Bombardier

# CHALLENGER 350



## AIRCRAFT SYSTEMS

TRAINING MANUAL

CL-350




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# FOREWORD

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# LIST OF EFFECTIVE PAGES

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**NOTE**

For printing purposes only, any revised pages will be noted at the footer with the current revision number.

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# TRAINING OBJECTIVES

The ground and flight training programs prepare the candidate for the FAA type rating emphasizing aircraft systems knowledge, crew coordination, operational utility, and overall flight safety. The candidate will be held to ATP type rating standards. Please review the full Airman Certification Standards (ACS) at: https://www.faa.gov/training_testing/testing/acs/media/atp_acs.pdf

An abbreviated PTS list is described below:

| Task | Airspeed | Heading/Course/Glidepath | Altitude |
|---|---|---|---|
| Takeoffs | +/- 5 kts | +/- 5° | |
| Arrival Procedures | +/- 10 kts | +/- 10° | +/- 100 ft. |
| Approaches Prior to FAF | +/- 10 kts | +/- 5° | +/- 100 ft. |
| Final Approach Segment | +/- 5 kts | CDI deflection: < ¼ scale deflection (either < vertical or lateral for Precision Approach) | MDA +50/-0 feet for Non-precision Approach) |
| Circling Approach | +/- 5 kts | +/- 5° | +100/-0 feet until descending below the MDA. |
| Go-Around/Missed Approach | +/- 5 kts | +/- 5° | +/- 100 feet during the procedure |
| Landing | +/- 5 kts | Touchdown with the runway centerline between the main landing gear at the runway aiming point markings -250/+500 feet | |
| Inflight Maneuvers | +/- 10 kts | +/- 10° / Bank: +/- 5° | +/- 100 ft. |

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# CHALLENGER 350 LIMITATIONS AND IMMEDIATE ACTION ITEMS

| SPEED LIMITATIONS | |
|---|---|
| MMO Above 29,475 ft | 0.83 Mach |
| VMO 8,001' – 29,475 ft | 320 KIAS |
| VMO below 8,000 ft | 300 KIAS |
| VRA (Rough Air) | 265 KIAS / 0.75 Mach |
| FLAPS | |
| Flaps Takeoff and Approach (10°) | 210 KIAS |
| Flaps Land (20°) | 210 KIAS |
| Flaps Full (30°) | 175 KIAS |
| LANDING GEAR | |
| Landing Gear Retracting (VLO) | 200 KIAS |
| Landing Gear Extending (VLO) | 250 KIAS |
| Landing Gear Extended (VLE) | 250 KIAS |
| Max Tire Ground Speed | 182 KTS |
| Min Operating Speed – Stick shaker onset prohibited | |

| WEIGHT LIMITATIONS | |
|---|---|
| Max Ramp | 40,750 lbs |
| Max Takeoff | 40,600 lbs |
| Max Landing | 34,150 lbs |
| Max Zero Fuel | 28,200 lbs |
| Min Flight Weight | 24,800 lbs |
| Steep Approach Max Landing | 31,600 lbs |

| ENVIRONMENTAL | |
|---|---|
| Maximum Operating Altitude | 45,000 ft |
| Max T/O & Land | 10,000 ft |
| Maximum Tailwind Component | 10 Knots |
| Minimum Ambient Temperature | -54°C |
| RUNWAY SLOPES | |
| Uphill | +2% |
| Downhill | -2% |

| ELECTRICS | |
|---|---|
| GENERATOR LOAD | |
| Two/Three generators | 400 amps continuous |
| One generator (ground) | 400 amps continuous |
| One generator (flight) | 500 amps continuous |
| Transient (5 minutes) | 600 amps |
| BATTERY | |
| Battery Temperature | Prohibited T/O <-20°C |

| ENGINE LIMITATIONS | | |
|---|---|---|
| PARAMETER | LIMIT | NOTES |
| Engine Type | | AS907-2-1A turbofan (HTF7350) |
| N1 LIMITS | | |
| Max N1 (TO/APR) | 96.8% | — |
| Max N1 (CLB) | 96.5% | — |
| Max N1 (REV) | 70.7% | — |
| ITT LIMITS | | |
| Max ITT (TO) | 955°C | — |
| Max ITT (MAX CONT) | 950°C | — |
| Max ITT START (GROUND) | 650°C | — |
| Max ITT START (AIR) | 800°C | — |
| OIL LIMITS | | |
| Oil Temp | -40°C min | — |
| Oil Press | 28 psi min | — |
| Oil conforming to | | Honeywell EMS 53110, Type II |
| POWER LIMITATIONS | | |
| Takeoff Power | Limited to 5 minutes | 5 MIN |
| APR Power (OEI) | Limited to 10 minutes | 10 MIN |
| Reverse Thrust Above Idle | Prohibited below 40 KIAS | — |

| FUEL LIMITATIONS | |
|---|---|
| MAX FUEL IMBALANCE | |
| >13,700 lbs total fuel | 250 lbs max |
| 13,700-10,000 lbs total | 315 lbs max |
| 10,000-4,700 lbs total | 450 lbs max |
| <4,700 lbs total fuel | 600 lbs max |
| FUEL CAPACITY | |
| Min Fuel for Go-Around | 500 lbs per side |
| Max Usable (pressure) | 14,150 lbs |
| Max Usable (gravity) | 13,000 lbs |
| TEMPERATURE & SPECIAL FUELS | |
| Min/Max Temp (JET fuel) | -37°C to +50°C |
| Russian/Ukrainian fuels (>30°C) | 37,000 ft max |
| JP-4/JET B fuels | 16,000 ft max |

## VNAV LIMITATIONS

VNAV PROHIBITED when:

- Barometric altitude corrected to QFE
- VFLC during climb in Mach reference
- MCRZ selection from VNAV CRUISE
- Following go-around during missed approach

| APU LIMITATIONS | |
|---|---|
| APU Type | Honeywell 36-150BD |
| Max Operating Altitude | 37,000 ft |
| APU Generator | 30,000 ft max |
| Bleed for Engine Start | 20,000 ft max |
| Bleed for ECS | 20,000 ft max |
| Max Start Altitude | 30,000 ft |
| Max Start Alt (ground) | 14,000 ft |
| Max RPM | 108% |
| Max EGT (start) | 973°C |
| Max EGT (normal) | 718°C |
| Max speed for start | 285 KIAS |
| MAX GEN LOAD | |
| Ground | 400 amps |
| < 30,000 ft | 400 amps |
| > 30,000 ft | Not authorized |
| Do not operate APU: During de-icing/anti-icing | |

| FLIGHT CONTROLS | |
|---|---|
| Flaps | Prohibited above 18,000 ft |
| Landing Gear | Prohibited above 18,000 ft |
| Flight Spoilers | Prohibited below 500 ft AGL |
| Exception | (except steep approach) |
| Flight Spoilers | Prohibited below Vapp + 8 KIAS |
| Spoilers to EMER | Emergency conditions only or by procedure |

| AUTOPILOT/AUTOFLIGHT | |
|---|---|
| Min Engage Height | 700 ft AGL |
| MIN USE HEIGHT | |
| Precision ≤3.5° | 80 ft AGL |
| Precision 3.5-4.5° | 160 ft AGL |
| Visual/Non-precision | 200 ft AGL |
| Max Alt w/Yaw Damper OFF | 31,000 ft |

| ANTI-ICE GROUND OPERATION | |
|---|---|
| Pitot/Static | 2 minutes max |
| ENGINE ANTI-ICE REQUIRED | |
| ≤10°C with visible moisture | Required |
| ≤10°C on contaminated ramps/taxiways/runways | Required |
| WING ANTI-ICE REQUIRED | |
| ≤5°C with visible moisture | Required |
| ≤5°C on contaminated ramps/taxiways/runways | Required |

| ANTI-ICE IN-FLIGHT OPERATION | |
|---|---|
| ENGINE ANTI-ICE REQUIRED | |
| 10°C to -40°C with visible moisture | Required |
| WING ANTI-ICE REQUIRED | |
| 10°C to -40°C w/visible moisture below 210KIAS | Required |
| Wing & Engine Anti-Ice must be ON anytime ICE DETECTED CAS message is displayed | |

| PRESSURIZATION | |
|---|---|
| MAX DIFFERENTIAL PRESSURE | |
| Ground (taxi) | 0.1 psi |
| Landing | 1.0 psi |
| A/C 20501-20886 | +9.4/-0.5 psi |
| A/C 20887-22999 | +10.1/-0.5 psi |

| STEEP APPROACH | |
|---|---|
| Glidepath Angles | 4.5° to 5.5° only |
| Configuration | Flaps 30, Gear Down, Spoilers Max |
| Landing Decision Point | 200 ft AGL |
| Autopilot | Prohibited |
| Autothrottle | Prohibited below 200 ft |
| Crosswind | 20 kts max |
| Tailwind | 0 kts (prohibited) |

## ENGINE OPERATING LIMITS

| Limit | Ground Start | Air Start 7 | Idle | Max Reverse | Maximum Continuous (CLB) 1 | Normal Takeoff (TO) 2 | APR (Max Power) 3 |
|---|---|---|---|---|---|---|---|
| $N_1$ | — | — | — | 70.7% 4 | 96.5% | 96.8% | 96.8% |
| $N_2$ | — | — | 46.0% min. | — | 98.0% | 98.0% | 98.6% |
| ITT | 650°C | 800°C 5 | — | 955°C | 950°C | 955°C | 955°C |
| Oil Temp | -40°C min. | — | 9 | — | 138°C max. | 138°C max. 27°C max. 6 | 138°C max. |
| Oil Press | — | — | 28 psi min. | 8 | 8 | 8 | 8 |

1. Climb (CLB) equals maximum continuous thrust (MCT).
2. Normal Takeoff power is limited to 5 minutes.
3. APR power (one engine inoperative) is limited to 10 minutes.
4. Maximum reverse thrust is automatically reduced (ramped) commencing at 85 KIAS.
5. Maximum ITT limit varies with $N_2$ speed (400 °C when $N_2$ <18% and ITT at start initiation <250 °C).
6. Minimum oil temperature must be achieved before commencing takeoff. Below –30 °C (–22 °F) the minimum oil temperature limit is 15 °C provided a fuel system icing inhibitor is used and the Cold Weather Operations procedures in FCOM, Vol. 1 are followed.
7. The in flight re–start envelope is defined in figure in chapter 05–32 of this manual.
8. Minimum oil pressure varies with engine speed. Maximum allowable oil pressure increases with engine speed and with low oil temperature.
9. A minimum oil temperature of 5 °C is required to operate engines above ground idle power. Between 5 and 14 °C, the engines may be operated from idle up to but not including CLB power.

# Quick Reference Card
## Challenger 350/3500

-RETURN QRC AFTER USE-

## ① APU

### APU FIRE

1. APU FIRE ..... FIRE push
2. FIRE EXT 2 ..... ARMED push

**Proceed to APU 01-1**

### APU OVERTEMP

1. APU ..... OFF

**Proceed to APU 01-2**

## ② AVIONICS

### AP STAB TRIM FAIL

1. Airspeed ..... STABILIZE
   and return to speed when AP STAB TRIM FAIL posted or when AP HOLDING message goes out.

**Proceed to AVNC 02-1**

### PULL UP (TAWS Aurals)

1. Autopilot ..... Disconnect
2. Autothrottle (if installed) ..... Disengage
3. Thrust levers ..... APR
4. FLIGHT SPOILERS ..... RETRACT
5. Climb at maximum practical rate.
6. LANDING GEAR ..... UP

**Proceed to AVNC 02-64**

### WINDSHEAR (TAWS Aurals)

1. Autopilot ..... Disconnect
2. Autothrottle (if installed) ..... Disengage
3. Thrust levers ..... APR
4. FLIGHT SPOILERS ..... RETRACT
5. **Rotate smoothly to the takeoff/go around pitch attitude**, allowing airspeed to decrease if necessary. Maintain wings level. Do not retract flaps or landing gear.

**Proceed to AVNC 02-65**

### Unreliable airspeed

⚠ **CAUTION:** Respect stall warning / stick shaker and stick pusher.

1. Autothrottle (if installed) ..... Disengage
2. Autopilot ..... Disconnect
3. FDs ..... Deselect
4. Airplane Altitude ..... Maintain a safe altitude

**If Climb or Go-Around is required:**

5. Pitch / N1 ..... 15 degrees / TO from SL to 15,000 ft
   10 degrees / CLB Above 15,000 ft
6. Airplane Configuration ..... Flaps 10 / Gear Up For Go-Around
   Flaps 0 / Gear Up Once climbing

**Proceed to AVNC 02-23**

## ② AVIONICS (Con't)

### ROAAS In–Air Warning

1. Go-around ..... INITIATE

**Proceed to AVNC 02-21**

### ROAAS On–Ground Warning

1. Brakes ..... APPLY maximum braking
2. Thrust reversers ..... APPLY maximum reverse thrust to a stop

**Proceed to AVNC 02-22**

## ④ ELECTRICAL

### L (R) BATT OVERHEAT

1. Affected BATT ..... OFF

**Proceed to ELEC 04-1**

## ⑤ ENGINE

### Dual Engine Flameout

1. Crew oxygen masks (if above 14,000 feet) ..... DON
2. Pilot and Copilot O2 MASK / NORM ..... O2 MASK
3. Airspeed ..... Establish 185 KIAS

**Proceed to ENG 05-15**

### L (R) ENGINE EXCEEDANCE

1. Autothrottle (if installed) ..... Disengage

**Affected Engine:**

2. Thrust lever ..... Retard

**Proceed to ENG 05-2**

### L (R) ENGINE FIRE (Below $V_1$)

3. Autothrottle (if installed) ..... Disengage
4. Thrust levers ..... IDLE
5. Brakes ..... Maximum or as required
6. Thrust reversers ..... MAX REV or as required

**After Stopping:**

7. PARK/EMER BRAKE ..... SET
8. Affected ENG FIRE ..... FIRE push
9. FIRE EXT 1 and 2 ..... ARMED push
10. EMER DEPRESS ..... ON
11. Non-affected ENG and APU FIRE ..... Push
12. Evacuation ..... Command
13. Controlling agency ..... Notify
14. STBY INST ..... OFF
15. L and R BATT ..... OFF

**Proceed to ENG 05-3**

### L (R) ENGINE FIRE (Above $V_1$)

18. Rotate at $V_R$
19. Pitch attitude ..... Adjust as required to achieve $V_2$
20. LANDING GEAR ..... UP after positive rate of climb
21. Autothrottle (if installed) ..... Disengage
22. Affected engine thrust lever ..... IDLE unless a critical thrust situation exists
23. Affected ENG FIRE ..... FIRE push

**After 10 seconds if L (R) ENGINE FIRE CAS persists or there are other indications of fire:**

24. FIRE EXT 1 ..... ARMED push

**After 30 seconds if L (R) ENGINE FIRE CAS persists or there are other indications of fire:**

25. FIRE EXT 2 ..... ARMED push

**Proceed to ENG 05-4**

## ⑤ ENGINE (Con't)

### L (R) ENGINE FIRE (In Flight)

38. Autothrottle (if installed) ..... Disengage

**Affected Engine:**

39. Thrust lever ..... IDLE unless a critical thrust situation exists
40. Affected ENG FIRE ..... FIRE PUSH

**After 10 seconds if L (R) ENGINE FIRE CAS persists or there are other indications of fire:**

41. FIRE EXT 1 ..... ARMED push

**After 30 seconds if L (R) ENGINE FIRE CAS persists or there are other indications of fire:**

42. FIRE EXT 2 ..... ARMED push

**Proceed to ENG 05-5**

### L (R) REVERSER UNSAFE (Below $V_1$)

3. Autothrottle (if installed) ..... Disengage
4. Thrust levers ..... IDLE
5. Brakes ..... MAXIMUM or as required
6. Thrust reversers ..... MAX REV or as required

**End of procedure.**

### L (R) REVERSER UNSAFE (above $V_1$)

8. Rotate at $V_R$
9. Pitch attitude ..... Adjust as required to achieve $V_2$
10. LANDING GEAR ..... UP after positive rate of climb
11. Autothrottle (if installed) ..... Disengage
12. Affected engine thrust lever ..... IDLE

**Proceed to ENG 05-5**

### Engine Failure (below $V_1$)

3. Autothrottle (if installed) ..... Disengage
4. Thrust levers ..... IDLE
5. Brakes ..... Maximum or as required
6. Thrust reversers ..... MAX REV or as required

**End of procedure.**

### Engine Failure (above $V_1$)

8. Rotate at $V_R$
9. Pitch attitude ..... Adjust as required to achieve $V_2$
10. LANDING GEAR ..... UP after positive rate of climb

**Proceed to ENG 05-22**

## ⑥ ENVIRONMENTAL / BLEED AIR

### CABIN ALTITUDE

1. Crew Oxygen Masks ..... DON
2. Pilot and Copilot O2 MASK / NORM ..... O2 MASK
3. Autothrottle (if installed) ..... Disengage
4. Thrust levers ..... IDLE
5. Autopilot ..... Disconnect
6. FLIGHT SPOILERS ..... EMER
7. Descend at $M_{MO}$ / $V_{MO}$, not below min safe altitude

**Proceed to ENVR 06-1**

### L (R) BLEED LEAK

1. XBLEED ..... CLOSED
2. Indicated BLEED ..... OFF

**R BLEED LEAK is on:**

3. L BLEED ..... ON
4. APU BLEED ..... OFF

**End of procedure.**

## ⑥ ENVIRONMENTAL / BLEED AIR (Con't)

### L (R) PYLON BLEED LEAK

1. Autothrottle (if installed) ..... Disengage

**Affected Engine:**

2. Thrust lever ..... IDLE

**Proceed to ENVR 06-4**

### PACK LEAK

1. AIR SOURCE ..... TRIM AIR ONLY

**Proceed to ENVR 06-5**

### TRIM AIR LEAK

1. AIR SOURCE ..... PACK ONLY

**Proceed to ENVR 06-5**

## ⑦ FLIGHT CONTROLS

### Overspeed

1. Autothrottle (if installed) ..... Disengage
2. Thrust levers ..... IDLE
3. Autopilot ..... Disconnect
4. FLIGHT SPOILERS ..... EMER
5. Level wings, then pitch up.

**Proceed to FCTL 07-20**

### Pitch Axis Uncommanded Motion/Trim Clacker Tone

1. Master disconnect (MSW) ..... PRESS AND HOLD

**Proceed to FCTL 07-21**

### Pitch Axis Uncommanded Motion/Trim Clacker Tone (EASA airplanes only)

1. Master disconnect (MSW) ..... PRESS AND HOLD
2. STALL PUSHER ..... OFF

**Proceed to FCTL 07-22**

### Pitch Control Jam

1. PITCH DISC ..... PULL and TURN
2. Determine and transfer control to pilot without jam.

**Proceed to FCTL 07-23**

### Roll Control Jam

1. ROLL DISC ..... PULL TO ACTUATE
2. Determine and transfer control to pilot without jam.

**Proceed to FCTL 07-25**

### Roll or Yaw Axis Uncommanded Motion

1. Master disconnect (MSW) ..... PRESS AND HOLD

**Proceed to FCTL 07-27**

## ⑧ FORCED LDG / EVACUATION

### Emergency Evacuation

1. PARK / EMER BRAKE ..... SET
2. EMER DEPRESS ..... ON
3. L and R ENG, and APU FIRE ..... PUSH
4. Evacuation ..... COMMAND
5. Controlling agency ..... NOTIFY
6. STBY INST ..... OFF
7. L and R BATT ..... OFF

**Proceed to F-LDG 08-2**

## ⑩ GEAR / BRAKES

### GEAR BAY OVHT

1. AIRSPEED ..... MAX 250 KIAS
2. LANDING GEAR ..... DN

**Proceed to GEAR 10-1**

### NORM BRAKES FAIL

1. Normal actual landing distance ..... Multiply by:
   1.65 without TR **or** 1.50 with TR

**After landing:**

2. FLIGHT SPOILERS ..... EMER
3. PARK / EMER BRAKE ..... PULL SMOOTHLY

**End of procedure.**

## ⑫ ICE PROTECTION

### WING ANTI-ICE LEAK

1. WING ANTI-ICE ..... OFF

**Proceed to ICE 12-1**

### L (R) WING OVERHEAT

1. WING ANTI-ICE ..... OFF

**Proceed to ICE 12-2**

## ⑬ OTHER

### Rejected Takeoff

1. Autothrottle (if installed) ..... Disengage
2. Thrust levers ..... IDLE
3. Brakes ..... MAXIMUM or as required
4. Thrust reversers ..... MAX REV or as required

**End of procedure.**

### STALL on PFD

1. Autopilot ..... Disconnect
2. Lower the pitch attitude to reduce angle-of-attack.
3. Autothrottle (if installed) ..... Disengage
4. Thrust levers ..... APR
5. FLIGHT SPOILERS ..... RETRACT
6. Level the wings.

**Proceed to OTHER 13-4**

## ⑭ SMOKE / FIRE

### Cabin / Cockpit Fire, Smoke or Fumes

1. Crew oxygen masks ..... DON, SELECT EMERGENCY
2. Smoke goggles ..... DON
3. Pilot and copilot O2 MASK / NORM ..... O2 MASK

**Proceed to SMK 14-1**

5

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# DEFINITIONS, ABBREVIATIONS AND ACRONYMS

The following definitions, abbreviations and acronyms may be used in cockpit displays, the flight management system or in other descriptions throughout this manual. Abbreviations may be further explained in the chapters where they are used.

## Symbols

**%** - Percent

**&** - And

**°C** - Degrees Centigrade/Celsius

**°F** - Degrees Fahrenheit

## A

**A/C** - Air Conditioning, Aircraft

**A/I** - Anti-Ice

**A/ICE** - Anti-Ice

**A/P** - Autopilot

**A/S** - Air Speed

**A/SKID** - Anti-skid

**AC** - Alternating Current

**ACARS** - Aircraft Communication Addressing and Reporting System / Aircraft Communications Addressing and Reporting System

**ACM** - Air Cycle Machine

**ACP** - Audio Control Panel

**ACPC** - Alternating Current Power Center

**ACU** - Air Conditioning Unit

**ACV** - Air Control Valve

**ADC** - Air Data Computer

**ADDR** - Address

**ADF** - Automatic Direction Finder

**ADI** - Attitude Director Indicator

**ADS** - (1) Air Data System (2) Automatic Dependent Surveillance

**ADS-B** - Automatic Dependent Surveillance–Broadcast

**ADS-C** - Automatic Dependent Surveillance–Contract

**AFCS** - Automatic Flight Control System

**AFD** - Adaptive Flight Display

**AFM** - Airplane Flight Manual

**AFN** - ATS Facilities Notification

**AGL** - Above Ground Level

**AHC** - Attitude Heading Computer

**AHRS** - Attitude Heading Reference System

**AIL** - Aileron

**AIRMET** - Airman's Meteorological Information

**ALD** - Actual Landing Distance

**ALIGN** - Aligning, Alignment

**ALT** - Altitude, Altimeter

**ALT CAP** - Altitude Capture (PDF/FD)

**ALT HOLD** - Altitude Hold (PDF/FD)

**ALTN** - Alternate

**AMPS** - Amperes

**ANNUN** - Annunciation

**ANT** - Antenna

**AOA** - Angle of Attack

**AOC** - Airline Operational Communications

**AP** - Autopilot

**APM** - Aircraft Personality Module

**APPR** - Approach Mode

**APPR, APCH** - Approach

**APR** - Automatic Power Reserve

**APU** - Auxiliary Power Unit

**ARF** - Above Runway Field

**ASCB** - Avionics Standard Communications Bus / Avionics Standard Communication Bus

**ASEL** - Altitude Preselect Mode

**ASYM** - Asymmetrical

**AT** - Autothrottle

**ATC** - Air Traffic Control

**ATN** - Aeronautical Telecommunications Network

**ATS** - Air Turbine Start, Air Traffic Services

**ATT** - Attitude

**AUTH** - Authority

**AUTO** - Automatic

**AUX** - Auxiliary

**AV** - Avionics

**AVAIL** – Available

## B

**B/C** - Back Course

**B/CRS** - Back Course

**BARO** - Barometric

**BAT** - Battery

**BATT** - Battery

**BC** - Back Course

**BCN** - Beacon

**BCU** - Brake Control Unit

**BIT** - Built-in-Test

**BITE** - Built-in-test equipment

**BLTS** - Belts

**BNK** - Bank

**BOOM** - Headset Microphone

**BRK** - Brake

**BRKR(S)** - Breaker(s)

**BRT** - Bright

**BTL** - Bottle

**BTMS** - Brake Temperature Monitoring System

## C

**C** - Center, Caution, Cabin

**CAA** - Civil Aviation Authority (UK)

**CAB** - Cabin

**CAI** - Cowl Anti-Ice

**CAIV** - Cowl Anti-ice Valve

**CAL** - Calibrate

**CAP** - Capture

**CAS** - (1) Calibrated Airspeed (2) Crew Alerting System (3) Computed Airspeed

**CAT** - Category

**CAT 2** - Category 2

**CB** - Circuit Breaker

**CBP** - Circuit Breaker Panel

**CBV** - Cross Bleed Valve

**CBW** - Cross–Bleed Wing

**CCBP** - Cockpit Circuit Breaker Panel

**CCP** - Cursor Control Panel

**CDI** - Course Deviation Indicator

**CDL** - Configuration Deviation List

**CDU** - Control Display Unit

**CG** - Centre of Gravity

**CH** - Chapter, Channel

**CHGR** - Charger

**CIS** - Commonwealth of Independent States

**CKPT** - Cockpit

**CKT** - Circuit

**CLB** - Climb

**CLK** - Clock

**CLSD** - Closed

**cm** - Centimeter(s)

**CMD** - Command

**CMPS** - Compass

**CMPTR** - Computer

**CMU** - Communications Management Unit

**CO2** - Carbon Dioxide

**COM** - Communication (Radio)

**COMM** - Communication

**COMP** - Compressor, Comparator

**COMPUTR** - Computer

**COND** - Condition, Continued

**CONFIG** - Configuration

**CONN** - Connection

**CONT** - Control, Continuous, Contactor, Controller

**CONT'D** - Continued

**COOL** - Cooling, cooler

**CPCP** - Cabin Pressure Control Panel

**CPCS** - Cabin Pressure Control System

**CPDLC** - Controller Pilot Data Link Communications / Controller–Pilot Data Link Communications

**CPLT** - Copilot

**CRM** - Crew Resource Management

**CRS** - Course

**CRZ** - Cruise

**CSU** - Configuration Strapping Unit

**CTA** - Centro Tecnico Aeroespacial (Brazil)

**CTP** - Control Tuning Panel

**CTR** - Center

**CTRL** - Control

**CVR** - Cockpit Voice Recorder

## D

**DA** - Drift Angle, or Decision Altitude

**DB** - Database

**dB** - decibel

**DBU** - Data Base Unit

**DC** - Direct Current

**DCMP** - DC Motor Pump

**DCP** - Display Control Panel

**DCPC** - Direct Current Power Center

**DCU** - Data Concentration Unit / Data Concentrator Unit

**DECEL** - Decelerate

**DECR** - Decrease

**DEFL** - Defuel

**DEG** - Degree

**DEGRAD** - Degraded / Degrade

**Delta P** - Differential Pressure

**DEPR** - Depressurize

**DEPRESS** - Depressurization

**DEPT** - Depart

**DEST** - Destination

**DET** - Detection, Detector

**DEV** - Deviation

**DFDR** - Digital Flight Data Recorder

**DG** - Directional Gyro

**DH** - Decision Height

**DIFF** - Differential

**DIM** - Dimming

**DIR** - Direct

**DIS** - Distance (to waypoint), Disconnect

**DISC** - Disconnect

**DISCH** - Discharge

**DISP** - Dispatch, Display

**DIST** - Distance

**DL** - (1) Data Link (2) Downlink

**DLCA** - Data Link Communication Application

**DMC** - DCU Module Cabinet

**DME** - Distance Measuring Equipment

**DN** - Down

**DOT** - Department of Transport (Canada) / Department of Transport

**DR** - (1) Dead Reckoning (2) Door

**DSK** - Data Select Knob

**DSM** - Digital Switching Module

**DSP** - Datalink Service Provider

**DSPL** - Display

**DSPY** - Display

**DU** - Display Unit

## E

**EASA** - European Aviation Safety Agency

**EAS** - Equivalent Airspeed

**ECH** - Electronic Charts

**ECS** - Environmental Control System

**ECU** - (1) Environmental Control Unit (2) Electronic Control Unit (3) External Compensation Unit

**ED** - Electronic Display

**EDP** - Engine Driven Pump/Engine Primary Hydraulic Pump / Engine Driven Pump, Engine Driven Pump/Engine Primary Hydraulic Pump

**EEC** - Electronic Engine Controller

**EFIS** - Electronic Flight Instrument System

**EFVS** - Enhanced Flight Vision System

**EGPWS** - Enhanced Ground Proximity Warning System (including windshear)

**EGNOS** - European Geostationary Navigation Overlay Service

**EGT** - Exhaust Gas Temperature

**EI** - Engine Instrument

**EICAS** - Engine Indication and Crew Alerting System

**EIS** - Engine Indicating System

**EL** - Elevation

**ELEC** - Electrical

**ELEV** - Elevator, Elevation / Elevator or Elevation

**ELT** - Emergency Locator Transmitter

**EMER** - Emergency

**EMER(G)** - Emergency

**EMS** - Electrical Management System

**ENG** - Engine

**ENGAGE** - Engagement

**EPC** - External Power Contractor

**EPR** - Engine Pressure Ratio

**EPU** - Estimated Position Uncertainty

**EQUIP** - Equipment

**ERP** - Eye Reference Position (datum)

**ESS** - Essential

**ET** - Elapsed Time

**ETA** - Estimated Time of Arrival

**ETP** - Equal Time Point

**EVAC** - Evacuation

**EVMS** - Engine Vibration Monitor System

**EVMU** - Engine Vibration Monitor Unit

**EVS** - Enhanced Vision System

**EXH** - Exhaust

**EXT** - External

**EXT PWR** - External Power

**EXTIN** - Extinguish(ed)

## F

**F/CTL** - Flight Controls / Flight Control

**F/D** - Flight Director

**FAA** - Federal Aviation Administration (USA)

**FADEC** - Full Authority Digital Engine Control

**FAF** - Final Approach Fix

**FAIL** - Failure

**FANS** - Future Air Navigation System

**FAP** - Final Approach Point

**FCC** - Flight Control Computer

**FCOM** - Flight Crew Operating Manual

**FCU** - Flight Control Unit

**FD** - Flight Director

**FDR** - Flight Data Recorder

**FDU** - Flux Detector Unit

**FECU** - Flap Electronic Control Unit

**FEED** - Feeder

**FF** - Fuel Flow

**F/F** - Fuel Flow

**FGC** - Flight Guidance Computer

**FGP** - Flight Guidance Panel

**FIDEEX** - Fire Detection and Extinguishing System

**FIRE BTL** - Fire Bottle

**FIREX** - Fire Extinguisher

**FL** - Flight Level

**FLC** - Flight Level Change (airspeed hold mode)

**FLD** - Field

**FLT** - Flight

**FLT DIR** - Flight Director

**FLUOR** - Fluorescent

**FMC** - Flight Management Computer

**FMS** - Flight Management System

**FOD** - Foreign Object Damage

**FOLD** - Factored Operational Landing Distance

**FPA** - Flight Path Angle

**FPG** - Flight Guidance Panel

**FPM** - Feet Per Minute

**FPU** - Flap Power Unit

**FPV** - Flight Path Vector

**FQGC** - Fuel Quantity Gauging Computer

**FQGS** - Fuel Quantity Gauging System

**FREQ** - Frequency

**FRMT** - Format

**FRTT** - Fuel Return To Tank

**FSA** - File Server Application

**FSU** - File Server Unit

**FT** - Feet, Foot

**FUSE** - Fuselage

**FW** - Fire Wall

**FWC** - Fault Warning Computer

**FWD** – Forward

## G

**G -** Receiver Gain

**GA** - Go–Around

**GAL** - Gallon

**GALY** - Galley

**GBAS** - Ground Based Augmentation System

**GCU** - Generator Control Unit

**GCS** - Ground Clutter Suppression

**GEN** - Generator

**GLC** - Generator Line Contactor

**GLD** - Ground Lift Dump / Ground Lift Dumping

**GMT** - Greenwich Mean Time

**GND** - Ground

**GNSS** - Global Navigation Satellite System

**GP** - Guidance Panel

**GPM** - Gallons Per Minute

**GPS** - Global Positioning System

**GPWS** - Ground Proximity Warning System

**GR** - Gear

**GEAR** - Landing Gear

**GRAV** - Gravity

**GRF** - Global Reporting Format

**GS** - Ground Speed

**GTC** - Generator Transfer Contactor

**GUIDE** - Guidance

**GW** - Gross Weight

**GWX** - Graphical Weather

## H

**HDD** - Head Down Display

**HDG** - Heading

**HDG HOLD** - Heading Hold

**HDG SEL** - Heading Select

**HDPH** - Headphone

**HEAT** - Heater

**HF** - High Frequency (3 – 30 mHz) / High Frequency (3–30 MHz)

**Hg** - Mercury / Inches of Mercury

**HI** - High

**HLDR** - Holder

**HOR** - Horizontal

**HORIZ** - Horizontal

**HOT** - Hot Oil Temperature

**HP** - High Pressure

**hPA** - HectoPascals / Hecto Pascal

**HPSOV** - High Pressure Shut Off Valve

**HSI** - Horizontal Situation Indicator

**HSTA** - Horizontal Stabilizer Trim Actuator

**HSTCU** - Horizontal Stabilizer Trim Control Unit

**HT** - Heater

**HTR** - Heater

**HUD** - Head–up Display / Heads–up display

**HW** - Hardware

**HYD** - Hydraulic

**Hz** – Hertz

## I

**I/B** - Inboard

**I/O** - Input/Output

**IAC** - Integrated Avionics Computer

**IAF** - Initial Approach Fix

**IAPS** - Integrated Avionics Processors System

**IAS** - Indicated Air Speed / Indicated Airspeed (knots), Integrated Air System

**ICAO** - International Civil Aviation Organization

**ICC** - Integrated Card Cage

**ICS** - Idle Corrected Speed, Inter–Communications System

**ID** - Identification

**IDENT** - Identification

**IEC** - IAPS Environment Controller

**IFR** - Instrument Flight Rules

**IFIS** - Integrated Flight Information System

**IGN** - Ignition

**IGV** - Inlet Guide Vanes

**ILS** - Instrument Landing System

**IM** - ILS Inner Maker

**IMC** - Instrument Meteorological Conditions

**IMP** - Imperial

**IMS** - Information Management System

**IN** - Inch, Inches

**INBD** - Inboard

**INCR** - Increase

**IND** - Indication, Indicator

**INFLT** - In Flight

**INHB** - Inhibit

**INHIB** - Inhibit

**inHG** - Inches of Mercury

**INIT** - Initialize

**IN Hg** - Inches of Mercury

**INOP** - Inoperative

**INPH** - Interphone

**INSP** - Inspection

**INST(S)** - Instrument(s)

**INSTR** - Instrument(s)

**INT** - Internal, Integral, Intersection

**INTEG** - Integral

**INTERCOMM** - Intercommunication

**Intercom** - Intercommunication

**INVAL** - Invalid

**IOC** - Input/Output Concentrator

**IOP** - Input/Output Processor

**IPC** - Integrated Processing Cabinet

**IRS** - Inertial Reference System

**IRU** - Inertial Reference Unit

**ISA** - International Standard Atmosphere

**ISI** - Integrated Standby Instrument

**ISO** - International Standards Organization / International Standard Organization

**ISOL** - Isolation, Isolated

**ITT** - Inter Turbine Temperature (°C), Engine / Interstage Turbine Temperature (°C)

## J

**JAA** - Joint Aviation Authorities

## K

**K** - Knots

**kg** - Kilogram

**kHz** - KiloHertz / Kilo Hertz

**KIAS** - Knots Indicated Airspeed

**kPa** - KiloPascals / Kilo Pascal

**KTAS** - Knots True Airspeed

**KTS** - Knots

**kts** - Knots

**kt** - Knots

**kVA** - KiloVolt–Ampere / KiloVolt-Ampere

**kW** - KiloWatt(s) / Kilo Watts

## L

**L** - Left, Landing

**LAPUC** - Left APU Contactor

**LAT** - Latitude

**LAT/LONG** - Latitude/Longitude

**LAV** - Lavatory

**LB** - Pound

**Lb** - Pound

**lb** - pounds

**LCN** - Load Classification Number

**LCV** - Load Control Valve

**LDG** - Landing

**LDG GR** - Landing Gear

**LDS** - Lightning Detection System

**LDU** - Lamp Driver Unit

**LE** - Leading Edge

**LEV** - Level

**LFE** - Landing Field Evaluation

**LFL** - Landing Field Length

**LG** - Landing Gear

**LG ECU** - Landing Gear Electronic Control Unit

**LGLC** - Left Generator Line Contactor

**LGW** - Landing Gross Weight

**LH** - Left Hand

**LIM** - Limit

**LK** - Leak

**LMS** - Load Management System

**LN** - Left Nose

**LNAV** - Lateral Navigation

**LNDG ALT** - Landing Altitude

**LO** - Low

**LOC** - ILS Localizer / Localizer, ILS Localizer

**LOGO** - Logo Graphics

**LOI** - Loss of Integrity

**LOM** - Compass Locator at Outer Marker

**LOP** - Low Oil Pressure

**LP** - Low Pressure

**LPM** - Liter Per Minute

**LPT** - Low Pressure Turbine

**LPV** - Localizer Performance with Vertical guidance

**LR** - Long Range / Left Rear, Long Range

**LRC** - Long Range Cruise

**LRN** - Long Range Navigation

**LRU** - Line Replaceable Unit

**LSB** - Lower Side Band

**LSC** - Low Speed Cue

**LSK** - Line Select Key

**LSS** - Lighting Sensor System

**LTG(s)** - Light(s)

**LTS** - Lights

**LW** - Left Wing

**LWD** - Left Wing Down

**LWR** - Lower

**LX** – Lightning

## M

**M** - Mach Number

**m** - Meter

**mB** - Millibars

**MAA** - Maximum Authorized IFR Altitude, Missed Approach Altitude

**MAC** - Mean Aerodynamic Chord

**MAG** - Magnetic

**MAINT** - Maintenance

**MALF** - Malfunction

**MAN** - Manual

**MAP** - Ground map (WXR)

**MAZ** - MLS Azimuth

**MCA** - Minimum Crossing Altitude

**MCL** - Maximum Climb Thrust

**MCR** - Maximum Cruise

**MCT** - Maximum Continuous Thrust

**MDA** - Minimum Descent Altitude

**MDC** - Maintenance Diagnostic Computer

**MEA** - Minimum Enroute IFR Altitude

**MECH** - Mechanic

**MED** - Medium

**MEL** - Minimum Equipment List

**METAR** - Meteorological Report – Aviation Routine

**MF** - Multi Function

**MFD** - Multi Function Display

**MFS** - Multi Function Spoilers

**MFW** - Multifunction Window

**MFZW** - Maximum Zero Fuel Weight

**MGP** - MLS Glideslope

**MHz** - MegaHertz / Mega Hertz (freq range)

**MI** - Miles / Mach indicated

**mi** - Miles

**MIC** - Microphone

**MID ATF** - Middle Aft ward

**MID FWD** - Middle Forward

**MILS** - .001 of an inch / 0.001 of an inch

**MIN** - Minimum

**MISC** - Miscellaneous

**MISCMP** - Miscompare

**MISMTCH** - Mismatch

**MKP** - Multifunctional Keyboard Panel

**MKR** - Marker

**MLG** - Main Landing Gear

**MLS** - Microwave Landing System

**MLW** - Maximum Landing Weight

**MM** - Middle Marker

**MMEL** - Master Minimum Equipment List

**MMO** - Maximum Operating Speed in Mach Number / Maximum operating Speed in Mach Numbers

**MNPS** - Minimal Navigational Performance Standards

**MOCA** - Minimum Obstruction Clearance Altitude

**MOD** - Module

**MON** - Monitor

**MPH** - Miles Per Hour

**MRA** - Minimum Reception Altitude

**MRS** - Manual Release System

**MRW** - Maximum Ramp Weight

**MSG** - Message

**MSL** - Mean Sea Level

**MSW** - Master Wheel Disconnect

**MTG** - Miles To Go

**MTO** - Maximum Take–off

**MTOW** - Maximum Take–off Weight / Maximum Take Off Weight

**MX** - Maximum

**MZFW** - Maximum Zero Fuel Weight

## N

**N/A** - Not applicable / Not Applicable

**N/W** - Nose Wheel

**N1** - Low Pressure Rotor / Fan Speed

**N2** - High Pressure Rotor / High Pressure Rotor RPM

**NAD83** - North American Datum 1983

**NAT** - North Atlantic Tracks

**NAV** - Navigation

**NAVAID** - Navigational Aid

**NAVSRC** - Navigation Source

**NCD** - No Computed Data

**ND** - Nose Down

**NDN** - Nose Down

**NDB (ADF)** - Non directional Beacon (Automatic Direction Finder)

**NDU** - Navigational Display Unit

**NEG** - Negative

**NEUT** - Neutral

**NL** - Nose Left

**NLG** - Nose Landing Gear / N LDG - Nose Landing Gear

**NM** - Nautical Miles / Nautical Mile

**No.** - Number

**NOPT** - No Procedure Turn Required

**NORM** - Normal

**NOSE** - Nose Wheel

**NR** - Nose Right

**NU** - Nose Up

**NUP** - Nose Up

NWS - Nose Wheel Steering

## O

**O/S** - Overspeed

**OAT** - Outside Air Temperature

**OB** - Outboard

**OBS** - Observer

**OCM** - Option Control Module

**OEI** - One Engine Inoperative

**OEW** - Operating Empty Weight

**OK** - Okay

**OLD** - Operational Landing Distance

**OM** - Outer Marker

**OMNI** - Omnidirectional

**OT** - Other Traffic

**OUTBD** - Outboard

**OVBD** - Overboard

**OVHT** - Overheat

**OVLD** - Overload

**OVRD** - Override

**OVTEMP** - Over Temperature

**OXY** - Oxygen

**O2** - Oxygen

**OZC** - Ozone Converter

## P

**P** - Pressure, Pressurization

**PA** - Passenger Announcement

**PACK** - Air–Conditioning Unit

**PAL** - Phase Alternating Line

**PASS** - Passenger

**PAX** - Passenger

**PBE** - Protective Breathing Equipment (Smoke Hood)

**PCU** - Power Control Unit

**PF** - Pilot Flying

**PFD** - Primary Flight Display

**PFS** - Pitch Feel System

**PIT** - Pitch

**PITOT** - Pitot–Static

**PLA** - Power Lever Angle

**PLT** - Pilot

**PNF** - Pilot Not Flying

**POS** - Position

**PPH** - Pounds Per Hour

**PRAIM** - Predictive Receiver Autonomous Integrity Monitoring

**PRESS** - Pressure, Pressurization

**PRI** - Primary

**PRIM** - Primary

**PROC** - Procedure

**PROTECT** - Protection

**PROT** - Protection

**PROX** - Proximity

**PRV** - Pressure Regulating Valve

**PSE** - Passenger Service Unit

**PSEU** - Proximity Sensor Electronics Unit

**PSI** - Pounds Per Square Inch

**PSID** - Pounds Per Square Inch Differential

**PSIG** - Pounds Per Square Inch Gauge

**PSS** - Proximity Sensor System

**PTCT** - Protect

**PTT** - Push To Talk

**PV** - Priority Valve

**PWR** – Power

## Q

**QAK** - Quick Access Keys

**QAR** - Quick Access Recorder

**QEC** - Quick Engine Change

**QFE** - Local Station Pressure

**QNE** - ISA, Barometric Pressure

**QNH** - Altimeter Setting

**QTY** – Quantity

## R

**R** - Right

**R/D** - Refuel/Defuel

**R/T** - Receiver–Transmitter

**RA** - Radar Altitude, Resolution Advisory / Resolution Advisory (TCAS) / Radio Altitude

**RADALT** - Radio Altitude

**RAI** - Registro Aeronautico Italiano (Italy)

**RAIM** - Receiver Autonomous Integrity Monitoring

**RAT** - Ram Air Turbine

**RCC** - Runway Condition Code

**RCCB** - Remote Controlled Circuit Breaker

**RCDR** - Recorder

**RCVR** - Receiver

**RDC** - Remote Data Concentrator

**RDCP** - Refuel/Defuel Control Panel

**RDR** - Radar

**REC** - Receiver, Recorder

**RECIRC** - Recirculation

**RECOG** - Recognition

**REF(s)** - Reference(s)

**REFL** - Refuel

**RET** - Retract

**REV** - Reverse / Reverser, Reverse or Reversion

**RF** - Russian Federation

**RH** - Right Hand

**RIU** - Radio Interface Unit

**RMD** - ROAAS Model Distance

**RMI** - Radio Magnetic Indicator

**RMU** - Radio Management Unit

**RNP** - Required Navigation Performance

**RNP AR** - Required Navigation Performance Approval Required

**ROAAS** - Runway Overrun Awareness and Alerting System

**ROL** - Roll

**ROT** - Rotation

**ROTR** - Record of Temporary Revisions

**rpm** - Revolutions per Minute

**RPM** - Revolutions Per Minute

**RSB** - Radio System Bus

**RSP** - Reversion Switch Panel

**RTA** - Required Time of Arrival / Receiver–transmitter Antenna (WXR)

**RTE** - Route

**RTO** - Rejected Take–off / Rejected Take Off

**Rt** - Receiver–Transmitter

**RUD** - Rudder

**RVR** - Runway Visual Range

**RVSM** - Reduced Vertical Separation Minimum

**RVSR** - Reverser

**RWD** - Right Wing Down

**RWY** – Runway

## S

**S** - Status

**SAAU** - State Aviation Administration of Ukraine

**SAT** - Static Air Temperature

**SAV** - Starter Air Valve

**SB** - Service Bulletin

**SBAS** - Space Based Augmentation System / Space/ Satellite Based Augmentation System

**SBY** - Standby

**SCAV** - Scavenge

**SCHED** - Schedule

**SCR** - Selector (Nav source)

**SCU** - Steering Control Unit

**SCV** - Surge Control Valve

**SEC** - Secondary

**SEL** - Select, Selector

**SELCAL** - Selective Calling

**SENS** - Sensitivity, Sensor

**SERV** - Service

**SG** - Signal Generator

**SID** - Standard Instrument Departure

**SIGMET** - Significant Meteorological Observation

**SLD** - Super–cooled Large Droplet

**SMKG** - Smoking

**SOV** - Shut–off Valve / Shut–Off Valve

**SP** - Speed

**SPC** - Stall Protection Computer

**SPD** - Speed

**SPDA** - Secondary Power Distribution Assembly

**SPKR** - Speaker

**SPLR(S)** - Spoiler(s)

**SPS** - Stall Protection System

**SQ** - Squelch

**SSB** - Single Side Band

**STA** - Station

**STAB** - Stabilizer

**STAT** - Status

**STBY** - Standby

**STD** - Standard

**STEER** - Steering

**SUPPL** - Supply

**SVC** - Synthetic Vision Computer

**SVCM** - Synthetic Vision Configuration Module

**SVCE** - Service

**SVO** - Servo

**SVS** - Synthetic Vision System

**SW** - Switch / Software

**SYN** - Synchronize

**SYNC** - Synchronization / Synchronization, Synchronous

**SYS** - System

**SYST** – System

## T

**T/C** - Top of climb

**T/D** - Top of descent

**T/R** - Thrust Reverser

**T2** - Temperature, inlet duct sensor

**TA** - Traffic Advisory (TCAS)

**TACAN** - UHF Tactical Air Navigation Aid

**TAE** - Track Angle Error

**TAF** - Terminal Airport Forecast

**TAS** - True Air Speed

**TAT** - Total Air Temperature

**TAWS** - Terrain Awareness Warning System

**TCAS** - Traffic Alert and Collision Avoidance System

**TCS** - Touch Control Steering

**TD** - Traffic Display

**TDR** - Transponder

**TE** - Trailing Edge

**TEMP** - Temperature

**TFC** - Traffic (TCAS)

**TFR** - Temporary Flight Restriction

**TGT** - Target, Turbine Gas Temperature

**TKE** - Track Angle Error

**TLA** - Thrust Lever Angle

**TMS** - Thermal Management System

**TO** - Takeoff

**TO/GA** - Takeoff / Go Around

**TOD** - Top of descent

**TOFL** - Take–off Field Length

**TOL** - Tolerance

**TOLD** - Take–off and Landing Data

**TR** - Terrain

**TRB** - Turbulence

**TRK** - Track

**TRM** - Trim

**TRU** - Transformer Rectifier Unit

**TSS** - Traffic Surveillance System

**TSSA** - Traffic Surveillance System Application

**TST** - Test

**TTR** - TCAS II Transmitter / Receiver

**TURB** – Turbulence

## U

**UNLKD** - Unlocked

**UNSCHD** - Unscheduled

**US** - United States

**USB** - Universal Serial Bus / Universal Serial Bus, Upper Side Band

**USG** - United States Gallons

**UTIL** – Utility

## V

**V** - Volt

**V_** - V–Speed

**V/L** - VOR/Localizer

**V/S** - Vertical Speed

**VA** - Design Maneuvering Speed

**VATE** - Autothrottle automatic engagement speed

**VB** - Design Speed for Maximum Gust Intensity Design

**VC** - Cruising Speed, Design Cruising Speed

**VD** - Design Diving Speed

**VDF/MDF** - Demonstrated Flight Diving Speed

**VDL** - VHF Data Link

**VEF** - Engine Failure Speed

**VERT** - Vertical

**VF** - Design Flap Speed

**VFC/MFC** - Maximum Speed for Stability Characteristics

**VFE** - Maximum Flaps Extended Speed

**VFR** - Visual Flight Rules

**VFTO** - Final take-off climb speed

**VG** - Vertical Gyro

**VGA** - Minimum Go Around Speed

**VHF** - Very High Frequency (30 – 300 mHz) / Very High Frequency (30–300 MHz)

**VIB** - Vibration

**VIU** - Video Interface Unit

**VLC** - Landing Climb Speed

**VLE** - Maximum Landing Gear Extended Speed

**VLO** - Maximum Landing Gear Operating Speed

**VLOF** - Lift-Off Speed

**VLV(s)** - Valve(s)

**VMC** - Minimum Control Speed with the Critical Engine Inoperative, Visual Meteorological Conditions

**VMCA** - Minimum Control Speed Air

**VMCG** - Minimum Control Speed Ground

**VMCL** - Minimum Control Speed Landing

**VMD** - Minimum Drag Speed

**VMO/MMO** - Maximum Operating Limit Speed / Maximum Operating Limit Speed / Mach Number

**VMU** - Minimum Unstick Speed

**VNAV** - Vertical Navigation Mode / Vertical Navigation System, Vertical Navigation Mode

**Vol** - Volume

**VOLT** - Voltage

**VOR** - VHF Omnidirectional Range Station

**VORTAC** - VOR and TACAN Co–located

**VR** - Rotation Speed

**VRA** - Rough Air Penetration speed

**VREF** - Reference Velocity

**VS** - Vertical Speed Mode / Stalling Speed or the Minimum Steady Flight Speed at which the Airplane is Controllable, Vertical Speed Mode

**VS1** - Stalling Speed or the Minimum Steady Flight Speed Obtained in a Specific Configuration

**VSD** - Vertical Situation Display

**VSI** - Vertical Speed Indicator

**VSO** - Stalling Speed or the Minimum Steady Flight Speed in the Landing Configuration

**Vspeeds** - Departure and arrival performance

**VZF** - Minimum zero flaps speed

**V1** - Take-off Decision Speed (formerly Denoted as Critical Engine Failure Speed)

**V2** - Take-off Safety Speed

**V2MIN** - Minimum Takeoff Safety Speed

## W

**W** – Warning

**W/C** - Wind Component

**W/S** - Wind Shear

**W/W** - Wheel Well

**WAAS** - Wide Area Augmentation System

**WAI** - Wing Anti–Ice

**WAIV** - Wing Anti–ice Valve

**WARN** - Warning

**WF** - Runway Length Limited Weight

**Wf** - Fuel Flow In Pounds Per Hour

**WG** - Wing

**WGS84** - World Geodetic System 1984

**WGT** - Weight

**WOW** - Weight–On–Wheels

**WPT(s)** - Waypoint(s) / Waypoint

**WS** - Second Segment Limited Weight

**WSHLD** - Windshield

**WT** - Weight

**WTC** - Windshield Temperature Control

**WX** - Weather

**WXR** - Weather Radar

## X

**XBLEED** - Cross Bleed

**XDUCER** - Transducer

**XFEED** - Cross Feed

**XFER** - Transfer

**XFLOW** - Cross Flow

**XMIT** - Transmit

**XPNDR** - Transponder

**XTD** - Cross Track Distance

**XTK** - Cross Track

**XWC** - Cross Wind Component

## Y

**YD** - Yaw Damper

**Y/D** - Yaw Damper

## Z

**ZFW** - Zero Fuel Weight

## AIRSPEEDS

| | |
|---|---|
| **CAS** | Calibrated airspeed – Indicated airspeed corrected for static source position error. |
| **EAS** | Equivalent airspeed – Calibrated airspeed corrected for compressibility. |
| **IAS** | Indicated airspeed – Airspeed indicator reading corrected for instrument error. Values in this manual assume zero instrument error. |
| **M** | Indicated Mach number – Machmeter reading corrected for instrument error. |
| **$M_T$** | True Mach number – Machmeter reading corrected for both instrument and static source position errors. |
| **TAS** | True airspeed – Equivalent airspeed corrected for density. |
| **$V_1$** | Take–off decision speed (formerly designated as Critical engine failure recognition speed) – The speed used as a reference at which, due to engine failure or other causes, the pilot may elect to stop or continue the take–off. |
| **$V_{1MBE}$** | Maximum $V_1$ for brake energy – The maximum speed on the ground from which a stop can be accomplished within the energy capabilities of the brakes. |

$V_{1MCG}$ Minimum $V_1$ limited by control on the ground – The take–off decision speed following an engine failure at $V_{MCG}$. $V_1$ may not be less than $V_{1MCG}$.

$V_2$ Take–off safety speed – Target climb speed to be attained at or before a height of 35 feet above the runway during a continued take–off, following an engine failure.

$V_A$ Design maneuvering speed – The maximum speed at which application of full available aileron, rudder or elevator will not overstress the airplane.

$V_{AC}$ Approach Climb Speed – The target climb speed to be attained after initiation of a Go–Around and selection of the approach climb configuration following an engine failure.

$V_{ATE}$ Autothrottle automatic engagement speed – The speed at which the Autothrottle will automatically engage. Corresponds nominally to 1.2 VS and displayed on the Airspeed tape by an amber line located above the low speed cue indication.

$V_{EF}$ Critical engine failure speed – The speed at which, if the critical engine fails, the engine failure is recognized at $V_1$.

$V_{FE}$ Maximum flap extended speed – is the highest speed permissible with the wing flaps in a prescribed extended position.

$V_{FTO}$ Final take–off climb speed – The speed attained at the end of the flight path acceleration segment during a continued take–off following an engine failure, and is the climb speed scheduled for the final take–off climb.

$V_{LC}$ Landing Climb Speed – The target climb speed to be attained after initiation of a Go–Around while in the landing configuration with all engines operating.

$V_{LE}$ Maximum landing gear extended speed – The maximum speed at which the airplane can be safely flown with the landing gear extended.

$V_{LO}$ Maximum landing gear operating speed – The maximum speed at which the landing gear can be safely extended or retracted.

$V_{MO}/M_{MO}$ Maximum Operating Limit Speed / Mach Number – The maximum operating limit speed (airspeed or Mach number) is the speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorized for flight test or pilot training operations.

$V_{MCA}$ Minimum control speed, air – Minimum flight speed at which the airplane is controllable when the critical engine suddenly becomes inoperative, with the remaining engine at maximum take–off thrust.

$V_{MCG}$ Minimum control speed, ground – Minimum speed on the ground at which control can be maintained and the take–off continued using aerodynamic controls alone, when the critical engine suddenly becomes inoperative, with the remaining engine at maximum take–off thrust.

$V_{MCL}$ Minimum control speed during landing approach – Minimum flight speed at which the airplane is controllable when the critical engine suddenly becomes inoperative, with the remaining engine at maximum take–off thrust.

$V_{MD}$ Minimum Drag Speed – The speed that provides the maximum lift/drag ratio.

$V_R$ Rotation speed – Speed at which rotation is initiated during take–off.

$V_{REF}$ Approach speed – The landing reference speed at a height of 50 feet above the runway threshold in the normal landing configuration.

$V_S$ Stalling speed.

## TEMPERATURE

**ISA** - International Standard Atmosphere.

**OAT** - Outside air temperature – The free air temperature, obtained either from in–flight temperature indications or ground meteorological sources.

**SAT** - Static air temperature – Outside air (ambient) temperature as computed by the Air Data Computer and presented on the SAT indicator.

**TAT** - Total air temperature – Static air temperature plus adiabatic compression (ram) rise.

## DISTANCES

**Take–off Field Length (Dry and wet runways)**
The take–off field length is the longer of: a. The take–off distance (see below). b. The accelerate–stop distance (see below).

**Take–off Distance (Dry runways)**
The take–off distance on a dry runway is the longer of: a. The distance from the start of the take–off roll to the point where the airplane attains a height of 35 feet above the take–off surface, with a failure of the critical engine at VEF. b. 115% of the distance from the start of the take–off roll to the point at which the airplane attains a height of 35 feet above the take–off surface, with all engines operating.

**Take–off Distance (Wet runways)**
The take–off distance on a wet runway is the longer of: a. The take–off distance on a dry runway. b. The distance from the start of the take–off roll to the point where the airplane attains a height of 15 feet above the take–off surface, with a failure of the critical engine at VEF. c. 115% of the distance from the start of the take–off roll to the point at which the airplane attains a height of 35 feet above the take–off surface, with all engines operating.

**Accelerate – Stop Distance (Dry runways)**
The accelerate – stop distance on a dry runway is the longer of subpara a. and subpara b. as defined below:

a. The sum of the distances necessary to:

1. Accelerate the airplane from a standing start to VEF with all engines operating;
2. Accelerate the airplane from VEF to V1 assuming the critical engine fails at VEF; and
3. Come to a full stop from the point reached at the end of the acceleration period prescribed in subpara a. 2) above, assuming that the pilot does not apply any means of retarding the airplane until that point is reached; plus
4. A distance equivalent to 2 seconds at constant V1.

b. The sum of the distances necessary to:

1. Accelerate the airplane from a standing start to V1 with all engines operating;
2. Come to a full stop at the end of the period prescribed in subpara b. 1) above, assuming that the pilot does not apply any means of retarding the airplane until that point is reached; plus
3. A distance equivalent to 2 seconds at constant V1.

**Accelerate – Stop Distance (Wet runways)**
The accelerate – stop distance on a wet runway is the longer of:

a. The accelerate – stop distance on a dry runway.

b. The accelerate – stop distance determined as per the accelerate – stop distance on a dry runway, except that the corresponding wet runway values of VEF and V1 are used.

**Take–off Run (Dry runways)**
The take–off run on a dry runway is the longer of: a. The distance from the start of the take–off roll to the mid point between lift–off and the point at which the airplane attains a height of 35 feet above the take–off surface, with a failure of the critical engine at VEF. b. 115% of the distance from the start of the take–off roll to the mid point between lift–off and the point at which the airplane attains a height of 35 feet above the take–off surface, with all engines operating.

**Take–off Run (Wet runways)**
The take–off run on a wet runway is equal to the take–off distance on a wet runway.

**Clearway**
An area beyond the runway, not less than 500 feet wide, centrally located about the extended centerline of the runway, and under the control of the airport authorities. The clearway is expressed in terms of a clearway plane, extending from the end of the runway with an upward slope not exceeding 1.25% above which no object nor any terrain protrudes. However, threshold lights may protrude above the plane if their height above the end of the runway is 26 inches or less and if they are located to each side of the runway.

**Stopway**
An area beyond the take–off runway at least as wide as the runway and centered upon the extended centerline of the runway, able to support the airplane during an aborted take–off without causing structural damage to the airplane, and designated by the airport authorities for use in decelerating the airplane during an aborted take–off.

**Actual Landing Distance**
Actual landing distance is the distance from a 50 feet height at VREF with the flaps in the normal landing configuration, to a full stop on a smooth, dry, level, hard–surfaced runway and ISA temperature.

**Landing Field Length**
The performance charts in this chapter include factors for operational rules which require the use of 60% of the available runway in determining landing field length requirements. The required landing field length on a dry runway is the actual landing distance divided by 0.6. The landing field length required under wet runway conditions is equal to 115% of the dry runway landing field length.

## TAKE-OFF PATH

**Take–Off Path**
The take–off path begins from a standing start and ends at 1500 feet above the take–off surface or at the point where transition from take–off to enroute configuration is completed, whichever is higher.

**Take–Off Flight Path**
The take–off flight path begins at the end of the take–off distance and at a height of 35 feet above the take–off surface, and ends at 1500 feet above the take–off surface, or at the point where transition from take–off to enroute configuration is completed, whichever is higher. This is also known as the Gross Take–off Flight Path.

**Net Take–Off Flight Path**
The net take–off flight path is the gross take–off flight path diminished by 0.8% climb gradient capability (or equivalent reduction in acceleration along that part of the take–off flight path at which the airplane is accelerated in level flight). The net take–off flight path must clear all obstacles in the take–off area by at least 35 feet vertically.

**Gross Level–off Height**
Actual (gross) geometric height above take–off surface for the flight acceleration segment.

## CLIMB GRADIENT

**Climb Gradient**
The ratio of the change in height, during a portion of a climb, to the horizontal distance traversed in the same time interval.

**Gross Gradient**
Climb gradient expressed as a percentage ratio, obtained using the following formula: (Change in height ÷ Horizontal distance travelled) x 100 The gradients shown on the charts are based on true (not pressure) rates of climb.

**Net Gradient**
The gross gradient reduced by the required margins.

**First Segment**
The first segment starts from the 35 foot height and extends to the point where the landing gear is fully retracted, at a constant V2 speed and flaps in the take–off position.

**Second Segment**
The second segment starts at the point where the landing gear is fully retracted up to at least 400 feet above the runway, flown at V2 speed and flaps in the take–off position.

**Acceleration Segment**
The acceleration segment is the part of the take–off flight path that begins at the end of the second segment and extends horizontally over the distance required to retract flaps to zero, and accelerate to the final take–off climb speed.

**Final Segment**
The final segment starts from the end of the acceleration segment and extends to the end of the take–off flight path, flown at the final segment climb speed, flaps up.

## MISCELLANEOUS

**Centre of gravity (c.g.)**
The point at which the airplane would balance if suspended. The c.g. distance from the reference datum is found by dividing the total moment by the total weight of the airplane.

**GW**
Gross weight – The maximum weight to which the airplane is certificated.

**MLW**
Maximum landing weight – The maximum airplane weight approved for the landing touchdown.

**Max OWE**
Maximum operating weight, empty – The maximum weight for a loaded airplane which includes the flight and cabin crew, galley loading and forward / aft stowage items.

**Min OWE**
Minimum operating weight, empty – The minimum weight for a loaded airplane which includes minimum crew, no galley loading and no stowage items.

**Min FW**
Minimum Flight Weight – The minimum flight weight is the minimum weight empty with 45 minutes of fuel reserve.

**MRW**
Maximum ramp weight – The maximum airplane weight approved for taxiing.

**MTOW**
Maximum take–off weight – The maximum airplane weight approved for the start of take–off.

**MZFW**
Maximum zero fuel weight – The Max OWE plus passengers and baggage.

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CL-350



CL-350 TRAINING MANUAL

# STRUCTURES 01

## AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# STRUCTURES

## I. INTRODUCTION

The Challenger 350 structural system represents a sophisticated, FAR Part 25 Transport Category design engineered to provide exceptional safety, performance, and operational flexibility throughout the aircraft's certified flight envelope. Built around a semimonocoque construction with constant circular cross-section fuselage, the airframe integrates fully cantilevered, 27%-swept supercritical wings with advanced winglet technology to optimize aerodynamic efficiency while maintaining structural integrity under all operational conditions.

The design employs a comprehensive approach to airframe integration, incorporating strategically positioned access panels, service doors, and structural openings that maintain pressurization integrity while providing essential maintenance accessibility and emergency egress capabilities. Critical structural elements include the pressurized cabin section designed to accommodate up to ten occupants in various seating configurations, integral wing fuel tank construction that contributes to overall structural strength, and a robust empennage assembly featuring advanced static discharge systems for electrical protection.

Safety is paramount throughout the structural design, with multiple emergency exit provisions, fail-safe pressurization systems, comprehensive door monitoring through EICAS integration, and strategically located equipment bays that house critical flight systems while maintaining structural load paths. This chapter will examine each component of this integrated structural system, detailing normal operations, maintenance access procedures, emergency egress protocols, door operating systems, weight and balance limitations, and the comprehensive monitoring systems that enable crews to maintain structural integrity awareness and ensure safe aircraft operations throughout all phases of flight and ground operations.

The Challenger 350 is a high-performance business jet certified to the following standards:

- Certified IAW FAR Part 25 Transport Category
- Certified IAW FAR Part 36 Noise Requirements (Stage 4)
- Semimonocoque construction with constant circular cross section
- Fully cantilevered, 27%-swept supercritical wings with winglets
- Relatively low takeoff and landing speeds permit operations at smaller airports (~4,850' @ MTOW)
- Two Honeywell HTF7350 (AS907-2-1A) high-bypass turbofan engines provide 7,372lbs of thrust to ISA +15°C (ISA +20°C with APR) at sea level
- Equipped with a Honeywell 36-150BD APU
- Accommodates eight passengers in the standard dual-club configuration
- Equipped with Collins Pro Line 21 Advanced Avionics System

# II. SPECIFICATIONS

## A. MAXIMUM WEIGHTS (IN POUNDS)

| Parameter | Weight |
|---|---|
| Maximum Ramp Weight (MRW) | 40,750 lbs |
| Maximum Takeoff Weight (MTOW) | 40,600 lbs |
| Maximum Landing Weight (MLW) | 34,150 lbs |
| Maximum Zero Fuel Weight (MZFW) | 28,200 lbs |
| Maximum Baggage Weight | 750 lbs |
| Minimum Flight Weight (MFW) | 24,800 lbs |

**Factors limiting maximum takeoff weight:**

- Maximum certified T/O weight
- Maximum T/O weight permitted by climb requirements
- Takeoff field length
- Brake Energy Limits
- Tire Speed
- Obstacle Clearance Limit

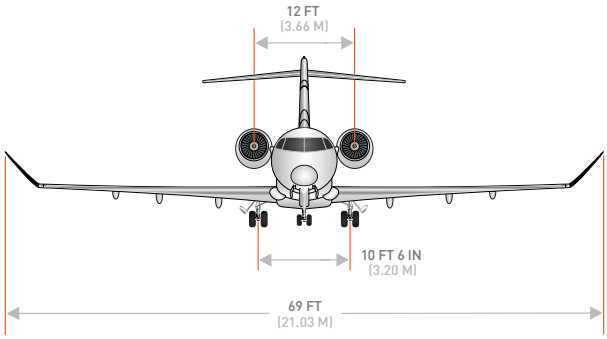
**Landing weight is limited to the most restrictive of:**

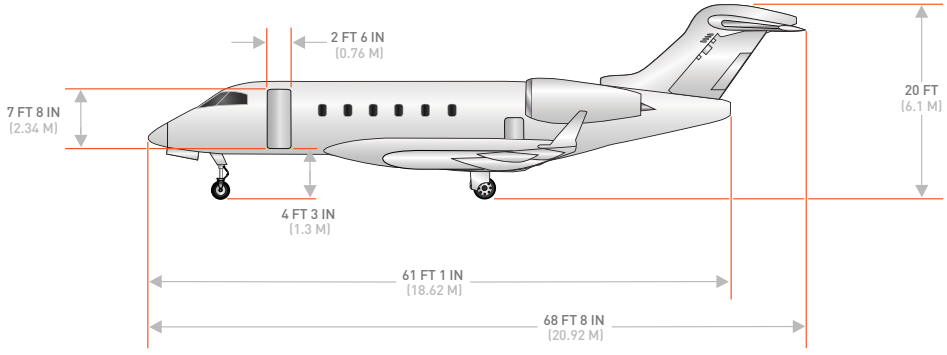
- Maximum certified landing weight
- Maximum landing weight permitted by brake energy limits
- Maximum landing weight permitted by climb requirement
- Landing distance

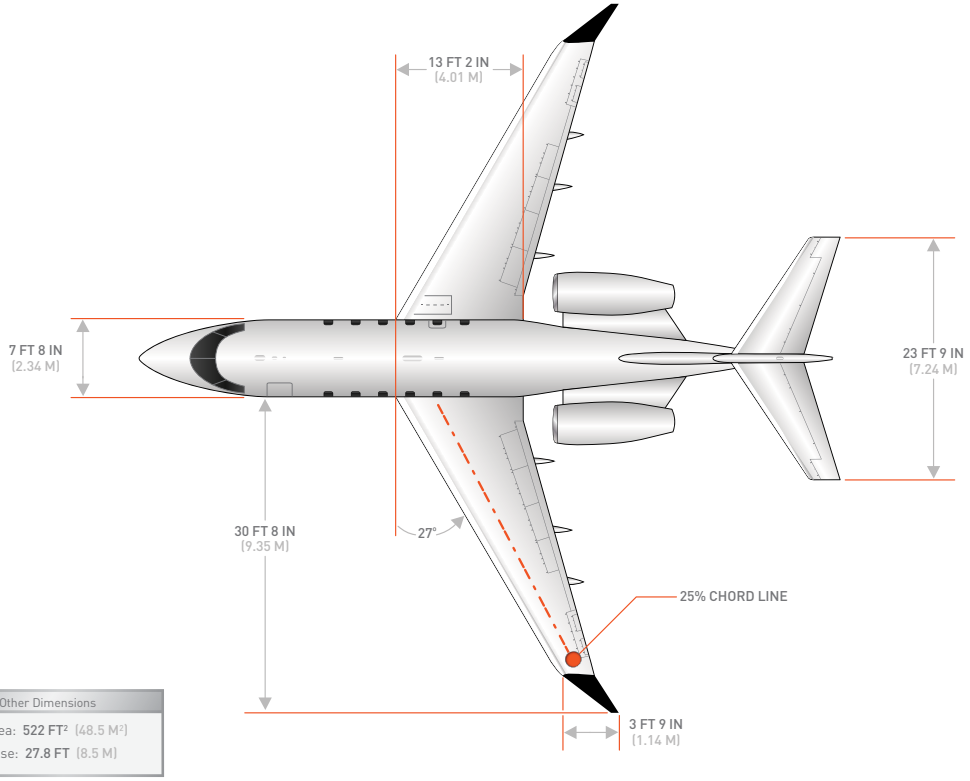
## B. DIMENSIONS

Exterior Dimensions (Feet)

| Parameter | Dimension |
|---|---|
| Wingspan | 69.0 ft. |
| Length | 68.75 ft. |
| Height | 20.0 ft. |
| Wheelbase | 27.75 ft. |
| Distance Between Main Gear | 10.5 ft. |



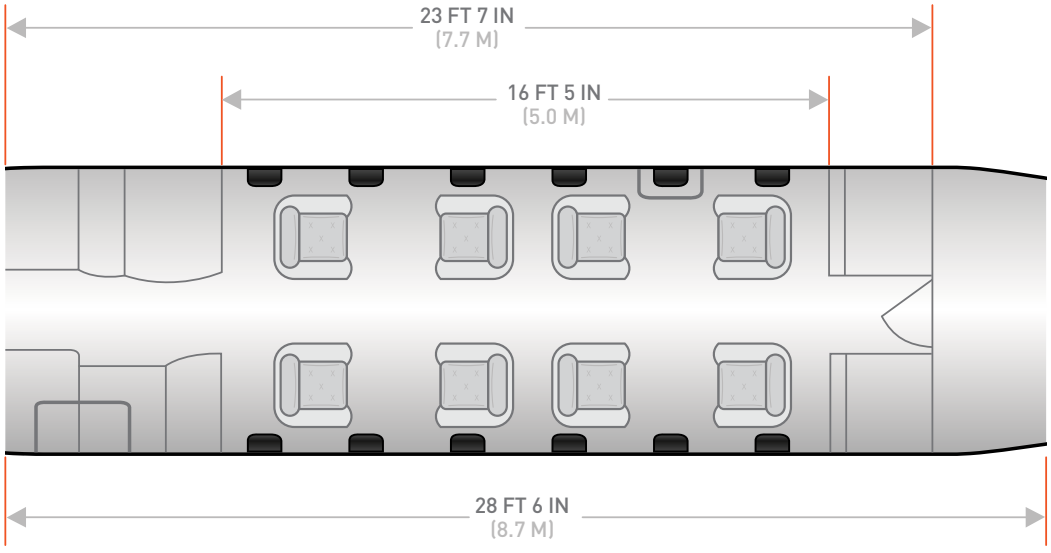



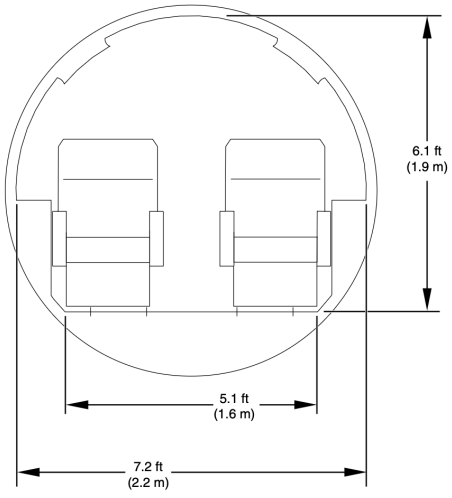




| Other Dimensions |
|---|
| Wing Area: 522 FT² (48.5 M²) |
| Wing Base: 27.8 FT (8.5 M) |

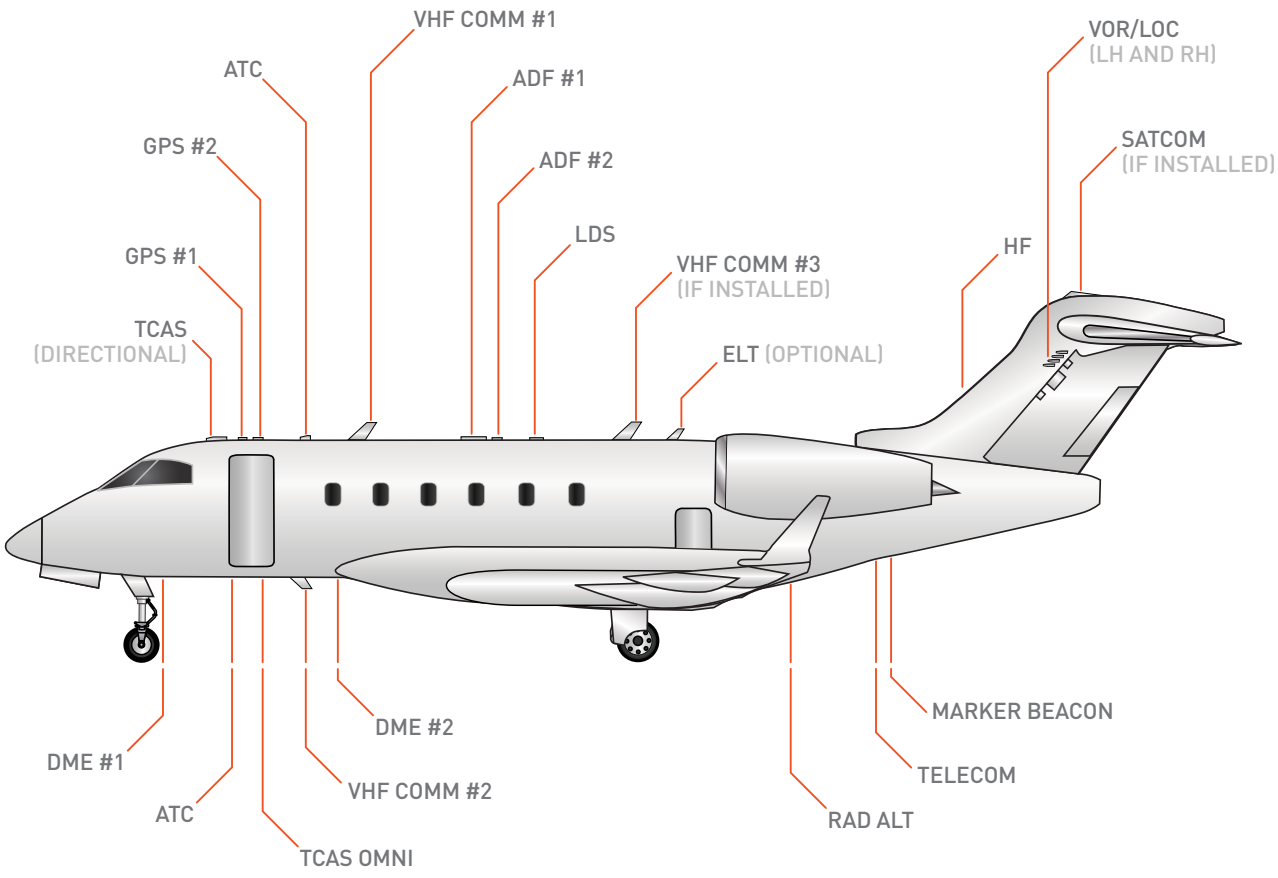
Interior Dimensions

| Parameter | Dimension |
|---|---|
| Length | 28.6 ft. |
| Width (Floor Line) | 5.1 ft. |
| Width (Centerline) | 7.16 ft. |
| Height | 6.1 ft. |
| Volume | 896 $ft^3$ |
| Floor Area | 146 $ft^2$ |



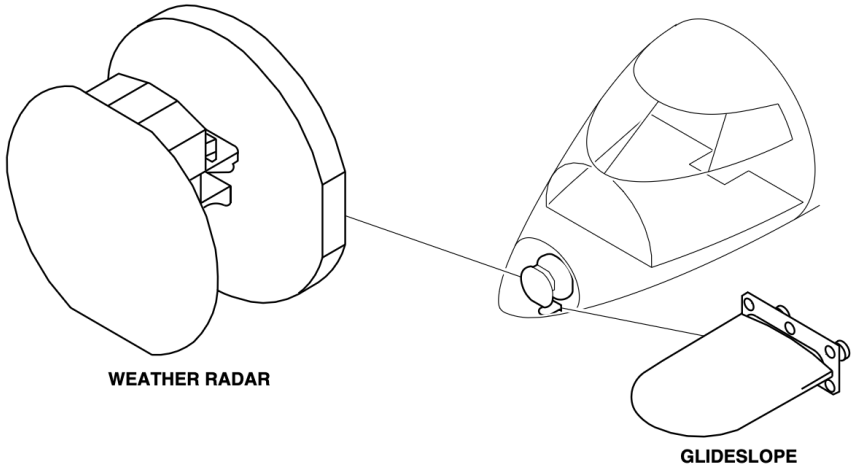



## C. ANTENNA LOCATION SCHEMATIC




**WARNING**

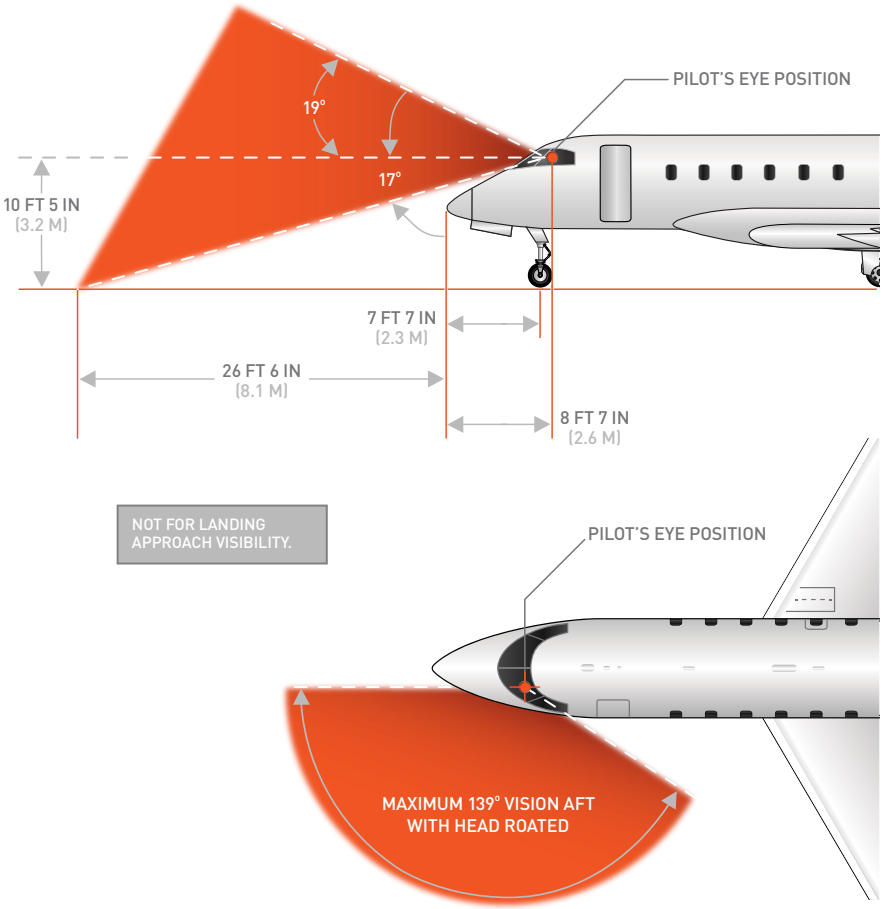
Personnel should not stand nearby and in front of the radar antenna when it is transmitting. When the antenna is not scanning, the danger increases.

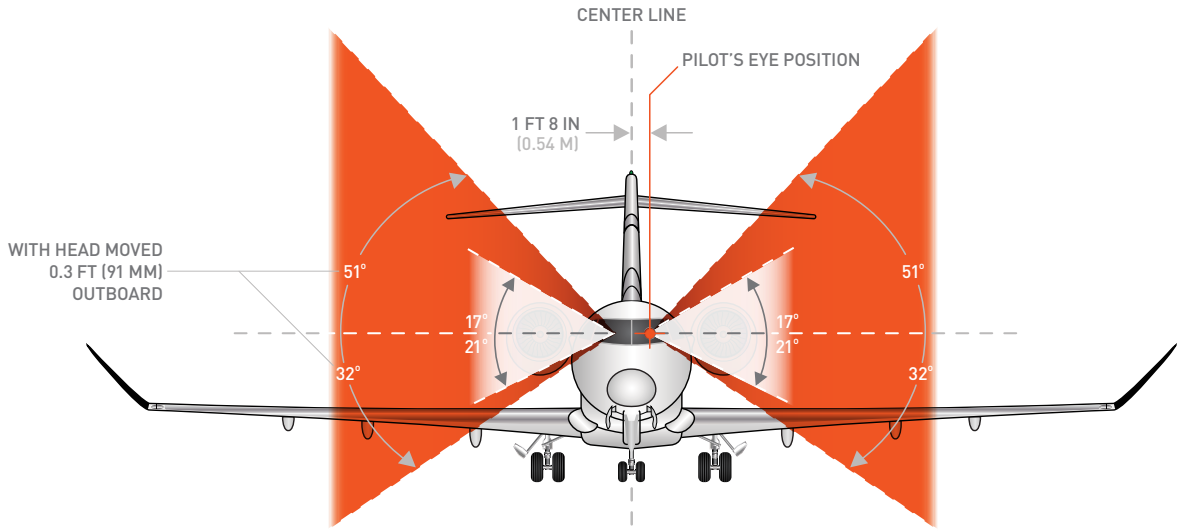


**WEATHER RADAR**

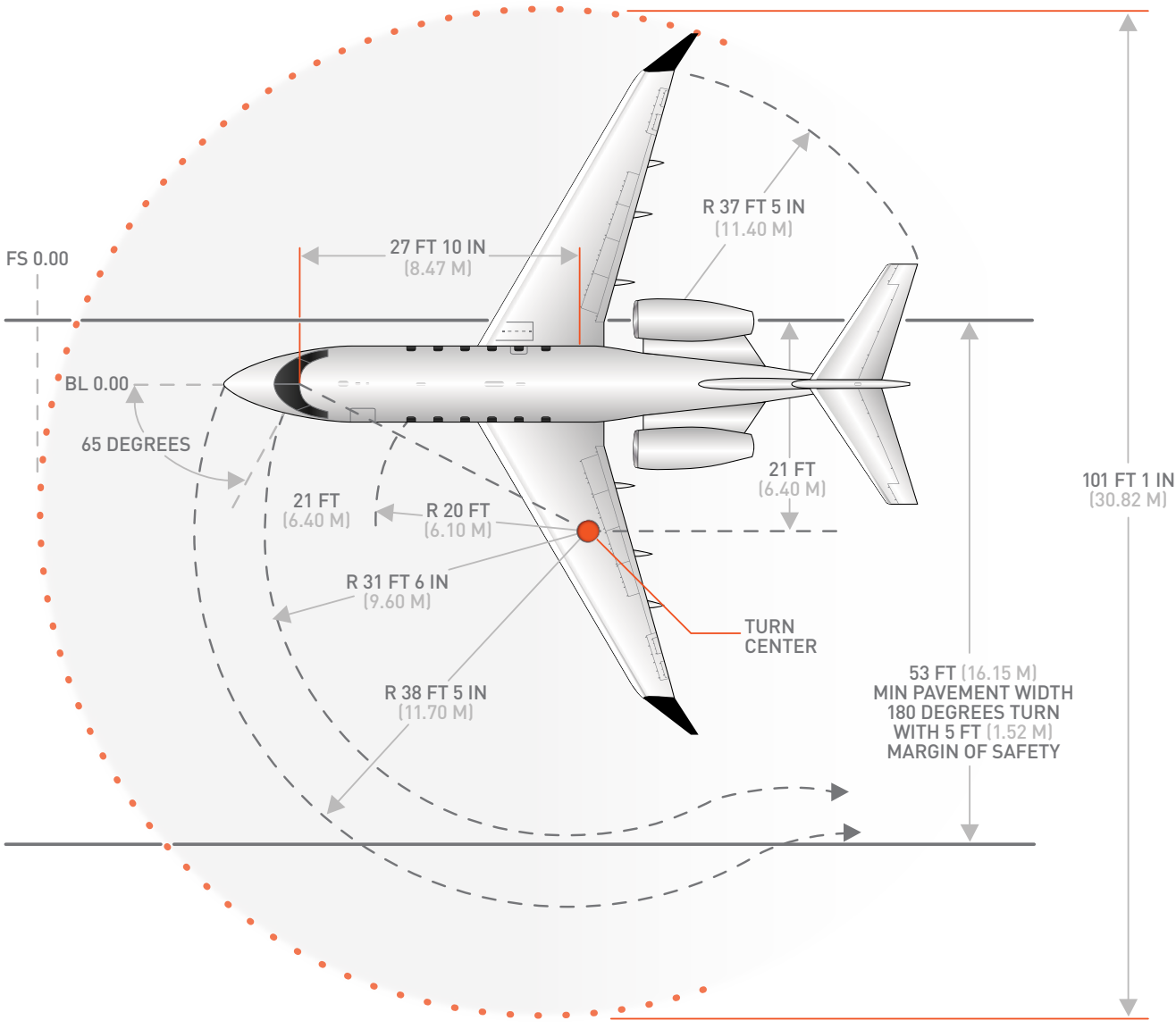
**GLIDESLOPE**

## D. VISUAL EYE REFERENCES FOR GROUND OPERATION



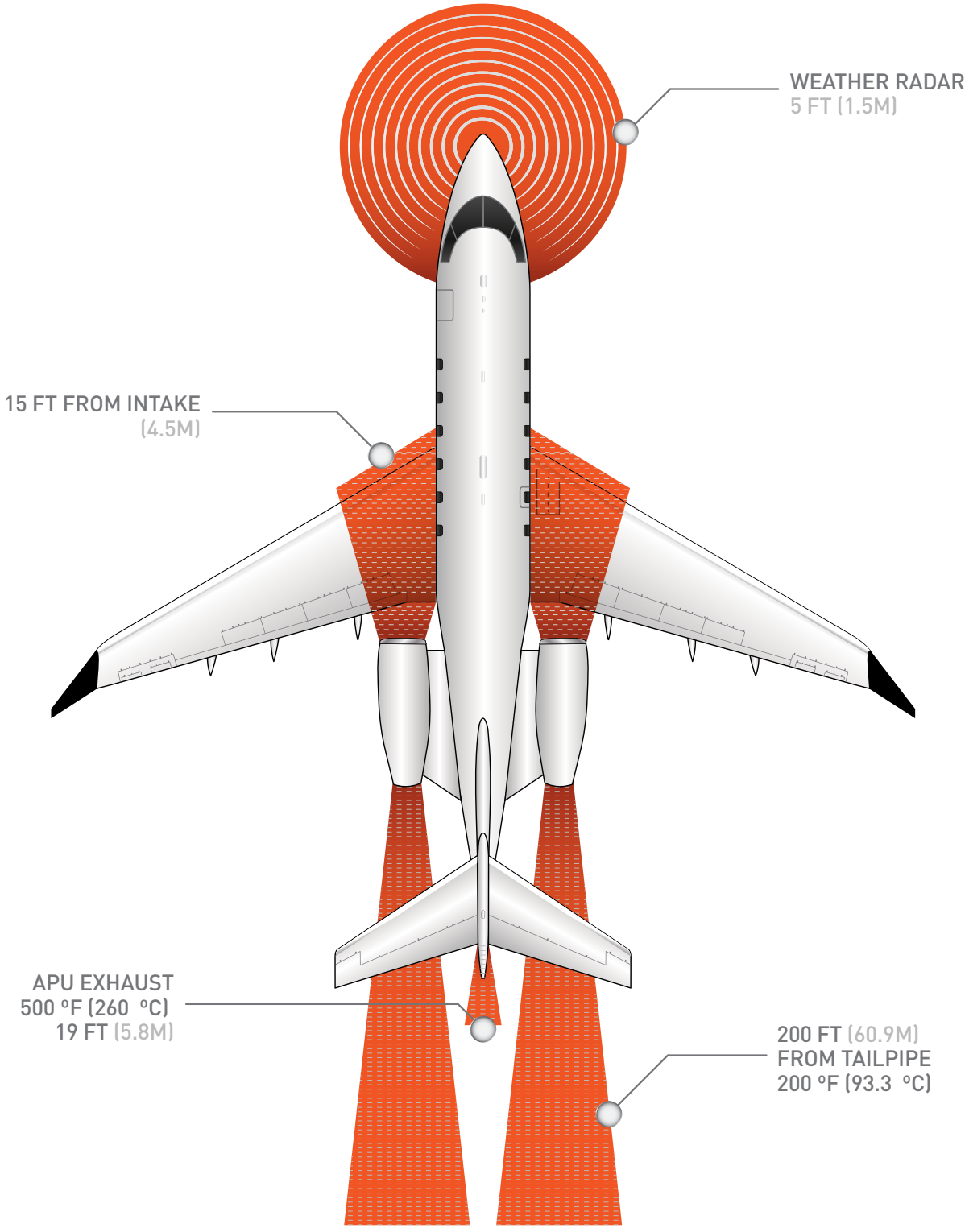
## E. STEERING AND TURNING RADII SCHEMATIC




**NOTES:**

- Maximum Steering
- Symmetrical and Idle Thrust
- No Differential Braking
- 65° Steering Angle
- 3° Slip
- Dry Runway
- Slow Continuous Turn
- Maximum Aircraft Weight
- Aft Center of Gravity

## F. DANGER AREAS



### G. CAPACITIES

System Capacities

| System | Capacity |
|---|---|
| Engine Oil (Each Engine) | 7.8 qts |
| Fuel (Max Usable) | 14,150 lbs (2,096 gal) |
| Oxygen Bottles | 115 cu ft & 77 cu ft. |
| Left Hydraulic Reservoir | 13 qts |
| Right Hydraulic Reservoir | 9.1 qts |

## III. RADOME

The nose radome is attached to the aircraft using four latches and has an anti-static conductive layer and lightning diverter strips.





## IV. AFT EQUIPMENT BAY

Door must be unlocked prior to taxi, takeoff, and landing.

**Components:**

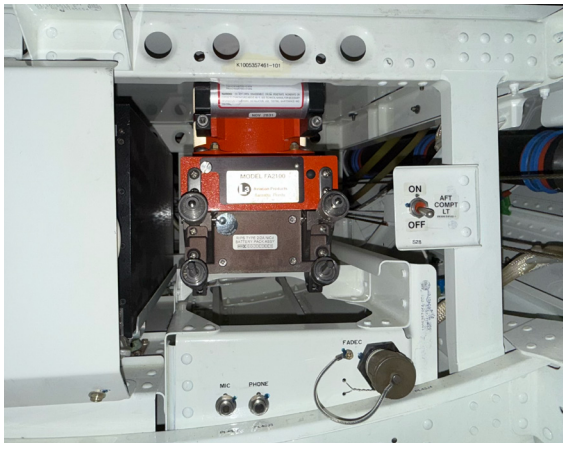
- Aft Equipment Bay Access Door and Ladder
- Left and Right DC Power Centers (DCPCs)
- Cockpit Voice Recorder (CVR)
- APU DC Power Center (DCPC)
- Flight Data Recorder (Black Box)

- Fire Bottles
- Fire Detection & Extinguishing System Control Unit
- Pneumatic Air Cycle Kit (PACK) / TRIM Air
- Left Hydraulic DC Motor-Driven Pump (DCMP)
- Right Hydraulic DC Motor-Driven Pump (DCMP)
- AUX DC Motor-Driven Pump (DCMP)

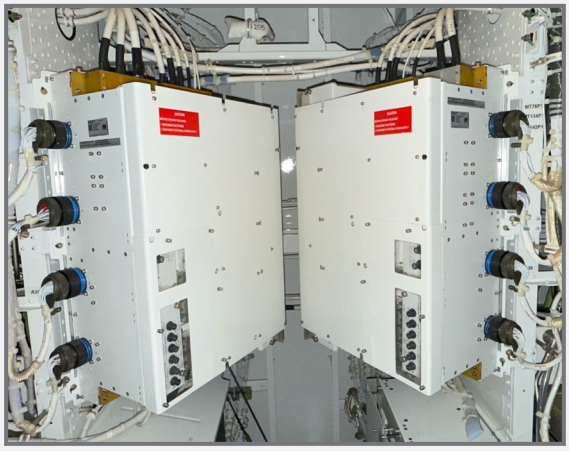
| EICAS MESSAGES |
| --- |
| AFT EQPT BAY DOOR |



Aft Equipment Bay Access Door




Cockpit Voice Recorder (CVR)



Left and Right DC Power Centers (DCPCs)

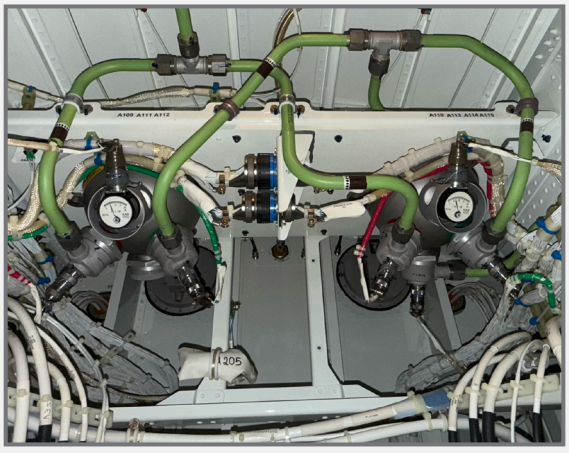
| EICAS MESSAGES | |
| --- | --- |
| L ESS BUS FAIL | R ESS BUS FAIL |
| L MAIN BUS FAIL | R MAIN BUS FAIL |
| L ESS BUS OFF | R ESS BUS OFF |
| L MAIN BUS OFF | R MAIN BUS OFF |
| L AUX BUS FAIL | R AUX BUS FAIL |
| L AUX BUS OFF | R AUX BUS OFF |



APU DC Power Center (DCPC)

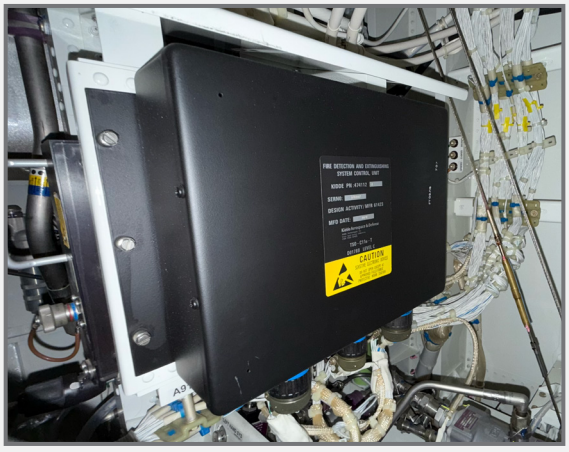


Flight Data Recorder (Black Box)



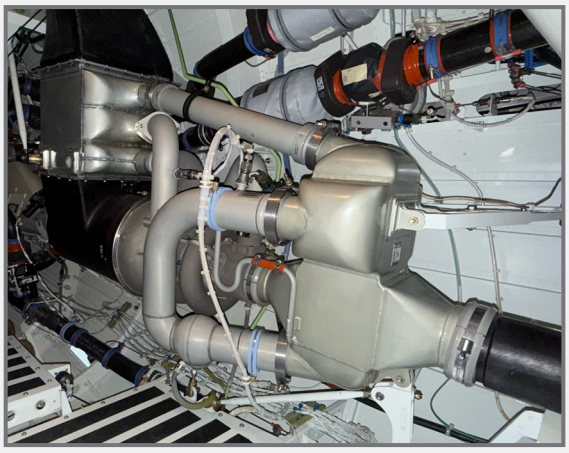
Fire Bottles

| EICAS MESSAGES | |
|---|---|
| FIREX APU SQUIB FAIL | FIREX BTL 1 LOW |
| FIREX BTL 1 (2) FAULT | FIREX BTL 2 LOW |



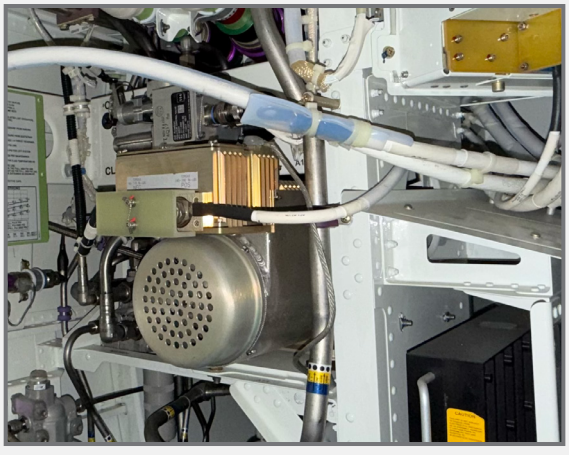
Fire Detection & Extinguishing System

| EICAS MESSAGES | |
|---|---|
| FIRE SYS FAULT | FIRE SYS FAULT |
| L FIRE DET FAIL | FIRE SYS IN TEST |
| R FIRE DET FAIL | FIRE SYS TEST OK |



Pneumatic Air Cycle Kit (PACK) / TRIM Air

| EICAS MESSAGES | |
|---|---|
| PACK LEAK | TRIM AIR FAIL |
| TRIM AIR LEAK | TRIM AIR LOOP FAIL |
| AIR COND TEMP FAIL | AIRCOND FAULT |
| AIR COND TEMP HIGH | PACK COOL AIR FAIL |
| PACK FAIL | PACK ONLY |
| PACK LOOP FAIL | TRIM AIR ONLY |
| PACK TEMP HIGH | |



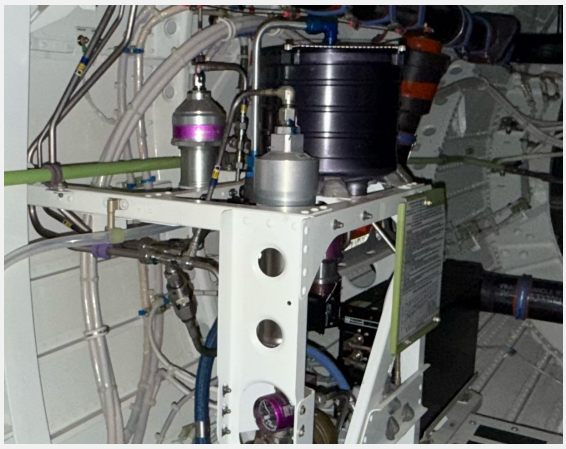
Left Hydraulic DC Motor-Driven Pump (DCMP)

| EICAS MESSAGES | |
|---|---|
| HYD PRESS LOW | L HYD DC PUMP FAIL |
| L HYD PRESS LOW | L HYD SOV CLOSED |
| L HYD SOV FAIL | HYD PUMP NOT AUTO |
| L HYD TEMP HIGH | L HYD SOV CLOSED |



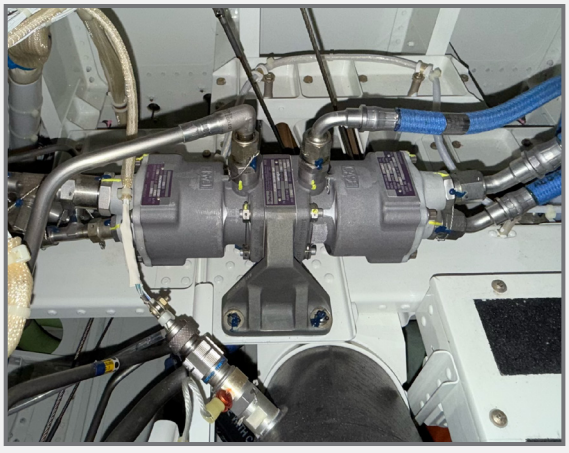
Right Hydraulic DC Motor-Driven Pump (DCMP)

| EICAS MESSAGES | |
|---|---|
| HYD PRESS LOW | R HYD DC PUMP FAIL |
| R HYD PRESS LOW | R HYD SOV CLOSED |
| R HYD SOV FAIL | HYD PUMP NOT AUTO |
| R HYD TEMP HIGH | R HYD SOV CLOSED |



AUX DC Motor-Driven Pump (DCMP)

| EICAS MESSAGES |
| --- |
| AUX HYD PUMP FAIL ON |
| AUX HYD SYS FAIL |
| AUX HYD TEMP HIGH |



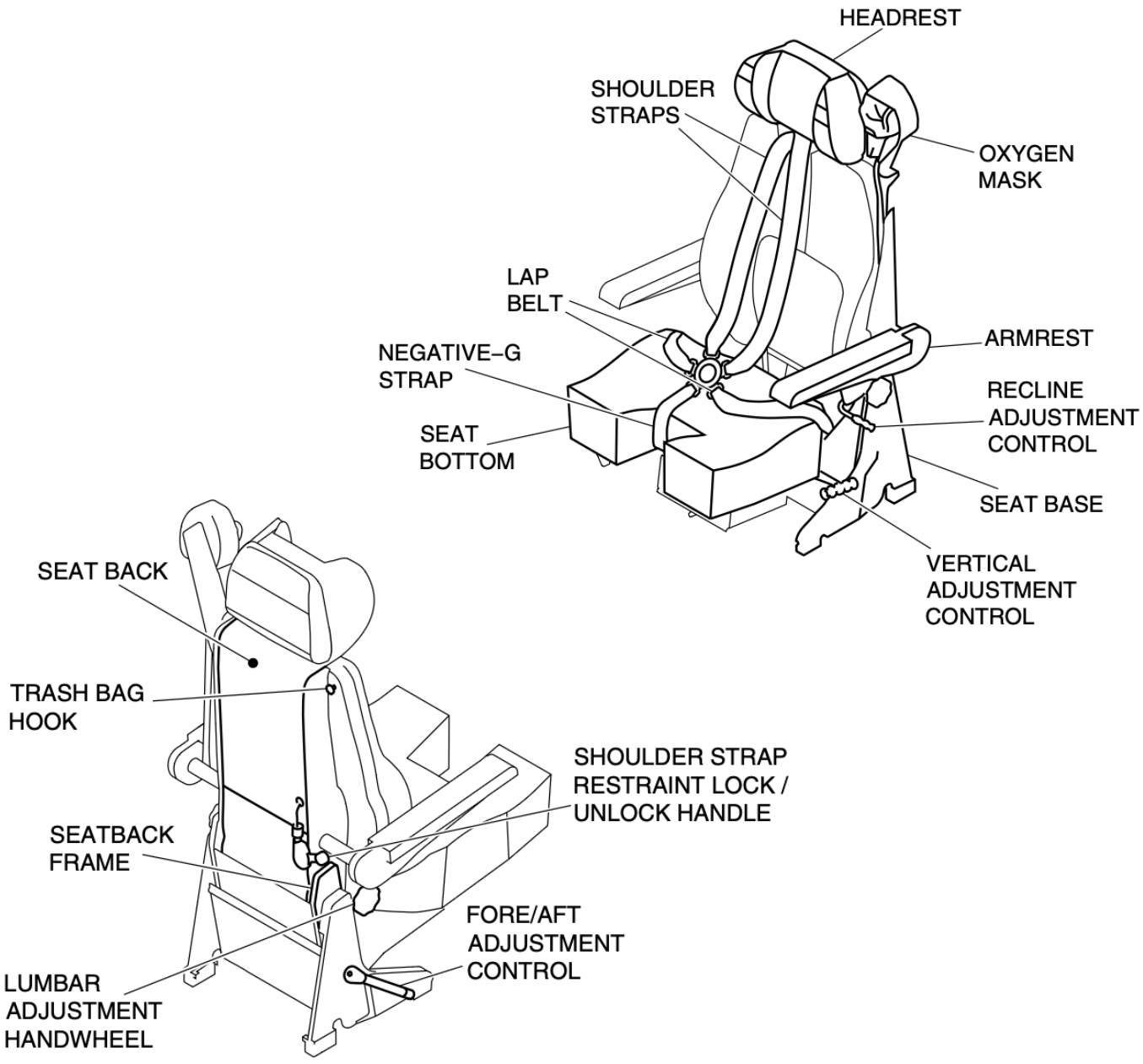
Hydraulic Power Transfer Unit (PTU)

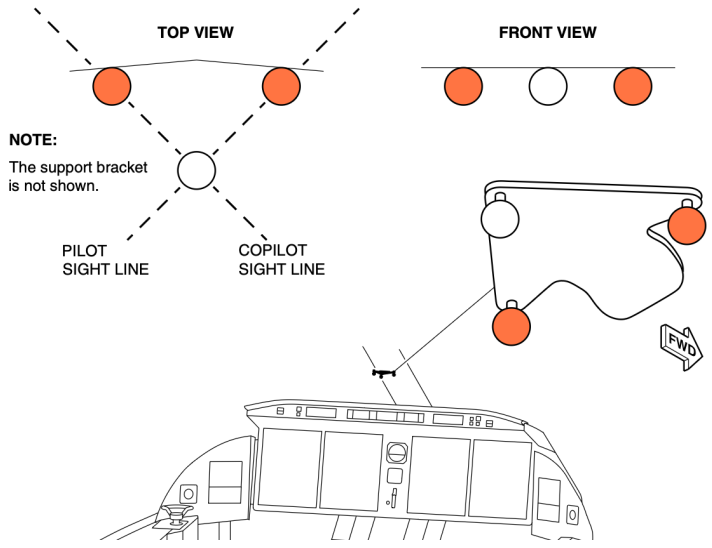
| EICAS MESSAGES |
| --- |
| HYD PTU FAIL |

# V. PRESSURIZED SECTION

## A. FLIGHT DECK

- Two crew stations
- Cockpit seats can be moved fore and aft, up and down, and tilted
- Cockpit seats should be adjusted vertically with the aid of the eye locator located below the



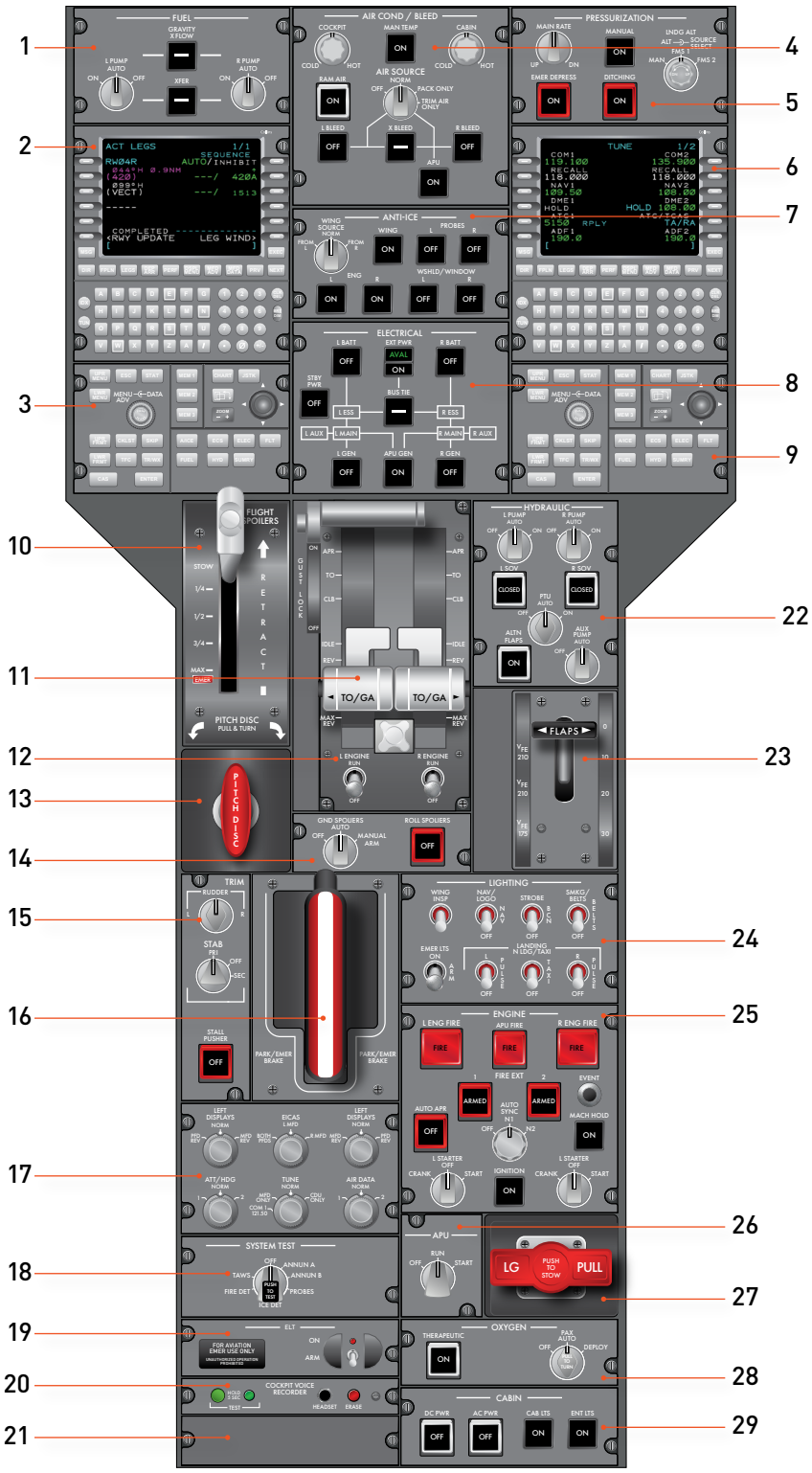



## B. CABIN

### COCKPIT LAYOUT

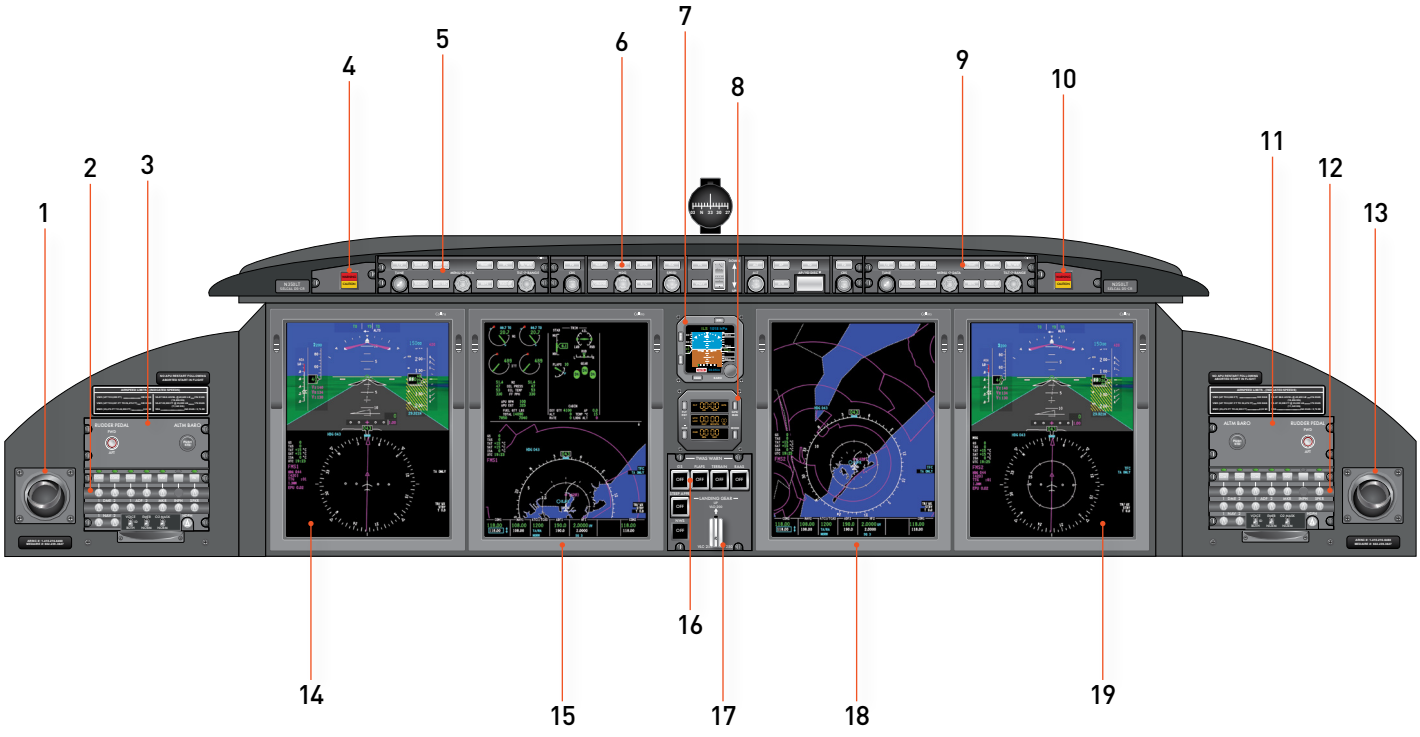


## CENTER PEDESTAL




1. Fuel Panel
2. FMS Control Display Unit (optional)
3. MFD Control Panel (standard)
4. Air-Conditioning/Bleed-Air Panel
5. Pressurization Panel
6. FMS Control Display Unit (standard)
7. Anti-ice Panel
8. Electrical Panel
9. MFD Control Panel (optional)
10. Flight Spoilers Handle
11. Thrust Levers
12. Engine Run Switch Panel
13. Pitch Disconnect Handle
14. Ground Spoilers/Roll Spoilers Panel
15. Trim and Stall Panel
16. Park/Emer Brake Handle
17. Reversion Panel
18. System Test Panel
19. ELT Panel
20. Cockpit Voice Recorder Panel
21. Cabin Control Panel
22. Hydraulic Panel
23. Flap Lever
24. Lighting Panel
25. Engine Panel
26. APU Switch
27. Landing Gear Manual Release Handle
28. Passenger Oxygen Panel
29. Cabin Control Panel

## INSTRUMENT PANEL



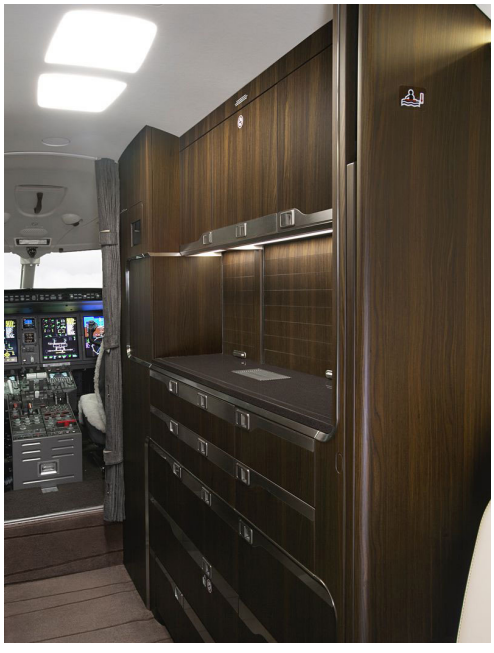

1. Air Outlet
2. Pilot Audio Control Panel
3. Pilot Compass/Baro/Rudder Pedal Adjusment
4. Master Waring/Caution
5. Pilot Display Control Panel (DCP)
6. Flight Guidance Panel (FGP)
7. Standby Instrument Panel
8. Clock
9. Copilot Display Control Panel (DCP)
10. Master Warning/Caution
11. Copilot Compass/Baro/Rudder Pedal Adjustment
12. Copilot Audio Control Panel
13. Air Outlet
14. Left Primary Flight Display (PDF)
15. Left Multifunction Display (MFD)
16. Taws Warning Panel
17. Landing Gear Handle
18. Right Multifunction Display (MFD)
19. Right Primary Flight Display (PFD)

The cabin features eight passenger seats arranged in a dual club configuration, with each seat equipped with an individual reading light, air vent, and concealed oxygen mask. An optional divan layout can accommodate nine passengers while providing sleeping accommodations, and adding the optional belted lavatory further increases capacity to ten passengers.



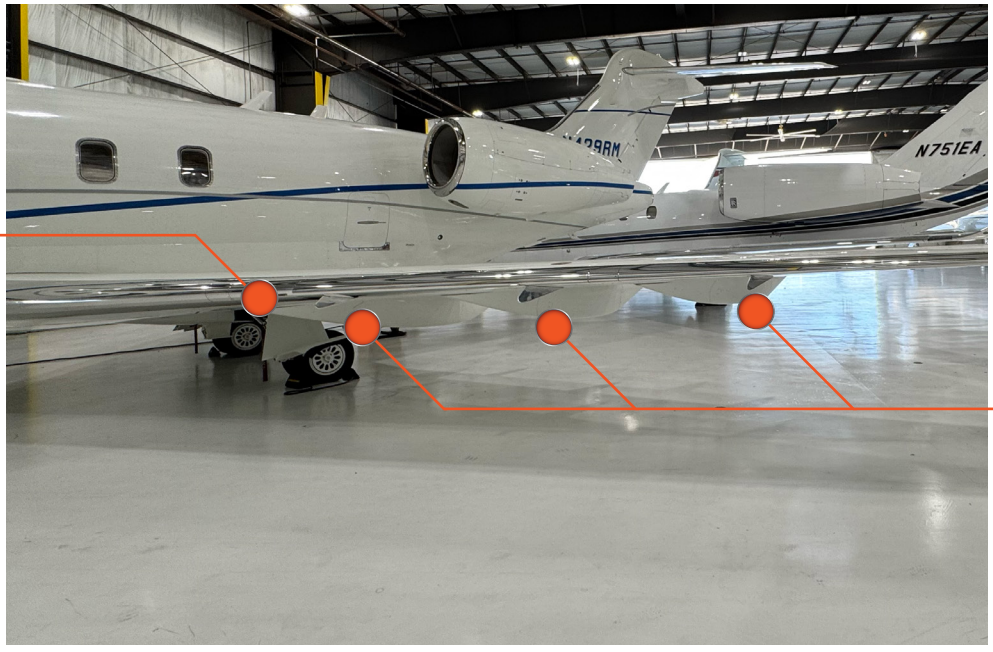
**Additional features:**

- Galley with microwave or optional high-temperature oven and hot coffee station
- Wardrobe
- Externally serviced Lavatory
- Unrestricted and safe access to a 106 ft³ cargo/baggage compartment



## VI. WINGS

Three Vortilons and slightly drooped outboard leading edge prevent spanwise flow along the 27%-swept supercritical wing without the need for traditional fences.






Wing Droop

## VII. STATIC DISCHARGE SYSTEM

Static wicks are installed to safely dissipate accumulated electrical charge from the aircraft during flight operations.
Static Wick Configuration

**Total Installation: 24 static wicks distributed across the aircraft**

1. Wing surfaces:
    - Winglets: 3 wicks per winglet (6 total)
    - Ailerons: 3 wicks per aileron (6 total)
2. Empennage surfaces:
    - Elevators: 3 wicks per elevator (6 total)
    - Rudder: 2 wicks (2 total)
3. Fuselage locations:
    - APU exhaust tailcone: 2 wicks (2 total)
    - Rear navigation light: 2 wicks (2 total)

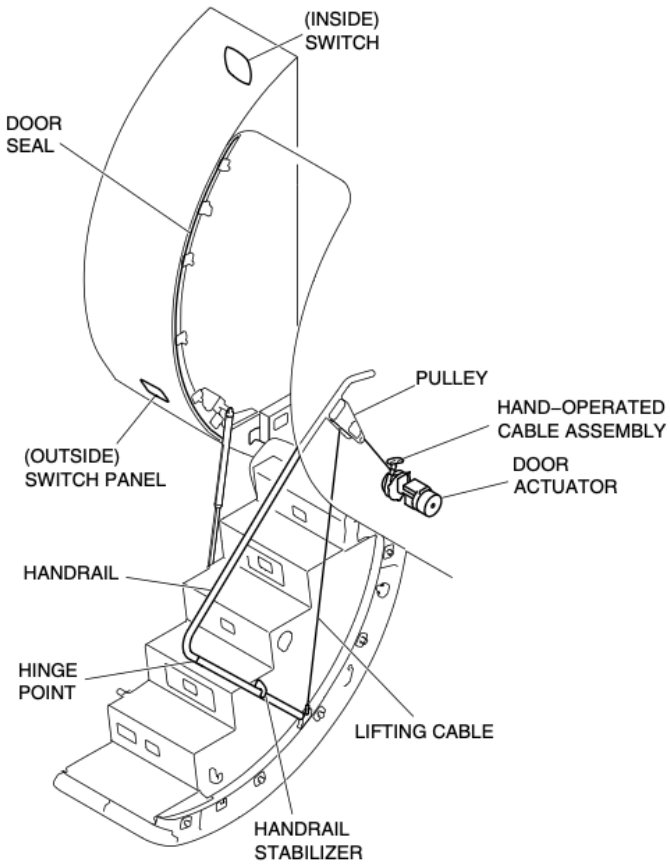
## VIII. MAIN CABIN ENTRY DOOR

### A. DESCRIPTION

The passenger/crew (cabin) entry door is located on the left side of the fuselage at the forward end of the passenger compartment.

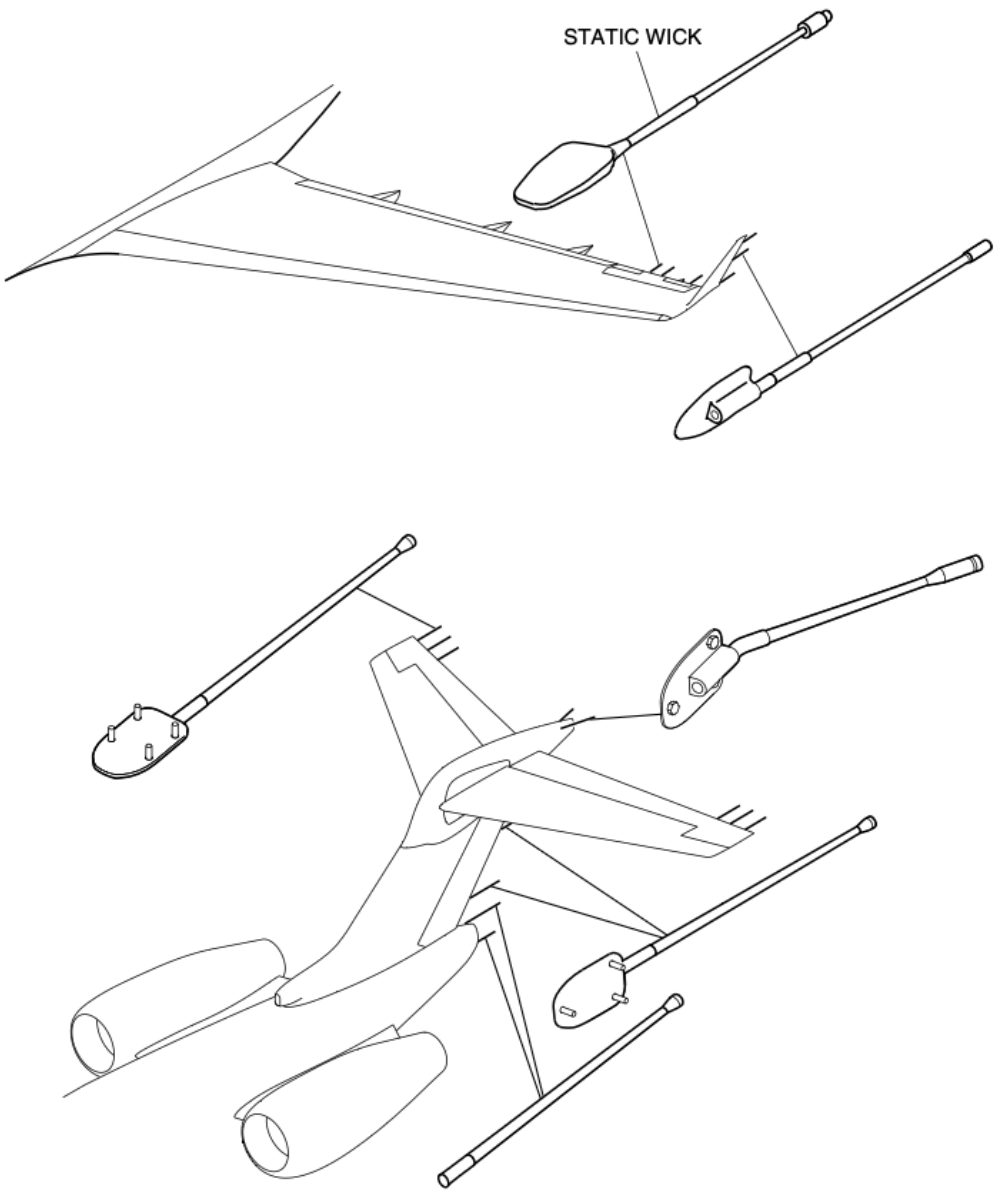
**Door Components and Features**

1. Ventilation and safety system:
    - Small vent flap (no window present)
    - Vent flap directly connected to pressure lock lever
    - Safety mechanism ensures cabin pressure equalizes to ambient pressure before door will open
2. Structural design:
    - Goose-neck hinge at door centerline connects to fuselage
    - Engineered to open outward and downward
    - Door seats within a channel in the fuselage when closed and locked
3. Integrated features:
    - Integral stairs with embedded stairway lighting
    - Two-part folding handrail on aft side of door



- Handrail unfolds parallel to stairs during door opening
- Two telescopic support struts control door movement
- Actuator assembly functions as inertia-reel to manage door descent

4. Lifting mechanism:
    - Door must move vertically upward from fuselage channel before swinging outward
    - Cam on primary shaft of latch mechanism applies force to lever
    - Lever moves door vertically when handles are operated
    - System engages when inside handle rotates to full up position or external handle lifts upward

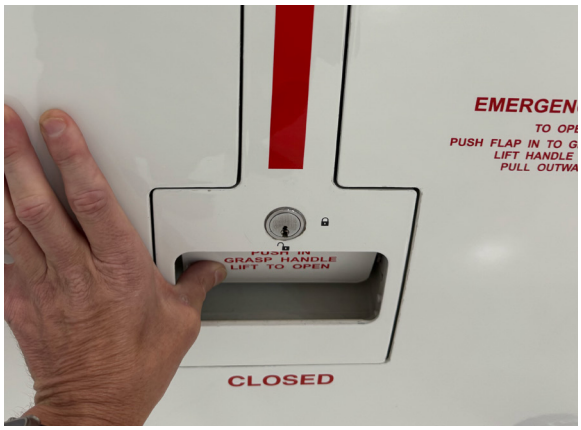



**STATIC WICKS**

## B. DOOR OPENING PROCEDURES

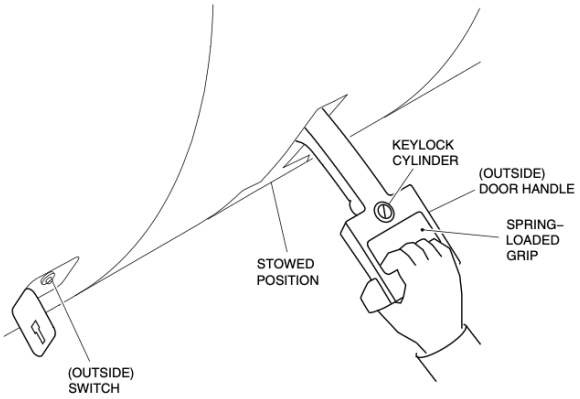
### Opening from Outside

1. Access the handle:
    - Push in the spring-loaded flap
    - Grasp the handle inside the flap
2. Operate the handle:
    - Pull the handle out from its recess
    - Rotate handle upward approximately 110° until it stops
    - Door will open via gravity and freefall




### Opening from Inside

1. Operate the interior handle:
    - Grasp the handle to the right of the large OPEN arrow
    - Pull upward approximately 100° while pushing door outward to arm's length
2. Complete the opening:
    - Door lifting and lock disengagement occurs automatically
    - Gravity assists door in opening outward and downward
    - Door reaches fully open position and lock function engages
    - Locking mechanism prevents excessive









## C. DOOR CLOSING PROCEDURES

### Electric Closing from Outside

1. Access controls:
    - Open the Passenger Door Operating Switch door
2. Execute electric closing:
    - Push and hold the door close button
    - Wait for electric motor to tighten retraction cable (may take several seconds)
    - Door will begin closing automatically
3. Complete the locking:
    - Continue holding button while door




### Manual Closing from Outside

1. Lift the door:
    - Physically lift door by pushing upward to closed position
    - Hold door in position (two-person operation may be required due to weight)
2. Lock the door:
    - Pull down on locking handle while maintaining door position
    - Release door only after handle is fully seated



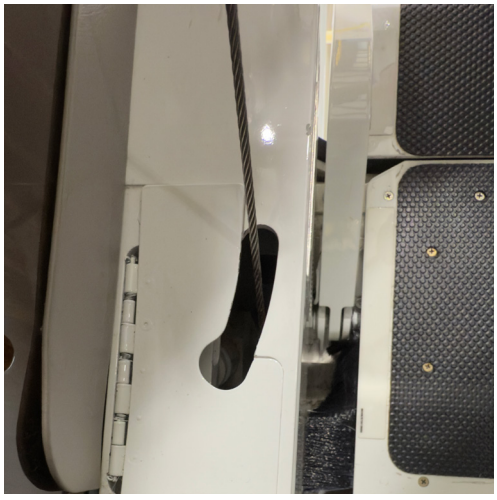

### Electric Closing from Inside

1. Operate electric controls:
    - Push and hold door retract switch on bulkhead (right of door)
    - Maintain pressure until door reaches closed position
2. Engage locking mechanism:
    - Continue holding button while pressing down on interior door lever
    - Rotate lever through 100° of travel
    - Verify green locked indicator is visible



**Manual Closing from Inside**

1. Access manual controls:
    - Open actuator housing on left side of door
    - Locate T-handle inside housing
2. Raise the door:
    - Repeatedly pull T-handle to wrap lifting cable into actuator
    - Use additional assist handle near top of
    - door as it nears closed position
3. Complete closure:
    - Pull door fully closed using assist handle
    - Engage locking handle to secure door



## D. SEALING SYSTEM

When closed and locked, the door mechanism pulls the door inward against a flexible seal made of silicone rubber and fabric lining the door frame.

This seal minimizes pressurization leaks and prevents water ingress, particularly critical in ditching scenarios.



A small cubby hole on the aft side of the door provides storage for gear pins.

## E. LIMITATIONS

- 1000 lbs Maximum Load Capacity
- Maximum of 3 Passengers are allowed on the stairway.

A PASSENGER DOOR caution (C) CAS message is displayed if the passenger door is not fully closed and the following conditions exist:

- The aircraft is on the ground with the left engine run switch in the ON position.
- The aircraft is in flight and the passenger door rollers are not fully engaged into the fitting guides.

# IX. CARGO COMPARTMENT

## A. SPECIFICATIONS

The cargo compartment is located aft of the lavatory and provides full accessibility from inside the aircraft during flight and from an external cargo door while on the ground. The cargo door is not certified as an emergency exit.

Door must be unlocked prior to taxi, takeoff, and landing.

**Cargo Compartment Specifications**

1. Capacity and limits:
    - Approximately 106 ft³ of baggage/cargo space
    - Maximum weight: 750 lbs
    - Loading limit: 400 lbs per longitudinal foot
2. Lighting systems:
    - Interior cargo light powered by left battery bus
    - Light shuts off automatically when cargo bay door closes
    - Controlled by switch inside cargo area or on lighting panel at main door
    - Exterior cargo light located directly below left engine pylon
    - Exterior light controlled by switch accessible when cargo door is open
3. Safety systems:
    - Smoke detector installed in cargo area
    - Detector triggers master warning light, audible chime, and CARGO SMOKE red EICAS message
4. Associated equipment:
    - 2.5-gallon potable water tank located forward of cargo door



Potable Water Tank

The cargo compartment door is a plug-type door located forward of the left engine nacelle. The door operates from inside or outside the aircraft and opens inward, moving upward on a roller/track assembly. A balance spring and cable assembly assists with door weight management.

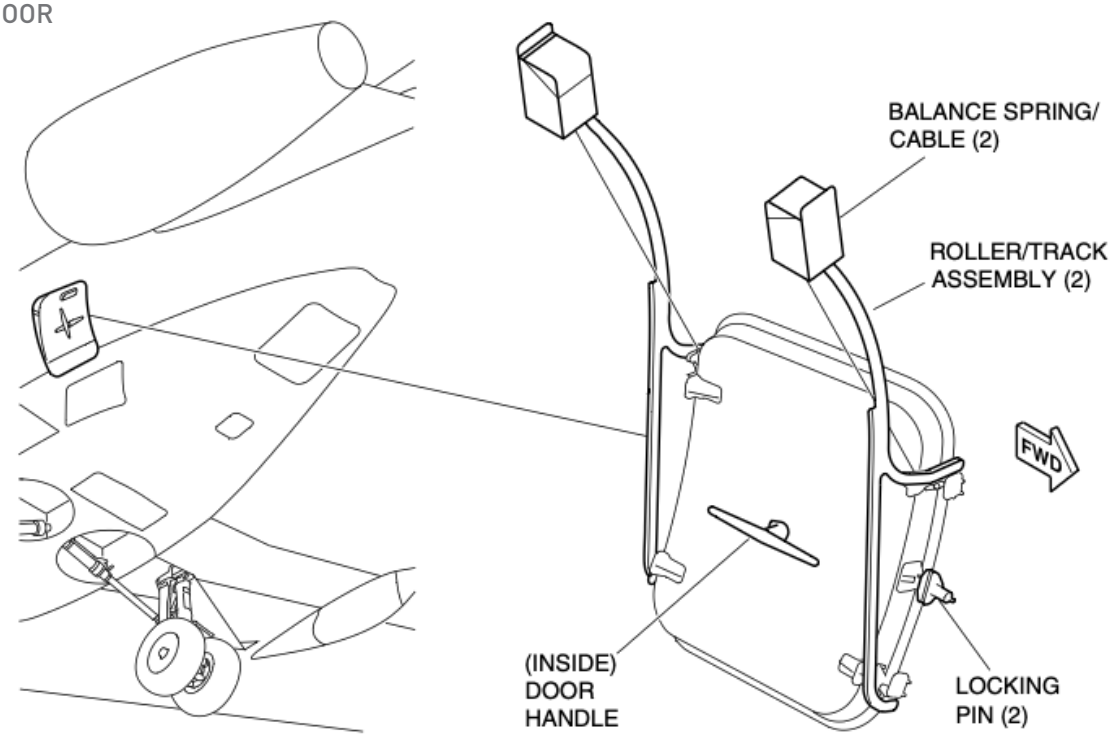
## B. CARGO DOOR OPERATION

**Opening from Outside**

1. Release the handle:
    - Press in on the trigger-lock in the handle
    - Handle will pop out from its recessed position
    - Overhead vent will open automatically
2. Open the door:
    - Rotate handle counterclockwise to 12 o'clock position
    - Push door inward and upward
    - Use hand strap to control door movement or pull door back down



CARGO BAY DOOR




**Opening from Inside**

1. Access interior controls:
    - Lift the blocking cover to expose handle release button
2. Operate the door:
    - Press in on handle release button
    - Push handle toward the door
    - Rotate handle to 12 o'clock position
    - Door will move inward and upward for cargo loading access




**Closing from Outside**

1. Position the door:
    - Grasp the hand strap
    - Pull door down and outward while maintaining control
2. Lock the door:
    - While holding door in position, rotate locking handle clockwise 90° to closed position
    - Press handle back into recessed position
    - Vent will close automatically

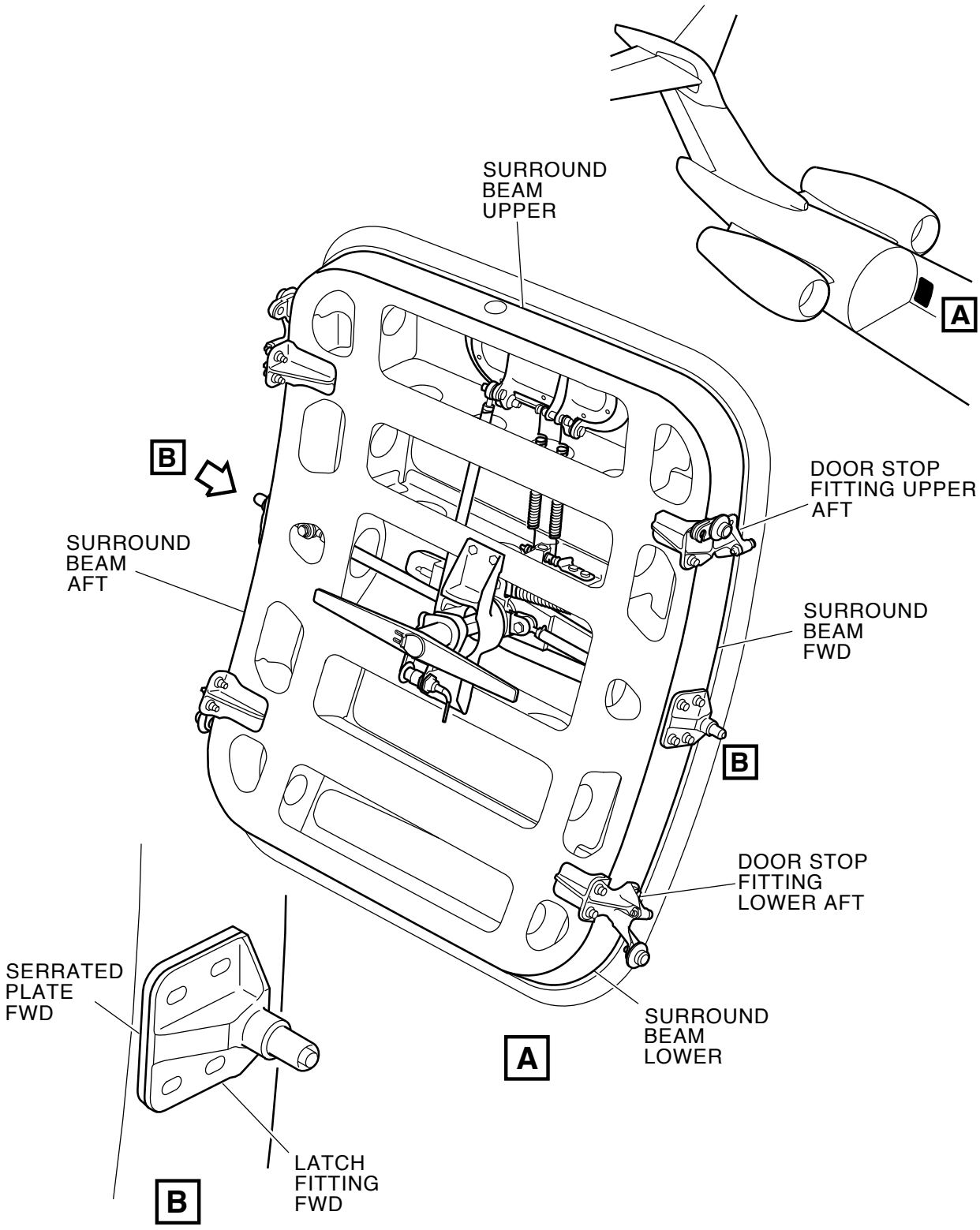
**Closing from Inside**

1. Lower the door:
    - Slide door down ensuring hand strap remains clear of door path
    - Ensure door reaches fully down position
2. Secure the door:
    - Push door outward to seated position
    - Rotate locking handle 90° clockwise to closed position
    - Pull handle toward you until it locks back into position




A **CARGO DOOR** (C) CAS message is displayed anytime the left engine run switch is selected ON. Otherwise, the **CARGO DOOR** (S) CAS message isilluminated.

**CAUTION:** The cargo door cannot be opened while aircraft is pressurized. The door incorporates a vent flap directly tied to a pressure lock lever to ensure cabin pressure equalizes to ambient pressure before opening.




Surround Structure and Fittings of the Baggage Door – Inspection/Check

# X. EMERGENCY EXIT

## A. DESCRIPTION

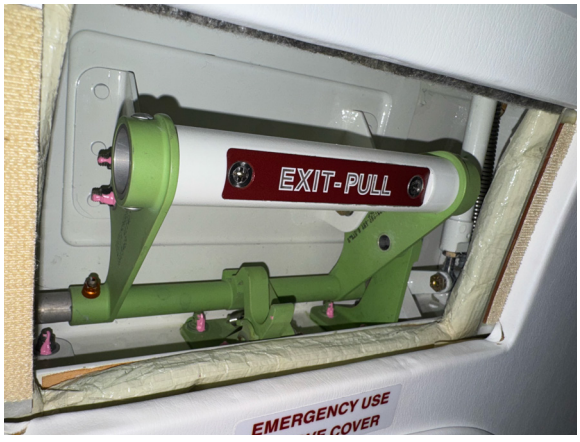
- The emergency exit is located on the right side of the fuselage at the rear of the passenger compartment
- Type III Plug type door – installed or removed from the inside or outside of the aircraft
- Approximately 40 lbs
- Interior locking pin prevents handles from moving, which locks the door from outside entry. Locking pin must be removed prior to flight
- Alternate exit in the event of a crash landing or evacuation
- Primary exit in the event of ditching




CARGO DOOR
INTERIOR CLOSED




Locking Pin Installed




Locking Pin Removed

## B. REMOVAL PROCEDURES (INTERIOR)

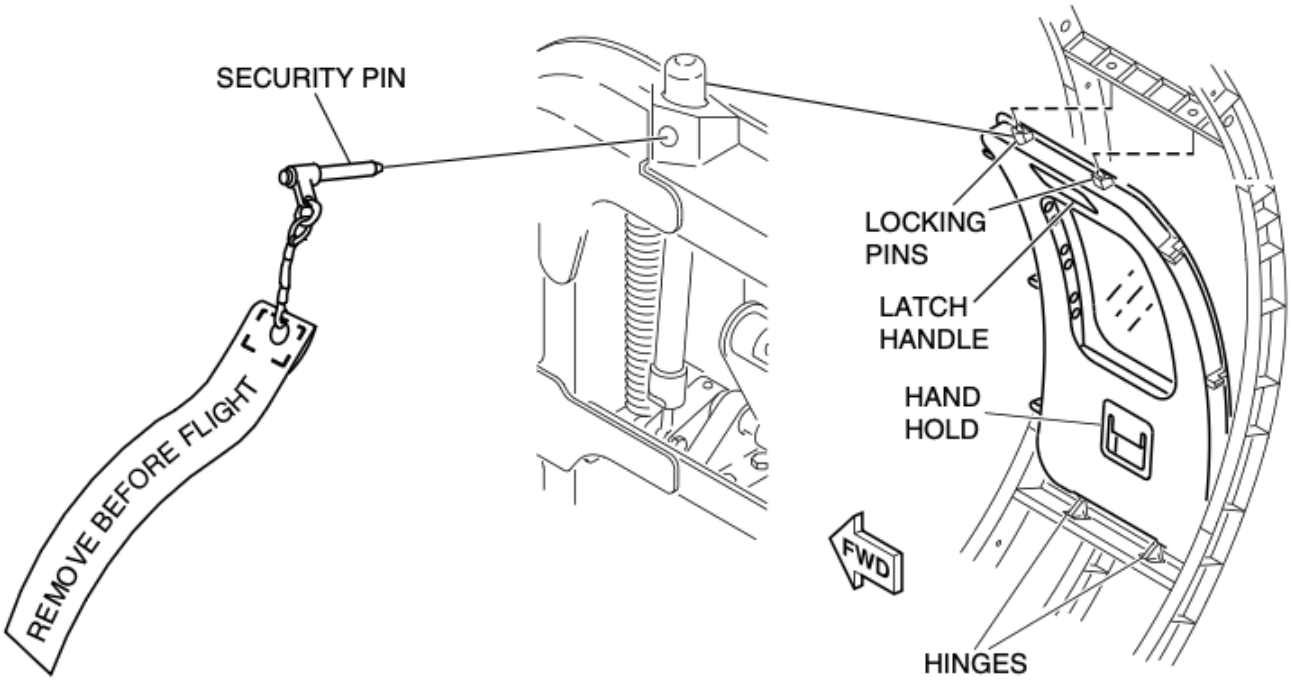
CAUTION: Emergency exit cannot be removed while aircraft is pressurized.

1. Prepare the exit:
    - Remove the upper handle cover and discard
    - Locate the cupholders at the bottom of the emergency exit
2. Expose the handles:
    - Grasp both cupholders firmly
    - Pull cupholders toward the aircraft centerline
    - Cupholders will rotate outward and downward
    - This exposes the bottom handle and ditching rope

3. Remove the exit:
    - Grasp the EXIT-PULL handle with one hand
    - Hold the lower handle with your other hand
    - Tilt the EXIT-PULL handle toward you
    - As the exit rotates inward, lift it clear of the fuselage
    - Place the removed exit inside the cabin, out of the evacuation path





## C. REMOVAL PROCEDURES (EXTERIOR)

CAUTION: Emergency exit cannot be removed while aircraft is pressurized.

1. Access the interior mechanism:
    - Locate the exterior flap on the emergency exit
    - Push in on the exterior flap to open access panel
    - Reach through the opening to locate the hatch handle inside
2. Disengage the exit:
    - Push the hatch handle forward until the exit disengages from its locking mechanism
    - Ensure you feel or hear the disengagement before proceeding
3. Remove the exit:
    - Grasp the exit firmly with both hands
    - Lift the exit straight out of its track
    - Guide the exit into the cabin interior
    - Position the removed exit clear of the emergency exit opening

## D. DITCHING PROCEDURES

**NOTE:** Three life rafts are located in the aircraft.

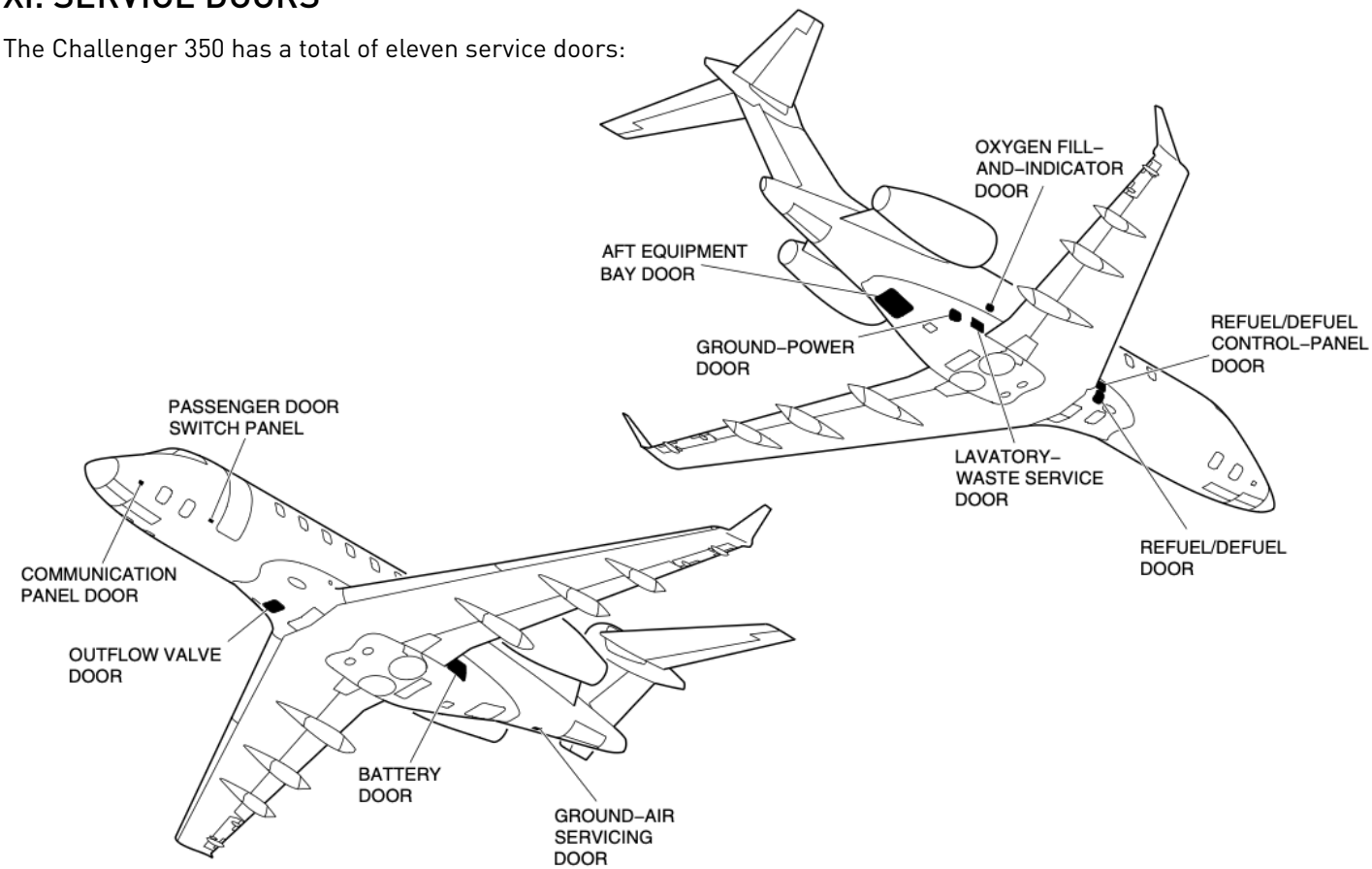
1. Locate ditching equipment:
    - Find the ditching rope below the emergency exit (exposed in interior removal step 2 above)
    - Identify the ditching ring on the exterior of the aircraft
2. Secure the rope:
    - Attach one end of the ditching rope to the exterior ditching ring
    - Secure the other end of the rope to the life raft
    - Verify both connections are secure before evacuation

An **EMERGENCY EXIT** (C) CAS message is displayed if the proximity sensor detects that the emergency exit hatch is not completely closed with the locking pins fully engaged.



## XI. SERVICE DOORS

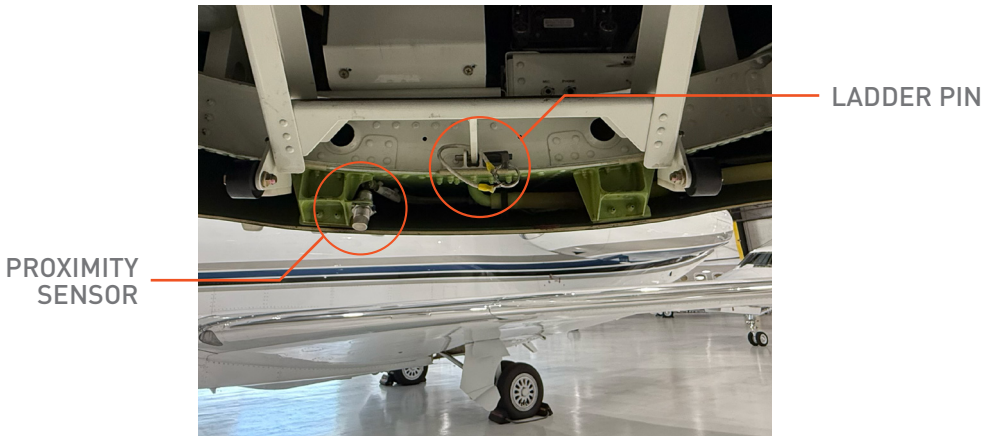
The Challenger 350 has a total of eleven service doors:




### A. AFT EQUIPMENT BAY DOOR

- Lever-style latch system
    - Dual locking cams for secure closure
    - Designed for reliable engagement in all operating conditions
- Integrated support strut
    - Automatically supports door in open position
    - Prevents door damage from wind or movement
- Small access ladder permanently installed
    - Pinned into place at the rear of the access hole when secured
    - When unpinned it will fold down and must be locked into position with a locking pin on each side of the ladder
- Proximity Sensor monitors door status
    - Alerts flight crew if not properly secured
    - Door must be unlocked prior to taxi, takeoff, and landing

An **AFT EQPT BAY DOOR** (C) CAS message is displayed if the aft equipment bay door is not closed.




## B. HIGH PRESSURE PNEUMATIC SUPPLY DOOR

- Ground connection to a high-pressure air source for engine starting.






## C. GROUND POWER SUPPLY ACCESS DOOR

- Connection for ground power
- Lamp Test button
- Guarded APU Shutdown switch



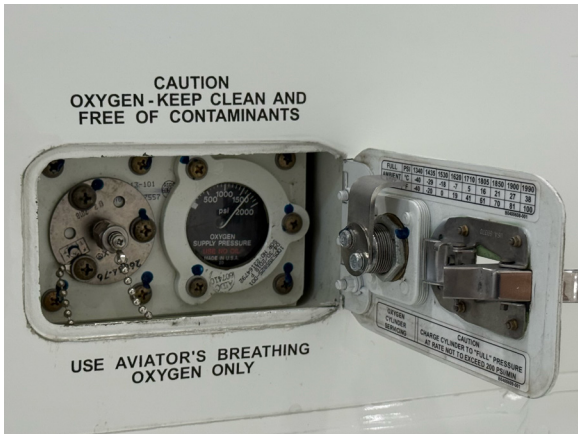
## D. LAVATORY WASTE ACCESS DOOR

- Allows external servicing of the lavatory.



## E. OXYGEN SERVICE DOOR

- External servicing port for oxygen Bottles located in the lavatory.



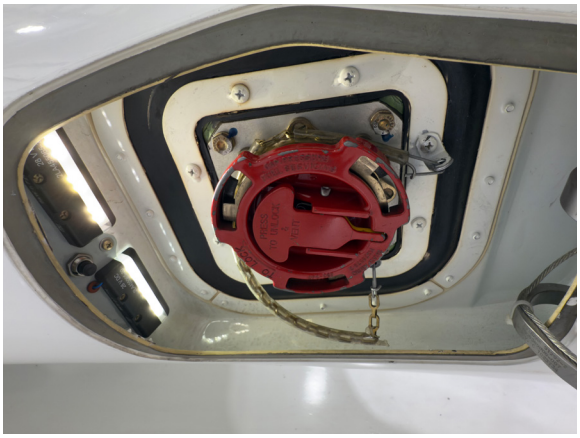

## F. REMOTE OIL LEVEL SENSOR (ROLS)/ FUEL PANEL

- ROLS panel allows the pilot to check the level of oil in the engines and manage fueling the aircraft.



## G. SINGLE POINT FUEL POINT DOOR

- Provides access to single point



## H. OUTFLOW VALVE DOOR

- Allows access to the pressurization outflow valve
- Door must be unlocked prior to taxi, takeoff, and landing
- Lever-style latch system
- Dual locking cams for secure closure
- Designed for reliable engagement in all operating conditions refueling system.



## I. GROUND COMMUNICATION DOOR

- Allows ground crew the ability to communicate with the flight crew.



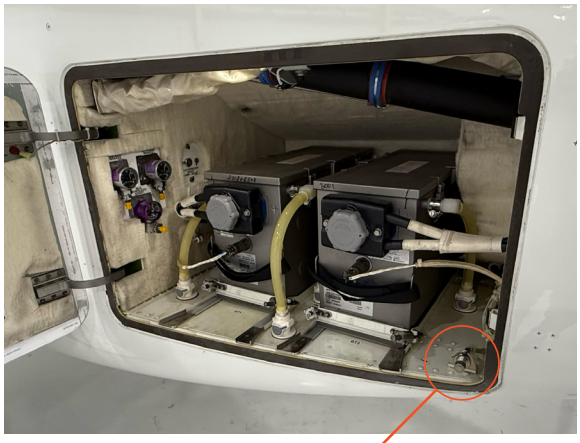
### J. MAIN CABIN PASSENGER DOOR OPERATING SWITCH DOOR

- Houses the controls for the main cabin door.




### K. BATTERY COMPARTMENT DOOR

- Houses the two ships batteries
- Door must be unlocked prior to taxi, takeoff, and landing
- Lever-style latch system
    - Dual locking cams for secure closure
    - Designed for reliable engagement in all operating conditions




## XII. DOOR WARNING SYSTEM

### A. DESCRIPTION

The door warning system provides continuous monitoring of critical aircraft doors during ground operations and flight. The system ensures flight crew awareness of door status through integrated visual and aural alerts via the EICAS display system.

### B. MONITORED DOORS

- Passenger door - Main cabin entry door
- Emergency exit - Over-wing Type III exit
- Cargo bay door - Forward left fuselage cargo access
- Aft equipment bay door - Rear fuselage maintenance access
- Battery bay door - Left aft wing-fuselage fairing access

## C. SYSTEM COMPONENTS

1. Proximity sensors
    - Electronic magnetic sensors installed at each monitored door
    - Interface with Proximity Sensor Electronic Unit (PSEU)
    - Provide precise door position feedback
2. Proximity Sensor Electronic Unit (PSEU)
    - Central processing unit for all door position signals
    - Interfaces with Data Concentrator Unit (DCU)
3. Data Concentrator Unit (DCU)
    - Processes sensor data for EICAS display
    - Generates appropriate warning messages and priorities
4. Multifunction Display (MFD)
    - Displays door warning messages through EICAS system
    - Provides visual indication with appropriate color coding

## D. SYSTEM OPERATION

**Ground Operations:**

- Door warnings display as CAUTION (amber) messages
- **PASSENGER DOOR** and **CARGO DOOR** cautions also trigger when left engine run switch is ON

**Flight Operations:**

- All door warnings display as CAUTION (amber) messages
- System remains active throughout flight envelope

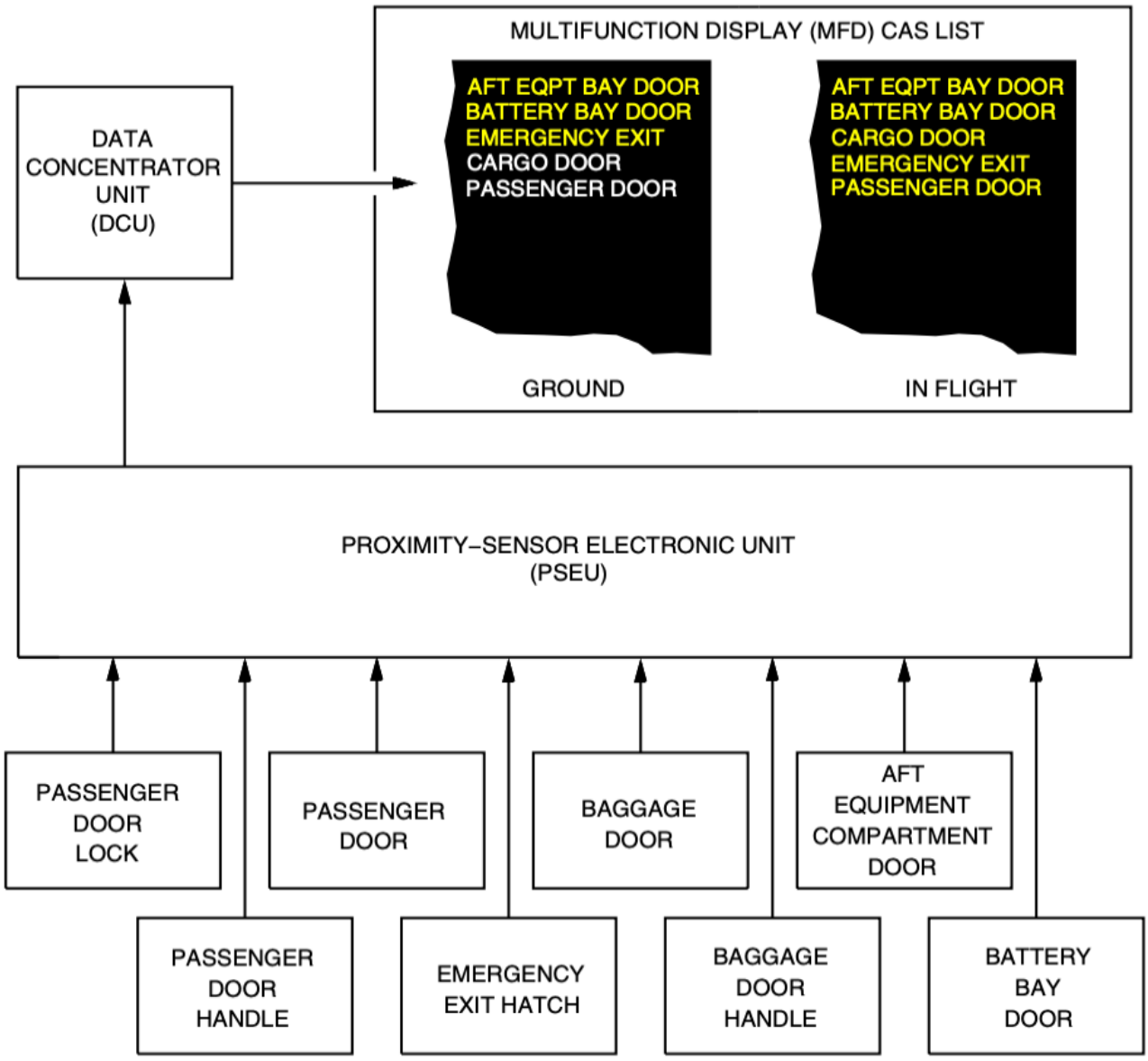
**Alert Response:**

- Single chime accompanies each caution message
- Messages remain displayed until door condition is corrected
- No message inhibits during critical flight phases

## E. EICAS INTEGRATION

The door warning system integrates seamlessly with the aircraft's Engine Indication and Crew Alerting System (EICAS), providing centralized door status monitoring consistent with all other aircraft systems.

**NOTE:** Each door caution message is accompanied by a single chime to ensure immediate crew awareness of door status irregularities.



# XIII. LIMITATIONS

## A. WEIGHT LIMITATIONS

| Parameter | Weight |
|---|---|
| Maximum Ramp Weight (MRW) | 40,750 lbs |
| Maximum Takeoff Weight (MTOW) | 40,600 lbs |
| Maximum Landing Weight (MLW) | 34,150 lbs |
| Maximum Zero Fuel Weight (MZFW) | 28,200 lbs |
| Maximum Baggage Weight | 750 lbs |
| Minimum Flight Weight (MFW) | 24,800 lbs |

## B. SPEED LIMITATIONS

| Parameter | Speed |
|---|---|
| MMO Above 29,475 ft | 0.83 Mach |
| VMO 8,001 ft – 29,475 ft | 320 KIAS |
| VMO up to 8,000 ft | 300 KIAS |

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## XIV. STRUCTURES QUIZ

1. According to FAR Part 25, the Challenger 350 is certified as what category aircraft?

    A) Light Sport Category
    B) Normal Category
    C) Transport Category
    D) Utility Category

2. What is the maximum takeoff weight (MTOW) of the Challenger 350 aircraft?

    A) 38,500 lbs
    B) 40,750 lbs
    C) 40,600 lbs
    D) 34,150 lbs

3. Which of the following doors must be unlocked prior to taxi, takeoff, and landing?

    A) Main Cabin Entry Door
    B) High Pressure Pneumatic Supply Door
    C) Ground Power Supply Access Door
    D) Outflow Valve Door

4. What is the maximum operating speed (VMO) of the Challenger 350 when flying between 8,001 ft and 29,475 ft?

    A) 300 KIAS
    B) 265 KIAS
    C) 320 KIAS
    D) 0.83 Mach

5. What is the maximum baggage weight limit for the cargo compartment in the Challenger 350?

    A) 400 lbs
    B) 750 lbs
    C) 106 lbs
    D) 1,000 lbs

6. What type of hinge does the main cabin door utilize?

    A) Piano hinge
    B) Goose-neck hinge
    C) Continuous hinge
    D) Butt hinge

7. How many static wicks are installed on the Challenger 350 aircraft?

    A) 12
    B) 18
    C) 24
    D) 32

8. Which component is located in the Aft Equipment Bay of the Challenger 350?

A) ROLS Panel
B) Single Point Fuel Point
C) Flight Data Recorder (FDR)
D) Main Cabin Entry Door Operating Switch

9. The cargo compartment door of the Challenger 350 is described as what type of door?

A) Hinge-type door
B) Sliding door
C) Plug-type door
D) Gull-wing door

10. What is the maximum operating Mach number (MMO) for the Challenger 350 when flying above 29,475 ft?

A) 0.75 Mach
B) 0.80 Mach
C) 0.83 Mach
D) 0.85 Mach

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CL-350



CL-350 TRAINING MANUAL

# POWERPLANT 02

## AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

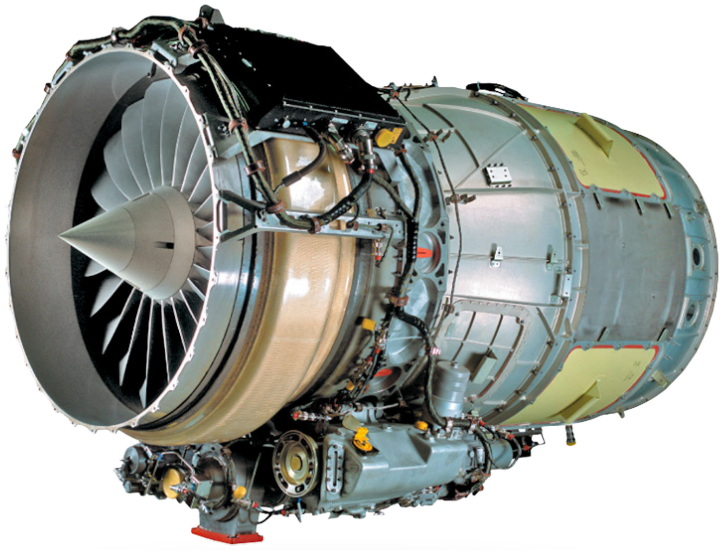
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# POWERPLANT HTF7350

## I. INTRODUCTION

The Bombardier Challenger 350 is powered by two Honeywell HTF7350 (AS907-2-1A) high-bypass turbofan engines. Each engine is mounted on the aft fuselage via a pylon structure and produces 7,372 pounds of thrust at takeoff power settings.

The engines feature Full Authority Digital Engine Control (FADEC) for optimal performance and efficiency across all flight regimes.





### A. ENGINE SPECIFICATIONS

| Parameter | Value |
|---|---|
| Engine Model | Honeywell HTF7350 (AS907-2-1A) |
| Type | High-bypass turbofan |
| Bypass Ratio | 4.2:1 |
| Takeoff Thrust (ISA) | 7,372 lbs |
| Flat Rating | ISA +15°C (86°F) at sea level |
| APR Flat Rating | ISA +20°C (95°F) |
| Fan Diameter | 34.2 inches |
| Dry Weight | 1,364 lbs |

### B. CERTIFICATION BASIS

The HTF7350 engines meet all applicable FAR Part 33 airworthiness standards for turbine engines and FAR Part 36 Stage 4 noise requirements.

# II. ENGINE CONSTRUCTION

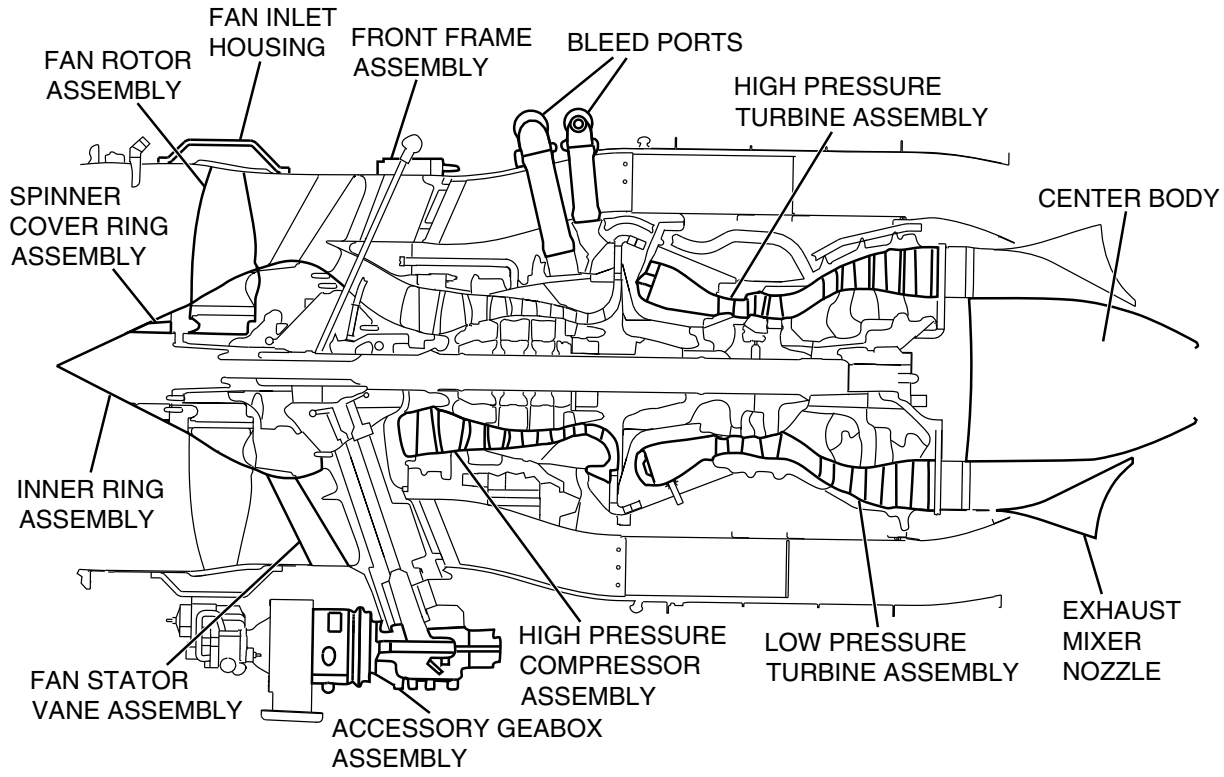
## A. MAJOR SECTIONS

The HTF7350 powerplant consists of two independent major assemblies operating on concentric shafts:

1. **$N_1$ Section (Low Pressure)**
    - Single-stage wide-chord fan with 22 titanium blades
    - Three-stage low-pressure turbine
    - Direct drive configuration
2. **$N_2$ Section (High Pressure)**
    - Four-stage axial compressor with two stages of variable geometry
    - Single-stage centrifugal compressor
    - Through-flow annular combustor with 16 fuel nozzles
    - Two-stage high-pressure turbine
    - Accessory gearbox

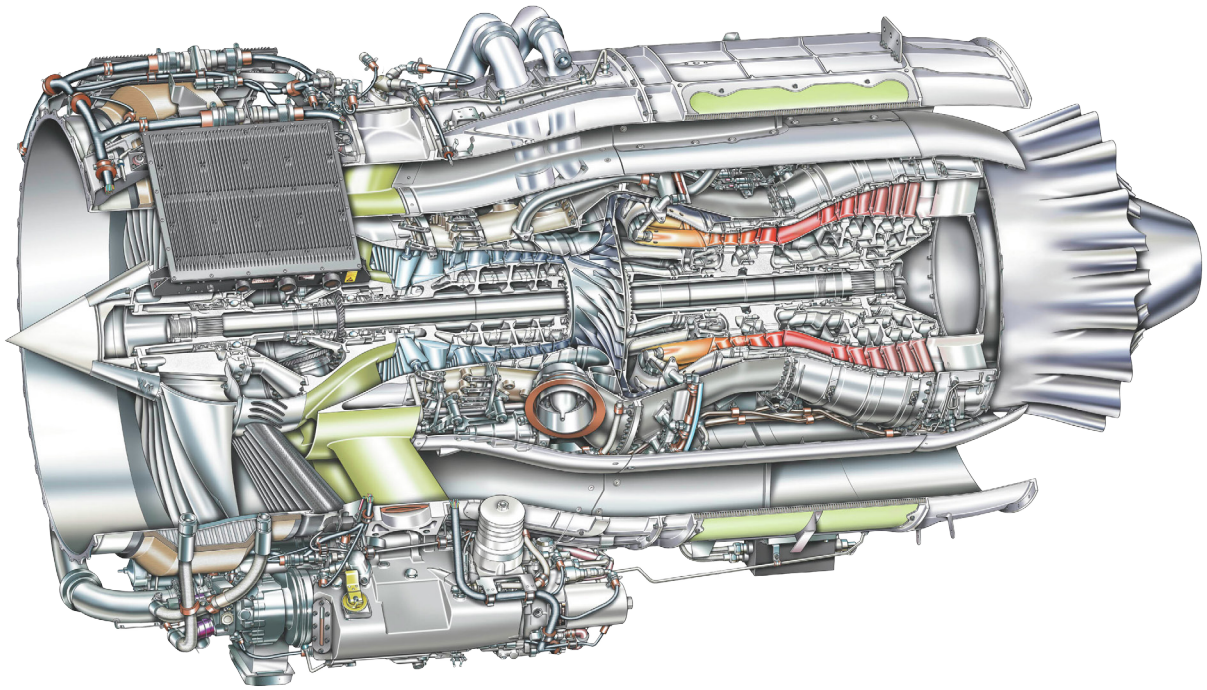
The $N_2$ compressor is a variable geometry (VG) axial flow compressor that is mechanically driven by the high-pressure turbine assembly. The VG system regulates airflow across the $N_2$ compressor by changing the position of the inlet guide vanes and the stator vane for the inlet and first stage of the compressor.

AS907 ENGINE SECTIONS



## B. AIRFLOW PATH

1. **Fan Section**
    - Inlet air accelerated by 22-blade titanium fan
    - Aluminum honeycomb containment with aramid fiber wrap
    - 4.2:1 bypass ratio splits airflow
2. **Core Path**
    - Four-stage axial compressor with variable geometry inlet guide vanes
    - Single-stage centrifugal compressor
    - Annular combustor with 16 fuel nozzles and 2 igniters
    - Two-stage high-pressure turbine
    - Three-stage low-pressure turbine
3. **Bypass Path**
    - Bypass air flows around engine core
    - Mixes with core exhaust at mixer nozzle
    - Provides majority of thrust at cruise conditions

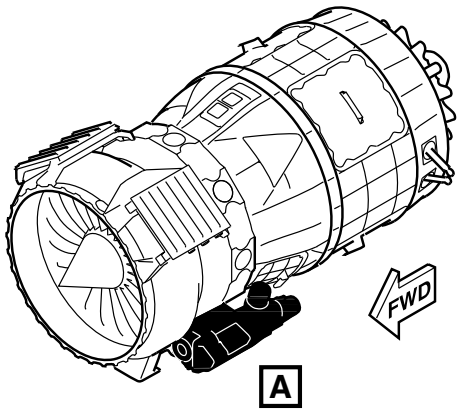


Honeywell AS907 (HTF7350)

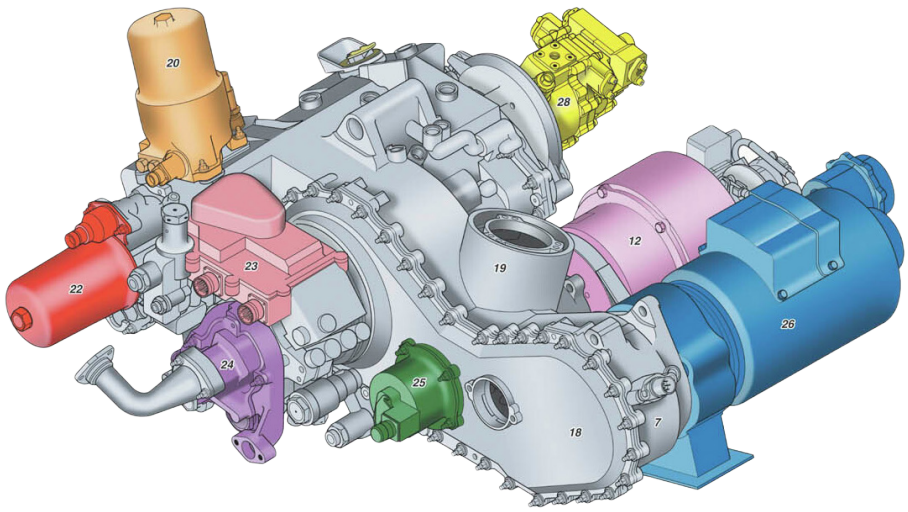
### C. ACCESSORY GEARBOX (AGB)

The accessory gearbox is mounted on the bottom of the engine and driven by the $N_2$ shaft through a tower shaft and bevel gears. Components include:

- Engine-driven hydraulic pump (EDP 1 or EDP 2)
- Engine-driven DC Generator
- Engine fuel pump and fuel metering unit (FMU)
- Air turbine starter
- Integral oil reservoir
- Permanent magnet alternator (PMA)(FADEC)
- Engine lubrication pumps




The PMA provides three-phase power to each engine control unit (ECU). The PMA is designed to provide the electric power required by the control system and engine at and above 45% $N_2$.

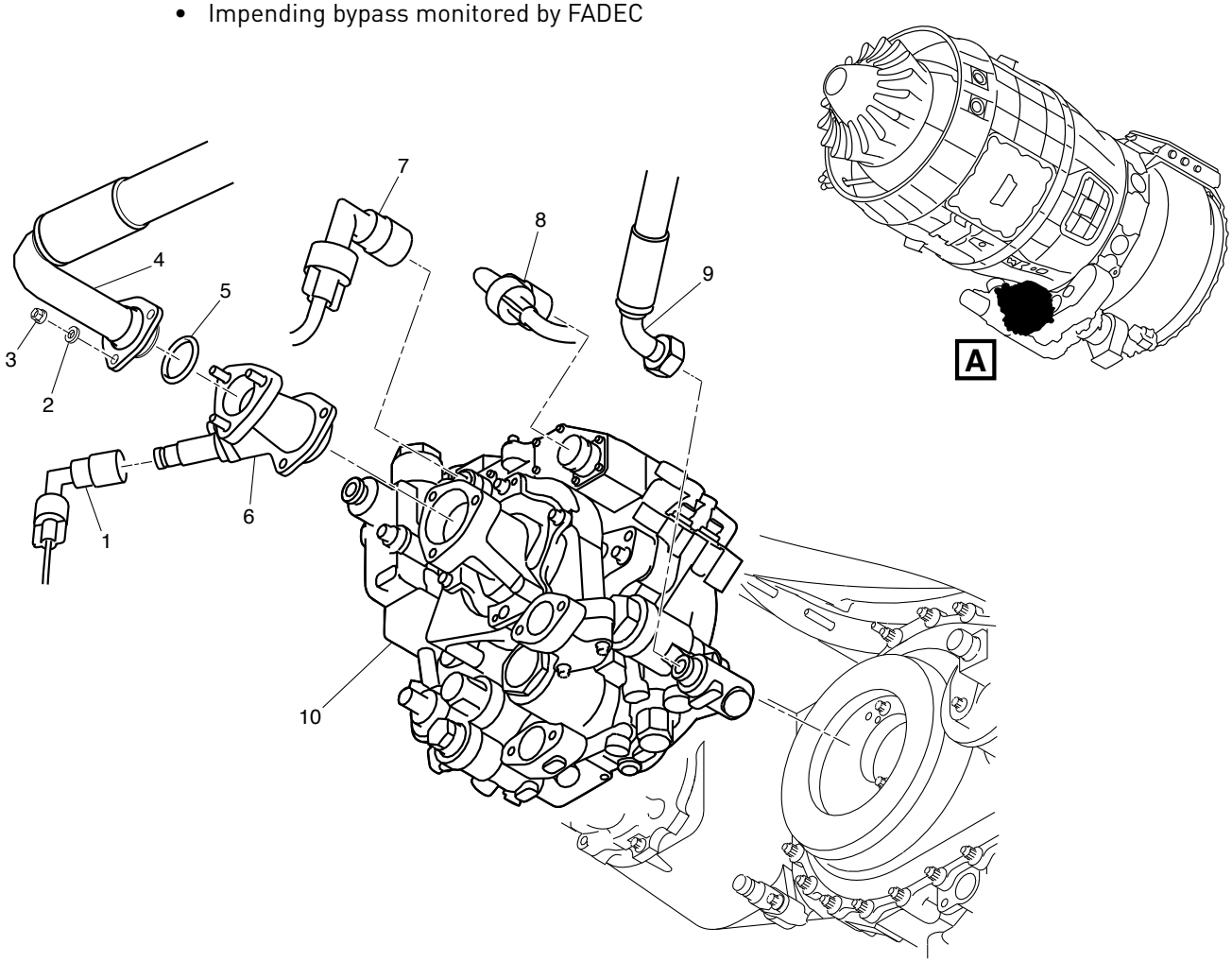


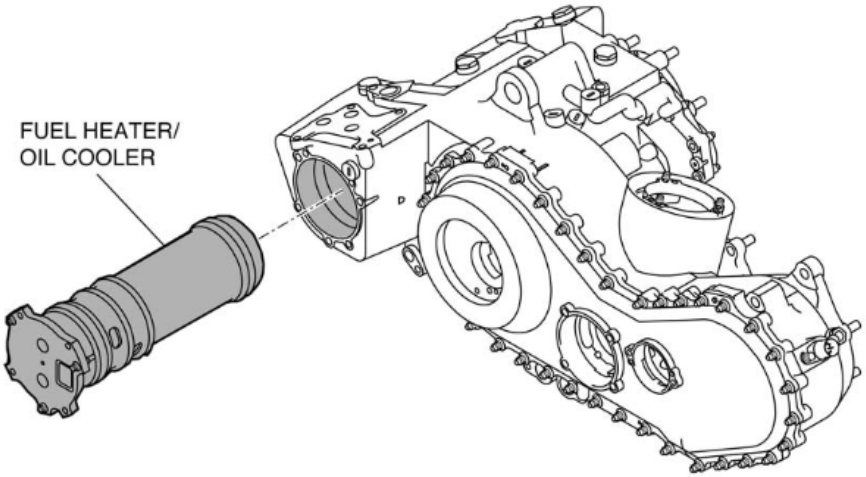

## III. ENGINE FUEL SYSTEM

### A. COMPONENTS of the HYDROMECHANICAL UNIT (HMU)

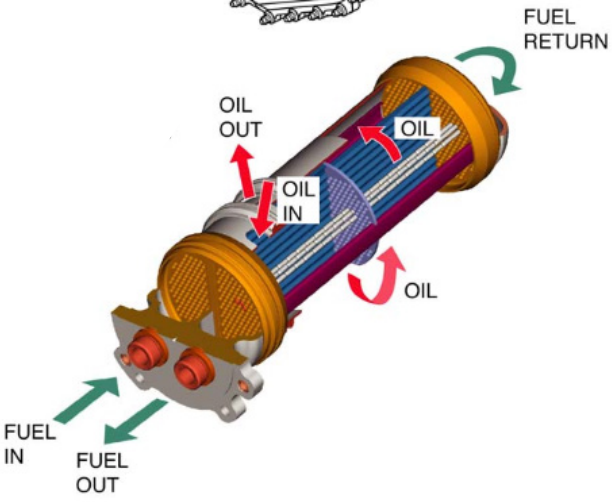
1. **Fuel Pump**
    - Three separate pumps in single housing
    - Provides high-pressure fuel exceeding engine requirements
    - Generates motive flow for scavenge and main fuel ejectors

2. **Fuel Metering Unit (FMU)**
    - Electrohydraulic device controlled by FADEC
    - Meters and distributes fuel for combustion
    - Contains fuel metering valve and pressurizing/shutoff valve
    - Supplies high-pressure fuel for variable geometry (VG) inlet/compressor vanes
3. **Fuel/Oil Heat Exchanger**
    - Warms engine fuel for ice prevention
    - Cools engine oil
    - Temperature monitored on FUEL synoptic page
4. **Fuel Filter**
    - 10-micron filtration
    - Bypass valve prevents loss of fuel flow
    - Impending bypass monitored by FADEC





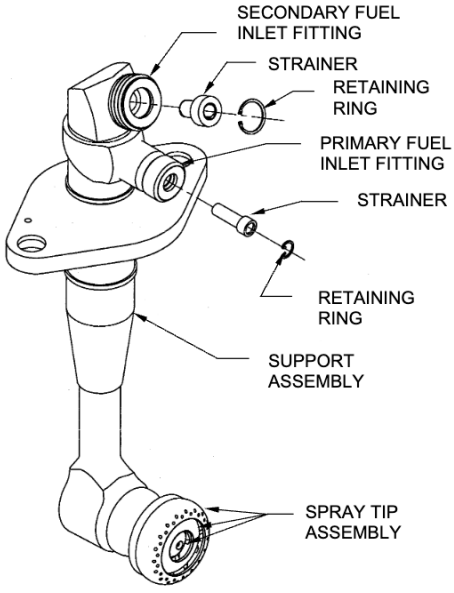



## B. FUEL NOZZLES

The combustor contains 16 fuel nozzles arranged circumferentially. Fuel distribution is optimized by the FADEC based on:

- Throttle position
- Ambient conditions
- Bleed air requirements
- $N_1$ and $N_2$ speeds



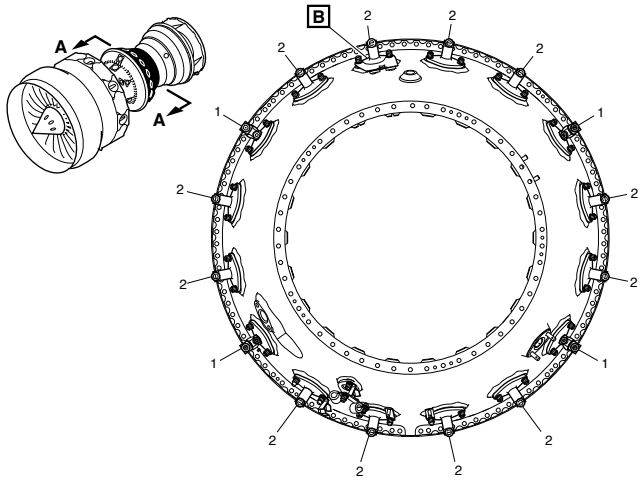
### C. FUEL SHUTOFF

**Fuel flow can be interrupted by:**

- L (R) ENGINE RUN switches to OFF position
- L (R) ENGINE FIRE switch activation
- FADEC commanded shutdown

A 10-micron fuel filter is used to remove solid contaminants from the fuel. The filter is depicted on the FUEL synoptic page.

An impending fuel filter bypass condition on either engine is reported by an advisory **L(R) ENGINE FUEL BYPASS** CAS message. A dual impending fuel filter bypass condition on both engines is reported by a caution **ENGINES FUEL BYPASS** CAS message.






Fuel System Components

| Component | Description |
|---|---|
| Fuel Pump | Three-element pump in single housing |
| Fuel Metering Unit (FMU) | Electrohydraulic device controlled by FADEC |
| Fuel/Oil Heat Exchanger | Warms fuel, cools oil |
| Fuel Filter | 10 micron filtration |
| Fuel Nozzles | 16 arranged circumferentially |

## IV. ENGINE OIL SYSTEM

### A. SYSTEM DESCRIPTION

The engine oil system provides lubrication and cooling for all engine bearings, gears, and splines. Oil capacity is approximately 8 quarts (7.6 liters) with 5.7 quarts at the FULL mark.

### B. OIL CIRCULATION

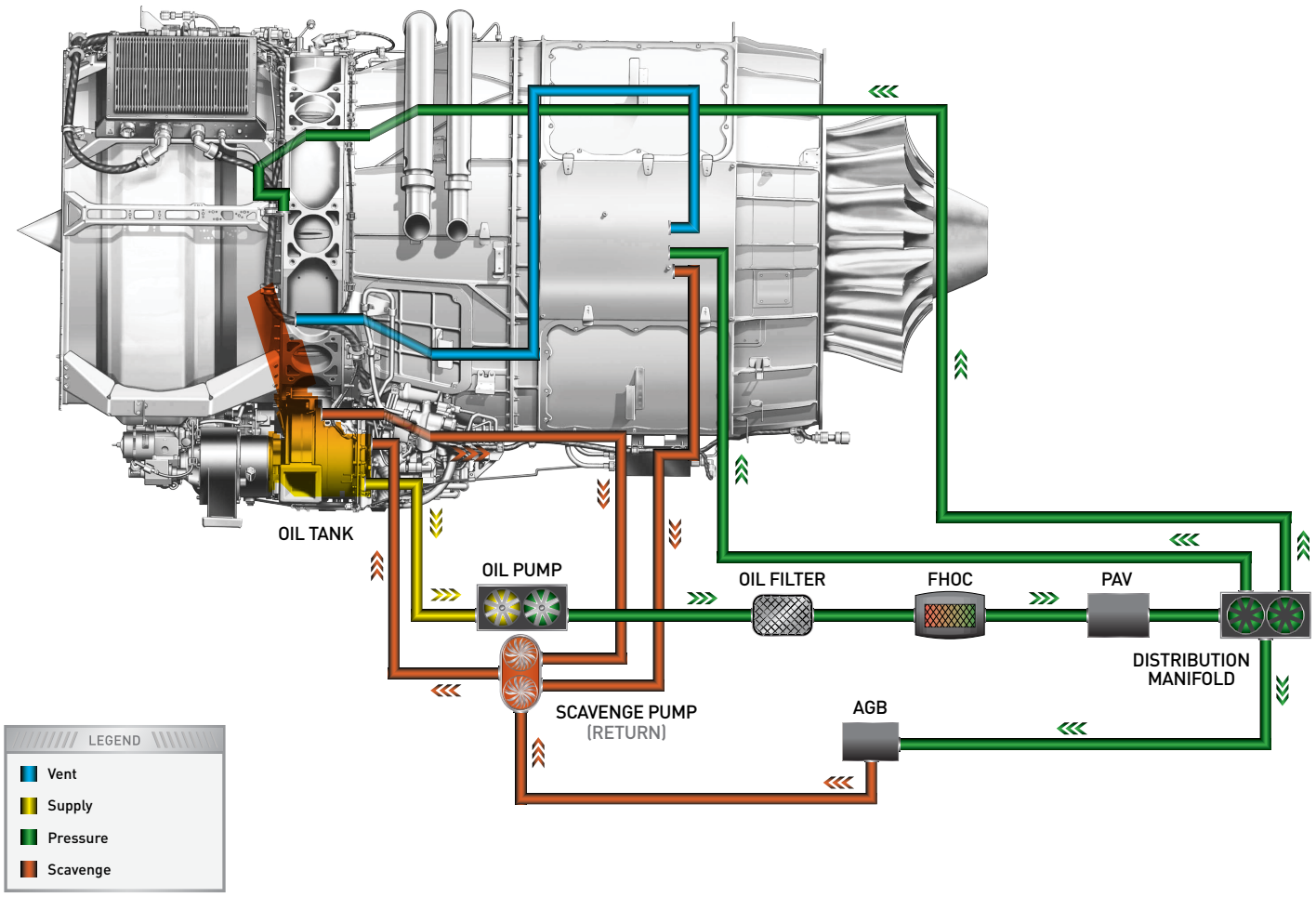
1. **Supply Path**
    - Oil drawn from integral tank by engine-driven pump
    - Filtered through 10-micron filter with 65 psi bypass capability
    - Chip detector identifies metal in the engine oil
    - Cooled in fuel/oil heat exchanger
    - Distributed to engine bearings and accessory gearbox

2. Scavenge Path
    - Two scavenge pumps return oil to tank
    - Chip detector monitors for metal contamination
    - Air/oil separator vents tank

Chip detector and impending oil filter bypass advisory CAS messages are presented as **L (R) ENGINE OIL CHIP** and **L (R) ENGINE OIL BYPASS**.

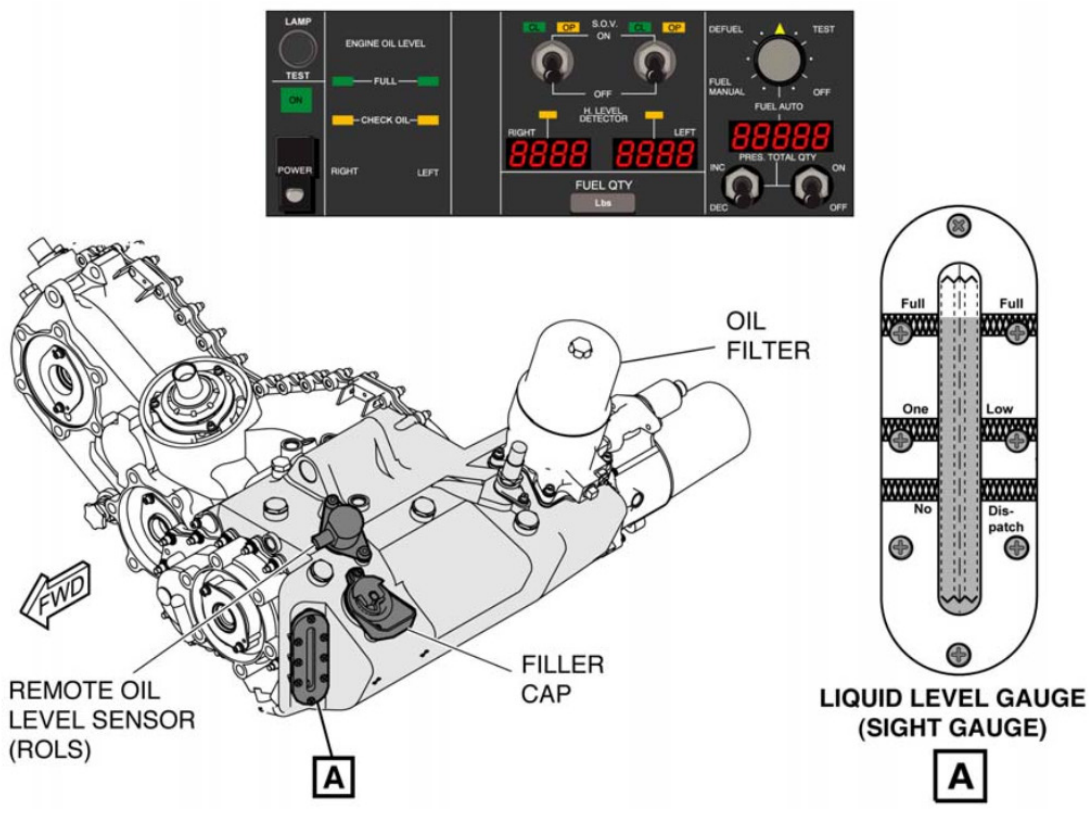
To provide system redundancy, a pressure switch and separate pressure transmitter are used to monitor the engine oil pressure. When low oil pressure is detected by the pressure switch, a **L (R) ENG OIL PRESS LOW** (W) CAS message is presented. Excessively high oil pressure is indicated by a **L (R) ENG OIL PRESS HIGH** (C) CAS message. An imminent bypass of the oil filter is annunciated by a **L (R) ENGINE OIL BYPASS** (A) CAS message.

## ENGINE OIL SCHEMATIC



## C. OIL LEVEL MONITORING

- Remote Oil Level Sensor (ROLS) transmits data to refuel/defuel panel
- Check oil level 5-30 minutes after shutdown
- Service if more than 1 quart below FULL
- NO DISPATCH band indicates 1.6 quarts below FULL



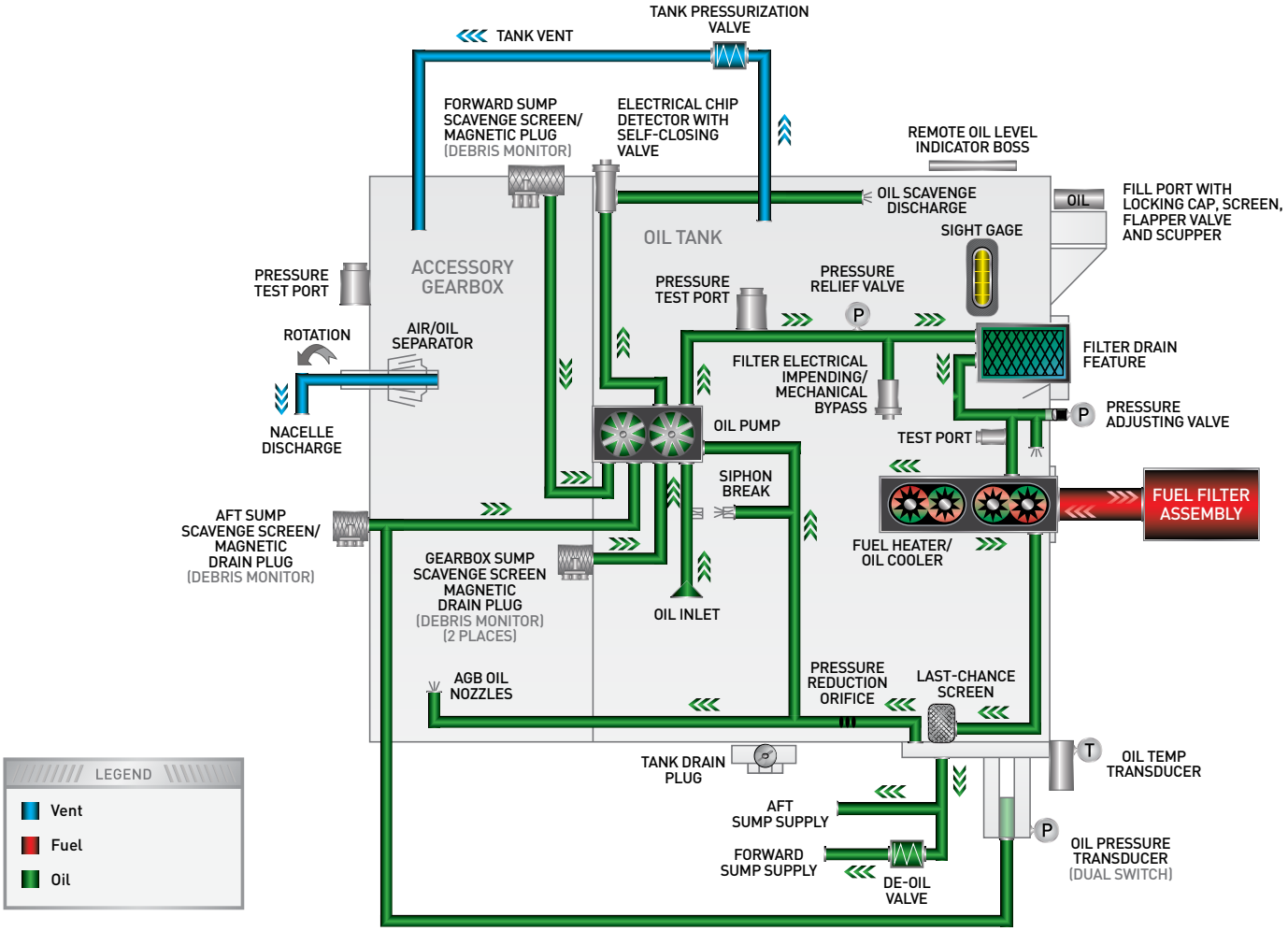

| Parameter | Normal Range | Caution | Warning |
|---|---|---|---|
| Oil Pressure | 45-90 PSI | 91-100 PSI (4 minutes max) | <28 PSI or >100 PSI |
| Oil Temperature | 5-138°C (154°C 2 minutes max) | 138°C | N/A |

## D. OIL PRESSURE AND TEMPERATURE LIMIT

Excessively high engine oil temperatures are displayed as an amber **L (R) ENG OIL TEMPERATURE HIGH** (C) CAS message.

NOTE: Engine should not operate above idle $N_2$ until oil temperature exceeds 5°C.

## ENGINE LUBRICATION SCHEMATIC




### Oil Specifications

| Parameter | Value |
|---|---|
| Oil Capacity | Approximately 8 quarts (7.6 liters) |
| Oil at FULL Mark | 5.7 quarts (5.4 liters) |
| ONE LOW Band | 1 quart below FULL |
| NO DISPATCH Band | 1.6 quarts below FULL |
| Oil Filter | 10 micron, bypass at 65 psi differential |
| Check Oil Level | 5-30 minutes after shutdown |

# V. ENGINE CONTROL SYSTEM

## A. FADEC SYSTEM

Each engine has a dual-channel FADEC providing:

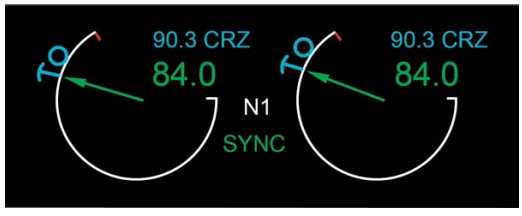
- Full authority engine control
- Thrust management
- Variable geometry (VG) control
- Overspeed protection
- Automatic relight capability

## B. FADEC CHANNELS

1. **Channel Operation**
    - One channel in control, one in standby
    - Automatic transfer on fault detection
    - Channels alternate control on successive starts
    - Cross-channel data sharing via crosstalk bus
    - Both channels respond during engine overspeed
2. **Power Sources**
    - Aircraft 28 VDC for start and $N_2$ <45%
    - PMA primary power source $N_2$ >45%

## C. FADEC FUNCTIONS

1. **Primary Control**
    - Fuel flow scheduling
    - Control of Variable Geometry Compressor Guide Vanes (CGVs)
    - Bleed valve control
    - Ignition control
2. **Protection Systems**
    - $N_1$ and $N_2$ overspeed protection
    - ITT limiting
    - Compressor stall detection and recovery
    - Flameout detection and auto-relight

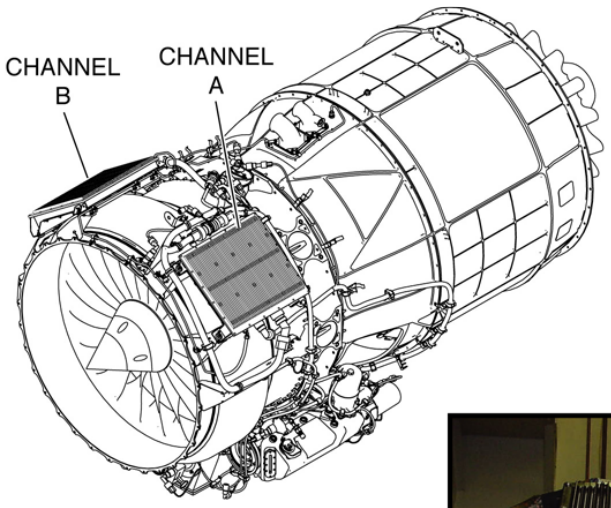


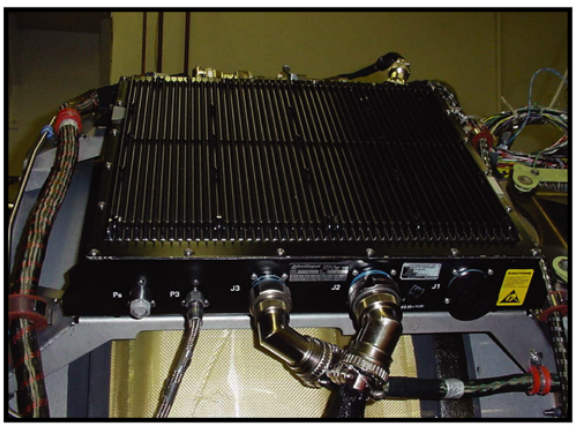

3. **Thrust Management**
    - Normal takeoff thrust computation
    - Automatic Power Reserve (APR)
    - Automatic Single engine thrust enhancement
    - $N_1/N_2$ synchronization
    - Thrust Reverser Operation

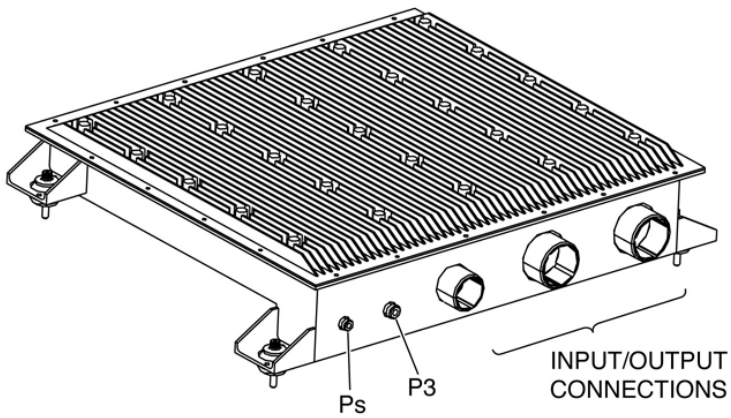
FADEC automatically computes a target thrust rating for thrust lever position and presents the target or maximum value on the $N_1$ indicator.

On the ground, normal rated takeoff thrust is automatically calculated when an engine is started. Normal rated $N_1$ takeoff rpm is continuously updated for changes in the Mach number, delta ambient temperature, and pressure altitude.

During the takeoff roll, the $N_1$ normal rated takeoff thrust value is continuously updated as the aircraft accelerates. At 65 kt discrete inputs for the thrust calculations are locked in. The calculation is unlocked when the aircraft altitude exceeds 400 ft AGL or the thrust lever is retarded from the TO detent.



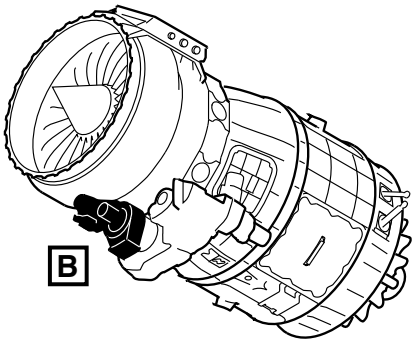





# VI. ENGINE STARTING SYSTEM

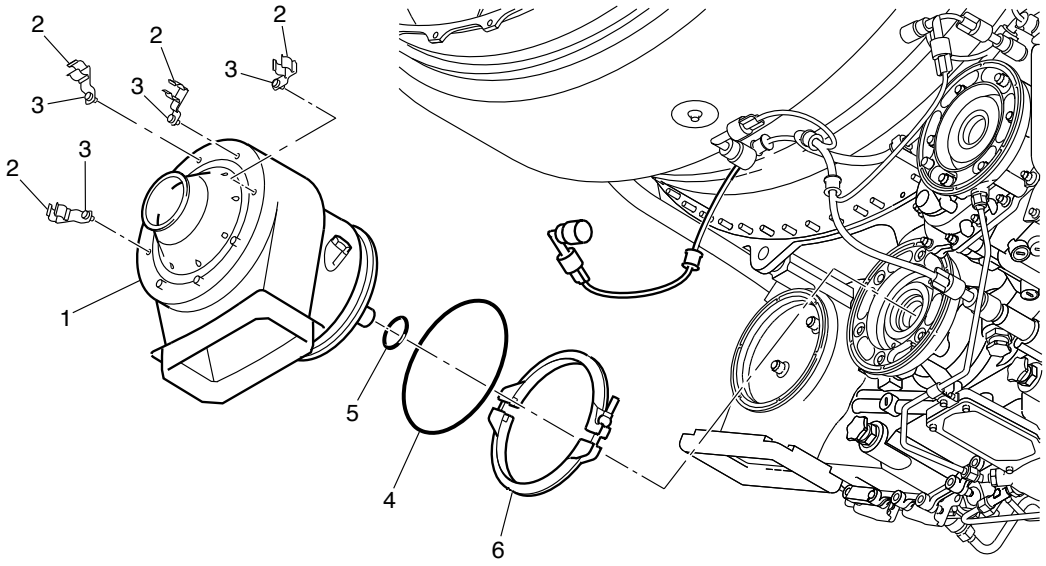
## A. AIR TURBINE STARTER

The air turbine starter (ATS) converts pneumatic energy to mechanical rotation through the accessory gearbox.




Starting air sources include:

- APU bleed air (normal)
- Ground cart HP air
- Cross-bleed from operating engine




B

## B. START SEQUENCE

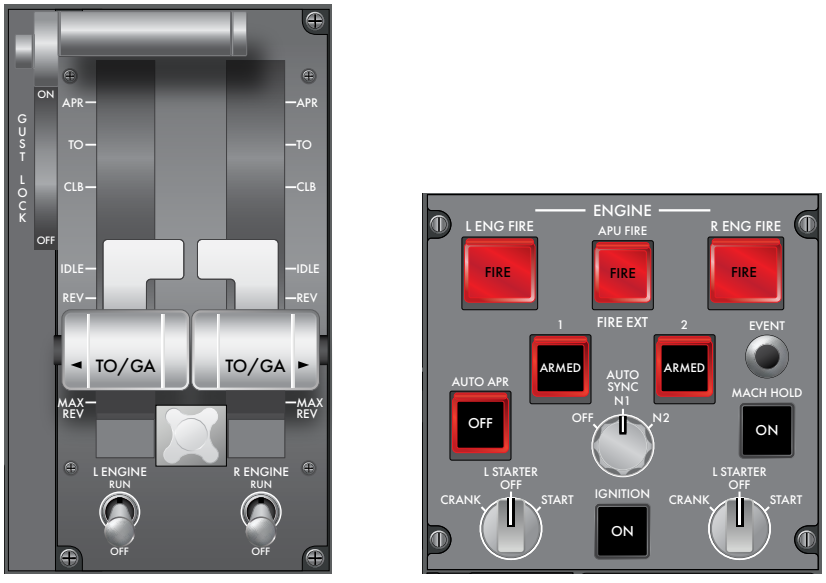
1. **Initiation**
    - L (R) ENGINE RUN switch to RUN (Electric fuel boost pump is activated)
    - L (R) STARTER switch to START (hold 1 second) – FADEC initiates start sequence
    - Start valve opens at pneumatic pressure >32 psi
2. **Light-off**
    - FADEC energizes single igniter (ground start)
    - Both igniters for air starts
    - Fuel flow initiated through FMU
    - ITT rise indicates combustion

3. **Acceleration**
    - Monitor $N_2$ acceleration and ITT
    - Start limit red triangle at 650°C during start
4. **Starter Cutout**
    - Automatic at 46.2% $N_2$
    - Start valve closes
    - ATS disengages
    - Ignition terminates
    - $N_2$ Idle varies with Altitude/Temp ~ 46%

If the start valve fails to close after achieving 50% $N_2$, a **L (R) STARTER FAIL ON** (C) CAS message is shown.

