BOMBARDIER
LEARJET

Pilot Training Guide

Learjet 40/40XR/45/45XR

Bombardier Aircraft Training
Learjet Inc.
2929 W. Airfield Drive
P.O. Box 619011
DFW Airport, TX 75261
888-679-4200

DFWcustomerservice@aero.bombardier.com

www.batraining.com
www.cic.bombardier.com

Rev 6

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GENERAL INFORMATION

Record of Revision

Changes to this manual are identified by their revision number. Each revision is to be inserted promptly.

Foreword

The Bombardier Aerospace Learjet 40/45 Pilot Training Guide provides clients with a summary of aircraft system descriptions and operating procedures. The Pilot Training Guide is for training purposes only. The publications listed in the table below take precedence.

The Pilot Training Guide is based on information from the documents listed in

Table 1 - Associated Documents

Title	Learjet 40	Learjet 45
Airplane Flight Manual	FM-132	FM-126
Crew Checklist and Quick Reference Manual	CL-132	CL-126
Pilot Manual	PM-132	PM-126
Master Minimum Equipment List		

This manual remains the intellectual property of the Bombardier Customer Training Center (BCTC) and are maintained in accordance with its publication revision schedule.

Volume Description

The manual is comprised of 20 chapters and 3 annexes.

Aircraft Systems:

- 1 Aircraft General
- 2 Automatic Flight Control System
- 3 Auxiliary Power Unit
- 4 Communication System
- 5 Electrical System
- 6 Emergency Equipment and Oxygen
- 7 Environmental Control Systems
- 8 Fire Protection Systems
- 9 Flight Controls
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- 19 Power Plant
- 20 Warnings—Aural and Visual

Annexes:

- Annex 1 Walkaround
- Annex 2 Performance and Weight and Balance
- Annex 3 Review Questions

Pagination

The 20 chapters are in alphabetical order and each is dedicated to a specific aircraft system description. The 3 annexes are at the end of the book.

Page Headers

The even numbered page headers provide the following information:

	Pilot Training Guide Learjet 40/40XR/45/45XR
↑	↑
Learjet Logo	Publication Name and Aircraft Series

The odd numbered page headers provide the following information:

General Information Learjet 40/40XR/45/45XR	
↑	↑
Chapter Title and Aircraft Series	Learjet Logo

Page Footers

The page footers on all pages provide the following information in mirror image on odd and even pages:

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↑		↑
Revision Number	Chapter and Page Number	

Warning, Caution, and Note Examples

Specific items requiring emphasis are expanded upon and ranked in decreasing order of importance.

WARNING

Operating procedure or practice which, if not carried out exactly as written, could result in personal injury or loss of life. Placed before the procedure and on the same page as the step or procedure which is the subject of the warning.

CAUTION

Operating procedure or practice which, if not carried out exactly as written, could result in damage or destruction of equipment. Placed before the procedure and on the same page as the step or procedure which is the subject of the caution.

NOTE

Highlights an event, procedure or practice. Follows the text or procedure material.

Units of Measurements

Learjet 40/45 displayed units conform with International Civil Aviation Organization (ICAO) standards. Weight and barometric pressure are expressed in accordance with either the International System of Units or the British Engineering System of Units.

ICAO Standards

Distances: Nautical Miles (nm)

Speed: Knots (kt)

Altitude: Feet (ft)

Time: Day, Hour, Minute, Second

Temperature: Degree Celsius (°C) or Fahrenheit (°F)

Electric current: Ampere (A)

Electric potential, potential difference, or e.m.f.: volt (v)

Frequency: Hertz (Hz)

Unit Conversion

Conversion Factor

Table 2 - Metric-Imperial-U.S. Units Conversion

Multiply	By	To Obtain
ft	0.304	m
ft2	0.0929	m2
ft3	0.0283	m3
gal (Imperial)	1.201	gal (U.S.)
gal (Imperial)	4.546	liter
gal (U.S.)	0.8327	gal (Imperial)
gal (U.S.)	3.785	liter
in	2.54	cm
kg	2.205	lb
kPa	0.145	psi
liter	0.22	gal (Imperial)
liter	0.2642	gal (U.S.)
lb	0.4536	kg
m	3.281	ft
psi	6.895	kPa

Temperature Conversion

Table 3 - Temperature Conversion

From	To	Factor
°C	°F	[°C X 9/5] + 32 = °F
°F	°C	[°F - 32] X 5/9 = °C

Barometric Pressure Conversion

Table 4 - Barometric Pressure Conversion

hPa	0	1	2	3	4	5	6	7	8	9
940	27.76	27.79	27.82	27.85	27.88	27.91	27.94	27.96	27.99	28.02
950	28.05	28.08	28.11	28.14	28.17	28.20	28.23	28.26	28.29	28.32
960	28.35	28.38	28.41	28.44	28.47	28.50	28.53	28.56	28.58	28.61
970	28.64	28.67	28.70	28.73	28.76	28.79	28.82	28.85	28.88	28.91
980	28.94	28.97	29.00	29.03	29.06	29.09	29.12	29.15	29.18	29.20
990	29.23	29.26	29.29	29.32	29.35	29.38	29.41	29.44	29.47	29.50
1000	29.53	29.56	29.59	29.62	29.65	29.68	29.71	29.74	29.77	29.80
1010	29.83	29.85	29.88	29.91	29.94	29.97	30.00	30.03	30.06	30.09
1020	30.12	30.15	30.18	30.21	30.24	30.27	30.30	30.33	30.36	30.39
1030	30.42	30.45	30.47	30.50	30.53	30.56	30.59	30.62	30.65	30.68
1040	30.71	30.74	30.77	30.80	30.83	30.86	30.89	30.92	30.95	30.98
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AIRCRAFT GENERAL

Introduction

This chapter discusses aircraft approved operations, noise levels, operation of the doors, emergency exits, and crew and passenger seats. Airplane dimensions (Fig. 1 and Fig. 2) and major sections, turning radius (Fig. 3 and Fig. 4), aircraft operating danger areas (Fig. 5), and cabin and cockpit layouts are included for familiarization. Figures in this chapter refer to the Learjet 40, 40XR, 45, and 45XR aircraft unless specifically noted.

Approved Operations

The Learjet 40/45 aircraft is certified in accordance with FAR Part 25, Airworthiness Standards: Transport Category Airplanes. The aircraft is approved for the following kinds of operations when the appropriate instruments and equipment required by the airworthiness and operating requirements are installed and operable.

- VFR
- IFR
- Day
- Night
- Icing conditions

This airplane is not certified for ditching under FAR 25.801. The minimum flight crew consists of a pilot and copilot.

Noise Levels

Noise levels are in compliance with the requirements of FAR Part 36, Stage 3, which are essentially equivalent to the requirements outlined in ICAO Annex 16, Chapter 3.

Systems Overview

The Learjet 40/45 aircraft is a pressurized, low-wing, turbofan-powered airplane with high aspect ratio swept wings and winglets. The aircraft is designed for all-weather operation at altitudes up to 51,000 ft.

The wings are manufactured using conventional rivet construction except for the upper section of the winglets which utilize a honeycomb core bonded to the outer skin.

The fuselage is a semimonocoque design with a constant circular cross-section in the upper half of the fuselage and an elongated cross-section in the lower half. Two delta fins fitted to the tailcone underside enhance stall recovery characteristics and lateral stability.

Thrust is provided by two pylon-mounted TFE-731-20 turbofan engines manufactured by AlliedSignal. Each engine is rated at 3500 lb thrust at sea level.

Fuel is stored in wing and fuselage fuel tanks. Fuel in the fuselage tank is transferred to the wing tanks and then supplied to the respective engine. The wing tanks are interconnected by a crossflow valve to facilitate fuel transfer between wings.

A hydraulic pump on each engine provides hydraulic power for operating the wheel brakes, landing gear, flaps, spoilers, and thrust reversers. An electric auxiliary pump provides backup and primarily pressurizes the brake accumulator and can also pressurize the normal braking system. Through the hydraulic cross-flow, the auxiliary pump can also provide pressure to operate the landing gear and flaps.

The landing gear uses the conventional oleo-pneumatic strut for main gear and nose gear shock absorption. The main gears are equipped with dual wheels while the nose gear has a single wheel. Nosewheel steering is electrically controlled, and wheel braking is accomplished with a brake-by-wire antiskid system.

The ailerons, rudder, and elevator are manually controlled through conventional cables, bellcranks, and push-pull tubes. Hydraulically actuated spoiler/spoileron panels are controlled electrically. The flaps are hydraulically actuated. An electric trim tab on the left aileron and rudder provides roll and yaw trim, respectively. A balance tab on each aileron minimizes control wheel forces during aileron deflection. Pitch trim is accomplished by a variable-incidence horizontal stabilizer controlled by an electric actuator.

The DC electrical system is supplied by two engine-driven generators. Two main batteries and an emergency battery primarily supply power for engine starting and essential avionics respectively. AC electrical power is supplied by two engine-driven alternators for windshield heating. While on the ground, the APU generator or a ground power unit may be used for electrical power supply prior to engine starting.

The cabin environment is regulated by electronically controlled air conditioning and pressurization systems. Cooling is supplemented by an air cycle machine which is supplied bleed air from the engines or the APU while on the ground. The aft baggage compartment is lighted and heated but not pressurized. The cabin stowage compartment is integral with the lavatory and is therefore heated and pressurized and accessible in flight.

The Learjet 40/45 aircraft is equipped with Honeywell Primus 1000 Avionics Systems as standard equipment. The all-glass cockpit consists of four display units which show flight, navigation, weather radar, engine indicating, and crew alerting information. Radio management units (RMUs) provide direct radio tuning and reversionary backup of engine and navigational displays in case of primary indicating failures.

Aircraft Dimensions

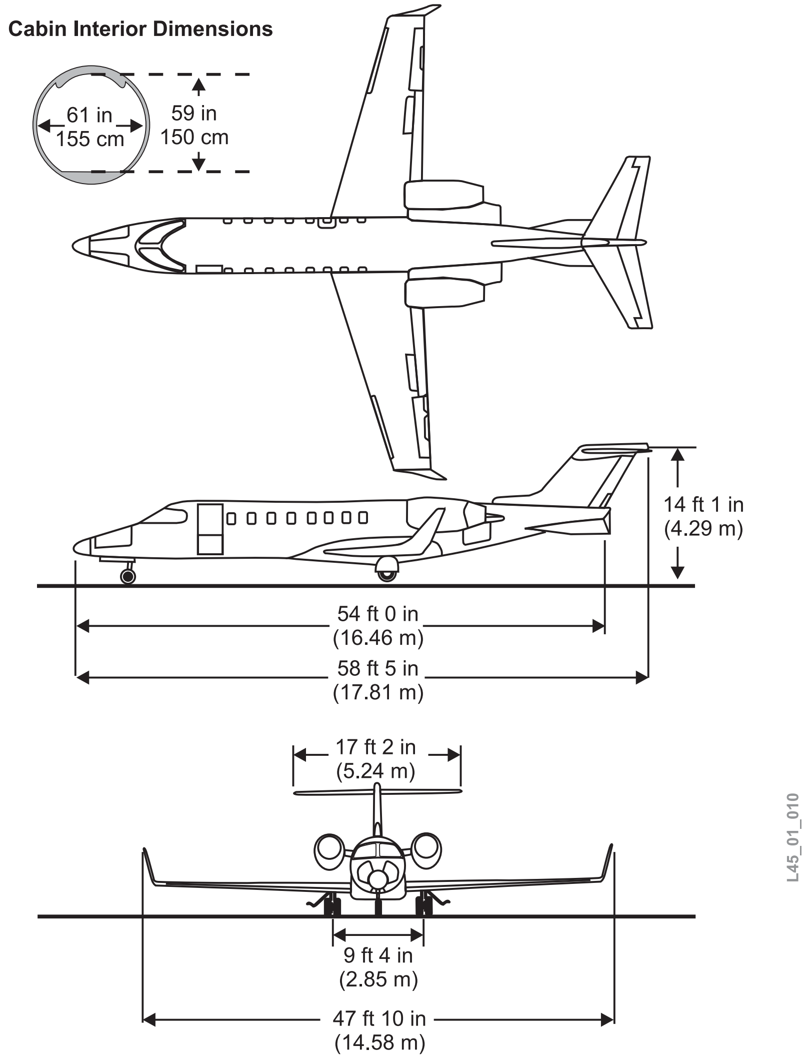


Figure 1 - Learjet 45 Aircraft Dimensions

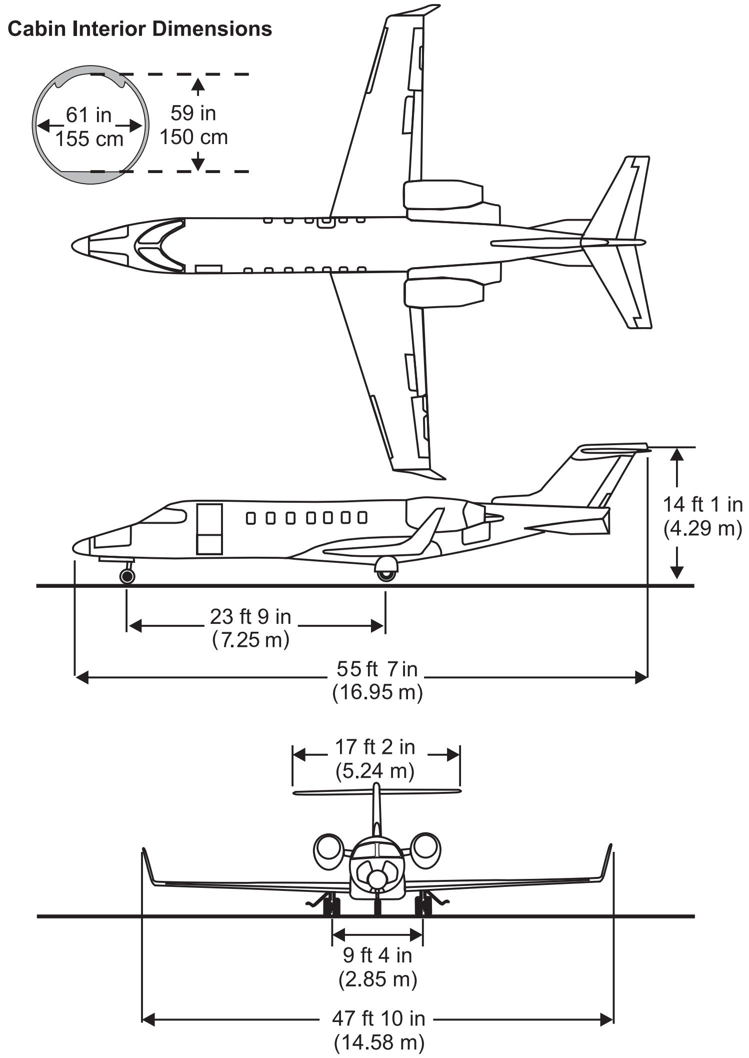
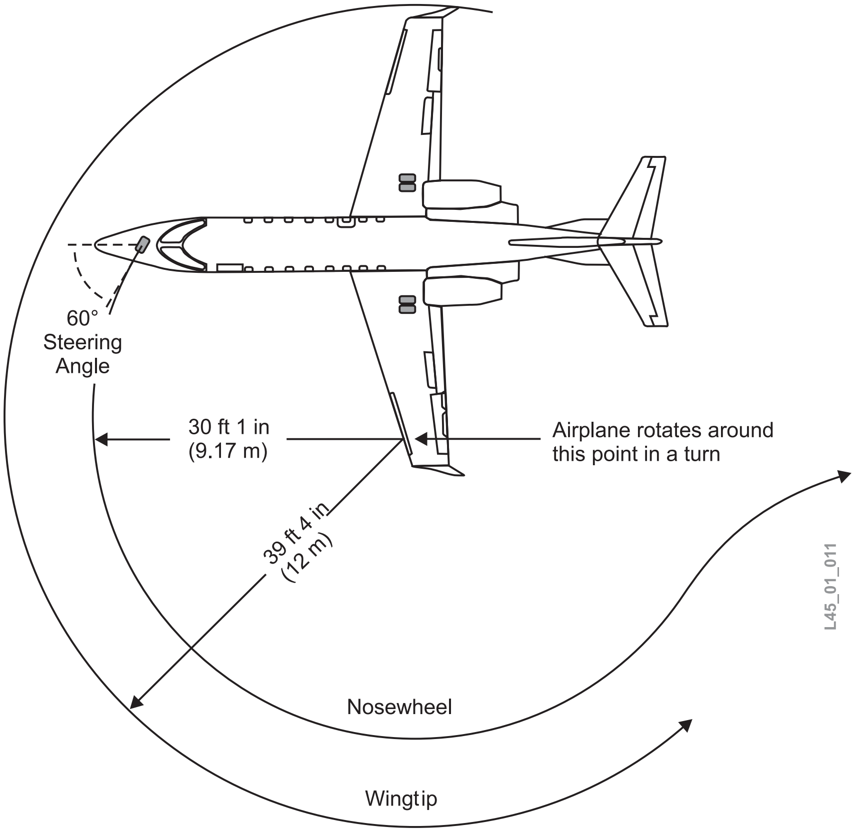


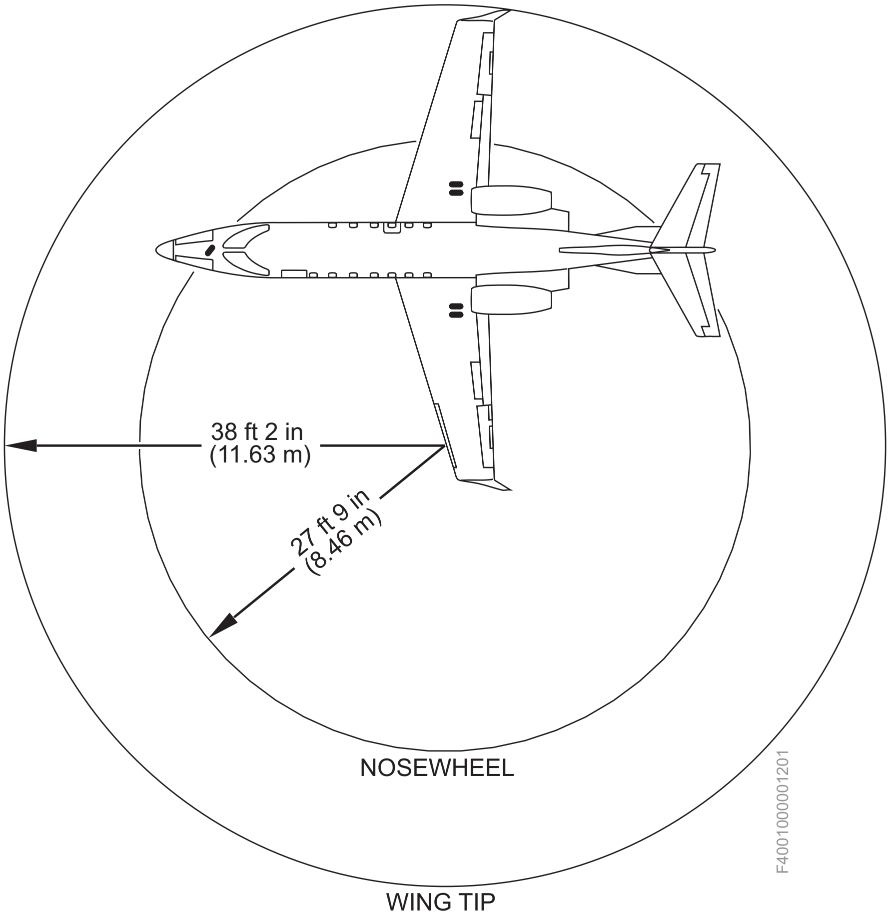
Figure 2 - Learjet 40 Aircraft Dimensions

Turning Radius



NOTE: Turning radius expressed above is based upon 60° nosewheel travel deflection.

Figure 3 - Learjet 45 Turning Radius



NOTE: Turning radius expressed above is based upon 60° nosewheel deflection.

Figure 4 - Learjet 40 Turning Radius

Danger Areas

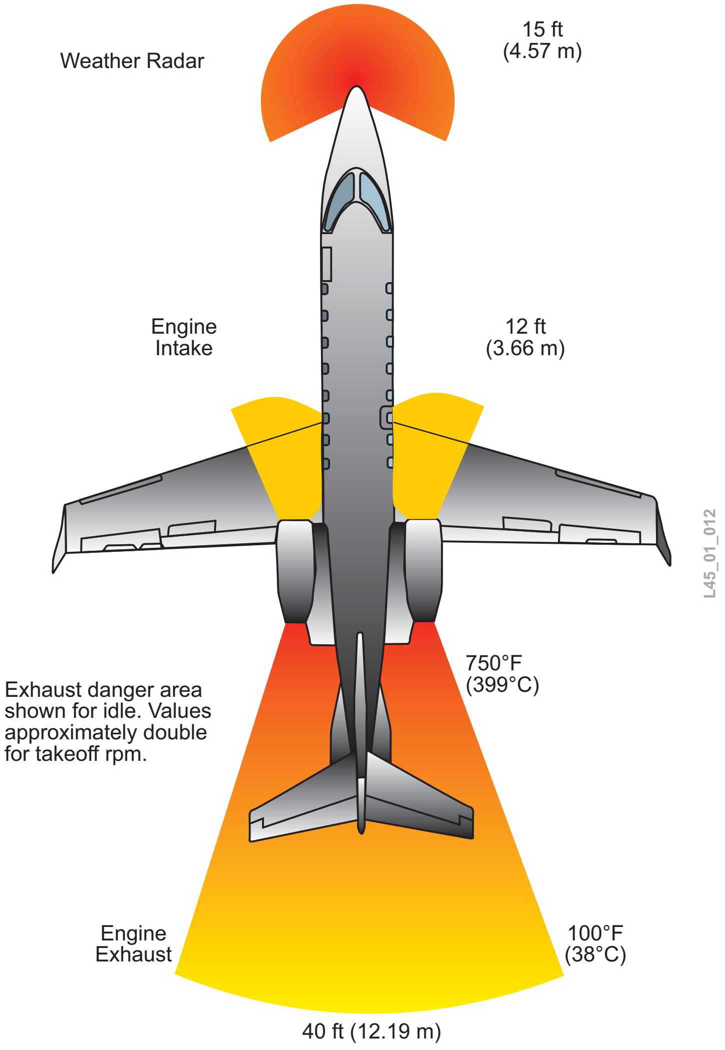


Figure 5 - Danger Areas

Doors and Emergency Exits

Description

The Learjet 40/45 aircraft has the following doors (Fig. 6):

- Cabin entry door
- Aft right emergency exit door
- Baggage compartment door
- Equipment bay door
- Servicing access doors and panels

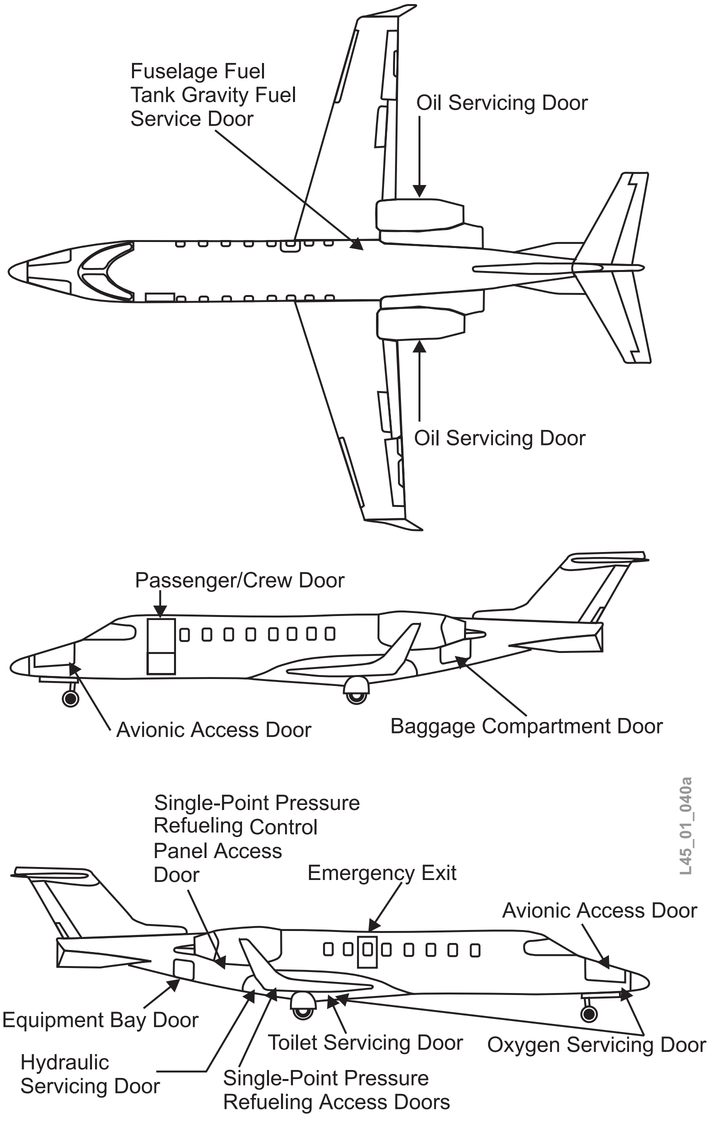


Figure 6 - Doors and Servicing Panels Location

Cabin Door

A clamshell-style cabin door is located in the forward left fuselage for normal entry/exit of passengers and crew (Fig. 7). The door is 30 in. wide and consists of upper and lower sections. The upper section opens upward to form a canopy while the lower door section opens downward. The lower section has two integral steps and a flip-down step which automatically extends by gravity as the door is deployed. During door closing, the lower door must be closed first, followed by the upper door. During door opening, the upper door is opened first, followed by the lower door.

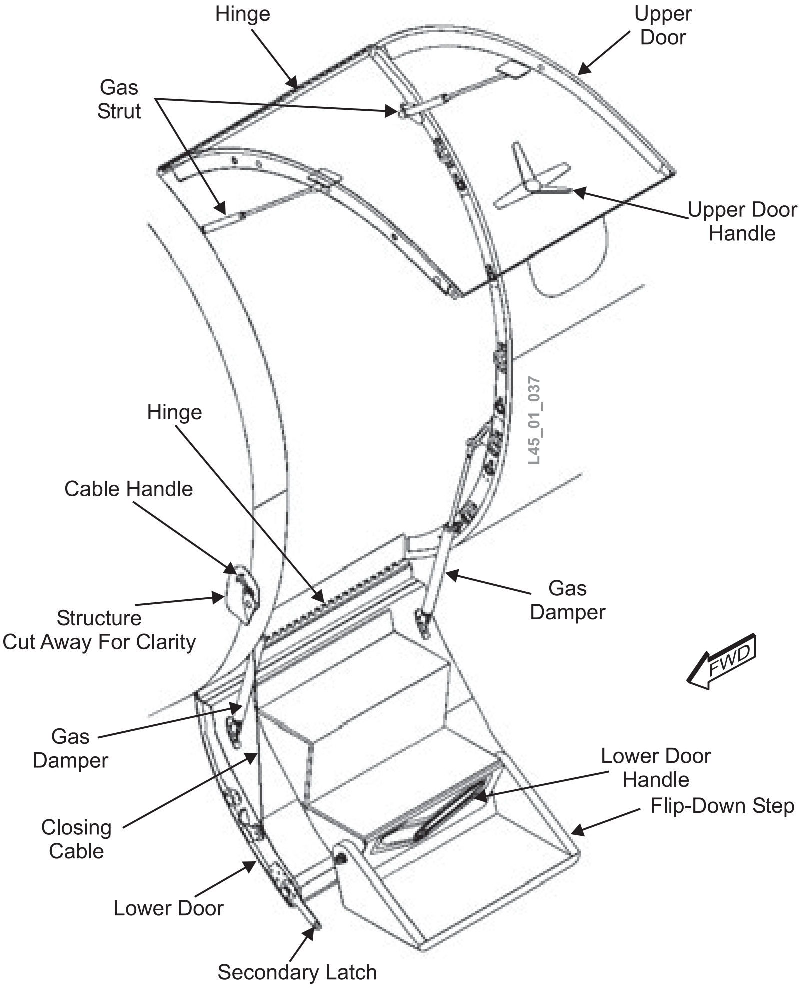
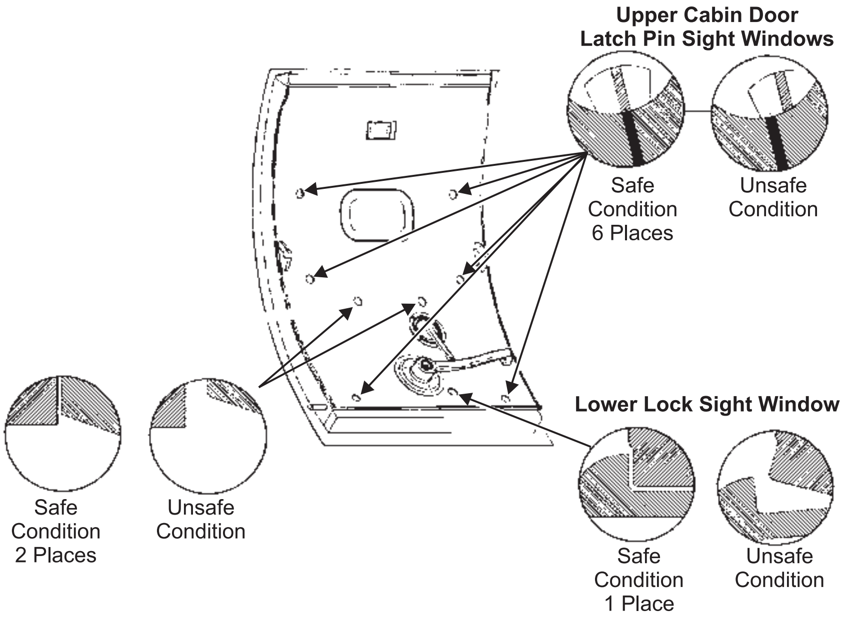


Figure 7 - Cabin Door Diagram

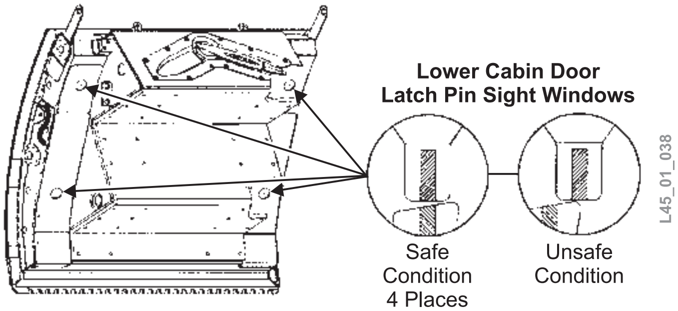
The cabin doors form a rigid structure with the fuselage when closed and latched. Locking of both doors is accomplished by extension of latch pins into the door jamb (four for the lower door; six for the upper door) (Fig. 8). In addition, two latch pins in the upper door also engage eyelets attached to the lower door, thereby securing the edges of the doors to each other.

Proper latch pin extension is visually confirmed through inspection windows. Indicators align when the respective latch pin is fully extended. Inspection windows are provided for each latch pin and the lock pawl.

The extension of each latch pin is monitored by a switch. The red ENTRY DOOR light illuminates on the crew warning panel and the red ENTRY DOOR message is displayed by the crew alerting system when any latch pin is not fully extended. When the door is open, the latch pin switches are monitored for disagreement (one or more switches not in the pin-retracted position). In such cases, the white ENTRY DOOR PIN message is also displayed by the crew alerting system (ground only).



View Looking Outboard At The Upper Passenger/Crew Door



View Looking Outboard At The Lower Passenger/Crew Door

Figure 8 - Cabin Door Inspection Windows

Lower Door

When open, the lower door is supported by a gas strut on each side of the door. The gas struts also assist in door closing as well as damping door movement if the door is allowed to freefall open. A door cable with a pull knob closes the door from the airplane interior. The knob is stowed on the forward door frame.

The lower door has a recessed operating handle in the riser of the lower step. Lock/unlock the door by rotating the operating handle in the appropriate direction. During closing, a secondary latch holds the door closed until it is locked. If the lower door is not locked, then the upper door is prevented from closing by a pin protruding from the lower door. During opening, the secondary latch is released by a lever on the forward edge of the door.

Upper Door

The upper door is equipped with a pair of gas struts which assist in raising the door as well as supporting the door after it is raised. The upper door is locked/unlocked by rotating either operating handle in the appropriate direction. The upper cabin door is also an emergency exit with both exterior and interior operating handles.

The exterior handle is recessed and includes a keylock to prevent unauthorized door opening. When locked, a blocking pawl extends on the interior of the door to prevent movement of the operating handle. During interior door opening, the keylock is overridden by pushing down on the blocking pawl while rotating the operating handle.

A pressurization vent in the upper door ensures unimpeded door operation by eliminating cabin pressurization forces against the door that would bind movement of the latch pins. The vent mechanically opens with initial movement of either operating handle, and remains open while the operating handles are in transit from the full open or close positions. The vent closes when the operating handles reach either full-travel position. The operating handle should be left in the full OPEN position after door opening to prevent ice accumulation in the vent opening or contamination of the door operating mechanism during inclement weather.

Operation

Exterior Opening Procedure

- Unlock the keylock
- Lift the upper door operating handle from its recess and rotate it with both hands clockwise to the full travel position
- Pull the upper door out and upward
- Reach inside and rotate the lower door operating handle clockwise to the open position
- While holding the lower door, lift the secondary latch lever on the forward side of the door frame to release the door
- Gently lower the door until it is suspended by the gas struts
- The flip-down step rotates to the down position as the door is lowered

Exterior Closing Procedure

- Rotate the flip-down step to the stowed position
- Raise the lower door and push it into the door seal until the secondary latch engages
- Reach inside and rotate the lower door handle counterclockwise to the full travel position
- Check that the upper door handle is in the open position. Pull the upper door down and push it into the door jamb
- Rotate the upper door operating handle counterclockwise full travel with both hands
- Check that the handle retracts into the recess in the door skin

Interior Opening Procedure

- Rotate the upper door operating handle to the open position
- Push the upper door outward and up, allowing the door struts to raise the upper door full open
- Rotate the lower door operating handle clockwise to the open position
- Pull the door cable taut while releasing the secondary latch located on the forward side of the door frame
- Lower the door to full open with the door cable. The flip-down step rotates to the deployed position as the door is lowered. Stow the door cable knob on the forward side of the door frame

Interior Closing Procedure

- Raise the lower door with the door cable until the door is within reach. Grasp the flip-down step before it falls inward and lower it to the stowed position
- Pull the lower door into the door seal until the secondary latch engages.
- Stow the door cable knob on the forward side of the door frame
- Rotate the door operating handle counterclockwise full travel
- Check that it is in the open position (pointing up). Pull the door into the door seal and rotate the operating handle clockwise full travel. If preparing for flight, check that the ENTRY DOOR light on the crew warning panel and the ENTRY DOOR message on the crew alert system display are extinguished
- Visually check all inspection windows on both door panels for proper indicator alignment

WARNING

The flip-down step could cause injury to the hand or fingers if it is allowed to suddenly swing down to the stowed position. The flip-down step must be grasped firmly as the door is raised, and lowered by hand before the door nears the vertical position.

The door cable should not be released with full extension. Care should be taken when recoiling the cable.

CAS Messages

Table 1 - CAS Messages

CAS Message	Definition	
	CWP Caption	Conditions/Parameters
ENTRY DOOR	ENTRY DOOR	• One or more of the locking pins in the entry door may not be fully engaged • Keylock is locked and electrical power is applied to the aircraft • DOOR circuit breaker has tripped Ground indication only • Latch pin disagreement is detected while the door is open
EMERGENCY EXIT	Right emergency exit not properly latched	
EXTERNAL DOORS	Either baggage compartment door or equipment bay door not closed	
ENTRY DOOR PINS	One or more switches not in the pin-retracted position (ground indication only)	

Emergency Exits

The designated emergency exits include an emergency exit hatch in the aft right fuselage (right emergency exit) and the upper door panel of the cabin door (left emergency exit).

Left Emergency Exit

The upper portion of the cabin door serves as the left emergency exit. Opening is accomplished via interconnected exterior and interior operating handles. The keylock must be unlocked before flight to ensure exterior opening capability by rescue personnel. If it is locked, it can be overridden during interior door opening by pushing down on the blocking pawl.

Interior Opening

- Rotate the upper door operating handle counterclockwise to the OPEN position
- Push the upper door out and upward. The lower cabin door remains closed which facilitates evacuation during ditching

Exterior Opening

- Rotate the upper door operating handle clockwise full travel with both hands
- Pull the upper door out and upward

Right Emergency Exit

The right emergency exit is a plug-type hatch near the wing leading edge (Fig. 9). It is located on the right side of the fuselage and includes the sixth cabin window. Hatch removal provides an exit opening of 20 by 36 in.

The hatch opens inward after release by the exterior or interior operating handles. During flight, the hatch is sealed closed by cabin differential pressure. When not pressurized, the hatch is held in place by spring-loaded latch pins extending from the top of the hatch.

A security pin installed from the interior prevents hatch opening by either operating handle. The pin includes an attached warning flag labeled REMOVE BEFORE FLIGHT.

Each latch pin is monitored for full extension. Improper extension of either pin activates display of the amber EMERGENCY EXIT message by the crew alerting system.

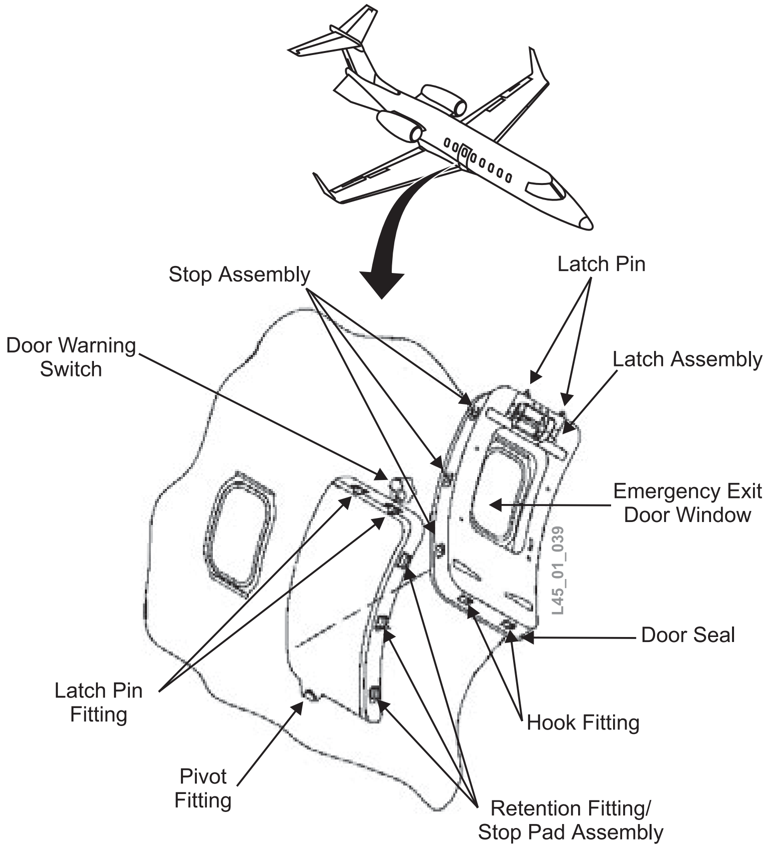


Figure 9 - Right Emergency Exit

Interior Hatch Opening Procedure

- Remove the cover from the operating handle
- Pull the EXIT - PULL handle full inward
- Tilt the top edge of the hatch inward
- Grasp the hatch at the armrest recess with the opposite hand and lift the hatch from the fuselage structure
- Rotate the hatch on its side edge and pass it through the exit opening

Exterior Hatch Opening Procedure

- Locate the exit latch above the window. It is adjacent to the “EMERGENCY DOOR—PUSH TO OPEN—DOOR OPENS INWARD” placard
- Push the latch inward as far as possible. The upper edge of the hatch will fall inward
- Rotate the hatch onto its edge and pull it back through the exit opening

Exit Hatch Installation

- Position the hatch next to the exit opening
- While tilting the hatch inward, place the hatch in the exit opening so that the fittings on the lower edge of the hatch align with the fittings in the exit opening
- While pulling the exit handle inward and down, push the upper edge of the hatch flush into the exit opening
- Release the exit handle
- Attach the handle cover to the inner panel. Safety wiring of the handle is a maintenance function

NOTE

The exit hatch is designed to be installed from inside the cabin only. Ensure the seat next to the emergency exit hatch is moved laterally to the full inboard position before installing the hatch.

Service Doors

Baggage Compartment Door

The baggage compartment door is located on the left fuselage below the engine nacelle (Fig. 10). The door is 33 in. wide and is secured by two latches and a keylock. A hold-open strut facilitates baggage access. Opening of either latch activates display of the amber EXTERNAL DOORS message by the crew alerting system.

Figure 10 - Baggage Compartment Door

Equipment Bay Door

The equipment bay door is located on the right fuselage aft of the engine nacelle (Fig. 11). The door provides access to the aft equipment bay. The door is secured on the upper side by two latches which are monitored for opening. Latch opening activates display of the amber EXTERNAL DOORS message by the crew alerting system.

Figure 11 - Equipment Bay Door

Cockpit

The cockpit is configured in a conventional pilot seating arrangement with a center pedestal between the seats. The instrument panel is tilted slightly forward to improve the view of the panel by the crew. The thrust lever quadrant is located between the center pedestal and the instrument panel. No switches, instruments, or placards are located overhead. Circuit breaker panels are located on each cockpit sidewall. Storage compartments are built into the lower sidewall panels for charts and manuals. Additional storage for manuals is provided in the left storage cabinet aft of the pilot seat. Drink holders are attached to the forward side of the storage compartments. A curtain separates the cockpit from the passenger cabin.

An eye reference locator is mounted on the windshield center post. The eye reference locator consists of three balls forming an aft-pointing triangle. Proper view through the windshield is obtained during approaches when the seat is adjusted so that the occupant’s vision of the forward ball is obscured by the aft ball.

Controls and Indications

Cockpit Diagram

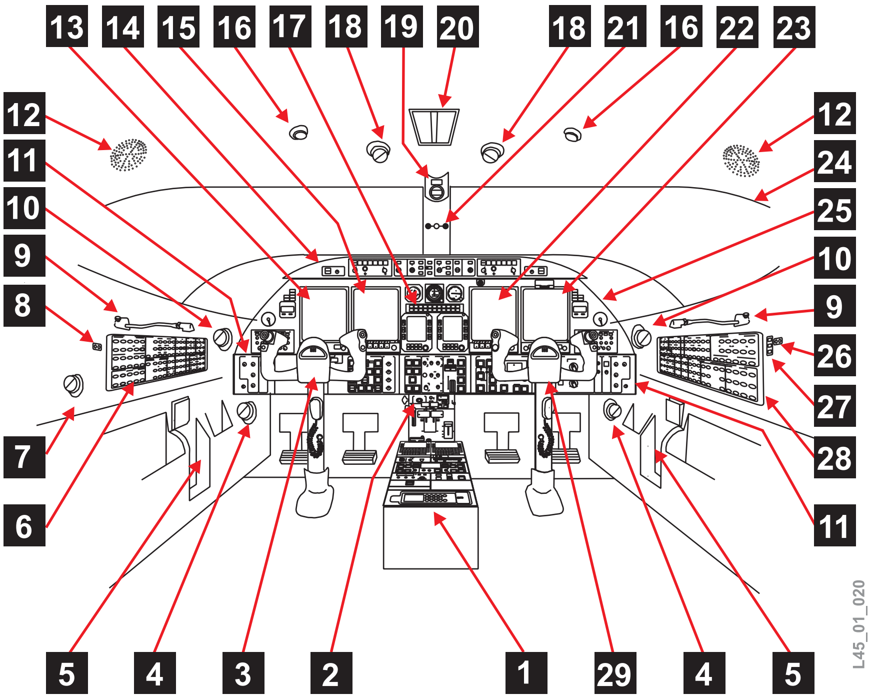


Figure 12 - Cockpit Diagram

1	Pedestal
2	Throttle Quadrant
3	Pilot Control Wheel
4	Air Outlet (Ankle)
5	Smoke Goggle Storage
6	Pilot Circuit Breaker Panel
7	Air Outlet (Armrest Level)
8	Pilot Microphone/Phone Jack Panel
9	Map Light
10	Air Outlet (Armrest Level)
11	Pilot and Copilot Subpanel

12 Cockpit Speakers

13 Pilot Primary Flight Display (PFD)

14 Glareshield Panels

15 Engine Indicating and Crew Alerting System (EICAS)

16 Dome Light

17 Crew Warning Panel (CWP)

18 Overhead Air Outlet

19 Magnetic Compass

20 Assist Handle

21 Eye Reference Locator

22 Multifunction Display (MFD)

23 Copilot Primary Flight Display (PFD)

24 Sunvisor

25 Instrument Panel

26 Copilot Microphone/Phone Jack Panel

27 Cabin Lighting Control

28 Copilot Circuit Breaker Panel

29 Copilot Control Wheel

Cockpit Layout

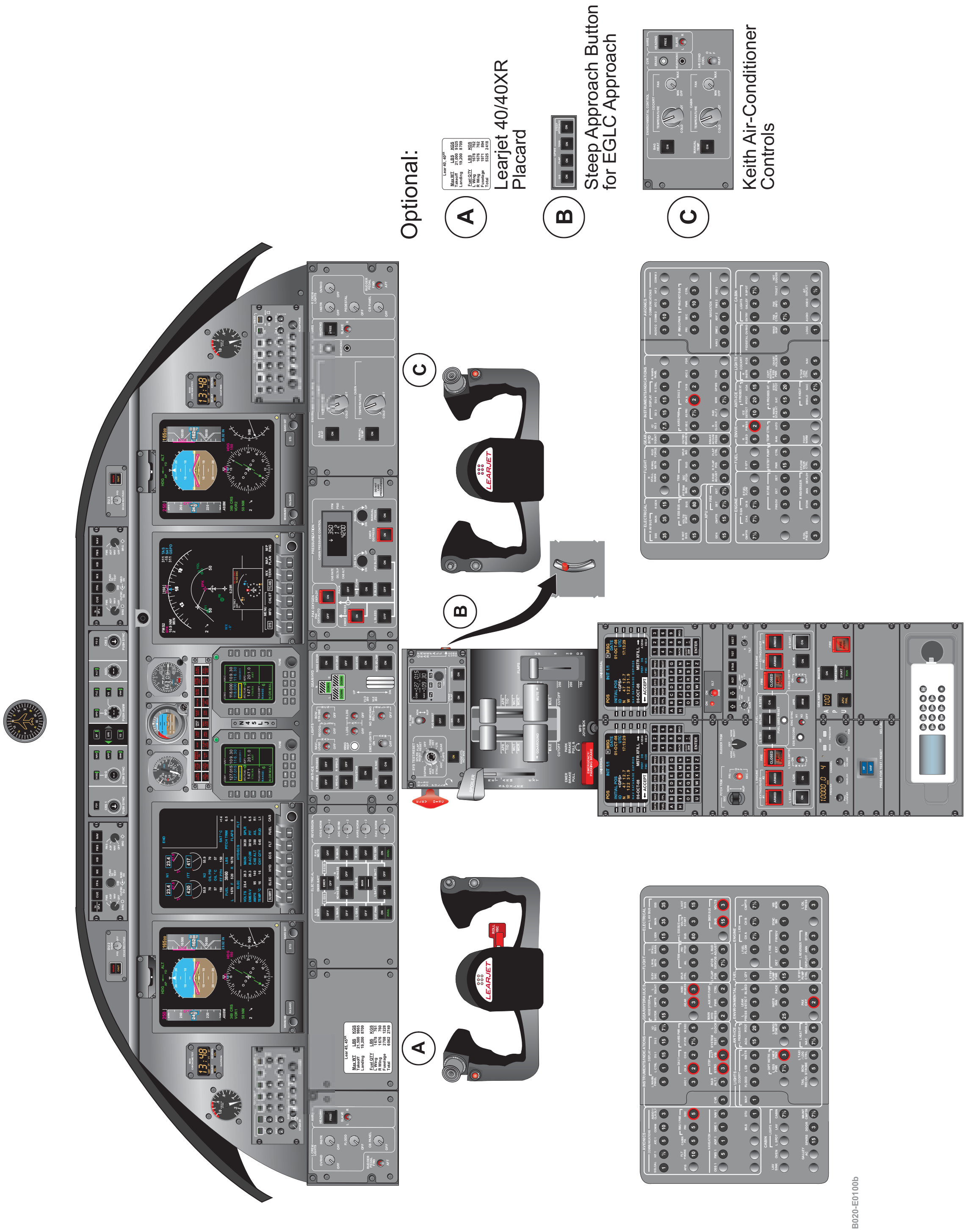


Figure 13 - Cockpit Layout

Instrument Panel Layout

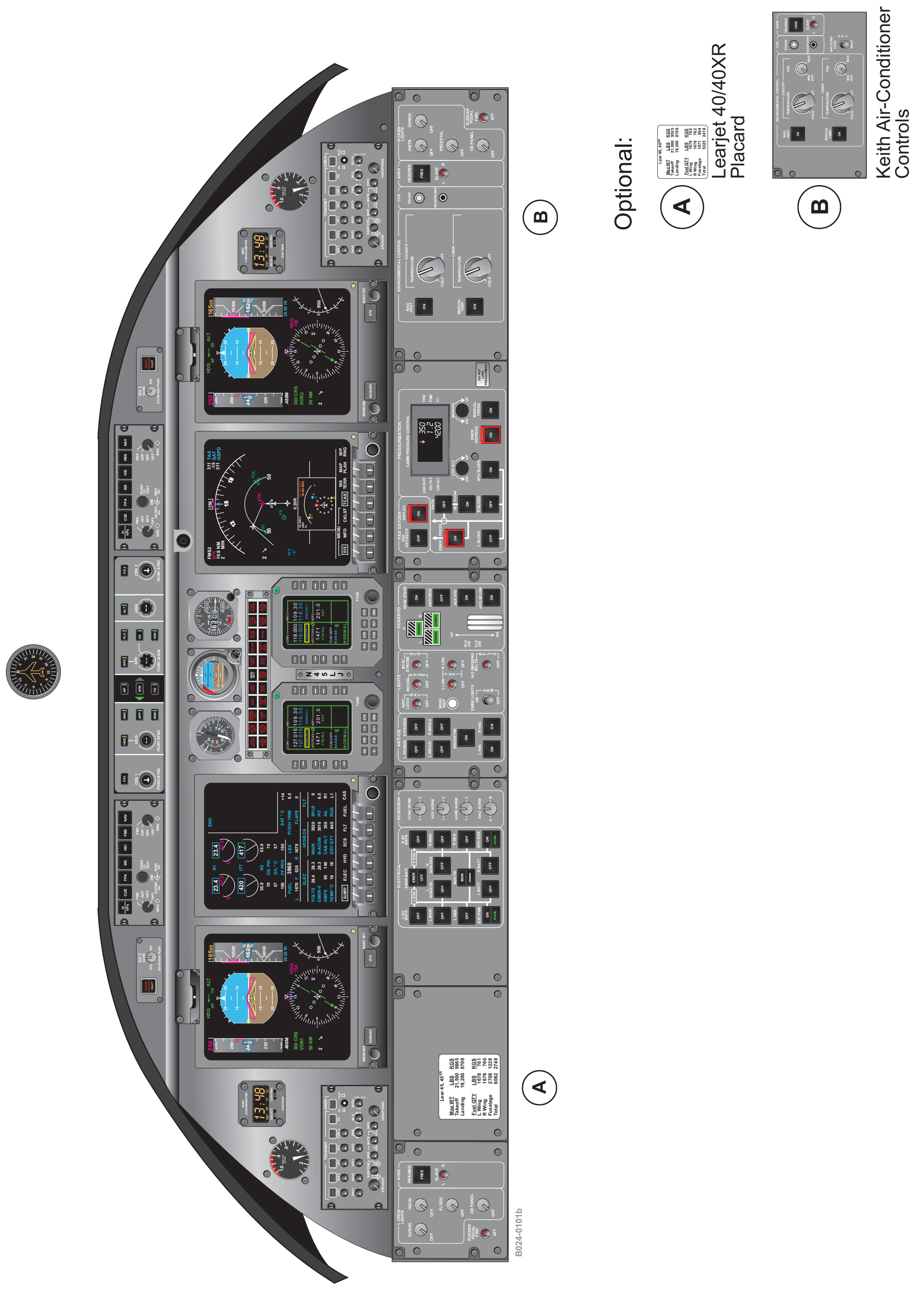


Figure 14 - Instrument Panel Layout

Pedestal Layout

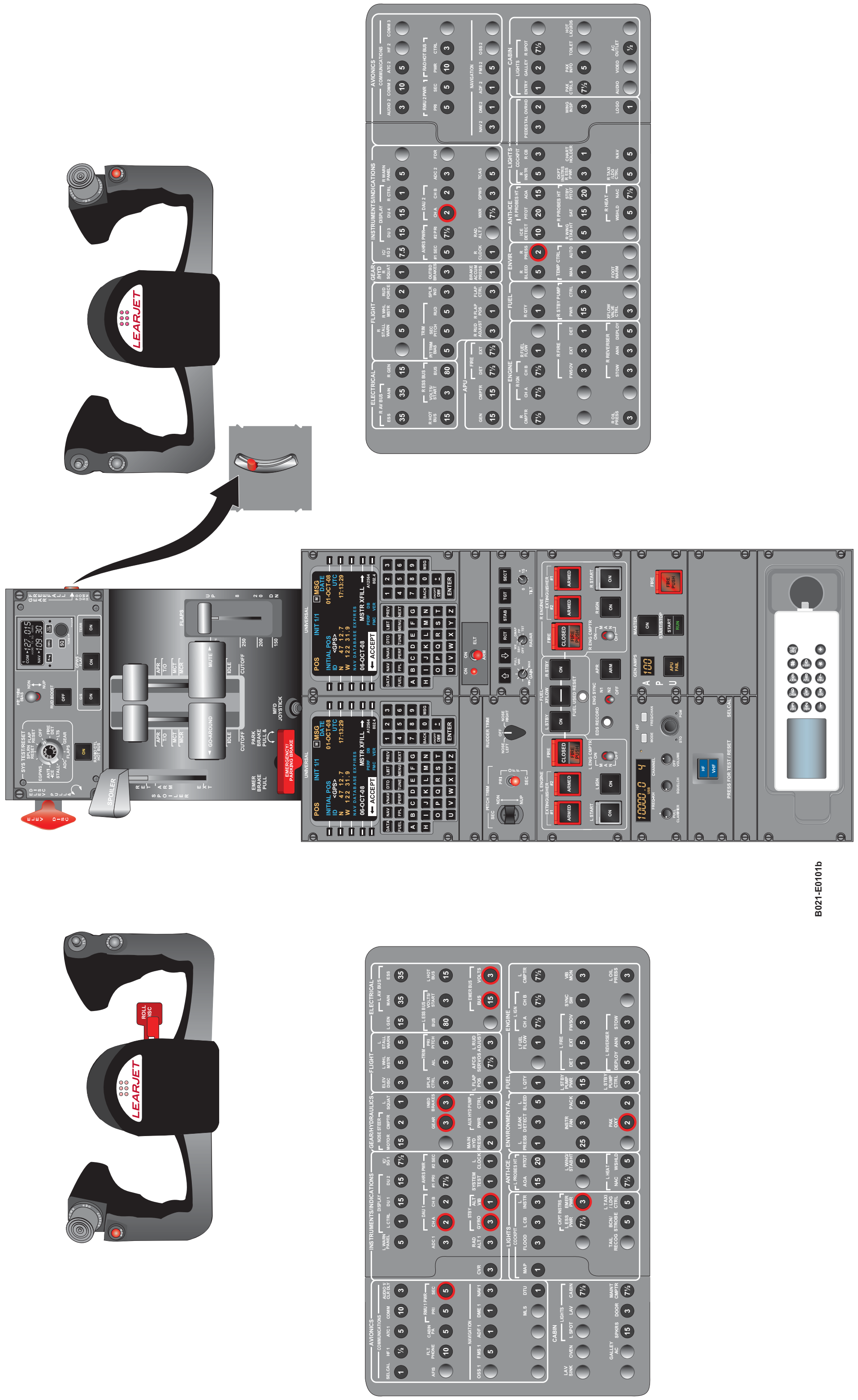
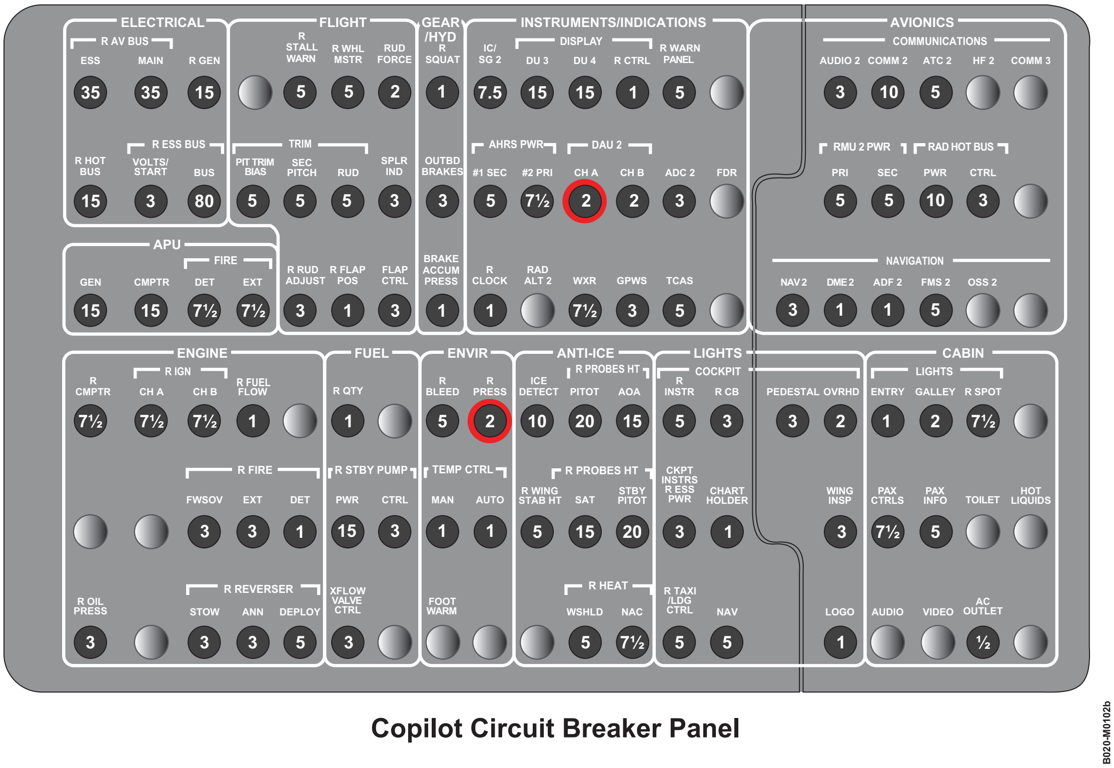
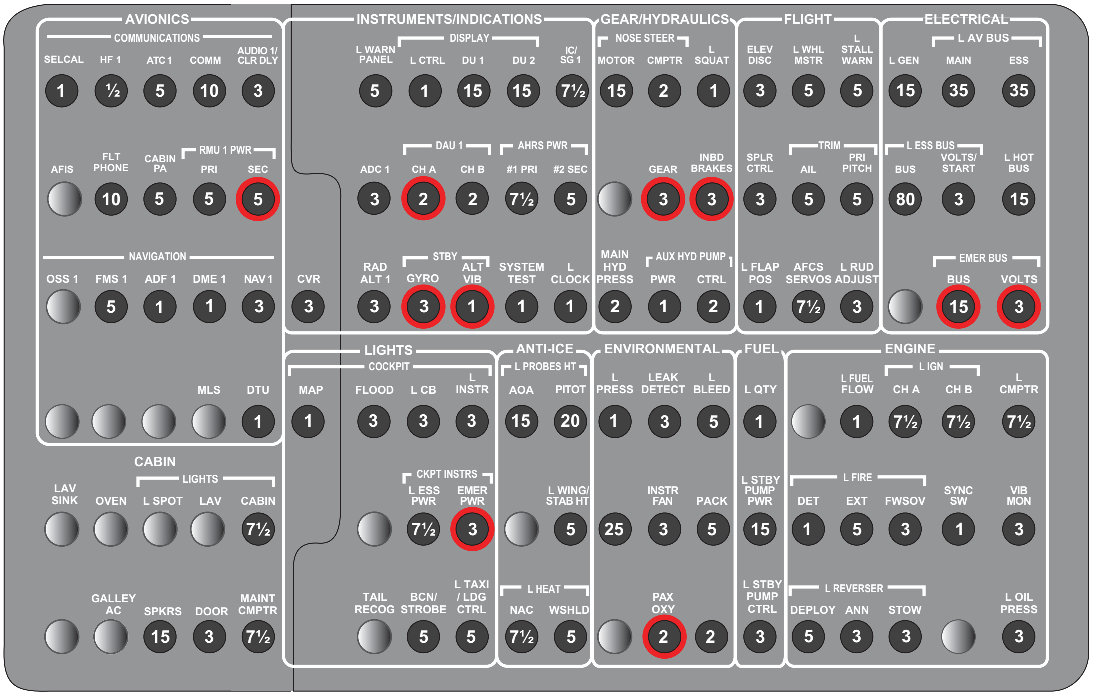


Figure 15 - Pedestal Layout

Pilot and Copilot Circuit Breaker Panel Layout



Copilot Circuit Breaker Panel



Pilot Circuit Breaker Panel

Figure 16 - Circuit Breaker Panels

Seating Areas

Crew Seats

The crew seats (Fig. 17) consist of a seat base, seat bottom, and seat back. The seat base is attached to the seat tracks. The seat bottom is located above the seat base and contains controls for pitch, height, fore-aft movement, lumbar adjustment, and seat back reclining adjustments. The seat back has adjustable armrests and headrest.

The crew seats are covered with foam padding and sheepskin. A five-point restraint system is standard with the lap belts and negative-G strap attached to the seat bottom. The locking handle for the shoulder harness is located on the inboard side of the seat back.

Vertical seat adjustments are accomplished by lifting the lever at the forward outboard edge of the seat bottom. When pulled, the seat moves downward under the occupant's weight. To raise the seat, reduce occupant weight via the assist handle while lifting the lever. The assist handle on the cockpit ceiling must be used while performing seat height adjustments; do not use the glareshield. Gas struts on the seat mechanism raise the seat automatically when weight is removed.

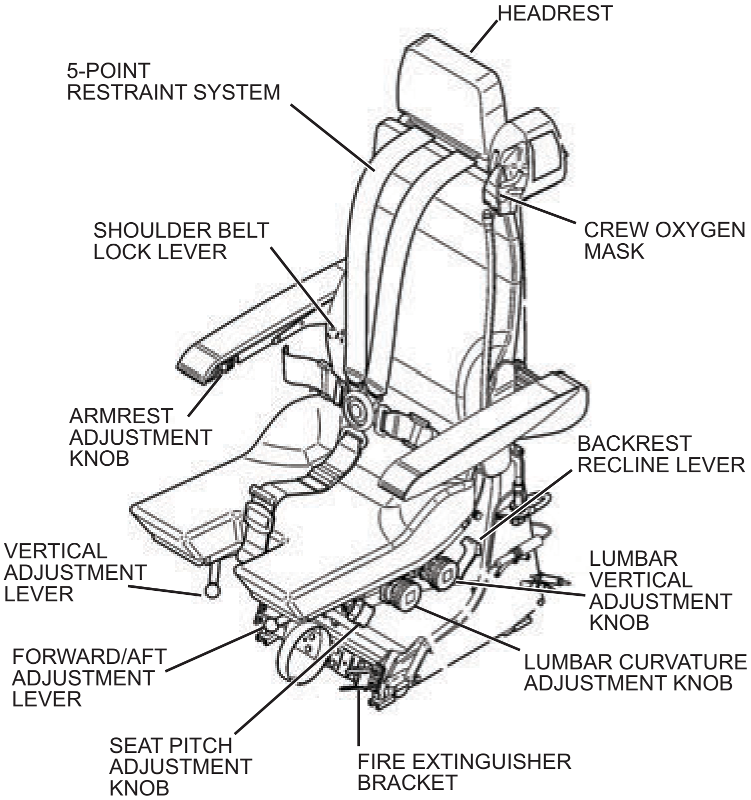


Figure 17 - Crew Seats

Forward/aft seat adjustments are accomplished by lifting the lever located under the forward inboard edge of the seat bottom. When the desired position is obtained, release the lever to lock it in position.

The seat back provides vertical and curvature lumbar adjustment. Both adjustment knobs are located on the outboard seat base. The forward knob adjusts the lumbar curvature; the aft knob adjusts the lumbar vertically.

The retractable armrests are deployed by sliding the armrest out from the seat back and rotating them down into position. An adjusting wheel on the underside of each armrest controls angle. The armrests should be stowed during crew movement to and from the cockpit.

The headrest extends from the seat back and is adjustable for both angle and height. An oxygen mask stowage box is located on each seat back adjacent to the headrest.

Passenger Seats

Standard passenger seating includes eight seats in the Learjet 45 aircraft and six seats in the Learjet 40 aircraft in a two-abreast configuration. Passenger amenities include individual reading lights and air outlets, drink holders, pull-out tables, window shades, and entertainment control panels.

The passenger seats are standard-equipped with a three-point restraint system consisting of lap belts and a built-in shoulder strap. The seats may include an optional inboard armrest which folds down to facilitate seat entry. The seat adjacent to the right emergency exit is standard-equipped with the folding armrest to facilitate unimpeded access to the emergency exit. An optional underseat storage drawer may be installed in the forward end of the seat.

The passenger seat adjusts laterally (to accommodate 360º swiveling) and fore-aft on the seat base. Lateral tracking allows the seat to move away from the cabin wall. An optional seat mechanism further allows the seat base to move fore-aft along the seat tracks. These adjustments are accomplished by lifting the larger of the two levers located at the end of the armrest. Partial lifting allows the seat to swivel only. Lifting all the way up allows the seat to move in all three directions simultaneously. Releasing the lever locks the seat in the current position.

The recline lever is the smaller of the two levers on the end of the armrest. The seat back reclines up to 85º and locks in place when the recline lever is released. Removing weight from the seat back while lifting the recline lever allows the seat back to raise. Each passenger seat also has a headrest which can be adjusted up or down.

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AUTOMATIC FLIGHT CONTROL SYSTEM

Introduction

The Primus 1000 system includes a flight guidance control system (FGCS) that automatically controls and stabilizes the flight path of the aircraft. Use of the FGCS reduces crew workload by automatically flying the aircraft and holding desired headings, attitudes, and altitudes.

FGCS functions include:

- Two-axis fail-passive autopilot/yaw damper
- Dual independent flight directors
- Automatic pitch trim
- Rudder boost system
- Yaw damper system
- Mach/configuration trim system

The main system components of the FGCS consist of the:

- IC-600 Integrated Avionics Computers (IACs)
- Flight guidance controller (FGC)
- Servo motors

For manually flying the airplane, dual flight directors communicate steering commands to the pilots through flight director command bars presented on the primary flight display (PFD).

Flight director steering commands may be coupled to the autopilot for automatic steering of the airplane.

Several lateral and vertical modes of operation are available for the flight director and autopilot. A green light in the switch illuminates when the mode is active.

The rudder boost system and Mach/configuration trim system are discussed in Chapter 9 Flight Controls.

Control and Indications

Flight Guidance Controller

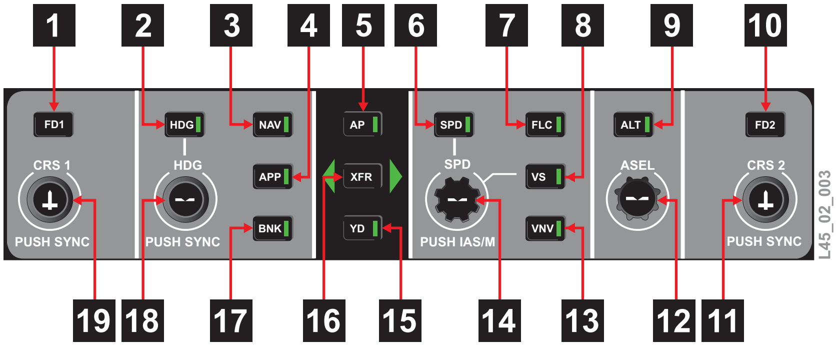


Figure 1 - Flight Guidance Controller

1 FD1 Button

- Press—(autopilot engaged)
  - No effect if FD1 is the master FD
  - Removes pilot FD command bars and annunciations if FD2 is the master FD
- Press—(autopilot disengaged)
  - No effect if no FD modes are selected
  - Removes both pilot and copilot FD command bars and annunciations if FD1 is the master FD
  - Removes pilot FD command bars and annunciations if FD2 is the master FD

2 HDG Button

- Press—
  - Alternately selects or clears heading select mode (HDG)

3 NAV Button

- Press—
  - Alternately selects or clears navigation mode (NAV) on the master side
  - Type of navigation mode is determined by the active navigation source

4 APP Button

- Press—
  - Alternately selects or clears approach mode (APP) on master side and arms the vertical mode (GS or VNV), if appropriate
  - Type of approach is determined by the active navigation source

5 AP Button

- Press—
  - Engages autopilot and yaw damper
  - Subsequent press disengages the autopilot only

6 SPD Button

- Press—
  - Alternately selects or clears indicated speed hold mode
  - Synchronizes the airspeed/Mach reference (bug) to the current airspeed/Mach value

7 FLC Button

- Press—
  - First press changes the mode to FLC
  - Second press changes the mode to FLCH
  - Third press reverts the mode to PIT
  - Toggles between normal and high-speed customized climb or descent profile modes

8 VS Button

- Press—
  - Alternately selects or clears vertical speed hold mode (VS) and sets the magenta bug to the current vertical speed
  - When VS is selected, the airspeed reference (bug) is removed from the airspeed scale

9 ALT Button

- Press—
  - Alternately selects or clears altitude hold mode (ALT)

NOTE **Engaging altitude hold during a climb or a descent causes the aircraft to overshoot through the desired altitude and then recover to the aircraft's altitude at the moment it was selected.**

10 FD2 Button

- Press—(autopilot engaged)
  - No effect if FD2 is the master FD
  - Removes copilot FD command bars and annunciations if FD1 is the master FD
- Press—(autopilot disengaged)
  - No effect if no FD modes are selected
  - Removes both pilot and copilot FD command bars and annunciations if FD2 is the master FD
  - Removes copilot FD command bars and annunciations if FD1 is the master FD

11 CRS2 Knob

- Rotate—Adjusts VOR No. 2 or LOC No. 2 course
- Push inset button—Synchronizes the onside HSI to provide a “direct-to” course to the station

12 ASEL Knob

- Rotate—Adjusts the preselect altitude on both PFD altimeters

13 VNV Button (applies to FMS only)

- Press—
  - Alternately selects or clears vertical navigation mode (VNAV)

14 SPD Knob

- Rotate—
  - Sets magenta speed bug when neither SPD nor VS mode are engaged
  - Adjusts IAS/Mach reference (bug) when speed hold mode is active
  - Speed range is 80 kt to VMO or 0.4 M to MMO
  - Adjusts the vertical speed reference (bug) when vertical speed hold mode is active
  - Vertical speed range is ±6000 fpm with a resolution of 100 fpm
- Push inset—Toggles airspeed tape between IAS and Mach

15 YD Button

- Press—
  - Disengages AP when active
  - Alternately engages or disengages the yaw damper

16 XFR Button

- Press—
  - Alternately selects pilot or copilot flight director as the master flight director
  - Illuminates respective transfer arrow to indicate which flight director is the master
  - Defaults to left side at power-up

17 BNK Button

- Press—
  - Alternately selects or clears low-bank mode
  - Mode is indicated by a green bar on both BNK angle scales
  - Above 41,600 ft, automatically engages if HDG or NAV (VOR) is engaged; automatically disengages when descending below 41,400 ft
  - Does not engage for FMS NAV, APP, or ROL modes

18 HDG Knob

- Rotate—Adjusts HDG bug on all displays
- Push knob inset—Synchronizes HDG bug on all displays to the current aircraft heading

19 CRS1 Knob

- Rotate—Adjusts VOR No. 1 or LOC No. 1 course
- Push inset button—Synchronizes the onside VOR to provide a “direct-to” course to the station on the HSI

Cockpit Switches—Autopilot/Flight Director Function

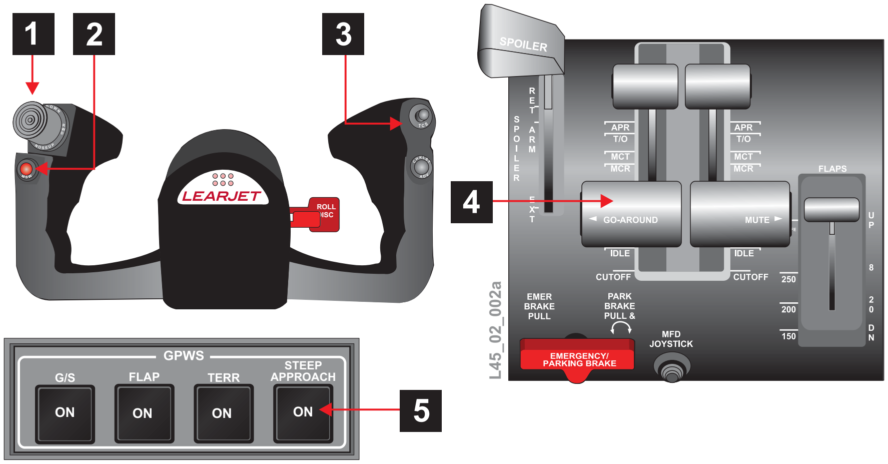


Figure 2 - Cockpit Switches—Autopilot/Flight Director Function

1 Control Wheel Trim Switch—Autopilot/Flight Director Function (spring-loaded to neutral)

- Each switch is a dual-function (trim and trim-arming) switch
- Push (both trim and trim-arming switch) NOSE UP, NOSE DN, LWD or RWD—
  - Disengages the autopilot
  - Drives the aileron trim tab or horizontal stabilizer
- Push trim barrel only NOSE UP or NOSE DN—
  - With the autopilot engaged, activates the flight director pitch attitude hold mode (PIT)
- Push trim barrel only LWD or RWD—
  - With the autopilot engaged, activates the flight director roll attitude hold mode (ROL)

2 Control Wheel Master Switch (MSW)—Autopilot Function

- Press and release—
  - Disengages the autopilot
  - Disengages the yaw damper

3 Touch Control Steering (TCS) Button

- Press and release—
  - Uncouples the autopilot servo clutches while button is held depressed, if the autopilot is engaged
  - Synchronizes the onside vertical mode flight director reference values to those presently flown by the aircraft when in PIT, ALT, VS, IAS, and MACH modes
  - Synchronizes the onside lateral mode flight director reference values to those presently flown by the aircraft when in roll attitude hold mode
  - Clears all modes if used when vertical GA mode is active (ROL and GA modes)
  - Switch has no effect if the onside flight director is in GS, climb or descent, or ALTS modes

4 GA Button

- Press—
  - Selects roll attitude hold mode (ROL) on both flight directors (wings level)
  - Selects vertical go-around mode (GA) on both flight directors
  - Disengages the autopilot

PFD Annunciations

Fig. 3 and Table 1 provide a summary of FGCS-related annunciations which may be presented on the PFD.

Armed Lateral Modes

BC	(W)
FMS	(W)
LOC	(W)
VAPP	(W)
VOR	(W)

*Captured Lateral Modes

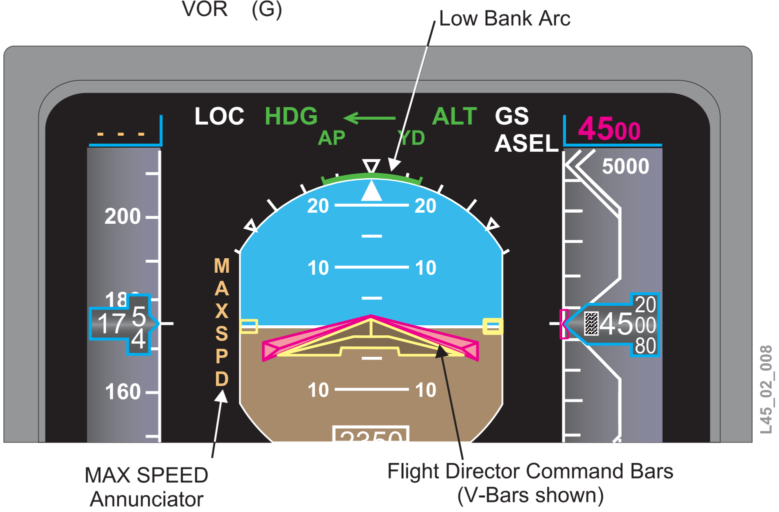
BC	(G)
FMS	(G)
HDG	(G)
LOC	(G)
ROL	(G)
VAPP	(G)
VOR	(G)

*Captured Vertical Modes

ALT	(G)	IAS	(G)
ASEL	(G)	MACH	(G)
FLC	(G)	PIT	(G)
FLCH	(G)	VNAV	(G)
GA	(G)	VS	(G)
GS	(G)		

Armed Vertical Modes

ASEL	(W)
GS	(W)
VNAV	(W)



Autopilot Status Annunciation

**AP	(A)
AP	(G)
AP	(R)
TCS	(W)

Flight Director Couple Arrow

←¬(G)
→¬(G)

Yaw Damper Status Annunciation

YD	(G)
YD	(A)
TEST	(A)
FAIL	(A)

LEGEND

(W)	White
(G)	Green
(A)	Amber
(R)	Redd

* A white box frames a captured/transition mode annunciation for 8 seconds after capture/transition logic is satisfied.

** AP and YD fields form composite amber "AP TEST" and "AP FAIL" annunciation.

Figure 3 - PFD Annunciations

Table 1 - PFD Annunciation Summary

Indication	Color	Description
ALT	G	Altitude hold mode active
ASEL	G	Altitude preselect mode capturing
	W	Altitude preselect mode armed
AP	G	Autopilot engaged
	A	Manual disengagement (flashes for 5 seconds)
	R	Monitored disengagement (flashes for 5 seconds, then steady)
AP FAIL	A	Autopilot failure
AP TEST	A	Autopilot is in self-test
←	G	Pilot flight director is master FD
→	G	Copilot flight director is master FD
BC	G	Back course mode active
	W	Back course mode armed
FD FAIL	A	Flight director is failed
FLC	G	Flight level change mode active; normal climb or descent profile
FLCH	G	Flight level change mode active; high-speed climb or descent profile
FMS	G	FMS navigation mode active
	W	FMS navigation mode armed
GA	G	Vertical go-around mode active
GS	G	Glideslope mode active
	W	Glideslope mode armed
HDG	G	Heading select mode active
IAS	G	Indicated airspeed hold mode active
LOC	G	Localizer navigation or approach mode active
	W	Localizer navigation or approach mode armed
MACH	G	Mach hold mode active
MAX SPEED	A	Overspeed protection is active (if in VS, SPD [IAS and Mach], and FLC modes). Honeywell (Phase III) upgrade adds PIT (S/N 005-169 if complied with SB45-22-4 S/N 170 and on)
PIT	G	Pitch attitude hold mode active
ROL	G	Roll attitude hold mode active

Table 1 - PFD Annunciation Summary (Cont)

Indication	Color	Description
TCS	W	Touch control steering selected
VAPP	G	VOR approach mode active
	W	VOR approach mode armed
VOR	G	VOR navigation mode active
	W	VOR navigation mode armed
VNAV	G	FMS vertical navigation mode active
	W	FMS vertical navigation mode armed
VS	G	Vertical speed hold mode active
YD	G	Yaw damper engaged
	A	Yaw damper disengaged Monitored disengagement (flashes for 5 seconds, then steady) Manual disengagement (flashes for 5 seconds)

IC-600 Integrated Avionics Computer

Description

The IC-600 Integrated Avionics Computers (IACs) contain the processors which provide flight director, autopilot, and yaw damper functions, as well as system monitors. The IAC receives sensor input data, performs the required calculations on the data, and provides the required computed steering commands for the flight director functions, as well as attitude stabilizing commands for the autopilot.

Operation

The No. 1 (pilot) IAC flight guidance computer has an independent flight director operation. It computes Mach/configuration trim and controls manual stabilizer trim (with the pilot manual trim system). Aircraft configuration inputs include spoilers, flaps, and landing gear.

The No. 2 (copilot) IAC flight guidance computer operates the autopilot and yaw damper/rudder boost, and includes an independent flight director function.

Refer to Fig. 4 for a block diagram of the flight guidance control system.

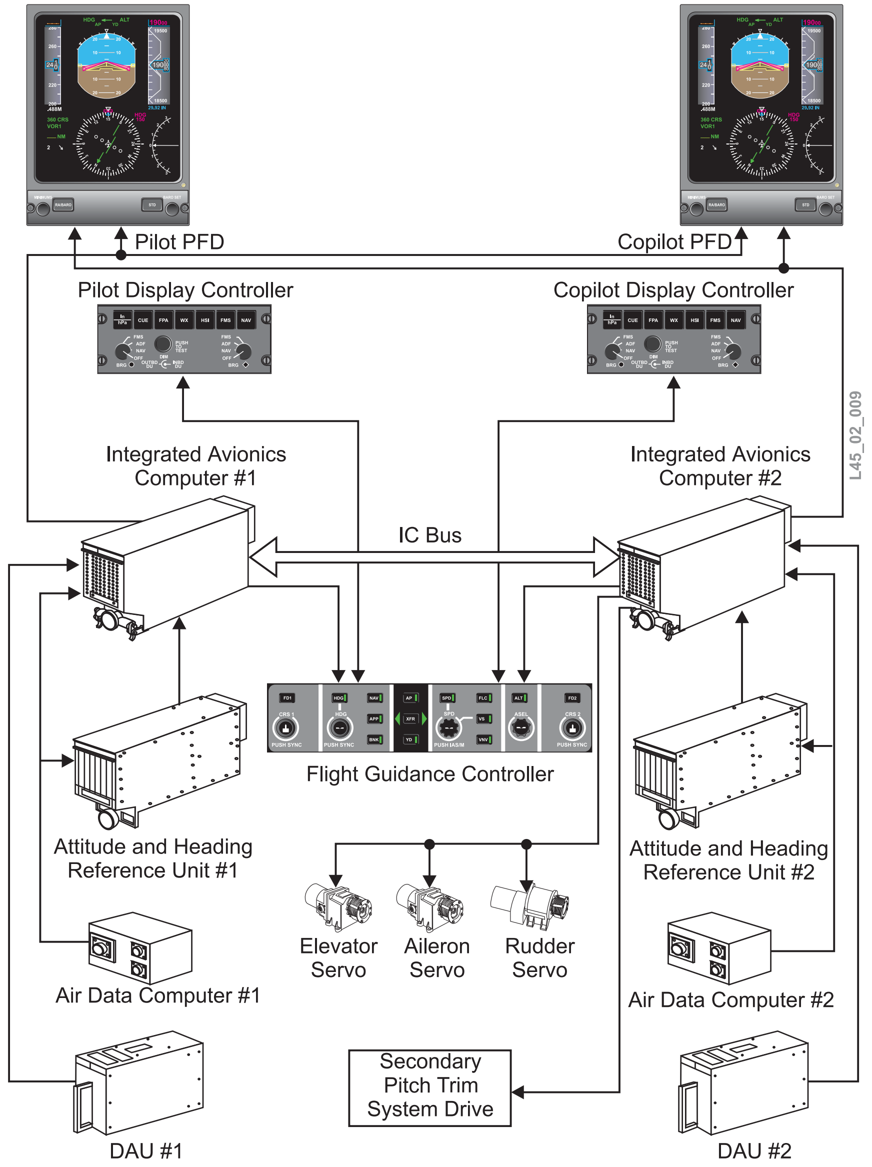


Figure 4 - Flight Guidance Control System

Autopilot

Description

The Learjet 40/45 has a single-channel two-axis fail-passive autopilot which may be coupled to either the pilot or copilot flight director. Elevator, aileron, and rudder surfaces are positioned by servo motors (one per axis). The rudder is controlled by the yaw damper system.

The fail-passive system prevents any significant displacement of the aircraft from its flight path, upon occurrence of any single failure.

The autopilot is integrated with the flight director to automatically control and direct the flight of the aircraft. When engaged, the autopilot controls the aircraft pitch and roll yaw axes in accordance with the coupled flight director commands.

Autopilot Self-Test

Both IACs initiate a self-test sequence when the aircraft is powered up: an amber AP TEST is displayed on both PFDs. If the self-test sequence detects a failure in the flight guidance control system, an amber AP FAIL message is displayed on the PFD autopilot annunciation field. The autopilot is also inhibited from engagement when the AP FAIL message is displayed.

Components and Operation

Autopilot Engagement

The autopilot can be engaged by depressing the AP button on the center of the flight guidance controller. Autopilot engagement (or coupling) is indicated by the illumination of a green vertical bar within the AP button (Fig. 5). In addition, a green AP annunciation appears on both PFDs just above the ADI (Fig. 6). When engaged, the autopilot couples to and follows the guidance commands from the master flight director.

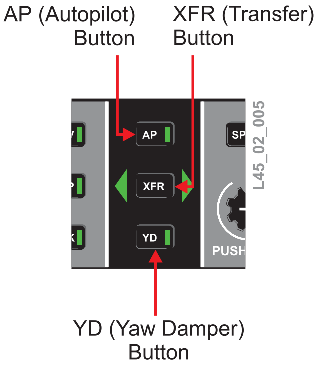


Figure 5 - Autopilot and Yaw Damper Buttons

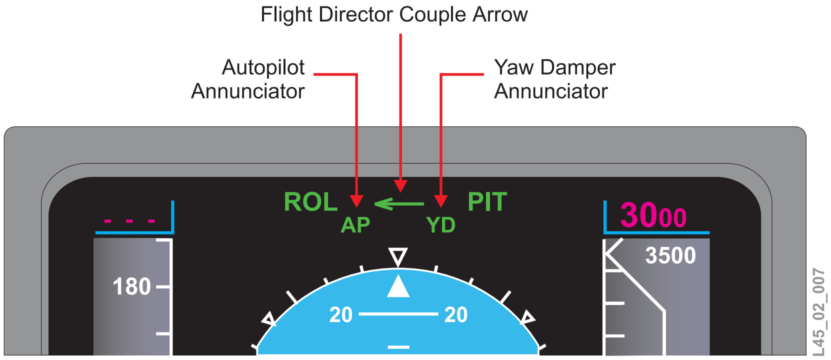


Figure 6 - Autopilot and Yaw Damper PFD Annunciations

Autopilot Disengagement

Manual Disengagement

The autopilot is normally disengaged by depressing the AP button.

The autopilot can also be manually disengaged by the following actions:

- Manually trimming (trim [barrel] and trim-arming switch actuated)
- Activating the SEC TRIM switch
- Selecting the pitch trim selector switch to OFF
- Depressing the YD button (yaw damper disengagement)
- Depressing the GA switch on the left thrust lever
- Selecting either AHRS reversionary switch away from NORM
- Depressing either control wheel master switch (MSW)

Depressing the MSW switch acts as an emergency disconnect in that it not only instructs the autopilot system to disengage, but immediately removes power from the servo clutches in all three axes. A white WHEEL MSTR CAS message appears when the MSW switch is actuated.

Whenever the autopilot is manually disengaged (by pilot action), the AP annunciation on both PFDs turns amber and flashes for 5 seconds before being removed. An autopilot disconnect aural tone (cavalry charge) is also sounded for 2 seconds.

Monitored Disengagement

The FGCS monitors aircraft sensors, servo data, the autopilot pitch trim system and internal parameters for faults. The autopilot automatically disengages if any of the following occurs:

- Autopilot monitor detects a fault
- Autopilot pitch trim system detects a fault
- Loss of any power source to the autopilot
- Loss of servo power
- IAC/SG failure
- Loss of either attitude/heading system input
- Aircraft is at an excessive attitude (35° bank, 25° noseup, or 15° nosedown)
- Either stick shaker activates

In the case of a monitored disconnect, the AP annunciation turns red and flashes for 5 seconds and then remains steady. The disconnect aural tone sounds continuously until acknowledged by the flight crew by depressing either MSW switch.

Autopilot Pitch Trim

The autopilot pitch trim function is contained in the IC-600 No. 2 computer and utilizes the secondary pitch trim system. When the autopilot is engaged, it provides commands to the horizontal stabilizer pitch trim actuator to remove continuous loads from the elevator servo motor.

Failure of the autopilot pitch trim system causes the autopilot to disengage and is indicated by the illumination of an amber SEC TRIM FAIL CAS message.

Trim-in-Motion Clacker

A trim-in-motion clacker alerts the crew of autopilot trim operation longer than 2 to 3 seconds. Unusual long periods of autopilot trimming may indicate trim runaway. The trim-in-motion clacker is only active when the autopilot is engaged.

CAS Messages

Table 2 - CAS Messages

CAS Message	Conditions/Parameters
AP ELEV MISTRIM	Autopilot pitch servo is holding excessive torque
AP AIL MISTRIM	Autopilot roll servo is holding excessive torque
AP ELEV MISTRIM	Autopilot pitch servo is holding excessive torque
WHEEL MSTR	Either MSW switch depressed or power to one of the MSWs lost. This CAS message is accompanied by the White PRI TRIM FAULT CAS message

Autopilot Authority Limits

Autopilot pitch authority is limited to 10° nosedown and 20° noseup.

Roll authority is limited to 35° bank.

Servo Motors

When the autopilot is engaged, IAC No. 2 directs roll and pitch commands to the aileron and elevator servo motors. When a change in roll or pitch attitude is required, the IAC No. 2 signals the aileron or elevator servo to bias the control cables to move the associated control surface.

The aileron servo is mechanically connected to the aileron control system through a capstan and servo cable.

The elevator servo is mechanically connected to the elevator through a capstan and servo cable.

Autopilot Mistrim Conditions

The FGCS continuously monitors all axes of the autopilot when it is engaged. If a control surface is detected to be significantly out of trim, a mistrim CAS message is displayed.

Depending on the mistrim severity, a white or amber AP ELEV MISTRIM CAS message is annunciated when the IAC detects that elevator servo loads have not been relieved by the pitch trim system.

An amber AP AIL MISTRIM CAS message is annunciated whenever the IAC detects that aileron servo loads have not been relieved.

NOTE

When the autopilot is disengaged in a mistrim condition, expect an abrupt change in control force.

At high altitudes and speeds, a condition known as High Mach Roll can occur. This causes one wing to gradually drop, requiring the pilot to apply aileron in the opposite direction. If on autopilot, an amber AP AIL MISTRIM CAS message alerts the crew to this condition. The pilot should follow checklist procedures.

Control Wheel Trim Switches—Autopilot/Flight Director Function

The control wheel trim switches, located on the outboard horn of the pilot and copilot control wheel, allow the pilots to input manual commands to the flight director without disengaging the autopilot. These switches are also referred to as “barrel” switches. Depressing the master FD side control wheel trim switch NOSE UP/NOSE DN or LWD/RWD causes the flight director pitch or roll attitude hold mode to be activated respectively. Discrete commands may then be applied by momentarily clicking the switch or continuous commands by holding the switch to the desired position.

If the ARM switch is depressed while an input is made through the control wheel trim switch, the autopilot immediately disengages.

Operation of the control wheel trim switch is further discussed with each applicable flight director mode.

Touch Control Steering

A touch control steering (TCS) button located on the inboard horn on each pilot control wheel, allows the flight crew to manually fly the airplane without disengaging the autopilot. The TCS also provides flight director pitch and roll synchronization. To use the TCS function, the master side TCS switch is pressed and the aircraft is maneuvered to the desired condition. When the desired condition is reached, the TCS switch is released and the autopilot resumes control of the aircraft.

TCS operation is further discussed with each applicable flight director mode.

Yaw Damper

Description

A single yaw damper system augments aircraft stability by opposing uncommanded motion about the yaw axis and providing turn coordination. The yaw damper function is provided by IAC No. 2 computer only.

The yaw damper operates independently of the autopilot.

Components and Operation

Yaw Damper Engagement

Depressing the AP button on the flight guidance controller automatically engages the yaw damper. The yaw damper system may also be engaged or disengaged independently of the autopilot by depressing the YD button on the flight guidance controller.

When engaged, a green YD annunciation is displayed on both PFDs, and the green bar within the YD button is illuminated.

Yaw Damper Servo Motor

The yaw damper servo motor and yaw damper capstan are located in the tail section of the aircraft. When engaged, the servo motor and capstan command the rudder to provide yaw stabilization.

Yaw Damper Disengagement

When the yaw damper is disengaged (manual or monitored disengagement), the autopilot disengages, if engaged.

Manual Disengagement

The yaw damper is normally disengaged by depressing the YD button. The yaw damper can also be manually disengaged by depressing either MSW switch.

Manual disengagement of the yaw damper causes the YD annunciation to flash amber before removal from both PFDs and the green bar within the YD button to be extinguished. A short disconnect aural tone is also sounded.

Monitored Disengagement

The yaw damper automatically disengages if the yaw damper monitors detect a failure condition. In the case of a monitored disconnect, the YD annunciation turns amber and flashes for 5 seconds and then remains steady. The disconnect tone continuously sounds until either control wheel master (MSW) switch is depressed.

Flight Director

Description

The flight director (FD) system, using two separate IC-600 IACs, provides dual flight director computations. IAC 1 drives the left side or pilot flight director (FD1) and IAC 2 drives the right side or copilot flight director (FD2).

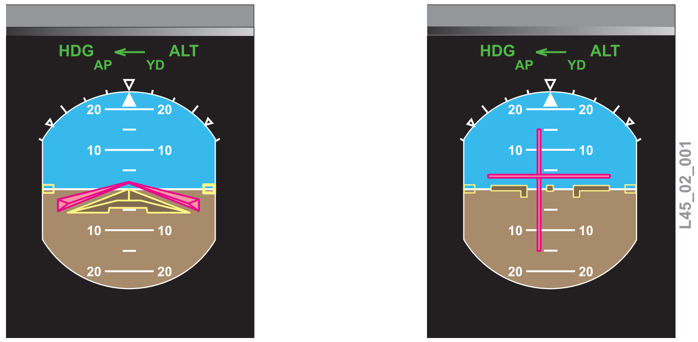
The flight director is the visual presentation of the flight guidance commands generated by the IACs. The flight director is displayed on the PFDs as command bars. Either flight director can be coupled to the autopilot or can be followed by the pilot when the aircraft is manually flown.

Operation

Flight Director Command Bars

The flight director provides integrated pitch and roll control guidance by means of magenta inverted V-shaped (single cue) command bars or cross pointer (split cue) command bars on the PFD (Fig. 7). The flight director command bar format is pilot-selectable between single or dual cue via the CUE switch on the respective display controller.

Command bars are always in view when the flight director is being used or when the autopilot is engaged. The command bars move up or down to command a climb or a descent, or turn right or left to command a right or left bank. The airplane should be maneuvered so that the airplane symbol is “flown into” the command bars until the two are aligned.



Single Cue Command Bars

Cross Pointer Command Bars

Figure 7 - Flight Director Command Bars

FD1 and FD2 Buttons

The flight director buttons (FD1 and FD2) are located on the flight guidance controller. The FD1 and FD2 buttons can be used to remove the flight director annunciations and command bars from the PFDs. Operation of the FD buttons are dependent on the status of the autopilot.

Any FD mode selection causes the FD command bars to appear on both PFDs. When the FD command bars are in view on both PFDs and the autopilot is not engaged, depressing the master side FD button drops all FD modes and removes the command bars from both sides. Pressing the slave side FD button removes the command bars from the PFD on that side only.

With the autopilot engaged, the FD command bars are in view at all times on the master (coupled) side and cannot be removed from the PFD. The slave side FD command bars can be removed from view by depressing the appropriate FD1 or FD2 button.

Flight Director Master/Slave Logic

The flight directors operate in a master/slave configuration. Only one flight director can be coupled to the autopilot. The flight director coupled to the autopilot is classified as the master flight director, and the other is classified as the slave flight director. The master flight director is indicated by the directional arrows on the flight director and flight guidance controller. The FD has a green couple arrow on the PFD, and the flight guidance controller has a green XFR arrow. Left-pointing arrows indicate the pilot flight director (FD1) is the master, and right-pointing arrows indicate the copilot flight director (FD2) is the master.

The slave side flight director always displays flight director guidance information from the master side flight director. This ensures that all FD modes and command cues displayed on the pilot and copilot PFDs remain synchronized. Upon power-up, the default master flight director is the pilot flight director or FD1.

When symbol generator reversion is selected to the slave flight director side, a forced flight director switch to the slave flight director occurs and is annunciated by the couple arrows on both the PFD and flight guidance controller. In this case, both flight directors automatically default to pitch and roll modes. If SG reversion is selected to the master side flight director, the modes on either flight director are not affected. Manual selection via the XFR button on the flight guidance controller is inhibited with SG reversion selected.

XFR Button

Either flight director may be selected as the master flight director via the XFR button on the flight guidance controller. If the autopilot is engaged and the XFR button is selected, the master/slave status toggles, and all engaged flight director modes drop to the basic lateral and vertical modes (ROL and PIT). If the autopilot is not engaged and the XFR button is selected, all FD modes cancel and the FD command bars are removed from view. New FD modes then need to be selected.

PFD Flight Director Mode Annunciations

The flight director vertical and lateral mode annunciations are always displayed on both PFDs (Fig. 8). The lateral mode annunciations are located on the left above the ADI. The vertical mode annunciations are on the right above the ADI.

Active/Captured Field

The active or captured lateral and vertical modes are represented in green characters. The flight director command bar guidance reflects the annunciated active/captured lateral and vertical modes.

Armed Field

The armed vertical and lateral mode annunciations are represented in white characters outside of the active modes. When the capture criteria for the armed mode is satisfied (such as localizer capture in LOC mode), the applicable armed mode annunciation blanks from the armed field and appears as the captured or active mode. A white flashing box frames a captured/transition mode annunciation for 8 seconds after the capture/transition logic is satisfied.

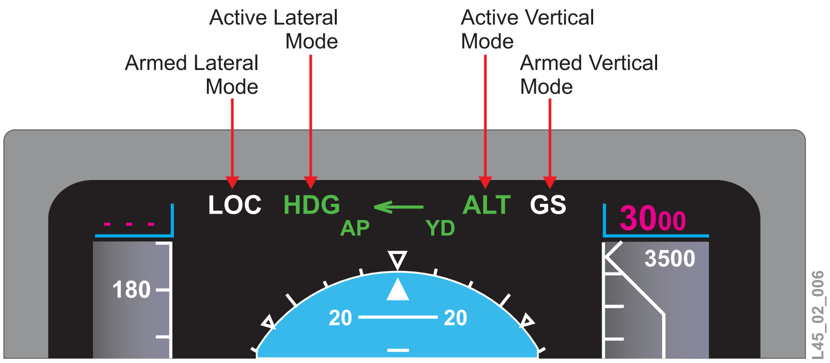


Figure 8 - Flight Director Mode Annunciations

Flight Guidance Controller

The flight guidance controller (FGC) is located on the glareshield and is accessible to both pilots (Fig. 9). It contains most of the buttons and annunciators for autopilot, yaw damper, and flight director operation. The FGC also has several knob controls to select IAS, MACH, and VS targets, altitude, course, and heading.

The flight director mode select buttons are grouped into lateral and vertical modes. Flight director modes are selected by depressing the applicable mode selector button on the flight guidance controller. Selected modes may be disengaged by depressing the mode selector button a second time or selecting an incompatible mode. The last mode selected disengages noncompatible modes for the roll or pitch axis. The mode selection buttons on the FGC panel each have a vertical green bar that illuminates whenever the mode is selected.

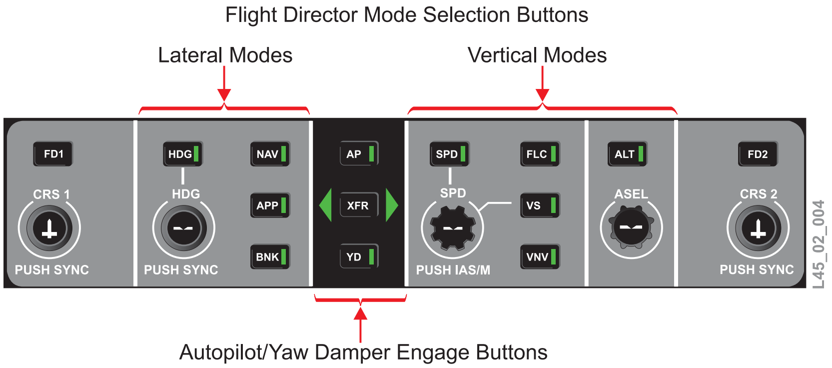


Figure 9 - Flight Guidance Controller

Flight Director Failure

During a flight director failure, a boxed amber FD FAIL annunciation is displayed in the vertical mode annunciation field and the flight director command bars are removed from the PFD.

If a sensor failure is detected affecting an active lateral or vertical mode, the applicable mode is dropped and the flight director reverts to default basic modes (roll and pitch).

Flight Director Lateral Modes

The flight director has several lateral modes as follows (bold letters refer to flight guidance controller button selections):

- Heading hold mode (ROL)
- Roll attitude hold submode (ROL)·
- Heading select mode **(HDG)**
  - Low bank **(BNK)**
- Navigation mode **(NAV)**
  - VOR (VOR)
  - Localizer (LOC)
  - FMS navigation (FMS)
- Approach **(APP)**
  - VOR (VAPP)
  - Localizer (LOC)
  - FMS (FMS)

Wings Level Mode

Wings level mode is the basic lateral flight director mode when the bank angle is <6°. It activates automatically when the command bars are in view and no other lateral mode is active. The PFD active lateral mode field indicates ROL when the mode is active.

The flight directors provide roll commands to maintain the current heading.

Roll Attitude Hold Mode

Roll attitude hold is the basic lateral flight director mode when bank angle is greater than 6° but less than 34°. It activates when the command bars are in view and no other lateral mode is active. The PFD active lateral mode field indicates ROL when the mode is active (Fig. 10).

When active, this mode causes the flight director to generate commands to maintain the existing bank angle. The desired bank angle may be established, with or without the autopilot engaged, by manually flying the aircraft to the desired roll attitude while depressing the TCS button. When the TCS button is released, the flight director generates commands to maintain the new bank attitude.

If the autopilot is engaged, the reference bank angle can also be established by selecting the control wheel trim (barrel) switch towards LWD or RWD until the desired bank angle is achieved. Momentary roll inputs from the barrel switch result in a 1.5° per second roll rate command, and sustained inputs (> 1 second) result in a roll rate command of 3° per second. The flight director limits the bank angle to a maximum of 35°.

The heading hold and roll attitude hold modes are automatically cleared.

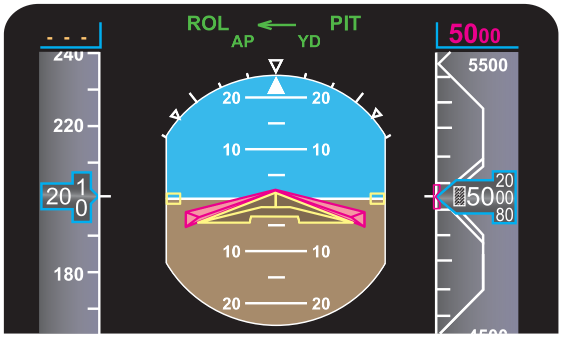


Figure 10 - Roll Attitude Hold Mode

Heading Select Mode

Pressing the HDG button on the flight guidance controller (FGC) selects heading select mode and causes the flight director to generate commands to capture and follow the PFD heading reference (bug). When active, the green bar within the HDG button illuminates, and both PFD flight director lateral mode fields annunciate HDG (Fig. 11). The direction of turn is always toward the direction the heading bug was moved to achieve the set heading. Flight director roll commands are limited to 27.5°.

The heading reference can be changed by rotating the HDG knob on the FGC. The HDG knob is rate sensitive which provides small incremental changes when rotated slowly or large changes when rotated rapidly. The heading bug can also be synchronized to the aircraft current heading by pushing the SYNC button within the HDG knob.

HDG mode is automatically cleared by selection and capture of another NAV or APPR.

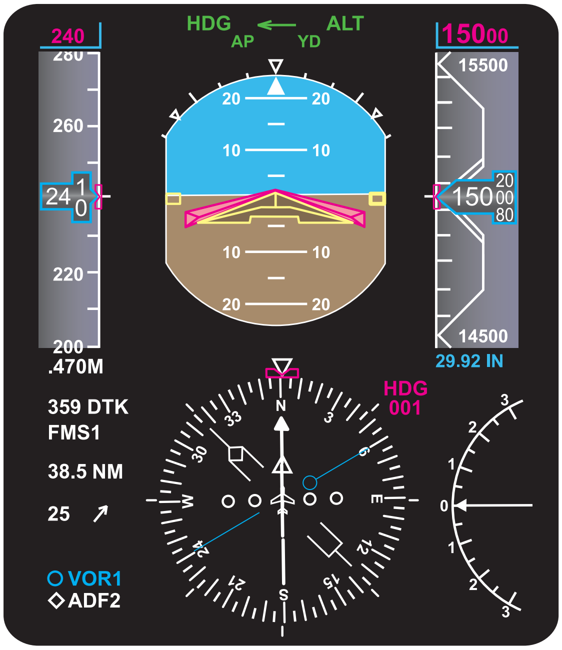


Figure 11 - Heading Select Mode

Low Bank Mode

Pressing the BNK button on the flight guidance controller (FGC) selects low bank mode and causes the flight director to limit the maximum commanded bank angle to approximately 14° instead of the normal 27.5°. When active, the green bar within the BNK button illuminates, and a green scale is placed on the roll scale of the PFD (Fig. 12). Low bank mode may only be engaged when either heading select or VOR navigation modes are active.

Low bank mode can be cleared by pressing the BNK button again. It automatically clears if a noncompatible lateral mode becomes active.

Automatic Low Bank Mode

In HDG and VOR (capture) modes, low bank mode automatically selects when the airplane's pressure altitude is at or above 41,600 ft. The low bank mode automatically clears when the airplane descends through a pressure altitude of 41,400 ft. Low bank will not engage for FMS NAV, APP, or ROL modes.

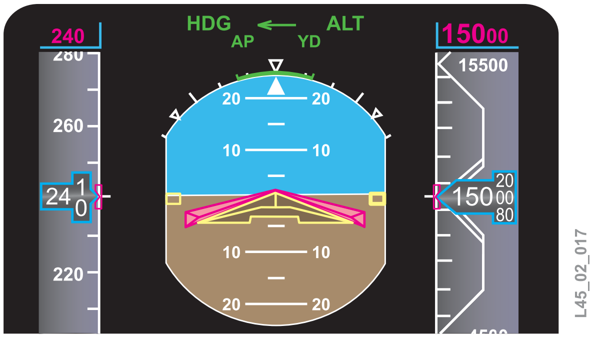


Figure 12 - Low Bank Mode

Navigation Mode

Pressing the NAV button on the flight guidance controller (FGC) selects NAV mode. It also causes the flight director to generate lateral commands to capture and track the active navigation course (VOR, LOC, or FMS course) as selected on the master side PFD display. When selected, the green bar within the NAV button illuminates.

The displayed navigation source determines which one of the following navigation submodes is in operation.

VOR Navigation Mode

In VOR navigation mode, the flight director generates lateral steering commands to capture and track a selected VOR radial (inbound or outbound), using the selected course displayed on the master side PFD HSI.

Selection of the VOR navigation mode automatically selects heading select mode and arms VOR navigation mode. When the VOR navigation mode is armed, a white VOR annunciation is displayed in the armed lateral mode field on both PFDs (Fig. 13). When the VOR mode is captured, the armed annunciation is removed and a green VOR annunciation is displayed in the captured lateral mode field on both PFDs.

The CRS1 and CRS2 knobs, located on the FGC, select the desired course on the pilot and copilot PFD HSI, respectively. Pressing the PUSH SYNC knob within the CRS knob synchronizes the corresponding course display and provides a direct-to VOR course.

VOR navigation mode permits tracking over station and allows for course changes while tracking. When over a VOR station, the system can accept and follow a course change of up to 90°. In either case, the FD lateral mode remains in VOR.

NOTE

In the VOR navigation mode, an invalid station is tuned in (or a valid signal is lost) and the FD drops to roll mode after 30 seconds.

When captured, VOR navigation mode is cleared automatically by selecting another lateral mode, by changing the active NAV source, or by loss of the VOR signal. VOR navigation mode can also be cleared by pressing the NAV button again.

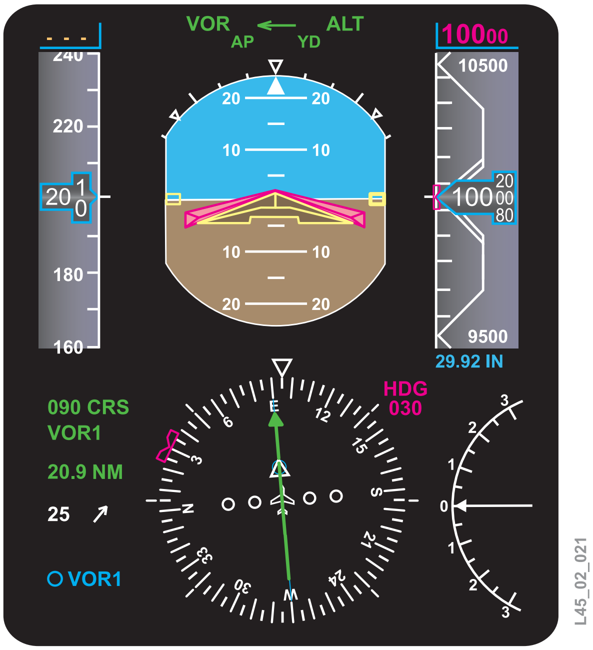


Figure 13 - VOR Navigation Mode

Localizer Navigation Mode

In localizer navigation mode, the flight director provides lateral steering commands to capture and track the tuned front course localizer.

Selection of the LOC navigation mode automatically selects heading select mode and arms LOC navigation mode. When the LOC navigation mode is armed, a white LOC annunciation is displayed in the armed lateral mode field on both PFDs (Fig. 14). When the LOC mode is captured, the armed annunciation is removed and a green LOC is displayed in the captured lateral mode field on both PFDs.

The CRS1 and CRS2 knobs located on the FGC select the desired localizer front course on the pilot and copilot PFD HSI, respectively.

When captured, LOC navigation mode is cleared automatically by selecting another lateral mode, by changing the active NAV source, or loss of localizer signal. LOC mode can also be cleared by pressing the NAV button again.

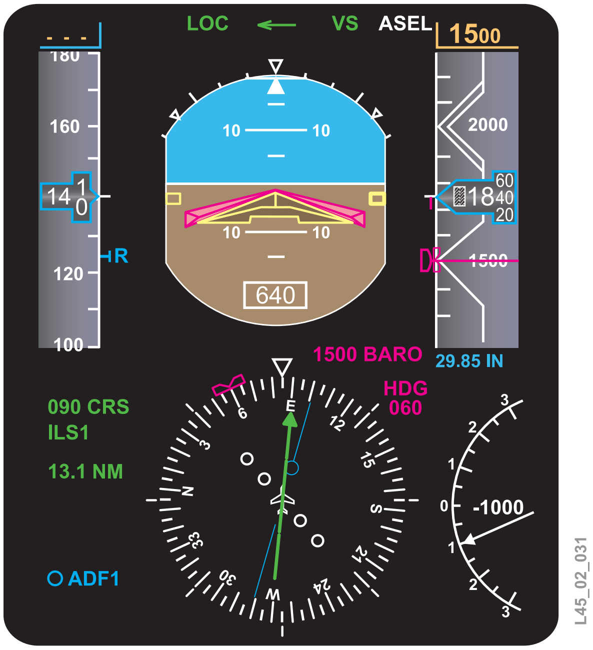


Figure 14 - LOC Navigation Mode

Back Course Navigation Mode

In back course navigation mode, the flight director provides lateral steering commands to capture and track the tuned localizer back course. Back course mode automatically selects during a localizer approach when the selected course differs from the aircraft heading by more than 105°.

When the back course mode is armed, a white BC annunciation is displayed in the armed lateral mode field on both PFDs (Fig. 15). When the mode is captured, the armed annunciation is removed and a green BC is displayed in the captured lateral mode field on both PFDs.

When flying a back course localizer approach, glideslope capture is automatically inhibited and the glideslope deviation scale and pointer are removed from view on both PFDs.

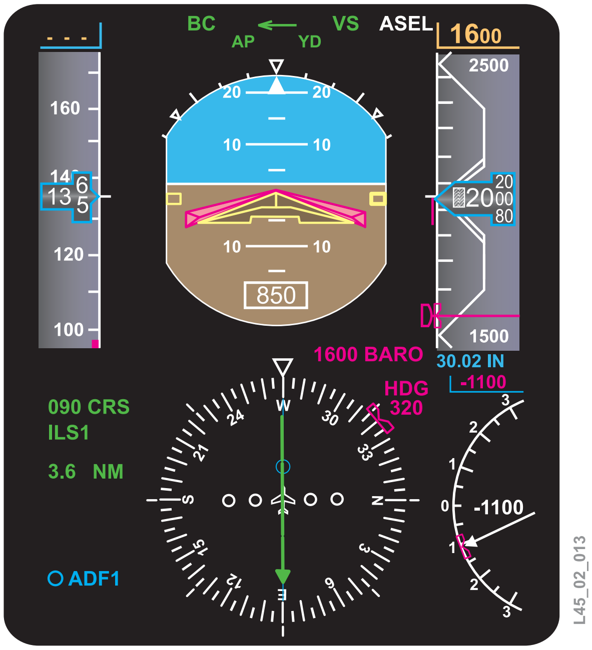


Figure 15 - Back Course Navigation Mode

FMS Navigation Mode

In FMS navigation mode, the flight director uses lateral steering commands from the flight management computer (FMC) to capture and track the desired track to the active waypoint.

When the NAV button is pressed, the FMS navigation mode arms and a white FMS annunciation is displayed on both PFDs (Fig. 16). When the FMC capture criteria are met, the armed annunciation is removed and a green FMS annunciation is displayed in the captured lateral mode field on both PFDs.

When captured, FMS navigation mode is cleared automatically by selection of another lateral mode, by changing the active NAV source, or by loss of FMS steering validity. FMS navigation mode can also be cleared by pressing the NAV button again.

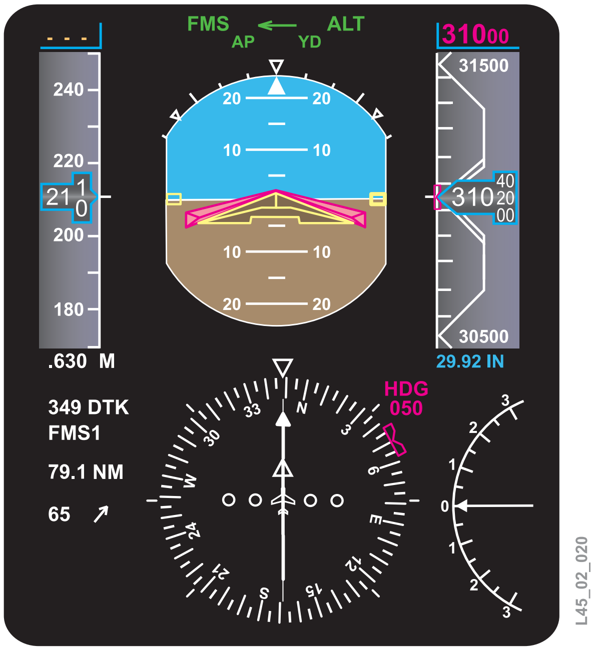


Figure 16 - FMS Navigation Mode

Approach Mode

Pressing the APP button on the flight guidance controller (FGC) selects approach mode and causes the flight director to generate lateral commands to capture and track the active navigation course (VOR, LOC or FMS course) as selected on the master side PFD display. Approach mode operation is similar to navigation mode, except that the sensitivity (gains) of the flight director is significantly increased. When selected, the green bar within the APP button illuminates.

As with navigation mode, the displayed navigation source determines which of the following submodes is in operation.

VOR Approach Mode

If the navigation source selected for display on the PFD is either VOR 1 or VOR 2, the flight director operates in the VOR approach mode. This mode provides the same capabilities as the VOR navigation mode, except that the flight director gains are optimized for operation close to station.

Selection of the VOR approach mode automatically selects heading mode and arms VOR approach mode. When VOR approach mode is armed, a white VAPP annunciation is displayed in the armed lateral mode field on both PFDs (Fig. 17).

When the mode is captured, the armed annunciation is removed (heading select mode cancels) and a green VAPP is displayed in the captured lateral mode field on both PFDs.When captured, VOR approach mode is cleared automatically by selecting another lateral mode, by changing the active NAV source, or by loss of the VOR signal. VOR approach mode can also be cleared by pressing the APP button again.

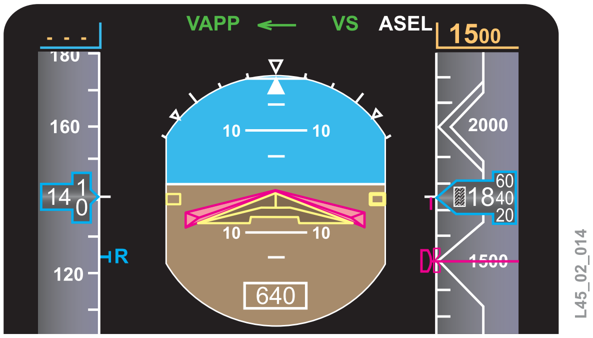


Figure 17 - VOR Approach Mode

Localizer Approach Mode

The localizer approach mode is used to fly a flight director/autopilot coupled ILS approach (Fig. 18). It is activated by pressing the APP button when the navigation source selected for display on the PFD is either ILS 1 or ILS 2.

The localizer approach mode operation is identical to the localizer navigation mode previously described on page 25. In addition to activating the localizer approach mode, this approach mode also activates the flight director to capture and track the glideslope beam. See the Glideslope Mode section on page 2-40 for additional information.

When captured, LOC approach mode is cleared automatically by selecting another lateral mode, by changing the active NAV source, or loss of localizer signal. LOC approach mode can also be cleared by pressing the APP or NAV buttons again or the GA button.

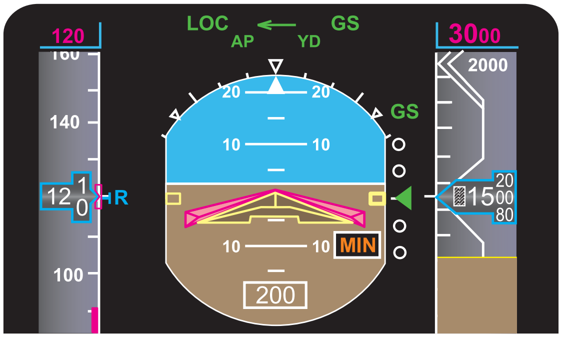


Figure 18 - Localizer Approach Mode

FMS Approach Mode

The FMS approach mode is coupled to AFCS by pressing the APP button when a valid FMS approach is selected and the airplane sequences onto the approach leg.

When the FMS approach mode is armed, a white FMS annunciation is displayed in the armed lateral mode field on both PFDs. When the mode is captured, the armed annunciation is removed and a green FMS is displayed in the captured lateral mode field on both PFDs.

When captured, FMS navigation mode is cleared automatically by selecting another lateral mode, by changing the active NAV source, or by loss of FMS steering validity. FMS navigation mode can also be cleared by pressing the NAV button again or the GA button.

Refer to the Airplane Flight Manual Supplement for a more detailed description of operation.

Flight Director Vertical Modes

- The flight director has several vertical modes as follows (bold letters refer to flight guidance controller button selections):
- Pitch attitude hold mode (PIT)
- Vertical speed hold mode **(VS)**
- Speed select mode **(SPD)**
- Flight level change **(FLC)**
- Altitude hold mode **(ALT)**
- Altitude preselect mode (ASEL)
- FMS vertical navigation mode **(VNAV)**
- Glideslope mode (GS)
- Go-around mode (GA)
- Overspeed protect mode
- Pitch Attitude Hold Mode

Pitch Attitude Hold Mode

Pitch attitude hold mode is the basic vertical flight director mode. The mode activates automatically when the command bars are in view and no other vertical mode is active. The mode is also activated when pitch trim commands are entered via the control wheel trim (barrel) switch. The PFD active vertical mode field indicates PIT when the mode is active (Fig. 19).

When active, the flight director provides commands to maintain the pitch attitude existing when PIT mode is selected. The desired pitch angle may be established (with or without the autopilot engaged) by manually flying the aircraft to the desired pitch attitude while depressing the TCS button. When the TCS button is released, the flight director generates commands to maintain the new pitch attitude.

The pilot may also change the reference pitch attitude via inputs from the master side control wheel trim (barrel) switch. The barrel switch commands a 0.5° per click pitch change or a continuous pitch change if held.

PIT mode is automatically cleared by selecting another vertical mode.

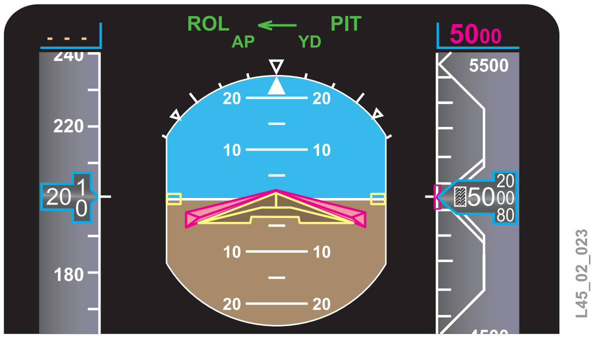


Figure 19 - Pitch Attitude Hold Mode

Vertical Speed Hold Mode

Pressing the VS button on the flight guidance controller (FGC) selects vertical speed mode and causes the flight director to generate commands to maintain the aircraft's vertical speed at the time the mode is selected. When VS mode is engaged, the green vertical bar within the VS button illuminates and a green VS annunciation is displayed in the captured vertical mode field on the PFDs. The PFDs also display the vertical speed target value in magenta above the vertical speed scale and a vertical speed target bug on the inner side of the vertical speed scale (Fig. 20).

The speed select bug on the airspeed tape is removed and the digital speed reference replaced with magenta dashes, when the VS mode is active.The vertical speed target can be set using the SPD knob on the FGC when the VS mode is active.

The vertical speed target may also be manually changed (resynchronized) by pressing the TCS button, maneuvering to the new vertical speed, and then releasing the TCS button.

Vertical speed mode is automatically cleared by selection or capture of another vertical mode or by pressing the VS button again.

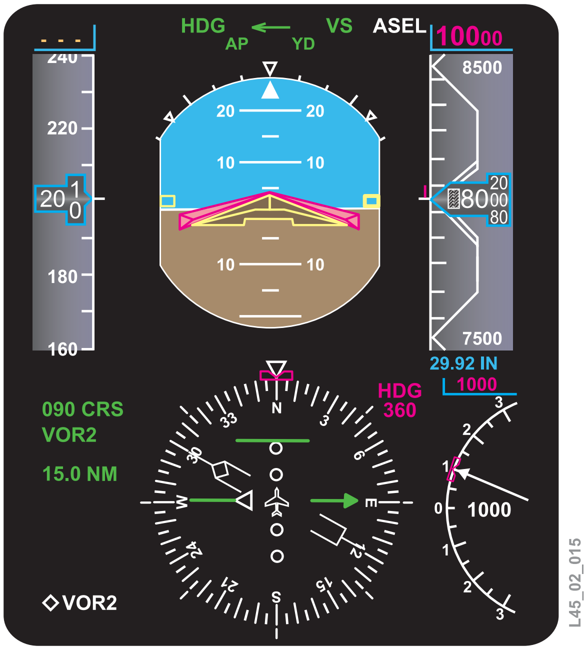


Figure 20 - Vertical Speed Mode

Speed Select Mode

Pressing the SPD button on the flight guidance controller (FGC) selects speed select mode. Speed select mode allows the flight crew to fly to a selected altitude using a reference airspeed or Mach number. The flight crew controls the rate of climb or descent by varying thrust. When speed select mode is active, the green bar within the SPD button illuminates and a green IAS or MACH annunciation is displayed in the captured vertical mode field on the PFDs (Fig. 21).

Whenever the SPD button is pressed, the reference speed automatically synchronizes to current aircraft airspeed/Mach. The flight directors provide commands to track the current speed (either IAS or MACH). The reference airspeed can be adjusted by the SPD knob on the FGC. The reference airspeed can also be changed (with or without the autopilot engaged) by pressing the TCS button while maneuvering the aircraft to a new airspeed. When the TCS button is released, the current airspeed becomes the reference airspeed.

The reference airspeed and airspeed display on the PFDs can be displayed in either IAS or MACH format, depending on pilot selection via the IAS/M pushbutton integral to the SPD knob.

Speed select mode is automatically cleared by selection or capture of another vertical mode.

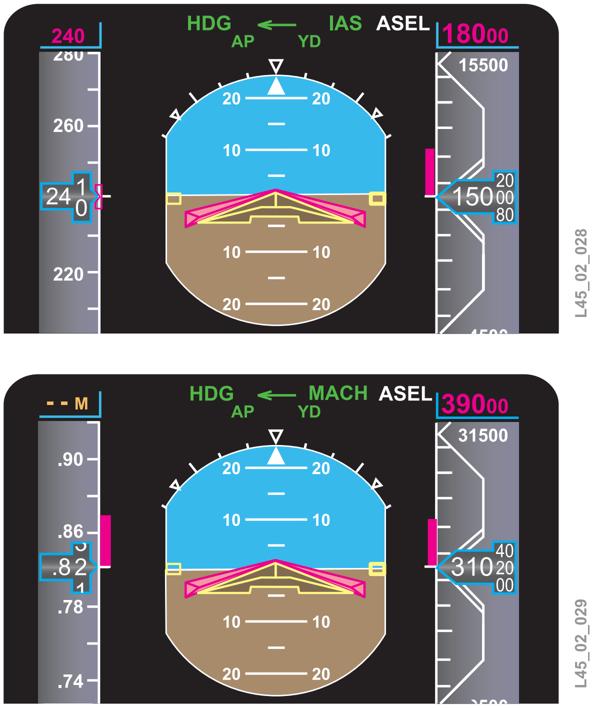


Figure 21 - Speed Select Mode

Flight Level Change Mode

The flight level change (FLC) mode flies to a new preselect altitude using customized airspeed profiles. There are four submodes of FLC: normal climb, high-speed climb, normal descent, and high-speed descent.

When FLC mode is engaged, the flight director generates commands to fly either an IAS or a Mach climb/descent profile. The IAS profiles are used at lower altitudes, and the Mach profiles are used at higher altitudes. An IAS-to-Mach or Mach-to-IAS transition occurs automatically for all modes. The point of transition depends on the selected profile.

Climb Mode

When the airplane is below the preselect altitude, pressing the FLC button on the FGC selects the normal climb profile. The normal climb profile maintains 250 KIAS to 0.70 Mach (changeover at approximately 32,000 ft) and then 0.70 Mach above that altitude (Fig. 22).

Pressing the FLC button again selects the high-speed climb profile. The high-speed climb profile maintains 250 KIAS to 10,000 ft, then accelerates to 275 KIAS (between 10,500 ft to 12,500 ft), maintains 275 KIAS to 0.73 Mach (changeover at approximately 30,000 ft) and then maintains 0.73 Mach above that altitude.

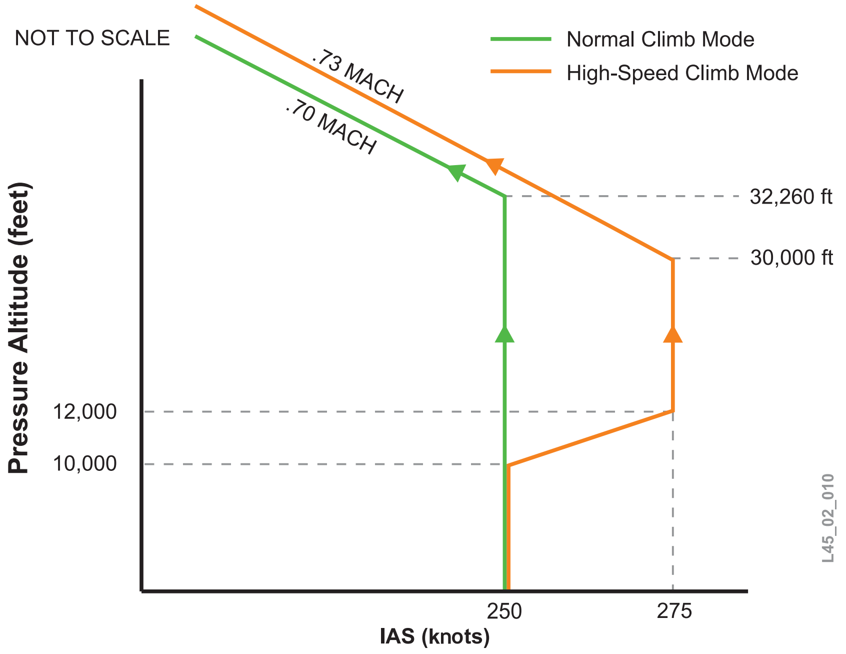


Figure 22 - FLC Climb Profiles

Pressing the FLC button a third time deselects FLC mode and engages the basic pitch mode (PIT).

When FLC climb mode is engaged, the green bar within the FLC button illuminates, and a green FLC (normal climb) or FLCH (high-speed climb) annunciation is displayed in the captured vertical mode field on the PFDs (Fig. 23). The PFDs also display the airspeed/Mach target bug on the inner side of the airspeed/Mach scale.

The TCS button can maneuver the aircraft as required. When the button is released, the flight director commands the aircraft to return to the preset FLCH target speed.

FLC climb mode is automatically cleared by selection or capture of another vertical mode.

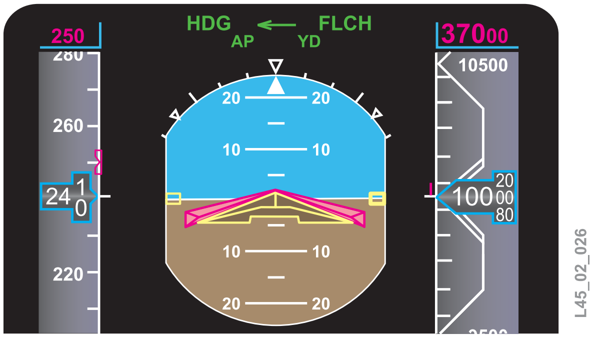


Figure 23 - FLC High-Speed Climb Mode

Descent Mode

When the airplane is above the preselect altitude, pressing the FLC button on the FGC selects the normal descent profile. The normal descent profile maintains 0.76 Mach to 300 KIAS (changeover at approximately 28,000 ft), maintains 300 KIAS to 12,500 ft, decelerates from 300 KIAS to 250 KIAS (end of deceleration by 10,500 ft) and then maintains 250 KIAS below 10,500 ft (Fig. 24).

Pressing the FLC button again selects the high-speed descent profile. The high-speed descent profile maintains 0.79 Mach to 320 KIAS (changeover at approximately 27,000 ft), maintains 320 KIAS to 14,500 ft, decelerates from 320 KIAS to 250 KIAS (end of deceleration by 10,500 ft) and then maintains 250 KIAS below 10,500 ft.

Pressing the FLC button a third time deselects FLC mode and engages the basic pitch mode (PIT).

FLC descent mode annunciations on the PFDs are identical as in the climb mode. FLC descent mode is automatically cleared by selection or capture of another vertical mode.

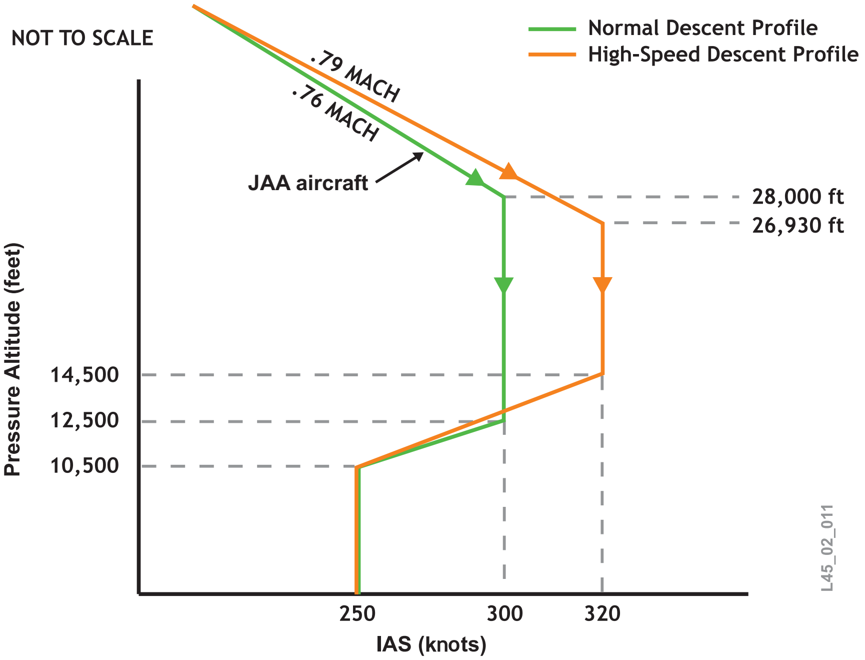


Figure 24 - FLC Descent Profiles

JAA Certified Aircraft

For aircraft configured for JAA certification, the high-speed descent profile has been changed to correlate with the lower VMO/MMO (0.78 Mach) requirement.

The high-speed descent profile maintains 0.76 Mach to 300 KIAS (changeover at approximately 27,000 ft), then 300 KIAS to 14,500 ft, then 300 KIAS to 250 KIAS (end of deceleration by 10,500 ft) and 250 KIAS below 10,500 ft.

Altitude Hold Mode

Pressing the ALT mode button on the FGC selects altitude hold (ALT) mode and causes the flight director to generate commands to maintain the pressure altitude at the moment the button was pressed. Flight director commands are always in reference to the master side baro-corrected altitude. When active, the green bar within the ALT button illuminates and a green ALT annunciation is displayed on both PFDs (Fig. 25).

Altitude hold mode also maintains the preselect altitude only if this altitude is achieved using the altitude select (ASEL) armed and capture sequence. Otherwise, it maintains the barometric altitude that exists when the mode is engaged.

The altitude reference may be manually changed by pressing the TCS button, flying to the new altitude, and then releasing the TCS button.

Altitude hold (ALT) mode is automatically cleared by selection or capture of another vertical mode or can be cleared by selecting the ALT button again.

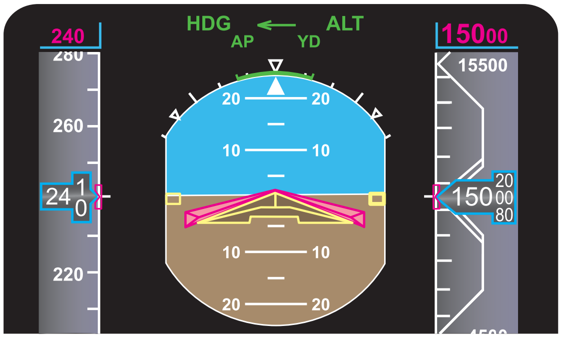


Figure 25 - Altitude Hold Mode

Altitude Preselect Mode

Altitude preselect (ASEL) mode causes the flight director to generate commands to capture and level off at the preselect altitude. On the ground, ASEL mode automatically arms as long as the preselect altitude is set above the field elevation. In the air, the ASEL mode automatically arms when the aircraft climbs or descends toward the preselect altitude and the following conditions are met:

- Preselect altitude is 250 ft above the current altitude
- Vertical speed is greater than 60 fpm for three seconds
- Glideslope is not captured

When the mode is armed, a white ASEL annunciation is displayed in the armed vertical mode field on the PFDs (Fig. 26).

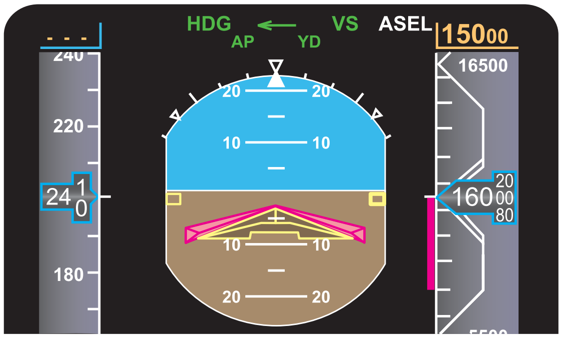
Another vertical mode such as PIT mode, speed hold (IAS or MACH) mode, VS mode, FLC mode, or VNAV mode must be used to climb or descend toward the preselect altitude.

When the aircraft nears the preselect altitude, the ASEL mode automatically captures (green ASEL annunciation displayed) and clears the previous vertical mode. After the aircraft levels off at the preselect altitude, the vertical mode automatically transitions to altitude hold mode (green ALT annunciation displayed).

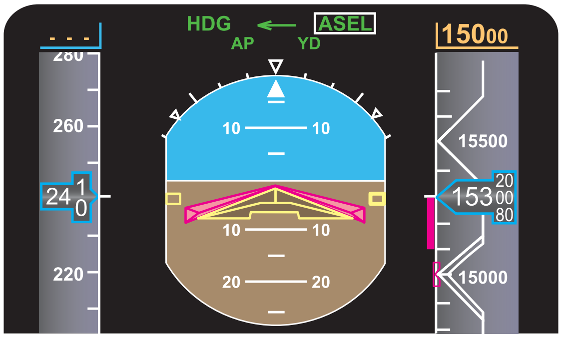
NOTE **Changing the preselect altitude while in the ASEL capture activates PIT mode and rearms ASEL mode.**

The preselect altitude is selected via the ASEL knob on the FGC and the readout is displayed on the top of the PFD altitude display.

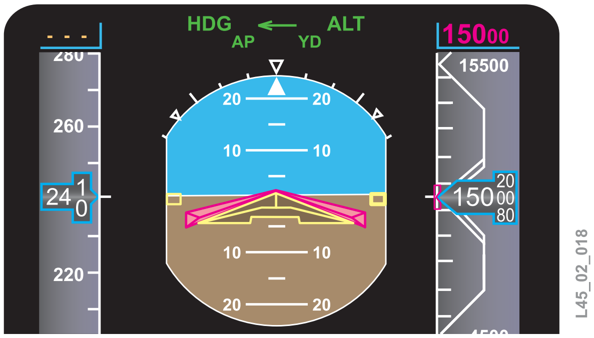
When captured or in track, altitude preselect mode is automatically cleared by selection or capture of another vertical mode.



ASEL ARMED



ASEL CAPTURED



ALT HOLD

Figure 26 - Altitude Select Mode

Altitude Alert

The altitude alert system provides aural and visual alerts of preselect altitude capture and tracking. It also provides aural and visual alerts of an altitude deviation from the preselect altitude (ASEL) (Fig. 27).

Altitude alert annunciations are controlled by the master flight director and are based on the baro-corrected altitude of the master side altimeter.

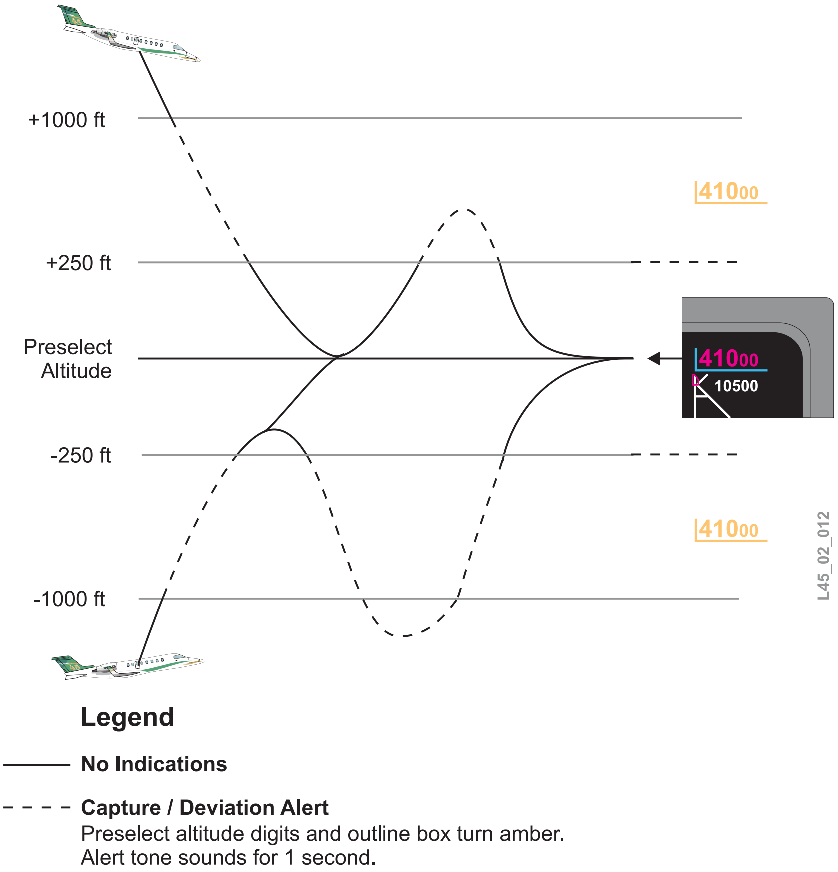


Figure 27 - Altitude Alert System

Capture Alert

When the aircraft closes within 1000 ft of the selected altitude, an aural tone (single chime) sounds for 1 second and the preselect altitude digits and outline box on both PFDs turn amber. When the aircraft closes to within 250 ft of the preselect altitude, the preselect altitude digits and outline box on both PFDs return to their normal magenta color.

Deviation Alert

Once the aircraft captures the preselect altitude, a deviation of more than 250 ft results in the aural and visual alert being activated (aural tone sounds for 1 second and the preselect altitude digits and outline box on both PFDs turn amber) until the aircraft returns within 250 ft of the preselect altitude.

FMS Vertical Navigation Mode

Pressing the VNAV button on the FGC selects VNAV mode. When VNAV mode is engaged, the flight director generates commands to capture and track a vertical profile defined by the FMS.

Selecting VNAV arms VNAV mode for capture when the FMS capture criteria is satisfied. VNAV does not arm or capture if the lateral FD mode is not engaged in FMS en route or approach phases. When armed, a white VNAV annunciation is displayed in the armed vertical mode field on the PFDs (Fig. 28).

A green VNAV annunciation is displayed in the captured vertical mode field when the mode captures the FMS track.

Selecting APP mode (during FMS approach phase only) automatically captures the FMS lateral steering mode and arm VNAV mode. The VNAV mode captures (determined by FMS) at the appropriate time based on FMS vertical deviation.

VNAV mode is automatically cleared by selecting or capturing another vertical mode, deselecting FMS as the navigation source, loss of FMS data, or by pressing the VNAV button again.

Refer to Chapter 17 Navigation for additional information on FMS VNAV operation.

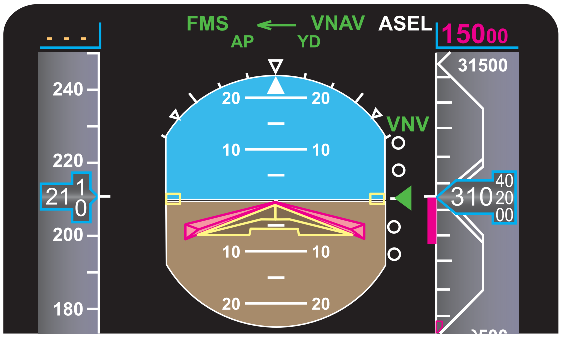


Figure 28 - VNAV Mode

Glideslope Mode

The glideslope (GS) mode allows automatic capture and tracking of the glideslope. Selecting glideslope mode is accomplished by pressing the APP button on the FGC with an ILS selected as the NAV source on the PFD.

When glideslope mode is selected, a white GS armed annunciation is displayed in the armed vertical mode field on the PFDs. This is replaced with a green GS annunciation in the captured vertical mode field when the mode captures the glideslope.

Glideslope mode capture can only occur after the localizer (LOC) mode has been captured. The aircraft may be positioned to capture the glideslope from above or below.

GS mode is cleared by selecting another vertical mode, loss of localizer or glideslope signal, by pressing the APP button again, or by selecting the GA button on the left thrust lever.

Go-Around Mode

Pressing the GA button on the left thrust lever selects GA mode and disconnects the autopilot. The lateral mode reverts to ROL mode and the vertical mode to GA mode. The flight director provides a wings-level command display in the lateral axis and a fixed pitch-up vertical command of 9°.

When the go around mode is active, a green GA is annunciated on the captured vertical mode field on both PFDs (Fig. 29).

GA mode can be cleared by selecting (or capturing) another vertical mode, pressing the onside TCS button, coupling the autopilot, or by pressing the FD 1/FD 2 button.

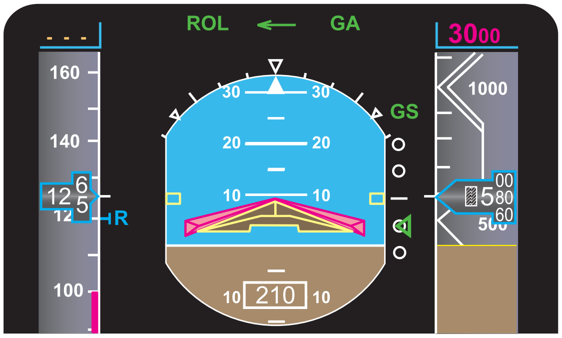


Figure 29 - Go-Around Mode

Overspeed Protection Mode

The autopilot incorporates an overspeed protection mode to limit the aircraft indicated airspeed/Mach from exceeding V_{MO}/M_{MO}. Overspeed protection is only applied in VS, SPD (IAS and Mach), PIT (Honeywell phase III,
S/N 005-169 if complied with SB45-22-4 and S/N 170 and on), and FLC modes.

When an overspeed condition is predicted and the flight director is in any of the above modes, it provides a nose-up pitch command to decelerate the aircraft to keep the airspeed below V_{MO}/M_{MO} (Fig. 30). An amber MAX SPD annunciation is also displayed vertically along the left side of both ADIs to warn the flight crew of an impending overspeed condition. While overspeed protection is active, the selected FD mode annunciations remain unaffected.

The FMS provides overspeed protection when in VNAV mode. FMS overspeed protection is provided for V_{MO}/M_{MO} as well as VFE (flap overspeed). FMS overspeed protection deviates away from the selected vertical path. Pilot action should be taken to reduce airspeed below V_{MO}/M_{MO}.

The MAX SPD annunciation remains displayed until the predicted overspeed condition no longer exists.

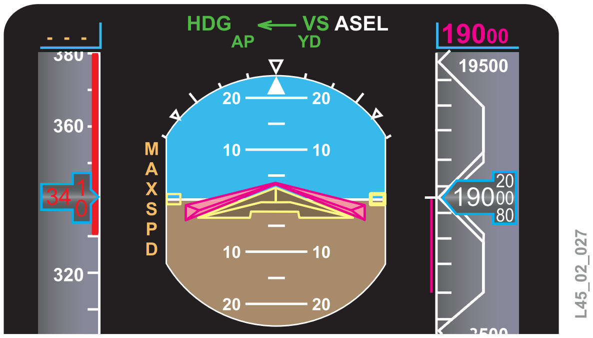


Figure 30 - Overspeed Protection Mode

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AUXILIARY POWER UNIT

Introduction

The Learjet 45 may be equipped with the optional Allied Signal Model RE100 [LJ] APU. The auxiliary power unit (APU) is a fully automatic gas turbine engine with automatic fault detection, automatic shutdown, and during a fire, automatic extinguishing. Essentially, the APU is designed to operate unattended.

The APU is capable of providing pneumatic and/or electrical power for ground operations only. It is a self-contained unit that requires only DC electrical power, fuel supply, and control input signals from the aircraft for operation.

Various flight deck panels provide normal start and stop sequencing, emergency shutdown sequence, and indications of APU failure, fire, generator amperage, generator, and bleed air.

The Learjet 40 is not equipped with an auxiliary power unit. An APU is not offered as optional aircraft equipment. On Learjet 40 aircraft, an R-134A vapor cycle system is an available option for cooling while on the ground or in flight.

Description

The APU is a self-contained, single-stage gas turbine engine installed in a fireproof enclosure in the upper right corner of the tailcone compartment (Fig. 1). The APU engine consists of a single-stage centrifugal impeller and a single-stage centrifugal turbine, both mounted on a common shaft, and an annular reverse flow combustor. The engine operates at a constant speed of 100% for all operational requirements.

The auxiliary power unit is comprised of the APU power and the gearbox sections.

