension, the DOORS light remains illuminated and the EICAS advisory message GEAR DOORS displays because all the hydraulically powered gear doors remain open.

Nose Wheel Steering

Nose wheel steering is powered by the center hydraulic system. In the event of a center hydraulic system leak, a reserve brakes and steering system can power the nose wheel steering.

Primary steering control is provided by the nose wheel steering tiller. Limited steering control is available through the rudder pedals. The tiller can turn the nose wheel up to 65 degrees in either direction. A pointer on the tiller assembly shows tiller position relative to the neutral setting. The rudder pedals can be used to turn the nose wheels up to seven degrees in either direction. Tiller inputs override rudder pedal inputs.

Brake System

Each main gear wheel has a multiple disc brake. The nose wheels have no brakes. The brake system includes:

- normal brake hydraulic system
- alternate brake hydraulic system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake

Normal Brake Hydraulic System

The normal brake hydraulic system is powered by the right hydraulic system. The brake pedals provide independent control of the left and right brakes.

Alternate Brake Hydraulic System

Alternate brake hydraulic system selection is automatic. If the right hydraulic system pressure is low, the center hydraulic system automatically supplies pressure to the alternate brake system. Pushing a brake pedal then sends hydraulic pressure through the alternate antiskid valves to the brakes.

The BRAKE SOURCE light illuminates and the EICAS advisory message BRAKE SOURCE displays if both normal and alternate brake system pressures are low.

Reserve Brakes and Steering

Pressing the RESERVE BKS & STRG switch provides hydraulic fluid to the center number one electric primary hydraulic pump. Pump pressure is then supplied exclusively to the alternate brake system and nose wheel steering system. The BRAKE SOURCE light and EICAS message extinguish when pressure is available.

The VALVE light illuminates and the EICAS advisory message RSV BRAKE VAL displays if a reserve brake valve disagrees with the commanded position.

Brake Accumulator

If normal and alternate brake hydraulic power is lost, the brake accumulator can provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake hydraulic systems.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When a wheel speed sensor detects a skid, the associated antiskid valve reduces brake pressure until skidding stops.

The alternate brake hydraulic system provides antiskid protection to laterally paired wheels.

Touchdown, hydroplaning, and locked wheel protection are provided.

The ANTISKID light illuminates and the EICAS advisory message ANTISKID displays to indicate a fault is detected in the antiskid system.

1403-1404, 1501-1506, 1521, 1602-1613, 1701-1708

The ANTISKID light illuminates and the EICAS advisory message ANTISKID OFF displays to indicate the antiskid system is inoperative.

121-139, 171-199, 1200-1201, 1401-1402, 1601

The antiskid OFF light illuminates and the EICAS advisory message ANTISKID OFF displays if the antiskid system is inoperative. The antiskid OFF light is on whenever the antiskid switch is off or anytime the parking brake valve in the antiskid return line is not open after releasing the parking brake.

Autobrake System

The autobrake system provides automatic braking at pre-selected deceleration rates for landing.

The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

The AUTO BRAKES light illuminates and the EICAS advisory message AUTOBRAKES displays if the autobrake system is disarmed or inoperative.

Rejected Takeoff

Selecting RTO prior to takeoff arms the autobrake system. The RTO mode can be selected only on the ground. The RTO autobrake setting commands maximum braking pressure if:

- the airplane is on the ground
- groundspeed is above 85 knots, and
- both thrust levers are retarded to idle

Maximum braking is obtained in this mode. If an RTO is initiated below 85 knots, the RTO autobrake function does not operate.

Landing

Five levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both thrust levers are retarded to idle, and
- the wheels have spun up

Autobrake application occurs slightly after main gear touchdown. Deceleration is limited until main landing gear truck untilt occurs, then deceleration increases to the selected level. The deceleration level can be changed (without disarming the system) by rotating the selector.

To maintain the selected airplane deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The system provides braking to a complete stop or until it is disarmed.

Autobrake – Disarm

The system disarms immediately, the AUTO BRAKES light illuminates, and the EICAS advisory message AUTOBRAKES displays if any of the following occur:

- pedal braking applied
- either thrust lever advanced after landing
- speedbrake lever is moved from the full up position after the speedbrakes have deployed on the ground
- DISARM or OFF position selected on the autobrakes selector
- autobrake fault
- normal antiskid system fault

When the autobrakes system disarms after landing:

- the autobrakes selector automatically moves to the DISARM position
- power is removed from the autobrake system
- the AUTO BRAKES light illuminates

When the autobrake system disarms during takeoff, the autobrakes selector remains in the RTO position. After takeoff, the autobrakes selector automatically moves to OFF.

Parking Brake

The parking brake can be set with the normal or alternate brake hydraulic system pressurized. If the normal and alternate brake systems are not pressurized, parking brake pressure is maintained by the brake accumulator. The brake accumulator is pressurized by the right hydraulic system. Accumulator pressure is shown on the BRAKE PRESS indicator.

The parking brake is set by fully depressing both brake pedals, pulling the parking brake handle up, then releasing the pedals. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the parking brake handle releases.

The PARK BRAKE light illuminates and the EICAS advisory message PARKING BRAKE displays when the parking brake is set.

Brake Temperature Indication

Wheel brake temperatures are displayed on the EICAS status page. Numerical values related to wheel brake temperature are displayed for each main gear brake. Brake temperature values range from 0 to 9. Temperature values are not instantaneous and tend to build for 10 to 15 minutes after the brakes are applied. Initial range values of 0 to 2 are cyan numbers in a cyan box. For normal range values of 3 and 4, the number is cyan and the box is white for the first brake per truck that exceeds a value of 2. Values in the high range of 5 to 9 have a white number and box. The BRAKE TEMP light illuminates for values of 5 and above.

Tailskid

The airplane is equipped with a tailskid system. The tailskid extends with the landing gear for takeoff and landing and retracts during flight. It helps to protect the pressurized part of the airplane from contact with the runway. The tailskid uses the main landing gear actuation system.

The TAILSKID light illuminates and the EICAS advisory message TAILSKID is displayed when the tailskid position disagrees with the landing gear lever position.

Intentionally
Blank

Landing Gear EICAS Messages

Chapter 14 Section 30

Landing Gear EICAS Messages

The following EICAS messages can be displayed.

Note: Refer to Chapter 15, Warning Systems, for configuration warning messages.

Brakes

Message	Level	Light	Aural	Condition
ANTISKID	Advisory	ANTISKID		A fault is detected in the antiskid system.

1403-1404, 1501-1506, 1521, 1602-1613, 1701-1708

ANTISKID OFF	Advisory	ANTISKID		Antiskid system is inoperative.

121-139, 171-199, 1200-1201, 1401-1402, 1601

ANTISKID OFF	Advisory	OFF		Antiskid system is inoperative.

AUTOBRAKES	Advisory	AUTO BRAKES		Auto brakes are disarmed or inoperative.
BRAKE SOURCE	Advisory	BRAKE SOURCE		Normal and alternate brake system pressures are low.
PARKING BRAKE	Advisory	PARK BRAKE		The parking brake is set.
RSV BRAKE VAL	Advisory	VALVE		Valve(s) position disagrees with the commanded position.

Landing Gear

Message	Level	Light	Aural	Condition
AIR/GND SYS	Advisory			Air/ground sensing system failed.

Message	Level	Light	Aural	Condition
GEAR DISAGREE	Caution	GEAR	Beeper	Gear position disagrees with landing gear lever position.
GEAR DOORS	Advisory	DOORS		One or more gear doors are not closed.
L DRAG BRACE R DRAG BRACE	Caution	GEAR	Beeper	The main gear drag brace is not locked down.
L SIDE BRACE R SIDE BRACE	Caution	GEAR	Beeper	The main gear side brace is not locked down.
NOSE A/G SYS	Advisory			Nose air/ground sensing system failed.

Tailskid

Message	Level	Light	Aural	Condition
TAILSKID	Advisory	TAILSKID		Tailskid position disagrees with landing gear lever position.

Warning Systems

Chapter 15

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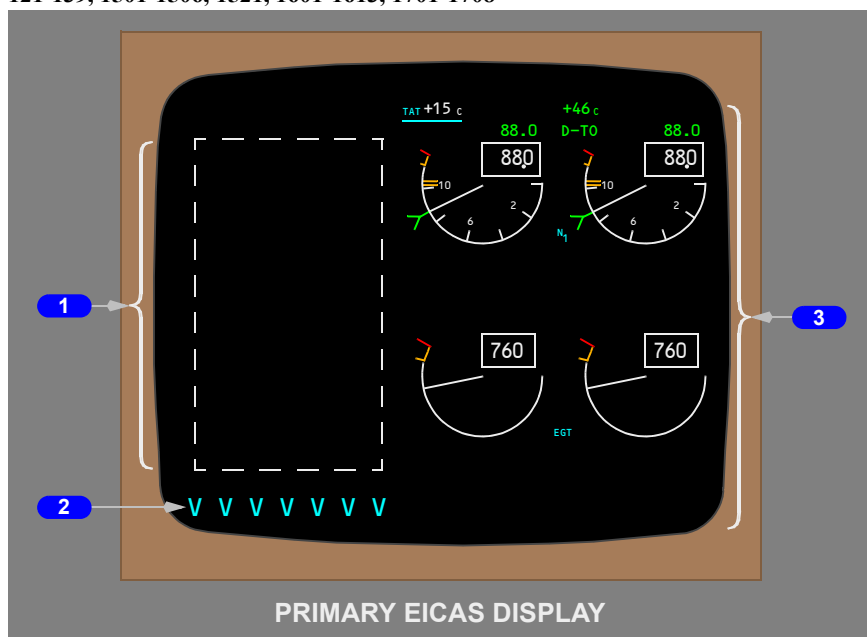
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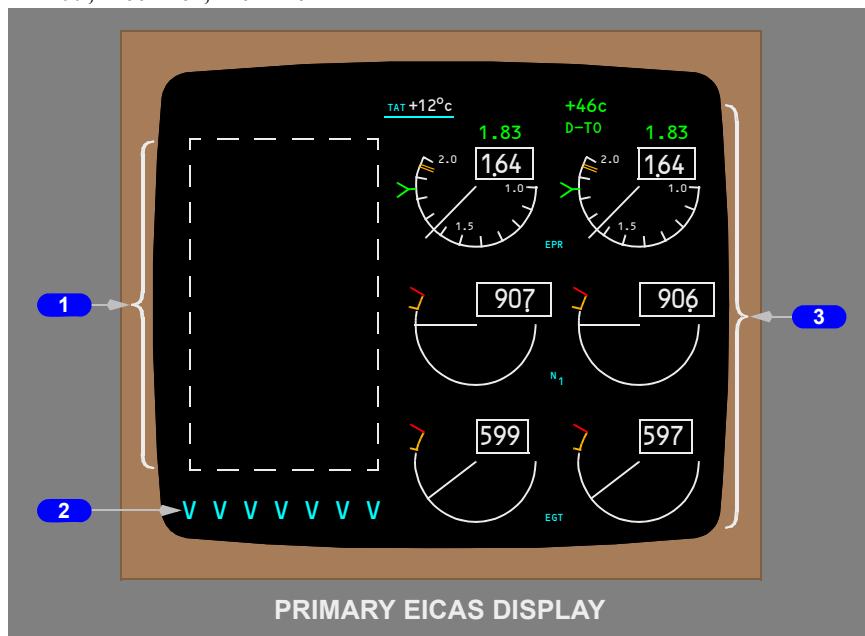
Intentionally
Blank

Engine Indication and Crew Alerting System (EICAS) Primary EICAS Display

121-139, 1501-1506, 1521, 1601-1613, 1701-1708



171-199, 1200-1201, 1401-1404



1 EICAS Message Field

Eleven lines are available for system and communications alerts.
Additional pages are available.

2 Engine Secondary Data Cue

Displays (cyan) – secondary engine data should be displayed on lower CRT.

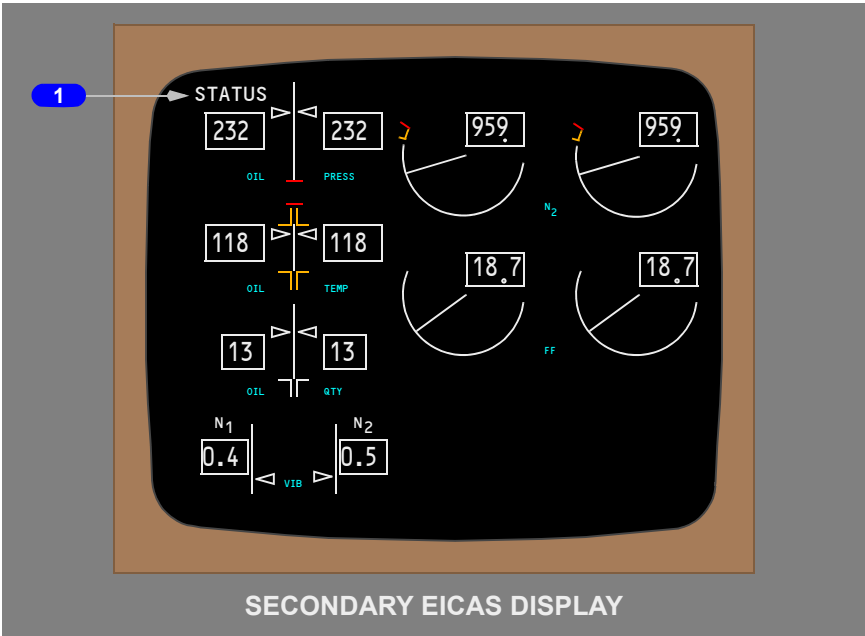
3 Primary Engine Indications

Displays full time on the EICAS display.