Air Turbine Starter Specifications

| Parameter | Value |
|---|---|
| Starter Type | Air Turbine Starter (ATS) |
| Starter Cutout | 46.25% $N_2$ |
| Start Valve Opens | Pneumatic pressure >32 psi |
| Ignition Ground Start | Single igniter, alternating |
| Ignition Air Start | Both igniters |
| ATS Duty Cycle | 3 consecutive starts, then 15 min cool |
| Dry Motoring | Maximum 5 minutes, then 15 min cool |




Thrust Lever Quadrant And Engine Control Panel

### C. START LIMITATIONS

| Parameter | Limit |
|---|---|
| Consecutive Start Cycles | Three, followed by 15 minutes cooling |
| Engine Motoring (Cranking) | Up to 5 minutes, followed by 15 minutes cooling |
| Motoring After Aborted Start | 30 seconds required |



### D. THERMAL BOW MITIGATION

HP spool thermal bow is normally due to asymmetrical cooling of engine parts after shut-down on a previous flight. It can occur when engine starts are initiated within 15-180 minutes after shutdown. If restart required in this window:

- Dry motor the engine with a target of 19.1% to 23.1% $N_2$
- Stop motoring when engine reaches 21% ±2% or after 15 seconds, whichever is first.
- Start engine between 3-40 minutes after dry motoring
- Repeat dry motoring if 40-minute start window exceeded

## VII. ENGINE IGNITION SYSTEM

### A. COMPONENTS

Each engine has dual independent ignition systems:

- Two ignition exciters
- Two igniter plugs (5 and 7 o'clock positions)
- Two sets of igniter leads

### B. IGNITION CONTROL

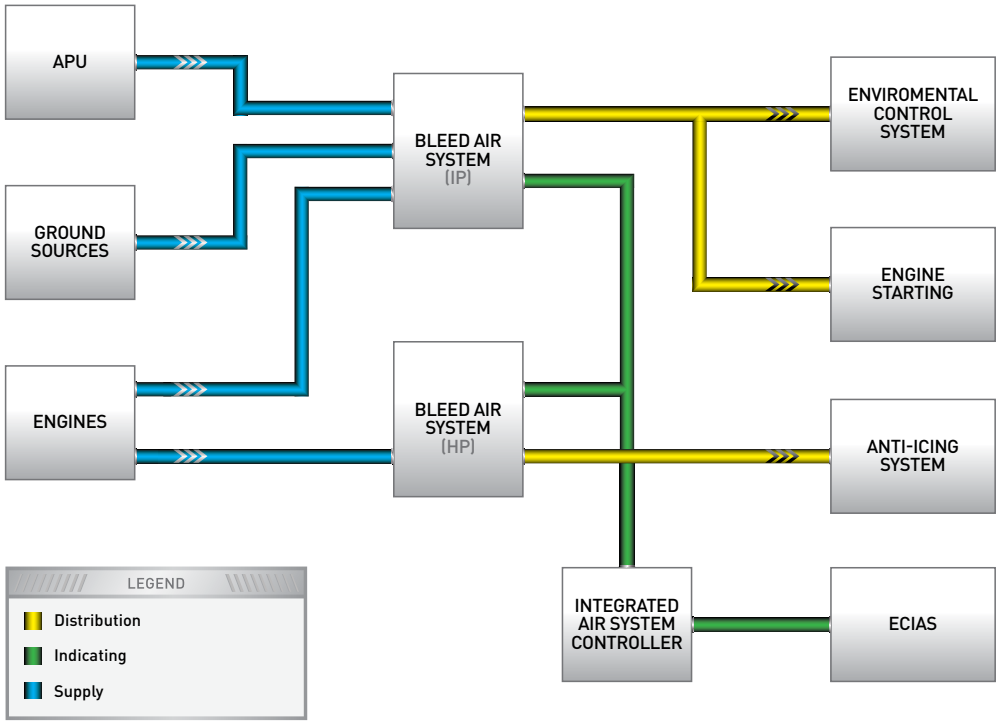
1. **Automatic Operation (IGNITION switch NORM)**
    - Ground start: Single igniter alternating
    - Air start: Both igniters
    - Stall protection: Both igniters at stick shaker
    - Flameout: Both igniters until recovery
2. **Manual Operation**
    - IGNITION switch ON: Continuous ignition both igniters

# VIII. ENGINE BLEED AIR SYSTEM

## A. BLEED AIR SOURCES

Engine bleed air extracted from $N_2$ compressor section provides:

- Environmental control and pressurization
- Wing and engine anti-ice
- Engine starting (cross-bleed)




## B. BLEED AIR CONTROL

1. **Integrated Air System Controllers (IASC)**
    - IASC 1 controls left engine bleed
    - IASC 2 controls right engine bleed
    - Automatic temperature and pressure regulation
2. **Intermediate Pressure Valve (IPV)**
    - Regulates bleed air extraction
    - Minimizes performance penalty
    - FADEC coordinated operation
3. **High Pressure (HP)**
    - Anti-Icing Systems

### C. SURGE BLEED VALVES

Engine surge bleed valves are managed by the FADEC and provide:

- Compressor stall protection
- Compressor surge protection
- Compressor stall recovery

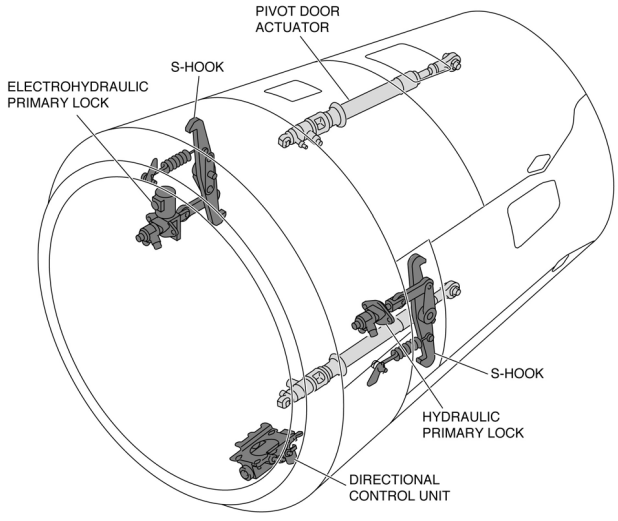
## IX. THRUST REVERSER SYSTEM

### A. SYSTEM DESCRIPTION

Each engine has a hydraulically operated pivot-door thrust reverser for ground use only. The system cannot deploy in flight due to multiple safety interlocks.

### B. COMPONENTS

1. **Hydraulic Components**
    - Isolation control unit
    - Directional control unit
    - Door actuators (upper and lower)
    - Primary locks (hydraulic and electro-hydraulic)
    - Tertiary locks (prevents uncommanded deployment)
2. **Electrical Components**
    - Stow switches (2 per door)
    - Deploy switch (1 per door)
    - Thrust lever microswitches
    - FADEC interface




### C. OPERATION

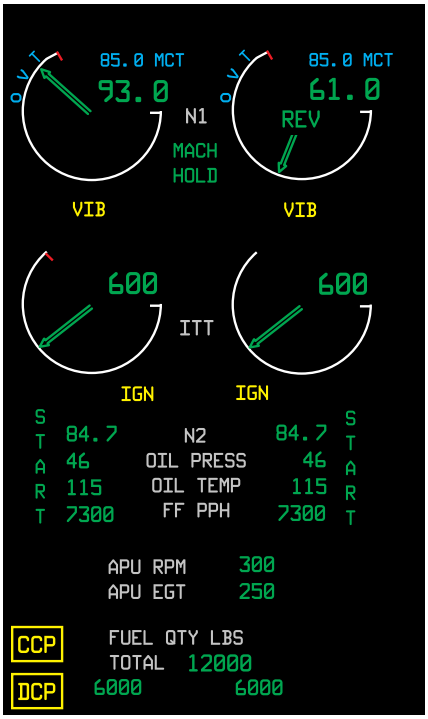
1. **Deployment**
    - Thrust levers to IDLE
    - Lift reverser levers
    - Move thrust levers aft to REV detent
    - White REV icon during transit
    - Green REV icon when deployed
    - Modulate between REV and MAX REV
2. **Stowing**
    - Return thrust levers to IDLE
    - Reverser levers automatically lower
    - White REV icon during transit
    - Icon extinguishes when stowed

### D. SAFETY FEATURES

- Weight-on-wheels and wheel spin-up required
- FADEC limits thrust to idle if unsafe condition
- Mechanical locks prevent inadvertent deployment
- Interlock balks control thrust lever movement
- FADEC limits max $N_1$ as aircraft slows to prevent controllability issues

## X. ENGINE INDICATIONS

### A. PRIMARY PARAMETERS




1. **$N_1$ Fan Speed**
    - Primary thrust indicator
    - Displayed as percentage
    - Thrust mode annunciations (APR, TO, CLB, CRZ, REV)
2. **$N_2$ Core Speed**
    - Digital readout only
    - Green: Normal (≤100%)
    - Yellow/Red: Exceedance with 5-second flash
3. **ITT (Interstage Turbine Temperature)**
    - Expanded scale 600-1050°C
    - Start limit triangle at 650°C (800°C In Flight)
    - 950°C continuous, 955°C transient (T/O / Reverse / APR)

### B. SECONDARY PARAMETERS

1. **Oil Pressure**
    - Digital readout
    - **L (R) ENG OIL PRESS LOW** warning <28 psi
2. **Oil Temperature**
    - Digital readout
    - **L (R) ENG OIL TEMP HIGH** caution >138°C
3. **Fuel Flow**
    - Digital readout in PPH
    - Totalizer accumulation

### C. ENGINE VIBRATION MONITORING

- Continuous fan vibration monitoring
- **L (R) ENGINE VIBRATION** caution when exceeded
- Amber VIB icon on affected engine
- Returns on landing if exceedance occurred

# XI. AUTOMATIC POWER RESERVE (APR)

## A. SYSTEM OPERATION

APR automatically increases thrust on operating engine during single-engine operations:

- Activates when $N_2$ speed mismatch >15%
- Requires TLA at TO detent or above
- Provides flat-rated thrust to ISA +20°C

## B. APR INDICATIONS

- Cyan APR icon right of $N_1$ indicator
- Cyan $N_1$ reference bug and digital readout
- AUTO APR OFF status message if disabled

## C. MANUAL APR

Both thrust levers to APR detent provides emergency thrust on both engines regardless of OEI condition.

# XII. ENGINE SYNCHRONIZATION

## A. $N_1$/$N_2$ SYNC

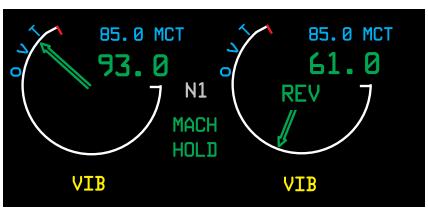
The AUTO SYNC system matches fan or core speeds between engines:

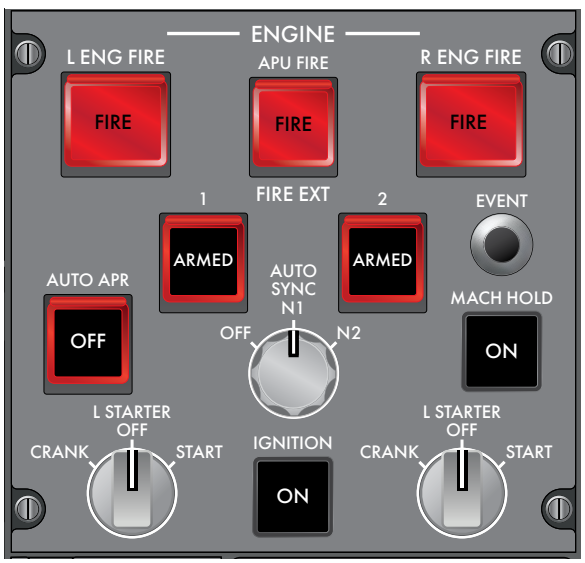
- $N_1$ sync at high power settings
- $N_2$ sync at low power settings
- Left engine normally master
- Available in CLB and CRZ thrust only

## B. MACH HOLD (Without AT System)

MACH HOLD minimizes throttle adjustments during cruise:

- Requires $N_1$ or $N_2$ sync active
- Autopilot in ALT HOLD or ALT SEL
- ±3% $N_1$ authority limits
- Green MACH HOLD displayed when active



# XIII. PROTECTION SYSTEMS

## A. OVERSPEED PROTECTION

1. **$N_1$ Overspeed**
    - Automatic fuel flow reduction
    - Both FADEC channels respond independently
2. **$N_2$ Overspeed**
    - Automatic fuel flow reduction
    - Engine shutdown if limit exceeded

## B. COMPRESSOR STALL PROTECTION

1. **Prevention**
    - Variable geometry optimization
    - Surge bleed valve modulation
    - Ignition at high AOA (stick shaker)
2. **Recovery**
    - FADEC modulates thrust
    - Both igniters energized
    - Automatic thrust restoration

At an excessively high angle of attack (AOA), there is a possibility that turbulent airflow from the wing root could disrupt the flow of air into the engine intake. Disruption of airflow at the intake could lead to engine compressor stall.

The FADEC and the stall protection computer provide two levels of compressor stall protection. As the aircraft AOA reaches the stick shaker firing angle, the stall protection computer signals the FADEC to energize both ignition channels.

If the FADEC detects a compressor stall or surge, the FADEC will modulate engine thrust to clear the event.

## C. FLAMEOUT PROTECTION

Automatic relight initiated when:

- Engine sub-idle with negative ITT rate
- $N_2$ deceleration below commanded
- Both igniters energized
- **L (R) ENGINE FLAMEOUT** caution displayed

# XIV. EICAS MESSAGES – GROUPED BY SEVERITY

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Aural Alert |
|---|---|---|
| **L (R) ENGINE EXCEEDANCE** | Engine exceeded speed or temperature limit | Triple chime |
| **L (R) ENGINE FIRE** | Fire detection loop activated. Usually accompanied by excessive ITT, erratic engine operation, fluctuating indications, or smoke | "**Left (Right) Engine Fire**" continuous voice |
| **L (R) ENG OIL PRESS LOW** | Low engine oil pressure | **TO/LAND** |
| **L (R) REVERSER UNSAFE** | Unsafe thrust reverser condition. Engine automatically decelerates to idle | — |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **L (R) ENGINE FLAMEOUT** | Engine flameout detected | — |
| **ENGINES FUEL BYPASS** | Both engine fuel filters impending bypass | **TO/LAND** |
| **L (R) ENG OIL TEMP HIGH** | High engine oil temperature | **TO/LAND** |
| **L (R) ENG ANTI-ICE FAIL** | Engine anti-ice system failed | **TO/LAND** |
| **L (R) ENG DSPL MISCOMP** | $N_1$ or ITT display disagreement | **TO/LAND** |
| **L (R) ENG FUEL SOV FAIL** | Fuel shutoff valve failed to close | **TO/LAND** |
| **L (R) ENG OIL PRESS HIGH** | High engine oil pressure | **TO/LAND** |
| **L (R) ENGINE VIBRATION** | Higher than normal vibration level | **TO/LAND** |
| **L (R) FADEC FAIL** | Major control system failure affecting both FADEC channels | **TO** |
| **L (R) REVERSER FAIL** | Thrust reverser failure | **TO** |
| **L (R) START ABORTED** | Ground engine start aborted | **TO/LAND** |
| **L (R) STARTER FAIL** | Engine starter failure | **TO/LAND** |
| **L (R) STARTER FAIL ON** | Starter failed in ON position | **TO/LAND** |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| DOWNLOAD FADEC | FADEC maintenance data should be downloaded | TO/LAND |
| L (R) ENG A/ICE FAIL ON | Nacelle anti-ice failed ON | TO/LAND |
| L (R) ENG FUEL TEMP LOW | Low fuel temperature in engine filter | TO/LAND |
| L (R) ENG IGN FAULT | Fault detected in engine ignition | TO/LAND |
| L (R) ENG THRUST FAULT | Fault detected in engine thrust | TO/LAND |
| L (R) ENGINE FAULT | General engine fault detected | TO/LAND |
| L (R) ENGINE FUEL BYPASS | Engine fuel filter impending bypass | TO/LAND |
| ENG MACH HOLD FAIL | Mach Hold out of authority or failed | TO/LAND |
| L (R) ENGINE MINOR FAULT | Minor engine fault detected | TO/LAND |
| L (R) ENGINE OIL BYPASS | Engine oil filter impending bypass | TO/LAND |
| ENGINE SYNC FAIL | Engine synchronization failed | TO/LAND |
| L (R) ENG VIBRATION FAIL | Loss of vibration signal | TO/LAND |

## D. NON-EICAS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning | |
|---|---|---|
| L (R) ENGINE OIL CHIP | Metal debris in engine lube system | TO/LAND |
| AUTO APR OFF | Auto APR selected OFF | — |
| L (R) ENGINE SHUTDOWN | Engine shutdown with RUN switch OFF or FIRE switch pushed | |
| L (R) REVERSER INOP | Thrust reverser mechanically pinned and isolated | |

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- Voice warnings are continuous until acknowledged
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right engine



# XV. LIMITATIONS

## A. ENGINE LIMITATIONS

| Limit | Ground Start | Air Start 7 | Idle | Max Reverse | Maximum Continuous (CLB) 1 | Normal Takeoff (TO) 2 | APR (Max Power) 3 |
|---|---|---|---|---|---|---|---|
| $N_1$ | — | — | — | 70.7% 4 | 96.5% | 96.8% | 96.8% |
| $N_2$ | — | — | 46.0% min. | — | 98.0% | 98.0% | 98.6% |
| ITT | 650°C | 800°C 5 | — | 955°C | 950°C | 955°C | 955°C |
| Oil Temp | -40°C min. | — | 9 | — | 138°C max. | 138°C max. 27°C max. 6 | 138°C max. |
| Oil Press | — | — | 28 psi min. | 8 | 8 | 8 | 8 |

1. Climb (CLB) equals maximum continuous thrust (MCT).
2. Normal Takeoff power is limited to 5 minutes.
3. APR power (one engine inoperative) is limited to 10 minutes.
4. Maximum reverse thrust is automatically reduced (ramped) commencing at 85 KIAS.
5. Maximum ITT limit varies with $N_2$ speed (400 °C when $N_2$ <18% and ITT at start initiation <250 °C).
6. Minimum oil temperature must be achieved before commencing takeoff. Below –30 °C (–22 °F) the minimum oil temperature limit is 15 °C provided a fuel system icing inhibitor is used and the Cold Weather Operations procedures in FCOM, Vol. 1 are followed.
7. The in flight re–start envelope is defined in figure in chapter 05–32 of this manual.
8. Minimum oil pressure varies with engine speed. Maximum allowable oil pressure increases with engine speed and with low oil temperature.
9. A minimum oil temperature of 5 °C is required to operate engines above ground idle power. Between 5 and 14 °C, the engines may be operated from idle up to but not including CLB power.

## XVI. POWERPLANT SYSTEM CIRCUIT BREAKERS

Powerplant System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| ENGINE CONTROL L | LEFT ESS | CB1-G1 |
| ENGINE CONTROL R | RIGHT ESS | CB2-G1 |
| FADEC L CH A | LEFT ESS | CB1-G2 |
| FADEC L CH B | LEFT BATT | CB1-G3 |
| FADEC R CH A | RIGHT ESS | CB2-G2 |
| FADEC R CH B | RIGHT BATT | CB2-G3 |
| IGNITION L | LEFT ESS | CB1-G4 |
| IGNITION R | RIGHT ESS | CB2-G4 |
| START VALVE L | LEFT ESS | CB1-G5 |
| START VALVE R | RIGHT ESS | CB2-G5 |
| THRUST REV L | LEFT MAIN | CB3-G6 |
| THRUST REV R | RIGHT MAIN | CB4-G6 |
| ENGINE SYNC | LEFT MAIN | CB3-G7 |
| ENGINE FIRE DET L | LEFT ESS | CB1-G8 |
| ENGINE FIRE DET R | RIGHT ESS | CB2-G8 |
| ENGINE FIRE EXT L | LEFT ESS | CB1-G9 |
| ENGINE FIRE EXT R | RIGHT ESS | CB2-G9 |

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## XVII. POWERPLANT QUIZ

1. What is the bypass ratio of the HTF7350 engine?

    A) 2.09:1
    B) 3.5:1
    C) 4.2:1
    D) 5.1:1

2. The HTF7350 engine is flat rated to:

    A) ISA +10°C at sea level
    B) ISA +15°C at sea level
    C) ISA +20°C at sea level
    D) ISA +25°C at sea level

3. How many fuel nozzles are in the combustor?

    A) 12
    B) 14
    C) 16
    D) 18

4. At what $N_2$ speed does the starter automatically disengage?

    A) 45.0%
    B) 46.25%
    C) 50.0%
    D) 52.0%

5. The PMA provides power to the FADEC when $N_2$ exceeds:

    A) 35%
    B) 40%
    C) 45%
    D) 50%

6. Minimum idle $N_2$ is:

    A) 46.0%
    B) 48%
    C) 53.4%
    D) 60.7%

7. Maximum ITT during ground engine start is:

    A) 650°C
    B) 800°C
    C) 877°C
    D) 955°C

8. The oil system capacity is approximately:

A) 6 quarts
B) 8 quarts
C) 10 quarts
D) 12 quarts

9. How many titanium blades are in the $N_1$ fan?

A) 18
B) 20
C) 22
D) 24

10. The oil filter bypass valve opens at:

A) 35 psi differential
B) 45 psi differential
C) 55 psi differential
D) 65 psi differential

11. Normal Takeoff power is limited to:

A) 3 minutes
B) 5 minutes
C) 10 minutes
D) Continuous

12. The dry weight of the HTF7350 engine is:

A) 1,264 lbs
B) 1,364 lbs
C) 1,464 lbs
D) 1,564 lbs

13. Engine synchronization is available when thrust levers are in:

A) All thrust settings
B) TO and CLB only
C) CLB or CRZ setting
D) CRZ only

14. For ground starts, the FADEC uses:

A) Single igniter, alternating each start
B) Both igniters simultaneously
C) No igniters
D) Manual selection required

15. APR activates when $N_2$ speed mismatch exceeds:

A) 10%
B) 15%
C) 20%
D) 25%

16. The accessory gearbox is driven by:

    A) $N_1$ shaft
    B) $N_2$ compressor
    C) Electric motor
    D) Pneumatic turbine

17. Reverse thrust above idle is prohibited below:

    A) 30 KIAS
    B) 40 KIAS
    C) 50 KIAS
    D) 60 KIAS

18. Maximum oil temperature limit is:

    A) 128°C
    B) 138°C
    C) 148°C
    D) 158°C

19. The ENGINE SYNC FAIL message is what type?

    A) Warning (Red)
    B) Caution (Amber)
    C) Advisory (Cyan)
    D) Status (White)

20. MACH HOLD authority allows $N_1$ adjustment within:

    A) ±1%
    B) ±2%
    C) ±3%
    D) ±5%

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CL-350



CL-350 TRAINING MANUAL

# FUEL 03

## AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# FUEL

## I. INTRODUCTION

The Challenger 350 fuel system represents a sophisticated, dual-redundant architecture designed to provide reliable fuel delivery to the aircraft's twin engines and auxiliary power unit while maintaining operational safety and efficiency throughout the flight envelope. Built around integral wet wing tanks with fuel-resistant sealant construction, the system utilizes collector tanks located in the aft section of each wing as the primary fuel source for all engine consumption.

The design employs two independent distribution systems—left feeding the left engine and right feeding both the right engine and APU—with primary fuel delivery accomplished through engine-driven ejectors using high-pressure motive flow for optimal efficiency. Redundancy is provided through electric DC boost pumps that automatically activate during engine start or ejector failure, while a dual-channel fuel computer continuously monitors system parameters and controls refueling operations.

The system incorporates multiple safety features including flapper check valves to prevent fuel flow during aircraft maneuvers, comprehensive water drainage systems, NACA scoop venting for pressure equalization, and strategically located fuel shutoff valves that integrate with the aircraft's fire protection systems.

This chapter will examine each component of this integrated fuel management system, detailing normal operations, emergency procedures, and the EICAS-driven monitoring that enables crews to maintain situational awareness of fuel distribution, quantity, and system health throughout all phases of flight.

### A. FUEL TANK CAPACITIES

Pressure Refuel

| Parameter | Value |
|---|---|
| Right Tank | 7,075 lb |
| Left Tank | 7,075 lb |
| Total Capacity | 14,150 lb |

Gravity Refuel (Airplane Level)

| Parameter | Value |
|---|---|
| Right Tank | 6,500 lb |
| Left Tank | 6,500 lb |
| Total Capacity | 13,000 lb |

**NOTE:** Based on fuel density of 6.75 lb/USG. Fuel mass provided for reference only.

## B. SYSTEM DESCRIPTION

- Two separate fuel distribution systems
- Left system feeds left engine
- Right system feeds right engine and APU
- All fuel flows through collector tanks
- Single-point and overwing refueling capability
- Underwing water drains for contamination removal
- Low drag NACA vent scoops for static venting

## C. APPROVED FUELS

**American Specifications:**

- ASTM D1655 (Kerosene Type: Jet A, Jet A-1; Wide-Cut Type: Jet B)
- MIL-DTL-5624 (Kerosene Type: JP-5; Wide-Cut Type: JP-4)
- MIL-DTL-83133 (Kerosene Type: JP-8)

**Canadian Specifications:**

- CAN/CGSB 3.23-97 (Kerosene Type: Jet A, Jet A-1)
- CAN/CGSB 3.22-97 (Wide-Cut Type: Jet B, JP-4)
- 3-GP-24c (Kerosene Type: JP-5)

**British Specifications:**

- Def-Stan 91-91/3 (Kerosene Type: Jet A, Jet A-1)
- Def-Stan 91-86/2 (Kerosene Type: JP-5)
- Def-Stan 91-87 (Kerosene Type: JP-8)
- Def-Stan 91-88/1 (Wide-Cut Type: Jet B, JP-4)

**Russian/Ukrainian Specifications:**

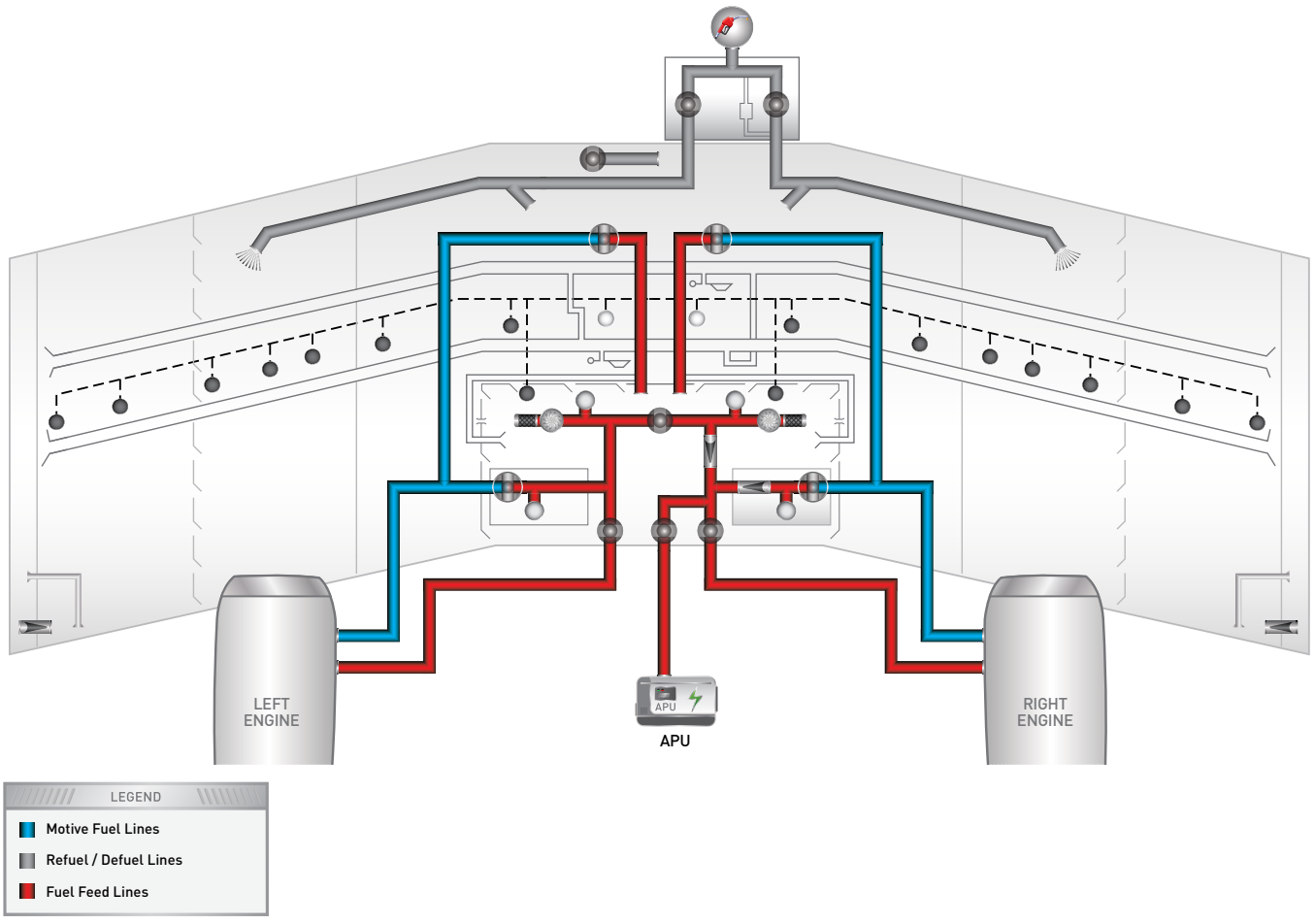
- TS-1 & RT

**Chinese Specifications:**

- GB 6537-2006 No. 3 JET

Note: Approved fuel additives include: Prist (MIL-DTL-27686), Methyl cellosolve, Biobor JF biocide (270 ppm), STADIS 450 (anti-static) and multiple corrosion inhibitors (check AFM)

## FUEL SYSTEM SCHEMATICS

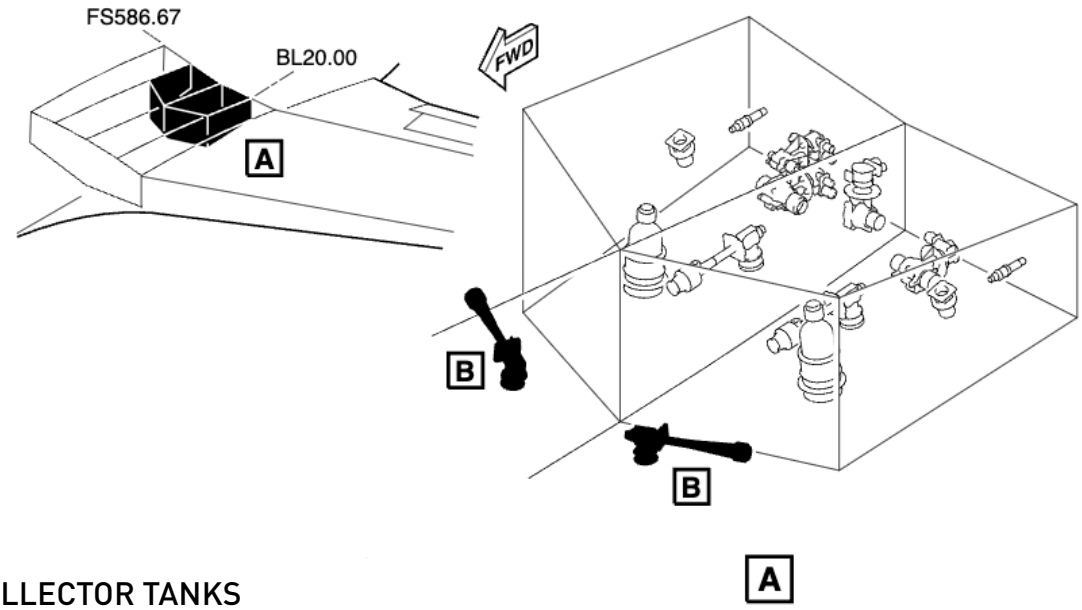


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# II. FUEL TANK SYSTEM

## A. TANK CONSTRUCTION

- Integral type fuel tanks
- Wet wing design
- Sealed with fuel-resistant sealant




## B. COLLECTOR TANKS

- Aft section of each wing tank
- Rear inboard corner of wing

**Fuel Supply:**

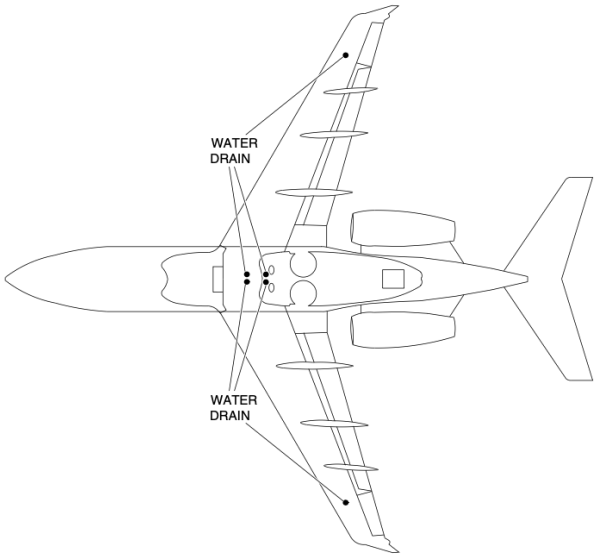
- Gravity flow through flapper check valves
- Scavenge ejectors (when engines operating)
- All engine fuel consumption from collector tanks

## C. WATER DRAIN VALVES

- Three valves per wing
- One for collector tank
- One for wing tank
- One for surge tank (outboard area)

**Function:**

- Drain water and contaminants
- Complete fuel removal during defueling
- Drain until fuel clear if contamination suspected



### D. FLAPPER CHECK VALVES

- Attached to internal wing ribs
- Prevent outward fuel flow during aircraft maneuvers

### E. VENT SYSTEM

**NACA Scoops:**

- Located on lower wing trailing edge surfaces
- One per wing
- Low drag vents
- Provide static ventilation
- Relieve air pressure differential

**Surge Bays:**

- Located outboard of wing tanks
- Hold 53.6 lb fuel each
- Additional expansion volume
- Prevent fuel spillage
- Flapper valves prevent outward fuel flow

## III. FUEL DISTRIBUTION

### A. ENGINE FUEL FEED

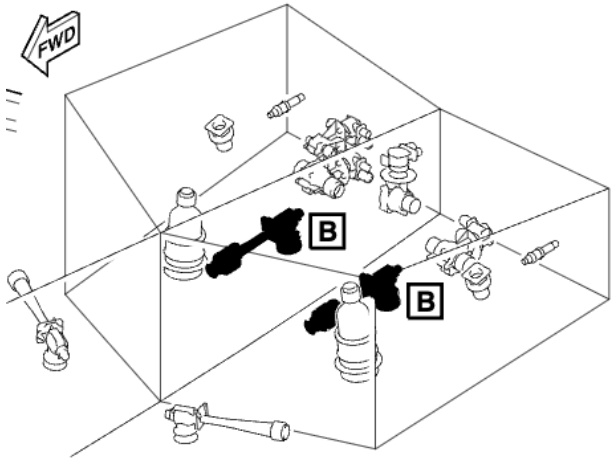
- Independent from respective tank
- Pressurized by ejector using engine motive flow
- High pressure fuel to ejector nozzle
- Same source drives scavenge ejector
- Self-energized by respective engine
- Pressure switch at ejector outlet signals proper operation

### B. APU FUEL FEED

- Right collector tank to APU
- Right main ejector (primary)
- Right DC fuel pump (if ejector pressure low)
- APU shutoff valve included

### C. MAIN EJECTORS

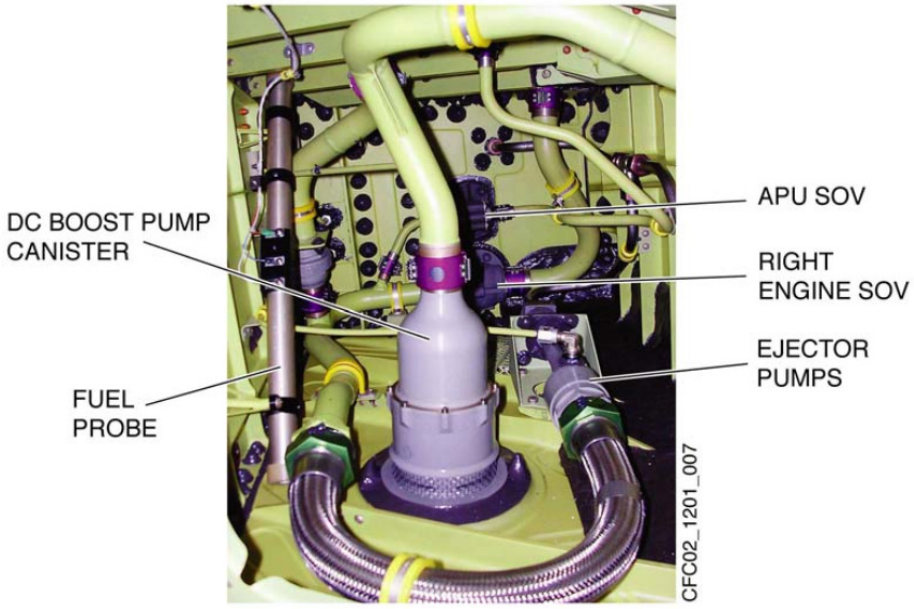
- Motive flow from engine-driven fuel pumps
- High-pressure output operation
- Take fuel from collector tanks
- Deliver fuel to engines
- Installed on bottom of collector tanks




Primary Ejector Pump Location

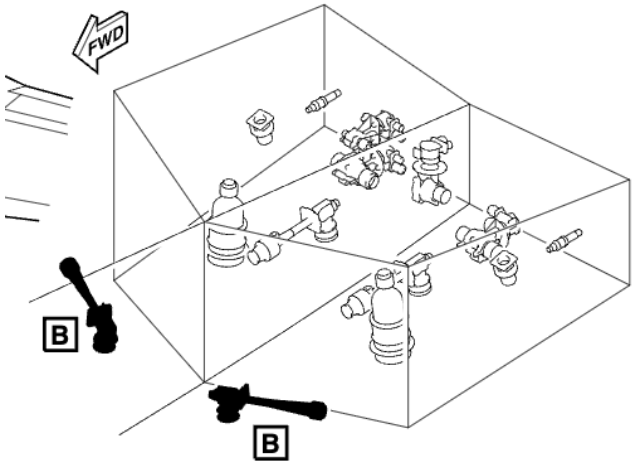
## D. MOTIVE FLOW OPERATION

- Engine-driven pump provides motive flow pressure
- High-pressure flow passes through ejector venturi
- Increased fluid velocity creates low pressure
- Suction moves fuel from tank




## E. SCAVENGE EJECTORS

- Lowest inboard point of each wing tank
- Motive flow from engine-driven fuel pumps
- Transfer fuel from wing tanks to collector tanks




Scavenge Ejector Pump Location

## F. ELECTRIC FUEL PUMPS (DC BOOST PUMPS)

**Primary Functions:**

- Fuel pressure during engine start
- Backup for main ejector pump failure
- Fuel transfer between wing tanks

**Operation:**

- Parallel with each feed ejector
- AUTO mode: ON when ENGINE RUN switch ON and boost pump armed
- Operates when feed ejector insufficient pressure
- 10-second time delay after ejector pressure achieved

## G. CROSSFLOW SYSTEMS

1. **Powered Transfer System**

   **Components:**

   - DC boost pumps
   - Transfer valve (interconnects pumps)
   - Manual pilot control

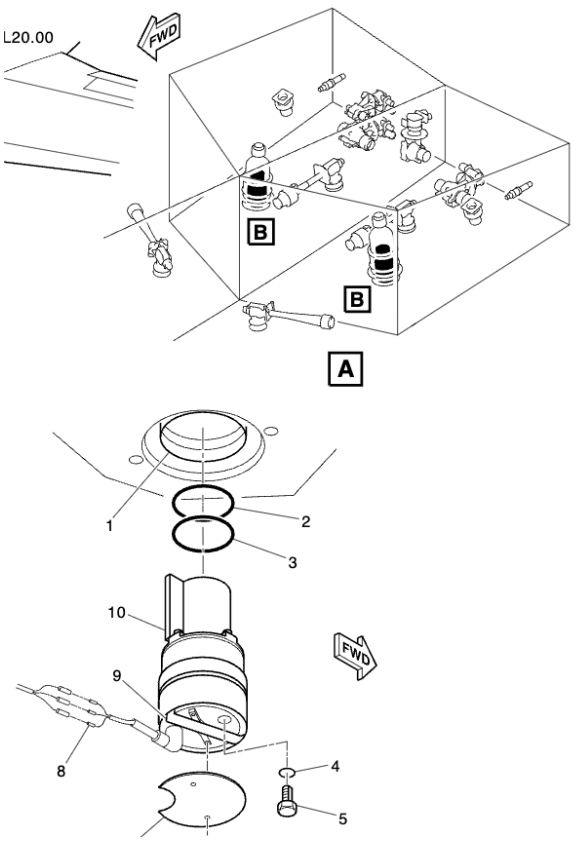
   **Operation:**

   - Transfer valve normally closed (isolates L/R systems)
   - Open transfer valve for fuel transfer
   - Switch ON DC boost pump
   - Fuel pumped through transfer valve and inactive pump
   - Visual monitoring via EICAS

2. **Gravity Crossflow System**

   **Operation:**

   - Independent of pumped system
   - Direct flow path between wings
   - Gravity crossflow shutoff valve control
   - Aircraft maneuvering may be required for minimal imbalance
   - Large imbalance requires no maneuvering

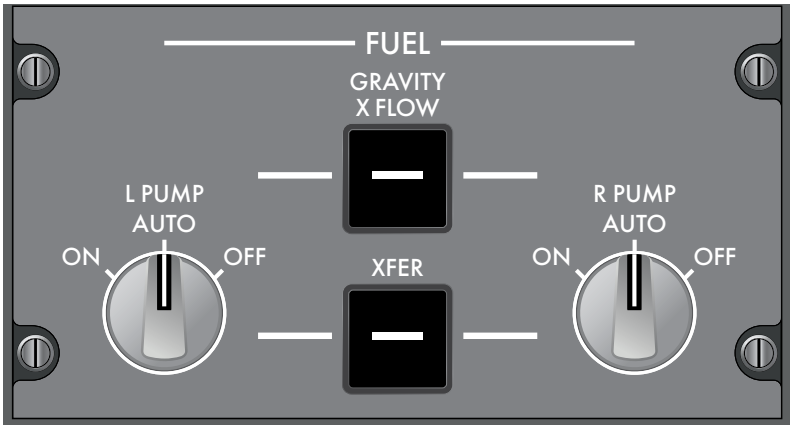



DC Boost Pump

# IV. CONTROLS AND INDICATION

## A. FUEL CONTROL PANEL

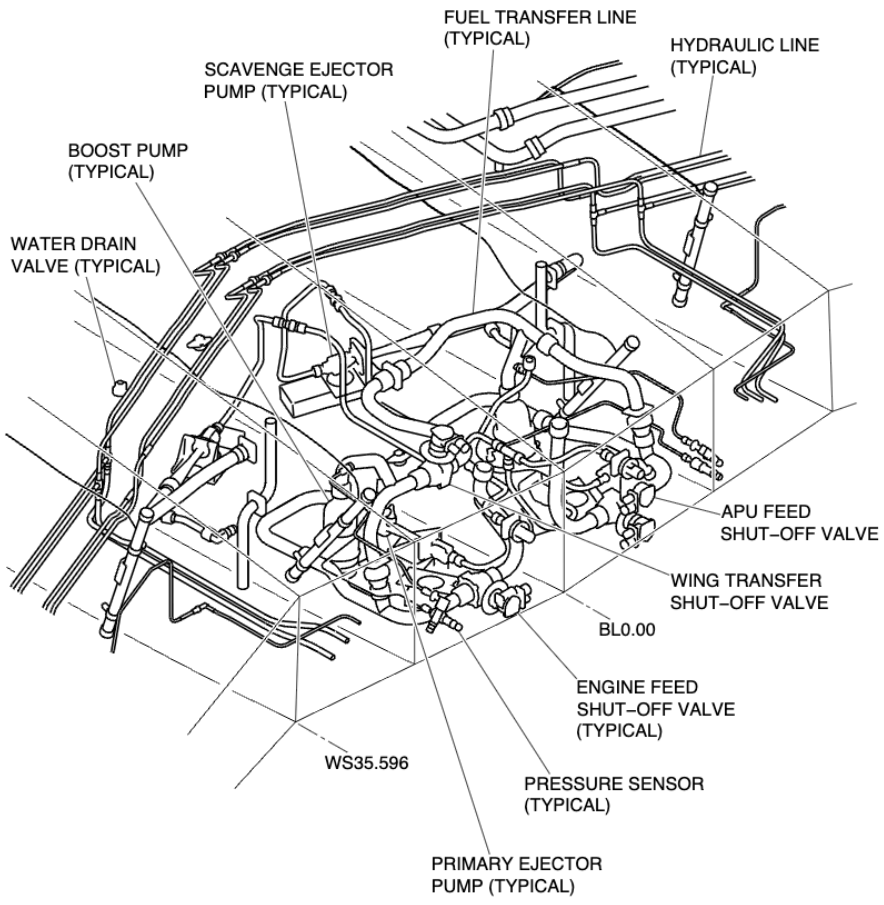
- L PUMP and R PUMP switches
- (OFF, AUTO, ON)
- XFER SWITCH
- GRAVITY XFLOW switch
- L (R) ENG FIRE switches




## B. BOOST PUMP CONTROL

**AUTO Mode Operation:**

- ENGINE RUN switch ON
- Boost pump armed
- Operates when ejector insufficient pressure
- 10-second delay after ejector pressure achieved




Fuel Component Locations

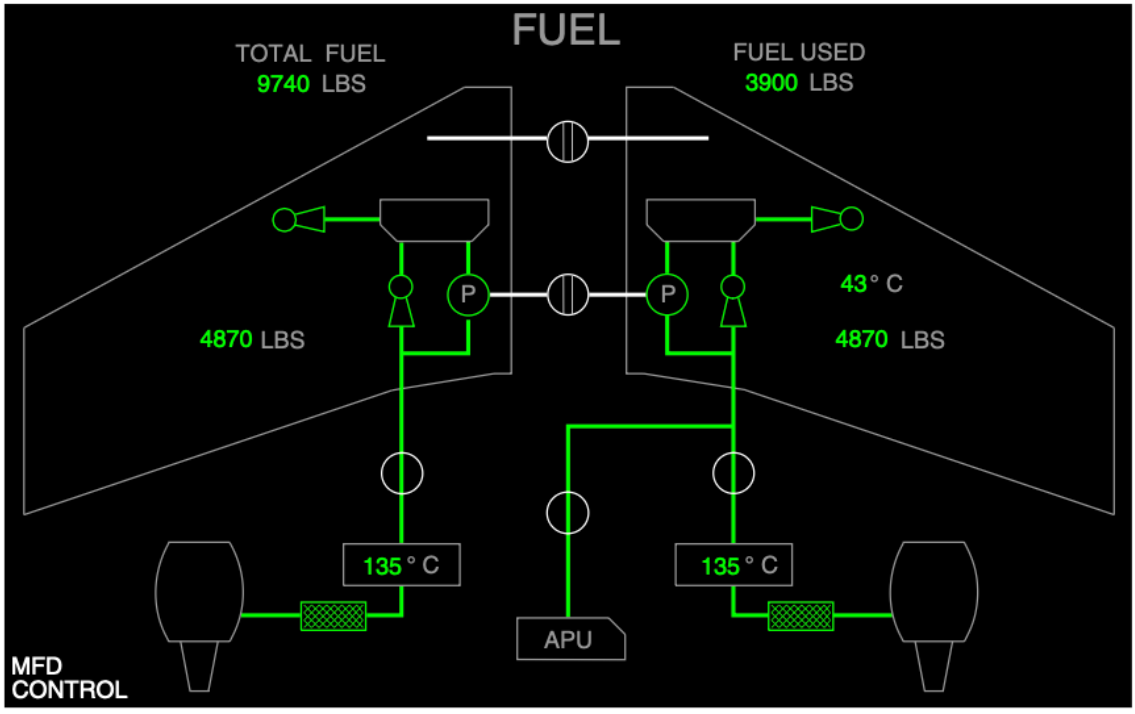
## C. FUEL DISPLAY

**FUEL Synoptic Page:**

- Digital fuel flow indications
- Fuel quantity displays
- Flow: PPH or KPH units
- Quantity: pounds or kilograms
- Magenta dashes indicate invalid input

## D. FUEL TEMPERATURE READOUTS

- Bulk Fuel Temperature:
- Right wing tank indication
- Green: Above –35°C (–31°F)
- **WING FUEL TEMP LOW** (C) message below –35°C (–31°F)






## E. FUEL QUANTITY INDICATIONS

**TOTAL FUEL:**

- Green digits: Over 1,000 lb total and 500 lb per wing

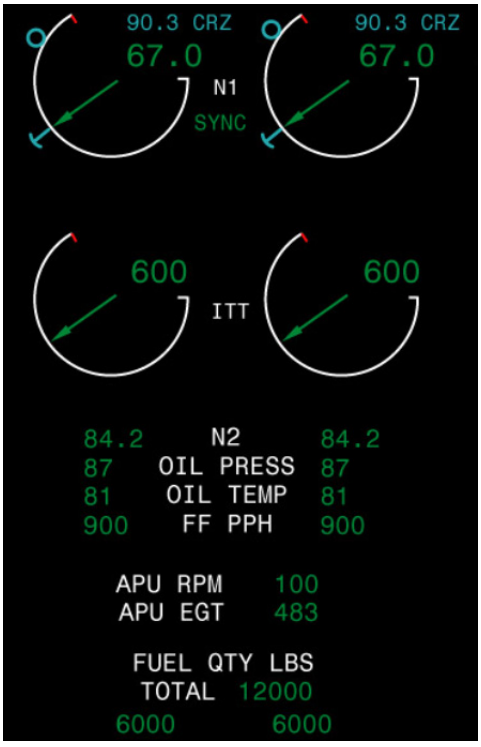
**FUEL IMBALANCE (C) Message Triggers:**

- 250 lb imbalance with total fuel > 13,700 lb
- 315 lb imbalance with total fuel 10,000-13,700 lb
- 450 lb imbalance with total fuel 4,700-10,000 lb
- 600 lb imbalance with total fuel < 4,700 lb

**FUEL USED:**

- Amount since counter reset
- Automatic reset on FADEC power-up
- Magenta dashes indicate invalid data

# V. FUEL QUANTITY GAGING




## A. FUEL COMPUTER

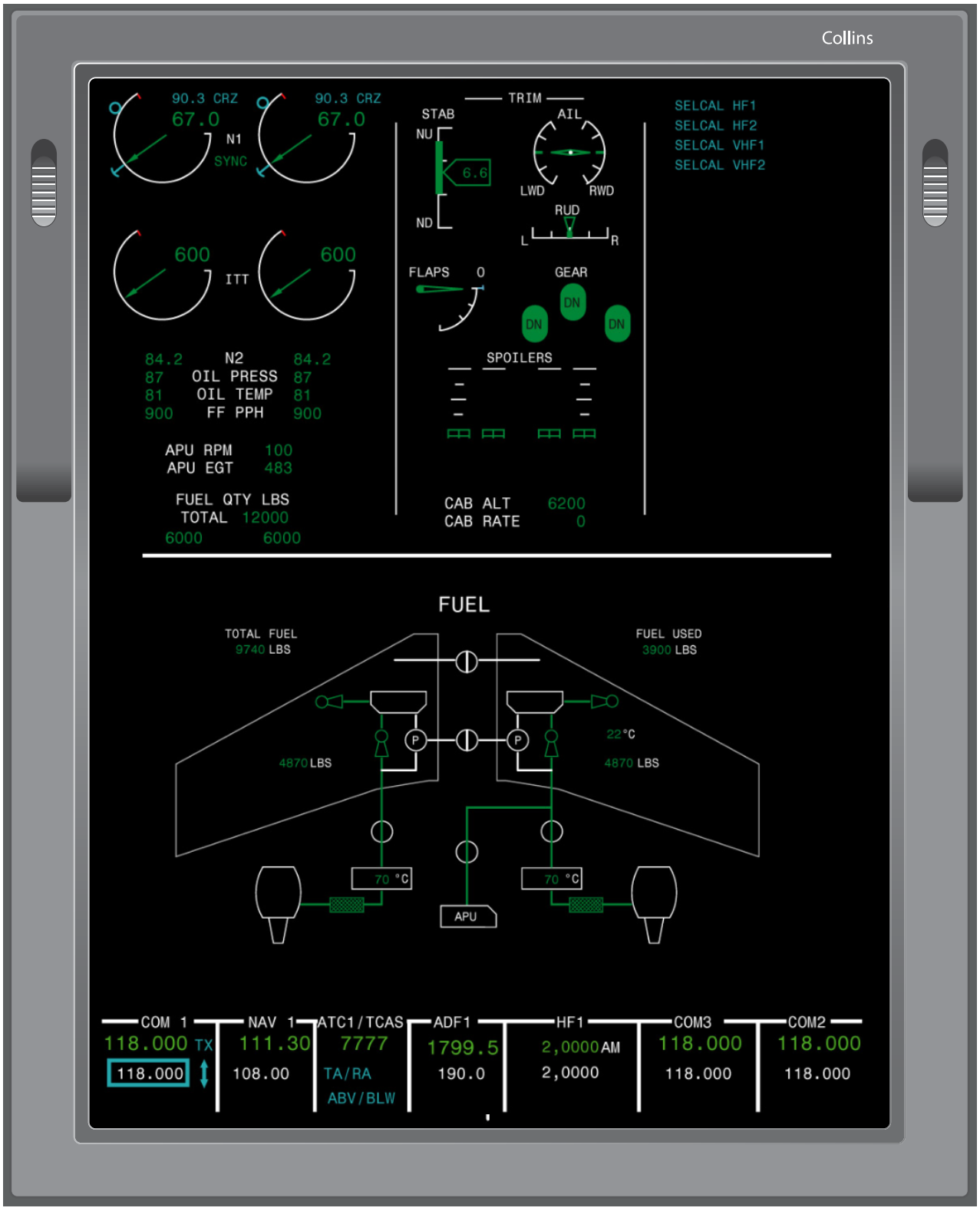
- Dual-channel fuel system computer
- Calculate onboard fuel quantity
- Control refueling operations
- One channel per side
- Automatic switchover if channel fails
- Receives signals from probes and IRS

**Calculation Inputs:**

- Fuel density
- Fuel probe readings
- Aircraft attitude and accelerations
- Weight-on-wheels (WOW) signal

## B. FUEL QUANTITY GAGING COMPUTER

- Fuel quantity probe signal processing
- Fuel density probe processing
- Fuel level and temperature processing
- Sensor signal processing
- Weight-off-wheels and attitude correction from IRS
- Accurate fuel quantity display on EFIS
- Failure monitoring and EICAS indication
- Maintenance diagnostic computer communication
- Automatic refueling/defueling control
- Engine oil level indication to refuel/defuel panel


Collins
90.3 CRZ
67.0
N1
SYNC
90.3 CRZ
67.0
600
ITT
600
84.2 N2 84.2
87 OIL PRESS 87
81 OIL TEMP 81
900 FF PPH 900
APU RPM 100
APU EGT 483
FUEL QTY LBS
TOTAL 12000
6000 6000
TRIM
STAB
NU
6.6
ND
AIL
LWD
RWD
RUD
L
R
FLAPS 0
GEAR
DN
DN
DN
SPOILERS
CAB ALT 6200
CAB RATE 0
SELCAL HF1
SELCAL HF2
SELCAL VHF1
SELCAL VHF2
FUEL
TOTAL FUEL
9740 LBS
FUEL USED
3900 LBS
4870 LBS
22 °C
4870 LBS
70 °C
70 °C
APU
COM 1
118.000 TX
118.000
NAV 1
111.30
108.00
ATC1/TCAS
7777
TA/RA
ABV/BLW
ADF1
1799.5
190.0
HF1
2,0000 AM
2,0000
COM3
118.000
118.000
COM2
118.000
118.000

### C. FUEL TEMPERATURE PROBE

- Located in right wing tank
- Provides temperature information to fuel indicating system

### D. FUEL LEVEL SENSORS

- Tank full sensor at top of each tank
- Cutoff signal to refuel valve when tank full



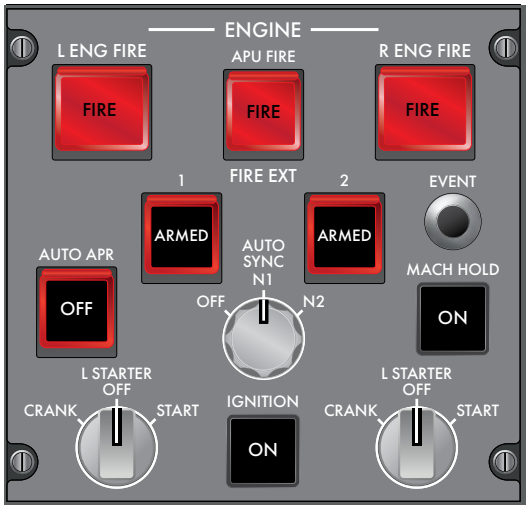

## VI. ENGINE FUEL SHUTOFF VALVES

### A. ENGINE FUEL SHUTOFF VALVE (SOV)

- Aft spar of wing box in main landing gear bay
- Controlled by the L (R) ENG FIRE switches on ENGINE control panel
- Electrically operated valves
- Stop fuel flow to engines
- Located forward of engine rotor burst areas
- Close on ENG FIRE switch activation
- Can be reopened by pushing switches again

### B. APU FUEL FEED SHUTOFF VALVE (SOV)

- Electrically operated shutoff valve
- APU FIRE switch on ENGINE control panel
- Automatic control during normal operations



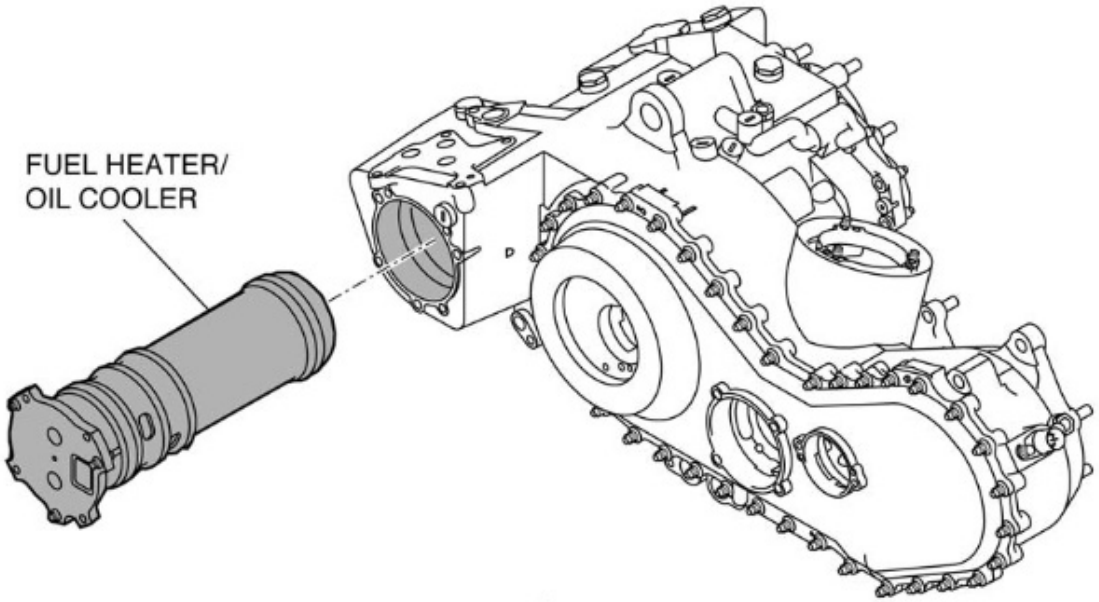

## VII. FUEL FILTERING AND HEATING

### A. FUEL HEATER/OIL COOLER (FHOC)

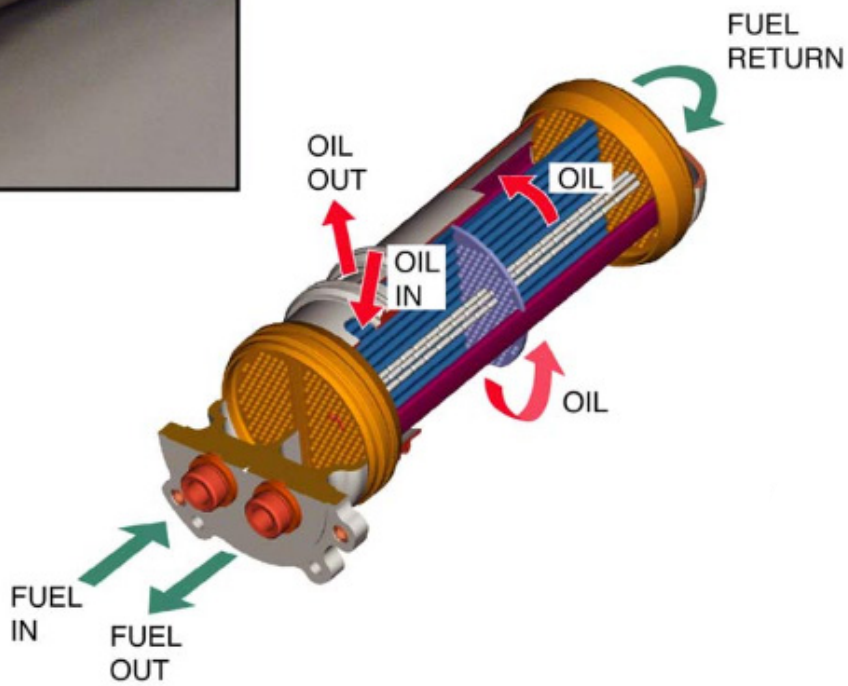
- Located in the engine accessory gearbox (AGB)
- Heat fuel to prevent ice formation in engine fuel system
- Maintain engine oil temperature within limits

### B. FUEL FILTER

- Just aft of oil tank on engine
- Impending bypass switch monitors contamination
- EICAS signal when fuel pressure parameters exceeded


FUEL HEATER/
OIL COOLER




FUEL
RETURN
OIL
OUT
OIL
OIL
IN
OIL
FUEL
IN
FUEL
OUT

# VIII. REFUELING/DEFUELING

## A. REFUELING METHODS

- **Pressure Refueling:** Preferred method – 14,150lbs max
    - Limited to 55 psig
- **Gravity Refueling:** When single-point unavailable – 13,000lbs max

## B. DEFUELING

- Suction defueling – limited to -8 psig
- Single-point refuel/defuel adapter
- Refuel/defuel control panel configuration
- Maintenance personnel function only



Single Point Fueling Port

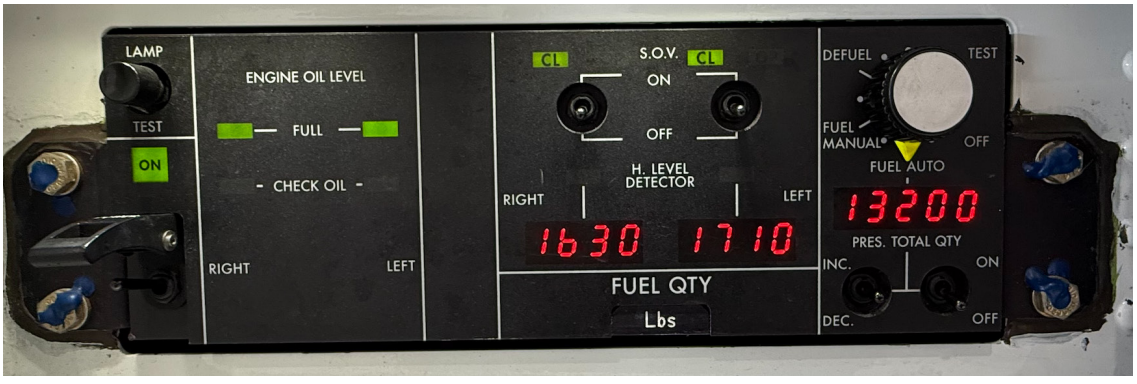
## C. REFUEL/DEFUEL CONTROL PANEL

**Right wing root leading-edge fairing**

- Preselected total fuel load
- Automatic computer control
- Manual control option
- High-level sensor prevents overfilling
- Simulated high-level sensor test capability

## D. FUEL COMPUTER CONTROL

- Dual-channel system monitors refueling process
- Controls refueling operations




Remote Oil / Fuel Panel

# IX. EICAS MESSAGES

## A. WARNING MESSAGES

None.

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| L (R) FUEL COLLECTOR LOW | The fuel collector tank quantity is less than 200 pounds | — |
| L (R) FUEL EJECTOR FAIL | The affected ejector pump has failed to provide sufficient pressure. | TO/LAND |
| L (R) ENG FUEL SOV FAIL | The respective engine fuel shutoff valve has failed to close when commanded | TO/LAND |
| FUEL IMBALANCE | The wing fuel imbalance is greater than: 250 lb with total fuel > 13,700 lb; 315 lb with total fuel 10,000-13,700 lb; 450 lb with total fuel 4,700-10,000 lb; 600 lb with total fuel < 4,700 lb | TO/LAND |
| L (R) FUEL PRESSURE LOW | The engine fuel pressure is below 6 psi (Maintain 18,500' or below for suction feed) | TO/LAND |
| L (R) FUEL PUMP FAIL | The respective electric fuel pump has failed | TO/LAND |
| FUEL QUANTITY FAIL | Both channels of the fuel quantity gauging computer have failed. fuel quantities will be indicated as magenta dashes on the EICAS | TO/LAND |
| FUEL QUANTITY LOW | Fuel quantity is 300 lbs or less in one or both wings. | TO |
| WING FUEL TEMP LOW | Fuel temperature in the wing is below –35°C (–31°F) | TO/LAND |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| FUEL GRAV XFLOW FAIL | The wing fuel gravity crossflow valve is not fully opened or closed as commanded | TO/LAND |
| L (R) FUEL PUMP ON | Indicated electrical fuel pump is on | TO/LAND |
| FUEL QUANTITY FAULT | The left or right channel has detected a fault or loss of temperature compensation | TO/LAND |
| FUEL XFER FAIL | The fuel transfer valve has failed | TO/LAND |

## D. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **L (R) ENG FUEL SOV CLSD** | Respective engine fuel shutoff valve is closed |
| **FUEL BALANCED** | The fuel is balanced within 100 lb with the FUEL XFER valve open |
| **FUEL GRAV XFLOW OPEN** | Wing fuel gravity crossflow valve is open |
| **L (R) FUEL PUMP OFF** | The respective fuel pump is OFF |
| **L (R) FUEL PUMP ON** | The respective fuel pump is ON |
| **FUEL XFER OPEN** | The fuel transfer valve is open |

**NOTES**

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message in inhibited during takeoff and landing phases
- "TO" indicates the message in inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right engine/system
- Fuel imbalance thresholds vary based on total fuel weight to account for aircraft balance sensitivity

# X. LIMITATIONS

## A. FUEL CAPACITY LIMITATIONS

Pressure Refuel

| Parameter | Value |
|---|---|
| Right Tank | 7,075 lb |
| Left Tank | 7,075 lb |
| Total Capacity | 14,150 lb |

Gravity Refuel (Airplane Level)

| Parameter | Value |
|---|---|
| Right Tank | 6,500 lb |
| Left Tank | 6,500 lb |
| Total Capacity | 13,000 lb |

**NOTE:** Based on fuel density of 6.75 lb/USG. Fuel mass provided for reference only.

## B. FUEL IMBALANCE LIMITATIONS

| Total Fuel Quantity | Maximum Imbalance |
|---|---|
| Total fuel > 13,700 lb | 250 lb |
| Total fuel 10,000-13,700 lb | 315 lb |
| Total fuel 4,700-10,000 lb | 450 lb |
| Total fuel < 4,700 lb | 600 lb |

## C. FUEL TEMPERATURE LIMITATIONS

Minimum Fuel Temperature by Fuel Type:

| Fuel Type | Minimum Temperature |
|---|---|
| Jet A | -30°C (-22°F) |
| Jet A-1 | -35°C (-31°F) |
| JP-5 | -35°C (-31°F) |
| JP-8 | -35°C (-31°F) |
| Jet B | -40°C (-40°F) (Max altitude 16,000') |
| JP-4 | -40°C (-40°F) (Max altitude 16,000') |

Minimum Fuel Temperature by Fuel Type:

| Fuel Type | Minimum Temperature |
|---|---|
| Russian TS-1 | -35°C (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F)) |
| Russian RT | -40°C (-40°F) (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F)) |
| Ukrainian TS-1 & RT | -40°C (-40°F) (-31°F) (Max altitude 37,000' if bulk temp > 35°C (86°F)) |
| GB 6537-2006 No. 3 JET | -37°C (-34.6°F) |

NOTES

- Takeoff is prohibited if bulk fuel temperature indications are above 50°C (122°F)
- When wing bulk fuel temperature is 45°C (113°F) or above, the following limitations apply:
  - Minimum fuel load for takeoff is 2,800 lbs
  - If there is less than 1,000 lbs per side, engine operation is limited to a maximum of 30 minutes.
  - Minimum fuel quantity for a go-around: 500 lbs per side

## XI. FUEL SYSTEM CIRCUIT BREAKERS

Fuel System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| FUEL PUMP L | LEFT ESS | CB1-F1 |
| FUEL PUMP R | RIGHT ESS | CB2-F1 |
| FUEL XFER L | LEFT MAIN | CB3-F2 |
| FUEL XFER R | RIGHT MAIN | CB4-F2 |
| FUEL QUANTITY L | LEFT ESS | CB1-F3 |
| FUEL QUANTITY R | RIGHT ESS | CB2-F3 |
| FUEL CONTROL L | LEFT ESS | CB1-F4 |
| FUEL CONTROL R | RIGHT ESS | CB2-F4 |
| REFUEL CONTROL | RIGHT MAIN | CB4-F5 |
| FUEL SHUTOFF L | LEFT ESS | CB1-F6 |
| FUEL SHUTOFF R | RIGHT ESS | CB2-F6 |
| FUEL TEMP | LEFT MAIN | CB3-F7 |
| FUEL FILTER BYPASS | RIGHT MAIN | CB4-F8 |

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## XII. FUEL SYSTEMS QUIZ

1. What is the maximum usable fuel capacity for pressure refueling?

    A. 13,000 lb
    B. 14,150 lb
    C. 15,000 lb
    D. 7,075 lb

2. Where are the collector tanks located?

    A. Forward section of each wing tank
    B. Center section of each wing tank
    C. Aft section of each wing tank
    D. Outside the wing tanks

3. How many water drain valves are in each wing?

    A. Two
    B. Three
    C. Four
    D. Five

4. What provides motive flow for the ejectors?

    A. Electric pumps
    B. Engine-driven fuel pumps
    C. APU-driven pumps
    D. Gravity feed

5. The scavenge ejectors are located at:

    A. The highest point of each wing tank
    B. The center of each wing tank
    C. The lowest inboard point of each wing tank
    D. The outboard area of each wing tank

6. How much fuel does each surge bay hold?

    A. 50.0 lb
    B. 53.6 lb
    C. 60.0 lb
    D. 75.0 lb

7. What is the minimum fuel temperature before a CAS message appears?

    A. –30°C (–22°F)
    B. –35°C (–31°F)
    C. –40°C (–40°F)
    D. –45°C (–49°F)

8. The fuel quantity gaging computer uses all of the following EXCEPT:

A. Fuel density
B. Aircraft attitude from IRS
C. Weight-on-wheels signal
D. Engine oil temperature

9. Where are the engine fuel shutoff valves located?

A. In the engine accessory gearbox
B. On the wing leading edge
C. On the aft spar of the wing box in the main landing gear bay
D. In the collector tanks

10. The time delay for boost pump operation after ejector pressure is achieved is:

A. 10 seconds
B. 15 seconds
C. 20 seconds
D. 30 seconds

11. Which fuel tank provides fuel to the APU?

A. Left tank only
B. Right tank only
C. Both tanks equally
D. Either tank as selected

12. The FUEL IMBALANCE (C). message appears when there is a 450 lb imbalance with total fuel between:

A. 13,700-10,000 lb
B. 8,000-6,700 lb
C. 10,000-4,700 lb
D. Above 13,700 lb

13. What type of fuel tank construction does the Challenger 350 use?

A. Integral wet wing tanks
B. Bladder tanks
C. Rigid fuel cells
D. External drop tanks

14. The main ejectors are installed:

A. At the top of the collector tanks
B. On the bottom of the collector tanks
C. In the center of the wing tanks
D. On the wing leading edge

15. During gravity crossflow, aircraft maneuvering may be required when:

A. The fuel imbalance is large
B. The aircraft is on the ground
C. Both engines are operating
D. The fuel imbalance is minimal

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CL-350



CL-350 TRAINING MANUAL

# HYDRAULICS | 04

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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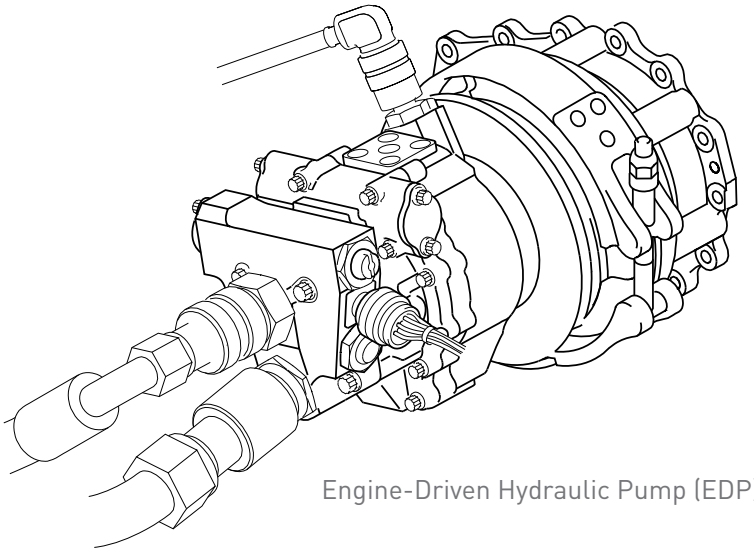
# HYDRAULICS

## I. INTRODUCTION

The hydraulic system of the Challenger 350 represents a sophisticated and highly redundant design that ensures continued aircraft control and operation even under adverse conditions. Comprised of three independent hydraulic systems—left, right, and auxiliary—this configuration provides multiple layers of safety and operational reliability throughout all phases of flight.

The left and right hydraulic systems operate as completely independent units, each powered by dedicated Engine-Driven Pumps (EDPs) with DC Motordriven Pump (DCMP) backup, while the auxiliary system serves as a critical tertiary backup tied to the right hydraulic system.

Operating at a nominal pressure of 3000 psi and utilizing Fire Resistant Phosphate Ester based MIL-H-5440 Type II fluid, these systems power essential aircraft functions including flight controls, landing gear operation, wheel brakes, thrust reversers, and various other critical subsystems.



Engine-Driven Hydraulic Pump (EDP)

The intelligent design ensures that hydraulic power remains available to vital flight control surfaces even after single or multiple system failures, with the auxiliary system providing power to the lower rudder Power Control Unit (PCU) when primary systems are lost. Understanding the operation, monitoring, and emergency procedures associated with this hydraulic system is fundamental to safe aircraft handling.

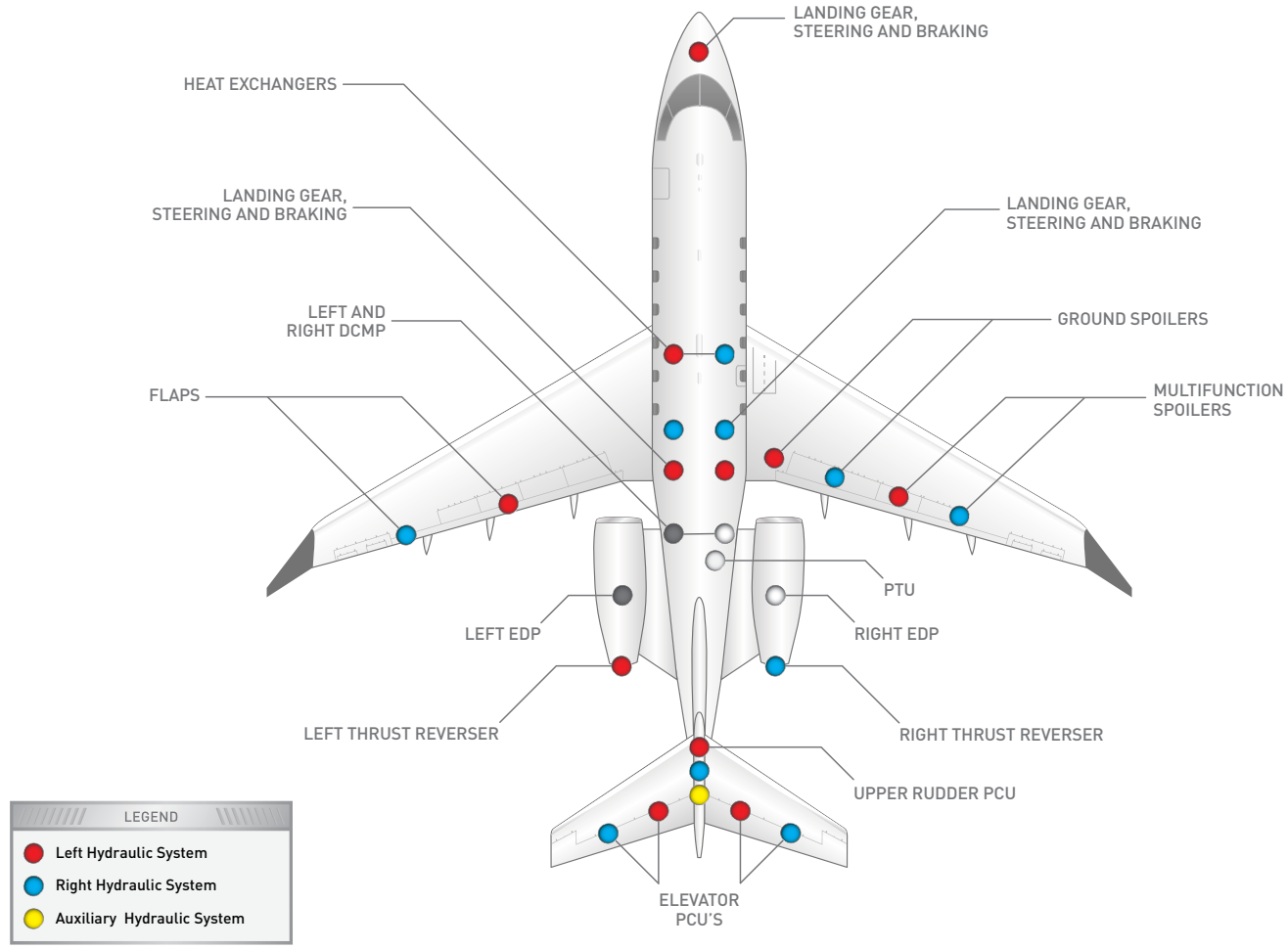
### A. HYDRAULIC SYSTEM SPECIFICATIONS

| Parameter | Left System | Right System | Auxiliary System |
|---|---|---|---|
| Operating Pressure | 3,000 psi | 3,000 psi | 2,500-3,350 psi |
| Reservoir Capacity | 750 cu in | 525 cu in | 150 cu in |
| Fluid Volume | 13 quarts | 9.1 quarts | — |
| Primary Pump | Engine-Driven Pump (EDP) | Engine-Driven Pump (EDP) | DC Motor Pump |
| Backup Pump | DC Motor Pump (DCMP) | DC Motor Pump (DCMP) | — |

**HYDRAULIC FLUIDS APPROVED FOR USE:** Phosphate Ester Fire-Resistant per BAMS 564-003 Type IV, Skydrol LD-4, Hyjet IV-a Plus

## B. SYSTEM FUNCTIONS

| Left Hydraulic System | Right Hydraulic System | Aux Hydraulic System |
|---|---|---|
| Multi-functional spoilers (inboard) | Multi-functional spoilers (outboard) | Low Rudder PCU |
| Ground spoilers (inboard) | Ground spoilers (outboard) | — |
| Rudder (upper PCU) | Rudder (lower PCU) | — |
| Left thrust reverser | Right thrust reverser | — |
| Inboard brakes, emergency | Outboard brakes | — |
| Nose wheel steering actuator | Main landing gear assist actuators | — |
| Elevator (inboard PCUs) | Elevator (outboard PCUs) | — |
| Alternate FLAPS | Normal FLAPS supply | — |
| Landing Gear | Power transfer unit | — |



# II. LEFT AND RIGHT HYDRAULIC SYSTEMS

## A. SYSTEM DESCRIPTION

**Major Components:**

- Engine-Driven Pumps (EDPs)
- DC Motor Pumps (DCMPs)
- Firewall Shutoff Valves (SOVs)
- Control valves
- Fluid reservoirs
- Sensors for monitoring and control

**Component Locations:**

- EDPs mounted on engine accessory gearboxes
- Heat exchangers located in respective wing fuel tanks
- Major components located in aft of the engine rotor burst zone
- Left and right hydraulic system reservoirs installed on respective sides in aft equipment compartment
- AUX hydraulic system installed right side in aft equipment compartment

**System Independence:**

- Left and right hydraulic systems operate independently
- Hydraulic fluid never mixed between left and right systems
- Each system has separate fuel/hydraulic fluid heat exchangers in wing fuel tank
- AUX system tied to right hydraulic system



Right DC Motor Pump



Left DC Motor Pump

## B. HYDRAULIC RESERVOIR

**Left Hydraulic Reservoir:**

- Fluid volume: 13 quarts
- Capacity: 750 cu in
- Located on left side in aft equipment compartment

**Right Hydraulic Reservoir:**

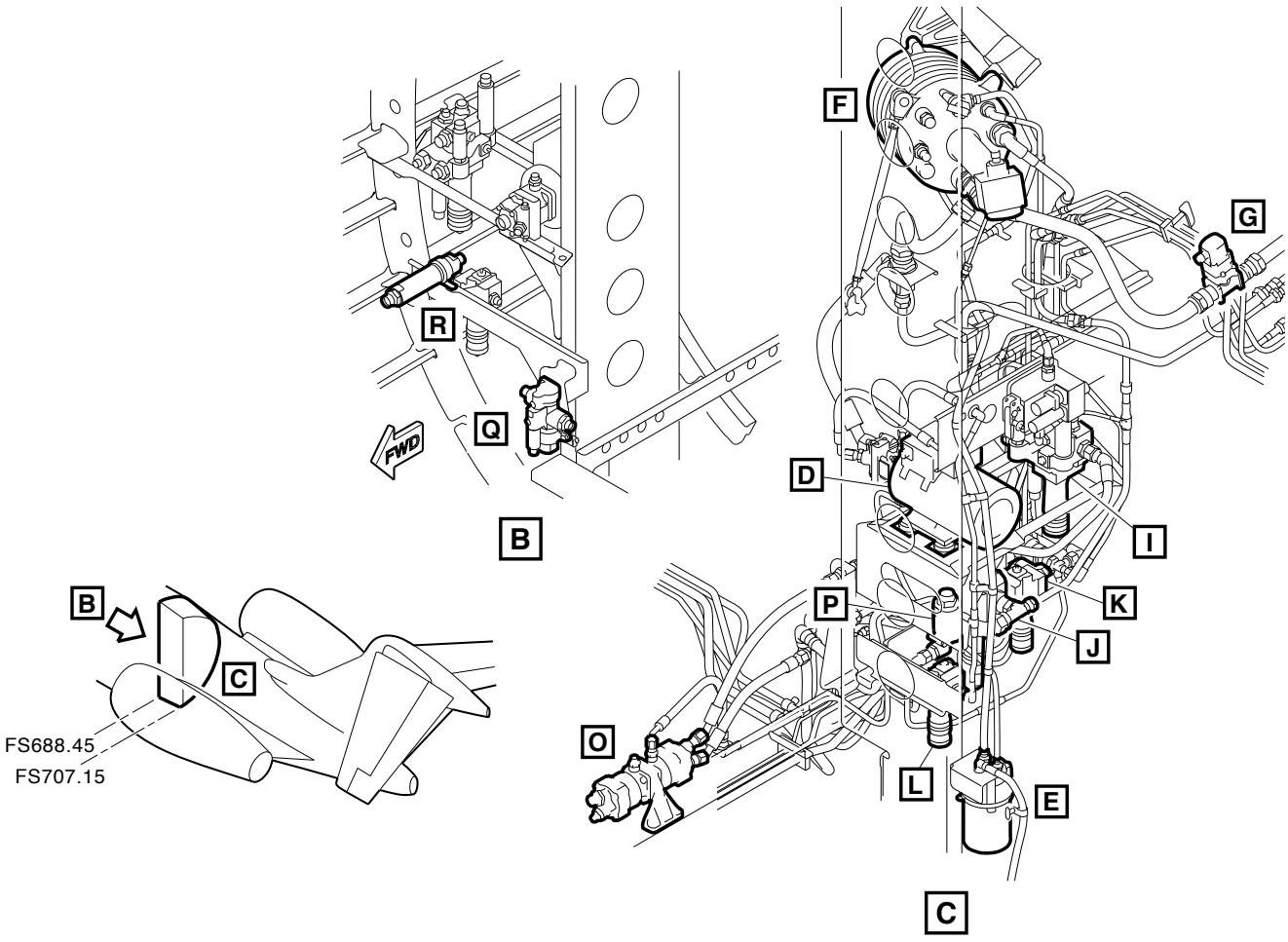
- Fluid volume: 9.1 quarts
- Capacity: 525 cu in
- Located on right side in aft equipment compartment

**Reservoir Components:**

- Bleed/relief valve for air removal
- Visual quantity indicator (0-100% in 10% increments)
- Suction shutoff valve in pump suction port
- Temperature switch and temperature transducer ports
- Check valve in fluid return port

**Reservoir Functions:**

- Storage of hydraulic fluid
- Pressurization of pump inlet
- Accommodate fluid volume changes due to thermal expansion/contraction
- System leakage compensation
- Differential area of user actuators (gear, flaps, etc)




| ID | Component | ID | Component |
|---|---|---|---|
| D | DC Motor Pump (DCMP) | K | Case Drain Filter Manifold |
| E | Ecology Bottle | L | Case Drain Filter Manifold |
| F | Hydraulic Reservoir | O | Power Transfer Unit (PIU) |
| G | Firewall Hydraulic Shutoff-Valve (SOV) | P | Heat-Exchanger Bypass Valve |
| I | Pressure Manifold Assembly | Q | PTU Select Valve |
| J | Return Filter Manifold | R | Balance Relief Valve |

## C. ENGINE-DRIVEN PUMPS (EDPs)

The left and right hydraulic systems are each powered by an Engine Driven Pump (EDP) that is flange-mounted to the respective engine gearbox and driven through a splined input shaft. These variable-delivery, piston-type pumps maintain a nominal system pressure of 3000 psi and operate continuously whenever the engines are turning.

Each EDP incorporates a solenoid isolation/actuation valve that can reduce discharge pressure and torque when energized, such as during engine windmill restart operations when activated by the FADEC. The EDPs serve as the primary hydraulic power source for their respective systems, with DC motor-driven pumps (DCMPs) providing backup capability.

**EDP Characteristics:**

- Variable-delivery, piston type pumps
- Maintain nominal system pressure of 3000 psi
- Flange-mounted to engine gearbox
- Driven through splined input shaft
- Operate anytime engines are turning

**EDP Features:**

- Solenoid isolation/actuation valve for discharge pressure reduction
- Quick-disconnect fittings on discharge, suction and case drain ports
- Case drain port located on top side near mounting flange
- Maximum case drain cooling of pump components
- Air bleeding assurance after new pump installation

**EDP Operation:**

- Pressure switches in pump outflow lines provide low-pressure indications
- Solenoid activated by FADEC during engine windmill restart to depressurize pump
- Left EDP flow and left DCMP flow combine in left filter manifold
- Right EDP flow and right DCMP flow combine in right filter manifold

## D. DC MOTOR-DRIVEN PUMPS (DCMPs)

**DCMP Purpose:**

- Pressurize hydraulic systems during engine or EDP failure
- Serve ground maintenance operation purposes
- Backup hydraulic pressure source

**DCMP Construction:**

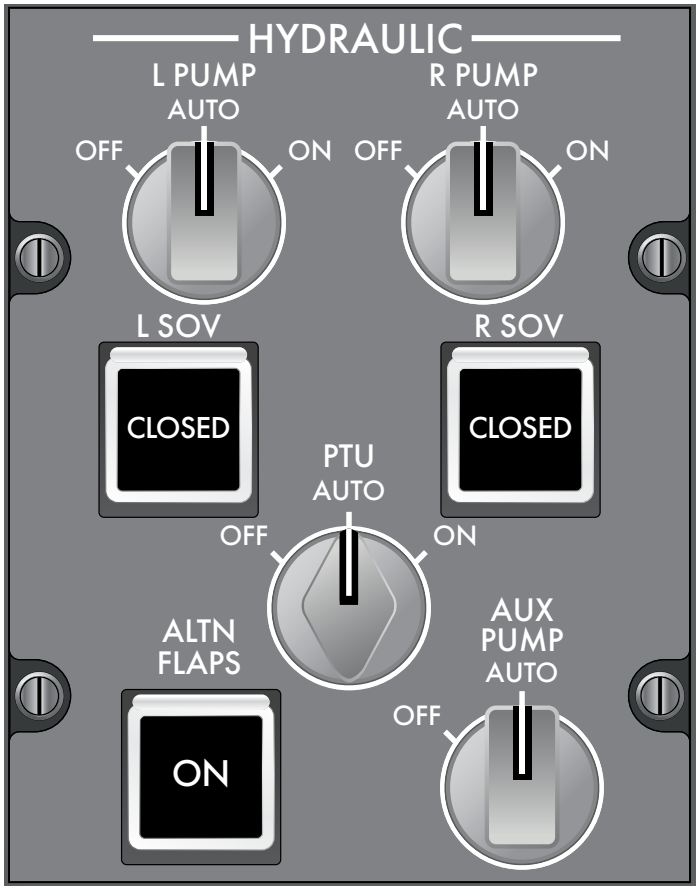
- DC electric motor attached to variable-delivery hydraulic pump
- DC motor operates pump to maintain necessary system pressure
- Can change volume of fluid flow as needed
- Left and right DCMPs installed on respective sides in aft equipment compartment

**DCMP Power Supply:**

- Electrical power supplied by DC bus through electrical connector
- R DC generator supplies power to left DCMP
- L DC generator supplies power to right DCMP
- Cross-feeding arrangement provides redundancy

**DCMP Control:**

- Three-position switch: OFF, AUTO, ON
- OFF and ON positions allow manual operation
- AUTO position is normal position for flight
- AUTO position: DCMPs off with flaps up, on with flaps at 10° or greater
- Automatic activation with low hydraulic system pressure detection




Hydraulic Control Panel

## E. HYDRAULIC SHUTOFF VALVES (SOVs)

**SOV Location and Function:**

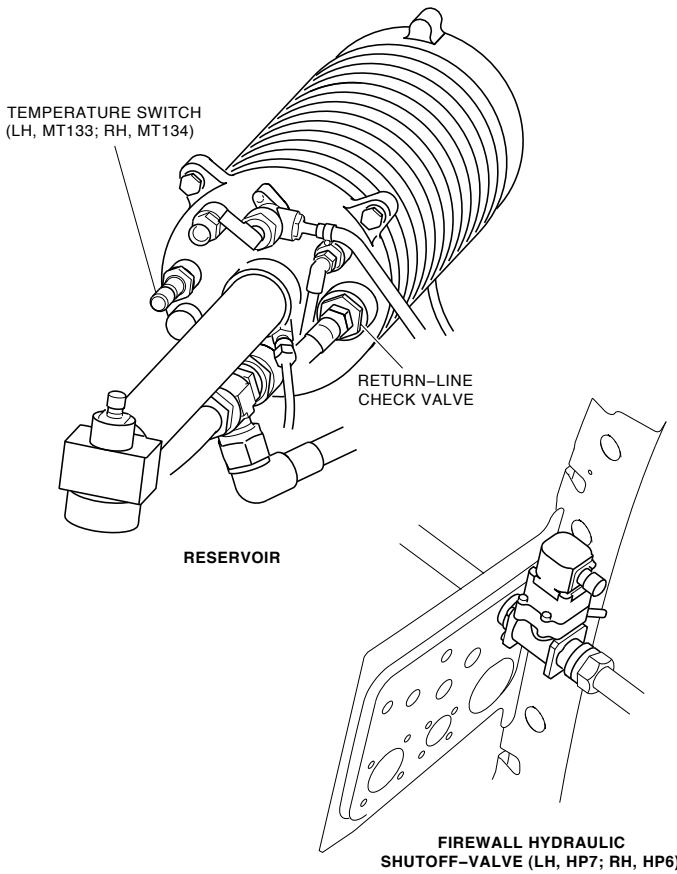
- Each left and right hydraulic system contains firewall shutoff valve
- Placed in EDP suction line outside pylon area
- Closes to stop hydraulic fluid from reaching engine area
- Located inside aft equipment compartment

**SOV Operation:**

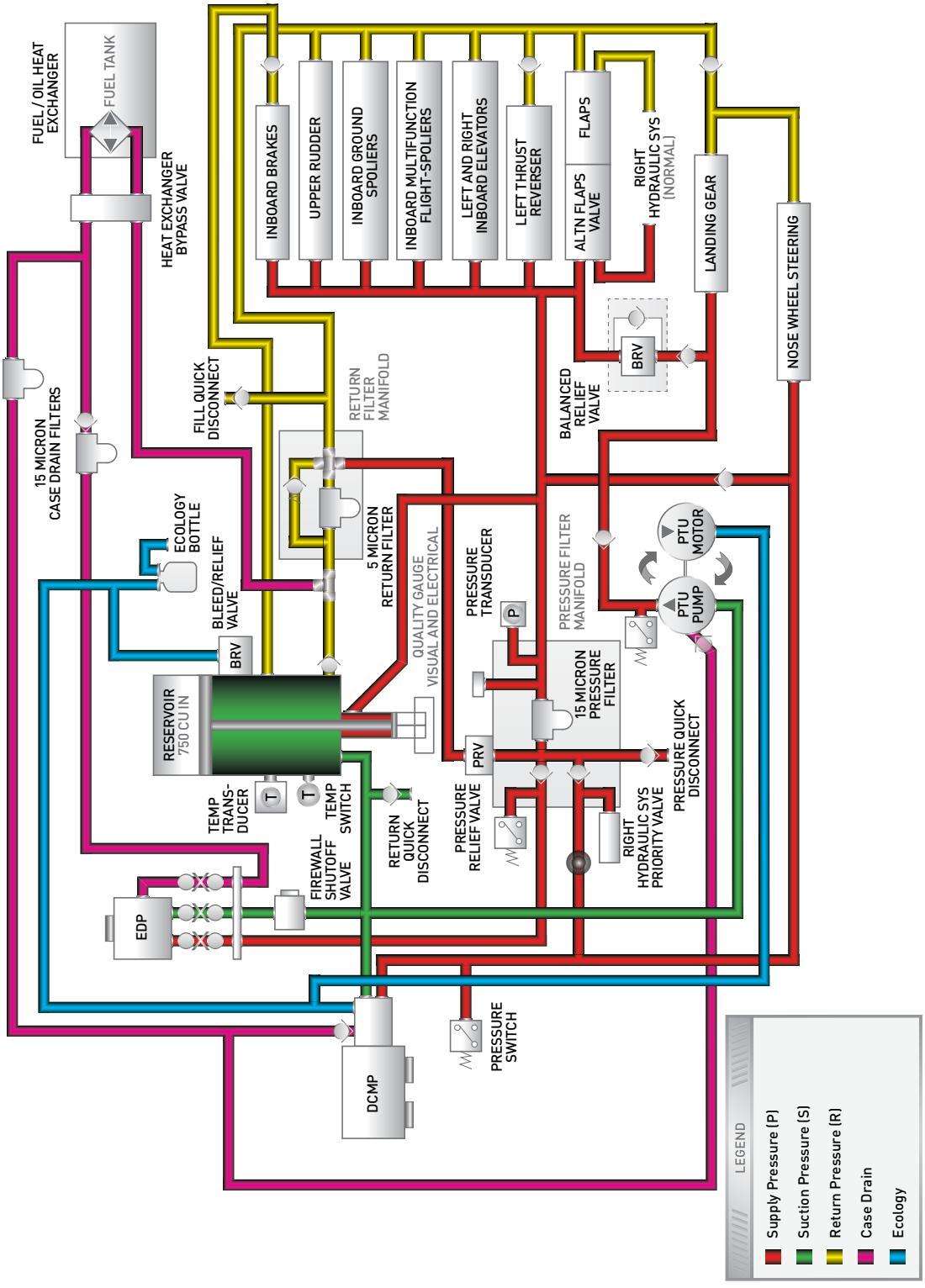
- Normally in open position during flight operations
- Can be closed manually by pressing L (R) SOV push button on hydraulic control panel
- Can be closed by L (R) ENG FIRE switch activation on engine control panel
- Control logic closes valve automatically when system fluid temperature exceeds 275°F

**SOV Effect:**

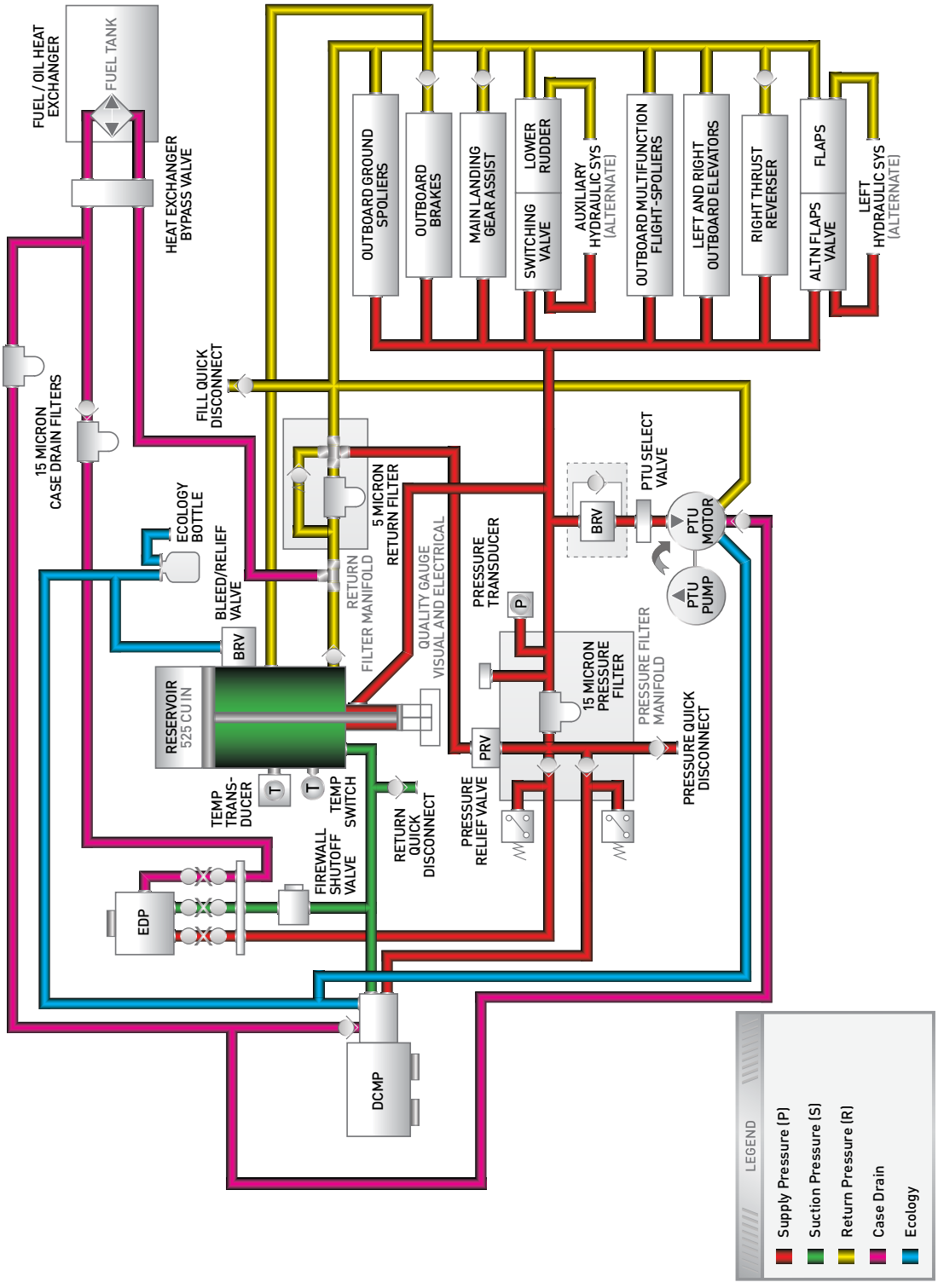
- When firewall SOV is operated, DCMPs provide only the hydraulic pressure source
- Available for left or right hydraulic systems



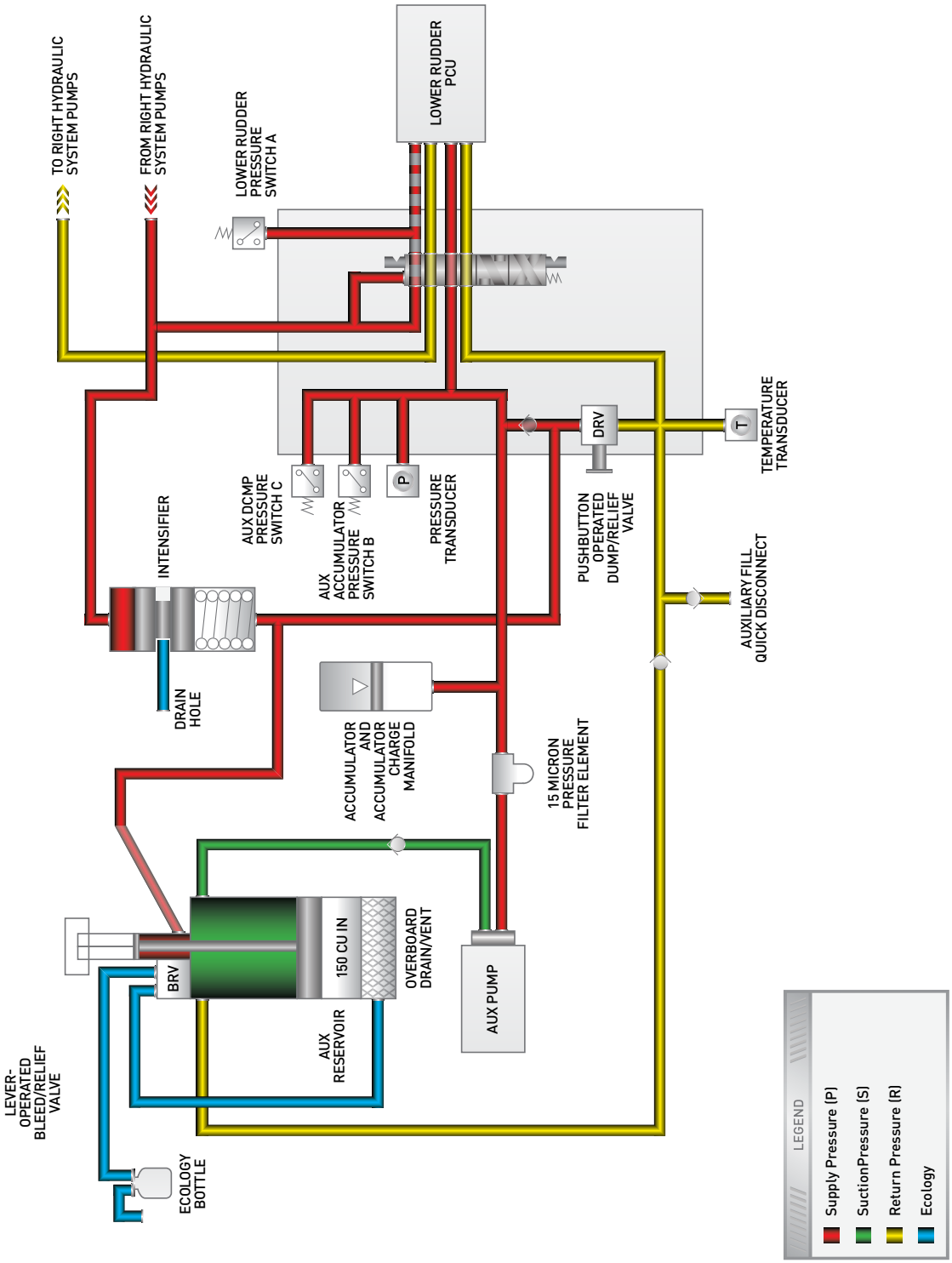
## LEFT HYDRAULIC SYSTEM SCHEMATIC



## RIGHT HYDRAULIC SYSTEM SCHEMATIC



## AUXILIARY HYDRAULIC SYSTEM SCHEMATIC



# III. AUXILIARY HYDRAULIC SYSTEM

The auxiliary hydraulic system serves as a backup to provide hydraulic pressure to the lower rudder PCU when the right hydraulic system fails. The system consists of a DC motor-driven pump (DCMP), reservoir, and accumulator, all located aft of the engine rotor burst zone for safety. It operates between 2,500 and 3,350 psi using Fire Resistant Phosphate Ester based fluid and is controlled from the HYDRAULICS panel on the center pedestal. The system features an intensifier that is pressurized by the right hydraulic system to prevent pump cavitation and ensure reliable operation during normal and emergency conditions.

## A. SYSTEM DESCRIPTION

**Purpose:**

- Provide hydraulic pressure to lower rudder PCU during right hydraulic system failure
- Located aft of engine rotor burst zone
- Independent backup system for rudder control

**Major Components:**

- DCMP (constant displacement)
- Reservoir
- Accumulator
- Pressure intensifier
- All components located aft of engine rotor burst zone

**System Operation:**

- Right hydraulic system normally powers lower rudder PCU
- During loss of right system pressure, hydraulic switching valve allows auxiliary system to provide pressure to lower rudder PCU
- Left or right hydraulic system may be activated without system already being pressurized
- Auxiliary system has intensifier pressurized by right hydraulic system



Aux Hydraulic System

## B. AUXILIARY DC MOTOR-DRIVEN PUMP

**Pump Function:**

- Maintain fluid pressure in auxiliary system accumulator
- Controlled by two-position AUX PUMP switch (OFF/AUTO)
- Constant displacement DCMP

**Pump Operation**

- When system pressure decreases to 2,500 psi, external pressure switch turns on pump
- Pump operates until pressure reaches 3,350 psi
- At 3,350 psi, pressure switch deactivates, commanding pump off
- OFF position disables pump
- AUTO position allows pump to activate as needed

## C. AUXILIARY SYSTEM ACCUMULATOR AND RESERVOIR

**Accumulator Specifications:**

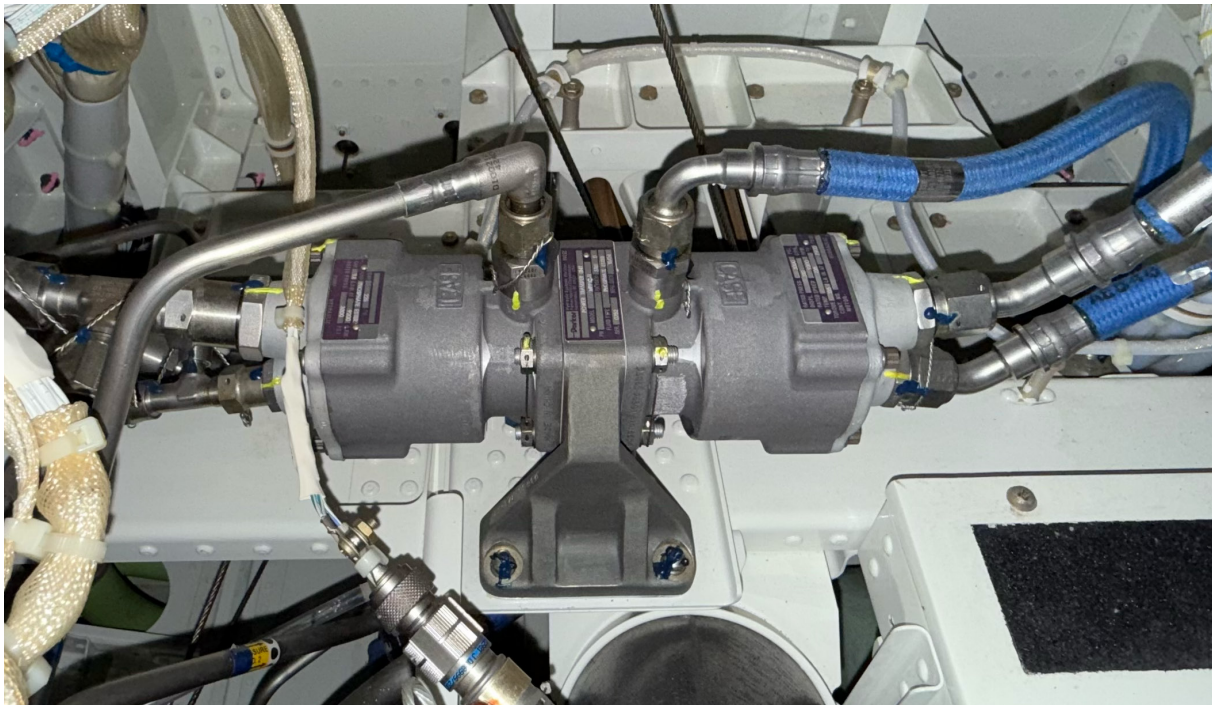
- Nominal gas volume: 50 cubic inches of dry nitrogen
- Pre-charge pressure varies with temperature
- Provides instantaneous hydraulic pressure demands
- Dampens pressure surges within system

**Accumulator Function:**

- When discharged, accumulator retains sufficient fluid for smooth continuous operation
- Lower rudder operates smoothly as pump comes online at approximately 2,500 psi
- Satisfies instantaneous demands of hydraulic pressure

**Intensifier Operation:**

- Spring-loaded piston transmits pressure from RH system to pressure side of auxiliary system reservoir
- Augments inlet pressure to auxiliary DCMP to prevent pump cavitation
- DC pumps supply intensifier with pressure before engines start
- AUX DCMP comes on if selected to AUTO, aircraft has power, and aux system accumulator pressure is low
- Once AUX DCMP pressurizes, operation is independent of RH system



Power Transfer Unit

# IV. POWER TRANSFER UNIT (PTU)

The Power Transfer Unit (PTU) consists of a hydraulic motor mechanically coupled to a hydraulic pump through a drive shaft. When energized, the PTU uses pressure from the right hydraulic system to drive its motor, which in turn operates the pump connected to the left hydraulic system. The PTU is dedicated to landing gear operation and provides normal gear retraction times when the left enginedriven pump (EDP) or left engine is inoperative. It serves as a critical backup system that prevents excessively slow gear operation that would otherwise occur when relying solely on the DC motor pump (DCMP).

## A. PTU DESCRIPTION

**PTU Construction:**

- Hydraulic motor coupled mechanically through drive shaft to hydraulic pump
- Motor driven by pressure from right hydraulic system
- Pump side connected to left system
- Dedicated to operation of landing gear

**PTU Function:**

- Used for gear operation when left EDP system or left engine not operational
- Provides pressurization for left hydraulic system reservoir
- Dedicated to retracting and extending landing gear
- Allows normal gear retraction time during left engine failure
- Priority valve protects right system pressure from excessive flow demand

## B. PTU OPERATION

**PTU Control:**

- Three-position switch: OFF, AUTO, ON
- OFF and ON positions: PTU valve manually closed or open
- AUTO position: normal operating mode

**AUTO Mode Activation Requirements:**

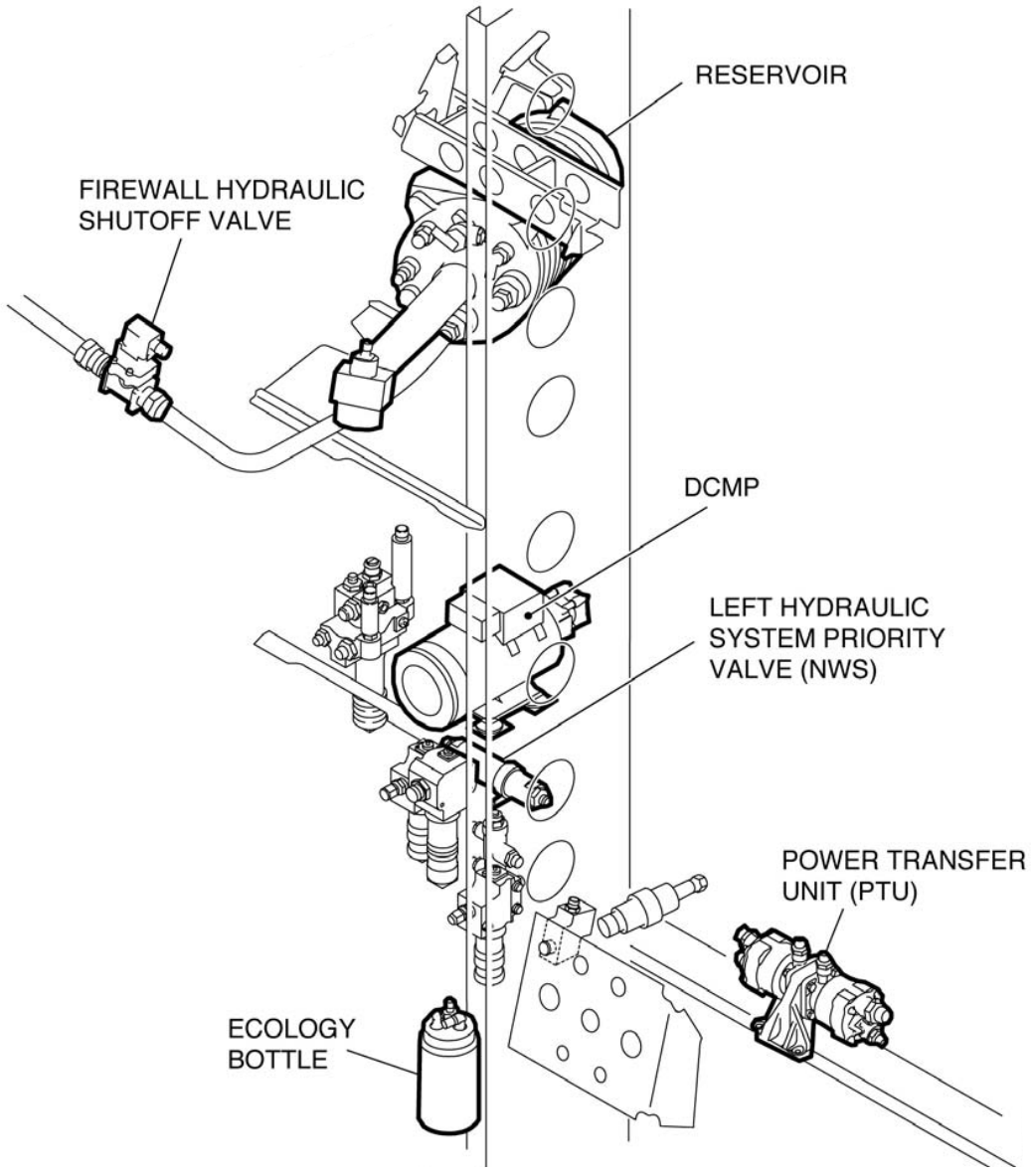
- Left engine or left EDP inoperative or failed
- Right EDP producing pressure
- Gear not in commanded position
- Aircraft in air

**PTU Performance:**

- Allows gear to operate at normal rate
- Slight increase in transit time due to PTU solenoid delays
- Solenoid energizing and PTU coming up to speed causes minor delay

**PTU Protection:**

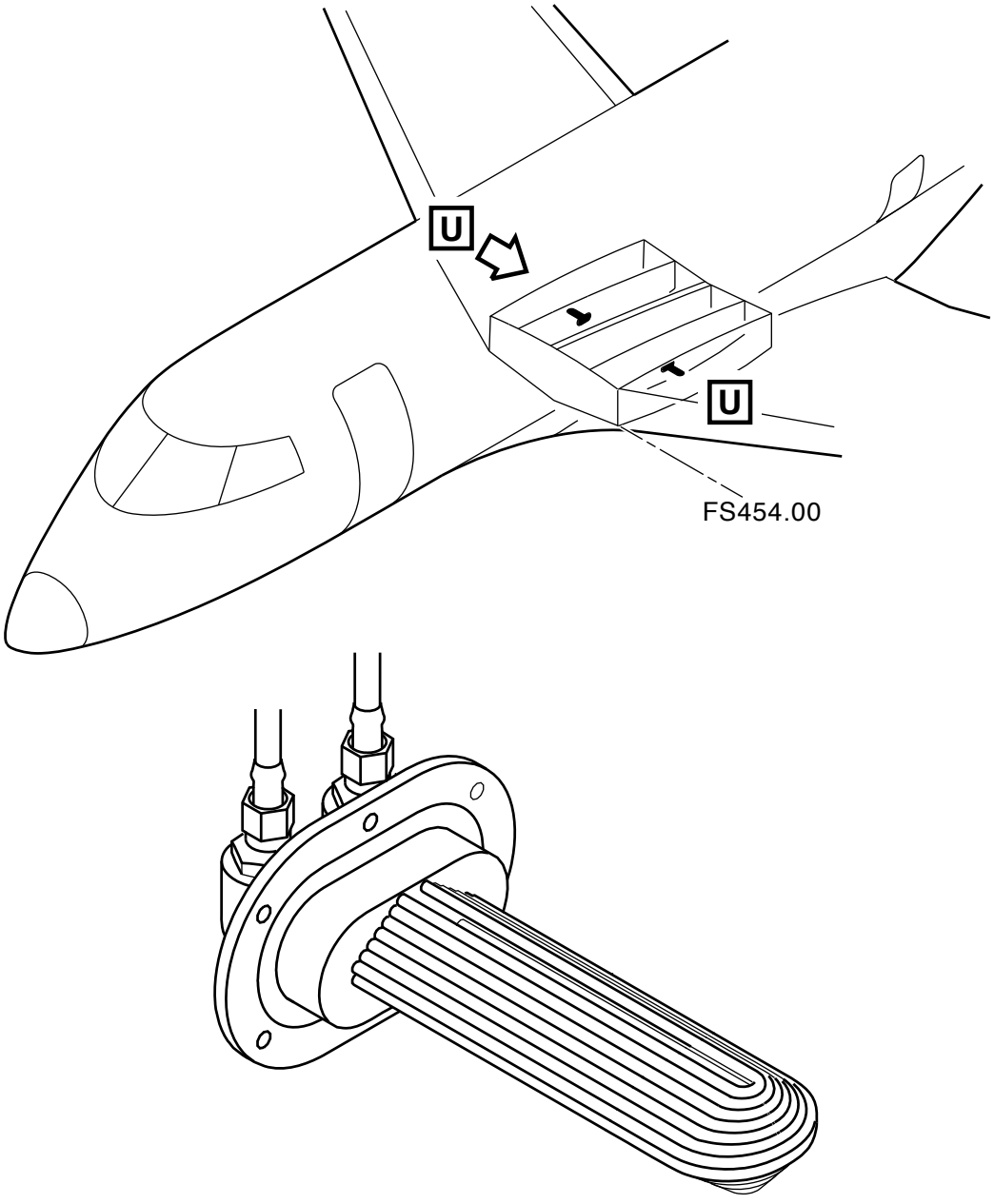
- When in AUTO and does not produce pressure within 15 second, latched off
- Protects load on Right Hydraulic System
- Latch reset if AUTO mode de-selected or power removed from PSEU




## V. HYDRAULIC SYSTEM COOLING

The left and right hydraulic systems require cooling due to heat generated by the engine driven pumps (EDPs) and other heat sources within the engine nacelle. Each system utilizes a fuel/hydraulic heat exchanger located in the respective wing tank, with flow controlled by a thermostatically controlled bypass valve that responds to fluid temperature.

At temperatures above 125°F, the valve directs all fluid through the heat exchanger for cooling, while below 125°F it bypasses the heat exchanger and routes fluid directly to the reservoir. If fluid temperature exceeds 212°F (100°C), the **L (R) HYD TEMP** HIGH (C) CAS message is triggered. If fluid reaches 275°F for more than 3 seconds,




**HEAT EXCHANGER**

U

the shutoff valve closes automatically.

### A. COOLING REQUIREMENTS

**Heat Sources:**

- Heat generated by EDPs
- Heat from other sources within engine nacelle
- Left and right hydraulic systems require cooling

**Heat Exchanger Location:**

- Fuel/hydraulic heat exchanger in each wing tank
- Left system heat exchanger in left wing fuel tank
- Right system heat exchanger in right wing fuel tank

### B. COOLING SYSTEM OPERATION

**Bypass Valve Function:**

- Thermostatically controlled bypass valve between heat exchanger inlet and outlet line
- Controls flow of pump case drain fluid to heat exchanger as function of fluid temperature
- Acts as thermal bypass valve if pressure drop through heat exchanger becomes excessive

**Temperature-Based Operation:**

- Above 125°F: valve in full open mode, routes all fluid through heat exchanger for cooling
- Below 125°F: valve in bypass mode, routes all fluid around heat exchanger directly to reservoir
- 275°F for more than 3 seconds: SOV closes and **L (R) HYD TEMP HIGH** (C) CAS message illuminated

## VI. HYDRAULIC SYSTEM COMPONENTS

### A. ECOLOGY BOTTLES

**Location and Purpose:**

- Left and right hydraulic systems each contain ecology bottle
- Installed in lower part of rear fuselage
- Transparent bottles to see hydraulic fluid level inside

**Ecology Bottle Function:**

- Collect hydraulic fluid leakage from DCMP shaft seals
- Collect leakage from PTU seal drain port
- Collect fluid from reservoir bleed/relief valves



Hydraulic System Normal Operating Ranges

| System | Normal Upper Level | Normal Lower Level |
|---|---|---|
| Left System | 85% | 30% |
| Right System | 85% | 40% |
| Auxiliary System | 85% | 20% |

## B. RESERVOIR QUANTITY PERCENTAGES

**Quantity Display:**

- Hydraulic reservoir quantity percentages displayed in 2% increments
- Displayed on Summary page and HYDRAULIC synoptic page
- Within normal range: quantity percentages displayed in green
- Above or below normal: percentages displayed in white

**Operational Considerations:**

- Approximately 25% of fluid in landing gear hydraulic lines and actuators when gear down
- Quantity percentages show lower but usually stay in normal range with gear down
- Fluid level percentages climb but stay in normal range when gear retracted
- System percentage less than normal lower-level displays in white and should be serviced prior to flight
- No CAS messages associated with percentages above or below normal levels




Hydraulic Reservoir Gauge

## C. UNLOADING OF HYDRAULIC PUMP FOR IN-FLIGHT RESTARTS

**EDP Depressurization:**

- Engine driven pump incorporates depressurization circuit
- Unloads pump and reduces input torque during engine relights
- When reservoir fluid temperature reaches 275°F, PSEU commands FADEC to depressurize EDP

**Automatic Operation:**

- DCMP automatically continues providing hydraulic pressure to other systems after EDP stops
- No flight crew action required
- Above procedures are automatic

# VII. CONTROLS AND INDICATIONS

## A. HYDRAULIC CONTROL PANEL

**Panel Location:**

- Located immediately to right of throttle quadrant on center pedestal
- Provides manual control of hydraulic system components

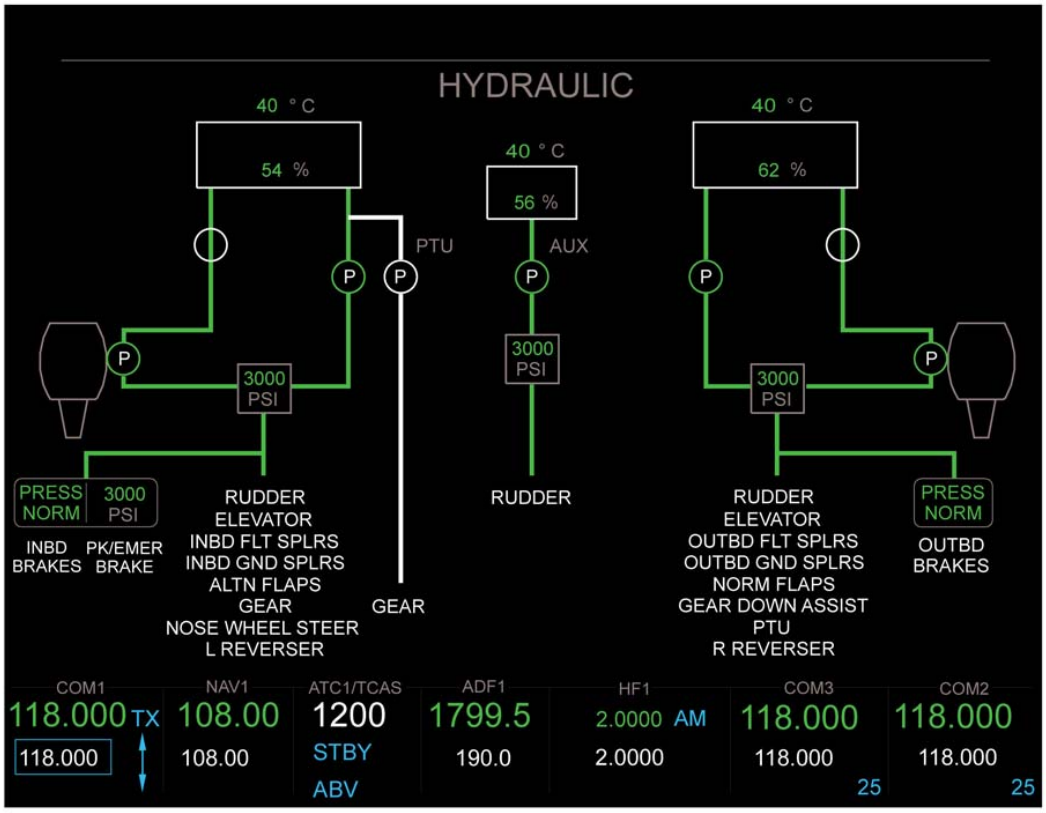
**Panel Functions:**

- Manual operation of electric hydraulic pumps
- Manual operation of shutoff and selector valves
- Manual operation of power transfer unit
- EICAS monitors and displays hydraulic system information

## B. HYDRAULIC SYNOPTIC PAGE

**Display Function:**

- Hydraulic system operation monitored and status displayed
- Shows system pressures and temperatures
- Displays pump operations and system status
- Fluid quantity percentages shown

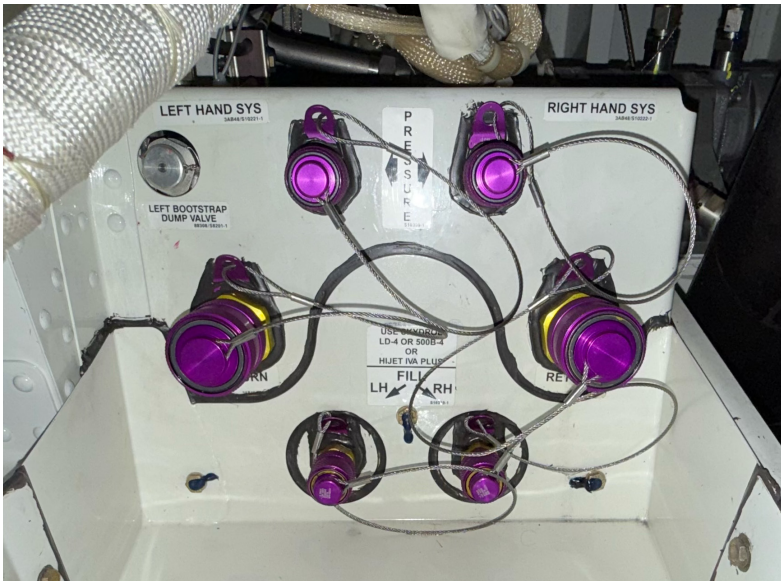


# VIII. HYDRAULIC SERVICING

## A. SERVICING DESCRIPTION

**Ground Service Quick-Disconnects:**

- Left and right hydraulic systems each have ground service quick-disconnects
- Ground fill, pressure and return fluid circuits
- Used for ground maintenance tasks



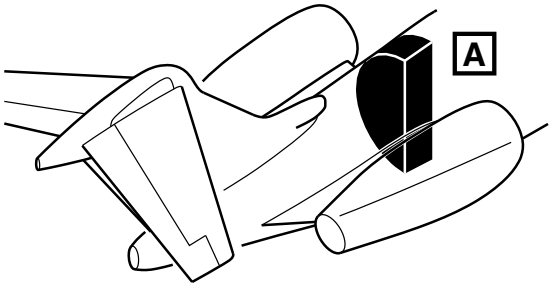

**Maintenance Functions:**

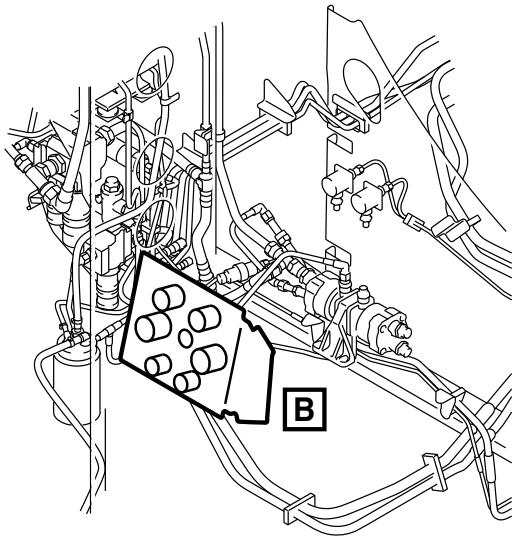
- System bleeding
- System flushing
- System draining
- Ground pressurization
- Auxiliary system filler has quick-disconnect to add hydraulic fluid to auxiliary reservoir

**Quick-Disconnect Location:**

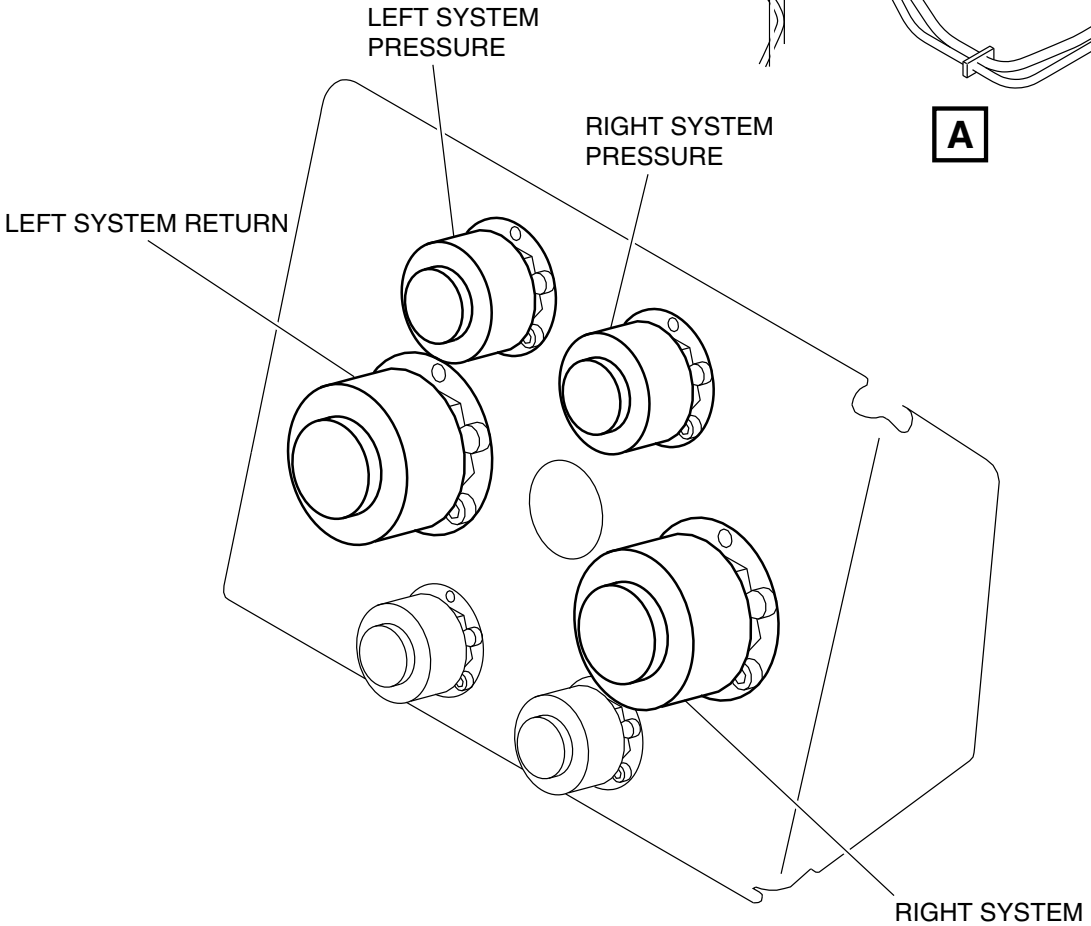
- Installed on panels near system access doors

HYDRAULIC SERVICING PANEL




A




**HYDRAULIC SERVICING PANEL**

B

# IX. EICAS MESSAGES – GROUPED BY SEVERITY

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| HYD PRESS LOW | The left and right hydraulic pressures are less than 1,800 psi | — |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| AUX HYD TEMP HIGH | The auxiliary hydraulic fluid system temperature is greater than 135°C | TO/LAND |
| L (R) HYD PRESS LOW | The affected hydraulic system pressure is less than 1,800 psi | TO/LAND |
| HYD PTU FAIL | The power transfer unit is not producing pressure when commanded | — |
| L (R) HYD SOV FAIL | The respective hydraulic shutoff valve did not close when commanded or is closed when it should be open | TO/LAND |
| L (R) HYD TEMP HIGH | The respective hydraulic system temperature is above 100°C | TO/LAND |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| AUX HYD SYS FAIL | The auxiliary hydraulic pump is not producing pressure when it should | TO/LAND |
| AUX HYD PUMP FAIL ON | The auxiliary hydraulic pump is running continuously | TO/LAND |
| L (R) HYD DC PUMP FAIL | The indicated hydraulic DC pump is not producing pressure when commanded | TO/LAND |
| L (R) HYD ENG PUMP FAIL | The indicated engine-driven hydraulic pump is not producing pressure when the associate engine is running | TO/LAND |
| L (R) HYD SOV CLOSED | The respective firewall hydraulic shutoff valve is closed (not manually selected/auto closed) | TO/LAND |

### D. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **HYD PUMP NOT AUTO** | At least one HYDRAULIC PUMP (L, R, PTU, or AUX) switch is not in the AUTO position |
| **L (R) HYD SOV CLOSED** | The respective firewall hydraulic shutoff valve is closed (manually selected) |

**NOTES**

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- Voice warnings are continuous until acknowledged
- "TO/LAND" indicates the message in inhibited during takeoff and landing phases
- "TO" indicates the message in inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right hydraulic system

## X. LIMITATIONS

### A. HYDRAULIC SYSTEM TEMPERATURE LIMITATIONS

| Parameter | Specification |
|---|---|
| Maximum Operating Temperature (L/R Systems) | 100°C maximum |
| Auxiliary System Maximum Temperature | 135°C maximum |
| Automatic Protection Temperature | 275°F (135°C) maximum: SOV closes automatically |
| Automatic SOV Closure | 275°F for more than 3 seconds |

## B. HYDRAULIC COOLING SYSTEM LIMITATIONS

| Parameter | Specification |
|---|---|
| Above 125°F Operation | Full cooling mode required |
| Below 125°F Operation | Bypass mode acceptable |
| Bypass Valve Control | Thermostatically controlled operation mandatory |

## C. POWER TRANSFER UNIT LIMITATIONS

| Parameter | Specification |
|---|---|
| PTU Automatic Shutoff | If PTU selected to AUTO and does not produce hydraulic pressure within 15 seconds, automatically latched OFF |
| Latch Reset Requirement | De-select AUTO mode or remove power from PSEU |
| PTU Operation Requirements | Left engine or left EDP inoperative or failed |
| | Right EDP producing pressure |
| | Gear not in commanded position |
| | Aircraft in air |

## XI. HYDRAULICS SYSTEM CIRCUIT BREAKERS

Hydraulics System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| AUX DCMP RCCB | LEFT ESS | CB1-D10 |
| HYD GEN HTR | RIGHT AUX | CB4-B4 |
| HYD GEN PWR/TEST | RIGHT ESS | CB4-B5 |
| HYD PTU | RIGHT ESS | CB2-C10 |
| HYD SYS AUX IND | LEFT ESS | CB1-D9 |
| HYD SYS L IND | LEFT ESS | CB1-C9 |
| HYD SYS R IND | RIGHT ESS | CB2-C8 |
| L DCMP RCCB | RIGHT MAIN | CB2-C11 |
| L HYD SOV | LEFT BATT | CB1-C10 |
| R DCMP RCCB | LEFT ESS | CB1-C11 |
| R HYD SOV | RIGHT BATT | CB2-C9 |

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## XII. HYDRAULICS QUIZ

1. What is the normal operating pressure for the left and right hydraulic systems?

    A) 2500 psi
    B) 3000 psi
    C) 3350 psi
    D) 1800 psi

2. Which type of hydraulic fluid is used in the Challenger 350 hydraulic systems?

    A) MIL-H-5606
    B) MIL-H-83282
    C) Phosphate Ester Fire-Resistant (BAMS 564-003)
    D) Petroleum-based Hydraulic Oil

3. What is the capacity of the left hydraulic system reservoir?

    A) 525 cu in
    B) 750 cu in
    C) 150 cu in
    D) 950 cu in

4. The auxiliary hydraulic system provides backup pressure to which component?

    A) Upper rudder PCU
    B) Lower rudder PCU
    C) Both rudder PCUs
    D) Nose wheel steering

5. At what temperature does the fuel/hydraulic heat exchanger bypass valve operate in full open mode?

    A) Above 100°F
    B) Above 125°F
    C) Above 150°F
    D) Above 175°F

6. What happens when the hydraulic system fluid temperature reaches 275°F for more than 3 seconds?

    A) DCMP automatically starts
    B) PTU activates
    C) SOV closes and L (R) HYD TEMP HIGH message appears
    D) Heat exchanger bypass valve opens

7. The Power Transfer Unit (PTU) is primarily used for:

    A) Flap operation
    B) Landing gear operation
    C) Brake operation
    D) Thrust reverser operation

8. What is the normal range for auxiliary hydraulic system accumulator pressure?

A) 1800-3000 psi
B) 2500-3350 psi
C) 3000-3500 psi
D) 2000-2800 psi

9. Which generator supplies power to the left DCMP?

A) Left DC generator
B) Right DC generator
C) APU generator
D) Both DC generators equally

10. The HYD PRESS LOW warning message appears when:

A) Only the left system pressure is below 1800 psi
B) Only the right system pressure is below 1800 psi
C) Both left and right hydraulic pressures are less than 1800 psi
D) Any hydraulic system pressure is below 3000 psi

11. What is the normal upper level percentage for hydraulic reservoir quantity indication?

A) 100%
B) 90%
C) 85%
D) 80%

12. The ecology bottles are used to:

A) Filter hydraulic fluid
B) Cool hydraulic fluid
C) Collect hydraulic fluid leakage
D) Store emergency hydraulic fluid

13. In AUTO mode, the DCMPs will turn on when:

A) Flaps are set to any position
B) Flaps are set to 10 degrees or greater
C) Landing gear is extended
D) Engine start is initiated

14. If the PTU is selected to AUTO and does not produce hydraulic pressure within how many seconds will it be latched OFF?

A) 10 seconds
B) 15 seconds
C) 20 seconds
D) 30 seconds

15. The left hydraulic system operates which of the following components?

A) Outboard brakes
B) Right thrust reverser
C) Inboard brakes
D) Normal flaps

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CL-350



CL-350 TRAINING MANUAL

# FLIGHT CONTROLS 05

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# FLIGHT CONTROLS

## I. INTRODUCTION

The Challenger 350 flight control system represents a sophisticated hydraulically-powered architecture designed to provide precise, responsive aircraft control throughout all phases of flight while maintaining multiple layers of redundancy and safety. The system utilizes three independent hydraulic systems; left, right, and auxiliary; to power primary flight control surfaces including ailerons, elevators, rudder, and multi-function spoilers.

The design employs dual-channel Power Control Units (PCUs) for critical control surfaces, with each channel powered by separate hydraulic systems to ensure continued controllability even after multiple hydraulic failures. Primary flight controls feature hydraulic actuation with mechanical reversion capability, while the rudder incorporates a unique dual PCU configuration that provides exceptional redundancy through dedicated connections to all hydraulic systems with the lower PCU automatically energized by the Auxiliary hydraulic system if Right is lost, providing redundancy across all three hydraulic systems.

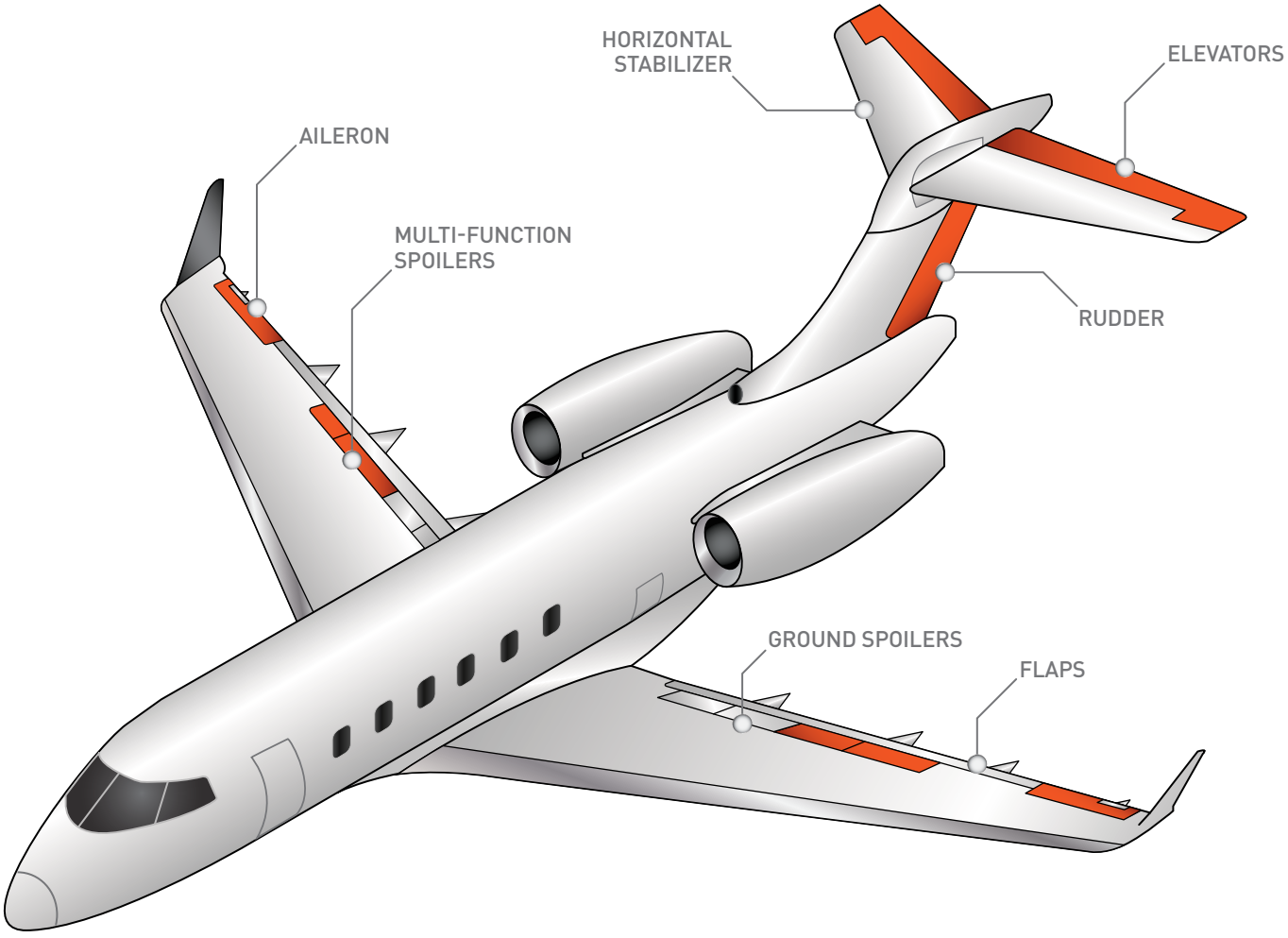
The system integrates advanced features including electronic yaw damper that provides turn coordination based on roll attitude for coordinated flight, automatic spoiler deployment for roll control and lift dumping, comprehensive artificial feel systems that provide appropriate control forces across the flight envelope, and multi-channel trim systems for all primary control axes. Safety is enhanced through strategically positioned shutoff valves, priority valves that ensure flight control hydraulic flow during high-demand situations, and integrated monitoring systems that provide real-time feedback on control surface position, hydraulic pressure, and system health.

The flight control computer continuously monitors control surface deflections and provides trim and stability augmentation inputs while interfacing with the EICAS system to alert crews to any abnormal conditions. This chapter will examine each component of this integrated flight control system, detailing normal operations, emergency procedures, manual reversion techniques, and the comprehensive monitoring systems that enable crews to maintain precise aircraft control

### A. FLIGHT CONTROLS SPECIFICATIONS

| Parameter | Value |
|---|---|
| Primary Flight Controls | Elevators, Rudder, Ailerons, Roll Spoilers |
| Secondary Flight Controls | Flaps, Spoilers (Symmetrically), Trim Systems |
| Aileron Control | Reversible mechanical cable system with Roll Disconnect |
| Elevator Control | Hydraulic PCUs with manual reversion and Pitch Disconnect |
| Rudder Control | Hydraulic PCUs with limited manual reversion |
| Spoiler Control | Electronic/hydraulic fly-by-wire system via SECU |
| Horizontal Stabilizer Range | 0 to 15° |
| Spoilers (per wing) | Four (two ground, two multifunction) |
| Takeoff Trim Range (Green) | 2.5 to 8.0 units |
| Flap Positions | 0°, 10°, 20°, 30° |

PRIMARY FLIGHT CONTROLS




## II. PRIMARY FLIGHT CONTROLS

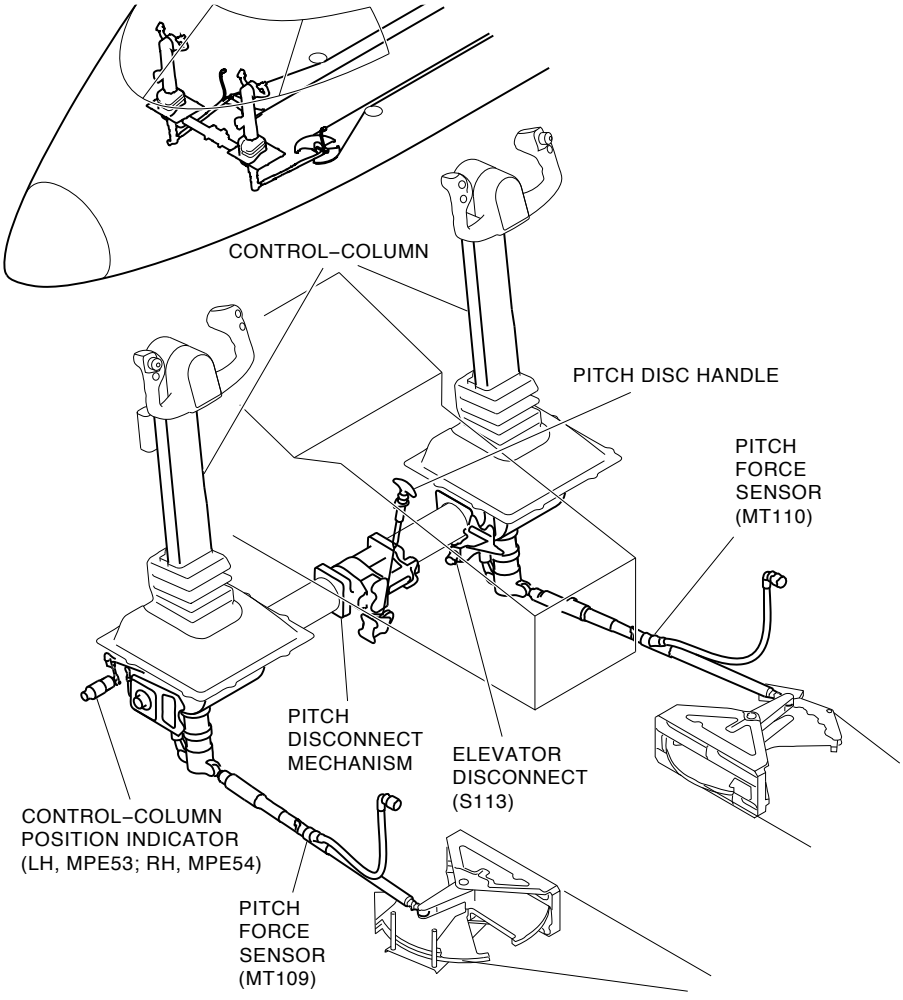
The Primary Flight Controls section covers the aircraft's fundamental control surfaces that provide direct pilot control over the three axes of flight. This section focuses on the elevators, rudder, ailerons, and roll spoilers - the systems that translate pilot inputs directly into aircraft movement and attitude changes.

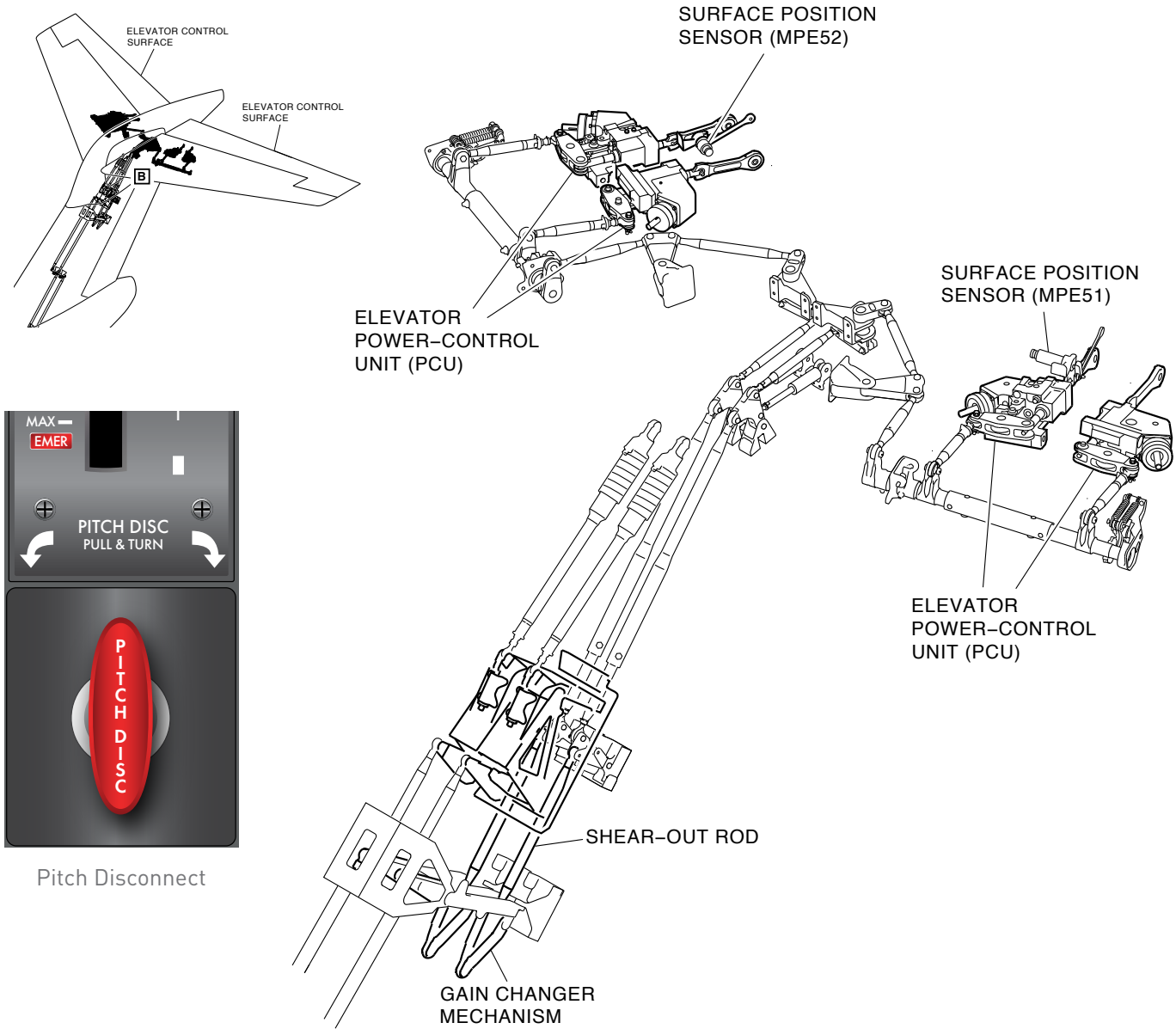
Key distinguishing characteristics of the primary flight control architecture include the cable-operated aileron system, the electronic/hydraulic fly-by-wire spoiler system, and the mechanically controlled, hydraulically powered elevator and rudder systems.

Each system incorporates specific reversion capabilities and backup systems to maintain control authority during various failure scenarios, from single system degradations to dual hydraulic failures.

## A. ELEVATORS

- Hydraulic PCUs with manual reversion capability
- Powered by the left and right hydraulic systems
- Pitch feel simulator provides artificial feel forces
- Dual control columns normally connected through torque tube
- Elevator position shown on FLIGHT CONTROLS synoptic page
- Pitch Disconnect is available for control column separation
- **PITCH DISCONNECT (S)** CAS message is displayed while disconnected
- **PITCH DISCONNECT (W)** CAS on ground if throttles at or above CLB
- Stall Protection Integration with stick shaker and pusher systems attached
- Manual Reversion is available in event of dual hydraulic failure
- Provides pitch control supplemented by a movable horizontal stabilizer









Pitch Disconnect

Note: Elevator command path includes a gain changer mechanism (4-bar linkage) providing non-linear gearing between control column movement and elevator surface, plus a pitch feel simulator that provides

## B. RUDDER SYSTEM

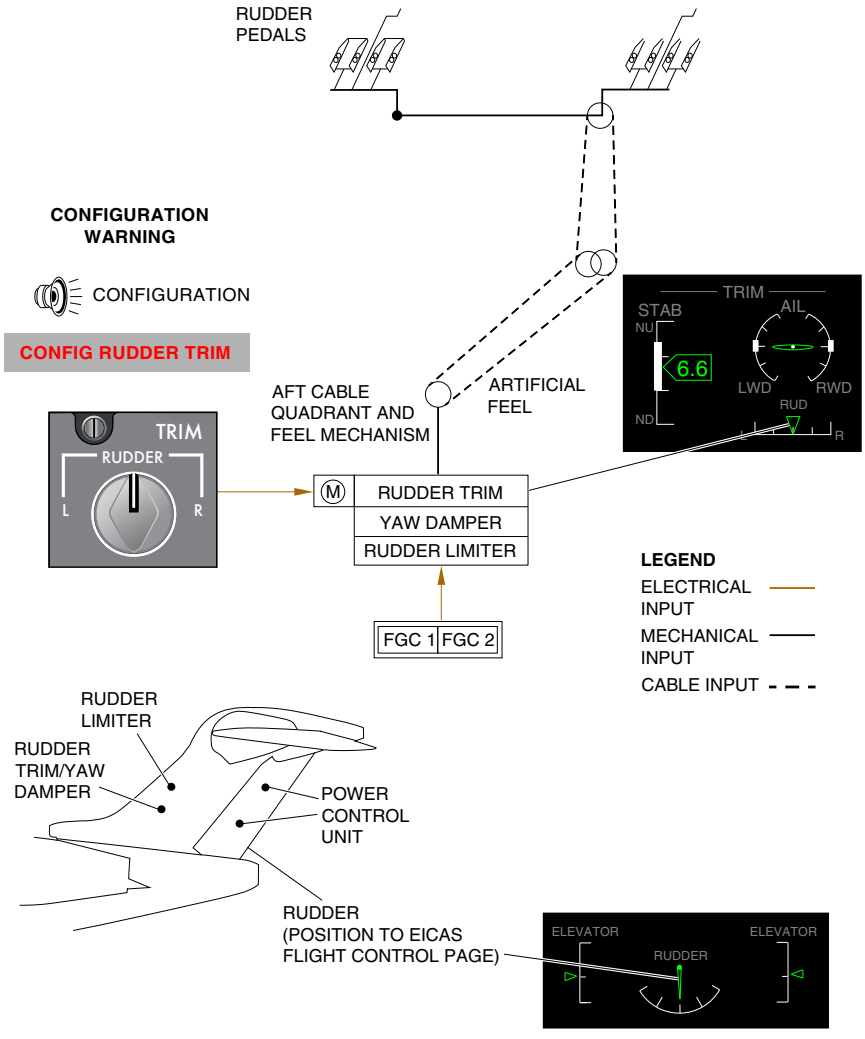
- Hydraulic PCUs with manual reversion
- Upper and lower rudder PCUs
- Left Hydraulic System – Upper PCU
- Right Hydraulic System – Lower PCU
- Lower PCU is automatically energized by the auxiliary hydraulic system if the right hydraulic system loses pressure

- Dual rudder pedals with cable and pushrod linkage
- Speed-sensitive travel limiting system controlled by the horizontal stabilizer trim electronic control unit (HST ECU)
- Rudder position indicated on EICAS flight control page
- **CONFIG RUDDER TRIM** (W) CAS for improper trim
- Rudder-Control feel unit provides simulated pedal load to pilots

Note: Rudder cables are routed separately through the engine rotor burst zone — a severed cable in this zone retains rudder functionality through the unaffected cables

### Electronic Yaw Damper

- Mechanically limited to 5° of rudder motion
- Provides turn coordination and damping of Dutch roll
- Does not move the rudder pedals
- Active on the ground but disable above 60 KIAS until weight is off the wheels
- If yaw damper channel fails or disconnects - **YAW DAMPER FAIL** (C) CAS is displayed



## C. AILERON SYSTEM

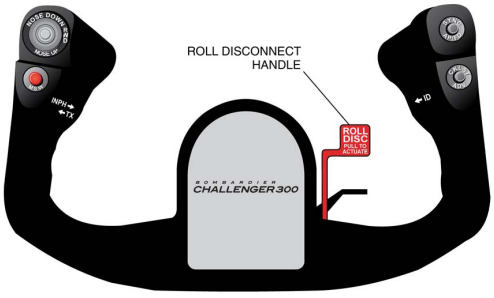
- Manual cable and pushrod mechanism (no PCUs)
- Geared balance tabs on each aileron can travel ±20° relative to aileron surface
- Permanently set tabs to minimize surface upfloat
- Left aileron equipped with electrically operated trim tab
- Two aileron position sensors for data recording and EICAS position display
- Direct mechanical linkage through cable system with Roll Disconnect
- Gust lock system prevents aileron damage when aircraft parked

**Roll Disconnect**

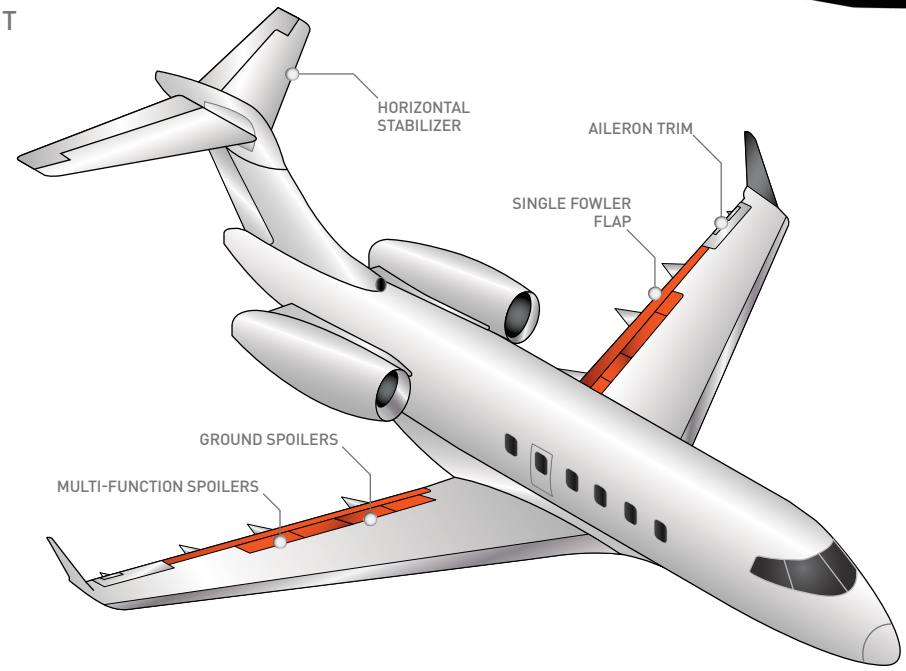
- Isolates left control wheel in event of mechanical aileron jam
- Left Control wheel retains roll control via multifunction spoilers
- Right control wheel remains mechanically connected to ailerons
- **ROLL DISCONNECT** (S) CAS message is displayed while disconnected
- **ROLL DISCONNECT** (W) CAS on ground if throttles at or above CLB
- Roll spoilers can be disabled in the event a jam occurs in the left control wheel

## D. ROLL SPOILERS

- Provide roll assist, proportional lift dump, ground lift dump
- Electronic/hydraulic fly-by-wire system
- Spoiler Electronic Control Units (SECU 1 and SECU 2)
- Left and right hydraulic systems power
- Control wheel angular movement input




SECONDARY FLIGHT CONTROLS



- Maximum 45° displacement from stowed position
- Primary and secondary roll assist schedules
- 8° control wheel movement about neutral (primary schedule)
- Two inboard panels, two outboard panels per wing

## III. SECONDARY FLIGHT CONTROLS

The Secondary Flight Controls section encompasses the aircraft's auxiliary control systems that enhance flight characteristics, provide trim functions, and support various flight phases. This section covers flaps, multifunction spoilers, ground spoilers, and the horizontal stabilizer, aileron, and rudder trim systems - all of which work in coordination with the primary flight controls to optimize aircraft performance and handling.

Key architectural features of the secondary flight control systems include the electrically controlled and hydraulically actuated flap system, the spoiler electronic control unit (SECU) managing multifunction and ground spoilers, and the electrically operated trim systems. These systems incorporate advanced automation features such as configuration trim that automatically adjusts stabilizer position during flap and spoiler deployment, and Mach trim that compensates for aerodynamic center shifts at varying speeds.

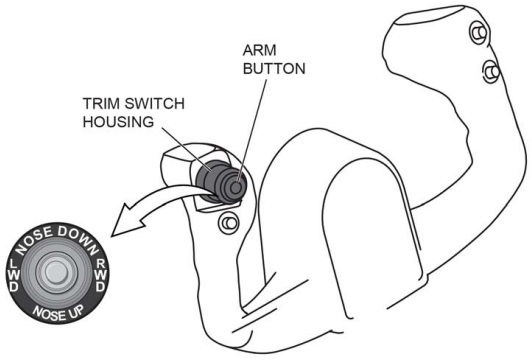
### A. HORIZONTAL STABILIZER TRIM

- Electric motor-driven jackscrew system
- Variable trim rate based on airspeed (Mach)
- Constant trim rate of 0.2 degree/second (secondary channel)
- 0 to 15 degrees angle of incidence
- Normal takeoff range 2.5 to 8.0 units (green)
- **CONFIG STAB TRIM** (W) CAS for out-of-range trim
- Automatic inputs from autopilot, flaps, spoilers, Mach trim
- Each trim motor equipped with brake to prevent trim runaway
- Digital readout on EICAS and synoptic page indicates stabilizer position in trim units, corresponding to horizontal stabilizer angle of incidence

**Primary Channel Trim Rates:**

- 0.4 degree/second up to Mach 0.4
- Linear decrease to 0.1 degree/second at Mach 0.8
- 0.1 degree/second above Mach 0.8
- Default 0.2 degree/second if Mach data unavailable

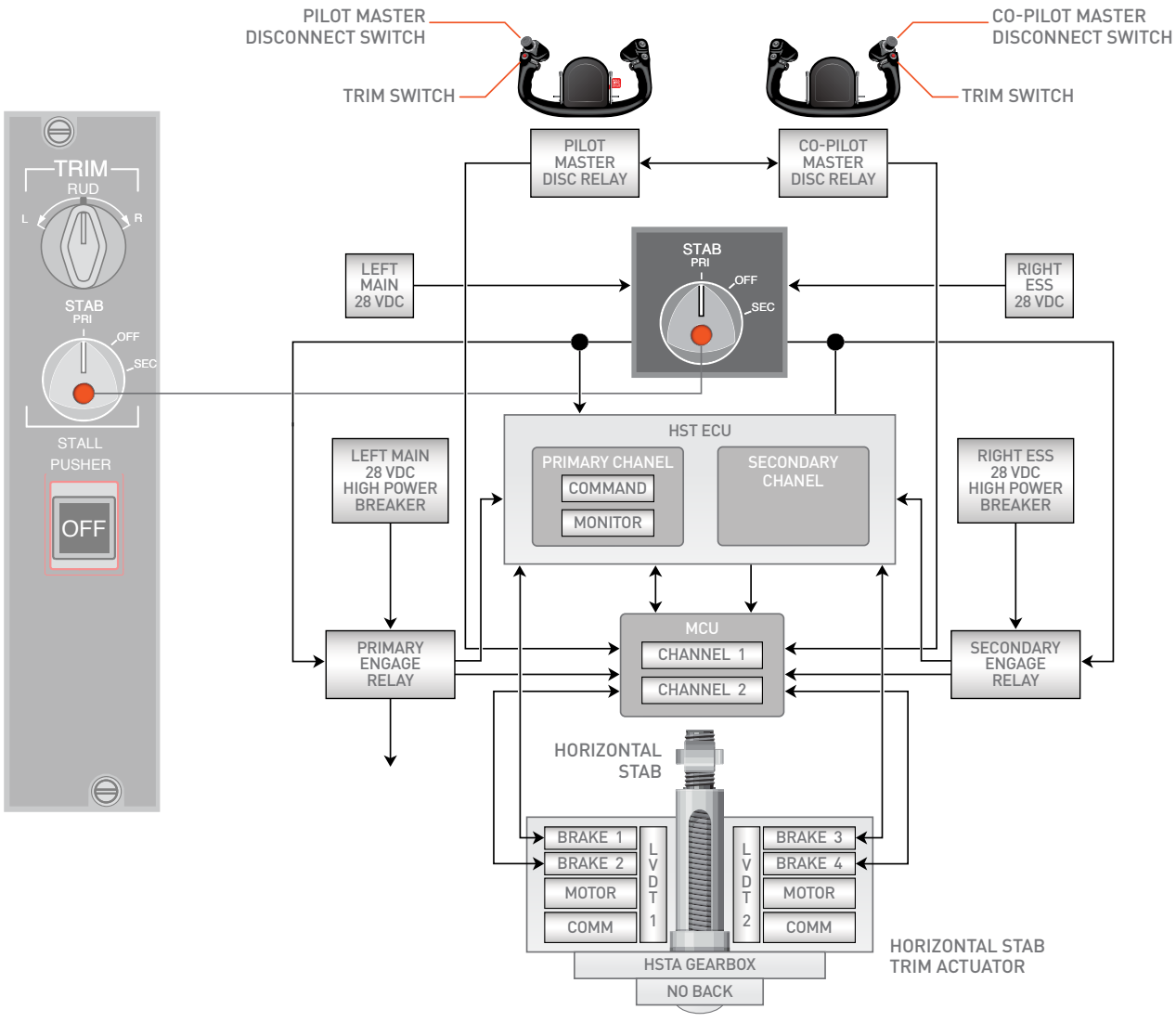
Manual primary (PRI) or secondary (SEC) Pitch trim or Roll trim commands are done through the control wheel Trim switch, located on the outer horn of either control wheel. The trim and arm functions are controlled by the same switch. The commanded trim (pitch or roll) is initiated by depressing and holding the arm button (center button) and then actuation of the control wheel trim switch (housing) in the desired direction (NOSE UP, NOSE DOWN, LWD or RWD).




Control Wheel Trim Switch

**NOTE:** Pilot side trim commands have priority over the copilot side trim commands.

FLIGHT CONTROLS HORIZONTAL STAB SCHEMATIC




## B. CONFIGURATION TRIM

- Automatic nose-up trim with flap extension
- Automatic nose-down trim with spoiler extension
- Reduces control column forces during configuration changes
- Works with horizontal stabilizer trim system
- Activates with flap or spoiler movement

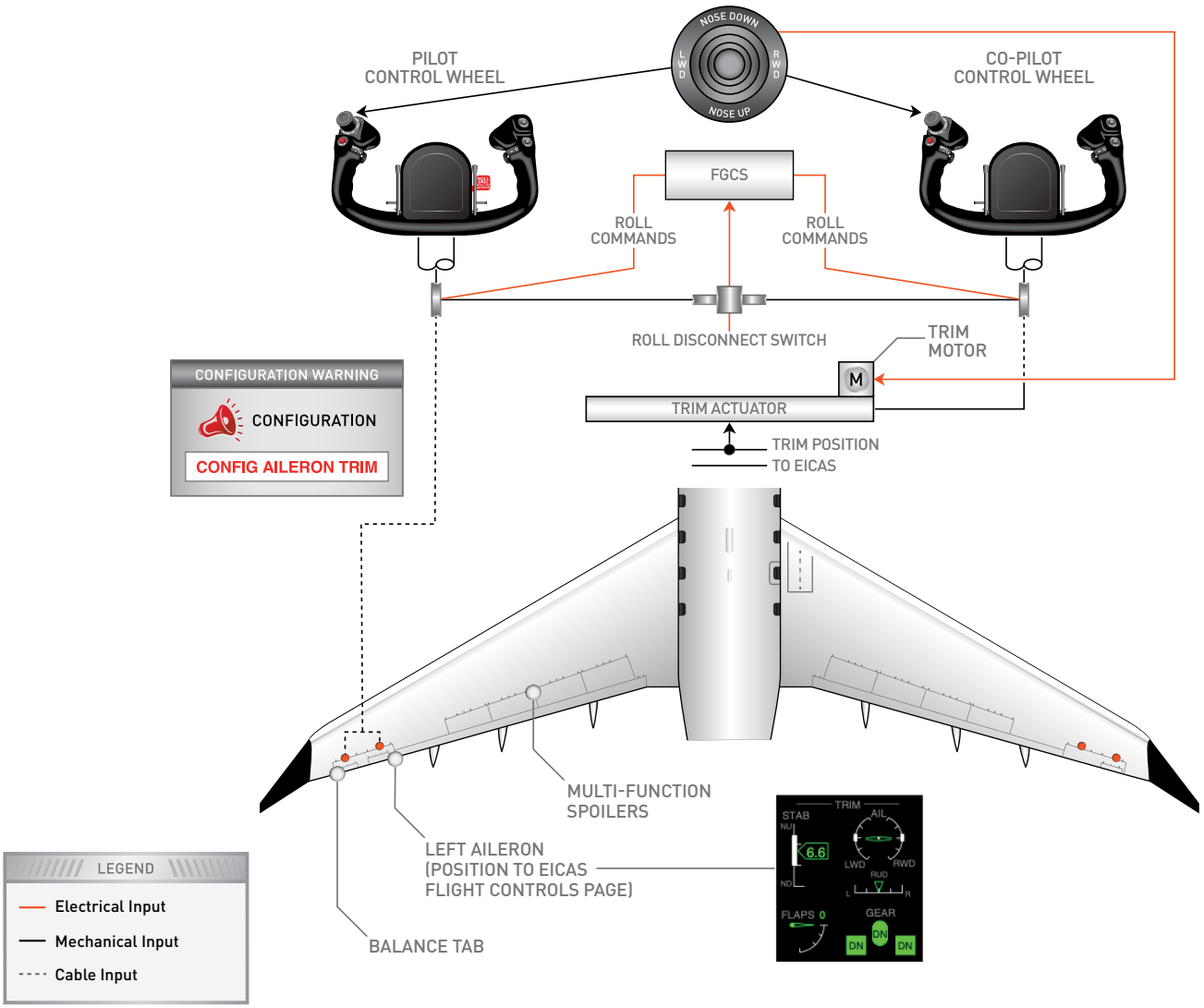
## C. MACH TRIM

- Compensates for aerodynamic center shift as Mach increases
- Air Data Computers (ADCs) provide data source

- Active when autopilot disengaged
- Slight nose-up trim input for speed increase stability
- Slight nose-down trim input for speed decrease stability
- Continuously monitored with EICAS fault display

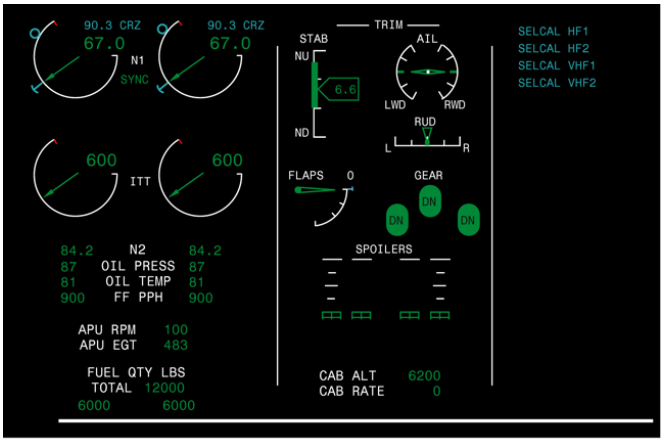
## D. AILERON TRIM

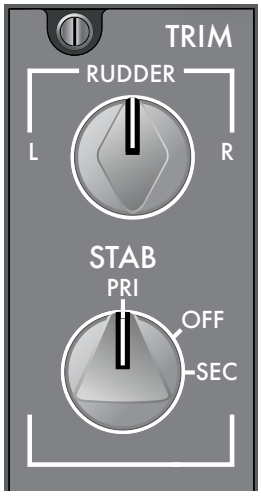
- Left aileron trim tab only
- Electromechanical actuator
- Reduce aerodynamic loads on pilot controls
- **CONFIG AILERON TRIM** (W) CAS for improper setting
- Trim position shown on EICAS synoptic page



## E. RUDDER TRIM

- Electromechanical actuator system
- Direct rudder surface movement (no trim tabs)
- RUD TRIM switch on center pedestal
- Signals to rudder Power Control Units
- **CONFIG RUDDER TRIM** (W) CAS for improper takeoff setting
- Rudder trim position on EICAS




## F. FLAP SYSTEM

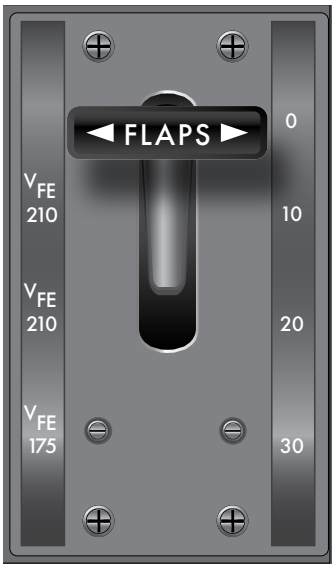
- Single Fowler flap per wing
- Electrically controlled by Flap Control Unit (FCU)
- Hydraulically actuated by the Flap Power Unit (FPU)
- 0°, 10°, 20°, 30° positions
- Right hydraulic system (primary)
- Left hydraulic system when ALTN FLAPS selected
    - **FLAPS ALT PRESS** (Green) EICAS when ALTN FLAPS selected
    - **FLAPS RATE LOW** (A) CAS w/Right Engine Failure or ALTN FLAPS selected
- Flap position on MFD and synoptic page
- When ALTN FLAPS is selected ON, the FLAPS ALT PRESS lamp illuminates in green on the EICAS
- Variable extension/retraction rates
    - Normal Rate – 0° to 30° extension - 20 Seconds
    - On RH DCMP or ALTN FLAPS – 0° to 20° is 60 to 70 seconds

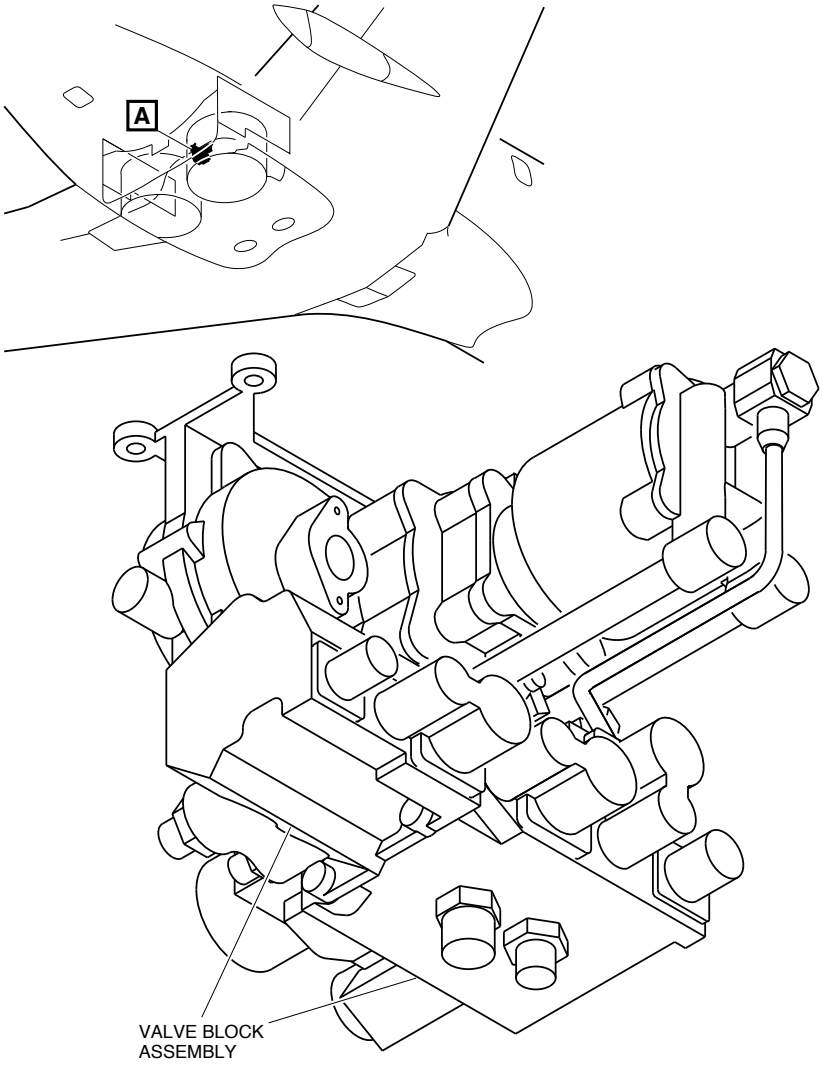
**Flap Alerting System** activates overspeed warning horn above these speeds:

- VFE 210 kt – 10°
- VFE 210 kt – 20°
- VFE 175 kt – 30°

**Flap Control Unit** performs the following functions

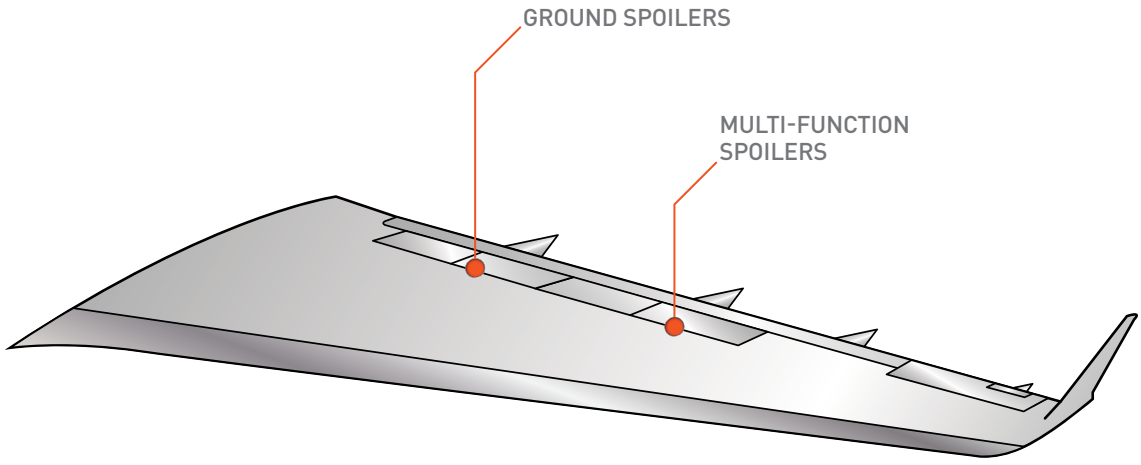
- Controls flap panel movement according to pilot commands
- Monitors critical conditions
    - Runaway or Uncommanded movement
    - Surface Asymmetry
    - System Jam or Overspeed/speed differential
- Switches the system to fail-safe when necessary
- Monitors the FPU for internal or external hydraulic leakage and notifies flight crew
- Communicates flap position to the EICAS and stall protection system
- Provides data for cockpit indication and maintenance
- Contains the left and right Flap Position Indicator Unit (FPIU)



## G. MULTIFUNCTION SPOILERS (MFS)

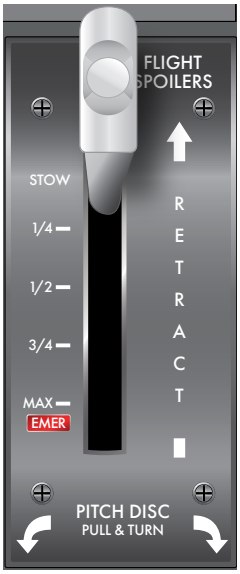
- Two multifunction spoiler panels per wing
- Roll assist, proportional lift dump, ground lift dump
- Electronic/hydraulic system (fly-by-wire)
- SECU 1 and SECU 2 control (Spoiler Electronic Control Unit) and received input from
    - Control Wheel Angular Input
    - Flight Spoiler Control Lever (FSCL) Position
    - Ground Lift Dump (GDL) inputs
    - Flap Position
- Asymmetric operation for roll control (SECU 2 Primary, SECU 1 secondary)
- Symmetric operation for ground spoiling (SECU 1 primary)
- Available for in-flight speed braking
- Spoiler position on EICAS synoptic page




The aircraft's multifunction spoilers (MFS) utilize two distinct roll assist schedules, primary and secondary, to aid the ailerons in providing roll control. The outboard MFS, controlled by SECU 2, operate on the primary schedule. This schedule incorporates an 8° dead zone for control wheel input around the center position, meaning there is no spoiler deployment for small initial wheel movements. Conversely, the inboard MFS, normally controlled by SECU 1, follow the secondary schedule, which initiates spoiler deployment when handwheel rotation reaches ±50° with flaps set to 0°.

Both inboard and outboard MFS achieve full deployment with a full deflection of the control wheel. The roll schedule is also designed to reduce spoiler roll authority for small control wheel inputs when the flap settings are greater than 0°. In the event of certain failures affecting the outboard MFS, the inboard MFS panels are capable of adopting the primary schedule.

## H. GROUND SPOILERS

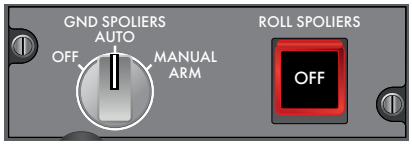



- Two ground spoiler panels (inboard) per wing
- Fully retracted or fully deployed positions (60°)
- Ground lift dumping functions only
- Tied together with multifunction spoilers
- Via Spoiler Electronic Control Units
- Left MFD display declutters spoiler graphic after 60 seconds retracted

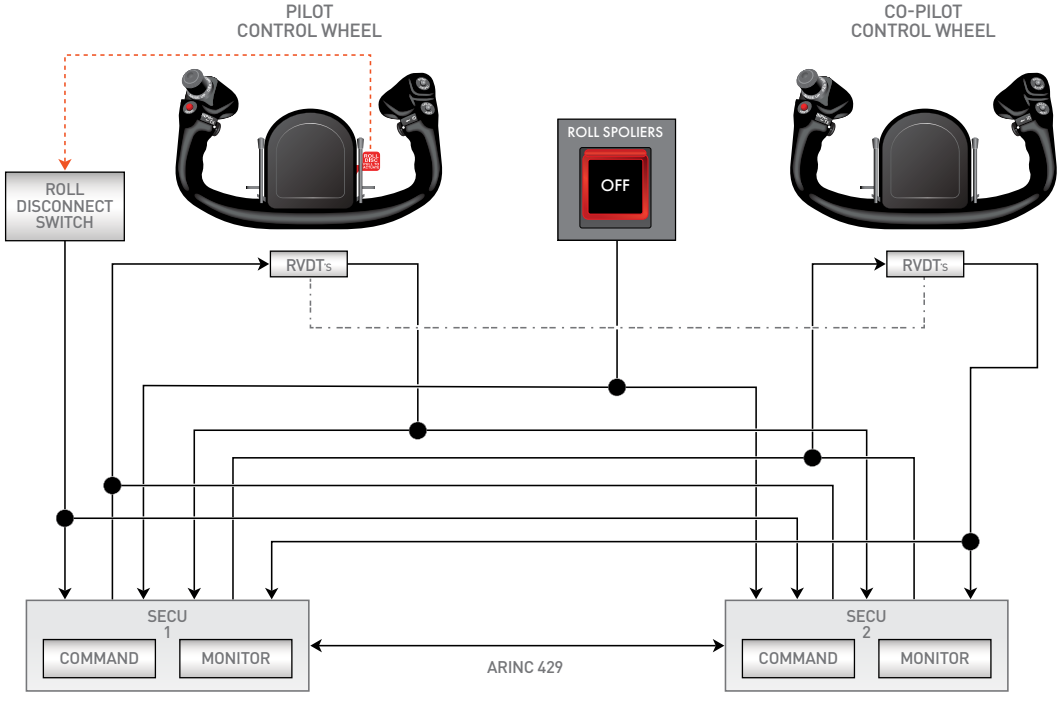
**Requirements to Deploy** (unless in manual arm)

- Throttles at idle and at least two of the following criteria:
    - RA less than 7'
    - Weight on Wheels
    - Wheel speed greater than 16 knots
- When deployed, extend to 60° while the MFSs extend to 45°

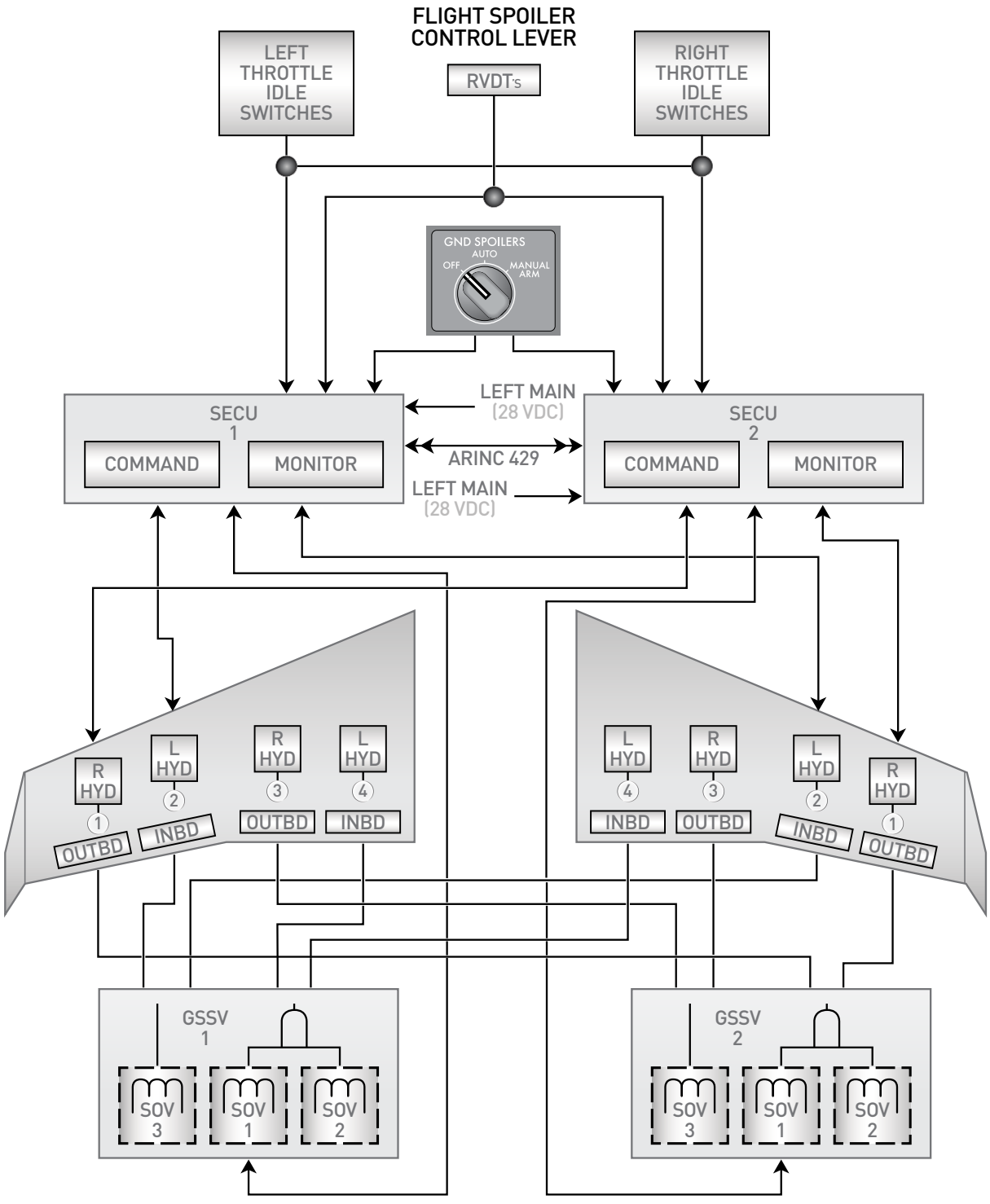
## I. SPOILER SYSTEM OPERATION




- Single power control unit per spoiler
- Flight Spoiler Control Lever (FSCL) selects position
- Nine detented positions, between 0 and MAX, the 0 Position is gated
- 10th position for EMER only or a required by a procedure and is gated
- Proportional Lift Dump during flight
- Float position if power lost



FLIGHT SPOILER SCHEMATIC



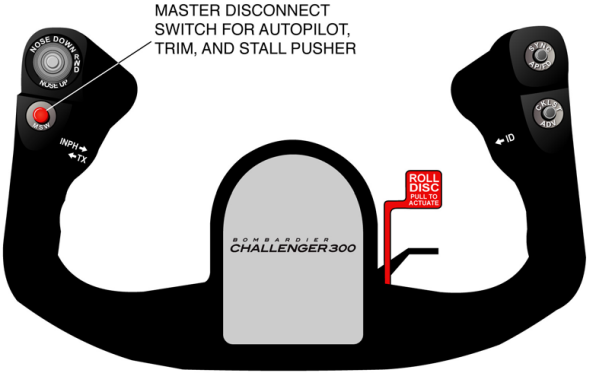
# IV. STALL PROTECTION SYSTEM (SPS)

The Stall Protection System section covers the aircraft's stall prevention and recovery architecture designed to provide multiple layers of crew alerting and automatic intervention. This system delivers progressive warnings through aural, visual, and tactile indications culminating in automatic stick pusher activation to prevent inadvertent stall conditions.

The stall protection system utilizes a dual-channel stall protection computer that continuously monitors angle-of-attack sensors, lateral acceleration, flap position, weight-on-wheels, and air data parameters to calculate dynamic angle-of-attack trip points. The system incorporates intelligent logic that adjusts activation thresholds based on angle-of-attack increase rates, preventing the aircraft from progressing too deeply into stall conditions during rapid pitch attitude changes.

## A. COMPONENTS

- One stick shaker on each control column
- Single stick pusher mechanism on left pitch control system
- Dual-channel stall protection computer
- Left and right angle-of-attack transducers (vanes)
- Flap position monitoring
- WOW 1 and WOW 2 inputs
- ADC 1, ADC 2, and standby instrument inputs
- Lateral acceleration inputs from IRS




## B. SYSTEM OPERATION

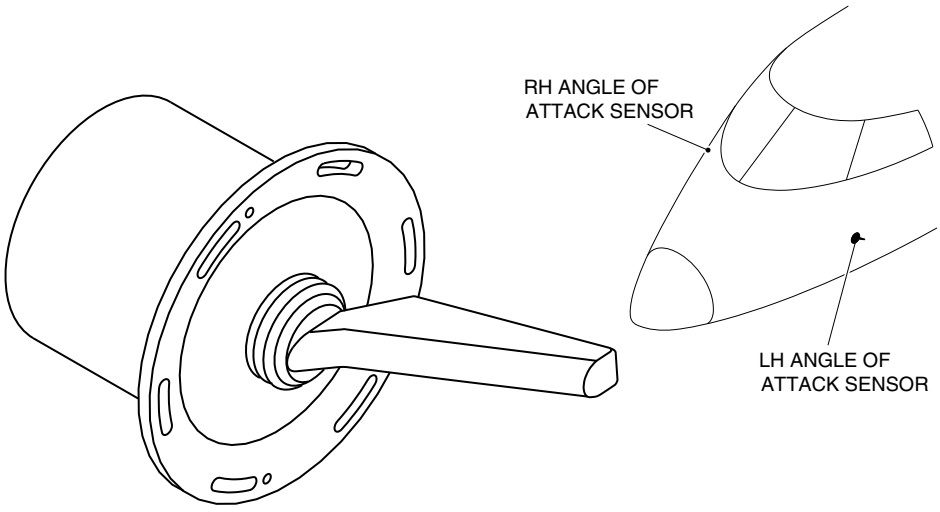
- Continuous angle-of-attack assessment
- Dynamic AOA limits based on configuration
- ADC data for stall margin adjustment
- Stick shaker and ignition activation together
- Lowers trip point if AOA increase >1°/second
- Prevents deep stall penetration

## C. STICK PUSHER FEATURES

- Master disconnect switches stop pusher
- Available when MSW released
- Disconnect function inoperable on EASA aircraft
- STALL PUSHER switch to OFF for manual disable in case of incorrect activation of pusher




Note: Pressing and holding either Master Disconnect Switch (MSW) also disengages the autopilot and renders stabilizer, configuration, Mach, aileron, and rudder trims inoperative while the switch is depressed.




**ANGLE OF ATTACK SENSOR (TYPICAL)**

## V. PROXIMITY SENSING SYSTEM

The Proximity Sensing System section covers the aircraft's comprehensive position monitoring network that ensures accurate component status information across multiple aircraft systems. This system provides critical input data for flight safety systems by continuously monitoring the physical relationship between various aircraft components and their commanded positions.

The Challenger 350's proximity sensing system centers on the proximity sensing electronic unit (PSEU) which processes positional data from landing gear, weight-on-wheels sensors, thrust reverser mechanisms, and fuselage door positions. The system utilizes proximity switches and sensors that generate "near" and "far" signals based on component positioning, enabling the PSEU to determine actual component status versus commanded positions and provide accurate feedback to dependent aircraft systems.

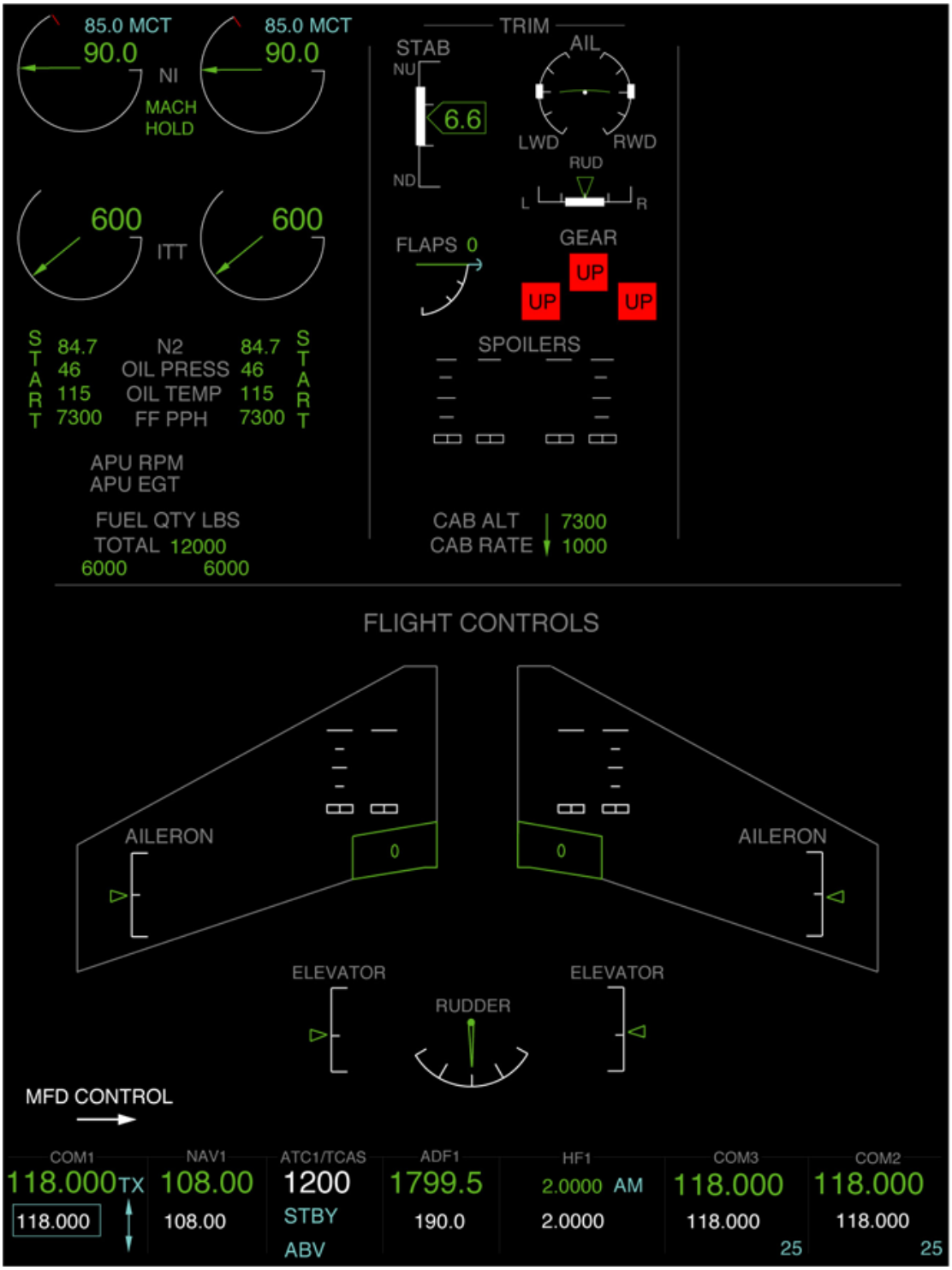
### A. COMPONENTS

- Proximity Sensing Electronic Unit (PSEU)
- Multiple position sensing devices
- Component relationship monitoring
- Gear position monitoring
- Weight-on-wheels position data
- Reverser position monitoring
- Fuselage door position data

### B. SYSTEM OPERATION

- "Near" and "far" signals based on component proximity
- PSEU processes all sensor inputs
- Provides commands to other aircraft systems
- Controls takeoff configuration warning system
- System failures indicated on EICAS display

FLIGHT CONTROL SYNOPTIC PAGE



# VI. EICAS MESSAGES – GROUPED BY SEVERITY

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| CONFIG AILERON TRIM | Aileron trim is not in the takeoff range (green band) | — |
| CONFIG AUTOPILOT | Autopilot not configured for takeoff | — |
| CONFIG FLAPS | Flaps not in takeoff position | — |
| CONFIG RUDDER TRIM | Rudder trim is not in the takeoff range (green band) | — |
| CONFIG SPOILERS | Spoilers are not in takeoff position | — |
| CONFIG STAB TRIM | Stabilizer trim is not in the takeoff range (green band) | — |
| PARK/EMER BRAKE ON | Emergency brake is engaged with throttles at or above climb | — |
| PITCH DISCONNECT | Pitch disconnect has occurred on the ground with throttles at or above CLB | — |
| ROLL DISCONNECT | Roll disconnect has occurred on the ground with throttles at or above CLB | — |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| ELEVATOR SPLIT | Left and right elevator surface positions difference exceeds allowable tolerance (differential angle is a function of airspeed) | — |
| FLAPS FAIL | The flap system has shutdown due to a failure. The flaps are not resettable | TO |
| FLAPS FAULT | The flaps are operating in a degraded mode. The fault may be resettable by movement of the flap selector handle | TO |
| FLAPS NORM PRESS LOW | The flaps normal hydraulic pressure is low. This will be accompanied by a FLAPS FAULT (C) CAS message. Alternate pressure may be available | TO/LAND |
| FLT SPOILERS DEPLOY | The flight spoilers are deployed below 500 ft, or the flight spoilers are deployed and the throttles are at CLB or above | — |
| FLT SPOILERS FAIL | All flight spoilers have failed | — |
| FLT SPOILERS FAULT | Either the inboard or outboard spoilers have failed | TO |
| GND SPLRS NOT ARMED | The ground spoilers are not armed and not selected OFF | — |
| GND SPOILERS FAIL | The ground spoilers have failed | — |

## B. CAUTION MESSAGES

### CAUTION MESSAGES

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| MACH TRIM FAIL | The Mach trim has failed | TO/LAND |
| PRI STAB TRIM FAIL | The stabilizer trim has failed. Mach trim, flap and spoiler config trim inoperative | — |
| ROLL SPOILERS FAIL | Roll assist function has failed but flight and ground spoilers have not. Roll control forces will be higher | — |
| ROLL SPOILERS FAULT | Either the inboard or outboard roll spoilers have failed. Roll control forces will be higher | — |
| ROLL SPOILERS OFF | The roll spoilers have been turned off with the ROLL DISC not activated | — |
| RUDDER LIMITER FAIL | The rudder limiter has failed | — |
| SEC STAB TRIM FAIL | The secondary stabilizer trim has failed. This message should not be displayed unless the primary stabilizer trim has already failed | — |
| SPOILERS FAIL | The spoilers have failed. If the spoilers were deployed, they will retract down to a float position. The spoilers will not float up. | — |
| SPOILERS FAULT | At least one ground spoiler is up prior to touchdown, or one spoiler panel has failed | — |
| STALL PROTECT FAIL | Stall protection has a failure in channel A or B, or pusher/AOA sensor failed, or miscompare detected between essential inputs | — |
| STALL PUSHER OFF | The control wheel master disconnect switch has been pressed for at least ten seconds, or a stall protection system failure has occurred that has inhibited operation of the stall pusher | — |
| YAW DAMPER FAIL | Yaw Damper has failed | TO/LAND |

## C. ADVISORY MESSAGES

### ADVISORY MESSAGES

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| FLAPS FAULT | There is a fault in the flap system. The flaps should operate normally | TO |
| FLAPS RATE LOW | The flap extension and retraction rates are slower than normal. This message will illuminate when the right engine is shutdown, or if the engine driven pump is shutdown | TO/LAND |

| ADVISORY MESSAGES | | |
|---|---|---|
| Crew awareness - no immediate action required | | |
| **Message** | **Meaning** | **Inhibits** |
| **RUDDER LIMITER FAULT** | A minor failure resulting in the loss of redundancy has occurred in the rudder limiter system. The rudder travel limiter will continue to function | **TO** |
| **SPOILERS FAULT** | There is a fault in the spoiler system that does not affect spoiler operation. Removing all power from the aircraft and re-powering will cause the message to clear | **TO/LAND** |
| **STAB TRIM FAULT** | A minor failure has occurred causing a loss of redundancy in the horizontal stabilizer trim system. The stabilizer trim will continue to function | **TO/LAND** |
| **STALL PROTECT FAULT** | The Stall Protection Computer has automatically reverted to settings for flaps 30 | **TO/LAND** |
| **L (R) STALL SHAKER FAIL** | The respective stall shaker has failed | **TO/LAND** |
| **STALL WARN BASIC** | The SPC has incorrectly reverted to basic mode while no engine thrust mismatch condition exists | **TO/LAND** |

## D. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **GND SPOILERS OFF** | The ground spoilers are selected OFF |
| **PITCH DISCONNECT** | The pitch disconnect has been selected. The pilot's control column moves the left elevator. The copilot's control column moves the right elevator. Autopilot will disengage and not re-engage |
| **ROLL DISCONNECT** | The roll disconnect has been selected. The pilot's control wheel moves the roll spoilers. The copilot's control wheel moves the aileron. The autopilot will disengage and not re-engage |
| **ROLL SPOILERS OFF** | The roll spoilers have been turned off and the roll disconnect has been activated |
| **RUD LIMITER IN TEST** | The rudder travel limiter system is conducting the manually activated system test |
| **SEC STAB TRIM ON** | The secondary channel of the horizontal stabilizer trim system is selected. The autopilot will be inoperative |
| **STAB TRIM OFF** | The STAB TRIM switch is in the off position. The autopilot will be inoperative |
| **STALL PUSHER OFF** | The stall pusher has been manually deactivated |
| **YAW DAMPER OFF** | The yaw damper is selected off |

**NOTES**

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- Aural warnings are continuous
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right system
- Configuration messages are accompanied by "CONFIGURATION" voice warning
- Elevator split tolerance is inversely proportional to airspeed (CAS). Approximately 32.5° at 150 kt CAS, decreasing to 7.5°at 320 kt CAS
- Flight spoiler deployment warnings consider both altitude and throttle position

## VII. LIMITATIONS

| A. Airspeed Limitations | |
|---|---|
| Rudder Limiter Failure | Maximum 185 KIAS |
| Rough Air Penetration Speed (VRA) | 265 KIAS / 0.75 MI |
| Maximum Flap Extended Speed (VFE) | Flaps 10: 210 KIAS<br>Flaps 20: 210 KIAS<br>Flaps 30: 175 KIAS |
| Flight Spoilers | Not to be extended below approach speed + 8 KIAS |
| Pitch Control Jam | Maximum 200 KIAS or speed at which jam occurred (whichever is greater) |

| B. Altitude Limitations | |
|---|---|
| Spoiler Panel Jammed | Maximum 41,000 feet |
| Yaw Damper Off | Maximum 31,000 feet |
| Flight Spoilers | Not to be extended below 500 feet AGL |
| Flaps | Prohibited to extend above 18,000 feet |

| C. Control Surface Deflection and Rate Limitations | |
|---|---|
| Primary Stabilizer Trim Rate | 0.4 deg/sec maximum |
| Secondary Stabilizer Trim Rate | 0.2 deg/sec constant |
| Balance Tab Travel | ±20° relative to aileron surface |
| Spoiler Roll Authority | Maximum 45° from stowed |
| Maximum Rudder Deflection (Standard Aircraft) | 30° either side of center |
| Maximum Rudder Deflection (Airplanes 20813+ or SB 350-27-008) | 31° either side of center |
| Yaw Damper Limitation | Mechanically limited to ±5° rudder motion |

| D. Operational Limitations | |
|---|---|
| Flight Spoilers to EMER | Only permitted in emergencies or required procedures |
| Intentional Stall Warning Activation | Prohibited unless for flight test or training |
| Maximum Crosswind Component - Takeoff | 28 knots demonstrated |
| Maximum Crosswind Component - Takeoff | 24 knots demonstrated |
| Flap Extension Time | 0° to 30°: 20 seconds normal rate |
| ALTN FLAPS Extension | 0° to 20°: 60-70 seconds |

## VIII. FLIGHT CONTROLS SYSTEM CIRCUIT BREAKERS

Flight Controls System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| STAB TRIM PRI 1 | LEFT ESS | CB1-D1 |
| STAB TRIM PRI 2 | RIGHT ESS | CB2-D1 |
| STAB TRIM SEC | LEFT MAIN | CB3-C1 |
| FLAPS NORM | RIGHT MAIN | CB4-C1 |
| FLAPS EMER | LEFT ESS | CB1-D2 |
| YAW DAMPER | LEFT MAIN | CB3-C2 |
| SPOILERS L | LEFT MAIN | CB3-C3 |
| SPOILERS R | RIGHT MAIN | CB4-C3 |
| SECU 1 | LEFT ESS | CB1-D3 |
| SECU 2 | RIGHT ESS | CB2-D3 |
| STALL PROT 1 | LEFT ESS | CB1-D4 |
| STALL PROT 2 | RIGHT ESS | CB2-D4 |
| STICK PUSHER | LEFT MAIN | CB3-C4 |
| STICK SHAKER L | LEFT ESS | CB1-D5 |
| STICK SHAKER R | RIGHT ESS | CB2-D5 |
| AILERON TRIM | LEFT ESS | CB1-D6 |
| RUDDER TRIM | RIGHT ESS | CB2-D6 |

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## IX. FLIGHT CONTROLS QUIZ

1. What type of control system is used for the ailerons on the Challenger 350?

    A) Hydraulic power control units
    B) Manual cable and pushrod mechanism
    C) Electric actuators
    D) Fly-by-wire system

2. What is the normal takeoff range for horizontal stabilizer trim?

    A) 0 to 15 degrees
    B) 2.5 to 8.0 units
    C) 0.2 to 0.4 degree/second
    D) ±20 degrees

3. How many spoiler panels are located on each wing?

    A) Two panels
    B) Three panels
    C) Four panels
    D) Six panels

4. What happens when the angle-of-attack increase rate exceeds 1 degree per second?

    A) The stick shaker activates immediately
    B) The stick pusher activates immediately
    C) The stall protection computer lowers the activation trip point
    D) The system automatically disengages

5. Which hydraulic systems power the elevator control?

    A) Left system only
    B) Right system only
    C) Left and right systems
    D) Auxiliary system only

6. What is the maximum travel range for the aileron balance geared tabs?

    A) ±15 degrees
    B) ±20 degrees
    C) ±30 degrees
    D) ±45 degrees

7. What is the primary channel horizontal stabilizer trim rate at Mach 0.6?

    A) 0.1 degree/second
    B) 0.2 degree/second
    C) Between 0.1 and 0.4 degree/second
    D) 0.4 degree/second

8. How many flap positions are available on the Challenger 350?

A) Three positions
B) Four positions
C) Five positions
D) Six positions

9. What does the proximity sensing system monitor?

A) Flight control surface positions only
B) Engine parameters only
C) Aircraft systems for correct operation and configuration
D) Hydraulic system pressures only

10. What is the maximum airspeed limitation with a rudder limiter failure?

A) 150 KIAS
B) 175 KIAS
C) 185 KIAS
D) 200 KIAS

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CL-350



CL-350 TRAINING MANUAL

# LANDING GEAR 06

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# LANDING GEAR

The Challenger 350 landing gear system represents a sophisticated retractable tricycle configuration designed to provide reliable ground support and safe aircraft operations throughout all phases of taxi, takeoff, and landing. This system consists of two main landing gear assemblies and a steerable nose landing gear assembly, each equipped with dual wheels and tires, with normal extension and retraction powered by the aircraft's left hydraulic system.

The design incorporates multiple redundancy features including a Manual Release System (MRS) that enables gear deployment assisted by right hydraulic system pressure and gravity/spring forces when normal extension is inoperative, comprehensive position monitoring through the Proximity Sensing Electronic Unit (PSEU), and a dual-channel brake control system with anti-skid protection.

The main landing gear feature self-adjusting multi-disc carbon brakes with the inboard wheels powered by left hydraulic pressure and outboard wheels by right hydraulic pressure, while the PARK/EMER BRAKE system provides hydro-mechanical backup capability without anti-skid protection.