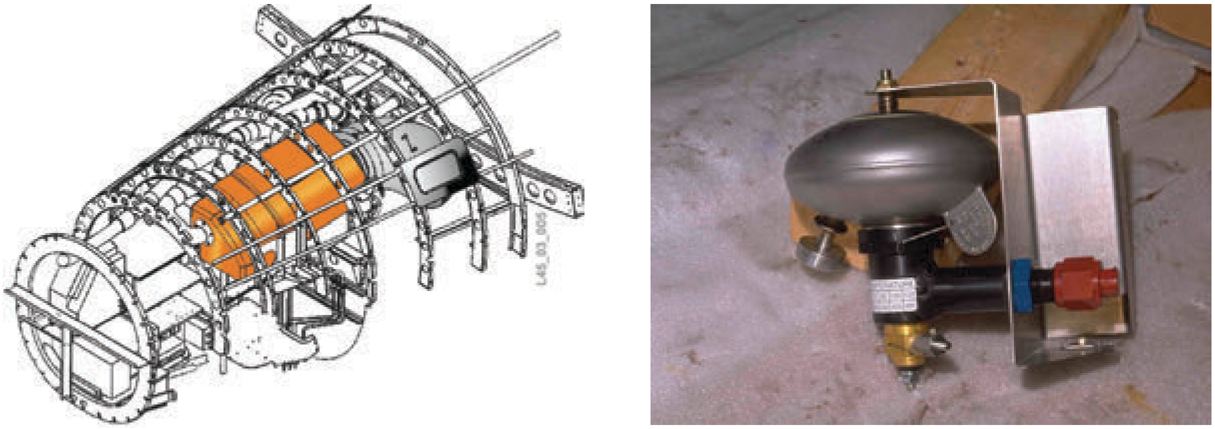


Figure 1 - Auxiliary Power Unit Installation and APU Fire Bottle

Controls and Indications

APU Control Panel

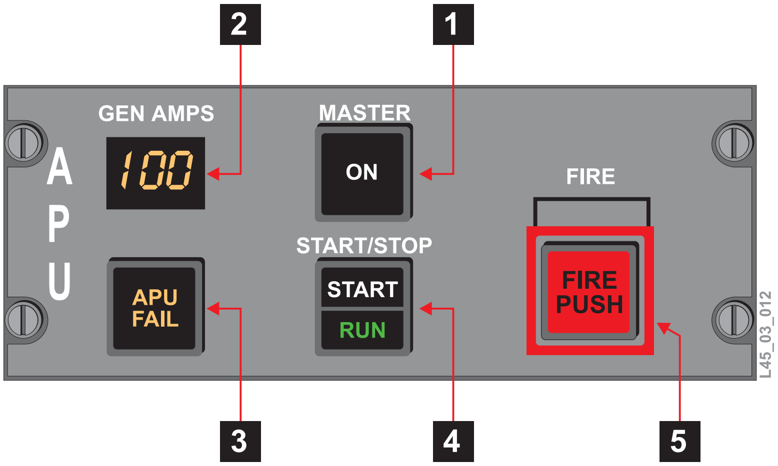


Figure 2 - APU Control Panel

1 APU MASTER Switch (alternate-action)

- Press—
  - Powers APU electronic control unit (ECU) and initiates APU built-in test (BITE)
  - Energizes the right wing tank standby pump
  - Opens the APU aircraft fuel shutoff valve
  - Subsequent press removes power from APU ECU
- Illuminated ON—Indicates ECU is powered

NOTE **Depressing the APU MASTER switch with the APU running shuts down the APU.**

2 GEN AMPS Indicator

- Indicates amperage output of the APU generator

3 APU FAIL Indicator

- Illuminated—Indicates an APU failure

4 APU START/STOP Switch Indicator (momentary-action)

- Press—
  - Initiates APU start sequence if pressed and APU is not running
  - Initiates shutdown sequence if pressed and APU is running
- START illuminated—Indicates APU start sequence is in progress
- RUN illuminated—Indicates APU is running

5 APU FIRE Switch (momentary-action, guarded)

- Illuminated—Indicates an APU fire condition
- Press—
  - Initiates an automatic fire protective shutdown
  - Discharges the APU fire extinguisher bottle

CAS Messages

Table 1 - APU CAS Messages

CAS Message	Condition/Parameter
APU FIRE	Indicates a fire detected in the APU compartment
APU AMPS HIGH	Indicates the APU generator load is above the limit
APU FAIL	Indicates the APU electronic control unit detected a failure and shut down the APU
R STBY PUMP ON	Indicates the right standby pump is energized

SYS TEST/RESET Switch—FIRE DET Function

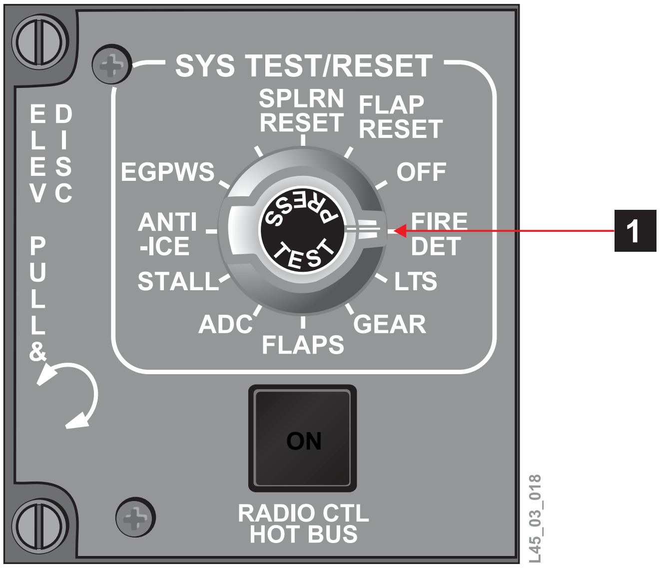


Figure 3 - SYS TEST/RESET Switch

1 FIRE DET Function

- Rotate to FIRE DET position and depress PRESS TEST button—
  - Initiates an engine fire detection system test
  - Initiates an APU fire detection system test
  - Initiates a bleed-air overheat sensor system test

Maintenance Control Panel

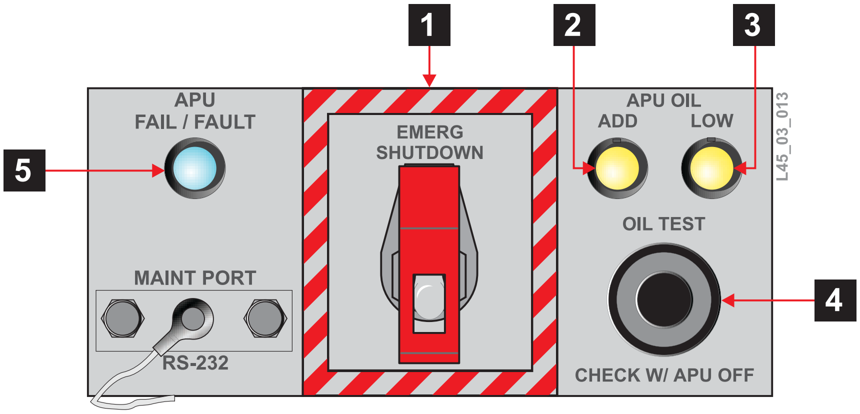


Figure 4 - APU Maintenance Control Panel

1 EMERG SHUTDOWN Switch (guarded)

- Lift—Removes power from ECU and initiates an emergency shutdown

2 APU OIL - ADD Indicator

- Illuminated (amber)—Indicates APU requires oil to be added

3 APU OIL - LOW Indicator

- Illuminated (amber)—Indicates low oil condition

NOTE **The APU OIL indications only appear during an OIL TEST.**

4 OIL TEST Switch (momentary-action)

- Press—Checks the APU oil system

NOTE **The right BATT switch must be selected ON for the OIL TEST to operate.**

5 APU FAIL/FAULT Indicator

- Illuminated (blue)—Indicates that ECU registered a fault condition

APU FAN FAIL Indicator

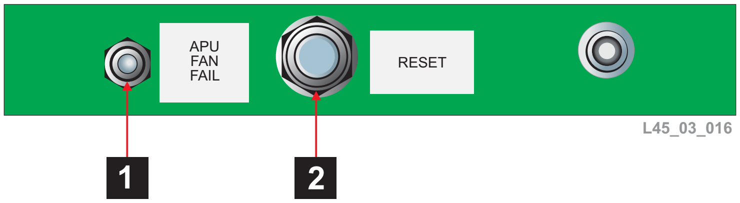


Figure 5 - APU FAN FAIL Indicator

1 APU FAN FAIL Indicator

- Illuminated (amber)—Indicates a tailcone overheat condition

NOTE **The APU may be operated at ambient temperatures up to 100°F (38°C) with an amber APU FAN FAIL indication.**

2 APU Fan Fail RESET Switch (momentary-action)

- Press—Resets APU FAN FAIL indicator

Pressurization Panel

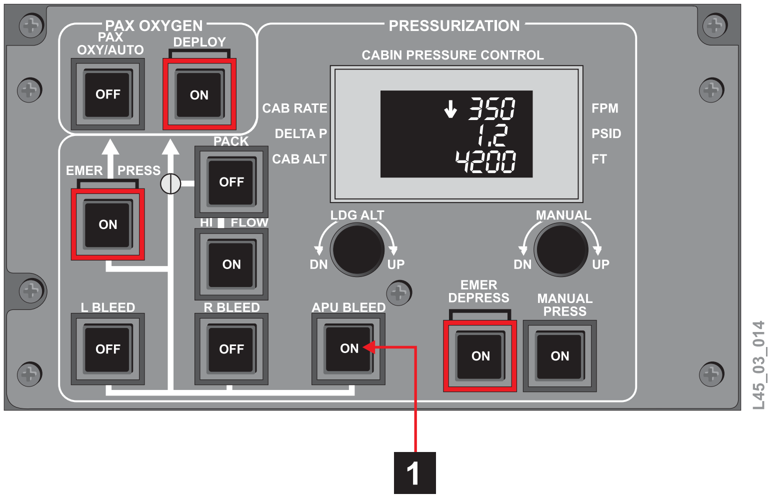


Figure 6 - Pressurization Panel

1 APU BLEED Switch Indicator (alternate-action)

- Press—Opens APU bleed-air valve
- Illuminated ON—Indicates APU bleed valve is open

Electrical Control Panel

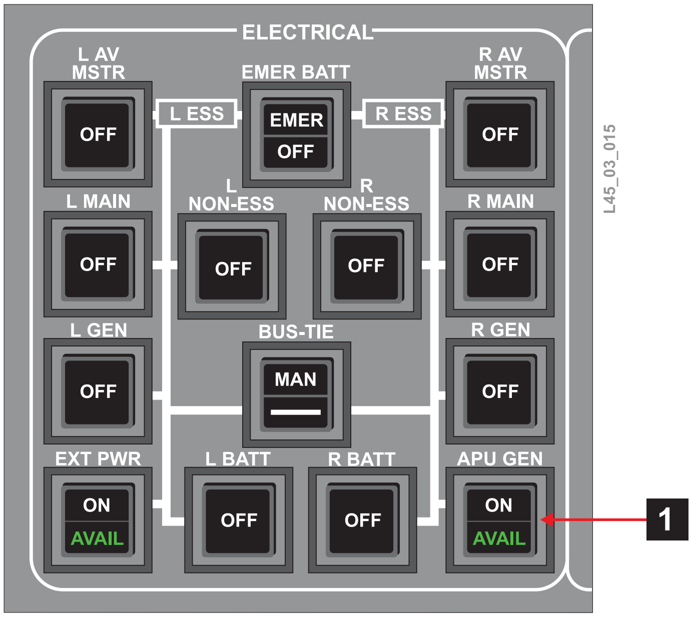


Figure 7 - Electrical Control Panel

1 APU GEN Switch (alternate-action)

- Press—
  - Connects APU generator to aircraft electrical system
  - Subsequent press disconnects APU generator from aircraft electrical system
- ON illuminated—Indicates APU generator is connected online
- AVAIL illuminated—Indicates APU generator is available to supply electrical power to the aircraft

EICAS/MFD Electrical System Page

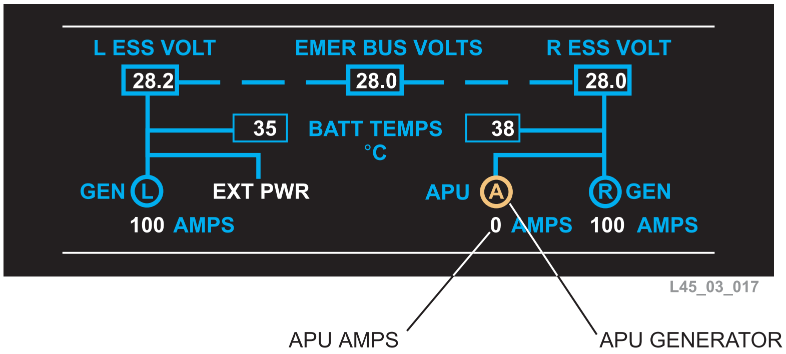


Figure 8 - EICAS/MFD Electrical System Page

Table 2 - EICAS/MFD Indications

Description	Symbol	Condition
Auxiliary power unit DC current readout	205 AMPS	APU DC current is in normal range (≤300 amp)
	320 AMPS	APU DC current is in caution range (>300 amp and ≤400 amp)
	460 AMPS	APU DC current is in warning range (>400 amp)
	- - - AMPS	Invalid APU DC current data
Auxiliary power unit DC generator symbol	Ⓐ	APU generator normal operation
	Ⓐ	APU generator failure

Components and Operation

APU Power Section

The air intake duct for the APU engine is located on the upper left portion of the fuselage, inboard of the left engine. The inlet air is used for both combustion and for APU cooling. Inlet screens are attached to the housing and provide protection against foreign object damage.

Air is drawn into the engine by the single-stage centrifugal rotating compressor. The air is then compressed and delivered to the combustor chamber. The compressed air is mixed with fuel injected into the combustion chamber and ignited by the ignition system. The heated gases expand in the combustor and accelerate through the turbine nozzle and flow to the turbine wheel. The rotating turbine wheel extracts the energy from the heated gas stream to mechanically drive the compressor, reduction drive assembly, and the reduction drive accessories. The gases flowing from the turbine wheel are then discharged overboard through an APU exhaust duct located on the upper right side of the aircraft, inboard of the right engine.

Accessory Gearbox Section

The accessory gearbox incorporates a gear system that reduces the turbine rotor shaft rpm to a speed suitable to drive the APU generator and other mounted accessories (lubrication module, starter, and a DC starter generator). The accessory gearbox also serves as an oil sump for the APU lubrication system.

APU Compartment and Accessory Cooling

Cooling of the APU enclosure and components, including the starter/generator, is accomplished by air that is drawn in through the APU inlet duct. The starter/generator exhaust and APU compartment cooling air is then drawn out of the APU enclosure by an exhaust eductor and mixed with the APU gas turbine exhaust. The combined exhaust gas stream is ejected outside of the aircraft via the APU exhaust duct.

APU Tailcone Ventilation and Equipment Cooling

There are two fans installed in the tailcone equipment bay: one on the tailcone access door and the other on the opposite side of the fuselage. These fans improve cooling in the tailcone when the APU is operating. The fans are automatically controlled.

If an overheat condition occurs in the tailcone area, an amber APU FAN FAIL appears on the tailcone indicator. The indicator is magnetically latched and remains in the amber position until manually reset using the adjacent RESET switch.

The APU FAN FAIL indicator should be checked prior to each start of the APU. If the indicator is activated, maintenance action should be obtained and a cooling fan failure should be suspected.

Start and Ignition System

Description

The start and ignition system components crank the APU for starting and provide the initial combustion of fuel during the APU start cycle.

Components and Operation

APU Starter/ Generator

In the starting mode, this dual-purpose unit operates as a starter. Upon completion of the starting cycle, the unit functions as a generator which can provide a continuous output of 300 amps at 30 volts DC. The generator is controlled by a dedicated generator control unit.

The generator can be connected to the aircraft electrical system by pressing the APU GEN ON/AVAIL switch indicator located on the pilot electrical panel (Fig. 9). When the APU is providing electrical load, the APU GEN AMPS displayed on the APU cockpit panel provides an indication of the APU generator load. APU electrical indications are also displayed on the EICAS/MFD electrical system page.

If the APU generator load exceeds its rated limit, an amber APU AMPS HIGH CAS message appears.

NOTE

The GPU and APU generator cannot provide airplane electrical power simultaneously. The APU generator automatically drops offline if the GPU is selected online.

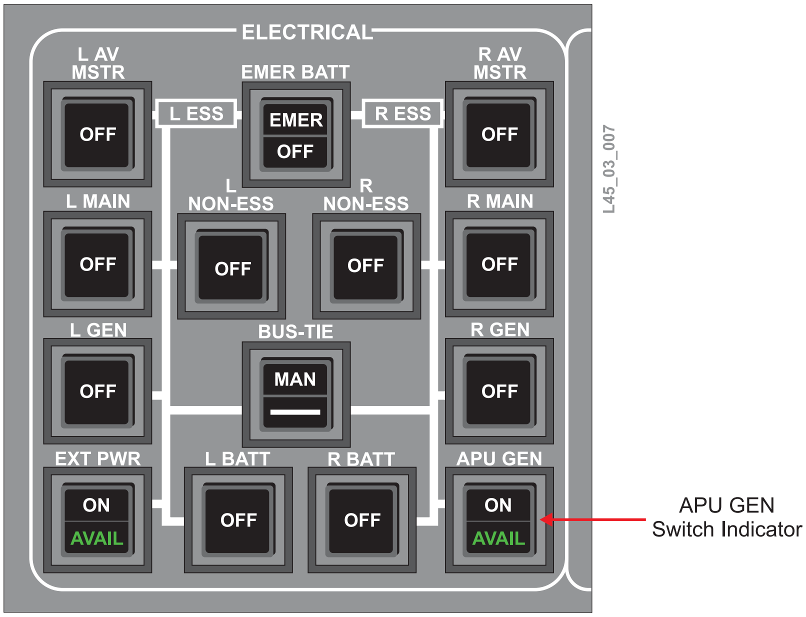


Figure 9 - Electrical Panel

Ignition System

The ignition system is automatically controlled. It consists of an ignition unit and an igniter plug. The system provides initial combustion of fuel during the APU start cycle.

APU Start/Stop Operation

Start Sequence

Prior to APU operation, the aircraft left, right, and emergency battery switches must be selected ON. The APU is started by selecting the APU MASTER switch indicator ON and then depressing the APU START/ STOP switch indicator.

Depressing the APU MASTER switch indicator illuminates the white ON switch annunciation and provides electrical power to the APU electronic control unit (ECU). When the ECU is powered, it performs built-in tests (BITEs) on the APU system to ensure that no faults exist that would inhibit a start.

The APU start sequence is then started by momentarily pressing the START/STOP switch indicator. Activation of the start sequence is indicated by the illumination of the START annunciation on the switch.

When the APU stabilizes on-speed:

- START annunciation on the START/STOP switch extinguishes and the green RUN annunciation illuminates
- AVAIL annunciation on the APU GEN switch illuminates
- APU AVAILABLE CAS message appears

The illumination of the RUN annunciation on the START/STOP switch indicates that the APU can provide pneumatic and electrical power to the aircraft.

Once the APU is operating on-speed (100% rpm), the electronic control unit commands the fuel control unit to maintain a constant APU speed under varying loads.

Should any fault be detected during the start sequence, the electronic control unit automatically terminates the start sequence.

Stop Sequence

The APU is normally shut down by momentarily pressing the APU START/STOP switch and then by deselecting the MASTER switch.

When the START/STOP switch is depressed with the APU running, the electronic control unit executes a commanded shutdown. A signal is sent to the hardware overspeed detection circuits, which inserts a false overspeed signal into the ECU, causing the APU to shut down. This procedure confirms proper operation of the hardware overspeed shutdown circuit and takes approximately 30 seconds.

If the hardware overspeed detection circuits fail, the electronic control unit causes the APU FAIL and APU FAULT indicators on the APU cockpit control panel and maintenance panel to illuminate. The ECU then directly shuts down the APU.

After the APU has shut down, the electronic control unit remains powered at idle until another start is commanded or the APU MASTER switch is turned OFF.

NOTE

Since the APU is for ground operation only, a squat switch signal ensures that the APU is shut down and not mistakenly left operating when the aircraft becomes airborne.

Alternate Manual Shutdown

The APU may also be manually shut down by pressing the APU fire switch indicator or by the emergency shutdown switch on the APU maintenance panel.

APU Automatic Shutdown

The ECU automatically shuts down the APU if any of the following abnormal conditions occur:

- APU fire
- Low oil pressure
- High oil temperature
- Overtemperature
- Overspeed
- Electronic control unit failure
- Loss of overspeed protection
- Loss of EGT thermocouple
- Slow start
- DC power loss
- No flame
- Loss of high oil temperature sensor
- Loss of inlet air temperature (T2 sensor)

An APU failure is indicated by an amber APU FAIL CAS message appearing and the illumination of the APU FAIL annunciation on the APU control panel.

Bleed-Air System

Description

The auxiliary power unit provides bleed air for the aircraft environmental control system (ECS). APU bleed air provided to the aircraft pneumatic ducting is controlled by the APU bleed-air valve. Airflow from the APU bleed-air valve then passes through a one-way check valve which provides reverse airflow protection for the APU.

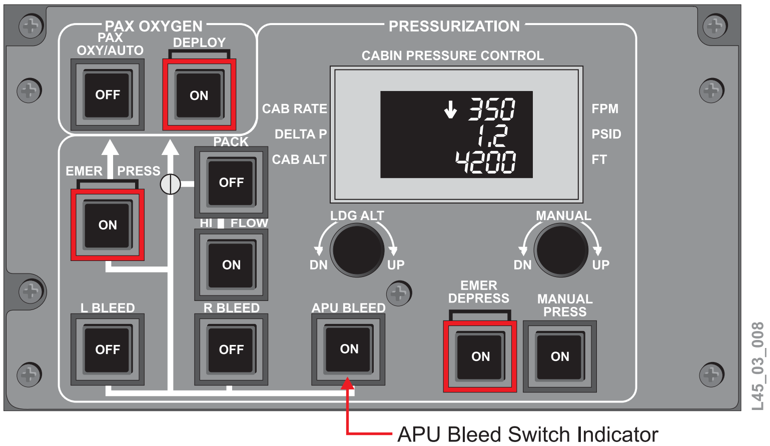
The APU also incorporates bleed-shed logic to limit the APU exhaust gas temperature during high demands.

Components and Operation

Bleed-Air Valve

The bleed-air valve is an electrically controlled, pneumatically operated valve. It controls the APU bleed air to the aircraft environmental control system and protects the APU from overtemperature conditions. The valve provides an open or closed position when commanded by the ECU.

The APU bleed-air valve is controlled by the APU BLEED switch indicator located on the PRESSURIZATION panel (Fig. 10). APU bleed air is available for use whenever the green RUN annunciator on the APU START/STOP switch indicator illuminates. When the APU BLEED switch indicator is depressed, the bleed-air valve is commanded open. The APU BLEED switch ON annunciation illuminates when the valve opens.



APU Bleed Switch Indicator

Figure 10 - Pressurization Panel

Bleed-Shed Protection

The APU control system provides for electrical generator power priority. If an applied combination load (electric and pneumatic) exceeds APU capabilities, the pneumatic load is removed to maintain APU operating parameters within normal limits.

The pneumatic control system controls the APU pneumatic output by sensing and comparing APU EGT with a predetermined set point within the ECU. If the EGT becomes excessively high, the ECU automatically closes the APU bleed-air valve. This eliminates the APU pneumatic load and maintains EGT within acceptable levels. APU bleed-air valve closing is indicated by the APU BLEED switch ON annunciator extinguishing. The bleed-air valve remains closed until the system is reset by cycling the APU BLEED switch indicator.

APU ECS Overheat Detection System

The APU ECS overheat detection system monitors the aircraft cabin duct and cockpit duct temperature. If an overheat condition is detected and the APU bleed-air valve is open, the electronic control unit commands the APU bleed-air valve to close (APU BLEED switch indicator ON annunciation extinguishes).

The bleed-air valve remains closed until the system is reset by cycling the APU BLEED switch indicator.

Bleed Leak Detection System

The bleed leak detection system monitors the left and right main engine bleed leak detection circuits, and signals the APU electronic control unit to initiate a shutdown if a bleed leak is detected and the APU is running.

Electronic Control Unit

Description

The electronic control unit (ECU) is a fully automatic digital unit that controls the APU start and shutdown sequence, monitors engine parameters during operation, and automatically shuts down the APU if a parameter is not within operational limits.

The flight crew and maintenance personnel provide commands to the APU electronic control unit via the APU control panel, electrical panel, pressurization panel, and the APU maintenance panel.

Refer to Chapter 5 Electrical Systems and Chapter 7 Environmental Control Systems for a detailed description of the electrical panel and the pressurization panel, respectively.

Components and Operation

Electronic Control Unit

The ECU controls the APU operation by receiving sensor inputs and commands, and sending control outputs to the aircraft systems and APU subsystems.

APU Cockpit Control Panel

The APU cockpit control panel (Fig. 11) is located on the center pedestal and houses APU operating controls and monitoring indications. APU fire detection/extinguishing controls are also provided on the panel.

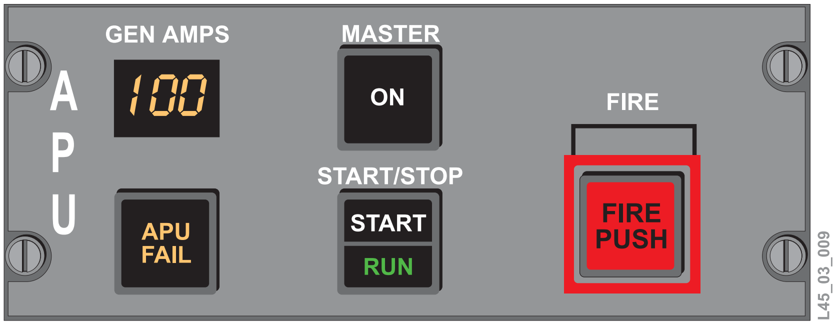


Figure 11 - APU Cockpit Control Panel

APU Maintenance Panel

The APU maintenance panel (Fig. 12) is located in the tailcone equipment bay. It houses the controls, indicators, and necessary interfaces for operation of the APU for maintenance. It also shuts down the APU in an emergency.

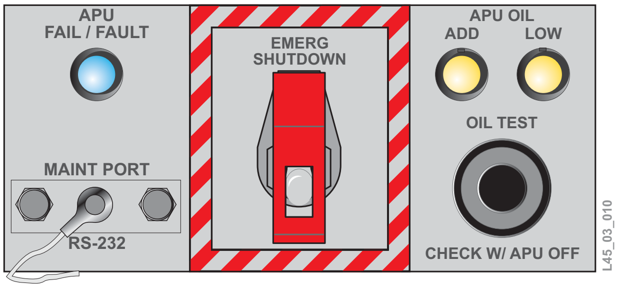


Figure 12 - APU Maintenance Panel

Fuel System

Description

The APU fuel system is fully automatic and controlled by the ECU. Fuel for the APU flows from the right wing fuel tank through the right standby pump, a shutoff valve, and a fuel filter prior to reaching the engine (Fig. 13). The APU uses approximately 150 lb of fuel per hour.

The major components of the fuel system consist of the fuel control unit (FCU) and the fuel solenoid valve.

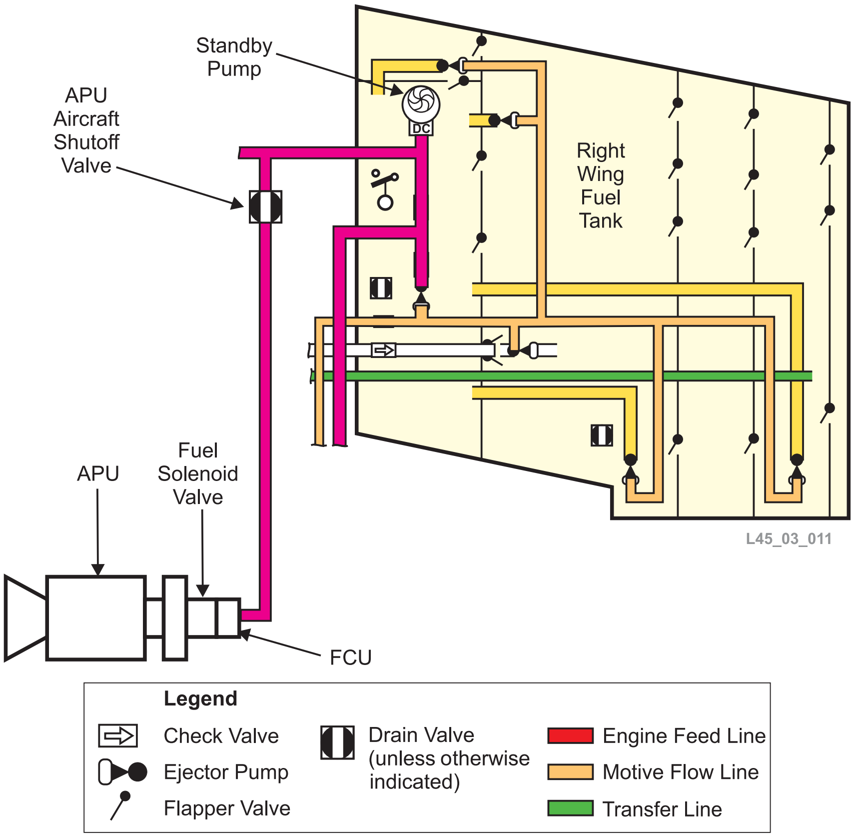


Figure 13 - APU Fuel System Schematic

Components and Operation

Right Standby Pump

The right standby pump provides pressurized fuel to the APU. The pump is automatically energized when the APU is selected ON (APU MASTER switch indicator depressed). Activation of the right standby pump is indicated by a displayed white R STBY PUMP ON message on the CAS.

APU Aircraft Fuel Shutoff Valve

When the APU MASTER switch indicator is selected ON, the APU electronic control unit provides electrical power to open the APU aircraft fuel shutoff valve. This allows right wing tank fuel to enter the fuel control unit.

Fuel Control Unit

The fuel control unit (FCU) provides the necessary fuel quantity to maintain combustion for acceleration and on-speed operation, in response to signals received from the ECU. The fuel filter is also housed within the FCU.

Fuel Solenoid Valve

The fuel solenoid unit is energized open by the electronic control unit during the APU start sequence. The fuel solenoid valve controls the fuel provided to the fuel nozzles.

APU Fire Warning System

Description

The APU is located in a fire containment enclosure. The APU fire warning system includes components which detect and extinguish an APU fire. These components consist of a sealed gas line (single fire loop), fire warning light, fire horn, fire extinguishing bottle, and fire system test switch.

Components and Operation

Fire Loop

The fire loop consists of a sealed gas line installed around the APU inside the APU enclosure. During an APU fire, the pressure in the sealed line increases and activates the fire warning system.

A shorted fire loop circuit is indicated by a false fire signal or failure of the APU fire warning system test, depending on the location of the short. The integrity of the fire loop can always be tested by selecting the SYSTEM TEST switch to the FIRE DET position and depressing the TEST button.

APU Fire Horn

The APU fire horn is located in the nose avionics bay. Since the APU may be operated unattended, the horn alerts personnel outside of the aircraft to an APU fire condition.

Fire Extinguisher Bottle

The fire extinguisher bottle is located adjacent to the APU enclosure. The bottle is filled with Halon 1301 and equipped with a squib and thermal relief mechanism to prevent bottle overpressure. Indication of a discharged bottle is by inspection of a pressure gauge mounted on the bottle compared with the pressure placard (Fig. 14).

Discharge of the squib ruptures a diaphragm which releases the extinguishing agent into the APU enclosure. The integrity of the squib circuit is tested whenever a FIRE DET system test is performed.

PRESSURE (±10%) VS TEMPERATURE

°F	-40	-20	0	20	40	60	70	80	100	120
PSIG	98	119	145	179	220	271	300	332	405	491

L45_03_019

Figure 14 - Pressure Placard

APU FIRE Switch

Illumination of the APU fire switch on the APU cockpit control panel indicates an APU fire condition. Depressing the APU FIRE switch commands an immediate shutdown of the APU and simultaneously discharges the fire bottle.

An APU fire condition is considered active as long the APU FIRE switch indicator is illuminated.

APU FIRE Warning

The following events occur whenever an APU fire is detected:

- APU shuts down
- APU FIRE CAS message appears
- MASTER tone and warning lights activate
- APU FIRE switch indicator illuminates
- APU FAIL annunciator illuminates
- APU fire warning horn sounds
- Within 10 seconds of activation/illumination of the APU FIRE switch indicator, the fire bottle automatically discharges

The fire extinguisher may also be activated manually by depressing the APU FIRE switch indicator.

In addition to the above indications, the APU automatically closes the APU fuel solenoid valve and the APU aircraft fuel shutoff valve, and de-energizes the right wing tank standby pump.

APU Fire Warning System Test

NOTE **Ensure personnel are clear of the nosewheel well/ avionics bay area during the APU system fire test.**

The APU fire warning system test verifies the integrity of the APU fire detection and extinguishing system. The APU fire warning test occurs simultaneously with the engine fire detection tests.

The test may be accomplished only when the APU is powered (APU MASTER switch ON). To initiate the test, rotate the SYS TEST/RESET switch to the FIRE DET position and depress the PRESS TEST button.

A proper system test is indicated by the following:

- APU FIRE CAS message appears
- MASTER tone and warning lights activate
- APU FIRE switch illuminates
- After 15 seconds, the APU fire warning horn sounds

NOTE **Holding the TEST button down for 30 seconds or more with the APU operating results in an APU FAIL indication and an APU shutdown.**

Oil System

Description

The APU has a self-contained lubrication system. Major components include the lube pump, an oil sump integral to the gearbox housing, and a pressure relief valve. Oil cooling is accomplished by heat conduction from the gearbox housing to the compressor inlet casing. The APU compartment ventilation airstream also provides some cooling.

Operation

Lubrication pressure is provided by the lube pump, which furnishes pressurized oil flow to the main rotor bearings and gear meshes; mist lubrication is supplied to low-load components. A pressure relief valve is incorporated to limit the pressure in the system.

The oil system incorporates sensors that protect against low oil pressure and high oil temperature conditions.

The APU maintenance panel can perform an oil level test. The test determines if the oil level is low and needs servicing.

APU Servicing

Oil

Oil service capacity is approximately 2 U.S. qt. The oil level should be verified during the exterior preflight checks by performing an oil test on the APU maintenance panel.

When the OIL TEST button on the APU maintenance panel is depressed, an amber indicator illuminates to indicate if servicing is required. Indicators illuminate ADD OIL or OIL LOW. If neither light is illuminated, the oil level is within the normal operating range.

Drains

Drain lines are routed to the lower right side of the aircraft aft of the right engine. These drains allow fluid drainage from the air intake, fuel control, and APU compartment. Servicing the APU drains consists of checking the drains prior to each flight.

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COMMUNICATION SYSTEMS

Introduction

The radio communication system on the Learjet 40/45 aircraft consists of a PRIMUS II integrated radio system and optional communication systems. The PRIMUS II is part of the PRIMUS 1000 Avionics System.

The PRIMUS II integrated radio system consists of:

- Audio control system
- Radio management units
- Clearance delivery control display head (CDH)

Auxiliary optional communication systems include a single HF system for long-range communications, selective calling (SELCAL), and a radio telephone system (covered in the miscellaneous chapter).

The aircraft is also equipped with a passenger address system and a cockpit voice recorder.

Radio Management Units

Description

Two radio management units (RMUs) monitor and control frequencies and operational modes. They are located on the center panel.

The RMUs may also be used as backup engine and navigation displays in the event of EFIS/EICAS failure. Engine data is automatically presented on RMU No. 1 if neither integrated computer is providing EICAS data.

Frequencies can also be controlled through the flight management system (FMS) or the clearance delivery control display head (CDH).

Controls and Indications

Radio Management Unit

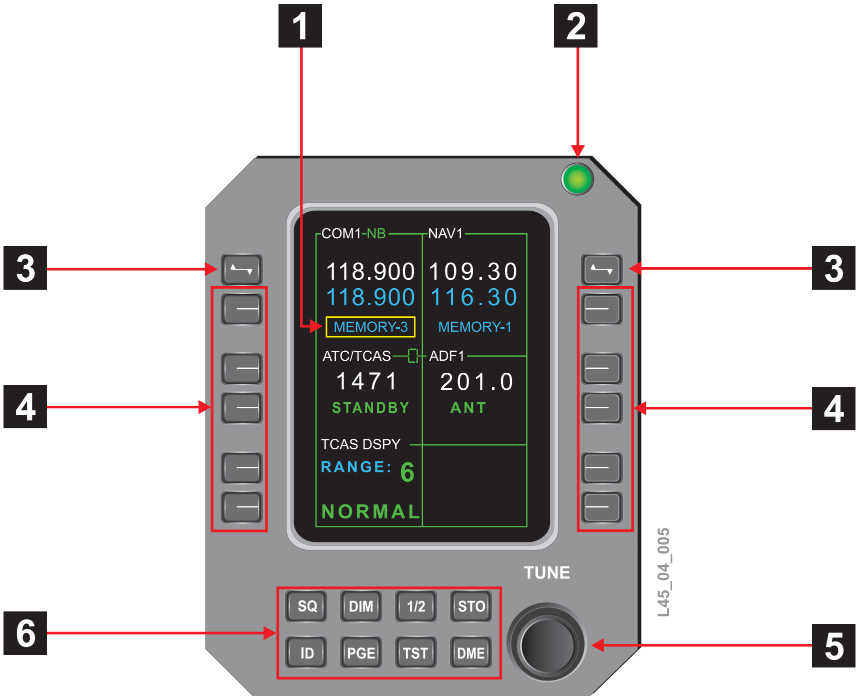

Figure 1 - Radio Management Unit

1 Yellow Box Cursor

- Indicates the data field selected by a line select key (20 seconds after the last operation, the cursor homes to the preset frequency in the VHF COM window [or HF if more recently used])

2 Photo Sensor (disconnected—use DIM function key)

- Senses the ambient light condition and adjusts the RMU intensity when passing from shadow to sunlight

3 Transfer Keys

- Push—Exchanges the active frequency (top line) with the preset frequency space (second line) of the window and labels it TEMP

4 Line Select Keys

- Push—
  - Selects the frequency or mode to be changed
  - Pressing more than once changes the selection from preset to memory or toggles mode

5 TUNE Knobs

- Rotate—Changes the selected data

6 Function Keys (Toggle Switches)

SQ

- Push—Opens COM radio squelch followed by the letters SQ annunciated on the top line of the window

DIM

- Push—Enables brightness control with the tuning knob

1/2 (Cross-side)

- Push—Transfers the entire RMU operation and display to the cross-side system

STO (Store)

- Push—
  - Stores the selected preset (TEMP) COM or NAV frequency in memory
  - Stores the current ATC code or ADF frequency in memory

ID

- Push—Causes transponder to squawk identification code for 18 seconds

PGE (Page)

- Push—
  - Displays the PAGE MENU
  - Pressing it a second time returns the display to the tuning page

TST (Test)

- Push—Activates the self-test on the selected function

DME

- Push—
  - De-slaves the DME from the active VOR so a different DME channel can be tuned without changing the active VOR (DME hold)
  - Successively pressing the DME key enables the display and selection of DME channels in VHF and TACAN modes

RMU Memory Operation

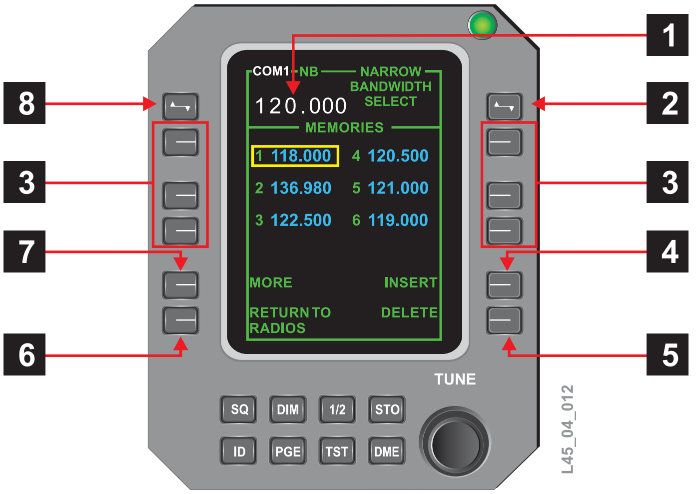

Figure 2 - Memory Operation

1 Active Frequency Display

- Displays the active frequency

2 BANDWIDTH Key

- Push—Toggles the bandwidth from narrow to wide

NOTE

The selected bandwidth is also annunciated above the COM window on the main tuning page.

In some areas of the world that use older equipment, wideband operation is required to properly receive ground transmissions.

3 Line Select Keys

- Push—Selects the memory set (frequency and sequence number) to be tuned

4 INSERT Key

- Push—
  - Inserts a new space (by moving the other memory sets one space down) displayed as 118.00 (COM) or 108.00 (NAV) which is then tuned to the desired frequency
  - MEMFULL appears momentarily in the adjacent INSERT field if the memory is full

5 DELETE Key

- Push—Deletes the selected frequency

6 RETURN TO RADIOS Key

- Push—Returns to the main tuning page

7 MORE Key

- Push—
  - Accesses more memory sets by toggling the two memory pages
  - Momentarily displays the message CAN’T (can’t toggle) in the adjacent INSERT field if the six memories on the first page are not filled

8 Memory Load Key

- Push—Loads the active channel with the selected memory

Operation

System Page Menu

From the SYSTEM PAGE MENU, the following functions can be accessed:

- Radio page
- Communication memory
- Navigation memory
- ATC/TCAS
- Return
- Navigation
- Engine page 1
- Engine page 2
- Maintenance (ground only)

Tuning

Main Tuning Page

The main tuning page of the RMU is divided into five sections or windows:

- COM
- NAV
- ATC (transponder) and TCAS
- ADF

The COM and NAV windows have three lines. The top line displays the active frequency. The second line displays a preset frequency (either memory or temporary scratchpad frequency). The third line accesses memory frequencies.

Preset Tuning

Tuning of the preset frequency (second line) can be achieved by pressing the line select key adjacent to the COM or NAV preset frequency and changing it with the TUNE knob. A TEMP indication appears. The new preset frequency transfers to active mode by pressing the transfer key, which exchanges the preset with the active (first) line.

Direct Tuning

Direct tuning is achieved by pressing the line select key adjacent to the preset frequency and holding it for more than 2 seconds. The cursor moves to the active frequency, allowing direct tuning. The preset space is blank. To exit direct tuning, the line select key must be pressed and held until the preset frequency appears.

RMU Cross-Side Operation

Description

The RMU normally controls tuning of the radio system on the respective side of the aircraft but may be switched to a cross-side mode to display and control the radio system on the other side of the aircraft (Fig. 3). This is available to both pilots and serves as a backup function when one RMU is inoperative.

The pilot may tune the copilot No. 2 set of radios on system No. 1 by pushing the 1/2 function key. Both RMU displays are then identical except for the function legends (COM 2, NAV 2, ADF 2) which show in magenta instead of white. The pilot can still control No. 1 COM and NAV memory and use it to control the No. 2 radios. Any frequency changed on the copilot side is then annunciated in yellow on the copilot RMU. (Any parameter annunciated in yellow indicates it was not set using the same-side RMU.) When the pilot pushes the 1/2 switch again, the RMUs revert to the original display.

Cross-side operation shifts between complete systems. It is not possible to display/control on one RMU partial pilot and copilot functions at the same time.

If the cursor is in the ATC or TCAS window, the 1/2 function key selects the operating transponder. (With TCAS II, it controls TCAS data in the cross-side display.)

NOTE

While in cross-side, RMU No. 1 does not access the memory of RMU No. 2 and vice versa.

The INPH control knob on the audio panel links the cross-side audio panel.

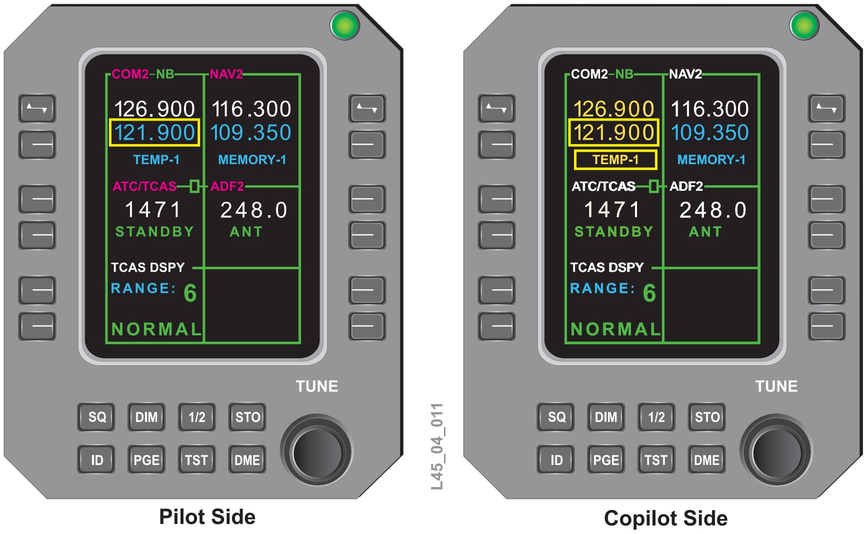

Figure 3 - Cross-Side RMU Display

COM Messages

The messages in Table 1 appear on top of the COM tuning window:

Table 1 - COM Tuning Window Messages

Message	Condition
MIC STK	When the microphone is stuck for approximately 2 minutes, a beep sounds on the audio. This message appears until the microphone button is released. Ten seconds after the MIC STK CAS alert appears, the selected transmitter automatically turns off.
AUX ON	Indicates the clearance delivery control is in emergency mode. The respective COM is being channeled by the clearance delivery head. The RMU is locked out from control of that COM.
TX	Indicates the transmitter is on.
SQ	Indicates the squelch has been opened with the SQ button.
NB	Indicates that narrow bandwidth has been selected.
WB	Indicates that wide bandwidth has been selected.

COM and NAV Memory

General

For both COM and NAV there are 12 memory locations numbered and displayed on two pages (six frequencies each). The ADF and ATC each have only one memory location.

Changing a preset frequency memory (COM or NAV) on the main tuning page may be done in two ways.

One way is by selecting the memory option (third line) of the COM or NAV window by pressing the corresponding line select key a second time. Frequencies stored in memory can now be scrolled in the preset window with the tuning knob. The labels used to number the memorized frequencies move simultaneously.

The second way is by displaying the SYSTEM PAGE MENU when pressing the PGE button. The memory pages may be accessed by selecting COM MEMORY or NAV MEMORY.

COM and NAV Memory Pages

In the upper right corner, the COM MEMORY page displays bandwidth while the NAV MEMORY page displays FMS ENABLED/DISABLED.

Pilot-Activated Self-Test

The pilot may initiate and conduct a self-test sequence of the COM radios. To perform a self-test, select the parameter and press the TST button. The TST button must be held down for the duration of the test: about 2 seconds for COM transceiver, 5 to 7 seconds for DME, ATC, or ADF, and about 20 seconds for NAV (VOR/ILS).

When the button is released (or held for 30 seconds or more) the function returns to normal operation.

After the test is complete, the green PASS or red ERR legend appears in the window.

Command Failure

If any of the components of the radio system fail to respond to commands from the RMU, the frequencies or commands associated with those functions are removed from the RMU and replaced with dashes. This alerts the crew to the fact that the radio system is not operating normally.

Audio Control System

Description

The audio control system provides an interface among crew microphones, speakers, headphones and the aircraft radio, warning and recording system. Amplifiers are included for headphones and speakers.

A separate audio control system is provided for the pilot and copilot. Both pilots can transmit and receive simultaneously on different communication systems and different frequencies.

Controls and Indications

Audio Control Panel

An audio control panel is installed at the outboard end of the pilot and copilot instrument panels. The panel controls the input and output audio to remote radio units as well as the intercom and passenger address system. Several different models are available.

Each panel is used in conjunction with the onside microphone, headphone, and cockpit speaker.

During oxygen mask operation the microphone (MASK) button is pushed and released to the extended position. This provides interphone audio to the cockpit speakers regardless of the SPKR ON/OFF button position. Speaker audio is set to a minimum level.

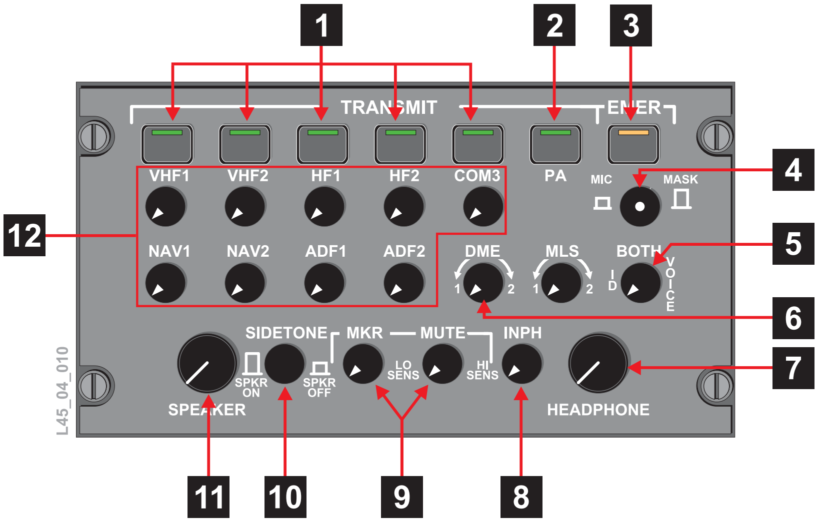

Figure 4 - Audio Control Panel

1 Transmit/Receive Selection Switches

- Push—Selects the desired radio for transmission and reception (illuminates green for night operations)

2 PA Switch

- Push—Connects the onside microphone to the passenger address amplifier independently of power applied to the audio panel (during passenger address, all other audio inputs are deselected except for warning tones)

3 Transmit/Receive Emergency Switch

- Push—
  - Overrides all other transmit/receive switches
  - Connects the onside microphone to the No. 1 VHF COM transmitter
  - Connects the received audio signals from No. 1 VHF COM and NAV to the onside headphones
  - Disables all other audio panel modes (except the headphone volume as long as power is applied to the audio panel)

4 Mic/Mask Selection Switch

- Push (remains in)—Selects the normal boom microphone (MIC) and/or handheld microphone
- Push (remains out)—Selects the oxygen mask microphone (MASK)

5 ID/BOTH/VOICE Control Knob

- Rotate—
  - ID eliminates the voice signal
  - VOICE filters audio to pass the voice content for received VOR/ILS audio (ADF audio is unaffected)
  - BOTH enables voice and identification signals to be heard together

6 DME Control Knob

- Push out—Selects the audio in both channels (1 and 2)
- Rotate—
  - In either direction (1 or 2)—Increases volume for that channel
  - In the centered (top) position—Each channel’s audio level is minimum

7 HEADPHONE Control Knob

- Rotate—Adjusts the overall volume of audio to the headphones except for warning tones

8 INPH Control Knob

- Push on—
  - Selects the interphone
  - Links the cross-side audio panel
  - Links the externally located maintenance audio jacks (optional)
- Rotate—
  - Adjusts the onside volume of the interphone to the headphones
  - With the oxygen mask, adjusts the onside volume to the speakers

9 MKR (Marker Beacon) and MUTE (HI/LO) Control Knob

MKR

- Push on—Enables marker beacon audio to transmit to the onside cockpit speaker or headphone
- Rotate—
  - Adjusts the marker beacon volume
  - Does not turn the volume down below a preset audible level which ensures the marker beacon signal is not missed

MUTE

- Push in (momentary)—Silences the marker beacon for the time it takes the aircraft to leave the influence of the marker beacon (resets for the next beacon)
- Rotate—Adjusts marker beacon sensitivity to HI SENS or LO SENS simultaneously on both pilot and copilot audio panels, regardless of the position of the other audio panel control

10 SIDETONE (SPKR ON/SPKR OFF) Control Knob

- Push (remains in)—Turns the onside speaker off to prevent feedback while transmitting (except for warnings or oxygen mask operation)
- Push (remains out)—Turns the onside speaker on while transmitting
- Rotate—Adjusts sidetone level

11 SPEAKER Volume Control Knob

- Rotate—Adjusts the overall volume of audio to the speakers except for warning tones

12 Audio Source Control Knobs
- Push (remains out)—Selects the corresponding audio channel or the different channels to be heard simultaneously
- Push (remains in)—Deselects corresponding audio channel reception
- Rotate—Adjusts the audio volume of the selected channel or channels

Passenger Address System

The passenger address system is used by the flight crew to speak to the passengers. It is activated via the PA switch on the audio control panel and connects to the hand, headset, and oxygen mask microphones.

Four passenger speakers are installed on the aircraft.

Signal communication is provided by audible chimes when the NO SMOKING/BELTS and BELTS switch is positioned on (Fig. 5).

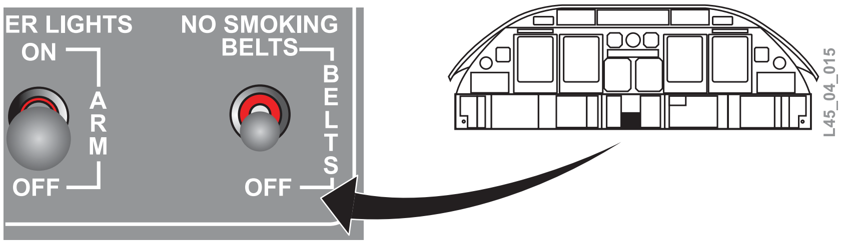

Figure 5 - NO SMOKING/BELTS and BELTS Controls

Clearance Delivery Head

Description

The clearance delivery head (as per the Honeywell manual) is also referred to as the clearance delivery radio (as per the Airplane Flight Manual) even though it is not a radio. It is a control head.

It is installed in the center pedestal.

The clearance delivery head provides an alternate tuning source when radio communications are required. It is not the desired source to power all aircraft avionics. The radio also provides an alternative radio tuning source to supplement the radio management units (RMUs) and provide tuning during an RMU failure.

Controls and Indications

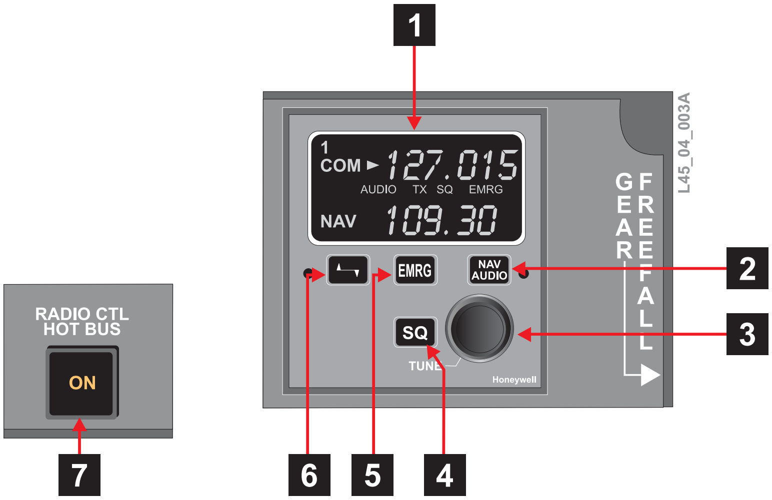

Figure 6 - Clearance Delivery Head

1 COM and NAV Displays

- Displays COM and NAV frequencies

2 NAV AUDIO Switch

- Push—Toggles NAV audio ON or OFF when in the EMER mode on the audio control panel

3 TUNE Knobs

- Rotate—Changes frequencies. The larger knob is the coarse tune (MHz) and the smaller knob is the fine tune (parts of MHz)

4 SQ Switch

- Push—Toggles COM squelch on or off

5 EMRG Switch

- Push—Selects the emergency mode (which takes exclusive control of COM 1 and NAV 1 tuning)

6 Transfer Key

- Push—Toggles to the COM or NAV frequency

7 RADIO CTL HOT BUS

- Push—When airplane batteries are OFF, powers (from the right hot bus) the clearance delivery radio control panel, the left audio control panel, and the COM and NAV integrated units

Operation

The clearance delivery head is powered from the aircraft hot bus during clearance delivery operation and from the left essential bus during normal operation.

Normal Operation

In the normal mode, the CDH acts as an additional tuning source for the No. 1 VHF communications and No. 1 VHF navigation radios. In this mode, the CDH displays the current active frequencies of the No. 1 COM and NAV radios.

Emergency Operation

All control functions in the emergency mode are identical to NORMAL mode. This mode is annunciated on the RMU by an amber AUX ON message at the top of the NAV 1 and COM 1 windows.

During this mode, the No. 1 COM and NAV units are exclusively tuned by the clearance delivery head.

Cockpit Voice Recorder

Description

The standard cockpit voice recorder (CVR) is a three-channel unit providing 30 minutes of recording. An optional unit is available which records for 120 minutes. Two of the channels record pilot and copilot audio. The third channel is used for the area microphone.

Located in the tailcone, the CVR is painted international orange with reflective tape to aid in emergency recovery. It also has an underwater locator beacon installed on one end of the unit. The recording is converted to a digital format and stored in crash-protected memory.

The area microphone is located in the upper portion of the instrument panel, slightly right of center.

Controls and Indications

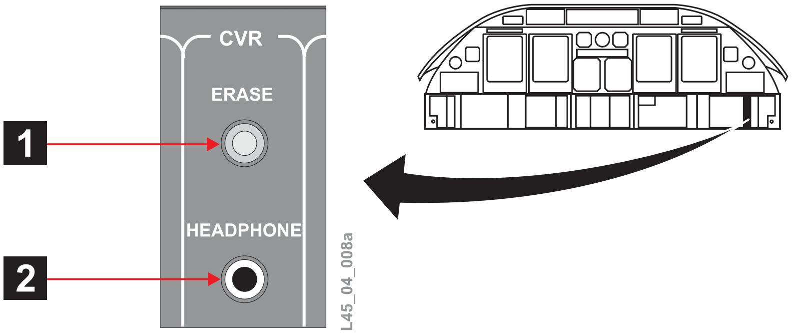

Figure 7 - Cockpit Voice Recorder

1 ERASE Button

- Press—Erases the cockpit voice recording

2 HEADPHONE Jack

- Allows the pilot to hook up to the audio sound which indicates when the erasing has finished

CAS Messages

Table 2 - Communication CAS Message

CAS Message	Conditions/Parameters
CVR FAIL	Cockpit voice recorder failed

Operation

An erase button and headphone jack are located on the CVR panel just beneath the copilot audio control panel. The erase function is initiated by pressing the erase button on the CVR panel. An interlocking device only allows this function to work when the airplane is on the ground and parking brake is set. When the erase function is complete, a three-second tone is output to the headphone jack.

Self-Test

The CVR performs a self-test at power-up and continuously self-monitors. If a fault is detected at any time, a white CVR FAIL CAS message displays.

HF Communications System

Description

The high frequency (HF) communication system provides long-range communication. Operating on any 0.1-kHz frequency between 2.0 and 29.9999 MHz, it can preset and store up to 99 channels.

Any channel can be preset to operate as semiduplex, simplex, or receiver only. In semiduplex mode, the radio transmits on one frequency and receives on another. In simplex operation, the radio transmits and receives on the same frequency.

The control unit stores frequency, emission mode, and channel data, even when the system is turned off.

Mode selection allows use of upper sideband (USB) or amplitude modulation (AM) transmission. The system consists of a control/display unit, remote power amplifier and antenna coupler, remote receiver/transmitter, and antenna. The HF receiver is SELCAL-compatible.

Controls and Indications

HF Control Panel

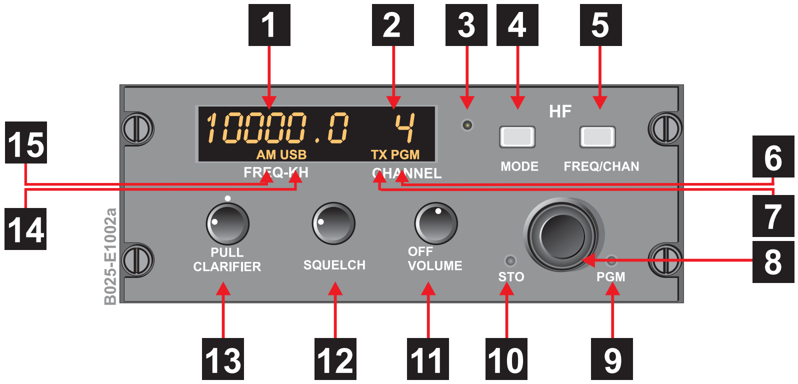

Figure 8 - HF Control Panel

1 Frequency Display

- Displays the operating frequency (2000 to 29,999.9 kHz in 0.1-kHz steps
- During semiduplex operation, displays receiver frequency except during transmission when the transmitting frequency is displayed

2 Preset Channel Number Display

- Displays the selected operating channel (from 1 to 99)

3 Photocell

- Dims display automatically

4 MODE Button (momentary)

- Press—Alternately selects USB or AM mode

NOTE

In CHAN operation, mode is preset but can be changed by the MODE button. Reselection of the channel returns the system to the original preset mode.

5 FREQ/CHAN Button

- Push in—Selects preset channel operation
- Push OUT—Selects direct tuning of frequency

6 PGM Indicator

- Indicates the program mode is activated

7 TX Indicator

- Illuminated steady—Indicated radio transmission is in progress
- Illuminated flashing—Indicates antenna tuning is in progress and memory storage operations

8 Frequency and Preset Channel Selection

Frequency Selection

- Outer knob selects the digit to be changed (selected digit flashes)
- Inner knob sets the numerical value of the flashing digit

NOTE **The cursor (flashing digit) can be stowed by moving it to the far left or right of the display followed by one more click.**

Preset Channel Selection

- Outer knob selects the digit to be changed (selected digit flashes)
- Inner knob selects channels 1 through 99 (the preset frequency is also displayed)

NOTE **The PGM button can be depressed with a pencil or any other pointed object**

9 PGM Switch

- Press—Changes frequency and emission mode of preset channel

10 STO Button

- Press—Stores the displayed frequency and emission mode in memory

NOTE **The PGM and STO switches can be depressed with a pencil or any other pointed object.**

11 OFF/VOLUME Knob

- Rotate—Turns the system off and on, and controls the volume

NOTE **No frequencies are displayed until the system has warmed up (approximately two minutes) after initial power-up.**

12 SQUELCH Knob

- Rotate—Adjusts the receiver squelch level (rotate the knob clockwise until background noise can be heard, then counter-clockwise until the noise is just barely audible or absent)

13 CLARIFIER Knob

- Pull out and rotate—Improves reception when the ground station is slightly off frequency, resulting in unnatural voice quality (should be rotated in either direction as required to give natural voice quality)
- Knob is normally pushed in until clarify control is necessary

14 USB Indicator

- Illuminated—Indicates USB mode is activated

15 AM Indicator

- Illuminated—Indicates AM mode is activated

Operation

Programming (Air or Ground)

The program mode (PGM) must be used for setting or changing any of the 99 preset frequencies. The operating mode (USB or AM) must be the same for both receive and transmit and can also be preset.

With the FREQ/CHAN button pushed in, use a pencil or other pointed object to depress the PGM button. The letters PGM appear in the lower part of the display window, and the system remains in the program mode until the PGM button is depressed again. (Switch is alternate-action: push-on, push-off). Each channel may be programmed in one of the following three ways:

- Receive only
- Simplex
- Semiduplex

Receive Only

- Rotate the large concentric knob to stow the cursor if a frequency digit is flashing (converts the smaller knob from a frequency set function to a channel select function when the program mode has been selected)
- Select the channel to be preset by tuning the smaller knob and observing the channel number in the display window
- Set the frequency
- Set the operating mode by depressing and releasing the MODE button until the desired mode appears in the lower part of the display window
- Depress and release the STO button once

At this point, TX flashes in the display window. This indicates that another activation of the STO button would store this frequency as the transmit frequency. Since a receive-only frequency is being set, ignore the flashing TX.

If another channel must be reset, use the smaller concentric knob to select the channel and repeat the steps for selecting a new frequency and mode. To return to one of the operating modes, depress the PGM button again.

Simplex

In simplex, transmission and reception are on the same frequency:

- Depress FREQ/CHAN button
- Depress PGM button; PGM light illuminates
- Select the channel to be preset
- Set the desired frequency
- Set the operating mode by depressing and releasing the MODE button until the desired mode appears in the lower part of the display window
- Depress and release the STO button twice

Again, another channel may be selected for resetting or the set may be returned to one of the operating modes by depressing the PGM switch.

Semiduplex

A channel established for semiduplex transmits on one frequency and receives on another:

- Depress FREQ/CHAN button
- Depress PGM button; PGM light illuminates
- Select the channel to be preset
- Set the desired frequency
- Set the operating mode by depressing and releasing the MODE button until the desired mode appears in the lower part of the display window (also transmits emission mode; they are always the same)
- Depress the STO button once (receiver is now set; TX should be flashing in the display window to show that the memory is ready to receive the transmit frequency)
- Set the transmit frequency in the display window
- Depress the STO button (stores the transmit frequency)

Once again, another channel may be called up for resetting or the system may be returned to one of the operating modes.

NOTE **The operating mode for each channel is stored along with the frequency. If the operating mode is changed, the system receives and transmits in the operating mode selected for transmit. (Transmit operating mode "writes over" the receive operating mode).**

Normal Operation

NOTE **When performing a ground radio check, make certain that all personnel are clear of the HF antenna before transmitting. Serious radio frequency (RF) burns can result from direct contact with the antenna or antenna terminal when the system is transmitting.**

- FREQ/CHAN button—Select FREQ (button out) and set in desired frequency and operating mode, or select CHAN (button in) and set in desired preset channel
- MIC key - Press

NOTE **When the MIC is keyed, the digits blank until the automatic tuning sequence is complete. It takes approximately 3 seconds for the antenna coupler to tune the antenna. During the tuning sequence, the letters TX flash in the display window. When the TX stops flashing and the frequency digits reappear, the tuning sequence is complete.**

- OFF/VOLUME knob—As desired
- SQUELCH knob—As required
- CLARIFIER knob—As required

Fault Indication

Certain faults during transmit or tuning of the antenna coupler make all the frequency digits flash. Key the MIC or switch channels to eliminate the fault indication. Keying the MIC clears the fault indication, not the fault. The flashing of the frequency display at the end of a coupler tuning sequence indicates that the coupler was unable to find an acceptable match. The flashing display is cleared with a second initiation of the MIC key. Repeated failures to tune the antenna normally indicate an equipment malfunction.

NOTE

When selecting any frequency on a preset channel, it is desirable to key the MIC when making a new frequency or channel selection. (Make sure that the transmit operation on the frequency is authorized). Keying the MIC automatically tunes the antenna coupler which improves receiver operation.

Choice of Frequencies

The long-distance propagation of HF signals depends on such factors as atmospheric conditions, conditions in the ionosphere, time of day, and frequency used. Whenever possible, the 99 preset channels should be chosen so that communication with each of several stations along the route is possible on three or more frequencies spaced out well across the HF band. Then, if there is some difficulty in communicating with a station on one frequency, other frequencies that station is guarding may be tried without having to set up a frequency digit by digit. Ground stations often publish frequencies desirable for various distances and time of day.

SELCAL System

Description

The SELCAL system permits the selective calling of individual aircraft over normal radio communications circuits linking the ground station with the aircraft. The SELCAL is integrated into the VHF (system 1 or 2) and HF communication systems to relieve the flight crew from continuously monitoring frequencies during flights of extended duration. The system consists of a decoder unit and the SELCAL control panel located just above the phone on the pedestal.

Upon receiving a call, the appropriate VHF or HF annunciator illuminates in the SELCAL control panel and an intermittent aural tone sounds. When the annunciator is depressed, communication with the caller can be established and the aural tone stops.

The system may be tested by depressing the VHF or HF button. The self-test causes the annunciator to flash and the aural tone to sound.

Controls and Indications

SELCAL

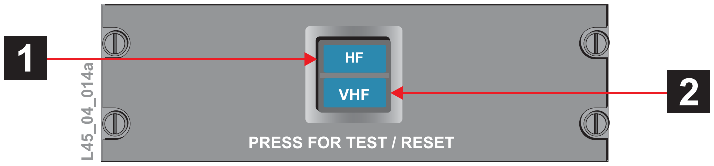

Figure 9 - SELCAL

1 HF Button

- Press—Connects with HF radio

2 VHF Button

- Connects with VHF 1 or VHF 2

Static Discharging System

Description

A static electrical charge, commonly referred to as precipitation static (P static) builds up on the surface of an aircraft while in flight and causes interference in radio and avionics equipment operation. The charge may be dangerous to persons disembarking as well as to persons performing maintenance on the aircraft.

Components and Operation

The static dischargers (Fig. 10) or wicks are installed on the aircraft trailing-edge extremities (winglet, tailcone stinger, navigation light fairing, delta fins, and elevator trailing edge) to dissipate static electricity with a minimal amount of radio interference.

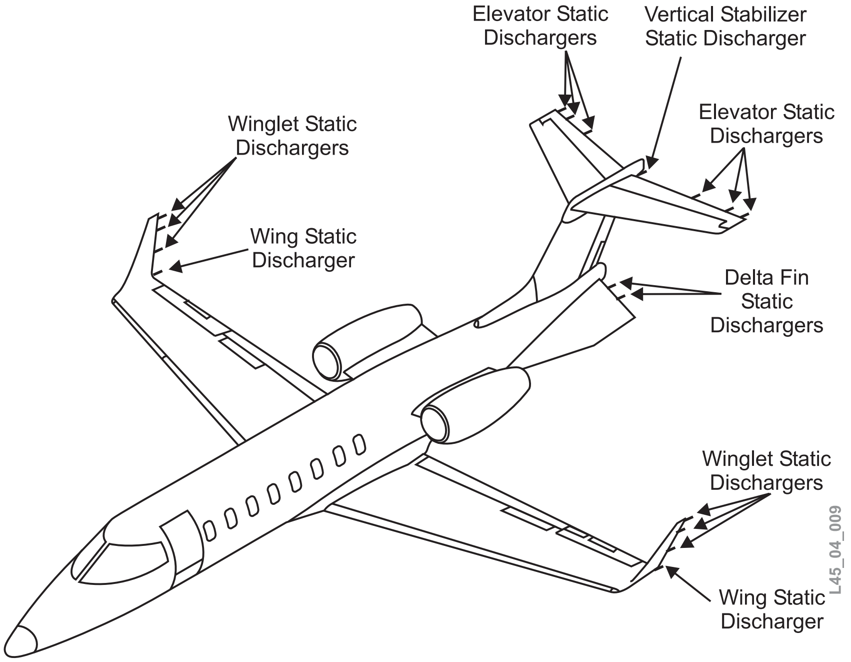

Figure 10 - Static Dischargers

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ELECTRICAL SYSTEMS

Introduction

The Learjet 40/45 electrical system consists of AC and DC generation systems. Secondary DC electrical power is supplied by two main batteries, and a single emergency battery provides power to standby equipment if the electrical system fails.

A ground power unit can also provide electrical power for system operation prior to engine start to assist in engine start and to charge aircraft batteries.

An optional APU may be installed to provide for systems operation on the ground and for engine start.

Controls and Indications

Electrical Control Panel

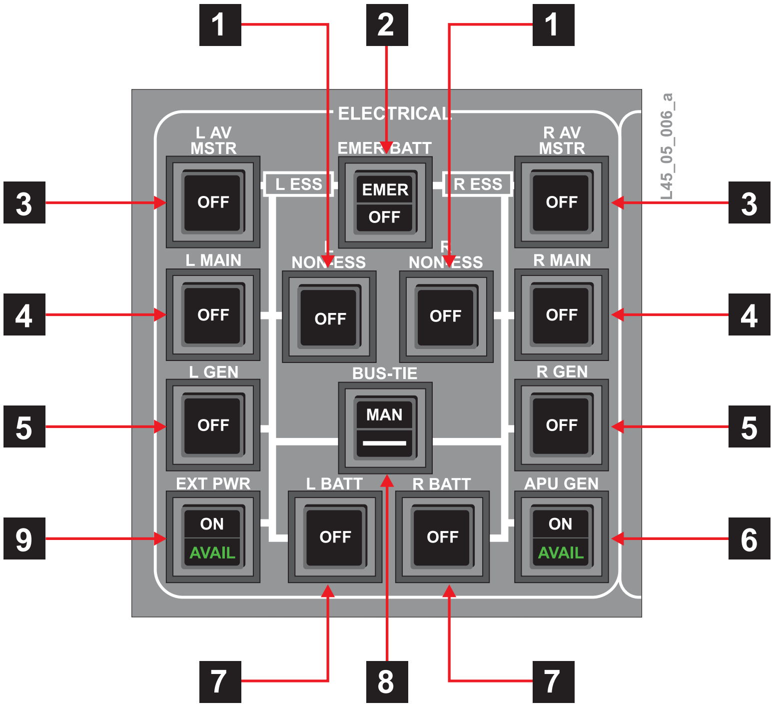

Figure 1 - Electrical Control Panel

1 L or R NON-ESS Switch Indicator

- Press—Connects or disconnects the left or right nonessential bus to or from itsrespective generator bus
- OFF—Indicates no power on the buses

2 EMER BATT Switch Indicator
- Press—Connects to the essential components during dual generator failure or to the essential buses during engine starting
- OFF—
  - Indicates no power to the EMER BAT bus
- EMER—
  - Indicates the emergency battery is discharging at a rate >1.0 amp
  - Indicates the emergency battery is powering the EMER BAT bus and the L and R EMER HOT buses

3 L or R AV MSTR Switch Indicator
- Press—Connects or disconnects respective main and essential avionics buses by manual selection
- OFF—Indicates no power on the buses

4 L and R MAIN Switch Indicator
- Press—Connects or disconnects respective main buses by manual selection
- OFF—Indicates no power on the buses

5 L or R GEN Switch Indicator
- Press—Connects or disconnects the generators by manual selection
- OFF—Indicates that the generators are offline

6 APU GEN Switch Indicator
- Press—Connects or disconnects the APU to or from the aircraft electrical system
- AVAIL—Indicates the APU is running and able to provide electrical power
- ON—Indicates the APU is connected to the right generator bus

7 L or R BATT Switch Indicator
- Press—Connects or disconnects the batteries by manual selection
- OFF—Indicates that the batteries are offline

8 BUS-TIE Switch Indicator
- Press—Manually overrides an automatic bus-tie operation to provide a split system or to tie the electrical system together
- MAN—Indicates that the automatic operation is disabled and the bus-tie is held in the existing position until deselected by the crew
- HORIZONTAL BAR—Indicates that the generator buses are tied together

9 EXT PWR Switch Indicator

- Press—Provides external electrical power to the aircraft
- AVAIL—Indicates that a GPU, with correct polarity, acceptable voltage and ripple limits, is connected to the aircraft
- ON—Indicates that the GPU is connected to the left generator bus

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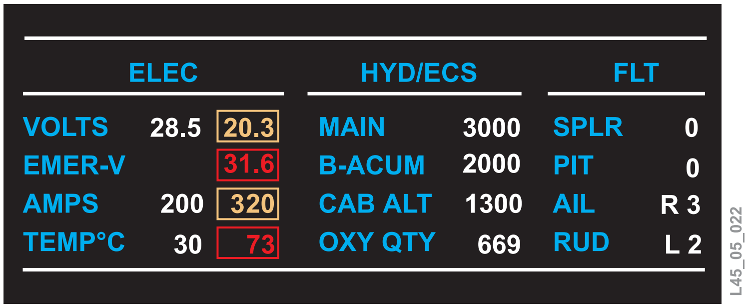
EICAS/MFD Indications



ELEC			HYD/ECS		FLT	
VOLTS	28.5	20.3	MAIN	3000	SPLR	0
EMER-V		31.6	B-ACUM	2000	PIT	0
AMPS	200	320	CAB ALT	1300	AIL	R 3
TEMP°C	30	73	OXY QTY	669	RUD	L 2

Figure 2 - EICAS/MFD Indications—Summary Page

Table 1 - EICAS/MFD Indications—Summary Page

Description	Symbol	Condition
DC bus voltage readout	 28.5 VOLTS EMER-V	DC bus voltage is in normal range
	 20.3 VOLTS EMER-V	DC bus voltage is in caution range (<22.1 volt or >29.4 volt)
	 31.6 VOLTS EMER-V	DC bus voltage is in warning range (<17.9 volt or >31.6 volt)
	 - - - VOLTS EMER-V	Invalid DC bus voltage data

Table 1 - EICAS/MFD Indications—Summary Page (Cont)

Description	Symbol	Condition
AMPS DC current readout	200 AMPS	AMPS DC current is in normal range (≤300 amp)
	320 AMPS	AMPS DC current is in caution range (>300 amp and ≤400 amp)
	460 AMPS	AMPS DC current is in warning range (>400 amp)
	--- AMPS	Invalid AMPS DC current data
Battery temperature readout	35 TEMP°C	Battery temperature is in normal range
	62 TEMP°C	Battery temperature is in caution range (>60°C and <70°C)
	73 TEMP°C	Battery temperature is in warning range (≥70°C)
	--- TEMP°C	Invalid battery temperature date

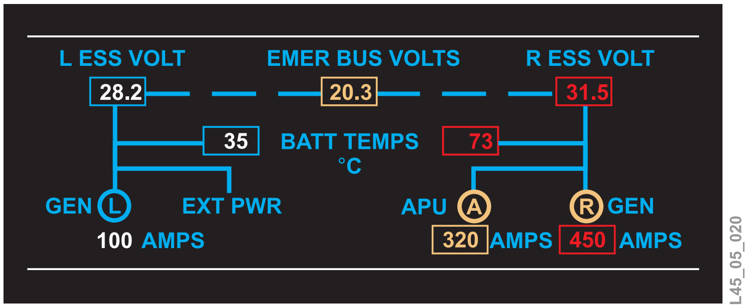


Figure 3 - EICAS/MFD Indications—Electrical Page

Table 2 - EICAS/MFD Indications—Electrical Page

Description	Symbol	Condition
AMPS DC current readout	205 AMPS	AMPS DC current is in normal range (≤300 amp)
	320 AMPS	AMPS DC current is in caution range (>300 amp and ≤400 amp)
	460 AMPS	AMPS DC current is in warning range (>400 amp)
	- - - AMPS	Invalid AMPS DC current data
DC generator symbol	Ⓛ Ⓡ Ⓐ	Generators normal operation
	Ⓛ Ⓡ Ⓐ	Respective generator failure
DC bus voltage readout	28.2 VOLT	DC bus voltage is in normal range
	20.3 VOLT	DC bus voltage is in caution range (<22.1 volt or >29.4 volt)
	31.7 VOLT	DC bus voltage is in warning range (<17.9 volt or >31.6 volt)
	- - - VOLT	Invalid DC bus voltage data

Table 2 - EICAS/MFD Indications—Electrical Page (Cont)

Description	Symbol	Condition
Battery temperature readout	35 °C	Battery temperature is in normal range
	62 °C	Battery temperature is in caution range (≥60°C and <70°C)
	73 °C	Battery temperature is in warning range (≥70°C)
	- - - °C	Invalid battery temperature data
External DC power	EXT PWR	External power is connected to the aircraft. No digital readout for external power DC current

RMU Indications

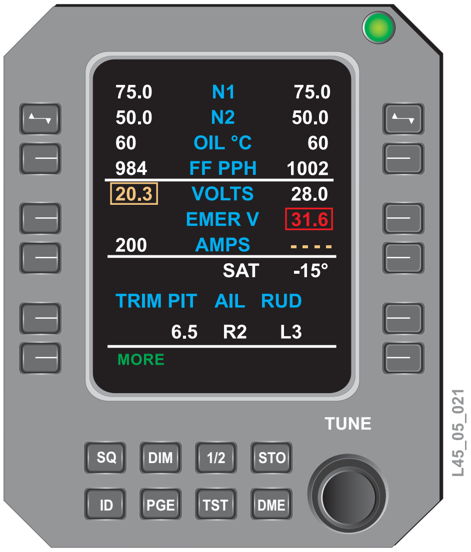
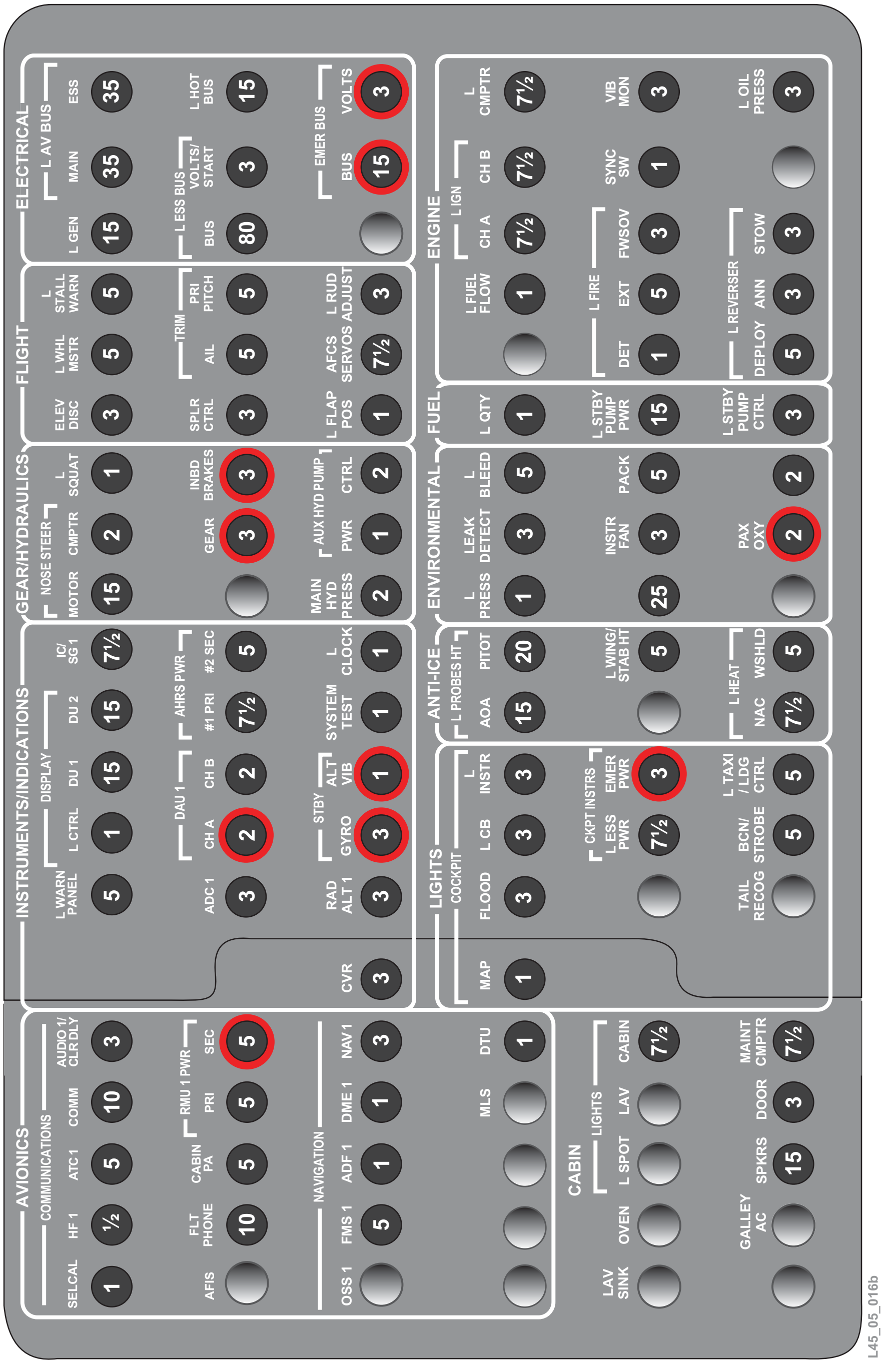


Figure 4 - RMU Indications

Table 3 - RMU Indications

Description	Symbol	Condition
DC bus voltage digital readout	28.0	DC bus voltage is in normal range
	20.3	DC bus voltage is in caution range (<22.1 volt or >29.4 volt)
	31.6	DC bus voltage is in warning range (<17.9 volt or >31.6 volt)
	- - - -	Invalid DC bus voltage data
AMPS DC current readout	200	AMPS DC current is in normal range (≤300 amp)
	320	AMPS DC current is in caution range (>300 amp and ≤400 amp)
	460	AMPS DC current is in warning range (>400 amp)
	- - - -	Invalid AMPS DC current data

Pilot Circuit Breaker Panel



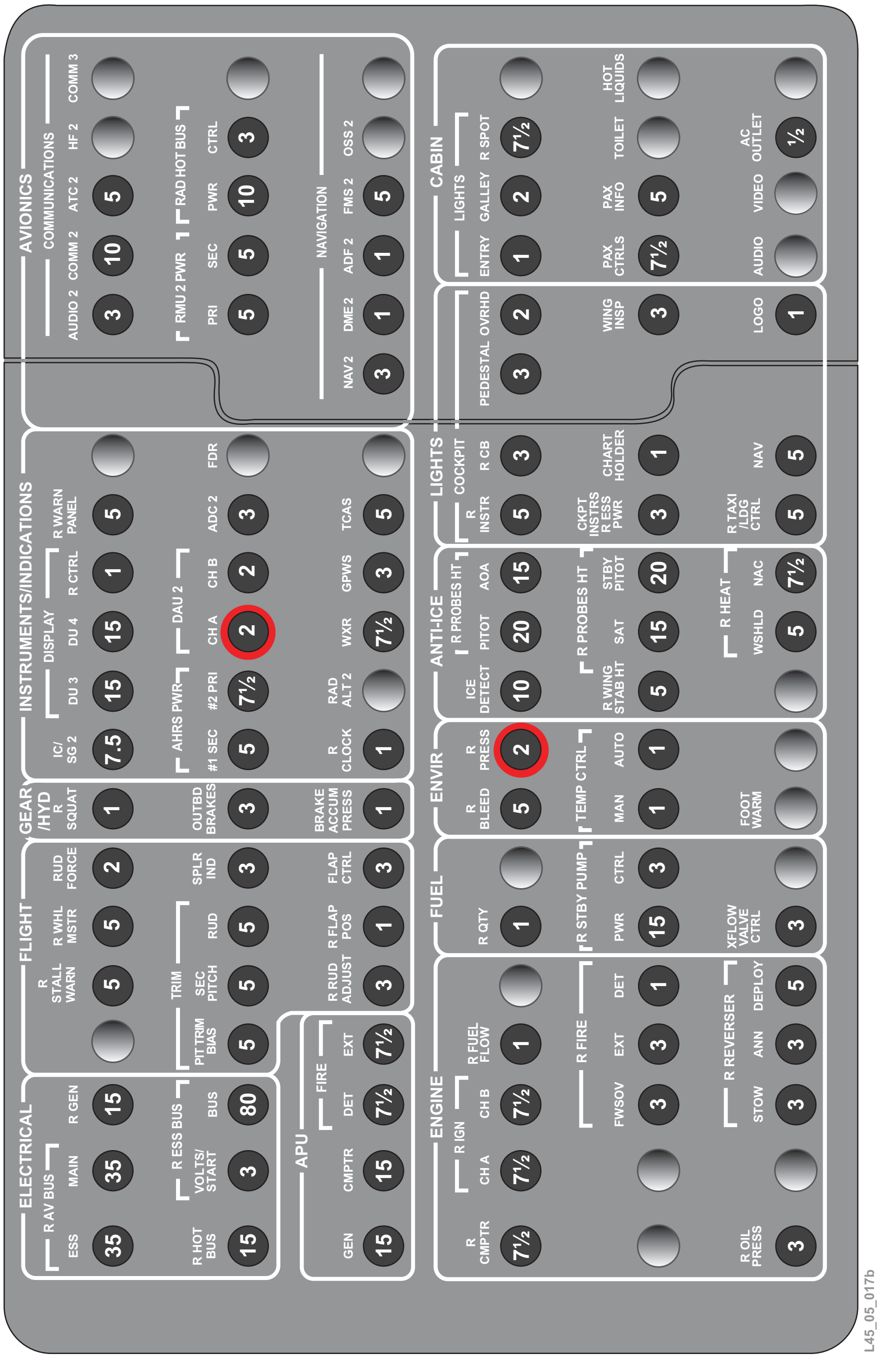
3 Denotes DC Circuit Breakers

2 Denotes DC Circuit Breakers on the Emergency Bus

● Denotes Unused Circuit Breaker Position

Figure 5 - Pilot Circuit Breaker Panel

Copilot Circuit Breaker Panel



3 Denotes DC Circuit Breakers

2 Denotes DC Circuit Breakers on the Emergency Bus

● Denotes Unused Circuit Breaker Position

Figure 6 - Copilot Circuit Breaker Panel

CAS Messages

Table 4 - CAS Messages and CWP Caption

CAS Message	CWP Caption	Conditions/Parameters
L BATT OVHT	L BATT OVHT	NICAD batteries only Respective battery internal temperature has exceeded 70°C
R BATT OVHT	R BATT OVHT	
L R GEN FAIL	GEN FAIL	Both engine-driven generators are offline. NON-ESS and MAIN buses are automatically deactivated in flight. MAIN buses can be selected ON if desired, but significantly reduce battery endurance GEN FAIL red CAS messages do not illuminate with a dual generator failure during ground operation. If the engine shuts down, the white ENG SHUTDOWN CAS message illuminates
L BATT OVHT		NICAD batteries only Respective battery internal temperature is ≥60°C
R BATT OVHT		
L R BATT OVHT		
EMER BATT LOW		Emergency battery is taking a charge in excess of 10 amp, and has not recovered from a previous discharge This CAS message is temporarily suppressed after an engine start
EMER BUS VOLTS		EMER bus voltage is <22 VDC or >29.6 VDC
L ESS BUS FAULT		Respective ESS bus contactor failed open on the ground
R ESS BUS FAULT		
L R ESS BUS FAULT		
L ESS BUS VOLTS		Respective ESS bus voltage is <22 VDC or >29.6 VDC. This CAS is temporarily suppressed during engine start
R ESS BUS VOLTS		
L R ESS BUS VOLTS		
L GEN AMPS HIGH		Respective generator output has exceeded 300 amps This CAS is temporarily suppressed after engine start
R GEN AMPS HIGH		
L R GEN AMPS HIGH		

Table 4 - CAS Messages and CWP Caption (Cont)

CAS Message	CWP Caption	Conditions/Parameters
L GEN FAIL		Respective generator is offline. The BUS-TIE automatically closes In flight, NON-ESS buses are not powered. NON-ESS buses can be selected ON, if desired. Also indicated as amber L or R symbols on the ELEC page
R GEN FAIL		
BUS TIE CLSD		BUS-TIE switch is closed (either automatically or manually). BUS-TIE switch illuminates with a white bar
BUS TIE MANUAL		Pilot manually selected the MAN position of the bus tie switch. Bus tie position changes and prevents automatic operation of the bus tie. MAN and a white bar (if generator buses are tied) on the switch illuminates Pressing the BUS-TIE switch a second time restores automatic control; MAN on the switch and BUS TIE MANUAL white CAS extinguish
L ESS BUS FAULT		Respective essential bus contactor failed open in flight
R ESS BUS FAULT		
L R ESS BUS FAULT		
EXTERNAL POWER		The external power source is connected to the aircraft (regardless of whether it is powering the aircraft) External power source is powered if the EXT PWR switch on the ELEC panel has a green AVAIL illuminated
	EMER BATT	Indicates that the emergency battery is discharging at a rate exceeding 1.0 amp

AC Electrical System

General

The AC power generation system provides AC electrical power to the aircraft for windshield heating.

AC electrical power is provided by two engine-driven alternators.

Components and Operation

The alternators are located on each engine accessory drive box, beside the starter/generator. The alternators are cooled by ram air in flight and integral fans during ground operation. Each alternator output is rated at 200 VAC and 5 KVA.

The output of the alternators is used only for windshield anti-ice and is discussed in Chapter 13 Ice Protection.

DC Electrical System

Description

The DC electrical system is powered by engine-driven generators, aircraft batteries, a ground power unit, or an APU (optional equipment).

It is a split, multiple-bus system interconnected by contactors, fuses, and circuit breakers, which automatically isolate a malfunctioning circuit. It is also possible to isolate a bus manually by pressing the switch indicators on the electrical control panel or by pulling the appropriate circuit breaker.

The split-bus electrical system has a left and right generator bus.

The generator buses supply power to the respective:

- Left and right essential buses
- Left and right main buses
- Left and right nonessential buses

Under normal flight conditions, the generator buses are split, increasing safety because any major electrical system fault only affects one side of the system.

Primary aircraft DC electrical power is provided by two engine-driven starter/generators. During normal operation, these generators supply 28 VDC power to the electrical system. An automatic electrical load-shedding system prevents generator overloading and prolongs battery duration during a single or dual generator failure.

With the loss of both generators, the main airplane batteries supply power to the essential bus, essential avionics bus, and hot bus components for a limited time. Once the batteries drop below the minimum operating voltage, an emergency battery operates selected essential equipment.

Components and Operation

The DC generation system (Fig. 7) consists of:

- Engine-driven starter/generators
- Generator control units
- Main batteries
- Electrical control panel
- External power receptacle
- APU generator
- Cockpit circuit breaker panels
- Aft circuit breaker panel

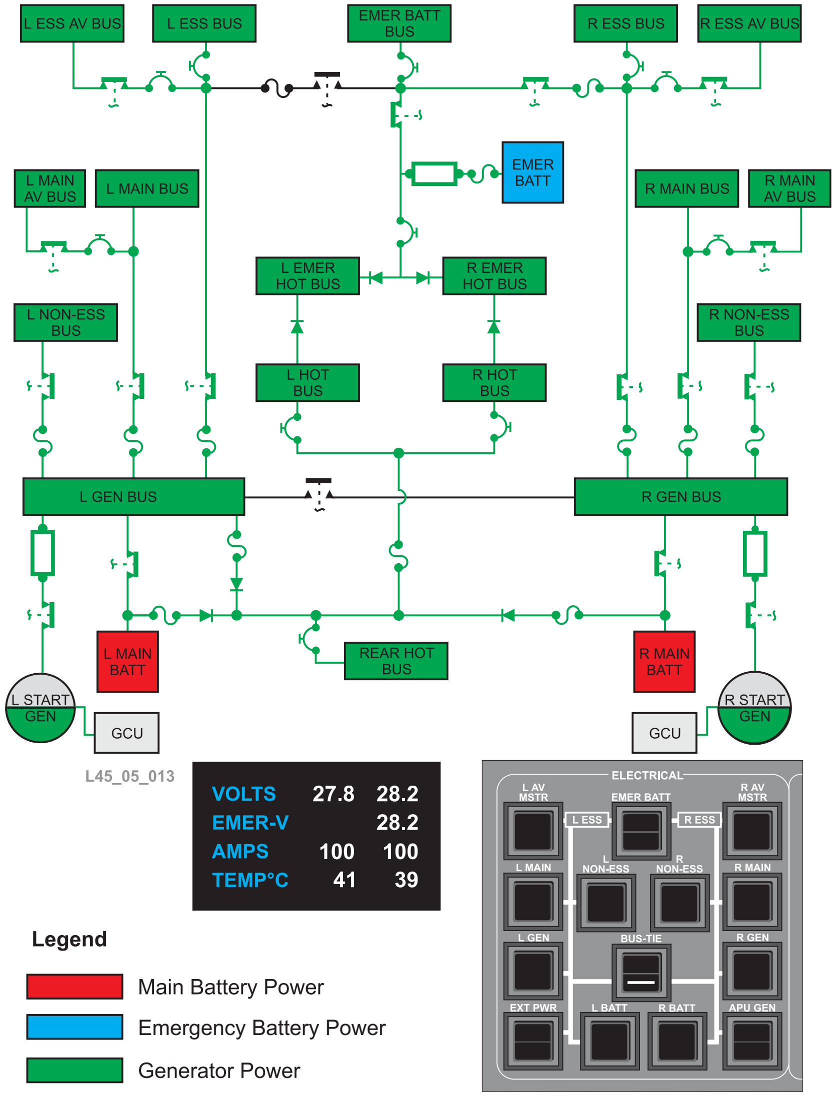


Figure 7 - Electrical System DC Generation—Normal Operation

Engine-Driven Starter/Generators

The starter/generators are brush-type DC units installed on each engine accessory section. Unless a GPU is powering the aircraft electrical system, the generator automatically comes online when the digital electronic engine control (DEEC) determines the engine is up to speed (approximately 95% of N_1 idle).

If a GPU is used for engine start, the generators automatically come online when the GPU is disconnected, if the engines are running. The generators also automatically come online when the EXT PWR switch indicator on the electrical control panel is depressed. This changes the annunciation from ON to AVAIL. The starter/generators turn the engines for starting and then supply 28-VDC power to the aircraft when the engines are at operating speed. Each starter/generator is rated at 30 VDC and 400 amp in a speed range of 6800 through 12,000 rpm.

The starter/generators are cooled by ram air in flight and integral fans during ground operation.

Generators Control Unit

Left and right generator control units (GCUs) monitor and control the engine-driven starter/generators. They are located in the aft power distribution panels. They regulate the voltage of the generators to approximately 28 volt and limit the output on the ground and for inflight cross-starting. The GCUs automatically disconnect the generators from the electrical system if a generator malfunction is detected.

If the generator fault was momentary or has cleared, generator operation may be restored by depressing the generator switch indicator once. If the fault has cleared, the field relay resets, allowing the generator to be energized and the line contactor to close. The field flashing relay and associated circuitry ensure that the generator can be built up from residual voltage without any other power source required. The GCUs also provide several engine starting functions.

GCU functions are as follows:

- Voltage regulation
- Generator current limiting
- Automatic starter cutoff
- Line contactor control
- Overvoltage protection
- Overspeed (runaway) protection
- Starter abort operation
- Undervoltage protection

Main Batteries

Battery power is supplied by two nickel-cadmium (NICAD) batteries (or two optional lead-acid batteries) located in the tailcone equipment section. The batteries are of sufficient capacity to accommodate the normal electrical requirements of the aircraft, including starting. Each battery contains two vents to expel the hydrogen gas from the battery during charging and discharging. The vents are cut at angles so that one vent takes air in and one vent expels the air.

The upper battery is connected to the left generator bus by depressing the L BATT switch indicator on the electrical control panel. The lower battery is connected to the right generator bus by depressing the R BATT switch indicator. A quick-disconnect is provided for use during battery removal and installation.

The battery contactors do not energize if the battery is in an unsafe condition (overtemperature or low voltage) and de-energize during a failed condition (overtemperature or low voltage). Two temperature switches and a thermistor installed in each battery warn the crew of a battery overheat condition (NICAD only). The thermistor monitors the battery system for battery temperature, and the temperature switches protect the battery system from overtemperature conditions. Battery temperature monitoring and overtemperature warning are also shown on the EICAS/MFD and CWP. The battery temperatures are displayed as follows:

- White—<140°F (60°C)
- Amber—140 to 160°F (60 to 70°C)
- Red—≥160°F (70°C)

If either battery temperature increases to 140°F (60°C), the 140°F (60°C) temperature switch closes and provides a signal to the applicable aft power distribution panel and an amber L or R BATT OVH CAS message is displayed. This signal must be absent to connect battery power to the aircraft.

If either battery temperature increases to 160°F (70°C), the 160°F (70°C) temperature switch closes and provides a signal to:

- Applicable aft power distribution panel to remove the applicable battery power from the aircraft
- Crew warning panel to illuminate the red L or R BATT OVHT annunciator
- Data acquisition system to display a red L or R BATT OVHT CAS message on the EICAS

The battery is protected from depletion with the aircraft on the ground. The battery contactors are controlled by voltage sensors to prevent battery discharge below 14 volt on load. If a battery is below 14 volt, the contactor does not close when the battery is selected ON. If the battery voltage drops below approximately 14 VDC for more than 10 seconds while on the ground, the battery contactor in the aft power distribution panel de-energizes and disconnects battery power from the aircraft. The depletion protection is disabled with the aircraft in the air.

Table 5 - Battery Duration

Main		Emergency	
Amp-hr	**Time[1],[2]**	**Amp-hr**	**Time[1]**
27 (NICAD) 28 (Lead-acid)	30 minutes	10 (Lead-acid)	1.0 hour
38 (NICAD)	1.0 hour	–	–

1. Time durations predicated upon operation on batteries only.
2. Time duration predicated upon the following conditions:
   - DU2—OFF
   - Standby pitot heat (R PROBES switch)—ON for no more than 30 minutes
   - L and R AV MSTR switches—OFF
   - EMER LIGHTS switch—ON for no more than 10 minutes
   - L and R MAIN switches—Remain OFF
   - L and R ENG CMPTR switches—MAN

External Power Receptacle

An external power receptacle, located on the left side of the tailcone, is available to connect an external electrical power source to the aircraft. The external power can provide power to aircraft systems when the engines are not operating, aid in engine starts, and to charge the aircraft batteries (Fig. 8).

Additional components in the external power system consist of a squat switch ground relay located in the aft relay panel and the antiflash external power contactor located in left aft power distribution panel.

When an external power source is connected to the aircraft, if it is of correct polarity and within acceptable voltage, the green AVAIL light is illuminated on the EXT PWR switch indicator on the left switch panel.

For external power to be connected to the aircraft, the voltage must be between 32.4 VDC and 24 VDC (±1.0) and the correct polarity must be sensed. If these conditions are met, the AVAIL caption illuminates on the EXT PWR switch indicator. Pressing this switch indicator closes the antiflash, bus tie, and nonessential contactors, and the EXT PWR switch indicator displays ON and the bus-tie bar is illuminated. Nonessential and generator bus bars become live, allowing operation of domestic services. Battery, generator, avionics, and main bus OFF indications are illuminated on the electrical panel. Emergency battery, essential, main, and avionics bus bars remain unpowered to prevent unnecessary component power-up.

NOTE

The generators cannot come online when a GPU is connected to the aircraft and external power switch is selected ON.

The Airplane Flight Manual (AFM) recommends that a GPU be used for engine starts when the ambient temperature is 32°F (0°C) or below.

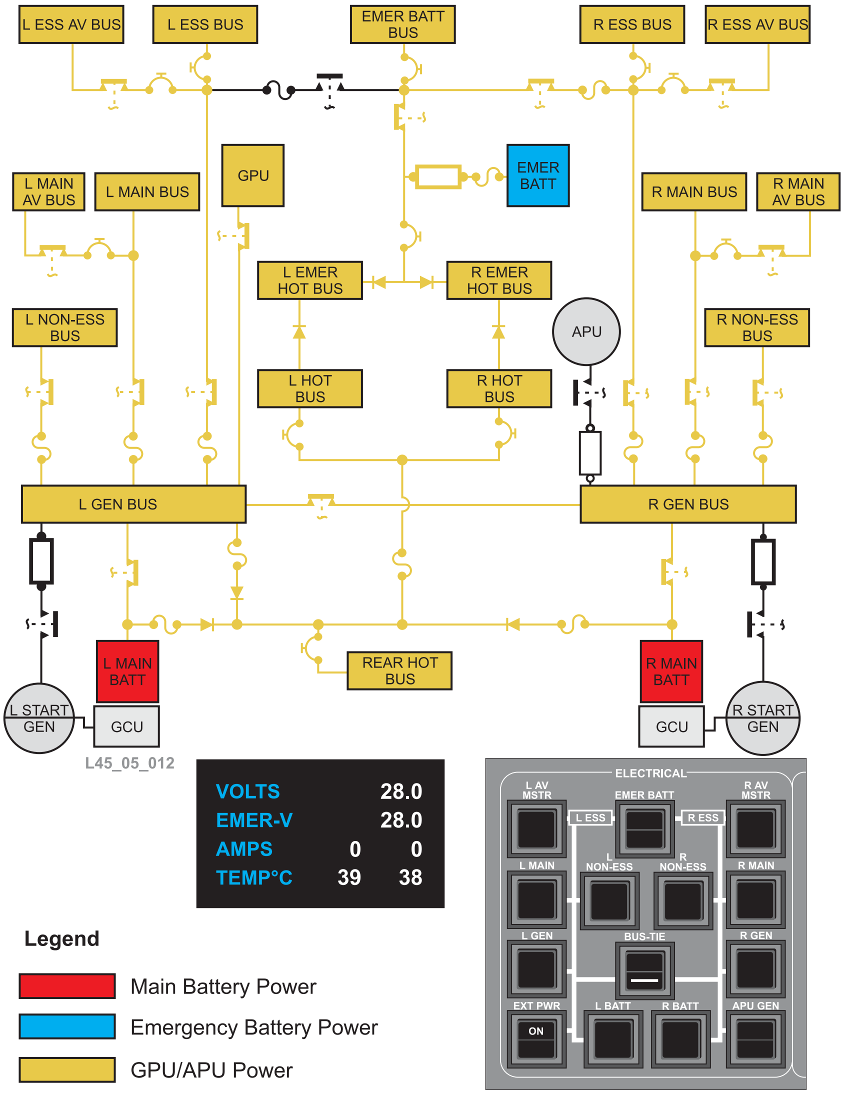


Figure 8 - External Power Distribution Schematic

APU Generator

The APU's primary function is to supply 28-VDC electrical power to the aircraft for ground operation only, including engine start. If the APU is operating with a GPU providing electrical power to the aircraft, the APU generator is kept offline. For additional information, refer to Chapter 5 Auxiliary Power Unit.

Cockpit Circuit Breaker Panels

The cockpit circuit breaker panels are located adjacent to each crewmember and contain circuit breakers needed to protect the aircraft from an electrical overload condition. The circuit breakers include those specified for individual systems and those used to supply power to electrical buses.

Aft Circuit Breaker Panel

The aft circuit breaker panel contains the circuit breakers to protect the aircraft from an electrical overload condition in various systems including pressure refueling, toilet servicing, and tailcone and baggage lights systems. The aft circuit breaker panel is mounted on a shelf in the left side of the tailcone.

Electrical Control Panel

The electrical control panel (Fig. 9) layout consists of an illuminated panel with 13 (or 14 when APU is fitted) switch indicators. All captions have white letters on a black background except for AVAIL, which is green on a black background. No switch indicator captions are illuminated during normal flight. For ease of cross-referencing, where electrical panel indications are repeated on EICAS or CWP, they are discussed below under the relevant electrical panel indicator description.

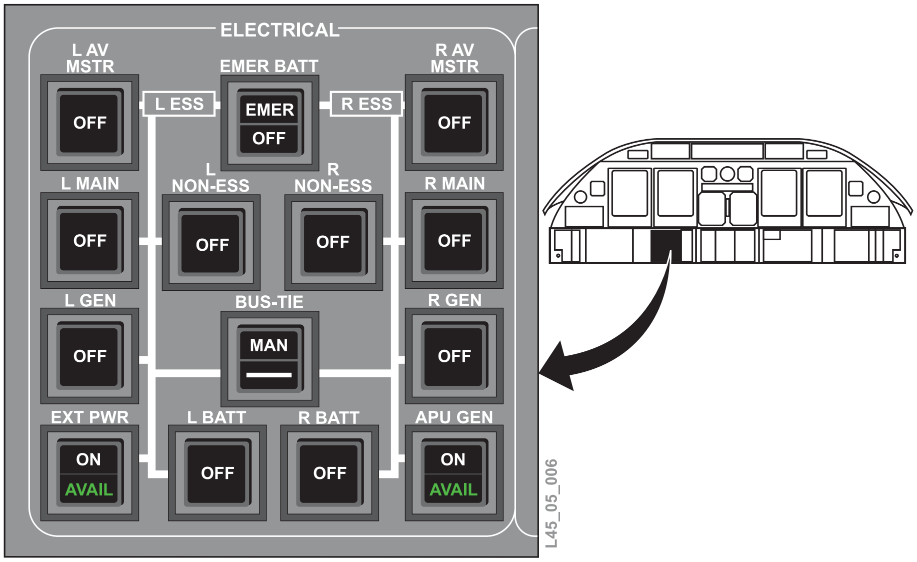


Figure 9 - Electrical Control Panel

Bus-Tie Switch Indicator

Automatic operation displays a horizontal bar when the generator bus bars are tied and no indication when the bus bars are split (normal condition). This indication is driven directly from the auxiliary contacts of the bus-tie contactor.

If required, this indicator may be pressed to manually override the existing state of the bus-tie contactor. The MAN (manual) caption is lit continuously to show that the automatic operation is disabled and the contactor is held in this position until reselected by pilot action. EICAS also provides a white BUS TIE CLSD CAS message when the BUS-TIE switch is closed (either automatically or manually). The BUS-TIE switch illuminates with a white bar and a white BUS TIE MANUAL CAS message when the pilot has manually selected the MAN position of the BUS-TIE switch. When a manual tie is selected, the contactor does not close unless both generator bus bars are indicating >20 volt at the time of the manual tie selection (to prevent tying a good generating side to a faulty generating side).

Emergency Battery Switch Indicator

The bottom of this alternate action switch indicator displays OFF when manually selected to OFF (i.e., emergency contactor de-energized). The top of the switch indicator displays EMER when the emergency battery is discharging at >1.0 amp. A white EMER BATT indicator on the CWP also illuminates in parallel with the EMER switch indicator illumination.

Battery Switch Indicator

This momentary action switch indicator is normally selected manually to connect and disconnect the main battery. The EICAS displays battery temperature information on the electrical page and provides an amber L or R BATT OVHT CAS overheat warning at 60°C via an internal battery thermistor. At 70°C, the battery contactor is automatically de-energized via a signal from an internal thermostat and the EICAS L/R BATT OVHT message changes to red and a red CWP L or R BATT OVHT indication appears. The battery switch indicator illuminates OFF. The battery may be regained manually when its temperature falls below 60°C.

Generator Switch Indicator

This is a momentary action switch indicator. Normal generator operation is automatic, and the OFF indication changes with the status of the generator. The pilot may override the automatic operation and select it offline by pressing the generator switch indicator. Reselection of this switch (to online condition) also incorporates a reset signal to the GCU.

If a generator trips offline, the switch displays OFF and the EICAS displays an amber L or R GEN FAIL CAS message. This indicates that the switch indicator should be pressed once to attempt a reset. If unsuccessful, the indicator again illuminates OFF. If both generators fail, the EICAS displays a red LR GEN FAIL CAS message and the CWP illuminates a red GEN FAIL.

Nonessential/ Main Bus Switch Indicators

These momentary action switch indicators are only pressed if the crew must override the automatic operation of these bus bars during generator failures. The OFF indication changes automatically with its relevant contactor status. Selection of the switch in normal operation, both generators online, isolates the appropriate bus bar and displays OFF. Reselection resumes normal operation.

External Power Switch Indicator

This momentary action switch indicator illuminates AVAIL only when a supply of correct polarity and acceptable voltage is provided at the external power connector. When pressed to provide external power to the aircraft, the AVAIL extinguishes and ON is illuminated. If the switch is again pressed, ON is extinguished and AVAIL is illuminated. EICAS displays a white EXTERNAL POWER message when the external power voltage is 5 volt or greater. If the GPU is connected to the aircraft but powered off, the EXTERNAL POWER CAS message will not be present.

Avionics Master Switch Indicator

The alternate-action avionic master switch indicators allow connection and disconnection of both main and essential avionics bus bars by manual selection.

APU GEN Switch Indicator

This momentary-action switch illuminates AVAIL only when the APU generator is in generating mode and ready to be connected to the aircraft electrical system. When pressed, the AVAIL caption extinguishes and the white ON is illuminated. If the switch is depressed again, ON is extinguished and AVAIL is reilluminated until the APU falls below 92% normal running rpm.

DC Power Distribution

Description

The DC power distribution system distributes, monitors, and controls DC electrical power in the aircraft. The system controls electrical power from the engine-driven generators, main aircraft batteries, emergency battery, external power receptacle, and, when installed, auxiliary power unit generator.

Components and Operation

The DC power distribution (Fig. 10) consists of:

- L and R generator buses
- L and R essential buses
- L and R main buses
- L and R nonessential buses
- L and R essential avionics buses
- L and R main avionics buses
- L, R, and rear hot buses
- L and R emergency hot buses
- Emergency battery bus
- Bus tie

Generator Buses

The generator buses normally receive power from their respective generators and are the main distribution points for electrical power. Generator buses can also receive power from the opposite generator and/or from the batteries, the APU, and the GPU.

Essential Buses

The essential buses are normally supplied electrical power when the essential bus contactors in the aft power distribution panels are energized. During an engine start, the left and right isolation contactors in the forward power distribution panels are energized to provide power to the essential buses.

The essential bus contactors are automatically energized when the main battery contactor on the same side is energized, the line contactor on the same side is energized, or the opposite line contactor and the bus-tie contactor are energized. The essential bus contactors are automatically de-energized during a start sequence and re-energized after the start sequence ends as long as one of the above conditions still exist. The left and right isolation contactors are automatically energized during a start sequence to power the essential buses. The essential buses are electrically tied through the isolation contactors in the forward power distribution panels. The isolation contactors are energized when only one essential bus contactor is energized and a line contactor is energized. There is no manual override to control the essential bus contactors.

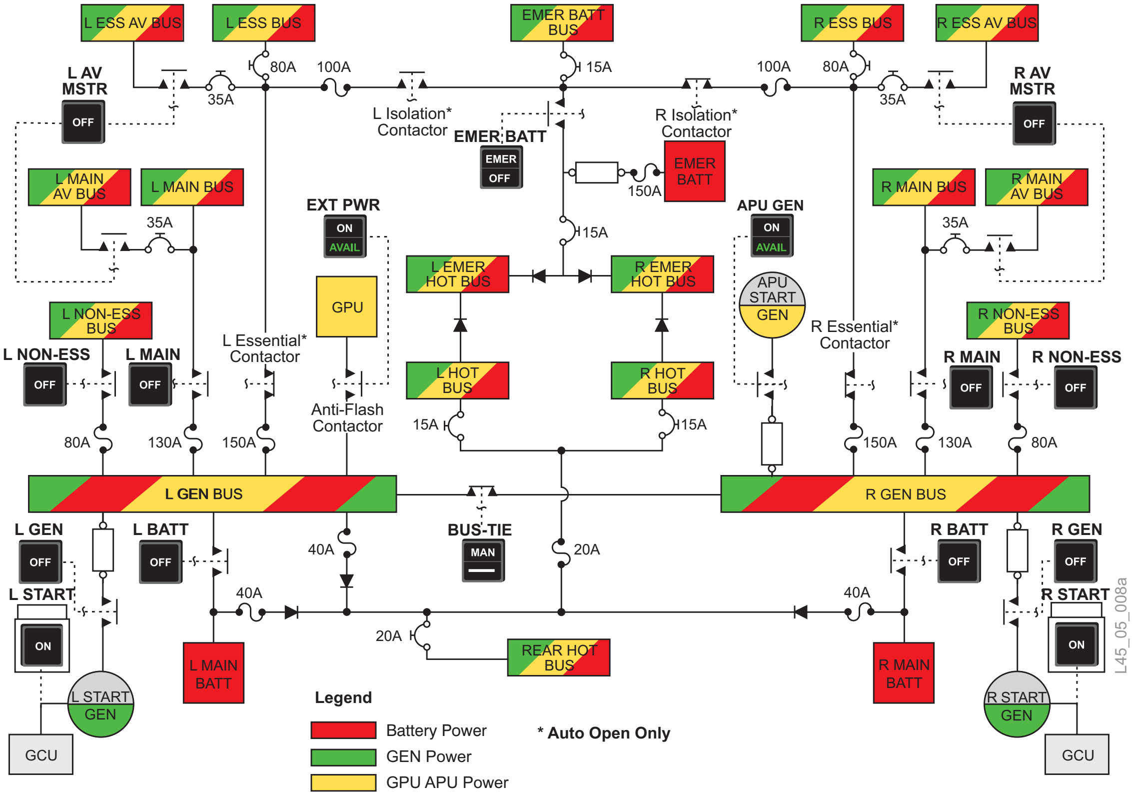


Figure 10 - DC Power Distribution Schematic

Main Buses

The main buses are supplied electrical power when the main bus contactors in the aft power distribution panel are energized. The main bus contactor is automatically energized when:

- Main battery contactor on the same side is energized with the aircraft on the ground
- Line contactor on the same side is energized
- Opposite side line contactor and the bus-tie contactor is energized

An energized main bus contactor may be manually de-energized using the main bus switch indicator. Depressing the main bus switch indicator again energizes the main bus contactor.

The main bus contactor may be manually energized using the main bus switch indicator only when both line contactors are de-energized in flight and the battery contactor on the same side is energized. When the aircraft is returned to a condition where the main bus contactor is normally energized, manual control of the contactor resets to automatic control. A manually energized main bus contactor is automatically de-energized during a start sequence. The main bus switch indicator OFF annunciator illuminates when the applicable main bus contactor is de-energized.

Nonessential Buses

The nonessential buses are supplied electrical power when the nonessential bus contactors in the aft power distribution panels are energized. The nonessential bus contactors are automatically energized when the antiflash contactor is energized (external electrical power being provided to the aircraft), one line contactor energized with aircraft on the ground, or both line contactors energized with aircraft in flight.

On aircraft with an auxiliary power unit (APU) installed, the nonessential bus contactors are also automatically energized when the APU contactor is energized. An energized nonessential bus contactor may be manually de-energized using the nonessential bus switch indicator. Depressing the nonessential bus switch indicator again energizes the nonessential bus contactor. Should the antiflash contactor de-energize with the nonessential bus contactor manually de-energized, the nonessential bus contactor returns to automatic control.

The nonessential bus contactors may be manually energized using the nonessential bus switch indicator only when a single line contactor is energized in flight. When the aircraft is returned to a condition where the nonessential bus contactor would normally be energized, manual control of the contactor resets to automatic control. The nonessential bus contactors are automatically de-energized during a start sequence unless the antiflash contactor is energized. The nonessential bus switch indicator OFF annunciator illuminates when the applicable nonessential bus contactor is de-energized

Essential Avionics Buses

The essential avionics buses are supplied electrical power when the essential avionics bus contactors in the forward power distribution panel are energized.

The essential avionics bus contactors are energized and de-energized using the avionics master switch indicator. If the essential and main avionics bus contactors on either side are simultaneously de-energized, the applicable avionics master switch indicator OFF annunciators illuminate.

The applicable ESS AV BUS circuit breaker must be closed to power the bus.

Main Avionics Buses

The main avionics buses are supplied electrical power when the main avionics bus contactors in the forward power distribution panel are energized. The main avionics bus contactor is energized and de-energized using the avionics master switch indicator. If the essential and main avionics bus contactors on either side are simultaneously de-energized, the applicable avionics master switch indicator OFF annunciators illuminate. The applicable MAIN AV BUS circuit breaker must be closed to power the bus. The main avionics bus contactor is automatically de-energized during a start sequence.

Hot Buses

The rear hot bus is located in the aft circuit breaker panel in the tailcone. The left and right hot buses are located in their respective cockpit circuit breaker panel. The hot buses are supplied electrical power from the main batteries.

L and R Emergency Hot Buses

The emergency hot buses, located in their respective cockpit circuit breaker panel, are supplied electrical power from the main batteries and emergency battery. The left and right fire extinguishers and the left and right firewall shutoff valves (FWSOVs) receive power through the left and right emergency hot buses respectively. On aircraft with an APU installed, the APU fire extinguisher receives power from the right emergency hot bus.

Emergency Battery Bus

The emergency battery bus is located in the pilot circuit breaker panel. The emergency battery bus is supplied electrical power by the emergency battery when the emergency battery contactor in the left forward power distribution panel is energized or by the right essential bus when the right isolation contactor in the right forward power distribution panel is energized. The emergency battery contactor is energized using the emergency battery switch indicator.

The right isolation contactor is energized by any of the following:

- Right line contactor and right essential bus contactor are energized
- Left line contactor, bus-tie contactor, and right essential bus contactor are energized
- Antiflash contactor, bus tie, and right essential bus contactor are energized

On aircraft with an APU installed, the right isolation contactor is also energized when the right essential bus contactor and APU contactor are energized.

Bus Tie

The bus-tie circuit may be used to electrically connect the generator buses in the aft power distribution panels. The bus-tie circuit is operable when the bus-tie contactor in the left aft power distribution panel is closed (bar in switch shows).

The bus-tie contactor is normally controlled automatically but may also be operated manually.

The bus-tie contactor is automatically closed when the antiflash contactor is closed, an engine is being started, or only one line contactor or APU line contactor is closed with both generator buses >20 VDC.

A closed bus-tie contactor may be manually opened using the bus-tie switch indicator. Depressing the bus-tie switch indicator again closes the bus-tie contactor. Should the antiflash contactor be closed, the bus-tie switch indicator does not open the bus-tie contactor.

An open bus-tie contactor may be manually closed using the bus-tie switch indicator. Depressing the bus-tie switch indicator again opens the bus-tie contactor and the contactor returns to automatic control. Both generator buses must be >20 VDC to close the bus-tie contactor.

The bus-tie switch indicator is blank when the bus-tie contactor is open. The bus-tie switch indicator MAN annunciator illuminates when the bus-tie contactor is manually opened or closed. Sensor circuits may not allow manual operation in some cases.

Emergency Power Supply System

Description

The emergency power supply system provides electrical power to essential components during a dual generator power failure or to the essential bus during engine starting. The emergency power supply system consists of an emergency battery located in the nose compartment. The emergency battery may be charged from the R GEN bus or a ground power unit.

Components and Operation

The emergency battery is located in the nose section of the aircraft. The emergency battery provides electrical power to standby equipment and to certain equipment that must remain powered during engine start (Fig. 11).

The emergency battery switch indicator controls the emergency battery contactor. It has the following positions:

- NORMAL—EMER BATT switch indicator is selected ON and is not illuminated. The emergency battery contactor closes, and the DC electrical system is operating normally. The right isolation contactor closes, connecting the emergency battery to the R GEN bus. The emergency battery is now being charged by the R GEN bus
- OFF—EMER BATT switch indicator is selected OFF and the OFF portion of the switch indicator is illuminated. The emergency battery disconnects from the EMER BATT bus and R GEN bus and is still connected to the L and R EMER HOT buses. The emergency battery is isolated, neither charging nor discharging
- EMER—The top of the switch indicator displays EMER only when the emergency battery is discharging at >1.0 amp. This indicates that the left and right isolation contactors are open (dual generator failure), and the emergency battery powers the EMER BATT bus and the L and R EMER BATT HOT buses. A white EMER BATT indicator on the CWP also illuminates in parallel with EMER switch indicator illumination

The emergency battery electrical discharge and recharge power is monitored by the left forward power distribution panel.

- If battery power discharge is >1.0 (±0.3) amp, the power distribution panel provides a signal to the emergency battery EMER switch indicator, and crew warning panel EMER BATT annunciator
- If the emergency battery recharge power is >10 (±2) amp, the power distribution panel provides a signal to the data acquisition system. This creates an amber EMER BATT LOW CAS message on the EICAS to indicate that the battery is not fully charged

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Monitoring

The emergency battery is protected from depletion with the aircraft on the ground. If the emergency battery is discharged below approximately 14 VDC, the emergency battery contactor in the left forward power distribution panel de-energizes and disconnects emergency battery power from the aircraft. The depletion protection is disabled with the aircraft in the air. For emergency battery duration, refer to Table 5 on page 16.

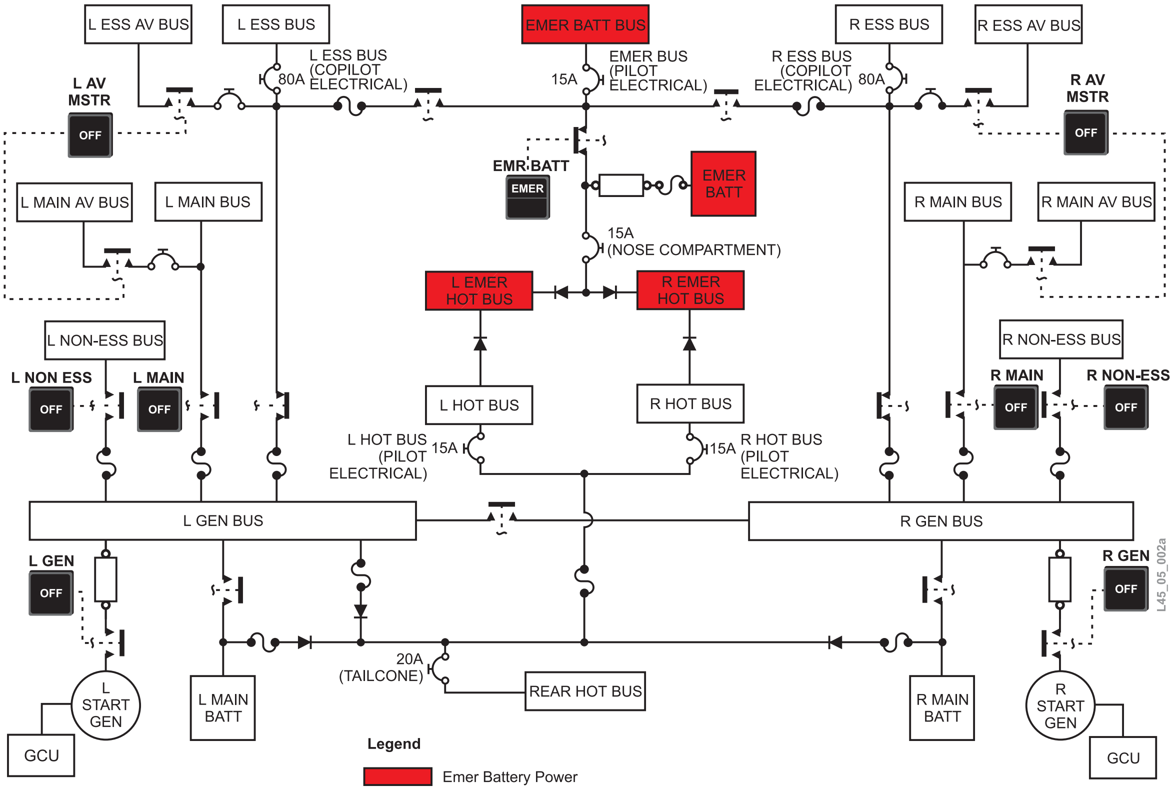

Figure 11 - Emergency Power Supply Distribution Schematic

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EMERGENCY EQUIPMENT AND OXYGEN

Introduction

The Learjet 40/45 aircraft is equipped with the following emergency equipment:

- Smoke goggles
- Fire fighting equipment (portable extinguishers)
- Life vests
- Flashlights
- First aid kits

Individual aircraft may have additional equipment.

An emergency locator transmitter (ELT) automatically or manually transmits distress signals.

The oxygen system supplies oxygen to the flight crew and passengers during emergency conditions.

Emergency Locator Transmitter

An optional emergency locator transmitter (ELT) may be installed which transmits distress signals assisting rescue personnel in locating a downed aircraft. Several different installations are offered.

This manual discusses the Dorne & Margolin ELT14 system.

Description

The emergency locator radio transmits distress signals on one or more internationally recognized emergency frequencies (depending on the model installed). The system automatically activates under emergency conditions (“g” switch) or may be manually activated with a cockpit-mounted switch. The system consists of a transmitter, antenna, and remote control and monitor unit.

Controls and Indications

Figure 1 - Dorne & Margolin ELT14

1 Status Light (ON)

- Illuminated continuously—Indicates the ELT is transmitting
- Flashing slowly (80 times per minute)—Indicates the ELT transmitter is switched off or the transmitter battery needs replacement
- Flashing quickly (5 times per second)—Indicates the remote control/monitor unit coin cell needs replacement
- Extinguished—Indicates the ELT is armed

2 ON/ARM/RESET Switch

- ON—Manually activates the ELT transmitter to transmit distress signals
- ARM—ELT transmitter automatically activates and transmits distress signals if the aircraft stops abruptly
- RESET (optional)—Deactivates the ELT transmitter and returns it to an armed status

Components and Operation

Transmitter and Antenna

The transmitter and antenna are installed in the aircraft tail section. Power for the transmitter is provided by an internal battery pack. The transmitter incorporates a three-position switch (ARM/OFF/ON). Access to the transmitter is through an access cover placarded ELT LOCATED HERE. The antenna is externally mounted and connects to the transmitter with antenna cable.

Transmitter Switch (ARM/OFF/ON)

Because of its location, this switch is not generally used by the crew. In the OFF position, the transmitter does not transmit distress signals. This position is normally used while servicing the aircraft. In the ON position, distress signals are transmitted continuously. In the ARM position, the transmitter automatically activates if the aircraft stops abruptly. The switch should be in the ARM position for flight.

Remote Control and Monitor Unit

The remote control and monitor unit is installed in the cockpit. Power for this unit is provided by an internal coin cell. A three-position ON/ARM/RESET switch provides the remote control for the ELT transmitter. A red LED, mounted in the end of the switch handle, provides the crew with the ELT status.

Emergency Equipment

Description

The Learjet 40/45 aircraft is equipped with safety equipment that is essential to the safety of the passengers and crew for different emergencies.

Cockpit Emergency Equipment

The cockpit is equipped with:

- Portable fire extinguishers
- Flashlights
- Life vests
- Smoke goggles
- First aid kit

Passenger Cabin Emergency Equipment

The passenger cabin is equipped with:

- Portable fire extinguisher
- Crash ax
- Life vests
- Portable breathing equipment

NOTE **The above equipment represents the basic equipment supplied by Learjet. The exact location and type of the emergency equipment on each aircraft may vary.**

Components and Operation

Smoke Goggles

Smoke goggles are provided for each crewmember and are stowed in a lower sidewall storage compartment. The goggles must be donned should smoke or fumes be present in the aircraft. Refer to the AFM for the specific procedures.

Portable Fire Extinguishers

Halon 1211 fire extinguishers (Fig. 2 - ?) are installed for cockpit and cabin fire protection. The fire extinguishers are capable of fighting Class A, B or C fires. One fire extinguisher is mounted on the front of each crew seat. A third fire extinguisher may be installed in the cabin next to the lavatory.

The extinguishers use a pressure gauge that indicates the state of propellant charge. This gauge should be checked prior to every flight. If properly charged, the indicator needle is within the green segment.

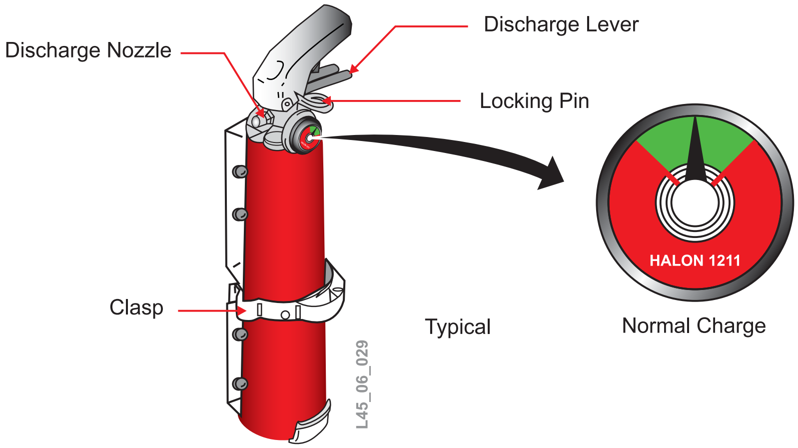


Figure 2 - Portable Fire Extinguisher

Life Vests

Life vests (Fig. 3 - ?) are stowed in a pocket in the crewmember's seat back and in a compartment under each passenger seat. The life vests are inflated by pulling the red CO2 release tabs.

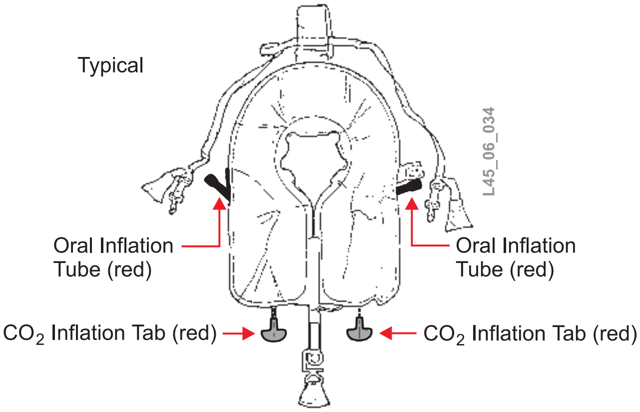


Figure 3 - Life Vest

Crash Ax

A crash ax is located at the rear of the cabin in the lavatory area for use by the crew or the passengers should it be required during an emergency evacuation.

Flashlights

Flashlights are located behind each crewmember seat. The pilot's flashlight is secured to a bracket mounted to the forward side of the forward left storage cabinet. The copilot's flashlight is secured to a bracket mounted to the forward side of the forward right storage cabinet.

First Aid Kits

The aircraft is initially equipped with one medical first aid kit. The first aid kit is located in a placarded position behind the pilot.

Protective Breathing Equipment (Optional)

Protective breathing equipment (PBE) is available for a crewmember to use in fighting cabin fires. The PBE is designed to protect the user's eyes and respiratory system from the harmful atmosphere that may be generated by a cabin fire. The PBE is a hood with a visor that is placed over the head; the hood seals around the neck. An oxygen-generating canister provides breathing oxygen for the user. The PBE is vacuum-sealed in a bag and stored in a box accessible to the crew. The PBE is a throwaway unit that must be replaced whenever the vacuum seal has been broken. It is imperative that the vacuum seal be maintained since the oxygen-generating chemicals react with moisture.

Duration of oxygen production is nominally 15 minutes depending upon the work rate and size of the user. Useful life of a sealed PBE is 10 years from the date of manufacture.

Oxygen System

Description

The Learjet 40/45 oxygen system (Fig. 4 - ? and Fig. 5 - ?) provides oxygen for the crew and passengers. Oxygen is available to the crew at all times and can be made available to the passengers either automatically above 14,500 (±250) ft cabin altitude, or manually at all altitudes through the use of the cockpit controls.

Smoking is prohibited when oxygen is in use.

Components

The system consists of a high-pressure oxygen storage system, a pressure regulating system, and a crew and passenger distribution system.

Oxygen Storage Cylinder

One oxygen storage cylinder is located in the aircraft. The standard oxygen storage cylinder is charged to 1850 psi at 70°F (21°C). The shutoff and pressure regulator assembly forms an integral part of the storage cylinder and provides for pressure regulation, pressure indication, and servicing. Under normal conditions, the shutoff valve will be left in the OPEN position.

Three bottle capacities are available. The standard 22-ft3 bottle is located in the nose section. An optional 40-ft3 or 77-ft3 bottle can be located in the passenger compartment.

The oxygen quantity of the cylinder is indicated on the EICAS Summary system page and the ECS system page.

During cockpit preflight, ensure that the system is activated by checking to see that the amber OXYGEN OFF CAS message is not displayed. If the shutoff valve is left in the closed position, the oxygen quantity can still be read on the EICAS oxygen quantity display.

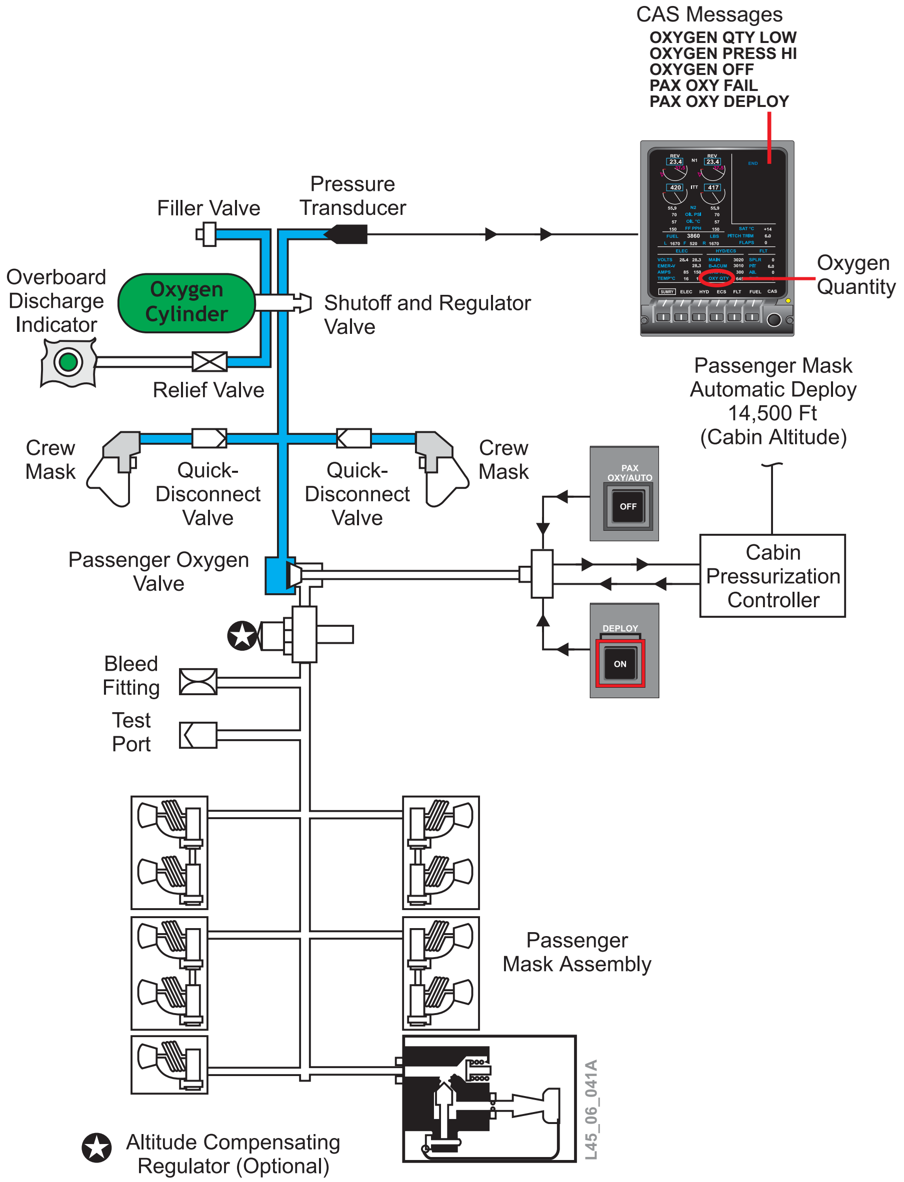


Figure 4 - Learjet 45 Oxygen System

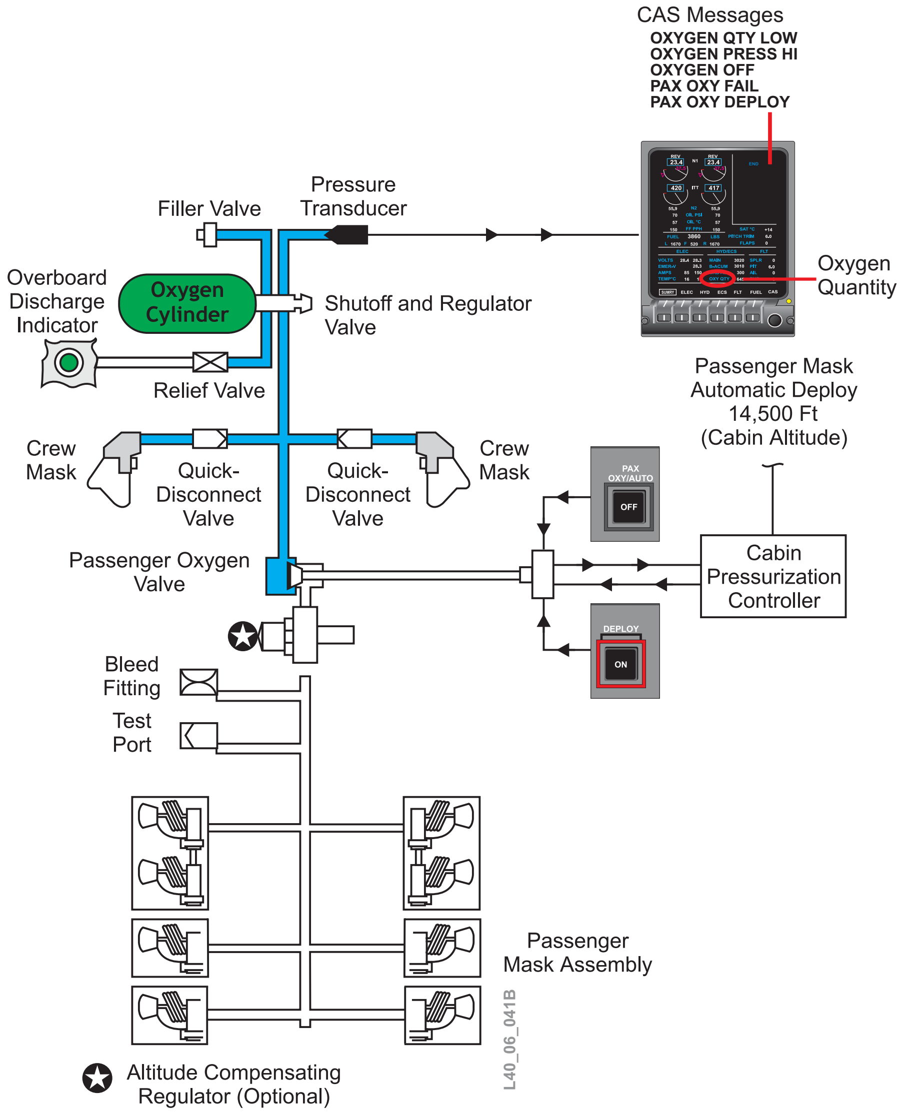


Figure 5 - Learjet 40 Oxygen System

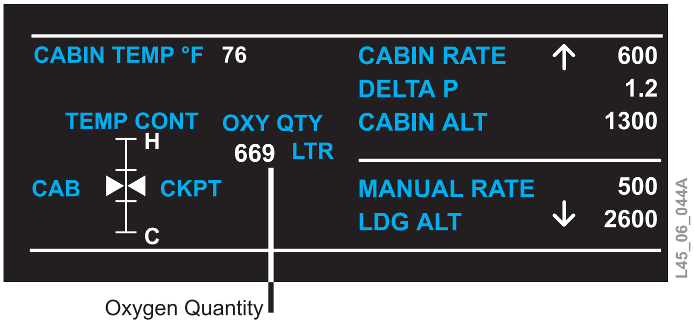
Oxygen Discharge Indicator

The shutoff and pressure regulator assembly incorporates a burst disc pressure relief valve (Fig. 6 - ?). This valve discharges the oxygen cylinder contents overboard if cylinder pressure reaches 2500 to 2775 psi.

Should the cylinder contents be discharged overboard, the green overboard discharge indicator on the outside surface of the aircraft near the storage cylinder ruptures or dislodges and the EICAS quantity display indicates amber dashes.

Figure 6 - Oxygen Overboard Discharge Indicator

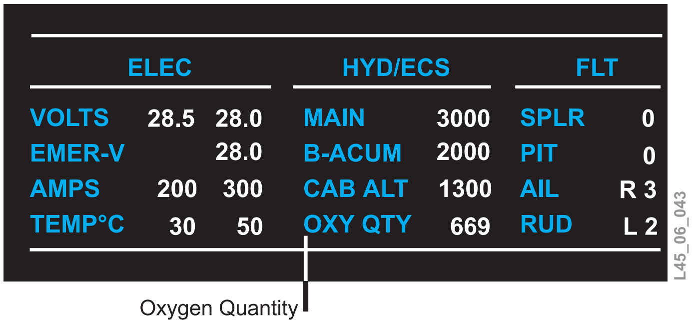
EICAS/MFD Environmental Control System Page



CABIN TEMP °F 76
TEMP CONT
H
CAB CKPT
C
OXY QTY
669 LTR
CABIN RATE ↑ 600
DELTA P 1.2
CABIN ALT 1300
MANUAL RATE 500
LDG ALT ↓ 2600

Figure 7 - EICAS/MFD ECS System Page

EICAS/MFD System Summary Page



ELEC			HYD/ECS		FLT	
VOLTS	28.5	28.0	MAIN	3000	SPLR	0
EMER-V		28.0	B-ACUM	2000	PIT	0
AMPS	200	300	CAB ALT	1300	AIL	R 3
TEMP°C	30	50	OXY QTY	669	RUD	L 2

Figure 8 - EICAS/MFD System Summary Page

Table 1 - EICAS/MFD ECS and System Summary Page

Description	Symbol	Condition
Oxygen Quantity Digital Readout	669	Oxygen quantity greater or equal to 554 liters
	400	Oxygen quantity less than 554 liters
	----	Invalid oxygen quantity data

Oxygen Quantity Low Trip Points

Table 2 - OXYGEN QTY LOW Trip Points

Configuration and Aircraft Type	OXY QTY LOW (liters)
22 ft^3 without regulator (Learjet 45 aircraft)	552
22 ft^3 with regulator (Learjet 45 aircraft)	410
40 ft^3 with regulator (Learjet 45 aircraft)	450
77 ft^3 with regulator (Learjet 45 aircraft)	540
22 ft^3 with regulator (Learjet 40 aircraft)	370
40 ft^3 with regulator (Learjet 40 aircraft)	410
77 ft^3 with regulator (Learjet 40 aircraft)	500

CAS Messages

Table 3 - Oxygen CAS Messages

CAS Message	Conditions/Parameters
OXYGEN OFF	Oxygen line pressure is low or the bottle is off
PAX OXY FAIL	Electric deploy valve has failed and may not allow automatic or manual oxygen mask deployment
OXY PRESS HI	Oxygen bottle is overserviced
OXYGEN QTY LOW	Oxygen quantity low
PAX OXY DEPLOY	Passenger masks have been manually or automatically commanded to deploy

Oxygen Duration

Prior to extended flight, plan oxygen requirements to provide sufficient oxygen for all occupants during a pressurization failure. Additional oxygen may be required to assure that both oxygen duration and range (fuel) requirements are satisfied. Refer to AFM Section IV (oxygen duration chart) for further details.

NOTE **Crew and passenger masks are not approved for use above 40,000 ft cabin altitude.**

Passenger Oxygen System Description

Oxygen flow is provided from the same storage cylinder as the crew oxygen and is initiated automatically through the cabin pressure controller or manually through the copilot PAX OXYGEN panel.

The passenger oxygen system consists of the passenger oxygen control valve, seven storage compartments, lanyard actuator valves, and nine passenger masks.

Passenger Oxygen Valve

The passenger oxygen valve controls oxygen availability to the passenger oxygen distribution system and provides for automatic or manual mode selection. The oxygen system cockpit controls consist of the PAX OXY/AUTO switch indicator and the DEPLOY switch indicator.

When the passenger oxygen valve is activated (automatically or manually), a white PAX OXY DEPLOY CAS message appears. If a failure of the passenger oxygen valve is detected, an amber PAX OXY FAIL CAS message appears.

Passenger Oxygen Mask Operation

Oxygen Mask Storage Compartments

The oxygen storage compartments are stowed in the headliner above the passenger seats. Each oxygen mask storage compartment consists of a door, one or two oxygen masks, and a lanyard for each mask. Each compartment door is latched and is opened when the passenger oxygen is activated automatically or manually. Oxygen pressure actuates the door actuators, forcing the doors open, allowing the passenger oxygen masks to drop.

The passenger oxygen masks (Fig. 9 - ?) consist of a soft silicone rubber facepiece with a reservoir air bag. The reservoir bag incorporates a green-colored chamber which inflates when oxygen is flowing to the mask.

Whenever the oxygen masks drop, passengers should don masks and pull the mask lanyard to initiate oxygen flow. The masks provide a constant flow of oxygen to the passenger. The mask must be placed over the nose and mouth; it is maintained in place with elastic straps around the head.

NOTE **Prolonged operation of passenger masks above 25,000 ft cabin altitude is not recommended.**

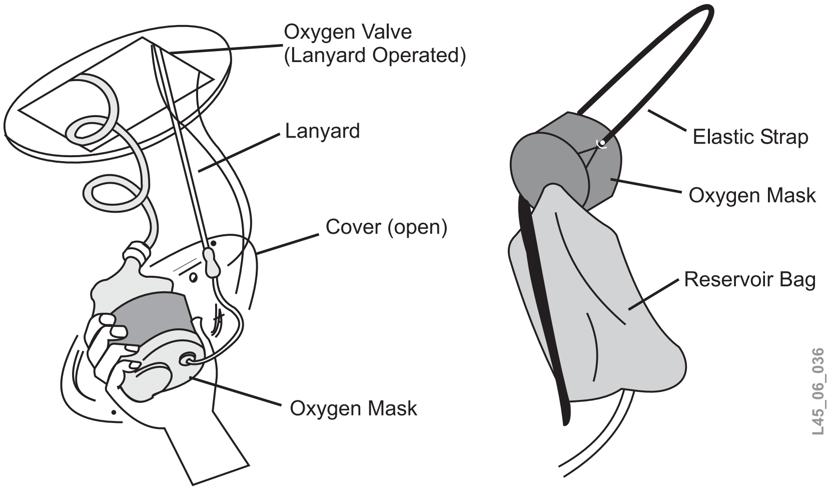


Figure 9 - Passenger Oxygen Mask

Automatic Deployment

With the PAX OXY/AUTO switch indicator selected ON, oxygen is available to the passenger distribution system and the passenger masks deploy automatically if the cabin altitude climbs to 14,500 ft. When the cabin altitude reaches 14,500 ft, an electrical signal from the cabin pressurization controller (CPC) causes the solenoid valve (integral with the passenger oxygen valve) to open. The passenger oxygen masks deploy, and the cabin overhead lights provide maximum visibility for donning masks.

Manual Deployment

With the DEPLOY switch indicator selected ON, oxygen is available to the passenger distribution system and the passenger masks deploy. Setting the passenger oxygen valve to the DEPLOY position manually opens the passenger oxygen valve and allows oxygen pressure to deploy the passenger masks. This position deploys the passenger masks at any cabin altitude.