121-139, 1501-1506, 1521, 1601-1613, 1701-1708



171-199, 1200-1201, 1401-1404



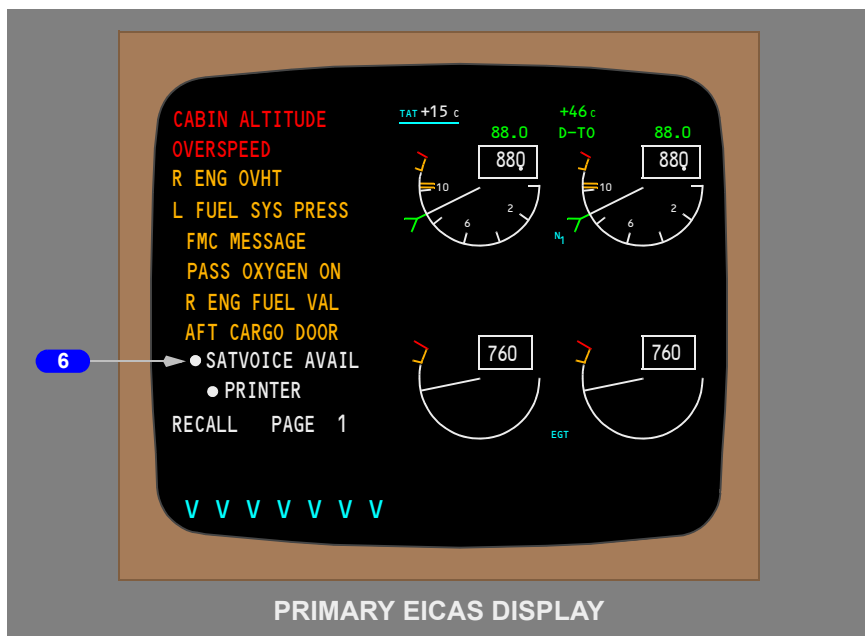
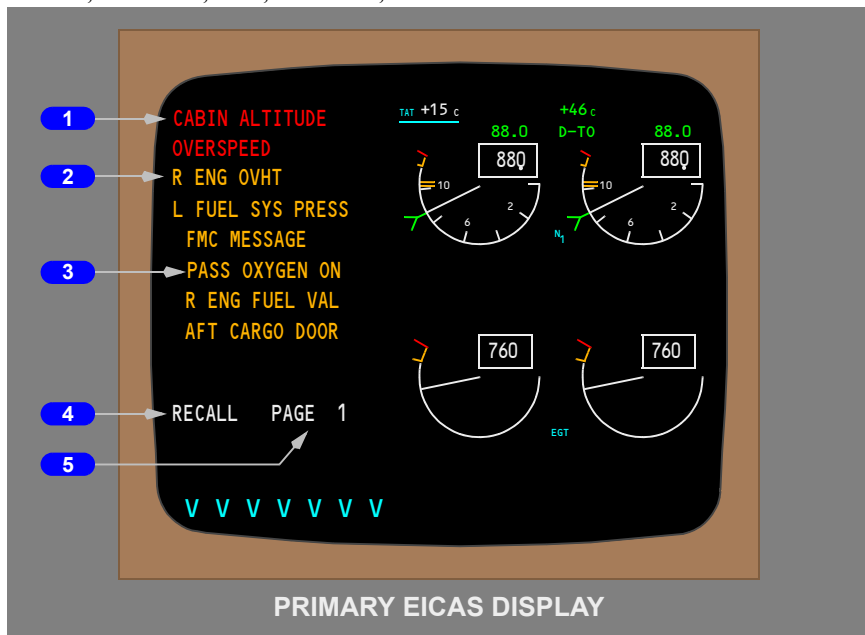
1 Status Cue

Displays when a new status message exists.

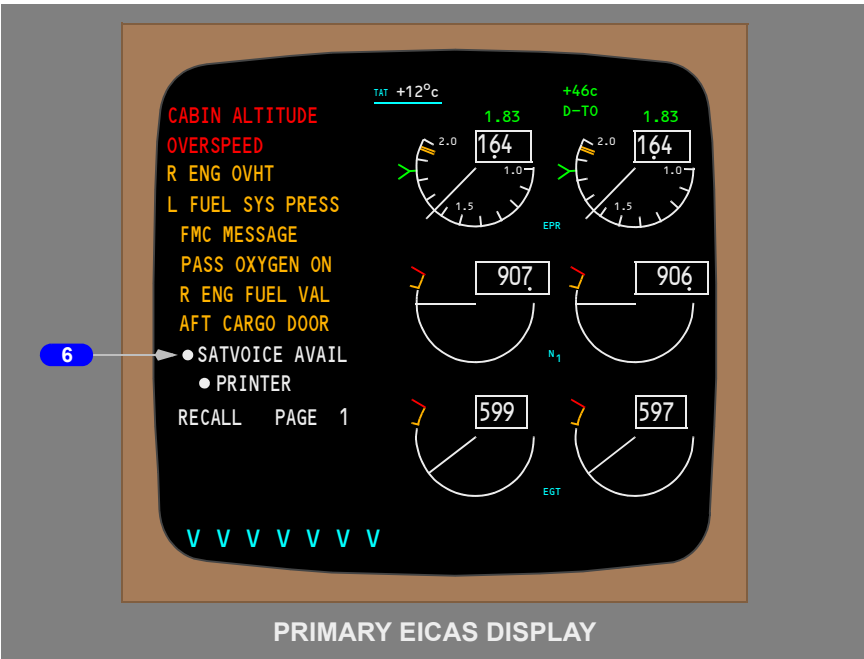
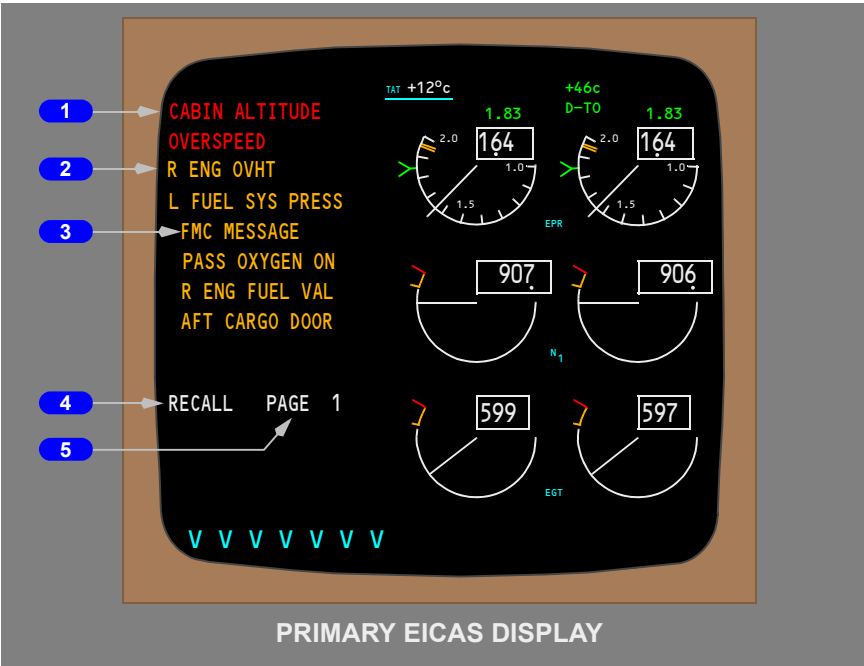
Removed when the status page is displayed.

EICAS Message Display

121-139, 1501-1506, 1521, 1601-1613, 1701-1708



171-199, 1200-1201, 1401-1404



1 Warning Messages

Displays (red) – the highest priority alert messages.

2 Caution Messages

Displays (amber) – the next highest priority alert messages after warning messages.

3 Advisory Messages

Displays (amber) –

- the lowest priority alert messages
- indented one space.

4 Recall Indication

Displays when the RECALL switch is pushed.

Remains displayed for one second after the switch is released.

5 Page Number

Displays (white) –

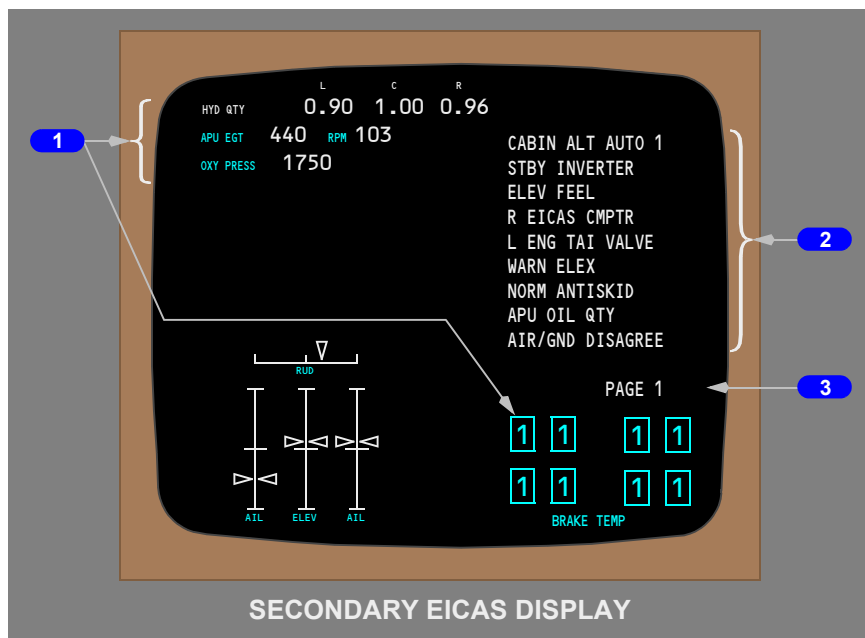
- more than one page of alert or communication messages exists
- indicates the number of the page selected.

6 Communication Messages

Displays (white) –

- indicates incoming communication messages
- preceded by a white dot
- COMM LOW messages are indented one space.

EICAS Status Display



1 Status Display

Displays system indications and status messages.

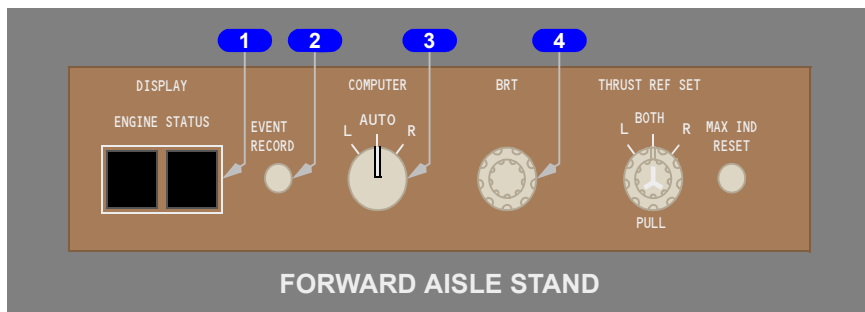
2 Status Messages

Status messages indicate conditions requiring minimum equipment list (MEL) reference for dispatch.

3 Page Number

A page number appears if additional pages of status messages exist.

EICAS Control Panel



1 STATUS Display Switch

Push – displays the status display on the lower EICAS CRT.

Subsequent pushes –

- displays the next page of status messages when additional pages exist
- the status display blanks after the last page of status messages is displayed.

2 EVENT RECORD Switch

Push – records the last EICAS event into memory.

3 COMPUTER Selector

L – left EICAS computer controls displays.

AUTO – EICAS display control automatically transfers to the right EICAS computer if the left computer fails.

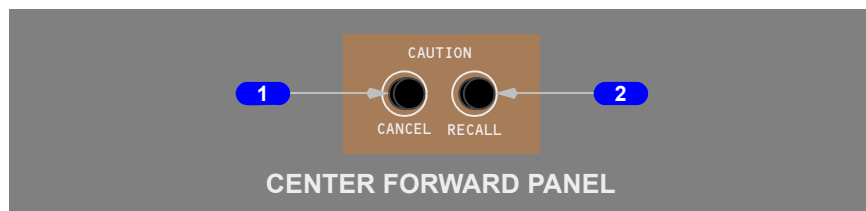
R – right EICAS computer controls displays.

4 Brightness (BRT) Control

Rotate –

- Outer control – adjusts brightness of lower display
- Inner control – adjusts brightness of upper display.

Caution Cancel/Recall Switches



1 CANCEL Switch

Push –

- displays the next page of EICAS messages when additional pages exist
- cancels caution and advisory messages when the last page is displayed

Note: Warning messages remain.

Note: Communication messages remain.

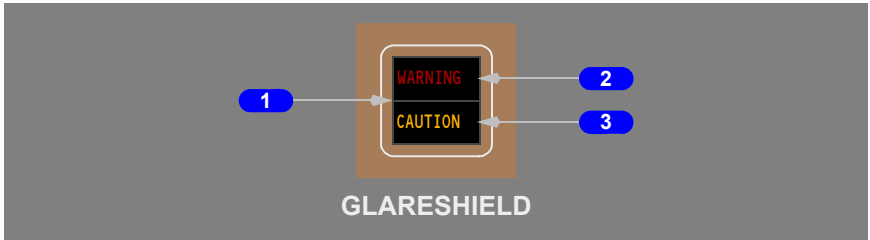
2 RECALL Switch

Push –

- displays the previously cancelled EICAS messages, if the associated condition(s) still exist
- displays the first page of messages when multiple pages exist.