## I. INTRODUCTION

### A. SYSTEM SPECIFICATIONS

Landing Gear System Specifications

| Parameter | Value |
|---|---|
| Configuration | Retractable tricycle |
| Main Gear Type | Trailing link, inward retracting |
| Nose Gear Type | Dual wheel, forward retracting |
| Extension/Retraction Power | Left hydraulic system primary |
| Emergency Extension | Manual Release System (MRS) |
| Wheel Configuration | Dual wheels all positions |
| Brake Type | Multi-disc carbon |
| Anti-skid System | Active down to 10 knots |
| Steering System | Electro-hydraulic nose wheel steering |
| Weight on Wheels | Multiple sensors all gear |
| Main Gear Retraction Direction | Inward toward centerline |
| Nose Gear Retraction Direction | Forward |
| Control System | Proximity Sensing System (PSS) |
| Ground Mode Activation | WOW >5 sec or wheel spin-up >50 kts |

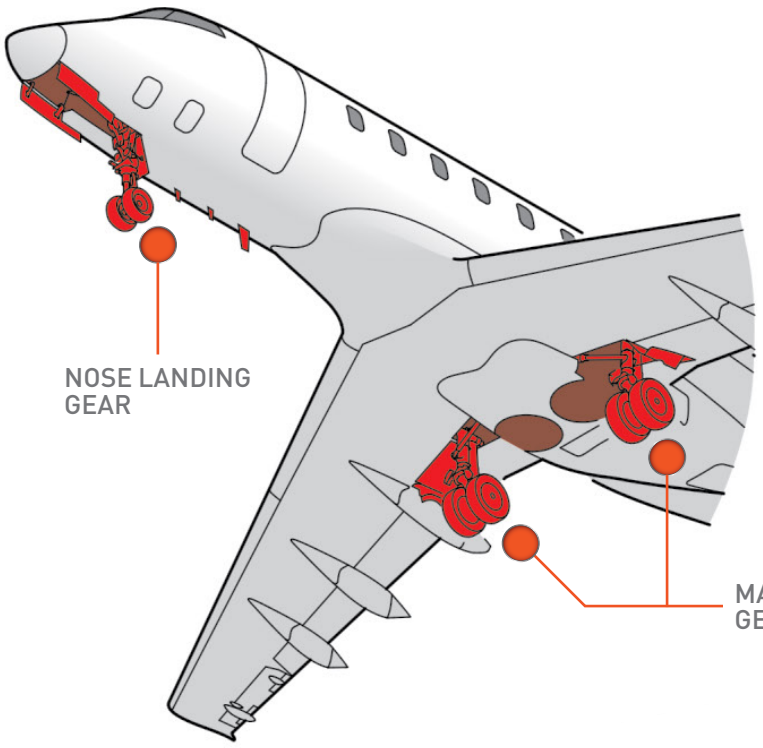
## B. SYSTEM ARCHITECTURE

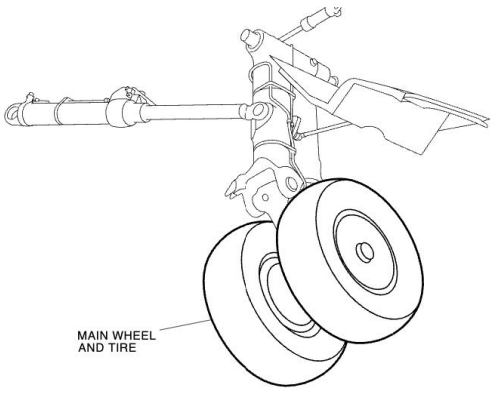
**Primary Components:**

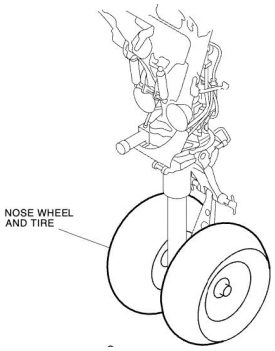
- Two main landing gear assemblies with trailing link design
- One steerable nose landing gear assembly
- Proximity Sensing Electronic Unit (PSEU) for sequencing and monitoring
- Landing gear selector valve (electrically controlled, hydraulically operated)
- Manual Release System (MRS) for emergency extension
- Brake Control Unit (BCU) for brake management and anti-skid

**Control Philosophy:**

- Normal operation via landing gear control handle (UP/DN positions)
- PSEU monitors proximity sensors and weight-on-wheels inputs
- Left hydraulic system powers normal extension/retraction
- Right hydraulic system assists MRS for main gear extension
- Gravity and spring forces extend nose gear during manual release



# II. MAIN LANDING GEAR

## A. COMPONENTS

**Structural Elements:**

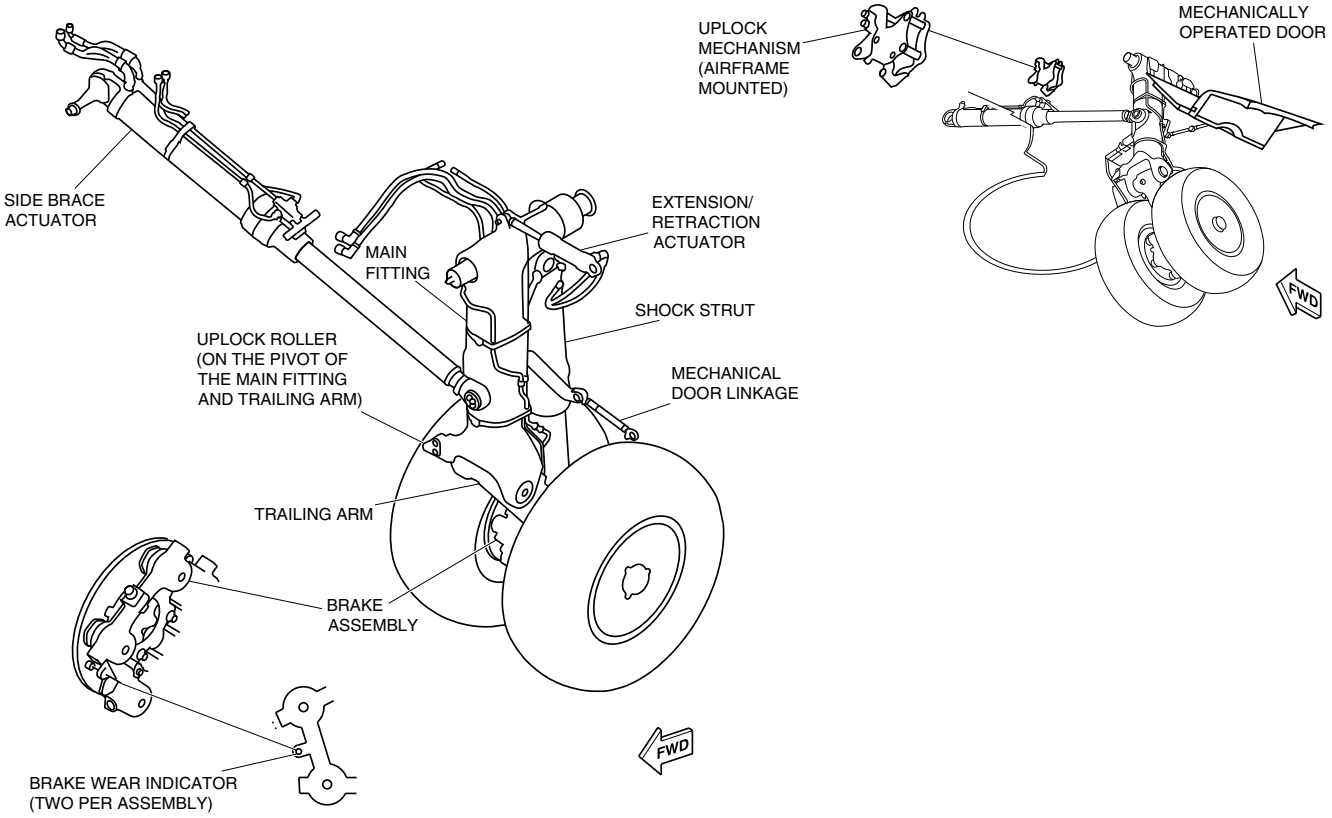
- Main fitting attached to wing structure
- Side brace actuator assembly with internal locking mechanism
- Nitrogen gas/oil filled shock strut
- Trailing arm assembly
- Axle with carbon brake assemblies
- Dual wheels with heat-sensitive fusible plugs
- Main landing door mechanically linked to gear

**Actuation System:**

- Side brace actuator (hydraulic piston-cylinder)
- Extension and retraction actuator
- Auxiliary extend assembly (MRS backup)
- MLG uplock assembly
- Internal segmented down-locking mechanism



Main Landing Gear



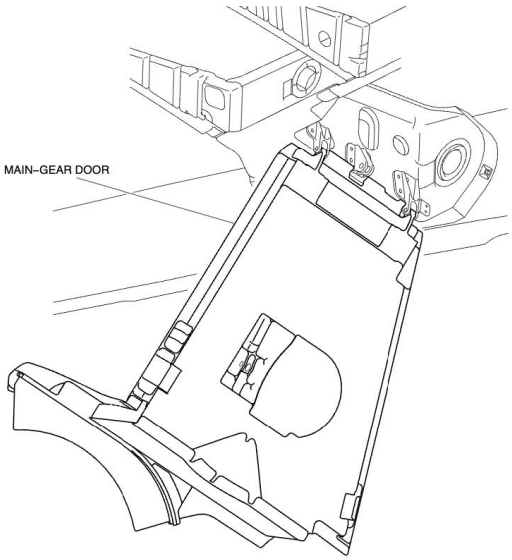
### B. MAIN GEAR DOORS

**Door Configuration:**

- Mechanically linked to MLG assembly
- Moves with gear during extension/retraction
- Two hinges attach door to wing structure
- Clad-aluminum alloy sheet construction
- Nylon door brush creates tire-to-fuselage seal

**Main Wheel Bins:**

- Recessed into MLG bay
- Isolates wheels from MLG bay equipment
- Single loop overheat detection wire per bin
- Removable for maintenance access
- Prevents tire-thrown debris damage




Main Gear Door

### C. UPLOCKS AND DOWNLOCKS

**Uplock Mechanism:**

- Housing bolted to airframe structure
- Latch lever and hook engage roller on landing gear
- Mechanically engaged when gear fully retracted
- Released hydraulically during normal extension
- Manual release via MRS cables

**Downlock System:**

- Hydraulically and mechanically engaged
- Internal to side brace actuator
- Segmented locking mechanism
- Locked position maintained without hydraulic pressure
- Locking pins insertable for ground operations



MLG Uplock

## III. NOSE LANDING GEAR

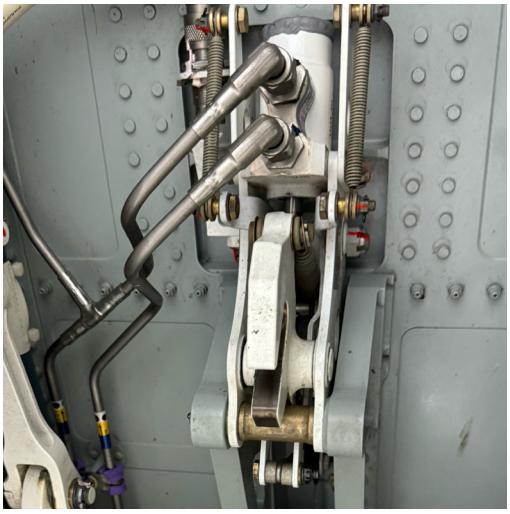
### A. COMPONENTS

**Structural Elements:**

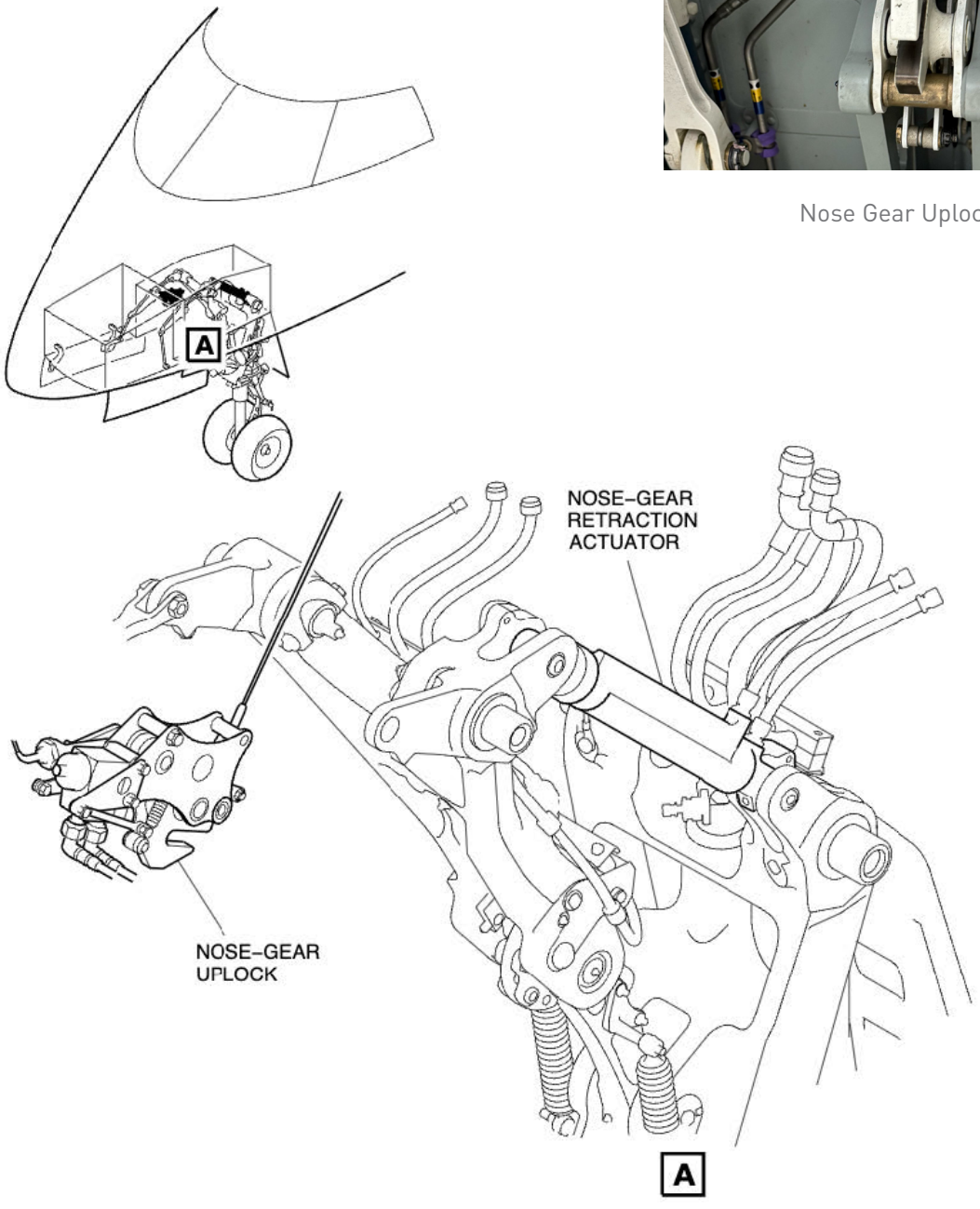
- Upper and lower drag braces
- Nitrogen gas/oil filled shock strut
- Torque links for wheel alignment
- Dual wheels with chine tires
- Forward and aft doors
- Door retraction actuator
- Steering actuator with rack and pinion

**Unique Features:**

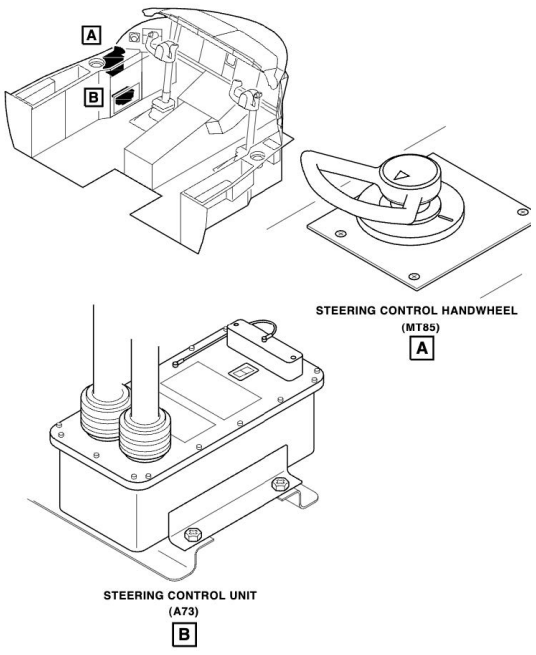
- Chine tires deflect water from engines
- Overcenter mechanism for uplock
- Restrictor in up hydraulic line for smooth retraction
- No brakes on nose wheels
- Free-castering capability when steering disabled



Nose Gear Uplock



## B. NOSE WHEEL STEERING



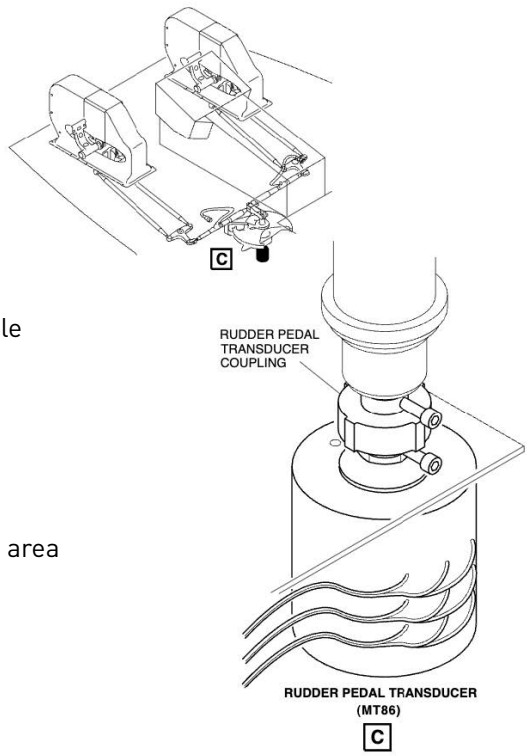

**System Components:**

- Steering Control Unit (SCU)
- Electro-hydraulic steering valve
- Steering actuator with position transducer
- Handwheel (pilot station)
- NWS ON/OFF switch on landing gear panel
- Steer-by-wire technology (no mechanical connection)

**Steering Authority:**

- Handwheel: ±65° at nose wheel (full authority)
- Rudder pedals: ±7° at nose wheel (limited authority)
- Combined input capability
- Free-castering mode when system OFF or failed
- Damping provided in all modes
- 15 knot crosswind landing limitation without NWS

## C. TOWING LIMITATIONS




**Standard Towing (Torque Links Connected):**

- Maximum rotation limited to 120° in either direction
- Exceeding 120° trips limit switch
- **NWS LIMIT EXCEEDED** (C) CAS message generated
- Potential structural damage to steering components
- Steering Control Unit (SCU) monitors angular limits

**Limit Exceeded Indicators:**

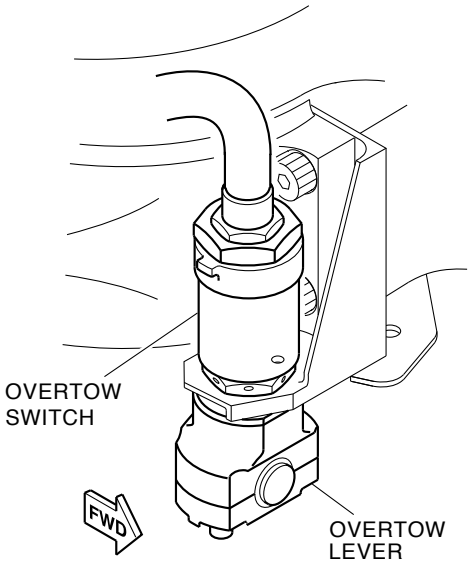
- Indicator pins located at approximately ±123° of steering angle
- Pins designed to yield if limit exceeded during towing
- Visual inspection required if pins show yielding
- Serves as maintenance indication of over-rotation
- Located on feedback mechanism assembly
- AMM inspection required for feedback links and surrounding area

**Exceeding Limits Consequences:**

- Structural damage to steering feedback mechanism
- Damage to torque links and steering actuator
- Potential damage to hydraulic lines
- Requires detailed maintenance inspection per AMM
- May affect nose wheel steering operation
- Documentation required in aircraft logbook

**Special Hangar Operations:**

- Torque links may be disconnected for unlimited rotation
- Minimum requirement: 3.50 inches of chrome
- showing on shock strut
- Allows towing at any angle for hangar positioning
- Free-castering mode with torque links disconnected
- Steering system must be OFF
- Reconnection procedures per AMM required before flight

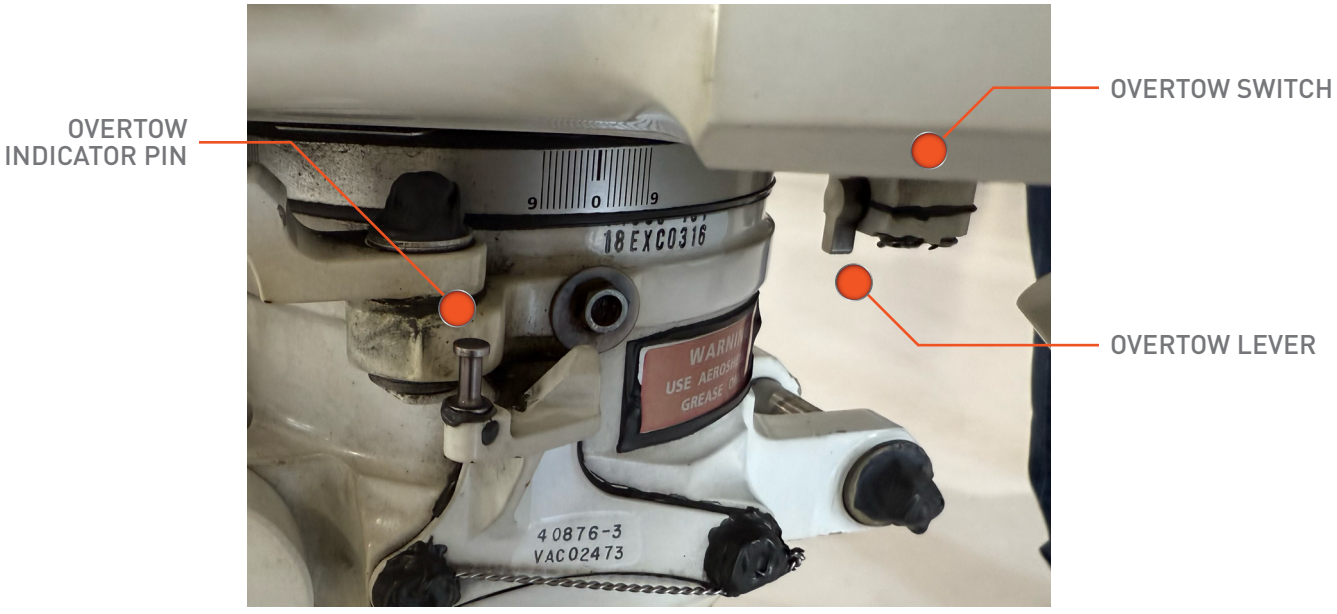


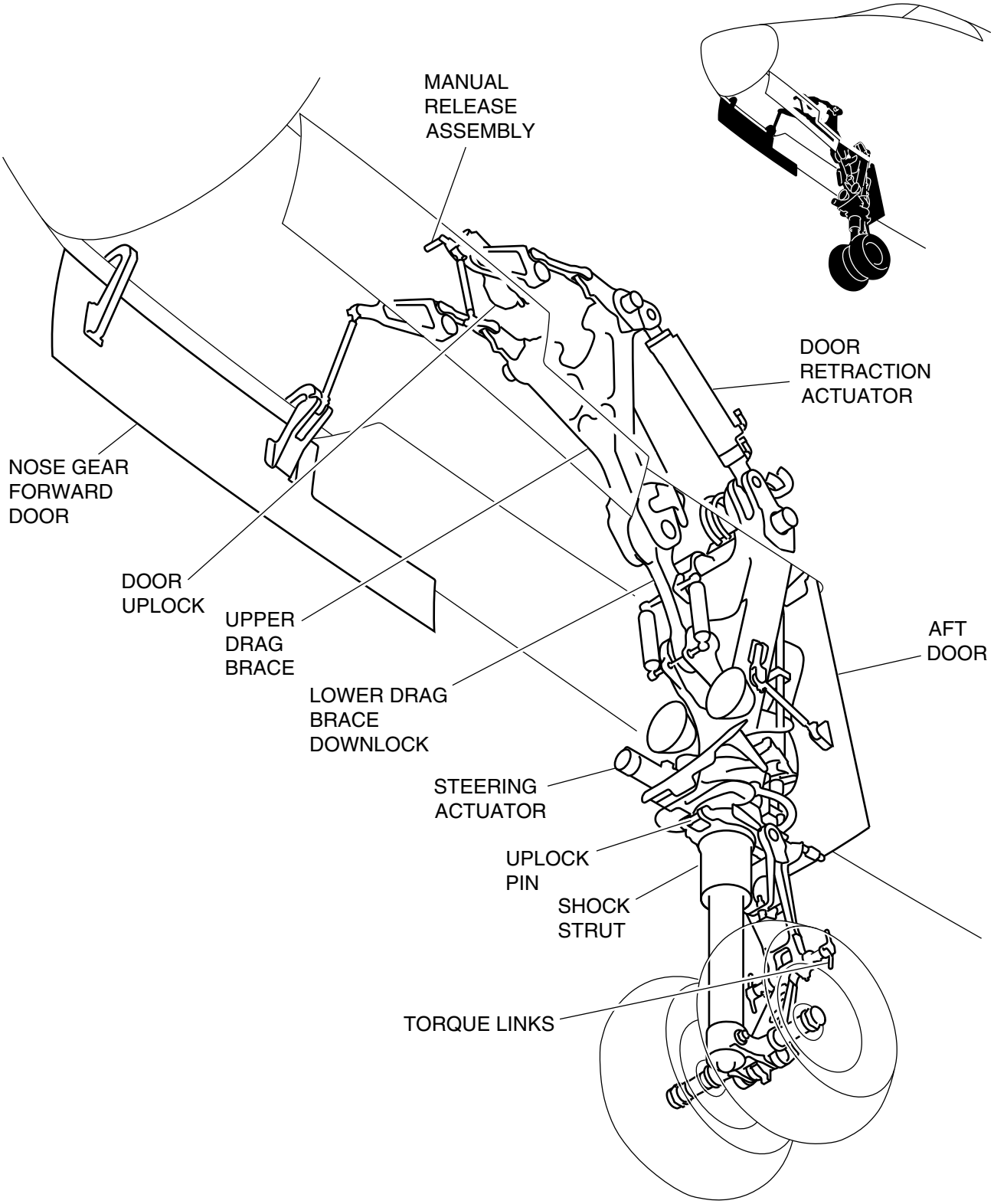

**Towing Precautions:**

- Verify NWS switch OFF before towing
- Use proper tow bar attachment points
- Monitor steering angle during all turns
- Maximum towing speed per ground handling manual
- Ensure adequate shock strut extension before disconnecting torque links
- Two-person operation recommended for torque link disconnect/reconnect

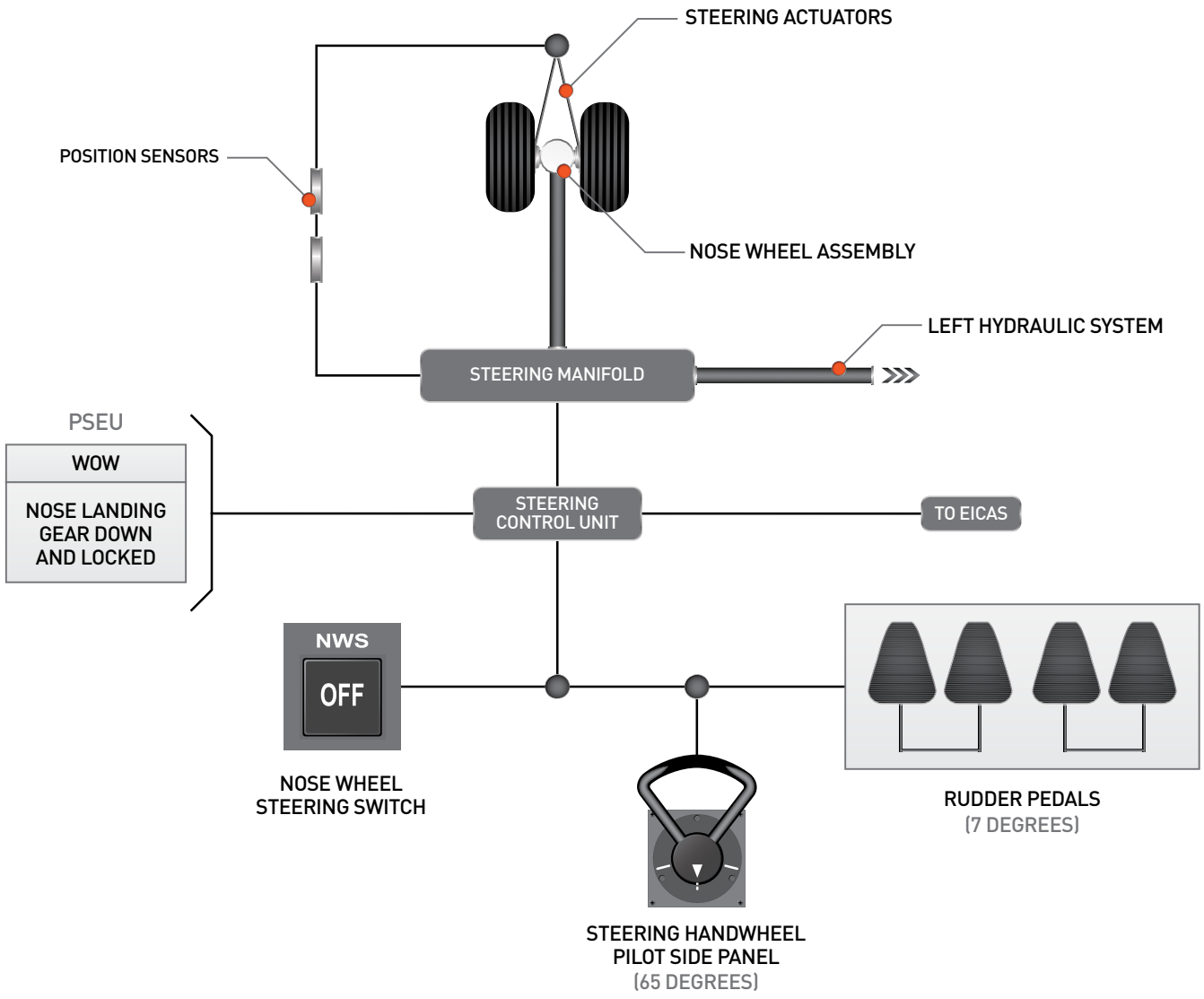
**Post-Towing Inspection:**

- Check indicator pins for yielding or damage
- Verify torque links properly connected (if disconnected)
- Inspect steering feedback mechanism
- Check for hydraulic leaks around steering actuator
- Verify NWS operation before taxi (if maintenance performed)
- Document any limit exceedance in maintenance log




MANUAL
RELEASE
ASSEMBLY
DOOR
RETRACTION
ACTUATOR
NOSE GEAR
FORWARD
DOOR
DOOR
UPLOCK
UPPER
DRAG
BRACE
LOWER DRAG
BRACE
DOWNLOCK
AFT
DOOR
STEERING
ACTUATOR
UPLOCK
PIN
SHOCK
STRUT
TORQUE LINKS

## STEERING CONTROL SYSTEM



# IV. EXTENSION AND RETRACTION SYSTEM

## A. NORMAL EXTENSION




**Sequence of Operations:**

- Landing gear handle selected to DN position
- PSEU verifies correct parameters
- Selector valve energized to extend position
- Hydraulic pressure releases MLG uplocks
- Nose overcenter mechanism releases
- NLG extends rearward, MLG extends outward
- Downlocks hydraulically and mechanically engage

**System Monitoring:**

- PSEU monitors all proximity sensors
- Position feedback to EICAS display
- Green indication when down and locked
- Transit indication during movement
- 28-second timeout for gear transit

## B. NORMAL RETRACTION

**Prerequisites:**

- No weight-on-wheels signal
- Landing gear handle UP selection
- Adequate hydraulic pressure

**Sequence of Operations:**

- Selector valve energized to retract position
- Downlocks hydraulically released
- BCU commands 350 psi brake pressure for 4 seconds
- NLG retracts forward, MLG retracts inward
- Uplocks mechanically engage when fully retracted
- Restrictor controls NLG retraction speed

## C. MANUAL RELEASE SYSTEM

In the event of a failure with the normal landing gear control circuitry or the left hydraulic system, the Challenger 350 is equipped with a Manual Release System (MRS) as an alternative means to extendthe landing gear. This system is activated by pulling the "LG PULL" handle, which is located near therear of the center pedestal on the copilot's side.

Operating the handle mechanically releases theuplocks, allowing the nose landing gear to extend using gravity and spring forces, while the mainlanding gear is assisted by hydraulic pressure from the right hydraulic system and an accumulator toensure it locks into the down position. This procedure is used in non-normal situations such as a totalhydraulic pressure loss or a **GEAR DISAGREE** (C) indication where the gear fails to extend normally.

**System Description:**

- Handle located rear center pedestal (copilot side)
- Closed loop cable assembly to MLG quadrants
- Activates dump valves and manual selector valve
- Right hydraulic system pressure to auxiliary actuators
- Gravity and spring forces extend nose gear

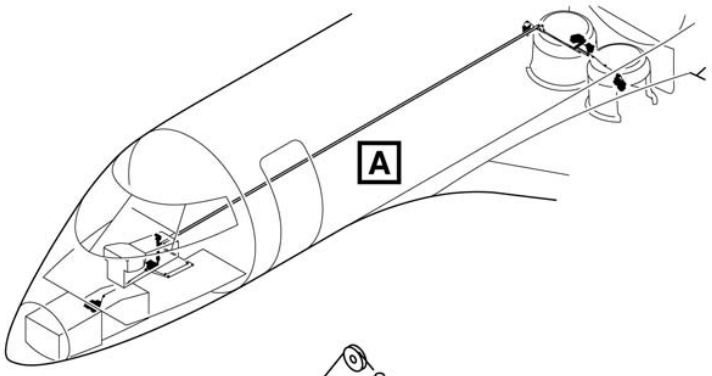
**MRS Operation:**

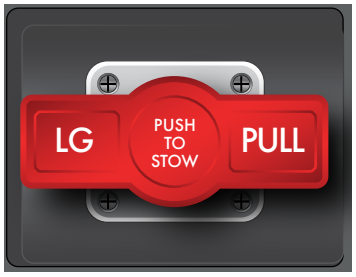
- Pull manual release handle
- Cable movement releases MLG uplocks
- Dump valves block normal hydraulic supply
- Manual selector valve admits right system pressure
- Auxiliary extend actuators assist MLG extension
- NLG extends by gravity and spring force
- All gears mechanically lock in down position

**Post-Extension:**

- Stow handle only after landing with gear pins installed
- System reset for normal operation
- Retraction requires landing gear handle to UP

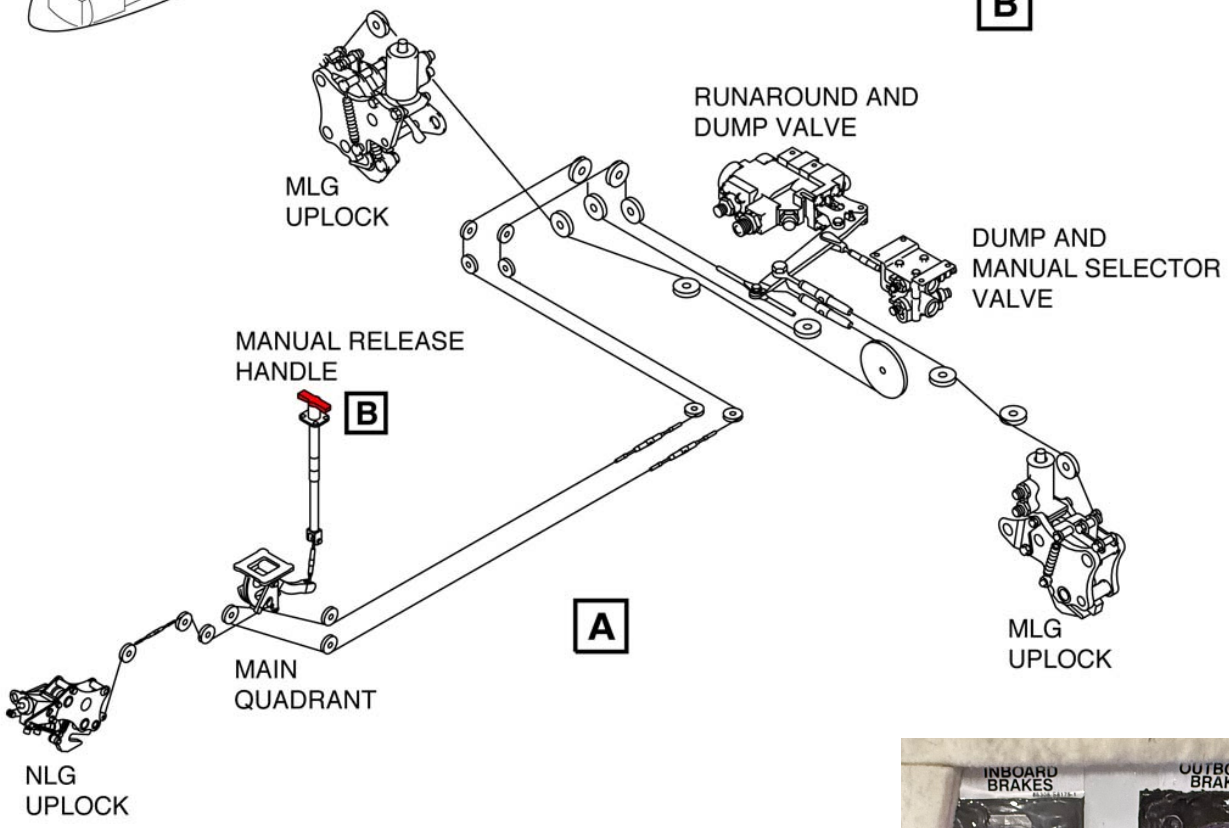





**LANDING GEAR MANUAL RELEASE HANDLE**

**B**







Main Landing Gear Download
Assist and Brake Accumulator gauges located in battery compartment.

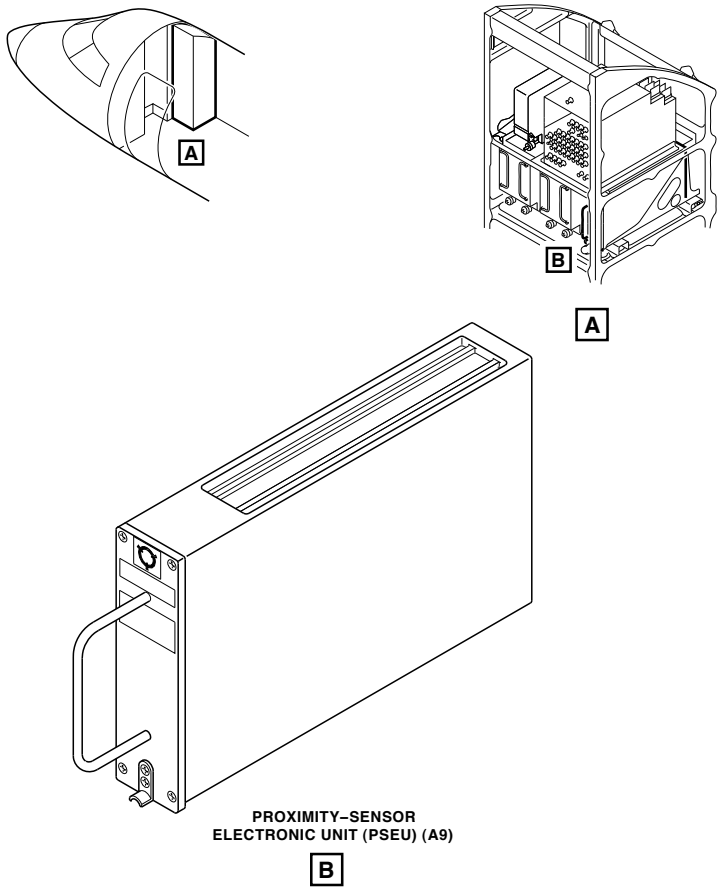
# V. PROXIMITY SENSING SYSTEM

The Proximity Sensing System (PSS) is an electronic system that monitors the position of various aircraft components, including the landing gear, its doors, and control handle. It is comprised of a Proximity Sensing Electronic Unit (PSEU) and numerous proximity sensors located throughout the aircraft.

For landing gear operations, the PSEU processes signals from these sensors to sequence the normal extension and retraction of the gear. It also provides crucial position monitoring, delivering gear status to the flight deck via EICAS messages and aural alerts, such as the "GEAR" warning.

A key safety function is the system's ability to detect disagreements between the landing gear's position and the selector handle's commanded position, triggering a **GEAR DISAGREE** caution message if a mismatch occurs or if the gear remains in transit for more than 28 seconds.

Furthermore, the PSS utilizes dual proximity sensors on each landing gear to determine Weight-On-Wheels (WOW) status, which is essential for enabling or disabling systems like nose wheel steering and ground spoilers.




## A. PSEU FUNCTIONS

**Primary Responsibilities:**

- Sequences landing gear operation
- Monitors door, thrust lever, and spoiler positions
- Processes proximity sensor "near" and "far" signals
- Controls hydraulic selector valves
- Provides position data to EICAS
- Manages takeoff configuration warnings

**System Interfaces:**

- Landing gear selector handle inputs
- Weight-on-wheels sensor processing
- Brake and steering system enable/disable
- EICAS display outputs
- Aural warning system activation

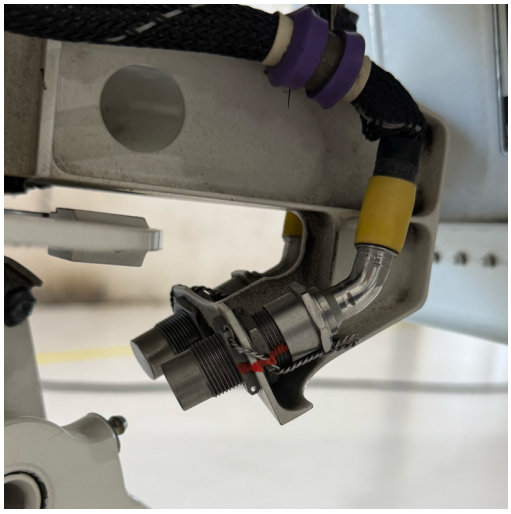
## B. POSITION MONITORING

**Sensor Configuration:**

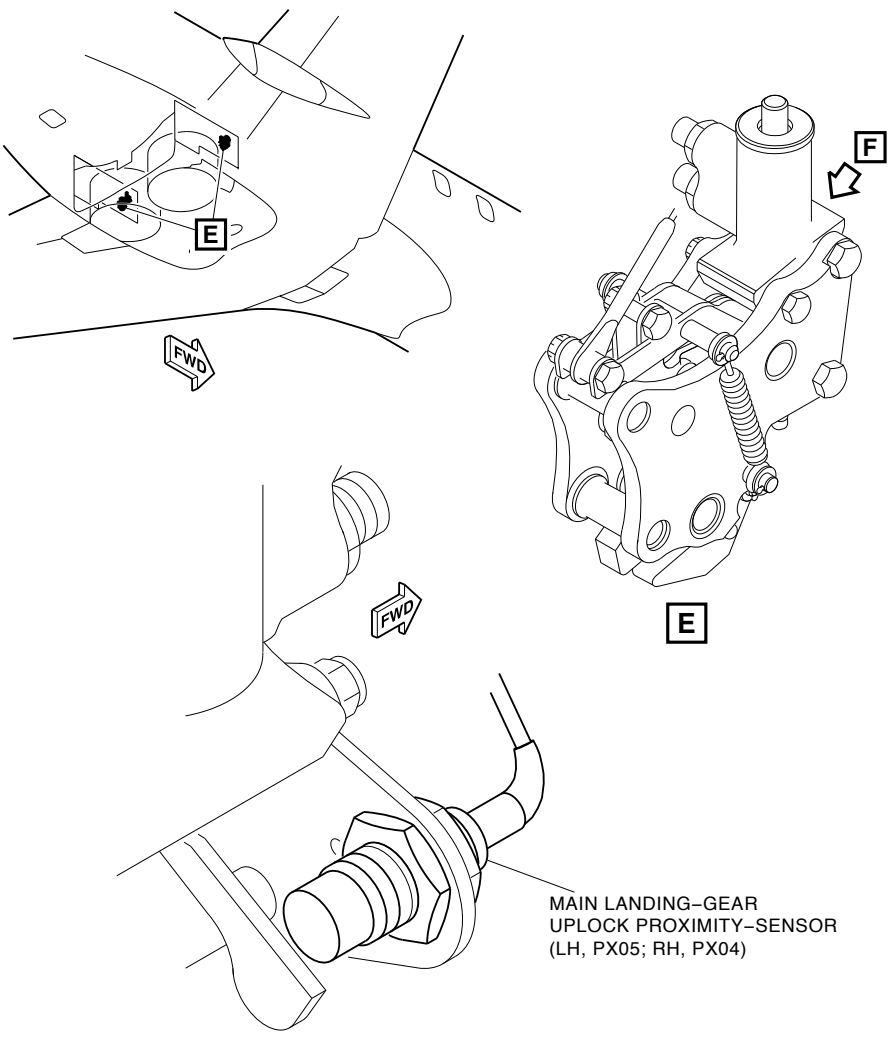
- Dual proximity sensors per landing gear
- Uplock and downlock position sensors
- Weight-on-wheels redundancy
- Door position monitoring
- Disagree logic for position conflicts

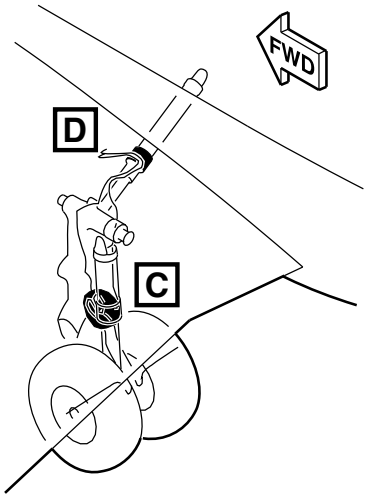
**EICAS Indications:**

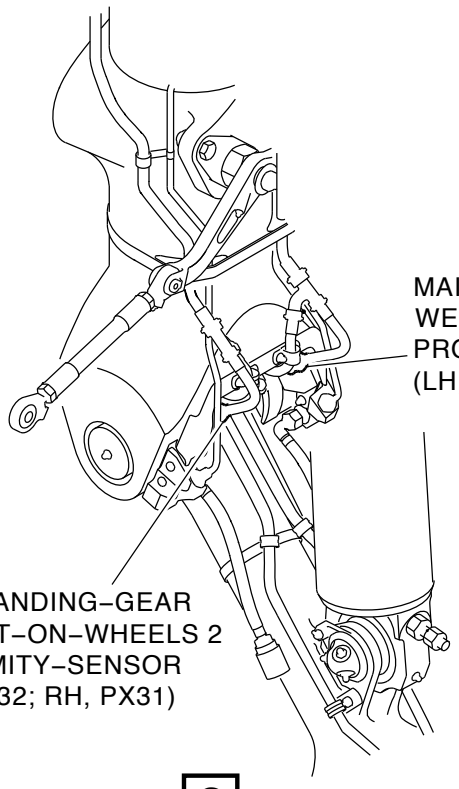
- Green - Down and locked
- White - Up and locked
- Amber - In transit
- Red - Unsafe/disagree condition
- Primary Flight Controls Page



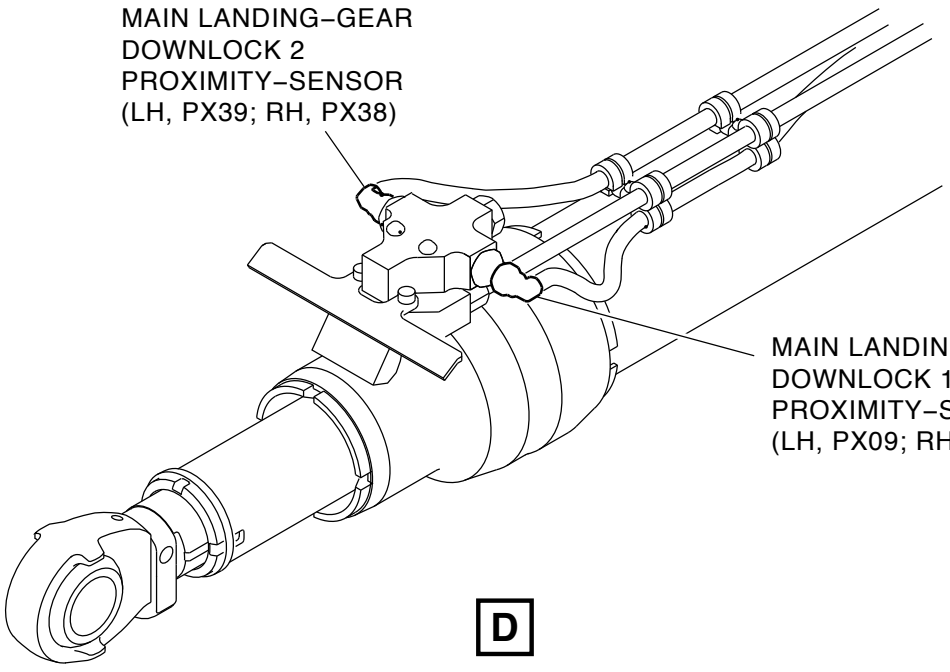
Weight-Off-Wheels Proximity Sensors



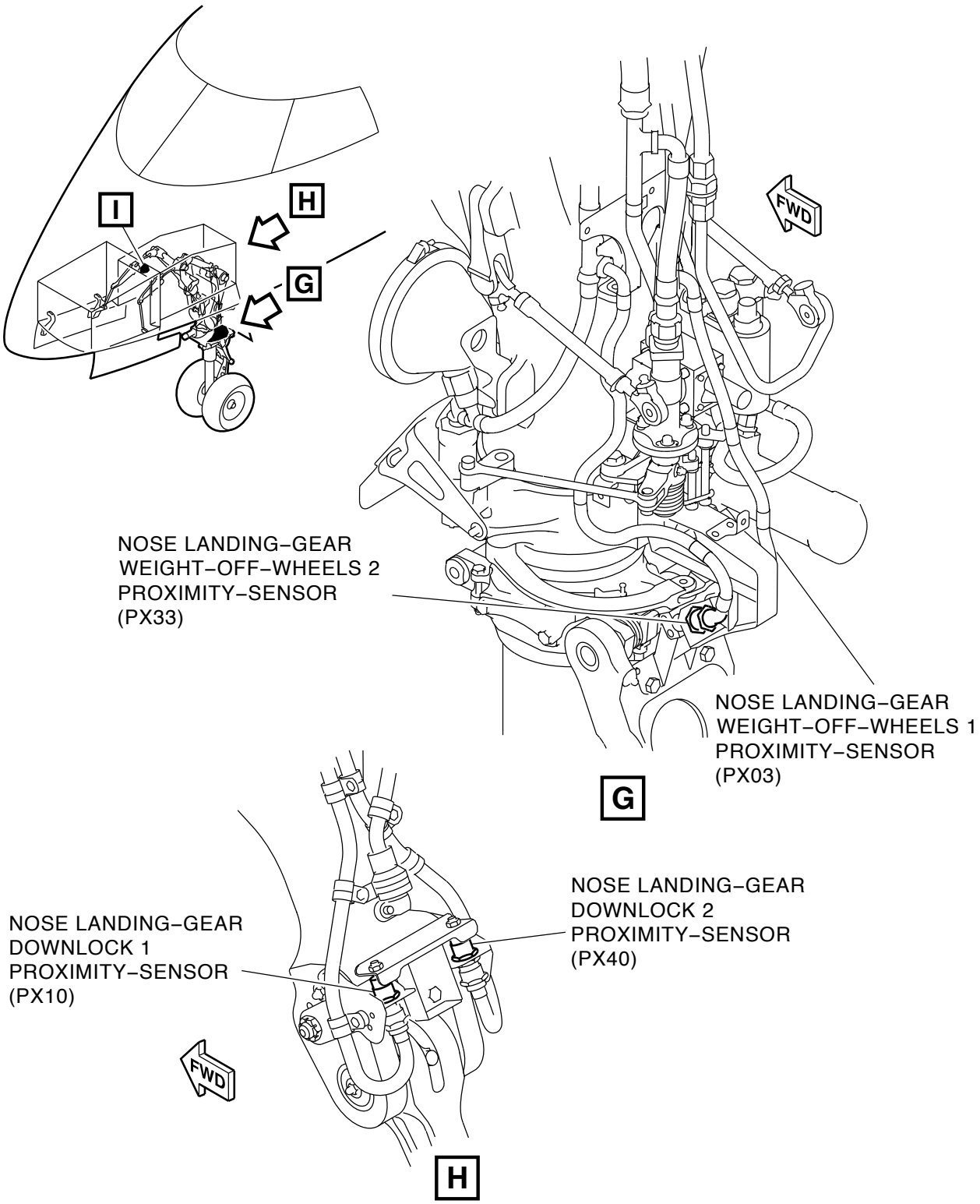

FWD
D
C


MAIN LANDING–GEAR
WEIGHT–ON–WHEELS 1
PROXIMITY–SENSOR
(LH, PX02; RH, PX01)
MAIN LANDING–GEAR
WEIGHT–ON–WHEELS 2
PROXIMITY–SENSOR
(LH, PX32; RH, PX31)

C


MAIN LANDING–GEAR
DOWNLOCK 2
PROXIMITY–SENSOR
(LH, PX39; RH, PX38)
MAIN LANDING–GEAR
DOWNLOCK 1
PROXIMITY–SENSOR
(LH, PX09; RH, PX08)

D


I
H
G
FWD
NOSE LANDING–GEAR
WEIGHT–OFF–WHEELS 2
PROXIMITY–SENSOR
(PX33)
NOSE LANDING–GEAR
WEIGHT–OFF–WHEELS 1
PROXIMITY–SENSOR
(PX03)
G
NOSE LANDING–GEAR
DOWNLOCK 2
PROXIMITY–SENSOR
(PX40)
NOSE LANDING–GEAR
DOWNLOCK 1
PROXIMITY–SENSOR
(PX10)
FWD
H

## LANDING GEAR INDICATIONS

The EICAS landing gear indications provide the pilots increased situational awareness regarding the position and condition of the landing gear.

**LANDING GEAR DOWNLOCKED "SAFE" :**

ONE OF THE TWO REDUNDANT DONLOCK SENSORS DETECTS THAT THE GEAR IS DOWN AND LOCKED.

**LANDING GEAR UP:**

UPLOCK SENSOR DETECTS GEAR UP & BOTH DOWNLOCK SENSORS DETECT GEAR NOT DOWNLOCKED.

GEAR UP & NO GEAR WARNING & EITHER NO GEAR DISAGREE OR GEAR DISAGREE WITH HANDLE UP.

GEAR UP & NO GEAR WARNING & GEAR DISAGREE & GEAR HANDLE NOT UP.

GEAR UP & GEAR WARNING.

**LANDING GEAR IN TRANSIT:**

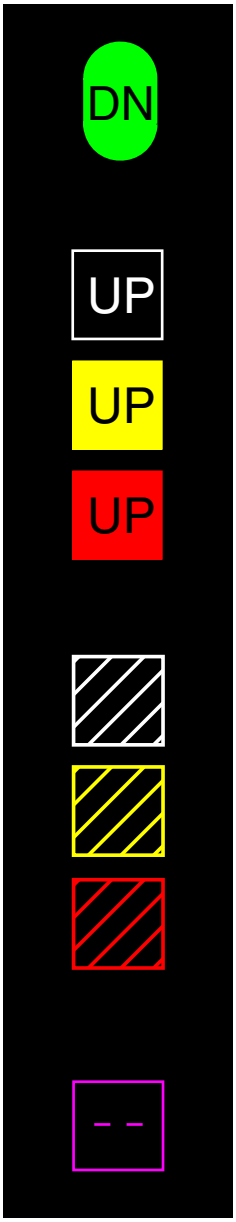
UPLOCK & DOWNLOCK SENSORS DETECT GEAR IS NOT LOCKED.

GEAR IN TRANSIT & NO GEAR DISAGREE & NO GEAR WARNING.

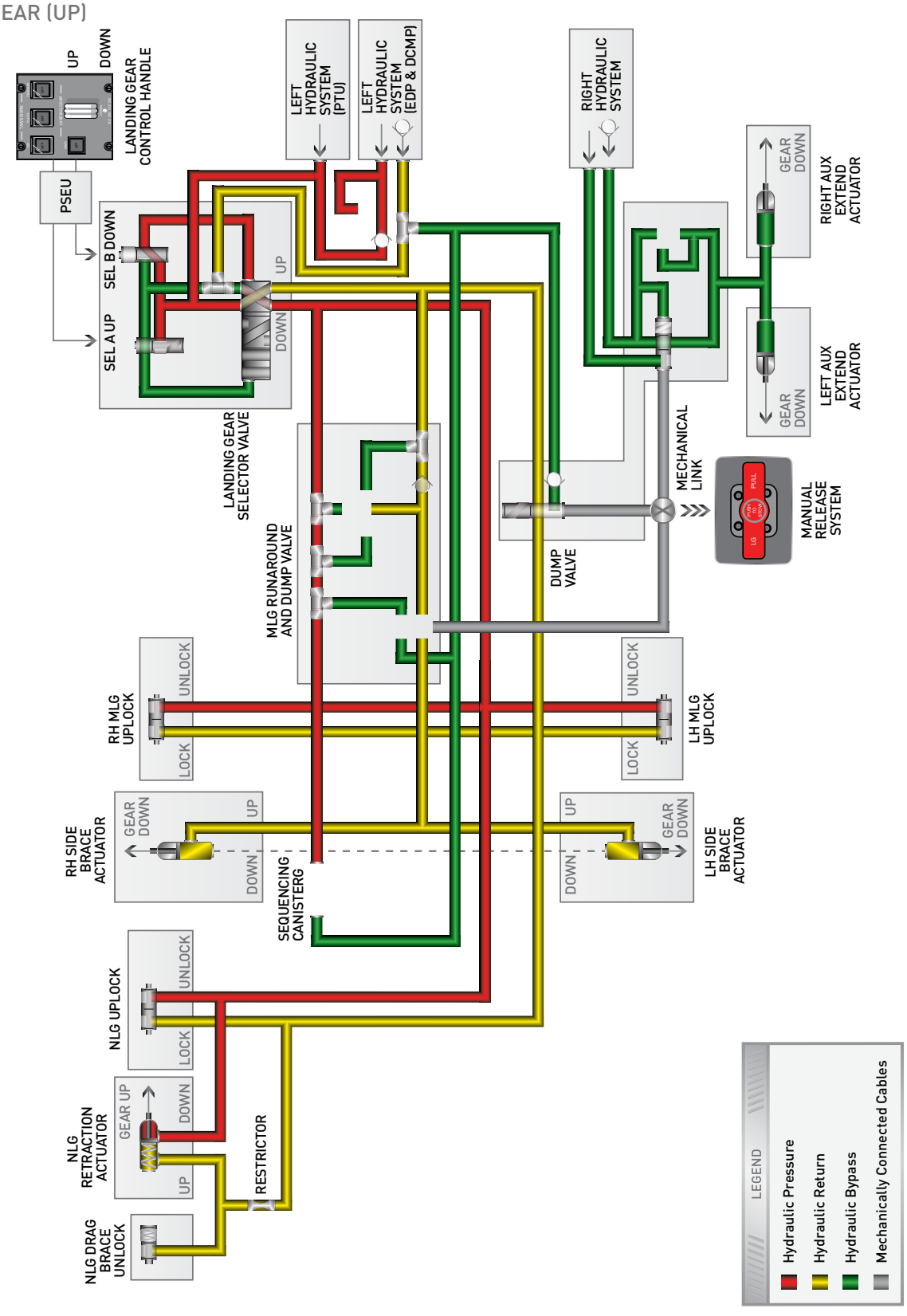
GEAR IN TRANSIT & GEAR DISAGREE & NO GEAR WARNING.

GEAR IN TRANSIT & GEAR WARNING.

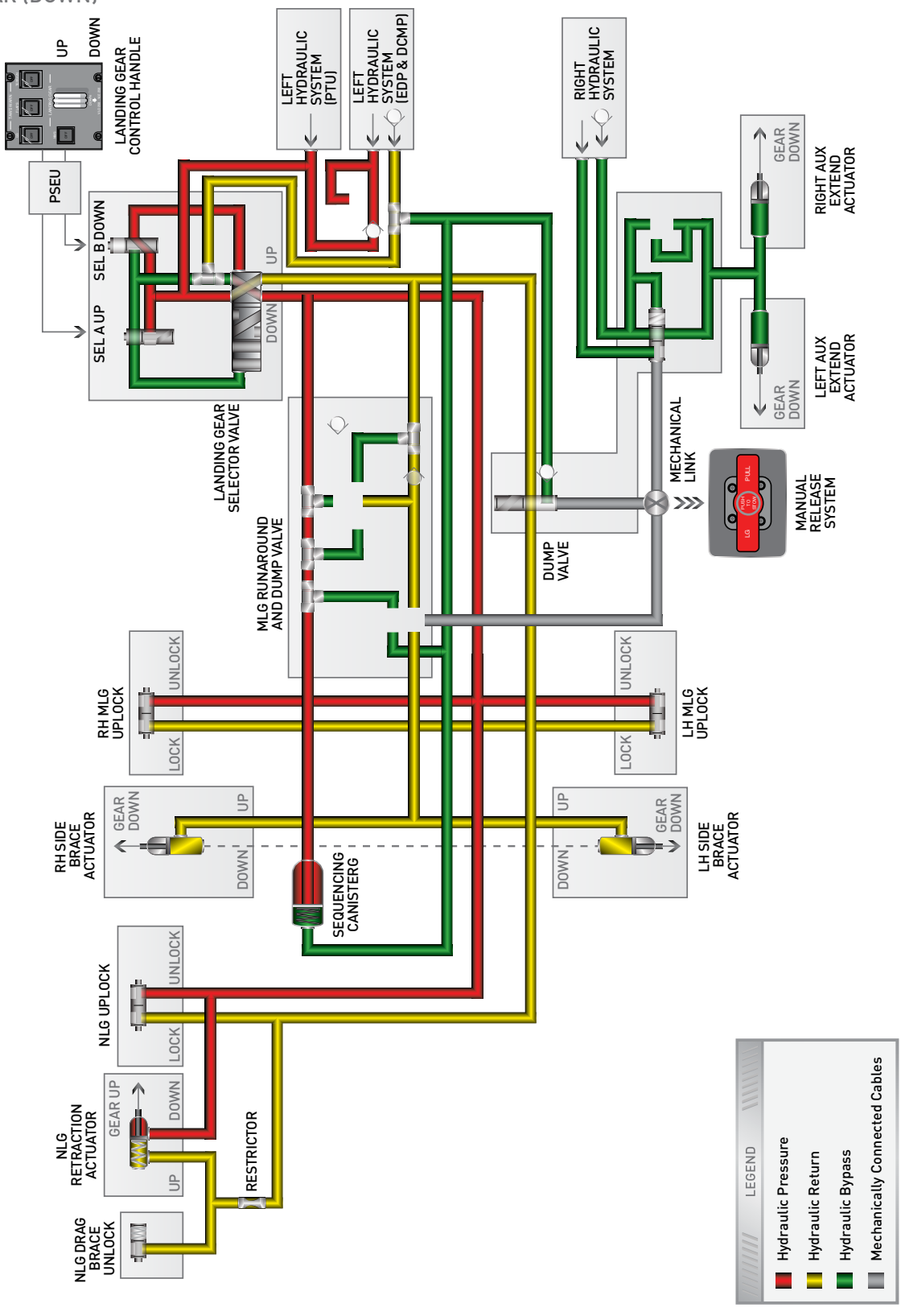
DATA FROM BOTH PSS SUBSYSYTEMS NOT AVAILABLE OR INVALID.



## LANDING GEAR (UP)



## LANDING GEAR (DOWN)



## C. WARNING LOGIC

Non-Mutable Warning Conditions:

- Any gear not down and locked AND
- Radio altimeter valid and <500 feet AND
- Thrust levers <26° OR Flaps ≥27°

Mutable Warning Conditions:

- Any gear not down and locked AND
- Radio altimeter invalid AND
- Left and Right Thrust Levers <26° Thrust Lever Angle AND
- Altitude <15,000 feet, OR
- Airspeed <170 KIAS AND Flaps <3°, OR
- Airspeed <160 KIAS with Flaps <13°, OR
- Airspeed <155 KIAS with Flaps >13°
- Warning silenced via Master Warning switch
- Automatic reset when condition resolved

Landing Gear Warning System

| Warning Type | Conditions | Additional Requirements |
|---|---|---|
| Non-Mutable "GEAR" Warning | Any gear not down and locked<br>AND<br>Radio Altimeter valid<br>AND<br>Radio Altimeter <500 feet | Left and Right Thrust Levers <26° TLA<br>OR<br>Flaps ≥27° |
| | Voice warning cannot be silenced when above conditions are met | |
| Mutable "GEAR" Voice Warning (Radio Altimeter Inoperative) | Any gear not down and locked<br>AND<br>Radio Altimeter invalid | Left and Right Thrust Levers <26° TLA<br>AND<br>Altitude <15,000 feet |
| | OR | |
| | Any gear not down and locked<br>AND<br>Radio Altimeter invalid | • Airspeed <170 KIAS AND Flaps <3°<br>• Airspeed <160 KIAS with Flaps <13°<br>• Airspeed <155 KIAS with Flaps >13° |
| | Voice warning can be muted when radio altimeter is inoperative | |
| Visual Warning | GEAR (W) message and red gear handle light/icons | |
| Warning Suppression | Mutable warnings can be silenced; visual indications and non-mutable warnings cannot | |

# VI. BRAKE SYSTEM

## A. SYSTEM ARCHITECTURE

**Dual Channel Design:**

- Inboard brakes - Left hydraulic system
- Outboard brakes - Right hydraulic system
- Independent electrical power sources
- Brake Control Unit (BCU) manages both channels
- Greater of pilot/copilot input used

**Brake Components:**

- Self-adjusting multi-disc carbon brakes with wear indicators
- Wheel speed transducers (all main wheels)
- Brake control valves (inboard/outboard)
- Shutoff valves for system isolation
- Brake accumulator (1,500+ psi nominal)

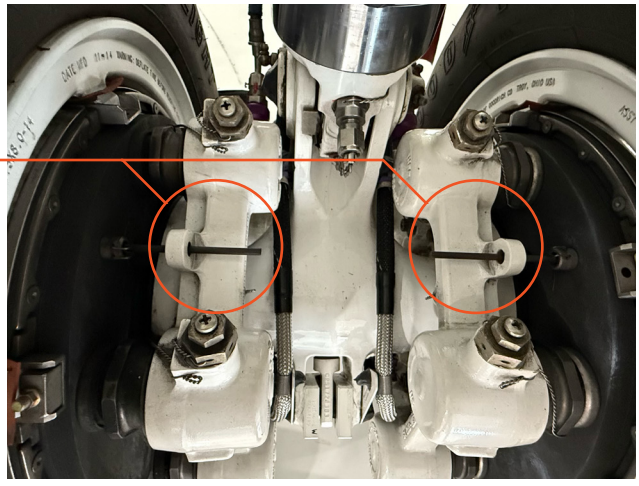
## B. ANTI-SKID SYSTEM

**System Operation:**

- Active from touchdown to 10 kt
- Independent protection for each wheel
- Wheel speed comparison logic
- Locked wheel crossover protection
- Touchdown protection (spin-up override)

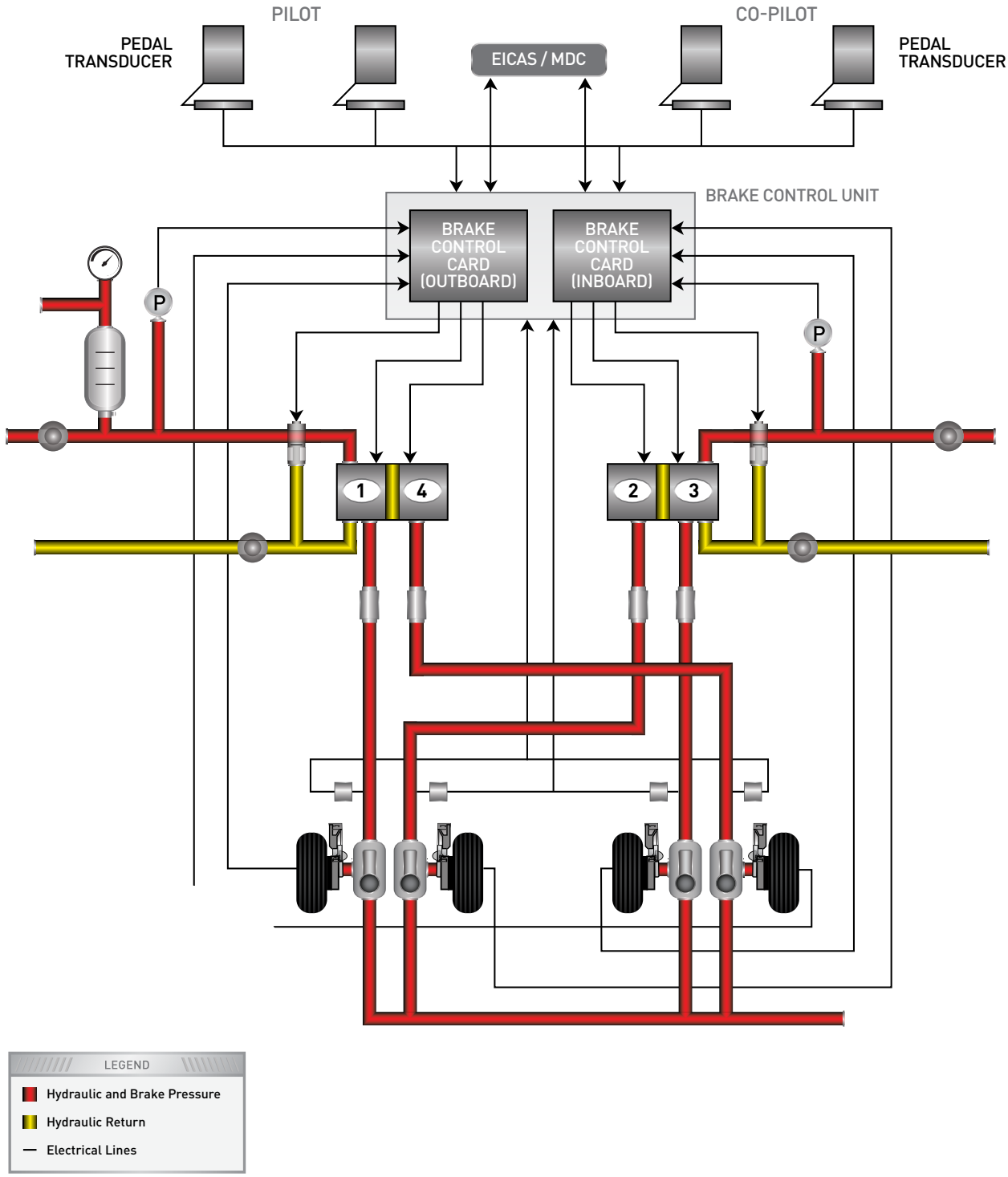
**Anti-Skid Logic:**

- Compares speeds within landing gear assembly
- Compares speeds between brake systems
- Releases brake on slower wheel
- Reapplies when speeds equalize
- Not available with PARK/EMER BRAKE

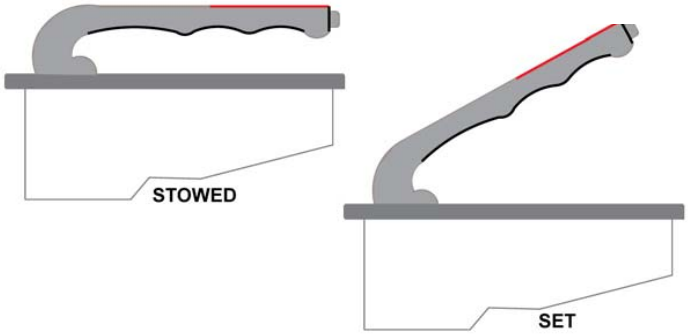



NOTE: The brake wear pins must be checked with the brakes applied and the left and right hydraulic

## BRAKE CONTROL SYSTEM



## C. PARK/EMER BRAKE

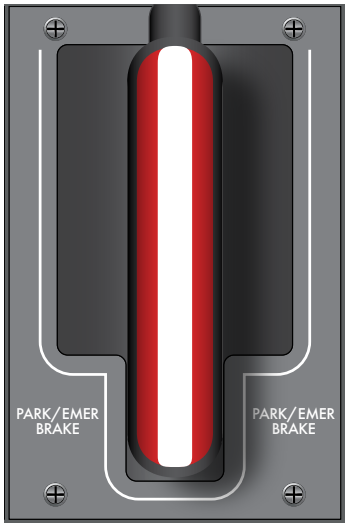



**System Description:**

- Hydro-mechanical backup system
- Handle on center pedestal
- Meters pressure to all four brakes
- Uses inboard brake accumulator
- No anti-skid protection available
- Differential braking not possible

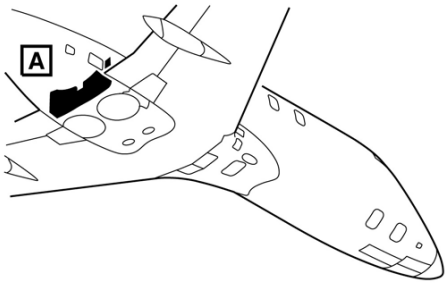
**Operation Sequence:**

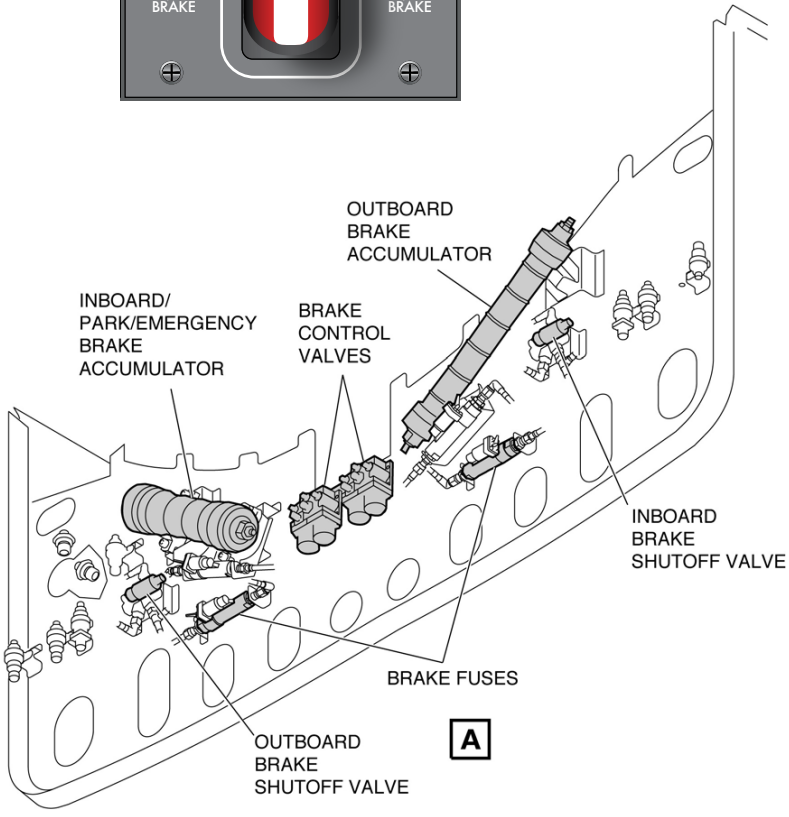
- Pull handle up to increase pressure
- Handle latches in park position
- Press button and push down to release
- Proper sequence prevents fluid migration
- Six emergency applications minimum




**Accumulator System:**

- Located in left hydraulic system
- 1,500+ psi nominal pressure
- Pressure transducer monitoring
- **PK/EMER BRK PRESS LO** (C) below 1,200 psi
- Extended parking capability



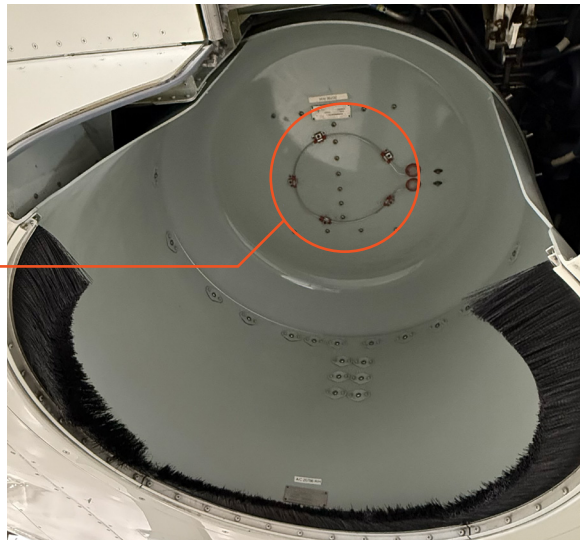
The specific sequence for setting and releasing the parking brake (PARK/EMER BRAKE) is critical to prevent the undesirable migration of hydraulic fluid between the aircraft's left and right hydraulic systems. This requirement is based on a conditional scenario: IF the parking brake was initially set while the pilot or copilot manually depressed the toe brake pedals (a common procedure when stopping after taxiing), then it must be released in the same manner.

When the toe brakes are depressed and the PARK/EMER BRAKE is subsequently set, hydraulic pressure from the right hydraulic system is utilized to engage the outboard brakes. If the pilot then releases the parking brake later without depressing the toe brake pedals beforehand, the trapped hydraulic fluid originating from the right system is incorrectly routed back into the left hydraulic system. This transfer of fluid can eventually lead to a hydraulic quantity imbalance: the left hydraulic system eventually becomes over-full, and conversely, the right hydraulic system registers a low quantity.

### D. BRAKE TEMPERATURE MONITORING

**Heat Protection:**

- Four fusible plugs per main wheel
- Melts at preset temperature
- Allows safe tire deflation
- MLG bay overheat detection loops
- GEAR BAY OVHT (W)




**Brake Wear Indicators:**

- Two pins per brake assembly
- Visual indication of wear status
- Must check with brakes applied
- Hydraulic systems pressurized
- Service when pin flush with housing

## VII. SYSTEM CONTROLS AND INDICATIONS

### A. COCKPIT CONTROLS

**Landing Gear Panel:**

- Landing gear control handle (UP/DN)
- NWS ON/OFF switch
- Position indicators (EICAS)
- Red indicates gear warning
- Manual release handle (center pedestal)

**PARK/EMER BRAKE:**

- Handle on center pedestal
- Pull up to apply
- Button release mechanism
- Visual position indication
- No cockpit pressure gauge

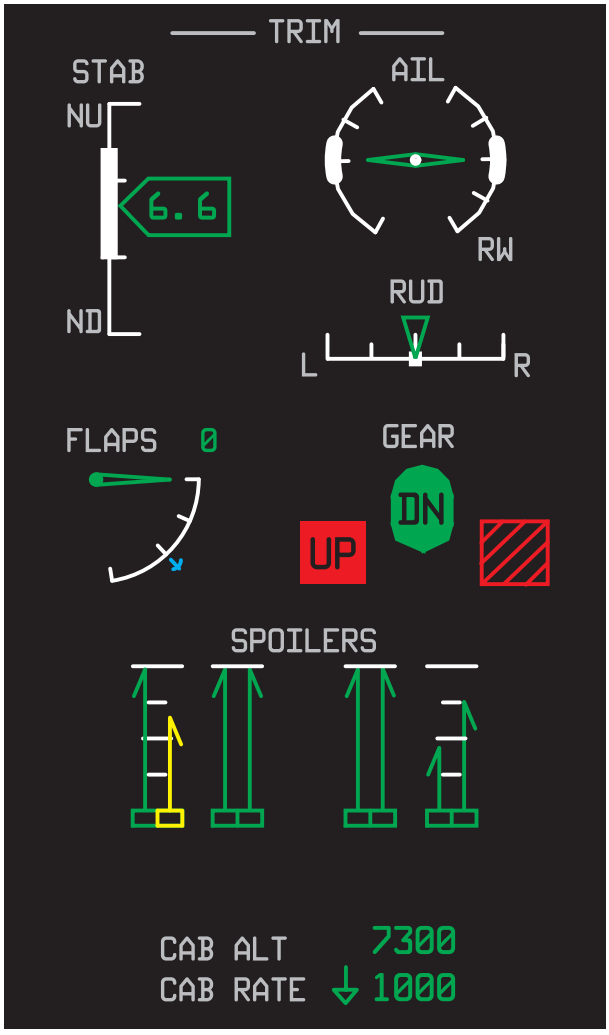
## B. EICAS DISPLAYS

**Primary Page:**

- Gear position symbols
- Transit indications
- Disagree warnings
- Gear doors status
- Displayed with flaps or gear extended

**Messages:**

- **GEAR** (W) - Warning with aural
- **GEAR DISAGREE** (C) - Position mismatch
- **PARK/EMER BRAKE ON** (S)
- Various system fault messages



# VIII. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| **PARK/EMER BRAKE ON** | Parking / Emergency brake is on during high thrust setting | — |
| **GEAR** | Landing gear is not down and locked when configuration requires it. The GEAR CAS will be accompanied by a gear icon on the MFD for each gear that is not down and locked | — |
| **GEAR BAY OVHT** | An overheat condition has been detected in the main landing gear bays | TO/LAND |
| **NORM BRAKES FAIL** | The NORM BRAKES FAIL CAS indicates that all normal brakes have failed | TO |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **CPLT BRAKE FAULT** | One or more of the copilot's brake pedal sensors (LVDTs) has failed | TO |
| **GEAR DISAGREE** | This indicates that the landing gear position and the LANDING GEAR switch position do not match after the 28 second delay | — |
| **GEAR SYS FAIL** | This indicates a complete failure of the gear control or the loss of the ARINC 429 signal from both channels. There is a potential for the loss of gear, door and/or spoiler indications | TO |
| **L (R) INBD BRAKE FAIL** | The respective (left or right but not both) inboard normal system brake has failed | TO |
| **INBD BRAKE PRESS LO** | The INBD brake accumulator pressure is less than 1,400 psi | TO |
| **INBD BRAKES FAIL** | Both inboard normal system brakes failed | TO |
| **NOSE GEAR DOOR** | The nose gear doors are not closed and the nose gear is up | TO/LAND |
| **NWS FAIL** | The nose wheel steering system has failed. In the event the nose wheel steering system malfunctions, internal monitors should disconnect the system allowing the nose wheels to castor | TO |
| **NWS LIMIT EXCEEDED** | The nose wheel steering turning limit has been exceeded. There may be damage to the NLG feedback link | TO/LAND |
| **L (R) OUTBD BRAKE FAIL** | The respective (left or right but not both) outboard normal system brake has failed | TO |
| **OUTBD BRAKE PRESS LO** | The OUTBD brake accumulator pressure is less than 1,400 psi | TO |

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **OUTBD BRAKES FAIL** | Left and right outboard normal system brakes have failed | **TO** |
| **PARK/EMER BRAKE ON** | Park brake pressure is sensed with weight-off-wheels. Do not cycle handle more than one time | **TO** |
| **PK/EMER BRK PRESS LO** | The INBD brake accumulator pressure is too low for full PARK/EMER brake performance (below 1,200 psi). Normal brakes should function properly | **TO** |
| **PLT BRAKE FAULT** | One or more of the pilot's brake pedal sensors (LVDTs) has failed | **TO** |
| **WOW FAIL** | One or more of the following conditions exist: Failures have been detected in two or more Weight On Wheels (WOW) sensors, or any disagreement or hardware failure of one or more WOW outputs associated with a critical function | **TO** |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| **BRAKE FAULT** | A minor brake system fault has occurred that does not affect brake performance. A subsequent brake failure could cause uncommanded braking | **TO/LAND** |
| **NWS FAULT** | The nose wheel steering selector valve is open. The system will operate normally | **TO/LAND** |
| **PROX SYS FAULT** | This indicates a failure in the proximity sensor channel or the loss of the signal from one of the channels | **TO/LAND** |

## D. STATUS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning |
|---|---|
| **NWS OFF** | The nose wheel steering has been selected OFF |
| **PARK/EMER BRAKE ON** | Park brake pressure is sensed while on the ground |

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- GEAR warning is accompanied by continuous warning horn and "Gear" aural
- NORM BRAKES FAIL warning is accompanied by "Normal Brakes Fail" aural
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right system
- Landing distance factors: See QRH for specific multiplication factors
- PARK/EMER BRAKE ON appears as Caution (TO inhibit) when airborne, Status when on ground

# IX. LIMITATIONS

## A. SPEED LIMITATIONS

Landing Gear Speed Limitations

| Parameter | Speed |
|---|---|
| VLO RET (Max Retraction Speed) | 200 KIAS |
| VLO (Operating Speed) | 250 KIAS |
| VLE (Extended Speed) | 250 KIAS |
| Maximum Tire Speed (Ground) | 182 knots |

## B. OPERATIONAL LIMITATIONS

Landing Gear Operational Limitations

| Parameter | Limit/Requirement |
|---|---|
| Gear Retraction Requirement | No Weight-On-Wheels signal |
| Manual Release Handle | Do not stow until gear pins installed |
| Maximum Extension Altitude | 18,000 feet |
| Brake Cooling Time (Malfunction) | 45 minutes minimum |
| In-flight Cooling (Training w/multiple landings) | 10 minutes gear extended |
| Brake Energy Limit | Per AFM charts |
| Landing Distance Multipliers | Per QRH procedures |
| Maximum Crosswind - Takeoff | 28 knots demonstrated |
| Maximum Crosswind - Landing | 24 knots demonstrated |
| Maximum Crosswind - Landing NWS In-Op | 15 knots demonstrated |

## X. LANDING GEAR CIRCUIT BREAKERS

Landing Gear System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| INBD BRAKES | LEFT ESS | CB1-C15 |
| INBD WHL SPD TRANSD | LEFT ESS | CB3-A4 |
| NWS PWR 1 | LEFT MAIN | CB1-C12 |
| NWS PWR 2 | RIGHT MAIN | CB2-C12 |
| OUTBD BRAKES | RIGHT ESS | CB2-C15 |
| OUTBD WHL SPD TRANSD | RIGHT ESS | CB4-A4 |
| WOW A/RET/EXT | LEFT ESS | CB1-C13 |
| WOW B | LEFT MAIN | CB1-C14 |
| WOW A/RET | RIGHT MAIN | CB2-C14 |
| WOW B/EXT | RIGHT ESS | CB2-C13 |

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## XI. QUIZ

1. What hydraulic system powers normal landing gear extension and retraction?

    A) Right hydraulic system
    B) Left hydraulic system
    C) Auxiliary hydraulic system
    D) Both left and right systems

2. What is the maximum landing gear operating speed (VLO)?

    A) 182 KIAS
    B) 200 KIAS
    C) 250 KIAS
    D) 275 KIAS

3. How many fusible plugs are installed in each main wheel?

    A) Two
    B) Three
    C) Four
    D) Six

4. What is the nose wheel steering authority using the handwheel?

    A) ±7 degrees
    B) ±45 degrees
    C) ±65 degrees
    D) ±90 degrees

5. Which system assists main landing gear extension during manual release?

    A) Left hydraulic system
    B) Right hydraulic system
    C) Electric motors
    D) Pneumatic pressure

6. At what wheel speed does anti-skid protection become inactive?

    A) 5 kt
    B) 10 kt
    C) 20 kt
    D) 30 kt

7. What type of tires are installed on the nose landing gear?

    A) Standard tires
    B) Chine tires
    C) Radial tires
    D) Bias-ply tires

8. How long does the BCU command brake pressure during gear retraction?

A) 2 seconds
B) 4 seconds
C) 6 seconds
D) 10 seconds

9. What is the gear transit timeout period monitored by the PSEU?

A) 15 seconds
B) 20 seconds
C) 28 seconds
D) 30 seconds

10. Which hydraulic system powers the inboard wheel brakes?

A) Right hydraulic system
B) Left hydraulic system
C) Auxiliary hydraulic system
D) Emergency hydraulic system

11. What is the minimum accumulator pressure for adequate PARK/EMER brake performance?

A) 1,000 psi
B) 1,200 psi
C) 1,500 psi
D) 1,800 psi

12. In which direction does the nose landing gear retract?

A) Forward
B) Rearward
C) Sideward
D) Upward

13. What component monitors and sequences landing gear operation?

A) BCU
B) SCU
C) PSEU
D) DCU

14. How many wheels are on each main landing gear assembly?

A) One
B) Two
C) Three
D) Four

15. What provides the force to extend the nose gear during manual release?

A) Right hydraulic pressure
B) Left hydraulic pressure
C) Gravity and spring forces
D) Electric actuator

16. What is the maximum nose wheel steering authority using rudder pedals?

A) ±5 degrees
B) ±7 degrees
C) ±10 degrees
D) ±15 degrees

17. Which system is NOT available when using PARK/EMER BRAKE?

A) Wheel brakes
B) Anti-skid
C) Brake pressure
D) Accumulator pressure

18. What happens to the landing gear doors during normal extension?

A) Remain closed
B) Open then close
C) Move with the gear
D) Open after gear locks

19. How many brake wear indicator pins are installed on each brake assembly?

A) One
B) Two
C) Three
D) Four

20. At what radio altitude does the non-mutable gear warning activate (with gear not down and locked)?

A) Below 300 feet
B) Below 500 feet
C) Below 750 feet
D) Below 1,000 feet

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CL-350



CL-350 TRAINING MANUAL

# ELECTRICAL 07

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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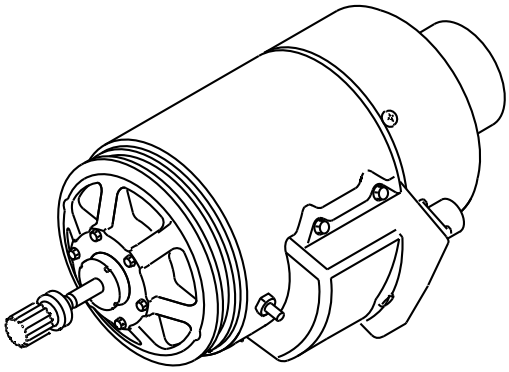
# ELECTRICAL

## I. INTRODUCTION

The Challenger 350 electrical system provides reliable 28VDC power through dual independent generator sources with comprehensive backup capabilities.

The system architecture features left and right DC power centers with integrated secondary power centers, dual nickel-cadmium batteries, and an APU generator for ground operations and emergency backup.

This redundant design ensures continuous electrical power availability during normal operations, single-point failures, and emergency conditions through automatic load shedding and isolation capabilities. 115V AC power is provided to the cabin by a separate cabin inverter.



**ENGINE GENERATORS (LH) G1, (RH) G2**

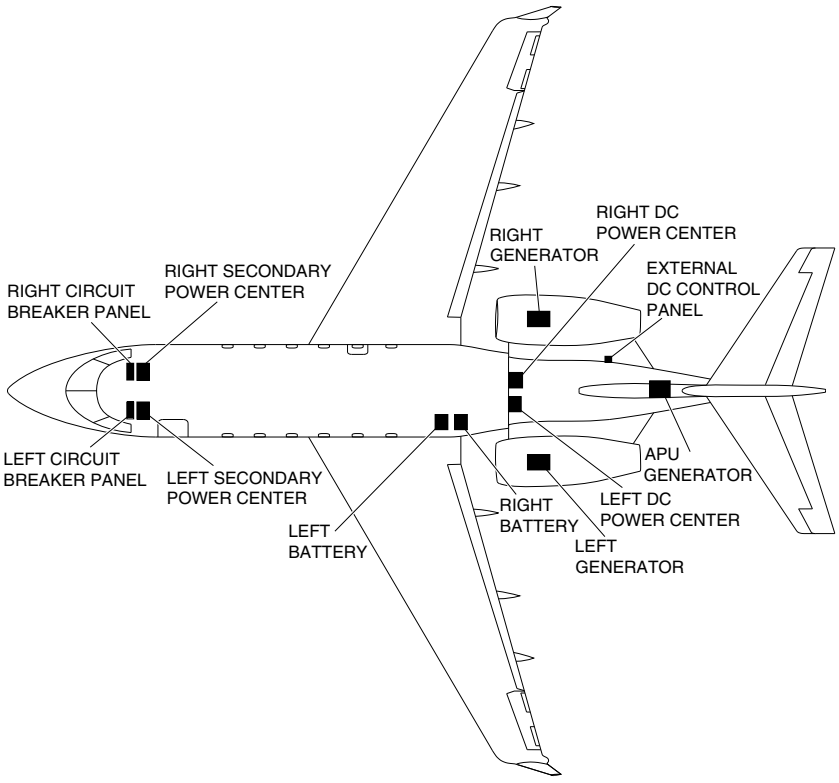


### A. ELECTRICAL SYSTEM SPECIFICATIONS

| Parameter | Value |
|---|---|
| System Voltage | 28 VDC |
| Main Generators | Two engine-driven, 12 kVA (400 amp) each |
| APU Generator | One, 12 kVA (400 amp) |
| Generator Output Voltage | 29.5 volts nominal |
| Main Batteries | Two 24V NICAD, 44 amp-hour |
| Standby Instrument Battery | One 24 VDC, 3.5-hour duration (after total loss of generated power) |
| External Power Voltage Range | 24 to 32 VDC |
| External Power Current Limit | 1,500 amps |
| Distribution Centers | Five (two DCPC, two SPC & Auxiliary DCPC for APU) |
| Circuit Breaker Panels | Four (two cockpit, two equipment rack) |
| Optional HMDG | Hydraulic Motor Driven Generator |

### B. SYSTEM ARCHITECTURE

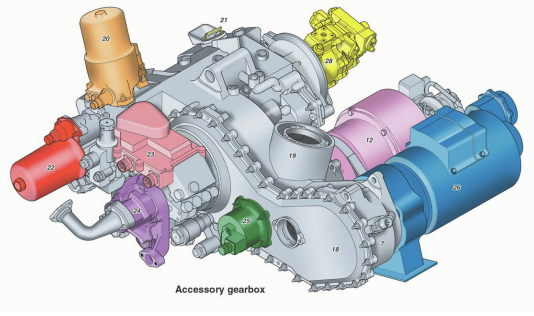
- Dual-channel design with electrical and physical segregation
- Power generation system with multiple redundant sources
- Power distribution system with four distribution centers
- Battery backup system for essential loads during emergencies
- External power capability for ground operations




# II. POWER GENERATION SYSTEM

## A. ENGINE-DRIVEN GENERATORS

- Two generators mounted on engine accessory sections
- 12 kVA (400 amp) capacity each
- Air-cooled design with integrated fan
- Automatic operation after engine start
- 29.5 volts nominal output voltage
- Either generator sufficient for normal operations
- Automatic bus tie closure with single generator operation
- Battery charging capability when online




## B. APU GENERATOR

- Identical to engine generators (12 kVA, 400 amp)
- Medium and low altitude capability for load sharing
- Emergency replacement for failed engine generators
- Automatic load distribution with engine generators
- Ground operation capability for all aircraft systems
- 30,000 ft max altitude for use as a backup generator
- Starts off the right battery which is isolated during start

### C. EXTERNAL POWER




**Ground Power Connection:**

- Lower right fuselage location below engine pylon
- Anti-flash contactor protection for voltage/polarity
- 24-to-32-volt acceptance range for GPU compatibility
- 1,500-amp current limitation for ground operations
- EXT PWR switch control on electrical control panel
- Green AVAIL indication when parameters acceptable
- Automatic bus tie operation when connected and selected
- Generators will not come online with external power in use

**External Power Indications:**

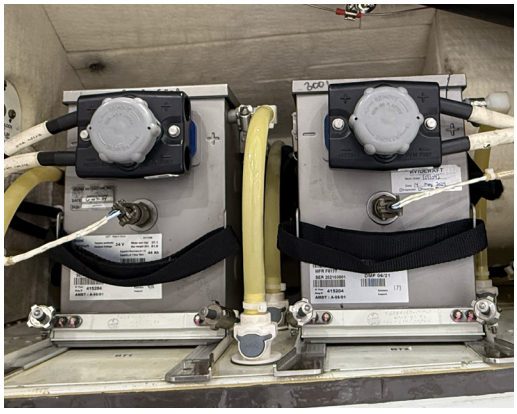
- White EXT PWR symbol when available
- Green EXT PWR symbol when selected ON
- Removed indication when disconnected
- ELECTRICAL synoptic display of power source status

### D. OPTIONAL HYDRAULIC MOTOR DRIVEN GENERATOR (HMDG)

- Non-time limited power source for total generator failure
- Hydraulically driven by main hydraulic system
- Emergency electrical power backup capability
- **ELEC HYD GEN ON** message when activated

## III. BATTERY SYSTEM

### A. MAIN BATTERIES



**Battery Specifications:**

- Two 24-volt NICAD batteries rated at 44 amp-hour
- Fuselage fairing location aft of left wing
- Overboard venting system for gas discharge
- Individual voltage and temperature monitoring synoptically
- Connected to the Essential bus when contactors closed
- Charged by the generators when online

**Battery Operation:**

- APU start isolation of right battery during start sequence
- 60 minutes of battery power with loss of all generators
    - No more than 3 APU start attempts
    - L WSHLD / WINDOW switch on for no more than 15 minutes
- Automatic disconnect protection for overtemperature conditions
- Bus tie closure with left battery for aircraft power during APU start

**Battery Charging:**

- Parallel connection charging when generators online
- Large charging current capability after deep discharge
- APU GEN OVERLOAD or L (R) GEN OVERLOAD messages possible during recharge

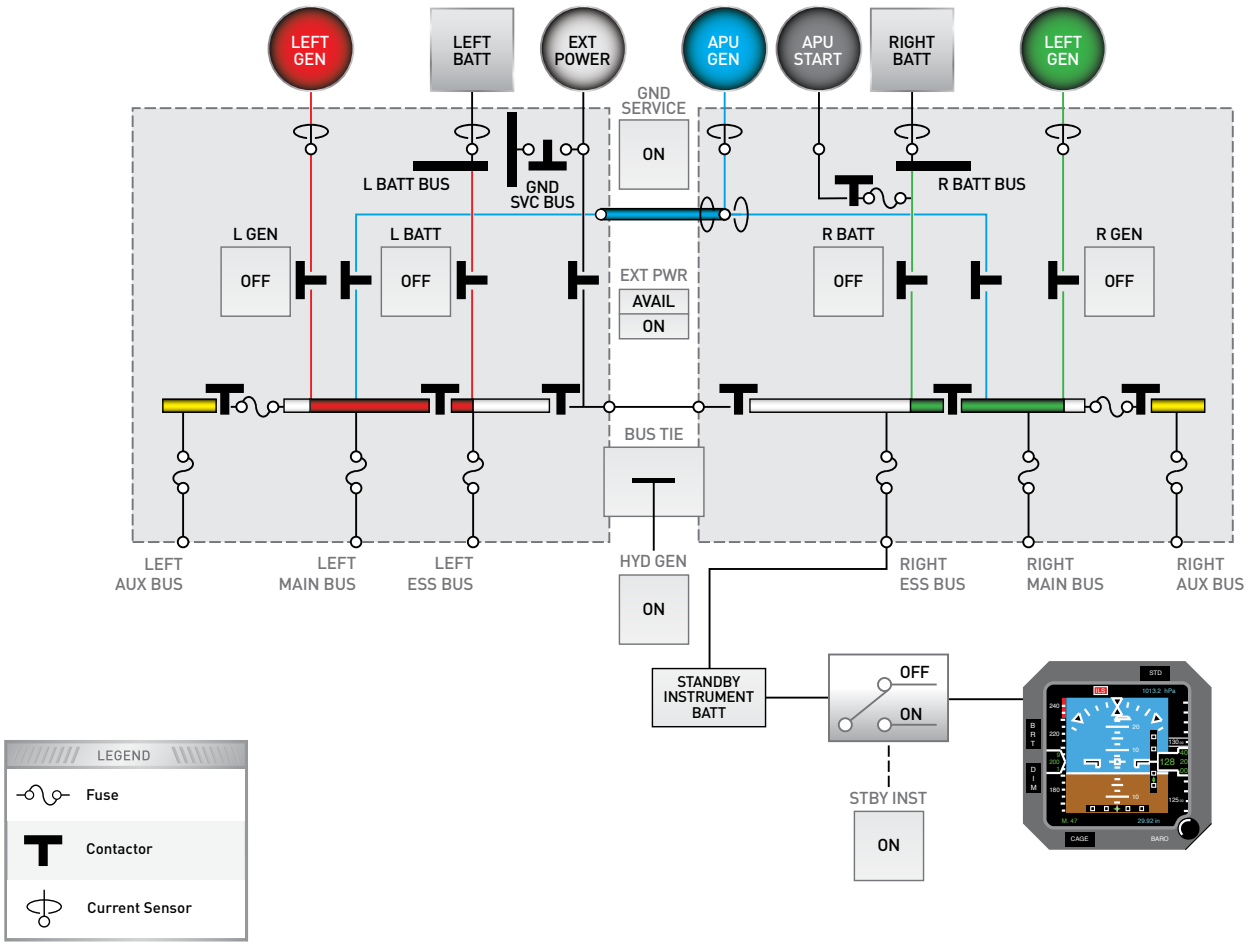


## B. STANDBY INSTRUMENT BATTERY

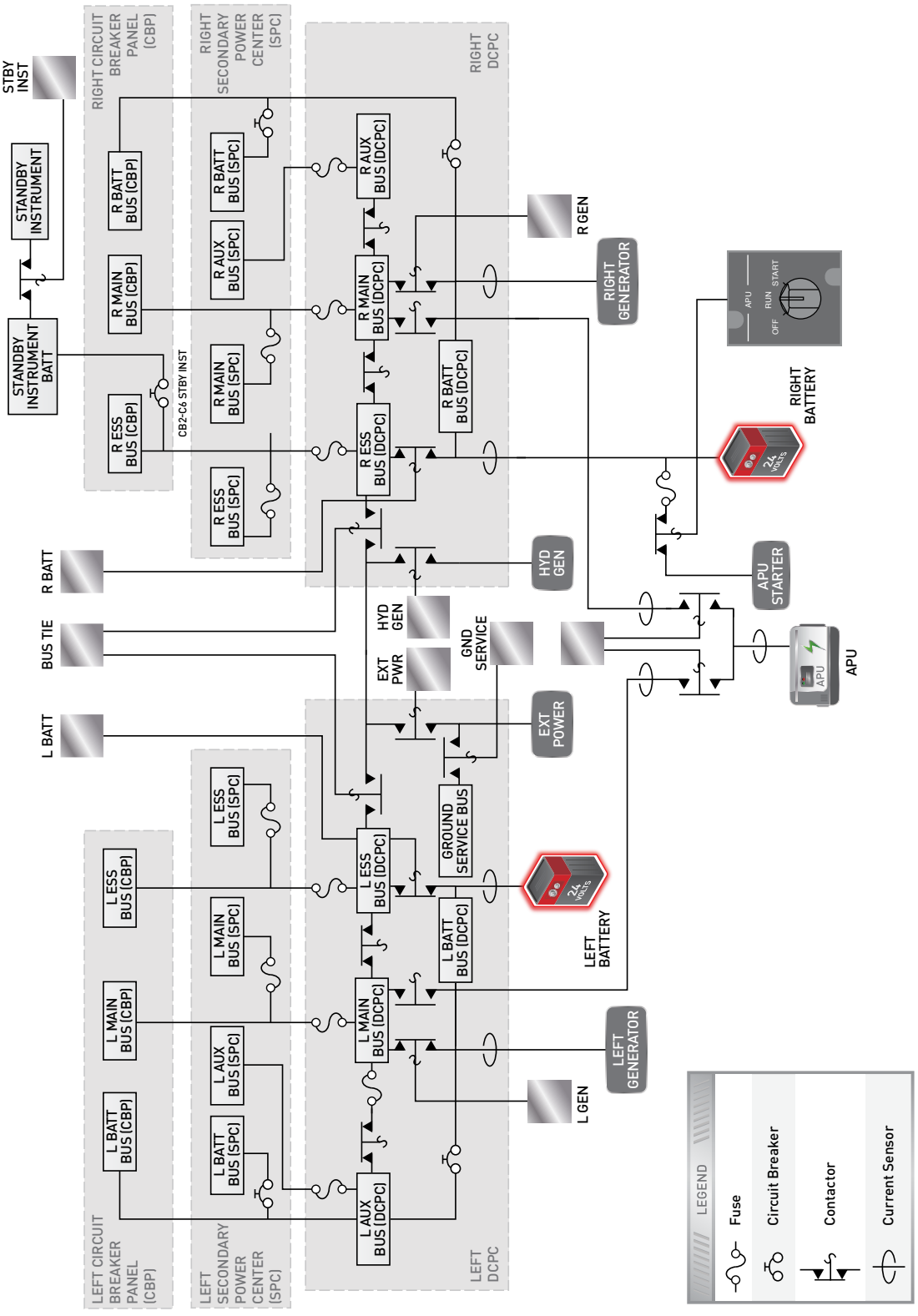
- Dedicated 24 VDC battery in nose landing gear bay
- 3.5 hour power duration when fully charged
- Separate STBY INST switch activation on electrical panel
- Independent power source for the Integrated Standby Instrument (ISI)
- No main system dependency for operation

# IV. POWER DISTRIBUTION SYSTEM

The Challenger 350 aircraft features a sophisticated and highly organized electrical power distribution



## DC ELECTRICAL SYSTEM



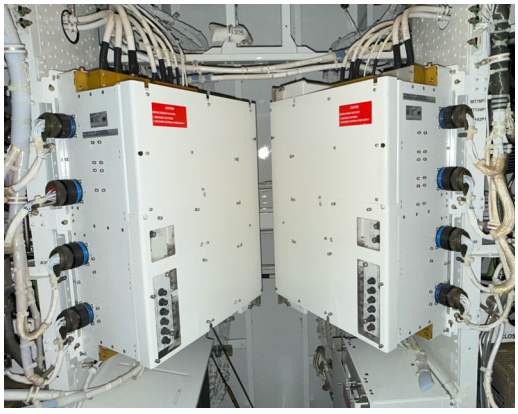
system, designed to efficiently manage and deliver 28 VDC power throughout the aircraft from various generation sources. This system is fundamentally structured around four primary electrical distribution boxes and associated circuit breaker panels, which ensure reliable power supply and protection against electrical anomalies.

The entire electrical system is electrically and physically segregated into two channels, with external DC power and the APU generator integrated to connect to these channels, ensuring redundancy and operational robustness. This comprehensive design allows for efficient power management, fault isolation, and continued operation even in various non-normal conditions.

## A. DISTRIBUTION CENTERS

**Direct Current Power Centers (DCPC):**

- Two DCPCs located in aft equipment bay
- Power source switching to distribution buses
- Aft fuselage load distribution capability
- Fed by generators, batteries, and external power



**Secondary Power Centers (SPC):**

- Two SPCs located in equipment rack, front fuselage
- Fed by DCPC distribution buses
- Front fuselage load distribution capability
- Circuit breaker panel power supply
- Auxiliary Power Center (AUX DCPC):
- Electrical distribution for APU power

## B. BUS STRUCTURE

**Bus Configuration:**

- Left and right main buses for primary power distribution
- Left and right essential buses for critical systems
- Left and right auxiliary buses for non-essential loads
- Left and right battery buses for battery-powered equipment
- Standby instrument bus for standby systems
- Ground service bus for ground operations



**Bus Tie Operation:**

- Automatic closure with single generator operation
- Manual control available via BUS TIE switch
- BUS TIE MAN OPEN message when manually opened
- Second switch press restores automatic operation

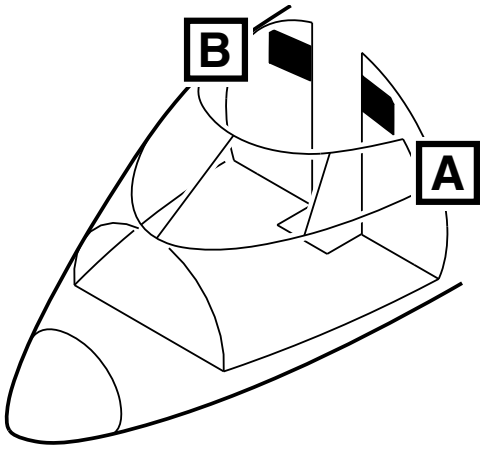
## C. CIRCUIT BREAKER PANELS

**Cockpit Panels:**

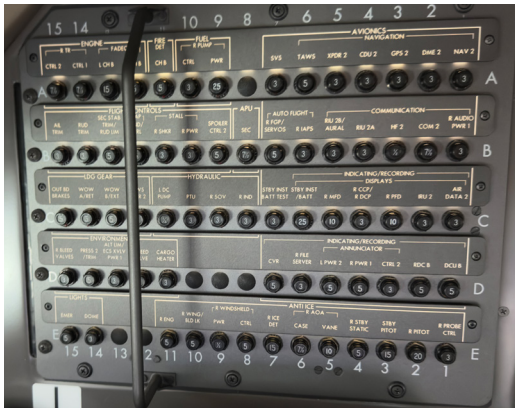
- CB1 Pilot circuit breaker panel - left side control
- CB2 Copilot circuit breaker panel - right side control
- Direct pilot access to circuit breakers
- Essential system protection and control

**Equipment Rack Panels:**

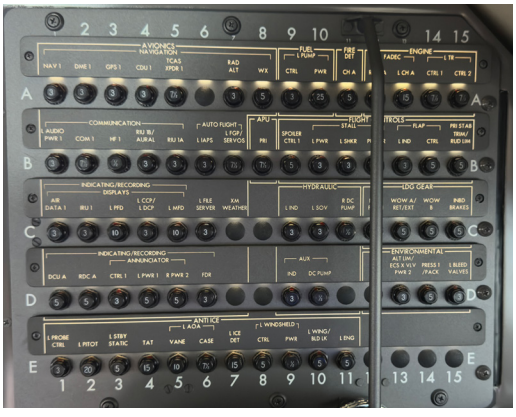
- CB3 Left equipment rack panel
- CB4 Right equipment rack panel
- Secondary power center feed
- System-specific circuit organization




## V. ELECTRICAL CONTROLS



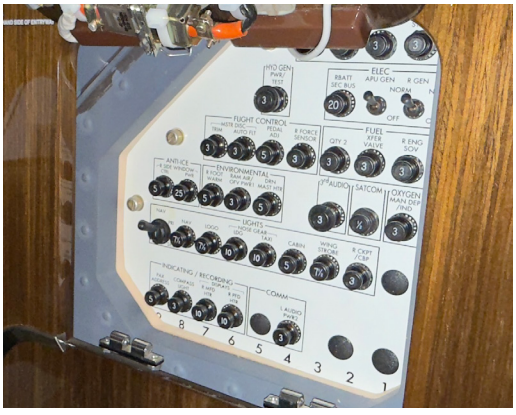
Co-Pilot Circuit Breaker Panel (CB2/RCBP)



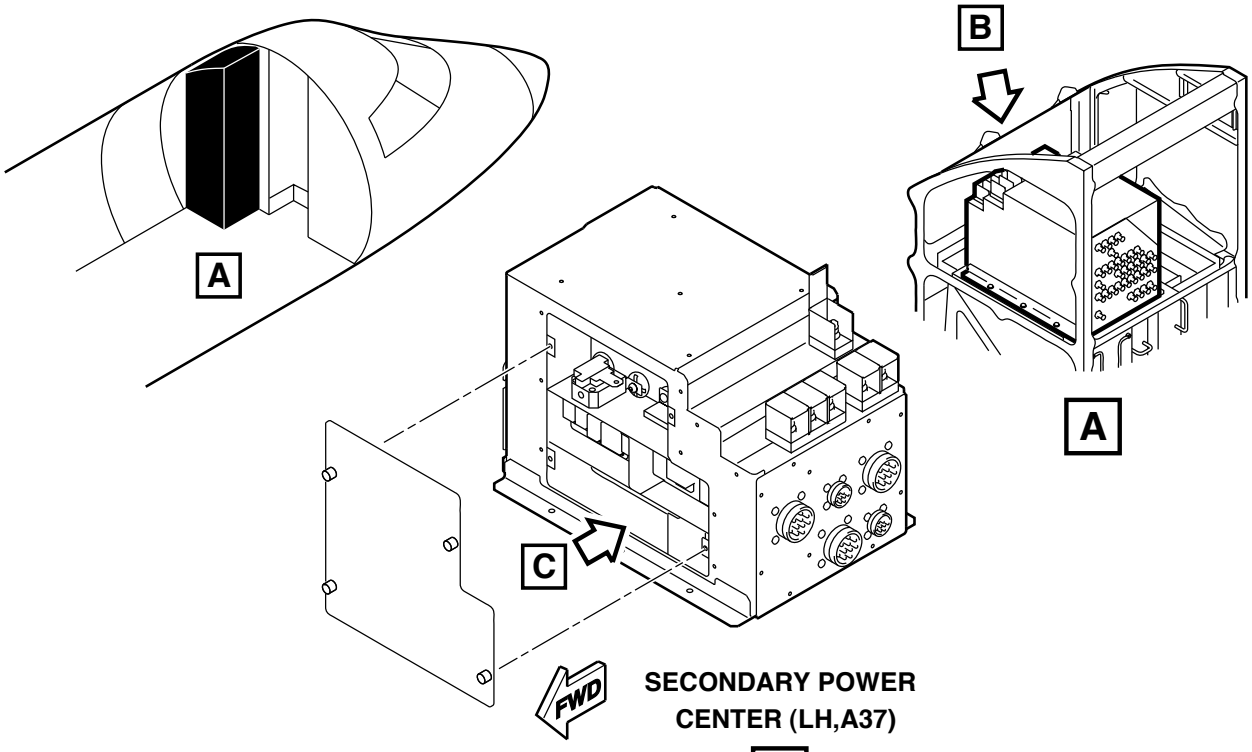
Pilot Circuit Breaker Panel (CB1/LCBP)



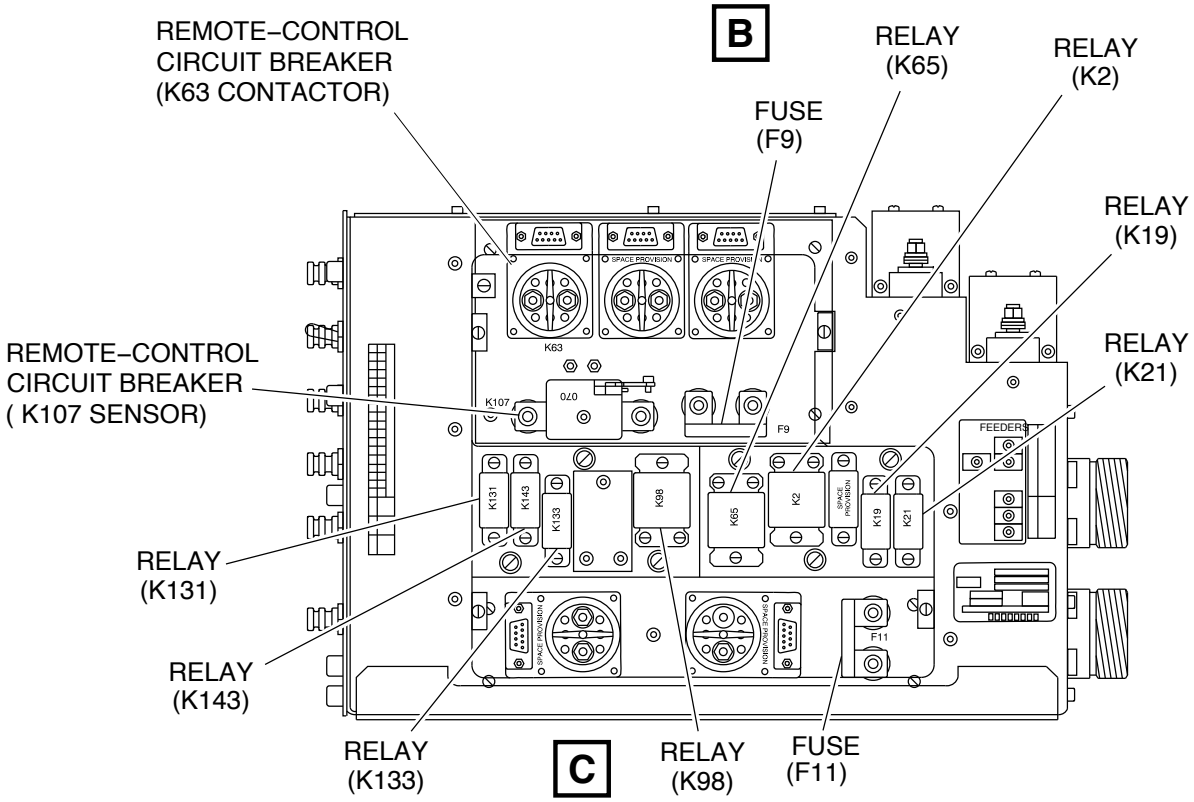
Left Secondary Power Center (CB3/LSPC)

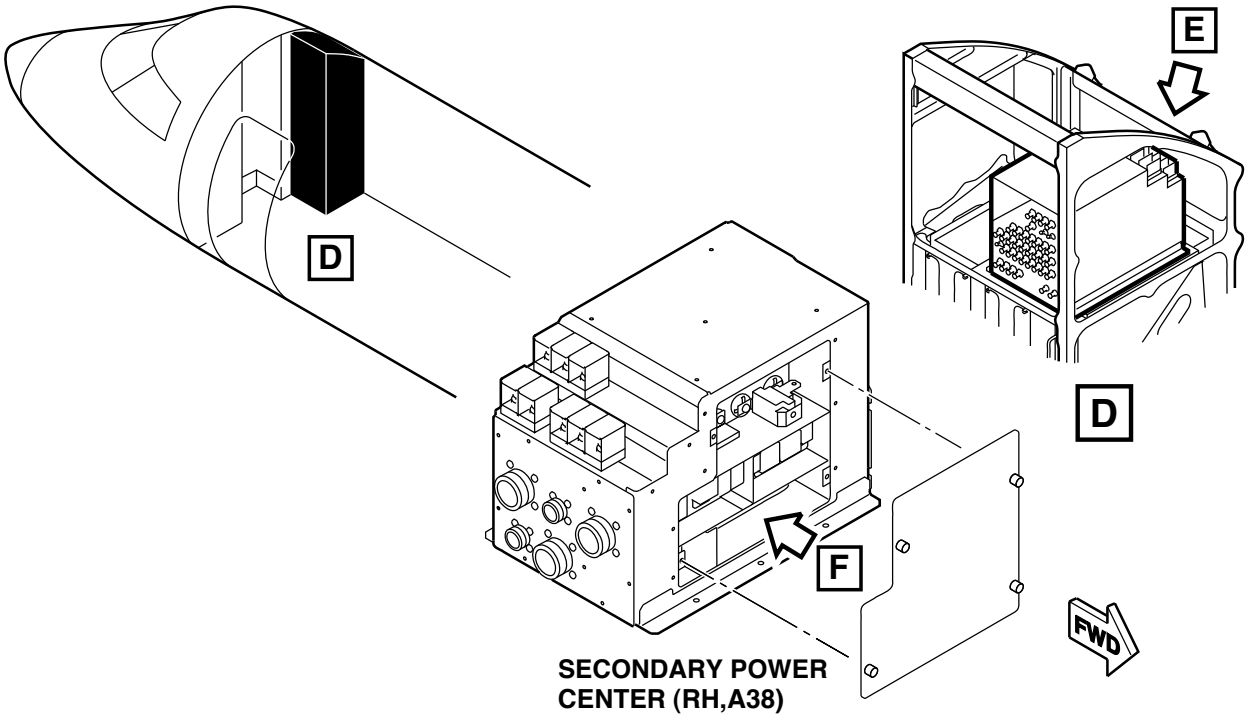


Right Secondary Power Center (CB4/RSPC)



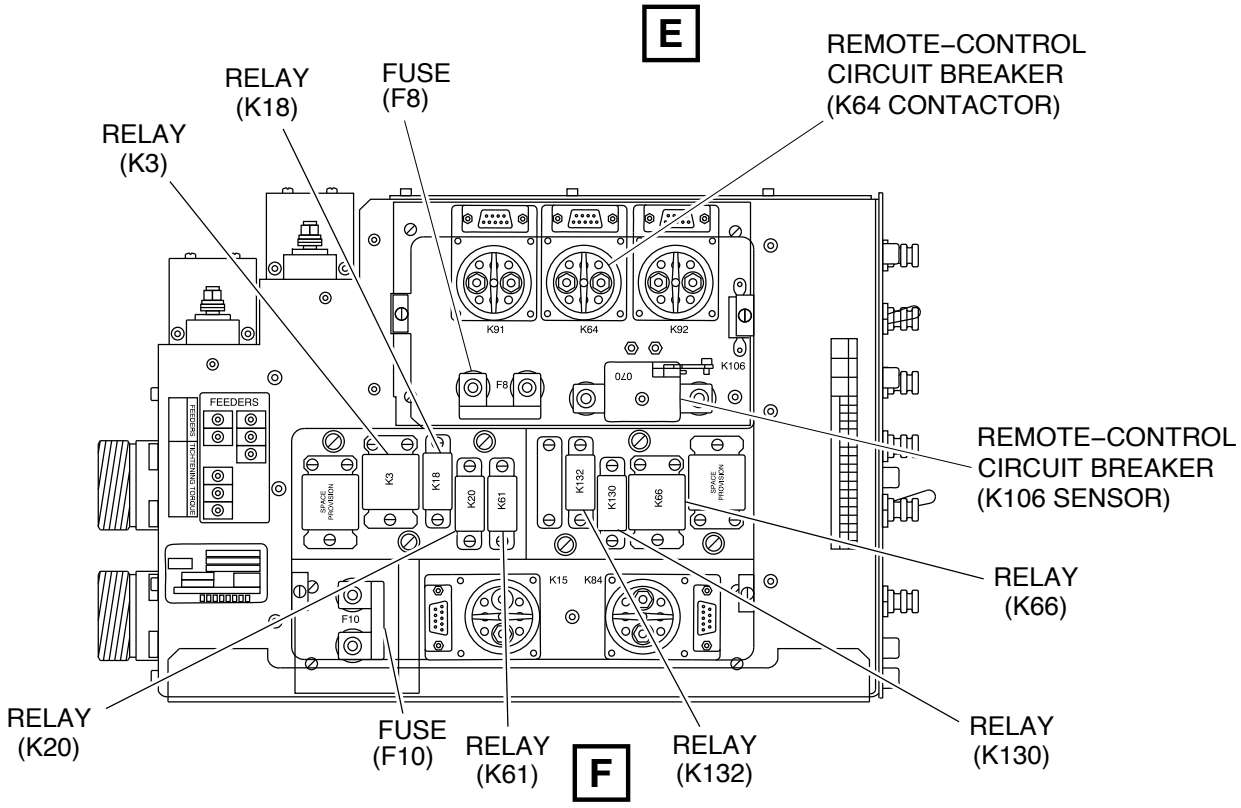

**SECONDARY POWER CENTER (LH,A37)**






**SECONDARY POWER CENTER (RH,A38)**

E



## A. ELECTRICAL CONTROL PANEL

**Generator Controls:**

- L GEN switch - left generator on/off control
- APU GEN switch - APU generator on/off control
- R GEN switch - right generator on/off control

**Battery Controls:**

- L BATT switch - left battery on/off control
- R BATT switch - right battery on/off control
- STBY INST switch - standby instrument battery control

**Bus Controls:**

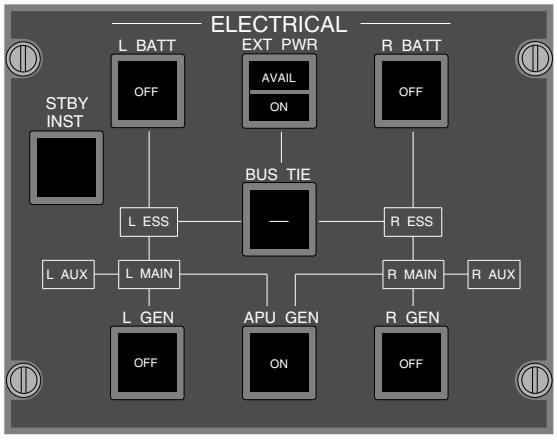
- BUS TIE switch - automatic/manual bus tie control
- EXT PWR switch - external power connection control
- AVAIL indication - external power availability
- HYD GEN switch - hydraulic generator control (if installed)

## B. ELECTRICAL SYNOPTIC PAGE

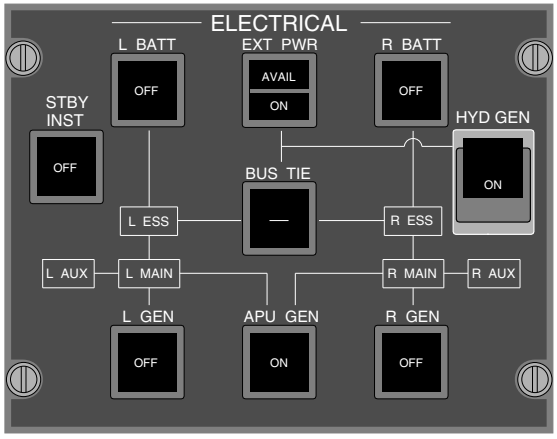
**Generator Indications:**

- Digital amperage displays for each generator
- Voltage indications for system monitoring
- Generator online status visual confirmation
- Bus tie status indication

**Battery Indications:**




Electrical Control Panel



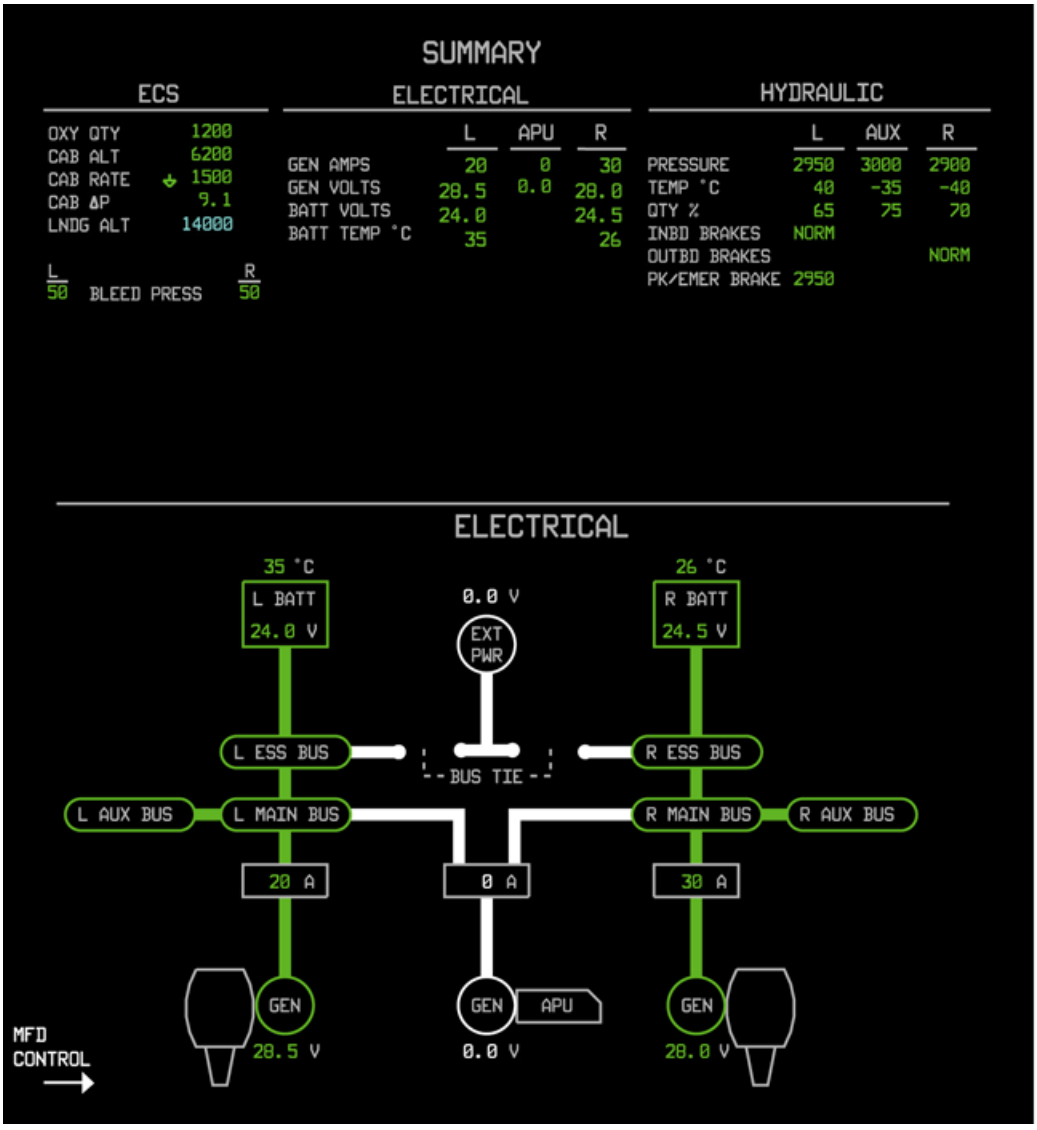

Electrical Control Panel with Optional Hydraulic Motor Generator System (HMDG) System

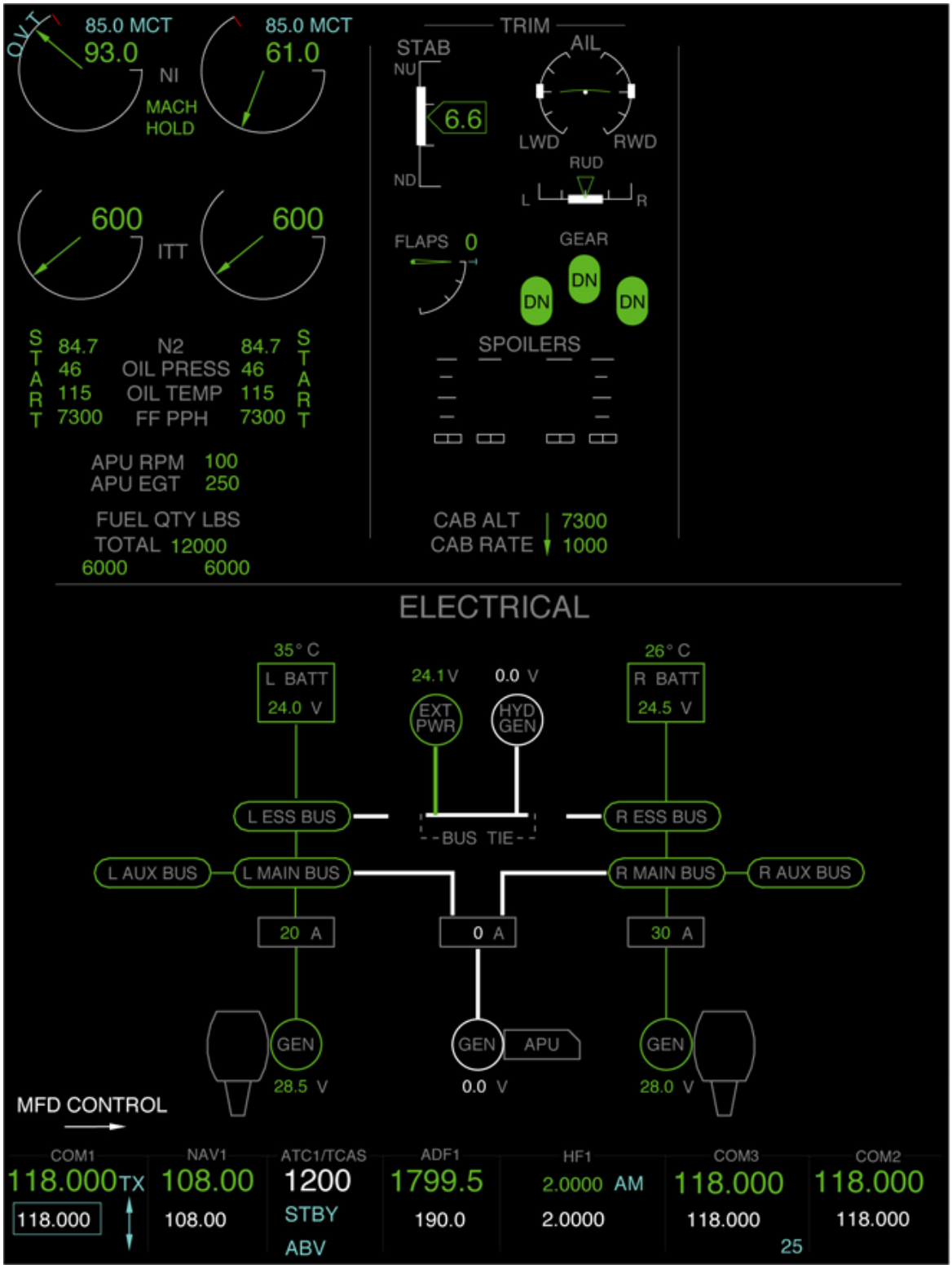
- Individual battery voltages displayed
- Battery temperatures monitoring capability
- Charging status indication when applicable

**Bus Status:**

- Bus power availability for each distribution bus
- Load distribution visual representation
- System interconnections shown graphically

## VI. COCKPIT FLOOR HEATING SYSTEM




OVT
85.0 MCT
93.0
NI
MACH
HOLD
85.0 MCT
61.0
600
ITT
600
START
84.7
46
115
7300
N2
OIL PRESS
OIL TEMP
FF PPH
84.7
46
115
7300
START
APU RPM 100
APU EGT 250
FUEL QTY LBS
TOTAL 12000
6000
6000
TRIM
STAB
NU
6.6
ND
AIL
LWD
RWD
RUD
L
R
FLAPS 0
GEAR
DN
DN
DN
SPOILERS
CAB ALT 7300
CAB RATE 1000
ELECTRICAL
35° C
L BATT
24.0 V
24.1 V
EXT PWR
0.0 V
HYD GEN
26° C
R BATT
24.5 V
L ESS BUS
BUS TIE
R ESS BUS
L AUX BUS
L MAIN BUS
R MAIN BUS
R AUX BUS
20 A
0 A
30 A
GEN
28.5 V
GEN
APU
0.0 V
GEN
28.0 V
MFD CONTROL
COM1
118.000TX
118.000
NAV1
108.00
108.00
ATC1/TCAS
1200
STBY
ABV
ADF1
1799.5
190.0
HF1
2.0000 AM
2.0000
COM3
118.000
118.000
25
COM2
118.000
118.000

The Challenger 350 aircraft is equipped with an automatic cockpit floor heating system, often referred to as cockpit foot warmers or heated mats, designed to enhance crew comfort during flight This system comprises four floor heaters, strategically located on each side of the two control columns in the flight.

These heaters operate without direct pilot controls, maintaining a regulated temperature range of 68°F (20°C) to 95°F (35°C) through a dedicated temperature-limiting circuit and internal thermal switches to prevent overheating. The pilot's floor heater receives electrical power from the Left Auxiliary Bus, while the copilot's is powered by the Right Auxiliary. Consequently, a loss of the respective auxiliary bus will render the associated foot warmers inoperative.



### A. FLOOR HEATER SYSTEM

- Four heaters installed on flight compartment floor
- One heater per control column side (pilot and copilot)
- Scuff plate protection covering heat strips
- Temperature limiting circuit maintains 68°F to 95°F (20°C to 35°C)
- Internal thermal switch prevents overheating
- No pilot controls required for operation

### B. POWER SUPPLY

- Pilot floor heaters connected to left equipment rack panel
- Copilot floor heaters connected to right equipment rack panel
- Individual circuit breaker protection for each heater
- Automatic temperature control system
- Automatically sheds with loss of an Engine Driven Generator

## VII. LOSS OF ELECTRICAL POWER

### A. SINGLE GENERATOR FAILURE

**NO APU**

- Bus Tie closes automatically
- Both L AUX and R AUX Busses auto shed (loss of foot warmers, cabin convenience power, co-pilot right window anti-ice)
- Remaining generator powers entire aircraft less aux busses
- **L(R) GEN FAIL** (C) CAS and L(R) **AUX BUS OFF** (A) CAS
- Maximum generator load 500 amps (600 amps for 5 minutes)

**WITH APU (Max Altitude 30,000')**

- All systems function normally including Aux busses

### B. DUAL GENERATOR FAILURE

**NO APU**

- **ESSENTIAL POWER ONLY** (W) CAS
- Only items on Essential Bus are powered by aircraft batteries (60 Minutes)
- Standby ISI powered by own source (3.5 Hours)

**WITH APU (Max Altitude 30,000')**

- Bus Tie closes automatically
- Both L AUX and R AUX Busses auto shed
- APU generator powers entire aircraft less aux busses
- **L(R) GEN FAIL** (C) CAS and L(R) **AUX BUS OFF** (A) CAS
- Maximum generator load 500 amps (600 amps for 5 minutes)

## VIII. ESSENTIAL BUS EQUIPMENT BY SYSTEM CATEGORY

### Essential Power Only Operation

**Condition:** Total loss of all generated power (both engine generators and APU generator offline) in flight

**Power Source:** Aircraft batteries only (two 44 amp-hour batteries)

**Duration:** Approximately 1 hour with generators off; Integrated Standby Instrument (ISI) powered for 3.5 hours

**Bus Status:** Auxiliary (AUX) and Main buses are automatically deactivated; only Essential buses remain powered

Essential Bus Equipment by System Category

| System Category | Left Essential Bus | Right Essential Bus |
|---|---|---|
| Air Conditioning & Pressurization | • Precooler crossover valve<br>• Emergency depressurization<br>• IASC 1 (Channel A)<br>• Ram air valve<br>• Pressurization outflow valve<br>• Left bleed valves | • Precooler crossover valve<br>• Emergency depressurization<br>• Oxygen deploy system<br>• Crossbleed (XBLEED) valve<br>• Right bleed valves |
| Autoflight | • Control wheel master disconnect switch (pilot) | • Control wheel master disconnect switch (copilot) |
| Avionics | • Left audio control panel<br>• COM 1<br>• Left MFD<br>• Data Concentrator Unit A<br>• CVR (A/C 20501-20739) / FDR (A/C 20740+)<br>• NAV 1<br>• CDU 1<br>• Transponder 1 / TCAS<br>• GPS 1<br>• Left Radio Interface Unit<br>• IRS 1<br>• File Server L<br>• EICAS RDC A | • Right Audio control panel<br>• Standby instrument<br>• FDR (A/C 20501-20739) / CVR (A/C 20740+) |
| Fire Protection | — | • Cargo smoke detector |

Essential Bus Equipment by System Category

| System Category | Left Essential Bus | Right Essential Bus |
|---|---|---|
| Flight Controls | • Left flap indicator<br>• Flap control unit<br>• Left stall shaker | • Right flap indicator<br>• Secondary stabilizer trim & rudder limiter<br>• Rudder trim<br>• Aileron trim |
| Fuel | • APU Shutoff Valve (SOV)<br>• Quantity (Channel A)<br>• Left pump<br>• Gravity crossflow valve | • Right pump |
| Ice & Rain Protection | • Left wing bleed leak detection<br>• Left standby static heat<br>• Left AOA vane heat<br>• Left window heat<br>• Left engine anti-ice valve<br>• Left engine T2 heater | • Right standby pitot heat<br>• Right standby static heat<br>• Right AOA vane heat<br>• Right engine anti-ice valve<br>• Right engine T2 heater |
| Hydraulics | • Auxiliary hydraulic pressure indication<br>• Auxiliary DC pump<br>• Right DC pump | • Right hydraulic pressure indication<br>• Power Transfer Unit (PTU) valve<br>• HYD GEN PWR/TEST (if installed) |
| Landing Gear, Wheel & Brakes | • PSEU (Channel A)<br>• Inboard brakes | • PSEU (Channel B)<br>• Outboard brakes |
| Miscellaneous Systems | • Left Bright/Dim lighting<br>• Lamp driver A | • Right Bright/Dim lighting<br>• Dome light<br>• Compass lighting |
| Powerplant | • Left FADEC (Channel A)<br>• Right FADEC (Channel A)<br>• Right ignition<br>• Left ignition<br>• Left thrust reverser<br>• Left starter<br>• Right starter | • Left FADEC (Channel B)<br>• Right FADEC (Channel B)<br>• Left ignition<br>• Right ignition<br>• Right thrust reverser<br>• Left starter<br>• Right starter |

Essential Power Only Inoperative Equipment

| System | Component |
|---|---|
| Auto Flight | Autopilot / Flight Director (except PIT & ROL will be available)<br>Flight Director 2<br>Yaw Damper |
| Flight Controls | PRI STAB TRIM<br>Spoilers<br>Stall pusher<br>Right stall shaker |
| Avionics | IRS 2<br>Left & right PFDs<br>Right MFD<br>FMS 2<br>GPS 2<br>NAV 2<br>COM 2<br>TAWS |
| Hydraulics | L DC PUMP |
| Ice Protection | Right side window anti-ice<br>Left and Right windshield anti-ice |
| Gear / Brakes | Nose wheel steering |
| Other Procedures | Cabin lights (other than dome)<br>External lights |

Left Essential Bus Equipment

| System Category | Equipment |
|---|---|
| Air Conditioning & Pressurization | • Precooler crossover valve<br>• Emergency depressurization<br>• Integrated Air System Controller 1 (IASC 1) (Channel A)<br>• Ram air valve<br>• Pressurization outflow valve<br>• Left bleed valves |
| Autoflight | • Control wheel master disconnect switch (pilot) |

Left Essential Bus Equipment

| System Category | Equipment |
|---|---|
| Avionics | • Left audio control panel<br>• Communication 1 (COM 1)<br>• Left Multi-Function Display (MFD)<br>• Data Concentrator Unit A<br>• Cockpit Voice Recorder (CVR) (A/C 20501-20739)<br>• Flight Data Recorder (FDR) (A/C 20740+)<br>• Navigation 1 (NAV 1)<br>• Control Display Unit 1 (CDU 1)<br>• Transponder 1 / TCAS (TSS)<br>• Global Positioning System 1 (GPS 1)<br>• Left Radio Interface Unit<br>• Inertial Reference System 1 (IRS 1)<br>• File Server L (per specifications)<br>• EICAS RDC A (per specifications) |
| Flight Controls | • Left flap indicator<br>• Flap control unit<br>• Left stall shaker |
| Fuel | • Auxiliary Power Unit (APU) Shutoff Valve (SOV)<br>• Quantity (Channel A)<br>• Left pump<br>• Gravity crossflow valve |
| Hydraulics | • Auxiliary hydraulic pressure indication<br>• Auxiliary DC pump<br>• Right DC pump |
| Ice & Rain Protection | • Left wing bleed leak detection<br>• Left standby static heat<br>• Left Angle of Attack (AOA) vane heat<br>• Left window heat<br>• Left engine anti-ice valve<br>• Left engine Total Temperature (T2) heater |
| Landing Gear, Wheel & Brakes | • Proximity Sensing Electronic Unit (PSEU) (Channel A)<br>• Inboard brakes |
| Miscellaneous Systems | • Left Bright/Dim lighting<br>• Lamp driver A |
| Powerplant | • Left Full Authority Digital Engine Control (FADEC) (Channel A)<br>• Right Full Authority Digital Engine Control (FADEC) (Channel A)<br>• Right ignition<br>• Left ignition<br>• Left thrust reverser<br>• Left starter<br>• Right starter |
| Power Distribution | • Left Battery (when connected) |

Right Essential Bus Equipment

| System Category | Equipment |
|---|---|
| Air Conditioning & Pressurization | • Precooler crossover valve<br>• Emergency depressurization<br>• Oxygen deploy system<br>• Crossbleed (XBLEED) valve<br>• Right bleed valves |
| Autoflight | • Control wheel master disconnect switch (copilot) |
| Avionics | • Right Audio control panel<br>• Standby instrument<br>• Flight Data Recorder (FDR) (A/C 20501-20739)<br>• Cockpit Voice Recorder (CVR) (A/C 20740+) |
| Fire Protection | • Cargo smoke detector |
| Flight Controls | • Right flap indicator<br>• Secondary stabilizer trim & rudder limiter<br>• Rudder trim<br>• Aileron trim |
| Fuel | • Right pump |
| Hydraulics | • Right hydraulic pressure indication<br>• Power Transfer Unit (PTU) valve<br>• HYD GEN PWR/TEST (if installed) |
| Ice & Rain Protection | • Right standby pitot heat<br>• Right standby static heat<br>• Right Angle of Attack (AOA) vane heat<br>• Right engine anti-ice valve<br>• Right engine Total Temperature (T2) heater |
| Landing Gear, Wheel & Brakes | • Proximity Sensing Electronic Unit (PSEU) (Channel B)<br>• Outboard brakes |
| Miscellaneous Systems | • Right Bright/Dim lighting<br>• Compass lighting<br>• Dome light |
| Powerplant | • Left Full Authority Digital Engine Control (FADEC) (Channel B)<br>• Right Full Authority Digital Engine Control (FADEC) (Channel B)<br>• Left ignition<br>• Right ignition<br>• Right thrust reverser<br>• Left starter<br>• Right starter |
| Power Distribution | • Right Battery (when connected) |

# IX. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| **L (R) BATT OVERHEAT** | Respective battery internal temperature exceeded 70°C | TO/LAND |
| **ESSENTIAL POWER ONLY** | The essential buses are powered by the batteries only. AUX and MAIN buses are automatically deactivated in flight | — |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **APU GEN FAIL** | The APU generator failed | TO/LAND |
| **APU GEN OVERLOAD** | The APU generator has exceeded 500 amp | TO/LAND |
| **L (R) BATT FAIL** | Either the respective battery contactor failed, or the battery has been automatically disconnected for overheat protection | TO/LAND |
| **ELEC HYD GEN FAIL** | The optional hydraulic generator has failed to come on-line | TO/LAND |
| **L (R) GEN FAIL** | The affected generator has failed. If the APU generator is not on line, the BUS-TIE will automatically close and, in-flight, the auxiliary buses will not be powered | TO/LAND |
| **L (R) ESS BUS FAIL** | Affected bus is not powered | TO/LAND |
| **L (R) GEN OVERLOAD** | Respective generator load exceeded 500 amp | TO/LAND |
| **L (R) MAIN BUS FAIL** | The affected MAIN bus is not powered | TO/LAND |
| **ELECTRICAL FAULT** | An electrical system failure has occurred that prevents display of electrical indications | TO/LAND |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| **L (R) AUX BUS FAIL** | The affected auxiliary BUS is not powered with a power source available | **TO/LAND** |
| **L (R) AUX BUS OFF** | Respective AUX BUS is selected off | **TO/LAND** |
| **L (R) ESS BUS OFF** | Respective ESS BUS is not powered and is not failed | **TO/LAND** |
| **L (R) MAIN BUS OFF** | Respective MAIN BUS is not powered and is not failed | **TO/LAND** |
| **ELECTRICAL FAULT** | An electrical system fault occurred, resulting in loss of redundancy in the display of electrical indications | **TO/LAND** |
| **STBY INST BATT FAULT** | At least one of the following has occurred: Standby instrument heater is inoperative; Standby instrument battery charger is inoperative; Standby instrument battery temperature is greater than 80°C; At least two cells of the standby instrument battery have failed | **TO/LAND** |

## D. STATUS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| **APU GEN OFF** | APU GEN switch has been selected OFF | — |
| **L (R) BATT OFF** | The affected battery has been selected OFF | — |
| **BUS TIE MAN OPEN** | The bus tie has been manually selected open. This prevents automatic operation of the bus tie. Pressing the BUS TIE switch a second time restores automatic control | — |
| **ELEC HYD GEN ON** | The optional hydraulic motor driven generator (HMDG) has been activated | — |
| **L (R) GEN OFF** | The affected engine generator switch has been selected OFF | — |

NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- Voice warnings are continuous until acknowledged
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right electrical system



# X. LIMITATIONS

## A. ELECTRICAL LOAD LIMITATIONS

| Operating Condition | Maximum Load |
|---|---|
| Two or Three Generators (Continuous) | 400 amps |
| One Generator Ground (Continuous) | 400 amps |
| One Generator Flight (Continuous) | 500 amps |
| Transient Load (5 minutes) | 600 amps • Load reduction required when overload messages appears |
| Generator Overload Threshold | 500 amps |
| Battery Temperature (Takeoff Minimum) | Above -20°C (-4°F) |
| Standby Battery Fault Temperature | Above 80°C |
| External Power Unit (Voltage) | 24 to 32 VDC |
| External Power Unit (Current) | 1,500 amps maximum |
| External Power Unit (Protection) | Polarity protection via anti-flash contactor |

# XI. ELECTRICAL SYSTEM CIRCUIT BREAKERS

Electrical System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| HYD GEN PWR/TEST | RIGHT ESS | CB4-B5 |
| GROUND SERVICE PWR 1 | GROUND SERVICE | CB5-C4 |
| GROUND SERVICE PWR 2 | GROUND SERVICE | CB5-C5 |
| DCPC ESS BUS L (Left) | LEFT ESS | CB5-C1 |
| DCPC ESS BUS L (Right) | RIGHT ESS | CB6-C1 |
| DCPC ESS BUS R (Left) | LEFT ESS | CB5-C2 |
| DCPC ESS BUS R (Right) | RIGHT ESS | CB6-C2 |
| BATT SEC BUS L | LEFT BATT | CB3-B3 |
| BATT SEC BUS R | RIGHT BATT | CB4-B3 |
| FADEC L CH A | LEFT ESS | CB1-A13 |
| FADEC R CH A | LEFT ESS | CB1-A12 |
| FADEC L CH B | RIGHT ESS | CB2-A13 |
| FADEC R CH B | RIGHT ESS | CB2-A12 |
| ENG START A | LEFT ESS | CB3-A1 |
| ENG START B | RIGHT ESS | CB4-A1 |
| ENG RUN CH A | LEFT ESS | CB3-A3 |
| ENG RUN CH B | RIGHT ESS | CB4-A3 |
| ENG ATS/HYD SOL L | LEFT ESS | CB5-A2 |
| ENG ATS/HYD SOL R | RIGHT ESS | CB6-A3 |
| CLOCK | LEFT BATT | CB3-F8 |
| CLOCK PWR | LEFT MAIN | CB3-F9 |
| FAN PWR 2 | RIGHT MAIN | CB6-B2 |
| IAPS FAN | LEFT MAIN | CB3-E1 |
| STBY INST/BATT | RIGHT ESS | CB2-C6 |
| STBY INST BATT TEST | RIGHT ESS | CB2-C7 |

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## XII. ELECTRICAL QUIZ

1. The Challenger 350 electrical system operates at what voltage?

    A) 115 VAC
    B) 28 VDC
    C) 24 VDC
    D) 400 VAC

2. How many main generators are installed on the Challenger 350?

    A) One
    B) Two
    C) Three
    D) Four

3. What is the capacity rating of each main generator?

    A) 8 kVA (300 amp)
    B) 10 kVA (350 amp)
    C) 12 kVA (400 amp)
    D) 15 kVA (500 amp)

4. Where are the main aircraft batteries located?

    A) Nose landing gear bay
    B) Fuselage fairing aft of left wing
    C) Aft equipment bay
    D) Engine compartment

5. What type of batteries are used for the main electrical system?

    A) Lead-acid
    B) Lithium-ion
    C) 24-volt NICAD
    D) Alkaline

6. The standby instrument battery provides power for approximately how long?

    A) 2 hours
    B) 3 hours
    C) 5 hours
    D) 8 hours

7. How many Direct Current Power Centers (DCPCs) are installed?

    A) One
    B) Two
    C) Three
    D) Four

8. External power is connected to the aircraft through a receptacle located where?

A) Left wing root
B) Nose gear bay
C) Lower right fuselage below engine pylon
D) Aft equipment bay

9. The bus tie automatically closes when:

A) Both generators are online
B) External power is connected, but not in use
C) Single generator operation in flight
D) APU is started

10. What is the nominal output voltage of the generators?

A) 24.0 volts
B) 28.0 volts
C) 29.5 volts
D) 32.0 volts

11. The optional hydraulic motor driven generator (HMDG) provides:

A) Time-limited backup power
B) Non-time limited backup power
C) APU starting power only
D) Battery charging power only

12. How many circuit breaker panels are located in the cockpit?

A) One
B) Two
C) Three
D) Four

13. The cockpit floor heaters maintain temperature between:

A) 60°F to 85°F (15°C to 29°C)
B) 65°F to 90°F (18°C to 32°C)
C) 68°F to 95°F (20°C to 35°C)
D) 70°F to 100°F (21°C to 38°C)

14. A generator overload condition occurs when load exceeds:

A) 300 amps
B) 400 amps
C) 500 amps
D) 600 amps

15. The maximum transient electrical load for 5 minutes is:

A) 500 amps
B) 600 amps
C) 700 amps
D) 800 amps

16. Battery temperature must be above what temperature for takeoff?

A) -25°C (-13°F)
B) -20°C (-4°F)
C) -15°C (5°F)
D) -10°C (14°F)

17. The standby instrument battery fault message appears when battery temperature exceeds:

A) 70°C
B) 75°C
C) 80°C
D) 85°C

18. External power voltage acceptance range is:

A) 20 to 30 VDC
B) 22 to 32 VDC
C) 24 to 32 VDC
D) 26 to 34 VDC

19. Which bus type provides power to critical aircraft systems?

A) Main bus
B) Auxiliary bus
C) Essential bus
D) Battery bus

20. The ELECTRICAL FAULT message indicates:

A) Generator failure only
B) Battery failure only
C) Bus failure only
D) System failure preventing display of electrical indications

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CL-350



CL-350 TRAINING MANUAL

# AUXILIARY POWER UNIT 08

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# AUXILIARY POWER UNIT

## I. INTRODUCTION

The Challenger 350 utilizes a Honeywell 36-150BD constant-speed gas turbine auxiliary power unit (APU) installed in a fireproof compartment in the aircraft tailcone. The APU functions as a fully automated gas turbine powerplant with automatic fault detection, automatic and remote shutdown capabilities, and automatic fire extinguishing in ground fire scenarios.



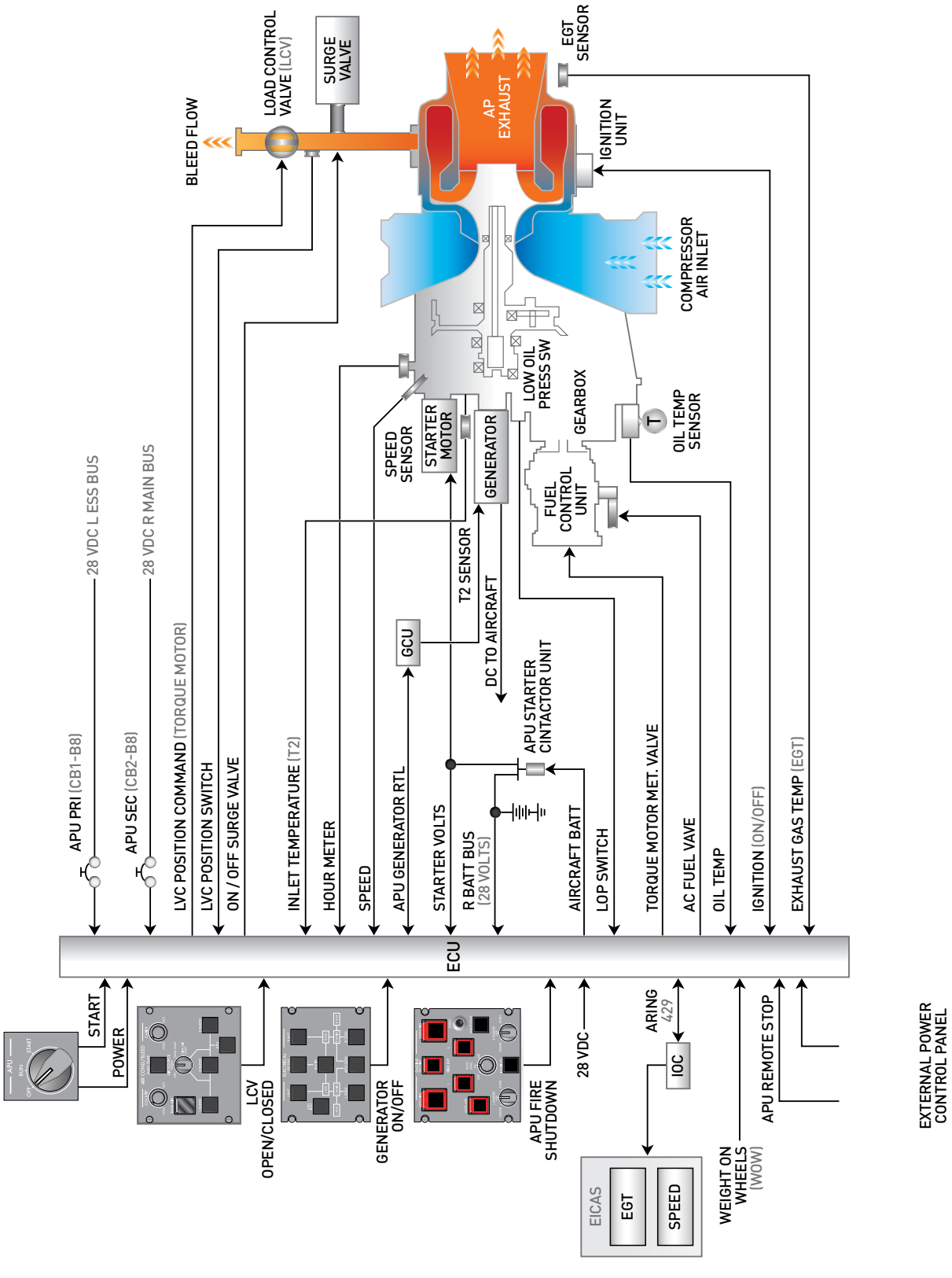
### A. APU SPECIFICATIONS

| Parameter | Value |
|---|---|
| APU Model | Honeywell 36-150BD |
| APU Type | Constant-speed gas turbine |
| Installation Location | Fireproof tailcone compartment |
| Control System | Electronic Control Unit (ECU) |
| Maximum RPM | 108% |
| Maximum EGT Start | 973°C |
| Maximum EGT Normal | 718°C |
| Generator Output | 12 kVA (400 amp) |
| Generator Voltage | 29.5 volts nominal |
| Primary Function | Gearbox-mounted 400 amp DC generator power supply |
| Secondary Functions | Bleed air supply for ECS and main engine starting |
| Fuel Source | Right hand collector tank |

### B. SYSTEM ARCHITECTURE

- Primary Function: Gearbox-mounted 400-amp DC generator power supply
- Secondary Functions: Bleed air supply for ECS and main engine starting
- Load Priority: Electrical loads take priority over pneumatic loads under high demand
- Control Philosophy: Single-switch operation with full ECU automation
- Access: Single panel aft of aft equipment bay door (fuselage underside)

## APU SCHEMATIC



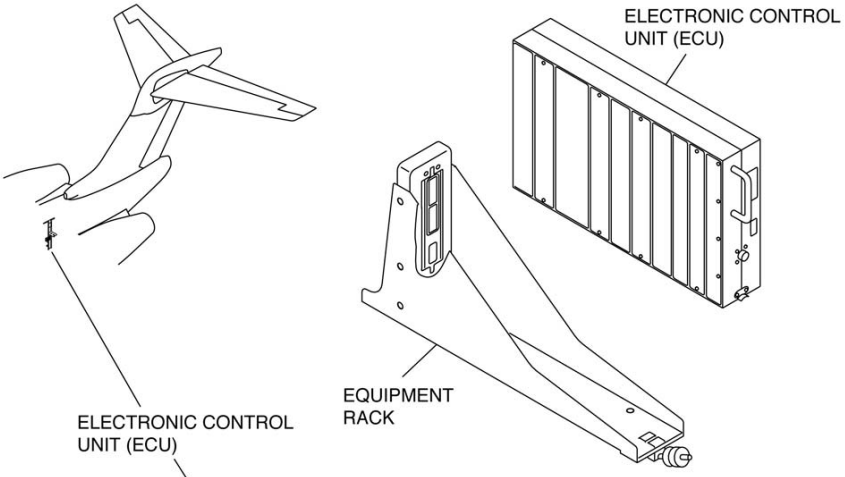
# II. ELECTRONIC CONTROL UNIT (ECU)

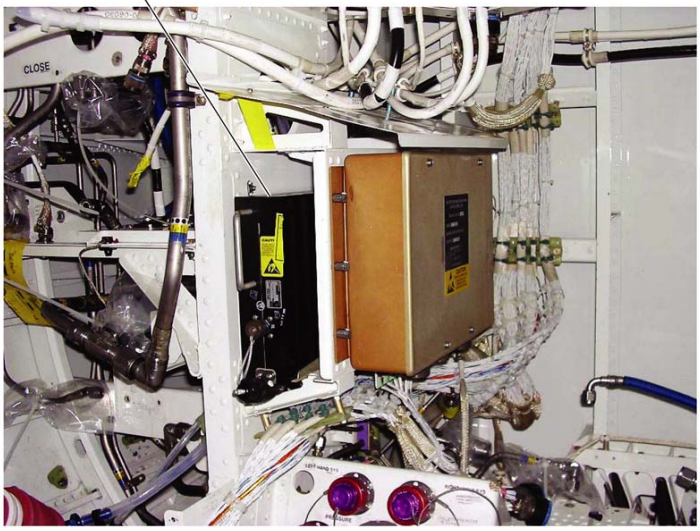
## A. ECU DESCRIPTION

- Installed in equipment rack in aft equipment compartment
- Electrically operated, computer-controlled digital controller
- Powered by the aircraft 28 VDC battery bus
- "Mini-FADEC" controlling all facets of APU operation

## B. ECU MONITORING CAPABILITIES

- Automatic recording and monitoring of operating hours
- Automatic counting and tracking of starts
- Fuel Acceleration Schedules: Automated DC-powered fuel scheduling
- EGT Schedules: Exhaust gas temperature monitoring and control
- Data Relay: Operating data transmission to EICAS displays



# III. START AND IGNITION SYSTEM

## A. STARTER SYSTEM

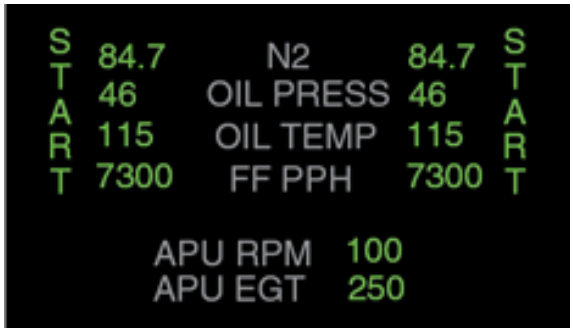
**Components:**

- DC starter motor controlled by ECU relay series
- Electronic control unit on battery bus
- APU starter on battery direct bus
- Right battery isolation during start sequence – Left battery powers both L & R essential busses during APU start

**Operation:**

- APU start contactor closure connects right battery to starter
- Right battery contactor opens during start to prevent voltage drop to essential busses
- **R BATT OFF** light illuminates momentarily during start
- R BATT flowline turns white on ELECTRICAL synoptic page
- Left battery maintains power to essential buses during APU start

## B. IGNITION SYSTEM



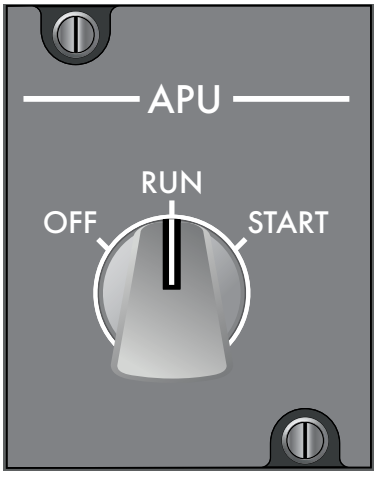

**Components:**

- Single ignition unit with igniter plug lead
- Single igniter plug configuration
- ECU-controlled ignition timing

**System Operation:**

- Ignition energized at 5% APU rpm
- Ignition de-energized at 95% APU rpm
- Automatic relight function for flameout conditions
- 28 VDC power from right aircraft battery bus

## C. START SEQUENCE




**Initiation:**

1. APU switch pulled up and set to RUN position for approx. 3 seconds until APU indications are displayed on the left MFD.
2. Move switch to START and hold until START icon appears on MFD
3. ECU automatically begins start sequence

**Auto Relight Features:**

- Automatic igniter firing during flameout
- Immediate restart capability below 10% rpm rolldown
- ECU auto relight function integration

### D. START LIMITATIONS

APU Start Limitations

| Ground | |
|---|---|
| Ground Start Attempts | Three attempts with 1-minute cooling between each attempt |
| Cooling After Third Attempt | 20 minutes |
| Additional Attempts | Two more after cooling period |
| Final Wait Period | 40 minutes minimum |
| Successive Starts | Six starts at 10-minute intervals with 1-hour wait |
| Maximum In-Flight Start Speed | 285 KIAS |
| Hung Start RPM Threshold | 30% RPM after 30 seconds |
| Left Engine Start Ground Limit | Do not use APU above 9,000 ft |
| Anti-icing Fluid Delay | 5 minutes after application to allow fluid to drain |

| In-Flight | |
|---|---|
| Unsuccessful Start | No restart attempts until after landing following unsuccessful start |
| Hung Start | No restart attempts until after landing following hung start |

**NOTE:** A Left Engine ground start above 9,000' MSL is prohibited utilizing the APU.

## IV. FUEL DISTRIBUTION SYSTEM

### A. SYSTEM DESCRIPTION

- Full Authority Digital Electronic Engine (FADEC) controlled
- Fuel is drawn from the right-hand collector tank
- Fuel flow automatically modulated to maintain RPM for electrical and pneumatic load requirements
- ECU over-temperature protection during acceleration

### B. FUEL SYSTEM COMPONENTS

**Primary Components:**

- DC-powered fuel pump
- Fuel feed shutoff valve (SOV)
- Fuel shutoff solenoid
- Fuel system filters
- High-pressure fuel pump (APU-mounted)
- Fuel control unit (FCU)
- Fuel manifold assembly

## C. FUEL CONTROL OPERATION

**Fuel Control Unit (FCU):**

- Meters fuel under ECU command
- Fuel shutoff solenoid opens at 5% rpm during start
- Fuel scheduling based on rpm, EGT, generator and bleed demands

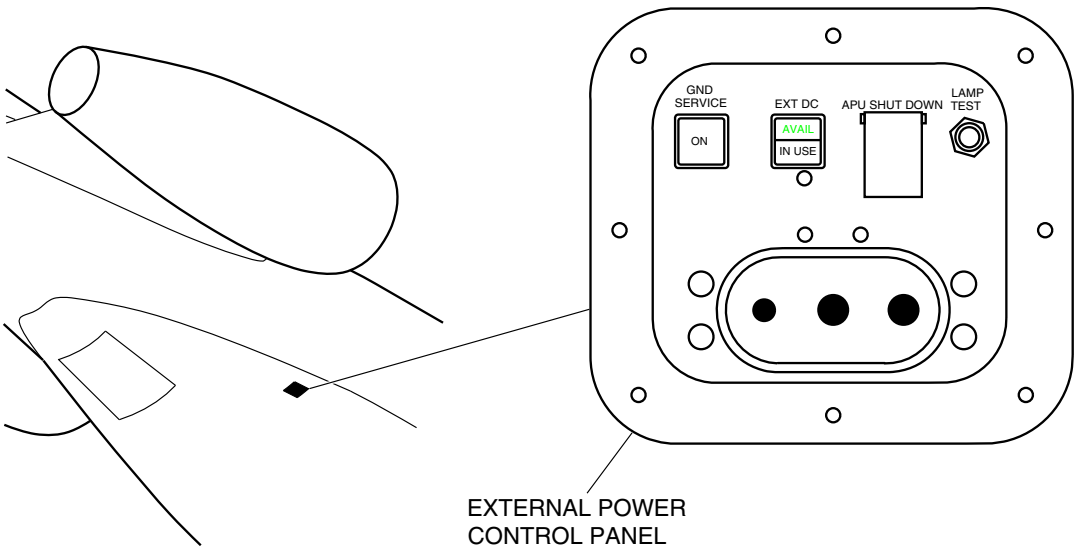
**Fuel Pump Operation:**

- DC-powered pump delivers fuel under pressure to FCU
- Pump ceases operation when right engine running
- Main engine ejector pump provides fuel when right engine running

**Shutdown Modes:**

- Normal shutdown: ECU commands fuel off
- Automatic shutdown: Overspeed signal closes fuel solenoid and torque motor
- Emergency shutdown: Fire or exceeded limit triggers fuel cutoff via ECU






For ground operations, a remote cutoff switch is located on the right side of the aircraft, aft of the wing and behind the electrical (ground power) connection access door.

## V. PROTECTIVE SHUTDOWNS

For certain aircraft configurations (specifically aircraft 20501 to 20696 not incorporating Service Bulletin SB 350-49-001), the Auxiliary Power Unit (APU) can operate in an **"essential mode" during flight**, where some of its protective shutdown mechanisms are inhibited.

For aircraft 20697 and subsequent models, or those that have incorporated Service Bulletin SB 350-49-001, the APU operates in a "non-essential mode" for both on-ground and in-flight operations, meaning these specific shutdowns are not inhibited.

Essential Mode Protective Shutdowns

| Shutdown Condition | Status |
|---|---|
| Fire Indication | Ground Only |
| Reverse Flow | Ground Only |
| Loss of EGT Signal | Ground Only |
| Low Oil Pressure | Ground Only |
| High Oil Temperature | Ground Only |
| Overtemperature | Ground Only |
| No Flame (during start) | Ground Only |
| No Acceleration (during start) | Ground Only |
| 28 V DC Power Loss | Ground/In-Flight |
| Overspeed | Ground/In-Flight |
| Emergency Fire | Ground/In-Flight |
| Internal ECU Failure | Ground/In-Flight |
| Loss of Overspeed Protection Circuit | Ground/In-Flight |

Non-Essential Mode Protective Shutdowns

| Shutdown Condition | Status |
|---|---|
| Fire Indication | Ground/In-Flight |
| Reverse Flow | Ground/In-Flight |
| Loss of EGT Signal | Ground/In-Flight |
| Low Oil Pressure | Ground/In-Flight |
| High Oil Temperature | Ground/In-Flight |
| Overtemperature | Ground/In-Flight |
| No Flame (during start) | Ground/In-Flight |
| No Acceleration (during start) | Ground/In-Flight |
| 28 V DC Power Loss | Ground/In-Flight |
| Overspeed | Ground/In-Flight |
| Underspeed | Ground/In-Flight |
| Emergency Fire | Ground/In-Flight |
| Internal ECU Failure | Ground/In-Flight |
| Loss of Overspeed Protection Circuit | Ground/In-Flight |
| No Crank | Ground/In-Flight |
| Loss of Speed Signal | Ground/In-Flight |
| Speed Fallback | Ground/In-Flight |



## VI. PNEUMATIC SUPPLY SYSTEM

Under high demand, the APU electrical loads take priority over pneumatic loads, such as bleed air supply. The APU's electronic control unit (ECU) manages the pneumatic load by controlling the bleed valve, which diverts compressor discharge air to the aircraft's bleed air manifold.

When bleed air is extracted, this pneumatic energy is no longer available to drive the turbine or cool the combustion system, leading to a significant increase in exhaust gas temperature (EGT). To prevent overtemperature, the ECU will reduce bleed air flow by modulating the bleed valve towards the closed position if the EGT limit is reached. This mechanism ensures that electrical power requirements are met first when both electrical and pneumatic demands are high.

### A. PNEUMATIC SYSTEM DESCRIPTION

- APU compressor bleed air pressurizes right bleed air manifold
- Provides bleed air for engine starting and air conditioning
- One-way check valve prevents reverse airflow

## B. PNEUMATIC CONTROL COMPONENTS

**Bleed Valve:**

- Controls airflow to aircraft bleed system
- Protects APU from overtemperature conditions
- Electrically controlled with pneumatic operation
- Butterfly valve mechanism with ECU position adjustment

**Surge Control Valve:**

- Automatically controlled by ECU
- Opens when APU supplies electrical loads above 15,000 ft
- Reduces APU surge potential during unloaded operation

## C. BLEED AIR OPERATION

**Load Control:**

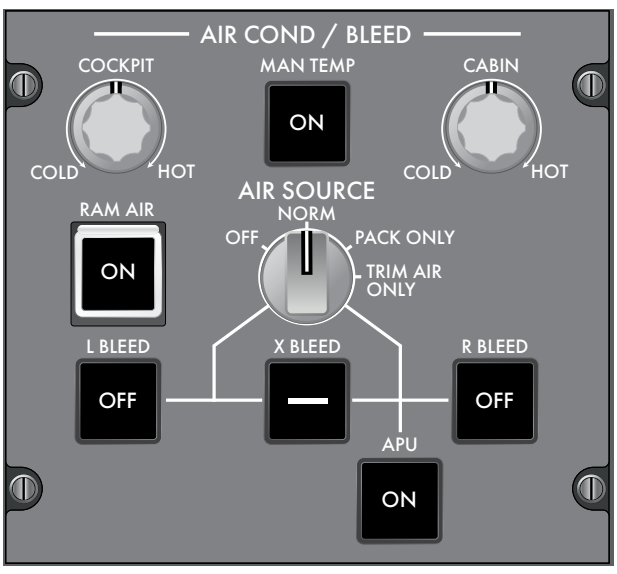
- ECU controls pneumatic load through bleed valve demands
- Bleed valve opens when flight deck switch placed to open position
- Bleed air extraction affects turbine pneumatic energy and combustion cooling
- Surge valve opens to reduce surge potential above 15,000' when APU is supplying electrical loads but no bleed loads

**EGT Management:**

- Bleed loads cause rpm drop and EGT increase
- ECU fuel flow increase recovers to governed speed
- ECU modulates bleed valve toward closed position to prevent overtemperature

**Availability Requirements:**

- APU must be above 95% maximum speed for bleed air energization
- ECU energizes bleed-air supply system at proper rpm threshold



# VII. ELECTRICAL GENERATOR SYSTEM

## A. GENERATOR SPECIFICATIONS

- Output Rating: 12 kVA (400 amp) - identical to engine generators
- Voltage Output: 29.5 volts nominal
- Altitude Capability: 30,000 ft maximum for backup generator use
- Load Sharing: Medium and low altitude capability with engine generators
- Start Power: Right battery with isolation from essential busses during start sequence

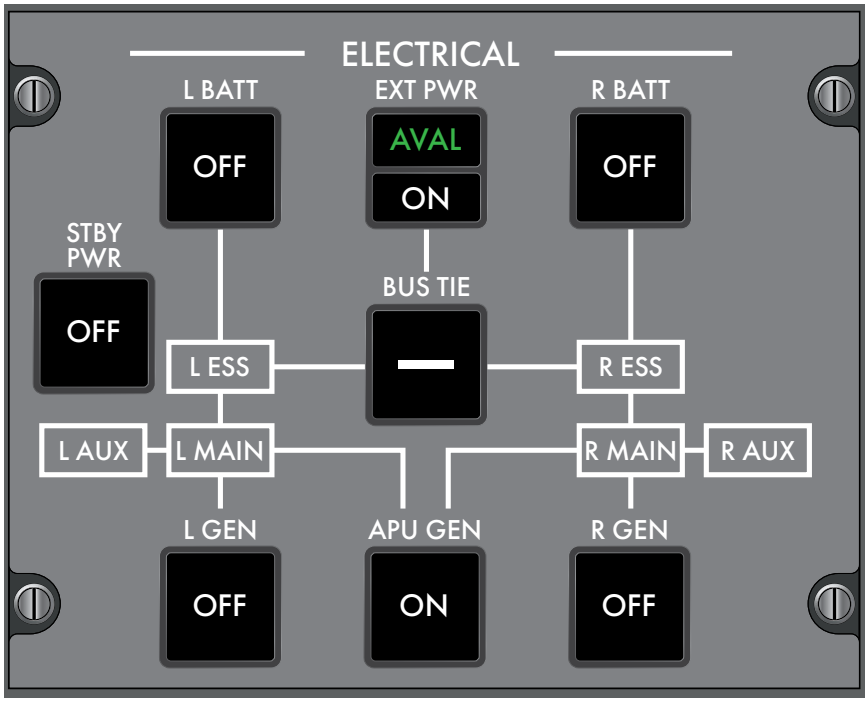
## B. GENERATOR OPERATION

**Power Distribution:**

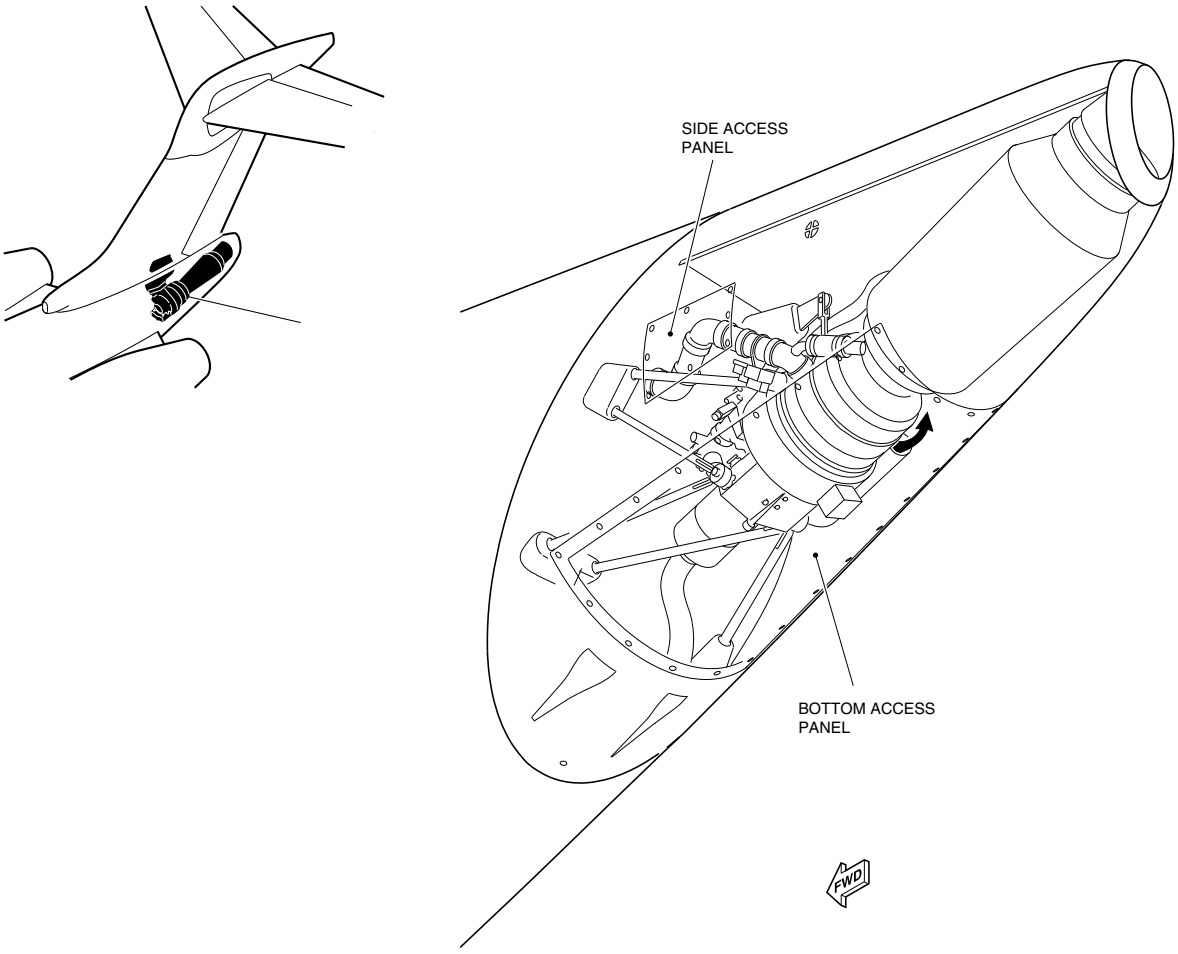
- Emergency replacement for failed engine generator(s)
- Automatic load distribution with engine generators
- Ground operation capability for all aircraft systems
- Connects through APU Power Center

**Generator Control:**

- DC electrical power controlled from ELECTRICAL panel
- Bus tie operations with generator priority
- Automatic connection systems for load management



# VIII. APU COMPARTMENT AND ACCESS




## A. COMPARTMENT DESIGN

**Location and Access:**

- Tailcone installation in fireproof compartment
- Access via single panel aft of aft equipment bay door
- Panel removal required from fuselage underside
- Self-contained unit design

**Ventilation System:**

- NACA inlet for compartment ventilation
- Air routing through compartment for APU cooling
- Exhaust via APU exhaust eductor
- Generator cooling with separate NACA inlet

### B. AIR INTAKE AND EXHAUST

**Air Intake:**

- Located above APU compartment on right fuselage side
- Positioned below vertical stabilizer
- Provides combustion air for APU operation

**Exhaust System:**

- Exhaust gases discharged via exhaust duct and eductor
- Insulated exhaust muffler coverage
- Tailcone exhaust routing

## IX. CONTROL AND INDICATIONS

### A. APU CONTROL PANEL

**Primary Control:**

- Single three-position switch (OFF/RUN/START)
- Ground operations remote cutoff switch on right fuselage
- Located aft of wing behind electrical connection access door

**Control Integration:**

- DC electrical power control from ELECTRICAL panel
- Bleed air services control from AIR COND/BLEED panel
- System monitoring via EICAS pages

### B. DISPLAY SYSTEMS

**EICAS Monitoring:**

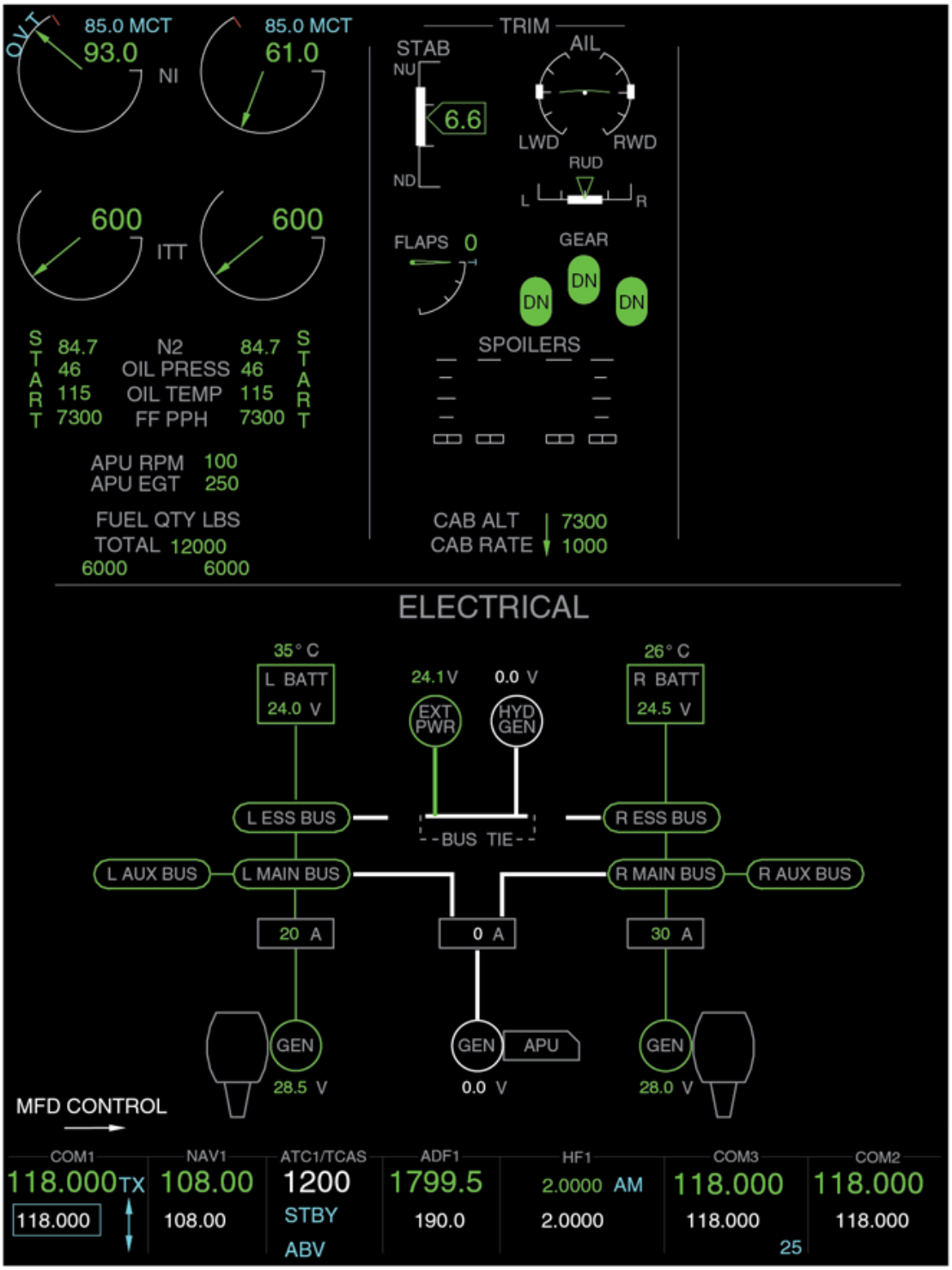
- FUEL synoptic page monitors APU pump and fuel SOV
- ECS synoptic page displays pneumatic operations
- ELECTRICAL synoptic page shows generator status

**Parameter Displays:**

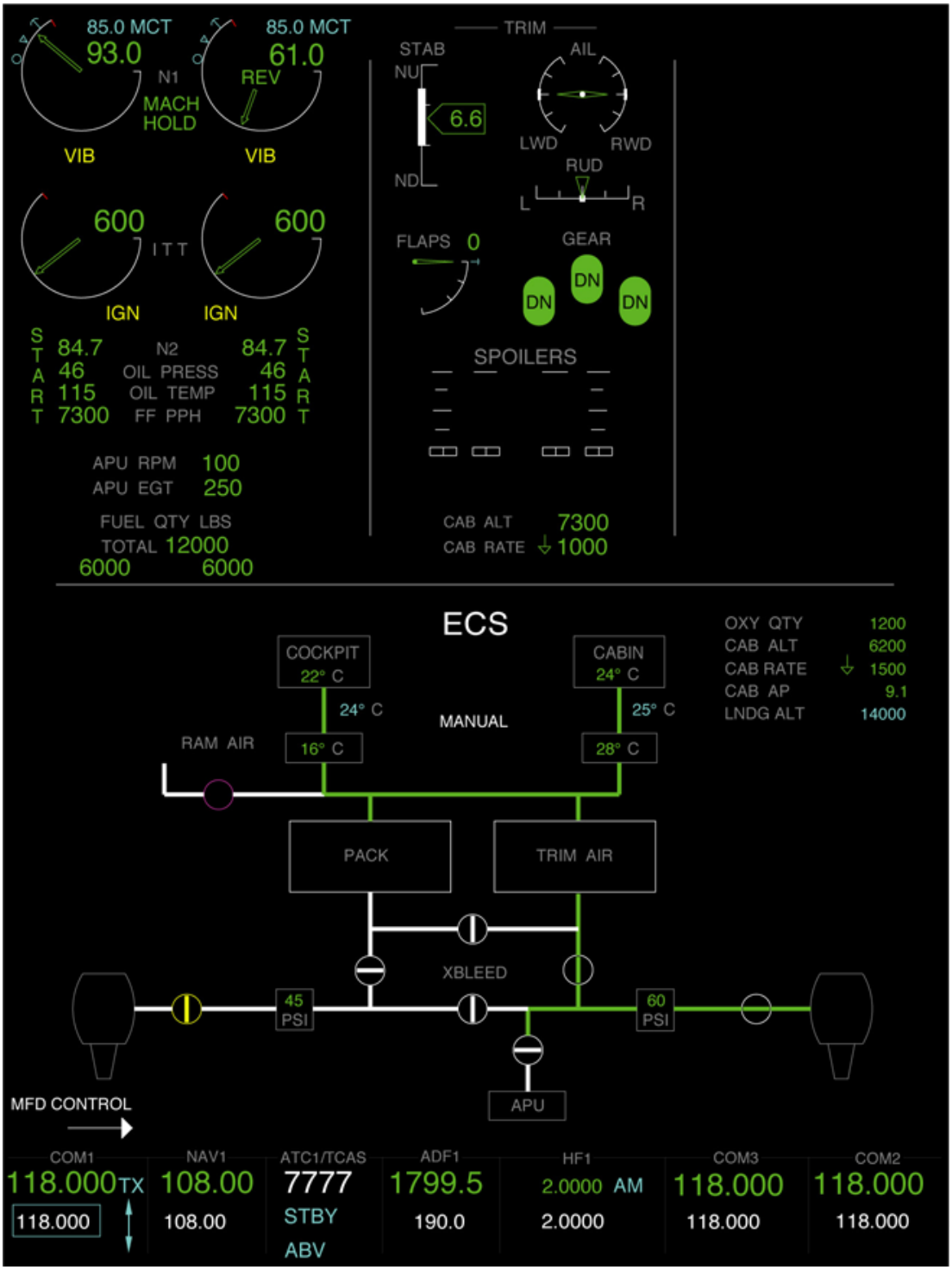
- Digital RPM display
- EGT digital readout
- Generator amperage and voltage indications
- Bleed air status indications

# X. SYNOPTIC PAGES

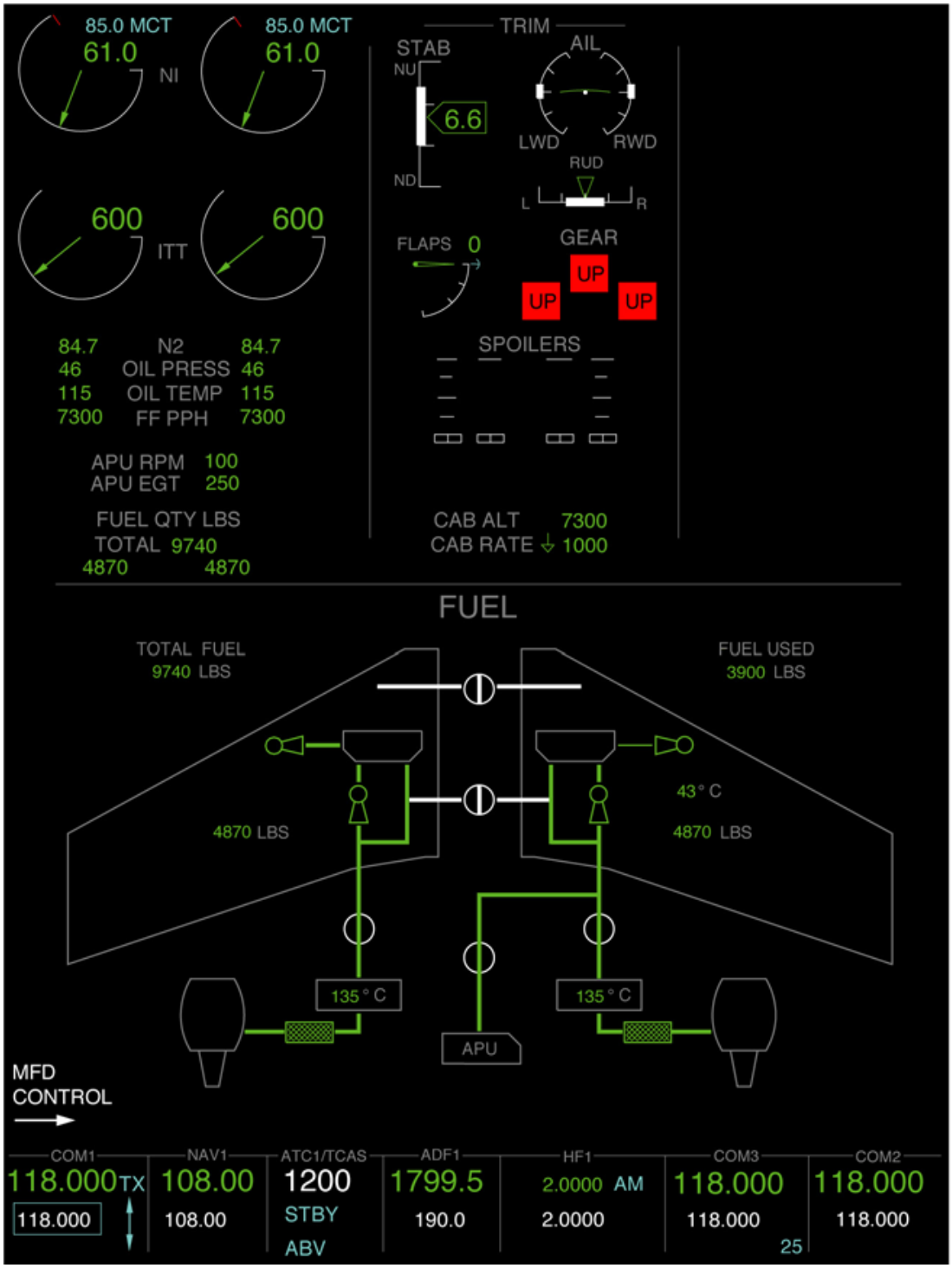
## A. ELECTRICAL SYNOPTIC PAGE



## B. ECS SYNOPTIC PAGE



## C. FUEL SYNOPTIC PAGE



# XI. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| APU FIRE | The APU fire detection loop has activated. On the ground the system should automatically shut the APU down and activate the fire extinguisher. In flight the APU will not automatically shut down or activate the fire extinguisher | — |
| APU OVERTEMP | An APU EGT overtemperature has been detected. On the ground, the APU will automatically shut down | TO/LAND |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| APU BLEED ALT LIMIT | APU bleed air has been commanded above 20,000 ft, or the APU bleed modulated due to excessive EGT | TO/LAND |
| APU FIRE DET FAIL | The APU fire detection system has failed | TO/LAND |
| APU FUEL SOV FAIL | The APU fuel feed shutoff valve has failed | TO/LAND |
| APU GEN FAIL | The APU generator has failed | TO/LAND |
| APU GEN OVERLOAD | APU generator overloaded | TO/LAND |
| APU OVERSPEED | The APU has shutdown due to an overspeed | TO/LAND |
| APU OIL PRESS LOW | The APU oil pressure is low while in flight | TO/LAND |
| APU OIL TEMP HIGH | The APU oil temperature is high while in flight | TO/LAND |
| APU STARTER FAIL ON | Power is still being supplied to the APU starter when electronic control unit is not commanding a start | TO/LAND |
| FIREX APU SQUIB FAULT | APU fire extinguisher squib is inoperative | TO/LAND |

### C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| **APU FAULT** | A fault is indicated in the APU system. One or more of the following has occurred: The APU bleed valve has failed, The APU fuel solenoid has failed, A start is prevented, The avionics are not communicating with the APU electronic control unit, Reverse flow has been detected | TO/LAND |
| **APU SHUTDOWN** | The auxiliary power unit electronic control unit has shut down the APU for protective reasons | TO/LAND |

**NOTES**

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- APU FIRE message includes continuous "APU FIRE" aural warning
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases

## XII. LIMITATIONS

### A. ALTITUDE LIMITATIONS

| Operation Type | Maximum Altitude |
|---|---|
| APU Operation | 37,000 ft |
| APU Generator | 30,000 ft |
| Bleed Air for Engine Start | 20,000 ft |
| Bleed Air for ECS | 20,000 ft |
| APU Start Altitude | 30,000 ft |
| APU Start (Ground) | 14,000 ft |
| Left Engine APU Start (Ground) | 9,000 ft msl |

## B. OPERATIONAL LIMITATIONS

| Ground | |
|---|---|
| Ground Start Attempts | Three attempts with 1-minute cooling between each attempt |
| Cooling After Third Attempt | 20 minutes |
| Additional Attempts | Two more after cooling period |
| Final Wait Period | 40 minutes minimum |
| Successive Starts | Six starts at 10-minute intervals with 1-hour wait |
| Maximum In-Flight Start Speed | 285 KIAS |
| Hung Start RPM Threshold | 30% RPM after 30 seconds |
| Left Engine Start Ground Limit | Do not use APU above 9,000 ft |
| Anti-icing Fluid Delay | 5 minutes after application to allow fluid to drain |

| In-Flight | |
|---|---|
| Unsuccessful Start | No restart attempts until after landing following unsuccessful start |
| Hung Start | No restart attempts until after landing following hung start |

| RPM and Temperature | |
|---|---|
| Maximum APU RPM | 108% |
| Max EGT Start | 973°C |
| Max EGT Normal Operations | 718°C |

**NOTE:** A Left Engine ground start above 9,000' MSL is prohibited utilizing the APU.

## XIII. APU SYSTEM CIRCUIT BREAKERS

APU System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| APU | LEFT ESS | CB1-B8 |
| APU SECONDARY CONTROL | RIGHT MAIN | CB2-B8 |

**NOTE:** MM Designators differ from QRH

CB1 = LCBP (Left Cockpit Breaker Panel)

CB2 = RCBP (Right Cockpit Breaker Panel)

CB3 = LSPC (Left Side Panel Circuit)

CB4 = RSPC (Right Side Panel Circuit)

CB5 = LDCPC (Left DC Power Center)

CB6 = RDCPC (Right DC Power Center)

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## XIV. APU QUIZ

1. What is the maximum altitude for APU generator operation?

A) 37,000 ft
B) 30,000 ft
C) 20,000 ft
D) 14,000 ft

2. At what RPM percentage does the APU ignition system energize?

A) 3%
B) 5%
C) 10%
D) 15%

3. What is the maximum EGT limit for normal APU operations?

A) 650°C
B) 718°C
C) 800°C
D) 973°C

4. How many consecutive APU start attempts are permitted on the ground before a cooling period?

A) Two
B) Three
C) Four
D) Five

5. Which battery is isolated during APU start?

A) Left battery
B) Right battery
C) Both batteries
D) Standby battery

6. What is the APU generator output rating?

A) 8 kVA (300 amp)
B) 10 kVA (350 amp)
C) 12 kVA (400 amp)
D) 15 kVA (450 amp)

7. At what percentage RPM does the fuel shutoff solenoid open during start?

A) 3%
B) 5%
C) 10%
D) 15%

8. What is the maximum altitude for APU bleed air use for engine starting?

A) 15,000 ft
B) 20,000 ft
C) 30,000 ft
D) 37,000 ft

9. Which system takes priority when APU is under high demand?

A) Pneumatic loads
B) Electrical loads
C) Both equally
D) Depends on altitude

10. What is the cooling period required after three consecutive start attempts?

A) 10 minutes
B) 15 minutes
C) 20 minutes
D) 40 minutes



11. At what RPM percentage does the APU ignition system de-energize?

A) 85%
B) 90%
C) 95%
D) 100%

12. What type of control system does the APU use?

A) Mechanical control
B) Hydraulic control
C) Electronic Control Unit (ECU)
D) Pneumatic control

13. What is the maximum RPM limit for the APU?

A) 105%
B) 106%
C) 107%
D) 108%

14. Which fuel tank supplies the APU?

A) Left collector tank
B) Right collector tank
C) Center tank
D) Both collector tanks

15. What happens to the right battery during APU start?

A) It remains connected
B) It is isolated from the essential bus
C) It is completely disconnected
D) It switches to standby mode

16. How long must anti-icing fluid be allowed to drain before APU start?

A) 2 minutes
B) 3 minutes
C) 5 minutes
D) 10 minutes

17. What is the maximum airspeed for APU start in flight?

A) 250 KIAS
B) 275 KIAS
C) 285 KIAS
D) 300 KIAS

18. Where is the APU ECU located?

A) APU compartment
B) Cockpit
C) Aft equipment compartment
D) Tailcone

19. At what RPM percentage must the APU operate for bleed air availability?

A) Above 90%
B) Above 95%
C) Above 98%
D) At 100%

20. What provides protection from reverse airflow in the pneumatic system?

A) Bleed valve
B) Surge control valve
C) One-way check valve
D) ECU control

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CL-350



CL-350 TRAINING MANUAL

# ICE & RAIN PROTECTION | 09

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# ICE AND RAIN PROTECTION

The Challenger 350 ice and rain protection system provides comprehensive protection against ice formation on critical aircraft surfaces during flight and ground operations. The system utilizes engine bleed air to heat wing leading edges and engine nacelles, while electrical heating protects air data probes, windshields, and windows, ensuring safe operation in all weather conditions.

## I. INTRODUCTION

### A. ICE PROTECTION SYSTEM OVERVIEW

- Wing leading edges heated with high-pressure engine bleed air
- Engine nacelle inlets protected with bleed air anti-icing
- Air data probes and sensors heated electrically
- Windshields and side windows heated with embedded electrical elements
- Two ice detectors provide automatic ice detection
- Anti-icing of tail surfaces not required
- Controlled by Integrated Air System Controllers (IASC)
- Monitored via ANTI-ICE synoptic display

Ice Protection System Specifications

| Parameter | Value |
|---|---|
| Ice Detection System | Two vibrating probe detectors |
| Wing Anti-Ice Source | High-pressure engine bleed air |
| Engine Anti-Ice Source | Engine bleed air |
| Probe/Window Heating | 28 VDC electrical power |
| Control System | Dual-channel IASC |
| Leak Detection Zones | Eight total - Four zones with dual loops, Four zones with single loops |
| Wing Temperature Sensors | Dual sensors per wing section |
| Windshield Heater Sections | Three sections per windshield |

# II. ICE DETECTION SYSTEM

The Challenger 350 aircraft is equipped with an ice detection system that uses two detectors, positioned on each side of the fuselage just above the nose landing gear doors. Each detector contains a vibrating probe that detects the presence of icing conditions; when ice collects on the probe, its vibration frequency decreases, prompting internal thermal heaters to de-ice it. This cycle of detection and de-icing allows the system to continuously monitor for ice.

While two detectors provide redundancy, a signal from just one is sufficient to generate a CAS message. When ice is detected and the anti-ice systems are not yet active, an **ICE DETECTED** (C) message is displayed on the EICAS, accompanied by an amber **ICE icon** on the Primary Flight Display (PFD). If the anti-ice systems are already selected on, an **ICE DETECTED** (A) message is shown.

A failure of both ice detectors results in an **ICE DETECTOR FAIL** (C), while the failure of a single detector generates an **ICE DETECTOR FAULT** (A), indicating the other detector remains operational. Pilots can also perform a test, with a successful outcome indicated by the **PROBE HEAT TEST OK** (S) status message and the momentary display of the **ICE DETECTED** (C) message with an ICE icon. In conditions where ice is detected or observed, the wing and engine anti-icing systems must be activated.

## A. SYSTEM DESCRIPTION

- Two ice detectors mounted above nose landing gear doors
- Vibrating probe technology for ice detection
- System redundancy with dual detectors
- Only one detector signal needed for EICAS message
- Supplied with 28 VDC power
- Continuous internal monitoring for failure conditions



Ice Detector

## B. COMPONENTS AND OPERATION

**Ice Detector Operation:**

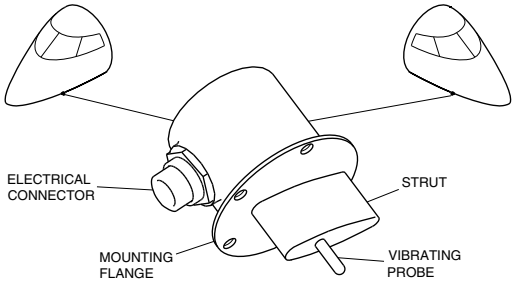
- Probes vibrate at high frequency
- Ice accumulation decreases vibration frequency
- Internal thermal heaters de-ice strut and probe
- Ice shedding restores normal vibration frequency
- Heating cycle repeats as ice accumulates
- Continuous reassessment of icing conditions

**Ice Detection Indications:**

- Amber ICE icon displayed on PFD (anti-ice systems off)
- **ICE DETECTED** (C) message (anti-ice systems off)
- **ICE DETECTED** (A) message (anti-ice systems on)

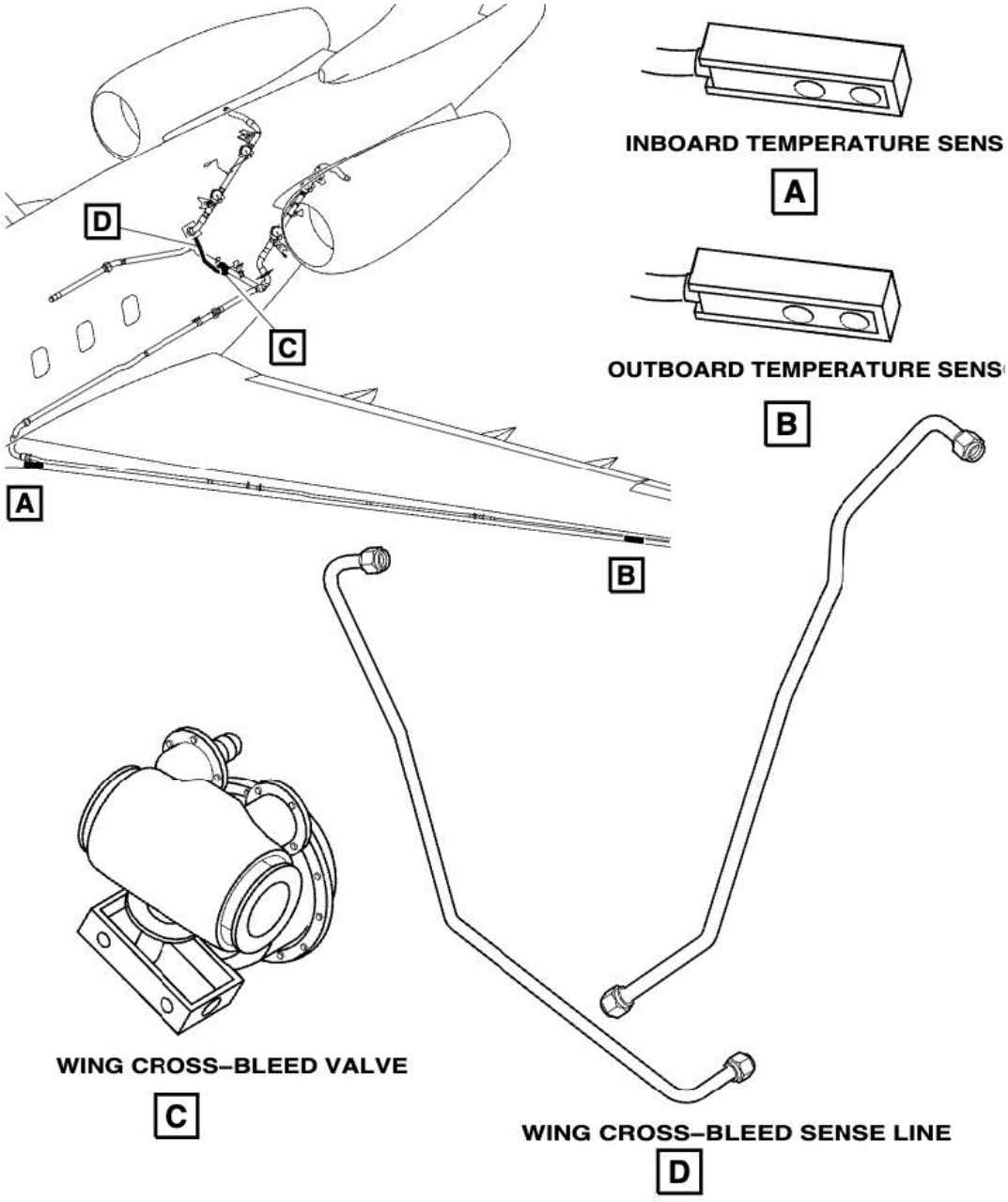
**Failure Indications:**

- **ICE DETECTOR FAIL** (C) - both detectors failed
- **ICE DETECTOR FAULT** (A) - one detector failed



## C. ICE DETECTOR TEST

- Test capability via SYSTEMS TEST panel
- Select ICE DET and push test switch
- Internal check of electronics performed
- Probe heater functionality tested
- CAS message verification included



# III. WING ANTI-ICE SYSTEM

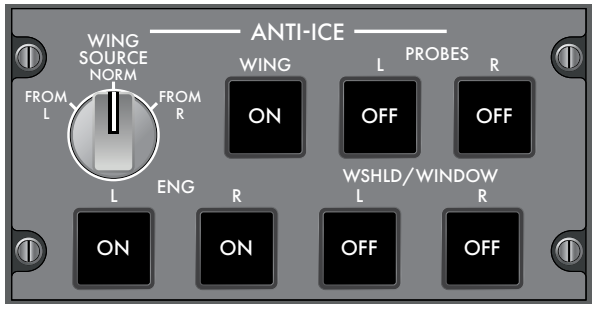
The wing anti-ice system is designed to heat the leading edge of the wing using high-pressure bleed-air from the aircraft's engines to prevent ice accumulation. It is controlled via a WING push button switch and a WING SOURCE rotary switch located on the ANTI-ICE control panel. While each wing is typically heated by its corresponding engine, the system allows for either engine to supply bleed-air to both wings.

The system's operation and leak detection are managed by two dual-channel Integrated Air System Controllers (IASC). These controllers utilize data from dual-temperature sensors, positioned in both the inboard and outboard sections of each leading edge, to precisely regulate the bleed-air supply and ensure the leading edges maintain the appropriate temperature range.

## A. SYSTEM DESCRIPTION

- Heats wing leading edges with high-pressure engine bleed air
- Left and right wings normally heated by respective engines
- Capability to supply bleed air from either engine to both wings
- WING push button switch operates the system
- WING SOURCE rotary switch selects bleed air source
- Anti-ice ducting continuously monitored for leakage

## B. WING SOURCE SELECTION




**NORM Position:**

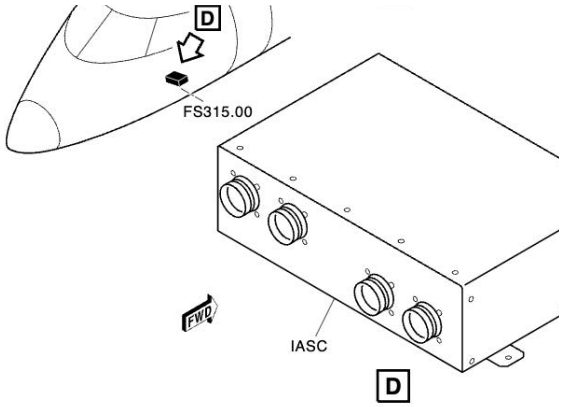
- Left wing heated by left engine
- Right wing heated by right engine
- Normal operational mode

**FROM L Position:**

- Both wings heated by left engine bleed air
- Right wing anti-ice and high-pressure valves closed
- Crossbleed valve opens

**FROM R Position:**

- Both wings heated by right engine bleed air
- Left wing anti-ice and high-pressure valves closed
- Crossbleed valve opens




## C. INTEGRATED AIR SYSTEM CONTROLLER (IASC)

- Two dual-channel controllers control wing anti-ice operat
- Control leak detection systems
- Receive data from dual temperature sensors
- Located in inboard and outboard sections of each leading
- Independently control bleed air amount to each wing
- Maintain leading edges in correct temperature range

## D. BLEED LEAK DETECTION SYSTEM

The bleed leak detection system is a fully automatic system, controlled by Integrated Air System Controllers (IASC), designed to monitor bleed air and anti-ice ducts for leakage. Its primary function is to protect aircraft components and structure from overheating and fire hazards.

The system is divided into eight distinct zones for EICAS presentation, including the left and right bleed ducts, wing anti-ice ducts, pylon ducts, pack ducts, and trim air ducts. Detection is achieved through single loops for areas like the main bleed and trim air ducts, and dual-sensing loops for critical areas such as engine pylons and wing leading edges. The use of dual-sensing loops helps minimize false leak indications and allows for dispatch under certain conditions even if one loop is inoperative.