NOTE **With the PAX OXY/AUTO switch indicator in the OFF position, oxygen is not available to the passenger distribution system regardless of cabin altitude. This position can be used when oxygen is required for the crewmembers only.**

Controls and Indications

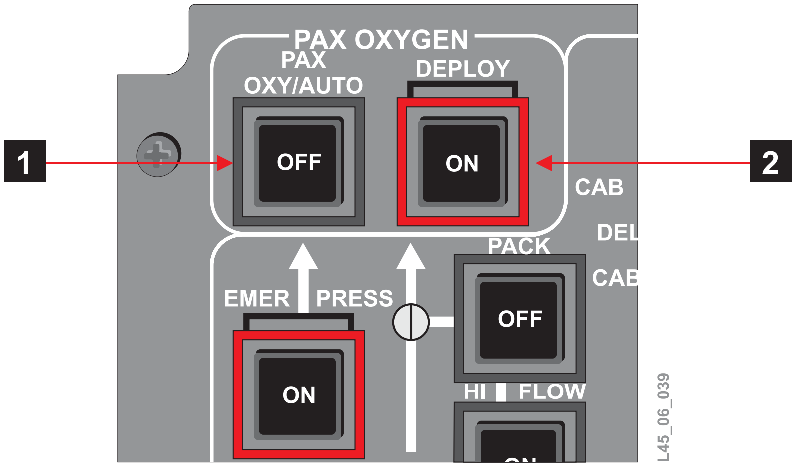


Figure 10 - Passenger Oxygen Controls

1 PAX OXY/AUTO Switch Indicator (alternate-action)

- Push (OFF in view)—Shuts off oxygen flow to passenger oxygen masks at all altitudes
- AUTO—Allows for automatic deployment of the passenger oxygen masks when the cabin altitude reaches 14,500 (±250) ft

2 DEPLOY Switch Indicator (alternate-action, guarded)

- Push (ON in view)—Manually deploys the passenger oxygen masks

Flight Crew Oxygen

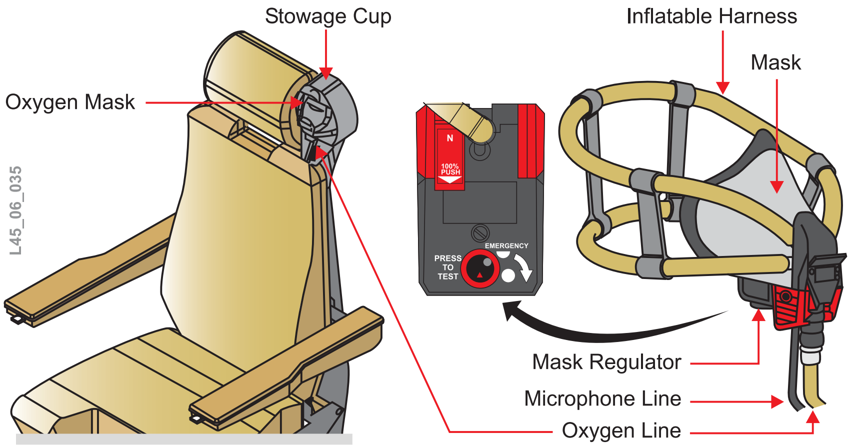
The crew oxygen distribution system delivers oxygen to the crew oxygen masks on a continuous basis. Each crewmember is supplied with a quick-donning pressure-demand mask with diluter capabilities. These masks are equipped with a microphone to allow for ease of communication.

The Learjet 40/45 aircraft is normally equipped with the Scott EROS quick donning mask (Fig. 11 - ? and Fig. 12 - ?) or, as an option, with the Puritan-Bennett sweep-on mask (Fig. 13 - ? and Fig. 14 - ?).

EROS Oxygen Mask

Mask Stowage Cups

The flight crew masks are stowed in accessible stowage cups (Fig. 11 - ?) over each crewmember's outboard shoulder.



Pilot seat shown. Copilot seat is mirror image.

Figure 11 - Scott EROS Quick Donning Mask and Stowage Cup

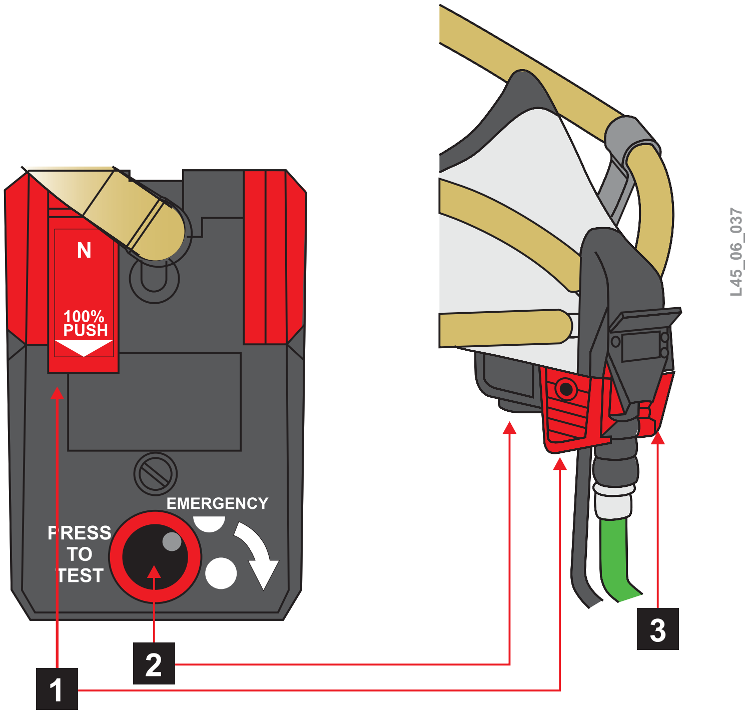
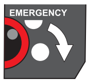


Figure 12 - EROS Oxygen Mask

1 NORMAL/100% Lever

- N (normal)—
  - Provides automatic dilution from sea level to 30,000 ft cabin altitude
  - Provides 100% oxygen above 30,000 ft cabin altitude
  - Provides automatic pressure breathing above approximately 37,000 ft cabin altitude
- 100%—Provides undiluted oxygen at all cabin altitudes

2 Emergency Flow Control Knob



- Half-circle—Provides on-demand oxygen
- Full circle— Provides a constant flow of 100% oxygen at a slightly positive pressure at all cabin altitudes
- PUSH—Initiates emergency flow through mask

3 Inflation Control Tab

- Depress—Inflates the harness to enable one-hand donning

Crew Oxygen Mask

The crew oxygen masks are quick-donning masks with an oxygen regulator, an inflatable harness, and a microphone. There are four mode settings on the crew mask pressure regulator: N (normal), 100% PUSH, EMERGENCY, and PUSH-TO-TEST. To use the oxygen mask, the crewmember grasps the mask by the hose near the regulator and pulls it from the stowage cup.

Normal/100% Lever

The normal/100% lever is part of the regulator unit that controls the flow of air to the mask. When the N/100% lever is in the N (normal) position, the mask provides automatic dilution from sea level to 30,000-ft cabin altitude, 100% oxygen above 30,000-ft cabin altitude, and automatic pressure breathing above approximately 37,000-ft cabin altitude. When the lever is in the 100% position (pushed down), the mask provides undiluted oxygen at all cabin altitudes.

Emergency Flow Control Knob

The emergency flow control knob is also part of the regulator unit. Normally, the emergency flow control knob is positioned to the half-circle symbol. In this position, oxygen flow in the crew mask is initiated by inhaling and stopped by exhaling.

If the knob is turned clockwise to the EMERGENCY (full-circle) position, the mask supplies a constant flow of 100% oxygen at a slightly positive pressure at all cabin altitudes. This setting protects the respiratory system against smoke or toxic fumes that might be present in the aircraft.

The emergency flow control knob also functions as a PUSH-TO-TEST button. If the knob is pushed in, oxygen flows into the crew mask.

Inflatable Harness Control

When the two red tabs on the mask are squeezed, the harness inflation valve opens, permitting the harness to inflate. When the tabs are released, the harness deflates and the mask holds tightly against the operator's face.

Microphone Control

Each mask uses a microphone controlled by the MIC/MASK switch on the respective audio control panel. When the MASK MIC is in use (out position), a voice-activated hot interphone is available for crewmember communication.

Puritan-Bennett Sweep-On Mask

Mask Stowage Cup

The masks are stowed in stowage cups over each crewmember’s shoulder.

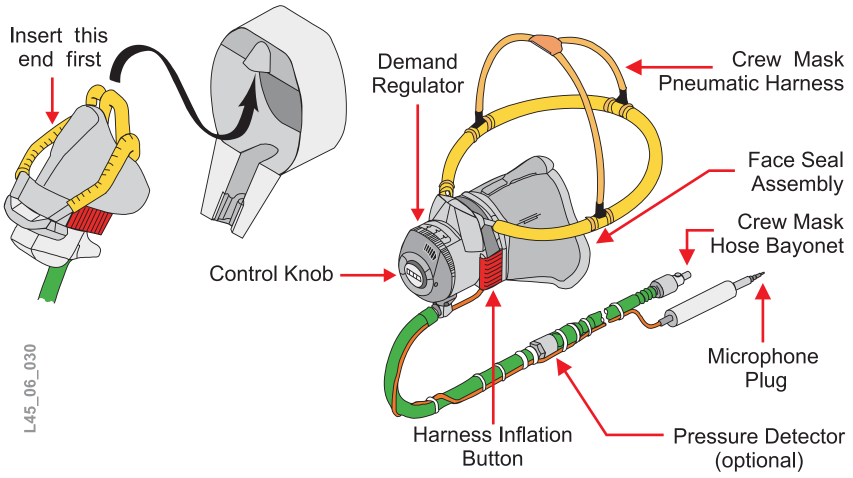


Figure 13 - Puritan Bennett Sweep-On Mask and Stowage Cup

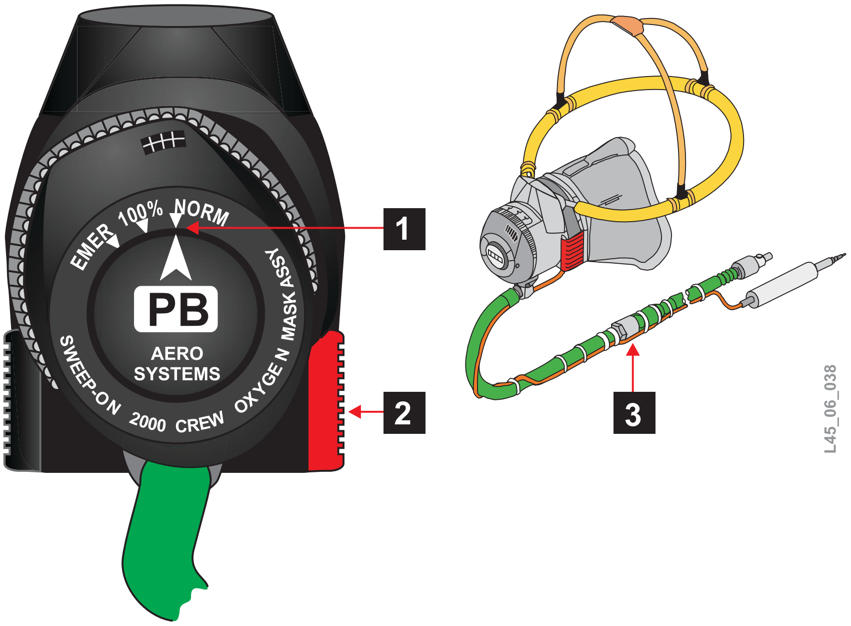


Figure 14 - Puritan Bennett Sweep-On Mask Crew Mask

1 Mode Control Knob

- NORM—Provides 100% oxygen above 35,000 ft cabin altitude
- 100% (100% mode)—Provides undiluted oxygen at all cabin altitudes

- EMER (emergency mode)—Provides a constant flow of 100% oxygen at a slightly positive pressure at all cabin altitudes

2 Inflation Control Tab

- Depress—Inflates the harness to enable one-hand donning

3 Oxygen Pressure Detector (optional)

- Appears green—Indicates sufficient oxygen pressure is available in the line for breathing
- Appears red—Indicates insufficient oxygen pressure is available in the line for breathing

Crew Oxygen Mask

The crew oxygen masks are quick-donning masks which contain a mask- mounted automatic diluter-demand regulator with a single knob mode control, an inflatable harness, and a microphone. An optional oxygen pressure detector is located in the oxygen supply line. There are three mode settings on the crew mask pressure regulator: NORM (normal), 100%, and EMER (emergency).

Mode Control Knob

The mode control knob is part of the pressure regulator that controls the flow of air to the mask. The modes function as follows:

- **Normal mode—**With the regulator set in the NORM (normal) position, the regulator provides an automatic oxygen dilution schedule. As cabin altitude increases, the percentage of ambient air entering the regulator is reduced until cabin pressure reaches approximately 35,000 ft cabin altitude. Above this altitude, the pressure regulator provides 100% oxygen
- **100% mode—**This setting provides 100% oxygen, regardless of cabin pressure altitude
- **Emergency mode—**The EMER (emergency) control setting, like the 100% setting, provides 100% oxygen, regardless of cabin pressure altitude. In addition, a slightly positive pressure is maintained in the mask for respiratory protection from smoke or fumes

Inflatable Harness

When the red harness inflation button on the regulator is pressed, the harness inflates. When the buttons are released, the harness deflates, and the mask holds tightly against the operator’s face.

Oxygen Pressure Detector

An oxygen pressure detector may be located in the oxygen line. If sufficient pressure is available in the line for breathing, the detector shows green. If pressure is not sufficient, the detector shows red.

Microphone

Each mask incorporates a microphone controlled by the NORM MIC/OXY MIC switch on the respective audio control panel. When the OXY MIC is in use, a voice-activated hot interphone is available for crewmember communication.

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ENVIRONMENTAL CONTROL SYSTEMS

Introduction

The environmental control system (ECS) controls air conditioning and pressurization for the occupied areas of the aircraft. Bleed air supplied from the engines or APU is temperature-regulated by the environmental control system. The primary ECS component is the air cycle machine. Conditioned air is distributed to the cabin and cockpit through floor and overhead vents. Temperature in the occupied areas is controlled either automatically or manually via a computerized controller.

The pressurization system regulates cabin altitude by control of two outflow valves. Emergency pressurization is available in lieu of normal airflow to the pressure vessel. Pressurization is controlled either automatically or manually via an electronic controller. The pressurization controller includes control logic for takeoff and landing operations from all altitude airports.

Air conditioning and pressurization indications and discrepancy alerts are shown on the EICAS/MFD displays. Pressurization indications are also shown on the pressurization controller display.

All controls for air conditioning and pressurization are located on the PRESSURIZATION and ENVIRONMENTAL CONTROL panels.

Controls and Indications

Environmental Control System Panel

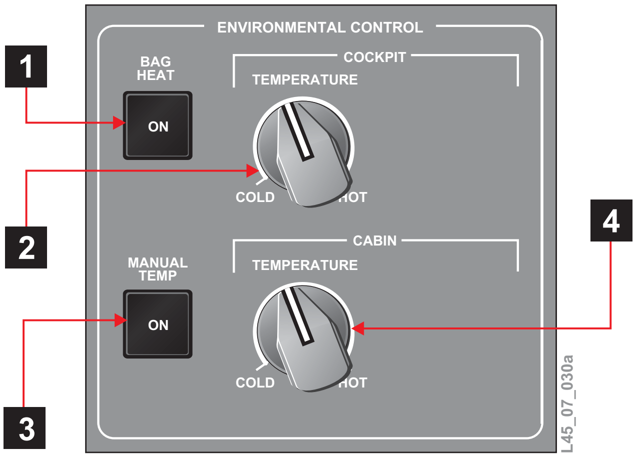


Figure 1 - Environmental Control System Panel

1 BAG HEAT Switch Indicator

- Push—Activates/deactivates baggage compartment heat
- ON—Indicates power is supplied to heating elements

2 COCKPIT TEMPERATURE Knob

- Rotate—Adjusts cockpit temperature (60°F [COLD] to 90°F [HOT]) in automatic mode

3 MANUAL TEMP Switch Indicator

- Push—
    - ON—Selects manual temperature control
    - OFF—Selects automatic temperature control
- Illuminated—Manual temperature control selected

4 CABIN TEMPERATURE Knob

- Rotate—Adjusts cabin temperature (60°F [COLD] to 90°F [HOT]) in automatic mode

Pressurization Panel

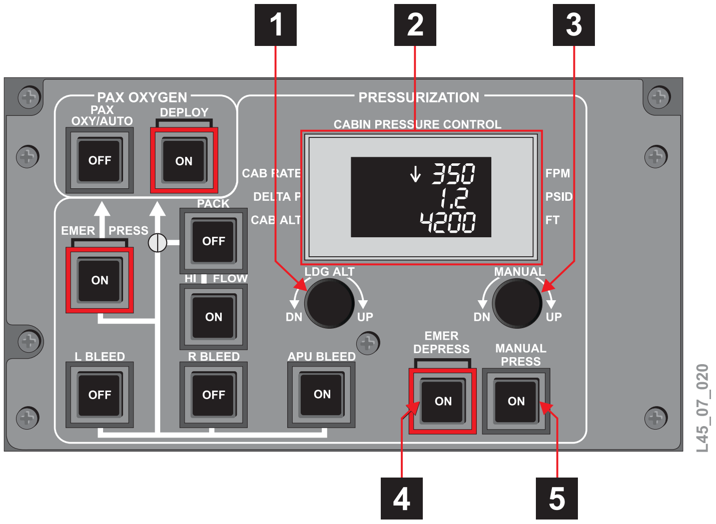


Figure 2 - Pressurization Panel

1 LDG ALT Knob

- Rotate—Selects landing field elevation for use in automatic mode (mean sea level altitude)
    - Counterclockwise rotation (toward DN) decreases landing altitude (–1000 ft maximum)
    - Clockwise rotation (toward UP) increases altitude (13,700 ft maximum)

Each detent of knob rotation equates to 100 fpm change in landing altitude in the associated direction.

LA (landing altitude) and the selected altitude are displayed in the CAB ALT line on the pressurization display when the LDG ALT knob is rotated. The cabin altitude indication returns after five seconds. The selected landing altitude is also shown on the EICAS SUMRY and ECS pages.

2 CABIN PRESSURE CONTROL Display

- CAB RATE
  - Displays cabin altitude rate-of-change in feet per minute (FPM) in white (adjacent arrow indicates the direction of altitude change)
  - During manual modes, the selected rate while the MANUAL knob is rotated. The actual cabin rate indication returns to the CAB RATE line after five seconds
  - CABIN RATE and MANUAL RATE are also simultaneously displayed on the EICAS/MFD ECS page
- DELTA P
  - Cabin differential pressure in pounds per square inch differential (PSID)
  - Indication flashes if normal pressure differential limits are exceeded
- CAB ALT
  - Cabin altitude in feet (FT) and the landing altitude when the LDG ALT knob is rotated. The actual cabin altitude indication returns to the CAB ALT line after five seconds
  - If landing elevation is set at or below 8000 ft, the indication flashes if cabin altitude exceeds 8750 ft
  - Cabin altitude is also indicated on the EICAS ECS page

3 MANUAL Knob

- Rotate—Selects cabin altitude rate-of-change during manual mode operations
  - MR (manual rate) appears in the controller CAB RATE line along with the selected rate while the MANUAL knob is rotated. Actual cabin rate is indicated after five seconds
  - Selected rate is also shown on the EICAS ECS page
  - Counterclockwise rotation (toward DN) progressively decreases cabin altitude at rates up to 2500 fpm (100 fpm for each click)
  - Clockwise rotation (toward UP) progressively increases cabin altitude at rates up to 2500 fpm (100 fpm for each click)

4 EMER DEPRESS Switch Indicator

- Push—Toggles the pressurization controller between emergency de-pressurization and the selected regulation mode (automatic or manual)
- ON—Emergency depressurization is selected. Both outflow valves are commanded fully open until a cabin altitude of 13,700 ft is attained

5 MANUAL PRESS Switch Indicator

- Push—Toggles the pressurization controller between automatic and manual modes
- ON—Manual mode is selected (cabin altitude is controlled by the MANUAL knob)

Thrust Lever MUTE Button

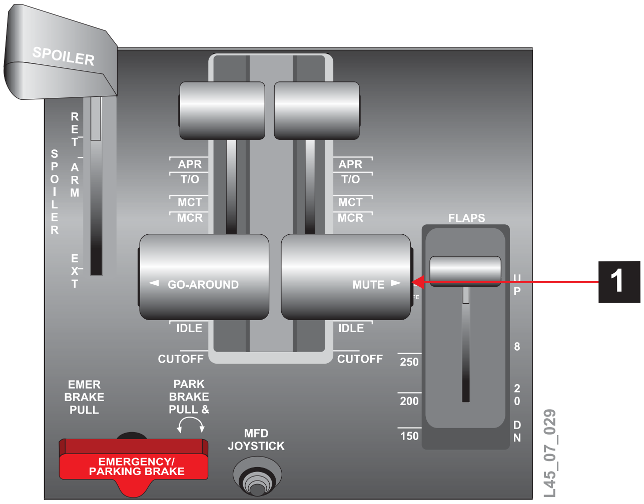


Figure 3 - Thrust lever MUTE Button

1 Thrust Lever MUTE Button

- Depress (momentary)—Cancels the “Cabin Altitude” aural alert for 60 seconds (continues until cabin altitude decreases below 8750 ft)

EICAS/MFD System Summary Page


EMER-V 28.0 B-ACUM 2000 PIT 6.5
AMPS 200 200 CAB ALT 1300 AIL R 1

Figure 4 - EICAS/MFD System Summary Page

Table 1 - EICAS/MFD System Summary Page

Description	Symbol	Condition
Cabin altitude readout	1300	Displays the cabin altitude • Range: –16,710 to +65,530 ft • Resolution: 10 ft
	8750	When cabin altitude exceeds 8750 ft
	10000	When cabin altitude exceeds 10,000 ft
	----	Invalid cabin altitude data

EICAS/MFD Environmental Control Systems Page

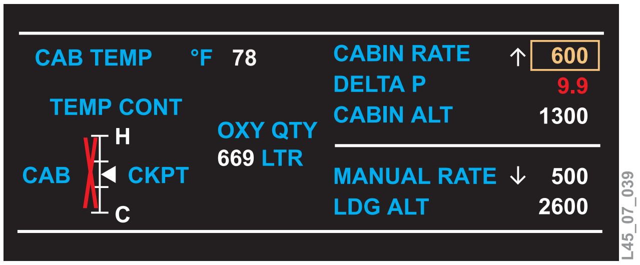

CAB TEMP °F 78
TEMP CONT
OXY QTY
669 LTR
CAB CKPT
H
C
CABIN RATE ↑ 600
DELTA P 9.9
CABIN ALT 1300
MANUAL RATE ↓ 500
LDG ALT 2600

Figure 5 - EICAS/MFD Environmental Control Systems Page

Table 2 - EICAS/MFD Environmental Control Systems Page

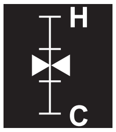
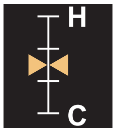
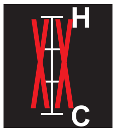
Description	Symbol	Condition
Cabin temperature digital readout	78	Current cabin temperature in ºF Range from 9 to 150ºF
Cabin and cockpit air supply temperature		Displays the air supply temperature in the ducting
		Indicates temperature in excess of 300ºF
		Indicates invalid air supply temperature
Cabin rate data readout	↑ 1000	Cabin rate settings are: • Climb/descent rate: 50 ft/minute • Pressure differential: 0.1 PSI • Altitude: 50 ft • Up and down arrows indicate cabin climb or descent
	----	Indicates invalid cabin rate data
Cabin differential pressure readout	5.4	Displays the cabin differential pressure • Range: –9.9 to +32.0 PSI • Resolution: 0.1 PSI
	9.7	Indicates excessive differential pressure (9.5 to 9.8)
	9.9	Indicates extreme differential pressure (greater than 9.9)
	----	Indicates invalid differential pressure data

Table 2 - EICAS/MFD Environmental Control Systems Page (Cont)

Description	Symbol	Condition
Cabin altitude readout	1300	Displays the cabin altitude • Range: –16,710 to +65,530 ft
	8750	When cabin altitude exceeds 8750 ft
	10000	When cabin altitude exceeds 10,000 ft
	----	Indicates invalid cabin altitude data
Manual cabin rate select digital readout	↑ 500	Manual cabin altitude settings are: • Range: ±2500 ft/minute • Resolution: 50 ft/minutes • Up and down arrows indicate cabin altitude climb or descent
	----	Indicates invalid selected cabin rate data

CAS Messages

Table 3 - Air Conditioning and Pressurization CAS Messages

CAS Message	Conditions/Parameters
CABIN ALTITUDE	• Repeating "Cabin Altitude" aural message activates when cabin altitude exceeds 10,000/14,500, depending on entered landing field elevation
CAB DUCT OVHT	Cabin supply air overheated
CKPT DUCT OVHT	Cockpit supply air overheated
L EMER PRESS ON	Left emergency pressurization valve is open
R EMER PRESS ON	Right emergency pressurization valve is open
L R EMER PRESS ON	Both emergency pressurization valves are open
PACK OVHT	Pack compressor discharge temperature is excessive
CABIN ALTITUDE	• Cabin altitude is above 8750/14,500, depending on the entered landing field elevation • Repeating "Cabin Altitude" aural message activates when cabin altitude exceeds 10,000/14,500, depending on entered landing field elevation
L R CAB PRESS FAIL	• Both cabin pressure controller channels failed • Cabin differential pressure increases to 9.7 psi
CAB PRESS MAN	Pressurization controller automatically switched to manual mode due to complete loss of ADC altitude data
CAB DELTA P	Cabin pressure differential above 9.5 psi (9.9 psi in manual mode) or below –0.5 psi
L CAB PRESS FAIL	Left cabin pressure controller channel failed
R CAB PRESS FAIL	Right cabin pressure controller channel failed
CAB PRESS MAN	Manual pressurization mode is selected by crew
EMER DEPRESS	Emergency depressurization selected
INSTR PNL TEMP	Instrument panel temperature is excessive
NOSE BAY TEMP	Nose avionics bay temperature is excessive
PACK HI FLOW	Pack valve is in high-pressure regulation mode

Air Conditioning

Description and Operation

Bleed-Air Source Control

The air-conditioning and pressurization systems receive bleed air from the pneumatic system. Low-pressure or high-pressure bleed air (as selected by the ECS controller) from each engine is pressure-regulated by the associated ECS bleed valves so that a consistent supply is available, independent of engine rpm variations. The bleed-air output from each engine is combined to supply the environmental control unit (ECU/PACK).

While on the ground, the optional APU can provide bleed air for air-conditioning purposes. Airflow from the APU is controlled by the APU load control valve in conjunction with the APU BLEED switch indicator in the PRESSURIZATION switch group. See Chapter 18 Pneumatics for further information on APU bleed-air management.

Environmental Control Unit

Hot bleed air from the engines or APU is routed to the environmental control unit (ECU/PACK) via the pack bilevel pressure regulating shutoff valve (PRSOV) (Fig. 7). The ECU is essentially an air cycle machine (pack), which accomplishes cooling through expansion as the air passes into a diverging duct.

The heart of the air cycle machine (Fig. 6) is the compressor-turbine rotor that is rotated by bleed air. The pack valve regulates the air pressure entering the ECU in conjunction with the PACK switch indicator. A portion of the air entering the ECU is diverted to the mixing chamber for use in cabin and cockpit temperature control.

The air entering the ECU is normally regulated at low pressure. If maximum cooling is required, then the pack valve is reset to regulate at a higher pressure via the HI FLOW switch indicator. The white PACK HIGH FLOW CAS message displays when HI FLOW is selected. The pack valve is powered from the left essential bus through the PACK circuit breaker and fails open to the normal regulation level if electrical power is lost.

Bleed air from the pack valve cools as it passes through the precooler and primary heat exchanger. Thereafter, the air enters the compressor section of the air cycle machine. The compressor compresses the bleed airflow to approximately twice the inlet pressure. This increases the temperature of the air, so the air exiting the compressor is routed through the secondary heat exchanger before it enters the turbine section. Pack temperature is monitored by a sensor at the outlet of the compressor. Overheating triggers display of the amber PACK OVHT message. Above 40,000 ft, the air cycle machine is bypassed via automatic opening of the ACM bypass valve.

Bleed air entering the turbine section causes the compressor-turbine rotor to rotate at very high rpm. As the air exits the turbine section, it undergoes rapid expansion, which produces low temperatures. Air exiting the turbine is directed to the water separator where water accumulating from the cooling process is removed. Water from the water separator is sprayed onto the cooling coils of the secondary heat exchanger to enhance cooling efficiency.

The air temperature at the turbine outlet is maintained above freezing to prevent ice formation in the outlet and in the water separator. This function is automatically accomplished by the low-limit temperature control valve, which meters hot bleed air into the expansion housing.

The ram air flow through the heat exchangers enters through an air scoop on the upper aft fuselage and exits through an opening above the right engine pylon. While on the ground, the ram air flow through the heat exchangers is minimal and ACM cooling capability decreases significantly. To maintain ACM efficiency while on the ground, ambient air is drawn through the heat exchanger by a fan driven by the compressor-turbine rotor.

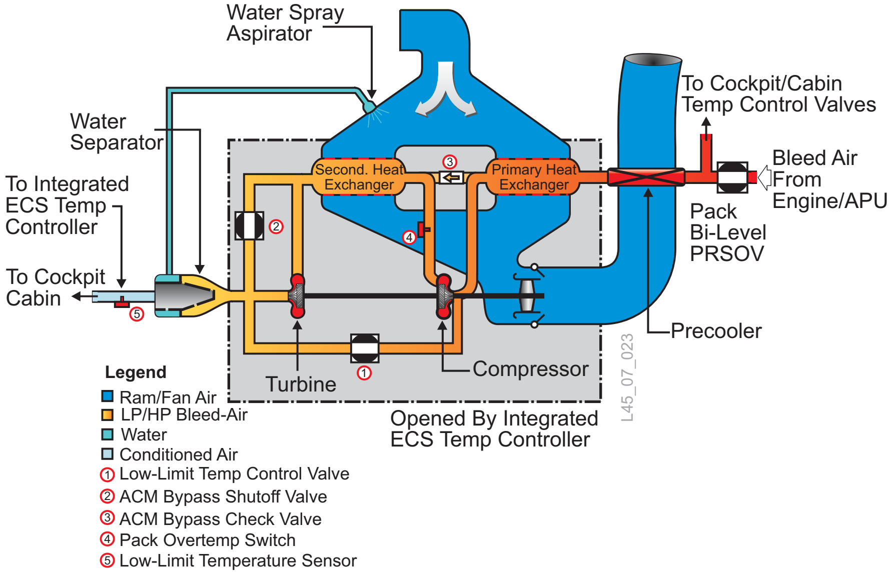


Figure 6 - Air Cycle Machine

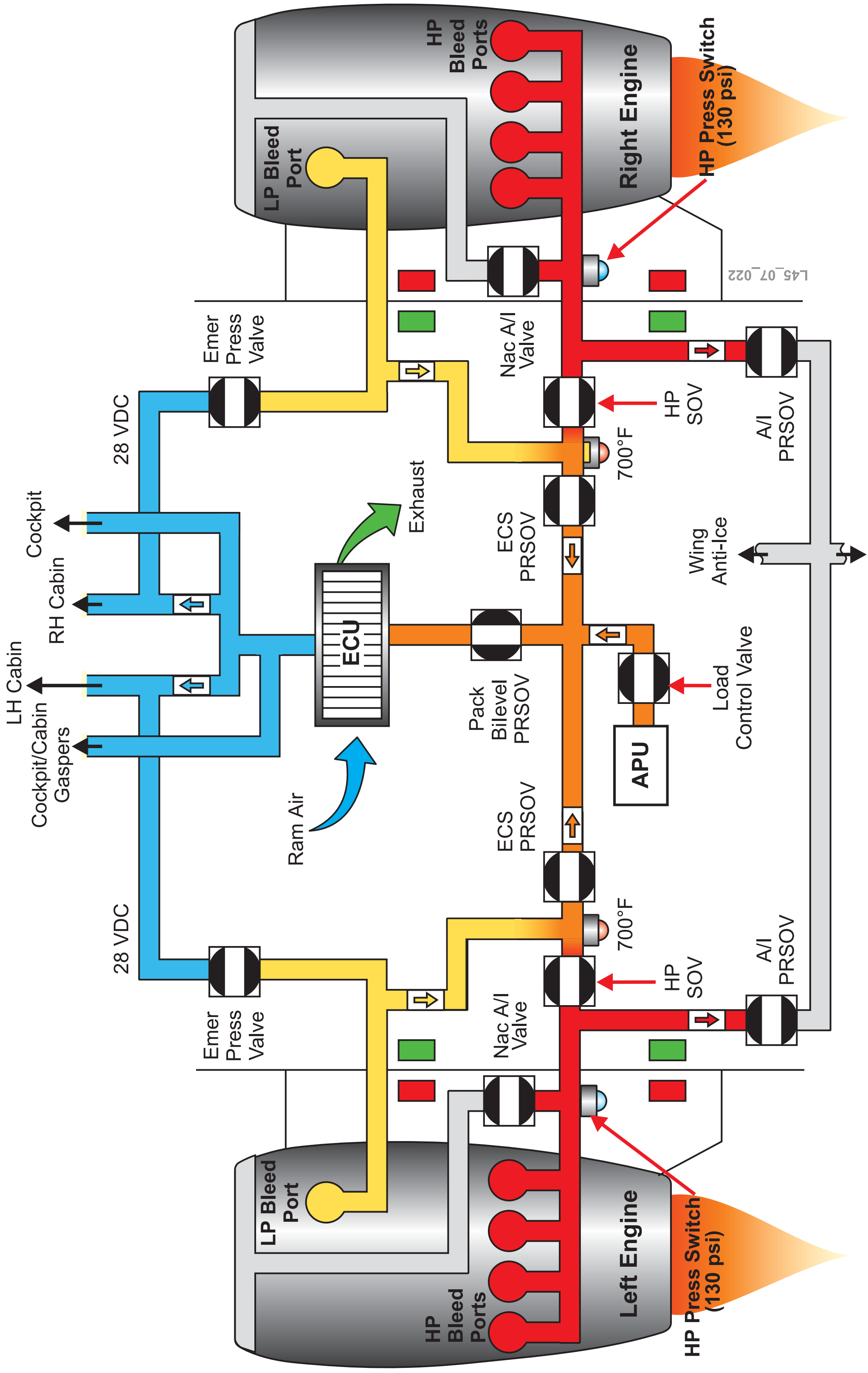


Figure 7 - ECU Diagram

Distribution and Temperature Control

Cold air exiting the ECU is routed to the gasper outlets in the cabin and cockpit ceiling. Cold air is also routed to the mixing chamber where it is mixed with hot bleed air. Air from the mixing chamber is distributed to the cabin and cockpit floor outlets. The air exiting the gasper vents is always colder than the air from the floor vents. The temperature of the air exiting the floor vents is governed by the cabin and cockpit temperature control valves (conditioned air).

The EICAS/MFD ECS page indicates cabin temperature. The temperature in the cockpit and cabin compartments is individually regulated by the associated temperature control valve. Compartment temperature is regulated by metering hot bleed air into the cold air duct leading to the corresponding compartment. The temperature control valves fail closed (cold) if electrical power is lost.

The temperature in the cabin and cockpit conditioned air ducts is indicated by the related pointer on the TEMP CTRL scale on the EICAS/ MFD ECS page. Duct temperature is normally limited by the ECS controller through control of the associated temperature control valve. Duct overheating triggers display of the associated amber DUCT OVHT CAS message.

Compartment temperature is controlled either automatically or manually as selected by the MANUAL TEMP switch indicator on the ENVIRONMENTAL CONTROL panel.

Automatic Mode

In automatic mode, the temperature control valves are controlled by the respective ECS controller channel in conjunction with the respective TEMPERATURE knob. The selected temperature is relative to knob position; clockwise rotation progressively increases the temperature for the related compartment.

Temperature control valve opening is controlled by the ECS, which compares the selected temperature with the signals received from the related compartment and distribution duct. To ensure accurate temperature sensing, the cabin sensor includes an integral fan to draw ambient air over the sensor.

For automatic mode, the ECS controller is supplied by the right main bus through the TEMP CTRL AUTO circuit breaker.

Manual Mode

Manual mode is selected by pushing the MANUAL TEMP switch indicator (ON illuminates). There is no CAS message indicating manual temperature mode is active.

The opening of each temperature control valve is directly controlled by the respective TEMPERATURE knob through the ECS controller—full clockwise position drives the temperature control valve full open (hot). Duct overheating results in display of the associated amber DUCT OVHT CAS message and removal of electrical power from the related valve (fails to cold position).

For manual mode operation, the ECS controller is supplied from the right essential bus through the TEMP CTRL MAN circuit breaker.

Baggage Compartment Heating

The tailcone baggage compartment is heated to prevent freezing of luggage items. The system consists of electric blanket-type heaters mounted on the compartment walls and floor. Compartment heating automatically activates when compartment temperature decreases to 40°F or less. System power is controlled through a switch located in the baggage compartment that must be selected ON prior to flight.

On serial #45-170 and subsequent, and those aircraft modified by SB 45-21-3, the switch is on the environmental control panel (in front of the copilot).

Footwarmer Heat System

Electric footwarmers heat the floorboard below each set of rudder pedals. System operation is automatic with no cockpit controls or indications.

Avionics Cooling System

Avionics cooling is accomplished by forced ventilation via the avionics cooling fan. The fan draws cooling air across the forward side of the instrument panels and directs it through the pedestal where it is discharged through vents. The system is fully automatic and has no controls requiring crew attention. Instrument panel overheating causes display of the white INSTR PNL TEMP CAS message.

The nose avionics bay is cooled by environmental air exhausted through the outflow valves. There is no fan associated with nose avionics bay cooling. Overheating in the nose avionics bay causes display of the white NOSE BAY TEMP CAS message.

Pressurization System

Description

In automatic operation, the pressurization system (Fig. 8) allows up to 9.3 psi cabin pressure differential, which provides an 8000-ft cabin altitude at 51,000 ft. Cabin pressurization is controlled by a computerized controller that regulates air escape through control of two outflow valves. The pressure vessel extends from the forward cockpit pressure bulkhead to the aft cabin bulkhead.

The CABIN PRESSURE CONTROL panel is located on the lower center panel and includes controls for entering landing elevation and for manual mode operation. The controller performs a self-test at power-up and thereafter continuously monitors its own operation and the validity of data received.

A display on the controller face indicates cabin altitude and rate-of-change, and cabin pressure differential. The information is also displayed on the EICAS/MFD ECS page. Cabin altitude is also indicated on the EICAS SUMRY page.

The pressurization controller consists of left and right control channels. The left channel directly controls the primary outflow valve while the right channel controls the secondary valve. The outflow valves are pneumatically linked so that either channel essentially controls both valves.

Only one channel is active at a time. A failure of one channel results in the remaining channel automatically assuming all control functions. A channel failure is indicated by display of the respective white CAB PRESS FAIL CAS message. The controller display is also blanked if a right channel failure occurs.

If both channels fail, the amber LR CAB PRESS FAIL CAS message is displayed, the controller blanks, and the EICAS/MFD indications are replaced by amber dashes. In this case, cabin pressure differential rises to and stabilizes at 9.7 psi via the differential pressure limiters in each outflow valve. Emergency depressurization is not available as the function requires an operable control channel. The PACK switch indicators must be selected OFF in preparation for landing to prevent landing while pressurized.

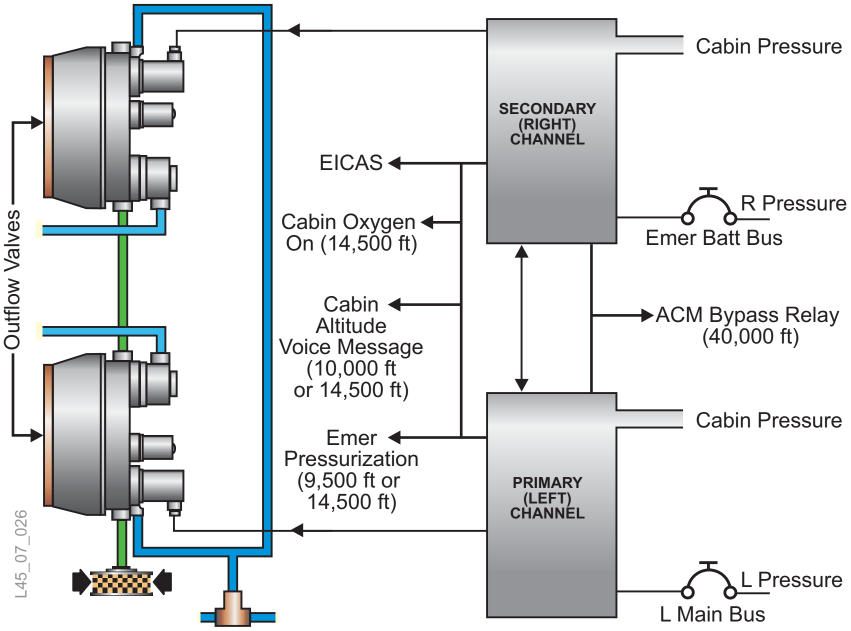


Figure 8 - Pressurization System

The left channel is supplied from the left main bus through the L PRESS circuit breaker while the right channel is supplied from the emergency battery bus through the R PRESS circuit breaker.

The pressurization controller receives the following data:

- Flight altitude, altimeter barometric setting, and true airspeed data from the air data computers
- Left thrust lever position relative to MCR
- Landing gear squat switches

If data acquisition unit (DAU) 1A channel fails, the LR CAB PRESS FAIL CAS message appears even though the pressurization system has not failed. Selecting DAU B restores data input and the CAS message is canceled. However, an erroneous white FDR FAIL CAS message appears.

If cabin altitude or differential pressure exceeds normal limits, the controller panel flashes the associated amber indication. Excessive pressure differential triggers display of the amber CAB DELTA P CAS message.

Excessive cabin altitude indications vary with altitude and are summarized in Table 4 and Fig. 4. The high altitude activation setpoints are applicable when takeoff or landing elevation is set above 8000 ft and the aircraft is below 24,500 ft.

Table 4 - Excessive Cabin Altitude Indications

Cabin Altitude (ft)	Activations and Indications
8750[1], [2] 14,500[3], 2	• Amber CABIN ALTITUDE CAS message appears • Controller panel CABIN ALT indication flashes • CAB ALT indication on the EICAS/MFD SUMRY or ECS pages is boxed and turns amber (inhibited when landing elevation is set above 8000 ft)
95001, 2 14,5003, 2	• Emergency pressurization is activated • Amber LR EMER PRESS ON CAS message appears • Controller CABIN ALT indication flashes
10,0001, [4] 14,5003, 4	• “Cabin Altitude” aural alert activates • Red CABIN ALTITUDE CAS message appears • Controller CABIN ALT indication flashes • EICAS/MFD CAB ALT indication turns red
14,500	• Passenger oxygen masks automatically deploy • Emergency lighting is activated • White PAX OXY DEPLOY CAS message appears

1. Normal activation setpoint.
2. Master CAUT switch indicators flash and single chime sounds.
3. High altitude activation setpoint.
4. Master WARN switch indicators flash and triple chime sounds.

Two identical outflow valves on the forward pressure bulkhead regulate the escape of cabin air overboard. The valves are pneumatically operated and electrically controlled. Each valve is spring-loaded closed and progressively opens as vacuum enters the control chamber through opening of a metering valve. The metering valves are controlled by electrical signals received from the associated controller channel. The vacuum required for outflow valve opening is developed by a jet pump supplied by bleed air from either engine or the APU. The outflow valve control chambers are interconnected by a pneumatic line so that both valves respond to control signals from either controller channel.

Each outflow valve contains safety valves that operate independently of controller command signals. These valves limit cabin pressure differential to 9.7 psi and altitude to 13,700 ft, whichever occurs first.

Negative pressure differential is limited electronically by the controller by reverse flow of ambient air through the valve when atmospheric pressure exceeds cabin pressure by 0.5 psi. Negative differential is also limited by check valves in the ram air ducts to the cabin. As pressure differential approaches zero, ram air begins flowing into the pressure vessel via opening of the ram-air check valves.

Operation

Automatic Mode

At power-up, the pressurization controller defaults to the automatic mode. Automatic mode controls cabin pressurization according to a programmed schedule and only requires landing elevation be entered before flight. The crew has no control over cabin altitude or rate. The controller operates in ground, climb, cruise, and descent phases.

Ground Phase

In ground phase, the cabin is maintained at zero differential by full opening of both outflow valves. This facilitates unimpeded opening of the cabin door or emergency exit. Ground phase continues until one of the following events occurs:

- Left thrust lever is advanced to MCR or higher (above MCR, the controller assumes the takeoff function)
- Airspeed exceeds 150 kt or the aircraft becomes airborne (controller assumes the climb phase)

Takeoff Function

The takeoff function (Fig. 9) is a subset of ground phase operation. The takeoff function pressurizes the cabin to nominal 150 ± 50 ft (0.1 psid) below takeoff elevation, which minimizes cabin pressurization surges at lift-off (takeoff cabin altitude).

The controller maintains the takeoff function until the left thrust lever is retarded below MCR, or airspeed exceeds 150 kt, or the aircraft is airborne, whichever occurs first.

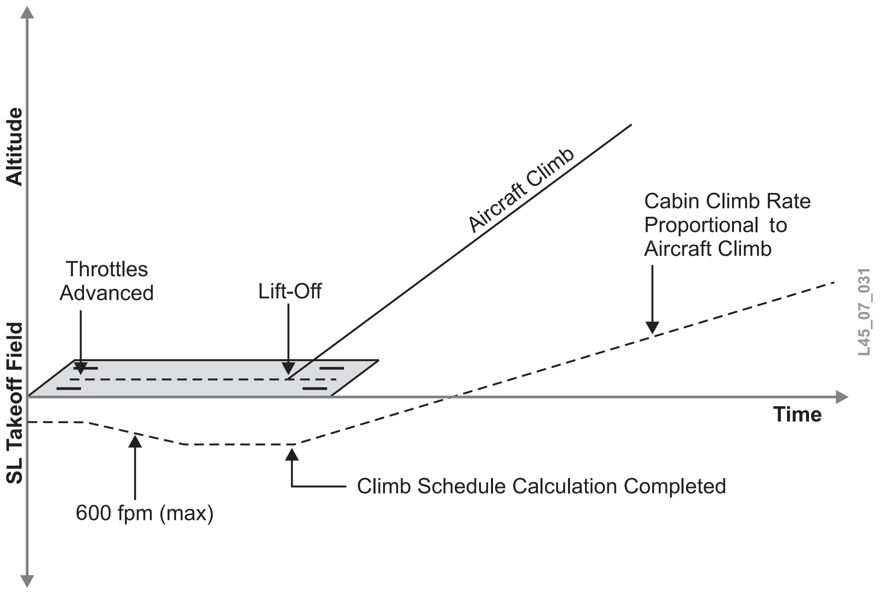


Figure 9 - Takeoff Mode

Takeoff-Abort Function

The takeoff-abort function (Fig. 10 and Fig. 11) is a subset of ground phase operation. If the left thrust lever is retarded below MCR, the controller initiates the takeoff-abort function, which depressurizes the cabin to takeoff field elevation at 500 fpm. After 20 seconds, the controller re-enters ground phase, which equalizes cabin altitude with takeoff elevation.

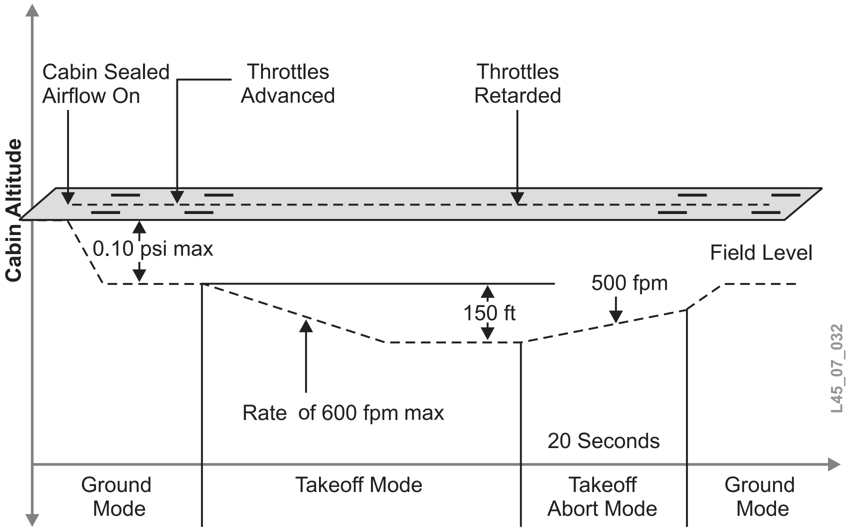


Figure 10 - Takeoff-Abort Mode

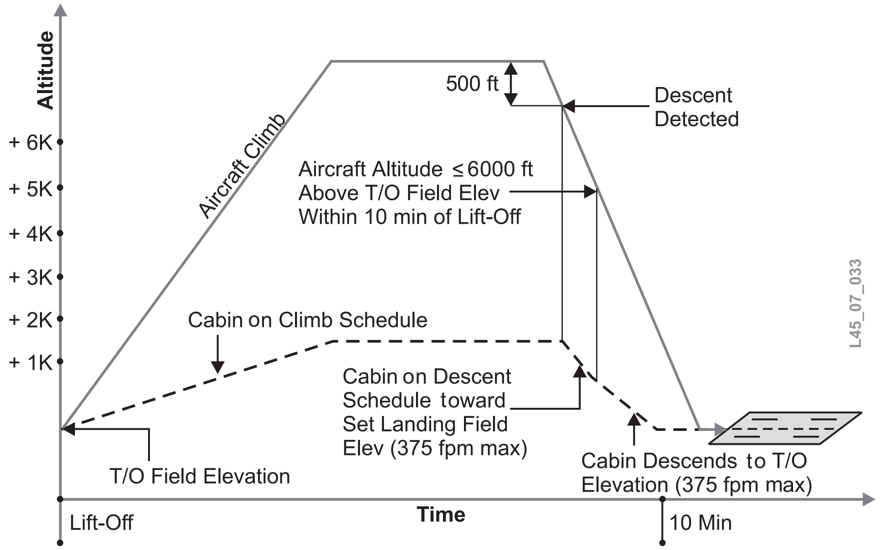


Figure 11 - Flight Abort Mode

Climb Phase

The controller enters climb phase at lift-off or when airspeed exceeds 150 kt. Takeoff cabin altitude is maintained until it equals the programmed altitude in the climb schedule. Thereafter, cabin altitude increases per the climb schedule at a rate not exceeding 600 fpm.

Takeoff field elevation is retained in controller memory for 10 minutes after takeoff. If an emergency return is required and flight altitude has not exceeded 6000 ft above takeoff elevation, the controller automatically resets landing elevation to takeoff elevation, thereby eliminating crew responsibility to do so. The emergency return feature is activated when the aircraft descends 500 ft.

Cruise Phase

The controller enters cruise phase after aircraft altitude has stabilized at ±100 ft change for one minute. In cruise phase, cabin altitude is held constant until a flight altitude change of 200 ft or more is made. This design maintains cabin altitude free of pressure oscillations that would otherwise accompany altitude variances normally associated with cruise flight.

Descent Phase

The controller enters descent phase (Fig. 12) when the aircraft descends 1000 ft. In descent phase, cabin altitude decreases in accordance with the descent schedule at a rate not exceeding 375 fpm.

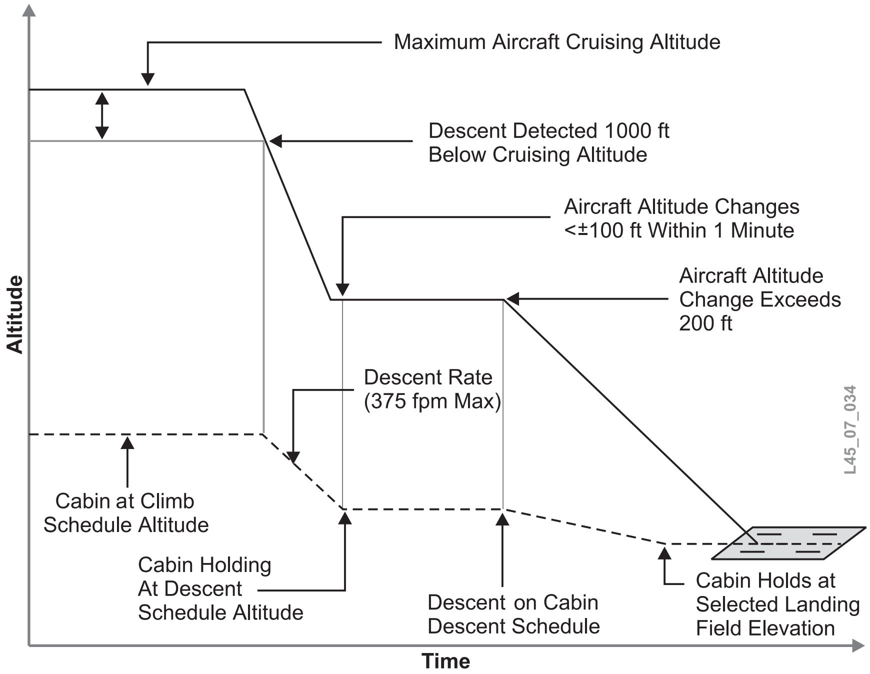


Figure 12 - Descent Mode

Landing Phase

The controller enters landing phase (Fig. 13) when airspeed decreases below 65 kt and the left thrust lever is retarded below MCR or the aircraft lands. At landing, cabin pressurization transitions to field elevation at –300/+500 fpm maximum.

If the thrust lever is advanced to MCR within 60 seconds of landing (as in a touch-and-go landing) the controller initiates the takeoff function. Otherwise, 60 seconds after landing, the outflow valves are commanded full open to maintain zero cabin differential.

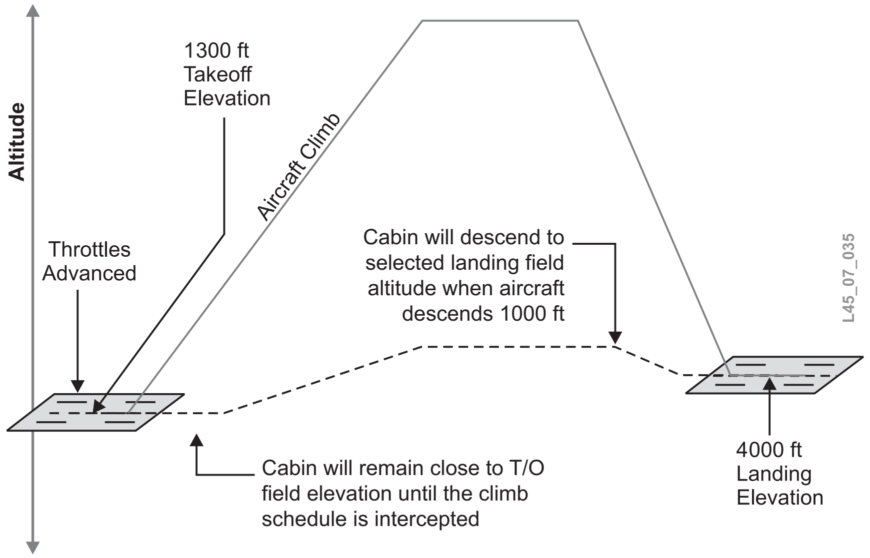


Figure 13 - Takeoff and Landing below 8000 Ft

High-Altitude Airport Operations

Takeoffs and landings at high-altitude airports (8000 to 13,700 ft) require the controller to use different operating logic to prevent triggering nuisance CAS alerts and activation of emergency pressurization. Three situations are considered in the controller programming:

- Takeoff and landing field elevations are both above 8000 ft (profile 1)
- Takeoff field elevation is above 8000 ft; landing elevation is below 8000 ft (profile 2)
- Takeoff elevation is below 8000 ft; landing elevation is above 8000 ft (profile 3)

Profile 1 (High Takeoff; High Landing)

After takeoff, cabin altitude initially decreases to 8000 ft at 600 fpm maximum (725 fpm if takeoff elevation is above 11,000) (Fig. 14). When the controller enters descent phase and flight altitude is below 24,500 ft, cabin altitude increases to the entered landing field elevation at 600 fpm maximum.

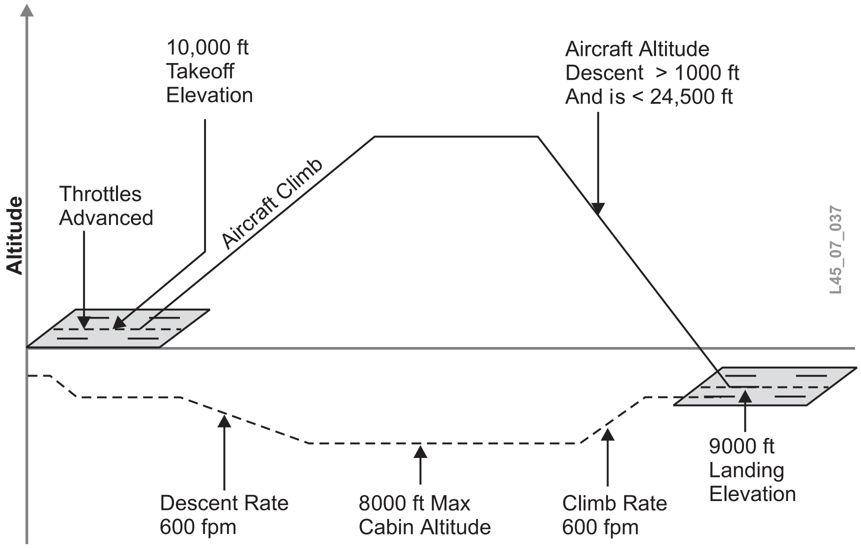


Figure 14 - Takeoff and Landing above 8000 Ft

Profile 2 (High Takeoff; Low Landing)

After takeoff, cabin altitude decreases to 8000 ft at 600 fpm maximum (Fig. 15). In descent phase, cabin altitude descends to the entered landing elevation.

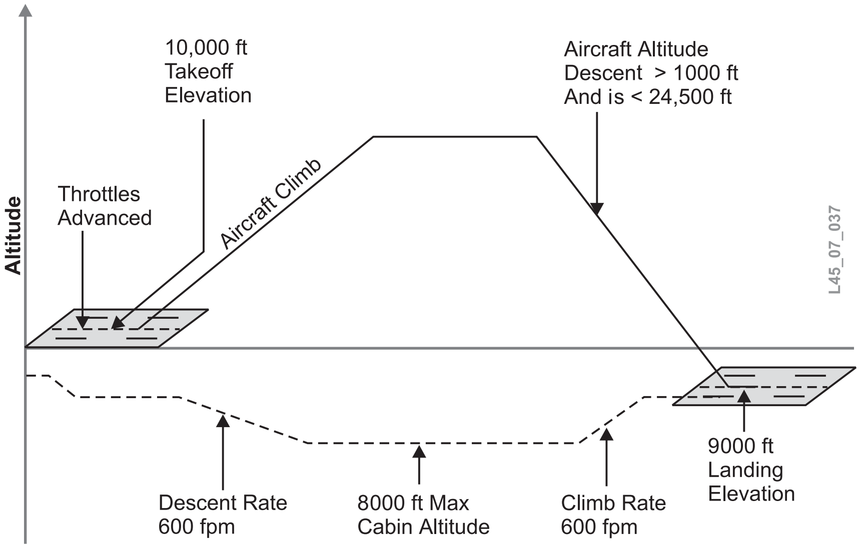


Figure 15 - Takeoff above 8000 Ft and Landing below 8000 Ft

Profile 3 (Low Takeoff; High Landing)

Pressurization is managed in the normal manner during takeoff and climb to cruise altitude (Fig. 16). In descent phase, cabin altitude increases to the entered landing elevation at 600 fpm maximum.

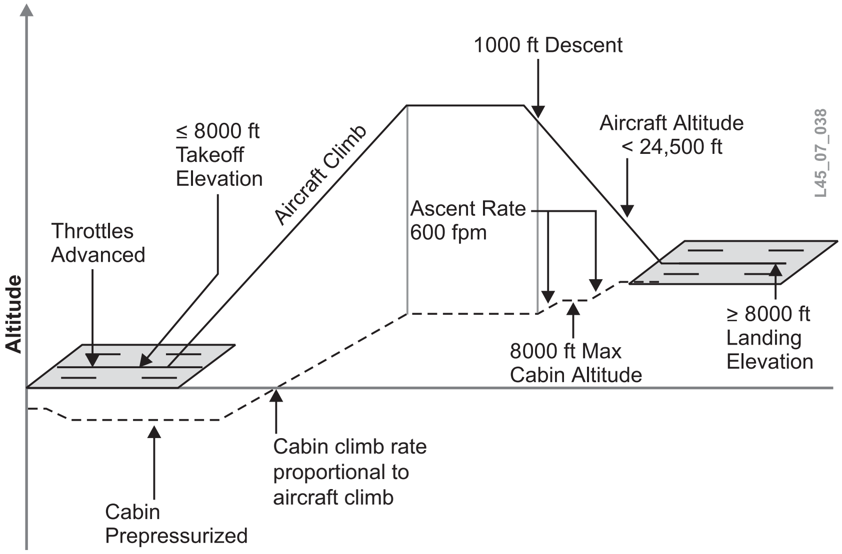


Figure 16 - Takeoff below 8000 Ft and Landing above 8000 Ft

Manual Mode

The manual operating mode allows the crew to manually control cabin pressurization after failure of the automatic mode. Manual mode requires at least one operable controller channel. Manual mode is selected by pushing the MANUAL PRESS switch indicator on the PRESSURIZATION panel. The white ON light illuminates in the switch indicator.

Automatic transfer to manual mode occurs if altitude data from both air data computers is lost, which triggers display of the amber CAB MAN PRESS CAS message. However, the ON light in the MANUAL PRESS switch indicator does not illuminate.

Pushing the MANUAL PRESS switch indicator triggers display of the white CAB PRESS MAN CAS message, and transfers control of the outflow valves to the MANUAL knob via the active controller channel. When switching to manual mode, the current cabin altitude is initially maintained, which provides a stable cabin altitude from which the crew can begin adjusting.

Cabin altitude can be adjusted at rates up to 2500 fpm through proportional control of the MANUAL knob. Each detent of knob rotation equates to 100 fpm in the associated direction. MR (manual rate) and the selected rate are indicated on the controller display CAB RATE line when the knob is turned. The actual cabin rate indication returns to the CAB RATE line after five seconds. The LDG ALT knob has no effect while in manual mode.

If manual mode is entered while on the ground, the system operates the same as automatic mode (ground phase and subfunctions are maintained). If a manual rate is selected while on the ground, then that rate is maintained after lift-off. At landing, the system automatically enters landing/ground phases.

Emergency Pressurization

If the pack valve fails closed, all incoming bleed air is shut off from the ECS. Cabin altitude subsequently begins increasing. In such cases, unconditioned low-pressure bleed air from each engine can be routed directly into the pressure vessel by opening the related emergency pressurization valve (Fig. 17).

Emergency pressurization is manually or automatically activated. Manual activation is accomplished by pushing the EMER PRESS switch indicator on the PRESSURIZATION panel. The pressurization controller automatically activates emergency pressurization when cabin altitude increases to 9500 or 14,500 ft, depending on entered landing elevation. When activated:

- ECS bleed valve and high-pressure bleed valve on each engine close
- Both emergency pressurization valves open
- Appropriate amber EMER PRESS ON CAS message appears

Check valves in the distribution ducts prevent reverse flow to the ECU when emergency pressurization is in use. The control circuits are designed so that the related BLEED switch indicator must be on to open an emergency pressurization valve. The valves can be individually closed by pressing the related BLEED switch indicator OFF. The emergency pressurization valves fail closed when electrical power is lost through the related BLEED switch indicator.

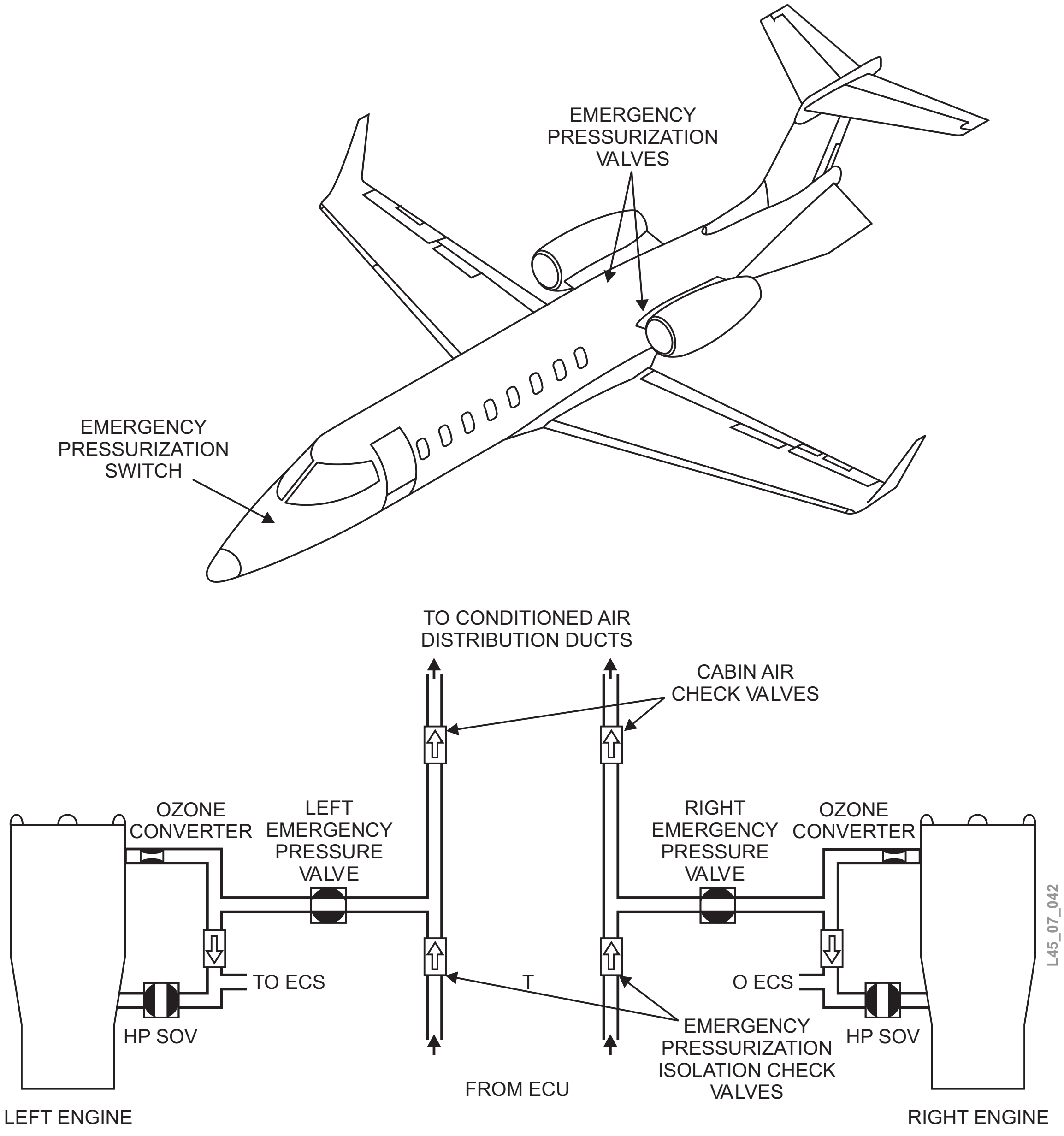


Figure 17 - Emergency Pressurization System

Emergency Depressurization

Cabin pressure differential is rapidly decreased (dumped) by pushing the guarded EMER DEPRESS switch indicator on the PRESSURIZATION panel. This feature is useful for purging the cabin of smoke and fumes and is available in automatic and manual modes. When pushed, the amber EMER DEPRESS CAS message appears and both outflow valves move full open. However, the altitude limiting function of each outflow valve remains active and cabin altitude is limited to 13,700 ft if bleed air is still flowing into the pressure vessel.

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FIRE PROTECTION SYSTEMS

Introduction

The fire protection systems on the Learjet 40/45 aircraft consist of two systems: detection and extinguishing.

Critical components within each nacelle are monitored for excessive temperature which activates engine fire alerting.

Engine fire extinguishing is accomplished by discharging extinguishing agent into the affected engine nacelle from two interconnected fire bottles.

The fire detection and extinguishing circuits are monitored for failure. Detected failures activate messages displayed by the crew alerting system (CAS). Engine fire detection and extinguishing controls are located on the engine fuel panel on the center pedestal.

Portable extinguishers are provided for fighting fires within the occupied areas of the aircraft.

Controls and Indications

Engine Fuel Panel

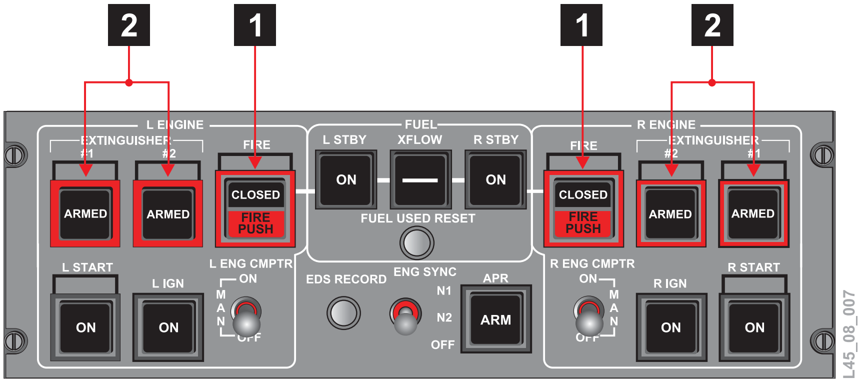

Figure 1 - Engine Fuel Panel

1 FIRE Switch Indicator

- FIRE PUSH (flashing)—Fire is detected
- FIRE PUSH (steady)—Switch indicator is pushed
  - Shows the white CLOSED caption on the switch indicator
  - Closes the bleed-air valves
  - Disconnects the generator and alternator
  - Disables the onside windshield heating
  - Closes fuel shutoff valve

    - Closes hydraulic shutoff valve
    - Electrically closes the thrust reverser isolation valve
    - Arms the fire bottle squibs
    - Displays the respective white FWSOV CLSD CAS message
    - Inhibits engine ignitors
- Remains illuminated as long as the fire/overheat condition exists

2 EXTINGUISHER #1 and #2 Switch Indicator

- ARMED—
    - Illuminates when the adjacent FIRE switch is pushed
    - Detonates a squib in the related fire bottle when pushed
- Extinguished—No effect without an illuminated ARMED caption

Engine Fire Detection System

Description

The engine fire detection system uses elements installed around the area of the engine hot section, engine accessories section, and firewall area to detect an engine fire.

Controls and Indications

CAS Messages

Table 1 - Fire Protection CAS Messages

CAS Message	Conditions/Parameters	Voice Alerts
FIRE (EI)	Fire/overheat condition detected in the related engine nacelle	Right engine fire Left engine fire
L ENG FIRE FAIL	Ground indication only Short circuit detected in the left engine fire-sensing elements	
R ENG FIRE FAIL	Ground indication only Short circuit detected in the right engine fire-sensing elements	
L R ENG FIRE FAIL	Ground indication only Short circuit detected in both engine fire-sensing elements	
L ENG FIRE FAIL	Airborne indication only Short circuit detected in the left engine fire-sensing elements	

Table 1 - Fire Protection CAS Messages (Cont)

CAS Message	Conditions/Parameters	Voice Alerts
R ENG FIRE FAIL	Airborne indication only Short circuit detected in the right engine fire-sensing elements	
L R ENG FIRE FAIL	Airborne indication only Short circuit detected in both engine fire-sensing elements	
L FWSOV CLSD	Left engine firewall shutoff valve is closed Indication normally displayed after the FIRE switch indicator is pushed	
R FWSOV CLSD	Right engine firewall shutoff valve is closed Indication normally displayed after the FIRE switch indicator is pushed	
L R FWSOV CLSD	Both engine firewall shutoff valves closed These indications normally display after both engine FIRE switch indicators are pushed	

Operation

Fire detection is accomplished by three heat-sensitive elements wired in series which are routed through potentional fire/overheat areas of the engine nacelle (Fig. 2). Each element consists of an insulated center wire surrounded by an outer metal sheath. The center wire carries a current while the metal sheath is grounded. Temperature rise along the element causes the electrical resistance of the insulating material to decrease which is monitored by the respective fire detection control unit. Each element is designed to activate alerting at a predetermined temperature threshold commensurate with the monitored area.

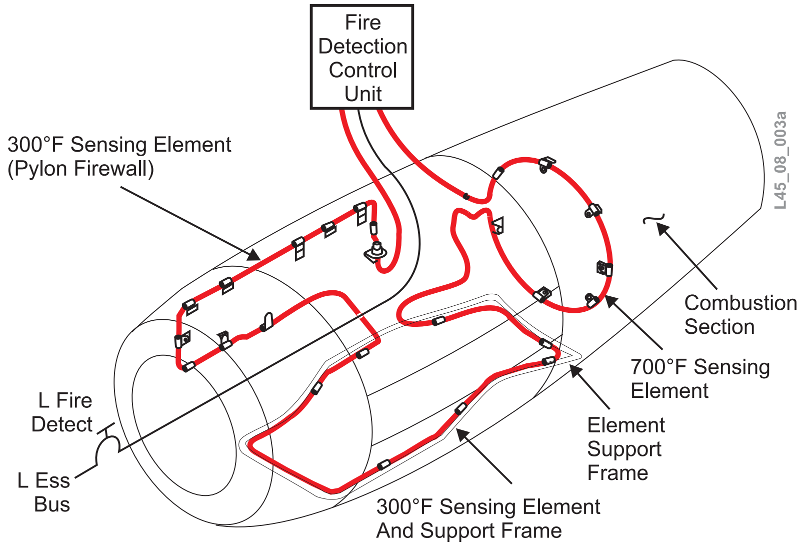

Figure 2 - Fire/Overheat Detection Elements

The areas monitored by the elements include the accessory gearbox, hot section, and pylon firewall. The heat-sensitive elements in each nacelle are monitored by the respective fire detection control units located in the tailcone. Each control unit is powered from the respective essential bus and FIRE DET circuit breaker. If a sensing element is severed, then the portion still attached to the controller remains operational for fire/overheat alerting. If a short circuit is detected in a sensing element while airborne, the related white ENG FIRE FAIL message is displayed by the CAS. If a short circuit is detected while on the ground, the related amber ENG FIRE FAIL message is displayed by the crew alerting system.

Engine fire indications include the following:

- Activation of the master WARN switch indicators and triple chime
- Illumination of the red FIRE PUSH caption in the associated FIRE switch indicator
- Aural alert (“Left Engine Fire” or “Right Engine Fire”), as appropriate
- Red flashing FIRE annunciation in the affected EICAS ITT display
- If selected, the RMU engine backup page displays red FIRE adjacent to the N_1 tape for the affected engine

Pushing either master WARN switch indicator:

- Extinguishes the master WARN switch indicator
- Cancels the aural alert (can also be muted with the MUTE switch on the right thrust lever)
- Causes the flashing FIRE annunciation in the EICAS display to illuminate steadily

The EICAS FIRE indication and the FIRE switch indicator remain illuminated as long as the fire/overheat condition exists.

Engine Fire Extinguishing System

Description

The engine fire extinguishing system provides fire extinguishing agent to control a fire within the aircraft engine nacelles.

Operation

Engine fire extinguishing is accomplished by discharging Halon 1301 extinguishing agent into the affected engine nacelle (Fig. 3). The agent is not ingested into the engine. The agent is stored under pressure in two fire bottles located inside the tailcone equipment bay. The fire bottle discharge manifolds are interconnected so that both bottles can be individually discharged to either engine.

The fire bottles are discharged by electrically fired pyrotechnic squibs. Squib firing is controlled by pushing the respective EXTINGUISHER switch indicator. Squib firing punctures a diaphragm on the related bottle which releases the extinguishing agent into the appropriate distribution manifold. Power for squib firing is supplied from the respective emergency hot battery bus.

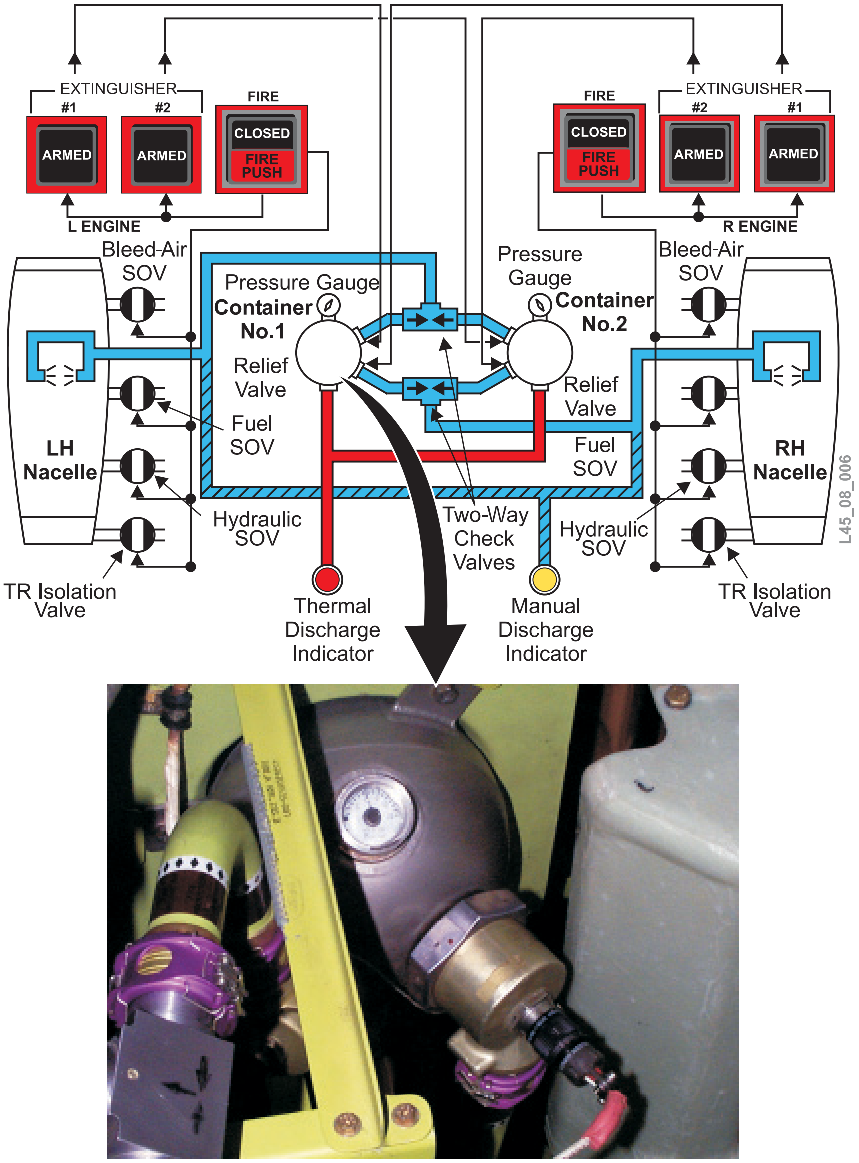

Figure 3 - Fire Extinguishing System

For preflight inspection purposes, fire bottle pressure is indicated by a pressure gauge on each bottle. Indicated pressure should be 400 to 800 psi. Fire bottle discharge is also detected by inspection of the red and yellow discs covering the vent openings located near the tailcone door (Fig. 4). The fire bottles automatically discharge to prevent overpressure due to excessive temperature (thermal discharge). In such cases, the agent from either bottle discharges overboard through the vent covered by the red disc. Thermal discharge is indicated when the red disc is ruptured or missing from the vent opening.

Discharge of either fire bottle due to squib firing (EXTINGUISHER switch indicator pushed) is indicated by rupture or loss of the yellow disc.

Figure 4 - Fire Bottle Discharge Indicators

Testing

SYS TEST/ RESET Panel

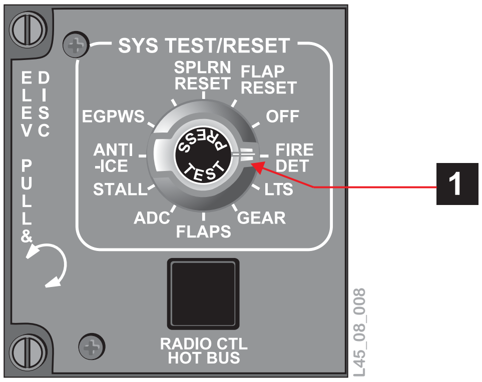

Figure 5 - SYS TEST/RESET Panel—FIRE DET Function

1 SYS TEST/RESET Switch—FIRE DET Function

- Rotate to FIRE DET position and depress
  - Master WARN switch indicators flash with triple chime
  - Aural alerts: “Left engine fire” followed by “Right engine fire”
  - Red FIRE PUSH captions in both FIRE switch indicators illuminate steady
  - White ARMED caption in all EXTINGUISHER switch indicators illuminate steady
  - Red LR BLEED AIR LEAK and WING/STAB LEAK CAS messages display
  - L BLEED AIR LEAK, R BLEED AIR LEAK, and WING/STAB LEAK CWP annunciators illuminate
  - Red FIRE annunciator flashes in both EICAS ITT displays
  - Red FIRE indication is displayed on the RMU engine page 1 next to the N_1 analog tape
  - APU FIRE switch indicator illuminates on the APU panel (only when the APU master switch indicator is on)
  - APU fire horn activates after a 15-second delay (only when the APU master switch indicator is on

NOTE

Holding the FIRE DET button an additional 15 seconds after the APU fire horn activates may cause the APU fire extinguisher to discharge.

Portable Extinguishers

Description

Three portable extinguishers are provided in the aircraft cabin (Fig. 6). Two extinguishers are located on the front side of the pilot and copilot seats. A third fire extinguisher is mounted in the passenger compartment. See Chapter 6 Emergency Equipment and Oxygen for information on types and use of portable extinguishers.

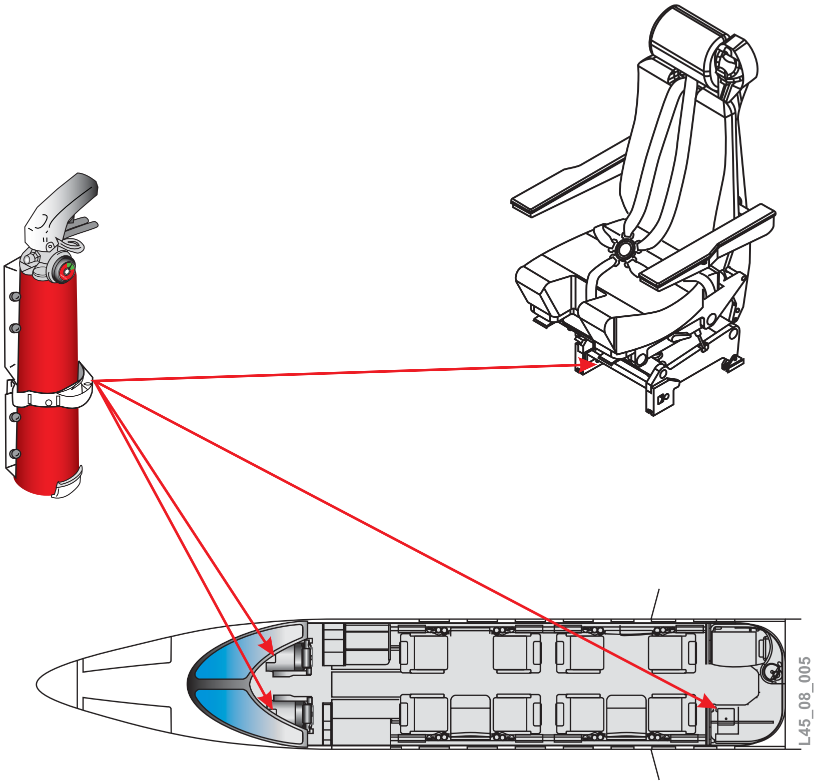

Figure 6 - Fire Extinguisher Locations

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FLIGHT CONTROLS

Introduction

The Learjet 40/45 is equipped with conventional primary flight controls operated by cables, bellcranks, and pushrods. The secondary flight controls consist of hydraulically actuated spoiler/spoileron panels and flaps. The spoiler/spoileron panels assist the ailerons in roll control and also function as drag devices. The flaps consist of a single panel on each wing. There are no movable wing leading-edge devices.

In case of aileron jamming, the pilot control wheel can be disconnected from the ailerons. Subsequent roll control by the pilot control wheel is accomplished exclusively by the spoilerons.

Roll and yaw trim is controlled by conventional trim tabs while pitch trim is controlled by a variable-incidence horizontal stabilizer.

Normally, pitch and roll trim is electrically controlled by the trim switch on either control wheel and rudder trim is electrically controlled by a dual element trim switch on the pedestal. Stabilizer trim is also controlled by the autopilot or No. 1 IC–600 integrated computer for Mach trim and configuration trim functions. A secondary trim system, used by the autopilot, also provides backup to normal stabilizer trim control.

Angle of attack (AOA) is monitored by independent stall warning channels. Alerting for excessive AOA is accomplished by aural and visual alerts and control column stickshakers. AOA values are shown on optional indicators on each flight instrument panel, and low-speed awareness is graphically shown on each primary flight display (PFD).

Trim position and selected spoiler and flap positions are indicated on the EICAS SUMRY and FLT pages. System faults and failures are indicated by CAS messages in the CAS window. All flight controls other than the control wheel and rudder pedals are located on the pedestal.

Controls and Indications

Control Wheels

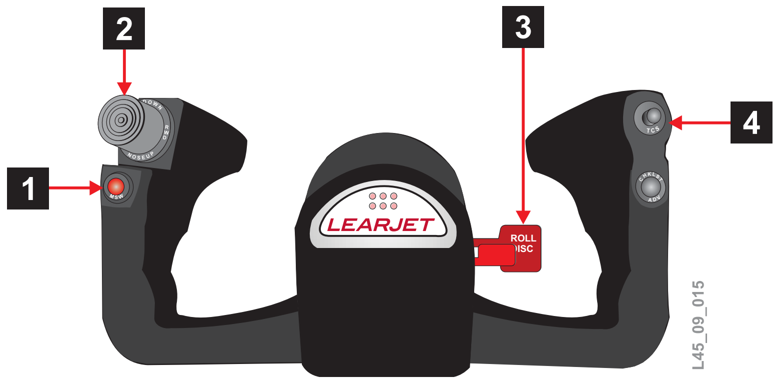


Figure 1 - Pilot Control Wheel Switches and ROLL DISC Lever

1 MSW (Master Switch) Button

- Emergency method of canceling undesired trim or spoiler actions
- When either master switch is pushed:
  - Spoiler shutoff valve closes (only on aircraft prior to 45-295 NOT incorporating SB 45-27-20)
  - Electrical power is removed from all trim actuators and autopilot servos
  - Flap power unit arming valve closes
  - If the malfunction is not remedied and the master switch is released, then the condition resumes
- White WHEEL MSTR CAS message appears if either master switch is pushed, or if a switch loses power. This message is accompanied by the white PRI TRIM FAULT CAS message

2 Trim Switches

- NOSE UP/NOSE DN—Horizontal stabilizer moves in the noseup or nosedown direction, respectively
- LWD/RWD—Aileron trim actuator moves in the left wing down or right wing down direction, respectively
  - Arming button in the center of the switch must be simultaneously pushed while deflecting the barrel to activate the related trim function
  - Depressing the arming button while the autopilot is engaged disconnects the autopilot
  - Pilot trim switch overrides the copilot switch in all functions

3 ROLL DISC Lever

- Separates the aileron control system from the pilot control wheel
    - Control by the pilot control wheel is limited to spoilerons only
    - Copilot wheel remains connected to the aileron control system
    - White or amber (as appropriate) ROLL DISC CAS message appears
- Pushing the ROLL DISC lever re-engages the aileron control system with the pilot control wheel

4 TCS (Touch Control Steering) Button

- Pushing the TCS button permits manual control of the aircraft without disengaging the autopilot
    - Clutch on pitch, yaw, and aileron servos are released
    - Flight director command bar aligns with the current aircraft pitch and roll attitude
    - Amber TCS appears in the primary flight display

Forward Pedestal Panel

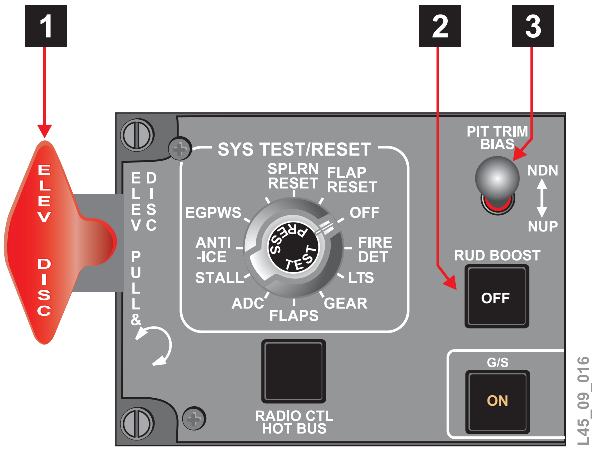


Figure 2 - Forward Pedestal Controls

1 ELEV DISC Handle

- Pull—Disengages both elevator disconnect units
    - Rotate 90º in either direction—Locks in position
    - Pilot control wheel operates the left elevator, and the copilot control wheel operates the right elevator
- Push (the handle back in)—Re-engages the disconnect units
- White (inflight) or amber (on the ground) ELEV DISC CAS message appears

2 RUD BOOST Switch

- OFF (illuminated)—System is turned off
- Switch blank—System is turned on

3 PIT TRIM BIAS Switch (lever-lock, spring-loaded)

- NDN (nosedown)—Biases the elevator in the nosedown direction
- NUP (noseup)—Biases the elevator in the noseup direction
- PIT TRIM BIAS (red) CAS message—Pitch trim bias is not at zero/neutral position (on the ground when thrust levers advanced for takeoff)
- PIT TRIM BIAS (white) CAS message—Pitch trim bias is not at zero/neutral position

NOTE **Do not use pitch trim bias during a jammed elevator condition.**

Trim Panel

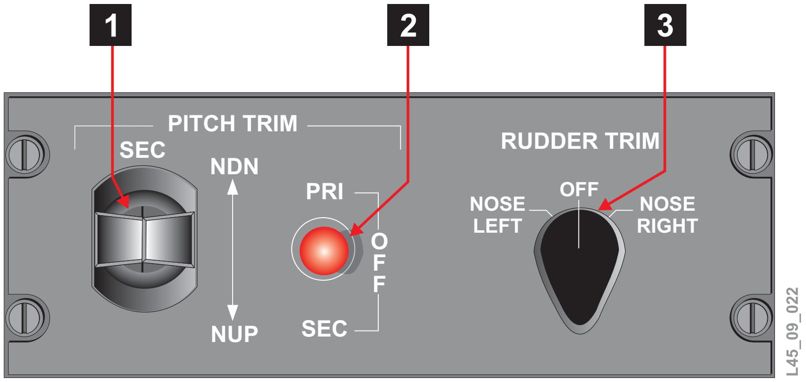


Figure 3 - PITCH TRIM and RUDDER TRIM Switches

1 SEC Switch (dual-element)

- When PITCH TRIM selector switch is set to SEC:
  - NDN (nosedown)—Moves the horizontal stabilizer in the nosedown direction
  - NUP (noseup)—Moves the horizontal stabilizer in the noseup directionPRI (primary)—Horizontal stabilizer is controlled by the No. 1 IC–600 integrated computer. Control is accomplished through either control wheel pitch trim switch

2 PRI-OFF-SEC Switch (lever-lock)

- OFF—Both trim systems are disabled
- SEC (secondary)—Horizontal stabilizer is controlled by the No. 2 IC–600 integrated computer
- Stabilizer is controlled via the SEC switchNOSE LEFT—Moves rudder trim tab in the nose left trim direction

3 RUDDER TRIM Switch (dual element, spring-loaded)

- OFF—Normal position
- NOSE RIGHT—Moves the rudder trim tab in the nose right trim direction

---

SPOILER and FLAPS Levers

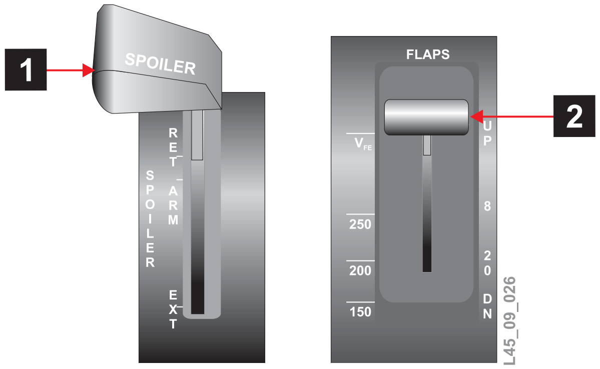


Figure 4 - SPOILER and FLAPS Handles

1 SPOILERS Lever

- RET (retract)—Spoilers fully retract
- ARM—
  - Spoilers automatically deploy after landing or during rejected takeoff if the following requirements are met:
    - Both squat switches are in the ground mode
    - Both thrust levers are retarded to idle or cutoff position
    - Wheel speed signal from each main gear is above 60 kt (from either wheel)

NOTE **During automatic deployment, the spoilers lever does not move.**

- Spoilers remain extended until the SPOILERS lever is selected to RET. However, the spoiler panels automatically retract if a thrust lever is subsequently advanced from idle

- EXT (extend)—
  - Spoilers extend up to 60º depending on indicated airspeed and flap position. When airborne, spoilers should not be extended when flaps are extended
  - Unmarked detents between the ARM and EXT positions provide spoiler extension to 15 and 28°
  - Intermediate positions produce spoiler panel extension commensurate with SPOILER lever position
  - White, amber, or red (as appropriate) SPOILER EXT CAS message is displayed
  - On the ground, spoilers extend fully if EXT is selected

2 FLAPS Lever

- Selects flaps—Detent positions: 0, 8, 20, and 40º
  - Flaps do not move unless the handle is moved from one detent position to another position

NOTE **Flaps should not be extended while spoilers are extended, except on the ground.**

RUDDER PEDAL Switch

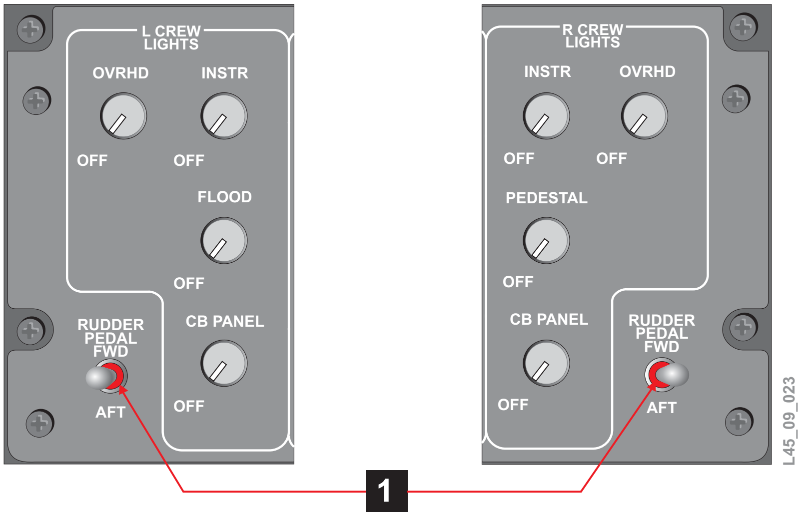


Figure 5 - RUDDER PEDAL Switch

1 RUDDER PEDAL Switch

- FWD (forward)—Rudder pedals move forward
- AFT—Rudder pedals move aft

Stall Warning

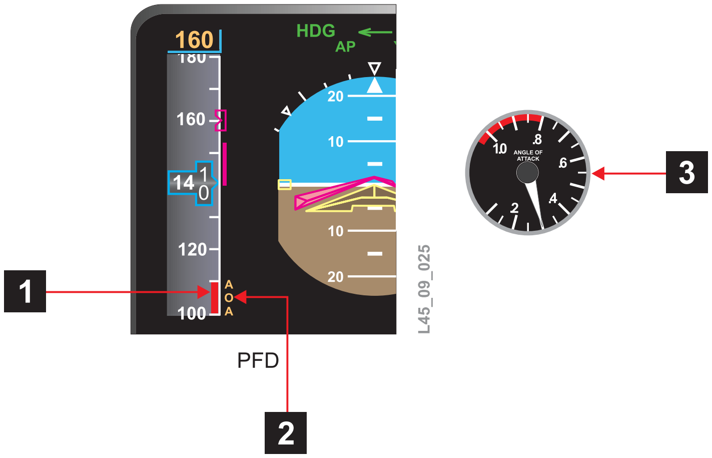


Figure 6 - Stall Indications

1 Low Speed Awareness Cue

- Top of low-speed awareness (LSA) bar is indicated airspeed at stick-shaker activation
- At this point stall warning computer activates the stickshaker on the respective control column
- Stall warning system repeats “Stall” aural alerts

2 Invalid Data Indication

- AOA (amber)—Indicates invalid data input to either IC–600 integrated computer

3 Angle-of-Attack Indicator (optional)

- Red segment—Indicates warning/stall range based on current setting
  - Shaker at .8 units
  - Stall at 1.0 units

SYS TEST/ RESET Panell

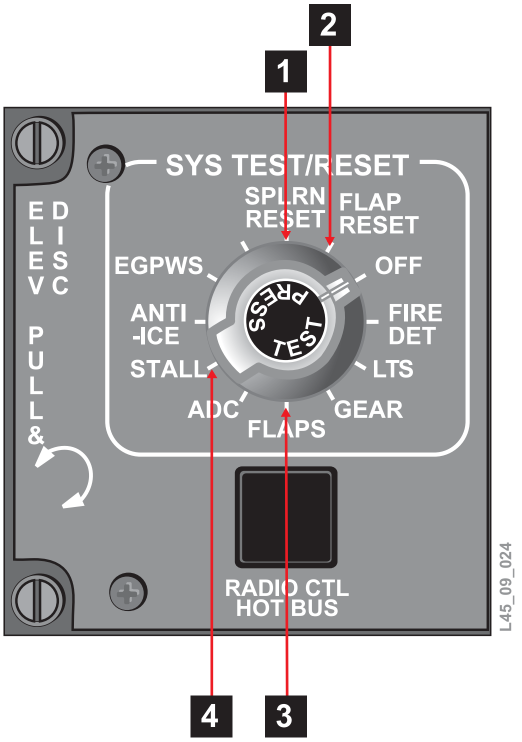


Figure 7 - SYS TEST/RESET Panel

1 SPLRN RESET Position

- Resets spoiler controller

2 FLAP RESET Position

- Resets flap control unit

3 FLAPS Position

- Observe the following indications:
    - Master CAUT flashers and single chime are activated
    - Amber FLAPS FAIL CAS message appears
    - Amber FLAPS FAULT CAS message appears
    - Amber/boxed flap position shown on EICAS full time display

4 STALL Position

- Initiates a 10-second test beginning with the pilot channel followed by the copilot channel. Observe the following indications:
    - Master CAUT flashers and single chime activate
    - Red ADC TEST appears above the PFD
    - Red LSA on PFD moves up

- Indication on AOA indicator increases (optional equipment)
- AOA HT FAIL CAS message appears
- “Stall” aural alert activates
- Stickshaker activates

EICAS/MFD Flight Controls System Page

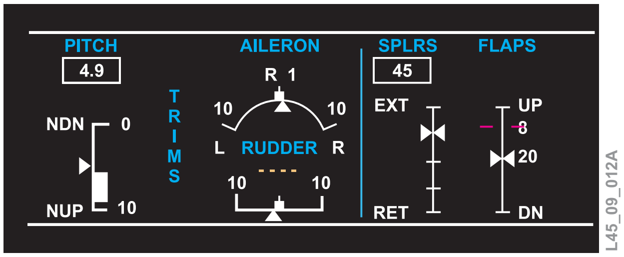


Figure 8 - EICAS/MFD Flight Controls System Page

Table 1 - EICAS/MFD Flight Controls System Page

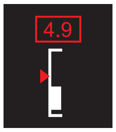
Description	Symbol	Condition
Pitch trim position display		Aircraft in air
		Weight on wheels Pitch trim position not between 5.3 and 8.7
		Weight on wheels Pitch trim position not between 5.3 and 8.7 Thrust lever at or beyond maximum cruise (MCR)
		Invalid pitch trim data

Table 1 - EICAS/MFD Flight Controls System Page (Cont)

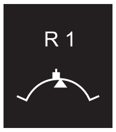
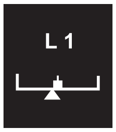
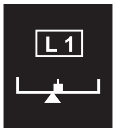
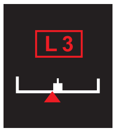
Description	Symbol	Condition
Aileron trim position display		Aircraft in air
		Weight on wheels Aileron trim position not between –2 and +2
		Weight on wheels Aileron trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
		Invalid aileron trim data
Rudder trim position display		Aircraft in air
		Weight on wheels Rudder trim position not between –2 and +2
		Weight on wheels Rudder trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
		Invalid rudder trim data

Table 1 - EICAS/MFD Flight Controls System Page (Cont)

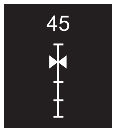
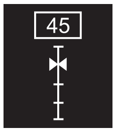
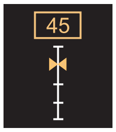
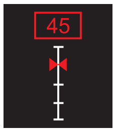
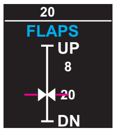
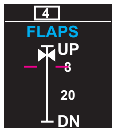
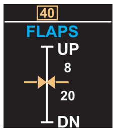
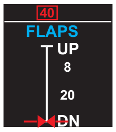
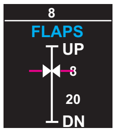
Description	Symbol	Condition
Spoiler position and digital readout		Normal condition for spoiler extended at 45°
		Spoilers extended 45° Weight on wheels Thrust lever at or beyond maximum cruise (MCR)
		Spoilers failure or fault
		Weight on wheels Spoilers extended Thrust lever at or beyond maximum cruise (MCR)
		Invalid spoiler position data

Table 1 - EICAS/MFD Flight Controls System Page (Cont)

Description	Symbol	Condition
Flap position and digital readout		Flap position select Flap position indicated within ±2°
		Flap position select Flap position not indicated within ±2° or Weight on wheels Flaps not set at either 8 or 20°
		Flap failure or Flap fault
		Weight on wheels Flaps not set at either 8 or 20° Thrust lever at or beyond maximum cruise (MCR)
		Invalid flap position data
		Selected flap position

EICAS/MFD Summary Page

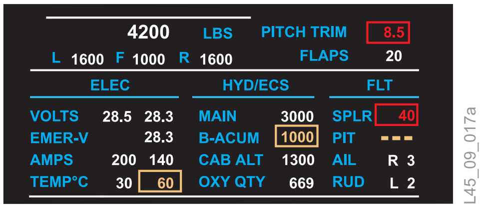


Figure 9 - EICAS/MFD Summary Page

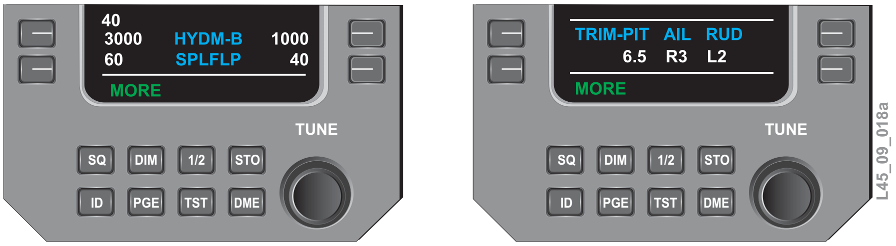
Table 2 - EICAS/MFD Summary Page

Description	Symbol	Condition
Pitch trim readout	5.7	Aircraft in air or Weight on wheels Trim inside the takeoff range
	4.9	Weight on wheels Trim out of takeoff range
	8.5	Weight on wheels Trim out of takeoff range Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid pitch trim data
Flap readout	20	Flap position is selected at 8 or 20°
	40	Weight on wheels Flaps not in takeoff range
	40	Flap failure or fault
	40	Weight on wheels Flaps not in takeoff range Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid indicated flap position

Table 2 - EICAS/MFD Summary Page (Cont)

Description	Symbol	Condition
Spoiler position readout	13	Normal condition of spoilers setting
	5	Weight on wheels Spoilers extended
	20	Spoilers failure or fault
	15	Weight on wheels Spoilers extended Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid spoiler position data
Aileron trim indication readout	R 3	Normal condition of ailerons setting
	R 7	Weight on wheels Aileron trim position not between –2 and +2
	R 7	Weight on wheels Aileron trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid aileron trim data
Rudder trim indication readout	L 1	Normal condition of rudder setting
	L 7	Weight on wheels Rudder trim position not between –2 and +2
	L 7	Weight on wheels Rudder trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid rudder trim position data

RMU Pages



SYSTEM PAGE 1 SYSTEM PAGE 2

Figure 10 - RMU Pages

Table 3 - RMU Pages

Description	Symbol	Condition
Spoiler position readout	13	Normal condition of spoilers setting
	5	Weight on wheels Spoilers extended
	20	Spoilers failure or fault
	15	Weight on wheels Spoilers extended Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid spoiler position data
Flap readout	20	Flap position is selected at 8 or 20°
	40	Weight on wheels Flaps not in takeoff range
	40	Flap failure or fault
	40	Weight on wheels Flaps not in takeoff range Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid indicated flap position

Table 3 - RMU Pages (Cont)

Description	Symbol	Condition
Pitch trim readout	5.7	Aircraft in air or Weight on wheels Trim inside the takeoff range
	4.9	Weight on wheels Trim out of takeoff range
	8.5	Weight on wheels Trim out of takeoff range Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid pitch trim data
Aileron trim indication readout	R 3	Normal condition of ailerons setting
	R 7	Weight on wheels Aileron trim position not between –2 and +2
	R 7	Weight on wheels Aileron trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid aileron trim position data
Rudder trim indication readout	L 1	Normal condition of rudder setting
	L 7	Weight on wheels Rudder trim position not between –2 and +2
	L 7	Weight on wheels Rudder trim position not between –2 and +2 Thrust lever at or beyond maximum cruise (MCR)
	– – – –	Invalid rudder trim position data

CAS Messages

Table 4 - CAS Messages

CAS Message	Conditions/Parameters	Voice Alerts
PIT TRIM BIAS	Pitch trim bias is not at zero on the ground and thrust levers at or above MCR.	“Configuration”
SPOILERS EXT	Spoiler extended with thrust levers at or above MCR on the ground.	“Configuration”
TAKEOFF TRIM	Pitch, aileron, or rudder trim not set for takeoff on ground with thrust levers at or above MCR.	“Configuration”
PIT TRIM MSCMP	Disagreement between pitch trim indication of IC–600s while on ground with thrust lever at or above MCR.	“Configuration”
ELEVATOR DISC	Elevators disconnected or elevator disconnect selected on ground.	
FLAPS FAIL	Flaps not operable or asymmetric shutdown.	
FLAPS FAULT	Degraded flap operation. May be reset manually or automatically.	
MACH TRIM FAIL	Mach trim inoperative while operating above 0.76 M.	
PRI TRIM FAIL	Primary pitch trim failed and is not available. Mach and configuration trim disabled.	
ROLL DISC	Spoiler controller in roll disconnect mode. Pilot control wheel disconnected from ailerons.	
RUD BOOST INOP	Switch is ON, but rudder boost is inoperative.	
SEC TRIM FAIL	Secondary trim failed and is not available. No autopilot available.	
SPOILERS FAIL	Spoiler monitor detected failure. Spoilers retract. May be reset.	
L STALL WARN FAIL	Respective stall system failed. No data available.	
R STALL WARN FAIL		
L R STALL WARN FAIL		
SPOILERS EXT	Spoilers extended with flaps extended beyond 3° (flight only).	
L SPOILER JAM	Respective spoiler jam detected (not accompanied by FAIL).	
R SPOILER JAM		
L R SPOILER JAM		

For Training Purposes Only

Table 4 - CAS Messages (Cont)

CAS Message	Conditions/Parameters	Voice Alerts
AUTOSPLR ARMED	Autospoilers armed.	
ELEVATOR DISC	Elevators disconnected or elevator disconnect selected in flight. Autopilot lost.	
MACH TRIM FAIL	Mach trim disabled while operating below 0.76 M.	
PIT TRIM BIAS	Pitch trim bias not at zero while airborne or on the ground with thrust levers below MCR.	
PIT TRIM MSCMP	Pitch trim indication in disagreement from primary and secondary actuators while airborne.	
PITCH TRIM OFF	Pitch trim switch is selected to OFF.	
PRI TRIM FAULT	IC-600 trim fault detected, primary bypass trim available.	
ROLL DISC	Spoiler controller in roll disconnect mode; pilot control wheel disconnected from ailerons.	
RUD BOOST INOP	Rudder boost switch selected OFF.	
SPOILERS EXT	Spoilers extended (flight or on ground).	
SEC TRIM FAULT	Power-up fault in secondary actuator.	
SEC PITCH TRIM	Secondary pitch selected. Autopilot is available.	
TAKE OFF TRIM	Pitch, aileron, or rudder trim not set for takeoff, on ground and thrust levers below MCR.	
WHEEL MSTR	Displayed when either master switch is pushed, or if a master switch has lost power. Is accompanied by the white PRI TRIM FAULT CAS message.	

Primary Flight Controls

Ailerons

Description

The ailerons (Fig. 11) are operated by cables, bellcranks, and pushrods. Aileron deflection is assisted by a mechanically operated balance tab on each aileron that progressively deflects as aileron deflection increases. The balance tabs deflect in the opposite direction of aileron movement. Roll control is also augmented by a spoileron panel on each wing upper surface.

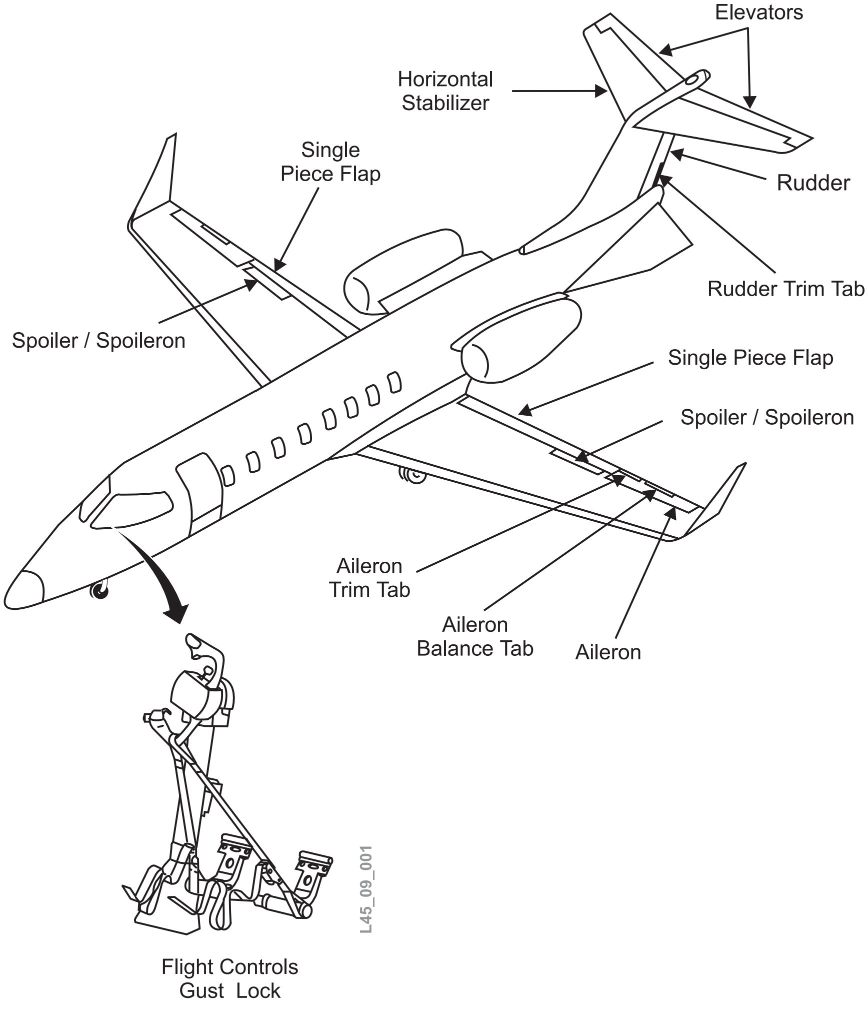


Figure 11 - Flight Control Surfaces

Components

Aileron Disconnect

In case of jamming, the ailerons may be disconnected from the pilot control wheel. After disconnection, bank angle is controlled from the pilot control wheel by the spoilerons. The copilot control wheel remains connected to the ailerons. Aileron trim should not be used during aileron disconnect.

Disconnect ailerons by pulling the ROLL DISC lever on the pilot control wheel (Fig. 12). This activates the ROLL DISC CAS message. The autopilot is inhibited from engagement after aileron disconnection

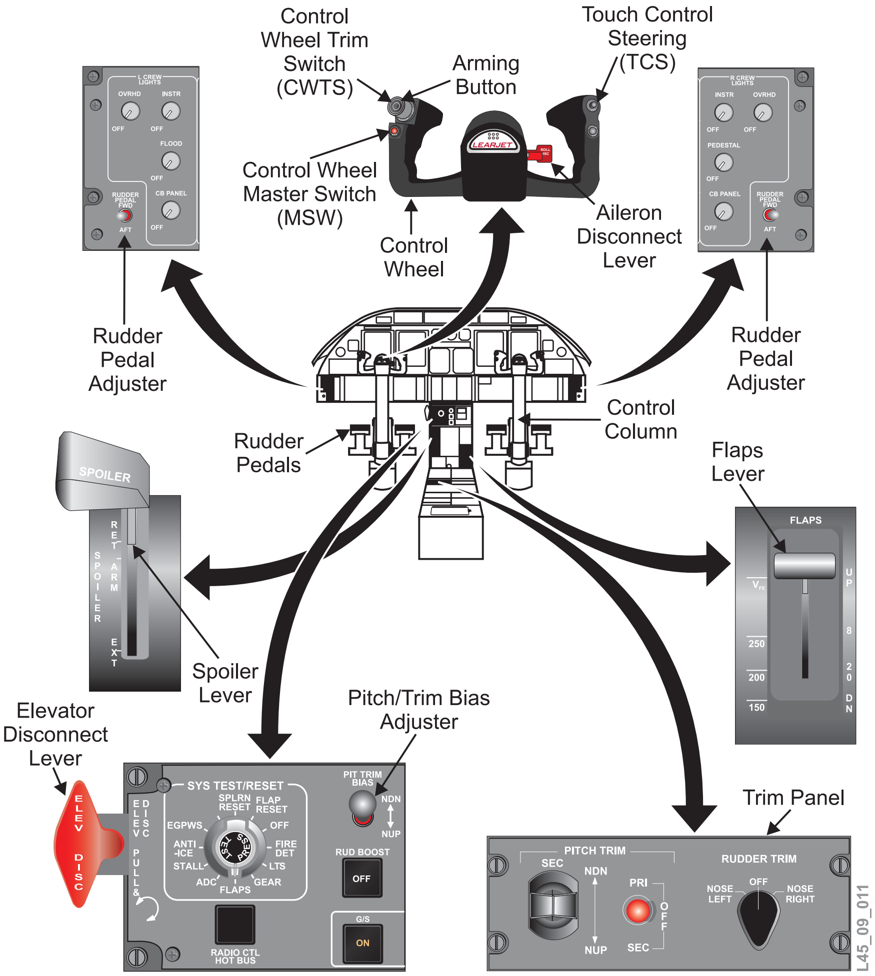


Figure 12 - Cockpit Flight Controls

Aileron Roll Servo

The autopilot controls the ailerons through the roll servo as it maintains the selected lateral mode. Aileron out-of-trim force is monitored by the autopilot (No. 2 IC–600 integrated computer) via feedback circuits in the servo. When the force exceeds a preset threshold, the autopilot activates the aileron trim actuator until the out-of-trim condition disappears.

There is no aileron trim-in-motion alerting. However, if the out-of-trim force against the roll servo is not relieved, the force eventually exceeds the capabilities of the servo (aileron mistrim). This scenario could result in release of the roll servo clutch and a subsequent abrupt change in bank angle.

The amber AP AIL MISTRIM CAS message is displayed if the torque produced by the aileron roll servo becomes excessive.

Elevators

Description

The elevators are operated by independent control cables to each elevator (Fig. 13). This protects against engine rotor burst and facilitates pitch control via a single elevator in case of elevator jamming. The pilot elevator control system directly controls deflection of the left elevator and the copilot system directly controls the right elevator. The control systems are joined together so that the elevators operate as a unit via either control wheel

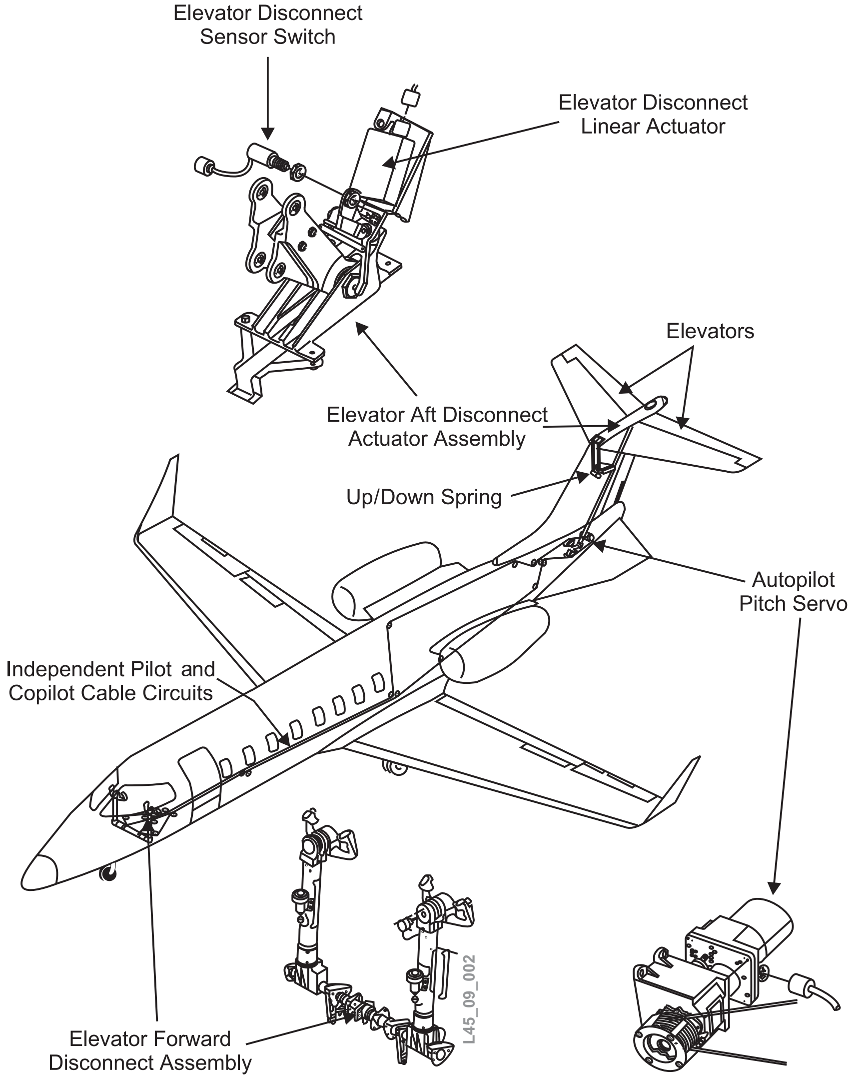


Figure 13 - Elevator Controls

Components

Elevator Disconnect Units

The elevator control runs are joined together by forward and aft disconnect units. The forward unit joins the control column torque tubes while the aft unit joins the elevator bellcranks. Both units are spring-loaded to engage.

If elevator jamming occurs, both disconnect units are simultaneously released by pulling the ELEV DISC handle on the pedestal. Pitch attitude is subsequently controlled by the operable elevator. Pulling the handle mechanically disengages the forward disconnect unit and electrically disengages the aft unit. Electrical power for releasing the aft unit is supplied through the ELEV DISC circuit breaker from the left essential bus. The amber ELEVATOR DISC CAS message is displayed when the elevators are disconnected.

Elevator Up/Down Spring

To enhance pitch stability throughout the airspeed envelope, elevator control resistance is increased as airspeed increases. This design results in relatively stiff pitch control at high speeds and minimal resistance at approach speeds. Control resistance is accomplished by deflecting the elevator up as the stabilizer moves up (nosedown trim) through compression of the up/down spring in the mechanism that operates the left elevator pushrod. The resistance is transmitted to the right elevator as long as the elevators are joined.

Elevator Pitch Servo

The autopilot controls the elevator via a servoactuator in the elevator control linkage. The servoactuator includes an electric motor and clutch assembly that responds to autopilot commands. The clutch engages (electrical power applied) only when the autopilot is engaged and is disengaged by:

- Disengaging the autopilot
- Pushing either control wheel master switch
- Pushing the touch control steering (TCS) switch on either control wheel (does not disengage the autopilot)

The pitch servo receives electrical power through the AFCS SERVOS circuit breaker from the left main bus.

Rudder

Description

The rudder is operated by independent cables to a common bellcrank. A separate control cable from each set of rudder pedals protects against rudder control loss due to engine rotor burst.

An integral trim tab accomplishes rudder trimming. A yaw servo accomplishes rudder boost and yaw damping functions.

Components

Rudder Pedal Adjustment

Each set of rudder pedals is adjustable fore-aft to accommodate differences in pilot leg length. The rudder pedals are moved by an electric motor via control of the RUDDER PEDAL switch on the respective lower panel. Electrical power is supplied through the respective main bus and RUD ADJUST circuit breaker.

Pedal Force Sensors

Each rudder pedal assembly includes a force sensor that monitors the force imposed by the pilot. Each sensor provides a dual output monitored by the No. 2 IC–600 integrated computer that controls the nosewheel steering and rudder boost systems. The force detected by one sensor or a combination of sensors between sets of pedals controls nosewheel steering and rudder boost system response.

Flight Controls Gust Lock

The gust lock prevents damage to the primary flight control surfaces due to high wind or jet/propeller blast. The gust lock consists of two straps that are applied to the pilot control wheel and rudder pedals. When installed, the rudder pedals are centered with full left aileron and full nosedown elevator.

Operation

Yaw Damper System

Yaw damping is accomplished by the yaw servo, which includes an electric motor and clutch assembly that responds to autopilot yaw damper commands. The yaw servo clutch engages only when yaw damping is active. When engaged, the motor operates cables attached to the bellcrank on the rudder torque tube.

Yaw damping is controlled by the YD button on the flight guidance control panel. Yaw damping is canceled by any of the following:

- Pushing either control wheel master switch
- Pushing the YD switch
- Pushing the touch control steering (TCS) switch on either control wheel

Electrical power for the yaw servo is supplied through the AFCS SERVOS circuit breaker from the left main bus.

Rudder Boost System

The rudder boost system automatically augments the rudder force required to hold a heading after an engine failure during takeoff through the rudder servo. The degree of assistance is proportional to the total force exerted on the rudder pedals as detected by the rudder pedal force sensors.

The rudder boost system is controlled by the RUDDER BOOST switch on the pedestal in conjunction with the No. 2 IC–600 integrated computer. The system is armed when flaps are extended beyond 3° and airspeed is below 180 KIAS. The system is activated when 50 lb force (on one pedal or in combination) is subsequently detected by a rudder pedal force sensor. Yaw damping is automatically inhibited when rudder boost is active.

The green RB annunciation appears on each PFD when rudder boost is active. If the system is disengaged while active, the RB annunciation turns amber and flashes on both PFDs for five seconds and then becomes steady.

The white RUD BOOST INOP CAS message is displayed when the RUDDER BOOST switch is OFF. The amber RUD BOOST INOP CAS message appears when the rudder boost system is inoperative while the switch is ON.

Rudder boost is canceled by pushing and holding either control wheel master switch, or by selecting the RUD BOOST switch to OFF.

Redundant electrical power sources are supplied through the RUD FORCE circuit breaker from the right essential bus and through the NOSE STEER COMPUTER circuit breaker from the left essential bus. If both power sources fail, the No. 2 IC–600 integrated computer disables the rudder boost system and the amber RUD BOOST INOP CAS message is displayed.

Trim Systems

Description

Control Wheel Trim Switches

The trim switch on each control wheel facilitates manual trim control (Fig. 14). Pitch or roll trim is commanded by deflecting the switch in the desired direction. An integral arming button in the center of each trim switch has to be simultaneously pushed to activate the trim servos.

If the autopilot is engaged, manual pitch trim commands may be entered by deflecting the trim switch in the desired direction without pushing the arming button. Depressing the arming button disconnects the autopilot. The pilot trim switch overrides the copilot switch in all functions.

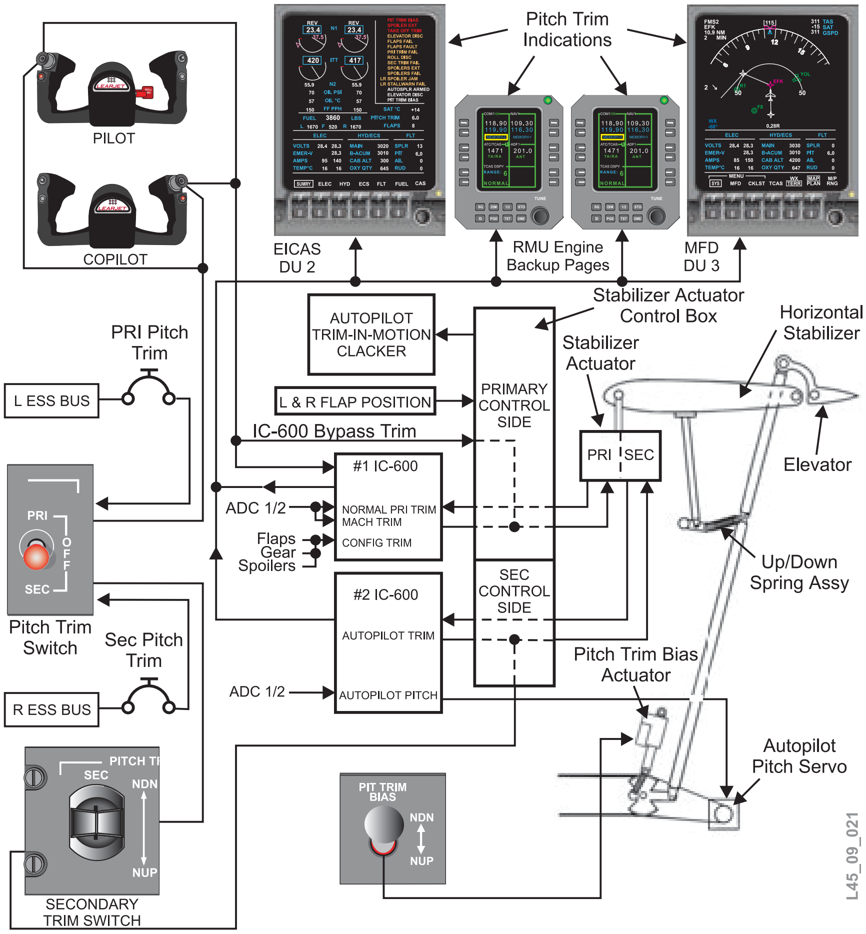


Figure 14 - Elevator and Pitch Trim System

Control Wheel Master Switches

Each control wheel includes a master switch for emergency canceling of runaway or improper operation of the following systems:

- Trims
- Spoilers
- Rudder boost
- Yaw damper
- Mach trim
- Configuration trim
- Pitch trim bias
- Autopilot

Operation

The operation of all systems are disabled for as long as either switch is pushed. The runaway/improper operation resumes when the master switch is released if the malfunction is not remedied by turning the affected system off or isolating the electrical power supply.

The white WHEEL MSTR CAS message is displayed when either master switch is pushed or a master switch has lost power. This message is accompanied by the white PRI TRIM FAULT CAS message.

Aileron Trim

Aileron trim is accomplished through deflection of the aileron trim tab on the left aileron. Trim selection by either trim switch activates the electric trim actuator in the appropriate direction. The aileron trim tab can be deflected up to 10 units either side of center.

There are no CAS indications for the aileron trim system, and there is no backup system. During approach and landing, only light control forces are required to compensate for a full aileron trim condition. Power for aileron trim is supplied through the TRIM-AIL circuit breaker from the left essential bus.

Aileron trim tab position is displayed in units on the EICAS SUMRY and FLT page displays. During takeoff, the red TAKEOFF TRIM CAS message is displayed and takeoff configuration alerting is activated if aileron trim is not set within the takeoff range.

Rudder Trim

Rudder trim is accomplished by the rudder trim tab via control of the RUDDER TRIM switch on the pedestal. Rotating the RUDDER TRIM switch activates the electric trim actuator in the appropriate direction. The rudder trim tab can be deflected up to 10 units either side of center. There are no CAS indications for the rudder trim system and there is no backup system.

The RUDDER TRIM switch is a dual-element switch. System operation requires that both elements be simultaneously operated in the desired direction. Runaway rudder trimming is canceled by pushing either control wheel master switch. Electrical power is supplied through the TRIM-RUD circuit breaker from the right essential bus.

Rudder trim tab position is displayed in units on the EICAS SUMRY and FLT page displays. During takeoff, the red TAKEOFF TRIM CAS message is displayed and takeoff configuration alerting is activated if rudder trim is not set within the takeoff range.

Horizontal Stabilizer Trim

A variable-incidence horizontal stabilizer accomplishes pitch trimming via an electric screwjack actuator. The stabilizer is hinged to the vertical stabilizer at the trailing edge and the leading edge moves up or down under control of the actuator in a range from 0 (full nosedown) to 10 (full noseup) units. The actuator incorporates primary and secondary sections that contain separate electric motors and control circuits. However, both motors drive a common transmission to operate the screwjack.

Trim-in-motion via the autopilot is indicated by an audible “clacker” alert that is activated whenever the autopilot commands a continuous stabilizer movement for more than 2 to 3 seconds. The clacker is not activated by any other means of stabilizer movement. The trim-in-motion system is supplied through the L WARN PANEL circuit breaker from the left essential bus.

The primary motor responds to manual pitch trim commands from the control wheel trim switches in conjunction with the No. 1 IC–600 integrated computer, which also controls the configuration and Mach trim functions. The secondary motor serves as a backup system to the primary system and responds to manual commands via the SEC switch on the pedestal and to autopilot signals from the No. 2 IC–600 integrated computer.

The desired trim system is selected by the PRI-OFF-SEC switch on the pedestal. The primary system (PRI) is normally selected for all operations, which also allows stabilizer trim control by the autopilot by the secondary system.

If on the ground, both stabilizer trim systems perform a self-test at power-up. The related white TRIM FAULT CAS message is displayed if failures are detected.

Stabilizer Primary Trim System

The primary trim system is normally used for all operations. When selected, manual pitch trim commands, trim speed, and the Mach trim and configuration trim functions are controlled by the No. 1 IC–600 integrated computer. Trim speed proportionally decreases with airspeed increase to prevent oversensitive pitch control. Airspeed data is supplied by both air data computers for use by the trim speed and Mach trim functions. Electrical power is supplied through the TRIM-PRI PITCH circuit breaker from the left essential bus.

Configuration Trim

When primary trim is selected, the No. 1 IC–600 integrated computer monitors flap position, selected spoiler position, and selected landing gear position. The stabilizer automatically adjusts to compensate for the pitch forces induced by a spoiler/flap/gear configuration change. Configuration trim only operates when the autopilot is off and primary trim is selected. Configuration trim function is accomplished by the autopilot when it is engaged. The configuration trim function is inhibited if either control wheel master switch is pushed.

Mach Trim

The Mach trim function automatically increases noseup stabilizer trim as Mach number increases to counteract the nosedown tendency associated with high Mach numbers. The Mach-trim-off threshold is 0.76 M at 23,400 ft and increases proportionally to 0.78 M at 42,000 ft. Mach trim is required above 0.78 M at all altitudes. Mach trim becomes an integral function of the autopilot when it is engaged.

The Mach trim function is overridden by pitch trim signals from the control wheel trim switches. When the trim switch is released, the Mach trim system synchronizes to the new stabilizer position and resumes operation. The Mach trim function is inhibited if either control wheel master switch is pushed.

The MACH TRIM FAIL CAS message is displayed if Mach trim system failures are detected. The message is white if the current Mach indication is less than the Mach-trim-off threshold and becomes amber if operating above the threshold. When the MACH TRIM FAIL CAS message is displayed and the autopilot is not engaged, the overspeed cue on the airspeed indicator automatically resets to the current Mach-trim-off threshold. If the autopilot is engaged, the overspeed cue remains at 0.81 M.

Autopilot Pitch Trim

The autopilot controls the elevators through the pitch servo as it maintains the selected vertical mode. Elevator out-of-trim force is monitored through feedback circuits in the servo. When the force exceeds a preset threshold, the autopilot activates the secondary stabilizer trim actuator until the out-of-trim condition disappears.

Sustained stabilizer trimming for more than 2 to 3 seconds via the autopilot activates the audible trim-in-motion “clacker” to alert the crew. If the out-of-trim force against the pitch trim servo is not relieved, then the force will eventually exceed the capabilities of the servo (pitch mistrim). This scenario could result in release of the clutch and a subsequent abrupt change in pitch attitude.

The AP ELEV MISTRIM CAS message is displayed when the torque produced by the pitch servo reaches 40% of its capacity. The message is initially shown in white and turns amber if the out-of-trim condition continues longer than 15 seconds.

Stabilizer Secondary Trim Control

The secondary trim system is activated when the PRI-OFF-SEC switch is selected to SEC. In this mode, manual pitch trim is controlled by the dual-element SEC switch in conjunction with the No. 2 IC–600 integrated computer. Pitch commands from the control wheel trim switches are disabled and the Mach and configuration trim functions provided by the primary system are lost. Pitch trim control by the autopilot is not affected. The secondary trim system always operates the stabilizer actuator at a slow rate.

The white SEC PITCH TRIM CAS message is displayed when secondary trim is selected. Electrical power is supplied through the TRIM SEC PITCH circuit breaker from the right essential bus.

Pitch Trim Computer Faults (Bypass Trim Mode)

In normal operation, each IC–600 integrated computer monitors its own command outputs that are compared to the position and rate signals received from the respective actuator section. In bypass mode, pitch commands from the related trim switch(es) bypass the failed computer and directly control the stabilizer actuator.

If a computer fault occurs, the affected computer fails passive and the associated trim system automatically reverts to bypass mode, which triggers display of the related white TRIM FAULT CAS message. Momentarily pushing either control wheel master switch may clear the fault and message.

Primary System Bypass Mode

If the primary trim system is in bypass mode, stabilizer trim speed operates at either high or low rates depending on the position of both flaps. If flap extension is less than 3° or a disagreement in flap position is detected, then the stabilizer moves at a slow rate. Otherwise, the stabilizer trim operates at a high rate. The secondary trim system always operates at a slow rate.

The configuration and Mach trim functions are lost when the primary trim system operates in bypass mode. Use of the autopilot is lost if the secondary system reverts to bypass mode.

Pitch Trim Actuator Faults

If an actuator fault occurs, all operation of the affected trim system is inhibited and the related amber TRIM FAIL CAS message appears. In this case, the crew must revert to the other trim system for stabilizer trim control.

Pitch Trim Bias

If stabilizer jamming occurs and an out-of-trim condition exists, the tension imposed by the elevator up/down spring can be biased (overridden) via the PIT TRIM BIAS switch on the forward pedestal. Pitch trim bias should not be used during elevator disconnect.

The pitch trim bias system operates an electric motor in the lower elevator bellcrank assembly. Operation of the motor modifies the geometry of a spring assembly that offsets the force imposed by the elevator up/down spring. Pushing either control wheel master switch cancels pitch trim bias operation as long as the switch is pushed.

The PIT TRIM BIAS CAS message is displayed anytime the pitch trim bias unit is not in the neutral/zero position. Electrical power is supplied through the PIT TRIM BIAS circuit breaker from the right essential bus.

Trim Indicating

The pitch trim (stabilizer) setting is continuously shown on the EICAS display below the CAS window. Pitch, aileron, and rudder trim positions are shown on the SUMRY and FLT synoptic pages, and RMU backup pages.

Secondary Flight Controls

Flap System

Description

The aircraft is equipped with a single-slot Fowler flap panel on each wing that is operated by two screwjack actuators (Fig. 15). The flaps are controlled by the flap control unit that controls operation of the hydraulic flap power unit. The outboard actuator on each flap panel provides flap position signals that are monitored by the flap control unit and other systems. When flaps are selected to a new position, the configuration trim automatically compensates for pitch forces induced by the configuration change.

The flaps may be selected to 0 (UP), 8, 20, and 40° (DN) by the FLAPS lever, which is an integral part of the flap control unit. Detents are provided for the lever at each position. A gate at the 8º position requires the FLAPS lever be pulled out to move to 0º.

Components

Flap Control Unit

Flap selection signals from the flap control unit are applied to the servo valve in the flap power unit. The flap control unit also provides a timed open signal to the arming valve in the flap power unit when the FLAPS lever is moved to a new detent position. The arming valve does not open if the FLAPS lever is not in a detent position. The valve-open signal automatically cancels when the flaps reach the selected position or 75 seconds has elapsed. Normal flap extension from 0 to 40º does not exceed 10 seconds with both engine-driven hydraulic pumps operating. Up to 60 seconds is required to extend the flaps from 0 to 20º in flight when using the auxiliary hydraulic pump and hydraulic crossflow.

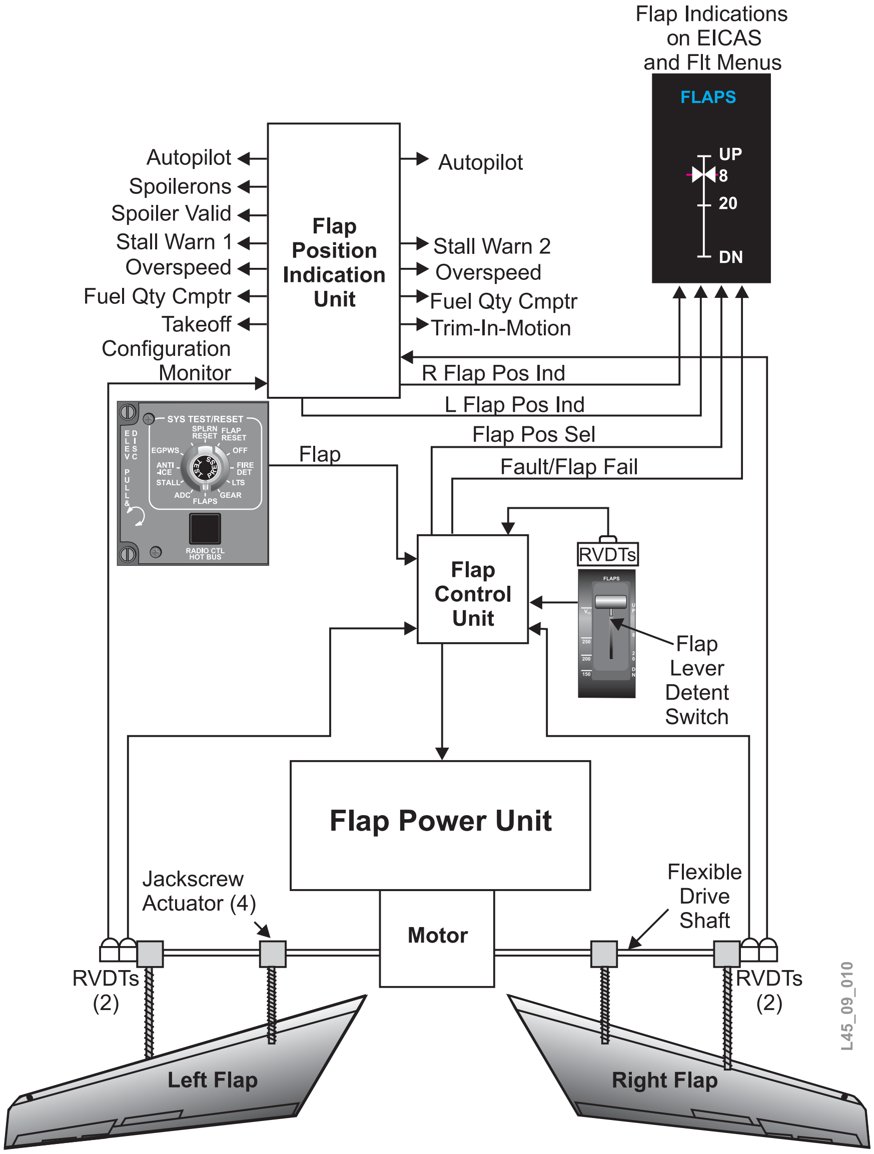


Figure 15 - Flap System

Flap Power Unit

The flap power unit includes the following:

- Hydraulic motor—Drives flexible cables connected to the actuators on each flap panel
- Servovalve—Controls application of hydraulic pressure to the hydraulic motor so it rotates in the proper direction. The control signal to the servo valve is canceled (hydraulic pressure shut off) when the flap position signals indicate flaps have reached the selected position
- Arming valve—Functions as a master valve that controls hydraulic pressure to the flap power unit. Hydraulic pressure downstream of the arming valve is monitored by a pressure switch
- The unit is hydraulic, but to operate, it requires electrical signals from the flap control unit.

Operation

Flap Alerting

Flap position is monitored along with airspeed, weight on wheel, and spoiler and gear positions. Crew alerting is activated if flaps are extended and any of the following conditions exist:

- Flaps are extended beyond 25° and all gear not downlocked
- Flaps are extended beyond 8° while above 15,000 ft at an airspeed above 300 kt
- VFE is exceeded. Flap limit speeds are shown on a placard adjacent to the FLAPS lever (8°–250 kt; 20°–200 kt; 40°–150 kt). In addition, the overspeed indicator on each PFD airspeed scale indicates the maximum speed for the current flap setting
- SPOILER EXT CAS message turns amber if flaps and spoilers are both extended

The flap control unit, supplied through the FLAP CTRL circuit breaker from the right essential bus, performs a self-test at power-up. Thereafter, the unit continuously monitors system components and operation. System malfunctions are classified as either flap faults or flap failures. These malfunctions trigger display of the respective FLAPS FAULT or FLAPS FAIL CAS messages.

The amber FLAPS FAULT CAS message is displayed when any of the following discrepancies are detected. Flap fault conditions allow continued flap system operation at a degraded level.

- Faults in the central processing unit or memory circuits (at power-up)
- Flap position vs. FLAPS lever miscompare (power-up)
- Flap stall (flap position does not reach selected position)
- Arming valve open signal continues longer than 90 seconds
- Hydraulic pressure is detected after flaps reach selected position (arming valve open)

The amber FLAPS FAIL CAS message is displayed when any of the following discrepancies are detected. Flap failure conditions result in closing of the arming valve, which locks the flaps in current position.

- Either flap position transmitter or the FLAPS lever position sensor fails
- Flap asymmetry is detected (2 to 7° or more, depending on airspeed); no reset possible
- Uncommanded movement or movement in the opposite direction to that selected; no reset possible
- Failure of the servovalve
- Hydraulic pressure is not detected after flap selection is made
- Internal failures in the flap power unit

FLAPS FAIL indications not involving flap asymmetry or uncommanded movement may possibly be reset by pushing the TEST button on the SYS TEST/RESET panel. See the Airplane Flight Manual for further information.

The flap system is tested prior to flight by the SYS TEST/RESET panel.

Spoiler System

Description

The spoiler system consists of a hydraulically actuated panel on the upper surface of each wing (Fig. 16). The panels are known as spoiler/spoileron panels, depending on their function, and are controlled by the spoiler controller for all operations.

In the spoiler function, the panels extend symmetrically to induce drag (speed brakes). In the spoileron function, the panels extend asymmetrically to augment aileron roll control. The spoiler and spoileron functions can be mixed.

Components

Spoiler Controller

The spoiler controller controls all spoiler/spoileron functions via electrical control of the servoactuator on each spoiler/spoileron panel. A sensor on each servoactuator provides position signals to the controller. The servoactuators fail to the retracted position if electrical control is lost. The panels subsequently blow down to approximately 10° but do not fully retract.

The spoiler controller also controls the spoiler shutoff valve, which functions as a master valve controlling hydraulic pressure to the servoactuators. A pressure sensor downstream of the valve monitors for hydraulic pressure loss.

The spoiler controller is supplied through the SPLR CTRL circuit breaker from the left essential bus. Spoiler indicating is supplied through the SPLR IND circuit breaker from the right essential bus. If electrical power is lost to the controller the spoilers retract and become inoperative in all modes. If electrical power is lost for indicating, only the spoileron function is available in roll disconnect mode.

The spoiler controller performs a self-test at power-up and thereafter continuously monitors its own operation as well as the operation of other system components (spoiler monitor).

Spoiler controller failures result in fail-safe shutdown of the system through closing of the spoiler shutoff valve and display of the amber SPOILER FAIL CAS message. Runaway spoilers are canceled by pushing and holding either control wheel master switch, which closes the arming valve. Some malfunctions may also be reset via the SYS TEST/RESET panel while airborne or on the ground.

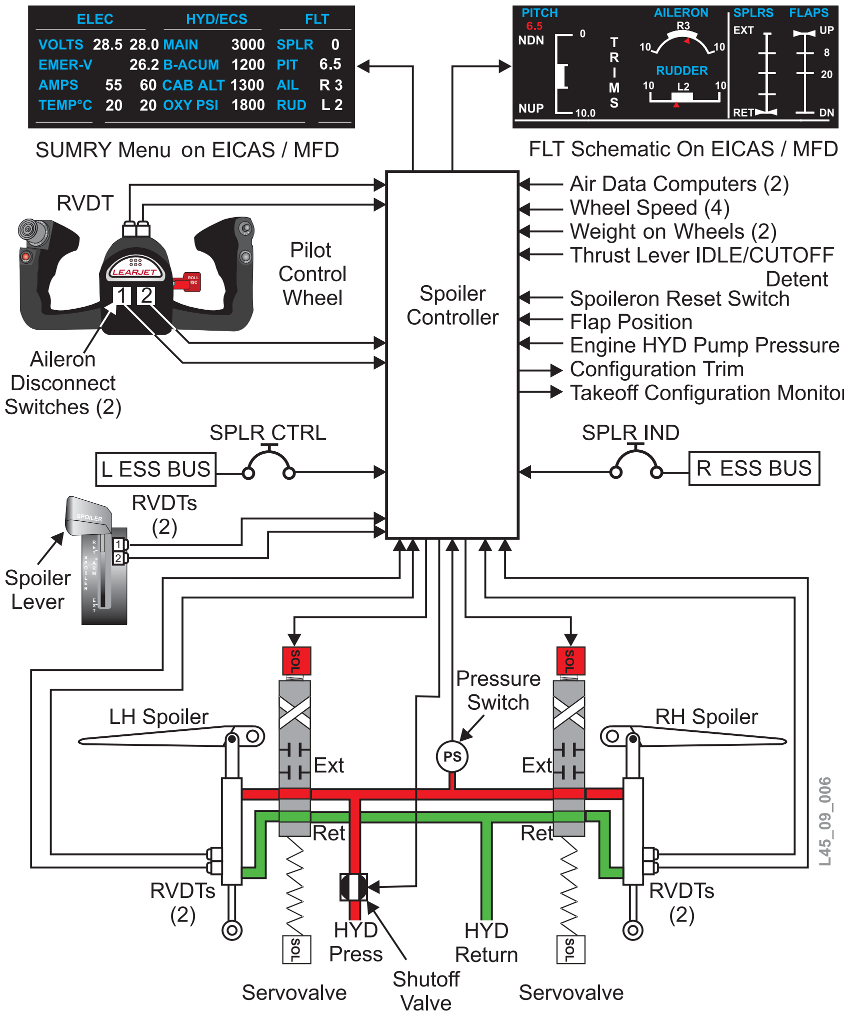


Figure 16 - Spoiler System Diagram

Operation

Spoileron Operation

A roll deflection sensor in the pilot control wheel provides signals to the spoiler controller, which extends the spoileron panel on the wing with the raised aileron. The spoileron panel begins extension at 5° wheel deflection and increases proportionately up to 60°. The spoileron on the side with the lowered aileron remains retracted.

Spoileron extension is limited by indicated airspeed. Full extension is available at speeds up to 175 kt and proportionately decreases to a maximum of 21° at 450 kt.

Roll Disconnect Mode

To overcome a jammed aileron, the aileron control system can be separated from the pilot control wheel, thereby permitting roll control with only the spoileron panels. Aileron disconnection is accomplished by pulling the ROLL DISC lever on the pilot control wheel. The white ROLL DISC CAS message is displayed if the aircraft is on the ground. The amber ROLL DISC CAS message is shown if airborne.

In roll disconnect mode the autopilot is not available, and the control wheel master switches have no affect on spoileron operation.

Spoiler Operation

Spoiler operation is controlled by the SPOILER lever on the pedestal. The lever operating range extends through RET-ARM-EXT ranges, as shown by the adjacent placard.