Warning System Switches and Lights

Master Warning/Caution Reset Switches and Lights



1 Master WARNING/CAUTION Reset Switch

Push –

- extinguishes the master WARNING lights
- extinguishes the Master CAUTION lights
- silences most associated aural alerts (for exceptions, see Section 20, Master Warning/Caution Reset Switches and Lights)

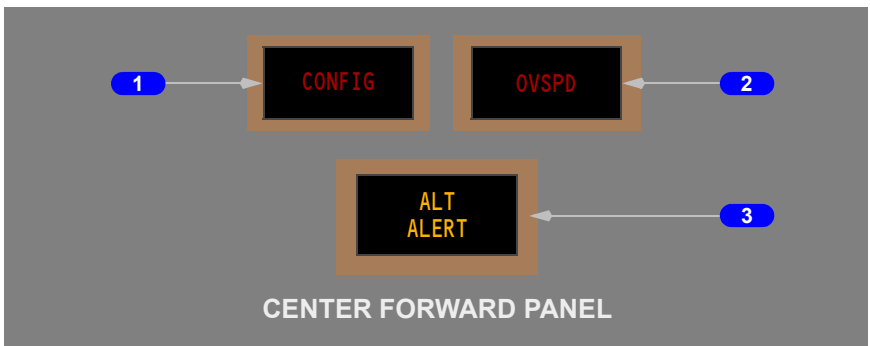
2 Master WARNING Light

Illuminated (red) – a time critical warning or warning condition exists

3 Master CAUTION Light

Illuminated (amber) – a caution condition exists

Miscellaneous Lights



1 Configuration (CONFIG) Light

Illuminated (red) – a configuration warning exists

2 Overspeed (OVSPD) Light

Illuminated (red) – airplane is exceeding Mmo or Vmo

3 Altitude Alert (ALT ALERT) Light

Illuminated (amber) –

- between 250 and 750 foot deviation from selected altitude



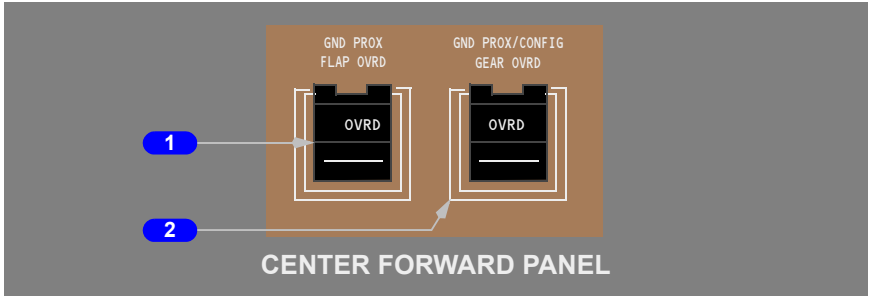
1 Altimeter Altitude (ALT) Light

Illuminated (white) –

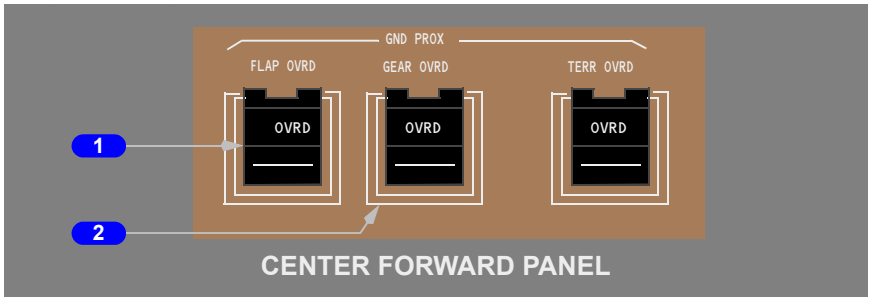
- between 250 and 750 foot deviation from selected altitude

Ground Proximity Warning System (GPWS) GPWS Controls

121-199, 1200-1201, 1401-1403, 1501-1506, 1521, 1601-1602, 1701-1704



1404, 1603-1613, 1705-1708



1 Ground Proximity Flap Override (GND PROX FLAP OVRD) Switch

Push (OVRD visible) –

- inhibits the ground proximity TOO LOW FLAPS caution
- inhibits the ground proximity TOO LOW TERRAIN caution

1404, 1603-1613, 1705-1708

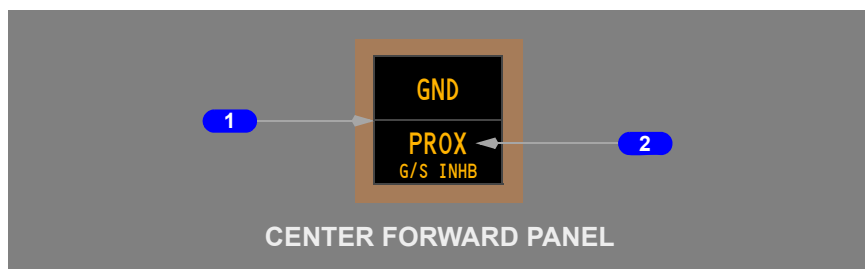
Note: The EICAS advisory message GND PROX SYS is displayed when FLAP OVRD is selected for more than 60 seconds while airspeed is greater than 250 knots.

2 Ground Proximity Configuration Gear Override (GND PROX/CONFIG GEAR OVRD) Switch

Push (OVRD visible) –

- inhibits the ground proximity TOO LOW GEAR caution
- inhibits the ground proximity TOO LOW TERRAIN caution
- inhibits the landing configuration warning siren

Note: The EICAS advisory message GND PROX SYS is displayed when GEAR OVRD is selected for more than 60 seconds while airspeed is greater than 290 knots.



1 Ground Proximity Glide Slope Inhibit (GND PROX G/S INHB) Switch

Push –

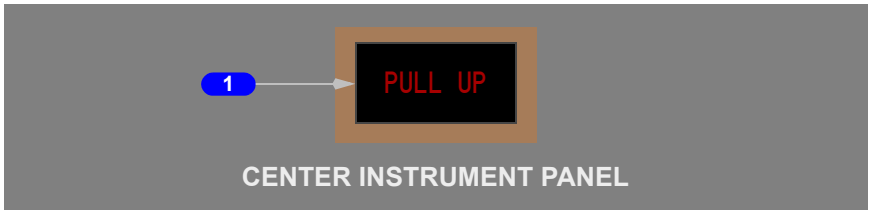
- illuminates (amber) the glideslope inhibit (G/S INHB) light
- inhibits the ground proximity GLIDE SLOPE caution when below 1,000 feet radio altitude

2 Ground Proximity (GND PROX) Light

Illuminated (amber) –.

- a ground proximity caution exists
- an enhanced GPWS look-ahead caution exists

GPWS Immediate-Alert Annunciations



1 PULL UP Light

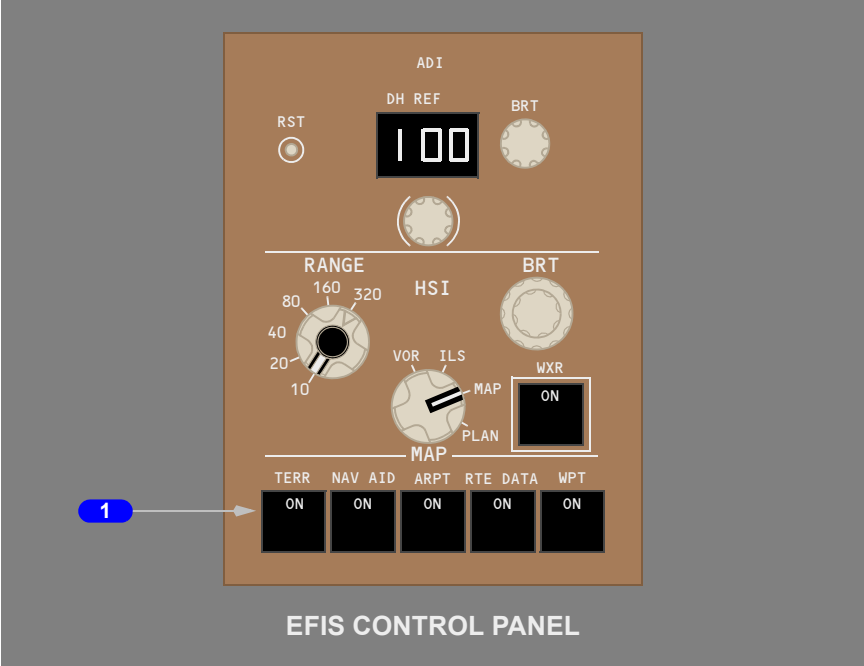
PULL UP (red) –

- the airplane descent rate is severe
- the airplane closure rate is excessive with the landing gear and/or flaps not in the landing configuration
- a GPWS look-ahead warning exists

GPWS with Look-Ahead Display and Alerting

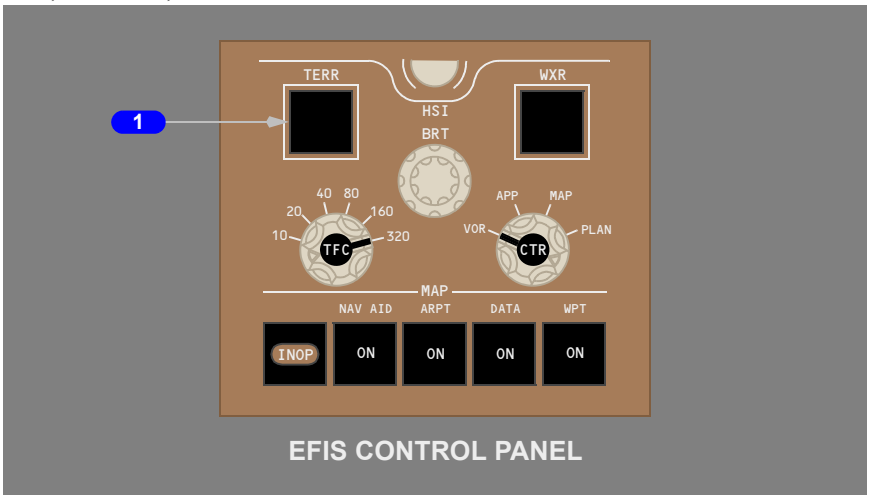
Look-Ahead Display Switches

121, 124-139, 1401-1403, 171-199, 1200-1201, 1501-1506, 1521, 1601-1602, 1701-1705



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1404, 1603-1613, 1705-1708

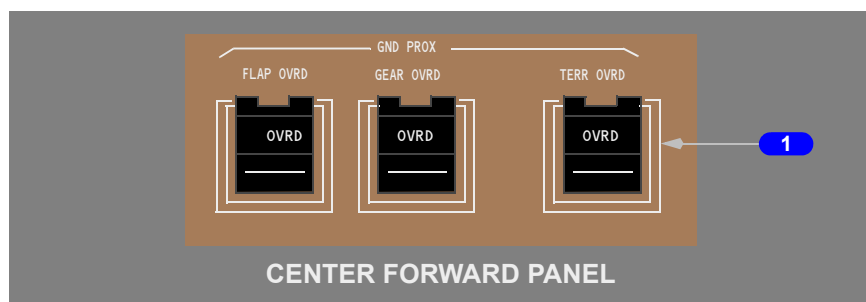


1 Terrain (TERR) Display Select Switch

Push –

- displays GPWS look-ahead data in VOR, APP, MAP, and CTR MAP modes
- arms GPWS look-ahead data in CTR VOR, CTR APP, and PLAN modes
- deselects the weather radar display regardless of the HSI mode selector position
- second push deselects GPWS look-ahead display

Look-Ahead Inhibit Switches

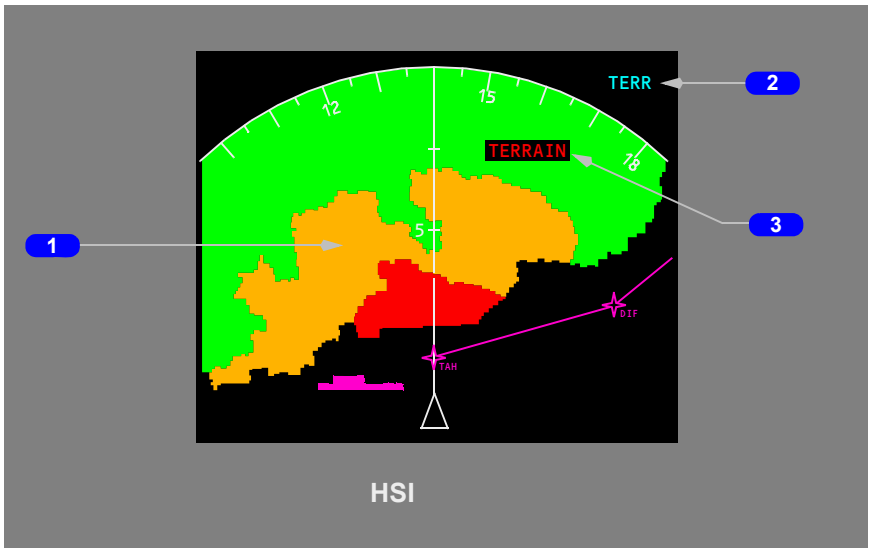


1 Terrain System Override Switch

Push – (OVRD visible)

- inhibits GPWS look-ahead alerts and displays
- second push deselects inhibit

Terrain Display



1 Terrain Display

Color and density vary based on terrain height verse airplane altitude:

- dotted green: terrain from 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude
- dotted amber: terrain 500 feet (250 feet with gear down) below to 2,000 feet above the airplane's current altitude
- dotted red: terrain more than 2,000 feet above airplane's current altitude
- dotted magenta: no terrain data available
- solid amber: look-ahead terrain caution active.
- solid red: look-ahead terrain warning active

Note: In areas without terrain data, look-ahead terrain alerting and display functions are not available. GPWS immediate-alert modes function normally.

Note: Terrain more than 2,000 feet below airplane altitude or within 400 feet of nearest airport runway elevation does not show.

Terrain is displayed automatically when:

- a look-ahead terrain alert occurs; and
- Terrain (TERR) Display Select Switch is not selected by either pilot; and
- HSI Mode Selector in the VOR, APP, MAP, or CTR MAP mode

The look-ahead display updates with a sweep similar to the weather radar display.

2 Terrain (TERR) Mode Annunciation

TERR (cyan) – terrain display enabled (manual or automatic display)

3 TERRAIN Annunciation

TERRAIN (red):

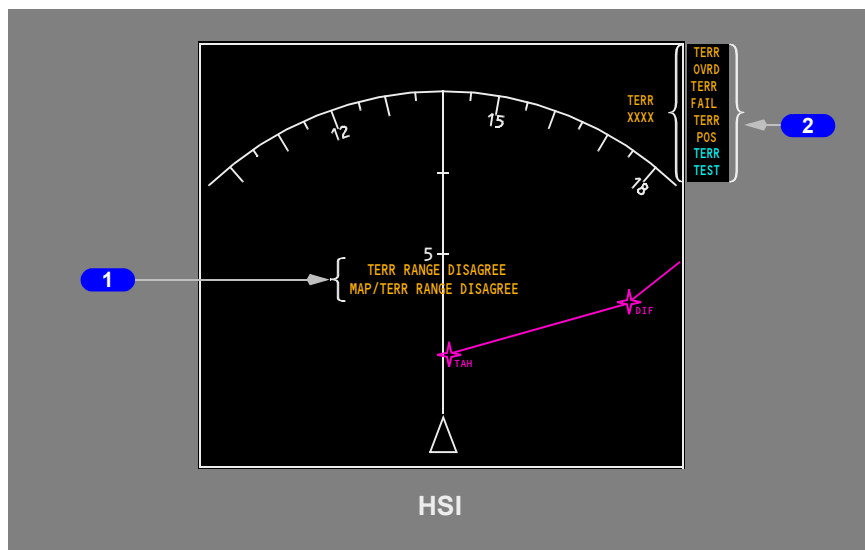
- terrain warning is occurring
- 20-30 seconds from projected impact with terrain

TERRAIN (amber):

- terrain caution is occurring
- 40-60 seconds from projected impact with terrain

Note: TERRAIN annunciation displays in all HSI modes.