**System Purpose:**

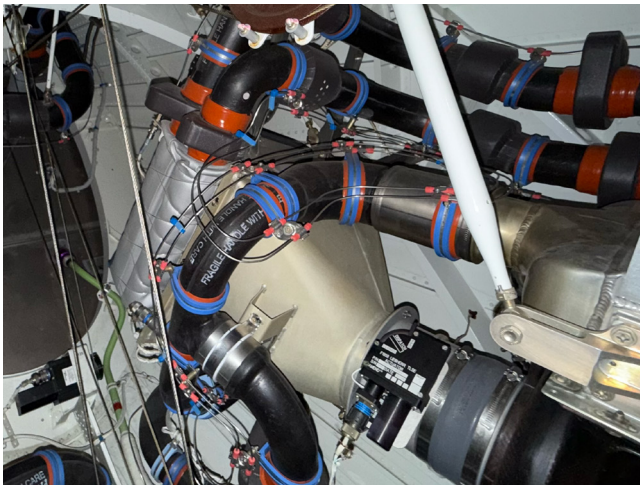
- Detect hot air leaks from bleed system
- Protect components and structure from overheating
- Prevent fire hazards

**Detection Zones:**

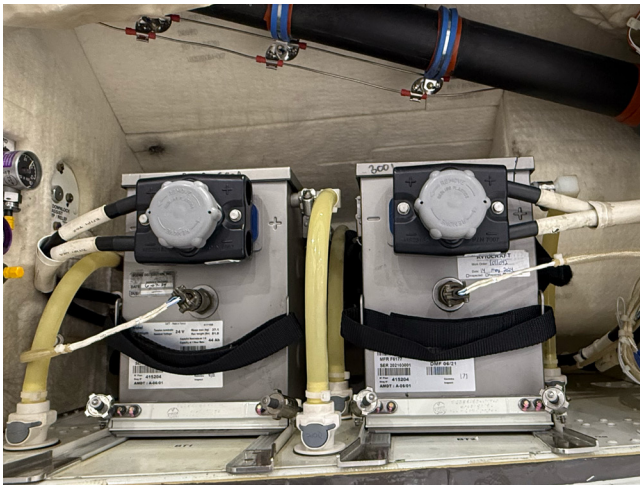
- Right pylon dual loops (powerplant to right IPV and HPV)
- Left pylon dual loops (powerplant to left IPV and HPV)
- Right anti-ice ducting dual loops (downstream of right HPV)
- Left anti-ice ducting dual loops (downstream of left HPV)

**Leak Detection Operation:**

- Pylon zone leak: **L (R) PYLON BLEED LEAK** (W) message
- Downstream leak: **WING ANTI-ICE LEAK** (W) message
- Automatic valve closure isolates downstream failures
- **L (R) WING ANTI-ICE FAIL** (C) message after isolation



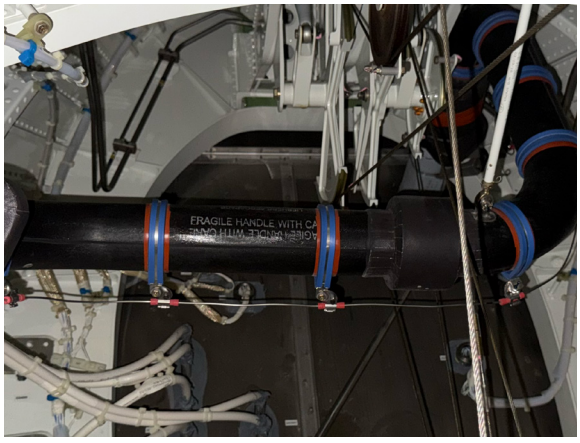
PACK Dual Bleed Loop



Battery Dual Bleed Loop

## E. WING TEMPERATURE SENSORS

- Dual temperature sensors provide feedback to IASC
- Two dual sensors in outboard section of each wing
- Two dual sensors in inboard section of each wing
- Channel B of each IASC receives data from one sensor per position
- Outboard sensors monitor for insufficient temperature
- Inboard sensors modulate wing anti-icing valves
- Overheat monitoring with **L (R) WING OVHT** (W) message



APU Single Bleed Loop

## F. WING ANTI-ICE VALVES

**Valve Operation:**

- Located on bleed air manifold in aft equipment bay
- Modulate based on wing temperature when WING switch ON
- Spring-loaded to closed position

**Valve Closure Conditions:**

- Bleed air supply pressure removed
- Loss of electrical power at valve
- Anti-ice duct failure detected by IASC
- System operated in FROM L or FROM R mode

**High Pressure Valves:**

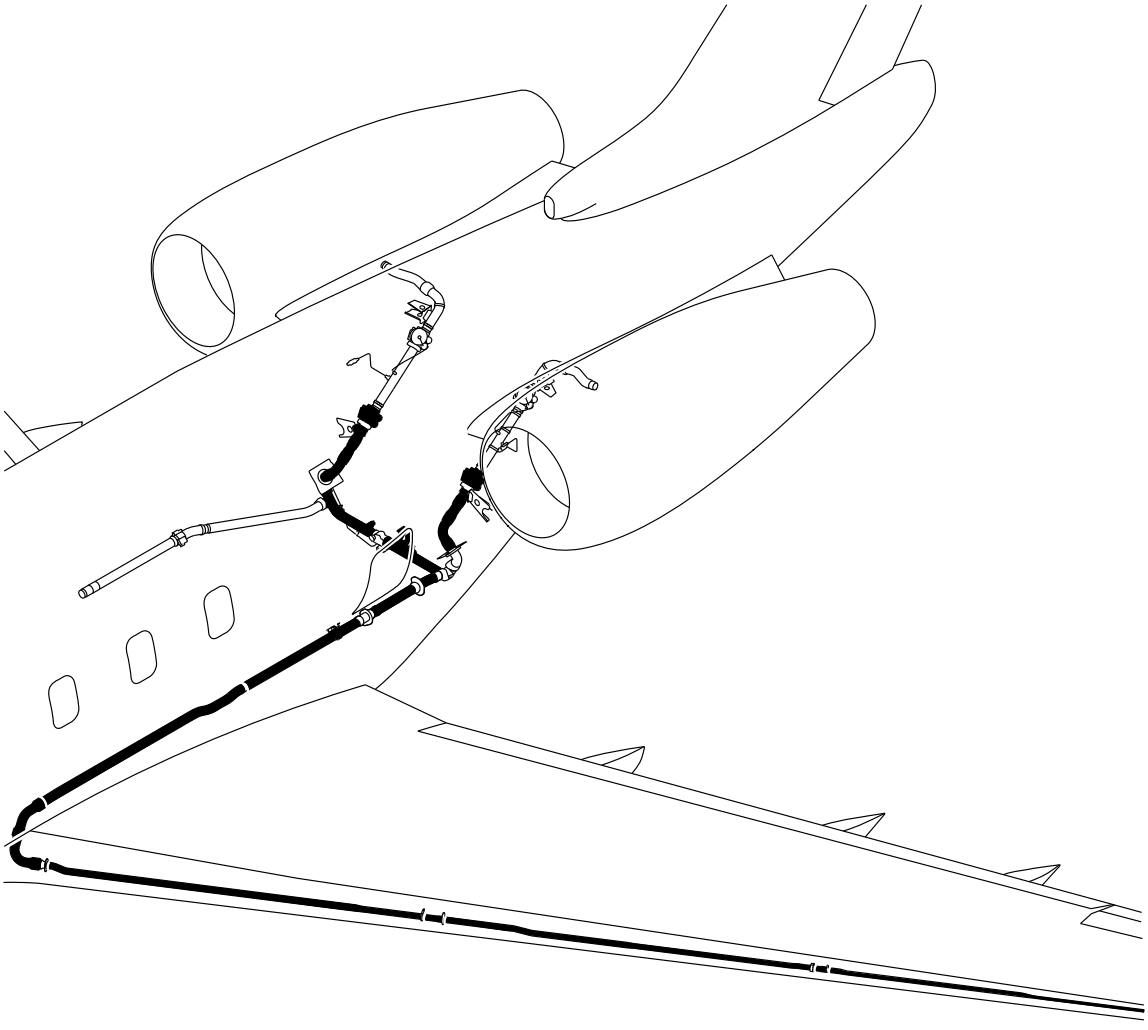
- Limit high stage engine bleed pressure to 36 ±3 psi
- Valve failure with pressure exceeding 46 psi triggers warning
- **L (R) WING A/I PRESS HI** (C) message displayed

## G. WING ANTI-ICE DUCTS

- Aft equipment bay and center fuselage ducts supply wings
- Hot air enters wing via piccolo tubes in leading edges
- Piccolo ducts spray hot bleed air onto inner leading-edge surfaces
- Air dissipated through vent holes on bottom wing surface
- Dual sensing loops and temperature sensors monitor ducts
- Discrimination between leak overheat and normal anti-ice temperatures

## H. WING OVERHEAT CONDITIONS

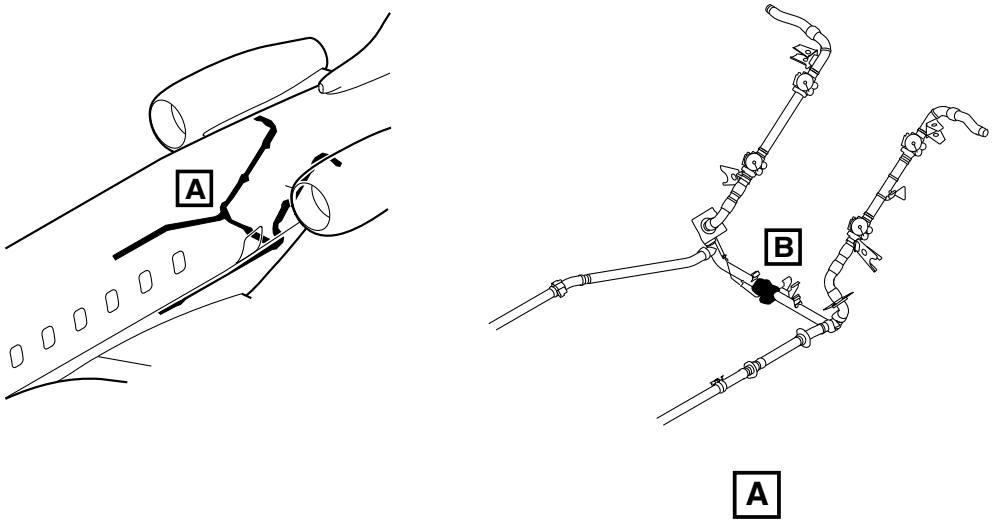
- Overheat Response:
- **L (R) WING OVERHEAT** (W) message illuminates
- Pilot shuts off wing anti-ice system
- Select FROM L or FROM R position
- Select system ON
- Bleed flow modulated by sensor on bleed source side
- Overheated leading edge identified in red on synoptic



Wing Anti-Ice Ducts

## I. WING ISOLATION VALVE

- Crossbleed duct bridges two anti-ice lines
- Pneumatically actuated, electrically controlled
- Normally closed in normal operation
- Automatic opening during engine failure
- Controlled from ANTI-ICE WING SOURCE switch

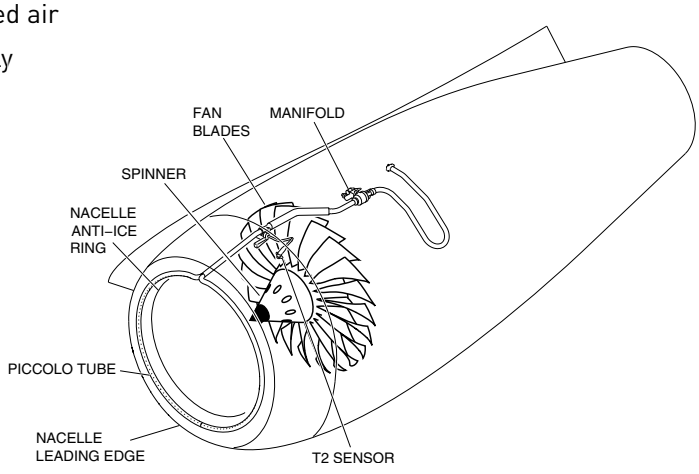



Wing Isolation / Cross-Bleed Valve

# IV. ENGINE ANTI-ICE SYSTEM

## A. SYSTEM DESCRIPTION

- Engine nacelle inlets anti-iced with engine bleed air
- Left and right systems controlled independently
- L (R) ENG switches on ANTI-ICE control panel
- Located on center pedestal




## B. NACELLE ANTI-ICING VALVES

- Located on top of each engine downstream of high-pressure duct
- Electrically operated and pneumatically controlled
- Fail safe open feature incorporated
- Direct hot bleed air to piccolo tube

## C. ENGINE NACELLE DUCTING

**Air Flow Path:**

- Hot bleed air directed to piccolo tube
- Sprayed onto inner surface of nacelle leading edge
- Air discharged overboard through exhaust duct
- Exhaust duct located at bottom of nacelle inlet

## D. T2 SENSOR

**Sensor Function:**

- Installed in inlet housing of each engine
- Senses engine inlet total air temperature (TAT)
- Supplies inlet TAT data to electronic control units (ECU)
- In-control ECU uses TAT data for power control

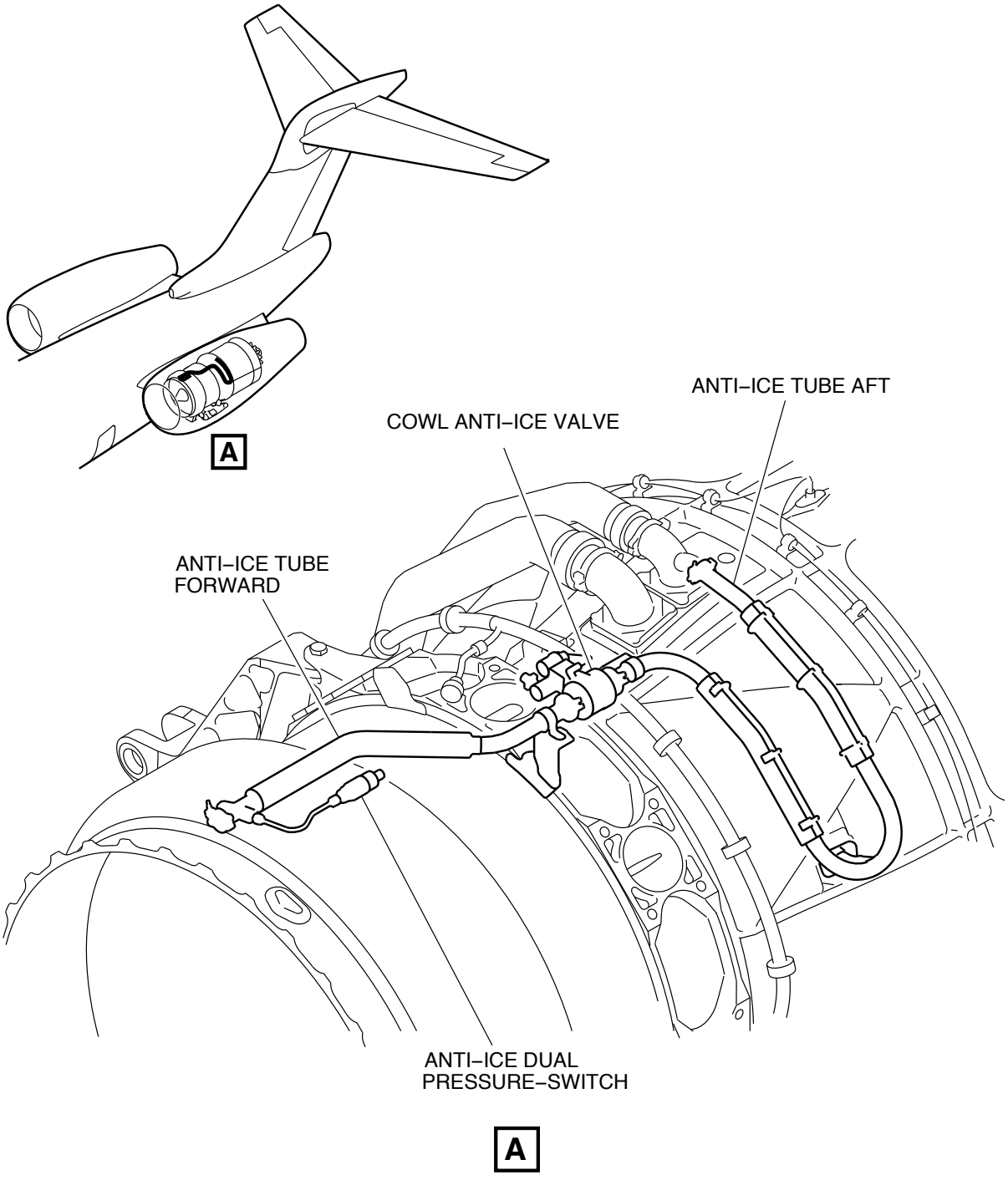
**Sensor Components:**

- Two resistance temperature devices
- Heat device for anti-ice protection
- Anti-ice function controlled from L (R) ENG switches



## E. ENGINE SPINNER

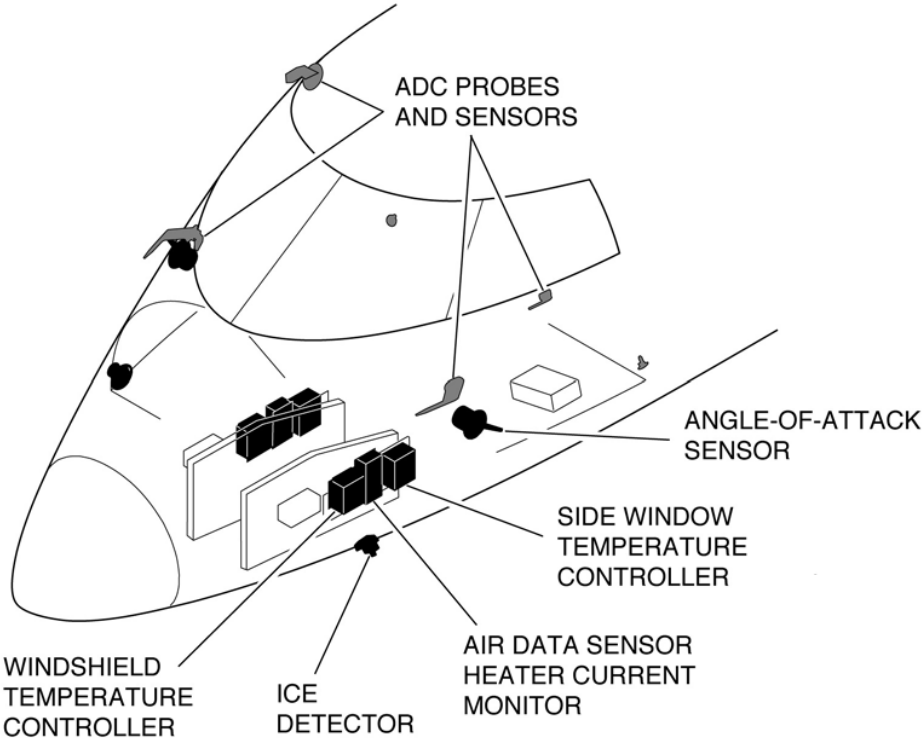
- Two-piece aluminum forging with conical shape
- Provides surface that sheds ice naturally
- Operates without anti-icing heating requirement



# V. AIR DATA AND ANTI-ICE SENSORS

## A. SYSTEM DESCRIPTION

- Air data probes and sensors located on aircraft nose sides
- Electrically heated to prevent ice formation
- Separate air data sensor heat controllers
- Control and monitoring of probe heaters
- L (R) PROBES switches on ANTI-ICE control panel




## B. HEATED COMPONENTS

**When PROBES Switch Selected ON:**

- Left and right standby static ports
- Left and right AOA sensors
- Left and right pitot-static probes
- TAT probe
- Standby pitot probe
- Failure signals DCU for appropriate EICAS message




Pitot Static Probe

### C. PITOT STATIC PROBES

- Two pitot static masts (one per aircraft side)
- Each mast consists of head and mounting base
- Two heaters per mast (head and base)

### D. STANDBY PITOT PROBE

- One standby pitot probe on left side of aircraft nose

### E. STANDBY STATIC PORTS

- One flush static port located on each aircraft side

### F. ANGLE-OF-ATTACK VANES (AOA)

- Located on each aircraft side under side windows
- Positioned behind pitot tubes
- Heated when activated by PROBES switch

### G. TOTAL AIR TEMPERATURE PROBE (TAT)

- One TAT sensor on right side of aircraft
- TAT heater operates in flight only




Standby Pitot Tube



Standby Static Port

## VI. WINDSHIELD ICE AND RAIN PROTECTION

### A. SYSTEM DESCRIPTION

- Windshield and side window heating system
- Two windshields and two side windows included
- Embedded heater elements and sensor elements
- Rain resistant coating treatment applied

### B. WINDSHIELD AND SIDE WINDOW HEATING

**Heater Element Configuration:**

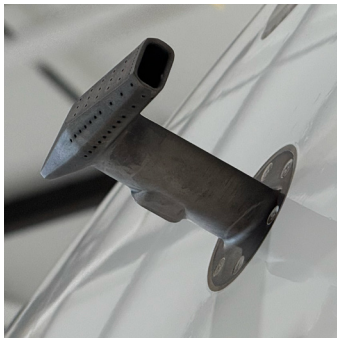
- Windshield heater elements segmented into three sections
- Concentration of heating in smaller windshield area
- Visibility maintenance in severe icing conditions
- Side window heater elements without segmentation

Temperature Control:

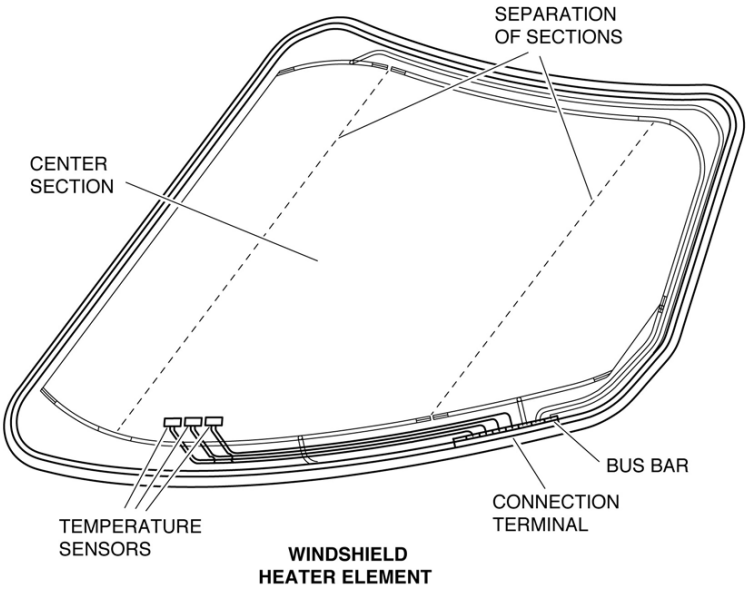
- Temperature controllers (one per windshield and window)
- Monitor electrical resistance of embedded temperature sensors
- Cycle power on and off to maintain predetermined temperature
- Super-cooled large droplet icing (SLD) indication possible



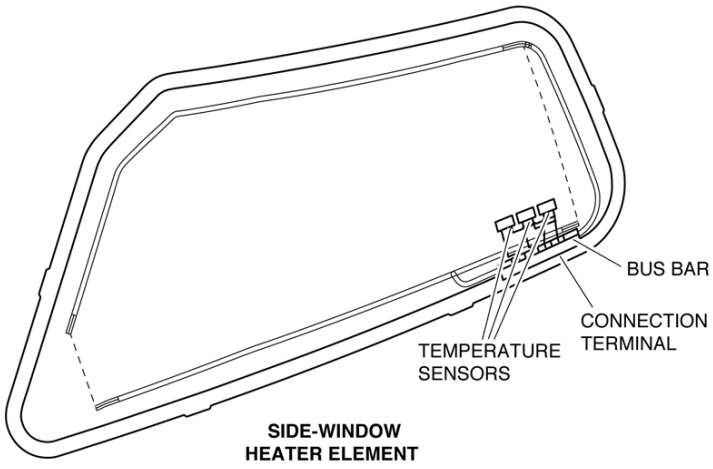

AOA Vane



TAT Probe




**WINDSHIELD HEATER ELEMENT**

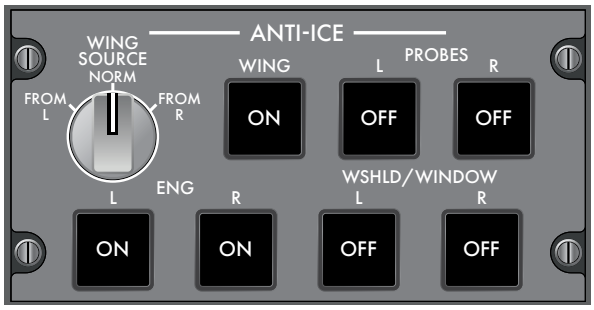



**SIDE-WINDOW HEATER ELEMENT**

## C. CONTROL SWITCHES AND FUNCTION

**Switch Operation:**

- L WSHLD/WINDOW switch controls left windshield and window
- R WSHLD/WINDOW switch controls right windshield and window
- Switches located on ANTI-ICE panel




**Overheat Protection:**

- Overheat protection circuits for each surface
- Power removal during overheat condition
- L (R) WSHLD/WINDOW off position de-energizes surface
- Temperature controller reset capability

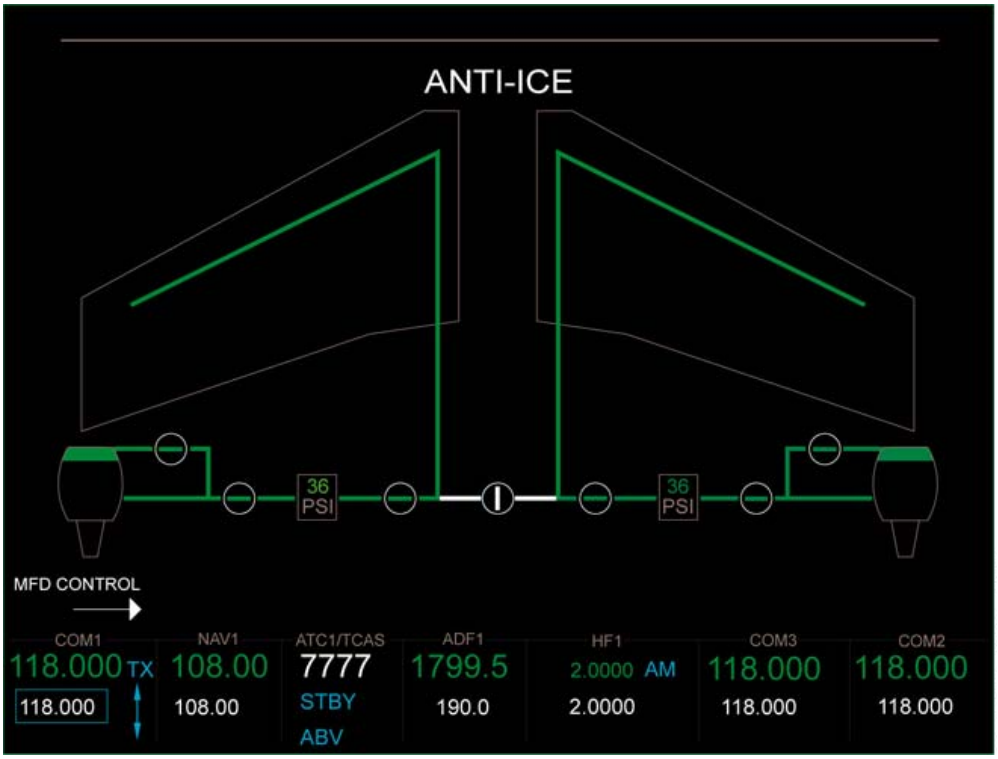
# VII. CONTROLS AND INDICATIONS

## A. ANTI-ICE CONTROL PANEL

- Located on center pedestal
- Controls operation of anti-ice systems
- WING push button switch
- WING SOURCE rotary switch (FROM L, NORM, FROM R)
- L (R) ENG push button switches
- L (R) PROBES switches
- L (R) WSHLD/WINDOW switches

## B. ANTI-ICE SYNOPTIC PAGE

- Monitors pneumatically operated anti-icing systems
- Ice detection system display
- Anti-ice system operation and fault presentation
- Visual confirmation of system status



# VIII. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| **WING ANTI–ICE LEAK** | A leak has been detected from the wing anti–ice ducting | TO/LAND |
| **L (R) WING OVERHEAT** | A wing anti–ice overheat condition exists in the indicated wing | — |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **L (R) AOA VANE HEAT FAIL** | The respective angle–of–attack vane heater has failed | TO/LAND |
| **L (R) ENG ANTI–ICE FAIL** | Bleed air pressure to the respective nacelle is too low for effective anti–icing, or the electrically heated T2 heater has failed when the respective L or R ENG switch is ON | TO/LAND |
| **ICE DETECTED** | Ice has been detected, and both the engine and wing anti–ice systems are not selected on | TO/LAND |
| **ICE DETECTOR FAIL** | Both ice detectors have failed | TO/LAND |
| **L (R) PITOT HEAT FAIL** | The respective pilot mast or base heater has failed | TO/LAND |
| **L (R) PROBE HEAT OFF** | Probe heat is off | TO/LAND |
| **STBY PITOT HEAT FAIL** | The standby pitot heater has failed | TO/LAND |
| **L (R) STBY STAT HT FAIL** | The respective standby static heater has failed | TO/LAND |
| **L (R) WING A/I LOW TEMP** | Indicates that the respective wing has an anti-ice low temperature condition | TO/LAND |
| **L (R) WING ANTI-ICE FAIL** | The respective anti-ice system has failed | TO/LAND |
| **L (R) WINDOW HEAT FAIL** | The respective window heat has failed and the temperature is too low or too high. A failure may also be indicated by the formation of condensation (fog) on the window | TO/LAND |
| **WING ANTI-ICE FAULT** | Both outboard wing leading–edge sensors have failed | TO/LAND |
| **L (R) WING A/I PRESS HI** | The pressure sensed in the wing anti–ice system is too high | TO/LAND |
| **L (R) WSHLD HEAT FAIL** | The respective window heat has failed, and the temperature is too low or too high. A failure may also be indicated by the formation of ice or condensation (fog) on the windshield | TO/LAND |

## C. ADVISORY MESSAGES

### ADVISORY MESSAGES

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| L (R) AOA CASE HEAT FAIL | The respective angle–of–attack case heater has failed | TO/LAND |
| L (R) ENG A/ICE FAIL ON | The respective engine nacelle anti–ice has failed ON. If the T2 probe heater has failed ON, an amber "T2" icon will be displayed on the anti–ice synoptic. If engine anti–ice bleed air has failed ON, a green flow line will be displayed downstream of the failed anti–ice valve on the synoptic | TO/LAND |
| ICE DETECTED | Ice has been detected, and both the engine and wing anti–ice systems are selected on | TO/LAND |
| ICE DETECTOR FAULT | One ice detector has failed; the other should continue to operate normally | TO/LAND |
| L (R) PROBE HT CTRL FAIL | The respective probe heat controller has failed. The probe heat will fail ON | TO/LAND |
| TAT HEAT FAIL | The total air temperature probe heater has failed | TO/LAND |
| WING SOURCE–XBLEED | Wing crossbleed valve is open and wing source selection is in NORM | TO/LAND |
| WING ANTI–ICE FAULT | One channel has failed on the outboard wing leading–edge sensor. The wing anti–ice should work normally | TO/LAND |
| WING A/ICE LOOP FAIL | One wing anti–ice leak detection loop has failed | TO/LAND |

## D. STATUS MESSAGES

| STATUS MESSAGES | | |
|---|---|---|
| Information only - no crew action required | | |
| **Message** | **Meaning** | **Inhibits** |
| **L (R) ENG ANTI–ICE ON** | The respective (or both) ENG ANTI–ICE switch(es) is/are ON | — |
| **ENG ANTI–ICE ON** | The respective (or both) ENG ANTI–ICE switch(es) is/are ON | — |
| **PROBE HEAT TEST OK** | Air data probe heat test (PROBES test) completed successfully — separate from ICE DET test | — |
| **WING ANTI–ICE ON** | The WING ANTI–ICE switch is selected ON | — |
| **WING/ENG ANTI–ICE ON** | The wing and both engine anti–ice systems are ON | — |
| **WING SOURCE–XBLEED** | Either FROM L or FROM R has been selected on the ANTI–ICE WING SOURCE switch | — |

### NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- L (R) notation indicates the message can appear for either left or right engine/system
- Ice detection is provided by two vibrating probe detectors for redundancy
- Wing anti-ice system uses high-pressure engine bleed air for heating
- Probe heating systems are electrically powered
- Windshield heating elements are segmented into three sections per windshield

# IX. LIMITATIONS

## A. OPERATION IN ICING CONDITIONS

| Condition | Requirement |
|---|---|
| Flap Extension | Do not hold in icing conditions with flaps extended |
| SLD Icing Indication | Flight in super-cooled large droplet icing (SLD) may be indicated by side window ice accretion |
| When Side Window Icing Observed | Wing and engine anti-icing systems must be ON |
| SLD Icing Action | Leave icing conditions as soon as possible |

## B. ENGINE ANTI-ICE LIMITATIONS

| Ground Operations | |
|---|---|
| Temperature | Engine anti-icing system must be ON when OAT 10°C (50°F) or below |
| Moisture | Visible moisture present (fog, rain, snow, sleet, ice crystals) |
| Visibility | Fog with visibility one mile (1,500 m) or less |
| Surface | Operating on surfaces with snow, ice, water, or slush |

| In-Flight | |
|---|---|
| Temperature | Engine anti-icing system must be ON when OAT 10°C (50°F) or below and visible moisture present |
| Ice Crystals | Ice crystals are encountered |

## C. WING ANTI-ICE LIMITATIONS

| Ground Operations | |
|---|---|
| Temperature | Wing anti-icing system must be ON for takeoff when OAT 5°C (41°F) or below |
| Moisture | Visible moisture present (fog, rain, snow, sleet, ice crystals) |
| Visibility | Fog with visibility one mile or less |
| Surface | Operating on surfaces with snow, ice, water, or slush |

| In-Flight | |
|---|---|
| Temperature | In-Flight: Icing conditions exist when TAT is 10 °C (50 °F) or below and visible moisture in any form is encountered (clouds, rain, snow, sleet, or ice crystals), except when SAT is -40 °C (-40 °F) or below. Wing anti-icing system must be ON when below 210 KIAS and in icing conditions or anytime when the ICE DETECTED CAS message is on." |

## D. WING ANTI-ICE PRESSURE LIMITATIONS

| Parameter | Limitation |
|---|---|
| High Pressure Valve Limit | High pressure valves limit pressure to 36 ±3 psi |
| Pressure Warning Threshold | Caution message at pressure exceeding 46 psi |

## X. ICE and RAIN SYSTEM CIRCUIT BREAKERS

Ice and Rain System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| WING A/I VALVE L | LEFT ESS | CB1-H1 |
| WING A/I VALVE R | RIGHT ESS | CB2-H1 |
| ENGINE A/I L | LEFT ESS | CB1-H2 |
| ENGINE A/I R | RIGHT ESS | CB2-H2 |
| PITOT HEAT L | LEFT ESS | CB1-H3 |
| PITOT HEAT R | RIGHT ESS | CB2-H3 |
| AOA HEAT L | LEFT ESS | CB1-H4 |
| AOA HEAT R | RIGHT ESS | CB2-H4 |
| STATIC HEAT L | LEFT ESS | CB1-H5 |
| STATIC HEAT R | RIGHT ESS | CB2-H5 |
| WINDSHIELD HEAT L | LEFT MAIN | CB3-H6 |
| WINDSHIELD HEAT R | RIGHT MAIN | CB4-H6 |
| WINDOW HEAT L | LEFT ESS | CB1-H7 |
| WINDOW HEAT R | RIGHT ESS | CB2-H7 |

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## XI. ICE and RAIN QUIZ

1. How many ice detectors are installed on the Challenger 350?

    A) One detector
    B) Two detectors
    C) Three detectors
    D) Four detectors

2. What type of technology do the ice detectors use?

    A) Infrared sensing
    B) Vibrating probe
    C) Capacitive sensing
    D) Optical detection

3. What is the source of anti-icing for the wing leading edges?

    A) Electrical heating elements
    B) Hot oil circulation
    C) High-pressure engine bleed air
    D) Hydraulic fluid heating

4. How many zones are monitored by the bleed leak detection system?

    A) Two zones
    B) Four zones
    C) Six zones
    D) Eight zones

5. What controls the operation of the wing anti-ice system?

    A) Single-channel controller
    B) Dual-channel IASC
    C) Manual pilot control only
    D) Engine ECU

6. At what pressure do the high pressure valves limit engine bleed air?

    A) 30 ±3 psi
    B) 33 ±3 psi
    C) 36 ±3 psi
    D) 39 ±3 psi

7. How many heater sections are in each windshield?

    A) Two sections
    B) Three sections
    C) Four sections
    D) Five sections

8. What happens when a leak is detected downstream of the high pressure valve?

A) Manual pilot action required
B) System continues operating
C) IASC automatically closes wing anti-ice valves
D) Engine shutdown required

9. Which probe heater operates in flight only?

A) Pitot probe heater
B) AOA vane heater
C) Static port heater
D) TAT probe heater

10. What is the maximum OAT for mandatory engine anti-ice operation on the ground?

A) 5°C (41°F)
B) 10°C (50°F)
C) 15°C (59°F)
D) 20°C (68°F)

11. How many temperature sensors monitor each wing section?

A) Single sensor
B) Dual sensors
C) Triple sensors
D) Four sensors

12. What indicates super-cooled large droplet icing conditions?

A) Wing leading edge ice
B) Engine inlet ice
C) Side window ice accretion
D) Pitot probe ice

13. What type of valve operation is used for nacelle anti-icing valves?

A) Hydraulically operated
B) Pneumatically operated
C) Electrically operated and pneumatically controlled
D) Manually operated

14. Which EICAS message indicates both ice detectors have failed?

A) ICE DETECTOR FAULT
B) ICE DETECTOR FAIL
C) ICE DETECTION LOST
D) ICE SYSTEM FAIL

15. What happens to wing anti-ice valves when electrical power is lost?

A) Valves remain in last position
B) Valves open fully
C) Valves close (spring-loaded closed)
D) Valves cycle continuously

16. How is the engine spinner protected from ice?

A) Electrical heating
B) Bleed air heating
C) Hot oil circulation
D) Conical shape sheds ice naturally

17. What triggers a L (R) WING A/I PRESS HI caution message?

A) Pressure below 30 psi
B) Pressure below 36 psi
C) Pressure exceeding 46 psi
D) Pressure exceeding 50 psi

18. Which component provides inlet TAT data to the ECU?

A) Pitot probe
B) Static port
C) AOA vane
D) T2 sensor

19. What should be done when side window icing is observed?

A) Continue normal operations
B) Turn off anti-ice systems
C) Turn on anti-ice systems and leave icing conditions
D) Land immediately

20. How many pitot static masts are installed on the aircraft?

A) One mast
B) Two masts
C) Three masts
D) Four masts

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CL-350



CL-350 TRAINING MANUAL

# ENVIROMENTAL 10

## AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

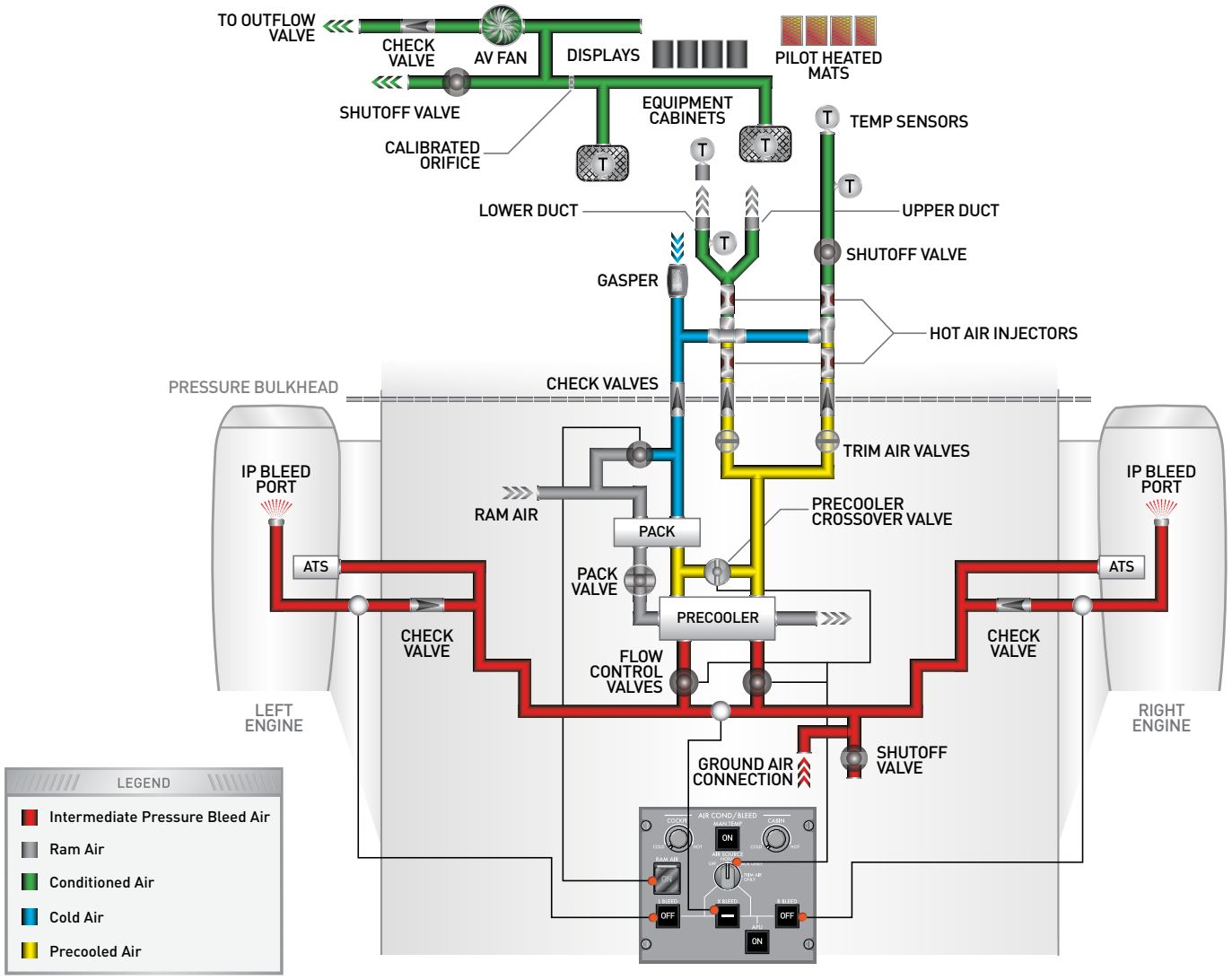
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# ENVIRONMENTAL

## I. INTRODUCTION

The Challenger 350 environmental control system uses hot pressurized bleed air to create a controlled atmosphere within the aircraft. Pressurized air from either the engines, APU, or a ground cart is sent through an air cycle machine (PACK) which cools the air to just above freezing. This cold air is then mixed with hot trim air to provide conditioned air at the desired temperature. Two integrated air system controllers (IASC) control a series of bleed air valves, flow control valves, the air cycle machine, the trim air valves, and the ram air regulating valve, managing the bleed leak detection, wing anti-ice and cabin pressurization functions throughout all phases of flight.

### COCKPIT/CABIN AIR DISTRIBUTION SCHEMATIC



## A. ENVIRONMENTAL SYSTEM SPECIFICATIONS

Environmental Control System Specifications

| Parameter | Value |
|---|---|
| System Type | Integrated air system with PACK and Trim Air |
| System Controllers | Two IASCs (Integrated Air System Controllers) |
| IASC Locations | One under floor, one under lavatory liner above floor |
| IASC 1 Channel A | Air conditioning control/monitoring, avionics cooling, cabin pressurization |
| IASC 1 Channel B | Wing anti-ice control/monitoring, bleed leak detection, backup control, backup cabin pressure sensor |
| IASC 2 Channel A | Air conditioning control/monitoring, avionics cooling, cabin pressurization |
| IASC 2 Channel B | Wing anti-ice control/monitoring, bleed leak detection, limited backup control |
| Temperature Control | Independent COCKPIT and CABIN zones |
| Temperature Control Range (Normal) | 15°C to 35°C |
| Temperature Control Range (Manual) | 10°C to 70°C |
| Control Modes | Automatic and Manual |
| Bleed Air Sources | Left/Right engines, APU, or ground cart |
| Bleed Leak Detection Zones | Eight zones for EICAS presentation |
| Engine Bleed Pressure Regulation | 50±3 psi |
| Bleed Fail Pressure Threshold | >60 psi |
| APU Bleed Air Availability | Up to 20,000 ft |
| Ram Air Valve Availability | Below 10,000 ft |
| Air Cycle Machine | Single PACK for air conditioning |
| Distribution System | Dual duct system with upper and lower distribution |
| Gasper Air Supply | Cold air only |
| Avionics Fan High Speed Trigger | 122°F (50°C) in 60 seconds |
| Avionics Cooling Valve Opens | 149°F (65°C) in 60 seconds above 10,000 ft |

# II. BLEED AIR SYSTEM

## A. SYSTEM DESCRIPTION

- High pressure (HP) bleed air from engines routed through HP valves and ducting to wing anti-ice system
- Intermediate pressure (IP) air from engines routed through IP valves to environmental control system (ECS)
- IP air supplies common manifold isolated left and right by cross bleed valve
- Manifold can be supplied by auxiliary power unit (APU) or external ground cart
- Regulating valves and check valves installed in aft equipment bay ducting
- Leak detection system monitors all bleed air ducting
- Pressure sensors in bleed air lines send information to IASC for EICAS display

Bleed Air System Specifications

| Parameter | Value |
|---|---|
| Bleed Air Sources | Left/Right engines, APU, ground cart |
| Bleed Valves | Electrically controlled, pneumatically operated |
| Crossbleed Valve | Connects left and right systems |
| Leak Detection Zones | Eight zones with dual-loop sensors |
| Leak Detection System | IASC controlled, fully automatic |
| Flow Control Valves | Two FCVs for PACK and TRIM AIR |
| Pre-cooler Crossover Valve | Directs flow to PACK or TRIM AIR |
| Ground Air Connection | External pneumatic supply port |

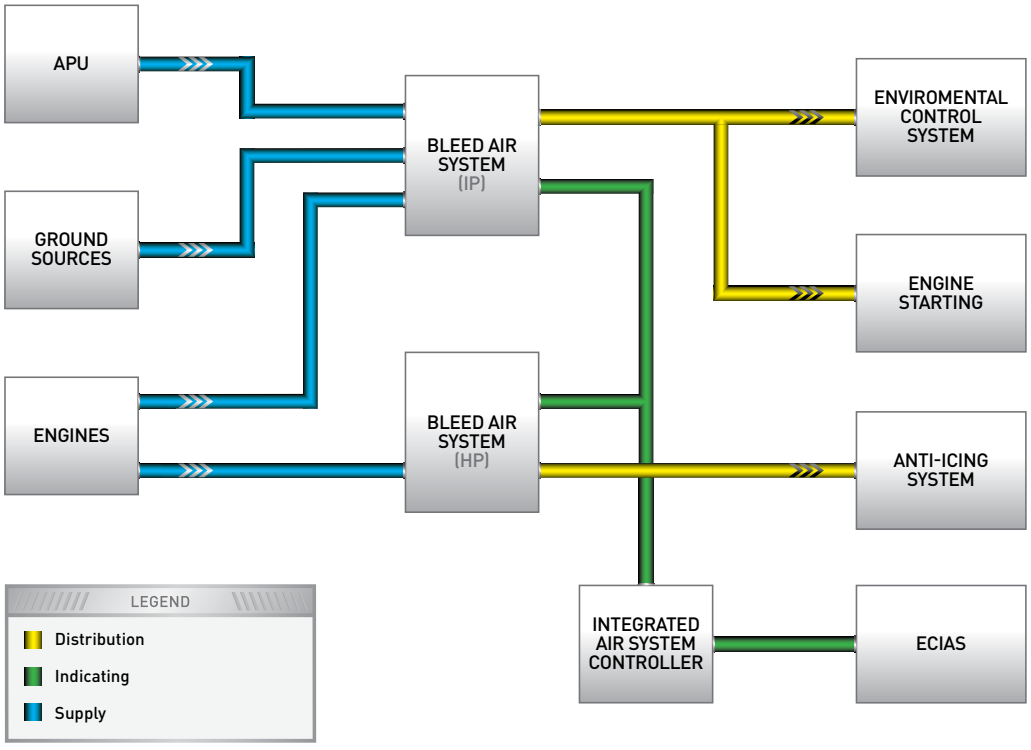
## B. BLEED AIR DISTRIBUTION

- Air for aircraft IP bleed air system distributed by common manifold

  **Bleed air management consists of:**

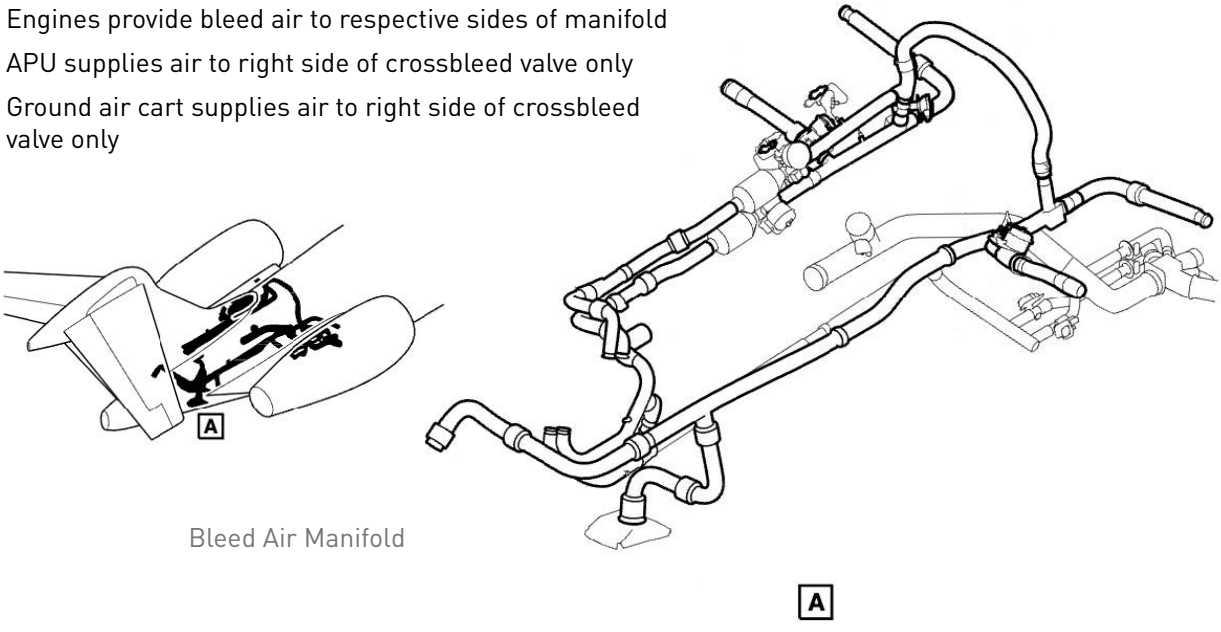
  - Bleed source selection
  - Valve operation
  - Air distribution
- Controlled by two integrated air system controllers (IASC)
- Pilot control from AIR COND/BLEED panel on center pedestal

BLEED AIR DISTRIBUTION




## C. BLEED AIR MANIFOLD

- Located in engine pylons and aft equipment bay
- Divided into right side and left side by crossbleed (XBLEED) valve
- Engines provide bleed air to respective sides of manifold
- APU supplies air to right side of crossbleed valve only
- Ground air cart supplies air to right side of crossbleed valve only




Bleed Air Manifold

## D. CHECK VALVES

**Four check valves installed in bleed air ducting:**

- Intermediate pressure check valve in each engine bleed air duct (prevents reverse flow into engines)
- Check valve at external ground air servicing connector (prevents air loss to atmosphere)
- Check valve in APU bleed air duct (prevents reverse flow to APU when shut down) (Check valves not depicted on ECS or ANTI-ICE synoptic displays)

## E. EXTERNAL GROUND AIR SERVICING

- Connector located to right of centerline towards rear fuselage
- Not depicted on ECS synoptic displays
- When connected, air pressure displayed as manifold pressure digital readout on ECS synoptic page

## F. BLEED AIR VALVES

**L (R) BLEED Valves**

- Controlled from AIR COND/BLEED control panel
- IASC 1 monitors left HP valve and left IP valve
- IASC 2 monitors right HP valve and right IP valve
- HP valves regulate HP bleed to 36±3 psi

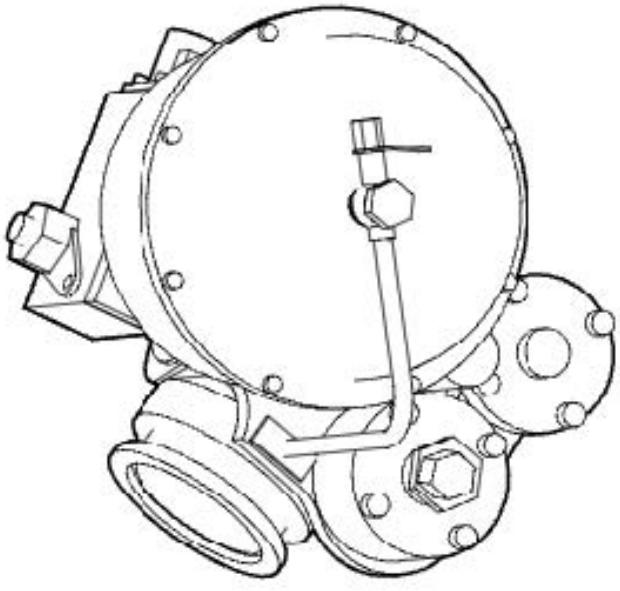
**XBLEED Valve**

- Controlled from AIR COND/BLEED control panel
- Enables cross-engine bleed operations

**APU BLEED Valve**

- Controlled via APU Electronic Control Unit (ECU)
- Amount of bleed air controlled by ECU sensing APU
- APU bleed switch on panel sends signal to ECU
- ECU determines when APU ready for bleed air loadir
- Controls opening, closing, and modulation of valve
- When open, delivers air to right side of bleed manifo
- Moves to fail-safe closed position when APU shut down or signal lost

High Pressure Bleed Valve



## G. ENGINE BLEED AIR PRESSURE REGULATION

- Engine air pressure increases in proportion with $N_2$ compressor speed
- IPV limits intermediate engine bleed pressure to 50±3 psi
- If valve fails and manifold pressure exceeds 60 psi: **L (R) BLEED FAIL** (C) CAS message displayed

Note: Under certain low thrust conditions (ground idle at high field elevations or idle with single bleed on), there may be insufficient pressure to keep the bleed valve open

## H. ENGINE START SEQUENCES

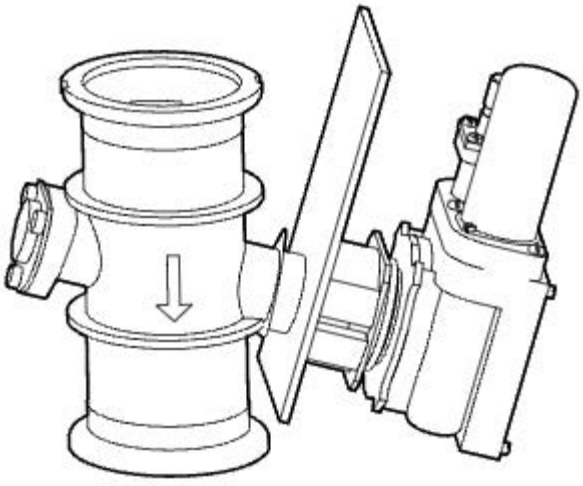
**When L (R) STARTER switch positioned to start:**

- Cross bleed valve opens (if previously closed)
- Flow control valves close (if previously opened)
- Associated start valve opens
- Engine air turbine starter (ATS) engages

**After engine achieves self-sustaining speed:**

- ATS disengages
- Start valve closes
- Flow control and cross bleed valves return to previous position

- Cross-engine bleed air can be used to power starter
- Interstage bleed air taken from selected engine for cross-engine bleed starting
- 32 psi minimum bleed pressure for crossbleed engine start; starting with a tailwind may require higher



Cross Bleed Valve

## I. APU/ENGINE BLEED SWITCHING

- All bleed switching done manually by aircrew from AIR COND/BLEED control panel

**Normal Takeoff and Landing Configuration:**

- APU bleed air switch ON
- Engine bleed air switches OFF
- XBLEED switch OPEN

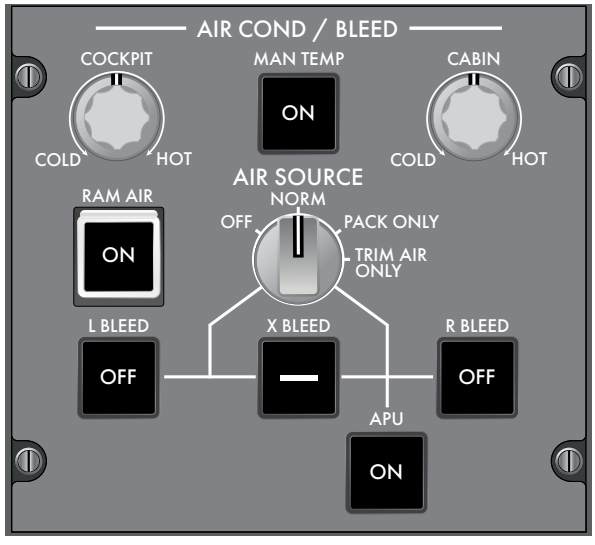
**During Climb:**

- XBLEED CLOSED
- L BLEED ON
- APU bleed OFF
- R BLEED ON
- APU OFF

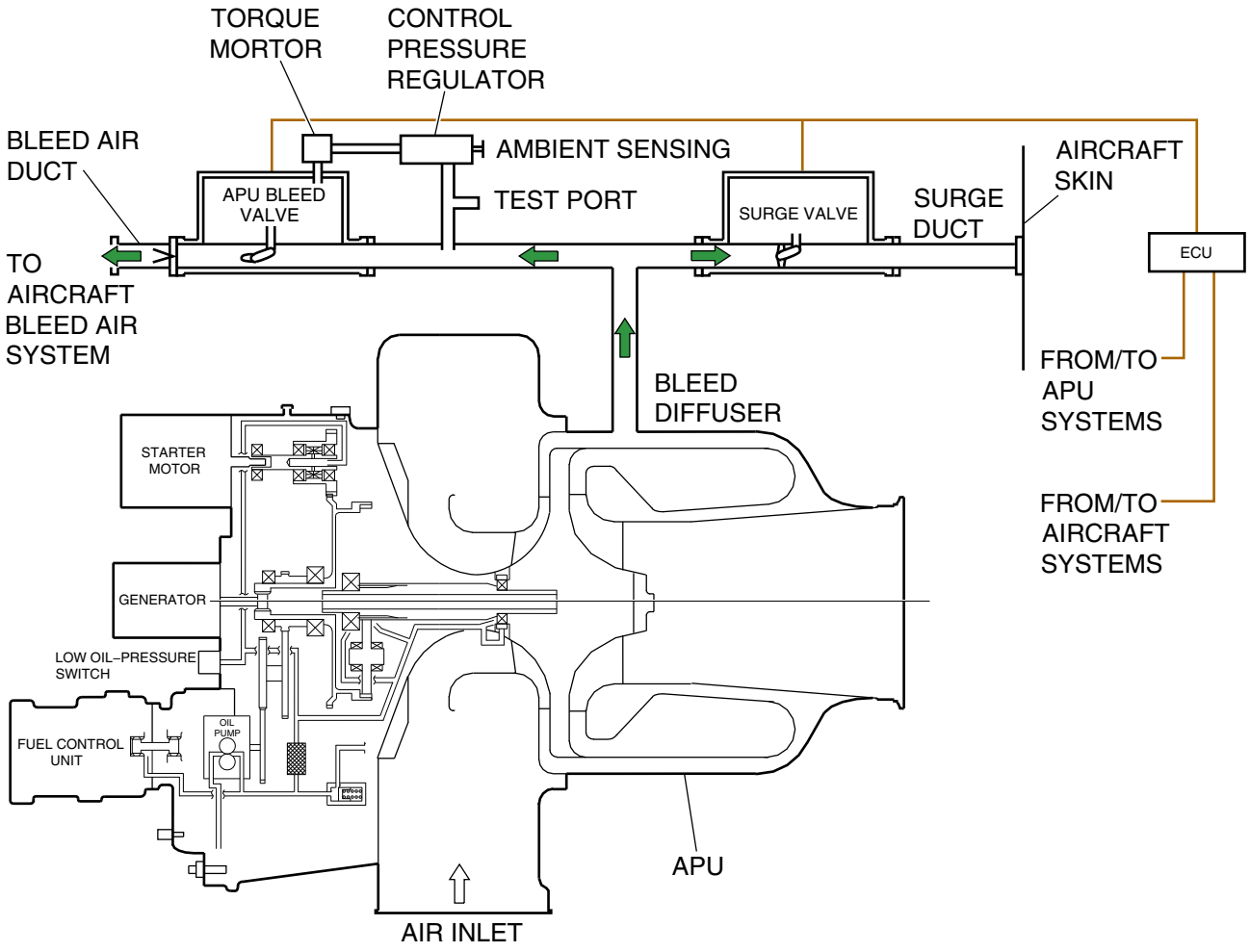
**During Approach:**

- Start APU
- R BLEED switch OFF
- APU BLEED ON
- L BLEED switch OFF
- XBLEED switch OPEN

- Sequence designed so that only one source of bleed air is feeding any given duct



## III. BLEED AIR LEAK DETECTION SYSTEM



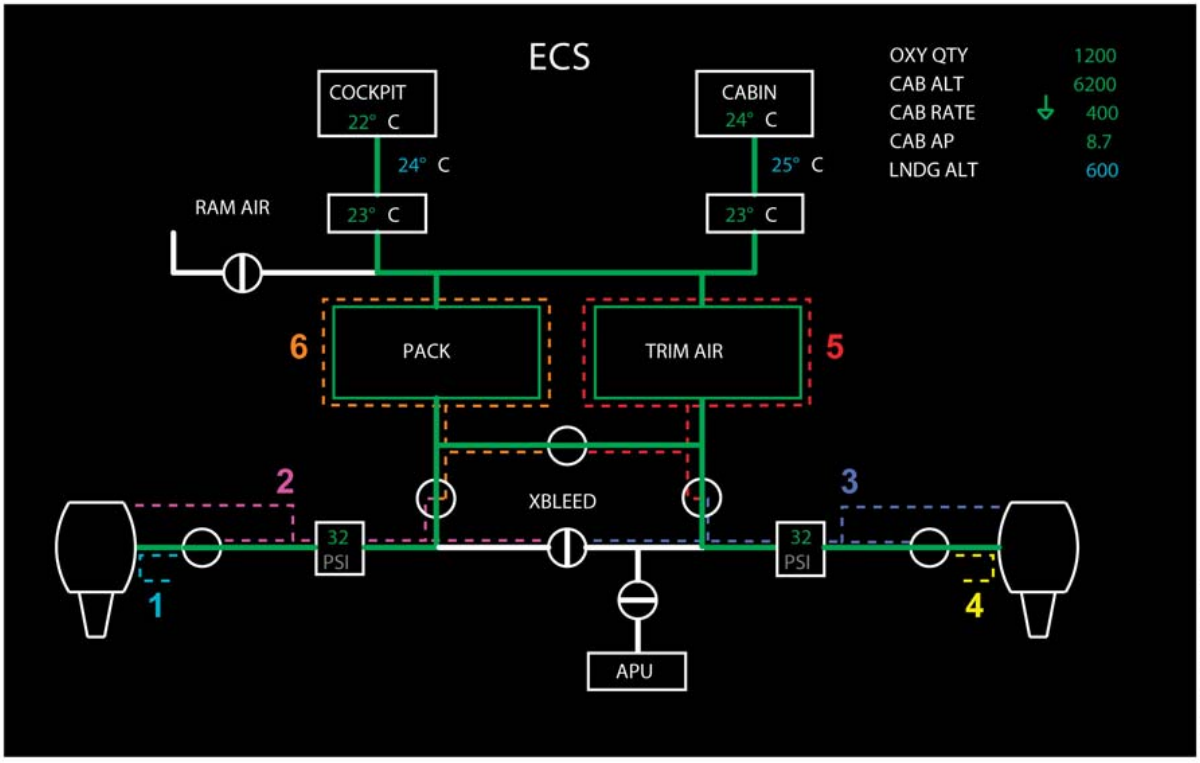

APU Bleed System

### A. SYSTEM DESCRIPTION

- Monitors bleed air and anti-ice ducts for leakage
- Controlled by integrated air system controllers (IASC)
- Fully automatic system
- Divided into eight zones for EICAS presentation

## B. EIGHT DETECTION ZONES

1. Left bleed duct
2. Right bleed duct
3. Left wing anti-ice duct
4. Right wing anti-ice duct
5. Right pylon duct
6. Left pylon duct
7. Pack ducts
8. Trim air ducts



## C. SINGLE LOOPS

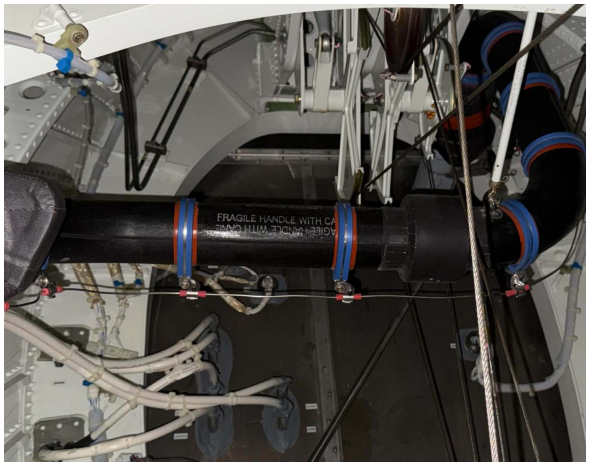
- Used for left and right bleed ducts
- Used for trim air ducts

## D. DUAL-SENSING LOOPS

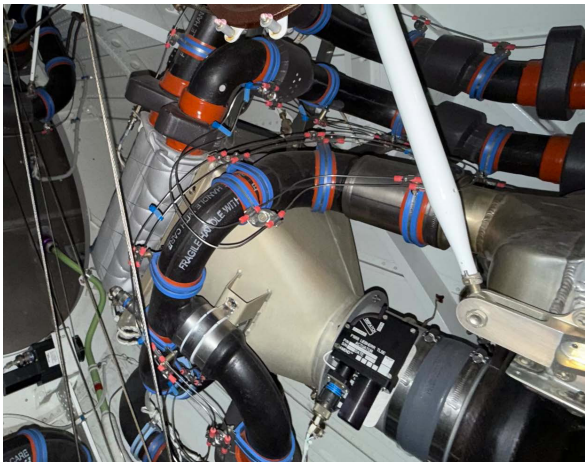
**Used to monitor:**

- Bleed air ducts in engine pylons
- Bleed air ducts in aft equipment bay
- Anti-ice ducts in aft equipment bay
- Anti-ice ducts in wing leading edges

- Dual-loop system minimizes false leak indications
- Allows aircraft dispatch under certain conditions with one loop inoperative
- Loop FAIL message indicates both loops inoperative
- Loop FAULT message indicates one loop inoperative



APU Single Bleed Loop



PACK Dual Bleed Loop

## E. DUCT CONSTRUCTION

- Bleed air ducts constructed of:
  - Stainless steel
  - Titanium
  - Aluminum
- Wrapped with insulation
- Series of vent holes in duct covers direct escaping bleed air to sensing loops

# IV. ENVIRONMENTAL CONTROL SYSTEM

## A. INTEGRATED AIR SYSTEM CONTROLLERS

- Two IASCs monitor and control air conditioning systems
- Each controller has two channels:
    - Channel A: Air conditioning control/monitoring, avionics cooling, cabin pressurization
    - Channel B: Wing anti-ice control/monitoring, bleed leak detection, limited backup air conditioning
- IASC 1 Channel B also has backup cabin pressure sensor

**Location of units:**

- One located under floor
- One under liner of lavatory, above floor

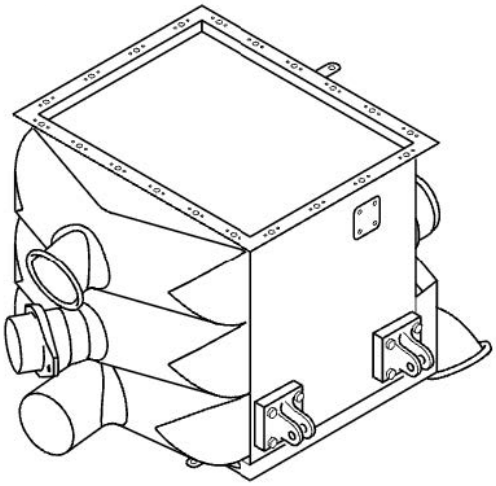
**Monitoring functions:**

- Collect data from air conditioning and bleed air control functions
- Monitor cabin pressure and airframe ice protection functions
- Pilot control of wing anti-ice from ANTI-ICE control panel on center pedestal

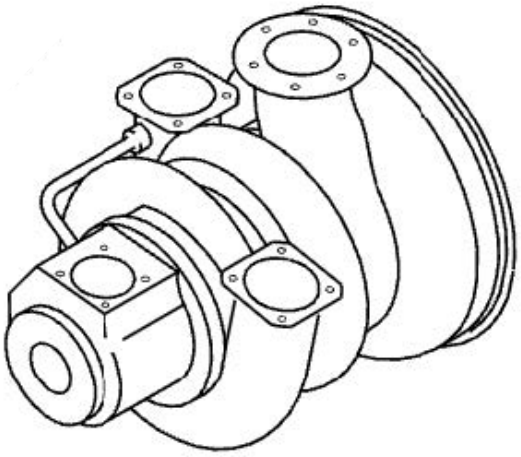
## B. AIR CONDITIONING PACK

The PACK, or Air Conditioning Unit, conditions bleed air from the engines to provide a comfortable cabin environment. After passing through the precooler, bleed air is first cooled in the primary heat exchanger, then compressed by the air cycle machine (ACM) compressor before passing through the secondary heat exchanger, where it sheds heat to ram air. It continues through the reheater/condenser, where water is extracted, and then expands across the ACM turbine, which both cools the air and reduces it to near-cabin pressure.

A final pass through the condenser heat exchanger enhances cooling efficiency. Outlet temperature is controlled by a modulating temperature control valve that blends in bypassed hot air as needed. Ram air drives the heat exchangers in flight, while the ACM fan pulls airflow on the ground. Flow control valves, commanded by the AIR SOURCE selector, regulate overall pack airflow to the cabin.

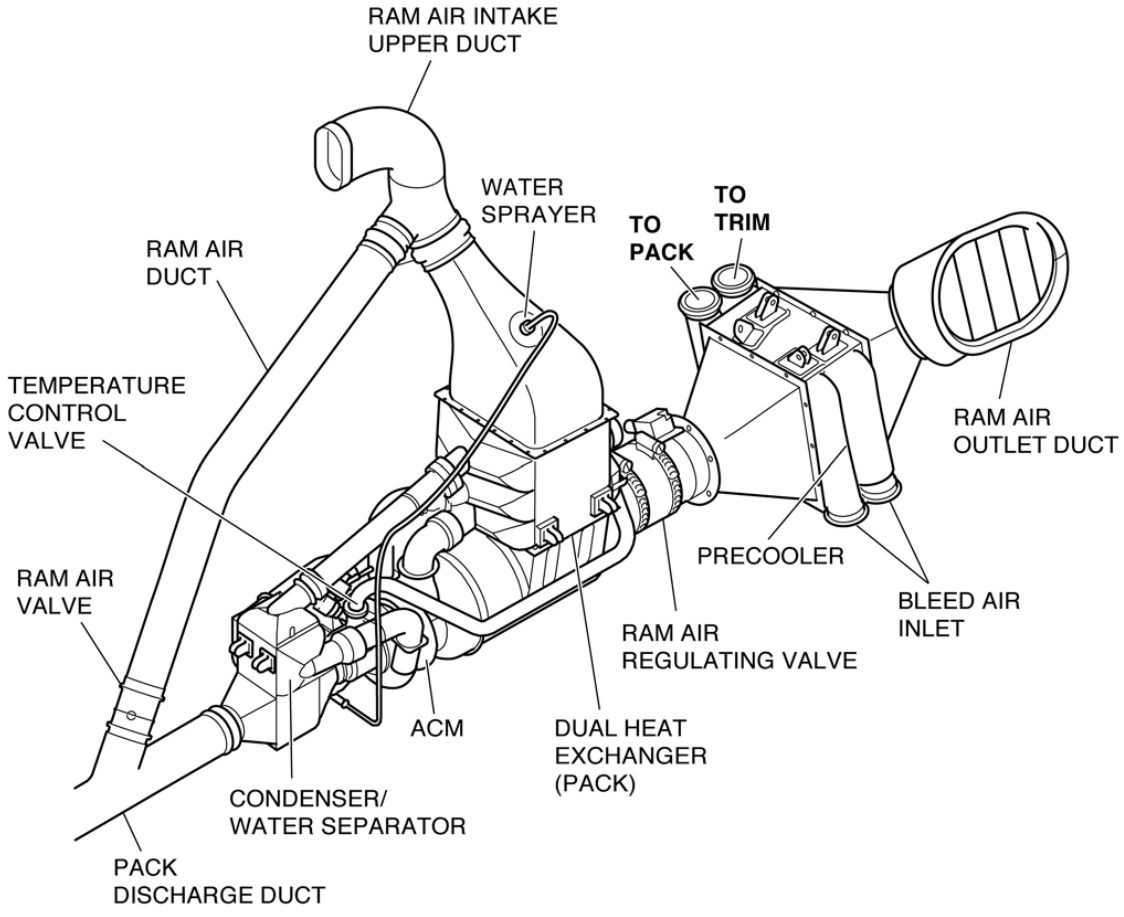


Dual Heat Exchanger



Air Cycle Machine

- Provides conditioned air for fuselage compartments
- Decreases temperature and water content of bleed air
- Supplied with pre-cooled bleed air for cabin air conditioning and cabin pressurization
- Air flow through PACK:
    - After passing through the precooler, bleed air enters at primary heat exchanger inlet
    - Primary heat exchanger reduces bleed air temperature
    - Air directed into compressor of air cycle machine (temperature and pressure increase)
    - Flows through secondary heat exchanger (pressure loss and temperature reduction)
    - Flows to reheater/condenser
    - Water extracted by centrifugal effect in water extractor
    - Routed to reheater cold air pass (temperature increases)
    - Expanded through turbine of air cycle machine to near cabin pressure
    - Temperature reduced at turbine outlet
    - Flows through condenser heat exchanger as coolant for water separation loop



Air Conditioning PACK Specifications

| Parameter | Value |
|---|---|
| Pack Type | Air cycle machine with turbine expansion |
| Heat Exchangers | Primary and Secondary dual heat exchangers |
| Pre-cooler | Dual pre-cooler heat exchanger |
| Water Extraction | Centrifugal water extractor |
| Temperature Control | Modulating temperature control valve |
| Ram Air Cooling | Ram air through heat exchangers |
| Ground Cooling | ACM-driven fan for static operation |
| Pack Outlet Temperature | Just above freezing |
| Flow Control Valves | Electrically controlled, pneumatically operated |

## C. TEMPERATURE CONTROL VALVE

- Adjusts air temperature at PACK outlet by opening or closing
- Modulates hot air flow
- Bypasses air cycle machine between primary heat exchanger inlet and turbine outlet

## D. FLOW CONTROL VALVES (FCVs)

- Control mass airflow through PACK and TRIM AIR system
- Electrically controlled, pneumatically operated, modulating shutoff valves
- Operated by AIR SOURCE selector on AIR COND/BLEED control panel

## E. RAM AIR COOLING

- Ram air supplied upstream of dual heat exchanger by ram air system
- Flows through dual heat exchanger and collected by plenum

**Ground operations:**

- Ram air flow generated by suction effect of air cycle machine fan
- Suction closes plenum check valve

**Flight operations:**

- Dynamic air available at ram air inlet
- Plenum check valve opens
- Air cycle machine fan bypassed
- Ram air driven by total pressure at ram air inlet
- Air ducted towards dual pre-cooler heat exchanger then overboard

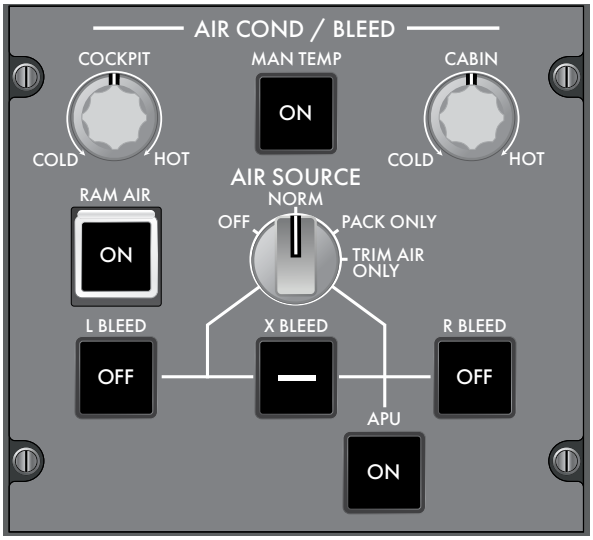
### F. TEMPERATURE CONTROL

- Independent temperature control for COCKPIT and CABIN
- Controlled in automatic and manual modes from AIR COND/BLEED panel

**Temperature ranges:**

- Normal mode: 15°C to 35°C
- Manual (MAN) mode: 10°C to 70°C

## V. AIR CONDITIONING CONTROLS




### A. CONTROL PANEL LOCATION

- AIR COND/BLEED panel on center pedestal

### B. TEMPERATURE SELECTORS

- Used to select desired temperature for cockpit and cabin
- MAN TEMP: Used when automatic temperature control using cabin or cockpit ventilation sensors not working

### C. AIR SOURCE SELECTOR POSITIONS

**OFF**

- Both flow control valves closed
- Prevents bleed air for pressurization and air conditioning from entering cabin
- AIR SOURCE OFF (S) CAS message displayed

**NORM**

- Normal switch position
- Allows bleed air from left and right sides of manifold
- Flow through PACK and TRIM AIR valves
- Provides conditioned air to cabin

**PACK ONLY**

- Opens left flow control valve
- Closes right flow control valve
- Closes precooler crossover valve (PCV)
- All bleed air flows through PACK
- None through trim air valves
- Used when TRIM AIR failure exists
- **PACK ONLY** (S) CAS message displayed

**TRIM AIR ONLY**

- Opens right flow control valve
- Closes left flow control valve
- Closes PCV
- All bleed air flows through trim air valves
- None through PACK
- Used when PACK failure exists

AIR SOURCE Selector Positions

| Position | Configuration |
|---|---|
| OFF | Both FCVs closed, no bleed air to cabin |
| NORM | Normal operation through PACK and TRIM AIR |
| PACK ONLY | Left FCV open, right FCV and PCV closed |
| TRIM AIR ONLY | Right FCV open, left FCV and PCV closed |

# VI. TRIM AIR SYSTEM

## A. SYSTEM DESCRIPTION

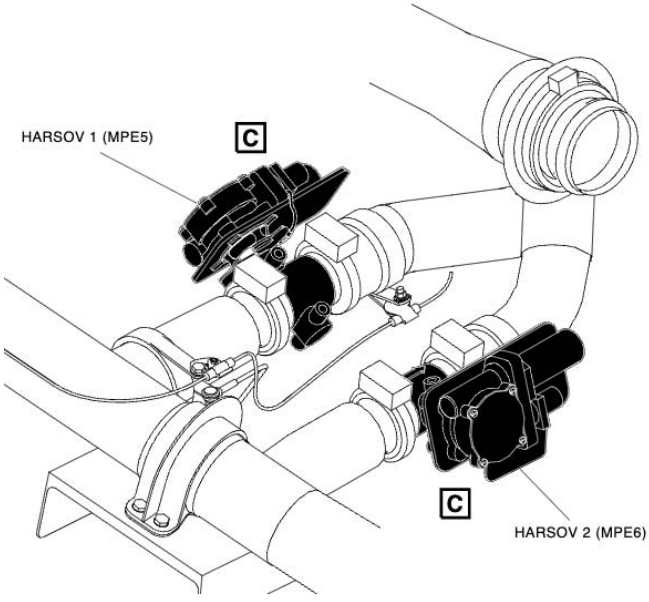
- Provides auxiliary pressurization and temperature control in event of complete PACK loss
- Provides hot trim air for normal cabin temperature control and cabin pressurization

## B. SYSTEM COMPONENTS

**Trim air ducting**

**Two Hot Air Regulating Shutoff Valves (HARSOV)**

- One for cabin low pressure distribution line
- One for cockpit low pressure distribution line
- Modulate hot air flow to adjust air supply temperature
- Ensure temperature control
- Fitted on trim air ducts in unpressurized aft equipment bay



**Two Hot Air Check Valves (HACKV)**

- Isolate pressurized area from unpressurized rear bay
- Prevent cabin decompression in case of trim air supply duct failure
- Located just downstream from trim air bulkhead

**Three Trim Air Injectors**

- Two for cabin supply
- One for cockpit supply

- Most components located in aft equipment bay

## C. SYSTEM OPERATION

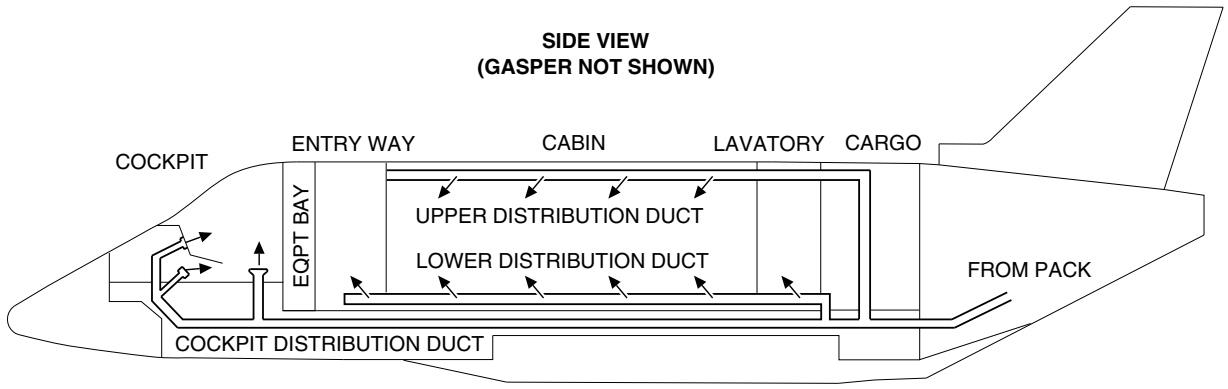
**Air ducted from precooler outlet (trim air side) towards two lines:**

- Line feeding cabin low pressure distribution through two cabin trim air injectors
- Line feeding cockpit low pressure distribution through one cockpit trim air injector

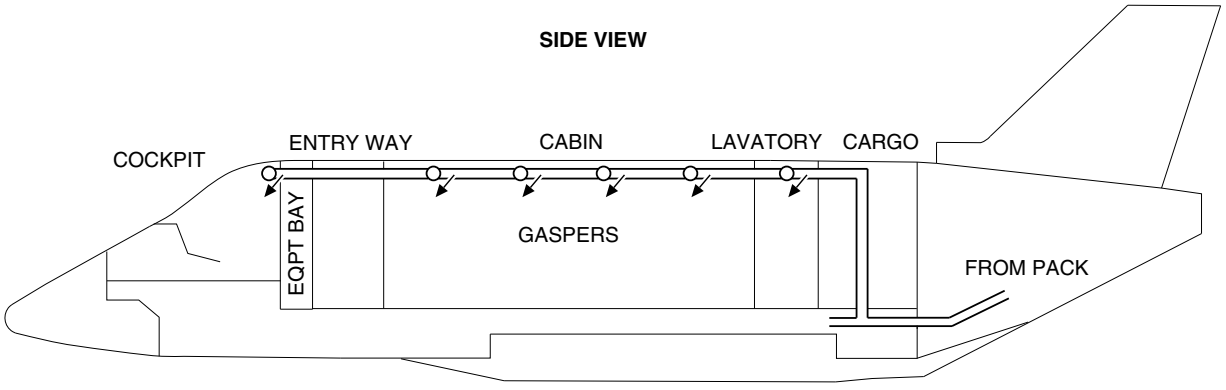
Trim Air System Specifications

| Parameter | Value |
|---|---|
| Function | Temperature control and auxiliary pressurization |
| Hot Air Regulating Shutoff Valves | Two HARSOVs (cockpit and cabin) |
| Hot Air Check Valves | Two HACKVs for bulkhead isolation |
| Trim Air Injectors | Three (two cabin, one cockpit) |
| Installation Location | Aft equipment bay |
| Air Source | Pre-cooler outlet (trim air side) |
| Distribution | Separate cockpit and cabin lines |
| Temperature Modulation | HARSOV valve positioning |

# VII. AIR DISTRIBUTION AND EXHAUST SYSTEM




CABIN DISTRIBUTION SYSTEM




## A. SYSTEM DESCRIPTION

- Distributes and exhausts conditioned air to and from the flight deck, cabin, and lavatory areas
- Consists of low-pressure ducting installed below and above aircraft floor

## B. FLIGHT DECK DISTRIBUTION

**Conditioned air distributed by:**

- Duct connected to bulkhead check valve manifold
- Runs under aircraft floor from aft pressure bulkhead area to cockpit

**Distribution outlets:**

- Foot and leg level on each side of instrument panel
- Grill outlet on each side console
- Overhead gaspers (cold air only)
- All outlets except gaspers are temperature controlled

## C. PASSENGER CABIN DISTRIBUTION

- Two main ducts connected to bulkhead check valve manifold provide air at:
    - Foot level (temperature controlled)
    - Head Level via gaspers

  **Upper feed line:**
    - Runs upwards between aircraft skin and liner of cargo compartment
    - Integral to interior furniture on either side of aircraft at head level
- Overhead gaspers: Cold air only

## D. LAVATORY VENTILATION

- Gasper supplies fresh air to lavatory compartment
- More air exhausted underfloor than supplied by conditioned air system
- Prevents unpleasant odors in passenger cabin
- Vent installed in lavatory wall to equalize pressure

## E. AIR EXHAUST AND VENTILATION PATH

- Fresh air supplied to cabin and cockpit dumped overboard through cabin pressure control system
- Air path designed for optimum comfort and equipment ventilation management

**Cabin exhaust air:**

- To under-floor area and outflow valve through holes in floor sill
- Some directed under floor to ventilate and heat battery compartment
- Then directly dumped overboard through avionic valve

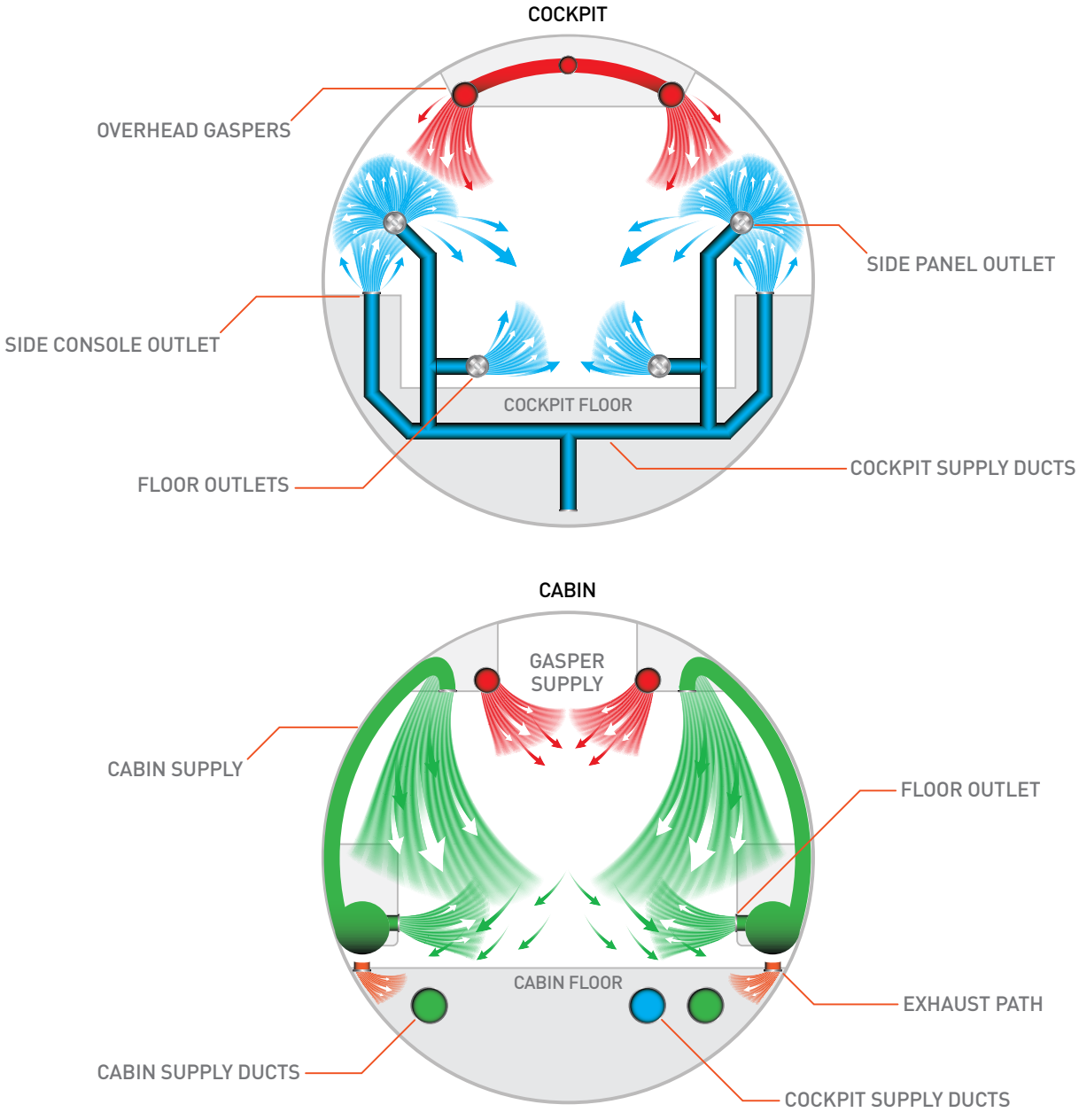
**Cockpit exhaust air:**

- To under-floor area and outflow valve through holes in cockpit floor
- Through holes in center pedestal
- Air circulation provided at back of cockpit display through specially designed grilles

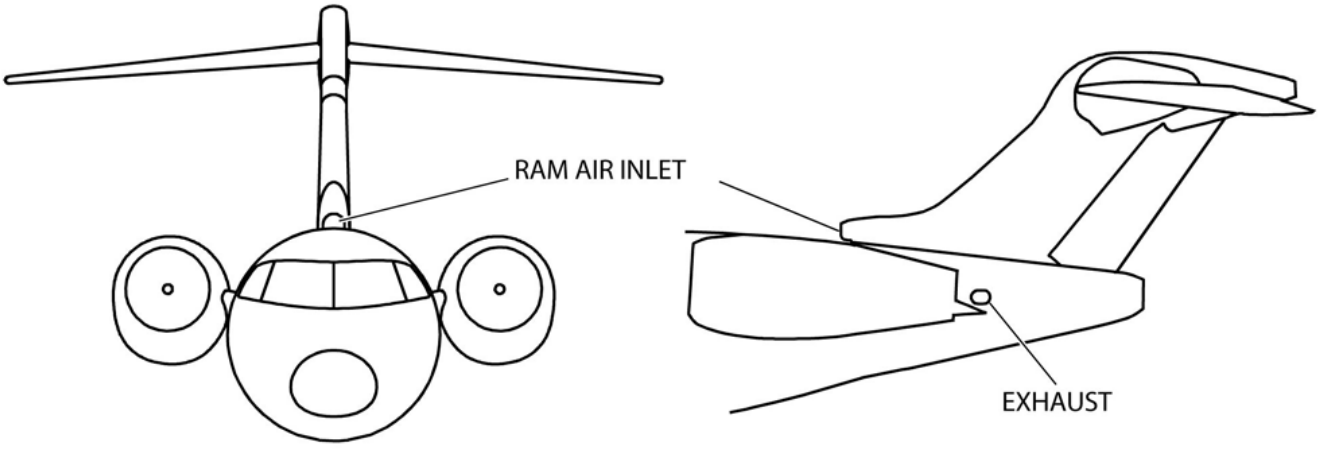
## F. AIR DISTRIBUTION FLOW PATHS

- Cockpit distribution duct
- Upper distribution duct
- Lower distribution duct
- Entry way distribution
- Cabin to lavatory to cargo flow pattern

## AIRFRAME AIR DISTRIBUTION SCHEMATIC



# VIII. RAM AIR SYSTEM




## A. RAM AIR INLET

- Located at base of vertical fin
- Ram air used as cooling medium for air-to-air heat exchangers

**Ram air flow path:**

- Passes through secondary heat exchanger
- Passes through primary heat exchanger
- Passes through precooler heat exchangers
- Heat extracted from air conditioning system
- Discharged overboard through exhaust vents

## B. GROUND OPERATIONS

- Airflow through ram air inlet inadequate for cooling heat exchangers
- Fan located in ram air duct
- Mechanically driven by air cycle machine
- Increases airflow through duct to cool heat exchangers

## C. RAM AIR VALVE

- Used if air conditioning system fails
- Provides cockpit and cabin ventilation below 10,000 ft

  **Operation:**

  - Descend below 10,000 ft
  - Select guarded RAM AIR switch to ON
  - Opens ram air valve to provide airflow into aircraft
- Used to provide ambient air ventilation in event of PACK and TRIM AIR failure

### D. PNEUMATIC SOURCES

**In Flight Operations:**

- Engines provide bleed air at all altitudes
- APU provides bleed air up to 20,000 ft

**Ground Operations:**

- Air conditioning PACK can operate with APU, engines, or external ground cart
- APU recommended due to low pressure from engines at ground idle

Ram Air System Specifications

| Parameter | Value |
|---|---|
| Ram Air Inlet Location | Base of vertical fin |
| Heat Exchanger Cooling | Secondary, Primary, and Pre-cooler |
| Ground Operation Fan | ACM-driven for static cooling |
| Ram Air Valve | Emergency ventilation below 10,000 feet |
| Plenum Check Valve | Opens with dynamic pressure available |
| Maximum Operation Altitude | 10,000 feet |
| Control Switch | Guarded RAM AIR switch |
| Emergency Use | PACK and TRIM AIR failure |

## IX. AVIONICS AND COCKPIT DISPLAYS VENTILATION

### A. SYSTEM DESCRIPTION

- Provides ventilation for avionics and cockpit displays
- Ensures aircraft reliability and safety requirements

### B. SYSTEM COMPONENTS

- Underfloor fan
- Avionics cooling valve

**Both can pull air from:**

- Cockpit panel area behind displays
- Above avionics racks

### C. OPERATING MODES

**Ground Operations:**

- Fan operated in high-speed mode

**Flight Operations:**

- Fan operated at low speed normally
- Fan operates at high speed if temperature in avionics racks reaches 122°F (50°C) in 60 seconds
- Above 10,000 ft: If temperature rises above 149°F (65°C) during 60 second period:
    - Fan turned off
    - Avionics cooling valve opened by IASC

## D. SYSTEM CONTROL

- Normal control and monitoring by IASC 1

**Degraded mode:**

- Controlled by IASC 2
- Avionics fan turned on
- If fan failed, avionics cooling valve opens

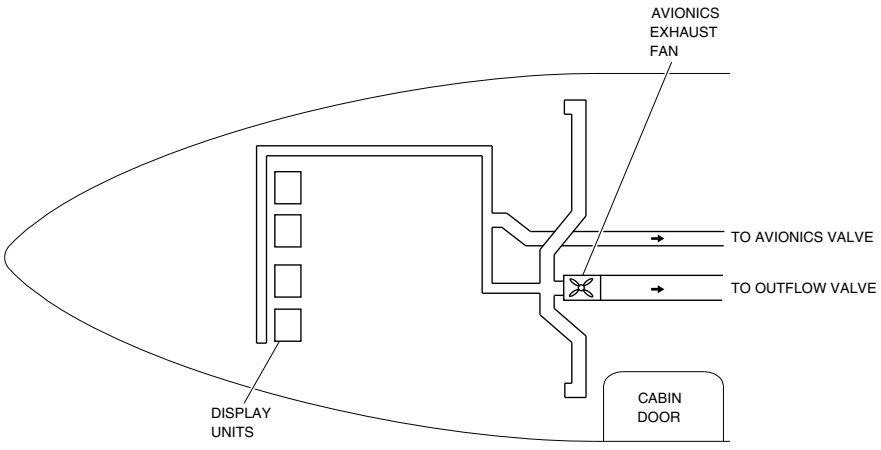
## E. FAILURE INDICATIONS

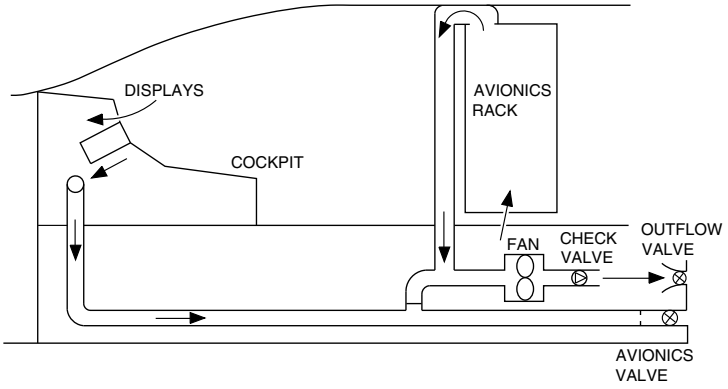
- **EQPT RACK COOL FAULT** (C) CAS message if fan or valve fails
- **EQPT RACK TEMP HIGH** (C) CAS message if overheat condition occurs in avionics rack

## F. CABIN AND COCKPIT AIR DISTRIBUTION SYSTEM

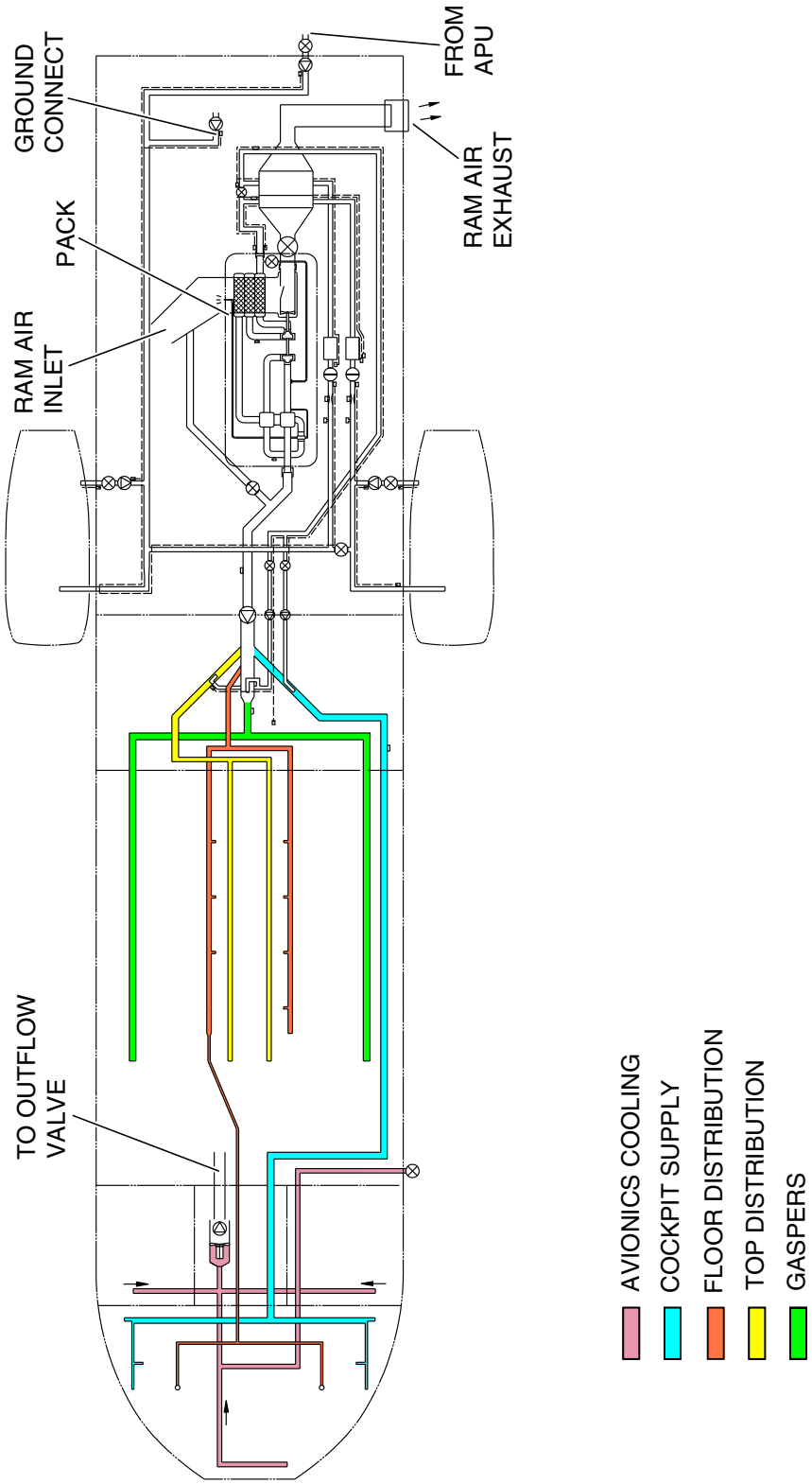
**Components shown on synoptic:**

- Ram air inlet
- PACK
- Ground connect
- From APU
- Ram air exhaust
- To outflow valve
- Top distribution
- Cockpit supply
- Floor distribution
- Gaspers
- Avionics cooling



CABIN AND COCKPIT AIR DISTRIBUTION SYSTEM



# X. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| CABIN ALTITUDE | Excessive Cabin Altitude (9,400' Normal; +1,550' T/O above 7,850'; Max 14,300' ) | TO/LAND |
| CABIN DELTA P | Excessive cabin differential pressure (greater than 9.2 psid or less than -0.5 psid) | TO/LAND |
| L (R) BLEED LEAK | A leak has been detected in the indicated bleed duct | TO/LAND |
| L (R) PYLON BLEED LEAK | Leak has been detected in the indicated engine pylon or tail cone | TO/LAND |
| PACK LEAK | A leak has been detected in the pack ducting | TO/LAND |
| TRIM AIR LEAK | Leak detected in trim air duct | TO/LAND |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| AIR COND TEMP FAIL | Automatic temperature control system has failed | TO/LAND |
| AIR COND TEMP HIGH | Excessive air temperature has been detected in the air distribution duct | TO/LAND |
| AUTO PRESS FAIL | Automatic cabin pressurization control has failed | TO/LAND |
| L (R) BLEED FAIL | Indicated engine bleed air valve has failed, or pressure is outside limit (high or low) | TO/LAND |
| L (R) BLEED LOOP FAIL | Both bleed air leak detection loops in the indicated zone have failed | TO/LAND |
| CABIN ALTITUDE | Excessive Cabin Altitude (8,500 ft for Normal Operations) | TO/LAND |
| CABIN PRESS FAULT | Either the pressure sensor has failed or cabin altitude limiter function has failed | TO/LAND |
| DITCHING NOT AVAIL | Ditching switch has been selected on with the pressurization switch in the manual mode | — |
| EQPT RACK TEMP HIGH | Overheat condition has occurred in the avionics rack | TO/LAND |
| OXYGEN QUANTITY LOW | Oxygen is less than 700 liters | TO/LAND |
| OXYGEN VALVE CLOSED | Oxygen bottle valve is closed or there is a miscompare on the electrical pneumatic actuating valve | TO/LAND |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| PACK FAIL | A failure has been detected in the pack system | TO/LAND |
| PACK LOOP FAIL | Both bleed air leak detection loops in the pack have failed | TO/LAND |
| PACK TEMP HIGH | Overheat detected in the air conditioning pack system | TO/LAND |
| PAX OXYGEN AUTO FAIL | Automatic mask deployment function has failed | TO/LAND |
| TRIM AIR FAIL | A hot air regulating valve has failed | TO/LAND |
| TRIM AIR LOOP FAIL | Both bleed air leak detection loops in the TRIM AIR have failed | TO/LAND |
| XBLEED FAIL | Crossbleed valve has failed to move to the commanded position | TO/LAND |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| AIR COND FAULT | A fault has been detected in the air conditioning system, or there has been a loss of temperature sensing | TO/LAND |
| L (R) BLEED FAULT | The bleed pressure data is invalid, or the indicated flow control valve is failed closed | TO/LAND |
| BLEED LOOP FAULT | A fault has been detected in the bleed leak detection loop system and redundancy is lost | TO/LAND |
| CABIN ALT WARN HIGH | A high-altitude airport takeoff or landing has been initiated and the pressurization system is in the automatic mode | — |
| EQPT RACK COOL FAULT | A fault has been detected in the avionics equipment rack cooling system | TO/LAND |
| MANUAL PRESS FAIL | Manual mode is not operational (on the ground only) | TO/LAND |
| PACK COOL AIR FAIL | Ram air regulating valve supplying cooling air to the air conditioning pack heat exchanger has failed | TO/LAND |
| L (R) PYLON LOOP FAIL | A bleed leak detection loop in the indicated pylon has failed | TO/LAND |
| RAM AIR FAIL | The ram air ventilation valve has failed | TO/LAND |

## D. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **AIR COND MAN TEMP ON** | The air conditioning temperature control is in manual mode |
| **AIR SOURCE OFF** | The AIR SOURCE switch is in the OFF position resulting in no conditioned air entering the cabin |
| **BLEED OFF** | The L, R, and APU BLEEDs are OFF |
| **DITCHING ON** | The DITCHING switch/indicator has been selected ON. |
| **EMER DEPRESS ON** | Emergency depressurization has been selected. Emergency depressurization commands the outflow valve open, but will attempt to limit the cabin altitude to approximately 15,000 ft |
| **MANUAL PRESS ON** | The MANUAL PRESSURIZATION mode has been selected |
| **PACK ONLY** | The AIR SOURCE switch is in the PACK ONLY position, resulting in all air conditioning bleed air being routed through the PACK |
| **PAX OXYGEN OFF** | The passenger oxygen switch has been selected OFF |
| **PAX OXYGEN ON** | Pressure has been detected in the passenger oxygen lines |
| **RAM AIR ON** | The RAM AIR switch has been selected ON, providing ram air ventilation |
| **TRIM AIR ONLY** | The AIR SOURCE switch is in the TRIM AIR ONLY position, resulting in all air conditioning bleed air being routed through the trim air system. The air will be warm |
| **XBLEED OPEN** | The crossbleed valve is open |

### NOTES

- All warning messages are accompanied by a triple chime
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right system
- The bleed leak detection system uses dual-sensing loops in critical areas to minimize false indications

## XI. LIMITATIONS

Environmental System Altitude Limitations

| Parameter | Maximum Altitude |
|---|---|
| TRIM AIR ONLY | Prohibited on the ground |
| APU Bleed Air for ECS | 20,000 feet |
| APU Bleed Air for Engine Start | 20,000 feet |
| Trim Air Only Operation (PACK Failed) | 35,000 feet |
| Oxygen Quantity Low | 25,000 feet |
| Cabin Pressure Fault | 31,000 feet |
| Unpressurized Flight | 9,000 feet |
| Ram Air Ventilation | 10,000 feet |
| Use of Engine Bleed during Steep Approach | Prohibited |

Note: The pack must be operating (APU or engine running and AIR SOURCE switch – NORM or PACK ONLY) when the airplane electrical power is on (BATTs or EXT PWR – On) for more than 30 minutes and the OAT is above 40°C (104°F).

## XII. ENVIRONMENTAL SYSTEM CIRCUIT BREAKERS

Environmental System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| ALT LIM/ECS XVLV PWR 1 | RIGHT ESS | CB2-D13 |
| ALT LIM/ECS XVLV PWR 2 | LEFT ESS | CB1-D13 |
| AUTO DEP THERAPTC | LEFT MAIN | CB3-D5 |
| BLEED VALVES L | LEFT ESS | CB1-D15 |
| BLEED VALVES R | RIGHT ESS | CB2-D15 |
| FOOT WARM L | LEFT AUX | CB3-D7 |
| FOOT WARM R | RIGHT AUX | CB4-D7 |
| OXYGEN MAN DEP/IND | RIGHT ESS | CB4-D1 |
| PRESS 1/PACK | LEFT ESS | CB1-D14 |
| PRESS 2/TRIM | RIGHT MAIN | CB2-D14 |
| RAM AIR/OFV PWR 1 | RIGHT MAIN | CB4-D6 |
| RAM AIR/OFV PWR 2 | LEFT ESS | CB3-D6 |
| X BLEED VALVE | RIGHT ESS | CB2-D12 |

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## XIII. ENVIRONMENTAL QUIZ

1. How many zones is the bleed leak detection system divided into for EICAS presentation?

    A) Six zones
    B) Seven zones
    C) Eight zones
    D) Nine zones

2. What type of loops are used for the trim air ducts in the bleed leak detection system?

    A) Dual-sensing loops
    B) Single loops
    C) Triple loops
    D) No loops

3. At what pressure does the IPV limit intermediate engine bleed pressure?

    A) 40±3 psi
    B) 45±3 psi
    C) 50±3 psi
    D) 60±3 psi

4. Where are the two IASCs located in the aircraft?

    A) Both in cockpit
    B) Both in aft equipment bay
    C) One under floor, one under lavatory liner above floor
    D) Both under floor

5. What is the temperature control range in normal mode?

    A) 10°C to 35°C
    B) 15°C to 35°C
    C) 15°C to 70°C
    D) 10°C to 70°C

6. How many check valves are installed in the bleed air ducting?

    A) Two
    B) Three
    C) Four
    D) Five

7. Which side of the bleed manifold does the APU supply air to?

    A) Left side only
    B) Right side only
    C) Both sides
    D) Center only

8. In the PACK ONLY position, which flow control valve is open?

A) Right FCV
B) Left FCV
C) Both FCVs
D) Neither FCV

9. How many trim air injectors are in the system?

A) Two
B) Three
C) Four
D) Five

10. At what temperature does the avionics fan switch to high speed in flight?

A) 100°F (38°C) in 60 seconds
B) 122°F (50°C) in 60 seconds
C) 149°F (65°C) in 60 seconds
D) 165°F (74°C) in 60 seconds

11. Below what altitude can the ram air valve be used for ventilation?

A) 8,000 ft
B) 10,000 ft
C) 15,000 ft
D) 20,000 ft

12. What drives the fan in the ram air duct during ground operations?

A) Electric motor
B) Hydraulic pump
C) Air cycle machine
D) APU bleed air

13. How many HARSOVs are in the trim air system?

A) One
B) Two
C) Three
D) Four

14. What happens to the APU bleed valve when the APU is shut down?

A) Remains in last commanded position
B) Moves to fail-safe open position
C) Moves to fail-safe closed position
D) Modulates based on temperature

15. During normal takeoff and landing, what is the APU bleed configuration?

A) APU bleed OFF
B) APU bleed ON
C) APU bleed modulating
D) APU bleed in standby

16. Which IASC channel is dedicated to wing anti-ice control and bleed leak detection?

A) Channel A
B) Channel B
C) Both channels
D) Neither channel

17. What type of valves are the flow control valves?

A) Hydraulically controlled, electrically operated
B) Electrically controlled, pneumatically operated
C) Manually controlled, pneumatically operated
D) Pneumatically controlled, electrically operated

18. At what manifold pressure does a **L (R) BLEED FAIL** (C) CAS message appear?

A) Exceeds 50 psi
B) Exceeds 55 psi
C) Exceeds 60 psi
D) Exceeds 65 psi

19. Where do the overhead gaspers in the cockpit supply air from?

A) Hot trim air
B) Mixed temperature air
C) Cold air only
D) Ram air

20. What materials are the bleed air ducts constructed from?

A) Composite materials only
B) Aluminum only
C) Stainless steel, titanium, or aluminum
D) Carbon fiber and titanium

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CL-350



CL-350 TRAINING MANUAL

# PRESSURIZATION 11

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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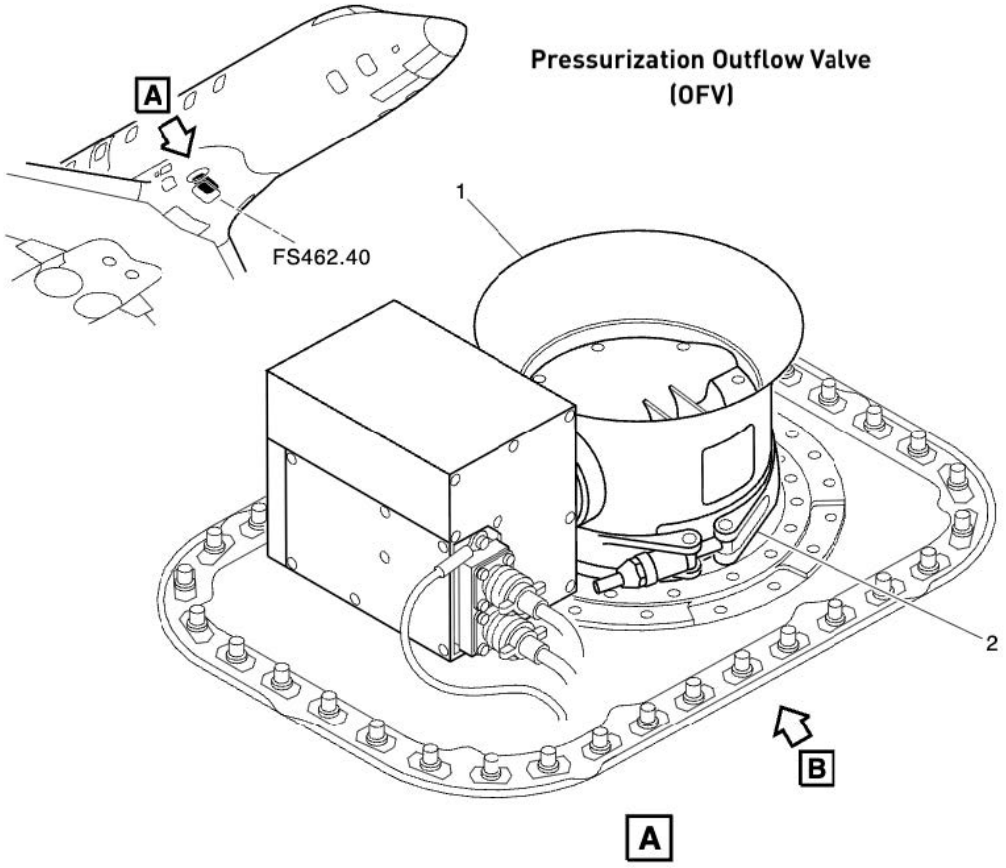
# PRESSURIZATION

## I. INTRODUCTION

The Challenger 350 pressurization system maintains a comfortable cabin environment throughout all phases of flight by precisely controlling the outflow of conditioned air through an electrically actuated outflow valve. The system operates through three independent control modes—two automatic modes managed by the dual-channel Integrated Air System Controllers (IASC) and one manual backup mode controlled through analog circuitry—ensuring redundancy and operational flexibility at all altitudes.

Two pneumatically operated safety valves provide independent overpressure and negative pressure protection regardless of the selected control mode, preventing cabin differential pressure from exceeding structural limits. During normal operations, the system automatically manages cabin altitude based on flight management system inputs, maintaining optimal pressure schedules that minimize passenger discomfort during climbs, cruise, and descents while adhering to physiological and structural limitations.

The design incorporates sophisticated control logic that handles special scenarios including high-altitude airport operations, emergency depressurization for smoke evacuation, and ditching sequences, with all system parameters continuously monitored and displayed through the EICAS to maintain complete crew situational awareness of cabin environment conditions.



### A. SYSTEM SPECIFICATIONS

Pressurization System Main Specifications

| Parameter | Value |
|---|---|
| System Type | Automatic and Manual pressure control |
| Outflow Valve | Single electrically actuated valve |
| Safety Valves | Two pneumatic on aft pressure bulkhead |
| Controllers | Two Integrated Air System Controllers (IASC) |
| Normal Cabin Altitude Limit | 7,850 feet |
| Cabin Altitude Caution | 8,500 feet (adjustable for high airports) |
| Cabin Altitude Warning | 9,400 feet (adjustable for high airports) |
| Passenger Oxygen Deployment | Automatic at 14,000 feet cabin altitude |
| Emergency Depressurization Limit | 14,000 ± 100 ft (AUTO), 14,500 ± 500 ft (MANUAL) |
| Ditching Function | Available in AUTO mode only (inhibited above 15,000 ft) |

## II. SYSTEM ARCHITECTURE

### A. CONTROL PHILOSOPHY

- Three independent modes of operation ensure redundancy
- Automatic control through dual IASCs with auto-switchover capability
- Manual backup control through IASC 1 analog circuitry
- Independent pneumatic safety valve protection
- EICAS integration for continuous monitoring

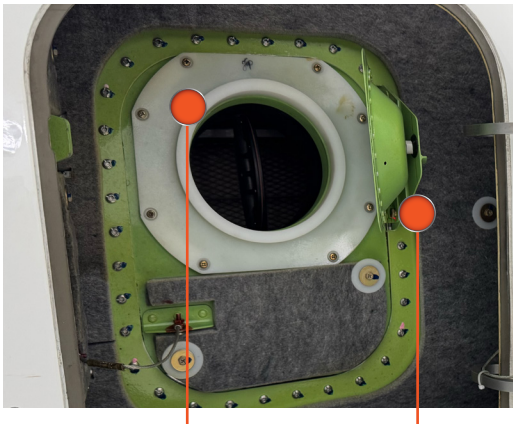
### B. PRIMARY COMPONENTS

**Integrated Air System Controllers (IASC):**

- Two digital controllers for automatic operation
- Only one controller active at a time
- Standby controller automatically assumes control upon active controller failure
- IASC 1 normally active after power-up unless fault detected
- IASC 2 operates in standby mode

**Outflow Valve:**

- Electrically actuated with dual motor design
- Composite flow body with butterfly plate
- Two motors, one for automatic operation the other for manual operation

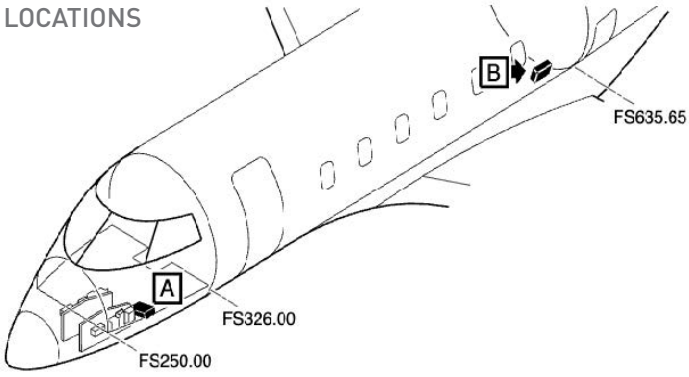


- Outflow Valve / Ditching Flapper
- One motor for manual operation
- Access panel forward of wing for maintenance

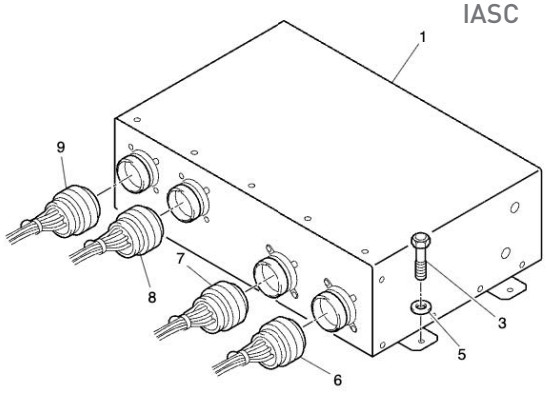
**Safety Valves:**

- Two pneumatically operated valves
- Located on aft pressure bulkhead
- Spring-loaded closed design
- Provide overpressure relief
- Provide negative pressure relief
- Operate independently of control mode

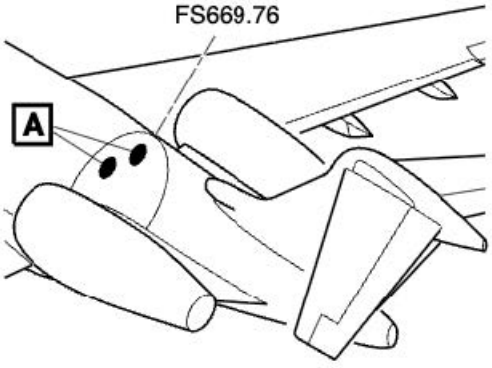
IASC LOCATIONS

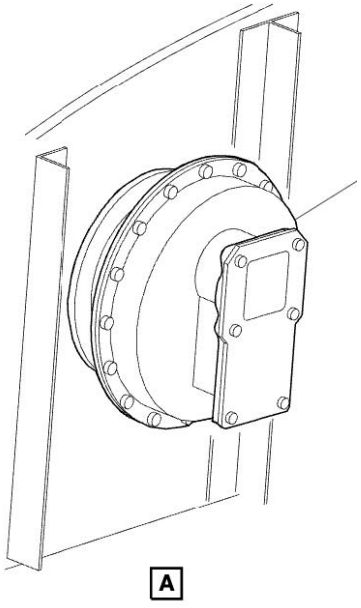



IASC




PRESSURIZATION SAFETY VALVES



# III. AUTOMATIC PRESSURIZATION MODES

## A. PRE-PRESSURIZATION MODE

- Activated on ground when thrust levers advanced for takeoff
- Cabin pressurized to 300 ft below actual field elevation
- Allows outflow valve to achieve controlling position before takeoff
- Eliminates noticeable pressure changes during takeoff

## B. TAKEOFF AND RETURN TO BASE SEQUENCE

- Initiated when aircraft leaves the ground
- Maintains pre-pressurization altitude of 300 ft below field elevation

  **Continues until:**
    - Aircraft reaches 6,000 ft mean sea level (MSL), or differential from takeoff reached, or
    - 10 minutes elapsed
- If descent initiated, cabin altitude descends to takeoff altitude
- Landing field elevation does not require resetting

## C. CLIMB MODE

- Cabin altitude programmed according to:
    - Selected landing elevation
    - Theoretical schedule of cabin vs. aircraft altitude
    - Cabin climb rate varies with aircraft climb rate
    - Typical cabin climb rate: 300-500 slfpm
    - Maximum cabin rate for light aircraft climbs: 635 slfpm
    - **NOTE:** For steep climbs above 25,000 ft with aircraft climb rates >6,000 fpm:
        - Cabin climb rate may exceed 635 slfpm normal limit
        - Recommended maximum aircraft climb rate: 6,000 fpm for comfort

## D. CRUISE MODE

- Activated when:
    - Aircraft climb rate <500 slfpm for >10 seconds, or
    - Aircraft climbing at any rate above 25,000 ft
- Cabin altitude stabilized per pressure schedule

## E. DESCENT MODE

- Cabin descent rate directly related to aircraft descent rate
- High-speed descent increases cabin descent rate based on:
    - Calculation of remaining flight time
    - Aircraft speed from Air Data Computer (ADC)

- Typical cabin descent rate: 300 slfpm
- Aircraft descent at 2,000 fpm → cabin descends at ~300 slfpm
- Aircraft descent >5,000 fpm → cabin descends at 750 slfpm
- Cabin descends until ~300 ft below selected landing elevation

### F. DEPRESSURIZATION SEQUENCE ON GROUND

- After landing or aborted takeoff
- Cabin depressurizes at 500 slfpm to equalize cabin
- OFV moves to full open
- Remains full open while on ground

## IV. MANUAL PRESSURIZATION MODE

### A. SYSTEM CONTROL

- Activated by pressing MANUAL switch ON
- OFV controlled electrically through MAN RATE knob
- UP selection → increases cabin altitude
- DN selection → decreases cabin altitude
- Center position → maintains cabin altitude
- Maximum rate of change: 2,500 fpm

### B. MANUAL OPERATION PROCEDURES

**Before Takeoff:**

- Note cabin altitude
- Start pre-pressurization by adjusting MAN RATE toward DN
- Recommended rate: -300 fpm
- If time permits before takeoff:
    - Upon reaching 300 ft below noted cabin altitude select cabin rate to zero
    - Allow cabin to stabilize (CAB RATE shows 0 FPM on ECS synoptic)
- If takeoff performed before pre-pressurization complete pressure bumps may occur

**Takeoff and Climb:**

- Cabin altitude may be selected as desired
- Monitor CAB ALT and CAB ΔP
- Make adjustments to keep delta P within limits:
    - +500 fpm to raise cabin altitude
    - -300 fpm to descend cabin altitude

**Cruise:**

- Cabin altitude selectable as desired
- Must observe limits for cabin altitude and delta P

**Descent and Landing:**

- Set desired cabin altitude to 300 ft below field elevation
- For initial descent steps: any comfortable rate
- For unrestricted descent:
    - Cabin rate should be proportional to aircraft descent time
    - Example: Aircraft at 27,000 ft with 3,000 fpm descent = 9 minutes to land
    - Divide difference between current cabin altitude and landing altitude by time
      **NOTE**: Monitor cabin delta P during descent
    - Keep delta P less than 1 psid (maximum for landing)

**After Landing:**

- Depressurize by adjusting MAN RATE toward UP
- Continue until field elevation attained

Pressurization Control Modes

| Mode | Description |
|---|---|
| AUTO 1 (Normal) | IASC 1 Channel A controls outflow valve |
| AUTO 2 (Alternate) | IASC 2 Channel A controls outflow valve |
| MANUAL | Manual control via MAN DN/UP rocker switch |
| Rate Control (AUTO) | 500 fpm climb, 300 fpm descent nominal |
| Rate Control (MANUAL) | Variable based on switch deflection |
| Pre-pressurization | -245 feet cabin altitude on ground |
| High Airport Mode | Adjusts alerts for field elevations above 7,850 feet |

## V. HIGH ALTITUDE AIRPORT OPERATIONS

Operating at airports situated above 7,850 feet presents unique challenges that extend beyond the typical considerations of density altitude and aircraft performance. At these elevations, the aircraft's pressurization system must alter its operating logic for both departure and arrival sequences, as this altitude marks the upper limit of normal cabin pressure scheduling.

During takeoff from these high-elevation fields, the pre-pressurization sequence maintains the cabin at 300 feet below field elevation rather than immediately climbing toward the standard cruise cabin altitude, while the system carefully manages the transition from ground operations through the initial climb phase.

Similarly, landing at these airports requires the pressurization controllers to reset warning and caution thresholds above their normal values with caution messages increasing to 650 feet and warning messages to 1,550 feet above landing field elevation to prevent nuisance alerts during approach.

## A. LANDING SEQUENCES (FIELD ELEVATIONS >7,850 FT)

- No additional crew action required if landing elevation selected before takeoff
- Scheduled cabin altitude normally limited to 7,850 ft in flight
- Automatically reset to landing field pressure altitude
- **CABIN ALTITUDE** (C) normally at 8,500 ft
- **CABIN ALTITUDE** (W) normally at 9,400 ft
- Below 41,000 ft descent:
    - Thresholds increase as function of aircraft altitude and descent rate
    - **CABIN ALT WARN HIGH** (A) displayed informing crew of higher limits
    - **CABIN ALTITUDE** (C) increases to landing field +650 ft (max 14,300 ft)
    - **CABIN ALTITUDE** (W) increases to landing field +1,550 ft (max 14,300 ft)

## B. TAKEOFF AND RETURN TO BASE SEQUENCES (FIELD ELEVATIONS >7,850 FT)

- System maintains pre-pressurization of 300 ft below takeoff altitude
- Maintained until aircraft reaches 6,000 ft AGL or 10 minutes elapsed
- Return to Base maintains pre-pressurization until landing to avoid cabin bumps
- Landing field elevation does not require resetting
- Caution and warning thresholds maintained at takeoff pressure altitude

## C. CLIMB MODE (HIGH ALTITUDE OPERATIONS)

- Cabin altitude decreases at -500 slfpm toward 7,850 ft limit
- Thresholds decrease as function of aircraft altitude and climb rate
- Minimum -500 slfpm required for thresholds to reach normal values before 41,000 ft

## D. CRUISE MODE (HIGH ALTITUDE OPERATIONS)

- Cabin altitude continues decreasing at -300 slfpm until 7,850 ft reached
- Warning threshold decreases at -300 fpm until 9,400 ft
- Caution threshold decreases at -300 fpm until 8,500 ft

## E. LEVELING OFF DURING DESCENT

**Above 41,000 ft:**

- Cabin altitude remains at 7,850 ft
- Caution and Warning thresholds remain at 8,500 ft and 9,400 ft

**Between 41,000 ft and 25,000 ft:**

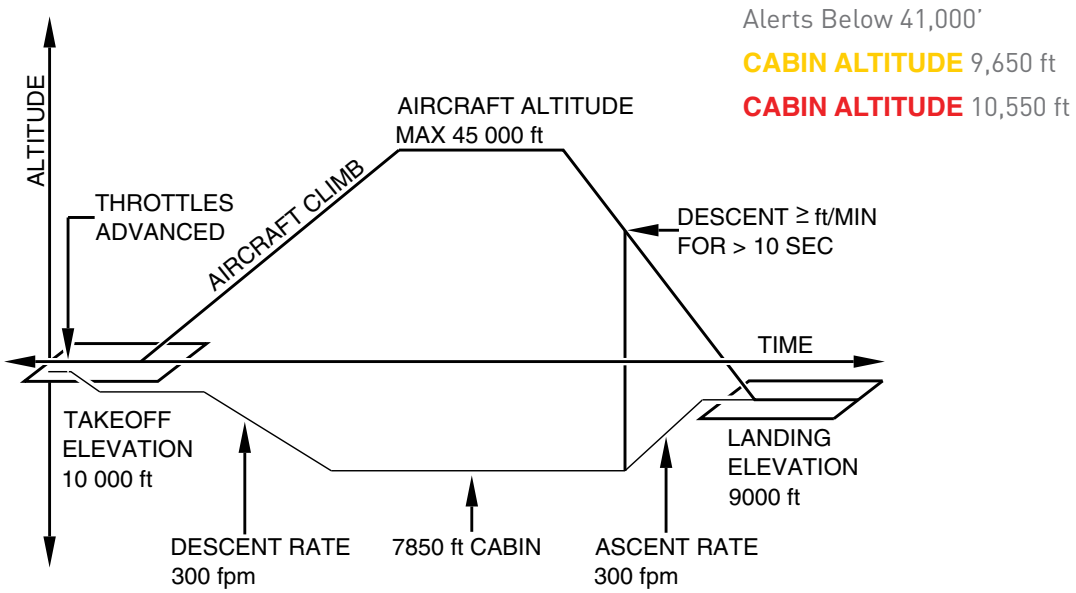
- Cabin altitude and thresholds level as function of aircraft altitude
- After 3 minutes: cabin descends at -300 slfpm toward 7,850 ft
- Thresholds also descend at -300 fpm until aircraft descent initiated

**At or Below 25,000 ft:**

- Cabin reaches landing field pressure altitude -300 ft
- Caution threshold: landing field +650 ft (max 14,300 ft)
- Warning threshold: landing field +1,550 ft (max 14,300 ft)

## F. EXAMPLES

1. **Taking off from airfields above 7,850 ft and landing field elevations above 7,850 ft.**



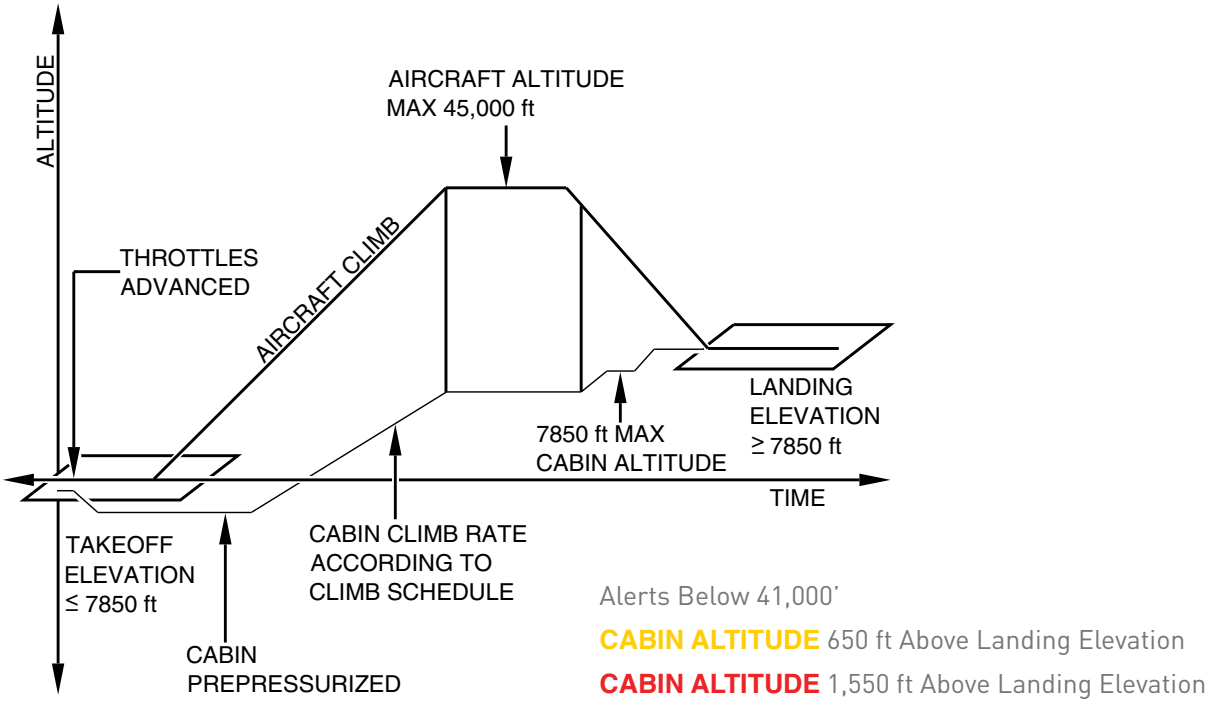

When departing from a field elevation of 10,000 feet, the automatic pressurization system initiates pre-pressurization as the thrust levers advance, establishing a cabin altitude of 9,700 feet (300 feet below field elevation) to eliminate pressure bumps during takeoff. This cabin altitude is maintained through liftoff and continues until the aircraft reaches either 6,000 feet above the departure field or 10 minutes has elapsed, whichever occurs first.

As the aircraft climbs above 16,000 feet MSL, the pressurization system transitions to climb mode, commanding the cabin to descend at a rate of 500 feet per minute toward the maximum normal cabin altitude limit of 7,850 feet. During the climb through 41,000 feet toward the cruising altitude of 45,000 feet, the cabin altitude stabilizes at 7,850 feet while the warning and caution thresholds simultaneously adjust downward, the caution threshold settling at 8,500 feet and the warning threshold at 9,400 feet.

When descent is initiated for landing at the 9,000-foot field elevation, the system automatically increases these thresholds as a function of aircraft altitude and descent rate, with the **CABIN ALT WARN HIGH** advisory alerting the crew to this adjustment. The cabin altitude gradually increases from 7,850 feet during the descent, ultimately stabilizing at approximately 8,700 feet (300 feet below the landing field elevation) to ensure a slightly pressurized landing that prevents uncomfortable pressure changes during touchdown.

Throughout this entire sequence, the cabin ascent and descent rates are carefully modulated at 300 to 500 feet per minute during normal operations, though these rates may increase to 750 feet per minute during rapid descents to ensure the cabin reaches the appropriate altitude before landing.

2. Taking off from airfields below 7,850 ft and landing field elevations above 7,850 ft.



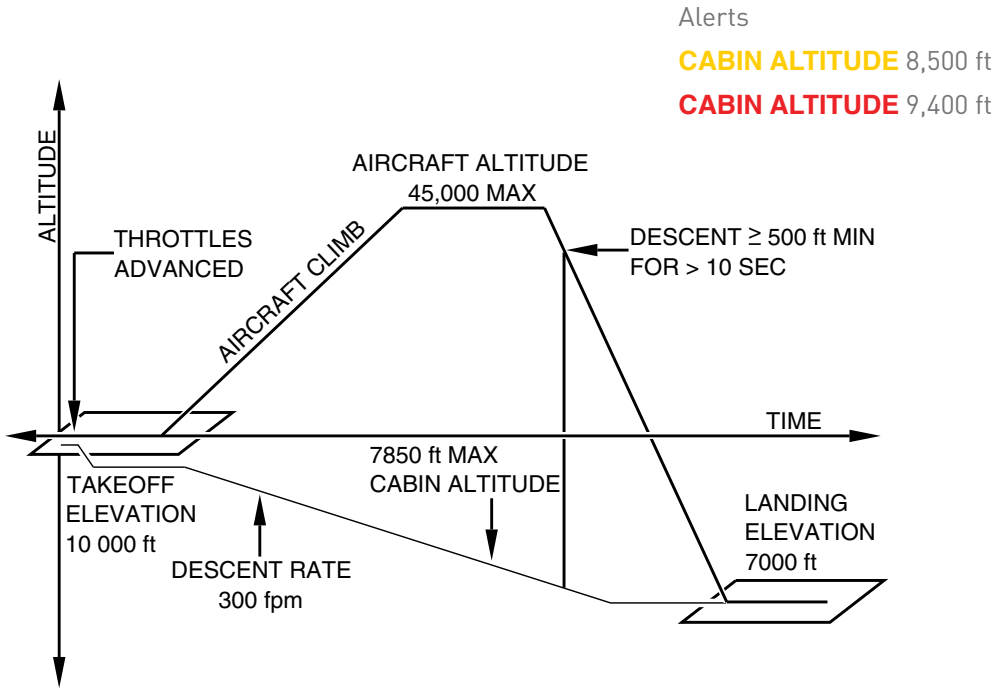

When departing from a field elevation below 7,850 feet, the automatic pressurization system follows the standard pre-pressurization sequence, establishing a cabin altitude 300 feet below the takeoff field elevation as thrust levers advance. After liftoff, this cabin altitude is maintained until the aircraft reaches 6,000 feet above the departure field or 10 minutes has elapsed.

As the aircraft enters climb mode, the cabin altitude increases according to the normal climb schedule at approximately 300 to 500 feet per minute, proportional to the aircraft's rate of climb. During cruise at 45,000 feet, the cabin altitude stabilizes at the maximum normal limit of 7,850 feet, with standard warning and caution thresholds set at 9,400 feet and 8,500 feet respectively.

The critical transition occurs when descent is initiated toward the landing field above 7,850 feet, at this point, the system recognizes that normal cabin altitude limits cannot be maintained for landing. As the aircraft descends through 41,000 feet, the automatic system begins increasing both the warning and caution thresholds as a function of aircraft altitude and descent rate, triggering the **CABIN ALT WARN HIGH** advisory message to alert the crew that these limits are being reset above normal values.

The cabin altitude, which had been maintained at 7,850 feet during cruise, now begins climbing at a controlled rate of approximately 300 feet per minute to reach the landing field pressure altitude minus 300 feet. By touchdown at the high-elevation destination, the caution threshold will have increased to 650 feet above landing field pressure altitude and the warning threshold to 1,550 feet above landing field pressure altitude (both limited to 14,300 feet maximum), ensuring the aircraft lands slightly pressurized while avoiding nuisance alerts during this transition from standard cruise altitudes to the elevated landing environment.

3. Taking off from airfields above 7,850 ft and landing field elevations less than 7,850 ft.



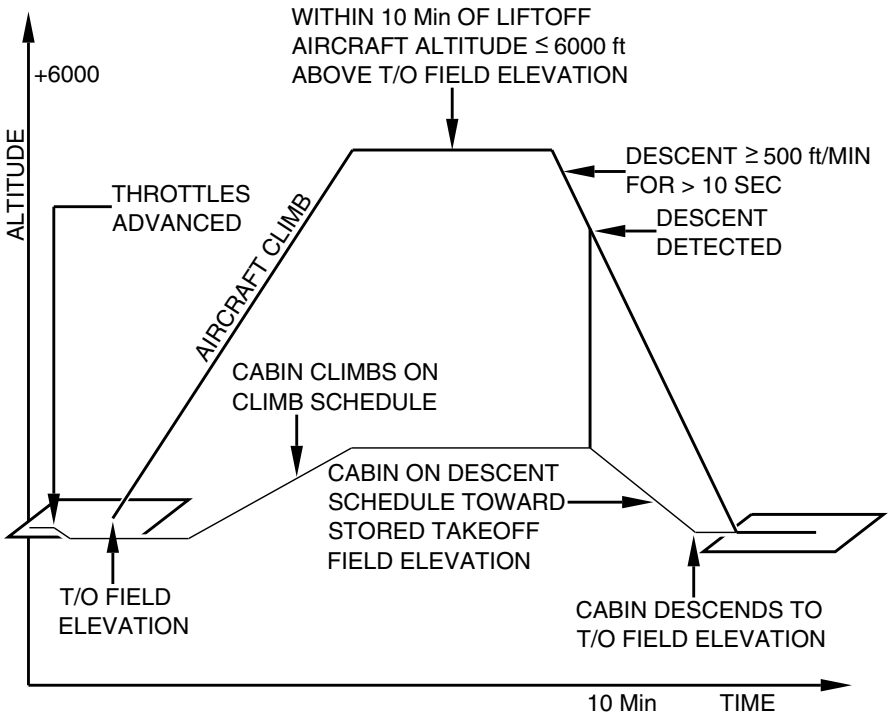

When departing from a field elevation above 7,850 feet, the automatic pressurization system establishes pre-pressurization at 300 feet below the high takeoff field elevation as thrust levers advance, maintaining this elevated cabin altitude through liftoff and until the aircraft reaches 6,000 feet above the departure field or 10 minutes has elapsed.

Once climb mode is initiated, the system recognizes that the destination field elevation is below 7,850 feet and begins reducing the cabin altitude at a rate of 500 feet per minute toward the standard maximum normal limit of 7,850 feet. As the aircraft continues climbing toward 45,000 feet, the cabin altitude steadily decreases from its high initial value, while the warning and caution thresholds simultaneously descend at a minimum rate of 500 feet per minute to ensure they reach their normal values, 8,500 feet for caution and 9,400 feet for warning, before the aircraft reaches 41,000 feet.

During cruise at 45,000 feet, the cabin altitude stabilizes at the normal 7,850 feet if it hasn't already reached this value, with the system potentially continuing a gradual descent at 300 feet per minute in cruise mode until this standard cabin altitude is achieved.

When descent is initiated toward the landing field below 7,850 feet, the pressurization system operates normally, with the cabin descending at approximately 300 feet per minute on the standard pressure schedule. The cabin ultimately stabilizes at 300 feet below the landing field elevation well before touchdown, providing a comfortable, slightly pressurized landing.

4. Takeoff and Return to Base



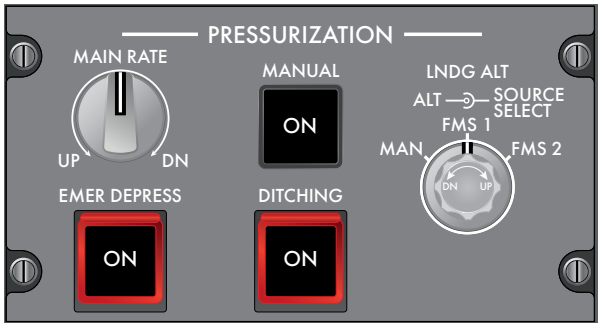

During a normal takeoff and return to base sequence, the automatic pressurization system employs a specialized logic designed to optimize comfort and eliminate the need for crew intervention if an immediate return becomes necessary. As thrust levers advance for takeoff, the system initiates pre-pressurization, establishing a cabin altitude 300 feet below the actual field elevation.

This pre-pressurization value is maintained through liftoff and continues as the aircraft climbs, held constant until either reaching 6,000 feet above the takeoff field elevation or 10 minutes has elapsed since brake release, whichever occurs first. The key advantage of this sequence becomes apparent if a return to the departure airport is required: when the aircraft initiates descent within this window, the pressurization system automatically recognizes the return to base scenario and commands the cabin to descend back toward the original takeoff field elevation, eliminating any need for the crew to reset the landing altitude selector.

The cabin remains slightly pressurized at the original pre-pressurization value, 300 feet below field elevation, throughout the approach and landing, preventing uncomfortable pressure bumps during touchdown while maintaining passenger comfort. This automated sequence ensures that whether dealing with a technical issue, weather consideration, or any other factor requiring an immediate return, the pressurization system automatically manages the cabin environment without requiring crew attention during what may already be a high-workload situation, allowing pilots to focus on the return procedure itself rather than manual pressurization management.

# VI. CONTROLS AND INDICATIONS

## A. PRESSURIZATION CONTROL PANEL




**MAN RATE Knob:**

- Controls cabin altitude rate of change in manual mode
- 12 o'clock position = 0 slfpm
- Rate adjustment range: -1,000 to +1,000 slfpm over 2/3 of knob travel
- Maximum rates at full travel: ±2,500 slfpm
- DN (counterclockwise) = cabin altitude decreases
- UP (clockwise) = cabin altitude increases

**MANUAL Switch:**

- Initiates manual control of pressurization system
- Illuminated ON when selected

**LNDG ALT Knob:**

- Two concentric knobs for landing field elevation selection
- Outer knob selections:
    - MAN: Enables inner knob control
    - FMS (single installation)
    - FMS 1 or FMS 2 (dual installation)
        - Inner knob: Sets landing altitude when MAN selected
        - FMS selection: Uses destination airport database

**EMER DEPRESS Switch:**

- Alternate-action switch with guard
- Used for smoke and fumes evacuation
- AUTO mode: Depressurizes at 2,500 slfpm to 14,000 ft ±100 ft or aircraft altitude
- MANUAL mode: Depressurizes at 3,000 slfpm to 14,500 ft ±500 ft or aircraft altitude
- **NOTE**: In manual mode, can also depressurize using MAN RATE to max UP

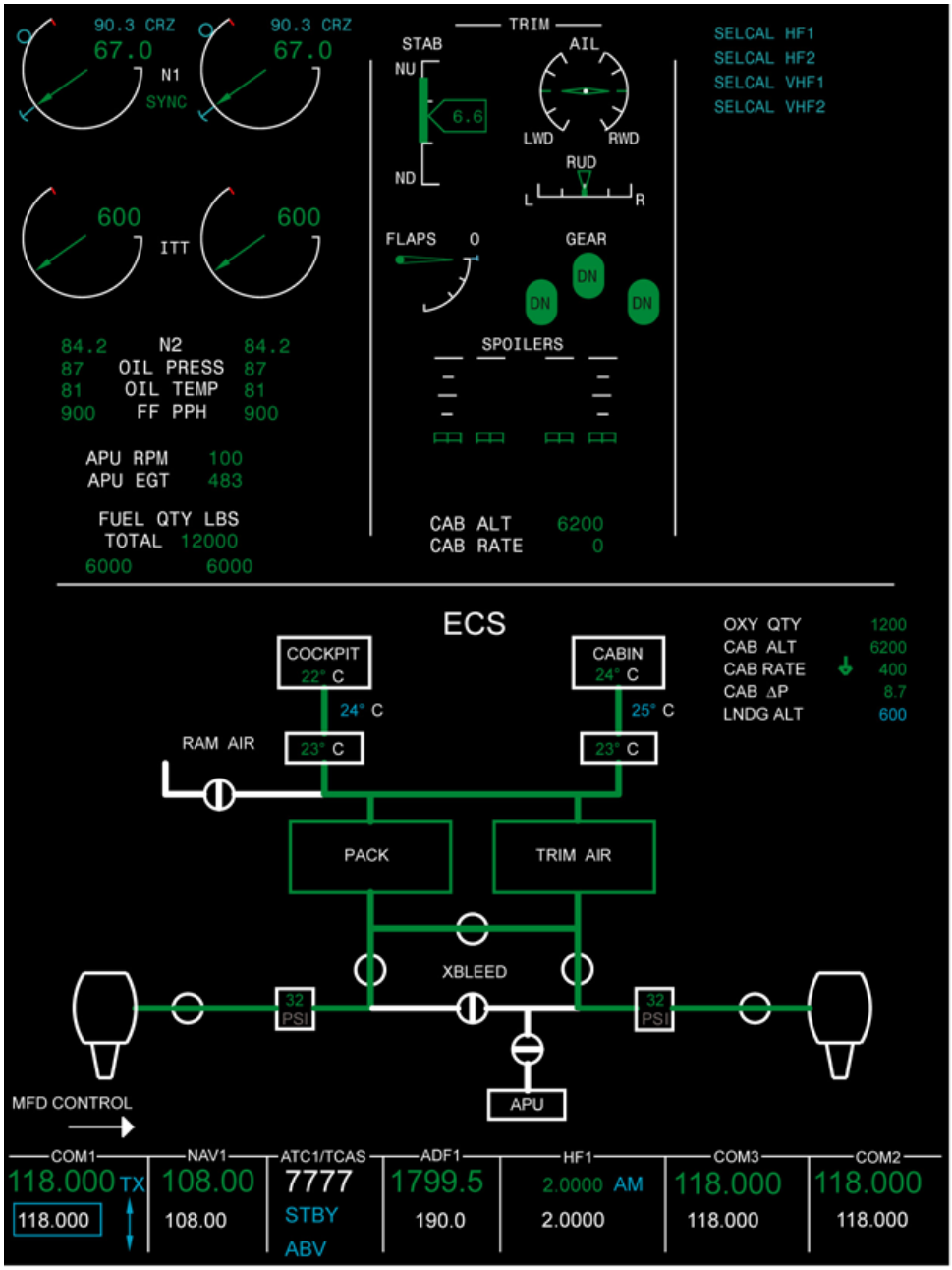
**DITCHING Switch (Not available in manual mode):**

- Depressurizes cabin
- Shuts off air conditioning
- Closes outflow valve for water landing
- Sequence activates automatically
- Inhibited above 15,000 ft
- To close outflow valve manually: MAN RATE to max DN

## B. EICAS DISPLAYS

- CAB ALT displayed on pilot's MFD
- CAB RATE displayed on pilot's MFD
- Pressurization parameters on ECS synoptic
- Pressurization parameters on SUMMARY synoptic

ECS SYNOPTIC PAGE



# VII. PRESSURIZATION SCHEDULES

## A. AIRCRAFT 20501-20886

**Climb and Cruise Schedule:**

Pressurization Schedule - Aircraft 20501 to 20886 (Climb and Cruise)

| Aircraft Altitude (ft) | Cabin Altitude (ft) | Cabin Delta P (PSID) |
|---|---|---|
| Sea Level | -245 | 0.1 |
| 5,000 | 294 | 2.3 |
| 10,000 | 816 | 4.2 |
| 15,000 | 1,379 | 5.7 |
| 20,000 | 2,091 | 6.9 |
| 25,000 | 2,984 | 7.7 |
| 30,000 | 4,111 | 8.3 |
| 35,000 | 5,612 | 8.5 |
| 40,000 | 6,827 | 8.7 |
| 45,000 | 7,850 | 8.8 |

**Descent and Hold Schedule (<25,000 ft):**

Pressurization Schedule - Aircraft 20501 to 20886 (Descent and Hold < 25,000 ft)

| Aircraft Altitude (ft) | Cabin Altitude (ft) | Cabin Delta P (PSID) |
|---|---|---|
| Sea Level | -299 | 0.2 |
| 5,000 | 173 | 2.4 |
| 10,000 | 626 | 4.3 |
| 15,000 | 1,118 | 5.8 |
| 20,000 | 1,756 | 7.0 |
| 25,000 | 2,569 | 7.9 |
| 30,000 | 3,591 | 8.5 |
| 35,000 | 5,487 | 8.6 |
| 40,000 | 6,828 | 8.7 |
| 45,000 | 7,850 | 8.8 |

## B. AIRCRAFT 20887-20999

**Climb and Cruise Schedule:**

Pressurization Schedule - Aircraft 20887 to 20999 (Climb and Cruise)

| Aircraft Altitude (ft) | Cabin Altitude (ft) | Cabin Delta P (PSID) |
|---|---|---|
| Sea Level | -245 | 0.1 |
| 5,000 | 75 | 2.4 |
| 10,000 | 397 | 4.4 |
| 15,000 | 756 | 6.0 |
| 20,000 | 1,201 | 7.3 |
| 25,000 | 1,775 | 8.3 |
| 30,000 | 2,625 | 9.0 |
| 35,000 | 3,742 | 9.3 |
| 40,000 | 4,650 | 9.7 |
| 45,000 | 5,850 | 9.7 |

**Descent and Hold Schedule (<25,000 ft):**

Pressurization Schedule - Aircraft 20887 to 20999 (Descent and Hold < 25,000 ft)

| Aircraft Altitude (ft) | Cabin Altitude (ft) | Cabin Delta P (PSID) |
|---|---|---|
| Sea Level | -299 | 0.2 |
| 5,000 | 23 | 2.5 |
| 10,000 | 349 | 4.4 |
| 15,000 | 712 | 6.0 |
| 20,000 | 1,161 | 7.3 |
| 25,000 | 1,726 | 8.3 |
| 30,000 | 2,445 | 9.1 |
| 35,000 | 3,423 | 9.5 |
| 40,000 | 4,572 | 9.7 |
| 45,000 | 5,850 | 9.7 |

# VIII. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits |
|---|---|---|
| **CABIN ALTITUDE** | The normal cabin altitude warning is at 9,400 ft. When a takeoff or landing is conducted above 7,850 ft, the warning is at the field elevation +1,550 ft, but limited to no higher than 14,300 ft | TO/LAND |
| **CABIN DELTA P** | For aircraft 20501-20886: The cabin differential pressure is greater than 9.2 psid or less than -0.5 psid. For aircraft 20887-20999: The cabin differential pressure is greater than 10.1 psid or less than -0.5 psid | TO/LAND |
| **L (R) BLEED LEAK** | A leak has been detected in the bleed air ducting downstream of the bleed valve | TO/LAND |
| **PACK LEAK** | A leak has been detected in the pack ducting | TO/LAND |
| **TRIM AIR LEAK** | A leak has been detected in the bleed air ducting downstream of the right flow control valve, up to the precooler crossover and up to the trim air check valve | TO/LAND |
| **L (R) PYLON BLEED LEAK** | A leak has been detected in the engine pylon or tail cone (before shut off valve) | TO/LAND |

## B. CAUTION MESSAGES

### CAUTION MESSAGES

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| AIR COND TEMP FAIL | The automatic temperature control system has failed | TO/LAND |
| AIR COND TEMP HIGH | Excessive air temperature has been sensed in the cabin or cockpit air distribution duct | TO/LAND |
| AUTO PRESS FAIL | Both automatic pressurization modes have failed | TO/LAND |
| L (R) BLEED FAIL | The affected engine bleed air valve has failed, or a temperature or pressure has exceeded limits, or the sensor has failed. Under certain low thrust conditions, there may be insufficient pressure to keep the bleed valve open | TO/LAND |
| L (R) BLEED LOOP FAIL | A failure (open or short circuit) has been detected in the bleed leak detection system | TO/LAND |
| CABIN ALTITUDE | Normal cabin altitude caution is 8,500 ft. During takeoff or landing above 7,850 ft, the caution is set to field altitude + 650 ft, with a maximum limit of 14,300 ft | TO/LAND |
| CABIN PRESS FAULT | Either the pressure sensor has failed or cabin altitude limiter function has failed | TO/LAND |
| DITCHING NOT AVAIL | The ditching switch has been selected ON with the pressurization switch in the manual mode | — |
| EQPT RACK TEMP HIGH | The temperature in either equipment rack is high | TO/LAND |
| OXYGEN QUANTITY LOW | Oxygen quantity is less than 700 liters | — |
| OXYGEN VALVE CLOSED | Oxygen bottle valve is closed or there is a miscompare on the electrical pneumatic actuating valve | — |
| PACK FAIL | A failure has been detected in the PACK system | TO/LAND |
| PACK LOOP FAIL | Both bleed air leak detection loops in the PACK have failed during the power up self test | TO/LAND |
| PACK TEMP HIGH | An overheat has been detected in the air conditioning PACK system | TO/LAND |
| PAX OXYGEN AUTO FAIL | Automatic oxygen mask deployment function has failed | — |
| TRIM AIR FAIL | A hot air regulating valve has failed | TO/LAND |
| TRIM AIR LOOP FAIL | The bleed air leak detection loops around the trim air ducting have failed | TO/LAND |
| XBLEED FAIL | The crossbleed valve has failed to move to the commanded position | TO/LAND |

## C. ADVISORY MESSAGES

### ADVISORY MESSAGES

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| **AIRCOND FAULT** | A fault has been detected in the air conditioning system, or there has been a loss of temperature sensing | TO/LAND |
| **BLEED LOOP FAULT** | A fault has been detected in the bleed leak detection loop system and redundancy is lost | TO/LAND |
| **L (R) BLEED FAULT** | The bleed pressure data is invalid, or the affected flow control valve is failed closed | TO/LAND |
| **CABIN ALT WARN HIGH** | A high airport takeoff or landing has been initiated, and the pressurization system is in the automatic mode | — |
| **EQPT RACK COOL FAULT** | A fault has been detected in the avionics equipment rack cooling system | TO/LAND |
| **MANUAL PRESS FAIL** | The manual pressurization mode is not operational | TO/LAND |
| **PACK COOL AIR FAIL** | The ram air regulating valve supplying cooling air to the PACK heat exchanger has failed | TO/LAND |
| **L (R) PYLON LOOP FAIL** | A bleed leak detection loop in the respective pylon has failed | TO/LAND |
| **RAM AIR FAIL** | The RAM AIR ventilation valve has failed to move to the commanded position | TO/LAND |

## D. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **AIR COND MAN TEMP ON** | The air conditioning temperature control is in manual mode |
| **AIR SOURCE OFF** | The AIR SOURCE switch is in the OFF position resulting in no conditioned air entering the cabin |
| **BLEED OFF** | The L, R, and APU BLEED switches are set to OFF |
| **DITCHING ON** | The DITCHING switch/indicator has been selected ON. This closes the flow control valves and commands the outflow valve open for 100 seconds after cabin differential pressure decreases below 1.595 psid. The outflow valve then closes |
| **EMER DEPRESS ON** | Emergency depressurization has been selected. Emergency depressurization commands the outflow valve open, but will attempt to limit the cabin altitude to approximately 15,000 ft |
| **MANUAL PRESS ON** | The MANUAL PRESSURIZATION mode has been selected |
| **PACK ONLY** | The AIR SOURCE switch is in the PACK ONLY position, resulting in all air conditioning bleed air being routed through the PACK |
| **PAX OXYGEN OFF** | The passenger oxygen switch has been selected OFF |
| **PAX OXYGEN ON** | Pressure has been detected in the passenger oxygen lines |
| **RAM AIR ON** | The RAM AIR switch has been selected ON, providing ram air ventilation |
| **TRIM AIR ONLY** | The AIR SOURCE switch is in the TRIM AIR ONLY position, resulting in all air conditioning bleed air being routed through the trim air system. The air will be warm |
| **XBLEED OPEN** | The crossbleed valve is open |

### NOTES

- All warning messages are accompanied by a triple chime (except CABIN ALTITUDE which has a "Cabin Altitude" voice warning)
- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- L (R) notation indicates the message can appear for either left or right engine/system
- Cabin altitude warning and caution thresholds are automatically adjusted for high altitude airports

## IX. CIRCUIT BREAKERS

Pressurization System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| PRESS 1/PACK | LEFT ESS | CB1-D14 |
| PRESS 2/TRIM | RIGHT MAIN | CB2-D14 |
| RAM AIR/OFV PWR 1 | RIGHT MAIN | CB4-D6 |
| RAM AIR/OFV PWR 2 | LEFT ESS | CB3-D6 |
| ALT LIM/ECS XVLV PWR 1 | RIGHT ESS | CB2-D13 |
| ALT LIM/ECS XVLV PWR 2 | LEFT ESS | CB1-D13 |
| AUTO DEP THERAPTC | LEFT MAIN | CB3-D5 |
| OXYGEN MAN DEP/IND | RIGHT ESS | CB4-D1 |

## X. LIMITATIONS

### A. DIFFERENTIAL PRESSURE LIMITATIONS

Pressurization Differential Pressure Limitations

| Parameter | Limitation |
|---|---|
| Maximum Differential Pressure (20501-20886) | 9.4 PSID |
| Maximum Differential Pressure (20887-22999) | 10.1 PSID |
| Maximum Negative Differential Pressure | -0.5 PSID |
| Warning Differential Pressure (20501-20886) | 9.2 PSID |
| Warning Differential Pressure (20887-22999) | 10.1 PSID |
| Maximum Ground Differential Pressure (Taxi) | 0.1 PSID |
| Maximum Landing Differential Pressure | 1.0 PSID |
| Normal Operating Cabin Differential (20501-20886) | 8.8 PSID |
| Normal Operating Cabin Differential (20887-22999) | 9.7 PSID |

## B. SYSTEM LIMITATIONS

Pressurization System Limitations

| Function | Limitation |
|---|---|
| Ditching Function Availability | Not available in manual mode |
| Ditching Function Altitude | Inhibited above 15,000 ft |
| Emergency Depressurization Target (AUTO) | 14,000 ft ±100 ft |
| Emergency Depressurization Target (MANUAL) | 14,500 ft ±500 ft |

## C. PRESSURIZATION ALTITUDE OPERATING LIMITATIONS

Pressurization Altitude Operating Limits

| Condition | Maximum Altitude |
|---|---|
| Cabin Pressure Controller Fault | 31,000 feet |
| Unpressurized Flight | 9,000 feet |
| Trim Air Only Operation | 35,000 feet |
| Ram Air Ventilation | 10,000 feet |
| Emergency Descent Initiation | Above 14,000 feet cabin altitude |
| Window/Windshield Failure | 15,000 feet (if cabin altitude uncontrollable), Reduce Delta P to 5.8 psid, leave icing as soon as possible |

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## XI. PRESSURIZATION QUIZ

1. What are the three independent modes of operation for the pressurization system?

    A) Manual, Semi-automatic, Fully automatic
    B) Primary, Secondary, Emergency
    C) Two automatic modes (IASC), One manual mode
    D) IASC 1, IASC 2, Backup mode

2. What is the maximum positive differential pressure for aircraft 20887-22999?

    A) 9.4 psi
    B) 9.7 psi
    C) 10.1 psi
    D) 8.8 psi

3. At what cabin altitude does the CABIN ALTITUDE warning normally activate?

    A) 7,850 ft
    B) 8,500 ft
    C) 9,400 ft
    D) 14,300 ft

4. Where are the two safety valves located?

    A) Forward pressure bulkhead
    B) Aft pressure bulkhead
    C) Bottom of fuselage
    D) Wing root area

5. What is the pre-pressurization value during the pre-pressurization mode?

    A) 300 ft above field elevation
    B) 500 ft below field elevation
    C) 300 ft below field elevation
    D) Field elevation

6. During manual pressurization mode, what is the maximum rate of change?

    A) 1,000 fpm
    B) 2,000 fpm
    C) 2,500 fpm
    D) 3,000 fpm

7. What conditions activate cruise mode?

    A) Aircraft on ground with engines running
    B) Aircraft climb rate <500 slfpm for >10 seconds or climbing above 25,000 ft
    C) Aircraft descending below 10,000 ft
    D) Landing gear extended

8. What is the emergency depressurization rate in AUTO mode?

A) 2,000 slfpm
B) 2,500 slfpm
C) 3,000 slfpm
D) 3,500 slfpm

9. Above what altitude is the ditching function inhibited?

A) 10,000 ft
B) 14,000 ft
C) 15,000 ft
D) 20,000 ft

10. What is the maximum differential pressure allowed during landing?

A) 0.1 psi
B) 0.5 psi
C) 1.0 psi
D) 1.5 psi

11. Which IASC normally becomes active after power-up tests?

A) IASC 1
B) IASC 2
C) Both simultaneously
D) Neither until selected

12. Where is the outflow valve located?

A) Top of fuselage
B) Bottom of fuselage
C) Aft pressure bulkhead
D) Forward cargo compartment

13. What is the typical cabin climb rate during normal operations?

A) 100-200 slfpm
B) 300-500 slfpm
C) 600-800 slfpm
D) 1000-1200 slfpm

14. During high-speed descent with aircraft descending >5,000 fpm, what is the cabin descent rate?

A) 300 slfpm
B) 500 slfpm
C) 750 slfpm
D) 1,000 slfpm

15. What happens after landing in automatic mode?

A) Cabin maintains pressure
B) Cabin depressurizes at 500 slfpm, OFV goes full open
C) Cabin immediately equalizes
D) System switches to manual mode

16. For high altitude airport operations, what is the maximum cabin altitude caution threshold?

A) 8,500 ft
B) 9,400 ft
C) 14,300 ft
D) Landing field elevation +650 ft (max 14,300 ft)

17. What voice aural warning accompanies the CABIN ALTITUDE warning message?

A) "Altitude"
B) "Cabin Pressure"
C) "Cabin Altitude"
D) No voice warning

18. How many motors does the outflow valve actuator have?

A) One
B) Two
C) Three
D) Four

19. What is the maximum negative differential pressure limit?

A) -0.1 psi
B) -0.3 psi
C) -0.5 psi
D) -1.0 psi

20. In manual mode, what knob position maintains current cabin altitude?

A) Full DN
B) Full UP
C) Center (12 o'clock)
D) 3 o'clock position

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CL-350



CL-350 TRAINING MANUAL

# OXYGEN SYSTEM | 12

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# OXYGEN SYSTEM

The Challenger 350 oxygen system provides supplemental breathing oxygen to flight crew and passengers in the event of cabin depressurization or smoke/fume conditions. The system consists of high-pressure gaseous oxygen stored in two cylinders (77 cu ft and 115 cu ft), distributed through an Electrical Pneumatic Actuating Valve (EPAV) to crew quick-donning masks and passenger drop-down masks.

Designed to meet emergency oxygen requirements, the system integrates with the cabin altitude monitoring systems to automatically deploy passenger masks at 14,500 ft ±500 feet cabin altitude while providing crew members with immediate access to quick-donning masks for smoke protection or supplemental oxygen needs.



## I. INTRODUCTION

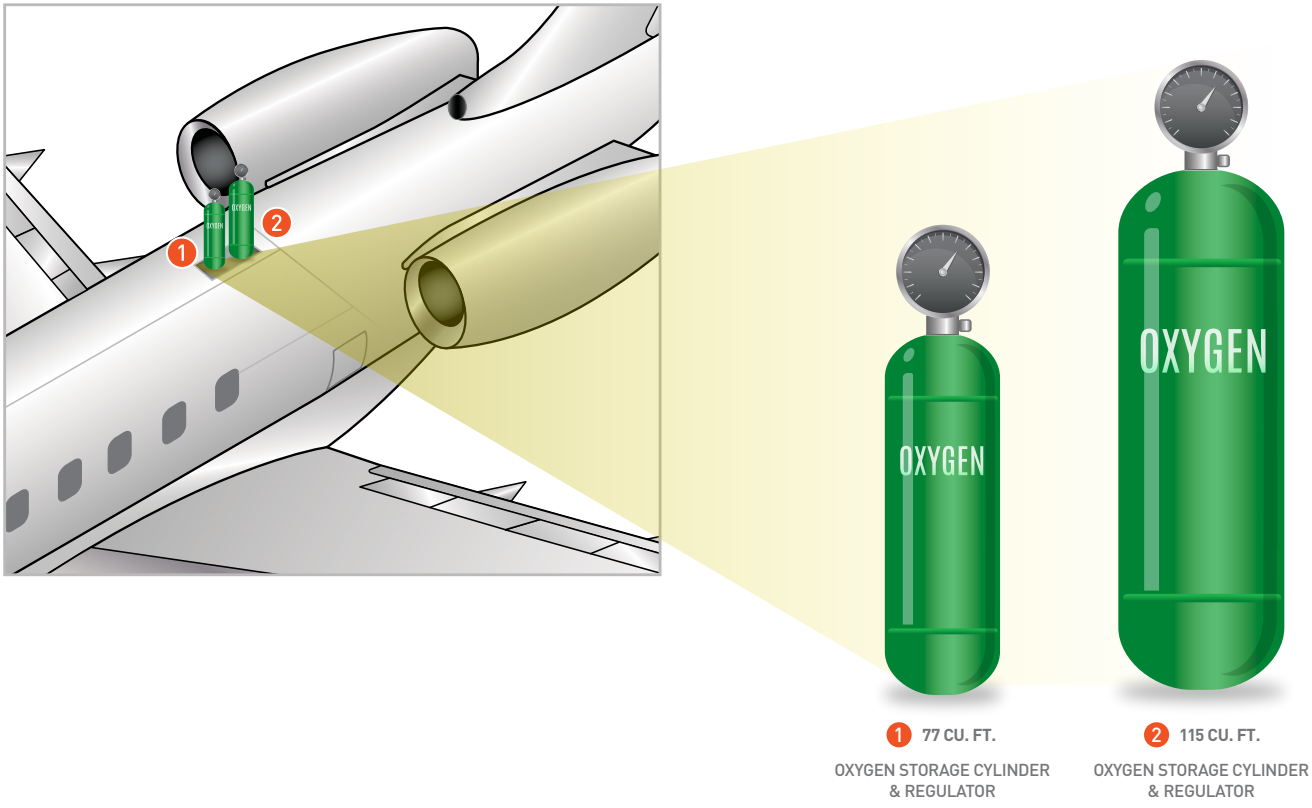
### A. OXYGEN SYSTEM SPECIFICATIONS

Oxygen System Specifications

| Parameter | Value |
|---|---|
| System Type | High-pressure gaseous oxygen |
| Number of Cylinders | 2 (Standard configuration) |
| Cylinder 1 Capacity | 77 cu ft (2,183 liters) |
| Cylinder 2 Capacity | 115 cu ft (3,256 liters) |
| Total System Capacity | 192 cu ft (5,439 liters) |
| Storage Pressure (Full) | 1,850 psi |
| Minimum Dispatch Quantity | 700 liters |
| Low Quantity Warning | Below 700 liters |
| Cylinder Location | Dedicated compartment, lavatory section (RH side) |
| Service Panel Location | Right side of fuselage forward of right engine |
| Overboard Discharge Indicator | Green indicator above oxygen service panel |
| Distribution Control | Electrical Pneumatic Actuating Valve (EPAV) |

## B. SYSTEM PURPOSE

- Provides supplemental oxygen during cabin depressurization events
- Supplies emergency oxygen for smoke/fume protection
- Ensures crew operational capability at high cabin altitudes
- Meets regulatory requirements for passenger emergency oxygen
- Provides therapeutic oxygen capability



# II. SYSTEM COMPONENTS

## A. OXYGEN STORAGE

**Oxygen Cylinders:**

- Two composite cylinders with integrated regulators
- Cylinder 1: 77 cu ft (2183 liters) capacity
- Cylinder 2: 115 cu ft (3256 liters) capacity
- Cylinders located in Lavatory
- Each cylinder equipped with pressure reducing regulator
- Manual on/off toggle valve on each cylinder
- High-pressure relief valve on high-pressure line
- Reduced pressure relief valve on low-pressure line
- Connected to overboard discharge lines and indicator

**Pressure and Temperature Monitoring:**

- Temperature and pressure transducer monitors system
- Provides ambient temperature in oxygen compartment
- Sends pressure signal to EPAV
- EPAV generates temperature-compensated pressure signal
- EICAS converts pressure to liters for display

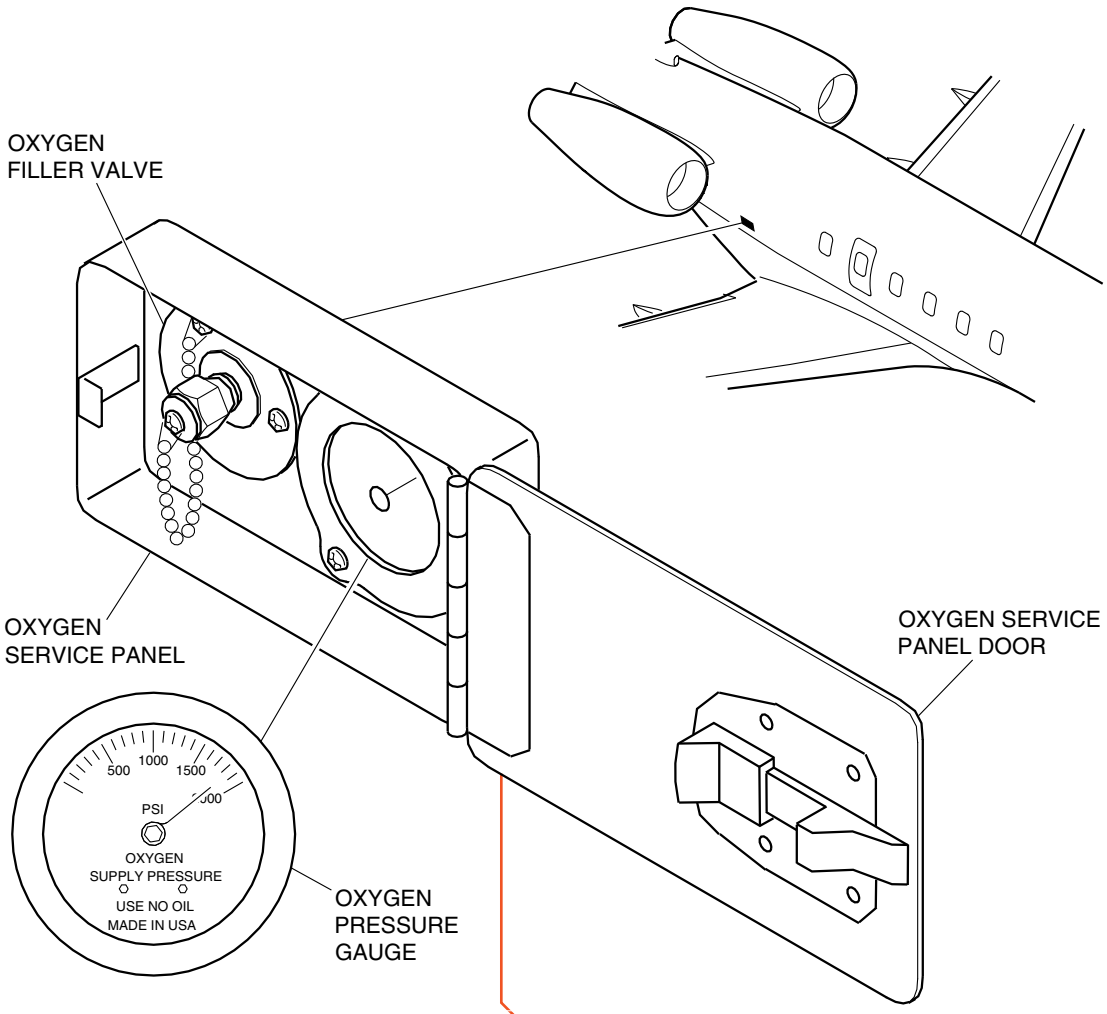
## B. DISTRIBUTION SYSTEM

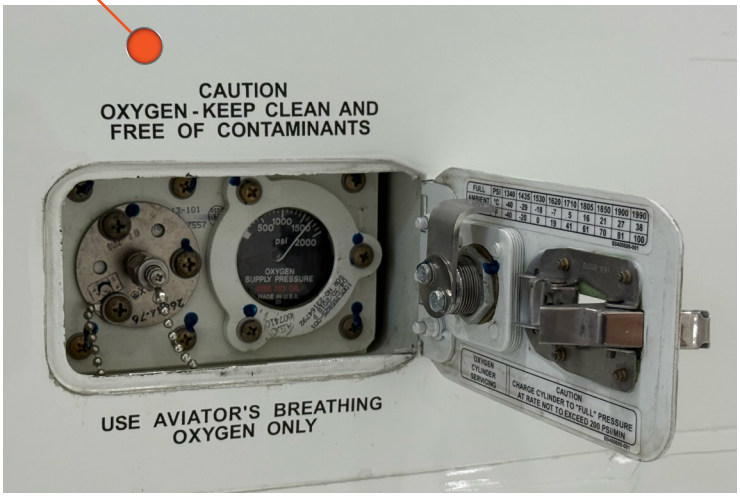
**Electrical Pneumatic Actuating Valve (EPAV):**

- Controls oxygen availability to distribution system
- Provides automatic or manual mode selection
- Three-position PAX OXYGEN switch (OFF, AUTO, DEPLOY)
- Optimizes passenger oxygen consumption
- Provides system information to EICAS
- Controls crew and passenger oxygen circuits separately

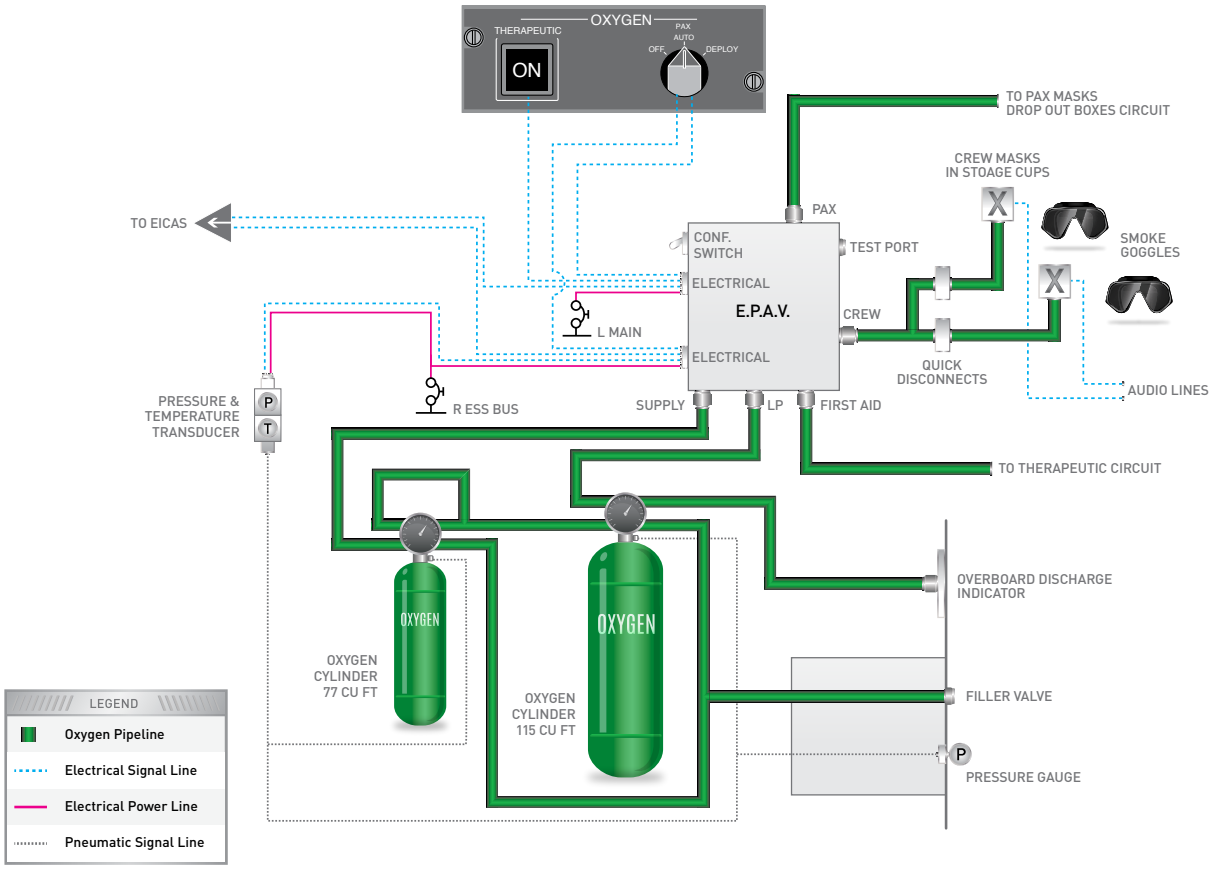
**Service Panel:**

- Located on right side of fuselage
- Forward of right engine position
- Contains filler valve for replenishment
- Pressure gauge for system monitoring
- Access door for maintenance operations


OXYGEN
FILLER VALVE
OXYGEN
SERVICE PANEL
OXYGEN SERVICE
PANEL DOOR
500
1000
1500
PSI
OXYGEN
SUPPLY PRESSURE
USE NO OIL
MADE IN USA
OXYGEN
PRESSURE
GAUGE


CAUTION
OXYGEN - KEEP CLEAN AND
FREE OF CONTAMINANTS
USE AVIATOR'S BREATHING
OXYGEN ONLY

## OXYGEN SYSTEM CONFIGURATION




## C. CREW OXYGEN SYSTEM

**Quick-Donning Masks:**

- Two masks for flight crew members
- EROS quick-donning type design
- Stowage containers behind crew stations
- Integrated regulator on each mask
- Audio communication capability maintained

**Mask Operating Modes:**

- NORMAL - Diluted demand oxygen
- 100% - Pure oxygen on demand
- EMERGENCY - Positive pressure oxygen
- Above FL350 mask supplies pure O2 at constant flow regardless of knob position
- Not approved for use above FL400



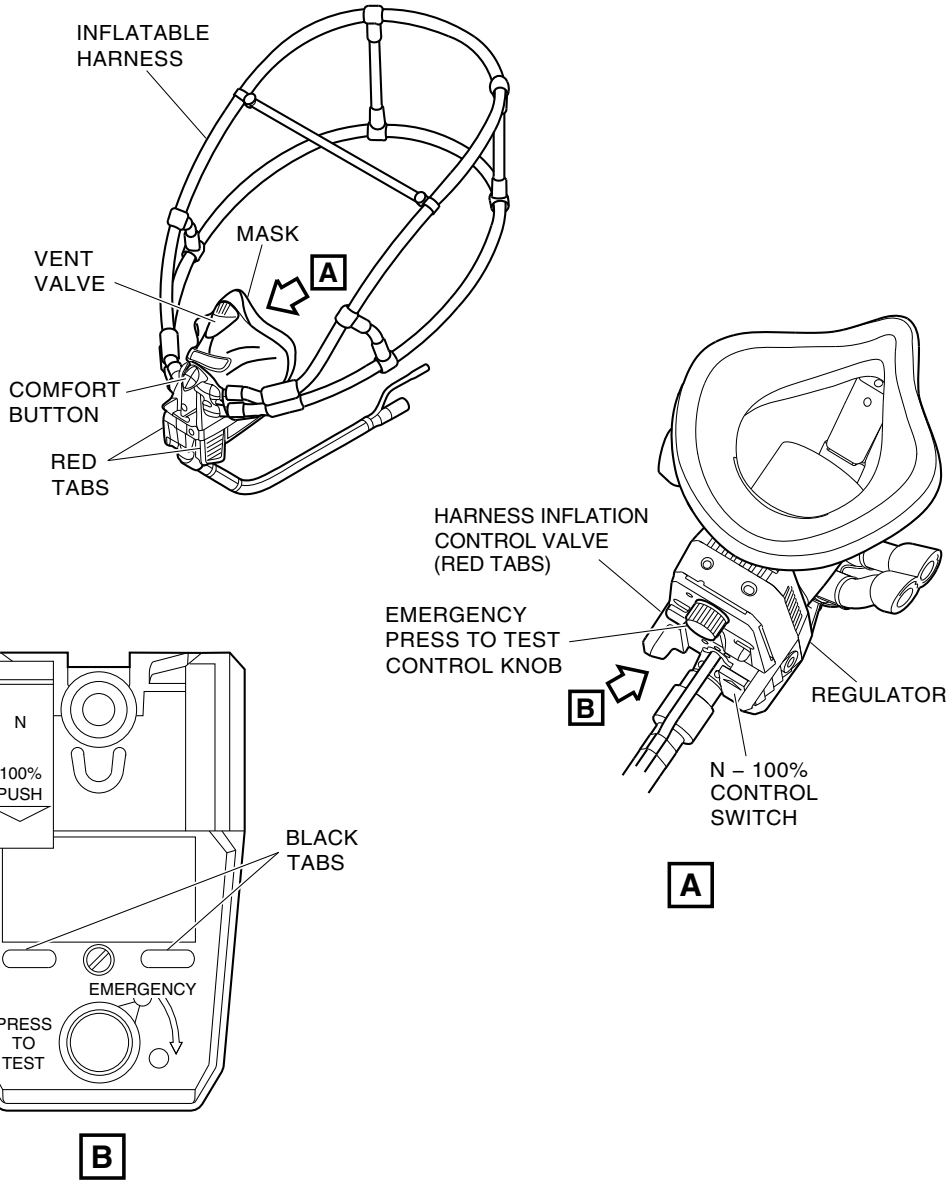
**Smoke Goggles:**

- Provided for both flight crew members
- Designed for use with EROS masks
- Equipped with vent valve
- Provides smoke and toxic gas protection

**Portable Breathing Equipment (PBE):**

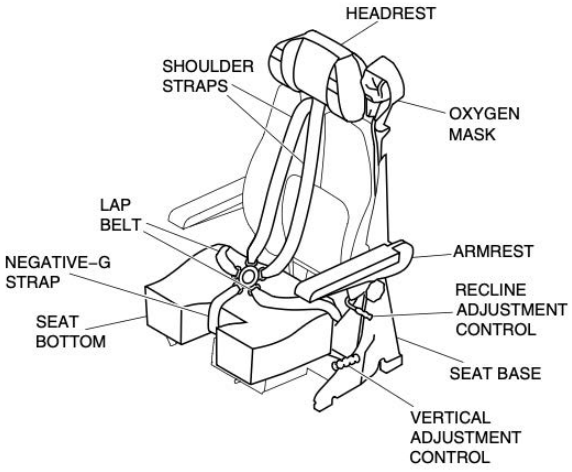
- One PBE container provided
- Located behind pilot's station on bulkhead
- Near floor level for accessibility





# III. PASSENGER OXYGEN SYSTEM

## A. DISTRIBUTION COMPONENTS

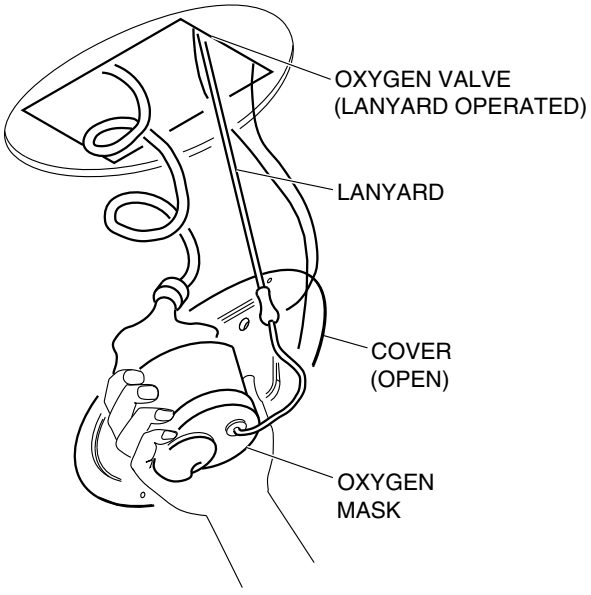


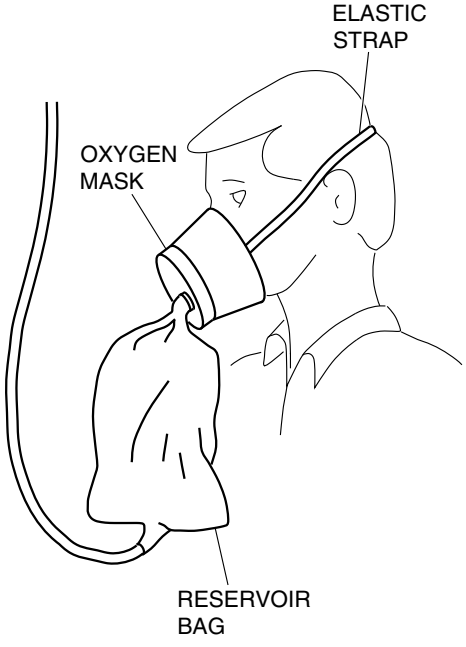

**Drop-Out Boxes:**

- Strategically located throughout cabin
- Automatic deployment mechanism
- Contains masks for seated passengers
- Connected to main oxygen distribution lines

**Passenger Masks:**

- Gaseous supply
- Duration determined by O2 tables
- Automatically presented when deployed
- Yellow cups indicate oxygen flow
- Prolonged use with cabin above FL250 not recommended
- Not approved for use above FL400



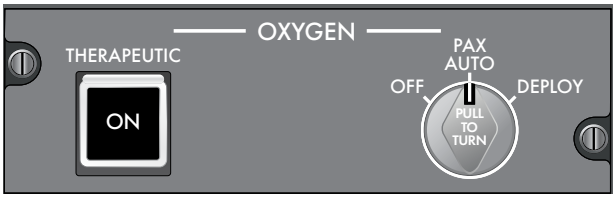

## B. DEPLOYMENT MODES

**Automatic Deployment:**

- Activates at 14,500 ft ±500 feet cabin altitude
- System must be in AUTO position
- EPAV controls automatic function
- Masks drop from overhead compartments

**Manual Deployment:**

- PAX OXYGEN switch to DEPLOY position
- Overrides automatic system
- Immediate mask presentation
- Allows dispatching with AUTO mode inoperative




### C. THERAPEUTIC OXYGEN

**System Components:**

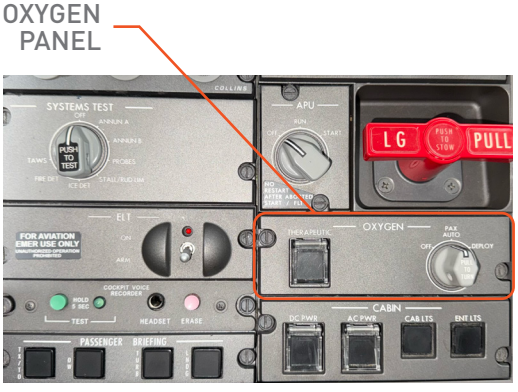
- Separate therapeutic oxygen circuit
- Dedicated outlets in cabin
- Independent control from emergency system
- Medical-grade oxygen delivery

## IV. CONTROLS AND INDICATORS

### A. COCKPIT CONTROLS

**OXYGEN Panel:**

- PAX oxygen switch (OFF/AUTO/DEPLOY)
- Guarded DEPLOY position
- AUTO position for normal operations
- You must PULL UP on switch to move it to DEPLOY




### B. EICAS DISPLAYS

**Oxygen Quantity Display:**

- Shows quantity in liters
- Temperature-compensated reading
- Displayed on EICAS and SUMMARY pages
- Changes to amber below 700 liters




**System Status:**

- Valve position indication
- Deployment status
- System pressure monitoring
- Fault detection display

## V. SYSTEM OPERATION

### A. NORMAL OPERATION

**Pre-flight Checks:**

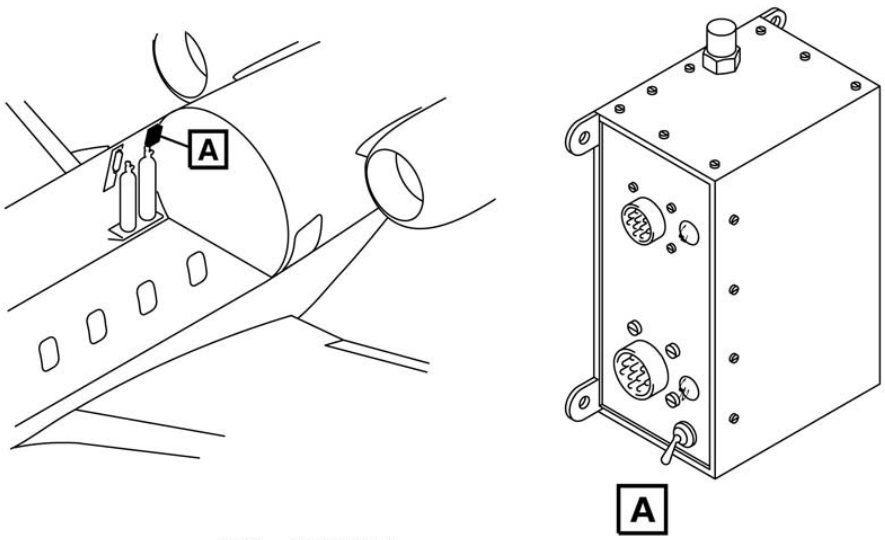
- Verify oxygen quantity adequate for flight
- Minimum 700 liters for dispatch
- Check PAX oxygen switch in AUTO

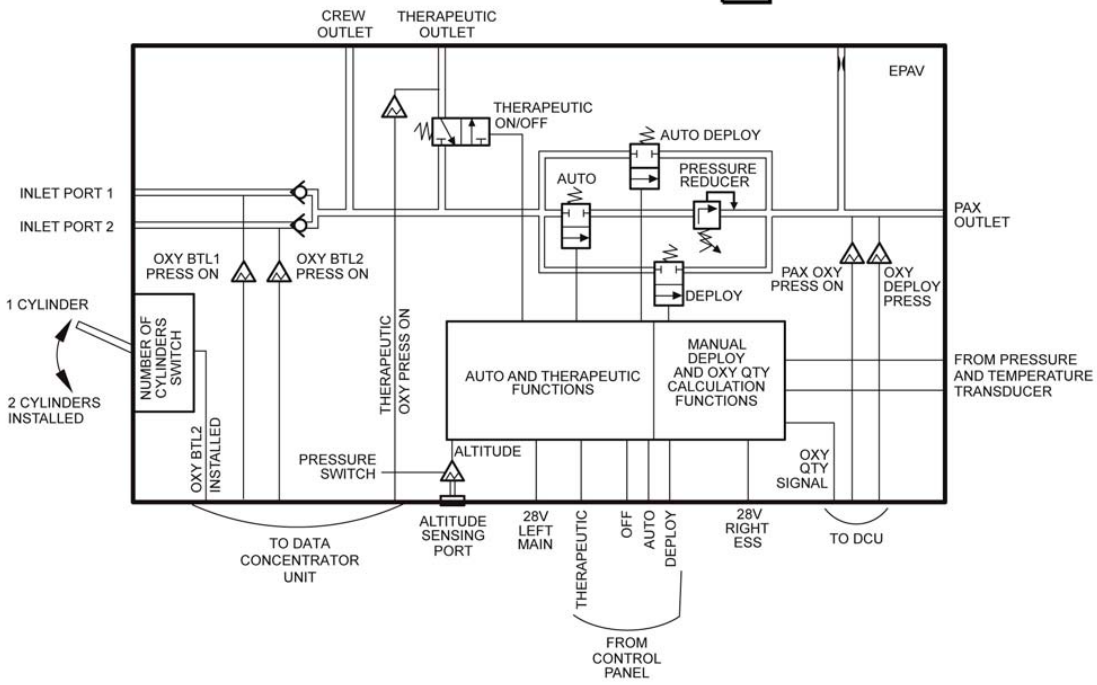
- Verify crew masks accessible
- Test mask deployment if required

**In-Flight Monitoring:**

- Monitor oxygen quantity on EICAS
- System operates automatically in AUTO
- No crew action required unless deployed
- Quantity decreases only when oxygen used






Electrical Pneumatic Actuating Valve (EPAV)

### B. AUTOMATIC FUNCTIONS

**Passenger Mask Deployment:**

- Cabin altitude exceeds 14,500 ft ±500 ft
- PAX switch must be in AUTO
- EPAV commands deployment
- **PAX OXYGEN ON** status message appears
- Cannot be reset in flight
- Electrical Pneumatic Actuating Valve (EPAV)

**System Protection:**

- Over-pressure relief automatic
- Temperature compensation active
- Leak detection monitoring
- Automatic EICAS alerting

## VI. OXYGEN DURATION

### A. CREW OXYGEN DURATION

**Factors Affecting Duration:**

- Number of crew members using oxygen
- Selected mask mode (NORMAL/100%/ EMERGENCY)
- Altitude of operation
- Individual breathing rates
- System pressure remaining

**Typical Duration:**

- Varies from 30 minutes to several hours
- Depends on altitude and usage mode
- Reference duration tables in FCOM2

**OXYGEN QUANTITY (LITERS) – ONE PILOT DURING NORMAL CRUISE**

| Time (h:min) | 41 000 ft or above Part 91 | | 35 000 ft or above Part 135 | |
|---|---|---|---|---|
| | Normal | 100% | Normal | 100% |
| 0:30 | 101 | 408 | 121 | 439 |
| 1:00 | 202 | 815 | 241 | 878 |
| 1:30 | 304 | 1223 | 362 | 1317 |
| 2:00 | 405 | 1631 | 483 | 1756 |
| 2:30 | 506 | 2038 | 603 | 2195 |
| 3:00 | 607 | 2446 | 724 | 2634 |
| 3:30 | 708 | 2854 | 845 | 3073 |
| 4:00 | 810 | 3261 | 965 | 3512 |
| 4:30 | 911 | 3669 | 1086 | 3951 |
| 5:00 | 1012 | 4077 | 1207 | 4389 |
| 5:30 | 1113 | 4484 | 1327 | 4828 |
| 6:00 | 1215 | 4892 | 1448 | - |
| 6:30 | 1316 | - | 1569 | - |
| 7:00 | 1417 | - | 1689 | - |
| 7:30 | 1518 | - | 1810 | - |
| 8:00 | 1619 | - | 1931 | - |

CFC0512_001A

### B. PASSENGER OXYGEN DURATION

**Minimum Requirements:**

- 10 minutes minimum duration per 14 CFR § 91.211
- Actual duration based on maximum passenger load
- Calculated for descent from altitude
- Meets regulatory requirements

**OXYGEN QUANTITY (LITERS) – EMERGENCY DESCENT AND RECOVERY (AUTO MODE)**

| Final Altitude [feet] | Number of Passengers on Board | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 10000 | 156 | 183 | 209 | 236 | 263 | 289 | 316 | 342 | 369 | 396 | 422 | 449 | 476 | 502 | 529 | 556 |
| 15000 | 156 | 182 | 209 | 235 | 261 | 288 | 314 | 340 | 367 | 393 | 419 | 446 | 472 | 498 | 525 | 551 |
| 19000 | 161 | 187 | 213 | 239 | 265 | 291 | 317 | 344 | 370 | 396 | 422 | 448 | 474 | 501 | 527 | 553 |
| 20000 | 161 | 188 | 214 | 241 | 267 | 294 | 320 | 346 | 373 | 399 | 426 | 452 | 478 | 505 | 531 | 558 |
| 25000 | 164 | 191 | 218 | 245 | 272 | 299 | 326 | 353 | 380 | 407 | 434 | 461 | 488 | 515 | 542 | 569 |

**NOTE: Both masks (pilot and copilot) are set to 100% mode only during descent.**

**OXYGEN QUANTITY (LITERS) - FINAL ALTITUDE (AUTO MODE)**
15 000 FT CABIN ALTITUDE

| Time (h:min) | Number of Passengers on Board | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 0:30 | **132**<br>572 | **166**<br>606 | **199**<br>639 | **233**<br>673 | **266**<br>707 | **300**<br>740 | **333**<br>774 | **367**<br>807 | **400**<br>841 | **434**<br>874 | **467**<br>908 | **501**<br>941 | **535**<br>975 | **568**<br>1008 | **602**<br>1042 | **635**<br>1076 |
| 1:00 | **264**<br>1145 | **331**<br>1212 | **398**<br>1279 | **465**<br>1346 | **532**<br>1413 | **599**<br>1480 | **667**<br>1547 | **734**<br>1614 | **801**<br>1681 | **868**<br>1749 | **935**<br>1816 | **1002**<br>1883 | **1069**<br>1950 | **1136**<br>2017 | **1203**<br>2084 | **1270**<br>2151 |
| 1:30 | **396**<br>1717 | **497**<br>1818 | **597**<br>1918 | **698**<br>2019 | **799**<br>2120 | **899**<br>2220 | **1000**<br>2321 | **1100**<br>2422 | **1201**<br>2522 | **1302**<br>2623 | **1402**<br>2723 | **1503**<br>2824 | **1604**<br>2925 | **1704**<br>3025 | **1805**<br>3126 | **1905**<br>3227 |
| 2:00 | **528**<br>2290 | **662**<br>2424 | **796**<br>2558 | **931**<br>2692 | **1065**<br>2826 | **1199**<br>2960 | **1333**<br>3095 | **1467**<br>3229 | **1601**<br>3363 | **1736**<br>3497 | **1870**<br>3631 | **2004**<br>3765 | **2138**<br>3900 | **2272**<br>4034 | **2406**<br>4168 | **2541**<br>4302 |
| 2:30 | **660**<br>2862 | **828**<br>3030 | **995**<br>3197 | **1163**<br>3365 | **1331**<br>3533 | **1499**<br>3701 | **1666**<br>3868 | **1834**<br>4036 | **2002**<br>4204 | **2169**<br>4371 | **2337**<br>4539 | **2505**<br>4707 | **2673**<br>4875 | **2840**<br>5042 | **3008**<br>5210 | **3176**<br>5378 |
| 3:00 | **792**<br>3434 | **993**<br>3636 | **1195**<br>3837 | **1396**<br>4038 | **1597**<br>4239 | **1798**<br>4441 | **2000**<br>4642 | **2201**<br>4843 | **2402**<br>- | **2603**<br>- | **2805**<br>- | **3006**<br>- | **3207**<br>- | **3408**<br>- | **3610**<br>- | **3811**<br>- |
| 3:30 | **924**<br>4007 | **1159**<br>4242 | **1394**<br>4476 | **1628**<br>4711 | **1863**<br>4946 | **2098**<br>- | **2333**<br>- | **2568**<br>- | **2802**<br>- | **3037**<br>- | **3272**<br>- | **3507**<br>- | **3742**<br>- | **3977**<br>- | **4211**<br>- | **4446**<br>- |
| 4:00 | **1056**<br>4579 | **1324**<br>4847 | **1593**<br>- | **1861**<br>- | **2129**<br>- | **2398**<br>- | **2666**<br>- | **2934**<br>- | **3203**<br>- | **3471**<br>- | **3740**<br>- | **4008**<br>- | **4276**<br>- | **4545**<br>- | **4813**<br>- | - |
| 4:30 | **1188**<br>- | **1490**<br>- | **1792**<br>- | **2094**<br>- | **2396**<br>- | **2697**<br>- | **2999**<br>- | **3301**<br>- | **3603**<br>- | **3905**<br>- | **4207**<br>- | **4509**<br>- | **4811**<br>- | - | - | - |
| 5:00 | **1320**<br>- | **1655**<br>- | **1991**<br>- | **2326**<br>- | **2662**<br>- | **2997**<br>- | **3333**<br>- | **3668**<br>- | **4004**<br>- | **4339**<br>- | **4674**<br>- | **5010**<br>- | - | - | - | - |
| 5:30 | **1452**<br>- | **1821**<br>- | **2190**<br>- | **2559**<br>- | **2928**<br>- | **3297**<br>- | **3666**<br>- | **4035**<br>- | **4404**<br>- | **4773**<br>- | - | - | - | - | - | - |
| 6:00 | **1584**<br>- | **1987**<br>- | **2389**<br>- | **2792**<br>- | **3194**<br>- | **3597**<br>- | **3999**<br>- | **4402**<br>- | **4804**<br>- | - | - | - | - | - | - | - |
| 6:30 | **1716**<br>- | **2152**<br>- | **2588**<br>- | **3024**<br>- | **3460**<br>- | **3896**<br>- | **4332**<br>- | **4769**<br>- | - | - | - | - | - | - | - | - |
| 7:00 | **1848**<br>- | **2318**<br>- | **2787**<br>- | **3257**<br>- | **3726**<br>- | **4196**<br>- | **4666**<br>- | - | - | - | - | - | - | - | - | - |
| 7:30 | **1980**<br>- | **2483**<br>- | **2986**<br>- | **3489**<br>- | **3993**<br>- | **4496**<br>- | **4999**<br>- | - | - | - | - | - | - | - | - | - |
| 8:00 | **2112**<br>- | **2649**<br>- | **3185**<br>- | **3722**<br>- | **4259**<br>- | **4796**<br>- | - | - | - | - | - | - | - | - | - | - |

NOTE: **XXXX** CREW MASKS SET TO NORMAL MODE
XXXX CREW MASKS SET TO 100% MODE

**Planning Considerations:**

- Time to descend to 10,000 feet
- Distance to suitable airport
- Terrain considerations
- Weather at destination

# VII. SERVICING

## A. OXYGEN REPLENISHMENT

**Service Requirements:**

- Maintenance function only
- Use service panel on right side
- Follow AMM procedures
- Verify proper pressure after servicing




**Safety Precautions:**

- No oil or grease near oxygen
- Use only approved equipment
- Verify area ventilation adequate
- Follow safety procedures

### B. OVERBOARD DISCHARGE

**Discharge Indicator:**

- Green disk above service panel
- Ruptures if system discharges
- Visual indication of discharge event
- Requires investigation if missing

**Discharge Causes:**

- Excessive system pressure
- Thermal relief activation
- Component failure
- Maintenance action

## VIII. EICAS MESSAGES

### A. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| OXYGEN QUANTITY LOW | Oxygen is less than 700 liters | TO/LAND |
| OXYGEN VALVE CLOSED | The oxygen bottle valve is closed, or there is a miscompare in the number of bottles installed and the number of bottles selected on the EAPV. This message will normally only occur on the ground | TO/LAND |
| PAX OXYGEN AUTO FAIL | Passenger oxygen system has failed to deploy with the cabin altitude greater than 15,000 ft and the pax oxygen system in AUTO. Either the pax masks have not deployed or the pax oxygen system is not pressurized | TO/LAND |

### B. STATUS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning |
|---|---|
| PAX OXYGEN OFF | The passenger oxygen switch has been selected OFF |
| PAX OXYGEN ON | Pressure has been detected in the passenger oxygen lines |

# IX. LIMITATIONS

## A. SYSTEM LIMITATIONS

Oxygen System Operational Limitations

| Parameter | Limitation |
|---|---|
| Minimum Dispatch Quantity | 700 liters |
| Maximum Passengers | Per seating configuration |
| Passengers < 2 Years | Per operator regulations |
| Cold Weather Operation | ⩾ -5°C for mask function |
| Oxygen Pressure Maximum | 1,850 psi |
| Automatic Deployment Altitude | 14,500 ft ±500 ft |
| Flow Termination Altitude | 9,500 ft ±500 ft |
| Emergency Mode | Positive pressure delivery |
| OXYGEN VALVE CLOSED (C) CAS | Maximum altitude 25,000 ft |
| OXYGEN QUANTITY LOW (C) CAS | Maximum altitude 25,000 ft |

## B. OXYGEN MASK LIMITATIONS

Oxygen Mask Limitations

| Condition | Limitation |
|---|---|
| Crew and Passenger Oxygen Masks | Not approved above 40,000 ft cabin altitude |
| Passenger Mask Operation | Prolonged operation above 25,000 ft cabin altitude not recommended |

# X. ABNORMAL OPERATIONS

## A. MANUAL DEPLOYMENT

**When Required:**

- Smoke or fumes in cabin
- Automatic deployment failure
- Cabin altitude above 14,000 feet without deployment
- Crew discretion for passenger safety

**Procedure:**

- PAX OXYGEN switch to DEPLOY
- Verify mask deployment
- Make passenger announcement
- Monitor oxygen quantity

## B. SYSTEM FAILURES

**Low Quantity:**

- Plan immediate descent
- Consider nearest suitable airport
- Monitor remaining quantity
- Brief crew on situation

**Deployment Failure:**

- Use manual DEPLOY switch
- If unsuccessful, consider emergency descent
- Brief passengers on situation
- Prepare for possible emergency

# XI. CIRCUIT BREAKERS

Oxygen System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| OXYGEN MAN DEP/IND | RIGHT ESS | CB4-D1 |
| AUTO DEP THERAPTC | LEFT MAIN | CB3-D5 |

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## XII. QUIZ

1. What is the total oxygen system capacity when both cylinders are installed?

    A) 77 cu ft
    B) 115 cu ft
    C) 192 cu ft
    D) 250 cu ft

2. At what cabin altitude do passenger oxygen masks automatically deploy?

    A) 10,000 feet
    B) 12,500 feet
    C) 14,500 feet ± 500 feet
    D) 15,000 feet

3. What is the minimum oxygen quantity for dispatch?

    A) 500 liters
    B) 700 liters
    C) 1000 liters
    D) 1850 liters

4. How many operating modes does the crew oxygen mask regulator provide?

    A) One
    B) Two
    C) Three
    D) Four

5. Where is the oxygen service panel located?

    A) Left side forward of left engine
    B) Right side forward of right engine
    C) Aft equipment bay
    D) Forward cargo compartment

6. What does EPAV stand for?

    A) Emergency Pneumatic Actuating Valve
    B) Electrical Pneumatic Actuating Valve
    C) Electronic Pressure Actuating Valve
    D) Emergency Pressure Activation Valve

7. What is the storage pressure when the oxygen system is fully charged?

    A) 1,500 psi
    B) 1,650 psi
    C) 1,850 psi
    D) 2,000 psi

8. What are the three positions of the PAX oxygen switch?

A) ON, OFF, AUTO
B) OFF, AUTO, DEPLOY
C) NORMAL, AUTO, EMERGENCY
D) OFF, NORMAL, DEPLOY

9. What indicates that the oxygen system has discharged overboard?

A) Red flag in cockpit
B) EICAS warning message
C) Green disk missing or ruptured
D) Pressure gauge reading zero

10. What is the capacity of the smaller oxygen cylinder?

A) 50 cu ft
B) 77 cu ft
C) 100 cu ft
D) 115 cu ft

11. In which mode does the crew oxygen mask provide positive pressure?

A) NORMAL
B) 100%
C) EMERGENCY
D) DILUTED

12. What is the minimum duration for passenger oxygen masks?

A) 10 minutes
B) 12 minutes
C) 15 minutes
D) 20 minutes

13. Where is the PBE (Portable Breathing Equipment) located?

A) Overhead bins
B) Behind pilot's station on bulkhead
C) Galley area
D) Aft cargo compartment

14. What EICAS message appears when oxygen quantity drops below 700 liters?

A) OXYGEN LOW
B) OXYGEN QUANTITY LOW
C) OXY QTY LOW
D) OXYGEN RESERVE

15. What happens when PAX OXYGEN switch is in OFF position?

A) System is depressurized
B) PAX OXYGEN OFF status message appears
C) Masks automatically retract
D) EPAV closes

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CL-350



CL-350 TRAINING MANUAL

# LIGHTING SYSTEM 13

AIRCRAFT SYSTEMS
TRAINING MANUAL

LOFT.AERO

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# LIGHTING SYSTEM

The Challenger 350 lighting system provides comprehensive illumination for all phases of flight operations, from preflight inspection through landing and passenger evacuation. The system integrates flight compartment lighting for crew operations, external lighting for aircraft visibility and ground operations, cabin lighting for passenger comfort, and emergency lighting for evacuation scenarios. Most lighting systems are controlled through dedicated panels in the cockpit, with automatic features for emergency situations and power loss conditions.