The lever must be lifted to move it from the RET position. Detents are provided for all labeled positions plus two unlabeled intermediate positions between ARM and EXT (15° and 28°). Spoiler extension is not limited to the detent positions—any intermediate extension is available. The selected spoiler extension angle is displayed on the EICAS SUMRY and FLT pages.

Spoiler operation is summarized as follows:

- Retract (RET) position—Spoiler panels fully retract. The SPOILER EXT CAS message is canceled
- ARM position (autospoilers)—Spoilers are armed for automatic deployment after landing and during aborted takeoffs (lift dump). System arming is indicated by the white AUTOSPLR ARM CAS message. When activated, the spoiler panels extend to 60° in one second. Autospoiler activation requires all of the following conditions are met:
  - Both squat switches must be in ground mode. The spoiler controller latches the signal from each squat switch to “on-ground” when the switch initially enters ground mode. This design prevents spoiler retraction in case of bounced landings
  - Both thrust levers must be retarded to idle or cutoff position

  - A wheel speed signal above 60 kt must be received from each main gear strut (from either wheel)
- Once deployed, the spoilers remain extended until the SPOILER lever is set to RET position. However, the spoiler panels automatically retract if a thrust lever is subsequently advanced from idle
- Extend (EXT) position—Spoiler panels extend up to 60° in 5 to 7 seconds. Intermediate detents between the ARM and EXT positions provide for spoiler extension to 15 and 28°. Intermediate SPOILER lever positions produce proportionate spoiler panel extension. Pitch trim is automatically adjusted by the configuration trim system to compensate for the effects of spoiler extension/retraction
- Spoiler panel extension is limited by indicated airspeed. Full extension is available at speeds up to 175 kt and proportionately decreases to a maximum of 21° at 450 kt, or higher
- Spoiler/configuration alerting is based on the position of the SPOILER lever:
  - White SPOILER EXT CAS message is displayed if the lever is not in the RET position
  - SPOILER EXT CAS message turns amber if flaps are extended. While in flight, spoilers should not be extended while flaps are extended except as specified in the Airplane Flight Manual
  - While on the ground, the red SPOILER EXT CAS message is displayed and takeoff configuration alerting is activated if the thrust levers are advanced for takeoff

Mixed Spoiler/ Spoileron Operation

Spoiler operation is combined with spoileron operation any time both functions are simultaneously activated. Combining the spoileron and spoiler functions results in composite control of the panels that fulfills the functions of both modes. Composite control retains the applicable airspeed limitations of each function but gives priority to the spoileron function.

Examples of spoiler/spoileron mixing are described below, assuming no flap extension or airspeed limitations:

- Spoiler lever at 28° followed by right bank spoileron deflection to 14°. Both panels are initially at 28°. As the control wheel is rotated, the left wing panel proportionately decreases to 14° (an amount equal to the difference between spoiler and spoileron extension commands). The right wing panel remains at 28°
- Spoiler lever at 28° followed by right bank spoileron deflection to 40°. Both panels are initially at 28°. As the control wheel is rotated, the left wing panel proportionately decreases to 0°. Thereafter, extension of the right wing panel proportionately increases to 40°

Spoiler Jamming

The spoiler controller reverts to the spoiler jam mode if the position signal from either panel indicates a jammed panel. In this case, the controller attempts to stow the affected panel and the appropriate amber SPOILER JAM CAS message is displayed. The operative spoiler panel continues normal operation.

Spoiler System Indicating

Spoiler/spoileron indications are shown on EICAS SUMRY and FLT pages as well as on the RMU engine/systems backup pages.

System Testing

While on the ground, spoiler system testing is performed via the SYS TEST/RESET panel when selected to SPLRN RESET. Some malfunctions requiring reset of the spoiler computer may be accomplished via the SYS TEST/RESET panel.

Stall Warning System

Description

Angle of attack (AOA) is monitored by independent stall warning systems that provide visual, audible, and tactile indications of impending stall (Fig. 17). The stall warning computer is comprised of independent pilot and copilot channels. Either channel can independently initiate stall alerting. There are no data comparisons made between channels.

AOA is monitored by a stall vane on each side of the forward fuselage. AOA indications are supplied to the stall warning computer along with altitude information from the associated air data computer and position of the FLAPS lever.

Each channel outputs data to the following components:

- Associated IC–600 integrated computer. The AOA data drives the low-speed awareness bar (LSA) on the related PFD. The LSA bar rises from the bottom of the airspeed tape as the margin to stall warning speed (VSW) decreases. The top of the LSA bar equals indicated airspeed at stickshaker activation. The autopilot is automatically disengaged with stall alerts
- Respective AOA indicator on the flight instrument panels (optional). The indicator is calibrated from .1 through 1.0 to indicate the percentage of lift being produced. Stall alerting begins when the sweep pointer enters the red arc at the .8 point. The indicators are powered through the respective essential bus and STALL WARN circuit breaker

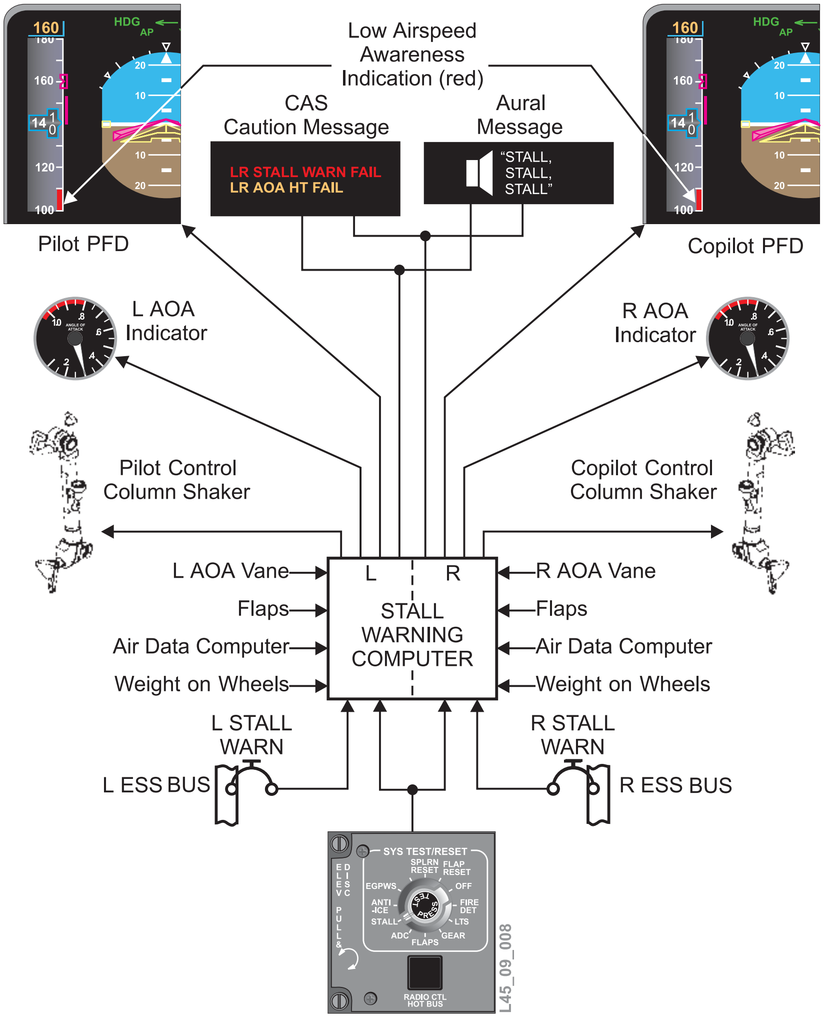


Figure 17 - Stall Warning System

Components

Stall Computers

Each channel of the computer performs a self-test at power-up and continuously monitors its own operation, the operation of other system components, and the reasonableness of data received. Detected malfunctions trigger display of the respective STALL WARN FAIL CAS message. Invalid AOA information is indicated by amber AOA at the lower end of the airspeed scale on the respective PFD. Failure of a stall vane heating circuit causes display of the respective AOA HT FAIL CAS message.

The pilot stall warning channel and stickshaker are supplied through the L STALL WARN circuit breaker from the left essential bus. The copilot channel and stickshaker are supplied through the R STALL WARN circuit breaker from the right essential bus. There are no on-off switches for the stall warning system.

The stall system is tested via the SYS TEST/RESET panel.

Operation

Stall Alerting

Impending stall detected by a stall warning channel triggers activation of the respective control column stickshaker and the repeating “Stall” voice alert. The related AOA indicator also points in the red arc. The stall alerts continue until the angle of attack decreases below the alert threshold.

Stall alerting is inhibited while on the ground and for three seconds after takeoff to eliminate nuisance alerting. The indications on the AOA indicators are valid at all times.

Table of Contents

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FLIGHT INSTRUMENTS

Introduction

The Primus 1000 electronic flight instrument system (EFIS) is an integrated system that displays the following flight information to the flight crew:

- Flight attitude
- Airspeed
- Vertical speed
- Altitude
- Heading
- Course/desired track orientation
- Flight path commands
- Weather and mapping displays
- Source annunciations
- Traffic alerts and collision avoidance system (TCAS) data (optional)
- Enhanced ground proximity warning system (EGPWS) data (optional)

The EFIS is fully integrated with the engine indicating and crew alerting system (EICAS), which displays engine operating information, warning, cautionary, and advisory messages for various aircraft systems.

Other subsystems contained in the Primus 1000 avionics system are discussed in more detail in the chapters that are more applicable for that particular function. The flight guidance controller and flight director are discussed in Chapter 2, Automatic Flight Control System (AFCS). The navigation-related functions of the Primus 1000 system are covered in Chapter 17 Navigation Systems. The EICAS and the crew alerting system (CAS) are covered in Chapter 20, Warnings—Aural and Visual.

Controls and Indications

Primary Flight Display

Attitude Director Indicator Display

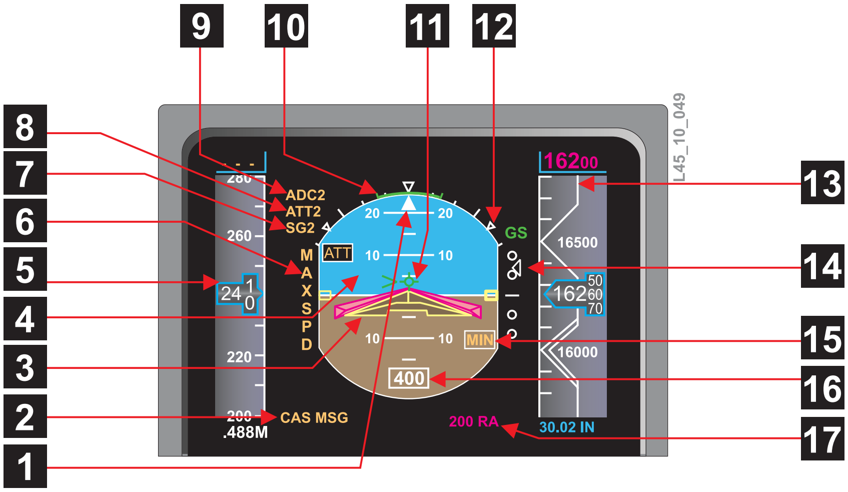

Figure 1 - Attitude Director Indicator Display

1 Roll Pointer

- Indicates the current roll attitude of the aircraft

2 CAS Comparison Monitor Annunciation

- Indicates a discrepancy between the CAS messages in the two integrated computer/signal generator (IC/SG) computers

3 Single Cue Aircraft Symbol

- Stationary representation of the aircraft

4 Flight Path Speed Trend

- Projects the acceleration along flight path of the aircraft
- Moves vertically on a plane next to the flight path angle (FPA) symbol

5 Airspeed Window

- Displays current IAS/Mach of the aircraft

6 Maximum Speed Annunciation

- Flight director detects an impending overspeed condition

7 IC/SG Source Annunciation

- Indicates which IC/SG data is being used

8 Attitude Source Annunciation

- Attitude heading reference system (AHRS) being used when an AHRS reversion is selected

9 Air Data Source Annunciation

- Indicates which air data computer (ADC) is being used when an ADC reversion is selected

10 Low Bank Arc

- A ±14° green arc appears when BNK is selected on the guidance controller

11 Flight Path Angle

- Actual vertical and lateral track of the aircraft

12 Roll Scale

- Linear scale indicating bank angle

13 Altimeter Scale

- Moving altitude scale

14 Vertical Deviation Display

- Displays vertical deviation from the source selected on the display controller

15 Below RA/BARO (radio/barometric) Altitude Minimums Annunciator

- Aircraft is near or at the minimum altitude (BARO or RA) selected

16 Radio Altitude Display

- Radio altitude of the aircraft when below 2500 ft AGL

17 RA/BARO Altimeter Minimums Set Data

- Minimum altitude selected by the flight crew

Airspeed Display

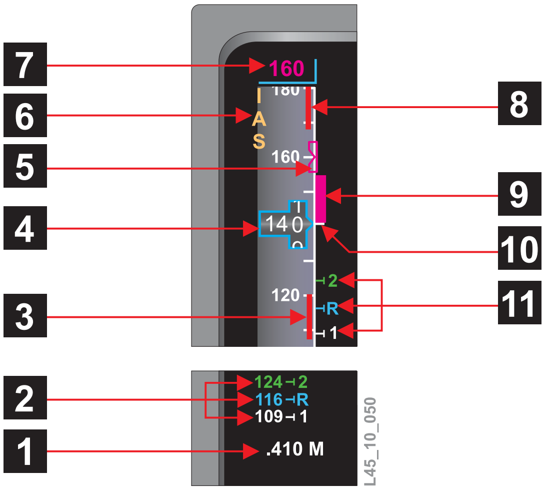

Figure 2 - Airspeed Displays

1 Mach Digital Display

- Current Mach speed

2 V_{SPEED} Set Values

- V_1, V_R, and V_2 are displayed (airspeed less than 40 KIAS)
  - V_1 is shown in white
  - V_R is shown in cyan
  - V_2 is shown in green

3 Low Speed Awareness Tape

- Red line drawn from bottom of the airspeed scale; top located at the stall warning stick shaker speed

4 Current Airspeed Digital Display/Window

- Current indicated airspeed

5 Airspeed Set Bug

- IAS/Mach reference selected on the guidance controller speed set knob

6 Indicated Airspeed/Mach Comparison Monitor Annunciators

- Indicates a difference between the pilot and copilot airspeed data

7 Speed Bug Digital Display

- IAS/Mach reference selected on the guidance controller speed set knob in digital form

8 V_{MO}/M_{MO} Overspeed Tape

- Fixed red bar originating at V_{MO}/M_{MO}

9 Airspeed Trend Vector

- Magenta line drawn from the airspeed reference line to the airspeed the aircraft will achieve in 10 seconds if the acceleration trend continues

10 Airspeed Reference Line

- Current airspeed or Mach number

11 V_{SPEED} Set Bugs

- Takeoff speed bugs (displayed as airspeed increases)

Mach Display

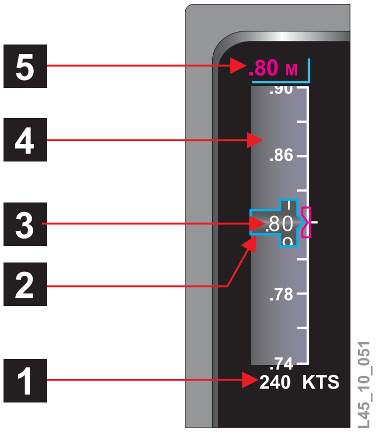

Figure 3 - Mach Display

1 IAS Digital Display

- Indicated airspeed

2 Speed Window

- Digital Mach number window

3 Speed Display

- Mach number digital display

4 Airspeed Tape

- Moving scale display with a fixed pointer and calibrated airspeed/Mach marks

5 Mach Command

- Mach number selected on the guidance controller speed select knob

Altitude Display

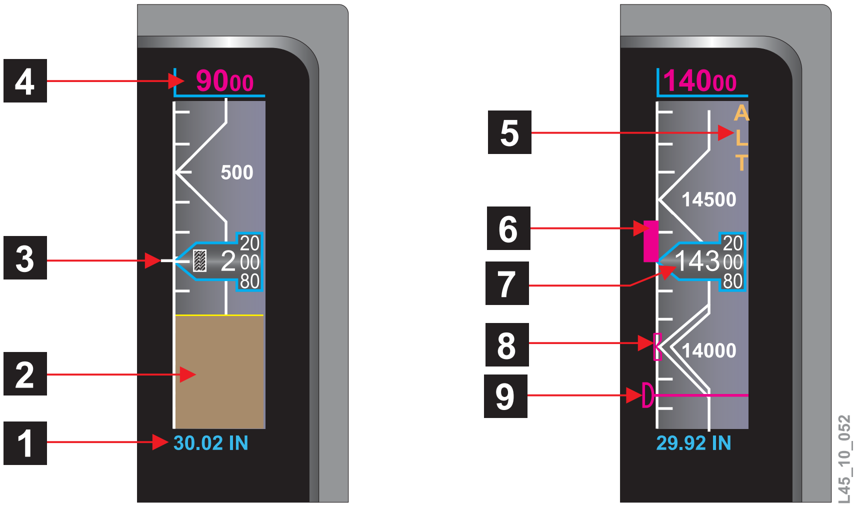

Figure 4 - Altitude Display

1 Barometric Altimeter Setting Display

- Barometric Setting

2 Low Altitude Awareness Symbol

- Appears at 550 ft radio altitude or less

3 Altitude Reference Line

- Current altitude indicated on the altitude scale

4 Altitude Preselect Display

- Altitude selected on the guidance controller altitude select knob

5 Altitude Comparison Monitor Annunciator

- Difference exists between the pilot and copilot display data

6 Altitude Trend Vector

- Altitude that will be reached in six seconds if the current rate of climb or descent does not change

7 Current Altitude Digital Display

- Aircraft altitude in digital format

8 Altitude Select Bug

- Altitude value set in the altitude alert select display

9 Baro Minimums Set Bug

- Selected baro minimums value

Vertical Speed Display

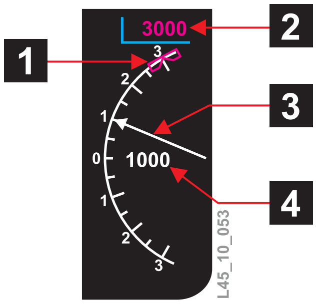

Figure 5 - Vertical Speed Display

1 Flight Director V/S Target Bug

- Value of the vertical speed set on the guidance controller speed set knob

2 Flight Director V/S Digital Target Display

- Digital readout of the vertical speed selected on the guidance controller speed set knob

3 Vertical Speed Pointer

- Aircraft current vertical speed

4 Current Vertical Speed Display

- Aircraft current vertical speed in digital format

Horizontal Situation Indicator Displays

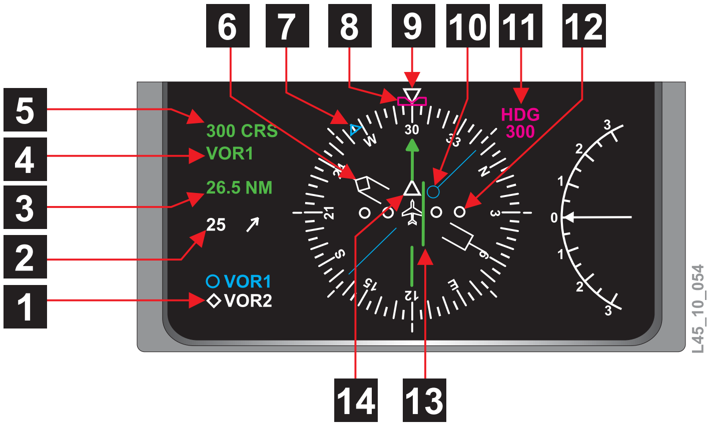

Figure 6 - HSI Display

1 Navigation Source
- Navigation source for selected bearing pointer

2 Wind Indicator
- Shows wind velocity and direction

3 DME
- Distance to selected navigation aid

4 Navigation Source Annunciation
- Current nav aid source selection

5 Course Select/Desired Track Digital Display
- Digital readout of the desired course

6 Bearing 2 Pointer
- Bearing of the selected navigation aid

7 Drift Bug
- Drift angle left or right of the desired track

8 Heading Bug
- Heading selected by the heading knob on the guidance controller

9 Current Heading Lubber Line
- Current heading of the aircraft

10 Bearing 1 Pointer
- Bearing of the selected navigation aid

11 Digital Heading Bug Display
- Heading selected by the heading knob on the guidance controller

12 Course Deviation Scale
- Deviation from the selected course

13 Course Deviation Indicator

- Deviation from the selected course

14 TO/FROM Pointer

- Selected course TO or FROM the navigation aid

PFD Bezel Controller

Figure 7 - PFD Bezel Controller

1 MINIMUMS Set Knob

- Rotate—Sets the radio altitude or barometric altitude minimums

2 RA/BARO Button

- Push—Selects either RA or BARO minimums as the reference on either PFD

3 STD (Standard) Button

- Push—Returns the barometric altimeter correction setting to standard value (29.92 inHg or 1013 hPa)

4 BARO Set Knob

- Rotate—Enters the barometric altimeter correction setting in either inHg or hPa

Display Controller

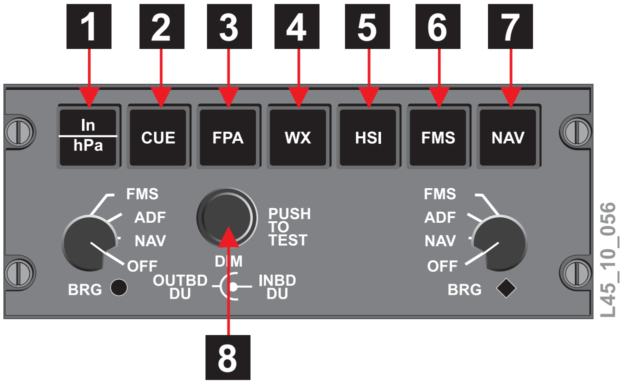

Figure 8 - Display Controller

1 In/hPa Button

- Push—Toggles between setting the altimeter barometric correction in inHg or hPa

2 CUE Button

- Push—Toggles between either a single cue or crosspointer flight director command bar display on both PFDs

3 FPA Button

- Push—Selects the flight path angle symbol to onside attitude indicator

4 WX Button

- Push—Sets the HSI to display an ARC format with weather radar information

5 HSI Button

- Push—Toggles the HSI between a full 360° and an ARC display

6 FMS Button

- Push—Displays FMS information on the onside HSI

7 NAV Button

- Push—
  - Displays VOR/LOC information on the HSI
  - First push displays onside navigation information
  - Second push displays cross-side navigation information

8 DIM Control Knob/Test Button

- Rotate outer knob—
  - Pilot knob controls brightness on No. 1 DU
  - Copilot knob controls brightness on No. 4 DU
- Rotate inner knob—
  - Pilot knob controls brightness on No. 2 DU
  - Copilot knob controls brightness on No. 3 DU
- Push inner button and hold for 5 to 6 seconds—onside DUs enter test mode

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MFD Bezel Controller

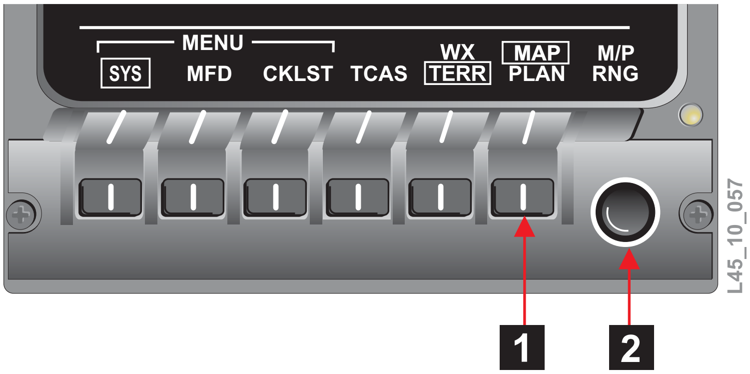

Figure 9 - MFD Bezel Controller

1 MAP/PLAN Selection Button

- Push—Toggles between the two MFD display formats (PLAN-MAP)

2 M/P Range Knob

- Rotate—Changes the range scale in either mode

Standby Airspeed/Mach Indicator and Standby Altimeter

Standby Airspeed/ Mach Indicator

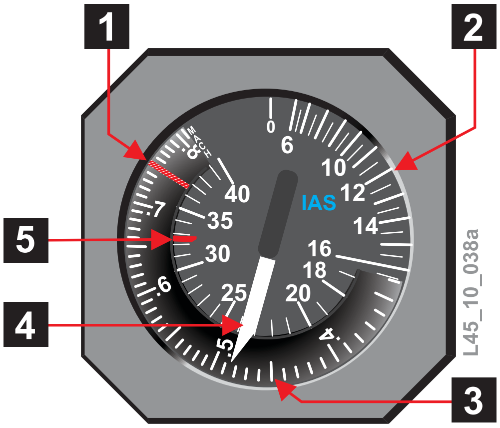

Figure 10 - Standby Airspeed/Mach Indicator

1 Maximum Allowable Mach Number
- Red and white striped radial mark on the Mach subdial indicating M_{MO}

2 Indicated Airspeed Scale
- Indicated airspeed

3 Indicated Mach Scale
- Indicated Mach number

4 Airspeed/Mach Pointer
- Current IAS and Mach number

5 Maximum Allowable Airspeed
- Red radial mark on the airspeed subdial indicating V_{MO}

Standby Compass

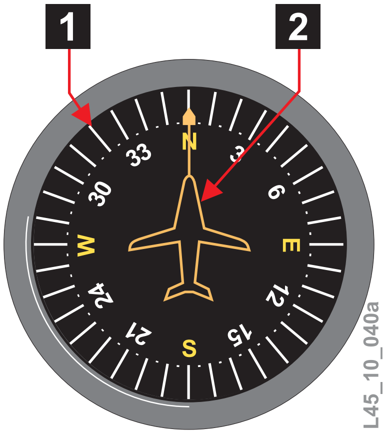

Figure 11 - Standby Compass

1 Compass Rose
- 360° compass dial

2 Lubber Line
- Current aircraft magnetic heading

Standby Altimeter

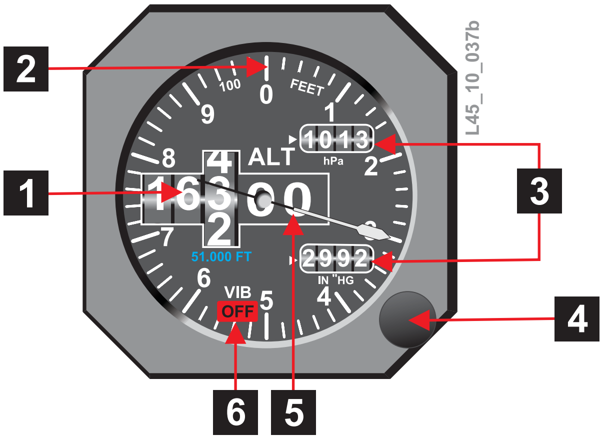

Figure 12 - Standby Altimeter

1 Digital Altitude Counter Drum Display Window
- Current aircraft altitude

2 Altitude Scale
- Aircraft altitude scale

3 Barometric Altitude Correction Setting
- Current barometric setting

4 Barometric Setting Knob
- Rotate—Adjusts the barometric setting

5 Altitude Pointer
- Points to the current altitude of the aircraft

6 OFF Flag
- Indicates a loss of power to the instrument vibrator

Standby Attitude Indicator

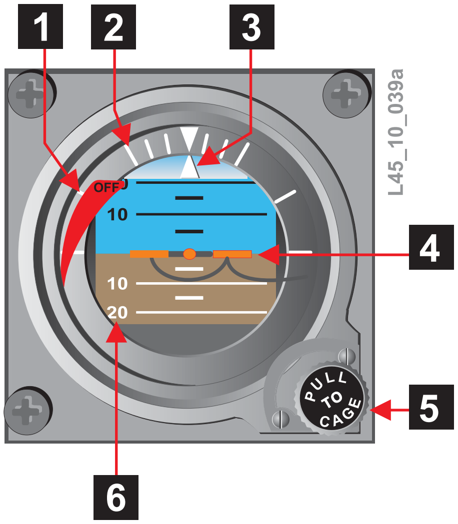

Figure 13 - Standby Attitude Indicator

1 Power Warning Flag
- Indicates proper electrical power supply to the instrument when out of view

2 Roll Scale
- Bank angle marked in 10° increments

3 Roll Pointer
- Current aircraft roll attitude against the roll scale

4 Aircraft Symbol
- Stationary representation of the aircraft

5 Pull-to-Cage Knob
- Pull—Erects and cages the gyro

6 Pitch Scale
- Current pitch attitude of the aircraft

Reversion Controls

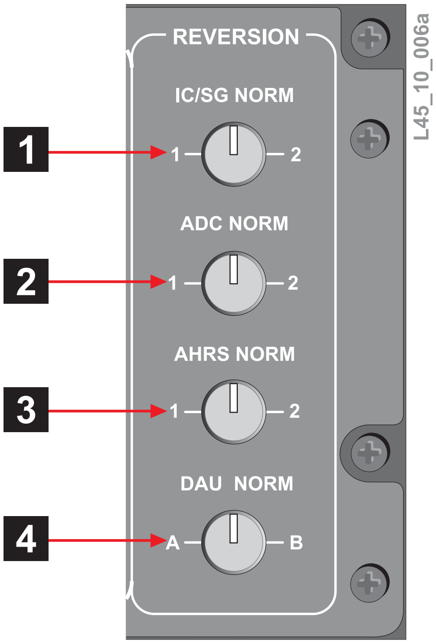

Figure 14 - System Reversionary Controller

1 IC/SG NORM Knob

- Rotate—
  - NORM—No. 1 IC/SG supplies the pilot (left) PFD; IC/SG No. 2 supplies the copilot (right) PFD and MFD
  - 1—No. 1 ADC supplies all displays
  - 2—No. 2 ADC supplies all displays

2 ADC NORM Knob

- Rotate—
  - NORM—ADC No. 1 supplies the onside (pilot) displays; ADC No. 2 supplies the onside (copilot) displays
  - 1—No. 1 ADC supplies all displays
  - 2—No. 2 ADC supplies all displays

3 AHRS NORM Knob

- Rotate—
  - NORM—No.1 AHRS supplies the onside (pilot) displays; No. 2 AHRS supplies the onside (copilot) displays
  - 1—No. 1 AHRS supplies all displays
  - 2—No. 2 AHRS supplies all displays

4 DAU NORM Knob

- Rotate—
  - NORM—Each integrated avionics computer (IC/SG) uses DAU 1, channel 1A and DAU 2, channel 2B
  - A—Each IAC uses DAU 1, channel 1A and DAU 2, channel 2A
  - B—Each IAC uses DAU 1, channel 1B and DAU 2, channel 2B

Display Unit Reversionary Controllers

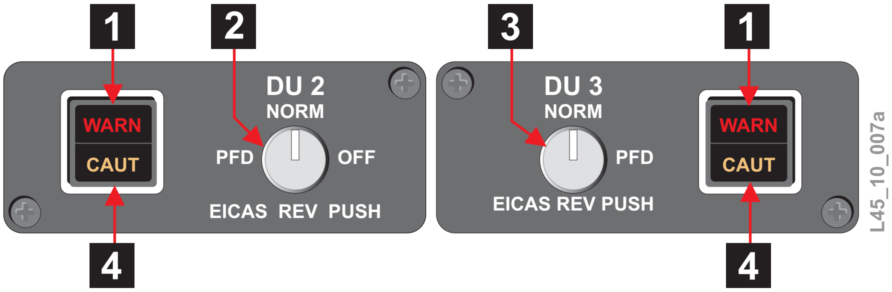

Figure 15 - DU Reversionary Controllers

1 WARN Annunciator

- Push—After flashing, acknowledges display of a warning CAS message

2 NORM/PFD/OFF Knob (Pilot)

- Rotate—
  - NORM—DU 2 has EICAS display
  - PFD—DU 2 shows PFD display originally on DU 1
  - OFF—Turns off DU 2
- Push—Toggles inboard display between EICAS and MFD

3 NORM/PFD/EICAS Knob (Copilot)

- Rotate—
  - NORM—DU 3 has MFD display
  - PFD—DU 3 shows PFD display originally on DU 4
- Push—Toggles inboard display between EICAS and MFD

4 CAUT Annunciator

- Push—After flashing, acknowledges display of a caution CAS message

AHRS Controls

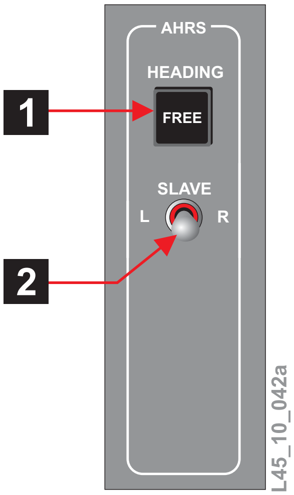

Figure 16 - AHRS Control

1 HEADING FREE Button

- Push—AHRS operates like a directional gyro in determining heading

2 SLAVE (L/R)

- Toggle—L/R switches let the pilot slew to the desired heading

PFD Caution and Failure Displays

Failure Annunciations

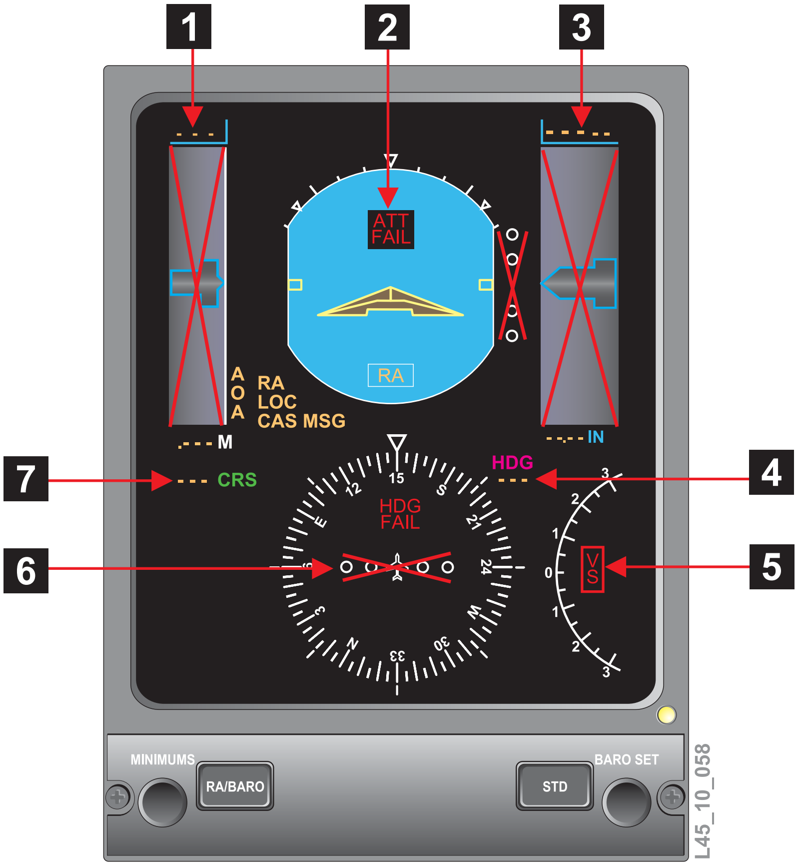

Figure 17 - PFD Failure Annunciations

1 Airspeed Display Data Failure
- Failure of the ADC airspeed data

2 Attitude Display Data Failure
- Failure of AHRS pitch and roll attitude data

3 Altitude Display Data Failure
- Failure of the ADC altitude data

4 Heading Select Failure
- Failure of the heading select signals or invalid heading display

5 Vertical Speed Data Failure
- Failure of the ADC vertical speed data

6 Heading Display Data Failure
- AHRS roll or pitch data failure

7 Course Display Data Failure
- Failure of the course deviation data or invalid condition

Caution Annunciations

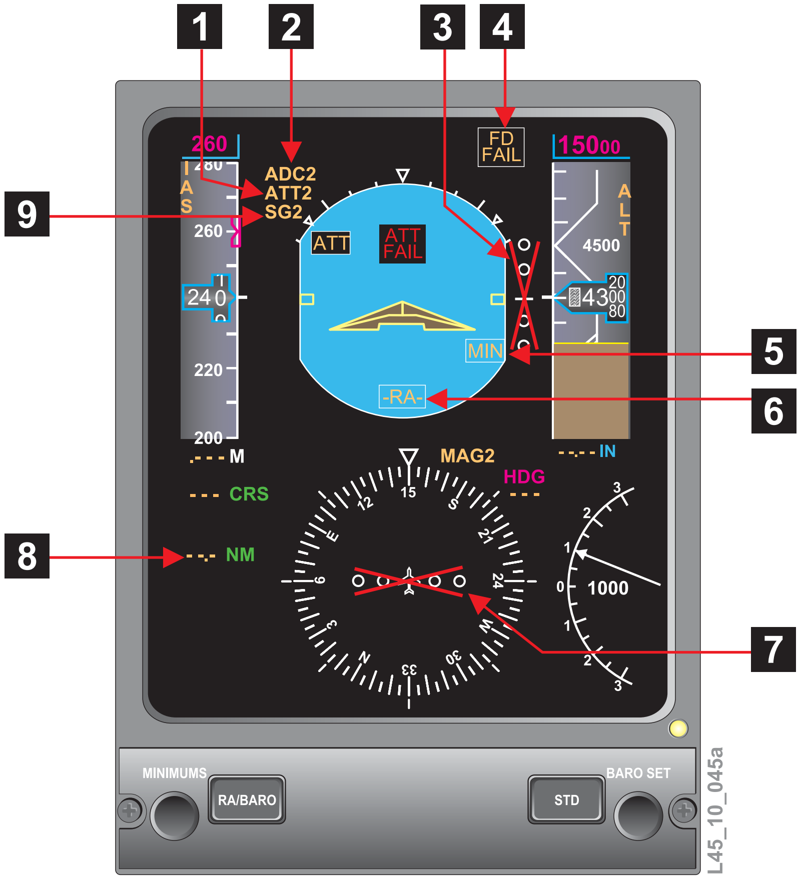

Figure 18 - PFD Caution Annunciations

1 Same Attitude Source

- If the pilot and copilot select the same attitude source, that attitude source (ATT1 or ATT2) is annunciated in amber on both PFDs

2 Same Air Data Source

- An amber source annunciation ADC1 or ADC2 is displayed when both pilots select the same source

3 Vertical Deviation Failure

- An invalid condition or failure of the radio source driving the vertical navigation scale

4 Flight Director (FD) Failure

- Flight director failure, an amber FD FAIL is displayed

5 Below Minimums Radio Altitude (RA or Barometric Altitude)

- When at or below the radio altitude decision height (RA) or minimum descent barometric altitude (BARO), an amber MIN is displayed

6 Radio Altimeter Failure
- Failure of the radio altimeter; an amber RA replaces the digital radio altitude value

7 Course Deviation Failure
- An invalid condition or failure of the course deviation data

8 Distance Display Failures
- Failure of either the DME or FMS distance signals

9 Common Symbol Generator
- Reversionary annunciation given in amber indicates the information source

CAS Messages

Table 1 - CAS Messages

CAS Message	Conditions/Parameters
AHRS 1-2 OVHT	1, 2, or both attitude heading reference system(s) reached an overheat condition or shut down
DU 1-2 OVHT	Indicates the respective DU is overheated
DU 3-4 OVHT	Indicates the respective DU is overheated
EICAS CHECK	EICAS wraparound monitor (available on MFD display only)
LBS/KGS CONFIG	Discrepancy between IC-600 and DAU strap configuration on ground
IC 1-2 OVHT	IC No. 1 or No. 2 is overheating
IC BUS FAIL	Offside IC failed or the IC bus invalid
L R PFD CHECK	Associated L or R primary flight display is displaying bad data
AHRS 1-2 BASIC	Attitude heading reference system (AHRS) 1 or 2; or 1 and 2 reverted to basic mode due to a loss of true speed from both ADCs. The attitude displays, autopilot, FMS, and radar stabilization operate normally
DU 1-2 FAN FAIL	Respective DU cooling fan 1 or 2; or combination of 1 and 2 failed
DU 3-4 FAN FAIL	Respective DU cooling fan 3 or 4, or combination of 3 and 4 failed
IC 1-2 FAN FAIL	Respective IC 1, 2, or 1 and 2 cooling fan failed
IC 1-2 WOW FAIL	WOW validity monitor (uses airspeed and altitude logic to check WOW)
LBS/KGS CONFIG	Discrepancy between IC-600 and DAU strap configuration (for ECR 7258 in air only)
CKLST MISMATCH	Different checklists are loaded into each IC-600

Primus 1000 Electronic Flight Instrument System

General

The Primus 1000 electronic flight instrument system (EFIS) is composed of the following major components:

- Integrated avionics computers/symbol generators (2)
- DUs (4)
- Pilot DU reversion control panel
- Copilot DU reversion control panel
- Flight guidance controller
- Remote-mounted joystick

Integrated Avionics Computers

There are two IC-600 integrated avionics computers (IACs) installed in the nose compartment, which provide the symbol generation function for the EFIS DU. The IC-600 is the focal point of information flow for the whole Primus 1000 system. The main EFIS function of the IC-600 is to convert input information into graphic format for the PFD, MFD, and EICAS displays. Control signals from the display controller, flight guidance controller, and the reversionary switch panels are used by the IC-600 to select display formats and sources of information. The flight guidance system is contained within the IC-600.

The IC-600 includes DU comparison and wraparound monitors. If the comparison check detects too great a difference, then the appropriate comparison monitor annunciation is displayed. If an error is detected, then the relevant amber L or R PFD CHECK crew alerting system message is displayed.

Air Data Systems

General

Air data information is provided to the flight instruments and other aircraft systems from the pitot-static systems and the temperature probe. Air data information for the flight management system (FMS) (optional) is supplied to the IC-600 and then on to the FMS.

The air data system and air data instruments depend upon pitot pressure, static pressure, and sensed air temperature. Air data is provided to the flight instruments and aircraft systems via the two air data computers (ADCs) except for the standby instruments that receive air data directly from the standby pitot static system. The Primus 1000 flight displays receive pitot and static information from the main pitot static system.

The ADCs additionally receive total air temperature information from the TAT probe, which is located near the right nose gear door and barometric correction inputs via the BARO set knob located on the corresponding PFD.

Components

Pitot-Static Systems

The pitot-static systems consists of the primary and standby pitot-static subsystems (Fig. 19).

Primary Pitot-Static System

The primary pitot-static subsystem provides free-stream total pitot and static pressure to the micro ADCs as sensed by the pitot-static probes located on both the left and right sides of the fuselage. The probes are physically located at the lowest point of the primary pitot static system plumbing and do not require moisture drains. Air data from the pilot pitot and static probe and the copilot static probe is fed to ADC 1. Air data from the copilot pitot and static probe and the pilot static probe is fed to ADC 2.

The pneumatic signals are converted into a digital format within the ADCs, then supplied to the IACs for formatting and presentation on the cockpit DUs.

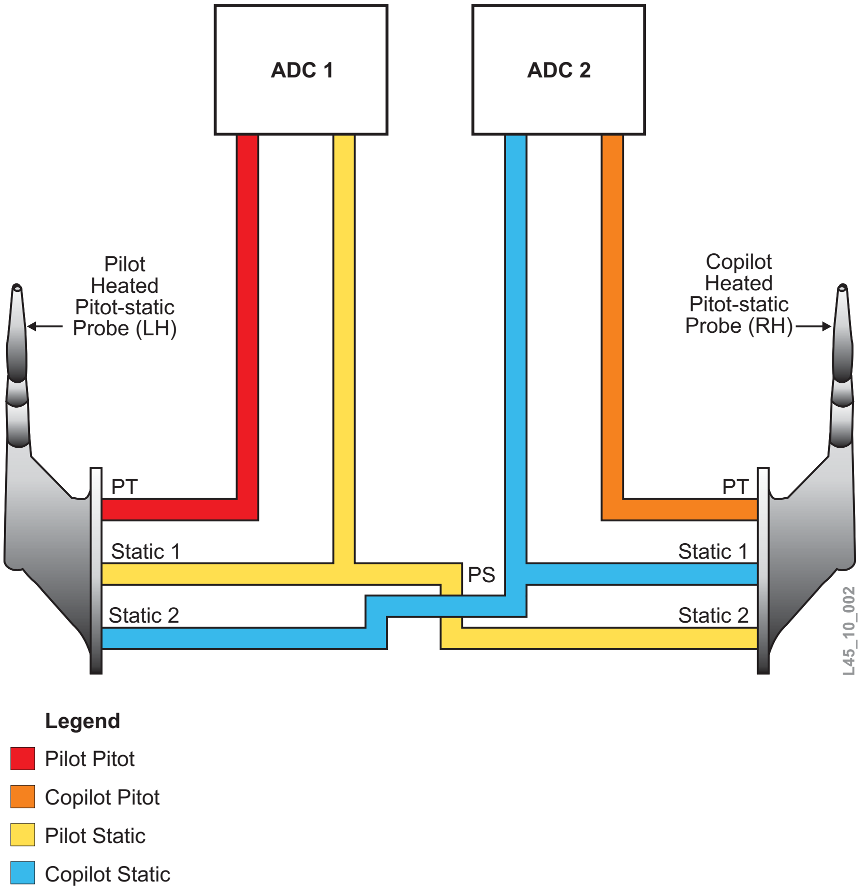

Figure 19 - Primary Pitot-Static System

Micro Air Data Computers

The aircraft is equipped with dual micro ADCs, which provide air data information for display on both PFDs, and is used by a number of other systems on the aircraft. Each air data computer is a self-contained unit incorporating solid-state technology. Each ADC accepts static air pressure, total air pressure, total air temperature, and barometric set input. Other systems that receive air data include:

- Stall warning systems
- AHRS
- FDR
- Spoileron computer
- ATC transponders
- Digital electronic engine controls (DEEC)
- Cabin pressure controller
- Landing gear warning system
- Traffic alert and collision avoidance system (TCAS)
- Autopilot
- Flight director
- Engine instruments
- Crew alerting system

The following outputs are provided:

- Barometric altitude
- Pressure altitude
- Indicated airspeed
- True airspeed
- Mach number
- Vertical airspeed
- Maximum operating airspeed
- Static and total air temperature

Standby Pitot-Static System

The standby system (Fig. 20) obtains air free-stream total and static pressure data from a third externally mounted standby pitot-static probe. It is located on the right side of the nose above the main pitot-static probe and is pneumatically connected to the standby altimeter and the standby Mach/airspeed indicator. The standby system is completely independent from the primary system, so the pressure data it obtains is available if the main pitot-static system fails.

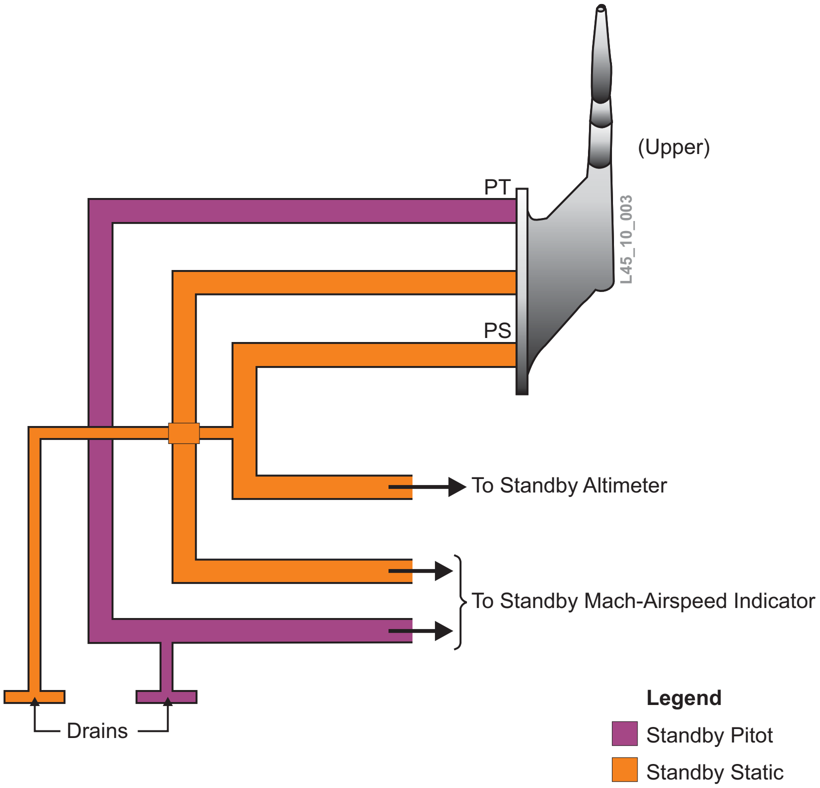

Figure 20 - Standby Pitot-Static System

Attitude Heading Reference System

The attitude heading reference system (AHRS) is a self-contained system that measures aircraft accelerations and provides aircraft velocity, heading, and attitude information.

AHRS consists of two attitude heading reference units (ring laser gyro). These units sense the aircraft angular and linear accelerations and then compute the aircraft attitude, magnetic heading, and mode status.

Two flux valves provide magnetic heading data to the associated attitude heading reference units (AHRUs). The flux valves are located at the end of the left and right wings.

Each AHRU provides heading and attitude information to the following:

- IC-600
- Weather radar
- Data acquisition units (DAU)
- Fuel gauging computer
- Weather radar
- ADCs
- Backup radio management units (RMUs) navigation system
- TCAS
- Flight management system (FMS) (optional)

The heading and attitude information is provided to both IACs and then forwarded for display on the PFDs and MFD. Both PFDs are normally set up to display pitch attitude, roll attitude, and heading information. The MFD also displays heading. If an EFIS fails, heading data is still provided to the DAUs, which can be displayed on the backup navigation page on the RMUs.

Attitude and Heading Comparison Monitors

The attitude and heading comparison monitors provide annunciations if the attitude or heading at both pilot displays differ by a predetermined amount. The annunciations alert the flight crew to the possibility that incorrect flight information may be displayed.

The attitude comparison function consists of two separate monitors, the roll comparison monitor and the pitch comparison monitor. If the pitch attitude displayed on the two sides differs by a predetermined amount, the pitch comparison monitor displays the PIT annunciation. Similarly if the roll attitude on both sides differs by a predetermined amount, the roll comparison monitor displays the ROL annunciation. If both the roll and pitch comparison monitors detect excessive differences at the same time, an ATT annunciation is displayed.

If the heading comparison monitor trips, HDG is displayed.

When comparison monitor annunciations occur, they flash for the first 10 seconds after activation and then illuminate steady.

The PFD wraparound monitors, contained within the IACs, monitor the attitude data displayed on the PFD against the attitude data sent from the AHRU. If the displayed data differs from that received from the AHRU, the PFD wraparound monitor displays the respective amber L R PFD CHECK CAS message.

AHRU Cooling

The AHRUs are equipped with cooling fans. If the temperature rises and exceeds predefined safe limits, an amber AHRS 1 or 2 OVHT CAS message is displayed.

Electronic Flight Instrument System

Display Units

The Primus 1000 avionics system normally powers up with the following DU configuration:

- DU No. 1—Pilot PFD No.1
- DU No. 2—EICAS display
- DU No. 3—MFD display
- DU No. 4—Copilot PFD No. 2

The DUs require forced air circulation for cooling, which is provided by two fans mounted on the rear of each unit. If a DU fan fails, an amber CAS message is displayed. If an overtemperature condition is detected, an amber CAS message is displayed.

Primary Flight Display

The PFD is an integrated display of attitude, navigation, and air data flight information. The PFD (Fig. 21) displays on one screen indications that were formerly on a number of separate instruments. The PFD screen is divided into the following areas:

- ADI
- Airspeed display
- Altitude display
- Vertical speed display
- Horizontal situation indicator display
- Autopilot and flight director mode annunciator

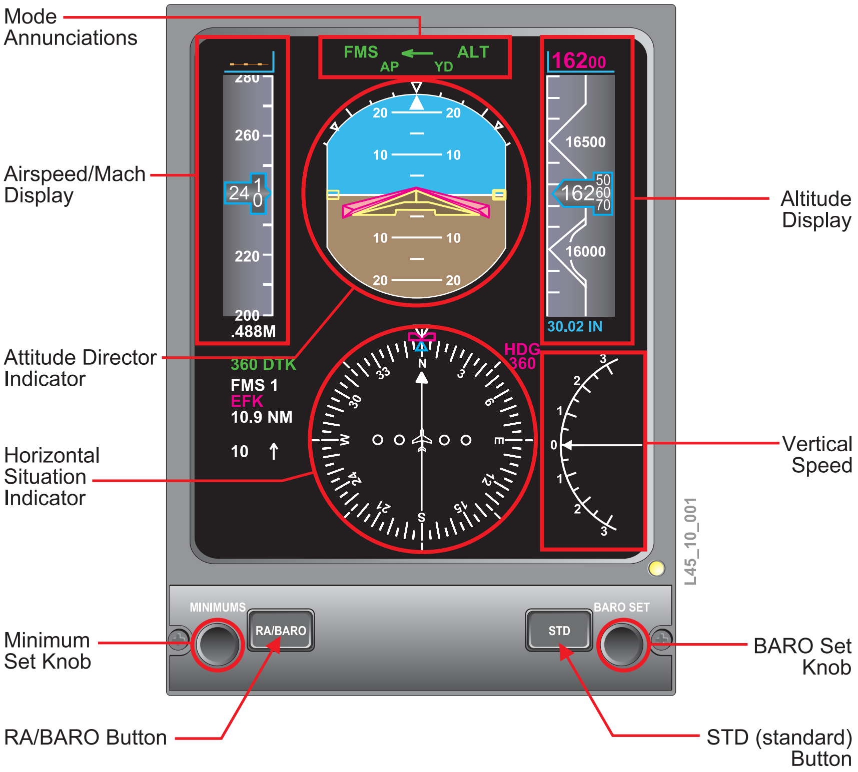

Figure 21 - Primary Flight Display

Attitude Director Indicator Display

The attitude director indicator uses a truncated sphere format to display standard attitude information (Fig. 22). The attitude display receives its inputs from the AHRS.

Roll Scale

The roll scale is linear with white markings at the standard angles of bank. The roll pointer is filled in, and the roll index center mark is not.

Low Bank Arc

When BNK is selected on the guidance controller, a ±14° green roll arc is displayed on the ADI roll scale.

Pitch Scale

The pitch scale tape consists of the white pitch scale with markings at:

- Up from level attitude: 10, 20, 30, 40, 60, and 90°
- Down from level attitude: 10, 20, 30, 45, 60, and 90°

There are reference marks at every 5° attitude interval between 10° and 30°. Red “fly-down” pitch warning chevrons are displayed at 45 and 65° pitch up, and “fly-up” warning chevrons are displayed at 35, 50, and 65° pitch down to aid in recovery from extreme attitudes

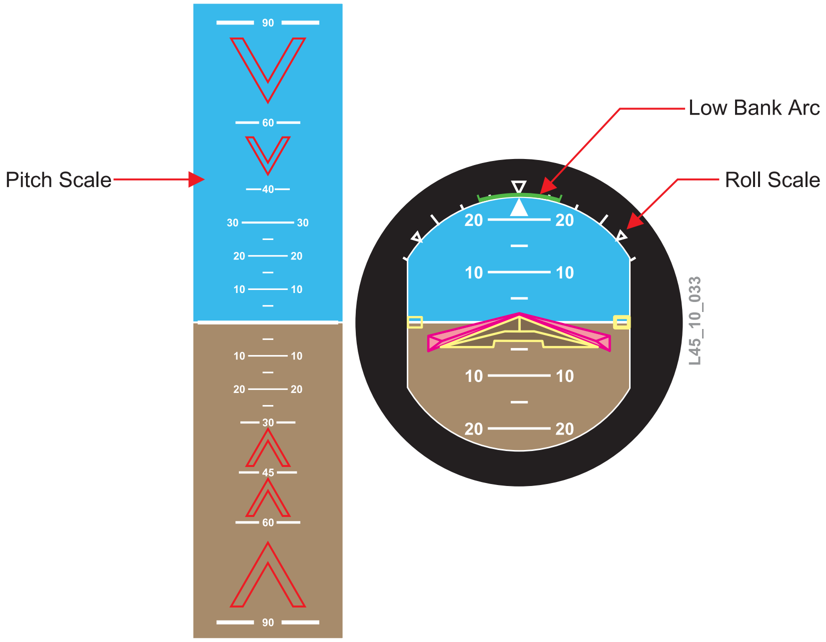

Figure 22 - Attitude Director Indicator

Airspeed/Mach Display

The indicated airspeed scale and digital readout (Fig. 23) is displayed when a valid signal is received from an ADC.

Airspeed Tape

The airspeed tape is a moving scale display with fixed pointer and calibrated airspeed marks. The white scale markings on the tape are in 10-kt increments of indicated airspeed (0.02 increments in Mach). The scale digits move such that larger numbers come from the top of the display. If V_{MO}/M_{MO} is exceeded, the current airspeed digits turn red.

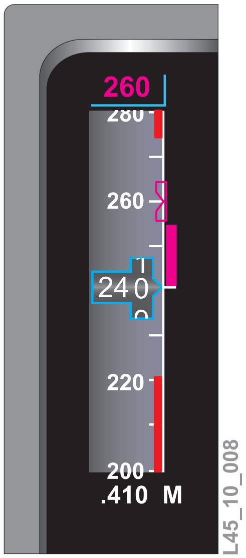

Figure 23 - Airspeed/Mach Display

Loss of a valid indicated airspeed or detection of a related input/output failure causes pointer/scale displays to show a failure by:

- Replacing the indicated airspeed pointer, digits, and scale with a blank window
- Drawing a red X through the scale

Airspeed Trend Vector

The airspeed trend vector (both knots and Mach tapes) is a magenta line that is drawn from the airspeed reference line, up (for accelerating airspeeds) or down (for decelerating airspeeds). The upper (or lower) tip of the trend vector indicates what the airspeed will be in ten seconds if the current acceleration rate continues. If the trend vector exceeds V_{MO}/M_{MO}, the current airspeed digits turn amber. The airspeed trend vector is driven by the ADCs.

Low-Speed Awareness Tape

The low-speed awareness tape is a red line drawn from the bottom of the airspeed scale. The top of the red line represents the stall warning stick shaker speed. The low-speed awareness indicator is driven by the stall warning system. The low-speed awareness is removed when indicated airspeed is invalid or the stall warning system is inoperative.

Airspeed Rolling Digit Display

A rolling digit display of the current indicated airspeed value is contained within the display window. This data is a magnification of the digits on the scale, and they are readable to a 1-kt or 0.01-Mach resolution. The digits within the pointer are white. When the current airspeed value is equal to or exceeds the maximum allowable airspeed (V_{MO} or M_{MO}), the digits turn red. When the airspeed trend vector exceeds V_{MO}/M_{MO} by 1 kt, the rolling digits turn amber unless red is required.

V_{MO}/M_{MO} Overspeed Tape (or V_{FE} Overspeed Tape)

The V_{MO}/M_{MO} overspeed tape is a fixed red bar originating at V_{MO}/M_{MO} and extending to the scale end. This bar is located along the inner side of the airspeed scale. When flaps are extended, this bar repositions to the selected flap V_{FE} speed.

Mach/Knot Digital Display

The digital Mach/knot speed display is the current Mach number (knots for the Mach tape) and is shown below the indicated airspeed tape. The color of the digits always agrees with the digital airspeed display. The minimum Mach speed that can be displayed is 0.39 Mach.

IAS/Mach Reference Bug and Display

Using the flight guidance controller SPD set knob, the pilot can adjust the knots indicated airspeed or Mach reference display that is displayed above the airspeed tape. The corresponding airspeed bug is shown on the right side of the airspeed tape. The digital display and bug are both magenta. The bug is removed, and the digits turn to amber dashes when the vertical speed (VS) mode is displayed.

NOTE **The bug is not removed in ALT hold or GS capture.**

V_{SPEED} Set Bugs

V_{SPEED} set bugs can be displayed on the PFD airspeed tape.

- V_1 bug

The white V_1 bug is set on the MFD SPDS page and is displayed on the airspeed scale on the PFD to provide the flight crew with takeoff decision speed reference.

- V_R bug

The cyan V_R bug is set on the MFD SPDS page and is displayed on the airspeed scale on the PFD to provide the flight crew with rotation, V_{REF} or V_{LND} speed reference.

- V_2 bug

The green V_2 bug is set on the MFD SPDS page and is displayed on the airspeed scale on the PFD to provide the flight crew with takeoff safety speed or V_{APP} speed reference.

NOTE

All V_{SPEEDS} may be set by the FMS if the FMS has the performance calculation capability installed.

Takeoff V_{SPEED} Display

When the current speed is less than 40 kt on the ground, V_1, V_R and V_2 are displayed in digital tabular form inside the lower portion of the airspeed tape. As the airspeed tape increases and the values come into view on the airspeed tape, the digital display is removed and subsequently replaced by the V_{SPEED} bugs.

Loss of a valid indicated airspeed or detection of a related input/output failure causes pointer/scale displays to show a failure by:

- Removing the indicated airspeed pointer, digits, and scale, leaving only a blank window
- Drawing a red X through the scale

Altitude Display

The altitude scale and digital readout (Fig. 24) is displayed when a valid ADC signal is received.

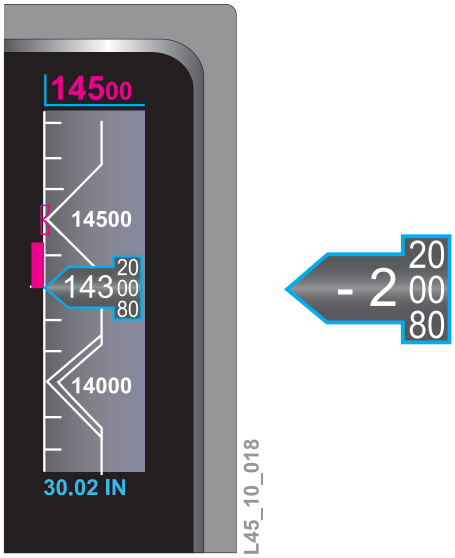

Figure 24 - Altitude Display

Altitude Analog Scale

The altitude tape is a moving scale display with fixed pointer. The scale markings on the tape are in 500-ft increments. The scale digits are arranged with the larger numbers at the top. The scale and the markings are white. Each 1000- and 500-ft altitude increment is enhanced, respectively, with a double or single chevron. The chevron along the shape of the altimeter reference line and altitude select bug are designed to align when the selected and current altitudes are at an altitude increment of 1000 or 500 ft.

If a loss of valid altitude information has occurred or a failure of the related input/output is detected, the pointer/scale displays indicate that altitude information may be unreliable by:

- Removing the pointer, chevron, digits, scale, and current airspeed box
- Drawing a red X through the scale

Altitude Digital Display

A digital display of the actual altitude value is shown in the display window. This data is a magnified version of the digits shown on the altitude scale and is readable to within a 20-ft resolution. The digits within the pointer are white. Below 10,000 ft, a boxed hash mark is located in the first digit to show that the 10,000-ft digit is missing.

Altitude Trend Vector

The altitude trend vector originates at the altitude reference line. The trend vector is a magenta thermometer shape that corresponds to altitude vertical speed and moves up (for climbs) and down (for descents) on the left side of the altitude tape. The tip of the vector indicates the altitude that will be reached, at the current rate of climb or descent in six seconds.

Altitude Alert Select Display

The altitude alert select data is displayed at the top of the altitude scale. The data is set by the guidance controller altitude select knob. The set data is magenta. When the aircraft is within the altitude alert operating region, the box around the set data turns from cyan to amber. The set data also turns amber. When departing from the selected altitude, the select display box changes from cyan to amber and the digits from magenta to amber.

The altitude alert operating region is defined as the time when the aircraft enters the region where it is within 1000 ft of the preselected altitude during a capture maneuver. At this time, the box around the set data turns to amber. Once the aircraft is within 250 ft of the preselected altitude, the box reverts to cyan. After capture, the aircraft reenters the altitude alert operating region if it departs more than 250 ft from the selected altitude.

A momentary audio alert is sounded when the aircraft approaches to within 1000 ft of the preselected altitude or departs 250 ft from the select altitude after capture.

BARO Minimum Set Bug

The barometric set bug (magenta D bug) travels vertically up and down the altitude tape. The bug is selected by pushing the RA/BARO button on the PFD bezel controller and setting the value using the MINIMUMS knob. When selected for display, the barometric set bug is set at the last set value, even if RA or off is selected using the RA/BARO button. Exceptions include when the BARO set bug is out of view, or the BARO digital value is less than 10 ft. The bug is not displayed at power-up.

Altitude Select Bug

A magenta altitude select bug travels along the left side of the altitude tape across from the altitude value set in the altitude alert select display by the pilot. This altitude select bug is notched to fit the 1000- or 500-ft altitude tape chevron format. If the bug is moved off the current scale range, half of the bug remains (parked) on the scale to indicate the direction to the set bug.

The altitude preselect mode may be used with the flight director activated or if engaged to the autopilot. This mode is annunciated at the top of the DU.

Low Altitude Awareness Symbol

At radio altitudes of 550 ft or less, the lower part of the altitude tape linearly changes from a gray to brown color and the altimeter scale markings are removed. At zero radio altitude, the brown raster touches the altimeter reference line.

Barometric Altimeter Setting

The cyan barometric set value is displayed below the altitude scale whenever barometric set and barometric altitude are valid. The setting display can be set in inches of mercury or hectopascals, as selected by the EFIS display controller In/hPa button. The current barometric pressure setting is set by using the barometric set (BARO SET) located on the bottom of the PFD bezel. If the barometric set or altitude information is invalid, the display is removed. The pilot barometric set knob controls only ADC No. 1; the copilot barometric set knob controls only ADC No. 2. Loss of valid air data from the selected source causes the barometric correction digits to be replaced by amber dashes.

Vertical Speed Display

The white scale and pointer (Fig. 25) is displayed whenever the vertical speed input from the selected ADC is valid.

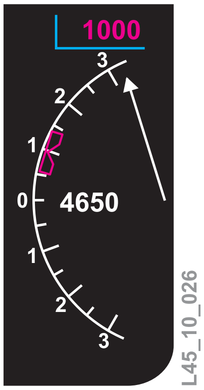

Figure 25 - Vertical Speed Display

Vertical Speed Analog Scale

The vertical speed scale is a fixed scale with a moving pointer. The scale on the display ranges from +8100 fpm to –8100 fpm. Display scale markings are 0, 1, 2, and 3. The scale and its markings are white. The scale is expanded between the +1000 to –1000 fpm range. For vertical speeds greater than ±8100 fpm, the pointer is positioned in the appropriate direction near the end of the scale. The digital display shows the actual vertical speed value. Loss of a valid input/output or detection of a related input/output failure causes the pointer/scale displays to show a failure by:

- Removing the pointer and the digits
- Displaying a vertical red vertical speed boxed in the center of the arc and amber dashes replace the digits in the vertical speed target box

Vertical Speed Digital Display

A digital display of the actual vertical speed value is located in a box on the zero reference line. This data is a magnification of the digits on the scale and is readable to a 50-fpm resolution. The digits are white. The maximum value is 9900 fpm. For values between ±500 fpm, the digital display is removed. At values beyond ±500 fpm, the digital value of vertical speed is displayed.

Flight Director VS Target Display and Bug

Engaging the vertical speed mode brings the vertical speed target bug into view. The vertical speed target bug moves along the inside of the vertical speed scale. The magenta bug lines up with the value on the vertical speed scale that is set with the guidance controller SPD knob. The digital readout of the target is displayed on top of this vertical speed scale and is limited to ±6000 fpm with a 100-fpm resolution. If the flight director is not in the vertical speed mode, the vertical speed target, bug, and box are removed from both pilot displays.

TCAS II Resolution Advisory (RA) Display (optional)

The TCAS II system displays a green fly-to-target and a red do-not-fly band on the vertical speed display that commands the pilot to comply with a RA to avoid potential aircraft conflict. When a TCAS II RA is displayed, the vertical speed digital display matches the color of the red or green band where the pointer is located.

TCAS Status Message (optional)

The TCAS I or TCAS II status messages are displayed to the bottom left of the vertical speed display.

Horizontal Situation Indicator Displays

The PFD HSI may be displayed in three formats.

Full Compass Display

The full compass display (Fig. 26) is a 360º HSI. It is covered in more detail in Chapter 17 Navigation.

Arc Display

The arc display is an expanded HSI with a 120º arc. It is covered in more detail in Chapter 17 Navigation.

Map Display

The map display is a 120º map with flight plan and weather radar information, if selected. It is covered in more detail in Chapter 17 Navigation.

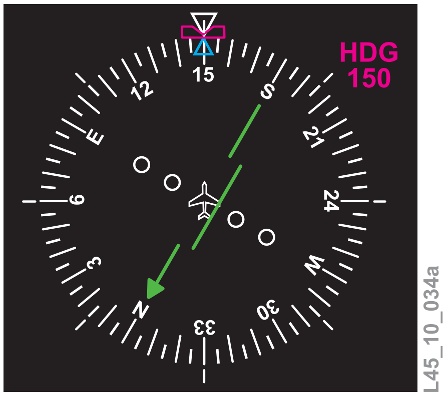

Figure 26 - HSI Full Compass Display

Comparison Monitoring

The amber comparison monitor annunciators are located in various locations on the PFD. They indicate that a difference has been detected between the pilot and copilot display. These annunciations are cleared when this difference has been eliminated. The comparison monitor annunciators are shown in (Table 2).

Table 2 - PFD Comparison Annunciators

Comparisons Monitored	PFD Annunciation
Indicated airspeed/Mach	I A S
Pitch/roll attitude	ATT
CAS	CAS MSG
Altitude	A L T
Heading	HDG

Mode Annunciations

The primary flight display (Fig. 27) shows the modes of operation of the flight guidance and flight director systems when they are activated. These annunciations enable the flight crew to determine which flight guidance system or flight director modes are in use without looking at another instrument or panel. All of these mode annunciations are discussed in more detail in Chapter 2 Automatic Flight Control System.

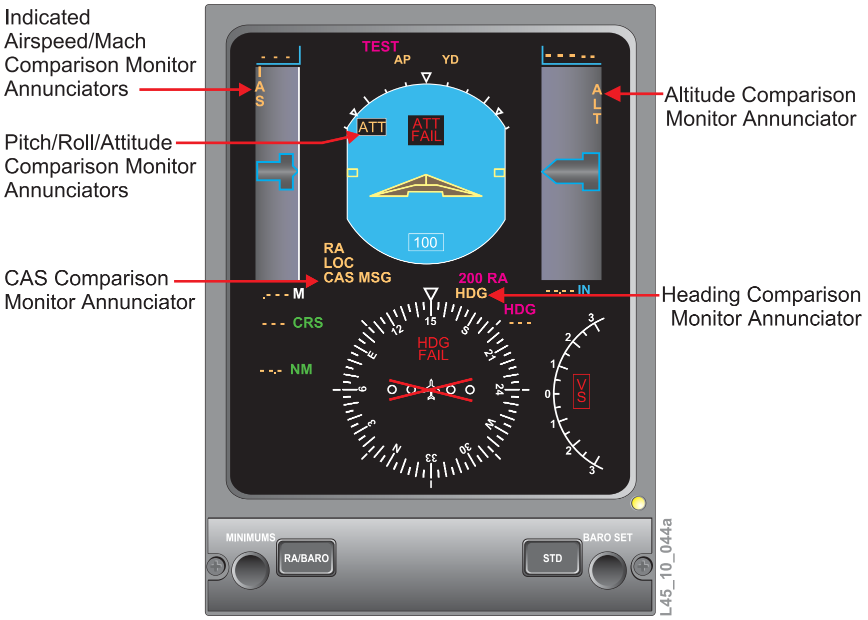

Figure 27 - PFD Comparison Monitor Annunciations

Excessive Attitude Declutter

This display removes displayed data to aid the pilot in reorientating the aircraft when an excessive attitude has been entered (Fig. 28). This excessive attitude causes the displayed data to be decluttered when any of the following situations occur:

- Bank angle greater than ±65º
- Pitch attitude greater than 30º noseup
- Pitch attitude greater than 20º nosedown

The following items are removed from the display to assist the flight crew in determining aircraft attitude:

- Marker beacons
- Vertical deviation scale, pointer, and annunciator
- Speed bugs and readout
- Radio altitude display
- Altitude select, airspeed display, and vertical speed bug data
- All flags and comparators except ATT and ADC (IAS/ALT)
- Low bank annunciator
- RA/BARO set digits

Figure 28 - Excessive Attitude Declutter

PFD Bezel Controller

The PFD bezel controller (Fig. 29) is mounted just below the PFD display units.

Figure 29 - PFD Bezel Controller

MINIMUMS Set Knob

The MINIMUMS set knob on either PFD controller sets radio altitude (RA) or barometric (BARO) minimums.

RA/BARO Button

The RA/BARO button selects either RA or BARO on either PFD.

STD (Standard) Button

The STD button sets the barometric altimeter correction to the standard atmosphere value (29.92 inHg or 1.013 hPa).

BARO Set Knob

The BARO set knob selects the barometric altimeter correction in either inHg or hPa.

Display Controller

The display controller (Fig. 30) selects various features on the PFD. These features include flight director/cue displays, HSI formats, navigation sources, weather display, dimming controls, bearing pointer selection, and other functions.

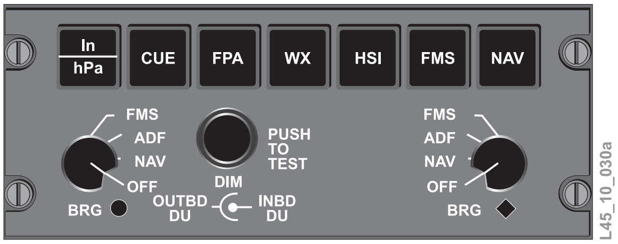

Figure 30 - Display Controller

Display Controller Buttons

The display controller has seven pushbuttons mounted along the top of the panel, concentric mounted DU dimming knobs with a momentary test pushbutton, and two rotary knobs to select navigation sources for the bearing pointer displays. If a display controller fails, a power-up default value generates the PFD display.

In/hPa

The In/hPa pushbutton selects an altitude for display that is corrected either in inches of mercury or hectopascals (hPa). The power-up default is in inches of mercury.

CUE

The CUE pushbutton selects either a single cue or cross pointer flight director command bar display on the attitude indicator. The powerup default is a single cue command bar.

FPA	The FPA pushbutton controls whether or not the flightpath angle symbol and flightpath acceleration symbol is displayed. The powerup default option is off.
WX	The WX button sets the HSI to display a partial compass format with weather radar information.
HSI	The HSI button toggles the HSI between a full 360° and a partial compass display.
FMS	When the FMS button is pushed, FMS information is displayed on the HSI. The first push displays onside navigation information, and the second push displays navigation information from the cross-side source.
NAV	When the NAV button is pushed, VOR/LOC information is displayed on the HSI. The first push displays onside navigation information, and the second push displays navigation information from the cross-side source.

Engine Indicating and Crew Alerting System

The EICAS is an integrated display system that replaces the majority of traditional gauges and warning lights throughout the cockpit. This system is covered in Chapter 20 Warnings—Aural and Visual.

Multifunction Display

The MFD shows a variety of information, especially navigation. The MFD screen is divided into distinct areas.

MFD Navigation Display

The MFD display may show navigation information. There are two basic formats of navigational display available on the MFD:

- MFD map (Fig. 31)
- MFD map MFD plan (north-up display) (Fig. 32)

This display is covered in more detail in Chapter 17 Navigation.

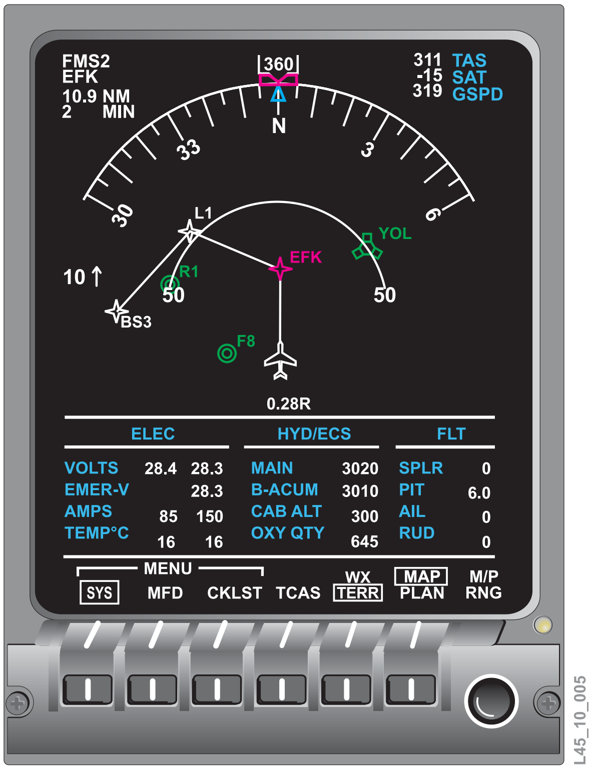

Figure 31 - MFD Display—Map

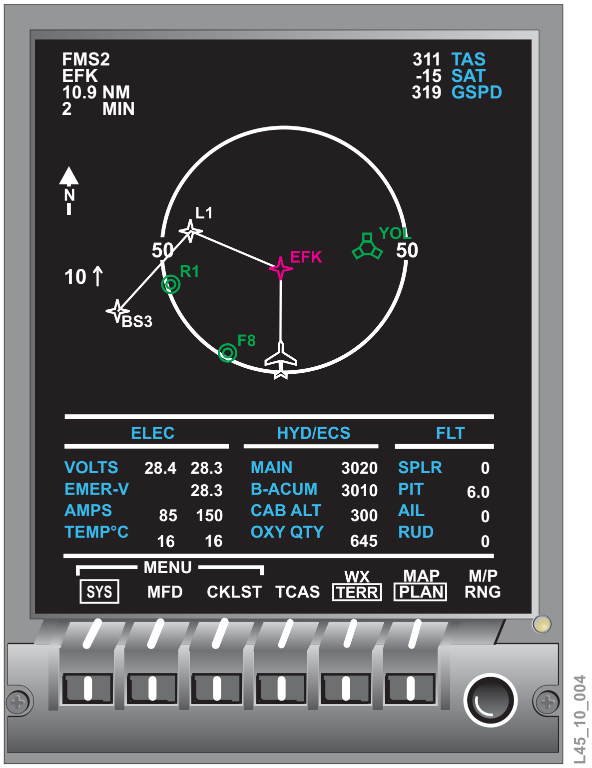

Figure 32 - MFD Display—Plan

System Display Area

The system display area presents the following:

- System data and parameters (see specific chapters)
- Synoptic system pages (see specific chapters)
- Checklist (see paragraph MFD main menu)
- TCAS (see paragraph MFD main menu)

MFD Menu Area

The lowest portion of the MFD is always reserved for displaying the menu and submenu sections. Refer to Primus 1000 Integrated Avionics System in the *Learjet 40/45 Pilot Manual* for more details about menu and submenu logic. An amber MENU INOP annunciation is displayed when the display controller is inoperative.

Reversion Controls

Reversionary controllers enable the flight crew to bypass failed subsystems. There are three reversion control panels that permit the flight crew to bypass subsystems:

- DU reversion controllers
- Integrated computer/symbol generator reversion
- Sensor reversion

DU Reversionary Controllers

The DU reversion switches (Fig. 33) are mounted on the glareshield in front of each pilot and enable a failed PFD to be replaced by using the other onside DU.

The pilot DU reversion switch allows control of what is displayed on DU No. 2. With the pilot DU reversion switch in the NORM position, EICAS is displayed on DU No. 2. The pilot DU reversion switch can be rotated to either the PFD position or to OFF. The PFD position moves the pilot PFD display onto DU No. 2 and the EICAS to DU No. 3 or the RMU backup page. The OFF position is used if additional electrical load shedding is required after the avionics master buses have been deenergized.

The copilot DU reversion switch provides control of what is displayed on DU No. 3. The operation of this switch is identical to the pilot switch with the exception that DU No. 3 cannot be selected off as there is no off position. In the NORM position, the MFD display is on DU No. 3. The PFD position moves the copilot's PFD display to DU No. 3. The functions of the bezel controllers are not affected by DU reversion and still control the display after it has been moved to the new DU.

NOTE **If a PFD failure occurs, the pilot must use the onside reversion knob to switch the display of the failed PFD to the inboard DU.**

Pushing the center button on either the NORM/PFD/OFF (pilot) or NORM/PFD (copilot) knob toggles the inboard display from EICAS/MFD to MFD/EICAS and vice versa. By pressing the center button on the pilot DU reversion switch, the displays on DU No. 2 and No. 3 switch, moving the MFD display to DU No. 2 and the EICAS to DU No. 3. By pressing the copilot reversion switch, the information displayed on DU No. 2 and No. 3 switches.

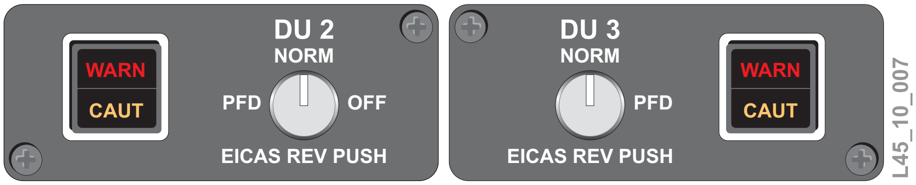

Figure 33 - DU Reversionary Controllers

Integrated Computer/Symbol Generator Reversion

If an IC-600 integrated computer/signal generator (IC/SG) reversion is required, it is accomplished by the switch located in the top center of the reversion switch section of the pilot switch panel.

Following failure of either IC-600, the pilot selects the remaining functioning IC-600 by the using the IC/SG reversion switch. All four displays are then driven from the remaining selected IC-600. A single IC-600 is capable of providing only two of the three formats (PFD, EICAS, or MFD) and driving four DUs at any one time. The cross-side PFD is a copy of the display on the selected source side.

An amber SG1 or SG2 is displayed on both PFDs depending on which is the selected source.

NOTE

When an IC/SG fails, the MFD cannot be displayed.

If either IC/SG 1 or 2 is selected for reversion, the EICAS display is shown on both center DUs.

If either IC/SG 1 or 2 is selected for reversion, the DUs on the failed IC/SG side repeat the selected data from the side with the operating integrated computer/symbol generator. This includes AHRS, ADC, and navigation data.

Reversion of a DU to a PFD or other format can result in the loss of that DU for up to 14 seconds.

Sensor Reversion

The sensor reversionary controller (Fig. 34), labeled REVERSION, is located on the pilot switch panel to the right of the ELECTRICAL control panel.

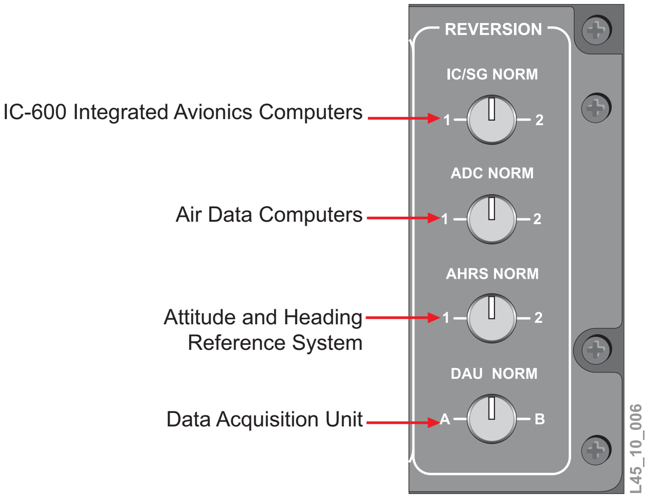

Figure 34 - Reversionary Controller

ADC NORM

Selects between NORM, No.1, or No. 2 ADC to supply the onside PFD.

NOTE

If reversionary ADC is selected, the current airspeed modes drop, but can be reengaged.

AHRS NORM

Selects between NORM, No. 1, or No. 2 AHRS to supply the onside PFD attitude and heading.

NOTE

If either AHRS has failed, the autopilot cannot be used.

DAU NORM

Selects between NORM, CH A, or CH B for each DAU to supply data to the IC/SGs.

In NORM, each IC/SG uses CH 1A and CH 2B. In reversionary, each IC/SG uses only the selected channel from both DAUs.

AHRS Controls

The AHRS controls (Fig. 35) are located on each inboard side of the crew lighting panel. The pilot side controls AHRS No. 1 and the copilot side controls AHRS No. 2.

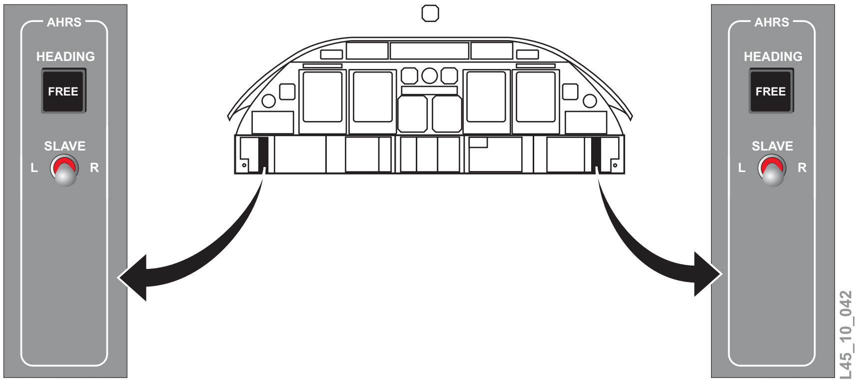

Figure 35 - AHRS Controls

Heading Free

When the FREE button is pushed, the AHRS operates as a directional gyro to determine heading. In this mode, the heading output is not slaved to the flux valve. The PFD annunciates this mode selection with a white DGx (where x designates which AHRS has been placed in the heading free mode, either a 1 or 2). The annunciation appears on the flight side of the HSI.

Left/Right (L/R)

When the FREE heading mode (directional gyro mode) is selected, the L/R switches allow either pilot to slew to the desired heading. The L position slews the heading to decrease at approximately 3° per second and the R position slews the heading to increase at approximately 3° per second.

PFD Caution and Failure Display

Failure Annunciations

Attitude Reference System Failure

Failure of either the pitch or roll data is indicated by removal of the pitch scale markings, a cyan attitude sphere, a red ATT FAIL in the top of the center of the attitude sphere, and a red HDG FAIL in the top center of the HSI (Fig. 36).

Air Data Computer Failures

Failure of either IAS or altitude data is indicated by removal of the current value pointer and scale markings, and a red X through the scale. The digital Mach CAS display failure is shown when the numerical value is replaced with amber dashes. In the case of the vertical speed, the current value pointer is removed and a red boxed VS replaces the digital display.

Heading Select Failure

When the heading (HDG) select signal fails, the digital HDG display is replaced with amber dashes. The heading bug is removed from the display. This indication is also given if a heading display is invalid.

Flight Director Failure

If a flight director (FD) failure occurs, an amber FD FAIL is displayed in the lateral mode annunciation box, and the flight director mode annunciations and cue are removed.

Caution Annunciations

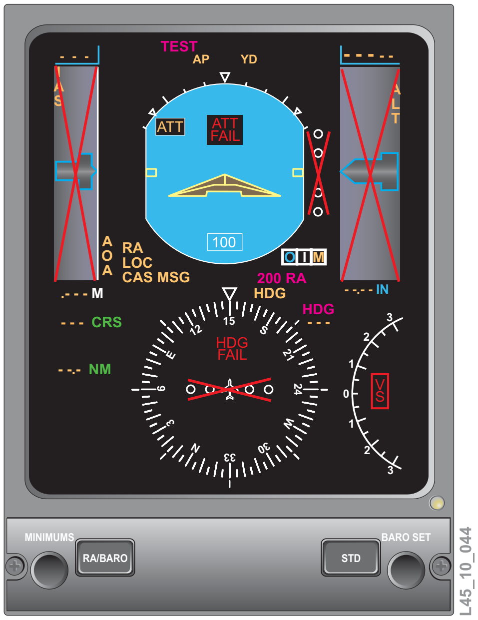

Figure 36 - PFD Failure Annunciations

Same Attitude Source

If the pilot and copilot are using their normal attitude information sources (onside), there is no attitude source annunciated. If the pilot and copilot select the same attitude source, it (ATT1 or ATT2) is annunciated in amber on both PFDs (Fig. 37).

Common Symbol Generator

When one IC/SG is controlling both pilot and copilot displays, reversionary mode has been selected and a reversionary annunciation is shown in amber that indicates the information sources in use for display information. This annunciation is displayed in the upper left corner next to the sphere and reads SG1 or 2, ADC1 or 2, ATT1 or 2, MAG1 or 2, depending on whether the pilot or copilot symbol generator is the selected source.

NOTE

The PFD and EICAS displays are copied on the other side when using the same NAV source.

Below Minimums Radio Altitude (RA or Barometric Altitude)

When at or below the radio altitude decision height (RA) or minimum descent barometric altitude (BARO), an amber MIN is displayed inside the white box and the MINIMUMS aural alert is sounded.

Same Air Data Source

When operating under normal operating conditions with each pilot obtaining air data information from the respective air data computer, the onside air data source annunciator is not displayed. When both pilots have selected the same air data source, an amber source annunciation ADC1 or ADC2 is displayed in the upper left corner of the PFD.

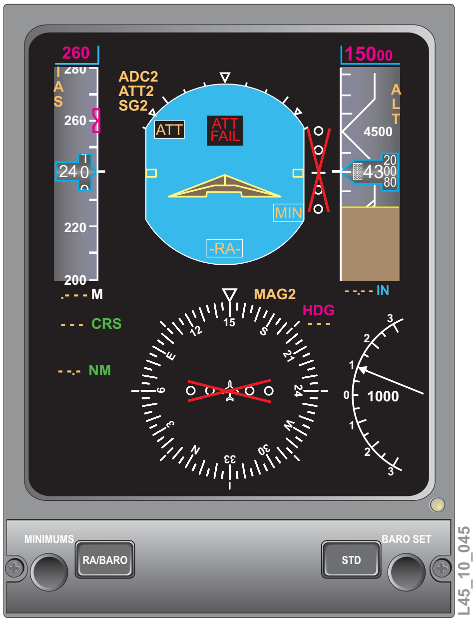

Figure 37 - PFD Caution Annunciations

Radio Altimeter Failure

If a radio altimeter failure occurs, the digital radio altitude value is replaced by an RA annunciator.

Vertical Deviation Failure

If an invalid condition or failure of the radio source driving the vertical navigation scale has occurred, it is shown by removing the deviation pointer and displaying a red X through the scale deviation dots. The scale and pointer is removed if invalid VNAV FMS data is being received.

Distance Display Failures

A digital distance value replaced with amber dashes indicates either the DME or FMS distance signal failed.

Course Deviation Failure

An invalid condition or failure of the course deviation data is shown by removal of the deviation bar and display of a red X through the scale deviation dots.

Traffic Alert and Collision Avoidance System Caution Messages

Any status messages for the traffic alert and collision avoidance system (TCAS) is displayed to the left of the vertical speed display. For more details, see Chapter 17 Navigation.

Standby Instruments

Description

The standby instrument group includes a standby airspeed/Mach indicator, an attitude indicator, and a barometric altimeter mounted on the center instrument panel above the crew warning panel and the RMUs (Fig. 38). The RMUs provide backup navigation displays if a PFD fails.

The standby instruments have their own independent pitot-static system to provide air data information. These instruments are traditional mechanical instruments. If a fault occurs that causes one of the ADCs to output misleading information to the PFDs, the standby instruments act as a useful comparison to indicate which of the three displays is incorrect.

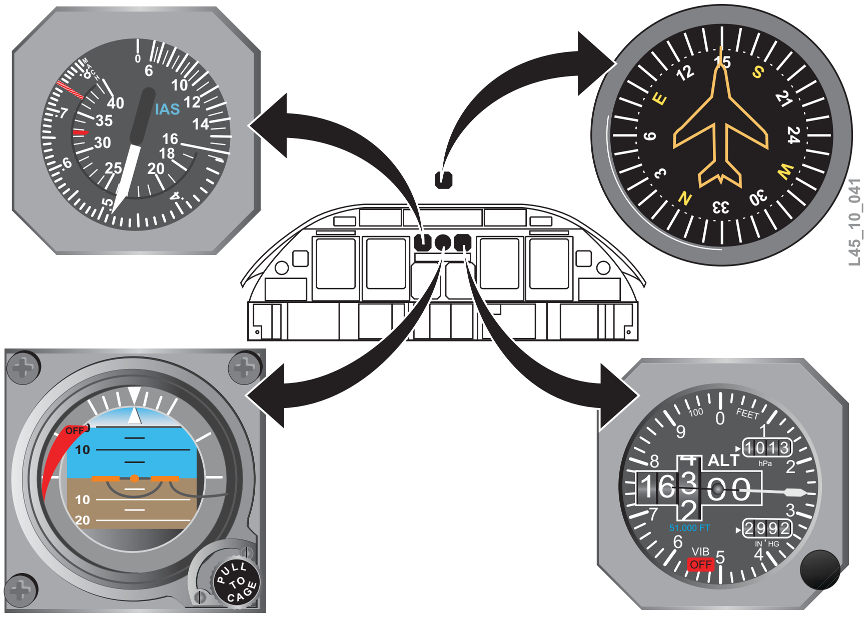

Figure 38 - Standby Instruments

Mach/Airspeed Indicator

The Mach/airspeed indicator (Fig. 39) provides indicated airspeed with a pointer. The scale is marked from 50 to 400 kt. A Mach subdial ranges from 0.3 to 1.0 Mach. Maximum allowable airspeed (V_{MO}) is indicated at 325 kt by a red radial mark on the airspeed dial. Maximum allowable Mach (M_{MO}) is indicated at 0.75 Mach by a red and white striped radial mark on the Mach subdial.

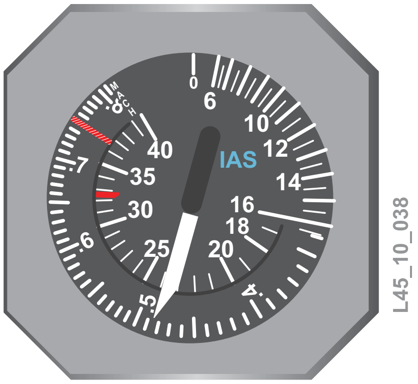

Figure 39 - Mach/Airspeed Indicator

Standby Compass

The standby magnetic compass is located at the top of the windshield center post (Fig. 40). It is a magnetic compass that does not require electrical power to provide a continuous standby heading display. The only electrical input to the compass is to illuminate it at night using internal lighting.

Figure 40 - Standby Magnetic Compass

Standby Attitude Indicator

The standby attitude indicator is a DC-powered electromechanical unit, which provides backup display of aircraft attitude (Fig. 41). It is powered from the emergency battery bus, and it remains powered for at least one hour after the loss of aircraft generator power. It contains an internal inverter that converts DC power to three-phase AC power, which then is used to electrically drive the gyro. The gyro vertical attitude is maintained by a mechanical erection system. A power warning flag on the instrument remains out of sight during normal operation. It appears if at least one phase of the AC power to operate the gyro is interrupted. The rotor speed and mechanical erection system enables the indicator to provide a minimum of nine minutes of useful attitude information after complete power interruption.

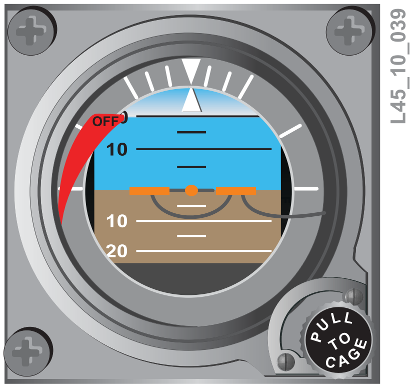

Figure 41 - Standby Attitude Indicator

Standby Barometric Altimeter

The standby altimeter displays corrected barometric altitude in a pointer/counter drum display (Fig. 42). The dial graduations are marked every 20 ft. Above sea level, the counter displays every 100 ft up to 55,000 ft of operational range. The indicator has an adjustable barometric correction scale, in both normal and standard units, from 27.90 to 31.00 inHg, and from 946 to 1050 hPa.

The standby altimeter contains a vibrator motor to prevent the instrument needle from sticking. The motor is powered from the emergency battery bus. A red OFF flag appears beneath VIB on the face of the instrument whenever power is lost to the vibrator.

Figure 42 - Standby Barometric Altimeter

Digital Clock

A dual digital clock system provides current time in local or Greenwich Mean Time (GMT) and timer functions. The digital clock system consists of two independent identical digital clocks (Fig. 43).

Digital clocks are installed on the left and right outboard sides of the instrument panel. The clocks are powered by 28 VDC supplied through the CLOCK circuit breakers located on the pilot and copilot circuit breaker panels. he clocks have a “keep alive” battery (type N alkaline) to preserve data during power outage.

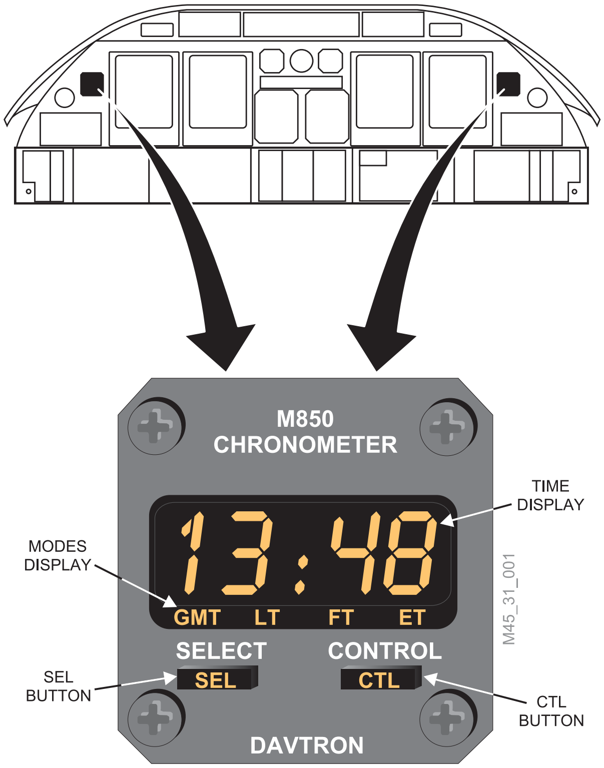

Figure 43 - Digital Clock

System Operation

The SEL button selects the mode to be displayed. The CTL button controls the selected mode. Time displayed is in a 24-hr format. The modes of operation are:

- Greenwich Mean Time (GMT)
- Local time (LT)
- Flight time (FT)
- Elapsed time (ET)

Greenwich Mean Time

Select GMT mode using the SEL button. Simultaneously press the SEL and CTL buttons to enter set mode. The tens of hours digit starts flashing.

Using the CTL button, set the tens of hours digit. Press the SEL button. The next digit is selected. After digits have been selected with the CTL button, press the SEL button. The lighted annunciator resumes normal flashing, indicating the GMT clock is operating.

Local Time

Select LT mode using the SEL button. Simultaneously press the SEL and CTL buttons to enter set mode. Tens of hours digit starts flashing. Using the CTL button, set tens of hours.

Press the SEL button. The hours digits are selected. After the digits have been selected with the CTL button, press the SEL button. The lighted annunciator resumes normal flashing, indicating the LT clock is operating.

NOTE

Minutes are synchronized with the GMT time and cannot be set in LT.

Flight Time Alarm

Select FT alarm mode using the SEL button. With FT displayed, simultaneously press the SEL and CTL buttons to enter set mode. The tens of hours digit starts flashing. Using the CTL button, set the tens of hours digit. Press the SEL button. The next digit is selected. After the digits have been selected with the CTL button, press the SEL button. The lighted annunciator resumes normal flashing, indicating the GMT clock is operating. When aircraft squat switches are in the air mode, FT starts counting.

When FT equals alarm time, the display flashes and the alarm audio output activates. If FT was not displayed at the time it became active, the clock automatically selects FT for display. Press either the SEL or CTL button to extinguish the alarm and “zero” alarm time. FT remains unchanged and continues counting. When aircraft squat switches are in the ground mode, FT stops counting.

Flight Time Reset

Ensure FT is displayed when resetting. Press and hold the CTL button for three seconds, or until 99:59 or 99:99 appears on the display. Digits displayed depend on clock programming, in hours and minutes, or in hours, tenths, and hundredths. FT is zeroed upon release of the CTL button.

Elapsed Time

Select the ET mode for display. Press CTL button. ET starts counting. Press the CTL button. ET resets to zero.

NOTE

ET counts up to 59 minutes, 59 seconds, and then switches to hours and minutes. It continues counting up to 99 hr and 59 minutes.

System Test

Press and hold the SEL button for three seconds. The display indicates 88:88 and activates all four annunciators.

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FUEL SYSTEM

Introduction

The Learjet 40/45 fuel system is simple, reliable, and safe. Several features in the fuel system increase system safety.

Fuel supply to each engine is entirely independent so that a failure or malfunction of the fuel supply system for one engine has no impact on the fuel supply system for the other engine. Fuel is supplied to the engines by ejector pumps which are extremely reliable because they have no moving parts and no electrical components. For added safety, the fuel supply system has electric standby pumps. These pumps are used to increase the fuel pressure when low pressure is detected in the line feeding each respective engine.

The fuel system requires no fuel system control inputs for normal system operation. Fuel transfer from the fuselage tank to the wing tanks is automatic by gravity and transfer line ejector pumps, which together maintain the wing tanks full as long as fuel remains in the fuselage tank. The flight crew may manually operate the electric standby fuel pump to ensure sufficient fuel pressure if a main ejector pump fails.

Description

The fuel system (Fig. 1) supplies fuel at an adequate flow rate and pressure to the engines during normal operating conditions. Each engine receives fuel from the wing tank on the same side of the aircraft.

The fuel system consists of the following subsystems:

- Fuel storage system
- Fuel vent system
- Fuel supply system
- Fuel transfer system
- Fuel quantity indication system
- Refueling/defueling system
  - Gravity point refuel system
  - Single-point pressure refuel system

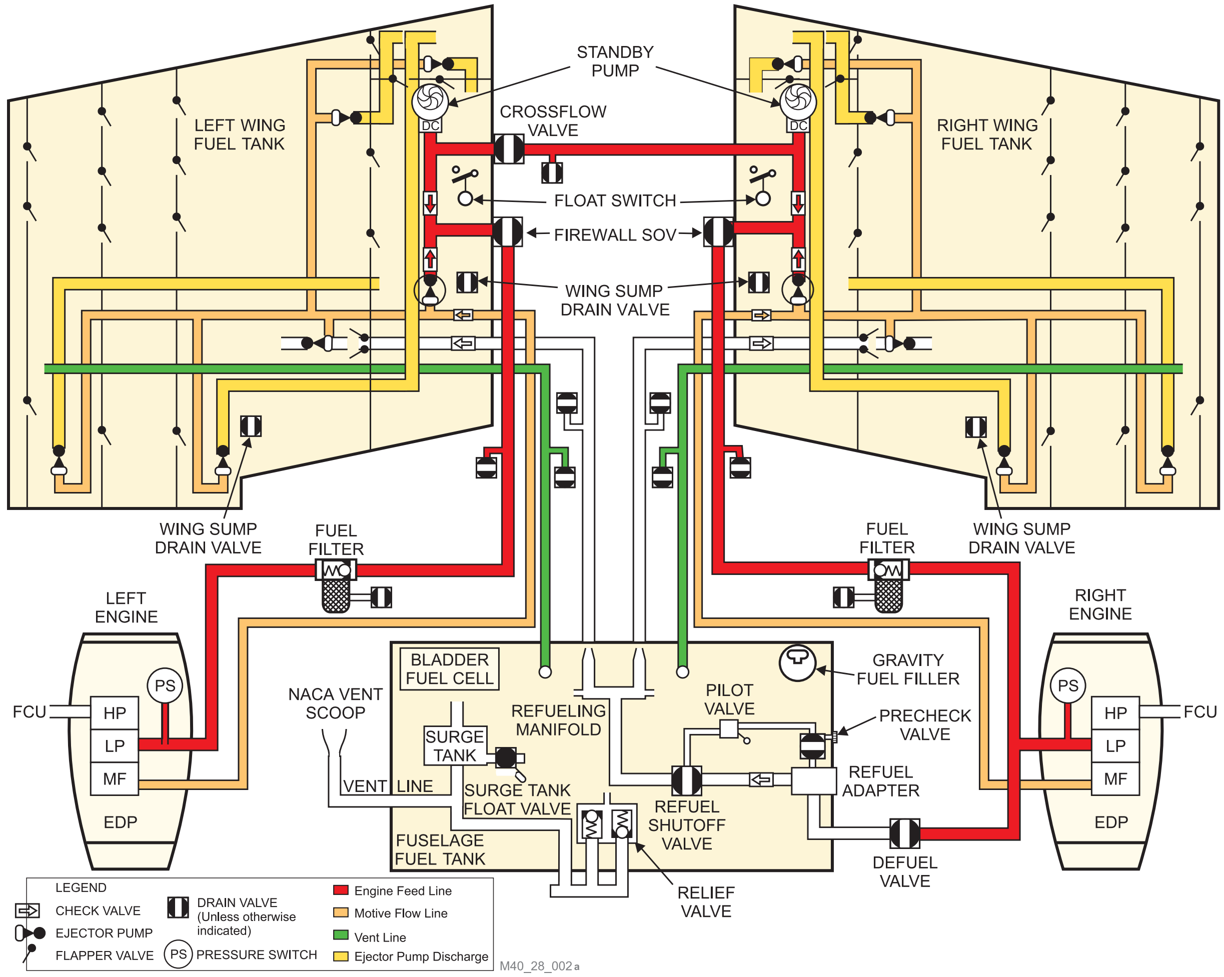


Figure 1 - Fuel System Schematic

Controls and Indications

Fuel Control Panel

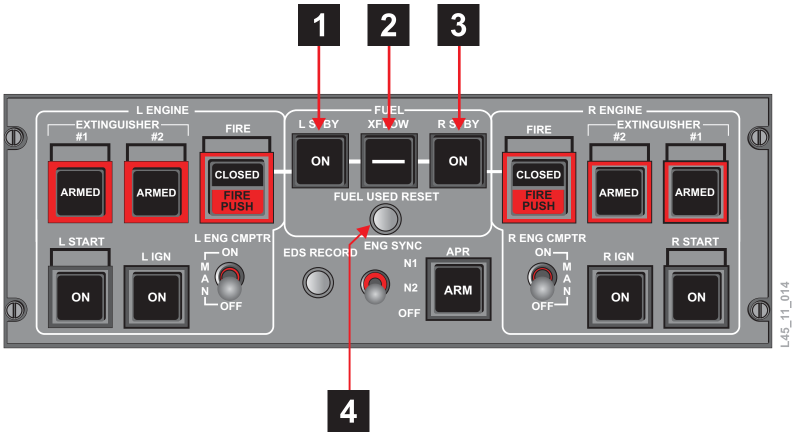


Figure 2 - Fuel Control Panel

1 L STBY Switch Indicator

- ON—Left standby electric fuel pump is energized
- Off—Left standby electric fuel pump is not energized

2 FUEL XFLOW Switch Indicator

- Normal—
  - Normal position
  - Power is applied to close the motorized crossflow shutoff valve so no fuel flows between wing tanks
- Depressed—
  - Illuminates a white bar
  - Power is applied to open the motorized crossflow shutoff valve allowing fuel flow between the wing tanks

3 R STBY Switch Indicator

- ON—Right standby electric fuel pump is energized
- Off—Right standby electric fuel pump is not energized

4 TOTALIZER RESET (momentary)

- Momentarily pressed—Resets the fuel used counter to zero

EICAS Primary Engine Display

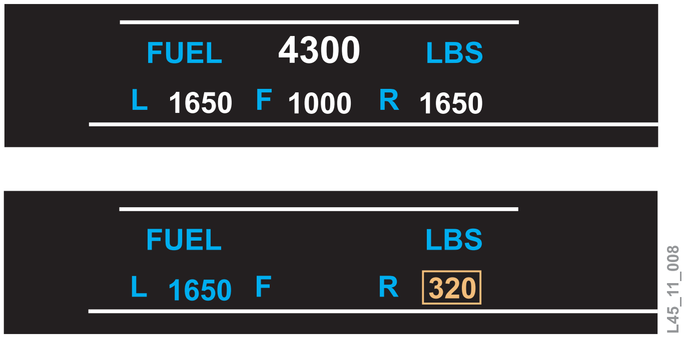


Figure 3 - EICAS Primary Engine Display

Table 1 - EICAS Primary Engine Display

Description	Symbol	Condition
Total fuel quantity digital readout	4300	Total fuel quantity readout
	----	Invalid total fuel quantity readout
Left wing, fuselage, right wing quantity digital readout	1650	Normal fuel tank quantity
	320	Fuel tank quantity less than 360 lb (163 kg) or fuel imbalance limit exceeded in flight, and this tank has the lowest quantity
	----	Invalid fuel tank quantity readout

EICAS Fuel System Page

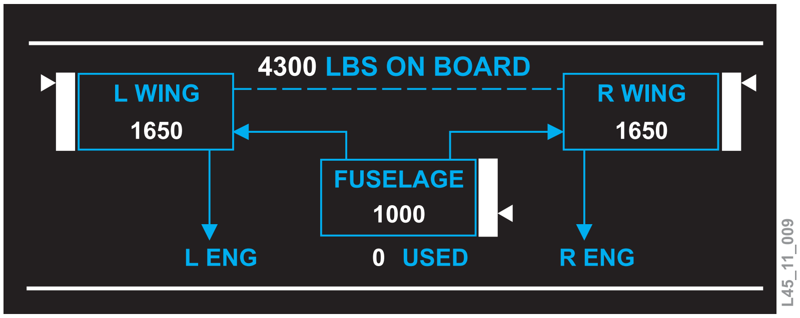
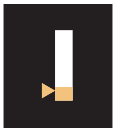


Figure 4 - EICAS Fuel System Page

Table 2 - EICAS Fuel System Page

Description	Symbol	Condition
Left and right fuel quantity digital readout	1650	Normal fuel quantity display
	100	Fuel quantity dropped below 360 lb (163 kg) or excessive fuel imbalance occurred, and this tank has lowest fuel quantity
	----	Invalid fuel quantity
Fuselage tank fuel quantity digital readout	1000	Normal fuel quantity display
Left and right wing fuel quantity analog scale and pointer		Normal fuel quantity display
		Fuel quantity has dropped below 360 lb (163 kg)
Total fuel quantity digital readout	1400	Total fuel quantity display

RMU Backup Page

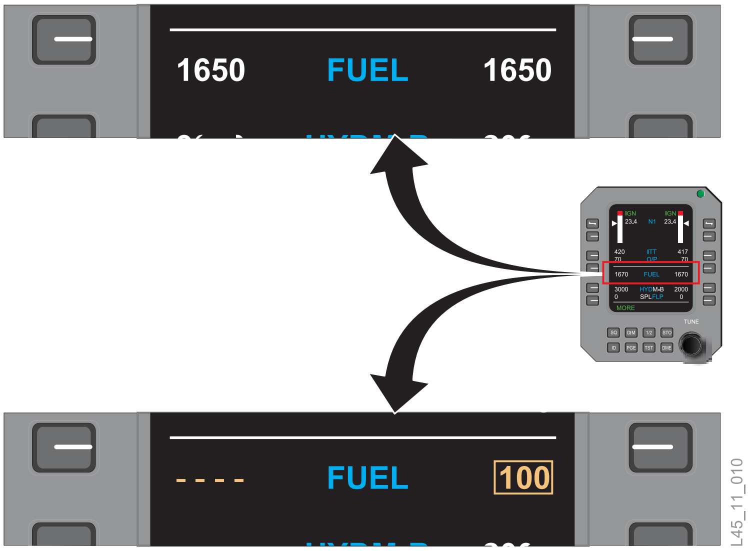


Figure 5 - RMU Engine Backup Page

Table 3 - RMU Backup Page

Description	Symbol	Condition
Left and right fuel quantity digital readout	1650	Normal fuel quantity display
	100	Fuel quantity has dropped below 360 lb (163 kg)
	----	Invalid fuel quantity

Fuel Storage System

Description

The Learjet 45 fuel storage system consists of two wing tanks and one fuselage tank with a total volume of 939.1 U.S. gal (6292 lb–2854 kg). The two wing tanks have a total usable fuel quantity of 500.6 U.S. gal (3354 lb–1525 kg). The fuselage tank has an usable fuel quantity of 404.2 U.S. gal (2708 lb–1231 kg).

The usable fuel volume of the Learjet 45 is stated on the aircraft type certificate as 904.8 U.S. gal which is equivalent to a weight of 6062 lb (2756 kg) of fuel. The exact weight of the fuel varies with the type of fuel and the fuel temperature in the tanks. As a result, the usable fuel tank volumes in Learjet 40/45 aircraft are rounded off to the nearest .10 gallon in normal operations (Table 4 and Table 5).

Table 4 - Learjet 45 Fuel Tank Usable Fuel

Fuel Tank	U.S. Gallons	Pounds	Kilograms
Left wing tank	250	1678	761
Fuselage tank	404	2708	1228
Right wing tank	250	1676	760
Total	904	6062	2746

Table 5 - Learjet 40 Fuel Tank Usable Fuel

Fuel Tank	U.S. Gallons	Pounds	Kilograms
Left wing tank	250	1678	761
Fuselage tank	302	2021	917
Right wing tank	250	1676	760
Total	802	5375	2438

Components

Wing Tanks

The wing tanks (Fig. 6) are the main fuel tanks on the Learjet 40/45. Each wing tank feeds its respective onside engine. The wing is divided into two separate fuel-tight compartments which serve as fuel tanks. Each tank extends from the wing root to a point just short of the winglets. The two wing tanks are joined together by a crossflow line. The wing tanks have no external fill ports and can only receive fuel through two gravity/ejector pump transfer lines from the fuselage tank (transfer is by gravity and transfer ejector pumps). Each wing fuel tank contains flapper valves which allow fuel to flow freely toward the main ejector pumps but restrict fuel flow away from the pumps.

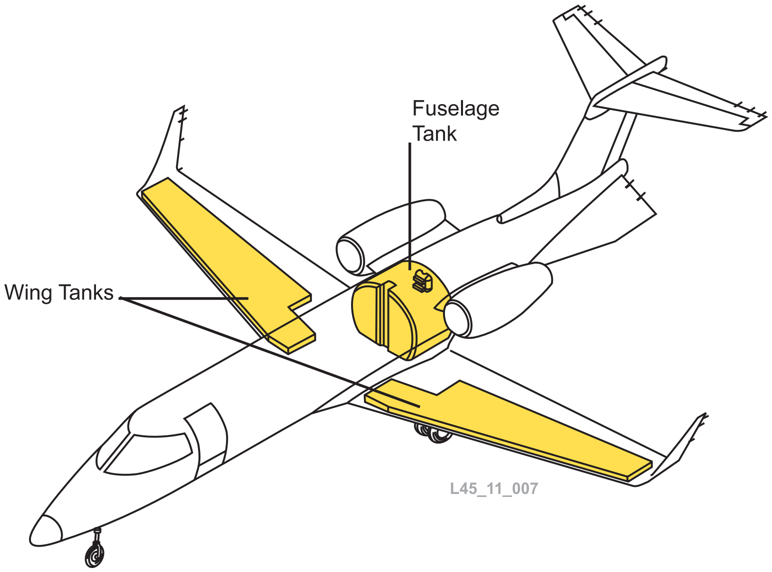


Figure 6 - Fuselage and Wing Tanks

Collector Bay

Each wing tank contains a collector bay located at its inboard-most section. The collector bays have been designed to safely collect fuel, in all aircraft attitudes, and to submerge the main ejector pumps to ensure proper fuel supply to the engines.

To maintain the collector bay full and the primary ejector pump fully submerged in all aircraft attitudes, four scavenge ejector pumps continuously supply fuel from sections of each wing tank so that fuel may not become trapped in their respective tanks. A fifth scavenge jet continuously pumps fuel from the forward end of the collector tank to the inlet of the main ejector pump at the aft end of the collector bay.

Float Switches

A float switch in each collector bay triggers the white L or R FUEL BAY LOW CAS message when the fuel level near the main ejector pump in the collector bay decreases. This CAS message is displayed when the respective engine is not operating.

Fuselage Tank

The fuselage fuel tank is a single bladder-type cell. Plumbing for the fuel tank vent system and the single-point refueling system is located within the fuel cell. The fuselage tank can be refueled by gravity through a filler port located on the top right side of the fuselage or by single-point pressure refueling.

Fuel Vent System

Description

The fuel vent/expansion system provides ram-air pressure to all of the interconnected components of the fuel system.

The fuel vent/expansion system consists of:

- Ram-air scoop (NACA flush)
- Surge tank
- Surge tank float valve
- Vent/expansion lines with auxiliary vacuum/pressure relief valve

Components

Ram-Air Scoop

Ram air is provided from the ram-air scoop to ensure positive pressure in the fuel tanks. The ram-air scoop is located on the upper left side of the fuselage near the left engine pylon.

Surge Tank

A surge tank is located in the fuselage fuel cell. Any fuel that bypasses the surge tank float valve or inadvertently enters through the forward opening of the surge tube is trapped in the surge tank and prevented from flowing out of the ram-air scoop.

Surge Tank Float Valve

The surge tank float valve, mounted to the lower side of the surge tank, opens when the aircraft is in a nose-down attitude or the fuel level is lower than the surge tank, to vent the fuel storage areas. If the aircraft is full of fuel or in a nose-up attitude, the float valve is closed, sealing the fuel from the stand tube leading to the ram-air scoop.

Vent/Expansion Lines

Wing tank overpressurization is prevented by vent/expansion lines between the wing tanks and the fuselage tank. This allows the main wing tanks to use the fuel vent/expansion space of the fuselage tank. Expansion space for each main tank is located at the top of the fuselage tank.

Fuel Transfer System

Description

The fuel transfer system enables fuel to be transferred between the wing tanks and from the fuselage tank to the wing tanks as required.

The fuel transfer system consists of the following components:

- Two transfer line ejector pumps (one in each wing)
- Eight scavenge ejector pumps (four in each wing)
- Crossflow shutoff valve
- Two transfer line check valves
- Crossflow switch

Components

Scavenge Ejector Pumps

The scavenge ejector pumps transfer fuel from areas of the wing tanks from which fuel does not flow, to the collector bay. This ensures an adequate supply of fuel at the main ejector pump inlets when the aircraft is in flight. The scavenge pumps are positioned to minimize the amount of unusable fuel on board the aircraft during climb, descent, and wing-low attitudes, as well as to ensure adequate fuel supply.

The scavenge ejector pumps have no moving parts and operate using the venturi principle. High-pressure fuel from an engine-driven motive flow fuel pump is pumped through each scavenge ejector pump venturi, causing the pump to transfer fuel. The scavenge ejector pumps operate simultaneously with the main ejector pumps.

Crossflow Shutoff Valve

The crossflow valve controls the flow of fuel from one wing fuel tank to the other. The crossflow valve is a DC electrical motor-driven valve; therefore, if electrical power is lost to the valve, it fails in the position it is in when electrical power is lost.

Crossflow Switch

The crossflow valve is normally closed, but may be opened if a fuel imbalance occurs during flight. When the crossflow valve is open, fuel can be pumped from one wing to the other using either electric standby pump. The pumps are centrifugal-type, and fuel can flow through them when they are not operating. Operation of the left standby pump causes the fuel to be transferred from the left to the right wing tank. Operation of the right standby pumps reverses the flow. The crossflow shutoff valve is controlled by the crossflow (XFLO) switch located on the pedestal or the defuel switch located on the refueling panel.

Transfer Line Check Valve

A transfer line check valve is located on the inboard side of each wing. The check valves allow fuel to flow only from the fuselage to the wing fuel tanks.

The crossflow valve is selected open by depressing the XFLOW switch. The white indicator bar on the switch illuminates when the valve is completely open. A white FUEL XFLO OPEN CAS message is displayed when the valve reaches the fully open position.

Depressing either standby pump switch activates the applicable standby pump. With the crossflow shutoff valve open, fuel is pumped from one wing tank to the other at approximately 50 ppm. The fuel flows through the open crossflow shutoff valve and the standby pump located in the other wing tank into the opposite wing tank. When the wing fuel tanks are in balance, the crossflow valve is closed by depressing the XFLOW switch until it pops out to the closed position. When the valve closes, the white indicator bar extinguishes.

The data acquisition unit receives information to monitor the crossflow shutoff valve position. The flight crew is informed on the EICAS display if the crossflow valve is open or has failed. If the valve does not correctly reposition to the position selected by the switch within 1.5 seconds, the white bar flashes and an amber FUEL XFLO CAS message is displayed.

The crossflow shutoff valve is remotely opened during aircraft defueling. During defueling, the crossflow switch position has no effect on the crossflow shutoff valve.

Fuel Supply System

Description

The fuel supply system ensures that fuel is distributed from the lowest point in each wing tank to its respective onside engine.

The engine fuel distribution system consists of two each of the following components:

- Main ejector pumps
- Engine-driven pumps
- Electric standby pumps
- Supply line check valves
- Motive flow check valves
- Engine firewall shutoff valves
- Standby pump switches
- Fuel filters

Components

Main Ejector Pumps

The main ejector pump in each wing tank supplies pressurized fuel to its respective onside engine. Each main ejector pump is located near the wing root (collector bay) of the wing tanks so that it is submerged in fuel until the tank is practically empty. The ejector pumps have no moving parts and operate using the venturi principle.

Engine-Driven Pumps

The engine-driven pumps receive fuel from the wing tanks. The two-stage pressure pump increases the fuel pressure for use in the engines. Excess fuel not used by the engines is sent to the motive flow pump which pressurizes fuel for all ejector pump operations. In addition, the engine-driven pump suction feeds fuel from the wing tanks under most operating conditions, acting as a second backup fuel pressure source to the fuel supply system.

Electric Standby Pumps

The electric standby pumps provide fuel pressure if the other pumps in the fuel system cannot provide it. The electric standby pumps are used:

- Automatically during engine start
- As a backup to the main ejector pumps
- For wing-to-wing fuel transfer

The standby electric pumps are located at the low point in each wing tank collector bay next to the main ejector pumps. The electric standby pumps are powered by the electrical system essential bus which remains powered during a loss of power from both generators.

Standby Pump Switches

The standby pump switches are located on the pedestal. The switches illuminate ON when the applicable standby pumps are operating.

Supply Line Check Valves

Supply line check valves are located downstream of each wing main ejector pump and standby pump. The check valves prevent reverse flow between the pumps. The check valves have small internal openings that allow fuel to drain back after engine shutdown to prevent damage from thermal expansion.

Motive Flow Check Valves

Motive flow check valves are located in each rib No. 1. High-pressure fuel from a motive flow pump flows through the motive flow check valves to the wing tank main and scavenge ejector pumps. Motive flow check valves prevent reverse fuel flow to the engine-driven pumps.

Engine Firewall Shutoff Valves

The engine firewall shutoff valves (FWSOVs) shut off fuel flow to the engines. The engine FWSOVs are electric motor-driven gate-type shutoff valves. There is one shutoff valve for each engine, located outside the tank in the engine feed line, attached to the inboard wing tank ribs.

Fuel Filters

There are two fuel filters located in each engine fuel supply system. Fuel filters in the airframe filter the fuel just downstream of the engine fuel FWSOVs in the airframe. Fuel filters in the engine filter the fuel between the two stages of the engine-driven fuel pump just before it is directed into the engine.

If any of the fuel filters become clogged, they are bypassed. A differential pressure switch near each fuel filter closes when the filter is being bypassed or if an increase in differential pressure is sensed. An increase in differential pressure indicates an impending filter bypass. When this happens, an amber L or R FUEL FILTER CAS message is displayed if the aircraft is on the ground. This same CAS message is activated when the engine fuel filter is being bypassed or about to be bypassed. In flight, the message associated with the airframe fuel filter is suppressed, but a white L or R FUEL FILTER CAS message annunciation occurs for an engine fuel filter bypass.

Operation

The standby pumps can be activated by depressing the L and/or R STBY switches on the engine/fuel control panel. The corresponding standby pump is activated automatically during the engine start sequence and subsequently deactivates automatically when the engine starter cuts out (at approximately 50% N2). If low-fuel pressure is indicated, the flight crew must activate the corresponding standby pump manually.

When the standby electric fuel pump is operating, a white L or R STBY PUMP ON CAS message is displayed and the standby pump switch ON indicator illuminates. This occurs whether the standby pump has been turned ON manually by crew action or if it has been automatically activated.

The shutoff valves are controlled by the appropriate left and right FIRE PUSH switches on the engine/fuel control panel. To avoid accidental activation, the switches have plastic guards installed which must be raised before the switch can be pressed. Whenever an engine fuel FWSOV is closed, a white L or R FWSOV CLSD CAS message displays. If the valve fails to open or close fully within 1.5 seconds after it has been selected, an amber L or R FWSOV FAULT CAS message displays. The valves are DC powered and remain in their last position if a DC power failure occurs.

During engine start, fuel is supplied by the corresponding electric standby pump until the engine-driven pumps are able to supply sufficient motive flow to power the ejector pumps. The electric standby pump automatically starts when each engine start switch is selected and stops when the engine starter cuts out (approximately 50% N2). When the standby pump stops, the main ejector pumps provide fuel to the engines.

During normal engine operation, high-pressure fuel from the motive flow pump is routed through nozzles in the ejector pumps. This creates a venturi which picks up fuel in the wing tanks and pumps the fuel back to the engine fuel pump. Each main ejector pump is dedicated to the engine on the same side.

Fuel from the motive flow pump is additionally routed back to the four scavenge ejector pumps and the transfer line ejector pump in each wing for motive flow. The scavenge ejector pumps move fuel to the collector tank area of the wing where the main ejector pump is located, and then the main ejector pump forwards fuel to the engine.

If a main ejector pump fails, a L or R FUEL PRESS LOW annunciator illuminates on the CWP in addition to a red L or R FUEL PRESS LOW CAS message.

CAS Messages

Table 6 - CAS Messages

CAS Message	CWP Caption	Conditions/ Parameters
L FUEL PRESS LOW	L FUEL PRESS LOW	Low pressure in the fuel line to the left engine fuel pump
R FUEL PRESS LOW	R FUEL PRESS LOW	Low pressure in the fuel line to the right engine fuel pump
L R FUEL PRESS LOW	L FUEL PRESS LOW R FUEL PRESS LOW	Low pressure in the fuel line to both the left and right engine fuel pump
DEFUEL OPEN	Defuel valve open	
FUEL IMBALANCE	Wing fuel imbalance greater than 500 lb with flaps retracted; wing fuel imbalance greater than 200 lb with flaps extended	
L FUEL QTY LOW[a]	Respective wing tank fuel quantity reached approximately 360 lb (approximately 45 minutes IFR reserve requirement) This message may be disabled.	
R FUEL QTY LOW[1]		
L R FUEL QTY LOW[1]		
FUEL XFLOW	Crossflow valve fault (not fully open/closed after 1.5 seconds)	
L FWSOV FAULT	Respective firewall shutoff valve (FWSOV) not fully open/closed (after 1.5 seconds)	
R FWSOV FAULT		
L R FWSOV FAULT		
L FUEL FILTER	(On aircraft incorporating ECR 7258) Respective engine fuel filter impending bypass with aircraft on the ground	
R FUEL FILTER		
L R FUEL FILTER		

Table 6 - CAS Messages (Cont)

CAS Message	CWP Caption	Conditions/ Parameters
L FUEL FILTER		(On aircraft not incorporating ECR 7258 only) Respective engine fuel filter impending bypass with aircraft on the ground
R FUEL FILTER		
L R FUEL FILTER		
L FUEL QTY FAULT		Respective fuel quantity indication fault
R FUEL QTY FAULT		
L R FUEL QTY FAULT		
FUEL XFLO OPEN		Crossflow valve open
L STANDBY PUMP ON		Power applied to the respective standby fuel pump
R STANDBY PUMP ON		
L R STANDBY PUMP ON		
L FUEL BAY LOW		Respective collector bay fuel level low
R FUEL BAY LOW		
L R FUEL BAY LOW		

a. This message may be disabled.

Fuel Quantity Indication System

Description

The quantity indication system provides the following:

- Cockpit fuel quantity indication
- Ground crew fuel quantity indication for refueling or defueling
- Fuel quantity indicating system fault detection
- LOW FUEL caution CAS message

NOTE

The LOW FUEL warning function may be temporarily deactivated on certain aircraft. Due to fuel movement in the wing tanks, the low fuel sensor uncovered at considerably higher quantities than intended, causing inadvertent display of the L R FUEL QTY CAS message.

The following fuel quantities are displayed at all times on the primary engine instruments section of the EICAS display and on the EICAS fuel system page when selected:

- Total fuel quantity
- Left wing tank fuel quantity
- Right wing tank fuel quantity
- Fuselage tank fuel quantity

The system provides a fuel quantity accuracy which indicates zero at zero usable fuel and is corrected for pitch and roll attitudes using information provided by the AHRS system.

The indicating system consists of:

- Fuel quantity signal conditioner
- Wing tank fuel quantity probes (16 total; 8 in each wing tank)
- Fuselage tank fuel quantity probe
- Refueling control panel

Components

Fuel Probes

The fuel probes provide data which is used by the fuel quantity signal conditioner to determine fuel quantity. The fuel probes change capacitance as the fuel level in the tanks change, and this capacitance affects the input to the signal conditioner which then determines the fuel quantity. There are eight probes in each wing tank and one in the fuselage tank. Seven probes in each wing tank determine fuel quantity. One probe in the collector tank section of each wing tank compensates the fuel quantity readings for fuel density variations in all fuel types commonly used on the Learjet 40/45 aircraft.

Fuel Quantity Signal Conditioner

The fuel quantity signal conditioner receives and interprets data from the fuel probes. This data helps determine the fuel quantity in the tanks. After analyzing this information, it is forwarded to the data acquisition units where it displays in the cockpit. The fuel quantity signal conditioner is a two-channel microprocessor unit. The left channel reads and processes signals from the left wing tank. The right channel reads and processes signals from the right wing tank. Both channels independently read the fuselage tank signals and receive aircraft pitch information from the No. 1 AHRS. This pitch data significantly increases the accuracy of the fuel gauging system during climbs and descents. The following EICAS messages are specific to the fuel quantity indicating system:

- White FUEL QTY FAULT CAS message alerts the flight crew of the following:
  - Loss of pitch information from the No. 1 AHRS unit (fuel indication system accuracy is degraded)

  - Loss of fuselage tank probe information (EICAS fuselage and total fuel quantity indications are replaced by amber dashes)
- White L or R or L R FUEL QTY FAULT CAS message displays:
  - If one probe is lost in either the left or right wing tank or both wing tanks, the fuel quantity indications on the EICAS for the affected wing tank remain displayed

If the white L or R FUEL QTY FAULT CAS message is caused by the loss of more than one probe in the affected wing tank, the fuel quantity indications for that wing tank and total fuel quantity are replaced by amber dashes.

The fuel quantity signal conditioner additionally monitors the fuel in the wing tanks for a quantity imbalance. Fuel imbalance thresholds are:

- On aircraft 45-002 through 45-258 and 45-260 not modified by SB 45-28-8:
  - During flight, wing fuel balance must be maintained within 500 lb (227 kg) flaps up or 200 lb (91 kg) with flaps greater than 3°

- On aircraft 45-259, 45-261 and subsequent, and on aircraft modified by SB 45-28-8:
  - During flight, wing fuel balance must be maintained within 200 lb (91 kg)

Operation

The fuel probe readings are received by the fuel quantity signal conditioner, along with the aircraft pitch attitude information from the AHRS. The fuel quantity signal conditioner uses these inputs to calculate fuel quantities for each tank and then transmits the fuel quantities to one of the DAUs for display.

Refueling/ Defueling System

Description

The Learjet 40/45 may be fueled using the gravity filler port, or by using the single-point pressure refueling (SPPR) method at the pressure refueling adapter. Fuel may be removed using the aircraft defueling system by applying suction at the pressure refueling adapter. Detailed procedures for refueling the aircraft are contained in the AFM Addendum I - Fuel Servicing. Refer to this addendum during refueling.

Components and Operation

Fuselage Gravity Refueling

The gravity filler port is located in the upper fuselage, forward of the right engine.

NOTE

Do not refuel through the gravity filler with an engine or the APU running.

Ground the fuel truck to the apron and the nose gear uplatch spacer, and ground the fuel nozzle to the applicable ground jack prior to removing filler cap. This helps prevent possible fire and/or explosion due to static electricity or sparks.

If the aircraft is to be refueled using the fuselage gravity filler port, comply with the following:

- Open the refuel panel door and fuselage gravity filler door
- Select FUEL PANEL switch to ON (fuel quantity indicator shows the total aircraft fuel load)
- Connect ground cable from refueling nozzle to aircraft
- Remove fuselage gravity filler cap
- Drain all fuel vent lines
- Start fueling operations

NOTE

Do not fill the aircraft beyond capacity or fuel will spill out of the gravity filler port. Refueling up to the level of the gravity filler port is acceptable.

During aircraft refueling, the fuselage tank fills faster than the wing tanks. Aircraft wing tanks are not full when the fuel level reaches the level of the gravity filler port lip. Refueling should be halted for five minutes when the indicator reaches approximately 4500 lb (2041 kg) until the wing tanks fill. If required, monitor the wing fuel tank quantity from the cockpit panel to ensure that the wing tanks are full. Continue refueling until approximately 6000 lb (2722 kg) of fuel is displayed on the fuel quantity indicator on the refueling control panel.

- Monitor the fuel quantity indicator on the refueling panel until reaching the desired quantity
- If maximum fuel capacity is desired, continue refueling until approximately 6000 lb (2722 kg) of fuel is displayed on the fuel quantity indicator on the refueling control panel
- Remove fuel nozzle and install fuselage gravity filler cap
- Disconnect the ground cable from the aircraft to the refueling nozzle
- Select the FUEL PANEL switch to OFF
- Close refueling panel door and gravity filler door

NOTE

The vent/expansion lines must be drained before gravity refueling if the fuselage tank fuel level is below the wing tip fuel level (i.e., wings not completely full and fuselage tank almost empty). If the vent/expansion lines are not drained, the wing tanks cannot be completely filled due to trapped air.

Fuel Drains

Fuel drains (Fig. 7) are provided in the fuel system for removal of water and fuel.

For the removal of water, there are nine spring-loaded rotary-type drain valves installed at the following locations:

- Crossflow line
- Left and right refuel/transfer lines
- Left and right vent/expansion lines
- Left and right engine feed lines
- Left and right fuel filters

These drain valves are located in the center wing section and are accessed through doors located in the underwing fairing. The outlets of the drain valves are routed to two drain masts under the wing center section.

The airplane tanks may be drained through a total of four sump drains, two located forward of the main landing gear wheel wells and two outboard of the main landing gear doors. The sump drains are flush-fitting push-and-turn types.

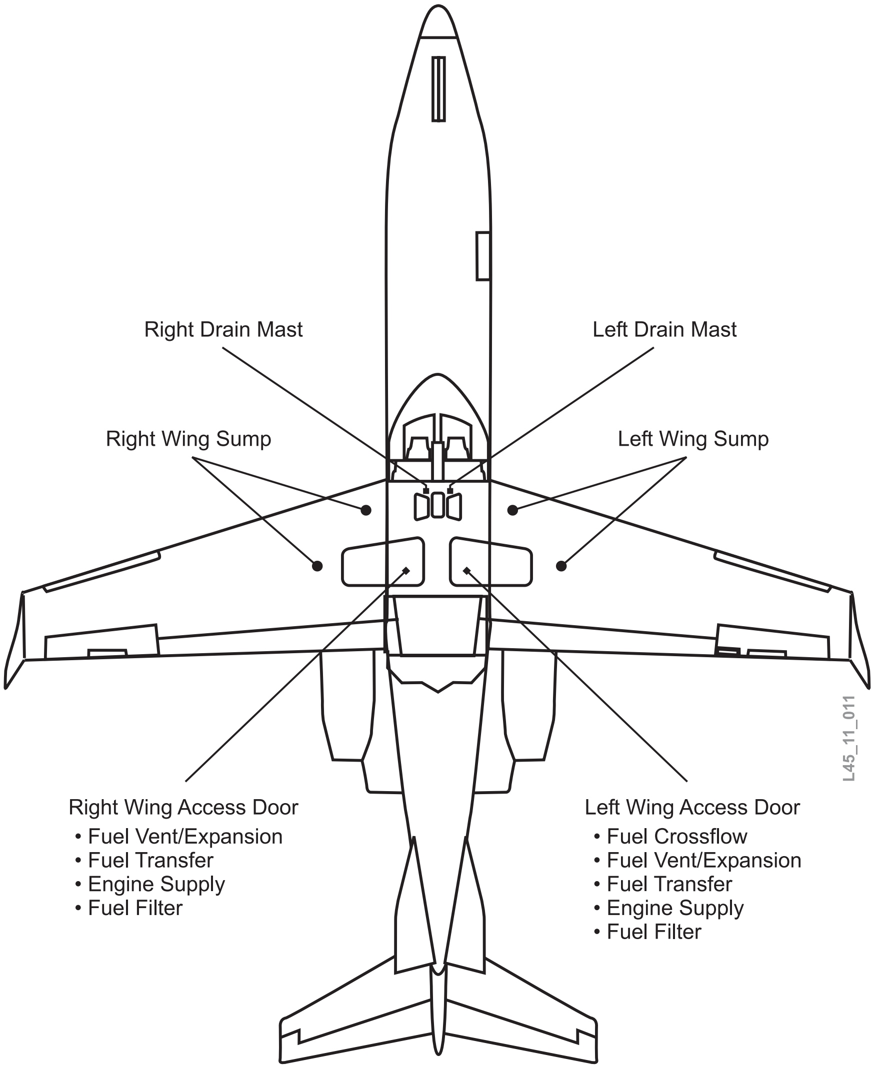


Figure 7 - Fuel Drains Locations

Single-Point Pressure Refueling

.The single-point pressure refueling (SPPR) system consists of the following:

- Refueling control panel
- Precheck valve
- Pressure refueling adapter
- Refueling line check valve
- Refuel shutoff valve
- Pilot valve
- Refueling manifold
- Defuel shutoff valve

Refueling Control Panel

The refueling control panel (Fig. 8) controls refueling and defueling processes. It contains an LED which displays the total quantity of fuel in the airplane. The fuel quantity can be displayed in either pounds or kilograms, as desired. The refueling control panel is located on the right side of the aircraft.

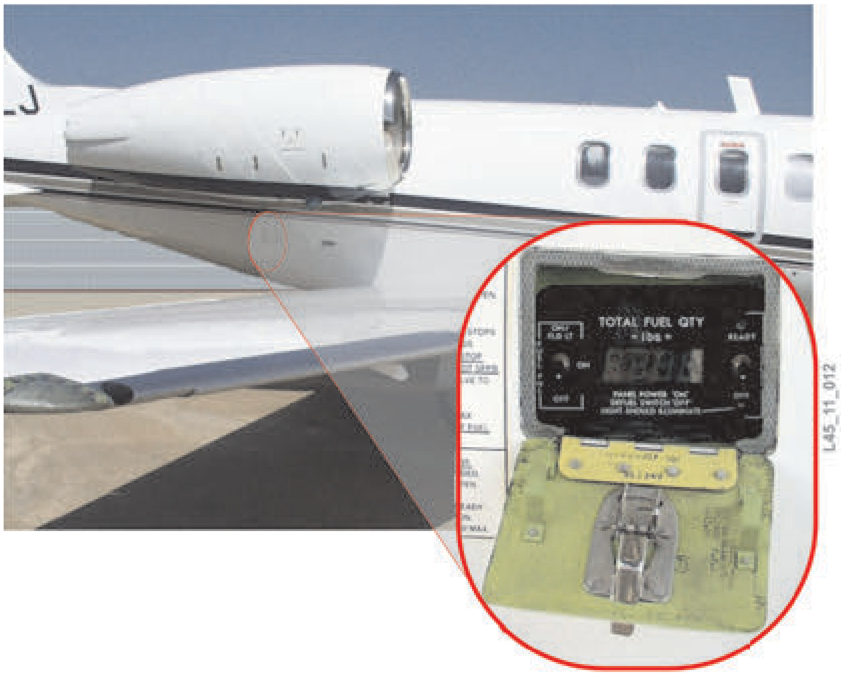


Figure 8 - Refueling Control Panel

The control panel contains the following:

- FUEL PNL power switch
- Defuel switch
- Amber LED indicator (illuminates when both the defuel shutoff and the crossflow shutoff valves are open)
- Green LED indicator (illuminates when both the defuel shutoff and the crossflow shutoff valves are closed)
- Four-digit LED fuel quantity indicator (indicates total usable fuel quantity during refueling and defueling operations)

The FUEL PANEL switch may be selected to the ON/FLD LT position to activate a floodlight installed in the lower surface of the right engine pylon. It is powered from the rear hot bus, thereby permitting refueling of the airplane without accessing the aircraft.

Precheck Valve

The precheck valve checks for proper functioning of the single-point refueling system prior to use. Prior to refueling, the proper operation of the shutoff system is verified by selecting the mechanically operated precheck valve to the OPEN position, which admits fuel directly from the refuel adapter into the pilot valve. This simulates a full tank by flooding the float chamber, and shuts off the refuel shutoff valve to stop fuel flow within approximately 20 seconds. After this test, the precheck valve is returned to the CLOSED position, draining the float chamber and allowing normal refueling. Control for the precheck valve is adjacent to the SPPR adapter. Placards indicate the OPEN and CLOSED positions.

Pressure Refueling Adapter

The pressure refueling adapter (Fig. 9) is located on the right side of the aircraft forward of the right engine behind an access panel. It connects the refueling vehicle to the aircraft refueling and defueling systems. The installation incorporates a grounding receptacle. It is designed to accept a standard nozzle and has a non-flush-fitting black cap.

Figure 9 - Pressure Refueling Adapter

Refuel Line Check Valve

The refuel line check valve is installed in the fuel line connected to the outlet of the pressure refuel adapter. The valve minimizes the quantity of fuel that may spill if the shutoff valve fails in the open position. This check valve allows fuel to flow only into the fuel storage areas during refueling. The valve is normally spring-loaded to the closed position.

Refuel Shutoff Valve

Fuel flow into the fuselage and wing tanks is controlled by the refuel shutoff valve. The valve is normally closed and opens when suitable refueling pressure is applied to the upstream side of the valve. The valve is closed when the refueling pressure is removed or as a result of the float-operated pilot valve, which detects when the fuel level in the fuselage tank has reached the maximum level and then directs fuel back to the valve which shuts to stop aircraft pressure refueling.

Pilot Valve

The pilot valve incorporates a float that closes the refuel shutoff valve. Aircraft pressure refueling ceases when the fuel level in the fuselage fuel cell reaches the pilot valve.

Refueling Manifold

The refueling manifold is located in the fuselage cell. During refueling, the manifold empties fuel into the fuel cell. A nozzle forces fuel through the transfer line into the wing fuel tanks. During normal operation, fuel bypasses the nozzle to transfer fuel from the fuselage fuel cell through the flapper valves in the transfer lines to the wing fuel tanks.

Defuel Shutoff Valve

The defuel shutoff valve is on the aft side of the fuselage fuel cell. The valve is energized open by the DEFUEL switch on the refueling control panel.

SPPR Operation

SPPR can fuel the aircraft from one location. SPPR fueling capacity is the same as gravity fill capacity, except that the SPPR system may shut off automatically at approximately 1 to 2 gal below the fuel level that would be obtained if the gravity fill method was used. Pressurized fuel is pumped into an adapter located on the right rear fuselage. Total aircraft fuel quantity may be monitored during aircraft refueling using the indicator on the refueling control panel.

Pressurized fuel from the truck enters the aircraft through the pressure refueling adapter, then passes through the refuel line check valve until it reaches the refuel shutoff valve. During refueling, the float attached to the pilot valve is down, opening the pilot valve. As a result, the refuel shutoff valve opens. When the fuel level in the fuselage fuel cell rises to the level that floods the pilot valve fuel collector, the float rises and closes the pilot valve. As a result, the refuel shutoff valve closes to shut off aircraft refueling.

Aircraft Defueling

The aircraft may be defueled by suction through the SPPR adapter located on the right rear fuselage. This procedure is not normally used by the flight crew, so it is recommended that maintenance personnel be consulted when defueling. Detailed instructions for this procedure are covered in the *Learjet 45 Maintenance Manual* Chapter 12 Servicing. Maximum permitted suction pressure for defueling is -10 psig. Total defueling can be accomplished in 45 minutes.

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HYDRAULIC SYSTEM

Introduction

The Learjet 40/45 uses a 3000-psi hydraulic system, consisting of two independently operating systems (main and auxiliary), which share a common hydraulic reservoir and source of reservoir pressurization. The reservoir internally isolates the main and auxiliary fluid quantities to preclude total fluid loss during a single system leak.

The main and auxiliary systems provide hydraulic power for operation of:

- Landing gear (extension/retraction, nose uplock release)
- Main landing gear inboard doors (extension/retraction, uplock)
- Flaps
- Spoilers/spoilerons
- Wheel brakes
- Thrust reversers

The main hydraulic system uses two engine-driven pumps, and the auxiliary hydraulic system uses a DC motor-driven pump.

If the main and auxiliary hydraulic systems malfunction, a hydraulically charged pneumatic brake accumulator provides emergency braking.

Hydraulic system controls are located on the GEAR/HYD panel. The system status can be monitored on the EICAS/MFD system summary page. In addition, a dedicated hydraulic system page display on the EICAS/MFD provides a schematic presentation of the hydraulic system.

The hydraulic system is serviced through the hydraulic ground service panel located below the right engine pylon on the right aft fuselage.

Controls and Indications

GEAR/HYD Panel

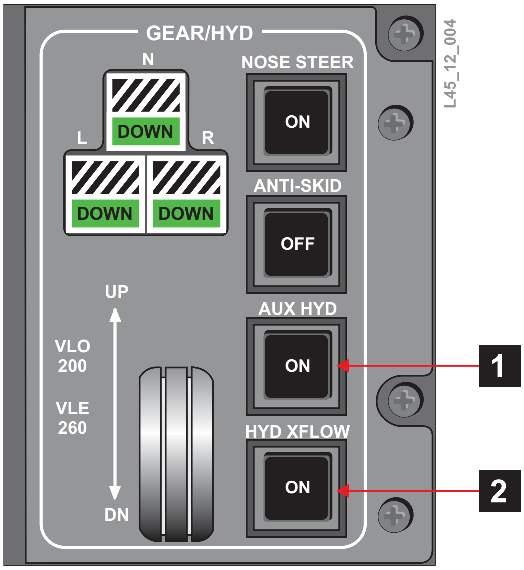


Figure 1 - GEAR/HYD Panel

1 AUX HYD Switch Indicator (alternate-action)

- Press—
  - Activates the auxiliary pump if it is not operating
  - Deactivates the auxiliary pump if it is operating

NOTE **When the landing gear lever is selected DN, the auxiliary pump is automatically activated. When the landing gear lever is selected UP, the auxiliary pump is automatically deactivated.**

  - ON illuminated—Indicates auxiliary hydraulic pump is operating

2 HYD XFLOW Switch Indicator (alternate-action)

- Press—
  - ON—Activates the crossflow valve
  - OFF—Closes the crossflow valve

NOTE **To initiate the hydraulic crossflow function, the auxiliary hydraulic pump must be running.**
The crossflow valve automatically deactivates if the auxiliary reservoir fluid level is too low.