Look-Ahead HSI Systems Annunciations



1 Terrain Range Disagree Annunciation

TERR RANGE DISAGREE (amber) –

- GPWS look-ahead display enabled
- GPWS look-ahead display output range disagrees with the HSI Range Selector

MAP/TERR RANGE DISAGREE (amber) –

- GPWS look-ahead display enabled
- GPWS look-ahead display output range disagrees with the HSI Range Selector
- map display output range disagrees with the HSI Range Selector

2 GPWS Status/Mode Annunciation

TERR OVRD (amber) – GND PROX TERR OVRD switch pushed

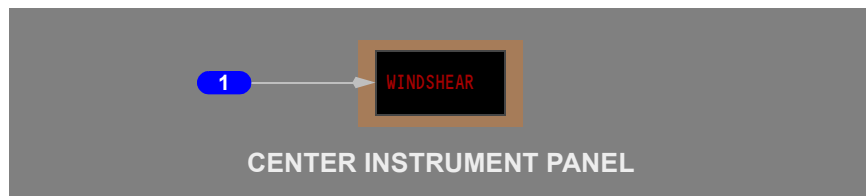
TERR FAIL (amber) – GPWS look-ahead alerting and display have failed

TERR POS (amber) – GPWS look-ahead alerting and display unavailable due to FMS position uncertainty

TERR TEST (cyan) – GPWS operating in self-test mode

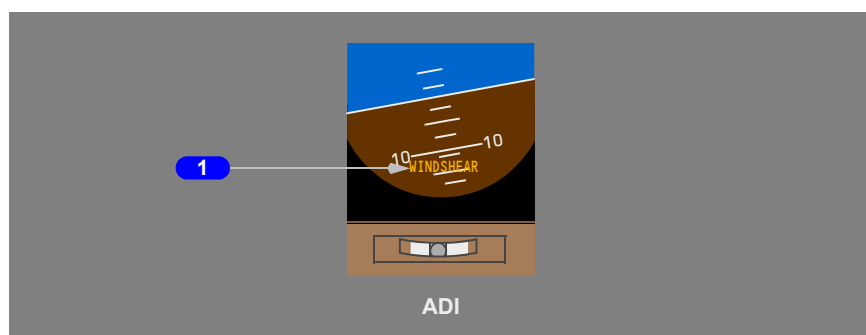
Windshear Warning System

Windshear Immediate-Alert Annunciations



1 WINDSHEAR Light

WINDSHEAR (red) – encountering a windshear condition



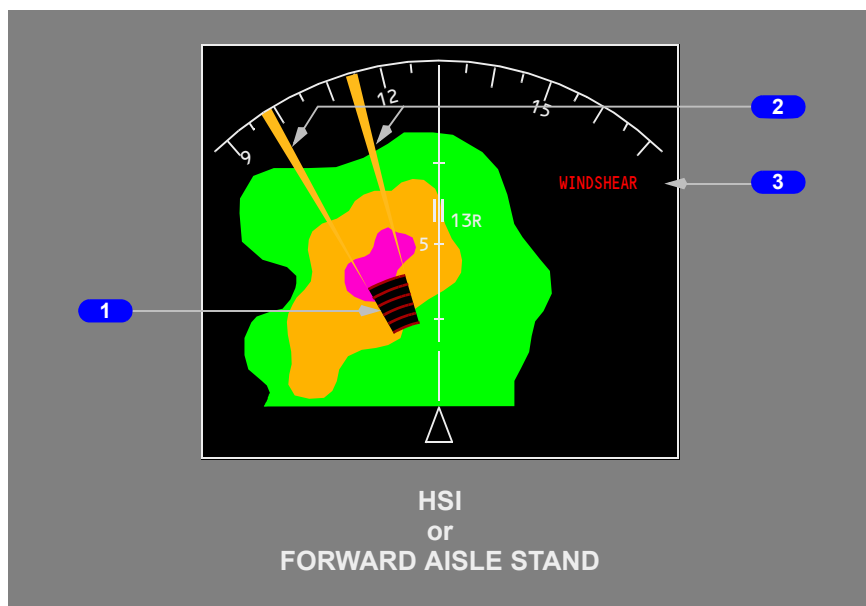
1 WINDSHEAR Annunciation

WINDSHEAR (red) – encountering a windshear condition

Predictive Windshear (PWS)

As installed

PWS Displays



1 Predictive Windshear Symbol

Displayed (red and black) – PWS alert active

Shows predicted windshear location and approximate geometric size (width and depth).

Symbol and radials display automatically on an HSI or on the Weather Radar Indicator when:

- the aircraft is below 1200' AGL
- a PWS alert occurs
- the respective HSI Mode Selector is in the VOR, APP, MAP or CTR MAP mode
- the TERR switch on the respective EFIS control panel is not pushed
- the Weather Radar Indicator Mode Selector is not in the OFF mode

2 Predictive Windshear Symbol Radials

Displayed (amber) – PWS alert active

Extend from predictive windshear symbol to help identify location of the PWS event.

3 WINDSHEAR

WINDSHEAR (red) – PWS warning is active

WINDSHEAR (amber) – PWS caution is active

Note: The size of the PWS symbol is proportional to the geographic size of the PWS event it represents and bears no relationship to its intensity.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls

Transponder Panel



1 TCAS Mode Selector

STBY – places transponders and TCAS system in standby

- displays TCAS OFF on Weather Radar Indicator
- displays TCAS STBY on VSI

ALT OFF/ALT ON – activates transponders with or without altitude reporting, TCAS system in standby

- displays TCAS OFF on Weather Radar Indicator
- displays TCAS STBY on VSI

TA – enables TCAS in Traffic Advisory mode

- display of Traffic Advisory (TA) symbols
- voice alerts
- displays TA ONLY on Weather Radar Indicator
- displays TA ONLY on VSI

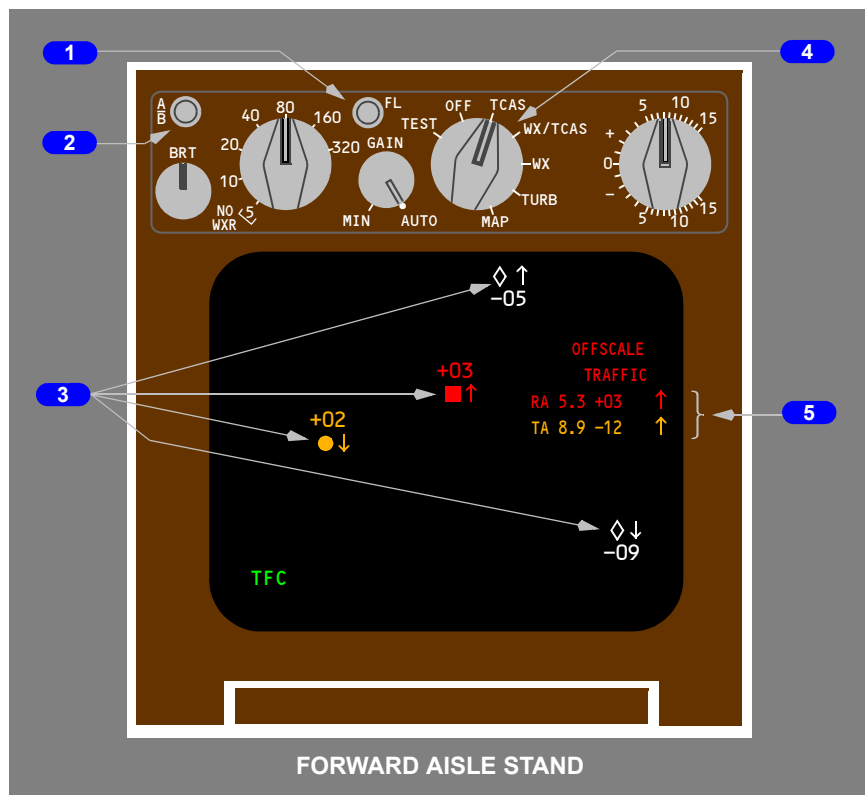
TA/RA – enables TCAS in Traffic Advisory and Resolution Advisory mode

- display of Traffic Advisory (TA) and Resolution Advisory (RA) symbols
- voice alerts
- vertical guidance for RAs
- displays TFC on Weather Radar Display.

TCAS Displays

VSI with TCAS Display

Weather Radar



1 Flight Level (FL) Switch

Push – replaces traffic’s relative altitude with absolute altitude in flight level format for 15 seconds. This function is inhibited at low altitude.

2 Above/Below (A/B) Switch

A (above) – sets TCAS-monitored airspace from 2700 feet below to 8700 feet above own airplane

B (below) – sets TCAS-monitored airspace from 8700 feet below to 2700 feet above own airplane.

3 Traffic Aircraft Symbology

Indicates the relative position of traffic aircraft.

4 Mode Selector

TEST – activates system test.

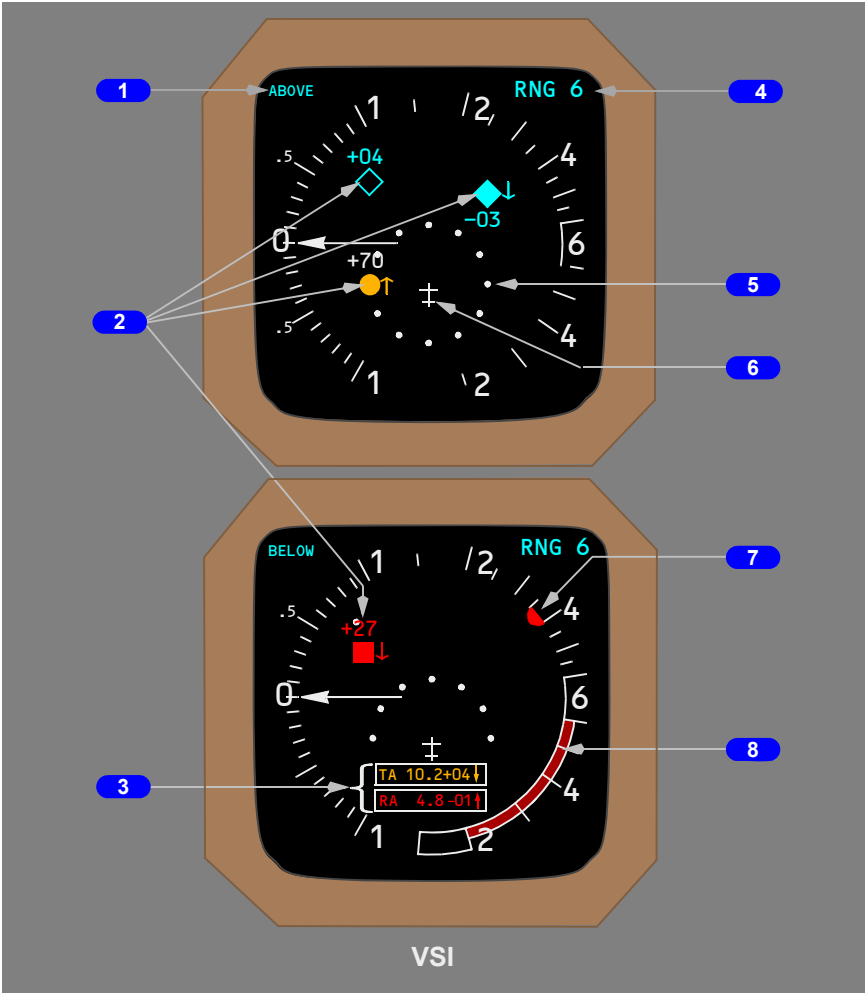
OFF – deactivates radar and indicator.

TCAS – displays TCAS traffic data.

WX/TCAS – displays TCAS traffic data and weather radar returns at selected gain level.

5 No-Bearing Symbolology

Indicates that an traffic alert (TA or RA) is occurring with no bearing information available.





1 (Blank)

Above/Normal/Below mode switching not installed.

2 Traffic Aircraft Symbolology

Indicates the relative position of traffic aircraft.

3 No Bearing Symbolology

Indicates that an traffic alert (TA or RA) is occurring with no bearing information available.

4 Range Annunciations

Indicates the TCAS display range selected on the TCAS control panel.

5 Range Ring

Displayed (white) – 2 mile range from airplane symbol.

6 Own Airplane Symbol

Displayed (white) – traffic aircraft are displayed relative to the airplane

7 Offscale Aircraft Symbolology

Displayed (red or amber):

- a TA (amber) or RA (red) is occurring outside the display range
- appears as a half-filled amber circle or a half-filled red square

8 Vertical Guidance

Displayed (red and green):

- RA is occurring
- red indicates vertical speeds to avoid
- green (or no colored arc) indicates safe vertical speeds

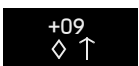
9 Failure Annunciations

See VSI TCAS symbology tables.

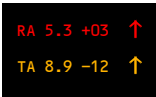
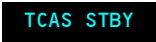
10 Mode Annunciations

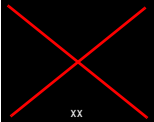
See VSI TCAS symbology tables.

VSI TCAS Symbology

Symbol	Name	Location	Remarks
	TCAS resolution advisory (RA), relative altitude (R)		These symbols are displayed when TA or TA/RA is selected with the transponder mode selector.
	TCAS traffic advisory (TA), relative altitude (A)		The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed.
	TCAS proximate traffic, relative altitude (W)		The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.
	TCAS other traffic, relative altitude (W)		The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.