## I. INTRODUCTION

### A. SYSTEM OVERVIEW

**Primary Functions:**

- Interior and exterior aircraft illumination
- Emergency evacuation guidance
- Aircraft visibility to other traffic
- Ground operations support
- Passenger comfort and safety

**Major Subsystems:**

- Flight compartment lighting system
- Emergency lighting system
- External aircraft lighting
- Entrance and cabin lighting
- Cargo and service compartment lighting

### B. SYSTEM SPECIFICATIONS

**Control Locations:**

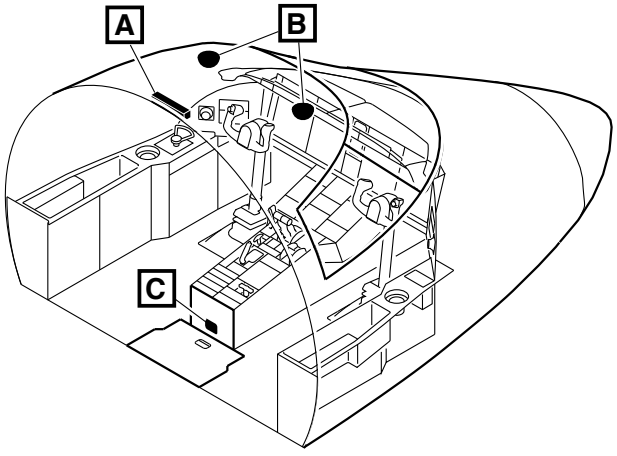
- **Center Pedestal:** Primary lighting control panel
- **Side Panels:** Flight crew lighting controls
- **Overhead Panel:** Dome light and reading lights
- **Wardrobe Bulkhead:** Stair lights switch

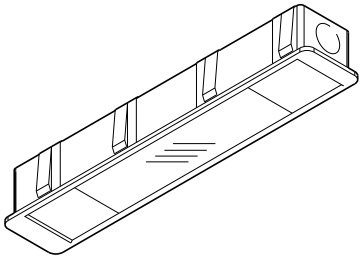
## II. FLIGHT COMPARTMENT LIGHTING

### A. COCKPIT DOME LIGHT

**Components:**

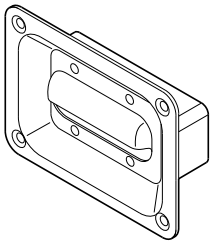
- LED array for soft illumination
- Low power consumption design
- Overhead panel mounting
- Potentiometer control



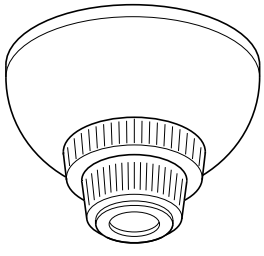
DOME LIGHT (DS1)

A



STOWAGE LIGHT (DS4)

C



FLIGHT–CREW READING LIGHT (PILOT, DS7) (CO–PILOT, DS8)

B

**Control Features:**

- DOME rotary switch on Co-Pilot's COCKPIT LIGHTS panel
- DIM to BRT continuous adjustment
- Powered by 28 VDC Right Essential Bus
- Protected by DOME circuit breaker (CB2 E14)

## B. INTEGRAL LIGHTING SYSTEM

**Zone 1 - Pilot Area:**

- Pilot panel illumination
- Left glareshield section
- GSHLD/L SIDE control knob
- DIM to BRT adjustment

**Zone 2 - Center Pedestal:**

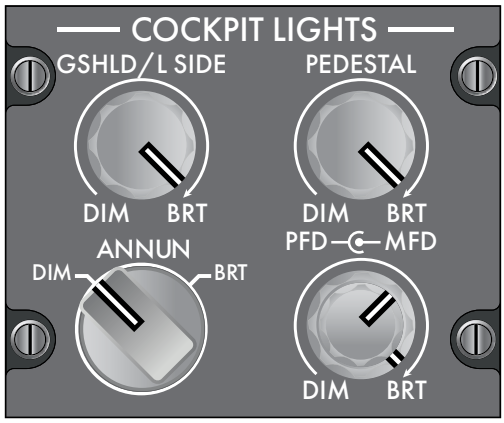
- Pedestal panel lighting
- PEDESTAL control knob
- Throttle quadrant illumination
- Center console coverage

**Zone 3 - Copilot Area:**

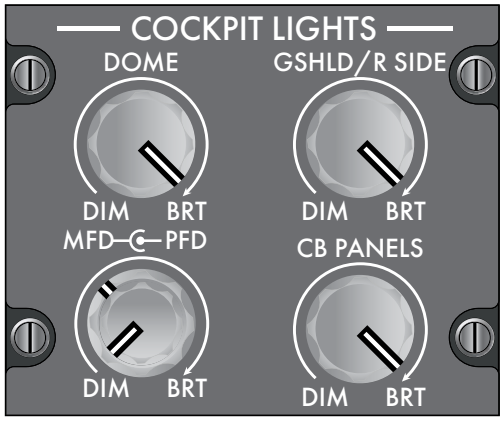
- Copilot panel illumination
- Right glareshield section
- GSHLD/R SIDE control knob
- DIM to BRT adjustment

**Zone 4 - Circuit Breakers:**

- Pilot and copilot CB panels
- CB PANELS control knob
- DIM to BRT adjustment
- Even illumination distribution




Left Cockpit Lights Panel




Right Cockpit Lights Panel

## C. CONTROL PANEL FEATURES

**Pilot's Individual Light Controls:**

- GSHLD/L SIDE dimming
- PEDESTAL
- ANNUN DIM/BRT switch
- MFD – PFD control knob

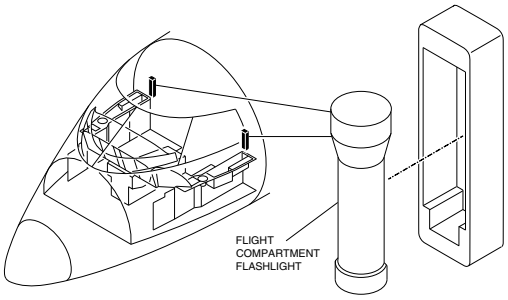
**Co-Pilot's Individual Light Controls:**

- DOME light switch
- GSHLD/R SIDE dimming
- MFD – PFD control knob
- CB PANELS illumination

## D. SPECIALIZED COCKPIT LIGHTING

**Crew Reading Lights:**

- Recessed in headliner
- ±30 degrees rotation
- Built-in shutter ON/OFF
- Continuous intensity adjustment
- Individual pilot/copilot units



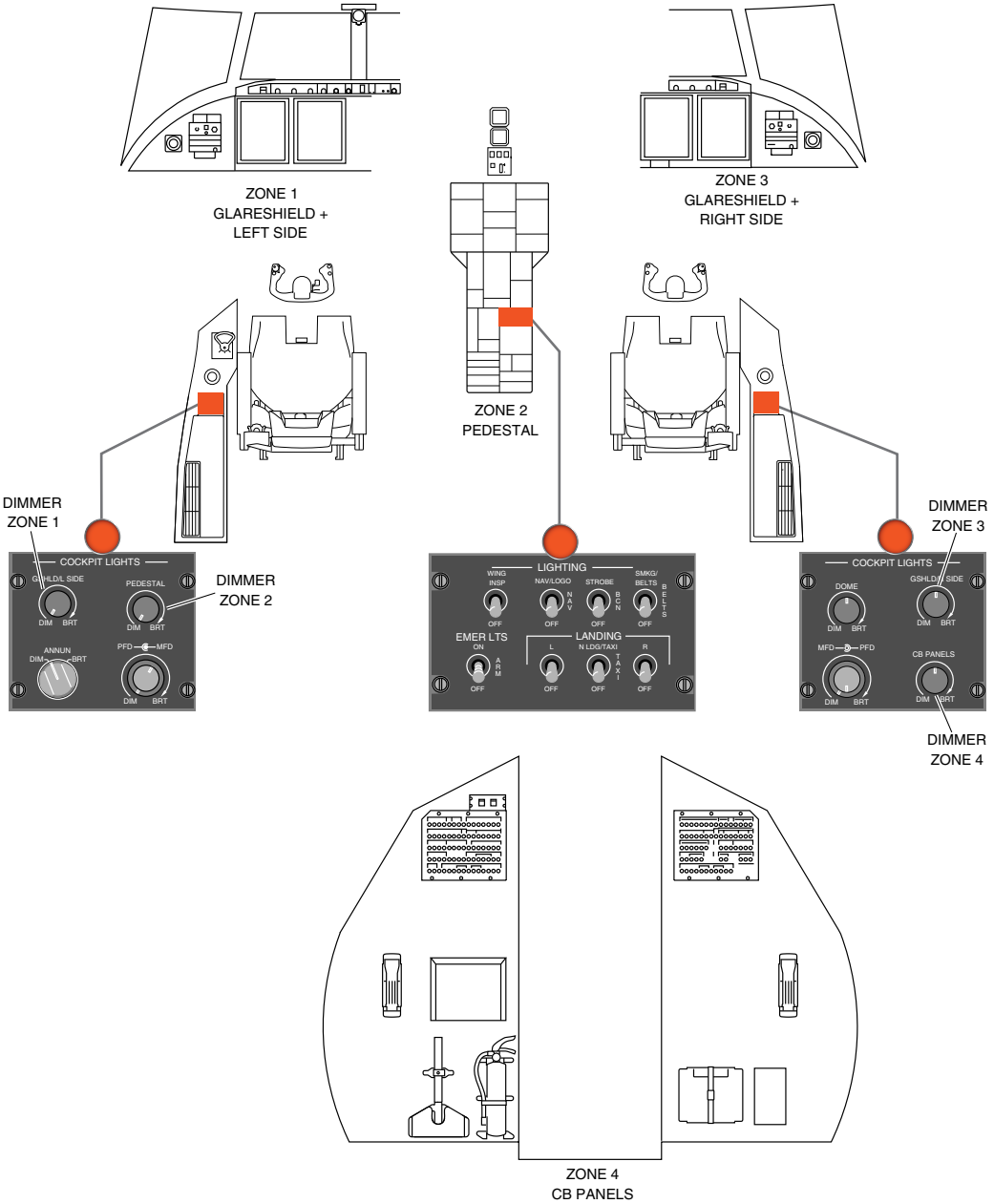



**Chart Holder Lights:**

- Integral to control yokes
- Direct chart illumination
- Independent left/right operation

**Cockpit Stowage Light:**

- Center pedestal aft end
- Door-activated switch
- Automatic ON when door open

**Flashlights:**

- 2 – Installed in holders behind the pilot's and copilot's seats below CB panels

# III. EMERGENCY LIGHTING

## A. SYSTEM DESCRIPTION

**Power Sources:**

- Two independent battery packs
- Rechargeable
- 15-minute maximum duration (10 minutes required for dispatch)

**Components:**

- Exit sign illumination
- Ceiling emergency floodlights
- Floor emergency floodlights
- Exterior emergency lights
- Floor track lighting

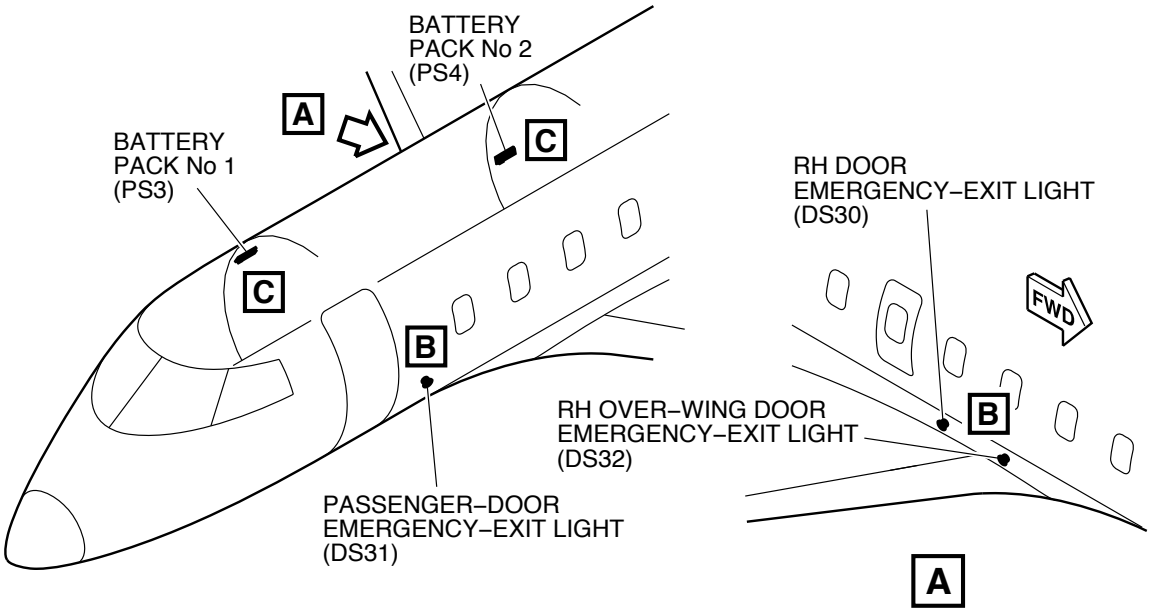
## B. CONTROL AND OPERATION

**EMER LTS Switch Positions:**

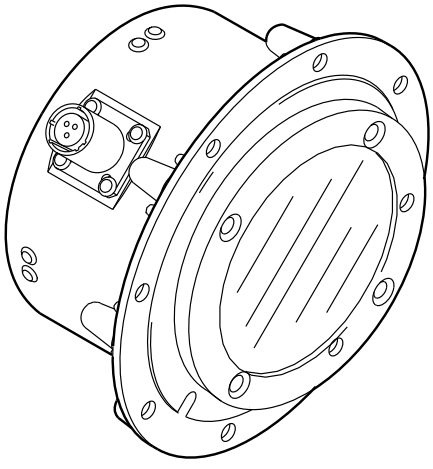
- **OFF**: System disabled, EMER LIGHTS OFF (C) displayed
- **ARM**: Automatic activation on R MAIN BUS loss
- **ON**: Manual activation, EMER LIGHTS ON (C) displayed

**Automatic Activation:**

- Occurs when ARM selected and R MAIN BUS power lost
- All interior lights illuminate
- All exterior lights illuminate
- No crew action required

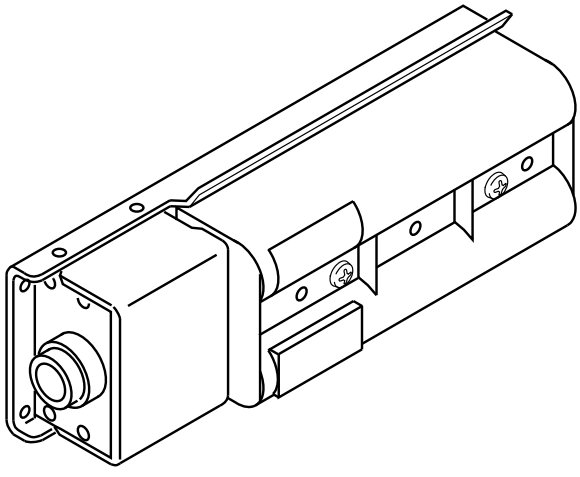



**A**



**EXTERNAL EMERGENCY LIGHT**

**B**



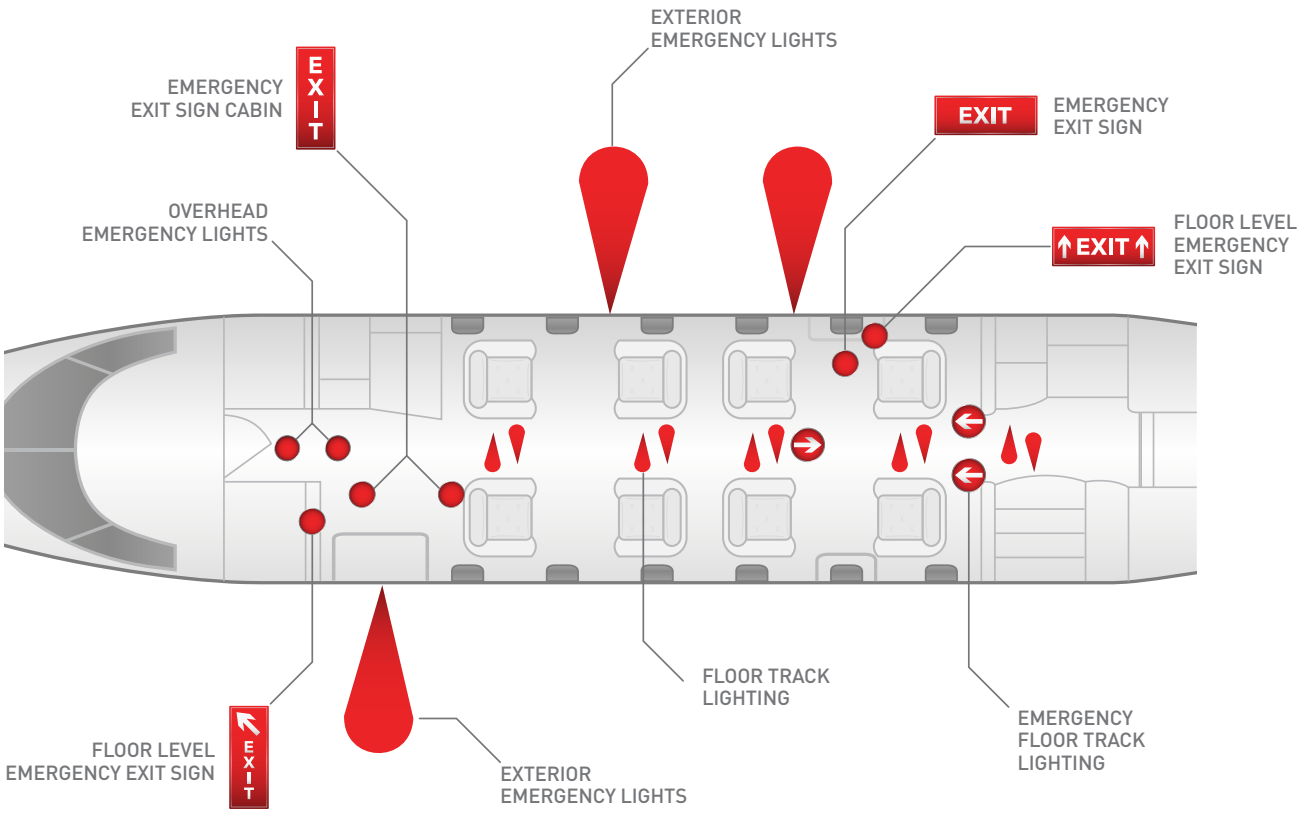
**EMERGENCY–LIGHTING POWER SUPPLY**

**C**

## C. EMERGENCY LIGHT LOCATIONS

**Interior Emergency Lighting:**

- 2 ceiling emergency floodlights
- 2 floor level emergency exit signs
- 3 emergency exit signs (two main cabin door, 1 emergency exit door)
- Floor track lighting (multiple segments)




**Exterior Emergency Lighting:**

- 3 exterior emergency lights
- Wing and fuselage area illumination
- Ground evacuation support

# IV. EXTERNAL LIGHTING

The navigation lights on the Challenger 350 utilize a dual light system, a design choice made to ensure increased dispatch reliability. This dual system is incorporated in both the wing tip navigation lights and the tail navigation light. For the wing tips, the system consists of a primary and a secondary unit housed under the same lens.

The tail navigation light also contains two identical high-intensity halogen lamps, where the lower unit serves as the primary light and the upper unit serves as the secondary light. If the primary navigation light fails, the secondary light will illuminate when the pilot selects the NAV SEC switch position (located on the right secondary power center).

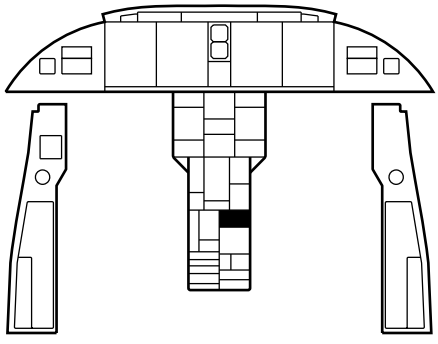
## A. NAVIGATION LIGHTS

**Standard Navigation Lights:**

- Left wing tip - Red
- Right wing tip - Green
- Tail position - White
- Controlled by NAV switch
- Optional NAV/LOGO combined switch (post-SB)

**Anti-Collision Strobes:**

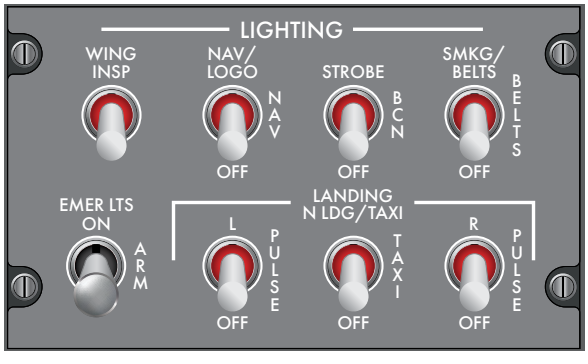
- 4 strobe light units (2 are optional)
- Wing tips and tail locations
- STROBE switch control (FDR activates w/switch)
- High-intensity white flashing



## B. LANDING AND TAXI LIGHTS

**Landing Lights:**

- 2 High Intensity Discharge (HID) units
- Wing-to-body fairing installation
- L and R LANDING switches
- Individual left/right control
- Sufficient illumination for night landing




**Taxi Lights:**

- Combined landing/taxi configuration
- N (Nose) position for taxi operations
- LDG/TAXI switch positions
- Enhanced ground maneuvering visibility

Note: Nose gear lights are only powered with the gear Down.

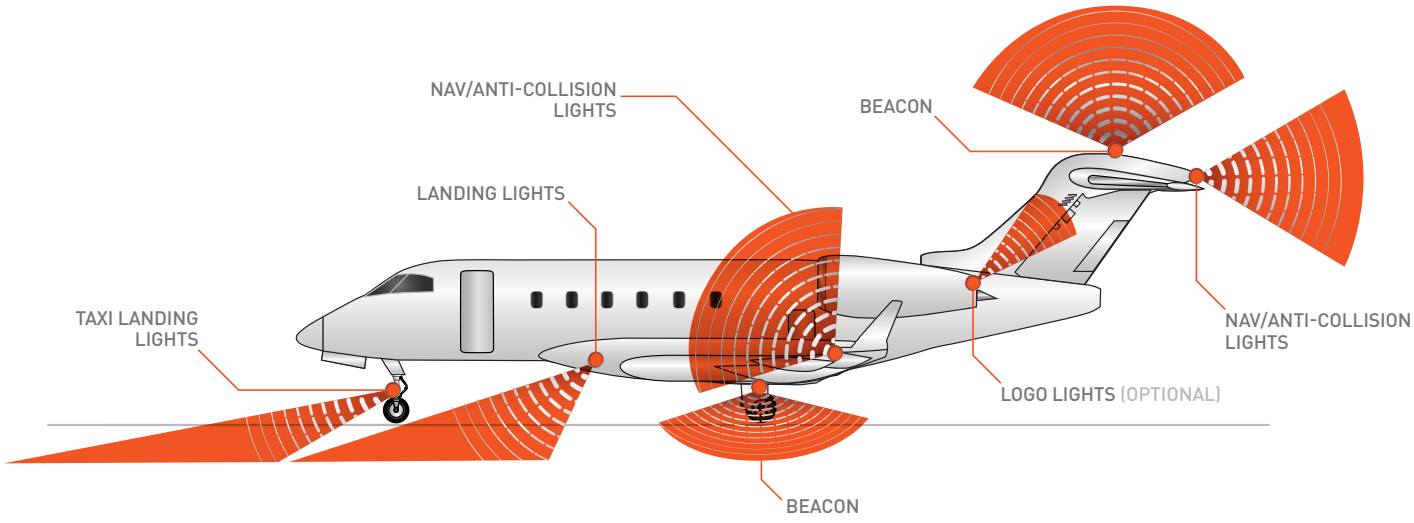
## C. ADDITIONAL EXTERNAL LIGHTS

**Wing Inspection Lights:**

- 2 units (left and right wings)
- WING INSP switch control
- Leading edge illumination
- Ice accumulation detection

**Beacon Lights:**

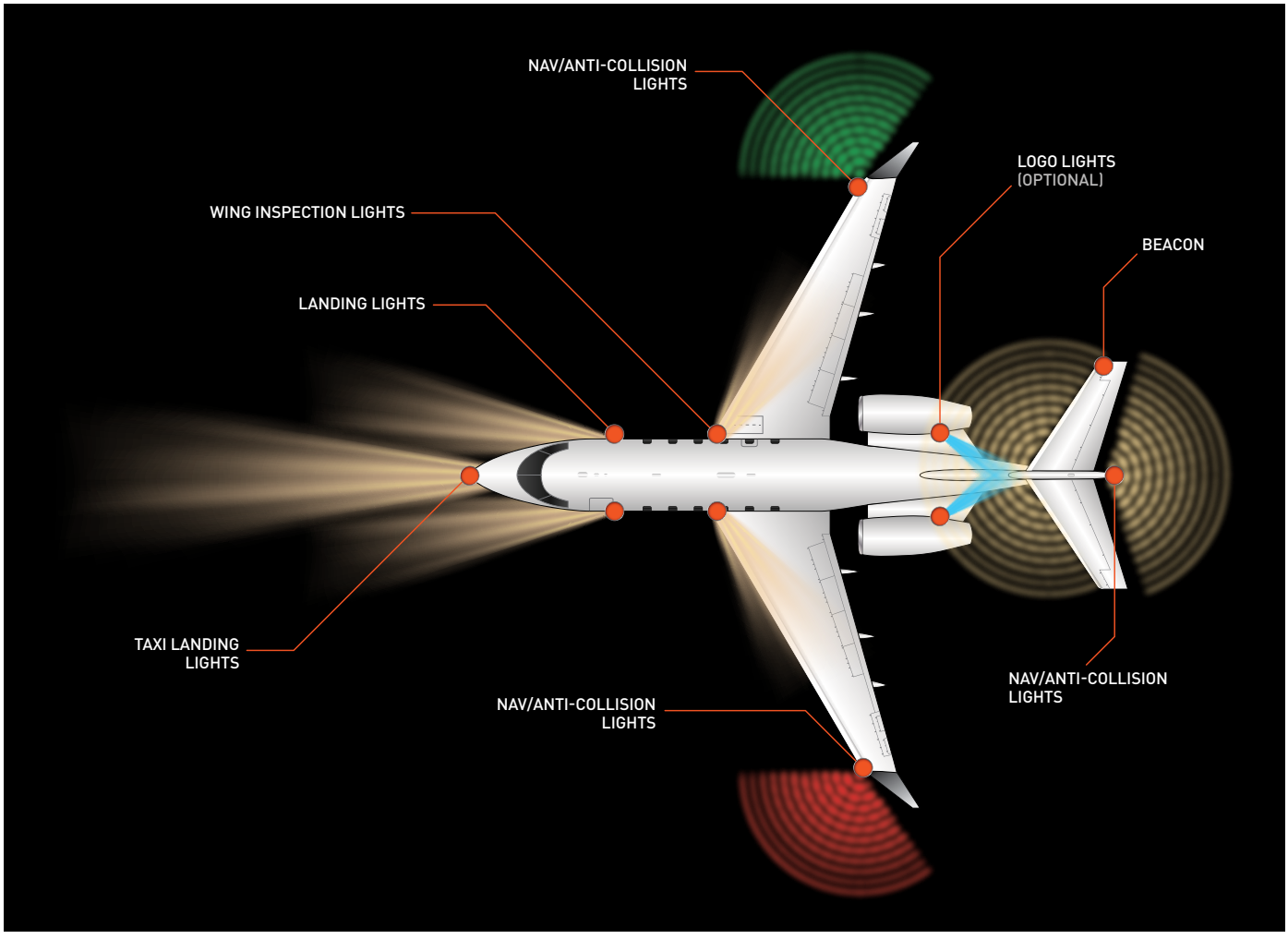
- 2 rotating beacon units
- BCN switch control
- Red flashing lights
- Ground operations warning




**Logo Lights (Optional):**

- Tail logo illumination
- NAV/LOGO combined switch
- Enhanced aircraft identification

## EXTERNAL AIRCRAFT LIGHTING SCHEMATIC



# V. ENTRANCE AND CABIN LIGHTING

## A. STAIR LIGHTING

**System Components:**

- 7 stair light units
- 4 LEDs per light
- 28 VDC from L BATT BUS

**Control Features:**

- STAIR LIGHTS switch on wardrobe bulkhead
- Microswitch door interlock
- Automatic OFF when door closed/locked
- CB3-E9 circuit protection

**Operation Note:**

- Switch off when not in use
- Prevents battery discharge
- Manual control override available

## B. CABIN LIGHTING

**Passenger Compartment:**

- Indirect LED lighting system
- Overhead passenger service units (PSUs)
- Adjustable reading lights
- Individual passenger control

**Galley Lights:**

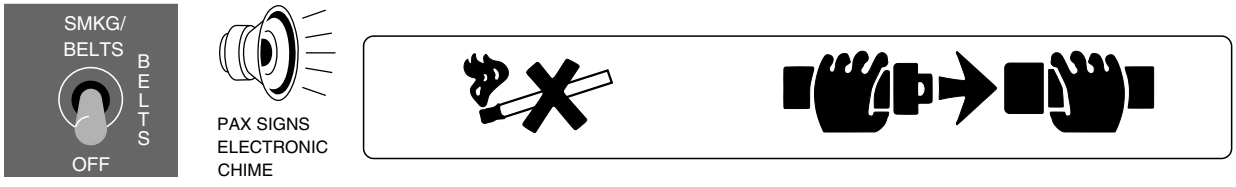
- Fluorescent lighting

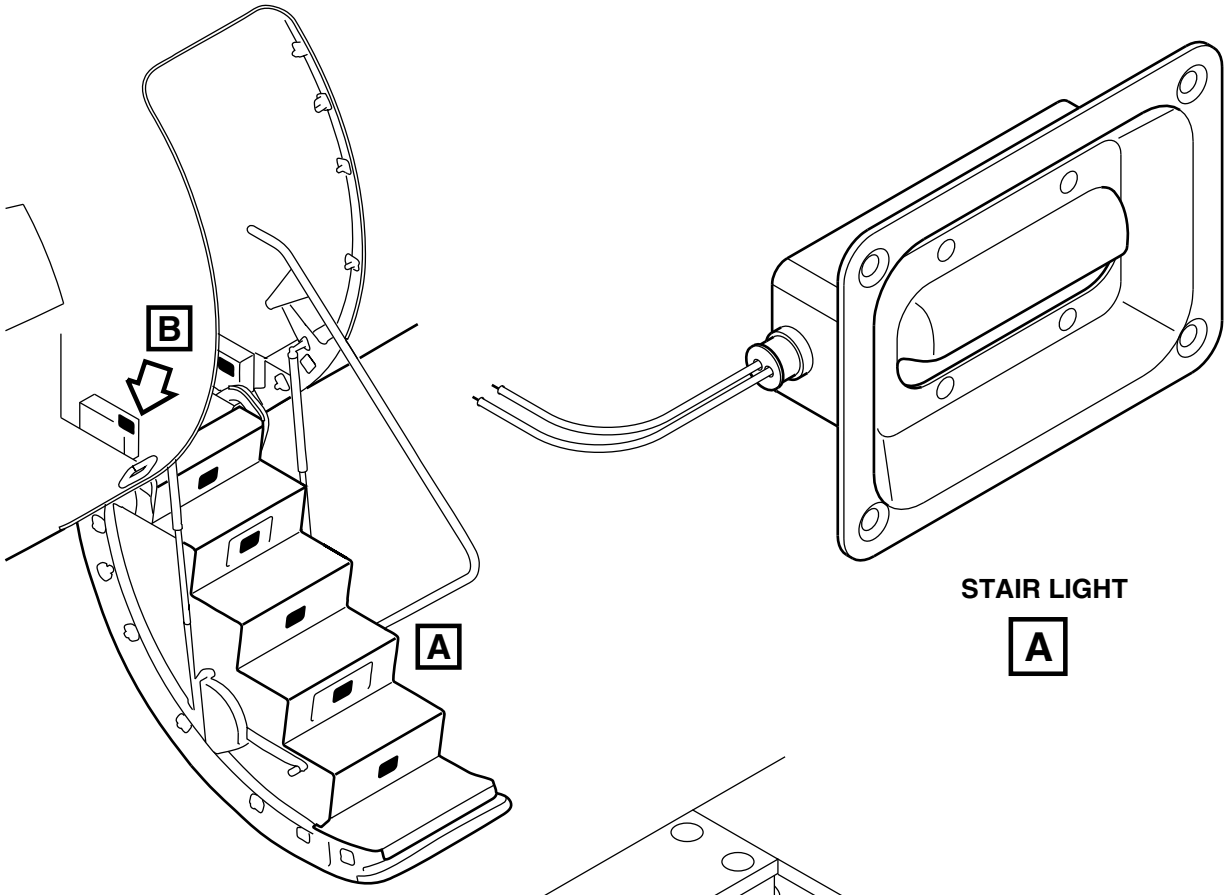
**Lavatory Lights:**

- Indirect LED lighting
- Located in Cabin PSU
- Controlled by CABIN LIGHT switch on lavatory control panel

**Seat Belts / No Smoking Lights:**

- Controlled via switch on Lighting Panel
- Three Position: OFF, BELTS, SMKG/BELTS
- Includes electronic chime

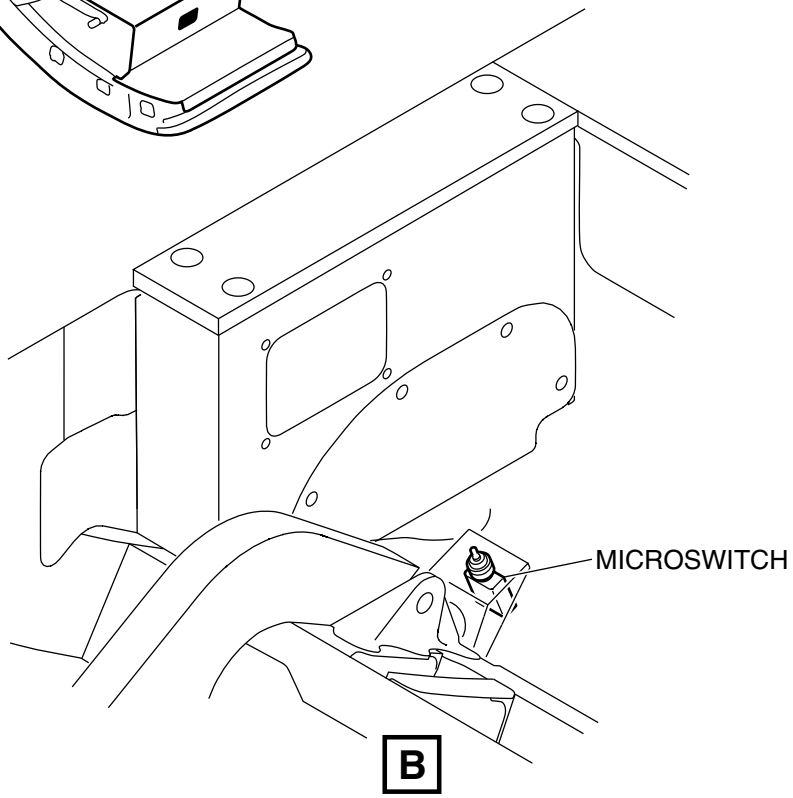







**STAIR LIGHT**

**A**



# VI. STANDBY INSTRUMENT LIGHTING

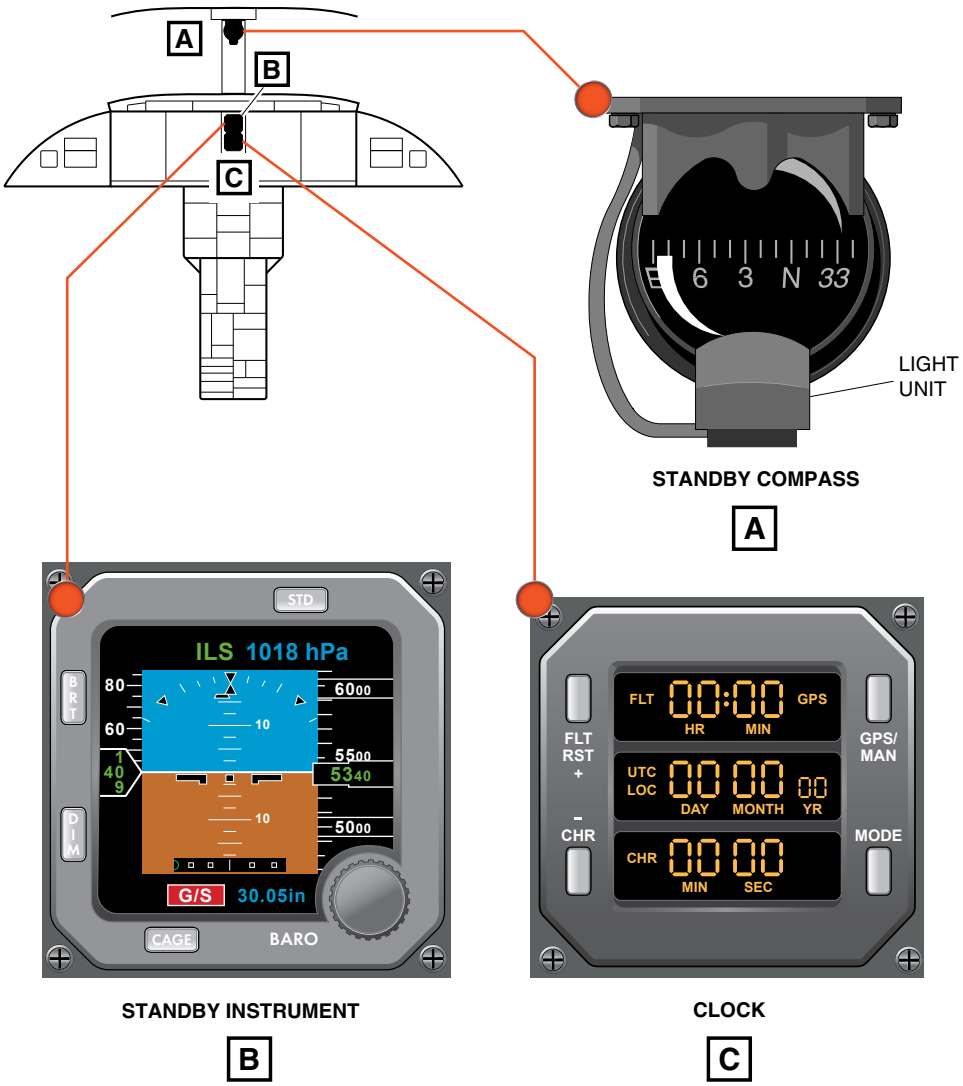
## A. COMPONENTS

**Illuminated Instruments:**

- Standby compass
- Standby flight instrument
- Clock

**Power Transfer:**

- Automatic switch to right essential bus
- Occurs on left main bus power loss
- Ensures continued instrument visibility



# VII. CARGO AND SERVICE COMPARTMENTS LIGHTING

## A. CARGO COMPARTMENT LIGHTING

**Cargo Loading Light:**

- Located in front of cargo door area
- Provides illumination for baggage loading operations
- Powered by left hot battery bus
- Connected directly to left battery
- Protected by circuit breaker CB5-A5 (LDCPC)

**Cargo Bay Light Controls:**

- Switch located in passenger cabin
- Automatic shutoff after 20 minutes when on battery power only
- Powered from left battery hot bus
- Manual ON/OFF operation

**Operation Notes:**

- Switch off when not in use
- Prevents unwanted battery discharge
- Available regardless of aircraft electrical configuration

**External Baggage Light:**

- Light located below left engine pylon
- Light switch located on the forward edge of cargo compartment
- Switched marked PYLON LIGHT



EXTERNAL BAGGAGE LIGHT



EXTERNAL BAGGAGE LIGHT SWITCH

## B. SERVICE COMPARTMENT LIGHTING

**Aft Equipment Compartment Lights:**

- Two service lights
- Illuminate aft compartment work areas
- Support general servicing activities
- Support maintenance operations
- Support inspection procedures

**Power Supply:**

- Powered by left battery hot bus
- Connected directly to left battery
- Protected by circuit breaker CB5-A5 (LDCPC)

## C. AUTO SHUT-OFF SYSTEM

**Timer Operation:**

- Single click activates normal operation
- 15 minutes normal illumination
- 10 seconds flashing warning period
- 5 minutes additional normal operation
- 20 minutes total before automatic shutoff

**Control Functions:**

- Reset/restart by pressing button while lights on
- Two quick clicks switches to standby mode
- Prevents battery depletion
- Visual warning before shutoff

**Timing Sequence:**

- 0-15 minutes: Normal continuous operation
- 15 minutes: 10-second flash warning
- 15-20 minutes: Normal operation resumes
- 20 minutes: Automatic switch to standby mode

## D. OPERATIONAL PROCEDURES

**Battery Conservation:**

- Always switch off when not in use
- Use two quick clicks for immediate standby
- Monitor 20-minute automatic timeout
- Reset timer as needed during extended operations

**Switch Locations:**

- Cargo Bay Light: Passenger cabin panel
- Service Lights: Push button with auto shut-off device
- Baggage External Light: BAG EXT light switch
- Aft Compartment Light: AFT COMP light switch

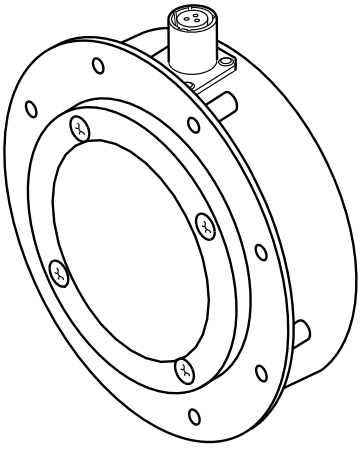
## E. SYSTEM INTEGRATION

**Battery Bus Connection:**

- Independent of main electrical system
- Available during ground operations
- Aircraft does not need to be powered up
- Direct battery connection ensures availability

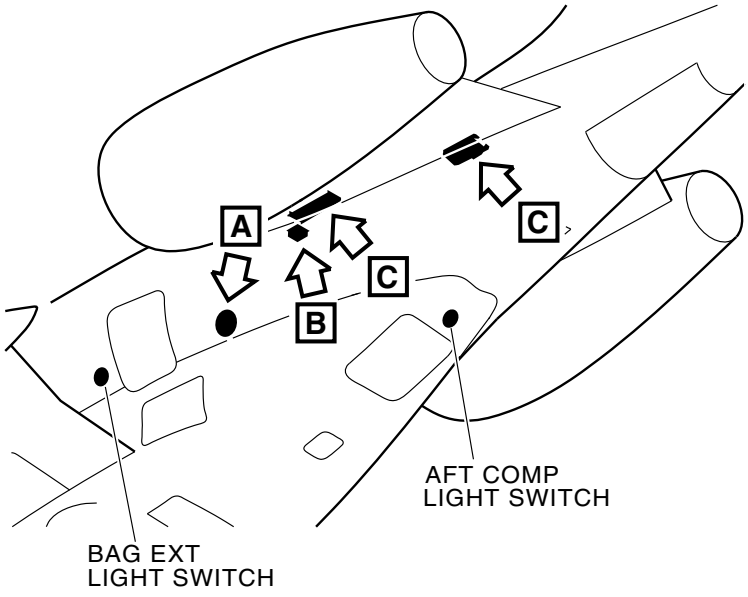
**Maintenance Support:**

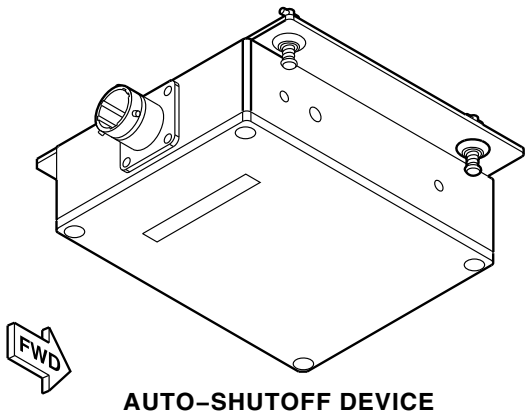
- Adequate illumination for inspection
- Work area lighting for servicing
- No external power requirement
- Timer prevents inadvertent discharge



**BAGGAGE–COMPARTMENT EXTERNAL LIGHT**

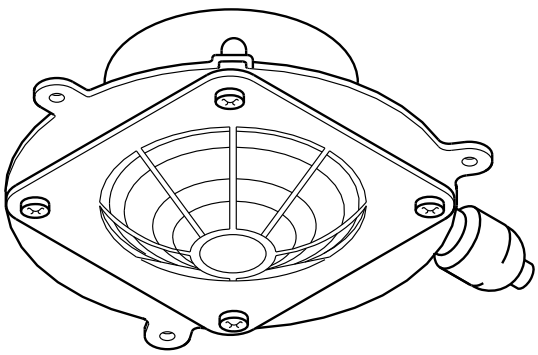
**A**




**AUTO–SHUTOFF DEVICE**

**B**



**AFT EQUIPMENT–COMPARTMENT LIGHT**

**C**

# VIII. SYSTEM LIMITATIONS

## A. OPERATIONAL LIMITATIONS

Lighting Limitations

| Category | Limitation |
|---|---|
| Emergency Lighting Duration | Minimum 10-minute duration required for dispatch |
| Emergency Lighting Armed | Must be armed for takeoff and landing |
| Strobe Lights Ground Operations | OFF during ground operations near personnel |

# IX. CIRCUIT BREAKERS

Lighting System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| BCN/STROBE LIGHT | LEFT MAIN | CB3-E8 |
| CABIN LIGHTS | RIGHT MAIN | CB4-E4 |
| CABIN SIGNS | LEFT MAIN | CB3-E5 |
| COMPASS LIGHTING | RIGHT ESS | CB4-F8 |
| DOMES LT | RIGHT ESS | CB2-E14 |
| EMER LTS | RIGHT MAIN | CB2-E15 |
| ENTRY LTS | LEFT BATT | CB3-E9 |
| EXT BAG/AFT BAY LIGHT | LEFT BATT | CB5-A5 |
| LH LDG LIGHT | LEFT MAIN | CB5-A6 |
| LIGHTS L CKPT/PED | LEFT MAIN | CB3-E4 |
| LIGHTS R CKPT/CBP | RIGHT MAIN | CB4-E2 |
| MAP STOW LIGHT | LEFT MAIN | CB3-E7 |
| NAV LTS | RIGHT MAIN | CB4-E8 |
| NOSE LDG LIGHT | RIGHT MAIN | CB4-E6 |
| NOSE TAXI LIGHT | RIGHT MAIN | CB4-E5 |
| OVHD LIGHTS | RIGHT ESS | CB2-E14 |
| RH LDG LIGHT | RIGHT MAIN | CB6-A6 |
| WING INSP LIGHT | LEFT MAIN | CB3-E6 |

# X. EICAS MESSAGES

## A. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| EMER LIGHTS OFF | The cabin emergency lights are off when they should be armed | TO/LAND |
| EMER LIGHTS ON | The cabin emergency lights are on | TO |

**NOTES**

- All caution messages are accompanied by a single chime
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- "TO" indicates the message is inhibited during takeoff only
- Emergency lights automatically illuminate when armed and R MAIN BUS power is lost
- Emergency light battery packs provide 15 minutes of power when activated

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## XI. LIGHTING SYSTEM QUIZ

1. How many minutes of emergency lighting are provided by the battery packs?

    A) 10 minutes
    B) 15 minutes
    C) 20 minutes
    D) 30 minutes

2. What type of lights are used for the landing light system?

    A) Halogen
    B) LED
    C) Incandescent
    D) High Intensity Discharge (HID)

3. Which bus powers the cockpit dome light?

    A) Left Essential Bus
    B) Right Essential Bus
    C) Left Main Bus
    D) Battery Bus

4. What happens to emergency lights when ARM is selected, and R MAIN BUS power is lost?

    A) They remain off
    B) They illuminate automatically
    C) They flash intermittently
    D) Crew must select ON

5. What controls the intensity of the circuit breaker panel lighting?

    A) MFD-PFD knob
    B) PEDESTAL knob
    C) CB PANELS knob
    D) DOME knob

6. The crew reading lights can rotate through what angle?

    A) ±15 degrees
    B) ±20 degrees
    C) ±25 degrees
    D) ±30 degrees

7. Which switch position combines navigation and logo lights (if installed)?

    A) NAV
    B) NAV/LOGO
    C) LOGO
    D) BCN

8. How many beacon light units are installed?

A) One
B) Two
C) Three
D) Four

9. What automatically turns off the stair lights?

A) Timer circuit
B) Door microswitch
C) Weight on wheels
D) Battery voltage

10. How many emergency exit signs are installed?

A) Five
B) Six
C) Seven
D) Eight



11. What powers the stair lighting system?

A) R BATT BUS
B) L BATT BUS
C) R ESS BUS
D) L MAIN BUS

12. The wing inspection lights are used primarily to check for?

A) Fuel leaks
B) Hydraulic leaks
C) Ice accumulation
D) Tire condition

13. What type of anti-collision lights are installed?

A) Rotating beacons
B) Strobe lights
C) LED flashers
D) Halogen pulsing

14. What is displayed when the EMER LTS switch is in the OFF position with battery switch ON?

A) **EMER LIGHTS ARM** (A)
B) **EMER LIGHTS TEST** (S)
C) **EMER LIGHTS OFF** (C)
D) No message

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CL-350



CL-350 TRAINING MANUAL

# FIRE PROTECTION 14

AIRCRAFT SYSTEMS
TRAINING MANUAL

LOFT.AERO

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# FIRE PROTECTION

The fire protection system provides comprehensive detection and extinguishing capabilities for critical aircraft areas including engines, auxiliary power unit, main landing gear bays, and cargo compartment. The system employs dual-loop detection technology for enhanced reliability, utilizing thermistor-based sensors that detect overheat conditions through electrical resistance changes.

Fire extinguishing capability is provided by two Halon 1301 bottles strategically positioned to protect engine and APU compartments, with automatic discharge features for ground operations and manual control during flight. The system integrates with the EICAS for real-time monitoring and crew alerting, incorporating multiple test functions to ensure system readiness.

## I. INTRODUCTION

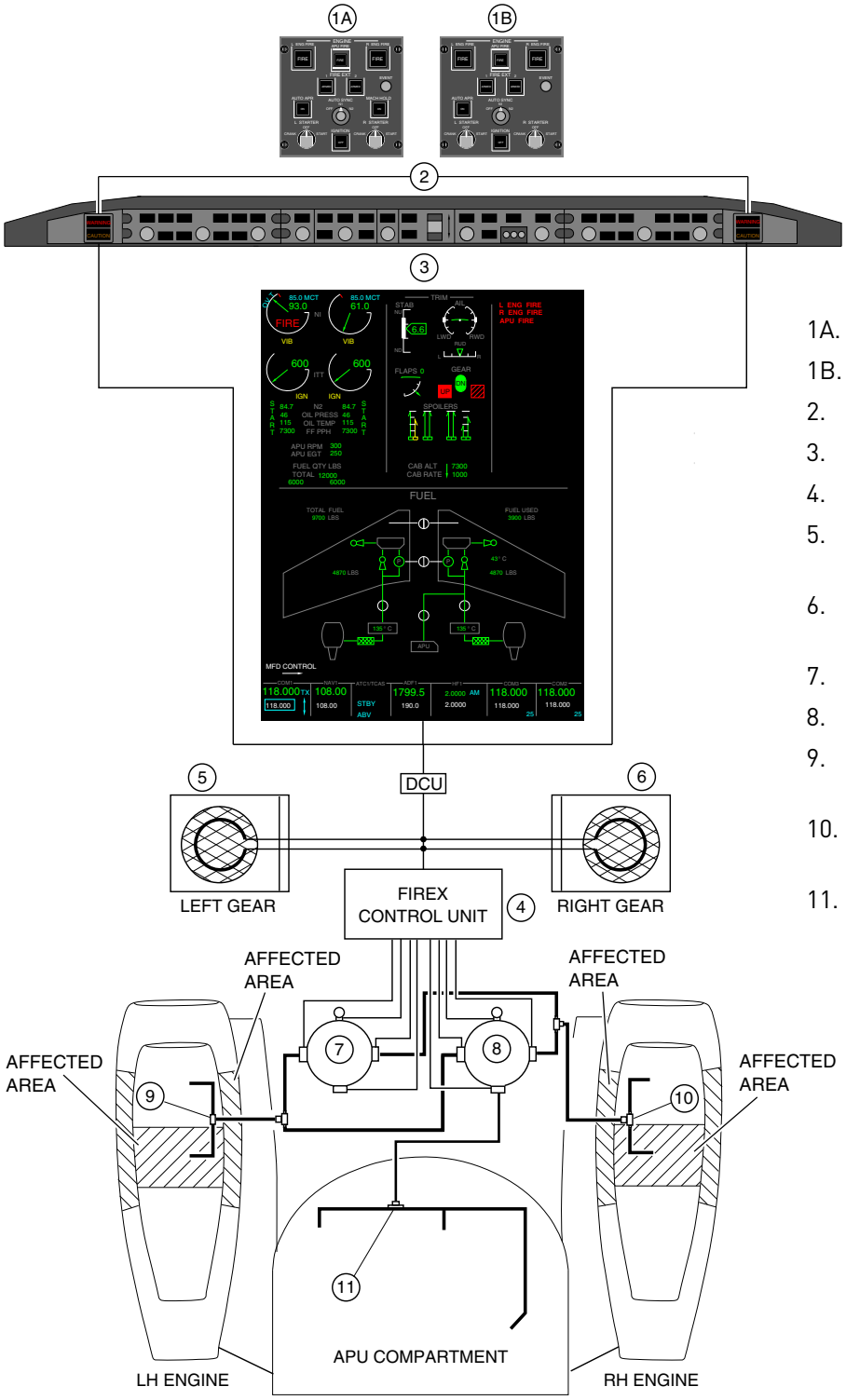
### A. FIRE PROTECTION SPECIFICATIONS

Fire Protection System Specifications

| Parameter | Value |
|---|---|
| Fire Detection Zones | Engines (2), APU, MLG Bays (2), Baggage Compartment |
| Detection System Type | Dual-loop thermistor-based (engines/APU), Single-loop (MLG) |
| Extinguisher Agent | Halon 1301 |
| Fire Bottles | 2 (Bottle #1: 2 squibs, Bottle #2: 3 squibs) APU Bottle #2 Only |
| Fire Control Unit (Aft Equipment Bay) | FIREX-CU (Fire Detection and Extinguishing Control Unit) |
| Loop Construction | Metal sheath with two internal wires separated by thermistor |
| Detection Logic | Both loops must sense fire condition to generate warnings |
| APU Ground Mode | Automatic shutdown and discharge after 5 seconds |
| APU Flight Mode | Manual discharge required after APU FIRE switch |
| Baggage Compartment Smoke Detector Type | Light-scatter |
| Gear Bay Detection | Single loop overheat detection |
| Fire System Test | SYSTEMS TEST rotary switch with FIRE DET position |
| Aural Warnings | “LEFT ENGINE FIRE”, “RIGHT ENGINE FIRE”, “APU FIRE” |
| Aerodrome Fire Category | 4 (ICAO), A (FAA), 4 (TC) |

**NOTE:** Main Landing Gear Bays and Baggage Compartment are detection only!

## FIRE PROTECTION SYSTEM OVERVIEW




1A. ENGINE PANEL WITHOUT AT SYSTEM
1B. ENGINE PANEL WITH AT SYSTEM
2. MASTER WARNING/CAUTION LIGHTS
3. LEFT MFD EICAS DISPLAY
4. FIREX CONTROL UNIT
5. LEFT MAIN WHEEL WELL OVERHEAT DETECTION
6. RIGHT MAIN WHEEL WELL OVERHEAT DETECTION
7. FIRE EXTINGUISHER BOTTLE NO. 1
8. FIRE EXTINGUISHER BOTTLE NO. 2
9. LEFT ENGINE COMPARTMENT DISCHARGE LINES
10. RIGHT ENGINE COMPARTMENT DISCHARGE LINES
11. APU COMPARTMENT DISCHARGE LINES

# II. ENGINE FIRE PROTECTION

## A. DETECTION SYSTEM

**Dual-Loop Configuration:**

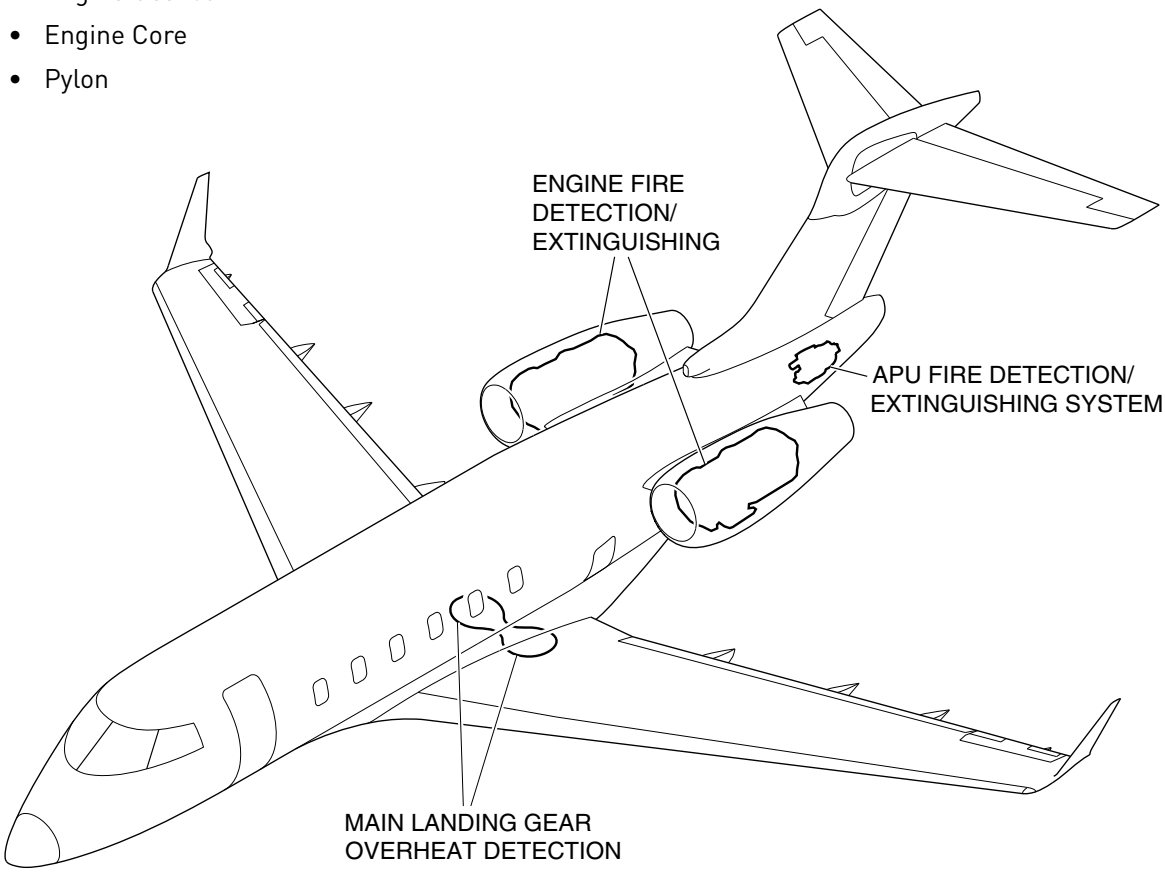
- Two independent fire detection loops per engine
- Both loops must sense fire conditions to trigger warning
- Single loop can detect fire if other loop fails
- Loops constructed with outer metal sheathing and internal thermistor material
- Resistance decreases with temperature increase

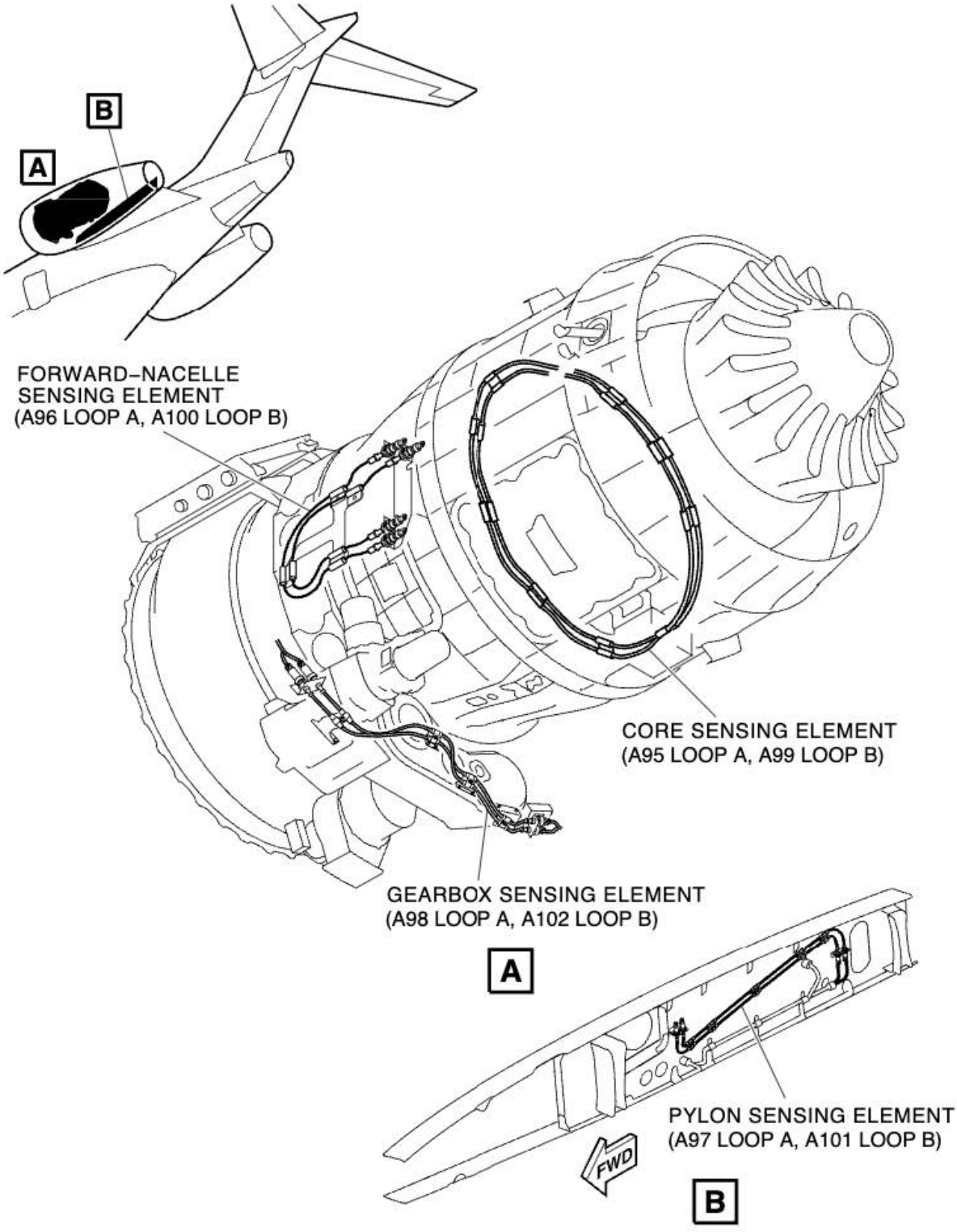
**Loop Monitoring:**

- FIREX-CU continuously monitors electrical resistance
- Preset time and resistance thresholds prevent false warnings
- Individual circuit monitoring for each loop
- Automatic fault detection and crew alerting

**Loop Locations:**

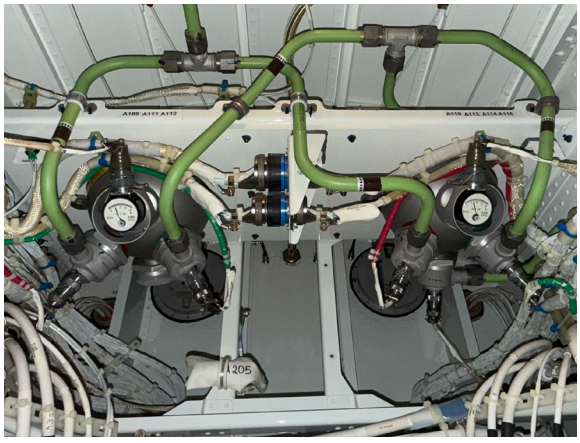
- Forward Engine Nacelle
- Engine Gearbox
- Engine Core
- Pylon






Engine Fire–Detection System – Component Location

### B. EXTINGUISHING SYSTEM



**Fire Bottles Configuration:**

- Bottle #1: Two discharge heads (one per engine)
- Bottle #2: Three discharge heads (both engines plus APU)
- Each squib has dual firing bridge wires
- Separate electrical circuits for redundancy

**Discharge Operation:**

- L/R ENG FIRE switch push: Shuts down engine and arms squib
- FIRE EXT 1 or 2 switch push: Discharges selected bottle
- Both bottles can discharge into single engine if required status, expect a post-discharge LOW advisory
- Pressure switches and gauges monitor bottle status, expect a post-discharge LOW advisory

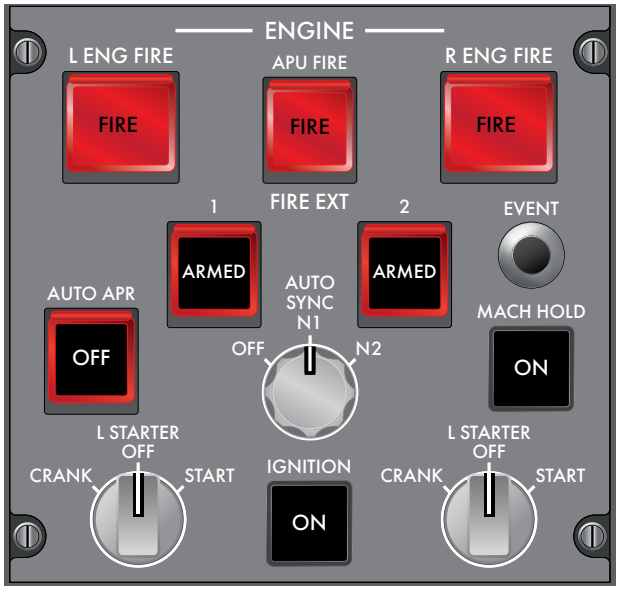
**NOTES**

- Regardless of which engine has the fire, FIRE EXT 1 should always be pushed first since the APU compartment can only be extinguished by bottle #2. Wait ~10 seconds before discharging first bottle and ~30 before discharging the second bottle is CAS persists.

### C. ENGINE FIRE SWITCH ACTIONS

**When Pushed:**

- Fuel shutoff valve closes
- Bleed-air shutoff valve closes
- Hydraulic shutoff valve closes
- Generator is selected offline
- FADEC commands engine shutdown
- Both fire bottle squibs armed
- Both FIRE EXT ARMED lights illuminate




## III. APU FIRE PROTECTION

### A. DETECTION SYSTEM

**Detection Loops:**

- Dual fire detection loops in APU enclosure
- Same thermistor technology as engine loops
- Both loops must sense overheat for fire indication
- Connected to FIREX-CU for monitoring

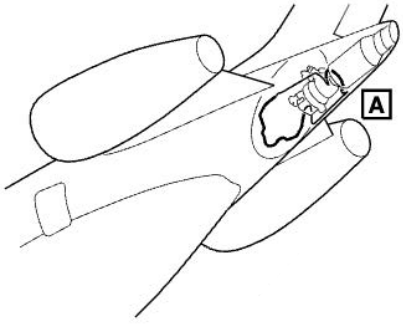
**Loop Locations:**

- APU Firewall
- APU Eductor

## B. OPERATIONAL MODES

**Ground Mode (Unattended):**

- Automatic APU shutdown upon fire detection
- Bottle #2 automatically discharges after 5 seconds
- No crew intervention required
- Protects aircraft during ground operations



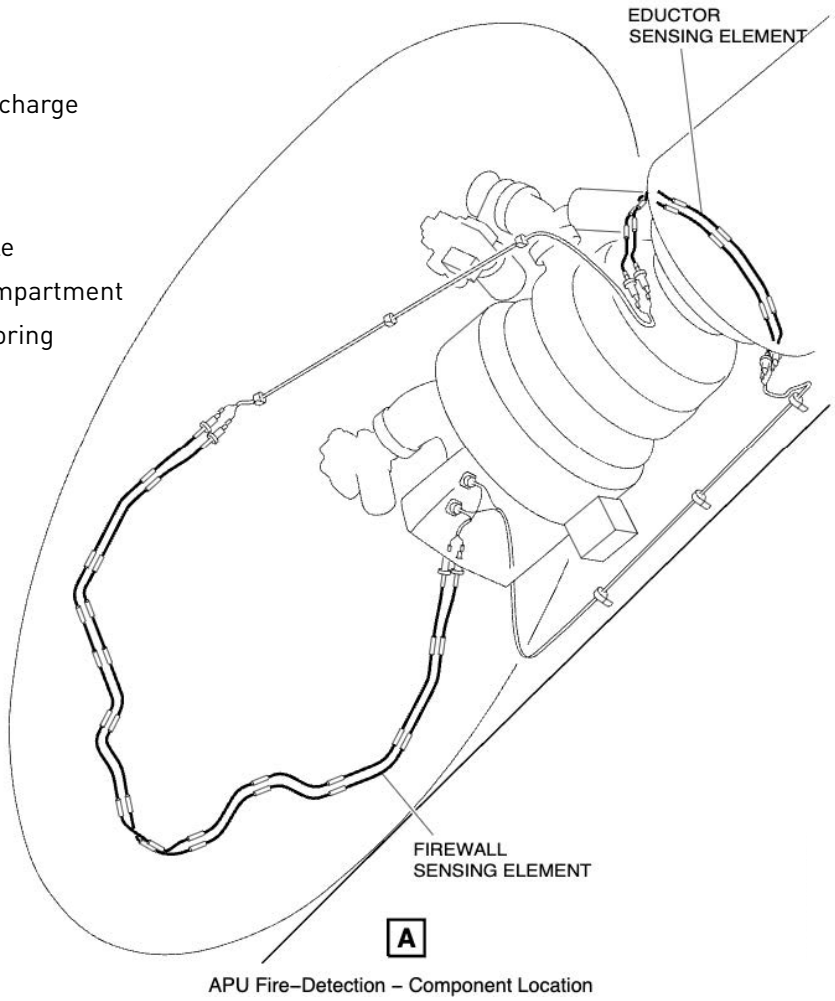

**Flight Mode:**

- APU FIRE switch push shuts down APU
- ECU closes APU fuel metering valve
- APU bleed-air shutoff valve closes
- APU generator selected offline
- Arms bottle #2 squib
- FIRE EXT 2 illuminates ARMED
- Crew must push FIRE EXT 2 to discharge

## C. EXTINGUISHING SYSTEM

**Bottle #2 Dedicated Functions:**

- Exclusive APU fire protection bottle
- Single explosive squib for APU compartment
- Pressure switch and gauge monitoring
- Halon 1301 extinguishing agent




APU Fire–Detection – Component Location

## Engine Fire Protection - Firex Bottle Pressures

During checks on the FIREX bottles, the following pressure/temperature chart can be used to determine if bottle pressure is within acceptable limits for bottle temperature. The table provided applies to bottles with a **4.3 lb nominal weight**.

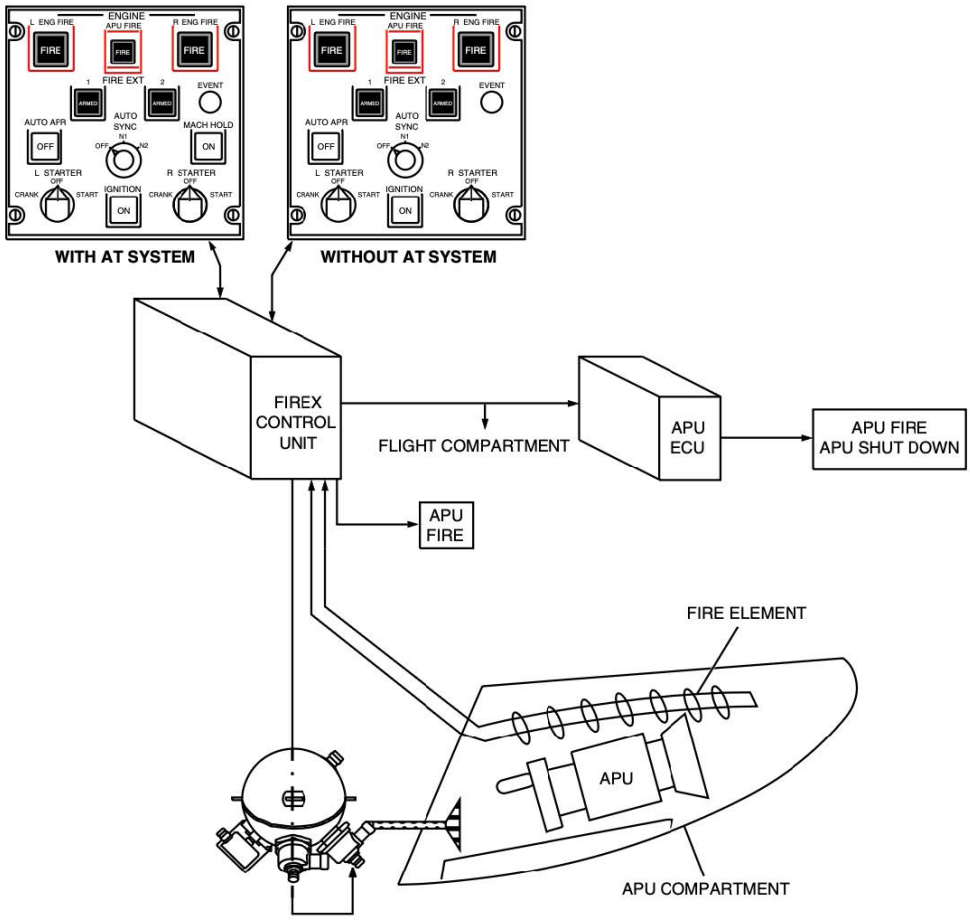
**Minimum/Maximum FIREX Bottle Pressure (4.3 lb nominal weight)**

| Temperature | | Gauge Reading (psig) | |
|---|---|---|---|
| °C | (°F) | Minimum | Maximum |
| –55 | (–67) | 251 | 343 |
| –50 | (–58) | 277 | 354 |
| –45 | (–49) | 288 | 367 |
| –40 | (–40) | 302 | 380 |
| –35 | (–31) | 315 | 394 |
| –30 | (–22) | 330 | 410 |
| –25 | (–13) | 347 | 427 |
| –20 | (–4) | 365 | 445 |
| –15 | (5) | 384 | 465 |
| –10 | (14) | 404 | 486 |
| –5 | (23) | 427 | 508 |
| 0 | (32) | 450 | 533 |
| 5 | (41) | 476 | 559 |
| 10 | (50) | 503 | 587 |
| 15 | (59) | 532 | 616 |
| 20 | (68) | 563 | 648 |
| 25 | (77) | 596 | 681 |
| 30 | (86) | 631 | 717 |
| 35 | (95) | 668 | 755 |
| 40 | (104) | 708 | 795 |
| 45 | (113) | 750 | 838 |
| 50 | (122) | 796 | 886 |
| 55 | (131) | 849 | 941 |
| 60 | (140) | 895 | 982 |
| 65 | (149) | 964 | 1096 |
| 70 | (158) | 1032 | 1165 |

### Engine Fire Protection - Firex Bottle Pressures

During checks on the FIREX bottles, the following pressure/temperature chart can be used to determine if bottle pressure is within acceptable limits for bottle temperature. The table provided applies to bottles with a **4.3 lb nominal weight**.

| Minimum/Maximum FIREX Bottle Pressure (4.3 lb nominal weight) | | | |
|---|---|---|---|
| Temperature | | Gauge Reading (psig) | |
| °C | (°F) | Minimum | Maximum |
| 75 | (167) | 1100 | 1235 |
| 80 | (176) | 1168 | 1305 |
| 85 | (185) | 1235 | 1375 |
| 90 | (194) | 1303 | 1445 |
| 95 | (203) | 1371 | 1515 |
| 100 | (212) | 1439 | 1585 |



# IV. MAIN LANDING GEAR OVERHEAT DETECTION



## A. SYSTEM DESIGN

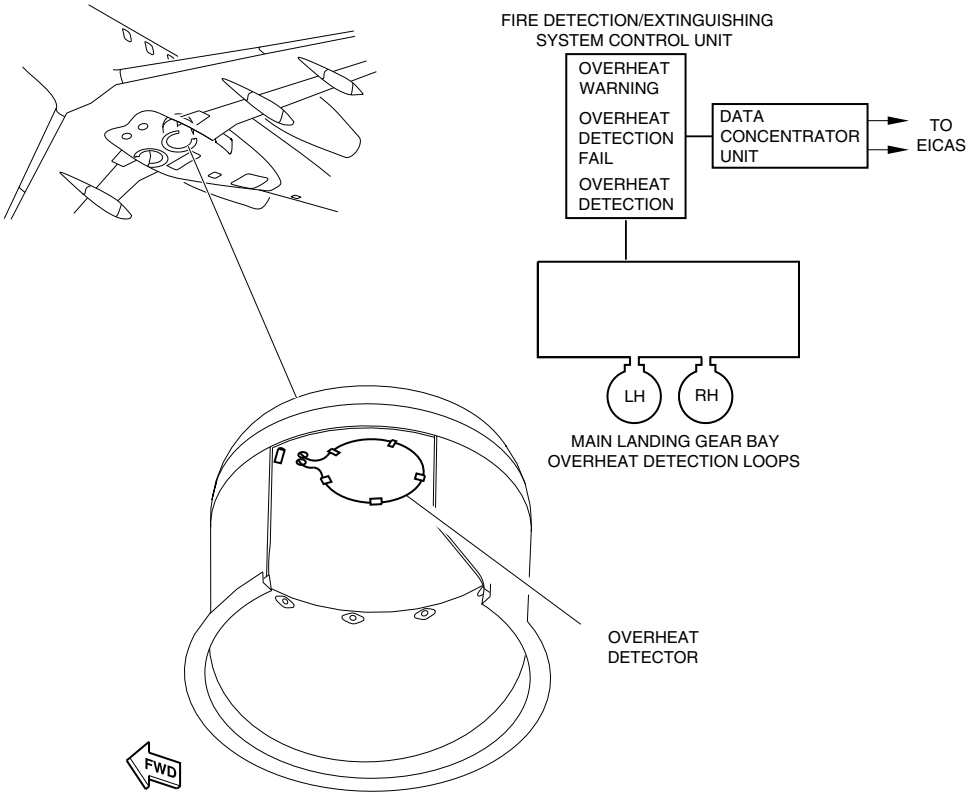
**Detection Configuration:**

- Single overheat detection loop per MLG bay
- Dual channel overheat detection unit
- Loops installed around the top of the inner wheel bin surface of each MLG wheel bin
- Brake/Tire overheat detection after takeoff, protects the composite-material wheel wells

## B. OPERATION

**Detection Process:**

- Thermistor material resistance decreases with heat
- Control unit monitors resistance changes
- Overheat signal sent to Data Concentrator Unit
- DCU routes signals to EICAS



**Crew Alerting:**

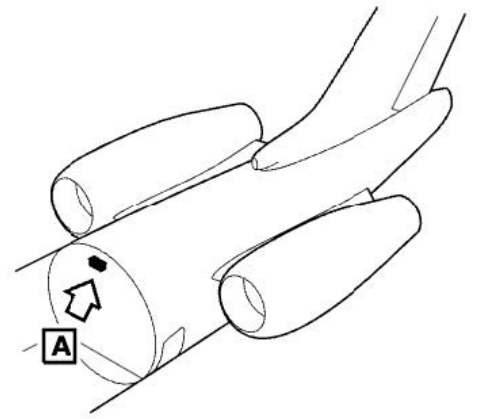
- Master warning lights illuminate
- Triple chime sounds
- **GEAR BAY OVHT** (W) CAS message
- No fire suppression capability (detection only)

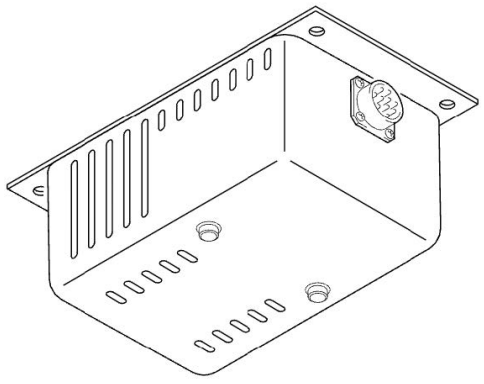
# V. BAGGAGE/CARGO COMPARTMENT FIRE PROTECT

## A. SMOKE DETECTION

**Detector Specifications:**

- Light-scatter type smoke detector
- Ceiling-mounted in cargo bay
- Specific smoke concentration threshold
- Connected to warning systems



BAGGAGE–COMPARTMENT SMOKE DETECTOR (A92)
A

## B. FIRE SUPPRESSION

**Portable Extinguishers:**

- Located behind copilot's seat bulkhead
- Additional unit in right aft enclosure ( in lavatory)
- Manual operation required
- Used for baggage compartment and flight compartment fires

## C. FALSE ALARMS

**Known Causes:**

- Mobile transceiver operation near detectors
- Ground equipment exhaust fumes

# VI. CONTROLS AND INDICATIONS

## A. COCKPIT CONTROLS

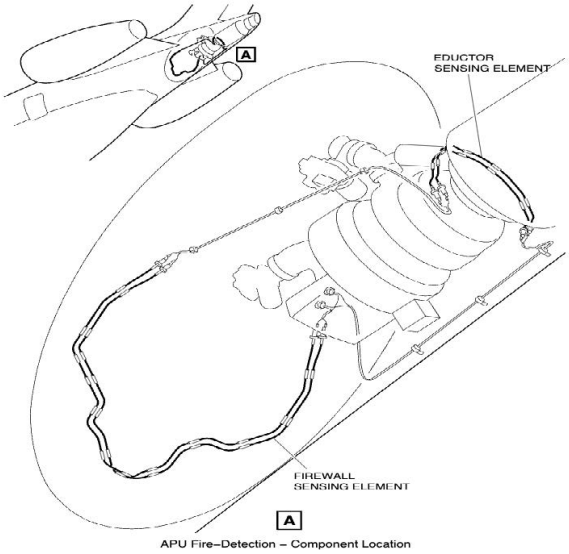
**Fire Switches:**

- L ENG FIRE switch (guarded, push-to-activate)
- R ENG FIRE switch (guarded, push-to-activate)
- APU FIRE switch (guarded, push-to-activate)
- FIRE EXT 1 switch (push to discharge)
- FIRE EXT 2 switch (push to discharge)

## B. TEST SYSTEM

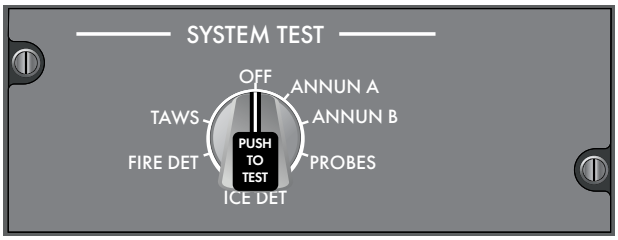
**SYSTEMS TEST Switch:**

- Located on pedestal near PARK/EMER brake
- Rotate to FIRE DET position for system test




APU Fire–Detection – Component Location

- Press to initiate test sequence
- No preflight test required (continuous monitoring)




**Test Sequence Actions:**

- Warning CAS messages illuminate (L ENGINE FIRE, R ENGINE FIRE, APU FIRE, GEAR BAY
- OVHT, CARGO SMOKE)Control unit tests detection/extinguishing components
- **FIRE SYS IN TEST** (S) CAS message
- Master warning lights flash
- Master warning chime activation
- 15-second aural test ("LEFT ENGINE FIRE" repeats)
- All fire switches illuminate
- **FIRE SYS TEST** OK upon completion



# VII. SYSTEM ARCHITECTURE

## A. COMPONENTS LOCATION

**Aft Equipment Bay:**

- FIREX Control Unit
- Fire extinguisher bottles (2)
- Associated pressure gauges
- Squib connections and wiring

**Engine Nacelles:**

- Dual detection loops per engine
- Loop routing through fire zones
- Connection to FIREX-CU

**APU Compartment:**

- Dual detection loops
- Discharge nozzles from bottle #2
- APU ECU interface connections

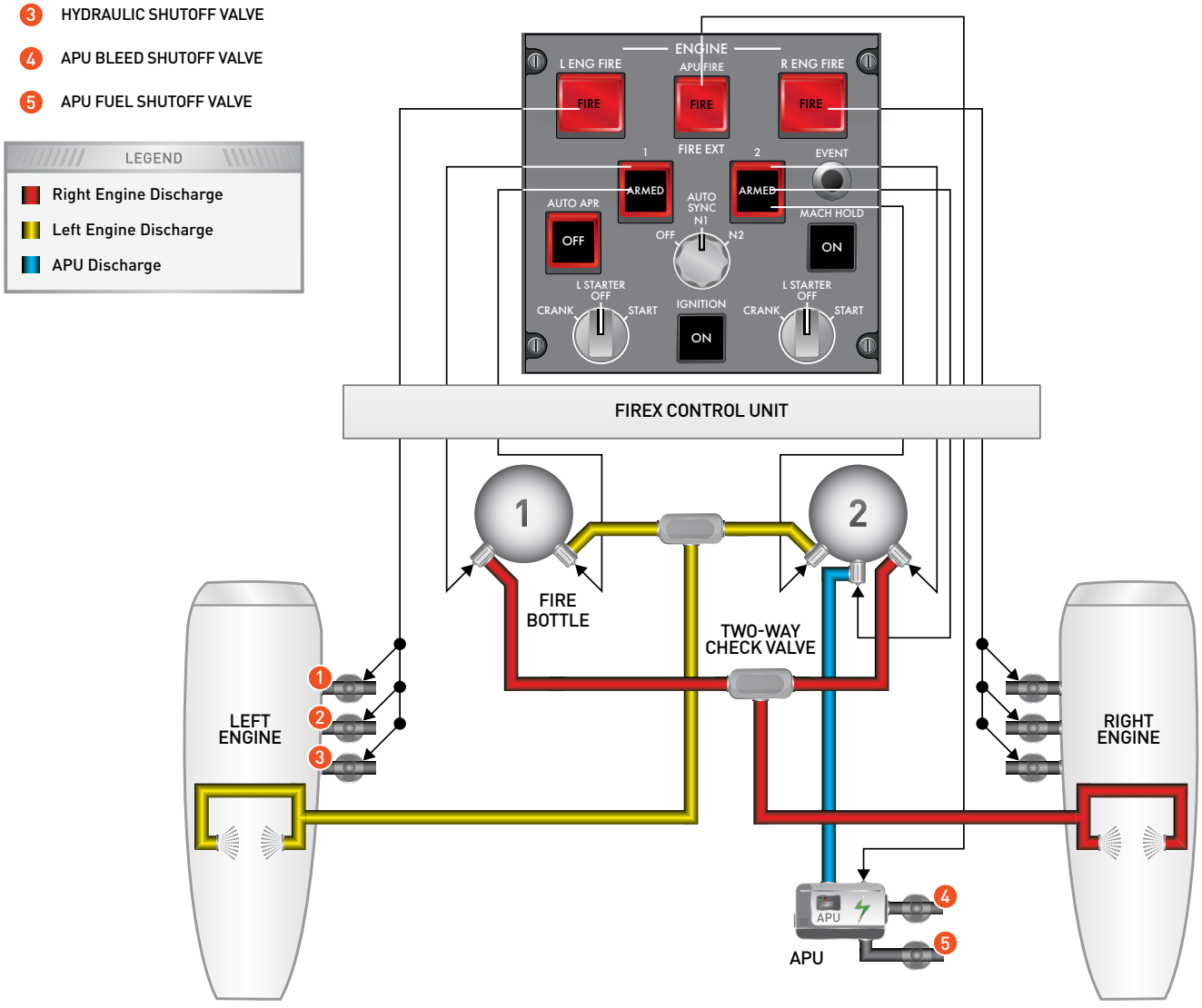
## B. ELECTRICAL INTEGRATION

**Power Sources:**

- LEFT ESS Bus: FIRE DET CH A
- RIGHT MAIN Bus: FIRE DET CH B
- LEFT BATT Bus: FIREX A
- RIGHT BATT Bus: FIREX B
- Dual channel redundancy maintained

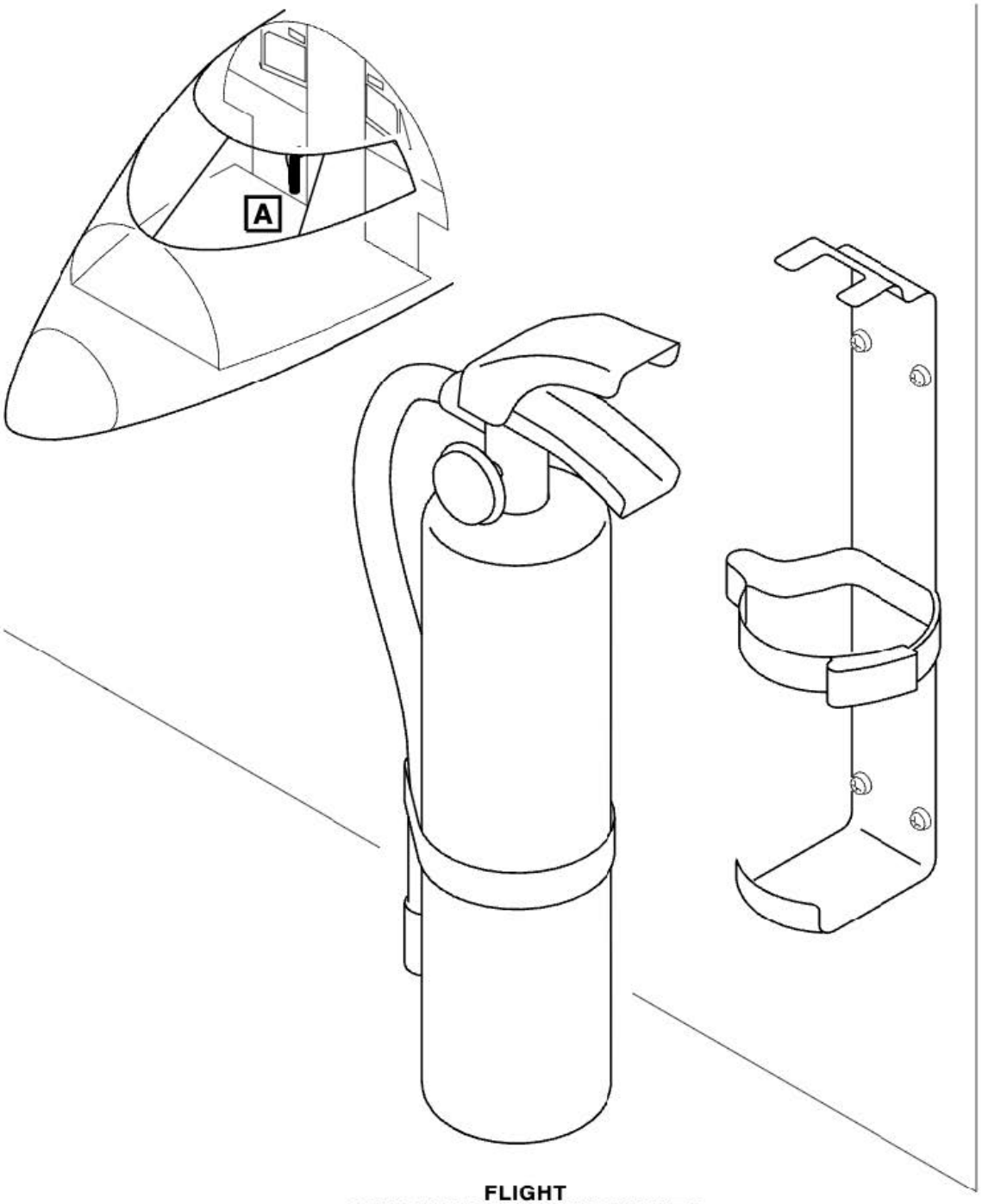
## FIREX CONTROL UNIT SCHEMATIC

1. HP AND IP BLEED-AIR VALVES
2. FUEL SHUTOFF VALVE
3. HYDRAULIC SHUTOFF VALVE
4. APU BLEED SHUTOFF VALVE
5. APU FUEL SHUTOFF VALVE




1. HP and IP Bleed-Air Valves
2. Fuel Shutoff Valve
3. Hydraulic Shutoff Valve
4. APU Bleed Shutoff Valve
5. APU Fuel Shutoff Valve
6. Two-Way Check Valve

Note: The two-way check valve at each engine prevents agent from a second-discharged bottle from backfilling into the bottle that was discharged first.




**FLIGHT COMPARTMENT EXTINGUISHER**

**A**

# VIII. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits | Aural Warning |
|---|---|---|---|
| **APU FIRE** | Fire has been detected in the APU compartment | — | Triple Chime<br>"APU Fire" |
| **L (R) ENGINE FIRE** | The L (R) ENGINE FIRE CAS, FIRE EI in the $N_1$ indicator, FIRE indication in the L (R) ENG FIRE switch, or "LEFT (RIGHT) ENGINE FIRE" voice message indicates that the engine fire detection loop has activated. An engine fire is usually accompanied by other indications, such as: excessive ITT, erratic or rough engine operation, fluctuating engine indications, or smoke in the cabin | — | Triple Chime<br>"Left (Right) Engine Fire" |
| **CARGO SMOKE** | Smoke has been detected in the cargo (baggage) area | — | Triple Chime |
| **GEAR BAY OVHT** | An overheat condition has been detected in the main landing gear bays | **TO/LAND** | Triple Chime |

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| **APU FIRE DET FAIL** | The APU fire detection system has detected a failure that will not allow the detection system to indicate a fire | **TO/LAND** |
| **CARGO SMOKE DET FAIL** | The cargo smoke detection system has failed | **TO/LAND** |
| **L (R) FIRE DET FAIL** | The engine fire detection system has failed | **TO/LAND** |
| **FIRE SYS FAULT** | The fire detection and extinguishing system has detected a fault | **TO/LAND** |
| **FIREX APU SQUIB FAIL** | APU fire extinguisher squib on bottle No. 2 has failed (NO low pressure indication) | **TO/LAND** |
| **GEAR BAY DET FAIL** | The gear bay overheat detection has failed | **TO/LAND** |

## C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| **FIRE SYS FAULT** | The FIREX control unit has detected a fault | **TO/LAND** |
| **FIREX BTL 1 (2) FAULT** | The respective bottle squib for the left or right engine has failed | **TO/LAND** |
| **FIREX BTL 1 (2) LOW** | The respective bottle pressure is low | **TO/LAND** |

## D. STATUS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning |
|---|---|
| **FIRE SYS IN TEST** | The fire detect test system is conducting the manually activated system test |
| **FIRE SYS TEST OK** | The fire detected test system has passed the system test |

**NOTES**

- All warning messages are accompanied by aural warnings as specified
- "APU Fire" voice warning for APU FIRE message
- "Left (Right) Engine Fire" voice warning for L (R) ENGINE FIRE message
- "TO/LAND" indicates the message is inhibited during takeoff and landing phases
- L (R) notation indicates the message can appear for either left or right engine

# IX. LIMITATIONS

## A. OPERATIONAL LIMITATIONS

**System Availability:**

- Continuous monitoring when electrical power available
- Ground mode automatic features require APU ECU power
- Test functions available when FIREX-CU is powered
- Preflight Fire System Test not required (fire system continually monitored)

**Environmental Considerations:**

- False alarm potential from radio transmissions
- Exhaust fume interference possible

## B. DISPATCH LIMITATIONS

**No-Go Items:**

- **APU FIRE** indication
- **L (R) ENGINE FIRE** indication
- **CARGO SMOKE** indication
- **GEAR BAY OVHT** indication
- Simultaneous **L (R) FIRE DET FAIL** and **APU FIRE DET FAIL**

**MEL Relief Available:**

- Single detection loop failure (engine/APU)
- Cargo smoke detector (with door monitoring)
- MLG OVHT inop (MEL/DDG)
- Various system fault conditions

# X. CIRCUIT BREAKERS

Fire Protection System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| FIRE DET CH A | LEFT ESS | CB1-A11 |
| FIRE DET CH B | RIGHT MAIN | CB2-A11 |
| FIREX A | LEFT BATT | CB5-A3 |
| FIREX B | RIGHT BATT | CB6-A4 |
| LAV SMK DET | RIGHT MAIN | CB4-D4 |

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## XI. FIRE PROTECTION QUIZ

1. How many fire detection loops are installed per engine?

    A) One
    B) Two
    C) Three
    D) Four

2. What type of extinguishing agent is used in the fire bottles?

    A) CO2
    B) Halon 1211
    C) Halon 1301
    D) Foam

3. How many discharge heads (squibs) does bottle #1 have?

    A) One
    B) Two
    C) Three
    D) Four

4. After how many seconds does bottle #2 automatically discharge during ground mode APU fire?

    A) 3 seconds
    B) 5 seconds
    C) 10 seconds
    D) 15 seconds

5. What type of smoke detector is used in the Baggage/Cargo Compartment?

    A) Ionization type
    B) Light-scatter type
    C) Photoelectric type
    D) Thermal type

6. Where is the FIREX Control Unit located?

    A) Cockpit overhead panel
    B) Forward equipment bay
    C) Aft equipment bay
    D) Nose compartment

7. What happens when an engine FIRE switch is pushed?

    A) Only arms the fire bottle
    B) Shuts down engine and arms squib
    C) Automatically discharges bottle
    D) Only silences the alarm

8. How many detection loops are in each main landing gear bay?

A) One
B) Two
C) Three
D) None

9. What is the ICAO Aerodrome Fire Category for the Challenger 350?

A) 2
B) 3
C) 4
D) 5

10. Which bus powers the FIRE DET CH A circuit breaker?

A) LEFT MAIN
B) LEFT ESS
C) LEFT BATT
D) RIGHT ESS

11. What aural warning is associated with APU FIRE?

A) Triple chime only
B) "APU Fire" voice message
C) Continuous bell
D) Single chime

12. Where are the portable fire extinguishers located?

A) Only in the cockpit
B) Behind copilot's seat and right aft enclosure in lav
C) Only in cargo bay
D) Under passenger seats

13. What must both engine fire loops sense to trigger a fire warning?

A) Smoke presence
B) Pressure change
C) Resistance decrease within preset time
D) Voltage increase

14. Which bottle can be discharged into the APU compartment?

A) Bottle #1 only
B) Bottle #2 only
C) Either bottle
D) Both bottles simultaneously

15. What CAS message appears during fire system test?

A) **FIRE TEST ACTIVE**
B) **FIRE SYS IN TEST**
C) **TEST MODE ON**
D) **FIRE DET TEST**

16. How many squibs does bottle #2 have?

A) One
B) Two
C) Three
D) Four

17. What happens to the master warning lights during FIRE DET test?

A) Remain steady
B) Flash
C) Turn off
D) Alternate left/right

18. Which detection system uses single loops instead of dual?

A) Engine fire
B) APU fire
C) Main landing gear overheat
D) Baggage Compartment smoke

19. What inhibit condition applies to FIREX BTL LOW messages?

A) None
B) TO only
C) LAND only
D) TO/LAND

20. How long does the "LEFT ENGINE FIRE" aural test last?

A) 5 seconds
B) 10 seconds
C) 15 seconds
D) 20 seconds

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CL-350



CL-350 TRAINING MANUAL

# ENGINE INDICATION AND CREW ALERTING SYSTEM

# 15

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# ENGINE INDICATION AND CREW ALERTING SYSTEM (EICAS)

The Engine Indication and Crew Alerting System (EICAS) serves as the primary interface between the aircraft systems and the flight crew, providing real-time monitoring of engine parameters and aircraft systems while delivering prioritized visual and aural alerts.

The system utilizes four liquid crystal adaptive flight displays (AFDs) to present critical information, with data concentrator units (DCUs) processing system inputs and generating appropriate crew alerts. The EICAS enhances flight safety through automatic system monitoring, integration of system information, color-coded visual presentation of operating limits, and standardized alert prioritization that enables crews to respond effectively to both normal and abnormal conditions.

## I. INTRODUCTION

### EICAS Specifications

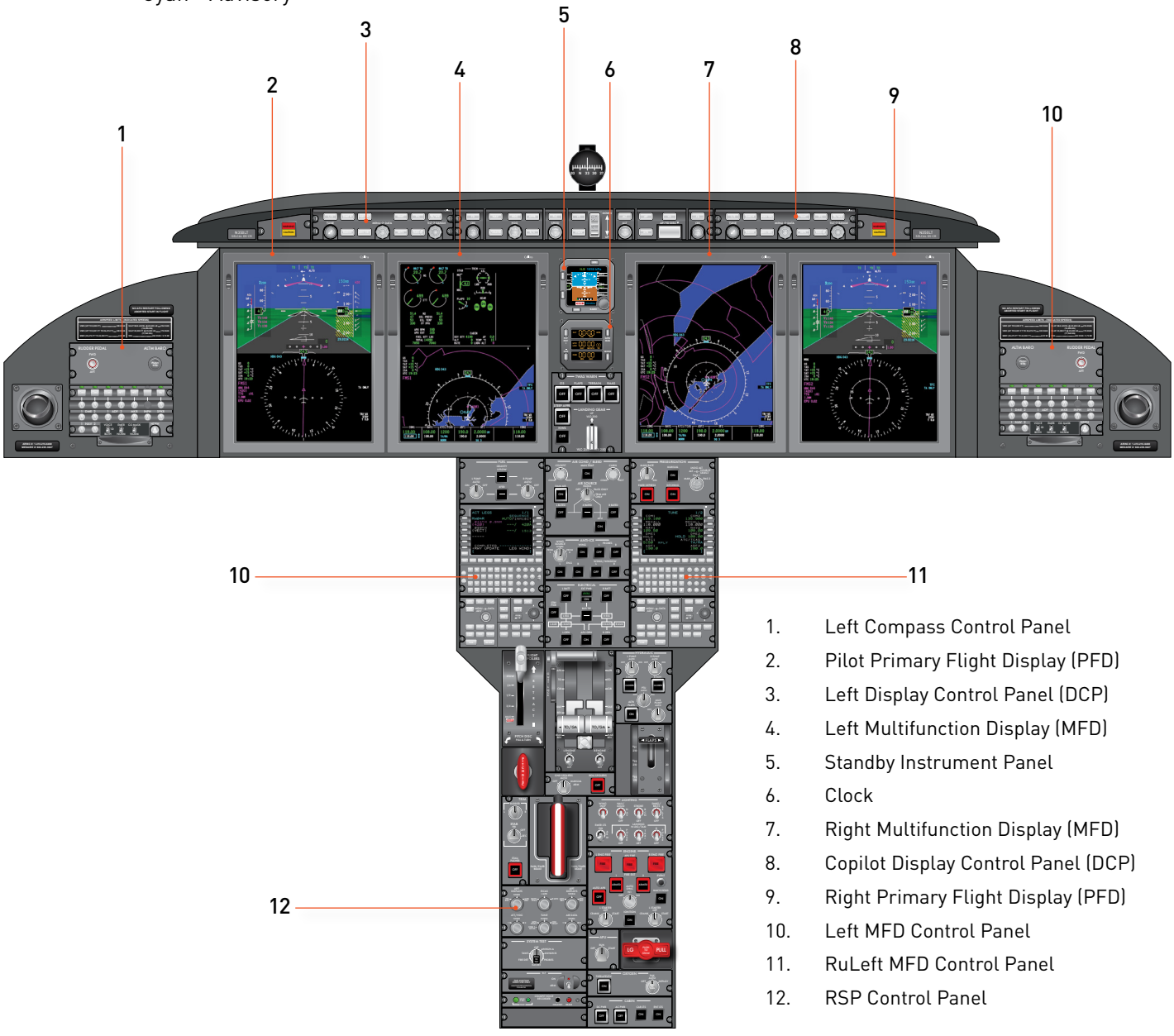
EICAS System Specifications

| Parameter | Value |
|---|---|
| Display Type | Liquid Crystal Adaptive Flight Displays (AFDs) |
| Number of Displays | 4 (2 PFDs, 2 MFDs) |
| Display Interchangeability | All four displays identical and interchangeable |
| Data Concentrator Units | 2 (DCU A and DCU B) |
| Remote Data Concentrators | RDC with Channel A and B |
| MFD Control Panel Location | Center pedestal |
| Display Cooling | Cooling Fan + Cockpit air distribution system |
| CVR Recording Duration | 2 hours |
| Maintenance Diagnostic Computer | Housed in IAPS Card Cage (ICC), but functionally separate from IAPS |
| Display Lighting Control | PFD/MFD knobs on COCKPIT LIGHTS pane on Left/Right side panelsl |

The Challenger 350 utilizes a Quiet Dark Cockpit Philosophy for system indications. This philosophy dictates that under normal operation, indications remain quiet and dark when conditions are met for daylight, Visual Meteorological Conditions (VMC), non-icing conditions, and cruise flight.

Color logic is used to depict system values:

- Red – Warning condition or system limit exceeded
- Amber – Component or function failed or there is no flow, energy or pressure
- Green – Normal operation for digital values. Normal flow, energy or pressure in flowlines
- White – Normal status of component (pump, valve, etc.) or no flow through the flowline
- Magenta – Invalid or unknown data
- Cyan - Advisory



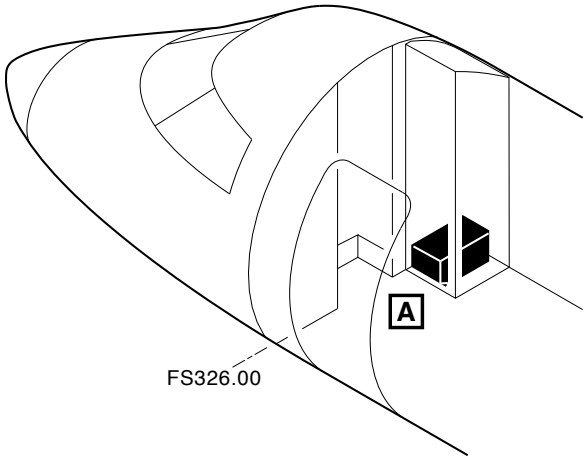

1. Left Compass Control Panel
2. Pilot Primary Flight Display (PFD)
3. Left Display Control Panel (DCP)
4. Left Multifunction Display (MFD)
5. Standby Instrument Panel
6. Clock
7. Right Multifunction Display (MFD)
8. Copilot Display Control Panel (DCP)
9. Right Primary Flight Display (PFD)
10. Left MFD Control Panel
11. RuLeft MFD Control Panel
12. RSP Control Panel

# II. SYSTEM COMPONENTS

## A. DATA CONCENTRATOR UNITS (DCUs)

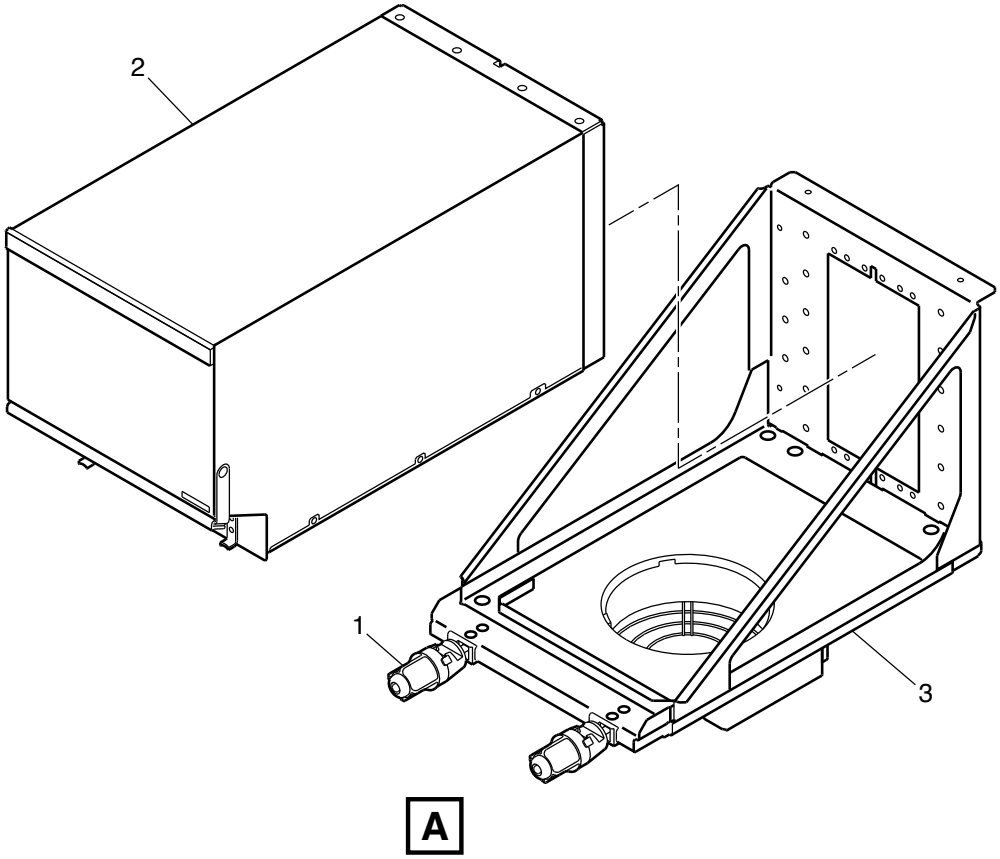
**DCU Functions:**

- Process aircraft system inputs and sensor data
- Generate visual and aural crew alerts
- Prioritize messages by importance and occurrence
- Interface with display units and warning systems
- Provide redundancy through dual-channel architecture
- Support maintenance diagnostic functions




**DCU Channels:**

- A and B channels
- One channel dedicated to engine data conversion
- Second channel handles general aircraft systems
- Automatic switchover upon channel failure
- Cross-channel data sharing for redundancy




Data Concentrator Unit (DCU) – Removal/Installation

## B. DISPLAY UNITS

**Primary Flight Displays (PFDs):**

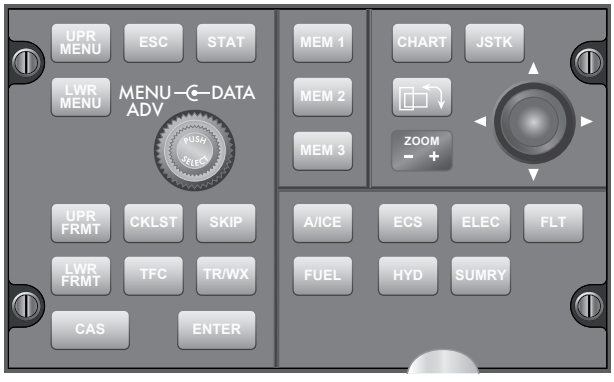
- Located outboard on each pilot position
- Display flight instruments and navigation data
- Capable of composite display during reversion

**Multifunction Displays (MFDs):**

- Located inboard on each pilot position
- Left MFD displays engine indications, configuration, and CAS messages
- Right MFD displays synoptic pages and electronic checklist
- Both MFDs can display navigation or system synoptic information

## C. CONTROL INTERFACES

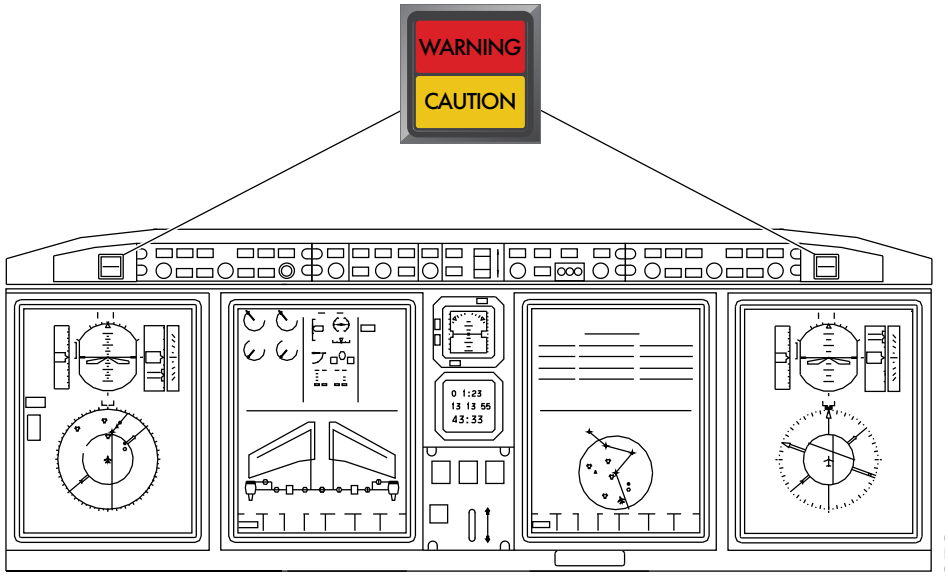
**MFD Control Panel (MCP):**




- Located on center pedestal
- CAS switch for message management
- CKLST switch for electronic checklist
- FRMT switch for display format selection
- Synoptic page selection switches

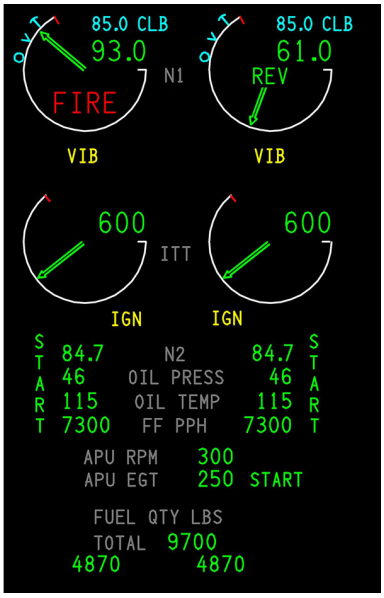
**Master Warning/Caution Switches:**

- Located on glareshield
- Dual switches for pilot and copilot
- Flash red for warnings with triple chime
- Flash amber for cautions with single chime
- Press to acknowledge. Flashing light and audio alerts and (where applicable) voice messages are reset. Gear warning aural is non-mutable.



# III. ENGINE INDICATIONS

## A. DISPLAYED PARAMETERS




**Primary Engine Parameters:**

- $N_1$ speed (%) - analog and digital display
- Interturbine temperature (ITT) (°C) - analog and digital
- $N_2$ speed (%) - digital only
- Oil pressure (psi) - digital only
- Oil temperature (°C) - digital only
- Fuel flow (lb/hr or kg/hr) - digital only

**Conditional Displays:**

- REV icons - displayed during thrust reverser operation
- VIB icon - displayed when vibration exceeds limits
- SYNC/MACH HOLD - displayed when mode selected
- IGN icon - displayed when ignitor operating
- START icon - displayed during engine start sequence

# IV. CREW ALERTING SYSTEM (CAS)

## A. MESSAGE PRIORITIZATION

The Crew Alerting System (CAS) provides visual and aural alerts during a malfunction. The CAS prioritizes messages by order of importance and order of occurrence.

**Warning Messages (Red):**

- Most urgent - require immediate action
- Displayed at top of CAS area
- Remain visible until problem resolved
- Cannot be cleared or hidden
- Accompanied by triple chime
- Master warning lights flash

**Caution Messages (Amber):**

- Require prompt action
- Displayed below warning messages
- Single chime alert
- Master caution lights flash
- Can be acknowledged

**Advisory Messages (Cyan):**

- Crew awareness required
- Displayed below caution messages
- May indicate automatic system activation
- Loss of redundancy notifications
- May have associated tone

**Status Messages (White):**

- Informational only
- Displayed below advisory messages
- Indicate manually selected system states
- No aural alerts

EICAS Message Priorities

| Priority Level | Characteristics |
|---|---|
| Warning (W) | Red color, triple chime, flashing master warning lights |
| Caution (C) | Amber color, single chime, flashing master caution lights |
| Advisory (A) | Cyan color, may have associated tone |
| Status (S) | White color, information only |

EICAS Color Logic

| Color | Meaning |
|---|---|
| Red | Warning condition or system limit exceeded |
| Amber | Component/function failed or no flow/energy/pressure |
| Green | Normal operation for digital values, normal flow/energy/pressure |
| White | Normal status of component or no flow through flowline |
| Cyan | Advisory messages |
| Magenta | Invalid or unknown data |

## B. MESSAGE INHIBITION

**Takeoff Inhibit:**

- Activated above 80 knots
- Released at 400 ft AGL
- Most cautions and all advisories inhibited
- Prevents crew distraction during critical phase

**Landing Inhibit:**

- Activated below 400 ft AGL
- Released below 40 knots
- Selected messages inhibited
- Reduces workload during approach

**Inhibited Message Display:**

- Messages triggered during inhibit stored
- Displayed when exiting inhibit envelope
- Master warning/caution illuminates as appropriate

EICAS Inhibit Logic

| Phase | Inhibit Parameters |
|---|---|
| Takeoff Inhibit Start | Airspeed above 80 kt and 400 ft AGL |
| Takeoff Inhibit End | Above 400 ft AGL |
| Landing Inhibit Start | Below 400 ft AGL |
| Landing Inhibit End | Airspeed less than 40 kt |
| Affected Messages | Some warnings, most cautions, all advisories |
| Inhibit Indicator | TO/LAND or TO only |

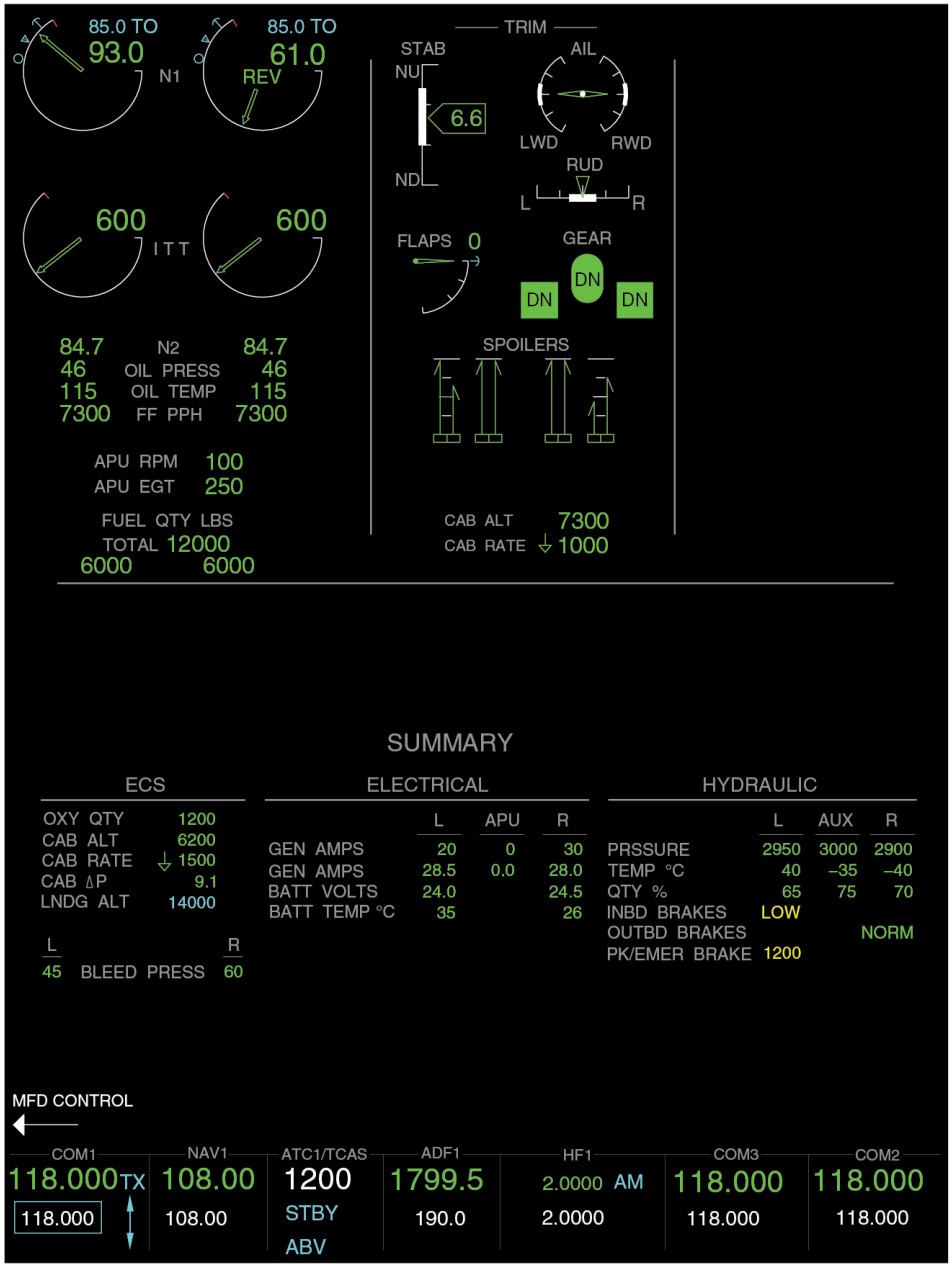


# V. SYNOPTIC PAGES

## A. SUMMARY SYNOPTIC

**Displayed Information:**

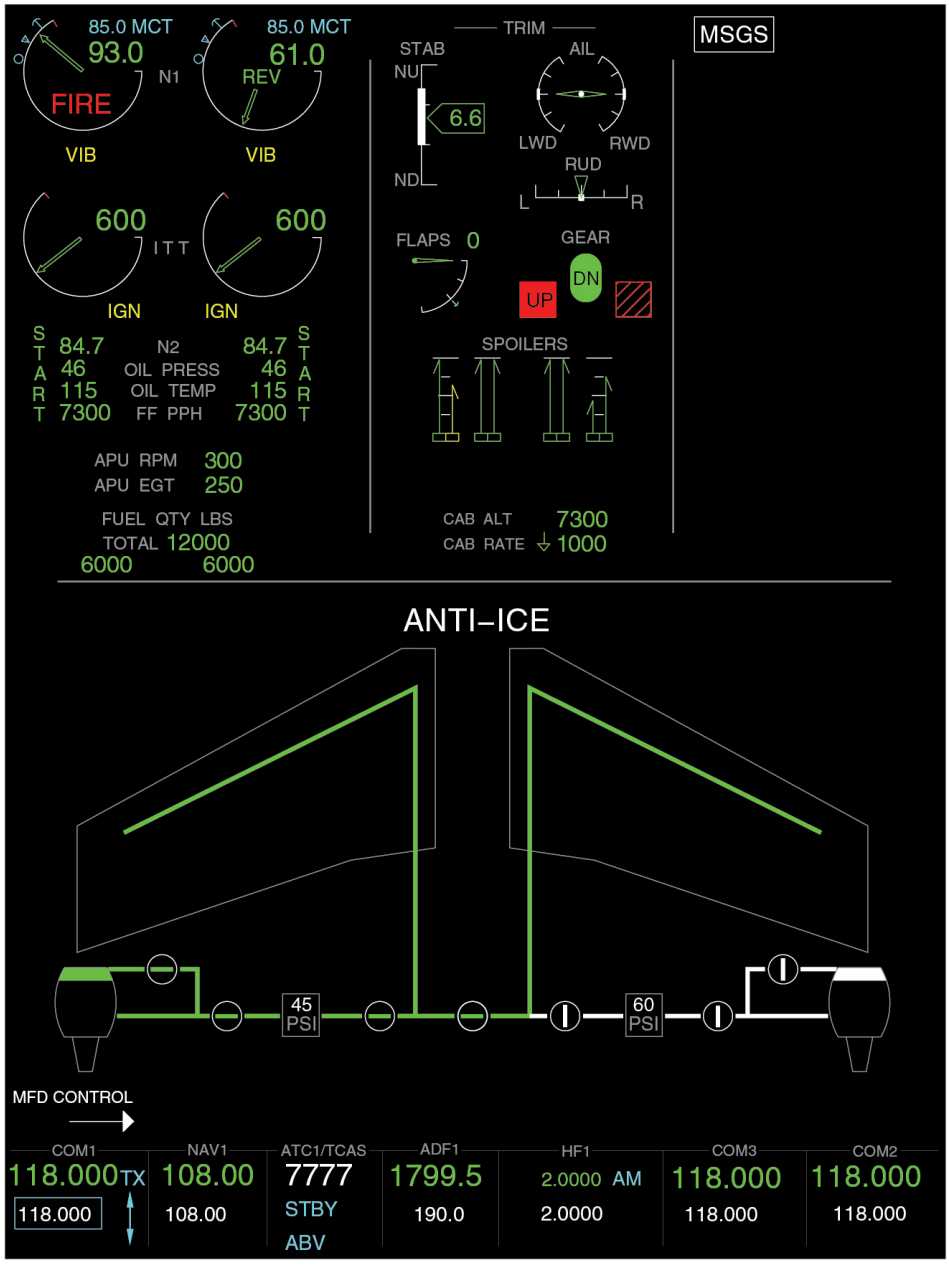
- Overview of multiple systems
- Default display on right MFD
- Quick system status assessment
- Available during display reversion



## B. ANTI-ICE SYNOPTIC

**System Displays:**

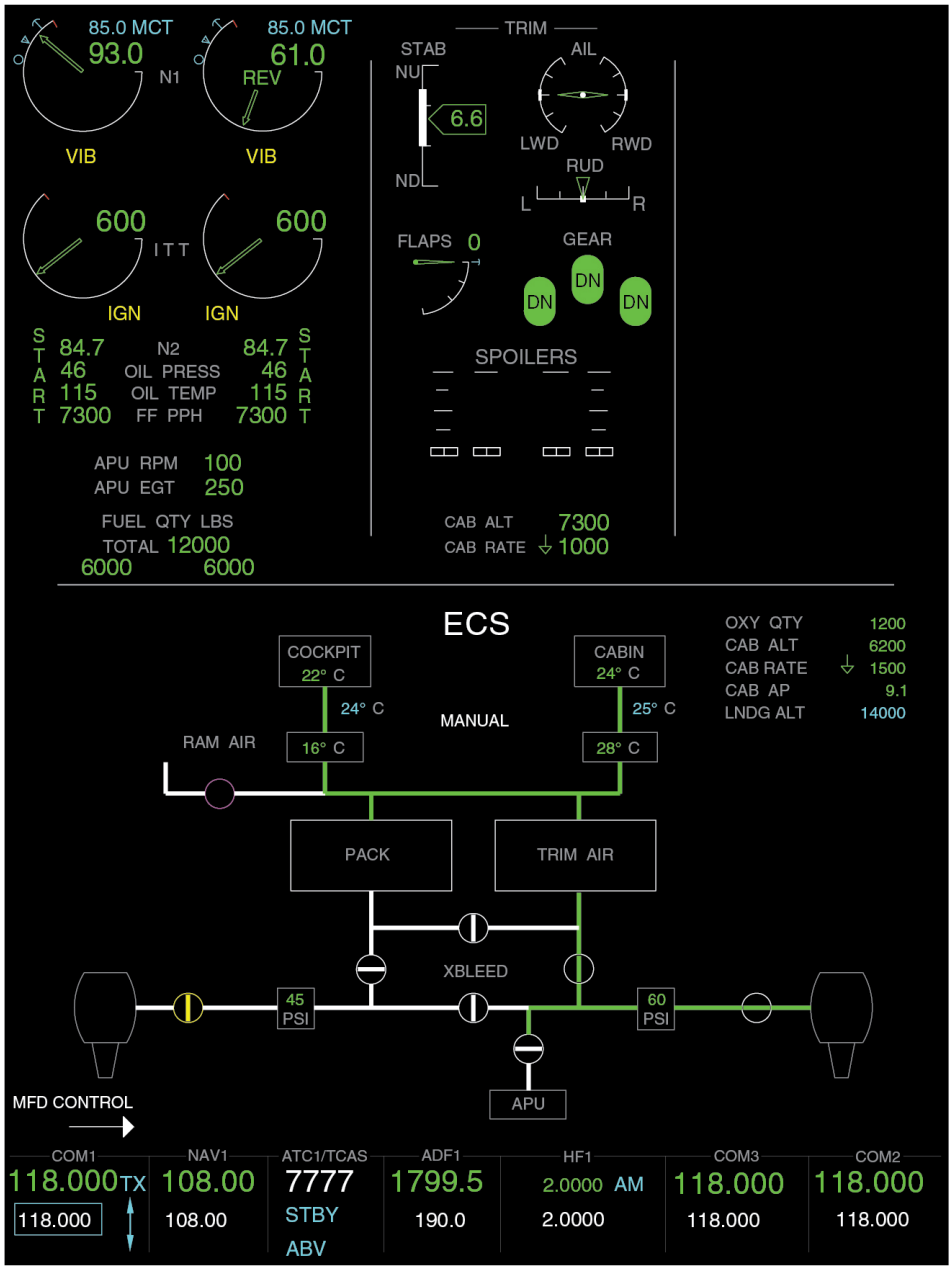
- Bleed air system status
- Wing anti-ice valve positions
- Engine anti-ice valve positions
- Temperature indications
- Flow path visualization



## C. ECS SYNOPTIC

**Environmental Control Displays:**

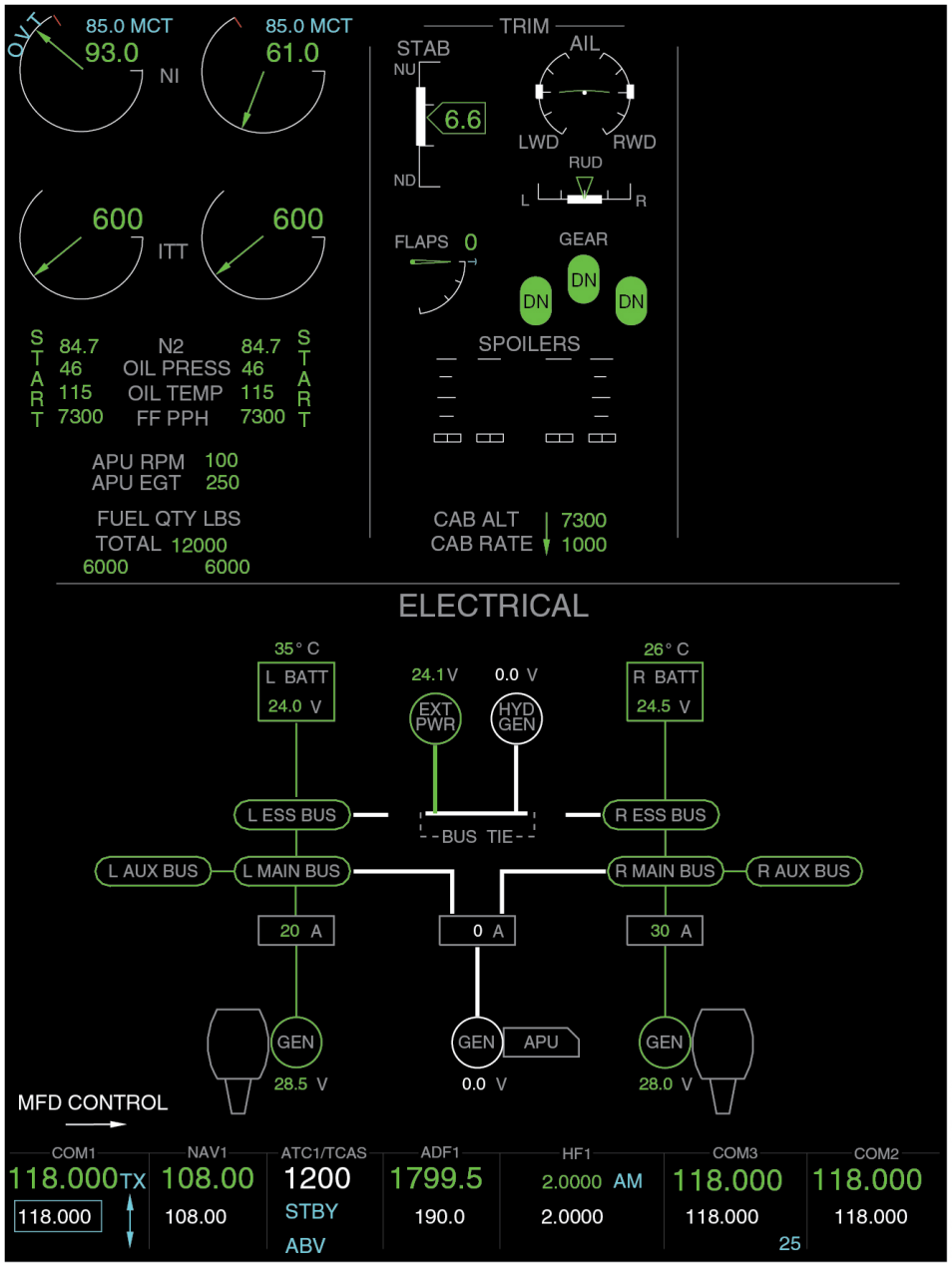
- Bleed air distribution
- Air conditioning pack operation
- Temperature zones and settings
- Pressurization parameters
- Ram air status



## D. ELECTRICAL SYNOPTIC

**Electrical System Display:**

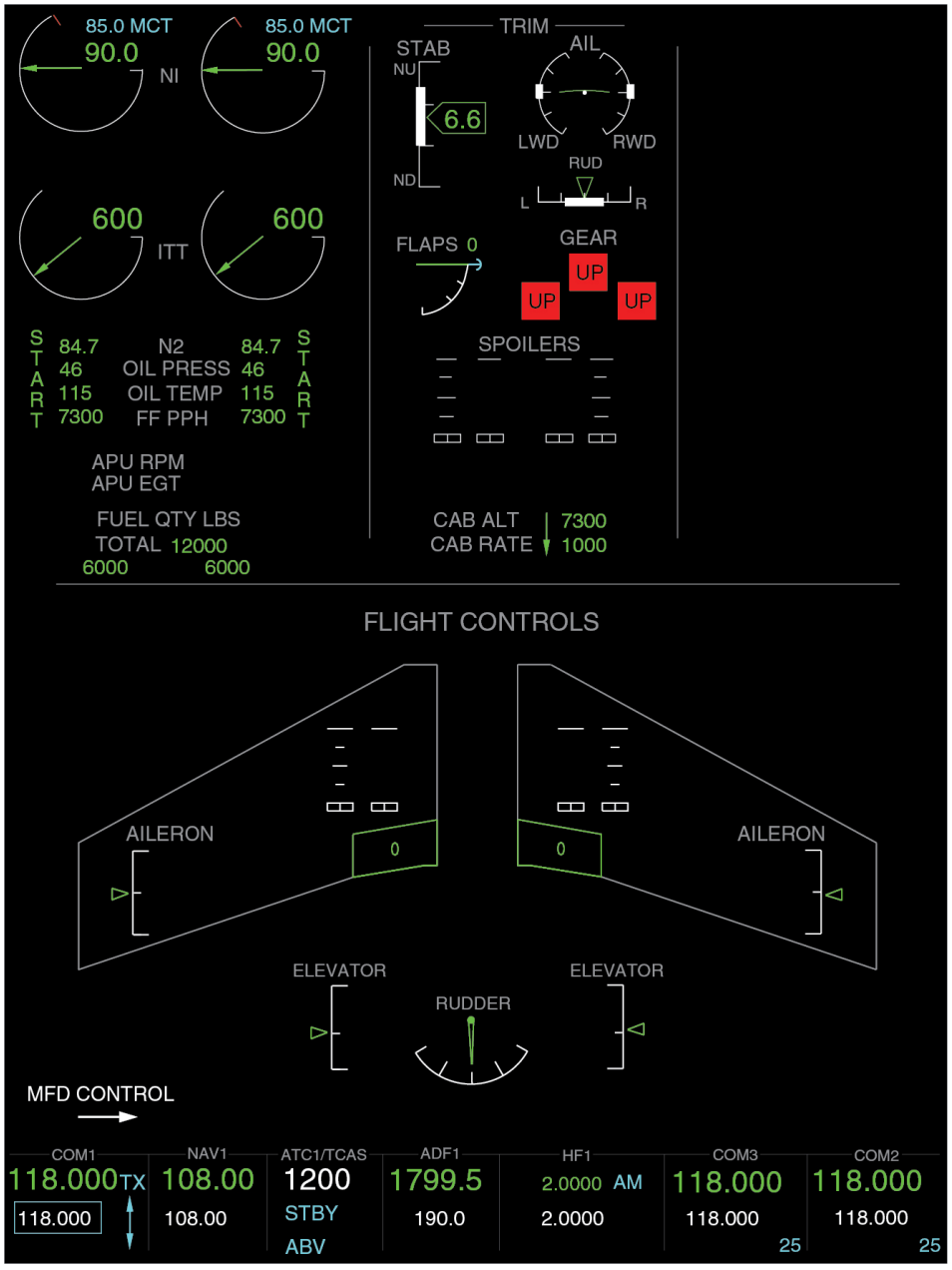
- Bus arrangement and status
- Generator status and output
- Battery status and charging
- External power availability
- Bus tie configuration



## E. FLIGHT CONTROLS SYNOPTIC

**Control Surface Positions:**

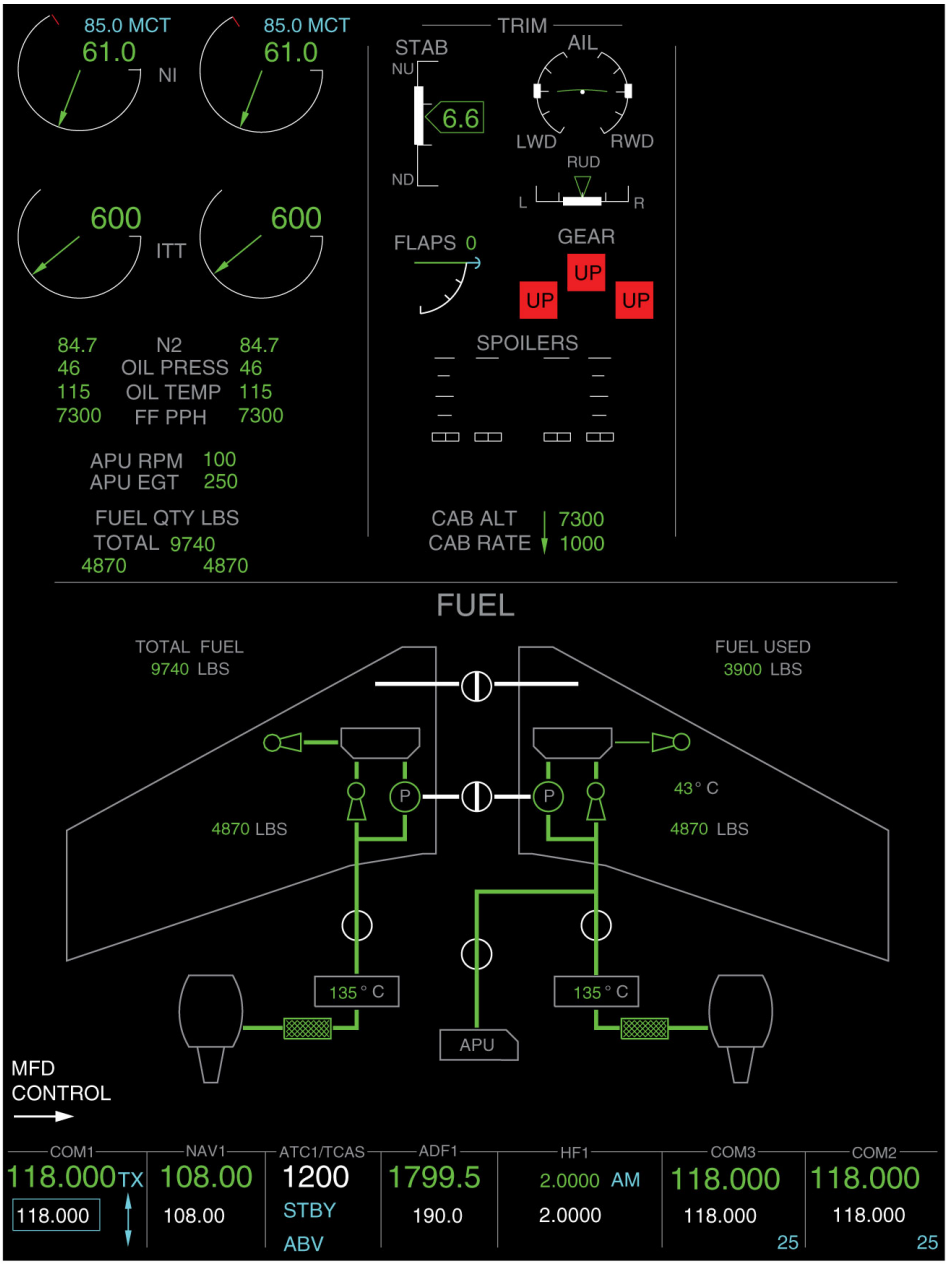
- Aileron deflection
- Elevator deflection
- Rudder deflection
- Spoiler positions
- Trim settings



## F. FUEL SYNOPTIC

**Fuel System Display:**

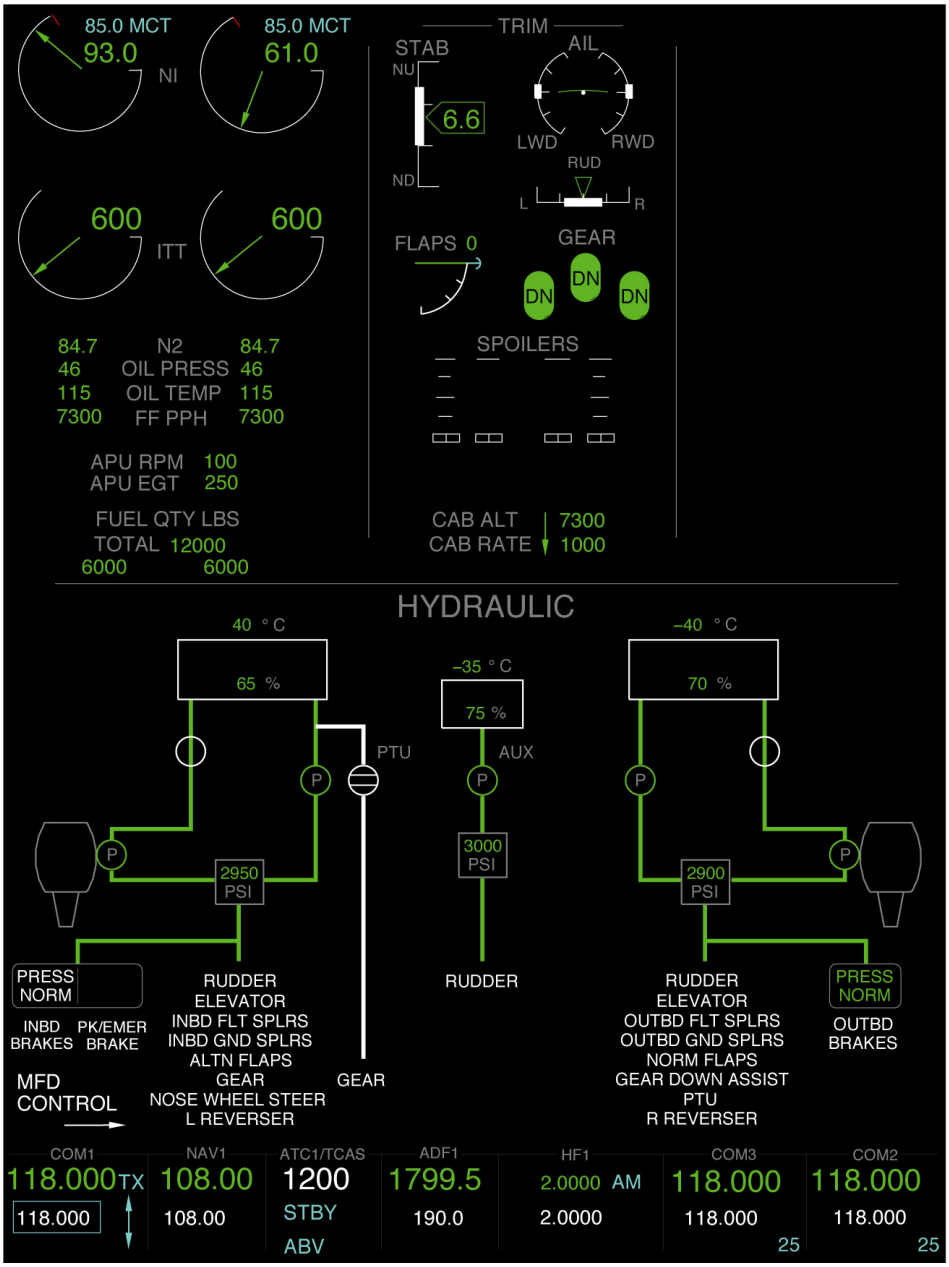
- Tank quantities
- Fuel temperature
- Pump operation status
- Valve positions
- Transfer status



## G. HYDRAULIC SYNOPTIC

**Hydraulic System Status:**

- System pressures
- Reservoir quantities
- Pump operation
- Temperature indications
- PTU status



# VI. SYSTEM TESTS

## A. TEST PANEL

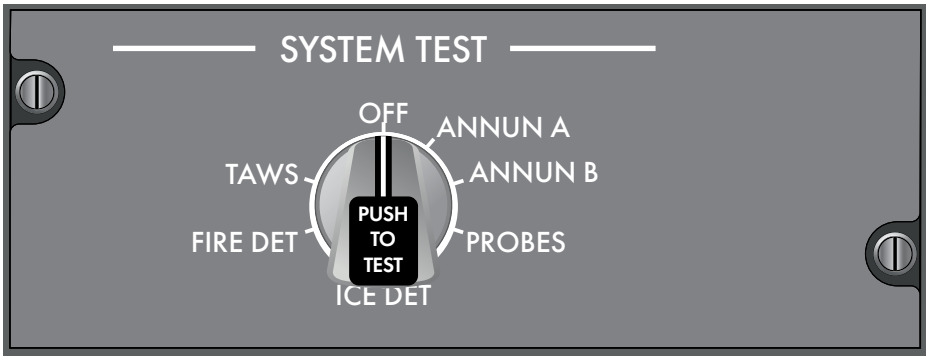
**Available Tests:**

- ANNUN A / ANNUN B test - verifies all CAS messages
- PROBES - tests air data probes and sensors
- STALL/RUD LIM - tests stall protection system
- ICE DET - tests ice detection system
- FIRE DET - tests fire detection and extinguishing
- TAWS - tests terrain avoidance warning system
- AUTO THROTTLE - tests autothrottle system (if installed)

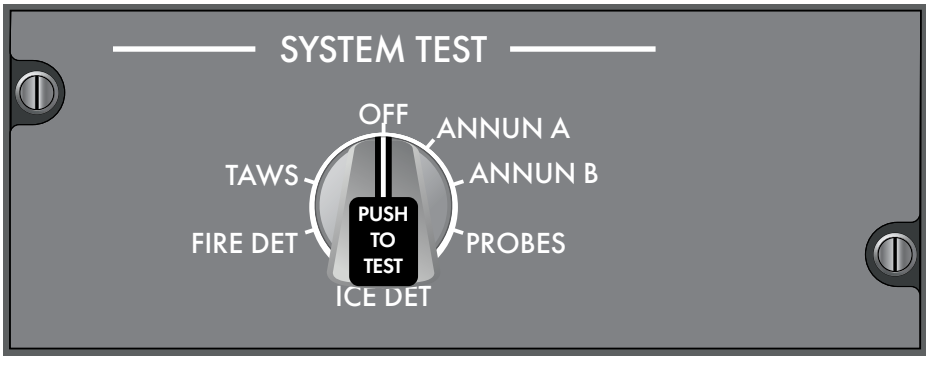
## B. CAS TEST PROCEDURE

**Test Sequence:**

- Initiated by pressing ANNUN A or ANNUN B system test switch for 15 seconds
- Illuminates all panel lights
- Verifies aural warning generation
- Tests master warning/caution lights




Systems Test Control Panel Without AT System



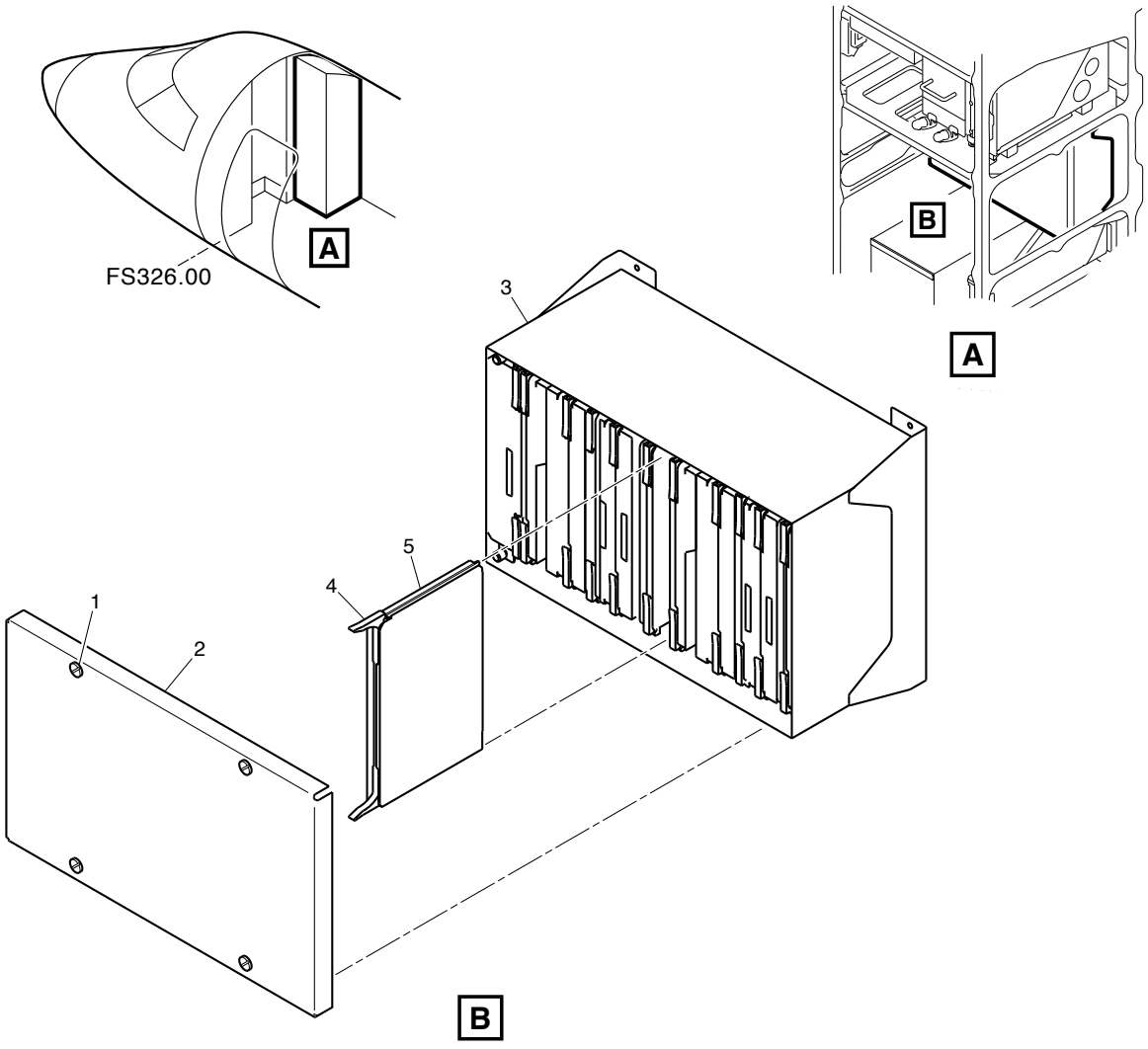

Systems Test Control Panel With AT System

# VII. MAINTENANCE FEATURES

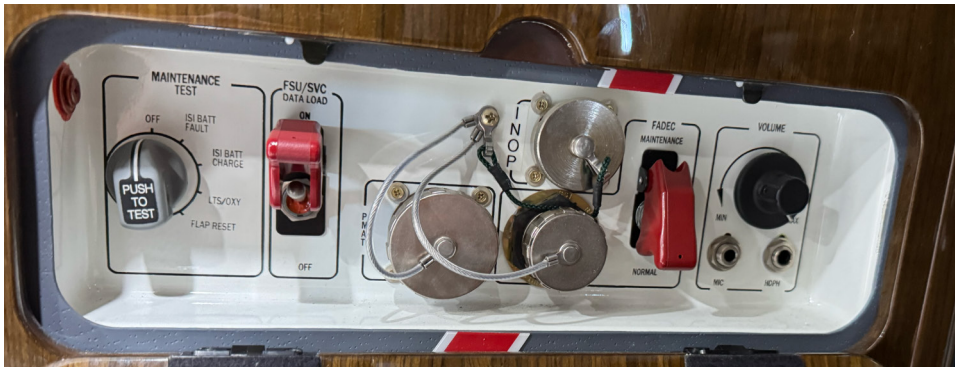
## A. MAINTENANCE DIAGNOSTIC COMPUTER (MDC)

**MDC Functions:**

- Records engine parameters, trend monitoring, start counts, exceedances, TR deployments
- Stores LRU status information
- Captures fault codes
- Supports ground maintenance activities
- Enables data download for analysis
- Access via Right MFD (Press A/ICE+ECS+FUEL at the same time on CCP)




Maintenance Diagnostic Computer (MDC) – Removal/Installation




Portable Maintenance Access Terminal (PMAT)
MDC Interface, top of main cabin stairs, bottom of cabinet.

### B. COCKPIT VOICE RECORDER (CVR)

**CVR Specifications:**

- Crash survivable design
- 2-hour recording capacity, starts a soon as power is applied to the aircraft
- Records cockpit audio environment
- Automatic overwrite of oldest data, must be WOW and parking brake set to manually erase
- Protected storage location
- Records Pilot/Copilot mics (mask, boom/handheld), Cockpit area microphone and Observer 3rd audio.
- Records for an additional 10 minutes after complete loss of normal aircraft power ifequipped with a Recorder Independent Power Supply (RIPS)



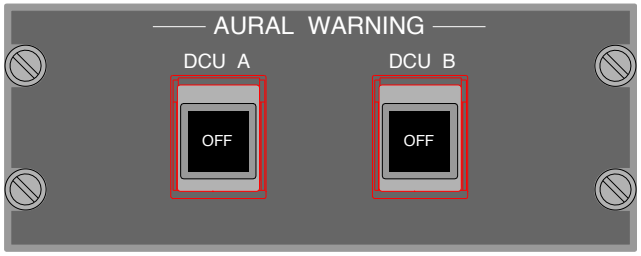

## VIII. AURAL WARNING SYSTEM

### A. AURAL ALERTS

**Warning Sounds:**

- Triple chime - warning messages
- Single chime - caution messages
- Voice alerts - specific warnings
- Triple Chime + voice 'CONFIGURATION' configuration warnings
- Cabin/LAV call – Single chime + CAS Advisory

### B. AURAL WARNING DISABLE




**Disable Switches:**

- Located on copilot aft bulkhead
- DCU A and DCU B switches
- OFF disables respective DCU aurals
- Both OFF disables all EICAS aurals
- Use only for system malfunction, or as directed by AFM (Gear Up/Unsafe Landing and Ditching)

## IX. DISPLAY REVERSION

The reversion switch panel is located on the pilot's side of the center pedestal below the parking brake handle. This panel provides alternative methods for displaying EICAS information and selecting data sources when displays or systems fail.

### A. REVERSION CAPABILITY

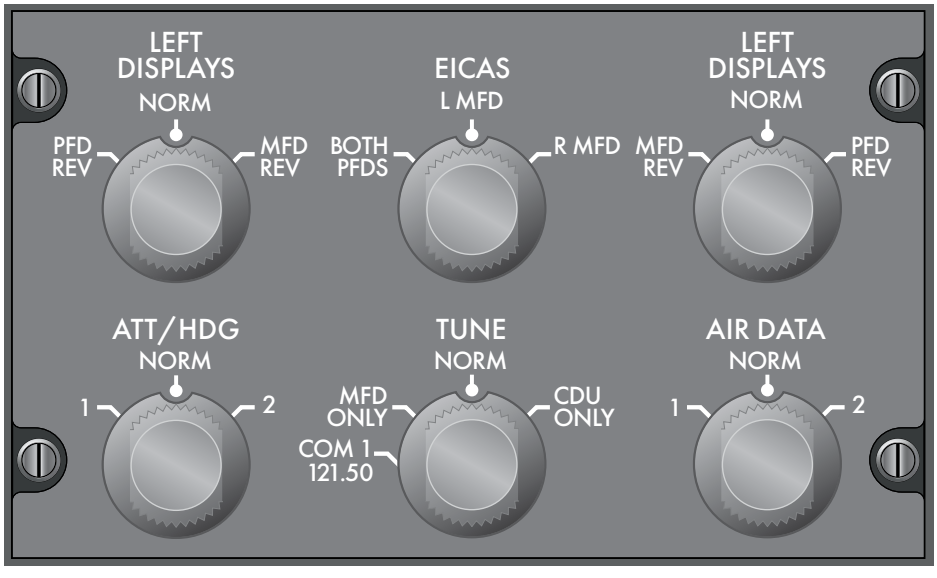
**Display Failure Modes:**

- PFD REV - displays composite on MFD
- MFD REV - transfers display to opposite MFD
- Maintains critical flight and engine information
- FRMT button accesses summary synoptic

### B. COMPOSITE DISPLAY

**Composite Format:**

- Combined flight instruments and EICAS
- Reduced but essential information set
- Prioritized parameter display
- Maintains primary flight data



## C. SWITCH FUNCTIONS

**Left Displays Reversion Switch:**

- **PFD REV** - Left PFD displays compressed format combining flight instruments and EICAS information. Left MFD is shut down
- **NORM** - Normal operation with Left PFD showing standard flight instruments and Left MFD displaying EICAS/navigation data
- **MFD REV** - Left PFD is shut down. Left MFD displays compressed format showing essential flight and engine information

**EICAS Reversion Switch:**

- **L MFD** - EICAS information displayed only on the Left MFD (normal configuration)
- **BOTH PFDs** - EICAS information displayed in compressed format on both PFDs. Used when both MFDs have failed or when maximum redundancy needed
- **R MFD** - EICAS information transferred to Right MFD. Used when Left MFD fails or for crew preference

**Right Displays Reversion Switch:**

- **MFD REV** - Right MFD displays compressed format with combined information. Right PFD is shut down
- **NORM** - Normal operation with Right MFD showing navigation/synoptic data and Right PFD displaying flight instruments
- **PFD REV** - Right MFD is shut down. Right PFD displays compressed format with essential flight and engine data

**ATT/HDG Reversion Switch:**

- **1** - All displays use IRS 1 attitude and heading data regardless of normal side allocation
- **NORM** - Displays use on-side IRS data (Pilot uses IRS 1, Copilot uses IRS 2)
- **2** - All displays use IRS 2 attitude and heading data for all flight instruments

**Tune Reversion Switch:**

- **COM1 121.50** - Emergency configuration. COM1 automatically tuned to 121.50 MHz emergency frequency
- **MFD ONLY** - Radio tuning enabled only through MFD controllers. CDU tuning capability disabled
- **NORM** - Normal dual tuning capability through both MFDs and CDUs as desired
- **CDU ONLY** - Radio tuning enabled only through CDUs. MFD tuning capability disabled. Primary mode during display failures

**Air Data Reversion Switch:**

- **1** - All displays receive air data from ADC 1 only. Used when ADC 2 fails
- **NORM** - Each display uses on-side air data (normal configuration)
- **2** - All displays receive air data from ADC 2 only. Used when ADC 1 fails

# X. INTEGRATED AVIONICS PROCESSOR SYSTEM (IAPS)

## A. SYSTEM DESCRIPTION

The Integrated Avionics Processor System (IAPS) represents a critical avionics architecture that consolidates multiple functional modules into an efficient mechanical package. This integration minimizes aircraft size, weight, and wiring complexity while significantly improving system reliability and maintainability. The IAPS serves as the central data processing and distribution hub for the aircraft's avionics systems.

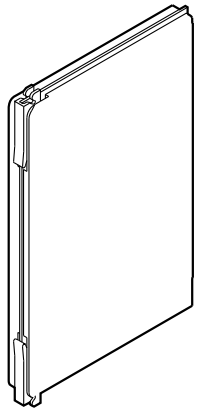
**Key Design Features:**

- Physical consolidation of avionics functions into single card cage
- Redundant signal transmission architecture
- Independent power supplies for each processing channel
- ARINC 429 data bus reading and transmission capability
- Modular design supporting maintenance and upgrades
- Environmental control system for thermal management

## B. IAPS COMPONENTS

**Integrated Avionics Processor System Card Cage (ICC):**

- Housing unit containing all IAPS components
- Located in right equipment rack
- Provides physical mounting and interconnection
- Includes cooling air distribution channels
- Houses FMCs, FGCs, and MDC (not part of IAPS itself)



**INPUT/OUTPUT CONCENTRATOR UNIT (IOC)**

C

**Input/Output Concentrator Units (IOCs):**

- Two independent IOCs (No. 1 and No. 2)
- Receive data words from external systems
- Transmit processed data to appropriate LRUs
- Route all display data to cockpit displays
- Provide ARINC 429 data processing and distribution
- Interface through ICC circuit card connections

**IAPS Power Supplies:**

- Dual independent 28 VDC power supplies
- Input from main DC busses
- Filtered and regulated power distribution
- No. 1 supply powers: No. 1 FGC, FMC, and IOC No. 1
- No. 2 supply powers: No. 2 FGC, FMC, MDC, and IOC No. 2
- Complete electrical isolation between channels

**Integrated Avionics Processor System Environmental Controller (IEC):**

- Independent temperature control system for ICC
- Dual ICC temperature sensors

- Two-speed cooling fans with automatic control
- Heat exchanger for thermal dissipation
- Two thermostats for redundant temperature monitoring
- Two transducer monitor circuits
- Maintains optimal operating temperature range

**Control Strapping Units (CSUs) and Options Control Modules (OCMs):**

- Configure IAPS operational parameters
- Set system strap settings
- Enable/disable optional functions
- Provide configuration management

## C. SYSTEM OPERATION

**Normal Operation:**

- Automatic system initialization at power-up
- Continuous data acquisition from aircraft systems
- Real-time processing and distribution
- No pilot intervention required
- Transparent operation to flight crew

**Data Processing:**

- Multiple independent data transmission paths
- Each signal transmitted more than once for redundancy
- Cross-channel data validation
- Automatic error detection and correction
- Priority-based message handling

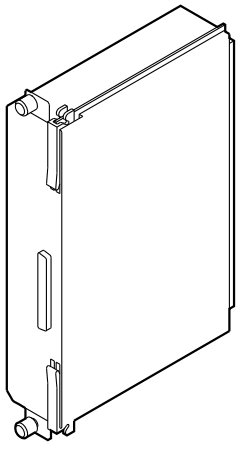
**System Interfaces:**

- Interfaces with all major avionics systems
- Provides data to EICAS displays
- Supports FMS operations
- Enables autopilot/flight director functions
- Interfaces with navigation systems

## D. FAILURE MODES AND REDUNDANCY

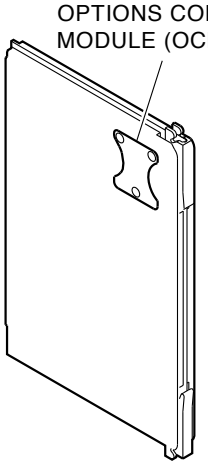
**Single IAPS Failure (L or R):**

- Automatic transfer to operative channel
- Requires manual FD transfer selection
- Tune reversion to CDU only
- Landing altitude source selection required
- Approach capability may be limited



**ENVIRONMENTAL CONTROLLER (IEC)**

**F**




**CONFIGURATION STRAPPING UNIT (CSU)**

**E**

**Dual IAPS Failure:**

- Extremely rare due to redundant design
- Basic flight instruments remain available
- Standby instruments provide backup
- Manual flight control maintained
- Land as soon as practical

## E. IAPS MESSAGES

**Caution Messages:**

- L (R) IAPS FAIL - respective IAPS channel failed

**Advisory Messages:**

- IAPS FAN FAULT - cooling system malfunction
- IAPS operational status indications

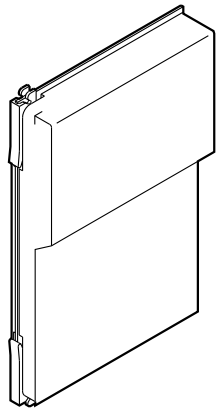
## F. MAINTENANCE FEATURES

**Built-in Test Equipment (BITE):**

- Continuous system monitoring
- Fault isolation to LRU level
- Diagnostic data storage
- Maintenance message generation

**Line Replaceable Units (LRUs):**

- Modular component design
- Quick disconnect capability
- No adjustment required
- Plug-and-play replacement



**INTEGRATED–AVIONICS PROCESSOR SYSTEM (IAPS) POWER SUPPLY (PWR)**

**D**

## G. OPERATIONAL CONSIDERATIONS

**Pilot Actions:**

- No normal operational actions required
- No pilot-controlled reversionary operations
- Monitor EICAS messages for failures
- Follow QRH procedures if failures occur

**Dispatch Considerations:**

- Single IAPS channel failure may be dispatchable
- Consult MEL for specific requirements
- Maintenance action required before next flight
- Performance limitations may apply

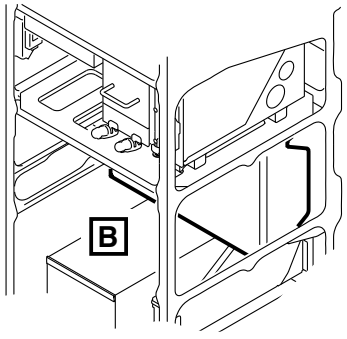
## H. SYSTEM INTEGRATION WITH EICAS

**EICAS Interface:**

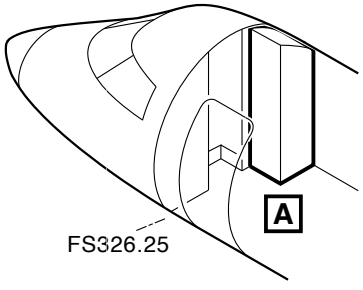
- IAPS provides processed data to DCUs
- Enables display of system parameters
- Supports CAS message generation
- Facilitates synoptic page displays
- Critical for EICAS functionality

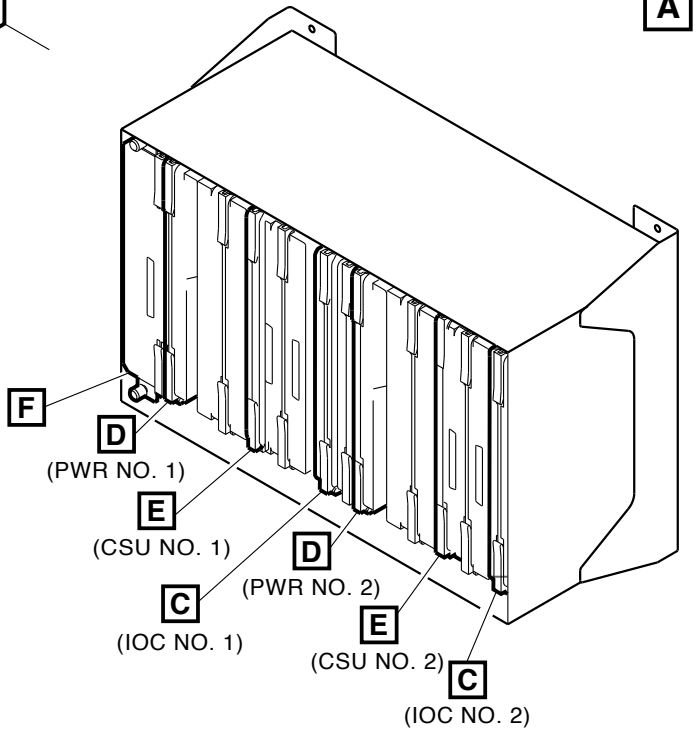
**Display Data Routing:**

- IOCs transmit all display data
- Direct interface with PFDs and MFDs
- Supports display reversion capability
- Enables cross-side data display
- Maintains display synchronization




A




**INTEGRATED–AVIONICS PROCESSOR SYSTEM (IAPS) CARD CAGE (ICC) (A4)**

B

# XI. OPERATIONAL CONSIDERATIONS

## A. NORMAL OPERATIONS

**System Monitoring:**

- Continuous automatic monitoring
- No crew action required for normal ops
- Automatic alert generation
- Color changes indicate parameter status

## B. MESSAGE MANAGEMENT

**CAS Switch Functions:**

- First press - removes caution/advisory/status
- MSGS icon displayed
- Second press - restores messages
- New messages appear above MSGS
- Warning messages cannot be hidden

## C. DISPATCH CONSIDERATIONS

**EICAS Messages and Dispatch:**

- Messages that cannot be cleared must be reviewed
- Reference MMEL/MEL for dispatch eligibility
- GO/NO GO guide provides quick reference
- Most warnings are not dispatchable
- Caution and advisory messages may have MMEL implications

## XII. ALL EICAS MESSAGES AND AUDIO (Chapter Refs are FCOM2)

| EICAS WARNING MESSAGES | | | | |
|---|---|---|---|---|
| Most warning messages are preceded by a triple chime, all voice alerts are continuous | | | | |
| Message | Inhibits | Chap. Ref. | Aural Alerts | Voice Alerts |
| APU FIRE | — | 5/9 | Triple Chime | "APU FIRE" |
| APU OVERTEMP | TO/LAND | 5 | Triple Chime | None |
| L (R) BATT OVERHEAT | TO/LAND | 7 | Triple Chime | None |
| ESSENTIAL POWER ONLY | — | 7 | Triple Chime | None |
| L (R) BLEED LEAK | TO/LAND | 2 | Triple Chime | None |
| CABIN ALTITUDE | TO/LAND | 2 | None | "CABIN ALTITUDE" |
| CABIN DELTA P | TO/LAND | 2 | Triple Chime | None |
| CARGO SMOKE | — | 9 | Triple Chime | None |
| CONFIG AILERON TRIM | — | 10 | Triple Chime | "CONFIGURATION" |
| CONFIG AUTOPILOT | — | 4 | Triple Chime | "CONFIGURATION" |
| CONFIG FLAPS | — | 10 | Triple Chime | "CONFIGURATION" |
| CONFIG RUDDER TRIM | — | 10 | Triple Chime | "CONFIGURATION" |
| CONFIG SPOILERS | — | 10 | Triple Chime | "CONFIGURATION" |
| CONFIG STAB TRIM | — | 10 | Triple Chime | "CONFIGURATION" |
| GEAR | — | 15 | Triple Chime | "GEAR" |
| GEAR BAY OVHT | TO/LAND | 9/15 | Triple Chime | None |
| L(R) ENG OIL PRESS LOW | TO/LAND | 18 | Triple Chime | None |
| L (R) ENGINE EXCEEDANCE | — | 18 | Triple Chime | None |
| L (R) ENGINE FIRE | — | 9 | Triple Chime | "LEFT (RIGHT) ENGINE FIRE" |
| HYD PRESS LOW | — | 13 | Triple Chime | None |
| NORM BRAKES FAIL | TO | 15 | Triple Chime | "NORMAL BRAKES FAIL" |
| PACK LEAK | TO/LAND | 2 | Triple Chime | None |
| PARK/EMER BRAKE ON | — | 15 | Triple Chime | "CONFIGURATION" |
| PITCH DISCONNECT | — | 10 | Triple Chime | "CONFIGURATION" |
| L (R) PYLON BLEED LEAK | TO/LAND | 2 | Triple Chime | None |
| L (R) REVERSER UNSAFE | — | 18 | Triple Chime | None |

| EICAS WARNING MESSAGES | | | | |
|---|---|---|---|---|
| Most warning messages are preceded by a triple chime, all voice alerts are continuous | | | | |
| Message | Inhibits | Chap. Ref. | Aural Alerts | Voice Alerts |
| ROLL DISCONNECT | — | 10 | Triple Chime | "CONFIGURATION" |
| TRIM AIR LEAK | TO/LAND | 2 | Triple Chime | None |
| WING ANTI–ICE LEAK | TO/LAND | 14 | Triple Chime | None |
| L (R) WING OVERHEAT | — | 14 | Triple Chime | None |

| EICAS CAUTION MESSAGES | | |
|---|---|---|
| All caution messages are preceded by a single chime | | |
| Message | Inhibits | Chapter Ref. |
| AFCS MESSAGES FAIL | TO | 4 |
| AFT EQPT BAY DOOR | TO/LAND | 1 |
| AIR COND TEMP FAIL | TO/LAND | 2 |
| AIR COND TEMP HIGH | TO/LAND | 2 |
| AIR DATA 1 (2) FAULT | TO/LAND | 11 |
| L (R) AOA VANE HEAT FAIL | TO/LAND | 14 |
| AP HOLDING LWD | TO | 4 |
| AP HOLDING RWD | TO | 4 |
| AP HOLDING NOSE DOWN | TO | 4 |
| AP HOLDING NOSE UP | TO | 4 |
| AP STAB TRIM FAIL | TO | 4 |
| APU BLEED ALT LIMIT | TO/LAND | 5 |
| APU FIRE DET FAIL | TO/LAND | 9 |
| APU FUEL SOV FAIL | TO/LAND | 12 |
| APU GEN FAIL | TO/LAND | 7 |
| APU GEN OVERLOAD | TO/LAND | 7 |
| APU OIL PRESS LOW | TO/LAND | 5 |
| APU OIL TEMP HIGH | TO/LAND | 5 |
| APU OVERSPEED | TO/LAND | 5 |
| APU STARTER FAIL ON | TO/LAND | 5 |
| AT RETARD INHIBIT | TO | 4 |

| EICAS CAUTION MESSAGES | | |
|---|---|---|
| All caution messages are preceded by a single chime | | |
| Message | Inhibits | Chapter Ref. |
| AUTO PRESS FAIL | TO/LAND | 2 |
| AUX HYD TEMP HIGH | TO/LAND | 13 |
| L (R) BATT FAIL | TO/LAND | 7 |
| BATTERY BAY DOOR | TO/LAND | 1 |
| L (R) BLEED FAIL | TO/LAND | 2 |
| L (R) BLEED LOOP FAIL | TO/LAND | 2 |
| CABIN ALTITUDE | TO/LAND | 2 |
| CABIN PRESS FAULT | TO/LAND | 2 |
| CARGO DOOR | TO/LAND | 1 |
| CARGO SMOKE DET FAIL | TO/LAND | 9 |
| CPLT BRAKE FAULT | TO | 15 |
| DITCHING NOT AVAIL | — | 2 |
| EFIS COMPARATOR INOP | TO/LAND | 3/11 |
| EFIS MISCOMPARE | — | 3/11 |
| ELEC HYD GEN FAIL | TO/LAND | 7 |
| ELECTRICAL FAULT | TO/LAND | 7 |
| ELEVATOR SPLIT | — | 10 |
| EMER LIGHTS OFF | TO/LAND | 16 |
| EMER LIGHTS ON | TO | 16 |
| EMERGENCY EXIT | TO/LAND | 1 |
| L (R) ENG ANTI–ICE FAIL | TO/LAND | 14/18 |
| L (R) ENG DSPL MISCOMP | TO/LAND | 18 |
| L (R) ENG FUEL SOV FAIL | TO/LAND | 12/18 |
| L (R) ENG OIL PRESS HIGH | TO/LAND | 18 |
| L (R) ENG OIL TEMP HIGH | TO/LAND | 18 |
| L (R) ENGINE FLAMEOUT | — | 18 |
| L (R) ENGINE VIBRATION | TO/LAND | 18 |
| ENGINES FUEL BYPASS | TO/LAND | 18 |
| EQPT RACK TEMP HIGH | TO/LAND | 2 |
| L (R) ESS BUS FAIL | TO/LAND | 7 |

| EICAS CAUTION MESSAGES | | |
|---|---|---|
| All caution messages are preceded by a single chime | | |
| Message | Inhibits | Chapter Ref. |
| L (R) FADEC FAIL | TO | 18 |
| FD MODE CHANGE | TO | 4 |
| L (R) FIRE DET FAIL | TO/LAND | 9/18 |
| FIRE SYS FAULT | TO/LAND | 9 |
| FIREX APU SQUIB FAIL | TO/LAND | 9 |
| FLAPS FAIL | TO | 10 |
| FLAPS FAULT | TO | 10 |
| FLAPS NORM PRESS LOW | TO/LAND | 10 |
| FLT SPOILERS DEPLOY | TO | 10 |
| FLT SPOILERS FAIL | — | 10 |
| FLT SPOILERS FAULT | — | 10 |
| L (R) FUEL COLLECTOR LOW | — | 12 |
| L (R) FUEL EJECTOR FAIL | TO/LAND | 12 |
| FUEL IMBALANCE | TO/LAND | 12 |
| L (R) FUEL PRESSURE LOW | TO/LAND | 12 |
| L (R) FUEL PUMP FAIL | TO/LAND | 12 |
| FUEL QUANTITY FAIL | TO/LAND | 12 |
| FUEL QUANTITY LOW | TO | 12 |
| GEAR BAY DET FAIL | TO/LAND | 9 |
| GEAR DISAGREE | — | 15 |
| GEAR SYS FAIL | TO | 15 |
| L (R) GEN FAIL | TO/LAND | 7 |
| L (R) GEN OVERLOAD | TO/LAND | 7 |
| GND SPLRS NOT ARMED | TO | 10 |
| GND SPOILERS FAIL | TO | 10 |
| L (R) HYD PRESS LOW | TO/LAND | 13 |
| HYD PTU FAIL | — | 13 |
| L (R) HYD SOV FAIL | TO/LAND | 13 |
| L (R) HYD TEMP HIGH | TO/LAND | 13 |
| L (R) IAPS FAIL | TO/LAND | 11 |

| EICAS CAUTION MESSAGES | | |
|---|---|---|
| All caution messages are preceded by a single chime | | |
| Message | Inhibits | Chapter Ref. |
| ICE DETECTED | TO/LAND | 14 |
| ICE DETECTOR FAIL | TO/LAND | 14 |
| L (R) INBD BRAKE FAIL | TO | 15 |
| INBD BRAKE PRESS LO | TO | 15 |
| INBD BRAKES FAIL | TO | 15 |
| MACH TRIM FAIL | TO/LAND | 10 |
| L (R) MAIN BUS FAIL | TO/LAND | 7 |
| NOSE GEAR DOOR | TO/LAND | 15 |
| NWS FAIL | TO | 15 |
| NWS LIMIT EXCEEDED | TO/LAND | 15 |
| L (R) OUTBD BRAKE FAIL | TO | 15 |
| OUTBD BRAKE PRESS LO | TO | 15 |
| OUTBD BRAKES FAIL | TO/LAND | 15 |
| OXYGEN QUANTITY LOW | TO/LAND | 8 |
| OXYGEN VALVE CLOSED | TO/LAND | 8 |
| PACK FAIL | TO/LAND | 2 |
| PACK LEAK | TO/LAND | 2 |
| PACK LOOP FAIL | TO/LAND | 2 |
| PACK TEMP HIGH | TO/LAND | 2 |
| PASSENGER DOOR | LAND | 1 |
| PAX OXYGEN AUTO FAIL | TO/LAND | 8 |
| L (R) PITOT HEAT FAIL | TO/LAND | 14 |
| PFD X–TALK FAIL | TO/LAND | 11 |
| PARK/EMER BRAKE ON | TO | 15 |
| PK/EMER BRK PRESS LO | TO | 15 |
| PLT BRAKE FAULT | TO | 15 |
| PRI STAB TRIM FAIL | — | 10 |
| L (R) PROBE HEAT OFF | TO/LAND | 14 |
| L (R) REVERSER FAIL | TO | 18 |
| ROLL SPOILERS FAIL | — | 10 |

| EICAS CAUTION MESSAGES | | |
|---|---|---|
| All caution messages are preceded by a single chime | | |
| Message | Inhibits | Chapter Ref. |
| ROLL SPOILERS FAULT | — | 10 |
| RUDDER LIMITER FAIL | — | 10 |
| ROLL SPOILERS OFF | — | 10 |
| SEC STAB TRIM FAIL | — | 10 |
| SPOILERS FAIL | — | 10 |
| SPOILERS FAULT | — | 10 |
| STALL PROTECT FAIL | — | 10 |
| STALL PUSHER OFF | TO/LAND | 10 |
| L (R) START ABORTED | TO/LAND | 18 |
| L (R) STARTER FAIL | TO/LAND | 18 |
| L (R) STARTER FAIL ON | TO/LAND | 18 |
| STBY PITOT HEAT FAIL | TO/LAND | 14 |
| L (R) STBY STAT HT FAIL | TO/LAND | 14 |
| TRIM AIR FAIL | TO/LAND | 2 |
| TRIM AIR LOOP FAIL | TO/LAND | 2 |
| L (R) WINDOW HEAT FAIL | TO/LAND | 14 |
| L (R) WING A/I LOW TEMP | TO/LAND | 14 |
| L (R) WING ANTI–ICE FAIL | TO/LAND | 14 |
| L (R) WING A/I PRESS HI | TO/LAND | 14 |
| WING ANTI–ICE FAULT | TO/LAND | 14 |
| WING FUEL TEMP LOW | TO/LAND | 12 |
| L (R) WSHLD HEAT FAIL | TO/LAND | 14 |
| WOW FAIL | TO | 15 |
| XBLEED FAIL | TO/LAND | 2 |
| XPDR 1 FAIL | — | 17 |
| XPDR 2 FAIL | — | 17 |
| YAW DAMPER FAIL | TO/LAND | 4 |

| EICAS ADVISORY MESSAGES | | |
|---|---|---|
| Crew awareness - no immediate action required | | |
| Message | Inhibits | Chapter Ref. |
| ACARS MESSAGE | TO/LAND | 6 |
| AFIS MESSAGE | TO/LAND | 6 |
| AIR COND FAULT | TO/LAND | 2 |
| L (R) AOA CASE HEAT FAIL | TO/LAND | 14 |
| APU FAULT | TO/LAND | 5 |
| APU SHUTDOWN | TO/LAND | 5 |
| L (R) AUX BUS FAIL | TO/LAND | 7 |
| L (R) AUX BUS OFF | TO/LAND | 7 |
| AUX HYD PUMP FAIL ON | TO/LAND | 13 |
| AUX HYD SYS FAIL | TO/LAND | 13 |
| AT FAIL | TO/LAND | 4 |
| L (R) BLEED FAULT | TO/LAND | 2 |
| BLEED LOOP FAULT | TO/LAND | 2 |
| BRAKE FAULT | TO/LAND | 15 |
| CABIN ALT WARN HIGH | — | 2 |
| CABIN CALL | TO/LAND | 6 |
| CVR FAIL | TO/LAND | 6 |
| DATALINK ACARS | TO/LAND | 6 |
| DATALINK CPDLC ATN | TO/LAND | 6 |
| DATALINK CPDLC FANS | TO/LAND | 6 |
| DATALINK FAIL | TO/LAND | 6 |
| DATALINK FANS FAIL | TO/LAND | 6 |
| DCU FAN FAULT | TO/LAND | 11 |
| DCU FAULT | TO/LAND | 11 |
| DOWNLOAD FADEC | TO/LAND | 18 |
| ELECTRICAL FAULT | TO/LAND | 7 |
| L (R) ENG A/ICE FAIL ON | TO/LAND | 18/14 |
| L (R) ENG IGN FAULT | TO/LAND | 18 |
| L (R) ENGINE FAULT | TO/LAND | 18 |
| L (R) ENG FUEL TEMP LOW | TO/LAND | 18 |

| EICAS ADVISORY MESSAGES | | |
|---|---|---|
| Crew awareness - no immediate action required | | |
| Message | Inhibits | Chapter Ref. |
| L (R) ENGINE FUEL BYPASS | TO/LAND | 18 |
| L (R) ENGINE MINOR FAULT | TO/LAND | 18 |
| L (R) ENGINE OIL BYPASS | TO/LAND | 18 |
| L (R) ENGINE OIL CHIP | TO/LAND | 18 |
| L (R) ENG THRUST FAULT | TO/LAND | 18 |
| L (R) ENG VIBRATION FAIL | TO/LAND | 18 |
| ENGINE SYNC FAIL | TO/LAND | 18 |
| ENG MACH HOLD FAIL | TO/LAND | 18 |
| EQPT RACK COOL FAULT | TO/LAND | 2 |
| L (R) ESS BUS OFF | TO/LAND | 7 |
| FAX RECEIVED | TO/LAND | 6 |
| FD 1 (2) FAIL | TO/LAND | 4 |
| FDR FAIL | TO/LAND | 6 |
| FDR FAULT | TO/LAND | 6 |
| FIRE SYS FAULT | TO/LAND | 9 |
| FIREX BTL 1 (2) FAULT | TO/LAND | 9 |
| FIREX BTL 1(2) LOW | TO/LAND | 9 |
| FLAPS FAULT | TO/LAND | 10 |
| FLAPS RATE LOW | TO/LAND | 10 |
| FUEL GRAV XFLOW FAIL | TO/LAND | 12 |
| L (R) FUEL PUMP ON | TO/LAND | 12 |
| FUEL QUANTITY FAULT | TO/LAND | 12 |
| FUEL XFER FAIL | TO/LAND | 12 |
| L (R) HYD DC PUMP FAIL | TO/LAND | 13 |
| L (R) HYD ENG PUMP FAIL | TO/LAND | 13 |
| L (R) HYD SOV CLOSED | TO/LAND | 13 |
| IAPS FAN FAULT | TO/LAND | 11 |
| ICE DETECTED | TO/LAND | 14 |
| ICE DETECTOR FAULT | TO/LAND | 14 |
| LAV CALL | TO/LAND | 6 |

| EICAS ADVISORY MESSAGES | | |
|---|---|---|
| Crew awareness - no immediate action required | | |
| Message | Inhibits | Chapter Ref. |
| L (R) MAIN BUS OFF | TO/LAND | 7 |
| MANUAL PRESS FAIL | TO/LAND | 2 |
| MFD X–TALK FAIL | TO/LAND | 11 |
| NWS FAULT | TO/LAND | 15 |
| PACK COOL AIR FAIL | TO/LAND | 2 |
| L (R) PROBE HT CTLR FAIL | TO/LAND | 14 |
| PROX SYS FAULT | TO/LAND | 15 |
| L (R) PYLON LOOP FAIL | TO/LAND | 2 |
| RAM AIR FAIL | TO/LAND | 2 |
| RDC FAULT | TO/LAND | 11 |
| RDC FAN FAIL | TO/LAND | 11 |
| ROAAS FAIL | TO/LAND | 17 |
| ROAAS NOT AVAIL | TO/LAND | 17 |
| ROAAS/RAAS FAIL | TO/LAND | 17 |
| ROAAS/RAAS NOT AVAIL | TO/LAND | 17 |
| RUDDER LIMITER FAULT | TO/LAND | 10 |
| SELCAL DATALINK | TO/LAND | 6 |
| SELCAL HF 1(2) | TO/LAND | 6 |
| SELCAL VHF 1 (2) (3) | TO/LAND | 6 |
| SPOILERS FAULT | TO/LAND | 10 |
| STAB TRIM FAULT | TO/LAND | 10 |
| STALL PROTECT FAULT | TO/LAND | 10 |
| L (R) STALL SHAKER FAIL | TO/LAND | 10 |
| STALL WARN BASIC | TO/LAND | 10 |
| STBY INST BATT FAULT | TO/LAND | 7 |
| TAT HEAT FAIL | TO/LAND | 14 |
| TAWS BASIC FAIL | TO/LAND | 17 |
| TAWS SYSTEM FAIL | TO/LAND | 17 |
| TAWS TERR FAIL | TO/LAND | 17 |
| TAWS TERR NOT AVAIL | TO/LAND | 17 |

| EICAS ADVISORY MESSAGES | | |
|---|---|---|
| Crew awareness - no immediate action required | | |
| Message | Inhibits | Chapter Ref. |
| TAWS WINDSHEAR FAIL | TO/LAND | 17 |
| TSS FAN FAIL | — | 17 |
| WING ANTI–ICE FAULT | TO/LAND | 14 |
| WING A/ICE LOOP FAIL | TO/LAND | 14 |
| WING SOURCE–XBLEED | TO/LAND | 14 |
| XPDR 1 FAIL | — | 17 |
| XPDR 2 FAIL | — | 17 |

| EICAS STATUS MESSAGES | | |
|---|---|---|
| Information only - no crew action required | | |
| Message | Inhibits | Chapter Ref. |
| AIR COND MAN TEMP ON | — | 2 |
| AIR SOURCE OFF | — | 2 |
| APU GEN OFF | — | 7 |
| AT IN TEST | TO/LAND | 4 |
| AT SERVO TEST | TO/LAND | 4 |
| AURAL WARN A (B) MUTED | — | 3 |
| AUTO APR OFF | — | 18 |
| L (R) BATT OFF | — | 7 |
| BLEED OFF | — | 2 |
| BUS TIE MAN OPEN | — | 7 |
| CARGO DOOR | TO/LANDING | 1 |
| DITCHING ON | — | 2 |
| ELECT HYD GEN ON | — | 7 |
| ELT ON | — | 6 |
| EMER DEPRESS ON | — | 2 |
| L (R) ENG ANTI–ICE ON | — | 14 |
| ENG ANTI–ICE ON | — | 14 |
| L (R) ENG FUEL SOV CLSD | — | 12 |

| EICAS STATUS MESSAGES | | |
|---|---|---|
| Information only - no crew action required | | |
| Message | Inhibits | Chapter Ref. |
| L (R) ENGINE SHUTDOWN | — | 18 |
| FIRE SYS IN TEST | — | 9 |
| FIRE SYS TEST OK | — | 9 |
| FUEL BALANCED | — | 12 |
| FUEL GRAV XFLOW OPEN | — | 12 |
| L (R) FUEL PUMP OFF | — | 12 |
| L (R) FUEL PUMP ON | — | 12 |
| FUEL XFER OPEN | — | 12 |
| L (R) GEN OFF | — | 7 |
| GND SPOILERS OFF | — | 10 |
| HYD PUMP NOT AUTO | — | 13 |
| L (R) HYD SOV CLOSED | — | 13 |
| IRS 1(2) IN ATT | — | 11 |
| MANUAL PRESS ON | — | 2 |
| NWS OFF | — | 15 |
| PACK ONLY | — | 2 |
| PARK/EMER BRAKE ON | — | 15 |
| PASSENGER DOOR | TO/LAND | 1 |
| PAX OXYGEN OFF | — | 8 |
| PAX OXYGEN ON | — | 8 |
| PITCH DISCONNECT | — | 10 |
| PROBE HEAT TEST OK | — | 14 |
| RAM AIR ON | — | 2 |
| L (R) REVERSER INOP | — | 18 |
| ROAAS OFF | — | 17 |
| ROAAS RCC 5 ON | — | 17 |
| ROAAS/RAAS OFF | — | 17 |
| ROLL DISCONNECT | — | 10 |
| ROLL SPOILERS OFF | — | 10 |
| RUD LIMITER IN TEST | — | 10 |

| EICAS STATUS MESSAGES | | |
|---|---|---|
| Information only - no crew action required | | |
| Message | Inhibits | Chapter Ref. |
| **SEC STAB TRIM ON** | — | 10 |
| **STAB TRIM OFF** | — | 10 |
| **STALL PUSHER OFF** | — | 10 |
| **STBY INST OFF** | — | 11 |
| **TAWS FLAPS OFF** | — | 17 |
| **TAWS GS WARN OFF** | — | 17 |
| **TAWS TERR OFF** | — | 17 |
| **TRIM AIR ONLY** | — | 2 |
| **WING ANTI–ICE ON** | — | 14 |
| **WING/ENG ANTI–ICE ON** | — | 14 |
| **WING SOURCE–XBLEED** | — | 14 |
| **XBLEED OPEN** | — | 2 |
| **XPDRS IN STBY** | — | 17 |
| **YAW DAMPER OFF** | — | 4 |

| MESSAGES/MESSAGE SOUNDS | |
|---|---|
| Complete list of EICAS messages and their associated sounds | |
| Message | Message Sound |
| **AFT EQPT BAY DOOR** | TONE |
| **ALTITUDE ALERT** | TONE |
| **"APU FIRE"** | VOICE MESSAGE |
| **APU FIRE DET FAIL** | TONE |
| **APU FUEL SOV FAIL** | TONE |
| **APU GEN FAIL** | TONE |
| **APU GEN OVERLOAD** | TONE |
| **"AUTOTHROTTLE"** | VOICE MESSAGE (for normal disconnect) |
| **"AUTOTHROTTLE, AUTOTHROTTLE"** | VOICE MESSAGE (continuous dual callout for auto disengage) |
| **AUTOPILOT DISCONNECT** | TONE |
| **AUX HYD TEMP HIGH** | TONE |
| **LEFT (R) BATT FAIL** | TONE |
| **BATTERY BAY DOOR** | TONE |
| **LEFT (R) BATTERY OVERHEAT** | TONE |
| **"CABIN ALTITUDE"** | VOICE MESSAGE |
| **CARGO DOOR** | TONE |
| **CARGO SMOKE** | TONE |
| **CARGO SMOKE DET FAIL** | TONE |
| **"CONFIG AILERON TRIM"** | VOICE MESSAGE |
| **"CONFIG AUTOPILOT"** | VOICE MESSAGE |
| **"CONFIG FLAPS"** | VOICE MESSAGE |
| **"CONFIG RUDDER TRIM"** | VOICE MESSAGE |
| **"CONFIG SPOILERS"** | VOICE MESSAGE |
| **"CONFIG STAB TRIM"** | VOICE MESSAGE |
| **CPLT BRAKE FAULT** | TONE |
| **ELEC HYD GEN FAIL** | TONE |
| **ELECTRICAL FAULT** | TONE |
| **LEFT (R) ENG ANTI–ICE FAIL** | TONE |
| **LEFT (R) ENG DSPL MISCOMP** | TONE |
| **LEFT (R) ENG FUEL SOV FAIL** | TONE |

| MESSAGES/MESSAGE SOUNDS | |
|---|---|
| Complete list of EICAS messages and their associated sounds | |
| Message | Message Sound |
| **LEFT (R) ENG OIL PRESS HIGH** | TONE |
| **LEFT (R) ENG OIL PRESS LOW** | TONE |
| **LEFT (R) ENG OIL TEMP HIGH** | TONE |
| **LEFT (R) ENGINE EXCEEDANCE** | TONE |
| **"LEFT (RIGHT) ENGINE FIRE"** | VOICE MESSAGE |
| **LEFT (R) ENGINE FLAMEOUT** | TONE |
| **LEFT (R) ENGINE VIBRATION** | TONE |
| **ENGINES FUEL BYPASS** | TONE |
| **ELEVATOR SPLIT** | TONE |
| **EMERGENCY EXIT** | TONE |
| **EMER LIGHTS OFF** | TONE |
| **EMER LIGHTS ON** | TONE |
| **LEFT (R) ESS BUS FAIL** | TONE |
| **ESSENTIAL POWER ONLY** | TONE |
| **LEFT (R) INBD BRAKE FAIL** | TONE |
| **INBD BRAKE FAIL** | TONE |
| **INBD BRAKE PRESS LO** | TONE |
| **LEFT (R) FADEC FAIL** | TONE |
| **FIRE SYS FAULT** | TONE |
| **FIREX APU SQUIB FAIL** | TONE |
| **FLAPS FAIL** | TONE |
| **FLAPS FAULT** | TONE |
| **FLAPS NORM PRESS LOW** | TONE |
| **FLT SPOILERS DEPLOY** | TONE |
| **FLT SPOILERS FAIL** | TONE |
| **FLT SPOILERS FAULT** | TONE |
| **FUEL IMBALANCE** | TONE |
| **LEFT (R) FUEL COLLECTOR LOW** | TONE |
| **LEFT (R) FUEL PRESSURE LOW** | TONE |
| **LEFT (R) FUEL PUMP FAIL** | TONE |

| MESSAGES/MESSAGE SOUNDS | |
|---|---|
| Complete list of EICAS messages and their associated sounds | |
| Message | Message Sound |
| **FUEL QUANTITY FAIL** | TONE |
| **FUEL QUANTITY LOW** | TONE |
| **"GEAR"** | VOICE MESSAGE |
| **GEAR BAY OVHT** | TONE |
| **GEAR BAY DET FAIL** | TONE |
| **GEAR DISAGREE** | TONE |
| **GEAR SYS FAIL** | TONE |
| **LEFT (R) GEN FAIL** | TONE |
| **LEFT (R) GEN OVERLOAD** | TONE |
| **GND SPOILERS FAIL** | TONE |
| **GND SPLRS NOT ARMED** | TONE |
| **HYD PRESS LOW** | TONE |
| **LEFT (R) HYD PRESS LOW** | TONE |
| **HYD PTU FAIL** | TONE |
| **LEFT (R) HYD SOV FAIL** | TONE |
| **LEFT (R) HYD TEMP HIGH** | TONE |
| **"LEFT (RIGHT) ENGINE FIRE"** | VOICE MESSAGE |
| **LEFT (R) FIRE DET FAIL** | TONE |
| **LEFT (R) MAIN BUS FAIL** | TONE |
| **"NORMAL BRAKES FAIL"** | VOICE MESSAGE |
| **NOSE GEAR DOOR** | TONE |
| **NWS FAIL** | TONE |
| **NWS LIMIT EXCEEDED** | TONE |
| **LEFT (R) OUTBD BRAKE FAIL** | TONE |
| **OUTBD BRAKE PRESS LO** | TONE |
| **OUTBD BRAKES FAIL** | TONE |
| **"OVERSPEED"** | VOICE MESSAGE |
| **"PARK/EMER BRAKE ON"** | VOICE MESSAGE |
| **PARK/EMER BRAKE ON** | TONE |
| **PASSENGER DOOR** | TONE |

| MESSAGES/MESSAGE SOUNDS | |
|---|---|
| Complete list of EICAS messages and their associated sounds | |
| Message | Message Sound |
| **"PITCH DISCONNECT"** | VOICE MESSAGE |
| **PK/EMER BRK PRESS LO** | TONE |
| **PLT BRAKE FAULT** | TONE |
| **PRI STAB TRIM FAIL** | TONE |
| **LEFT (R) REVERSER FAIL** | TONE |
| **LEFT (R) REVERSER UNSAFE** | TONE |
| **MACH TRIM FAIL** | TONE |
| **"ROLL DISCONNECT"** | VOICE MESSAGE |
| **ROLL SPOILERS FAIL** | TONE |
| **ROLL SPOILERS FAULT** | TONE |
| **ROLL SPOILERS OFF** | TONE |
| **RUDDER LIMITER FAIL** | TONE |
| **SEC STAB TRIM FAIL** | TONE |
| **"SELCAL DATALINK"** | VOICE MESSAGE |
| **"SELCAL HF 1 (2)"** | VOICE MESSAGE |
| **"SELCAL VHF 1 (2) (3)"** | VOICE MESSAGE |
| **SPOILERS FAIL** | TONE |
| **SPOILERS FAULT** | TONE |
| **"STALL"** | VOICE MESSAGE |
| **LEFT (R) START ABORTED** | TONE |
| **LEFT (R) STARTER FAIL** | TONE |
| **LEFT (R) STARTER FAIL ON** | TONE |
| **TRIM CLACKER** | TONE |
| **VERTICAL TRACK ALERT** | TONE |
| **WING FUEL TEMP LOW** | TONE |
| **WOW FAIL** | TONE |

## XIII. CIRCUIT BREAKERS

EICAS System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| EICAS DCU A | LEFT ESS | CB1-D1 |
| EICAS DCU B | RIGHT MAIN | CB2-D1 |
| EICAS RDC A | LEFT ESS | CB1-D2 |
| EICAS RDC B | RIGHT MAIN | CB2-D2 |
| L IAPS | LEFT ESS | CB1-B6 |
| R IAPS | RIGHT ESS | CB2-B6 |
| L PFD | LEFT ESS | CB1-C3 |
| L PFD HTR | LEFT MAIN | CB3-F6 |
| R PFD | RIGHT MAIN | CB2-C3 |
| R PFD HTR | RIGHT MAIN | CB4-F6 |
| L MFD | LEFT ESS | CB1-C5 |
| L MFD HTR | LEFT MAIN | CB3-F7 |
| R MFD | RIGHT MAIN | CB2-C5 |
| R MFD HTR | RIGHT MAIN | CB4-F7 |
| FAN PWR 1 | LEFT ESS | CB1-B2 |
| FAN PWR 2 | RIGHT MAIN | CB6-B2 |
| RIU 1A | LEFT ESS | CB1-B5 |
| RIU 1B/AURAL | LEFT ESS | CB1-B4 |
| RIU 2A | RIGHT MAIN | CB2-B4 |
| RIU 2B/AURAL | RIGHT MAIN | CB2-B5 |

# XIV. EICAS MESSAGES

## A. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed - Single chime

| Message | Meaning | Inhibits |
|---|---|---|
| EFIS COMPARATOR INOP | EFIS comparator unable to compare one or more of the following parameters: altitude, airspeed, roll attitude, pitch attitude, heading, radio altitude, flight director, localizer or glideslope | TO/LAND |
| EFIS MISCOMPARE | There is a mismatch between the onside and cross-side data and accompanied by a PFD annunciation ALT, IAS, ROL, PIT, HDG, LOC, GS, RA, or FD | — |
| L (R) IAPS FAIL | The respective Integrated Avionics Processing System has failed | TO/LAND |
| PFD X-TALK FAIL | Communication between the PFDs has failed. REFs menu pages 1, 2 and 3 are not synchronized. The EFIS comparator will be inoperative and is unable to compare one or more of the following parameters: altitude, airspeed, roll attitude, pitch attitude, heading, radio altitude, flight director, localizer or glideslope | TO/LAND |

## B. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness required - May have associated tone

| Message | Meaning | Inhibits |
|---|---|---|
| **DCU FAN FAULT** | The data concentrator unit fan is inoperative | **TO/LAND** |
| **DCU FAULT** | Channel A or B in the DCU has failed. The yaw damper may fail. The rudder travel limiter monitoring may be inoperative | **TO/LAND** |
| **MFD X-TALK FAIL** | Communication between the MFDs has failed, and cross side tuning will not be available | **TO/LAND** |
| **RDC FAN FAIL** | The remote data concentrator fan is inoperative | **TO/LAND** |
| **RDC FAULT** | The remote data concentrator channel A or B has failed with no loss of functionality | **TO/LAND** |

## C. STATUS MESSAGES

**STATUS MESSAGES**

Information only - no crew action required

| Message | Meaning |
|---|---|
| **AURAL WARN A (B) MUTED** | The respective AURAL WARNING DCU A or DCU B switch has been selected, muting all warnings through that channel |

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## XV. EICAS QUIZ

1. What are the four levels of CAS message priority from highest to lowest?

    A) Warning, Advisory, Caution, Status
    B) Warning, Caution, Advisory, Status
    C) Caution, Warning, Advisory, Status
    D) Warning, Caution, Status, Advisory

2. What color is used for advisory messages on the EICAS display?

    A) Amber
    B) Red
    C) Cyan
    D) White

3. How many hours of cockpit voice recordings does the CVR store?

    A) 1 hour
    B) 2 hours
    C) 3 hours
    D) 4 hours

4. What happens when the CAS switch is pressed once?

    A) All messages are cleared
    B) Warning messages are hidden
    C) Caution, advisory, and status messages are removed
    D) The system performs a self-test

5. At what speed does the takeoff inhibit activate?

    A) 60 knots
    B) 70 knots
    C) 80 knots
    D) 90 knots

6. Where are the master warning/caution switches located?

    A) Center pedestal
    B) Glareshield
    C) Overhead panel
    D) Side console

7. What color indicates loss of data or invalid information?

    A) Red
    B) Amber
    C) White
    D) Magenta

8. Which MFD normally displays engine indications?

A) Left MFD
B) Right MFD
C) Both MFDs
D) Neither MFD

9. What aural alert accompanies a warning message?

A) Single chime
B) Double chime
C) Triple chime
D) Continuous tone

10. How many synoptic pages are available in the EICAS system?

A) 5
B) 6
C) 7
D) 8

11. What philosophy does the Challenger 350 EICAS use for system indications?

A) Dark and Quiet Cockpit
B) Quiet Dark Cockpit
C) Silent Cockpit
D) Minimal Display

12. Where is the MFD Control Panel (MCP) located?

A) Overhead panel
B) Glareshield
C) Center pedestal
D) Side console

13. What does pressing the master warning switch accomplish?

A) Clears the warning message
B) Silences aural alerts and stops light flashing
C) Initiates emergency procedures
D) Switches to backup display

14. At what altitude is the landing inhibit activated?

A) 200 ft AGL
B) 300 ft AGL
C) 400 ft AGL
D) 500 ft AGL

15. What does the VIB icon indicate when displayed?

A) Normal vibration
B) Vibration sensor failure
C) Vibration exceeds predetermined value
D) Vibration test in progress

16. Which display shows the summary synoptic by default?

A) Left PFD
B) Right PFD
C) Left MFD
D) Right MFD

17. What is displayed when thrust reversers are deployed?

A) REV icon in green
B) TR icon in amber
C) REV icon in white
D) TR icon in green

18. Where are the AURAL WARNING disable switches located?

A) Center pedestal
B) Copilot aft bulkhead
C) Overhead panel
D) Glareshield

19. What happens to messages triggered during an inhibit period?

A) They are permanently deleted
B) They are displayed when exiting the inhibit envelope
C) They are logged but never displayed
D) They override the inhibit

20. What test is NOT available on the test panel?

A) CAS test
B) HYDRAULIC test
C) FIRE DET test
D) TAWS test

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CL-350



CL-350 TRAINING MANUAL

# COMMUNICATIONS SYSTEM | 16

AIRCRAFT SYSTEMS
TRAINING MANUAL

LOFT.AERO

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# COMMUNICATIONS SYSTEM

## I. INTRODUCTION

The Challenger 350 Communications System provides comprehensive voice and data communication capabilities through multiple integrated subsystems designed to ensure reliable air-to-ground and intra-aircraft communications throughout all phases of flight.

The system consists of dual VHF transceivers, optional HF and SATCOM systems, audio control panels, and recording devices that operate through redundant architectures to maintain communication capability during system failures. Advanced features including data link communications, automatic frequency management, and global satellite coverage enable the aircraft to maintain continuous contact with air traffic control and company operations worldwide while the integrated audio system manages all internal and external communications through a centralized control interface.

### A. SYSTEM SPECIFICATIONS

Communications System Specifications

| Parameter | Value |
|---|---|
| VHF Communications | Two independent VHF transceivers |
| VHF Frequency Range | 118.000 - 136.991 MHz |
| VHF Channel Spacing | 8.33/25 kHz |
| HF Communications (Optional) | Single HF transceiver |
| HF Frequency Range | 2.0 - 29.9999 MHz |
| SATCOM (Optional) | Satellite communication system |
| Audio Control Panels | Two (pilot and copilot) |
| Cockpit Voice Recorder | 2 hour recording duration |
| Emergency Locator Transmitter | 406 MHz with GPS position |
| SELCAL (Optional) | 4-letter selective calling system |
| Data Link (Optional) | FANS 1/A+ and ATN B1 CPDLC capability |
| Radio Integration Units | Two for system integration |
| Passenger Address | Integrated PA system |
| Interphone System | Internal and external positions |
| Radio Tuning | MFD primary, CDU backup |

### B. RADIO COMMUNICATION SYSTEM (RCS) COMPONENTS

- Two VHF communication transceivers
- Two VHF communication antennas
- HF transceiver (optional)
- HF antenna (optional)
- Two Audio Control Panels (ACP)
- Two Maintenance Interphone Panels
- Two Radio Interface Units (RIU)

## II. VHF COMMUNICATION SYSTEM

### A. SYSTEM ARCHITECTURE

Two independent VHF-4000 transceivers provide primary communication capability.

**Key Features:**

- Remote-mounted transceivers ensure physical separation
- Dual VHF antennas for redundancy
- Integrated displays in lower MFD sections
- Cross-side control capability from either pilot position
- Memory retention during power interruptions
- Optional third VHF radio for additional capability

### B. FREQUENCY COVERAGE

**Operating Bands:**

- Domestic band: 118.000 to 136.991 MHz
- 25 kHz spacing: 118.000 to 136.975 MHz
- 8.33 kHz spacing: 118.000 to 136.991 MHz
- 20 preset channels selectable via CDU

### C. CONTROL METHODS

**Primary Control Interfaces:**

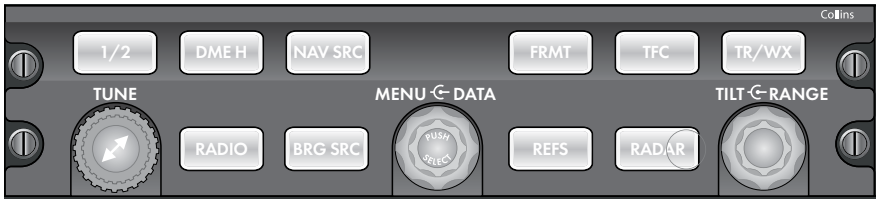
- Multi Function Display (MFD) - primary tuning source
- Display Control Panel (DCP) on glareshield
- MENU knob for radio selection
- TUNE knob for frequency adjustment (coarse/fine)
- Transfer button for frequency activation
- 1/2 button for side selection

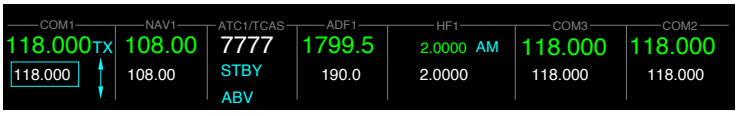



Control Display Unit (CDU)

**CDU Control:**

- Available for normal convenience operation
- Primary control in reversionary mode
- RSP TUNE switch to CDU ONLY for reversion
- Single point control of on-side and cross-side radios
- Integrated control from pilot or copilot position




## D. TUNING REVERSION

**Reversion Selection Panel**
**Switch Positions:**

- MFD ONLY - Radio tuned using DCP only, CDU TUNE page blank
- NORM - Radio tuned using either DCP or CDU
- CDU ONLY - Radio tuned using CDU only, MFD radio menu blanked
- COM 1 121.50 - Forces COM 1 to emergency frequency 121.50 MHz

**Normal Configuration:**

- MFD provides master tuning control in NORM position
- CDU available for convenience operation
- Both DCP and CDU commands accepted
- Seamless transition between control methods

**Reversionary Control Logic:**

- MFD failure requires alternate tuning source selection
- Compressed PFD format eliminates MFD radio tuning
- CDU becomes primary control in reversionary mode
- Single point control maintained from either pilot position

**MFD ONLY Selection:**

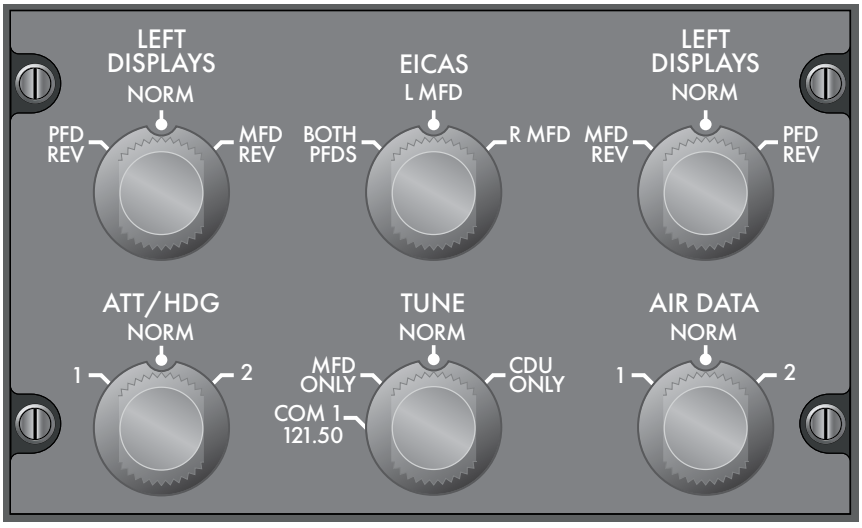
- MFDs ignore tuning commands from CDUs
- CDU TUNE page displays blank
- DCP maintains full control capability
- Radio frequencies retained in memory

**CDU ONLY Selection:**

- CDUs ignore tuning commands from MFDs
- MFD radio menu displays blank
- Display Control Panel (DCP)
- Full on-side and cross-side radio control
- Integrated control from pilot or copilot position

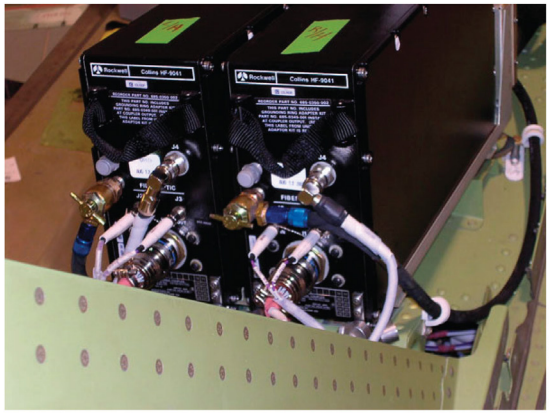
**Emergency Frequency Override:**

- COM 1 121.50 position forces emergency frequency
- Normal tuning continues for other radios
- MFD remains master tuning control
- Immediate emergency frequency access capability




## III. HIGH FREQUENCY RADIO (HF) (OPTIONAL)

### A. SYSTEM OVERVIEW



- Optional HF communication system for longrange operations
- Receiver/transmitter unit located in aft equipment bay
- Conformal antenna integrated in vertical stabilizer leading edge
- SELCAL capability for selective calling

### B. FREQUENCY SPECIFICATIONS

- Operating frequency range: 2.0 to 29.9999 MHz
- 280,000 communication channels available

- Channel spacing: 100 Hz (0.1 kHz)
- Maximum tuning time: 6 seconds
- Modulation modes: USB, LSB, AM
- Six emergency channels available
- 16 programmable preset channels
- Maximum tuning time – 6 seconds (typically less than 1 second)

## C. ANTENNA SYSTEM

- Conformal-type antenna integral to vertical stabilizer leading edge
- Antenna coupler provides impedance matching
- Automatic tuning adjusts for selected frequency

## D. OPERATIONAL CAPABILITIES

- Long-range voice communications for oceanic and remote area operations
- SELCAL (Selective Calling) capability
- Preset frequency storage for commonly used channels (1-20)
- Integration with aircraft audio system

## E. TUNING PROCEDURES

- CDU TUNE page or MFD radio menu access
- Direct frequency entry in MHz format
- Preset channel selection (channels 1-20)
- Antenna automatically tunes to selected frequency  within 6 seconds

## F. SELCAL SYSTEM

- Unique four-letter code assigned to individual aircraft
- Ground stations transmit code to call aircraft
- Aural and visual alerts notify crew
- EICAS “SELCAL HF 1” or “SELCAL HF 2” message displays upon reception
- Eliminates need for continuous frequency monitoring

## G. POLAR OPERATIONS

- HF radio essential for polar region operations outside VHF coverage
- Flight in polar regions allowed when forecast favorable for HF propagation
- VHF communication unreliable above 70° North and below 70° South latitude

## H. VOICE/ID/BOTH SWITCH

- VOICE position: Filters out Morse code identifier signals
- ID position: Identifier tone reception only
- BOTH position: Simultaneous voice and identifier reception

## IV. AUDIO CONTROL SYSTEM

### A. AUDIO CONTROL PANELS (ACP)




**Control Functions:**

- Monitor navigation radios
- Monitor/transmit VHF and HF radios
- PA system control
- Intercom system control
- Individual volume adjustment
- Speaker selection and control

### B. AUDIO SELECTORS

**SPKR Selector:**

- Routes selected audio to on-side crew speaker
- Warning audio audible in any position
- Volume adjustable via SPKR knob
- Push to deselect speaker

**INPH Selector:**

- Enables crew intercommunication
- Connects to external service positions
- Hot microphone capability
- Volume control for each position

### C. SPECIAL CONTROLS

**VOICE/ID/BOTH Switch:**

- VOICE - filters out morse code identifier
- ID - only NAV/ADF identifier audible
- BOTH - station identifier and voice audible

**EMER/NORM Switch:**

- NORM - standard audio routing
- EMER - bypasses RIU, direct to headphones
- Locking toggle mechanism

**O2/MASK Switch:**

- NORM - boom microphone active
- O2 - oxygen mask microphone active

Note: Audio signals from the aural warning system, TAWS, and TCAS do not go through the volume control switches.