- ON illuminated—Indicates crossflow valve is open

EICAS/MFD Hydraulic System Page

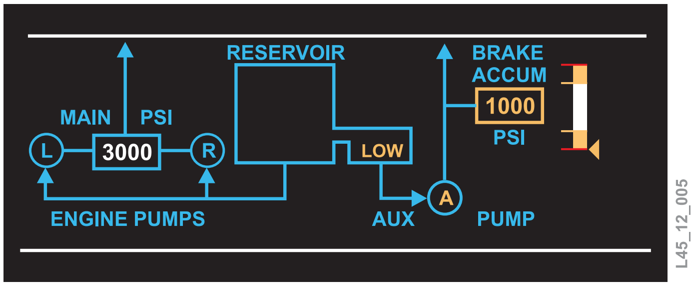
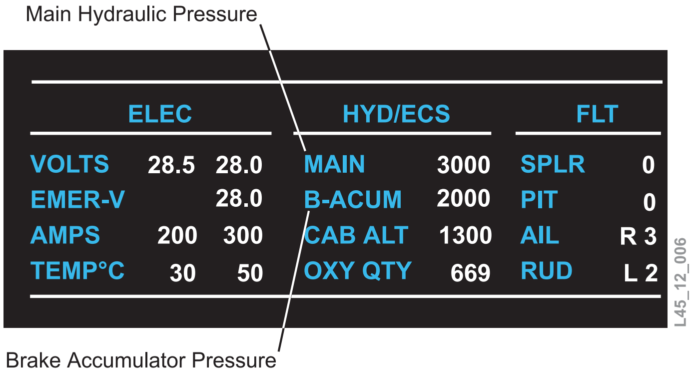


Figure 2 - EICAS/MFD Hydraulic System Page

Table 1 - EICAS/MFD Hydraulic Systems Page

Description	Symbol	Condition
Main hydraulic pressure digital readout	3000	Main hydraulic pressure normal (>1500 psi and <3800 psi)
	1200	Main hydraulic pressure <1500 psi or >3800 psi
	- - - -	Invalid data
Hydraulic pump symbols	Ⓛ Ⓡ Ⓐ	Normal pump operation
	Ⓛ Ⓡ Ⓐ	Respective HYD PUMP LOW CAS message is present or invalid data
Brake accumulator pressure digital readout and pointer	3000	Brake accumulator pressure normal (>1200 psi and <3800 psi)
	1200	Brake accumulator pressure <1200 psi or >3800 psi
	- - - -	Invalid data
Auxiliary hydraulic quantity low indicator	LOW	Auxiliary hydraulic reservoir quantity extremely low (appears in conjunction with the amber AUX HYD QTY LO CAS message)

EICAS/MFD System Summary Page



ELEC			HYD/ECS		FLT	
VOLTS	28.5	28.0	MAIN	3000	SPLR	0
EMER-V		28.0	B-ACUM	2000	PIT	0
AMPS	200	300	CAB ALT	1300	AIL	R 3
TEMP°C	30	50	OXY QTY	669	RUD	L 2

Figure 3 - EICAS/MFD System Summary Page

Table 2 - EICAS/MFD System Summary Page

Description	Symbol	Condition
Main hydraulic pressure digital readout	3000	Main hydraulic pressure normal (>1500 psi and <3800 psi)
	$\boxed{1000}$	Main hydraulic pressure <1500 psi or >3800 psi
	- - - -	Invalid main hydraulic pressure data
Brake accumulator pressure digital readout	3000	Brake accumulator pressure normal (>1200 psi and <3800 psi)
	$\boxed{1000}$	Brake accumulator pressure <1200 psi or >3800 psi
	- - - -	Invalid brake accumulator pressure data

RMU Backup EICAS

Figure 4 - Backup EICAS Display

Table 3 - Backup EICAS Display

Description	Symbol	Condition
Main hydraulic pressure digital readout	3000	Main hydraulic pressure normal (>1500 psi and <3800 psi)
	1000	Main hydraulic pressure <1500 psi or >3800 psi
	- - - -	Invalid main hydraulic pressure data
Brake accumulator pressure digital readout	3000	Brake accumulator pressure normal (>1200 psi and <3800 psi)
	1000	Brake accumulator pressure <1200 psi or >3800 psi
	- - - -	Invalid brake accumulator pressure data

CAS Messages

Table 4 - Hydraulic CAS Messages

CAS Message	Conditions/Parameters
AUX HYD PUMP LO	Auxiliary hydraulic pump is ON, and the pump output pressure is <1900 psi
AUX HYD QTY LO	Auxiliary hydraulic reservoir quantity is low
BRK ACUM PRESS	Emergency brake accumulator pressure is too low or too high
MAIN HYD PRESS	Main hydraulic pressure is <1500 psi or >3800 psi
HYD XFLOW ON	Hydraulic crossflow valve is open
MAIN HYD QTY LO	Main hydraulic quantity is low or filter clogged
HYD PUMP LOW	Left engine hydraulic pump pressure is <1900 psi
R HYD PUMP LOW	Right engine hydraulic pump pressure is <1900 psi
L R HYD PUMP LOW	Both left and right engine hydraulic pump pressures are <1900 psi

Main Hydraulic System

Description

The main hydraulic system has the capability of providing hydraulic power to all aircraft services requiring hydraulic power except the brake accumulator.

The main hydraulic system consists of the following components:

- Reservoir
- Hydraulic firewall shutoff valves
- Engine-driven pumps
- Main filter manifold
- Main accumulator

Refer to (Fig. 5) for an illustration of the main hydraulic system schematic.

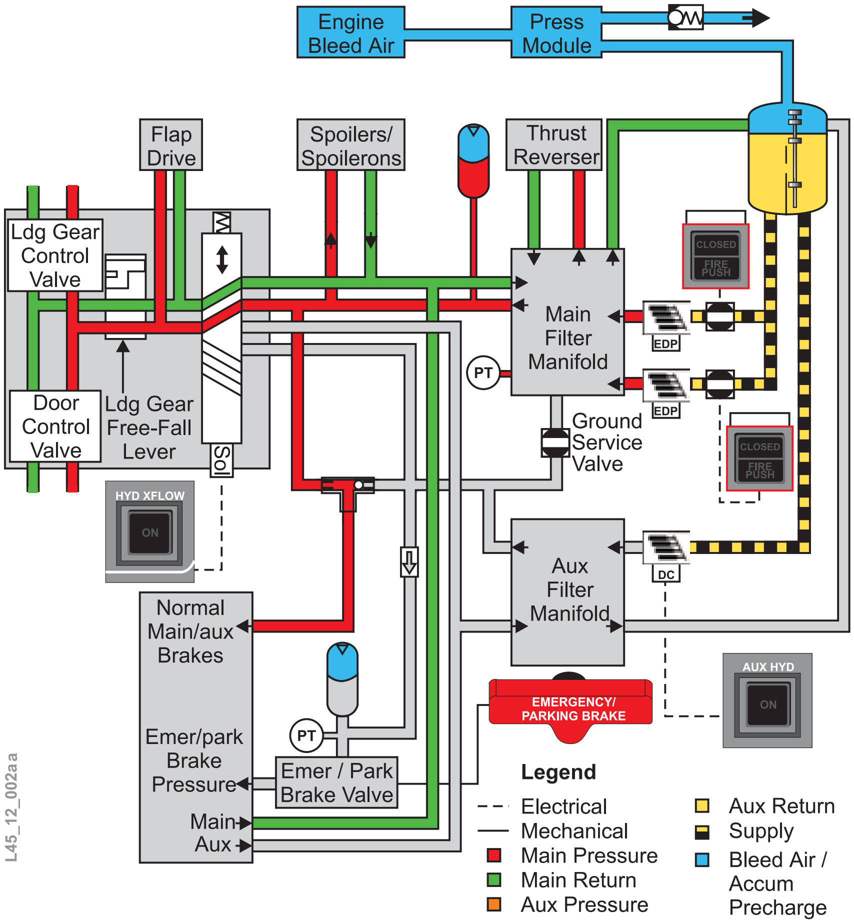


Figure 5 - Main Hydraulic System Operation

Components and Operation

Reservoir

Description

The hydraulic reservoir supplies hydraulic fluid to the main and auxiliary hydraulic systems. Below a certain level, the reservoir is designed with a separation wall which isolates a dedicated quantity of hydraulic fluid for use independently in the auxiliary system. This feature ensures that a leak in the main or auxiliary system does not totally deplete the reservoir fluid content. The reservoir is located forward of and above the tailcone baggage compartment and is pressurized by regulated engine bleed air.

Reservoir Fluid Level Sensor

A fluid level sensor records hydraulic fluid level and signals the EICAS and ground service panel reservoir indicators. The unit measures four fluid levels which correspond to reservoir OVER full, reservoir FULL, ADD fluid, and auxiliary fluid low.

The OVER, FULL, and ADD levels trigger illumination of the respective LED on the hydraulic panel on the right side of the tailcone. The ADD level also triggers the CAS white MAIN HYD QTY LO message. An additional float monitors low fluid level in the auxiliary compartment. Low fluid triggers AUX HYD QTY LO on the CAS.

When the fluid level sensor detects a low condition, a white MAIN HYD QTY LO CAS message appears. If the reservoir hydraulic fluid is critically low (auxiliary fluid low detected), an amber AUX HYD QTY LO CAS message appears in conjunction with an amber LOW indication within the auxiliary reservoir tank symbol on the EICAS/MFD hydraulic system page display.

With SB 45-29-6, the full light is green and an additional green light below the full light is called O.K. light. Power to the hydraulic service panel is provided by the single-point refuel switch.

Refer to the Servicing section of this chapter (page 13) for further information on the ground service panel reservoir indications.

Hydraulic Firewall Shutoff Valves

Two motor-driven hydraulic firewall shutoff valves are located in the supply line to each engine-driven hydraulic pump. These valves isolate the supply of hydraulic fluid from the reservoir to the engine-driven pumps during an engine fire. Each valve is electrically operated by the corresponding FIRE PUSH switch on the ENGINE/FUEL panel. The firewall shutoff valves are powered from the respective emergency hot bus. Loss of power causes the valves to remain in their last position.

Engine-Driven Pumps

The main hydraulic system has two identical engine-driven pumps, one located on each engine accessory gearbox. The pumps are a variable-volume, piston type that maintain a nominal system pressure of 3000 psi.

Pressure from each engine-driven pump flows to a central main filter manifold, where it is combined to provide the main system flow. Check valves, prior to the flow combination point (integral to the main filter manifold), isolate each pump and maintain system integrity if an engine or pump fails.

The engine-driven pumps operate any time the engines are running. Either engine-driven pump is capable of supplying sufficient pressure to operate all services requiring hydraulic power. Pressure switches located in the pump output lines provide low-pressure indications to the flight crew. When the left or right engine-driven pump output pressure decreases to 1900 psi or less, a white L HYD PUMP LOW or R HYD PUMP LOW message appears on the CAS. In addition, the hydraulic pump symbol on the EICAS/MFD HYD system page display turns amber.

Main Filter Manifold

The primary function of the main filter manifold is to provide fluid filtration of both the pressure and return lines. The return line filter incorporates a bypass relief valve which diverts return hydraulic fluid to the reservoir if the return filter becomes blocked. Both filters have differential pressure switches which cause the respective MAIN FILTER LED indicator on the ground service panel to illuminate, indicating an impending filter blockage. There is no cockpit indication of filter blockage or bypass. A white CAS message, MAIN HYD QTY LO also indicates the filter is plugged.

In addition to fluid filtration, the main manifold protects against overpressure conditions due to excessive fluid temperature or an engine-driven pump malfunction. In an overpressure condition, relief valves bleed off pressure to the reservoir return line.

A pressure transducer, located in the main filter manifold, provides main system pressure information on the EICAS/MFD summary system page and on the hydraulic system page display. An amber MAIN HYD PRESS CAS message is displayed if the pressure is <1500 psi or >3800 psi.

The filter manifold has an electrically operated ground service valve attached which allows the auxiliary system to power the main system. Refer to the Servicing section of this chapter (page 13).

Main Accumulator

A precharged hydraulic accumulator is installed downstream of the pressure outlet from the main filter manifold. The main accumulator dampens and absorbs pressure surges within the main hydraulic system.

The main accumulator requires no servicing.

Auxiliary Hydraulic System

Description

The auxiliary system provides three basic functions:

- Hydraulic pressure to charge the brake accumulator
- Backup power for the flaps, landing gear, and wheel brakes if the main system malfunctions
- Power to operate hydraulic services via the main filter manifold during ground servicing

The crossflow valve is used in conjunction with the auxiliary system to provide power to the flaps and landing gear. A brake system shuttle valve automatically moves to allow the hydraulic system with the highest pressure (main or auxiliary) to power the brakes.

Components and Operation

Brake Accumulator

A separate brake accumulator, charged by the auxiliary system to 3000 psi, supplies pressure for the emergency/parking brakes. The accumulator provides at least six emergency brake applications or parking brake pressure for approximately 48 hours. Although the brake accumulator has been demonstrated to maintain parking brake pressure; it is not designed to be used in place of aircraft chocks.

A pressure transducer on the brake accumulator provides accumulator pressure information for display on the EICAS/MFD SUMRY and hydraulic (HYD) system page displays. An amber BRK ACUM PRESS CAS message appears if the brake accumulator pressure is too low or too high.

Auxiliary Pump

Description

The auxiliary pump located in the tailcone consists of a combined hydraulic pump and DC motor. The auxiliary pump operates on 28 volts DC controlled from the L ESS BUS and powered from the left generator bus.

The auxiliary pump is automatically controlled by the landing gear lever and manually controlled by the AUX HYD switch indicator. The AUX HYD switch indicator ON annunciation illuminates when the pump is activated either manually or automatically.

Manual Operation

Depressing the AUX HYD switch indicator provides an electrical signal to latch control relays, which supply electrical power to activate the auxiliary pump (Fig. 6).

When the auxiliary pump is activated with the aircraft on the ground prior to engine start, the system provides hydraulic pressure to the wheel brakes and charges the brake accumulator to the required pressure.

Manually activating the auxiliary pump in flight (with the crossflow valve selected open) provides an alternate source of power to operate the flaps, landing gear, main gear doors, and wheel brakes if the main system malfunctions.

Depressing the AUX HYD switch indicator with the auxiliary pump operating causes the control relays to unlatch, which removes electrical power from the auxiliary pump.

NOTE

Operation of the auxiliary system does not permit the use of spoilers or thrust reversers. When using the auxiliary pump as the sole hydraulic source, the full flap (40º) position is not permitted by *Airplane Flight Manual* instructions.

Automatic Operation

After initial gear retraction, selecting the landing gear lever to DN automatically energizes the auxiliary pump. In this role, the system serves as a standby, alternate source of power if the main system malfunctions. During this phase, it also recharges the brake accumulator for aircraft parking once on the ground or for emergency brake application on touchdown if the main and auxiliary systems malfunction.

Selecting the landing gear lever to UP automatically de-energizes the auxiliary pump.

The AUX HYD switch indicator can always manually control the auxiliary pump, after activation or deactivation by the landing gear lever.

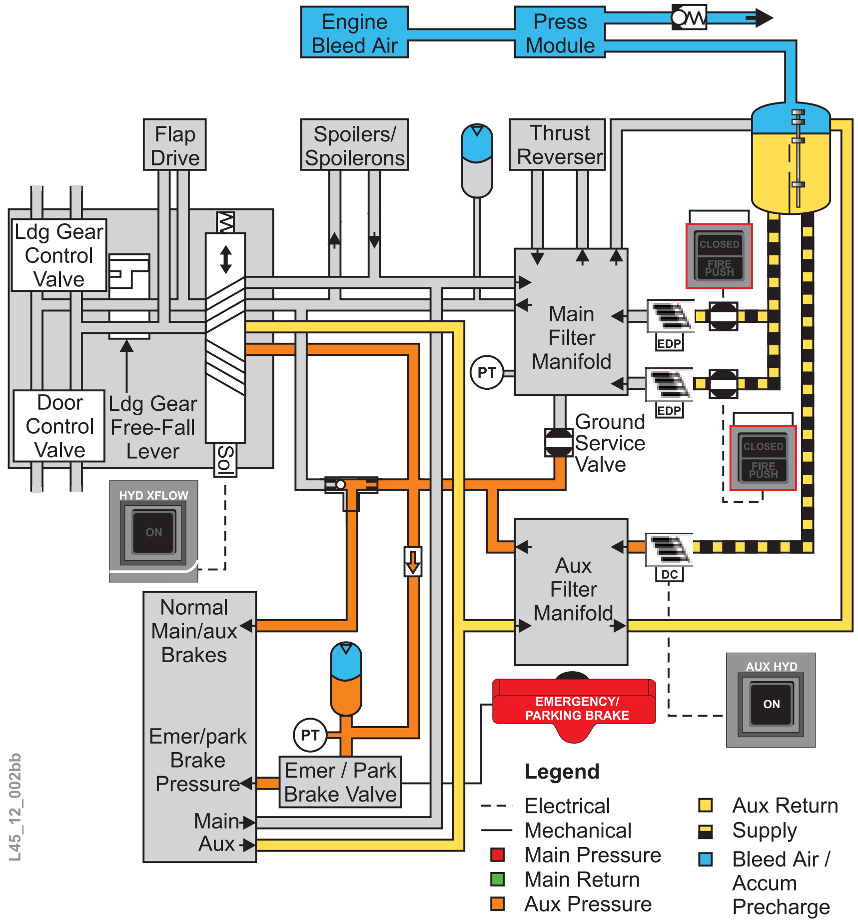


Figure 6 - Auxiliary System Operation—Crossflow Valve Closed

Auxiliary Filter Manifold

The auxiliary filter manifold shares many of the design features and operating characteristics previously identified for the main filter manifold (pressure and return filter, impending bypass indication, pressure relief).

A pressure switch integral to the auxiliary filter manifold provides auxiliary pump pressure information to the EICAS/MFD. If the auxiliary pump pressure drops below 1900 psi, an amber AUX HYD PUMP LO CAS message appears. In addition, the auxiliary hydraulic pump symbol on the EICAS/MFD HYD system page display turns amber.

Crossflow Valve

A solenoid-operated crossflow valve controls the source (main or auxiliary) of hydraulic pressure to the landing gear and flaps systems (Fig. 7).

If the main hydraulic system pressure is lost, crossflow can be accomplished by depressing the HYD XFLOW switch indicator on the GEAR/HYD panel with the auxiliary hydraulic pump running. When the valve is energized, the white ON annunciation on the HYD XFLOW switch indicator illuminates and a white HYD XFLOW ON CAS message appears.

Should the auxiliary fluid level become low (amber AUX HYD QTY LO CAS message appears), the crossflow valve automatically deactivates to conserve fluid for the brake system

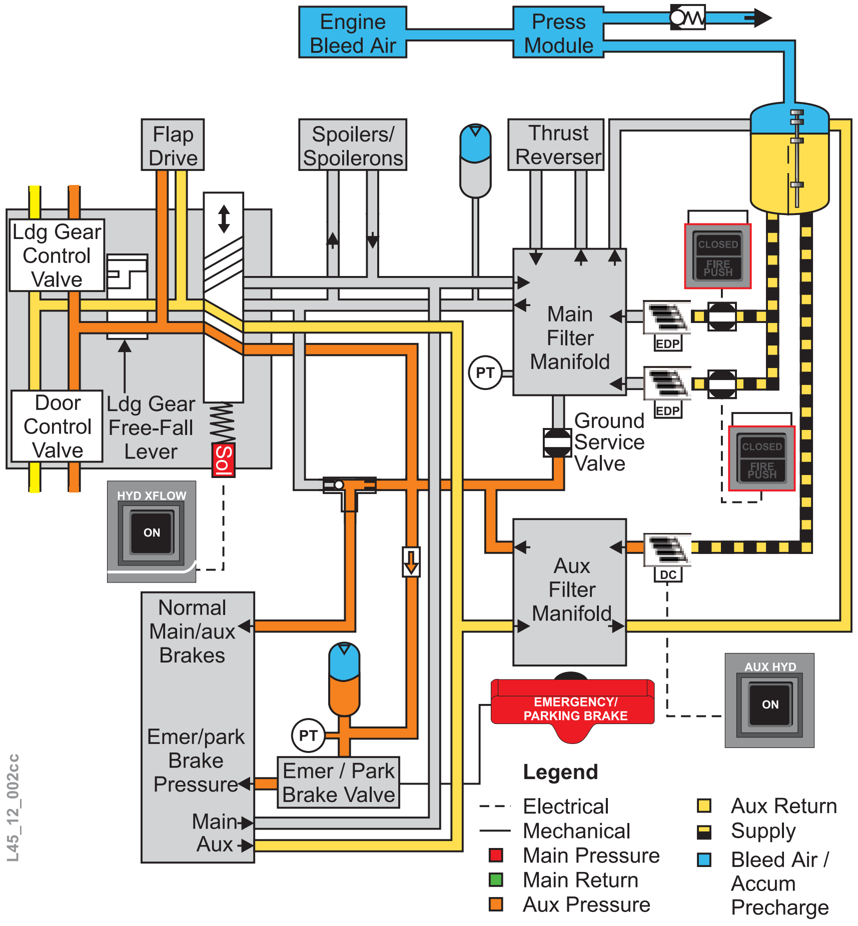


Figure 7 - Auxiliary System Operation—Crossflow Valve Open

Emergency Brake System

If the main hydraulic system malfunctions, a mechanical release mechanism can lower the main gear inboard doors, main landing gear, and nose landing gear.

If the brake accumulator is charged to 3000 psi from the auxiliary system prior to takeoff, it provides sufficient stored energy for emergency braking.

Refer to Chapter 14 Landing Gear and Brakes for additional information on the emergency brake system.

Hydraulic Servicing

Hydraulic Ground Service Panel

The hydraulic system is serviced through the hydraulic ground service panel (Fig. 8) located under the engine pod on the right side of the aircraft. The panel includes indicator lights and quick-disconnect ports. The lights indicate reservoir quantity and filter bypass conditions. The quick-disconnect ports pressurize the system using a hydraulic ground power unit.

During exterior preflight, a view port shows the reservoir and FILTER indicator lights without removing the outer cover.

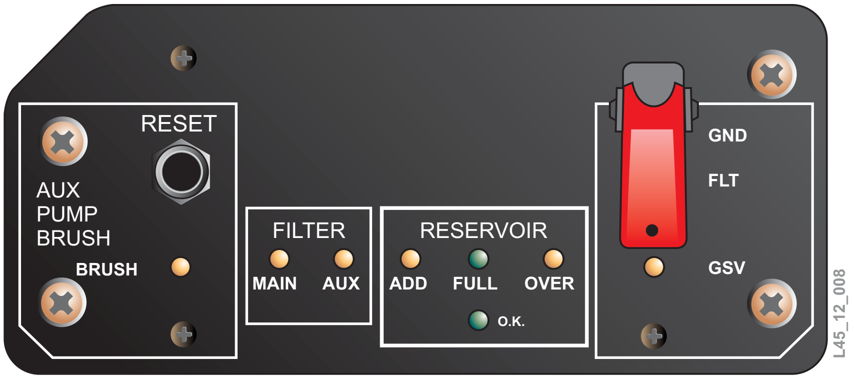


Figure 8 - Hydraulic Ground Service Panel

RESERVOIR Section

The RESERVOIR section of the ground service panel contains three indicator lights labeled ADD, FULL, and OVER. The ADD light illuminates when the reservoir requires servicing, the FULL light illuminates when the reservoir quantity reaches the normal level, and the OVER light illuminates when the reservoir is over full. The reservoir contains approximately 2 U.S. gal when FULL is indicated. Servicing the reservoir is a maintenance function.

Only hydraulic fluids conforming to MIL-H-5606 are approved.

FILTER Section

The FILTER section of the panel contains two indicator lights which are labeled MAIN and AUX. The MAIN and AUX lights illuminate when triggered by the main/auxiliary system pressure or return filter differential pressure sensors. Illumination indicates impending filter blockage.

Ground Service Valve Section

The panel has a guarded switch that operates the ground service valve (GSV). The ground service valve allows the auxiliary system to pressurize the main system through the main filter manifold. The ground service valve is opened by lifting the switch to the GND position.

Since operation of the valve is limited to ground use only, the switch guard is designed so that once the outer cover is placed on the ground service panel, the guard is pushed in, causing the switch to toggle to the FLT position.

AUX PUMP BRUSH Section

The AUX PUMP BRUSH section of the panel contains a BRUSH indicator light which illuminates when excessive wear (90%) on the auxiliary pump DC motor brushes is detected.

NOTE

Illumination of the BRUSH light indicates the brushes for the auxiliary hydraulic pump are approaching service limits. Flight may be conducted with the BRUSH light illuminated, but maintenance should be performed at the next suitable opportunity.

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ICE AND RAIN PROTECTION

Introduction

Aircraft anti-ice protection is provided through the use of electrically heated and engine bleed-air heated anti-ice systems. Electrically heated anti-ice protection is provided to the following:

- Pitot-static probes
- Total air temperature probe
- Engine inlet air temperature/pressure sensors
- Stall warning vanes
- Windshields

Engine bleed air provides anti-icing for the leading-edge surfaces of the wing, the leading-edge surfaces of the horizontal stabilizer, and the engine nacelle inlets. These systems are cockpit controlled through the ANTI-ICE control panel, centrally located on the instrument panel.

If anti-ice systems are required during takeoff, they should be turned ON at least two minutes prior to setting takeoff power. Appropriate takeoff power and performance charts must be used. Windshield heat is always selected on prior to takeoff.

The anti-ice systems must be turned on before icing conditions are encountered. Icing conditions exist when:

- Outside air temperature (OAT) on the ground and for takeoff is 10°C (50°F) or below, or the static air temperature (SAT) in flight is 10° to –40°C (50° to –40°F) and visible moisture in any form is present (such as clouds, fog with visibility of one mile or less, rain, snow, sleet, or ice crystals)
- OAT on the ground and for takeoff is 10°C (50°F) or below when operating on ramps, taxiways, or runways where surface snow, ice, standing water, or slush may be ingested by the engines or freeze on engines, nacelles, or engine sensor probes

Controls and Indications

Anti-ice Control Panel

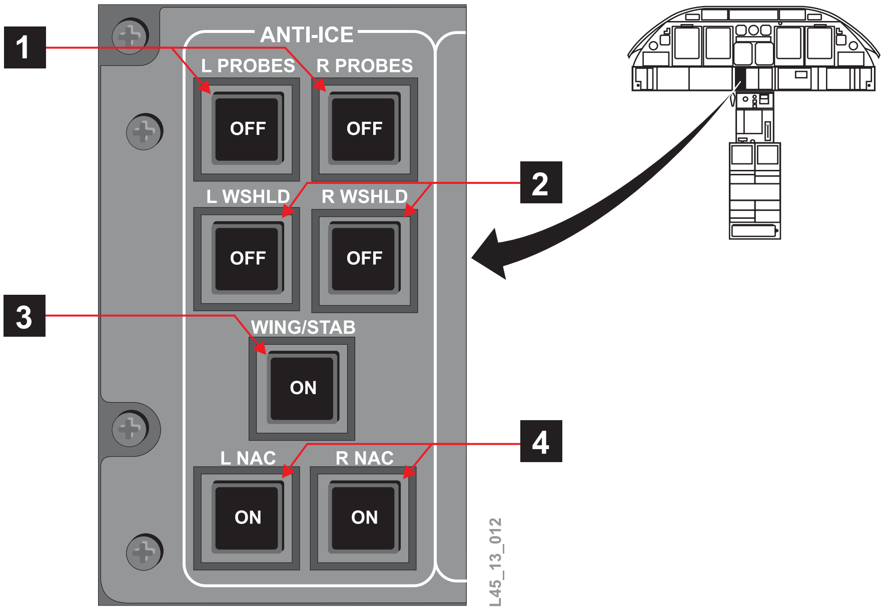

Figure 1 - Anti-ice Control Panel

1 L and R PROBES Switch Indicator

- Press—Applies or removes power to the respective side heated probes
- OFF—Indicates that the respective side heated probes have no power

2 L and R WSHLD Switch Indicator

- Press—Applies or removes power to the respective windshield anti-ice heating
- OFF—Indicates that the respective windshield anti-ice heating has no power

3 WING/STAB Switch Indicator

- Press—Applies or removes power to the anti-ice pressure regulating shutoff valves
- ON—Indicates that the anti-ice pressure regulating shutoff valves have power

4 L and R NAC Switch Indicator

- Press—Applies or removes power to the respective engine nacelle P_2T_2 heating elements and nacelle anti-ice shutoff valve

- ON—Indicates that the respective engine nacelle P_2T_2 heating elements and nacelle anti-ice shutoff valve have power

Lights Control Panel

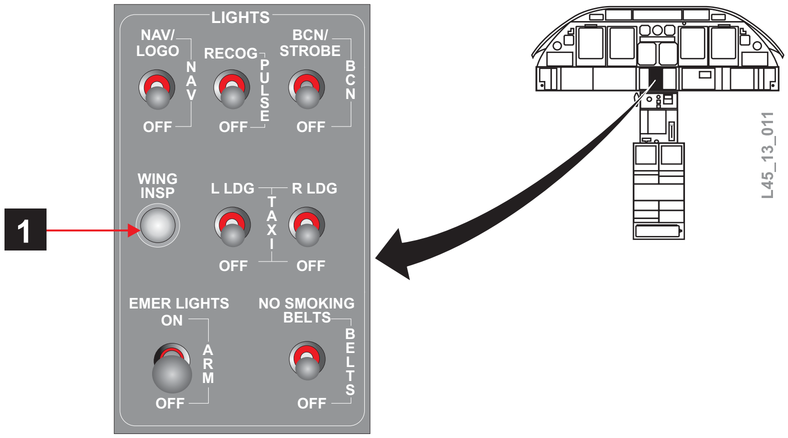

Figure 2 - Lights Control Panel

1 WING INSP Switchlight (momentary)

- Press—Wing inspection light illuminates black dot on right wing leading edge

CAS Messages

Table 1 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
WING/STAB LEAK	WING/STAB LEAK	Leak detected in wing or stab supply line
STAB OVHT	STAB OVHT	Stabilizer overheat
WING OVHT	WING OVHT	Wing overheat
L AOA HT FAIL		Respective AOA vane heater failed with probe heat ON
R AOA HT FAIL		
L R AOA HT FAIL		
ICE DET FAIL		Ice detection system failed
ICE DETECTED		Ice detected, anti-ice system off
L NAC HT		Respective switch indicator is turned ON, low pressure detected in respective duct or PT_2T_2 probes heater current failed
R NAC HT		
L R NAC HT		

Table 1 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
L NAC HT FAIL ON		Respective switch indicator is turned off, bleed-air pressure is still present at the nacelles
R NAC HT FAIL ON		
L R NAC HT FAIL ON		
L PITOT HT		Respective probe heat is OFF or both pitot heat failed
R PITOT HT		
L R PITOT HT		
SAT HT FAIL		SAT/TAT probe heat failed with right probe heat on
STAB TEMP LOW		Anti-ice ON, stabilizer underheated >10 seconds
STBY PITOT HT		Standby (right) probe heat OFF or failed
WING TEMP LOW		Anti-ice ON, wing underheated >10 seconds
L WSHLD HT FAIL		Respective windshield heat on, system failed, underheat temperature
R WSHLD HT FAIL		
L R WSHLD HT FAIL		
L WSHLD OVHT		Respective windshield overheat temperature
R WSHLD OVHT		
L R WSHLD OVHT		
ICE DETECTED		Ice detected with anti-ice system on
STAB TMP FAULT		One of the two horizontal stabilizer temperature sensors failed
WG/STAB HT OK		Wing and stabilizer anti-ice controller and sensors properly tested with pilot activation of the SYS TEST/RESET switch
WING TMP FAULT		One or more of the four wing temperature sensors failed
L WSHLD HT FAULT		Temperature modulating function of the respective windshield system is operating in a degraded mode
WING TMP FAULT		One or more of the four wing temperature sensors failed
L WSHLD HT FAULT		Temperature modulating function of the respective windshield system is operating in a degraded mode
R WSHLD HT FAULT		
LR WSHLD HT FAULT		

Engine Indications

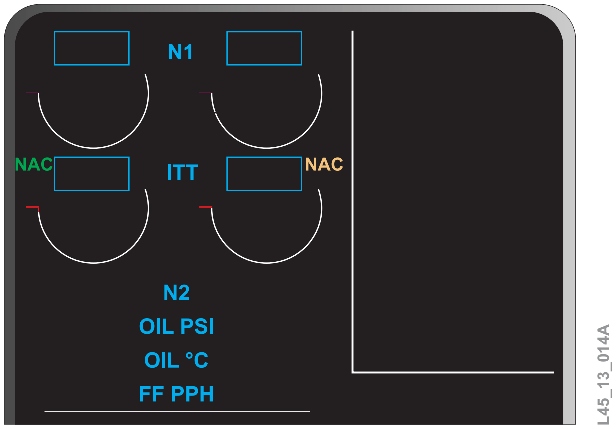

Figure 3 - NAC Engine Indications

Table 2 - NAC Engine Indications

EICAS Annunciation	NAC Annunciation
NAC	Respective NAC switch indication is in the ON position
NAC	Annunciation displays near the associated ITT when NAC HT and/or NAC HT FAIL ON CAS message displays

System Test/ Reset Switch

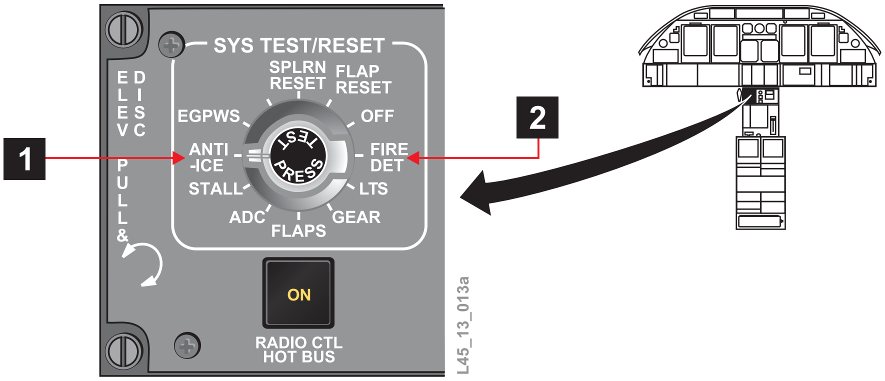

Figure 4 - SYS TEST/RESET Switch

1 System Test ANTI-ICE Function
- Rotate to ANTI-ICE and depress
  - Initiates a self-test of the anti-ice system
  - Displays a white WG/STAB HT OK advisory in CAS window when the ground test of airfoil anti-ice system is successfully complete

- Illuminates the red WING OVHT and STAB OVHT annunciators on the crew warning panel (CWP) during testing

2 System Test FIRE DET Function

- Rotate to FIRE DET and depress—Initiates the test for the anti-ice leak detection

---

Detection Systems

Ice Detector

Description

Aircraft ice detection is accomplished when the ice detector transmits an icing signal to the crew alert system (CAS). The ice detector is located in the lower left nose area just outboard of the nose wheel box (Fig. 5). The sensor is a cylindrical probe that extends approximately 1.25 in. (3.18 mm) beyond the skin surface.

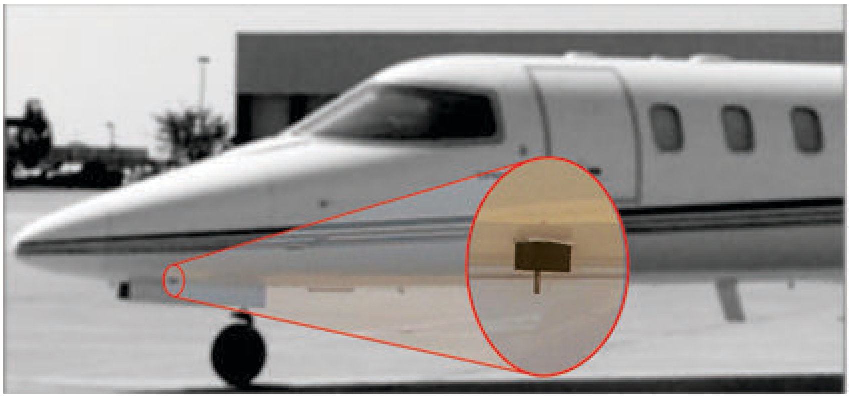

Figure 5 - Ice Detector Location

Operation

The sensor element of the ice detector is an ultrasonic axially vibrating tube whose natural frequency of vibration changes with the added mass of ice. An icing signal is actuated when the frequency changes. The signal is sent by the detector unit to the EICAS initiating a CAS message displayed.

The ice detector de-ices itself through integral heating elements. Heater power is applied until the frequency rises back. The heaters are then left on for an additional 4 to 5 seconds to ensure complete deicing. Upon initial power, the ice detector automatically conducts a self-test.

EICAS displays the following messages for the ice detection system:

- White ICE DETECTED when:
  - Ice detector detects ice
  - Aircraft is airborne
  - WING/STAB anti-ice ON
  - L NAC anti-ice ON, and
  - R NAC anti-ice ON
- Amber ICE DETECTED when:
  - Ice detector detects ice
  - Aircraft is airborne
  - L NAC anti-ice off, or
  - R NAC anti-ice off, or
  - WING/STAB anti-ice off
- Amber ICE DET FAIL when the ice detector detects a system failure

Ice detection advisory and caution messages, except ICE DET FAIL message, are suppressed during ground operation.

NOTE

Do not touch the ice detector probe when the airplane is powered. The ice detector probe always has power applied when the airplane electrical system is powered.

If the ice detector probe is touched or bumped, the ice detector senses this as ice, and tries to deice the probe causing the probe to get extremely hot.

Visual Ice Detection

Description

The wing inspection light, located on the right forward fuselage, may be used to visually inspect the right wing leading edge for ice accumulation during night operations (Fig. 6).

Figure 6 - Wing Inspection Light

Operation

The light is illuminated by depressing and holding the WING INSP switch located in the LIGHTS group of the center switch panel. The light illuminates a black dot on the outboard wing leading edge to enhance visual detection of ice accumulation.

Electrically Heated Anti-ice Systems

Description

The electrically heated anti-ice systems include the pitot-static probes, TAT probe, engine inlet air temperature/pressure sensors, stall warning vanes, and windshields (Fig. 7).

Figure 7 - Electrically Heated Anti-ice Systems

Pitot-Static System

Description and Operation

Pitot-static, stall warning, and TAT probe anti-ice protection are controlled by the L PROBES and R PROBES switches located on the anti-ice control panel. The switch-indicators are illuminated OFF and are blank when they are selected on. When the probes switches are selected OFF, amber LR PITOT HT and amber STBY PITOT HT CAS messages are displayed and extinguished if switches are selected on.

With a single generator failure, all the probe elements remain operative. With a dual generator failure, only the standby pitot-static heat remains powered.

All heating elements can be activated on the ground except the TAT probe which must receive an air mode signal.

Windshield Anti-ice/Defog System

Description

The windshield anti-ice/defog system (Fig. 8) consists of:

- Two engine-mounted alternators
- Two external relays and two windshield heat relays
- Two heating elements
- Two normal, two overheat, and two spare sensors
- Anti-ice control panel switches
- Dual channel windshield heat controller (DC powered)

Operation

To be heated, the two windshield anti-ice sections are independently controlled and powered through the respective left and right engine-driven alternators mounted on the front right side of the engine gear boxes.

Both windshield sides are controlled independently by the dual-channel controller, normal sensors, and overheat sensors. Each channel of the controller independently regulates the output of the respective alternator through an external relay. The relay controls the temperature of the onside windshield section and disconnects power from the heating element if the section overheats.

The controller provides outputs signals through the data acquisition units to initiate CAS messages.

If one alternator fails, the corresponding side windshield anti-ice/defog is inoperative.

The windshield anti-ice/defog system switch indicators are illuminated OFF when not operating and are blank when they are selected on.

Normal Operation

The controller regulates the alternator outputs to maintain the windshield temperature.

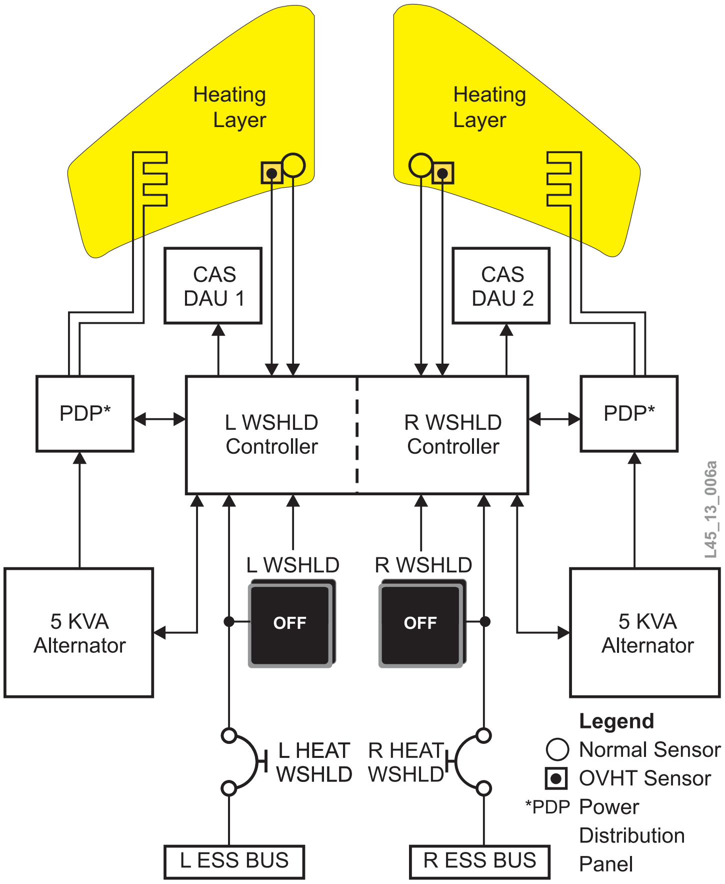

Figure 8 - Windshield Anti-ice/Defog System

Degraded Mode

If there is a fault in the circuitry for normal operation, the system can continue to operate in a degraded mode. In this case, the outputs of the alternators are no longer modulated. A white L or R WSHLD HT FAULT CAS message is displayed when a channel of the controller is operating in the degraded mode.

System failure is annunciated by an amber L or R WSHLD FAIL CAS message when the windshield temperature is below 50ºF while the system is turned on.

There is no cockpit indication of an alternator failure other than the loss of windshield heat on the respective side.

If an overheat sensor detects an overheat temperature condition, an amber L or R WSHLD OVHT CAS message displays.

Engine Bleed-Air Heated Systems

Description

The engine bleed-air heated systems consist of:

- Engine and nacelle anti-ice system
- Wing/stab anti-ice system

The engine bleed-air heated anti-ice systems are working when the bleed-air switches on the pressurization switch panel are on.

Engine and Nacelle Anti-ice System

Description

The engine nacelle anti-ice system (Fig. 9) provides anti-ice protection for the nacelle inlets and the engine inlet air pressure/temperature sensors. The engine nacelle is anti-iced by directing engine high-pressure bleed air through a piccolo tube to the inner surfaces of the nacelle inlet lip. The engine bleed air is directed to the internal surface of the nacelle inlet. The hot air is exhausted through a cylindrical tube located on the lower port side of the nacelle. The engine inlet air pressure/temperature sensors are anti-iced by integral electrical heating elements.

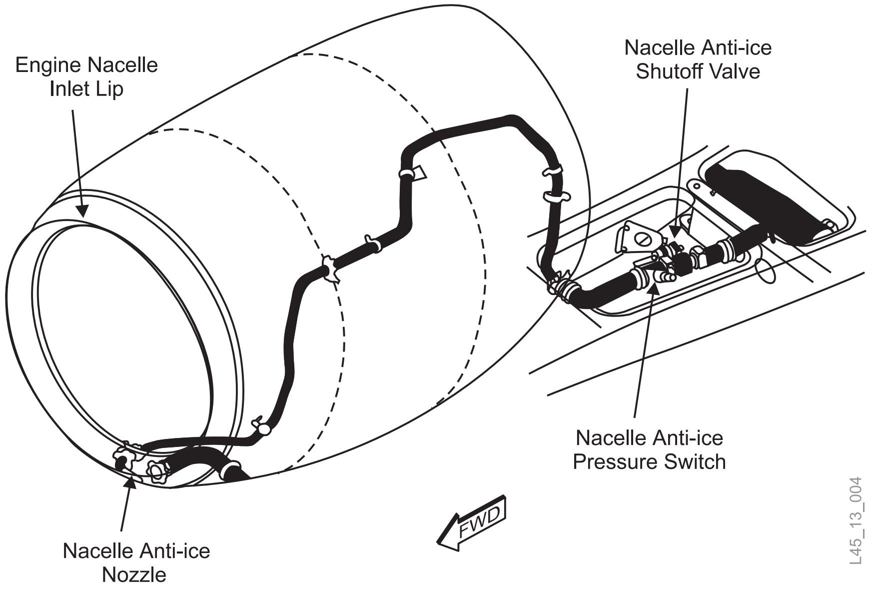

Figure 9 - Engine Nacelle Anti-ice System

Operation

Two switches on the ANTI-ICE control panel labeled L NAC and R NAC independently provide engine bleed air to the nacelle inlet lip areas of each engine through the nacelle anti-ice shutoff valves. The switches energize the heat elements in the Pt_2Tt_2 probes.

Each switch indicator indicates ON when the switch indicator is depressed and the switches are blank when off.

The inline pressure regulating shutoff valves control the on/off operation of the nacelle anti-icing system and regulate engine bleed-air pressure introduced into the nacelle inlet lip during anti-icing. Once the pressure regulating shutoff valves open, bleed air passes through the pressure switch which is activated open. Loss of electrical power causes the nacelle anti-ice pressure regulating shutoff valves to open when the corresponding engine is running.

System activation is indicated by a green NAC illuminated next to each engine ITT display. The illumination indicates that the respective L or R NAC switches are ON and the adequate bleed-air pressure is supplied to each nacelle lip. An amber NAC illumination indicates that the respective L or R NAC switches are ON with inadequate bleed-air pressure supplied to the nacelle lip or a circuitry fault to the pressure sensor. This indication is accompanied by an amber L or R NAC HT CAS message.

If a bleed-air pressure of 6.5 psi or greater is sensed at the nacelle anti-ice shutoff valve with the L or R NAC switches off, the amber NAC indication is accompanied by the respective amber L or R NAC HT FAIL ON CAS message.

WING/STAB Anti-ice System

Description

System components consist of:

- Piccolo tubes
- Anti-ice pressure regulating
- Pressure regulating shutoff valves
- Anti-ice check valves
- WING/STAB switch indicator
- Wing temperature control and under/overheat sensors
- Electrical circuitry
- Inputs from integrated ECS temperature controller

Operation

The wing/stab anti-ice system (Fig. 10) is selected ON by depressing the WING/STAB switch indicator located on the anti-ice control panel. When the switch indicator is depressed, an ON caption is illuminated. When the system is off, the switch indicator is blank. The wing/stab anti-ice system uses high-pressure bleed air directed through piccolo tubes in the leading edge of the wing and horizontal stabilizer. The bleed air used to warm the wing is then vented through the wheel wells. The bleed air used to heat the stabilizer is vented overboard at the outboard ends of the stabilizer.

Loss of electrical power causes the wing/stab anti-ice shutoff valves to close. If the airplane experiences a single generator failure, the system is not affected. Under/overheat sensors monitor wing and stabilizer temperature and provide signals to display the following CAS messages:

- Amber WING TEMP LOW
- Amber STAB TEMP LOW
- Red WING OVERHEAT
- Red STAB OVERHEAT

If a wing sensor fails or the high- or low-temperature sensor input is invalid, a white WING TMP FAULT CAS message is displayed. If the stabilizer sensor failed or the high- or low-temperature sensor input is invalid, a white STAB TMP FAULT CAS message displays.

Wing and stabilizer anti-ice should function normally with either fault message displayed.

Test

The wing/stab anti-ice system is tested by rotating the airplane system test selector knob to the ANTI-ICE position, and depressing the push-to-test button. The red WING OVHT and STAB OVHT annunciators on the CWP illuminate during the test. A white WG/STAB HT OK CAS message is displayed for a satisfactory test.

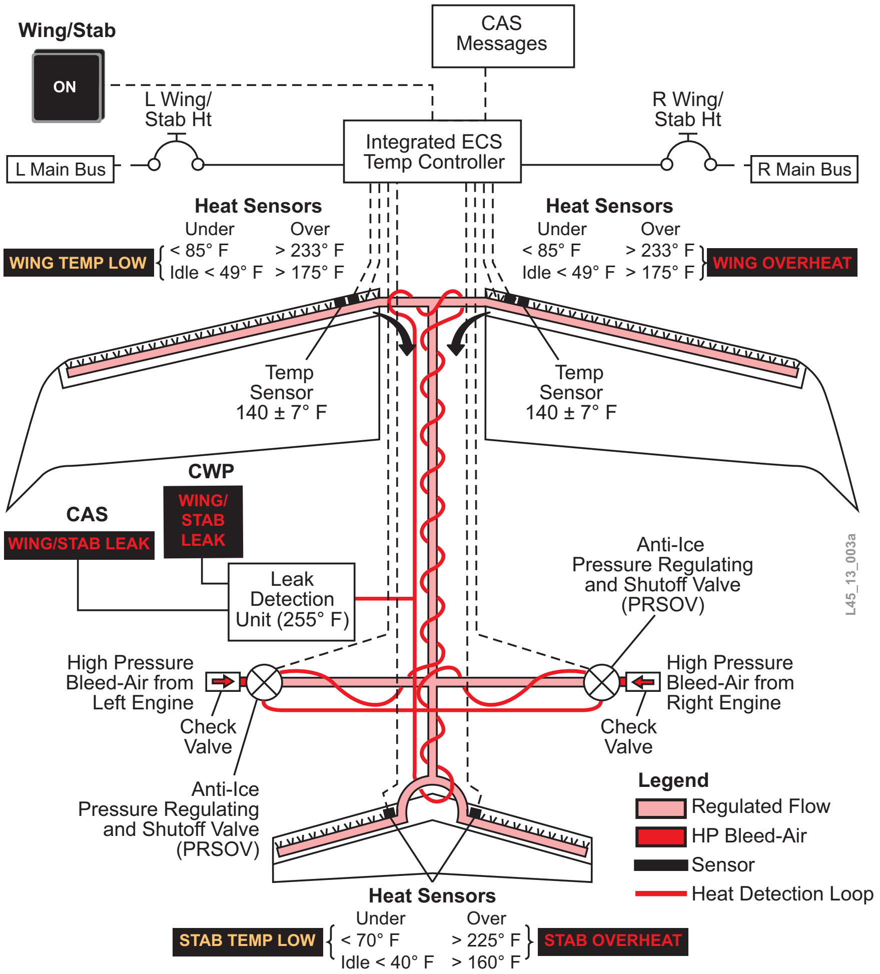

Figure 10 - Wing/Stab Anti-ice System

Wing/Stab Anti-ice Leak Detector

Ducting for the wing and stabilizer anti-ice bleed air is monitored by a leak detection system. It is a series of interconnected heat detection elements connected to a leak detector unit. The system works the same as the engine fire detection system.

The heat detecting elements are routed beside the anti-ice ducting from the wing leading edge, aft, and up through the vertical stabilizer to the leading edge of the horizontal stabilizer.

A bleed-air leak or overtemperature anywhere along the heat detection element causes the red WING/STAB LEAK CAS message and the WING/STAB LEAK on the CWP. These warnings remain on until the temperature decreases.

The anti-ice leak detection elements are tested with the FIRE DET position on the system test knob.

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LANDING GEAR AND BRAKES

Introduction

The landing gear for the Learjet 40/45 is arranged in a standard retractable tricycle configuration and consists of a single wheel nose landing gear and two dual wheel main landing gear assemblies.

Associated systems include a landing gear free fall system, landing gear warning system, wheel brakes with antiskid protection, nosewheel steering system, and squat switches.

Hydraulic power operates the landing gear and wheel brake systems.

Description

The main landing gear is electrically controlled and hydraulically actuated. It retracts inward toward the centerline of the fuselage. Hydraulic pressure for gear retraction and extension is electrically controlled by position-sensing switches and two solenoid-operated selector valves, one for the main landing gear inboard doors and another for the main and nose landing gear.

The nose landing gear is electrically controlled and hydraulically actuated. The nose landing gear is a forward retracting assembly. The nose gear doors operate mechanically with a linkage attached to the nose gear shock strut.

During a hydraulic or electrical failure, an emergency extension system allows the landing gear to free fall to the extended position.

Controls and Indications

Gear and Brakes Miscellaneous

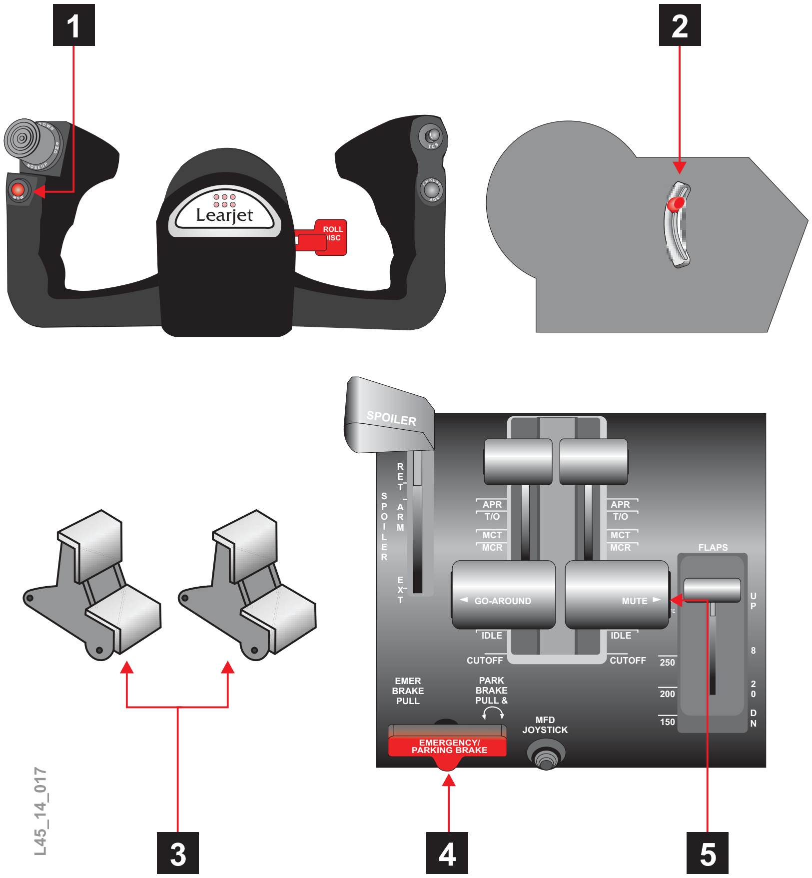

Figure 1 - Landing Gear and Brakes Miscellaneous

1 Control Wheel Master Switch (MSW) — Nosewheel Steering Function

- Depress and release (on the ground)—Disengages nosewheel steering system

2 Landing Gear FREE FALL Lever

- Push down (until lever latches)—Unlocks the uplock actuators of the nose and main gear doors to allow the gear to free fall

3 Brake Pedals

- Push top of pedal—Activates corresponding wheel brakes

4 EMERGENCY/PARKING BRAKE Handle

- Pull—
  - Engages emergency braking
  - Brake force is proportional to amount of handle force applied
- Pull and rotate (clockwise or counterclockwise)—Engages parking brake

5 MUTE Button

- Depress—Silences landing gear caution message

Components and Operation

Main Landing Gear

The main landing gear consists of:

- Shock strut assembly
- Axle beam and torque link
- Side brace actuator
- Dual wheels

Two main gear shock struts are attached to the wing and provide the majority of the load-carrying capabilities of the aircraft when it is on the ground. The shock struts are conventional air-hydraulic (oleo) units. Each shock strut is equipped with two sets of brakes, wheels, and tires.

The main landing gear is extended and retracted by a hydraulic side brace actuator which includes an internal downlock mechanism.

Main Landing Gear Uplocks and Downlocks

The main landing gear (Fig. 2) is held in the retracted position by the main landing gear inboard door which is mechanically latched by an uplock mechanism. The inboard door uplock mechanism is normally released by its hydraulic actuator. An external release lever connected to the uplock latch allows manual unlocking of the mechanism through the emergency extension system.

The main landing gear is held in the extended position by the internal downlock mechanism located within the side brace actuator. The downlock mechanism mechanically actuates when the main landing gear becomes fully extended. During gear retraction, the downlock mechanism is released by hydraulic pressure.

Figure 2 - Main Landing Gear

Main Landing Gear Doors

The main gear outboard door is hinged on the wing structure, and it is actuated by a mechanical linkage attached to the gear. It covers the gear only partially and a separate inboard door closes the wheel well area.

The main inboard door is hinged on the wing structure and is hydraulically opened or closed by an actuator. The door is positively latched in the closed position by an uplock mechanism which also ensures that the main gear is up and locked when in the retracted position.

The inboard doors are kept closed when the main gear is either up and locked or down and locked, and remain open during gear movement or after an emergency extension.

Nose Landing Gear

The nose landing gear assembly consists of:

- Shock strut
- Actuator
- Nosewheel steering system components
- Single wheel

The shock strut is a conventional gas/oil oleo. As with the main gear, the strut provides load-carrying capabilities of the aircraft when on the ground. The nose gear actuator retracts and extends the nose landing gear and includes an internal mechanism that locks the landing gear when in the extended position.

The nose strut (Fig. 3), when properly serviced with air pressure, assists expansion of the nosegear at lift-off. During expansion, nose strut centering cams mechanically cause the nosewheel to center for retraction. The nosewheel is also electrically centered by the nosewheel steering system.

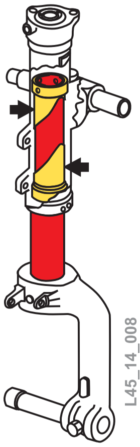

Figure 3 - Nosewheel Centering Cam

NOTE **During external preflight, verify that the nosewheel is properly positioned.**

Nose Landing Gear Uplock and Downlock

The nose gear (Fig. 4) is mechanically held in the retracted position by an uplock mechanism (latch lock). During gear extension, the latch is hydraulically actuated to unlock the nose gear.

The nose gear is mechanically held in the extended position by a downlock mechanism internal to the nose gear actuator. The downlock mechanism is hydraulically released for gear retraction. An external release lever connected to the uplock mechanism (latch) provides for manual release through the emergency extension system.

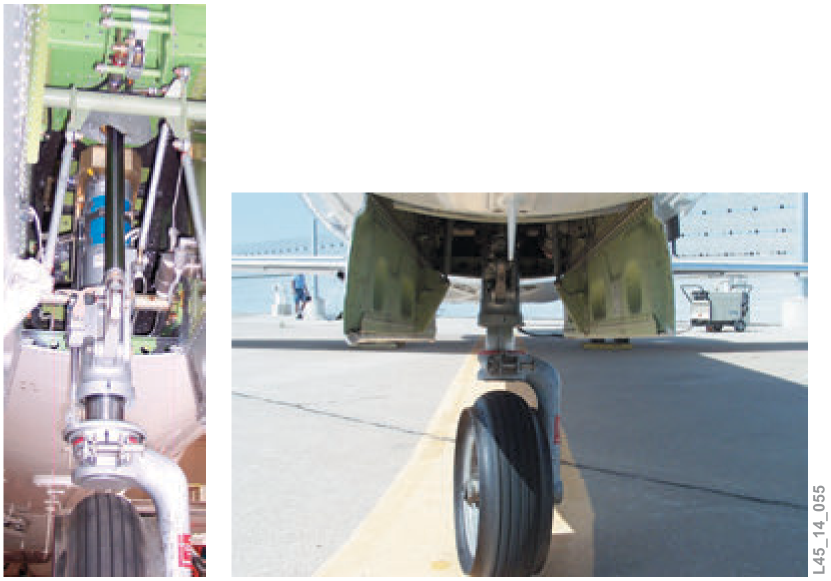

Figure 4 - Nose Landing Gear

Nose Gear Door

The nose gear doors are mechanically linked to the nose gear and are mechanically actuated by the nose gear through pushrods and levers mounted on the strut. The nose gear doors are kept open when the nose gear is in the extended position.

Landing Gear Operation

Normal retraction or extension of the landing gear is initiated by selecting the landing gear lever UP or DN. The switch controls the position of the solenoid-operated gear selector valve and the door selector valve through gear and door position-sensing switches, to extend or retract the gear.

The landing gear control circuits are powered from the EMER BATT BUS.

Gear Extension

When the landing gear lever is placed in the DN position, the following sequence of events occurs:

1. The open solenoid of the door selector valve energizes, and hydraulic pressure is applied to both main gear inboard door uplock actuators and door actuators
2. When the main gear doors open, door-open switches complete a circuit from the landing gear lever to the down solenoid of the gear selector valve. Hydraulic pressure simultaneously is applied to release the nose gear uplock, apply pressure to the main and nose gear actuator, and extend all three landing gear

3. When the main gear is fully extended, gear-down switches complete a circuit from the landing gear lever to the close solenoid of the door selector valve. Then hydraulic pressure is applied to the main gear inboard door actuators to close the gear doors
4. The gear doors are locked into position by the inboard door uplock assemblies

During the gear extension sequence (Fig. 5), the three advisory lights illuminate when the landing gear does not correspond with the position of the landing gear handle. When the landing gear handle is moved from the UP to the DN position, the advisory lights illuminate. The respective advisory light remains on until the nose gear is down and locked for the nose landing gear, and the inboard doors are up and locked for the main landing gear. Green DOWN lights illuminate when the respective nose or main landing gear are down and locked. If the landing gear is extended using the emergency extension handle, the main landing gear advisory lights do not extinguish because the main gear doors do not retract as they do in normal operation.

The normal extension cycle takes approximately 10 seconds to complete with one or two main pumps operating, and approximately 30 seconds with only the auxiliary pump operating.

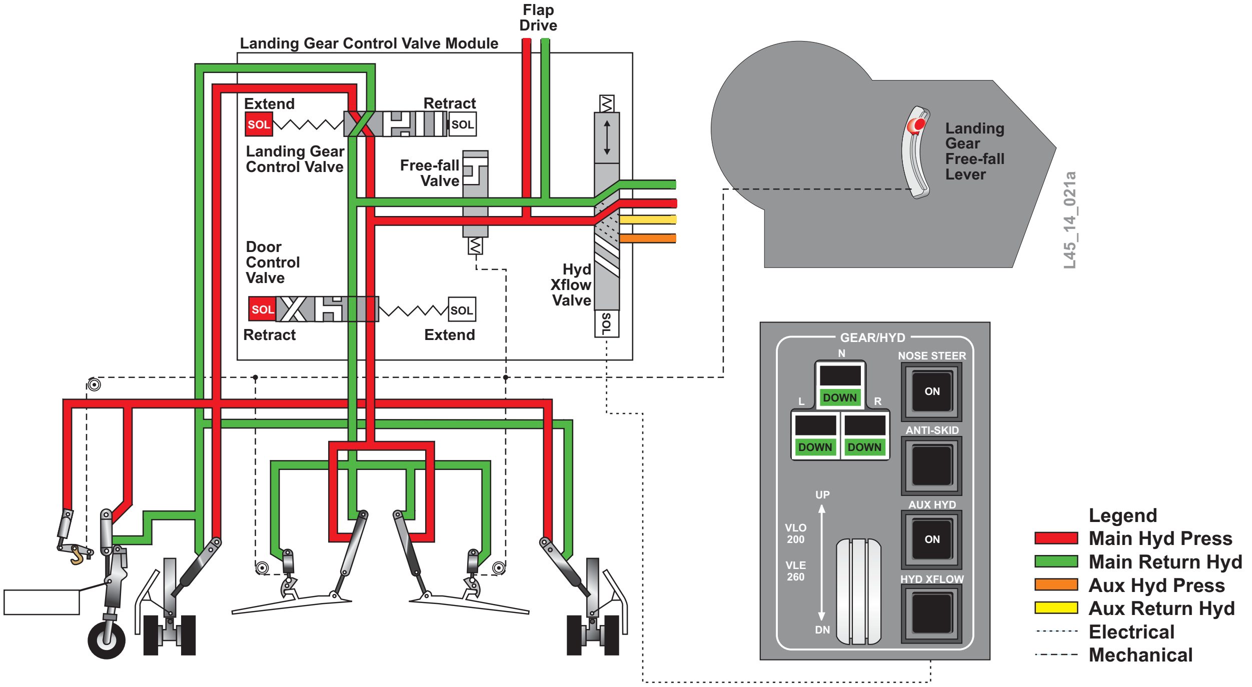

Figure 5 - Gear Extension Schematic

Gear Retraction

When the landing gear lever is placed in the UP position and the squat switches are in the air mode, the following sequence of events occurs:

1. The open solenoid of the door selector valve energizes, and hydraulic pressure is applied to both main gear inboard door uplock actuators and door actuators
2. When the main gear inboard doors open, door open switches complete a circuit from the landing gear lever to the up solenoid of the gear selector valve. Then hydraulic pressure is applied to the main and nose gear actuators, and the gear retracts
3. When the main gear retracts, gear-up switches complete a circuit from the landing gear lever to the close solenoid of the door selector valve. Then hydraulic pressure is applied to the main gear inboard door actuators to close the gear doors. Pressure remains on the main gear actuators until the doors are in the locked position
4. The gear doors are locked into position by the inboard door assemblies

During the gear retraction sequence (Fig. 6), the three advisory lights illuminate when the sequence is initiated, remain illuminated throughout the retraction cycle, and then extinguish when the nose gear is up and locked, and the main gear inboard doors close.

The retraction cycle takes approximately 10 seconds to complete with one or two main pumps operating, and approximately 30 seconds if only the auxiliary pump is operating.

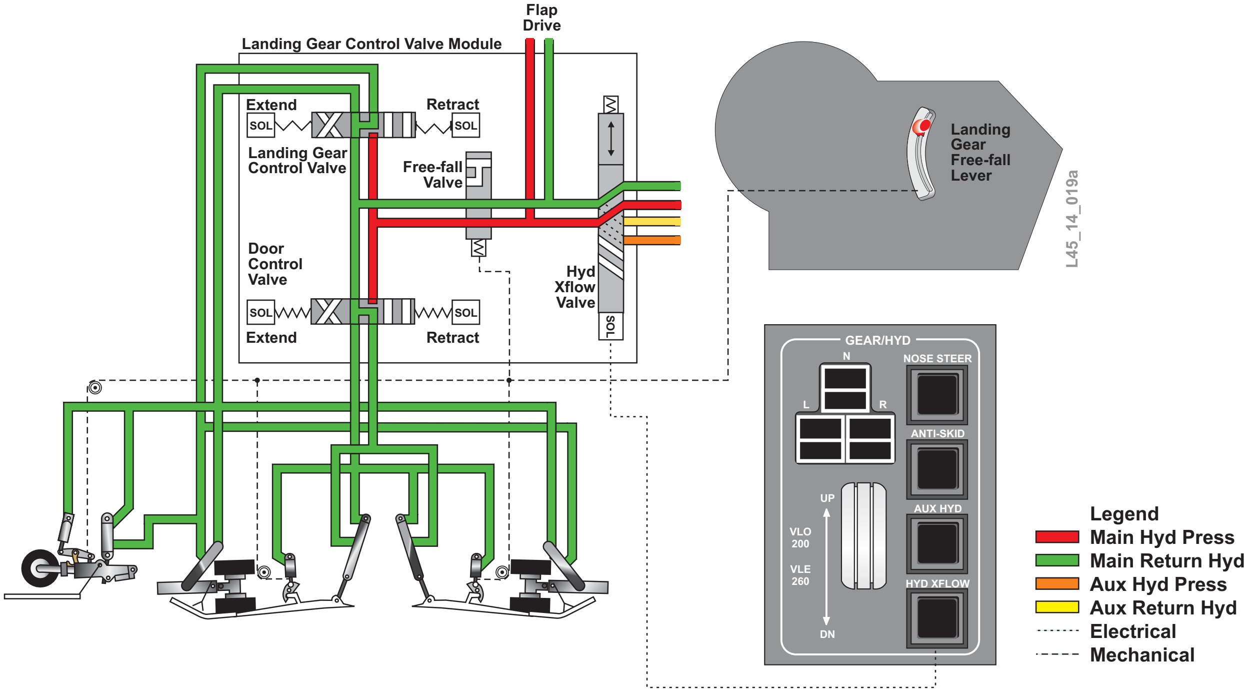

Figure 6 - Gear Retraction Schematic

Landing Gear Free Fall

Description

If the main/auxiliary hydraulic system fails or an electrical system malfunctions, the landing gear can be extended using the emergency extension system. The emergency extension system allows aerodynamics and the weight of the landing gear to extend it to the down-and-locked position.

The emergency extension system uses a GEAR FREE FALL lever, free fall control cables, and a free fall valve (Fig. 7).

Operation

The emergency extension system is operated by the GEAR FREE FALL lever located on the right side on the forward pedestal. Pushing this lever down mechanically unlocks the uplock actuators of the nose gear and main gear doors via the free fall control cables. This action also actuates the free fall valve, allowing the hydraulic pressure and return lines of the door selector and gear selector valves to connect, which isolates them from the main and auxiliary hydraulic systems. Hydraulic resistance is then minimized and the landing gear free falls to the down-and-locked position.

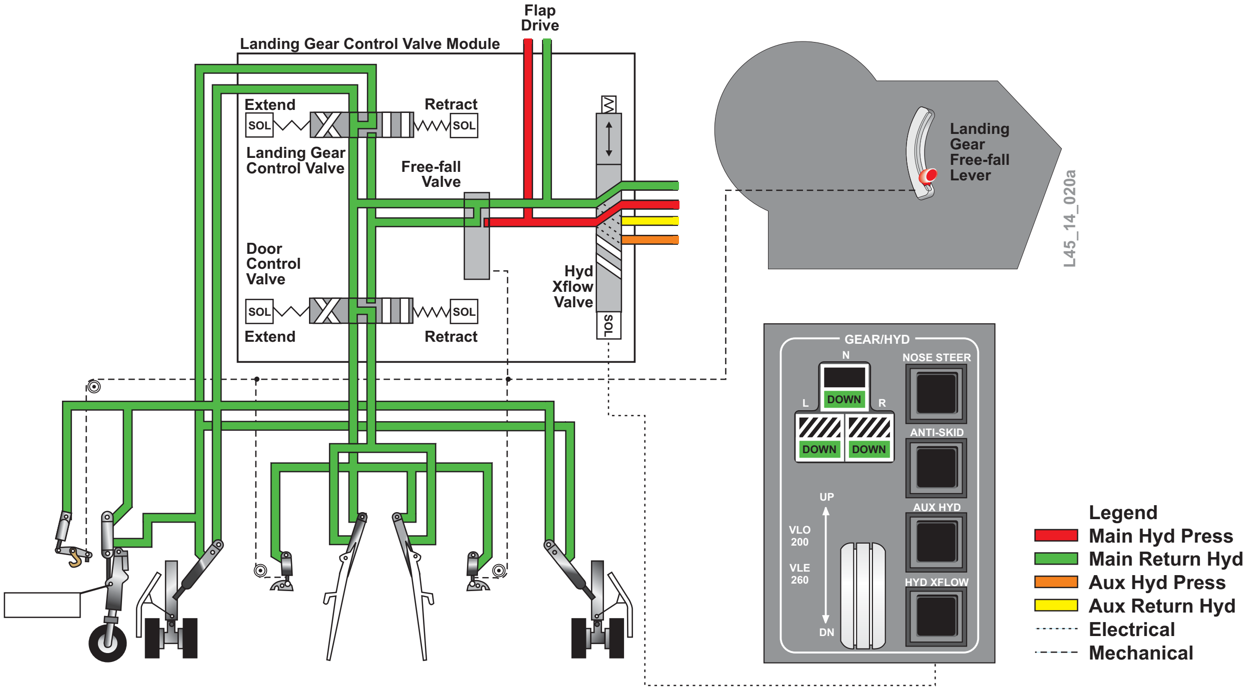

Figure 7 - Gear Free Fall Schematic

Whenever free fall gear extension is to be accomplished due to an electrical problem, the landing gear lever should be placed in the DN position and the GEAR circuit breaker on the copilot circuit breaker panel should be pulled after gear extension. This prevents inadvertent gear retraction if electrical power to the system is regained.

During the landing gear free fall, the three advisory lights illuminate when the sequence is initiated. The main gear advisory lights remain illuminated after the main landing gear are down and locked since the inboard doors remain open. The main gear DOWN lights illuminate when the corresponding gear is down and locked.

Landing Gear Warning System

Description

The landing gear warning system provides aural and visual warnings to alert the flight crew of potentially unsafe flight conditions with the landing gear retracted or in transition. The system provides outputs to the CWP and the EICAS which activate voice and visual warnings during such conditions. Depending upon the flight condition encountered, a distinct warning or caution is indicated.

Operation

Gear Caution

The gear caution indications are activated when one of the following two situations exist:

- All of the following occur:
  - One or more landing gear not down and locked
  - Both thrust levers set less than MCR
  - Airspeed below approximately 170 KIAS
  - Altitude below approximately 14,500 ft
  - Radio altimeter invalid
- Either of the following occurs when airspeed is greater than 210 KIAS:
  - One or more landing gear in transition
  - Either main gear door not up and locked

The GEAR caution function (Fig. 8) can be muted.

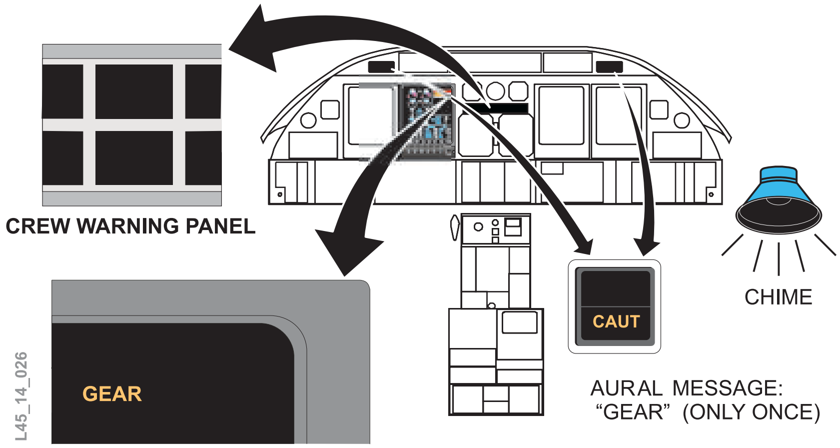

Figure 8 - Gear Caution

Gear Warning

The gear warning indications (Fig. 9) are activated by either of the following conditions:

- One or more landing gear is not down and locked, and the flaps are lowered beyond 25°
- One or more landing gear is not down and locked, both thrust levers are set less than 82%, and the radio altimeter (valid) is less than 500 ft

The "GEAR" aural warning cannot be muted during a gear warning condition.

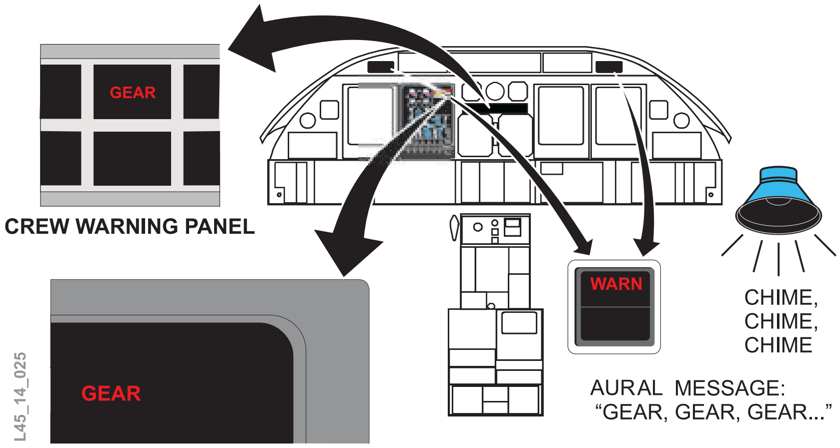

Figure 9 - Gear Warning

CAS Messages

Table 1 - CAS Messages

CAS Message	CWP Caption	Conditions/ Parameters	Aural Alerts
NORM BRK FAIL	NORMAL BRAKE	All four brakes (normal system) have failed	
EMER/PARK BRK		Emergency/parking brake is engaged, and either thrust lever has been advanced (MCR or above) with aircraft on the ground	“Configuration”
GEAR		Landing gear is not down and locked for landing	“Gear”
ANTI-SKID FAIL		Failure of anti-skid to one or more brakes, or ANTI-SKID switch indicator is OFF	
CPLT BRK FAULT		One or more of the copilot brake pedal transducers has failed	
PLT BRK FAULT		One or more of the pilot brake pedal transducers has failed	
L INBD BRK FAIL		Respective inboard normal system brake has failed	
R INBD BRK FAIL			
L R INBD BRK FAIL			
L OUTBD BRK FAIL		Respective outboard normal system brake has failed	
R OUTBD BRK FAIL			
L R OUTBD BRK FAIL			
GEAR		Indicates that: Gear is in transit and airspeed is greater than 210 KIAS Radio altimeter is inoperative, airspeed is less than 170 KIAS, altitude is below 14,500, thrust levers are less than MCR, and the landing gear is not down and locked	“Gear”
NWS FAIL		Nosewheel steering system has failed	
BRAKE FAULT		Brake system fault has been sensed that results in minor system degradation	
EMER/PARK BRK		Emergency brake is being used or the parking brake valve is not fulled released, and the thrust levers are less than MCR	
NWS FAULT		Nosewheel steering system faults have been sensed that result in system degradation	

System Test Switch GEAR Function

The landing gear warning system can be tested by placing the SYS TEST/RESET switch to the GEAR position and depressing the TEST button. Depressing the TEST button with the SYS TEST/RESET switch in GEAR position causes:

- Red GEAR CAS message to appear
- “GEAR” aural warning to sound
- Gear position lights to illuminate

Releasing the TEST button removes all the gear warning indications.

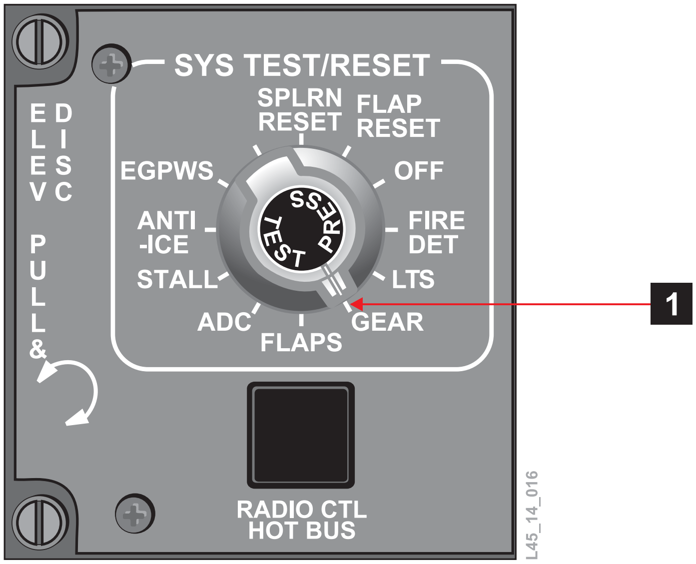

Figure 10 - SYS/TEST RESET Switch

1 SYS TEST/RESET Switch—GEAR Function

- Rotate to GEAR position and depress PRESS TEST button—Initiates landing gear warning system test

Nosewheel Steering System

Description

The nosewheel steering system (NWS) is a steer-by-wire digital system. It provides on-ground nosewheel variable authority steering in response to generated commands from a combination of rudder pedal position and force. The NWS system limits steering authority as a function of ground speed to provide steering angles which are within safe aircraft NWS operating parameters. At ground speeds less than 5 kt, the nosewheel may be turned to a maximum of 60º in either direction.

The NWS also provides a self-centering function after lift-off. An electrical signal centers the nosewheel prior to nose gear retraction. Full extension of the nose gear, assisted by air pressure within the strut, mechanically centers the nosewheel due to centering cams.

Components and Operation

Nosewheel Steering Computer

The nosewheel steering computer receives pilot commands through dual rudder pedal position sensors and dual rudder pedal force sensors. The computer processes information from the rudder pedal position, rudder force sensors, and wheel speed sensors. Steering authority is then computed as a function of these inputs and aircraft ground speed, and the nosewheel actuator is commanded accordingly. Nosewheel position information is fed back to the computer which monitors the system for proper operation.

The nosewheel steering computer also performs self-test functions and continually monitors the system for proper operation. Refer to Fault Monitoring and Protection in this chapter for further information.

Nosewheel Steering Engagement

When the aircraft is on the ground, the nosewheel steering system can be selected ON (armed) by momentarily depressing the NOSE STEER switch indicator located on the GEAR/HYD panel. The system arms when all of the following conditions exist:

- Both system DC power sources are available to the computer
- Nose gear is down and locked
- No system faults are detected

Arming of the nosewheel steering system is indicated by ON annunciation on the NOSE STEER switch indicator.

Once armed and a weight-on-wheels condition is detected by the nosewheel steering computer, the system automatically engages and steering commands are transmitted to the nosewheel steering actuator accordingly.

Ground Operation

During taxi, fully deflecting the rudder pedal provides limited nosewheel steering authority. Once the maximum rudder pedal displacement is reached, further nosewheel deflection is generated by applying additional force to that rudder pedal.

Steering authority on takeoff decreases with increasing ground speed. As the ground speed increases to 70 kt, the maximum wheel deflection is progressively reduced to ±7°.

The nosewheel system remains active through lift-off.

Flight Operation

After lift-off, the nosewheel steering system electrically centers the nosewheel prior to gear retraction. Air pressure within the strut assists full expansion of the strut at lift-off. Nose strut centering cams mechanically center the nosewheel as the strut fully expands.

When the nose gear is no longer in the down-and-locked position, the nosewheel system disarms. This is indicated by the extinguishing of the NOSE STEER switch indicator ON annunciation. The computer remains powered and continues to monitor the system for faults.

In flight, the nosewheel steering system automatically arms when all the arm criteria are satisfied (ON annunciation on the NOSE STEER switch indicator illuminates). After touchdown, the nosewheel steering automatically engages to provide adequate directional control. The system incorporates a fade-in feature that allows several seconds to transition from rudder steering to nosewheel steering, to avoid an oversteer condition. Nosewheel authority increases as the ground speed decreases.

Nosewheel Steering Disengagement

The nosewheel steering system can be manually disengaged at anytime by depressing the NOSE STEER switch indicator. If the aircraft is on the ground, depressing or depressing and releasing either control wheel master switch (MSW) also disarms the system. When the system is disengaged, the NOSE STEER switch indicator ON annunciation extinguishes and a disconnect tone sounds.

Fault Monitoring and Protection

The nosewheel steering computer continuously monitors the nosewheel steering system for faults. Depending on the severity of the fault, the system may allow for degraded operation of the system or disengage and inhibit further system operation. A failure causing degraded operation is indicated by the illumination of the white NWS FAULT CAS message and a system failure is indicated by the illumination of the amber NWS FAIL CAS message.

If a fault or failure is annunciated on the EICAS, the NOSE STEER switch indicator can be momentarily depressed to initiate a reset of the NWS computer, in an attempt to clear the fault/failure.

If there is a failure or the NWS system is manually disarmed by the flight crew, the NWS reverts to the free-castering mode. Aircraft steering must be accomplished using aerodynamic forces (rudder) and/or differential braking.

Wheel Brake/ Antiskid System

Description

The wheel brake/antiskid system is a brake-by-wire system that electronically controls hydraulic brake pressure to stop the aircraft. The brake pedals independently control the left and right brakes. The brake system includes:

- Antiskid protection
- Touchdown protection
- Locked wheel protection
- Retraction braking function

The normal brake system is electronically controlled by the dual channel brake control unit (BCU) and is normally powered by the main hydraulic system. If a main hydraulic system fails, a brake source shuttle valve automatically opens and allows the auxiliary hydraulic system to power the wheel brakes.

The emergency/parking and normal braking system share components; they are not separate independent systems, but the former handles the emergency and parking brake functions. This backup system is mechanically controlled by the EMERGENCY/PARKING BRAKE handle located on the aft pedestal. Hydraulic power for the emergency/ parking brake system is provided by the auxiliary hydraulic system and a dedicated brake accumulator.

The R ESS BUS and the EMER BAT BUS power the wheel brake system.

Controls and Indications

GEAR/HYD Panel

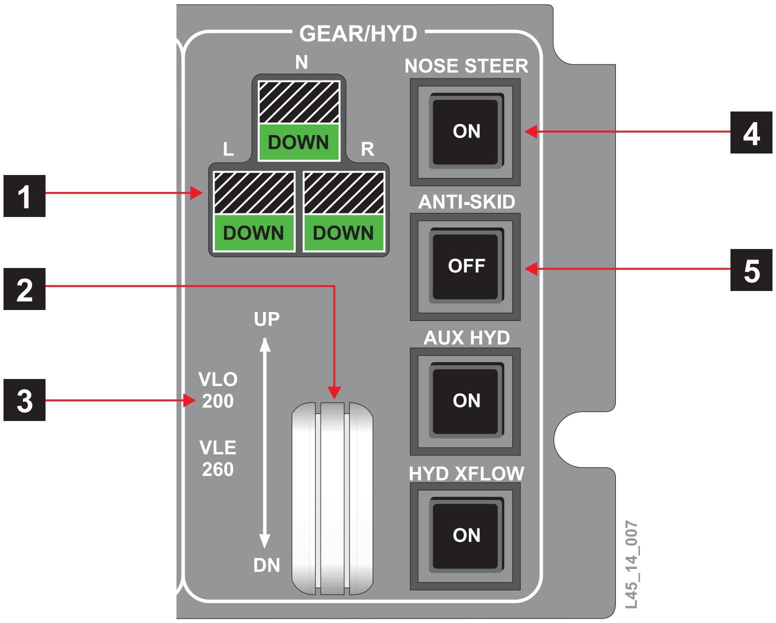

Figure 11 - GEAR/HYD Panel

1 Landing Gear Position Lights

- Illuminated advisory (white hash)—
  - Indicates corresponding gear position does not agree with landing gear lever position
  - Indicates corresponding main gear inboard door is not up and locked
- Illuminated DOWN (green)—Indicates corresponding gear is down and locked

2 Landing Gear Lever

- UP—Retracts landing gear
- DN—Extends landing gear

NOTE

The landing gear lever must be pulled aft before selecting UP or DN.

3 Landing Gear Placard

4 NOSE STEER Switch Indicator

- Press—
  - Arms the nosewheel steering system
  - Subsequent press disarms the nosewheel steering system
- ON annunciation—Indicates nosewheel steering system is armed

5 ANTI-SKID Switch Indicator (alternate-action)

- Press—
  - On—Enables antiskid function
  - OFF—Disables antiskid function

Components and Operation

Antiskid Protection

Antiskid protection (Fig. 12) is provided for the normal brake system.

The BCU applies hydraulic power to the brakes through the brake control shutoff valves and brake control valves. The BCU uses inputs from the brake pedal transducers, wheel speed transducers, squat switches, and brake control pressure transducers. The system independently controls the braking of each main gear wheel. When the system detects a skid, the associated brake control valve reduces brake pressure until skidding stops.

The antiskid function can be disabled by depressing the ANTI-SKID switch indicator located on the GEAR/HYD panel. The switch indicator illuminates OFF whenever the antiskid function is disabled. Selecting the ANTI-SKID switch indicator to OFF or failure of the antiskid system causes the amber ANTI-SKID CAS message to appear. The CAS can also display other messages pertaining to wheel brake system faults or failures.

Touchdown Protection

Braking is enabled after touchdown when wheel spin-up is achieved (ground speed > 50 kt) or after the main gear weight-on-wheel switches are in the ground mode and a three-second delay period has expired. This feature prevents landing with the brakes engaged and allows spin-up time for traction to be established.

Locked Wheel Protection

Locked wheel protection is provided by the BCU. Brake pressure is removed from a wheel if its velocity is less than or equal to 30% of the velocity of the paired wheel. Removal of brake pressure from the slow wheel allows traction to be reestablished.

Retraction Braking

This function stops the wheels from spinning before they are retracted into the wheel wells. After the squat switches indicate air mode (weight off wheels) and when the gear control handle is in the UP (retract) position, the BCU sends a hydraulic pulse to stop the wheels from spinning.

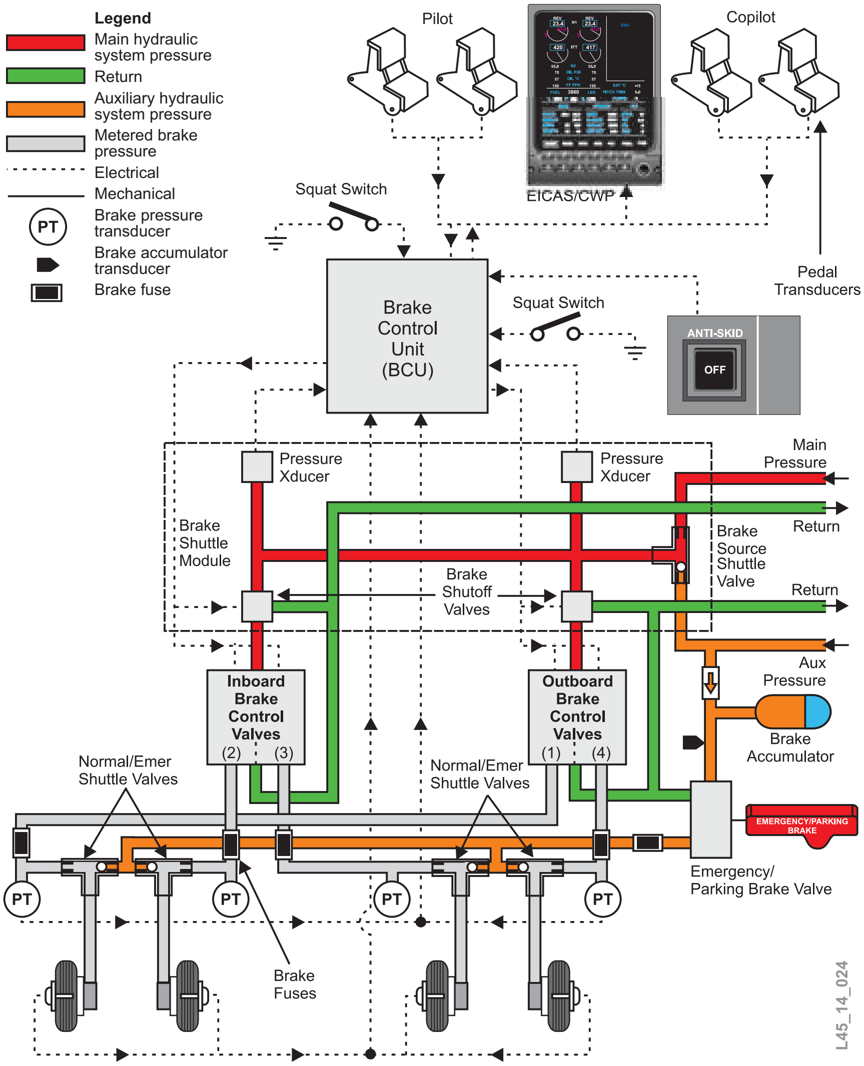

Figure 12 - Wheel Brake Control/Antiskid System

Emergency Braking

Emergency braking stops the aircraft when the normal braking system is not available. Emergency braking is controlled by the EMERGENCY/PARKING BRAKE handle on the aft pedestal. Hydraulic power is stored in the brake accumulator and is provided to the wheel brakes by pulling the handle. The amount of hydraulic pressure applied to the brakes is proportional to the amount the handle is pulled. Releasing the handle to the off position disengages the emergency brakes. Antiskid protection and differential braking is not available during emergency braking.

Brake Accumulator

A separate brake accumulator, fed by the auxiliary system, maintains pressure for the emergency/parking brakes. The brake accumulator provides a reserve pressure of 3000 psi for emergency and parking brake operation. The accumulator provides at least six emergency brake applications or parking brake pressure for approximately 48 hr.

A pressure transducer on the brake accumulator provides accumulator pressure information for display on the EICAS/MFD SUMRY and hydraulic (HYD) system page displays. An amber BRK ACUM PRESS CAS message appears if the brake accumulator pressure is less than 1200 psi or greater than 3800 psi.

Parking Brake

The emergency brake also serves as the parking brake and is engaged by pulling the EMERGENCY/PARKING BRAKE handle and rotating it clockwise or counterclockwise to the locked position. This commands the emergency/parking brake valve to close. When the parking brake is set, a white EMER/PARK BRK CAS message appears. If the parking brake is not released and the thrust levers are advanced for takeoff, the CAS message turns red and the takeoff warning sounds.

Main Landing Gear Wheel and Tires

The main landing gear is equipped with dual wheels with multidisk carbon brakes. Each main wheel has thermal relief plugs which are designed to melt and release tire pressure if the wheel becomes excessively hot. The main wheel tires are rated at 165 kt ground speed.

Brake Wear Indicator

A brake wear indicator pin is installed on each wheel brake which allows the flight crew and maintenance personnel to visually inspect disk brake wear. To properly check brake wear, the normal or auxiliary system must be fully pressurized (3000 psi) and the parking brake set. If the end of the wear indicator pin is flush or recessed with the wear indicator sleeve, the brakes must be replaced.

The brake wear indicator should be verified during the exterior preflight.

Nosewheel and Tire

The nosewheel uses a single dual-chine tire which deflects water and slush away from the engine inlets. The nosewheel tire is rated at 165 kt ground speed.

Squat Switches

Description

Each main landing gear is equipped with two squat switches mounted on the landing gear torque link. The squat switches allow various aircraft systems to detect when the aircraft is in an “on ground” or “in air” mode.

Operation

Squat Switches

When there is weight on wheels, the main gear struts compress and actuate the squat switches to provide a ground mode signal. On lift-off, the main gear struts extend and actuate the squat switches to provide an air mode signal.

The squat switches provide ground or air mode signals to the systems in Table 2.

Table 2 - Squat Switch Air/Ground Mode Signals

Systems	Normal Inflight Operation	Normal On-Ground Operation
Landing gear	Gear can be retracted	Gear retraction inhibited
Autospoiler	Operation disabled	Operation enabled
TO TRIM annunciator	Annunciator disabled	Annunciator enabled
Thrust reverser	Thrust reverser operation inhibited	Thrust reverser operation enabled
Electrical system	Load shedding enabled during single generator operation	No load shedding
Clearance delivery radio	Error code appears when in emergency mode	No error code displayed in emergency mode
Squat switch relay box	Relay box operates in air mode	Relay box operates in ground mode

Squat Switch Relay Box

The squat switch relay box, like the squat switches, provides an “on ground” or “in air” mode to various aircraft systems. When the squat switches (left and right inboard squat switches) are in ground mode, the relay box provides an “on ground” mode to aircraft systems. The squat switch relay box is powered by the 28 VDC ESS BUS from the L SQUAT and R SQUAT circuit breakers. If the L SQUAT or R SQUAT circuit breaker is open, the respective outputs revert to air mode even when the aircraft is on the ground.

The squat switch relay box provides ground and air mode signals to the following systems (Table 3).

Table 3 - Squat Switch Relay Box Air/Ground Mode Signals

Systems	Normal Inflight Operation	Normal On-Ground Operation
Pressurization controller	Pressurization controller operates in appropriate modes	Pressurization controller operates in ground mode
PA system	PA level operates in high level	PA level operates in low level
CVR	CVR ERASE inhibited	CVR ERASE enabled
Stall warning system	• Shaker enabled • Stall warning test disabled	• Shaker inhibited • Stall warning test enabled
TAT probe heater	Enabled	Disabled
EICAS	• ICE detector alerts enabled • Door red CAS messages enabled	• ICE detector alerts disabled • Door red CAS messages inhibited
Clocks	N/A	Flight time computed when aircraft transitions from ground to air
IAC	Used for weight-on-wheels monitor	Used for weight-on-wheels monitor
Takeoff warning system	Takeoff warning disabled	Takeoff warning enabled
Wheel brakes anti-skid	• Provides braking during gear retraction • With the ANTI-SKID switch indicator on, the brakes are disabled until wheel spin-up	• Touchdown protection enabled • Anti-skid system is operative
Nosewheel steering	Nosewheel steering disarmed	Nosewheel steering armed and engaged
Strobe light	Enabled	Disabled
WXR	Operates as selected	Operates in forced standby mode
Transponder	Transponder replies to ATC interrogation	Transponder does not reply to ATC interrogation
DEEC	DEEC commands flight idle with thrust levers at idle	DEEC commands ground idle with thrust levers at idle
APU	Operation disabled	Operation enabled
Fuel quantity signal conditioner	Uses inflight calculation software	Uses on-ground calculation software
Hourmeter	Enabled	Disabled
ADC SYSTEM test	Disabled	Enabled
FLAP SYSTEM test	Disabled	Enabled

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LIGHTING

Introduction

The Learjet 40/45 lighting system illuminates the cabin, cockpit, and all flight instruments, as well as all required exterior lighting. Floodlights of either the fluorescent or incandescent type are used for general illumination. Standard warning lights are available for the cabin area. Emergency lights illuminate the exits during an emergency.

Exterior lighting consists of landing, taxi, recognition, strobe, navigation, beacon, and a wing inspection light. Optional exterior lighting consists of tail logo lights and exterior convenience lights, mounted under the engine pylons, that illuminate the single-point refueling and baggage door areas.

The lighting system is divided into interior and exterior lighting systems.

Interior Lighting System

Description

The interior lights illuminate the cockpit area and all flight instruments (Fig. 1). The majority of the instruments are internally lighted. Floodlights of either the fluorescent or incandescent type are used for general illumination.

Cockpit lighting consists of:

- Map lights
- Glareshield floodlights
- Instrument/indicator lights
- Panel lights
- Dome lights
- Cockpit switch panels (2) for control

Cabin lighting consists of:

- Entry/exit light
- Overhead
- Passenger reading/table light
- Refreshment cabinet light
- Lavatory (read/vanity) lights
- NO SMOKING/FASTEN SEAT BELT annunciation
- Baggage lights
- Tailcone light

Additional interior lighting consists of an emergency cabin lighting system that uses existing overhead lights, additional exit lights, and seat base-mounted floor proximity lights.

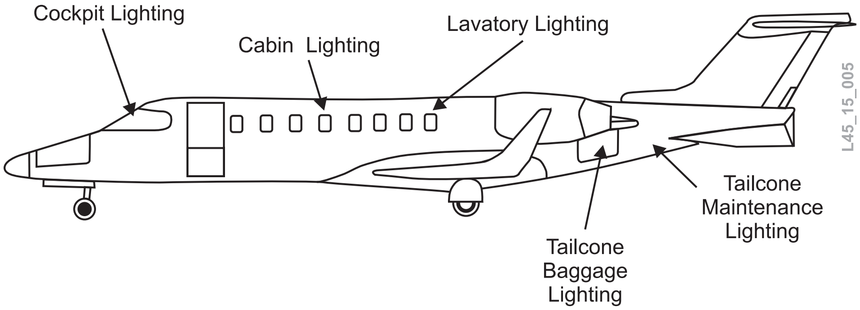


Figure 1 - Interior Lighting

Controls and Operation

Cockpit Lighting

Cockpit lighting is controlled through two cockpit control panels (Fig. 2). Two multidirectional gooseneck map lights are also located in the cockpit, one on each side. Dimming is controlled by a rheostat located at the base of each gooseneck light assembly. The color projected by the light can be controlled by a swivel case on the bulb end of the gooseneck. The light can appear red or white. A majority of the switches in the cockpit are pushbuttons with lighted indicators. To support the "quiet/dark cockpit" concept, none of the indicators illuminate under normal conditions.

L and R CREW LIGHTS Panels

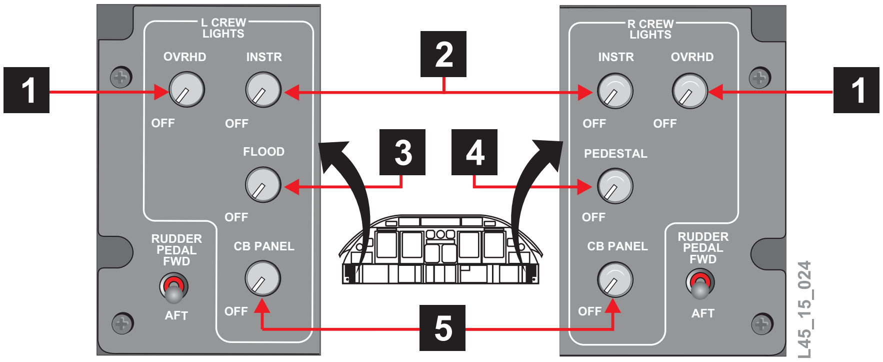


Figure 2 - L and R CREW LIGHTS Panels

1 OVRHD Control Knob

- Rotate—Adjusts the intensity of the cockpit overhead dome lights

2 INSTR Control Knob
- Rotate—Adjusts the intensity of pilot/copilot instrument lighting

3 FLOOD Control Knob
- Rotate—Adjusts the intensity of the instrument panel floodlights

4 PEDESTAL Control Knob
- Rotate—Adjusts the intensity of the center pedestal lighting

5 CB PANEL Control Knob
- Rotate—Adjusts the intensity of the pilot/copilot circuit breaker panel lighting

The following is a description of each of the potentiometer controls located on the left crew lights panel:

OVRHD—The pilot overhead swivel light is controlled by the OVRHD potentiometer. The pilot overhead light can also be turned on with the COCKPIT light switch on the main entryway control panel when the cabin door is opened and the OVRHD control is OFF. When the upper cabin door is closed, cockpit overhead light control from the main entryway control panel is disabled. The pilot overhead light receives power from the right hot bus.
INSTR—The pilot instrument panel lights and the bezel controllers backlighting are controlled via the INSTR potentiometer and powered by the left essential bus. Display units and the radio management units have internal lighting, and the intensity is controlled through sensors and controls.
FLOOD—The entire instrument panel can be illuminated by a fluorescent floodlight located beneath the glareshield. Dimming is controlled via a potentiometer. Power for the floodlight comes from the left essential bus.
CB PANEL—This potentiometer controls the intensity of overlay lighting on the pilot circuit breaker panel. Circuit breaker panel lighting is powered by the main bus.

The following is a description of each of the potentiometer controls located on the right crew lights panel:

INSTR—The copilot instrument panel lighting and the bezel controllers backlighting are controlled via the INSTR potentiometer. Display units and the radio management units have internal lighting and the intensity is controlled through sensors and controls. Right instrument lights are powered by the right main bus.
OVRHD—The copilot overhead swivel light is controlled by the OVRHD potentiometer and is powered from the right hot bus.
PEDESTAL—This potentiometer controls the lighting intensity of equipment installed in the pedestal and is powered by the right main bus. The FMS display intensity is regulated by the dim button on FMS control panel.

CB PANEL—This potentiometer controls the intensity of overlay lighting on the copilot circuit breaker panel and is powered by the right main bus.

System Test/Reset Switch Panel

A light test may be initiated by selecting LTS on the system test knob (center pedestal) and depressing the PRESS TEST button (Fig. 3). Depressing the PRESS TEST button for over 15 seconds also initiates the aural warning test.

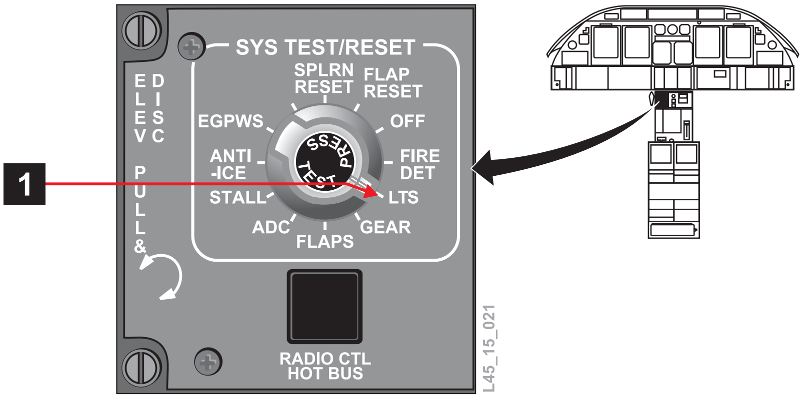


Figure 3 - SYS TEST/RESET Switch—LTS Function

1 SYS TEST/RESET—LTS Function

- Rotate to LTS and depress—Initiates a light bulb test of the instrument panel

Cabin Lighting

Cabin lighting (except entry/exit light) is powered by the left and right nonessential buses. This arrangement allows cabin lighting to be used with a GPU powering the nonessential buses.

Primary cabin lighting control is through the main entryway control panel which is located on the left storage cabinet, forward of the cabin door.

Entry/Exit Lights

The cabin entry/exit door light is installed in the upper door to illuminate the lower door steps and ground when both doors are opened. This light is controlled by the ENTRY light switch and is powered by the hot bus regardless of the BATT switch position.

The light is inoperative when the upper entry door is closed.

Overhead Lights

The overhead lights consist of indirect lighting located within the cabin passenger service unit.

Covered by lenses, the overhead lights are controlled by the CABIN LIGHT switch on the main entryway control panel and the master control panel.

Passenger Reading/ Table Lights

Reading and table lighting consists of lights installed in the passenger service unit above the seats on each side of the cabin. The seats have only one light while the table lights consist of a two-light assembly, installed above each table. Control for the reading lights is provided by the seat-mounted control units and by the SPOT light switch on the main entryway control panel (Fig. 4).

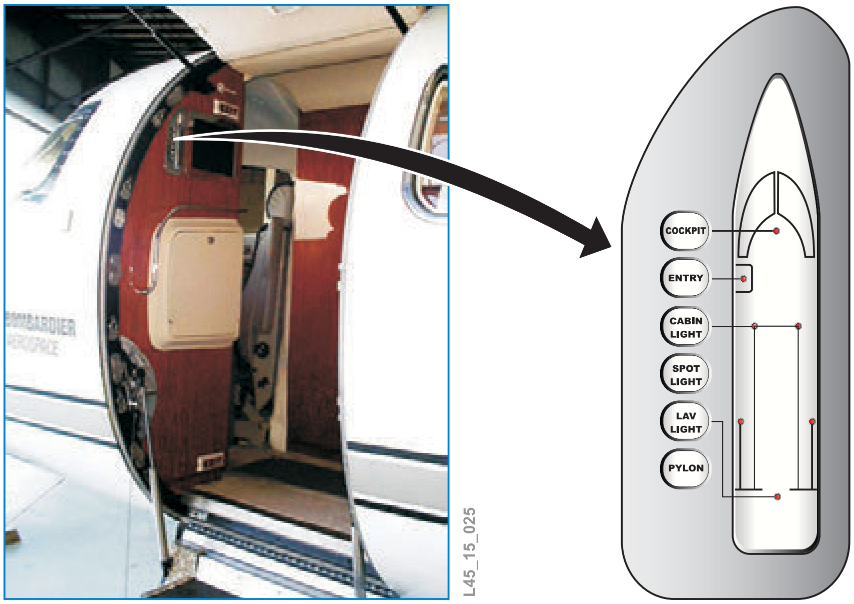


Figure 4 - Cabin Lighting

Lavatory Lights

Lavatory lights consist of two overhead spotlights (one located above the left cabin stowage area and one located above the toilet) and wraparound overhead fluorescent lights. Control of the spotlights is by the lavatory control panel and the main entryway control panel.

The fluorescent light is controlled by the LAV LIGHT switch on the main entryway control panel and the LAV LIGHT switch on the lavatory control panel.

Additional Lighting

Additional lighting controls are located in the individual seat passenger control units (for reading and table lights), master control panel, and the lavatory control panel (fluorescent and spotlights).

In the standard configuration, the master control panel is located in the right mid-aft seat storage box.

NO SMOKING/ FASTEN SEAT BELT Annunciation

Control of the NO SMOKING/FASTEN SEAT BELT sign is through a switch located on the LIGHTS control panel in the cockpit (Fig. 5). This switch is a three-position switch labeled OFF, BELTS, and NO SMOKING/BELTS. Movement of the switch also actuates a chime to draw attention to the light.

Figure 5 - EMER LIGHTS and NO SMOKING/BELTS Control

Baggage Lights

The baggage lights are powered by the hot bus. If inadvertently left on, the lights automatically extinguish when the access door is closed.

Tailcone Light

The tailcone light is powered by the hot bus. If inadvertently left on, the light automatically extinguishes when the access door is closed.

Emergency Lighting System

The emergency lighting system is standard and consists of cabin spotlights, floor proximity lights, and emergency exit area lights that illuminate during a failure of the normal electrical system.

Control of the emergency lighting system is through a three-position switch located on the LIGHTS control panel (Fig. 5). The emergency lighting group consists of:

- Exit signs (5)
- Floor proximity lights (8)
- Lavatory light
- External egress
- Entry light
- Cabin spotlights

The cockpit EMER LIGHTS switch is lever-locked and labeled OFF, ARM, and ON.

When the cockpit switch is in the OFF position, the emergency lights are inhibited.

When the cockpit switch is in the ON position, the emergency lighting group illuminates. Activation periods are limited by a timing circuit to a minimum of 10 minutes and a maximum of 12 minutes.

To function automatically, the cockpit switch must be in the ARM position. Once armed, the emergency lighting system automatically illuminates when normal electrical power is lost (dual generator failure) or when passenger oxygen masks deploy.

When the emergency lights are activated automatically, they may be deactivated by placing the EMER LIGHTS switch to the OFF position. The crew is alerted when airplane power is on and the emergency lights are not armed. To indicate this condition, an amber EMER LIGHTS CAS message is illuminated.

The emergency lights receive power from both main batteries and the emergency battery. The emergency lights are divided into four lighting zones:

- Forward
- Mid-forward
- Mid-aft
- Aft

Each zone is powered in parallel from both electrical sources.

CAS Messages

Table 1 - CAS Messages

CAS Message	Conditions/Parameters
EMER LIGHTS	Indicates the emergency lights are not armed
EMER LIGHTS	Emergency lights are ON (automatically or selected)

Abnormal Interior Lighting Conditions

Single Generator Failure

If a single generator fails, the airplane electrical system automatically sheds the nonessential buses. Although some of the lights can be powered by the emergency lighting system, normal power to the following cabin lighting is lost:

- Lavatory lights
- Galley lights
- Reading lights

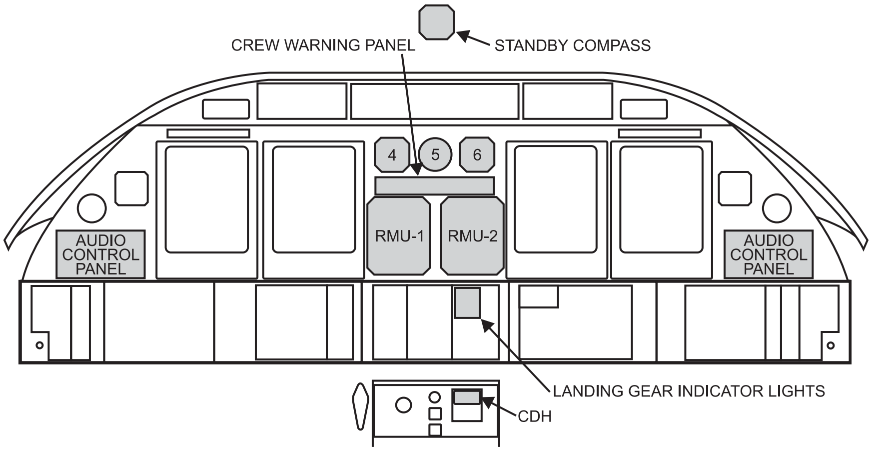
To regain cabin lighting, the nonessential buses may be reconnected at the discretion of the pilot.

Cockpit lighting is not affected by single generator failure.

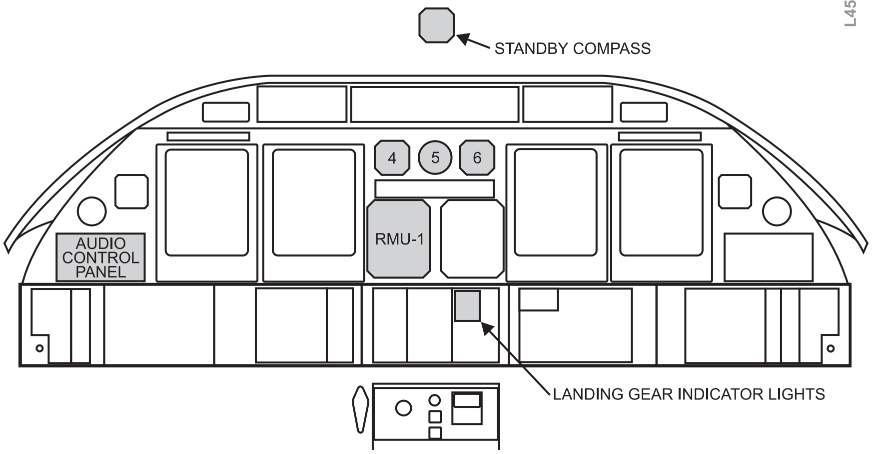
Dual Generator Failure

Should the airplane experience a dual generator failure, cockpit interior lighting is affected in addition to the cabin lighting already lost with a single generator failure. The following instruments remain illuminated in this situation (Fig. 6):

- Audio control panels (2)
- Clearance delivery head (CHD)
- RMUs (2)
- Landing gear indicator lights
- CWP
- Standby instruments
- Standby compass



BATTERY MODE LIGHTING



EMERGENCY BATTERY MODE LIGHTING

Figure 6 - Abnormal Cockpit Lighting

The cockpit flood lights and map lights remain operational as long as the main batteries stay online.

Inoperative cockpit lights include copilot instruments, center pedestal, and left and right circuit breaker panels. In addition to the list of items lost following a single generator failure, the cabin overhead fluorescent lights are inoperative.

The emergency lights operate in flight as long as either main battery has power. However, after approximately 10 minutes, the emergency lights shut off but may be reset by recycling the EMER LIGHTS switch.

If both main batteries expire, the left cockpit overhead light, left map light, and the floodlight are inoperative but the emergency battery continues to power the following cockpit instruments:

- Left audio control panel
- Left RMU
- Standby instruments
- Standby compass
- Landing gear indicator lights

Exterior Lighting System

Description

To illuminate the outside of the aircraft and enhance visual identification, the aircraft is equipped with the following (Fig. 7):

- Landing/taxi lights
- Recognition lights
- Strobe lights
- Navigation lights
- Beacon light
- Wing inspection light

The exterior lights are controlled by switches located on the center switch panel in the LIGHTS group.

Optional exterior lighting consists of tail logo and exterior convenience lights that illuminate the single-point refueling (SPPR) and baggage door areas.

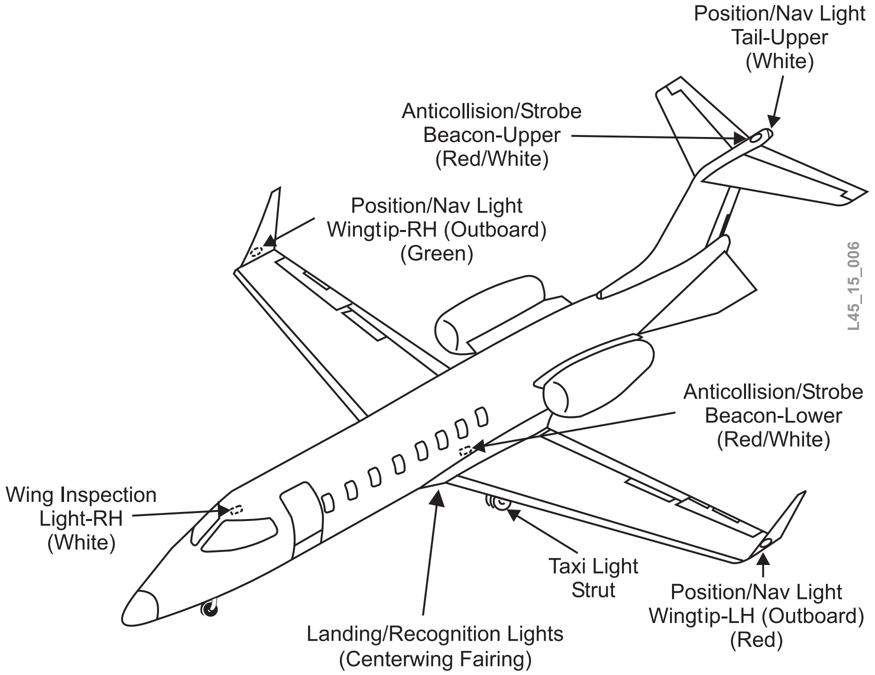


Figure 7 - Exterior Lighting

Controls and Operation

Exterior LIGHTS Panel

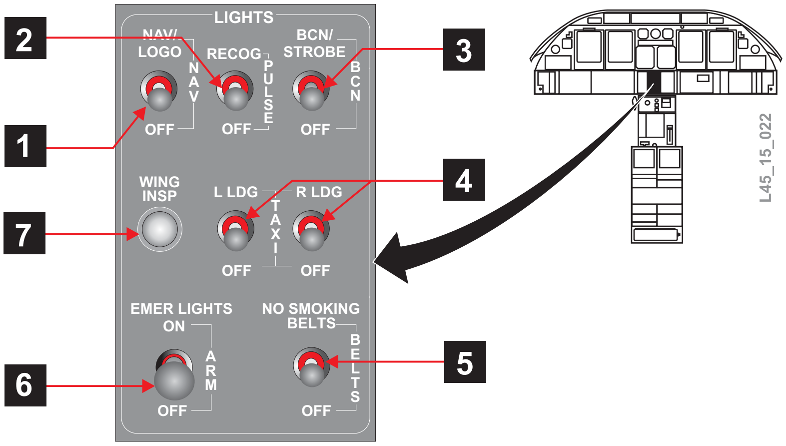


Figure 8 - Exterior Lights Panel

1 NAV/LOGO Switch

- NAV/LOGO—Red and green wingtip lights, tail navigation lights, and tail logo lights illuminate
- OFF—Red and green wingtip lights, white tail navigation lights, and tail logo lights extinguish
- NAV—Red and green wingtip lights and tail navigation lights illuminate

2 RECOG Switch

- OFF—Outboard bulbs on each of the two landing light assemblies extinguish
- RECOG—Outboard bulbs on each of the two landing light assemblies illuminate
- PULSE—Outboard bulbs illuminate by pulsing until selected OFF or until landing lights are selected on

3 BCN/STROBE (anticollision) Light Switch

- OFF—Red beacon and white strobe lights extinguish
- BCN—Red beacon lights on top of the vertical stabilizer and on the bottom of the fuselage illuminate
- BCN/STROBE—
  - On the ground—Red beacon lights on top of the vertical stabilizer and on the bottom of the fuselage illuminate
  - In flight—White strobe lights on top of the vertical stabilizer and on the bottom of the fuselage illuminate

4 LDG/TAXI Switches

- OFF—Landing and taxi lights extinguish
- TAXI—Taxi lights illuminate
- L LDG or R LDG—
  - Taxi lights illuminate if landing gear is down and locked
  - Landing/recognition lights illuminate

5 NO SMOKING Switch

- OFF—No smoking and fasten seat belts signs extinguish
- BELTS—
  - Fasten seat belt sign illuminates
  - Chime sounds
- NO SMOKING/BELTS—
  - No smoking and fasten seat belts signs illuminate
  - Chime sounds

6 EMER LIGHTS Switch

- OFF—
  - All emergency lights extinguish
  - Amber EMER LIGHTS CAS message illuminates
- ARM—Arms the emergency lights to automatically activate should the normal electrical power be lost or when passenger oxygen mask deployment occurs

NOTE **Selecting ARM prior to powering the aircraft causes the emergency lights to activate immediately.**

- ON—
  - Emergency lighting group illuminates
  - White EMER LIGHTS CAS message illuminates

7 WING INSP Button (momentary)

- Press—Wing inspection light illuminates black dot on right wing leading edge

Exterior Convenience Pylon Lights

An area light mounted beneath each engine pylon illuminates the baggage compartment area on the left side of the aircraft and the single-point pressure refueling (SPPR) access door area on the right side. Both area lights are powered from the rear hot bus through the EXT PYLON LIGHTS circuit breaker located on the options CB panel. The SPPR area light is controlled via the SPPR panel power switch and illuminates when power is applied to the refueling panel, day or night. The pylon switch light on the entryway control panel controls illumination of the left pylon exterior light.

Baggage/Tailcone Area Light

Lighting for the baggage compartment consists of two overhead dome lights. The lights are controlled by the baggage LIGHTS switch located near the baggage compartment door. The baggage compartment lights are powered by the hot bus. If the lights are inadvertently left ON, the lights automatically extinguish when the access door is closed. The tailcone equipment bay internal light is also powered by the hot bus system. The switch is located near the access door and if it is inadvertently left ON, the light automatically extinguishes when the door is closed.

SPPR Area Light

The SPPR area light is controlled via the SPPR panel power switch. The light illuminates when the refuel power switch is selected to the ON/FLD LT position. Both area lights are powered from the hot bus.

Landing/Taxi Lights

The landing lights consist of two dual bulb light assemblies mounted in the fuselage center-wing fairing. The taxi lights consist of a single filament light mounted on each main landing gear strut.

When the LDG-TAXI lights switches are placed in the TAXI position, the taxi light on each main gear strut illuminates if the gear is down and locked. When these switches are placed to the LDG position, the taxi lights remain illuminated and the landing lights under the fuselage illuminate. The gear does not have to be down for the landing lights to illuminate.

The landing lights consist of two bulbs in an assembly under the right side of the fuselage and two bulbs in an assembly under the left side of the fuselage.

The outboard bulb in each assembly also serves as a recognition light when the landing lights are not turned ON.

Recognition Lights

Landing and recognition lights (Fig. 9) are combined into one assembly under the center wing area. The outboard filaments illuminate when the recognition light switch is placed in RECOG; the outboard filaments pulse illuminate when the recognition light switch is placed in PULSE; both inboard and outboard filaments illuminate steady when the respective landing light switch is placed to R/L LDG. Pulsating recognition lights markedly improve the visibility of the aircraft.

When the landing lights are on, the recognition lights illuminate even when the RECOG switch is OFF.

Figure 9 - Landing/Recognition Lights

Navigation Lights

The navigation lights system consists of three position lights. Two are visible from each side, and one tail-mounted position light is visible from the rear. The left and right position lights are located on the outboard side of each winglet. The aft position light is located on the top trailing edge of the vertical stabilizer.

All three navigation lights are controlled by the NAV light switch. Additionally, setting the NAV light switch to NAV automatically dims all cockpit switch/indicator lights on the instruments panel and the center pedestal. The NAV switch is a two-position (OFF/NAV) switch on airplanes not equipped with optional LOGO lights.

Tail Logo Lights (Optional)

Tail logos are illuminated by two lights installed on the bottom of the horizontal stabilizer. These lights illuminate both sides of the vertical stabilizer. The lights are controlled by a NAV/LOGO position on the NAV light switch. Power is from the right nonessential bus. The circuit breaker is located on the copilot circuit breaker panel within the LIGHTS group.

Anticollision Lights

The anticollision light system consists of two dual-selectable beacon/strobe light units. The upper anticollision light is located on the top of the vertical stabilizer and the lower light is mounted on the bottom of the wing/fuselage fairing. Each light unit incorporates two flashtubes, one clear and the other one with an aviation red filter.

Control of both anticollision lights is via the three-position BCN/STROBE-BCN-OFF light switch on the LIGHTS control panel.

When the switch is set in the BCN/STROBE position:

- Red light in each unit flashes on the ground (via squat switch ground signal)
- Clear flashtube flashes in flight (via squat switch air mode signal)

When the switch is set in the BCN position:

- Red flashtube in each light unit flashes on the ground or in flight

Wing Inspection Light

The wing inspection light system allows the copilot to visually detect ice buildup on the airplane wings during night operations. The system consists of the following:

- WING INSP light pushbutton located on the LIGHTS control panel
- Halogen spotlight assembly flush-mounted in the right side of the fuselage aft of the cockpit
- Black spot located on the right wing leading edge (enhances visual detection of ice accumulation)

NOTE

Clear ice may not be detected by visual inspection alone.

The WING INSP pushbutton is a momentary action switch. The inspection spotlight illuminates the wing area only when the switch is held depressed.

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MISCELLANEOUS

Introduction

This chapter of the Pilot Training Guide describes interior and optional equipment and accessories of the Learjet 40/45 aircraft. Not all aircraft have the optional items installed. The information is provided as general information for all operators.

There are several pieces of equipment in the cockpit to assist the pilots in performing their duties and in the passenger cabin to provide better amenities to the passengers.

Crew Compartment

Flashlights

Two flashlights are installed in the crew compartment. The flashlights are located behind each crewmember seat.

Rechargeable flashlights are available as optional equipment. The rechargeable flashlights are mounted in a location similar to the standard flashlights. The rechargeable flashlights float, and are waterproof and flame-retardant.

Approach Plate Holders

Standard

A spring-loaded chart holder is installed on each control panel. The holders are large enough to hold an entire approach plate.

Optional

Optional illuminated chart holders are available for each control wheel. A chart holders light illuminates the approach plates.

Sunvisors

Sunvisors may be installed as optional equipment. Two sunvisors are located at the upper edge of the windshield, one on each side. Each sunvisor is hinged so it can be folded down and slid along its track as desired.

Forward Pocket Doors

Optional solid sliding doors may be installed which separate the cockpit from the entryway galley and passenger compartment.

Flight Phone

The optional digital airborne telephone (Magnastar C2000) is a two-voice/data system that has direct dialing, multiple calls, fax/data modem, uplink calls, interphone, speed dialing, and call-charging features.

Handsets are installed in both the cockpit and the passenger compartment.

The passenger compartment handset can be located in any of the cabin armrest storage boxes. The handset in the cockpit is located on the aft end of the center pedestal.

Passenger Compartment

Description

The Learjet 40/45 cabin is divided into three areas:

- Entry galley
- Passenger seating area
- Lavatory and aft cabin stowage compartment

Entry Galley

The typical galley is equipped with:

- Coffee warmer
- Trash container
- Ice chest and food/beverage storage
- Preparation equipment

Passenger Seating Area

The typical passenger compartment has:

- Eight individual seats in a two-abreast configuration with one seat on each side of the aisle (Fig. 1); Learjet 40 has a slightly different configuration (Fig. 2)
- Individual reading lights
- Air outlets
- Drinkholders
- Pull-out tables
- Entertainment control panels

Figure 1 - Learjet 45 Internal Configuration

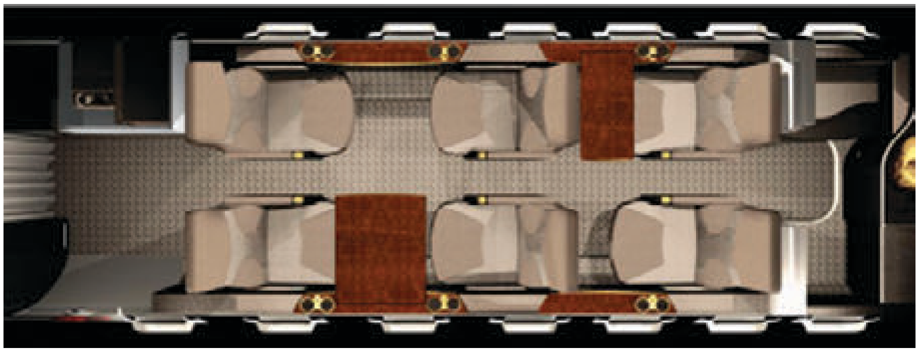

Figure 2 - Learjet 40 Internal Configuration

Lavatory and Aft Cabin Stowage Compartment

The lavatory is located on the aft side of a partition at the aft end of the passenger compartment. The partition features sliding doors between the lavatory and passenger compartment.

The lavatory consists of a toilet and a vanity cabinet.

Access to the aft cabin stowage compartment is accomplished through the lavatory at the center aisle. The aft stowage compartment is equipped with a decorative coat rod and a baggage restraining net.

Electric power to operate the flushing circuit is 28 VDC supplied through the TOILET circuit breaker on the copilot circuit breaker panel.

The optional sink is located at the aft end of the lavatory. The water faucet is operated by depressing the PUMP button on the vanity adjacent to the basin. Water in the basin is drained by depressing the DRAIN button next to the PUMP button.

If equipped with the optional sink, the lavatory has a 1.5-gal potable water tank and pump under the vanity counter. The pump and heated tank draw electrical power from the 15-amp LAV SINK circuit breaker on the pilot circuit breaker panel. The sink is drained through a heated drain mast on the bottom of the aircraft. The heater prevents ice from forming in the drain mast.

To fill the water tank, remove the snap plug from the top of the water tank, fill with potable water, and install snap plug. To remove the tank, first disconnect electrical power from the aircraft. Remove the toilet side cushion and water tank closeout panel. Disconnect the electrical connector and lift the tank far enough to gain access to the water supply line. Disconnect the line from the tank and remove the tank from the aircraft. To install a tank, reverse these directions.

Equipment

AC Electrical Outlet

Four optional 110 VAC/ 60Hz electrical outlets may be installed in the cabin. One of the outlets is located in the galley cabinet. Two of the outlets are located in the passenger compartment lower sidewall (one on each side) between the facing passenger seats. The fourth outlet is equipped with a ground fault interrupt (GFI) and is installed across from the lavatory in the cabin stowage area at the floor. The GFI outlet can be reset by depressing the TEST/RESET button.

A 230 VAC/50 Hz circuit is available as an option for aircraft which are primarily used overseas.

Window Shades

Each cabin window is equipped with a window shade. The shades are adjustable and can be raised and lowered to any desired level. The shades are made of pleated translucent material.

Gasper Outlets

Individual gasper outlets (air outlets) are located in the cabin overhead convenience panels. The outlets are adjacent to the lights and can be turned to approximately 40° around their centers to direct airflow as desired. Counterclockwise rotation opens the outlet, and clockwise rotation closes it.

Remote Cabin Temperature Controls

A remote cabin temperature control is incorporated into the master control unit in the cabin (Fig. 3). Cabin temperature adjustments can be made by pressing the MENU button on the master control unit until the symbol C .:: H is displayed in the display window. Temperature can then be adjusted by pressing the SELECT ▲ or SELECT ▼ button as desired. The segment .:: increases or decreases reflecting the corresponding adjustment.

The remote cabin temperature control can only adjust the temperature ±4.5°F of the current setting on the copilot cabin temperature control.

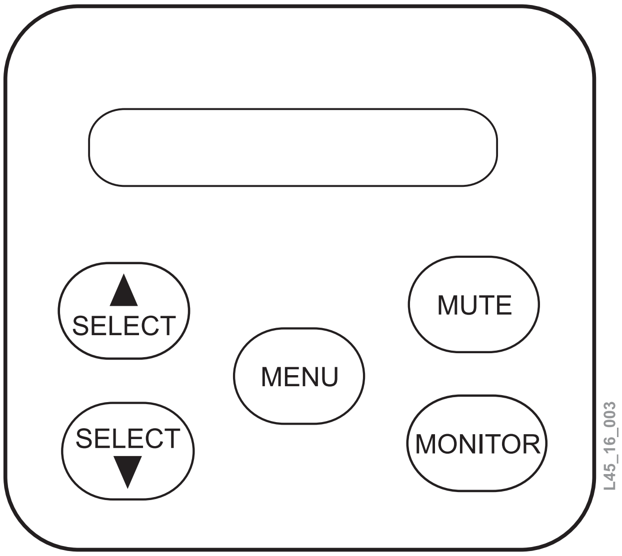

Figure 3 - Master Control Unit

Audio System

The optional audio system consists of:

- CD player (10-disc)
- Cassette player
- Audio amplifier
- Four cabin speakers
- Subwoofer speaker
- Master control unit for cabin speaker control

The audio system also includes a passenger distribution system located in the outboard armrests with headphone jacks, output controls, and an audio headphone set at each passenger seat location. Selections are made through the passenger control unit (Fig. 4).

Audio output can be directed to the cabin speakers or to individual headphone audio jacks.

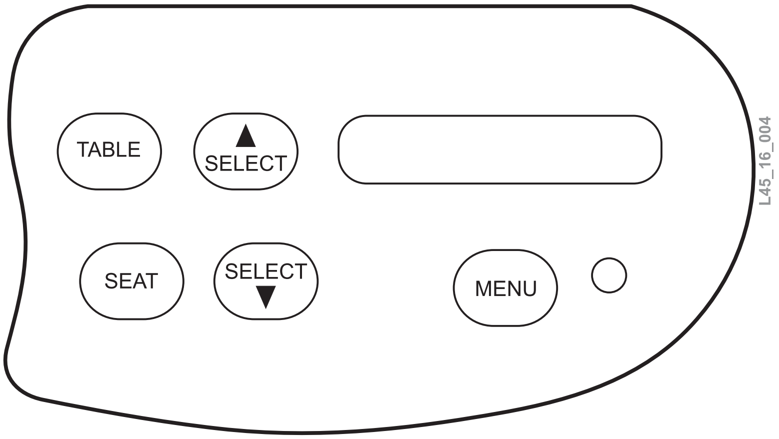

Figure 4 - Passenger Control Unit

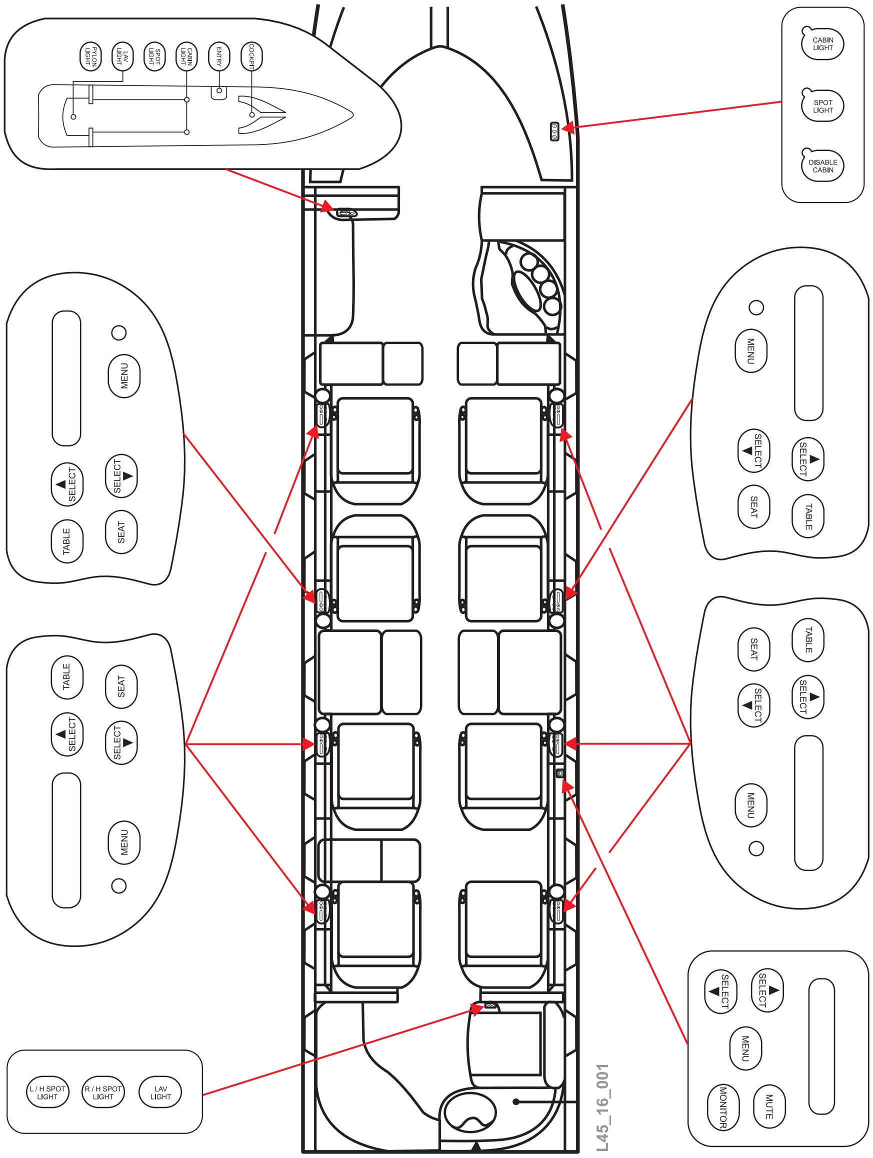

Figure 5 - Typical Learjet 45 Cabin Audio and Lighting Panels

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NAVIGATION

Introduction

This chapter describes the components and operation of the navigation systems of the Learjet 40/45 aircraft. The systems calculate and display the attitude, altitude, and position of the aircraft, based on data from other aircraft systems, ground stations, and sensed environmental conditions around the aircraft. The displayed information includes aircraft movement, distance, speed, and direction of travel around all three axes. The present position and computed future positions can also be displayed.

The navigation system consists of the following systems:

- VHF navigation system
- ADF system
- DME system
- ATC transponder
- Traffic alert and collision avoidance system (TCAS)
- Enhanced ground proximity warning system (EGPWS)
- Weather radar
- Flight management system (FMS)

VHF Navigation System

Description

There are two VHF NAV systems on the aircraft. The navigation receiver provides guidance information for en route/terminal navigation (VOR), approach and landing (LOC/GS), and distance-to-runway (MKR). It is controlled from the pilot and copilot radio management units (RMUs).

The VOR and LOC/GS data are displayed on the pilot primary flight display (PFD) and the copilot PFD and RMU as backup navigation display. The marker beacon information is displayed on the pilot and copilot PFD. The VHF NAV system also supplies VOR/LOC and marker beacon station identification to the audio integrating system.

Operation

VHF NAV Receiver

The navigation receiver unit houses four major components:

- VOR/LOC receiver
- Glideslope receiver
- Marker beacon receiver
- Power supply/processors

The navigation receiver module is a conventional VOR/ILS receiver. It operates within a frequency range of 108.00 to 117.95 MHz. The glideslope receiver operates between 329.15 and 335.00 MHz.

Included in the navigation receiver module is the single-channel MKR receiver, which operates at a fixed frequency of 75 MHz and has a HI/LO sensitivity control. This marker receiver provides audio and marker light information for cockpit annunciators.

VOR Operation

In VOR operation, the receivers monitor and process the VOR signals to determine the deviation from the selected VOR course. The receivers supply VOR bearing and validity data to the PFDs and RMUs, through the integrated computer (IC). A VOR station identification audio signal is also supplied to the audio control unit for the flight compartment speakers and/or the pilot and copilot headsets.

ILS Operation

In ILS operation, the VHF/NAV receivers supply final approach guidance data. The receivers monitor the localizer/glideslope signals from the selected localizer and glideslope stations. When the navigation receiver is tuned to a localizer frequency, a glideslope frequency is automatically paired-tuned.

The localizer signals provide lateral deviation and validity status. The glideslope signals provide vertical deviation and validity status. The localizer and glideslope deviation outputs are supplied to the pilot and copilot PFDs and RMUs. The glideslope deviation and validity data from VHF/NAV are also sent to the EGPWS. A localizer identification audio signal is supplied to the audio control unit for the flight compartment speakers and/or the pilot and copilot headsets.

Marker Beacon Operation

In marker beacon operation, the VHF/NAV receivers supply a visual and aural indication of aircraft proximity to the runway threshold. Visual marker indication is displayed on the PFDs and RMUs. The marker audio signals are supplied to the audio integrating system. The marker receiver monitors the outer (blue O), the middle (amber M), and the airway markers (white I).

Radio Management Unit

Each radio management unit (RMU) provides onside and cross-side control of all radios. The RMU (Fig. 1) displays radio frequencies and operating parameters in page formats.

The default radio tuning page of the RMU contains six dedicated windows: COM, NAV, ATC, TCAS, ADF, and one unused window. Pressing the PGE button opens several other pages of data (i.e., radio maintenance log, power on/off control, and software versions).

The VHF NAV memory page has 12 memory locations associated with the NAV window. Each memory location is numbered and appears on one of the two memory pages. Each page stores up to six frequencies. Push the line select key next to a memory location to tune that location. Push the memory load key to load the active channel with the memory channel. The VHF NAV receiver is tuned by the radio tuning units located on the instrument panel. VHF NAV receiver No. 1 is also tuned from the clearance delivery head located on the pedestal.

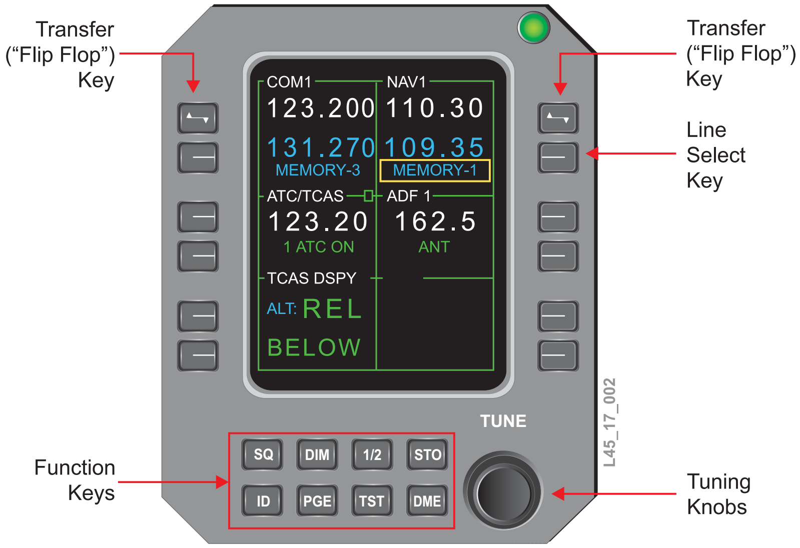


Figure 1 - Radio Management Unit

The RMU can also be used as backup navigation display by pushing the line select key next to NAVIGATION on the RMU page menu (Fig. 2). Refer to the Communication System chapter for detailed operation of the RMU and the clearance delivery heads.

Figure 2 - RMU Page Menu

Bearing Source Selection

Two different bearing sources can be set for display at a time. They are identified as VOR 1 and VOR 2. The bearing source selection is done through the EFIS display controller (Fig. 3).

Figure 3 - EFIS Display Controller

Marker Beacon Switches

The marker beacon MUTE and LO/HI sensitivity switchknob is located on the bottom row of the audio control unit (Fig. 4). Pushing the switch activates the marker mute function, and rotating the switch adjusts the marker high/low sensitivity.

The switch on the pilot audio control unit is for VHF NAV receiver No. 1, and the switch on the copilot audio control unit is for VHF NAV receiver No. 2.

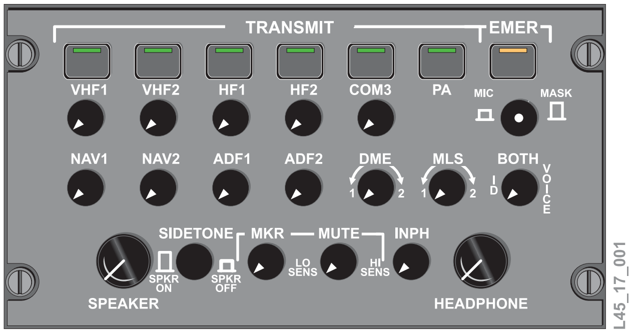


Figure 4 - Marker MUTE and LO/HI Sensitivity Switchknob

Operational Tests

Power-On Self-Test

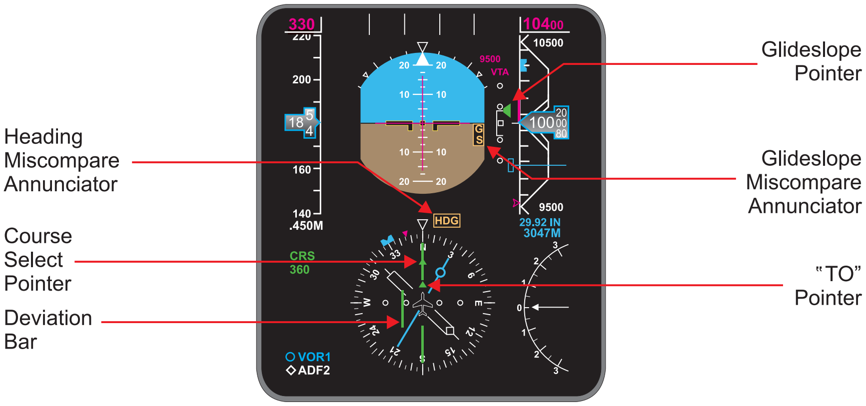
On the ground, the RMU initiates a NAV system power-on self-test (POST) when power is first applied. At other times, the POST initiates with weight on wheels when power has been off for more than 10 seconds.

During POST, the following test displays (Fig. 5) are provided on the horizontal situation indicator (HSI) on both PFDs in the order shown:

- OM (blue)—400-Hz tone
- MM (amber)—1300-Hz tone
- IM (white)—3000-Hz tone
- Localizer and glideslope deviation bars center for approximately 2 seconds with flags out of view
- Localizer and glideslope deviation bars deflect one dot left and up respectively, for approximately two seconds with flags out of view
- VOR deviation bar centers and the TO/FROM annunciator indicates TO
- DME test appears; 10.0 nm, and 120 kt
- ADF pointer slews to 135 ±10° relative to aircraft heading
- Audio identification tone is heard through the audio system

The first page to appear on the RMU is POST in progress. POST lasts 45 seconds.

RMU POST In Progress L45_17_007 RMU POST Result Page



PFD - POST In Progress

Figure 5 - Power-On Self-Test

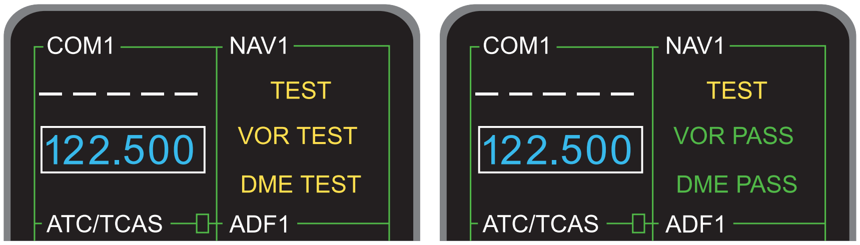
Pilot-Activated Self-Test

The system also includes a pilot-activated self-test (PAST), which is activated by pushing a line select key to place the yellow cursor in the window for the module to be tested, and then pushing and holding the TST button on the RMU.

The status and result of the testing are displayed in the radio window from which the particular functions are being tested. All the radio windows, with the exception of the TCAS and ATC windows, display in a similar format. For example, performing a PAST on the NAV functions, the window appears as in “PAST In Progress” in Fig. 6.

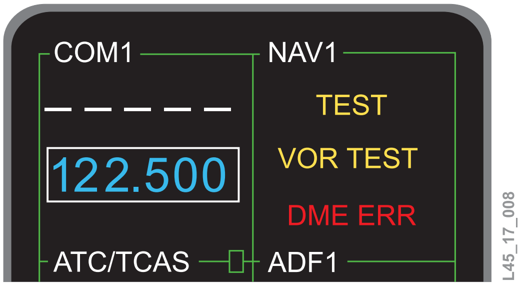
Upon successful completion of the test, the window changes as in “PAST Passing” in Fig. 6.

If a failure were to be detected with the PAST, the window could appear as in Figure “PAST Function Failure” in Fig. 6, depending on the function failure.



RMU - PAST in Progress

PAST Passing



PAST Function Failure

Figure 6 - Pilot-Activated Self-Test

System Fault Indications

Fault indications are presented on the RMU and the PFD (Fig. 7).

PFD Indications

Loss of valid vertical deviation from the NAV receiver causes the following:

- Removal of the vertical deviation pointer
- Red Xed scale
- Inhibit of the GS/GP miscompare annunciation

Loss of valid lateral deviation from the NAV receiver causes the following:

- Removal of the HSI lateral deviation pointer
- Red Xed HSI lateral scale
- Inhibit of the LOC miscompare annunciation
- Removal of the previewed course arrow/deviation bar

Loss of valid distance information from the DME module causes the following:

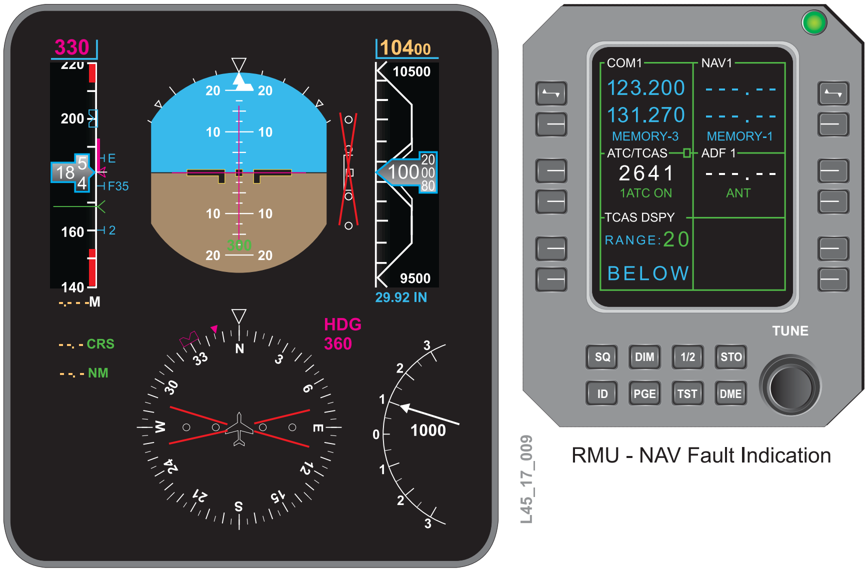
- Removal of the Morse identifier
- Amber dashes of the distance digital readout

Loss of valid bearing information from the NAV receiver module causes the following:

- Removal of the HSI lateral deviation pointer
- Red Xed HSI lateral scale
- Removal of the TO/FROM display
- Removal of the absolute bearing pointer

RMU Indications

Any failure of a module causes the RMU to remove the frequencies or commands associated with that particular function and to replace them with dashes.



PFD - NAV Fault Indication

RMU - NAV Fault Indication

Figure 7 - System Fault Indications

Backup Navigation Display

The backup navigation page can be selected by the flight crew. Pushing the PAGE button brings up the PAGE MENU display, and then pushing the line select key next to NAVIGATION shows the navigation page. VOR, ILS, ADF, and DME data is shown on this page. The information is available to the RMUs. A typical NAVIGATION page is shown in Fig. 8. For a detailed description, refer to See “RMU Backup Navigation Display” on page 56.

Standby navigation display failure (Fig. 9) indications show course glideslope deviations when the deviation bar or pointer is removed and replaced with a red X. The standby indications also give a digital display of DME distance, NAV or ADF frequency digital bearing failures by replacing data with amber dashes.