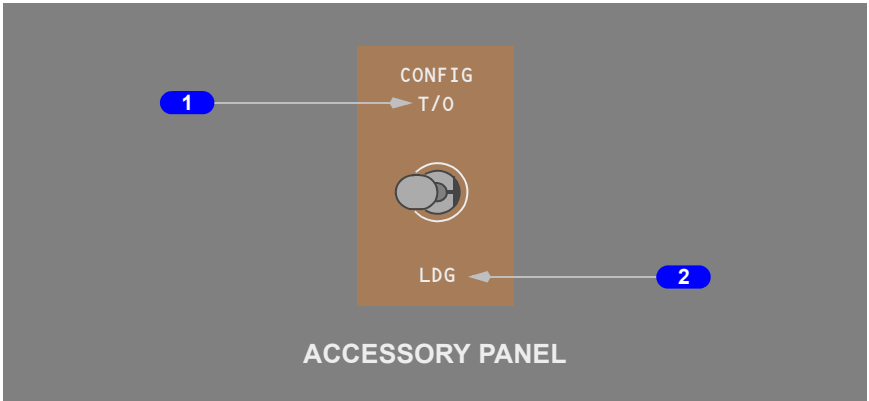
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Symbol	Name	Location	Remarks
	TCAS no bearing message (RA-R, TA-A)	Lower Center	A TA (amber) or RA (red) is occurring and bearing information is not available • maximum of two messages • data tag provides distance (nm), relative altitude (hundreds of feet), and vertical motion (in excess of 500 feet per minute)
	TCAS display range (C)	Upper Right	TCAS display range in nautical miles.
	TCAS mode (C)	Lower Left	TCAS computer is not computing RAs. TCAS control panel Mode Selector in: • TA
	TCAS standby mode (C)	Lower Left	TCAS computer is in standby mode and not computing TAs or RAs. TCAS control panel Mode Selector not in: • TA/RA or • TA
	TCAS test mode (C)	Lower Left	TCAS self-test is in progress.

Symbol	Name	Location	Remarks
	TCAS fail message (A)	Lower Left	TCAS system is not operational.
	TCAS display fail message (A)	Lower Center	Indicates TCAS display failure.
	RA fail message (A)	Lower Center	TCAS RAs are not available.
	VSI display failure (R)		Red cross on blank display indicates failure of the VSI display. TCAS Voice annunciations will still occur.

Miscellaneous Switches

Configuration (CONFIG) Test Switches



1 Takeoff (T/O) Test Switch

Spring-loaded to center

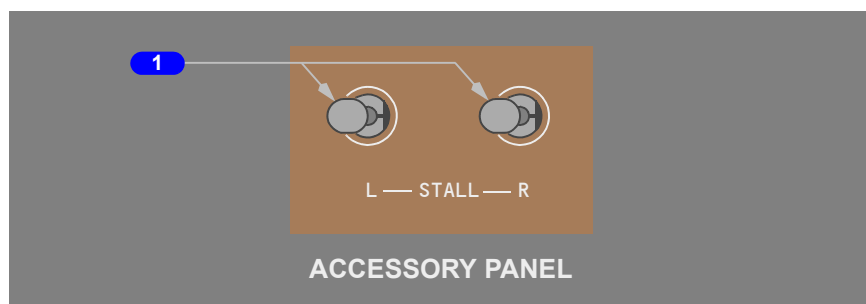
T/O – activates configuration warning if improper takeoff configuration exists

2 Landing (LDG) Test Switch

Spring-loaded to center

LDG – activates a landing configuration warning

Stall Warning Test Switches

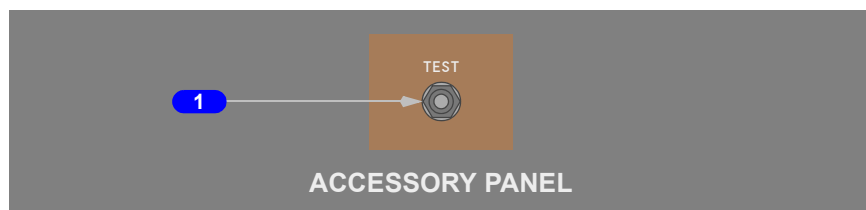


1 Stall (STALL L/R) Warning Test Switch

Spring-loaded to center

Activates stall warning system

EICAS Test Switch



1 TEST Switch

Push – activates EICAS test

Warning Systems

System Description

Chapter 15

Section 20

Introduction

The warning system consists of the following separate systems:

- engine indication and crew alerting system (EICAS)
- warning system
- ground proximity warning system (GPWS)

These systems provide all airplane crew alerting.

Alert is defined as a visual, tactile and/or aural alert requiring crew awareness and possible crew action.

Engine Indication and Crew Alerting System (EICAS)

EICAS consolidates engine and subsystem indications and provides a centrally located crew alerting message display. EICAS also displays some system status and maintenance information. EICAS provides:

- system alerts
- maintenance information
- status messages
- communication alerts

System Alert Messages

System alert messages are associated with aircraft-system failures or faults. These may require performance of non-normal procedures, or affect the way the flight crew operates the airplane. There are four categories of system alert messages:

- time critical warning
- warning
- caution
- advisory.

Non-normal airplane system conditions not affecting the normal operation of the airplane are not alert conditions. These are annunciated using status or maintenance messages.

System alert messages not associated with aircraft-system failures or faults but which may affect the way the flight crew operates the airplane include the following:

- configuration
- airspeed
- altitude
- windshear

- Ground Proximity Warning System (GPWS)
- communication alert messages such as SELCAL, ACARS, ATC or PRINTER
- FMC messages (See Chapter 11, Flight Management, Navigation)

Non-normal airplane system conditions not affecting the normal airplane operations are annunciated using status or maintenance messages.

System Alert Level Definitions

Time Critical Warnings

Time critical warnings alert the crew of a non-normal operational condition requiring immediate crew awareness and corrective action to maintain safe flight. Time critical warnings are usually associated with primary flight path control. Master WARNING lights, voice alerts, and ADI indications or stick shakers announce time critical warning conditions.

Warnings

Warnings alert the crew to a non-normal operational or system condition requiring immediate crew awareness and corrective action.

Cautions

Cautions alert the crew to a non-normal operational or system condition requiring immediate crew awareness. Corrective action may be required.

Advisories

Advisories alert the crew to a non-normal operational or system condition requiring routine crew awareness. Corrective action may be required.

Communication Alerts

Communication alerts are triggered by the communication management system. These alerts direct the crew to the appropriate message display:

There are three levels of communication alert:

- low – identifies an incoming communication requiring timely awareness and response
- medium – identify an incoming communication requiring immediate awareness and a prompt response. It is accompanied by an aural chime
- high – reserved for future use.

A detailed description of the communication management system is described in Chapter 5, Communications.

Status Messages

Status messages identify system faults affecting airplane dispatch and are not considered crew alerts. The messages are displayed on the EICAS STATUS page.

Alert Message Displays

Alert messages are displayed in both prioritized and chronological order. The priority in descending order is:

- warning (red)
- caution (amber)
- advisory (amber, indented)
- medium level communication (white, preceded by a dot)
- low level communication (white, indented, preceded by a dot)

Warnings, cautions, and advisories are displayed from the top down in the EICAS display message area.

The most recent message is displayed at the top of its respective level.

If the number of messages exceeds eleven, the area below the alert field displays a page cue, indicating more than one page of messages is available for display. Paging is accomplished by pushing the CANCEL/RECALL switch on the display select panel.

Warning alerts can only be cleared by correcting the condition causing the warning. All caution and advisory alerts can be cleared. When the last page is displayed, pushing the CANCEL/RECALL switch clears all displayed caution and advisory alerts. Cleared caution and advisory alerts whose conditions still exist can be recalled by pushing the CANCEL/RECALL switch again. This also recalls the first page for review.

Communication alert messages are displayed at the bottom of the message area. Except for the Communication Alert Line, an overflow of system alert messages displaces communication alerts.

The Communication Alert Line, the bottom line of the EICAS message field (line 11), is reserved for a communication alert (medium or low) if one is active. The Communication Alert Line can not be displaced by a system alert even if more than 10 lines are active.

Communication alerts are removed when a pilot has acknowledged the communication alert via the appropriate display unit or selects the appropriate switch on the Pilot's call panel (See Chapter 5, Communications).

Master Warning/Caution Reset Switches and Lights

Two Master WARNING/CAUTION reset switches each contain a Master WARNING light and Master CAUTION light.

The red Master WARNING lights illuminate when any warning alert or time critical warning occurs (except a stall warning). The lights remain illuminated as long as the warning alert exists or until either Master WARNING/CAUTION reset switch is pushed. Pushing either switch:

- extinguishes both Master WARNING lights
- resets the lights for future warning alerts.

Pushing either Master WARNING/CAUTION reset switch also silences the warning siren and fire bell except for the following warnings:

- landing configuration (for example, when the flaps are in a landing position and landing gear are not down)
- autopilot disconnect
- takeoff configuration
- overspeed warning

Pushing either Master WARNING/CAUTION reset switch also silences the overspeed warning siren.

The amber Master CAUTION lights illuminate when any caution alert occurs. The lights remain on as long as the caution alert exists or until either Master WARNING/CAUTION reset switch is pushed. Pushing either switch:

- extinguishes both Master CAUTION lights
- resets the lights for future caution alerts.

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used in conjunction with EICAS messages to:

- help locate and identify affected systems and controls
- reduce the potential for error.

The annunciator lights provide system feedback in response to flight crew action. The lights also assist in fault detection and system preflight configuration when the engines are shut down and to supplement EICAS information.

Aural Alerts

Aural alerts are provided to ensure crew attention, recognition, and response. Aural alerts include synthetic voices and tones. Aural voice alerts are the most direct and rapid method of communicating a specific alert condition to the crew. Aural tones are used to alert the crew and to discriminate between the different alert types and levels.

Aural alerts annunciate warning and caution alerts. There are no aural annunciations associated with advisories.

Aural alerts also annunciate medium level communication alerts. There are no aural alerts associated with low level communication alerts.

The aural alerts are:

- **Beeper** – used for all system alert caution level messages. The beeper consists of a tone that sounds four times in a second. The beeper automatically silences after one series of four beeps
- **Bell** – used for fire warnings. The bell sounds repeatedly until crew action is initiated
- **Voice** – synthetic voices annunciate time critical warning alert conditions. Synthetic voices also annunciate certain normal but time critical operational information, such as approach phase altitude callouts.
- **Siren** – used to annunciate cabin altitude, configuration, autopilot disconnect, and overspeed warning alerts. The siren consists of alternating high and low tones
- **Chime** – a high–low tone chime used for medium level communication alerts. The chime sounds once for each communication alert.

All continuous aural alerts are silenced automatically when the respective alert condition no longer exists.

Alert Inhibits

Alerts are inhibited during part of the takeoff in order not to distract the crew. Alerts are also inhibited when they are operationally unnecessary or inappropriate.

Alert messages, except for warnings and messages directly relevant to flight operations, are inhibited during engine start to eliminate nuisance messages.

Alert messages are inhibited individually at other times, such as during the preflight and postflight phases or engine shutdown, when they are operationally unnecessary.

Message Consolidation

On the ground with both engines shut down, certain caution and advisory alert messages are inhibited by collecting them into more general alert messages. These include individual fuel, hydraulic, door, and electrical messages. For example, two or more individual entry, cargo, and access door EICAS messages are replaced by the EICAS advisory message DOORS.

Engine Start Message Inhibits

During ground engine start, most new caution and advisory alerts are inhibited from engine start switch engagement until one of the following occurs:

- the engine reaches idle RPM
- the start is aborted, or
- 2 minutes elapse from engine start switch engagement.

The following messages are not inhibited:

- ENG FUEL VAL
- ENG SHUTDOWN
- ENG STARTER
- FMC MESSAGE
- STARTER CUTOUT.

Takeoff Inhibits

Warning Inhibits

The Master WARNING lights and fire bell are inhibited for fire during part of the takeoff. The inhibit begins at nose gear extension during rotation and continues until the first to occur:

- 400 feet AGL, or
- 20 seconds elapsed time

If a fire occurs during the inhibit, an EICAS warning message appears, but the fire bell and Master WARNING lights do not activate. If the warning condition still exists when the inhibit is removed, the fire bell and Master WARNING lights activate immediately.

Note: Takeoff configuration warnings are terminated at rotation.

Caution Inhibits

The Master CAUTION lights and aural annunciations are inhibited for all cautions during part of the takeoff. The inhibit begins at 80 knots and continues until the first to occur:

- 400 feet AGL, or
- 20 seconds elapsed time following nose gear extension

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If a caution occurs during the inhibit and exists on the ground when the airspeed decreases below 75 knots, both Master CAUTION lights and aural activate.

Note: EICAS caution messages are not inhibited during takeoff.

Advisory Inhibits

The following EICAS advisory messages are inhibited on takeoff:

- DATALINK LOST to indicate data link is temporarily lost.
- **1404, 1603-1613, 1705-1708**
- WINDSHEAR SYS to indicate the windshear alerting functions are inoperative

The inhibit begins from the time either engine is advanced to takeoff thrust until the first to occur:

- 400 feet AGL, or
- 20 seconds elapsed time following nose gear extension

All other EICAS advisory messages are not inhibited on takeoff:

Communication Inhibits

The following are inhibited during takeoff:

- EICAS communication alert messages such as SELCAL, ACARS, ATC or PRINTER and associated aural chimes. The CABIN ALERT message is not inhibited. The chime associated with the CABIN ALERT message is inhibited.

The inhibit begins from the time either engine is advanced to takeoff thrust until the first to occur:

- 400 feet AGL, or
- 20 seconds elapsed time following nose gear extension

Inhibits are cleared on the ground with both engines below takeoff thrust. If a message alert occurs during the inhibit and exists when the inhibit ends, the EICAS alert message and aural chime activate.

Landing Inhibits**Communication Inhibits**

The following are inhibited during landing

- EICAS communication alert messages such as SELCAL, ACARS, ATC or PRINTER and associated aural chimes. The CABIN ALERT message Deleted text for all other associated chimes are not inhibited.