# V. INTERPHONE SYSTEM

## A. FLIGHT COMPARTMENT EQUIPMENT

**Headset Provisions:**

- Jack panels at pilot positions
- Headphone (HDPH) and microphone (MIC) jacks
- Individual volume control capability
- Always-available headphone audio

## B. HAND MICROPHONES

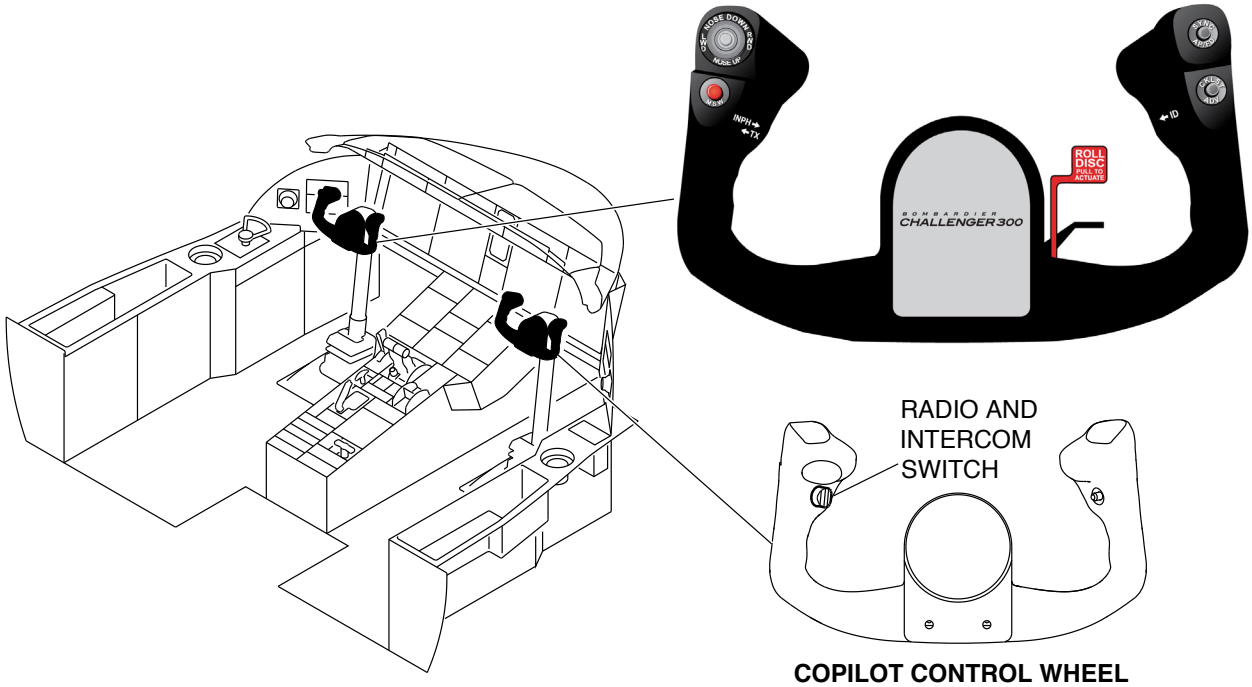
**Installation and Operation:**

- Mounted on control columns
- Available at each pilot station
- Primary backup communication method
- Direct interface with audio system

## C. CONTROL WHEEL SWITCHES

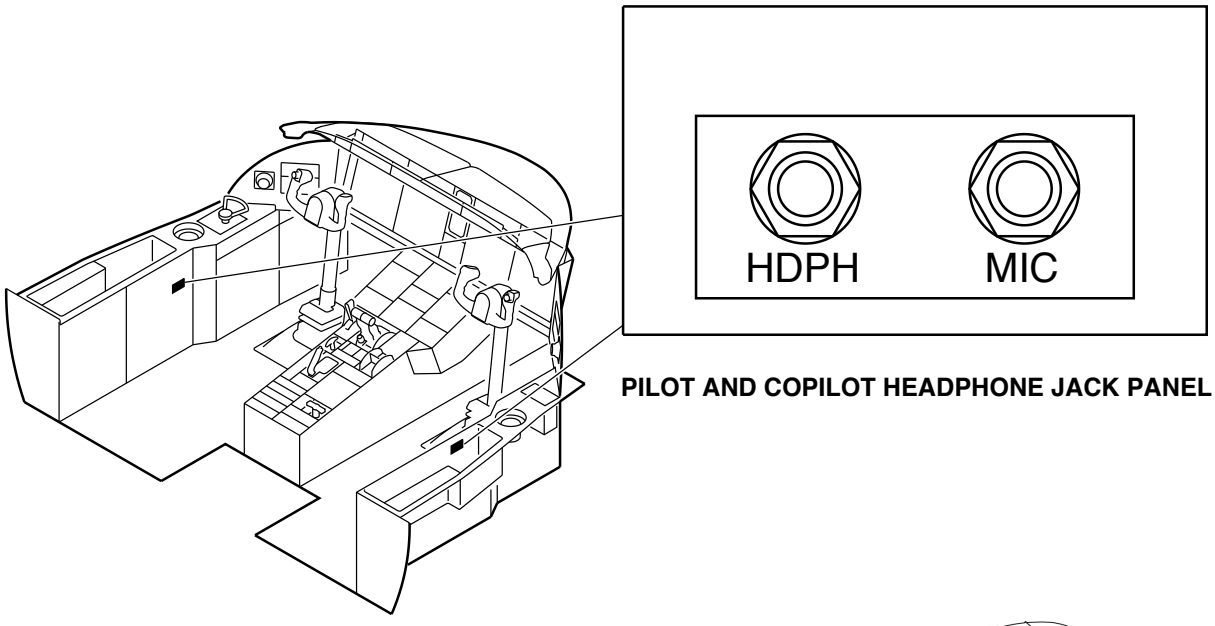
**TX/INPH Functions:**

- TX position for radio transmission
- INPH for intercom transmission
- Momentary switch operation
- Available on both control wheels



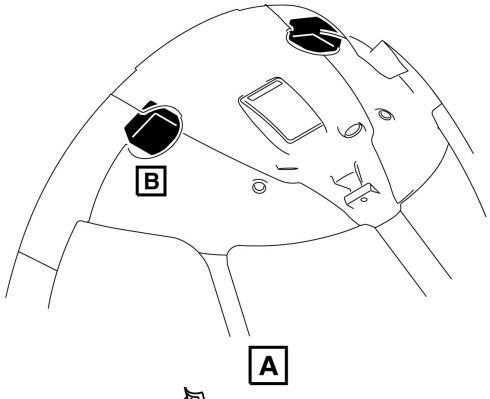

**COPILOT CONTROL WHEEL (REAR VIEW)**

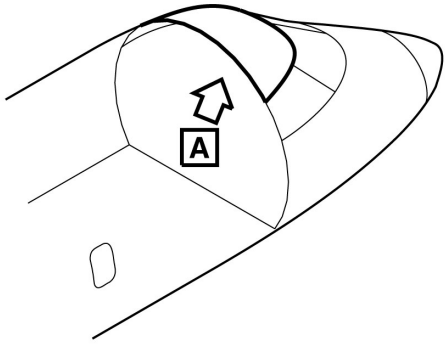
The control wheel radio/intercom switches at each pilot's station and the hand microphones allow the pilots to transmit on the communication radios or interphone.

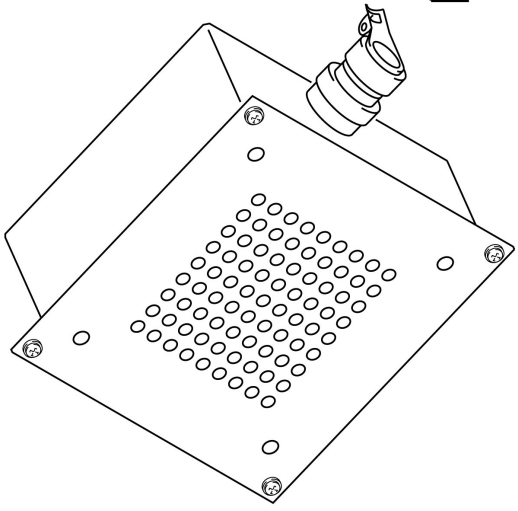



**PILOT AND COPILOT HEADPHONE JACK PANEL**

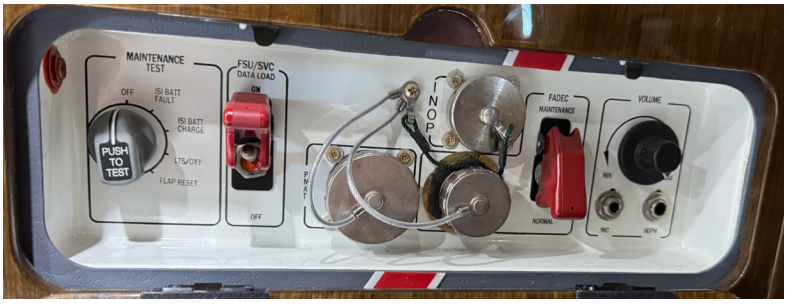
Two speakers are located overhead in the flight compartment **(B)**. The speaker volume can be adjusted by rotating the SPKR knob. The speaker can be selected off by pressing the SPKR knob in.



## D. MAINTENANCE INTERPHONE




**External Communication Points:**

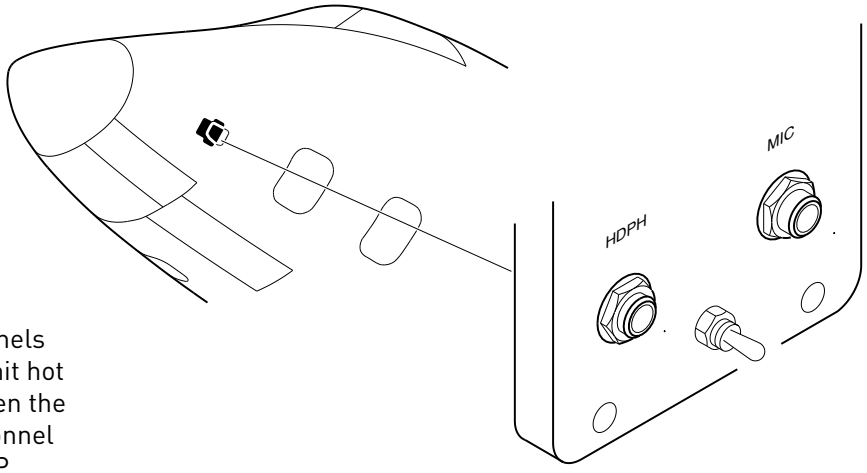
- Nose compartment panel (left side)
- Aft equipment compartment panel
- Hot microphone communication
- Headphone and microphone jacks

**Observer Interphone Panel:**

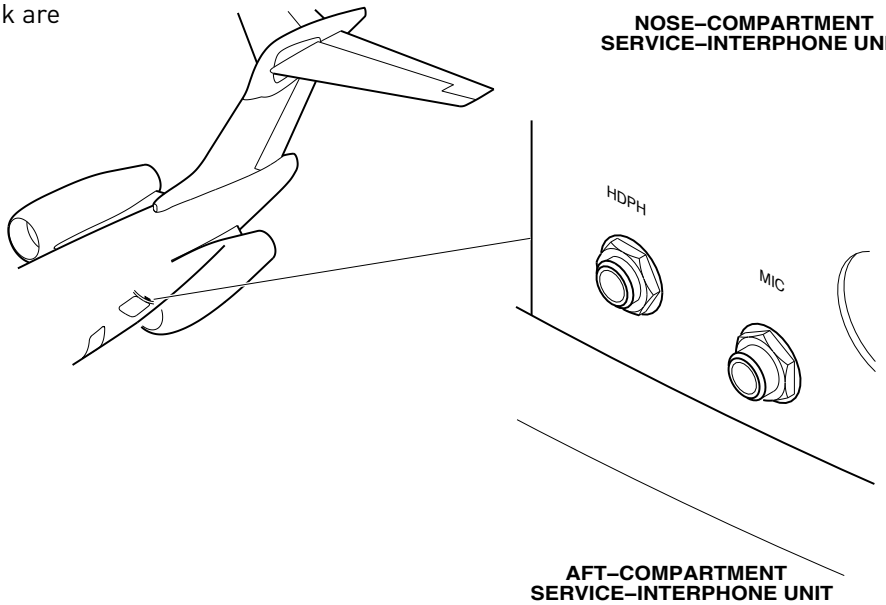
- Located on the Portable Maintenance Access Terminal PMAT (aft left avionics rack)
- Dedicated headphone/mic jacks
- Volume controller included

**MAINTENANCE INTERPHONE PANELS**

The two maintenance interphone panels are located on the aircraft, and permit hot microphone communications between the flight crew and ground service personnel when selected on the flight deck ACP. A headphone and microphone jack are installed at each location.



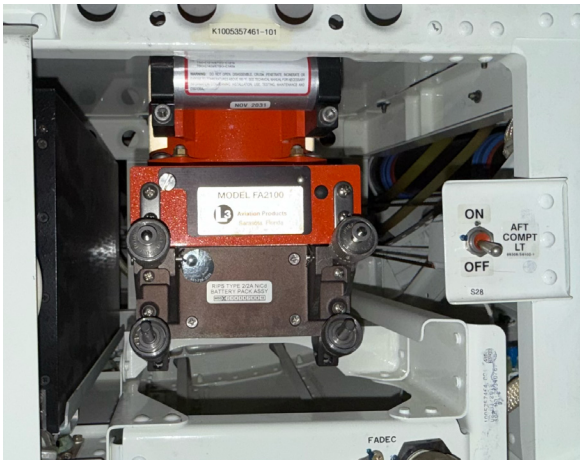

**NOSE–COMPARTMENT SERVICE–INTERPHONE UNIT**




**AFT–COMPARTMENT SERVICE–INTERPHONE UNIT**

# VI. COCKPIT VOICE RECORDER

## A. SYSTEM DESCRIPTION




**Physical Characteristics:**

- Bright orange with reflective stripes
- Mounted in aft equipment bay
- 120 minutes recording capacity
- Non-volatile solid-state memory

## B. RECORDING CHANNELS

**Four-Channel Audio Capture:**

- Channel 1: Observer station
- Channel 2: Copilot position
- Channel 3: Pilot position
- Channel 4: Area microphone (glareshield center)

## C. CONTROL PANEL

**Panel Components:**

- Green TEST button with indicator lamp
- Headset jack for monitoring
- ERASE button (ground operation only)
- Automatic recording on power application

**Erase Function Requirements:**

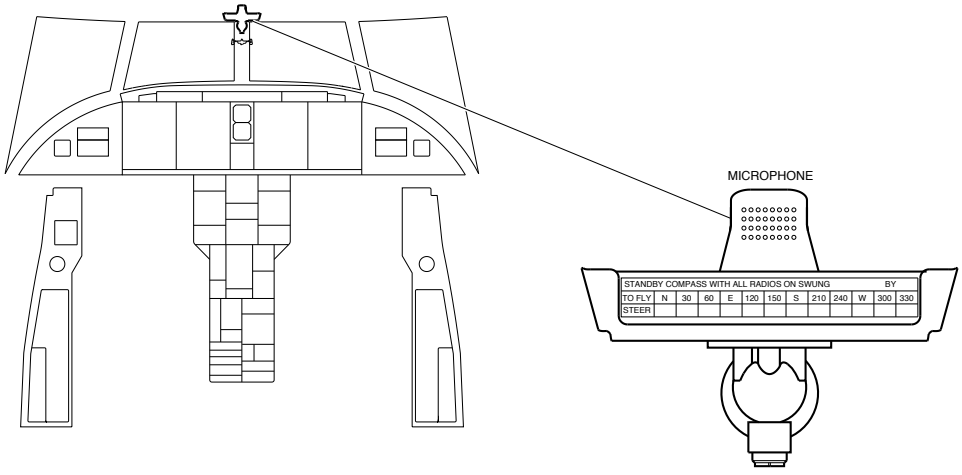
- Aircraft on ground
- Hydraulic systems pressurized
- Parking brake set
- All conditions must be met




## D. AREA MICROPHONE

**Installation and Function:**

- Located above liquid compass
- Windshield center post mounting
- Records all flight compartment sounds
- Continuous recording during operation



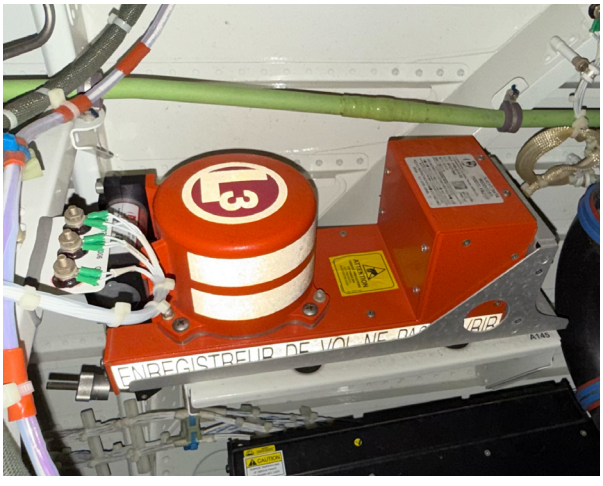

**AREA MICROPHONE**

### E. UNDERWATER LOCATOR DEVICE

**Emergency Location Features:**

- 6-year battery life expectancy
- Front bracket mounting for access
- Pulsed acoustic signal transmission
- 30-day transmission capability
- Automatic water activation

## VII. FLIGHT DATA RECORDER (OPTIONAL)



### A. SYSTEM COMPONENTS

**Recorder Unit Features:**

- Tail section installation
- Crash-survivable container
- 25-hour recording capacity
- Solid state non-volatile memory
- Automatic power removal on impact

### B. ACTIVATION TRIGGERS

**Recording Initiation:**

- STROBE/BEACON switch in BEACON position
- STROBE/BEACON switch in STROBE position
- Weight-off-wheels signal from PSEU

### C. TRI-AXIAL ACCELEROMETER

**Acceleration Measurement:**

- Vertical acceleration monitoring
- Lateral acceleration monitoring
- Longitudinal acceleration monitoring
- Located near aircraft center of gravity
- Data formatted through DCU

### D. UNDERWATER LOCATOR

**ULD Specifications:**

- Battery-operated pulse generator
- Front panel mounting
- Water submersion activation
- 30-day transmission capability position

## VIII. EMERGENCY LOCATOR TRANSMITTER

### A. SYSTEM DESCRIPTION

**Installation Details:**

- Top left side aft fuselage location
- Automatic activation on excessive longitudinal forces
- Manual activation capability
- ELT ON CAS message when transmitting

### B. TRANSMISSION FREQUENCIES

**Triple-Frequency Operation:**

- 121.5 MHz (VHF guard)
- 243.0 MHz (UHF guard)
- 406.025 MHz (satellite)




### C. CONTROL SWITCH

**Three-Position Operation:**

- ARM - normal standby position
- ON - manual activation/test
- RESET - system reset function

### D. ELT BUZZER

**Ground Alert System:**

- Rear fuselage installation
- Near venting cutout location
- Audible during ground operations
- Not distracting to flight crew

## IX. SATCOM SYSTEM (OPTIONAL)

### A. SYSTEM ARCHITECTURE

**System Components:**

- Space system - geosynchronous satellites
- Ground system - GESs and networks
- Aircraft earth station (AES)

### B. COVERAGE AREA

**Operational Limits:**

- 75 degrees north latitude maximum
- 75 degrees south latitude maximum
- Geosynchronous orbit at 22,300 mi (36,000 km)
- Overlap in coverage areas
- Polar regions excluded

### C. SYSTEM COMPONENTS

**Hardware Installation:**

- Satellite data unit (SDU)
- Radio interface unit (RIU)
- High-power amplifier
- Radio frequency unit
- High-gain antenna on vertical stabilizer
- Antenna control unit (ACU)

### D. COMMUNICATION CHANNELS

**Channel Allocation:**

- Minimum three channels required
- Two voice channels standard
- One data channel standard
- Flight compartment dedicated voice
- OITS (Office in the Sky) telephone channel
- AFIS/fax/modem data channel

## E. SATCOM ANTENNA

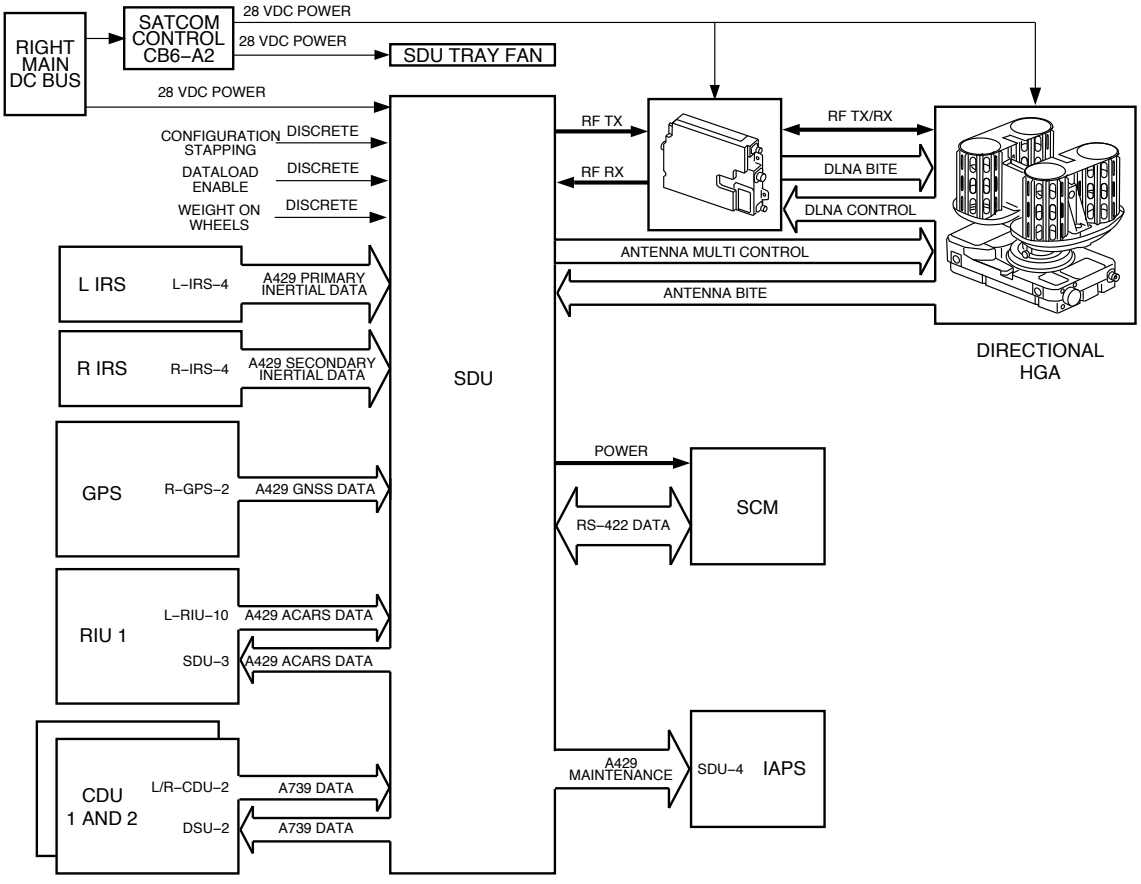
**Directional Antenna System:**

- Vertical stabilizer mounting
- Mechanically controlled pointing
- L-band transmission/reception
- Duplexer integration
- ACU position calculation

## F. DATA CAPABILITIES

**Packet Data Services:**

- ACARS message transmission
- AFIS data exchange
- Aircraft condition reporting
- Departure/arrival time data
- Flight delay information
- Voice, fax, and PC modem support



# X. DATA LINK SYSTEM (OPTIONAL)

## A. SYSTEM OVERVIEW

Integrated data link supporting VHF, HF, and SATCOM communications.

**Control Interface:**

- FMS CDU primary control
- VDL Mode 2 capability
- Circuit breaker CB3 E2 COM 3 power
- RIU No. 1 (CMU) integration

## B. FANS-1/A+ FUNCTIONALITY (Future Air Navigation System)

**System Capabilities:**

- Air Traffic Services (ATS) Facilities Notification (AFN)
- Automatic Dependent Surveillance-Contract (ADS-C)
- Controller-Pilot Data Link Communications (CPDLC)
- Dual DLCA (Data Link Communication Application) hosted by FMC1 and FMC2
- VHF or SATCOM message routing

**AFN Functions:**

- Ground station aircraft identification
- Data link capability information
- Positive aircraft identification
- ATS provider connection establishment

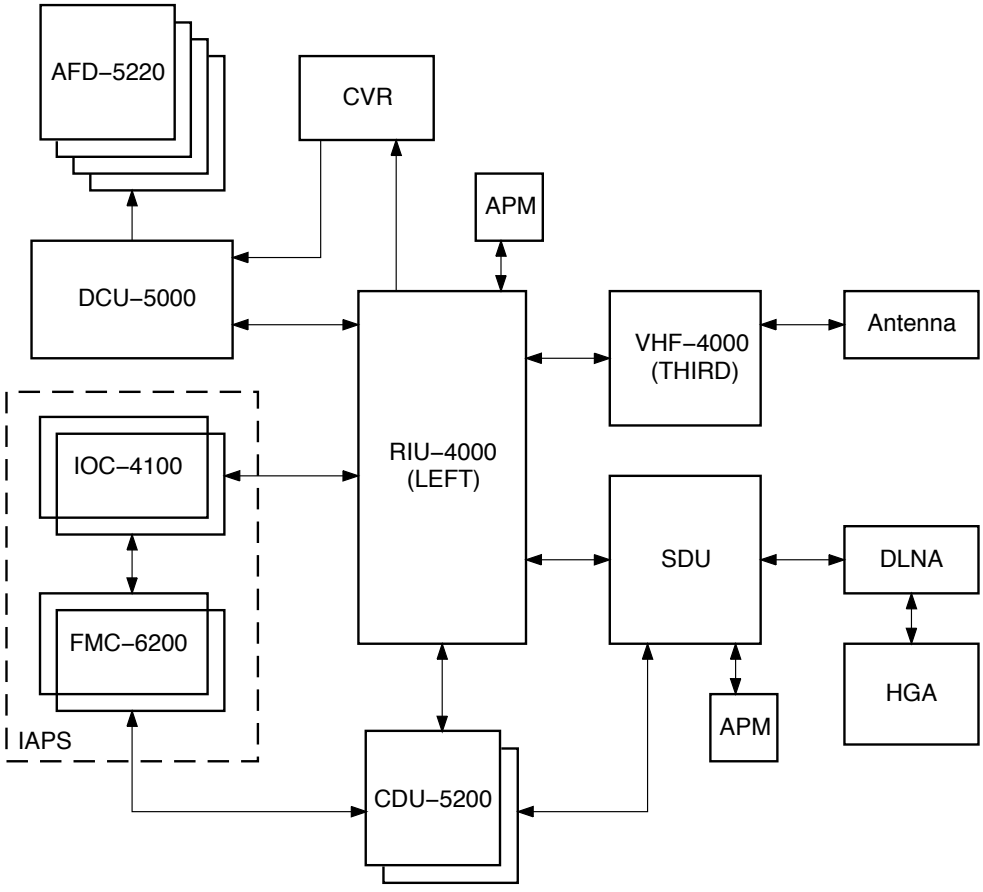
**ADS Operations:**

- Automatic downlinked reports
- ATS contract establishment
- Information type specification
- Transmission condition definition

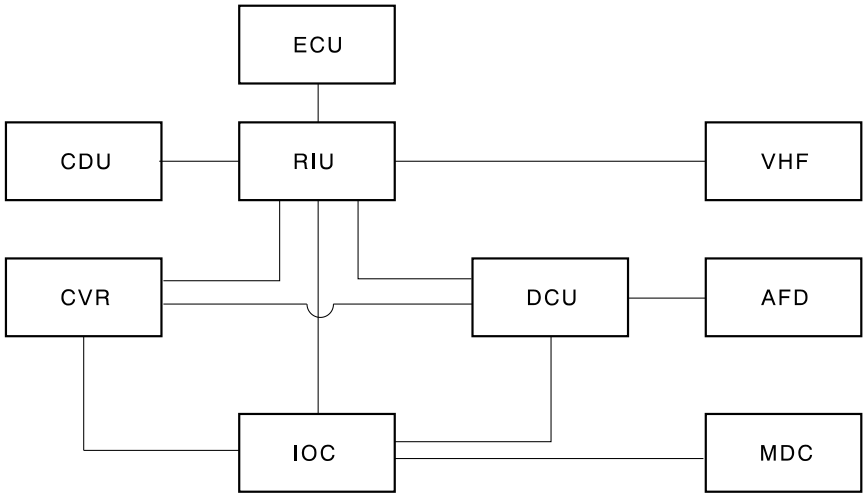
**CPDLC Features:**

- Text-based message exchange
- ATS/ATC/AOC communications
- Two data authorities maximum
- Current data authority (CDA) control

## FANS-1/A+ DATA LINK INTERFACE




## ATN DATA LINK SYSTEM ARCHITECTURE



### C. LINK 2000+ ATN (OPTIONAL)

European Commission mandated system enhancement.

**Service Capabilities:**

- Data link initiation capability (DLIC)
- ATC communications management (ACM)
- ATC clearance (ACL) services
- ATC microphone check (AMC)

**Frequency Management:**

- Multiple frequency attempts
- Automatic frequency switching
- Ground station commanded changes
- Communication continuity maintenance

### D. DATA LINK FEATURES

**Message Services:**

- Terminal weather uplink
- SIGMETS/AIRMETS reception
- Wind aloft reports
- Free text messaging
- Flight plan exchange
- Position report downlink
- Off/On reports
- Graphical weather (C23-403/406 options)
- DL SELCAL capability

## XI. PASSENGER ADDRESS SYSTEM

### A. SYSTEM INTEGRATION

**PA Capabilities:**

- Flight deck PA control
- Audio control panel interface
- Override of cabin entertainment
- Emergency announcement priority

### B. CABIN COMMUNICATION

**Optional System Features:**

- Private branch exchange network
- Nine active device capability
- Two air-to-ground channels
- UHF antenna connection
- Internal modem capability

### C. DIGITAL HANDSET

**Flight Compartment Equipment:**

- Backlit LCD display
- Telephone-style keypad
- Credit card reader
- Volume control buttons
- Call selection options

## XII. ADDITIONAL COMMUNICATION EQUIPMENT

### A. FLIGHT COMPARTMENT SPEAKERS

**Speaker System:**

- Two overhead speakers
- Individual volume control
- SPKR knob adjustment
- Push-in to deselect
- Warning audio override

### B. FLIGHT COMPARTMENT PRINTER (OPTIONAL)

**Printer Capabilities:**

- Copilot side console installation
- ARINC 429 interface
- Standard PC interface
- CAIMS maintenance printing
- DATALINK message printing
- Weather data printing
- Full format and graphic capability

### C. CABIN COMMUNICATION SYSTEM (OPTIONAL)

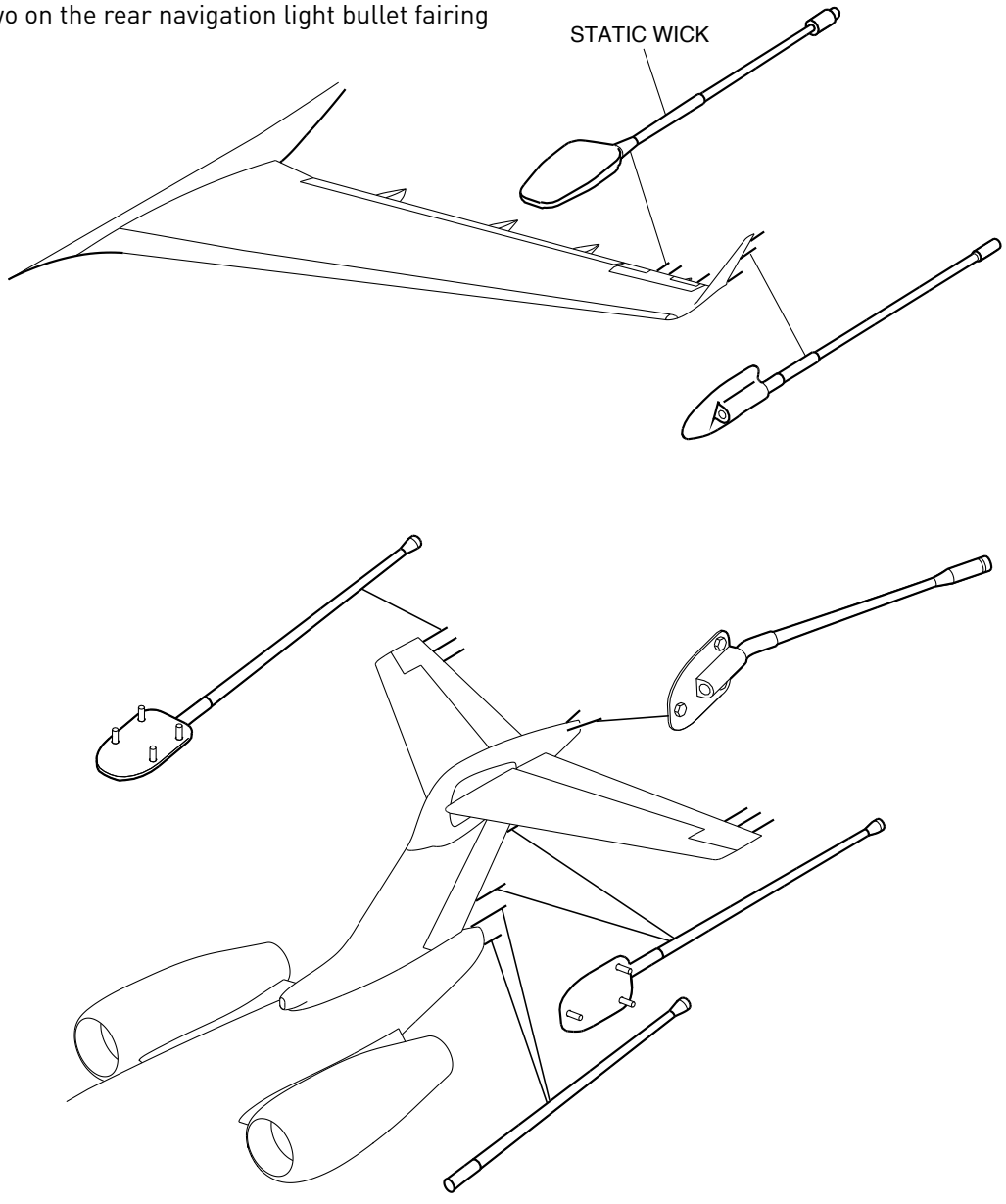
**Digital Radio Components:**

- One UHF antenna
- Duplexer unit
- Airborne radio telecommunication unit
- Basic telephone equipment
- SATCOM link connections
- FAX/modem/datalink support

## D. STATIC WICKS

**Reduces Radio Interference:**

- 24 Wicks installed on aircraft
- Three on each winglet/wingtip
- Three on each aileron
- Three on each elevator
- Two on the rudder
- Two on the tailcone
- Two on the rear navigation light bullet fairing




**STATIC WICKS**

# XIII. EICAS MESSAGES

## A. ADVISORY MESSAGES

### ADVISORY MESSAGES

Crew awareness required - May have associated tone

| Message | Meaning | Inhibits |
|---|---|---|
| ACARS MESSAGE | An airborne communications addressing and reporting system message has been received | TO/LAND |
| AFIS MESSAGE | An airborne flight information system message has been received | TO/LAND |
| CABIN CALL | A call has been made from the cabin | TO/LAND |
| CVR FAIL | The cockpit voice recorder has a fault or the CVR A429 input is faulty | TO/LAND |
| DATALINK ACARS | An ACARS datalink message has been received | TO/LAND |
| DATALINK ATN CPDLC | A CPDLC message has been received (Post FANS) | TO/LAND |
| DATALINK FAIL | The CMU has failed (Link 2000+ function) | TO/LAND |
| FANS 1/A FAIL | The CMU has failed (Post FANS) | TO/LAND |
| FANS CPDLC | A new CPDLC message has been received or an uncommanded loss of a CPDLC connection (Post FANS) | TO/LAND |
| FAX RECEIVED | A FAX has been received | TO/LAND |
| FDR FAIL | The flight data recorder has failed | TO/LAND |
| FDR FAULT | The longitudinal, lateral or normal acceleration parameters in the flight data recorder are inoperative | TO/LAND |
| LAV CALL | A call has been made from the lavatory | TO/LAND |
| SELCAL DATALINK | The SELCAL code has been received on DATALINK | TO/LAND |
| SELCAL HF 1 | The SELCAL code has been received on HF 1 | TO/LAND |
| SELCAL HF 2 | The SELCAL code has been received on HF 2 | TO/LAND |
| SELCAL VHF 1 | The SELCAL code has been received on VHF 1 | TO/LAND |
| SELCAL VHF 2 | The SELCAL code has been received on VHF 2 | TO/LAND |
| SELCAL VHF 3 | The SELCAL code has been received on VHF 3 | TO/LAND |

Note: All ACARS, DATALINK, CPDLC and SECAL are accompanied by an aural chime or voice.

### B. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **ELT ON** | The emergency locator transmitter is transmitting |

## XIV. LIMITATIONS

Operating Limitations

| Parameter | Limitation |
|---|---|
| VHF Operating Temperature | -55°C to +70°C |
| HF Maximum Power Output | 200 watts |
| SATCOM Operating Altitude | Sea level to 51,000 ft |
| CVR Operating Temperature | -55°C to +70°C |
| FDR Operating Temperature | -55°C to +70°C |
| ELT Operating Temperature | -40°C to +55°C |
| Maximum SATCOM Antenna Speed | 350 KIAS |
| HF Antenna Operating Speed | No limitation |
| Data Link Maximum Altitude | 51,000 ft |

Time Limitations

| System | Time |
|---|---|
| CVR Test | Maximum 5 minutes continuous |
| HF Transmission | 1 minute transmit, 4 minutes receive |
| SATCOM Voice | No limitation |
| SATCOM Data | No limitation |
| ELT Manual Test | 5 seconds maximum during first 5 minutes of any hour |

Note: These limitations are equipment manufacturer limitation are not AFM Limitations.

## XV. CIRCUIT BREAKERS

Communications System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| COM 1 | LEFT ESS | CB1-B2 |
| COM 2 | RIGHT MAIN | CB2-B2 |
| COM 3 (DATA LINK VHF 3) | LEFT MAIN | CB3-E2 |
| CVR | LEFT MAIN | CB1-D6 |
| ELT/NAV | LEFT ESS | CB3-D4 |
| FDR | RIGHT ESS | CB2-D7 |
| FLIGHT PHONE | RIGHT MAIN | CB4-F5 |
| HF | LEFT MAIN | CB1-B3 |
| SATCOM | RIGHT MAIN | CB6-A2 |

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## XVI. QUIZ

1. What is the VHF communication frequency range?

A) 108.00 - 117.95 MHz
B) 118.000 - 136.991 MHz
C) 121.50 - 135.975 MHz
D) 108.00 - 136.991 MHz

2. How many channels of audio does the CVR record?

A) 2
B) 3
C) 4
D) 5

3. What is the recording duration of the CVR?

A) 30 minutes
B) 60 minutes
C) 90 minutes
D) 120 minutes

4. Where is the area microphone located?

A) Center pedestal
B) Above liquid compass on windshield center post
C) Overhead panel
D) Behind copilot seat

5. What are the three transmission frequencies of the ELT?

A) 121.5 MHz, 243.0 MHz, 406.025 MHz
B) 118.0 MHz, 243.0 MHz, 406.0 MHz
C) 121.5 MHz, 246.0 MHz, 406.0 MHz
D) 125.5 MHz, 243.0 MHz, 408.025 MHz

6. What is the normal position for the ELT switch?

A) ON
B) OFF
C) ARM
D) RESET

7. How many hours of flight data does the FDR record?

A) 10 hours
B) 15 hours
C) 20 hours
D) 25 hours

8. What is the SATCOM coverage latitude range?

A) 60° North to 60° South
B) 70° North to 70° South
C) 75° North to 75° South
D) 80° North to 80° South

9. What is the HF radio frequency range?

A) 1.5 - 25.0 MHz
B) 2.0 - 29.9999 MHz
C) 3.0 - 30.0 MHz
D) 2.5 - 28.5 MHz

10. How many communication channels does the HF radio have?

A) 180,000
B) 220,000
C) 250,000
D) 280,000

11. What is the maximum HF tuning time?

A) 3 seconds
B) 4 seconds
C) 5 seconds
D) 6 seconds

12. What conditions must be met to erase the CVR?

A) Aircraft on ground only
B) Aircraft on ground and parking brake set
C) Aircraft on ground, hydraulics pressurized, and parking brake set
D) Aircraft on ground and engines shut down

13. How long can the ULD transmit after activation?

A) 15 days
B) 20 days
C) 25 days
D) 30 days

14. What is the minimum number of SATCOM channels required?

A) 2
B) 3
C) 4
D) 6

15. Where is the HF receiver/transmitter located?

A) Forward equipment bay
B) Aft equipment bay
C) Nose compartment
D) Avionics rack

16. What does the VOICE position on the VOICE/ID/BOTH switch do?

A) Allows voice transmission only
B) Filters out morse code identifier
C) Enables voice recording
D) Activates voice warnings

17. What is the altitude at which satellites orbit for SATCOM?

A) 18,500 mi
B) 20,000 mi
C) 22,300 mi
D) 25,000 mi

18. How many VHF radios are standard on the Challenger 350?

A) 1
B) 2
C) 3
D) 4

19. What does CPDLC stand for?

A) Controller Pilot Data Link Communications
B) Controlled Pilot Digital Link Communications
C) Controller Pilot Digital Link Connection
D) Controlled Pilot Data Link Connection

20. What power source is required for the datalink VHF 3 transceiver?

A) CB1 B4 COM 1
B) CB2 B4 COM 2
C) CB3 E2 COM 3
D) CB4 A2 COM 4

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CL-350



CL-350 TRAINING MANUAL

# AUTOMATIC FLIGHT CONTROL SYSTEM 17

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# AUTOMATIC FLIGHT CONTROL SYSTEM

## I. INTRODUCTION

The Automatic Flight Control System (AFCS) provides automated aircraft flight path control through steering commands via flight director displays or automatic flight control through the autopilot system. The system consists of dual independent flight directors, a two-axis autopilot controlling pitch and roll, and a single-axis yaw damper that work together to reduce pilot workload. The AFCS interfaces with the Integrated Avionics Processor System (IAPS) to receive data and provide flight guidance throughout all phases of flight.



### A. SYSTEM SPECIFICATIONS

Automatic Flight Control System Specifications

| Parameter | Specification |
|---|---|
| Flight Directors | Dual independent |
| Autopilot Type | Two-axis digital fail-passive |
| Autopilot Control | Pitch and roll only |
| Yaw Control | Single-axis yaw damper |
| Flight Guidance Computers | Two identical FGC cards |
| Minimum Engagement Altitude | 700 ft AGL |
| Maximum Operating Altitude | 45,000 ft |
| Approach Capability | Category I ILS |
| FGC Processor Location | Integrated Avionics Processor System |
| Pitch Trim | Automatic via horizontal stabilizer |
| Roll Trim | Left aileron tab only |
| Command Bar Display | Single cue or cross-pointer options |

# II. FLIGHT DIRECTORS

## A. SYSTEM DESCRIPTION

**Flight Director Features:**

- Display flight guidance cues on attitude indicators
- Command bars show desired pitch and roll attitudes
- Three operational modes: raw data (FD off), manual with FD, or coupled to autopilot
- Dual independent processing through FGC cards
- Each FD provides guidance to onside displays during precision approach and go-around modes
- Single FD provides guidance to both displays in other modes
- Transfer capability via XFR button on Flight Guidance Panel

## B. FLIGHT GUIDANCE COMPUTER UPGRADE (SB 350-22-001)

Aircraft incorporating Service Bulletin 350-22-001 receive enhanced FGC capabilities.

**Upgrade Improvements:**

- Reduced oscillations during trim operations
- FGC Lateral Mode activation to TO during Touch and Go operations
- LNAV arming enabled during takeoff
- Increased roll angle limit for LNVx Active Mode
- LNAV capture capability at 50 ft AGL

## C. OPERATIONAL CONSIDERATIONS

**ILS Approach Operations:**

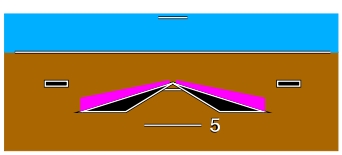
- Flight director vertical guidance gains dependent on radio altitude
- Category I requirements met with failed radio altimeter
- Degraded vertical guidance possible with inoperative RA
- Intermittent or incorrect RA readings may cause objectionable FD commands
- Manual flight with raw data recommended for RA anomalies

**EFFECTIVITY:**

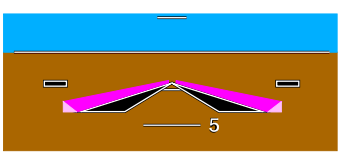
On airplanes 20664 and subsequent, and airplanes incorporating SB 350-34-012:

SINGLE CUE COMMAND BARS (V-BARS)

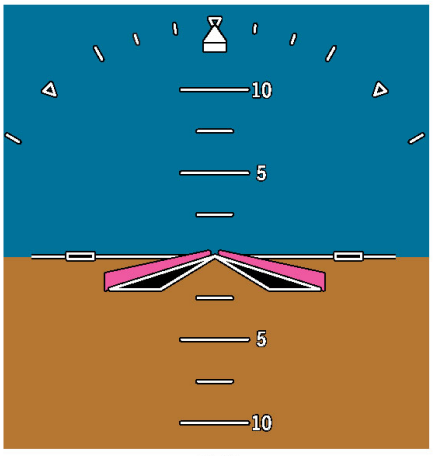
The flight director "V-Bars" display includes white triangles at the end of the "V-Bar". This modification improves tracking during certain precision operations.




V–BARS BEFORE VERSION 2.2



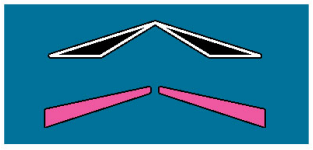

V–BARS WITH VERSION 2.2



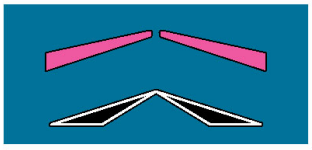

ADI



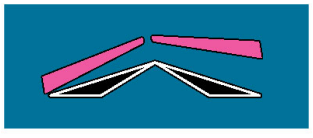
SINGLE CUE
DESIRED ATTITUDE



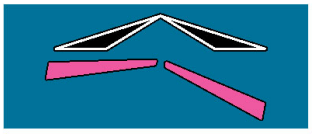
PITCH DOWN
COMMAND



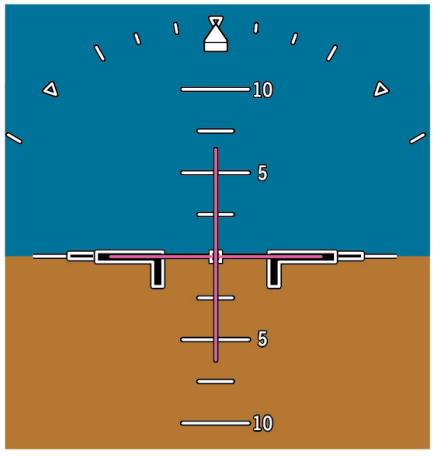
PITCH UP
COMMAND



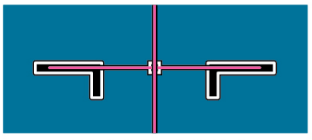
ROLL LEFT AND CLIMB
COMMAND



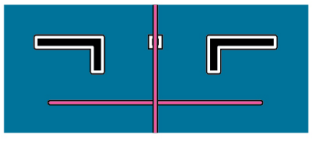
ROLL RIGHT AND DESCEND
COMMAND



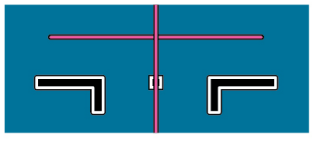

ADI



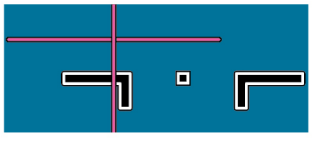
DOUBLE CUE
DESIRED ATTITUDE



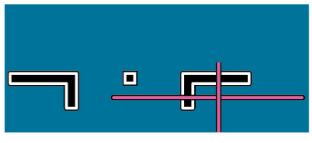
PITCH DOWN
COMMAND



PITCH UP
COMMAND



ROLL LEFT AND CLIMB
COMMAND



ROLL RIGHT AND DESCEND
COMMAND

# III. AUTOPILOT SYSTEM

The Challenger 350 is equipped with a two-axis digital fail-passive autopilot system, which operates as a component of the Automatic Flight Control System (AFCS). The system exhibits a high degree of functional integrity and is engineered to avoid catastrophic failure modes. Upon the occurrence of any single failure, the fail-passive autopilot will automatically disconnect in a manner that ensures safe continuation of flight without immediate crew intervention to recover control.

Specifically, the autopilot is designed not to cause any significant displacement of the aircraft from its path or result in altitude loss below the nominal glide path. Upon disengagement due to a failure, any resulting out-of-trim condition will be easily controlled by the pilot. The design ensures that no uncommanded actions occur within the flight control system that are not readily apparent to the pilot through control column movement or advisory display. Upon disconnect, a "Cavalry Charge" aural will sound. Two DCU disable switches located on the copilot aft bulkhead silence aural alerts.

## A. SYSTEM ARCHITECTURE

**Autopilot Components:**

- Aileron servo located on right aileron cable run
- Elevator servo located in left elevator cable run
- Both servos move interconnected control surfaces
- Automatic pitch trim through horizontal stabilizer
- Yaw control provided by separate yaw damper system
- Dual FGCs – both required for autopilot operation
- Dual Air Data Computers
- Dual Inertial Reference Units
- Dual Input / Output Concentrators
- Data Concentration Unit

## B. ENGAGEMENT REQUIREMENTS

**Prerequisites for Autopilot Engagement:**

- Yaw damper must be operable
- Both FGCs must be serviceable
- Primary horizontal stabilizer trim channel engaged
- No faults detected in horizontal stabilizer trim system
- No significant aircraft instability present
- Engagement via AP switch on Flight Guidance Panel

## C. AUTOPILOT OPERATION

**Engagement Characteristics:**

- Both autopilot channels couple to onside FGC when engaged
- Green "AP" indication on PFD confirms engagement
- Control wheel synchronization switch allows FD synchronization
- AP/YD DISC switch provides disconnect capability
- Pressing AP switch when engaged causes disconnect

- AP/YD DISC, MSW, TO/GA, AP and YD switches all provide disconnect capability
- Utilizing Stab trim switch when engaged causes disconnect
- AP Automatically disconnects on STALL warning

**Servo Motor Function:**

- FGC directs pitch and roll commands to respective servos
- Aileron servo biases cables to move control surfaces
- Elevator servo moves both elevators when interconnected
- Out-of-trim conditions trigger horizontal stabilizer trim

## D. FAILURE PROTECTION

Upon any single failure, the autopilot will automatically disconnect in a manner that ensures safe continuation of flight without immediate crew intervention to recover control.

**Fail-Passive Autopilot, upon failure of the autopilot:**

- No significant displacement from approach path
- No altitude loss below nominal glide path
- No out-of-trim condition upon disconnection not easily controlled
- All control system actions readily apparent to pilot
- Control column movement or advisory display provides visual indication

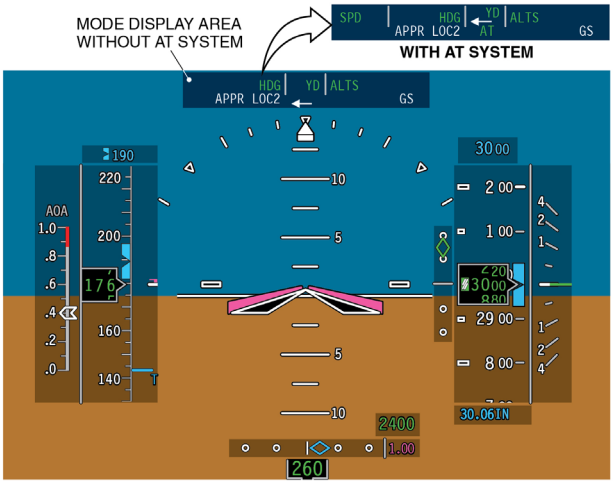
**Pitch Axis Uncommanded Motion:**

- Uncommanded motion results in Trim Clacker
- Push and hold MSW to disable pitch trim

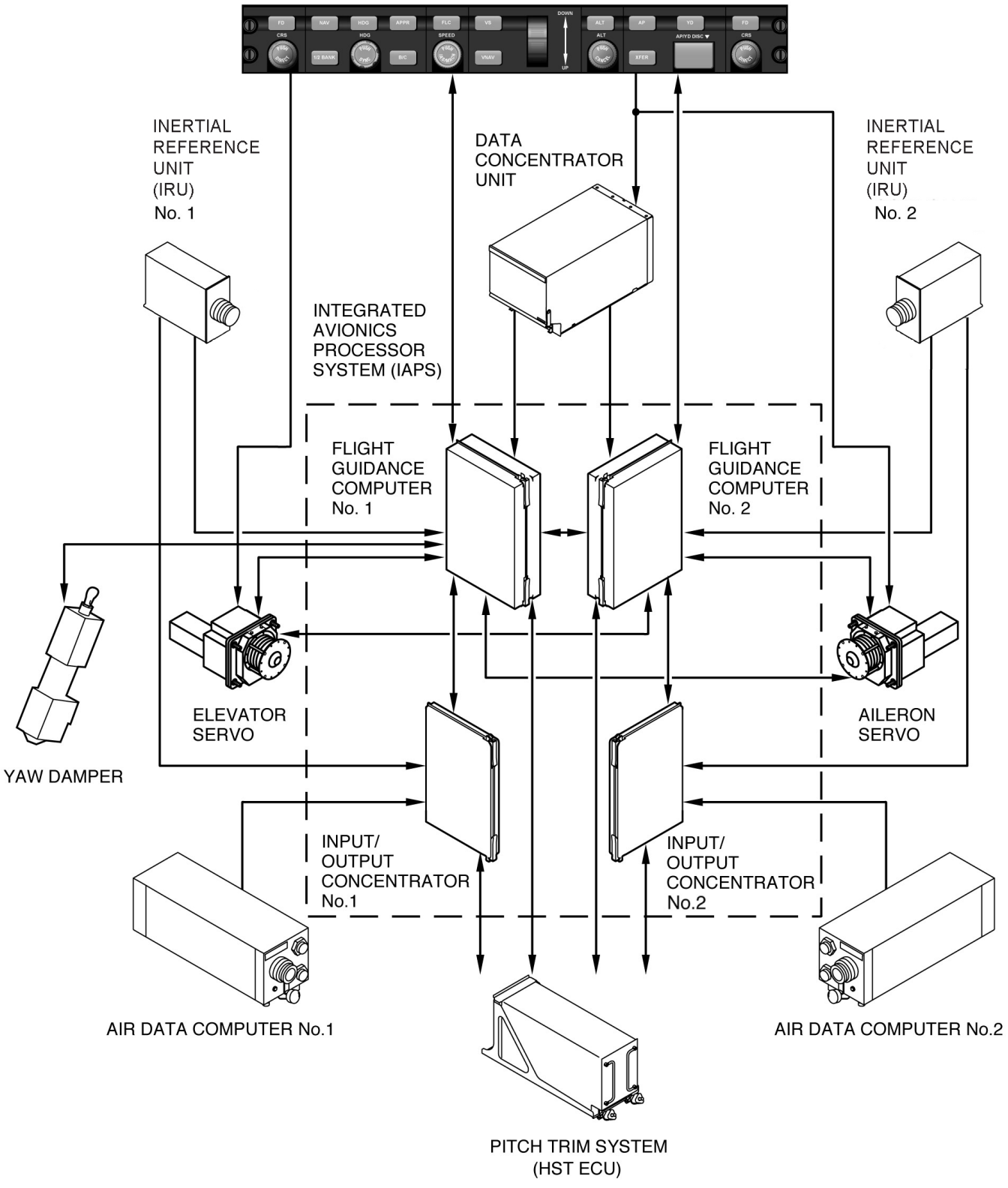
## E. FLIGHT GUIDANCE MODE DISPLAY AREA

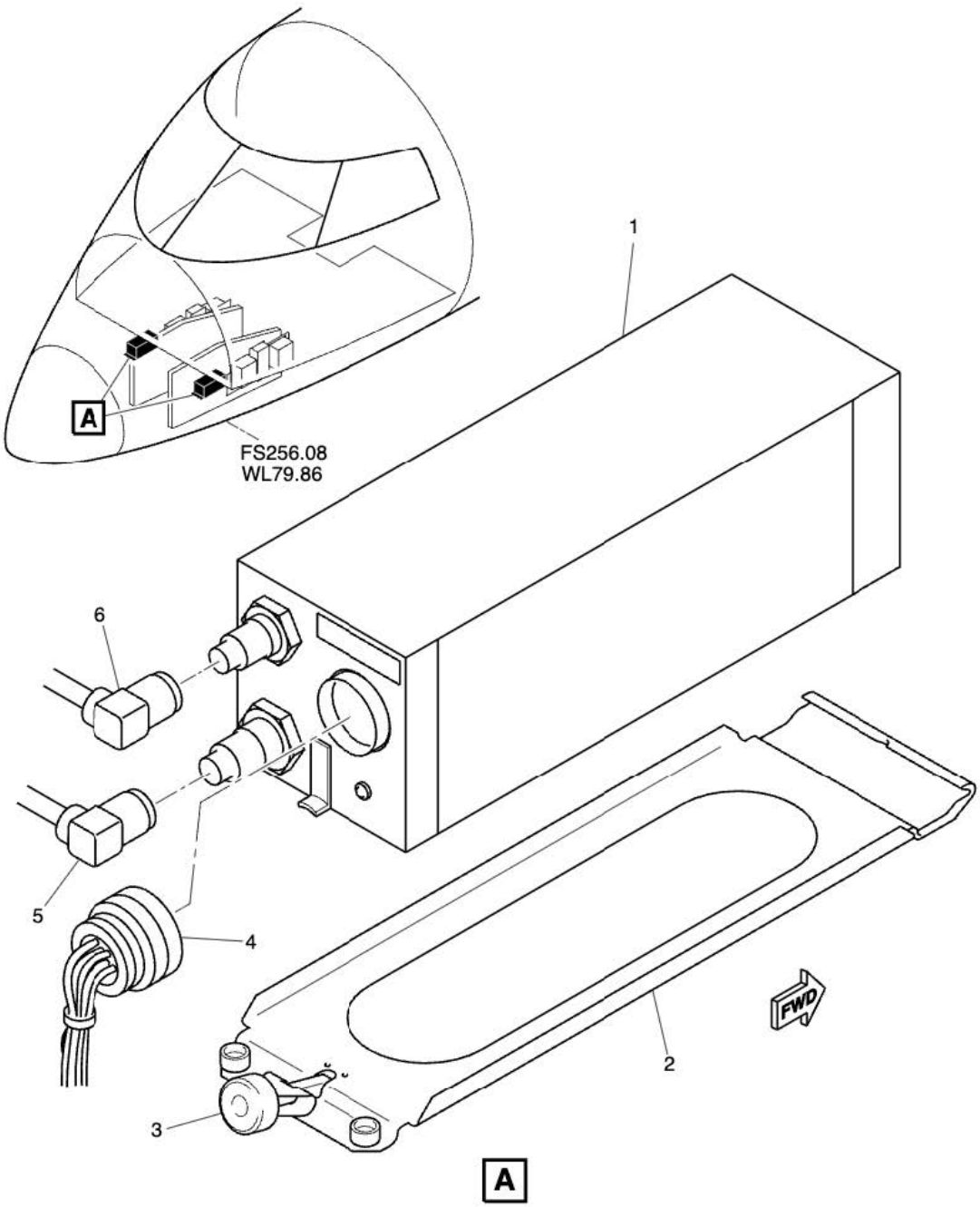
Lateral and vertical FD modes are presented in the flight mode annunciator display on each PFD. The flight guidance mode display area is located above the attitude indicator.

The mode display area is divided into three sections, separated by two gray vertical lines. The left section displays lateral modes. The center section displays the autopilot, yaw damper, and active flight director status. The right section displays vertical modes. Active modes are displayed in green on the top line, and armed modes are displayed in white on the bottom line.

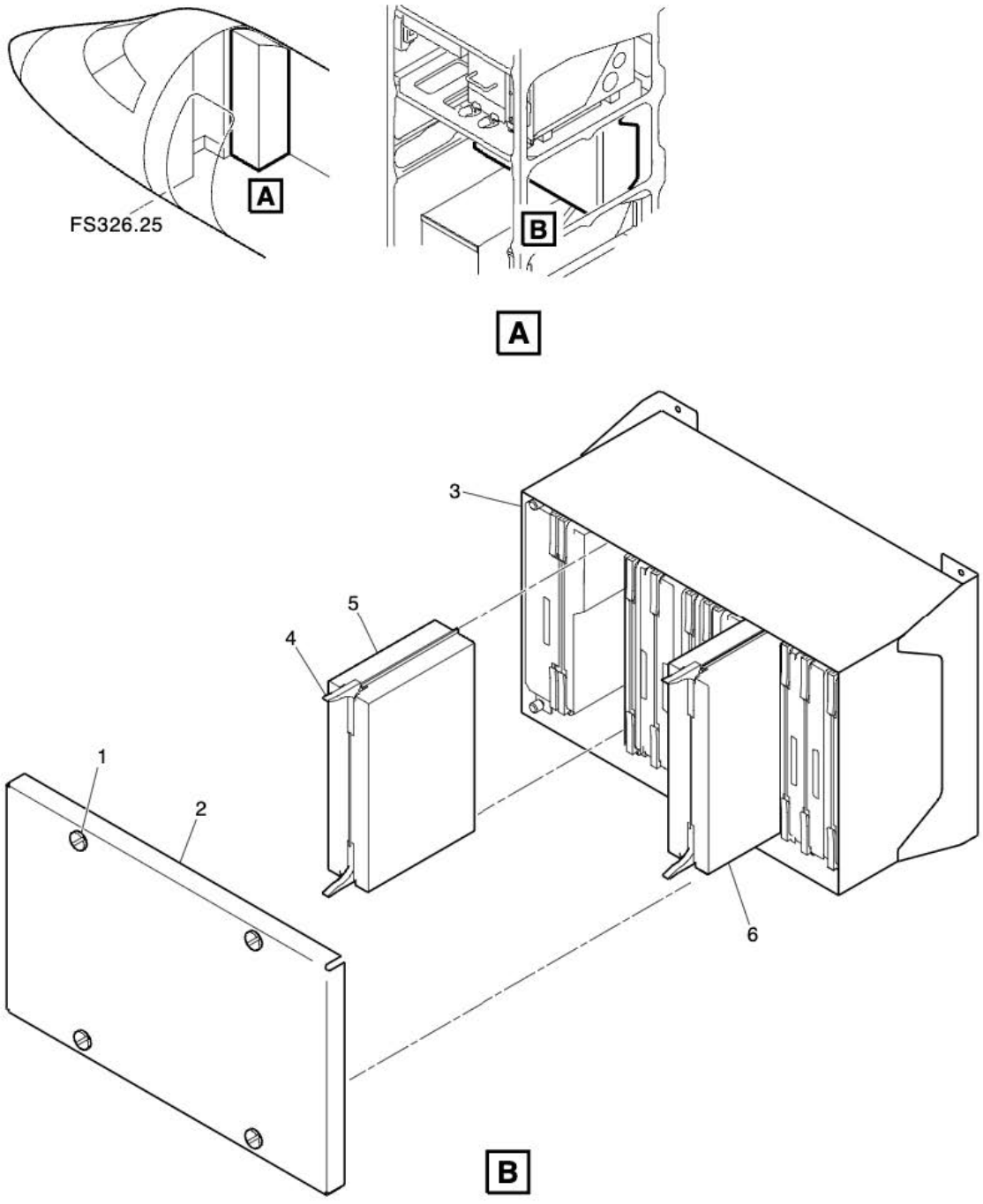


## FLIGHT GUIDANCE PANEL

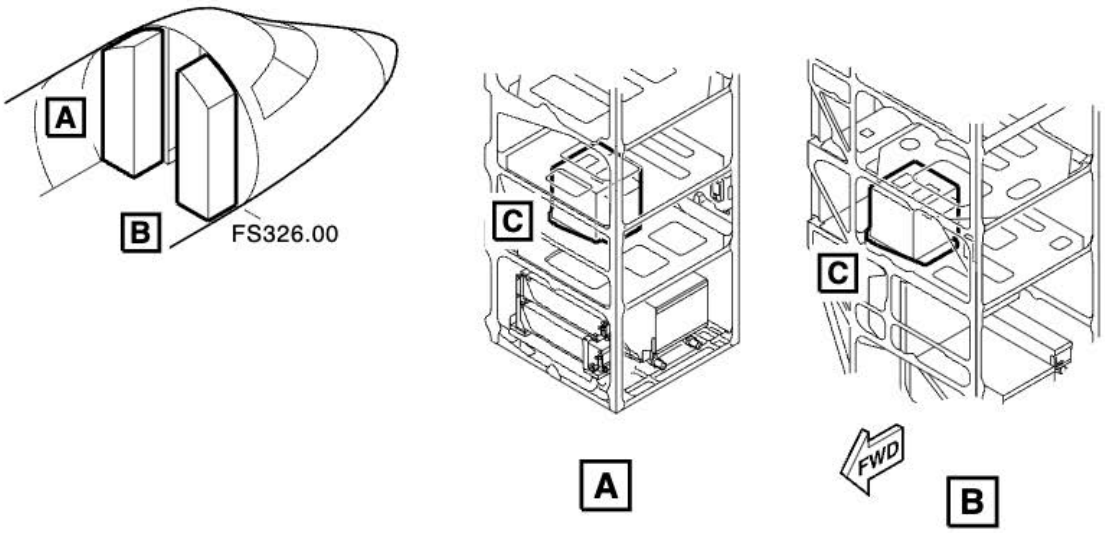


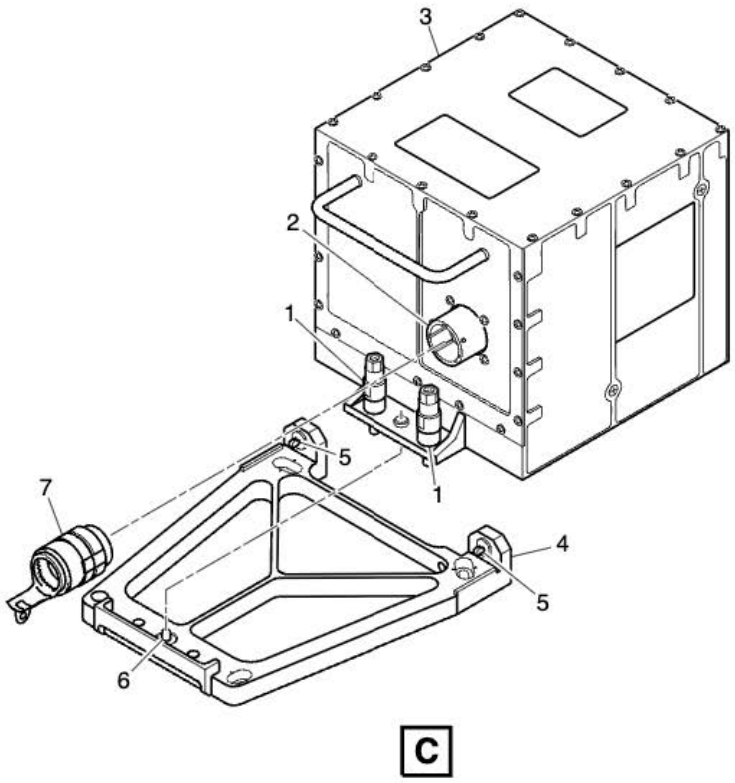



Air Data Computer – Removal/Installation

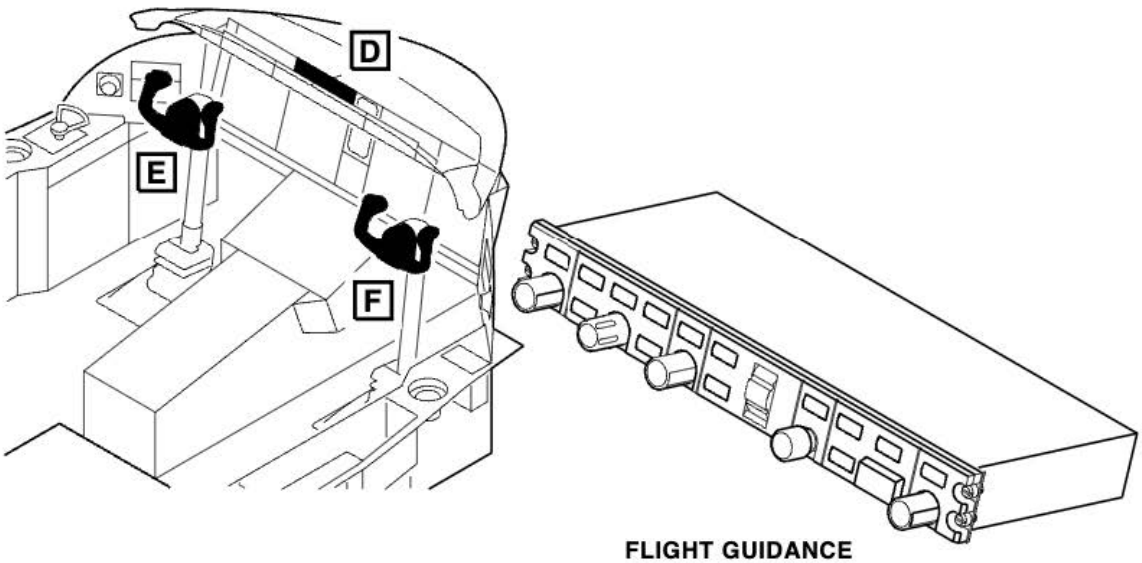



Flight Guidance Computer – Removal/Installation



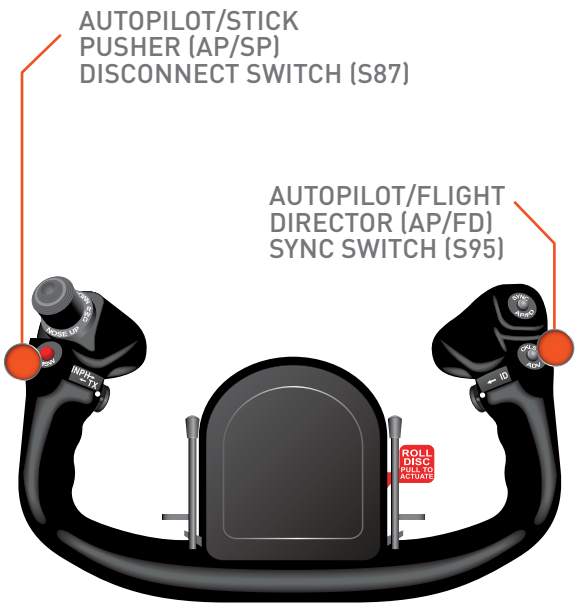




Inertial Reference Unit (IRU) – Removal/Installation



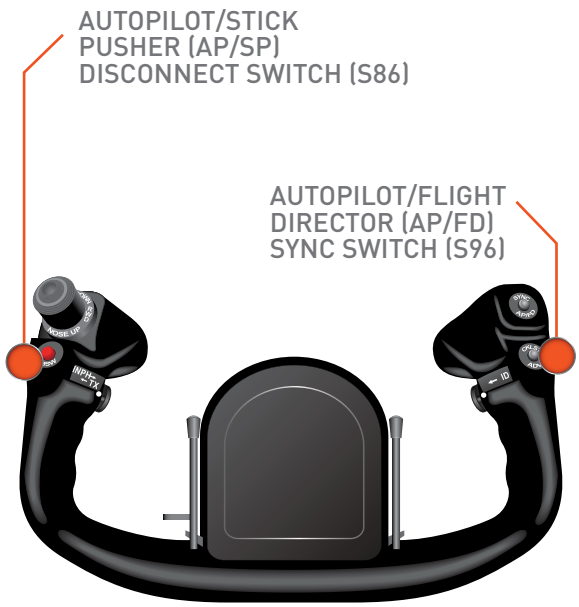

**FLIGHT GUIDANCE PANEL (FGP) (PL9)**

**D**



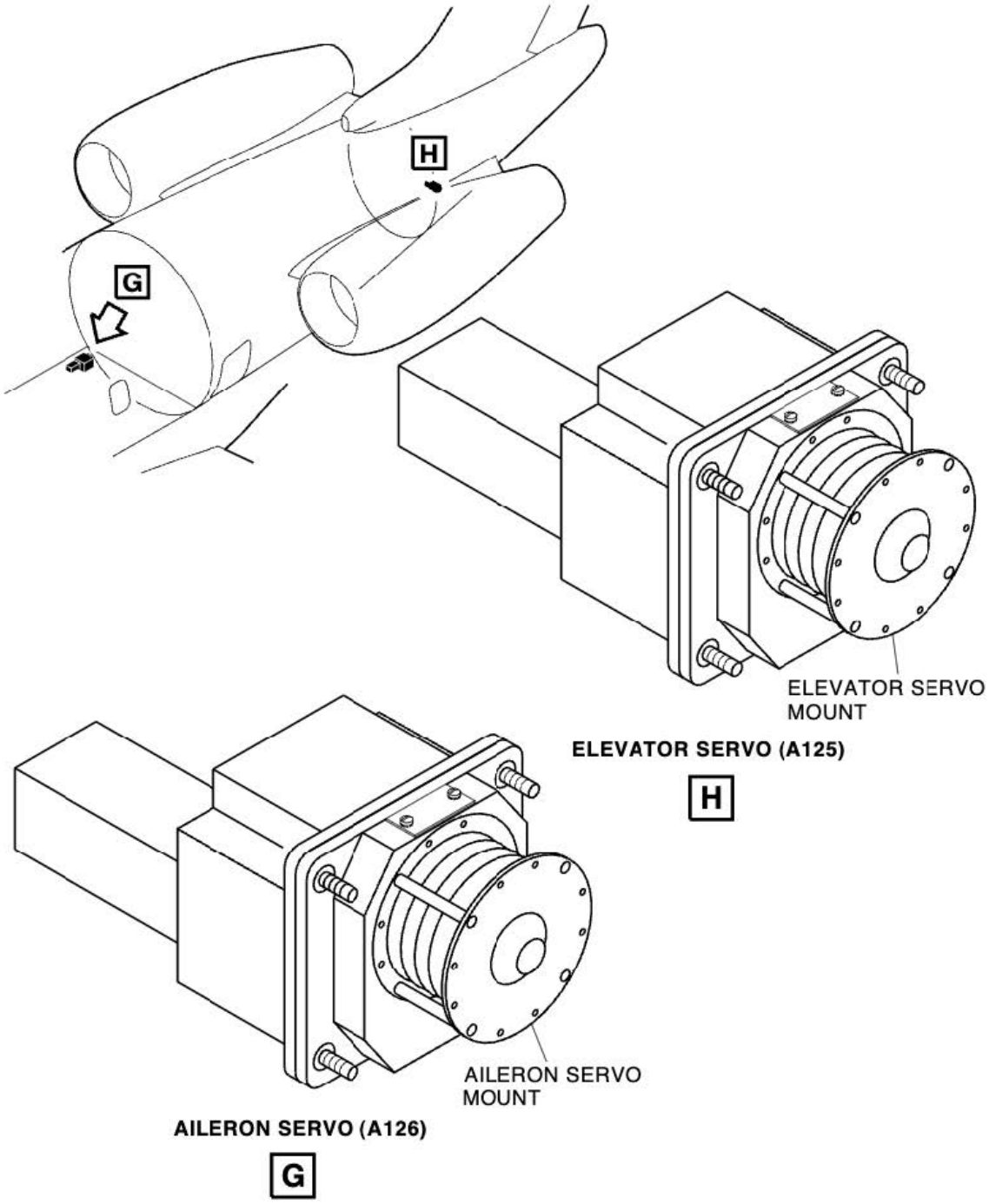

PILOT CONTROL YOKE

**E**




COPILOT CONTROL YOKE

**F**



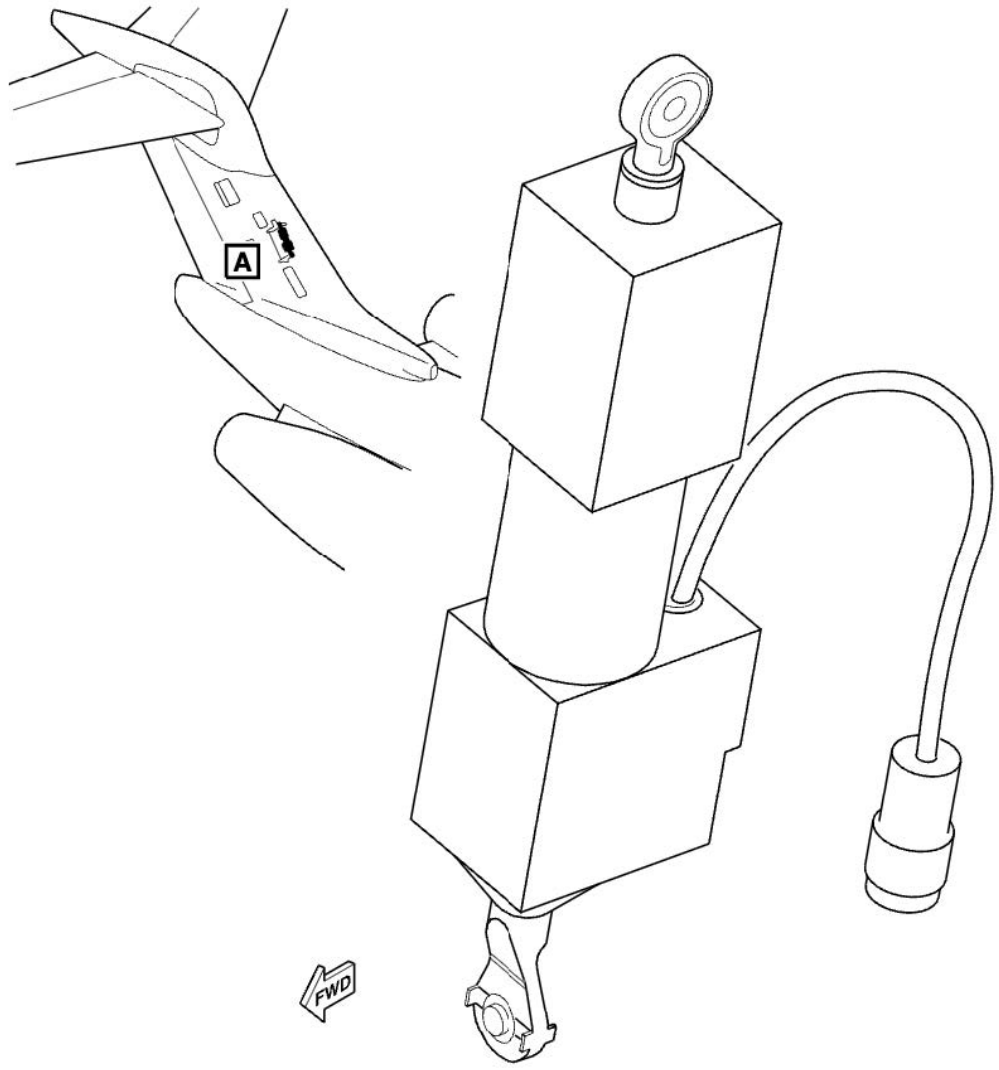

Automatic Flight–Control System (AFCS) – Component Location

# IV. YAW DAMPER

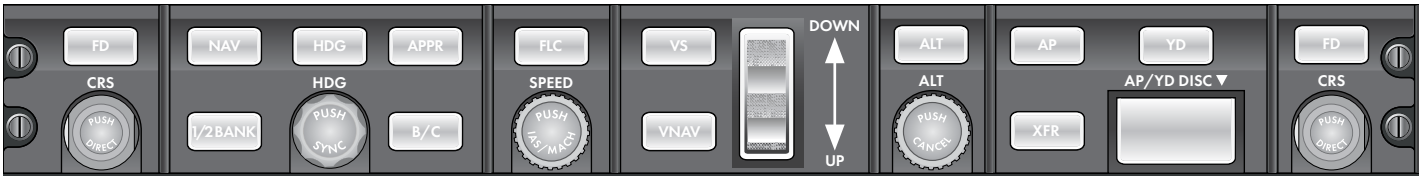
## A. SYSTEM FUNCTION

**Yaw Damper Features:**

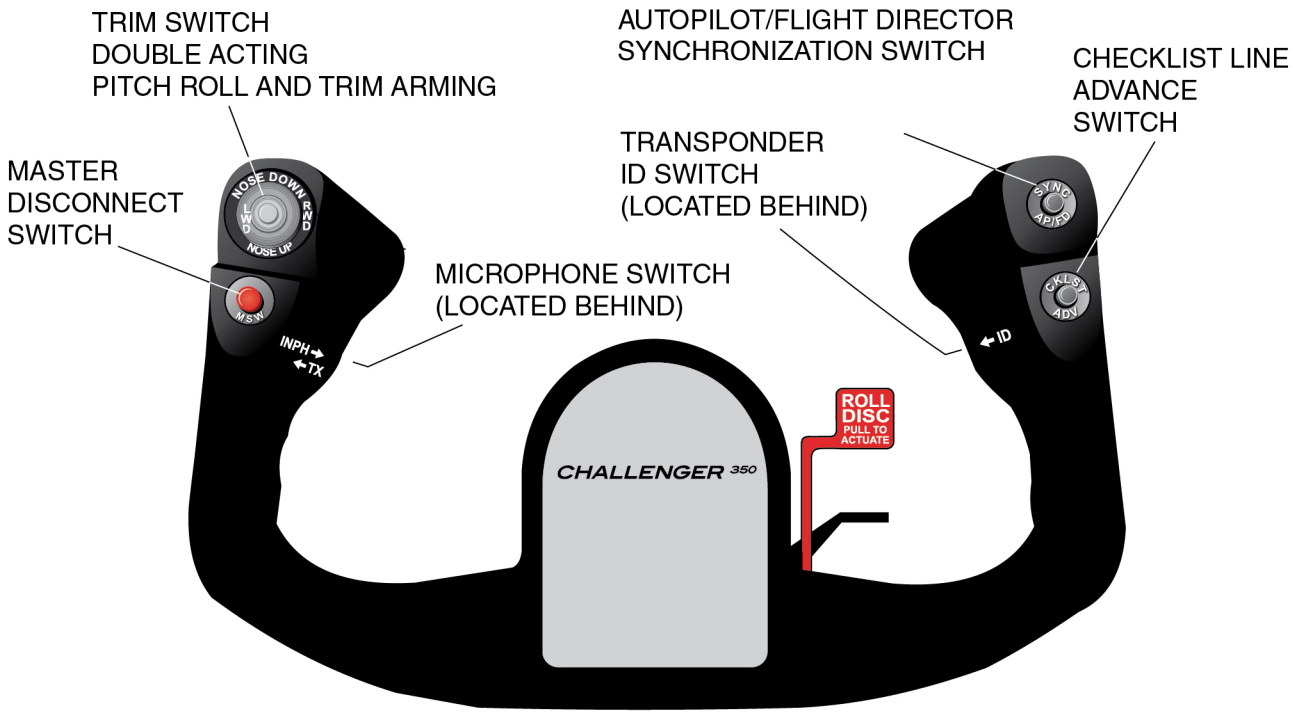
- Automatic yaw control during all flight phases
- Required for autopilot engagement
- Yaw damper required to be engaged on the ground for TO/GA mode
- Provides Dutch roll damping
- Operates through rudder control system
- Independent operation from autopilot pitch/roll functions



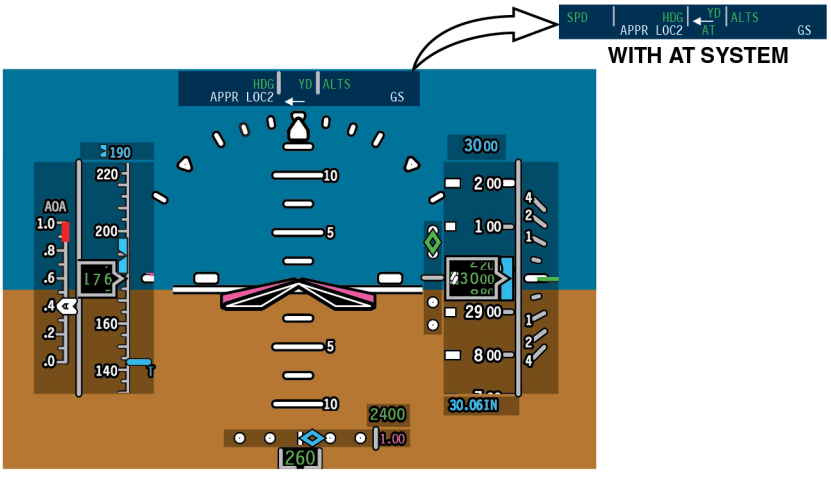

**YAW DAMPER**
**LINEAR–ACTUATOR (A127)**




**FLIGHT GUIDANCE PANEL**




**CONTROL WHEEL**




**ADI**

# V. FLIGHT GUIDANCE PANEL (FGP)

## A. PANEL DESCRIPTION

**FGP Controls:**

- AP switch for autopilot engagement/disengagement
- Onside FD switches for flight director control
- XFR button for flight director transfer
- Mode selection buttons for lateral and vertical guidance modes
- Speed, heading, altitude, course and vertical speed controls

## B. MODE ANNUNCIATIONS

**PFD Display Elements:**

- Flight Mode Annunciator (FMA) shows active and armed modes
- Command bars display flight director guidance
- Autopilot engagement status indication
- System malfunction annunciations
- White indicates armed modes
- Green indicates active modes

Note: It is prohibited to select the XFR button on the flight guidance panel while simultaneously making inputs on an FMS CDU.

# VI. CONTROL WHEEL INTERFACES

## A. AUTOPILOT SYNCHRONIZATION SWITCH

The Flight Director Synchronization feature, initiated by the AP/FD sync switch located on the side of each control wheel, provides the ability to synchronize the Automatic Flight Control System (AFCS) lateral and vertical references to the current flight conditions. If the Autopilot (AP) is disengaged, pressing the momentary SYNC switch sets the current flight values as the new reference for compatible modes, such as Roll, Heading, Pitch, Vertical Speed (VS), Altitude Hold, or Flight Level Change (FLC).

If the AP is engaged, pressing and holding the SYNC switch releases the aileron and elevator servo clutches, permitting the pilot to manually fly the aircraft without disconnecting the autopilot, and upon release, the AP smoothly resumes following the steering commands generated by the Flight Guidance Computer. During activation, the message SYNC displays in yellow above the upper left corner of the attitude display for a minimum of 3 seconds.

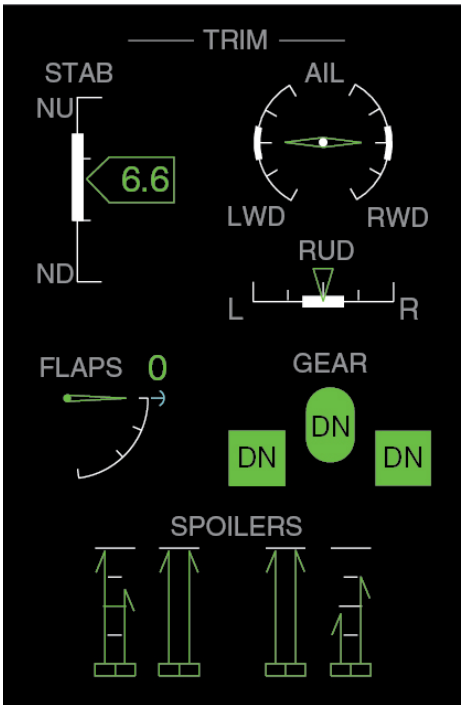
## B. MASTER DISCONNECT SWITCH (MSW)

- Red button on control wheels
- Primary autopilot disconnect method
- Also disconnects autothrottle if engaged (if installed)
- Provides tactile feedback on activation

### C. TRIM SWITCHES

**Control Wheel Trim Controls:**

- Pitch/Roll trim switch for manual trim inputs
- Disconnects autopilot when activated




## VII. FLIGHT CONTROL SYSTEM TRIM

### A. HORIZONTAL STABILIZER TRIM

**Pitch Trim Features:**

- Primary and secondary trim channels
- Autopilot requires primary channel operation
- FGC signals trim control unit for repositioning
- Out-of-trim conditions automatically corrected
- Manual electric trim override capability

### B. MACH TRIM

Compensates for aerodynamic center shift with speed changes when autopilot is not engaged.

**Mach Trim Operation:**

- Air Data Computers provide Mach data
- Active when autopilot is disengaged
- Slight nose-up trim for speed increase stability
- Slight nose-down trim for speed decrease stability
- Continuously monitored with **MACH TRIM** (C) CAS display

### C. AILERON TRIM

**Roll Trim System:**

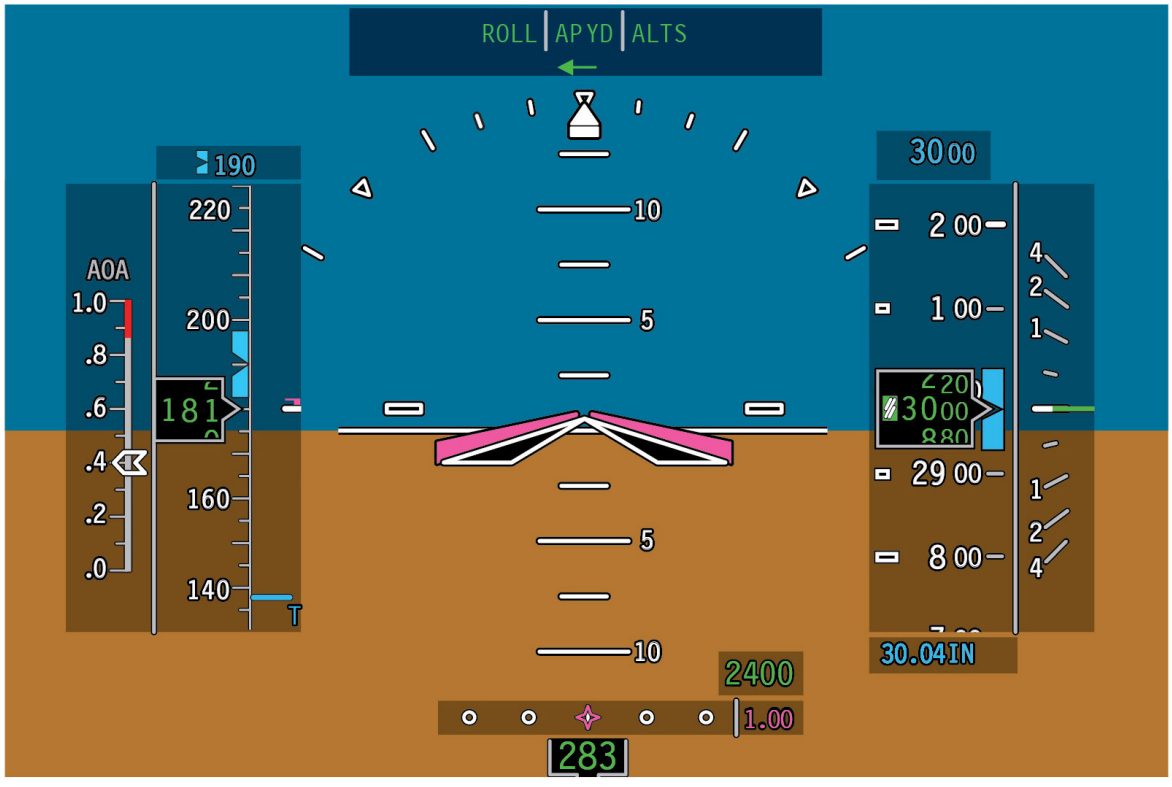
- Left aileron trim tab only
- Electromechanical actuator operation
- Reduces control forces for sustained turns
- Trim position displayed on EICAS synoptic page
- **CONFIG AILERON TRIM** (W) for improper setting

# VIII. LATERAL NAVIGATION MODES

## A. ROLL MODE

**ROLL Mode Characteristics:**

- Default mode when autopilot engaged with no lateral mode selected
- Holds existing heading when roll angle under 5°
- Holds roll angle when over 5° at mode selection
- Reference resets to current heading/roll on AP engagement
- Automatic reversion from NAV when source lost
- Green ROLL annunciation in active lateral field
- No effect from half bank mode on ROLL operation



## B. TAKEOFF MODE (TO)

**Lateral TO Mode Features:**

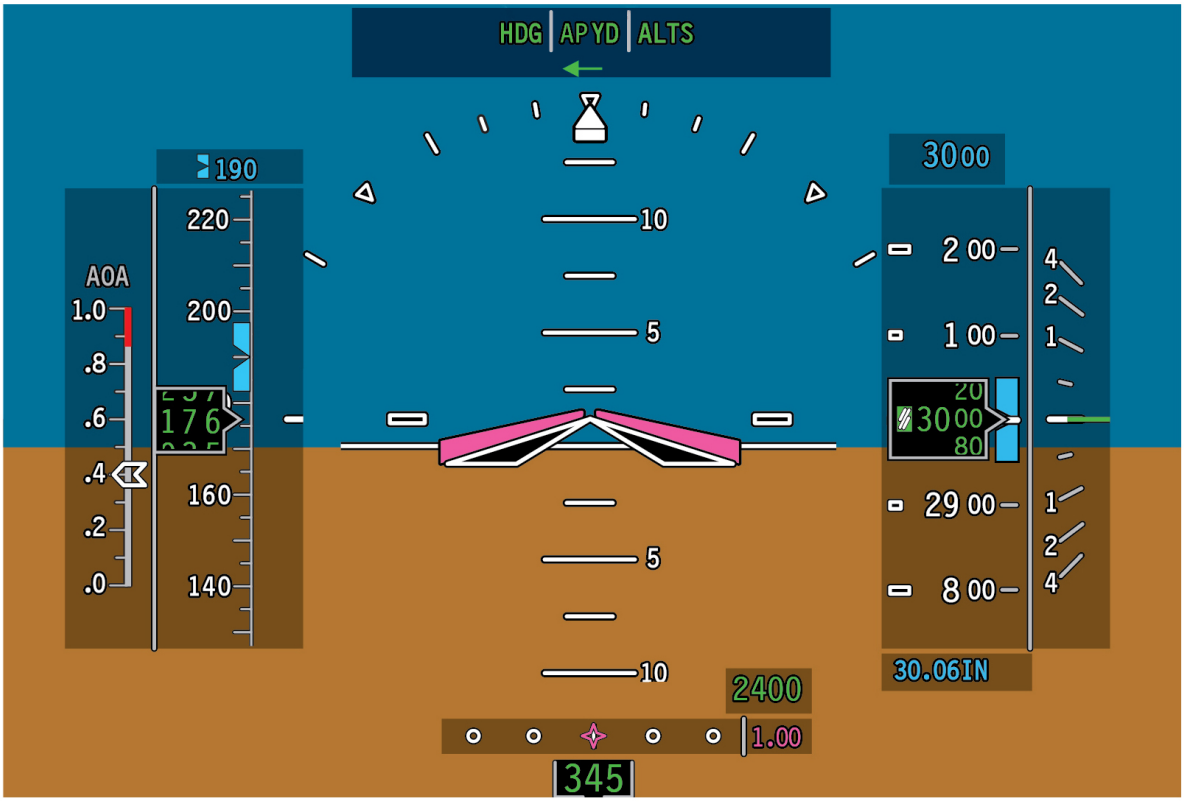
- Activated by TO/GA switches prior to takeoff
- Requires takeoff flap setting and V-speeds entered
- Generates heading hold command once airborne
- Based on aircraft heading at weight-off-wheels
- 5° bank angle authority for heading maintenance
- Green TO annunciation in active lateral field
- Cleared by other mode selection or altitude capture



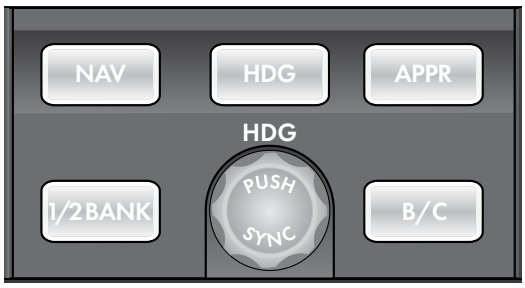
## C. HEADING MODE (HDG)

**HDG Mode Operation:**

- Selected by HDG button on FGP
- Heading bug and digital readout control
- Center push button synchronizes to current heading
- Commands turn in direction of bug movement
- Bank angle limited to 30° (15° in half bank)
- Green HDG annunciation in lateral capture field
- Deselected by HDG button press or other mode selection



## D. NAVIGATION MODE (NAV)




**NAV Mode Features:**

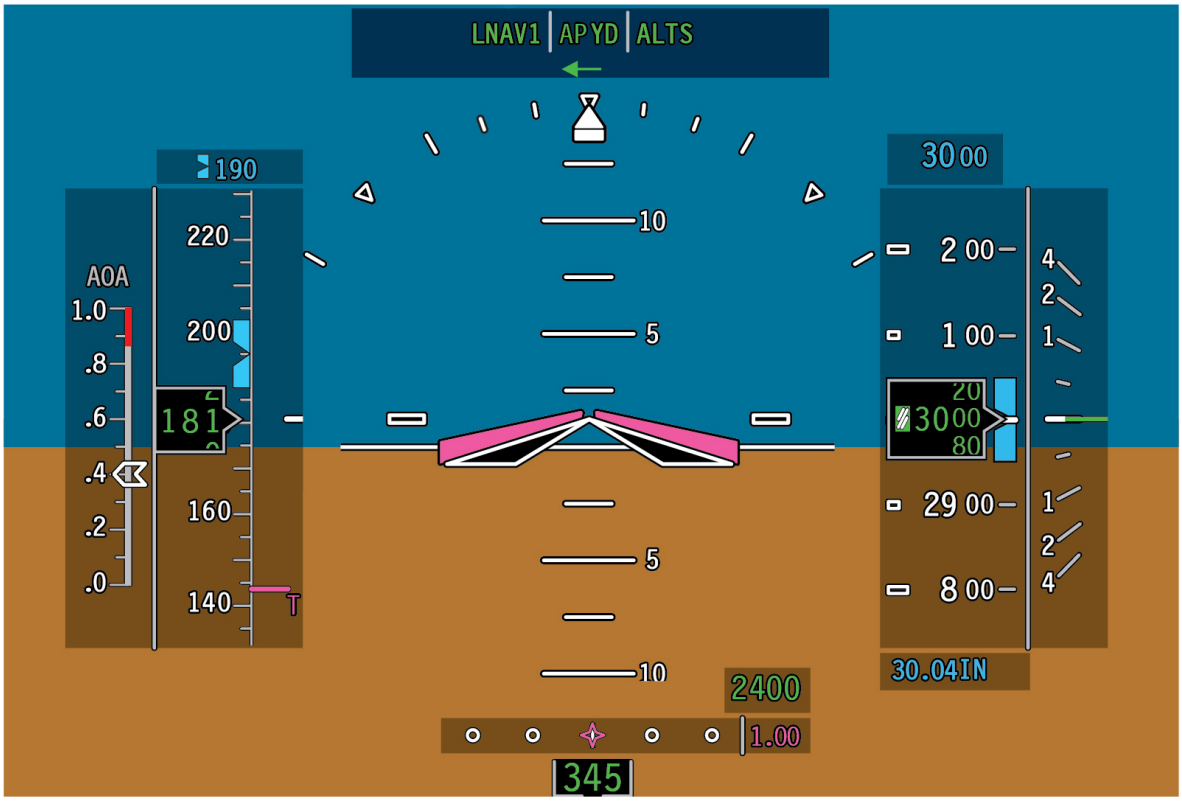
- Activated by NAV button on FGP
- Operates in heading mode prior to capture
- Capture point based on closure rate
- Clears heading select mode on capture
- Localizer capture also clears half bank mode

**NAV Sub-modes:**

- FMS navigation mode (FMS1, FMS2)
- VOR navigation mode (VOR1, VOR2)
- LOC mode (LOC1, LOC2)
- Back course mode capability
- Dead reckoning during VOR station passage
- Automatic NAV-to-NAV transition logic

**NAV Mode Annunciations:**

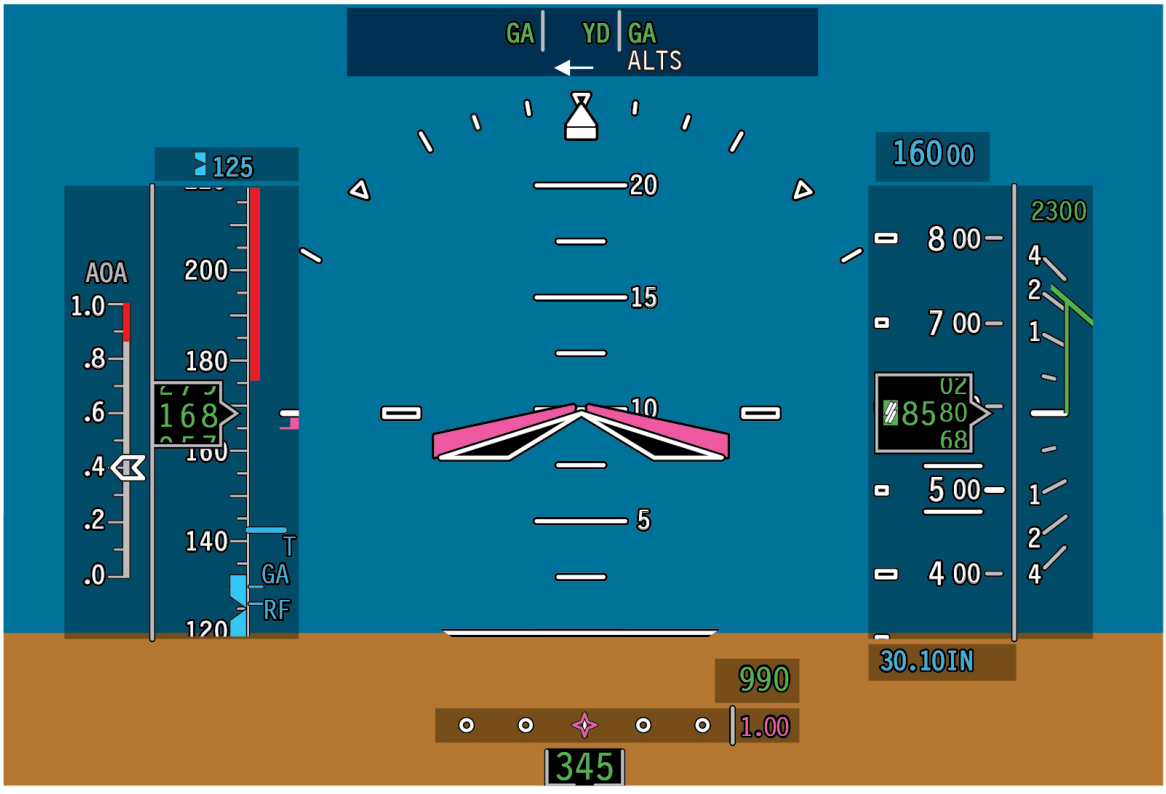
- White NAV source in lateral arm field when armed
- Green NAV source in lateral capture field when active
- Small green DR added during dead reckoning



## E. GO-AROUND MODE (GA)

**Lateral GA Mode Characteristics:**

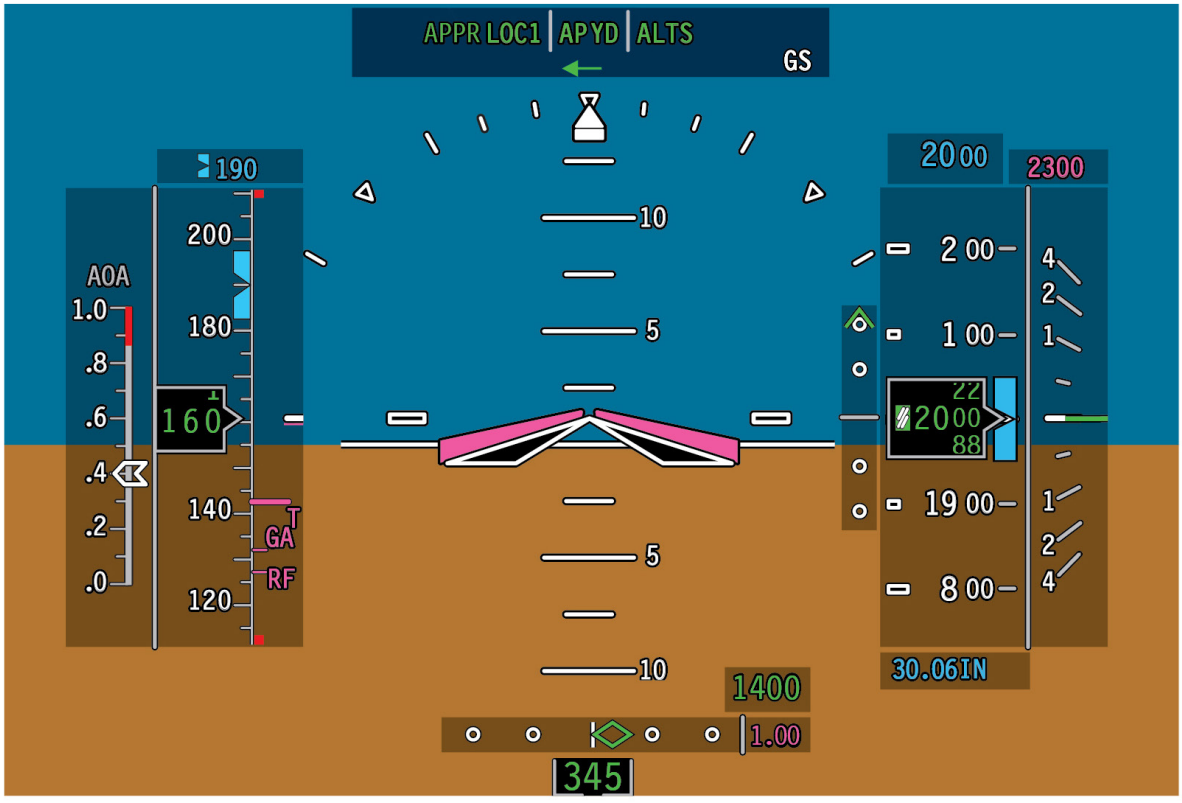
- Selected by TO/GA switches while airborne
- Wings level command initially – 5° bank angle authority for heading hold
- Dual-independent FD configuration
- Turns on both flight directors
- Disengages autopilot (maintains yaw damper)
- Clears all other lateral modes
- Green GA annunciation in lateral capture field
- Cleared by FD off, AP engagement, or other mode



## F. APPROACH MODE (APPR)

**APPR Mode Functions:**

- Selected by APPR button on FGP
- Used for all approaches regardless of NAV source
- Arms both localizer and glideslope modes
- Provides lateral steering for ILS and FMS approaches
- VOR approach with VOR frequency tuned
- ILS approach with ILS frequency tuned
- Automatic transition from armed to captured
- Green approach source annunciation when active



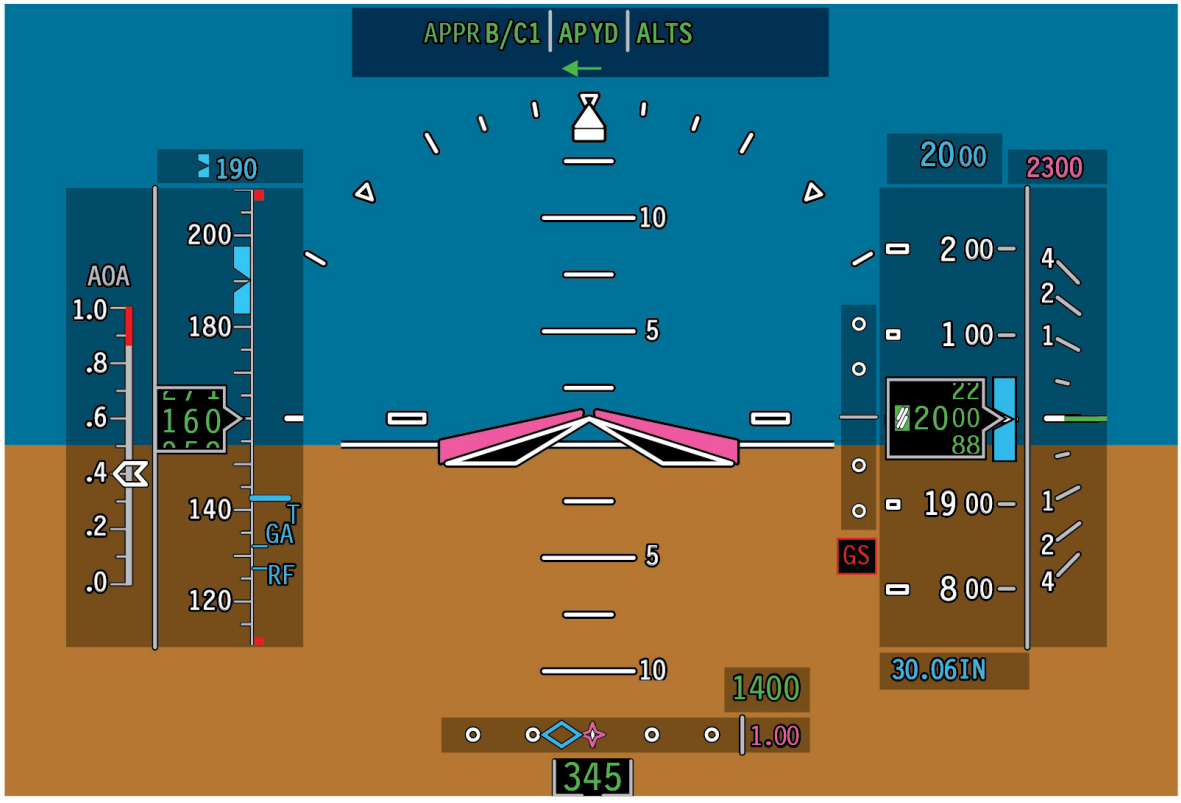
## G. BACK COURSE MODE (BC)

**BC Mode Operation:**

- Selected by B/C button on FGP
- Captures and tracks back course signal
- Arms for LOC capture if FMS tracking
- Clears half bank and heading modes on capture
- Green BC1 or BC2 in lateral capture field
- Green B/C in lateral arm field

**BC Mode Deselection:**

- B/C button press
- Another lateral mode selection
- Frequency change of navigation signal
- Preselect navigation source change



## H. HALF BANK MODE (1/2 BANK)

**Half Bank Features:**

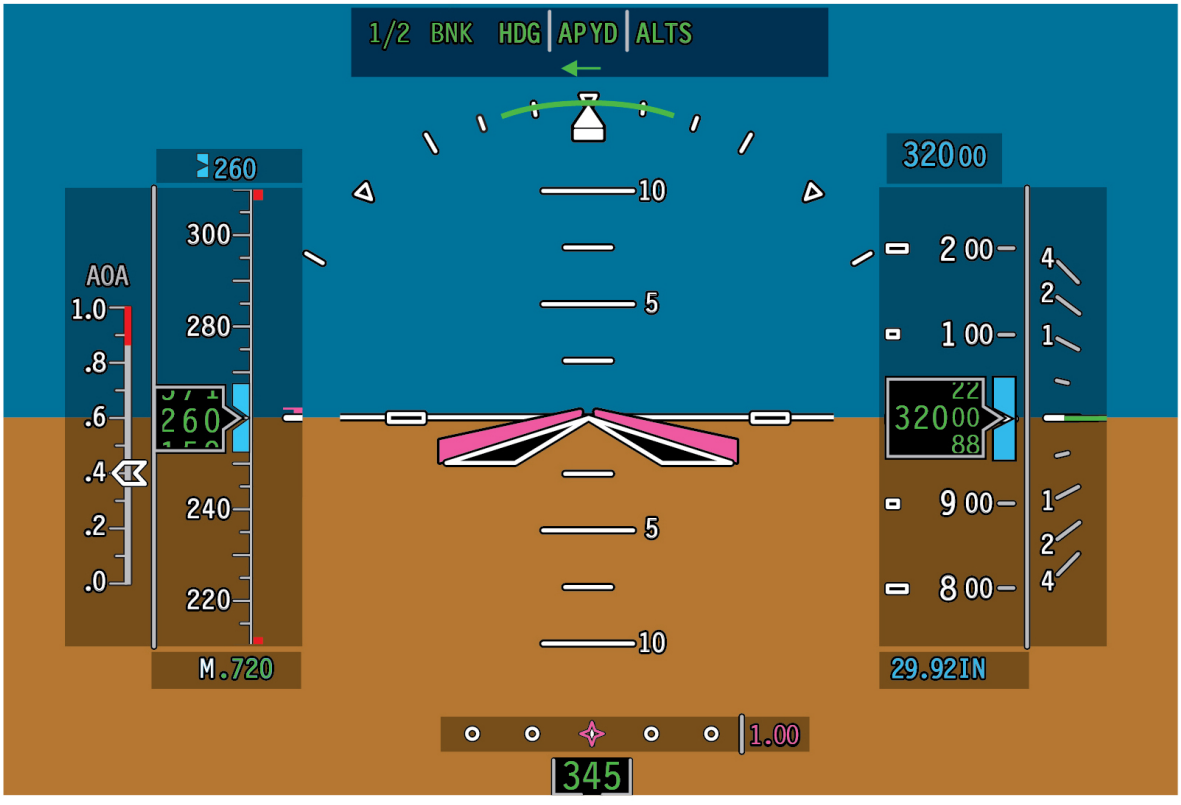
- Manually selected by 1/2 BANK button
- Automatically selected climbing through 31,600 ft
- Reduces maximum bank angle to 15°
- Green arc above roll scale (±15° marks)
- No effect on ROLL mode operation

**Half Bank Inhibitions:**

- Takeoff mode active
- Approach capture or track
- NAV capture or track in LOC
- Go-around mode active
- FMS lateral mode below 31,600 ft

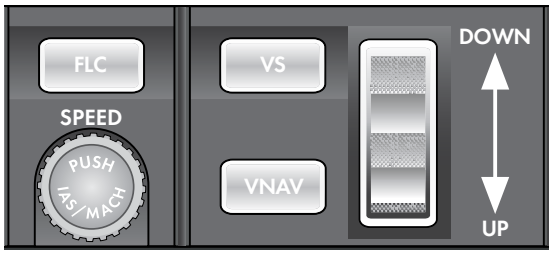
**Half Bank Deselection:**

- Manual deselection by button press
- Descending through 31,600 ft
- TO, GA, or approach capture
- Localizer capture



# IX. VERTICAL NAVIGATION MODES

## A. PITCH MODE (PTCH)

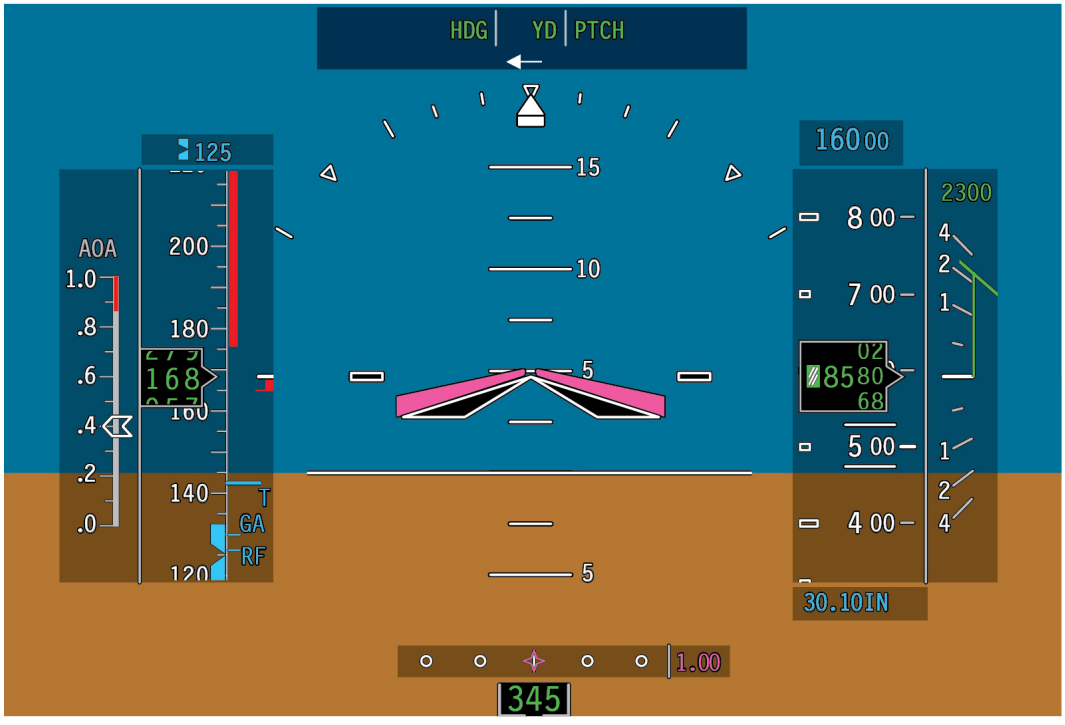



**Pitch Mode Activation:**

- Automatic when other vertical modes deselected
- Autopilot engaged with FD off
- Flight Director ON with no vertical mode selected
- SYNC button pressed in go-around mode
- GO-AROUND active and another lateral mode selected
- Coupled side changed while AP engaged or FD ON
- Preselect altitude changed during capture
- UP/DOWN wheel moved (except in VS, VGP capture or track, or overspeed)
- FMS selects pitch hold in VNAV mode

**Pitch Mode Operation:**

- Reference value changed by UP/DOWN wheel (0.5°/click)
- Reference resets to current pitch on AP engagement
- Deselected when another vertical mode captures
- Green PTCH annunciation in vertical capture field



## B. ALTITUDE MODES (ALT/ALTS/ALTS CAP)




**Altitude Hold (ALT):**

- Maintains current barometric altitude
- Activated by ALT button or automatic capture
- Deselected by FD off, other mode selection, or ALT button press
- Green ALT annunciation in vertical capture field

**Altitude Preselect (ALTS):**

- Arms capture of selected altitude
- Automatic transition to ALTS CAP near target
- White ALTS shown in vertical arm field

**Altitude Capture (ALTS CAP):**

- Active during altitude acquisition
- Transitions to ALT at capture
- Green ALTS CAP during capture phase

**Altitude Alert System:**

- Aural and visual indications of altitude capture and tracking
- Processes data from ADCs and is independent of Flight Director or autopilot modes
- Approximately 1,000 ft prior to altitude provides aural tone and flashing altitude preselect digits
- If the aircraft deviates more than 200 ft from selected altitude, altitude bugs flash and tone is produced
- At ± 1,000 ft deviation bugs flash amber and audible tones are produced



## C. TAKEOFF MODE (TO)

**TO Mode Features:**

- Selected by TO/GA switch with takeoff flaps
- Requires V2 and VR values entered
- Pitch command calculated from V-speeds
- Engine loss reduces pitch command appropriately
- Command bars removed if V-speeds not entered
- Green TO annunciation in active vertical field
- Requires YD to be engaged

## D. VERTICAL SPEED MODE (VS)

**VS Mode Operation:**

- Initial rate is sensed vertical speed at engagement
- UP/DOWN wheel adjusts reference (±100 ft/min per click)
- Maintains feet per minute rate
- Automatic altitude capture at preselected altitude
- Green VS annunciation in vertical capture field
- Range from -8,000 to +8,000 fpm



## E. FLIGHT LEVEL CHANGE (FLC)

**FLC Mode Functions:**

- Acquires and tracks IAS or Mach reference
- Speed adjusted via SPEED knob on FGP
- Synchronizes to current speed on selection
- Inhibited during vertical approach capture/track
- Can be selected by FMS in VNAV mode
- Deselected by FD off, other mode selection, or FLC button press
- Green FLC annunciation in vertical capture field

## F. OVERSPEED MODE

Automatic protection against excessive airspeed.

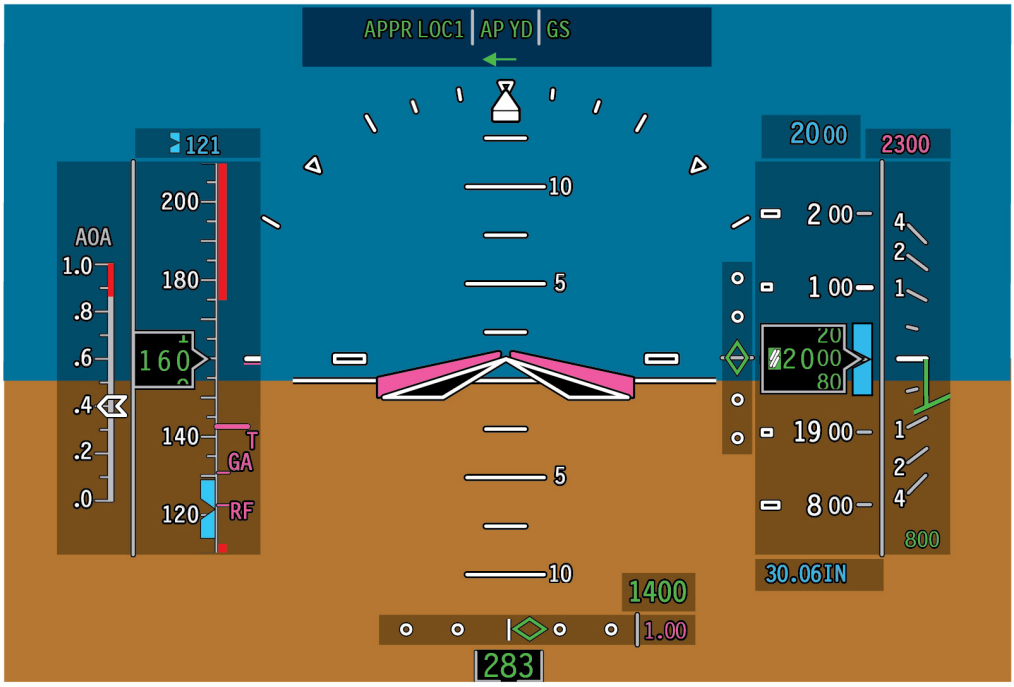
**Overspeed Protection:**

- Engages at Mach 0.845 indicated above transition altitude
- Engages 10 kt above VMO below transition altitude
- Overrides all modes except ALT hold and ALTS capture
- Automatically turns on flight directors
- Inhibits FD turn-off until another mode selected
- Commands speed reduction to below VMO/MMO
- Flashing amber FLC OSPD or VFLC OSPD annunciation

## G. GLIDESLOPE MODE (GS)

**GS Mode Features:**

- Arms with APPR button selection
- Captures ILS glideslope
- Dependent on radio altitude for gain adjustment
- Category I approach capability
- Automatic transition from armed to captured
- Green GS annunciation when captured
- Manual flight with raw data recommended for RA anomalies




## H. VERTICAL NAVIGATION (VNAV)

**VNAV Mode Characteristics:**

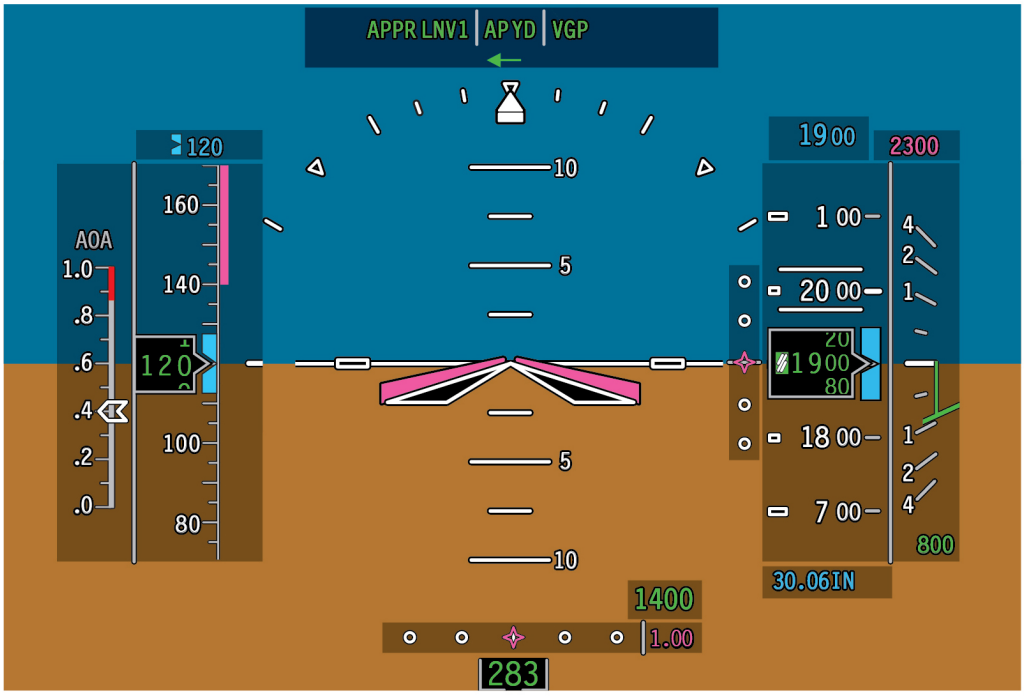
- FMS executes vertical flight plan
- Commands various FCS vertical modes
- Selected by VNAV button on FGP
- Requires onside FMS as active NAV source
- Inhibited during vertical approach capture with ILS
- Deselected by FD off, TO/GA selection, or source change
- Enables FMS vertical profile management

## I. VERTICAL GLIDEPATH (VGP)

FMS-computed vertical path tracking.

**VGP Mode Operation:**

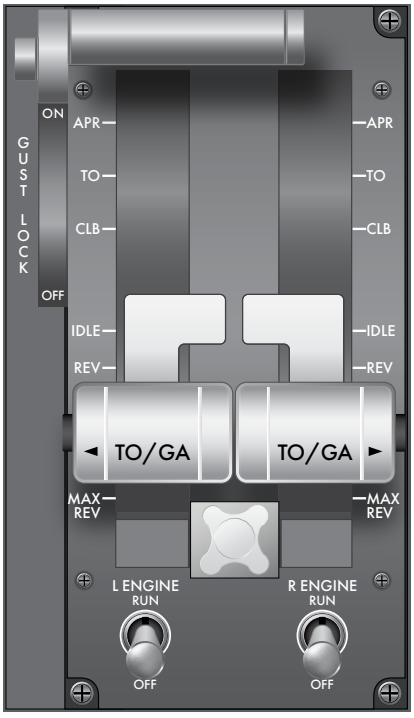
- Selected only by FMS automatically
- Requires VNAV mode and approach mode active
- FMS as active Nav source required
- No preselect Nav source active
- FMS VNAV must be valid
- No manual selection button on FGP
- Tracks FMS-defined vertical path
- Disables preselected altitude operation
- White GP armed, green VGP when captured




## J. GO-AROUND MODE (GA)

**GA Mode Features:**

- Selected by TO/GA switch while airborne
- Turns on both flight directors
- Disengages autopilot (maintains yaw damper)
- Clears all vertical modes except overspeed
- Dual-independent flight guidance configuration
- Generates 8° pitch up command
- Cleared by FD off, AP engagement, or other mode selection
- Green GA annunciation in capture fields



# X. PDF MESSAGES

PDF Messages

The following indications are presented on the PFD. A brief explanation of each indication is provided.

| # | Message | Color | Description |
|---|---|---|---|
| 1 | ALT | Green | Altitude HOLD mode – capturing/tracking |
| 2 | ALTS | White | Altitude select mode – armed preselect |
| | | Green | Altitude select mode – track, preselect |
| | | Flashing Yellow | Altitude select mode – aborted capture preselector |
| 3 | ALTS CAP | Green | Altitude select mode – armed for FMS |
| 4 | ALTV | White | Altitude select mode tracking FMS |
| | | Green | Altitude select mode – track, preselect |
| | | Flashing Yellow | Altitude select mode – aborted capture FMS |
| 5 | ALTV CAP | Green | Altitude select mode – capturing FMS |
| 6 | ← AP | White | AP disengaged and not transferred – left FD selected |
| | | Green | AP engaged and not transferred – left FD selected |
| | | Flashing Red | AP disengage warning, and not transferred – left FD selected |
| | | Yellow | AP engaged and not transferred, with AP synchronization in process (the aileron and elevator clutches are released) |
| 7 | → AP | White | AP disengaged and transferred – right FD selected |
| | | Green | AP engaged and transferred – right FD selected |
| | | Flashing Red | AP disengage warning, and transferred to the right FD |
| | | Yellow | AP engaged and transferred, with AP synchronization in process (the aileron and elevator clutches are released) |
| 8 | ATT (boxed) | Red | The red, boxed, ATT attitude flag shows when attitude data from the selected IRS are missing or invalid |
| | | Yellow | Each PFD compares the attitude data from the on-side Inertial Reference System (IRS). The ATT flag is yellow when both pitch and roll data are out of limits |
| 9 | B/C1<br>B/C2 | White | Back course mode – capture/tracking (annunciated in the lateral arm field, by identifying the NAV source) |
| | | Green | Back course mode armed (annunciated in the lateral arm field, by identifying the NAV source) |
| 10 | DR | White | Dead Reckoning operation |
| 11 | FD (boxed) | Red | Flight director flag (within the attitude ball) |
| 12 | FD1 | Green | FD computations performed by FD1 (on the copilot's PFD) |
| 13 | FD2 | Green | FD computations performed by FD2 (on the pilot's PFD) |

| # | Message | Color | Description |
|---|---|---|---|
| 14 | FLC | Green | Flight level change mode (on the vertical capture field) |
| 15 | GA | Green | Lateral Go-Around Mode (in lateral capture field) |
| | | Green | Vertical Go-Around Mode (in vertical capture field) |
| 16 | LNV1/LNV2<br>LOC1/LOC2<br>VOR1/VOR2 | White | Navigation or approach mode – armed (annunciator in the lateral arm field, by identifying NAV source) |
| | | Green | Navigation or approach mode – capture/tracking (in the lateral capture field by identifying the NAV source) |
| 17 | GS | White | Glideslope mode – armed (announced in the vertical arm field) |
| | | Green | Glideslope mode – captured (in the vertical capture field) |
| 18 | GP | White | Glidepath mode – armed in the vertical arm field |
| 19 | HDG | Green | Heading select mode |
| 20 | PATH | Green | Vertical Nav mode – capturing/tracking a vertical path |
| 21 | PTCH | Green | Pitch mode |
| 22 | ROLL | Green | Roll mode |
| 23 | SYNC | Yellow | FD synchronization in process |
| 24 | TEST | Yellow | Diagnostic Mode (displayed in large text) |
| 25 | TO | Green | Lateral takeoff mode (annunciator in lateral capture field) |
| | | Green | Vertical takeoff mode (annunciator in vertical capture field) |
| 26 | V | Green | VNAV mode, FMS NAV is valid and not overspeed mode (V is prefixed on the vertical capture annunciator) |
| | | Flashing Yellow | VNAV mode, FMS NAV is valid and overspeed mode (V is prefixed on the vertical capture annunciator) |
| 27 | VNV | Yellow | VNAV mode, and FMS NAV is valid and overspeed mode (V is prefixed on the vertical capture annunciator) |
| 28 | VS | Green | Vertical Speed mode |
| 29 | 1/2 BNK | Green | Half Bank mode |
| 30 | v-bars | Magenta | Integrated lateral and vertical flight guidance commands (not present if either command is invalid) |
| 31 | Pitch command cross-pointer | Magenta | Vertical flight guidance command (not present if the command is invalid) |
| 32 | Roll command cross-pointer | Magenta | Lateral flight guidance command (not present if the command is invalid) |
| 33 | Cross-line over the annunciation symbol(s) | Red | A required data source is invalid, for the active lateral outer loop (the line is drawn through the active lateral mode annunciation) |
| | | Red | A required data source is invalid, for the active vertical outer loop (the line is drawn through the active vertical mode annunciation) |

# XI. EICAS MESSAGES

## A. WARNING MESSAGES

**WARNING MESSAGES**

Immediate crew action required

| Message | Meaning | Inhibits | Aural Warning |
|---|---|---|---|
| **CONFIG AILERON TRIM**<br>**CONFIG AUTOPILOT**<br>**CONFIG FLAPS**<br>**CONFIG RUDDER TRIM**<br>**CONFIG STAB TRIM**<br>**CONFIG SPOILERS** | The aircraft is on the ground and the takeoff parameters (autopilot, flaps, spoilers, and trims in any axis) are not properly configured for takeoff. Illumination of the respective red CAS will be accompanied by the takeoff "CONFIGURATION" voice warning | — | "CONFIGURATION" (continuous) |

Note: "CONFIG AILERON TRIM, FLAPS, RUDDER TRIM, STAB TRIM, and SPOILERS appear in this chapter because they share the takeoff CONFIGURATION warning; their procedural detail is in the Flight Controls chapter."

## B. CAUTION MESSAGES

**CAUTION MESSAGES**

Crew awareness required

| Message | Meaning | Inhibits |
|---|---|---|
| **AFCS MESSAGES FAIL** | Monitoring and indication of the autopilot modes may be unreliable | **TO** |
| **AP HOLDING LWD**<br>**AP HOLDING RWD**<br>**AP HOLDING NOSE DOWN**<br>**AP HOLDING NOSE UP** | The autopilot is holding control force in the direction indicated | **TO** |
| **AP STAB TRIM FAIL** | The autopilot is unable to make a trim correction to the horizontal stabilizer | **TO** |
| **AT RETARD INHIBIT** | The AT cannot arm/activate or remain in retard mode. CAS is latched and reset if AT disengages or GA is selected. | **TO** |
| **FD MODE CHANGE** | An indirect mode change has occurred within the flight director. An example of an indirect mode change would be NAV or APPR mode changing to ROLL with a navigation source or frequency change | **TO** |
| **YAW DAMPER FAIL** | The yaw damper has failed | **TO/LAND** |

### C. ADVISORY MESSAGES

**ADVISORY MESSAGES**

System status information

| Message | Meaning | Inhibits |
|---|---|---|
| **AT FAIL** | AT system malfunction/internal failure. Loss of input required for the current active mode. Loss of communication between AT system and other avionics | **TO/LAND** |
| **FD 1 FAIL**<br>**FD 2 FAIL** | The respective flight director has failed accompanied by an FD flag on the PFD | **TO/LAND** |

### D. STATUS MESSAGES

**STATUS MESSAGES**

System configuration status

| Message | Meaning |
|---|---|
| **YAW DAMPER OFF** | The yaw damper is selected OFF |



## XII. LIMITATIONS

### AUTOPILOT LIMITATIONS

Autopilot Limitations

| Parameter | Limitation |
|---|---|
| Minimum Engagement Height | 700 ft AGL |
| Minimum Disengagement Height | GP ⩽ 3.5°: 80ft AGL; Precision approach GP 3.5°-4.5°: 160ft AGL; Visual / non-precision: 200ft AGL |
| Maximum Operating Altitude | 45,000 ft |
| Maximum Airspeed | 0.83 Mach above 29,475ft; 300 KIAS to 8,000ft; 320 KIAS above 8,000ft |
| Approach Minimums | Category I ILS |
| Single FGC Operation | Autopilot unavailable |
| Turbulence Penetration | Disengage in severe turbulence |
| Maximum Altitude w/YD Off | 31,000ft |

Note: TO inhibit: messages suppressed when airspeed > 80 kt and aircraft below 400 ft AGL on takeoff; lifted at 400 ft AGL. LAND inhibit: messages also suppressed when descending below 400 ft AGL with airspeed < 40 kt.

## XIII. CIRCUIT BREAKERS

Automatic Flight Control System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| AP PRI | LEFT ESS | CB1-B8 |
| AP SEC | RIGHT MAIN | CB2-B8 |
| FD L PWR | LEFT MAIN | CB1-A7 |
| FD R PWR | RIGHT MAIN | CB2-A7 |
| MASTER DISC AUTO FLIGHT | RIGHT ESS | CB4-C6 |
| YAW DAMPER | LEFT MAIN | CB1-C9 |
| AIL TRIM | RIGHT ESS | CB2-B15 |
| PRI STAB TRIM/RUD LIM | LEFT MAIN | CB1-B15 |
| SEC STAB TRIM/RUD LIM | RIGHT ESS | CB2-B13 |
| TRIM/MSTR DISC | LEFT ESS | CB3-C6 |
| TRIM/MSTR DISC | RIGHT ESS | CB4-C7 |
| AT SERVO | LEFT MAIN | CB1-D8 |
| AT CONTROL | RIGHT MAIN | CB2-D8 |
| MACH TRIM | LEFT MAIN | CB1-E5 |
| FGC PWR 1 | LEFT MAIN | CB3-A8 |
| FGC PWR 2 | RIGHT MAIN | CB4-A8 |

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## XIV. QUIZ

1. How many flight directors does the AFCS have?

    A) One
    B) Two independent
    C) Three
    D) Two dependent

2. What is the minimum autopilot engagement altitude?

    A) 400 ft AGL
    B) 500 ft AGL
    C) 700 ft AGL
    D) 800 ft AGL

3. The autopilot controls which axes?

    A) Pitch only
    B) Roll only
    C) Pitch and roll
    D) Pitch, roll, and yaw

4. What must be operational for autopilot engagement?

    A) Only one FGC
    B) Yaw damper and both FGCs
    C) Just the yaw damper
    D) Only autothrottle

5. What provides the autopilot with pitch trim?

    A) Elevator trim tabs
    B) Horizontal stabilizer
    C) Rudder trim
    D) Aileron tabs

6. The FGC cards are located in which system?

    A) Flight Control Computer
    B) IAPS
    C) Avionics Bay
    D) Electronic Equipment Bay

7. What is the maximum autopilot operating altitude?

    A) 41,000 ft
    B) 43,000 ft
    C) 45,000 ft
    D) 51,000 ft

8. Which trim system has only a left-side tab?

A) Elevator trim
B) Rudder trim
C) Aileron trim
D) Horizontal stabilizer trim

9. What color indicates an armed mode on the FMA?

A) Green
B) White
C) Amber
D) Cyan

10. The aileron servo is located on which cable run?

A) Left aileron
B) Right aileron
C) Both ailerons
D) Center aileron

11. What happens when pressing the AP switch while engaged?

A) Nothing
B) Autopilot disconnects
C) Goes to standby
D) Switches to other FGC

12. LNAV capture is possible at what altitude with FGC upgrade?

A) 200 ft AGL
B) 100 ft AGL
C) 50 ft AGL
D) Ground level

13. What provides Mach trim data?

A) FGCs
B) Air Data Computers
C) IAPS
D) Radio altimeter

14. What message appears for improper aileron trim setting?

A) AILERON TRIM FAIL
B) CONFIG AILERON TRIM
C) TRIM FAULT
D) AIL TRIM INOP

15. Category I ILS approaches may be degraded with failed:

A) GPS
B) Radio altimeter
C) ADC
D) FMS

16. How many lateral flight director modes are available?

A) Six
B) Seven
C) Eight
D) Nine

17. How many vertical flight director modes are available?

A) Eight
B) Nine
C) Ten
D) Eleven

18. At what altitude does half bank mode automatically engage?

A) 29,600 ft
B) 31,600 ft
C) 33,600 ft
D) 35,600 ft

19. What is the bank angle limit in half bank mode?

A) 10 degrees
B) 15 degrees
C) 20 degrees
D) 25 degrees

20. The ROLL mode holds heading when bank angle is under:

A) 3 degrees
B) 5 degrees
C) 7 degrees
D) 10 degrees

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CL-350



CL-350 TRAINING MANUAL

# FLIGHT INSTRUMENTS | 18

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# FLIGHT INSTRUMENTS

## I. INTRODUCTION

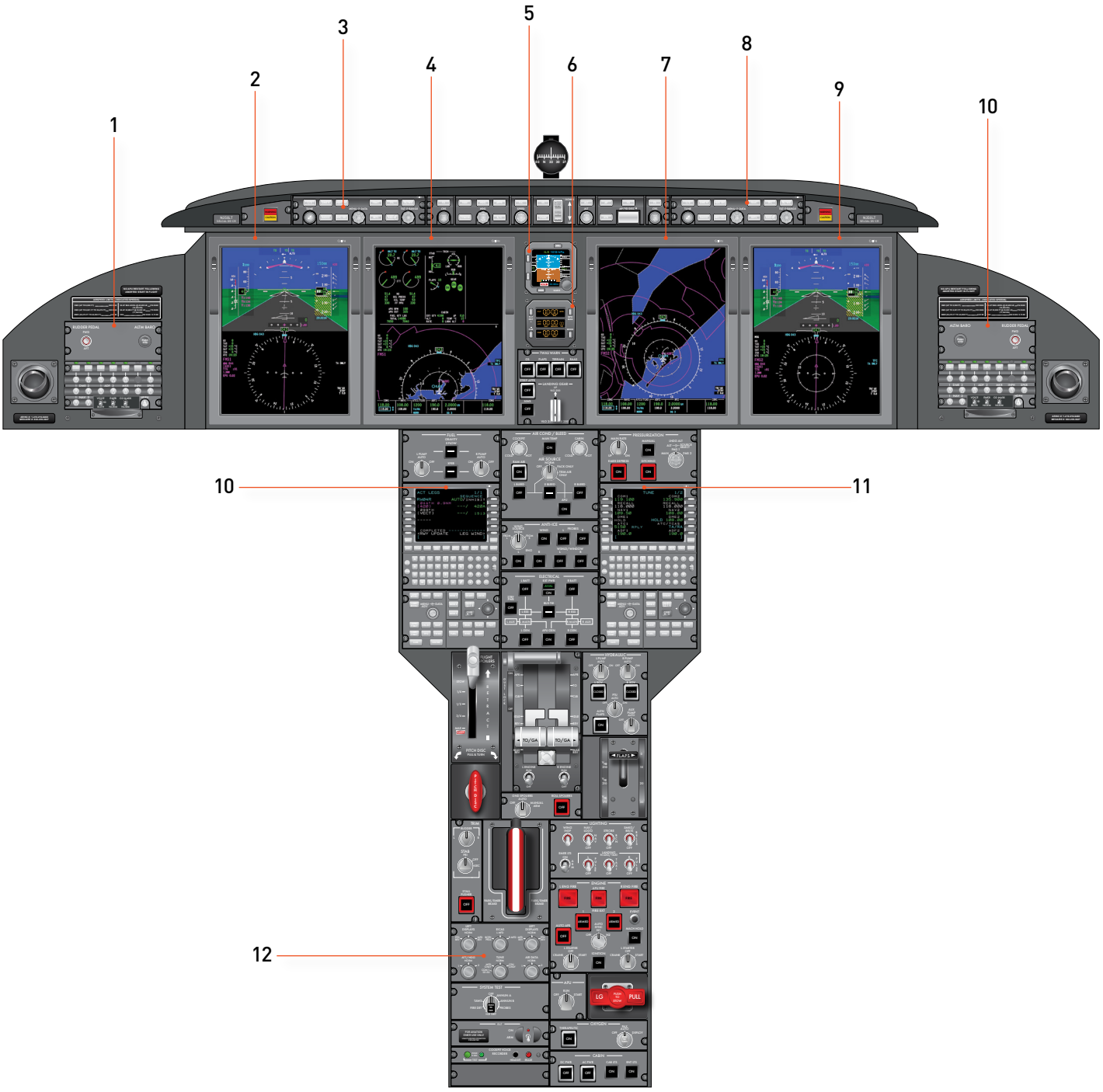
The Challenger 350's Electronic Flight Instrumentation System (EFIS) provides integrated flight information through four adaptive flight displays (AFDs), consisting of two Primary Flight Displays (PFDs) and two Multifunction Displays (MFDs), controlled by Display Control Panels (DCPs), MFD Control Panels (MCPs), and a Reversion Switch Panel (RSP).

The system interfaces with the Integrated Avionics Processor System (IAPS), which serves as the focal point for aircraft information flow, containing flight guidance computers, flight management computers, and maintenance diagnostic computers, while receiving data from air data systems, inertial reference systems, and multiple aircraft subsystems for comprehensive flight deck displays.

### System Specifications

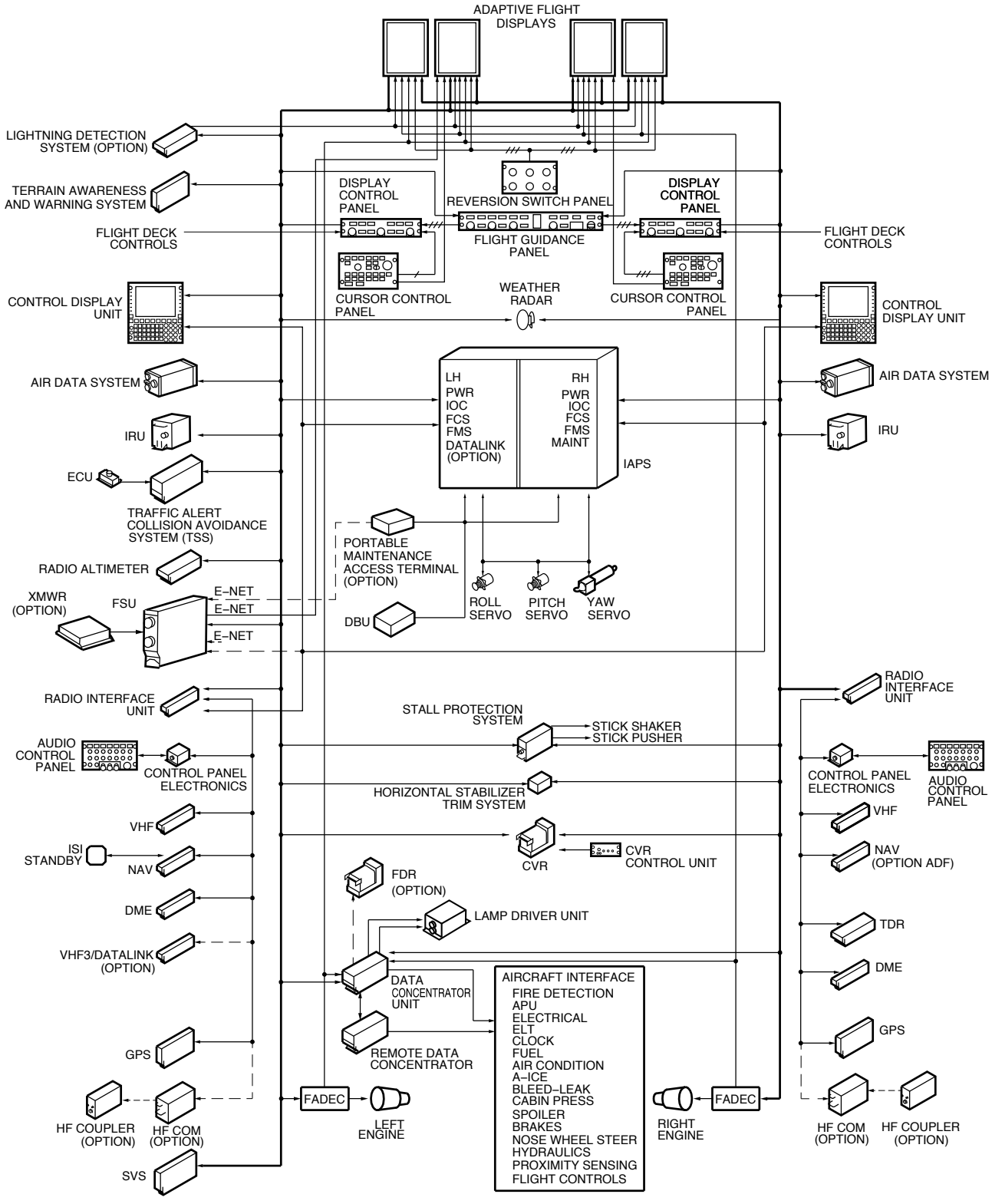
Flight Instruments System Specifications

| Parameter | Specification |
|---|---|
| Adaptive Flight Displays (AFDs) | Color, Liquid Crystal Displays |
| PFD Configuration | 2 Primary Flight Displays (Outboard) |
| MFD Configuration | 2 Multifunction Displays (Inboard) |
| Inertial Reference Units | 2 (Dual IRS) |
| IRS Alignment Time | 5 minutes (Equator) to 17 minutes (Latitudes above 70.24°) |
| Integrated Standby Instrument (ISI) Alignment Time | 70 Seconds |
| Air Data Computers | 2 (ADC 1 and ADC 2) |
| Synthetic Vision Computers | 1 (Optional) |
| File Server Units | 1 Standard (2nd Optional) |




1. Left Compass Control Panel
2. Pilot Primary Flight Display (PFD)
3. Left Display Control Panel (DCP)
4. Left Multifunction Display (MFD)
5. Standby Instrument Panel
6. Clock
7. Right Multifunction Display (MFD)
8. Copilot Display Control Panel (DCP)
9. Right Primary Flight Display (PFD)
10. Left MFD Control Panel
11. RuLeft MFD Control Panel
12. RSP Control Panel

## FLIGHT INSTRUMENTS BLOCK DIAGRAM



# II. PRIMARY FLIGHT DISPLAYS (PFDs)

## A. PFD DISPLAY AREAS

- Angle of Attack (AOA) display - Left side vertical scale
- Attitude display - Center sphere with pitch and roll indications
- Airspeed/Mach display - Left vertical tape format
- Altitude display - Right vertical tape format
- Vertical speed display - Right side of altitude tape
- Flight Mode Annunciator (FMA) - Top center display area
- Navigation display - Lower portion with HSI format



## B. ANGLE OF ATTACK (AOA) SYSTEM

The AOA indicator can assess lift under any flight condition, speed, altitude, wing loading and aircraft configuration. The AOA display is used for crew awareness only and is not a primary flight instrument or a stall warning device. The indicated airspeed remains the primary reference for stall awareness.

**AOA Indicator Components:**

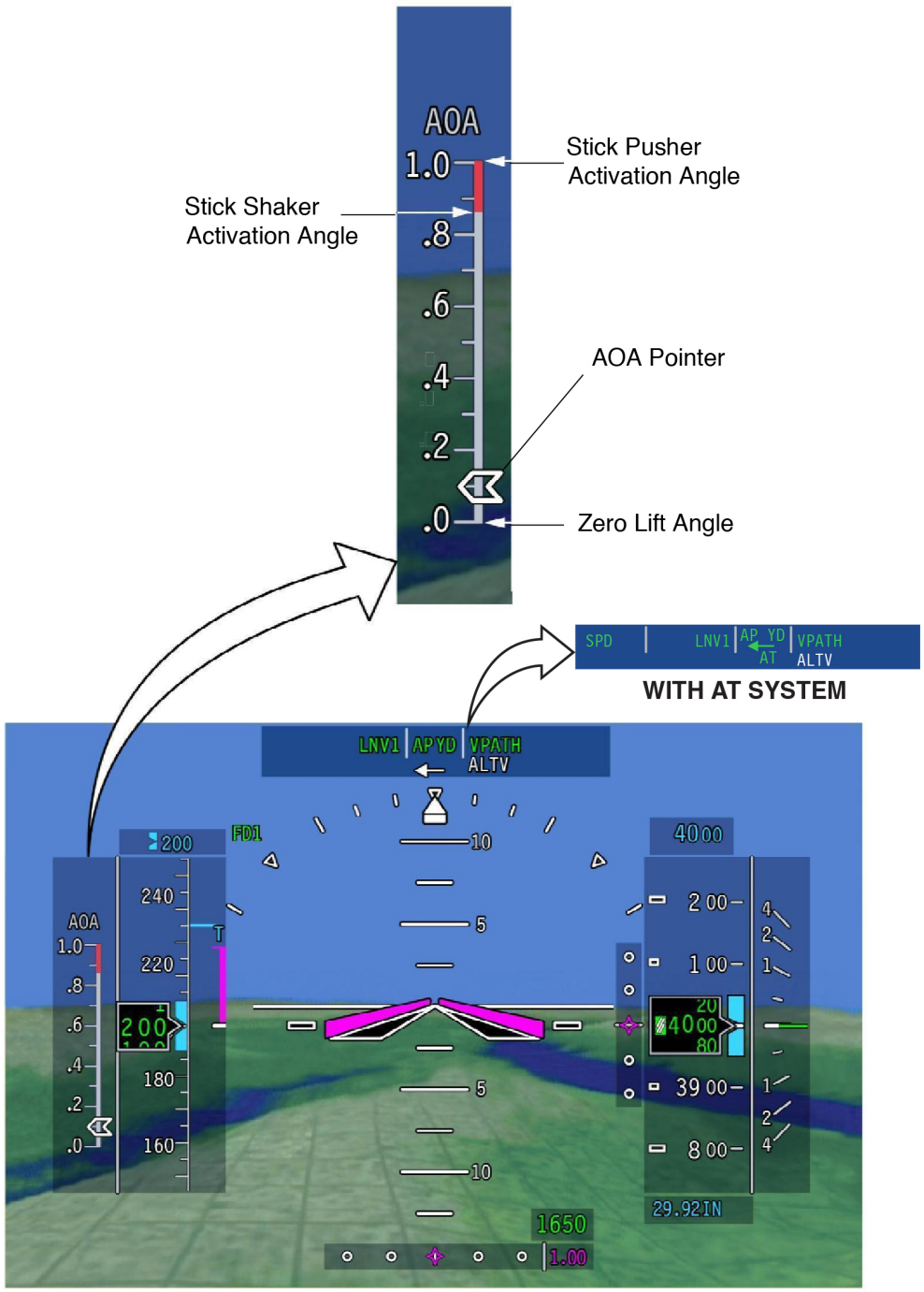
- Analog scale indicator graduated from 0.0 to 1.0
- Zero lift angle represented at 0.0 position
- Stick pusher activation angle at 1.0 position
- AOA pointer showing current normalized angle
- Variable red band with dynamic positioning
- Lower edge of red band indicates stick shaker activation
- Upper edge of red band indicates stick pusher activation
- Green arc showing normal operating range
- Display enabled through CSU strapping configuration

**AOA Dynamic Response Features:**

- Automatic adjustment for rapid pitch changes
- Trip point lowering if AOA increase exceeds 1°/second
- Prevention of deep stall penetration
- Real-time margin to stick shaker indication
- Real-time margin to stick pusher indication
- Configuration-based limit calculations
- Mach number compensation
- Bank angle compensation during turns

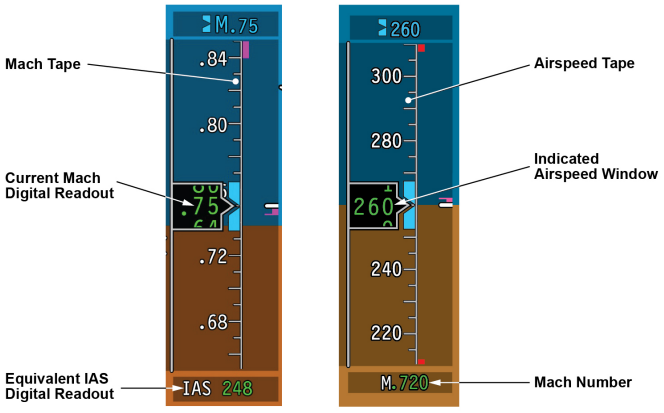
## C. AIRSPEED DISPLAY

The airspeed display consists of a moving vertical tape located on the left side of each Primary Flight Display with a fixed digital readout window showing current airspeed in the center. The tape displays indicated airspeed from 40 to 400 knots with scale markings every 5 knots and numerical labels every 20 knots, providing continuous visual reference throughout the aircraft's operating envelope.



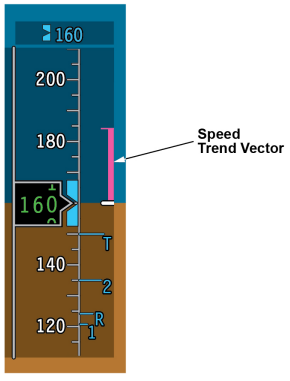
**Display Format Selection:**

- IAS or Mach tape format selectable via IAS/MACH button on FGP
- Manual selection available when speed greater than Mach 0.4
- Automatic transition from IAS to Mach tape at 35,561 feet
- Automatic transition from Mach to IAS tape descending through 35,561 feet
- Equivalent Mach or IAS readout displayed digitally at bottom of tape
- Current format indicated by tape scaling and digital readout type
- Pilot selection overrides automatic transition when above Mach 0.4



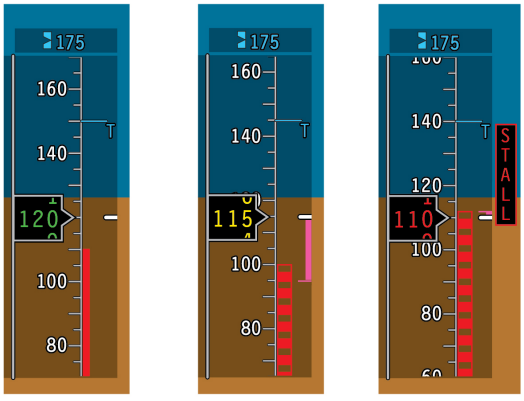

**Airspeed Trend Vector:**

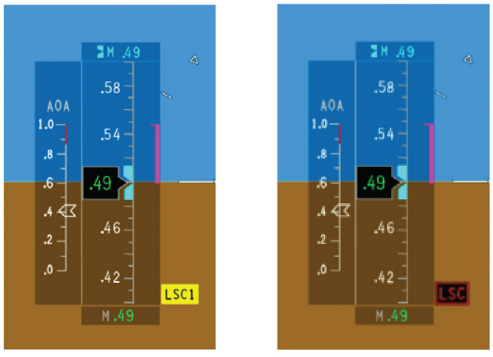
- Magenta line extending up or down from current airspeed
- Indicates predicted airspeed in 10 seconds based on current acceleration



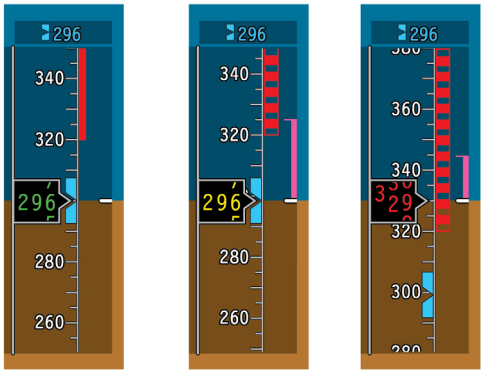

**Low Speed Cue (LSC):**

- Solid red line rising from bottom of airspeed scale
- Indicates calculated airspeed of 1.06 Vs (stall speed)
- Top of cue represents stick shaker activation speed
- Changes to expanded red checkerboard pattern when within few knots of stick shaker
- LSC caution flag shows when single source is used to determine the stall window
- LSC warning flag shows when no stall speed comparison is available



**Overspeed Cue:**




- Solid red line descending from top of airspeed scale
- Indicates VMO (maximum operating speed) or MMO (maximum Mach)
- Reduces to flap operating speed limit when flaps extended
- Changes to red checkerboard pattern when approaching overspeed
- Wider checkerboard pattern when trend vector reaches cue
- "OVERSPEED" aural warning when airspeed reaches cue

**V-Speed References:**

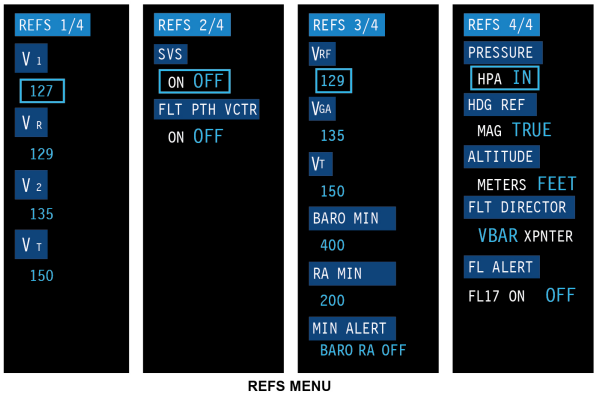
- V-speed reference bugs (V1, VR, V2, VT, VGA, VREF)
- Manually set V speed values are cyan, FMS-calculated are magenta
- Set through REFS button on Display Control Panel

**Speed Bug:**

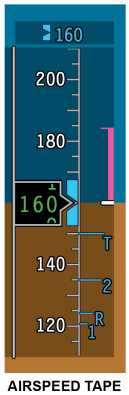
- Cyan bug positioned at selected airspeed
- Set via SPEED knob on Flight Guidance Panel
- ±5 knot deviation scale adjacent to bug
- Remains visible throughout tape range

**Airspeed Comparator Function:**

- Continuous comparison between pilot and copilot airspeed
- EFIS MISCOMPARE message if difference exceeds limits
- IAS amber flag if mismatch detected
- Automatic display of cross-side data on failure
- Part of integrated monitoring system




REFS MENU




AIRSPEED TAPE

## D. ALTITUDE DISPLAY

### Altitude Tape

- Vertical moving tape displayed on right side of PFD
- Barometric altitude readout range from -100 to 50,000 feet

### Preselected Altitude System

- Cyan bug on altitude tape indicating selected altitude
- Digital readout of selected altitude above tape (cyan)
- ALT knob on Flight Guidance Panel controls selection
- Push function for 1,000-foot increments
- Automatic reset to nearest thousand when pushed from hundred-foot value

### Altitude Alerting System

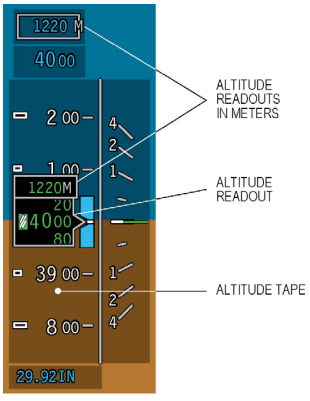
- Altitude bug flash cyan and C-chord is heard when within 1,000' of preselected altitude
- Altitude deviation C-chord alert if departing selected altitude >200 feet
- Amber ALT flashing in Flight Mode Annunciator during deviation

### VNAV Altitude References

- Magenta altitude constraints from FMS displayed on tape

### Barometric Setting Display

- Barometric correction value displayed below altitude tape
- Manual setting via BARO knob on Display Control Panel
- STD button selection displays "29.92 IN" or "1013 HPA"
- Cross-side barometric comparison monitoring
- BARO miscompare alert for differences >0.04 IN



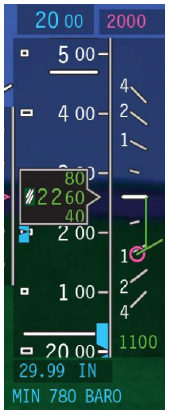

### Radio Altitude Display

- Digital readout appears below 2,500 feet AGL
- Automatic declutter above 2,500 feet AGL
- "RA" flag displayed for invalid radio altitude

### Altitude Display Integration

- Data from dual Air Data Computers (ADC 1 and ADC 2)
- Automatic source selection based on onside/offside logic
- Manual source selection via reversionary panel
- Comparison monitoring between ADC sources
- ALT flag displayed for invalid altitude data

## E. VERTICAL SPEED DISPLAY




The vertical speed display consists of a vertical analog scale positioned to the right of the altitude tape, featuring a moving pointer with a distinctive green "drag line" that emphasizes rate changes as the pointer moves up or down the scale to indicate current vertical speed.

**Scale Range and Markings:**

- Scale range of ±4,000 feet per minute
- Zero reference line at center of scale

**VS Pointer and Drag Line:**

- White triangular pointer indicates current vertical speed
- Green drag line extends from zero to pointer position

**Digital Readout Display:**

- Part-time digital readout appears at scale extremes
- Displayed at top of scale during climb operations
- Displayed at bottom of scale during descent operations

**Selected VS Bug:**

- Cyan bug appears when VS mode active on autopilot
- Positioned at selected vertical speed value
- Set via UP/DOWN wheel on Flight Guidance Panel

**FMS Vertical Speed Required (VSR) Pointer:**

- Magenta open circle symbol on VS scale
- Indicates minimum average VS to meet altitude constraint
- Calculated from present position to next constraint
- Only displayed when FMS is active navigation source

**TCAS Resolution Advisory Display:**

- Red and green zones appear during TCAS RA
- Red zone indicates prohibited vertical speeds
- Green zone indicates required vertical speeds
- Corrective RA shows "CLIMB" or "DESCEND" zones
- Preventive RA shows "DO NOT CLIMB/DESCEND" zones
- Zones dynamically adjust based on traffic geometry
- Override normal VS display during RA event

**VS Comparator Function:**

- Continuous comparison between pilot and copilot VS
- Part of EFIS comparator monitoring system
- Triggers EFIS MISCOMPARE if difference excessive
- Automatic cross-check between ADC sources

- Supports system integrity monitoring

**VS Failure Indication:**

- Red boxed "VS" flag replaces scale when data invalid
- Flag appears in center of VS display area
- All VS indications removed when flagged
- Digital readouts blanked during failure
- Selected VS bug removed from display
- Requires ADC data for normal operation

## F. ATTITUDE DISPLAY

The attitude display provides the primary aircraft attitude reference through the Attitude Director Indicator (ADI), presenting pitch, roll, and yaw information supplied by the Inertial Reference System with enhanced features including Flight Path Vector symbology, unusual attitude recovery guidance, and optional Synthetic Vision System integration.

**Attitude Director Indicator Configuration:**

- Wall-to-wall ADI format occupying full display width

**Pitch Scale Specifications:**

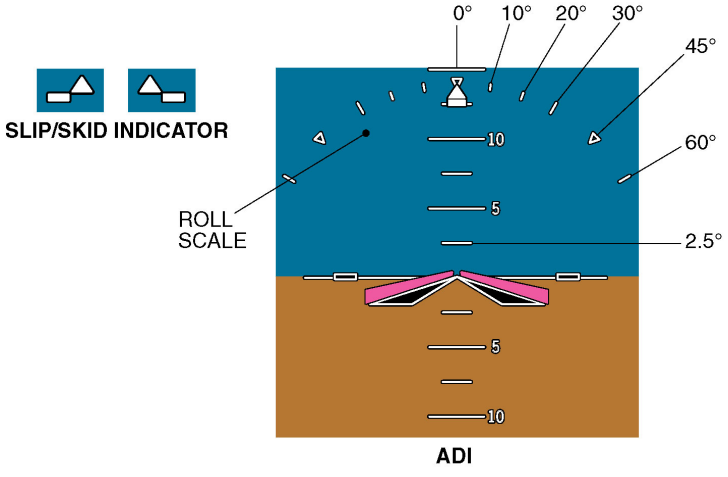
- Normal display range of ±12 degrees (wall-to-wall format)
- Horizon line at 0 degrees pitch reference
- Flight director takeoff commands greater than 12 degrees parked at +12 degrees

**Roll Scale Configuration:**

- White tick marks at 10°, 20°, and 30° symmetrically positioned
- Unfilled white triangular ticks at 0° (wings level) and 45°
- White tick outside 45° triangles indicate 60° of roll
- Large tick marks at ±30 and ±60 degrees

**Slip/Skid Indicator:**

- White rectangular indicator below roll pointer
- One rectangle width deflection equals one conventional ball displacement



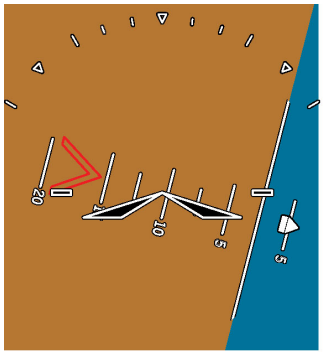



- Uses roll pointer base as reference point
- Rotates with roll pointer during bank maneuvers
- Displays actual flight path vector in space
- Lateral position represents azimuth of ground track to heading
- Vertical position represents climb/descent angle to horizon

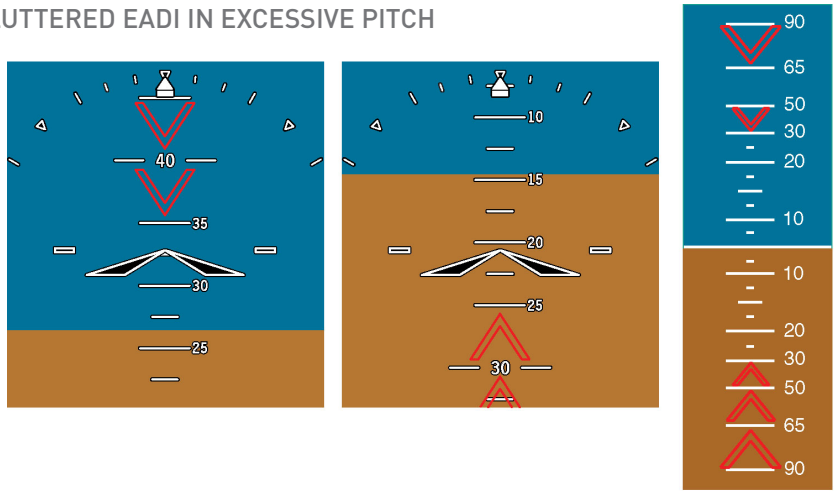
**Unusual Attitude Recovery Features:**

- Excessive pitch attitude chevrons:
    - Red chevrons appear at +23 degrees nose up
    - Red chevrons appear at -13 degrees nose down
    - Full chevrons visible at +27 degrees and -18 degrees
- Display declutter mode activation:
    - Triggers at pitch >30° up or >20° down
    - Triggers at roll angle >65 degrees
    - Removes non-essential information
    - Returns to normal at pitch ≤25° up or ≤-15° down
    - Returns to normal at roll angle ≤60 degrees
- Only the following information will be displayed while de-cluttered
    - Altitude
    - Airspeed, trend vector
    - Attitude, slip/skid
    - Vertical Speed

EXAMPLE OF DE–CLUTTERED EADI IN EXCESSIVE ROLL

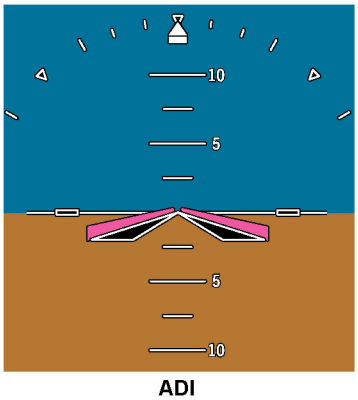



EXAMPLE OF DE–CLUTTERED EADI IN EXCESSIVE PITCH

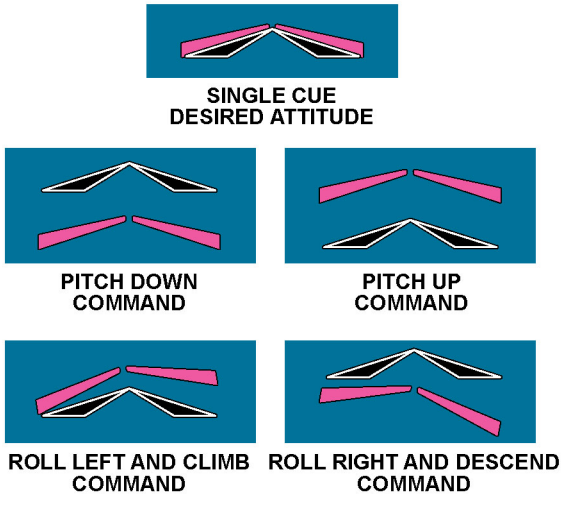



- Compass
- AOA Indications
- AP/YD engage/disengage

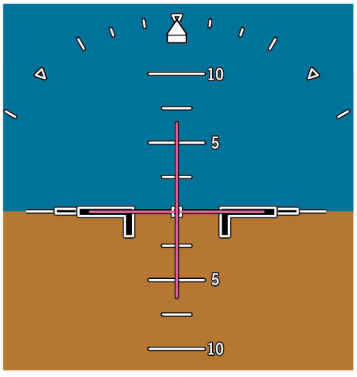
SINGLE CUE COMMAND BARS



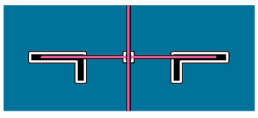

ADI

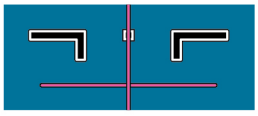


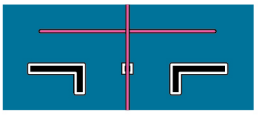
## CROSS-POINTER COMMAND BARS

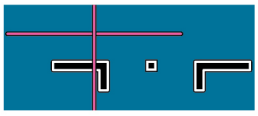


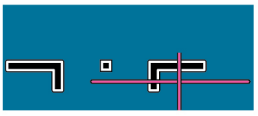
ADI


DOUBLE CUE
DESIRED ATTITUDE


PITCH DOWN
COMMAND


PITCH UP
COMMAND


ROLL LEFT AND CLIMB
COMMAND


ROLL RIGHT AND DESCEND
COMMAND

**Flight Director Command Bars:**

- Magenta inverted V-bars (standard configuration)
- Optional cross pointers for split cue format

**Marker Beacon Annunciations:**

- Displayed on right side of ADI
- Synchronized with audio marker tones

**Vertical Deviation Display:**

- Located right of attitude display
- White fixed scale with moving deviation pointer
- Green pointer for on-side data
- Amber pointer for cross-side data
- Two dots above and below reference line
- Each dot represents 1/4 degree deviation
- Diamond symbol for glideslope data
- Star symbol for VNAV data
- Red boxed GS flag when ILS glideslope invalid

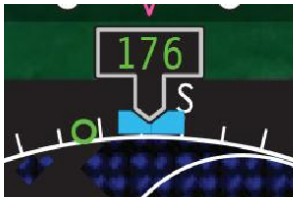
**Failure Modes and Flags:**

- ATT flag displayed when attitude data invalid
- Command bars removed with invalid steering inputs
- FPV symbol removed when source data unavailable
- SVS image removed per defined failure conditions
- Automatic declutter in unusual attitudes
- Reversion to backup attitude sources via switches

## G. HEADING DISPLAY

The heading display presents aircraft directional information on a partial compass card at the bottom of the PFD, providing magnetic or true heading reference with integrated navigation and bearing pointer displays supplied by the IRS system.

**Selected Heading System:**




- Heading bug displayed as rectangular symbol on compass periphery
    - Positioned according to HDG knob selection on flight guidance panel
    - Bug vector line extends from heading bug position
    - Displays in cyan color when actively set
- Selected heading digital readout
    - Three-digit display preceded by HDG legend
    - Both readout and legend shown in cyan
    - Located to left of heading readout
    - Shares display location with heading comparator flag (flag has priority)

**Track Pointer and Drift Angle:**



- Track pointer displayed as green open circle shape
- Positioned on compass rose or compass tape at current aircraft track over earth
- Difference between track pointer position and lubber line indicates drift angle
- Continuously updated based on IRS data

**Bearing Pointer System:**

- Dual bearing pointer capability
    - Number 1 bearing source: cyan single-lined pointer
    - Number 2 bearing source: white double-lined pointer
    - Both pointers can be displayed simultaneously
- Bearing icons displayed as miniature pointer representations
    - Used to identify actively selected bearing pointers
    - Display in same color as associated bearing pointer
- Bearing source selection via BRG SRC button on DCP
    - Opens bearing source menu vertically on left side of PFD
    - Selection box moved with MENU knob between pointer 1 and pointer 2
    - PUSH SELECT or DATA knob used to select source or OFF
- Available bearing sources:
    - VOR 1/VOR 2
    - ADF 1/VOR 2

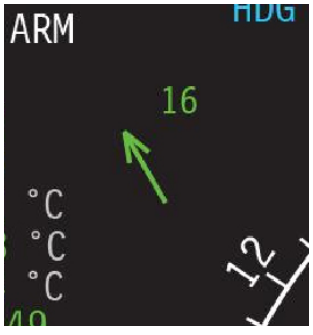



- ADF 1/ADF 2
- FMS 1/FMS 2
- OFF (no display)

- Bearing source behavior:
  - Display blank when BRG source selection is OFF
  - Pointer removed from view when bearing source invalid

**Navigation Display Integration:**

- Navigation source indicator in digital format
  - Selected using NAV SRC button on DCP
  - Menu window opens vertically on left side of PFD
  - Repeated NAV SRC switch presses cycle through available sources
- Available navigation sources:
  - VOR 1/LOC 1
  - VOR 2/LOC 2
  - FMS 1/FMS 2
  - OFF (no display)
- Course display system:
  - Three-digit display preceded by CRS label
  - Range from 1 to 360 degrees
  - Selected via CRS knob on FGP
- Course pointer presentation:
  - Arrow pointing to course position on compass card
  - Controlled by CRS selector knob on FGP
  - On-side displays in green color
  - Cross-side displays in amber color
- Lateral deviation bar:
  - Indicates aircraft deviation from selected course
  - Moves laterally with position read against deviation scale




**Wind Vector Display:**

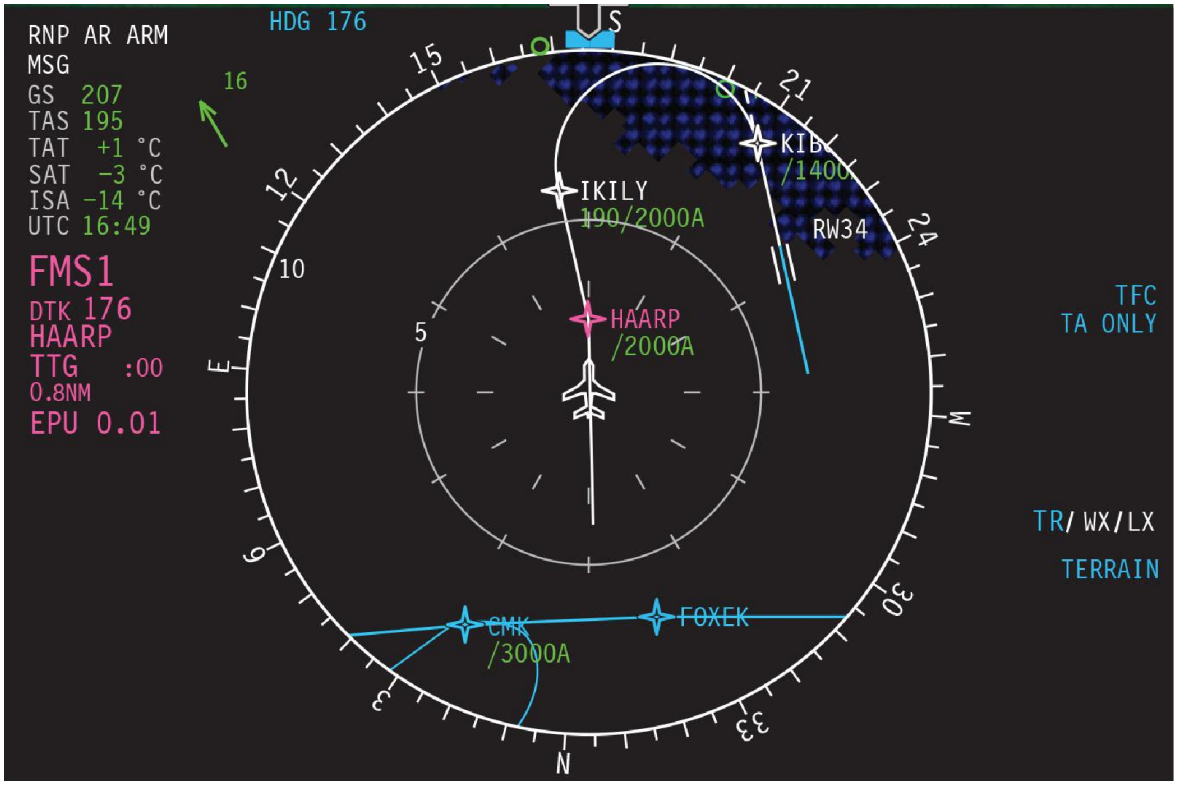
- Wind magnitude and direction shown in green
  - Located between GS/TAS/TAT/SAT/ISA/UTC block and selected map
  - Wind direction arrow represents wind relative to aircraft
  - Arrow pointing to 6 o'clock indicates direct headwind
- Data source selection:
  - Primary: on-side FMS
  - Alternate: cross-side FMS when selected as active NAV source

**Heading Type Selection (IRS-equipped aircraft):**

- Magnetic or true heading selectable
    - Selection via REFS 4/4 page through DCP
    - Alternative selection via CDU through FMS CTL page
- TRUE legend displayed in cyan to right of heading readout when true selected
- DG displayed in cyan to right of heading readout if IRS enters ATTITUDE mode

**Failure Indications:**

- Attitude flag (ATT):
    - Red boxed flag displayed when attitude information invalid
    - All other PFD information disappears when flag displayed
- Heading flag (HDG):
    - Red boxed flag displayed when heading source invalid
    - Replaces heading readout when displayed
    - Compass rose/arc rotates to North-up orientation
    - Lubber line around digital heading removed

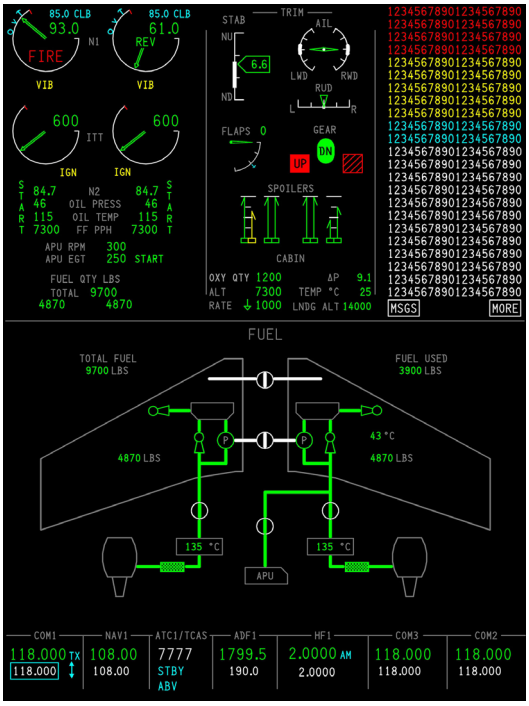


# III. MULTIFUNCTION DISPLAYS (MFDs)

## A. MFD FORMAT PAGES

**Available Display Formats:**

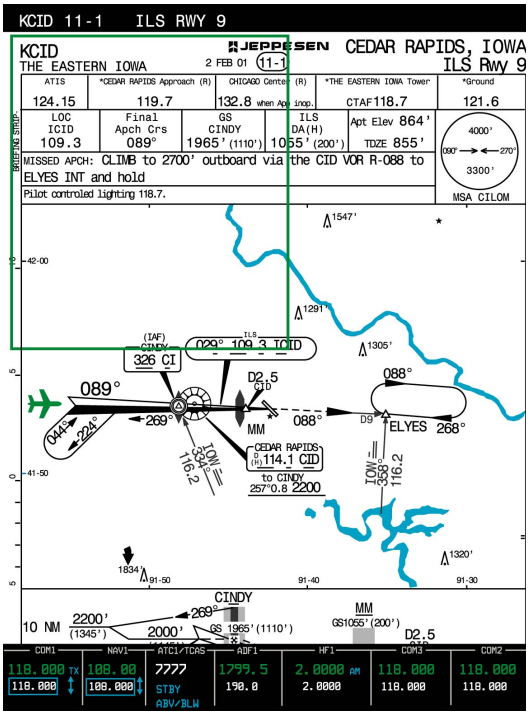
- Navigation map displays (PPOS and PLAN modes)
- Engine indication page (EICAS format)
- Systems synoptic pages
- Electronic checklists
- Flight plan display
- Datalink weather displays
- Electronic charts (if equipped)
- TCAS traffic display
- Terrain awareness display
- Status and maintenance pages




## B. MFD NAVIGATION DISPLAYS

**Map Display Features:**

- Present position (PPOS) moving map
- Flight plan (PLAN) static map
- Range scales from 0.25 to 600 nm
- Waypoint information and identifiers
- Airports, VORs, NDBs symbology
- Airways and airspace boundaries
- Weather radar overlay capability
- Terrain display overlay
- TCAS traffic overlay
- North up or heading up orientation

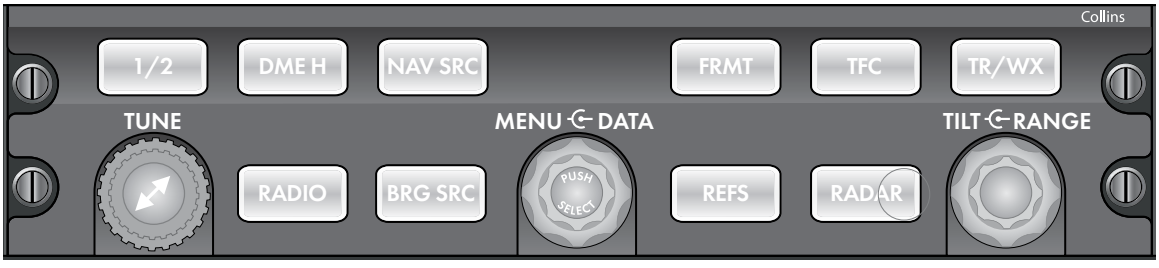


# IV. DISPLAY CONTROL SYSTEMS

## A. DISPLAY CONTROL PANEL (DCP)

**DCP Controls and Functions:**

- 1/2 button - Selects cross-side radio menu on MFD
- DME H button - Holds DME while tuning VOR independently
- NAV SRC button - Cycles through navigation sources
- FRMT button - Toggles between PPOS and ROSE formats
- TFC button - Overlays TCAS traffic on display
- TR/WX button - Selects terrain, weather, or lightning display
- TUNE knob - Controls MFD radio tuning
- RADIO button - Activates radio tuning submenu
- BRG SRC button - Selects bearing pointer sources
- MENU/DATA knobs - Navigate and select menu items
- PUSH SELECT button - Confirms selections
- REFS button - Displays V-speed reference pages
- RADAR button - Controls weather radar menu
- TILT/RANGE knob - Adjusts display range and radar tilt

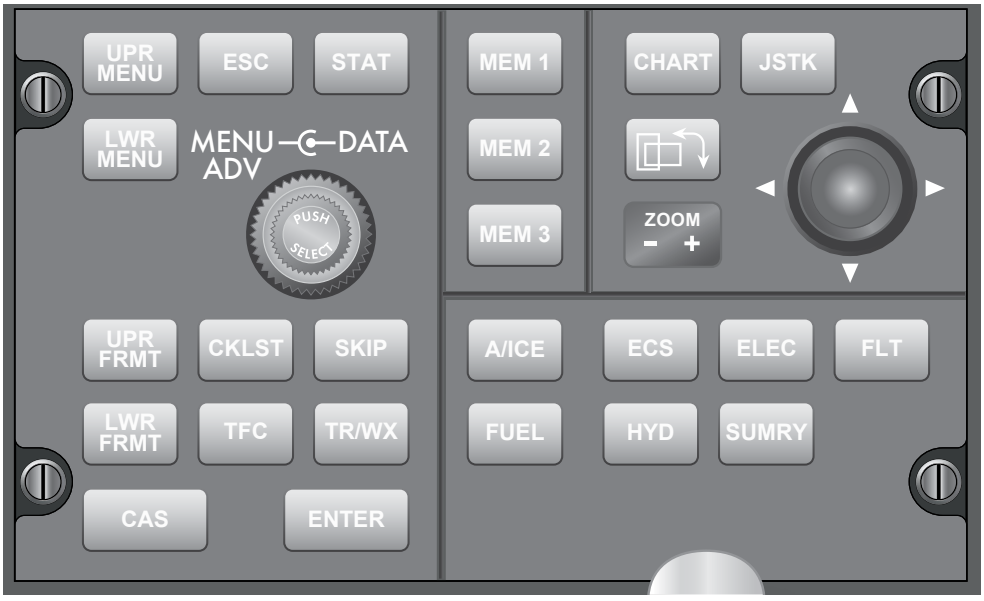



## B. MFD CONTROL PANEL (MCP/CCP)

**MCP Controls and Functions:**

- UPR MENU button - Displays upper menu options
- LWR MENU button - Displays lower menu options
- MENU ADV knob - Moves cursor through menu items
- ESC button - Moves up menu hierarchy
- STAT button - Shows status format pages
- MEM buttons (1, 2, 3) - Quick access to memory items
- CHART button – E-Charts
- JSTK button - Activates joystick cursor control
- ZOOM button - Changes map zoom level

- CAS button - Controls CAS message paging
- ENTER button - Confirms data entry
- CKLST button - Displays electronic checklists
- SKIP button - Bypasses checklist items
- A/ICE button – Anti-Ice synoptic page
- ECS button - Environmental control system synoptic page
- ELEC button - Electrical system synoptic
- FLT button - Flight controls synoptic
- FUEL button - Fuel system synoptic
- HYD button - Hydraulic system synoptic
- SUMRY button - Summary page display




## C. REVERSION SWITCH PANEL (RSP)

**RSP Switch Functions:**

**Left Displays Switch:**

- MFD REV - Left MFD in compressed format, left PFD shutdown
- NORM - Normal left MFD and PFD operation
- PFD REV - Left PFD in compressed format, left MFD shutdown

**EICAS Switch:**

- BOTH PFDS – Display configured as PFD displays EICAS information in compressed format
- L MFD – Selects the left MFD into a presentation that includes EICAS
- R MFD - Selects the right MFD into a presentation that includes EICAS

**Right Displays Switch:**

- MFD REV - Right MFD in compressed format, right PFD shutdown
- NORM - Normal right MFD and PFD operation
- PFD REV - Right PFD in compressed format, right MFD shutdown

**ATT/HDG Switch:**

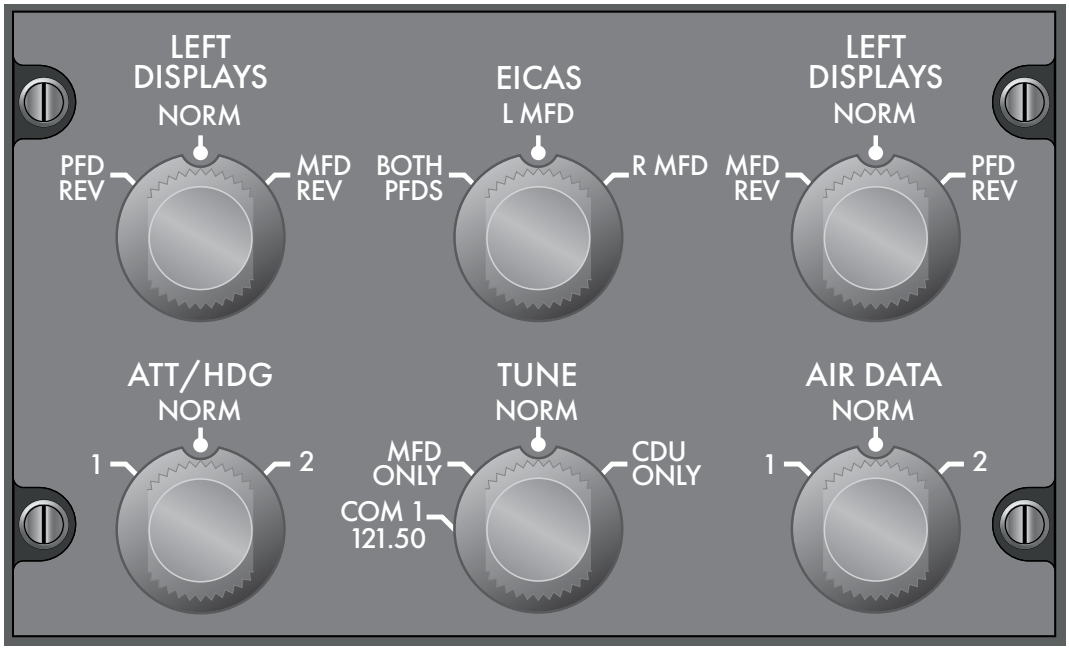
- Position 1 - All displays use IRS 1 data
- NORM - Onside IRS data (pilot IRS1, copilot IRS2)
- Position 2 - All displays use IRS 2 data

**TUNE Switch:**

- COM 1 121.50 - L-VHF COM tuned to emergency frequency
- MFD ONLY - CDU tuning disabled, MFD tuning enabled
- NORM - Normal tuning operation
- CDU ONLY - MFD tuning disabled, CDU tuning enabled

**AIR DATA Switch:**

- Position 1 - All displays use ADC 1 data
- NORM - Onside ADC data (pilot ADC1, copilot ADC2)
- Position 2 - All displays use ADC 2 data



# V. AIR DATA SYSTEM

## A. AIR DATA COMPUTERS (ADCs)

**ADC Calculated Parameters:**

- Pressure altitude
- Static pressure
- Total pressure
- Vertical speed
- Airspeed
- Mach number
- VMO/MMO values
- Baro correction
- Barometric corrected altitude
- Static air temperature (SAT)
- Total air temperature (TAT)
- True airspeed (TAS)
- ISA temperature deviation

## B. PITOT STATIC SYSTEM

**Primary System Components:**

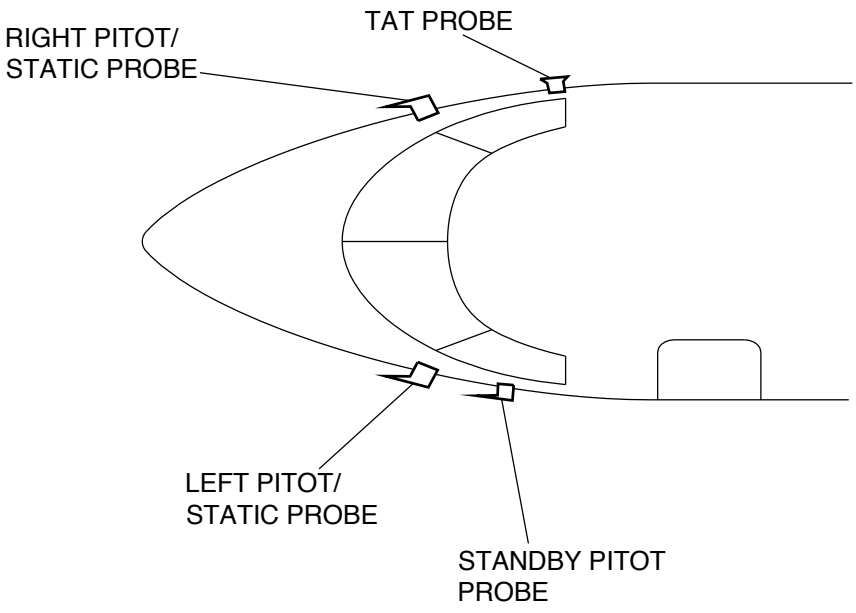
- Left pitot/static probe - One total pressure port, two static ports
- Right pitot/static probe - One total pressure port, two static ports
- Total air temperature probe - Right forward fuselage mounted
- Electrically heated probes for ice protection

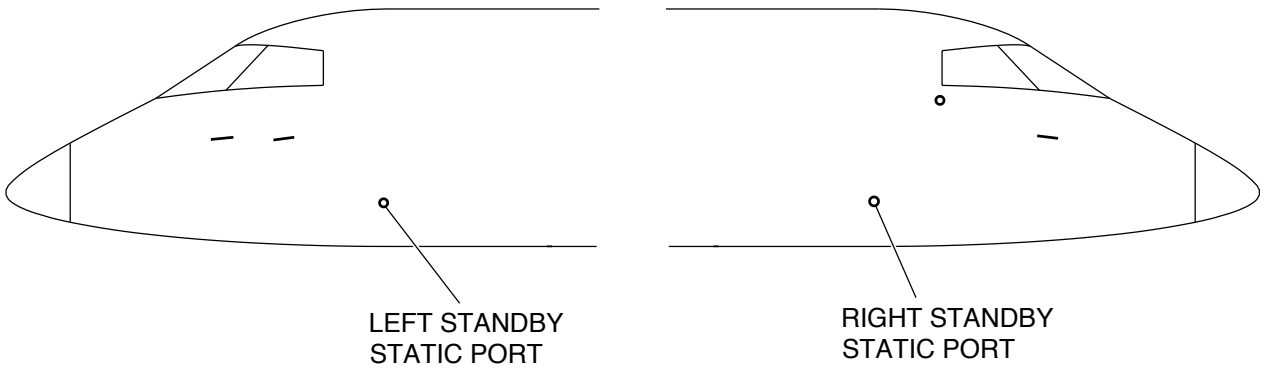
**Standby System Components:**

- Standby pitot probe - Single pressure port
- Two flush-mounted standby static ports
- Provides data to integrated standby instrument

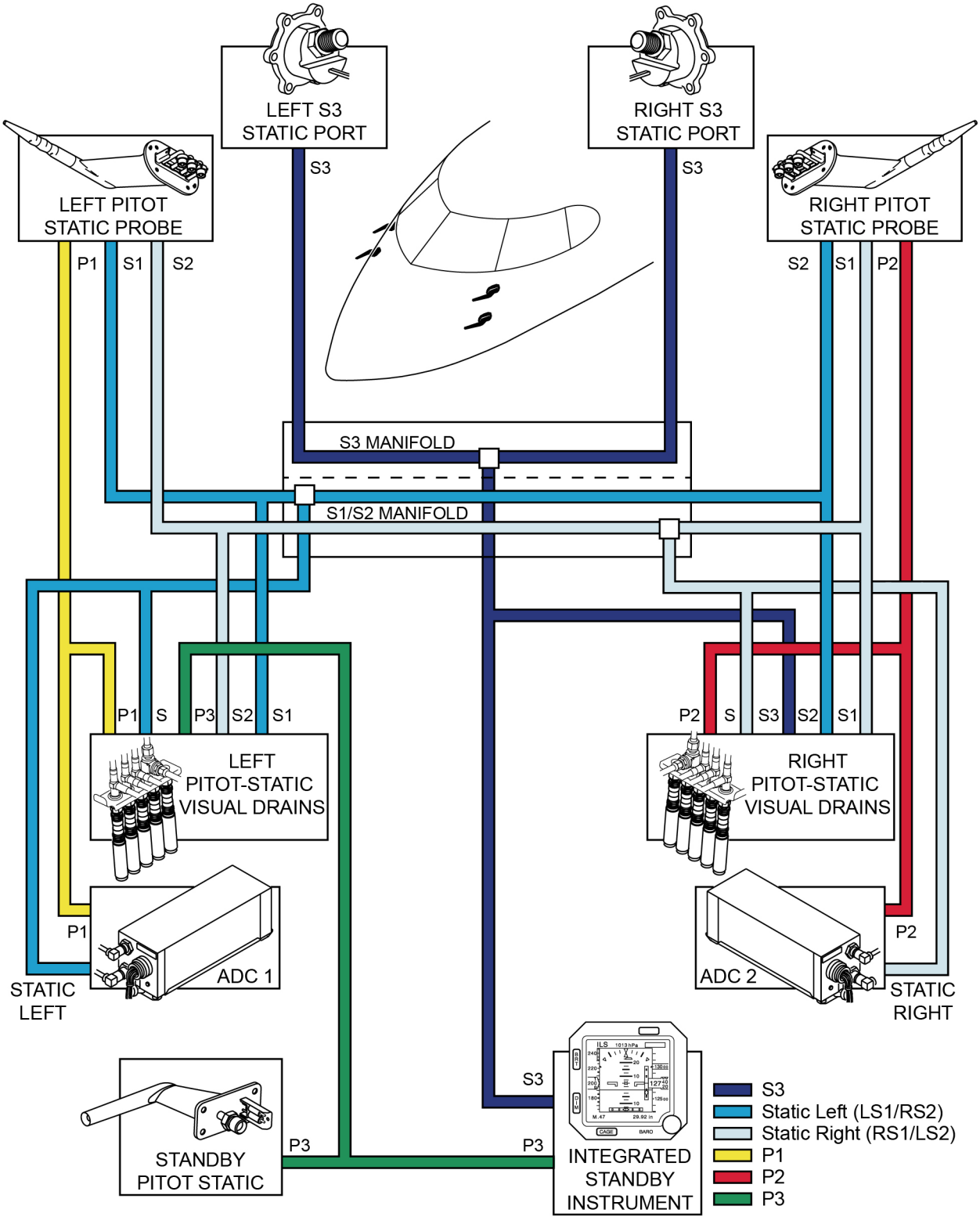
**Pitot Static Distribution:**

- P1 normal pitot input to ADC 1
- S1 normal static input to ADC 1
- P2 normal pitot input to ADC 2
- S2 normal static input to ADC 2


RIGHT PITOT/
STATIC PROBE
TAT PROBE
LEFT PITOT/
STATIC PROBE
STANDBY PITOT
PROBE


LEFT STANDBY
STATIC PORT
RIGHT STANDBY
STATIC PORT

## PITOT STATIC SCHEMATIC

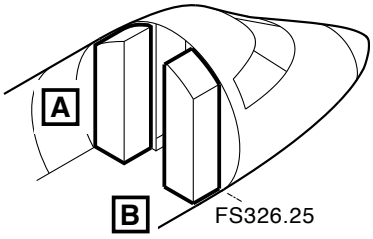


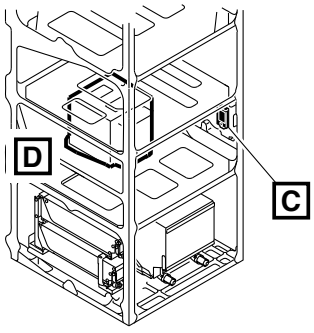
# VI. INERTIAL REFERENCE SYSTEM (IRS)

## A. IRS COMPONENTS

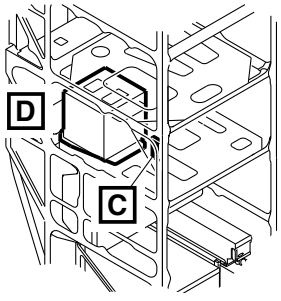
**System Architecture:**

- Two Inertial Reference Units (IRUs)
- Two mounting trays with shock isolation
- Two Aircraft Personality Modules (APMs)
- Dual independent attitude/heading references



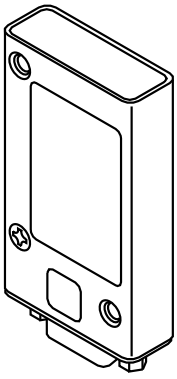

A





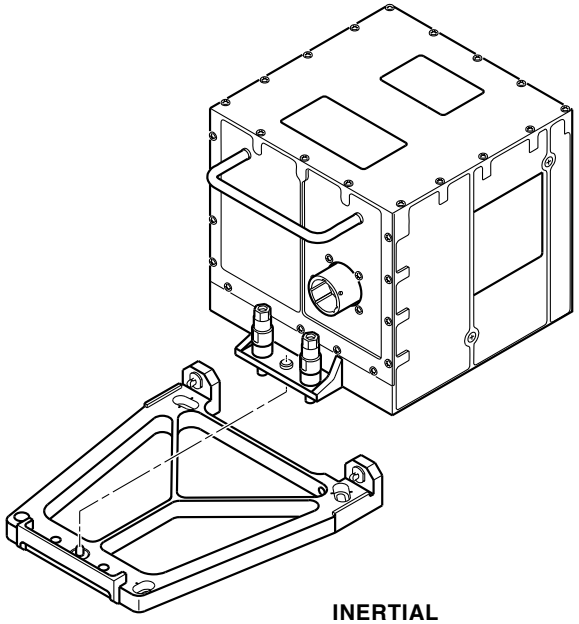


B



**AIRCRAFT PERSONALITY MODULE (APM)**

C



**INERTIAL REFERENCE UNIT (IRU)**

D

## B. IRS PARAMETERS PROVIDED

**Navigation Data Outputs:**

- Attitude (pitch and roll)
- Magnetic and true heading
- Angular rates and accelerations
- Inertial altitude and vertical speed
- Linear rates and accelerations
- Track angle and ground speed
- Wind speed and direction
- Flight path angle
- Aircraft position

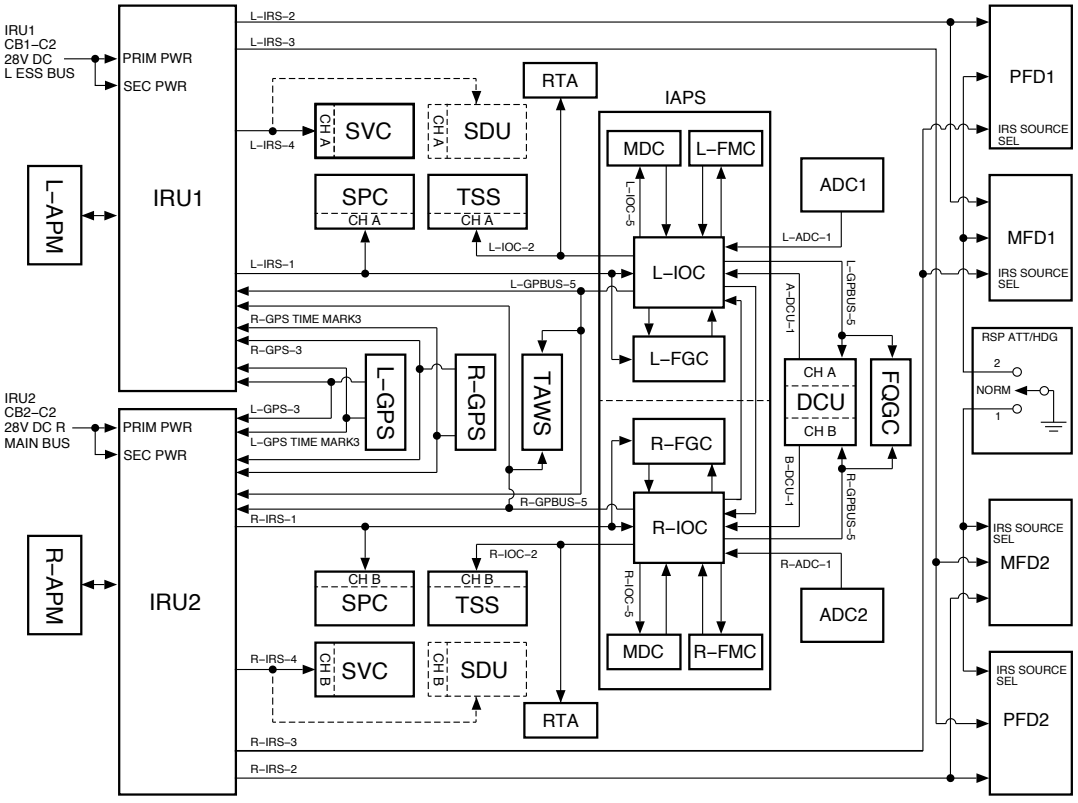
## C. IRS INTERFACES

- Aircraft Personality Module (APM)
- Global Positioning System (GPS)
- Synthetic Vision System (SVS)
- EFIS/EICAS Adaptive Flight Displays
- Weather radar system through IOCs (Input/Output Concentrator)
- Autoflight control system (FGCs in IAPS)
- IOCs in the Integrated Avionics Processing System (IAPS)
- Terrain Awareness Warning System (TAWS)
- Traffic Surveillance System (TSS) (TCAS/XPDR 1) through IOCs
- Stall Protection System (SPC)
- Flight Management Computer (FMC)
- Maintenance Diagnostic Computer (MDC)

## D. IRS OPERATING MODES

- OFF - System not powered
- ALIGN - Initial alignment mode (full or fast)
- NAV - Normal navigation mode
- ATT - Attitude-only mode (reversionary)
- AIM - Alignment in motion (air restart)

IRS INTERFACES




# VII. INTEGRATED STANDBY INSTRUMENT (ISI)

## A. ISI DISPLAY FEATURES

- Attitude indication
- Airspeed tape display
- Altitude tape display
- Slip/skid indicator
- Localizer and glideslope deviation (when ILS tuned)
- Barometric setting adjustment and display

**NOTE**: No heading information is provided




## B. ISI OPERATION

**Alignment Process:**

- Self-test initiated on power-up (10-20 seconds)
- ALIGNING flag displayed during attitude alignment
- Countdown timer shows alignment progress
- Operational after approximately 70 seconds

**ISI Controls:**

- CAGE button - Gyro caging function
- STD button - Standard barometric setting
- BRT/DIM buttons - Display brightness adjustment
- BARO knob - Barometric pressure correction

### C. ISI DATA SOURCES

- Standby pitot probe for airspeed
- Standby static ports for altitude
- Internal attitude reference system
- VHF NAV 1 for ILS data
- Red LOC or GS flag if data is invalid, scales removed

### D. ISI POWER SUPPLY

- 28V DC power
- Internal battery backup



## VIII. CLOCK/CHRONOMETER

### A. CLOCK FUNCTIONS




- UTC time display
- Local time display
- Elapsed time counter
- Count-up/count-down timer
- Date display

### B. CLOCK OPERATIONS

**Flight Time (FLT / RST):**

- Tracks flight time automatically
- Status determined by in air/on ground discrete input
- Press and hold FLT/RST for 2 seconds to reset timer

**Chronograph:**

- Pressing CHR starts a count-up timer
- Press again to stop, third press resets timer to 00:00

**GPS / MAN Mode:**

- In GPS mode clock displays external GPS time (GPS displayed on face)
- In MAN mode clock utilizes a highly accurate internal time base

**MODE:**

- Pressing toggles between UTC, LOC (local) time and Date displays
- Pressing and holding with enter the UTC, LOC and date mode

# IX. STANDBY COMPASS

## A. COMPONENTS AND LOCATION

**Primary Components:**

- Self-contained transparent molded bowl filled with silicon fluid
- Compass dial sphere with heading markings suspended in fluid
- Two adjustment compensators for magnetic interference correction
- Non-magnetic light bulb powered by 5 VDC from integral light controller
- Metal bellows allowing fluid volume expansion and contraction with temperature and altitude changes

## B. DISPLAY CHARACTERISTICS

**Heading Markings:**

- Cardinal headings displayed: N, E, S, W
- Numerals shown every 30 degrees
- Bars indicated every 10 degrees
- Last numeral omitted (e.g., "24" represents "240")

**Reading Method:**

- Aircraft heading read against vertical lubber line
- Center index mark on adjustment scale serves as reference point

## C. ADJUSTMENT FEATURES

**Mechanical Adjustments:**

- Vertical axis adjustment via two screws through extended holes in mounting bracket
- Index error adjustment scale at top of compass with center major index mark

**Magnetic Compensation:**

- Two compensators (B and C) installed at top area of compass
- Used to adjust readings for magnetic interferences
- Inertial Reference System (IRS) provides heading reference during adjustment procedures

## D. COMPASS CORRECTION CARD

**Description:**

- Installed on bracket above standby compass
- Contains STEER row for recording corrected headings

**Calibration Points:**

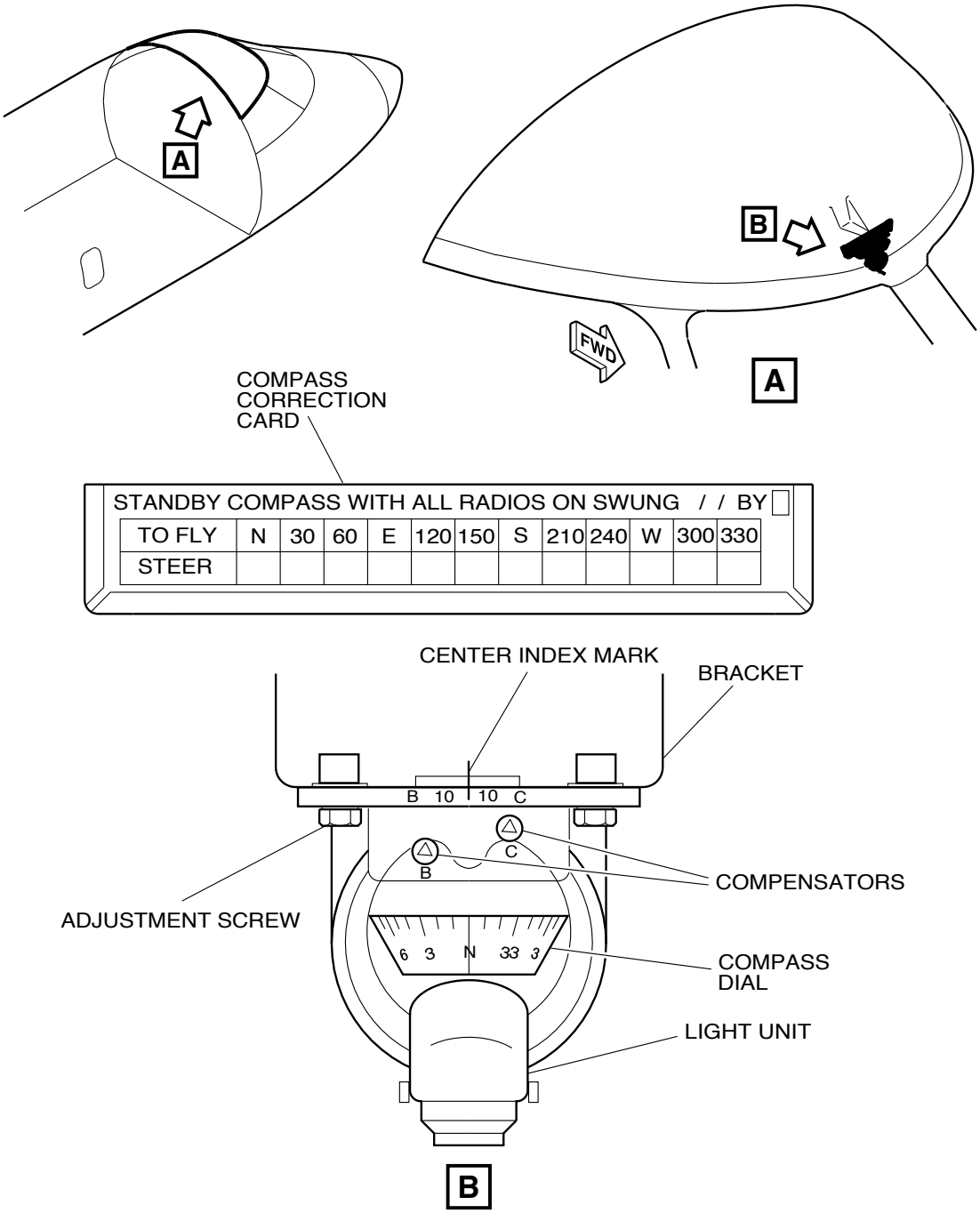
- Corrected headings recorded for cardinal directions (N, E, S, W)
- Additional corrections noted at 30-degree increments

## E. POWER REQUIREMENTS

- Lighting: 5 VDC from integral light controller
- Basic operation: No electrical power required for magnetic heading indication

## F. FLUID SYSTEM

- Fluid type: Silicon fluid for smooth movement and accurate indication
- Temperature compensation: Metal bellows accommodate fluid volume changes
- Function: Ensures free movement of compass dial for accurate heading display

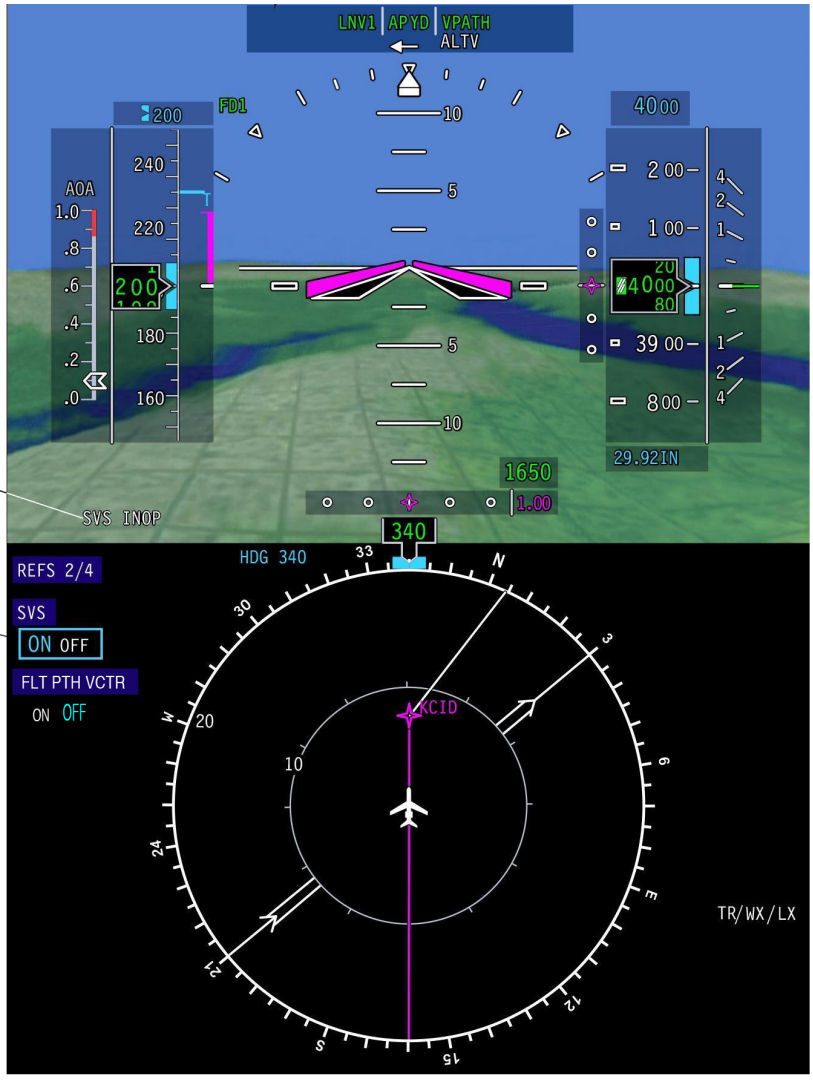



Note: L and R WSHLD/WINDOW switches must be temporarily selected OFF while the standby compass is being read.