Standby indications of heading failures are shown with the following:

- Red HDG FAIL is placed in the center of the arc display
- Course pointer and its digital readout are removed
- All bearing pointer information is removed

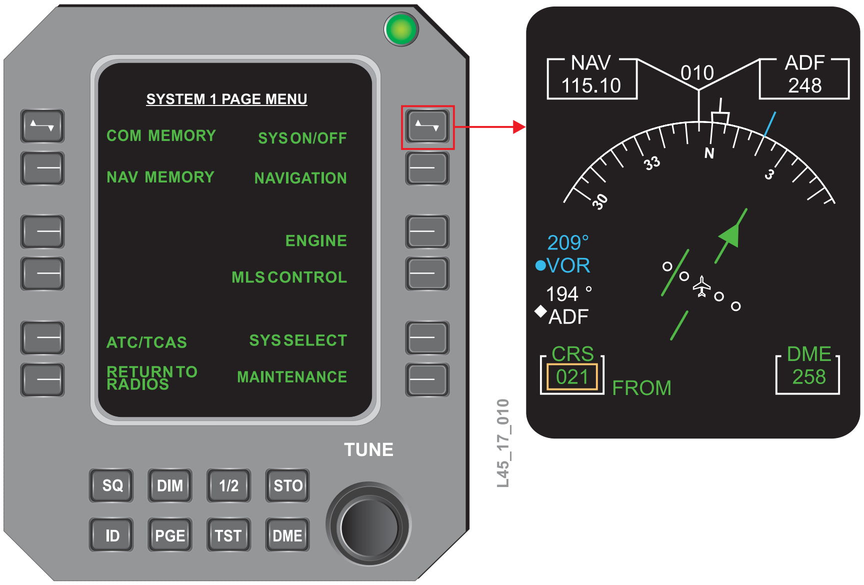


Figure 8 - Nav Backup Display

Figure 9 - Standby Navigation Display Failure Indications

Automatic Direction Finder System

Description

The automatic direction finder (ADF) system is a single (dual optional) low-frequency radio system. The ADF system indicates the bearing to a selected ground station. The ADF system supplies station identification and aural signals to the audio integrating system. The transmitting stations can be nondirectional beacons (NDBs) or standard broadcasting stations in the frequency range of 190.0 to 1799.5 KHz. The bearing-to-station data is shown on the pilot PFD, copilot PFD, and backup navigation display (RMU).

Operation

Radio Management Unit

The ADF system is controlled by the RMU ADF window.

ADF Frequency Line Select Key

This key sets ADF frequencies. When this line key is pushed, the cursor boxes the frequency annunciation. With the cursor around the frequency, the TUNE knobs change the frequency, clockwise to increase frequency and counterclockwise to decrease frequency. When the key is pressed and held for three seconds, the ADF frequency memory is recalled.

ADF Mode Line Select Key

This key selects ADF modes of operation. When this line key is pushed, the cursor boxes the mode annunciation. ADF operations are selected by turning the TUNE knob or pushing the line select key repeatedly.

- ANT mode—In the ANT mode, the ADF receiver operates as an AM radio receiver. The receiver sensitivity is higher in this mode because the loop circuits in the antenna are disabled. An audio output is supplied to the audio integrating system but no bearing-to-station is displayed.
- ADF mode—In the ADF mode, the ADF receiver shows bearing-to-station output on the pilot and copilot PFDs and back-up navigation displays. An audio tone output is also supplied to the audio integrating system.
- BFO function—When the beat frequency oscillation (BFO) function is switched on, the ADF receiver supplies a 1000-Hz tone output to the audio integrating system when a continuous wave (cw) signal is received.
- Voice mode—In this mode, the ADF has maximum audio clarity and fidelity but no bearing.

STO (Store) Function Key

With the cursor around the frequency readout, pushing the STO function key stores that frequency. Each RMU has one ADF frequency storage location.

1/2 Function Key

In single ADF systems, the 1/2 function key toggles between the onside and offside colors, but has no other effect on the ADF window. In dual ADF systems, the 1/2 function key toggles between ADF No. 1 and ADF No. 2.

TUNE Knobs

The TUNE knobs tune the ADF frequency when the cursor is around the frequency readout. The large knob controls the first digits of the frequency, and the smaller knob controls the last digits of the frequency. Turning the knob slowly changes the frequency by one step. Multiple step changes can be made by turning the knob rapidly.

TST (Test) Function Key

When the cursor is positioned anywhere in the ADF window, pushing and holding the TST key initiates the ADF PAST. The RMU returns to normal operation when the TST key is released or after 30 seconds.

Bearing Source Selection

Two different bearing sources can be set for display at a time. They are identified as ADF 1 and ADF 2. The bearing source is selected through the EFIS display controller (Fig. 10).

The ADF bearing information is displayed on PFDs and backup navigation display. For a detailed description, refer to See “Control and Indications” on page 51.

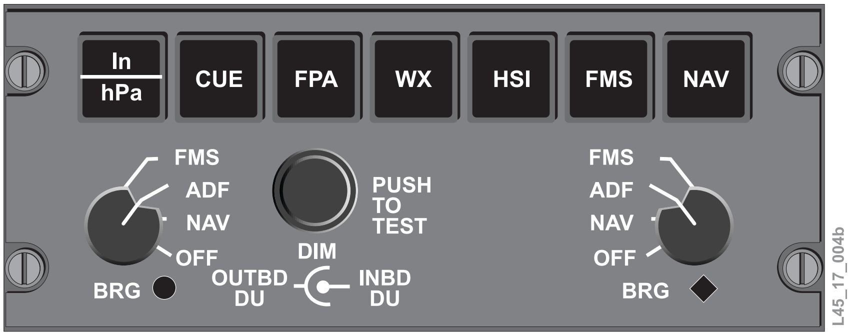


Figure 10 - EFIS Display Controller

Operational Test

Position the cursor in the ADF receiver window on the radio management unit (RMU). Select ADF 1.

Press and hold the TST button on the RMU. The word TEST appears in the ADF window.

For a detailed description, refer to See “Operational Tests” on page 4.

System Fault Indication

For a detailed description, refer to See “System Fault Indications” on page 6.

Backup Navigation Display

For a detailed description, refer to See “Backup Navigation Display” on page 8.

Distance Measuring Equipment System

Description

The distance measuring equipment (DME) is a dual system installation. This system computes and decodes the following information:

- Slant distance to the DME ground station
- Relative closure rate
- Time to station
- Station identifier

The DME information is displayed on the pilot PFD, copilot PFD, and the backup navigation display (RMU).

Operation

The DME transceiver operates in the frequency range of 962 to 1213 MHz. There are 200 DME frequency channels paired with the VHF navigation frequency channels. The DME module has the capability of automatic frequency tuning based on paired VHF NAV frequencies.

Frequency Selection

The DME frequency channels are paired with the VHF navigation channels (VOR/LOC). The frequency is selected with the pilot or copilot RMUs in the frequency range of 108.000 to 117.950 MHz.

DME Hold Function

The DME hold (Fig. 11) function splits the paired tuning between DME and VHF navigation systems to enable independent operation. The DME hold function holds the DME transceiver to the current VHF navigation frequency and permits the VHF navigation receiver to be independently tuned. The DME frequency can also be tuned independently while the VHF navigation receiver is kept at the current frequency.

This function is selected when the DME pushbutton on the RMU is pressed. The paired VHF navigation frequency display is activated. If the DME HLD pushbutton is pushed again, the DME hold function is canceled. The paired VHF navigation frequency display is also removed.

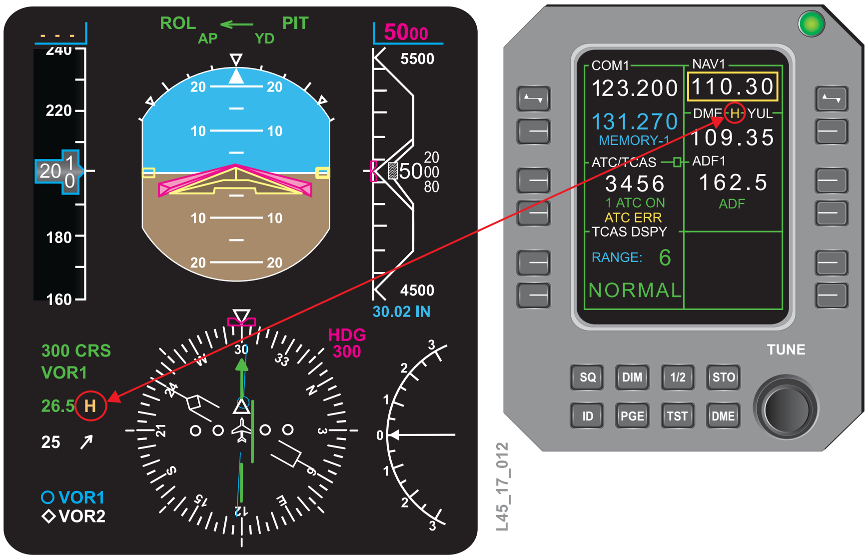


Figure 11 - DME Hold

Station Identification

If a station identifier signal is received, the resulting audio signal is supplied to the audio control unit for selection to the flight compartment speakers or the pilot and copilot headsets.

The distance indication is calculated by the DME transceiver and displays on the pilot and copilot PFDs and RMUs through the integrated computer (IC). The distance display is shown in a four-digit field followed by NM. When a no-computed data condition occurs, the distance indication is replaced with dashes.

Operational Tests

For a detailed description, refer to See “Operational Tests” on page 4.

System Fault Indication

For a detailed description, refer to See “System Fault Indications” on page 6.

Backup Navigation Display

For a detailed description, refer to See “Backup Navigation Display” on page 8.

ATC Transponder System

Description

The Mode S (mode select) transponder system is a dual system used for air traffic control (ATC). The transponder system supplies the ATC radar beacon system (ATCRBS) ground stations, or in traffic alert and collision avoidance system (TCAS) -equipped aircraft, with aircraft identification and altitude data in response to an interrogation. Only one transponder can operate at a time. The Mode S transponder has data link capability that permits the TCAS-equipped aircraft to handle air traffic control and aircraft separation assurance functions. The Mode S transponder responds and replies to interrogations in Mode A, Mode C, and Mode S.

Operation

Modes of Operation

Standby Mode

In the standby mode, the Mode S transponder can receive interrogation signals but cannot send replies.

Mode A

In Mode A, the Mode S transponder receives interrogation signals from a ground station. The transponder then sends a reply that includes the ATC identification code.

Mode C

Mode C is the altitude reporting mode which interrogates the aircraft uncorrected altitude. If the transponder is interrogated in Mode C, it sends a reply that contains the encoded pressure altitude. The air data computers (ADC) supply the altitude information transponder.

Mode S

In Mode S, the transponder capabilities are increased. The Mode S capabilities allow the ground controller, or a TCAS-equipped aircraft, to send interrogations to the aircraft of immediate interest. The aircraft address code is provided at installation by the local regulatory agency. The aircraft unique address code (squitter) is transmitted continuously at one-second intervals. When an aircraft receives a Mode S interrogation, it sends replies in a Mode S format, which includes the aircraft address. Transponders used with TCAS have two antennas which allow transmission and receipt of interrogations above and below the aircraft without the signal being masked by the airframe.

Radio Management Unit— ATC Controls

Detailed operation of the RMU function keys are described in the Communication System chapter. This section covers ATC transponder functionality only.

ATC Code Select

The line select key opposite the ATC legend places the cursor over the transponder code to be changed (Fig. 12). The large outer tuning knob controls the left two digits; the smaller inner knob controls the two right digits.

The transponder system responds to all valid ATC radar interrogation with a coded identification and/or reporting altitude reply. The transponder response code is normally selected on the onside RMU. If required, the offside RMU can control the response code.

Since only one transponder can operate at a time, both RMUs in a dual installation display the same transponder information. Therefore, if a code or mode is changed on one RMU, the other RMU tracks it. Since the other RMU is being tuned by a remote source, the changed data appears in yellow.

One transponder code may be stored in memory by pressing the STO button while the cursor is on the transponder code. To retrieve the code from the memory, press and hold the line select key for three seconds.

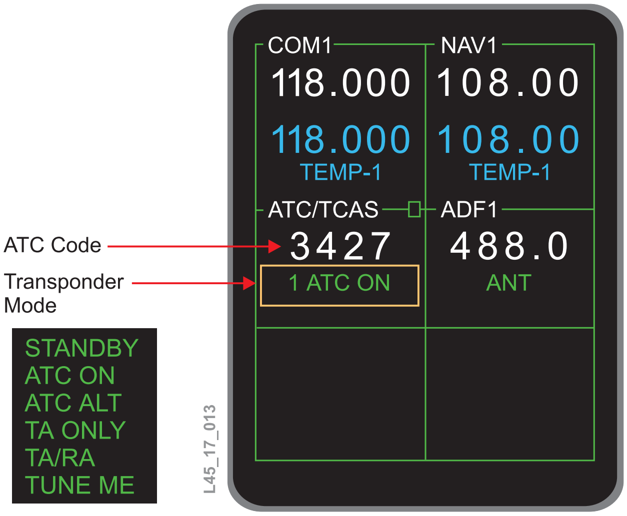


Figure 12 - ATC Code and Mode Select

ATC Mode Select

The line select key associated with the transponder mode also changes between standby, transponder 1 ON, and transponder 2 ON.

Pressing the line select key associated with the transponder mode places the cursor around the mode annunciator which then enables the tuning knobs to be used for mode selection. Either knob may select a mode. The modes are shown in Table 1.

Table 1 - ATC Modes

Mode	Definition
STANDBY	Receives interrogation signal but cannot reply
ATC ON	Replies on Modes S and A, no altitude reporting
ATC ALT	Replies on Modes A, C, and S, with altitude reporting
TA ONLY	Replies on Modes A, C, and S, with altitude reporting, and TCAS traffic advisory mode (TA) selected
TA/RA	Replies on Modes A, C, and S, with altitude reporting, and TCAS traffic advisory mode (TA) and resolution advisory mode (RA) selected
TUNE ME	Transponder operating mode is invalid (pilot must attempt to tune a mode using the TUNE knobs)

RMU - ATC/TCAS Control Page Menu

Pressing the PGE button provides access to the page menu. This menu allows access to the TCAS operational selections by using the ATC/TCAS select button.

ATC IDENT

Four IDENT buttons, one on each RMU and control wheel, initiate an IDENT pulse from the transponders when requested.

Pressing the ID button places the transponder into IDENT mode, and an ID annunciator appears in the transponder window indicating that the transponder is in the identification mode.

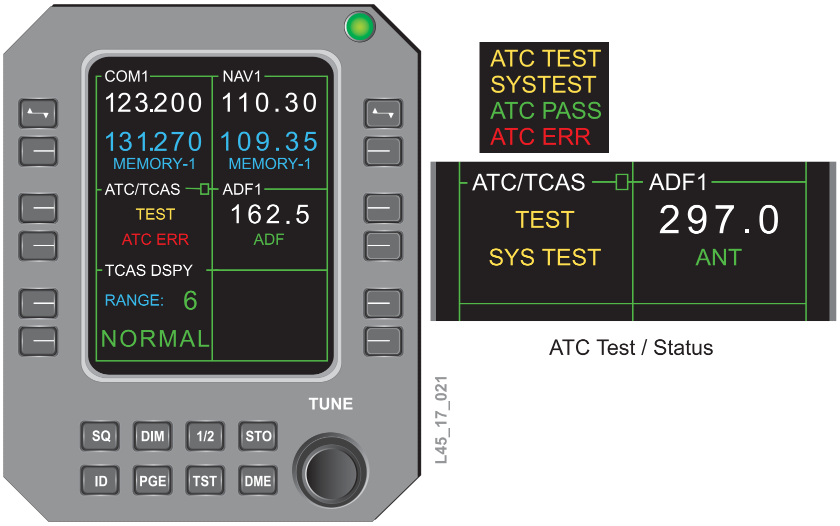
Self-Test

To perform a transponder test:

- Position the cursor in the ATC transponder window on the RMU. Select transponder 1
- Press and hold the TST button on the RMU (amber TEST appears in the ATC window) (Fig. 13)
- Upon completion of the test, the words ATC PASS in green, or ATC ERROR in red appears in the ATC window
- When TCAS is installed, SYS TEST is displayed, indicating both TCAS and transponder are testing
- TCAS itself can also be tested with the cursor in the TCAS display window (in addition, the TCAS aural warning annunciates TCAS TEST, TCAS PASS, or TCAS FAIL separately)

NOTE

It is possible to hold the TST button long enough (8 seconds), to force TCAS and the TCAS traffic display into the maintenance mode. Normal operation can be re-established by entering a transponder code.



ATC Test / Status

ATC Test Window

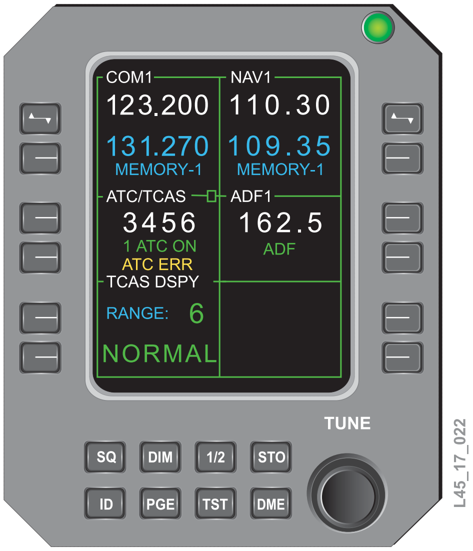
Figure 13 - ATC Test Status Window

System Fault Indications

If the squitter (aircraft unique address transmitted continuously at one-second intervals) function fails in flight, an ATC ERR message displays in yellow at the bottom of the ATC window. This message indicates that the selected TCAS-compatible Mode S transponder has degraded ability to operate as part of a collision avoidance system.

If the yellow ATC ERR message is present, perform PAST on the ATC. If the test fails (ATC ERR in red in ATC window), the transponder is not transmitting properly (Fig. 14). Select the other side transponder.

If the transponder passes PAST, only the squitter function is inoperative. This slightly reduces the TCAS reply time. It is preferable to use the other side transponder.



RMU - ATC Failure Indication

Figure 14 - ATC Failure Indication

Traffic Alert and Collision Avoidance System

Description

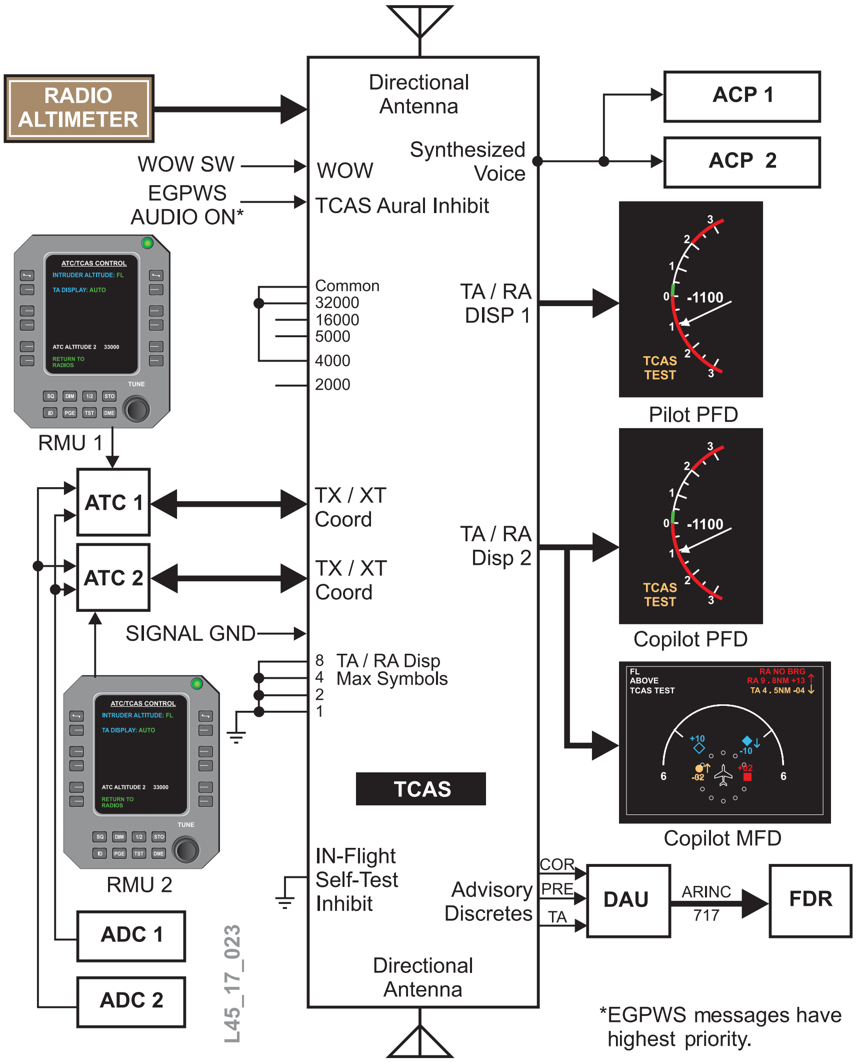
The TCAS 2000 or CAS 67A system provides the crew with aural and visual indications of potentially dangerous flightpaths relative to other aircraft in the vicinity. The system uses the transponder to interrogate other transponder-equipped aircraft and determine bearing, range, and altitude (if the intruder has an altitude encoding transponder in operation). With this information, the TCAS processor can generate traffic advisories (TA) and resolution advisories (RA) to prevent or correct traffic conflicts.

The TCAS 2000 system (Fig. 15) consists of a processor, two bearing antennas, configuration module, and associated aircraft wiring. The system is controlled through the RMUs. Power for system operation (28 VDC) is supplied through the 5-amp TCAS circuit breaker (copilot INSTRUMENTS/INDICATIONS group).

Advisories are issued to the crew via the aircraft audio system, the MFD (TCAS zoom window), and the pilot and copilot PFD (vertical speed display). Aural warnings generated by the ground proximity/windshear warning system (if installed) has priority over aural warnings generated by the TCAS 2000 and all CWP aural alerts.

NOTE

The audio volume for the TCAS aural advisories is constant and does not increase or decrease with changing ambient audio levels like the CWP aural alerts.



*EGPWS messages have highest priority.

Figure 15 - TCAS Block Diagram

Operation

The TCAS 2000 system is active whenever DC power is available to the receiver/transmitter/processor and TA ONLY or TA/RA mode is selected on the RMU.

Refer to the Honeywell TCAS 2000 Traffic Alert and Collision Avoidance System Pilot's Manual or AlliedSignal (CAS 67A) Pilot's Guide for a detailed description and operation of the corresponding system. Additional TCAS system controls and operation are included in the Honeywell PRIMUS 1000 Integrated Avionics System for the Learjet Model 45 Pilot's Manual (Pub. No. A28-4446-106-00). The following summarizes system operation highlights:

- TA/RA mode is the normal mode of the TCAS 2000 system
- TCAS 2000 operational status is provided by annunciations on the PFDs, the MFD, and in the ATC/TCAS window within the RMUs. Normal TCAS 2000 operational status is indicated by no TCAS annunciations being present on the PFDs, TCAS annunciated on the MFD (TCAS zoom window selected), and 1 (or 2)* TA/RA being displayed in the ATC/TCAS window within the RMUs.
  (* number identifies the active transponder)
- A white TCAS OFF annunciation (on the MFD and both PFDs) indicates the system is in standby mode
- With TA/RA mode selected on the RMU and the aircraft below 900 ft during descent or below 1100 ft during climb, the TCAS II system enters and displays TA ONLY mode
- "Traffic, Traffic" aural warning is inhibited below 1100 ft AGL radio altitude during climb, and below 900 ft AGL radio altitude during a descent. For CAS 67A system "Traffic, Traffic" aural warning is inhibited:
  - Change 6.04a - Below 1100 ft AGL radio altitude during climb, and below 900 ft AGL radio altitude during a descent
  - Change 7 - Below 600 ft AGL radio altitude during climb, and below 400 ft AGL radio altitude during a descent
- TCAS display range is selected in the TCAS DSPY window within the RMUs
- Selecting the flight level mode (using the ATC/TCAS CONTROL PAGE on the RMU) displays the absolute altitude of any intruder that may be displayed on the MFD. FL annunciates in the upper left corner of the TCAS zoom window. After approximately 15 seconds, the displayed altitude of any intruder reverts to a relative altitude

- TCAS 2000 altitude band (NORMAL, ABOVE, BELOW) is selected in the TCAS DSPY window within the RMUs
  - NORMAL display limit is 2700 ft above and 2700 ft below
    - NORMAL is usually selected during level flight
  - ABOVE display limit is 7000 ft above and 2700 ft below, and ABV annunciates on the MFD
  - BELOW display limit is 2700 ft above and 7000 ft below, and BLW annunciates on the MFD. No auto range capability is available
    - ABOVE or BELOW is usually selected during high-rate climbs or descents
- TCAS traffic map (zoom window) can be displayed on the MFD automatically or manually. Use the TA DISPLAY function (ATC/TCAS CONTROL PAGE on the RMU) to select AUTO or MANUAL mode. When AUTO mode is selected, the zoom window pops up when a TA or RA is generated. The zoom window cannot be removed until the conflict has passed and no RAs, TAs, or proximity traffic are displayed. When MANUAL mode is selected, the TCAS bezel button (on the MFD) becomes available when a TA or RA is generated. Depressing the TCAS bezel button displays the zoom window. Pressing the TCAS bezel button again removes the zoom window from the display.

Traffic Identification

Resolution Advisory

TCAS monitors a time-based warning area that extends 15 to 35 seconds from the time the intruder is predicted to enter the TCAS aircraft collision area. When an intruder enters this area, an escape strategy in the form of an RA is issued by the TCAS unit.

The RA is a vertical maneuver recommended to the pilot by TCAS to increase or maintain vertical separation relative to an intruding aircraft. The RA is annunciated both visually and aurally. It consists of either a CORRECTIVE ADVISORY calling for a change in aircraft vertical speed, or a PREVENTIVE ADVISORY restricting vertical speed change.

The intruder amber circle TA symbol on the MFD changes to a red square RA symbol (Fig. 16).

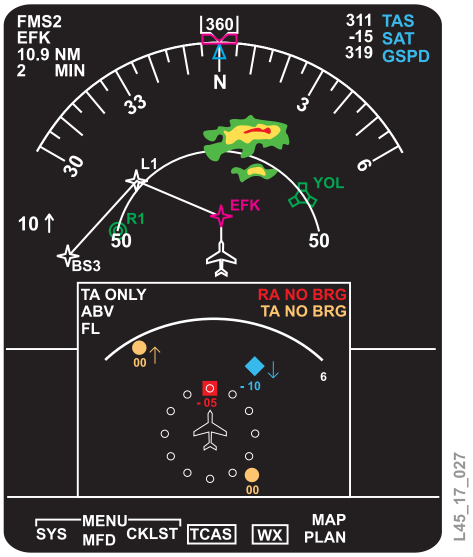


Figure 16 - MFD TCAS Traffic Display

Traffic Advisory

TCAS monitors a time-based caution area that extends 20 to 48 seconds from the time the intruder is predicted to enter the TCAS aircraft collision area. When an intruder enters this caution area, traffic information in the form of a TA is issued by TCAS. This information should be used as an aid to visually locate the intruder and avoid a conflict.

The intruder is represented as an amber circle TA symbol on the MFD. The traffic displayed includes the range, bearing and altitude (if available) of the intruder relative to the TCAS aircraft.

Proximate Traffic

Aircraft within display range and within the selected vertical window are represented as a solid cyan diamond. Proximate traffic (PT) is shown to improve situational awareness during a potential conflict with higher priority RA or TA aircraft.

Other Traffic

Any transponder-replying traffic that is not classified as an intruder or proximate traffic:

- Within the display range
- Within the selected vertical window
- Represented as hollow cyan diamond (only in view when no RA or TA is in progress)

The predicted flightpaths of PT and other traffic (OT) do not penetrate the collision area of the aircraft.

TCAS
Aural Messages

Table 2 - TCAS Aural Messages

Advisory	Aural Alert	Description
Traffic	"Traffic, Traffic" spoken once	Intruder entering collision area within 20 to 48 seconds (simultaneously, the TCAS traffic display displays the location of the intruder)
Preventive resolution	"Monitor Vertical Speed, Monitor Vertical Speed"	
Corrective resolution	"Climb, Climb, Climb" "Descend, Descend, Descend" "Reduce Climb, Reduce Climb" "Reduce Descent, Reduce Descent" "Climb, Crossing Climb - Climb, Crossing Climb" "Descend, Crossing Descend - Descend, Crossing Descend"	
Clear of conflict	"Clear of Conflict" single announcement	Encounter has ended, and separation is increasing
Increased strength or reversed corrective advisory	"Increase Climb, Increase Climb" "Increase Descent, Increase Descent" "Climb, Climb, Now! - Climb, Climb, Now!" "Descend, Descend, Now! - Descend, Descend, Now!"	Previously announced advisory must be increased or reversed
TCAS Test Fail	"TCAS Test Fail"	A failure has been detected during the self-test sequence

NOTE

The increased strength or reversed corrective advisory aural alerts are expected to occur only on rare occasions, usually when an intruder suddenly changes its flightpath.

These aural warning are given with significantly increased emphasis.

Self Test

Self test is initiated as follows:

- Select the TCAS traffic display format on the MFD
- Place cursor in the TCAS DSPY window within the RMU
- Depress the TST button on the RMU for at least 2 seconds to initiate test

NOTE

The automatic TCAS self-test function in flight inhibits normal TCAS operation for up to 15 seconds. For this reason, the crew should use caution when initializing the test in flight.

The MFD displays the following:

- TCAS TEST displays in the upper left corner of the TCAS zoom window
- A resolution advisory (solid red square) appears at 3 o'clock, range of 2 mi, 200 ft above the flying level
- A traffic advisory (solid yellow circle) appears at 9 o'clock, range of 2 mi, 200 ft below and climbing
- Proximity traffic (solid cyan diamond) appears at 1 o'clock, range of 3.6 mi, 1000 ft below and descending
- Non-threat traffic (open cyan diamond) appears at 11 o'clock, range of 3.6 mi, flying level 1000 ft above

Both PFDs and the MFD display the TCAS self-test (Fig. 17).

Upon successful completion of the self-test, "TCAS Test Pass" aural message activates on both the headphone and cockpit speakers. TCAS FAILURES displays as a header in the upper right corner of the MFD zoom window at the end of each test.

Any failures detected during self-test are listed under the TCAS FAILURES header. The "TCAS Test Fail" aural message activates through both the headphone and cockpit speakers.

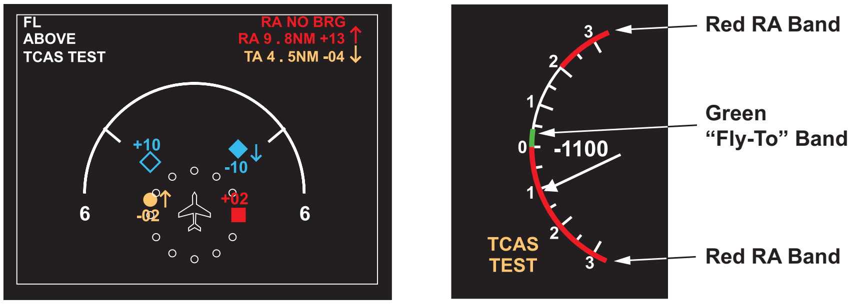


Figure 17 - TCAS Self-Test

Enhanced Ground Proximity Warning System

Description

The enhanced ground proximity warning system (EGPWS) provides the pilot with aural and visual warning of potentially dangerous flightpaths relative to the ground and windshear conditions (Fig. 18).

The system automatically and continuously monitors the airplane flightpath with respect to terrain when the aircraft is below 2450 ft radio altitude (AGL). If the projected flightpath would imminently result in terrain impact, the system issues appropriate visual and aural warnings. Warnings are issued for excessive sink rate, excessive terrain closure rate, descent after takeoff or missed approach, proximity to terrain with flaps and/or gear not in the landing configuration, and descent below glideslope.

The system computes windshear and alerts the crew to windshear of sufficient magnitude to be hazardous to the aircraft. Windshear alerts are given for increasing headwind /decreasing tailwind and/or updraft. Windshear warnings are given for decreasing headwind/increasing tailwind and/or downdraft.

The EGPWS extends the ground proximity warning capabilities by adding terrain awareness alerting and display (TAAD) and terrain clearance floor (TCF) functions.

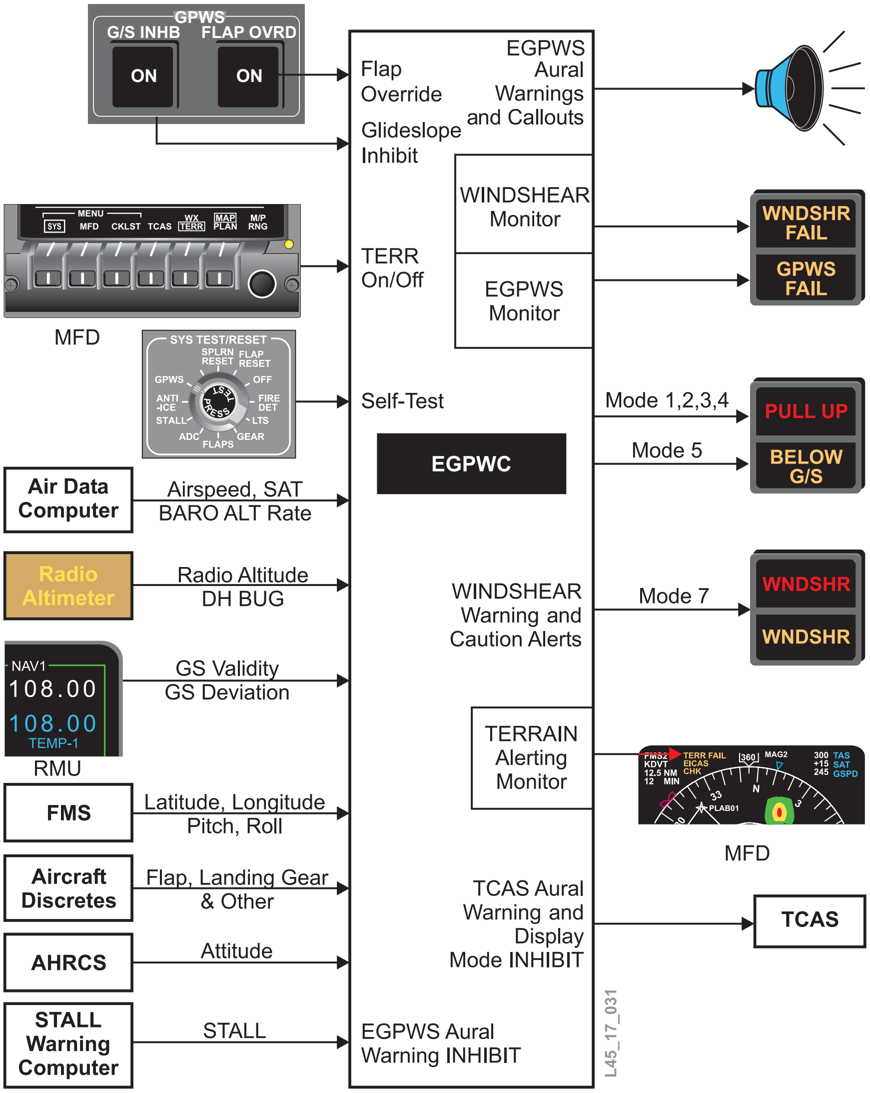


Figure 18 - EGPWS Block Diagram

Operation

The system consists of the EGPWS computer, a set of annunciator lights on the instrument panel at each crew position, and flap override, glideslope inhibit, and terrain pop-up switches. Aural warnings are made through the cockpit speakers and the headphones at a fixed volume. Aural warnings generated by the EGPWS have priority over aural warnings generated by the TCAS (if installed) and all CWP aural alerts.

NOTE

The audio volume for the GPWS/WS aural advisories is constant and does not increase or decrease with changing ambient audio levels as the CWP aural alerts.

The system operates on 28 VDC supplied through the 3-amp GPWS circuit breaker on the copilot circuit breaker panel.

The EGPWS system is active when DC power is on the aircraft, the AV MSTR switches are on, and the GPWS FAIL and WNDSHR FAIL annunciators are not illuminated. The system requires the following inputs: both ADCs, both AHRSs, both VHF NAV receivers, flap position, landing gear position down-and-locked signals, radio altimeter, and stall warning vane position. System output is dependent on the audio system and warning lights.

The EGPWS provides aural and visual warnings of possible terrain danger in the following conditions:

- Mode 1—Excessive Sink Rate
- Mode 2—Excessive Closure on Terrain
- Mode 3—Descent after Takeoff
- Mode 4—Unsafe Terrain Clearance
- Mode 5—Below Glideslope
- Mode 6—Advisory Callouts
- Mode 7—Windshear Warnings and Cautions

Mode 1—Excessive Sink Rate

Mode 1 (Fig. 19) provides warnings for excessive descent rates with respect to radio altitude. This mode has an inner and outer warning boundary. Penetration of the outer warning boundary illuminates the PULL UP annunciators and activates the “Sink Rate” aural message. The aural message occurs at least twice and does not repeat unless penetration increases. Penetration to the inner boundary leaves the PULL UP annunciators on, but changes the aural message to “Pull Up.” The descent rate required to cause the “Sink Rate” warning to occur is automatically increased if the pilot is safely repositioning down from slightly above the glideslope centerline. Flying the aircraft out of the envelope stops the warning.

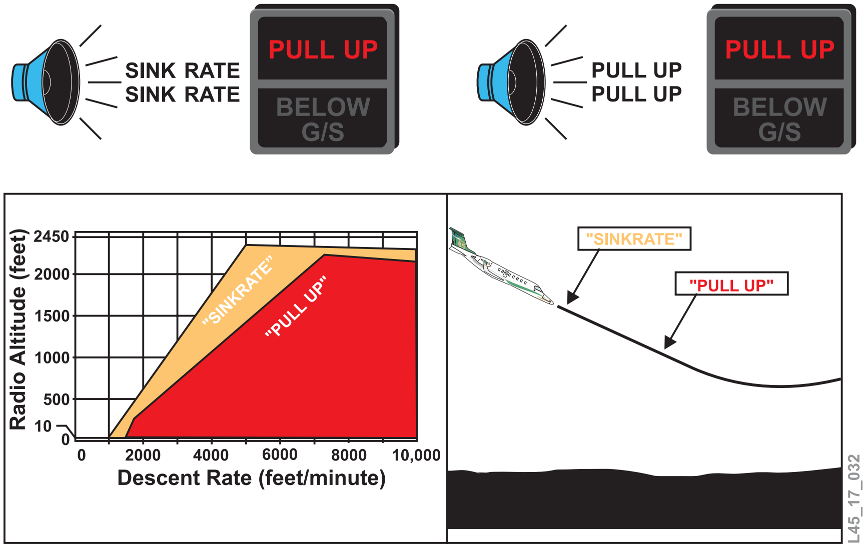


Figure 19 - Mode 1—Excessive Sink Rate

Mode 2—Excessive Closure on Terrain

NOTE

The GPWS may give little or no warning or alert for flight into steep terrain with little or no terrain preamble.

Mode 2 provides warnings for excessive closure rates to terrain with respect to radio altitude, phase of flight, and airspeed. Two types of warnings are given: 2A and 2B.

Mode 2A

Mode 2A (Fig. 20) is armed when the flaps are not in the landing configuration and the aircraft is not on the glideslope centerline. Typically, the mode is active during climbout, cruise, and initial approach. When the envelope is penetrated, the PULL UP annunciators illuminate and the “Terrain, Terrain” aural warning followed by a continuous “Pull Up” aural warning operates. If the terrain closure rate decreases and the gear is up, a continuous “Terrain, Terrain, Terrain” aural warning replaces the “Pull Up” aural warning. The PULL UP annunciators remain on until one of the following conditions are met:

- 300 ft of pressure altitude is gained
- Safe altitude above ground level is maintained for a short time
- GPWS FLAP OVRD switch is activated. Sensitivity is increased with increasing airspeed above 220 kt (up to a maximum at 310 kt)

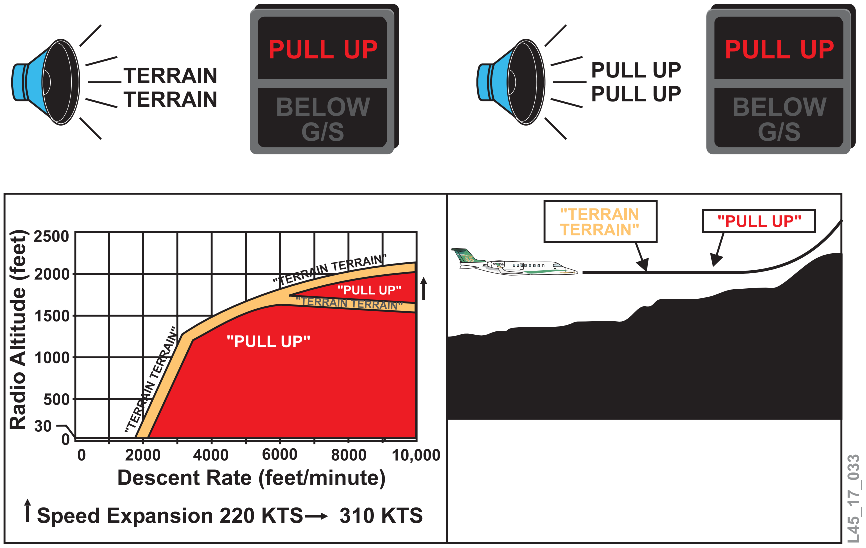


Figure 20 - Mode 2A—Excessive Terrain Closure Rate

Mode 2B

Mode 2B (Fig. 21) is selected with flaps in full landing configuration or when making an ILS approach with glideslope deviation less than ±2 dots. When the envelope is penetrated, the PULL UP annunciators illuminate and the “Terrain, Terrain” aural warning operates.

With the flaps and gear down, the “Terrain, Terrain” aural warning is followed by a repetitive “Terrain.” The lower boundary of the envelope varies with altitude rate.

With the flaps or gear up, a “Pull Up” aural warning operates when the “Terrain, Terrain” warning is complete. The lower boundary of the envelope is 30 ft above ground level.

Aural warnings stop when the envelope is exited.

NOTE

The GPWS FLAP OVRD switch can be used when operations must be conducted in close proximity to terrain. Ensure that the switch is reset as soon as normal terrain clearances are established.

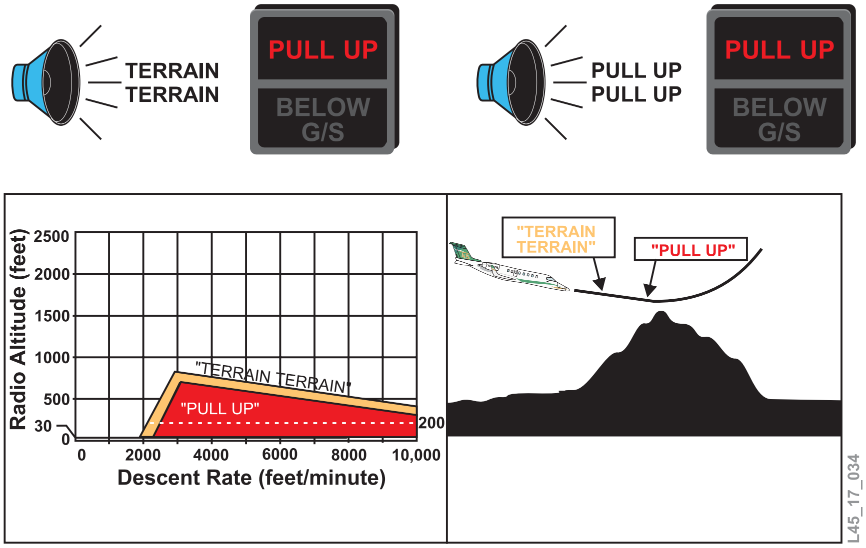


Figure 21 - Mode 2B—Excessive Terrain Closure Rate

Mode 3—Descent after Takeoff

In Mode 3 (Fig. 22), warning is given for significant altitude loss after a takeoff or go-around. This mode is active after takeoff once the aircraft reaches 30 ft radio altitude and provides warnings until the aircraft exceeds 1500 ft radio altitude. This mode is also activated if a go-around is initiated from below 245 ft radio altitude with gear and flaps in the landing configuration. Raising the gear and/or flaps signals the system that a go-around has been initiated. Once activated, this mode provides warnings based on radio altitude and barometric altitude loss as shown on the Mode 3 chart. If the altitude loss warning boundary is penetrated, the PULL UP annunciators illuminate and the “Don’t Sink” aural warning activates. The aural warning is repeated twice unless altitude loss continues to accumulate.

The altitude loss required to trigger the warning varies with radio altitude. For example: at a climbout altitude of 100 ft, an altitude loss of 15 ft causes the warning; at 700 ft, an altitude loss of 70 ft is required to cause the warning.

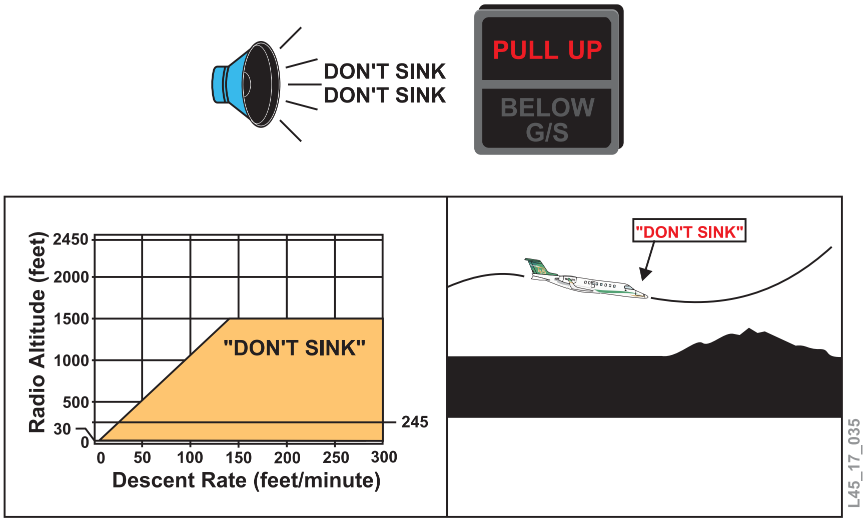


Figure 22 - Mode 3—Descent After Takeoff

Mode 4—Unsafe Terrain Clearance

Warning is given for insufficient terrain clearance with respect to aircraft configuration and airspeed. These warnings are given even with low closure rates. Three types of warnings are given under this mode.

Mode 4A

Mode 4A (too low gear warning) (Fig. 23) is active during cruise and approach with gear up. If the aircraft penetrates 500 ft radio altitude below 190 KIAS with the landing gear up, the PULL UP annunciators illuminate and the “Too Low, Gear” aural warning is given. Above 190 KIAS, the “Too Low, Terrain” aural warning operates. The warnings repeat only if the aircraft penetrates further into the envelope.

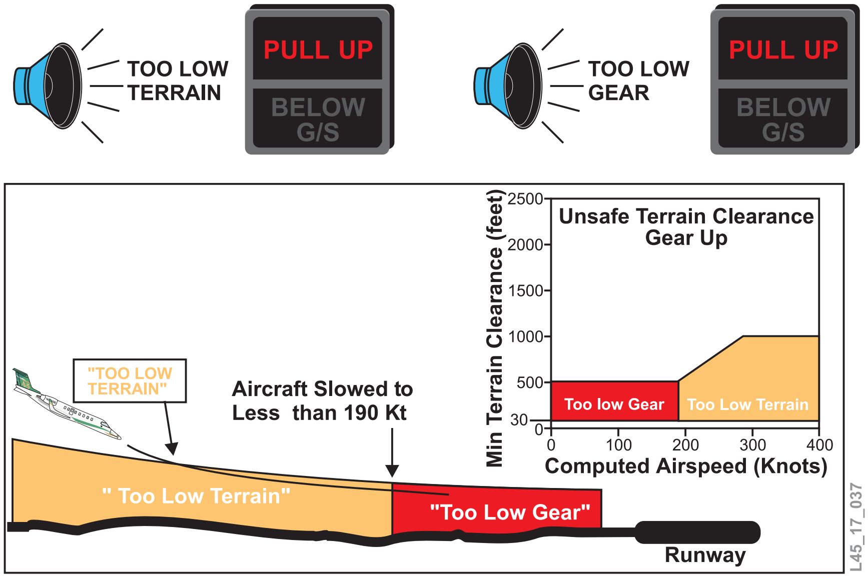
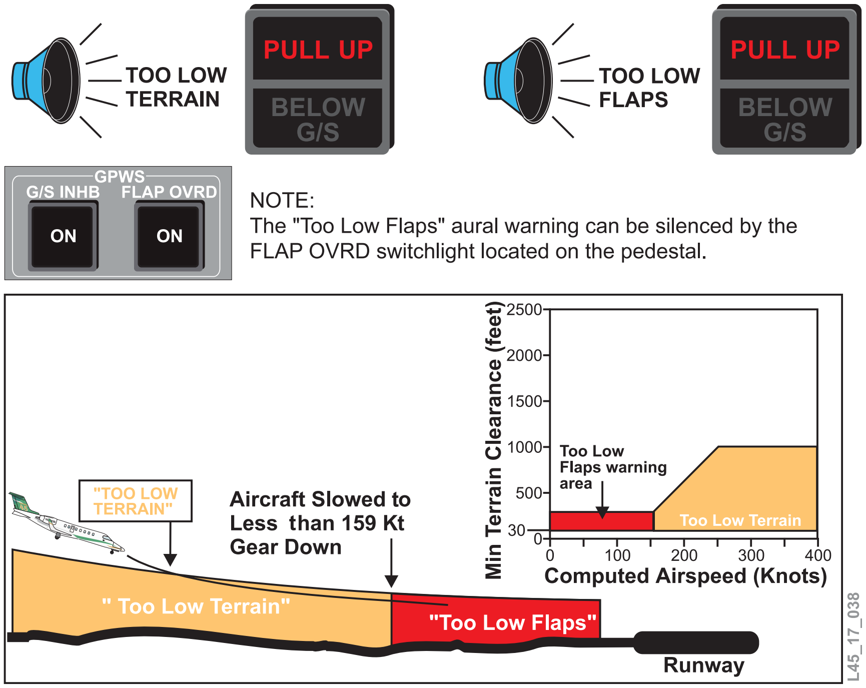


Figure 23 - Mode 4A—Proximity to Terrain Gear Up

Mode 4B

Mode 4B (too low flap warning) (Fig. 24) is active during cruise and approach with gear down and flaps not in landing configuration (40°). If the aircraft penetrates 245 ft radio altitude below 160 KIAS with the flaps not in landing configuration, the PULL UP annunciators illuminate and the “Too Low, Flaps” aural warning is given. The “Too Low, Flaps” aural warning can be inhibited using the GPWS FLAP OVRD switch indiction on the pedestal. Above 160 KIAS, the “Too Low, Terrain” aural warning operates. The warning repeats only if the aircraft penetrates further into the envelope.



NOTE:
The "Too Low Flaps" aural warning can be silenced by the FLAP OVRD switchlight located on the pedestal.

Figure 24 - Mode 4B—Proximity to Terrain Flaps <40°

Mode 4C

Mode 4C (too low terrain warning) (Fig. 25) provides terrain warning after takeoff or go-around. This mode is active after takeoff at 100 ft AGL and provides warnings until the aircraft exceeds 2450 ft radio altitude. This mode is also activated if a go-around is initiated from below 245 ft radio altitude with gear and flaps in the landing configuration. Raising the gear and/or flaps signals the system that a go-around has been initiated. The mode is based on a minimum terrain clearance, or floor, that increases with radio altitude. This floor is at 75% of the highest value of radio altitude that has occurred during takeoff. If the aircraft penetrates the floor, the PULL UP annunciators illuminate and the "Too Low, Terrain" aural warning operates. The warning repeats only if the aircraft penetrates further into the envelope.

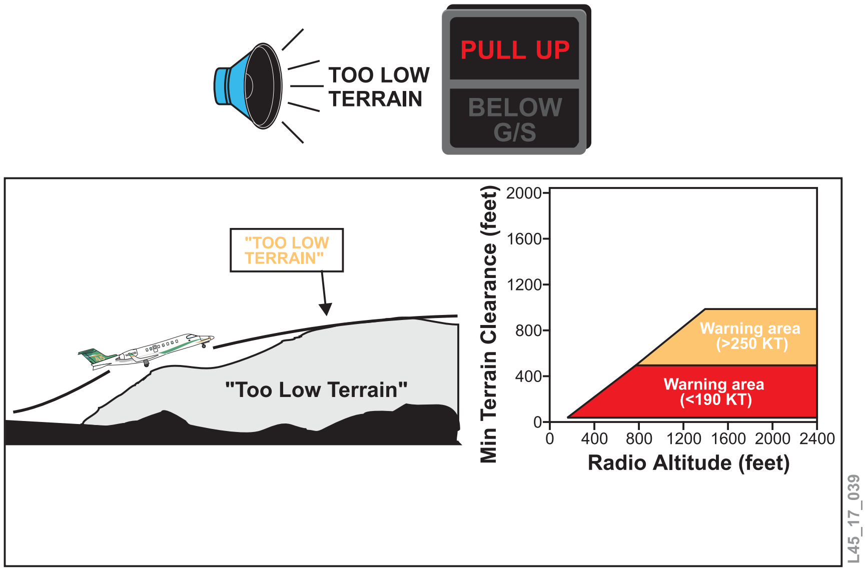


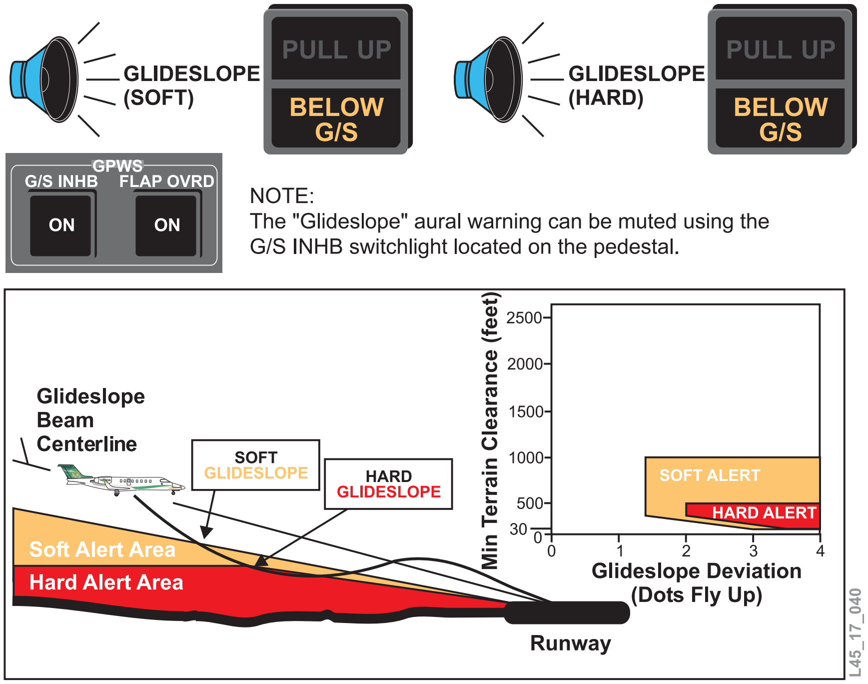
Figure 25 - Mode 4C—Minimum Terrain Clearance

Mode 5—Below Glideslope

Mode 5 (Fig. 26) provides alerts for excessive glideslope deviation when the aircraft descends below the glideslope on front course ILS approaches. If the aircraft rate of descent exceeds 500 fpm, alerts are given below 1000 ft radio altitude when glideslope deviation exceeds 1.3 dots fly-up. If the aircraft rate of descent is from 500 to 0 fpm, the radio altitude at which alerts are given is reduced linearly from 1000 to 500 ft radio altitude. The alert occurs at two audio levels. When the glideslope deviation reaches 1.3 dots fly-up, the BELOW G/S annunciators illuminate and the quieter "Glideslope" aural warning operates. The "Glideslope" aural warning in the soft (quiet) area operates once and repeats only if the condition worsens. Below 300 ft radio altitude and deviation of 2.0 dots fly-up or more, the louder "Glideslope" aural warning is given. A "Glideslope" alert in the louder area repeats at an increased rate.

Glideslope alerts may be canceled by flying the aircraft to within 1.0 dot deviation or by depressing the G/S INHB switch. Glideslope alert function may be inhibited using the G/S INHB switch anytime below

2000 ft radio altitude. The cancel function is automatically reset prior to the next approach, provided the aircraft has descended below 30 ft, or climbed above 2000 ft radio altitude.



NOTE:
The "Glideslope" aural warning can be muted using the G/S INHB switchlight located on the pedestal.

Figure 26 - Mode 5—Descent Below Glideslope

Mode 6—Advisory Callouts

The optional Mode 6 function provides an aural callout (“Five Hundred”) for descent through 500 ft radio altitude during the final approach phase of flight. Only aural callout is provided; no visual alert is given. If the aircraft is tracking a valid glideslope within 2 dots of the glideslope centerline, the “Five Hundred” aural callout is not given. If the aircraft deviates more than 2 dots from the glideslope centerline or if a valid glideslope is not in use, the “Five Hundred” aural callout is given. The “Five Hundred” aural callout is given once per nonprecision approach.

Mode 7—Windshear Warnings and Cautions

NOTE

Windshear detection and annunciation is determined by onboard measurement of air mass and acceleration occurring to the aircraft and cannot predict actual severity of windshear ahead of the aircraft.

Mode 7 (Fig. 27) windshear warnings and cautions are provided between 30 and 1500 ft AGL during the initial takeoff and between 1500 and 10 ft AGL during the final approach phases of flight when the level of windshear exceeds predetermined threshold values. The measured windshear value represents the vector sum of inertial and air mass accelerations along and perpendicular to the flightpath. These shears result from vertical winds and rapidly changing horizontal winds.

Windshear Warnings (Decreasing Performance)

Windshear warnings are given for decreasing headwind (or increasing tailwind) and severe vertical downdrafts. Windshear warnings activate the red WNDSHR annunciators, a siren (optional), and the “Windshear, Windshear, Windshear” aural warning. The aural warning does not repeat unless another event occurs, but the WNDSHR warning annunciator remains on for as long as the decreasing headwind/downdraft condition persists.

The warning threshold is nominally set at 0.115 G, which represents approximately 2.2 kt per second horizontal wind change or 15 kt (1500 ft/min) downdraft. A bias of 0.01 G is added during takeoff or go-around in consideration of increased climb performance. The threshold is modulated as a function of flightpath angle, and for stabilized airspeeds significantly above or below reference approach speed during final approach. The threshold is sensitized for unusual air temperature fluctuations typically associated with the leading edge of microburst windshears.

Windshear Cautions (Increasing Performance)

Windshear cautions are given for increasing headwind (or decreasing tailwind) and vertical updrafts typically associated with the leading edge of microburst windshears. Windshear cautions activate the amber WNDSHR annunciators. The WNDSHR caution annunciator remains on for as long as the increasing headwind/updraft condition persists. The warning threshold is nominally set at 0.115 G, which represents approximately 2.2 kt per second horizontal wind change or 15 kt (1500 ft/min) updraft. A bias of 0.01 G is added during takeoff or go-around in consideration of increased climb performance.

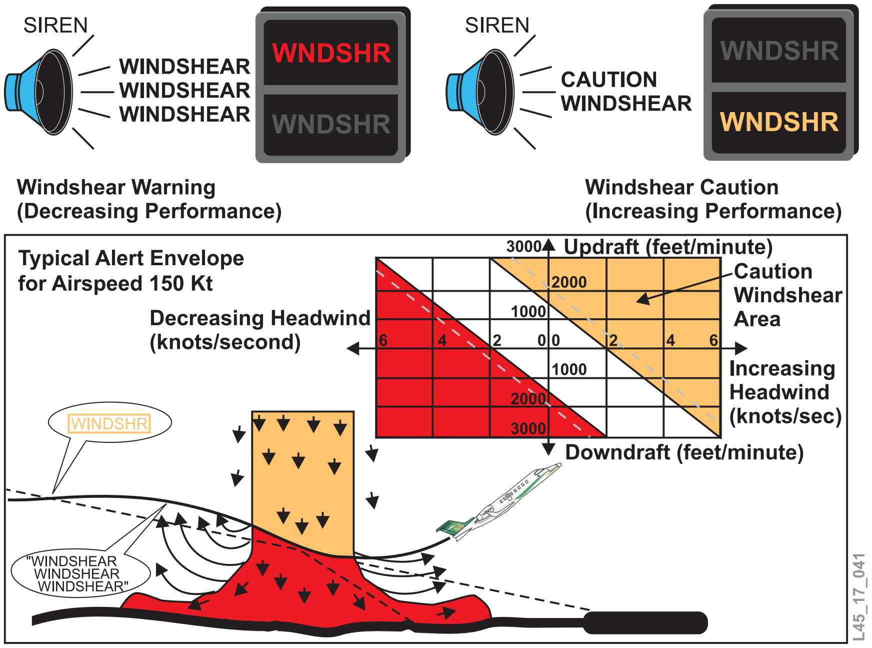


Figure 27 - Mode 7—Windshear

Terrain Awareness Alerting Display

The terrain awareness alerting display (TAAD) (Fig. 28) shows an image of the surrounding terrain ahead of the airplane in varying density dot patterns of red, yellow and green. The image is generated by comparing aircraft altitude and the terrain data stored in the EGPWS computer. The dot patterns represent specific terrain separation with respect to aircraft position. A “Caution Terrain, Caution Terrain” (“Terrain Ahead, Terrain Ahead”, if selected) alert is generated approximately 60 seconds from projected terrain conflict. Caution terrain areas display in solid yellow. A “Terrain, Terrain, Pull Up” (“Terrain Ahead, Pull Up - Terrain Ahead, Pull Up”, if selected) terrain warning is generated approximately 30 seconds from projected terrain conflict. The terrain warning areas display solid red.

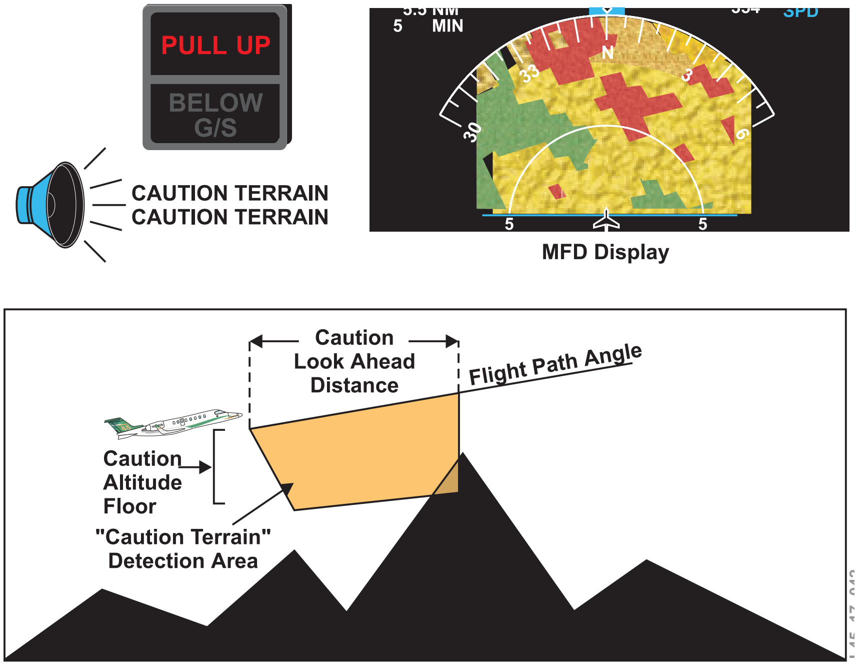


Figure 28 - Terrain Awareness Alerting Display—CAUTION

Terrain/Obstacle "Pop-Up" Display

The EGPWS is strapped for the "pop-up" display feature on the MFD terrain display.

During a terrain/or obstacle alert (Fig. 29), the MFD automatically changes ("pops-up") to display terrain (or obstacle). If desired, the indicator may be manually selected back to the weather radar display, by depressing the TERR⁄WX switch on the MFD bezel controller. The terrain image indicator range scale displays in the last resolution mode which was selected for RADAR.

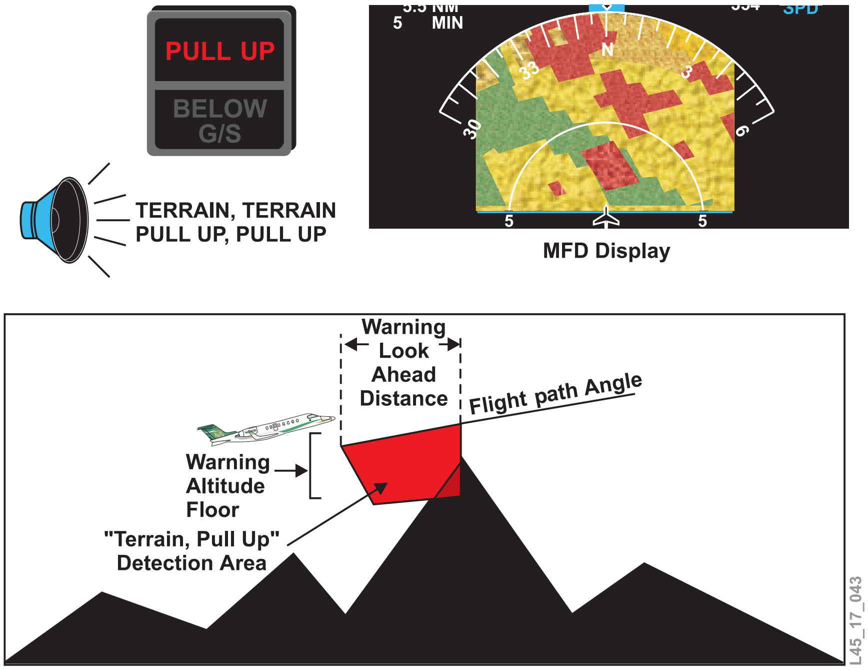


Figure 29 - Terrain Awareness Alerting Display—WARNING

Terrain Clearance Floor

The terrain clearance floor (TCF) alert function warns the pilot of possible premature descent, regardless of aircraft configuration. The TCF function creates a high-resolution terrain clearance envelope around the airport to provide protection against controlled flight into terrain (CFIT) situations not covered by the basic GPWS.

TCF alerts are based on current airplane location, nearest runway centerpoint position, and radio altitude, along with an internal database that includes all worldwide, hard-surfaced runways greater than 2000 ft in length.

Self-Test

Two separate self-test sequences are available. These self-tests use the SYS TEST/RESET panel (Fig. 30). To perform a complete self-test, both procedures should be used.

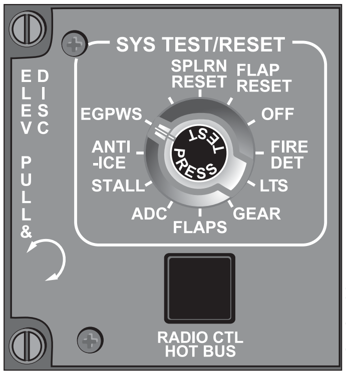


Figure 30 - SYS TEST/RESET Panel

Short Sequence

SYS TEST/RESET switch—Set to GPWS and momentarily depress. The test proceeds as follows:

- GPWS FAIL and WNDSHR FAIL annunciators illuminate on the pilot and copilot instrument panel. These annunciators remain illuminated for the entire self-test. The BELOW G/S annunciators, on the pilot and copilot instrument panel, also illuminate
- One “Glideslope” aural alert occurs, then the BELOW G/S annunciators extinguish
- PULL UP annunciators illuminate on the pilot and copilot instrument panel and one “Pull Up” aural warning occurs. Then the PULL UP annunciators extinguish
- Red WNDSHR annunciators illuminate on the pilot and copilot instrument panel, a siren (optional) sounds, and the “Windshear, Windshear, Windshear” aural warning occurs. Then the red WNDSHR annunciators extinguish
- Amber WNDSHR annunciators illuminate on the pilot and copilot instrument panel, then extinguish
- GPWS FAIL and WNDSHR FAIL annunciators extinguish

Long Sequence (Not Available in Flight)

SYS TEST/RESET Switch—Set to GPWS, depress and hold for approximately two seconds. The test proceeds as follows:

- GPWS FAIL and WNDSHR FAIL annunciators illuminate on the pilot and copilot instrument panel. These annunciators remain illuminated for the entire self-test. The BELOW G/S annunciators, on the pilot and copilot instrument panel, also illuminate
- One “Glideslope” aural alert occurs after which the BELOW G/S annunciators extinguish
- PULL UP annunciators illuminate on the pilot and copilot instrument panel, and one “Pull Up” aural warning occurs. Then the PULL UP annunciators extinguish

- Red WNDSHR annunciators illuminate on the pilot and copilot instrument panel, a siren (optional) sounds and the “Windshear, Windshear, Windshear” aural warning occurs. Then the red WNDSHR annunciators extinguish
- Amber WNDSHR annunciators illuminate on the pilot and copilot instrument panel, then extinguish
- “Sink Rate” aural warning occurs
- “Pull Up” aural warning occurs
- “Terrain” aural warning occurs
- “Pull Up” aural warning occurs
- “Don’t Sink, Don’t Sink” aural warning occurs
- “Too Low, Terrain” aural warning occurs
- “Too Low, Gear” aural warning occurs
- “Too Low, Flaps” aural warning occurs
- “Too Low, Terrain” aural warning occurs
- “Glideslope” aural alert occurs
- “Five Hundred” aural alert (optional) occurs
- Optional siren operates and “Windshear, Windshear, Windshear” aural warning occurs
- GPWS FAIL and WNDSHR FAIL annunciators extinguish

System Constraints

NOTE **The GPWS may give little or no advance warning time for flight into steep terrain with little or no terrain preamble.**

Terrain clearances or descent rates during radar vectoring that are not compatible with those required by the minimum regulatory standards for ground proximity warning equipment may cause unwanted warnings or alerts.

Windshear detection and annunciation is determined by onboard measurement of air mass and acceleration terms occurring to the aircraft and cannot predict actual severity of windshear ahead of the aircraft.

Weather Radar System

Description

The Primus 660 weather radar is an X-band color weather radar system used for atmospheric moisture detection and ground mapping. The weather radar provides displays of radar-detectable precipitation within ±60° of the flightpath at a selectable range up to 300 nm. The weather radar also provides ground mapping and incorporates features such as autotilt, ground clutter suppression, range compensation, and path attenuation correction (Fig. 31 -).

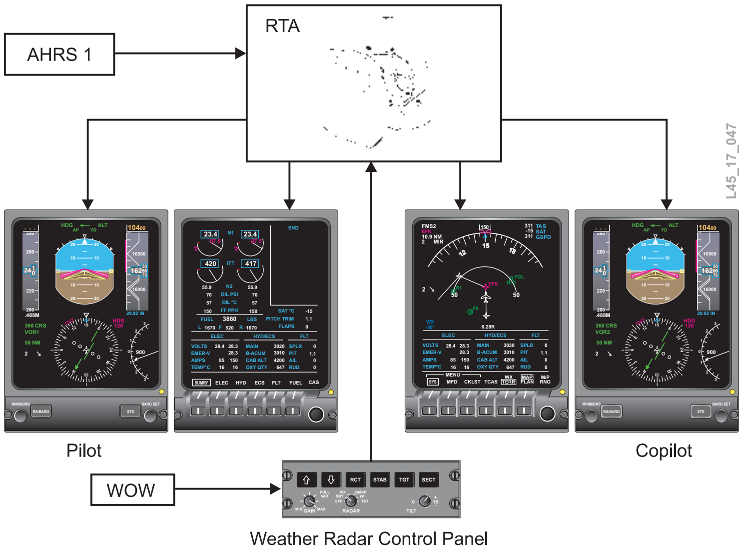


Figure 31 - Weather Radar Block Diagram

Operation

The system consists of a receiver transmitter antenna (RTA) and a single controller (dual controllers are optional) (Fig. 32). Radar information is normally displayed on the multifunction display (MFD) in the MAP mode. The AHRS provides stabilization input to the RTA.

In the weather detection mode, areas of little or no rainfall have a black background and areas of detected turbulence display in soft white. Storm intensity levels are displayed in four bright colors, contrasted against a deep black background:

- Very heavy rainfall—magenta
- Heavy rainfall—red
- Less severe rainfall—yellow
- Moderate rainfall—green

Range marks and identifying numerics, displayed in contrasting colors, help evaluate the location of storm cells relative to the aircraft.

The ground mapping (GMAP) function improves resolution and identification of small ground targets at short ranges. The reflected signals from ground surfaces are displayed as magenta, yellow, or cyan (most to least reflective).

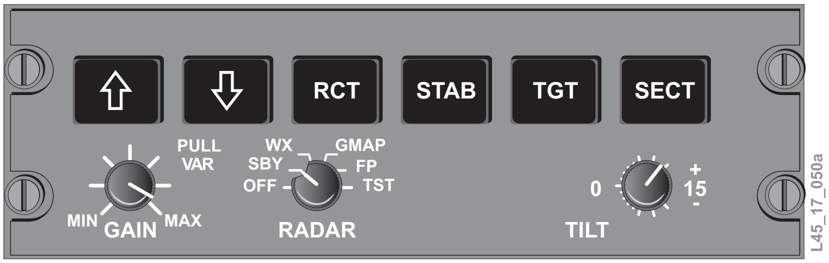


Figure 32 - Weather Radar Controller

Modes of Operations

Refer to the Primus 880/660/440 Digital Weather Radar System Pilot's Manual for detailed operation.

Standby Mode

When STBY is selected, the antenna is stowed in tilt-up position and is neither transmitting nor scanning, although power is still applied to the system. With weight on wheels, a forced standby mode (FSBY) automatically forces the system into standby. Depressing both range buttons simultaneously overrides this function.

Forced Standby

Forced standby (FSBY) is an automatic, nonselectable radar mode. FSBY mode is a safety feature that inhibits the transmitter on the ground, eliminating the X-band microwave radiation hazard. The controller is wired to the weight-on-wheels (WOW) switch. The RTA is in FSBY mode when the aircraft is on the ground.

In the FSBY mode, the transmitter and antenna scan are both inhibited, the memory is erased, and the FSBY (cyan) legend is displayed in the MFD mode field. When in FSBY, pushing the STAB button four times within three seconds overrides the FSBY mode.

NOTE

When weather radar is displayed on the MFD, FSBY is dropped once the aircraft is airborne.

Weather Radar Mode

When the weather (WX) mode is selected, the radar returns (Fig. 33) from precipitation are analyzed to produce a display of the weather ahead of the aircraft. Each color in the display represents a specific target intensity (Table 3).

Figure 33 - Weather Radar Return

Table 3 - Rainfall Rate Color Cross-Reference

Rainfall Rate		Intensity	Color
>2.1 in./hr	>50 mm/hr	Very heavy	Magenta
.5 to 2.1 in./hr	12 to 50 mm/hr	Heavy	Red
.17 to .5 in./hr	4 to 12 mm/hr	Less severe	Yellow
.04 to .17 in/hr	1 to 4 mm/hr	Moderate	Green

Target Alert Mode

The target (TGT) alert function is selectable for any weather range except 300 nm. This function monitors for red level or greater targets at ranges greater than the display range and within ±7.5° of dead-ahead.

Rain Echo Attenuation Compensation Technique (REACT) Mode

The REACT mode (RCT button) (Fig. 34) allows the radar receiver to adjust its own sensitivity automatically to compensate for attenuation losses as the radar pulse passes through weather targets on the way to other targets. When the maximum sensitivity level is reached, REACT ceases and a cyan field is added to the display. REACT is available in WX mode.

Figure 34 - REACT Mode

Ground Mapping Mode

When GMAP is selected, radar is in ground mapping mode (Fig. 35). The system is fully operational and all internal parameters are set to enhance returns from ground targets. The TILT control is turned down until the desired amount of terrain is displayed. The degree of down-tilt depends upon the aircraft altitude and the selected range.

With experience, interpretation skills for color display patterns can be developed. Color display patterns indicate water regions, coast lines, hilly or mountainous regions, cities, or even large structures.

The pilot should practice ground mapping from time to time during WMC flights where the radar display can be compared visually with the terrain.

FP Position

In the FP position, the WX transmitter is placed in standby and the PFD or MFD map range is selected up to 1000 nm. There is no radar data displayed in this mode.

Figure 35 - GMAP Mode

Fault Monitoring

PFD

If a weather radar failure occurs, regardless of the display format (FULL/ARC/WX), an amber WX is annunciated on the lower left side of the HSI.

MFD

If a weather radar failure occurs, an amber WX is displayed in the WX mode annunciation display field.

Test

Power-Up

On power-up, the pilot selects either STBY or TST mode on the weather radar controller panel. When power is first applied, the radar is in WAIT for 45 seconds, to allow the magnetron to warm up.

If forced standby is incorporated, it is necessary to momentarily push both range switches to exit forced standby.

After the warmup, the pilot can select the test mode and verify that the test pattern is displayed (Fig. 36). If the noise band is missing or broken, it indicates system problems.

Figure 36 - Weather Radar Test Pattern

Precautions

NOTE

If FSBY is overridden, output power is radiated in test mode.

If the radar system is to be operated in any mode other than standby on the ground:

- Direct the nose of the aircraft so that the antenna scan sector is free of large metallic objects such as hangars or other aircraft, for a distance of 100 ft (30 m), and tilt the antenna fully upward
- Do not operate the radar during aircraft refueling or during refueling operations within 100 ft (30 m)
- Do not operate the radar if personnel are standing too close to the 270° forward sector of the aircraft
- Operating personnel should be familiar with FAA AC 20-68B

Flight Management System

UNS-1C Description

The Universal single (Fig. 37) or dual (Fig. 38) UNS-1C flight management system (FMS) is a fully-integrated navigation and flight management system. It provides the pilot with centralized control for the aircraft navigation sensors, computer-based flight planning, and advisory fuel management.

The UNS-1C unit consists of a flat-panel, full-color, high-resolution display; alphanumeric function keys; line select keys; a GPS sensor; and a master computer, all housed in a single pedestal-mounted box. A data transfer unit (DTU) loads the periodic Jeppesen data base updates via 3.5-in. disks.

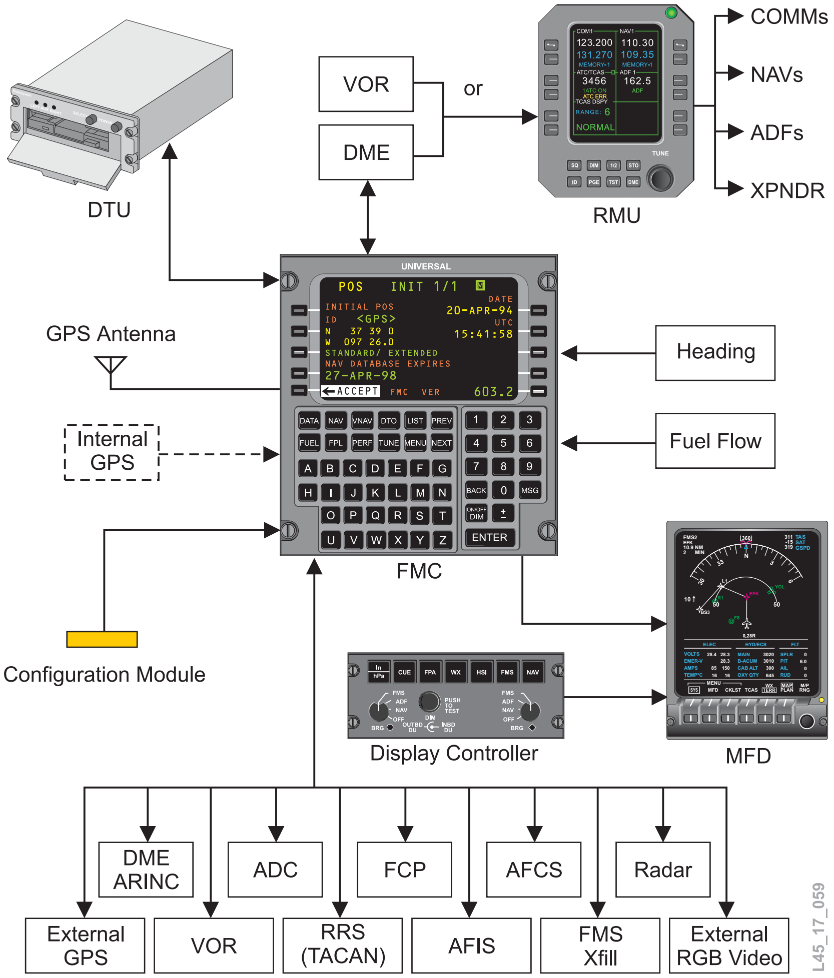


Figure 37 - FMS Configuration—Single

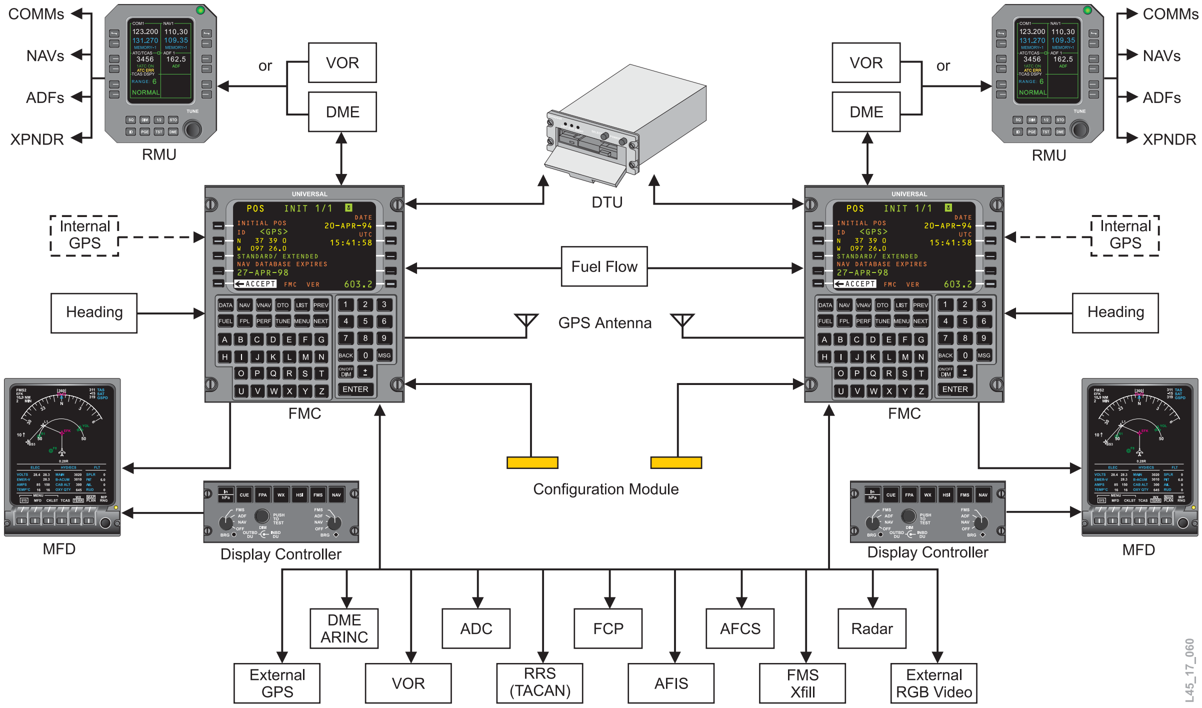


Figure 38 - FMS Configuration—Dual

Operation

Refer to the UNS-1C Operator’s Manual for a detailed description and operation of the flight management system.

The UNS-1C receives the following:

- ADC (pressure altitude, baro-corrected altitude, Mach, indicated airspeed, true airspeed, total air temperature, altitude rate, and static air temperature)
- AHRS (magnetic heading, pitch attitude, roll attitude, longitudinal accelerations, and normal acceleration)
- Initial fuel quantity (FMS 1 only on aircraft 45-002 thru 45-027 and 45-029 through 45-053 not modified by SB 45-22-1)
- Fuel flow
- Flap position
- Overspeed (MMO/VMO/VFE) from the dual Honeywell IC-600/ symbol generators

The UNS-1C provides navigation and steering data to the dual Honeywell IC-600/symbol generators/digital flight guidance computers.

ADC No. 1 normally supplies air data to FMS 1; ADC No. 2 normally supplies air data to FMS 2 (if installed). If an ADC fails, the FMS automatically reverts to the remaining ADC. Also, if the pilot selects aircraft ADC No. 1 or 2 reversion, the FMS reverts to the selected ADC.

AHRS No. 1 normally supplies attitude/heading/acceleration data to FMS 1; AHRS No. 2 normally supplies attitude/heading /acceleration data to FMS 2 (if installed). If an AHRS fails, the FMS automatically reverts to the remaining AHRS. Also, if the pilot selects aircraft AHRS 1 or 2 reversion, the FMS reverts to the selected AHRS.

NAV 1 supplies VOR and DME data to FMS 1. NAV 2 supplies VOR and DME data to FMS 2 (if installed). In addition to the VOR/DME channel tuned by the pilot, the FMS tunes and uses one other DME channel in the onside NAV unit.

The UNS-1C provides capability for point-to-point navigation, SIDs, STARs, holding patterns, and approaches (including GPS only). Both lateral and vertical (descent only) steering are provided for en route, terminal area, and approach operation.

System Integration

Honeywell Primus 1000 Display of FMS Navigation Information

The FMS button, on the appropriate EFIS display controller, selects the desired FMS for display on the PFD and the corresponding MFD (Fig. 39). FMS 1 is the default for the pilot’s side, and FMS 2 is the default for the copilot’s side. In dual installations, subsequent pushes change between FMS 1 and FMS 2.

Navaids (VOR, DME, TACAN), NDB, and airport identifiers may be displayed as background data on the MFD when selected by the APT/NAV bezel button on the MFD. The background identifier display may consist of a maximum of four navaids, four NDBs, and if selected, four airports.

Full lateral scaling (2 dots) for en route operations is 5 nm, terminal operations is 1 nm, and approach mode is 0.3 nm.

A vertical deviation scale is displayed to the right of the attitude sphere if a valid VNAV is programmed, and FMS is the selected NAV source. Full vertical scaling (2 dots) for en route operations is 1500 ft, terminal scaling is 500 ft and approach scaling is 200 ft.

Figure 39 - PFD and MFD Displays

Frequency Management

Radio tuning may be accomplished via the UNS-1C. All FMS radio tuning may be manually overridden at any time by normal operation of either or both radio management unit. The radios tuned by the FMS are:

- VHF Comm 1 and 2
- VHF Nav 1 and 2
- ADF 1 and 2 (if installed)
- Transponder 1 and 2

In 8.33 kHz radio installations, FMS tuning is available only on 25 kHz spaced frequencies. The FMS CDU does not display the tuned frequency and defaults to 118.00.

HF radio, if installed, must be tuned via its controller.

NOTE

FMS tuning may be enabled or disabled via either RMU NAV MEMORY page select key.

FMS Autotune and Override

On the RMU main page, an FMS autotune VOR or ILS frequency is displayed on the main tuning page (Fig. 40). It is indicated by a magenta VOR or ILS frequency, and a magenta AUTO in the top border of the NAV window as shown.

To override an FMS autotune VOR or ILS frequency, change the active and the preset frequencies with the line select key adjacent to the active NAV frequency. If in the direct tuning mode, place the cursor around the frequency and change it using the TUNE knobs. The active frequency color returns to white and autotune remains inhibited until it is restored on the FMS control display unit.

Once FMS autotuning is overridden in this manner, it can only be reactivated through the FMS control display unit.

Figure 40 - FMS Autotune RMU Main Page

VOR “Q” Factor

During en route operations, the VOR “Q” factor may occasionally increase to 99. This happens because the navaid is tuned to a VOR that is not needed for radial update since the system is using multiple-DME for position fixing.

Approach Operations

LOC, B/C, GPS, and GPS overlay, NDB, RNAV, VOR, VOR/DME, and VFR approaches may be linked into the flight plan and coupled to the autopilot both laterally and vertically. APP annunciates on the PFD when the selected FMS approach mode is active.

- GPS remains selected for navigation if the approach is Jeppesen-defined and is in the USA or Canada database regions (with WGS-84 datum)
- GPS is deselected automatically for pilot-defined IFR approaches and for approaches outside of USA or Canada (refer to UNS-1C Operator’s Manual)
- Manual NAV leg sequencing is disabled after selecting flight director GO AROUND mode if an ILS (advisory) approach is linked into the FMS flight plan. MFD background and flight plan waypoint information clears after 30 seconds. Manual NAV leg sequencing may be restored and background and flight plan information redrawn if GO AROUND is deselected

Refer to the Automatic Flight Control System chapter and UNS-1C Operator’s Manual for detailed information on the flight director and autopilot operation when FMS is the selected NAV source.

Navigation Systems

The UNS-1C+/1E flight management system master computer processes multiple sensor inputs to provide a best computed position for enroute and terminal navigation. The system incorporates a navigation computer, 12-channel GPS receiver and control/display functions in one compact, lightweight system. It includes a 5-in. (13-cm) active matrix LCD display unit and a data transfer unit (DTU) for updating the worldwide database. It includes the following:

- Honeywell Phase IV avionics
- Second UNS-1C+/1E FMS (optional)
- Primus 880 weather radar (optional)
- Enhanced ground proximity warning system (optional)
- Traffic alert and collision avoidance system 2000 (optional)
- Emergency locator transmitter C406-2 (optional)

The UNS-1C+/1E encompasses the following enhancements over the UNS-1C:

- Improved computational performance (25 x faster)
- Increased memory (stores the world wide database) (4 x capacity)
  - Stores COM/NAV frequencies (from the world wide database)
- Wide area augmentation system (WAAS) capable (also known as satellite-based augmentation system [SBAS])
- Uplink capable

The UNS-1C+/1E system meets navigation qualifications for North Atlantic tracks (GPS primary means of navigation) and complies with minimum navigation performance specification (MNPS). The internal 12-channel global navigation satellite system (GNSS) receiver provides real-time and predictive receiver autonomous integrity monitoring (RAIM), fault detection and exclusion (FDE), step detection, and manual satellite deselect capability.

Navigation can be accomplished with GNSS accuracy throughout all phases of flight. RNAV, GPS, and GPS-overlay approaches are contained in the database along with their transitions and missed approach procedures. Software programming provides features including flight planning capabilities with SID/STAR procedures and airways, a best computed position, autoscanning DME-DME, enroute maneuvers such as direct-to, heading commands, and PVOR tracking, VNAV, holding patterns, and a 3-D approach mode.

Control and Indications

Display Controller

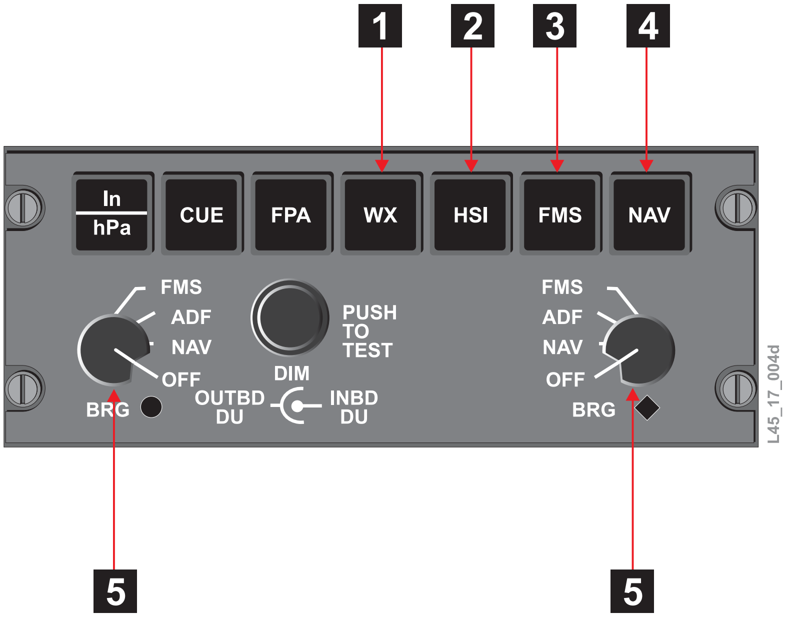


Figure 41 - PFD Display Controller

1 WX Button

- Push—Sets the HSI to display a partial compass format with weather radar information

2 HSI Button

- Push—
  - Toggles the HSI between a full 360° and a partial compass display
  - HSI MAP display is available only on the side that is not displaying the MFD
  - When the HSI MAP display is selected (with or without weather), the display range is controlled by the weather radar controller

3 FMS Button (optional)

- Push—
    - FMS information is displayed on the HSI
    - FMS NAV source for both the MFD and PFD is selected with the display controller
    - With dual FMS installations
- MFD defaults to the onside FMS source
- PFD powers up with short-range navigation (SRN) as default
- Push the FMS button to synchronize the PFD to the MFD source. Subsequent pushes toggle the FMS source for both the PFD and the MFD

4 NAV Button

- Push—
    - VOR/LOC information is displayed on the HSI
    - First push displays onside NAV
    - Second push displays the cross-side NAV
- To ensure that the proper source is used with the selected flight director modes, the EFIS resets the lateral FD modes (except for heading) when the NAV source is changed on the master side

5 BRG (Bearing) Knobs

- Rotate—HSI can display two independent bearing pointers. The selectable bearing sources for each pointer are described in Table 4.

Table 4 - Navigation Bearing Pointers

BRG (Circle) Single Needle	BRG (Diamond) Double Needle
OFF	OFF
ADF 1	ADF 2
NAV 1	NAV 2
FMS 1	FMS 2

NOTE

For single FMS or ADF, the 1 or 2 on the PFD is removed and the single FMS/ADF is available from both bearing pointers.

PFD NAV Indications

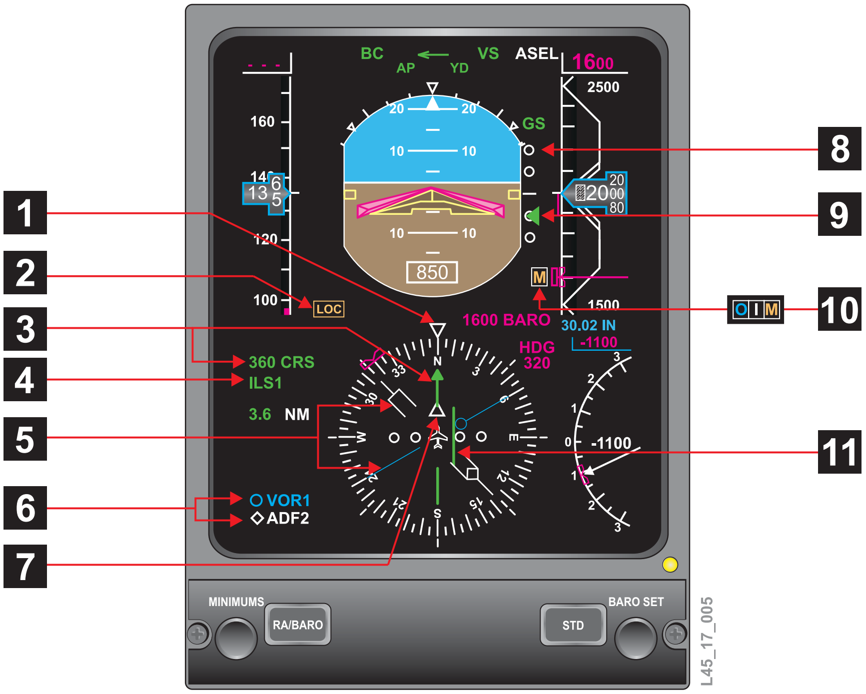


Figure 42 - PFD HSI Full Compass Display

1 Lubber Line

- Indicates—Heading and position relative to selected course

2 Localizer Miscompare

- Indicates—Difference between the pilot and copilot display data (comparison is made when the pilot and copilot have the same type but different sources selected for display)

3 Course Select/Desired Track Digital Display and Pointer

- Rotates around the center of the heading display and shows—Digital readout of the selected course appears with a label indicating which navigation source has been selected
  - If short-range NAV has been selected, the label is CRS
  - If long-range NAV has been selected, the label is DTK (desired track)
  - Short-range NAV is selected by rotating the onside CRS knob on the FGC
  - When the FMS is selected, the course select data is generated by the FMS and displays in various colors (Table 5)

Table 5 - Course/Desired Track Pointer Colors

Navigation Source		Lateral Deviation Display	
Pilot Selected Source	**Copilot Selected Source**	**Pointer Color on Pilot PFD**	**Pointer Color on Copilot PFD**
SRN 1	SRN 2	Green	Green
SRN 2	SRN 1	Green	Green
FMS 1	FMS 2	White	White
FMS 2	FMS 1	White	White
SRN 1	SRN 1	Yellow	Yellow
SRN 2	SRN 2	Yellow	Yellow
FMS 1	FMS 1	Yellow	Yellow
FMS 2	FMS 2	Yellow	Yellow
FMS[1]	FMS1	Yellow	Yellow
Any SRN	Any FMS	Green	White
Any FMS	Any SRN	White	Green

1. Single FMS installation

4 NAV Source Annunciation

- CDI responds to the NAV source selected on the display controller and indicates—
  - Available navigation sources are VOR 1/2, ILS 1/2, and FMS 1/2
  - If the display controller is invalid, the default is VOR 1 (pilot side) and VOR 2 (copilot side)
  - If FMS is the selected NAV source, the magenta TO waypoint displays immediately below the FMS NAV source annunciation (Table 6)

Table 6 - NAV Source Annunciations

Primary Navigation Source	Annunciation
NAV No 1	**VOR1**
NAV No 2	**VOR2**
NAV No 1	**ILS1**
NAV No 2	**ILS2**
FMS	**FMS**

5 Bearing Pointers

- Pointers (rotate around the heading arc center in the same way as the course pointer) indicate—Bearing point source selections from the onside display controller

NOTE **If the onside display controller fails, the default sources are VOR 1 on circle (pilot PFD) and VOR 2 on diamond (copilot PFD).**

6 Bearing Pointer Annunciations

- Annunciator color matches the bearing pointer color, cyan for the circle pointer and dim white for the diamond pointer. The bearing (BRG) pointer selections are listed in the display controller section

NOTE **For single FMS or ADF, the 1 or 2 on the PFD is removed and the single FMS/ADF is available from both bearing pointers.**

7 TO/FROM Indicator

- Indicator displays as a triangle in front of the airplane (TO) or behind the airplane (FROM)

8 Vertical Deviation Scale

9 Vertical Deviation Pointer

10 Marker Beacon Annunciator

- Green O—Outer marker
- Amber M—Middle marker
- White I—Inner marker

11 Course Deviation Indicator (CDI) and Scale

- Displays—
  - Lateral deviation scale in the form of two dots on either side of the airplane symbol
  - Lateral deviation dots rotate with the airplane symbol around the center of the course pointer, and any deviation from the selected course is graphically displayed by the CDI moving out of alignment with the rest of the course pointer

RMU Backup Navigation Display

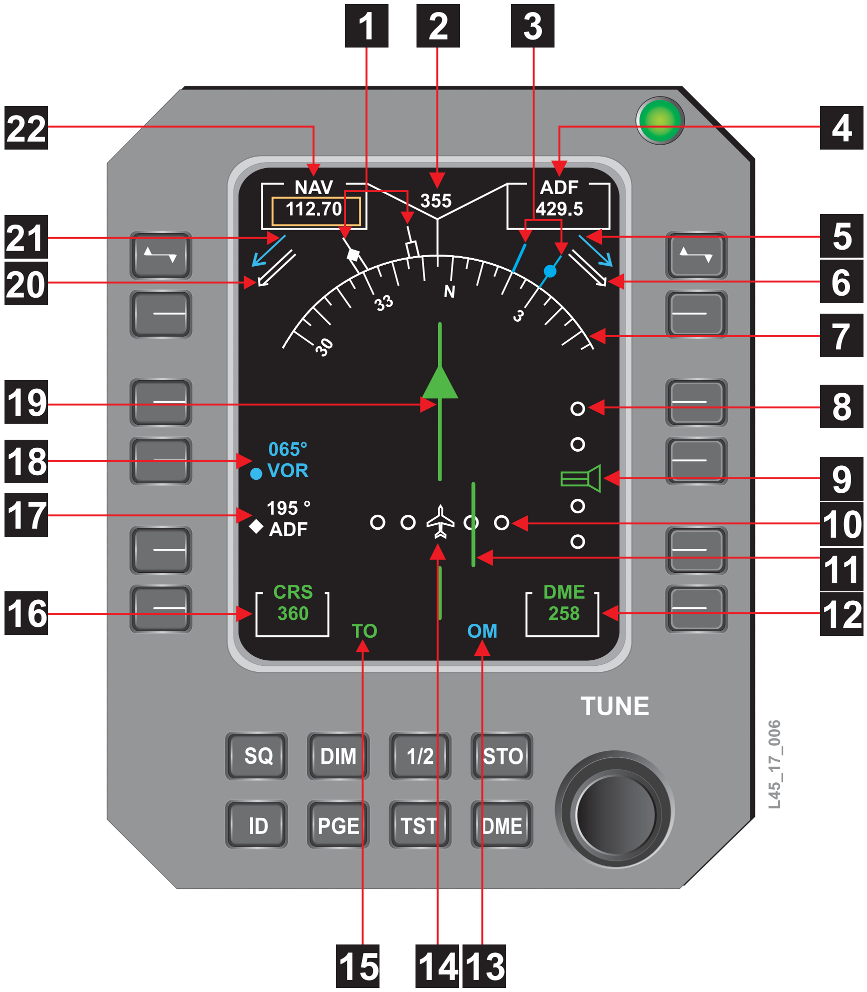


Figure 43 - RMU Backup Navigation Display

1 ADF Bearing Pointer (♦) “Head and Tail”

- Displays—
  - Bearing pointer, legend, and digital position in white
  - When the pointer (or its tail) is not in view, a double white arrow is displayed above the compass arc, on either the left or right side to indicate its location

2 Digital Heading

3 VOR Bearing Pointer (●) “Head and Tail”

- Displays—
  - Bearing pointer, legend, and digital position in cyan
  - When the pointer (or its tail) is not in view, a single cyan arrow is displayed above the compass arc, on either the left or right side, to indicate its location

4 ADF Frequency Display

- Displays—
  - ADF frequency in white
  - When the RMU line select key adjacent to the appropriate window is pushed, the frequency is enclosed in the RMU yellow tuning box
  - Tune knob selects the desired frequency

5 VOR Pointer Out of View Right

6 ADF Pointer Out of View Right

7 Heading Arc Display

- Displays—90° arc of heading in white

8 Glideslope Scale

9 Glideslope Pointer

- When a localizer frequency is tuned, displays—
- Green glideslope pointer (scale in white)
- VOR (●) bearing pointer, VOR bearing readout, and bearing label are removed

10 Lateral Deviation Scale

11 Lateral Deviation Indication

- Indicates—
  - NAV CDI with TO/FROM indicator
  - Lateral deviation is shown with two dots on either side of the centered position
  - This represents navigation deviation from the selected course for the specific source
  - TO or FR (from) indication is shown to the right of the selected course readout in green digits

12 DME Distance

- Indicates—DME distance to the selected VOR or ILS in green

13 Marker Beacon

- Displays—Marker beacon data is shown in Table 7:

Table 7 - Marker Beacon Data

OM (cyan)	Outer marker
MM (amber)	Middle marker
IM (white)	Inner marker

14 Aircraft Symbol

15 TO/FR Indicator

16 Selected Course

17 Digital ADF Bearing

18 Digital VOR Bearing

19 Course Pointer

- Displays—
  - Green course arrow
  - Green digital readout of the selected course is displayed in the lower left corner
  - When the RMU line select key next to the course readout is pushed, it is boxed in yellow
  - RMU tune knob sets a new course
  - Inner knob selects 1° changes, and the outer knob selects 10° changes

NOTE **The yellow tune box returns to the course window after 20 seconds of RMU inactivity.**

20 ADF Pointer Out of View Left

21 VOR Pointer Out of View Left

22 NAV Frequency Display

- Displays—
  - VOR/ILS tuned frequency in white
  - When the RMU line select key adjacent to the appropriate window is pushed, the frequency is enclosed in the RMU yellow tuning box
  - Tune knob selects the desired frequency

MFD Menus and Submenus

MFD Main Menu

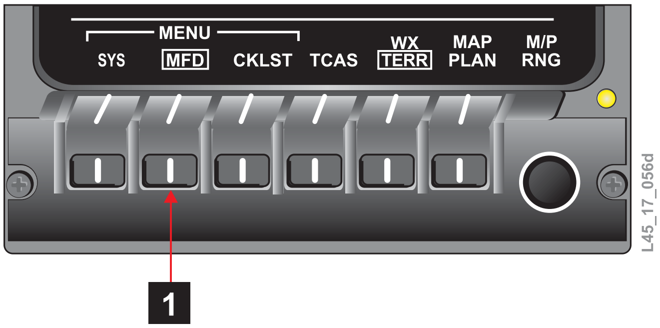


Figure 44 - MFD Main Menu

1 MFD Button

- Push—Selects one of the MFD menus shown in Fig. 45.

MFD Menu with FMS Installed

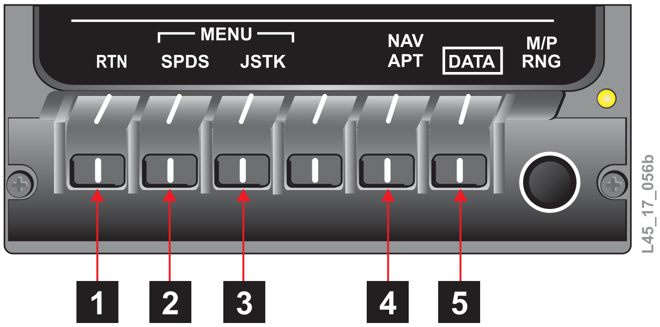


Figure 45 - MFD Menu (with Single or Dual FMS)

1 RTN Button

- Push—Returns the menu to the MFD main menu

2 SPDS (Speeds) Button

- Push—Selects the V-speeds submenu (refer to Chapter 11 Flight Instruments for detailed operation)

3 JSTK (Joystick) Button

- Push—Selects the joystick submenu (refer to Fig. 46 “Joystick Submenu” on page 60 for detailed information)

4 NAV/APT (Navigation/Airport) Button

- Push—
  - Selects the combination of VOR/DME navigation stations and airport symbols for display
  - Powerup default is with neither configuration selected
  - Maximum of eight navaids can be displayed at any time
  - Maximum of four VORs and four ADFs
  - VOR navaids can be a combination of VORs and VORTACs
  - Background navaids are output from the FMS

5 DATA Button

- Push—
  - Selects display of the NAV and APT names
  - Toggles between DATA on and DATA off (default is DATA on)

Joystick Submenu

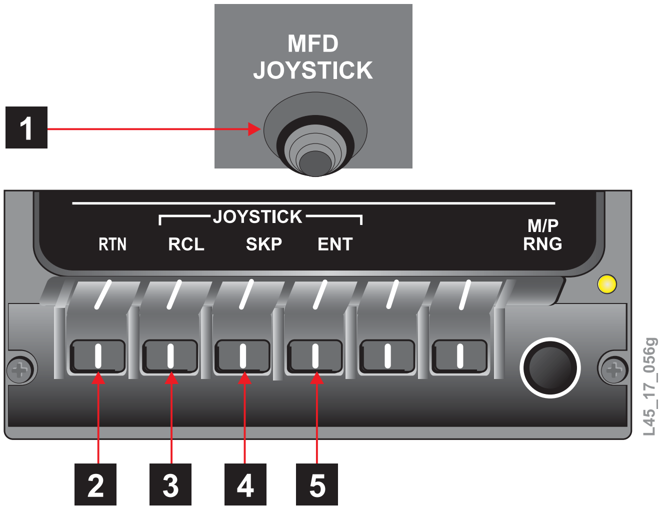


Figure 46 - Joystick Submenu

1 Joystick (five-position, spring-loaded to center)

- Press—Controls the designator on the MFD map or plan views, or generates FMS waypoints (the joystick submenu buttons are used in conjunction with the pedestal-mounted joystick)

2 RTN Button

- Push—
  - Returns the MFD to the MFD main menu display
  - If a system page is being displayed when the RTN button is pushed, the system page remains displayed

3 RCL (Recall) Button

- Push—
  - In the MAP mode when the designator is not at its referenced waypoint, recalls the designator to that position
  - If the referenced waypoint was the aircraft, recalls the designator to the present aircraft position
  - In the PLAN mode, repositions the flight plan display so that the referenced waypoint is in the center of the PLAN map area

4 SKP (Skip) Button

- Push—
  - Skips the designator's home position to the next displayed waypoint
  - When pushed with the designator at the last displayed waypoint, the designator returns to present position
  - When displaying the MAP format, if the designator is co-located with a connected waypoint, positions the designator box over the next waypoint
  - When displaying the PLAN format, if the designator is co-located with a connected waypoint, positions the flight plan so the next waypoint is displayed over the designator (in the center of the PLAN map area)

5 ENT (Enter) Button

- Push—Transmits the LAT/LON of the designator to the FMS as a requested waypoint

TCAS (OPTIONAL)
Selection

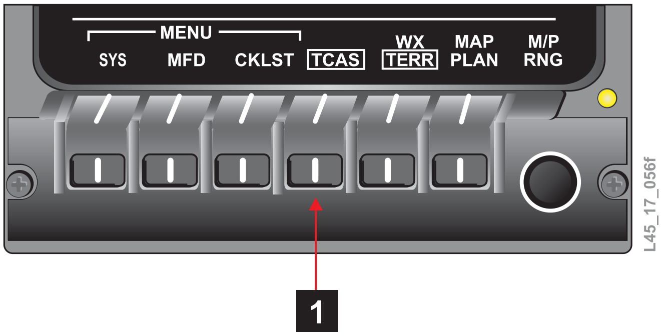


Figure 47 - TCAS Selection from Main Menu

1 TCAS Selection

- Push—
  - Selects the TCAS zoom display
  - Second push returns the window to the previously selected display
  - TCAS is annunciated with a white box around the menu name

NOTE **If TCAS is not installed on the aircraft, the TCAS button is not on the bezel menu.**

- Auto recall of the main menu is available whenever a traffic advisory (TA) or resolution advisory (RA) is triggered
- TCAS button selection is available after the auto main menu recall

NOTE **TCAS auto range is not available in this installation. When TCAS is selected, it displays the last range that was in the RMU memory.**

WX (Weather) Selection

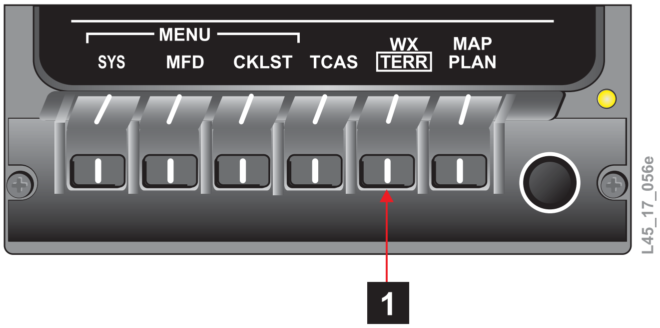


Figure 48 - WX (Weather Selection)

1 WX Button

- Push—Adds weather information to the MAP display
- The WX display is annunciated with a white box around the menu name
- Second push removes the weather information

NOTE

If the weather radar is off or not transmitting, pushing the WX button has no effect.

If the WX button is pushed while in PLAN mode, the display changes to the MAP mode.

Weather radar selections are controlled from the weather radar controller.

MAP range is controlled by the weather radar controller when weather is displayed.

When weather is displayed, M/P RNG above the rotary knob is removed, and the knob is disabled.

MAP/PLAN Selection

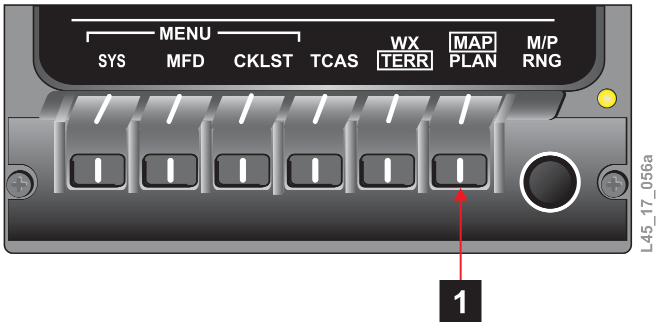


Figure 49 - MAP/PLAN Selection

1 MAP/PLAN Button

- Push—
  - Toggles between the two MFD formats
  - Powerup default is MAP
  - A white box frames the selected display

NOTE

If WX is selected and the plan format is selected, the WX is deselected and the box is removed. When MAP is reselected, the weather display is reenabled.

Traffic Alert and Collision Avoidance System

ATC Transponder Operating Controls

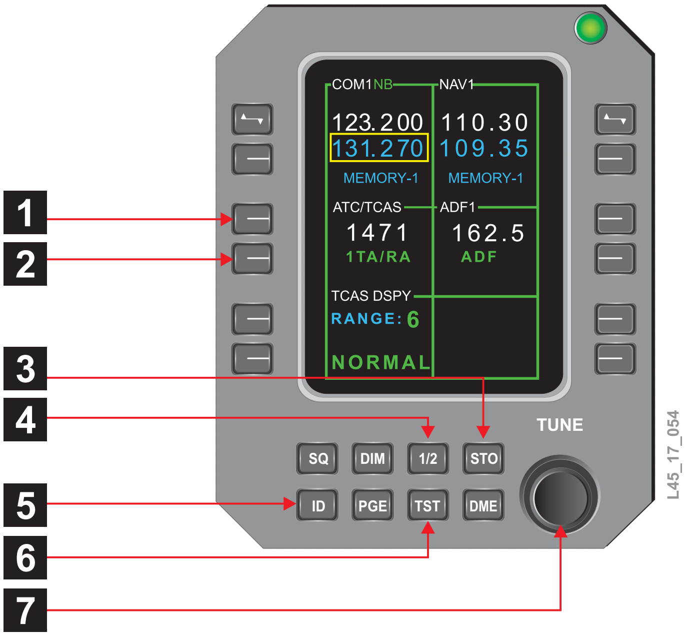


Figure 50 - RMU ATC/TCAS Operating Controls

1 ATC Code Line Select Key

- Press—Places the cursor box around the transponder code: with the box around the code, the TUNE knobs are used to change the transponder code

2 ATC Mode Line Select Key

- Press—Moves the cursor to this line
- Pressing again or turning either tuning knob—Selects TCAS/ATC operation modes:
    - TA only—Does not display resolution advisory on the PFD
    - TA/RA—Full operation of TCAS is selected
- Other modes include STANDBY, ATC ON, ATC ALT, and TUNE ME modes (refer to “ATC Transponder System” on page 13)

3 STO (Store) Function Key

- Press (when the cursor box is around the ATC code)—
    - Stores the transponder reply code
    - Pushing and holding the ATC code line selects the key to retrieve a code from memory

4 1/2 Function Key

- Press—
  - In dual ATC installation, the function toggles the active transponder between No. 1 and No. 2
  - Not functional in single transponder installation

5 ID (Ident) Function Key

- Press—
  - Activates the identification function for 18 seconds
  - ID annunciation appears in the transponder window
  - Enabled anytime the transponder is ON and the RMU is not displaying the maintenance pages

6 TST (Test) Function Key

- Push and hold 2 seconds (if cursor box is in ATC window)—Transponder pilot-activated self-test (PAST) initiates. During the ATC test, yellow ATC TEST displays, indicating the transponder is performing a self-test. When the test is complete, a green ATC PASS or red ACT ERR displays in the ATC window. The other transponder can be tested by selecting it as active (using the 1/2 key) and pushing the TST key

7 TUNE Knob

- Rotate—Sets the reply codes
- Outer knob controls the left two digits
- Inner knob controls the right two digits

ATC Window Annunciations

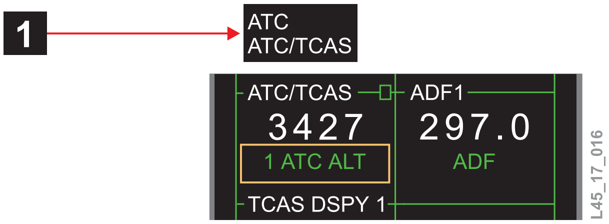


Figure 51 - RMU ATC/TCAS Window Labels

1 ATC Window Label

- Displays—Either white ATC or ATC/TCAS

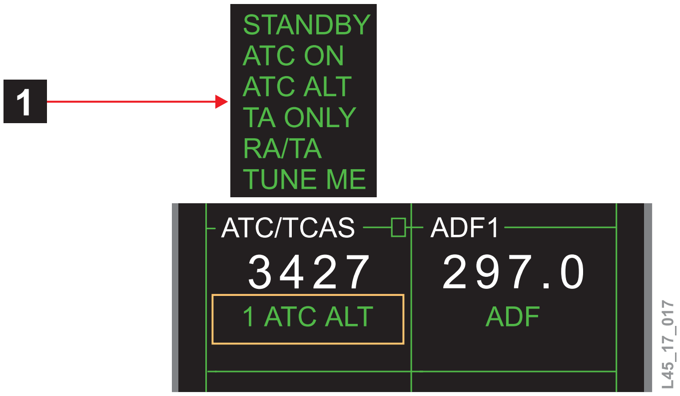


Figure 52 - ATC Modes

1 ATC Modes

- Displays—
  - Green STANDBY, ATC ON, ATC ALT, TA ONLY, TA/RA, or TUNE ME
  - Dashes when active transponder is offline

Table 8 - ATC Modes

Mode	Definition
STANDBY	Receives interrogation signal but cannot reply
ATC ON	Replies on Modes S and A, no altitude reporting
ATC ALT	Replies on Modes A, C, and S, with altitude reporting
TA ONLY	Replies on Modes A, C, and S, with altitude reporting, and TCAS traffic advisory mode (TA) selected
TA/RA	Replies on Modes A, C, and S, with altitude reporting, and TCAS traffic advisory mode (TA) and resolution advisory mode (RA) selected
TUNE ME	Transponder operating mode is invalid (pilot must attempt to tune a mode using the TUNE knobs)

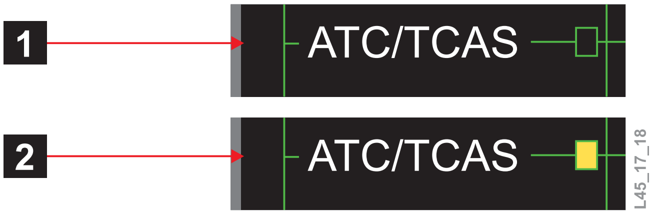


Figure 53 - ATC Reply Light

1 Empty Green Box

- Indicates the transponder has no reply in progress

2 Yellow Box

- Displays when the transponder is sending a reply

Figure 54 - ATC Ident

1 ATC Ident

- ID button (or remote IDENT switch) is pressed

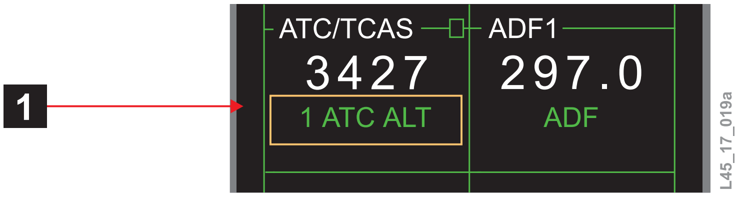


Figure 55 - ATC Code

1 ATC Code

- Indicates—
  - ATC four-digit code selected, with leading zeroes if required
  - Digits are normally WHITE
  - Digits turn YELLOW when remotely tuned
  - Dashes replace the digits if the active transponder goes offline

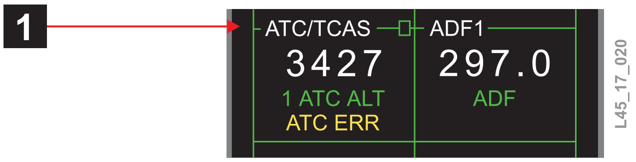


Figure 56 - ATC Status/Failure Warnings

1 ATC Status/Failure Warnings

- Indicates—Yellow ATC ERR annunciation under the ATC mode if the transponder is signaling squitter (aircraft identification code) failure

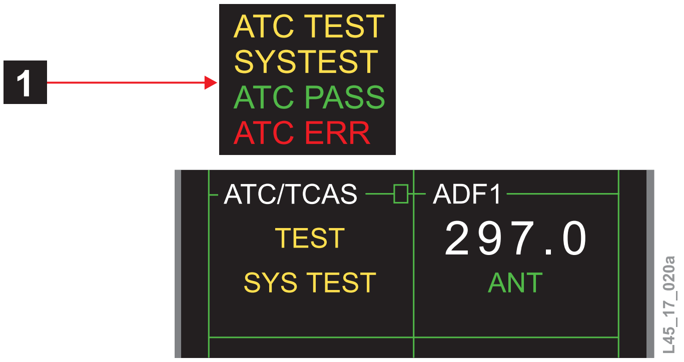


Figure 57 - ATC Test In Progress/Status

1 ATC Test in Progress/Status

- During pilot-activated self-test (PAST) or power on self-test (POST), the normal window annunciations are removed
- ID annunciation is removed, and the reply light (if displayed) reverts to the empty green box. Test and status annunciations are shown in Table 9

Table 9 - PAST or POST Message Definitions

Message	Color	Status
ATC TEST	Yellow	PAST or POST in progress (without TCAS installed)
SYS TEST	Yellow	PAST or POST in progress (with TCAS installed)
ATC PASS	Green	PAST or POST passed
ATC ERR	Red	PAST or POST failed

Surveillance Window

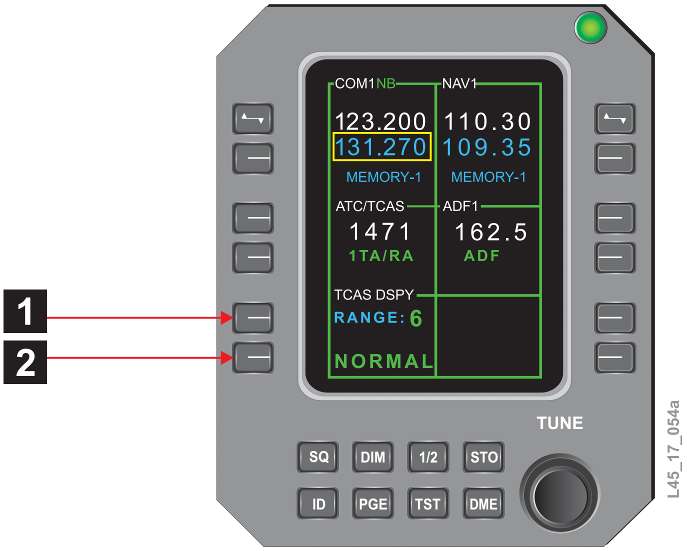


Figure 58 - Surveillance Window

1 TCAS Range Line Select Key

- Push—Sets the range of the TCAS zoom window to 6, 12, 20, 40 nm (80 and 120 nm optional) by toggling the line select key adjacent to the range annunciation, or by rotating either of the tune knobs when the cursor is around the range selection

NOTE **The 80 nm and 120 nm option is available if the Change 7 software is installed in the TCAS computer unit and TCAS RANGE 80/120-enable is selected on the RMU setup page.**

2 Window Size Line Select Key

- Press—
  - Moves the cursor to this line
  - Pressing this key again or turning either tuning knob selects one of the following surveillance window sizes:
    - NORMAL—Traffic ±1200 ft when the system is in AUTO, and ±2700 ft when system is in MANUAL
    - ABOVE—Traffic +7000 ft above to –2700 ft below the aircraft
    - BELOW—Traffic +2700 ft above to –7000 ft below the aircraft
  - These modes are selected by the flight crew on RMU 1 and RMU 2, depending on the vertical path of the aircraft. NORMAL would be selected during level flight. ABOVE or BELOW would be selected during high-rate climbs or descents.

Primary Flight Display Annunciations

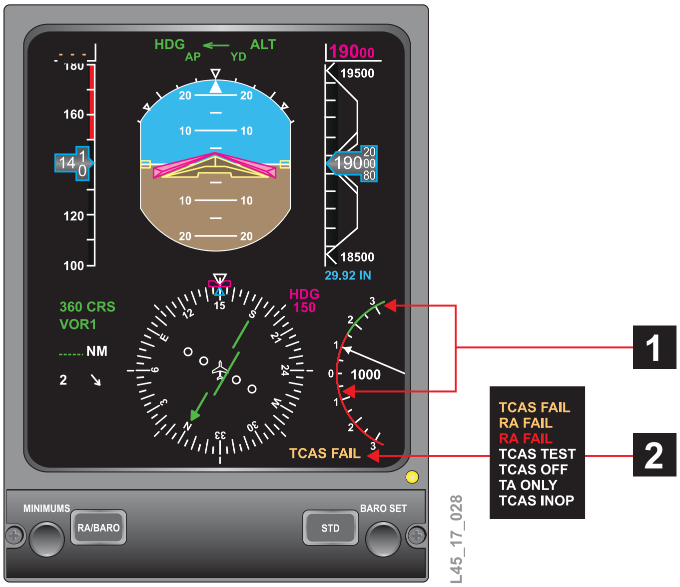


Figure 59 - TCAS Annunciations—PFD

1 Resolution Advisory

- VSI green band (TCAS fly-to zone) indicates vertical speed to be achieved when a corrective action RA is present
- VSI red band (TCAS no-fly zone) indicates vertical speed to be avoided when a corrective action RA is present

2 TCAS Status Annunciation

- TCAS TEST (white)—Located below the VSI display, this annunciation indicates that the TCAS system self-test is in progress
- TCAS OFF (white)—Located below the VSI display, this annunciation indicates that the system is functional but in standby mode, or nonfunctional due to incorrect or failed ADC operation
- TA ONLY (white)—Located in the upper left corner of the TCAS zoom window, this annunciation indicates traffic displays at relative altitudes of –2700 ft to +7000 ft
- TCAS INOP (white)—Located below the VSI display, this annunciation indicates that TCAS is not enabled, but the system has been strapped to accept it

Multifunction Display Annunciations

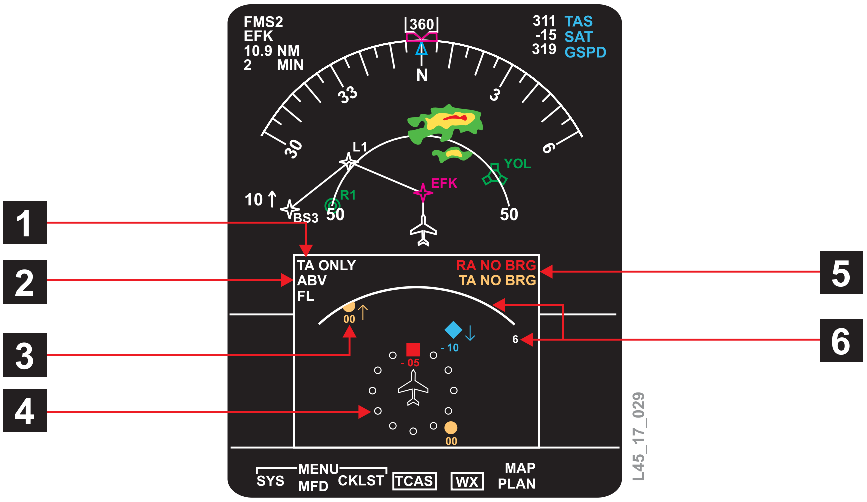


Figure 60 - TCAS Annunciations—MFD

1 TCAS Mode Annunciations

- TA ONLY (white)—No resolution advisory information or guidance is provided
- TCAS (white)—Normal TCAS system operation (default TCAS message)
- TCAS FAILURES (white)—At the end of each self-test, if any part of the self-test fails, a description of the failure displays
- TCAS OFF (white)—System is functional but in standby mode, or non-functional due to incorrect or failed ADC operation
- TCAS TEST (white)—TCAS system self-test is in progress

2 TCAS Altitude Display

- ABV (white)—Traffic displays at relative altitudes of –2700 ft to +7000 ft
- BLW (white)—Traffic displays at relative altitudes of –7000 ft to +2700 ft
- FL (white)—Flight level mode has been selected. All traffic altitudes display in three-digit flight level format (i.e., 19,000 ft displays as 190)

3 Traffic Symbols

- Traffic symbols are shown in Fig. 61

4 2NM Range Ring

- Indicates—
  - When the selected TCAS range is less than 20 nm, the 2 nm range ring is displayed
  - At ranges greater than 20 nm the range ring is removed

5 NO Bearing Target Readout

- Indicates—
  - RA NO BEARING (Red) TCAS is unable to determine bearing of intruder (collision threat: 15 to 35 seconds from own aircraft position)
  - TA NO BEARING (Amber) TCAS is unable to determine bearing of intruder (potential hazard: more than 15 to 35 seconds from own aircraft position)

6 TCAS Range Display

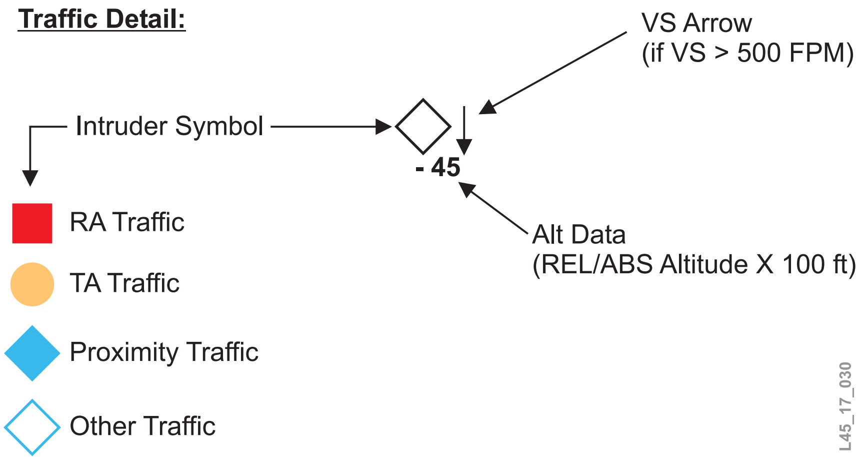


Figure 61 - Traffic Symbols

Enhanced Ground Proximity Warning System

GPWS Switches (GPWS Installation Only)

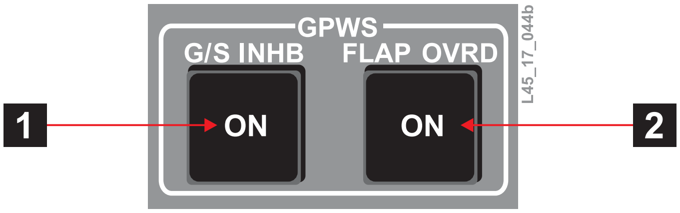


Figure 62 - GPWS Switches

1 G/S INHB Switch Indicator

- Press—
  - After descending below 2000 ft radio altitude, inhibits the “Glideslope...” aural alert sounds and the BELOW G/S annunciator illuminates

- G/S INHB cancels (ON extinguishes) prior to the next approach, provided the aircraft has descended below 30 ft or climbed above 2000 ft AGL
- ON Illuminated—Glideslope inhibit feature has been selected

2 FLAP OVRD Switch Indicator

- Press—Inhibits the Mode 4 “Too Low Flaps” aural warning by simulating the flaps in the landing configuration (40°)
- ON not illuminated—Normal setting, the “Too Low Flaps” aural warning is enabled
- ON illuminated—Override setting, the aural warning and associated PULL UP annunciators are inhibited

EGPWS Switches (EGPWS Installation)

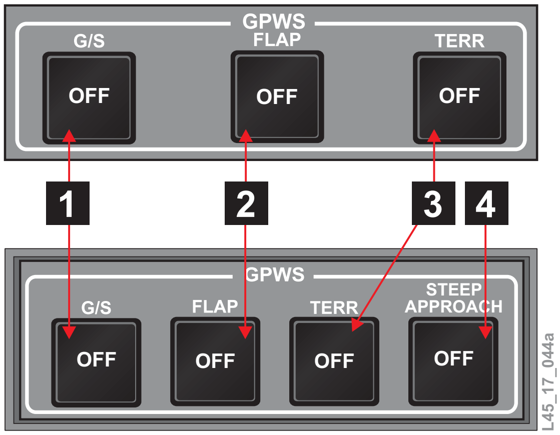


Figure 63 - EGPWS Switches

1 G/S Inhibit Switch Indicator

- Press ON—Inhibits Mode 5 visual and aural alerts (illuminates switch)

2 FLAP Override Switch Indicator

- Press ON—Inhibits the Mode 4 “Too Low Flaps” aural warning, GPWS FLAP OVRD CAS message displays, and the aural message “Landing Flaps” sounds (illuminates switch)

3 TERR Inhibit Switch

- Press ON—Terrain awareness and terrain clearance floor features of the EGPWS are inhibited, aural alert “Terrain Off” is sounded, and the white message TERR INHB is displayed on the upper left corner of the MFD (illuminates switch)

4 STEEP APPROACH Switch

- Press ON—Modifies the excessive sink rate mode to prevent an aural warning during published steep approaches

GPWS Annunciators

GPWS annunciators are located either outboard of DU1 and DU4 on older models, or will appear on the PFD attitude indicator on latter models.

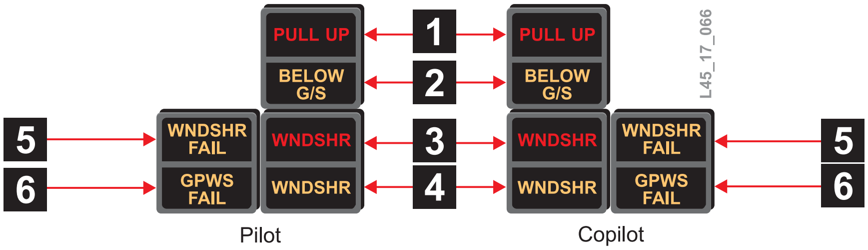


Figure 64 - GPWS Annunciators

1 PULL UP Annunciators

- Illuminated (in conjunction with Modes 1, 2, 3, and 4)—
  - Modes 1 and 2—In conjunction with the “Sink Rate,” “Terrain, Terrain,” and “Pull Up” aural warnings
  - Mode 3—In conjunction with the “Don’t Sink” aural warning
  - Mode 4—In conjunction with the “Too Low... (Gear, Flap, or Terrain)” aural warning

2 BELOW G/S Annunciators

- Illuminated—
  - Indicate that glideslope deviation is more than 1.3 dots below the glideslope
  - BELOW G/S annunciation is always given in conjunction with the “Glideslope” aural alert
  - BELOW G/S annunciation and the aural alert can be inhibited using the G/S INHB switch

3 WNDSHR Annunciators (Red)

- Illuminated—
  - Indicate decreasing headwind (or increasing tailwind) and vertical downdrafts associated with windshear
  - Always in conjunction with a siren (optional) and the “Windshear, Windshear, Windshear” aural warning

4 WNDSHR Annunciators (Amber)

- Illuminated—Indicate increasing headwind (or decreasing tailwind) and vertical updrafts typically associated with the leading edge of microburst windshears

5 WNDSHR FAIL Annunciators (Amber)

- Illuminated—
  - Windshear monitor detects loss of power or loss of inputs required for windshear monitoring functions (such as the stall warning vane)
  - Also illuminates during system self-test

6 GPWS FAIL Annunciators (Amber)

- Illuminated—
  - GPWS monitor detects a loss of 28-VDC power or loss of inputs required for GPWS functions (such as air data system, radio altimeter, etc.)
  - Also illuminates during system self-test

Terrain Awareness and Alerting Display (EGPWS Only)

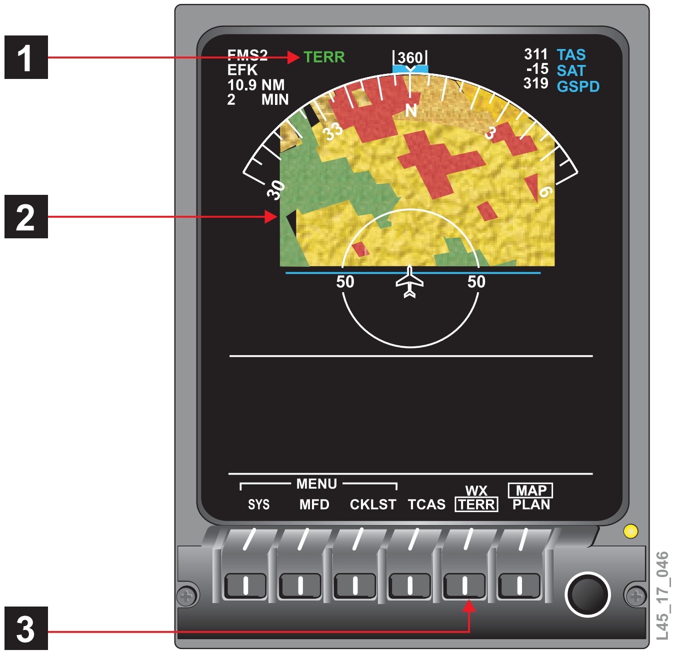


Figure 65 - Terrain Awareness and Alerting Display

1 EGPWS Annunciations

- EGPWS annunciations are shown in Table 10

Table 10 - EGPWS Annunciations

Annunciation	Description
TERR INHIB	TERRAIN display and aurals associated with TERRAIN are inhibited (annunciation in white)
TERR FAIL	TERRAIN failed Terrain is no longer displayed
TERR TEST	EGPWS in test mode
TERR N/A	TERRAIN map not available
TERR	TERRAIN map selected for display

2 EGPWS Terrain Display

- Pop-up mode automatically displayed—Aircraft in imminent danger due to ground proximity (Table 11)

Table 11 - EGPWS Terrain Display Annunciations

Terrain Elevation Relative to Aircraft	Terrain Color
Terrain is 2000 ft or more above the aircraft	**RED/ BLACK MIXTURE**
Terrain is 1000 to 2000 ft above the aircraft	**YELLOW/ BLACK MIXTURE**
Terrain is 0 to 1000 ft above the aircraft	LIGHT YELLOW/ **BLACK MIXTURE**
Terrain is 0 to 1000 ft below the aircraft	**LIGHT GREEN/ BLACK MIXTURE**
Terrain is 1000 to 2000 ft below the aircraft	VERY LIGHT GREEN/ **BLACK MIXTURE**

3 MFD Terrain Display Selection

- Push—
  - Selects terrain for display
  - EGPWS sends terrain data to replace weather display with terrain information

Weather Radar System

Arc Display

Most of the arc display annunciations are the same as for full compass HSI display. When the HSI ARC display is selected by pushing the WX button, the course pointer can be rotated to nearly off-scale (not visible). The course/track digital readout is still available.

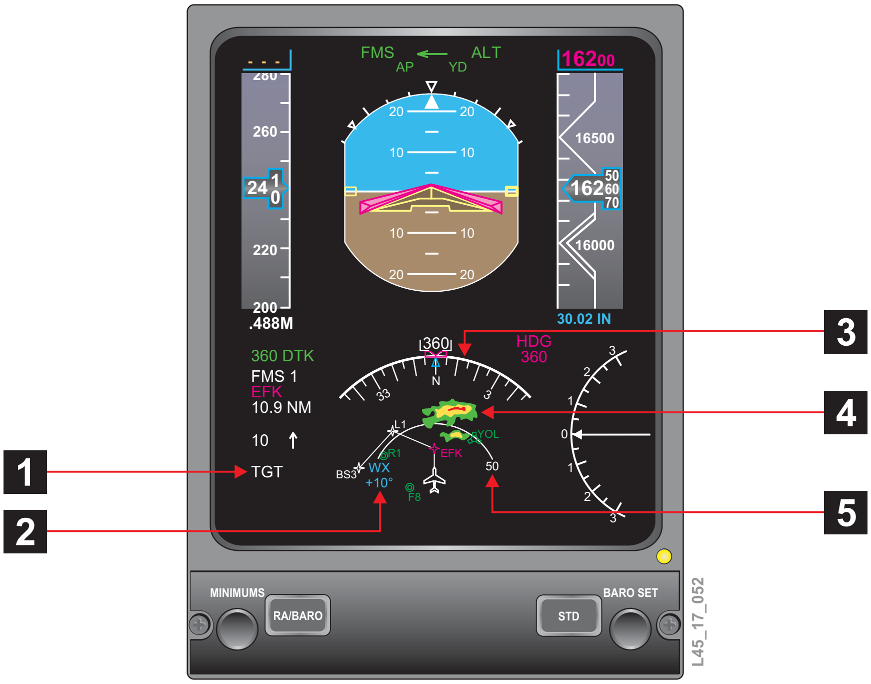


Figure 66 - Weather Radar Information—PFD or MFD

1 Weather Radar TGT and Warning Annunciation

- Displays—
  - TGT in white when it is enabled
  - TGT turns to amber when activated, flashes for 10 seconds, then remains steady amber (Table 12)

Table 12 - Weather Warning Annunciations

CAS Message	Conditions/Parameters
VAR	Variable gain
TGT	Target alert enable
TGT	Target alert enabled and level 3 weather return detected in forward 15° of antenna scan

2 Weather Radar Modes and Tilt Angle

- TILT angle—Cyan number with + (up) or – (down) sign
- Weather radar mode annunciations (Table 13)—
    - All modes are annunciated in this area except target alert (Fig. 65)
    - Amber VAR is displayed above the mode annunciation when radar gain is selected

Table 13 - Weather Radar Mode Annunciations

R/T Mode	Mode Annunciation and Color
OFF	WX
R/T in warmup	WAIT
REACT mode	RCT
Ground clutter reduction[1]	**GCR**
RCT and GCR modes active1	**GR/R**
Forced standby	FSTBY
Standby	**STBY**
Test mode	TEST
Weather mode	**WX**
Variable	**VAR**
Weather and turbulence1	WX/T
RCT and turbulence1	**R/T**
Ground map mode	GMAP
Flight plan mode	FPLN
R/T fail	**FAIL**
Invalid weather	**WX**
Target armed	**TGT**
Target warning	**TGT**

1. PRIMUS® 880 weather radar system option

3 Arc Display

- Most of the arc display annunciators are the same as for full compass HSI display. When the HSI ARC display is selected by pushing the WX button, the course pointer can be rotated to nearly off-scale (not visible). The course/track digital readout is still available.

4 Weather Radar Return

- Rainfall rate colors are shown in Table 14

Table 14 - Rainfall Rate Color Cross-Reference

Rainfall Rate		Intensity	Color
> 2.1 in./hr	> 50 mm/hr	Very heavy	MAGENTA
.5 to 2.1 in./hr	12 to 50 mm/hr	Heavy	RED
.17 to .5 in./hr	4 to 12 mm/hr	Less severe	YELLOW
.04 to .17 in/hr	1 to 4 mm/hr	Moderate	GREEN

5 Weather Radar Range

- Half range ring and value are controlled by the weather radar controller, regardless of weather WX is selected on the display controller
- Half ranges are 2.5, 5, 12.5, 25, 50, 100, 150, 250*, 500*
  * Not available if WX is selected from the display controller

Weather Radar Controller

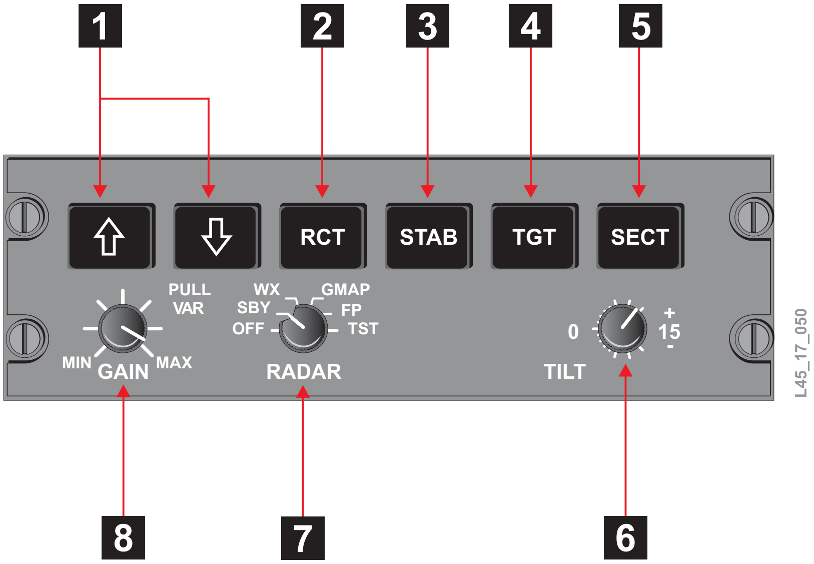


Figure 67 - Weather Radar Controller

1 Up and Down Range Buttons (momentary)

- Press—
  - Up arrow selects increasing ranges
  - Down arrow selects decreasing ranges

  - WX ranges can be set from 5 to 300 nm full scale on both the MFD and PFDs

NOTE **For dual controller installations, the weather radar range is controlled by the onside weather radar controller.**

2 RCT (REACT)—Rain Echo Attenuation Compensation Technique Button

- Press—Selects the RCT mode
- RCT is a submode of the WX mode, and selecting RCT forces the system to a preset gain
- When RCT is selected, the RCT legend is displayed on the PFD or MFD
- RCT circuitry compensates for attenuation of the radar signal as it passes through rainfall
- Cyan field indicates areas where further compensation is not possible
- Any target detected within the cyan field cannot be calibrated and should be considered severe weather

3 STAB (Stabilization) Button

- Press—Selects or deselects the stabilization function that automatically compensates for aircraft roll and pitch maneuvers

4 TGT (Target) Button

- Press—
  - TGT button enables and disables the radar target alert mode
  - Target alert is selectable in all but the 300-mi range

NOTE **Target alert mode monitors for red level or greater targets beyond the displayed range within ±7.5° of heading.**

5 SECT (Sector) Button

- Press—Selects (toggles) either the normal 4second/120º scan, or the faster update 3 second/60º sector scan

6 TILT Knob

WARNING **To avoid flying under or over storms, frequently select manual tilt to scan both above and below the aircraft's flight level. Always use manual tilt for weather analysis.**

- Rotate—Sets the tilt angle of the antenna beam with relation to the aircraft longitudinal axis
  - Clockwise (CW) rotation tilts the beam upward to +15º, and counterclockwise (CCW) rotation tilts the beam downward to -15º
  - Digital readout of the antenna tilt angle is displayed on the MFD

7 RADAR Mode Knob

CAUTION **Weather type targets are not calibrated when the radar is in the GMAP mode. Because of this, the pilot should not use the GMAP mode for weather detection.**

- OFF—Turns the radar system off. An amber WX displays in the MFD mode field
- SBY (standby)—Radar system is placed in standby, a ready state, with the antenna scan stopped. The transmitter is inhibited, and the display memory is erased. A STBY(green) is displayed in the MFD mode field
  - If SBY is selected before the warmup period is over (approximately 45 seconds), a WAIT (green) legend is displayed in the MFD mode field. When the warmup period is over, the system automatically switches to the STBY (green) mode
- WX (weather)—Selecting WX places the radar system in the weather detection mode. The system is fully operational and all internal parameters are set for enroute weather detection
  - If WX is selected before the initial RTA warmup period is over (approximately 45 seconds), a WAIT (green) legend displays. In the WAIT (green) mode, the transmitter and antenna scan are inhibited and the memory is erased. When the warmup period is over, the system automatically switches to WX mode, and WX (green) displays in the MFD mode field
- GMAP—Selecting the GMAP position places the radar system in ground mapping mode. The system is fully operational and all internal parameters are set to enhance returns from ground targets (see Fig. 35 “GMAP Mode” on page 43).
- FP (flight plan)—Not enabled in Learjet 40/45 aircraft

NOTE **When weather is not selected for display, the MFD has its own range control. The PFD does not have a separate range control.**

- TEST—Selects the radar test mode. A special test pattern is displayed to verify system operation. The TEST (cyan) legend displays in the MFD mode field

8 GAIN Knob

WARNING **Hazardous targets are eliminated from the display with low settings of variable gain.**

- Push—System enters the preset, calibrated gain mode. Calibrated gain is the normal mode and is used for weather avoidance. In calibrated gain, the rotary function of the GAIN control is disabled
- Pull—
  - System enters the variable gain mode. Variable gain is used for additional weather analysis and for ground mapping. In the WX mode, variable gain can increase receiver sensitivity over the calibrated level to show very weak targets, or it can be reduced below the calibrated level to eliminate weak returns
    - In the GMAP mode, variable gain reduces the level of strong returns from ground targets
    - Minimum gain is set with the control at its fully CCW position. Gain increases as the control is rotated in a CW direction from full CCW to the 12 o'clock position. At the 12 o'clock position, both the gain and the sensitivity time control (STC) are at their maximum values. Additional CW rotation removes STC. At the full CW position, the gain is at maximum and the STC is at minimum
    - STC reduces the receiver gain at the start of the trace, and increases it as the more distant returns are received. With STC, a uniform display of cell strength is displayed for both near and distant cells
    - Variable VAR (amber) legend annunciates variable gain. Selecting RCT or TGT forces the system into preset gain. Preset gain is not annunciated

Flight Management System

CDU (Universal)

Figure 68 - Control Display Unit

1 CDU Display

- 5-in. diagonal flat-panel display with color display
- CDU displays various colors with different meanings (Table 15)

Table 15 - Universal CDU Color Logic

Color	Logic
GREEN	Page title Normal data Key data Old message Active frequency
GRAY	Deselected data Manual data
YELLOW	Unverified data Cautions Windows
MAGENTA	Current leg data (TO data)
WHITE	Available options Unavailable options New message
CYAN	Submodes Preselects Recall frequencies
SALMON	Fixed text (labels)
RED	Warnings
BROWN	Lines

2 Line Select Keys

- Press—Positions the cursor to input desired data using alphanumeric keys (pressing ENTER completes the entry)

3 Function Keys

- DATA key press—
  - Allows data input to various FMS operations
  - Obtains information and status about the FMS, its NAV database, and the attached sensors which operate with the FMS
  - Selects and deselects individual NAV sensors
  - Makes additions, deletions, or changes to pilot-defined locations
- NAV key press—
  - Accesses the navigation function display pages
  - Normally two NAV pages are available
  - When another NAV mode such as APPROACH or HEADING is selected, there are two or more display pages which are cycled through by pressing the PREV or NEXT function keys

- VNAV key press—
  - Accesses the VNAV function and allows the flight crew to define a desired vertical flight profile along the flight plan route
  - Once the data is entered, navigation computer unit (NCU) computes the aircraft deviation from that profile for display
- DTO key press—
  - Accesses the “direct-to” function which is specifically dedicated to changing the flight plan in response to “direct-to” clearances
  - If the “direct-to” location is off the flight plan, provisions are made to link the location into the flight plan
- LIST key press—
  - Provides a list of relevant options for the data to be entered
  - While performing data entry, pressing the LIST key presents a list of selections appropriate to the entry being made
- FUEL key press—Accesses all the fuel management functions
- FPL key press—
  - Accesses the flight plan page or accesses stored arrivals and routes
  - Flight plan pages may be accessed to construct a new flight plan, alter the current flight plan, or to insert a SID, STAR, or approach into the flight plan
- PERF key press—
  - Accesses PERF 1/X
  - PERF 1/1 provides a synopsis of pertinent inflight performance information
  - Some aircraft use advanced performance features, with pages for takeoff, climb/cruise, and landing data
- TUNE key press—
  - Accesses the main tune page functions
  - Main TUNE page helps tune the aircraft radios COM, NAV, ADF and ATC, select and store preselected frequencies for each radio, and view the selected frequencies (active and preset) for each radio
- MENU key Press—Presents a list of alternate formats or options for the following displayed modes:
  - FUEL
  - FPL
  - TUNE
  - Small boxed letter “M” appears on the title line of any page in which the MENU key is active

4 Alphabetic and Numeric Keyboards

- Press—Inputs characters into a variable field marked by the cursor
- Alphabetic keys are located immediately below the function keys and the numeric keys are to the rightEnables data input and control of the display

5 Control Keys

- ON/OFF – DIM key press—
  - Provides power-up, display dimming, and unit shutdown functions
  - During initial power-up, energizes the system and initiates self-test of the navigation computer
  - After the system is turned on, causes a control window to be displayed on the right side of the active page with the options BRIGHT, DIM, CANCEL, DISPLAY, and OFF selectable using the line select keys

NOTE

BRIGHT/DIM provides display dimming only and does not dim the key backlighting. Key backlighting is dimmed along with aircraft instrument lights.