The inhibit begins on descent at 800 feet AGL and terminates at:

- less than 75 knots groundspeed
- 900 feet AGL on missed approach

If a communication alert message occurs during the inhibit and exists when inhibit ends, the EICAS alert message and associated aural chime activate.

Engine Shutdown Inhibits

Engine-driven pumps, generators, and other components whose alert messages would result from an engine shutdown are inhibited by the ENG SHUTDOWN message. When an engine is shutdown (FUEL CONTROL switch in cut off or fire handle pulled), the EICAS alert message L ENG SHUTDOWN or R ENG SHUTDOWN is displayed and the following L or R alerts are inhibited:

- ENG ANTI-ICE
- ENG BLEED OFF
- GEN DRIVE
- GEN OFF
- ENG OIL PRESS
- HYD PRIM PUMP
- **171-199, 1200-1201, 1401-1404, 1521, 1601-1708**
- ENG CONTROL
- **121-139, 1501-1506**
- ENG EEC

When the airplane is on the ground and both FUEL CONTROL switches are in the CUT OFF position, the Master CAUTION lights and the caution alert beeper are inhibited. This prevents alerts associated with routine gate operations from triggering nuisance lights and aural alerts.

When the shutdown inhibit is removed, the Master CAUTION lights and alert beeper do not activate for alerts that existed prior to its removal. For example, if the right hydraulic system is depressurized with both engines shutdown, and the left engine is then started, the Master CAUTION lights and beeper do not activate. The Master CAUTION lights and beeper activate only when the alert first occurs, provided no other inhibit is in effect.

Alert Message Inhibits

Alert message inhibits are those inhibits where one message is inhibited by the presence of another alert message. For example, individual fuel or hydraulic pump pressure messages are inhibited by higher priority system pressure messages.

Certain alert messages are time delayed, even though discrete system lights may illuminate. Time delay inhibits prevent normal in-transit indications from appearing as EICAS system alert messages. For example, valves are generally only sensed open and/or closed, not in-transit. When a valve is in-transit, the alert message indicating the valve has failed to open or close is inhibited to allow the valve time to move to the commanded position. If the valve is not in the commanded position at the end of the inhibit period, an EICAS system alert message is displayed.

Altitude Alerting Inhibits

Altitude alerting is inhibited in flight with all landing gear down and locked.

Master Caution Lights and Beeper Inhibits

The Master CAUTION lights and the associated alert beeper are inhibited for the L and R ENG SHUTDOWN caution level message.

EICAS Event Record

The flight crew can manually capture and record any suspect condition into EICAS memory using the EICAS EVENT RECORD switch.

Systems which provide recorded information when the switch is activated include:

- anti-ice, ice detection
- air systems
- APU
- electrical
- electronic engine control
- fire protection
- flight controls/flaps and slats
- fuel quantity and fuel management
- hydraulic
- landing gear and brakes
- performance.

Only the last manual event recorded will be retained for future retrieval. The event record function also has an automatic feature. When an EICAS event occurs, conditions are automatically written to EICAS memory.

EICAS Failure Indications

If a fault is detected in one of the cathode ray tubes (CRTs), the faulty display is blanked. Engine indications and crew alerting messages appear on the operable display. An EICAS DISPLAY advisory message displays when one CRT fails.

To ensure that all engine indications can be displayed with a CRT failure, an EICAS compacted display mode is available. The compacted display mode is described in the Engines, APU chapter.

If the EICAS control panel fails an EICAS CONT PNL advisory message displays and the EICAS full up engine mode automatically displays. The full engine mode is described in Chapter 7, Engines, APU. The cancel and recall switches will not operate when the EICAS control panel fails, however, brightness and computer select controls remain operative.

If both EICAS computers or CRTs fail, a standby engine indicator (SEI) is automatically activated. The SEI, system lights and indicators are used to monitor the engines and system operation when a total EICAS failure occurs.

Warning System

The warning system consists of flight deck speakers, Master WARNING/CAUTION lights, EICAS alert messages, and stick shaker motors.

The warning system controls and activates alerts for:

- fire (See Chapter 8, Fire Protection)
- cabin altitude (See Chapter 2, Air Systems)
- autopilot disconnect (See Chapter 4, Automatic Flight)
- configuration
- airspeed
- altitude
- Ground Proximity Warning System (GPWS)
- windshear

Configuration Alerts

Takeoff

Takeoff configuration warnings are armed when the airplane is on the ground and thrust is in the takeoff range on either engine. Takeoff configuration warnings consist of:

- Master WARNING lights illuminate
- CONFIG warning light illuminates
- aural warning siren sounds
- applicable EICAS configuration warning alert message(s) are displayed.

Takeoff configuration warning messages include:

- FLAPS
- PARKING BRAKE
- SPOILERS
- STABILIZER.

Takeoff configuration warnings are disarmed at rotation.

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Existing takeoff configuration warning are:

- cancelled when the configuration error is corrected
- terminated at rotation

When a takeoff configuration warning occurs, pushing either Master WARNING/CAUTION reset switch resets the Master WARNING lights but does not silence the siren or clear the EICAS alert message. Before reaching rotation, the siren can be silenced and the EICAS alert message cleared only by retarding both thrust levers or correcting the condition. If thrust is reduced, the EICAS takeoff configuration message remains displayed for 10 seconds so the crew can positively identify the configuration problem.

Holding the configuration test switch in the takeoff (T/O) position simulates accelerating an engine to takeoff power. No warnings occur when testing an airplane properly configured for takeoff. If the airplane is not configured for takeoff a configuration warning results. Releasing the test switch cancels the test.

Landing

The landing configuration warning system alerts the crew that the landing gear is not extended for landing. The landing configuration warning activates if:

- the airplane is in flight, and
- any landing gear is not down and locked, and
- either of the following conditions exists:
 - flaps in a landing position (25 or 30), or
 - any thrust lever is at idle with radio altitude below 800 feet.

The landing configuration warning consists of:

- Master WARNING lights illuminate
- CONFIG warning light illuminates
- aural warning siren activates
- the GEAR NOT DOWN EICAS warning alert message is displayed.

With the flaps in a landing position, the siren and alert message cannot be deactivated with the Master WARNING/CAUTION reset switches. The siren and message continue until the condition is corrected or the gear override switch is pushed.

If the warning is due to an idle thrust setting at low altitude, pushing either Master WARNING/CAUTION reset switch silences the siren and extinguishes the Master WARNING lights. The EICAS message remains displayed until the configuration error is corrected.

Holding the configuration test switch in the landing (LDG) position results in a configuration warning regardless of landing gear position. All warning indications disappear when the switch is released.

Airspeed Alerts

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns. If the flaps are in the retracted position and the angle of attack continues to increase, a control column nudger moves the control column forward. Both systems are energized in flight and deactivated on the ground through air/ground logic.

Holding the stall warning tests switches to either the L or R position checks the left and right stall warning systems, respectively. If the systems are tested at the same time, both columns vibrate and the control column nudger activates.

Overspeed Warning

An overspeed warning occurs if Vmo/Mmo limits are exceeded. The overspeed warning consists of:

- Master WARNING lights illuminate
- OVSPD light illuminates
- the EICAS warning alert message OVERSPEED is displayed
- aural warning siren sounds

All warning indications remain activated until airspeed is reduced below Vmo/Mmo.

The aural warning can be silenced by pushing either Master WARNING/CAUTION reset switch.

Altitude Alerts

Altitude alerting occurs when approaching or departing the MCP-selected altitude.

Approaching a Selected Altitude

At 750 feet prior to reaching the selected altitude, the ALT light on each pilot's altimeter illuminates. At 250 feet prior to reaching the selected altitude, the ALT lights extinguish.

Deviating From a Selected Altitude

When deviating by 250 feet from the selected altitude:

- the Master CAUTION lights illuminate
- the caution aural sounds
- the EICAS caution message ALTITUDE ALERT is displayed
- the ALT ALERT light illuminates.

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When deviating more than 750 feet from the selected altitude, or upon returning to within 250 feet of the selected altitude:

- the Master CAUTION lights extinguish
- the EICAS caution message is no longer displayed
- The ALT ALERT light extinguishes.

Resetting To A Selected Altitude

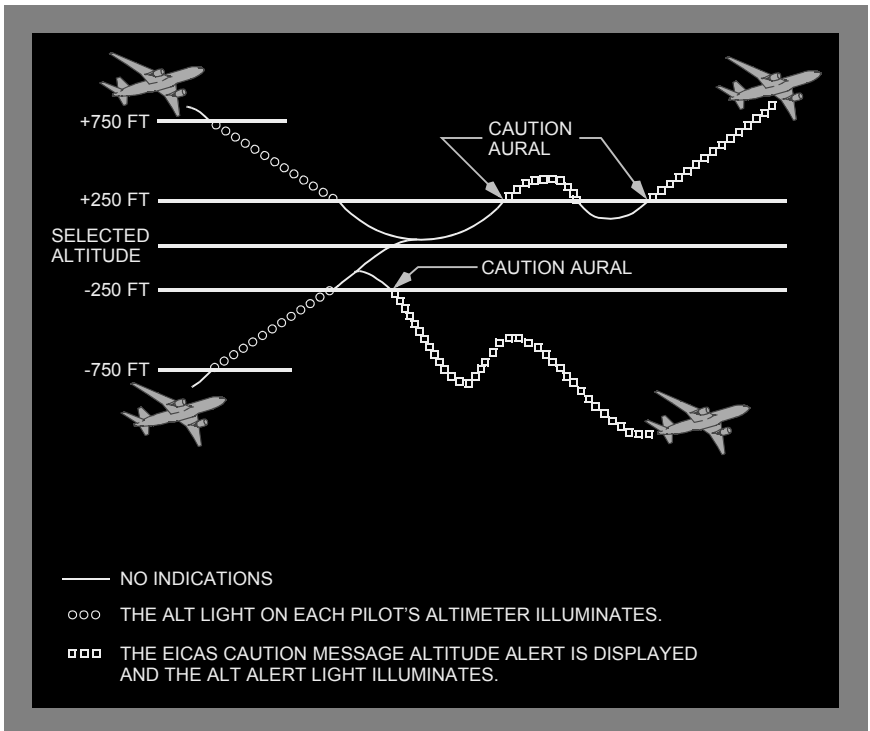
Altitude alerting is reset when:

- the airplane returns to within 250 feet of the altitude selected or deviates more than 750 feet from the altitude selected
- the MCP-selected altitude is changed

Altitude Alert Inhibits

Altitude alerting is inhibited in flight with all landing gear down and locked.

Altitude Alert Profiles



Ground Proximity Warning System (GPWS)

Introduction

GPWS provides time-critical alerts for potentially hazardous flight conditions involving imminent impact with the ground. GPWS is enabled whenever power is applied to the airplane. Override or inhibit switches allow the flight crew to inhibit certain GPWS alerts.

GPWS also provides voice callouts (Mode 6) to assist the flight crew with situational awareness and to advise the flight crew of the aircraft's approximate height above the ground.

GPWS also provides time-critical alerts for potential hazardous flight conditions involving windshear.

Note: Terrain ahead of the airplane may exceed available climb performance. A ground proximity caution or warning does not guarantee terrain clearance.

Note: The GPWS does not provide an alert for flight toward vertically sheer terrain or slow descents into terrain while in the landing configuration.

In addition to aircraft configuration, GPWS requires inputs from the following for proper operation:

- air data system
- inertial reference system
- instrument landing system
- radio altimeters

In addition, the terrain awareness alerting and terrain display functions require inputs from the GPS.

Note: Loss of an input does not necessarily inhibit operation of the entire GPWS.

GPWS immediate alerts are radio altitude based and provided for the following:

- excessive and severe descent rate (Mode 1)
- excessive terrain closure rate (Mode 2)
- altitude loss after takeoff or go-around (Mode 3)
- unsafe terrain clearance when not in the landing configuration (Mode 4)
- excessive deviation below an ILS glide slope (Mode 5)
- altitude awareness (Mode 6)
- windshear (Mode 7)

Enhanced GPWS

In addition to standard alerts, enhanced GPWS provides look-ahead terrain awareness, including alerting and display functions. These functions compare the airplane's geographic position and altitude against an internal terrain database to predict and display potential conflicts between the airplane flight path and terrain.

In addition to standard GPWS inputs, enhanced GPWS requires inputs from the following for proper operation:

- global positioning system

Note: Loss of an input does not necessarily inhibit operation of the entire GPWS.

GPWS Alert Prioritization

GPWS and Windshear Warning System alerts are prioritized based on the level of hazard and the required flight crew response. The following are listed in order of decreasing priority:

GPWS Alerts

Condition	Alert Level	Description
Windshear - Immediate	Warning	Mode 7 - Actual windshear conditions (downdraft) A windshear immediate-alert warning inhibits all other GPWS and windshear alerts.
Ground proximity - Immediate	Warning	Mode 1 - Severe decent rate
Ground proximity - Immediate	Warning	Mode 2 - Severe terrain closure rate
Terrain - Awareness	Warning	Look-Ahead - Terrain along flight path (Near)
Windshear - Awareness	Warning	Predictive - Windshear condition along flight path
Ground proximity - Immediate	Caution	Mode 2 - Excessive terrain closure rate
Terrain - Awareness	Caution	Look-Ahead - Terrain along flight path

Condition	Alert Level	Description
Ground proximity - Immediate	Caution	Mode 4 - Unsafe terrain clearance
Altitude - Awareness		Mode 6 - Altitude callouts
Ground proximity - Immediate	Caution	Mode 4 - Unsafe terrain clearance - Gear
		Mode 4 - Unsafe terrain clearance - Flaps
		Mode 1 - Excessive decent rate
		Mode 3 - Decent (sink rate) after takeoff
		Mode 5 - Below glideslope - ILS deviation
Windshear - Awareness	Caution	Predictive - Windshear adjacent to flight path
Windshear - Immediate	Caution	Mode 7 - Entering actual windshear condition (updraft)

GPWS Immediate-Alert Modes

GPWS immediate alerts are radio altitude based and provided for the following:

- excessive and severe descent rate (Mode 1)
- excessive terrain closure rate (Mode 2)
- altitude loss after takeoff or go-around (Mode 3)
- unsafe terrain clearance when not in the landing configuration (Mode 4)
- excessive deviation below an ILS glide slope (Mode 5)
- windshear (Mode 7)

GPWS immediate-alert warnings (Modes 1-2) are accompanied by:

- visual alerts (see tables)
- aural alerts (see tables)

If illuminated, pushing a Master WARNING/CAUTION Reset switch resets the Master WARNING lights but does not inhibit the GPWS warning.