## X. SYNTHETIC VISION SYSTEM (SVS)

The Synthetic Vision System (SVS) is designed as a sophisticated situational awareness enhancement feature for the flight crew. It replaces the normal sky/ground view on the Primary Flight Display (PFD) with a virtual view of the external environment, displaying elements such as surrounding terrain (color-coded by elevation) and depictions of the FMS flight plan origin/destination airports and runways.

The SVS utilizes aircraft system data, including current position and attitude from sources like the Inertial Reference System (IRS) and Global Positioning System (GPS), along with dedicated SVS terrain and airport/runway databases. This system is intended to assist the flight crew during situations like poor weather, at night, and with visual maneuvering.



## A. SVS COMPONENTS

**Hardware Elements:**

- Synthetic Vision Computer (SVC)
- SVS Configuration Module (SVCM)
- Video Interface Unit (VIU)
- FSU/SVC Data Load Switch
- Database Unit (DBU) interface

## B. SVS DISPLAY FEATURES

**Terrain Visualization:**

- 3D terrain representation
- Large bodies of water
- FMS flight plan integration
- Origin and destination airports
- Runway depictions (Position, Heading, Width, Length)
- Extended runway centerlines

## C. SVS DATA SOURCES

**Input Systems:**

- Air Data Computer for pressure altitude and temperature
- FMS for flight plan and airport data
- GPS for position information
- IRS for attitude and heading
- Database unit for terrain and airport databases

## D. SVS DATABASES

**Terrain Database:**

- Worldwide coverage
- No expiration date
- Enhanced regional updates available
- Aligns with runway databases

**Airport/Runway Database:**

- Updated every 28 days
- Synchronized with FMS navigation database
- Position, heading, width, length data
- Status indication when not current

| Elevation (ASL) | Color |
|---|---|
| <0 | Green |
| 0 to 1000 | Green |
| 1000 to 2000 | Green |
| 2000 to 3000 | Green |
| 3000 to 4000 | Tan |
| 4000 to 5000 | Tan |
| 5000 to 6000 | Tan |
| 6000 to 7000 | Tan |
| 7000 to 8000 | Brown |
| 8000 to 9000 | Brown |
| 9000 to 10000 | Brown |
| 10000 to 11000 | Brown |
| >11000 | Gray |
| Water | Blue |
| Sky | Blue |
| Missing | Black |

## E. SVS LIMITATIONS

**Operational Restrictions:**

- Situational awareness enhancement only
- Not for approach continuation below minimums
- Not a replacement for natural vision
- Not for low visibility operations
- No operational credit applicable
- Cannot be sole reference for flight tasks

## F. SVS CONTROLS AND ANNUNCIATIONS

- ON/OFF selection on REFS 2/4 menu
- Automatically enables FPV when selected ON
- SVS INOP annunciation below airspeed tape
- SVS RWY INOP for runway database issues
- No CAS messages for SVS system

## G. INTEGRATION

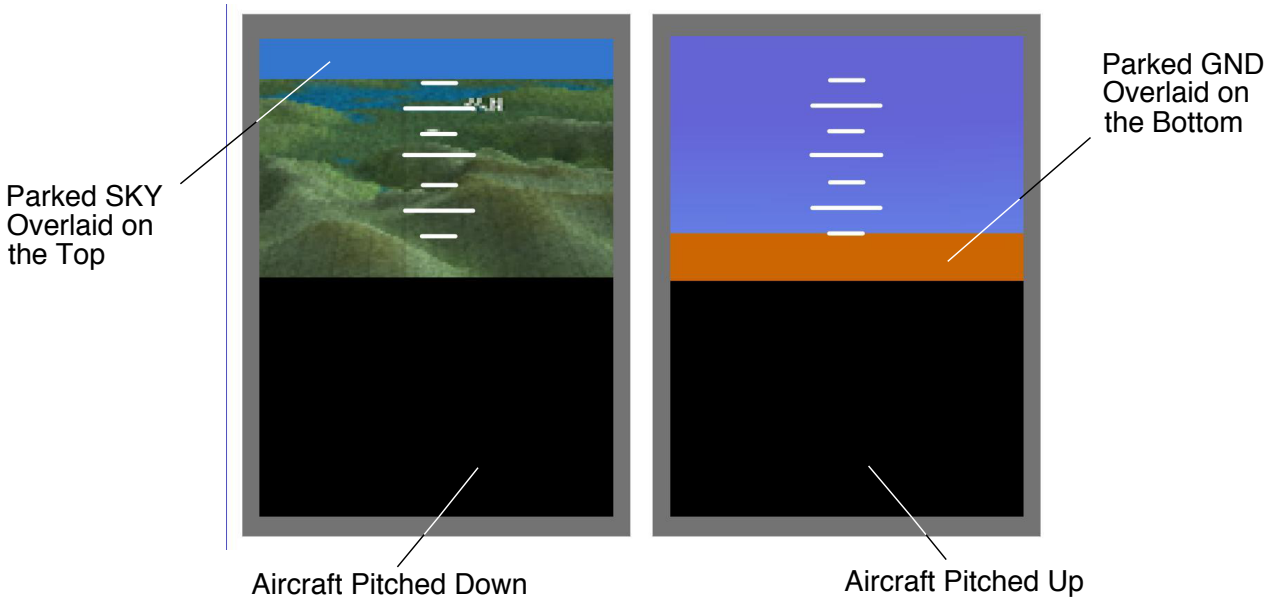
**Synthetic Vision System Integration:**

- Replaces traditional blue/brown ADI background
- Virtual terrain view with topographical features
- Large water bodies displayed in distinct blue
- Airport and runway symbology from FMS flight plan
- Terrain elevation color-coded altitude bands
- Texture patterns, shading, and grid overlays
- Missing terrain data displayed as black at sea level
- Controlled via SVS ON/OFF on REFS 2/4 menu

**SVS Parked Sky/Ground References:**

- Pitched down condition (below 20,000 feet):
    - Blue sky reference parks at top when horizon out of view
    - Instantly shown at -13 degrees pitch
    - Removed when pitch greater than -12 degrees
- Pitched down condition (above 20,000 feet):
    - Sky parks at horizon line position
    - Horizon out of view at -13.1 degrees
    - Instantly shown at -11 degrees
    - Removed when pitch greater than -10 degrees

- Pitched up condition (below 20,000 feet):
    - Brown ground reference parks at bottom
    - Instantly shown at +13 degrees pitch
    - Removed when pitch less than +12 degrees
- Pitched up condition (above 20,000 feet):
    - Ground parks at horizon line position
    - Horizon out of view at +13.1 degrees
    - Instantly shown at +11 degrees
    - Removed when pitch less than +10 degrees




**SVS System Removal Conditions:**

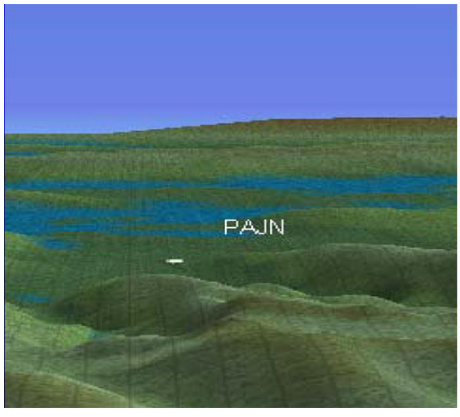
- SVS selected OFF via menu
- SVS failure detected
- Compressed PFD format selected
- Incorrect BARO setting below terrain (ground only)
- Unusual attitude occurrence
- Data miscompare conditions:
    - Heading, pitch, or roll miscompare
    - Airspeed or altitude miscompare
    - Attitude or Mach miscompare
- Display attitude differs from SVS image attitude
- Video image invalid or VIU failure

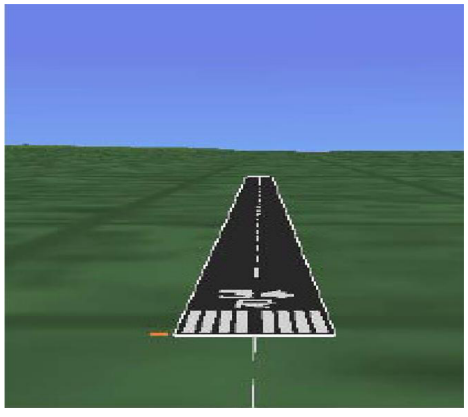
**SVS Annunciations:**

- SVS INOP message displayed when:
    - PFD-PFD or PFD-SVS pitch/roll/heading miscompare
    - GPS position accuracy inadequate
    - SVS safety monitor failure
    - SVC BIT or AFD video input failure
    - SVC terrain database failure
- SVS RWY INOP message displayed when:
    - SVC airport/runway database failure
    - Airport and runway symbols removed
    - SVS image remains displayed
- Annunciations positioned below airspeed tape
- SVS INOP takes precedence over SVS RWY INOP

**SVS Airports/Runways:**

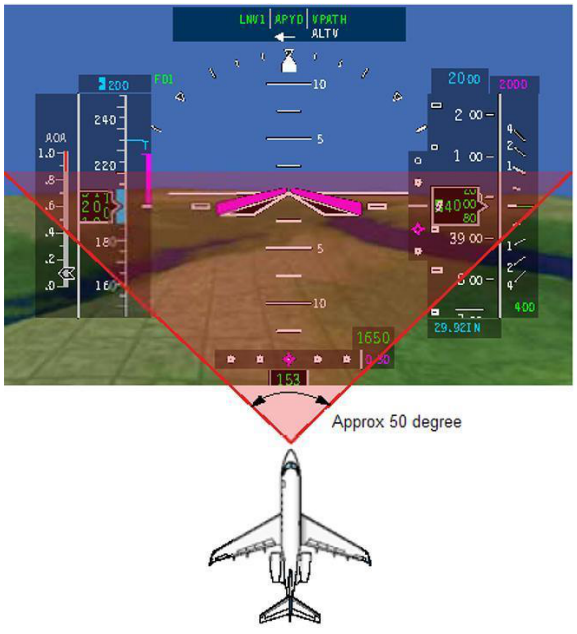
- Depiction of airport/runway requires an active flight plan in the FMS
- Airport symbol shows when 10-15 NM out
- Runway symbol is shown within 10 NM if runway selected in FMS
- Extended centerline is shown out to 7.5 NM
- Origin runway is removed 20 seconds after airborne
- Arrival runway is removed 120 seconds after landing
- Runway marking are generic and may not match actual markings
- Markings include identifier, centerline and threshold



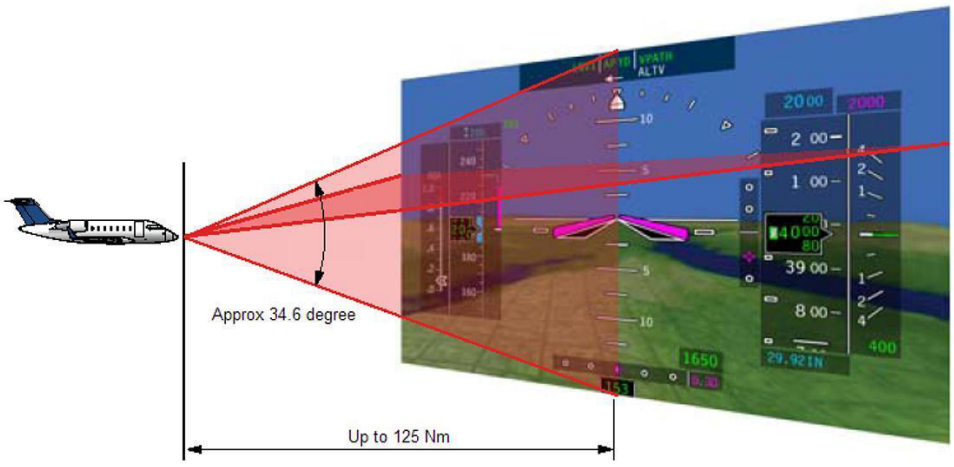



**SVS Field of View:**

- Conformal to the pitch tape
- 50° horizontal 34.6° vertical and up to 125 NM




**HORIZONTAL VIEW**

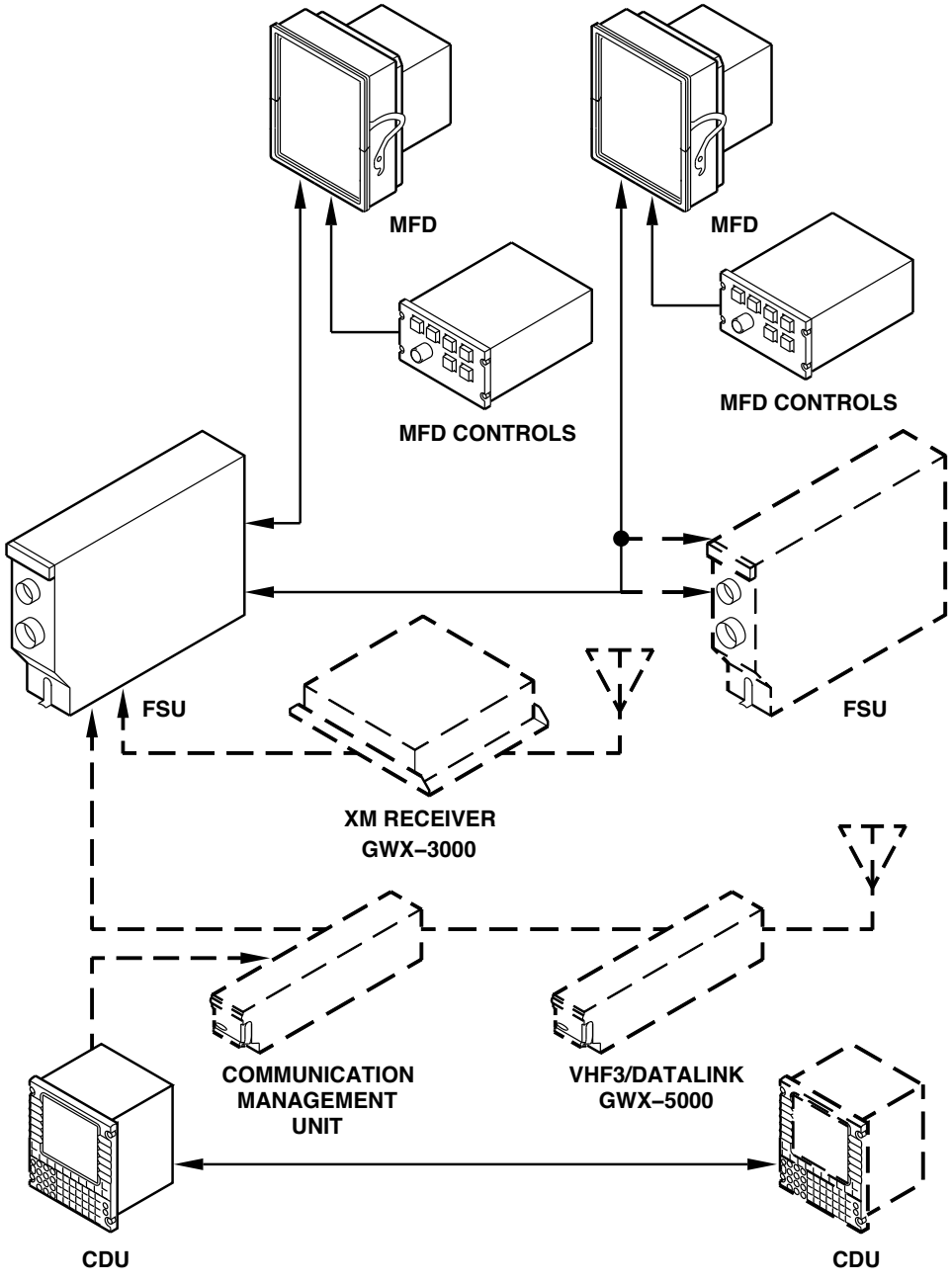



**VERTICAL VIEW**

## XI. INTEGRATED FLIGHT INFORMATION SYSTEM (IFIS)

The Integrated Flight Information System (IFIS) is fundamentally a Multifunction Display (MFD) upgrade intended to provide the flight crew with enhanced situational awareness. The IFIS integrates features such as Electronic Charts (E-Charts), Enhanced Map Overlays, and Graphical Weather (GWX) directly onto the MFD displays. Central to the system is the File Server Unit (FSU), which manages the processing and storage for all IFIS functions.

The system relies on various databases (including charts, airspace, airways, and graphical weather) and displays geo-political boundaries, airspace, and airways on the MFD (Enhanced Map overlays). The IFIS does not include enroute charts, and all weather products displayed are considered advisory in nature.



## A. IFIS COMPONENTS

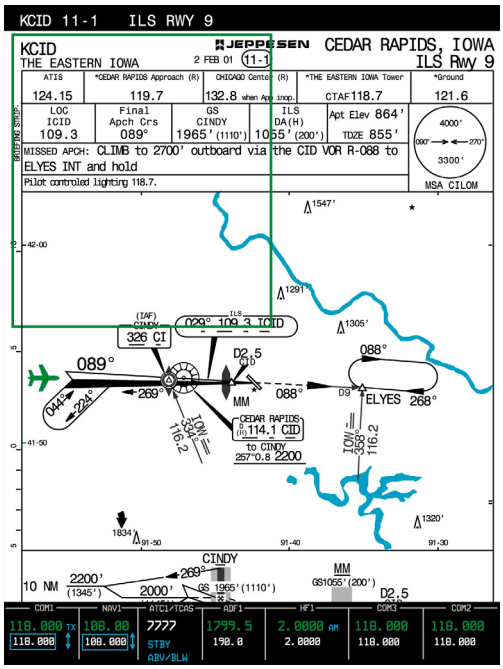
**System Architecture:**

- One or two File Server Units (FSUs)
- Two Multifunction Controls
- Two MFD displays
- XM Weather Receiver (optional)
- Database storage and processing

## B. ELECTRONIC CHARTS (ECH-5000)

**Chart Capabilities:**

- Approach plates
- Departure procedures (SIDs)
- Arrival procedures (STARs)
- Airport diagrams
- En route charts
- Terminal area charts
- Own-ship position overlay
- Dynamic zoom and pan functions




## C. ENHANCED MAP OVERLAYS (OVL-5000)

**Overlay Features:**

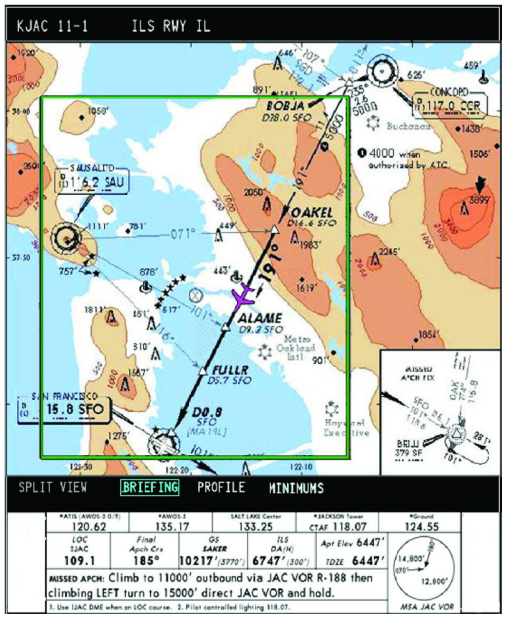
- Victor airways depiction
- Jet routes display
- Special use airspace boundaries
- Class B, C, D airspace
- Restricted and prohibited areas
- MOAs and warning areas
- Temporary flight restrictions (TFRs)
- Graphical TFR display with NOTAM ID

## D. GRAPHICAL WEATHER (GWX-3002)

**Weather Products Available:**

**US Weather Products:**

- NEXRAD radar imagery
- Echo tops
- Icing conditions
- Turbulence
- Lightning strikes
- Cloud tops




Briefing Split View

- Winds aloft with arrows
- TAF/METAR reports
- SIGMET/AIRMET text
- Surface analysis
- Temporary flight restrictions

**Canadian Weather Products:**

- TAF and METAR reports
- Textual SIGMETS and AIRMETS
- High resolution NEXRAD radar
- Winds aloft data
- Radar coverage areas

**Puerto Rico Weather Products:**

- Radar coverage
- High resolution NEXRAD
- TFR information




Profile Split View

## E. CHART ACCESS METHODS

**Quick Access:**

- Push CHART button on MFD control to display last viewed E-Chart
- Chart automatically selected by FMS when flight plan entered
- Loss of on-side FMS data prevents automatic fill-in of airports
- Select off-side FMS as NAV source to restore automatic fill-in

**Manual Selection Methods:**

- Via Chart Main Index menu
- Via Chart Type menu
- Via Chart List menu
- Using DATA knob to cycle through linked charts




Minimums Split View

## F. CHART MAIN INDEX OPERATIONS

**Accessing Chart Main Index:**

- With E-Chart displayed, push UPR or LWR
- MENU button
- From Chart Type/List/NOTAM menu, push
- ESC button
- Airport Field Configuration:
- Origin - Supplied by FMS from flight plan
- Destination - Supplied by FMS from flight plan
- Alternate - Supplied by FMS from flight plan
- Other Airport - Manual entry by pilot

**Shortcut Controls Available:**

- ORIGIN shortcuts:
    - Airport
    - Departure
    - Any Chart
    - Chart NOTAMS
- DESTINATION shortcuts:
    - Arrival
    - Approach
    - Airport
    - Any Chart
    - Chart NOTAMS
- ALTERNATE/OTHER AIRPORT shortcuts:
    - Any Chart (two selections)
    - Chart NOTAMS

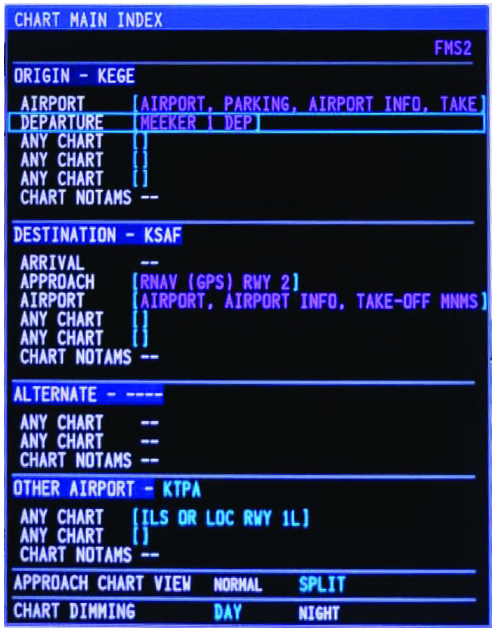



Chart Main Index View

**Shortcut Color Coding:**

- Magenta - Chart selected automatically by FMS
- White - FMS found no match or multiple matches
- Cyan - Chart selected manually by pilot

## G. CHART SELECTION PROCEDURES

**Using ANY CHART Function:**

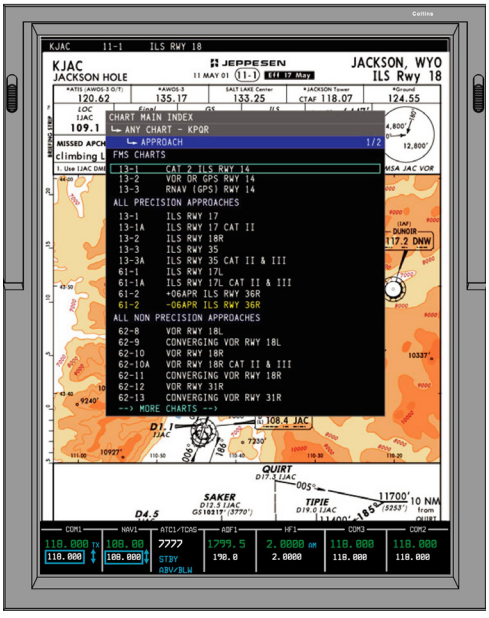
- Turn MENU ADV knob to position cursor on ANY CHART shortcut
- Push and hold PUSH SELECT button to access Chart Type menu
- Select from available chart types:
    - Approach
    - Airport
    - Departure
    - Arrival
    - Airspace
    - Noise

**Direct Chart Selection:**

- Turn MENU ADV knob to position cursor on desired chart shortcut
- Push PUSH SELECT button to display associated chart

**Using Chart List:**

- Access via Display Chart, Chart Main Index, or Chart Type menus
- Turn MENU ADV knob to position cursor on desired chart
- Push PUSH SELECT button to select chart for display




## H. CHART MANIPULATION CONTROLS

**Zoom Operations:**

- ZOOM (+) button increases magnification
- ZOOM (–) button decreases magnification
- Operate joystick to move pan/zoom window to desired area
- Chart initially scaled with width filling display
- Landscape rotation rescales height to fill display

**Pan Operations:**

- Use joystick to move desired area into view when zoomed
- Horizontal joystick movement pans horizontally
- Vertical joystick movement pans vertically
- Last viewed pan position recalled when chart reselected

**Orientation Control:**

- Push orientation button (below CHART button) to rotate ninety degrees
- First push rotates chart ninety degrees
- Second push returns to original orientation
- Default orientation determined by chart database
- Last viewed orientation recalled when chart reselected

## I. SPLIT VIEW OPERATIONS

**Accessing Split View:**

- Navigate to APPROACH CHART VIEW on Chart Main Index
- Turn DATA knob to select SPLIT option
- Push PUSH SELECT button when SPLIT becomes cyan

**Split View Display Options:**

- Top half - Chart display
- Bottom half selectable:
- BRIEFING - Briefing data display
- PROFILE - Approach profile view
- MINIMUMS - Minimums data

## J. DATA ENTRY OPERATIONS

**Airport Identifier Entry:**

- Use MENU ADV knob to position cursor on data entry field
- Rotate DATA knob clockwise to move forward through characters
- Rotate DATA knob counterclockwise to move backward through characters
- Push PUSH SELECT to confirm entry

**Cycling Through Linked Charts:**

- With chart displayed, rotate DATA knob
- Cycles through charts associated with displayed airport

## K. MENU NAVIGATION

**Menu Tree Navigation:**

- UPR MENU button - Display/remove upper menu
- LWR MENU button - Display/remove lower menu
- ESC button - Move up one level in menu tree
- PUSH SELECT button - Select highlighted item

**Window Control with JSTK:**

- Push JSTK button to change active window in split formats
- JOYSTICK annunciation arrow indicates active window
- Valid for Checklist, PPOS Map, Plan
- Map, 3D Plan Map, XM Weather




## L. CHART STATUS INDICATIONS

**Effectivity Messages:**

- White text - Current chart
- Yellow text - Non-current chart
- OUT OF DATE - Chart cycle expired
- CHECK DATE - Unable to verify effectivity

**FMS Integration Status:**

- Loss of FMS data evident by unavailable auto fill-in
- Switching to off-side FMS restores functionality

## M. CHART DIMMING CONTROL

**Day/Night Selection:**

- Turn MENU ADV knob to CHART DIMMING line item
- Turn DATA knob to select DAY or NIGHT
- Control located at bottom of Chart Main Index




## N. NOTAMS ACCESS

**Viewing Chart NOTAMS:**

- Access from CHART NOTAMS shortcut on Chart Main Index
- Displays NOTAMS for selected airport
- NOTAM summary and details shown
- Data entry field allows selection of specific NOTAM

**NOTAM Display Fields:**

- NOTAM type
- Effectivity dates
- Begin/end dates
- Summary information
- Detailed NOTAM text

# XII. DISPLAY FAILURE FLAGS AND ANNUNCIATIONS

## A. PFD/MFD FLAGS

**Critical Failures (Red Flags):**

**WARNING PFD/MFD Flags**

Critical failures displayed in red

| Message | Meaning | Inhibits | Aural Warning |
|---|---|---|---|
| **AOA** | A red, boxed, AOA flag shows in a centered location in the AOA indicator field when no valid AOA data is available. The flag flashes for five seconds, then remains steady. | — | — |
| **ALT** | Indicates an invalid altitude source. Crosscheck standby instruments altitude to validate instruments | — | — |
| **AP** | Indicates a monitored autopilot disconnect | — | — |
| **ATT** | Indicates an invalid attitude source and shows in the center of the attitude sphere. Most likely cause is an IRS failure. The attitude ball, pitch tape, and roll pointer are removed when the ATT flag is in view. | — | — |
| **FD** | Indicates a fault in the flight guidance computer | — | — |
| **FMS 1 FMS 2** | Indicates that data from the active nav source is missing or invalid | — | — |
| **LOC 1 LOC 2** | Indicates that data from the active nav source is missing or invalid | — | — |
| **VOR 1 VOR 2** | Indicates that data from the active source is missing or invalid | — | — |
| **HDG** | Indicates an invalid heading source and shows in place of the heading digital readout in the center of the PFD. Most likely cause is an IRS failure. The compass is positioned so North is directly under the lubber line when the HDG flag is in view. | — | — |
| **IAS** | Indicates an invalid air data source and illuminates in the center of the airspeed tape | — | — |
| **LSC** | Shows when no stall warning speed comparison is available and the LSC will not show | — | — |
| **MACH** | Indicates an invalid air data source and illuminates in the center of the airspeed tape | — | — |
| **RA** | Indicates an unreliable radar altitude | — | — |
| **VNV** | Indicates when VNAV data from the FMS is missing or invalid | — | — |
| **VS** | Indicates in place of the vertical speed scale when vertical speed data from the air data computer is missing or invalid | — | — |

## B. COMPARATOR FLAGS (AMBER)

### CAUTION MESSAGES

Timely crew awareness/action needed - Each accompanied by a single chime

| Message | Meaning | Inhibits | Aural Warning |
|---|---|---|---|
| AIR DATA 1 (2) FAULT | The angle of attack input to the ADC has failed. The affected altitude may indicate up to 150 ft low | TO/LAND | — |
| EFIS COMPARATOR INOP | The EFIS comparator is unable to compare one or more of the following parameters: altitude, airspeed, roll attitude, pitch attitude, heading, radio altitude, flight director, localizer or glideslope, FMS lateral and vertical deviation pointers. | TO/LAND | — |
| EFIS MISCOMPARE | There is a mismatch between the onside and cross-side data. Accompanied by an amber PFD annunciation (flag): ALT, IAS, ROL, PIT, ATT, HDG, LOC, GS, RA, or FD | — | — |
| L IAPS FAIL | The left integrated processing system has failed | TO/LAND | — |
| R IAPS FAIL | The right integrated processing system has failed | TO/LAND | — |
| PFD X-TALK FAIL | Communication between the PFDs has failed. REFs menu pages 1, 2 and 3 are not synchronized. The EFIS comparator will be inoperative and is unable to compare one or more of the following parameters: altitude, airspeed, roll, attitude, pitch attitude, heading, radio altitude, flight director, localizer or glideslope | TO/LAND | — |

### ADVISORY MESSAGES

Crew awareness - no immediate action required

| Message | Meaning | Inhibits | Aural Warning |
|---|---|---|---|
| DCU FAN FAIL | The avionics data concentrator unit fan has failed | TO/LAND | — |
| DCU FAULT | Channel A or B in the data concentrator unit has failed, the yaw damper may fail. The rudder travel limiter monitoring may be inoperative. | TO/LAND | — |
| IAPS FAN FAULT | The IAPS is indicating an over temperature condition or fan failure. Opening avionics rack doors and/or lowering cabin and cockpit temperatures may aid in cooling | TO/LAND | — |
| MFD X-TALK FAIL | Communication between the MFDs has failed, and cross side tuning will not be available | TO/LAND | — |
| RDC FAN FAIL | The remote data concentrator fan is inoperative. | TO/LAND | — |
| RDC FAULT | Channel A or B of the remote data concentrator has failed with no loss of functionality | TO/LAND | — |

Status Messages:

| STATUS MESSAGES | | | |
|---|---|---|---|
| Information only - No crew action required | | | |
| Message | Meaning | Inhibits | Aural Warning |
| **IRS 1 IN ATT** | IRU 1 is in Attitude mode. | — | — |
| **IRS 2 IN ATT** | IRU 2 is in Attitude mode. | — | — |
| **STBY INST OFF** | The standby instrument has been selected OFF. | — | — |

## B. COMPARATOR FLAGS

- **IAS** - Displays when the difference between the two airspeed values is not within 10 knots.
- **ALT** - Displays when the difference between the two pressure altitude values is not within the limit.
- **PIT** - Displays when the pitch data between the two Attitude Heading Computers (AHCs) is out of limits.
- **ROL** - Displays when the roll data between the two AHCs is out of limits.
- **ATT** - Displays when both the pitch and roll data between the two AHCs are out of limits.
- **FD** - Displays during a monitored approach when the difference between the two flight director steering commands is not within limits.
- **FMS** - Displays during an LPV approach when the difference between the two LPV (or ANP) lateral deviations is not within the limit.
- **GS** - Displays during a monitored approach when the difference between the two glideslope deviations is not within the limit.
- **HDG** - Displays when the difference between the two heading values is not within 6 degrees (active whenever the roll angle is less than or equal to 20 degrees).
- **LOC** - Displays during a monitored approach when the difference between the two localizer deviations is not within the limit.
- **MACH** - Displays when the difference between the two Mach values is greater than .03 Mach.
- **RA** – Displays when the difference between the radio altitudes supplied to the on-side and cross-side is not within the limit (active whenever the radio altitude is less than 2,450 feet AGL).
- **VNV** - Displays during an LPV approach when the difference between the FMS-computed vertical deviation from each AFD exceeds the comparator limit.
- **VSPD** - Displays if any on-side FMS VSPEED is 2 or more knots different from its cross-side counterpart, or if a PFD cannot compare VSPEEDS from both FMSs.
- **STAB** - Replaces the horizontal stabilizer trim legend on the Primary Flight Controls display when a miscompare condition exists.
- **Tilt** - The tilt value changes to amber if the tilt value commanded and the tilt value returned from the weather radar disagree for more than 5 seconds.

## C. SYSTEM WARNING FLAGS (RED)

- **ALT** - Displays when the barometric altitude data from the Air Data Computer (ADC) is missing or invalid.
- **AOA** - Displays when no valid AOA data is available, or when the stall protection system fails.

- **AP** - Flashes red to indicate that the autopilot has disengaged manually or automatically.
- **ATT** - Displays when the attitude data from the selected AHRS or IRS is missing or invalid.
- **FD** - Displays when there is a detected fault in the Flight Guidance Computer (FGC) or the signals required for basic flight director operation.
- **GS** - Displays when the localizer (LOC) is the active NAV source and the vertical deviation data is missing or invalid.
- **HDG** - Displays when heading data from the AHC/IRS is missing or invalid.
- **IAS** - Displays when the indicated airspeed data from the ADC is missing or invalid.
- **LOC or FMS** - Displays when the lateral deviation data from the active NAV source (LOC or FMS) is missing or invalid.
- **LSC** - Displays when the data required to compute the low speed cue marker is unavailable, indicating no stall warning speed comparison is available.
- **MACH** - Displays when Mach data from the ADC is missing or invalid when the airspeed reaches or exceeds .99 Mach.
- **NAV Source (VOR1, VOR2, LOC1, LOC2, FMS1, FMS2)** - The active NAV source message turns red and is boxed when data from that active NAV source is missing or invalid.
- **RA** - Displays when radio altitude data is missing or invalid.
- **STALL** - Displays when a stall condition is detected by the Stall Protection Computer (SPC).
- **VNAV / VNV -)**: Displays when VNAV data from the FMS is missing or invalid.
- **VS** - Displays when vertical speed data from the ADC is missing or invalid

## D. SYSTEM FAULT/CAUTION FLAGS (AMBER/CYAN)

- **CCP** - Displays in amber when the Cursor Control Panel (CCP) is reported as failed.
- **DCP** - Displays in amber when the Display Control Panel (DCP) is reported as failed.
- **LOCx (Preselect NAV Source)** - Displays struck through with a cyan line if the preselect localizer is invalid or erroneous.
- **LX FAIL** - Displays in amber when a Lightning Detection System (LDS) fault is reported while the lightning overlay is selected.
- **MAP** - Displays in amber if a fault is detected in any data that is required to show the map.
- **TCAS FAIL** - Displays in amber when a TCAS system fault is detected.
- **TERRAIN FAIL** - Displays in amber when the Terrain Awareness Warning System (TAWS) is reported as failed.
- **TERRAIN NOT AVAILABLE** - Displays in amber when TAWS is reporting that terrain data is not available for the current location.
- **WX FAIL**- Displays in amber when weather data is not available to the display while the weather radar overlay is selected.
- **WX FAULT**- Displays in amber when the weather radar reports itself as failed.
- **XTLK** - Displays in amber when a PFD or MFD loses communication with any other PFD or MFD.
- **YD** - Displays in amber to indicate the yaw damper has disengaged (e.g., manually, automatically due to limits, or because data from the FGC is missing).

# XIII. EICAS MESSAGES

### WARNING MESSAGES

None specific to flight instruments system

### CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed - Each accompanied by a single chime

| Message | Inhibits | Meaning | Aural |
|---|---|---|---|
| AIR SATA 1 (2) FAULT | TO/LAND | The angle of attack input to the ADC has failed. The affected altitude may indicate up to 150 ft low | - |
| EFIS COMPARATOR INOP | TO/LAND | The EFIS comparator is unable to compare one or more of the following parameters: altitude, airspeed, roll attitude, pitch attitude, heading, radio altitude, flight director, localizer or glideslope, FMS lateral and vertical deviation pointers. | - |
| EFIS MISCOMPARE | - | There is a mismatch between the onside and cross-sde data. Accompanied by an amber PFD annunciation (flag): ATL, IAS, ROL, PIT, ATT, HDG, LOC, GS, RA, or FD | - |
| L IAPS FAIL | TO/LAND | The left integrated processing system has failed | - |
| R IAPS FAIL | TO/LAND | The right integrated processing system has failed | - |
| PFD X-TALK FAIL | TO/LAND | Communication between the PFDs has failed. REFs menu pages 1, 2 and 3 are not synchronized. The EFIS comparator will be inoperative and is unable to compare one or more of the following parameters: altitude, airspeed, roll, attitude, pitch attitude, heading, radio altitude, flight director, localizer or glidescope. | - |

### ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Inhibits | Meaning |
|---|---|---|
| DCU FAN FAIL | TO/LAND | The avionics data concentrator unit fan has failed. |
| DCU FAULT | TO/LAND | Channel A or B in the data contractor unit has failed, the yaw damper may fail. The rudder travel limiter monitoring may be inoperative. |
| IAPS FAN FAULT | TO/LAND | The IAPS indicating an over temperature condition or fan failure. Opening avionics rack doors and/or lowering cabin and cockpit temperatures may aid in cooling. |
| MFD X-TALK FAIL | TO/LAND | Communication between the MFDs has failed, and cross side tuning will not be available. |
| RDC FAN FAIL | TO/LAND | The remote data concentrator fan is inoperative. |
| RDC FAULT | TO/LAND | Channel A or B of the remote data concentrator has failed with no loss of functionality. |

### STATUS MESSAGES

| STATUS MESSAGES | | | |
|---|---|---|---|
| Information only - No crew action required | | | |
| **Message** | **Inhibits** | **Meaning** | **Aural** |
| **IRS 1 IN ATT** | - | IRU 1 is in Attitude mode. | - |
| **RS 2 IN ATT** | - | IRU 2 is in Attitude mode. | - |
| **STBY INST OFF** | - | The standby intrument has been selected OFF. | - |

# XIV. LIMITATIONS

### DISPLAY LIMITATIONS

- Synthetic Vision System not approved for operational credit
- SVS not to be used as sole reference for any flight task

# XV. CIRCUIT BREAKER

Flight Instruments System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| PFD 1 | LEFT ESS | CB1-C3 |
| PFD 2 | RIGHT MAIN | CB2-C3 |
| MFD 1 | LEFT ESS | CB1-C5 |
| MFD 2 | RIGHT MAIN | CB2-C5 |
| DCP 1 | LEFT ESS | CB1-C4 |
| DCP 2 | RIGHT MAIN | CB2-C4 |
| IRU 1 | LEFT ESS | CB1-C2 |
| IRU 2 | RIGHT MAIN | CB2-C2 |
| ADC 1 | LEFT ESS | CB1-B2 |
| ADC 2 | RIGHT ESS | CB2-B2 |
| ISI | LEFT ESS | CB1-B3 |
| CLOCK | LEFT ESS | CB3-F9 |
| CLOCK STBY | LEFT BATT | CB3-F8 |
| SVC/VIU | RIGHT MAIN | CB2-A7 |
| FSU 1 | LEFT MAIN | CB1-C6 |
| FSU 2 | RIGHT MAIN | CB2-D6 |
| XM WX | LEFT MAIN | CB1-C7 |
| PFD 1 HTR | LEFT MAIN | CB3-F6 |
| PFD 2 HTR | RIGHT MAIN | CB4-F6 |
| MFD 1 HTR | LEFT MAIN | CB3-F7 |
| MFD 2 HTR | RIGHT MAIN | CB4-F7 |

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## XVI. CHAPTER 18 QUIZ

1) How many adaptive flight displays (AFDs) are installed in the Challenger 350 EFIS?

A) 2
B) 3
C) 4
D) 5

2) What is the normal alignment time for the Integrated Standby Instrument (ISI)?

A) 30 seconds
B) 70 seconds
C) 90 seconds
D) 120 seconds

3) What is the tilt range for the weather radar in manual mode?

A) -10° to +10°
B) -15° to +15°
C) -20° to +20°
D) -30° to +30°

4) Which button on the Display Control Panel toggles between PPOS and ROSE formats?

A) NAV SRC
B) TFC
C) FRMT
D) BRG SRC

5) At what altitude does the radio altitude display on the PFD?

A) Below 1,500 feet AGL
B) Below 2,000 feet AGL
C) Below 2,500 feet AGL
D) Below 3,000 feet AGL

6) What power source supplies the left PFD?

A) 28V DC L ESS BUS
B) 28V DC L MAIN BUS
C) 28V DC R MAIN BUS
D) 28V DC BATT BUS

7) Which system provides attitude, heading, and position data to the flight displays?

A) Air Data Computer
B) Flight Management System
C) Inertial Reference System
D) GPS only

8) How often is the SVS airport/runway database updated?

A) Every 14 days
B) Every 28 days
C) Every 56 days
D) Never expires

9) What happens when the ATT/HDG reversion switch is placed in position 1?

A) All displays use IRS 2 data
B) All displays use onside IRS data
C) All displays use IRS 1 data
D) IRS system is disabled

10) Which CAS message indicates the EFIS cannot compare parameters between sides?

A) EFIS MISCOMPARE
B) PFD X-TALK FAIL
C) EFIS COMPARATOR INOP
D) DCU FAULT

11) What is the default TCAS range when selected via long press of the TFC button?

A) 5 nm
B) 10 nm
C) 20 nm
D) 40 nm

12) The ROAAS in-air warning occurs between which altitudes?

A) 500 to 200 feet
B) 450 to 200 feet
C) 200 feet to touchdown
D) 100 feet to touchdown

13) Which button on the MCP is used to display electronic checklists?

A) STAT
B) CKLS
C) ESC
D) SUMRY

14) What color indicates terrain 500 feet or more below the aircraft on TAWS?

A) Red
B) Yellow
C) Green
D) Cyan

15) When DME HOLD is selected, what happens?

A) DME frequency changes with VOR
B) DME holds current frequency while VOR can be tuned
C) DME is turned off
D) DME displays distance to next waypoint

16) Which switch position on the RSP TUNE selector enables emergency frequency?

A) MFD ONLY
B) CDU
C) COM 1 121.50
D) NORM

17) What indicates a Traffic Advisory on the TCAS display?

A) White diamond
B) Yellow circle
C) Red square
D) Cyan diamond

18) The Air Data Computer calculates all of the following EXCEPT:

A) Pressure altitude
B) True airspeed
C) Angle of attack
D) Wind speed and direction

19) How many File Server Units can be installed for IFIS?

A) 1 only
B) 1 or 2
C) 2 only
D) Up to 4

20) Which database for the SVS never expires?

A) Airport database
B) Runway database
C) Terrain database
D) Navigation database

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CL-350



CL-350 TRAINING MANUAL

# NAVIGATION SYSTEM | 19

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# NAVIGATION SYSTEM

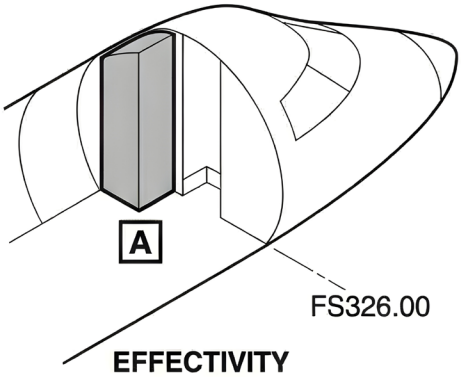
## I. INTRODUCTION

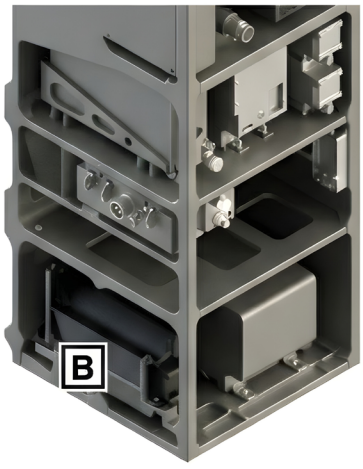
The navigation system provides comprehensive positioning, guidance, and situational awareness capabilities for all phases of flight operations. The system integrates multiple navigation sensors including VHF and HF communication radios, VHF navigation receivers, GPS/GNSS, DME, ADF, inertial reference systems, and terrain awareness systems to deliver precise navigation solutions through the dual Flight Management System. Advanced features including terrain awareness, traffic collision avoidance, synthetic vision, and runway awareness enhance operational safety and efficiency throughout the flight envelope.

### SYSTEM SPECIFICATIONS

Navigation System Specifications

| Parameter | Value/Description |
|---|---|
| Navigation Receivers | NAV-4000 and NAV-4500 |
| VOR Frequency Range | 108.00 to 117.95 MHz |
| VOR Channel Spacing | 50 kHz (160 channels) |
| Localizer Frequency Range | 108.10 to 111.95 MHz |
| Localizer Channel Spacing | 50 kHz (40 channels) |
| Glideslope Frequency Range | 329.15 to 335.00 MHz |
| Glideslope Channel Spacing | 150 kHz (40 channels) |
| Marker Beacon Frequency | 75.00 MHz (preset) |
| DME Frequency Range | 962 to 1213 MHz |
| DME Maximum Tracking Range | 300 nm |
| ADF Frequency Range | 190 to 1799 kHz |
| Maritime Distress Bands (via ADF) | 2088 to 2094 kHz, 2179 to 2185 kHz |
| GPS Sensors | 2 (dual redundancy) |
| FMS Computers | 2 x FMC-6200 |
| Database Unit | DBU-5010E |
| Transponder Modes | Mode A, Mode C, Mode S, ADS-B Out |
| TCAS Version | TCAS II Version 7.1 |
| Weather Radar Range | 300 nm maximum |
| Radio Altimeter Range | -20 to 2500 feet AGL |
| TAWS Modes | 1-7 plus sterrain awareness |




A

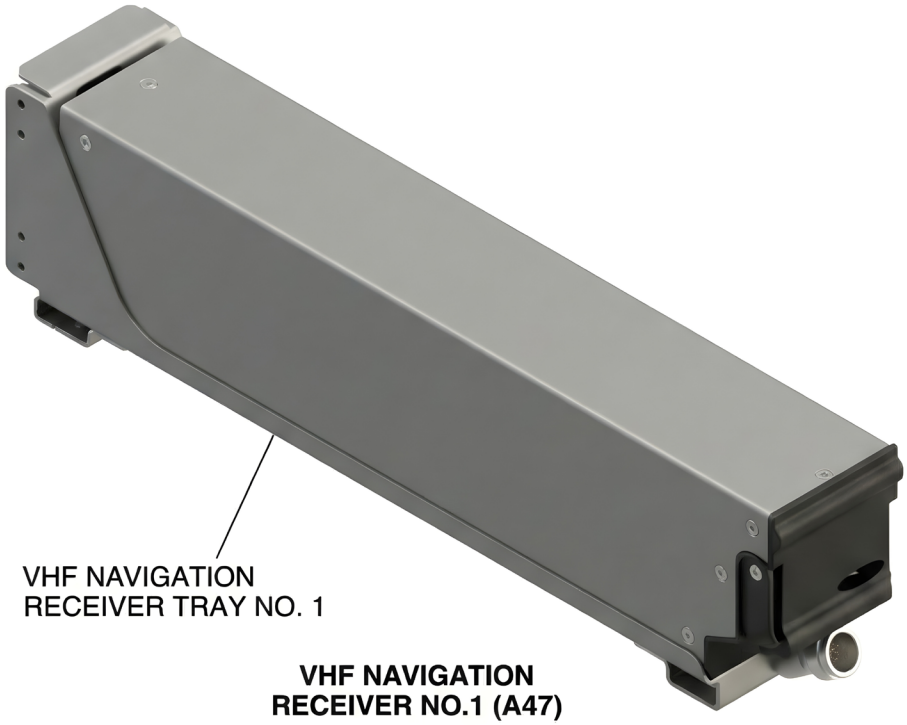
**EFFECTIVITY**

01 A/C Post SB350–34–001

02 A/C 20501 to 20874 and A/C Pre SB350–22–004

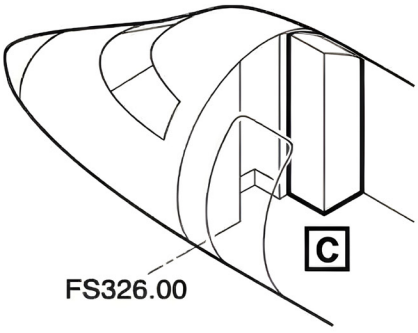
03 A/C 20875 to 20936 Pre SB350–22–002 and
A/C 20994 Post SB350–22–005 and A/C 20622
Post SB350–22–004 and A/C 21095 and Subs Post SB350–76–005

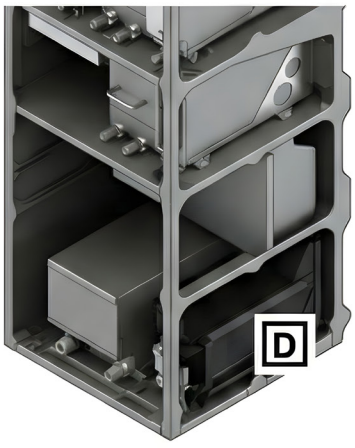
04 A/C 20622 and 20875 to 20936
Post SB350–22–002 and A/C Pre SB350–22–005 and
A/C 20937 to 21094 and A/C 21095 and Subs Pre SB350–76–005



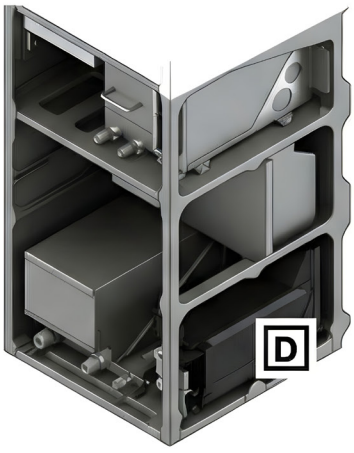

**VHF NAVIGATION**
**RECEIVER NO.1 (A47)**

B

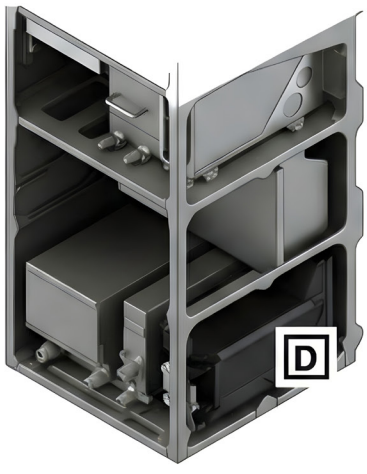


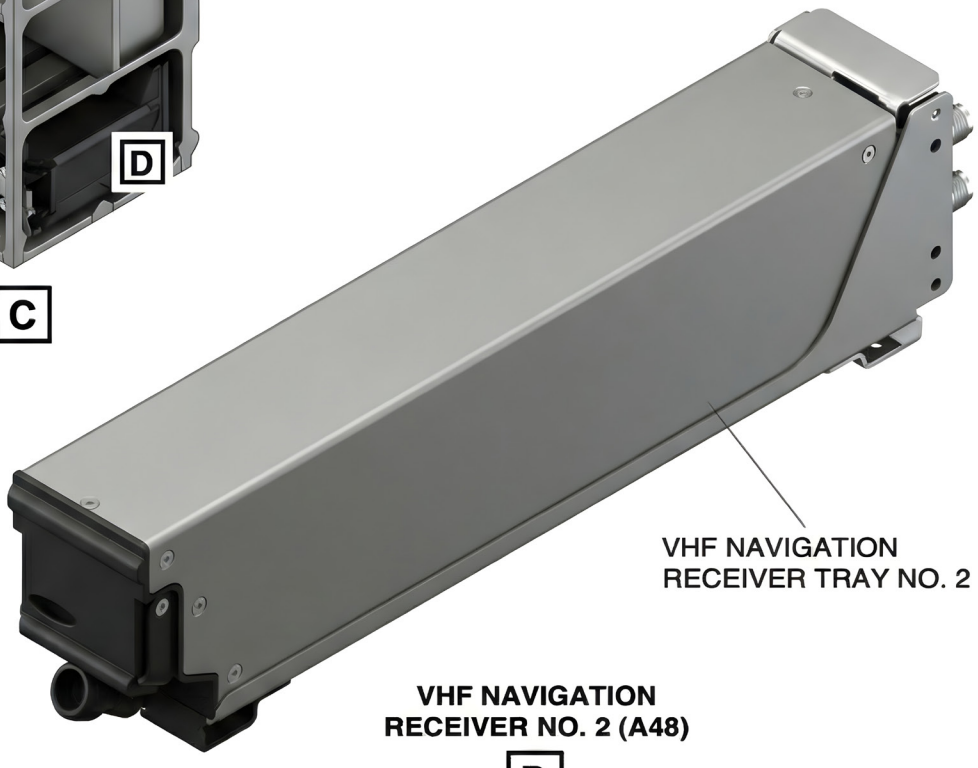

02 C




03 C

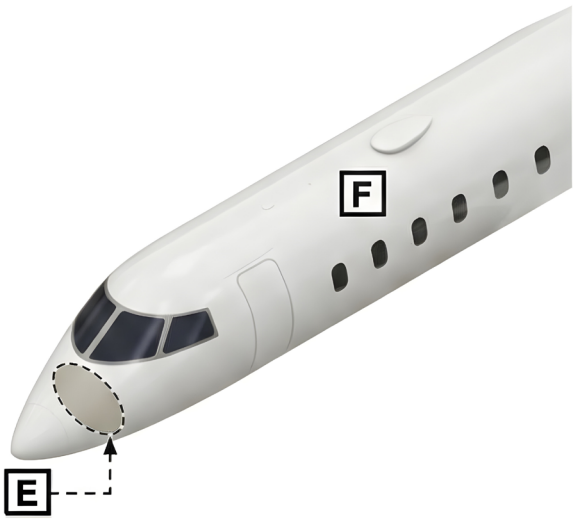



04 C




**VHF NAVIGATION RECEIVER NO. 2 (A48)**

D





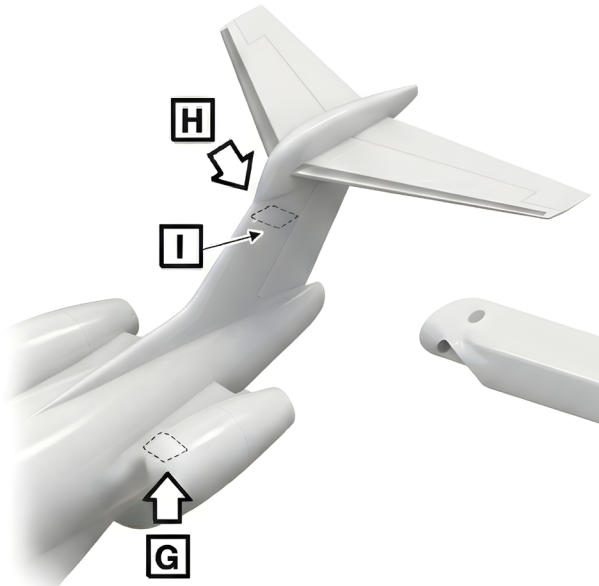

**GLIDESLOPE ANTENNA (E15)**

E



**DUAL AUTOMATIC DIRECTION FINDER (ADF) ANTENNA (E22)**

01 F






**MARKER BEACON ANTENNA**
**(LH) (E21) (RH) (E16)**

**G**



**VOR/LOC ANTENNA**
**(LH) (E17) (RH) (E18)**

**H**



**VOR/LOC ANTENNA**
**COUPLER (CP2)**

**I**

# II. VHF COMMUNICATION SYSTEM

## A. SYSTEM CONFIGURATION

- Dual VHF COM radios installed as standard equipment
- Operating frequency range: 118.000 to 136.991 MHz
- 8.33 kHz channel spacing capability for European operations
- 25 kHz channel spacing for standard operations
- Remote-mounted transceivers with cockpit control interfaces
- FM immunity compliant with ICAO Annex 10 and ED-23B/DO-186 standards
- HF

## B. COM RADIO CONTROL INTERFACES

- Primary control through Display Control Panel (DCP)
- Secondary control through Control Display Unit (CDU)
- MFD radio menu provides radio summary and control access
- Cross-side radio control capability from either pilot position
- Master tuning control selectable between MFD and CDU

## C. COM RADIO TUNING - MFD METHOD

- Push RADIO button on DCP to display radio menu on MFD
- Push 1/2 button to select between side 1 and side 2 radio menus
- Turn MENU knob to move selection box to COM radio frequency display
- Turn TUNE knob to adjust desired frequency
- Push TUNE knob to acknowledge and activate new frequency
- Frequency changes immediately transmitted to radio transceivers



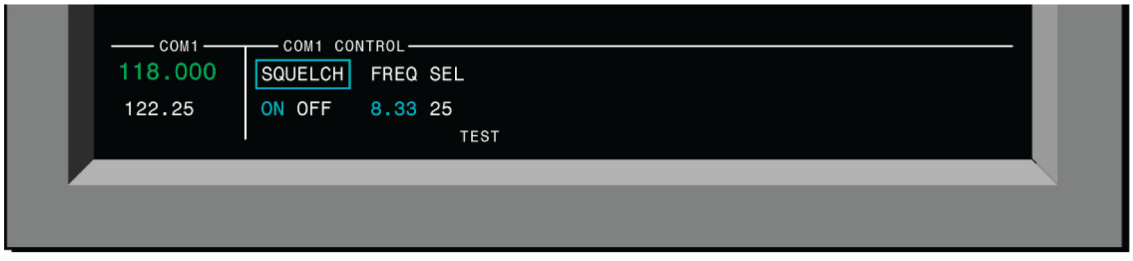
## D. COM RADIO TUNING - CDU METHOD




- Push TUN key on CDU to display TUNE page
- Enter frequency directly into scratchpad
- Push line select key adjacent to appropriate COM radio
- Alternative: Enter preset channel number (1-20) in scratchpad
- Push line select key to activate preset frequency
- Empty scratchpad and push line select to access CONTROL page

## E. COM RADIO CONTROL MENU FUNCTIONS

- Access CONTROL menu by pushing RADIO button with radio selected
- Squelch adjustment using DATA knob
- Voice/data mode selection via DATA knob or PUSH SELECT
- Test mode activation through TEST control selection
- Preset frequency storage and recall functions
- Exit CONTROL menu by pushing RADIO button again




## F. TUNING REVERSION CAPABILITY

- Normal operation: MFD serves as master tuning control
- Reversion panel TUNE knob selects tuning source
- MFD ONLY position: MFDs control all tuning
- CDU ONLY position: CDUs control all tuning
- COM 121.50 position: Forces COM1 to emergency frequency
- CDU tuning blanked when MFD is master control



# III. VHF NAVIGATION SYSTEM

## A. SYSTEM OVERVIEW

- Standard configuration includes dual VOR/localizer receivers, dual glideslope receivers, dual marker beacons, single DME, and single ADF
- Optional second ADF and second DME available
- NAV-4000 receiver integrates VOR/LOC/GS/MKR/ADF in single unit
- NAV-4500 contains VOR/LOC/GS/MKR without ADF module

## B. VOR/LOCALIZER RECEIVERS

- Operating frequency range: 108.00 to 117.95 MHz
- 50 kHz channel spacing (160 channels)
- Automatic tuning through FMS or manual via CDU/DCP
- VOR bearing information displayed on PFD navigation displays
- LOC deviation displayed on PFD during approach operations
- Audio identification signals routed to audio control unit

## C. NAV RADIO TUNING - MFD METHOD

- Push RADIO button on DCP to display radio menu
- Turn MENU knob to move selection box to NAV radio (NAV1 or NAV2)
- Turn TUNE knob to adjust desired VOR/LOC frequency
- Push TUNE knob to acknowledge new frequency
- DME automatically pairs with selected VOR/ILS frequency
- Push RADIO button with NAV selected to access NAV CONTROL menu

## D. NAV RADIO TUNING - CDU METHOD

- Push TUN key on CDU to display TUNE page
- Enter frequency directly into scratchpad
- Push line select key adjacent to appropriate NAV radio
- Alternative: Enter three-letter NAVAID identifier in scratchpad
- Push line select key for NAV 1 or NAV 2 to tune by identifier
- Enter preset channel number (1-20) for preset selection

## E. NAV CONTROL MENU OPERATIONS

- DME frequency tuning independent of paired NAV frequency
- Turn MENU knob to select DME frequency when DME HOLD active
- Turn TUNE knobs to adjust DME frequency independently
- Marker sense mode selection (LO or HI) via MKR SENSE control
- Turn DATA knob or push PUSH SELECT to toggle marker sensitivity
- NAV TEST mode activation through TEST control selection




### F. GLIDESLOPE RECEIVERS

- Operating frequency range: 329.15 to 335.00 MHz
- 40 channels with 150 kHz spacing
- Automatically paired with localizer frequency selection
- Vertical deviation displayed on PFD during ILS approaches
- Signal processing through IAPS computers

### G. MARKER BEACON SYSTEM

- Fixed frequency operation at 75.00 MHz
- HI/LO sensitivity control selection via NAV CONTROL menu
- Visual indications on PFD during station passage
- Audio alerts through speakers and headsets when selected
- Dual marker beacon antennas on fuselage bottom
- Outer marker (400 Hz), middle marker (1300 Hz), inner marker (3000 Hz)

## IV. AUTOMATIC DIRECTION FINDER (ADF)

### A. SYSTEM CONFIGURATION

- Single or dual ADF configuration available
- Integrated within NAV-4000 receiver
- Frequency range: 190-1799 kHz plus maritime distress bands
- Maritime bands: 2088-2094 kHz and 2179-2185 kHz

### B. OPERATIONAL FEATURES

- Beat frequency oscillator (BFO) for keyed carrier stations
- AM radio reception capability
- Bearing information displayed on PFD and MFD
- Manual tuning through CDU or DCP
- Audio identification through audio control unit

### C. ADF RADIO TUNING PROCEDURES

- Push RADIO button on DCP to display radio menu
- Turn MENU knob to move selection box to ADF radio (ADF 1 or ADF 2)

- Turn TUNE knob to adjust desired frequency
- Push TUNE knob to acknowledge new frequency
- Push RADIO button to access ADF CONTROL menu

### D. ADF CONTROL MENU OPERATIONS

- ADF/ANT mode selection via MODE control
- Turn DATA knob or push PUSH SELECT to toggle between ADF and ANT modes
- BFO mode control for carrier wave reception
- Turn DATA knob to select BFO ON or OFF
- ADF TEST mode activation through TEST control selection

## V. DISTANCE MEASURING EQUIPMENT (DME)

### A. SYSTEM ARCHITECTURE

- DME-4000 remote-mounted three-channel unit
- Single DME configuration: Channel 1 (pilot), Channel 2 (copilot), Channel 3 (FMS)
- Dual DME configuration option with six total channels
- Operating frequency: 962-1213 MHz

### B. OPERATIONAL CAPABILITIES

- Line-of-sight distance measurement to ground stations
- Rate of closure and time-to-station calculations
- Maximum tracking range: 300 nm (altitude dependent)
- Paired tuning with VOR/ILS frequencies (108.00-117.95 MHz)
- Distance display format: four digits followed by NM
- No-computed-data indicated by dashes

### C. DME HOLD FUNCTION

- Activated via DME H push button on DCP
- Splits paired tuning between DME and VHF navigation systems
- Enables independent VHF/DME operation
- DME frequency displayed with “H” suffix when hold active
- Turn MENU knob to select DME frequency field when hold active
- Turn TUNE knobs to adjust DME frequency independently
- Push DME H button again to cancel hold function

## VI. GLOBAL POSITIONING SYSTEM (GPS/GNSS)

### A. GPS RECEIVERS

- Dual GPS sensors for redundancy
- Multi-satellite simultaneous processing capability

- Minimum four satellites required for navigation solution
- Three satellites plus calibrated barometric altitude acceptable
- Position, velocity, and time computations

### B. GNSS CONTROL

- GPS Control page displays position differences (POS DIFF)
- Manual enable/disable for each GPS sensor
- Position difference shown in direction and distance
- Disabled sensors remain off until manually enabled
- Automatic switchover on sensor failure

### C. SBAS CAPABILITY (Satellite-Based Augmentation System)

- WAAS for North America and Hawaii
- EGNOS for Europe
- MSAS for Japan
- GAGAN for India
- Selection through SBAS Service Providers page
- Enables LPV approach capability
- Augmented GPS precision for approach operations
- RAIM prediction for destination and flight plan

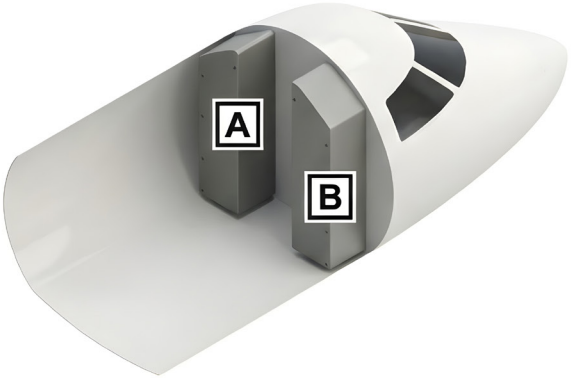
## VII. INERTIAL REFERENCE SYSTEM (IRS)

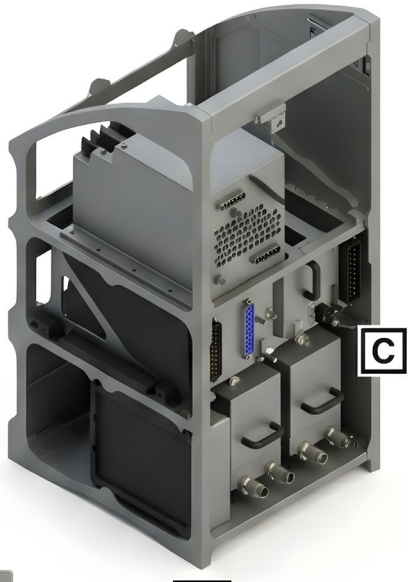
### A. SYSTEM CONFIGURATION

- Dual IRS units for redundancy
- Laser ring gyro technology
- Independent operation capability

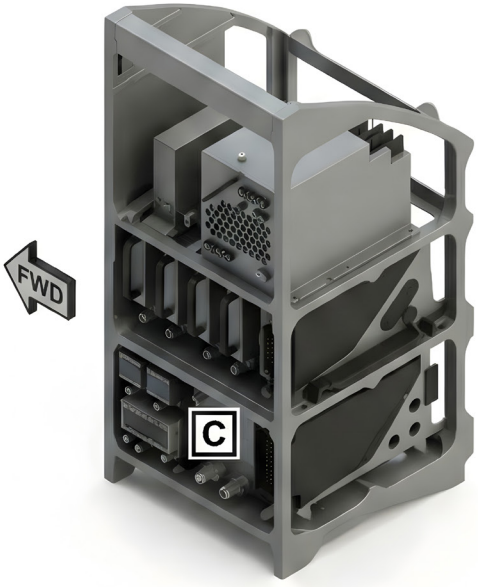
### B. FUNCTIONAL CAPABILITIES

- Attitude and heading reference
- Position and velocity computation
- Integration with FMS for navigation
- IRS Control page for sensor management
- Automatic cross-side switching on failure
- Attitude mode operation capability
- SET POS command for position update




A

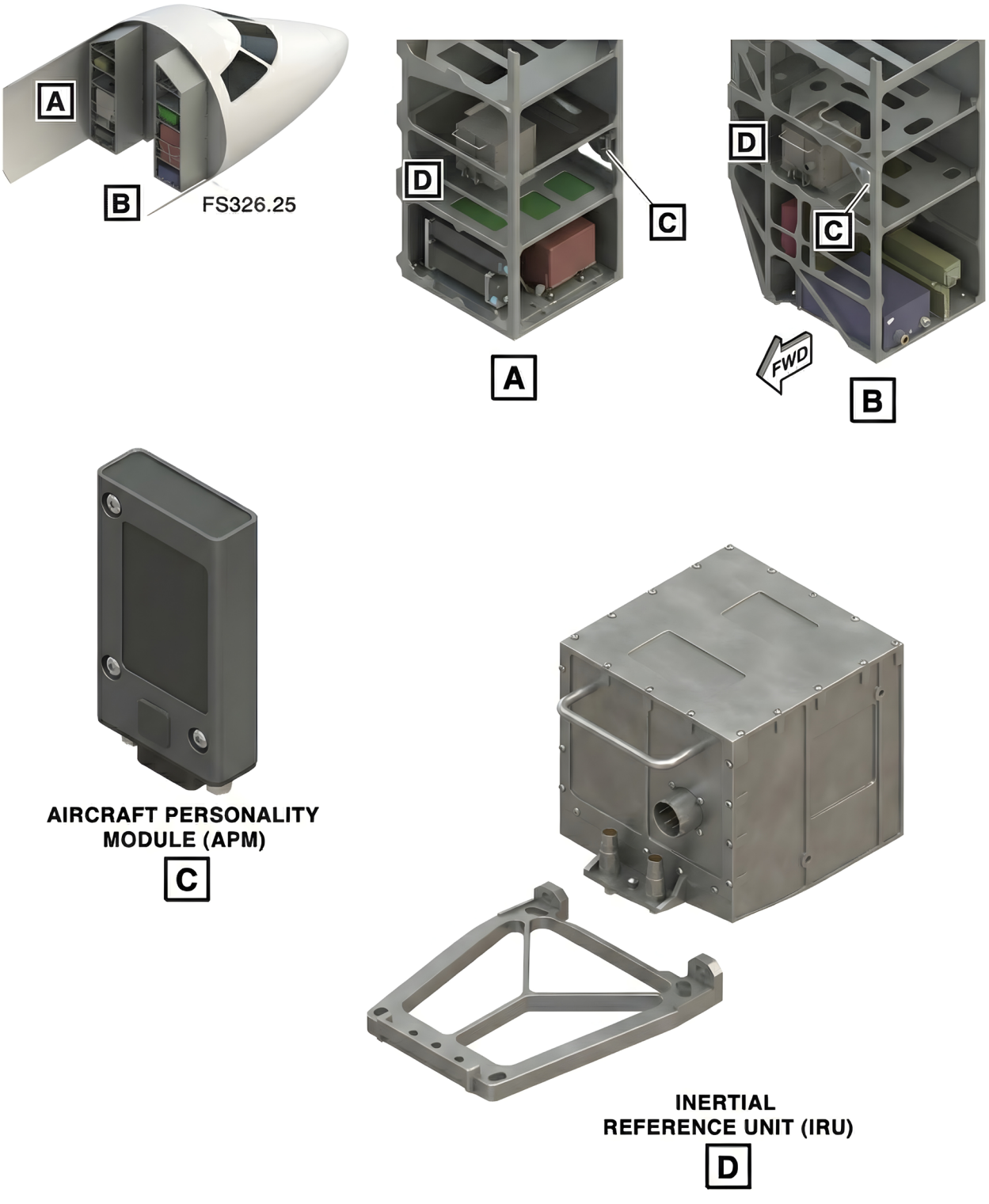



B



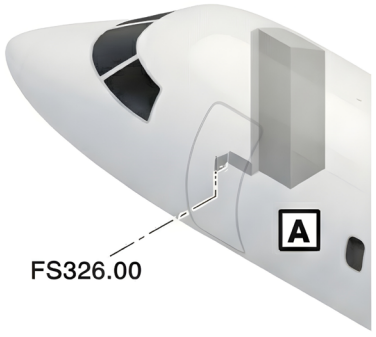

GPS RECEIVER PANEL

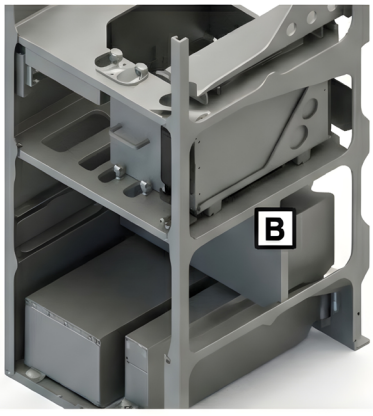
C



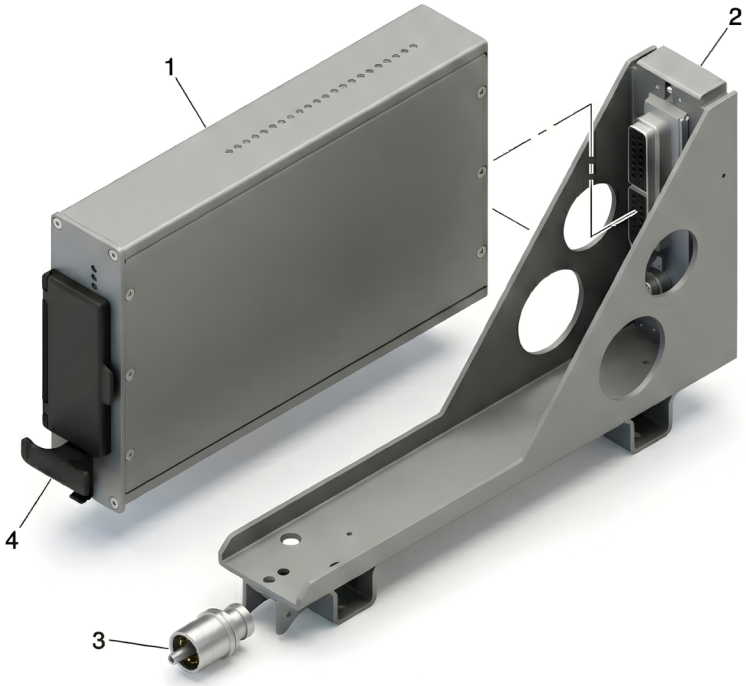

Inertial Reference Unit (IRU) – Component Location

## VIII. TERRAIN AWARENESS WARNING SYSTEM (TAWS)




A




B

Terrain–Avoidance Warning System (TAWS) Computer – Removal/Installation




MFD Control Panel (MCP)




TAWS Control Panel




Display Control Panel (DCP)

## GPWS / EGPWS MODES & WARNINGS

**MODE 1:** EXCESSIVE DESCENT RATE

WARNINGS:
- SINKRATE
- PULL UP!

**MODE 2:** EXCESSIVE TERRAIN CLOSURE RATE

WARNINGS:
- TERRAIN..TERRAIN
- PULL UP!

**MODE 3:** SINK AFTER TAKEOFF

WARNING:
- DON'T SINK!

**MODE 4:** TOO CLOSE TO TERRAIN

WARNINGS:
- TOO LOW–TERRAIN
- TOO LOW–GEAR
- TOO LOW–FLAPS

**MODE 5:** ILS EXCESSIVE DEVIATION BELOW GLIDESLOPE

WARNING:
- GLIDESLOPE

**MODE 6:** EXCESSIVE BANK ANGLE

WARNING:
BANK ANGLE!
ALTITUDE CALL-OUTS
"…FIVE HUNDRED…"

**MODE 7:** WINDSHEAR CAUTION/WARNING

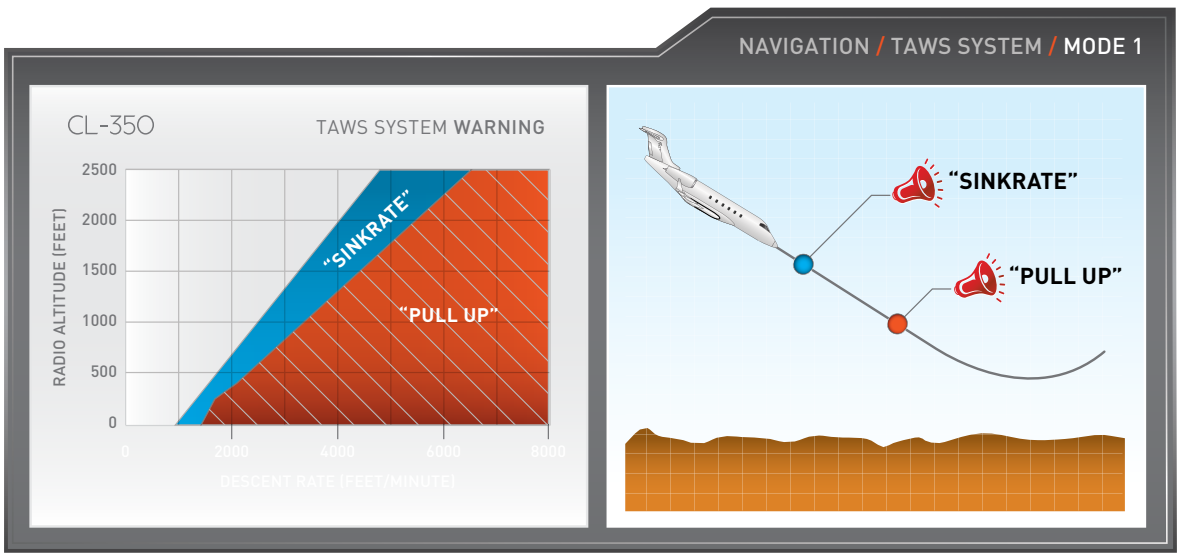
WARNINGS:
- WINDSHEAR, WINDSHEAR
- WINDSHEAR

## A. SYSTEM ARCHITECTURE

- Three systems integrated in one line replaceable unit
- Ground Proximity Warning System (GPWS) - Modes 1-6
- Terrain/obstacle awareness system
- Windshear detection system (Mode 7)
- Enhanced Ground Proximity Warning Computer (EGPWC) processes all inputs
- Provides aural alerts and visual annunciations for CFIT avoidance
- PULL UP and GND PROX annunciations displayed on PFD
- Worldwide terrain database with obstacles
- Smart Runway/Smart Landing capability (if equipped with SB 350-34-008)

## B. MODE 1 - EXCESSIVE DESCENT RATE

- Active when airplane is less than 2,500 feet AGL
- Requires radio altitude and rate-of-descent data
- Alert area penetration:
- GND PROX amber CAS alert on PFD
- Aural "SINKRATE, SINKRATE"
- Aural alert annunciated once
- Repeated if condition degrades by more than 20% based on computed time to impact
- Visual alert remains until condition rectified
- Warning area penetration:
- PULL UP red CAS alert on PFD
- Aural "PULL UP" warning
- Aural warning annunciated continuously until condition rectified

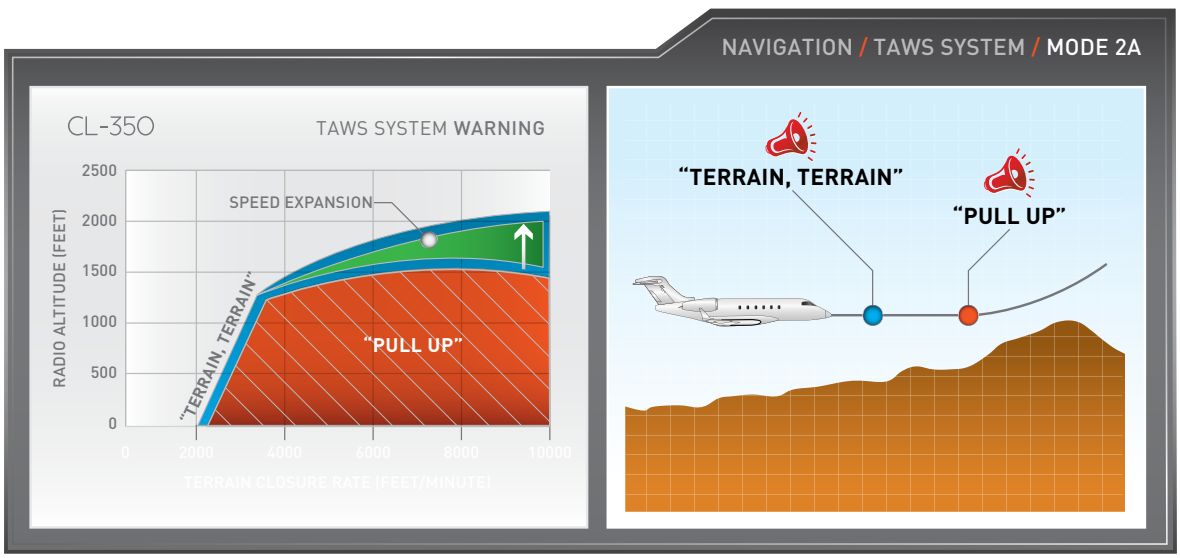


## C. MODE 2 - EXCESSIVE TERRAIN CLOSURE RATE

- Detects excessive closure rate between airplane and terrain
- Active in descent, level flight, or climb with rising terrain
- Uses radio altitude and vertical speed inputs
- Two sub-modes: Mode 2A and Mode 2B

**Mode 2A - Flaps Not in Landing Position**

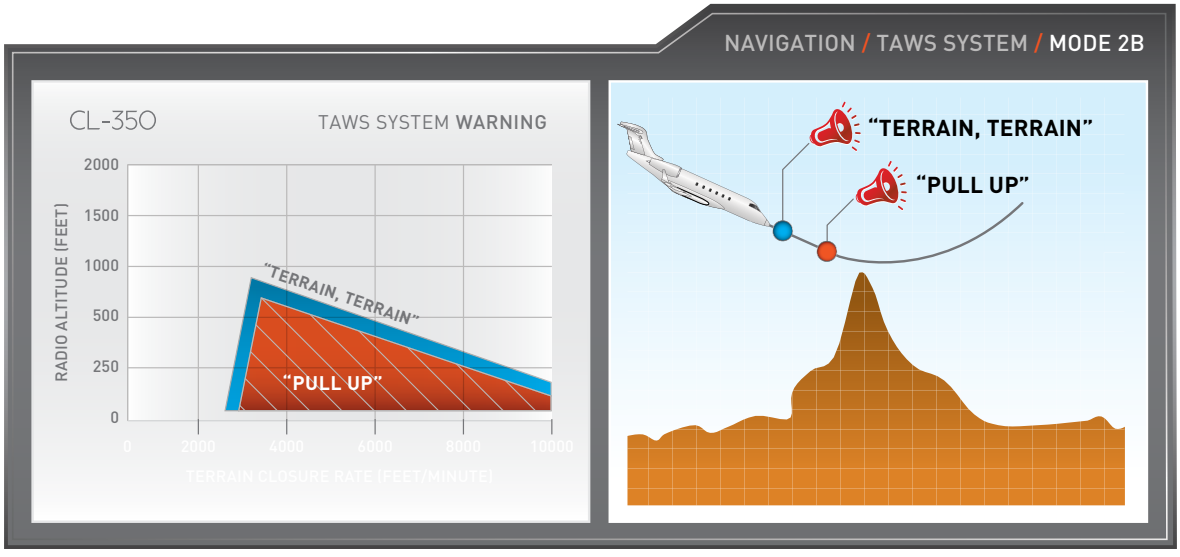
- Activated when flaps are not in landing configuration
- Alert area penetration:
- GND PROX amber CAS on PFD
- Aural "TERRAIN, TERRAIN" warning
- Aural warning annunciated once
- Visual alert remains until condition rectified
- Warning area penetration:
- PULL UP red CAS alert on PFD
- Aural "PULL UP" warning
- Aural and visual warnings continuous until rectified




**Mode 2B - Flaps in Landing Configuration**

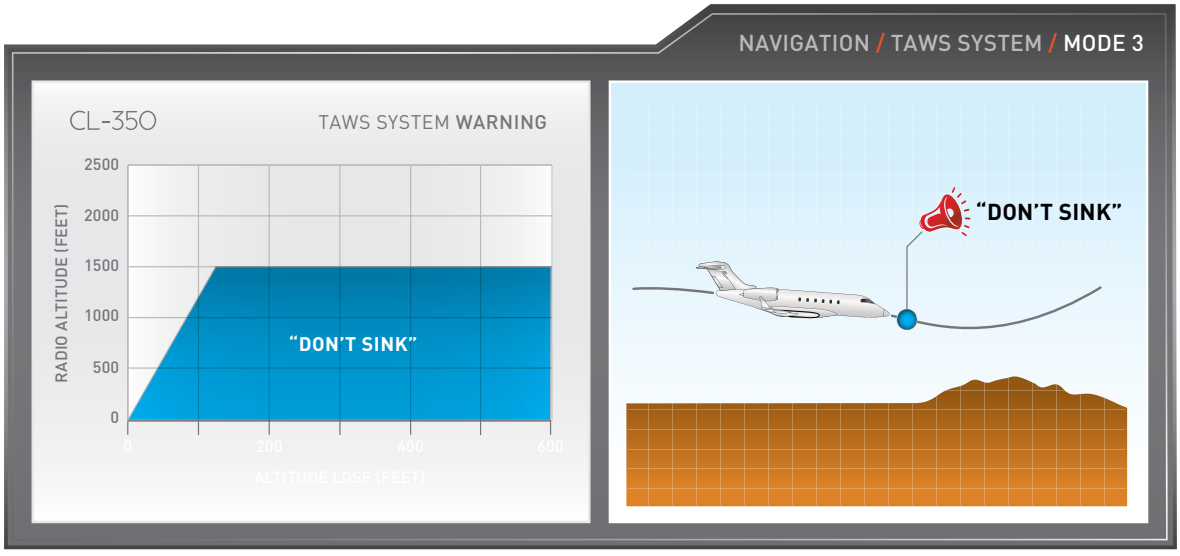
- Activated when:
- Flaps are in landing configuration, OR
- Flaps up with airplane on ILS approach (GS/LOC deviations <±2 dots), OR
- Within 60 seconds after takeoff
- Alert area penetration:

- GND PROX amber CAS on PFD
- Aural "TERRAIN, TERRAIN" warning
- Aural and visual alerts continuous until rectified
- Warning area penetration:
- PULL UP red CAS warning on PFD
- Aural "PULL UP" warning
- Aural and visual warnings continuous until rectified
- Warning envelope inhibited below 30 feet AGL




## D. MODE 3 - ALTITUDE LOSS AFTER TAKEOFF

- Provides warnings for significant altitude loss after takeoff or go-around
- Uses radio altitude, barometric altitude, and altitude rate
- Enabled after takeoff or go-around when gear/flaps not in landing configuration
- Remains enabled until sufficient altitude gained (no longer in takeoff phase)
- Stores altitude value at descent initiation and compares to successive data
- Alert area penetration:
- GND PROX alert on PFD
- Aural "DON'T SINK, DON'T SINK" warning
- Aural warning annunciated once
- Repeated at 20% degradation intervals from initially stored value
- Condition remains until airplane regains initial altitude
- Mode 3 inhibited for radio altitude values exceeding 1,500 feet

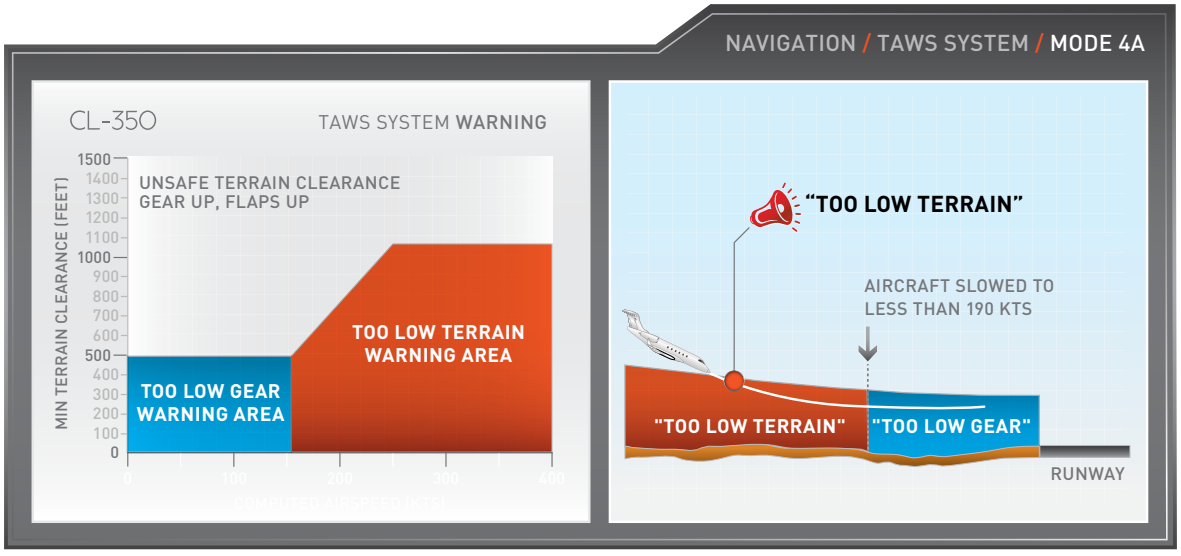



## E. MODE 4 - UNSAFE TERRAIN CLEARANCE

- Provides alerts for insufficient terrain clearance based on phase of flight and speed
- Requires radio altitude, computed airspeed, gear position, and flap position
- Three sub-modes: Mode 4A, Mode 4B, and Mode 4C

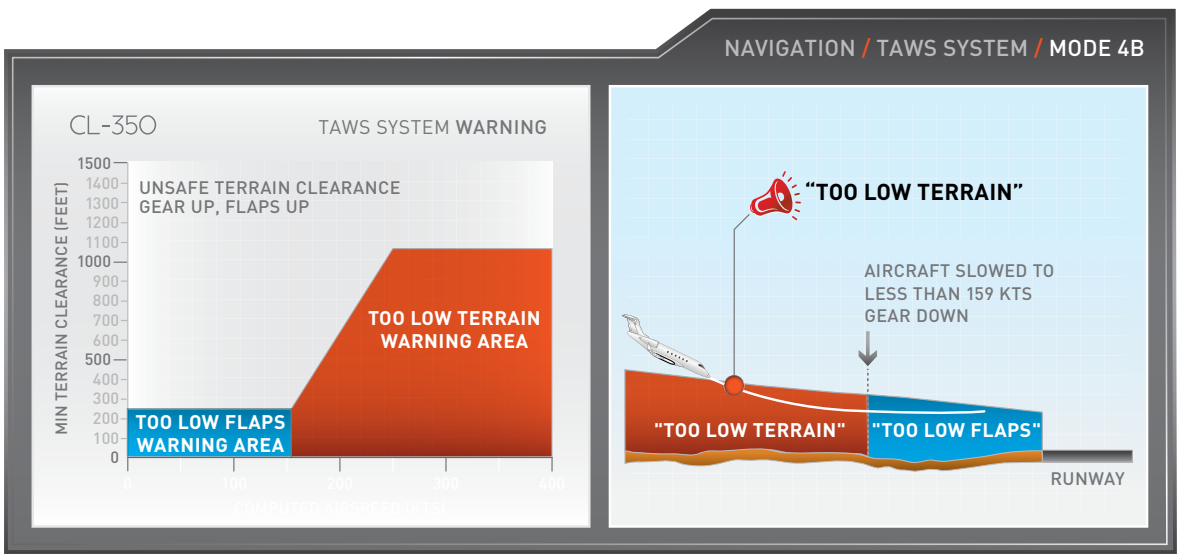
**Mode 4A - Gear Up, Flaps Not in Landing Position**

- Active in cruise or approach with landing gear not down
- Alert envelope: 30 feet AGL to 500 feet AGL
- Upper boundary increases with airspeed (1,000 feet at 250+ knots)
- Above 190 knots penetration:
- Amber GND PROX display on PFD
- Continuous aural "TOO LOW TERRAIN" warning
- Below 190 knots penetration:
- Amber GND PROX alert on PFD
- Aural "TOO LOW GEAR" warning
- Warnings remain until airplane exits envelope



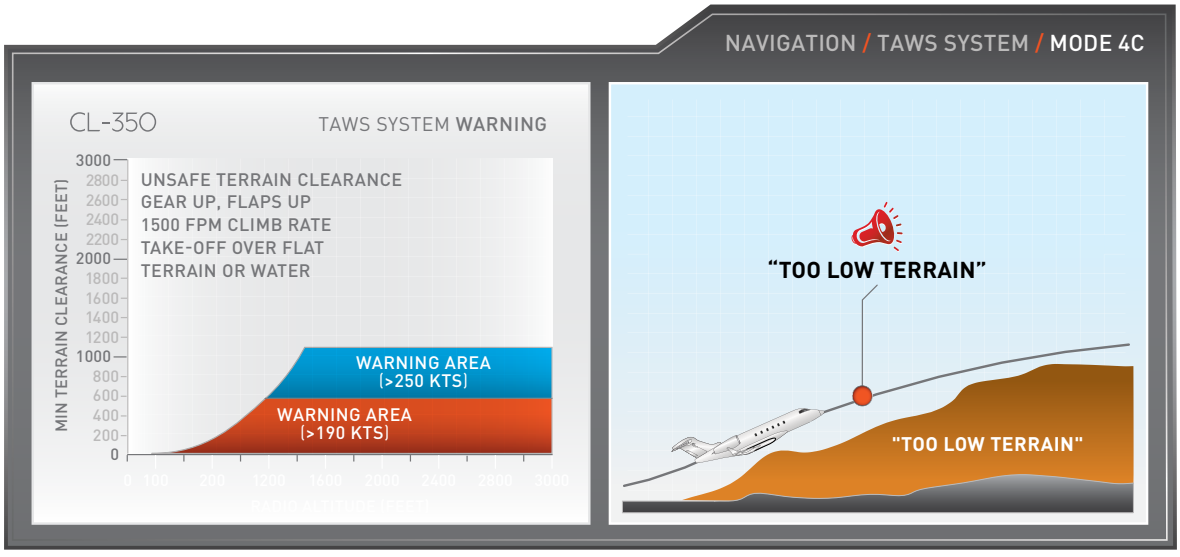

**Mode 4B - Gear Down, Flaps Not in Landing Position**

- Active in cruise or approach with landing gear down
- Alert envelope: 30 feet AGL to 245 feet AGL
- Above 159 knots penetration:
- Amber GND PROX display on PFD
- Continuous aural “TOO LOW TERRAIN” warning
- Below 159 knots penetration:
- Amber GND PROX display on PFD
- Aural “TOO LOW FLAPS” warning
- “TOO LOW FLAPS” can be silenced with FLAPS switch OFF on TAWS panel



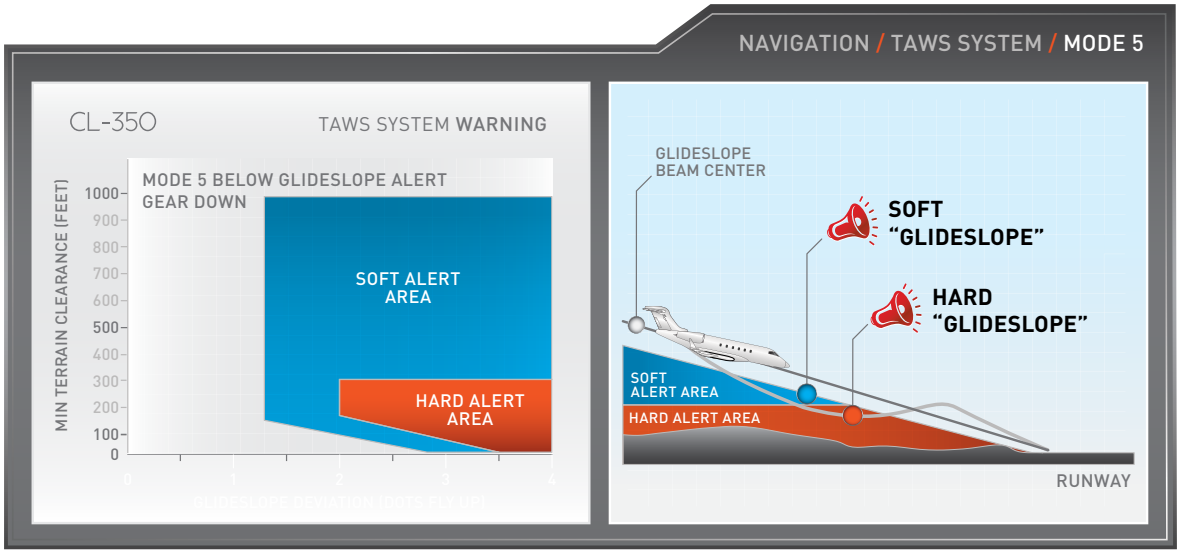
**Mode 4C - Takeoff Configuration**

- Based on minimum terrain clearance floor that increases with radio altitude
- Active during takeoff over flat terrain or water
- Assumes 1,500 FPM climb rate
- Warning areas vary by speed (<190 kts vs >250 kts)
- Any altitude decrease below minimum terrain clearance:
- Amber GND PROX display on PFD
- Aural "TOO LOW TERRAIN" warning




## F. MODE 5 - DESCENT BELOW GLIDESLOPE

- Provides alerts when airplane descends below ILS glideslope
- Applicable to ILS and GPS/SBAS LPV approaches
- Two-tone warning system based on glideslope position
- Soft alert (1.3-2.0 dots below glideslope):
- Quiet (6 dB) aural "GLIDESLOPE"
- Hard alert (>2.0 dots below glideslope):
- Full volume aural "GLIDESLOPE" warning
- Amber GND PROX displayed on PFD
- Alerts continuous until airplane exits alert envelope
- "GLIDESLOPE" aural can be muted with GS switch OFF on TAWS panel



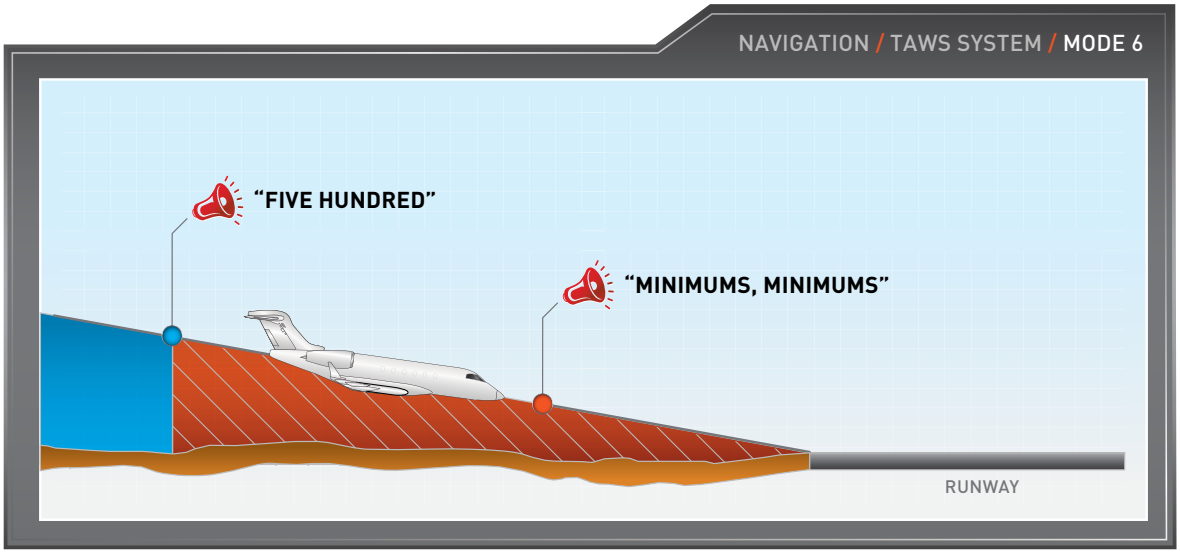

## G. MODE 6 - ALTITUDE CALLOUTS AND EXCESSIVE BANK ANGLE

**Approach Minimums Transition**

- Activates for APPROACHING DECISION HEIGHT or APPROACHING MINIMUMS
- Generates aural "MINIMUMS, MINIMUMS" warning
- Enabled between 1,000 feet and 10 feet radio altitude or DH minimums
- Requires corrected altitude exceeding MDA value by 200 feet
- Landing gear must be down for activation

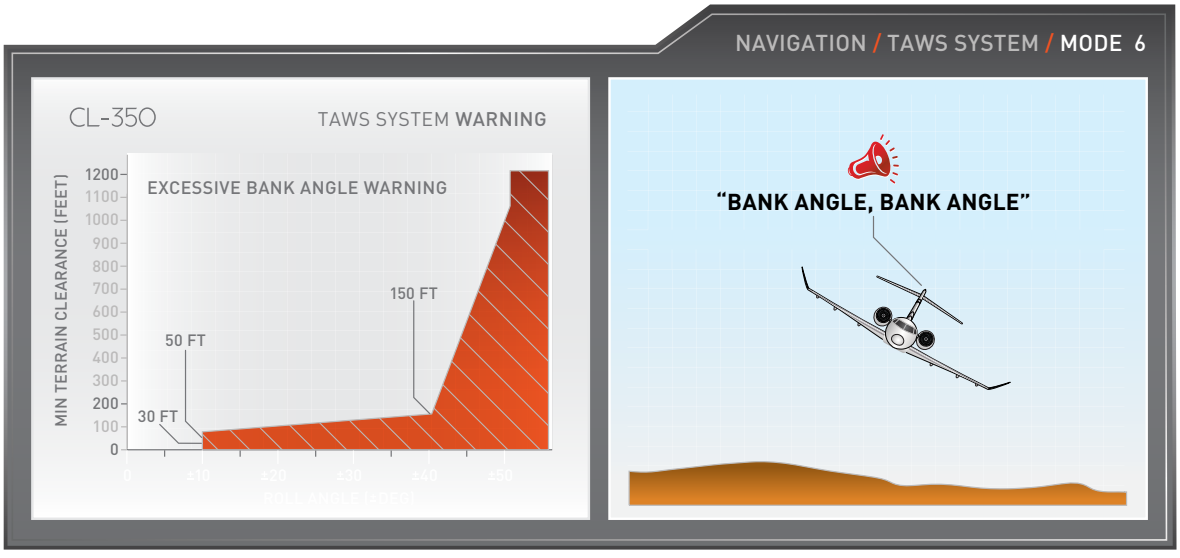
**Altitude Callouts**

- Standard callouts: "ONE HUNDRED", "FIFTY", "THIRTY" feet AGL
- Last annunciated altitude memorized to prevent repeat annunciation
- Memory cleared when climbing above 1,000 feet or transitioning to takeoff mode
- Smart altitude callout "FIVE HUNDRED":
- Generated at 500 feet radio altitude during non-precision approach
- Generated during precision approach if >±2 dots deviation from GS or LOC
- Also generated during backcourse approach
- Additional callouts available: "FORTY", "TWENTY", "TEN" feet AGL




**Excessive Bank Angle**

- Alert envelope varies with altitude AGL:
- 10° bank at 30 feet AGL
- 40° bank at 150 feet AGL
- 55° bank at 2,450 feet AGL
- Generates aural "BANK ANGLE, BANK ANGLE"
- Alert annunciated once, repeats if bank angle increases by 20%
- Continuous annunciation if bank angle increased to 55°
- Alert continues until bank angle decreased below threshold



## H. MODE 7 - WINDSHEAR WARNING

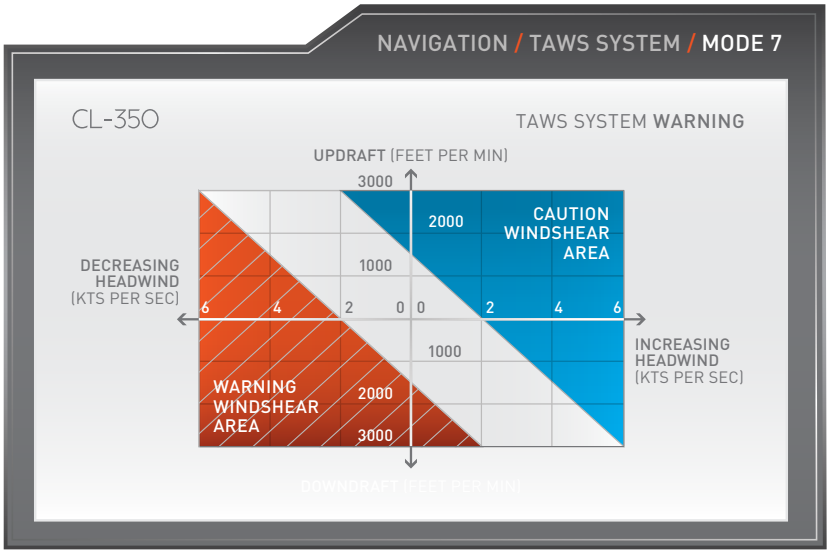
- Active during takeoff and landing phases between 10 and 1,500 feet AGL
- Two types of windshear detection:

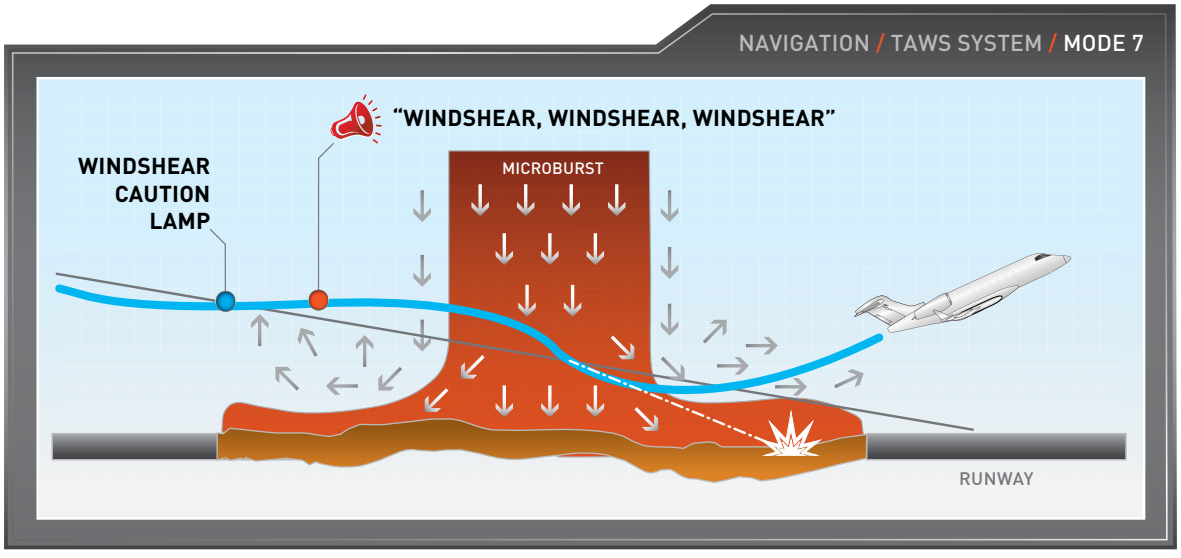
**Increasing Performance Shear (Updraft/Headwind)**

- Flight director display removed
- WINDSHEAR © flashes for 5 seconds then steady
- Aural tone "CAUTION WINDSHEAR" warning

**Decreasing Performance Shear (Downdraft/Tailwind)**

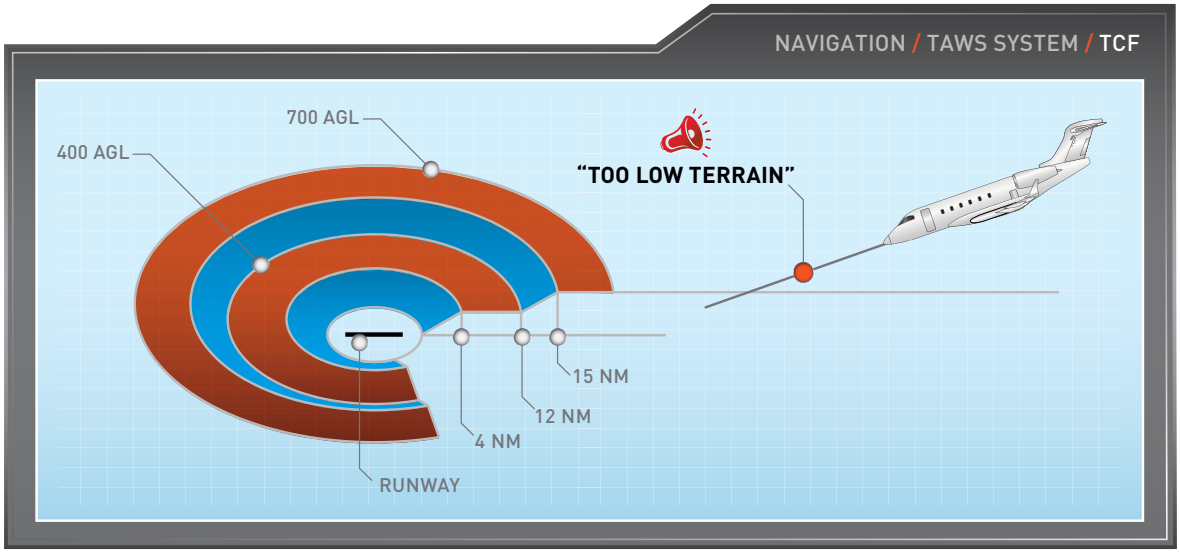
- Flight director display removed
- WINDSHEAR (W) flashes for 5 seconds then steady
- Aural tone "WINDSHEAR WINDSHEAR" warning



## I. TERRAIN CLEARANCE FLOOR (TCF)

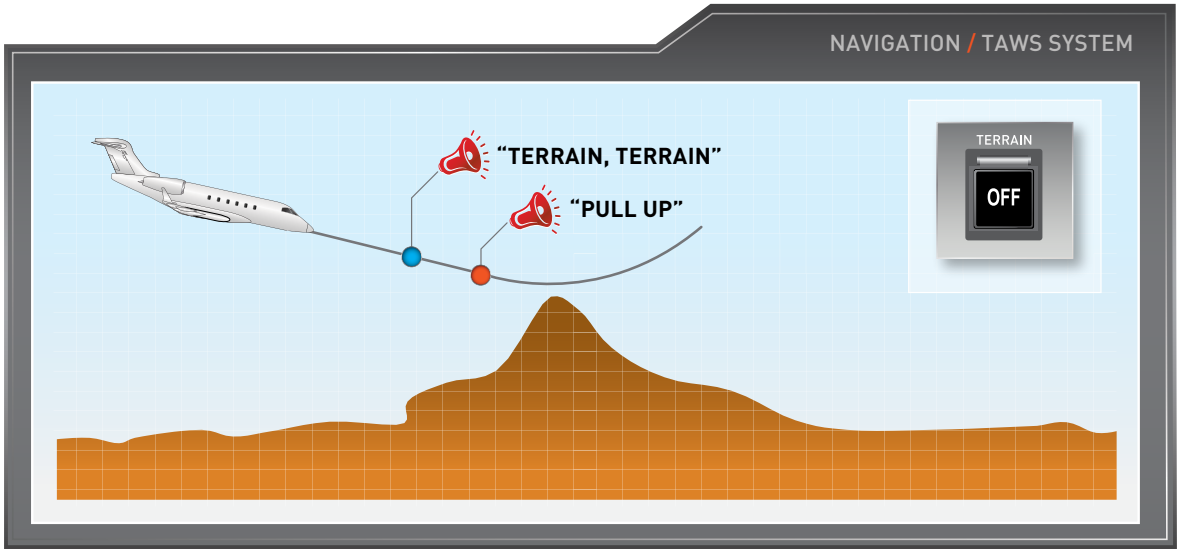
- Supplements GPWS with additional terrain clearance envelope around airports
- Based on current airplane location and nearest runway center point
- Internal database includes worldwide hard-surface runways >3,500 feet
- Creates increasing terrain clearance envelope related to distance from runway
- Alert envelope penetration:
- Aural "TOO LOW TERRAIN"
- Amber GND PROX displayed on PFD
- Aural alert repeated twice
- Repeated again if radio altitude decreases >20% from initial warning altitude
- Amber GND PROX remains until airplane exits envelope




## J. TERRAIN AWARENESS ALERTING

- Computes minimum terrain clearance envelopes along flight path
- Uses airspeed and flight path angle with worldwide terrain database
- Terrain display available by pressing TR/WX button on DCP
- Displays terrain within 2,000 feet of airplane altitude
- Automatic terrain display at 10 nm range when caution at 60 seconds from impact
- Terrain threat detection:
- Aural "CAUTION TERRAIN, CAUTION TERRAIN"
- Amber GND PROX on PFD
- Amber areas on MFD display
- Terrain collision prediction:

- Aural "TERRAIN PULL UP, PULL UP"
- Amber PULL UP on PFD
- Red areas on MFD display
- Automatic display at 10 nm range when warning at 30 seconds from impact
- Can be inhibited by selecting the TERRAIN switch OFF (TAWS WARN PANEL)




## K. TERRAIN DISPLAY COLOR CODING

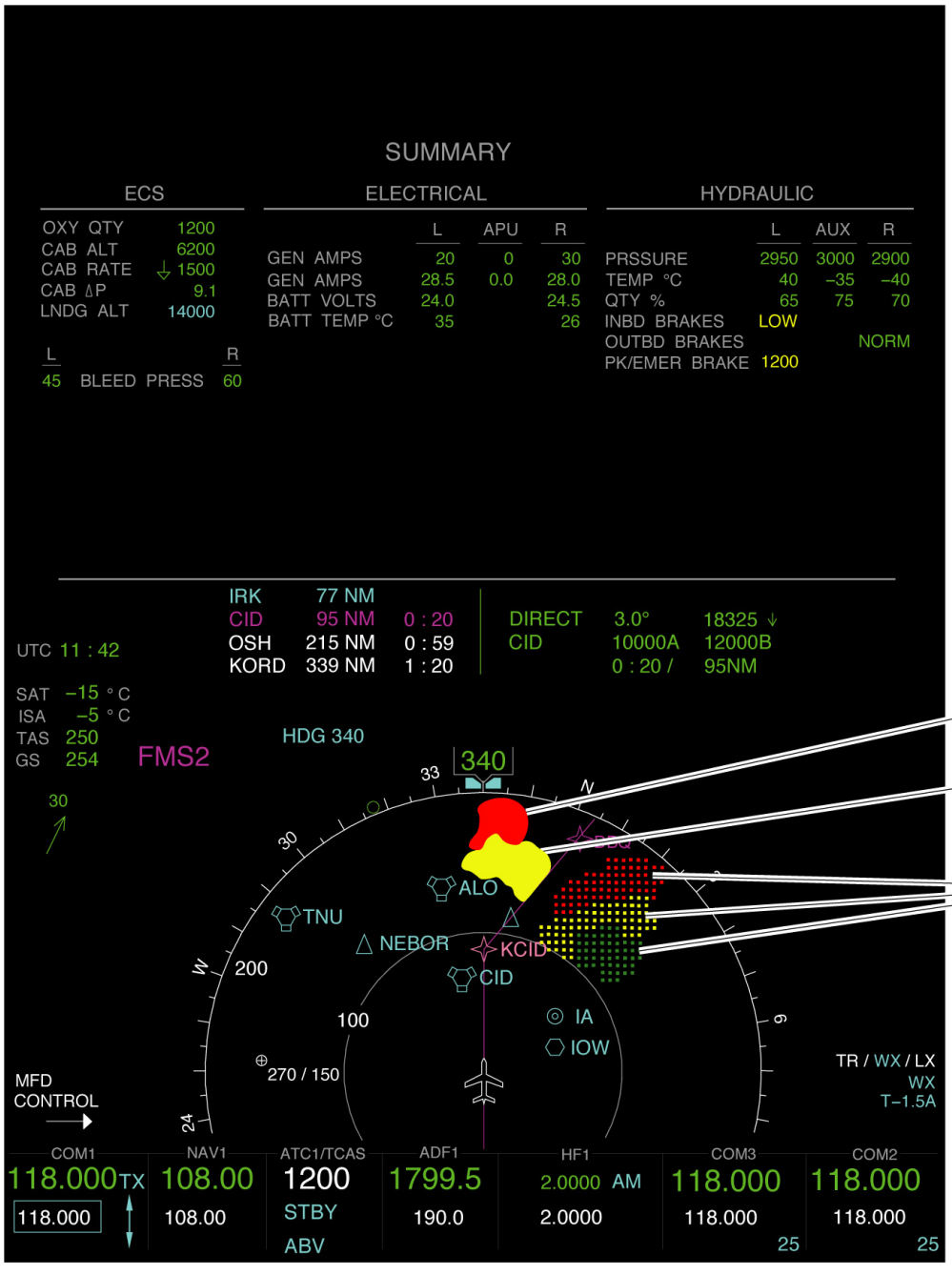
- SOLID RED: Areas satisfying terrain warning alert criteria
- SOLID AMBER: Areas satisfying terrain caution alert criteria
- GREEN, AMBER, RED DOT PATTERN: Areas significantly close but not satisfying alert criteria
- Terrain automatically displays in MAP mode during alerts

## L. TAWS CONTROL PANEL

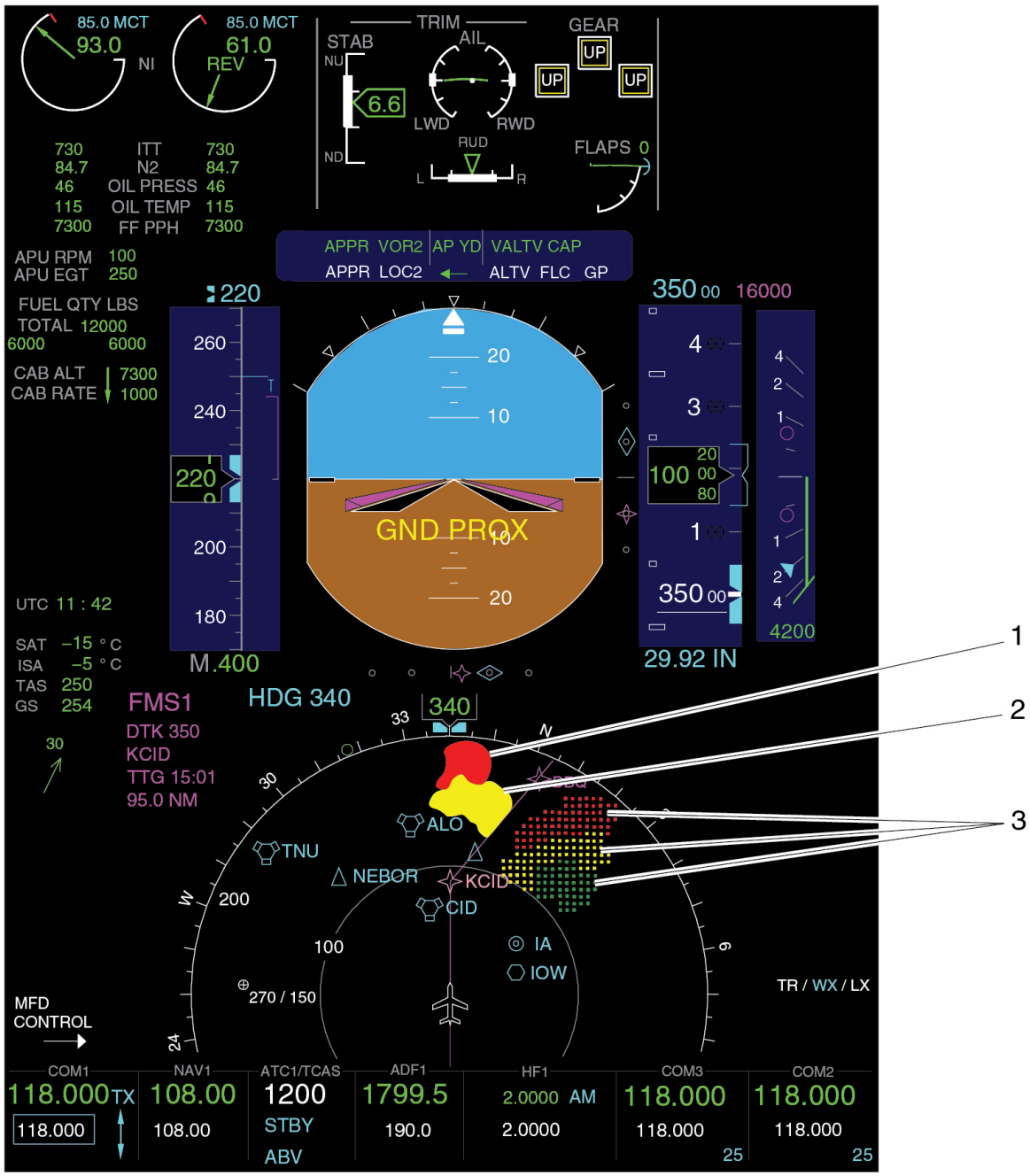
- Located on center instrument panel
- GS switch: Mutes "glideslope" warnings (normally OFF for backcourse approaches)
- FLAPS switch: Mutes related GPWS warnings when landing with flaps not at 30 degrees
- TERRAIN switch: Deselects terrain function of TAWS
- RAAS switch (if equipped): Inhibits SR/SL advisories except altitude monitor
- Status messages displayed when switches selected OFF




TAWS Control Panel

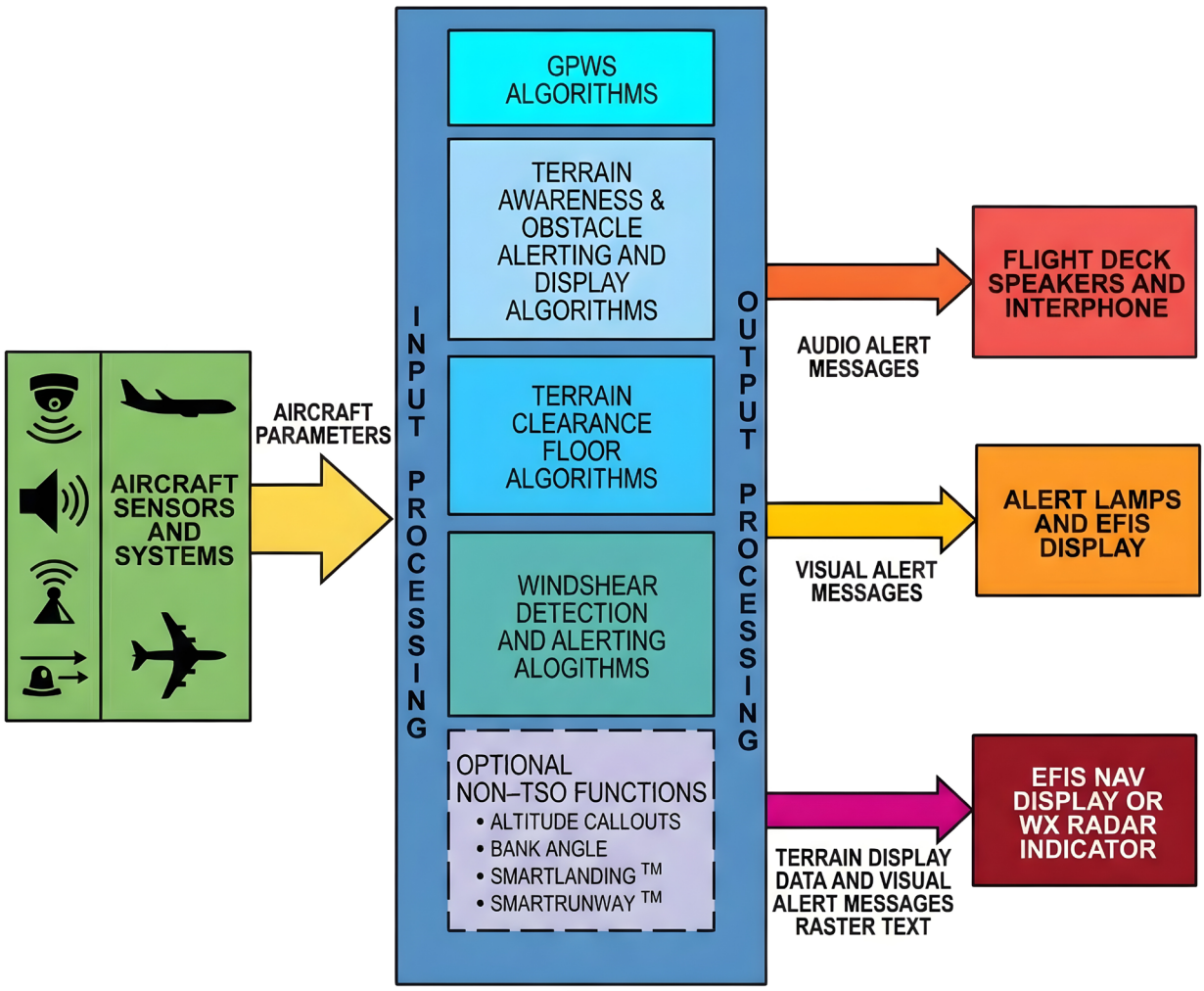



1. SOLID RED – Areas of terrain that satisfy the terrain warning alert criteria.
2. SOLID AMBER – Areas of terrain that satisfy the terrain caution alert criteria.
3. GREEN, AMBER, RED DOT PATTERN – Areas of terrain that are significantly close to the aircraft but do not satisfy warning alert or caution alert criteria.




PFD Display Indicating Terrain Data

1. SOLID RED – Areas of terrain that satisfy the terrain warning alert criteria.
2. SOLID AMBER – Areas of terrain that satisfy the terrain caution alert criteria.
3. GREEN, AMBER, RED DOT PATTERN – Areas of terrain that are significantly close to the aircraft but do not satisfy warning alert or caution alert criteria.


AIRCRAFT SENSORS AND SYSTEMS
AIRCRAFT PARAMETERS
INPUT PROCESSING
GPWS ALGORITHMS
TERRAIN AWARENESS & OBSTACLE ALERTING AND DISPLAY ALGORITHMS
TERRAIN CLEARANCE FLOOR ALGORITHMS
WINDSHEAR DETECTION AND ALERTING ALOGITHMS
OPTIONAL NON–TSO FUNCTIONS
• ALTITUDE CALLOUTS
• BANK ANGLE
• SMARTLANDING ™
• SMARTRUNWAY ™
OUTPUT PROCESSING
AUDIO ALERT MESSAGES
FLIGHT DECK SPEAKERS AND INTERPHONE
VISUAL ALERT MESSAGES
ALERT LAMPS AND EFIS DISPLAY
TERRAIN DISPLAY DATA AND VISUAL ALERT MESSAGES RASTER TEXT
EFIS NAV DISPLAY OR WX RADAR INDICATOR

EGPWC

## M. SMART RUNWAY/SMART LANDING (SR/SL) / (RAAS) - If Equipped

- Available with EGPWC MK V computer (SB 350-34-008)
- Provides runway awareness and alert system (RAAS)
- Supplements pilot awareness of aircraft position and configuration
- Aural and visual advisories during ground and flight operations
- RAAS inhibit switch on TAWS WARN panel
- Configurable options: Voice gender, units (feet/meters), altimeter setting callout

**SR/SL Advisory Functions**

- Approaching Runway - In Air/On Ground:
- Aural "Approaching XX" or "Approaching Runways"
- Visual APP XX (green) or APP RWYS (green)
- On Runway:
- Aural "On Runway XX" or "On Runways"
- Visual ON XX (green) or ON RWYS (green)
- Distance Remaining (Landing & Rollout):
- Maximum 2000 feet callout
- Aural "ZZ Remaining"
- Runway End (<100 feet):
- Aural "One Hundred Remaining" (feet) or "Thirty Remaining" (meters)
- Insufficient Runway Length (In Air):
- 5000 feet threshold
- Aural "Approaching Runway XX, ZZ available"
- Visual APP XX ZZ (amber)
- Insufficient Runway Length (On Ground):
- 6000 feet threshold
- Aural "On Runway XX, ZZ remaining"
- Visual ON XX ZZ (amber)
- Extended Hold On Runway:
- Initial/Repeats: 180 sec/180 sec
- Aural "On Runway XX - On Runway XX"
- Visual ON XX (amber)
- Taxiway Takeoff:
- Aural "Caution, On Taxiway"
- Visual advisory



RAAS Advisory Settings

| Advisory Group | Advisory/Alert | Enabled | Settings | Audio | Visual |
|---|---|---|---|---|---|
| RAAS | GPS Antenna Location | – | 15 feet | – | – |
| | Advisory Suppress Window | YES | 450–550 ft | – | – |
| RAAS | Approaching Runway – In Air/On Ground | YES | – | "Approaching XX" "Approaching Runways" (if more than one runway meets the qualifying condition) | APP XX (in green) APP RWYS (in green)(if more than one runway meets the qualifying condition) |
| | On Runway | YES | – | "On Runway XX" "On Runways" (if more than one runway meets the qualifying condition) | ON XX (in green) ON RWYS (in green)(if more than one runway meets the qualifying condition) |
| | Distance Remaining (Landing & Rollout) | YES | 2000 feet max | "ZZ Remaining" | NONE |
| | Runway End (< 100 feet) | YES | – | "One Hundred Remaining" (in feet) "Thirty Remaining" (in meters) | NONE |
| | Insufficient Runway Length (In Air) | YES | 5000 feet | "Approaching Runway XX, ZZ available" | APP XX ZZ (in amber) |
| | Short Runway Landing | NO | – | – | – |
| | Insufficient Runway Length (On Ground) | YES | 6000 feet | "On Runway XX, ZZ remaining" | ON XX ZZ (in amber) |
| | Short Runway Takeoff | NO | – | – | – |
| | Extended Hold On Runway Initial/ Repeats | YES | 180 sec/ 180 sec | "On Runway XX – On Runway XX" | ON XX (in amber) |
| | Taxiway Takeoff | YES | – | "Caution, On Taxiway! On Taxiway" | ON TAXIWAY (in amber) GND PROX alert on PFD also illuminated |
| | Distance Remaining (Rejected Takeoff) | YES | 50% of Runway | "ZZ Remaining" | NONE |
| | Taxiway Landing | YES | – | "Caution, Taxiway! Caution, Taxiway!" | TAXIWAY (in amber) GND PROX alert on PFD also illuminated |
| | Takeoff Flaps | YES | Min: 6°; Max: 24° | "On Runway XX, Flaps– Flaps" | FLAPS (in amber) GND PROX alert on PFD also illuminated |

### Stability Approach Monitor Settings

| Advisory Group | Advisory/Alert | Enabled | Settings | Audio | Visual |
|---|---|---|---|---|---|
| Stability Approach Monitor | Landing Flaps (Not Aligned With Runway) | NO | – | – | – |
| | Landing Flaps (Aligned With Runway) | YES | 800 feet | "Flaps–Flaps" | FLAPS (in amber) |
| | Too High (During Approach) | YES | – | "Too High–Too High" | TOO HIGH (in amber) |
| | Too Fast (During Approach) | YES | – | "Too Fast–Too Fast" | TOO FAST (in amber) |
| | Unstable (During Approach) | YES | – | "Unstable–Unstable" | UNSTABLE (in amber) GND PROX alert on PFD also illuminated |

### Long Landing Monitor Settings

| Advisory Group | Advisory/Alert | Enabled | Settings | Audio | Visual |
|---|---|---|---|---|---|
| Long Landing | Long Landing Distance | YES | 2000 ft past approach end | "Long Landing – Long Landing" | LONG LANDING (in amber) GND PROX alert on PFD also illuminated |
| | Long Landing Percentage | | 67% remaining | "Long Landing – Long Landing" | LONG LANDING (in amber) GND PROX alert on PFD also illuminated |
| | Long Landing Distance Remaining | | 3000 ft past approach end | "ZZ Remaining" | LONG LANDING (in amber) GND PROX alert on PFD also illuminated |
| | Long Landing Distance Remaining Percentage | | 60% remaining | "ZZ Remaining" | LONG LANDING (in amber) GND PROX alert on PFD also illuminated |

### Corrected Altitude Monitor Settings

| Advisory Group | Advisory/Alert | Enabled | Settings | Audio | Visual |
|---|---|---|---|---|---|
| Corrected Altitude Monitor | Altimeter Setting (Below Transition Altitude) | YES | – | "Altimeter Setting" | ALTM SETTING (in amber) |
| | Altimeter Setting (Above Transition Altitude) | YES | – | "Altimeter Setting" | ALTM SETTING (in amber) |

### N. ALERT PRIORITIES

- TAWS/GPWS warnings (highest)
- ROAAS warnings
- TAWS/GPWS cautions
- ROAAS cautions
- RAAS cautions (lowest)

| PFD ALERT | DESCRIPTION | PRIORITY |
|---|---|---|
| WINDSHEAR PULL UP | GPWS Warning<br>GPWS/TAWS Warning | 1 |
| RWY LENGTH DECELERATE | ROAAS IN-AIR Warning<br>ROAAS ON-GROUND Warning | 2 |
| GND PROX WINDSHEAR | GPWS/TAWS Caution<br>GPWS Caution | 3 |
| RWY LENGTH DECELERATE | ROAAS IN-AIR Caution<br>ROAAS ON-GROUND Caution | 4 |
| GND PROX | RAAS (if installed) Cautions | 5 |

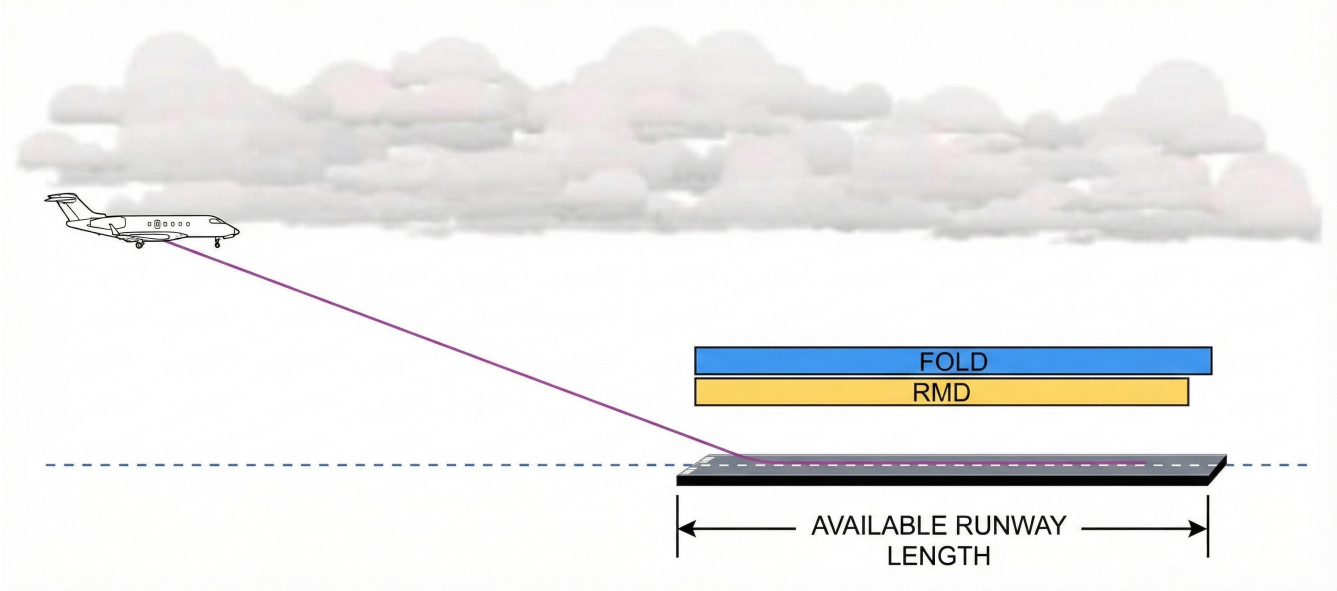
## IX. RUNWAY OVERRUN AWARENESS AND ALERTING SYSTEM (ROAAS)

### A. SYSTEM FUNCTIONS

- Landing distance assessment
- Runway condition monitoring
- Approach stabilization alerts
- Distance remaining annunciations

### B. COMPONENTS AND OPERATION

- ROAAS is hosted on the TAWS computer
- Uses TAWS database for available runway length computations
- Utilizes Factored Operational Landing Distance (FOLD) as it's basis
- Uses RCC condition code 6 and 5 only
- ROAAS Model Distance calculations (RMD) approximated by FOLD
- See FCOM1 Chapter 6 for FOLD Information (or QRH 1, P-43)
- Automatically armed during approach within 4.5 NM and 1,000 ft above landing runway
- Two modes: In-Air and On-Ground



**Receives data from the following systems:**

- FMS – Gross weight & true track angle
- GPS – Position, speed, true track angle, GNSS height and vertical and horizontal position errors
- IRS – Inertial vertical speed, ground speed
- ADS – Pressure altitude, true airspeed, static air temperature
- Landing Gear – Main gear Weight on Wheels (WOW)
- Flaps – Flap lever in landing configuration
- Engine – Thrust Level Angles (TLA), Thrust Reversers status
- Brakes – Brake pressure
- Radio Altimeter – Radio height
- Flight Guidance System – FG coupled side, vertical go-around

**ROAAS PBA Switch:**

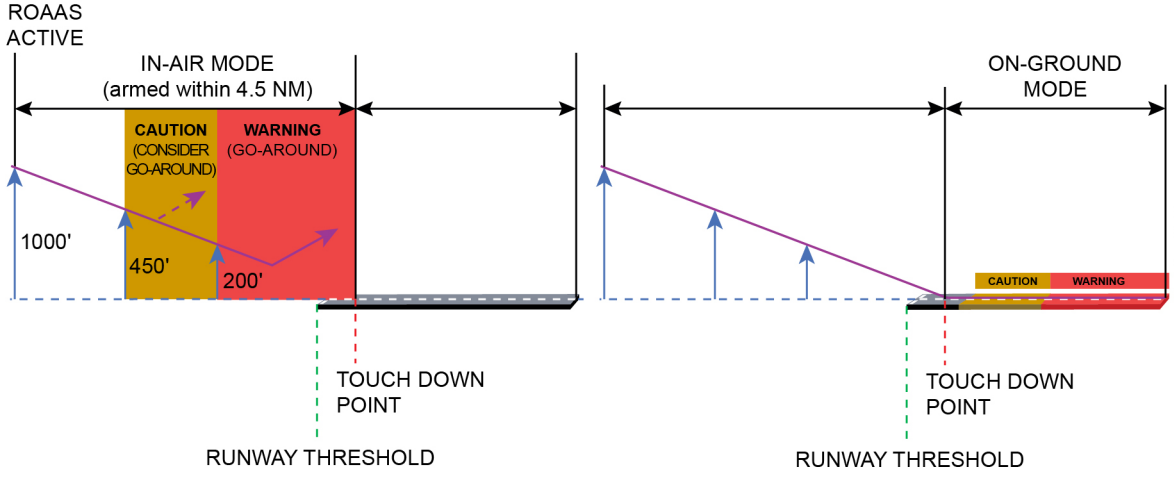
- Located on TAWS WARN Panel
- Inhibits ROAAS functions
- White OFF light is illuminates when pushed in

**ROAAS RCC 5 PBA Switch:**

- Located on TAWS WARN Panel
- Inhibits ROAAS functions
- White OFF light is illuminates when pushed in

**Runway Selection Criteria:**

- ROAAS uses aircraft position and actual track to select the intended runway
- Aircraft track must be within 20° of the runway extended centerline
- Runway selection is automatic and independent of FMS inputs
- Runway parameters are retrieved from TAWS database
- For ROAAS runway selection, must be ROAAS-enabled airport and runway over 3,000'

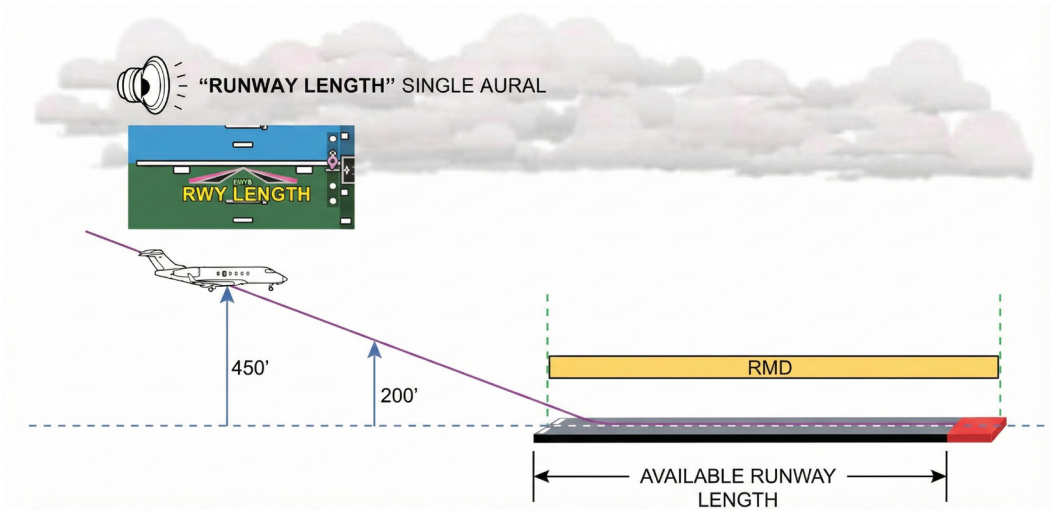


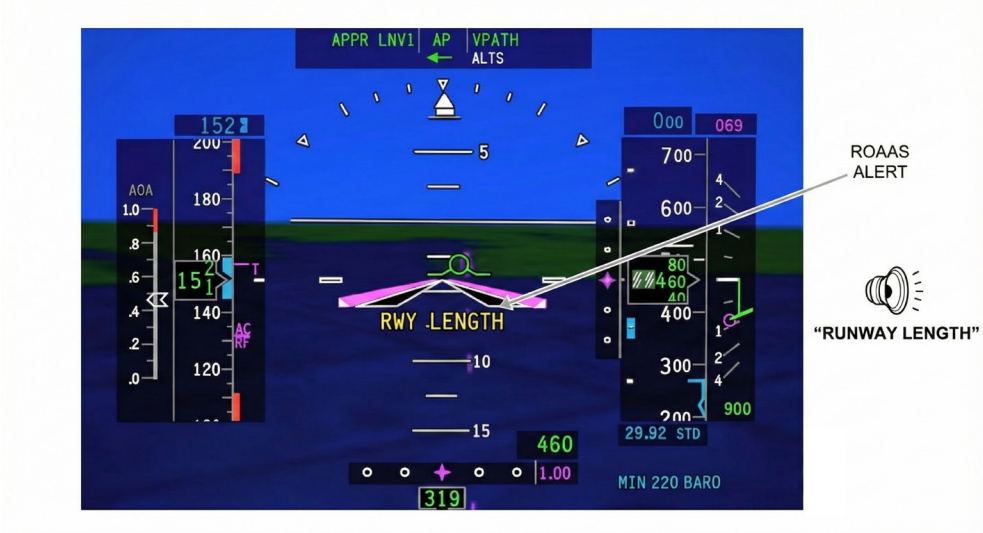
## C. IN-AIR MODE

- Monitors aircraft state through air data, IRS, FMS, GNSS data
- Uses selected Runway Condition Code (RCC 5 or 6)
- Continuously calculates predicted distance required for landing and stopping (RMD)
- Compares to ROAAS Model Distance (RMD)
- Constantly compares RMD (ROAAS Model Distance) to available runway length
- When RMD is within available runway length, no ROAAS Alerts are triggered
- Should RMD be longer than the remaining available runway length, ROAAS generates an alert

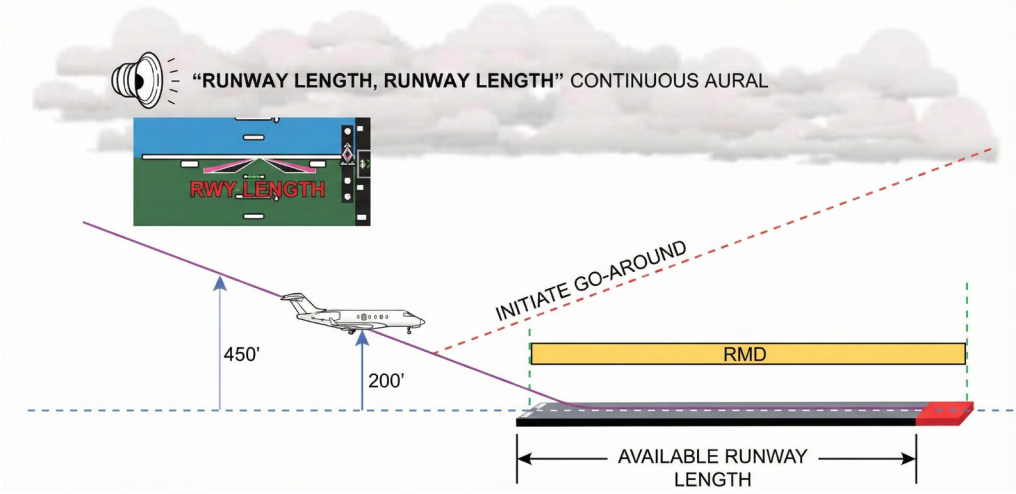
**Two Levels of In-Air Alerts:**

- CAUTION **RWY LENGTH** Alert displayed when RMD is longer than available landing distance
- Active during caution threshold zone – 450' to 200' above runway elevation
- Single aural "RUNWAY LENGTH"



- WARNING **RWY LENGTH** Alert displayed when RMD is longer than the available landing distance
- Active below 200' above runway elevation to touch down
- Continuous aural "RUNWAY LENGTH, RUNWAY LENGTH"

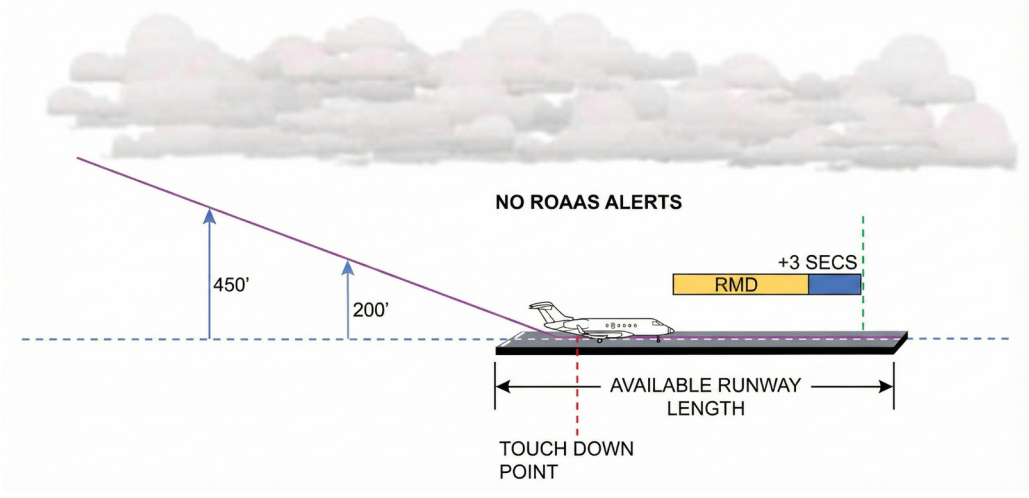



## D. ON-GROUND MODE

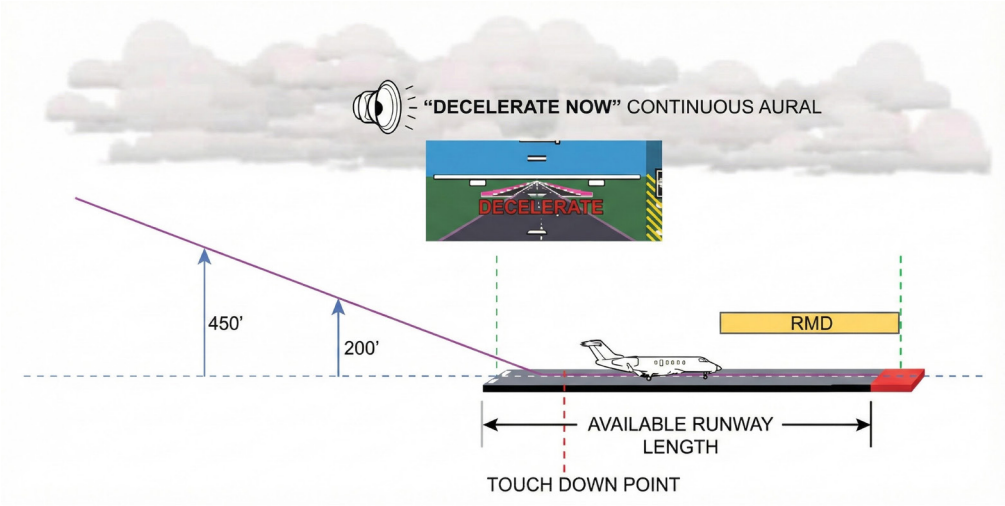
- Roll out phase of landing
- Active between touchdown and 40 knots ground speed
- Continuously monitors its RMD and deceleration and compares to remaining runway length
- Should RMD exceed the remaining available runway length, ROAAS generates an alert

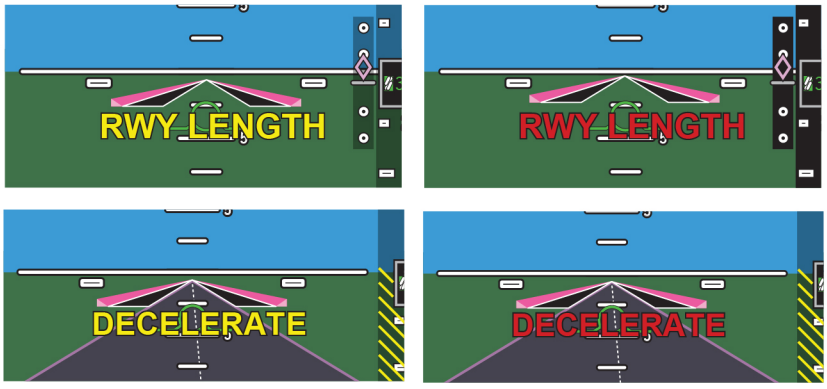
**Two Levels of On-Ground Alerts:**

- CAUTION **DECELERATE** Alert displayed when:
    - 3 Seconds prior to when RMD is longer than the available landing distance
    - Predicted stopping point (based on deceleration) is at or beyond the end of the runway
- Active between touchdown and 40 knots ground speed
- Single aural "DECELERATE"



- WARNING **DECELERATE** Alert displayed when RMD is longer than the available landing distance
- Active between touchdown and 40 knots ground speed
- Continuous aural "DECELERATE NOW"




ROAAS visual alerts are displayed on the center of the PFD. The visual alerts with flash for five seconds when first displayed, then remain steady. When a ROAAS visual alert is displayed, it will also be accompanied by a corresponding aural.

## E. CAS MESSAGES

- ROAAS alerts are unaffected by the CAS inhibit logic
- Provides aural/visual alerts if RMD exceeds remaining available runway length

**ADVISORY ROAAS/RAAS Advisory Messages**

Crew awareness and potential action

| Message | Meaning | Inhibits |
|---|---|---|
| **ROAAS FAIL** | ROAAS failed (Internal software failure, input signal failure) | TO/LAND |
| **ROAAS NOT AVAIL** | ROAAS is not available.<br>**ROAAS NOT AVAIL** will be displayed and ROAAS alerts will not occur for the following scenarios:<br>• Landing above MLW<br>• Not aligned with runway below 500 feet above runway elevation<br>• Landing at a non-ROAAS airport<br>• Steep Approach<br>Landing on a runway below the minimum length (3000 feet) | TO/LAND |
| **ROAAS/RAAS FAIL** | ROAAS and RAAS failed (if RAAS installed) | TO/LAND |
| **ROAAS/RAAS NOT AVAIL** | ROAAS and RAAS are not available (if RAAS installed) | TO/LAND |

**STATUS ROAAS/RAAS Status Messages**

Information only - no crew action required

| Message | Meaning |
|---|---|
| **ROAAS OFF** | ROAAS PBA (switch) is set to OFF (ROAAS is inhibited) |
| **ROAAS RCC 5 ON** | ROAAS RCC 5 PBA (switch) is set to ON (RCC 5 has been selected) |
| **ROAAS/RAAS OFF** | ROAAS and RAAS PBAs (switches) are set to OFF (ROAAS and RAAS are inhibited) |

# X. TRANSPONDER SYSTEM

## A. SYSTEM CONFIGURATION

- Dual TSS-4100 Mode S transponders installed
- Mode A, Mode C, and Mode S capability
- Enhanced surveillance capabilities
- ADS-B Out compliant per 14 CFR 91.227
- Automatic transponder selection

## B. TRANSPONDER OPERATION

- Beacon code entry through MFD or CDU
- Active tuning control for codes 0000-7777
- IDENT function via control wheel switches
- 18-second IDENT transmission duration
- Automatic altitude reporting in Mode C/S

## C. TRANSPONDER/TCAS CONTROL MENU

- Push RADIO button to access radio menu
- Turn MENU knob to TRANSPONDER/TCAS display
- Push RADIO button to display control menu
- Active transponder selection (ATC 1 or ATC 2)
- Flight ID entry using TUNE knobs
- Test mode activation via TEST control



### D. MODE SELECTION

- STBY: Transponder in standby mode
- ALT ON: Altitude reporting enabled
- ALT OFF: Altitude reporting disabled
- 2-second delay prevents transient mode changes
- XPDR FAIL annunciation on transponder failure




## XI. TRAFFIC COLLISION AVOIDANCE SYSTEM (TCAS)

### A. TCAS II VERSION 7.1

- Resolution advisories (RA) for vertical guidance
- Traffic advisories (TA) for awareness
- Coordinated RAs with other TCAS aircraft
- 40 aircraft simultaneous tracking capability
- RA inhibited below 1000 feet AGL

### B. TCAS DISPLAY MODES

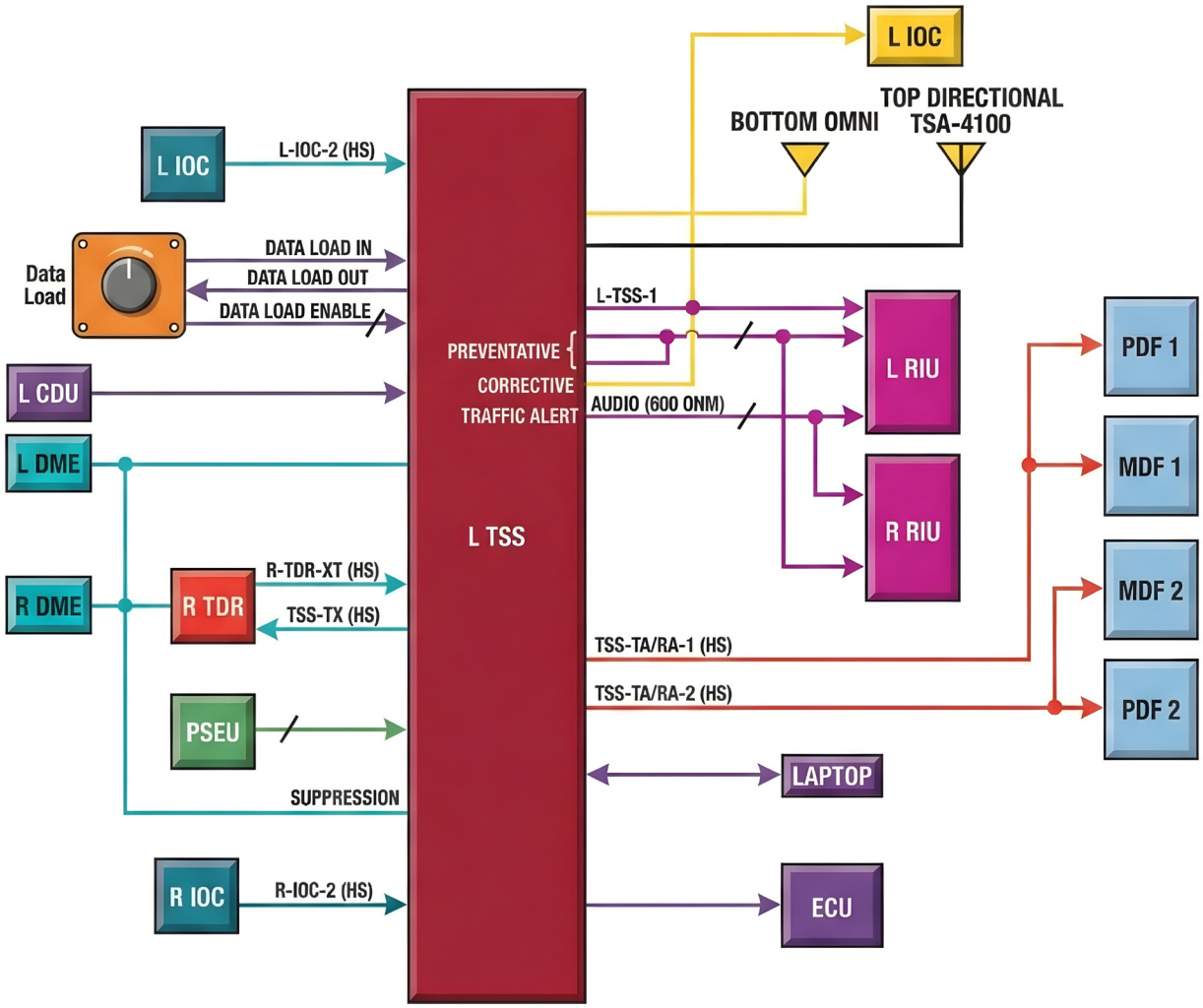
- Traffic displayed on PFD and MFD
- Relative altitude or absolute altitude display
- ABV/NORM/BLW altitude filter selections
- Intruder symbology based on threat level
- Range rings for distance reference

### C. TCAS OPERATIONAL MODES

- TA/RA: Full TCAS protection active
- TA ONLY: Traffic advisories without RAs
- Traffic altitude mode selection (REL or ABS)
- Non-threat traffic display ON/OFF selection
- Altitude limits customization

### D. TCAS ALERTS

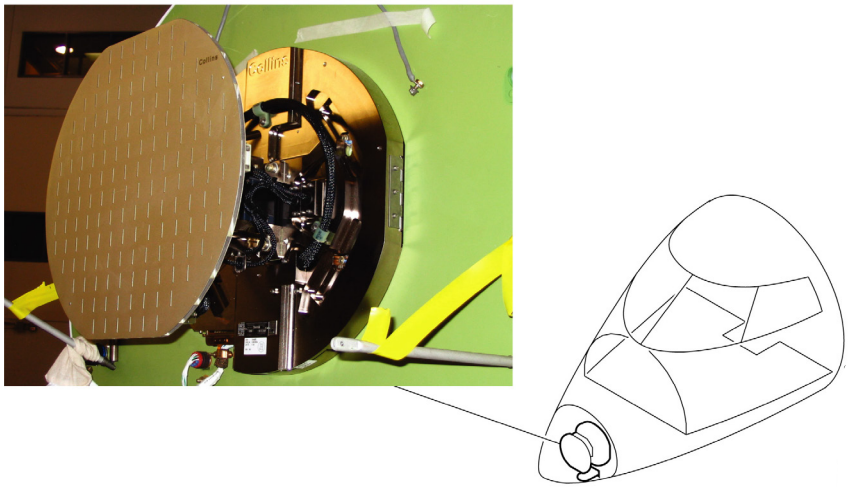
- Aural announcements through speakers
- Visual RA guidance on PFD VSI
- Red and amber threat symbology
- “TRAFFIC TRAFFIC” for TAs
- Vertical speed commands for Ras

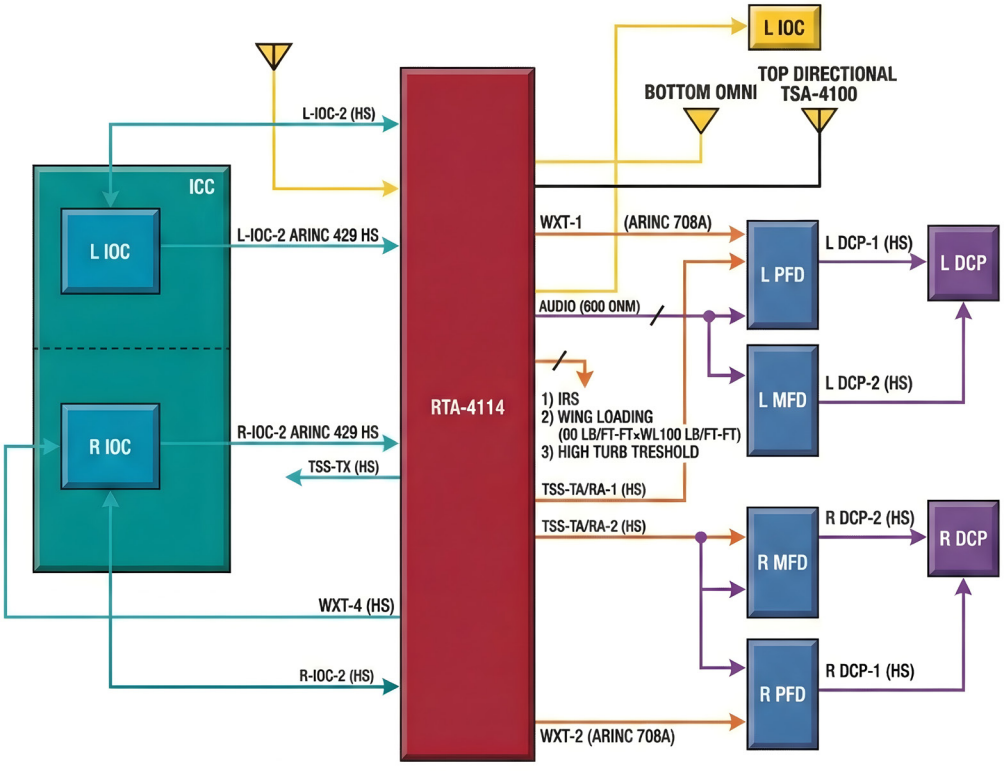

L IOC
TOP DIRECTIONAL
TSA-4100
BOTTOM OMNI
L IOC
L-IOC-2 (HS)
Data
Load
DATA LOAD IN
DATA LOAD OUT
DATA LOAD ENABLE
L-TSS-1
PREVENTATIVE
CORRECTIVE
TRAFFIC ALERT
AUDIO (600 ONM)
L RIU
R RIU
PDF 1
MDF 1
MDF 2
PDF 2
L CDU
L DME
R DME
R TDR
R-TDR-XT (HS)
TSS-TX (HS)
L TSS
TSS-TA/RA-1 (HS)
TSS-TA/RA-2 (HS)
PSEU
LAPTOP
SUPPRESSION
R IOC
R-IOC-2 (HS)
ECU

## XII. WEATHER RADAR SYSTEM

The Challenger 350 weather radar system is an essential tool for detecting and avoiding hazardous weather conditions during all phases of flight. Utilizing X-band radar technology through the RTA- 4114 Multiscan receiver/transmitter/antenna assembly, the system provides flight crews with comprehensive precipitation detection, turbulence identification, and ground mapping capabilities up to 300 nautical miles ahead of the aircraft.

The Multiscan WXR features advanced automated functions including path attenuation compensation, ground clutter suppression, and overflight protection that work together to present an optimized weather picture on the cockpit displays, enabling crews to make informed decisions about weather avoidance and route selection.





## A. SYSTEM DESCRIPTION

- X-band color weather radar for atmospheric moisture detection and ground mapping
- Single radar installation type: RTA-4114 (multiscan weather radar)
- Provides radar-detectable precipitation and precipitation-based turbulence displays ±60° of aircraft heading
- Maximum detection range of up to 300 nautical miles
- Ground mapping capability for navigation reference
- System features include autotilt, ground clutter suppression, range compensation, and path attenuation correction

## B. SYSTEM COMPONENTS

- Receiver/Transmitter/Antenna (RTA) assembly - RTA-4114
- Radar cockpit controls via Display Control Panel (DCP) and Cursor Control Panel (CCP)
- Dual controller configuration for pilot and copilot operation
- IRS Laseref VI provides attitude information for stabilization function
- Internal worldwide terrain database for weather formation intensity detection

## C. RADAR ANTENNA SPECIFICATIONS

- Antenna scan: 60° left and right of airplane heading (total 120° scan arc)
- Manual tilt adjustment range: -15° (down) to +15° (up)
- Auto tilt adjustment range: -30° (down) to +30° (up)
- Stabilization function maintains consistent scan angles relative to earth's horizon
- IRS provides attitude information for stabilization

## D. POWER SUPPLY

- Weather radar RTA powered by Left Main DC Bus
- Circuit breaker: 5-A at CB1-A8
- Circuit breaker nomenclature: WX

## E. WEATHER DISPLAY COLOR CODING

**Precipitation Intensity (Weather Detection Mode)**

- BLACK (Background): Little or no rainfall
- GREEN: Moderate rainfall
- AMBER: Less severe rainfall
- RED: Heavy rainfall
- MAGENTA: Very heavy rainfall
- MAGENTA: Areas of detected turbulence



**Ground Map Mode (MAP)**

- GREEN: Least reflective ground surfaces
- YELLOW: Moderately reflective ground surfaces
- RED: Highly reflective ground surfaces
- MAGENTA: Most reflective ground surfaces

## F. RADAR CONTROL MENU ACCESS

- Radar menu displayed on PFD by pressing RADAR button on DCP
- Radar display selection via TR/WX button on DCP
- Range control via inside knob of TILT-RANGE control on DCP
- Manual tilt control via outside knob of TILT-RANGE control on DCP
- TARGET and SEC SCAN functions covered by AUTO control in menu




Weather Radar Operational Modes

| Mode | Description |
|---|---|
| STBY (Standby) | Default mode; antenna parked, no transmission |
| AUTO Control | Recommended mode; automatic tilt, gain, PAC, GCS, Smart Scan |
| MAN (Manual) | Backup mode; manual tilt and gain control |
| WX | Four-color weather display; detects rain, snow, wet hail |
| WX+T | Weather plus turbulence detection (up to 40 NM) |
| TURB | Turbulence-only mode; 30-second timeout to WX+T |
| MAP | Ground mapping for navigation reference |
| TEST | Rainbow pattern display for system verification |

## G. OPERATIONAL MODES

### STBY (Standby) Mode

- Default selection in RADAR CONTROL menu
- Antenna does not transmit in this mode
- Flat plate antenna parked at bore sight position
- Automatically set after 65 seconds from Air to Ground transition
- Selecting either side to STBY causes both sides to go STBY
- **NOTE:** While on ground, if radar control is other than STBY or TEST, white "RADAR ON" annunciation displays on PFD

### AUTO Control Mode

- Normal control mode for WXR system
- System sends multiple scans at different elevation tilt angles
- Provides best possible weather picture with ground clutter suppression from lower scan
- Radar can act like two independent radars - pilot and copilot can select desired mode
- If AUTO selected on either side, both sides configured to automatic function
- Gain adjustable while in AUTO to examine weather cells
- Tilt function automatically adjusted; "A" displayed after tilt readout
- **NOTE:** Manual tilt is not available in AUTO control mode
- AUTO mode with GAIN set to NORM is the default and recommended radar operation

### AUTO Mode Automatic Features

- Conventional increase/decrease of receiver sensitivity with variable temperature-based gain
- Path attenuation compensation (PAC) – Yellow arc at display perimeter indicates uncertainty sectors
- Smart scan – Improves weather detection during aircraft turns
- Overflight protection – Stores and displays weather data until you are past the storm
- Ground Clutter Suppression (GCS) – Eliminates 98% of ground returns; auto-resets after 30 seconds
- Target Alert (TGT) – Auto search 7-50 NM; cyan/yellow TGT annunciation

### MAN (Manual) Control Mode

- Crew can adjust tilt and gain from DCP
- Intended as secondary/backup mode when AUTO mode has failed
- GCS, PAC, and Overflight Protection features NOT available in manual mode
- **NOTE:** Manual mode is encouraged only when AUTO mode is not available

### WX Mode

- Four-color weather display representing four different precipitation rates
- PAC and STC features automatically enabled
- GCS available
- Detects rain, snow, and wet hail

**WX+T Mode**

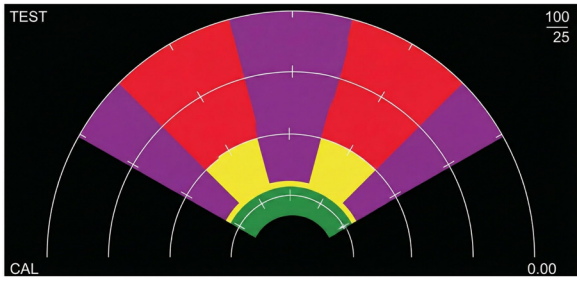
- Four-color weather display plus turbulence mode
- Detects turbulence up to 40 NM range
- Turbulence detection always active even if range set greater than 50 NM

**TURB Mode**

- Turbulence-only mode
- Allows turbulence to be separated from heavy rainfall
- GCS available
- Turbulence detection limited to 40 NM
- After 30 seconds of operational time-out, WX+T mode automatically selected

**MAP Mode**

- Used for detection and display of prominent ground features as navigation aid
- PAC, GCS, and turbulence detection features automatically disabled
- STC derived from different algorithm than weather modes




**TEST Mode**

- Simulated target return creates rainbow-like pattern on display
- Verifies system ability to display weather target information
- Transmitter turned OFF during test
- Scan rotation not allowed
- Test pattern output to displays
- **NOTE:** Inconsistent color pattern or blanking indicates system malfunction

## H. RANGE CONTROL

- Available in all mode operations
- Controlled by onside DCP range knob (inside knob of TILT-RANGE control)
- Controls display range on MFD and PFD
- Available range settings: 5, 10, 25, 50, 100, 200, and 300 NM

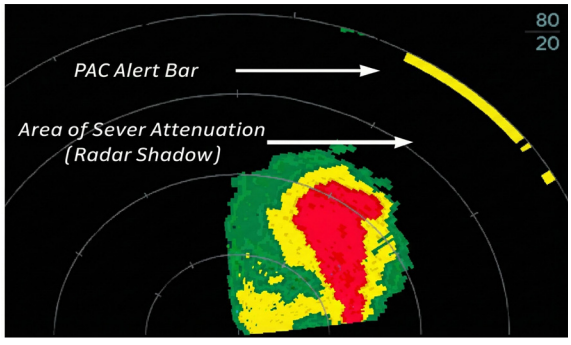
## I. TILT CONTROL

- Only available in Manual (MAN) control mode
- Controlled by outside knob of TILT-RANGE control on DCP
- Used to analyze weather/ground targets by adjusting antenna elevation
- Compensates radar beam angle when aircraft changes altitude
- Tilt angle range: +15° to -15°
- Tilt angle preceded by "T" on radar status line
- "A" displayed after tilt readout if autotilt active
- **NOTE:** In AUTO mode, tilt is automatically adjusted and manual tilt is not available

## J. GAIN CONTROL

- Function can be varied from -3 to +3
- Default and recommended setting: NORM
- Lower gain setting used to analyze intense weather activity
- Higher gain used to detect light precipitation
- Available in AUTO and MAN modes; NOT available in STBY or TEST mode
- Gain value selected by DATA knob, activated by pressing MENU SELECT button on DCP
- Each dB of gain increase causes equal change in total STC compensation
- Receiver gain shows letter "G" and value in radar status field if other than NORM
- **NOTE:** Weather radar false returns can display at higher than NORM gain settings
- **NOTE:** If gain set too low, weather targets ahead may not appear on display
- IMPORTANT: In AUTO control mode, always reset GAIN to NORM after analyzing

## K. PATH ATTENUATION COMPENSATION (PAC)



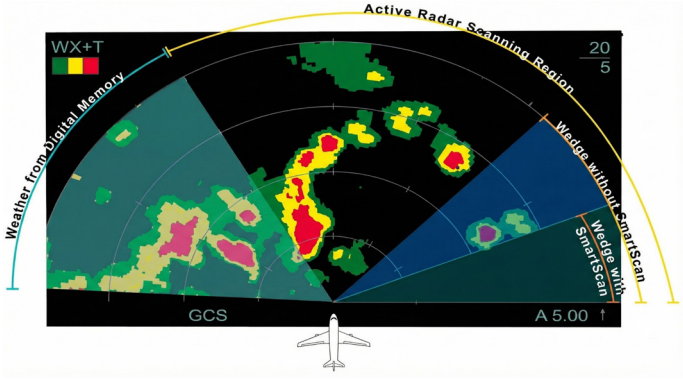

- Compensates for radar beam absorption as it penetrates precipitation cells
- Yellow PAC alert arc appears at perimeter of radar display
- Highlights sectors of uncertainty for pilot to avoid
- Automatically enabled in AUTO mode
- Not available in MAN (manual) mode

## L. SENSITIVITY TIME CONTROL (STC)

- Compensates for stronger radar returns at closer range
- Allows true intensity of precipitation cells to be displayed
- Automatically enabled in WX and WX+T modes

## M. GROUND CLUTTER SUPPRESSION (GCS)

- Eliminates 98% of ground returns from display
- Allows radar to scan at lower tilt angle where most reflective portion of storm is located
- In AUTO mode, GCS always ON by default
- Can be turned OFF from RADAR menu
- Automatically switches back to ON after 30 seconds
- GCS is OFF in MAN (manual) mode




## N. SMART SCAN

- Improves weather detection when aircraft is turning
- Automatically enabled in AUTO mode
- Not available in MAN mode

## O. OVERFLIGHT PROTECTION

- Multiscan WXR stores weather data and displays it until aircraft has flown past the storm
- Automatically enabled in AUTO mode
- Not available in MAN mode

## P. TARGET ALERT (TGT)

- In AUTO mode with no on-side weather radar overlay display selected:
    - WXR automatically searches for weather targets and turbulent areas
    - Search range: 7 nm to 50 nm
    - Cyan TGT message displays in radar status field on PFD and MFD (target mode active)
    - TGT message changes from cyan to yellow to indicate target alert
    - If turbulence detected, TRB shows in yellow to left of TGT message
- Target alert issued if either channel (pilot or copilot side) reports a target
- TGT message flashes for 5 seconds, then remains steady while target detected
- **NOTE:** If both on-side PFD and MFD selected to terrain, no TGT/TRB alert will occur
- **NOTE:** TGT message displays in white to show target mode is inactive

## Q. SECTOR SCAN (SEC SCAN)

- Reduced antenna azimuth scan mode
- Restricts mechanical scan angle used and processed by RTA
- Can be used with any other scanning mode of operation
- Used to increase radar update rate
- **NOTE:** Antenna scan range limited to maximum ±30° from aircraft heading line in this mode
- **NOTE:** If either command channel is in target mode, sector scan is disabled

## R. TERRAIN DATABASE

- Multiscan WXR has internal worldwide terrain database
- Used in conjunction with aircraft geographic position from FMC
- Determines factor for intensity of detecting weather formation
- Terrain Database Fault message displays if database error occurs

## S. DUAL INDEPENDENT OPERATION

- Radar can act like two independent radars
- Pilot and copilot can select desired mode independently
- If AUTO selected on either side, both sides configured to automatic function
- Each dB of gain increase causes equal change in total STC compensation for current display Range

## T. STABILIZATION

- Allows radar to scan with appropriate angles consistently relative to earth's horizon
- Compensates for change of aircraft attitude

- IRS Laseref VI provides attitude information for stabilization function
- Loss of IRS input to RTA results in WX FAULT message in yellow on radar status line

## U. LIGHTNING DETECTION SYSTEM (OPTIONAL)

- Maps location of thunderstorm activity 360° around airplane
- Detection range: up to 200 nautical miles
- Displays lightning bolt icons on MFD
- Color coding by intensity:
    - **YELLOW**: Light level cells (1-4 strikes)
    - **RED**: Medium level cells (5-9 strikes)
    - **MAGENTA**: Heavy level cells (over 9 strikes)

## V. WEATHER RADAR FAULT INDICATIONS

- No EICAS messages for weather radar system
- Fault messages displayed on radar status line in PFD/MFD
- Fault indication flashes for 5 seconds then becomes steady
- Fault annunciations removed by deselecting radar overlay

### WX FAIL

- Displayed on map when loss of operation of weather radar video bus
- All weather data and radar modes removed
- WX FAIL flashes for 5 seconds when first displayed, then becomes steady

### WX FAULT

- Displayed when ability to detect precipitation, turbulence, or perform ground mapping is degraded or inoperative
- Caused by: failed internal bit, parity strap failure, or loss of aircraft pitch and roll data
- Radar continues to attempt to display weather data

### TURB FAULT

- Displayed when turbulence function is not available
- Radar's ability to detect turbulence degraded or inoperative
- Radar continues to attempt to provide turbulence information

### AUTO FAULT

- Displayed when automatic mode is not available
- Radar's ability to automatically control tilt degraded or inoperative
- Usually indicates loss of ARINC input data
- Switch to manual operation when AUTO FAULT is displayed

### CTRL FAULT

- Displayed when control fault is detected
- Indicates loss of control bus data on pilot side, copilot side, or both

- If displayed on one side only, that side slaves to other side
- If both sides display CTRL FAULT:
    - Radar continues to function in last range/mode selected until power turned off
    - If power cycled and control bus still not present on both sides, radar defaults to STBY mode

## W. MODE TRANSITION NOTES

- MANUAL to AUTO mode transition (or vice versa): minimum 2-minute wait required for accurate weather data results
- After 30 seconds of TURB mode operation, WX+T mode automatically selected
- GCS automatically resets to ON after 30 seconds if turned OFF in AUTO mode

## X. WEATHER RADAR SPECIFICATIONS TABLE

Weather Radar System Specifications

| Parameter | Specification |
|---|---|
| Radar Type | RTA-4114 Multiscan Weather Radar |
| Frequency Band | X-band |
| Maximum Range | 300 NM |
| Antenna Scan | ±60° of aircraft heading |
| Manual Tilt Range | -15° to +15° |
| Auto Tilt Range | -30° to +30° |
| Range Settings | 5, 10, 25, 50, 100, 200, 300 NM |
| Gain Range | -3 to +3 |
| Default Gain Setting | NORM |
| Turbulence Detection Range | Up to 40 NM |
| Target Alert Range | 7 to 50 NM |
| Sector Scan Range | ±30° maximum |
| Ground Clutter Suppression | 98% ground return elimination |
| Data Bus | ARINC 708A |
| Stabilization Source | IRS Laseref VI |

## Y. OPERATIONAL NOTES

- AUTO mode with GAIN set to NORM is the default and recommended radar operation
- Manual mode intended as secondary/backup mode when AUTO mode has failed
- Always reset GAIN to NORM after analyzing weather cells in AUTO mode
- Weather radar false returns can occur when gain is higher than NORM

- Weather targets may not appear if gain is set too low
- Minimum 2-minute wait required when transitioning between MANUAL and AUTO modes for accurate data
- Use lower gain settings to analyze intense weather activity
- Use higher gain settings to detect light precipitation
- Turbulence detection limited to 40 NM regardless of display range setting
- PAC, GCS, and Overflight Protection features are NOT available in manual control mode

## XIII. FLIGHT MANAGEMENT SYSTEM (FMS)

The Rockwell Collins dual Flight Management System represents the core navigation and flight management capability of the Challenger 350 aircraft. This fully integrated system provides comprehensive lateral and vertical navigation, flight plan management, multi-sensor navigation solutions, and performance calculation throughout all phases of flight.

The FMS integrates position data from GPS/GNSS receivers, inertial reference systems, DME, and VOR to deliver precise navigation solutions that support en-route, terminal, and approach operations including advanced RNP and LPV approach capabilities.

### A. DUAL FMC-6200 CONFIGURATION

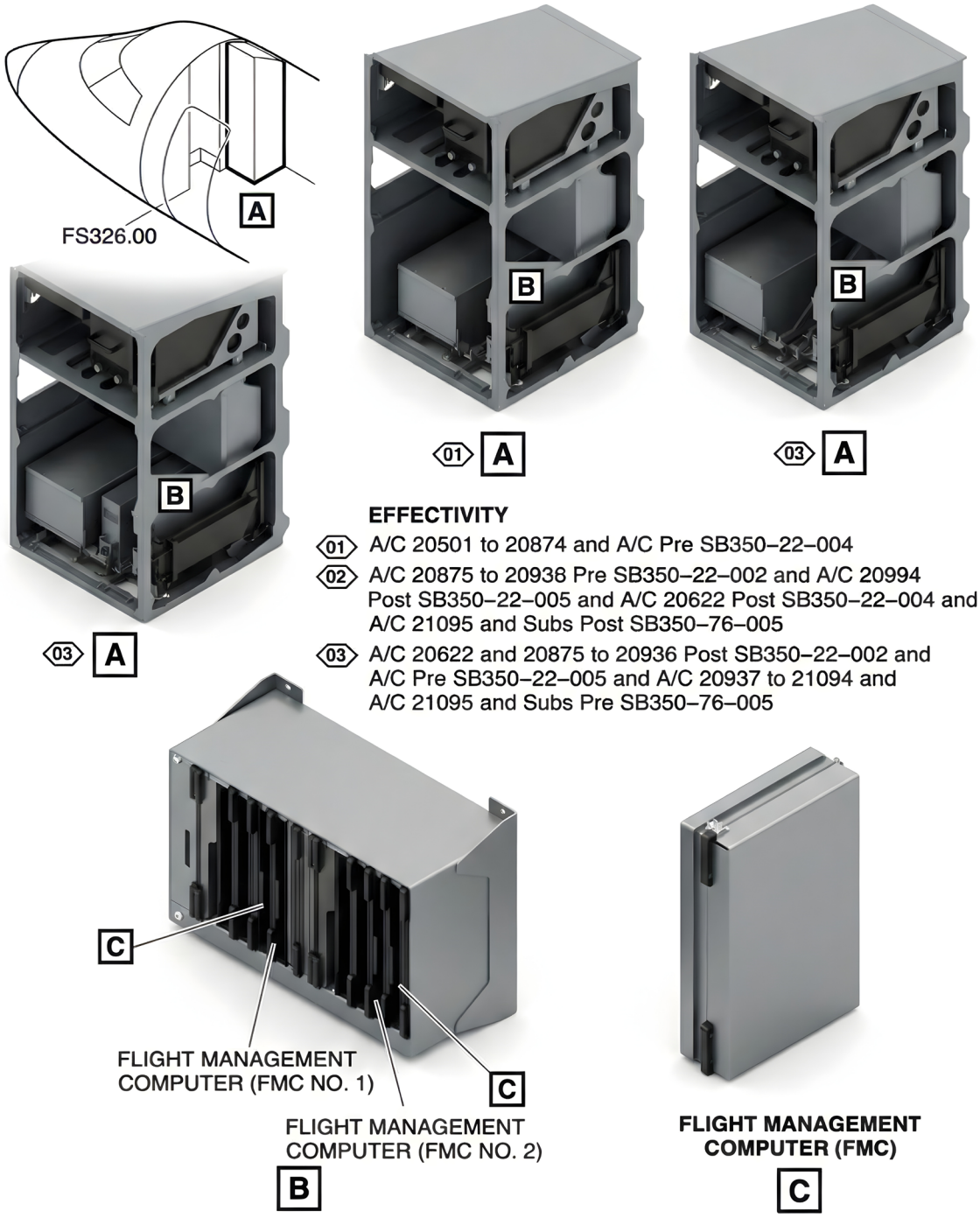
- Dual FMC-6200 flight management computers installed
- PowerPC 460EX processor architecture
- Independent operation capability for redundancy
- Cross-channel data comparison for integrity monitoring
- Automatic reversion capability on single FMS failure
- +5V and +/-12V power supplies from respective IAPS card cage
- IAPS 1 powers left FMC, IAPS 2 powers right FMC

### B. SOFTWARE ARCHITECTURE

- FMS Application (FMSA) - Provides flight planning and guidance functions, FMS maps, and pilot interfaces via CDU pages
- Radio Tuning System Application (RTSA) - Controls radio tuning including auto tune VOR/DME, tune-by-ident, and airport frequency lookup
- Data Link Communication Application (DLCA) - Implements FANS 1/A applications including AFN, ADS-C, and CPDLC

### C. FMC-6200 TECH INSERTION FEATURES

- Increased number of fix points from 5 to 10
- Flight planning enhancement from 9 to 10 characters in route names
- Increased pilot defined waypoints from 50 to 100
- Sensor selection words changed to ENABLED/DISABLED instead of YES/NO
- Abbreviation changes: GNSS for GPS, TKE for TAE, XTK for XTD, TTG for ETE, EPU for POS Accuracy




Flight Management System – Component Location

## D. NEW CAPABILITIES

- Localizer Precision with Vertical Guidance (LPV)
- Airway to airway transitions
- Radius to Fix (RF) legs
- Step down fixes
- Inertial Reference System (IRS) support
- IRS CTL page
- Magnetic heading display
- FMS latitude limits

## E. CONTROL DISPLAY UNIT (CDU)




- Dual CDUs for pilot and copilot operation
- Full alphanumeric keyboard for data entry
- Line select keys for menu navigation
- Dedicated function keys: DIR, FPLN, LEGS, DEP ARR, PERF, DSPL MENU, MFD ADV, MFD DATA, PREV, NEXT
- MSG key for message access
- EXEC key for flight plan execution
- IDX key for index page access
- TUN key for radio tuning functions

## F. MODIFIED CDU PAGES

- GNSS Control (formerly GPS Control)
- Frequency Data
- Fix Info
- VOR/DME Control (formerly VOR Control)
- Pos Init
- Hold List
- Progress
- Defaults
- Arrival Data
- Fuel Management
- Nearest Airports
- Index
- LRN Status (to GNSS Status and IRS Status)
- Depart/Arrival
- Data Base

## G. NEW CDU PAGES

- SBAS Service Providers
- RNP RAIM
- FPLN PRAIM
- IRS Control

## H. MULTI-SENSOR NAVIGATION

**Navigation Sensor Inputs:**

- DME - Distance measuring equipment
- VOR - VHF omnidirectional range
- GPS (GNSS) - Global Navigation Satellite System
- IRS - Inertial Reference System
- DR - Dead reckoning (when no position data available)

**Sensor Data Processing:**

- FMS provides navigation data in en-route, terminal, and approach phases
- Primary navigation mode uses all selected sensors
- FMC smooths transients caused by changes in available sensor data
- Automatic switchover to cross-side system if on-side data is invalid (ADS, IRS)
- IRS Control page used for IRS select/deselect for FMC usage
- IRS Control page accessed from IRS CTL option on INDEX page

**GPS/GNSS Integration:**

- Dual GPS sensors process transmissions from multiple satellites simultaneously
- Minimum four satellites with acceptable geometry required for navigation solution
- Three satellites plus calibrated barometric altitude acceptable as alternative
- Computed GPS position, velocity, and time are inputs to FMS
- GPS data integrated into flight plan based navigation solution
- IRS, ADC, DME, and VOR systems supply supplementary data

**GNSS Control Page:**

- Displays position differences (POS DIFF) between each GPS sensor and FMS calculated position
- Shows direction and distance of position differences
- Line select key enables or disables each GPS sensor
- Disabled GPS sensor remains disabled until manually enabled
- Manual enable/disable capability for each sensor

## I. DEAD RECKONING (DR) MODE

**DR Mode Operation:**

- Activated when no navigation sensor data is available
- Estimates position based on last known position, heading, and airspeed

- FMS DR annunciated on MFD when active
- FMS DR annunciated on PFD if NAV SOURCE is FMS
- DR status shows on CDU message line and MESSAGES page

**DR Mode Limitations:**

- Prohibited to use FMS as primary navigation source during dead reckoning
- FMS DR message indicates DR mode is active
- RNAV operations prohibited when FMS DR is annunciated
- Navigation by other means must be utilized

## J. FLIGHT PLAN MANAGEMENT

**Flight Plan Initialization:**

- FMS can be initialized by various means
- Waypoints set and destinations selected through CDU
- AUTO position initialization uses on-side GNSS sensor position
- MAN selection posts INITIALIZE POSITION crew awareness message if position not initialized
- IRS position can be set via SET POS command (latitude/longitude) when not in Navigation mode

**Route Capabilities:**

- SID, STAR, and airways accommodated
- Great circle route calculated between waypoints for en-route LNAV
- Company route database capability
- Pilot-stored waypoint capacity: 100 waypoints
- Route names up to 10 characters
- Runway database with threshold coordinates

**Flight Plan Features:**

- Flight plan management through FPLN pages
- Legs page displays waypoint sequence
- Departure and arrival procedure selection
- Direct-to navigation capability
- Flight plan modifications with EXEC key confirmation
- Secondary flight plan function (use prohibited per AFM)

**Flight Plan Limitations:**

- Prohibited to load pilot routes from PILOT ROUTE LIST during flight
- Prohibited to upload flight plans from ROUTE MENU (FPLN RECALL) during flight
- Prohibited to select FPLN WIND UPDATE from ROUTE MENU
- IFR navigation prohibited unless pilot verifies database currency or waypoint accuracy

## K. LATERAL NAVIGATION (LNAV)

**LNAV Features:**

- Great circle route computations between waypoints
- Roll steering provided to flight control system (FCS)
- Fly-by and fly-over waypoint logic
- Radius to Fix (RF) path terminators
- Offset flight path capability
- Parallel track offset operations
- Airway to airway transitions

**LNAV Guidance:**

- LNAV can be advisory only if FMS not coupled
- Coupled LNAV provides automatic roll steering
- Cross track distance (XTK) displayed
- Track angle error (TKE) displayed
- Course deviation indicator (CDI) shows lateral deviation

## L. VERTICAL NAVIGATION (VNAV)

**VNAV Capabilities:**

- Climb, cruise, and descent profiles
- Speed and altitude constraints
- Sophisticated interface with FCS for vertical mode selection
- Coupled VNAV interface allows FMS to select FCS vertical modes
- VNAV and LNAV capability can be advisory only if FMS not coupled
- FMS provides vertical steering when required by FCS

**VNAV Modes:**

- VNAV PATH mode
- VNAV SPD mode
- Economic cruise speed calculations
- Step climb recommendations
- Altitude intervention capability

**VNAV Limitations:**

- Vertical guidance is aid to assist pilots with altitude restrictions
- Primary barometric altimeter must be used for altitude compliance
- Use of VNAV prohibited when barometric altitude corrected to QFE
- Use of VFLC prohibited during climb when airspeed reference displayed as Mach
- Prohibited to select MCRZ from FMS VNAV CRUISE page
- Prohibited to select VNAV following go-around during missed approach
- Baro-VNAV prohibited on airplanes 20501-20663 not incorporating SB 350-34-012

**VNAV Cautions:**

- Errors to VNAV paths may occur due to database coding errors or altimetry errors
- Actual VNAV path may deviate below intended path in very cold temperatures
- Temperature compensation function corrects for non-standard temperatures
- Database coding may result in VNAV paths below MDA, DA, or DH
- VNAV paths (pseudo glide paths) are not equivalent to ILS glideslope
- Position must be verified prior to VNAV descent
- Required visual reference must be obtained before descent below published minimums

## M. PERFORMANCE COMPUTATIONS




**Performance Functions:**

- Optimum altitude calculations
- Step climb recommendations
- Fuel predictions and reserves
- Time predictions and ETAs
- Wind calculations and corrections
- Economic cruise speed calculations

**Performance Data:**

- FMS performance data is advisory only
- ETE/ETA and Fuel Remaining information is advisory only
- Airplane operation must not be predicated upon FMS performance data
- Measured mode or manual entry fuel predictions not updated while flight plan modification is open

**Performance Database:**

- Performance database part number must be verified: 096-5327-001 (airplanes 20578 and subsequent)
- V-speed database part number: 096-5016-001 (airplanes 20501-20663) or 096-5016-002 (20664 and subsequent)
- Contaminated runway data enabled on V-speed database 096-5016-002

## N. FMS CALCULATED VSPEEDS

**VSPEED Function:**

- Allows pilot to set or adjust takeoff and approach speeds on PFD
- Reference speeds shown on airspeed tape
- VSPEEDS grouped into takeoff speeds and approach speeds
- FMS calculated VSPEEDS are optional feature

**VSPEED Display:**

- Reference speed shown as digital readout on speed reference table

- Reference bug set for each VSPEED on airspeed scale
- Manually set values displayed in cyan characters
- FMS calculated values displayed in magenta characters
- Combination of FMS calculated and manually set values permitted

**VSPEED Verification:**

- FMS does not compare actual aircraft data against manually input data
- Pilot must verify aircraft configuration matches FMS inputs
- Pilot must validate environmental conditions match FMS inputs
- Verification required before posting FMS computed VSPEEDS on PFD
- Takeoff performance summary on MFD TAKEOFF REFERENCE page
- Approach performance summary on MFD APPROACH REFERENCE page

**REFS Menu Operation:**

- Access via REFS button on DCP
- Menu automatically removed 20 seconds after last activity
- Push another menu button on DCP to manually exit
- MENU, DATA, or PUSH SELECT knob activity resets timeout

## 0. REQUIRED NAVIGATION PERFORMANCE (RNP)

**RNP Capabilities:**

- RNP 4 - Oceanic/Remote operations
- RNP 2 - En Route operations
- RNP 1 - Terminal operations
- RNP APCH - GNSS Non-Precision Approach
- RNP AR APCH - Authorization Required approaches

**RNP Function:**

- RNP is statement of navigation performance accuracy for defined airspace
- RNP value may be specified by pilot on FMS PROGRESS page
- FMS computes expected position accuracy based on sensors in use
- POS ACCURACY (now EPU) displayed on PROGRESS page
- FMS position error should be less than RNP value 95% of time
- LOW POS ACCURACY message displayed when EPU exceeds RNP value

**RNP AR Approaches:**

- RNP AR approaches to RNP of 0.30 available
- Applicable to airplanes incorporating SB 350-34-009

**CDI Scale Requirements:**

- RNP APCH: CDI Scale 0.3 nm
- BASIC RNP-1: CDI Scale 1.0 nm
- RNP-2: CDI Scale 2.0 nm

- RNP-4: CDI Scale 4.0 nm (pilot selected)
- RNP-10: CDI Scale 4.0 nm (pilot selected)

**RNP Leg Length Limitations:**

- BASIC RNP-1: Maximum 200 nm per leg
- RNP-2: Maximum 400 nm per leg
- RNP-4 and RNP-10: Maximum 500 nm per leg
- Pilot defined waypoints must not create legs shorter than limiting length

## P. RAIM AND INTEGRITY MONITORING

**RAIM Prediction:**

- RNP RAIM page performs RAIM prediction on destination only
- FPLN PRAIM page performs RAIM prediction over entire flight plan
- Five satellites required to detect satellite error
- Six satellites required to isolate error to individual satellite

**RAIM Accuracy Criteria:**

- 4 nm for oceanic/remote operations
- 2 nm for en-route operations
- 1 nm for terminal operations
- 0.3 nm for approach operations

**Satellite Deselect:**

- Individual satellites can be deselected by entering identifier
- Used when satellite is NOTAM'd under test
- FMS ignores data from deselected satellite

**Loss of Integrity Messages:**

- Two types: Advisory (white) and Caution (yellow)
- LOI message displayed on PFD when caution level reached
- Messages pertain to GNSS HPL/HIL (horizontal protection/integrity limits)
- LOI not displayed during Approach phase

## Q. SBAS AND LPV APPROACHES

**SBAS Service Providers:**

- WAAS - North America and Hawaii
- EGNOS - Europe
- MSAS - Japan
- GAGAN - India
- Selection through SBAS Service Providers page
- Enables LPV approach capability

**LPV Approach Capabilities:**

- Localizer Performance with Vertical guidance
- SBAS-VNAV used for vertical guidance
- Similar to ILS approach capability
- FMS provides steering commands along flight plan route

**LPV Approach Requirements:**

- Dual PFD required
- Two GNSS/SBAS sensors required to commence approach
- One GNSS/SBAS sensor required to continue approach
- Dual FMS required
- LPV APPR annunciation must be displayed on PFD

**LPV Approach Limitations:**

- LP approaches cannot be performed
- Prohibited to conduct LPV with FMS2 as pilot nav source and FMS1 as copilot nav source
- RNP operations to LPV minimum prohibited with VNV flag, NO APPR, EFIS MISCOMPARE,
- LPV NOT AVAIL

## R. FMS APPROACH OPERATIONS

**FMS Approach Guidance:**

- Lateral and vertical guidance available throughout FMS-based approaches
- FMS lateral guidance uses GNSS position data unless sensor fails or disabled
- FMS vertical guidance based on Baro-VNAV
- SBAS-VNAV used for SBAS LPV or SBAS LNAV/VNAV
- FMS provides steering commands to fly flight plan route
- Captures FMS-generated lateral and vertical flight path for approach

**Approach Requirements:**

- Instrument approaches must use procedures in FMS database
- RNP APPR or LPV APPR annunciation required on PFD
- Vectored ILS approaches exempt (do not rely on FMS guidance)
- ILS back course approaches exempt if vectored

**Coordinate Reference Requirements:**

- FMS with GNSS may only be used if approach referenced to WGS84 or NAD83
- GNSS sensors must be deselected when approach not referenced to WGS84 or NAD83
- SVS shall be deselected when conducting approach in non-WGS84/NAD83 airspace

**Approach Limitations:**

- FMS as primary nav source beyond FAF prohibited for ILS, LOC, LOCBC approaches
- FMS as supplementary nav source permitted when APPR or REF APPR annunciated

- Nav aid referenced in procedure must be displayed and monitored during approach
- Prohibited to tune localizer on TUNE page using identifier only

## S. FMS NAVIGATION SOURCE REQUIREMENTS

**Navigation Source Minimum Requirements (Airplanes 20664 and subsequent):**

- One GNSS; or
- Two DMEs; or
- One VOR/DME; or
- One IRS

**Navigation Source Minimum Requirements (Airplanes 20501-20663):**

- Two GNSSs required

**Latitude Limitations:**

- FMS navigation and magnetic heading display prohibited:
    - All latitudes greater than N82°
    - Latitudes greater than N73° if between W080° and W170°
    - Latitudes greater than S82°
    - Latitudes greater than S60° if between E120° and E160°
    - Canadian Northern Domestic Airspace
- Prohibited to load FMS procedures referenced to True Heading

## T. FMS ANNUNCIATIONS

**Annunciation Locations:**

- PFD annunciation lines FMS A1 and A2 below NAV source data
- A1 line allows up to 11 characters
- A2 line allows 8 characters only
- PFD message shows below and right of aircraft symbol on HSI
- MFD message shows right and lower than aircraft symbol
- CDU message line shows crew awareness and CDU annunciations
- Messages stay on while condition exists, minimum 5 seconds

**Repeater Display:**

- Amber FMS messages on PFD A1 line repeated on ADI (airplanes with SB 350-34-009)
- Display located below and left of FMS indication

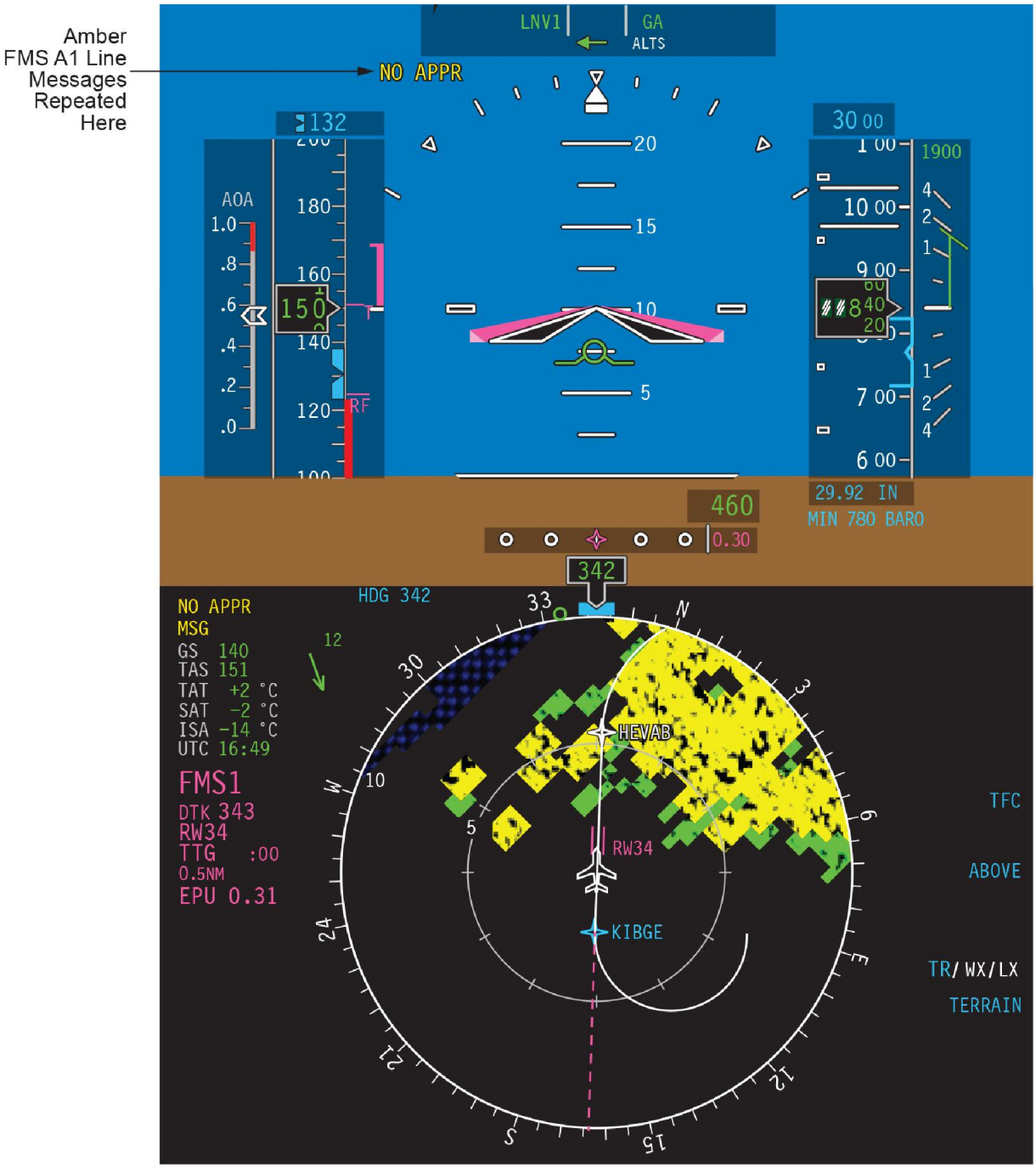
**EPU Display (Estimated Position Uncertainty):**

- EPU value continuously displayed on PFD below distance to go readout
- Applicable to airplanes incorporating SB 350-34-009

**FMS A1 and A2 Message Lines:**

- Message lines moved to top of data block (airplanes with SB 350-34-009)

REPEATER DISPLAY



## A1 AND A2 MESSAGE LINES



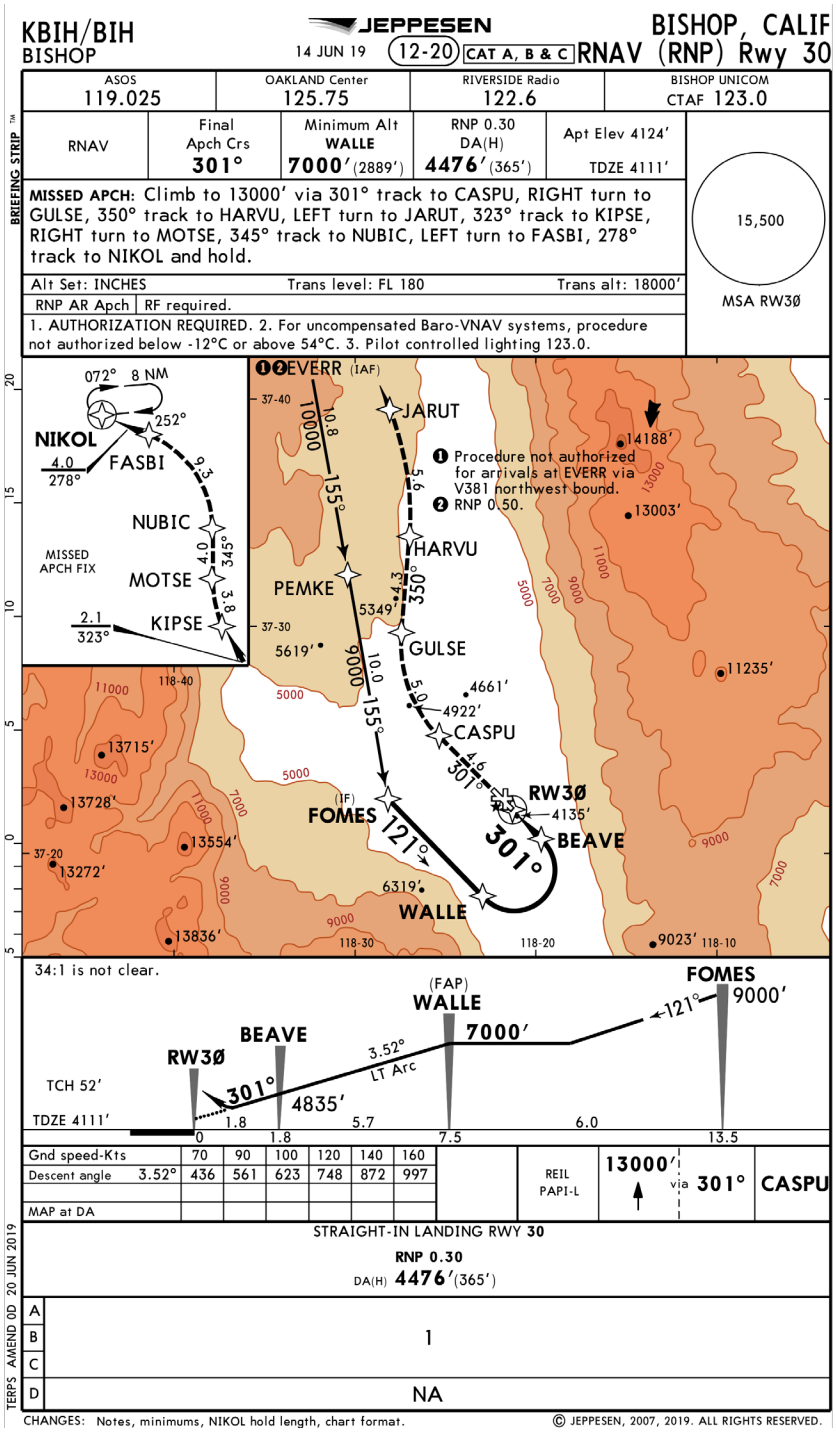
EPU (ESTIMATED POSITION UNCERTAINTY) DISPLAY



## REQUIRED NAVIGATION PERFORMANCE – AUTHORIZATION REQUIRED (RNP AR)

Applicable to airplanes incorporating SB 350-34-009

RNP AR Approaches to an RNP of 0.03 is now available.