Press DISPLAY line select key. Overlay shows UP, DOWN, CANCEL to allow parallax adjustment between screen and line select keys.

- PREV key press—Cycles backward, one page at a time, through multiple pages of the same mode
- NEXT key press—Cycles forward, one page at a time, through multiple pages of the same mode
- BACK key press—When the cursor is over a data entry field, serves as a delete or backspace key
- ± “State Change” key—
  - Used in conjunction with the alphanumeric keys to enter data
  - Press—Changes + to –, N to S, and L to R. It is also used in strictly alphanumeric fields like a dash or period
- ENTER key press—
  - Stores input data in memory
  - Completes entry of data and is required for all data entries
- MSG key—
  - When a system message becomes active, “MSG” appears on the far right side of the top line on the display
  - Press—Causes the MESSAGE page to display, showing the active messages

- Abnormality messages may require corrective action from the crew; a box around the procedures following the message definition indicates a crew action
- For messages that are of an advisory nature, no action is specified
- After the messages are viewed, the display may be returned to the previous page by selecting the RETURN option on the MESSAGE page, by pressing the MSG key again, or by pressing the BACK key

NOTE **Refer to the Universal Operator's Manual to find the detailed list of messages with meanings and action required.**

PFD Display (FMS Annunciations)

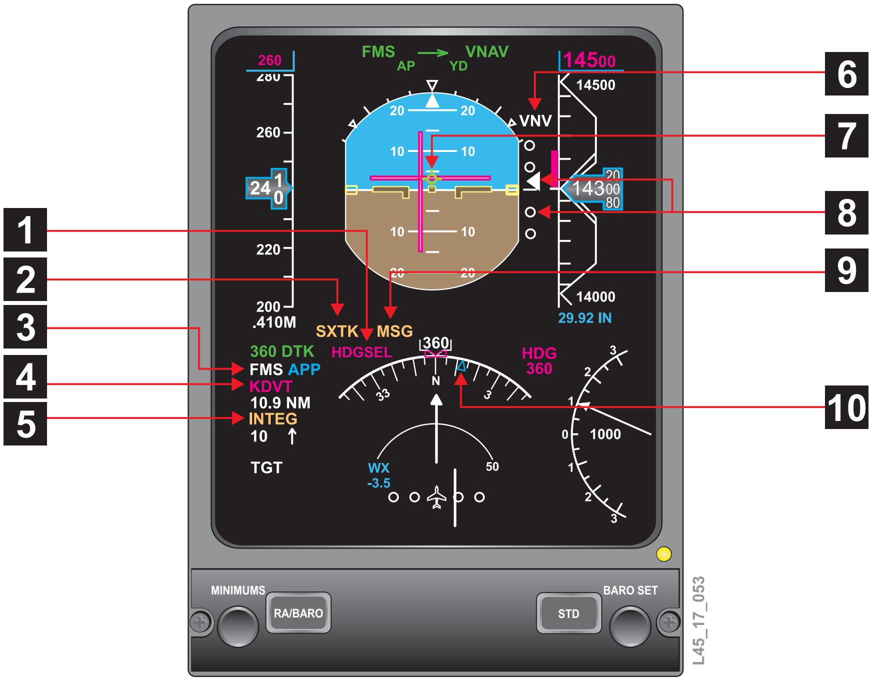


Figure 69 - PFD Display (FMS Annunciations)

1 FMS Heading Select Annunciation

- When heading guidance is supplied from the FMS, a magenta FMS heading annunciation is displayed:
  - Heading select (HDGSEL)
  - Heading intercept (HDGINT)
  - Procedural heading (PRCHDG)

2 Crosstrack

- SXTK (amber)—Displayed during the time the FMS is in the selected crosstrack mode

3 FMS Scaling Annunciation

- FMS scaling annunciations (cyan) are shown on Table 16

Table 16 - FMS Scaling Annunciation

Message	Logic
APP	Displayed during time the FMS is in approach mode
TERM	Displayed during time the FMS is in command or procedural heading mode

4 “TO” Waypoint

5 FMS Status Annunciators

- FMS status annunciators (amber) are shown in Table 17

Table 17 - FMS Status Annunciators

Message	Logic
WPT	Displayed in conjunction with a WAYPOINT ALERT message on the CDU ON and steady— • Alerts to a lateral waypoint change and occurs 15 seconds prior to the changeover waypoint while enroute and 5 seconds during approach ON and flashing— • Alerts to a vertical waypoint change and occurs 15 seconds prior to the changeover waypoint while enroute and 5 seconds during approach
INTEG	Displayed if the GPS horizontal integrity limits (HIL) for the current phase of flight have been violated During approach active, or for an approach for which GPS is being used, this indication appears if receiver autonomous integrity monitoring (RAIM) is not available
DGR	Degraded mode
DR	Displayed if the FMS is not receiving navigation sensor input from any other source, and the FMS is determining its position solely from dead reckoning (DR)

6 Vertical Track Alert (VTA) Annunciation

- VTA (amber) is displayed above the vertical deviation scale in place of VNAV
- When the vertical track alert is triggered, input comes from the selected FMS

7 Flightpath Angle (FPA) and Trend

- Green symbol projects the actual vertical and lateral track of the aircraft
- FPA trend symbol green (>) indicates the acceleration along the flight path
- FPA is selected from the display controller
- FPA display is computed from AHRS input and FMS ground speed

8 Vertical Deviation Display

- White deviation scale is displayed on the right side of the attitude sphere
- Pointer is selected by the display controller from any one of the following sources:
  - ILS glideslope (green pointer)
  - VNAV from the FMS (white pointer)
- Green GS label is displayed on the scale when the vertical deviation is supplied by an ILS glideslope, and a white VNAV label is displayed when the vertical deviation is supplied by an FMS

NOTE **If both sides are using the same navigation source, the pointer and label are yellow.**

- When invalid information is present from the ILS glideslope receiver, the pointer is removed and an X is drawn through the scale
- The scale, label, and pointer are removed from invalid FMS data

9 FMS Message Annunciation

- MSG—Alert indication that an FMS message is on the CDU

10 Drift Bug

- Drift bug is a cyan triangle that is output from the FMS
- With respect to the lubber line, the drift angle bug annunciates drift angle left or right of the desired track
- Drift angle, with respect to the compass card, annunciates the aircraft's actual track
- Bug moves around the inside of the compass card in either FULL, ARC, or MAP modes
- With a valid FMS, the drift bug is displayed regardless of the NAV source selected

MFD Display—Map Mode (FMS Annunciations)

Map Mode Format

The MAP mode format is the power-up default display on the MFD. It is oriented to magnetic north (in contrast to the PLAN mode, which is oriented to true north). Current heading is always at the top of the display (in contrast to the PLAN mode, where true north is always at the top).

Figure 70 - MFD Display—Map Mode (FMS Annunciations)

1 Navigation Source Annunciation (FMS, FMS 1, FMS 2)

- Displays—Navigation source in white digits

2 Active Waypoint

- Displays—Active waypoint in magenta digits

3 Distance and Time-to-Go to Active Waypoint

- Displays—Distance and time-to-go to active waypoint in white digits

4 Heading Select Display Arrow

- When the heading bug is off-scale, indicates the shortest direction to the bug’s position in magenta

5 Wind Vector
- Indicates—
  - Wind vector information from the selected FMS in white to the left of the map display
  - Wind angle arrow shows the direction of the wind relative to the airplane symbol in MAP mode
  - Wind vector is referenced to north up in the PLAN mode
  - Associated number indicates wind velocity

6 Pilot Designator
- Remote-mounted joystick and SKP/RCL MFD JSTK submenu functions from the MFD bezel menu change the position of the pilot designator
- Distance and bearing location of the designator relative to its reference point are shown in the lower right corner
- When the designator (the aircraft symbol) is parked in its home position, it is not displayed
- When anchored at a waypoint, it has the same color as the waypoint
- Designer distance/bearing readout is cyan

NOTE **If checklist is selected for display, the joystick cannot be used with the MAP designator.**

7 Aircraft Symbol
- Indicates—
  - Aircraft position relative to actual heading and selected heading
  - Nose of the aircraft is the starting point of an FMS flight plan if it is being displayed

8 Lateral Deviation Digital Display
- FMS lateral deviation is shown as a combination digital display with
  L/R direction
- Displays centered above the systems page display area

NOTE **When the TCAS (optional) or checklist window is active, lateral deviation is not displayed.**

9 MAP/PLAN Bezel Button
- Push to view the MFD MAP mode format

10 Groundspeed (GSPD)

- From the FMS, displayed in white digits

11 Drift Bug

- Cyan drift bug displayed on the compass arc is generated by the FMS
- Position of the bug relative to the compass display represents actual track across the ground
- Position of the bug relative to the heading reference line represents the aircraft drift angle (once the aircraft is established on course)
- Looks and operates like the PFD drift bug

12 Range Rings

- Range rings are displayed to determine the position of radar returns and active flight plan parameters
- Range ring boundary is the compass card arc
- Displays the MFD controller selected range
- Midrange ring is displayed and labeled with the half-range distance (2.5, 5, 12.5, 25, 50, 100, 150, 250*, 500*)
  * Not available if WX is selected for display.

NOTE **When weather radar data is displayed, the radar controller controls the MFD range.**

13 Waypoint and NAVAID Symbols

- Waypoints within the range of selected MAP range are displayed along the flight plan that is output from the FMS (Fig. 71)

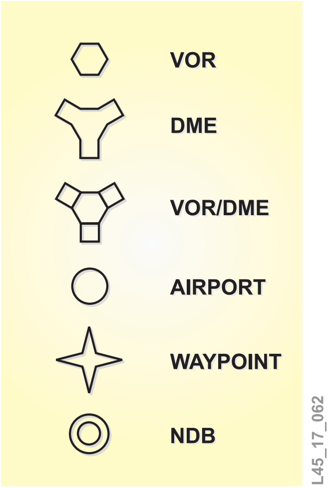


Figure 71 - Waypoint and NAVAID Symbols

- Up to 10 waypoints (one is the FROM waypoint) can be displayed at a time
- Any selected background navaid symbols can be displayed if they are within the selected MAP range (up to eight navaids and four airports)

NOTE **If the FMS flight plan exceeds 10 waypoints, it is not possible to view the entire flight plan on the MFD.**

14 Background Data

- Displays—NAV (green) and/or APT (cyan), as selected from the MFD menu

15 MFD Pilot Designator

- Displays—Designator bearing and distance from present position data

Plan Mode Format

MFD plan mode format is oriented to true north (in contrast to MAP mode, which is oriented to magnetic north). True north is always at the top of the display (in contrast to the MAP mode, where current heading is always at the top). The aircraft symbol is always shown with present position relative to the active flight plan and oriented to true north.

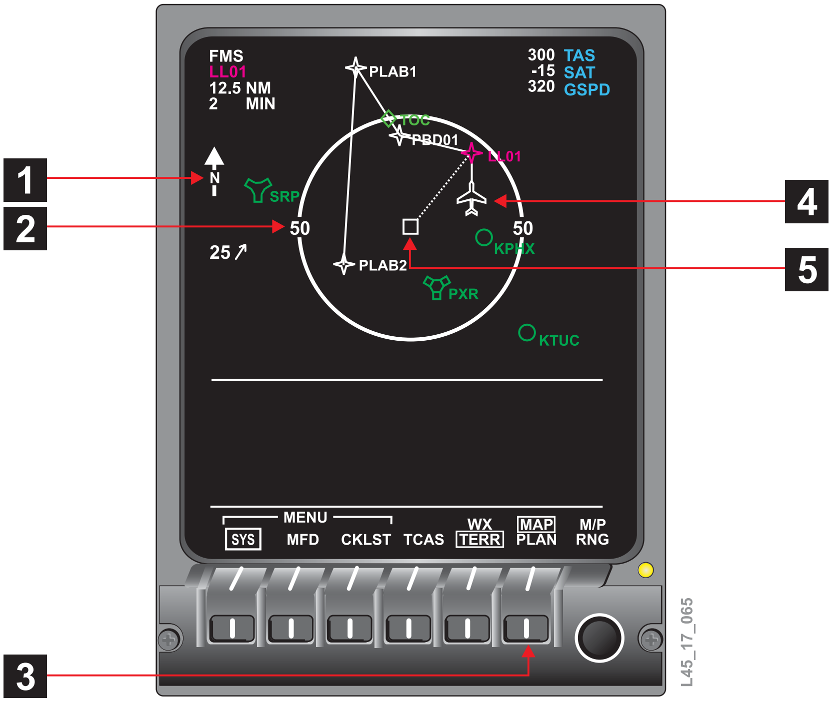


Figure 72 - MFD Display—Plan Mode (FMS Annunciations)

1 North Up Arrow

- Indicates—Display orientation is true north

2 Selected Range Rings

- Range ring is displayed to determine the position of the active flight plan parameters
- Circle radius corresponds to the selected range, and its digital value is displayed on the right and left sides of the range ring
- Range values are 5, 10, 25, 50, 100, 200, 300, 500, and 1000 nm

3 MAP/PLAN Bezel Button

- Push to bring up the MFD plan mode format

4 Aircraft Symbol

- Aircraft symbol moves on the display as a function of aircraft present position
- Aircraft symbol is a visual cue to the actual aircraft position relative to the true north and the active flight plan

5 Pilot Designator

- SKP, RCL, ENT, MFD, JSTK submenu functions and the remote-mounted joystick still function with the designator
- Primary use of the joystick and designator in the PLAN view is to position the circular viewing ring so that either the route being flown or the maneuvering aircraft can be better observed
- This feature is useful in maintaining position orientation in the terminal area while the aircraft is following the final approach vector
- Bearing and distance display of the designator's position relative to its anchor waypoint is also displayed; it operates the same way as the pilot designator in MAP mode

---

CAS Messages

Table 18 - Navigation System CAS Messages

CAS Message	Conditions/Parameters
GPWS FAIL	Ground proximity warning system failed (if installed)
WINDSHEAR FAIL	Windshear system failed (if installed)

Reduced Vertical Separation Minimums

Reduced vertical separation minimums (RVSM) decreases separation of aircraft above FL 290 from 2000 ft to 1000 ft. RVSM airspace is special qualification airspace; the operator and respective aircraft must be approved to operate in it. Upon successful completion of the approval process, the Flight Standards District Office/Certificated Management Office (FSDO/CMO) grants RVSM operational approval by issuing a letter of authorization (LOA) for Part 91 operators or an operations specification for Part 135 operators. For Part 91 operators, the LOA is reissued on a biennial basis.

Operators requesting RVSM operations submit a maintenance and inspection program as part of a continuous airworthiness maintenance program for approval by the FAA. Specific periodic maintenance inspections and rigorous height-keeping performance error isolation and maintenance action are required to maintain RVSM airworthiness. Additionally, specific personnel training, test equipment calibration/ usage, and special documentation are also required.

To assess continuing operational integrity, operators must participate in postoperational verification of aircraft height-keeping performance. Two programs, administered by ARINC, satisfy these requirements. Onboard GPS-based monitoring units (GMUs) or ground radar-based height monitoring units (HMUs) provide these functions. Prior to a GMU verification flight, the operator notifies FAATC and ARINC so that appropriate Mode C and meteorological data is collected. Following the flight, collected data is sent to ARINC for processing. Prior to an HMU overflight, operators must contact the HMU site to verify its operational status and perform HMU monitoring during the flight. Each RVSM-approved aircraft must be successfully monitored using one of the above methods once every two years.

The following equipment is required for RVSM airspace:

- Pitot heater systems installed on all probes
- Two micro air data computers
- Standby altimetry instruments
- Primus 1000 integrated EFIS display system
- Autopilot
- Altitude alerter system
- ATC transponder with Change 7.0 (quantity as required by FAR for airspace)

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PNEUMATICS

Introduction

The pneumatic system provides bleed air from the left and right engine compressor sections of each engine to aircraft systems which use bleed air. Many systems on the Learjet 40/45 require pneumatic power to operate. Engine bleed air is used for airframe anti-icing, environmental control, pneumatic valve control, hydraulic reservoir pressurization, and cabin pressure control system vacuum supply. The pneumatic system provides engine bleed air at the required pressure and temperature to these systems. Low-pressure bleed air, supplemented automatically as required by high-pressure bleed air, is supplied to the environmental control unit to meet environmental control system and pressurization requirements.

Controls and Indications

Pressurization/ Oxygen Control Panel

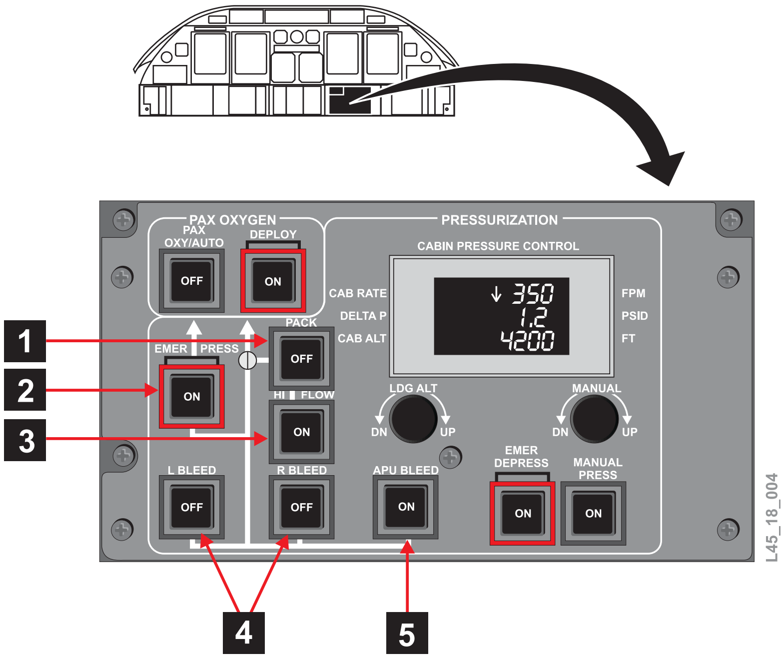

Figure 1 - Pressurization Controls

1 PACK Switch Indicator

- On (blank)—PACK bilevel PRSOV regulates the bleed-air supply pressure to the ECU
- OFF—PACK bilevel PRSOV is closed and engine bleed air is prevented from entering the environmental control unit

2 EMER PRESS Switch Indicator

- ON (if both L and R bleed switches are on)—
  - ECS PRSOV—Closed
  - HP SOV—Closed
  - Emergency pressurization valves—Open
- Off (Blank)—
  - ECS PRSOV—Open
  - HP SOV—Open/Closed
  - Emergency pressurization valves—Closed

3 HI FLOW Switch Indicator

- ON—Pack bilevel PRSOV goes to the fully open position to provide a higher pressure to the ECU
- OFF (Blank)—Pack bilevel PRSOV regulates the bleed-air supply to the ECU to a lower value

4 L and R BLEED Switch Indicators (momentary-action)

- On (blank)
  - ECS PRSOV—Operates in pressure-regulating mode
  - HP SOV—Operates open or closed dependent on thrust lever position
  - EMER PRESS—Armed to be opened by the CPCS or EMER PRESS switch
  - Anti-ice PRSOV—Open/Closed
- OFF—
  - ECS PRSOV—Closed
  - HP SOV—Closed
  - Emergency pressurization valve—Closed
  - Anti-ice PRSOV—Closed (if BOTH bleed valves are selected OFF)

5 APU BLEED Switch Indicator (alternate action)

- ON—APU bleed-air valve is commanded open
- Off (Blank)—APU bleed-air valve is commanded closed

CAS Messages

Table 1 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
L ENG PYLON OVHT	L ENG PYLON OVHT	Respective bleed-air overheat has been detected in the pylon or just inside the tail-cone in the respective left or right system
R ENG PYLON OVHT	R ENG PYLON OVHT	
L RENG PYLON OVHT	L ENG PYLON OVHT	
	R ENG PYLON OVHT	
L BLEED AIR LEAK	L BLEED AIR LEAK	Respective bleed-air leak has been detected in the bleed-air or anti-ice ducts in the respective left or right system
R BLEED AIR LEAK	R BLEED AIR LEAK	
L R BLEED AIR LEAK	L BLEED AIR LEAK	
	R BLEED AIR LEAK	
L BLEED OVHT	Overheat condition detected in the respective bleed-air duct in the respective left or right system.	
R BLEED OVHT		
L R BLEED OVHT		
PACK HI FLOW	Hi-flow switch has been selected ON, and high-pressure (high flow) bleed air is supplied to the environmental control unit	

Description

The pneumatic system consists of two independent engine bleed-air distribution systems (Fig. 2). Each engine can independently supply bleed air for the systems that require it. The source of this air is low- and high-pressure ports on each engine compressor section. This bleed air is controlled and routed through shutoff and regulating valves which are controlled by the environmental control system (ECS) valve controller.

The pneumatic system may be divided into the following major sections:

- Low-pressure bleed-air section
- High-pressure bleed-air section
- High- and low-pressure section
- Auxiliary power unit (APU) bleed-air section

Low-Pressure Bleed-Air Section

Low-pressure bleed air is provided to the following aircraft systems:

- Environmental control unit (for air conditioning and pressurization)
- Emergency pressurization system

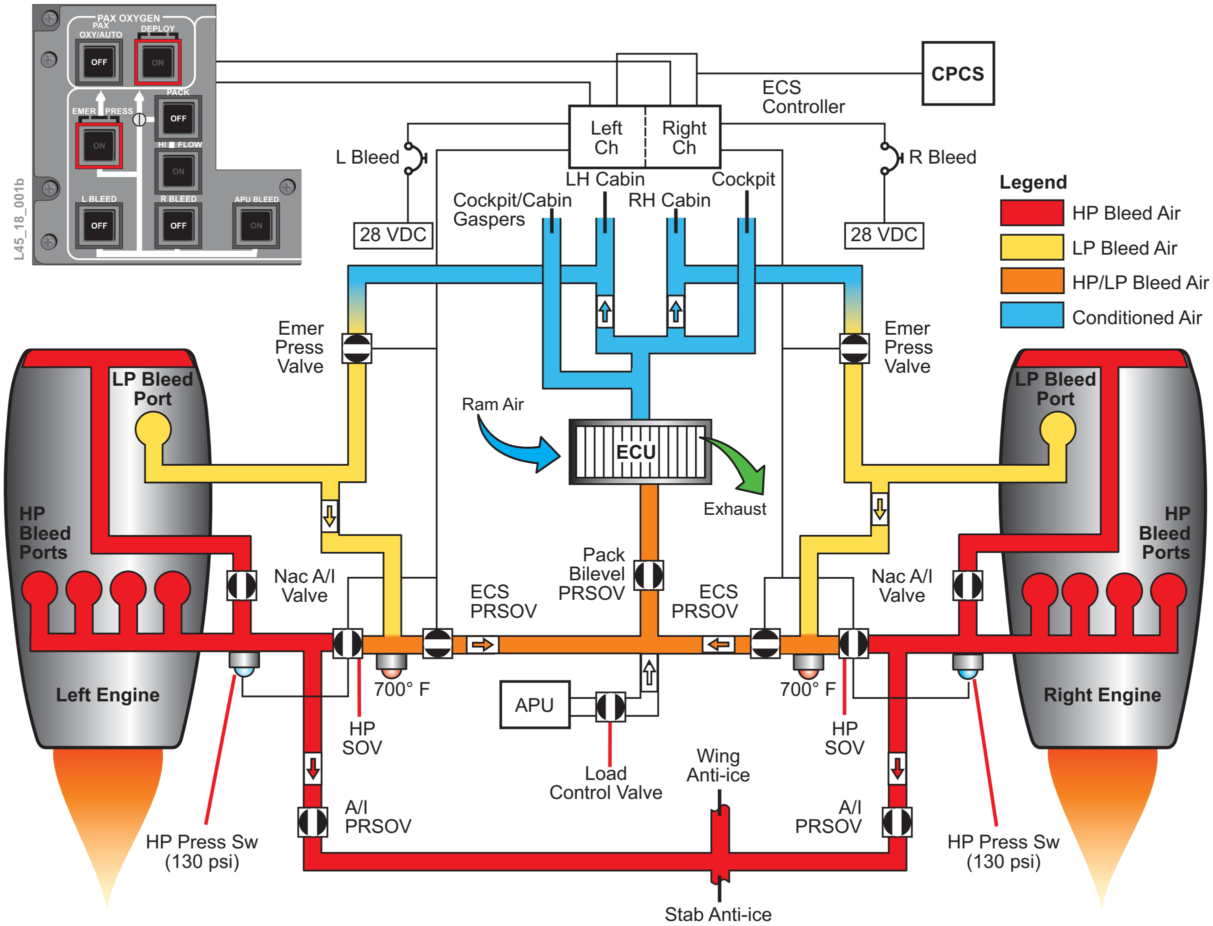

Figure 2 - Bleed-Air Schematic

The low-pressure bleed air is extracted from a port located on the low-pressure compressor of each engine. The low-pressure bleed air is ducted from this port on the inboard side of each engine, through the pylon and into the tailcone. There it joins in a common manifold with the low-pressure ducting from the other engine. Check valves within the ducting prevent reverse flow from the high-pressure port into the low-pressure port and from engine to engine. Low-pressure bleed air can be rerouted directly into the cabin through emergency pressurization valves if a disruption occurs in the normal ECS supply. In this case, the normal bleed-air ducting in the tailcone and the environmental control unit is bypassed.

High-Pressure Bleed-Air Section

High-pressure bleed air is provided to the following aircraft systems:

- Nacelle anti-ice system
- Airfoil anti-ice system
- Wing/stab anti-ice system
- Environmental control unit (if required to maintain pressure)
- Servo air system which distributes regulated bleed air to the following:
  - Hydraulic reservoir
  - Cabin pressurization controller system jet pump
  - Air cycle machine low-limit temperature control valve
  - Cockpit temperature control valve
  - Cabin temperature control valve

The high-pressure bleed air is extracted from four outlets located on the high-pressure compressor section of each engine. Bleed air from the four high-pressure outlets is routed through a manifold on each engine before being ducted through the engine pylons to the left and right high-pressure shutoff valves in the tailcone.

Bleed Airflow

The low and high-pressure bleed-air sections from each engine join in the tailcone into common ducting and the bleed air then passes through the environmental control system pressure regulating shutoff valves (ECS PRSOV) on each side in the tailcone. After passing these valves, the airflow then proceeds to the pack bilevel PRSOV before flowing to the environmental control unit (ECU). The ECU, commonly called a pack, provides air conditioning before the air is distributed into the cabin.

Auxiliary Power Unit Bleed-Air Section

When the aircraft is on the ground, the auxiliary power unit (APU), if installed, may be another source of bleed air for cabin/cockpit heating and cooling. The APU bleed air is ducted into the ECU through the APU control valve and the pack bilevel PRSOV. These valves are controlled by the PACK and APU BLEED switch indicators located on the pressurization control panel and from the APU control panel, which is located on the center pedestal.

Components

Major components in the pneumatic system are:

- Environmental control system valve controller
- High-pressure shutoff valves (HP SOV)
- ECS PRSOV
- Pack bilevel pressure regulating shutoff valve

The pneumatic system has several overheat and leak detection systems which are discussed later:

- Pylon overheat detection system
- Bleed-air duct overheat detection system
- Tailcone leak detection system
- Emergency pressurization valves

Environmental Control System Valve Controller

The ECS valve controller installed in the tailcone is a dual channel computer which provides the circuitry to open or close the following valves:

- HP SOV
- ECS PRSOV
- Emergency pressurization valve

The left and right channels of the controller independently control their respective onside valves. Each of the valves is electrically controlled and pneumatically actuated (electropneumatic).

To determine valve control position commands, each valve controller channel receives the following inputs:

- Bleed-air switch status
- Emergency pressurization switch status
- High-pressure bleed-air pressure
- Cabin altitude
- Engine FIRE PUSH switch indicator status
- Thrust lever angle
- Barometric corrected altitude data
- 28 VDC from L/R essential bus

Each channel additionally provides the following outputs for different pneumatic system functions and indications:

- Emergency pressurization annunciation to illuminate the EMER PRESS switch indicator when either emergency pressurization valve has opened
- Emergency pressurization valve position to the DAU to indicate if these valves are opened or closed
- Emergency pressurization valve control by energizing or deenergizing the solenoid to open or close the valve
- High-pressure shutoff valve control to energize the solenoid to open the valve
- ECS pressure regulator and shutoff valve control to energize the solenoid to close the valve

High-Pressure Shutoff Valves

HP SOVs control high-pressure bleed air from the engines into the high- and low-pressure section of the pneumatic system. Controlled by the ECS valve controller, they are a part of the low-pressure/high-pressure bleed-air switching function. These valves are electrically energized in the open position, spring-loaded to the closed position, and pneumatically actuated. The high-pressure shutoff valves are electrically deenergized closed when the corresponding L or R BLEED switch is OFF.

ECS Pressure Regulating and Shutoff Valves

The ECS PRSOVs provide balanced bleed-air sharing between engines for specific operating valve inlet pressures. The valves may be opened or closed by the ECS valve controller. These valves are electrically controlled and pneumatically actuated. During high-altitude operation, when the low-pressure bleed-air pressure drops below 20 psi, the valve moves to the full open position to maintain sufficient airflow for cabin pressurization. When either the L or R BLEED switch is selected on, the respective ECS PRSOV electrically deenergizes to the OPEN position. These valves normally remain in the open position during flight. When the L or R BLEED switch is selected OFF, the corresponding ECS PRSOV is electrically energized from the ECS valve controller to the closed position.

Pack Bilevel Pressure Regulating and Shutoff Valve

The pack bilevel pressure regulating and shutoff valve controls the pressure of the air into the ECU which provides air conditioning and pressurization to the cabin. The pack bilevel PRSOV is controlled through the PACK and the HI FLOW switches located on the pressurization control panel. The low-pressure setting ensures bleed-air economy, while the high setting ensures sufficient pack inlet pressure for proper cooling and heating.

PACK Switch

When the PACK switch indicator is turned on, the pack bilevel PRSOV is deenergized to the open position. The valve regulates the engine or APU (if installed) bleed-air supply pressure to the ECU for cabin pressurization and temperature control.

If the PACK switch is selected to OFF, engine bleed air is prevented from entering the ECU. In this case, pressurization of the cabin through the emergency pressurization system is still possible.

HI FLOW Switch

The HI FLOW switch indicator, located beneath the PACK switch indicator, signals the PACK bilevel valve to go to the high-pressure setting to allow increased airflow through the ECU. The normal position is off with no legend illuminated in the switch. When selected on, the switch indicator illuminates ON, and a white PACK HIGH FLOW message is posted on the CAS.

Operation

Normal Operation

The bleed-air system is controlled by the cockpit mounted L and R BLEED switches. The environmental control system valve controller provides control of the left and/or right emergency pressurization valve, HP SOV, and ECS PRSOV when the L and/or R BLEED switch is on. When the L and/or R BLEED switch is OFF, the ECS valve controller commands the previous three valves on the left or right side to the closed position.

During normal operation, the ECS is supplied with low-pressure bleed air, and the anti-icing system and pneumatic controls are supplied with high-pressure bleed air. However, some operating situations require that the ECS be supplied with high-pressure bleed air. This is accomplished by bleed-air control logic in the ECS valve controller which opens and closes the high-pressure shutoff valve. A pressure switch, a throttle signal, and the altitude determine how to adjust these valves.

Each channel of the ECS controller receives inputs of air pressure from a pressure switch located in the corresponding high-pressure duct. If the air pressure is below 115 psi, the ECS controller, after considering inputs from the thrust lever angle position and/or altitude energizes the high-pressure shutoff valve to the fully open position. If the air pressure is over 130 psi, the ECS controller, after considering inputs from the thrust lever angle and altitude, deenergizes the HP SOV to the fully closed position.

At low engine power settings, the high-pressure port pressure and temperature are relatively low and air flows through the high-pressure bleed line and the HP SOV, forcing the ECS shutoff valve toward closed. As engine power is increased, the high-pressure air is shut off when adequate pressure is available from the low-pressure port. This ensures that the minimum amount of cooling is required to obtain air at a suitable temperature and that bleed air of adequate pressure is available to the systems that require it.

Non-normal Operation

Engine Fire Suppression System Activated

If the engine FIRE PUSH switch indicator is depressed, each channel of the ECS valve controller provides outputs that automatically energize the ECS PRSOV to the closed position to stop the flow of bleed air into the cabin.

Emergency Pressurization System Activated

The ECS valve controller receives inputs of the following items:

- Bleed-air switch status
- Emergency pressurization switch status
- Cabin altitude
- Barometric corrected altitude data

When the emergency pressurization system is activated:

- HP SOVs are electrically deenergized closed
- ECS PRSOV closes

Each channel additionally provides the following outputs for different pneumatic system functions and indications:

- Emergency pressurization annunciation to illuminate the EMER PRESS switch indicator when either emergency pressurization valve is open
- Emergency pressurization valve position to indicate if these valves are opened or closed
- Emergency pressurization valve control by energizing or deenergizing the solenoid to open or close the valve
- HP SOV control to energize the solenoid to open the valve
- ECS PRSOV control to energize the solenoid to close the valve

Electrical System Failure

The following actions occur if an electrical system failure occurs:

- HP SOV is spring-loaded to the closed position and closes
- ECS SOV valve is electrically energized closed; therefore, a loss of electrical power causes the valve to fail open, providing bleed air only from the low-pressure port on the engine
- Pack bilevel PRSOV is electrically energized closed; therefore, loss of electrical power causes the valve to fail in the open position
- EMER PRESS is spring-loaded to the closed position and closes

Overheat and Leak Detection Systems

The overheat and leak detection systems alert the flight crew if a bleed-air leak and/or overtemperature condition occurs in the pneumatic system. The pneumatic system has several overheat and leak detection systems which are discussed:

- Pylon overheat detection system
- Bleed-air duct overheat detection system
- Tailcone leak detection system
- Emergency pressurization valves

The overheat and leak detection system has the following sensors located at different locations in the pneumatic system to detect possible overheat conditions and leaks:

- Four pylon overheat thermostat switches
- Four tailcone overheat thermostat switches
- Two bleed-air overtemperature switches

Pylon Overheat Detection

There are four overtemperature switches for each engine pneumatic system:

- Two in each pylon
- Two on each side of the tailcone adjacent to the pylons

If an overheat condition occurs at any of the sensor locations:

- Red L or R ENG PYLON OVHT message appears on the CAS (indicating a bleed-air leak has occurred in the pylon or just inside the tailcone on the respective engine)
- Red L or R ENG PYLON OVHT annunciator illuminates on the CWP

If an overheat condition occurs, at least one sensor on both the left and right sides of the aircraft:

- Red L R ENG PYLON OVHT message appears on the CAS (indicating a bleed-air leak has occurred in the pylon or just inside the tailcone on both respective engines)
- Both the L and R ENG PYLON OVHT annunciators illuminate on the CWP

Bleed-Air Duct Overheat Detection

A bleed-air overtemperature switch is installed in the bleed-air supply duct just downstream of the HP SOV on each side of the tailcone. If the bleed-air supply duct overheats, an amber L or R BLEED OVHT message is posted on the CAS.

Tailcone Bleed-Air Leak Detection System

The bleed-air leak detection system monitors for bleed-air leaks along the tailcone and anti-ice system ducts to alert the crew of a bleed-air or anti-ice duct leak. Detection of a bleed-air leak in the tailcone is through heat sensing elements routed along the ducts. The elements are the same loop-type elements as used for engine fire detection. Left and right sensing elements monitor for bleed-air leaks in the ducts from the high-pressure shutoff valves on each side, inboard to the pack bilevel PRSOV. If a leak occurs between either the HPSOV and the ECS check valve downstream of it:

- Corresponding red L or R BLEED AIR LEAK message is posted on the CAS
- Corresponding red L or R BLEED AIR LEAK annunciator illuminates on the CWP

If both bleed-air leak loops detect a leak:

- Red L R BLEED AIR LEAK message is posted on the CAS
- Both red L R BLEED AIR LEAK annunciators illuminate on the CWP

The bleed-air duct leak detection sensors, anti-icing duct leak sensors, and the engine fire detect sensors are all tested at the same time with the FIRE DET position on the system test switch.

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For Training Purposes Only

POWERPLANT

Introduction

Early Learjet 40/45 aircraft are powered by two AlliedSignal TFE731-20AR-1B turbofan engines, each rated at 3500 lb (15.6 kN) of thrust at 87ºF (30.5ºC) and up to 3650 lb (16.2 kN) of thrust with automatic performance reserve (APR) engaged at sea level.

Other Learjet 40/45 aircraft are powered by two AlliedSignal TFE731-20BR turbofan engines, each rated at 3500 lb (15.6 kN) of thrust at 103°F (39.4°C) and up to 3650 lb (16.2 kN) of thrust with APR engaged at sea level.

The TFE731 is a two-spool, geared front fan, medium bypass ratio turbofan engine. The fan is driven by a planetary gearbox from the low-pressure (N_1) spool which consists of a four-stage axial compressor coupled through the center shaft to a three-stage, low-pressure (N_1) axial turbine. The high-pressure spool consists of a single-stage centrifugal compressor (N_2) driven by a single-stage (N_2) axial turbine through the outer concentric shaft.

Each engine is equipped with an automatic control system and a manual backup system. An engine-mounted digital electronic engine control (DEEC) senses the demands of the engine and inlet air pressure and temperature to maintain proper engine operation.

The engine complies with current FAR 36, Stage 3, and ICAO noise limitations.

Controls and Indications

Thrust Lever Quadrant

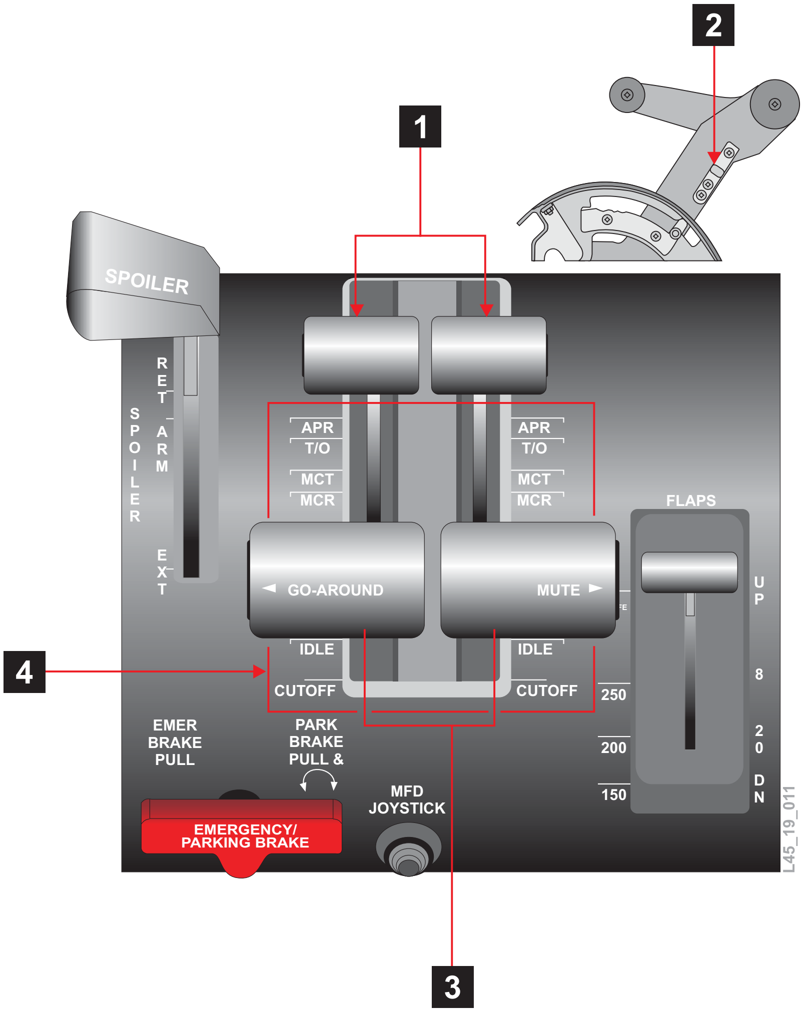


Figure 1 - Thrust Lever Quadrant

1 Thrust Reverser Levers

- Lift
  - Controls engine reverse thrust
  - Cannot select reverse thrust unless corresponding thrust lever is at IDLE

NOTE **Thrust reverser lever movement is locked at IDLE/DEPLOY detent by a balk solenoid until the corresponding TR door is fully deployed.**

2 Idle Stop Release (spring-loaded down)
- Lift—Allows thrust levers to be moved to the CUTOFF detent

3 Thrust Levers
- Push forward/pull aft—
  - Controls engine thrust
  - Cannot be advanced if thrust reverser lever is in the deployed position

4 Thrust Lever Quadrant Detents
- CUTOFF—DEEC initiates engine shutdown procedure
- IDLE—Thrust lever flight IDLE or ground IDLE position
- MCR, MCT, T/O, APR—
  - When the thrust levers are positioned to one of these positions, a green MCR, MCT, T/O, or APR is displayed in the EICAS just outboard of the N_1 digital displays
  - There is no modulation of power between MCR and MCT, MCT and T/O, and T/O and APR
  - When the thrust levers are set to one of the detents, the DEECs compute the N_1 according to the ambient conditions, position the N_1 bugs, and signal the fuel control unit to schedule fuel
  - The N_1 bugs indicate the N_1 limit for the current detent (only MCR, MCT, T/O, and APR) and indicate the N_1 limit for the last selected detent, when between detents
- MCR—Maximum cruise power setting
- MCT—Maximum continuous thrust setting
- T/O—Maximum takeoff power setting
- APR—Directly selects the additional thrust that is provided by APR

Engine Control Panel

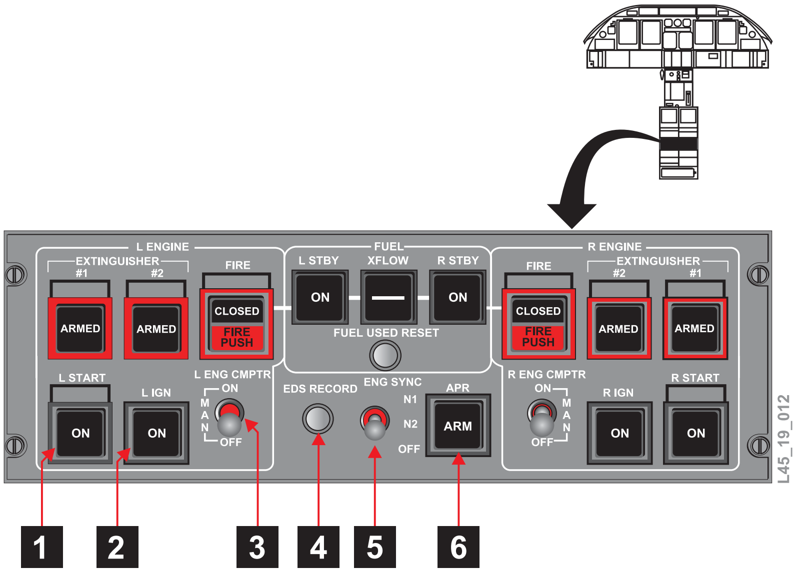


Figure 2 - Engine Control Panel

1 Start Switch Indicator (spring-loaded indicator switch)

- Push—Energizes starter motor and initiates start sequence
- Illuminated—Starter is engaged

2 Ignition Switch Indicator (spring-loaded switch)

- Push—Activates continuous ignition
- Illuminated—Ignition system is energized by the DEEC or by the ignition switch

3 Engine Computer Toggle Switch (lever-locked switch)

- OFF—
  - Removes power from the DEEC
  - DEEC has no control over the FCU
- MAN—
  - DEEC has no control over FCU fuel metering schedules
  - Provides engine fault monitoring and “ultimate” overspeed protection of 107% N_1 or 109% N_2
- ON—
  - Normal switch position
  - DEEC in automatic mode
  - DEEC controls fuel metering schedules

4 EDS RECORD Switch (spring-loaded to return)

- Push—Permits engine parameter recording for maintenance purposes four minutes before and one minute after switch activation

5 ENG SYNC (Engine Synchronization) Toggle Switch

- N_1—N_1 speed used by DEEC synchronization circuits
- N_2—N_2 speed used by DEEC synchronization circuits
- OFF—Synchronization system deactivated

6 APR Switch Indicator

- Push—Selects or deselects the APR system
- Illuminated—Indicates APR system armed when selected

EICAS Displays and Annunciations

Thrust Lever Detents

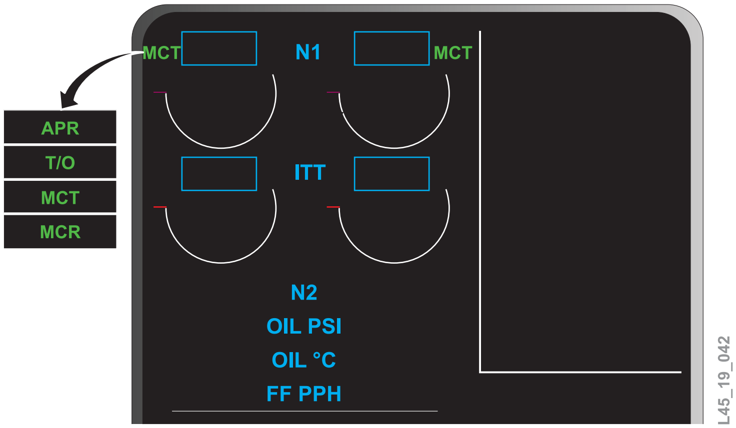


Figure 3 - EICAS—Thrust Lever Detent Display

Table 1 - EICAS—Thrust Lever Detent Annunciations

EICAS Annunciation	Description
APR	Thrust lever in automatic power reserve detent
T/O	Thrust lever in takeoff detent
MCT	Thrust lever in maximum continuous thrust detent
MCR	Thrust lever in maximum cruise detent

N_1 Digital Displays

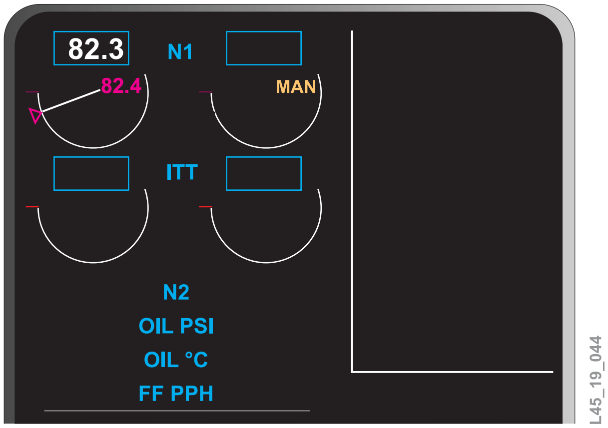


Figure 4 - EICAS—N_1 Digital Display

Table 2 - EICAS—N_1 Digital Annunciations

EICAS Annunciation	Description
82.3	N_1 value between 0 and 100%
101.0	N_1 value between 100.1 and 110%

Table 3 - EICAS—DEEC Manual Annunciations

EICAS Annunciation	Description
MAN	Manual DEEC override
MAN	DEEC fault detection

Table 4 - EICAS—DEEC Reference Bug Annunciation

EICAS Annunciation	Description
▷ 82.4	Displays DEEC power reference On the ground and in flight with flaps extended, digital readout displays takeoff power setting

ITT Digital Displays

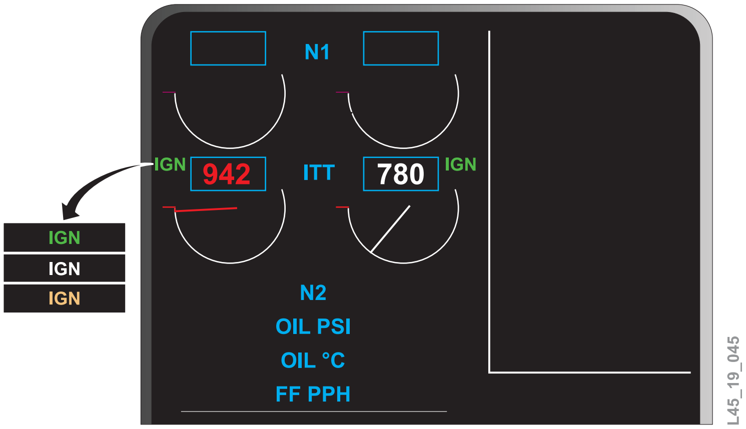


Figure 5 - EICAS—ITT Digital Display

Table 5 - EICAS—ITT Annunciations

EICAS Annunciation	Description
780	Valid range for ITT is –60 to 1100°C Normal range—Digits and analog arc/pointer display white
942	Parameters exceeded—Digits and analog arc/pointer display amber or red

Table 6 - EICAS—Engine Igniter Annunciations

EICAS Annunciation	Description
IGN	Two igniters operating on the applicable engine
IGN	One igniter operating on the applicable engine
IGN	No igniter operating on the applicable engine

Engine Indications

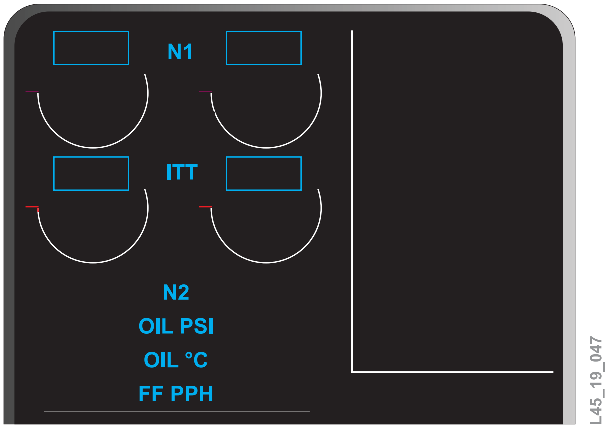


Figure 6 - EICAS—Engine Indication Display

Table 7 - EICAS—Engine Indication Annunciations

EICAS Annunciation	Description
 91.9 N2 89.0	N_2 value between 0 and 100% rpm (101% - APR active)
 101.5 N2 101.5	N_2 value between 100.1 and 102.5% rpm
 105 N2 105	N_2 value between 102.6 and 115% rpm
 74 OIL PSI 74	Oil pressure is between 65 and 80 psi
 55 OIL PSI 88	Oil pressure is 50 to 64 psi or 81 to 120 psi (81 to 100 psi if N_2 > 82%)
 45 OIL PSI 124	Oil pressure is 0 to 49 psi (lower limit) or 121 to 150 psi (upper limit) (101 to 150 psi if N_2 > 82%)
 81 OIL °C 80	Oil temperature is between 30 and 127°C (140°C if the current altitude > 30,001 ft)
 0 OIL °C 10	Oil temperature is between –53 and +29°C
 81 OIL °C 148	Oil temperature is between 128 and 175°C (128 to 141°C if the altitude > 30,001 ft)
 1210 FF PPH 900	Fuel flow is configured for pounds per hour
 545 FF KPH 410	Fuel flow is configured for kilograms per hour

Engine Start

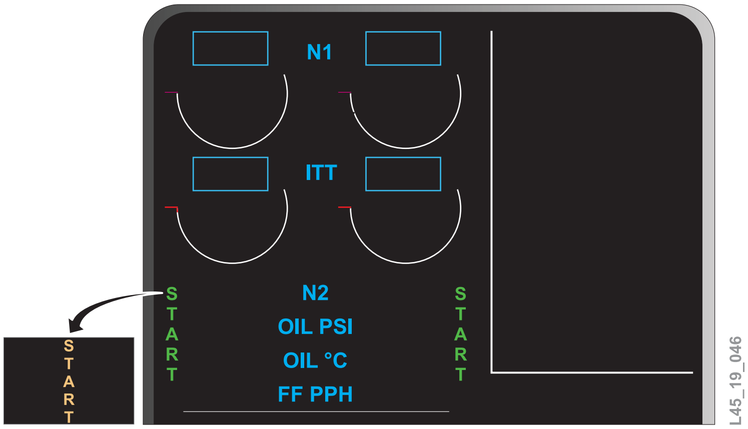


Figure 7 - EICAS—Engine Start Display

Table 8 - EICAS—Engine Start Annunciations

EICAS Annunciation	Description
	Normal start indication N_2 rpm < 51%
	Abnormal start indication (flashing) N_2 rpm > 51%

Automatic Performance Reserve

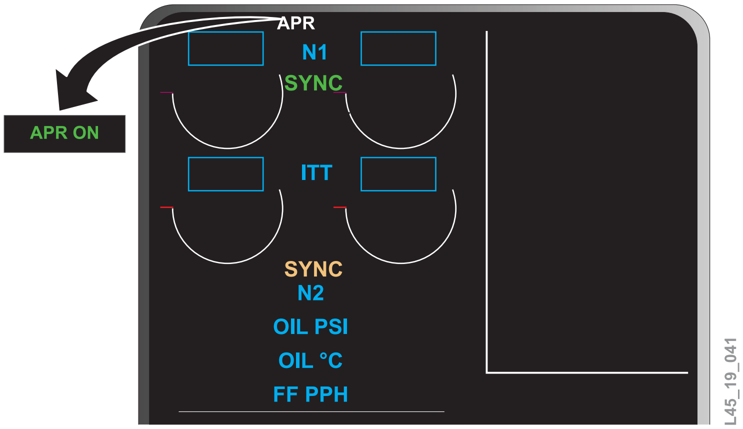


Figure 8 - EICAS—APR Display

Table 9 - EICAS—APR Annunciations

EICAS Annunciation	Description
APR	APR armed
APR	Thrust lever in APR detent
APR ON	APR activated by DEEC

Table 10 - EICAS—N_1/N_2 SYNC Annunciations

EICAS Annunciation	Description
SYNC	Landing gear up
SYNC	Landing gear down or >5% difference between engine N_1 / N_2 (as selected)

Thrust Reversers

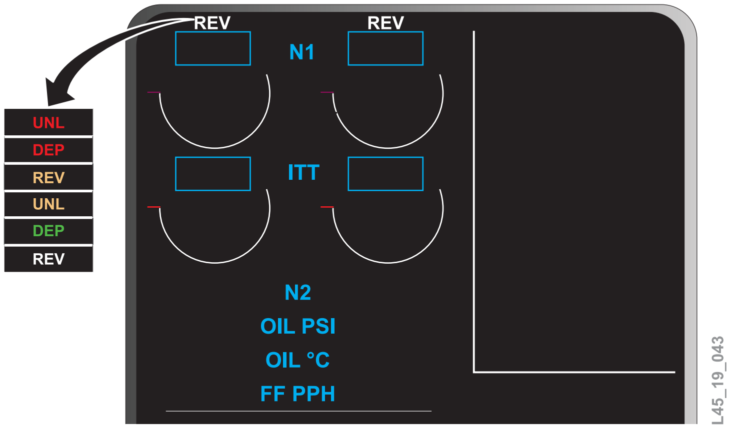
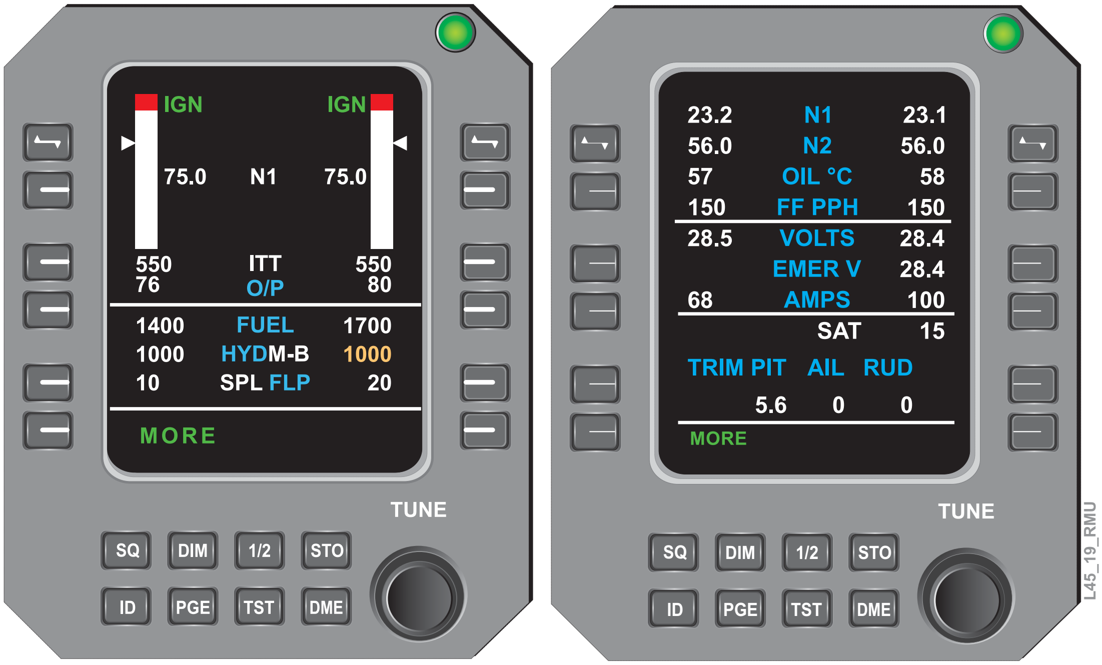


Figure 9 - EICAS—Thrust Reverser Display

Table 11 - EICAS—Thrust Reverser Annunciations

EICAS Annunciation	Description
UNL	The thrust reverser is unlocked in flight (flashing)
DEP	TR is deployed—in flight (flashing) TR deployed—on the ground, thrust lever MCR or above (flashing)
REV	TR armed—In flight (flashing) TR armed—TLA MCR or above on the ground (flashing)
UNL	TR unlocked—on the ground (normal) TR unlocked—thrust lever MCR or above on the ground (flashing) TR unlocked—abnormal unlock indication on the ground (flashing)
DEP	TR deployed on the ground
REV	TR armed on the ground

Radio Management Unit Backup Display



EICAS Backup Display Page 1 Engine Backup Display Page 2

Figure 10 - Radio Management Unit Backup Displays

CAS Messages

Table 12 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
L FUEL PRESS LOW	L FUEL PRESS LOW	Fuel pressure at the associated engine fuel pump inlet is low
R FUEL PRESS LOW	R FUEL PRESS LOW	
L R FUEL PRESS LOW	L FUEL PRESS LOW	Fuel pressure at both engine fuel pump inlets is low
	R FUEL PRESS LOW	
L OIL PRESS LOW	L OIL PRESS LOW	Associated engine oil pressure is below 50 psi
R OIL PRESS LOW	R OIL PRESS LOW	

Table 12 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
L R OIL PRESS LOW	L OIL PRESS LOW	Oil pressure is below 50 psi in both engines
	R OIL PRESS LOW	
“Left Reverser Unsafe” or “Right Reverser Unsafe” aural message	L REV UNSAFE	Thrust reverser unlocked in flight or on the ground without having been armed
	R REV UNSAFE	
	L REV UNSAFE	Thrust reverser unlocked in flight or on the ground without having been armed (both engines)
	R REV UNSAFE	
L ENG CMPTR FAULT	Major fault in the associated engine computer has been detected	
R ENG CMPTR FAULT		
L R ENG CMPTR FAULT		
L FUEL HEATER	Fuel heater is not keeping the associated engine fuel warm enough	
R FUEL HEATER		
L R FUEL HEATER		
L ENGINE CHIP	Metal particles have been detected in the associated engine oil system with the aircraft on the ground	
R ENGINE CHIP		
L R ENGINE CHIP		
L OIL FILTER	The engine oil filter has an impending bypass—aircraft on the ground	
R OIL FILTER		
L R OIL FILTER		

Table 12 - CAS Messages

CAS Message	CWP Caption	Conditions/Parameters
L ENGINE CHIP		Metal particles have been detected in the engine oil system—aircraft in flight
R ENGINE CHIP		
L R ENGINE CHIP		
L FUEL FILTER		Either the respective engine or aircraft fuel filter has an impending bypass during flight
R FUEL FILTER		
L R FUEL FILTER		
L ENG CMPTR FAULT		Minor fault detected in the associated engine computer system
R ENG CMPTR FAULT		
L R ENG CMPTR FAULT		
L APR FAULT		Respective DEEC has detected a fault with the APR function of the computer
R APR FAULT		
L R APR FAULT		
L REV AUTOSTOW		Respective thrust reverser autostow function has activated
R REV AUTOSTOW		
L R REV AUTOSTOW		
L REV FAULT		Any of the following conditions have occurred to the respective thrust reverser: • Full TR deploy detected—no hydraulic pressure • Squat switch input to the TR has failed • Full TR deploy has been detected—no unlock command • Full TR deploy detected—no deploy command • Autostow system has activated
R REV FAULT		
L R REV FAULT		
L FUEL HEATER		Associated engine fuel heater is heating the fuel to too high a temperature
R FUEL HEATER		
L R FUEL HEATER		
L OIL FILTER		Associated engine oil filter is becoming plugged
R OIL FILTER		
L R OIL FILTER		
L ENG VIB MON		Associated engine vibration level is higher than normal
R ENG VIB MON		
L R ENG VIB MON		

Power Plant

Description

Major Sections

The major sections of the TFE731-20 engine (Fig. 11) are:

- Fan and rotor (compressor and turbine) assemblies
- Combustion section
- Exhaust
- Accessory gearbox

Engine Sections

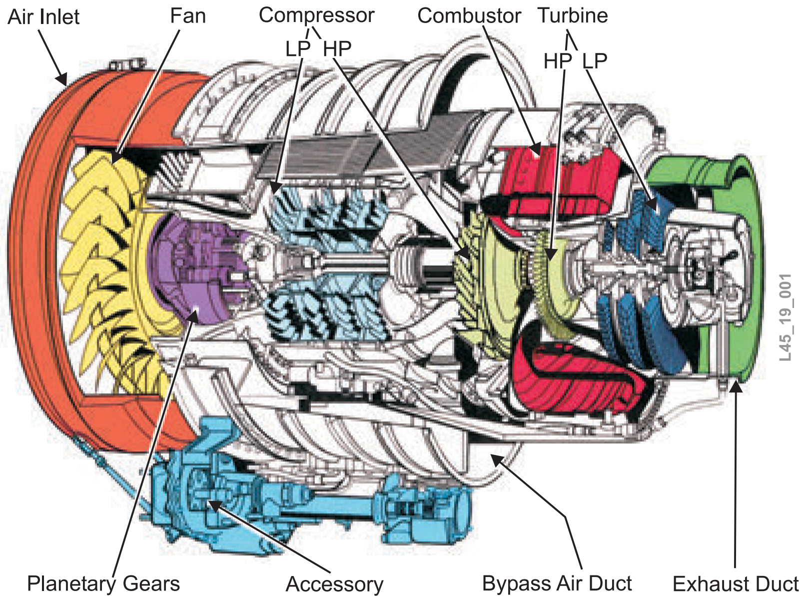


Figure 11 - Power Plant Sections

Components and Operation

Fan and Rotor Assemblies

The engine consists of a single-stage fan and two rotor assemblies. The low-pressure (LP) or N_1 rotor consists of a four-stage axial compressor coupled through a center shaft to a three-stage axial turbine. The single-stage axial fan assembly, located at the front of the engine, is driven by the N_1 rotor assembly shaft through a planetary gearbox.

The high-pressure (HP) or N_2 rotor assembly consists of a single-stage centrifugal compressor coupled to a single-stage axial turbine by an outer concentric shaft.

While the fan rotates in a counterclockwise direction, the N_1 and N_2 rotor assemblies rotate in a clockwise direction, (with all three viewed from the rear of the engine). This causes the torsional effects of the core and bypass airflows to roughly cancel each other's aerodynamic torque effect on the airframe.

Combustion Section

The combustion section consists of a reverse flow, annular combustor that provides heated, and high-energy gas flow to the turbines.

Exhaust

The exhaust section combines the core (hot exhaust gas) and bypass (fan) airflows and directs the exhaust gases from the rear of the engine to provide thrust. A thrust reverser system is incorporated as part of the exhaust duct.

Accessory Gearbox

The accessory gearbox (AGB) is located at the forward bottom part of the engine. The AGB is driven by the HP rotor (N_2) through a tower shaft and transfer gearbox arrangement.

The following components are driven by the AGB:

- Hydraulic pump
- Fuel pump and fuel control unit (FCU) components
- DC starter/generator
- AC alternator
- Oil pressure and scavenge pumps
- Auxiliary motive fuel pump

Engine Airflow Path

Engine airflow (Fig. 12) is divided into two components: bypass (fan) airflow and core (compressor) airflow.

Bypass Airflow

The air is accelerated by the single-stage N_1 fan through a set of stators and a faired bypass duct before exiting with the core flow through a common exhaust. The bypass airflow produces approximately 60% of the thrust at sea level.

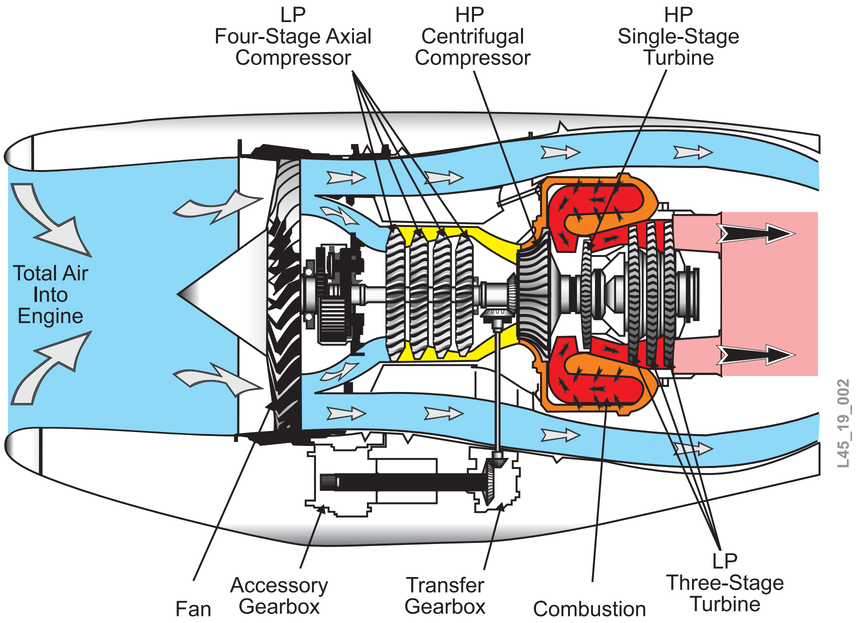


Figure 12 - Engine Airflow Path

Core Airflow

The core airflow enters the four-stage LP axial compressor and a single-stage HP compressor and exits through a diffuser into the reverse flow annular combustor where it is mixed with fuel and ignited. The resulting combustion gases are then exhausted through the high-pressure single-stage N_2 turbine, and three-stage low-pressure N_1 turbine assembly, driving both rotor assemblies and exiting through the exhaust nozzle with the bypass airflow. The core airflow produces approximately 40% of the thrust at sea level.

Bypass Ratio

The bypass airflow ratio to core airflow is approximately 3.1:1 with the bypass airflow producing approximately 60% of the thrust at sea level. This ratio changes with altitude, and at approximately 40,000 ft, the bypass airflow produces only 40% of the available thrust.

Bleed Air

Compressor bleed-air extraction is available for aircraft use during all phases of engine operation, except during engine start. Since bleed-air extraction is not permitted during engine start operations, all aircraft systems that require bleed air, such as ECS and anti-icing, must be turned off.

Engine Fuel and Control System

Description

Engine thrust is controlled by a digital electronic engine control (DEEC) which schedules fuel and bleed valve position in response to the thrust lever position, N_1 and N_2 spool speeds, exhaust gas temperature, and ambient conditions to achieve the desired power setting.

The engine fuel system must deliver fuel in the right amount to the engine combustor that corresponds to the power lever setting demand and to the atmospheric and engine operating conditions.

The main components of the engine fuel and control system are:

- Thrust levers
- Thrust lever control quadrant
- DEEC
- FCU and system components

Components

Thrust Levers

The thrust levers are operated in a conventional manner with the full forward position as maximum power. Each lever is connected to its respective engine hydromechanical FCU by a thrust lever control cable.

A flight director go-around switch is installed in the left thrust lever handle, and a landing gear/cabin altitude warning horn mute switch is installed in the right thrust lever handle. A thrust reverser control lever is mounted piggyback fashion on each thrust lever.

Thrust Lever Control Quadrant

The thrust lever control quadrant contains the thrust levers, thrust reverser levers, switches, and internal stops necessary to control the engines in forward and reverse thrust.

The thrust lever control quadrant contains rotary variable differential transformers (RVDTs). These provide thrust lever angle by an electrical signal to the DEEC installed on each engine.

Thrust Lever Detents

The thrust lever quadrant has several detents. They are marked, from back to front: CUTOFF, IDLE, MCR, MCT, T/O, and APR.

CUTOFF

When the thrust lever is placed in the CUTOFF position, the shutoff valve in the fuel control unit is closed, the DEEC initiates an engine shutdown procedure, and the white L/R ENG SHUTDOWN CAS message illuminates.

IDLE

Depending on the signal from the squat switches, the IDLE position provides one of the following:

- FLIGHT IDLE with approximately 65% N_2 at low altitude (increasing proportionally with altitude)
- GROUND IDLE with approximately 52 % N_2 commanded 20 seconds after the aircraft touches down, unless a higher engine speed is requested

A mechanical stop prevents inadvertent movement of each thrust lever from IDLE to cutoff. The mechanical stops can be released by pulling up on a finger lift on the outboard side of each thrust lever.

MCR, MCT, T/O, and APR

When the thrust levers are positioned to one of these positions, a green MCR, MCT, T/O, or APR annunciation is displayed on the EICAS just outboard of the N1 digital displays.

There is no modulation of power between MCR and MCT, MCT and T/O, and T/O and APR.

When the thrust levers are set to one of the detents, the DEEC computes the N_1 according to the ambient conditions, positions the N_1 bug, and signals the fuel control unit to schedule fuel.

The N_1 bugs indicate the N_1 limit for the current detent (only MCR, MCT, T/O, and APR) and indicate the N_1 limit for the last selected detent, when between detents.

- MCR detent sets the maximum cruise power
- MCT detent sets the maximum continuous thrust. MCT data are found in the AFM, Section V
- T/O (Takeoff thrust) detent sets the maximum takeoff power. Takeoff data are found in the AFM, Section V
- APR (automatic performance reserve) position is a forward limit stop rather than a detent. This position allows the crew to directly select the additional thrust that would be provided by APR

Digital Electronic Engine Control

A DEEC is provided for each engine (Fig. 13). The DEEC provides automatic start sequencing, rotor speed and temperature limits, surge-free acceleration and deceleration, automatic ignition, engine synchronization, and performance reserve. The DEEC improves engine operating economy and durability while reducing pilot workload.

The DEEC controls engine fuel flow through electrical inputs to a torque motor located in the hydromechanical fuel control.

The DEEC uses the following input parameters for controlling functions:

- Total inlet pressure and temperature (PT_2, TT_2)
- Interstage turbine temperature (ITT)
- Low-pressure rotor speed (N_1)
- High-pressure rotor speed (N_2)
- Power lever angle (PLA)
- Airframe inputs (ADC, WOW, etc.)

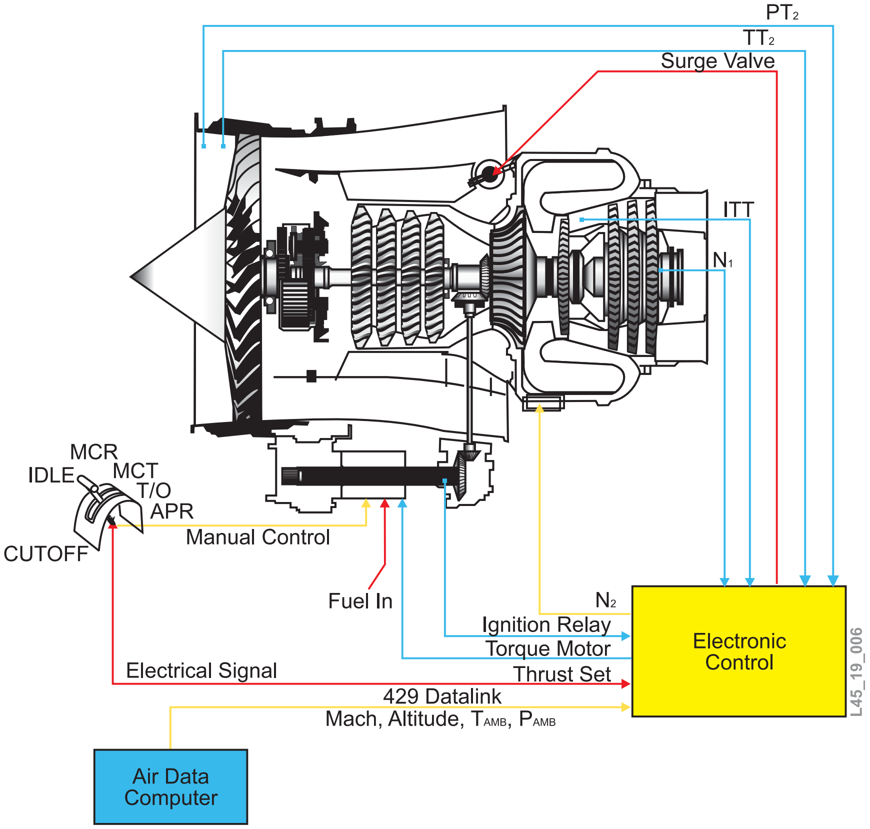


Figure 13 - Engine Control Schematic

Operation

The DEECs are controlled by two switches located on the fuel/engine control panel labeled L/R ENG CMPTR (Fig. 14). The switch controls DC power to the DEEC and has the following positions:

- ON—Provides power to the DEEC and allows it to have full (automatic) control of the engine
- MAN—Selects manual mode operation with the DEEC providing only electronic overspeed protection
- OFF—Disconnects DC power from the DEEC, which no longer has any effect on engine operation

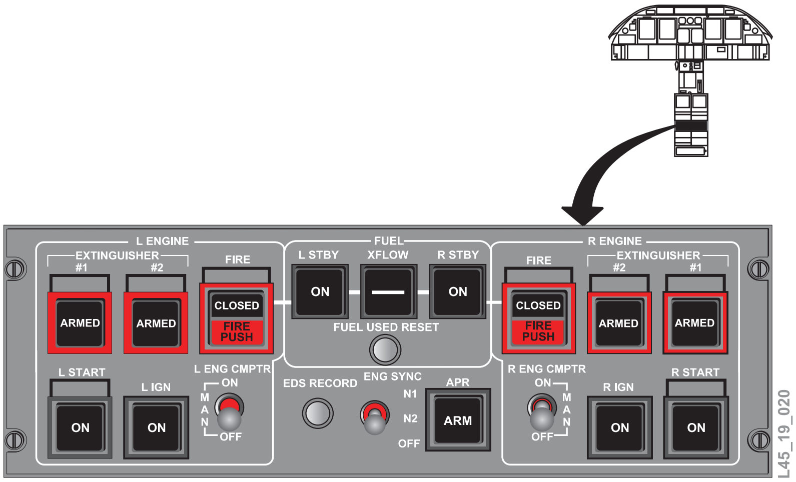


Figure 14 - DEEC Control Switches

Operating Modes

The DEEC has three modes of operation: ON (automatic), MAN, and OFF.

Automatic Mode

To operate the engine fuel control system in normal (automatic) mode, the DEEC must be selected to ON. The DEEC provides the following functions:

- Acceleration and deceleration fuel schedules
- Engine overspeed protection
- Proportional thrust with power lever position
- Surge protection (prevents compressor stalls and surges)
- Engine synchronization
- APR when selected

The DEEC controls fuel scheduling by means of a torque motor which controls the fuel metering section located within the fuel control unit. This enables the DEEC to control the engine within its temperature and rpm limits. The DEEC provides electronic overspeed protection and activates the ultimate overspeed solenoid valve at 107% N_1 or 109% N_2 to cut off fuel flow to the engine.

Manual Mode

To operate in manual mode, the ENG CMPTR switch must be in the MAN position or the DEEC must fail and revert to manual mode. Under MAN mode, the following conditions are in effect:

- Surge valve partially open (1/3 open)
- Fuel scheduling is controlled by the FCU
- Limits are controlled by the pilot (overtemperature protection not automatically available)
- Available for emergency use and maintenance troubleshooting

In the manual mode of operation, the surge valve remains partially open, and fuel is controlled by the FCU through thrust lever angle inputs transmitted by the control cable. Since the DEEC is not controlling engine operating parameters, the pilot must observe the instrument indications to ensure that the speed and temperature limits are not exceeded. The engine acceleration time in manual mode is considerably slower than automatic mode.

The DEEC provides electronic engine overspeed protection during the manual mode of operation. Note that manual mode provides for an ultimate overspeed of 107% N_1 or 109% N_2.

OFF Mode

When the switch is OFF, the DEEC has no authority over any engine control functions.

Surge Bleed Control

The engine is protected from compressor surges and stalls by a surge control system. Stall-surge protection for the low-pressure compressor is provided by a surge bleed valve automatically controlled by the DEEC. This prevents engine stall during rapid deceleration or acceleration by precise fuel scheduling. If the DEEC fails or is in the MAN or OFF modes, the surge bleed control valve remains in a one-third open position.

Messages and Annunciations

Circuits within the DEEC continuously monitor power supply, computer circuits, and inputs to the computer. A loss of input power or a computer malfunction causes the monitor circuits to illuminate the applicable DEEC CAS display of the EICAS display unit.

If a major fault occurs within the DEEC, it may remain in the automatic mode or revert to the manual mode, depending on the fault severity. In either case, an amber L/R ENG CMPTR FAULT CAS message displays.

Should the DEEC revert to manual mode, in addition to the CAS message, an amber MAN annunciation appears in the top right corner of the respective EICAS N_1 rpm indicator.

With the DEEC reverted to the manual mode, cycling the applicable FUEL CMPTR switch from ON to OFF and back to ON resets the DEEC. If the faults clears, both the CAS and EICAS N_1 messages disappear.

If the CAS and EICAS messages remain, the DEEC must be selected to the MAN position for the remainder of the flight. The CAS and EICAS messages change from amber to white.

On the ground, when the respective DEEC has detected a minor malfunction, a white L/R ENG CMPTR FAULT CAS message displays.

Fuel Control Unit and System Components

The fuel system associated with the engine consists of:

- Engine fuel pumps
- Fuel heater/oil cooler
- FCU

Engine Fuel Pumps

The two-stage engine-driven fuel pump is located to the aft left side of the accessory gearbox. The first stage is a centrifugal pump, and the second stage is a high-pressure gear-type pump. Fuel pressure is boosted by the first stage and sent through the fuel heater and fuel filter to the high-pressure pump. The fuel filter has a bypass capability and warns of an impending bypass situation by displaying a white FUEL FILTER CAS message.

A separate engine-driven auxiliary motive flow pump (AMFP) is located on the front left side of the accessory gearbox. Fuel from the AMFP operates the various fuel tank ejector pumps.

Fuel Heater/ Oil Cooler

Hot engine oil and engine fuel are routed through the fuel heater/oil cooler where, through conduction, the oil is cooled and the fuel is heated. Fuel flow through the fuel heater/oil cooler is continuous; if the fuel becomes too hot, a valve functions to bypass the hot oil and limit the fuel temperature. If the fuel heater/oil cooler fails to the hot condition, a white L/R FUEL HEATER CAS message displays. One of the functions of the fuel heater/oil cooler is to prevent fuel icing. If the fuel temperature is less than 10ºC and the oil temperature is greater than 86ºC, an amber L/R FUEL HEATER CAS message displays.

Fuel Control Unit

The FCU is mounted on the fuel pump attached to the AGB and contains:

- Fuel metering section
- Thrust lever input and position potentiometer
- Mechanical governor
- Shutoff valve

When activated, the DEEC controls fuel scheduling with a torque motor which controls the hydromechanical metering section of the fuel control unit.

The FCU has a mechanical governor that protects the engine from overspeed (105% N_2 rpm) by operating a metering valve to restrict fuel flow. In the manual mode of operation, the mechanical governor, working in conjunction with thrust lever inputs, controls the metering valve and thereby controls the N_2 rpm.

Should the mechanical overspeed protection fail, the DEEC activates the ultimate overspeed solenoid valve to a closed position at 107% N_1 or 109% N_2 and cuts off fuel flow to the engine. This feature is not functional if the applicable ENG CMPTR switch is in the OFF position.

When the thrust lever is moved from IDLE to CUTOFF, in both the manual and auto modes, the manual fuel shutoff valve (SOV) closes and cuts off fuel to the combustion chamber.

Fuel Flow Indicating System

The system consists of a dual fuel flow converter and two temperature sensing volumetric fuel flow transmitters located in the high-pressure line between the fuel control unit and the fuel flow divider of each engine. The fuel flow transmitter senses the fuel flow rate and fuel temperature and provides these parameters to the fuel flow converter. The converter processes these signals so that a mass flow rate can be obtained. The flow rate and the total fuel used is transmitted to the DAU and displayed on the EICAS. Fuel flow information is also sent from DAU to the FMS for fuel used and remaining fuel computations and displays.

Located in the engine/fuel panel on the center console is a totalizer reset pushbutton. It resets the total fuel used counter to zero when activated for at least two seconds.

NOTE

Fuel flow to the APU is not transmitted to the DAU. FMS fuel quantity must be reset after APU shutdown for accurate FMS fuel computations.

Performance Reserve

The automatic performance reserve (APR) and the manual performance reserve (MPR) provide increased thrust for specific operations. The increased thrust mode is intended for short duration emergency use only. The system consists of the DEEC, a single push-on/push-off switch indicator located in the fuel/engine control panel, and the thrust levers.

The APR system must be armed prior to takeoff for the system to activate. When the system is armed, the DEEC performs a verification and sends a signal which allows the pilot to forgo the split-thrust-lever verification of the APR function. The software verification checks the validity of the cockpit switch and the presence of N_1 and N_2 speed signals required for the APR operation.

The DEEC activates the APR system based on a speed mismatch of 15% N_2 between the left and right engine. The engine must increase speed and temperature (1.7% N_2 and 22ºC) to produce the approximately 150 lb of increased thrust provided by the system.

Cycling the APR ARM switch to the OFF position is required to revert to normal operations from the APR mode.

MPR provides the additional thrust independent of the status of the opposite engine. This means additional thrust is available on demand by pushing the thrust lever to the APR detent. MPR disengages as the power lever is pulled below the APR detent.

When selected, the APR switch illuminates and a white APR message is displayed on the EICAS, indicating the system is armed and ready for automatic operation. When the system is activated, the white APR annunciation changes to a green APR ON annunciation.

Engine Vibration Monitoring System

The engine vibration monitoring system provides a signal to the EICAS when the engine accelerometer detects excessive vibration. The CAS displays a white L/R ENG VIB MON message.

Engine Diagnostic System

An engine diagnostic system (EDS) provides engine fault recording and condition trend monitoring. The system periodically records engine parameters and allows the crew to record conditions anytime. The system is not designed for inflight diagnostics or monitoring. The data may be downloaded at any time for maintenance purposes.

A spring-loaded EDS RECORD switch is located on the aft pedestal inboard of the L ENG CMPTR switch. Activating the switch once causes the EDS circuits to record engine parameters existing four minutes prior to and one minute after pressing the switch. The information is stored in the DEEC engine condition and trend monitoring (ECTM) circuits and is retrieved by a special external unit.

The CAS displays a white CHECK EDS message to indicate:

- EDS lost power
- EDS BITE detected a system failure
- EDS memory is 80% or more full
- EDS detected an engine condition which is outside of acceptable limits

Engine Synchronizer System

The engine synchronization system uses the left engine as the master engine and the right engine as the slave. Synchronization is accomplished by maintaining the speed of the slave engine in sync with the speed of the master engine.

The engine synchronizer system consists of the following:

- ENG SYNC toggle switch labeled: N_1, N_2, and OFF
- Synchronizer circuitry
- EICAS display annunciations

Operation

The synchronizer functions only when both DEECs are serviceable, the two ENG CMPTR switches are in the ON position, and the APR system is disarmed.

During flight, the engine synchronizer, if selected, maintains the right fan speed (N_1) or turbine speed (N_2) in sync with the left engine fan speed (N_1) or turbine speed (N_2).

The engine synchronizer should not be used during takeoff, landing, or single-engine operation.

Operating Modes

With the ENG SYNC switch OFF, the synchronization system is inactive.

For automatic mode, the following conditions are required:

- ENG SYNC switch in the N_1 or N_2 position
- Both DEECs in automatic mode (ON)
- Thrust reversers stowed
- APR system disarmed

If the N_1 or N_2 position is selected on the ENG SYNC switch, an engine instruments (EI) annunciation reading SYNC appears in the space between the two N_1 or two N_2 digital readouts. Under normal operations, with the landing gear up and locked, the SYNC annunciation is green. If the landing gear is down, the SYNC annunciation is amber to alert the crew to turn the system off before takeoff or landing.

Engine Oil System

The engine oil system is a pressure-scavenge system that provides lubrication and cooling for the accessory gearbox (AGB), planetary gearbox, and main engine bearings.

Components and Operation

The oil tank is located on the forward right side of the engine (Fig. 15). The oil pump package, which includes a pressure pump and four scavenge pumps, is mounted on and driven by the AGB.

Oil for lubrication is drawn from the engine oil tank by the engine-driven pressure pump. From the pump, the oil passes through a pressure-regulating valve, a filter, a fuel heater, and the oil-to-air heat exchanger. The heat exchanger is a three-segment finned cooler that forms the inner surface of the fan duct.

From the oil-to-air heat exchanger, the oil flow is divided so that part of the oil is directed to the accessory and transfer gearboxes and the engine rotor shaft bearings. The remaining oil is diverted to an oil temperature regulator (oil-to-fuel heat exchanger) and then to the fan gearbox. Oil is scavenged from the gearboxes and engine bearings by the four scavenge pumps and the scavenged oil is delivered to the oil tank.

A magnetic chip detector is located in the oil return line from the engine oil pump to the tank. Ferrous metal particles on the chip detector causes an electrical circuit to be completed, sending a signal to the DAU and then to the EICAS.

With the aircraft on the ground, an amber L/R ENGINE CHIP CAS message is displayed when metal particles have been detected in the oil. With the aircraft in flight, a white L/R ENGINE CHIP CAS message is displayed when metal particles are detected in the oil.

Aircraft engine oil pressure and temperature information are displayed on the EICAS display unit. Oil pressure warnings are denoted on the EICAS by a change of color of the oil pressure symbology, displayed as a CAS message and as a warning annunciation on the CWP.

The oil filter assembly incorporates a bypass valve and an impending bypass switch. Should the impending bypass switch sense an impending oil filter bypass condition, a signal is sent to the respective data acquisition unit, which causes a white L/R OIL FILTER CAS advisory message to illuminate on the EICAS while in flight, or an amber L/R OIL FILTER CAS caution message while on the ground. Under cold oil conditions (cold weather operations) the bypass indication is inhibited when the oil temperature is less than 100°F (38°C). If the filter becomes blocked, the bypass valve opens, allowing oil to bypass the filter. During an engine start under cold oil conditions (cold weather operations) the bypass valve opens to prevent nuisance indications during start due to high oil viscosity at cold temperatures.

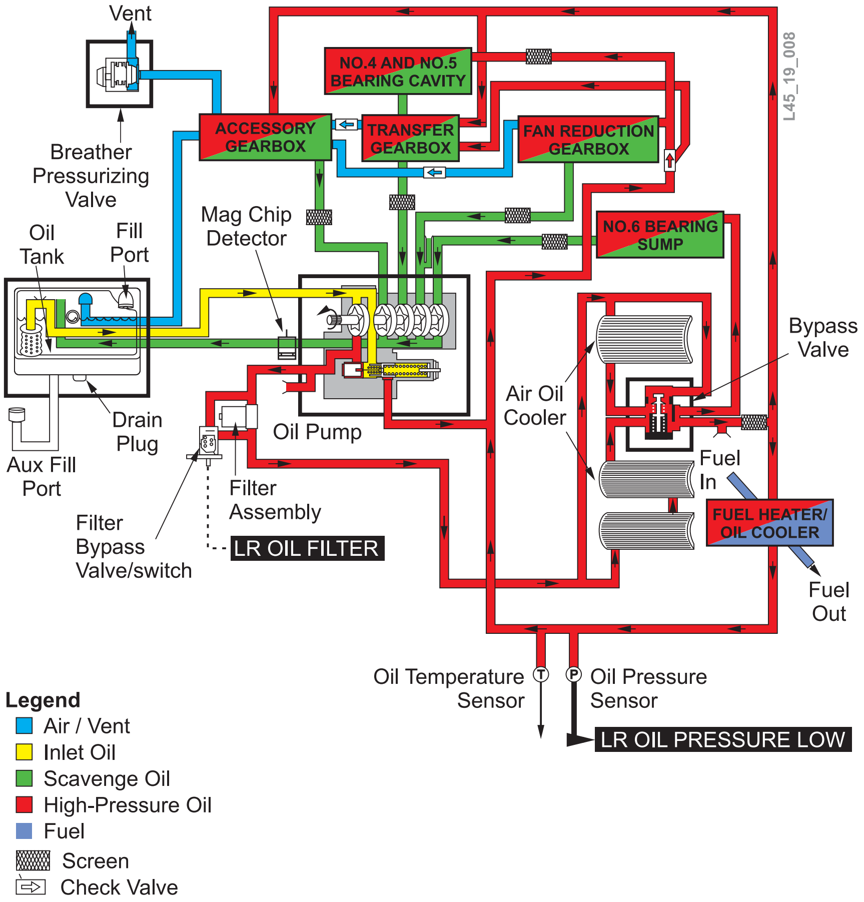


Figure 15 - Engine Oil System Schematic

Oil System Servicing

The engine oil servicing doors are located on the forward and outboard side of each engine nacelle (Fig. 16). Oil quantity can be checked by a dipstick and replenished through an oil filler port for the right engine. The left engine is supplied with an oil filler port with dipstick, connected to the oil tank by a crossover pipe.

Oil level is to be checked within one hour of engine shutdown and the tank serviced if more than 1 qt (0.95 l) low.

Refer to Addendum II - Oil Servicing in the Airplane Flight Manual for approved lubricants and servicing instructions.

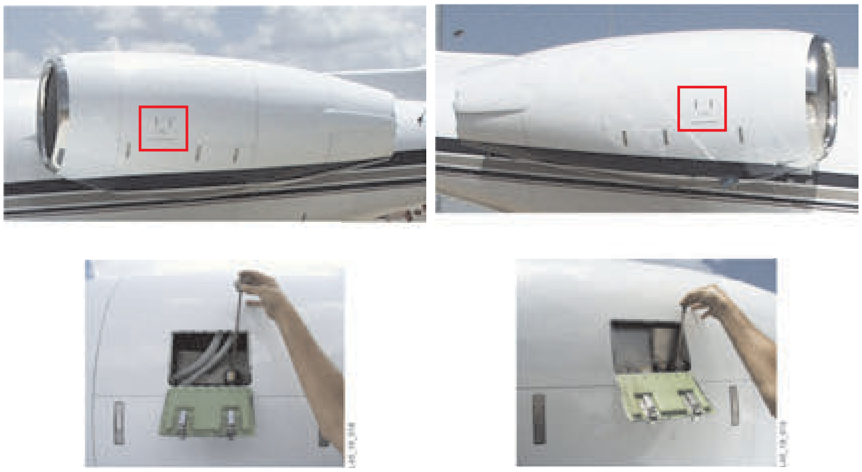


Figure 16 - Engine Oil System Servicing

Lubrication System Limits

Refer to the Airplane Flight Manual for lubrication system limits.

Cold Weather Operations

If the engine is exposed to extremely cold temperature (below –40ºF or –40ºC) for an extended period, the engine should be heated prior to attempting a start. During cold oil temperature starts, higher than normal oil pressure can be expected which may exceed the maximum allowable transient oil pressure observed during normal temperature starts. Engine rpm should not be increased above idle speed with oil temperature below 30ºC due to reduced fuel icing protection and in the interest of optimum lubrication performance.

Engine Ignition System

The engine ignition system is a dual channel (A and B), dual-igniter system requiring DC power input for operation. The system consists of an ignition unit connected to two spark igniters by high-voltage shielded cables. The system is capable of either continuous or intermittent operation.

Operation

Automatic Mode (Normal)

During a normal start, the ignition system is actuated automatically by the DEEC which commands ignition at 6.8 % N_2. The ignition unit furnishes continuous voltage to the spark igniters until N_1 reaches 70% of IDLE, when the DEEC commands the ignition off.

The DEEC energizes the ignition system during uncommanded deceleration of the engine. During this mode, if N_1 is below the set point and N_2 is not accelerating, the ignition system is commanded on by the DEEC.

The DEEC energizes the ignition system if commanded deceleration is excessive. During this mode, if physical deceleration of the engine exceeds the commanded deceleration, the ignition is commanded on for at least one second. This mode protects the engine from a possible flameout.

Selective Mode (Manual)

The ignition system may be operated continuously by selecting the corresponding L or R IGNITION switch, located on the engine panel, to the on (L or R) position.

Indications

L and R IGN annunciators illuminate on the outboard upper side of the ITT digital display on the EICAS whenever the ignition unit is commanded on.

The data acquisition unit furnishes information to the EICAS on ignition system status. The system status is indicated by changing the color of the IGN legend on the EICAS as follows:

- Green—Both channels are operating properly
- White—One channel is not operating or either channel is operating when not commanded to operate
- Amber—Neither channel is operating

Actuation of the left or right FIRE PUSH switch de-energizes both ignition channels A and B. This action removes the ignition system as a possible fire ignition source.

Engine Starting System

The engine starting system rotates the engine(s) prior to the application of fuel and ignition for engine operation. Electrical power for starting is provided by the aircraft batteries, an external power source (ground power unit), the opposite engine starter/generator, or the APU. The starter system consists of a starter/generator for each engine and associated controls.

An external power source or APU is recommended for starts when the OAT is 32°F (0°C) or below.

Operation

The starter/generator is mounted on the accessory gearbox of each engine. It acts as a start motor for rotating the engine during the start sequence and then as an electrical generator when the start sequence is terminated.

The starter/generator is controlled by its respective push START switch/indicator located at the rear outboard corner of the L ENGINE and R ENGINE control panels on the cockpit pedestal. When the switch is momentarily pushed, a white ON legend illuminates on the switch; the starter/generator is energized through a series of relays and rotates the engine. At the same time, a green vertical START annunciator is displayed on the EICAS display unit and remains as long as the starter is engaged. At 50% N_2 turbine speed, the DEEC commands the starter to cut out and the engine continues to run on its own. The white ON and green START annunciations extinguish. Should the starter remain engaged above 51% N_2, the START annunciator turns amber.

The cooling periods in Table 13 must be observed between consecutive start attempts:

Table 13 - Starter Cooling Periods

After Start Attempt	Wait
1	1 minute
2	2 minutes
3	30 minutes

Thrust Reverser System

Description

The Dee Howard TR5045 thrust reverser (TR) system assists in stopping the aircraft on landing and during a rejected takeoff (RTO). The system is operable on the ground only.

Each engine is equipped with an independent, electrically controlled and hydraulically actuated clamshell door-type thrust reverser. The upper and lower clamshell-shaped doors are located on the nacelle. When deployed, they redirect the flow of fan air and exhaust gases forward, providing a decelerating force for ground braking. In the stow position, the thrust reverser acts as the engine exhaust nozzle.

The thrust reverser system consists of clamshell-type thrust reverser doors, hydraulic actuators and associated linkage, latchbox assemblies, an isolation valve, hydraulic control units (HCUs), electronic control units (ECUs), and system controls.

Components

Latch Assemblies

Each thrust reverser assembly (Fig. 17) is equipped with left and right latch mechanisms (assemblies) installed on the inboard and outboard sides of the exhaust pipe. Each latch assembly includes a pair of latch hooks, a latch actuator, two leaf springs, one lock/unlock switch, and one latch/unlatch switch, all mounted on a machined fitting.

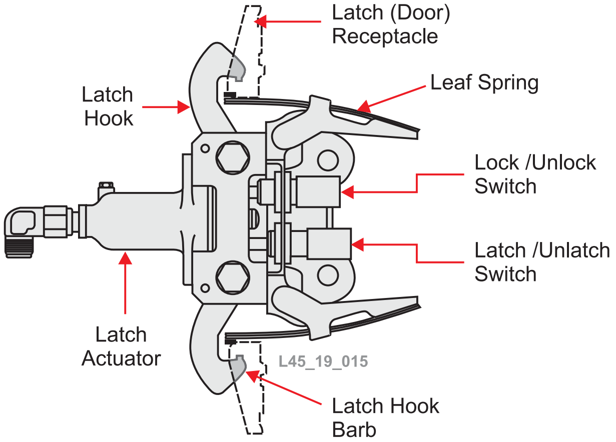


Figure 17 - Thrust Reverser Latch Assembly

Hydraulic System

Hydraulic power for system operation is normally supplied by the main aircraft hydraulic system (Fig. 18).

Main hydraulic system power is routed to the thrust reverser left and right hydraulic isolation valves. The right and left hydraulic circuits are identical and operate independently from each other.

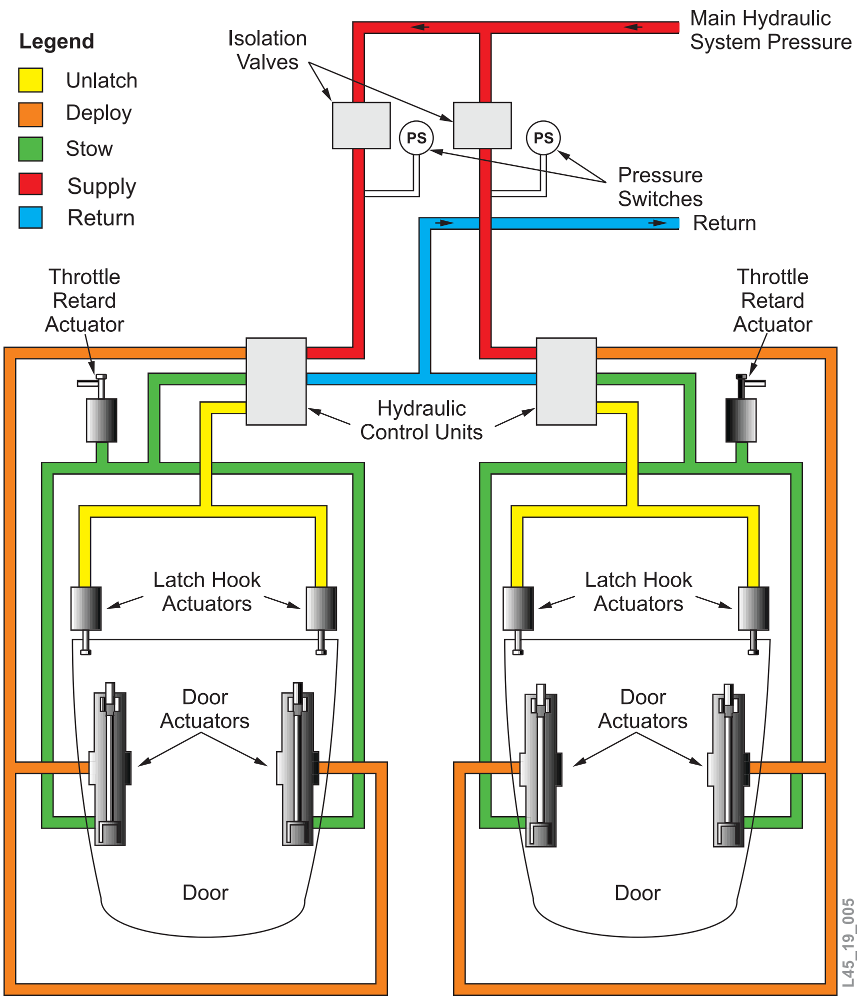


Figure 18 - Thrust Reverser Hydraulic System

Isolation Valve

The isolation valves separate the respective thrust reverser hydraulic circuits from the aircraft main hydraulic system. On command from the onside ECU, the isolation valve provides hydraulic fluid supply and return flow for the appropriate left or right thrust reverser circuits.

When the FIRE PUSH switch is selected ON, a signal is sent to the ECU which closes the affected isolation valve. This isolates the flow of fluid between the aircraft and thrust reverser hydraulic systems.

If a valve fails, the isolation valve returns to the closed (safe) position.

Hydraulic Control Valve

The hydraulic flow control valve (Fig. 19) provides directional control of hydraulic power to the thrust reverser hydraulic components in response to the thrust reverser ECU signals.

The deploy flow control valve controls the deploy time interval of the thrust reverser doors by limiting the fluid discharge rate from the stow side of the primary actuator.

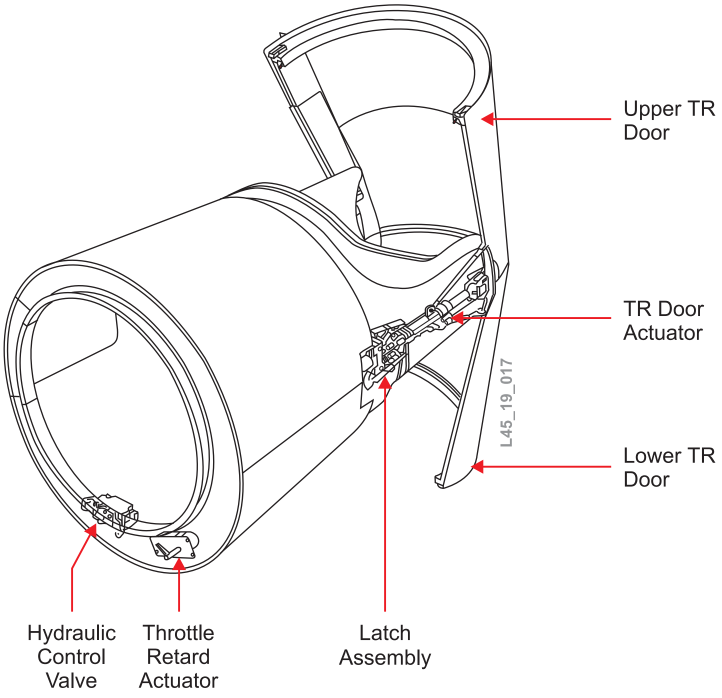


Figure 19 - Thrust Reverser Components

Primary Actuator

Each thrust reverser is equipped with two identical primary double-acting actuators that move the doors during the overstow, deploy, and stow operation.

Automatic Thrust Lever Retard System

An automatic thrust lever retard system reduces engine power to IDLE when a deploy sequence is initiated and the thrust lever is in a position forward of IDLE. The system actuator forcibly moves the thrust lever to the IDLE position.

Electronic Control Unit

The two thrust reverser ECUs, one per engine, are mounted in the aft fuselage avionics bay. The thrust reverser latchbox assemblies, engine/fire panel, deploy switch, hydraulic pressure switch, and landing gear squat switches continuously supply status signals to the onside electronic control unit.

On command from the thrust lever quadrant switches, the ECU integrates these signals and controls all thrust reverser deploy, stow, and annunciation functions, through hardware interfaces.

Thrust Reverser Controls

The thrust reverser controls (Fig. 20) for both the left and right thrust reverser assemblies are independent and identical in operation. Thrust reverser door deployment and reverse thrust power are controlled by the reverse thrust levers located on each engine thrust lever.

The main landing gear left and right weight-on-wheels (WOW) switches provide ground and flight information to both thrust reverser ECUs.

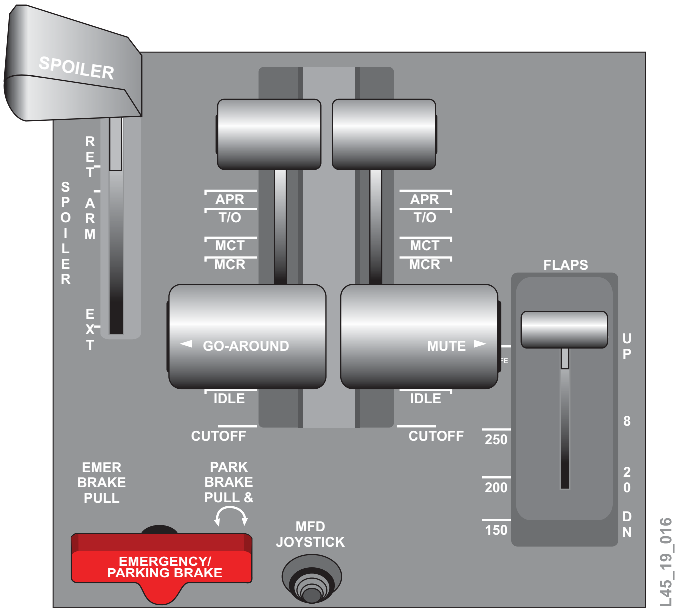


Figure 20 - Thrust Reverser Levers

Operation

Arming

To arm the thrust reverser, the engine thrust levers must be placed in the IDLE detent and both left and right landing gear squat switches must be in GROUND mode. An internal pressure switch detects hydraulic pressure and provides a signal illuminating the white REV armed annunciation on the EICAS. A thrust lever quadrant balk solenoid blocks any movement of the reverse thrust lever from the IDLE position until the TR doors are fully deployed.

Deployment Initiation

Thrust reverser deployment is initiated by raising the reverse thrust levers to the DEPLOY (reverse IDLE) detent (Fig. 21). This initiates overstow of the doors by the primary actuators, retraction of the latches, and activation of the thrust lever retard actuator (ensuring the thrust levers are at idle).

Before the thrust reverser door unlocks or deploys, a two-step sequence of motion must occur. First, the thrust reverser doors must be overstowed, (fully retracted beyond the normal stow position) to allow the latches to unlock, and second, the latch actuator must retract the latch hooks.

The primary actuators must overcome exhaust gas pressure to achieve the overstow position and permit the TR doors to unlatch. This condition can only be achieved when the engine is at an IDLE power setting.

As the latch hooks retract, they allow the inboard/outboard lock/unlock microswitches to provide a signal for illumination of the amber UNL annunciation on the EICAS.

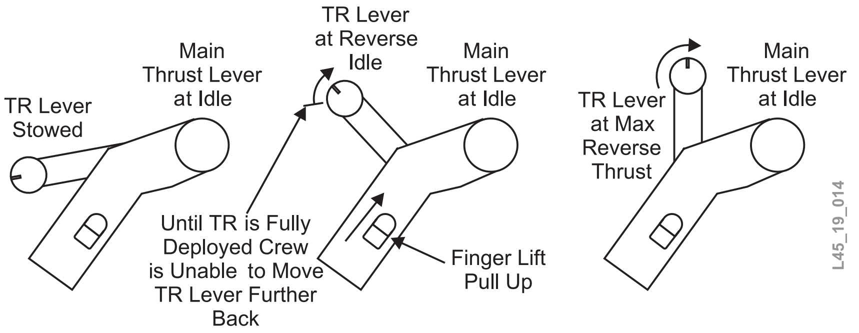


Figure 21 - Thrust Reverser Lever Operation

Deployment

Once the thrust reverser doors are fully deployed, a signal is routed to the ECU and the green DEP annunciation illuminates on the EICAS. The ECU then releases the balk solenoid in the engine thrust lever quadrant to allow the reverse thrust levers to move aft to increase reverse thrust until the maximum reverse thrust detent is encountered.

Stow Cycle

Stowing the thrust reverser is initiated by lowering the reverse thrust lever from its reverse thrust position forward into the IDLE (stow) detent. As the thrust reverser doors begin to move from their deployed positions, the green DEP annunciation extinguishes and an amber UNL annunciation illuminates. When the TR doors are latched, the amber UNL annunciation extinguishes.

Autostow

In the extremely unlikely event of an inadvertent reverser deployment, an autostow system is activated. The system incorporates a thrust reverser latch warning system circuit. Autostow is automatically initiated if both inboard and outboard latches are detected to be unlocked or one latch is unlocked with hydraulic pressure present. Hydraulic pressure is directed to the stow side of the primary actuators (Fig. 18). Autostow continues until no more than one hook is in the unlocked position. At the same time, the thrust lever retard actuator forcefully moves the appropriate thrust lever to the IDLE position.

An autostow activation in flight is annunciated visually by a red UNL and a white L/R REV AUTOSTOW on the EICAS DU, a red L/R REV UNSAFE on the CWP, and a “Left/Right Reverser Unsafe” aural warning.

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WARNINGS—AURAL AND VISUAL

Introduction

The engine indicating and crew alerting system (EICAS) provides:

- Primary display of engine data to the flight crew
- Automatic system monitoring
- Integration of system information
- Color logic for presentation of minimum/maximum limits
- Aural and voice warning generation

Normally, the EICAS display is provided on display unit (DU) 2 located on the pilot instrument panel (Fig. 1).

Master warning and caution lights installed on the glareshield attract the attention of the pilots to abnormal and emergency conditions.

Aural and voice warnings are generated on the crew warning panel and are heard through the cockpit speakers and headphones.

The radio management units (RMUs) can function as a backup EICAS display. They are capable of displaying engine and system parameters if both DU 2 and DU 3 fail.

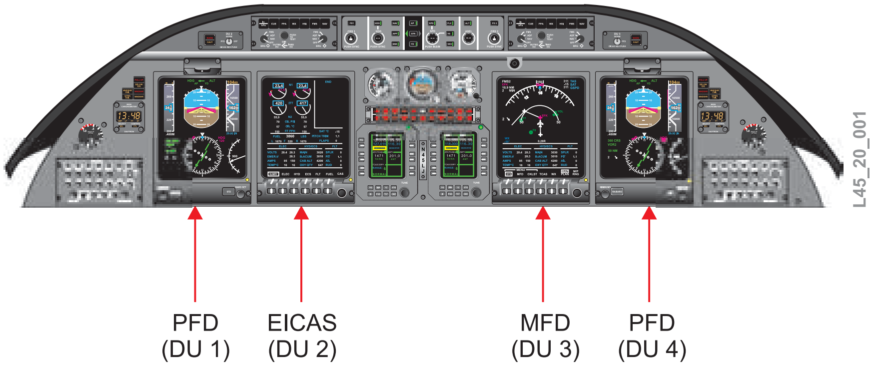


Figure 1 - EFIS and EICAS Display

Controls and Indications

Display Unit Reversion Panels

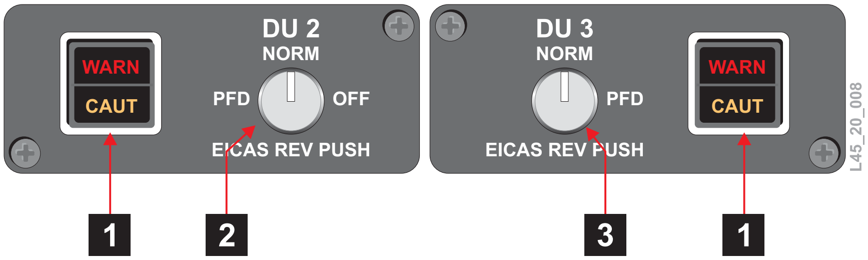


Figure 2 - Display Unit Reversion Panels

1 Master WARN/CAUT Annunciator

- WARN annunciator illuminated flashing—Indicates new red CAS messages are displayed
- CAUT annunciator illuminated flashing—Indicates new amber CAS messages are displayed
- Press—
    - Extinguishes both flashing master WARN/CAUT annunciators
    - Stops new red and amber CAS messages from flashing
    - Resets master warning and caution systems for additional activation

2 Pilot Reversion Selector Knob

- Press—Swaps DU 2 (normally EICAS) and DU 3 (normally MFD) display formats
- Rotate—
    - PFD—Displays PFD format on DU 2
    - OFF—Blanks DU 2

3 Copilot Reversion Selector Knob

- Press—Swaps DU 2 (normally EICAS) and DU 3 (normally MFD) display formats
- Rotate—
    - PFD—Displays PFD format on DU 3

Reversionary Control Panel

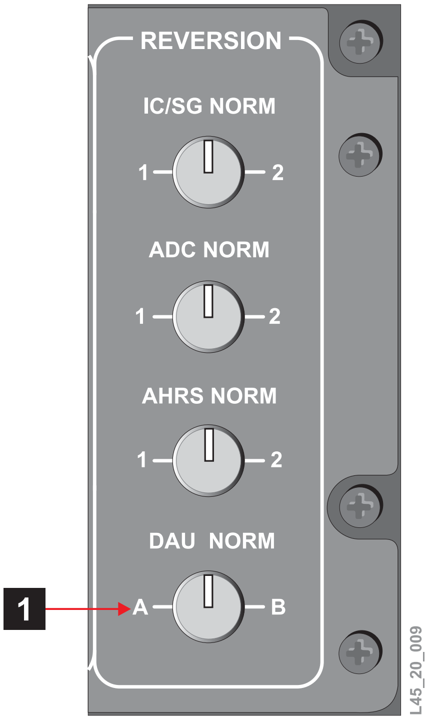


Figure 3 - Reversionary Control Panel

1 DAU Reversion Switch

- NORM—Both IC-600s use data from DAU 1 channel A and DAU 2 channel B data
- A—Both IC-600s use data from both DAU 1 and 2 channel A
- B—Both IC-600s use data from both DAU 1 and 2 channel B

EICAS Bezel Controller— System Menu

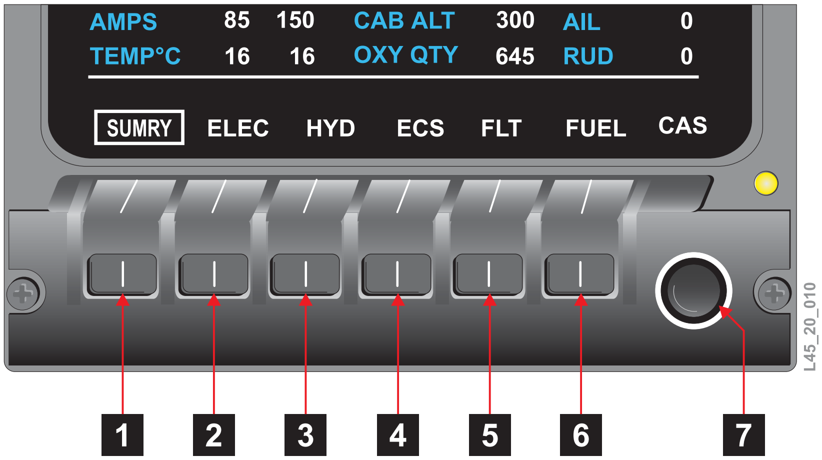


Figure 4 - EICAS Bezel Controller

1 SUMRY Button
- Press—Displays the summary system page
- Press—Blanks system area of the EICAS screen

2 ELEC Button
- Press—Displays the electrical system page
- Press—Blanks system area of the EICAS screen

3 HYD Button
- Press—Displays the hydraulic system page
- Press—Blanks system area of the EICAS screen

4 ECS Button
- Press—Displays the environmental control system page
- Press—Blanks system area of the EICAS screen

5 FLT Button
- Press—Displays the flight controls system page
- Press—Blanks system area of the EICAS screen

6 FUEL Button
- Press—Displays the fuel system page
- Press—Blanks system area of the EICAS screen

7 EICAS Knob—CAS Function

- Rotate clockwise (one click)—Scrolls the caution and advisory/status message display stack up one line
- Rotate counterclockwise (one click)—Scrolls the caution and advisory/status message display stack down one line

NOTE

Warning messages cannot be scrolled. Scrolling is inhibited when a message is flashing.

SUMRY System Page

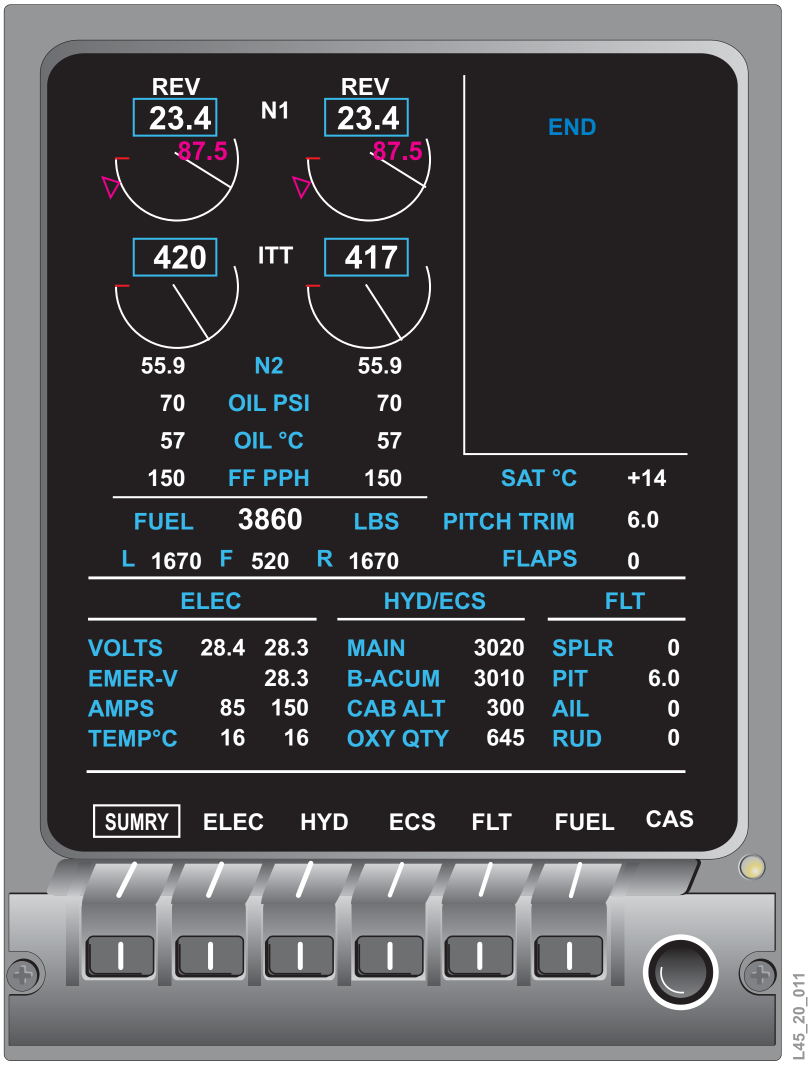


Figure 5 - SUMRY System Page

ELEC System Page

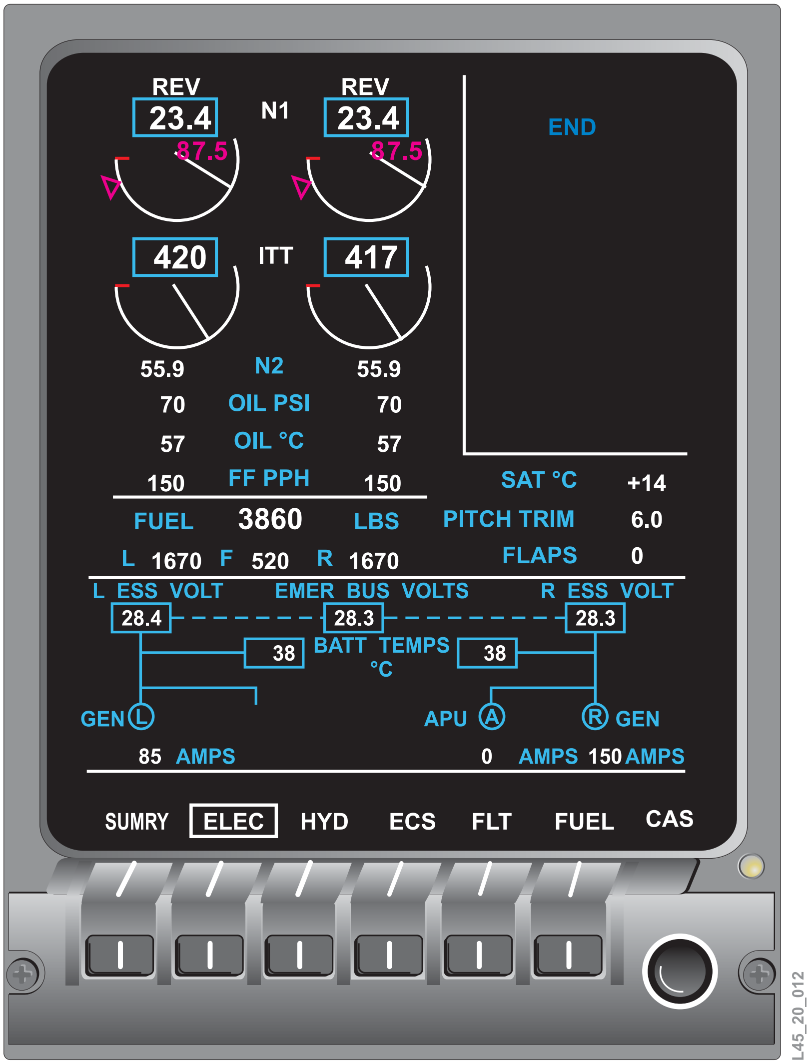


Figure 6 - ELEC System Page

HYD System Page

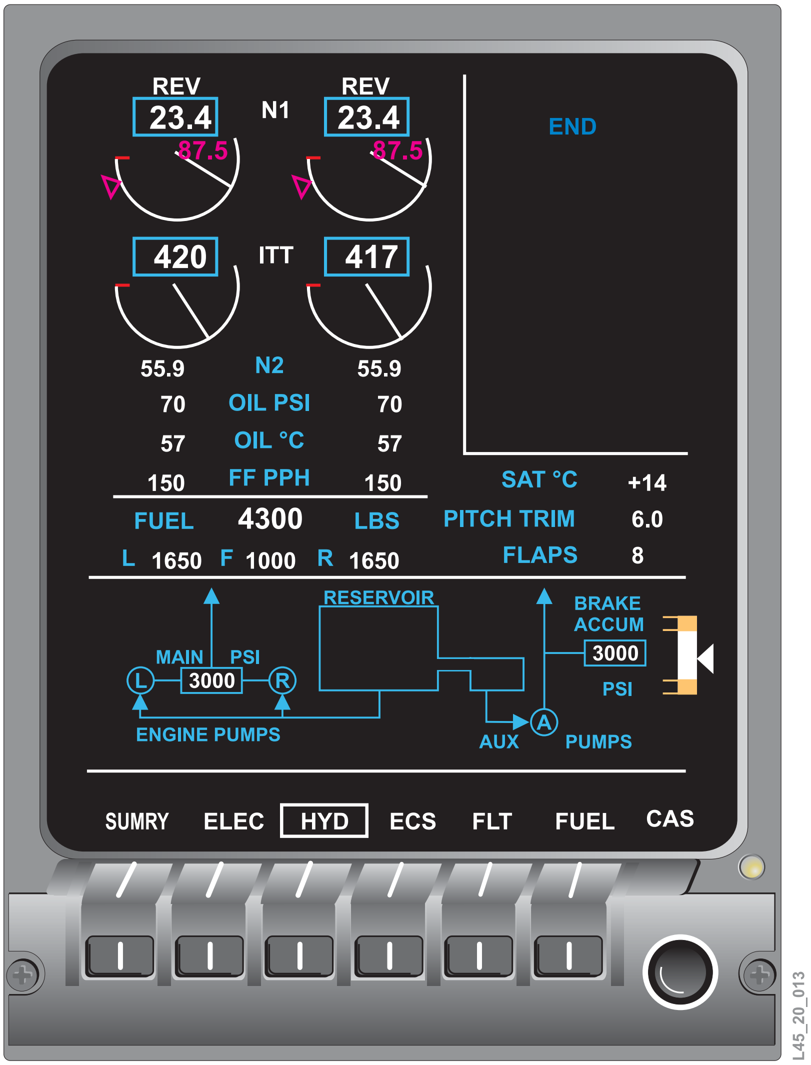


Figure 7 - HYD System Page

ECS System Page

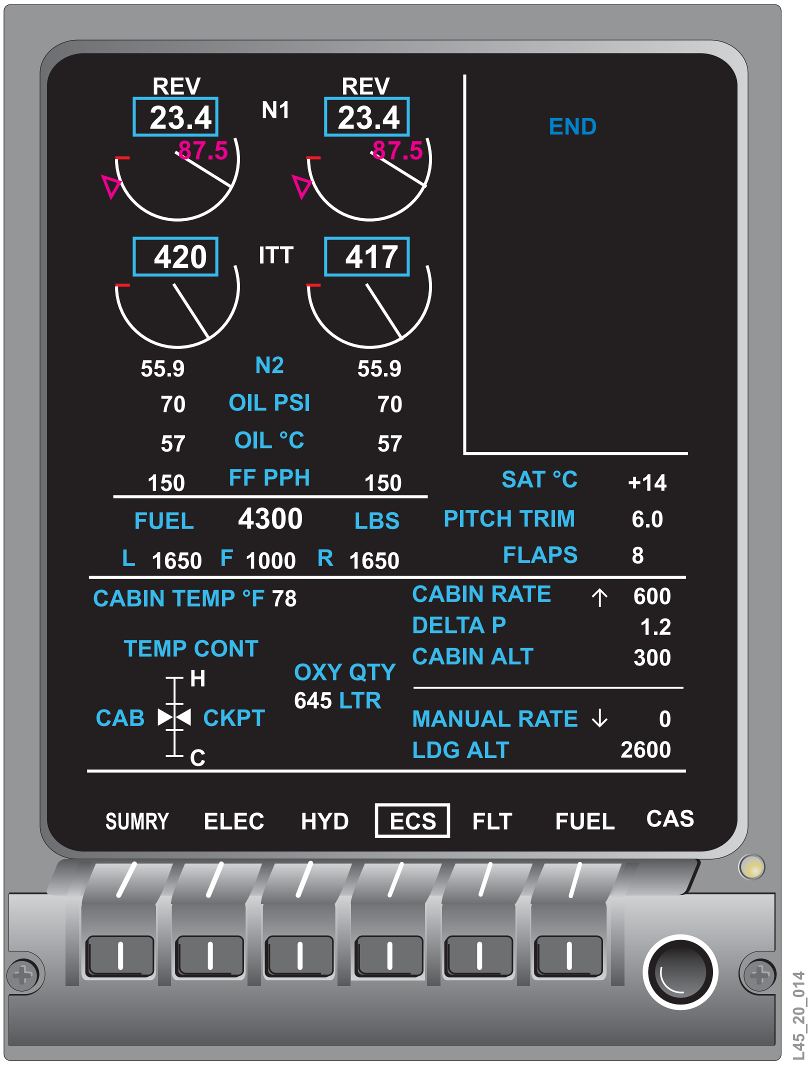


Figure 8 - ECS System Page

FLT System Page

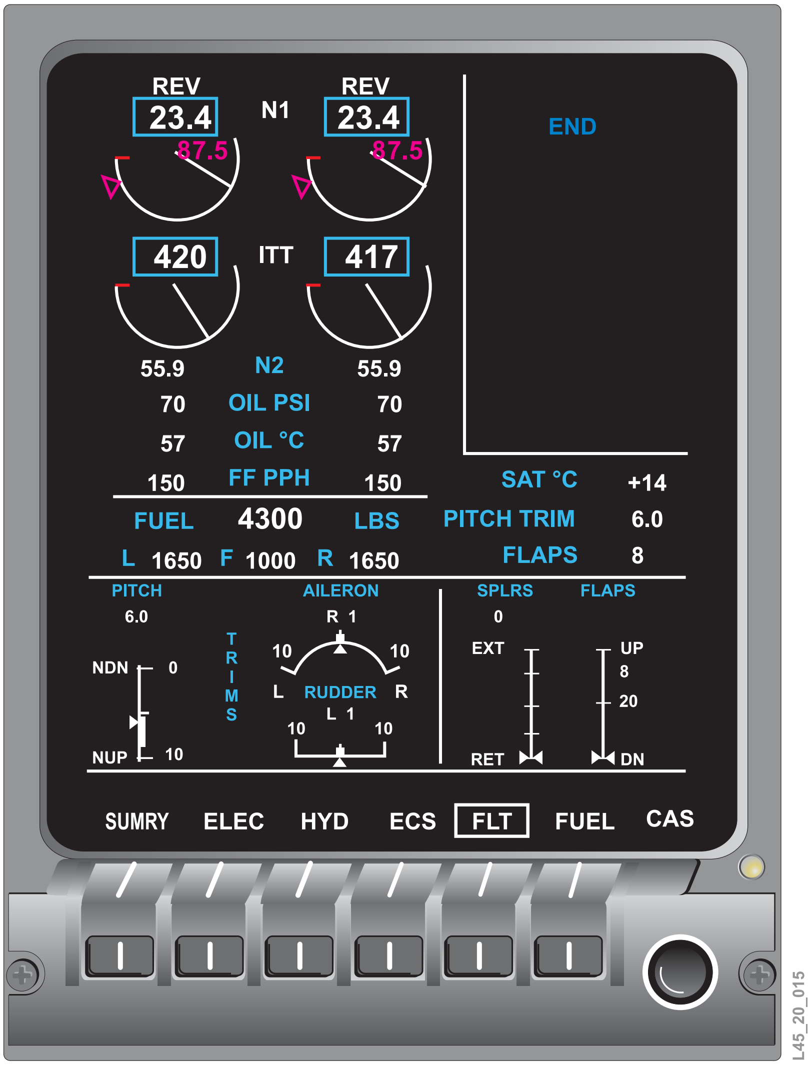


Figure 9 - FLT System Page

FUEL System Page

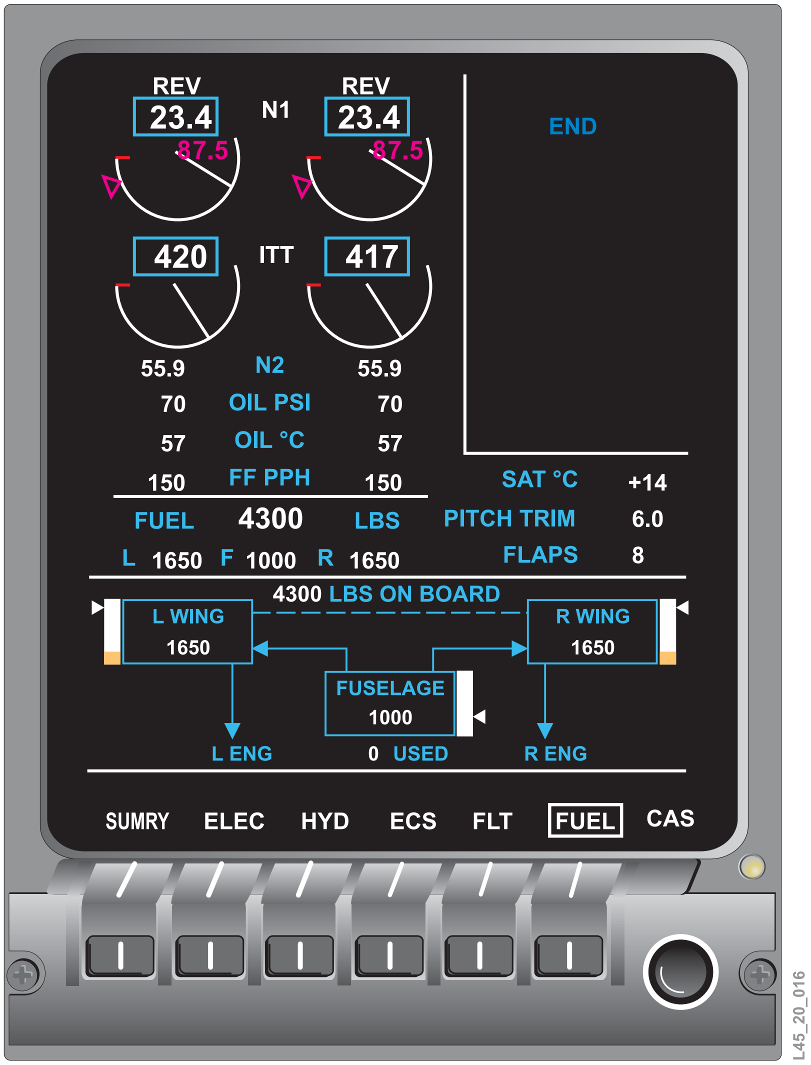
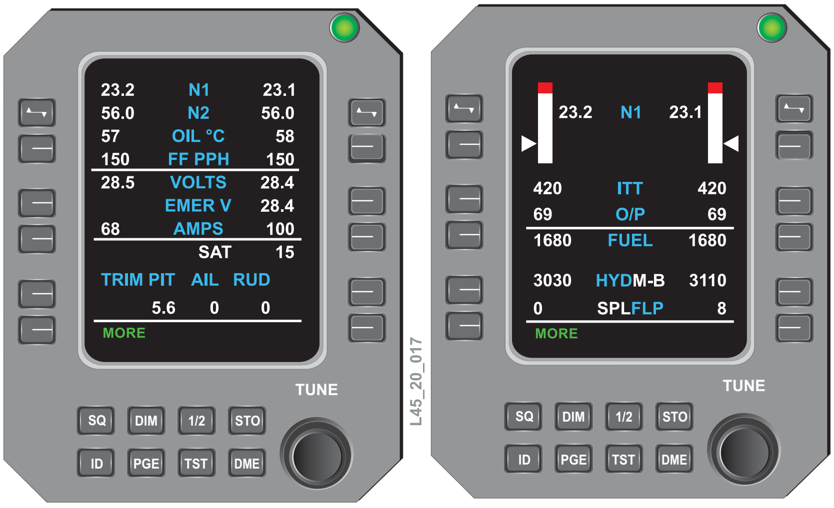


Figure 10 - FUEL System Page

RMU Backup EICAS Display



PGE 1

PGE 2

Figure 11 - Backup EICAS Display

CAS Messages

Table 1 - EICAS Related CAS Messages

CAS Message	Conditions/Parameters
DAU 1A FAIL	Channel A of DAU 1 failed
DAU 1B FAIL	Channel B of DAU 1 failed
DAU 1A-1B FAIL	Channel A and B of DAU 1 failed
DAU 2A FAIL	Channel A of DAU 2 failed
DAU 2B FAIL	Channel B of DAU 2 failed
DAU 2A-2B FAIL	Channel A and B of DAU 2 failed
L DAU ENG MISCMP	Left integrated computer (IC) detected a primary engine miscompare between channels A or B of its onside DAU (N1, ITT, and N2)
R DAU ENG MISCMP	Right IC detected a primary engine miscompare between channels A or B of its onside DAU
L DAU SYS MISCMP	Left IC detected a system page parameter miscompare between channels A and B for its onside DAU
R DAU SYS MISCMP	Right IC detected a system page parameter miscompare between channels A and B for its onside DAU
LBS/KGS CONFIG	Pounds/kilograms configuration strapping of the IC-600 disagrees with the configuration strapping of the DAU 1 or DAU 2 on the ground

Table 1 - EICAS Related CAS Messages

CAS Message	Conditions/Parameters
EICAS CHK	Located to the left of the heading readout on the MFD, this illumination indicates that the IC/SG displaying the EICAS engine data (N1, ITT, or N2) detected an error in the displayed data compared to the inputs from the DAU
CAS MSG	Located below the attitude sphere on the left side on the PFD, this illumination indicates a comparison mismatch of IC 1 and IC 2 CAS messages
WARN AUDIO	Crew warning panel audio output function failed
L R WARN PWR FAIL	Both left and right CWP power supplies failed
DAU A REV	Pilot selected DAU reversion to channel A
DAU B REV	Pilot selected DAU reversion to channel B
LBS/KGS CONFIG	Pounds/kilograms configuration strapping of the IC-600 disagrees with the configuration strapping of DAU 1 and DAU 2 during flight
IC 1 WOW INOP	IC 1 tripped the weight-on-wheels monitor by a detected mismatch between the weight-on-wheel inputs and airspeed logic
IC 2 WOW INOP	IC 2 tripped the weight-on-wheels monitor by a detected mismatch between the weight-on-wheel inputs and airspeed logic
IC 1-2 WOW INOP	IC 1 and 2 tripped the weight-on-wheels monitor by a detected mismatch between the weight-on-wheel inputs and airspeed logic
WARN AUDIO	CWP detected a fault in either one of the output channels or in the automatic gain control (AGC) input. The CWP is still operational, and the tone/aural volume is set at a fixed (high) level
L WARN PWR FAIL	Left CWP power supply failed or lost power. The CWP is still operational from the opposite power supply; however, the CWP annunciators may be dim
R WARN PWR FAIL	Right CWP power supply failed or lost power. The CWP is still operational from the opposite power supply; however, the CWP annunciators may be dim

Engine Indicating and Crew Alerting System

Description

The function of the EICAS is to display the engine instruments, visual crew alerting messages, and real-time interpretation of aircraft system operation.

The various system pages are selectable by the bezel controller at the bottom of the display unit. Normally, the airplane system summary page (SUMRY on the menu) is in view, which provides brief status reports of all subsystems. Color depicts normal and abnormal ranges of operation. System pages can also be viewed on the MFD display.

The crew alerting system (CAS) provides visual and aural alerts when the IC-600s (IC/SG) detect a malfunction condition. The CAS prioritizes messages by order of occurrence and importance. The most recent message always appears on the top of its associated list.

The order of importance is accomplished by color and aural alerts. There are three levels of CAS message importance:

- Warning (red)
- Caution (amber)
- Advisory/status (white)

Refer to Fig. 12 for a block diagram of the engine indicating and crew alerting system.

Components and Operation

Data Acquisition Units

The data acquisition unit (DAU) is the central data collection point for the EICAS.

There are two dual-channel DAUs installed in the airplane. The DAUs receive engine and airplane systems sensor information and pass it, primarily, to the IC-600 computers and the RMUs. Both channels A and B of DAU 1 provide left engine data, and both channels A and B of DAU 2 provide right engine data. For redundancy, both channels of each DAU independently convert onside engine information to a common data format and send it to both IC-600s.

In addition to engine information, the DAUs also collect analog data from other airplane systems for display on the various EICAS system pages. DAU channels 1A and 2A output directly to the RMUs for engine backup pages.

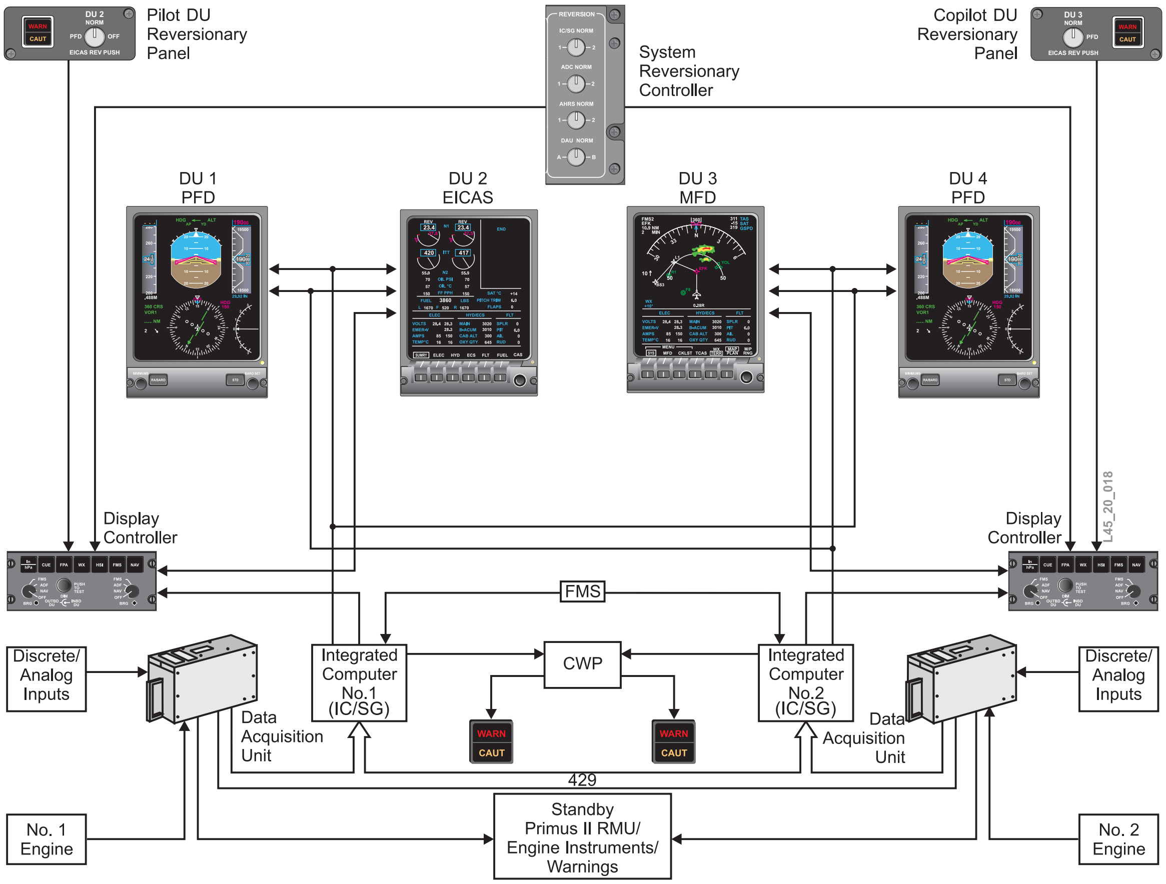


Figure 12 - EICAS—Block Diagram

IC-600 Integrated Avionics Computers

The IC-600s integrated avionics computers (IACs) (also referred to as integrated computer/symbol generators [IC/SG]) process the information received by the DAUs and associated control panels and send it to the selected display unit (normally DU 2) for EICAS display. Normally, both IC-600 computers output DAU channels 1A and 2B data to the displays.

Each IC-600 normally drives two DUs. The pilot IC-600 drives the pilot PFD and EICAS display, and the copilot IC-600 drives the copilot PFD and the MFD display. However, if one IC-600 computer fails, the remaining functional IC-600 can drive all four DUs using the IC/SG reversionary switch.

EICAS Display

The EICAS display (Fig. 13) is a CRT video display. The DUs dim through the pilot EFIS display controller. The CRT also incorporates a bezel controller that can select the systems display pages.

One EICAS display is divided into four designated areas:

- Primary engine indication
- Crew alerting system (CAS)
- System page
- Bezel menu

DU 2 is powered by the left essential bus.

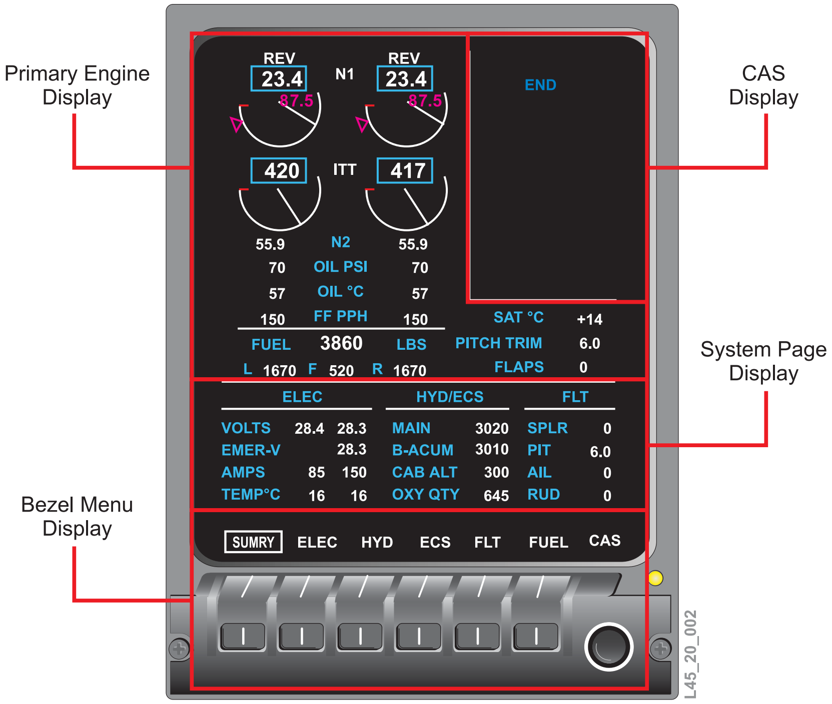


Figure 13 - EICAS Display

Crew Warning Panel

The crew warning panel (CWP) (Fig. 14), located on the center instrument panel, provides a redundant display medium for certain red CAS messages. The crew warning panel annunciators illuminate when triggered by the associated system input signal and remain illuminated as long as the abnormal condition exists. The crew warning panel also supplies the logic for illuminating and flashing the two master WARN lights.

Another function of the crew warning panel is to generate the aural warning tones and voice messages. These warnings are provided to the audio system and transmitted through both pilots' headphones and cockpit speakers.

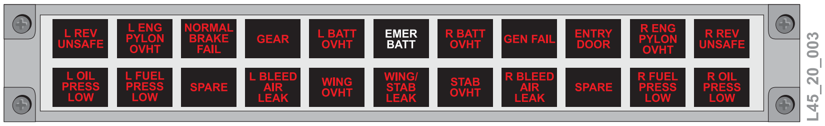


Figure 14 - Crew Warning Panel

Aural Warnings

The crew warning panel provides tone generation and/or aural messages (except for the trim-in-motion clacker) to the cockpit audio system for alerting. Aural alerting is provided anytime a warning or caution CAS message is triggered. The crew warning panel also provides other independent aural alerts for various events that may occur in the cockpit. These aural alerts differ from each other by tone frequency, intensity, and duration.

TCAS, EGPWS, and other optional equipment generate their own aural/audible warnings.