GPWS immediate-alert cautions (Modes 1-5) are accompanied by:

- visual alerts (see tables)
- voice aural alerts (see tables)

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GPWS Immediate-Alert Warnings

Aural Alert	Visual Alert	Description
PULL UP	PULL UP light (Red) Master WARNING lights	Follows SINK RATE alert if descent rate becomes severe. (Mode 1) Follows TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration. (Mode 2)

GPWS Immediate-Alert Cautions

Aural Alert	Visual Alert	Description
TERRAIN	GND PROX light (amber)	Excessive terrain closure rate. (Mode 2)
DON'T SINK	GND PROX light (amber)	Excessive altitude loss after takeoff or go-around. (Mode 3)
GLIDE SLOPE	GND PROX light (amber)	Deviation below glide slope. (Mode 5) Volume and repetition rate increase as deviation increases. Note: Pushing the ground proximity G/S INHB switch cancels or inhibits the alert below 1,000 feet radio altitude.
SINK RATE	GND PROX light (amber)	Excessive descent rate. (Mode 1)
TOO LOW, FLAPS	GND PROX light (amber)	Unsafe terrain clearance at low airspeed with flaps not in landing configuration. (Mode 4) Note: Pushing the GND PROX FLAP OVRD switch to OVRD inhibits the alert.
TOO LOW, GEAR	GND PROX light (amber)	Unsafe terrain clearance at low airspeed with landing gear not down. (Mode 4) Note: Pushing the GND PROX GEAR OVRD switch to OVRD inhibits the alert.

Aural Alert	Visual Alert	Description
TOO LOW, TERRAIN	GND PROX light	Follows DON'T SINK if another descent is initiated after initial alert and before climbing to the altitude where the initial descent began. (Mode 3) Unsafe terrain clearance at low airspeed with either landing gear not down or flaps not in landing position. (Mode 4) Note: Pushing the GRND PROX FLAP OVRD switch to OVRD inhibits the alert, when the alert is due to flaps not in landing position. Note: Pushing the GRND PROX GEAR OVRD switch to OVRD inhibits the alert, when the alert is due to gear not down.

GPWS Callouts

GPWS provides callouts or aural alerts to assist the flight crew with situational awareness and to advise the flight crew of the aircraft's approximate height above the ground.

Callout	Description
BANK ANGLE, BANK ANGLE	Voice callout occurs when airplane roll angle reaches: • 35 degrees • 40 degrees • 45 degrees Note: Callout is reset when roll angle decreases below 30 degrees.
TWENTY FIVE HUNDRED	Airplane is at 2,500 feet AGL
ONE THOUSAND	Airplane is at 1,000 feet AGL
FIVE HUNDRED	Airplane is at 500 feet AGL
ONE HUNDRED	Airplane is at 100 feet AGL
FIFTY	Airplane is at 50 feet AGL
FOURTY	Airplane is at 40 feet AGL
THIRTY	Airplane is at 30 feet AGL
TWENTY	Airplane is at 20 feet AGL
TEN	Airplane is at 10 feet AGL
APPROACHING MINIMUMS	Airplane reaching 100' prior to the DH set in either Decision Height Reference Window.
MINIMUMS	Airplane reaching the DH set in either Decision Height Reference Window.

Look-Ahead Display and Alerts

Enhanced GPWS provides look-ahead alerts for potentially hazardous flight conditions involving impact with the ground. GPWS monitors terrain proximity and generates a display from a world-wide terrain data base in the GPWS computer. The data base contains detailed terrain data near major airports and data in lesser detail for areas between airports.

Note: The GPWS terrain data base, look-ahead terrain alerting, and terrain display do not account for man-made obstructions.

Airplane horizontal position is determined using the GPS.

Barometric altitude errors induced from temperature extremes or from non-standard pressure altitudes are minimized. Airplane vertical position is determined using a blended solution calculated from the following:

- GPS altitude
- barometric altitude
- radio altitude
- static air temperature

Note: The terrain display is not designed to be used as an independent navigation aid.

Look-Ahead Displays

When the EFIS control panel terrain (TERR) display select switch is pushed on, the TERR annunciation is displayed on the HSI and terrain contours may be displayed.

GPWS look-ahead data and weather radar returns cannot be displayed simultaneously on an HSI. If either pilot selects terrain while the other selects weather radar, each display updates on alternating sweeps. All other navigation displays can be simultaneously displayed with terrain data.

When the airplane is lower than 2,000 feet above the terrain, terrain within 2,000 feet of airplane barometric altitude is displayed on the HSI. Non-threat terrain is depicted as several densities of dot patterns in green, amber, or red depending on relative vertical distance between the airplane and the terrain.

When the airplane is higher than 2,000 feet above the terrain or within 400 feet of the nearest airport runway elevation, terrain is not displayed.

Note: The GPWS look-ahead display is not designed to be used as an independent navigation aid.

Look-Ahead Alerting

The enhanced GPWS computer continuously computes clearance envelopes looking down and ahead of the airplane. Estimated time to impact is calculated from airplane position, barometric altitude, present track, vertical path, and ground speed. FMC VNAV or LNAV (Refer to Chapter 11, Flight Management, Navigation) paths are not considered in the estimated time to impact.

When the terrain clearance boundaries are crossed the GPWS issues alerts. Alert levels, warning or caution, are based on estimated time to impact. Look-ahead alerts will cause the GPWS look-ahead awareness display to "pop-up" when:

- the HSI display is in an appropriate mode (see tables)
- neither terrain (TERR) display select switch is ON

GPWS look-ahead warning alerts are accompanied by:

- visual alerts (see tables)
- voice aural alerts (see tables)
- solid red terrain displayed on HSIs

If illuminated, pushing a Master WARNING/CAUTION Reset switch resets the Master WARNING lights but does not inhibit the GPWS warning.

GPWS look-ahead caution alerts are accompanied by:

- visual alerts (see tables)
- voice aural alerts (see tables)
- solid amber terrain displayed on HSIs

Note: Terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning alert does not guarantee terrain clearance.

Look-Ahead Alerting - Warnings

Aural Alert	Visual Alert	Description
TERRAIN TERRAIN PULL UP	PULL UP light (red) Master WARNING lights Solid red terrain on HSI Red TERRAIN annunciation on both HSIs	20 to 30 seconds from projected impact with terrain shown solid red on the HSI. Pop-up look-ahead display is only available in the following modes: • VOR, APP, MAP and CTR MAP Note: Pushing the GRD PROX TERR OVRD switch to OVRD inhibits the alert.

Look-Ahead Alerting - Cautions

Aural Alert	Visual Alert	Description
CAUTION TERRAIN	Solid amber terrain on HSI GND PROX light Amber TERRAIN message on both HSIs	40 to 60 seconds from projected impact with terrain shown in solid amber on the HSI. Pop-up look-ahead display is only available in the following modes: • VOR, APP, MAP and CTR MAP Note: Pushing the GRD PROX - TERR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light (amber)	Terrain Clearance Floor (TCF) alert indicating unsafe terrain clearance based on current airplane location, nearest runway center point and radio altitude. Similar to Mode 4 but available in all flight modes. Note: Pushing the GND PROX - TERR OVRD switch to OVRD inhibits the alert.

Windshear Warning System

Windshear Immediate-Alerts

The GPWS takes additional data from the stall warning computer (STC) and determines if decreasing-performance windshear conditions are occurring in the immediate vicinity of the airplane. GPWS issues Windshear Immediate-Warnings whenever decreasing-performance windshear conditions are present during takeoff, approach and landing.

Warnings

Windshear warnings are accompanied by:

- visual alerts (see tables)
- voice or aural alert (see tables)

If illuminated, pushing a Master WARNING/CAUTION reset switch resets the Master WARNING lights but does not deactivate the windshear warning.

Windshear Immediate-Alert Warnings

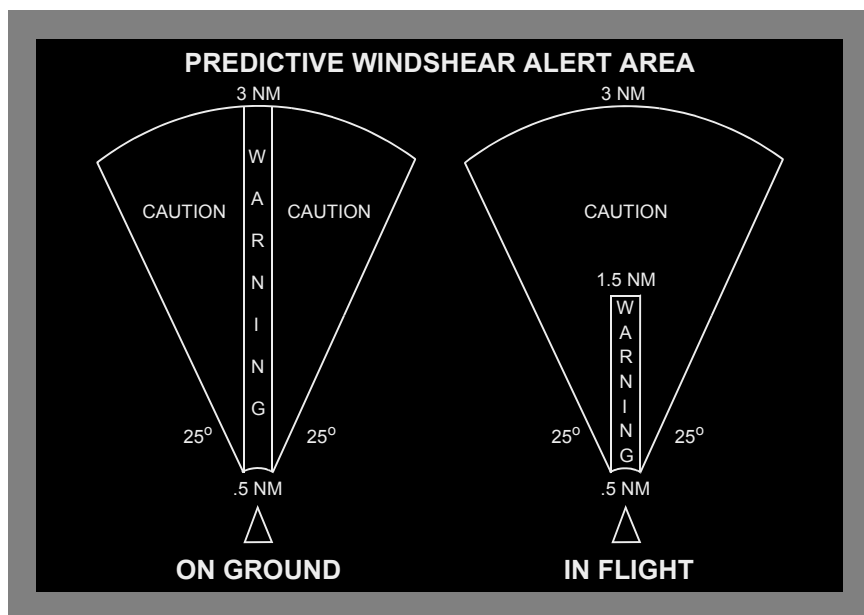
Aural Alert	Visual Alert	Description
Two-tone siren followed by WINDSHEAR	WINDSHEAR light (red) Master WARNING lights Red WINDSHEAR on both ADIs	Excessive windshear at the current airplane position detected by GPWS. Enabled below 1,500 feet radio altitude. GPWS Windshear detection begins at rotation.

Predictive Windshear (PWS)

1404, 1603-1613, 1705-1708

The weather radar (See Chapter 11, Flight Management, Navigation) provides PWS alerts when it detects disturbed air ahead of the aircraft which contains moisture or particulate matter and which fits a known pattern of windshear activity.

The PWS alert area ahead of the aircraft is shown as follows:



When the PWS mode is enabled, the radar system is time-shared between the weather display and the PWS display. During the time-share:

- the weather display is slower to update
- PWS alerts are available approximately 12 seconds after the system begins scanning
- PWS automatically, regardless of actual Weather Radar Control Panel settings, adjusts the antenna TILT and the system GAIN for optimum windshear detection

The PWS mode is automatically enabled when:

- on the ground, the thrust levers are set for takeoff
- in flight, the aircraft is below 2,300 feet AGL
- on the ground, WXR is selected on the EFIS control panel and any mode other than TEST is selected on the weather radar control panel

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PWS alerts are automatically enabled below 1,200 feet AGL.

Note: PWS does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

Warnings

PWS warnings are accompanied by:

- visual alerts (see tables)
- voice or aural alerts (see tables)

If illuminated, pushing a Master WARNING/CAUTION reset switch resets the Master WARNING lights but does not deactivate the windshear warning.

Predictive Windshear Warnings

Aural Alert	Visual Alert	Description
WINDSHEAR AHEAD WINDSHEAR AHEAD	WINDSHEAR light (Red) MASTER WARNING lights Red WINDSHEAR annunciation on both ADIs RED and BLACK PWS symbol on HSI and on Weather Radar Indicator Red WINDSHEAR annunciation on HSI and on Weather Radar Indicator	Enabled during takeoff, below 1,200 feet AGL. Windshear within 3.0 miles and directly ahead of the airplane. If weather (WXR) is not selected on either HSI, the weather display, including PWS symbology, will automatically pop-up on the HSI. PWS symbol on the HSI shows windshear position and size when the HSI Mode Selector is in the VOR, APP, MAP or CTR MAP mode. PWS symbol on the Weather Radar Indicator shows windshear position and size when the Weather Radar Indicator Mode Selector is not in the OFF mode.
GO AROUND, WINDSHEAR AHEAD	WINDSHEAR light (Red) MASTER WARNING lights Red WINDSHEAR annunciation on both ADIs RED and BLACK PWS symbol on HSI and on Weather Radar Indicator Red WINDSHEAR annunciation on HSI and on Weather Radar Indicator	Enabled during approach, below 1,200 feet AGL. Windshear within 1.5 miles and directly ahead of the airplane. If weather (WXR) is not selected on either HSI, the weather display, including PWS symbology, will automatically pop-up on the HSI. PWS symbol on the HSI shows windshear position and size when the HSI Mode Selector is in the VOR, APP, MAP or CTR MAP mode. PWS symbol on the Weather Radar Indicator shows windshear position and size when the Weather Radar Indicator Mode Selector is not in the OFF mode.

Cautions

PWS caution alerts are accompanied by:

- visual alerts (see tables)
- voice or aural alerts (see tables)

Predictive Windshear Caution

Aural Alert	Visual Alert	Description
MONITOR RADAR DISPLAY	RED and BLACK PWS symbol on HSI and on Weather Radar Indicator Amber WINDSHEAR annunciation on HSI and on Weather Radar Indicator	Windshear within 3 miles and not directly ahead of the airplane Enabled during takeoff and approach, below 1,200 feet AGL PWS symbol on the HSI shows windshear position and size only when the HSI Mode Selector is in the VOR, APP, MAP or CTR MAP mode and the TERR switch is not pushed PWS symbol on the Weather Radar Indicator shows windshear position and size when the Weather Radar Indicator Mode Selector is not in the OFF mode

Inhibits

PWS alerts are inhibited during takeoff and landing as follows:

- WARNINGS, between 100 knots and 50 feet AGL
- CAUTIONS, between 80 knots and 400 feet AGL

Note: These inhibits do not remove existing PWS alerts.