## U. DATABASE MANAGEMENT

**Data Base Unit (DBU-5010E):**

- Performs data file transfer between USB drive and aircraft LRUs
- Installed in left equipment rack facing forward
- Provides enhanced data loading functionality over DBU-5000

**DBU Capabilities:**

- Upload FMS navigation and Vspeed databases
- Upload/download pilot waypoints and routes
- Upload/download MDC data: MDT and fault reports
- Load IFIS files and databases (e-charts, GWX, enhanced maps)
- Upload/download multiple LRUs simultaneously

## V. FMS LIMITATIONS SUMMARY

**Operational Limitations:**

- FMS must be operated per AFM and Rockwell Collins Operators Guide
- AFM takes precedence over Operators Guide if differences exist
- Operators Guide must be immediately available when FMS navigation used
- Approved software versions: HSCD CPN 946-2720-101 (or later) / 946-2720-130 (20664 and subsequent)

**Prohibited Operations:**

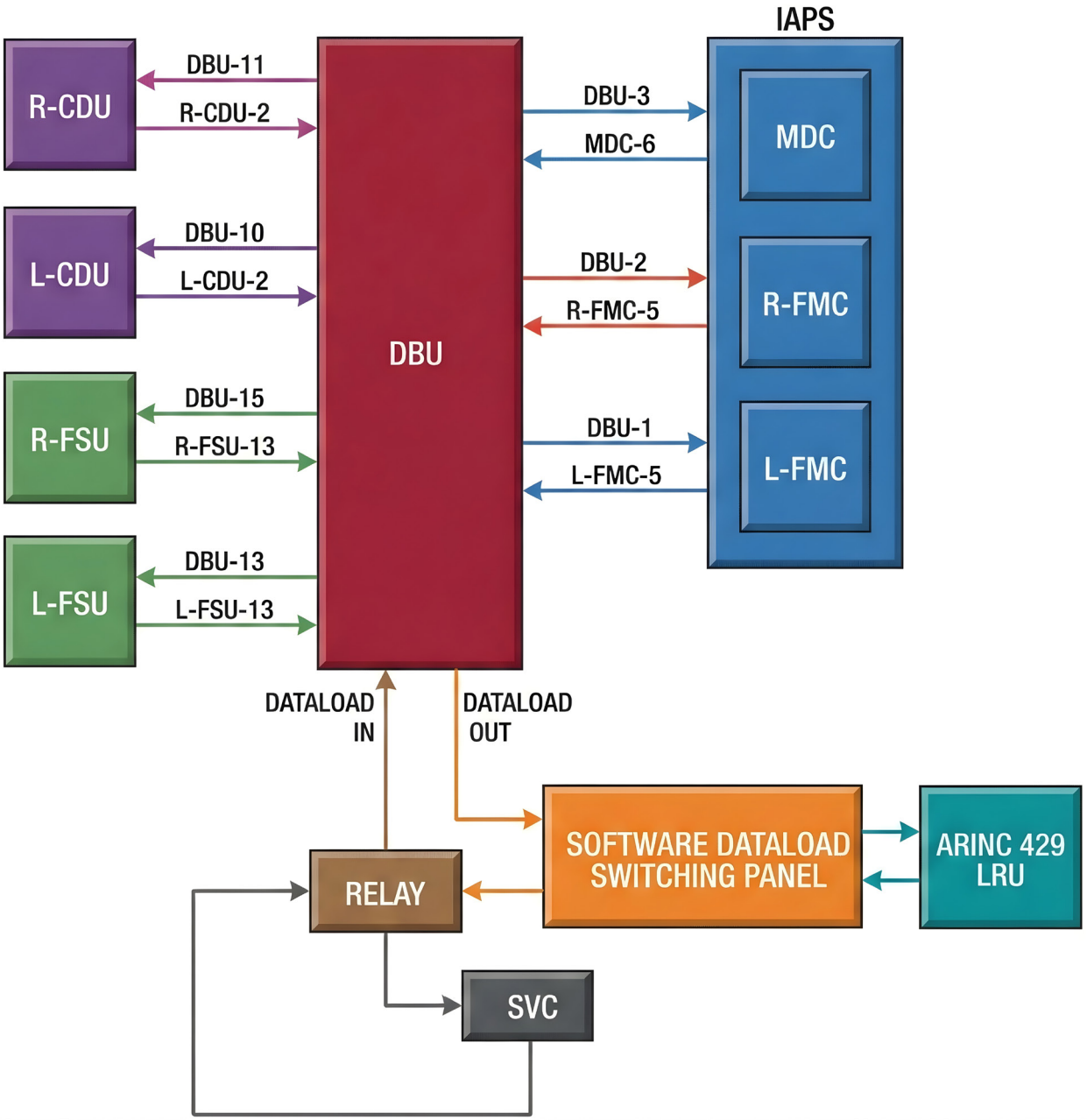
- RF leg procedures prohibited on airplanes 20501-20663 without SB 350-34-012
- FMS DR navigation as primary source
- RNAV operations with FMS DR, IRS ONLY, VOR/DME ONLY, VOR/DME DIST > 40.0 NM, or CHK POS
- RNP operations with NO APPR or UNABLE RNP messages
- NAV RADIO SELF TEST during flight

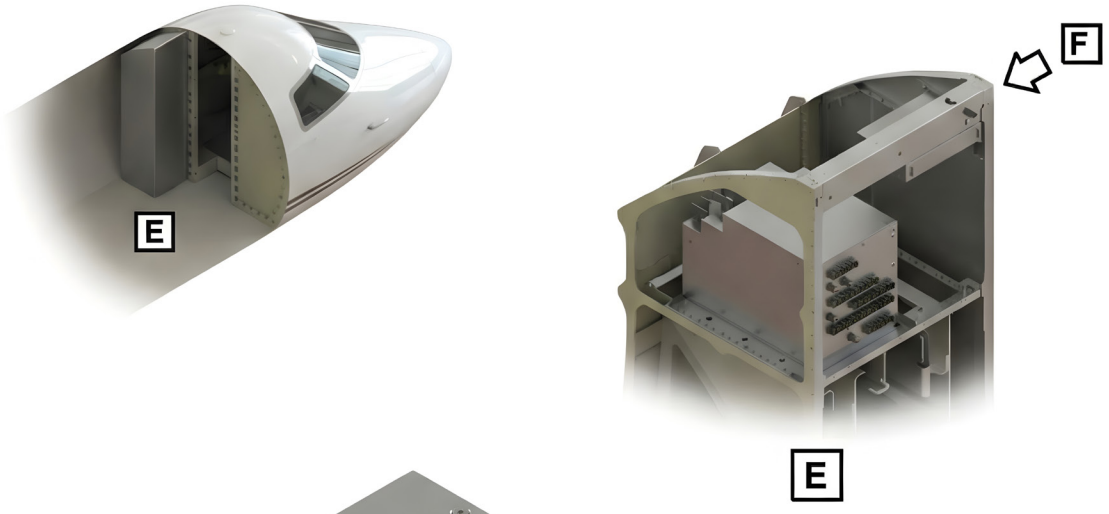
**Database Requirements:**

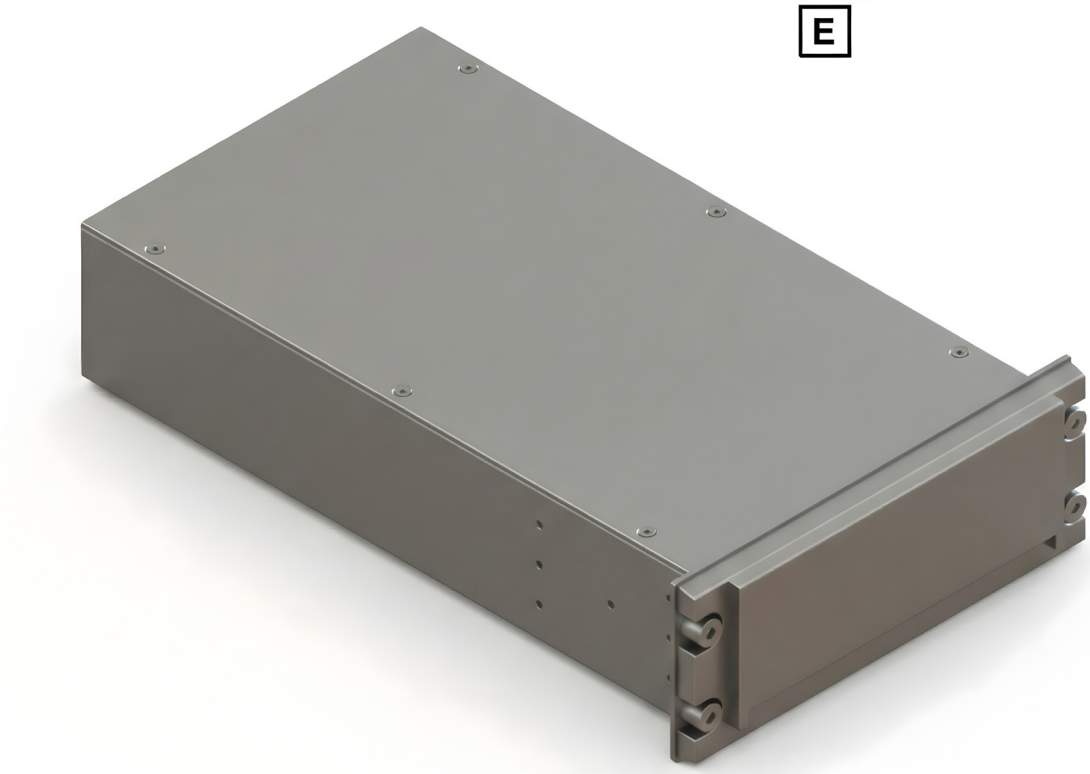
- IFR navigation requires verified current database or waypoint verification
- FMS automatically displays displaced thresholds if identified in database
- Manual runway length entry disables headwind/crosswind computation



DBU Interface





DATA LOADER (A191)

F

# XIV. ADS-B

## A. ADS FUNCTIONS

- ADS-B Out certified operation
- ADS-C for oceanic operations
- Automatic position reporting
- Intent broadcasting capability
- Enhanced surveillance support

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# XV. EICAS MESSAGES

## A. CAUTION MESSAGES

**CAUTION MESSAGES**

Timely crew awareness/action needed

| Message | Meaning | Inhibits |
|---|---|---|
| XPDR 1 & 2 FAIL | For TSS equipped aircraft: Transponders 1 and 2 have failed | — |
| XPDR 1 (2) FAIL | For TSS equipped aircraft: Transponders 1 or 2 have failed | — |

## B. ADVISORY MESSAGES

**ADVISORY MESSAGES**

Crew awareness - no immediate action required

| Message | Meaning | Inhibits |
|---|---|---|
| TAWS BASIC FAIL | Some or all of the basic modes (Mode 1 thru 6) of the terrain awareness warning system have failed. The terrain awareness warning system has failed | TO/LAND |
| TAWS SYSTEM FAIL | The terrain awareness warning system has failed | TO/LAND |
| TAWS TERR FAIL | The terrain function of the terrain awareness system has failed | TO/LAND |
| TAWS TERR NOT AVAIL | The TAWS terrain database has no data for the current location | TO/LAND |
| TAWS WINDSHEAR FAIL | The windshear function of the terrain awareness warning system has failed | TO/LAND |
| TSS FAN FAIL | For aircraft with TSS installation: The cooling fan on the TSS mounting tray is not operating properly | — |
| XPDR 1 (2) FAIL | For TSS equipped aircraft: The indicator transponder has failed | — |

## C. STATUS MESSAGES

| STATUS MESSAGES | |
|---|---|
| Information only - no crew action required | |
| **Message** | **Meaning** |
| **TAWS FLAPS OFF** | The flap warning function of the terrain awareness warning system has been selected OFF by the crew |
| **TAWS GS WARN OFF** | The glideslope warning function of the terrain awareness warning system has been selected OFF |
| **TAWS TERR OFF** | The terrain warning function of the terrain awareness warning system has been selected OFF |
| **XPDRS IN STBY** | For aircraft with TSS installation: Both transponders 1 and 2 are in standby mode. (If one of the transponders has failed, this message will not display.) |

# XVI. LIMITATIONS

## A. FMS LIMITATIONS

Flight Management System (FMS) Limitations

General FMS Prohibitions (All Aircraft)

The following limitations apply to ALL aircraft:

- It is **Prohibited** to load pilot routes from the PILOT ROUTE LIST during flight.
- It is **Prohibited** to upload flight plans from ROUTE MENU (FPLN RECALL) during flight.
- It is **Prohibited** to select FPLN WIND UPDATE from the ROUTE MENU.
- It is **Prohibited** to tune a localizer on the TUNE page using the identifier only.
- It is **Prohibited** to initiate a NAV RADIO SELF TEST from either the NAV radio tuning page on the FMS CDU or the MFD nav radio menu during flight.
- It is **Prohibited** to use the FMS as the primary source of navigation during periods of dead reckoning (indicated by the FMS DR message).
- It is **Prohibited** to load FMS procedures that are referenced to True Heading into the flightplan.
- IFR navigation is **Prohibited** unless the pilot verifies the currency of the database or verifies the waypoints for accuracy by reference to current publications.
- TAWS TERRAIN OFF **must be selected** when QFE operations, and GPS is not available.

FMS Navigation Source Requirements

Effectivity: On airplanes 20664 and subsequent, and airplanes incorporating SB 350-34-012:

- It is **Prohibited** to use the FMS as a navigation source when it is not receiving suitable navigation information from the following: One GNSS; or Two DMEs; or One VOR/DME; or One IRS.

Effectivity: On airplanes 20501-20663 not incorporating SB 350-34-012:

- It is **Prohibited** to use the FMS as a navigation source when it is not receiving suitable navigation information from Two GNSSs.
- Use of the FMS Secondary Flight Plan function is **Prohibited**.

FMS Geographic Prohibitions (All Aircraft)

The following limitations apply to ALL aircraft:

- FMS navigation (FMS selected as NAV Source) and display of magnetic heading is **Prohibited** in Canadian Northern Domestic Airspace and at the following locations:

| Location | Restriction |
|---|---|
| Northern Latitudes | All latitudes greater than N82° |
| Canadian Arctic | Latitudes greater than N73° if between W080° and W170° longitude |
| Southern Latitudes | Latitude greater than S82° |
| Antarctic Region | Latitude greater than S60° if between E120° and E160° longitude |

## B. VNAV LIMITATIONS

Vertical Navigation (VNAV) Limitations

General VNAV Prohibitions (All Aircraft)

The following limitations apply to ALL aircraft:

- Use of VNAV vertical guidance is **Prohibited** when the barometric altitude is corrected to the landing field elevation (QFE).
- Use of VFLC (FLC with VNAV) is **Prohibited** during climb when the airspeed reference is displayed as Mach.
- It is **Prohibited** to select MCRZ from the FMS VNAV CRUISE page.
- It is **Prohibited** to select VNAV following a go-around during the missed approach procedure.
- Use of VNAV vertical guidance for VMDA type approach between the final approach fix and the missed approach fix is **Prohibited**.
- The flight crew must verify any altitude/speed constraints on the last waypoint of any entered STAR procedure and/or the first waypoint of any entered approach procedure.

Barometric VNAV Prohibition

Effectivity: On airplanes 20501-20663 not incorporating SB 350-34-012:

- Use of barometric VNAV vertical guidance is **Prohibited**.

## C. NAV RECEIVER LIMITATIONS

Navigation Receiver Limitations

The following limitations apply to ALL aircraft:

- It is **Prohibited** to conduct ILS Approach operations with LOC2 as pilot navigation source and LOC1 as copilot navigation source.
- It is **Prohibited** to navigate using VOR or LOC as Nav source when displaying true heading mode.

## D. SYNTHETIC VISION SYSTM (SVS) LIMITATIONS

### Synthetic Vision System (SVS) Limitations

The following limitations apply to ALL aircraft:

- TAWS alerts must take priority over the image depicted on SVS.
- Use of the SVS for airplane navigation is **Prohibited**.
- Use of the SVS is **Prohibited** when the barometric altitude is corrected to the landing field elevation (QFE).
- When conducting an approach in airspace not referenced to WGS-84 or NAD-83, the SVS shall be deselected prior to passing the FAF.
- When conducting an approach to a runway not entered in the FMS flight plan, the SVS shall be deselected.
- The SVS Airport/Runway database must incorporate the current update cycle. If not, the SVS shall be deselected prior takeoff and prior to passing the FAF.
- The SVS does not render a video image above latitude 85°N and below latitude 85°S. The SVS shall be deselected prior reaching these latitudes.

**SVS Shall Not Be Sole Source For:**

| Prohibited Use |
|---|
| Continuation of an approach, landing or takeoff below published minima |
| Execution of an approach, landing or takeoff in low visibility conditions |
| Replacement for natural vision where specific visual requirements exist |
| Replacement for basic attitude, flight guidance or navigation displays |
| Performance of any specific flight related task |
| Flight crew judgment, decision or action solely based on SVS display |
| Application of any operational credit |

## E. TERRAIN AWARENESS WARNING SYSTEM (TAWS) LIMITATIONS

### Terrain Awareness Warning System (TAWS) Limitations

The following limitations apply to ALL aircraft:

- Navigation must not be predicated upon the use of the terrain awareness display.
- TAWS TERRAIN OFF must be selected when using QFE operations, and GPS is not available.

#### TAWS Mode Operating Parameters

| Mode | Active Altitude | Function |
|---|---|---|
| Mode 1 | Below 2,500 ft AGL | Excessive Descent Rate |
| Mode 4A | Below 190 kts: "TOO LOW GEAR"<br>Above 190 kts: "TOO LOW TERRAIN" | Unsafe Terrain Clearance |
| Terrain Display | Maximum 300 nm range | Terrain Awareness |

## F. WEATHER RADAR LIMITATIONS

### Weather Radar Limitations

The following limitations apply to ALL aircraft:

- Weather Radar information must be displayed continuously on at least one (1) PFD or MFD during the entire flight.
- Following a TAWS terrain caution or terrain warning, the Weather Radar information must be reinstated on at least one (1) PFD or MFD, after the encounter has been resolved.

#### Weather Radar Operating Parameters

| Parameter | Value |
|---|---|
| Maximum Range | 300 nm |
| Turbulence Mode Scan | ±15° |
| Tilt Range | -15° to +15° |
| Predictive Windshear | Available below 1,200 feet AGL |

## G. RUNWAY AWARENESS and ADVISORY SYSTEM (RAAS) LIMITATIONS

### Runway Awareness and Advisory System (RAAS) Limitations

The following limitations apply to ALL aircraft with RAAS installed:

- RAAS advisories are not intended for navigation purposes.
- Pilots should not deviate from ATC clearances or otherwise correct aircraft position based solely on RAAS advisories.
- Pilots may not use RAAS advisories as a replacement for NOTAM or ATIS information.
- RAAS Short and Insufficient Runway functions do not take into account aircraft performance factors such as aircraft weight, wind, runway conditions, slope, air temperature and altitude of airport.
- Data on newly constructed runways, changes to length of existing runways, or the rare change of runway identifier may not necessarily be included in the RAAS runway database.
- RAAS does not have knowledge of where painted hold lines are located at airports.
- The RAAS system is a situational awareness tool and should not be used as the primary source of determining field position, runway length, field performance, etc.
- Altimeter Monitor-Below Transition Altitude function is not available at airports defined as QFE in the EGPWS database.

## H. RUNWAY OVERRUN AWARENESS and ALERTING SYSTEM (ROAAS) LIMITATIONS

### Runway Overrun Awareness and Alerting System (ROAAS) Limitations

The following limitations apply to ALL aircraft with ROAAS installed:

- The use of ROAAS for approach and landings to runways with the departure end of runway (far end) temporarily displaced is **Prohibited**.
- With ROAAS on, to avoid ROAAS alerts, the landing distance available must be equal to or greater than FOLD (Factored Operational Landing Distance).

#### ROAAS Operating Parameters

| Parameter | Value |
|---|---|
| Minimum Runway Length | 3,000 feet |
| Arm Distance | Within 4.5 nm of runway |
| Arm Altitude | Less than 1,000 feet above runway |
| Track Alignment | Within 20° of runway centerline |
| In-Air Caution Zone | 450 to 200 feet above runway |
| In-Air Warning Zone | 200 feet to touchdown |
| On-Ground Active Range | Touchdown to 40 kts groundspeed |
| Alert Clearing Speed | Below 25 kts groundspeed |

## I. TRAFFIC ALERT and COLLISION AVOIDANCE SYSTEM (TCAS) LIMITATIONS

### Traffic Alert and Collision Avoidance System (TCAS) Limitations

The following limitations apply to ALL aircraft:

- Maneuvers must not be based solely on information presented on the traffic map overlay.
- TCAS Resolution Advisories (RA) are inhibited below 1,000 feet AGL.

### TCAS Operating Parameters

| Parameter | Value |
|---|---|
| Maximum Range | 40 nm |
| Maximum Intruders Displayed | 32 aircraft |
| RA Inhibit Altitude | Below 1,000 feet AGL |
| TA Time to CPA | Approximately 35 seconds |
| RA Time to CPA | Approximately 25 seconds |

### TCAS Regional Limitations

Effectivity: For airplanes on the Russian Federation (RF) and Commonwealth of Independent States (CIS) countries' registry:

- Flight is not permitted along routes where ATC service provided is not in RBS mode.
- TCAS II TA/RA mode is not recommended on routes where ATC modes not limited to RBS are provided. On these routes, while in TA mode, the pilot action shall be coordinated with ATC.

## J. INTEGRATED FLIGHT INFORMATION SYSTEM (IFIS) LIMITATIONS

### Integrated Flight Information System (IFIS) Limitations

The following limitations apply to ALL aircraft:

- Incorporation of Dual IFIS does not constitute operational approval to dispatch without adequate backup documentation.
- The IFIS related databases utilized (charts, airspace, airways, geographic, political, graphical weather) must incorporate the current update cycle.
- The IFIS does not include enroute charts.
- The airplane symbol on the electronic charts is advisory and is presented for increased situational awareness. It is not to be used for navigation.
- The display of geo-political boundaries, airspace and airways on the MFD (Enhanced Map overlays) is for enhanced situational awareness only, and use for navigation is **Prohibited**.
- All weather products data linked to the airplane are advisory.
- For a single IFIS, adequate backup documentation must be immediately available to the flight crew.
- The airplane symbol displayed on airport diagram charts during ground operations is advisory and is presented for increased situational awareness. It is not to be used for precision maneuvering on the ground.
- It is not possible to display landscape formatted approach charts in split view.

## K. RADIO ALTIMETER LIMITATIONS

### Radio Altimeter Limitations

The following limitations apply to ALL aircraft:

| Parameter | Value |
|---|---|
| Operating Range | -20 to 2,500 feet AGL |
| Display Range | Below 2,500 feet AGL |

## L. STANDBY INSTRUMENT (ISI) and COMPASS LIMITATIONS

### Standby Instrument Limitations

The following limitations apply to ALL aircraft:

- Use of the standby instrument localizer deviation guidance is **Prohibited** during localizer backcourse approaches.
- L and R WSHLD/WINDOW switches must be temporarily selected OFF while the standby compass is being read.

## M. DISTANCE MEASUREMENT EQUIPMENT (DMA) LIMITATIONS

Distance Measuring Equipment (DME) Limitations

The following limitations apply to ALL aircraft:

| Parameter | Value |
|---|---|
| Maximum Tracking Range | 300 nm |
| Operating Frequency | 962 to 1213 MHz |
| Limitation | Line-of-sight operations only |

## N. AUTOMATIC DIRECTION FINDER (ADF) LIMITATIONS

Automatic Direction Finder (ADF) Limitations

The following limitations apply to ALL aircraft:

| Parameter | Value |
|---|---|
| Frequency Range | 190-1799 kHz |
| Maritime Distress Bands | 2088-2094 kHz and 2179-2185 kHz |
| Limitation | Subject to thunderstorm interference |

## 0. APPROACH LIMITATIONS

### Approach Limitations

#### General Approach Requirements (All Aircraft)

The following limitations apply to ALL aircraft:

- Instrument approaches must be accomplished only in accordance with instrument approach procedures that are contained in the FMS database.
- It is **Prohibited** to conduct LPV Approach operations with FMS2 as pilot navigation source and FMS1 as copilot navigation source.
- Use of FMS instrument approaches is **Prohibited** unless RNP APPR or LPV APPR is annunciated on the PFD.
- FMS as a primary navigation source beyond the FAF is **Prohibited** for ILS, LOC and LOCBC approaches.
- When conducting an instrument approach with a T-Transition and utilizing VNAV for descent guidance, indicated airspeed at the initial approach fix must be 210 KIAS or less.
- Other than automatic FMS temperature compensation, changes to altitudes in the final approach segment (including FAF and step-down fixes) for any FMS approach procedures are **Prohibited**.
- The FMS with inputs from GNSS may only be used for approach guidance if the reference coordinate data system for the instrument approach is WGS84 or NAD83.
- GNSS sensors must be deselected when on approach in airspace not referenced to WGS84 or NAD83.

#### LPV Approach Prohibitions (All Aircraft)

The following limitations apply to ALL aircraft:

- RNP operations down to LPV minimum when any of the following messages are present, are **Prohibited**:

| Message/Condition | Location |
|---|---|
| Red boxed "VNV" flag | Vertical deviation scale on PFD |
| NO APPR | PFD |
| EFIS MISCOMPARE | CAS message |
| EFIS COMPARATOR INOP | CAS message |
| LPV NOT AVAIL | CDU |

#### LPV Equipment Requirements (All Aircraft)

The following limitations apply to ALL aircraft:

| Equipment | Requirement |
|---|---|
| PFD | Dual PFD required |
| GNSS/SBAS Sensors | Two required to commence; one required to continue |
| FMS | Dual FMS required |

### LPV Geographic Prohibition

**Effectivity: For airplanes NOT incorporating Service Bulletins SB350-34-025 or SB350-34-033:**

- LPV approach operations are **Prohibited** in the area defined by the following coordinates:

| Point | Latitude | Longitude |
|---|---|---|
| A | N75° | W175° |
| B | N75° | W130° |
| C | N50° | W175° |
| D | N50° | W155° |

## P. RNP OPERATIONS LIMITATIONS

### RNP Operations Limitations

#### CDI Scale Requirements (All Aircraft)

The following limitations apply to ALL aircraft:

- When conducting RNP operations the pilot must verify the PFD CDI scale annunciation is appropriate for the RNP leg:

| RNP Type | Required CDI Scale |
|---|---|
| RNP APCH | 0.3 nm |
| BASIC RNP-1 | 1.0 nm |
| RNP-2 | 2.0 nm |
| RNP-4 | 4.0 nm (selected by pilot) |
| RNP-10 | 4.0 nm (selected by pilot) |

#### Flight Plan Leg Length Limitations (All Aircraft)

The following limitations apply to ALL aircraft:

| RNP Operation | Maximum Leg Length |
|---|---|
| BASIC RNP-1 | 200 nm |
| RNP-2 | 400 nm |
| RNP-4 or RNP-10 | 500 nm |

- Pilot defined waypoints (e.g. along track offset) must not be used to create individual legs shorter than the limiting length.
- When conducting non-AR RNP operations, pilots should maintain CDI lateral deviation less than +/-1 dot deviation except brief deviation in excess of +/-1 dot deviation during waypoint sequencing is permitted.

## P. RNP OPERATIONS LIMITATIONS (continued)

### Radius-to-Fix (RF) Leg Prohibition

Effectivity: On airplanes 20501-20663 not incorporating SB 350-34-012:

- Performing any departure, arrival, approach or missed approach procedure that contains any radius-to-fix (RF) leg(s) is **Prohibited**.

### RNAV Prohibited Operations (All Aircraft)

The following limitations apply to ALL aircraft:

- RNAV operations per AC 90-100A or AC 90-96A in RNAV 1, RNAV 2 or RNAV 5 are **Prohibited** with any of the following FMS messages annunciated:

| Message | Location |
|---|---|
| FMS DR | PFD, MFD or CDU |
| IRS ONLY | PFD, MFD or CDU |
| VOR/DME ONLY or V/D ONLY | CDU or PFD |
| VOR/DME DIST > 40.0 NM | CDU |
| CHK POS | PFD or CDU |

- RNP operations with any of the following FMS messages annunciated are **Prohibited**:

| Message | Location |
|---|---|
| NO APPR | PFD |
| UNABLE RNP | PFD |

## XVII. CIRCUIT BREAKERS

Navigation System Circuit Breakers

| CB Name | Bus | Location |
|---|---|---|
| CB Name | Bus | Location |
| NAV 1 | LEFT ESS | CB1-A1 |
| NAV 2 | RIGHT MAIN | CB2-A1 |
| DME 1 | LEFT MAIN | CB1-A2 |
| DME 2 | RIGHT MAIN | CB2-A2 |
| GPS 1 | LEFT ESS | CB1-A3 |
| GPS 2 | RIGHT MAIN | CB2-A3 |
| CDU 1 | LEFT ESS | CB1-A4 |
| CDU 2 | RIGHT MAIN | CB2-A4 |
| TCAS/XPDR1 | LEFT ESS | CB1-A5 |
| XPDR 2 | RIGHT MAIN | CB2-A5 |
| TAWS | RIGHT MAIN | CB2-A6 |
| WX | LEFT MAIN | CB1-A8 |
| ATT HDG 1 | LEFT ESS | CB1-C2 |
| ATT HDG 2 | RIGHT MAIN | CB2-C2 |
| ELT/NAV | LEFT ESS | CB3-D4 |

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## XVIII. NAVIGATION SYSTEM QUIZ

1. What is the VHF COM radio frequency range?

A) 108.00 to 117.95 MHz
B) 118.000 to 136.991 MHz
C) 121.50 to 135.975 MHz
D) 108.00 to 136.991 MHz

2. How many VHF COM radios are standard on the Challenger 350?

A) 1
B) 2
C) 3
D) 4

3. What is the maximum tracking range of the DME system?

A) 200 nm
B) 250 nm
C) 300 nm
D) 350 nm

4. How many GPS satellites are required minimum for a navigation solution?

A) Three satellites
B) Four satellites
C) Five satellites
D) Six satellites

5. What is the fixed operating frequency of the marker beacon receiver?

A) 75.00 MHz
B) 108.00 MHz
C) 110.00 MHz
D) 121.50 MHz

6. Which SBAS service provider is used for North American LPV approaches?

A) EGNOS
B) MSAS
C) GAGAN
D) WAAS

7. At what altitude is Mode 1 TAWS active?

A) Below 2000 feet AGL
B) Below 2500 feet AGL
C) Below 3000 feet AGL
D) Below 3500 feet AGL

8. At what altitude is TCAS resolution advisory inhibited?

A) Below 500 feet AGL
B) Below 1000 feet AGL
C) Below 1500 feet AGL
D) Below 2000 feet AGL

9. What is the operating range of the radio altimeter system?

A) -10 to 2000 feet
B) -20 to 2500 feet
C) 0 to 3000 feet
D) -50 to 5000 feet

10. How many channels does the DME-4000 unit provide?

A) Two channels
B) Three channels
C) Four channels
D) Five channels

11. What processor powers the FMC-6200 flight management computer?

A) Intel Core i7
B) ARM Cortex
C) PowerPC 460EX
D) MIPS R3000

12. What is the maximum range of the weather radar system?

A) 160 nm
B) 240 nm
C) 300 nm
D) 400 nm

13. Which navigation receiver integrates VOR/LOC/GS/MKR/ADF functions?

A) NAV-4000
B) NAV-4500
C) NAV-5000
D) NAV-6000

14. What annunciation is required on the PFD for FMS instrument approaches?

A) NAV ARM
B) RNP APPR or LPV APPR
C) FMS ACTIVE
D) APPR MODE

15. What is the ADF frequency range for maritime distress band monitoring?

A) 2088-2094 kHz and 2179-2185 kHz
B) 1900-2000 kHz and 2100-2200 kHz
C) 2050-2100 kHz and 2150-2200 kHz
D) 2000-2050 kHz and 2200-2250 kHz

16. At what speed does Mode 4A change from "TOO LOW GEAR" to "TOO LOW TERRAIN"?

A) 159 knots
B) 190 knots
C) 250 knots
D) 300 knots

17. What is the glideslope receiver operating frequency range?

A) 108.00 to 117.95 MHz
B) 329.15 to 335.00 MHz
C) 960 to 1215 MHz
D) 108.10 to 111.95 MHz

18. Which Mode S transponder model is installed in the Challenger 350?

A) TSS-3000
B) TSS-3500
C) TSS-4100
D) TSS-4500

19. At what latitude limits does the SVS system stop rendering terrain?

A) 80°N and 80°S
B) 85°N and 85°S
C) 90°N and 90°S
D) 75°N and 75°S

20. What happens when a GPS sensor is manually DISABLED?

A) It automatically re-enables after 5 minutes
B) It remains disabled until manually enabled
C) It re-enables on the next flight
D) It re-enables when crossing 10,000 feet

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CL-350 TRAINING MANUAL

# EMERGENCY EQUIPMENT | 20

AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

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# EMERGENCY EQUIPMENT

## I. INTRODUCTION

The Challenger 350 is equipped with safety equipment that is essential to the safety of passengers and crew. This equipment includes portable fire extinguishers containing Halon 1211, protective breathing equipment (PBE) for smoke and fire protection, crash axe, flashlights, life vests for overwater operations, optional life rafts, and first aid supplies. These items are strategically positioned throughout the flight deck and passenger cabin to provide crew members with immediate access during emergency situations.

### A. EMERGENCY EQUIPMENT SPECIFICATIONS

Emergency Equipment Specifications

| Parameter | Value |
|---|---|
| Flight Deck Flashlights | 2 |
| Flight Deck PBE | 1 |
| Flight Deck Crash Axe | 1 |
| Flight Deck Fire Extinguisher | 1 (Halon 1211) |
| Flight Deck Life Vests | 2 |
| Passenger Cabin First Aid Kit | 1 |
| Passenger Cabin Fire Extinguishers | 2 |
| Passenger Cabin PBE | 1 |
| Passenger Life Vests | 1 per seat |
| Life Rafts (Optional) | 1-3 (4-person each) |

## II. FLIGHT DECK EMERGENCY EQUIPMENT

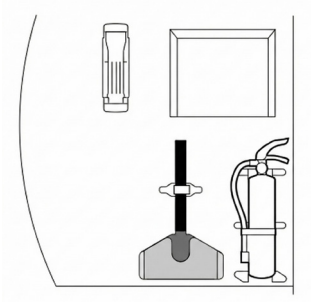
### A. EQUIPMENT LIST

- 2 flashlights
- 1 portable breathing equipment (PBE)
- 1 crash axe
- 1 fire extinguisher
- 2 life vests
- Smoke Goggles

### B. CRASH AXE

- Located on the bulkhead behind the copilot seat

Img: crash_ax_location





Img: Gemtor-D42-Axe

# III. PORTABLE FIRE EXTINGUISHER

## A. DESCRIPTION

- Hand-operated fire extinguisher located in the flight compartment
- Contains Halon 1211
- Effective on electrical, oil, and fuel fires
- Suitable for use in cold weather
- Effective in fighting Class A, B, and C fires




Img: cl350_fire_extinguisher_label

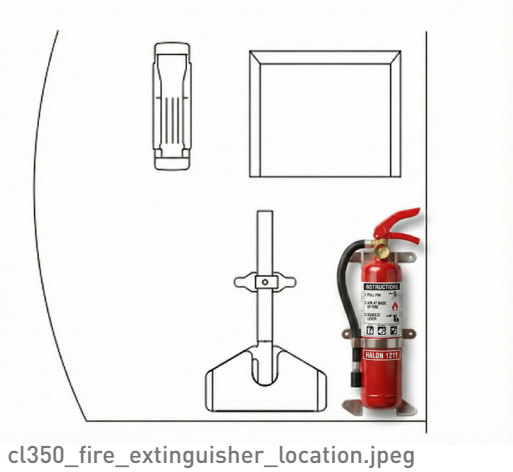
## B. COMPONENTS

- Discharge nozzle
- Discharge lever
- Clasp
- Pressure gauge (indicates normal charge)
- Locking pin
- Nylon tie

## C. OPERATION

- Remove from stowage bracket
- Hold the extinguisher upright in either hand
- Slide the locking pin down with thumb
- Aim the nozzle towards the base of the fire
- Press the lever
- Discharge stops when the lever is released
- Full discharge occurs in 10 seconds when lever held in ON position
- Ventilate compartment promptly after extinguishing fire to reduce gases produced by fire and Halon

Behind Copilot's Seat

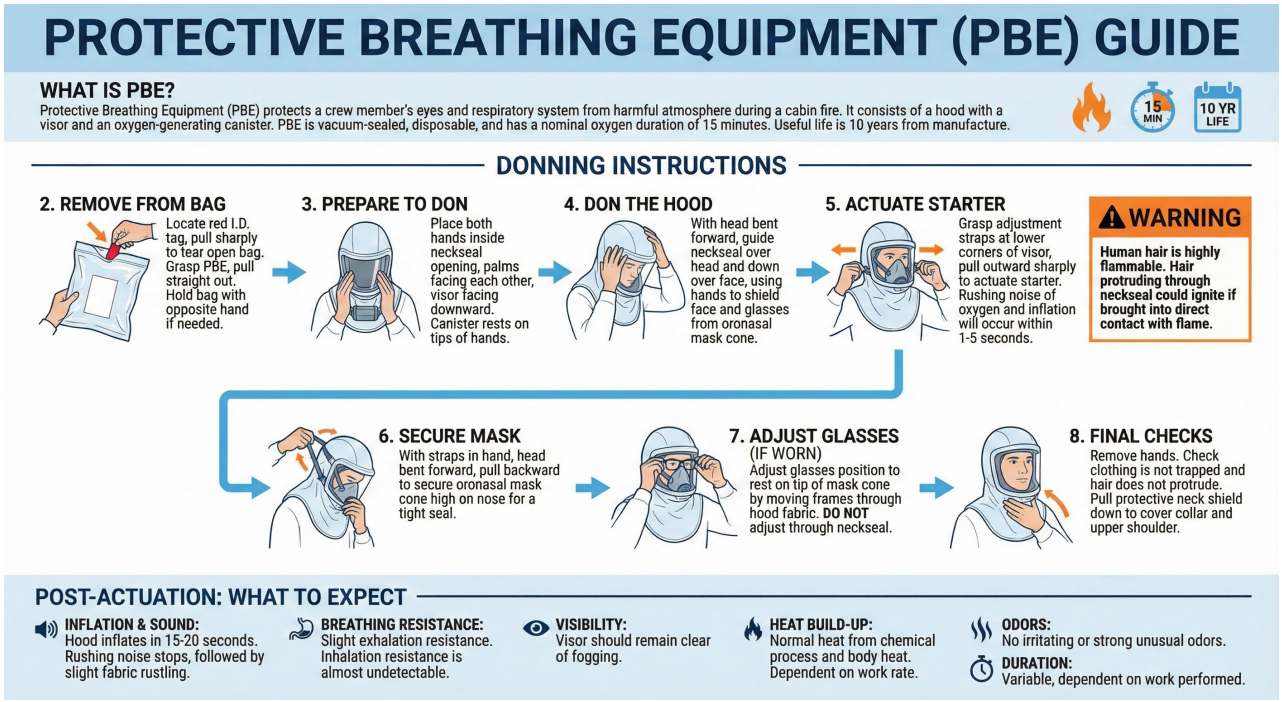


Img: cl350_fire_extinguisher_location.jpeg

## D. WARNINGS

- **WARNING**: If a fire extinguisher is discharged in the flight compartment, all flight crew must put on oxygen masks with EMERGENCY selected (100% oxygen) and don smoke goggles. Crew exposure to high levels of Halon vapor may result in dizziness, impaired coordination, and reduced mental sharpness.

# IV. PROTECTIVE BREATHING EQUIPMENT (PBE)




## A. DESCRIPTION

- Available for crew member use when fighting a cabin fire
- Designed to protect user's eyes and respiratory system from harmful atmosphere generated by cabin fire
- Consists of hood with visor placed over head that seals around neck
- Oxygen generating canister provides breathing oxygen
- Vacuum sealed in bag and stored in box behind pilot's station and in lavatory
- Disposable unit that must be replaced whenever vacuum seal is broken
- Vacuum seal must be maintained since oxygen-generating chemicals react with moisture
- Duration of oxygen production is nominally 15 minutes depending upon work rate and size of user
- Useful life of sealed PBE is 10 years from date of manufacture

## B. STORAGE LOCATIONS

- Mounted on bulkhead behind pilot's seat
- Some aircraft may have second portable container stowed in cabinet in cabin area
- Additional PBE stored in lavatory

## C. DONNING THE PBE

**Removing from Container:**

- Portable container: Lift single latch on cover and lift; remove sealed bag from container

- Mounted container: Grasp red access handle firmly and pull forcibly to disengage cover; when cover removed, immediately drop it (vacuum sealed bag does not need to be removed from container to open)
- To remove PBE from vacuum sealed bag: Locate red I.D. tag and pull sharply to tear open bag; reach into opened bag and firmly grasp PBE; pull straight out of bag
- Place both hands inside neckseal opening with palms facing each other and PBE visor facing downward with oxygen generating canister resting on tip of hands
- With top of head bent forward, guide PBE neckseal over head and down over face using hands to shield face and glasses from oronasal mask cone
- Grasp adjustment straps at lower corners of visor and pull outward sharply to actuate starter candle
- Within 1-5 seconds, rushing noise of oxygen entering hood will be heard and inflation will be evident

WARNING: Human hair is highly flammable. Hair that protrudes through the neckseal could ignite if brought into direct contact with flame.

## D. NORMAL OPERATION

- Following actuation, hood will inflate over 15-20 second period
- After this period, starter candle will cease flowing
- Only sound will be slight rustling of fabric on each inhalation and exhalation
- Slight exhalation resistance as exhaled breath forced through oxygen generating canister
- Inhalation resistance almost undetectable since inhalation directly from interior of hood through diaphragm type check valve at base of oronasal mask
- Visor should remain clear of fogging or misting
- Heat produced by both chemical air regeneration process and transfer of body heat during rebreathing cycle
- Heat build-up within hood is normal and dependent upon amount of work performed
- No irritating or strong unusual odors should be present within hood
- Operational duration is variable dependent upon amount of work performed

## E. EXHAUSTION INDICATORS

- Gradual reduction in expended volume of hood until collapsed tightly around head at end of full inhalation
- Rapid buildup of heat and moisture in hood as canister loses effectiveness
- At exhaustion point, wearer should immediately retire to safe breathing area clear of flame and toxic fumes and remove device

## F. REMOVING THE PBE

- Go to safe area away from immediate contact with fire or open flame and/or toxic fumes
- With both hands, reach for two lower corners of visor area and push forward on metal tabs of adjustment strap buckles to release strap tension
- Place both hands under neck seal in forward area and pull up, guiding oronasal cone and neck seal over face/glasses until PBE clear of head
- Place expended PBE in safe place to cool away from fire or exposure to water

### G. DISPOSAL

- Expended PBE still contains unreacted oxidizing material and strong alkali materials
- At completion of flight, must be turned over to maintenance for authorized disposal

### H. ABNORMAL CONDITIONS

**CAUTION**: This device produces oxygen which will vigorously accelerate combustion. Do not intentionally expose device to direct flame contact, or remove in immediate presence of fire or flame. Due to oxygen saturation of hair, do not smoke or become exposed to fire or flame immediately after removing.

**Failure of Starter Candle:**

- If starter candle fails to actuate when adjustment strap pulled, additional sharp pull on strap may dislodge lanyard pin and actuate device
- If device still fails to actuate, hood will continue to function although initial purge capability is lost
- Sticking fingers into neck seal to allow large lung inhalation may be required to enable sufficient breathing volume until chemical regeneration system begins producing surplus of oxygen

**Inadequate Oronasal Mask Seal:**

- Absence of tight seal of oronasal cone to face may result in excess leakage of exhaled breath into hood, short circuiting oxygen-generating canister
- May result in build-up of CO2 within rebreathing volume in hood
- Excessive CO2 indicated by breathing distress such as rapid and labored breathing accompanied by general feeling of insufficient ability to get breath, although no restriction to breathing
- Presence of moisture or fogging on visor and sensation of air escaping from mask, particularly around nose and eyes, indicate lack of proper fit
- Adjustment of mask straps and mask position to minimize leakage should rapidly alleviate problem
- If perception of breathing distress persists, go quickly to safe area and remove PBE and don alternate breathing equipment if required

**Loss of Infiltration Seal:**

- Smoke and toxic fumes from combustion of aircraft cabin interior materials have many strong irritants
- Continued presence of strong irritation odors inside hood resulting in eye and respiratory tract discomfort indicates lack of effective infiltration seal
- Verify seal is in contact with skin of neck and does not have clothing or jewelry trapped in seal, or hair protruding between seal and neck
- If condition persists or evidence of tear in neckseal, go quickly to safe area and don alternate breathing equipment if required

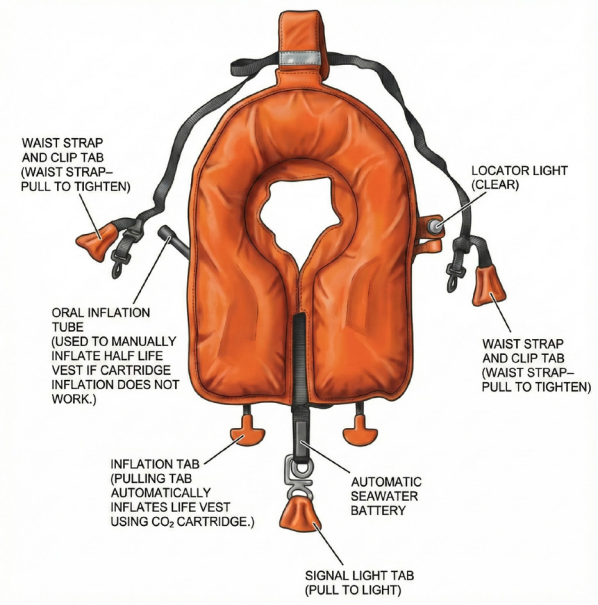
## V. PASSENGER CABIN EMERGENCY EQUIPMENT

### A. EQUIPMENT LIST

- 1 first aid kit
- 2 fire extinguishers (lavatory and forward closet)
- 1 life vest under each seat
- 1 portable breathing equipment (PBE)

# VI. OVERWATER EMERGENCY EQUIPMENT

## A. LIFE VEST




**Description:**

- Life vests provided for crew and passengers
- Flight crew life vests located under pilot and copilot's seats
- Passenger life vests located in compartment under each passenger seat
- Inflated by pulling red CO2 release tabs
- Oral inflation tube available if CO2 cartridge does not inflate vest

**Components:**

- Waist strap and clip tab (waist strap - pull to tighten)
- Oral inflation tube (used to manually inflate half life vest if cartridge inflation does not work)
- Inflation tab (pulling tab automatically inflates life vest using CO2 cartridge)
- Automatic seawater battery
- Signal light tab (pull to light)
- Locator light (clear)

**Donning Procedure:**

- Find life vest under seat
- Put life vest over head
- With back piece behind
- Fasten rings to catch
- Pull straps tight
- Jerk down on inflation tabs

**IMPORTANT**: Inflate life vest just before jumping out of airplane. If using overwing emergency exit, inflate life vest when on the wing.

- If necessary, life vest can be inflated by blowing into oral inflation tubes

**NOTE**: When using adult/child life vest for children, pass straps between legs, fasten hooks. Inflate only one chamber.




## B. LIFE RAFTS (OPTIONAL)

- One to Three optional, self-contained, 4-person life rafts provided for passengers and crew
- Located either on bottom shelf of galley, crew closet, or in aft pyramid cabinet, depending on cabin configuration



## VII. EMERGENCY LOCATOR

- TRANSMITTER (ELT)
- Refer to chapter 06 Communications for ELT information

## VIII. PLACARDS

- Emergency equipment locations identified by placards throughout aircraft:
- O2 (oxygen cylinder location)
- LIFE-VEST UNDER CREW MEMBER SEAT
- HALON FIRE EXTINGUISHER
- FIRST AID KIT

## IX. LIMITATIONS

Emergency Equipment Limitations

| Parameter | Limitation |
|---|---|
| PBE Useful Life | 10 years from date of manufacture |
| PBE Vacuum Seal | Must be replaced if broken |
| Fire Extinguisher Full Discharge | 10 seconds with lever held |
| PBE Oxygen Duration | Nominally 15 minutes (varies with work rate and user size) |

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## X. EMERGENCY EQUIPMENT QUIZ

1. How many flashlights are located in the flight deck?

    A) One
    B) Two
    C) Three
    D) Four

2. What type of fire extinguishing agent is contained in the flight compartment fire extinguisher?

    A) CO2
    B) Halon 1211
    C) Dry chemical
    D) Water

3. The fire extinguisher is effective in fighting which classes of fires?

    A) Class A only
    B) Class B and C only
    C) Class A, B, and C
    D) Class D only

4. If the discharge lever is held in the ON position, how long until the fire extinguisher is fully discharged?

    A) 5 seconds
    B) 10 seconds
    C) 15 seconds
    D) 20 seconds

5. Where is the crash axe located?

    A) Under the pilot seat
    B) On the bulkhead behind the copilot seat
    C) In the lavatory
    D) In the forward closet

6. What is the nominal duration of oxygen production from the PBE?

    A) 10 minutes
    B) 15 minutes
    C) 20 minutes
    D) 30 minutes

7. What is the useful life of a sealed PBE?

    A) 5 years from date of manufacture
    B) 10 years from date of manufacture
    C) 15 years from date of manufacture
    D) 20 years from date of manufacture

8. Where is the flight deck PBE stored?

A) Under the pilot seat
B) In a box behind the pilot's station
C) In the forward closet
D) In the galley

9. When must the PBE be replaced?

A) After each use only
B) Whenever the vacuum seal is broken
C) Every 5 years
D) After annual inspection

10. After a fire extinguisher is discharged in the flight compartment, what action must the flight crew take?

A) Open the cabin door
B) Put on oxygen masks with EMERGENCY selected (100% oxygen)
C) Descend to 10,000 feet
D) Turn off all electrical equipment

11. What inflates the life vest when the inflation tab is pulled?

A) Compressed air
B) CO2 cartridge
C) Nitrogen cartridge
D) Manual pump

12. Where are the flight crew life vests located?

A) In the overhead compartment
B) Under the pilot and copilot's seats
C) Behind the copilot seat
D) In the forward closet

13. How many fire extinguishers are in the passenger cabin?

A) One
B) Two
C) Three
D) Four

14. How many 4-person life rafts are optionally available?

A) One
B) Two
C) Three
D) Four

15. When should the life vest be inflated during an emergency evacuation?

A) As soon as donned
B) While seated
C) Just before jumping out of the airplane
D) After entering the water

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CL-350 TRAINING MANUAL

# QUIZ ANSWERS 21

## AIRCRAFT SYSTEMS

TRAINING MANUAL

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# CL-350 Chapter Quiz -- Answer Summary

## AFCS

1) B (FCOM2 04-01-1, AFM 02-04-1, ASTM 17-3)

2) C (AFM-Limitations 02-04-1, FCOM2 04-01-1, ASTM 17-35)

3) C (FCOM2 04-01-1, AFM 02-04-1, ASTM 17-3)

4) B (FCOM2 04-01-6, AFM 02-04-1, ASTM 17-6)

5) B (FCOM2 04-01-1, AFM 02-04-1, ASTM 17-6)

6) B (FCOM2 04-01-1, ASTM 17-3)

7) C (AFM-Limitations 02-03-6, FCOM2 04-01-1, ASTM 17-3)

8) C (FCOM2 04-01-30, ASTM 17-17)

9) B (FCOM2 04-01-3, ASTM 17-7)

10) B (FCOM2 04-01-1, ASTM 17-6)

11) B (FCOM2 04-01-6, ASTM 17-6)

12) C (FCOM2 04-01-1, ASTM 17-4)

13) B (FCOM2 04-01-32, ASTM 17-17)

14) B (FCOM2 04-01-37, ASTM 17-17)

15) B (FCOM2 04-01-1, ASTM 17-4)

16) C (FCOM2 04-01-9, ASTM 17-18)

17) C (FCOM2 04-01-16, ASTM 17-26)

18) B (FCOM2 04-01-15, ASTM 17-25)

19) B (FCOM2 04-01-15, ASTM 17-25)

20) B (FCOM2 04-01-9, ASTM 17-18)

## APU

1) B (AFM-Limitations 02-06-3, FCOM2 05-01-1, ASTM 8-19)

2) B (FCOM2 05-01-10, ASTM 8-6)

3) B (AFM-Limitations 02-06-3, ASTM 8-20)

4) B (AFM-Limitations 02-06-3, FCOM2 05-01-10, ASTM 8-7)

5) B (FCOM2 05-01-10, ASTM 8-6)

6) C (FCOM2 07-01-3, FCOM2 05-01-1, ASTM 8-12)

7) B (FCOM2 05-01-8, ASTM 8-8)

8) B (AFM-Limitations 02-06-3, ASTM 8-19)

9) B (FCOM2 05-01-1, ASTM 8-3)

10) C (AFM-Limitations 02-06-3, FCOM2 05-01-10, ASTM 8-7)

11) C (FCOM2 05-01-10, ASTM 8-6)

12) C (FCOM2 05-01-5, ASTM 8-5)

13) D (AFM-Limitations 02-06-3, ASTM 8-20)

14) B (FCOM2 05-01-8, ASTM 8-7)

15) B (FCOM2 05-01-10, ASTM 8-6)

16) C (FCOM2 05-01-10, ASTM 8-7)

17) C (AFM-Limitations 02-06-3, ASTM 8-7)

18) C (FCOM2 05-01-5, ASTM 8-5)

19) B (FCOM2 05-01-11, ASTM 8-11)

20) C (FCOM2 05-01-11, ASTM 8-10)

## COMMUNICATIONS

1) B (FCOM2 06-01-7, ASTM 16-4)
2) C (FCOM2 06-01-24, ASTM 16-12)
3) D (FCOM2 06-01-25, ASTM 16-12)
4) B (FCOM2 06-01-25, ASTM 16-12)
5) A (FCOM2 06-01-27, ASTM 16-14)
6) C (FCOM2 06-01-27, ASTM 16-14)
7) D (FCOM2 06-01-28, ASTM 16-13)
8) C (FCOM2 06-01-16, ASTM 16-15)
9) B (FCOM2 06-01-12, ASTM 16-3)
10) D (FCOM2 06-01-12, ASTM 16-7)
11) D (FCOM2 06-01-12, ASTM 16-7)
12) C (FCOM2 06-01-24, ASTM 16-12)
13) D (FCOM2 06-01-25, ASTM 16-13)
14) B (FCOM2 06-01-16, ASTM 16-15)
15) B (FCOM2 06-01-12, ASTM 16-6)
16) B (FCOM2 06-01-2, ASTM 16-8)
17) C (FCOM2 06-01-16, ASTM 16-15)
18) B (FCOM2 06-01-7, ASTM 16-4)
19) A (FCOM2 06-01-20, ASTM 16-17)
20) C (FCOM2 06-01-20, ASTM 16-17)

## EICAS

1) B (ASTM 15-8, FCOM2 03-02-8)

2) C (ASTM 15-8, FCOM2 03-02-9)

3) B (ASTM 15-19, FCOM2 03-01-1)

4) C (ASTM 15-6, FCOM2 03-02-6)

5) C (ASTM 15-9, FCOM2 03-02-9)

6) B (ASTM 15-6, FCOM2 03-02-5)

7) D (ASTM 15-8, FCOM2 03-02-2)

8) A (ASTM 15-9, FCOM2 03-02-1)

9) C (ASTM 15-8, FCOM2 03-02-8)

10) C (ASTM 15-10, FCOM2 03-02-9)

11) B (ASTM 15-4, FCOM2 03-02-2)

12) C (ASTM 15-6, FCOM2 03-02-6)

13) B (ASTM 15-6, FCOM2 03-02-8)

14) C (ASTM 15-9, FCOM2 03-02-9)

15) C (ASTM 15-7, FCOM2 03-02-7)

16) D (ASTM 15-9, FCOM2 03-02-1)

17) A (ASTM 15-7, FCOM2 03-02-7)

18) B (ASTM 15-20, FCOM2 03-02-5)

19) B (ASTM 15-9, FCOM2 03-02-9)

20) B (ASTM 15-17, FCOM2 03-02-3)

## ELECTRICAL

1) B (ASTM 7-3, FCOM2 07-01-1)
2) B (ASTM 7-4, FCOM2 07-01-3)
3) C (ASTM 7-4, FCOM2 07-01-3)
4) B (ASTM 7-5, FCOM2 07-01-5)
5) C (ASTM 7-5, FCOM2 07-01-5)
6) C (ASTM 7-3, FCOM2 07-01-1, QRH1 ELEC 04-2)
7) B (ASTM 7-8, FCOM2 07-01-1)
8) C (ASTM 7-5, FCOM2 07-01-3)
9) C (ASTM 7-8, FCOM2 07-01-3)
10) C (ASTM 7-4, FCOM2 07-01-3)
11) B (ASTM 7-5, FCOM2 07-01-6)
12) B (ASTM 7-9, FCOM2 07-01-1, FCOM2 07-01-7)
13) C (ASTM 7-15, FCOM2 07-01-7)
14) C (ASTM 7-23, FCOM2 07-01-20, AFM-Limitations 02-04-14)
15) B (ASTM 7-23, AFM-Limitations 02-04-14)
16) B (ASTM 7-23, AFM-Limitations 02-04-14)
17) C (ASTM 7-22, FCOM2 07-01-21)
18) C (ASTM 7-5, FCOM2 07-01-3)
19) C (ASTM 7-8, FCOM2 07-01-20)
20) D (ASTM 7-21, FCOM2 07-01-20)

## EMERGENCY EQUIPMENT

1) B (ASTM 20-3, FCOM2 08-01-23)

2) B (ASTM 20-4, FCOM2 08-01-24)

3) C (ASTM 20-4, FCOM2 08-01-25)

4) B (ASTM 20-4, FCOM2 08-01-24)

5) B (ASTM 20-3, FCOM2 08-01-24)

6) B (ASTM 20-5, FCOM2 08-01-26)

7) B (ASTM 20-5, FCOM2 08-01-26)

8) B (ASTM 20-5, FCOM2 08-01-26)

9) B (ASTM 20-5, FCOM2 08-01-26)

10) B (ASTM 20-4, FCOM2 08-01-24)

11) B (ASTM 20-8, FCOM2 08-01-30)

12) B (ASTM 20-8, FCOM2 08-01-30)

13) B (ASTM 20-7, FCOM2 08-01-23)

14) B (ASTM 20-9, FCOM2 08-01-33)

15) C (ASTM 20-8, FCOM2 08-01-30, QRH2 F-LDG 08-1)

## ENVIRONMENTAL

1) C (ASTM 10-9, FCOM2 02-02-6)
2) B (ASTM 10-11, FCOM2 02-02-7)
3) C (ASTM 10-7, FCOM2 02-02-3, FCOM2 02-02-5)
4) C (ASTM 10-12, FCOM2 02-02-5)
5) B (ASTM 10-15, FCOM2 02-02-2)
6) C (ASTM 10-7, FCOM2 02-02-2)
7) B (ASTM 10-7, FCOM2 02-02-2, FCOM2 02-02-4)
8) B (ASTM 10-15, FCOM2 02-03-4)
9) B (ASTM 10-17, FCOM2 02-03-1)
10) B (ASTM 10-23, FCOM2 02-03-10)
11) B (ASTM 10-21, FCOM2 02-03-5)
12) C (ASTM 10-21, FCOM2 02-03-5)
13) B (ASTM 10-16, FCOM2 02-03-1)
14) C (ASTM 10-7, FCOM2 02-02-4)
15) B (ASTM 10-8, FCOM2 02-02-5)
16) B (ASTM 10-12, FCOM2 02-02-5, FCOM2 02-03-1)
17) B (ASTM 10-14, FCOM2 02-03-2)
18) C (ASTM 10-7, FCOM2 02-02-5)
19) C (ASTM 10-18, FCOM2 02-03-6)
20) C (ASTM 10-11, FCOM2 02-02-7)

## FIRE

1) B (FCOM2 09-01-4, ASTM 14-5)

2) C (FCOM2 09-01-5, FCOM2 09-01-12, ASTM 14-3)

3) B (FCOM2 09-01-5, ASTM 14-7)

4) B (FCOM2 09-01-11, ASTM 14-8)

5) B (FCOM2 09-01-15, ASTM 14-12)

6) C (FCOM2 09-01-4, ASTM 14-13)

7) B (FCOM2 09-01-9, ASTM 14-7)

8) A (FCOM2 09-01-14, ASTM 14-11)

9) C (FCOM2 09-01-2, ASTM 14-3)

10) B (ASTM 14-13)

11) B (FCOM2 09-01-13, FCOM2 09-01-17, AFM-Emergency 03-15-1, ASTM 14-16)

12) B (FCOM2 09-01-15, ASTM 14-12)

13) C (FCOM2 09-01-4, ASTM 14-5)

14) B (FCOM2 09-01-5, FCOM2 09-01-9, FCOM2 09-01-12, ASTM 14-8)

15) B (FCOM2 09-01-15, FCOM2 09-01-17, ASTM 14-13)

16) C (FCOM2 09-01-5, ASTM 14-7)

17) B (FCOM2 09-01-15, ASTM 14-13)

18) C (FCOM2 09-01-14, ASTM 14-11)

19) D (FCOM2 09-01-17, ASTM 14-17)

20) C (FCOM2 09-01-15, ASTM 14-13)

## FLIGHT CONTROLS

1) B (FCOM2 10-01-1, FCOM2 10-01-2, ASTM 5-8)

2) B (FCOM2 10-02-2, ASTM 5-9)

3) C (FCOM2 10-02-9, ASTM 5-9)

4) C (FCOM2 10-02-15, ASTM 5-17)

5) C (FCOM2 10-01-7, ASTM 5-5)

6) B (FCOM2 10-01-2, ASTM 5-8)

7) C (FCOM2 10-02-2, ASTM 5-9)

8) B (FCOM2 10-02-1, ASTM 5-12)

9) C (FCOM2 10-02-14, ASTM 5-18)

10) C (AFM-Non-Normal 05-23-9, QRH2 FCTL 07-14, ASTM 5-24)

## FLIGHT INSTRUMENTS

1) C (FCOM2 11-01-1, ASTM 18-3)

2) B (FCOM2 11-01-43, ASTM 18-29)

3) B (FCOM2 11-01-41, ASTM 18-21)

4) C (FCOM2 11-01-49, ASTM 18-21)

5) C (FCOM2 11-01-13, ASTM 18-11)

6) B (FCOM2 11-01-5, ASTM 18-49)

7) C (FCOM2 11-01-29, ASTM 18-28)

8) B (FCOM2 11-01-17, ASTM 18-34)

9) C (FCOM2 11-01-31, ASTM 18-23)

10) C (FCOM2 11-01-62, ASTM 18-47)

11) B (FCOM2 11-01-49, ASTM 18-21)

12) C (FCOM2 17-01-51, AFM-Limitations 02-04-12, ASTM 19-37)

13) B (FCOM2 11-01-46, ASTM 18-22)

14) D (FCOM2 17-01-40, ASTM 18-34)

15) B (FCOM2 11-01-49, ASTM 18-21)

16) C (FCOM2 11-01-53, ASTM 18-23)

17) B (FCOM2 17-01-17, ASTM 19-42)

18) D (FCOM2 11-01-26, ASTM 18-24)

19) B (FCOM2 11-02-1, ASTM 18-40)

20) C (FCOM2 11-01-17, ASTM 18-34)

## FUEL

1) B (FCOM2 12-01-1, AFM 02-05-3, ASTM 3-3)
2) C (FCOM2 12-01-4, ASTM 3-7)
3) B (FCOM2 12-01-3, ASTM 3-7)
4) B (FCOM2 12-01-4, ASTM 3-9)
5) C (FCOM2 12-01-4, ASTM 3-9)
6) B (FCOM2 12-01-4, ASTM 3-8)
7) B (FCOM2 12-01-12, FCOM2 12-01-14, ASTM 3-11)
8) D (FCOM2 12-01-4, FCOM2 12-01-9, ASTM 3-13)
9) C (FCOM2 12-01-6, ASTM 3-15)
10) A (FCOM2 12-01-5, ASTM 3-9)
11) B (FCOM2 12-01-1, FCOM2 12-01-4, ASTM 3-8)
12) C (FCOM2 12-01-12, FCOM2 12-01-14, ASTM 3-12)
13) A (FCOM2 12-01-2, ASTM 3-7)
14) B (FCOM2 12-01-4, ASTM 3-8)
15) D (FCOM2 12-01-6, ASTM 3-10)
16) C (AFM 02-05-2, FCOM2 12-01-7, ASTM 3-17)
17) B (FCOM2 12-01-6, ASTM 3-15)
18) B (FCOM2 12-01-14, QRH FUEL 09-1, ASTM 3-18)
19) C (FCOM2 12-01-7, FCOM2 12-01-9, ASTM 3-17)
20) C (AFM 02-05-4, ASTM 3-21)

## HYDRAULICS

1) B (ASTM 4-3, FCOM2 13-01-2)

2) C (AFM-Limitations 02-04-15, ASTM 4-3)

3) B (ASTM 4-5, FCOM2 13-01-3, FCOM2 13-01-6)

4) B (ASTM 4-13, FCOM2 13-01-8)

5) B (ASTM 4-18, FCOM2 13-01-5)

6) C (ASTM 4-18, FCOM2 13-01-5)

7) B (ASTM 4-15, FCOM2 13-01-11)

8) B (ASTM 4-13, FCOM2 13-01-8)

9) B (ASTM 4-8, FCOM2 13-01-2)

10) C (ASTM 4-23, FCOM2 13-01-16, QRH HYD 11-1)

11) C (FCOM2 13-01-5, ASTM 4-19)

12) C (ASTM 4-18, FCOM2 13-01-4)

13) B (ASTM 4-8, FCOM2 13-01-2)

14) B (ASTM 4-15, FCOM2 13-01-11)

15) C (FCOM2 13-01-1, ASTM 4-4)

## ICE & RAIN

1) B (ASTM 9-4, FCOM2 14-01-1)
2) B (ASTM 9-4, FCOM2 14-01-1)
3) C (ASTM 9-6, FCOM2 14-01-2)
4) B (ASTM 9-7, FCOM2 14-01-2)
5) B (ASTM 9-6, FCOM2 14-01-2)
6) C (ASTM 9-8, FCOM2 14-01-4)
7) B (ASTM 9-14, FCOM2 14-01-8)
8) C (ASTM 9-7, FCOM2 14-01-2)
9) D (ASTM 9-14, FCOM2 14-01-8)
10) B (ASTM 9-19, AFM-Limitations 02-01-1)
11) B (ASTM 9-8, FCOM2 14-01-3)
12) C (ASTM 9-14, FCOM2 14-01-8, AFM-Limitations 02-01-1)
13) C (ASTM 9-11, FCOM2 14-01-6)
14) B (ASTM 9-4, FCOM2 14-01-1)
15) C (ASTM 9-8, FCOM2 14-01-4)
16) D (ASTM 9-12, FCOM2 14-01-7)
17) C (ASTM 9-8, FCOM2 14-01-4)
18) D (ASTM 9-11, FCOM2 14-01-6)
19) C (ASTM 9-14, AFM-Limitations 02-01-1)
20) B (ASTM 9-14, FCOM2 14-01-7)

## LANDING GEAR

1) B (FCOM2 15-01-1, FCOM2 15-01-9, ASTM 6-4)

2) C (AFM-Limitations 02-03-1, FCOM2 15-01-21, ASTM 6-30)

3) C (FCOM2 15-01-11, ASTM 6-26)

4) C (FCOM2 15-01-17, ASTM 6-8)

5) B (FCOM2 15-01-9, FCOM2 15-01-10, ASTM 6-13)

6) B (FCOM2 15-01-11, FCOM2 15-01-16, ASTM 6-23)

7) B (FCOM2 15-01-11, ASTM 6-7)

8) B (FCOM2 15-01-9, FCOM2 15-01-11, ASTM 6-12)

9) C (FCOM2 15-01-1, FCOM2 15-01-24, ASTM 6-12)

10) B (FCOM2 15-01-1, ASTM 6-23)

11) B (FCOM2 15-01-25, ASTM 6-29)

12) A (FCOM2 15-01-6, FCOM2 15-01-9, ASTM 6-12)

13) C (FCOM2 15-01-2, ASTM 6-15)

14) B (FCOM2 15-01-1, FCOM2 15-01-11, ASTM 6-5)

15) C (FCOM2 15-01-9, ASTM 6-13)

16) B (FCOM2 15-01-17, ASTM 6-8)

17) B (FCOM2 15-01-1, FCOM2 15-01-13, ASTM 6-25)

18) C (FCOM2 15-01-3, ASTM 6-6)

19) B (FCOM2 15-01-11, ASTM 6-26)

20) B (FCOM2 15-01-2, ASTM 6-22)

## LIGHTING

1) B (ASTM 13-6, FCOM2 16-01-8)
2) D (ASTM 13-9, FCOM2 16-01-9)
3) B (ASTM 13-4, FCOM2 16-01-5)
4) B (ASTM 13-6, FCOM2 16-01-8)
5) C (ASTM 13-4, FCOM2 16-01-5)
6) D (ASTM 13-5, FCOM2 16-01-2)
7) B (ASTM 13-9, FCOM2 16-01-9)
8) B (ASTM 13-10, FCOM2 16-01-9)
9) B (ASTM 13-12, FCOM2 16-01-10)
10) A (ASTM 13-8, FCOM2 16-01-8)
11) B (ASTM 13-12, FCOM2 16-01-10)
12) C (ASTM 13-9, FCOM2 16-01-9)
13) B (ASTM 13-9, FCOM2 16-01-9)
14) C (ASTM 13-6, FCOM2 16-01-8)

## NAVIGATION

1) B (ASTM 19-8, FCOM2 17-01-1 (VHF NAV table covers 108-117.9 for NAV))

2) B (ASTM 19-8, FCOM2 17-01-1)

3) C (ASTM 19-12, FCOM2 17-01-7)

4) B (ASTM 19-13, FCOM2 17-01-63)

5) A (ASTM 19-11, FCOM2 17-01-2)

6) D (ASTM 19-13, FCOM2 17-01-69)

7) B (ASTM 19-18, FCOM2 17-01-31)

8) B (ASTM 19-42, FCOM2 17-01-18)

9) B (ASTM 19-145, FCOM2 11-01-13)

10) B (ASTM 19-12, FCOM2 17-01-7)

11) C (ASTM 19-53, FCOM2 17-01-67)

12) C (ASTM 19-45, FCOM2 17-01-55)

13) A (ASTM 19-10, FCOM2 17-01-2)

14) B (ASTM 19-62, AFM-Limitations 02-04-7)

15) A (ASTM 19-11, FCOM2 17-01-2)

16) B (ASTM 19-21, FCOM2 17-01-35)

17) B (ASTM 19-11, FCOM2 17-01-2)

18) C (ASTM 19-41, FCOM2 17-01-15)

19) B (AFM-Limitations 02-04-11, ASTM 19-141)

20) B (ASTM 19-13, FCOM2 17-01-65)

## PRESSURIZATION

1) C (FCOM2 02-04-1, ASTM 11-4)
2) C (AFM-Limitations 02-04-1, FCOM2 02-04-12, ASTM 11-22)
3) C (FCOM2 02-04-12, ASTM 11-18)
4) B (FCOM2 02-04-1, ASTM 11-5)
5) C (FCOM2 02-04-1, ASTM 11-6)
6) C (FCOM2 02-04-3, FCOM2 02-04-6, ASTM 11-7)
7) B (FCOM2 02-04-2, ASTM 11-6)
8) B (FCOM2 02-04-7, ASTM 11-14)
9) C (FCOM2 02-04-7, ASTM 11-14)
10) C (AFM-Limitations 02-04-1, FCOM2 02-04-3, ASTM 11-22)
11) A (FCOM2 02-04-1, ASTM 11-4)
12) B (FCOM2 02-04-1, ASTM 11-5)
13) B (FCOM2 02-04-1, ASTM 11-6)
14) C (FCOM2 02-04-2, ASTM 11-7)
15) B (FCOM2 02-04-3, ASTM 11-7)
16) D (FCOM2 02-04-7, FCOM2 02-04-13, ASTM 11-9)
17) C (FCOM2 02-04-12, QRH ENVR 06-1, ASTM 11-21)
18) B (FCOM2 02-04-1, ASTM 11-4)
19) C (AFM-Limitations 02-04-1, FCOM2 02-04-12, ASTM 11-22)
20) C (FCOM2 02-04-3, FCOM2 02-04-6, ASTM 11-14)

## STRUCTURES

1) C (ASTM 1-3, FCOM2 01-02-1, TCDS T00005NY Rev 12 p.1, AFM-Limitations 02-02-1)

2) C (ASTM 1-4, AFM-Limitations 02-02-1, TCDS T00005NY Rev 12 p.4)

3) D (ASTM 1-37, FCOM2 01-05-13)

4) C (ASTM 1-41, AFM-Limitations 02-03-1)

5) B (ASTM 1-4, AFM-Limitations 02-02-1)

6) B (FCOM2 01-05-1, ASTM 1-22)

7) C (ASTM 1-22)

8) C (ASTM 1-11, FCOM2 01-05-13)

9) C (ASTM 1-27, FCOM2 01-05-10)

10) C (ASTM 1-41, AFM-Limitations 02-03-1)

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CL-350



CL-350 TRAINING MANUAL

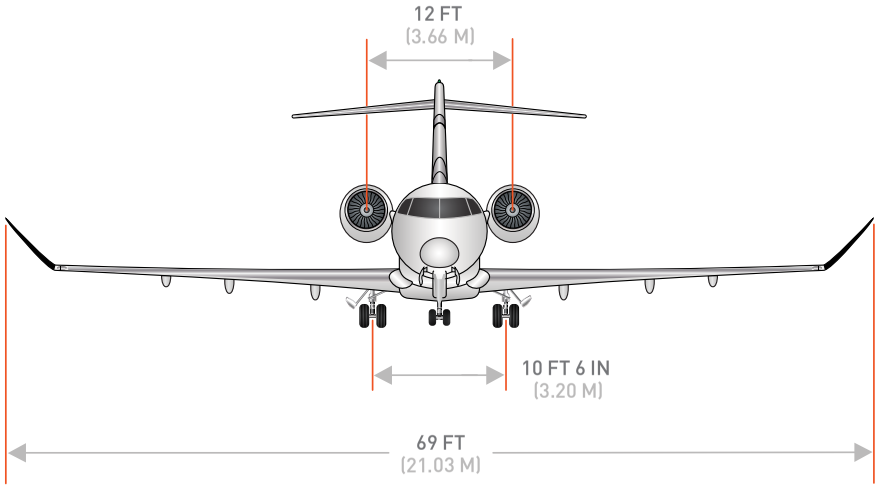
# SCHEMATICS | 22

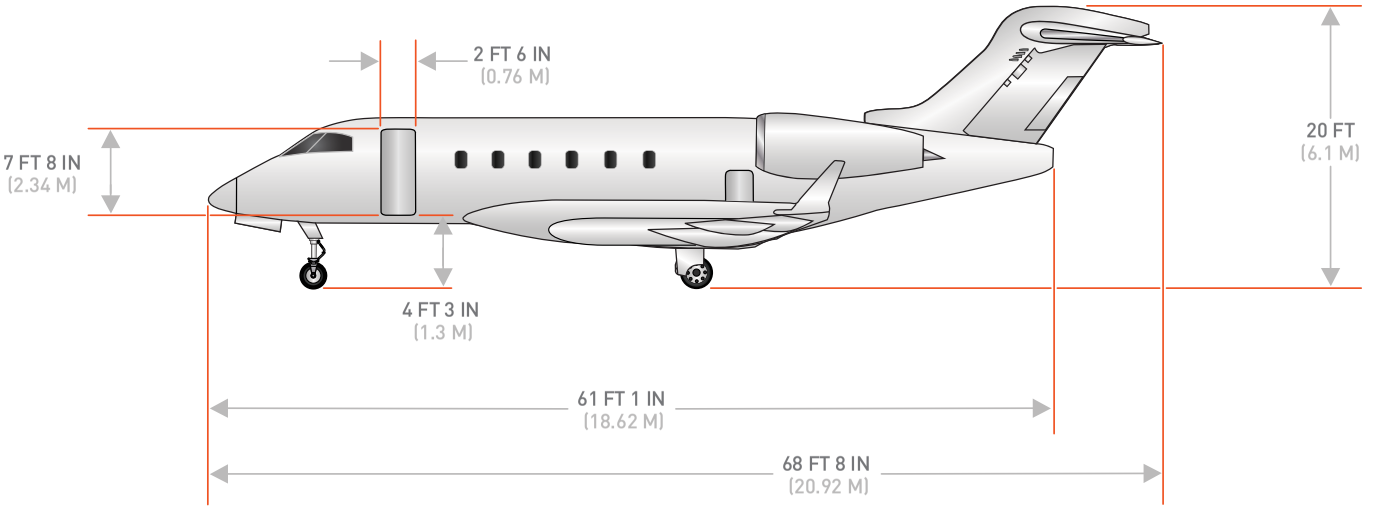
AIRCRAFT SYSTEMS

TRAINING MANUAL

LOFT.AERO

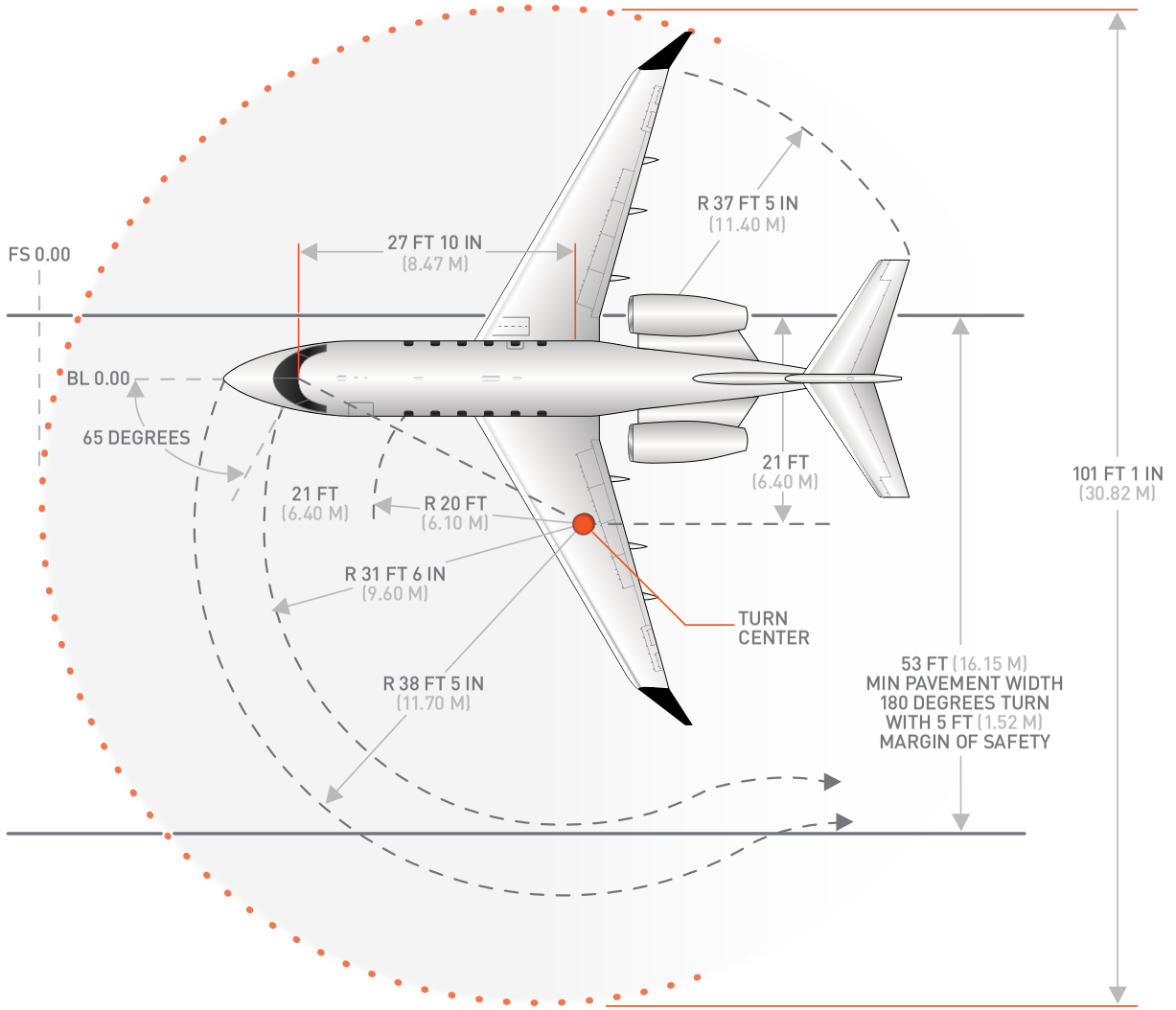
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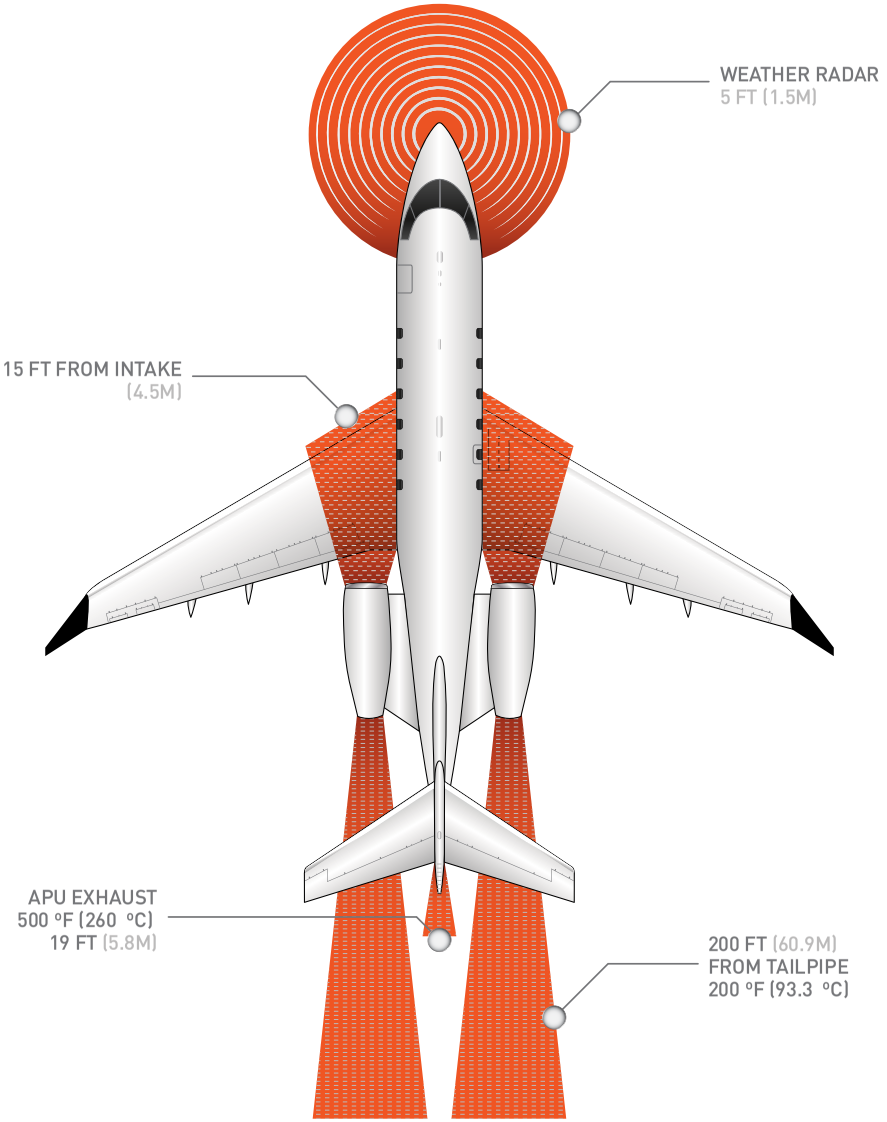

12 FT
(3.66 M)
10 FT 6 IN
(3.20 M)
69 FT
(21.03 M)

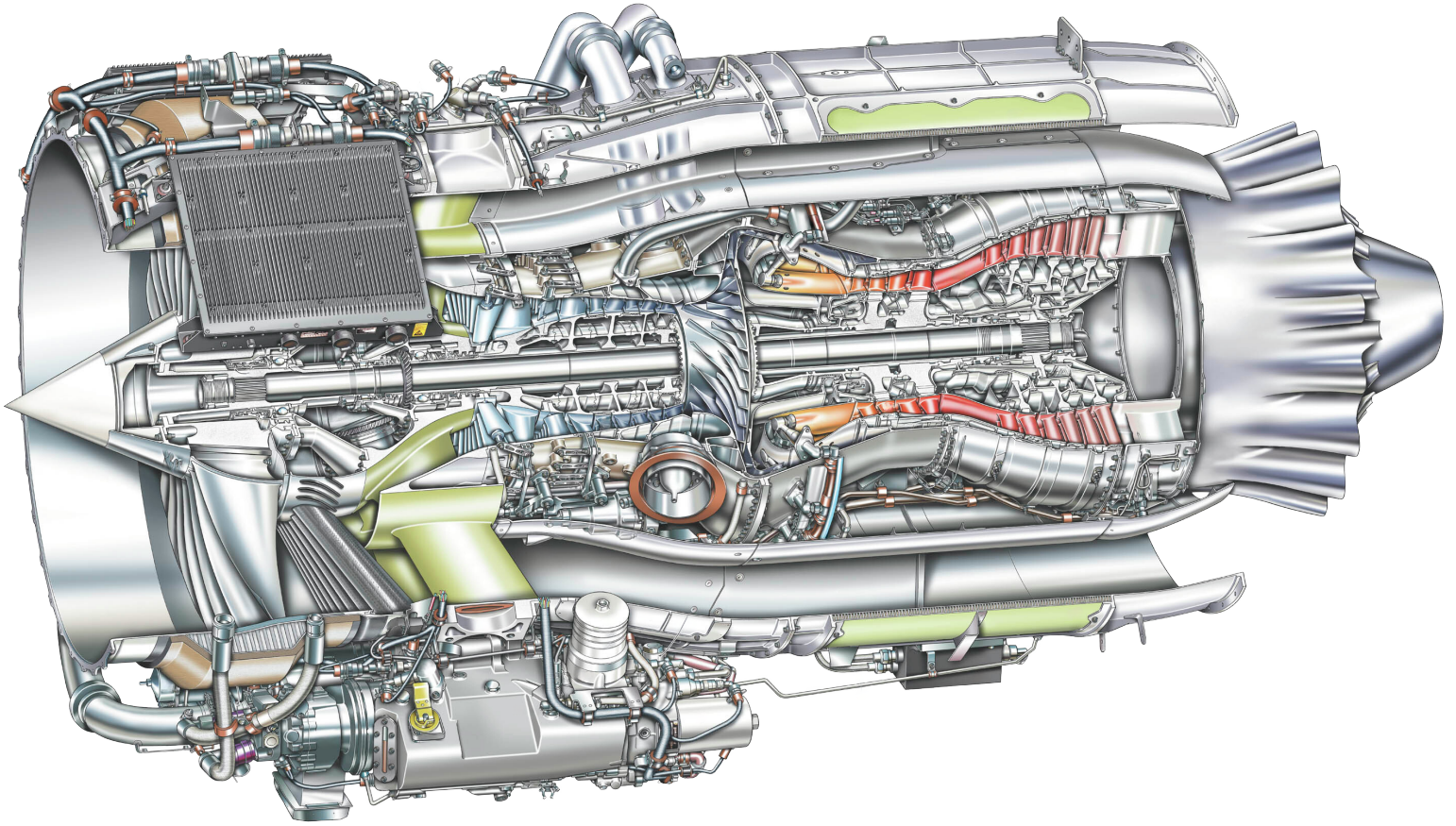

2 FT 6 IN
(0.76 M)
7 FT 8 IN
(2.34 M)
20 FT
(6.1 M)
4 FT 3 IN
(1.3 M)
61 FT 1 IN
(18.62 M)
68 FT 8 IN
(20.92 M)

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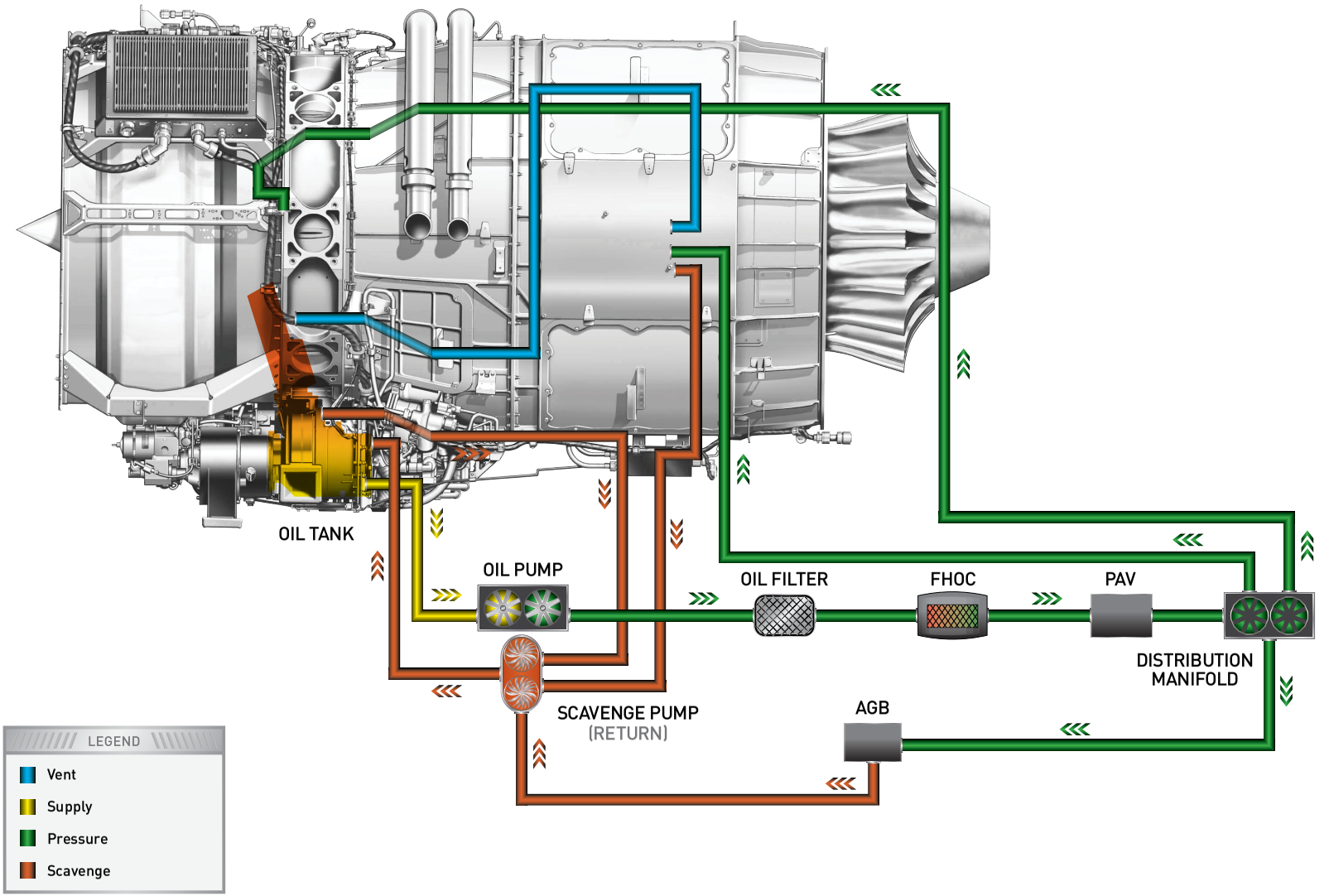
STRUCTURES
## STEERING AND TURNING RADII



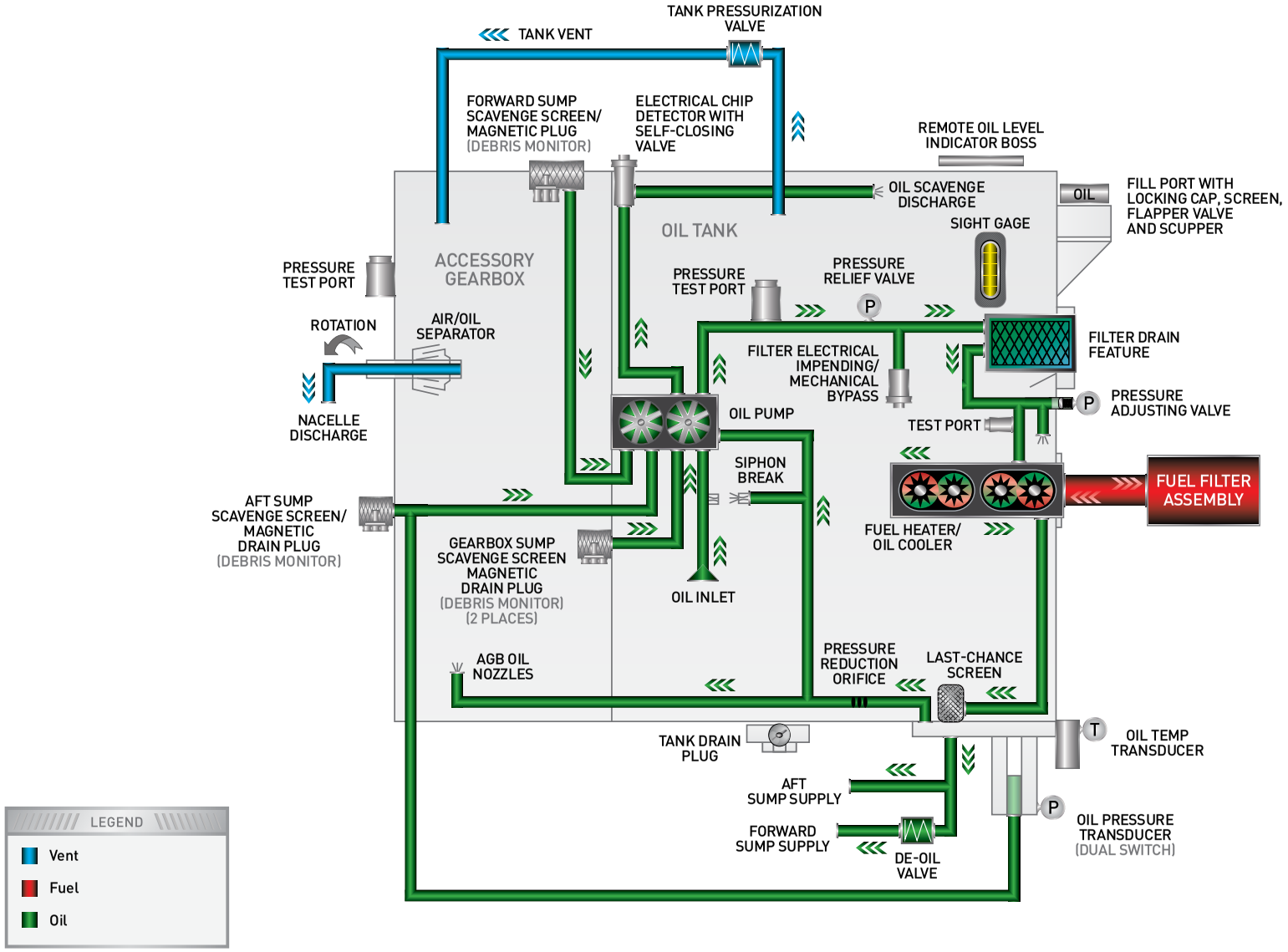

WEATHER RADAR
5 FT (1.5M)
15 FT FROM INTAKE
(4.5M)
APU EXHAUST
500 °F (260 °C)
19 FT (5.8M)
200 FT (60.9M)
FROM TAILPIPE
200 °F (93.3 °C)



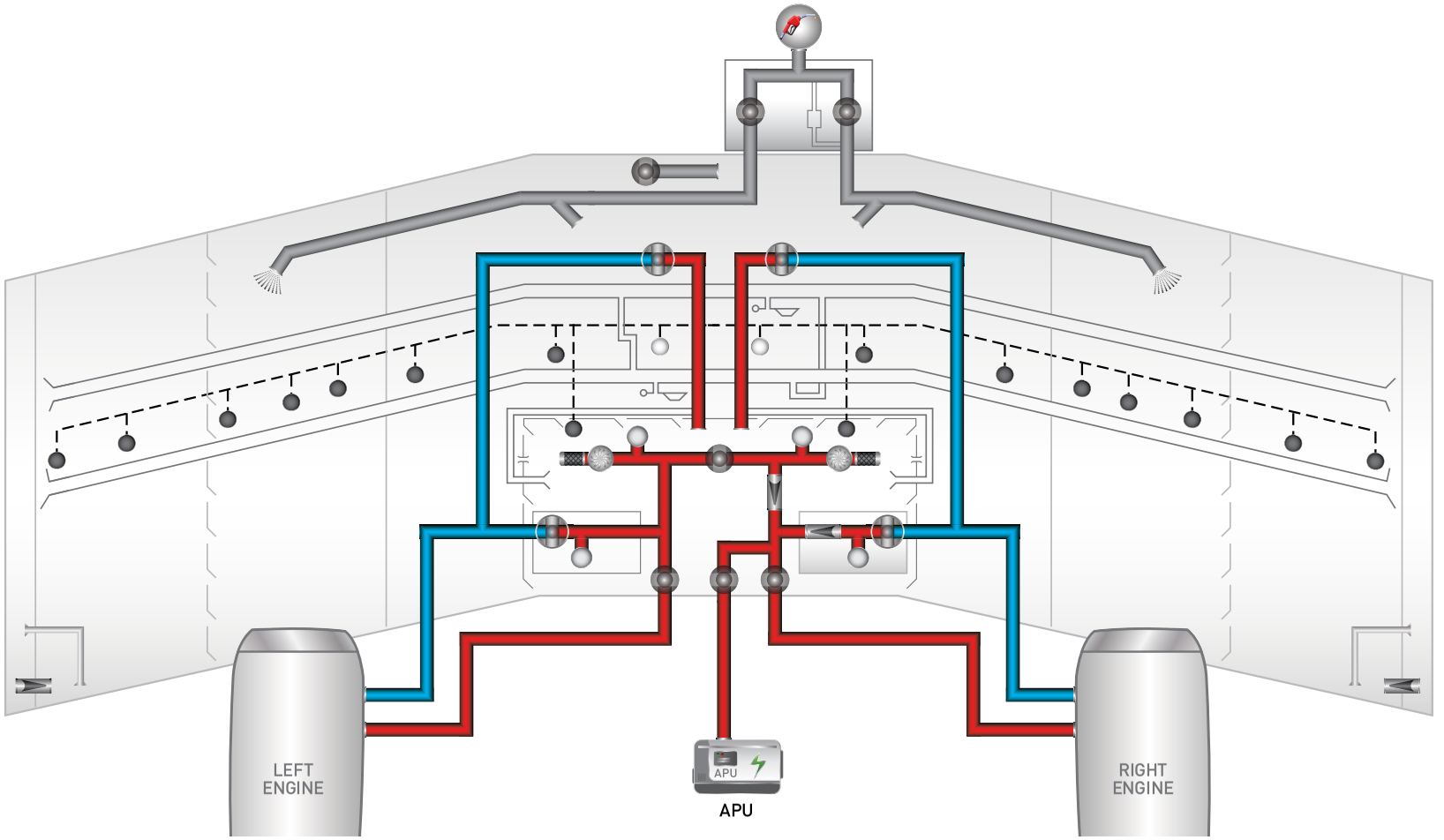
**Honeywell** AS907 (HTF7350)


OIL TANK
OIL PUMP
OIL FILTER
FHOC
PAV
DISTRIBUTION MANIFOLD
SCAVENGE PUMP (RETURN)
AGB
LEGEND
Vent
Supply
Pressure
Scavenge

## ENGINE - LUBRICATION



# FUEL SYSTEM DISTRIBUTION SCHEMATIC



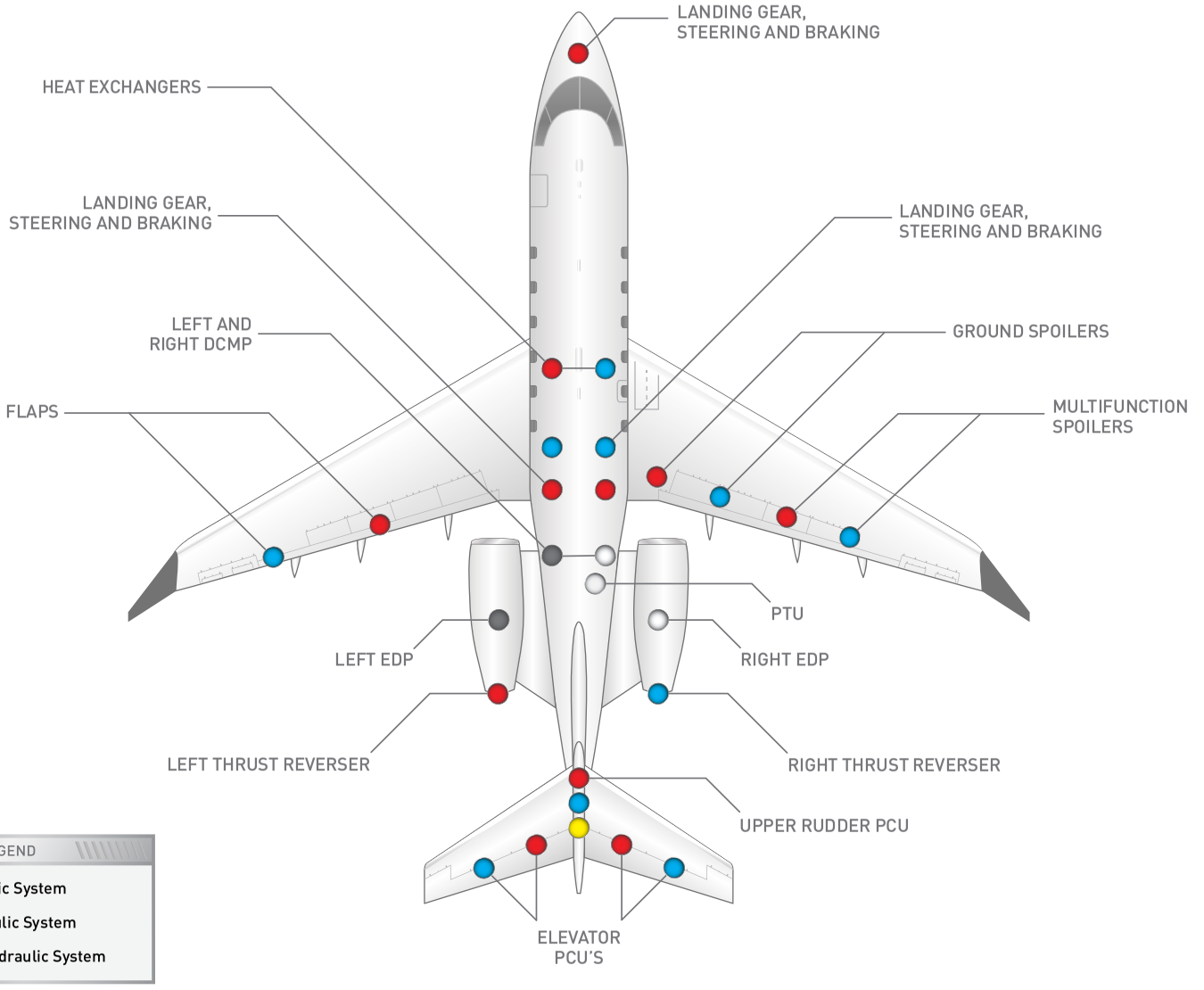

LEGEND

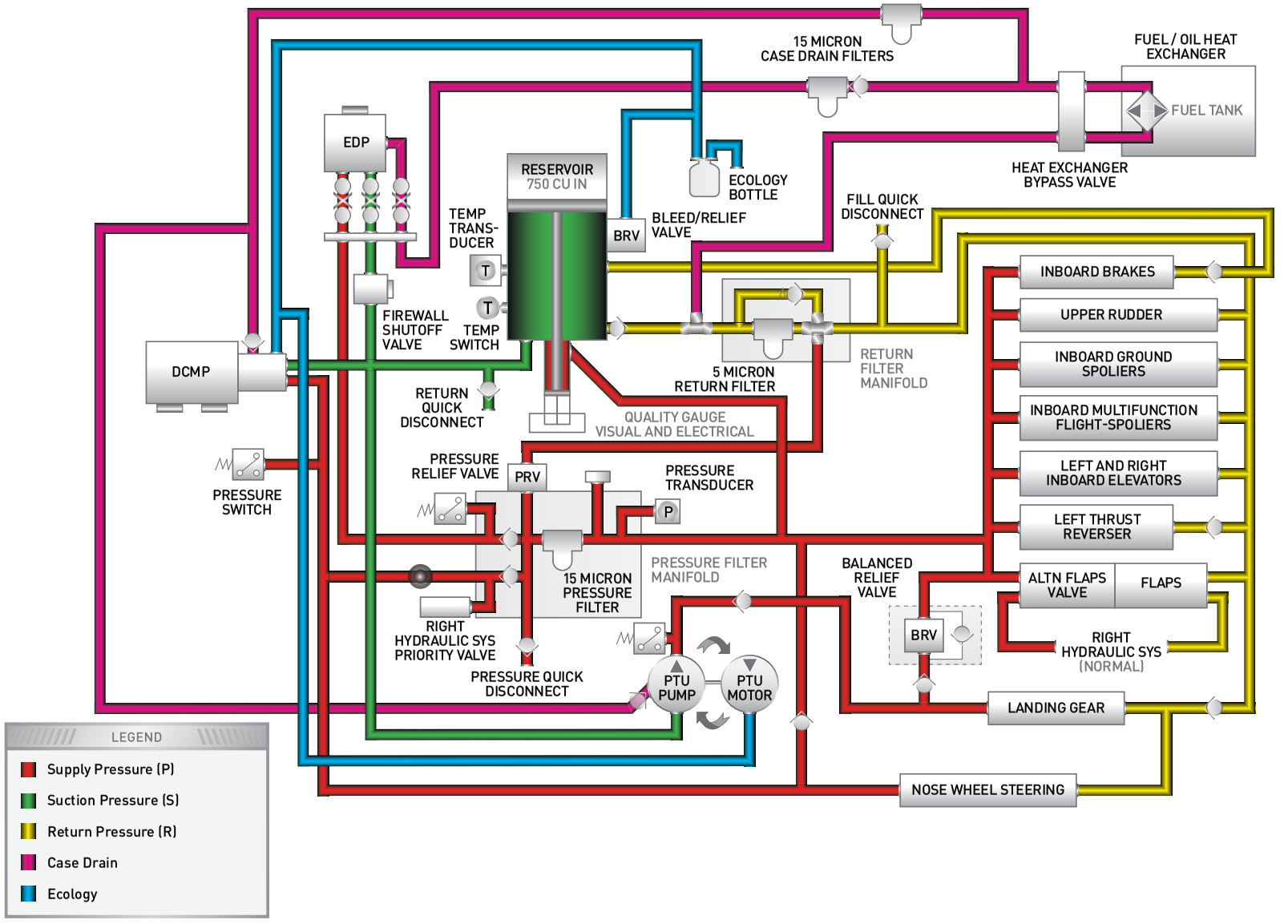
- Motive Fuel Lines
- Refuel / Defuel Lines
- Fuel Feed Lines

CL-350

HYDRAULICS

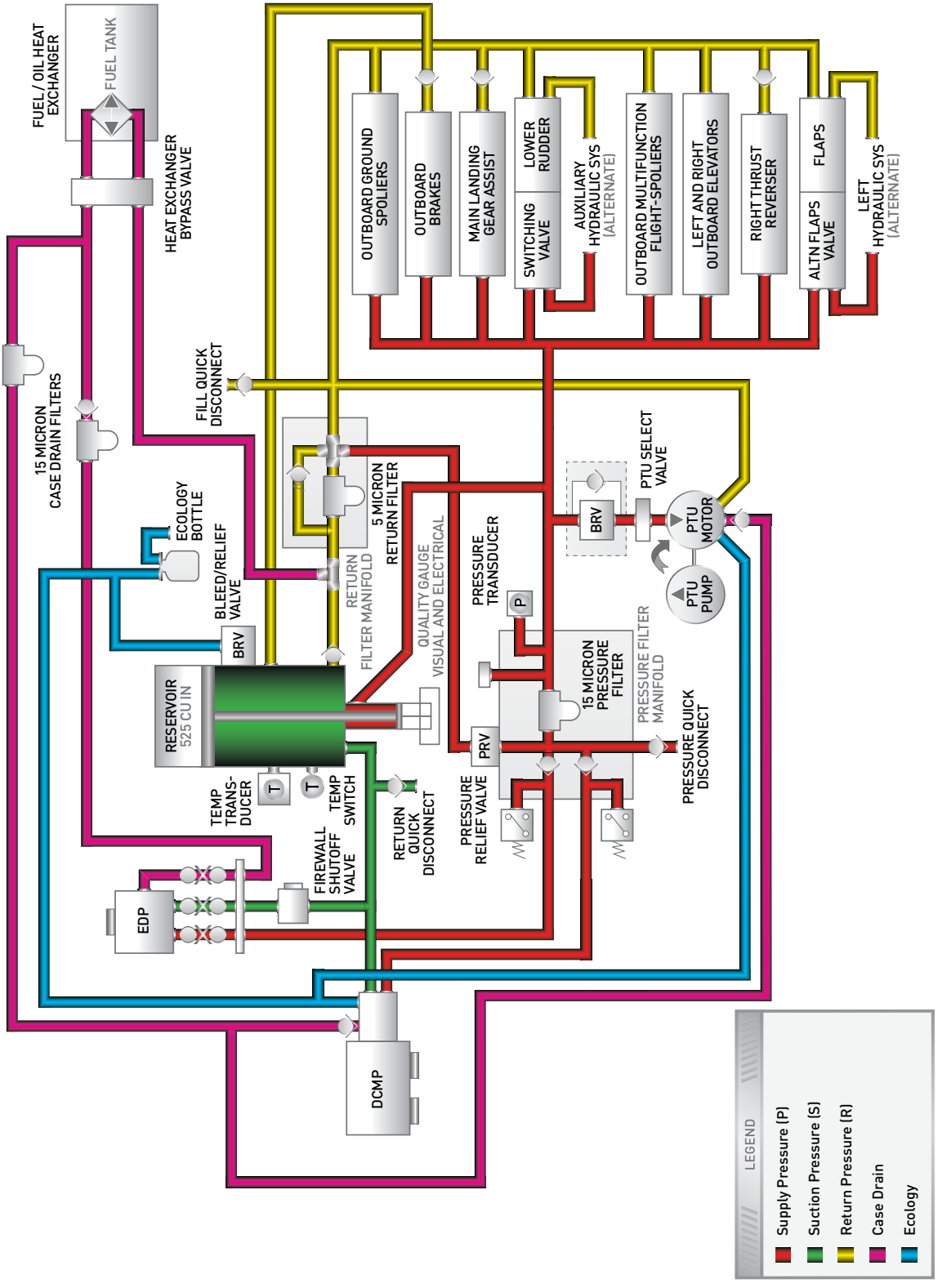
## HYDRAULIC SYSTEM LOCATIONS

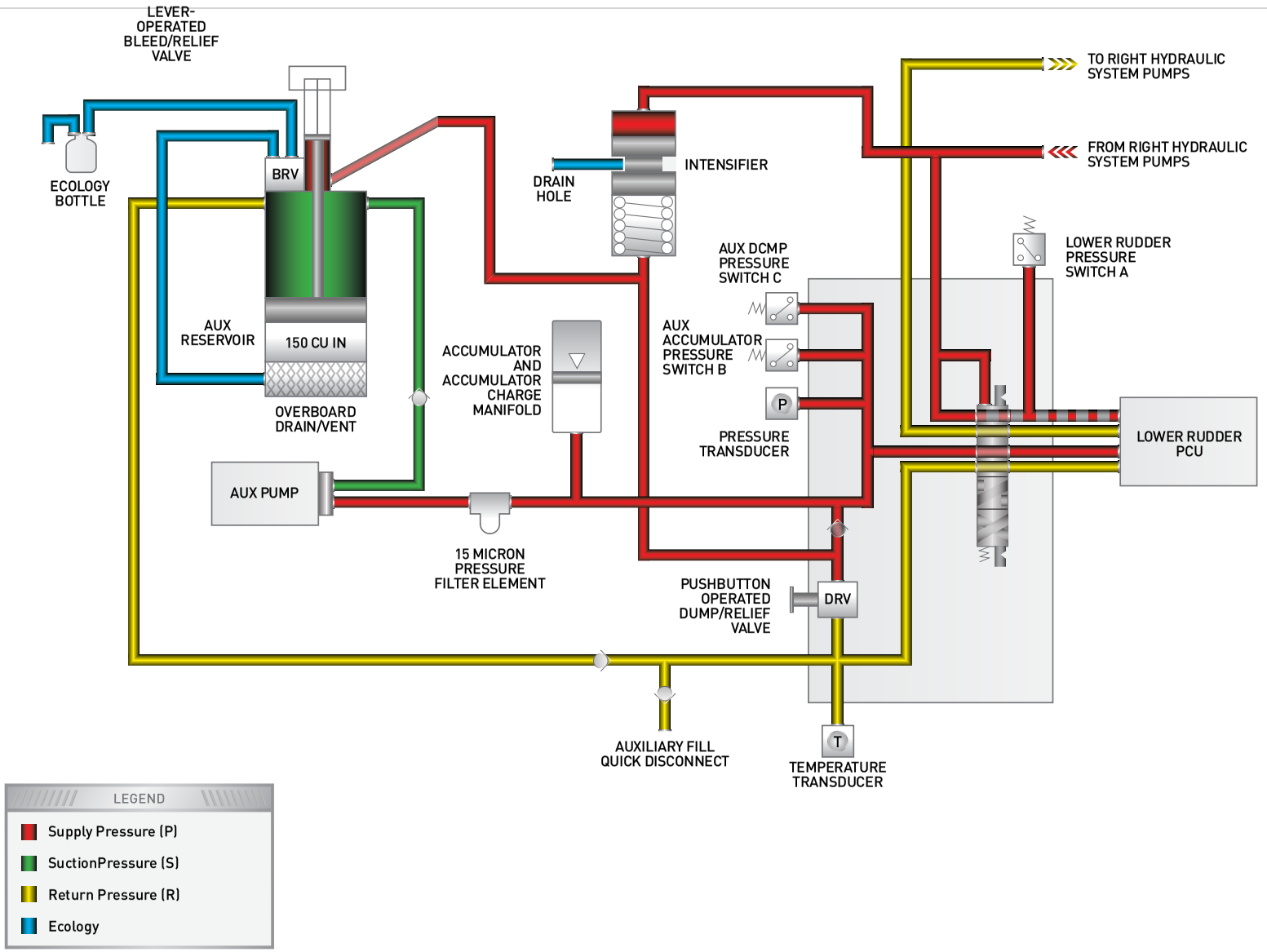



15 MICRON
CASE DRAIN FILTERS
FUEL / OIL HEAT
EXCHANGER
FUEL TANK
HEAT EXCHANGER
BYPASS VALVE
EDP
RESERVOIR
750 CU IN
ECOLOGY
BOTTLE
TEMP
TRANS-
DUCER
BRV
BLEED/RELIEF
VALVE
FILL QUICK
DISCONNECT
INBOARD BRAKES
UPPER RUDDER
INBOARD GROUND
SPOLIERS
INBOARD MULTIFUNCTION
FLIGHT-SPOLIERS
LEFT AND RIGHT
INBOARD ELEVATORS
LEFT THRUST
REVERSER
ALTN FLAPS
VALVE
FLAPS
RIGHT
HYDRAULIC SYS
(NORMAL)
LANDING GEAR
NOSE WHEEL STEERING
FIREWALL
SHUTOFF
VALVE
TEMP
SWITCH
DCMP
RETURN
QUICK
DISCONNECT
5 MICRON
RETURN FILTER
RETURN
FILTER
MANIFOLD
QUALITY GAUGE
VISUAL AND ELECTRICAL
PRESSURE
SWITCH
PRESSURE
RELIEF VALVE
PRV
PRESSURE
TRANSDUCER
P
PRESSURE FILTER
MANIFOLD
15 MICRON
PRESSURE
FILTER
BALANCED
RELIEF
VALVE
BRV
RIGHT
HYDRAULIC SYS
PRIORITY VALVE
PRESSURE QUICK
DISCONNECT
PTU
PUMP
PTU
MOTOR
LEGEND
Supply Pressure (P)
Suction Pressure (S)
Return Pressure (R)
Case Drain
Ecology

HYDRAULICS

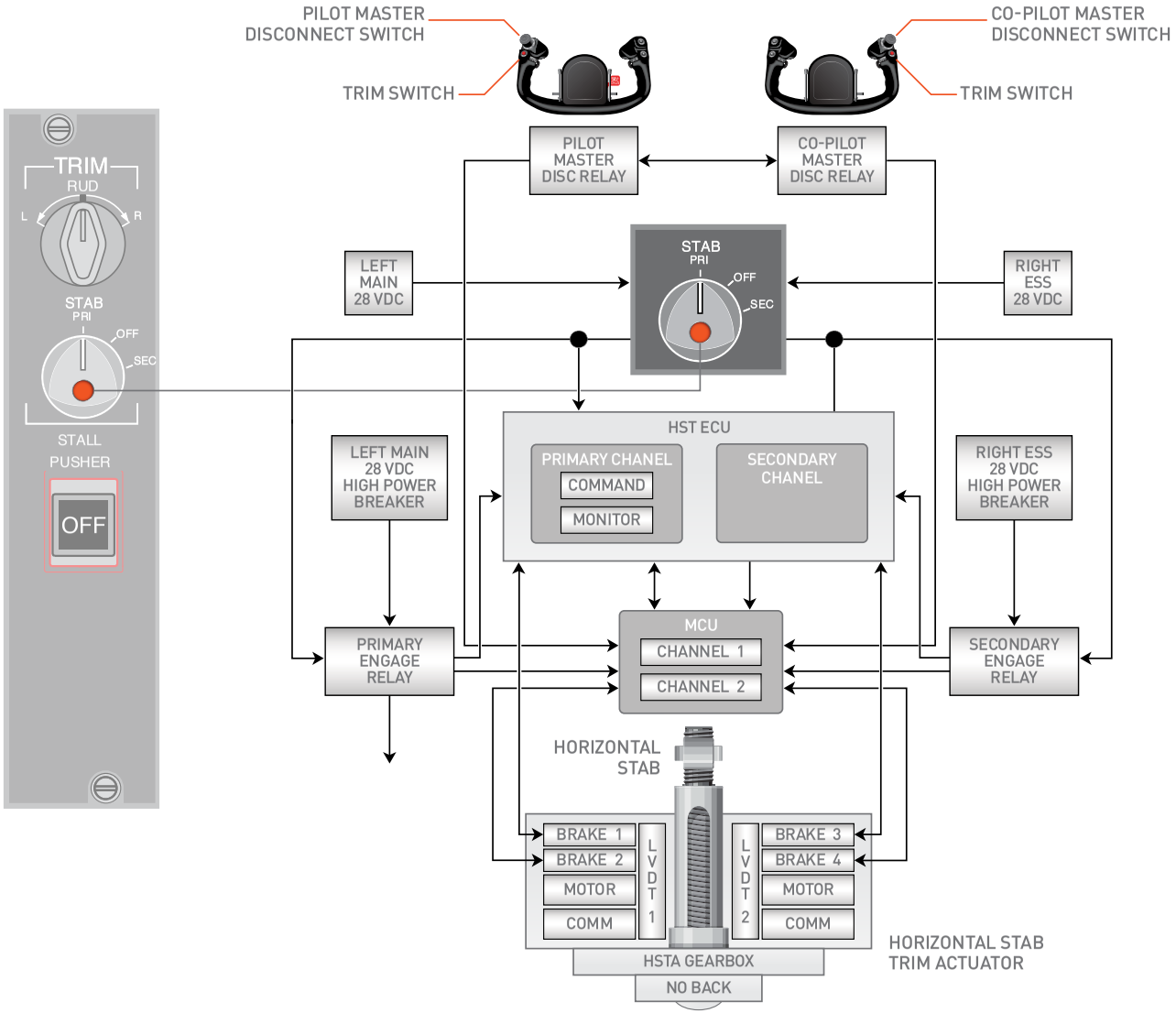
## RIGHT HYDRAULIC SYSTEM

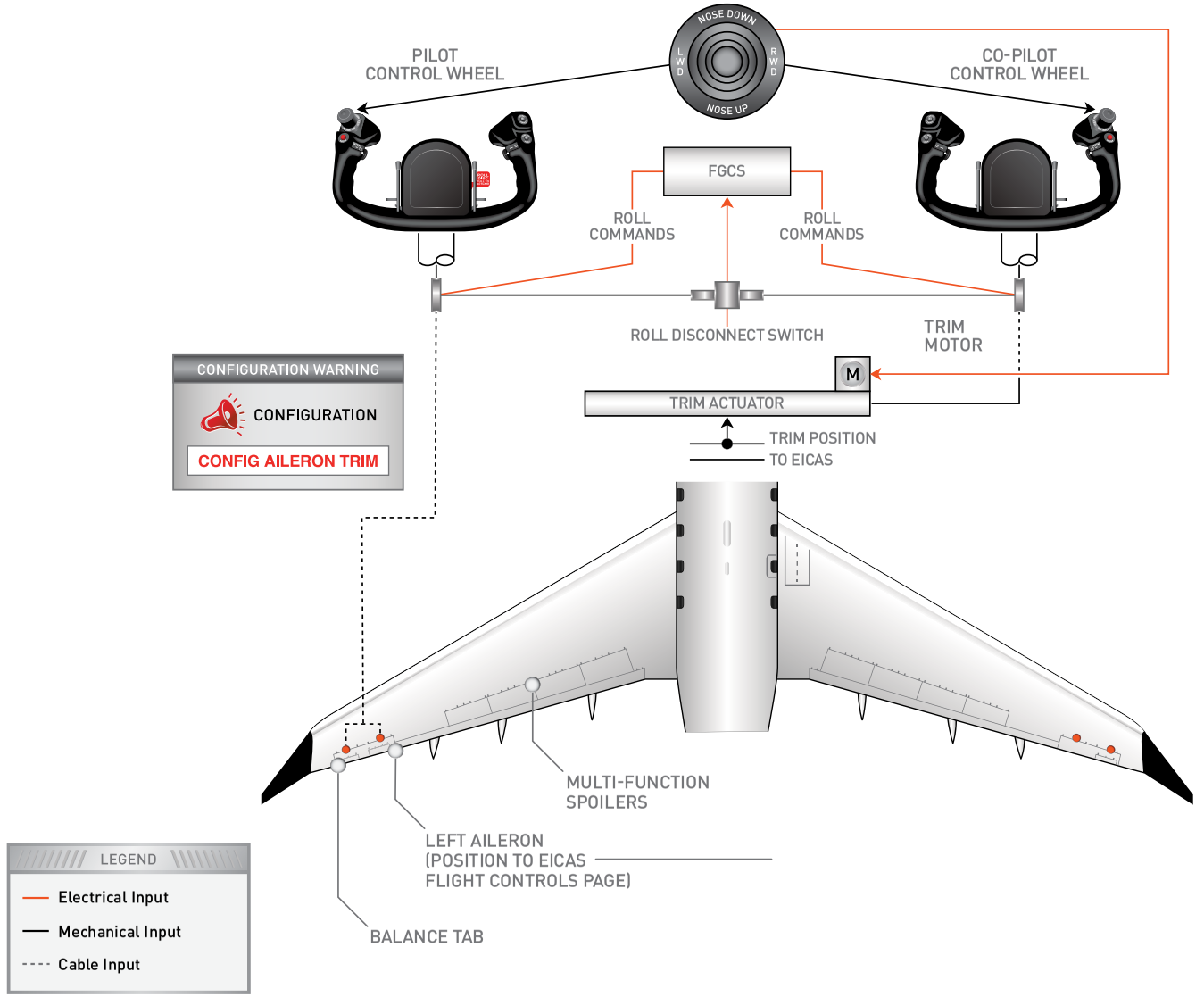


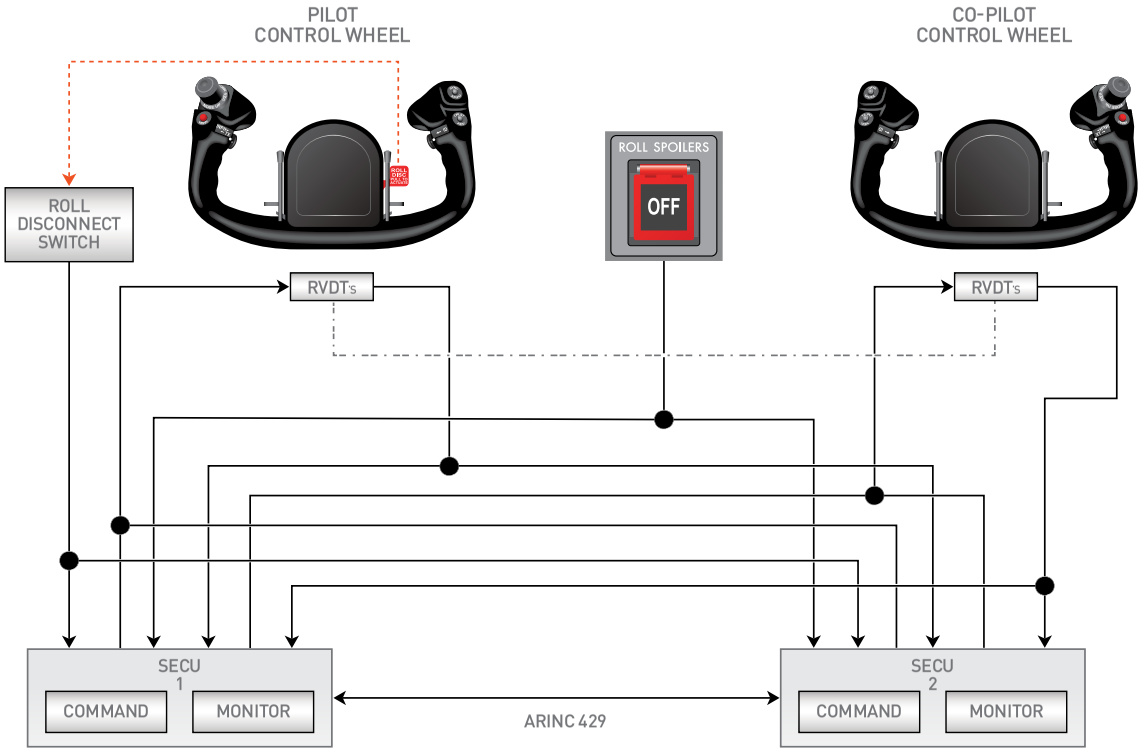

LEVER-OPERATED BLEED/RELIEF VALVE
ECOLOGY BOTTLE
BRV
AUX RESERVOIR
150 CU IN
OVERBOARD DRAIN/VENT
AUX PUMP
DRAIN HOLE
INTENSIFIER
ACCUMULATOR AND ACCUMULATOR CHARGE MANIFOLD
15 MICRON PRESSURE FILTER ELEMENT
AUX DCMP PRESSURE SWITCH C
AUX ACCUMULATOR PRESSURE SWITCH B
P
PRESSURE TRANSDUCER
PUSHBUTTON OPERATED DUMP/RELIEF VALVE
DRV
AUXILIARY FILL QUICK DISCONNECT
T
TEMPERATURE TRANSDUCER
TO RIGHT HYDRAULIC SYSTEM PUMPS
FROM RIGHT HYDRAULIC SYSTEM PUMPS
LOWER RUDDER PRESSURE SWITCH A
LOWER RUDDER PCU
LEGEND
Supply Pressure (P)
SuctionPressure (S)
Return Pressure (R)
Ecology

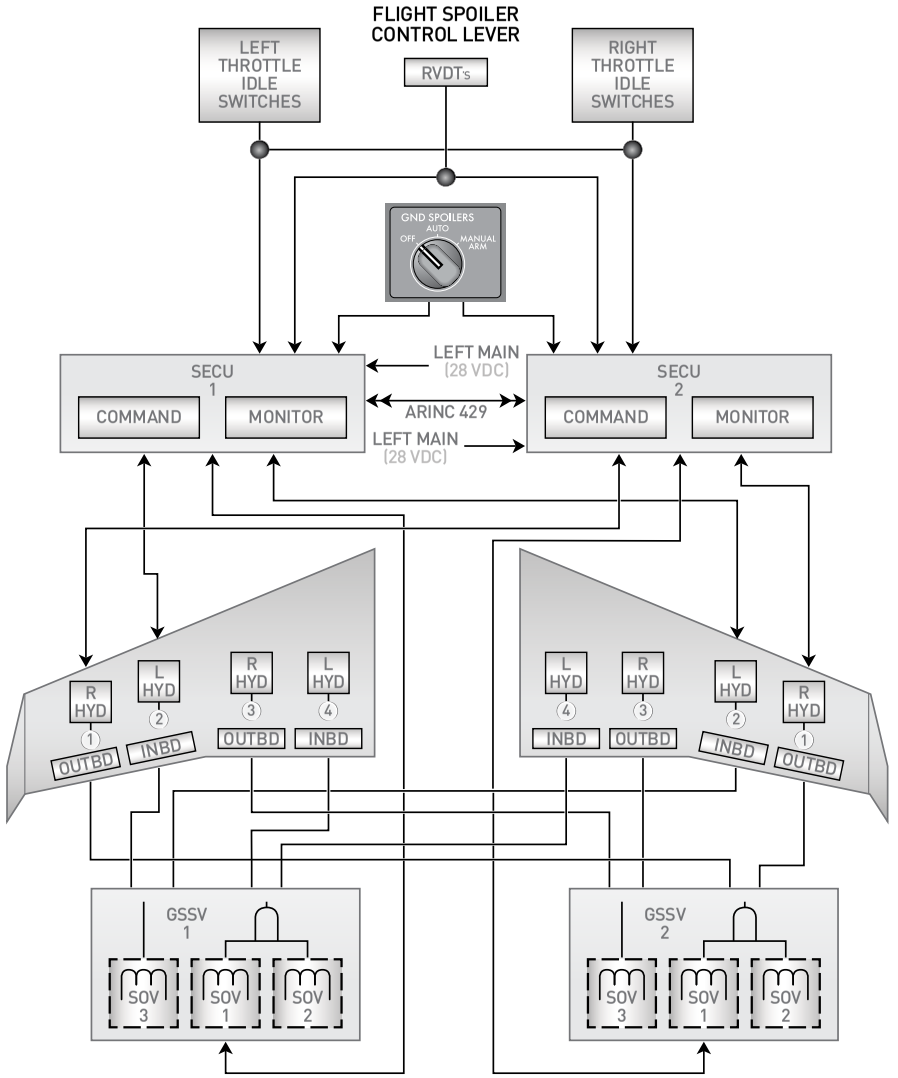
SECONDARY FLIGHT CONTROLS

# HORIZONTAL STABILIZER TRIM SCHEMATIC

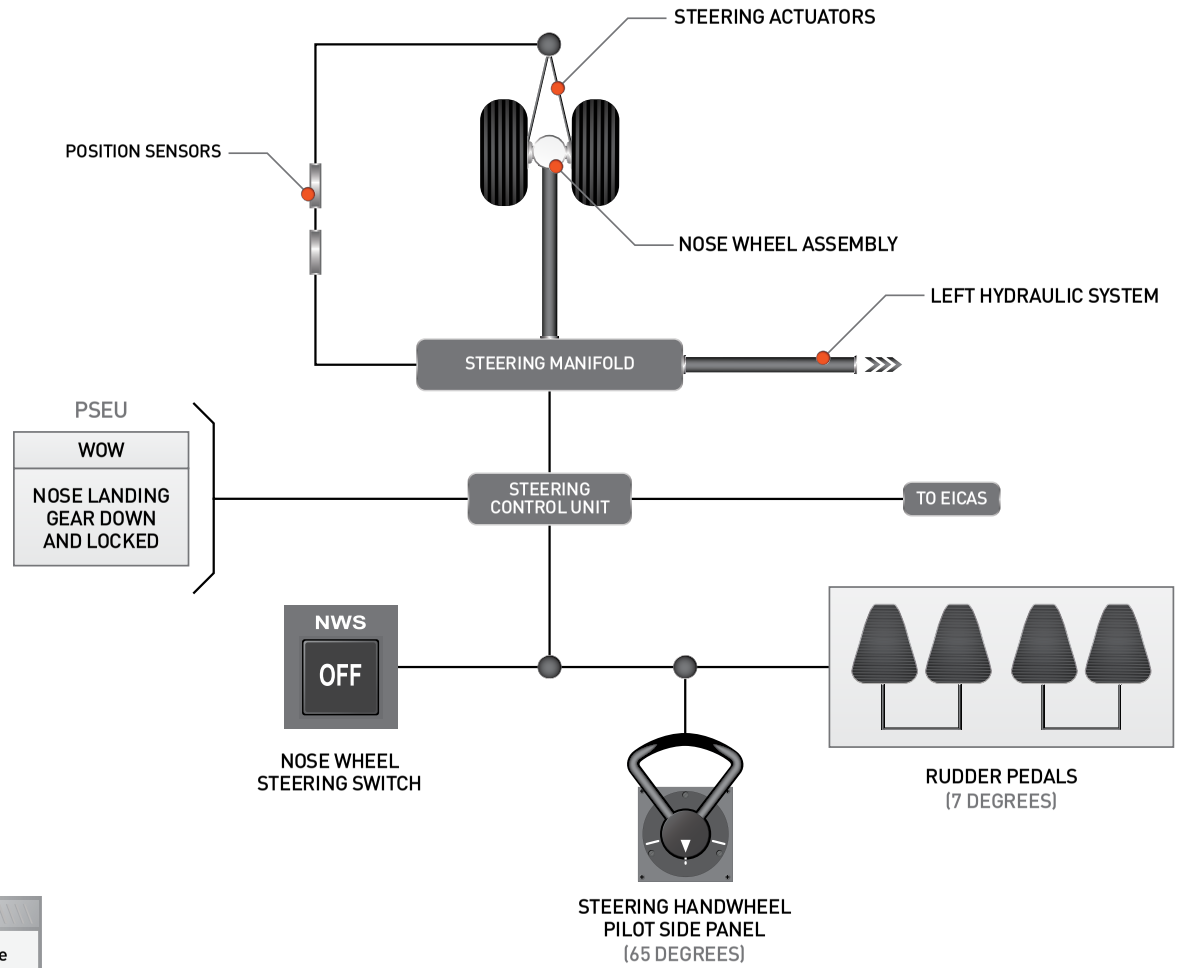


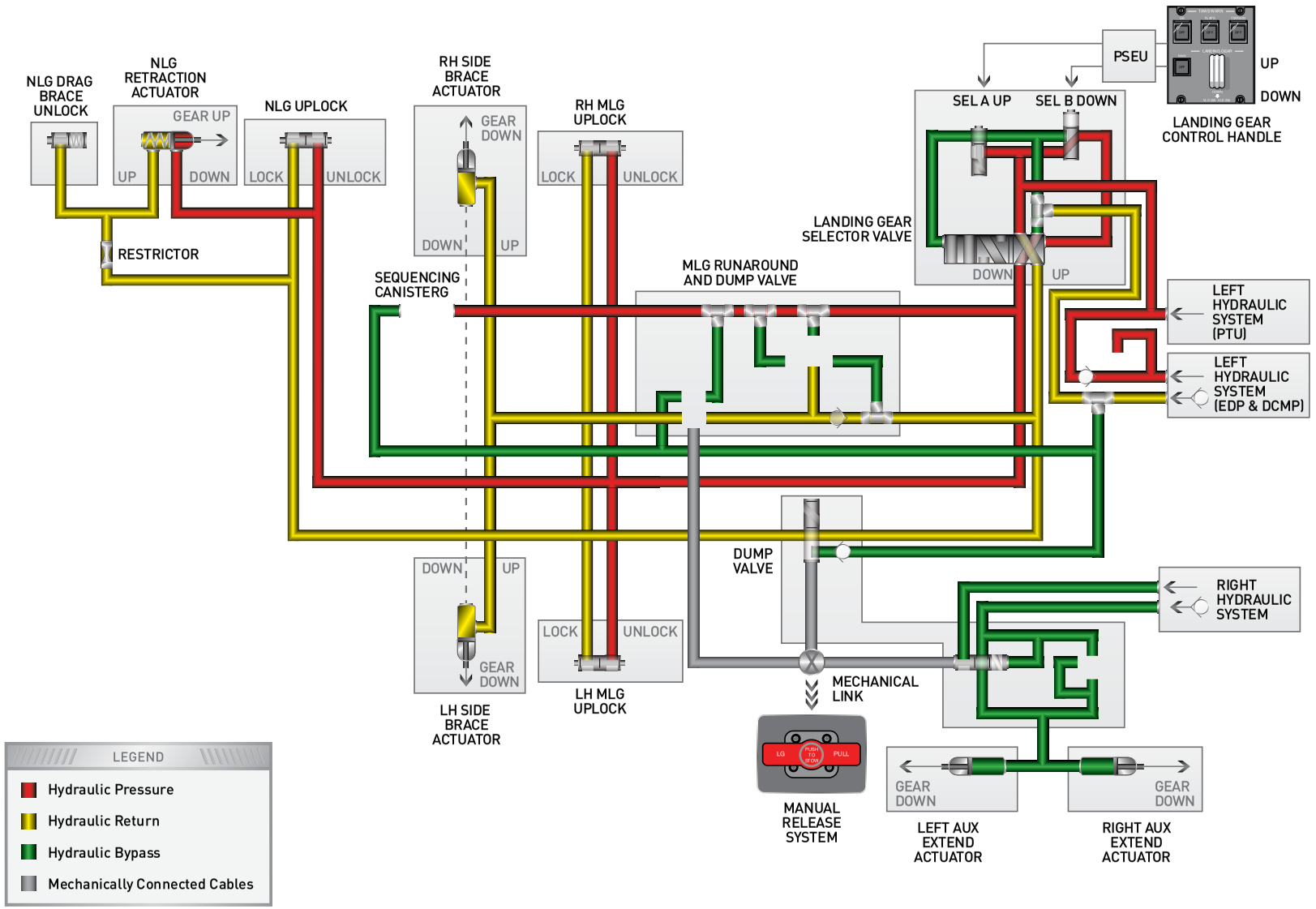

NOSE DOWN
NOSE UP
L W D
R W D
PILOT
CONTROL WHEEL
CO-PILOT
CONTROL WHEEL
FGCS
ROLL
COMMANDS
ROLL
COMMANDS
ROLL DISCONNECT SWITCH
TRIM
MOTOR
M
TRIM ACTUATOR
TRIM POSITION
TO EICAS
CONFIGURATION WARNING
CONFIGURATION
CONFIG AILERON TRIM
MULTI-FUNCTION
SPOILERS
LEFT AILERON
(POSITION TO EICAS
FLIGHT CONTROLS PAGE)
BALANCE TAB
LEGEND
Electrical Input
Mechanical Input
Cable Input


PILOT
CONTROL WHEEL
CO-PILOT
CONTROL WHEEL
ROLL
DISCONNECT
SWITCH
ROLL SPOILERS
OFF
RVDT's
RVDT's
SECU
1
COMMAND
MONITOR
ARINC 429
SECU
2
COMMAND
MONITOR


FLIGHT SPOILER
CONTROL LEVER
LEFT
THROTTLE
IDLE
SWITCHES
RVDTs
RIGHT
THROTTLE
IDLE
SWITCHES
GND SPOILERS
AUTO
OFF
MANUAL
ARM
SECU
1
COMMAND
MONITOR
LEFT MAIN
(28 VDC)
ARINC 429
LEFT MAIN
(28 VDC)
SECU
2
COMMAND
MONITOR
R
HYD
1
OUTBD
L
HYD
2
INBD
R
HYD
3
OUTBD
L
HYD
4
INBD
L
HYD
4
INBD
R
HYD
3
OUTBD
L
HYD
2
INBD
R
HYD
1
OUTBD
GSSV
1
SOV
3
SOV
1
SOV
2
GSSV
2
SOV
3
SOV
1
SOV
2

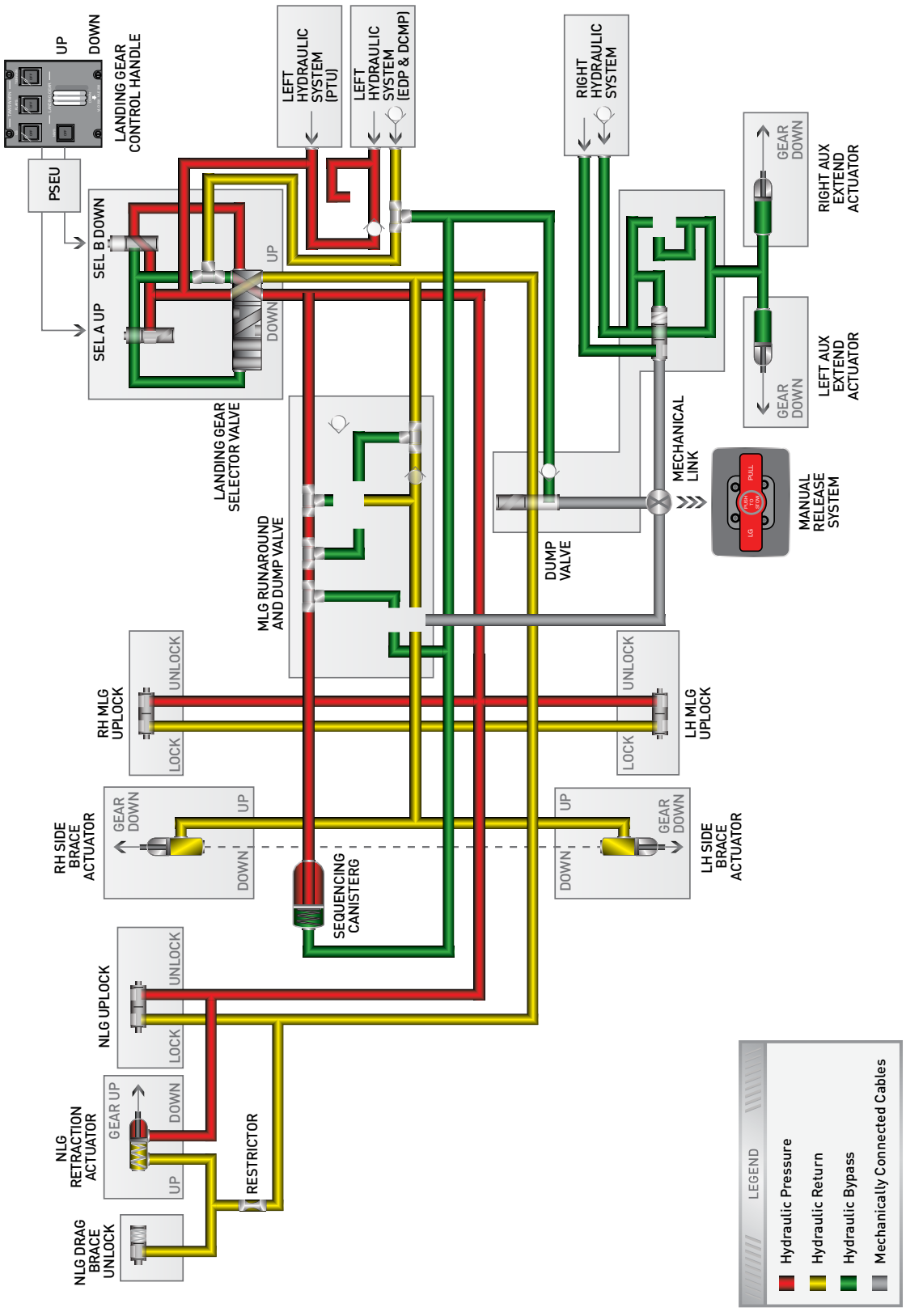
# STEERING CONTROL SYSTEM

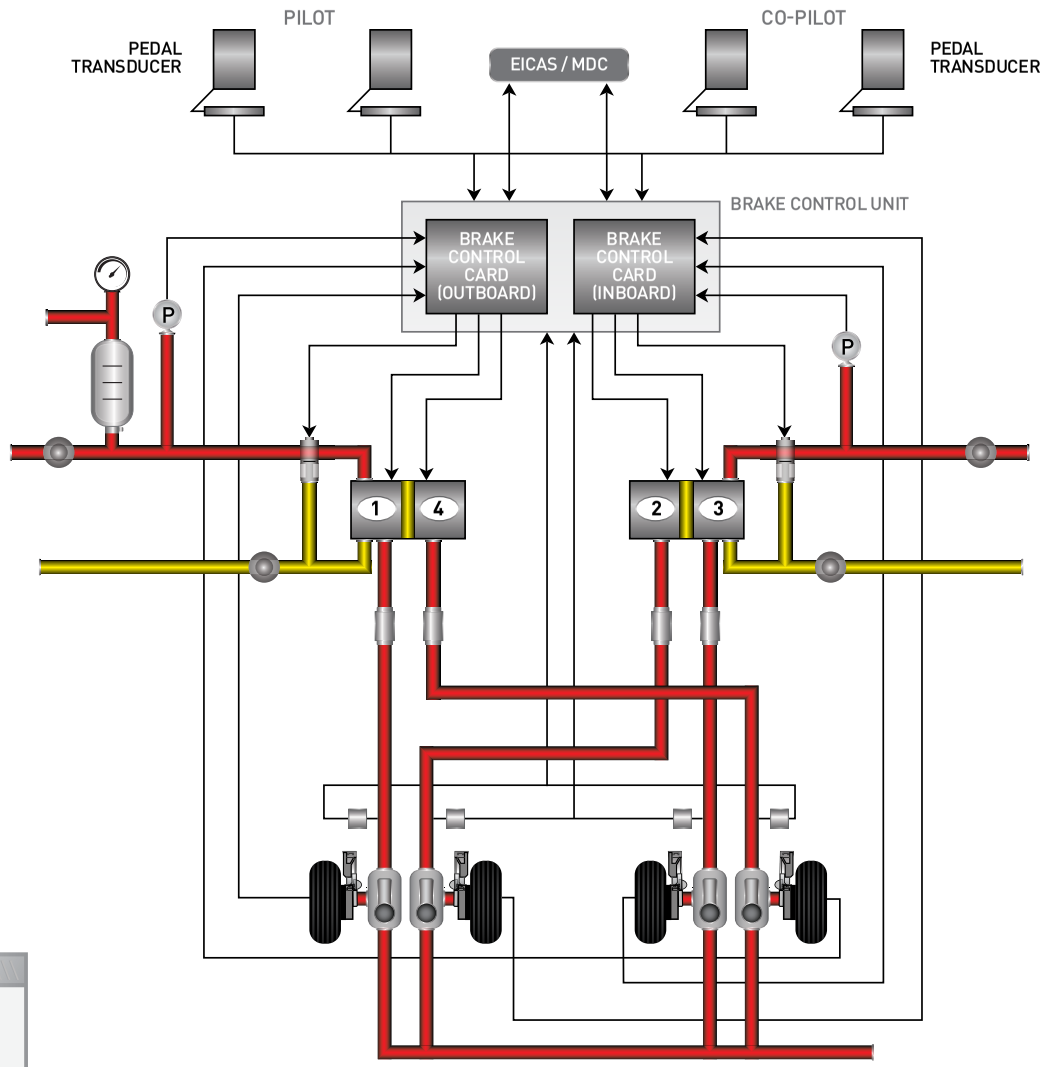



NLG DRAG BRACE UNLOCK
NLG RETRACTION ACTUATOR
GEAR UP
UP
DOWN
NLG UPLOCK
LOCK
UNLOCK
RESTRICTOR
RH SIDE BRACE ACTUATOR
GEAR DOWN
DOWN
UP
RH MLG UPLOCK
LOCK
UNLOCK
SEQUENCING CANISTERG
MLG RUNAROUND AND DUMP VALVE
PSEU
UP
DOWN
LANDING GEAR CONTROL HANDLE
SEL A UP
SEL B DOWN
LANDING GEAR SELECTOR VALVE
DOWN
UP
LEFT HYDRAULIC SYSTEM (PTU)
LEFT HYDRAULIC SYSTEM (EDP & DCMP)
DUMP VALVE
RIGHT HYDRAULIC SYSTEM
DOWN
UP
GEAR DOWN
LH SIDE BRACE ACTUATOR
LOCK
UNLOCK
LH MLG UPLOCK
MECHANICAL LINK
MANUAL RELEASE SYSTEM
GEAR DOWN
LEFT AUX EXTEND ACTUATOR
GEAR DOWN
RIGHT AUX EXTEND ACTUATOR
LEGEND
Hydraulic Pressure
Hydraulic Return
Hydraulic Bypass
Mechanically Connected Cables

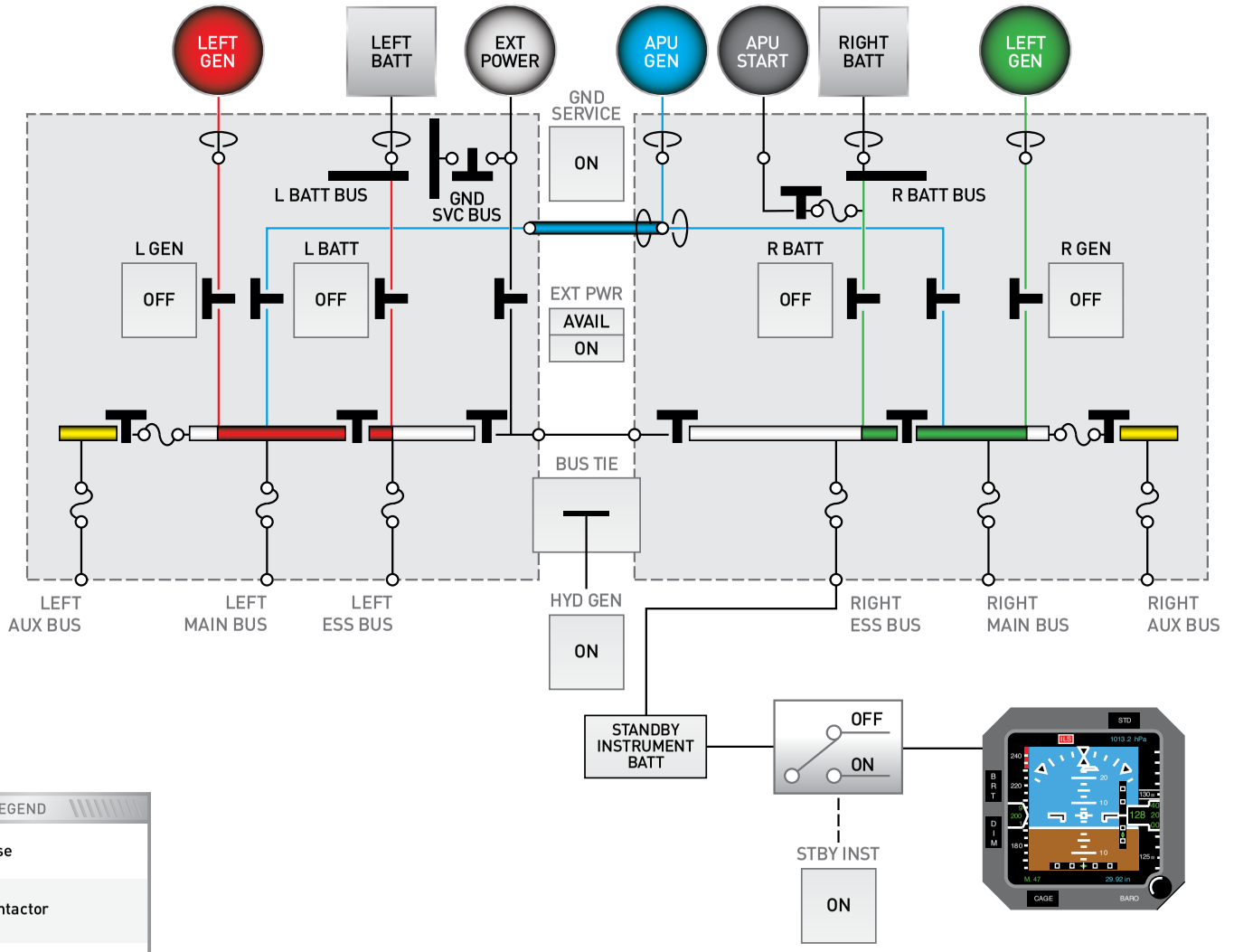
CL-350

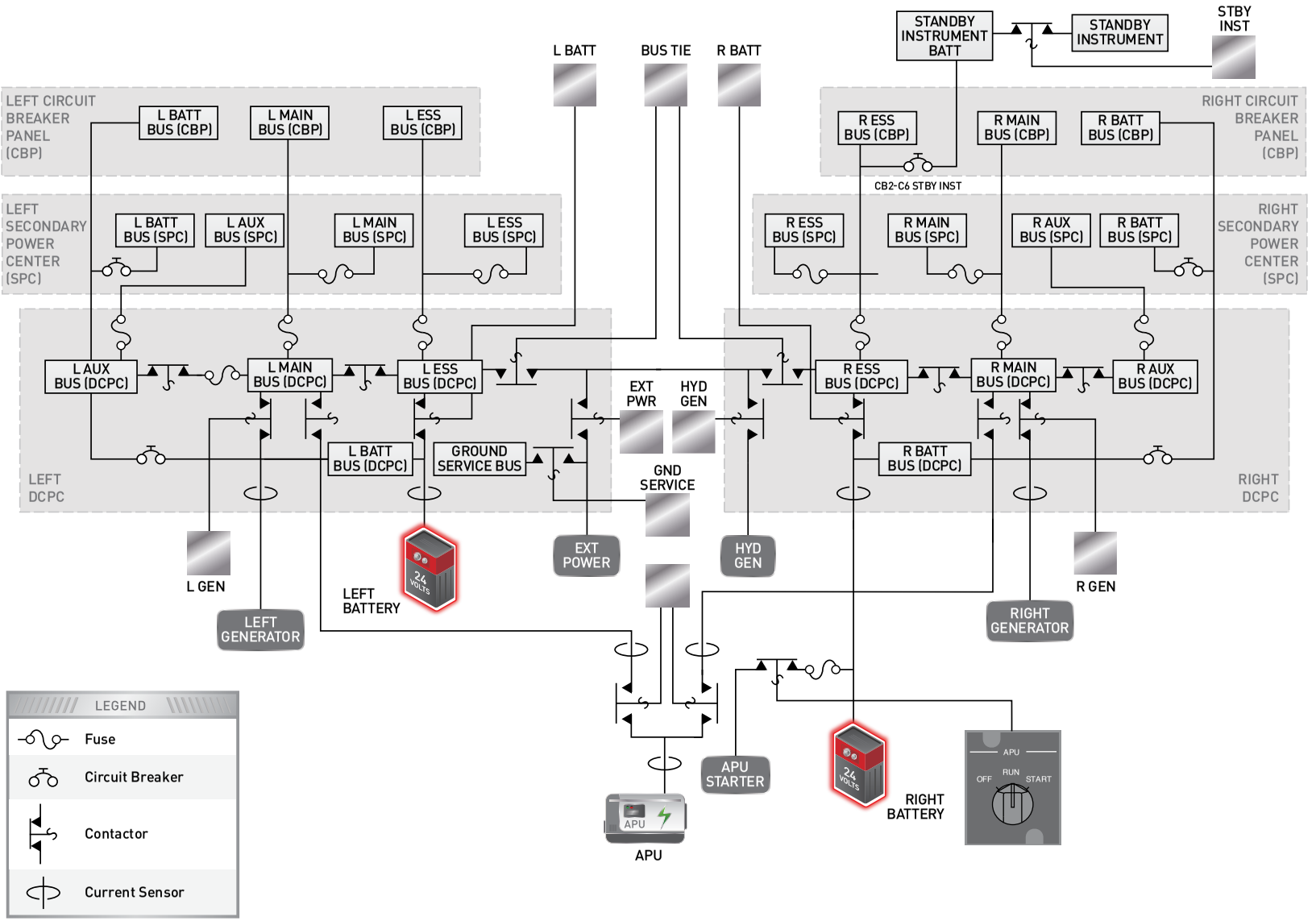
## LANDING GEAR - DOWN




PILOT
CO-PILOT
PEDAL TRANSDUCER
EICAS / MDC
PEDAL TRANSDUCER
BRAKE CONTROL UNIT
BRAKE CONTROL CARD (OUTBOARD)
BRAKE CONTROL CARD (INBOARD)
P
P
1
4
2
3
LEGEND
Hydraulic and Brake Pressure
Hydraulic Return
Electrical Lines

# DC SYSTEM PRIMARY ARCHITECTURE

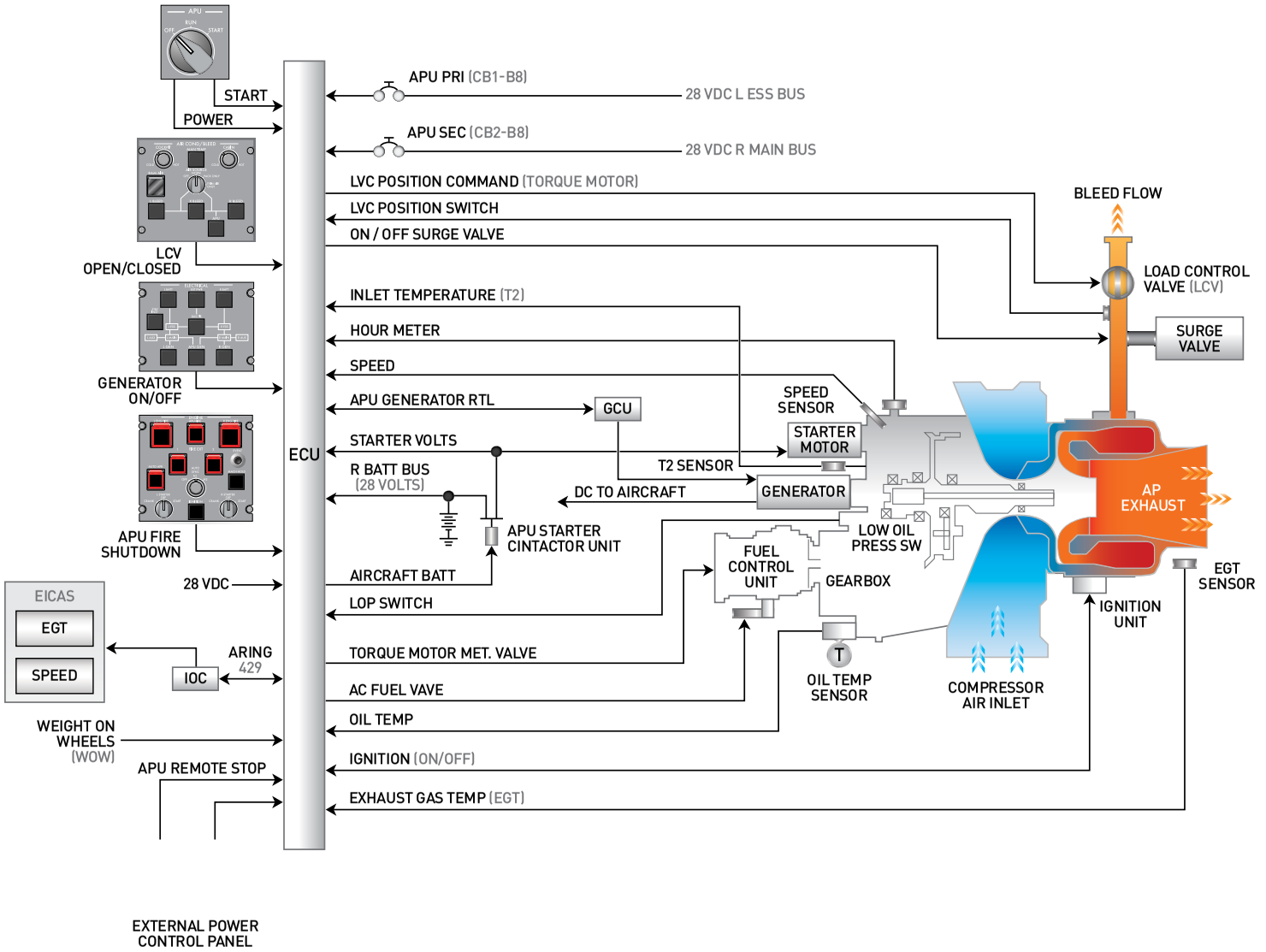



STANDBY INSTRUMENT BATT
STANDBY INSTRUMENT
STBY INST
L BATT
BUS TIE
R BATT
LEFT CIRCUIT BREAKER PANEL (CBP)
L BATT BUS (CBP)
L MAIN BUS (CBP)
L ESS BUS (CBP)
R ESS BUS (CBP)
R MAIN BUS (CBP)
R BATT BUS (CBP)
RIGHT CIRCUIT BREAKER PANEL (CBP)
CB2-C6 STBY INST
LEFT SECONDARY POWER CENTER (SPC)
L BATT BUS (SPC)
L AUX BUS (SPC)
L MAIN BUS (SPC)
L ESS BUS (SPC)
R ESS BUS (SPC)
R MAIN BUS (SPC)
R AUX BUS (SPC)
R BATT BUS (SPC)
RIGHT SECONDARY POWER CENTER (SPC)
L AUX BUS (DCPC)
L MAIN BUS (DCPC)
L ESS BUS (DCPC)
EXT PWR
HYD GEN
R ESS BUS (DCPC)
R MAIN BUS (DCPC)
R AUX BUS (DCPC)
L BATT BUS (DCPC)
GROUND SERVICE BUS
GND SERVICE
R BATT BUS (DCPC)
LEFT DCPC
RIGHT DCPC
L GEN
LEFT GENERATOR
LEFT BATTERY
EXT POWER
HYD GEN
R GEN
RIGHT GENERATOR
APU STARTER
RIGHT BATTERY
APU
APU
OFF
RUN
START
LEGEND
Fuse
Circuit Breaker
Contactor
Current Sensor

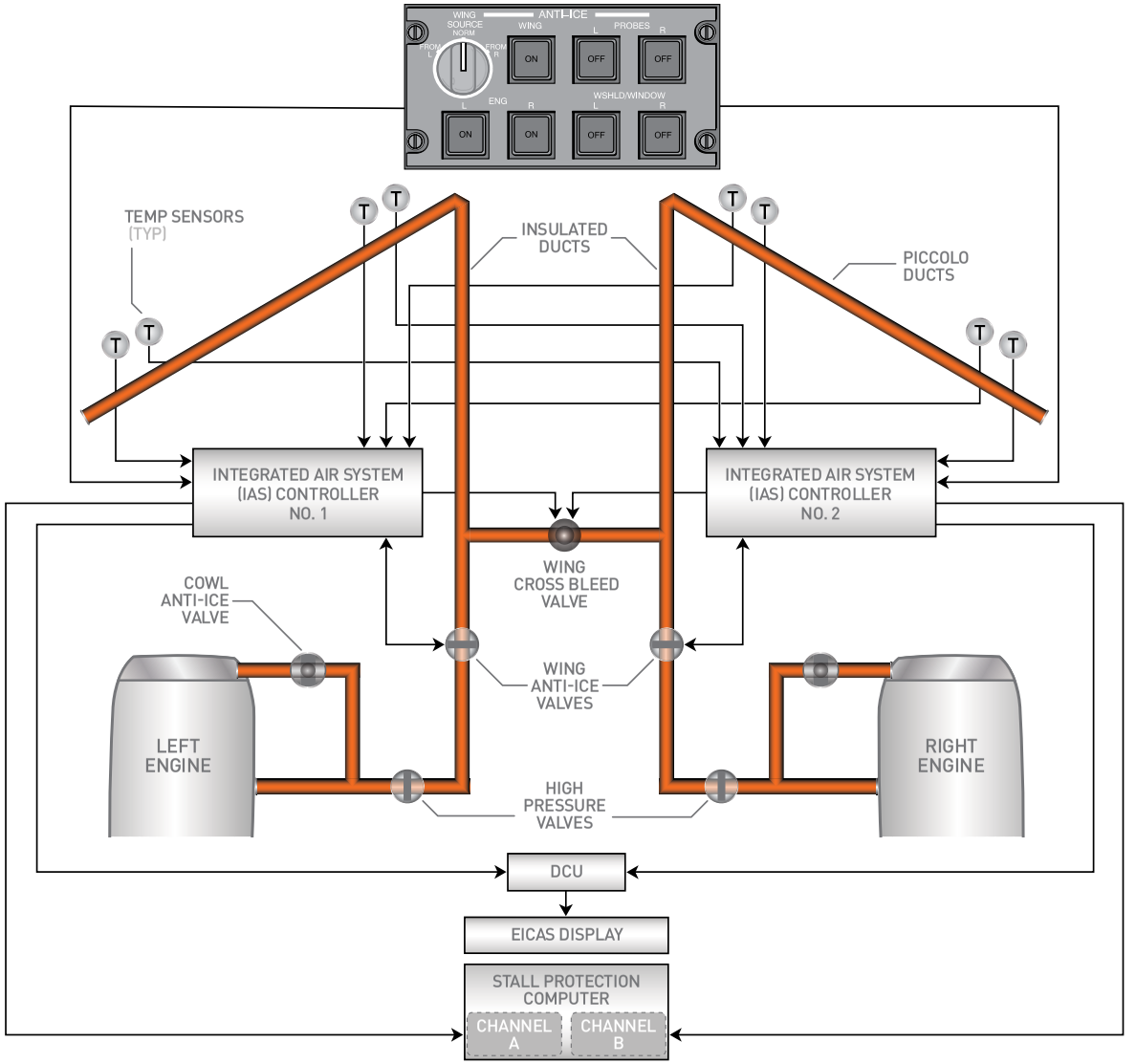
CL-350

APU

# AUXILIARY POWER UNIT SCHEMATIC



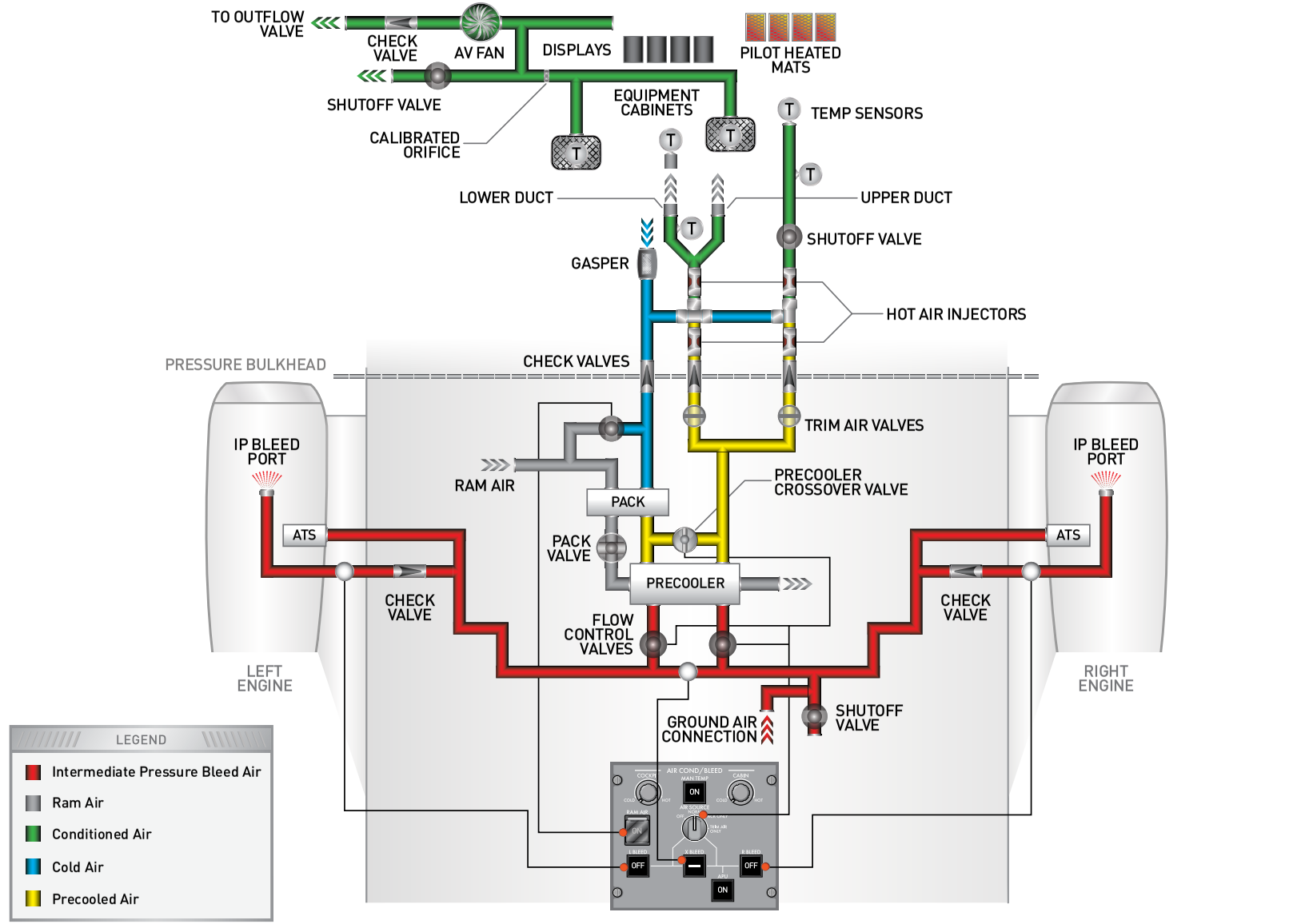
# WING ANTI-ICE SYSTEM SCHEMATIC

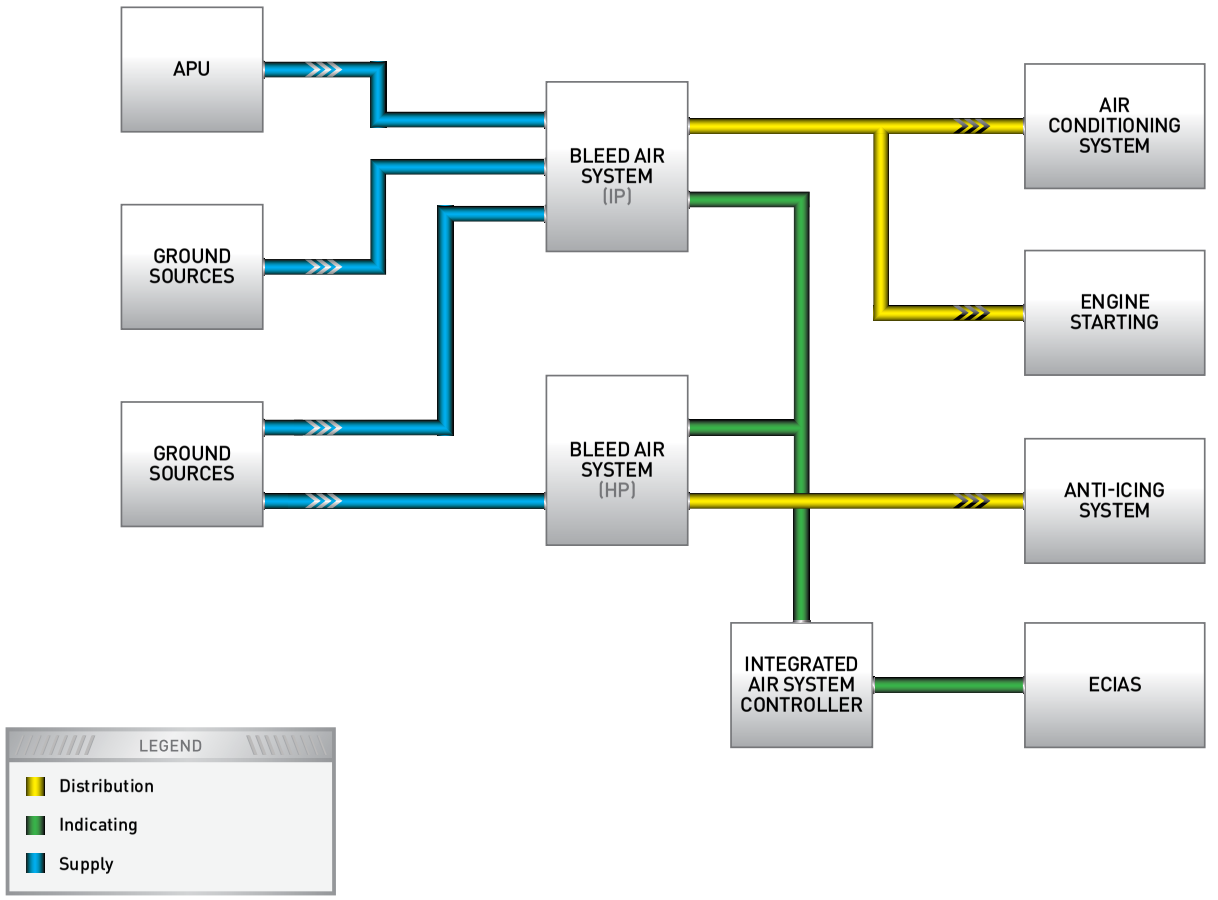


CL-350

ENVIRONMENTAL

## COCKPIT/CABIN AIR DISTRIBUTION SCHEMATIC

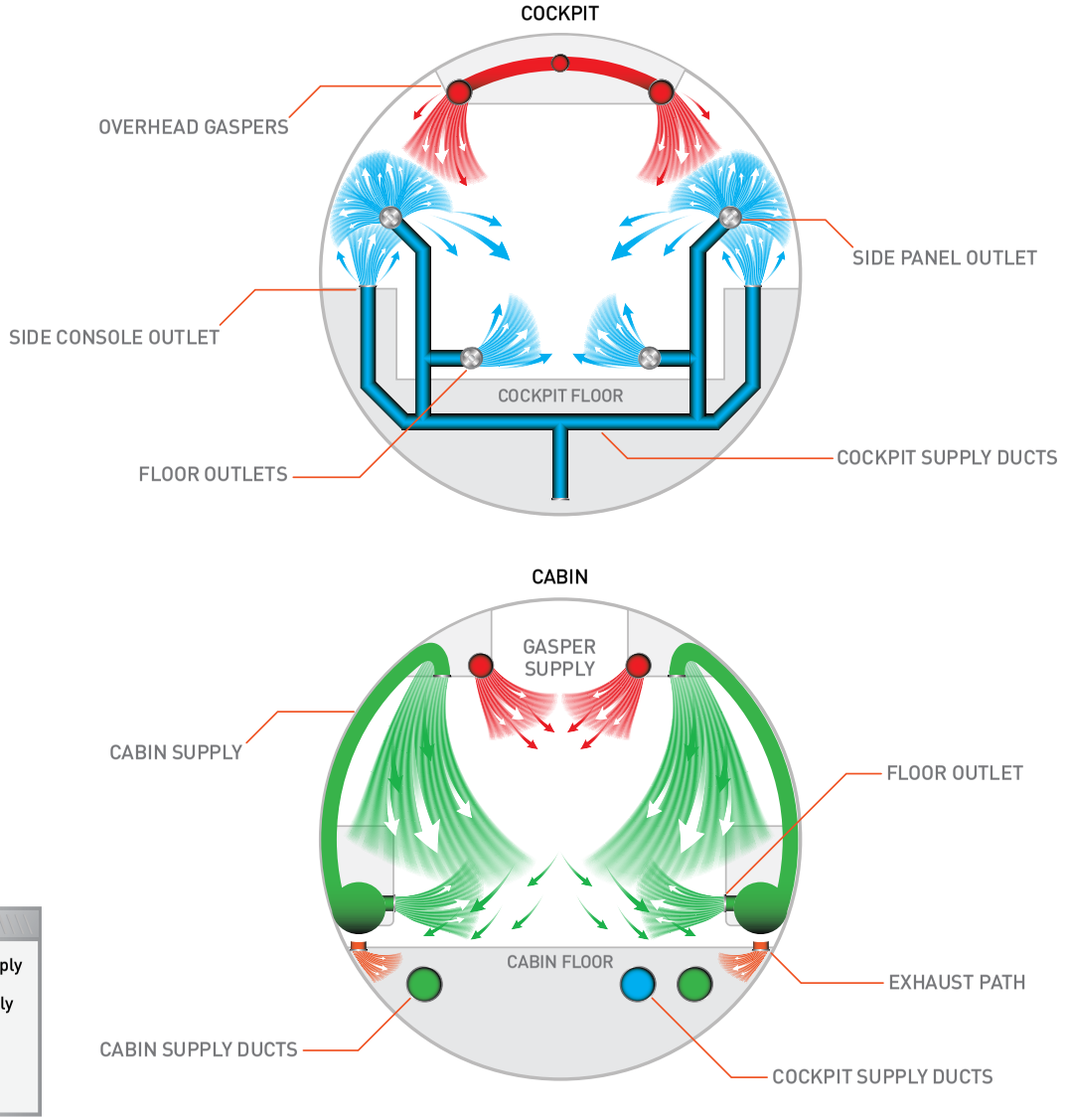


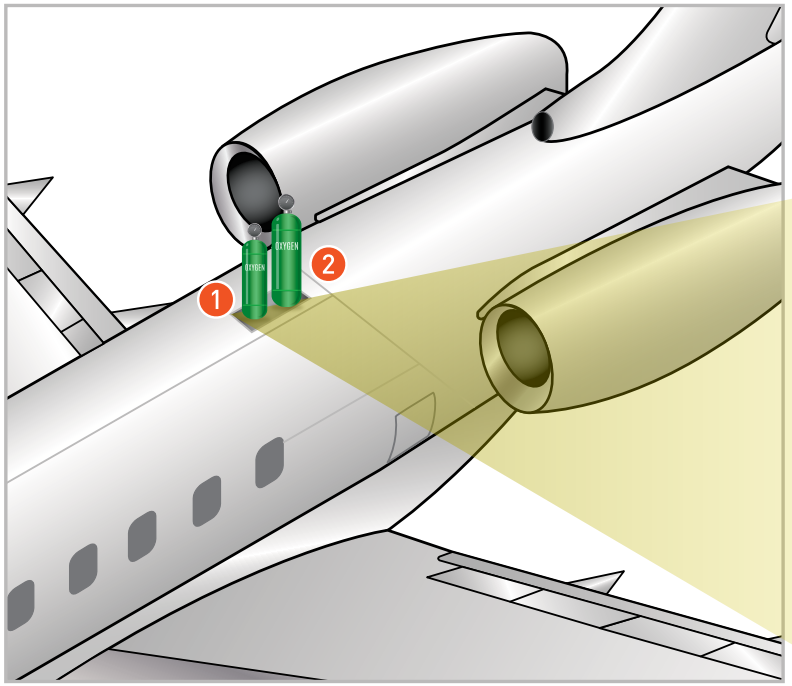

APU
GROUND SOURCES
GROUND SOURCES
BLEED AIR SYSTEM (IP)
BLEED AIR SYSTEM (HP)
AIR CONDITIONING SYSTEM
ENGINE STARTING
ANTI-ICING SYSTEM
INTEGRATED AIR SYSTEM CONTROLLER
ECIAS
LEGEND
Distribution
Indicating
Supply

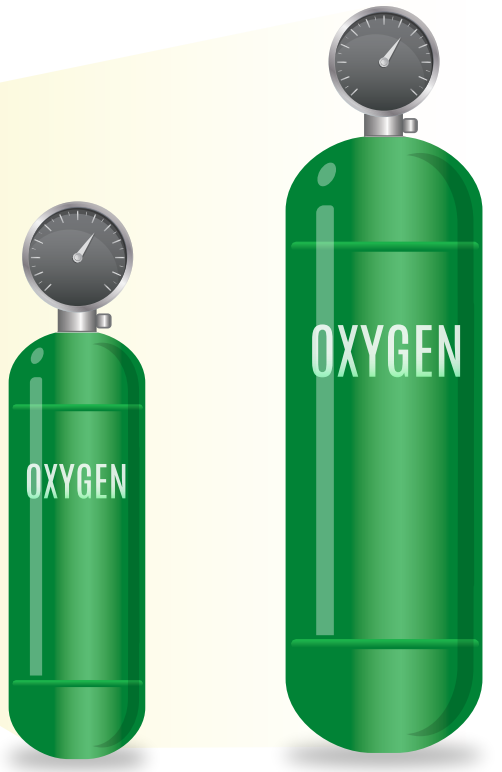
CL-350

ENVIRONMENTAL

# AIRFRAME AIR DISTRIBUTION SCHEMATIC





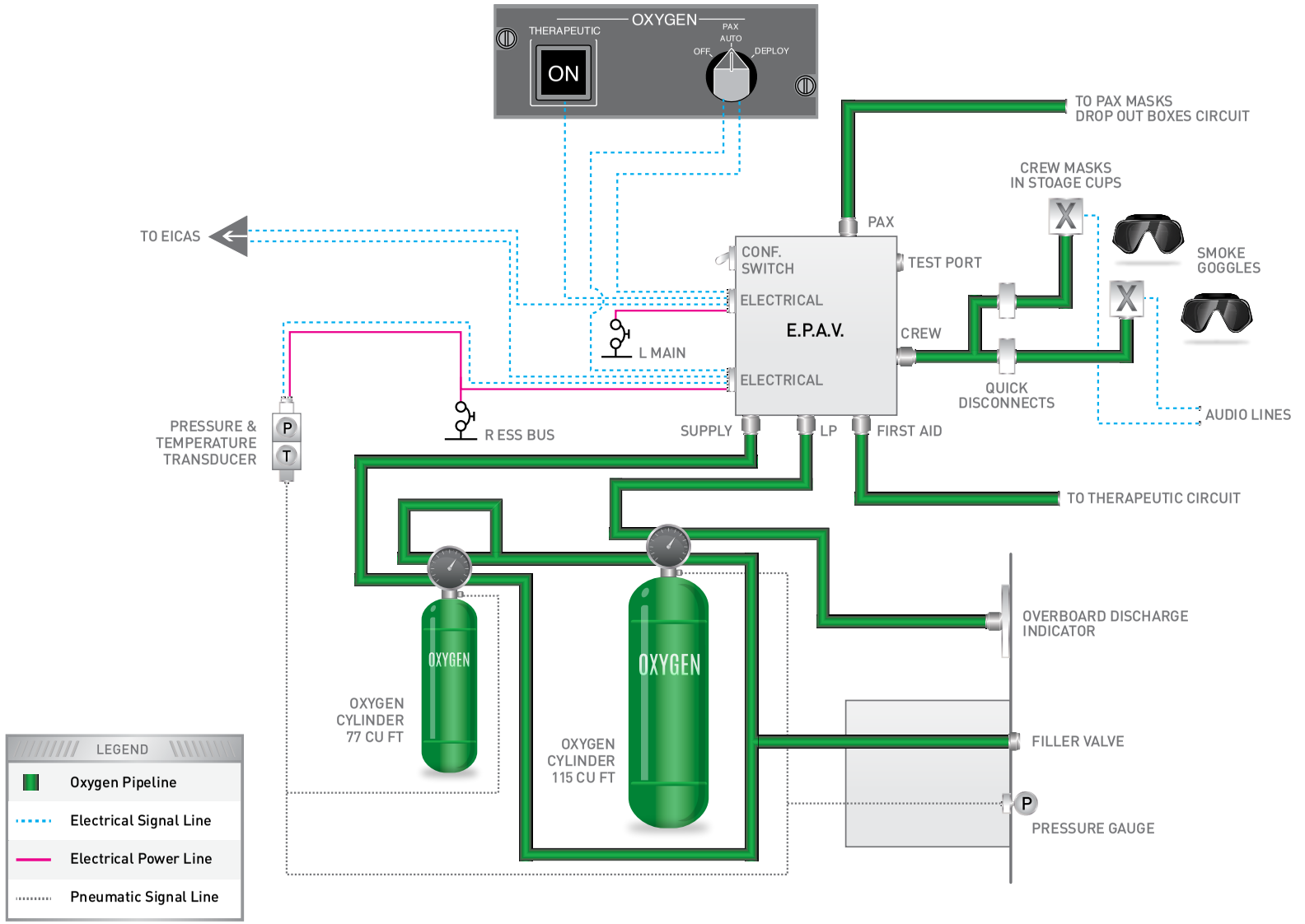

1 77 CU. FT.
OXYGEN STORAGE CYLINDER & REGULATOR

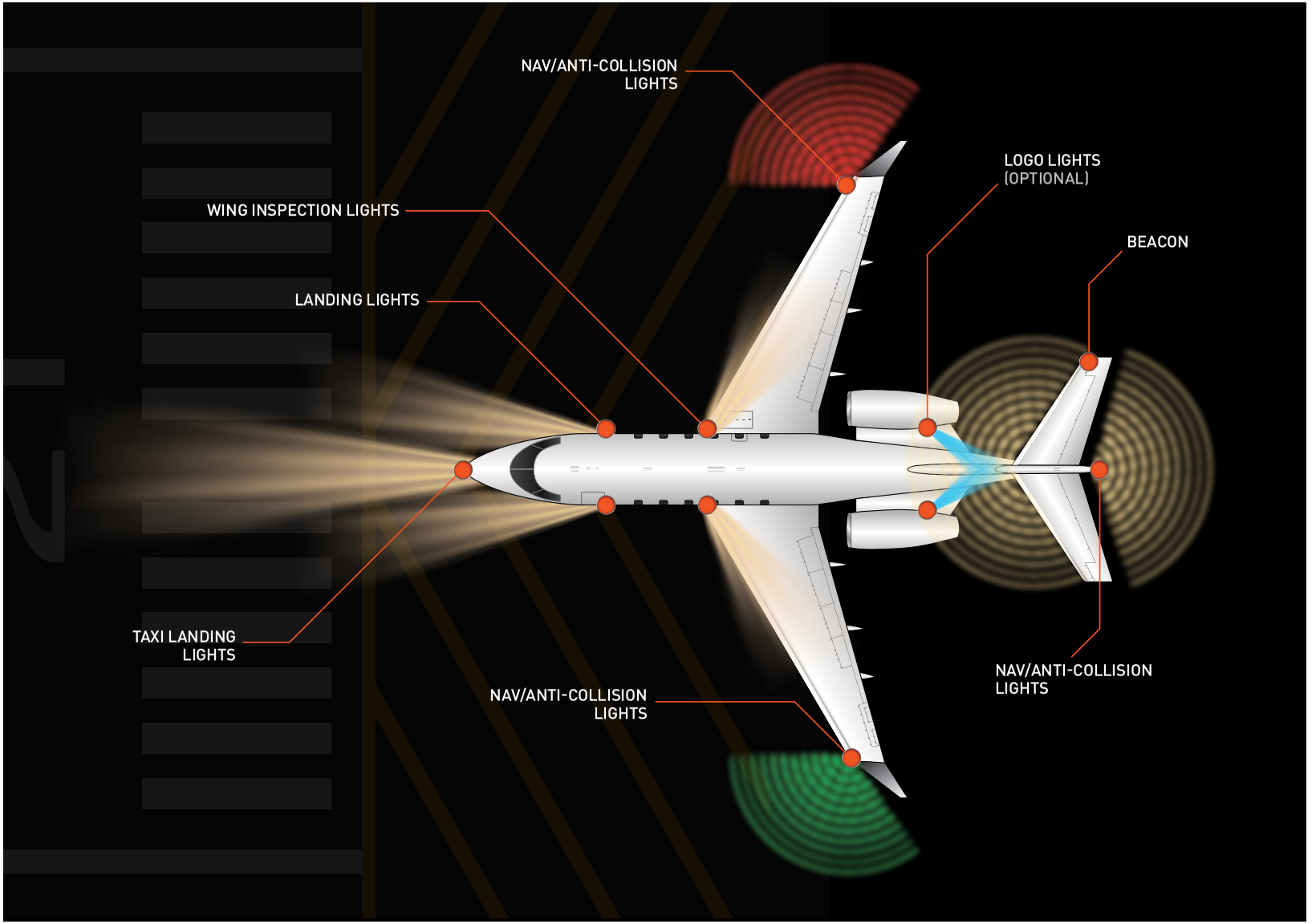
2 115 CU. FT.
OXYGEN STORAGE CYLINDER & REGULATOR

CL-350

OXYGEN SYSTEM

# OXYGEN SYSTEM COMPONENTS AND OPERATION

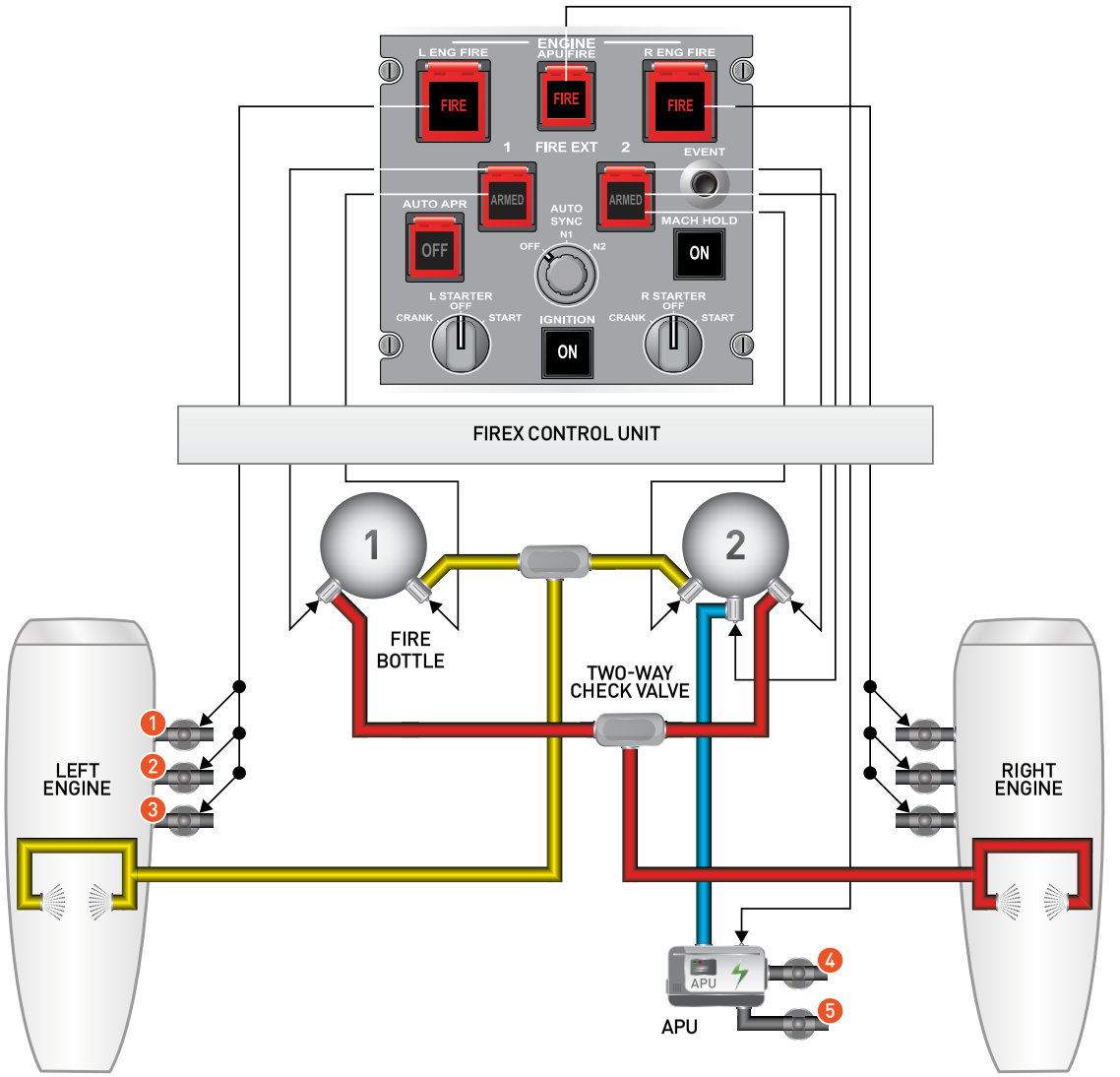



NAV/ANTI-COLLISION LIGHTS
LOGO LIGHTS (OPTIONAL)
WING INSPECTION LIGHTS
BEACON
LANDING LIGHTS
TAXI LANDING LIGHTS
NAV/ANTI-COLLISION LIGHTS
NAV/ANTI-COLLISION LIGHTS

CL-350

FIRE PROTECTION

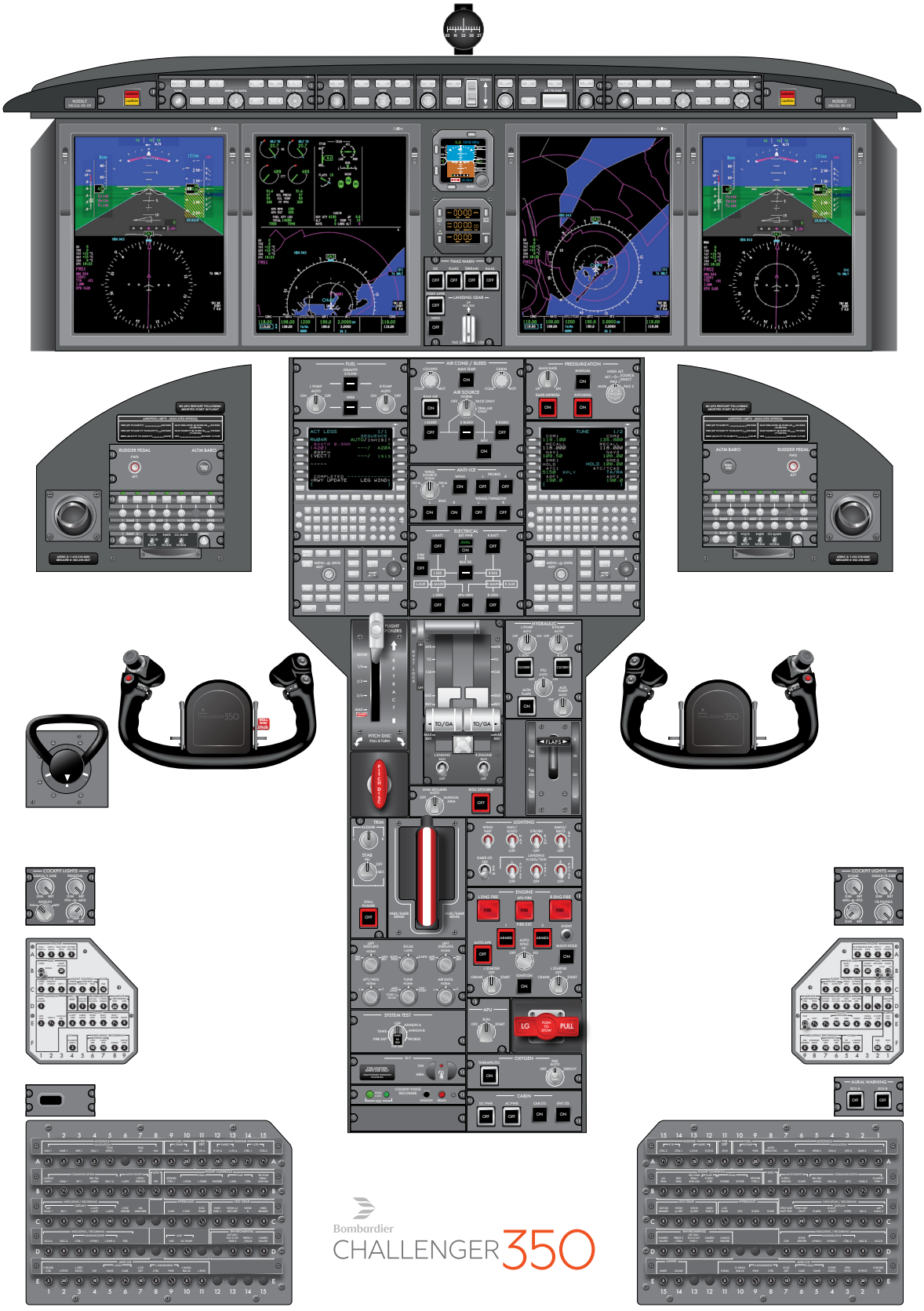
# FIREX CONTROL UNIT SCHEMATIC




1. HP AND IP BLEED-AIR VALVES
2. FUEL SHUTOFF VALVE
3. HYDRAULIC SHUTOFF VALVE
4. APU BLEED SHUTOFF VALVE
5. APU FUEL SHUTOFF VALVE

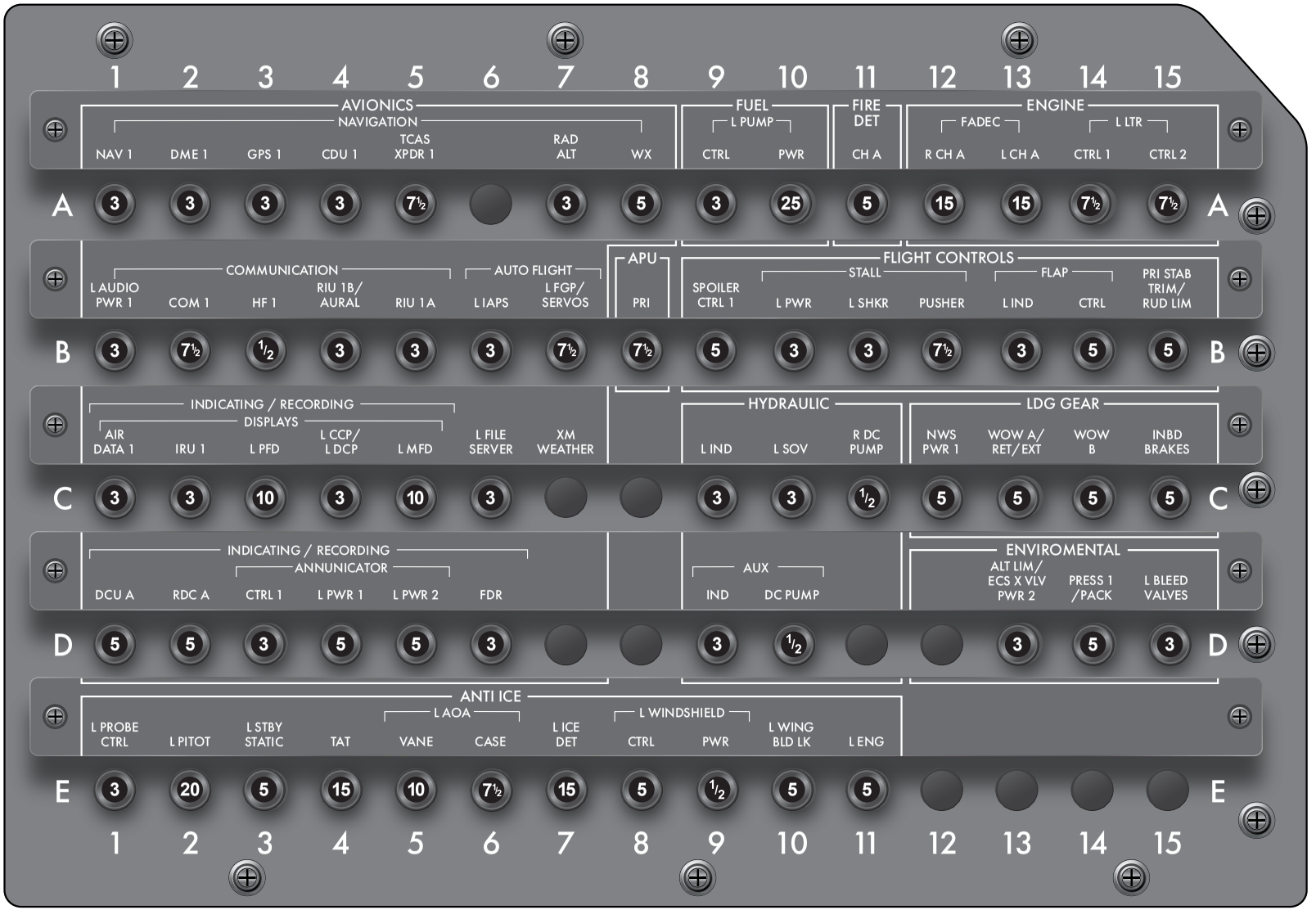
LEGEND

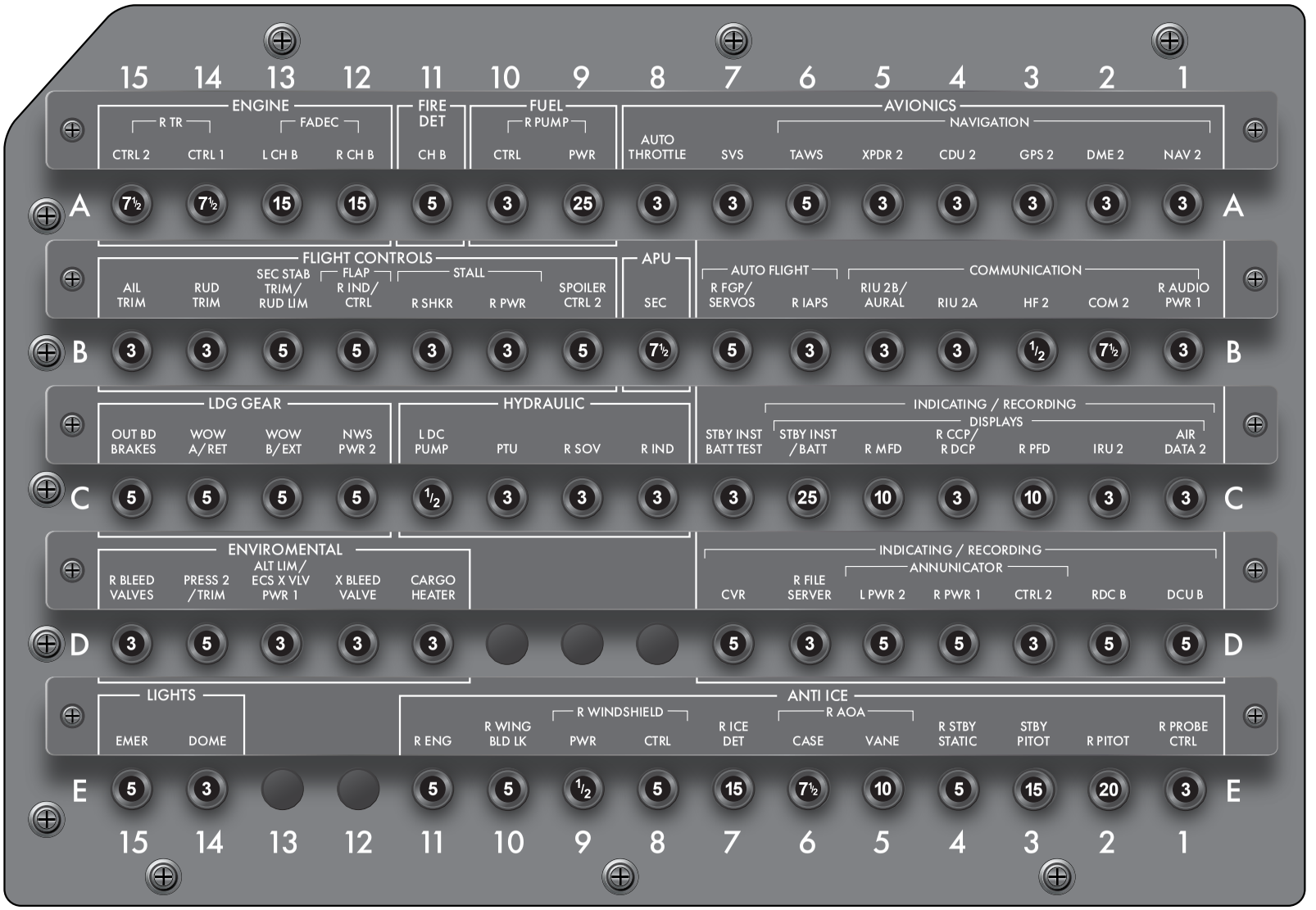
- Right Engine Discharge
- Left Engine Discharge
- APU Discharge

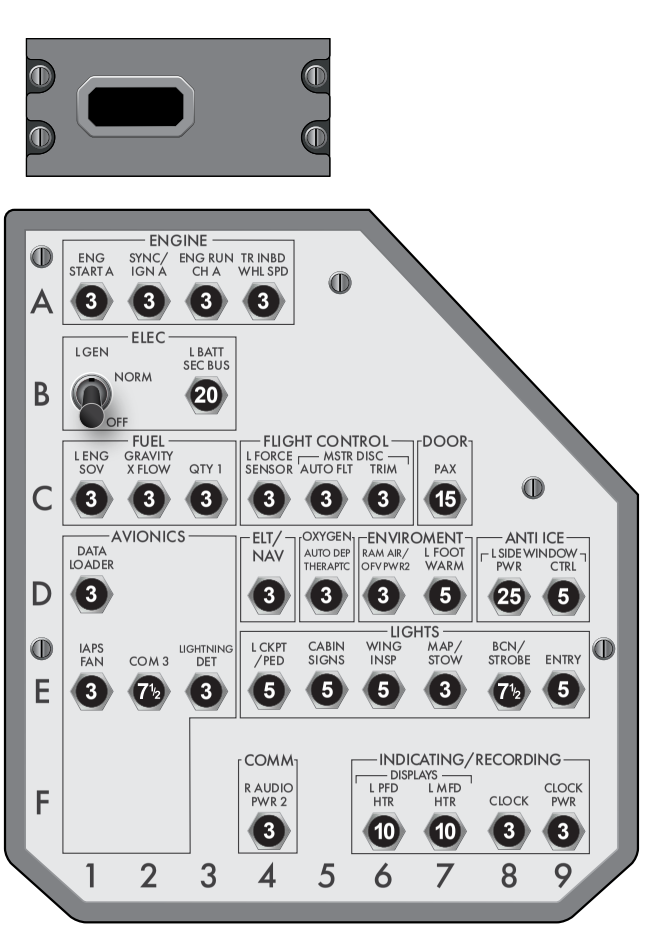

Bombardier
CHALLENGER 350

AVIONICS PANEL ELEMENTS

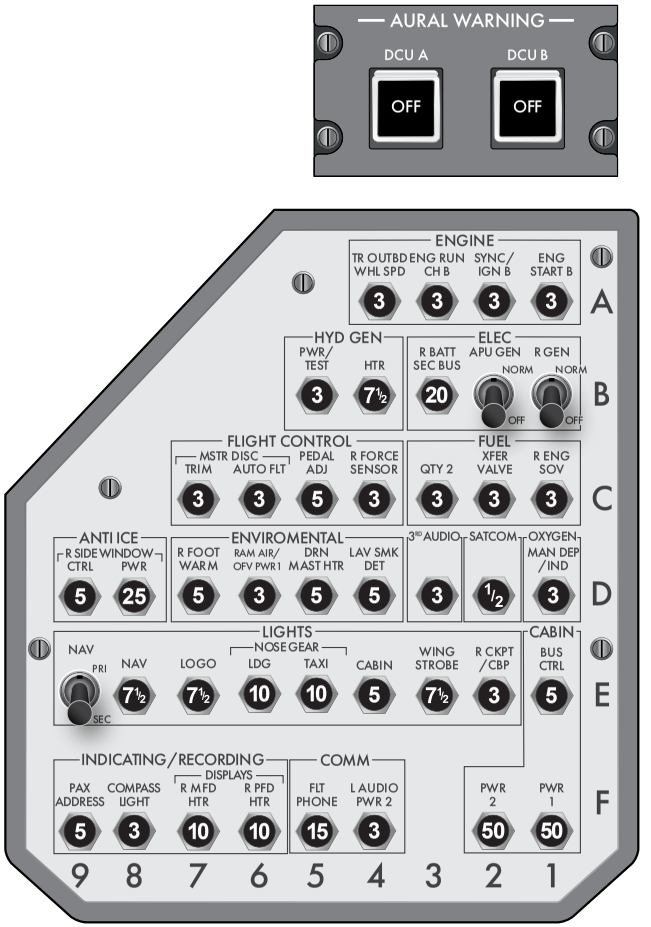
# CIRCUIT BREAKER PANELS - PILOT SIDE




15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
ENGINE
R TR
CTRL 2
CTRL 1
FADEC
L CH B
R CH B
FIRE DET
CH B
FUEL
R PUMP
CTRL
PWR
AVIONICS
AUTO THROTTLE
SVS
NAVIGATION
TAWS
XPDR 2
CDU 2
GPS 2
DME 2
NAV 2
A 7½ 7½ 15 15 5 3 25 3 3 5 3 3 3 3 3 A
FLIGHT CONTROLS
AIL TRIM
RUD TRIM
SEC STAB TRIM/ RUD LIM
FLAP
R IND/ CTRL
STALL
R SHKR
R PWR
SPOILER CTRL 2
APU
SEC
AUTO FLIGHT
R FGP/ SERVOS
R IAPS
COMMUNICATION
RIU 2B/ AURAL
RIU 2A
HF 2
COM 2
R AUDIO PWR 1
B 3 3 5 5 3 3 5 7½ 5 3 3 3 ½ 7½ 3 B
LDG GEAR
OUT BD BRAKES
WOW A/RET
WOW B/EXT
NWS PWR 2
HYDRAULIC
L DC PUMP
PTU
R SOV
R IND
INDICATING / RECORDING
DISPLAYS
STBY INST BATT TEST
STBY INST /BATT
R MFD
R CCP/ R DCP
R PFD
IRU 2
AIR DATA 2
C 5 5 5 5 ½ 3 3 3 3 25 10 3 10 3 3 C
ENVIROMENTAL
R BLEED VALVES
PRESS 2 /TRIM
ALT LIM/ ECS X VLV PWR 1
X BLEED VALVE
CARGO HEATER
INDICATING / RECORDING
ANNUNICATOR
CVR
R FILE SERVER
L PWR 2
R PWR 1
CTRL 2
RDC B
DCU B
D 3 5 3 3 3 5 3 5 5 3 5 5 D
LIGHTS
EMER
DOME
ANTI ICE
R ENG
R WING BLD LK
R WINDSHIELD
PWR
CTRL
R ICE DET
R AOA
CASE
VANE
R STBY STATIC
STBY PITOT
R PITOT
R PROBE CTRL
E 5 3 5 5 ½ 5 15 7½ 10 5 15 20 3 E
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1




PILOT




CO-PILOT

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