SYS TEST/RESET Switch

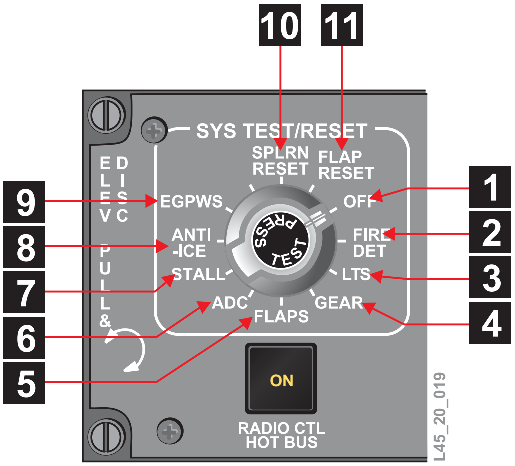


Figure 15 - SYS TEST/RESET Switch

1 OFF Position

- No system selected for testing

2 FIRE DET Position

- Master WARN chimes and flashers
- “Left engine fire” aural alert
- “Right engine fire” aural alert
- Both FIRE switches illuminate
- All EXTINGUISHER switches illuminate
- Flashing red FIRE in ITT
- Steady red FIRE on radio management unit (RMU)
- Red LR BLEED AIR LEAK on crew warning panel (CWP) and crew alerting system (CAS)
- APU FIRE switch illuminated
- APU fire horn in wheel well (15 sec)

3 LTS Position

- All cockpit switches illuminate
- All crew warning panel (CWP) lights illuminate

- Flight guidance computer (FGC) panel lights progressively illuminate
- After 15 sec, aural and audible alerts:
  - "Overspeed"
  - "Stall"
  - "Cabin altitude"
  - "Configuration"
  - Calvary charge tone (AP disc)
  - "Gear"
  - "Left engine fire"
  - "Right engine fire"
  - "Left reverser unsafe"
  - "Right reverser unsafe"
  - "Brakes fail"
  - Single tone (altitude alert)
  - "Minimums, minimums"
  - Triple chime (master WARN)
  - "Gear" (caution)
  - Single chime (master CAUT)
  - Alarm clock tone
  - SELCAL alert

4 GEAR Position

- Master WARN chimes and flashers
- "Gear" aural alert
- Red GEAR on crew warning panel (CWP) and crew alerting system (CAS)
- Gear in transit white lights illuminate

5 FLAPS Position

- Master CAUT chimes and flashers
- Amber FLAPS FAIL on crew alerting system (CAS)
- Amber FLAPS FAULT on crew alerting system (CAS)
- Amber boxed digital flap displays

6 ADC Position

- “Overspeed” aural alert
- Red ADC TEST on both primary flight displays (PFDs)
- Airspeed = 330 kt (red)
- Mach = .81 (red)
- Altitude = 1000 ft
- Altitude trend = +1500 fpm
- Vertical speed = +5000 fpm
- Overspeed cue = 330 kt and above
- TAS (MFD) = 466 kt
- SAT (MFD) = – 45°C

7 STALL Position

- Left side indications first; repeated on right side
    - Master CAUT chimes and flashers
    - Red ADC TEST on both primary flight displays (PFDs)
    - Low-speed awareness moves up
    - Angle-of-attack (AOA) indicator pointer sweeps (optional)
    - Amber L AOA HT FAIL crew alerting system (CAS)
    - “Stall, stall” aural alerts
    - Stick shaker activates

8 ANTI ICE Position

- Master WARN chimes and flashers
- White WG/STAB HT OK on crew alerting system (CAS)

9 EGPWS Position

- PRESS TEST button)—If test fails, it automatically stops and a long test is recommended
    - Short test (push and release)
    - Red TERR TEST message on multifunction display (MFD) remains on through self-test
    - Momentary white GPWS SYS FAIL on crew alerting system (CAS)
    - Simultaneous “glideslope” aural alert and amber GND PROX on primary flight displays (PFDs)

NOTE **At this point there can be a momentary G/S INHB CAS message on the PFDs.**

- Red PULL UP illuminates on both PFDs, “pull up” aural alert, PULL UP extinguishes

  - Red WIND SHR on both PFDs for approximately .75 seconds
  - Terrain display self-test pattern on MFD, red PULL UP on PFDs
  - “Terrain, terrain, pull up” aural alert, red PULL UP extinguishes, momentary amber GND PROX message

NOTE **The terrain display self-test pattern goes off after several sweeps, and the MFD returns to the condition it was in before the Level 1 self-test.**

  - TERR TEST on MFD extinguishes at end of Level 1 self-test
- Long test (depress and hold PRESS TEST two seconds)
  - Red TERR TEST on MFD
  - Momentary white GPWS SYS FAIL on crew alerting system (CAS)
  - “Sink rate” aural alert, white GPWS SYS FAIL on CAS through rest of test
  - “Terrain, terrain” aural alert, terrain display appears on MFD through rest of test

NOTE **Other messages can appear on the PFDs and on the CAS display through the remaining part of this test.**

- Aural alerts:
  - “Glideslope”
  - “Pull up”
  - “Windshear, windshear, windshear”
  - “Terrain, terrain”
  - “Pull up”
  - “Sink rate”
  - “Pull up”
  - “Terrain”
  - “Pull up”
  - “Don’t sink, don’t sink”
  - “Too low, terrain”
  - “Too low, gear”
  - “Too low, flaps”
  - “Too low, terrain”
  - “Glideslope”
  - “Five hundred”
  - “Windshear, windshear, windshear”

- “Too low, terrain”
- “Caution terrain, caution terrain”
- “Terrain, terrain, pull up”
- “Caution obstacle, caution obstacle”
- “Obstacle, obstacle, pull up”

10 SPLRN RESET Position

11 FLAP RESET Position

Master WARN Annunciator

The master WARN annunciators are located on the glareshield directly in front of each crewmember (Fig. 16). These annunciators supplement the red warning annunciators located in the crew warning panel and the red warning messages that are displayed in the CAS window of the EICAS.

When the IC-600s generate a warning CAS message, the two master WARN annunciators are signaled to flash red. When the annunciator is depressed, the flashing light is reset.

Master CAUT Annunciator

The amber master CAUT annunciators use a split-legend switch with the master WARN lights, and supplement the amber caution messages displayed on the CAS window of the EICAS.

When the IC-600s generate a caution message, the two master CAUT annunciators are commanded to flash amber. When the annunciator is depressed, the flashing light is reset.

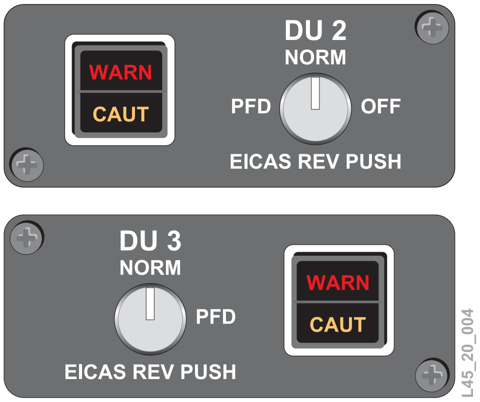


Figure 16 - Master WARN/CAUT Annunciators

Primary Engine Display

The engine instruments page (Fig. 17) is displayed full-time on the primary EICAS display format.

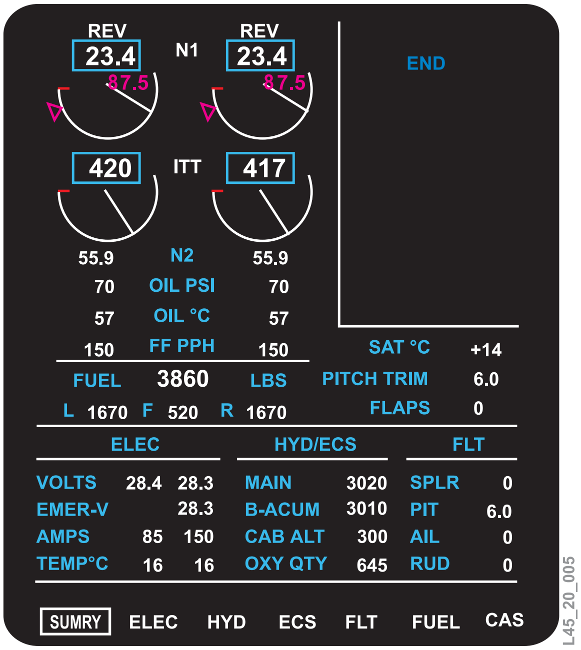


Figure 17 - EICAS Primary Engine Display

Engine Indications

Engine indications are presented in both the traditional analog gauge format and as digital readouts. Displayed engine parameters include:

- N_1 speed
- Inter-turbine temperature (ITT)
- N_2 speed
- Oil pressure
- Oil temperature
- Fuel flow

In addition, the following engine-related annunciations may appear:

- N_1 SYNC
- N_2 SYNC
- IGN (ignition)
- REV (thrust reverser display status)
- MCR, MCT, TO (thrust lever detent)
- NAC (nacelle heat)
- APR (engine auxiliary power reserve)
- START (engine starter engaged)
- MAN (fuel computer manual)
- FIRE

Related information displayed in full-time digital format includes:

- SAT (static air temperature)
- Pitch trim
- Flap position

CAS Display

The CAS provides visual and aural alerts when the IC-600 detects a malfunction. The CAS prioritizes messages by order of occurrence and importance.

The most recent message always appears on the top of its associated list. In addition, new messages are displayed flashing until they are acknowledged by depressing either master WARN/CAUT annunciator.

The order of importance is accomplished by using color and aural alerts.

CAS Display Color

There are three levels of CAS message importance: warning, caution, and advisory/status. Refer to Table 2 for the definition of each message color and Fig. 18 for the display.

Table 2 - CAS Color Logic

Priority	Color	Meaning
Warning (top message stack)	Red	May require immediate crew action
Caution (middle message stack)	Amber	May require subsequent crew action
Advisory/status (bottom message stack)	White	May require pilot or maintenance action at some point in time

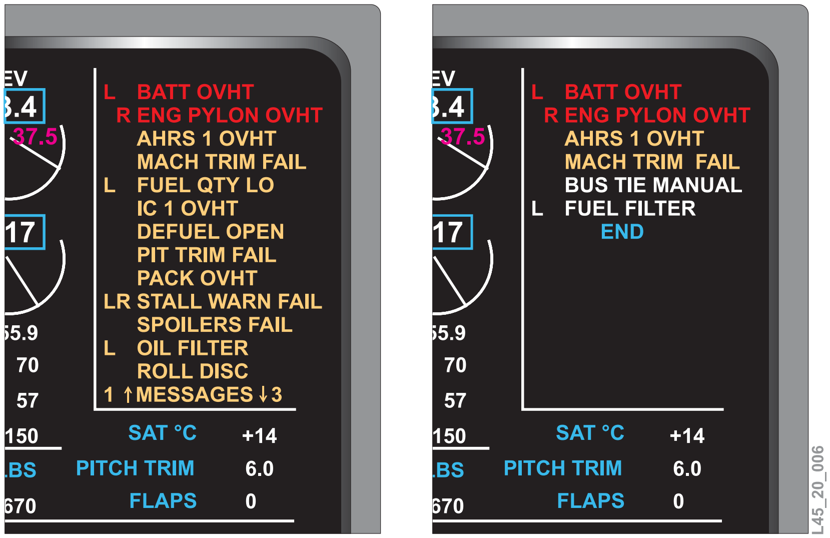


Figure 18 - CAS Display

CAS Message Scrolling

A message scrolling function allows the flight crew to move up and down through the stack of caution and advisory messages not currently on display. The scrolling function is performed by the CAS knob on the EICAS bezel controller.

If more than 14 CAS messages are displayed in the CAS display area at any one time, the last line of the CAS window (message status line) indicates to the pilot the number of undisplayed caution or advisory messages. To view the undisplayed cautionary or advisory message, rotate the CAS knob. Each clockwise or counterclockwise click of the CAS knob scrolls the CAS message down or up one line, respectively. The last message in the list is always END.

Rotating the CAS knob also scrolls amber and white messages off the display. The quantity of scrolled messages is displayed at the bottom of the CAS area.

NOTE **Red messages or flashing new messages cannot be scrolled.**

Warning Messages

The most urgent messages are warnings. They are red in color. When any red CAS message annunciation becomes active, it appears flashing and is accompanied by the following:

- Triple chime
- Aural message following the triple chime (if applicable)
- Flashing master WARN annunciators
- Red annunciation on the CWP (if applicable)

Pressing either master WARN annunciator acknowledges the master WARN annunciator and accomplishes the following:

- Stops the red CAS message from flashing
- Silences the aural alerts
- Extinguishes the master WARN annunciators
- Resets the master warning system to allow it to annunciate another fault

NOTE **Since the master WARN/CAUT annunciator is a single switch, depressing it also acknowledges all new warning and caution CAS messages.**

If red CAS messages are already on the CAS display when a new red message becomes active, the new message displays on top of the red message stack. Warning messages remain visible until the condition causing the CAS message is resolved.

Caution Messages

Caution messages are second in the order of importance. Amber caution messages appear directly below any red warning messages that are displayed. When any amber CAS message becomes active, it is accompanied by:

- Single chime
- Flashing master caution annunciators

Pressing either master CAUT annunciator acknowledges the master CAUT annunciator and:

- Stops the amber CAS message from flashing
- Silences the aural alert
- Extinguishes the master CAUT annunciators
- Resets the master caution system to allow it to annunciate another fault

If the existing amber or white messages are scrolled off the CAS display, the amber and white message stacks are brought back on the CAS display with the new message displayed at the top of the amber stack.

Caution messages are removed from the CAS display when the condition causing the CAS message is resolved.

Advisory/Status Messages

White advisory/status messages are displayed below the amber CAS messages. When a white CAS message becomes active, it flashes on the CAS display for five seconds and then becomes steady. These CAS messages advise of the following:

- Status of a system that has been manually or automatically activated
- Identity of a noncritical system failure

If the existing white messages are scrolled off the CAS display, the white message stack is brought back on the CAS display with the new message displayed at the top of the white stack.

Advisory/status messages are removed from the CAS display when the condition causing the message is resolved.

CAS Inhibits

Takeoff and landing inhibits of certain caution (amber) and advisory/status (white) CAS messages reduce pilot distractions during critical phases of flight. Warning (red) messages and advisory/status messages associated with pilot selection are not inhibited.

NOTE

On aircraft with Service Bulletin LR45-22-8 or LR40-22-03, a red CAS BRAKE FAIL message is inhibited during takeoff.

Takeoff and Landing Inhibit

A white CAS TAKEOFF INHIBIT or CAS LANDING INHIBIT is displayed within the EICAS page menu area when the inhibit function is enabled. During this phase, the inhibited CAS messages cannot change state (either displayed or removed from the CAS display). The master CAUT is not triggered for an inhibited CAS message. When the inhibit logic is disabled, inhibited CAS messages (with the master CAUT, as appropriate) trigger on the CAS.

The takeoff inhibit logic is enabled when all the following conditions exist:

- Weight on wheels
- Airspeed above 40 KIAS
- Both thrust levers at MCR or above

The takeoff inhibit logic is disabled by any of the following:

- Takeoff and climb above 400 ft radio altitude
- Weight off wheels plus 30 seconds
- Abort, airspeed less than 40 KIAS
- 60 seconds after enable

The landing inhibit logic is enabled when all the following conditions exist:

- Gear down while airborne
- Both thrust levers below MCR
- Radio altitude below 400 ft

The landing inhibit logic is disabled by any of the following:

- Weight on wheels below 40 KIAS
- Weight on wheels plus 30 seconds
- Climb above 400-ft radio altitude

Master Caution Inhibit Mode

The master caution inhibit mode allows the flight crew to inhibit triggering the master CAUT annunciators when the aircraft is on the ground during preflight. To enable the master CAUT inhibit, the aircraft must be on the ground (both squat switches in ground mode) and at least one the following red CWP annunciators illuminated:

- L or R OIL PRESS LOW
- L or R FUEL PRESS LOW

The flight crew may enter this mode by depressing the master CAUT annunciator for at least 2 seconds. Activation of this mode is signaled by one flash of the master CAUT annunciators. The mode is exited when either all the previously mentioned CWP annunciators extinguish or either squat switch signals air mode.

MUTE Switch

The cockpit speaker mute prevents all audio, including warnings and tones, from being heard through the cockpit speakers. The mute function will be disabled if:

- Switchlight is depressed a second time
- Either pilot selects the oxygen mask mic on the audio panel
- Power is removed from the aircraft

Figure 19 - MUTE Switch

EICAS System Pages

The bottom section of the EICAS display contains the system pages. The following pages are available for display:

- SUMRY
- ELEC
- HYD
- ECS
- FLT
- FUEL

The various system pages are selected for display by pressing the appropriate pushbutton on the EICAS display bezel controller. The system pages can also be selected for display on the MFD.

SUMRY Button

The summary button selects a digital tabular summary of the electrical, hydraulic, environmental, and flight control systems. The box around the system page label indicates the selected page. Pushing the boxed button declutters all system pages of the EICAS display.

The electrical section of the summary page is displayed on the left side of the system page window and contains the following parameters:

- Left and right essential bus voltages
- Left and right generator current
- Emergency battery bus voltage
- Left and right main battery temperatures (NICAD batteries only)

The hydraulic and ECS section of the summary page is displayed in the middle of the system page window and contains the following parameters:

- Main hydraulic pressure
- Brake accumulator pressure
- Cabin altitude
- Oxygen quantity

The flight controls section of the summary page is displayed on the right of the system page window and contains the following parameters:

- Spoiler position
- Pitch trim position
- Aileron trim position
- Rudder trim position

The SUMRY page is displayed by default upon power-up.

ELEC Button

Pushing the ELEC button displays the electrical system schematic/ parameters.

These parameters include the left and right essential bus voltages, the left and right generator current, the left and right main battery temperatures (NICAD batteries only), the emergency battery bus voltage, APU current (if installed), and an external power-on indicator.

HYD Button

Pushing the HYD button selects the main hydraulic system schematics to include brake accumulator pressures and hydraulic systems quantity.

ECS Button

Pushing the ECS button displays the main environmental control system parameters. These parameters include cabin temperature, oxygen quantity, cabin rate of climb or descent, cabin differential pressure, cabin altitude, manual rate, landing altitude, and both analog scale and digital display of cabin and cockpit duct temperature.

FLT Button

Pushing the FLT button displays selected and actual flap position, as well as both digital and analog display of pitch trim, aileron trim, rudder trim, and spoiler position.

FUEL Button

Pushing the FUEL button displays aircraft fuel quantity and fuel used.

EICAS Color Logic and System Page Presentation

Generally, the color logic in Table 3 is used for the EICAS primary engine and system page display formats.

Table 3 - EICAS Color Logic

Color	Meaning
RED	Warning and exceedance data
AMBER	Caution and invalid data
GREEN	Status/selections data
CYAN	Label, scales, flow line outlines
MAGENTA	Computed or pilot selected data (DEEC)
WHITE	Normal data

Display Reversionary Control

DAU Reversionary Mode

A DAU reversionary switch is provided on the reversionary control panel located below DU 2 (Fig. 20). The switch positions are labeled A, DAU NORM, and B. With the switch in DAU NORM, both IC-600s use channel A from the DAU 1 and channel B from DAU 2 for engine/systems displays. In the reversionary positions (A or B), each IC-600 uses only the selected channel from both DAUs.

If either channel of either DAU should fail, or if either A or B reversion is selected, or if an engine or system miscompare is detected, an appropriate CAS message illuminates.

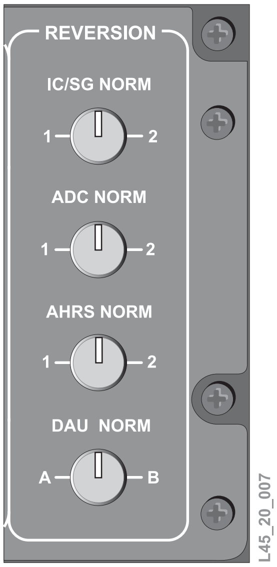


Figure 20 - Reversionary Control Panel—DAU

Display Unit Reversionary Mode

A display unit reversion panel is located on the glareshield above the PFDs on each side of the cockpit. The panel on the pilot side is for controlling the display on DU 2, and the panel on the copilot side is for controlling display on DU 3. The reversion selector knob on these panels, plus the push function of the knobs, allow the flight crew to switch the inboard DUs (DU 2 and DU 3) to display either PFD, MFD, or EICAS formats.

With both reversion selector switches in NORM, an EICAS format is displayed on DU 2 and an MFD format on DU 3. Depressing the selector knob on either reversion panel flip-flops the DU 2 and DU 3 displays, reversing the MFD and EICAS display locations. Placing the reversion selector to the PFD position on either side causes the PFD format to move to the inboard display tube on that side and the outboard display to blank.

It is important to note that when selecting display unit reversion, the bezel controllers on DU 1 and DU 4 continue to work with the PFD display when it is transferred to an inboard display unit.

Radio Management Unit—Backup EICAS Display

Description

Either RMU can be used as a backup EICAS display for providing engine and system parameters. The MORE line select key chooses between pages 1 and 2.

Backup EICAS display page 1 displays the following information:

- N_1
- ITT
- Oil pressure
- Left and right tank fuel quantity
- Main and brake hydraulic pressure
- Spoiler and flap positions

Backup page 1 can also display IGN (ignition) or FIRE adjacent to the N_1 display. No other CAS messages are displayed on the RMU.

Backup EICAS display page 2 displays the following information in tabular format:

- N_1
- N_2
- Oil temperature

- Fuel flow
- Left and right DC generator volts
- Emergency bus volts
- Generator current draw
- Static air temperature
- Pitch, aileron, and rudder trim positions

Loss of data results in the digital data being replaced by amber dashes.

Operation

Under normal operation, the backup EICAS display pages are manually selected by depressing the PGE button on either RMU.

If less than three DUs are available however, the pilot RMU automatically reverts to the backup EICAS display.

NOTE **If the pilot RMU is displaying EICAS information due to an automatic selection, the RMU returns to the EICAS display 20 seconds after the last selection on the RMU.**

Takeoff Configuration Monitor

The takeoff configuration monitor system, in conjunction with the crew warning system, provides aural and visual alerts on the ground when an unsafe takeoff configuration exists. The “Configuration” aural message activates during ground operations when either thrust lever is advanced above MCR position and one or more of the following conditions exists:

- Flaps not set for takeoff
- Spoilers not retracted
- Pitch trim not in a safe position for takeoff
- Parking brake not released
- Thrust reverser unlocked
- Rudder trim not in a safe position for takeoff (over one unit)
- Aileron trim not in a safe position for takeoff (over one unit)
- Pitch trim bias not in proper position

In addition to the “Configuration” aural message, the condition causing the warning is identified by the applicable red CAS message appearing or by the monitored parameter being displayed on the EICAS in red and outlined with a red box.

The “Configuration” aural warning cannot be muted and silences when:

- All of the above conditions are corrected
- Both thrust levers are retarded below MCR position
- Airplane becomes airborne

Checklist Memory Items

GROUND–TAKEOFF

Emergency Evacuation

1. EMERGENCY/PARKING BRAKE .... **Set**
2. Thrust Levers .... **CUTOFF**
3. EMER LIGHTS .... **ON**
4. EMER BATT, L & R BATT .... **OFF**

Engine Failure

Below V1 Speed

1. Brakes .... **Apply**
2. Thrust Levers .... **IDLE**

Above V1 Speed

1. Attitude Control .... **As Required**
2. Accelerate to VR. Keep nose wheel on ground.
3. Rotate at VR to target takeoff pitch attitude; Climb at V2.
4. Gear .... **UP**
5. Climb to 1500 feet AGL or Obstacle Clearance Altitude (as appropriate), accelerate to V2 +25, retract flaps, then accelerate to 200 KIAS en route climb speed.

Emergency Braking

1. EMERGENCY/PARKING BRAKE .... **Pull Smoothly**

REV UNSAFE, UNL, or DEP

During takeoff:

Below V_1 Speed

1. Brakes .... **Apply**
2. Thrust Levers .... **IDLE**

Above V_1 Speed

1. Attitude Control .... **As Required**
2. Accelerate to V_R.
   Keep nose wheel on the ground.
3. Rotate at V_R; Climb at V_2.
4. Gear .... **UP**
5. Climb to 1500 feet AGL or Obstacle Clearance Altitude (as appropriate), accelerate to V_2 +25, then retract flaps.

Nosewheel Steering Malfunction

1. Control Wheel Master (MSW) .... **Depress & Release**
2. Thrust Levers .... **IDLE**

Aborted Takeoff

1. Brakes .... **Apply**
2. Thrust Levers .... **IDLE**

IN FLIGHT

Engine Fire

Affected Engine:

1. Thrust Lever .... **IDLE**
   (Unless a Critical Thrust Situation Exists)
2. •If fire continues more than 15 seconds or there are other indications of fire:
   a. Thrust Lever .... **CUTOFF**
   b. Applicable FIRE (ENGINE) .... **FIRE PUSH**
   c. EXTINGUISHER #1 (ENGINE) .... **ARMED Push**

Emergency Descent

1. Crew Oxygen Masks .... **Don & 100%**
2. Thrust Levers .... **IDLE**
3. Autopilot .... **Disengage**
4. SPOILER**EXT**
5. Descend at MMO/VMO , but not below minimum safe altitude.
6. DEPLOY .... **ON**
7. Pilot & Copilot MIC/MASK .... **MASK**
8. Pilot & Copilot INPH .... **INPH**

Recovery from Inadvertent Overspeed

1. Thrust Levers .... **IDLE**
2. Autopilot .... **Disengage**
3. SPOILER. .... **EXT**
4. Identify aircraft pitch & roll attitude.
5. Level wings.
6. Elevator & Pitch Trim .... **As Required**

Immediate Engine Airstart

Affected Engine:

1. Thrust Lever .... **IDLE**
   IGN will automatically activate
2. STBY (FUEL) .... **ON**

Aileron Control Jam

1. Attitude Control .... **As Required**
   Use Rudder & Thrust as Necessary
2. ROLL DISC Lever .... **Pull**
   a. Pilot—Control aircraft with the spoilerons.
   b. Do Not use copilot control.
   c. Do Not use AIL TRIM.

Stall

1. Lower the pitch attitude to reduce angle of attack.
2. Thrust Levers .... **T/O**
   (Manual APR, if Required)
3. Level the wings.
4. Accelerate out of stall condition.

Roll or Yaw Axis Uncommanded Motion

1. Control Wheel Master (MSW) .... **Depress & Hold**
2. Attitude Control .... **As Required**

Cabin/Cockpit Fire, Smoke, or Fumes

1. Crew Oxygen Masks .... **DON & 100%**
2. Smoke Goggles .... **Don**
3. EMER DEPRESS .... **ON**
4. Pilot & Copilot MIC/MASK .... **MASK**
5. Pilot & Copilot INPH .... **INPH**

Elevator Control Jam

1. Attitude Control .... **As Required**
   Use Pitch Trim & Thrust as Necessary
2. ELEV DISC .... **Pull & Rotate**
3. Determine elevator without the jam & transition flight control to that pilot.
   a. Do Not apply additional control force to the jammed control.
4. Do Not use PIT TRIM BIAS.

Pitch Axis Uncommanded Motion

1. Control Wheel Master (MSW) .... **Depress & Hold**
2. Attitude Control .... **As Required**
3. Thrust Levers .... **As Required**

Rudder Control Jam

1. Attitude Control .... **As Required**
   Use Roll Control & Thrust as Necessary

Loss of Both Generators and Both Main Batteries

1. L&R BATT .... **On, One at a Time**
2. L&R GEN Circuit Breakers (respective ELECTRICAL group) .... **Set**
3. Engine N_2 .... **80% or Above**
4. L&R GEN .... **One at a Time, Depress (Approx 1 Sec)**

Checklist Memory Items

EMERGENCY PROCEDURES

“PULL UP”
“TERRAIN, TERRAIN, PULL UP”
“OBSTACLE, OBSTACLE, PULL UP”

1. Autopilot .... **Disengage**
2. Thrust Lever(s) .... **Select T/O or APR, As Required**
3. Increase pitch attitude and climb as required to avoid terrain.
4. SPOILER Lever .... **RET**
5. Flaps ....**Retract (8° or UP), As Required**
6. Gear..**UP**
7. Flaps ....**UP**

Windshear Warning during Final Approach

Siren (optional), “Windshear, Windshear, Windshear” aural warning and red WIND SHR warning on the PFD are illuminated:

1. Immediately initiate AFM go-around procedure except do not retract flaps or landing gear.

NOTE

Depressing GO-AROUND button in left thrust lever handle disengages autopilot and selects flight director go-around mode.

2. Thrust Lever(s)............... **SELECT T/O OR APR, AS REQUIRED**
3. Rotate smoothly to the go-around/takeoff pitch attitude, allowing airspeed to decrease if necessary. Maintain wings level.
4. If the aircraft continues to descend, increase pitch target attitude smoothly and in small increments, bleeding airspeed as necessary to stop the descent. Use stall warning onset (stick shaker) as the upper limit of pitch attitude.
5. Maintain escape attitude and thrust and delay retracting flaps or landing gear until safe climbout is assured.

Windshear Warning during Takeoff

Siren (optional), “Windshear, Windshear, Windshear” aural warning and red WIND SHR warning on the PFD are illuminated:

1. Thrust Lever(s) ....**SELECT T/O OR APR, AS REQUIRED**
2. Maintain takeoff target pitch attitude and wings level, allowing airspeed to decrease if necessary. Do not retract flaps or gear.
3. If the aircraft continues to descend, increase pitch target attitude smoothly and in small increments, bleeding airspeed as necessary to stop the descent. Use stall warning onset (stick shaker) as the upper limit of pitch attitude.
4. Maintain escape attitude and thrust and delay retracting flaps or landing gear until safe climbout is assured.

List of Figures

WALKAROUND

Introduction

This Annex of the Pilot Training Guide illustrates the steps performed by the crew during the preflight exterior inspection or preflight walkaround (Fig. 1). It contains the steps described in the Airplane Flight Manual as normal preflight procedures (all checklist items).

An abbreviated procedure (through-flight checklist) can also be used during intermediate stops when the following conditions have been met:

- No change in flight crew personnel
- No maintenance performed on the aircraft (routine line servicing is not considered maintenance)
- No more than three hours elapsed time between engine shutdown and start
- Extreme weather conditions (heavy precipitation, ice, snow, extreme cold, etc.) have not occurred which would change the preflight status of the aircraft

For intermediate stops with one or no engine shut down, completion of the quick turn-around procedure in the AFM provides the minimum preflight requirements.

Refer to the Airplane Flight Manual for a more detailed description of all preflight procedures.

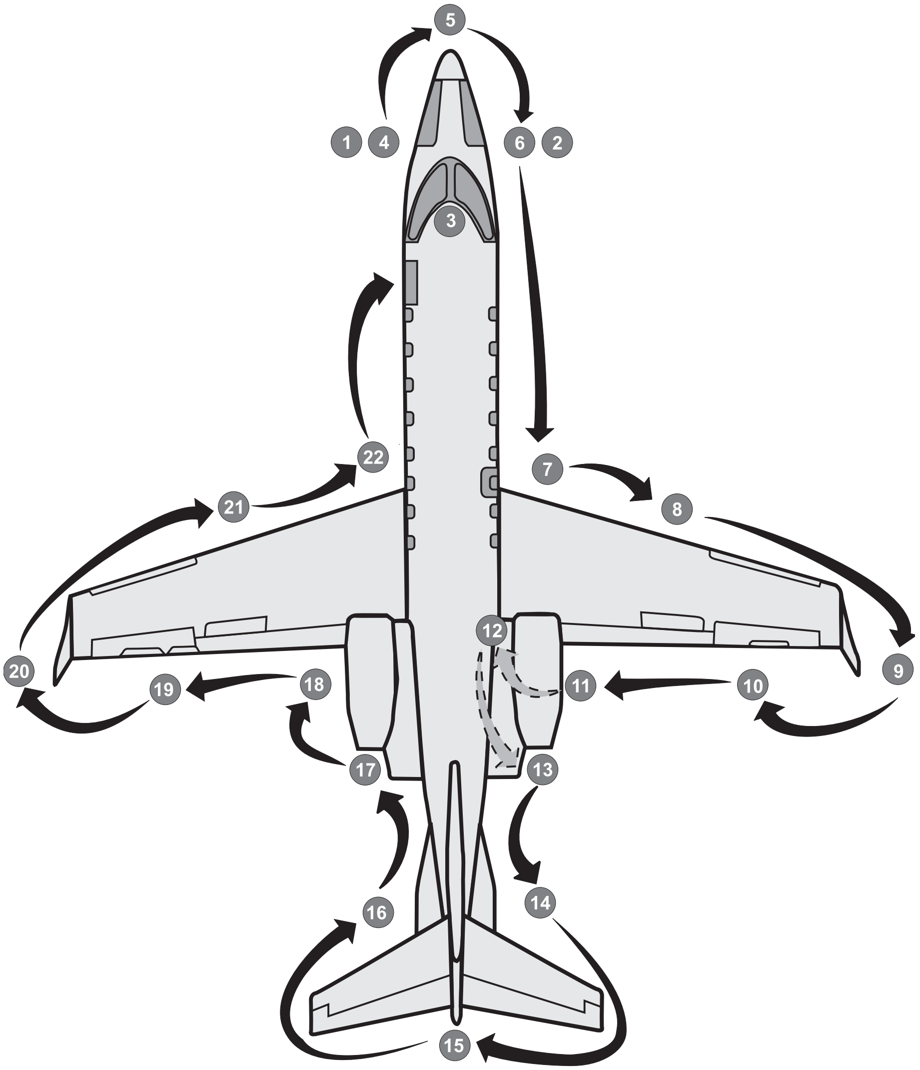


Figure 1 - Preflight Walkaround Steps

Figure 1a—Left Pitot-Static Probe
Cover removed, clear of obstructions
Stall Warning Vane
Freedom of movement
Ice Detect Probe

Figure 2a—Right and Standby Pitot-Static Probes
Cover removed, clear of obstructions
Stall Warning Vane
Freedom of movement

Figure 3a—Controls Lock
Remove and stow

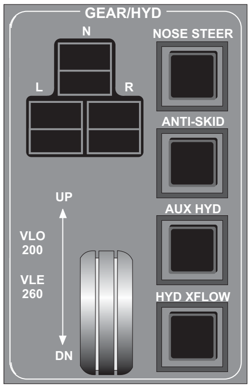


Figure 3b—Gear
Down

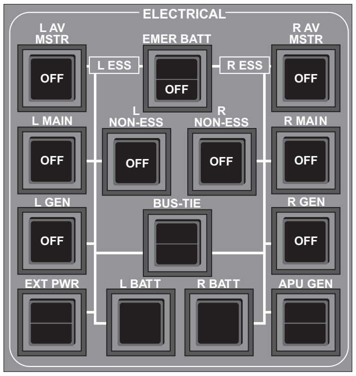


Figure 3c—L and R BATT Switches
On

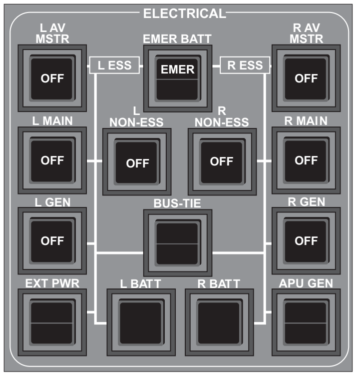


Figure 3d—EMER BATT Switch
EMER

FUEL 4300 LBS
L 1650 F 1000 R 1650

Figure 3e—Fuel Quantities
Check

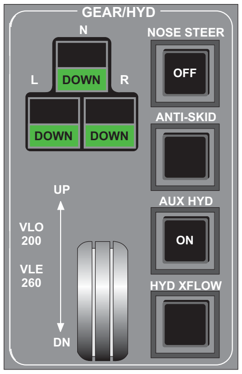
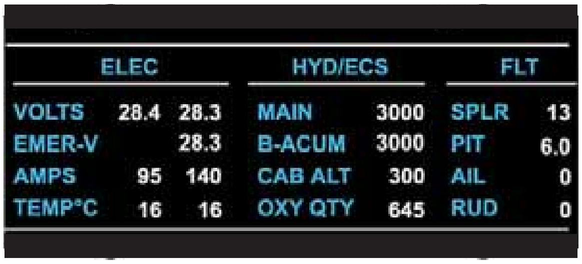


Figure 3f—AUX HYD Switch
ON



ELEC			HYD/ECS		FLT	
VOLTS	28.4	28.3	MAIN	3000	SPLR	13
EMER-V		28.3	B-ACUM	3000	PIT	6.0
AMPS	95	140	CAB ALT	300	AIL	0
TEMP°C	16	16	OXY QTY	645	RUD	0

Figure 3g—SUMRY Page B-ACUM Pressure
2610 to 3600 psi

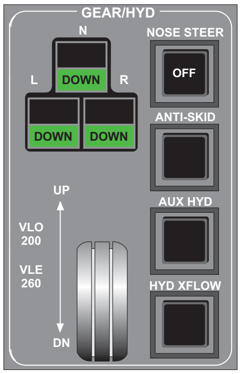


Figure 3h—AUX HYD Switch
Off

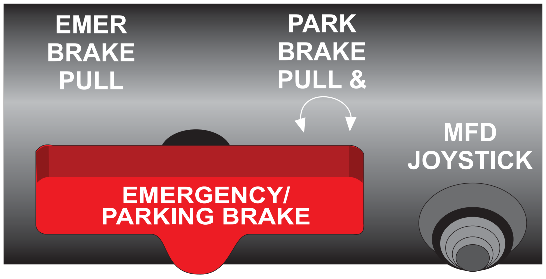
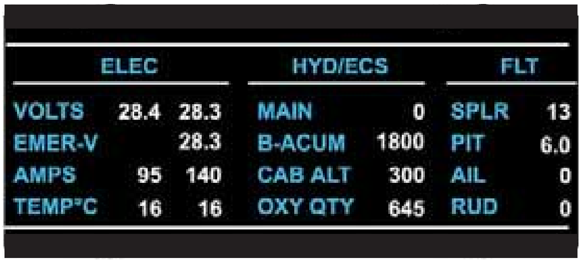


Figure 3i—EMERGENCY/PARKING BRAKE
Set



ELEC			HYD/ECS		FLT	
VOLTS	28.4	28.3	MAIN	0	SPLR	13
EMER-V		28.3	B-ACUM	1800	PIT	6.0
AMPS	95	140	CAB ALT	300	AIL	0
TEMP°C	16	16	OXY QTY	645	RUD	0

Figure 3j—SUMRY Page B-ACUM Pressure
1200 psi or greater

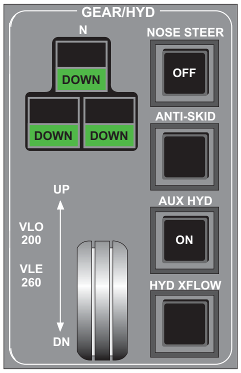


Figure 3k—AUX HYD Switch
ON

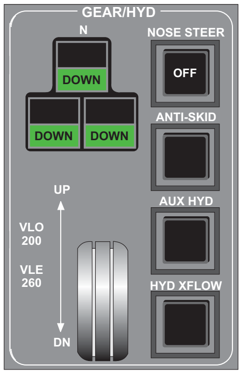


Figure 3l—AUX HYD Switch
Off

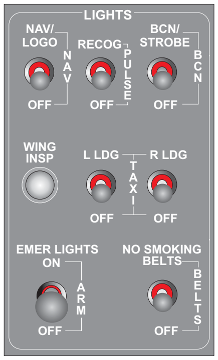


Figure 3m—All Exterior Light Switches (if night flight is anticipated)
On. Check proper illumination
All Exterior Light Switches
OFF

Figure 12a—Hydraulic Service Panel
Check FILTER (MAIN or AUX) and reservoir (ADD or OVER) lights not illuminated.
Access panel secure.

WARNING

BRUSH light illumination indicates auxiliary pump brushes approaching service limits. Flight may be conducted with light on but maintenance should be performed at next suitable opportunity.

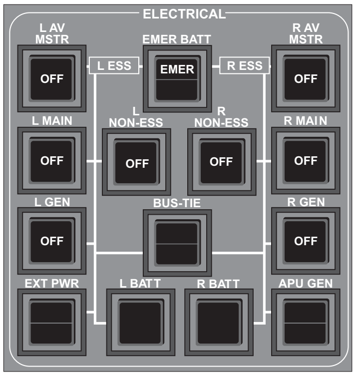


Figure 3n—EMER BATT Switch
OFF

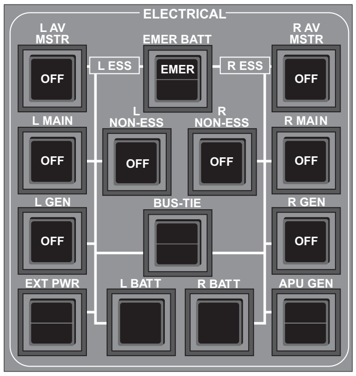


Figure 3o—L and R BATT Switches
OFF

Figure 4a—Windshield
Condition

Figure 4b—Gear and Wheel Well
Hydraulic leakage, condition, and cooling vents clear
Nose gear strut proper extension

Figure 4c—Nose Compartment Doors, Wheel, and Tire
Condition and nose gear uplock forward

Figure 4d—Ground Wire
Disconnected

Figure 5a—Radome and Radome Erosion Shoe
Condition

Figure 6a—Windshield
Condition

Figure 6b—Oxygen System Discharge Indicator and Service Door
Check and secure

Figure 6c—Nose Compartment Doors
Secure

Figure 6d—Wing Inspection Light and Lens
Condition

Figure 6e—Standby Pitot and Static Drains
Push up to drain. Required if moisture is known or suspected.

Figure 6f—Learjet 40 Oxygen Overboard Discharge Indicator
(Optional)

Figure 7a—Emergency Exit
Secure

Figure 7b—Upper Fuselage Antennas and Dorsal Inlets
Condition

Figure 7c—Upper Fuselage, Gravity Fueling Door
Check and secure

Figure 7d—Right Engine Inlet and Fan
Clear of obstructions and condition

WARNING **If fan is windmilling, stop by pressing on fan spinner. Do not attempt to stop windmilling by grabbing blades. The engine inlet must be free of frost, snow, and ice.**

Figure 7e—Right Generator and Alternator Cooling Scoops and NAC Bleed Outlet
Clear

Figure 7f—Lower Fuselage Antennas, Landing Light Fairing, and Lens
Condition

Figure 7g—Fuel Drains and Access Door
Drain if contamination is suspected and secure

NOTE **Fuel drains are low points in the system. When opened, fuel drains from the mast immediately in front of the door.**

Figure 7h—Toilet Servicing Door
Secure

Figure 7i—Right Main Gear
Check: wheel well, hydraulic/fuel leakage—condition; taxi light and lens—condition; wheels, brakes, and tires—condition; main gear strut—check proper extension

Figure 8a—Right Wing
Check: Leading edge, stall strips, triangles, vortilons, and ice detect patch—condition; access panels—fuel/hydraulic leakage

WARNING **The wing and flight control surfaces must be free of frost, snow, and ice.**

Figure 9a—Right Winglet NAV Light/Lens and Static Wicks (4)
Condition

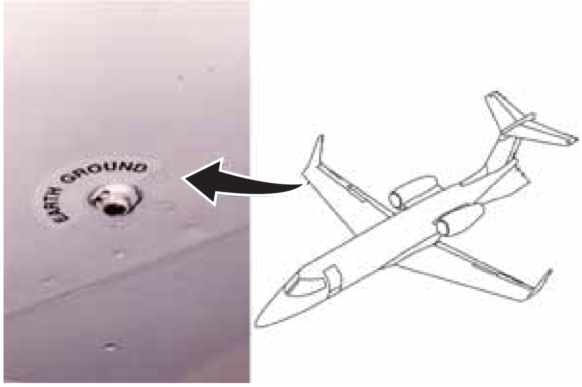


Figure 9b—Ground Wire
Disconnected

Figure 10a—Right Aileron
Check free motion, balance tab linkage, and brush seal condition

Figure 10b—Right Spoiler and Flap
Condition

Figure 11a—Right Brakes and Brake Wear Indicators
Condition

NOTE

The wear pins should be exposed with the PARKING BRAKE set.

Figure 11b—Right Engine Oil
Check oil level (normal)

NOTE

If preflight oil level checks are low, start and run engine until stabilized at idle. Shut down engine and recheck oil level. If there is no oil level indication, add enough oil to obtain an indication before starting engine to recheck oil level.

Figure 12b—Single-Point Fueling Access Doors
Secure

Figure 12c—Fuel Quantity Panel Access Door
Secure

Figure 13a—Right Engine Turbine Exhaust Area
Condition, clear of obstructions

Figure 13b—Right Thrust Reverser
Condition and completely stowed

Figure 14a—Tailcone Interior
Open and check for: fluid leaks, main engine fire bottle pressure, security and condition of installed equipment; remote circuit breakers—set; APU (if installed) fire bottle pressure and APU FAN FAIL indicator; condition of door seal, then close access

NOTE **APU may be operated at ambient temperatures up to 38°C (100°F) with an amber APU FAN FAIL indication.**

Figure 14b—Engine Fire Extinguisher Discharge Indicators
Condition

Figure 14c—Right VOR/LOC Antenna
Condition

Figure 14d—APU Exhaust (if installed)
Clear of obstructions

Figure 15a—V Stabilizer, Rudder, H Stabilizer, Elevator, Delta Fins, and Logo Lights (if installed)
Condition, drain holes clear

WARNING **The vertical and horizontal stabilizers and flight control surfaces must be free of frost, snow, and ice.**

Figure 15b—Static Discharge Wicks
(6 on elevators, 1 above stringer, and
4 on delta fins)
Condition

Figure 15c—Beacon/Strobe Light and Lens
Condition

Figure 15d—Tailstand
Removed

Figure 16a—APU Inlet (if installed)
Clear of obstructions

Figure 16b—Left VOR/LOC Antenna
Condition

Figure 16c—Battery Vents
Clear

Figure 16d—Baggage Compartment Door
Open: baggage heat switch—on, as desired; check condition of door seal, then close

NOTE **Baggage heat switch relocated to cockpit in many aircraft.**

Figure 17a—Left Engine Turbine Exhaust Area
Condition, clear of obstructions

Figure 17b—Left Thrust Reverser
Condition and completely stowed

Figure 18a—Left Engine Oil
Check oil level (normal)

NOTE **If preflight oil level checks low, start and run engine until stabilized at idle. Shut down engine and recheck oil level. If there is no oil level indication, add enough oil to obtain an indication before starting engine to recheck oil level.**

Figure 18b—Left Brakes and Brake Wear Indicators
Condition

NOTE **The wear pins should be exposed with the parking brake set.**

Figure 19a—Left Spoiler and Flap
Condition

Figure 19b—Left Aileron
Check: free motion, balance, and trim tab linkage and brush seal condition

Figure 20a—Left Winglet Navigation Light/Lens and Static Wicks (4)
Condition

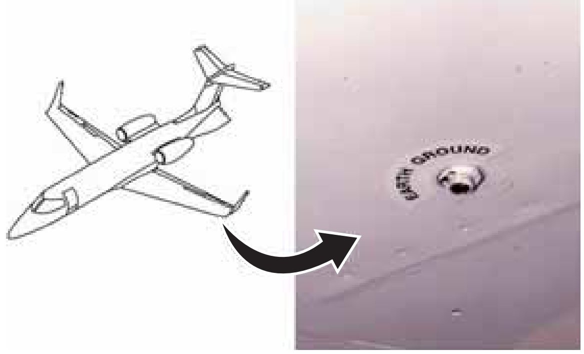


Figure 20b—Ground Wire
Disconnected

Figure 21a—Left Wing
Check: leading edge, stall strips, triangles, vortilons, and ice detect patch—condition; access panels—fuel/hydraulic leakage

WARNING **The wing and flight control surfaces must be free of frost snow, and ice.**

Figure 21b—Learjet 40 Oxygen System Discharge Indicator
(Optional)

Figure 22a—Fuel drains and Access Door
Drain if contamination is suspected and secure

NOTE **The fuel drains are low points in the fuel system. Fuel drains from these when opened.**

Figure 22b—Left Main Gear
Check: wheel well—hydraulic/fuel leakage and condition; taxi light and doors—condition; wheels, brakes, and tires—condition; main gear strut—check proper extension

Figure 22c—Left Engine Inlet and Fan
Clear of obstructions and condition

WARNING **If fan is windmilling, stop by pressing on fan spinner. Do not attempt to stop windmilling by grabbing blades. The engine inlet must be free of frost, snow, and ice.**

Figure 22d—Left Generator and Alternator Cooling Scoops and NAC bleed outlet
Clear

Figure 22e—Upper Fuselage, Fuel Vent Inlet
Clear of obstructions and condition

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PERFORMANCE AND WEIGHT AND BALANCE

Aircraft Loading Instructions

It is the responsibility of the pilot to see that the aircraft is loaded within the weight and C.G. limits. The loading form (Table 3) may be used.

1. Enter the aircraft basic empty weight and moment from the current weighing record.
2. Enter the payload weights and moments (crew, passengers, provisions, baggage, etc.) using the Payload Moments Charts provided in the aircraft weight and balance data package.
3. Compute the zero fuel weight and moment (operating weight) values plus passenger and baggage values.
4. Enter the fuel weights and moments using the Fuel Moments Charts (Table 5).
5. Compute ramp weight and moment (zero fuel weight values plus fuel values).
6. Compute takeoff weight and moment (ramp weight values minus taxi burnoff out of wings).
7. Compare takeoff weight and moment with weight and C.G. limits from the Center-of-Gravity Envelope Table 7 or the Weight-Moment-C.G. Envelope, Table 5. If not within limits, reduce weight or rearrange load as required to obtain weight and C.G. within limits.
8. Landing weight and moment may be calculated by adding the fuel weight and moment remaining at the destination to the zero fuel weight.
9. The formula to calculate the C.G. in % MAC for the Learjet 40 and 45 is as follows:

$$\text{C.G. in \% MAC} = \left(\frac{\text{Fuselage Station (C.G.)} - 413.77\text{ in.}}{87.22\text{ in.}}\right) \times 100$$

or

$$\text{C.G. in \% MAC} = \left(\frac{\text{Fuselage Station (C.G.)} - 10{,}510\text{ mm}}{2215\text{ mm}}\right) \times 100$$

Dimension Data

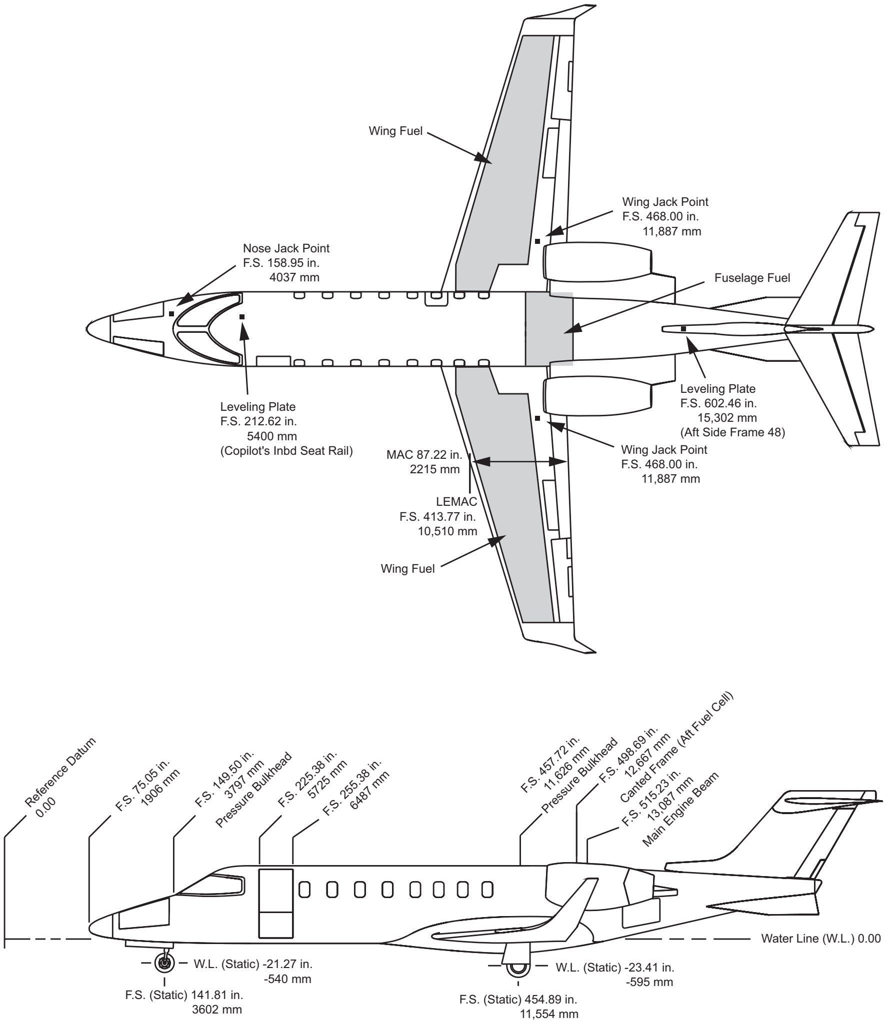


Figure 1 - Learjet 45 Aircraft Dimension Information

Table 1 - Learjet 45 Aircraft Dimension Data

Nosewheel	℄ Wheel Fus. Sta.	Main Wheels	℄ Wheel Fus. Sta.
Fully compressed	142.15 in. 3611.00 mm	Fully compressed	—
Static	141.81 in. 3602.00 mm	Static	454.89 in. 11,554.00 mm
Fully extended	140.79 in. 3576.00 mm	Fully extended	450.03 in. 11,431.00 mm

For Training Purposes Only

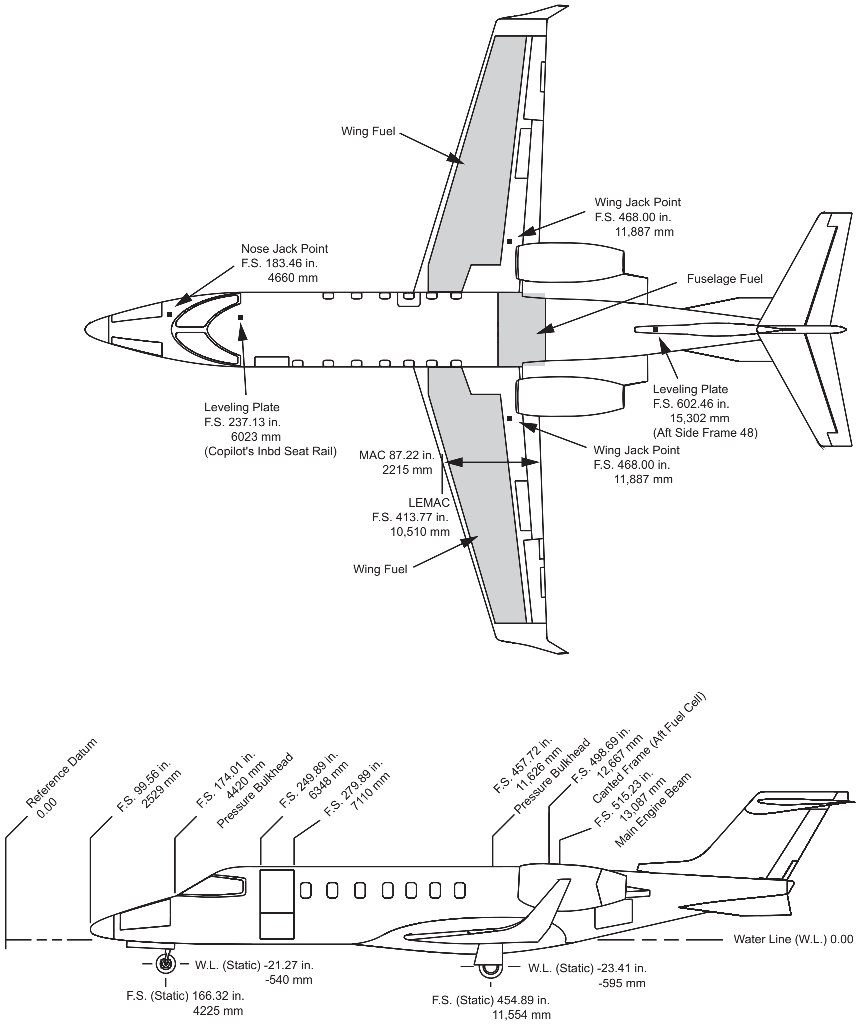


Figure 2 - Learjet 40 Aircraft Dimension Information

Table 2 - Learjet 40 Aircraft Dimension Data

Nosewheel	℄ Wheel Fus. Sta.	Main Wheels	℄ Wheel Fus. Sta.
Fully compressed	166.66 in. 4233.00 mm	Fully compressed	—
Static	166.32 in 4225.00 mm	Static	454.89 in. 11,554.00 mm
Fully extended	165.30 in. 4199.00 mm	Fully extended	450.03 in. 11,431.00 mm

Table 3 - Aircraft Loading Form—Master

Aircraft Loading Form

Missing or Additional Equipment ______________________________

Item	Weight	FS	MOM/1000	% MAC ((CG-413.77)/87.22)x100
Basic Empty Weight				
Missing/Additional Equipment				
Crew				
Left Cabinet				
Closet				
Toilet/Lavatory				
Miscellaneous				
Operating Empty Weight				
Baggage—Cabin				
Baggage—Tailcone				
Passenger 1				
Passenger 2				
Passenger 3				
Passenger 4				
Passenger 5				
Passenger 6				
Passenger 7				
Passenger 8				
Zero Fuel Weight				
Fuel—Fuselage and Wing Tanks				
Ramp Weight				
Taxi Burnoff (approx. 3.3 lb/min)				
Takeoff Gross Weight				

Zero Fuel Weight				
Fuel—Fuselage and Wing Tanks				
Landing Weight				

Table 4 - Aircraft Loading Form—Sample

Aircraft Loading Form

Missing or Additional Equipment ____

Item	Weight	FS	MOM/1000	% MAC ((CG-413.77)/87.22)x100
Basic Empty Weight	14,232	432.49	6155.2	21.5
Missing/Additional Equipment				
Crew	400			
Left Cabinet	20			
Closet	10			
Toilet/Lavatory	30			
Miscellaneous				
Operating Empty Weight				
Baggage—Cabin				
Baggage—Tailcone	200			
Passenger 1	200			
Passenger 2	150			
Passenger 3	200			
Passenger 4	150			
Passenger 5				
Passenger 6				
Passenger 7				
Passenger 8				
Zero Fuel Weight				
Fuel—Fuselage and Wing Tanks	4000			
Ramp Weight				
Taxi Burnoff (approx. 3.3 lb/min)	-100			
Takeoff Gross Weight				

Zero Fuel Weight				
Fuel—Fuselage and Wing Tanks	500			
Landing Weight				

Table 5 - Learjet 45 Moment/1000 In-Lb

45-XXX

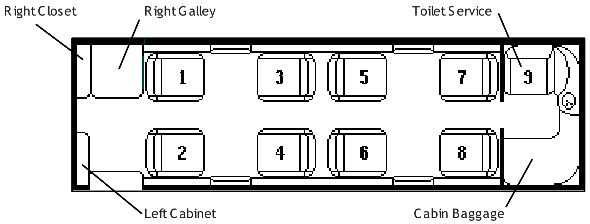
MOMENT/1000 (IN-LBS)

PAYLOAD MOMENTS

FUS. STA.	➡	203.4	222	226.4	244	274.5	274.5	317.7	317.7	356.2	356.2	397.6	397.6	430.3	414.0	414.0	431.7	448.6	434.3	544.0	⬅	FUS. STA.
ITEM	➡	PILOT/ COPILOT	LEFT SERVICE CABINET PROV. 20# MAX	RIGHT HAND CLOSET 90# MAX	GALLEY PROV. 150# MAX	PASS. 1	PASS. 2	PASS. 3	PASS. 4	PASS. 5	PASS.	PASS. 7	PASS. 8	PASS. 9	LH PYRAMID 20# MAX	RH PYRAMID 20# MAX	TOILET PROV. 30# MAX	SINK PROV. 15# MAX	CABIN BAGGAGE 170# MAX	TAIL BAGGAGE 500# MAX	⬅	ITEM
WEIGHT POUNDS	10	2.03	2.22	2.26	2.44	2.75	2.75	3.18	3.18	3.56	3.56	3.98	3.98	4.30	4.14	4.14	4.32	4.4	4.34	5.44	10	WEIGHT POUNDS
	15	3.05	3.33	3.40	3.66	4.12	4.12	4.77	4.77	5.34	5.34	5.96	5.96	6.45	6.21	6.21	6.48	6.73	6.51	8.16	15	
	20	4.07	4.44	4.53	4.88	5.49	5.49	6.35	6.35	7.12	7.12	7.95	7.95	8.61	8.28	8.28	8.63	-	8.69	10.88	20	
	30	6.10	-	6.79	7.32	8.24	8.24	9.53	9.53	10.69	10.69	11.93	11.93	12.91		-	12.95	-	13.03	16.32	30	
	40	8.14	-	9.06	9.76	10.98	10.98	12.71	12.71	14.25	14.25	15.90	15.90	17.21	-	-	-	-	17.37	21.76	40	
	50	10.17	-	11.32	12.20	13.73	13.73	15.89	15.89	17.81	17.81	19.88	19.88	21.52	-	-	-	-	21.72	27.20	50	
	60	12.20	-	13.58	14.64	16.47	16.47	19.06	19.06	21.37	21.37	23.86	23.86	25.82	-	-	-	-	26.06	32.64	60	
	70	14.24	-	15.85	17.08	19.22	19.22	22.24	22.24	24.93	24.93	27.83	27.83	30.12	-	-	-	-	30.40	38.08	70	
	80	16.27	-	18.11	19.52	21.96	21.96	25.42	25.42	28.50	28.50	31.81	31.81	34.42	-	-	-	-	34.74	43.52	80	
	90	18.31	-	20.38	21.96	24.71	24.71	28.59	28.59	32.06	32.06	35.78	35.78	38.73	-	-	-	-	39.09	48.96	90	
	100	20.34	-	-	24.40	27.45	27.45	31.77	31.77	35.62	35.62	39.76	39.76	43.03	-	-	-	-	43.43	54.40	100	
	110	22.37	-	-	26.84	30.20	30.20	34.95	34.95	39.18	39.18	43.74	43.74	47.33	-	-	-	-	47.77	59.84	110	
	120	24.41	-	-	29.28	32.94	32.94	38.12	38.12	42.74	42.74	47.71	47.71	51.64	-	-	-	-	52.12	65.28	120	
	130	26.44	-	-	31.72	35.69	35.69	41.30	41.30	46.31	46.31	51.69	51.69	55.94	-	-	-	-	56.46	70.72	130	
	140	28.48	-	-	34.16	38.43	38.43	44.48	44.48	49.87	49.87	55.66	55.66	60.24	-	-	-	-	60.80	76.16	140	
	150	30.51	-	-	36.60	41.18	41.18	47.66	47.66	53.43	53.43	59.64	59.64	64.55	-	-	-	-	65.15	81.60	150	
	160	32.54	-	-	-	43.92	43.92	50.83	50.83	56.99	56.99	63.62	63.62	68.85	-	-	-	-	69.49	87.04	160	
	170	34.58	-	-	-	46.67	46.67	54.01	54.01	60.55	60.55	67.59	67.59	73.15	-	-	-	-	73.83	92.48	170	
	180	36.61	-	-	-	49.41	49.41	57.19	57.19	64.12	64.12	71.57	71.57	77.45	-	-	-	-	-	97.92	180	
	190	38.65	-	-	-	52.16	52.16	60.36	60.36	67.68	67.68	75.54	75.54	81.76	-	-	-	-	-	103.36	190	
	200	40.68	-	-	-	54.90	54.90	63.54	63.54	71.24	71.24	79.52	79.52	86.06	-	-	-	-	-	108.80	200	
	210	42.71	-	-	-	57.65	57.65	66.72	66.72	74.80	74.80	83.50	83.50	90.36	-	-	-	-	-	114.24	210	
	220	44.75	-	-	-	60.39	60.39	69.89	69.89	78.36	78.36	87.47	87.47	94.67	-	-	-	-	-	119.68	220	
	230	46.78	-	-	-	63.14	63.14	73.07	73.07	81.93	81.93	91.45	91.45	98.97	-	-	-	-	-	125.12	230	
	240	48.82	-	-	-	65.88	65.88	76.25	76.25	85.49	85.49	95.42	95.42	103.27	-	-	-	-	-	130.56	240	
	250	50.85	-	-	-	68.63	68.63	79.43	79.43	89.05	89.05	99.40	99.40	107.58	-	-	-	-	-	136.00	250	
																				141.44	260	
																				146.88	270	
																				152.32	280	
																				157.76	290	
																				163.20	300	
																				168.64	310	
																				174.08	320	
																				179.52	330	
																				184.96	340	
																				190.40	350	
																				195.84	360	
																				201.28	370	
																				206.72	380	
																				212.16	390	
																				217.60	400	
																				223.04	410	
																				228.48	420	
																				233.92	430	
																				239.36	440	
																				244.80	450	
																				250.24	460	
																				255.68	470	
																				261.12	480	
																				266.56	490	
																				272.00	500	

NOTES:

- This table presented for use with Aircraft Loading Form.
- Passenger weights include carry-on baggage stowed under seats.
- Passenger moments based on seats located against seat stop or index and facing as shown.
- Crew weights based on seats being in the nominal position.



NOTE: CHECK CABINETS' PLACARDS FOR MAXIMUM ALLOWABLE WEIGHTS

Table 6 - Learjet 40 Moment/1000 In-Lb

45-XXXX

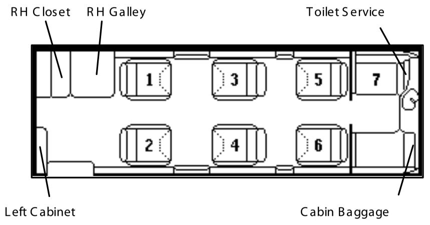
MOMENT/1000 (IN-LBS)

PAYLOAD MOMENTS

FUS. STA. ➡		227.9	247.5	260.7	278.0	308.4	308.4	356.6	356.6	397.6	397.6	430.3	414.0	414.0	431.7	448.6	434.3	544.0	⬅	FUS. STA.
ITEM ➡		PILOT/ COPILOT	LEFT SERVICE CABINET PROV. 20# MAX	RIGHT HAND CLOSET 90# MAX	GALLEY PROV. 150# MAX	PASS. 1	PASS. 2	PASS. 3	PASS. 4	PASS. 5	PASS. 6	PASS. 7	LEFT HAND PYRAMID 20# MAX	RIGHT HAND PYRAMID 20# MAX	TOILET PROV. 30# MAX	SINK PROV. 15# MAX	CABIN BAGGAGE 170# MAX	TAIL BAGGAGE 500# MAX	⬅	ITEM
	10	2.28	2.48	2.61	2.78	3.08	3.08	3.57	3.57	3.98	3.98	4.30	4.14	4.14	4.32	4.49	4.34	5.44	10	
	15	3.42	3.71	3.91	4.17	4.63	4.63	5.35	5.35	5.96	5.96	6.45	6.21	6.21	6.48	6.73	6.51	8.16	15	
	20	4.56	4.95	5.21	5.56	6.17	6.17	7.13	7.13	7.95	7.95	8.61	8.28	8.28	8.63	-	8.69	10.88	20	
	30	6.84	-	7.82	8.34	9.25	9.25	10.70	10.70	11.93	11.93	12.91	-	-	12.95	-	13.03	16.32	30	
	40	9.12	-	10.43	11.12	12.34	12.34	14.26	14.26	15.90	15.90	17.21	-	-	-	-	17.37	21.76	40	
	50	11.40	-	13.04	13.90	15.42	15.42	17.83	17.83	19.88	19.88	21.52	-	-	-	-	21.72	27.20	50	
	60	13.67	-	15.64	16.68	18.50	18.50	21.40	21.40	23.86	23.86	25.82	-	-	-	-	26.06	32.64	60	
W	70	15.95	-	18.25	19.46	21.59	21.59	24.96	24.96	27.83	27.83	30.12	-	-	-	-	30.40	38.08	70	W
E	80	18.23	-	20.86	22.24	24.67	24.67	28.53	28.53	31.81	31.81	34.42	-	-	-	-	34.74	43.58	80	E
I	90	20.51	-	23.46	25.02	27.76	27.76	32.09	32.09	35.78	35.78	38.73	-	-	-	-	39.09	48.96	90	I
G	100	22.79	-	-	27.80	30.84	30.84	35.66	35.66	39.76	39.76	43.03	-	-	-	-	43.43	54.40	100	G
H	110	25.07	-	-	30.58	33.92	33.92	39.23	39.23	43.74	43.74	47.33	-	-	-	-	47.77	59.84	110	H
T	120	27.35	-	-	33.36	37.01	37.01	42.79	42.79	47.71	47.71	51.64	-	-	-	-	52.12	65.28	120	T
	130	29.63	-	-	36.14	40.09	40.09	46.36	46.36	51.69	51.69	55.94	-	-	-	-	56.46	70.72	130	
P	140	31.91	-	-	38.92	43.18	43.18	49.92	49.92	55.66	55.66	60.24	-	-	-	-	60.80	76.16	140	P
O	150	34.19	-	-	41.70	46.26	46.26	53.49	53.49	59.64	59.64	64.55	-	-	-	-	65.15	81.60	150	O
U	160	36.46	-	-	-	49.34	49.34	57.06	57.06	63.62	63.62	68.85	-	-	-	-	69.49	87.04	160	U
N	170	38.74	-	-	-	52.43	52.43	60.62	60.62	67.59	67.59	73.15	-	-	-	-	73.83	92.48	170	N
D	180	41.02	-	-	-	55.51	55.51	64.19	64.19	71.57	71.57	77.45	-	-	-	-	-	97.92	180	D
S	190	43.30	-	-	-	58.60	58.60	67.75	67.75	75.54	75.54	81.76	-	-	-	-	-	103.36	190	S
	200	45.58	-	-	-	61.68	61.68	71.32	71.32	79.52	79.52	86.06	-	-	-	-	-	108.80	200	
	210	47.86	-	-	-	64.76	64.76	74.89	74.89	83.50	83.50	90.36	-	-	-	-	-	114.24	210	
	220	50.14	-	-	-	67.85	67.85	78.45	78.45	87.47	87.47	94.67	-	-	-	-	-	119.68	220	
	230	52.42	-	-	-	70.93	70.93	82.02	82.02	91.45	91.45	98.97	-	-	-	-	-	125.12	230	
	240	54.70	-	-	-	74.02	74.02	85.58	85.58	95.42	95.42	103.27	-	-	-	-	-	130.56	240	
	250	56.98	-	-	-	77.10	77.10	89.15	89.15	99.40	99.40	107.58	-	-	-	-	-	136.00	250	
																		141.44	260	
																		146.88	270	
																		152.32	280	
																		157.76	290	
																		163.20	300	
																		168.64	310	
																		174.08	320	
																		179.52	330	
																		184.96	340	
																		190.40	350	
																		195.84	360	
																		201.28	370	
																		206.72	380	
																		212.16	390	
																		217.60	400	
																		223.04	410	
																		228.48	420	
																		233.92	430	
																		239.36	440	
																		244.80	450	
																		250.24	460	
																		255.68	470	
																		261.12	480	
																		266.56	490	
																		272.00	500	

NOTES:

- This table presented for use with Aircraft Loading Form.
- Passenger weights include carry-on baggage stowed under seats.
- Passenger moments based on seats located against seat stop or index and facing as shown.
- Crew weights based on seats being in the nominal position.



NOTE: CHECK CABINETS' PLACARDS FOR MAXIMUM ALLOWABLE WEIGHTS

Table 7 - Learjet 45 Center of Gravity

NOTE
Data given for weights above 21,500 pounds reflects the ground handling envelope only.

MOMENT / 1000

POUNDS GROSS WEIGHT	FWD LIMIT			5 % MAC STA 418.13	10 % MAC STA 422.49	15% MAC STA 426.85	20% MAC STA 431.21	AFT LIMIT		
	% MAC	STA						% MAC	STA	
14000	1.0	414.64	5804.96	5853.82	5914.86	5975.90	6036.94	25.0	435.57	6097.98
14100	1.0	414.64	5846.42	5895.63	5957.11	6018.59	6080.06	25.3	435.83	6145.20
14200	1.0	414.64	5887.89	5937.45	5999.36	6061.27	6123.18	25.6	436.10	6192.62
14300	1.0	414.64	5929.35	5979.26	6041.61	6103.96	6166.30	25.9	436.36	6239.95
14400	1.0	414.64	5970.82	6021.07	6083.86	6146.64	6209.42	26.2	436.62	6287.33
14500	1.0	414.64	6012.28	6062.89	6126.11	6189.33	6252.55	26.5	436.88	6334.76
14600	1.0	414.64	6053.74	6104.70	6168.35	6232.01	6295.67	26.8	437.14	6382.24
14700	1.0	414.64	6095.21	6146.51	6210.60	6274.70	6338.79	27.1	437.40	6429.78
14800	1.0	414.64	6136.67	6188.32	6252.85	6317.38	6381.91	27.4	437.67	6477.52
14900	1.0	414.64	6178.14	6230.14	6295.10	6360.07	6425.03	27.7	437.93	6525.16
15000	1.0	414.64	6219.60	6271.95	6337.35	6402.75	6468.15	28.0	438.19	6572.85
15100	1.2	414.82	6263.78	6313.76	6379.60	6445.44	6511.27	28.0	438.19	6616.67
15200	1.4	414.99	6307.85	6355.58	6421.85	6488.12	6554.39	28.0	438.19	6660.49
15300	1.6	415.16	6351.95	6397.39	6464.10	6530.81	6597.51	28.0	438.19	6704.31
15400	1.8	415.34	6396.24	6439.20	6506.35	6573.49	6640.63	28.0	438.19	6748.13
15500	2.0	415.51	6440.41	6481.02	6548.60	6616.18	6683.76	28.0	438.19	6791.95
15600	2.2	415.69	6484.76	6522.83	6590.84	6658.86	6726.88	28.0	438.19	6835.76
15700	2.4	415.86	6529.00	6564.64	6633.09	6701.55	6770.00	28.0	438.19	6879.58
15800	2.6	416.04	6573.43	6606.45	6675.34	6744.23	6813.12	28.0	438.19	6923.40
15900	2.8	416.21	6617.74	6648.27	6717.59	6786.92	6856.24	28.0	438.19	6967.22
16000	3.0	416.39	6662.24	6690.08	6759.84	6829.60	6899.36	28.0	438.19	7011.04
16100	3.2	416.56	6706.62	6731.89	6802.09	6872.29	6942.48	28.0	438.19	7054.86
16200	3.4	416.73	6751.03	6773.71	6844.34	6914.97	6985.60	28.0	438.19	7098.68
16300	3.6	416.91	6795.63	6815.52	6886.59	6957.66	7028.72	28.0	438.19	7142.50
16400	3.8	417.08	6840.11	6857.33	6928.84	7000.34	7071.84	28.0	438.19	7186.32
16500	4.0	417.26	6884.79	6899.15	6971.09	7043.03	7114.97	28.0	438.19	7230.14
16600	4.2	417.43	6929.34	6940.96	7013.33	7085.71	7158.09	28.0	438.19	7273.95
16700	4.4	417.61	6974.09	6982.77	7055.58	7128.40	7201.21	28.0	438.19	7317.77
16800	4.6	417.78	7018.70	7024.58	7097.83	7171.08	7244.33	28.0	438.19	7361.59
16900	4.8	417.96	7063.52	7066.40	7140.08	7213.77	7287.45	28.0	438.19	7405.41
17000	5.0	418.13	7108.21	7108.21	7182.33	7256.45	7330.57	28.0	438.19	7449.23
17100	5.2	418.30	7152.93		7224.58	7299.14	7373.69	28.0	438.19	7493.05
17200	5.4	418.48	7197.86		7266.83	7341.82	7416.81	28.0	438.19	7536.87
17300	5.6	418.65	7242.65		7309.08	7384.51	7459.93	28.0	438.19	7580.69
17400	5.8	418.83	7287.64		7351.33	7427.19	7503.05	28.0	438.19	7624.51
17500	6.0	419.00	7332.50		7393.58	7469.88	7546.18	28.0	438.19	7668.33
17600	6.2	419.18	7377.57		7435.82	7512.56	7589.30	28.0	438.19	7712.14
17700	6.4	419.35	7422.50		7478.07	7555.25	7632.42	28.0	438.19	7755.96
17800	6.6	419.53	7467.63		7520.32	7597.93	7675.54	28.0	438.19	7799.78
17900	6.8	419.70	7512.63		7562.57	7640.62	7718.66	28.0	438.19	7843.60

FM-126
FAA Approved 5-19-2004

EFFECTIVITY
Aircraft 45-002 & Subsequent
modified by SB 45-11-4

CENTER-OF-GRAVITY TA

MOMENT / 1000

POUNDS GROSS WEIGHT	FWD LIMIT			5 % MAC STA 418.13	10 % MAC STA 422.49	15% MAC STA 426.85	20% MAC STA 431.21	AFT LIMIT		
	% MAC	STA						% MAC	STA	
18000	7.0	419.87	7557.66		7604.82	7683.30	7761.78	28.0	438.19	7887.42
18100	7.3	420.16	7604.90		7647.07	7725.99	7804.90	28.0	438.19	7931.24
18200	7.7	420.46	7652.37		7689.32	7768.67	7848.02	28.0	438.19	7975.06
18300	8.0	420.75	7699.73		7731.57	7811.36	7891.14	28.0	438.19	8018.88
18400	8.3	421.04	7747.14		7773.82	7854.04	7934.26	28.0	438.19	8062.70
18500	8.7	421.33	7794.61		7816.07	7896.73	7977.39	28.0	438.19	8106.52
18600	9.0	421.62	7842.13		7858.31	7939.41	8020.51	28.0	438.19	8150.33
18700	9.3	421.91	7889.72		7900.56	7982.10	8063.63	28.0	438.19	8194.15
18800	9.7	422.20	7937.36		7942.81	8024.78	8106.75	28.0	438.19	8237.97
18900	10.0	422.49	7985.06		7985.06	8067.47	8149.87	28.0	438.19	8281.79
19000	10.3	422.78	8032.82			8110.15	8192.99	28.0	438.19	8325.61
19100	10.7	423.07	8080.64			8152.84	8236.11	28.0	438.19	8369.43
19200	11.0	423.36	8128.51			8195.52	8279.23	28.0	438.19	8413.25
19300	11.3	423.65	8176.45			8238.21	8322.35	28.0	438.19	8457.07
19400	11.7	423.94	8224.44			8280.89	8365.47	28.0	438.19	8500.89
19500	12.0	424.23	8272.49			8323.58	8408.60	28.0	438.19	8544.71
19600	12.3	424.53	8320.79	BEYOND LIMITS		8366.26	8451.72	28.0	438.19	8588.52
19700	12.7	424.82	8368.95			8408.95	8494.84	28.0	438.19	8632.34
19800	13.0	425.11	8417.18			8451.63	8537.96	28.0	438.19	8676.16
19900	13.3	425.40	8465.46			8494.32	8581.08	28.0	438.19	8719.98
20000	13.7	425.69	8513.80			8537.00	8624.20	28.0	438.19	8763.80
20100	14.0	425.98	8562.20			8579.69	8667.32	28.0	438.19	8807.62
20200	14.3	426.27	8610.65			8622.37	8710.44	28.0	438.19	8851.44
20300	14.7	426.56	8659.17			8665.06	8753.56	28.0	438.19	8895.26
20400	15.0	426.85	8707.74			8707.74	8796.68	28.0	438.19	8939.08
20500	15.3	427.15	8756.58				8839.81	28.0	438.19	8982.90
20600	15.7	427.44	8805.26				8882.93	28.0	438.19	9026.71
20700	16.0	427.72	8853.80				8926.05	28.0	438.19	9070.53
20800	16.3	427.98	8901.98				8969.17	28.0	438.19	9114.35
20900	16.7	428.33	8952.10				9012.29	28.0	438.19	9158.17
21000	17.0	428.59	9000.39				9055.41	28.0	438.19	9201.99
21100	17.3	428.85	9048.74				9098.53	27.6	437.84	9238.42
21200	17.7	429.20	9099.04				9141.65	27.3	437.58	9276.70
21300	18.0	429.46	9147.50				9184.77	26.9	437.23	9313.00
21400	18.3	429.73	9196.22				9227.89	26.5	436.88	9349.23
21500	18.7	430.08	9246.72				9271.02	26.2	436.62	9387.33
21600	19.0	430.34	9295.34				9314.14	25.8	436.27	9423.43
21700	19.3	430.60	9344.02				9357.26	25.5	436.01	9461.42
21750	19.5	430.77	9369.25				9378.82	25.3	435.84	9479.52

Figure 6-8.3

Table 8 - Learjet 40 Center of Gravity

NOTE
Data given for weights above 21,000 pounds reflects the ground handling envelope only.

MOMENT / 1000

POUNDS GROSS WEIGHT	FWD LIMIT % MAC	FWD LIMIT STA		7 % MAC STA 419.88	10 % MAC STA 422.49	15% MAC STA 426.85	20% MAC STA 431.21	AFT LIMIT % MAC	AFT LIMIT STA	
13500	7.0	419.88	5668.38	5668.38	5703.62	5762.48	5821.34	23.5	434.27	5862.65
13600	7.0	419.88	5710.37	5710.37	5745.86	5805.16	5864.46	23.8	434.53	5909.61
13700	7.0	419.88	5752.36	5752.36	5788.11	5847.85	5907.58	24.1	434.79	5956.62
13800	7.0	419.88	5794.34	5794.34	5830.36	5890.53	5950.70	24.4	435.05	6003.69
13900	7.0	419.88	5836.33	5836.33	5872.61	5933.22	5993.82	24.7	435.31	6050.81
14000	7.0	419.88	5878.32	5878.32	5914.86	5975.90	6036.94	25.0	435.58	6098.12
14100	7.0	419.88	5920.31	5920.31	5957.11	6018.59	6080.06	25.3	435.84	6145.34
14200	7.0	419.88	5962.30	5962.30	5999.36	6061.27	6123.18	25.6	436.10	6192.62
14300	7.0	419.88	6004.28	6004.28	6041.61	6103.96	6166.30	25.9	436.36	6239.95
14400	7.0	419.88	6046.27	6046.27	6083.86	6146.64	6209.42	26.2	436.62	6287.33
14500	7.0	419.88	6088.26	6088.26	6126.11	6189.33	6252.55	26.5	436.88	6334.76
14600	7.0	419.88	6130.25	6130.25	6168.35	6232.01	6295.67	26.8	437.14	6382.24
14700	7.0	419.88	6172.24	6172.24	6210.60	6274.70	6338.79	27.1	437.41	6429.93
14800	7.0	419.88	6214.22	6214.22	6252.85	6317.38	6381.91	27.4	437.67	6477.52
14900	7.0	419.88	6256.21	6256.21	6295.10	6360.07	6425.03	27.7	437.93	6525.16
15000	7.0	419.88	6298.20	6298.20	6337.35	6402.75	6468.15	28.0	438.19	6572.85
15100	7.2	420.05	6342.76		6379.60	6445.44	6511.27	28.0	438.19	6616.67
15200	7.4	420.22	6387.34		6421.85	6488.12	6554.39	28.0	438.19	6660.49
15300	7.6	420.40	6432.12		6464.10	6530.81	6597.51	28.0	438.19	6704.31
15400	7.8	420.57	6476.78		6506.35	6573.49	6640.63	28.0	438.19	6748.13
15500	8.0	420.75	6521.63		6548.60	6616.18	6683.76	28.0	438.19	6791.95
15600	8.2	420.92	6566.35		6590.84	6658.86	6726.88	28.0	438.19	6835.76
15700	8.4	421.10	6611.27		6633.09	6701.55	6770.00	28.0	438.19	6879.58
15800	8.6	421.27	6656.07		6675.34	6744.23	6813.12	28.0	438.19	6923.40
15900	8.8	421.45	6701.06		6717.59	6786.92	6856.24	28.0	438.19	6967.22
16000	9.0	421.62	6745.92		6759.84	6829.60	6899.36	28.0	438.19	7011.04
16100	9.2	421.79	6790.82		6802.09	6872.29	6942.48	28.0	438.19	7054.86
16200	9.4	421.97	6835.91		6844.34	6914.97	6985.60	28.0	438.19	7098.68
16300	9.6	422.14	6880.88		6886.59	6957.66	7028.72	28.0	438.19	7142.50
16400	9.8	422.32	6926.05		6928.84	7000.34	7071.84	28.0	438.19	7186.32
16500	10.0	422.49	6971.09		6971.09	7043.03	7114.97	28.0	438.19	7230.14
16600	10.2	422.67	7016.32			7085.71	7158.09	28.0	438.19	7273.95
16700	10.4	422.84	7061.43			7128.40	7201.21	28.0	438.19	7317.77
16800	10.6	423.02	7106.74	BEYOND LIMITS		7171.08	7244.33	28.0	438.19	7361.59
16900	10.8	423.19	7151.91			7213.77	7287.45	28.0	438.19	7405.41
17000	11.0	423.36	7197.12			7256.45	7330.57	28.0	438.19	7449.23
17100	11.2	423.54	7242.53			7299.14	7373.69	28.0	438.19	7493.05
17200	11.4	423.71	7287.81			7341.82	7416.81	28.0	438.19	7536.87
17300	11.6	423.89	7333.30			7384.51	7459.93	28.0	438.19	7580.69
17400	11.8	424.06	7378.64			7427.19	7503.05	28.0	438.19	7624.51

EFFECTIVITY
Aircraft 45-2001 & Subsequent
modified by SB 40-11-1

MOMENT / 1000

POUNDS GROSS WEIGHT	FWD LIMIT % MAC	FWD LIMIT STA		7 % MAC STA 419.88	10 % MAC STA 422.49	15% MAC STA 426.85	20% MAC STA 431.21	AFT LIMIT % MAC	AFT LIMIT STA	
17500	12.0	424.24	7424.20			7469.88	7546.18	28.0	438.19	7668.33
17600	12.2	424.41	7469.62			7512.56	7589.30	28.0	438.19	7712.14
17700	12.4	424.59	7515.24			7555.25	7632.42	28.0	438.19	7755.96
17800	12.6	424.76	7560.73			7597.93	7675.54	28.0	438.19	7799.78
17900	12.8	424.93	7606.25			7640.62	7718.66	28.0	438.19	7843.60
18000	13.0	425.11	7651.98			7683.30	7761.78	28.0	438.19	7887.42
18100	13.2	425.28	7697.57			7725.99	7804.90	28.0	438.19	7931.24
18200	13.4	425.46	7743.37			7768.67	7848.02	28.0	438.19	7975.06
18300	13.6	425.63	7789.03			7811.36	7891.14	28.0	438.19	8018.88
18400	13.8	425.81	7834.90			7854.04	7934.26	28.0	438.19	8062.70
18500	14.0	425.98	7880.63			7896.73	7977.39	28.0	438.19	8106.52
18600	14.2	426.18	7926.95			7939.41	8020.51	28.0	438.19	8150.33
18700	14.4	426.37	7973.12			7982.10	8063.63	28.0	438.19	8194.15
18800	14.7	426.57	8019.52			8024.78	8106.75	28.0	438.19	8237.97
18900	14.9	426.76	8065.76			8067.47	8149.87	28.0	438.19	8281.79
19000	15.1	426.96	8112.24				8192.99	28.0	438.19	8325.61
19100	15.3	427.15	8158.57				8236.11	28.0	438.19	8369.43
19200	15.6	427.35	8205.12				8279.23	28.0	438.19	8413.25
19300	15.8	427.54	8251.52				8322.35	28.0	438.19	8457.07
19400	16.0	427.74	8298.16				8365.47	28.0	438.19	8500.89
19500	16.2	427.93	8344.64				8408.60	28.0	438.19	8544.71
19600	16.5	428.13	8391.35	BEYOND LIMITS			8451.72	28.0	438.19	8588.52
19700	16.7	428.32	8437.90				8494.84	28.0	438.19	8632.34
19800	16.9	428.52	8484.70				8537.96	28.0	438.19	8676.16
19900	17.1	428.71	8531.33				8581.08	28.0	438.19	8719.98
20000	17.4	428.91	8578.20				8624.20	28.0	438.19	8763.80
20100	17.6	429.10	8624.91				8667.32	28.0	438.19	8807.62
20200	17.8	429.30	8671.86				8710.44	28.0	438.19	8851.44
20300	18.0	429.49	8718.65				8753.56	28.0	438.19	8895.26
20400	18.2	429.69	8765.68				8796.68	28.0	438.19	8939.08
20500	18.5	429.88	8812.54				8839.81	28.0	438.19	8982.90
20600	18.7	430.08	8859.65				8882.93	28.0	438.19	9026.71
20700	18.9	430.27	8906.59				8926.05	28.0	438.19	9070.53
20800	19.1	430.47	8953.78				8969.17	28.0	438.19	9114.35
20900	19.4	430.66	9000.79				9012.29	28.0	438.19	9158.17
21000	19.6	430.86	9048.06				9055.41	28.0	438.19	9201.99
21100	19.8	431.05	9095.16				9098.53	27.6	437.88	9239.27
21200	20.0	431.25	9142.50				9141.65	27.3	437.56	9276.27
21250	20.2	431.35	9166.19					27.1	437.41	9294.96

Table 9 - Learjet 45 Usable Fuel Moments

WING AND FUSELAGE TANK

POUNDS/KG	GALLONS/ LITERS KEROSENE 6.7 #/GAL	MOMENT/1000 IN-POUNDS
100/ 45	14.9/ 56.5	43.65
200/ 91	29.9/ 113.0	87.77
300/ 136	44.8/ 169.5	131.54
400/ 181	59.7/ 226.0	174.97
500/ 227	74.6/ 282.5	218.83
600/ 272	89.6/ 339.0	263.24
700/ 318	104.5/ 395.5	306.97
800/ 363	119.4/ 452.0	350.73
900/ 408	134.3/ 508.5	394.70
1000/ 454	149.3/ 565.0	438.74
1100/ 499	164.2/ 621.5	482.84
1200/ 544	179.1/ 678.0	526.93
1300/ 590	194.0/ 734.5	571.06
1400/ 635	209.0/ 791.0	615.22
1500/ 680	223.9/ 847.5	659.72
1600/ 726	238.8/ 904.0	704.39
1700/ 771	253.7/ 960.5	748.87
1800/ 816	268.7/ 1017.0	793.50
1900/ 862	283.6/ 1073.5	838.26
2000/ 907	298.5/ 1130.0	883.33
2100/ 953	313.4/ 1186.5	928.31
2200/ 998	328.4/ 1243.0	973.29
2300/ 1043	343.3/ 1299.5	1018.48
2400/ 1089	358.2/ 1356.0	1063.45
2500/ 1134	373.1/ 1412.5	1108.58
2600/ 1179	388.1/ 1469.0	1153.80
2700/ 1225	403.0/ 1525.5	1199.07
2800/ 1270	417.9/ 1582.0	1244.54
2900/ 1315	432.8/ 1638.5	1290.59
3000/ 1361	447.8/ 1695.0	1336.81

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	POUNDS/KG	GALLONS/ LITERS KEROSENE 6.7 #/GAL	MOMENT/1000 IN-POUNDS
	3100/ 1406	462.7/ 1751.3	1383.14
	3200/ 1452	477.6/ 1807.8	1429.55
	3300/ 1497	492.5/ 1864.3	1475.91
WINGS FULL ▶	3354/ 1521	501.1/ 1894.7	1500.95
	3400/ 1542	507.5/ 1920.7	1522.29
	3500/ 1588	522.4/ 1977.2	1568.70
	3600/ 1633	537.3/ 2033.7	1616.32
	3700/ 1678	552.2/ 2090.2	1663.98
	3800/ 1724	567.2/ 2146.7	1711.24
	3900/ 1769	582.1/ 2203.2	1758.69
	4000/ 1814	597.0/ 2259.7	1806.28
	4100/ 1860	611.9/ 2316.2	1854.02
	4200/ 1905	626.9/ 2372.7	1901.51
	4300/ 1950	641.8/ 2429.2	1949.11
	4400/ 1996	656.7/ 2485.7	1996.76
	4500/ 2041	671.6/ 2542.2	2044.49
	4600/ 2087	686.6/ 2598.7	2092.32
	4700/ 2132	701.5/ 2655.1	2140.26
	4800/ 2177	716.4/ 2711.6	2187.71
	4900/ 2223	731.3/ 2768.1	2235.09
	5000/ 2268	746.3/ 2824.6	2282.55
	5100/ 2313	761.2/ 2881.1	2330.06
	5200/ 2359	776.1/ 2937.6	2377.63
	5300/ 2404	791.0/ 2994.1	2425.28
	5400/ 2449	806.0/ 3050.6	2472.89
	5500/ 2495	820.9/ 3107.1	2520.55
	5600/ 2540	835.8/ 3163.6	2568.27
	5700/ 2586	850.7/ 3220.1	2616.20
	5800/ 2631	865.7/ 3276.6	2664.40
	5900/ 2676	880.6/ 3333.1	2712.53
	6000/ 2722	895.5/ 3389.6	2760.90
AIRPLANE FULL ▶	6062/ 2749	904.8/ 3424.5	2790.72

Figure 6-9

Table 10 - Learjet 40 Usable Fuel Moments

WING AND FUSELAGE TANK

POUNDS/KG	GALLONS/ LITERS KEROSENE 6.7 #/GAL	MOMENT/1000 IN-POUNDS
100/ 45	14.9/ 56.5	43.65
200/ 91	29.9/ 113.0	87.77
300/ 136	44.8/ 169.5	131.54
400/ 181	59.7/ 226.0	174.97
500/ 227	74.6/ 282.5	218.83
600/ 272	89.6/ 339.0	263.24
700/ 318	104.5/ 395.5	306.97
800/ 363	119.4/ 452.0	350.73
900/ 408	134.3/ 508.5	394.70
1000/ 454	149.3/ 565.0	438.74
1100/ 499	164.2/ 621.5	482.84
1200/ 544	179.1/ 678.0	526.93
1300/ 590	194.0/ 734.5	571.06
1400/ 635	209.0/ 791.0	615.22
1500/ 680	223.9/ 847.5	659.72
1600/ 726	238.8/ 904.0	704.39
1700/ 771	253.7/ 960.5	748.87
1800/ 816	268.7/ 1017.0	793.50
1900/ 862	283.6/ 1073.5	838.26
2000/ 907	298.5/ 1130.0	883.33
2100/ 953	313.4/ 1186.5	928.31
2200/ 998	328.4/ 1243.0	973.29
2300/ 1043	343.3/ 1299.5	1018.48
2400/ 1089	358.2/ 1356.0	1063.45
2500/ 1134	373.1/ 1412.5	1108.58
2600/ 1179	388.1/ 1469.0	1153.80
2700/ 1225	403.0/ 1525.5	1199.07
2800/ 1270	417.9/ 1582.0	1244.54
2900/ 1315	432.8/ 1638.5	1290.59
3000/ 1361	447.8/ 1695.0	1336.81

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Change 2

POUNDS/KG	GALLONS/ LITERS KEROSENE 6.7 #/GAL	MOMENT/1000 IN-POUNDS
3100/ 1406	462.7/ 1751.3	1383.14
3200/ 1452	477.6/ 1807.8	1429.55
3300/ 1497	492.5/ 1864.3	1475.91
3400/ 1542	507.5/ 1920.7	1522.29
3500/ 1588	522.4/ 1977.2	1568.70
3600/ 1633	537.3/ 2033.7	1616.32
3700/ 1678	552.2/ 2090.2	1663.98
3800/ 1724	567.2/ 2146.7	1711.24
3900/ 1769	582.1/ 2203.2	1758.69
4000/ 1814	597.0/ 2259.7	1806.28
4100/ 1860	611.9/ 2316.2	1854.02
4200/ 1905	626.9/ 2372.7	1901.51
4300/ 1950	641.8/ 2429.2	1949.11
4400/ 1996	656.7/ 2485.7	1996.76
4500/ 2041	671.6/ 2542.2	2044.49
4600/ 2087	686.6/ 2598.7	2092.32
4700/ 2132	701.5/ 2655.1	2140.26
4800/ 2177	716.4/ 2711.6	2187.71
4900/ 2223	731.3/ 2768.1	2235.09
5000/ 2268	746.3/ 2824.6	2282.55
5100/ 2313	761.2/ 2881.1	2330.06
5200/ 2359	776.1/ 2937.6	2377.63
5300/ 2404	791.0/ 2994.1	2425.28
5375/ 2438	802.0/ 3037.0	2460.99

AIRPLANE FULL ▶

Figure 6-9

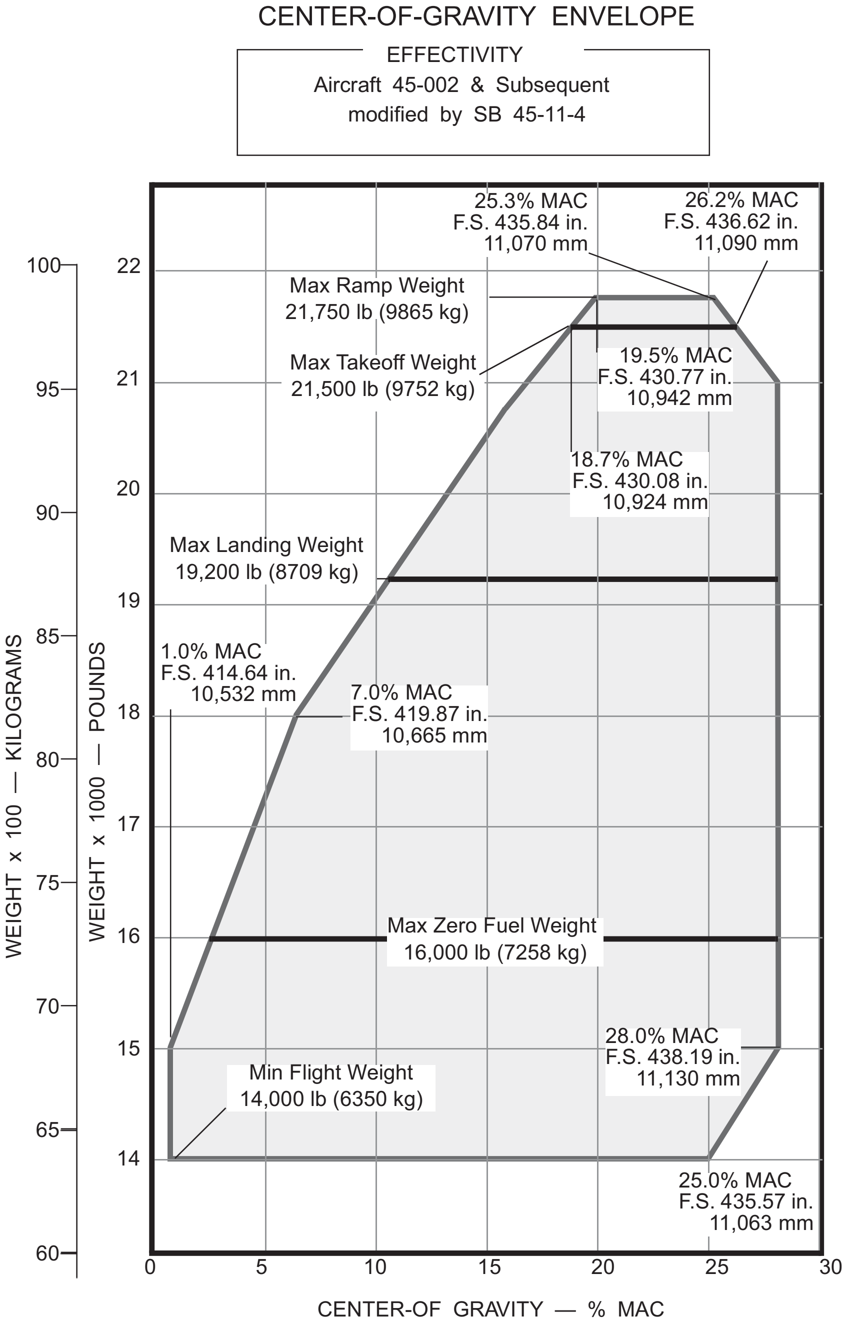

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Figure 6-1.3

Figure 3 - Learjet 45 Center-of-Gravity Envelope

CENTER-OF-GRAVITY ENVELOPE

EFFECTIVITY
Aircraft 45-2001 & Subsequent
modified by SB 40-11-1

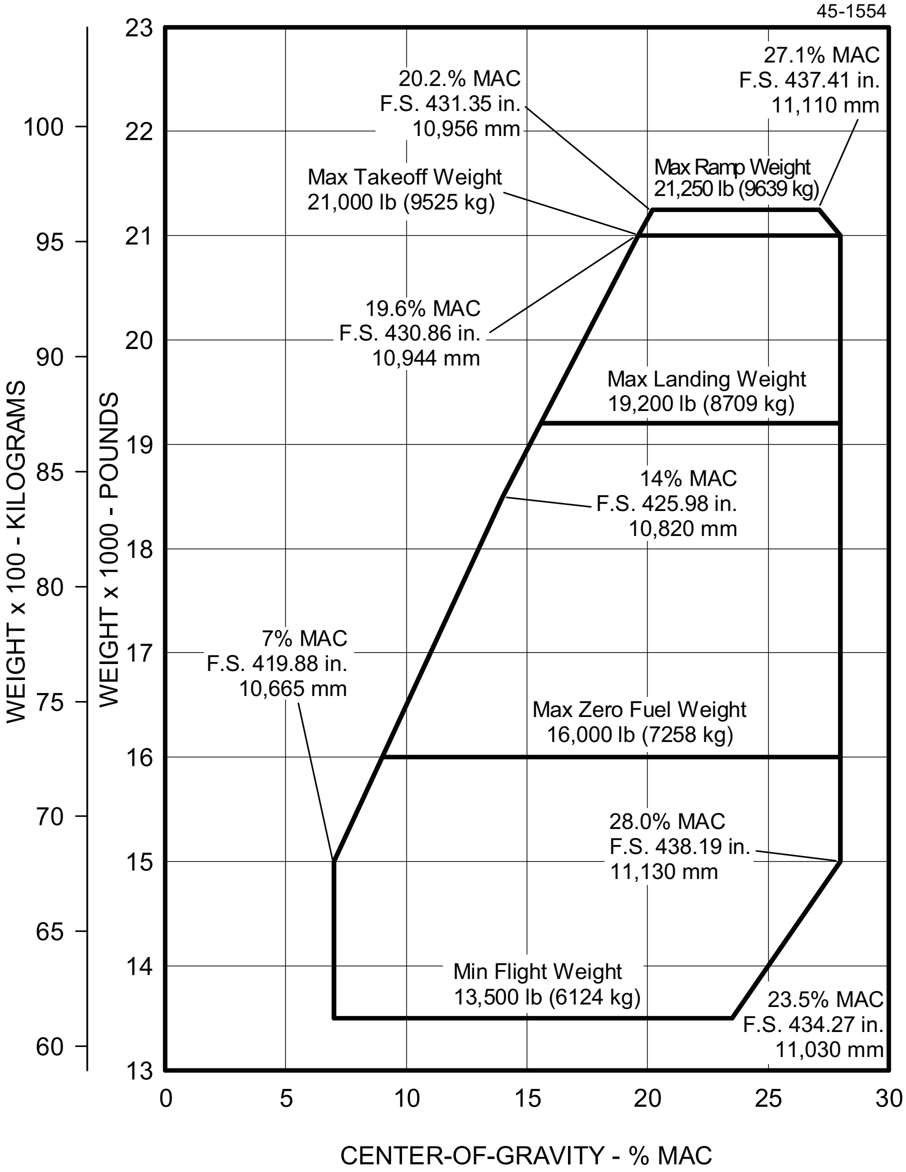

Figure 4 - Learjet 40 Center-of-Gravity Envelope

EFFECTIVITY
Aircraft 45-002 & Subsequent
modified by SB 45-11-4

NOTE
The landing gear retraction moment is (minus) 979 inch-pounds.

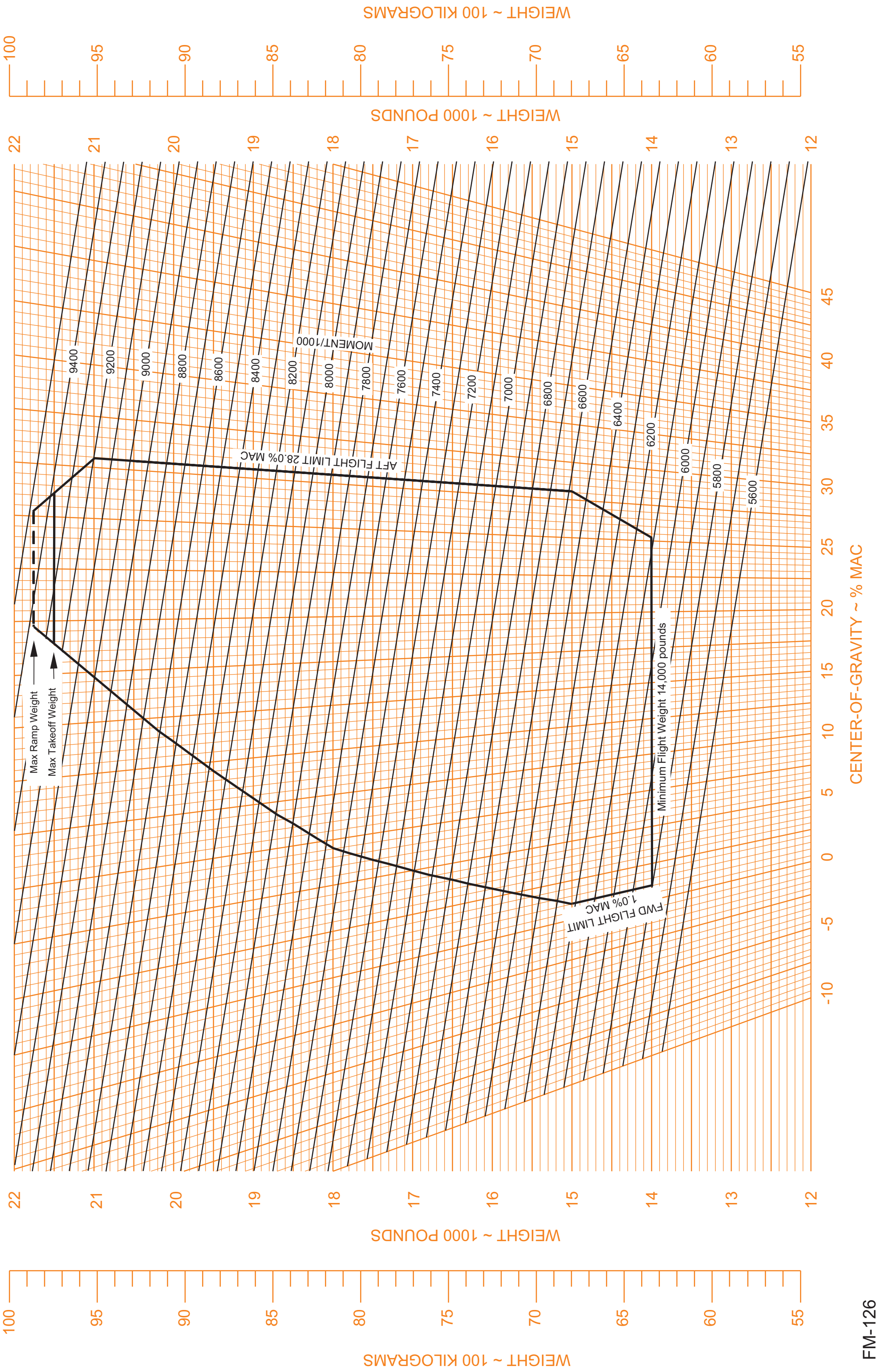

Figure 6-7.3

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Figure 5 - Learjet 45 Weight-Moment-C.G. Envelope

Figure 6-7.1

EFFECTIVITY

Aircraft 45-2001 & Subsequent modified by SB 40-11-1

NOTE

The landing gear retraction moment is (minus) 800 inch-pounds.

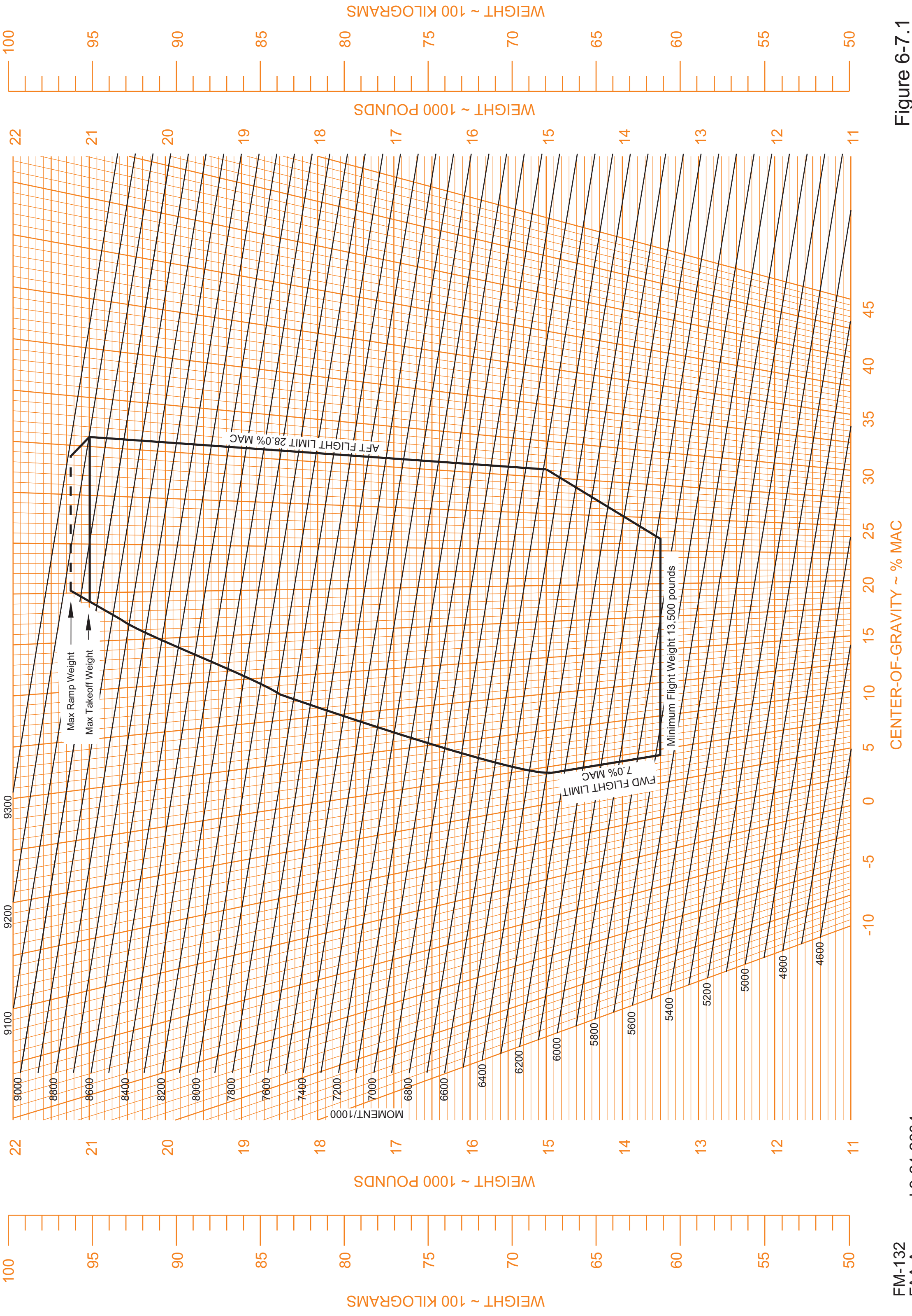

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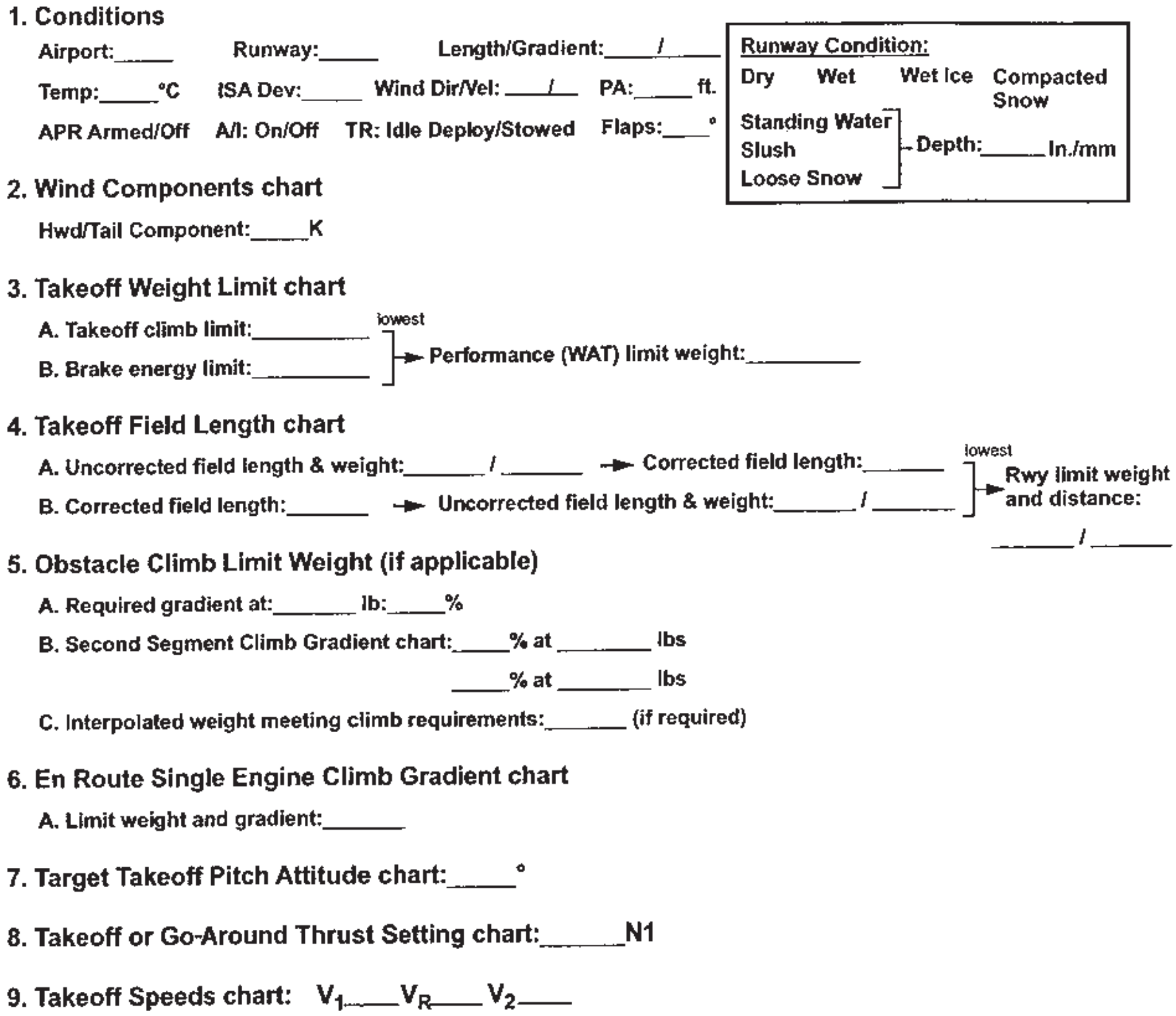
Figure 6 - Learjet 40 Weight-Moment-C.G. Envelope

Table 11 - Takeoff Performance Planning Worksheet



1. Conditions

Airport:_____ Runway:_____ Length/Gradient:_____/_____

Temp:_____°C ISA Dev:_____ Wind Dir/Vel: ____/____ PA:_____ ft.

APR Armed/Off A/I: On/Off TR: Idle Deploy/Stowed Flaps:____°

Runway Condition:

Dry Wet Wet Ice Compacted Snow

Standing Water / Slush / Loose Snow → Depth:_____ In./mm

2. Wind Components chart

Hwd/Tail Component:_____K

3. Takeoff Weight Limit chart

A. Takeoff climb limit:__________

B. Brake energy limit:__________

lowest → Performance (WAT) limit weight:__________

4. Takeoff Field Length chart

A. Uncorrected field length & weight:_______ / _______ → Corrected field length:_______

B. Corrected field length:_______ → Uncorrected field length & weight:_______ / _______

lowest → Rwy limit weight and distance: _______ / _______

5. Obstacle Climb Limit Weight (if applicable)

A. Required gradient at:_______ lb:_____%

B. Second Segment Climb Gradient chart:_____% at ________ lbs

_____% at ________ lbs

C. Interpolated weight meeting climb requirements:_______ (if required)

6. En Route Single Engine Climb Gradient chart

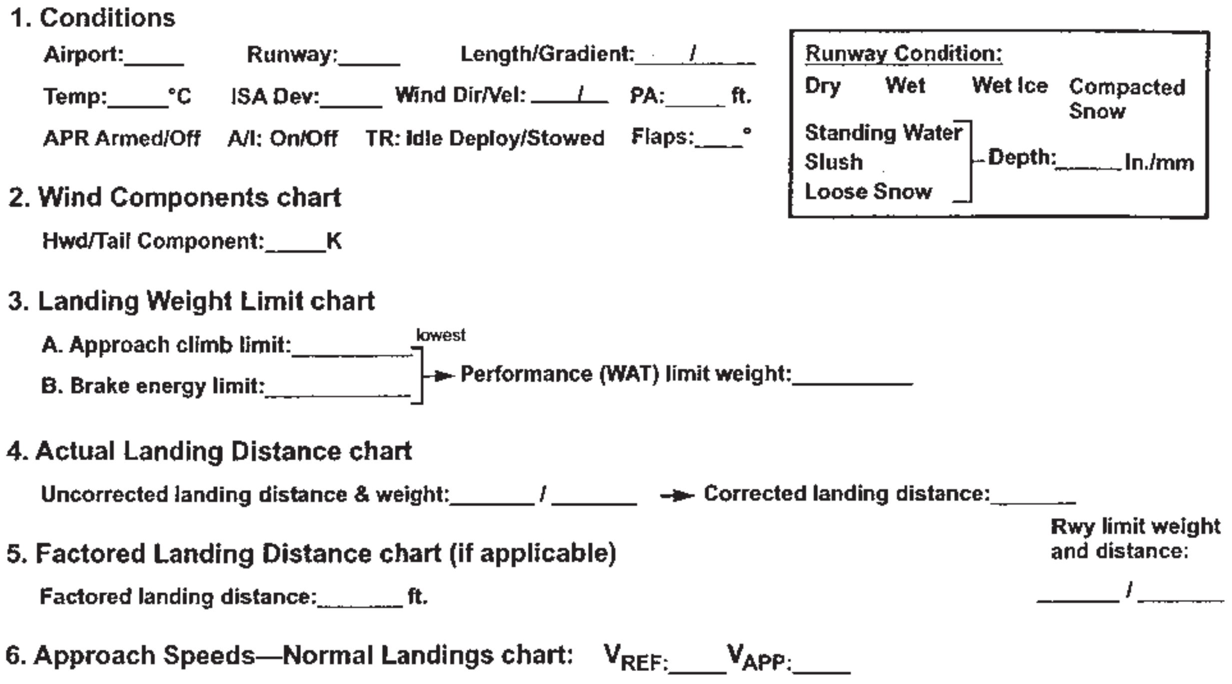
A. Limit weight and gradient:_______

7. Target Takeoff Pitch Attitude chart:_____°

8. Takeoff or Go-Around Thrust Setting chart:_______N1

9. Takeoff Speeds chart: V_1____ V_R____ V_2____

Table 12 - Landing Performance Planning Worksheet



1. Conditions

Airport:_____ Runway:_____ Length/Gradient:_____/_____

Temp:_____°C ISA Dev:_____ Wind Dir/Vel: ____/____ PA:_____ ft.

APR Armed/Off A/I: On/Off TR: Idle Deploy/Stowed Flaps:____°

Runway Condition:

Dry Wet Wet Ice Compacted Snow

Standing Water
Slush
Loose Snow
Depth:_____ In./mm

2. Wind Components chart

Hwd/Tail Component:_____K

3. Landing Weight Limit chart

A. Approach climb limit:__________
B. Brake energy limit:__________
lowest → Performance (WAT) limit weight:__________

4. Actual Landing Distance chart

Uncorrected landing distance & weight:_______ / _______ → Corrected landing distance:_______

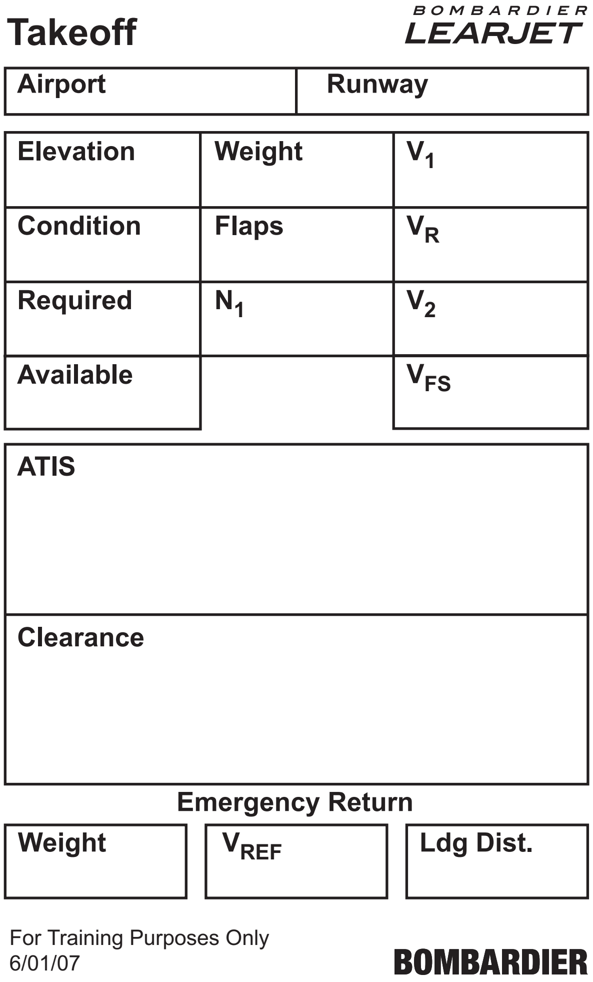
Rwy limit weight and distance:
_______ / _______

5. Factored Landing Distance chart (if applicable)

Factored landing distance:_______ ft.

6. Approach Speeds—Normal Landings chart: V_{REF}:____ V_{APP}:____

TOLD Card—Takeoff



Takeoff

BOMBARDIER LEARJET

Airport	Runway

Elevation	Weight	V_1
Condition	Flaps	V_R
Required	N_1	V_2
Available		V_{FS}

ATIS

Clearance

Emergency Return

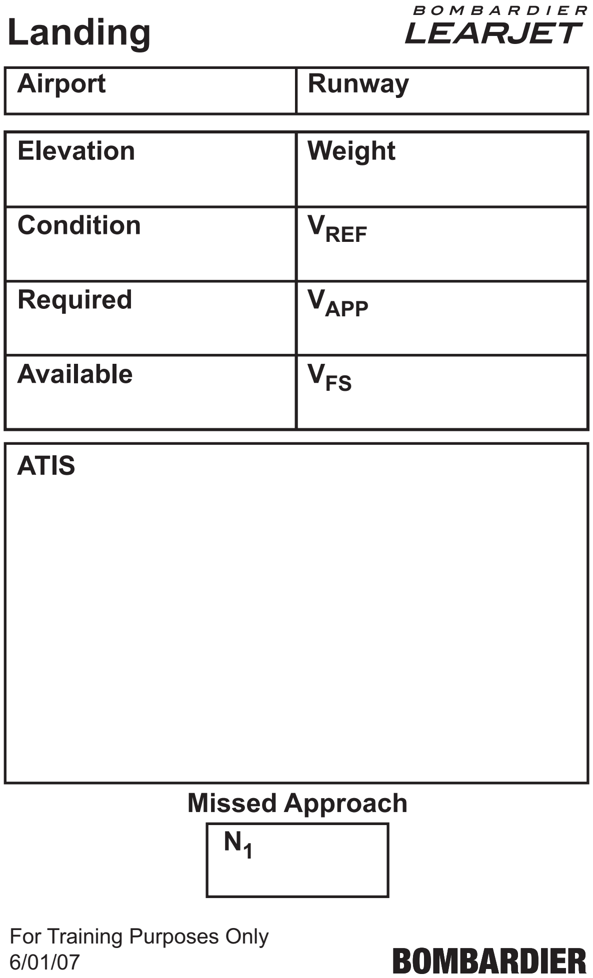
Weight	V_{REF}	Ldg Dist.

For Training Purposes Only
6/01/07

BOMBARDIER

Figure 7 - TOLD Card–Takeoff

TOLD Card—Landing



Landing

Airport	Runway

Elevation	Weight
Condition	V_{REF}
Required	V_{APP}
Available	V_{FS}

ATIS

Missed Approach

N_1

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6/01/07

BOMBARDIER

Figure 8 - TOLD Card–Landing

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Table of Contents

Page

Review Questions

Answer Key

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REVIEW QUESTIONS

The following questions can be answered with reference to the specific chapter in this Pilot Training Guide or the Aircraft Flight Manual.

Chapter 1 Aircraft General

1. What is the maximum ramp weight?
2. What is the maximum certified takeoff weight?
3. What is the maximum certified landing weight?
4. What are the pressurization Delta P limits?
5. What is the aircraft overall length and width?
6. What is the aircraft overall height?
7. What is the aircraft (wingtip) turning radius with nosewheel steering fully deflected to 60°?

Chapter 2 Automatic Flight Control System

1. How many flight directors are in the FGCS?
2. Which IC-600 provides the autopilot function?
3. Does pushing the trim arming switch disengage the autopilot?
4. What results from pushing the master side trim (barrel) switch NOSE UP with the flight director vertical mode in IAS mode and the autopilot engaged?
5. The TCS button has what effect when pressed with the autopilot engaged?
6. The active flight director modes appear in what color?
7. What does the presence of a left-pointing green arrow on the pilot and copilot PFD indicate?
8. What effect does depressing the FD1 button with the autopilot engaged and the pilot FD operating as the master FD?
9. What results from pressing the YD button when the autopilot and yaw damper are engaged?
10. If the autopilot is engaged (AP button pressed) with no active flight director modes, what lateral and vertical modes annunciate on the PFDs?
11. What lateral mode is best used by the flight crew to fly ATC vectored headings?

12. Selecting the BNK button on the flight guidance controller limits the flight director's maximum bank angle to approximately how many degrees?
13. Is altitude select (ASEL) mode inhibited when approach mode is active (localizer and glideslope captured and tracking)?
14. What occurs if the ALT SEL knob is rotated during preselect altitude capture?
15. In FLCH mode, does the high-speed descent profile provide pitch commands to maintain 250 kt below 10,000 ft?
16. If the VS button is pressed while the aircraft is in a descent, to where does the vertical speed reference (bug) default?
17. How is the airspeed tape changed from indicating KIAS to Mach?
18. \What does an active FD mode enclosed by a white box indicate?
19. After takeoff, what is the minimum altitude to engage the autopilot?
20. Autopilot operation during a precision approach is prohibited below what altitude?

Chapter 3 Auxiliary Power Unit

1. What is the function of the APU MASTER switch indicator?
2. What provides the flight crew with an indication that the APU is ready to provide pneumatic and electrical power to the aircraft?
3. How is the APU normally shut down when it is running?
4. What occurs when the APU FIRE PUSH switch indicator is depressed with the APU running?
5. What does illumination of the white ON annunciation on the APU BLEED switch indicator mean?
6. What is the maximum operating field pressure altitude of the APU?
7. Fuel for APU operation is supplied from which fuel tank?
8. What is the waiting period before starting the APU after attempting a third failed start?

Chapter 4 Communication System

1. What happens when the emergency COM switch on the pilot side audio panel is depressed?
2. What is the function of the ID/BOTH/VOICE control?
3. What is the primary function of each RMU?

4. What is the indication when an RMU is associated with the cross-side system?
5. What are the functions of the clearance delivery head?
6. If the EMERG annunciator is being displayed on the CDH, what does it mean?

Chapter 5 Electrical Systems

1. What does the AC electrical system consist of?
2. What does the DC electrical system consist of?
3. What does the emergency electrical system consist of?
4. With both engine-driven generators off-line, which buses are automatically deactivated in flight?
5. What do the engine-driven generators supply?
6. What CAS message is displayed with an amber L or R GEN FAIL?
7. If the left battery overheats, what are the indications in the cockpit?
8. If a GPU is used for engine start, when does the generator automatically come online?
9. When illuminated, what does the horizontal bar on the BUS-TIE switch indicator indicate?
10. What does an EMER caption illuminated on the emergency battery switch indicate?
11. What is the function of the AC system?
12. What happens if the EXT PWR switch indicator is depressed when AVAIL is illuminated?

Chapter 6 Emergency Equipment and Oxygen

1. How many portable fire extinguishers are installed in the Learjet 45?
2. What EICAS indication(s) appear(s) if the oxygen cylinder shutoff valve is selected OFF?
3. What happens if the oxygen cylinder contents are discharged overboard?
4. What is the purpose of the PAX OXY/AUTO switch?
5. What is the purpose of the DEPLOY switch?
6. With the PAX OXY/AUTO switch selected on, at what cabin altitude would the passenger oxygen masks automatically deploy?

Chapter 7 Environmental Control Systems

1. Which aircraft system requires no pilot monitoring or regulation?
2. If a dual generator failure occurs in flight, how are the cockpit/cabin temperature control systems managed?
3. Where can cabin temperature be monitored?
4. What is required for automatic activation of emergency pressurization at 9500 ft?
5. What is inoperative when emergency pressurization is activated on both sides?
6. If emergency pressurization activates inadvertently and the appropriate L or R BLEED circuit breaker is pulled, what happens?
7. If a complete electrical failure occurs in flight, what happens with the pressurization system?
8. Where is the landing altitude displayed on the pressurization control panel?
9. Where can the selected manual rate and the actual cabin rate be observed at the same time?
10. At what cabin altitude does the CAB ALT indication on the controller panel begin flashing?
11. After dual generator failure in flight, what happens to the cabin pressurization system?

Chapter 8 Fire Protection Systems

1. What areas in each engine nacelle do the heat-sensing elements monitor?
2. Where are the engine fire extinguisher containers located?
3. How can the “Left engine fire” aural message be canceled?
4. During preflight inspection, what should the fire bottle pressure indicate?

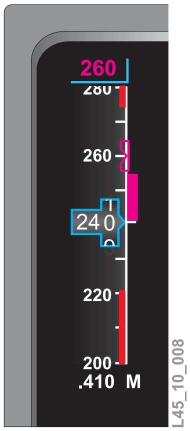
Chapter 9 Flight Controls

1. What is the purpose of the up/down spring?
2. What is the purpose of rudder boost?
3. What are the conditions for arming the rudder boost?
4. What is bypass pitch trim mode?
5. When is the configuration trim mode functional?
6. What is the function of pitch trim bias?

Chapter 10 Flight Instruments

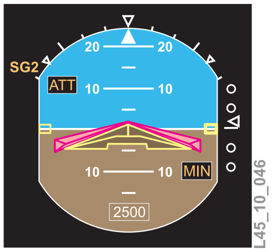
1. If a double generator failure occurs, how are the attitude heading reference units powered?
2. If a white DG2 heading source annunciation appears on the pilot's HSI, what does it indicate?

Questions 3 through 5 refer to the speed tape illustrated below:



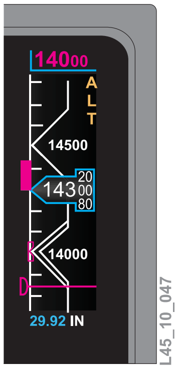
3. What does the magenta "260" (at the top of the tape) indicate?
4. What occurs when the airspeed reaches 220 kt?
5. What occurs when the airspeed reaches 275 kt?

For questions 6 through 8, refer to the ADI shown below:



6. When is the amber ATT annunciation displayed?
7. When does the amber annunciation SG2 appear?
8. When does the steady amber annunciation MIN appear?

Questions 9 and 10 refer to the altitude scale illustration shown below:



9. At what is the minimum altitude set?
10. How can the local altimeter setting selected on the display be changed to the standard setting (29.92 in)?
11. What happens if the the pilot DU reversion switch is pushed?
12. What does selecting the PFD position on the pilot DU reversion switch do?

Chapter 11 Fuel System

1. What is the maximum usable fuel capacity of the Learjet 45?
2. How is fuel in the fuselage tank normally transferred into the wing tanks?
3. Ejector pumps operate using what principle?
4. How is motive flow created to operate the ejector pumps?
5. What kind of pumps are the standby fuel pumps?
6. What are the indications if the crossflow valve is in the open position?

Chapter 12 Hydraulics

1. The main and auxiliary hydraulic systems operate at what nominal pressure?
2. When does an engine-driven hydraulic pump operate?
3. If a leak develops in the main hydraulic system line between the engine-driven pump and the main filter manifold, does the hydraulic reservoir fully deplete?
4. How is the hydraulic reservoir fluid quantity verified during the exterior preflight?
5. The main hydraulic system provides power to which systems and components?
6. If a main system fails during flight, which systems receive hydraulic power when the AUX HYD and HYD XFLOW switches are selected ON?
7. What does the white L HYD PUMP LO CAS message indicate?

8. Where is brake accumulator pressure information displayed?
9. How many applications of emergency brakes are available?
10. How is the brake accumulator charged?
11. Which CAS message indicates a main hydraulic system low pressure condition?
12. If the amber AUX HYD QTY LO CAS message appears, what occurs?
13. If the main and auxiliary hydraulic systems fail in flight, is wheel braking available on landing?

Chapter 13 Ice and Rain Protection

1. Which anti-icing systems do not work on the ground?
2. What happens if the left alternator fails?
3. During a total loss of the electrical power, does the WING/STAB anti-ice system work?
4. Which indications show a satisfactory anti-ice system test?
5. How is the wing/stab anti-ice leak detection system tested?
6. What does an amber ICE DETECT CAS message indicate?

Chapter 14 Landing Gear and Brakes

1. Which electrical bus powers the landing gear control circuits?
2. What does the illumination of the left white/hash landing gear position light indicate?
3. When does the amber GEAR CAS message appear?
4. When the amber GEAR CAS message is displayed, can the “Gear” aural warning be silenced?
5. When the red GEAR CAS message is displayed, can the “Gear” aural warning be silenced?
6. What is the maximum nosewheel authority in degrees (in either direction of center) when theaircraft ground speed is 5 kt or less?
7. What does the white NWS FAULT CAS message indicate?
8. What are the indications when the nosewheel steering is manually disengaged?
9. How is emergency braking applied?
10. How many emergency brake applications can the brake accumulator provide?
11. How long should the brake accumulator hold pressure?
12. If the main hydraulic system fails during landing, how is hydraulic power supplied to the wheel brakes?
13. What does a red EMER/PARK BRK CAS message indicate?
14. What is the tire limiting speed?
15. What is the VLO airspeed?

Chapter 15 Lighting

1. What conditions cause the emergency lighting system to automatically illuminate?
2. Which light(s) can be controlled with the aircraft unpowered?
3. What does the wing inspection light illuminate?
4. During a single generator failure, which cockpit lights are lost?
5. During a dual generator failure with both main batteries expired, what is powered by the emergency battery?

Chapter 17 Navigation

1. What is the normal mode of operation for TCAS II?
2. What does a red band appearing on the vertical speed scale mean?
3. On which displays are traffic advisories shown?
4. What are the functions of the terrain awareness alerting display (TAAD)?
5. How does the pilot select the TCAS altitude band (normal, above, and below)?
6. How far above and below the aircraft is the NORMAL TCAS altitude limit band?
7. The PFD and MFD bearing pointers are selected for display through which cockpit panel?
8. The active navigation source is selected for display through which cockpit panel?
9. What does a red RA NO BRG located in the upper TCAS zoom window indicate?
10. What is the function of the GPWS flap override switch?
11. Since the indications for the X-band weather radar depends on the reflective characteristics of water, what types of precipitation give the strongest radar return in order of reflectivity?
12. What can the weather radar terrain mapping capability GMAP be used for?
13. What is the FSBY mode on the weather radar system?
14. In a weather radar echo, what color indicates the highest level of reflectivity and precipitation rate?
15. What is the function of the RCT mode of the weather radar system?
16. How is the FMS best computed position (BCP) normally determined?
17. What does an amber INTEG annunciation on the left of the HSI (PFD) indicate?
18. What is the GPS integrity limit for the approach phase of flight

Chapter 18

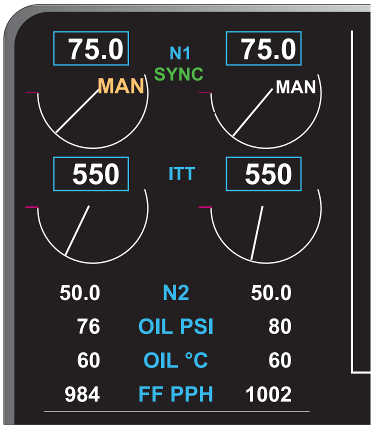
Pneumatics

1. What switches must be selected ON to provide engine bleed air to the environmental control unit for pressurization and air conditioning?
2. When should PACK HI FLOW not be used?
3. How does an engine shutdown in flight affect bleed air?
4. To what position are the high-pressure shutoff valves energized?
5. With total loss of electrical power, to what position do the following valves fail?
    - A. ECS-pressure regulating and shutoff valve
    - B. High-pressure shutoff valve
    - C. Emergency pressurization valve
6. How are the bleed-air duct leak detection sensors tested?

Chapter 19

Power Plant

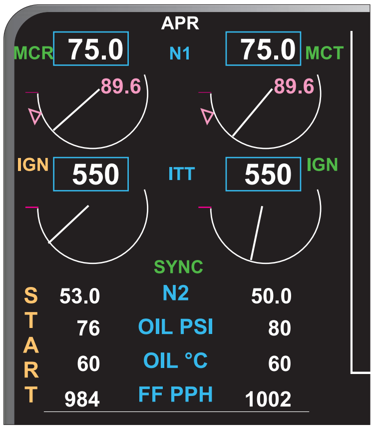
Questions 1 to 3 refer to the figure below:



L45_19_021

1. What does the left amber MAN annunciation indicate?
2. In which position is the SYNC switch?
3. What is the value of N_1?

Questions 5 to 7 refer to the figure below:



L45_19_022

4. What does the white APR symbol indicate?
5. What does the left magenta 89.6 value indicate?
6. What does the left amber START symbol indicate?
7. How can you revert to normal operations from the APR mode?
8. What does an amber UNL symbol located at the top of the right N_1 digital display mean?
9. What does an amber REV symbol located on the top of the right N1 digital display indicate?
10. What does a white REV symbol located on the top of the right N_1 digital display indicate?

Chapter 20 Warnings— Aural and Visual

1. Which display units can provide the EICAS format?
2. What collects aircraft sensor data for display on the EICAS?
3. In general, what does an amber CAS message indicate?
4. At what airspeed does the CAS TAKEOFF INHIBIT activate?
5. What DAU data is used by the IC-600 computers when the DAU reversionary switch is selected to NORM?
6. With respect to the AFM EICAS or MFD limitations, which system pages are required to be selected prior to takeoff or landing?
7. How are CAS messages organized for display?
8. What CAS messages cannot be scrolled off the CAS display?
9. What accompanies display of an amber CAS message?
10. When a new amber CAS message is generated, how long does it flash?
11. When does a flashing amber CAS message appear steady?
12. How is a takeoff configuration warning indicated?

ANSWER KEY

Chapter 1 Aircraft General

1. Learjet 45/45XR:
   Aircraft not modified by SB 45-11-420,750 lb (9412 kg)
   Aircraft modified by SB 45-11-421,750 lb (9865 kg)

   Learjet 40/40XR:
   Aircraft not modified by SB 40-11-0120,600 lb (9344 kg)
   Aircraft modified by SB 40-11-0121,500 lb (9639 kg)
2. Learjet 45/45XR:
   Aircraft not modified by SB 45-11-420,500 lb (9299 kg)
   Aircraft modified by SB 45-11-421,500 lb (9752 kg)

   Learjet 40/40XR:
   Aircraft not modified by SB 40-11-0120,350 lb (9231 kg)
   Aircraft modified by SB 40-11-0121,000 lb (9525 kg)
3. 19,200 lb
4. +9.9 to –0.5 psi
5. 58 ft 5 in and 47 ft 10 in
6. 14 ft 1 in
7. Learjet 45/45XR: 39 ft 4 in. (12 m)
   Learjet 40/40XR:38 ft 2 in. (11.63 m)

Chapter 2 Automatic Flight Control System

1. Two
2. IAC #2
3. Yes
4. Revert the flight director vertical mode to PIT
5. Allows manual control of the aircraft without disengaging the autopilot
6. Green
7. The autopilot couples to the pilot (left) flight director if the AP button is pressed
8. None
9. Disengage the yaw damper and autopilot
10. ROL and PIT
11. HDG
12. 14°
13. Yes
14. ASEL is replaced by PIT as the active mode, and altitude preselect mode rearms to capture the new preselect altitude
15. Yes
16. To the rate of descent at the moment the button is released

17. When the PUSH IAS/M button within the SPD knob is depressed
18. A captured/transition mode
19. 500 ft AGL
20. 200 ft AGL

Chapter 3 Auxiliary Power Unit

1. It controls electrical power to the electronic control unit (ECU)
2. The green RUN annunciation on the APU START/STOP switch indicator illuminates
3. By depressing the APU START/STOP switch indicator and then the APU MASTER switch indicator
4. The electronic control unit (ECU) commands an APU fire shutdown and the APU fire bottle is discharged
5. The APU BLEED switch indicator is depressed, and the bleed air valve is open
6. 10,000 feet MSL
7. Right wing tank
8. 15 minutes

Chapter 4 Communication System

1. The onside microphone is connected directly to the No.1 VHF COM transmitter, and the No.1 VHF COM and NAV receivers are connected directly to the onside headphone
2. In the ID mode, only the VOR and ADF morse code identification is audible; in the voice mode, the IDENT audio is filtered to pass the voice content; and in the both mode, voice and identification signals may be heard together
3. The primary function of each RMU is to select and control the frequencies and operational modes of each radio
4. The legend color changes from white to magenta
5. The CDH provides a clearance delivery function on the ground for whenever radio communications are required and it is not desirable to power all aircraft avionics; the CDH provides an alternative radio tuning source to supplement the RMUs; the CDH provides tuning in case of RMU failure
6. The No. 1 COM and NAV units are exclusively tuned by the clearance delivery head

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Chapter 5 Electrical Systems

1. Two engine-driven alternators
2. Engine-driven generators, aircraft batteries, ground power unit, and auxiliary power unit (if installed)
3. Emergency battery
4. Nonessential buses and main buses
5. 28 VDC

6. A white BUS TIE CLSD
7. After the engines are running when the GPU is disconnected or when the EXT PWR switch indicator is depressed
8. CWP and EICAS page show L BATT OVHT
9. The bus tie contactor is closed
10. The EMER battery is discharging
11. Provides power to the windshield heating
12. The external ground power unit is connected

Chapter 6 Emergency Equipment and Oxygen

1. Three
2. An OXYGEN OFF CAS message is displayed
3. A green oxygen discharge indicator on the outside surface of the aircraft is ruptured or missing
4. Control the automatic deployment of the passenger oxygen masks if cabin pressure is lost
5. Manually deploy the passenger oxygen masks
6. At 14,500 ft cabin altitude

Chapter 7 Environmental Control System

1. The cockpit footwarmers
2. Must be operated in manual
3. EICAS/MFD ECS page
4. At least one BLEED switch must be ON, and electrical power must be available to the ECS controller channels
5. Cabin temperature control
6. That will close the appropriate EMER PRESS valve
7. The ECS valves and the PACK valve deenergize open
8. On the CAB ALT line when the LDG ALT knob is rotated
9. On the EICAS/MFD ECS page
10. 8750 ft
11. It is unaffected since the secondary (right) pressurization channel is powered by the emergency battery bus

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Chapter 8 Fire Protection Systems

1. Accessory gearbox, hot section, and pylon firewall
2. In the tailcone
3. Mute button located on the right thrust lever, or the glareshield master WARN/CAUT switch
4. Between 400 and 800 psi

Chapter 9 Flight Controls

1. It augments pitch stability throughout the airspeed envelope
2. Assists when heavy rudder pedal force is required for directional control
3. Flaps must be extended beyond 3º and airspeed must be below 180 kt
4. The No. 1 integrated computer has detected a fault and the related manual trim switches directly control the trim actuator
5. When the trim selector switch is in the PRI position and the autopilot is not engaged
6. Reduces control force if the pitch trim fails

Chapter 10 Flight Instruments

1. Both attitude heading reference units are powered by the main batteries
2. That the AHRS No. 2 has switched into the free heading mode with the AHRS reversion switch in the 2 position
3. The preselected speed
4. Stick shaker activation
5. An overspeed condition
6. When incorrect pitch or roll data is being received
7. When the pilot and copilot are using the same integrated computer/symbol generator
8. When the aircraft is at or below the selected Minimums Alerter altitude
9. 13,850 ft
10. Using the set button located on the PFD bezel controller or pushing the STD knob located on the PFD bezel controller
11. The EICAS and MFD pages move to the opposite display
12. Display the PFD on the DU No. 2

Chapter 11 Fuel System

1. Learjet 45/45XR6062 lb (2746 kg)
   Learjet 40/45XR5375 lb (2438 kg)
2. Gravity
3. The venturi principle
4. The engine-driven motive flow pumps
5. They are electric pumps
6. A white FUEL XFLO OPEN CAS message is displayed and the white bar on the crossflow switch is illuminated

Chapter 12 Hydraulics

1. 3000 psi
2. Whenever the respective engine is running
3. No
4. By verifying the status of the reservoir LED indicators on the ground service panel
5. Landing gear and inboard gear doors, flaps, spoilers, wheel brakes, and thrust reversers
6. Landing gear and inboard gear doors, flaps, and wheel brakes
7. The left engine-driven pump output pressure is low
8. Brake accumulator pressure information is displayed, on the EICAS/MFD
9. Approximately six applications of the emergency brakes
10. The brake accumulator can only be charged by the auxiliary hydraulic system
11. Amber MAIN HYD PRESS
12. The crossflow valve automatically closes (deactivate), an amber LOW annunciation is displayed within the auxiliary tank symbol on the EICAS/MFD hydraulics system page display, and the auxiliary hydraulic pressure is not available to operate the landing gear and flaps
13. If fully charged, the brake accumulator will provide hydraulic power for emergency braking

Chapter 13 Ice and Rain Protection

1. TAT heat
2. The left windshield is no longer de-iced
3. The wing and the stabilizer does not work
4. Illumination of the red WING OVHT annunciator in the crew warning panel, illumination of the red STAB OVHT annunciator in the crew warning panel, and a white WG/STAB HT OK CAS message at the end of the test
5. The wing/stab anti-ice leak detection is included in the fire detection test
6. Icing is detected and WING/STAB or L or R NAC anti-ice is not turned on

Chapter 14 Landing Gear and Brakes

1. EMER BATT Bus
2. The left main gear position does not agree with the position of the landing gear control switch or the left main gear inboard door is not up and locked
3. One or more landing gear is in transition, or either main landing gear inboard door is not up and locked, and airspeed is 210 KIAS or above; or one or more landing gear is not down and locked, both thrust levers are less than MCR, airspeed is below 170 KIAS, altitude is below 14,500 feet, and the radar altimeter is invalid
4. Can be silenced by depressing either master caution light or the Mute switch on the right thrust lever handle
5. Cannot be silenced
6. 60
7. The nosewheel steering system is operating in a degraded mode
8. The nosewheel selector switch is dark
9. Pulling out the EMERGENCY/PARKING BRAKE HANDLE with a force proportional to amount of braking desired
10. A fully charged accumulator can provide 6 emergency brake applications
11. Approximately 48 hours
12. The auxiliary system provides hydraulic power to the wheel brakes
13. Indicates a takeoff configuration warning and is accompanied by the “Configuration” aural warning
14. 165 kt ground speed
15. 200 KIAS

Chapter 15 Lighting

1. Passenger oxygen mask deployment or dual generator failure
2. Baggage compartment, tailcone maintenance, cabin entry lights, cockpit overhead and pylon lights
3. The black spot on the right wing to enhance visual detection of ice
4. Cockpit lighting is not affected by a single generator failure
5. The left audio panel, left RMU, standby instruments and standby compass, and landing gear indicator lights

Chapter 17 Navigation

1. TA/RA for TCAS II system
2. Guidance to avoid RA traffic
3. All intruder aircraft (TA, RA, PT, OT) are displayed on the MFD only, and RA guidance is displayed on the VSI portion of the PFD
4. It is a feature to predict potential conflicts between aircraft flightpath and the terrain and cannot be used for navigation
5. Selecting the line select key for TCAS DSPY on the RMU
6. 2700 ft above and 2700 ft below
7. Display controller
8. Display controller
9. That an RA has been encountered, but no bearing to that RA is available for display
10. It is used to inhibit the “Too Low Flaps” aural warning
11. Wet hail, rain, and ice crystals
12. To verify position, ground speed, altitude, as well as weather avoidance
13. It is an automatic nonselectable mode that inhibits both the antenna scan and the transmitter while the aircraft is on the ground
14. Magenta
15. To provide a cyan field at the outer perimeter of the display indicating the areas in which rainfall rate is unknown but which could contain dangerous cells
16. Using a blended position of GPS, DME, and other aircraft sensor inputs (TAS, barometric altitude, and heading from the AHRS)
17. The GPS integrity is outside the allowable limits for phase of flight
18. .3 nm

Chapter 18 Pneumatics

1. L or R bleed-air switch indicators
2. HI FLOW should not be used when takeoff power is selected, during landing, above 30,000 ft or while using anti-ice equipment
3. The bleed air supplied by a single engine is capable to provide all normal bleed-air needs during flight that is not in icing conditions
4. The high-pressure shutoff valves are energized to the open position
5. The valves fail as follows:
   A. ECS pressure regulating and shutoff valves—OPEN
   B. High-pressure shutoff valves—CLOSE
   C. Emergency pressurization valves—CLOSE
6. With the FIRE DET position on the system test switch

Chapter 19 Power Plant

1. The left DEEC has reverted itself to manual mode
2. N_1
3. 75.0
4. APR system is armed
5. Maximum cruise N_1 value
6. The left starter is still energized above 51% N_2
7. Cycle the APR ARM switch to the OFF position
8. The right thrust reverser is unlocked on the ground
9. Right thrust reverser is armed in flight or on the ground; right TLA greater than MCR
10. Right thrust reverser is armed with the aircraft on the ground

Chapter 20 Warnings—Aural and Visual

1. DU 2 and DU 3
2. Data acquisition units (DAUs)
3. Requires subsequent crew action
4. At 40 KIAS
5. DAU 1 Channel A and DAU 2 Channel B data
6. SUMRY or FLT
7. By order of color (red, amber, white) and then in order of occurence
8. Red messages
9. Flashing master CAUT lights and a single chime
10. Until either master CAUT light is pressed
11. Until either Master WARN/CAUT light switch is pressed
12. Repetitive "Configuration" aural warning sounds, applicable red CAS messages appear, and applicable EICAS parameters appear boxed in red