PWS alerts are also inhibited by:

- Windshear Immediate-Alert Warnings
- GPWS Immediate-Alert Warnings
- GPWS Look-Ahead-Alert Warnings

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to conflicting traffic. The system identifies a three-dimensional airspace around the airplane where a high likelihood of air traffic conflicts exist. These dimensions depend upon closure rates between the airplane and potentially conflicting traffic. The system can display up to thirty aircraft and simultaneously coordinate a resolution advisory for up to three threat aircraft. TCAS does not alleviate the pilot's responsibility of maintaining safe visual separation from other aircraft.

TCAS interrogates operating transponders in other aircraft, analyzes the replies, predicts flight paths and designates possible conflicting traffic as a "traffic aircraft."

When the system designates a traffic aircraft, TCAS provides the flight crew with a situational display. Additionally, TCAS may provide an aural annunciation and flight path guidance.

Note: Other aircraft that do not have an operating transponder can not initiate situational displays, aural annunciations or flight path guidance.

Note: TCAS is independent of ground-based air traffic control.

During normal operations, when TCAS designates a traffic aircraft, the system provides the following advisories and displays:

- Resolution Advisories (RA) and Display
- Traffic Advisories (TA) and Displays
- Proximate Traffic and Other Traffic Displays

Normal Operations

TCAS is enabled from the Transponder Panel. The system is normally operated with the TCAS Mode Selector in the TA/RA mode.

The TA only mode is used when directed by non-normal procedures such as Engine Failure, when adequate thrust may not be available to follow RA commands.

Resolution Advisories (RA) and Displays

A Resolution Advisory (RA) is an immediate-threat prediction that traffic aircraft will enter the TCAS collision airspace within approximately 20 to 30 seconds. If altitude data from the traffic aircraft's transponder is not available, no RA can be provided.

When TCAS issues a RA:

- a voice alert sounds
- vertical guidance is displayed
- symbology is displayed

Voice Alert

When TCAS issues a RA, voice alerts will sound. These voice alerts aurally elaborate on the displayed Vertical Guidance and are described in this Chapter under Voice Annunciations.

TCAS 7.1 replaces several ADJUST VERTICAL SPEED alerts with a LEVEL OFF RA. The level off should be achieved promptly, not at the next flight level.

Vertical Guidance

Vertical guidance is displayed for a traffic-avoidance maneuver. Traffic avoidance is ensured by adjusting or maintaining:

- a VSI vertical speed outside the displayed red RA regions

Note: If the traffic aircraft also has TCAS and an operating mode S transponder, vertical guidance is coordinated with the traffic aircraft.

Display Symbolology

The RA traffic symbol is a filled red square with an accompanying data tag when the traffic aircraft is providing altitude information.

The data tag appears in red and contains the following information about the traffic aircraft:

- a two-digit number preceded with a "+" or a "-" sign and positioned above or below the RA symbol. This number represents, in hundreds of feet, the relative vertical position and altitude difference between the airplane and the traffic aircraft.
- a vertical arrow appears to the right of the RA symbol when the traffic aircraft is either climbing or descending in excess of 500 feet per minute.

The RA is displayed as follows:

- Weather Radar
 - When the red TRAFFIC message appears and the traffic aircraft is within the selected display range, the traffic symbol's relative position is displayed.
 - When the RA is outside the selected range, the red OFFSCALE message appears.
 - When TCAS is unable to track the traffic aircraft's bearing, the red RA symbol is displayed below the TRAFFIC message.

- VSI
 - When the traffic aircraft is within the display range, the traffic symbol's relative position is displayed.
 - When the RA is outside the display range, the red RA symbol appears as an half-filled red square and is positioned relative to the airplane on the outer edge of the display.
 - When TCAS is unable to track the traffic aircraft's bearing, the red RA symbol appears in the lower center of the display.

Traffic Advisories (TA) and Displays

A Traffic Advisory (TA) is a prediction that traffic aircraft will enter the TCAS collision airspace within approximately 35 to 40 seconds. TAs are intended to assist the crew in establishing visual contact with the traffic aircraft.

When TCAS issues a TA:

- a voice alert sounds
- symbology is displayed

Voice Alert

When TCAS issues a TA, the Voice Annunciation, TRAFFIC TRAFFIC will sound to aurally alert the crew.

Display Symbology

The TA traffic symbol is a filled amber circle with an accompanying data tag when the traffic aircraft is providing altitude information.

The data tag appears in amber and contains the following information about the traffic aircraft:

- a two-digit number preceded with a "+" or a "-" sign and positioned above or below the TA symbol. This number represents, in hundreds of feet, the relative vertical position and altitude difference between the airplane and the traffic aircraft.
- a vertical arrow appears to the right of the TA symbol when the traffic aircraft is either climbing or descending in excess of 500 feet per minute.

The TA is displayed as follows:

- Weather Radar
 - When the amber TRAFFIC message appears and the traffic aircraft is within the selected display range, the traffic symbol's relative position is displayed.
 - When TCAS is unable to track the traffic aircraft's bearing, the amber TA symbol is displayed below the TRAFFIC message.
 - When the TA is outside the selected range, the amber OFFSCALE message appears.
- VSI
 - When the traffic aircraft is within the display range, the traffic symbol's relative position is displayed.
 - When the TA is outside the display range, the amber TA symbol appears as an half-filled amber square and is positioned relative to the airplane on the outer edge of the display.
 - When TCAS is unable to track the traffic aircraft's bearing, the amber TA symbol appears in the lower center of the display.

Proximate Traffic and Other Traffic Displays

Proximate Traffic is a traffic aircraft that is neither a RA nor a TA but is within:

- six miles laterally, and
- 1,200 feet vertically

Other Traffic is a traffic aircraft that is neither a RA, TA, or Proximate Traffic

When TCAS identifies Proximate Traffic or Other Traffic:

- symbology is displayed

Display Symbology

The Proximate Traffic symbol is a filled diamond and the Other Traffic symbol is a hollow diamond. Both Proximate Traffic and Other Traffic symbols are displayed with an accompanying data tag when the traffic aircraft is providing altitude information.

The data tag contains the following information about the traffic aircraft:

- a two-digit number preceded with a "+" or a "-" sign and positioned above or below the Proximate or Other Traffic symbol. This number represents, in hundreds of feet, the relative vertical position and altitude difference between the airplane and the traffic aircraft.
- a vertical arrow appears to the right of the Proximate or Other Traffic symbol when the traffic aircraft is either climbing or descending in excess of 500 feet per minute.

Proximate Traffic and Other Traffic are displayed as follows:

- VSI
 - When Proximate Traffic is within the display range, the traffic aircraft's relative position is displayed as a filled cyan diamond.
 - When Other Traffic is within the display range, the traffic aircraft's relative position is displayed as an unfilled cyan diamond.
- Weather Radar
 - When Proximate Traffic is within the selected display range, the traffic aircraft's relative position is displayed as a filled white diamond.
 - When Other Traffic is within the selected display range, the traffic aircraft's relative position is displayed as an unfilled white diamond.

Voice Annunciations

Voice Annunciation	Visual Alert	Description
TRAFFIC, TRAFFIC	TCAS has issued a TA	Attempt to visually locate the traffic
CLIMB, CLIMB	Present vertical speed is within the red RA regions	Adjust vertical speed to remain outside the red RA regions
DESCEND, DESCEND	Present vertical speed is within the red RA regions	Adjust vertical speed to remain outside the red RA regions
LEVEL OFF, LEVEL OFF	Present vertical speed is within the red RA regions	Adjust vertical speed to remain outside the red RA regions
ADJUST VERTICAL SPEED ADJUST	TCAS requires change in vertical rate Present vertical speed is within the red RA regions	Adjust vertical speed to remain outside the red RA regions
MONITOR VERTICAL SPEED	Present vertical speed is outside the red RA regions	Continue to keep vertical speed outside the red RA regions
MAINTAIN VERTICAL SPEED MAINTAIN	Present vertical speed is outside the red RA regions	Continue to keep vertical speed outside the red RA regions
MAINTAIN VERTICAL SPEED CROSSING MAINTAIN	Present vertical speed is outside the red RA regions Airplane will pass through the traffic aircraft's altitude	Continue to keep vertical speed outside the red RA regions
CLIMB, CROSSING CLIMB CLIMB, CROSSING CLIMB	Present vertical speed is within the red RA regions Airplane will climb through the traffic aircraft's altitude	Adjust vertical speed to remain outside the red RA regions
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	Present vertical speed is within the red RA regions Airplane will climb through the traffic aircraft's altitude	Adjust vertical speed to remain outside the red RA regions

Aural Alert	Visual Alert	Description
INCREASE CLIMB, INCREASE CLIMB	TCAS requires change in vertical rate Present vertical speed is within the red RA regions	Adjust vertical speed to remain outside the red RA regions
INCREASE DESCENT, INCREASE DESCENT		
CLIMB, CLIMB NOW CLIMB, CLIMB NOW	Previous vertical guidance was to descend TCAS now requires a climb Present vertical speed is within the red RA regions	Climb and adjust vertical speed to remain outside the red RA regions
DESCEND, DESCEND NOW DESCEND, DESCEND NOW	Previous vertical guidance was to climb Present vertical speed is within the red RA regions	Descend and adjust vertical speed to remain outside the red RA regions
ADJUST VERTICAL SPEED ADJUST	Minimum vertical speed required to ensure separation has changed Present vertical speed is outside the red RA regions	Adjust vertical speed as required Continue to keep vertical speed outside the red RA regions
CLEAR OF CONFLICT	Vertical guidance is no longer displayed and traffic symbology changes to TA Separation between the airplane and the traffic aircraft is increasing CLEAR OF CONFLICT will not sound if TCAS can no longer predict the track of the traffic aircraft	Attempt to visually locate the traffic aircraft

Display Messages

VSI Messages

Voice	Visual	Description
TA ONLY	White	TCAS Mode Selector is not in the TA/RA mode
TCAS TEST	White	TCAS in test mode
RA FAIL	Amber	RAs not available
TD FAIL	Amber	VSI unable to provide traffic displays

Weather Radar Messages

Message	Color	Description
TFC	Cyan	Traffic (TFC) Switch pushed Not displayed when TCAS TEST, TCAS FAIL, or TCAS OFF is annunciated HSI Mode Selector in the VOR, APP, MAP or CTR MAP mode
TRAFFIC	Red	RA is occurring
OFFSCALE	Red	RA is occurring outside the selected display range
TRAFFIC	Amber	TA is occurring
OFFSCALE	Amber	TA is occurring outside the selected display range
TA ONLY	Cyan	TCAS Mode Selector is not in TA/RA
TCAS FAIL	Amber	TCAS is inoperative Only displayed when TFC selected on EFIS control panel
TCAS TEST	Cyan	TCAS in test mode
TCAS OFF	Amber	TCAS Mode Selector is not in TA or TA/RA Only displayed when TFC selected on EFIS control panel Not displayed when TCAS FAIL is annunciated

Inhibits

INCREASE DESCENT RAs are inhibited below approximately 1,450 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 approximately 1,000 feet when the TA/RA mode is selected on the transponder panel, TA only mode is enabled automatically. All TCAS voice annunciations are inhibited below approximately 500 feet radio altitude.

Note: GPWS Immediate-Alert and Windshear Immediate-Alert annunciations inhibit all TCAS alerts.

Non-Normal Operations

VSI Messages

When the VSI message:

- RA FAIL is displayed the RA symbology, vertical guidance and voice annunciations are unreliable.
- TD FAIL is displayed, the TCAS display functions have failed.
- TCAS FAIL is displayed, the TCAS system is not operational.
- TCAS FAIL has priority over the TD FAIL message.

Weather Radar Messages

When the weather radar message:

- TCAS OFF is displayed, neither TA nor TA/RA is selected with the TCAS Mode Selector. The system cannot display symbology or vertical guidance. Voice Annunciations will not occur.
- TCAS FAIL is displayed, the system cannot display symbology or vertical guidance. Voice annunciations will not occur.

Note: TCAS OFF does not display if TCAS FAIL is annunciated.

Warning Systems

EICAS Messages

Chapter 15

Section 30

Warning Systems EICAS Messages

The following EICAS messages can be displayed.

GPWS

Message	Level	Light	Aural	Condition
ALT CALLOUTS	Advisory			Altitude callouts are no longer provided.
GND PROX SYS	Advisory			Ground proximity alerts may not be provided.
TERR OVRD	Advisory			Ground proximity terrain override switch is in OVRD.
TERR POS	Advisory			Terrain position data has been lost.
WINDSHEAR SYS	Advisory			Windshear alerts may not be provided.

Configuration

Message	Level	Light	Aural	Condition
FLAPS	Warning	CONFIG	Siren	Flaps are not in a takeoff position when either engine's thrust is in the takeoff range on the ground.
GEAR NOT DOWN	Warning	CONFIG	Siren	Any landing gear is not down and locked when either thrust lever is closed below 800 feet radio altitude or when flaps are in a landing position.

Message	Level	Light	Aural	Condition
PARKING BRAKE	Warning	CONFIG	Siren	Parking brake is set when either engine's thrust is in the takeoff range on the ground.
SPOILERS	Warning	CONFIG	Siren	Speedbrake lever is not DOWN when either engine's thrust is in the takeoff range on the ground.
STABILIZER	Warning	CONFIG	Siren	Stabilizer is not within the greenband when either engine's thrust is in the takeoff range on the ground.

TCAS

Message	Level	Light	Aural	Condition
TCAS	Advisory			TCAS system is inoperative.
TCAS OFF	Advisory			The TCAS system is off.
TCAS FAIL	Advisory			TCAS system is inoperative.

Miscellaneous

Message	Level	Light	Aural	Condition
ALTITUDE ALERT	Caution	ALT ALERT	Beeper	Airplane has deviated from the selected altitude.
EICAS CONT PNL	Advisory			EICAS control panel is inoperative.
EICAS DISPLAY	Advisory			One EICAS CRT is inoperative.
OVERSPEED	Warning	OVSPD	Siren	Airspeed has exceeded Vmo/Mmo.

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